Assessing the potential of the Atmospheric Infrared Sounder (AIRS) surface temperature and specific humidity in turbulent heat flux estimates in the Southern Ocean

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Objective and Outline

Main objective: to evaluate whether AIRS retrievals, in conjunction with microwave sea surface temperatures from the Advanced Microwave Scanning Radiometer (AMSRE), can provide sufficiently accurate parameters to estimate sensible and latent heat fluxes in the data-limited Southern Ocean .

Outline:

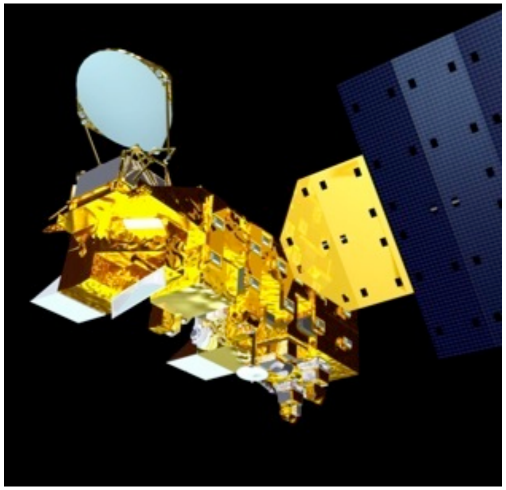
- Brief introduction of AIRS.
- Compare AIRS near-surface parameters with shipboard measurements, and discuss possible causes for their differences.
- Examine potential uncertainties in the derived turbulent latent and sensible heat fluxes that use the AIRS near-surface retrievals.

What is AIRS?

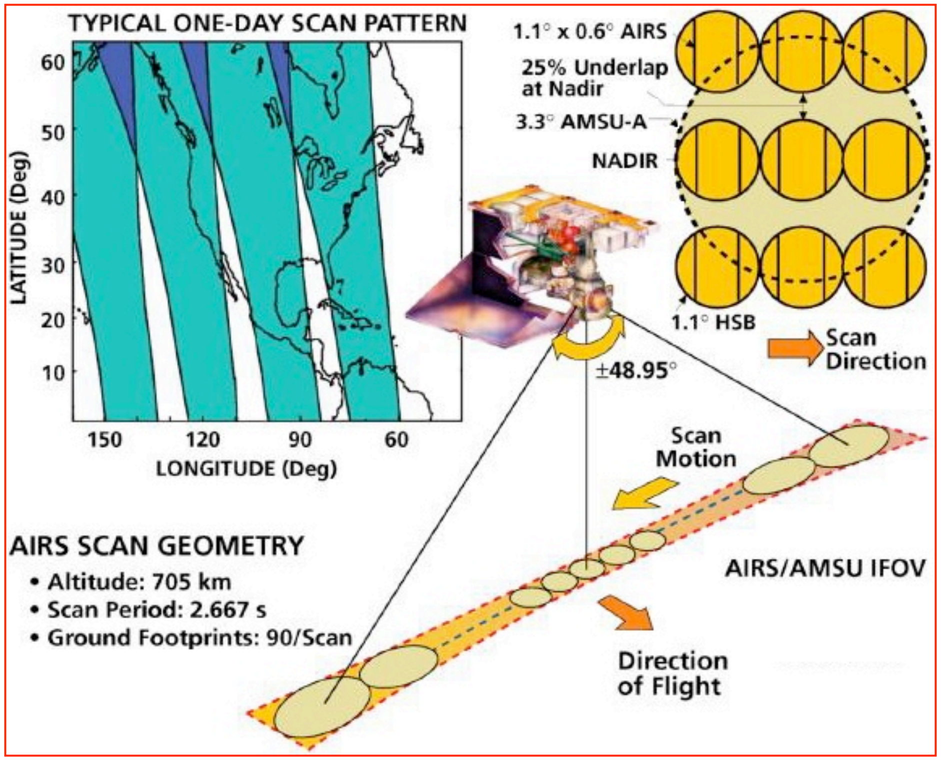
- AIRS is one of six instruments on board the EOS Aqua satellite; it represents the most advanced atmospheric sounding system ever deployed in space to date.

- The goal of AIRS is to provide 3-D maps of air and surface temperature, water vapor and cloud properties.

- With 2378 spectral channels, AIRS has a spectral resolution more than 100 times greater than previous IR sounders and provides more accurate information on vertical profiles of atmospheric temperature and moisture for climate research and weather forecasting.



How AIRS works

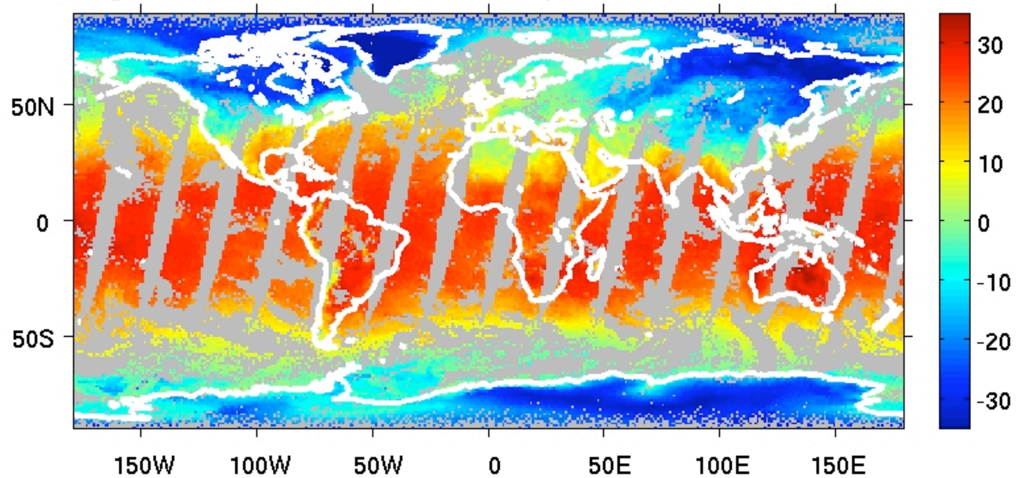


- AIRS is a cross-track scanning sounder with ±49 degree ground coverage. The AIRS IR spatial resolution is 13.5 km at nadir.
- The high-spectral resolution gives AIRS the ability to retrieve an entire profile of temperature and water vapor in the presence of up to 70% cloud cover.

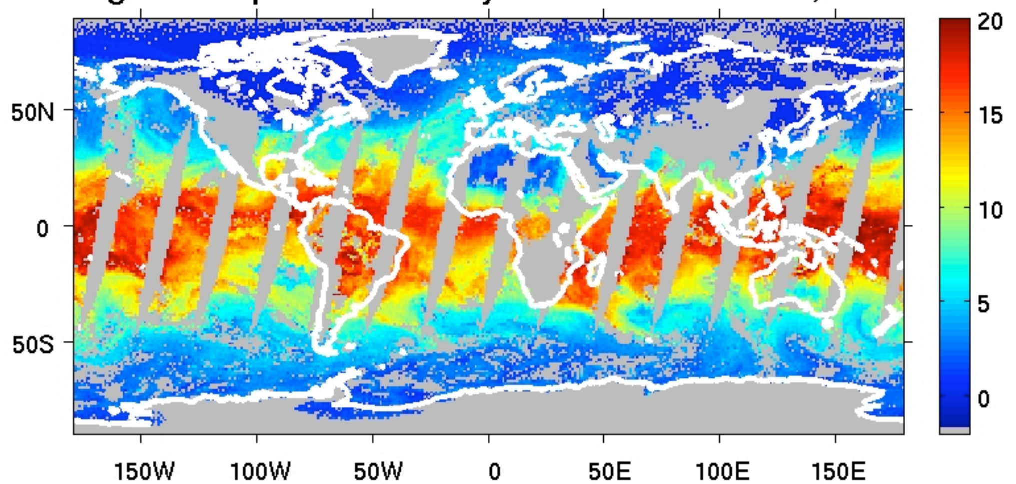
- Aqua satellite, lunched in May 2002, follows a sun-synchronous polar obit, so observations occur at roughly the same local time each day. The orbit moves northward at 13:30 and southward at 01:30 at equator local time and crossings at 55°S are around 15:00 and 01:00 local time.

Example of AIRS Measurements

Nighttime near-surface air temperature for Jan.1, 2005



Nighttime specific humidity at 1000 mb for Jan.1, 2005



Data and Method

Satellite Measurements:

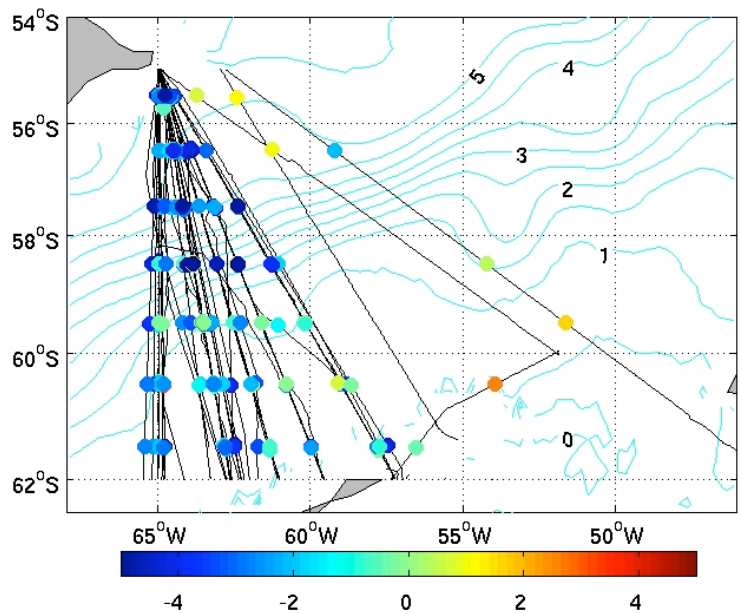
surface air temperature (T_A), sea surface temperature (T_O), and specific humidity (q_a) from the Aqua Atmospheric Infrared Sounder (AIRS).

AIRS version 5 level 3 data are used. AIRS L3 products are derived from L2 (swath) data that has been binned and averaged onto a 1°×1° grid.

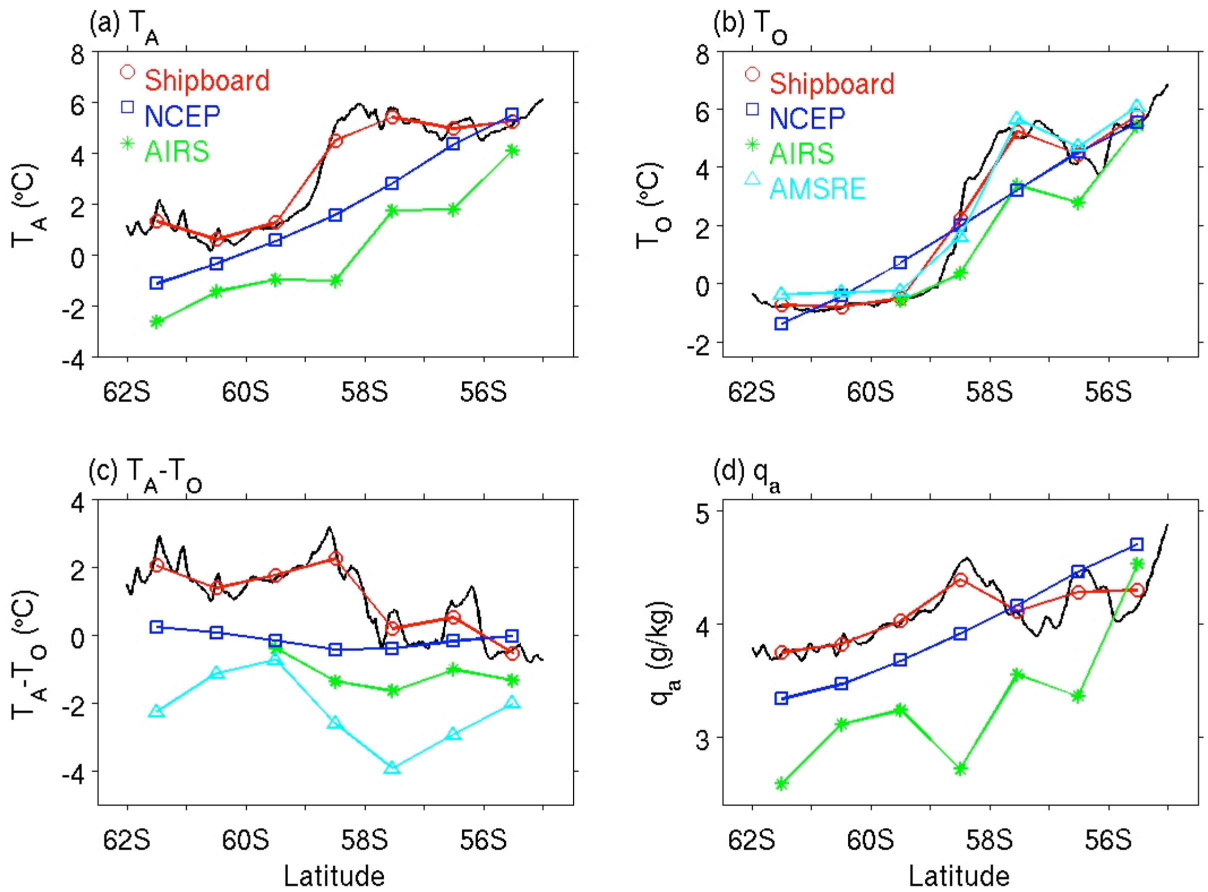
Shipboard Measurements:

near surface temperature, humidity, and wind data from the R/V Laurence M. Gould (LMG), the principal supply ship of the U.S. Antarctic Program for Palmer Station.

A total of 88 ship crossings from September 2002 to June 2007.



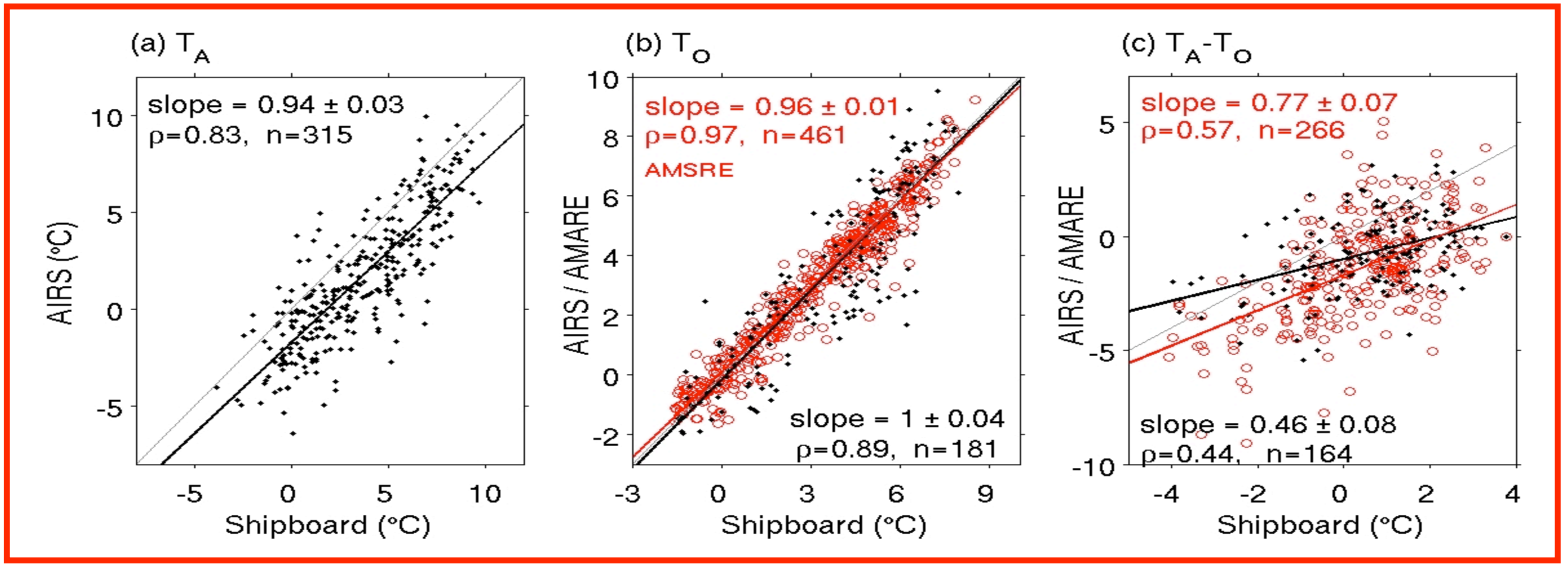
Temperature and Specific Humidity Distribution

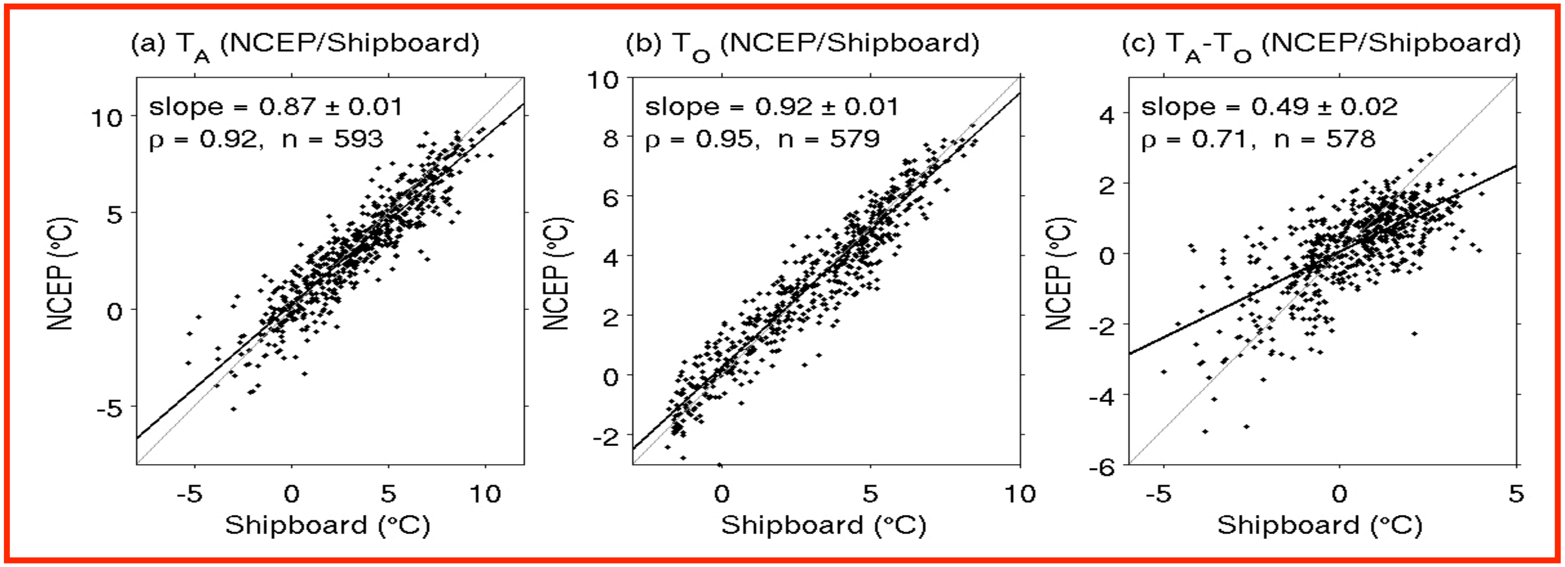


Airs T_A and T_O:

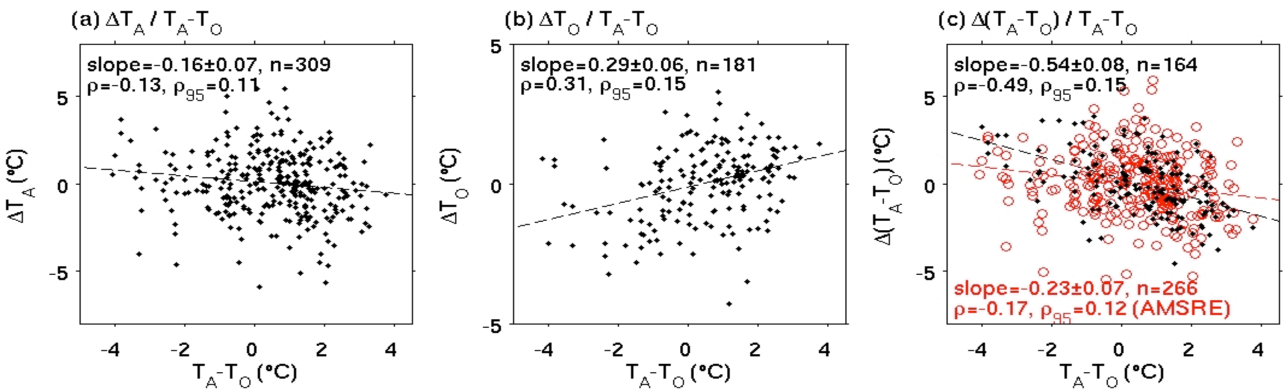
- Consistently colder than the corresponding shipboard measurements
- Better represent the observed meridional variability

Comparison of Near-Surface Temperatures

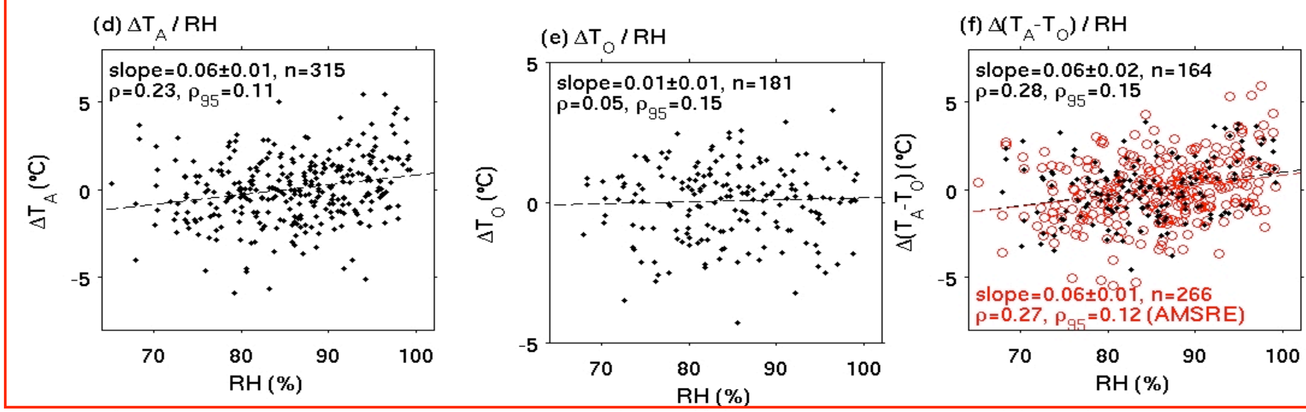




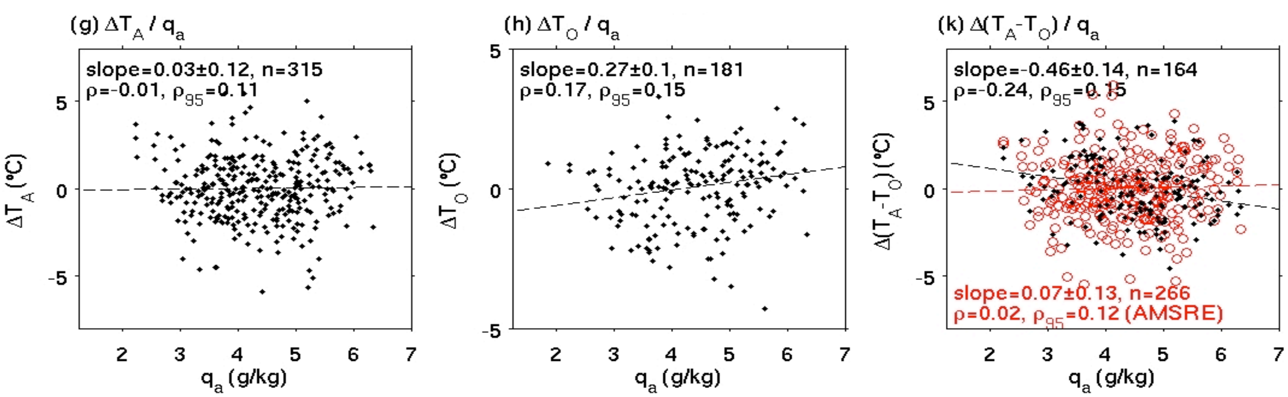
Causes for Near-Surface Temperatures Biases



Temperature biases significantly depend on air-sea temperature difference

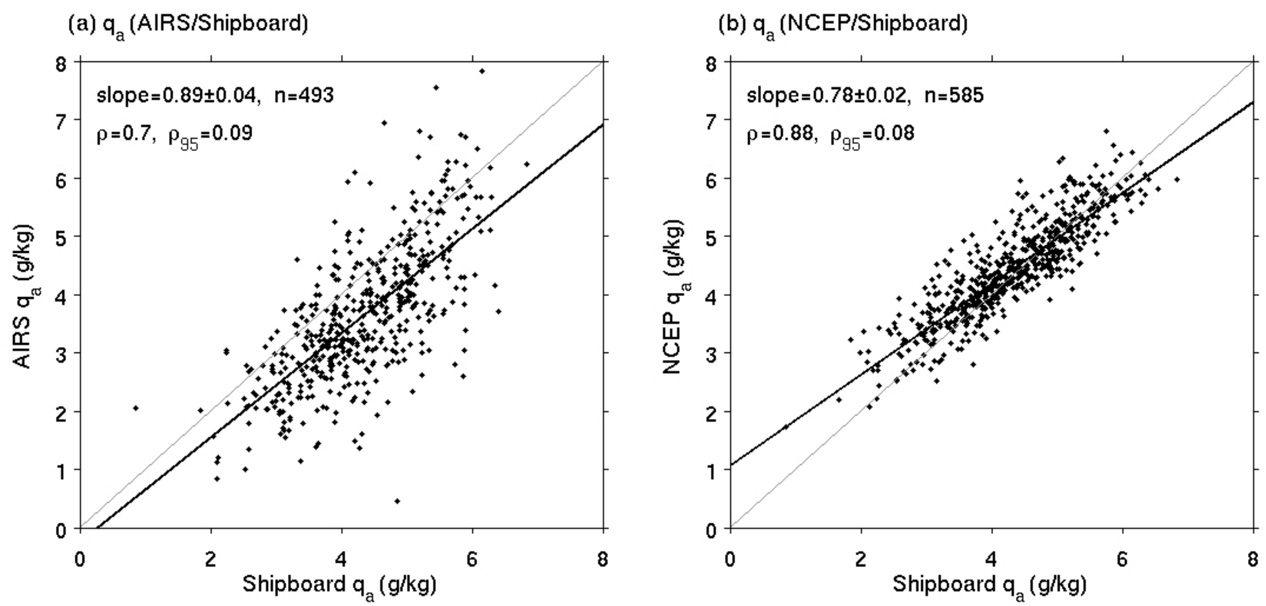


Biases in T_A show significant dependence on relative humidity



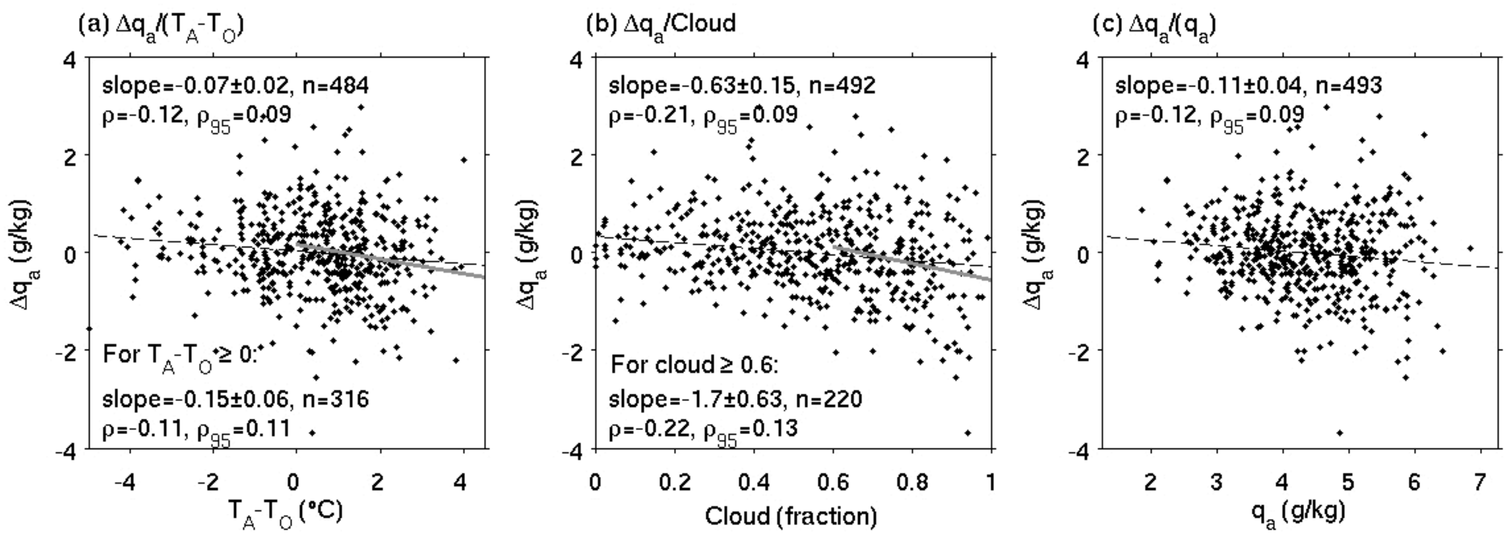
Temperature biases significantly depend on specific humidity

Comparison of Near-Surface Specific Humidity



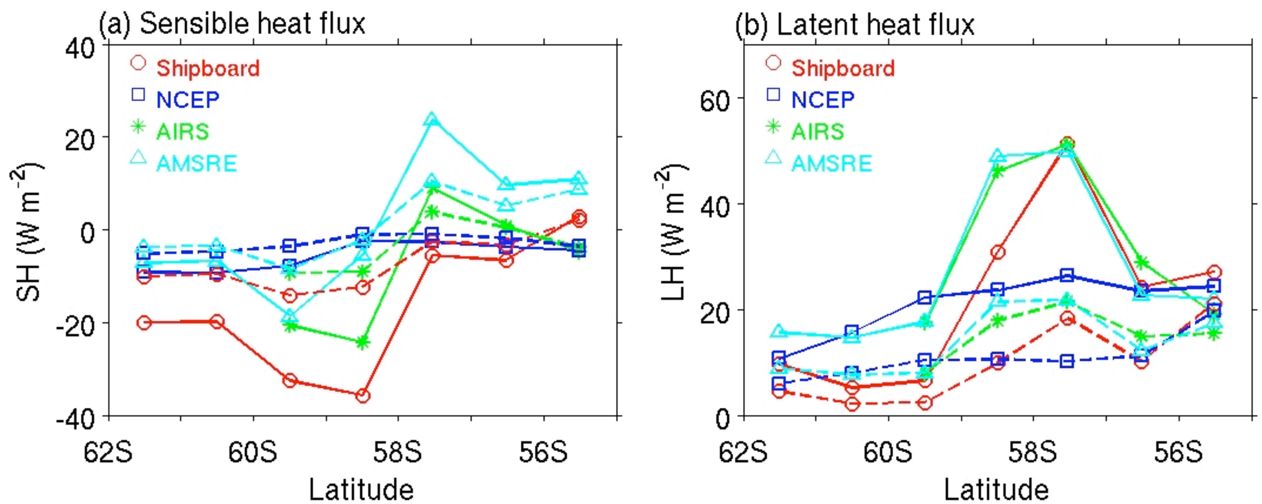
- The relatively large regression slope (regress AIRS q_a to shipboard q_a) suggests that the AIRS q_a captures the observed q_a variability.
- The large scatter of AIRS q_a versus shipboard q_a indicates that it remains in question whether the AIRS q_a can improve the latent heat flux estimate.

Causes for Near-Surface Specific Humidity Biases

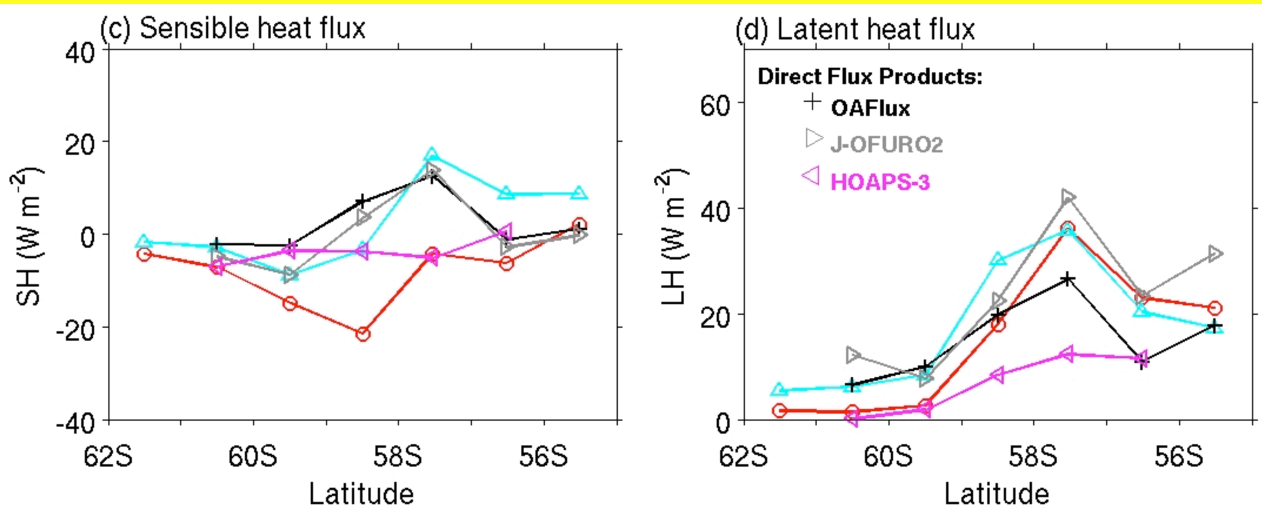


- Biases in AIRS q_a decrease with increasing air-sea temperature difference, and the dependence is stronger for cases when the air-sea temperature difference is positive.
- The dependence of biases in AIRS q_a on cloud is relatively strong for cases with a cloud fraction exceeding 0.6.

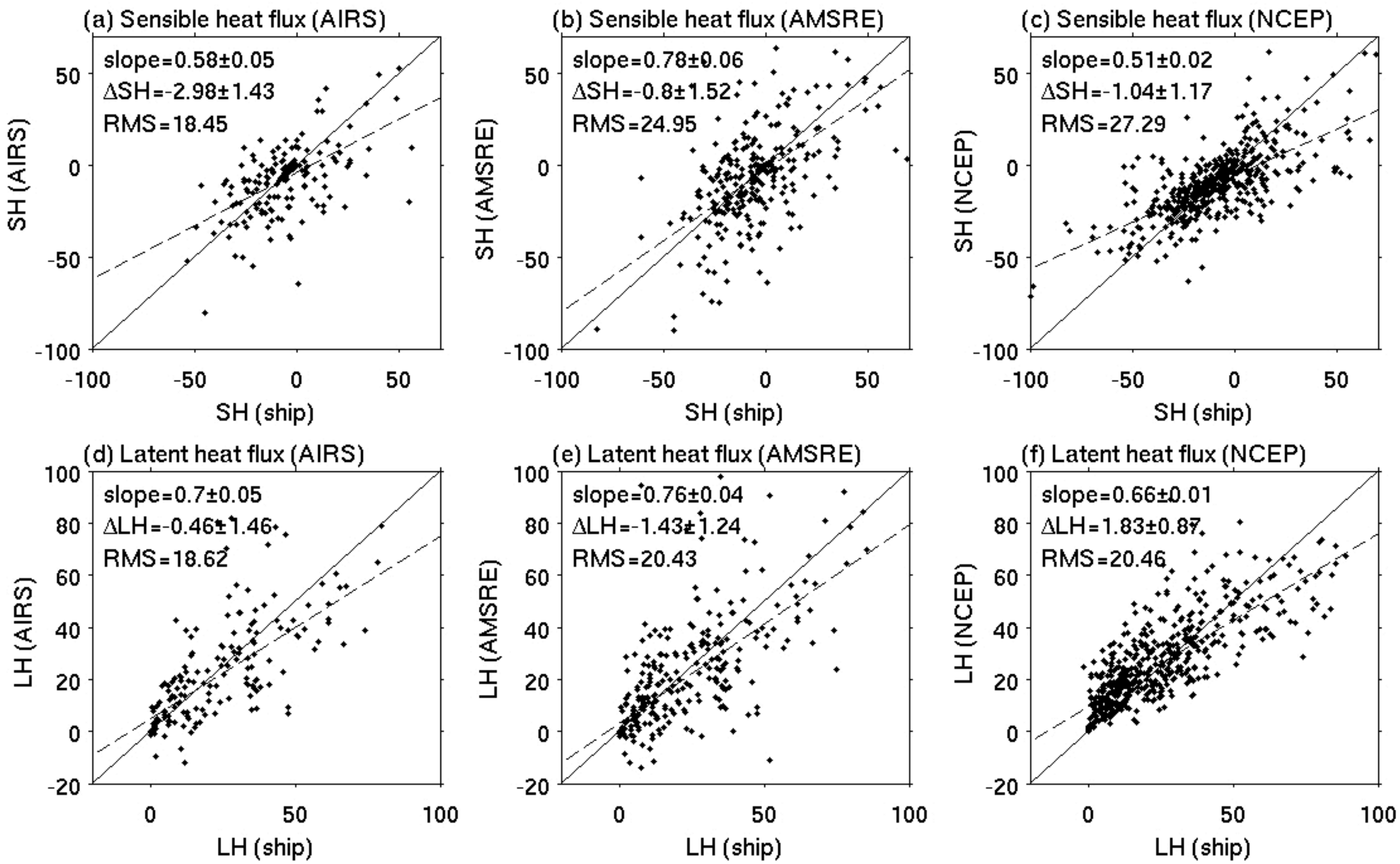
Comparison of Turbulent Heat Flux Estimates (1)



- ➢Turbulent heat fluxes estimated from satellite parameters show good representation of the flux variability in shipboard estimates across the Drake Passage.
- ➢Turbulent heat flux estimates are sensitive to wind speed applied.



Comparison of Turbulent Heat Flux Estimates (2)



Comparison of Turbulent Heat Flux Estimates (3)

Units: W m^{-2}	Sensible Heat Flux		Latent Heat Flux	
	RMS	Slope	RMS	Slope
AIRS	19.31	0.53±0.06	19.01	0.79±0.07
AIRS/AMSRE	21.88	0.73±0.06	18.96	0.84±0.05
NCEP	16.69	0.47±0.02	10.68	0.59±0.02
OAFlux	15.50	0.60±0.03	17.01	0.78±0.04
J-OFURO2	15.62	0.58±0.03	26.70	0.88±0.07
HOAPS-3	25.23	0.22±0.03	23.17	0.72±0.07

Conclusions

- our comparison indicates that, in cases with minimal cloud/water vapor contamination when the AIRS near-surface parameters are mostly available for the entire region, AIRS and AMSRE together can provide a better representation of the spatial variation evident in the shipboard measurements in the Drake Passage compared to the much smoother NCEP data.

- turbulent heat flux estimates using the COARE3.0 algorithm indicate that the AIRS/AMSRE combination performs better than the existing reanalysis or satellite-derived heat fluxes in terms of capturing the full range of turbulent heat flux values from the Drake Passage shipboard observations.