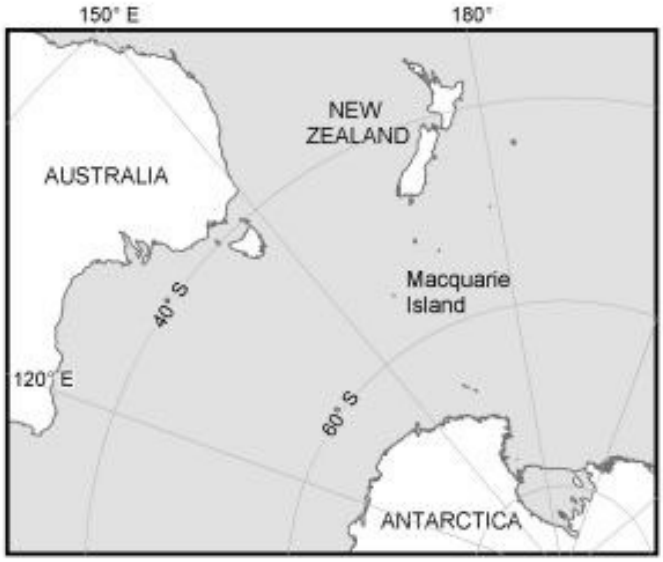
ARM
CLIMATE RESEARCH FACILITY

Macquarie Island Cloud and Radiation Experiment

Recent research reveals that the Southern Ocean, which encircles Antarctica, may be a missing piece in global climate models. The large Southern Ocean soaks up much of humanity's carbon emission and stores much of the planet's heat, yet details of the processes occurring there have been little observed and remain elusive.

Scientists believe that the clouds themselves over the Southern Ocean may be unique. Southern Ocean clouds appear to have more supercooled water than northern hemisphere clouds; this may be due to a lack of aerosol (particles on which cloud droplets form) in this remote region. Current knowledge of cloud and aerosol properties for the Southern Ocean relies heavily on satellite data that is more uncertain because of a lack of in situ validation. Additional data, especially surface radiative fluxes, and cloud and aerosol properties from this region, are necessary to improve climate model simulations.

The Atmospheric Radiation Measurement (ARM) Climate Research Facility will conduct a two-year research campaign, beginning in spring 2016, to obtain these data from Macquarie Island, ideally situated between New Zealand, Australia, and Antarctica.

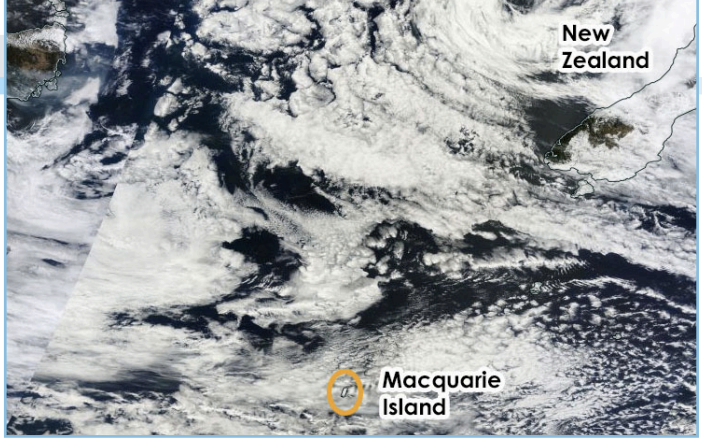


Science Objective

The overarching objective of this field campaign is to make observations of the surface broadband radiative fluxes in combination with other measurements useful in characterizing cloud and aerosol properties. In addition to having large uncertainties, satellite data sets for the Southern Ocean are incomplete because they are not continuous, rarely sample the diurnal cycle, and view primarily the tops of cloud systems. This is especially problematic for retrievals of aerosol, low-cloud properties, and layers of supercooled water embedded within (rather than at the top of) clouds.

The ARM measurements and retrievals will be used to address the following scientific issues:

- How accurate are satellite-derived and climate-model-simulated surface radiative fluxes at Macquarie Island?



In situ observations of Southern Ocean clouds are needed to help improve global climate models. Image courtesy of NASA Worldwide.

A collection of ARM instruments, similar to this instrument field in the Azores, will be installed on Macquarie Island for a two-year deployment, beginning spring 2016.

- How do surface radiative errors vary with large-scale/ synoptic conditions and cloud-type?
- How do satellite retrievals compare with ground-based retrievals?
- Are satellites capturing the seasonal cycle of these properties correctly?
- How do satellite retrievals of aerosol optical properties compare with ground-based results, and what are the implications in terms of aerosol physical properties and seasonal variability?

Addressing the above questions will help pinpoint conditions under which satellite observations and models are most in need of improvement; and the results will help guide the development of processed-based modeling studies. The twice-daily radiosondes launched from Macquarie Island will aid in understanding conditions that drive errors, as well as help constrain large-scale forcing needed in processed-based modeling studies.

Collaboration

MICRE is an international collaboration between the U.S. Department of Energy, the Australian Bureau of Meteorology (BOM), and the Australian Antarctic Division (AAD), which operates a research station on Macquarie Island. This experiment will be conducted in coordination with BOM and AAD activities planned at Macquarie.

MICRE is part of a larger planned campaign—the Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study (SOCRATES), an international and multi-agency observational activity—in which scientists hope to add measurements from aircraft and ship.

Research Instrumentation

The ARM Facility will deploy a variety of ground-instrumentation to Macquarie Island including:

- a set of surface broadband radiometers (sky and ground radiation),
- a microwave radiometer to measure water vapor and cloud liquid water,
- a ceilometer to measure cloud base height,
- a Multi-Filter Rotating Shadowband Radiometer (MFRSR) to measure aerosol optical depth,
- a laser disdrometer to measure precipitation, and
- a sun photometer, or other instrument capable of narrow-band narrow-field of view measurements.

AAD and BOM will deploy a cloud radar and lidar during MICRE.

Contacts

Hanna Goss, ARM Communications Team Lead and Public Information Officer
Pacific Northwest National Laboratory
hanna.goss@pnnl.gov

Roger Marchand, MICRE Principal Investigator
University of Washington
rojmarch@u.washington.edu

Kim Nitschke, AMF Facility Manager
Los Alamos National Laboratory
nitschke@lanl.gov

DOE/SC-ARM-15-088

U.S. DEPARTMENT OF ENERGY | Office of Science

The ARM Climate Research Facility is funded through the U.S. Department of Energy's Office of Science.
Additional information is available on the ARM website at www.arm.gov.