Southern Ocean Surface Meteorology and Radiative Flux, Past Observations and Comparison to CERES SYN1deg Data Product

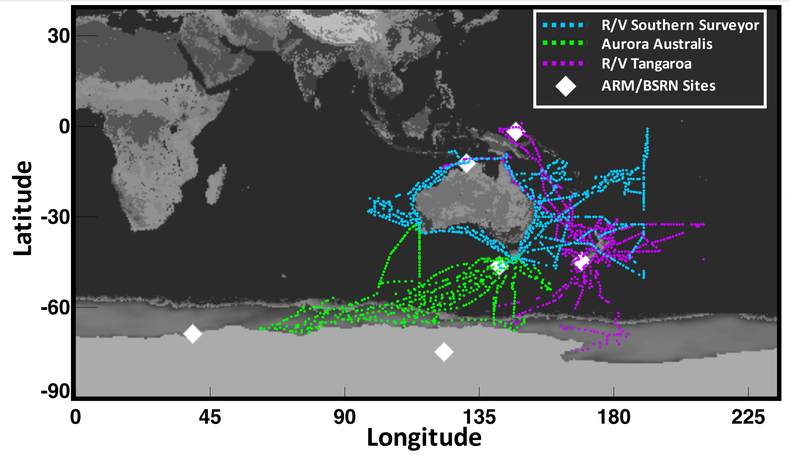
David Rutan[1], Fred Rose[1], David Doelling[2], Bill Smith Jr.[2] and Seiji Kato[2,]

1. Science Systems and Applications Inc., Hampton, VA. 2. NASA Langley Research Ctr., Science Directorate, Hampton, VA

A lack of observational data in southern hemisphere oceans has long hindered validation of Global Climate Models, re-analyses and other data products (e.g. ISCCP FD, CERES SYN1Deg*, etc..) that model radiative transfer components in these regions. Hence the need for the ARM/AMF "MARCUS" deployment. However, the ship upon which the ARM/AMF is deployed, Australian Antarctic supply vessel Aurora Australis, along with other Australian ships have made "simpler" observations (meteorology and broadband surface radiative flux) for a number of years and are available from the **Australian Oceanic Data Network (https://portal.aodn.org.au/).** To that end we obtained meteorology and surface flux observations from three ships, the Aurora Australis, R/V Southern Surveyor, and R/V Tangaroa across 9 years (2008 – 2016) for comparison to CERES SYN1deg product.

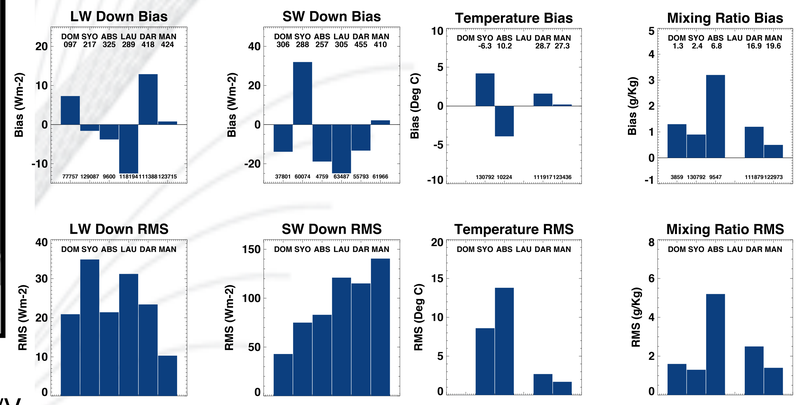
SYN1Deg available at: https://ceres.larc.nasa.gov/order_data.php

*NASA Langley's CERES SYN1deg data product is a global, 1 degree equal angle, hourly data set providing observed (at the top-of-atmosphere) and calculated irradiances at six levels in the atmosphere from Mar 2000 through Nov 2017 (on-going.) Cloud properties are derived from MODIS and Geostationary imagers, meteorological input comes from Goddard Modeling and Assimilation Office (GMAO) GEOS5.4.1 re-analysis, aerosols come from the Model for Atmospheric Chemistry (MATCH) which assimilates MODIS collection 6 aerosol optical depths



Grid box locations where AODN data from, Aurora Australis, R/V Southern Surveyor, and R/V Tangaroa across 9 years (2008 – 2016), are compared to CERES SYN1Deg data product.

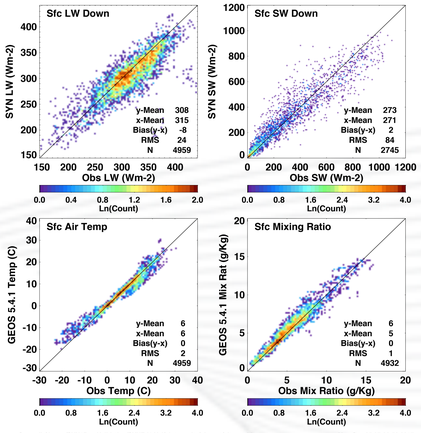
BSRN/ARM/Buoy Validation (Hourly)



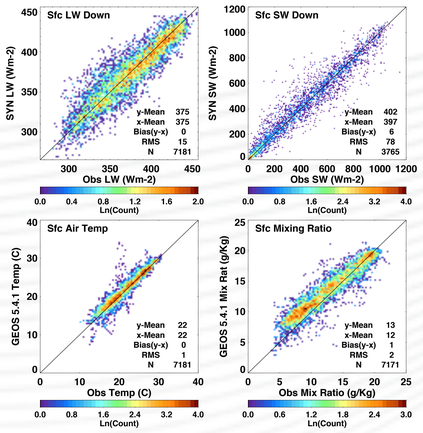
Modeling irradiance in the Southern Ocean/Antarctic regions constitutes some of the most challenging regions of the globe. Statistics from surface sites in these areas such as Syowa and Dome C in Antarctica show large bias and RMS. Hence the addition of ship observations provides valuable independent validation statistics.

Ship Vs. Computed Surface Validation (Hourly)

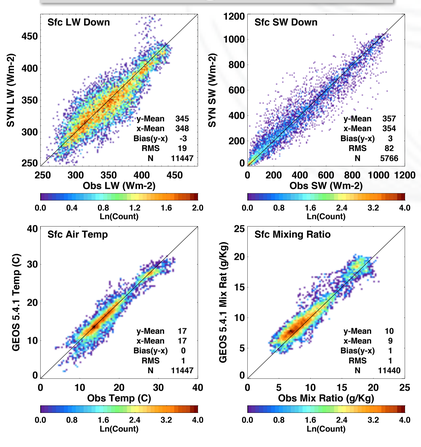
Aurora Australis



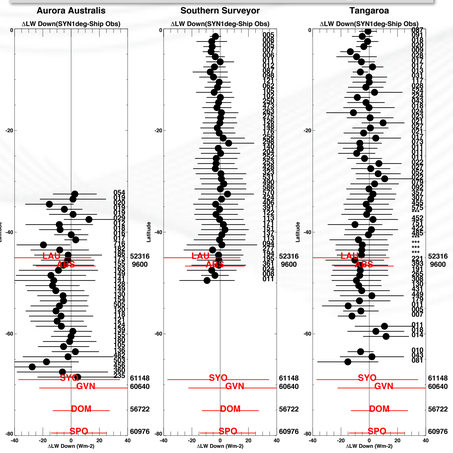
Southern Surveyor



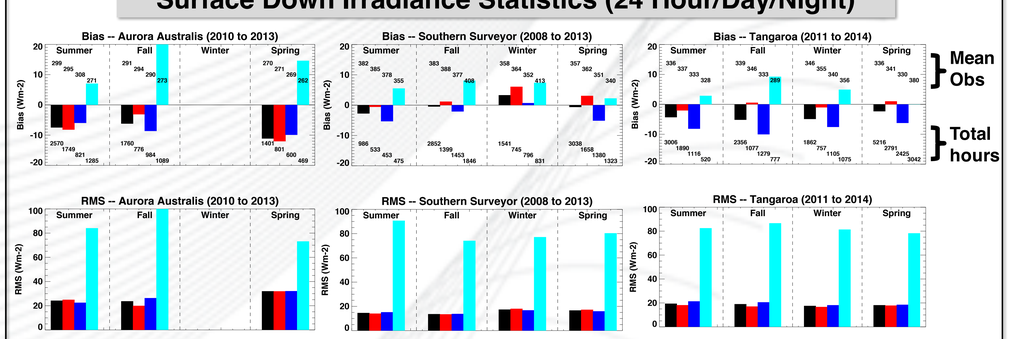
Tangaroa



LW Statistics Across Longitude

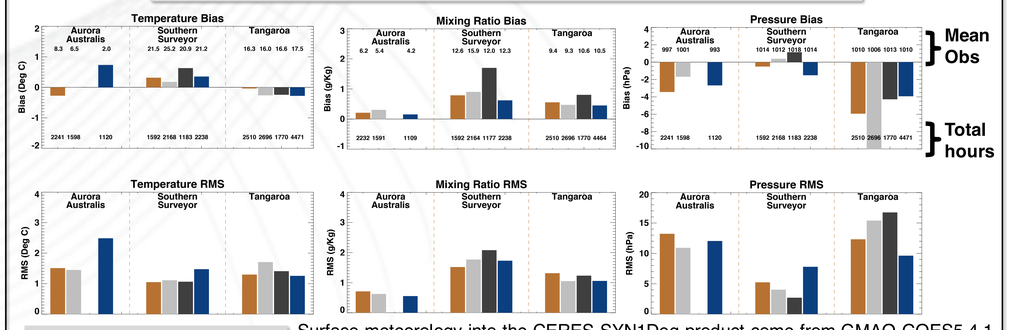


Surface Down Irradiance Statistics (24 Hour/Day/Night)



The Aurora Australis and Tangaroa (which each spent quite a bit of time in the southern ocean) show generally negative LW bias w.r.t. observations. The Southern Surveyor (which spends more of its time in the tropical S Ocean has the smallest LW and SW bias' and generally lower RMS'. The largest Bias & RMS are found on Aurora Australis cruises during the fall (for SW) and spring (for LW).

Surface Meteorology Statistics (24 Hour)

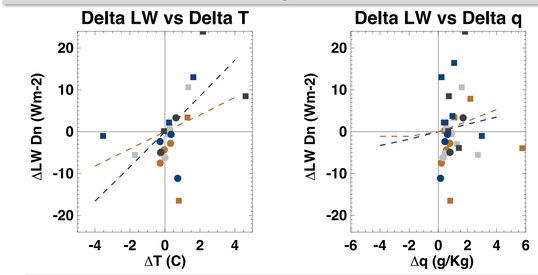


Surface meteorology into the CERES SYN1Deg product come from GMAO-GOES5.4.1 Reanalysis. Surface temperature bias tends towards negative in the southern ocean part of the cruises and positive for the Southern Surveyor (hence more tropical sample.) Note that as a percentage the difference is most significant for the Aurora Australis with the RMS greater than the mean during the spring season. Observed surface mixing ratio is uniformly higher than it's reanalysis equivalent.

S Hemisphere Season: Summer, Winter, Fall, Spring

Seasons are Austral

Surface Down LW Irradiance Bias vs. T & q Bias



S Hemisphere Season: Summer, Winter, Fall, Spring

Ship

ARM/BSRN Site

Functional change in DLF with change in surface temperature and water vapor.

Sub-Arctic Winter Atmosphere

Tropical Atmosphere

Plots show LW surface down flux (SYN1Deg –Observation) versus differences in surface air temperature and mixing ratio (GEOS5.4.1-Observation) by season and surface observation source. Dashed lines show theoretical change in DLF due to changes in input surface air and mixing ratio values. Results indicate irradiance bias is generally not attributable to input water vapor and temperature biases found here.

Summary & Future Work

Surface downward longwave and shortwave irradiances, along with surface temperature and water vapor, as measured by three Australian research vessels (and several land/buoy sites) are compared to calculated (input) irradiance (meteorology) from NASA Langley's CERES SYN1deg data product. Irradiance bias(RMS) from the ships do not show significantly different results from land based sites in similar areas at similar times of year. Differences in surface temperature and water vapor are greater (particularly water vapor as a percentage) however there appears little functional dependence of the irradiance bias on the input biases. We look forward to the release if ARM/AMF data that will come from the MARCUS deployment which will characterize a number of meteorological parameters besides the currently available irradiance, temperature and surface relative humidity shown here.

Corresponding Author: David.A.Rutan@NASA.gov