## 4.20. A NEW PILOT AUSTRALIAN TROPICAL ATMOSPHERIC RESEARCH STATION (ATARS)

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### Introduction

The tropics play a major role in global climate through both natural and anthropogenic processes, for which many potential feedbacks are poorly understood. The tropical regions globally are expected to be sensitive to future climate change due to vulnerabilities in the large carbon pools of tropical vegetation, influenced by biomass burning, deforestation and the draining of the tropical peatlands [Canadell *et al.*, 2007].

The tropics, especially the SE Asian tropics, are a region of significant transport of trace gases into the lower stratosphere. The tropical atmosphere has high photochemical activity, with high levels of ultraviolet (UV) radiation, hydroxyl radical (OH) and organic precursor species; the tropics have a significant impact on the changing global atmosphere for reactive gases, greenhouse gases (GHGs) and related trace gases, through a wide range of processes. To understand these processes, high quality atmospheric observation programs are required in these important regions.

Tropical regions are, however, the most sparsely sampled in global atmospheric observing networks. To address this deficiency, a new pilot Australian Tropical Atmospheric Research Station (ATARS) has been established in the Australian tropical region near Darwin in the Northern Territory (June 2010), a coastal site in the Tropical Warm Pool (TWP) region.

The Cape Grim Baseline Air Pollution Station (CGBAPS) serves as the key reference site for ATARS, in addition to the expanding Australian Greenhouse Gas Observation Network (AGGON), a high precision atmospheric observation network for greenhouse gases (GHG) and related trace gas species. The primary objectives of this new pilot tropical station and associated network are to:

1. improve the understanding of global climate change forcing by providing observations of climatically active atmospheric constituents in the critically undersampled tropical latitudes;
2. significantly reduce the uncertainties in estimates of GHG emissions from Australia; and
3. characterise the Australian tropical atmosphere in terms of aerosols and cloud condensation nuclei (CCN) formation, and the levels of reactive gases (including volatile organic compounds - VOCs) and provide accurate representation of reactive chemistry and aerosols in the atmospheric chemistry component of the Australian Community Climate Earth System Simulator (ACCESS).

The long-term objective is to determine the viability and scientific value of such an atmospheric research facility in the Australian tropical region and then develop a plan to establish long-term support for a more permanent research facility at the most suitable location available [van der Schoot and Fraser, 2010].

### Pilot ATARS site at Gunn Point

The pilot ATARS currently consists of a single container laboratory with a 12 metre high air intake mast, and was installed at the existing Bureau of Meteorology research radar station at Gunn Point (latitude 12.2°S, longitude 131.0°E, elevation 25 m) (Figures 1 and 2). The Gunn Pt. site is located approximately 30 km directly from Darwin city but 70 km via road on a former prison farm site (closed 1990). The site has been leased by the Bureau of Meteorology since 1997. It is an Atmospheric Radiation Measurement (ARM) site that complements the main ARM site at Darwin Airport. It is supported financially by the US Department of Energy and managed by the Centre for Australian Weather and Climate Research/Bureau of Meteorology. The site has been involved in a number of tropical meteorological experiments/aircraft campaigns: 'Maritime Continent Thunderstorm Experiment' (MCTEX[1]); 'Tropical Rainfall Measuring Mission' (TRMM[2]); 'Darwin Area Wave Experiment' (DAWEX) [Hamilton *et al.*, 2004], and 'Tropical Warm Pool - International Cloud Experiment' (TWPICE[3]).

### Local Meteorology (Gunn Pt/Darwin)

In the Austral summer monsoonal season (December-April) air masses predominantly originate from the northwest direction (refer Figure 3) with an air sampling/chemical footprint extending to the TWP, Timor Sea, Indonesia and Malaysia (refer Figure 4). In the winter dry season (May-September) wind directions are predominantly from the east to southeast (refer Figure 3) with air masses almost exclusively covering the northern continental tropics dominated by vast tropical savannah ecosystems (refer Figure 4). The location of the Gunn Pt. site, therefore, is ideal to quantify biogenic emissions from the extensive biomass burning events that routinely occur seasonally in this region.

[1] http://cawcr.gov.au/bmrc/wefor/research/mctex2.htm
[2] http://pmm.nasa.gov/precipitation-measurement-missions
[3] http://www.arm.gov/campaigns/*twp2006twp*-ice

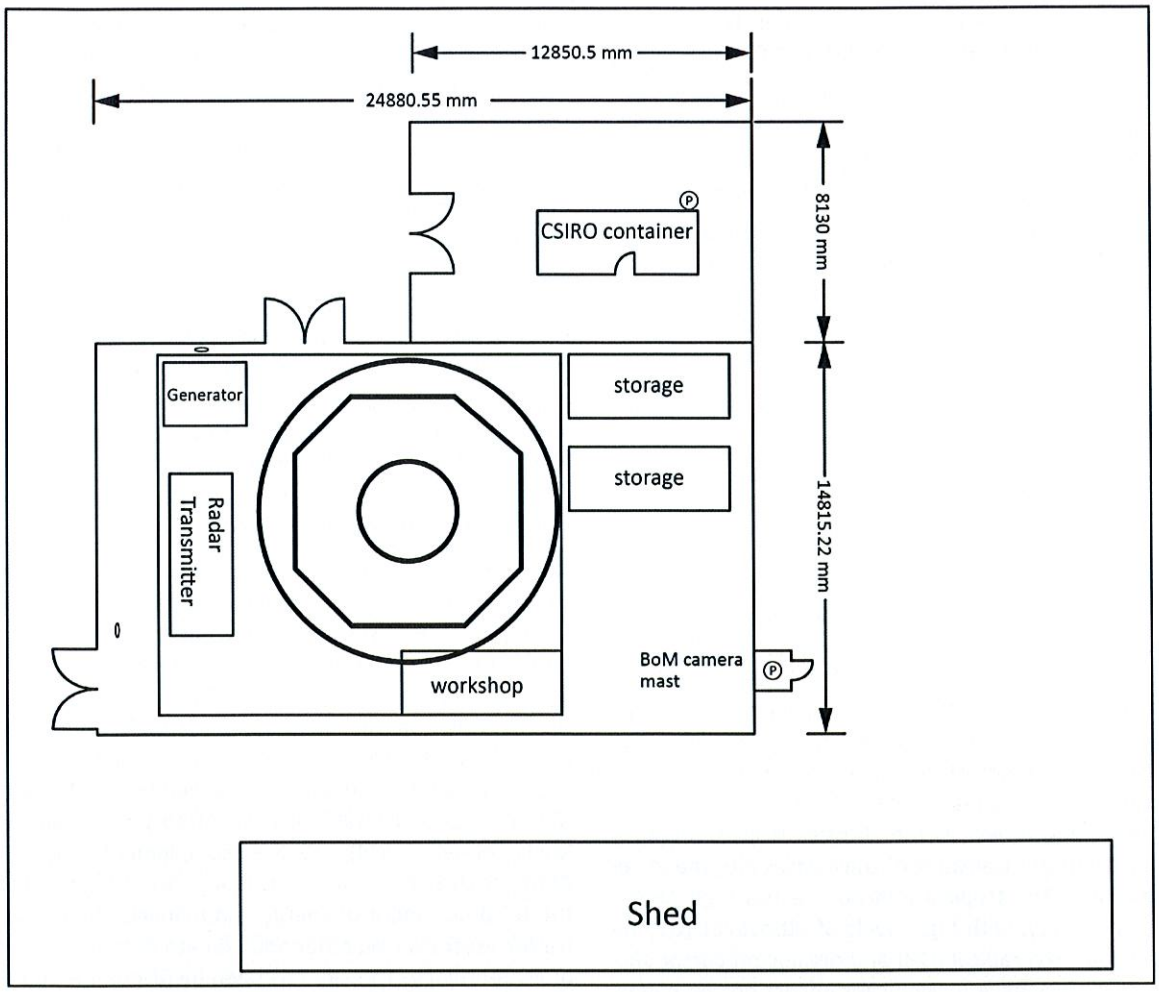


**Figure 1**. Gunn Point radar station site schematic.

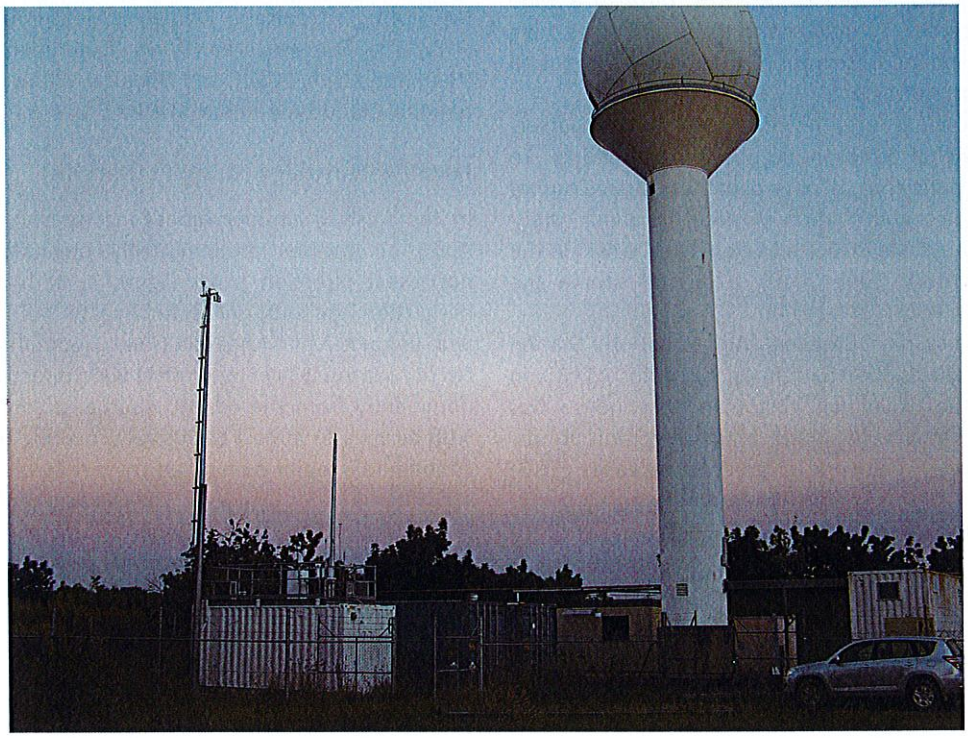

**Figure 2**. Gunn Point radar station with ATARS (white container in foreground)

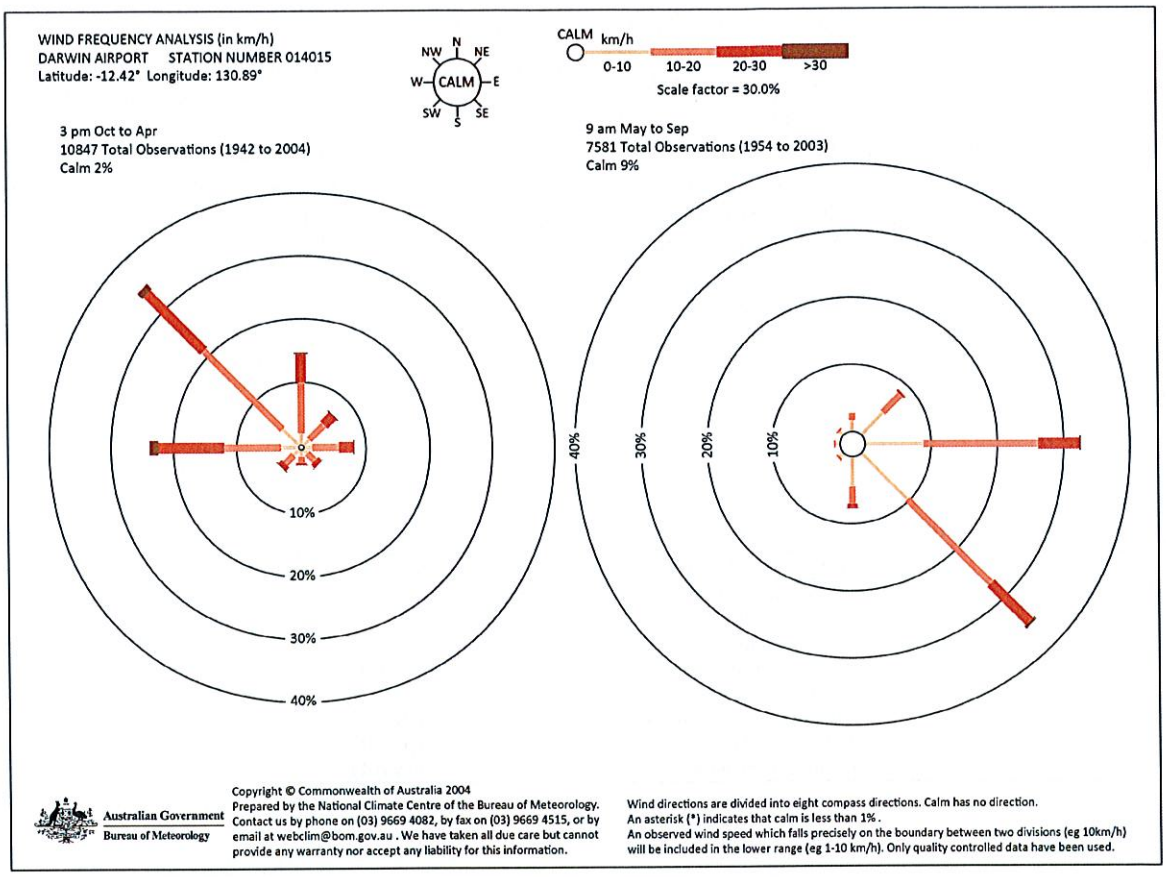


**Figure 3.** Wind frequency analysis Darwin airport (Bureau of Meteorology)

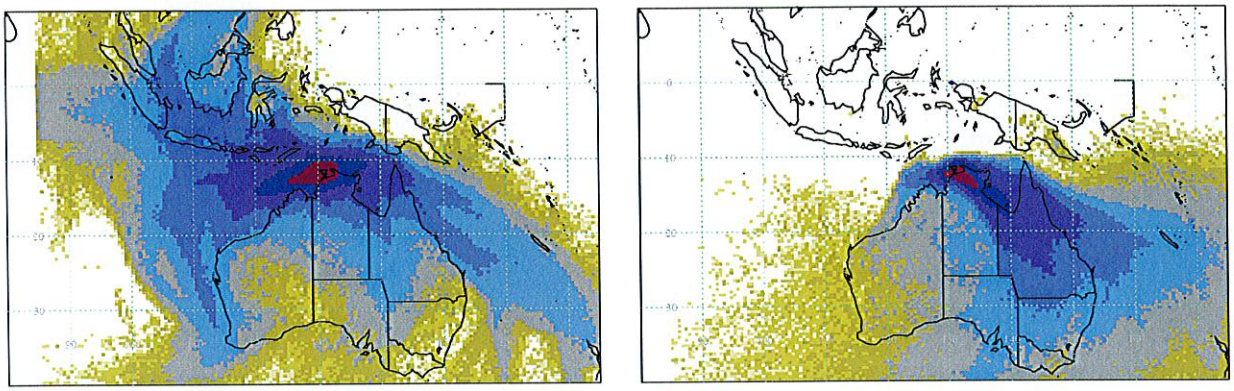

**Figure 4.** Gunn Pt monsoon (left) and dry season (right) air mass origin maps using Lagrangian Dispersion Model (NAME), 2007 average (courtesy of A. Manning, UK Met Office)

## Research Program

The ATARS research program is being implemented in phases. The initial phase is focussed on establishing the GHG and related trace gases observation programs with both *in situ* measurement and discrete flask air sample collection programs. The program will then extend to establishing reactive gases and aerosols/particles research programs with the planned installation of a second container laboratory (refer Table 1).

In June 2010 an intensive ground-based measurement campaign was also conducted at the station, investigating VOC, ambient aerosols and CCN. A Scanning Mobility Particle Sizer (SMPS) spectrometer measured the size-resolved aerosol number concentration for particles between 14 and 700 nanometers. A CCN counter measured the size resolved CCN number concentration for CCN between 0.75 and 10 micrometers, over a super saturation range of 0.1 to 0.9 %. The size-resolved chemical composition of aerosols was determined on samples collected using a cascade impactor and low volume aerosol samplers. All the samples collected during the field campaign were influenced by background biomass burning smoke. Preliminary conclusions indicate that in the presence of smoke, the number of CCN increases however the fraction of CN able to form CCN decreases.

VOC and oxygenated VOC (OVOC) measurements were made by pumping air through adsorbent tubes and DNPH cartridges. Samples were analysed at CSIRO Marine and Atmospheric Research by Automated Thermal Desorption (ATD) GC-FID/MS and HPLC.

The research program will be further expanded with:

- $CO/N_2O$ *in situ* analyser (off-axis integrated cavity output spectroscopy) (Los Gatos Research, USA) to be installed 2012
- Short-lived halocarbons ($CHBr_3/CH_2Br_2/CHCl_3/C_2Cl_4/CH_3CCl_3/CCl_4$) (GC-ECD, University of Cambridge) to be installed 2012
- Aerosols/particles/VOCs to be installed 2012
- Automated weather station to be purchased

## References

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Hamilton, K., R., A. Vincent and P. T. May, Darwin Area Wave Experiment (DAWEX) field campaign to study gravity wave generation and propagation, *J. Geophys. Res.*, 109, D20S01, doi:10.1029/2003JD004393, 2004.

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**Table 1.** Gunn Pt. research program

| Species | Technique (instrument) | Commencement date |
|---|---|---|
| *in situ* $CO_2$ & $CH_4$ | Cavity Ring Down Spectroscopy (CRDS) (Picarro) | June 2010 |
| *in situ* $^{13}CO_2/^{12}CO_2$ | CRDS (Picarro) | June 2010 |
| flask $CO_2$, $CH_4$, $^{13}CO_2/^{12}CO_2$, $N_2O$, CO, $H_2$ | Gas Chromatography/mass spectrometry | June 2010 |
| radon-222 | ANSTO radon detector | July 2011 |
| meteorological (WS/WD) | Windsonics anemometer | June 2010 |
| ozone | UV spectrometry (Ecotech) | July 2011 |
| CO | NDIR (Ecotech) | July 2011 |
| NO/NOx | Chemiluminescence (Ecotech) | July 2011 |