Datasets and First Results from the Macquarie Island Cloud and Radiation Experiment (MICRE)

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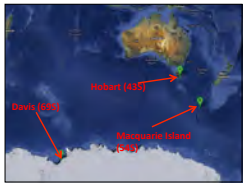
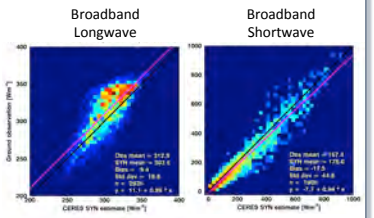
Background : What is MICRE ?



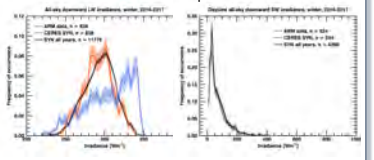
- Clouds over the Southern Ocean are poorly represented in present day reanalysis products and global climate model simulations, and errors in top-of-atmosphere broadband radiative fluxes in this region are among the largest globally. These errors have large implications for modeling both regional and global scale climate responses.
- However, much of our knowledge regarding cloud and aerosol properties over the Southern Ocean, relies heavily on satellite datasets; and uncertainty in satellite retrievals of cloud and aerosol properties, as well as estimates of surface shortwave and longwave fluxes based on these properties, are especially large for the Southern Ocean.
- In response to the need for additional measurements of surface radiative fluxes, cloud, precipitation, and aerosol properties over the Southern Ocean, ARM deployed a variety of ground-instrumentation to Macquarie Island as part of the Macquarie Island Cloud and Radiation Experiment (MICRE).
- Macquarie island has a small manned research station, which is operated by the Australian Antarctic Division (AAD) and manned, in part by the Australian Bureau of Meteorology (BoM).
- MICRE began in March 2016 and just ended in March of 2018.
- MICRE is part of a set of Southern Ocean experiments in 2016 through 2018, which include the ARM-supported ship-based Measurements of Aerosols Radiation and CloUds over the Southern Oceans (MARCUS) experiment, as well as the NSF-supported Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study (SOCRATES) in which the NSF GV Aircraft was deployed to the region.
- Together, measurements from these experiments are expected to be used to (1) improve our understanding of Southern Ocean cloud, aerosol, precipitation and radiation properties, (2) evaluate satellite datasets, and (3) address scientific questions which are difficult (if not impossible) to do well with data from only ground, ship, aircraft or satellite (as explained in the SOCRATES white paper).
- In particular, MICRE data will be crucial in furthering our understanding of seasonal and diurnal cycle and testing satellite datasets.

MICRE Instrumentation	Notes / Quantities Measured
SKYRAD, GRDRAD	Upwelling and downwelling surface broadband shortwave and longwave fluxes.
Ceilometer	Cloud base heights and backscatter
Microwave Radiometer (MWR)	Microwave brightness temperatures for the retrieval of column water vapor and liquid water path. (Plan was for 2 and 3 channel MWR but ...)
Multi-Filter Rotating Shadowband Radiometer (MFRSR)	Direct and diffuse radiances at several visible and shortwave infrared frequencies / associated retrieval of aerosols and cloud optical depth.
Disdrometer (Parsivel)	Drop size distribution, precipitation rate, type, and amount.
CIMEL sun photometer	Narrow field of view radiances at several visible and shortwave infrared frequencies (retrievals of aerosol optical depth and angstrom exponent).
Cloud Radar	Alain Protat, Centre for Australian Weather and Climate Research (CAWCR) W-band Doppler radar Deployed one year : March 2016 to March 2017
Polarization Lidar	Simon Alexander, Australian Antarctic Division (AAD) 532nm polarization capable lidar
Ceilometer	Adrian McDonald, University of Canterbury [plan to combine with ARM to make more complete record).
Aerosol Filter Samples	Paul DeMott, Colorado State University, Analysis of Ice Nucleating Particles (data collection began 04/2017).
CPC and CCNC	Ruhi Humphries and Melita Keywood, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
BOM station - twice daily sondes - surface met	Pressure, Temperature, Humidity. BoM records go back to 1949. Have recently added sky camera and radiometers (which we will compare with ARM).

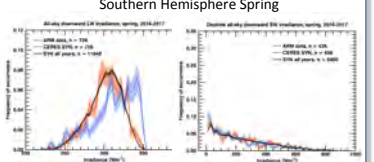
ARM and CERES Surface Fluxes



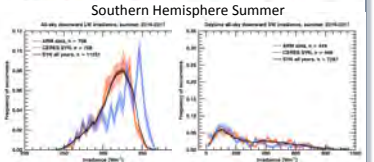
Southern Hemisphere Winter



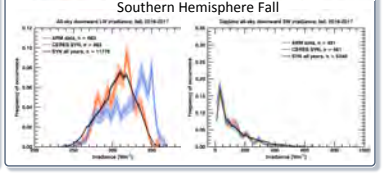
Southern Hemisphere Spring



Southern Hemisphere Summer



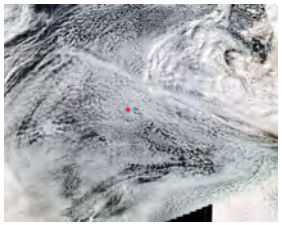
Southern Hemisphere Fall

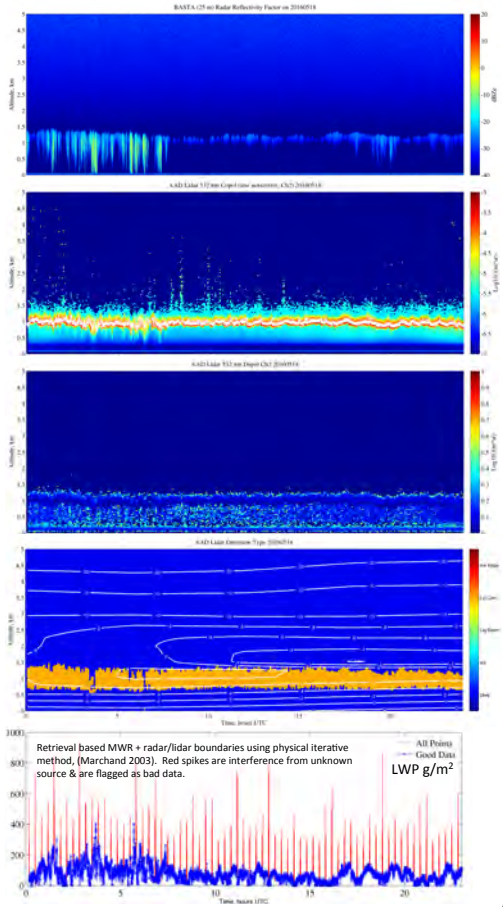


An Interesting Case

Several recent papers [e.g. Bodas-Salcedo et al. 2012, 2014] suggest that models struggle to predict low cloud cover and supercooled water in the cold sector of SO cyclonic systems.

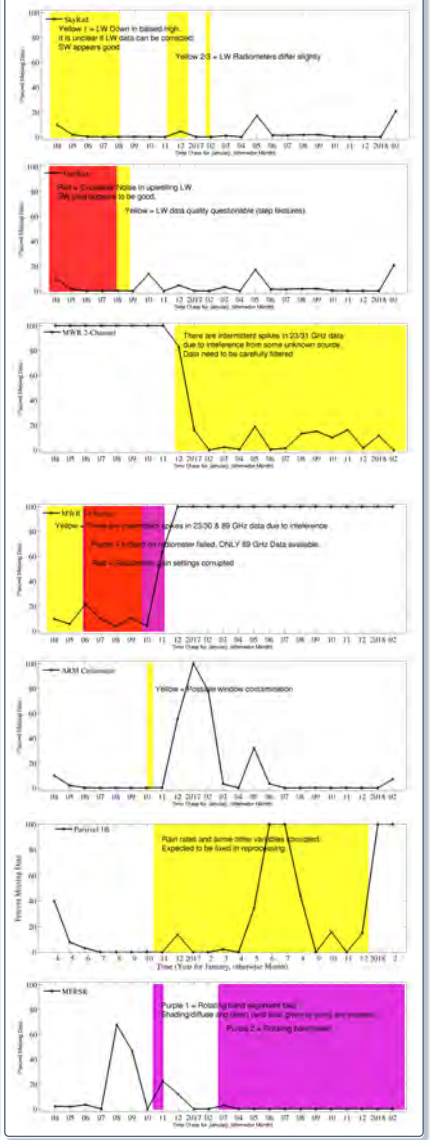
MICRE data should prove useful in characterizing cloud and precipitation properties and regime dependent errors.





Retrieval based MWR + radar/lidar boundaries using physical iterative method, (Marchand 2003). Red spikes are interference from unknown source & are flagged as bad data.

Status of ARM Data Streams



Surface Precipitation

Satellite-based climatologies of precipitation (both amount and occurrence) disagree significantly over the Southern Ocean (Behrangi et a. 2014). MICRE data should advance understanding of the differences and help broadly characterize precipitation for this region.