Great Keppel Island Resort EIS

For GKI Resort Pty Ltd

Climate Change Report

20 October 2011

Opus International Consultants (PCA) Pty Ltd

ABN 89 096 110 262

Level 1, 2 Mayneview Street, Milton, QLD 4064

PO Box 1703, Milton, QLD 4064

+61 7 3367 4900

+61 7 3367 4999

EXECUTIVE SUMMARY

This Report has been prepared by Opus International Consultants ('Opus') on behalf of GKI Resorts Pty Ltd to provide an assessment of potential climate change impacts on the proposed Great Keppel Island (GKI) Revitalisation Plan and mitigation measures to address these impacts. This Report has been prepared to address section 3.1 of the *Terms of Reference for EIS – Great Keppel Island Resort Project* issued by the Queensland Coordinator-General and relevant requirements of the "Guidelines for an Environmental Impact Statement for the Great Keppel Island Tourism and Marina Development, Queensland" issued by the Australian Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) in conjunction with the Great Barrier Reef Marine Park Authority.

The GKI Revitalisation Plan proposes to create a low rise, eco-tourism resort on Great Keppel Island, incorporating a new 250 suite, 4 or 5 star resort hotel at Fisherman's Beach; a new 250 berth, all-weather safe access marina facility at Putney Beach including a retail village; an 18-hole championship golf course; a new runway and airport terminal; 750 eco-tourism villas; 300 eco-tourism apartments; staff accommodation and sporting fields. As part of the GKI Revitalisation Plan, a new GKI Research Centre and Biodiversity Conservation Fund (BCF) will be established, the original Leeke's Homestead will be restored and a significant proportion of the Island will be protected for conservation.

Approximately 685 full time, part time and casual staff will be employed by the resort once fully operational.

Great Keppel Island is the largest island in the Keppel Island Group and is located approximately 12 km off the coast of Yeppoon on the Central Queensland coast. GKI is included within the Rockhampton Regional Council local government area. Until recently the Island has been occupied by a number of different commercial accommodation facilities ranging from camping ground style accommodation to resort level accommodation. The original GKI Resort was the main tourism resort located on the Island and comprised 190 guest rooms. These facilities were closed in early 2008. The Island is currently occupied by two backpackers' facilities, ten residential properties and ten commercial premises. Access to the Island is currently via ferry and cruise ship services from the Rosslyn Bay / Keppel Bay Marina on the mainland.

Great Keppel Island is characterised by a mild, sub-tropical climate. Rainfall is quite variable with average annual rainfall varying from a low of 494mm/year up to 1,936mm/year, and averaging about 975mm/year. Rainfall typically occurs during the Summer months. Evaporation rates on the Island are relatively high and comparison with rainfall data indicates that there is an average annual rainfall deficit of 803mm/year. Average maximum daily temperatures on the Island are likely to range from 21^{o}C in Winter up to 29.5^{o}C in Summer, although maximum temperatures up to about 35^{o}C may occur. Average minimum temperatures on the Island are likely to range from approximately 16.5^{o}C in Winter up to 24^{o}C in Summer, with minimum temperatures as low as 5^{o}C recorded on islands in the region.

Great Keppel Island is located within a tropical cyclone zone. On average, the Island may experience up to 0.4 cyclones per year with the frequency increasing up to 0.6 cyclones per year during La Nina events. Maximum wind gusts up to 163 km/hr have previously been recorded on nearby Heron Island.

The Great Keppel Island Revitalisation Plan will be designed and constructed to both mitigate the adverse impacts of predicted climate change while also minimising the Project's contribution to global greenhouse gas emissions:

Based on a review of available literature and data relating to predicted climate change, the key climatic changes likely to impact on the GKI Resort Revitalisation Plan have been identified as:

- Decreased total rainfall;
- Increased rainfall intensity;
- Increased intensity of tropical cyclones, including:
    - Increased maximum wind speeds;
    - Increased storm surge etc;
- Increased evaporation;
- Increased temperatures; and
- Increase sea levels.

These factors will be incorporated into the design of the GKI Resort Revitalisation Plan to ensure built infrastructure is either located to avoid these impacts, is able to adapt to or is resilient to these climatic changes. Proposed mitigation measures include:

- Ensuring buildings are designed in accordance with latest design standards which have allowed for projected increases in wind speeds and cyclonic intensity;
- Ensuring built infrastructure is located above projected storm surge levels accounting for sea level rise (eg. building pad levels shall be located above 3.74m AHD at Putney Beach and 3.82m AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise) and building foundations are designed to withstand potential erosion of sandy substrate;
- Ensuring stormwater and wastewater infrastructure is designed for maximum flows accounting for increased rainfall intensity; and
- Ensuring sustainable water supplies will be available despite a decrease in average rainfall and increased average evaporation rates.

In addition to mitigating the impacts of climate change on the GKI Resort Revitalisation Plan, it is recognised that minimising the Project's contribution to human-induced climate change is necessary to ensure the future viability of coral reef and other ecosystems that attract visitors to the Island and is therefore necessary for ensuring the viability of the resort itself. As such, the following measures are proposed to minimise the carbon footprint of the GKI Resort Revitalisation Plan:

- Primary electricity supply shall be derived from solar photovoltaic cells installed on the roof tops of villas and other resort buildings, with only supplementary and emergency electricity sourced from standby diesel generators and mainland electricity cable connection. Sufficient solar panels shall be installed to meet the energy demands of the GKI Resort Revitalisation Plan plus 5% with excess energy generated to be returned to the mainland grid via a submarine cable;
- Buildings shall be designed to minimise energy consumption for heating and cooling by maximising use of natural ventilation and solar access; and

- Proposed buildings and infrastructure shall be located to minimise the clearing of native vegetation. As part of the GKI Resort Revitalisation Plan, planting of vegetation will occur to offset losses in biodiversity and carbon sequestration capacity.

Other initiatives proposed as part of the GKI Revitalisation Plan will also contribute to maintaining the resilience of coral reef and other ecosystems to climate change including:

- Establishment of a research centre within the Keppel Island Group;
- Funding of the research centre and associated research and educational activities through establishment of a Biodiversity Fund comprised of a portion of GKI Resort Pty Ltd's profit and visitor donations; and
- Conducting regular monitoring of water quality and the condition of coral reefs and coastal ecosystems.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DOCUMENT HISTORY

REVISION / ISSUE RECORD

DATE	DESCRIPTION	REV	AUTHOR	VERIFIED
15/07/11	Draft for Comments	A	Tracey Birt	Vicki Laurie
9/8/11	Approval	B	Tracey Birt	Vicki Laurie
20/10/11	Final Issue	C	Tracey Birt	Vicki Laurie

DISTRIBUTION RECORD

	REVISION No. / Qty Issued				
RECIPIENT	**A**	**B**	**C**	**D**	**E**
GKI Resort Pty Ltd	1				
GKI Resort Pty Ltd		1			
GKI Resort Pty Ltd			1		

per. K. Jongen

Prepared By:

TRACEY BIRT
Work Group Manager ~
Environmental and Planning

Vicki Laurie

Reviewed By:

VICKI LAURIE
Environmental Team Leader

George Chen

Approved for Issue:

GEORGE CHEN
Project Manager

1. INTRODUCTION

This Report has been prepared by Opus International Consultants ('Opus') on behalf of GKI Resorts Pty Ltd to provide an assessment of potential climate change impacts on the proposed Great Keppel Island (GKI) Revitalisation Project and mitigation measures to address these impacts. The contents of this Report are to be included as part of the overall Environmental Impact Statement (EIS) prepared for the GKI Revitalisation Project.

1.1 PROJECT OVERVIEW

The GKI Revitalisation Plan (refer to **Appendix A – GKI Revitalisation Plan**) proposes to create a low rise, eco-tourism resort on Great Keppel Island.

The proposal involves:

- Demolition of the old resort and construction of a new 4 or 5 star resort hotel at Fisherman's Beach comprising 250 suites and day spa;
- Dredging activities for construction of the marina and re-nourishment of Putney Beach using dredge spoil;
- A new all-weather safe access marina facility at Putney Beach comprising 250 berths, a ferry terminal, emergency services facilities, yacht club, and dry dock storage;
- A retail village with a mix of cafes, restaurants and clothing shops around the marina;
- An 18-hole golf course, designed by Greg Norman Golf Course Design and including club house, integrated with essential habitats and ecological corridors, and located on previously disturbed grazing lands;
- New runway and airport terminal;
- 750 eco-tourism villas incorporating sustainable building design, rooftop solar panels and water tanks;
- 300 eco-tourism apartments incorporating sustainable building design, rooftop solar panels and water tanks;
- Installation of submarine connection of power, water and telecommunications between the Island and mainland;
- Associated service facilities and utilities (waste collection area, fire-fighting and emergency services hub, fuel, solar, wastewater treatment plant etc), including 200 bed staff accommodation facilities;
- Establishment of the GKI Research Centre and Biodiversity Conservation Fund (BCF) which will aim to deliver a better understanding of the surrounding marine and terrestrial environments and to actively undertake conservation works to enhance the natural environment;
- A new sports oval which can be used by resort guests and other GKI residents and visitors; and
- Restoration of the original Leeke's Homestead.

It is envisaged that approximately 685 full time, part time and casual staff will be required once the resort is fully operational. Most operational staff will work standard shift hours and will be sourced from the Capricorn Region. The majority of staff will travel to the Island via ferry for each shift, before returning home to the mainland after their shifts. Up to approximately 200 staff may be accommodated in the new staff accommodation to be provided on the Island as part of the GKI Revitalisation Plan.

The GKI Revitalisation Plan will be constructed in stages, with Stage 1 involving construction of the Fishermans Beach hotel and day spa, the marina facility including retail precinct, one hundred and fifty (150) apartments and internal infrastructure (power, water, sewerage, roads). It is expected that Stage 1 will take approximately 18 months to construct at a cost of around $150 million. Completion of the GKI Revitalisation Plan is expected to take 12 years, finishing around 2023.

Construction workers will be ferried to and from the Island where possible and practical. It is envisaged that rooms at the old resort as well as other accommodation options on the Island will be utilised to provide accommodation on the Island for some construction workers.

1.2 LOCALITY OVERVIEW

Great Keppel Island is located approximately 12 km off the coast of Yeppoon on the Central Queensland coast. GKI is included within the Rockhampton Regional Council local government area.

GKI is the largest island in the Keppel Island Group, which comprises a group of sixteen islands, including North Keppel Island, Corroboree Island, Pumpkin Island, Miall Island, Middle Island, Barren Island, Halfway Island, and Humpy Island. Apart from GKI and Pumpkin Island, all of the other Keppel Islands are designated National Parks.

The proposed Revitalisation Plan applies to the areas of GKI that are leased by GKI Resort Pty Ltd, which covers an area of approximately 900 hectares consisting of multiple land tenures. The GKI Revitalisation Plan also includes Unallocated State Land to be developed for the marina and areas to accommodate submarine connections between GKI and the mainland.

There are seventeen beaches on GKI and its natural environment offers a wide range of activities including swimming, diving, snorkelling and bushwalking.

1.3 CURRENT AND PREVIOUS DEVELOPMENT

Until recently the Island has been occupied by a number of different commercial accommodation facilities ranging from camping ground style accommodation to resort level accommodation. The original GKI Resort was the main tourism resort located on the Island and comprised 190 guest rooms. These facilities were closed in early 2008.

The Island is currently occupied by two backpackers' facilities, ten residential properties and ten commercial premises. Access to the Island is currently via ferry and cruise ship services from the Rosslyn Bay / Keppel Bay Marina on the mainland.

In the 1990s, the average daily population on the Island (staff, residents, overnight and day visitors) was approximately 765 persons while the maximum possible daily population was approximately 2,600 persons (Foresight Partners, 2011). The peak daily population for the Island during operation of the former resort (ie. 2,600 persons) is therefore comparable with the anticipated average daily population projected for the revitalised resort (ie. 2,274 persons) (Foresight Partners, 2011).

1.4 SCOPE AND OBJECTIVES

This Report has been prepared to address section 3.1 of the *Terms of Reference for EIS – Great Keppel Island Resort Project* issued by the Queensland Coordinator-General, which requires the following issues to be considered in the Environmental Impact Statement (EIS):

> ***3.1 Climate, natural hazards and climate change***
>
> ***3.1.1 Natural hazards and climate change adaptation***
>
> ***3.1.1.1 Description of environmental situation***
>
> *This section should describe the current and future climatic conditions that may affect construction and operation of the project. This includes a description of the vulnerability of the project area to:*
>
> - *seasonal conditions.*
> - *extremes of climate.*
> - *natural or induced hazards.*
>
> ***3.1.1.2 Potential impacts and mitigation measures***
>
> *A risk assessment and management plan should be provided detailing these potential threats to the construction, and operation of the project.*
>
> *The most recent information on potential impacts of climatic factors should be addressed in the appropriate sections of the EIS. An assessment of climate change risks and possible adaptation strategies should included, as well as the following:*
>
> - *a risk assessment of changing climate patterns that may affect the viability and environmental management of the project;*
> - *the preferred and alternative adaptation strategies to be implemented; and*
> - *commitments to undertaking, where practicable, a cooperative approach with government, other industry and other sectors to address adaptation to climate change.*

Consideration has also been given in the preparation of this Report, to the relevant requirements of the "Guidelines for an Environmental Impact Statement for the Great Keppel Island Tourism and Marina Development, Queensland" issued by the Australian Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) in conjunction with the Great Barrier Reef Marine Park Authority.

2. OVERVIEW OF EXISTING CLIMATE

Limited climatic data is available from the Bureau of Meteorology (BoM) specifically for Great Keppel Island. According to the BoM Climate Data Online (BoM, 2011), the following data is available specifically for the Great Keppel Island South observation site (Site No. 033260).

- Daily Rainfall (1988 to 2011); and
- Daily Solar Exposure (November 2010 to April 2011)

The following BoM observation sites located within close proximity of Great Keppel Island have been identified as having more comprehensive climatic data:

Table 1: Summary of Climate Observation Sites in Vicinity of Great Keppel Island

Site Name	Site No.	Site Coordinates (Latitude / Longitude)	Elevation	Data Collection Commenced	Comment
Keppel Island South	033260	23.16°S / 150.96°E	25m	1987	Daily rainfall and solar exposure data only.
Yeppoon The Esplanade	033294	23.14°S / 150.75°E	6m	1993	No daily evaporation or maximum wind gust speed.
Pacific Heights	033077	23.10°S / 150.73°E	75m	1891	No daily evaporation or relative humidity data, or maximum wind gust speed.
Rockhampton Aero	039083	23.38°S / 150.48°E	10m	1939	All standard BoM weather information collected.
Rundle Island	039322	23.53°S / 151.28°E	20m	1994	No rainfall data or solar exposure data. No daily evaporation or relative humidity data, or maximum wind gust speed.
Heron Island Research Station	039122	23.44°S / 151.91°E	3m	1956	No solar exposure data.

Available monthly rainfall data for Keppel Island South (Site No. 033260) has been compared to the above sites to determine the level of consistency in climatic attributes (refer to **Figure 1**).

Figure 1 illustrates that each of the sites identified in **Table 1** are characterised by similar monthly rainfall patterns. Compared to the mainland and near-shore island (eg. South End Curtis) sites, the end of the wet season appears to extend further into April, May and to some extent June at the two (2) offshore island sites (Keppel Island South and Heron Island Research Station). However, the onset to the wet season at these sites appears to start more so in December rather than November for the mainland and near-shore sites. Pacific Heights has a much higher average rainfall for January, February and March, while Rockhampton Airport is on average, characterised by slightly lower average rainfall than the other sites.

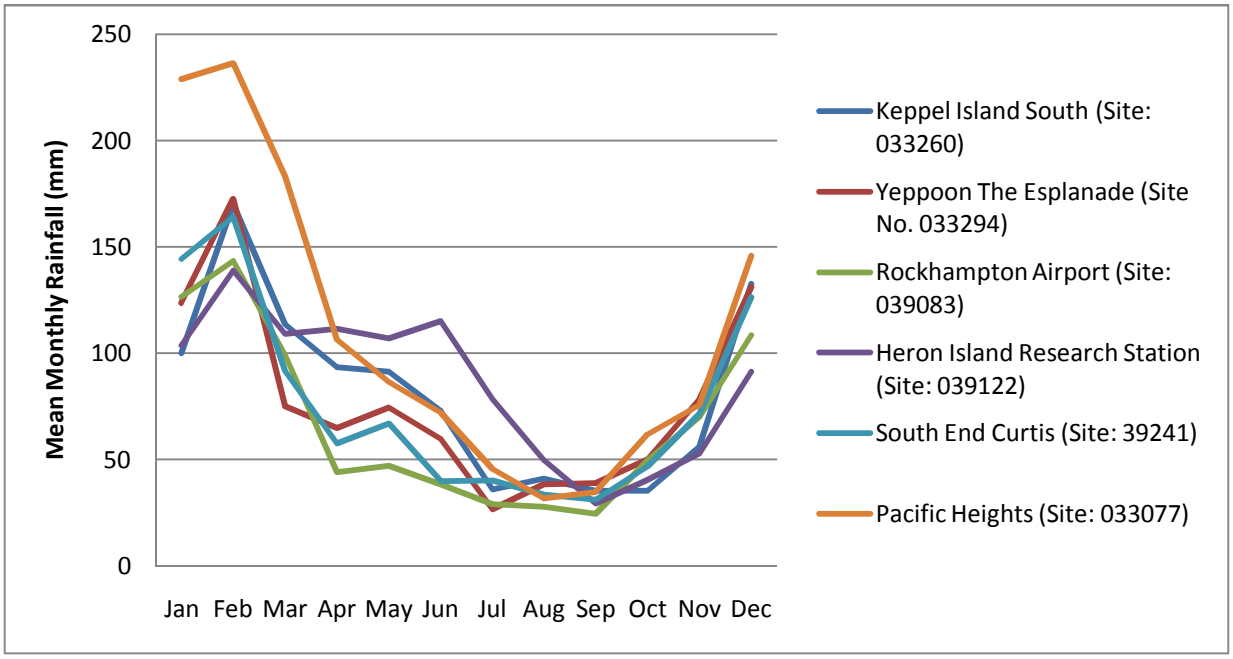


Figure 1: Comparison of Mean Monthly Rainfall Data (Keppel Island South and Nearby Sites)

Based on the range of climatic data available for each site and the comparability of monthly rainfall data with the Keppel Island South observation site, the following sites are considered most relevant for consideration of climatic attributes likely to be experienced at Great Keppel Island:

- Heron Island Research Station (Site: 039122);
- Rockhampton Airport (Site: 039083); and
- Yeppoon The Esplanade (Site: 033294).

Relevant climatic attributes for these sites are discussed below.

2.1 AIR TEMPERATURE

Figures 2 to 4 present average and extreme temperature ranges for the three (3) observation sites considered most relevant to Great Keppel Island. This data indicates that mean maximum temperatures at the Rockhampton Airport range from 23.1°C in July up to 32.1°C in December. Mean maximum temperatures on the coast at Yeppoon and on Heron Island are slightly lower than inland at the Rockhampton Airport. Mean maximum temperatures range from 21.4°C in July up to 29.3°C in January / February at Yeppoon. Very similar mean maximum temperatures are experienced on Heron Island ranging from 21.5°C in July up to 29.8°C in January. The highest maximum temperatures recorded at Rockhampton Airport, Yeppoon and Heron Island are 45.3°C, 40.5°C and 34.7°C respectively, which were recorded in November / December.

Mean minimum temperatures at the Rockhampton Airport range from 9.5°C in July up to 22.1°C in January / February. Mean minimum temperatures on the coast at Yeppoon and on Heron Island are slightly warmer than inland at the Airport. Mean minimum temperatures range from 11.8°C in July up to 23.7°C in January / February at Yeppoon. Mean minimum temperatures experienced on Heron Island are slightly warmer again ranging from 16.5°C in July up to 24.2°C in January / February. The lowest

minimum temperatures recorded at Rockhampton Airport, Yeppoon and Heron Island are -1.0°C, -0.1°C and 5.0°C respectively, which were recorded in June / July.

This data illustrates that Great Keppel Island is characterised by cooler Summers and warmer Winters relative to adjacent mainland locations, with temperatures on the Island are likely to be attractive to tourists all year round.

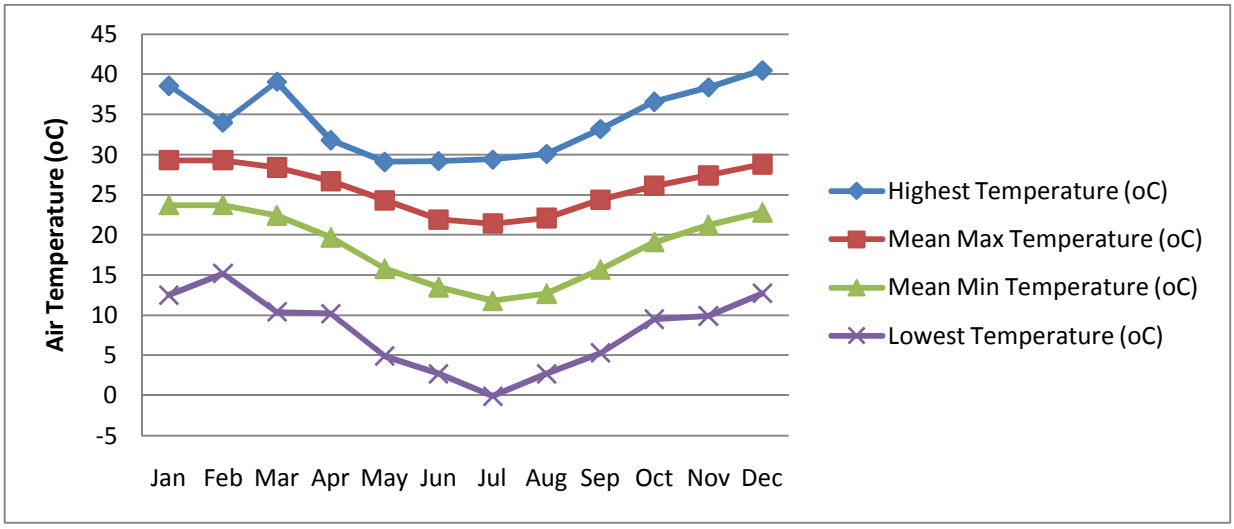


Figure 2: Yeppoon The Esplanade (Site: 033294) – Monthly Air Temperature

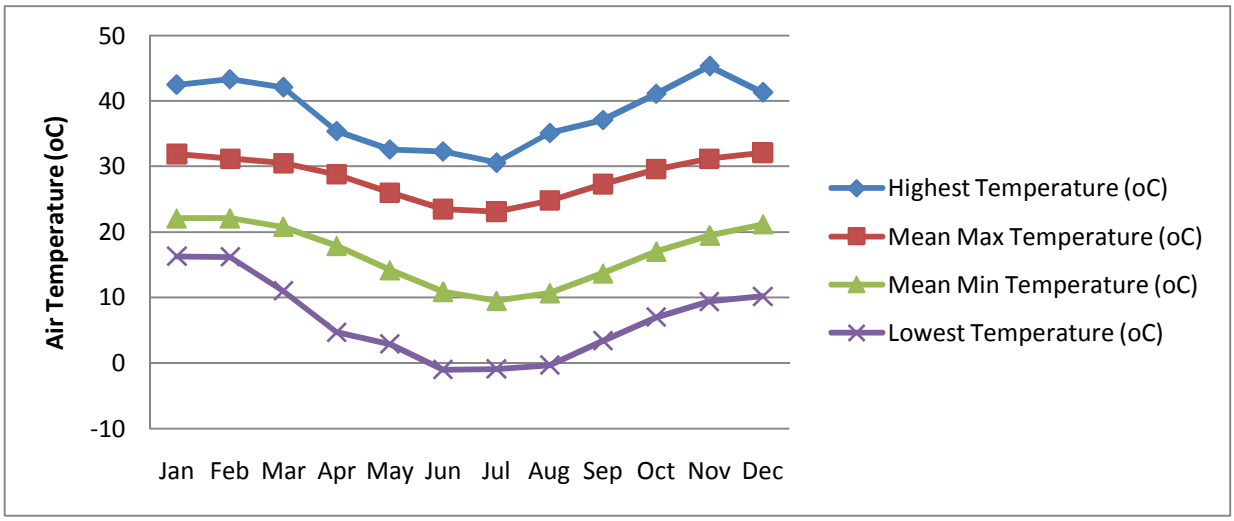


Figure 3: Rockhampton Airport (Site: 039083) – Monthly Air Temperature

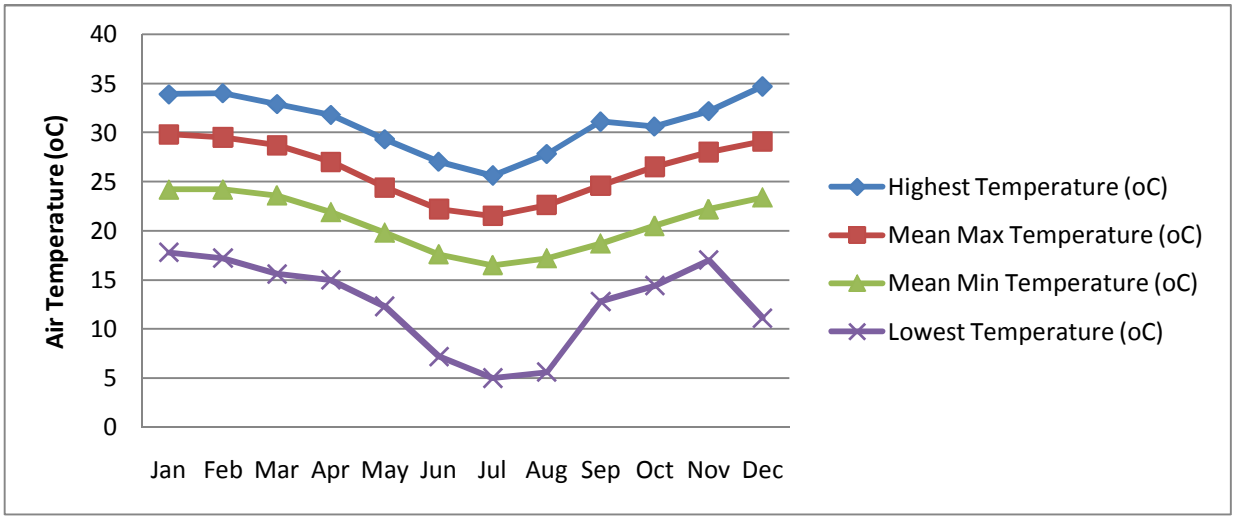


Figure 4: Heron Island Research Station (Site: 039122) – Monthly Air Temperature

2.2 RELATIVE HUMIDITY

Figures 5 to 7 present typical humidity ranges for the three (3) observation sites considered most relevant to Great Keppel Island. This data indicates that relative humidity on the Yeppoon coast and Heron Island varies little between 9am and 3pm, with relative humidity on the Yeppoon coast averaging between 60% and 80% throughout the day, year round with minimal variation. Relative humidity on Heron Island varies more substantially throughout the year with the lowest relative humidity occurring in September at about 67% (9am) and 63% (3pm), and the highest relatively humidity occurring in February / March at about 74% (9am) and 71% (3pm). Rockhampton Airport is characterised by higher relative humidity in the morning, averaging between 62% and 73%, compared to the afternoon when relative humidity averages between 40% and 57% across the year.

Relatively humidity on Great Keppel Island is likely to be most comparable with Heron Island being an island located roughly the same distance from the mainland.

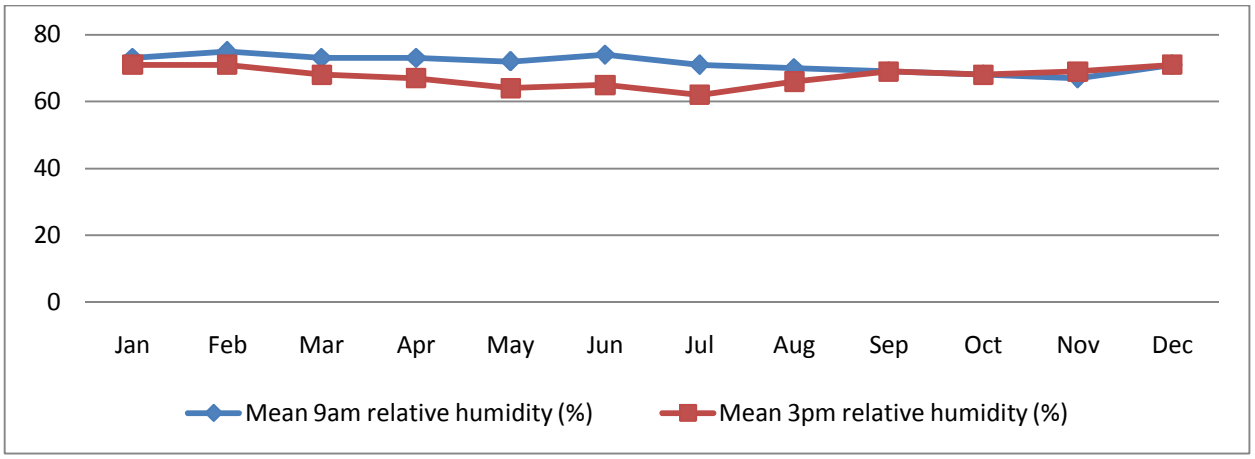


Figure 5: Yeppoon The Esplanade (Site: 033294) – Monthly Average Relative Humidity

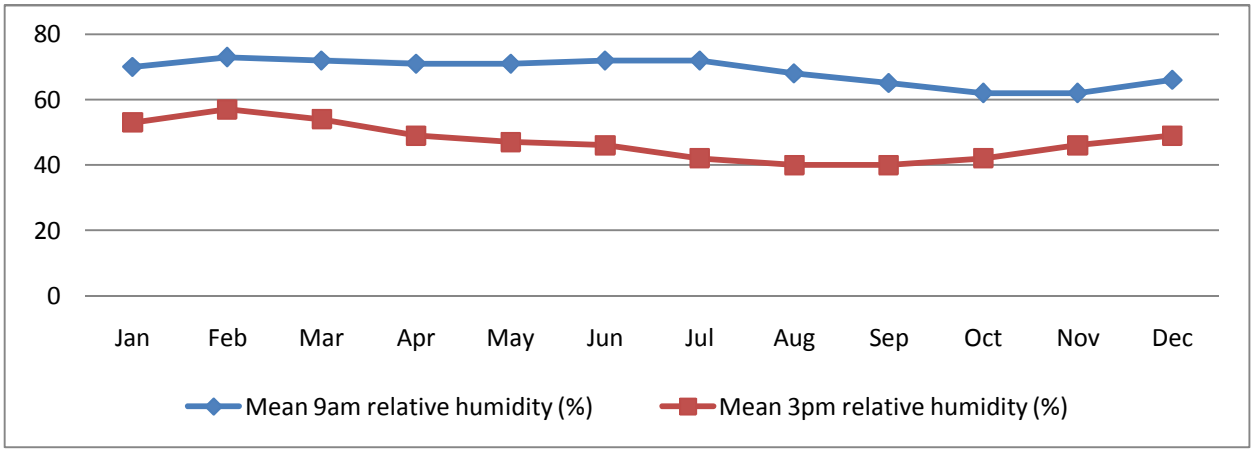


Figure 6: Rockhampton Airport (Site: 039083) – Monthly Average Relative Humidity

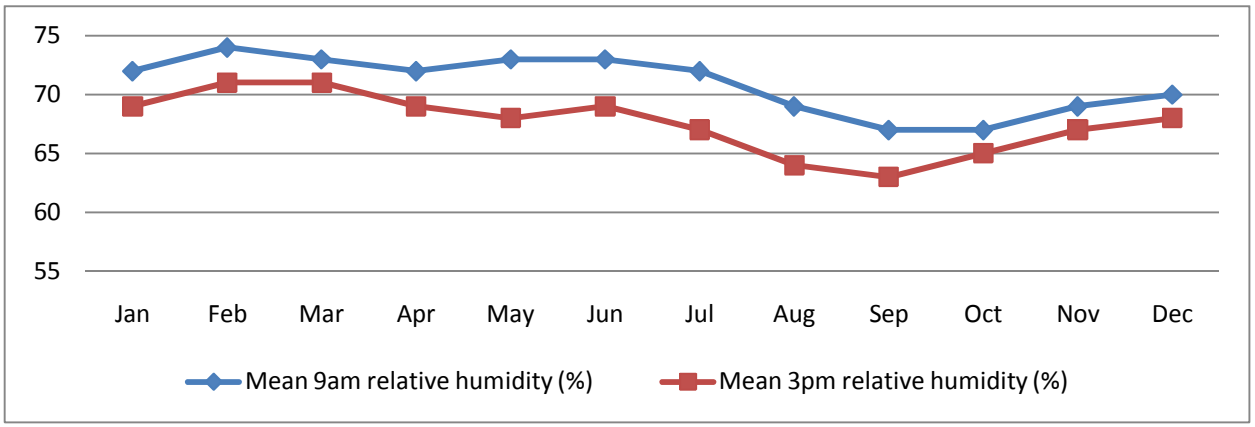


Figure 7: Heron Island Research Station (Site: 039122) – Monthly Average Relative Humidity

2.3 RAINFALL

Monthly rainfall data from the Keppel Island South site collected by BoM for the period between January 1988 and March 2011 indicates that total annual rainfall varies between a low of 494.2mm recorded in 2001 and a high of 1,936.2mm recorded in 2010. Rainfall data for the 2010 period has not yet been quality control approved by BoM. The next highest annual rainfall total that has been quality controlled by BoM was 1,685.0mm recorded in 1990. The mean annual rainfall recorded over this period was 975.8 mm.

Figure 8 presents monthly rainfall data from the Keppel Island South site collected by BoM for the period between January 1988 and March 2011. This data indicates that February is typically the wettest month, with a mean monthly rainfall of 170.1mm and 95th percentile of 439.5mm. **Figure 8** also illustrates however, that monthly rainfall can vary considerably on the Island, particularly in terms of the volume of rainfall occurring during the Summer months. For example, the highest monthly rainfall recorded on the Island to date, occurred in March 1990 when 615.4mm of rainfall was recorded. In March 1993 however, only 1.8mm of rainfall was recorded. Similarly, 595.2mm of rainfall was recorded in February 2010 yet only 16.2mm of rainfall was recorded in February 1996. In comparison, the variation in rainfall occurring during the typically drier, Winter months, is less dramatic but may still vary

by between 120mm and 200mm per month between the highest and lowest recorded monthly rainfall totals between July and October.

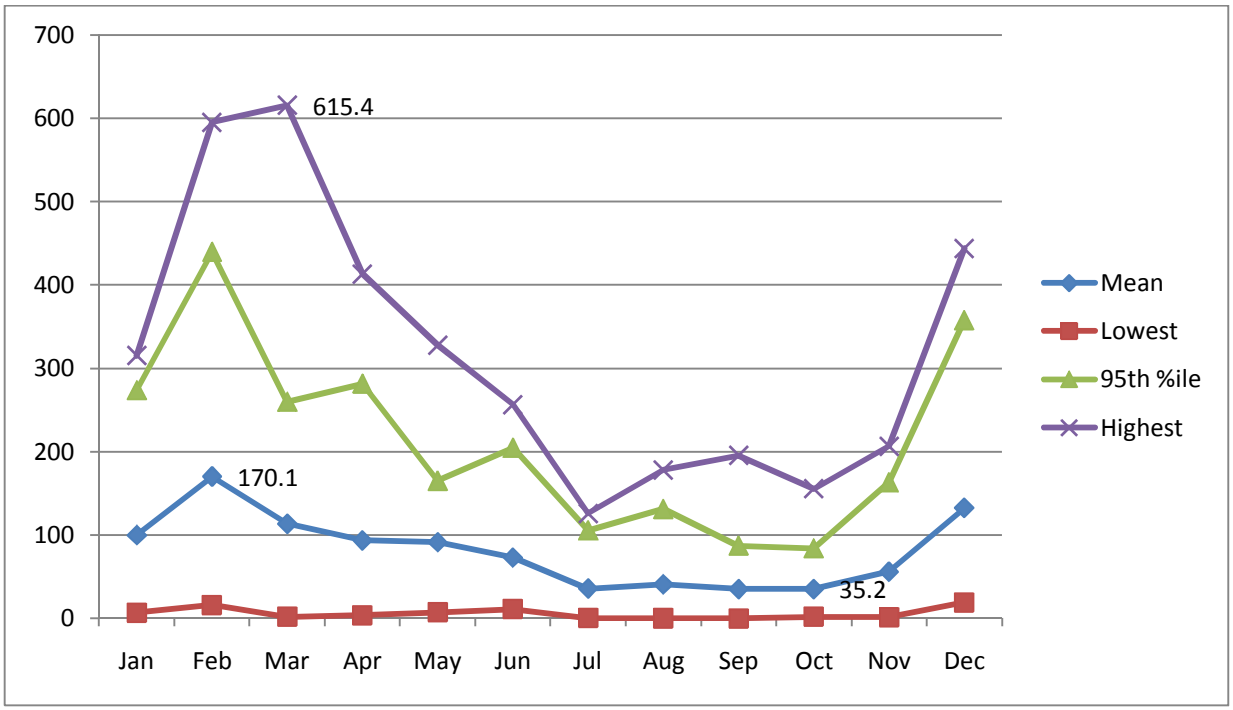


Figure 8: Keppel Island South (Site: 033260) – Monthly Rainfall

Figure 9 presents daily rainfall data compiled for Great Keppel Island by the Department of Environment and Resource Management (DERM) for the period from January 1957 to December 2009. This data indicates an average annual rainfall for Great Keppel Island of approximately 1,045mm/year, with a 10th percentile of 688mm/year and a 90th percentile of 1,478mm/year. Between January 1957 and December 2009, the maximum rainfall for a 24-hour period was recorded as 344mm, which occurred on 18 February 1961.

Figure 10 presents as comparison of the mean number of days recording rainfall greater than or equal to 1mm for the three (3) observation sites considered most relevant to Great Keppel Island. This data indicates that the number of rain days is highest at the Heron Island Research Station where a total of 84.7 days on average recorded at least 1mm of rainfall, followed by the coastal mainland site at Yeppoon where a total of 76.1 days on average recorded at least 1mm of rainfall. The more inland site at Rockhampton Airport recorded the lowest average number of days recording at least 1mm of rain, with only 62.8 days.

The number of rain days per month is generally higher during the wetter, Summer months from December to March, averaging around 6-10 days. Heron Island Research Station experiences on average at least 6 rain days per month from December through to July, with the coastal mainland observation site at Yeppoon receiving at least 6 rain days per month from December through to June.

Great Keppel Island is likely to be similar to Heron Island in terms of having more rain days per month than mainland sites.

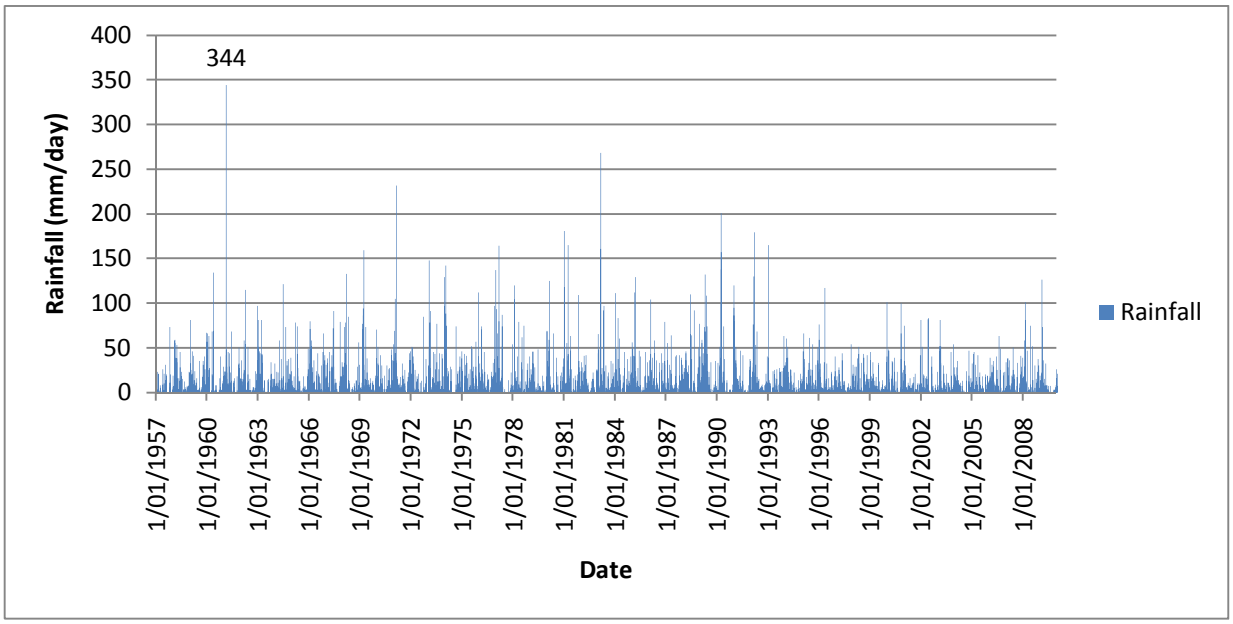


Figure 9: Daily Rainfall Data Compiled for Great Keppel Island

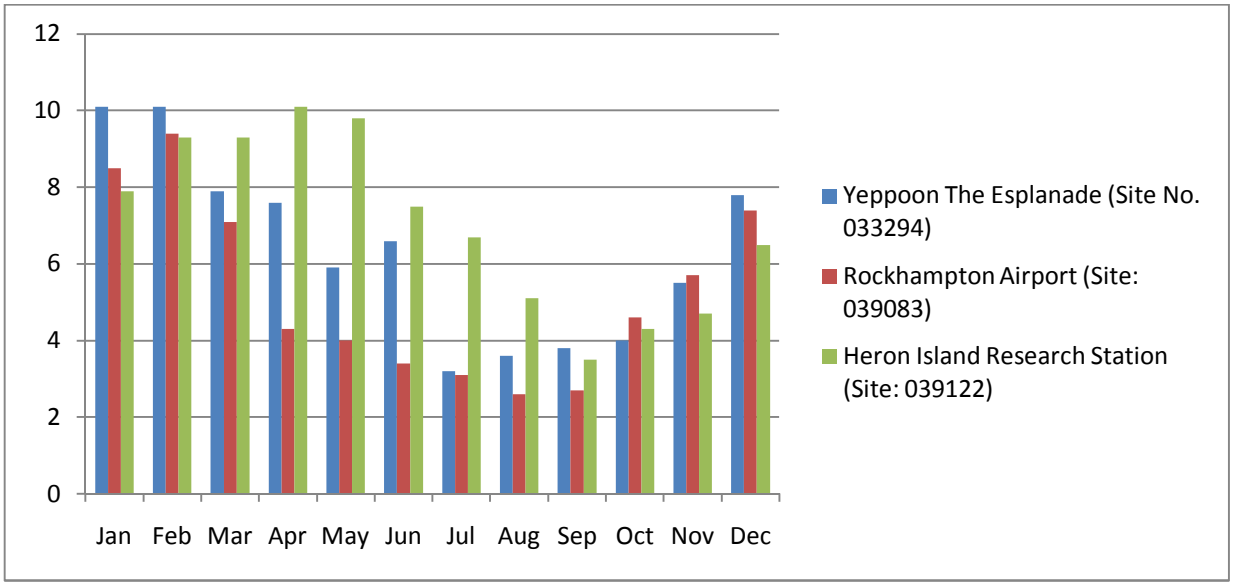


Figure 10: Number of Days Recording At Least 1mm of Rainfall

2.4 EVAPORATION

Daily pan evaporation data compiled for Great Keppel Island by the DERM for the period from January 1957 to December 2009 indicates an average pan evaporation rate for Great Keppel Island of approximately 1,848mm/year, with a 10th percentile of 1,715mm/year and a 90th percentile of 1,997mm/year. Comparing this to rainfall data over the same time period indicates that there is an average annual rainfall deficit of 803mm/year. During a year of above average evaporation and below average rainfall, the annual rainfall deficit may be up to 1,309mm/year, while in a year of below average evaporation and above average rainfall, the annual rainfall deficit may be as low as 237mm/year.

2.5 WIND REGIMES

Wind rose diagrams for the three (3) climate observation sites considered most relevant to Great Keppel Island are provided in **Appendix B - Wind Rose**.

Rockhampton Airport tends to experience calmer conditions (ie. <10km/h) more frequently than the other sites, while Heron Island more frequently experiences much stronger winds (ie. 30-40km/h and >40km/h) than the two (2) mainland sites. Yeppoon is characterised by pronounced changes in wind direction during the afternoon through most months, reflecting the sea breezes typically associated with coastal sites. Stronger wind speeds are also experienced at Yeppoon in the afternoon relative to the morning, with afternoon winds at the Rockhampton Airport also strengthening however, to a lesser extent. Wind speeds are relatively constant at Heron Island between 9am and 3pm.

At the Yeppoon observation site, wind direction during January and February is predominantly from the south east in the morning (9am) swinging to more of an easterly wind in the afternoon (3pm). Wind speed is generally between 10-20km/h and 20-30km/h in the morning, tending to be slightly stronger in the afternoon falling mostly within the 20-30km/h range. A similar pattern occurs in March and April. Morning southerly and westerly winds mostly within the 10-20km/h range increasingly occur from May through to July, while afternoon winds during this period tend to be more from the east but also within the 10-20km/h range. Through August and September, morning winds swing back around to the south easterly direction but remain predominantly within the 10-20km/h range. By the afternoon, winds typically strengthen to increasingly fall within the 20-30km/h range or higher, and coming more from an easterly to north easterly direction. From October through to December, morning winds tend to be predominantly from the east and north east in either the 10-20km/h or 20-30km/h range. These winds remain from this direction in the afternoon, but strengthen to predominantly fall within the 20-30km/h range, although stronger northerly and north easterly winds over 40km/h also occur during October to December.

Heron Island experiences predominantly south easterly winds, morning and afternoon throughout January to May, with an increase in southerly winds occurring in June, July and August. September through to December is characterised by south easterly, easterly, north easterly and northerly winds in almost equal proportion. Wind speeds on Heron Island are quite variable, with the dominant wind in each month roughly being 10% >40km/h, 20% in the 30-40km/h range, 30% in the 20-30km/h range, 30% in the 10-20km/h range and 10% in the <10km/h range.

Rockhampton Airport is characterised by south easterly winds less than 30km/h in the morning from January through to May, with afternoon winds during these months moving slightly more towards the east. This pattern remains strong throughout June and August; however winds are slightly more variable during this period with southerly and south westerly winds also common. During September to December, morning winds remain predominantly from the south east but also occur increasingly from the north and east. Afternoon winds during these months are also predominantly from the east or north east. Wind speeds at the Rockhampton Airport are roughly 35% in the 20-30km/h range, 40% in the 10-20km/h range, 20% <10m/h and 5% >40km/h.

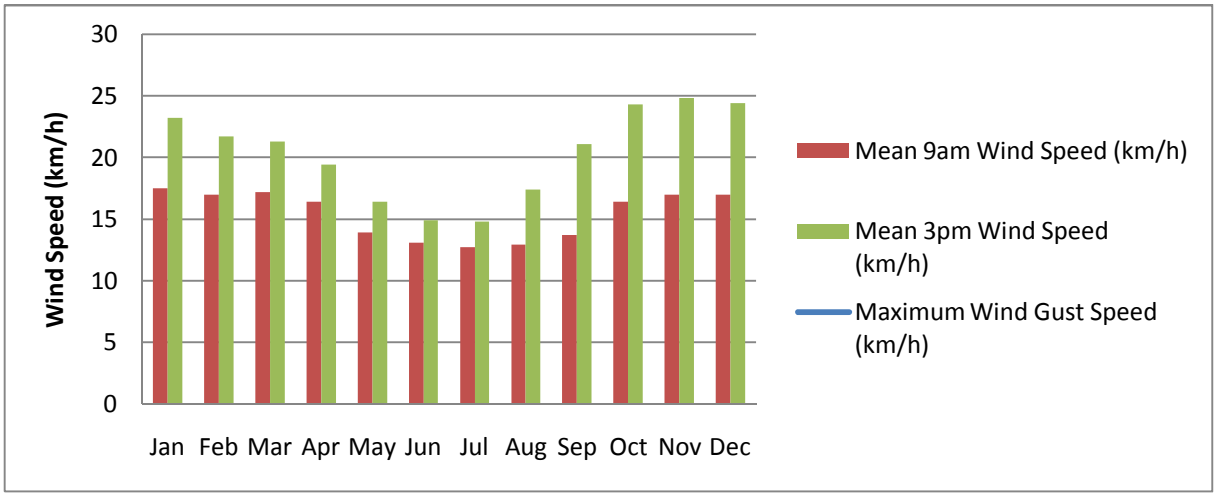


Figure 11: Yeppoon The Esplanade (Site: 033294) – Morning and Afternoon Wind Speeds

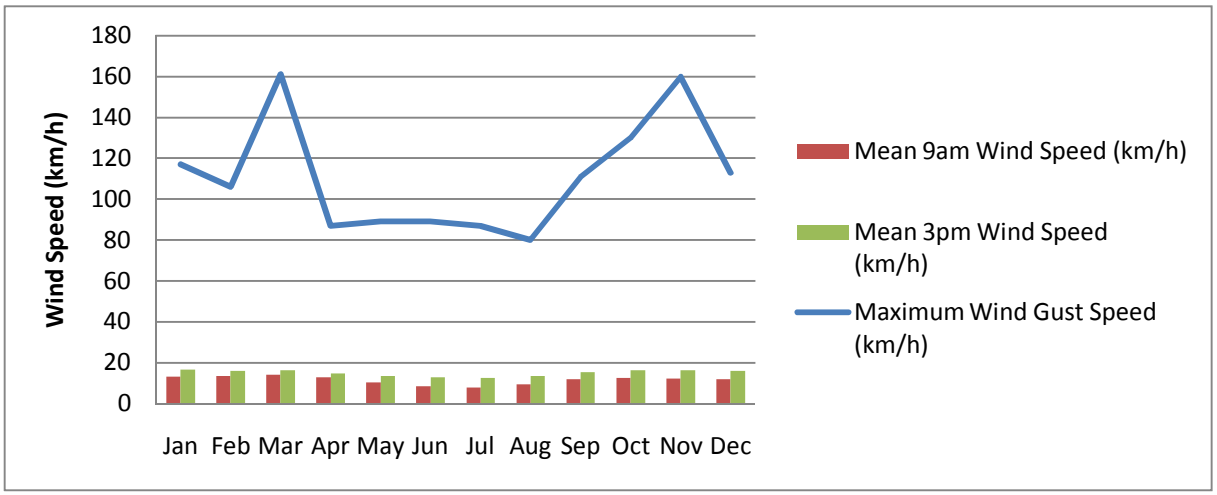


Figure 12: Rockhampton Airport (Site: 039083) – Morning and Afternoon Wind Speeds and Maximum Wind Gusts

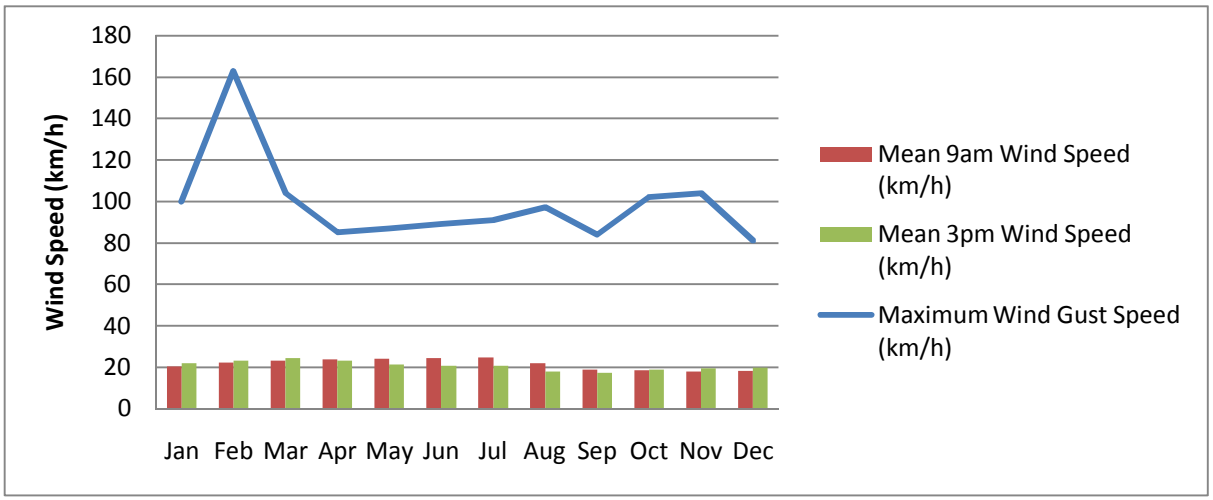


Figure 13: Heron Island Research Station (Site: 039122) – Morning and Afternoon Wind Speeds and Maximum Wind Gusts

Figures 12 and 13 illustrate that maximum wind gusts substantially higher than mean wind speeds have been recorded at both the Rockhampton Airport and Heron Island Research Station. No data relating to maximum wind gust speed is available for the Yeppoon site. Maximum wind gusts have occurred in the Summer months, most probably associated with cyclonic activity. Maximum wind gusts speeds of 161km/hr and 163km/hr have been recorded for Rockhampton Airport and Heron Island Research Station respectively.

2.6 TROPICAL CYCLONES

Tropical cyclones in the Queensland region mostly form from lows within the monsoon trough, between November and April. On average 4.7 tropical cyclones per year affect the Queensland Tropical Cyclone Warning Centre's area of responsibility, which extends from Torres Strait to northern New South Wales (BoM, 2011). Tropical cyclones rarely form south of 25° latitude in Queensland due to the cooler sea surface temperatures. Being located at approximately 23.16° latitude, Great Keppel Island is located within the tropical cyclone zone.

There is a strong relationship with eastern Australian tropical cyclone impacts and the El Niño-Southern Oscillation phenomenon, with almost twice as many impacts during La Niña events than during El Niño events. On average, the Great Keppel Island area is expected to experience up to approximately 0.4 cyclones per year, while in La Nina years the area may expect to experience up to approximately 0.6 cyclones per year (refer to **Figures 14 and 15**).

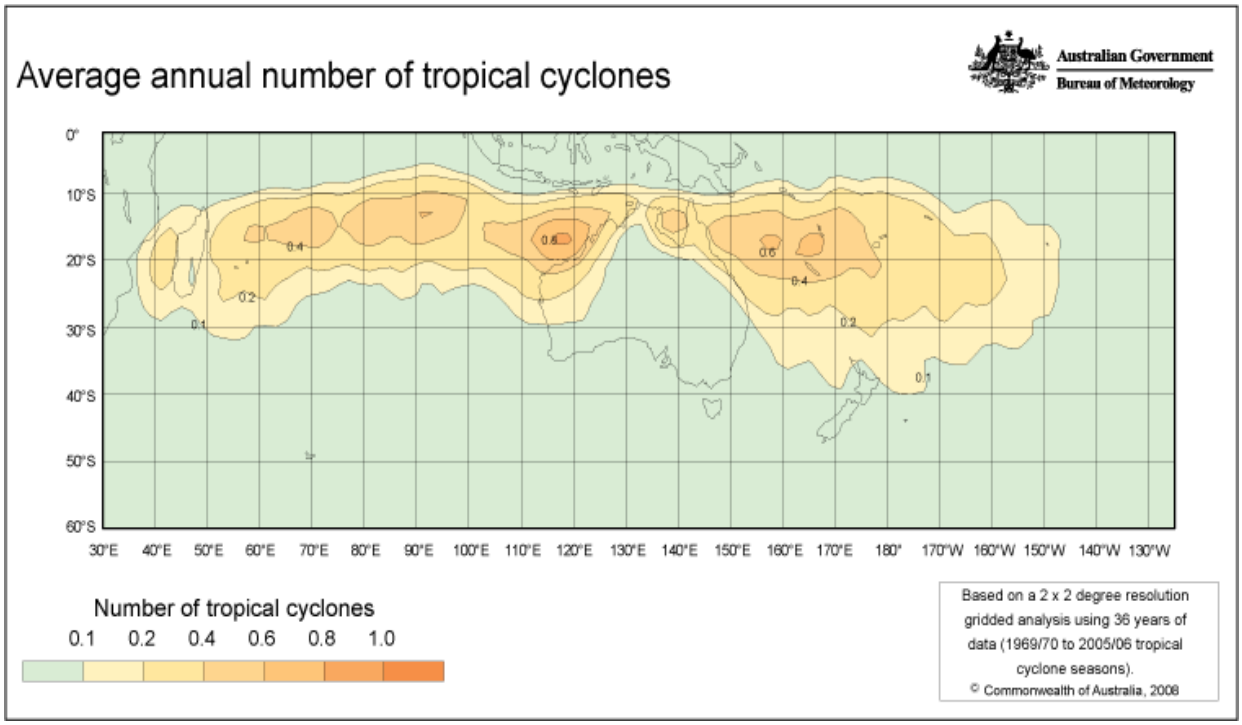


Figure 14: Average Annual Number of Tropical Cyclones
(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

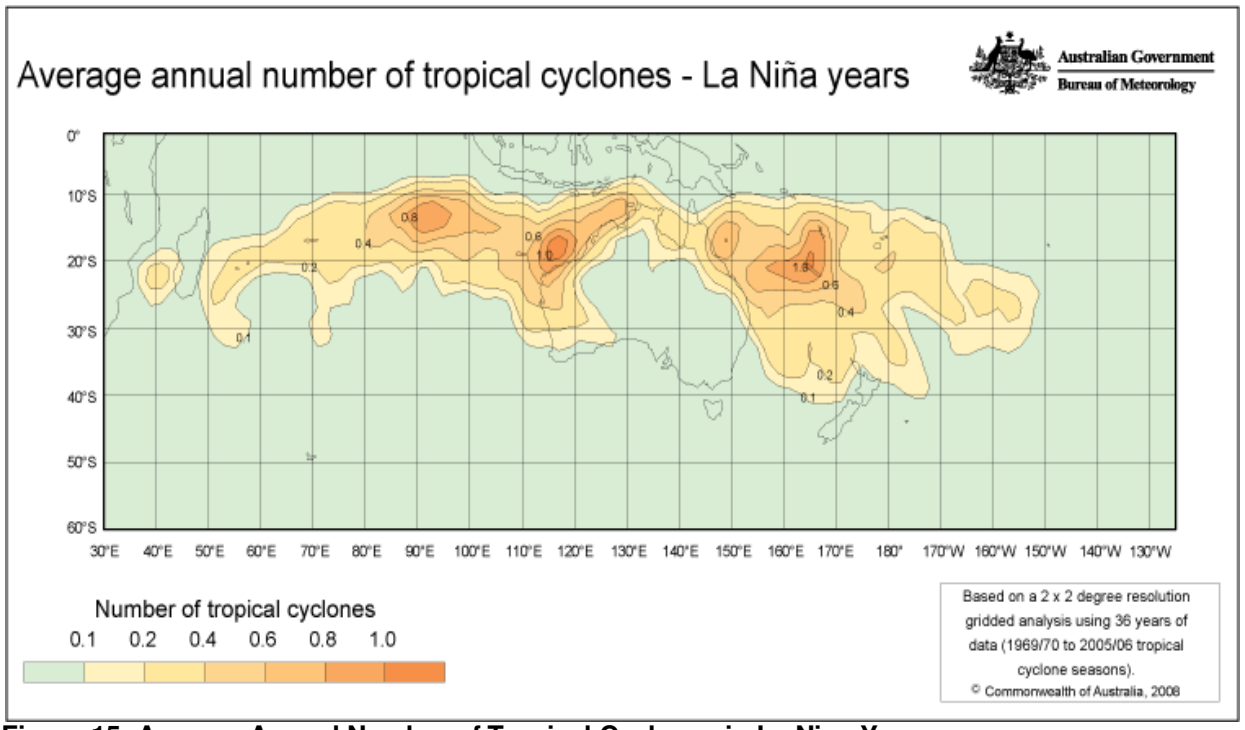


Figure 15: Average Annual Number of Tropical Cyclones in La Nina Years
(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

There have been 207 known impacts from tropical cyclones along the east coast of Queensland since 1858. Such impacts include coastal erosion and flooding, property damage and loss of life (BoM, 2011). **Figure 16** illustrates the number of cyclones that have affected the Great Keppel Island area. Between 1956 and 2006, twelve (12) cyclones have been identified as affecting the Great Keppel Island area including:

- Tropical Cyclone Rewa (1994);
- Tropical Cyclone Fran (1992);
- Tropical Cyclone Pierre (1985);
- Severe Tropical Cyclone Simon (1980);
- Tropical Cyclone Paul (1980);
- Severe Tropical Cyclone Kerry (1979);
- Tropical Cyclone Dawn (1976);
- Tropical Cyclone David (1976);
- Tropical Cyclone Emily (1972);
- Tropical Cyclone Fiona (1971);
- Tropical Cyclone Dinah (1967); and
- Un-named Tropical Cyclone (1961).

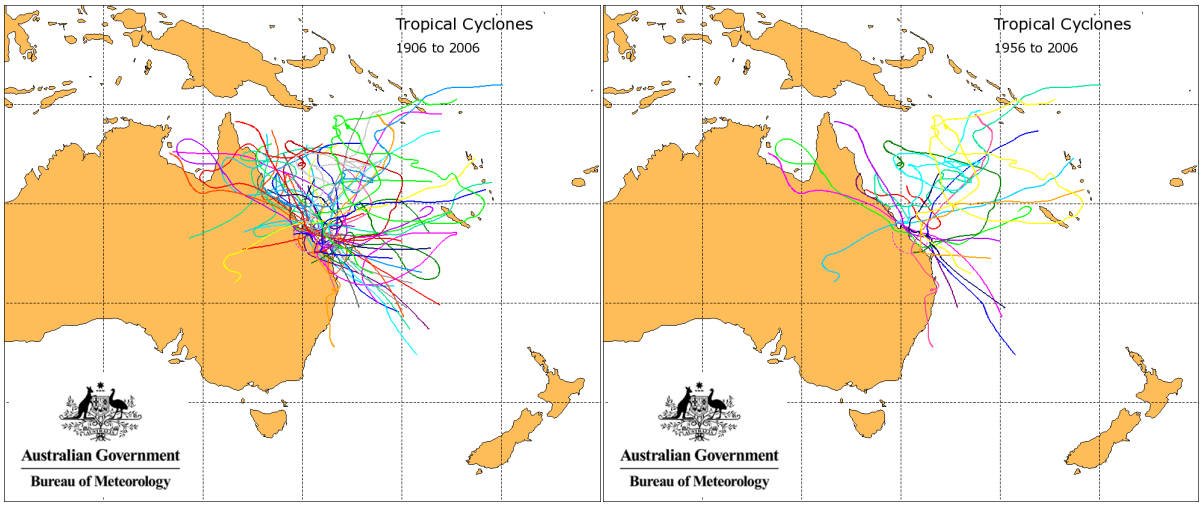


Figure 16: Tropical Cyclone Paths Impacting on the Great Keppel Island Area from 1906-2006 and 1956-2006.

(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

Associated with cyclonic activity, is often the affects of storm surge. Storm surge is a rise above the normal water level along a shore resulting from strong onshore winds and / or reduced atmospheric pressure. Although storm surges generally accompany tropical cyclones as they come ashore, they may also be formed by intense low-pressure systems in non-tropical areas. The greatest impacts occur when a storm surge arrives on top of a high tide and when combined with powerful waves generated by cyclonic winds.

Storm surges may result in flooding and shoreline erosion, with associated damage to infrastructure and property, including potential to wash away roads and damage buildings, and to cause ships to run aground. Storm surge is also a risk to public safety, and has been known to result in a number of drownings in Queensland in previous years (BoM, 2011). The height of storm surge depends on a number of factors, including the intensity of the cyclone, the forward moving speed of the cyclone, the angle at which the cyclone crosses the coast, the shape of the sea floor; and local topography.

The current 100 year ARI storm surge level estimated for the Queensland coast around 23^{o} latitude is approximately 0.3 metres (QCCCE, 2010). Analysis undertaken by Water Technology for the GKI Revitalisation Project taking into account local conditions, has estimated the following storm tide recurrence intervals for various locations on GKI (refer **Table 2**). Storm tide levels specified in **Table 2** reflect the height of mean sea level plus storm surge level relative to the Australian Height Datum (AHD) at each location.

TABLE 2: Current Estimated Storm Tide Levels for Various Recurrence Intervals

ARI	Yeppoon	Putney Beach	Fishermans Beach
	m AHD	m AHD	m AHD
50 year	2.75	2.32	2.37
100 year	2.94	2.67	2.74
500 year	3.49	2.75	2.83

3. CLIMATE CHANGE PROJECTIONS

3.1 HISTORICAL CONTEXT

The climate of the earth is a complex and dynamic system, changing continually over a range of timescales and as a result of a range of factors, internal and external to the climate system, natural and anthropogenic. Since 1988 the scientific findings on atmospheric change and the potential for human induced changes in the Earth's climate have been reviewed and summarised by the Intergovernmental Panel on Climate Change (IPCC). Four major reports have been issued (IPCC 1990; IPCC 1996; IPCC 2001 and IPCC 2007).

The IPCC defines 'climate change' as:

> *"a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer."*

In 2007, the IPCC released its Fourth Assessment Report (AR4) on the physical science basis of climate change (IPCC 2007), which concluded amongst other things, that:

- *Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years;*
- *Warming of the climate system is unequivocal as is now evident from observations of increases in global average air temperatures, widespread melting of snow and ice, and rises in global average sea level;*
- *At continental, regional, and ocean-basin scales, numerous long-term changes in climate have been observed;*
- *Palaeo-climate information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1300 years;*
- *Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Discernible human influences now extend to other aspects of climate, including ocean warming, continental average temperatures, temperature extremes and wind patterns. For the next two decades a warming of about 0.2ºC per decade is projected for a range of SRES emission scenarios;*
- *Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century; and*
- *There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and of ice.*

The IPCC AR4 remains the authoritative reference for climate change policy development by the Queensland Government (DERM, 2010). It has therefore been referenced in the following sections, along with various other national, state and regionally specific reports addressing the issue of climate

change, to identify and where possible quantify, the potential impacts of climate change on the proposed GKI Resort Revitalisation Plan.

Before seeking to identify potential future impacts, a review of historical patterns of climate variation has been undertaken. In this regard, observational data compiled by the Australian Bureau of Meteorology and presented in the *Climate Change in Australia - Technical Report 2007* (CSIRO and BoM, 2007) reveals that significant climate change has occurred in Australia over the last century. A summary of key climatic changes observed is provided below:

Surface Air Temperature

Average global temperatures have increased by approximately 0.75°C since 1900 (IPCC, 2007). Australia's annual mean surface air temperature has increased at a slightly higher rate of approximately 0.9°C since 1910. This rising trend is consistent with mean temperature data from the Rockhampton Airport, which comprises the nearest BoM observation site with adequate historical data (refer **Figure 17**).

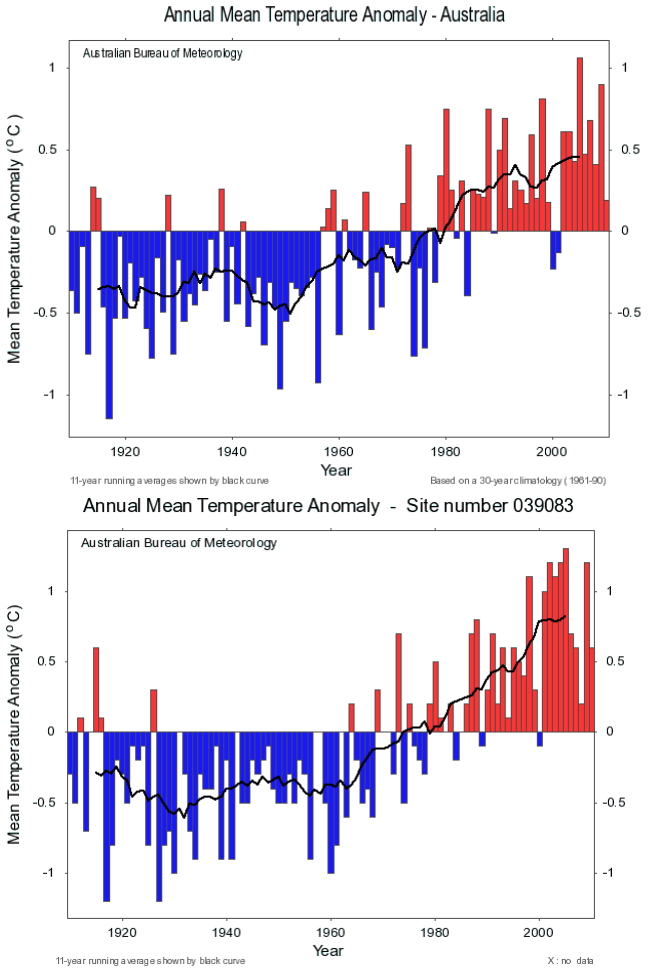


Figure 17: Annual mean surface temperatures (Australia and Rockhampton Airport) taken as anomalies from a 30-year climatology 1961 to 1990 average. The black line represents an 11-year running mean.

(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

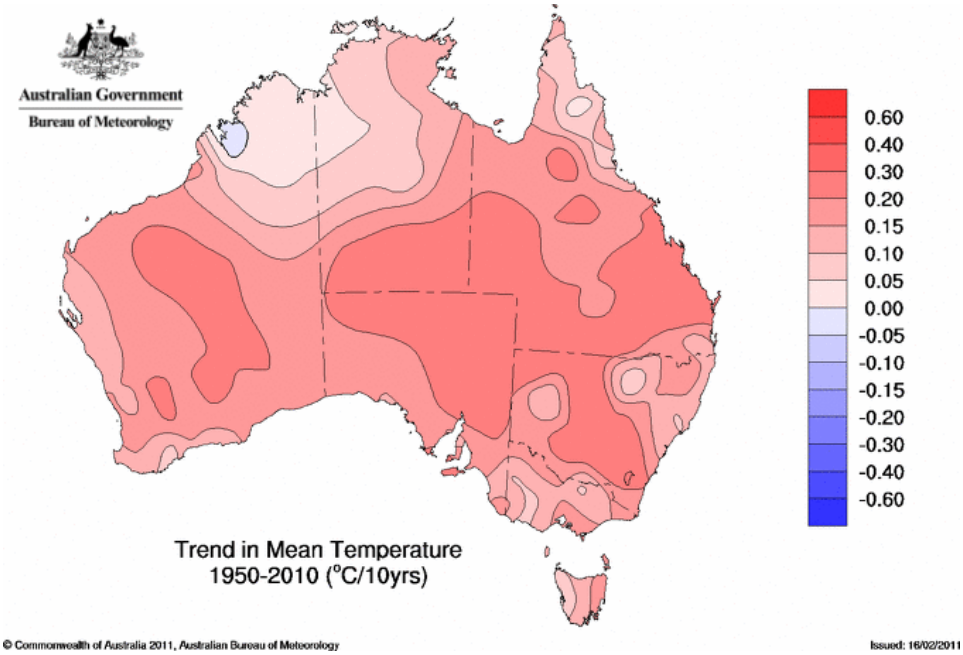


Figure 18: Trend in annual mean surface temperatures across Australia since 1950.
(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

Spatial variation is evident in this apparent warming trend, with maximum warming (exceeding 0.3°C per decade) observed since 1950 occurring in central-eastern Australia (refer to **Figure 18**), including mainland areas adjacent to Great Keppel Island.

Rainfall

Since 1950, a significant spatial trend in rainfall variation has been observed across Australia with the north west of the continent recording an increase in average annual rainfall, while eastern and south western Australia have recorded a decrease in average annual rainfall. The most significant drying has occurred along the east coast where a decrease of more than 50mm per decade has been observed. The same spatial pattern of increasing and decreasing average annual rainfall across the continent is also apparent in data recorded since 1900, however the magnitude of the decrease in average annual rainfall along the east coast is less significant at approximately 5-10mm per decade (refer **Figure 19**).

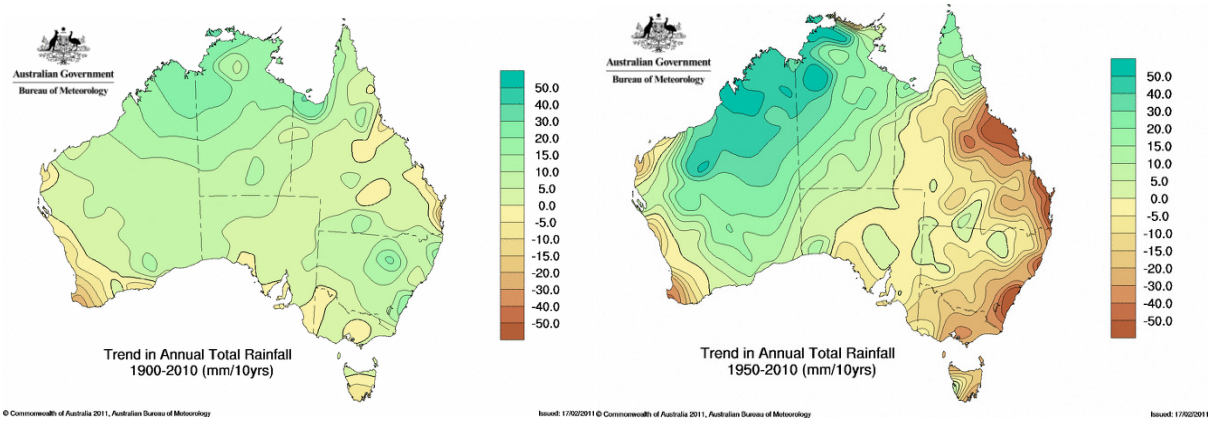


Figure 19: Trend in annual mean rainfall across Australia since 1900 and 1950.
(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

Sea Level

Sea level has fluctuated over the glacial-inter-glacial cycles of the last 140,000 years over a range of more than 120 metres (refer to **Figure 20**). During the last interglacial period, about 125 000 years ago, paleo data from corals indicates that sea level was 4 to 6 m (or more) above present day sea levels , with melting of the Northern Hemisphere ice sheets believed to have contributed 2.2 to 3.4 metres to the higher sea level (CSIRO, 2011).

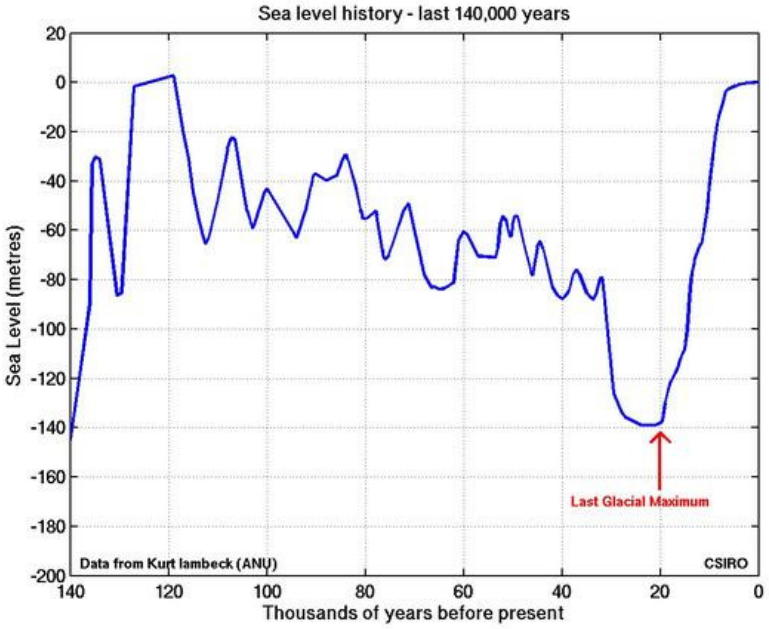


Figure 20: Fluctuation of global mean sea levels over last 140,000 years
(Source: CSIRO, 2011)

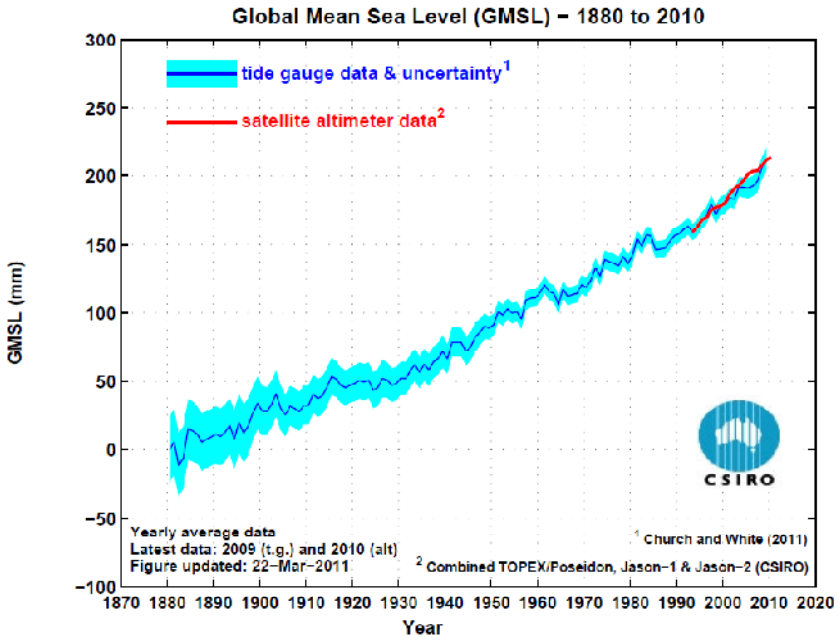


Figure 21: Increase in global mean sea level rise since 1880
(Source: CSIRO, 2011)

During the last ice age, sea level fell to more than 120 metres below present day sea level. From about 20,000 years ago until about 6000 years ago, ice sheets started melting and sea levels rose rapidly at rates ranging from about 10mm per year (1m per century) to 40mm per year (4m per century) (CSIRO, 2011). Sea levels have risen much more slowly over the past 7,000 years, with little net change in sea level from 2000 years ago until the start of the 19th century (CSIRO, 2011).

According to the most recent estimates by CSIRO (2011), global mean sea level has risen by approximately 0.2m since 1880 (refer to **Figure 21**).

Sea Surface Temperatures

Observational data collated by BoM, indicates a pattern of warming annual sea surface temperatures in waters surrounding Australia (refer **Figure 22**). However, there is some uncertainty as to whether this apparent warming of sea surface temperatures is related to greenhouse gas induced climate change or whether it is caused by natural variability that has resulted in a large number of El Nino events occurring since the 1970s (CSIRO and BoM, 2007).

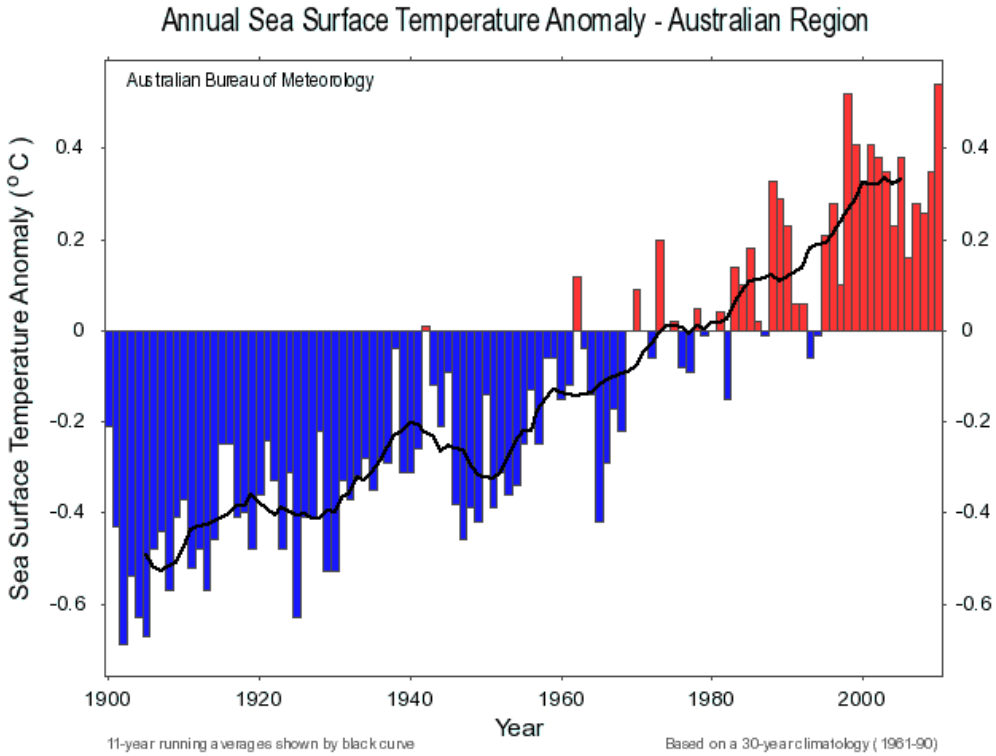


Figure 22: Annual mean sea surface temperatures for Australia taken as anomalies from a 30-year climatology 1961 to 1990 average. The black line represents an 11-year running mean.
(Source: Commonwealth of Australia 2011, Bureau of Meteorology)

3.2 PREDICTED CLIMATE CHANGE

3.2.1 Global Context

The IPCC's AR4, as with each previous major IPCC report, provides a range of forecast climate scenarios from several models based on a range of emission scenarios. The range of emissions scenarios explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting greenhouse gas emissions. The emissions scenarios are widely used in assessments of future climate change and are further described in the IPCC *Special Report on Emissions Scenarios* (IPCC, 2000) (refer to **Figure 23**). The IPCC report documents estimated future climate changes at a global scale based on modelling of these scenarios.

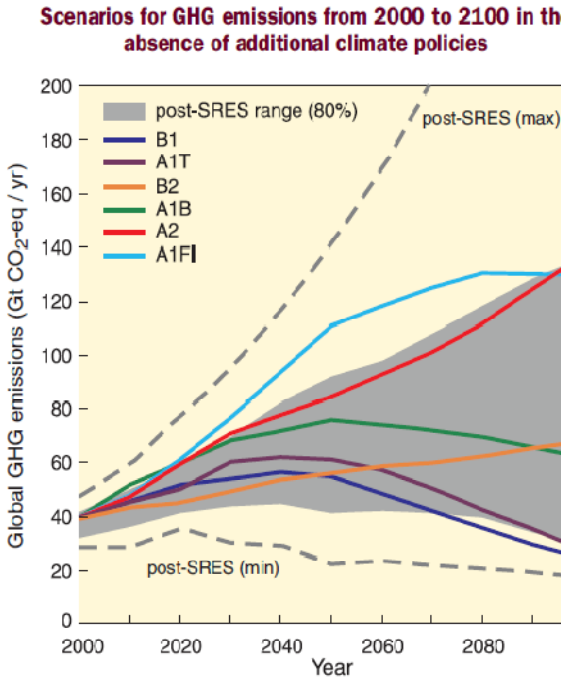


Figure 3.1. Global GHG emissions (in GtCO$_2$-eq per year) in the absei additional climate policies: six illustrative SRES marker scenarios (co lines) and 80th percentile range of recent scenarios published since (post-SRES) (gray shaded area). Dashed lines show the full range o SRES scenarios. The emissions include CO$_2$, CH$_4$, N$_2$O and F-gases. { 1.3, 3.2, Figure SPM.4}

Figure 23: Scenarios for GHG Emissions Presented in IPCC Report

Figure 24 presents model-based projections of global average sea level rise and temperature change up to the end of the 21st century as derived from the IPCC AR4. This includes a prediction that average global temperature will increase by between 1.8°C and 4.0°C by 2100. Over this same period, global sea levels are projected to rise by between 0.18 metres and 0.59 metres.

The projected sea level rise figures presented do not account for future rapid dynamical changes in ice sheet flows. If taken into account, using linear extrapolation of measured ice flow data from the melting of the Greenland and Antarctic ice sheets, it is expected the upper ranges of sea level rise would increase by 0.1 to 0.2 metres. For this reason, most reports based on data contained in the IPCC AR4 adopt an upper range for sea level rise based on the highest emissions scenario (A1F1) of 0.79 metres by 2100.

Table 3.1. Projected global average surface warming and sea level rise at the end of the 21st century. {WGI 10.5, 10.6, Table 10.7, Table SPM.3}

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) [a, d]		Sea level rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations[b]	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Notes:
a) These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity, and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs) as well as observational constraints.
b) Year 2000 constant composition is derived from AOGCMs only.
c) All scenarios above are six SRES marker scenarios. Approximate CO_2-eq concentrations corresponding to the computed radiative forcing due to anthropogenic GHGs and aerosols in 2100 (see p. 823 of the WGI TAR) for the SRES B1, AIT, B2, A1B, A2 and A1FI illustrative marker scenarios are about 600, 700, 800, 850, 1250 and 1550ppm, respectively.
d) Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899 add 0.5°C.

Figure 24: Projected Increases in Global Surface Temperature and Sea Levels
(Source: Table 3.1. Projected global average surface warming and sea level rise at the end of the 21st century in IPCC, 2007)

Best estimates for global temperature rise over the interim period, including projections for 2030, 2050 and 2070 are provided in **Figure 25**.

Table 4.3: Global warming estimates [and representative ranges] relative to 1990 for selected years and emission scenarios. (Based on IPCC 2007a Figure SPM-3 and Meehl *et al*. 2007).

	2030	2050	2070
B1	0.75 [0.45-1.2]	1.1 [0.66-1.76]	1.5 [0.9-2.4]
B2	0.9 [0.54-1.44]	1.29 [0.77-2.06]	1.8 [1.08-2.88]
A2	0.8 [0.48-1.28]	1.4 [0.84-2.24]	2.25 [1.35-3.6]
A1B	0.9 [0.54-1.44]	1.53 [0.92-2.45]	2.13 [1.28-3.41]
A1T	1.0 [0.6-1.6]	1.7 [1.0-2.72]	2.2 [1.32-3.52]
A1F1	0.87 [0.52-1.39]	1.8 [1.08-2.88]	2.9 [1.74-4.64]

Figure 25: Estimated Mean Surface Temperature Rise (°C) for 2030, 2050 and 2070 based on six SRES emissions scenarios
(Source: Table 4.3 in CSIRO and BoM, 2007)

3.2.2 Australian Context

The IPCC AR4 provides limited detail in terms of regional scale climate change projections. As such, the Australian Greenhouse Office, through the Australian Climate Change Science Programme, engaged CSIRO and the Bureau of Meteorology to develop regional climate change projections for Australia. These regional projections are based upon international climate change research, including conclusions from the IPCC's fourth assessment report as well as building on a large body of climate research that has been undertaken for the Australian region in recent years. Details of climate change projections for regions within Australia are contained in the *Climate Change in Australia Technical Report 2007* (CSIRO and BoM, 2007).

Table 3 presents a summary of predicted climatic changes derived from the *Climate Change in Australia Technical Report 2007* (CSIRO and BoM, 2007) for 2030, 2050 and 2070 for emissions scenarios B1 (Low) and A1F1 (High). Near-term changes projected to 2030 are subject to less uncertainty than longer term projections, because near-term changes in climate are strongly affected by inertia in the climate system due to past greenhouse emissions. In contrast, climate changes later in the century are subject to more uncertainty, as they are more dependent on the particular pattern of greenhouse emissions that occur through the century (ie. as represented by the different emissions scenarios) (CSIRO and BoM, 2007). However, in terms of planning for climate change adaptation, it is recognised that despite the uncertainty, consideration also needs to be given to longer term projections due to the expected life of built infrastructure and the relative permanency of land use planning decisions.

Table 3: Projected Changes in Key Climatic Variables based on B1 (Low) and A1F1 (High) Scenarios

Climate Variable	2030[1]	2050 (B1 Scenario)	2050 (A1F1Scenario)	2070 (B1 Scenario)	2070 (A1F1Scenario)
Temperature	Best Estimate = +1.0°C Range = +0.7 to +0.9°C	Best Estimate = +1.2°C Range +0.8 to +1.8°C	Best Estimate = +2.2°C Range = 1.5 to +2.8°C	Best Estimate = +1.8°C Range = +1.0 to +2.5°C	Best Estimate = +3.4°C Range +2.2 to +5.0°C
Rainfall	-10% to -5% (northern)	-15% to +7.5% (northern and eastern)	-20% to +10% (northern and eastern)	-20% to +10% (northern and eastern)	-30% to +20% (northern and eastern)
Solar Radiation	Best Estimate = +/-1% Range = -1% to +2%	Best Estimate = +/-1% Larger range	Best Estimate = +/-1% Larger range	Best Estimate = +/-1% Larger range	Best Estimate = +/-1% Larger range
Relative Humidity	Best Estimate = -1% Range = -2% to +5%	Best Estimate = -1% Larger range	Best Estimate = -1% Larger range	Best Estimate = -1% Larger range	Best Estimate = -1% Larger range
Potential Evaporation	Best Estimate = +2% Range = 0% to +6%	Only slightly stronger than 2030		Best Estimate = +6% Range +2% to +8% (northern and eastern)	Best Estimate = +10% Range +6% to +16% (northern and eastern)
Drought	Increased occurrence (up to 20% more drought months)	Increased occurrence		Increased occurrence (up to 40% more drought months)	Increased occurrence (up to 40% more drought months)
Average Wind Speed	Best Estimate = +2% to +5% Range = -2% to +7.5% (coastal)	Approx. -10%	Approx. +15%	Approx. -10%	Approx. +15%
Sea Level Rise[2]	Range = +7cm to +38cm	Range = +13cm to +68cm			
Tropical Cyclones		5% to 10% increase in intensity (5 to 10% decrease in central pressure). 1.3 degree southward migration of cyclone zone. 10% to 30% increase in rainfall associated with cyclone			

Climate Variable	2030[1]	2050 (B1 Scenario)	2050 (A1F1Scenario)	2070 (B1 Scenario)	2070 (A1F1Scenario)
Storm Surge		0.3m increase in storm surge level (excluding mean sea level rise)			
Sea Surface Temperature	Best Estimate = +0.3% to +0.6%			Range = +1.2% to +1.5%	Range = +2.2% to +2.5%

1. Limited sensitivity to emissions scenarios.
2. Derived from *Great Barrier Reef Tourism and Climate Change Strategy 2009-2012* (GBRMPA, 2009)

Since release of the *Climate Change in Australia Technical Report 2007,* CSIRO developed three scenarios for sea level rise (relative to 1990) for the Australian coastline for 2030, 2070 and 2100 based on the B1, A1F1 and High End scenarios contained in the IPCC AR4. These scenarios are presented in **Table 4** below:

Table 4: Sea Level Rise Scenarios for Australia's Coastline

Year	B1 Scenario	A1F1 Scenario	High End Scenario
2030	+0.132m	+0.146m	+0.200m
2070	+0.333m	+0.471m	+0.700m
2100	+0.496m	+0.819m	+1.100m

(Source: Table 2.1 Three sea-level rise scenarios, 2030-2100 (metres) in DCC, 2009)

A high end sea level rise projection of 1.1 metres by 2100 was adopted as the basis for assessments contained in the *Climate Change Risks to Australia's Coast: A first pass national assessment* (DCC, 2009) on the basis that although higher than the sea level rise of 0.79 metres by 2100 adopted by the IPCC AR4, the 1.1 metre projection takes into account post-AR4 analysis combining thermal expansion and potential rates of ice melt. However, sea level rise varies regionally due to various factors including topography, sediment type and coastal processes. In this regard, it is noted that the Queensland Government has chosen not to adopt this higher projected sea level rise on the basis that detailed modelling by CSIRO undertaken for the New South Wales Government did not find any regional variation for the Queensland coast and the IPCC AR4 projection was deemed appropriate for application to Queensland's coast (QCCCE, 2011).

3.2.3 Queensland Context

In 2010, the Queensland Government published *Climate Change in Queensland – What the Science is Telling Us* (DERM, 2010), which provided an update on the 2008 publication by the same name. In addition to providing an overview of basic climate science and expected global climate change, *Climate Change in Queensland – What the Science is Telling Us* (QCCCE, 2010) describes projected changes in temperature, rainfall and extreme events for various regions within Queensland, and an assessment of the outcomes and expected impacts of expected climate change on key sectors.

Table 1 of the Climate Change in Queensland Report contains a summary of climate projections and key impacts for 13 Queensland regions based on data derived largely from the *Climate Change in Australia Technical Report 2007* (CSIRO and BoM, 2007) and modelling undertaken by CSIRO on behalf of the Queensland Climate Change Centre for Excellence (QCCCE). The relevant data relating to projected temperature, rainfall and evaporation changes for Central Queensland region, which contains Great Keppel Island is presented in **Table 5,** in addition to a description of changes projected for other climatic variables as derived from the balance of the Climate Change in Queensland Report.

The High and Low scenarios are based on the B1 and A1FI Scenarios respectively as adopted by the IPCC.

Table 5: Summary of Projected Climatic Changes for Central Queensland Region

Climate Variable	Projected Change
Temperature	Baseline Mean = 21.6°C 2050 Projected Change to Mean: Low = +1.2°C High = +2.0°C Increase in 'exceptionally hot' years (years having a mean temperature in the highest 5% of long term mean annual temperature). Increased frequency of 'exceptionally hot' years from average of 1 every 22 years to 1 every 1.7 years by 2010-2040.
Rainfall	Baseline Mean = 692mm 2050 Projected Change to Mean: Low = -4% High = -7% Increased rainfall intensity, resulting in more rain on 'wet days' but fewer 'wet days'.
Evaporation	Baseline Mean = 1997 2050 Projected Change to Mean: Low = +4% High = +7%
Sea Level Rise	IPCC Global Sea Level Rise Projection = 0.79m by 2100 Localised East Coast QLD Sea Level Rise (2070) = 0.05m (Medium A1B Scenario) Total Projected Sea Level Rise (2070) = 0.84m
Drought	Increase in 'exceptionally hot' years (years having a mean temperature in the highest 5% of long term mean annual temperature). Increased frequency of 'exceptionally hot' years from average of 1 every 22 years to 1 every 1.7 years by 2010-2040. Increase in frequency of 'exceptionally low' soil moisture years. Increased in extent of Queensland affected by 'exceptionally low' soil moisture years.
Hot Days / Warm Nights	Increased number of 'hot days' (>35°C). Increased number of 'warm nights' and minimum temperature increases greater than mean temperature increases.
Extreme Rainfall	Increase in 2-hour, 24-hour and 72-hour extreme rainfall events (A2 Scenario projects 48% increase in 2-hour rainfall, 16% increase in 24-hour rainfall and 14% increase in 72-hour rainfall events in parts of South East Queensland by 2070) potentially resulting in more flooding.
Bushfire Hazard	Increased temperature, increase in number of hot days and less frequent rainfall events are likely to increase number of 'High' Forest Fire Danger Index days.

Climate Variable	Projected Change
Tropical Cyclones	Possible decrease or no change in tropical cyclone frequency. Possible increase in tropical cyclone intensity. Possible migration of tropical cyclone source area 120-200km to the south. Possible increase in rainfall associated with cyclones (within 100km of the eye).
Storm Surge	Height of storm surge likely to rise with rising mean sea level and changes in tropical cyclone behaviour. Projected increase in storm surge levels along coastline up to 0.35m by 2050 not taking into account projected sea level rise. Estimated level for mainland coastline adjacent to Great Keppel Island based on latitude is up to 0.2m storm surge increase (refer to Figure 21 of DERM, 2010)).

For the purpose of managing the effects of sea level rise on coastal development, the *Queensland Coastal Plan* (DERM, 2011) recently approved by the Queensland Government, adopts a sea level rise factor of 0.8 metres by 2100 based on the upper range of projections by the IPCC contained in the Fourth Assessment Report. The upper projection for sea level rise was adopted on the basis that greenhouse emissions, temperature and sea level as measured, is currently tracking above the IPCC projections. The longer term planning horizon of 2100 was adopted to reflect the longevity and relative permanence of most land use and development decisions.

3.2.4 Great Barrier Reef Context

The *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012* (GBRMPA, 2009) outlines the following projected changes in the climate for the Great Barrier Reef for 2020 and 2050:

Table 6: Projected Climate Changes for Great Barrier Reef

Projected Change	2020	2050
Air Temperature*	+0.6 to +1.4°C	+0.9 to +2.6°C
Sea Surface Temperature*	+0.5°C	+1.1 to +1.2°C
Sea Level Rise*	+7 to 38cm	+13 to + 68cm
Rainfall	• Reduction in total rainfall. • Increase in intensity of droughts. • Increase in intensity of high rainfall events.	
Tropical Cyclones	• Intensity of tropical cyclones expected to increase.	
*relative to 1961-1990 average.		

(Source: Table 1. Projected changes in climate for the Great Barrier Reef for 2020 and 2050 in GBRMPA, 2009)

Analysis undertaken by Water Technology for the GKI Revitalisation Project taking into account local conditions, has estimated the following storm tide recurrence intervals for various locations on GKI (refer **Table 7**).

TABLE 7: Predicted Storm Tide Recurrence Intervals for Great Keppel Island in 2100 Incorporating Projected Mean Sea Level Rise (+0.8m) and Increased Cyclone Intensity (+10%)

ARI	Yeppoon		Putney Beach		Fishermans Beach	
	2010 m AHD	2100 m AHD	2010 m AHD	2100 m AHD	2010 m AHD	2100 m AHD
50 year	2.75	3.74	2.32	3.34	2.37	3.39

ARI	Yeppoon		Putney Beach		Fishermans Beach	
	2010 m AHD	2100 m AHD	2010 m AHD	2100 m AHD	2010 m AHD	2100 m AHD
100 year	2.94	4.33	2.67	3.74	2.74	3.82
500 year	3.49	4.62	2.75	3.87	2.83	3.97

3.2.5 Summary

In determining climate change factors to be applied to risk assessments for the proposed Great Keppel Island Resort Revitalisation Project, priority has been given to the use of the most site specific and / or most recent data from the sources described above. On this basis, the following climate change factors have been adopted:

Table 8: Quantitative Climate Change Factors Applied to Risk Assessments

Climate Variable	2030	2050	2070	2100
Mean Sea Level	+0.2m[1]	+0.4m[2]	+0.7m[1]	+0.8m[3]
Mean Surface Temperature	+1.4°C[5]	+2.0°C[4]	+3.4°C[6]	+4.0[7]
Mean Rainfall	-5%[6]	-7%[4]	-9%[6]	--
Rainfall Intensity	--	--	2-hour event: +48% 24-hour: +16% 72-hour event: +14%	--
Solar Radiation	+1%[8]	+1%[8]	+1%[8]	--
Relative Humidity	-1%[8]	-1%[8]	1%[8]	--
Potential Evaporation	+2%[8]	+7%[4]	+10%[6]	--
Average Wind Speed	+7.5%[6]	+15%[6]	+15%[6]	--
Storm Surge (Q100)		+0.3m (excluding mean sea level rise)[8]	--	--
Mean Sea Surface Temperature	+0.5°C[5]	+1.2°C[5]	--	--

Source:

1. 'Table 2.1 Three sea-level rise scenarios, 2030-2100 (metres)' in *Climate Change Risks to Australia's Coast: A First Pass National Assessment*, Department of Climate Change, 2009.
2. 'Table 1. Project changes in climate for the Great Barrier Reef for 2020 and 2050' in *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012*, Great Barrier Reef Marine Park Authority, 2009 within projected range of +0.13 to +0.68 assumes consistent 0.1m increase per decade between 2030 and 2070.
3. *Queensland Coastal Plan*, Department of Environment and Resource Management, 2011.
4. 'Table 1. Summary of climate projections for 2050 and key impacts for 13 Queensland regions' in *Climate Change in Queensland: What the Science is Telling Us*, Queensland Climate Change Centre for Excellence, Department of Environment and Resource Management, 2010 based on High Emissions (A1F1) Scenario for Central Queensland region.
5. 'Table 1. Project changes in climate for the Great Barrier Reef for 2020 and 2050' in *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012*, Great Barrier Reef Marine Park Authority, 2009 at upper limit of projected range.
6. *Climate Change in Australia: Technical Report 2007*, CSIRO and BoM, 2007 based on High Emissions (A1F1) Scenario.

7. *Fourth Assessment Report*, Intergovernmental Panel on Climate Change, 2007 based on best estimate for High Emissions (A1F1) Scenario.
8. *Climate Change in Australia: Technical Report 2007*, CSIRO and BoM, 2007 based on Best Estimate across all emissions scenarios.

Assessment of potential construction impacts should focus on projected changes for 2030, given the anticipated 12-year construction period.

Assessment of potential impacts on operation of the resort, should consider longer term projections, with risks related to built infrastructure being assessed in relation to the projections for 2100 (where available) or 2070.

4. CLIMATE CHANGE IMPACTS AND MITIGATION

Predicted changes in a range of climatic variables as described in Section 3.2, have the potential to significantly impact, directly and indirectly, upon the Project during both construction and operation phases.

A risk assessment of potential climate change impacts for each phase of the Project has been undertaken and is described in the following sections, along with proposed mitigation measures to address each identified risk. A standard risk assessment matrix as presented in **Table 9** has been used for the purpose of assessing climate changes risks associated with this Project.

TABLE 9: Risk Assessment Matrix

Probability	Consequences				
	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Catastrophic
(1) Rare	(1) Low	(2) Low	(3) Low	(4) Low	(5) Medium
(2) Unlikely	(2) Low	(4) Low	(6) Medium	(8) Medium	(10) Medium
(3) Moderate	(3) Low	(6) Medium	(9) Medium	(12) High	(15) High
(4) Likely	(4) Low	(8) Medium	(12) High	(16) High	(20) Extreme
(5) Almost Certain	(5) Medium	(10) Medium	(15) High	(20) Extreme	(25) Extreme

4.1 CONSTRUCTION PHASE

A summary of potential impacts and proposed mitigation for the construction phase is provided in **Table 10** below. Construction of the resort and associated facilities will be undertaken in stages, with the first stage comprising the hotel, marina facility and internal infrastructure (ie. roads, water, sewerage, electricity) expected to take approximately 18 months to complete.

Completion of the overall GKI Revitalisation Plan is expected to take 12 years or until approximately 2023. As such, in terms of considering the potential climate change impacts on the construction phase, the projected climate change factors for 2030 summarised in **Table 8**, are considered most relevant.

TABLE 10: Summary of Potential Climate Change Impacts and Proposed Mitigation for Construction Phase

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
Increase in cyclone intensity, including increase in extreme daily rainfall, maximum wind velocity and storm surge.	Increased risk to safety of construction staff on the Island during severe cyclonic events.	High	Med	Construction works during the cyclone season shall be minimised where practical. Evacuation plans shall be developed to ensure all construction staff can be safely evacuated in the event of a severe cyclone. The requirements of the evacuation plan and procedures for communicating advice on cyclone threats will be presented during staff inductions. No buildings or other structures shall be constructed within the erosion prone area unless foundations are designed to withstand potential erosion of sandy substrate. Buildings shall be designed in accordance with relevant building codes for Central Queensland, allowing for projected increases in wind speed. Stormwater diversion systems shall be designed to prevent inundation of work sites and erosion and sediment control measures shall be designed to remain effective during more intense rainfall events. A 20% buffer shall be applied to maximum design flows to allow for a possible 16% increase in the intensity of a 24-hour rain event projected for 2070. Construction of the marina
	Direct damage to built infrastructure and construction materials, and possible inundation of construction sites through storm surge and more intense rainfall.	High	Med	
	Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity.	Med	Low	
	Increased shoreline erosion resulting from wave action and storm surge, creating difficulties for barge access etc prior to construction of marina facility.	Med	Med	
	Possible delays to construction where severe cyclones force evacuation of Island.	Med	Low	

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
				shall occur in Stage 1. This will establish a permanent barge access for the Island that does not need beach access. The barge access will be designed to incorporate nominated sea level rises. Until completion of the permanent barge access, the barge access will be the same as the current situation, which requires access across the beach. Access across the beach will not be significantly affected by the small sea level rise that may occur prior to completion of the permanent barge access in Stage 1.
Increase in rainfall intensity.	Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity.	Med	Low	Stormwater diversion systems shall be designed to prevent inundation of work sites and erosion and sediment control measures shall be designed to remain effective during more intense rainfall events. A 20% buffer shall be applied to maximum design flows to allow for a possible 16% increase in the intensity of a 24-hour rain event projected for 2070.
	Increased potential for inundation of construction sites as more intense rainfall exceeds capacity of stormwater diversion systems.	High	Low	
Decreased average rainfall and higher probability of drought periods.	Increased potential for dust generation and erosion as grass coverage more difficult to establish and maintain.	Low	Low	Construction works shall be staged to minimise the extent of ground surface exposed at any one time. Sufficient water supply shall be available during construction to undertake dust suppression as required, preferably sourced from recycled water supplies.
Increased average	Increased bushfire hazard resulting in increased risk to	High	Low	Prior to construction works commencing on the Island, a

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
temperature.	built infrastructure and public safety.			bushfire management plan shall be prepared in accordance with *State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood*. This shall include identification of adequate water supply sources for fire fighting purposes.
Increased average evaporation.	Increased bushfire hazard resulting in increased risk to built infrastructure and public safety.	High	Low	Prior to construction works commencing on the Island, a bushfire management plan shall be prepared in accordance with *State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood*. This shall include identification of adequate water supply sources for fire fighting purposes. Construction works shall be staged to minimise the extent of ground surface exposed at any one time. Sufficient water supply shall be available during construction to undertake dust suppression as required, preferably sourced from recycled water supplies.
	Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain.	Low	Low	
Increased mean sea levels.	Projected sea level rise by 2030 of +0.2m may create difficulties for barge access etc prior to construction of marina facility.	Low	Low	Construction of the marina shall occur in Stage 1. This will establish a permanent barge access for the Island that does not need beach access. The barge access will be designed to incorporate nominated sea level rises. Until completion of the permanent barge access, the barge access will be the same as the current

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
				situation, which requires access across the beach. Access across the beach will not be significantly affected by the small sea level rise that may occur prior to completion of the permanent barge access in Stage 1.
Increased concentration of CO_2 in oceanic waters.	Nil	N/A	N/A	N/A

4.2 OPERATIONAL PHASE

A summary of potential impacts and proposed mitigation for the operational phase is provided in **Table 11** below. Construction of the overall GKI Revitalisation Plan is expected to be completed by approximately 2030. Built infrastructure associated with the Project will be designed for a minimum 50-year design life. As such, in terms of considering the potential climate change impacts on the operational phase, the projected climate change factors for 2100 summarised in **Table 8** above, are considered most relevant.

TABLE 11: Summary of Potential Climate Change Impacts and Proposed Mitigation for Operational Phase

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
Increase in cyclone intensity, including increase in extreme daily rainfall, maximum wind velocity and storm surge.	Increased risk to safety of visitors and staff on the Island during severe cyclonic events.	High	Med	Evacuation plans shall be developed to ensure all staff and visitors can be safely evacuated in the event of a severe cyclone. The requirements of the evacuation plan and procedures for communicating advice on cyclone threats will be presented to all staff during inductions and information provided to guests on arrival. No buildings or other structures shall be constructed within the erosion prone area unless foundations are designed to withstand potential erosion of
	Direct damage to built infrastructure.	High	Med	
	Increased shoreline erosion resulting from wave action and storm surge resulting in accessibility and amenity issues.	Med	Med	
	Increased potential for erosion and sediment control measures to become ineffective as rainfall intensity exceeds design capacity.	Med	Low	

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	Increased potential for flooding as more intense rainfall events exceed the design capacity of stormwater drainage infrastructure.	High	Low	sandy substrate. Buildings shall be designed in accordance with relevant building codes for Central Queensland, allowing for projected increases in wind speed and cyclone intensity. Building pad levels shall be located above 3.74m AHD at Putney Beach and 3.82m AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise. Stormwater infrastructure shall be designed with an increased capacity sized to account for projected increases in rainfall intensity, including 48% increase for 2-hour event, 16% increase for 24-hour and 14% increase for 72-hour event. Open recycled water storages shall be designed with an increased capacity sized to account for projected increases in rainfall intensity, including 48% increase for 2-hour event, 16% increase for 24-hour and 14% increase for 72-hour event.
	Increase potential for overflow of recycled water storage facilities as more intense rainfall events exceed design capacity resulting in potential impacts on water quality.	High	Low	
	Increased physical damage to coral reef ecosystems resulting in impacts on biodiversity and declining tourist numbers.	High	High	
Increase in rainfall intensity.	Increased potential for flooding as more intense rainfall events exceed the design capacity of stormwater drainage infrastructure.	High	Low	As above. Ensure activities are undertaken in a manner that maintains or enhances the health of the reef to create greater resilience to mainland flooding and other severe weather events (eg. severe cyclones) including: • Minimising physical damage to reefs through control of moorings, boat traffic,
	Increase potential for overflow of recycled water storage facilities as more intense rainfall events exceed design capacity.	High	Low	

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	Potential for mainland flooding and associated discharge of sediment / nutrient laden runoff to impact on coral reef ecosystems resulting in impacts on biodiversity and declining tourist numbers.	High	Med	scuba diving and snorkelling activities, and • Preventing decline in reef water quality by ensuring all stormwater and recycled water that directly or indirectly discharged to natural waters is appropriately treated.
Decreased average rainfall and higher probability of drought periods.	Decreased reliability of rainfall dependent water supplies (eg. rainwater tanks, groundwater bore supplies).	High	Low	A sustainable water supply strategy shall be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island. Rainwater storages shall be sized to maximise capture during increasingly intense rainfall events. Use of recycled water for irrigation shall be maximised. A bushfire management plan shall be prepared for the GKI Resort Revitalisation Plan in consultation with local fire services authorities and in accordance with *State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood*.
	Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain.	Low	Low	
	Increased demand for irrigation water supplies for maintenance of golf course and landscaped areas.	Med	Low	
	Increased bushfire hazard resulting in increased risk to built infrastructure and public safety.	High	Low	
Increased average temperature.	Increased bushfire hazard resulting in increased risk to built infrastructure and public safety.	High	Low	A bushfire management plan shall be prepared for the GKI Resort Revitalisation Plan in consultation with local fire services authorities and in accordance with *State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood*.
	Increase in demand for air-conditioning and subsequent increase in energy consumption.	Med	Low	

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	A potential increase in water demand as a result of higher temperatures and evaporation resulting in increased pressure on water supplies.	Med	Low	The bushfire management plan shall include provision for access for fire-fighting equipment and evacuation of visitors and staff, firebreaks to protect buildings and critical infrastructure, and adequate water supply sources for fire fighting purposes. The marina shall include a berth and associated facilities as required by emergency services. A sustainable water supply strategy shall be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island. Rainwater storages shall be sized to maximise capture during increasingly intense rainfall events. Design principles shall be incorporated into all buildings within the GKI Resort Revitalisation Plan to maximise natural ventilation and solar access, to reduce demand for air conditioning, including use of appropriate building materials and site aspect, and retention of native vegetation for shading.
	Changes in temperatures may result in migration of certain tropical and temperate terrestrial and marine species southward, and increased coral bleaching (DCC, 2009).	High	Med	
	Increased geographical spread of diseases such as malaria, dengue fever etc due to more favourable conditions for vectors.	High	Med	
	Increased heat-related illness in humans.	High	Med	
Increased average evaporation.	Increased bushfire hazard resulting in increased risk to built infrastructure and public safety.	High	Low	A bushfire management plan shall be prepared for the GKI Resort Revitalisation Plan in consultation with local fire

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	Increase potential for dust generation and erosion as grass coverage more difficult to establish and maintain.	Low	Low	services authorities and in accordance with *State Planning Policy 1/03: Mitigating the Adverse Impacts of Bushfire, Landslide and Flood*.
	Increased demand for irrigation water supplies for maintenance of golf course and landscaped areas.	Med	Low	Use of open storages for water supplies (other than recycled water storage) should be minimised to reduce exposure to evaporation. A sustainable water supply strategy shall be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island. Stormwater harvesting infrastructure, including rainwater tanks, shall be designed with a capacity to maximise collection of rainwater to offset increased evaporation rates.
Increased mean sea levels.	A sea level rise +0.8m is projected by 2100. Potential damage to built infrastructure due to increased shoreline erosion. Rising sea levels, combined with changes in the frequency and magnitude of extreme weather events, are likely to cause soft shorelines to recede (DCCandEE, 2010) particularly if the frequency of such events increases resulting in insufficient time for natural coastal replenishment processes to replace eroded	Extreme	Med	Only buildings and structures with foundations designed to withstand erosion of sandy substrate shall be constructed within erosion prone areas, including potential erosion prone areas associated with projected sea level rise. An assessment of storm surge risks has accounted for projected sea level rise and increased cyclonic intensity. Building pad levels shall be located above 3.74m AHD at Putney Beach and 3.82m AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	sediments.			level rise. Design of essential coastal infrastructure (eg. marina, public access infrastructure) within the coastal hazard zone shall be designed to adapt to a 0.8m sea level rise by 2100.
	Increased risk of saline intrusion into aquifers impacting on quality of groundwater supplies.			A sustainable water supply strategy shall be adopted. This will include installation of rainwater tanks, use of recycled water for irrigation and potentially toilet flushing, as well as installing a water supply connection to the mainland to provide greater water security for the Island. Although potable groundwater reserves exist on the Island, use of groundwater to provide water supply to the resort is not proposed. As such, the resort will not place any increased pressure on groundwater reserves ensuring greater resilience to possible saline intrusion resulting from sea level rise.
	Potential impacts on various ecosystems resulting in possible declines in biodiversity and tourist numbers. For example: • Possible loss of habitats in near-shore environments such as beaches, mangroves, saltmarshes and sea grass beds as a result of shoreline erosion; • Possible loss of coastal freshwater wetlands due to salinisation of and	Extreme	Med	It is anticipated that the Research Centre will undertake regular monitoring of water quality and reef ecosystem health, as well as undertaking specific research projects aimed at improving understanding and protection of the reef. In addition, it is anticipated that monitoring undertaken as part of GKI Revitalisation Plan will include: • Monitoring of water quality in estuarine and coastal waters; • Monitoring of inter-tidal and riparian vegetation; and

Climate Change Factor	Potential Impacts	Risk Level (Unmitigated)	Risk Level (Mitigated)	Proposed Mitigation
	inundation of low-lying areas (DCCandEE, 2010).			• Monitoring of releases to water from irrigation / discharges of recycled water and stormwater.
Increased concentration of CO^2 in oceanic waters.	Decreased health of coral reef ecosystems impacting on biodiversity and possibly resulting in decline in tourist numbers. For example: • Possible decrease in coral growth and coral reef maintenance due to increased acidification of sea water resulting from increased dissolved CO_2, which reduces the availability of carbonate ions that many marine organisms use to build solid carbonate shells and skeletons (DCC, 2009). • Possible impacts on respiration of fish and larval development through changed solubility of nutrients and toxins (DCC, 2009).	Extreme	Med	It is anticipated that the Research Centre will undertake regular monitoring of water quality and reef ecosystem health, as well as undertaking specific research projects aimed at improving understanding and protection of the reef. In addition, it is anticipated that monitoring undertaken as part of GKI Revitalisation Plan will include: • Monitoring of water quality in estuarine and coastal waters; • Monitoring of inter-tidal and riparian vegetation; and Monitoring of releases to water from irrigation / discharges of recycled water and stormwater.

5. GREAT BARRIER REEF TOURISM CLIMATE CHANGE ACTION STRATEGY

Given the potential for climate change to impact on the operation of the resort, the proponent has identified a moral and economic need to implement measures to minimise the carbon footprint of the Resort, to increase awareness of staff and visitors about the risks of climate change and where practical, implement other measures to contribute to reducing the impacts of global climate change.

This is consistent with the objectives of the *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012* (GBRMPA, 2009), which was developed to provide the tourism industry with a strategy to improve reef health and the viability of the marine tourism industry, recognising that the future health of the Great Barrier Reef and the sustainability of the tourism industry are inextricably linked and both are vulnerable to climate change.

As such, the proposed GKI Resort Revitalisation Plan has been assessed against the objectives and strategies outlined in the *Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012*.

Table 12: Response to Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012

Objectives and Strategies	Project Response
Objective 1: Raise Awareness about climate change impacts to the Great Barrier Reef.	
Strategy 1.1. Raise the awareness of Reef marine tourism operators about climate change	All staff and associated tourism operators will be provided with climate change awareness training as part of their induction, including a requirement to demonstrate commitment to GKI's sustainability policies and advice on how staff and tourism operators can contribute to reducing the carbon footprint of their activities.
Strategy 1.2. Raise the awareness of visitors	A range of information will be provided to visitors to increase their awareness of the potential impacts of climate change on the natural ecosystems they've come to see and experience, as well as advice on how visitors can reduce their contribution to the resort's carbon footprint during their stay. This may range from information presented during guided tours to signage around the resort advising guests on opportunities to conserve energy during their stay.
Strategy 1.3. Raise the awareness of government agencies and tourism industry partners	GKI Resort Pty Ltd will seek to actively participate in tourism industry forums and other opportunities to achieve the objectives of the Great Barrier Reef Tourism Climate Change Strategy, including participating in the Tourism Climate Change Action Group.
Objective 2: Reduce carbon footprints	
Strategy 2.1. Audit and reduce operational greenhouse gas emissions	The Project will be designed to be "carbon positive" in terms of electricity consumption. This will be achieved by incorporating solar panels into the resort, which will generate sufficient energy to meet the needs of the resort and ancillary activities, while returning excess energy to the mainland electricity grid. Design principles for the GKI Resort Revitalisation Plan will ensure buildings are designed to maximise natural ventilation, solar access, and incorporate energy efficient lighting and appliances to reduce demand for non-renewable

Objectives and Strategies	Project Response
	energy resources. Where appropriate, Green Star building design standards shall be adopted.
Strategy 2.2. Offset emissions	In addition to generating more than enough energy to meet the electricity needs of the resort and ancillary activities, all vegetation cleared for construction of the Project will be offset by planting endemic vegetation species in areas selected to improve ecological corridors and habitat values. Offset planting will aim to minimise any loss in the carbon sequestration capacity of Island vegetation as a result of clearing for the GKI Resort Revitalisation Plan. Consideration may also be given to establishing a carbon offset option for visitors to the Island that could be voluntarily applied to the cost of the ferry transfer.
Objective 3: Support climate change monitoring, reporting and research	
Strategy 3.1. Support research that fosters understanding of climate change and its impacts	As part of the GKI Revitalisation Plan, the proponent plans to establish a research centre, which will provide the first dedicated research facility within the Keppel Island Group. The research centre will be designed and managed by Central Queensland University, and will provide a facility where researchers can undertake their work and students can obtain a hands-on educational experience. The GKI research centre will be funded through a Biodiversity Fund developed by the proponent to ensure sufficient financial resources are available to fund research and education initiatives at the Centre in the long term. The Biodiversity Fund will be comprised of a portion of the GKI Resort Pty Ltd's profit as operating capital for the facility. Visitors will be able to donate additional funds, while a range of other tourism business activities are also envisaged to contribute to funding research and educational activities at the Centre.
Strategy 3.2. Support Reef monitoring and reporting programs	It is anticipated that the Research Centre will undertake regular monitoring of water quality and reef ecosystem health, as well as undertaking specific research projects aimed at improving understanding and protection of the reef. In addition, it is anticipated that monitoring undertaken as part of GKI Revitalisation Plan will include: • Monitoring of water quality in estuarine and coastal waters; • Monitoring of inter-tidal and riparian vegetation; and • Monitoring of releases to water from irrigation / discharges of recycled water and stormwater.
Objective 4: Improve the resilience of the Great Barrier Reef	
Strategy 4.1. Minimise physical impacts to the Reef	Construction of the marina will provide a dedicated mooring place for vessels accessing GKI. This is expected to reduce the potential damage to reefs that may be caused by the current moorings of boats all around the Island.
Strategy 4.2. Minimise negative	Stormwater runoff from potentially contaminated areas will be treated prior to

Objectives and Strategies	Project Response
impacts to water quality from daily operations or construction activities	release to receiving waters. For example, grassed swales and bio-retention basins will be used for treatment of stormwater runoff from the golf course to reduce nutrient and sediment loads. Irrigation of recycled water on the golf course and other landscaped areas of the resort will be managed to prevent excessive leaching of nutrients to groundwater and surface waters, including treatment to reduce nutrient levels in sewage effluent and scheduling irrigation to minimise deep drainage and runoff. Erosion and sediment control plans will be developed and implemented for all construction phases of the Project.
Objective 5: Integrate climate change into business operations and planning	
Strategy 5.1. Plan for declining reef conditions and changing climate	Although the natural wonders of the Great Barrier Reef are undoubtedly the primary attraction to tourists visiting GKI, by providing a range of non-reef based activities such as the golf course, water sports, day spa, interpretive historical and natural island walks, etc, GKI Resort Pty Ltd is seeking to provide some resilience in the business to the potential impacts of climate change.
Strategy 5.2. Develop business strategies to mitigate the impacts of climate change	Business planning will consider the potential impacts of climate change in terms of ensuring built infrastructure is designed and located to withstand or adapt to predicted climatic change. Appropriate plans will be developed to ensure that staff and visitors can be safely and efficiently evacuated from the resort and villas in the event of severe tropical cyclones. Business plans will consider the potential loss of revenue resulting from declines in tourist numbers following severe weather events that impact on reef attractions (eg. severe cyclones, flooding).
Strategy 5.3. Maintain industry viability	Establishment of the research centre, being the first based within the Keppel Island Group, will support researchers in their studies of the impacts of climate change and other threats to the Great Barrier Reef. This research will inform actions to be implemented to protect the coral reef and island ecosystems, which provide the foundation to tourism industry viability.
Strategy 5.4. Develop environmental management and engineering strategies	Design principles for the GKI Resort Revitalisation Plan will incorporate allowances for reasonably predicted climate change factors based on current research as described in this Report. This includes allowance for: • Increased cyclonic intensity (eg. increased maximum wind speeds, storm surge, wave action); • Increased sea levels in design and placement of built infrastructure; and • Allowance for increased rainfall intensity, decreased average rainfall and increased evaporation in design of water cycle infrastructure.

Objectives and Strategies	Project Response
Objective 6: Influence and facilitate change	
Strategy 6.1. Establish incentives to facilitate change	GKI Resort Pty Ltd will establish a research centre and Biodiversity Fund to support research initiatives to improve understanding and protection of the Great Barrier Reef.
Strategy 6.2. Foster industry capacity to implement change	GKI Resort Pty Ltd will seek to actively participate in tourism industry forums and other opportunities to achieve the objectives of the Great Barrier Reef Tourism Climate Change Strategy, including participating in the Tourism Climate Change Action Group.

6. CONCLUSION

The Great Keppel Island Revitalisation Plan will be designed and constructed to both mitigate the adverse impacts of predicted climate change while also minimising the Project's contribution to global greenhouse gas emissions:

Key climatic changes likely to impact on the GKI Resort Revitalisation Plan have been identified as:

- Decreased total rainfall;
- Increased rainfall intensity;
- Increased intensity of tropical cyclones, including:
    - Increased maximum wind speeds;
    - Increased storm surge etc;
- Increased evaporation;
- Increased temperatures; and
- Increase sea levels.

These factors will be incorporated into the design of the GKI Resort Revitalisation Plan to ensure built infrastructure is either located to avoid these impacts, is able to adapt to or is resilient to these climatic changes. This includes:

- Ensuring buildings are designed to latest design standards which have allowed for projected increases in wind speeds and cyclonic intensity;

- Ensuring built infrastructure is located above projected storm surge levels accounting for sea level rise (eg. building pad levels shall be located above 3.74m AHD at Putney Beach and 3.82m AHD at Fisherman's Beach, which comprises the projected Q100 storm surge level for 2100 accounting for projected sea level rise);

- Ensuring stormwater and wastewater infrastructure is designed for maximum flows accounting for increased rainfall intensity; and

- Ensuring sustainable water supplies will be available despite a decrease in average rainfall and increased average evaporation rates.

To minimise the carbon footprint of the GKI Resort Revitalisation Plan, the following measures will be implemented:

- Primary electricity supply shall be derived from solar photovoltaic cells installed on the roof tops of villas, with only supplementary and emergency electricity sourced from standby diesel generators and mainland electricity cable connection. Sufficient solar panels shall be installed to meet the energy demands of the GKI Resort Revitalisation Plan plus 5% with excess energy generated to be returned to the mainland grid via submarine cable;

- Buildings shall be designed to minimise energy consumption for heating and cooling by maximising use of natural ventilation and solar access; and

- Proposed buildings and infrastructure shall be located to minimise the clearing of native vegetation. As part of the GKI Resort Revitalisation Plan, planting of vegetation will occur to offset losses in biodiversity and carbon sequestration capacity.

Aspects of the Great Barrier Reef Tourism Climate Action Plan have also been incorporated into the proposed GKI Resort Revitalisation Plan to reduce the ecological footprint and maintain the resilience of the surrounding ecosystems of the Island to climate change, including:

- Establishment of a research centre within the Keppel Island Group;

- Funding of the research centre and associated research and educational activities through establishment of a Biodiversity Fund comprised of a portion of GKI Resort Pty Ltd's profit and visitor donations; and

- Conducting regular monitoring of water quality and the condition of coral reefs and coastal ecosystems.

7. REFERENCES

Bureau of Meteorology (BoM) (2011a). Climatic Statistics for Australian Sites. Available at: http://www.bom.gov.au/climate/averages/tables/ca_qld_names.shtml. Accessed: 21 April 2011.

Bureau of Meteorology (BoM) (2011b). Tropical Cyclones in Queensland. Available at: http://www.bom.gov.au/cyclone/about/eastern.shtml. Accessed: 21 April 2011.

Church, J. A. and White, N.J. (2006). *A 20th Century Acceleration in Global Sea Level Rise*. Geophysical Research Letters, vol. 33, pp. L01602.

CSIRO (2011). *Sea Level Rise: Understanding the past: Improving projections for the future*. Available at: http://www.cmar.csiro.au/sealevel/. Accessed: 21 April 2011.

CSIRO and BOM (2007). *Climate Change in Australia – Technical Report 2007*. CSIRO, Bureau of Meteorology and the Australian Greenhouse Office in partnership with the Australian Climate Change Science Program, Canberra. Available at www.climatechangeinaustralia.gov.au/technical_report.php . Accessed: 21 April 2011.

Department of Environment and Resource Management (DERM) (2011). *Queensland Coastal Plan*, Queensland Government, Brisbane.

Department of Climate Change and Energy Efficiency (2010). *Developing a National Coastal Adaptation Agenda: A Report on the National Climate Change Forum*, Commonwealth of Australia, Canberra.

Department of Climate Change and Energy Efficiency (2009). *Climate Change Risks to Australia's Coast: A first pass assessment*, Commonwealth of Australia, Canberra.

Department of Sustainability, Environment, Water, Population and Communities and Great Barrier Reef Marine Park Authority (2011). *Guidelines for an Environmental Impact Statement for the Great Keppel Island Tourism and Marina Development, Queensland* (February, 2011), Commonwealth of Australia, Canberra.

Foresight Partners Pty Ltd (2011). *Forecast Economic Impacts – Proposed Revitalisation of Great Keppel Island*, Foresight Partners Pty Ltd, Brisbane.

Great Barrier Marine Park Authority (2009). *Great Barrier Reef Tourism and Climate Change Action Strategy 2009-2012*, Commonwealth of Australia, Canberra.

Intergovernmental Panel on Climate Change (IPCC) (1990). *Climate Change: The Intergovernmental Panel on Climate Change Scientific Assessment*. J.T. Houghton, G.J. Jenkins, and J.J. Ephraums (eds.). Cambridge University Press, Cambridge, 365 pp.

Intergovernmental Panel on Climate Change (IPCC) (1996). *Climate Change 1995: The Science of Climate Change. Contribution of the Working Group I to the Second Assessment Report of the*

Intergovernmental Panel on Climate Change. J.T. Houghton, et al. (eds.). Cambridge University Press, Cambridge, 572 pp.

Intergovernmental Panel on Climate Change (IPCC) (2000). *Emissions Scenarios. Special Report of the Intergovernmental Panel on Climate Change*. Nakicenovic, N., and R. Swart, (eds). Cambridge University Press, UK. 570 pp.

Intergovernmental Panel on Climate Change (IPCC) (2001). *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Watson, R.T. and the Core Writing Team (eds.). Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Intergovernmental Panel on Climate Change (IPCC) (2007a). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Pachauri, R.K., Resinger, A. (Eds.). IPCC, Geneva, Switzerland.

Intergovernmental Panel on Climate Change (IPCC) (2007b). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller (Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 996 pp.

Queensland Climate Change Centre for Excellence (QCCCE) (2010) *Climate Change in Queensland – What the Science is Telling Us,* Department of Environment and Resource Management, Queensland Government, Brisbane.

Queensland Climate Change Centre for Excellence (QCCCE) (2011). *Queensland Coastal Processes and Climate Change*, Department of Environment and Resource Management, Queensland Government, Brisbane.

Queensland Coordinator General (2011). *Great Keppel Island Resort Project – Terms of Reference for the Environmental Impact Statement June 2011*. Department of Employment, Economic Development and Innovation, Queensland Government, Brisbane.

APPENDIX A

GKI Revitalisation Plan

GREAT KEPPEL ISLAND RESORT ~ REVITALISATION PLAN

REVITALISATION PLAN 2011

PROJECT #: 093024

08 JULY 2011

GREG NORMAN GOLF COURSE DESIGN

WATG

APPENDIX B

Wind Rose Diagrams

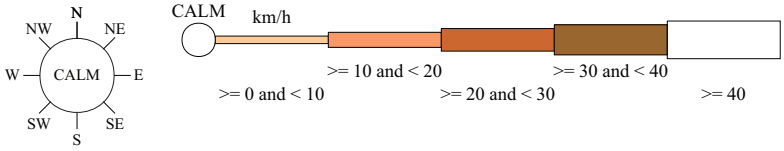
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 28 Feb 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

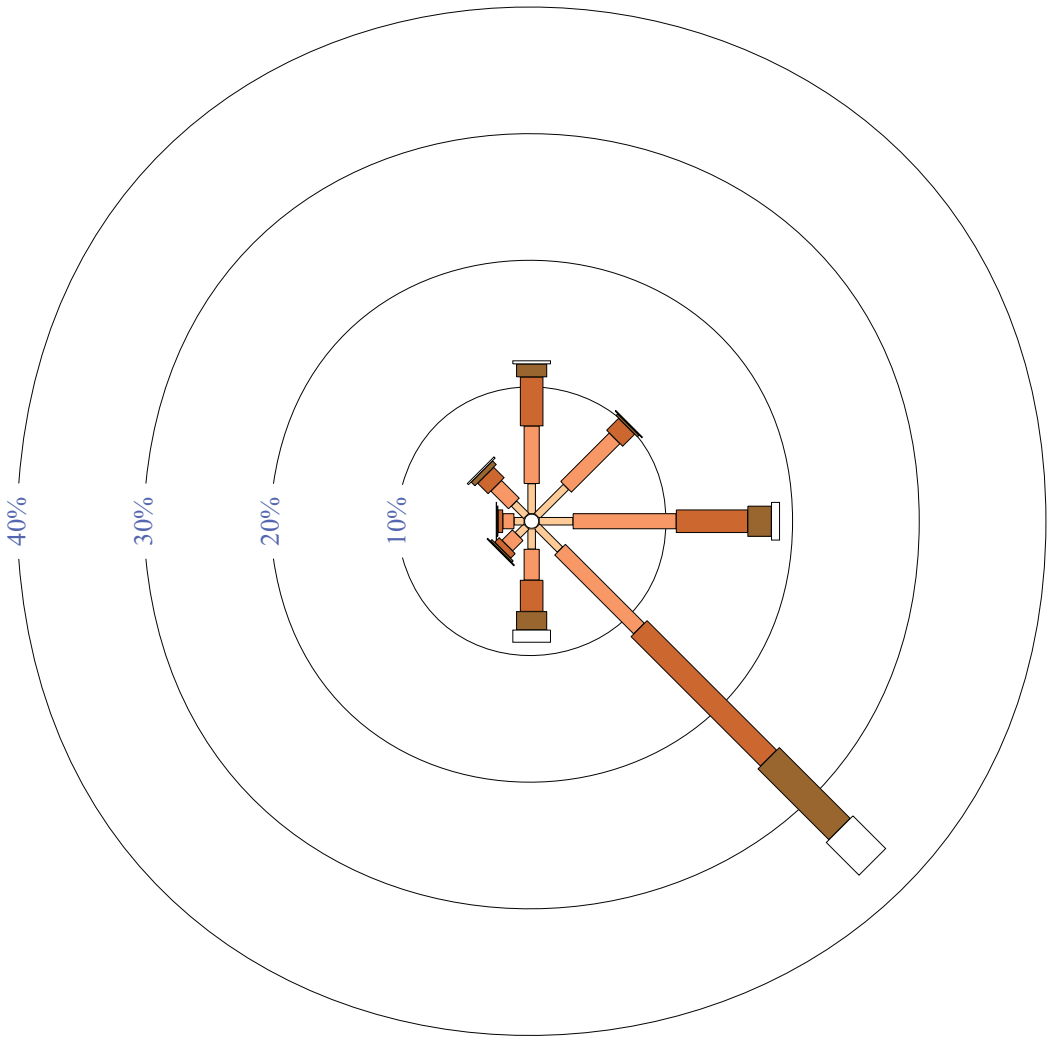
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
10105 Total Observations

Calm 3%



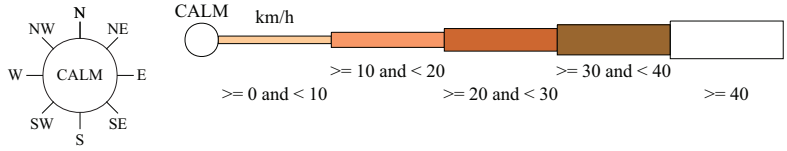
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

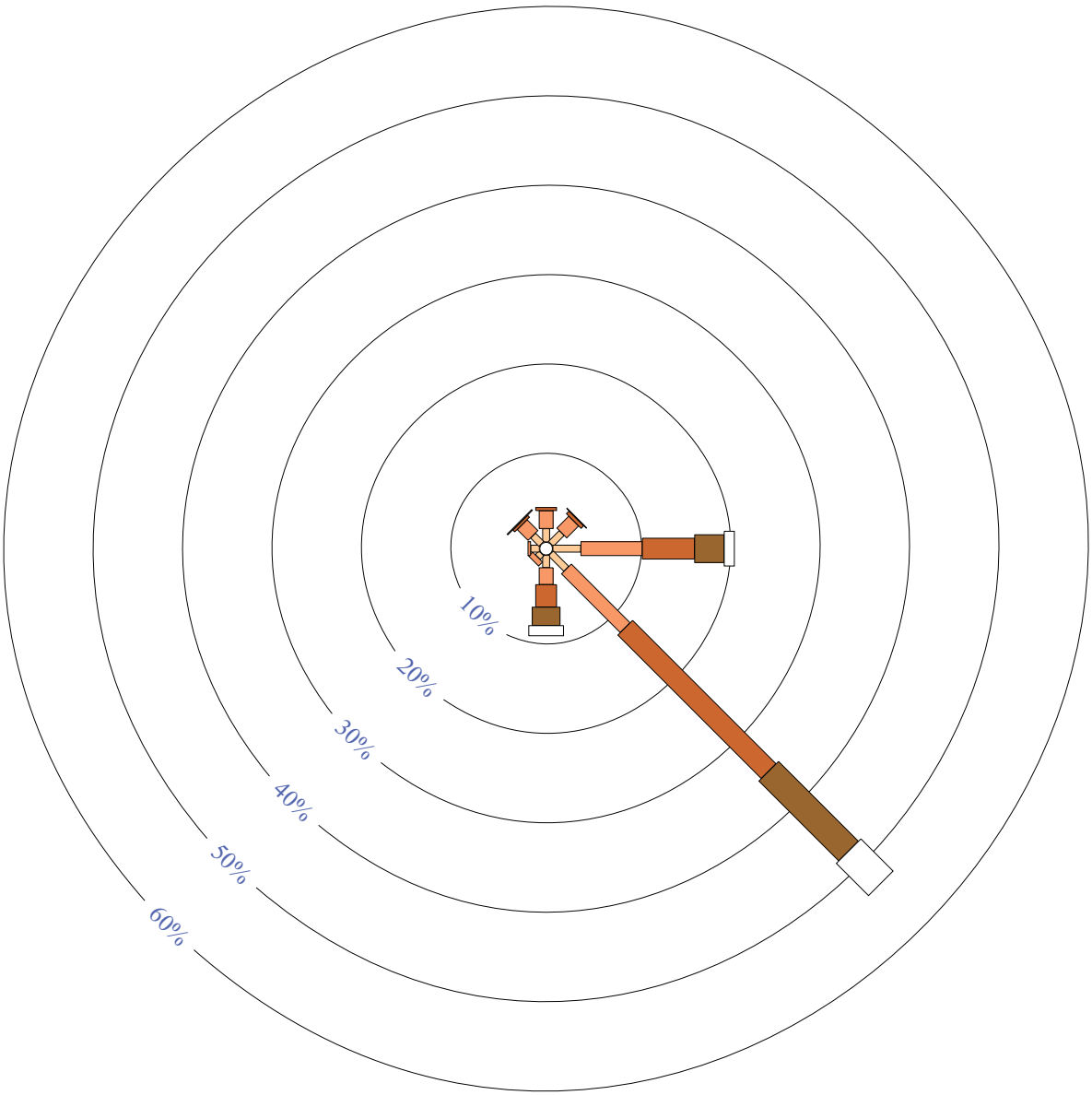
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Apr
869 Total Observations

Calm 4%



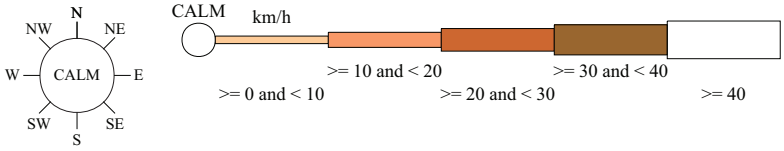
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

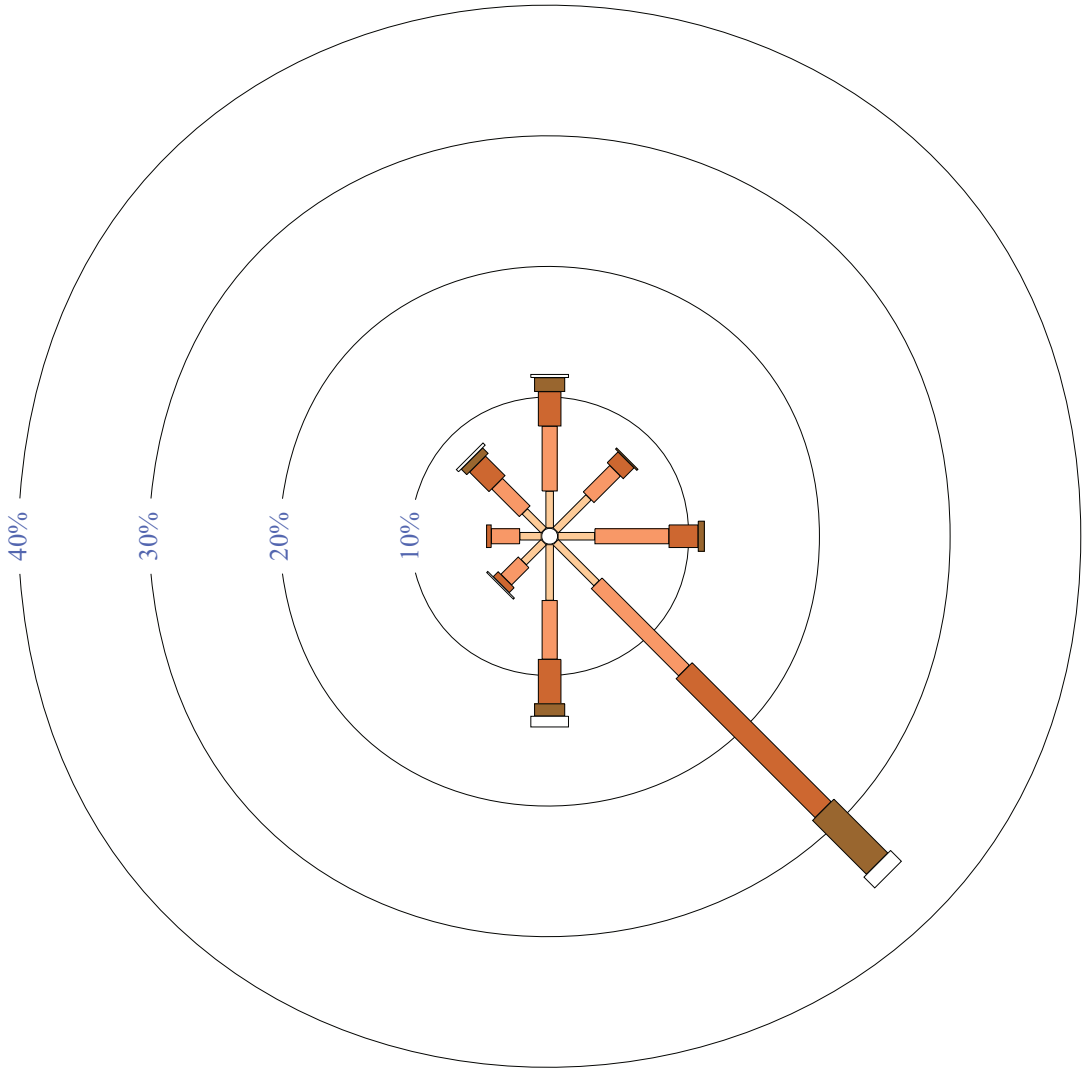
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Aug
858 Total Observations

Calm 3%



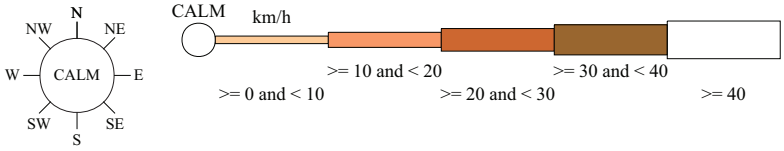
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

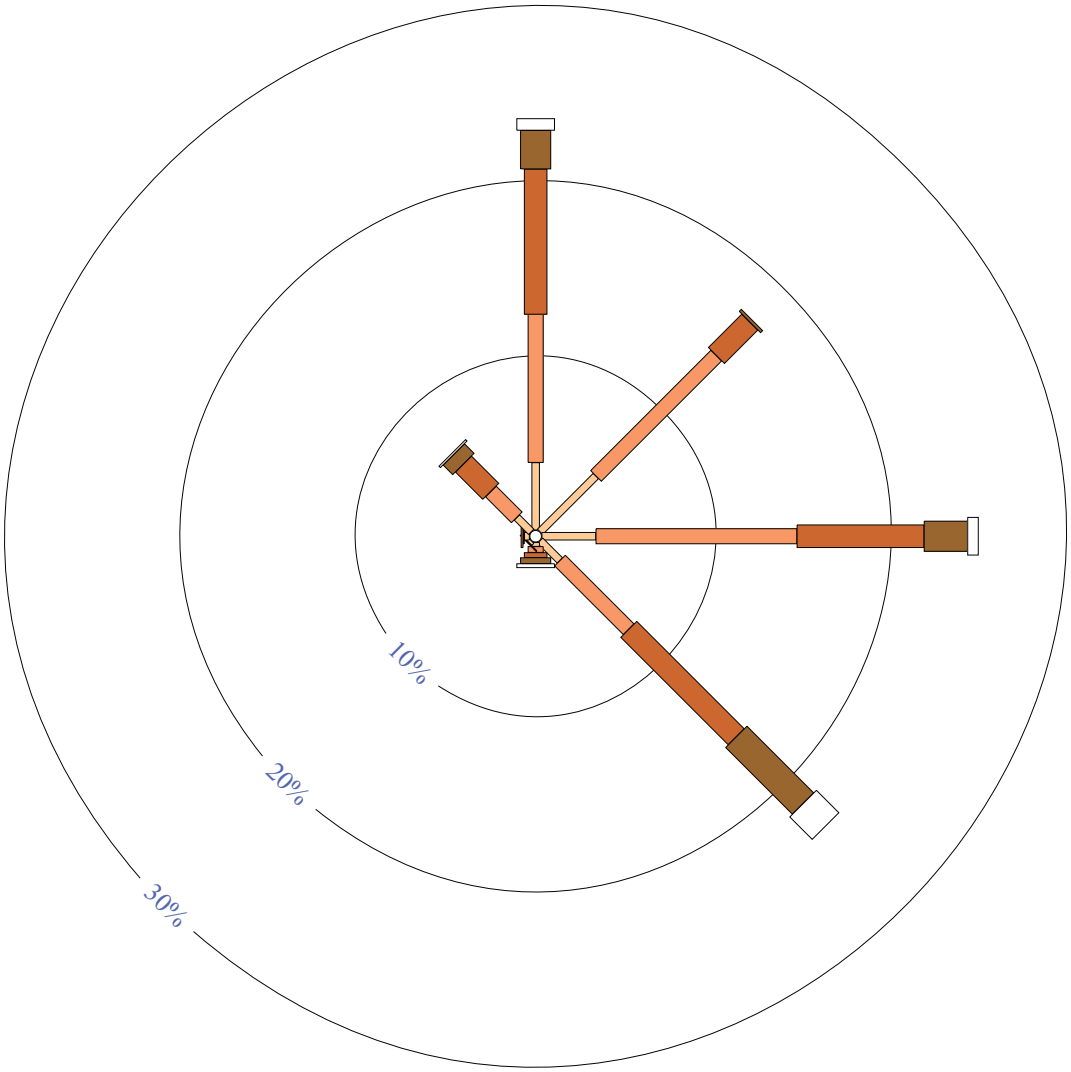
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Dec
896 Total Observations

Calm 2%



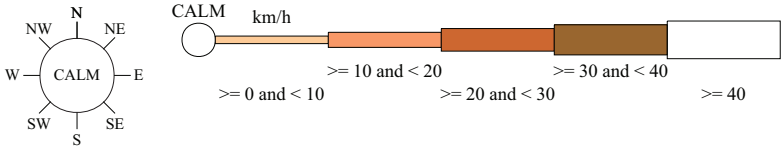
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

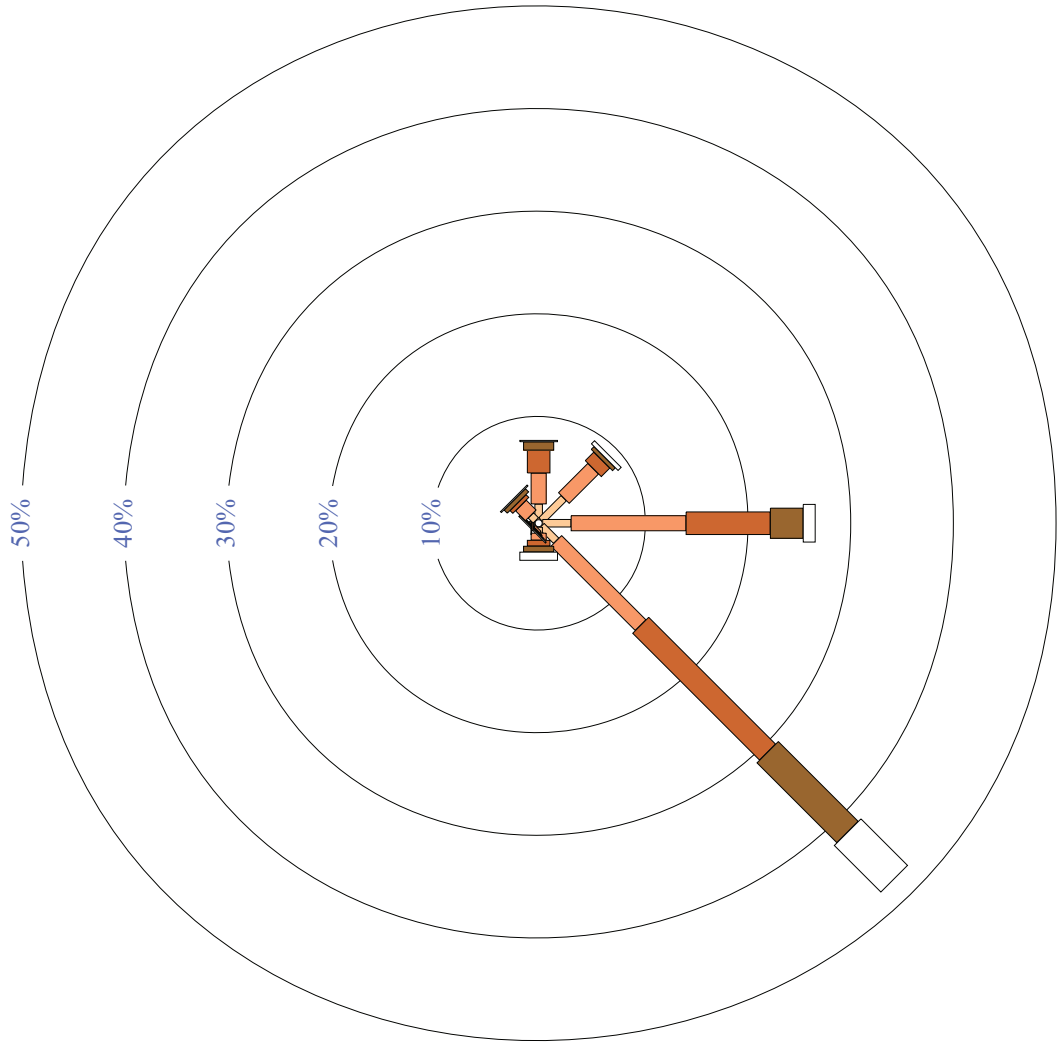
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Feb
819 Total Observations

Calm 2%



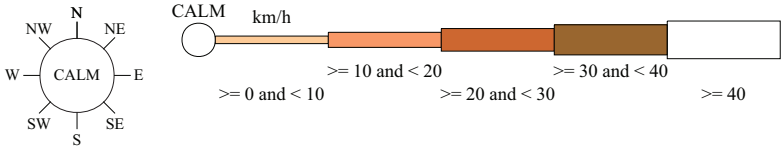
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

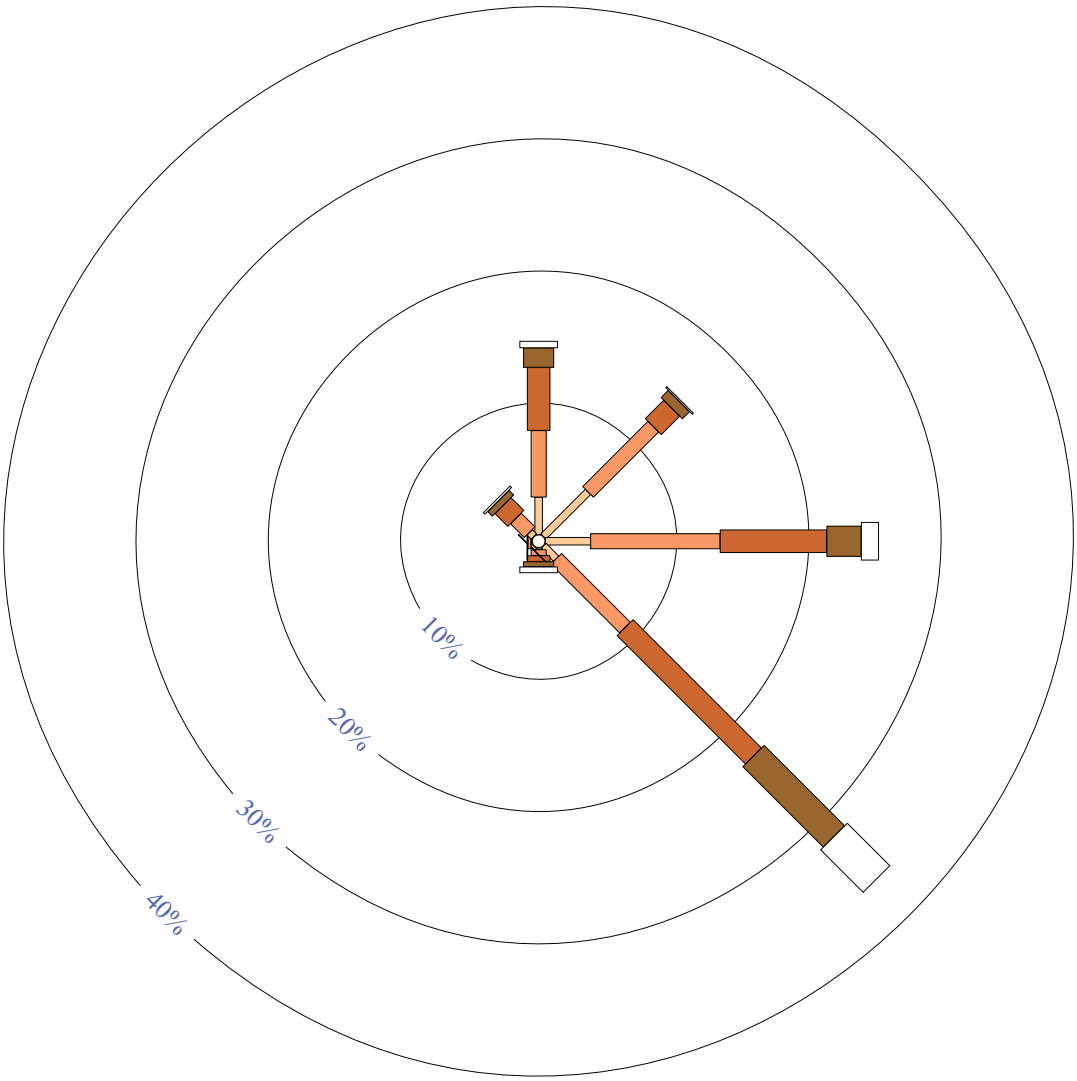
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jan
910 Total Observations

Calm 2%



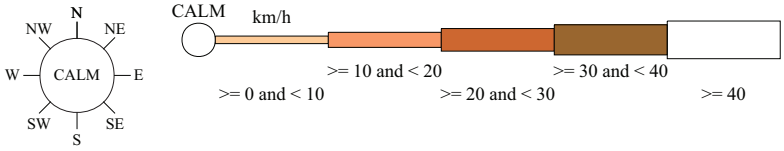
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

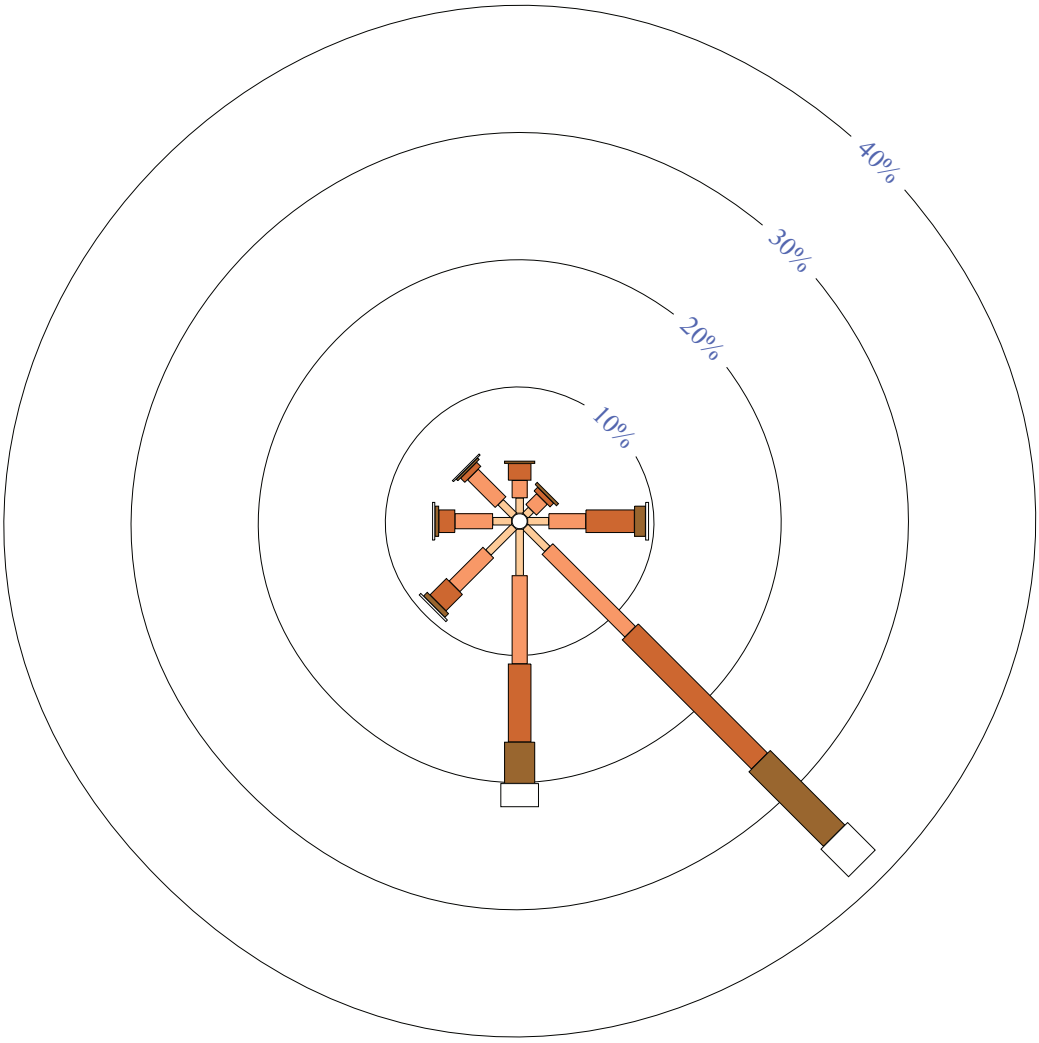
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jul
866 Total Observations

Calm 3%



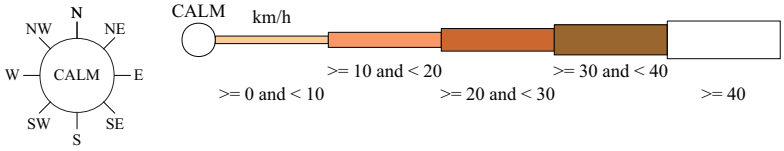
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

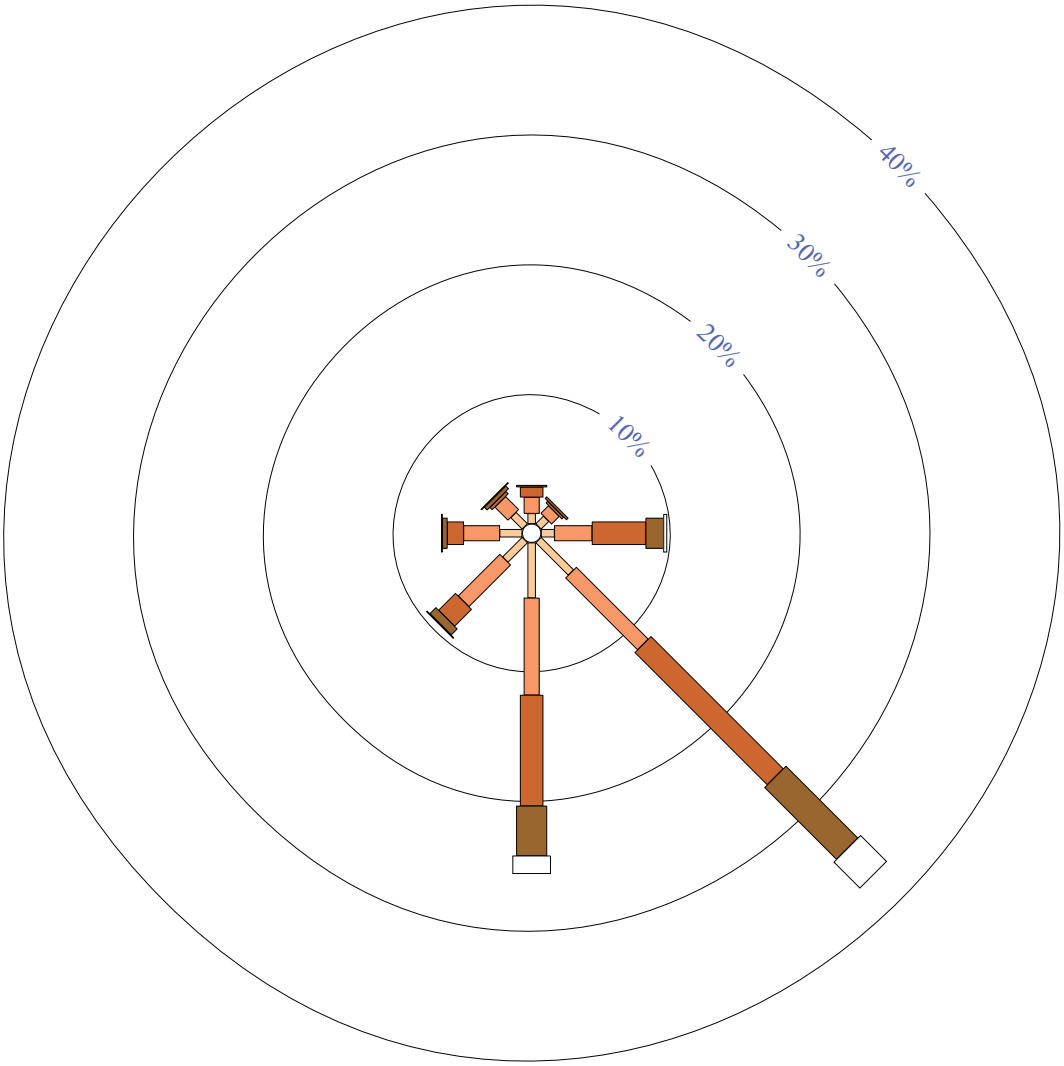
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jun
836 Total Observations

Calm 4%



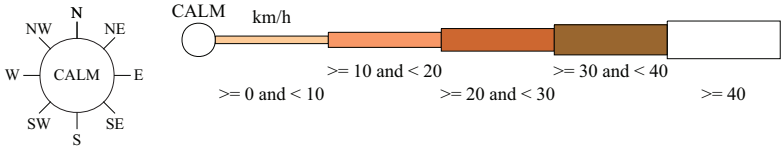
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

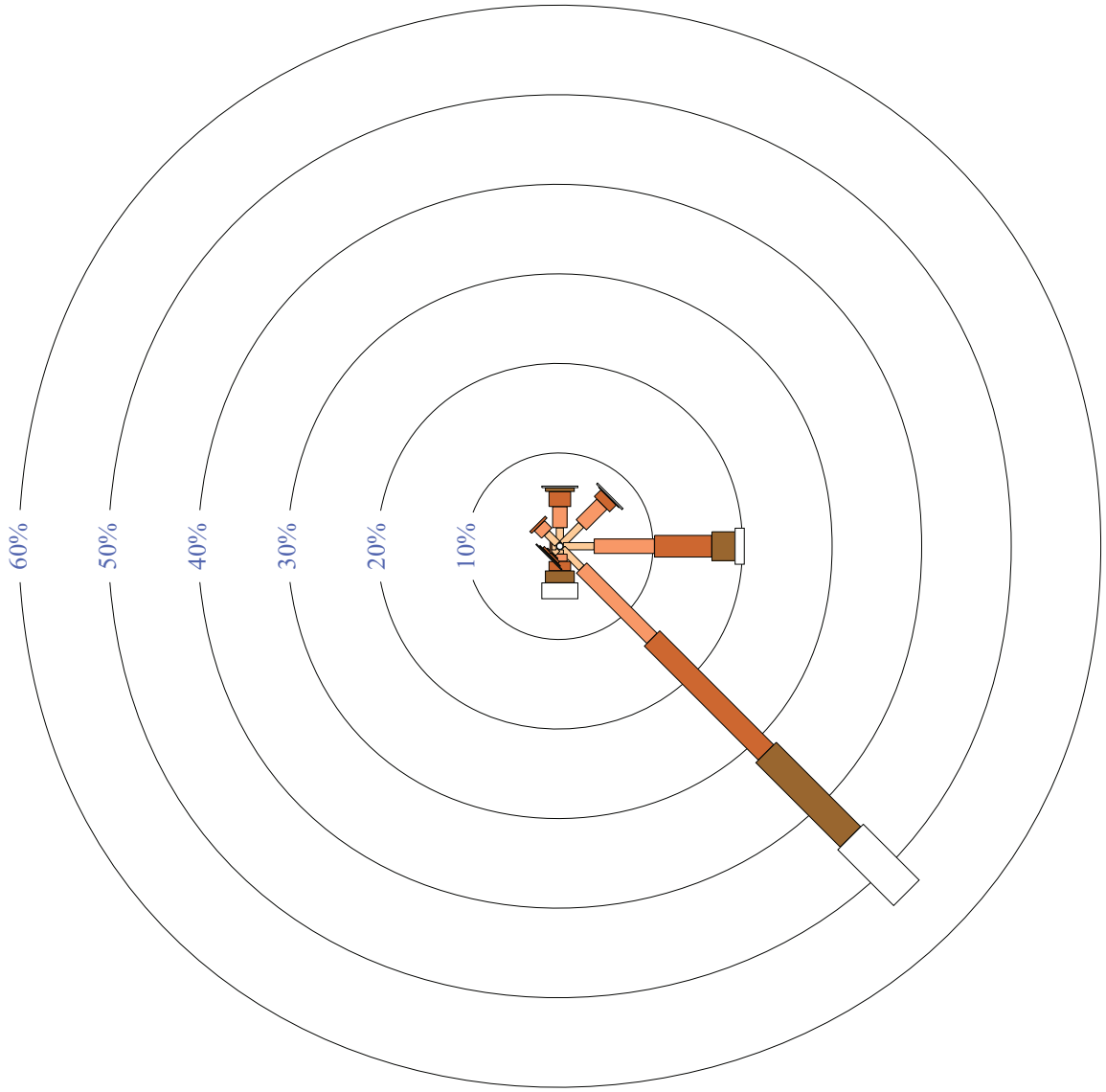
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Mar
879 Total Observations

Calm 2%



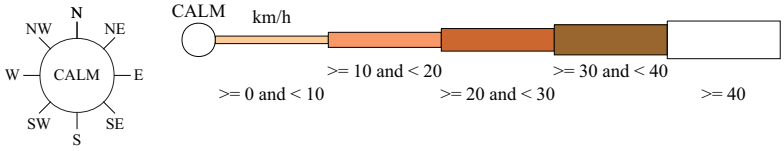
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

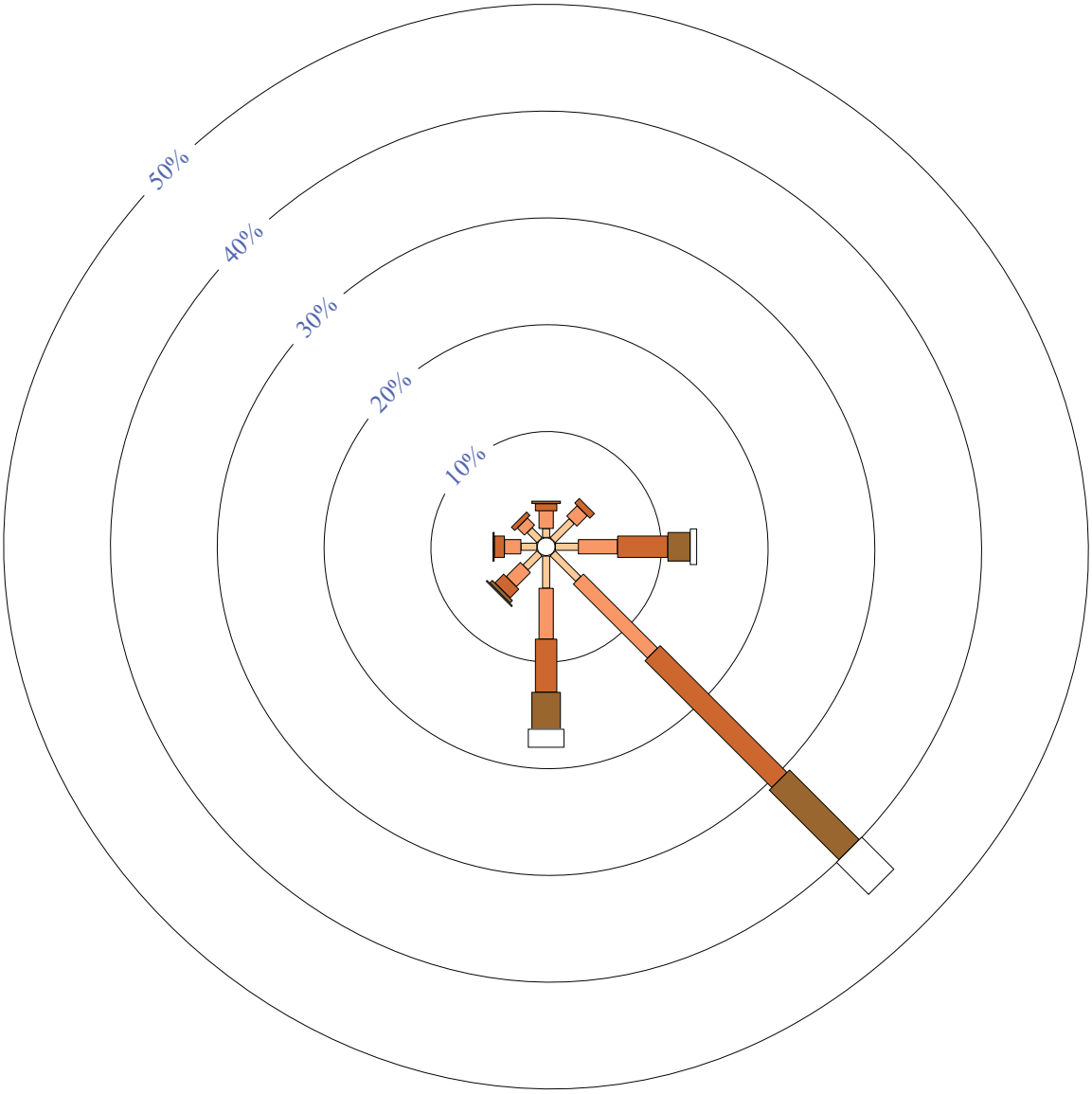
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm May
902 Total Observations

Calm 4%



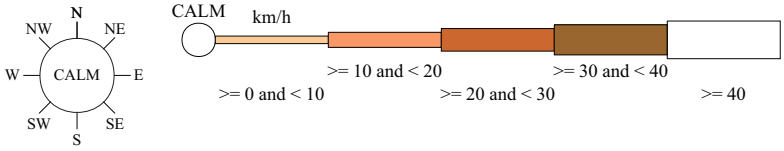
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

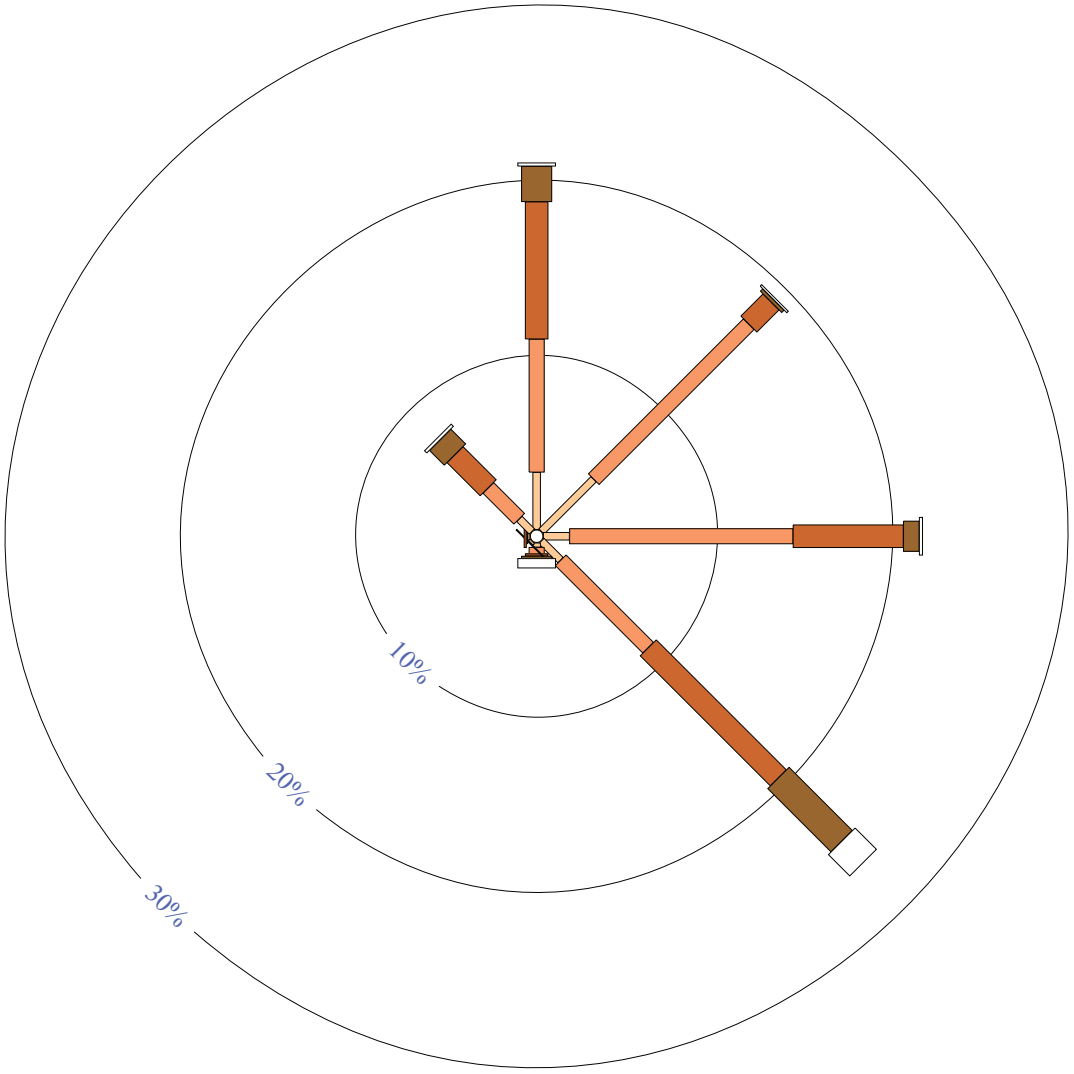
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Nov
829 Total Observations

Calm 2%



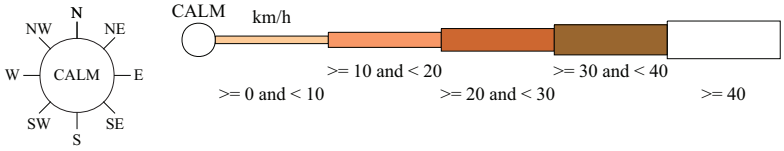
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

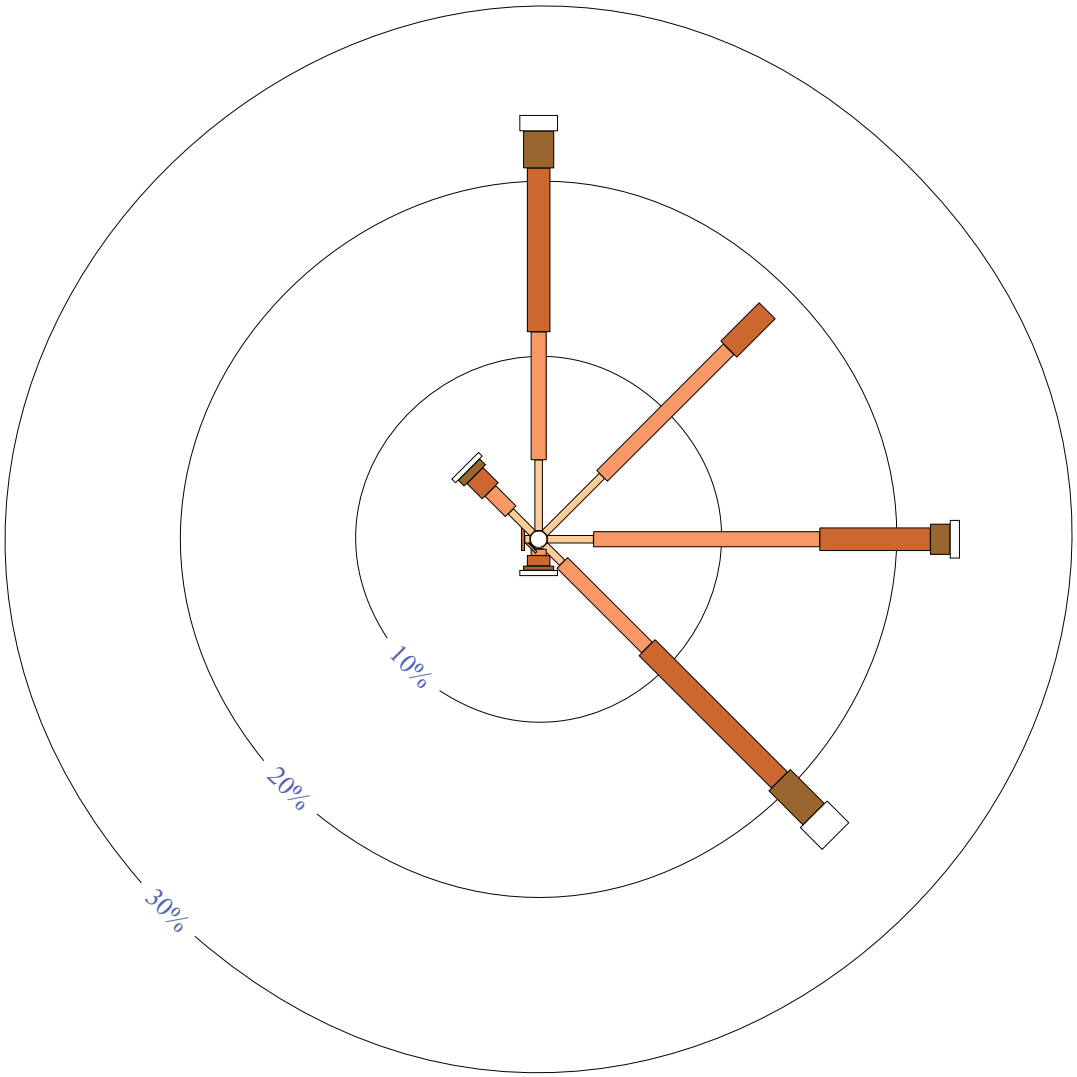
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Oct
842 Total Observations

Calm 2%



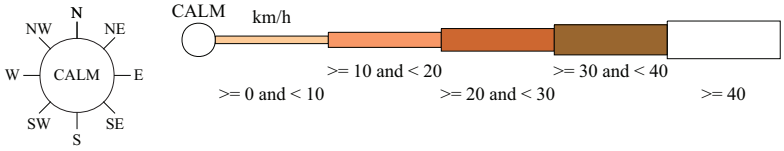
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

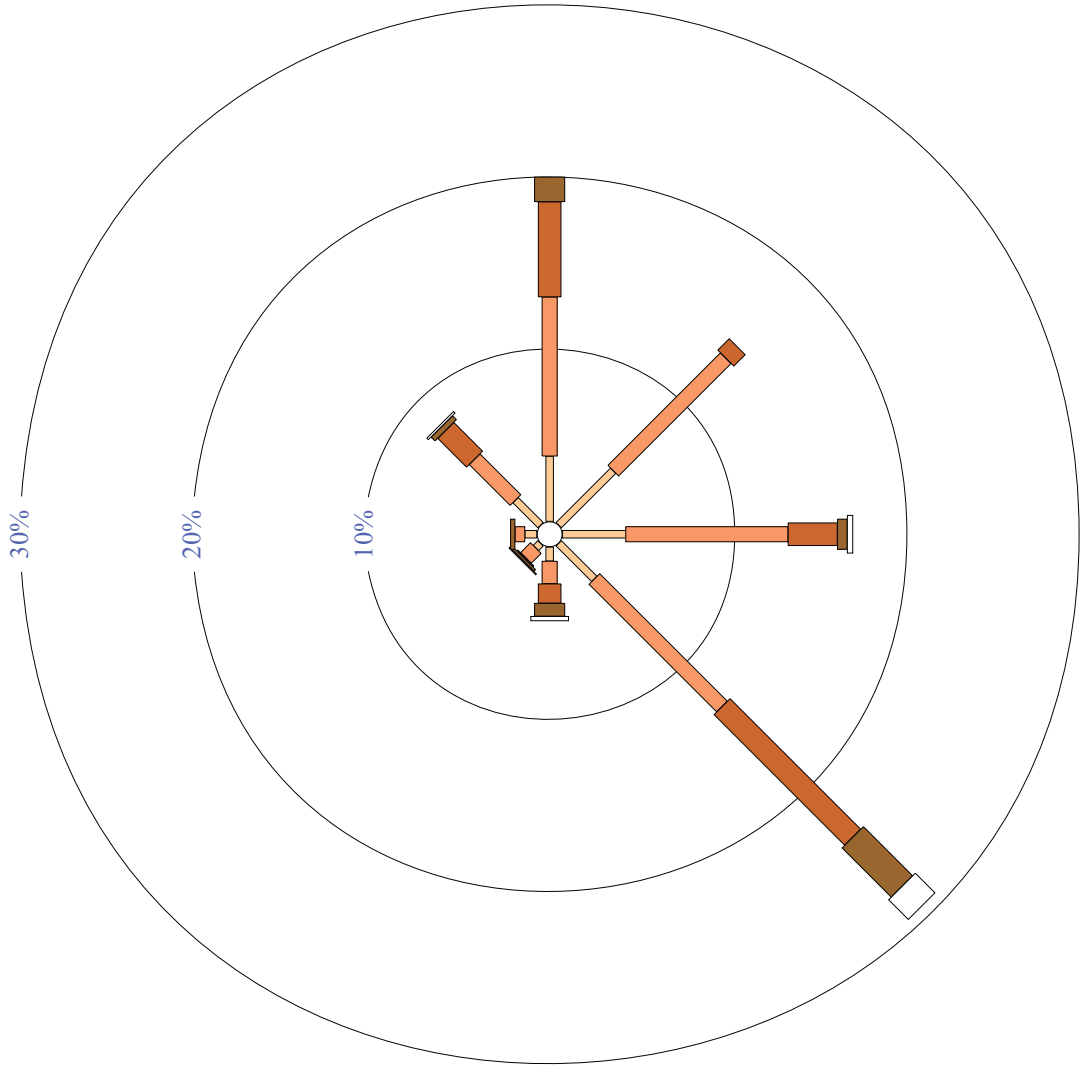
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Sep
807 Total Observations

Calm 4%



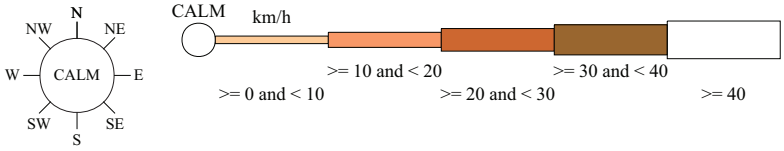
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 28 Feb 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

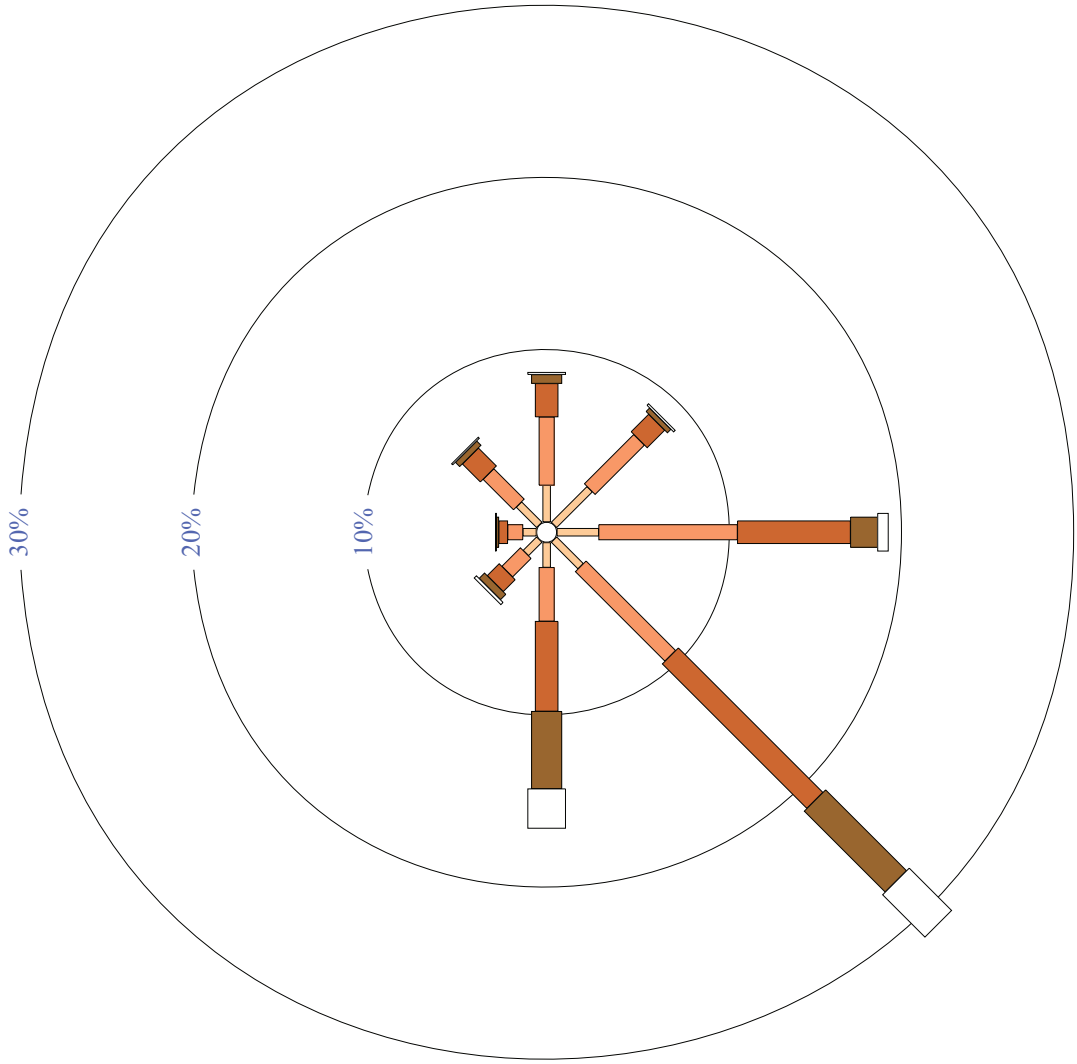
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
10327 Total Observations

Calm 3%



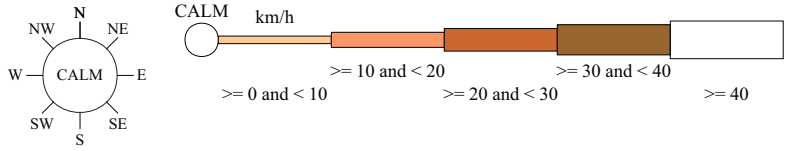
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

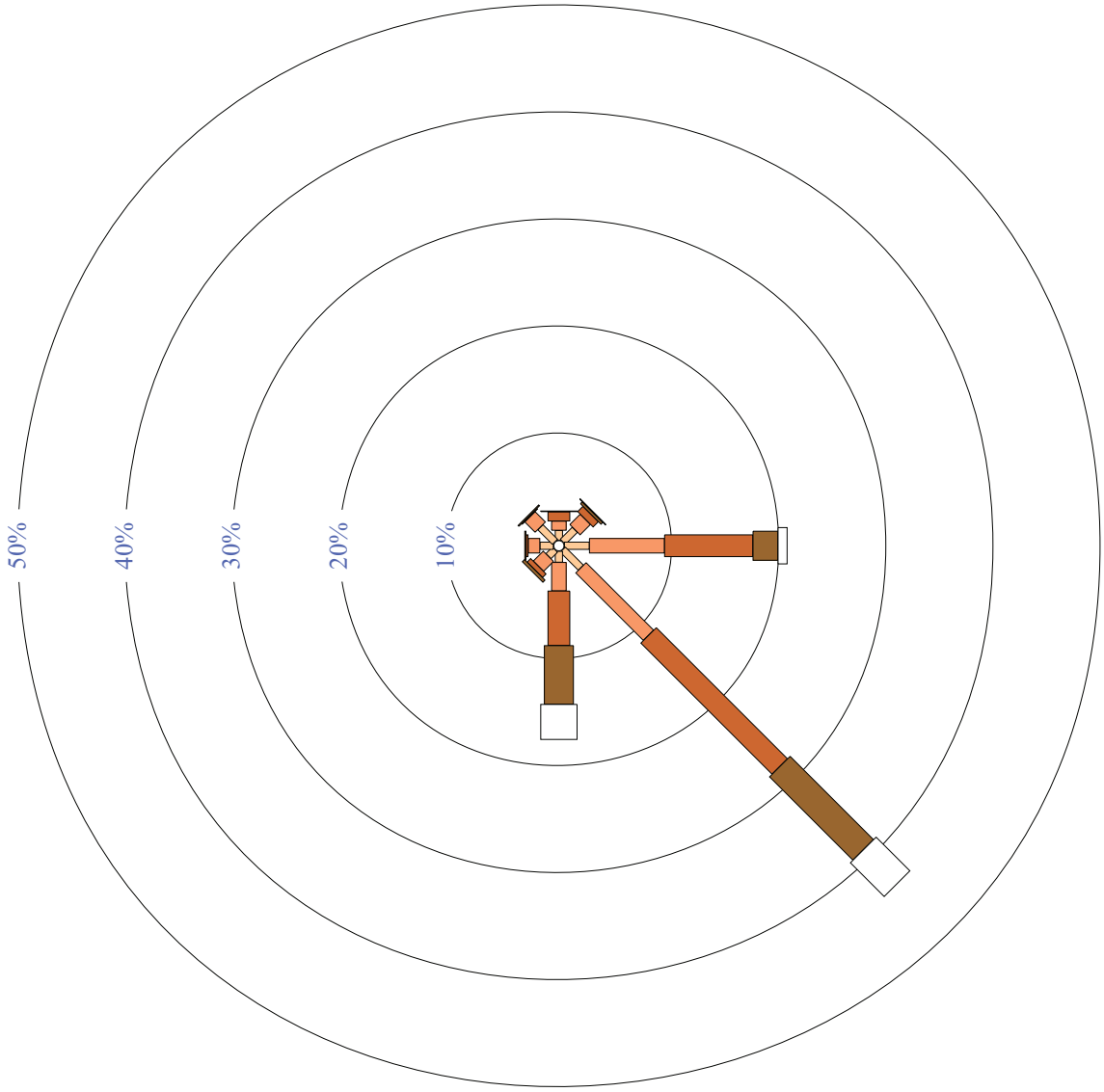
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Apr
887 Total Observations

Calm 2%



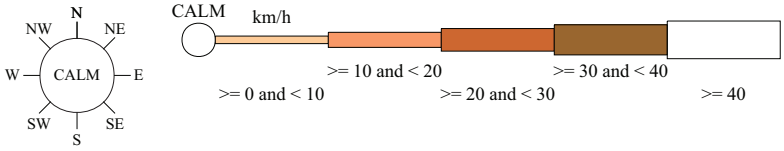
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

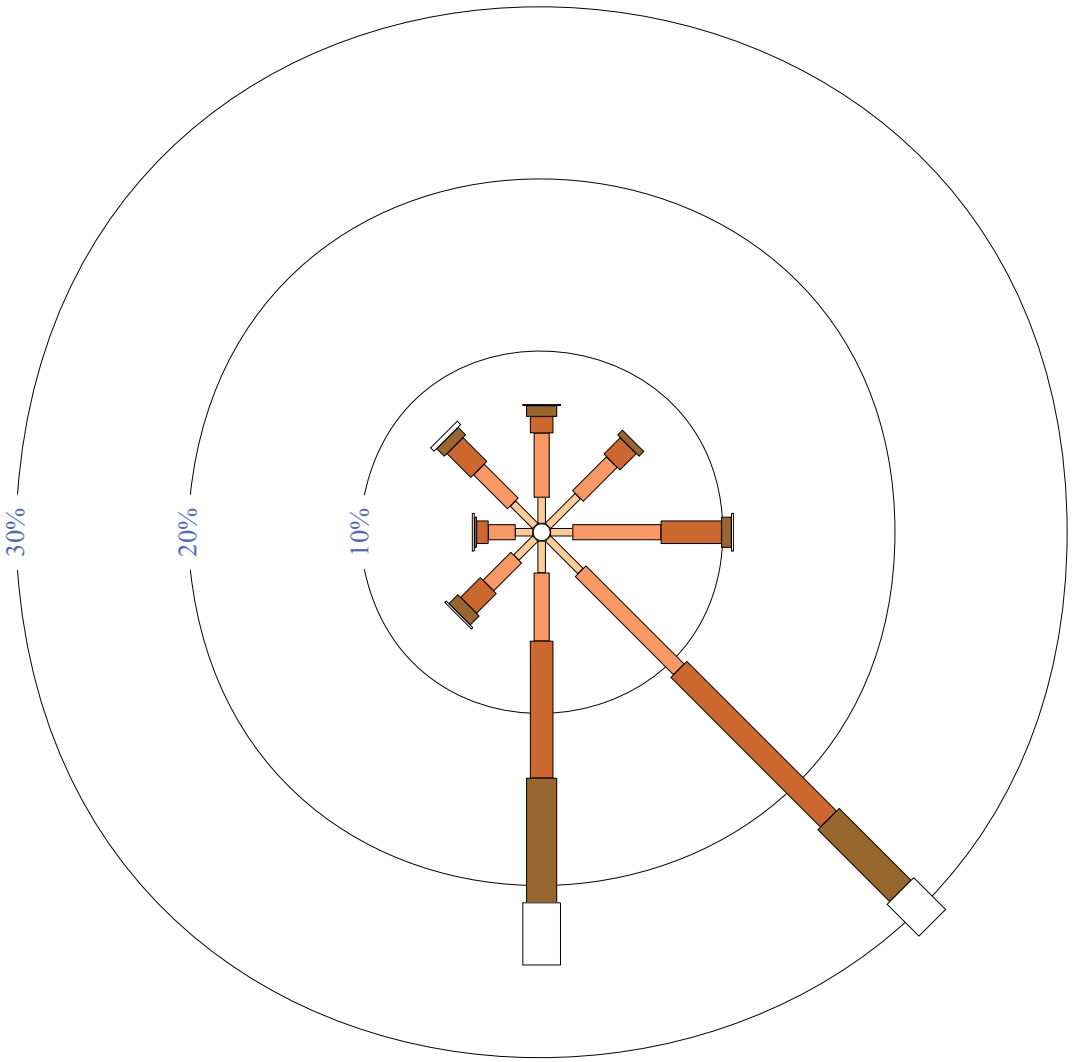
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Aug
900 Total Observations

Calm 2%



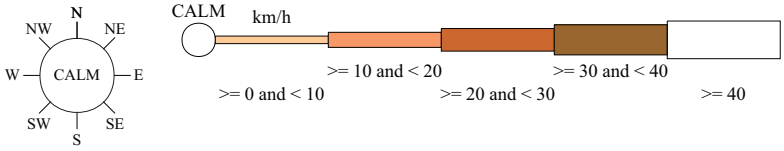
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

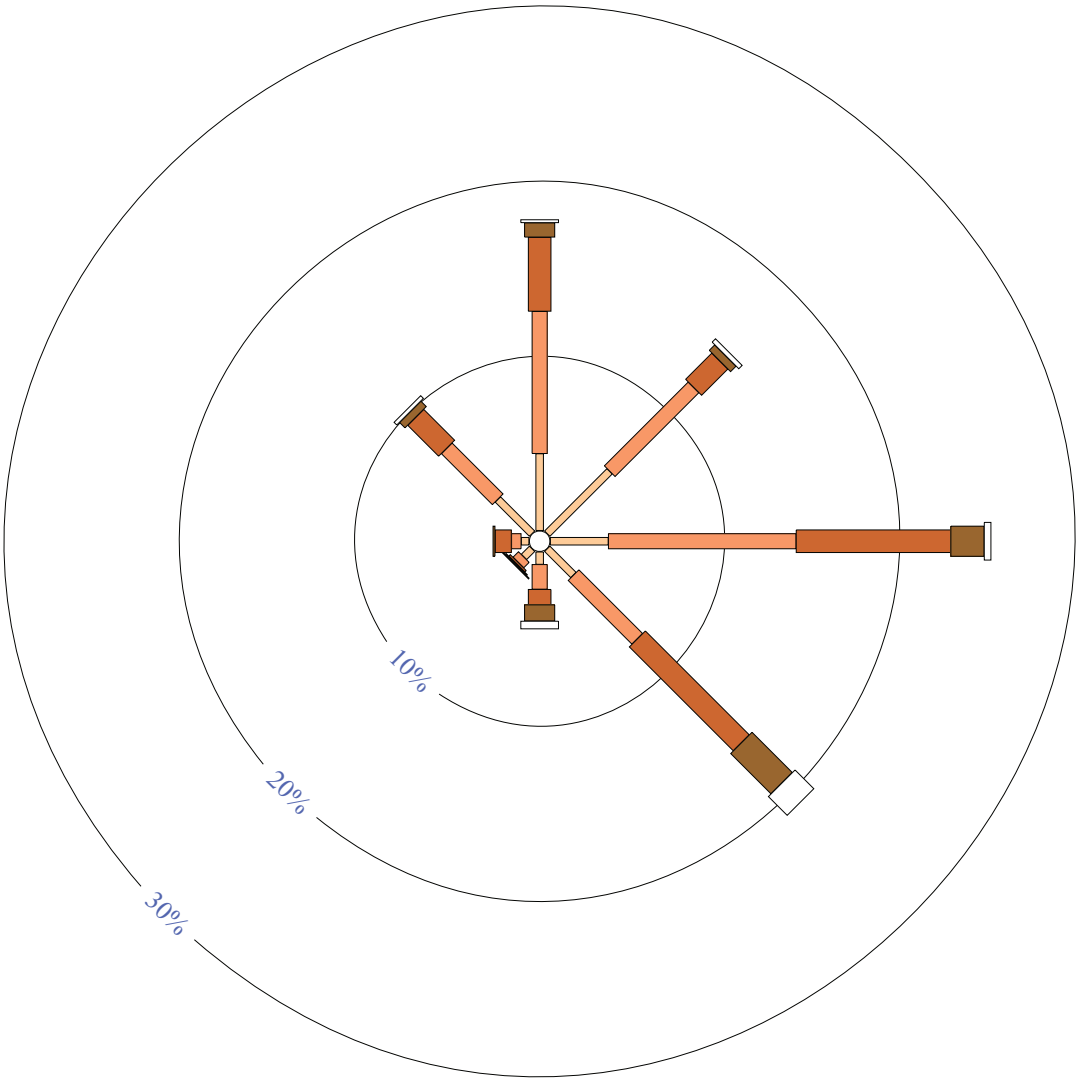
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Dec
909 Total Observations

Calm 3%



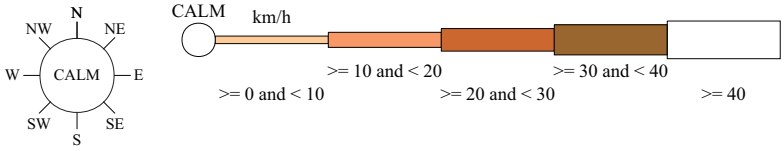
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

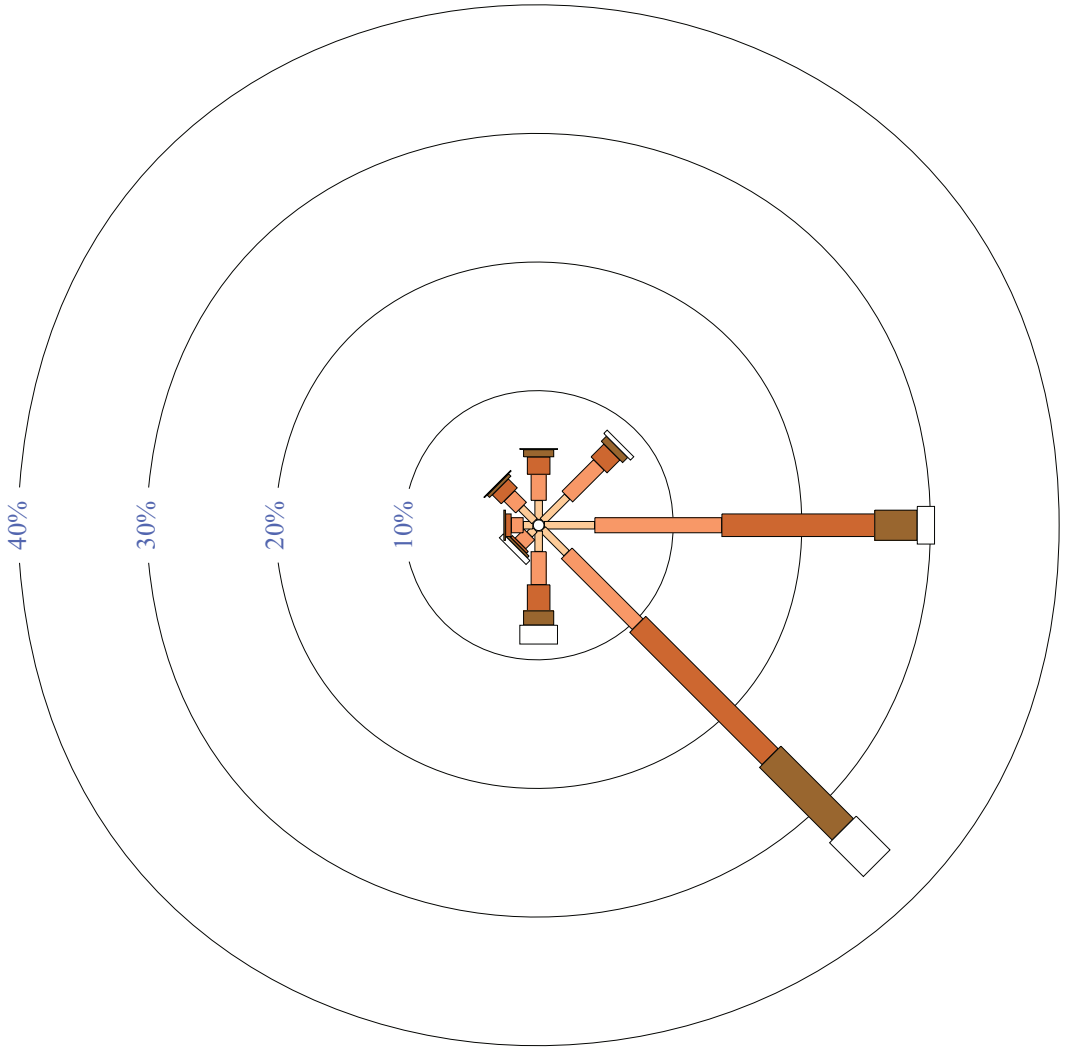
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Feb
822 Total Observations

Calm 2%



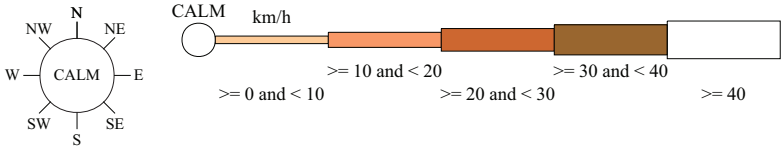
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

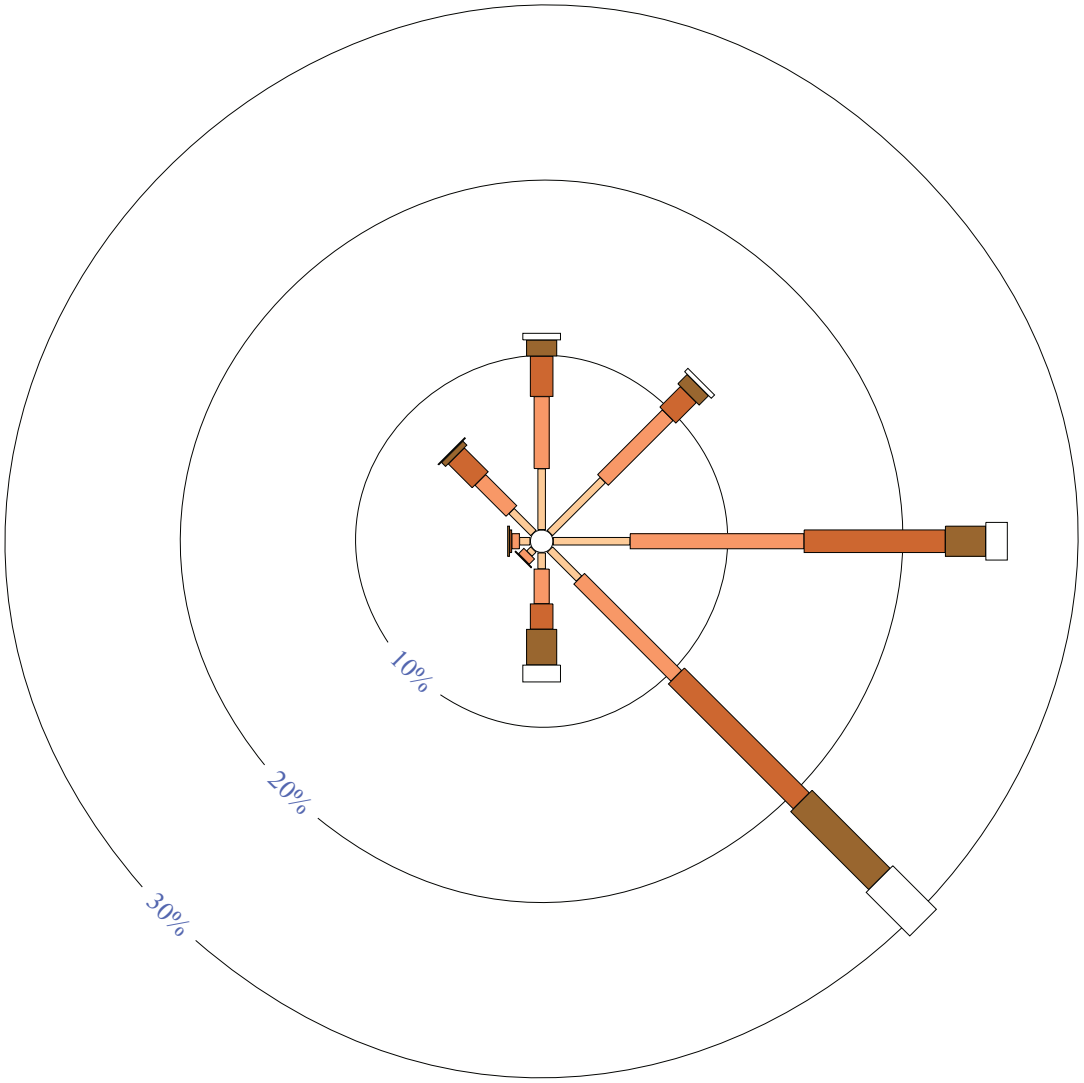
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jan
922 Total Observations

Calm 3%



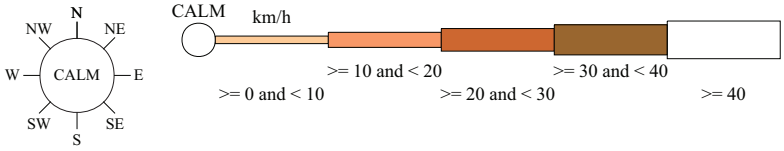
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

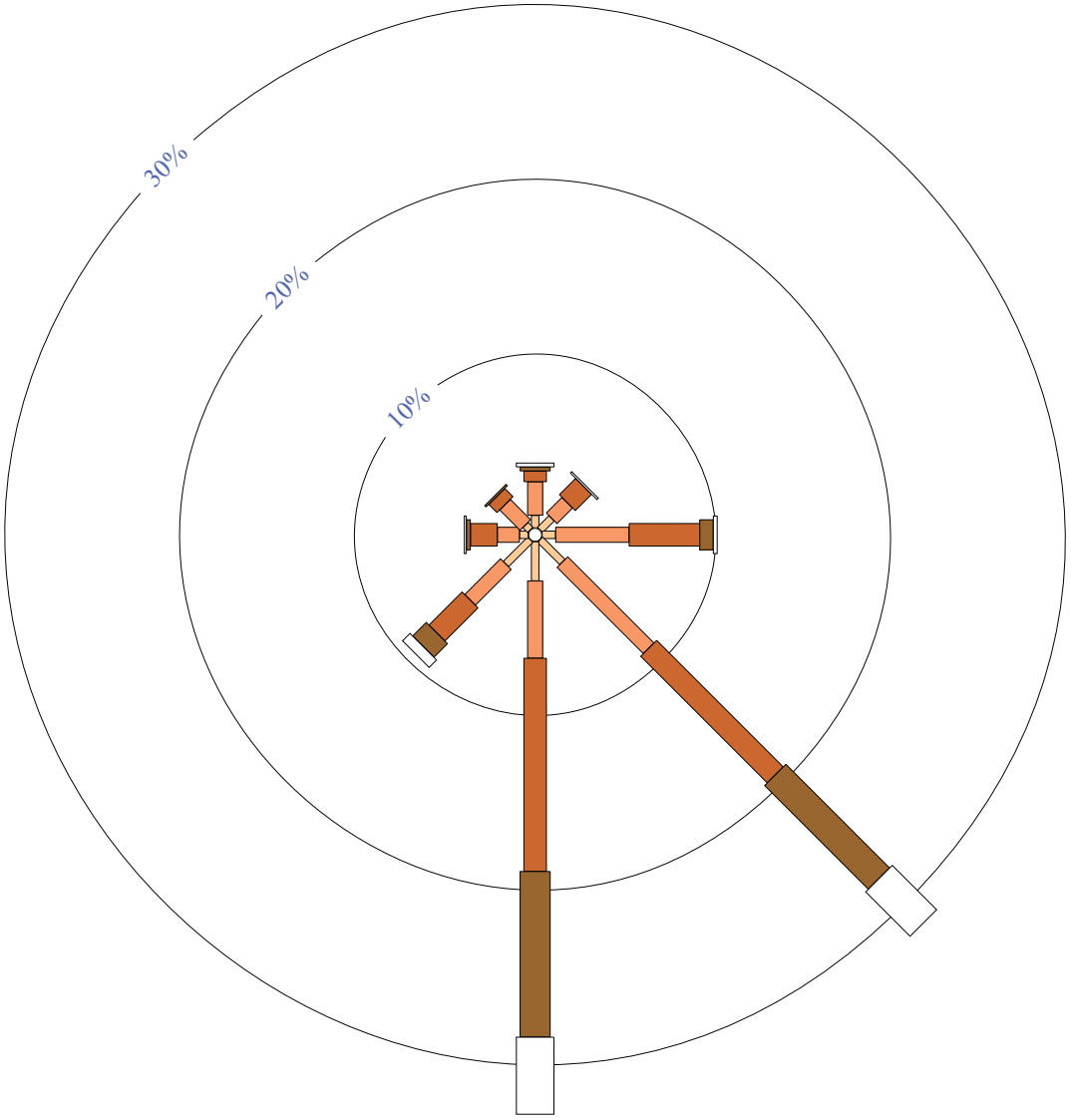
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jul
903 Total Observations

Calm 2%



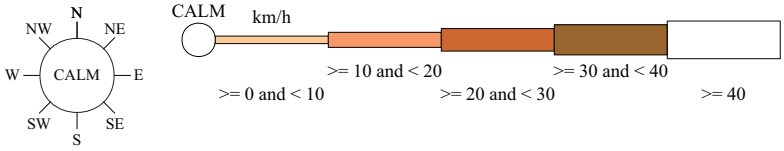
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

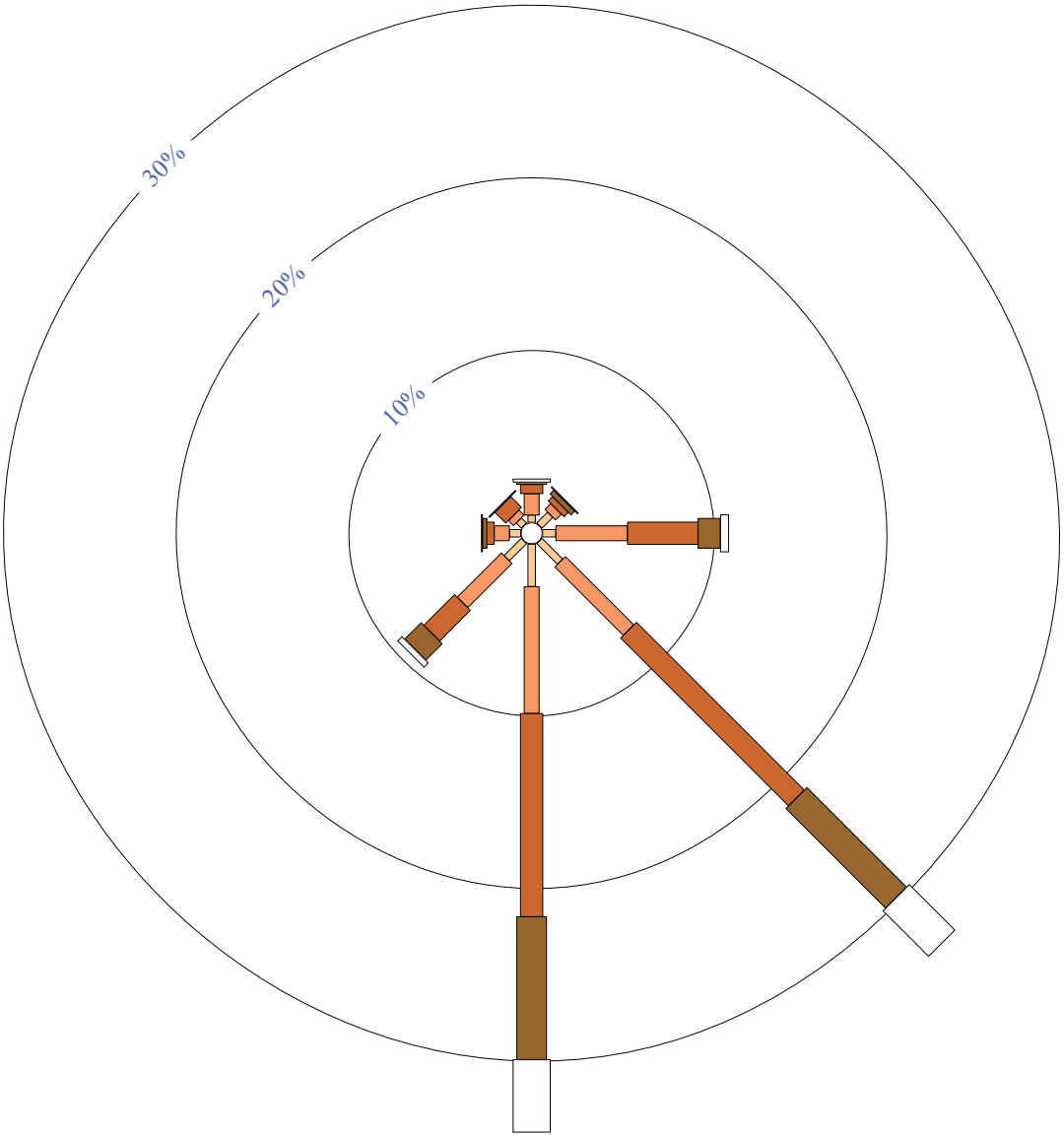
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jun
844 Total Observations

Calm 3%



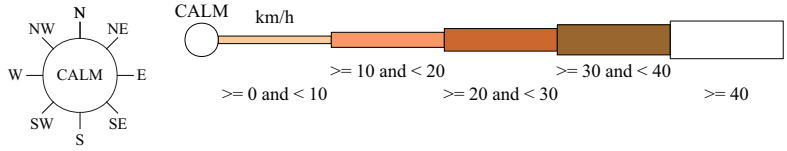
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

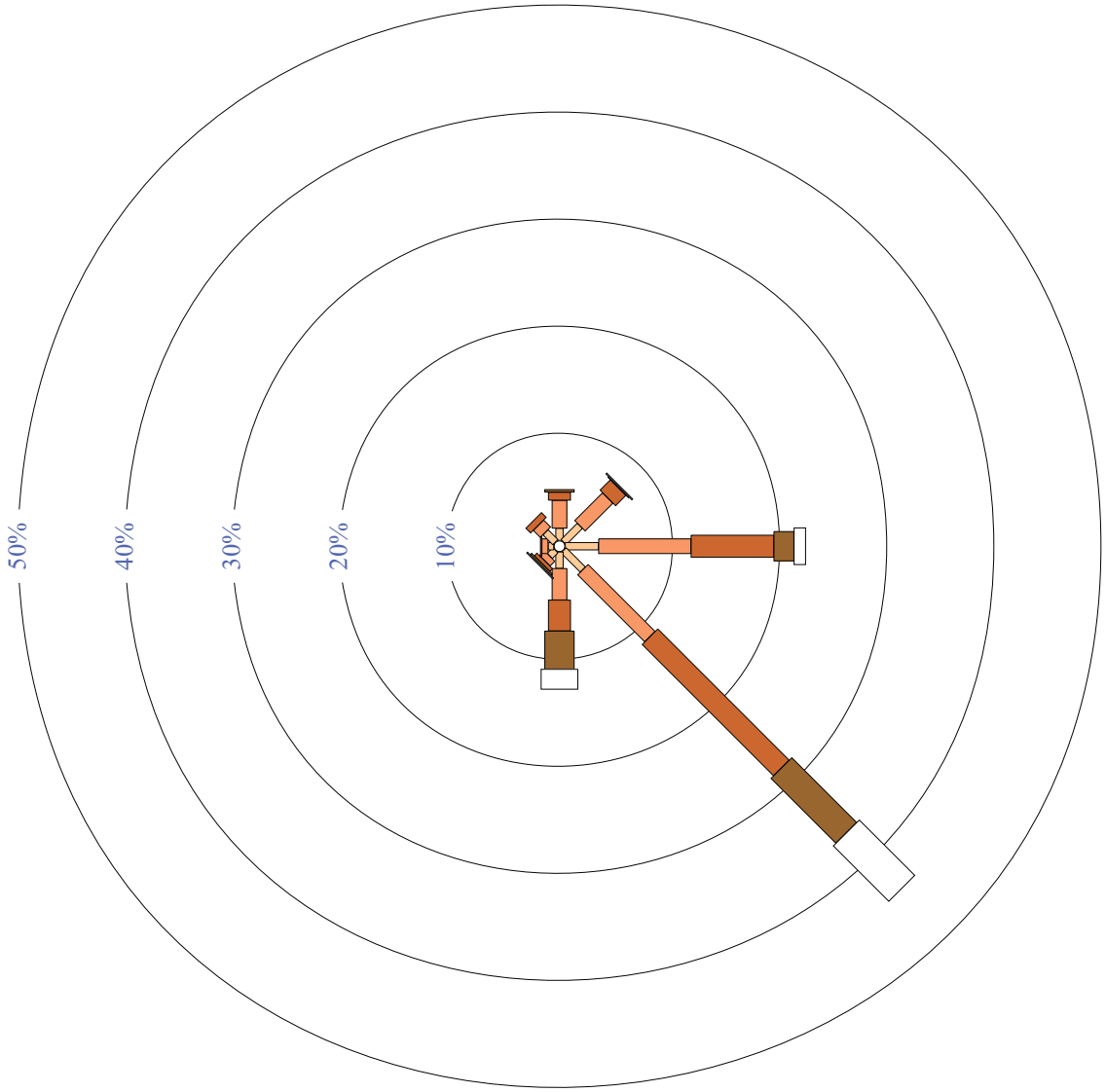
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Mar
889 Total Observations

Calm 2%



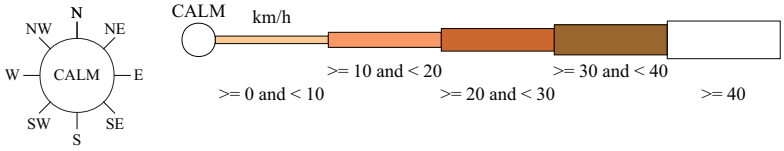
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

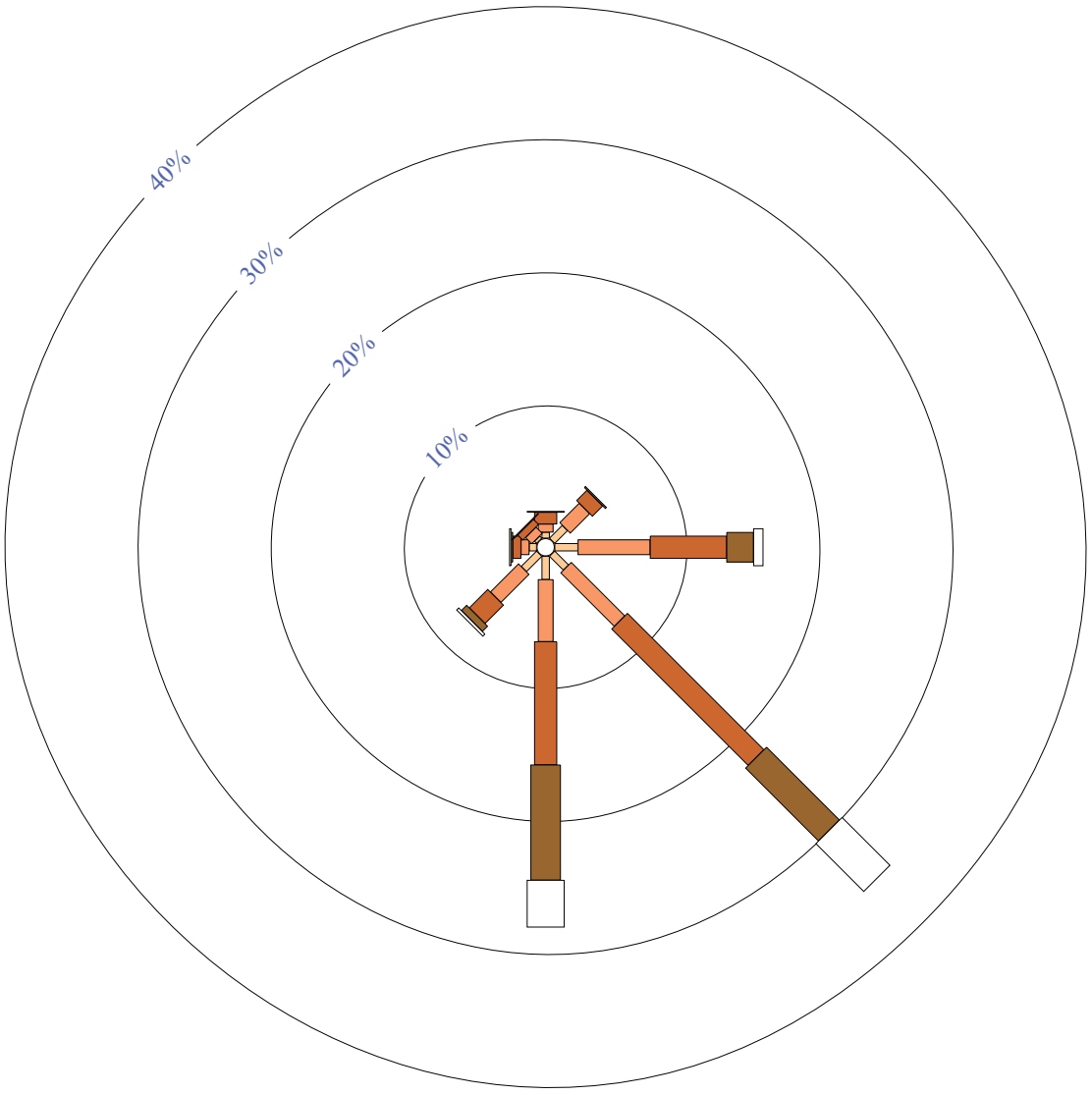
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am May
909 Total Observations

Calm 3%



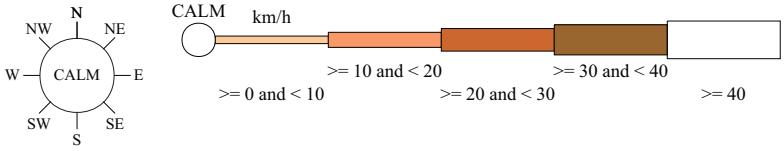
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

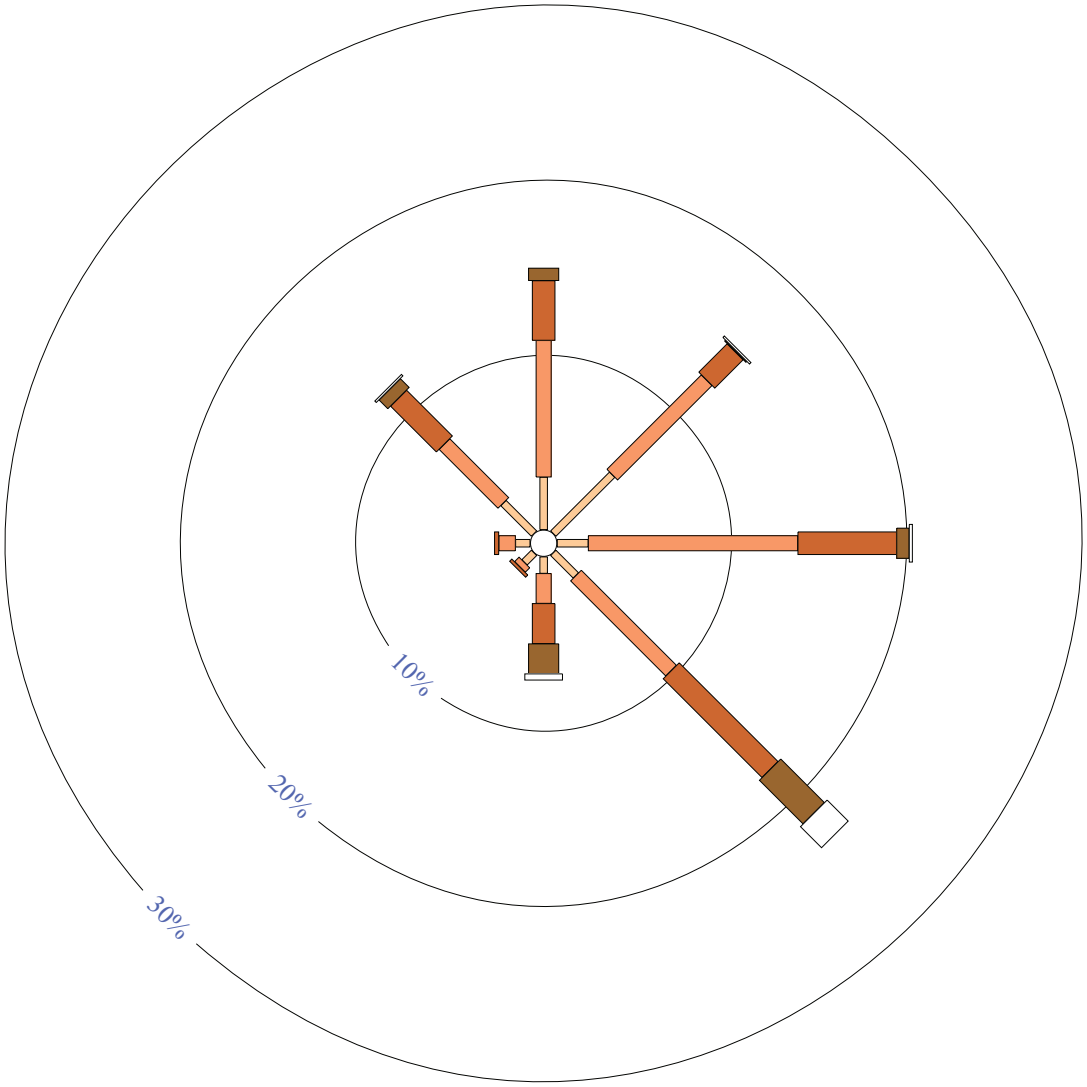
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Nov
839 Total Observations

Calm 4%



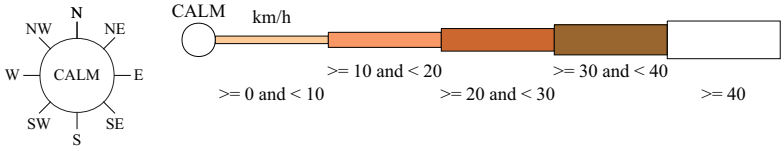
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

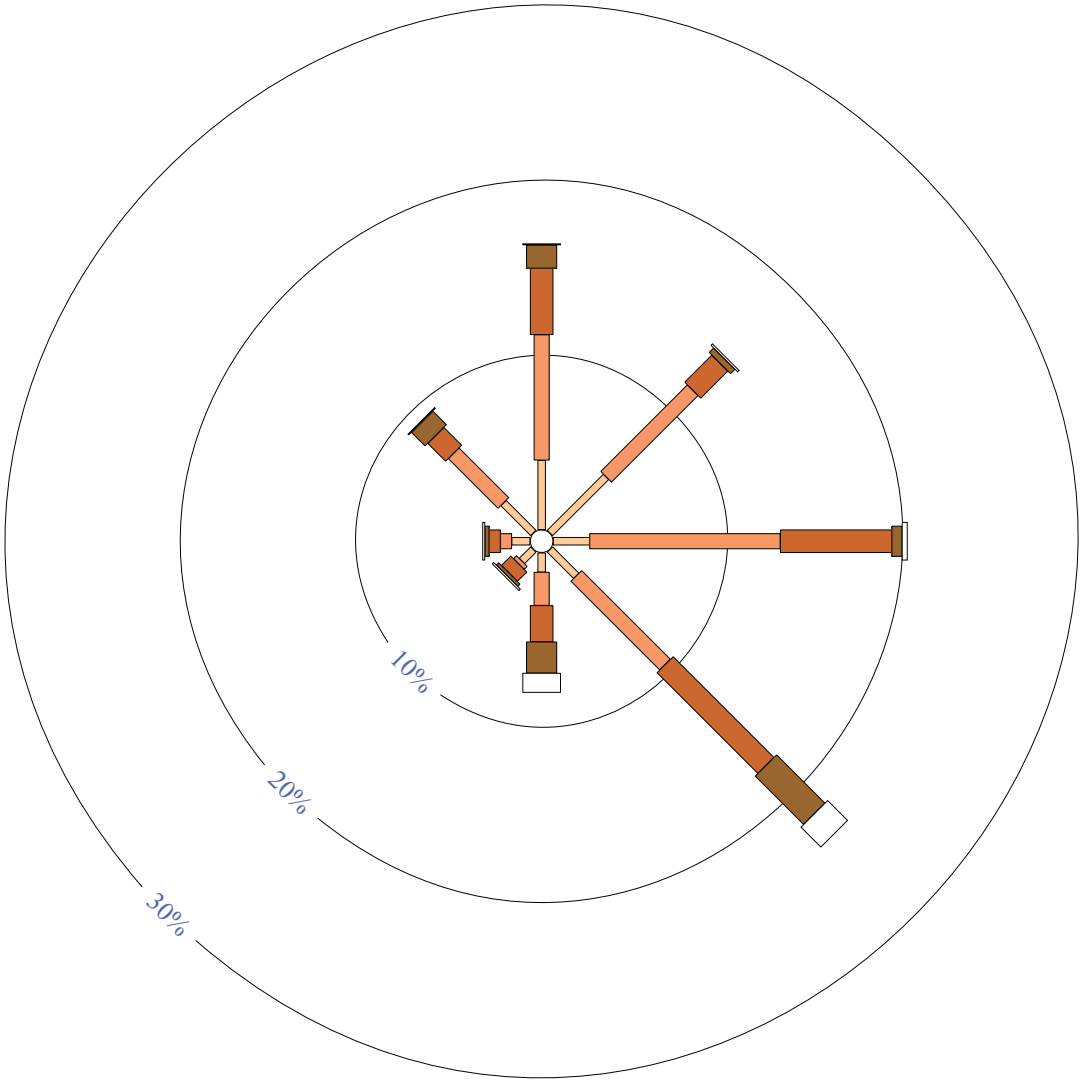
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Oct
859 Total Observations

Calm 3%



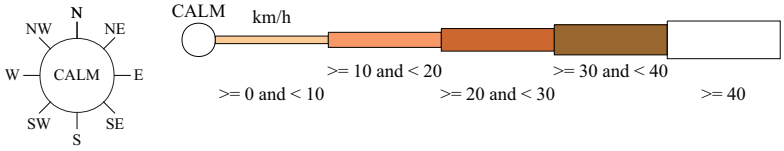
Rose of Wind direction versus Wind speed in km/h (01 Jan 1962 to 30 Sep 2010)

Custom times selected, refer to attached note for details

HERON ISLAND RES STN

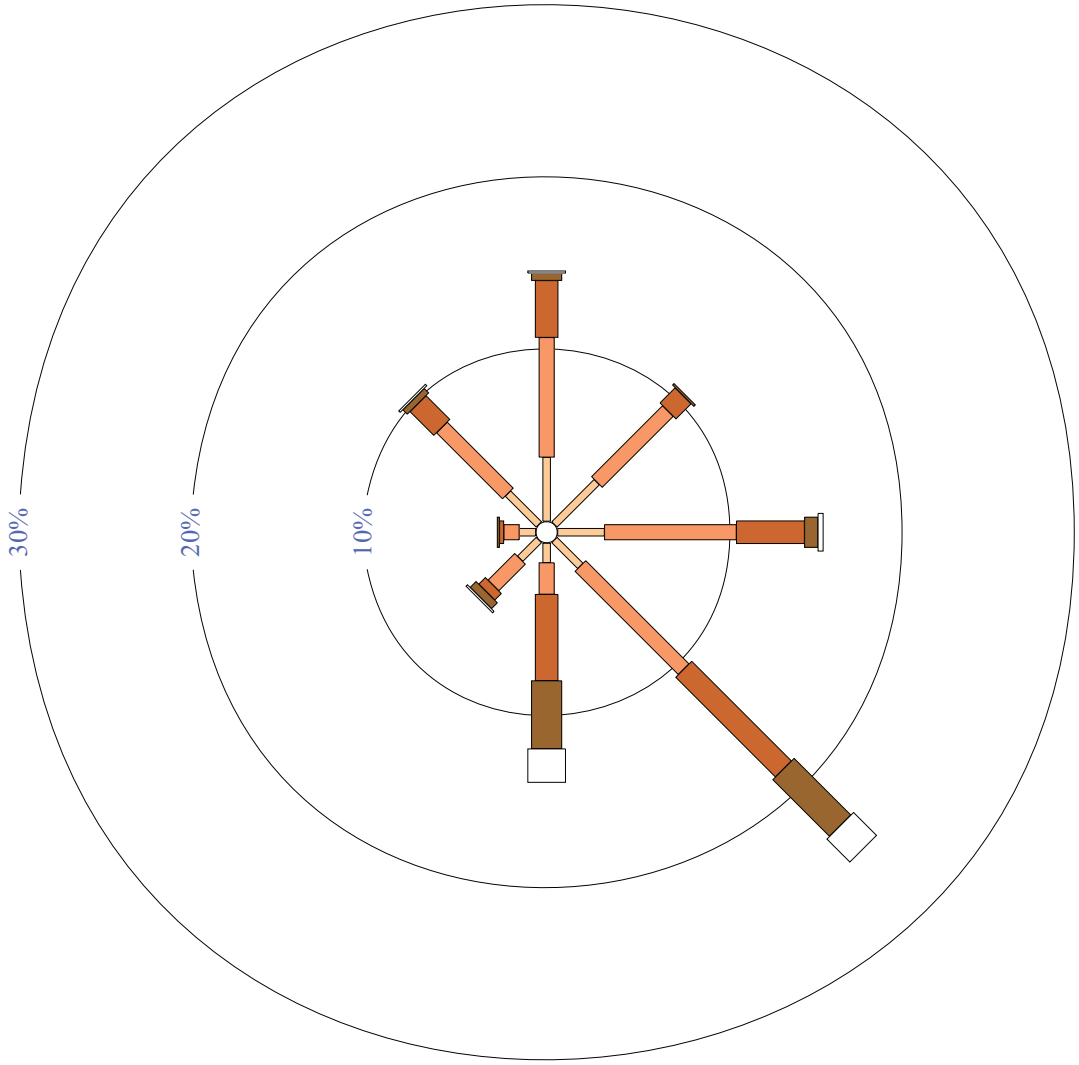
Site No: 039122 • Opened Jan 1956 • Still Open • Latitude: -23.4422° • Longitude: 151.9131° • Elevation 3.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Sep
850 Total Observations

Calm 3%



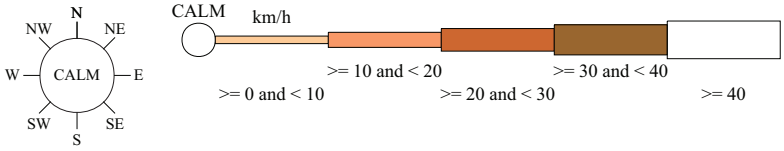
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 28 Feb 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

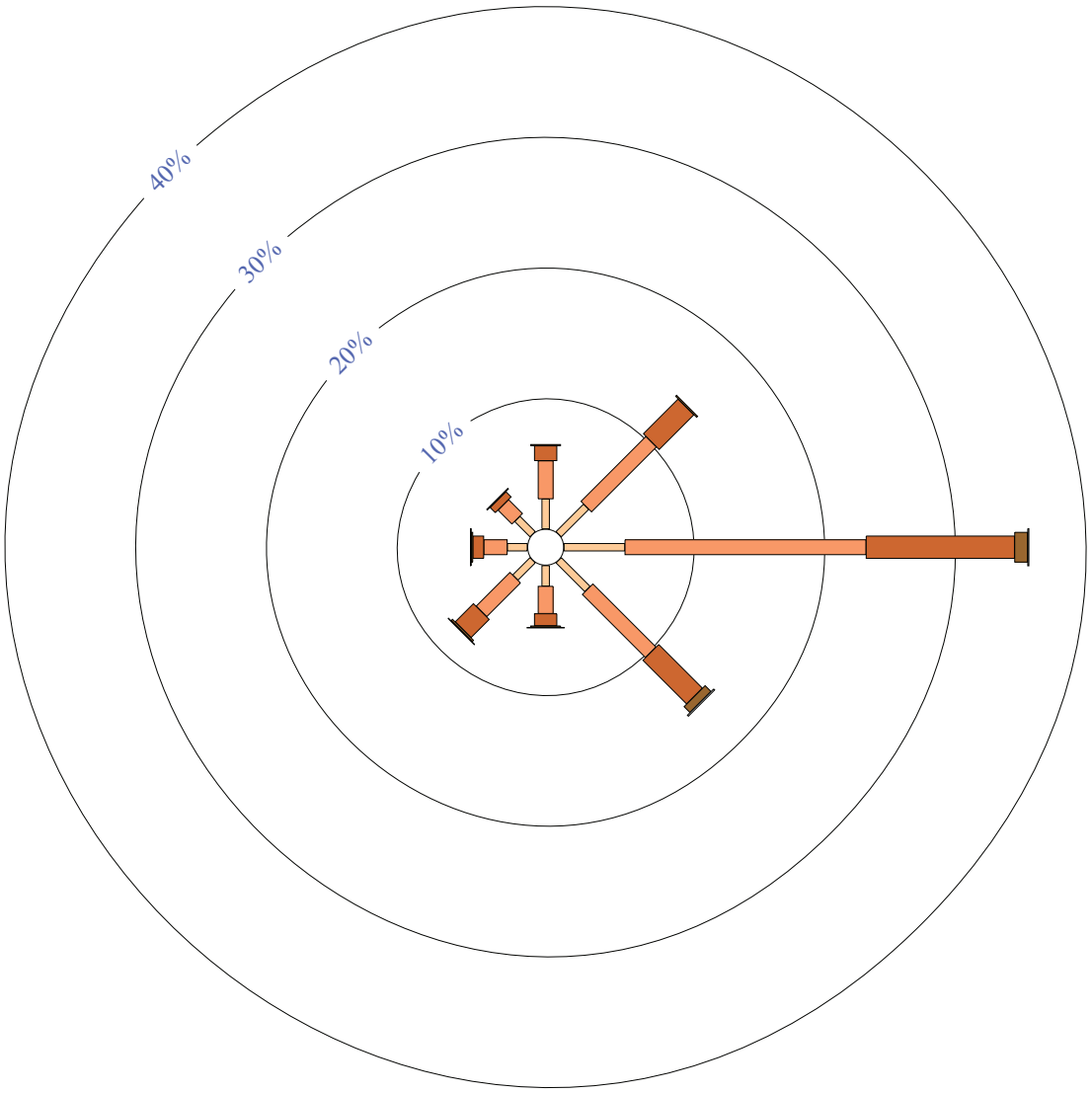
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
25689 Total Observations

Calm 7%



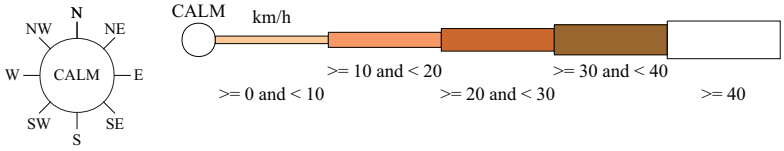
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

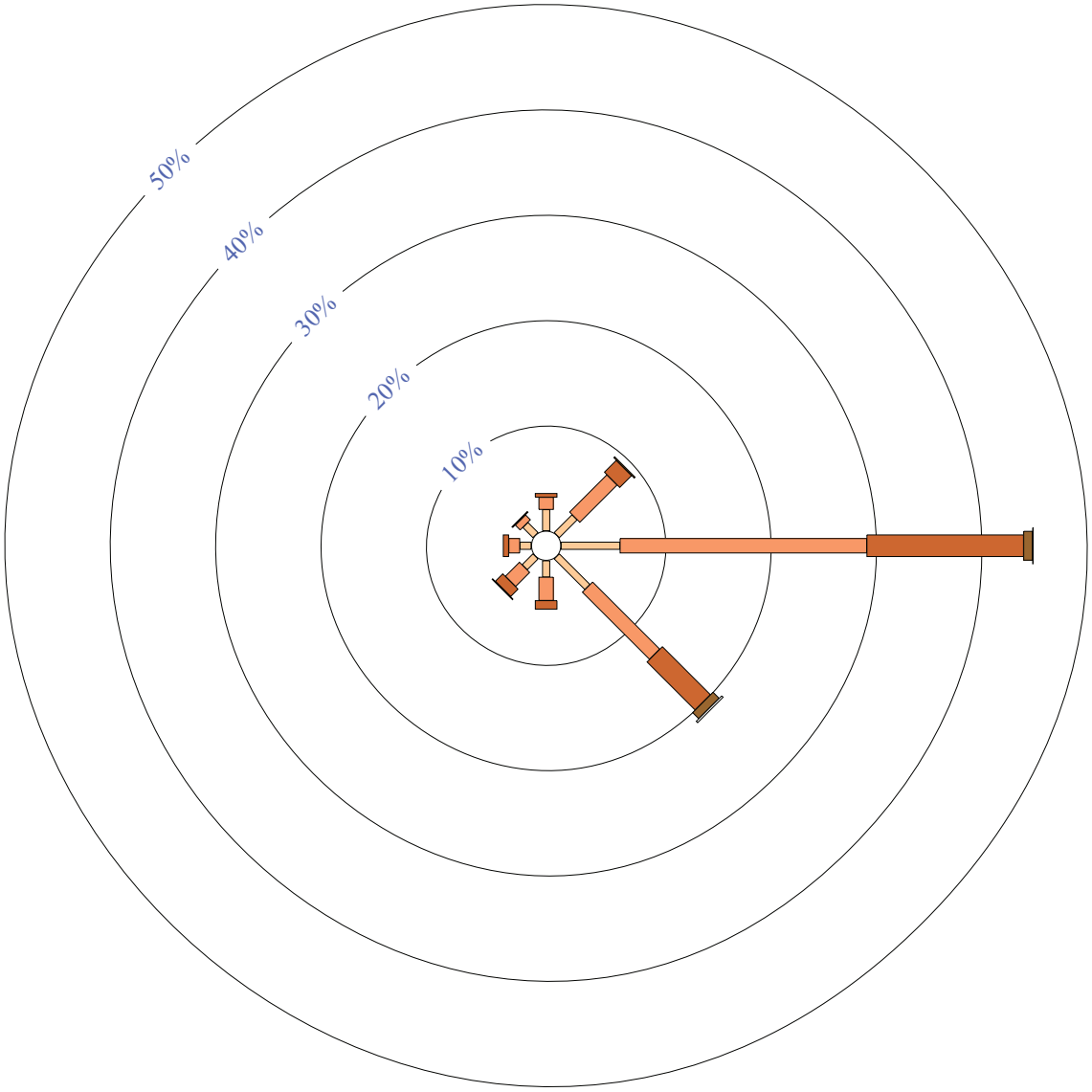
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Apr
2146 Total Observations

Calm 7%



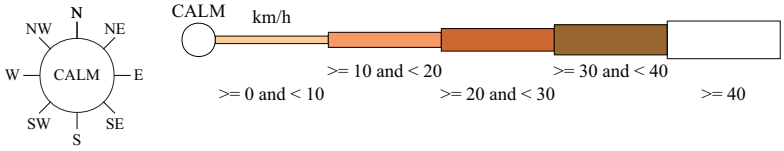
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

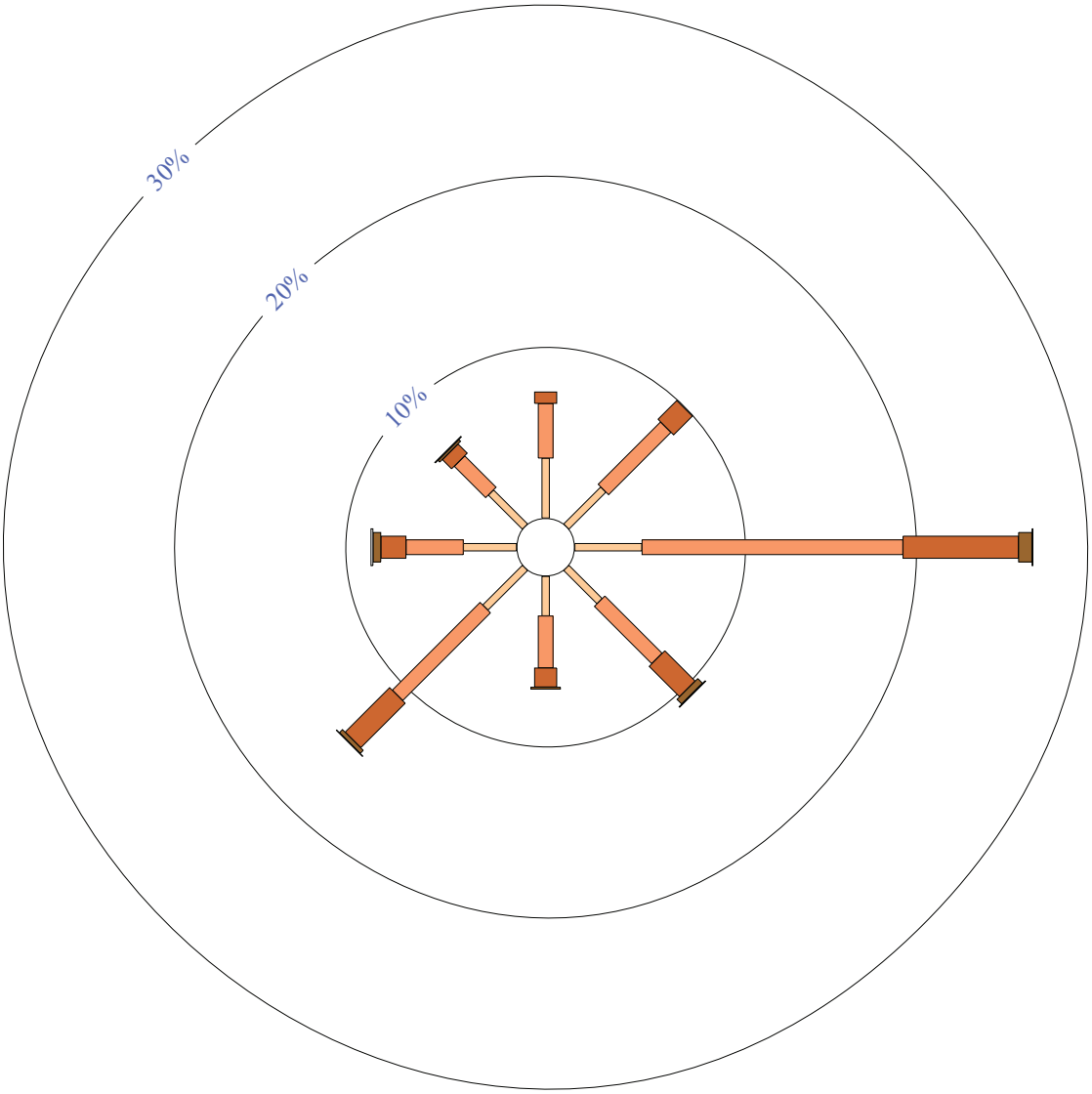
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Aug
2225 Total Observations

Calm 9%



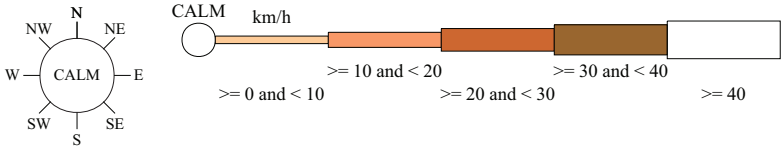
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

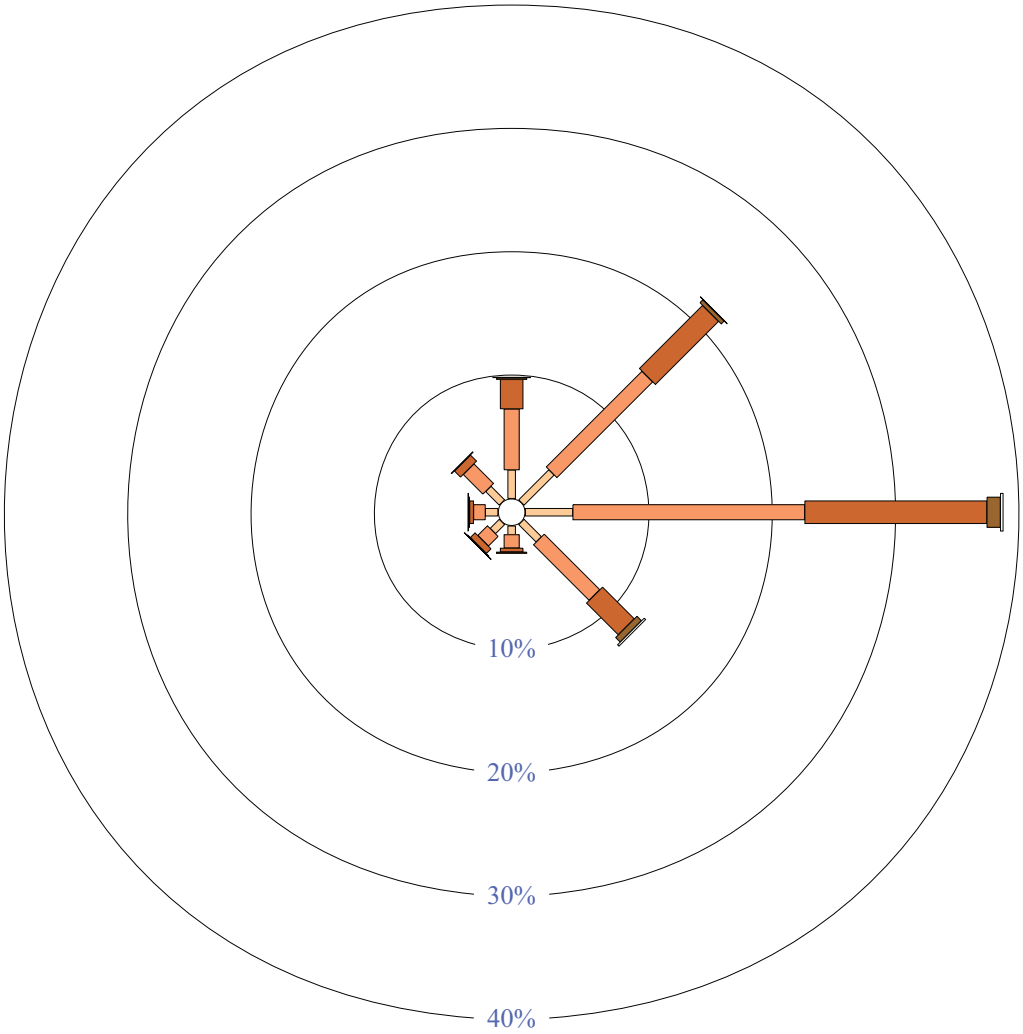
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Dec
2194 Total Observations

Calm 5%



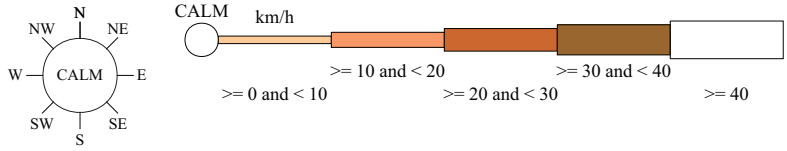
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

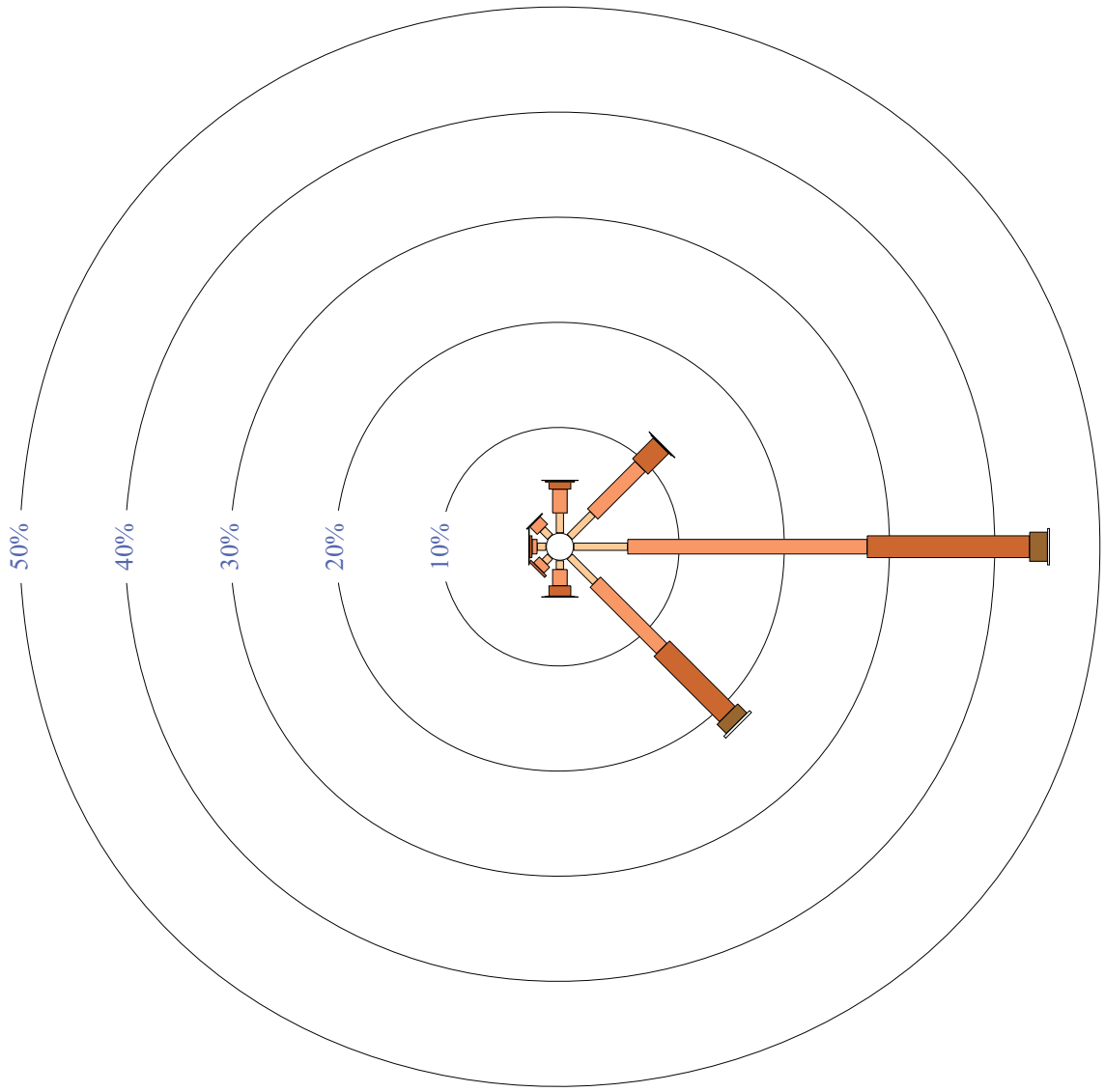
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Feb
1963 Total Observations

Calm 6%



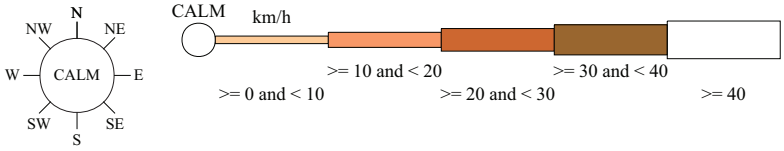
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

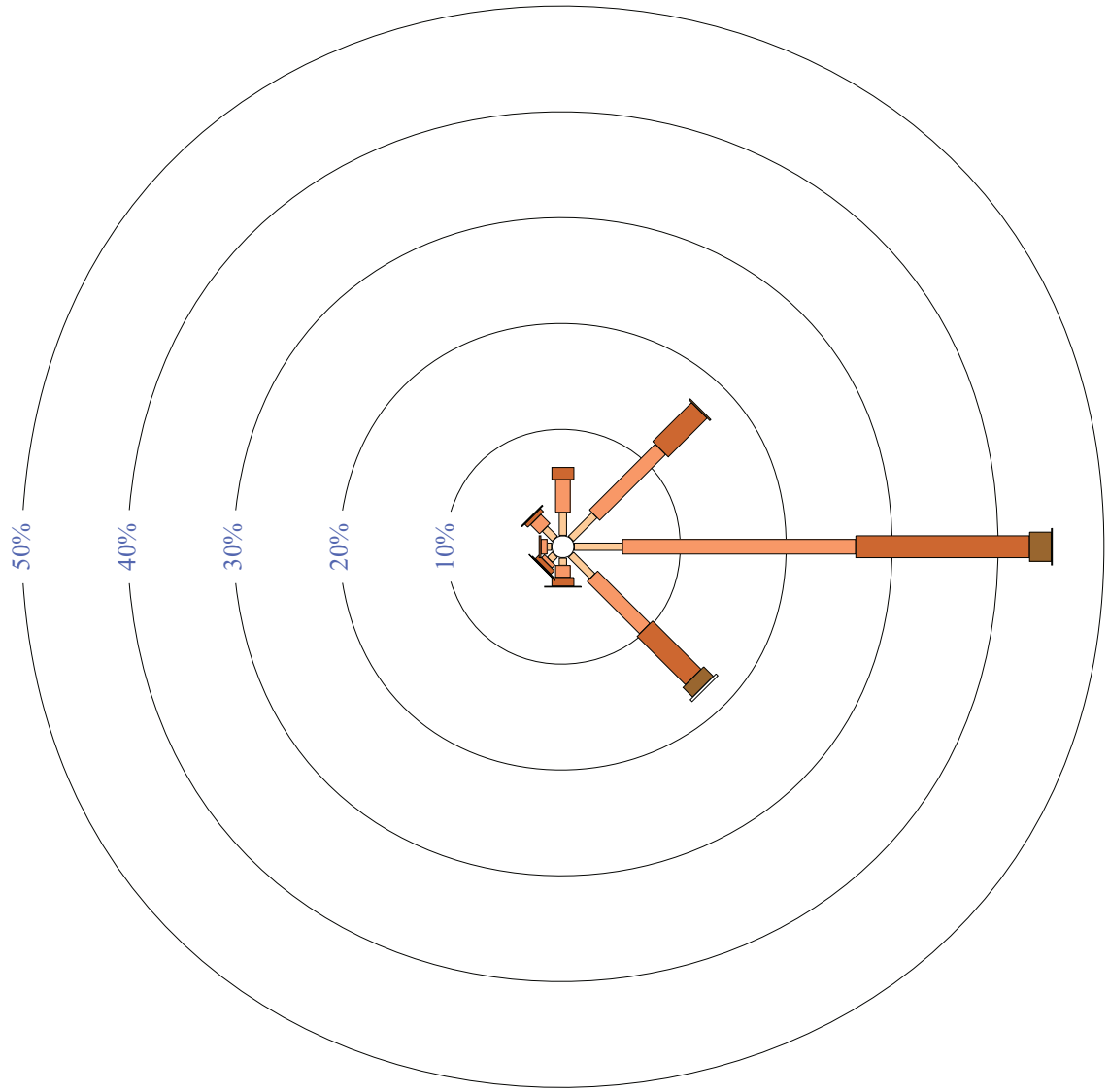
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jan
2164 Total Observations

Calm 5%



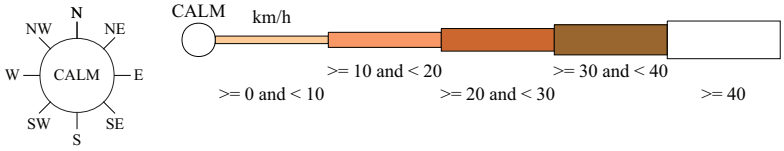
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

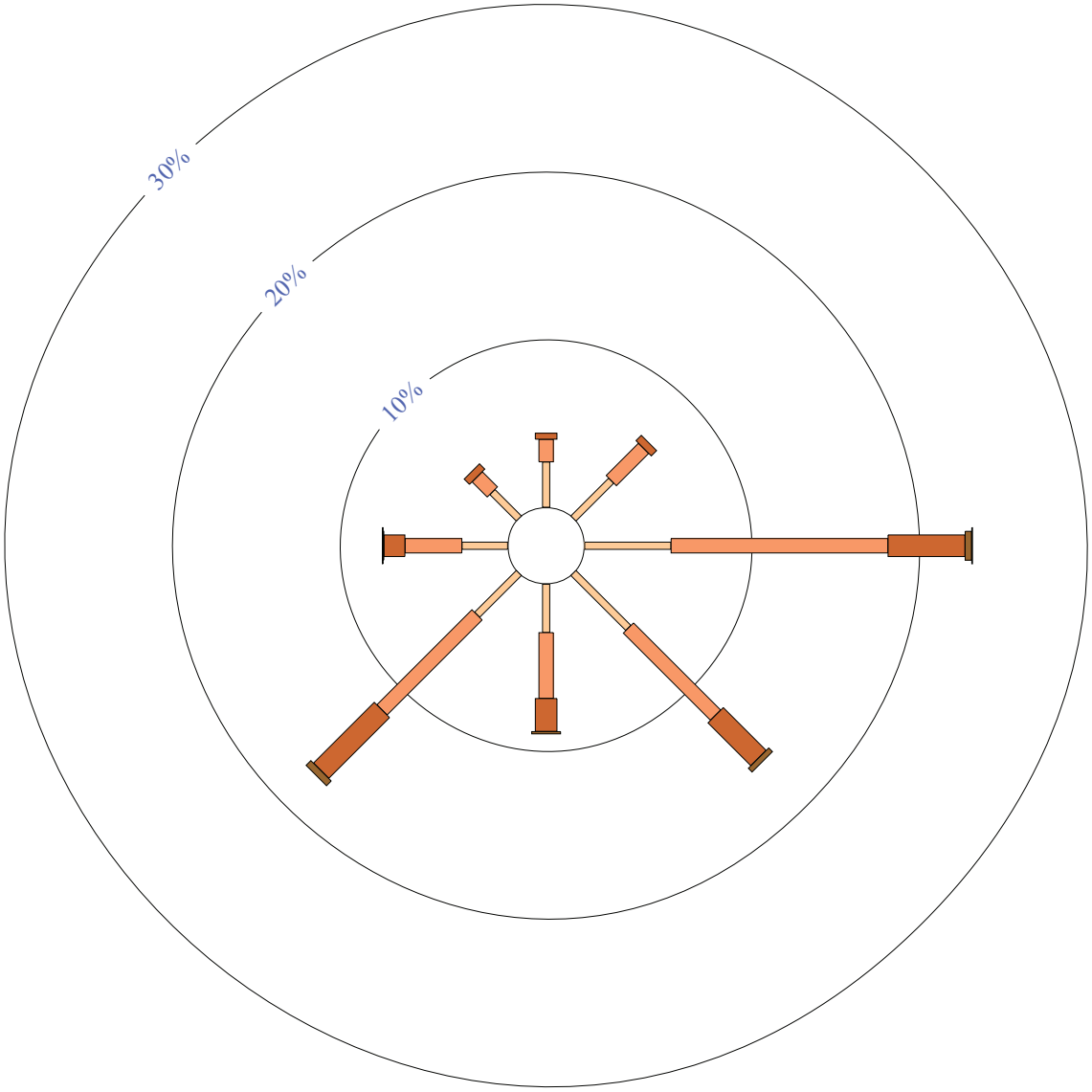
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jul
2209 Total Observations

Calm 12%



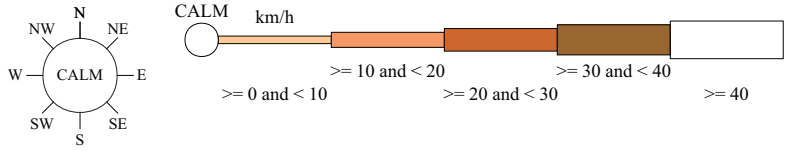
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

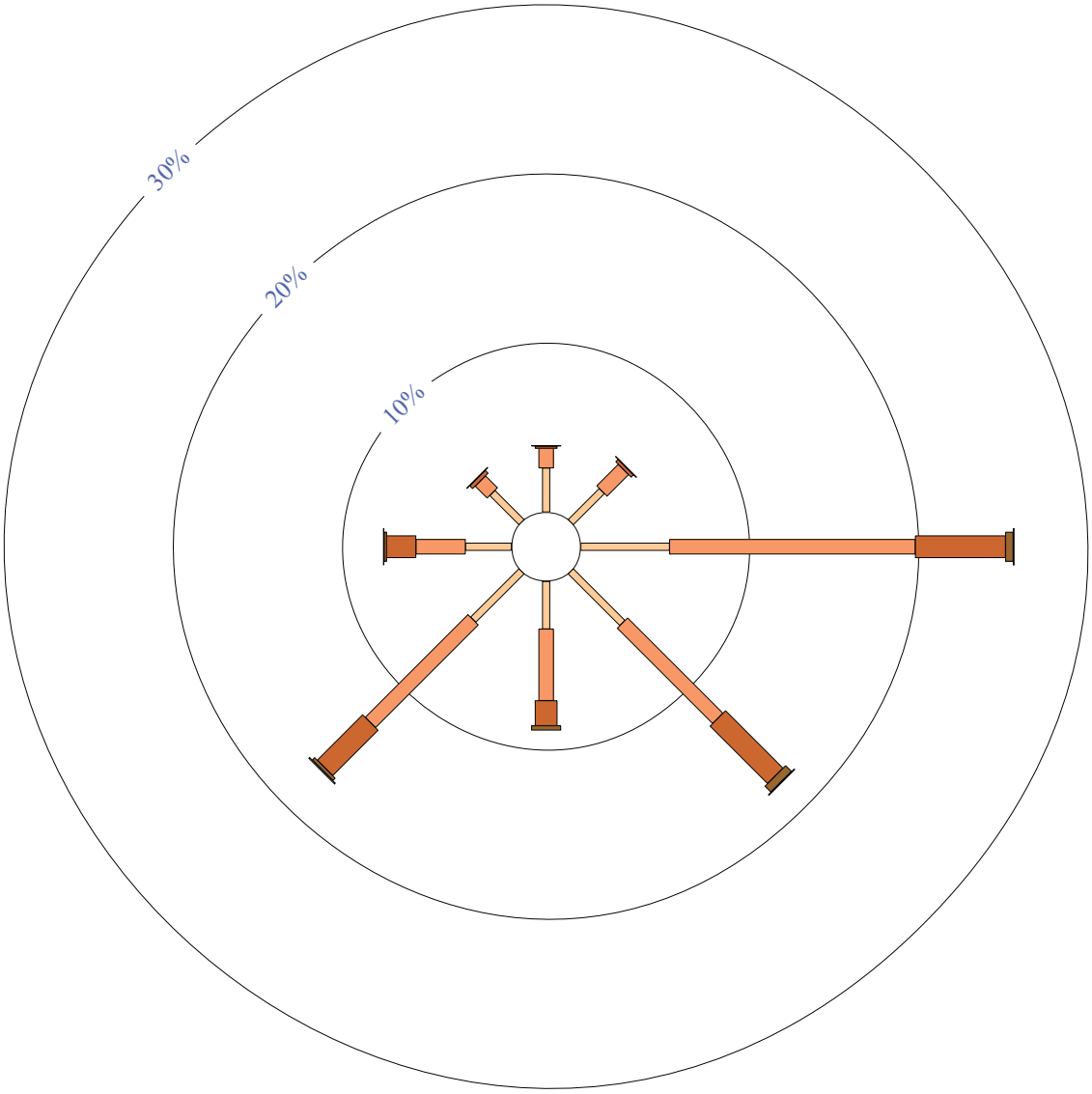
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jun
2143 Total Observations

Calm 10%



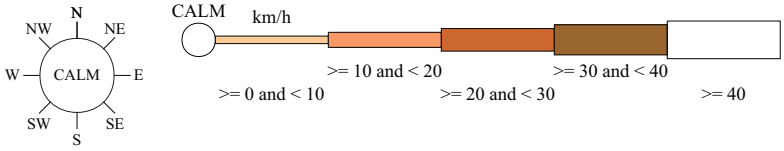
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

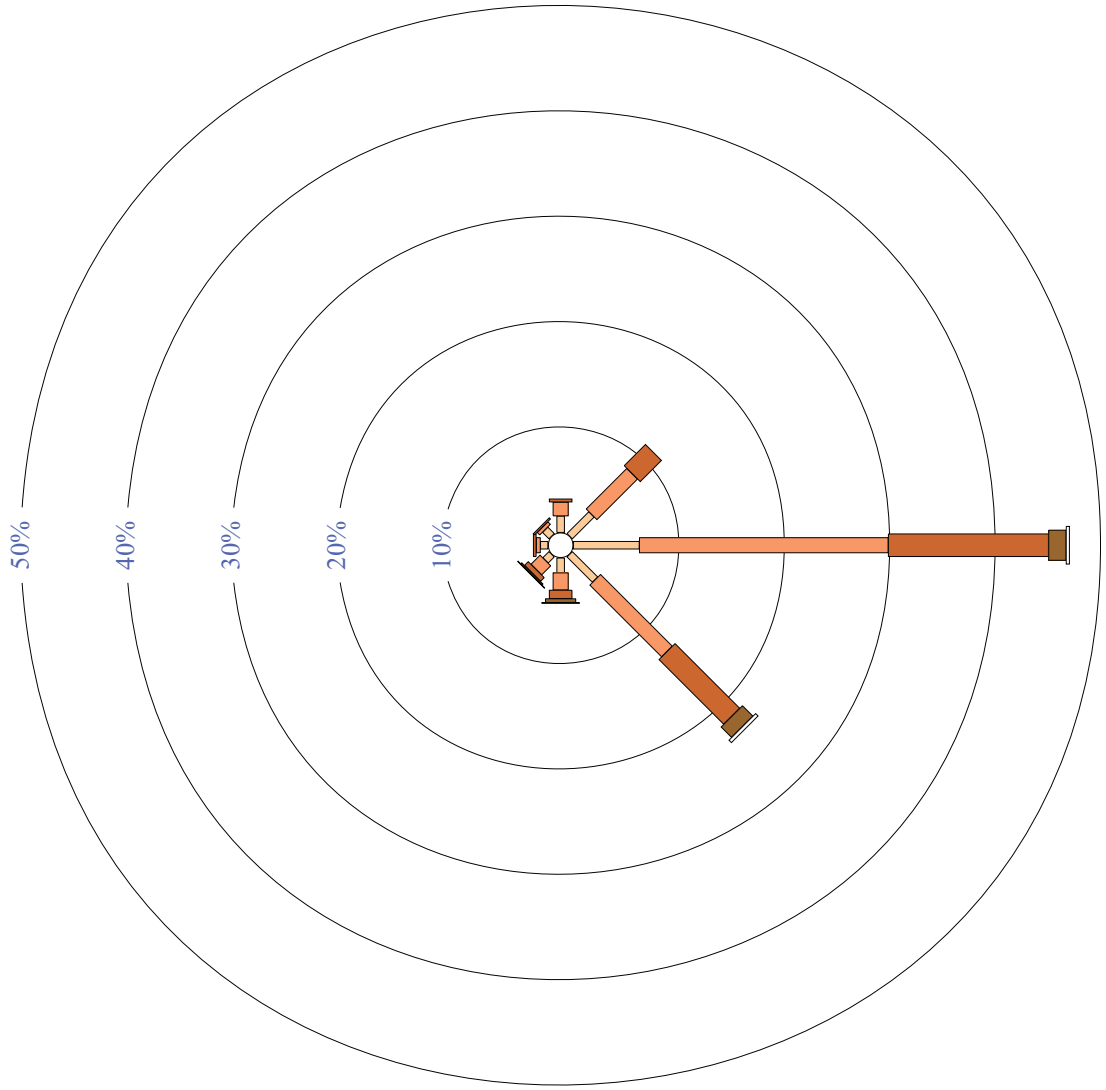
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Mar
2164 Total Observations

Calm 6%



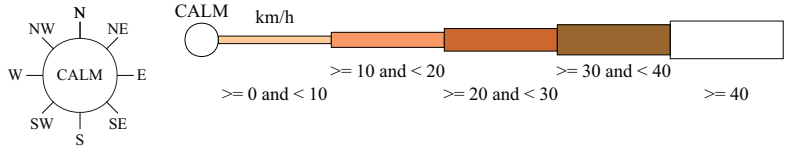
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

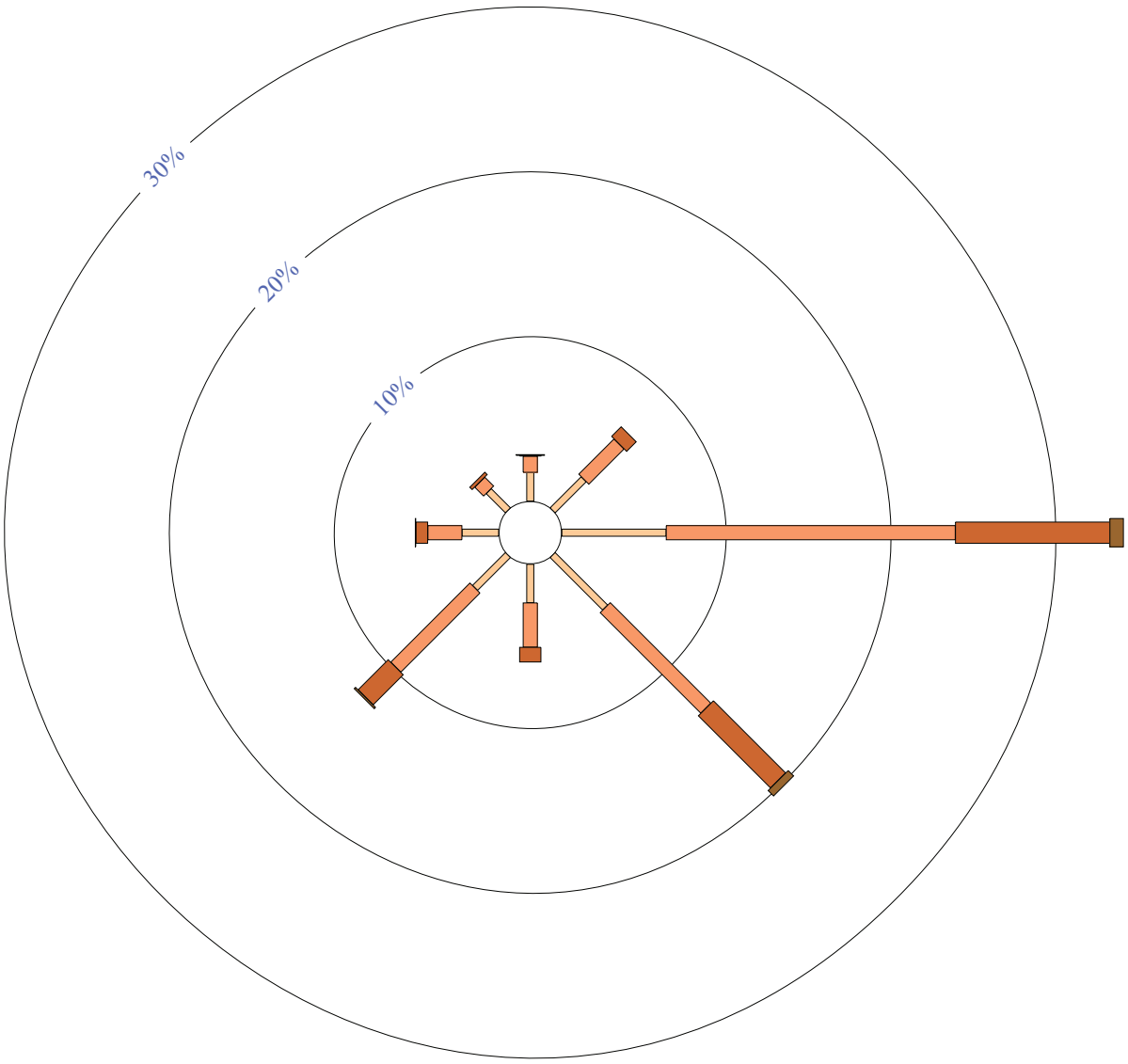
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm May
2217 Total Observations

Calm 10%



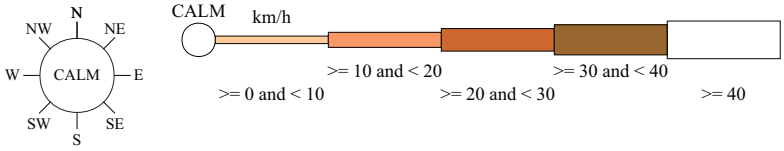
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

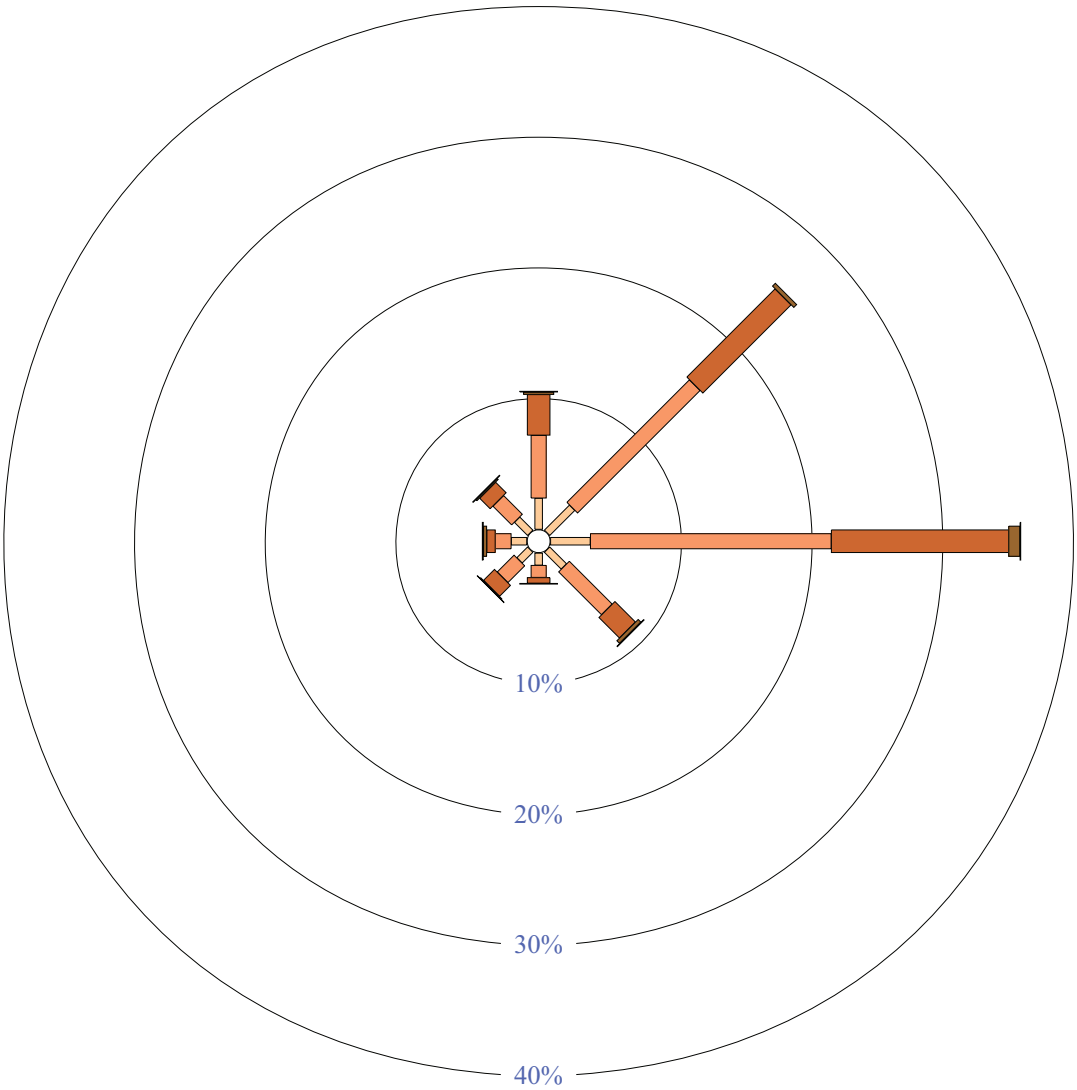
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Nov
2129 Total Observations

Calm 4%



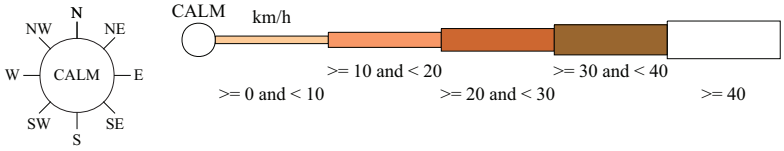
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

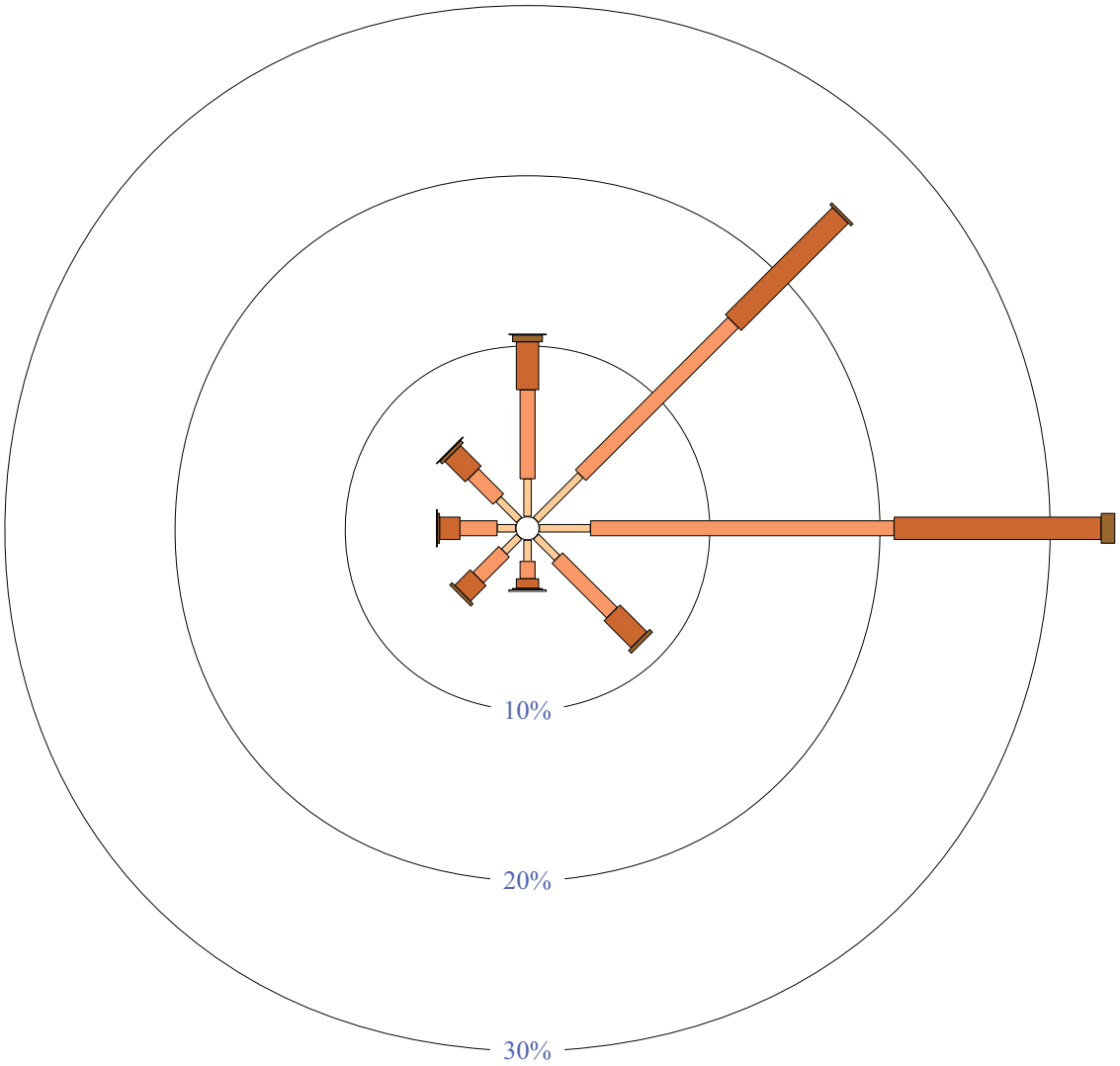
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Oct
2194 Total Observations

Calm 3%



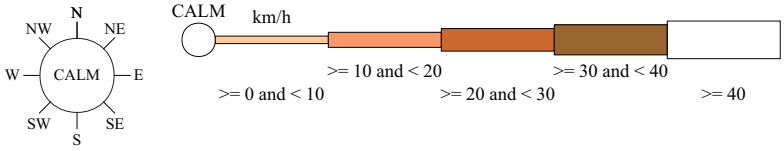
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

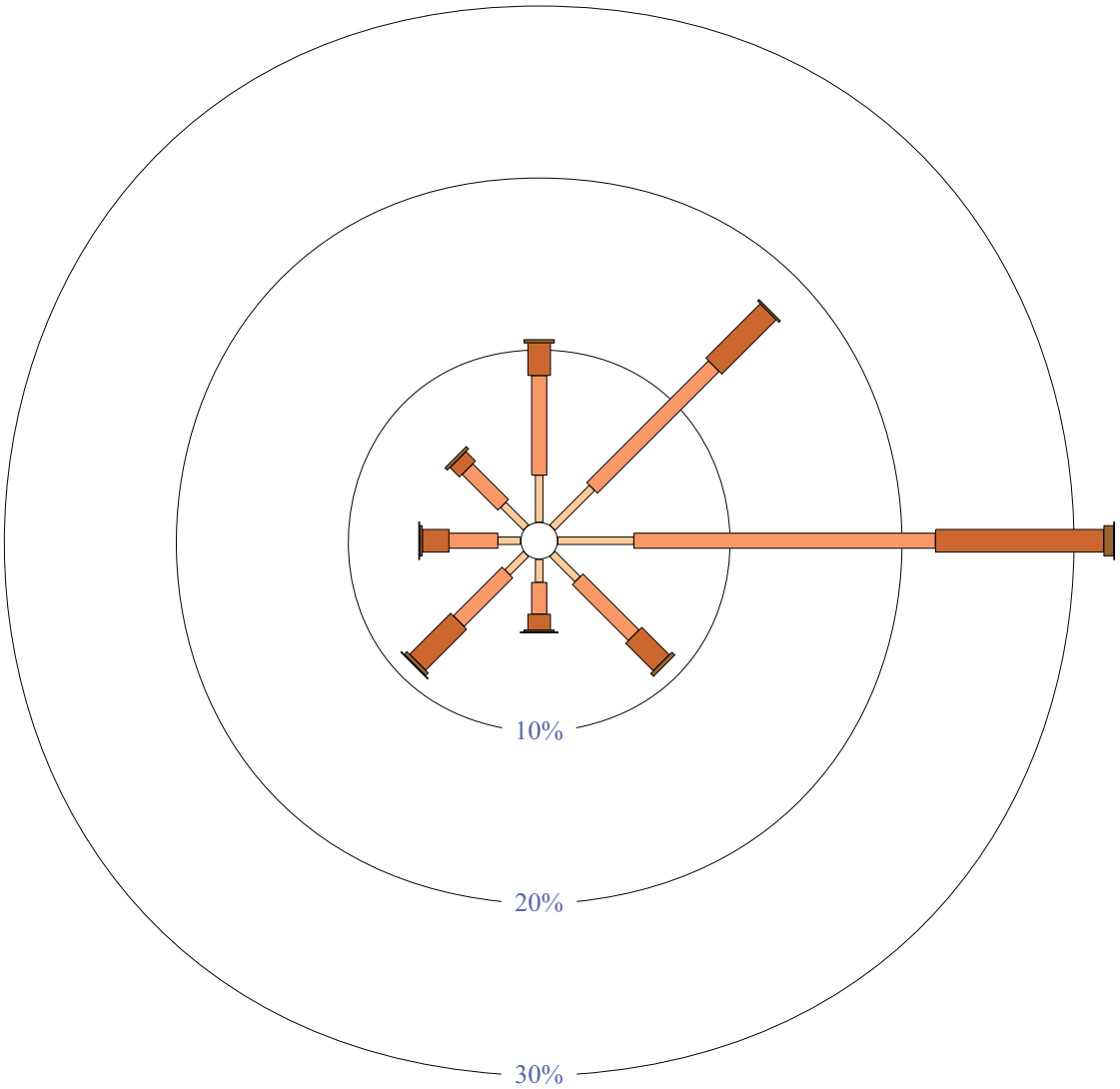
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Sep
2155 Total Observations

Calm 5%



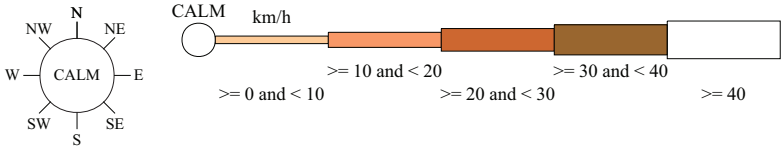
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 28 Feb 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

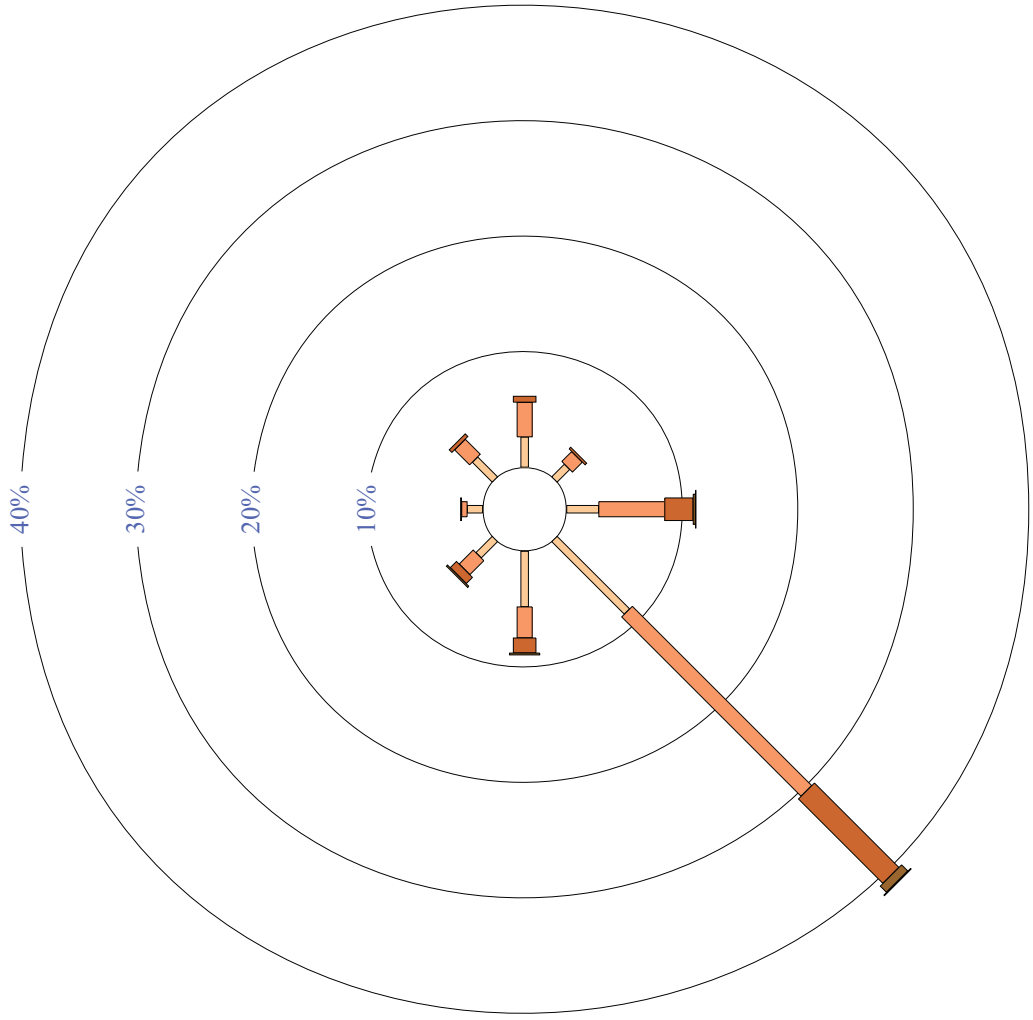
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
25715 Total Observations

Calm 18%



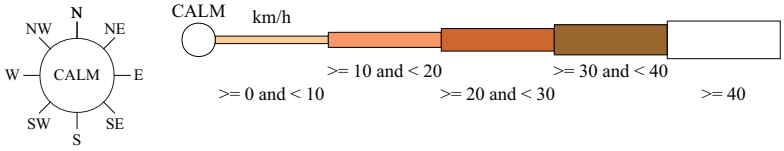
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

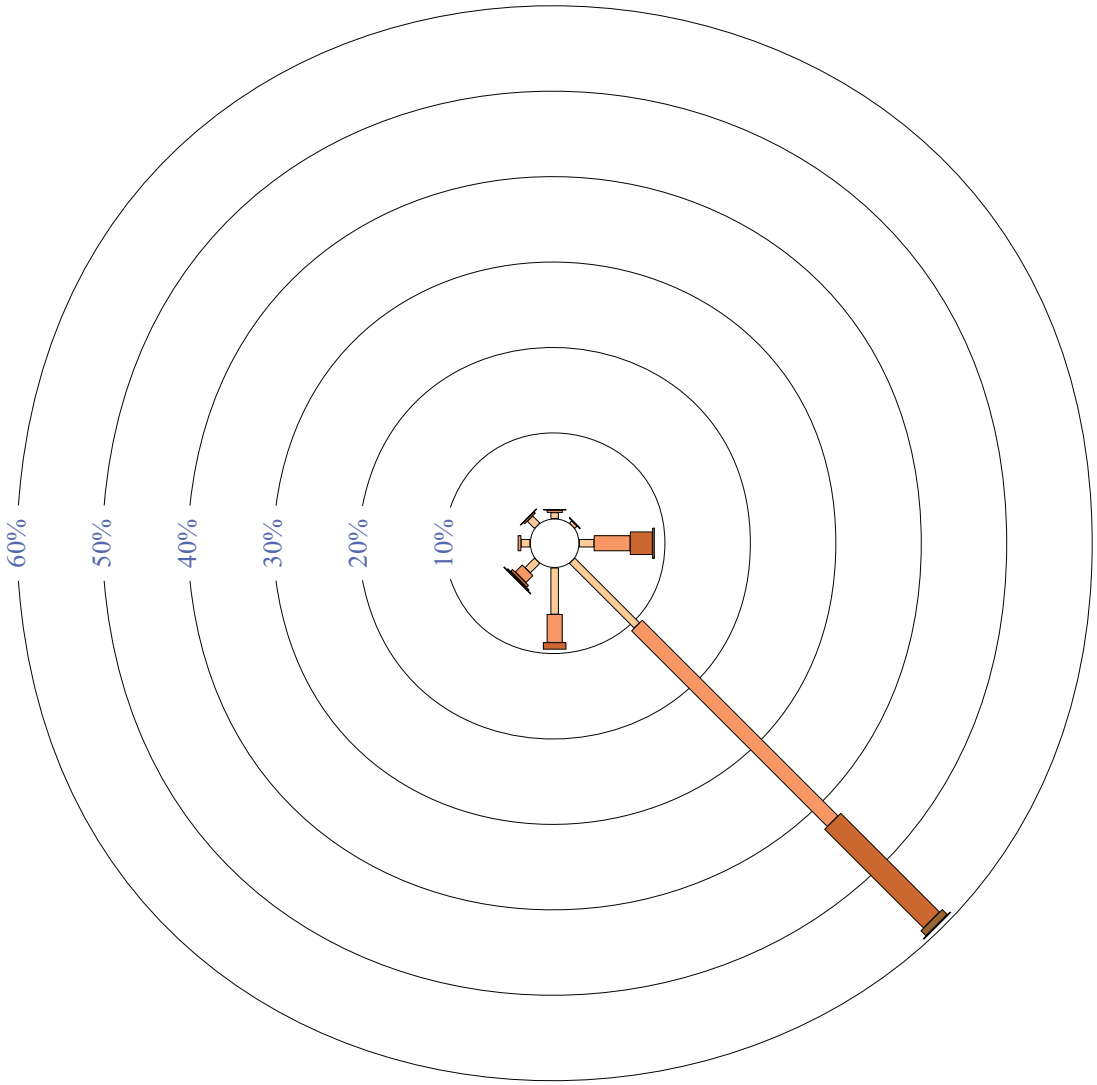
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Apr
2156 Total Observations

Calm 14%



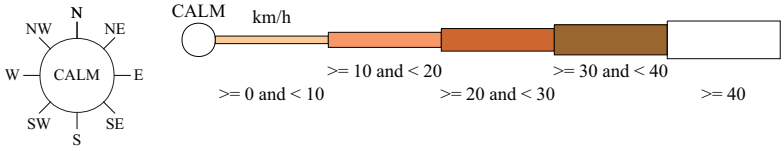
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

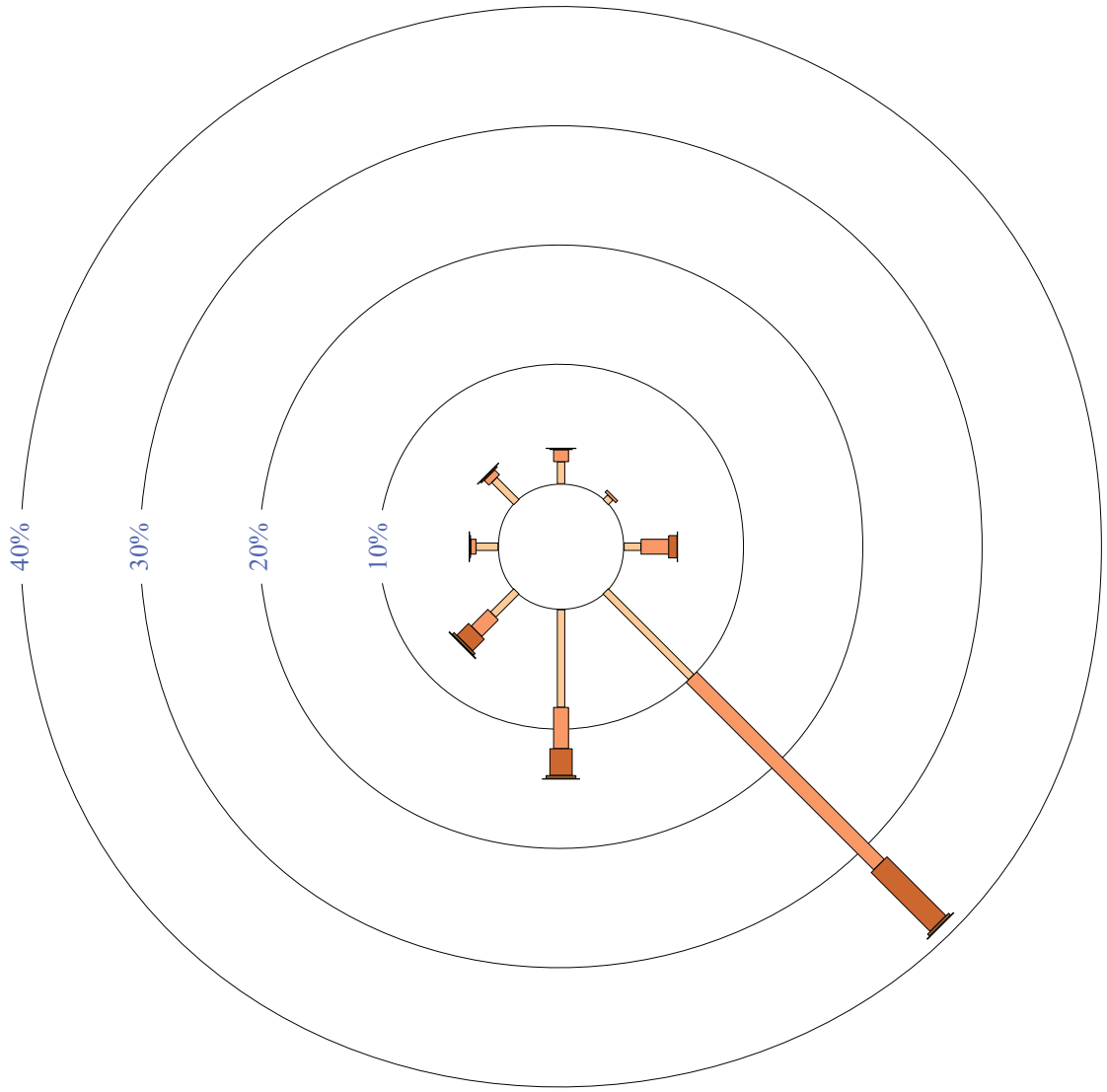
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Aug
2223 Total Observations

Calm 26%



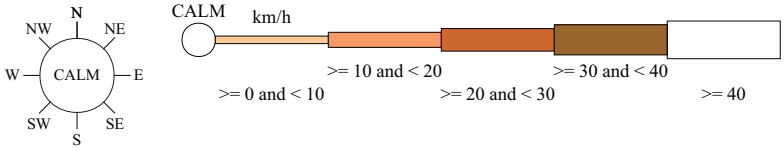
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

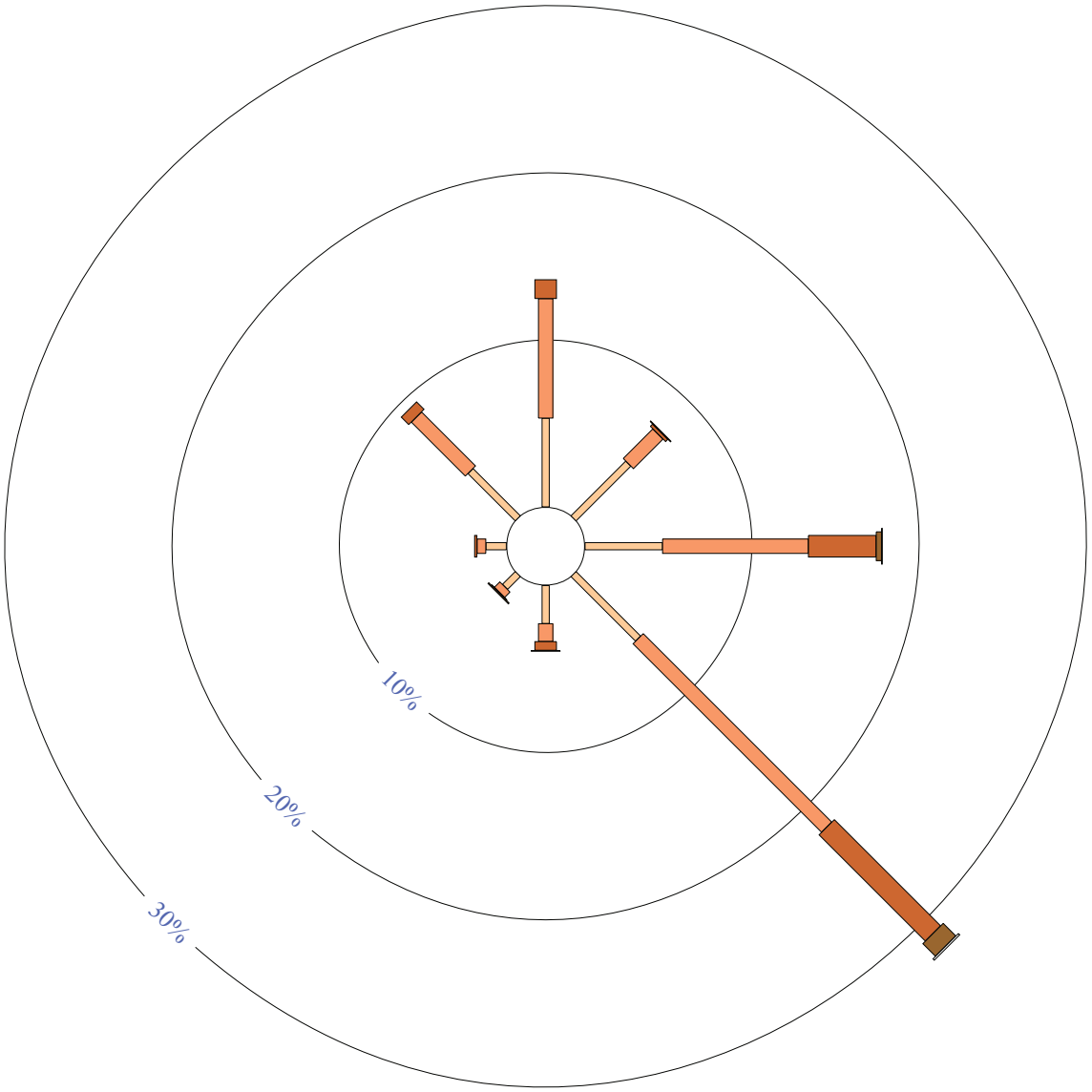
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Dec
2190 Total Observations

Calm 12%



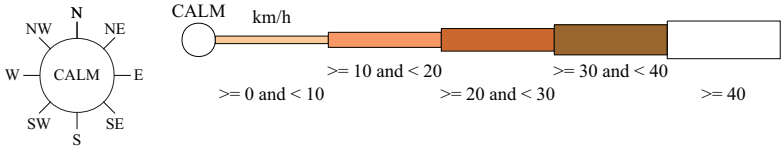
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

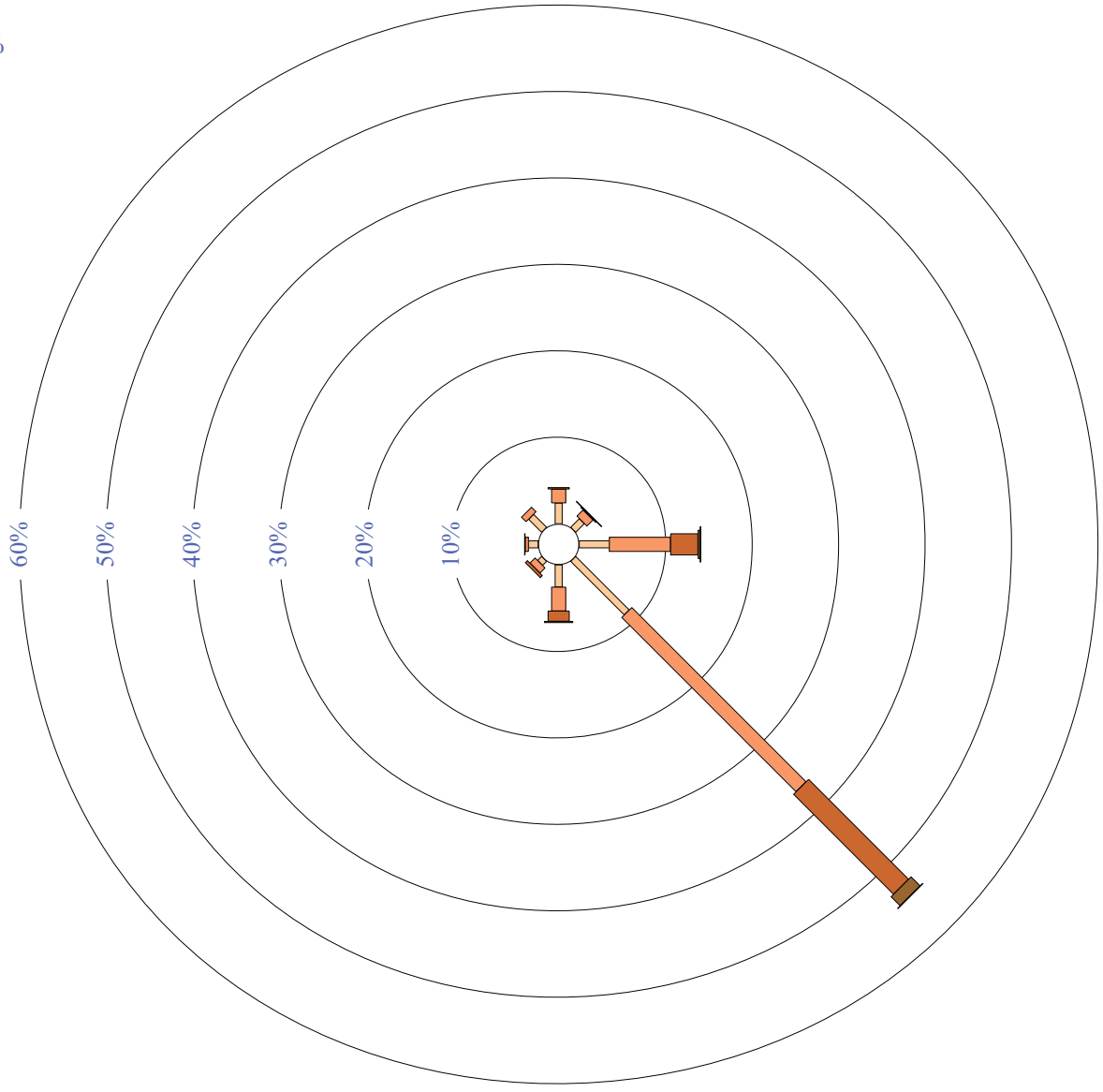
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Feb
1969 Total Observations

Calm 12%



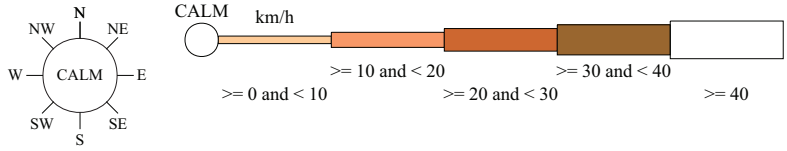
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

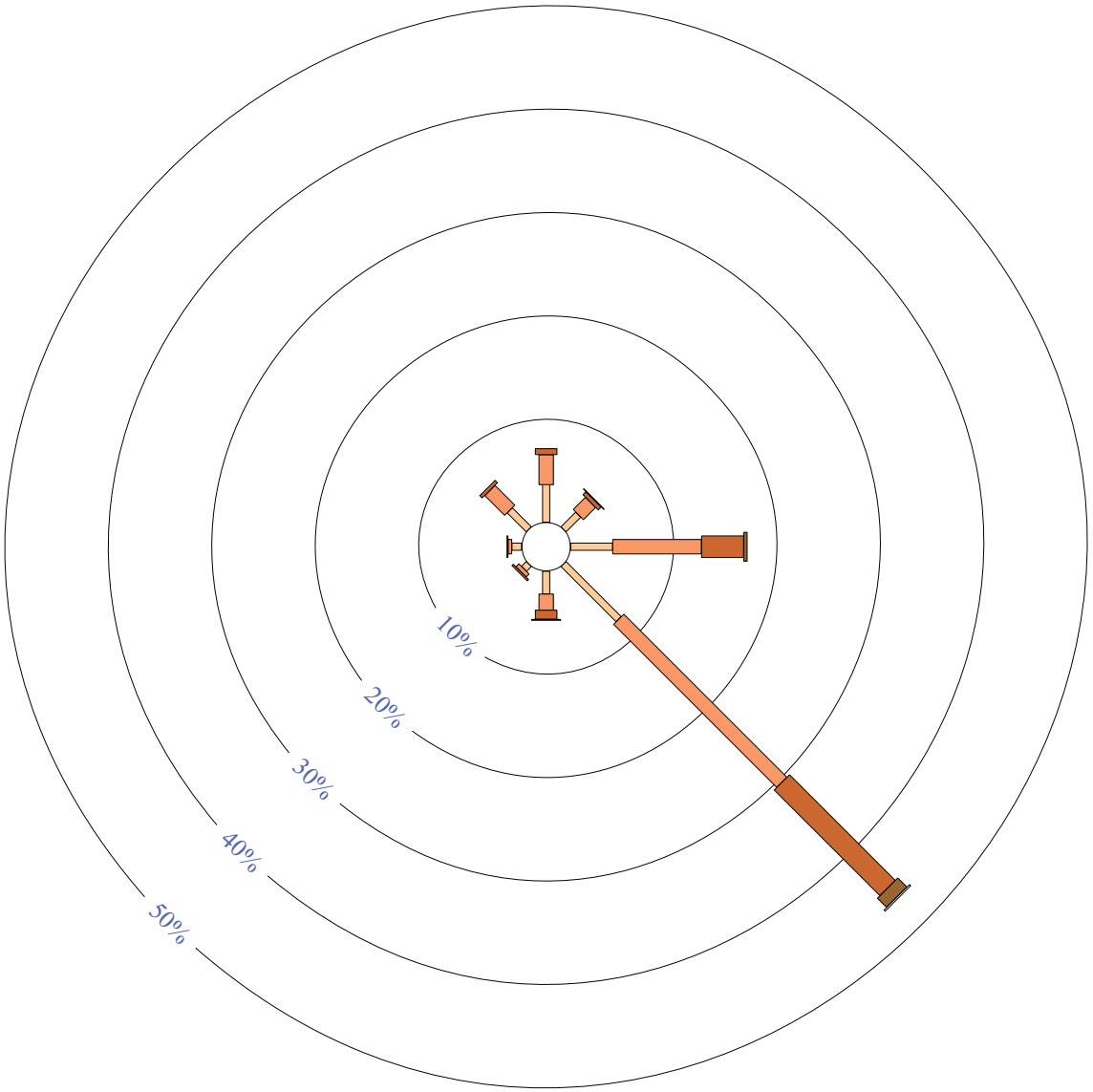
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jan
2168 Total Observations

Calm 12%



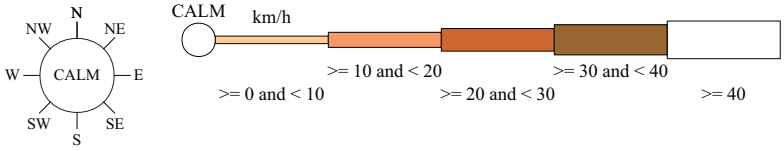
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

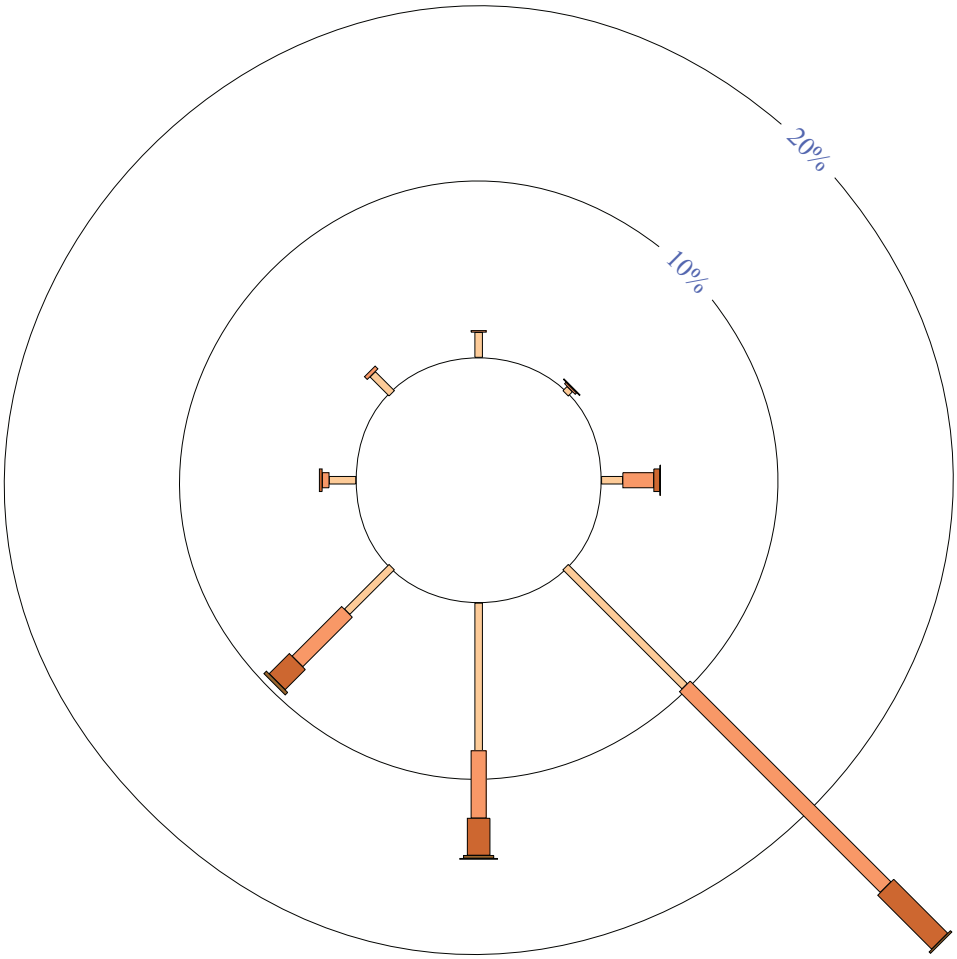
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jul
2214 Total Observations

Calm 36%



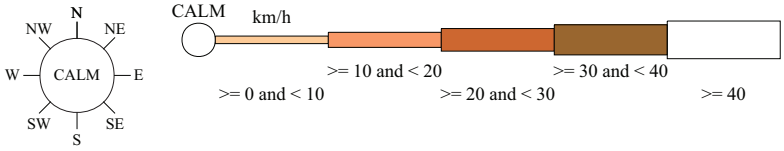
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

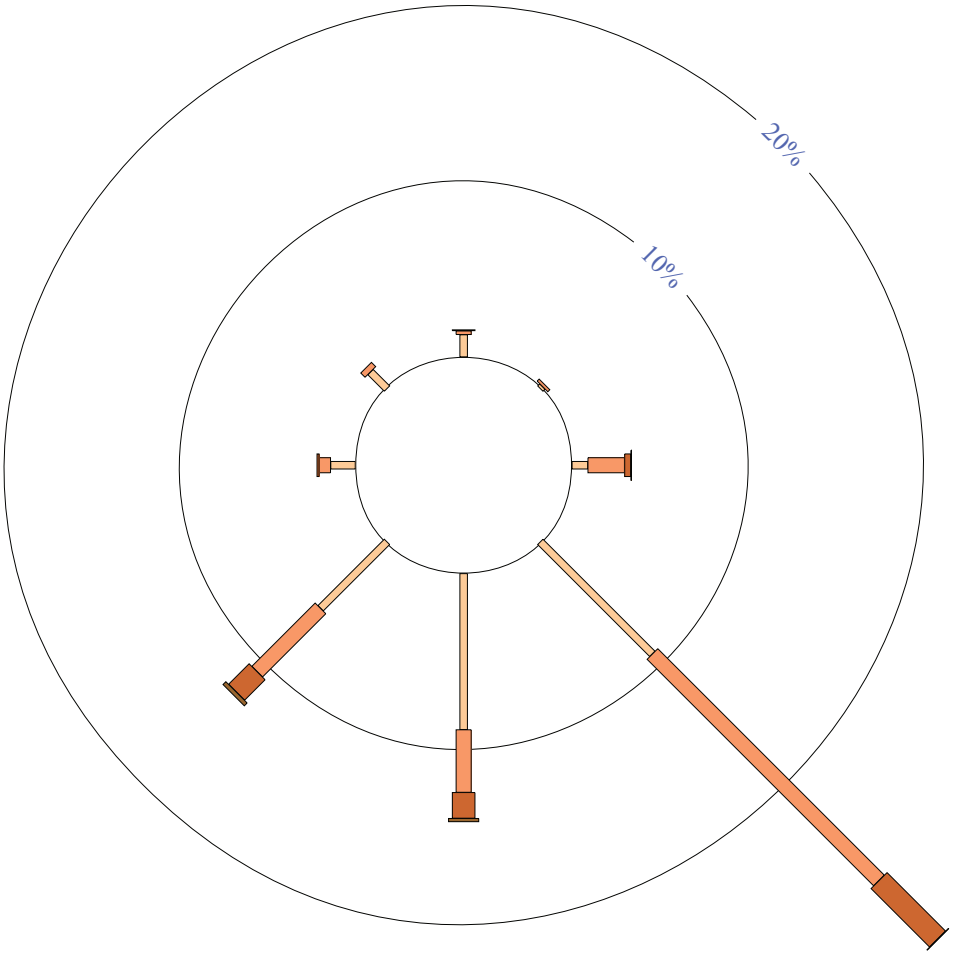
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jun
2148 Total Observations

Calm 31%



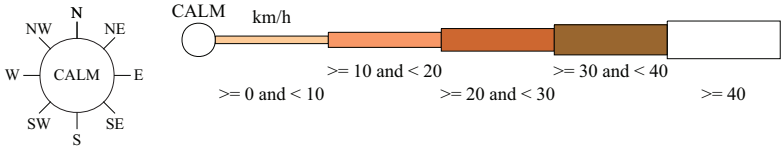
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

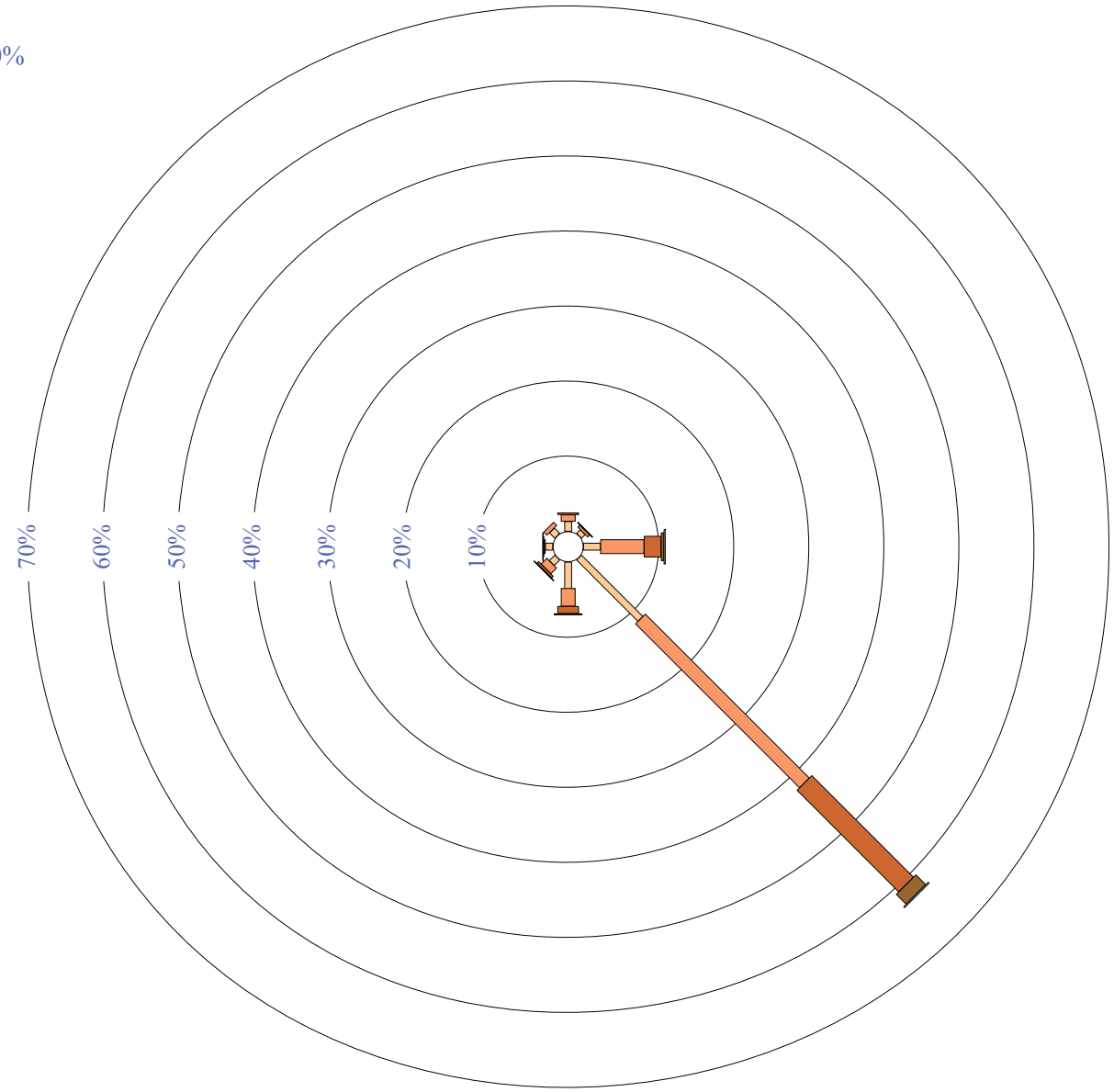
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Mar
2167 Total Observations

Calm 10%



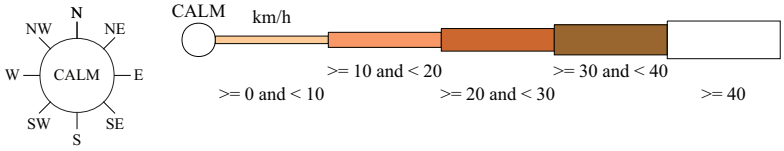
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

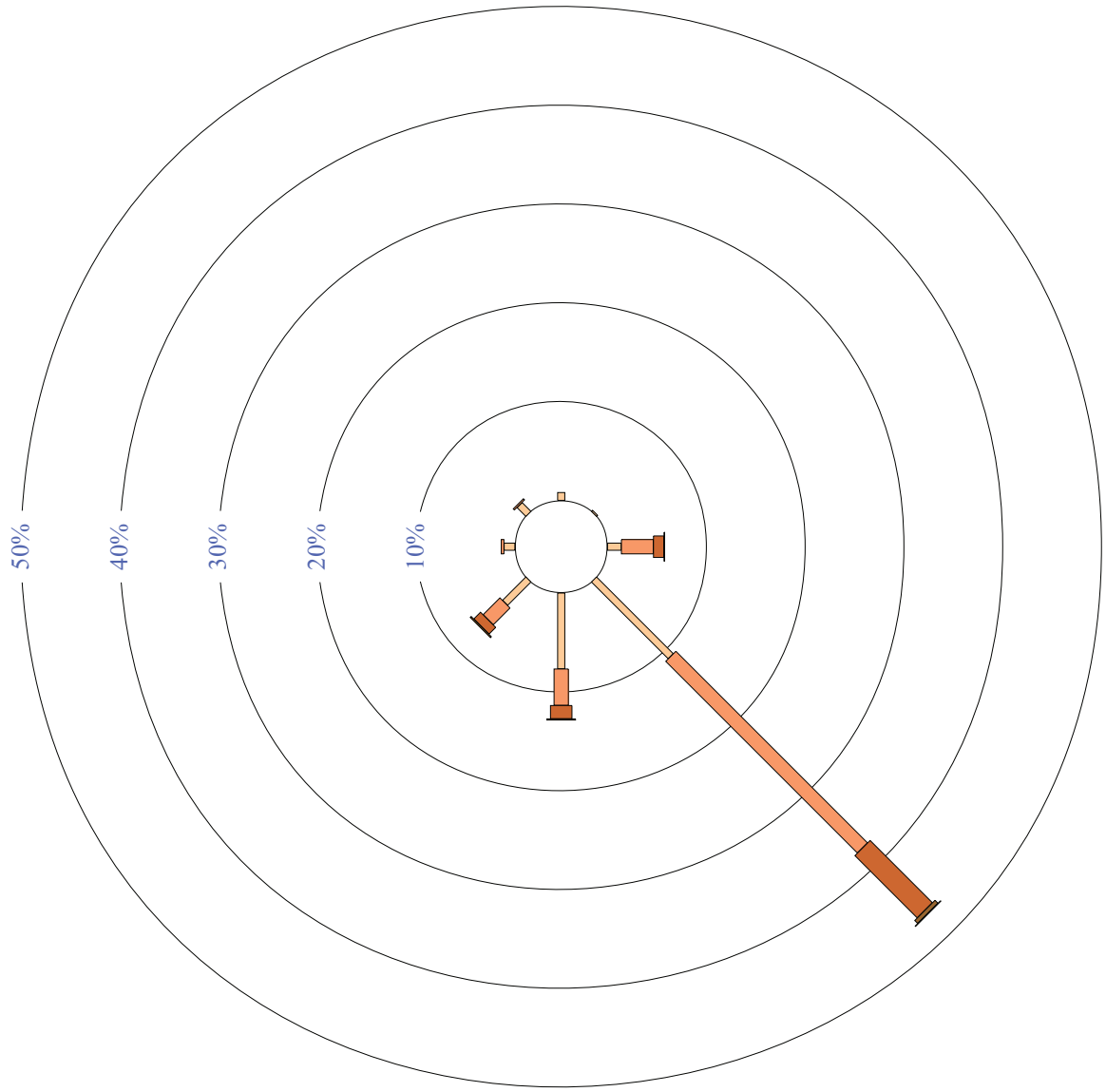
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am May
2219 Total Observations

Calm 23%



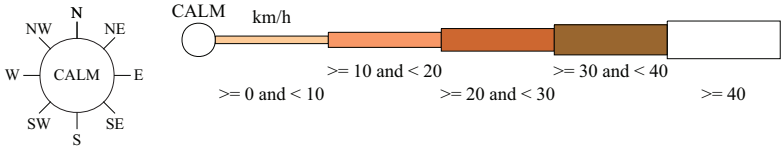
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

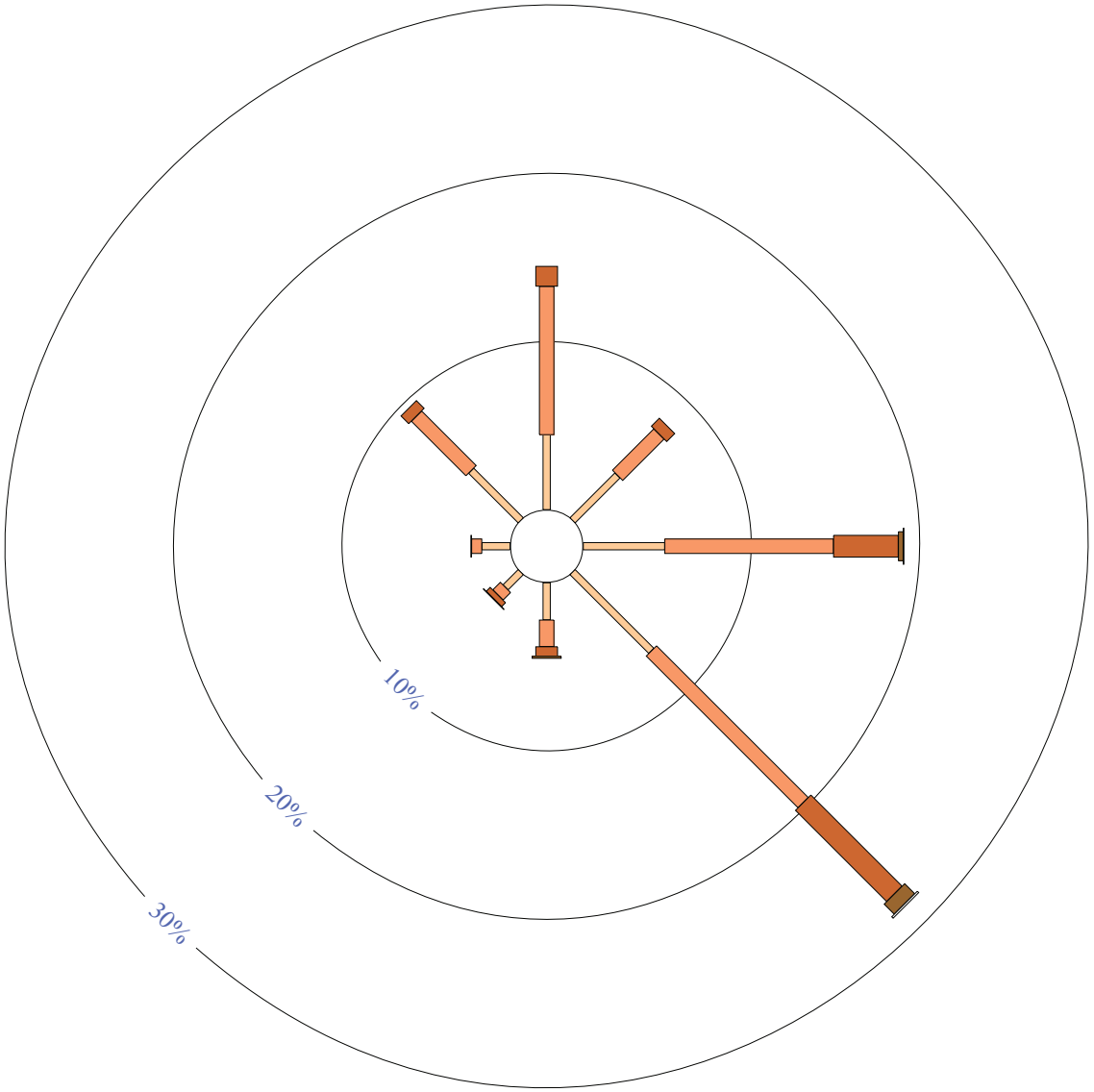
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Nov
2127 Total Observations

Calm 11%



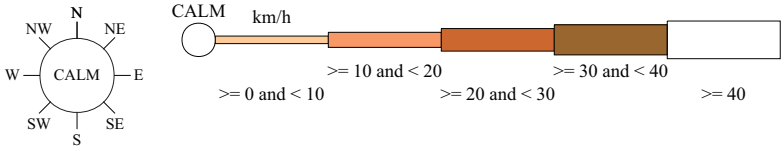
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

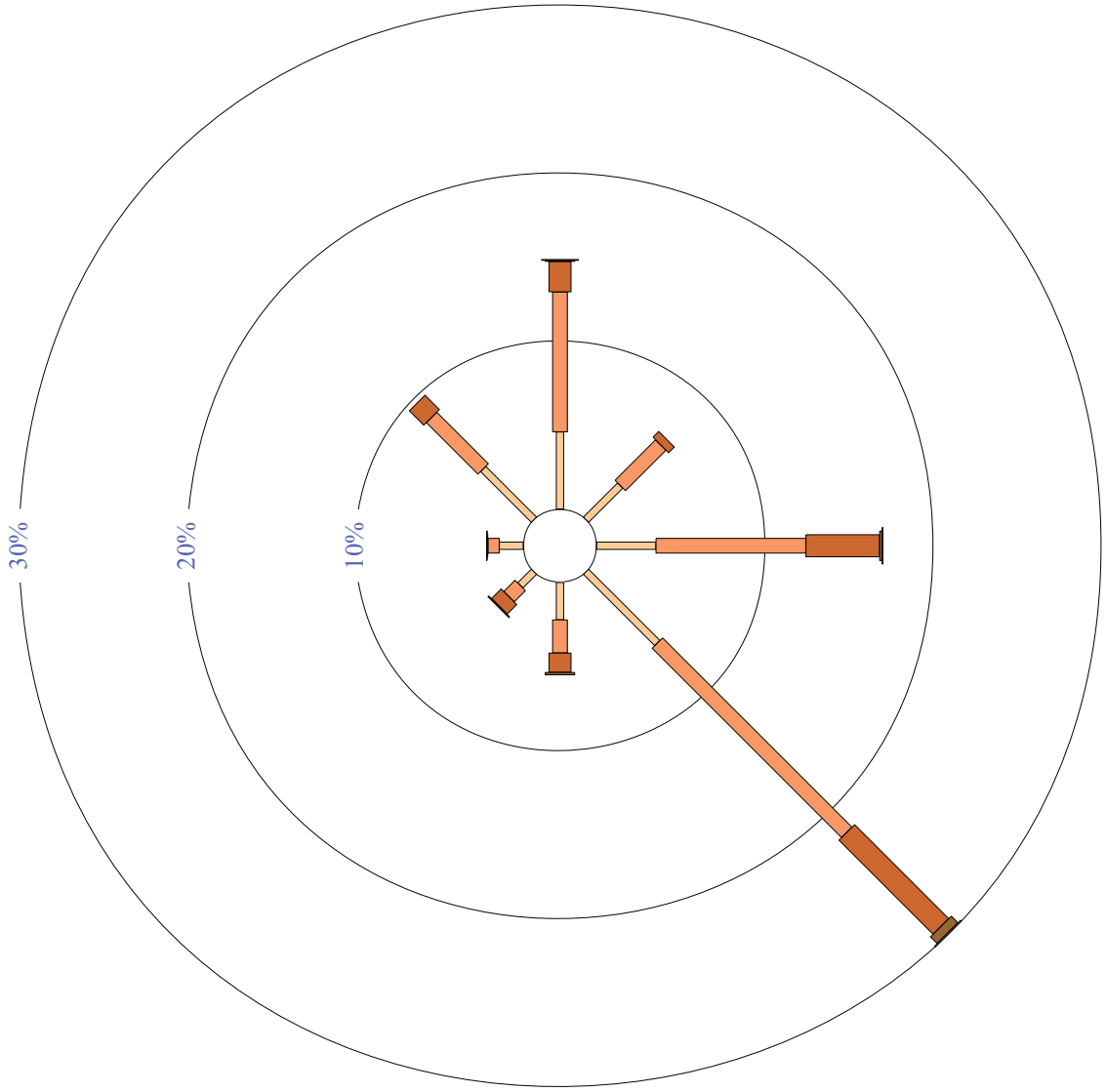
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Oct
2195 Total Observations

Calm 11%



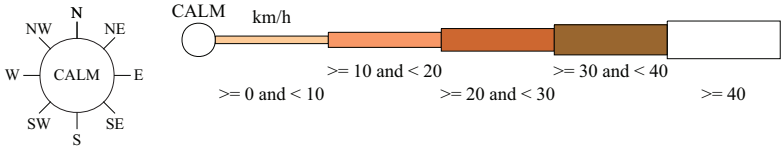
Rose of Wind direction versus Wind speed in km/h (01 Apr 1939 to 30 Sep 2010)

Custom times selected, refer to attached note for details

ROCKHAMPTON AERO

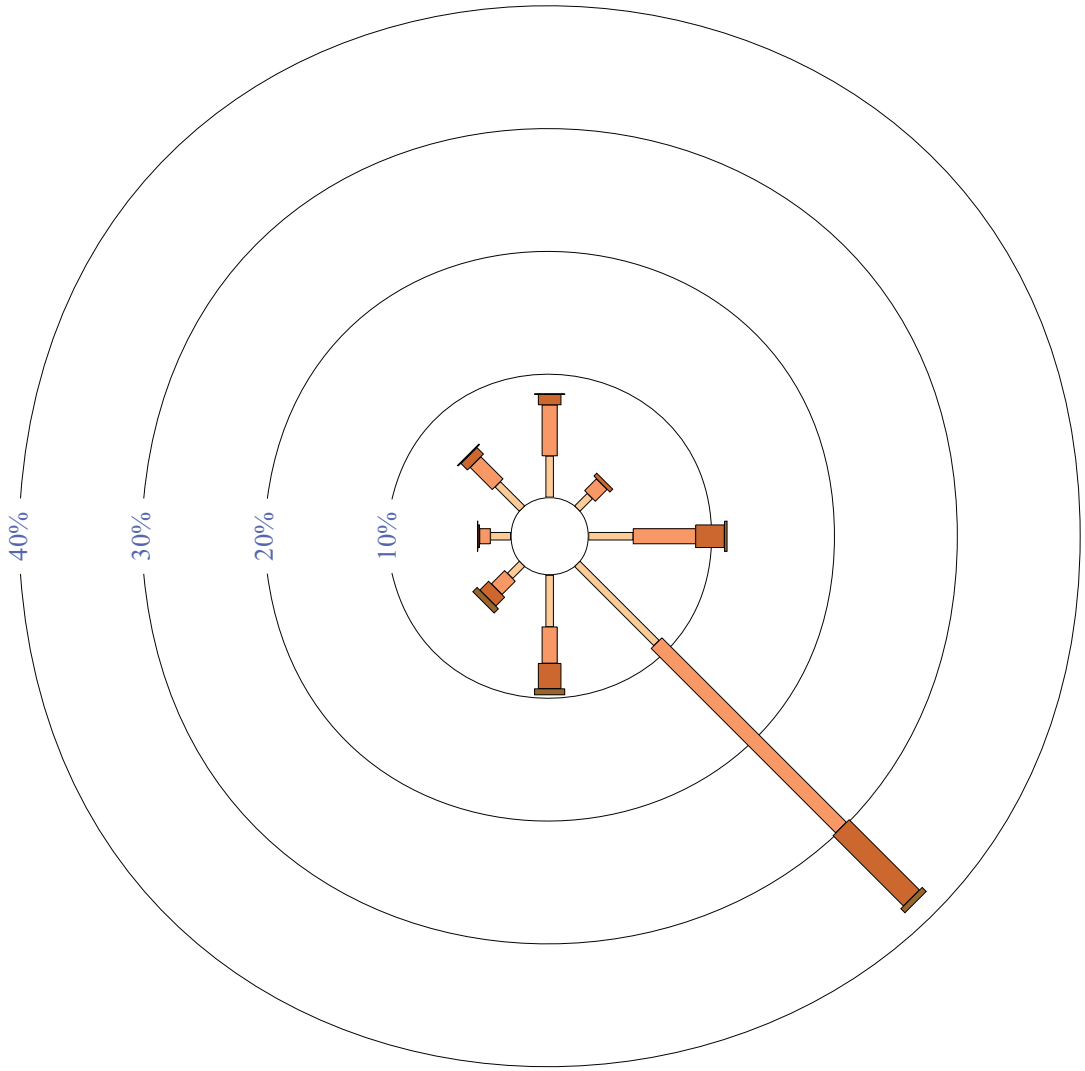
Site No: 039083 • Opened Jan 1939 • Still Open • Latitude: -23.3753° • Longitude: 150.4775° • Elevation 10.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Sep
2153 Total Observations

Calm 16%



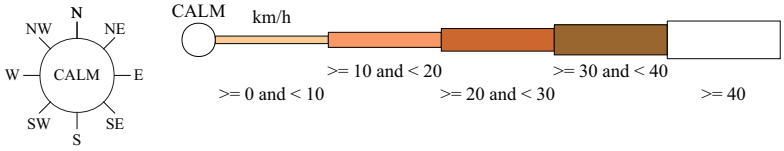
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

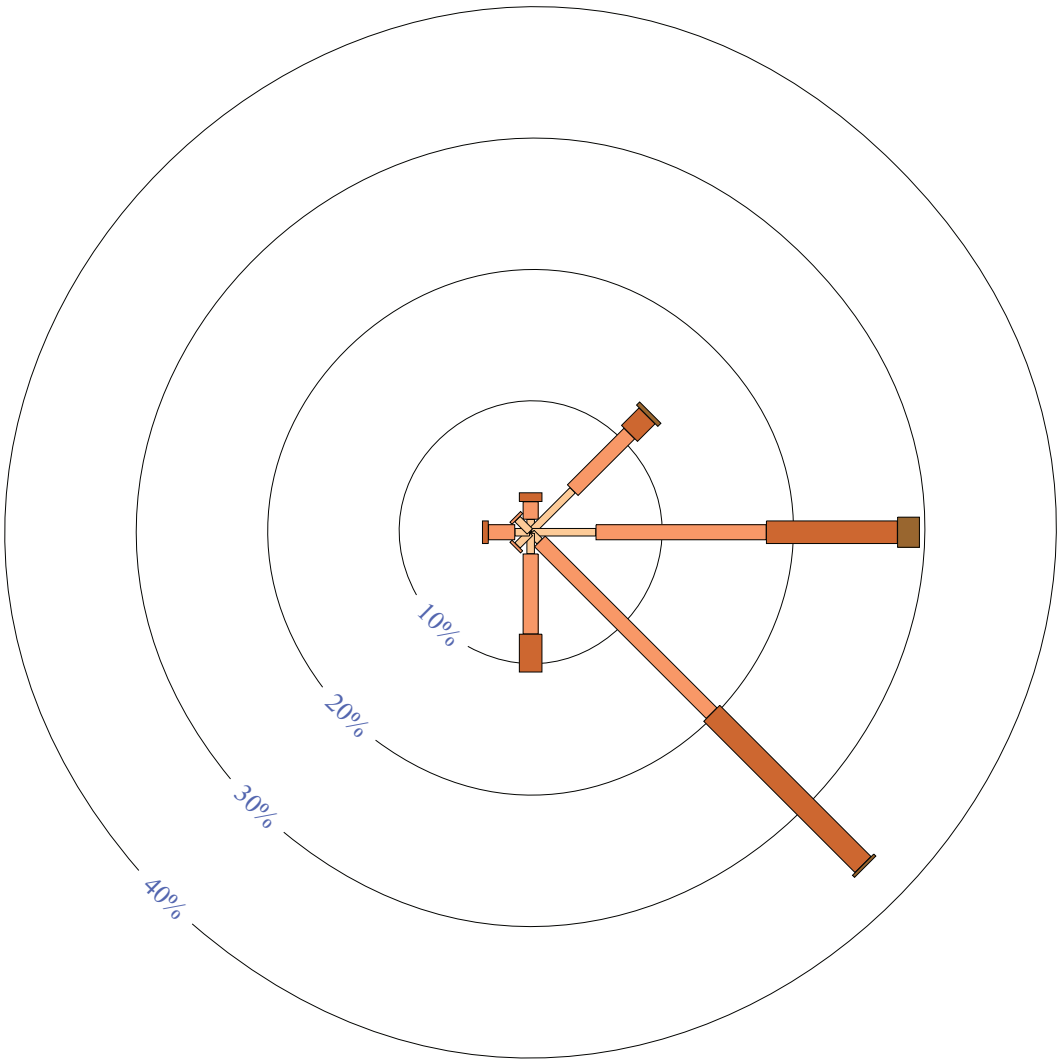
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Feb
444 Total Observations

Calm *



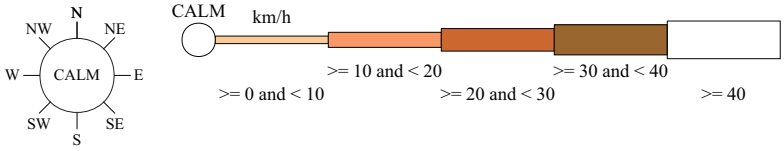
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

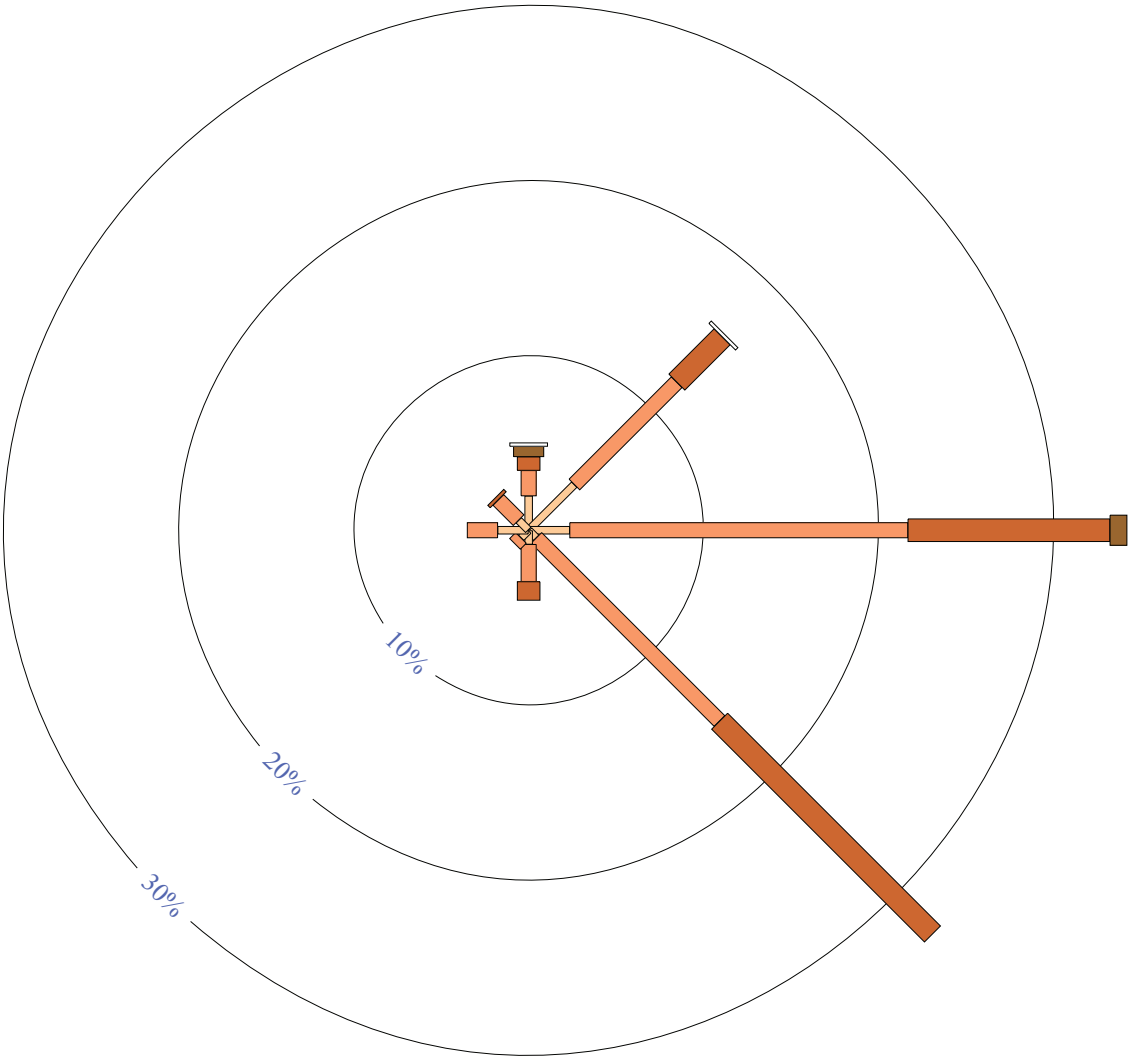
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jan
512 Total Observations

Calm *



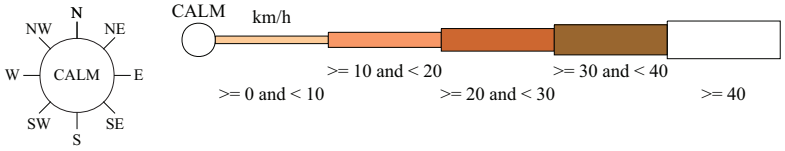
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

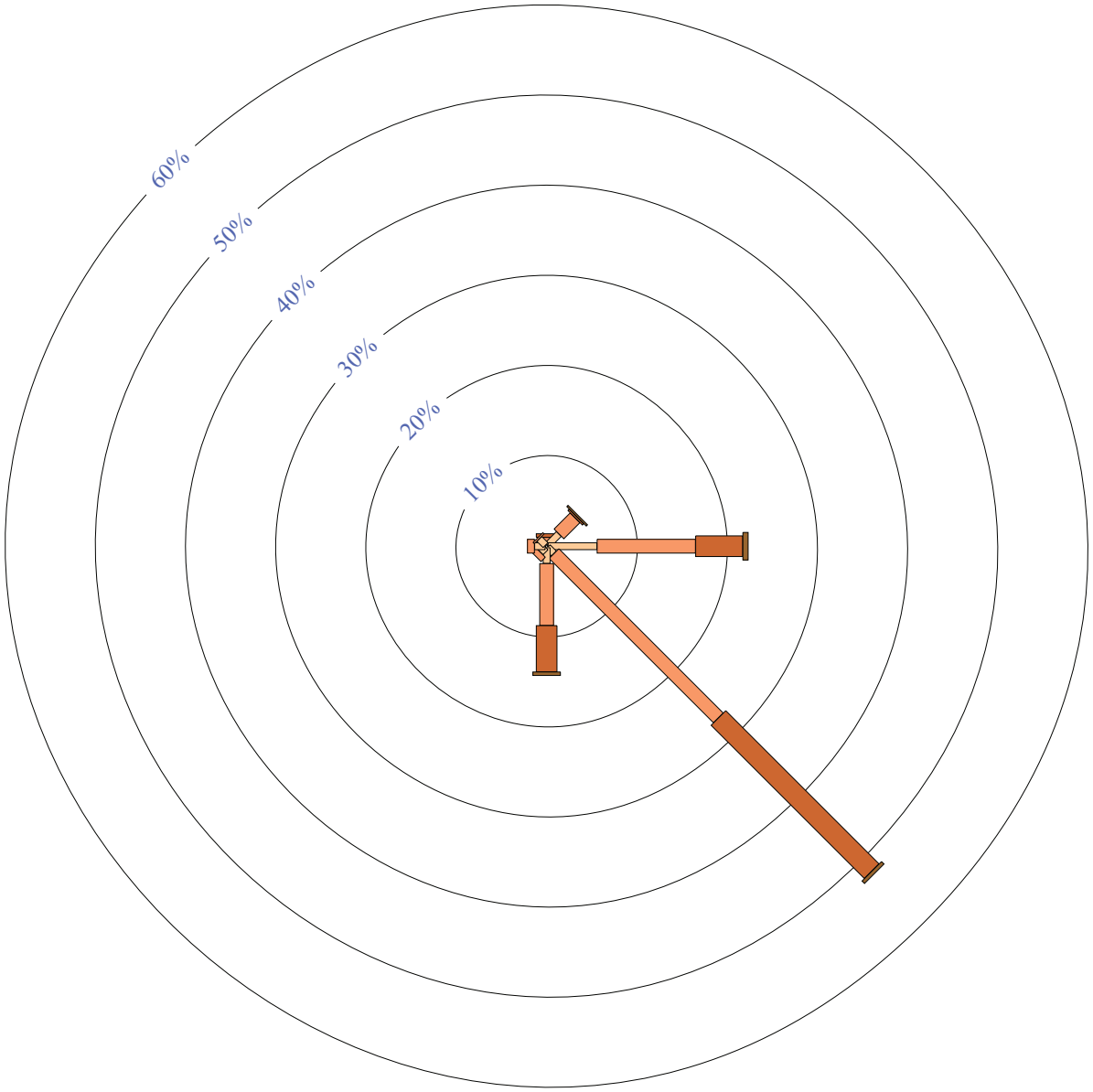
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Mar
509 Total Observations

Calm 1%



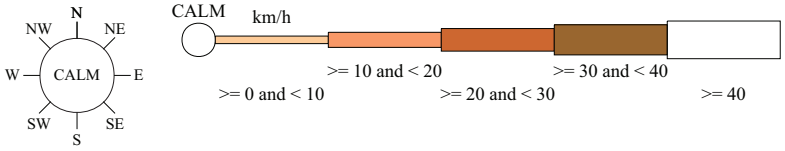
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 28 Feb 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

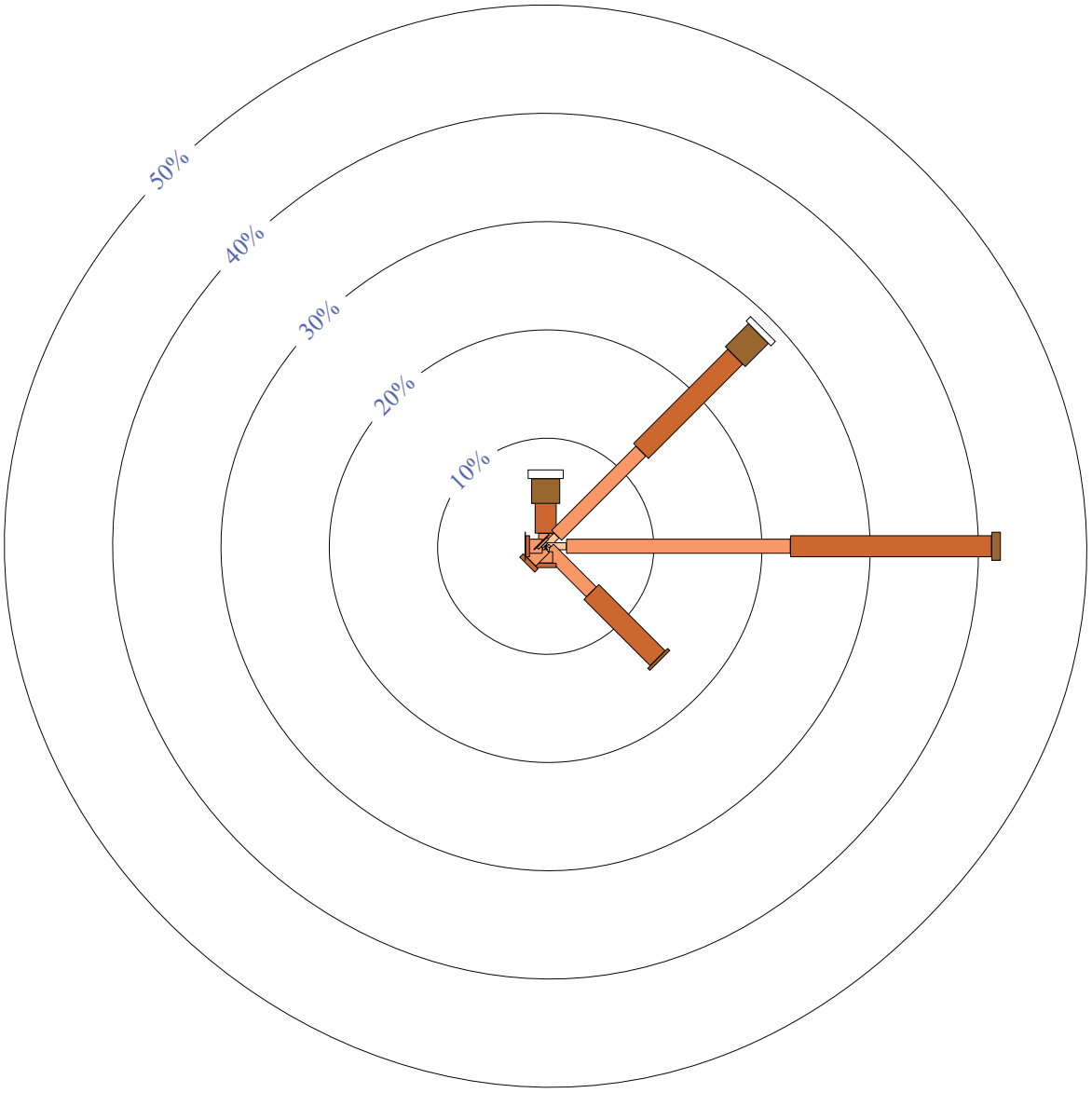
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
5809 Total Observations

Calm *



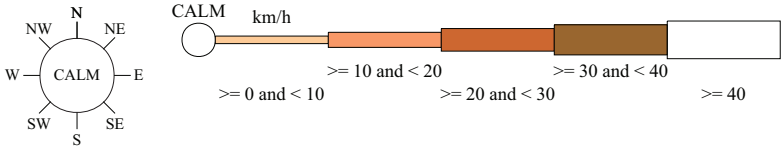
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

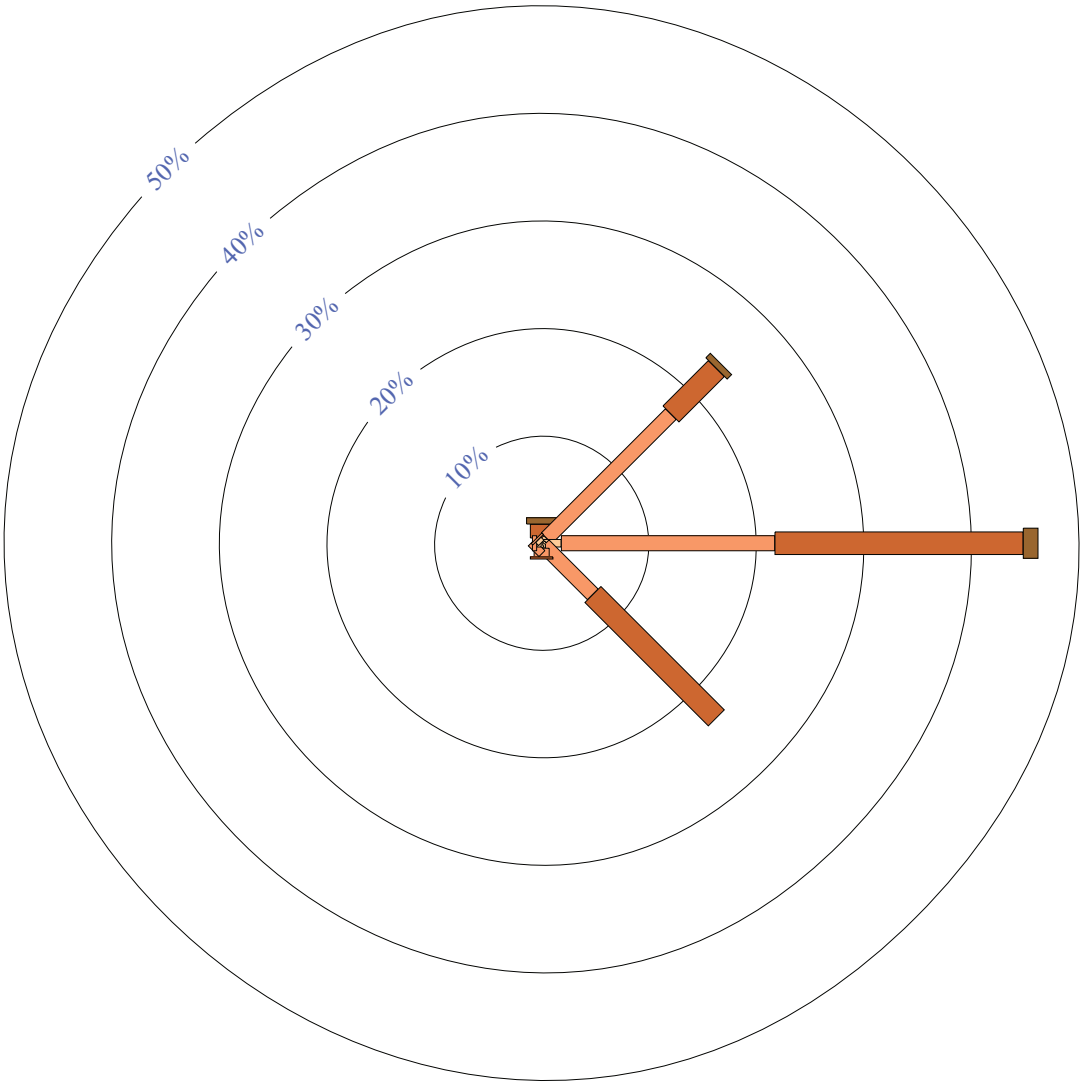
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Apr
503 Total Observations

Calm *



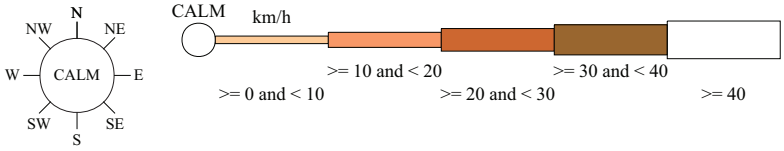
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

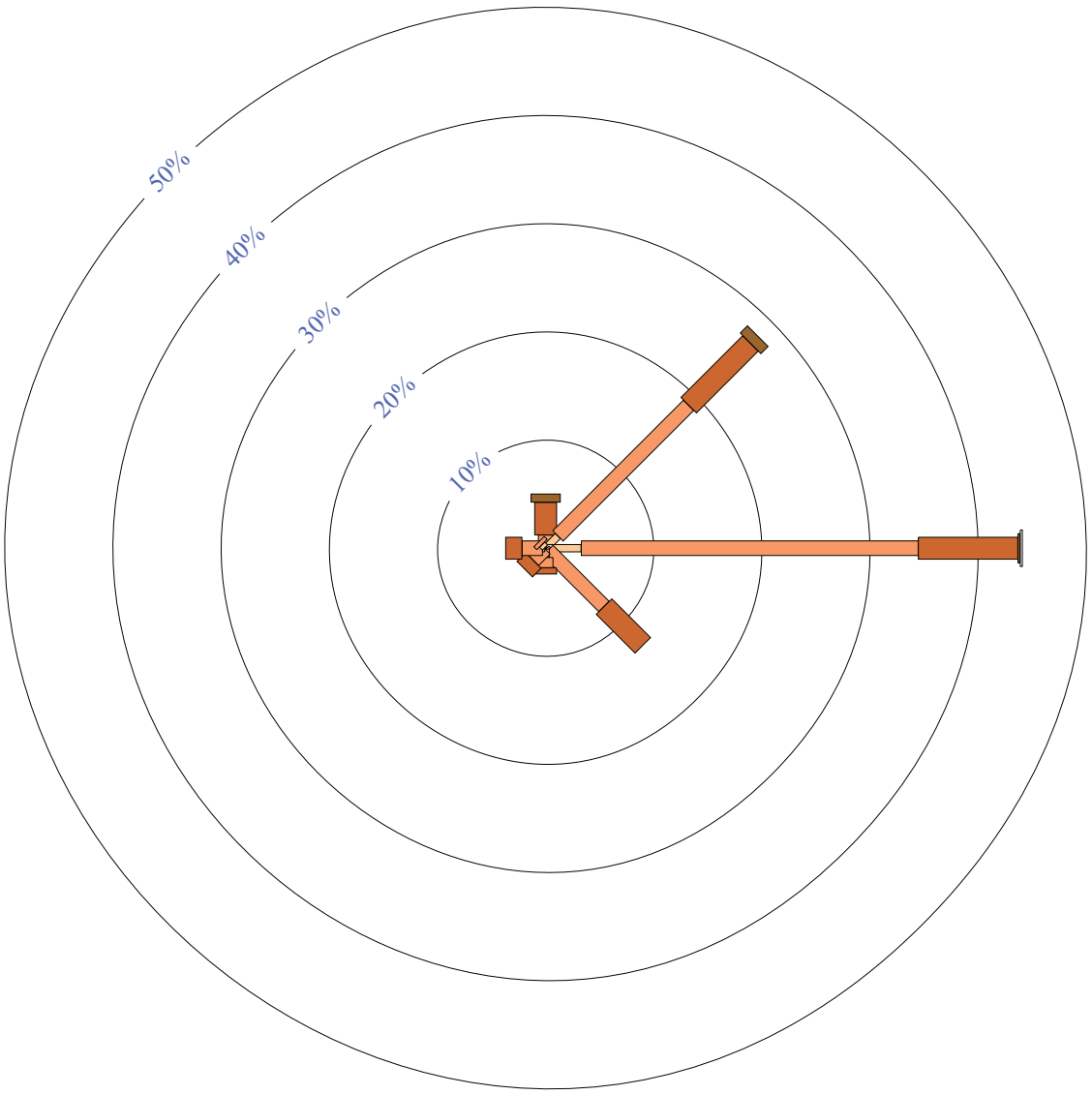
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Aug
524 Total Observations

Calm *



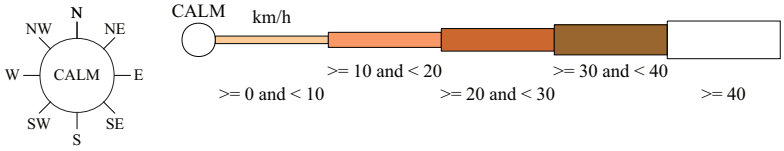
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

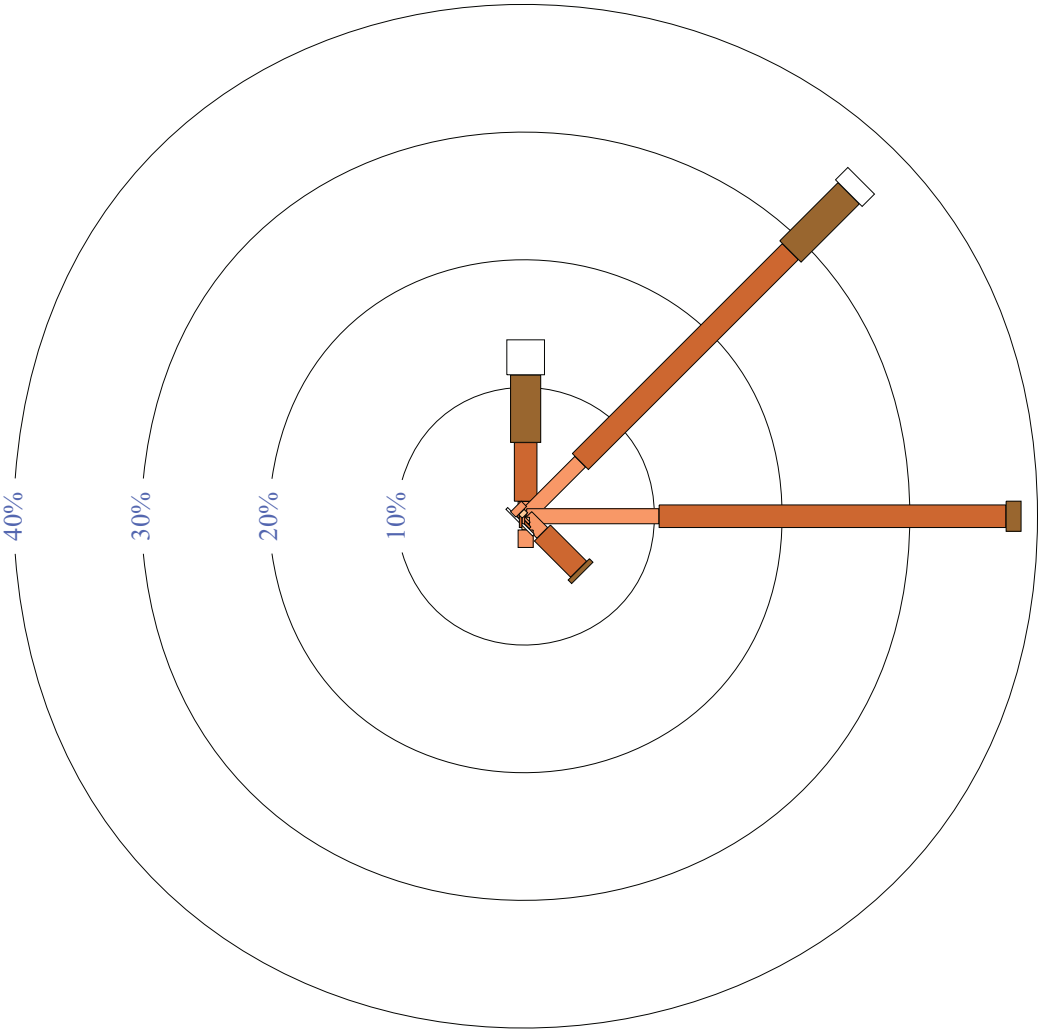
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Dec
512 Total Observations

Calm *



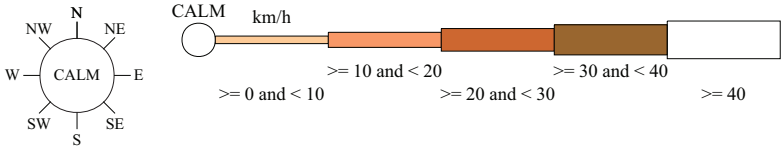
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

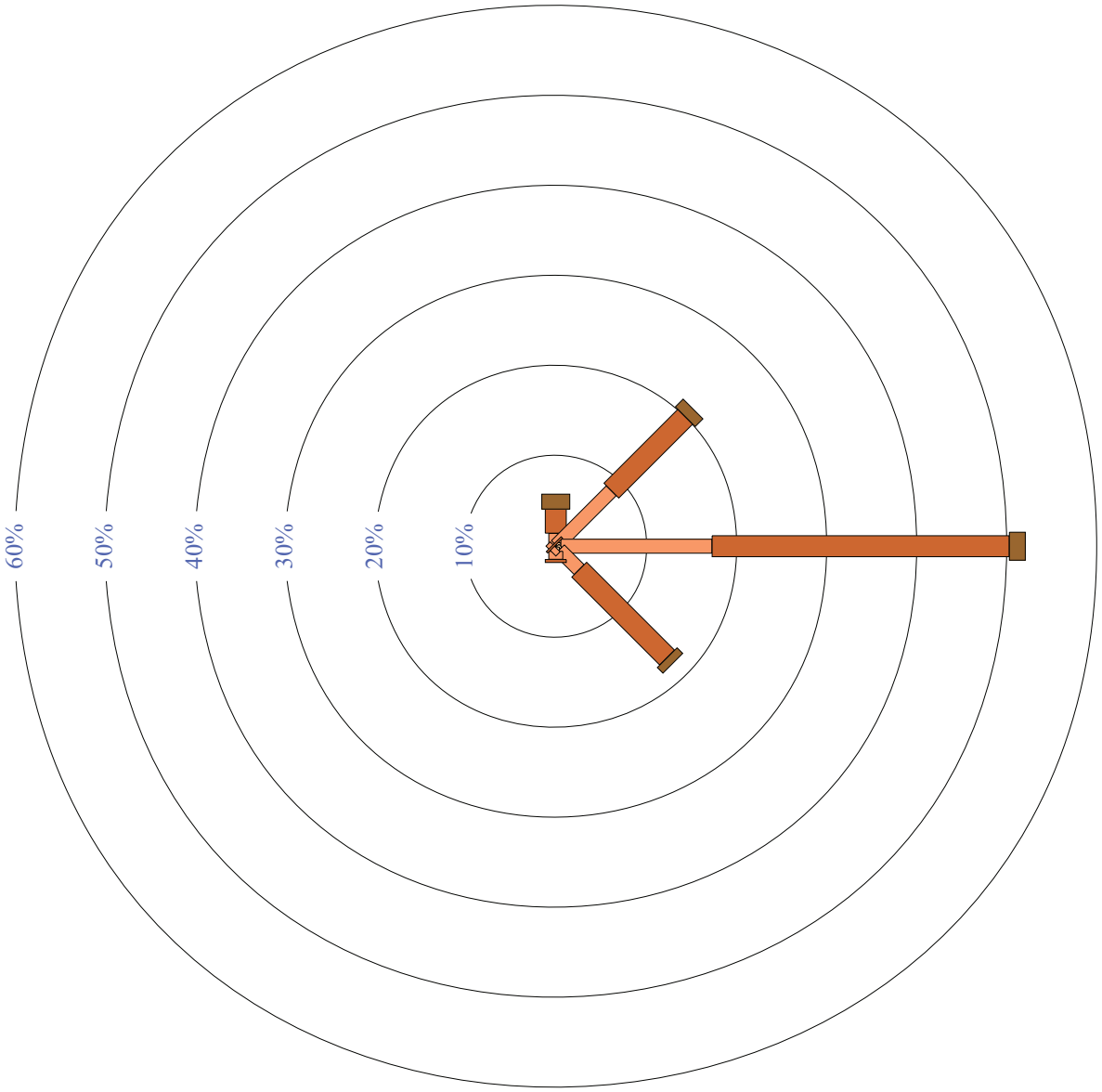
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Feb
453 Total Observations

Calm *



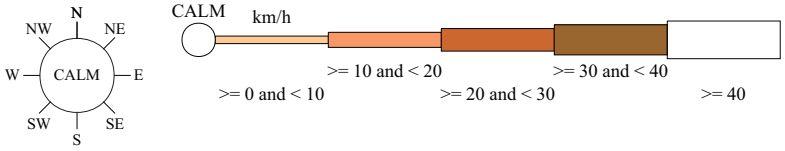
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

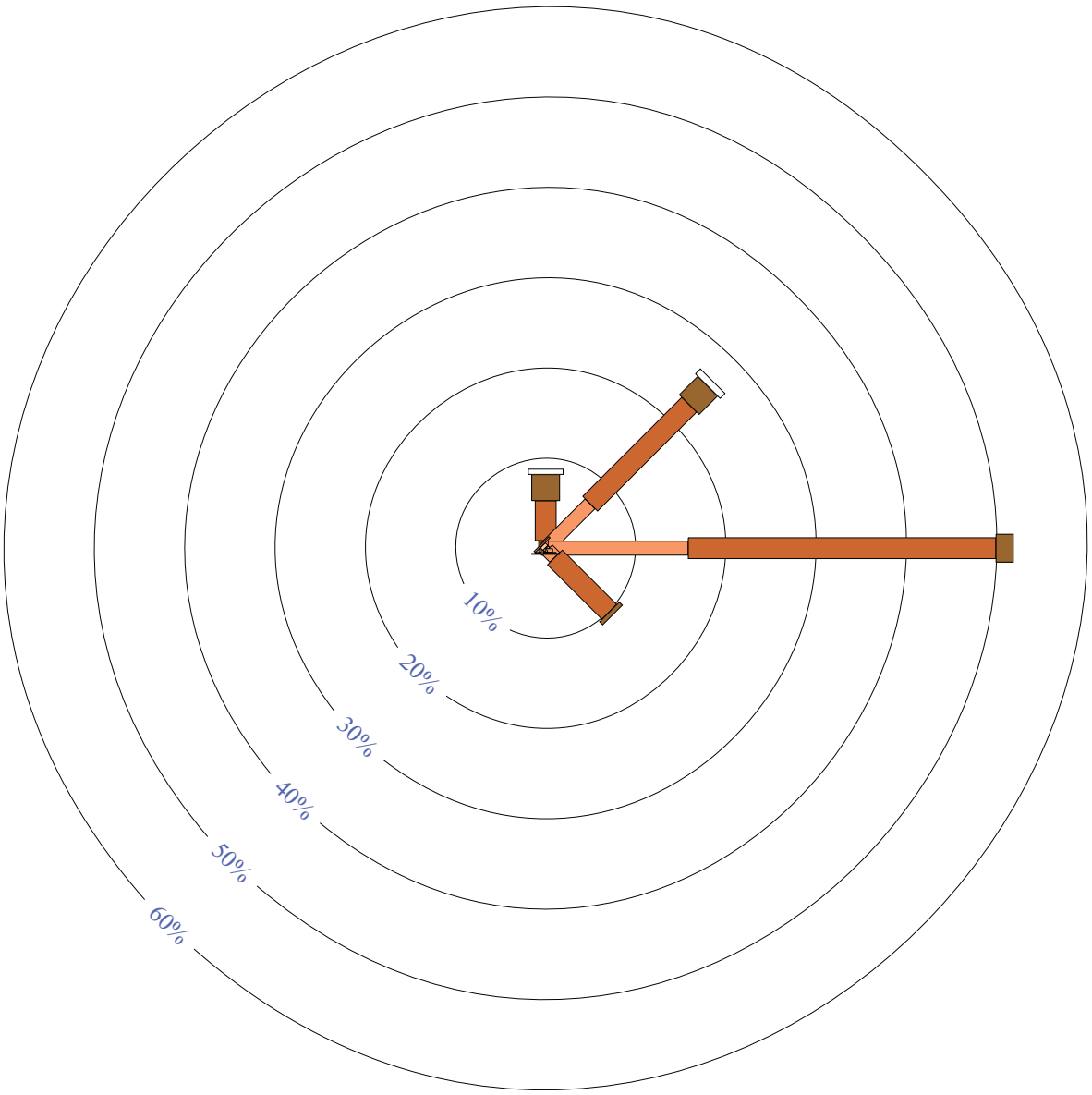
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jan
514 Total Observations

Calm *



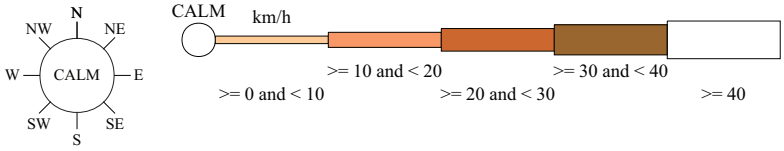
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

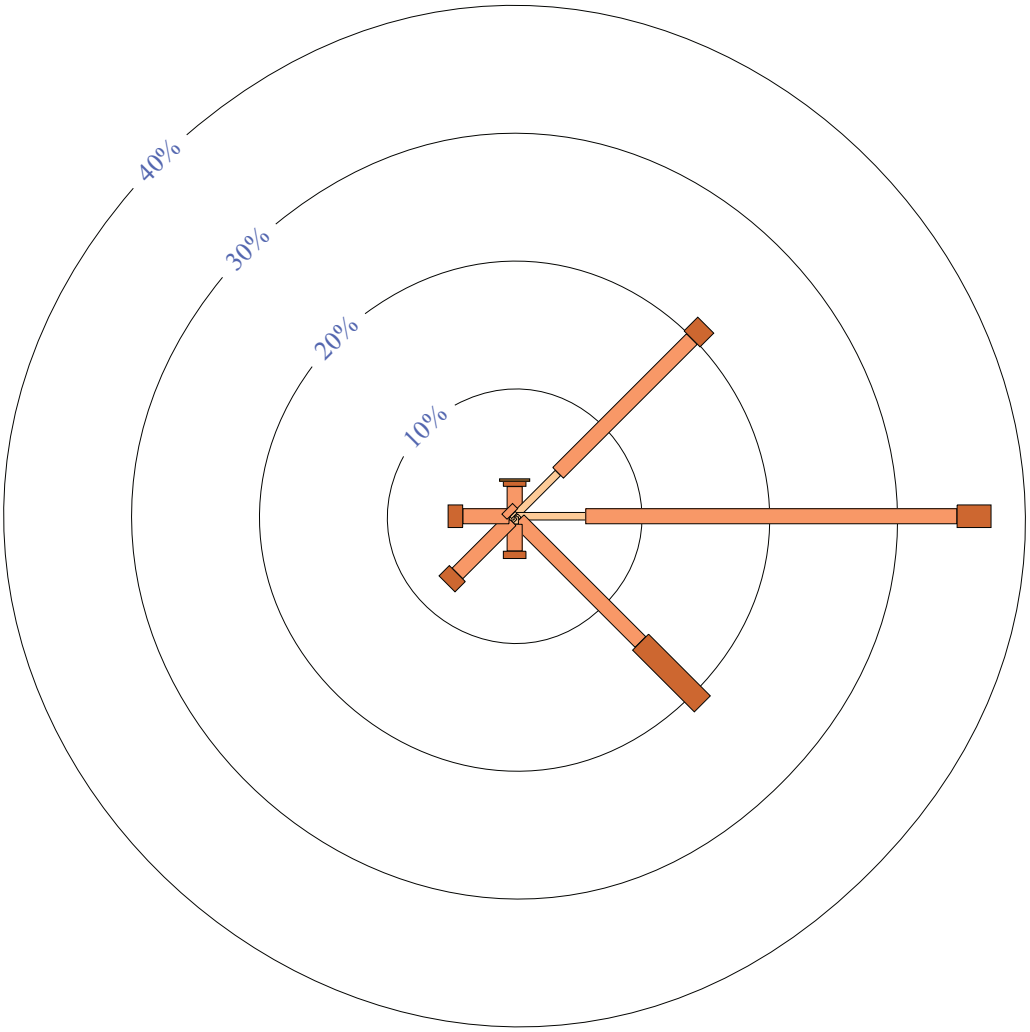
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jul
518 Total Observations

Calm *



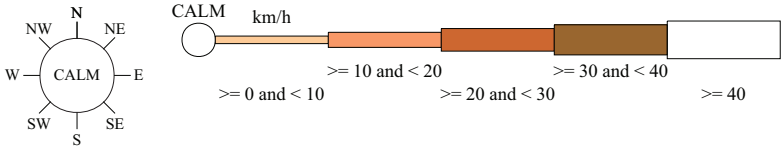
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

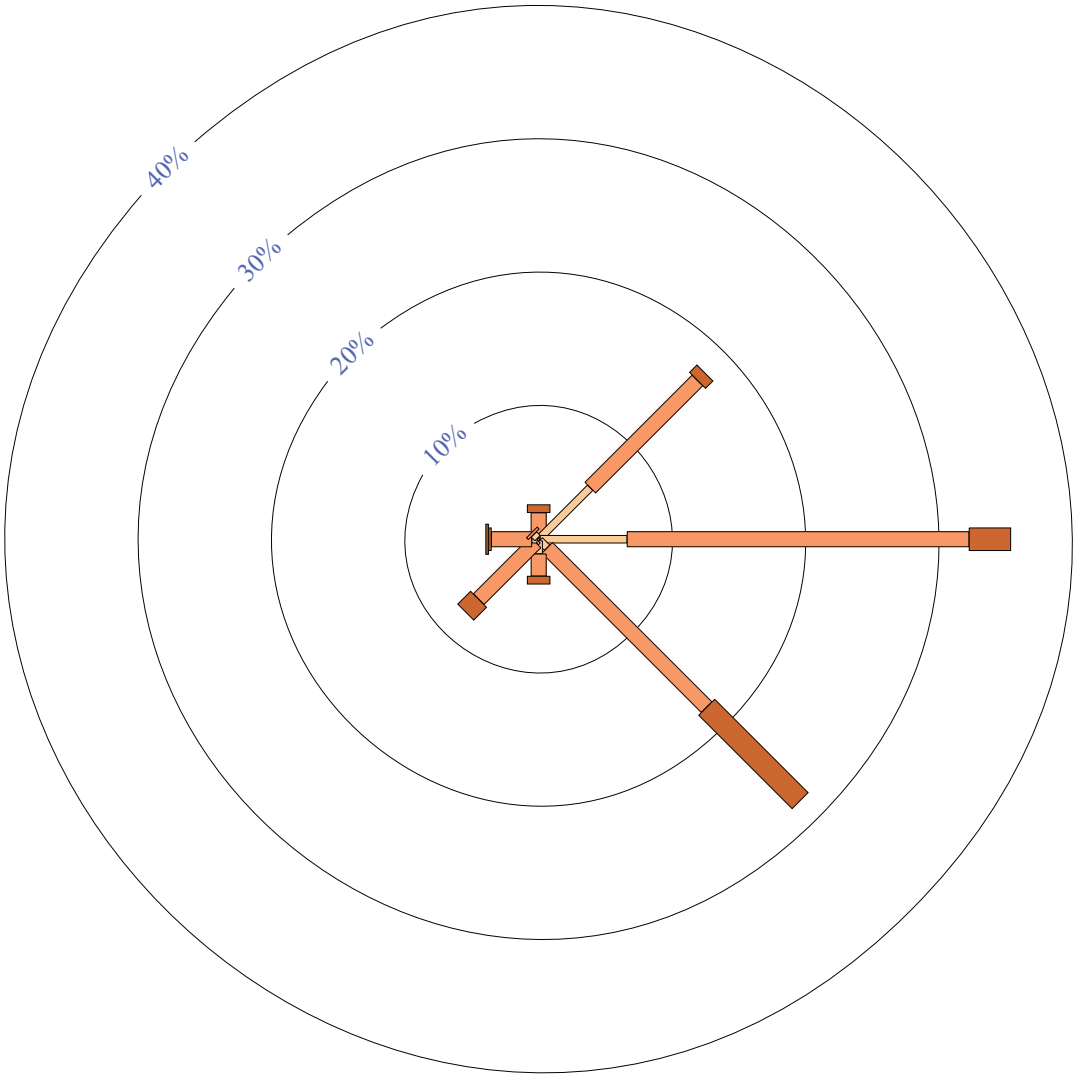
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Jun
506 Total Observations

Calm *



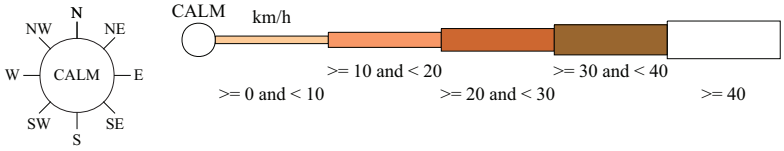
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

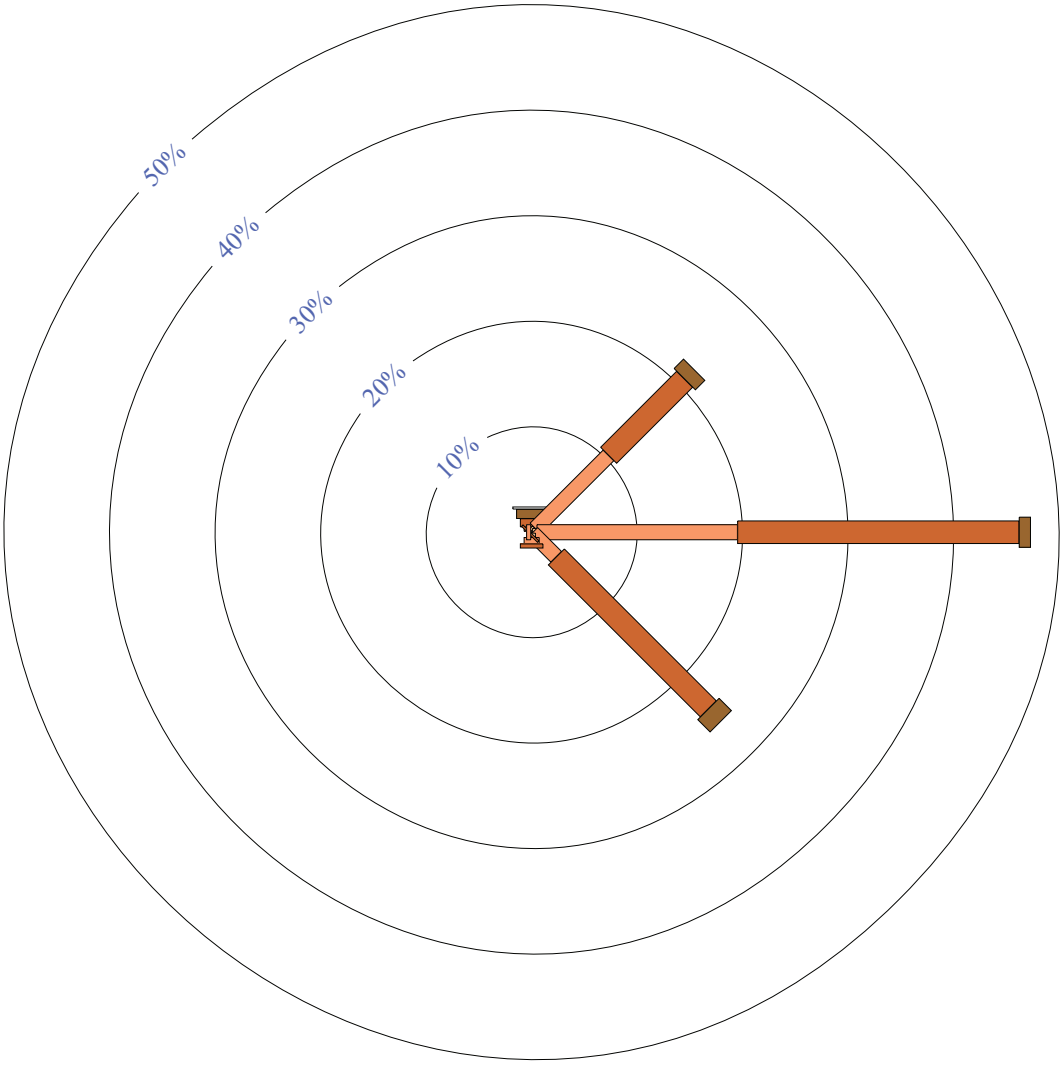
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Mar
507 Total Observations

Calm *



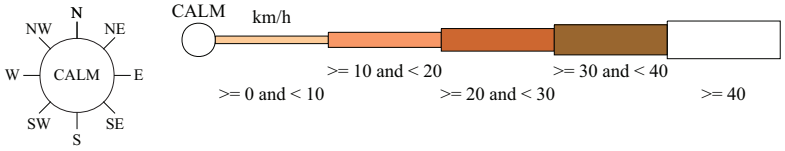
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

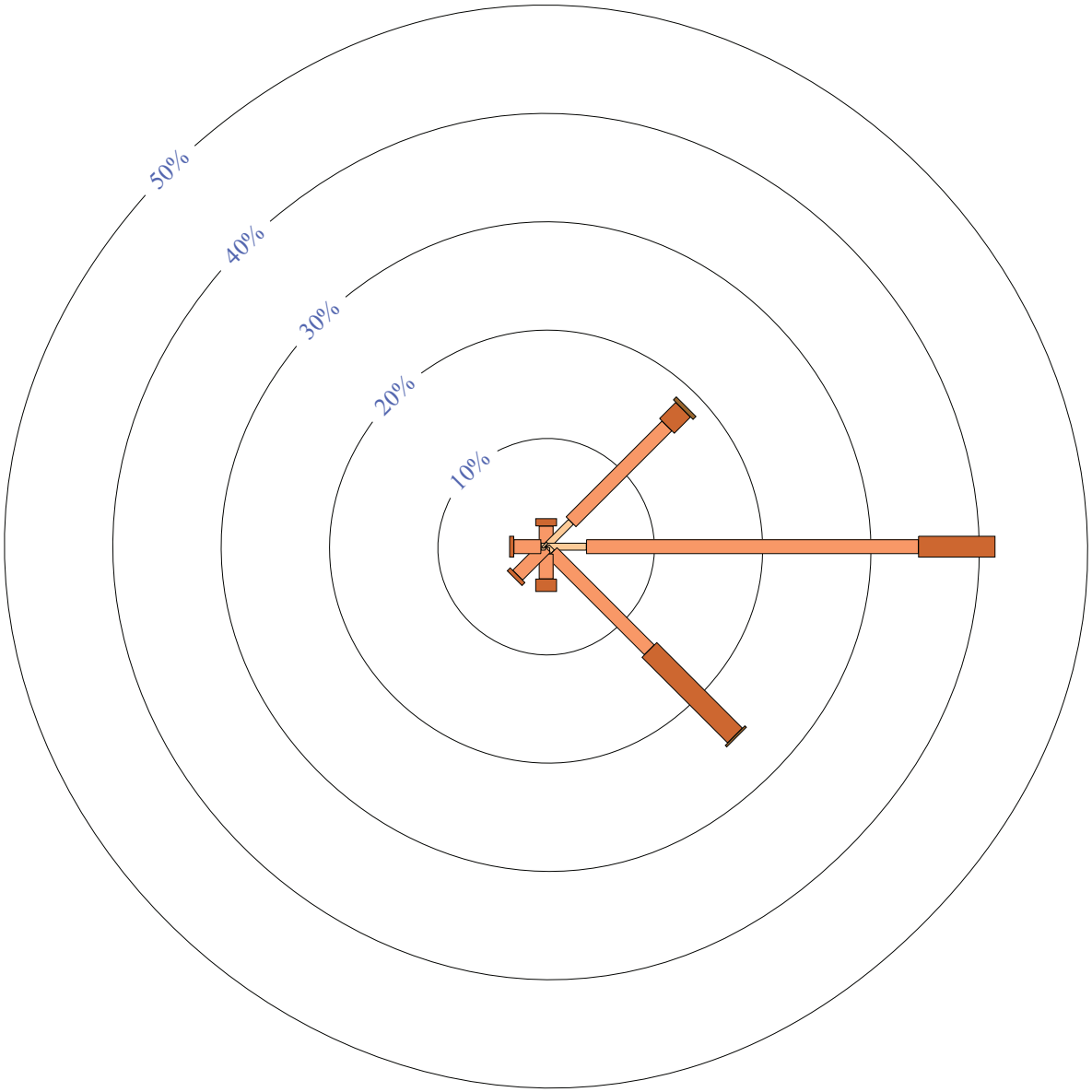
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm May
515 Total Observations

Calm *



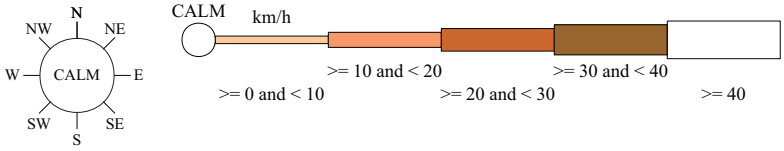
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

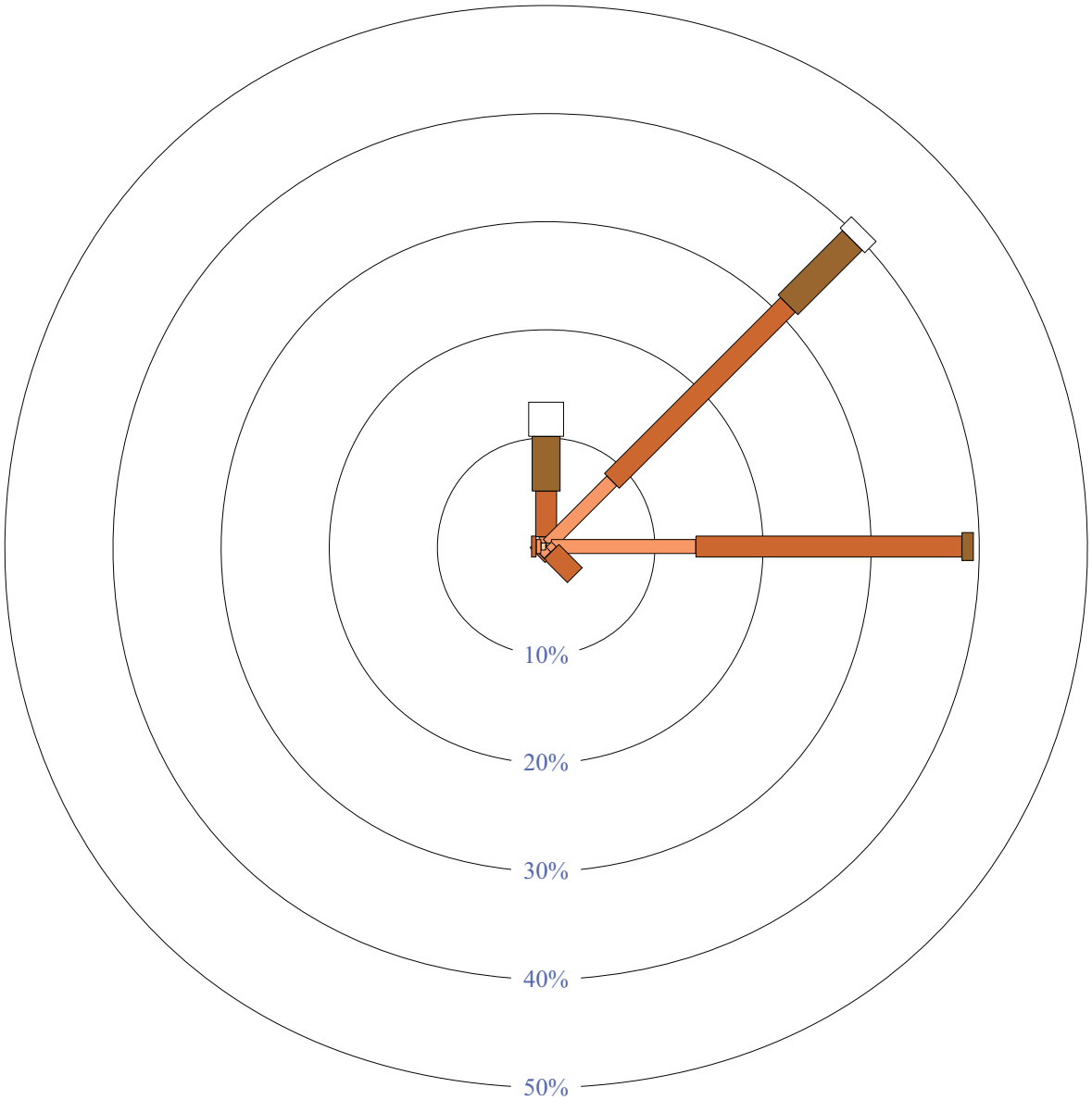
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Nov
476 Total Observations

Calm *



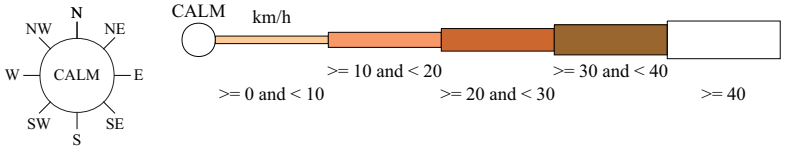
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

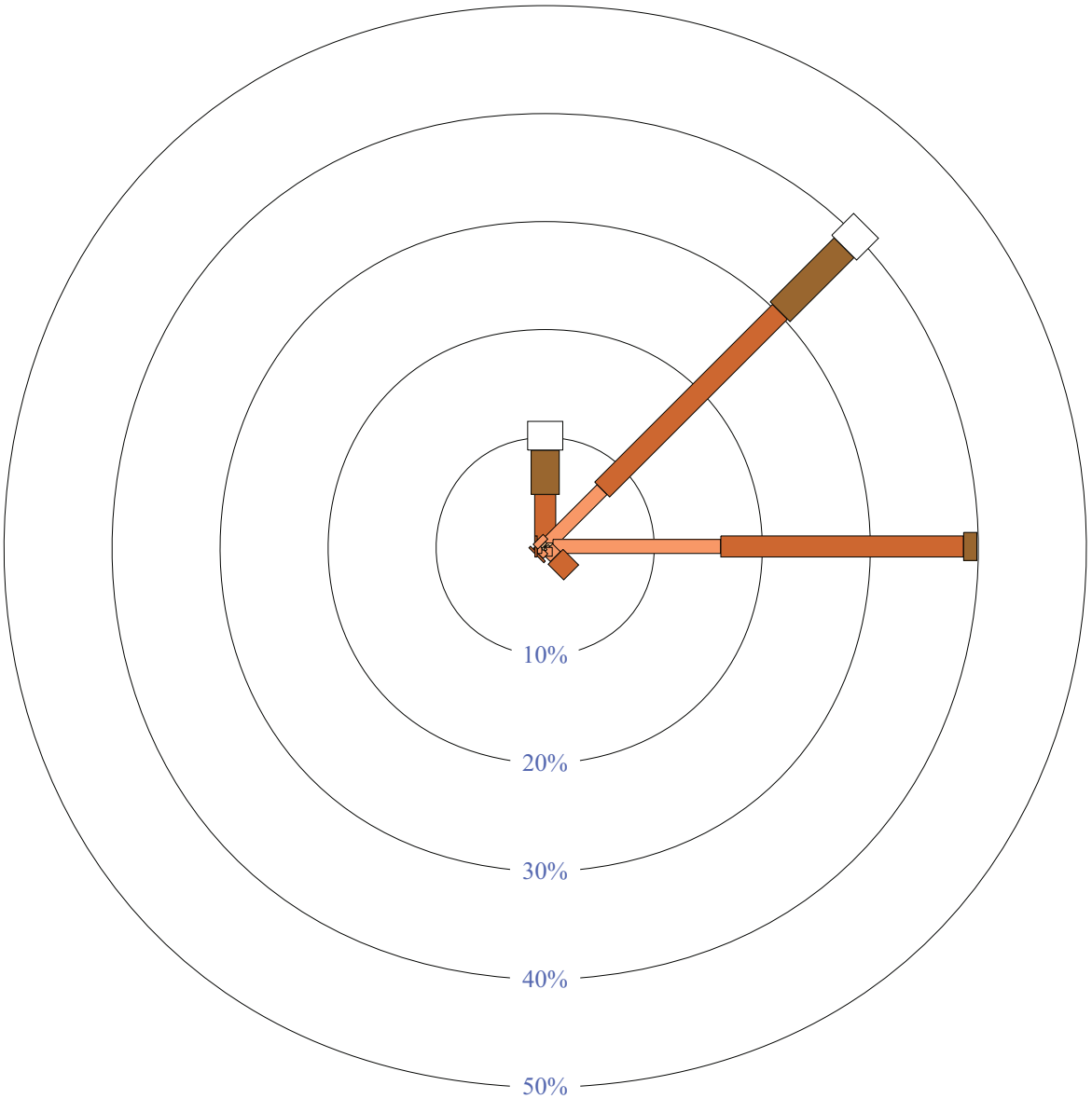
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Oct
490 Total Observations

Calm *



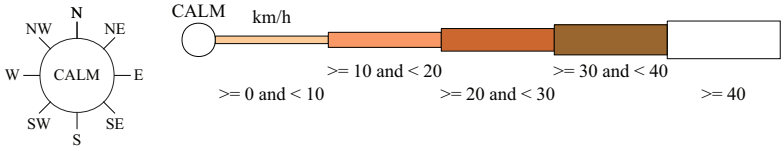
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

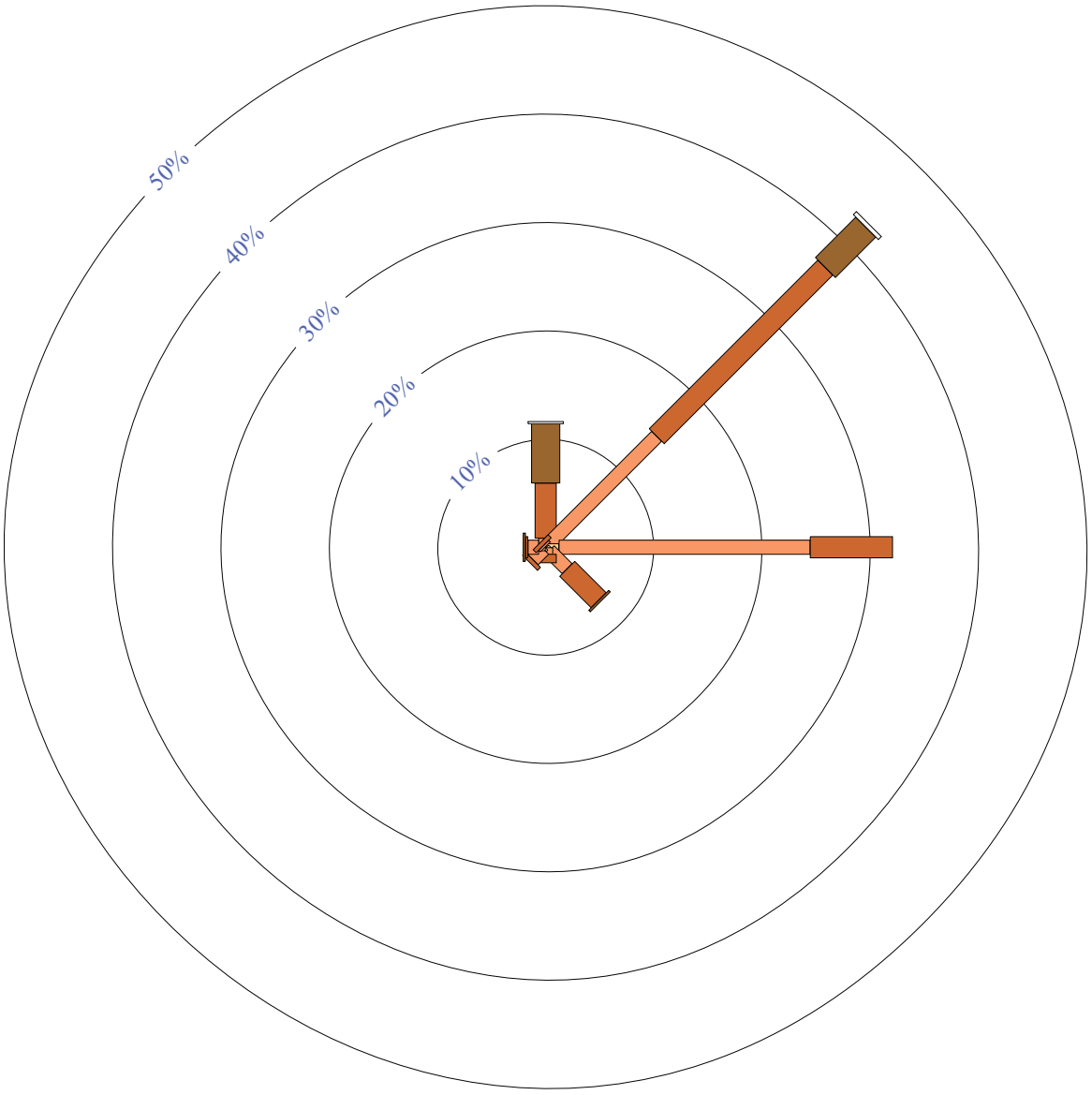
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Sep
505 Total Observations

Calm *



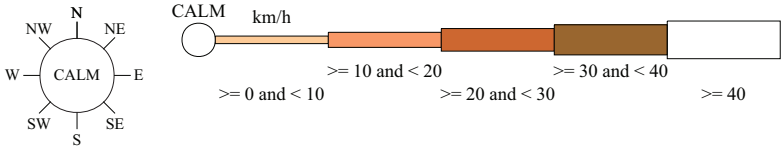
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 28 Feb 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

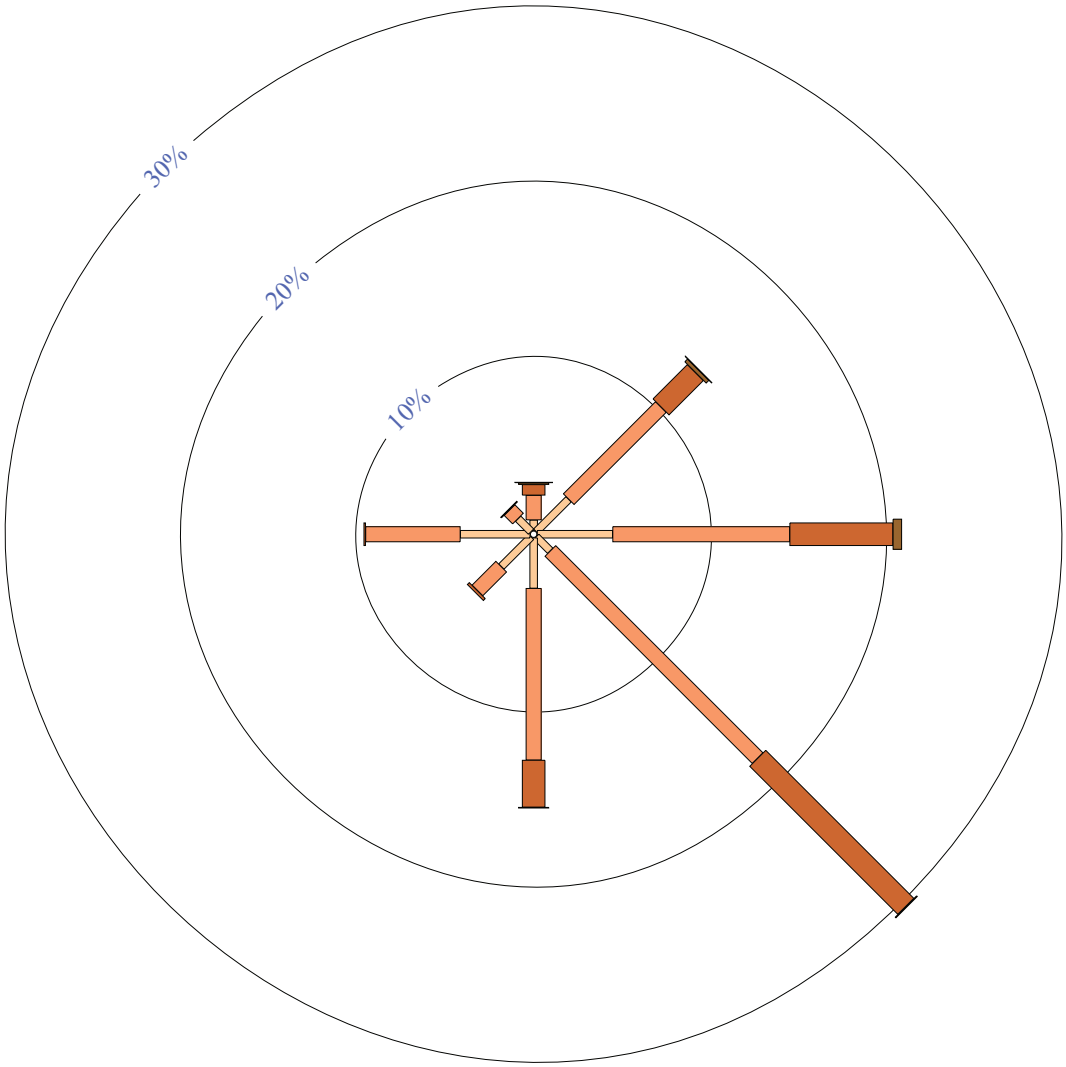
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
5770 Total Observations

Calm 1%



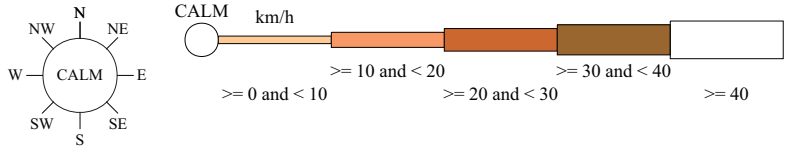
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

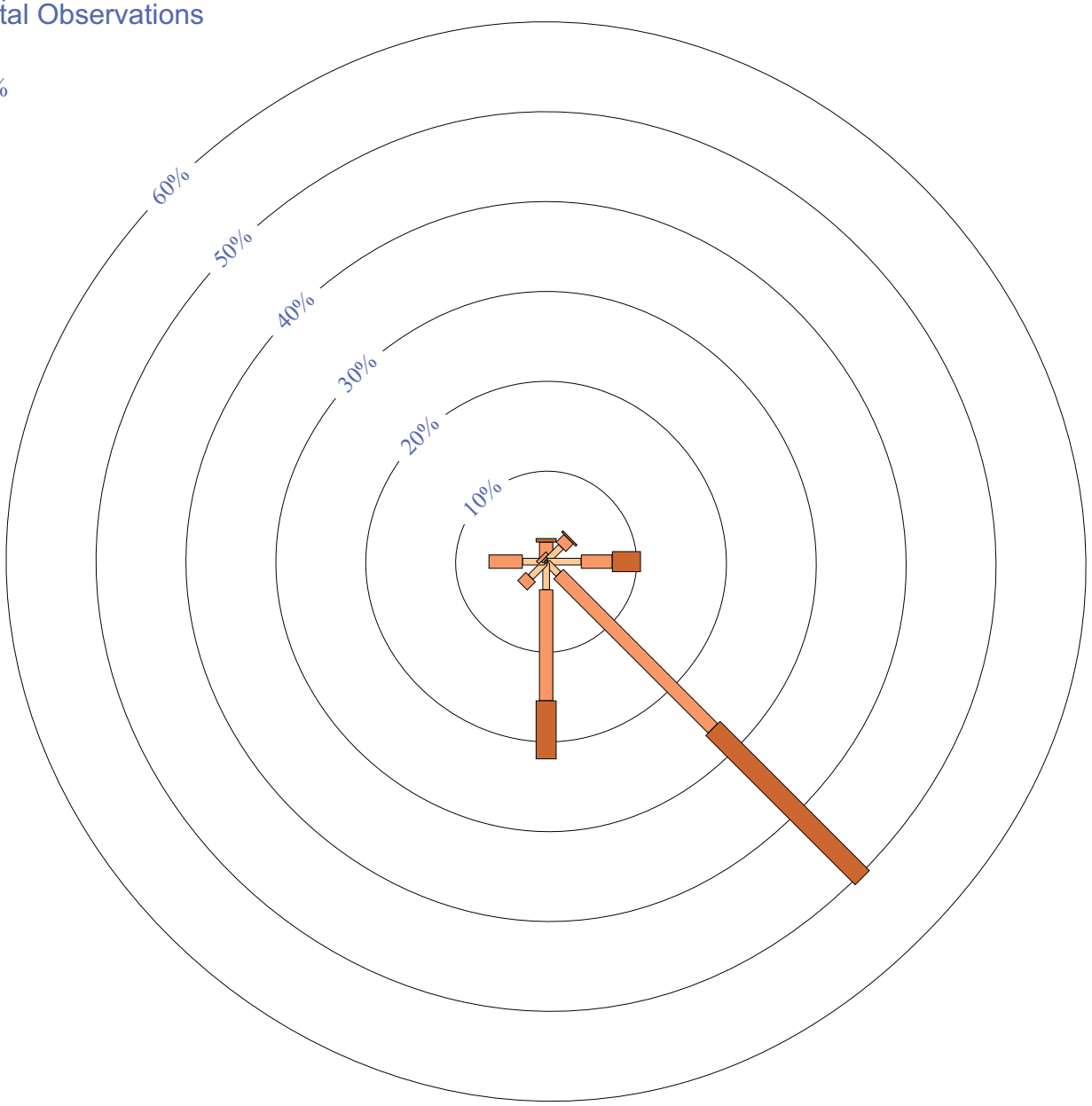
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Apr
502 Total Observations

Calm 1%



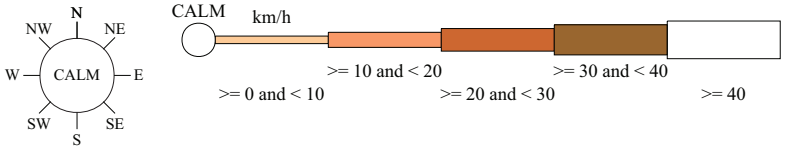
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

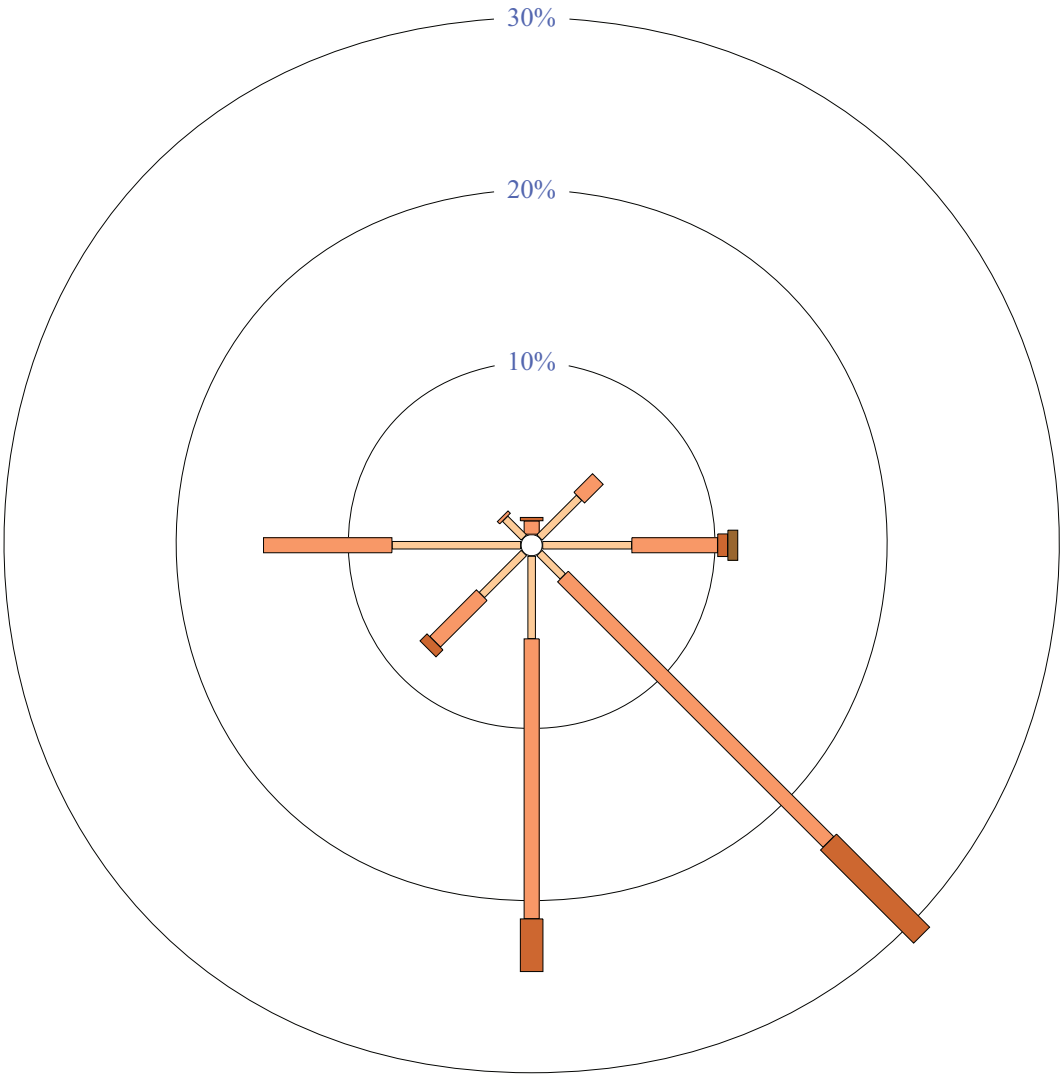
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Aug
523 Total Observations

Calm 3%



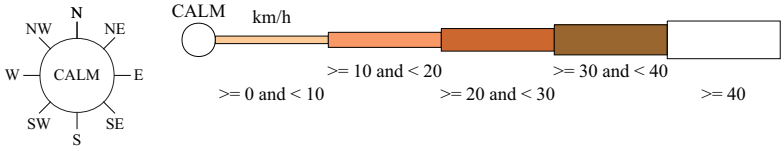
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

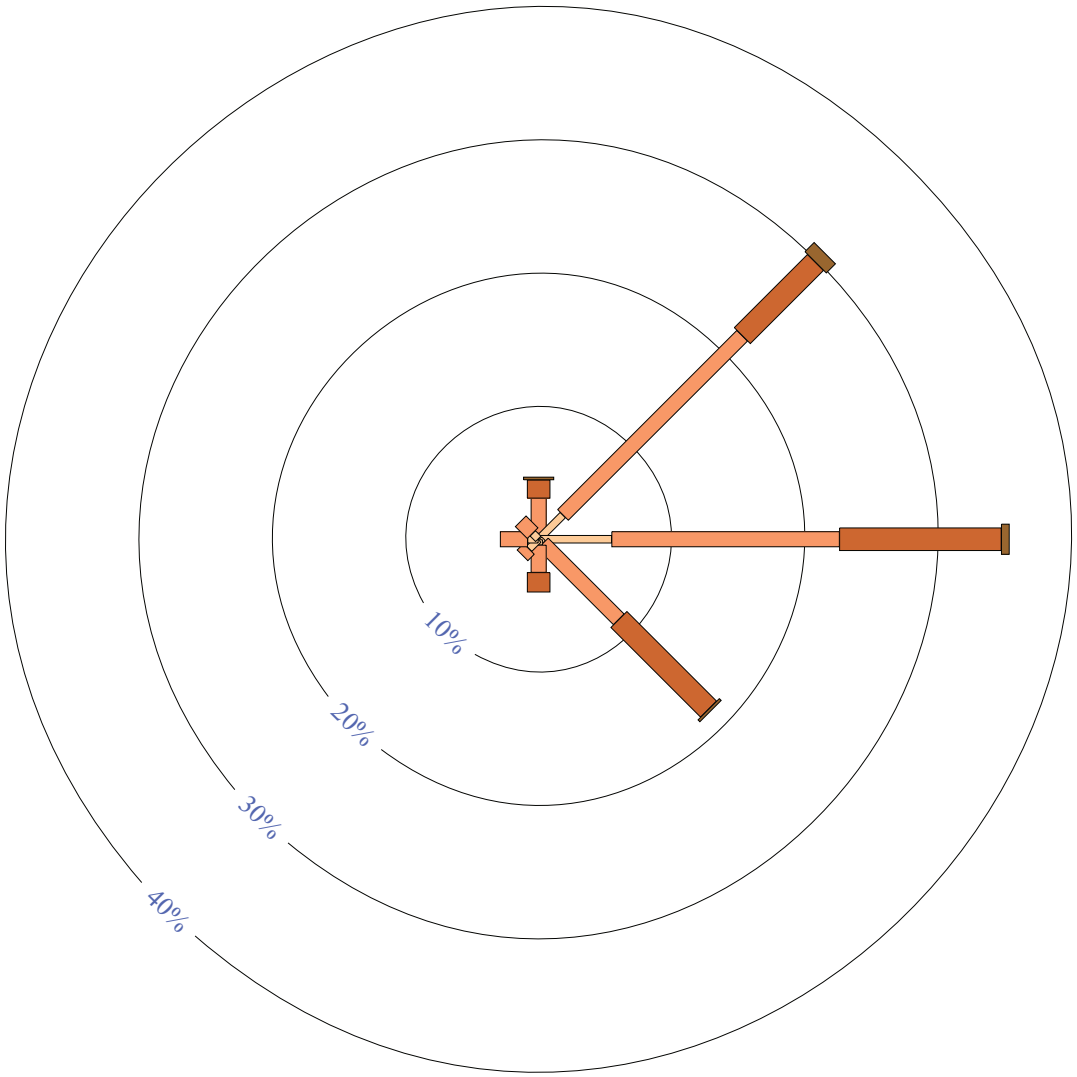
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Dec
507 Total Observations

Calm *



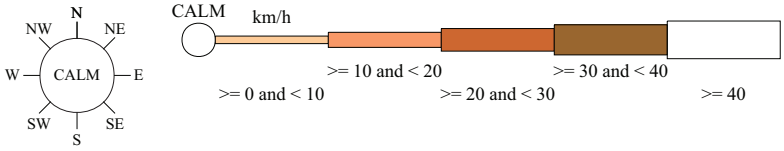
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

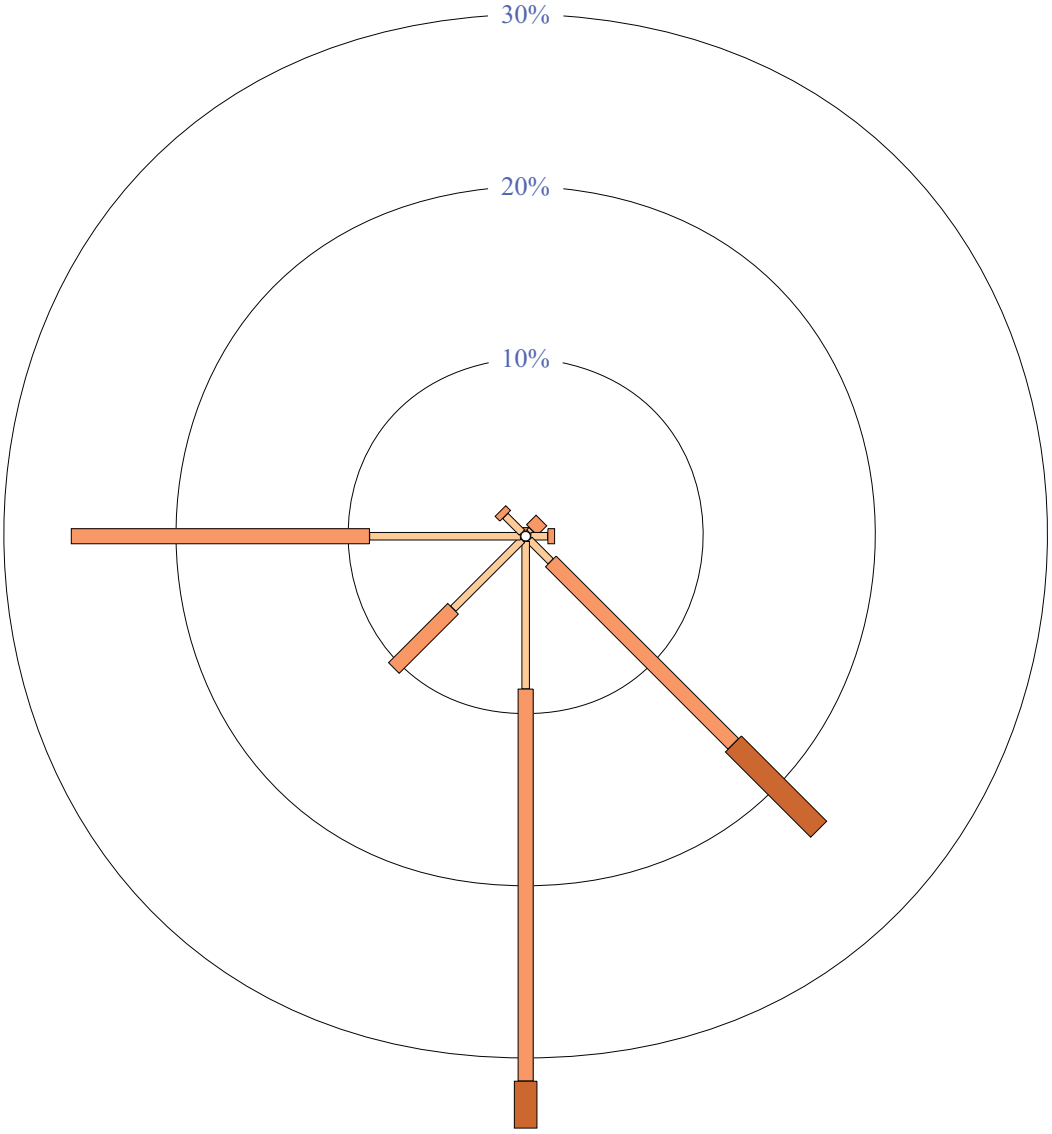
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jul
514 Total Observations

Calm 1%



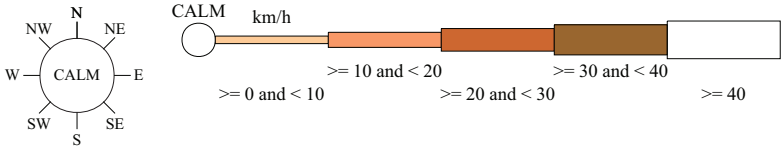
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

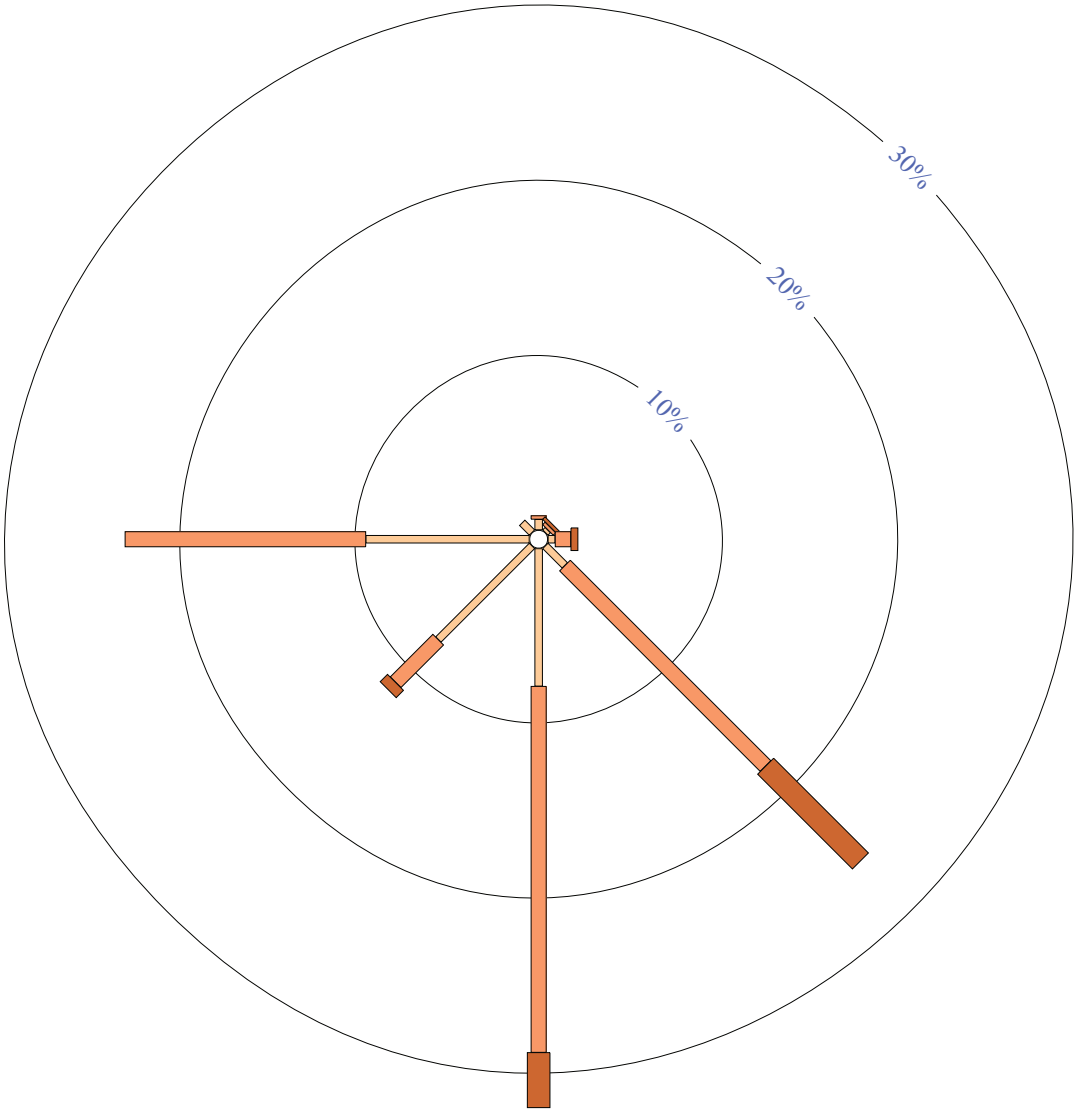
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Jun
501 Total Observations

Calm 3%



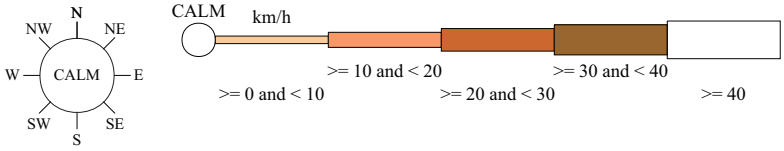
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

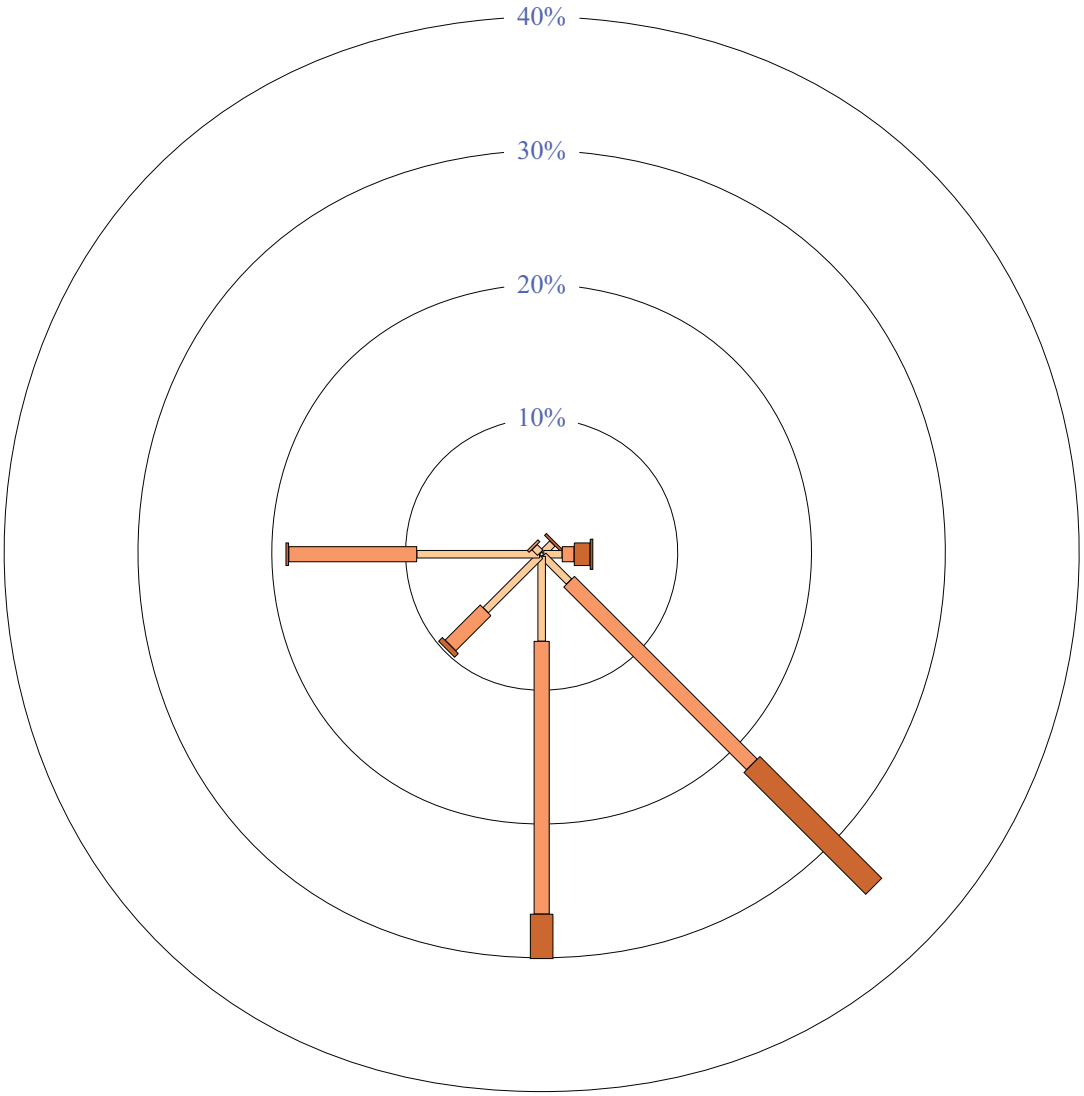
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am May
513 Total Observations

Calm 1%



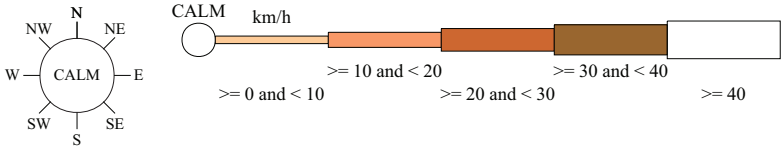
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

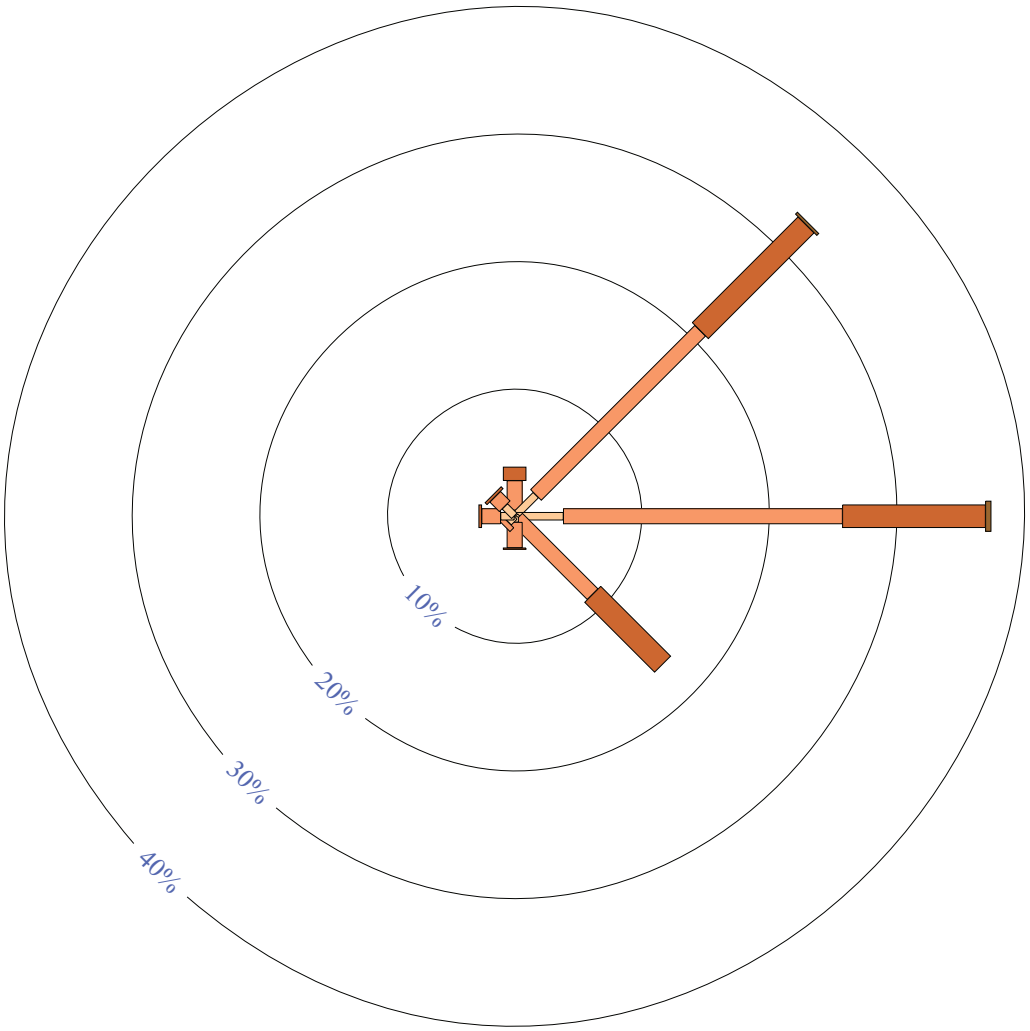
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Nov
470 Total Observations

Calm *



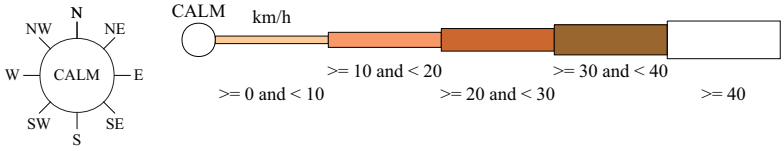
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

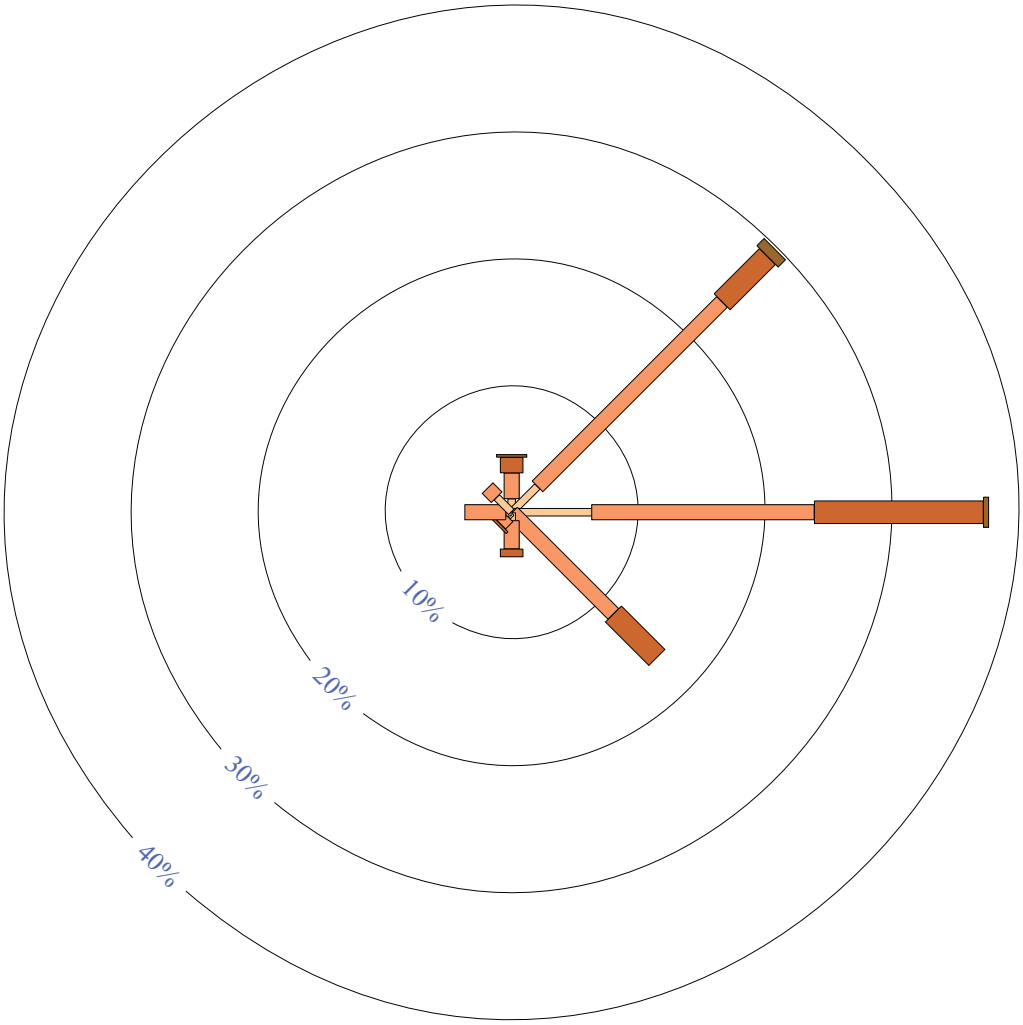
Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Oct
488 Total Observations

Calm *



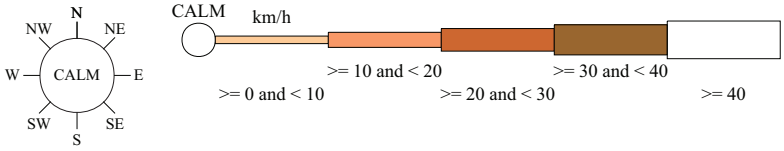
Rose of Wind direction versus Wind speed in km/h (23 Nov 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

YEPPOON THE ESPLANADE

Site No: 033294 • Opened Nov 1993 • Still Open • Latitude: -23.1364° • Longitude: 150.7506° • Elevation 5.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am Sep
501 Total Observations

Calm 2%