Polar Meteorology Group, Byrd Polar and Climate Research Center, The Ohio State University, Columbus, Ohio

Evaluating Cloud and Radiation Forecasts produced by the Antarctic Mesoscale Prediction System (AMPS) using AWARE Observations from WAIS Divide and Ross Island

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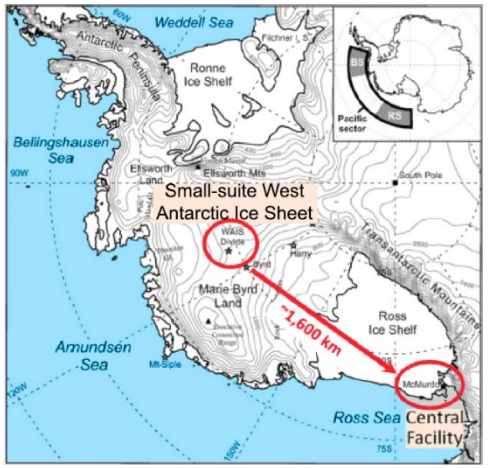

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ARM CLIMATE RESEARCH FACILITY

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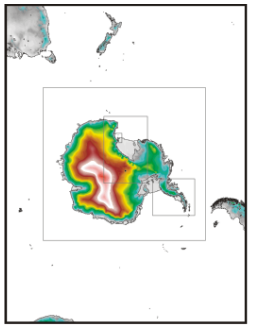
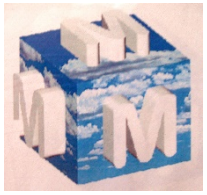
The Antarctic Mesoscale Prediction System (AMPS)



- **Adapted numerical weather prediction system for Antarctica**
  - **Polar WRF (Weather Research and Forecasting Model)**
  - **Variable resolution to 1.1 km**
- **Priority Mission: U.S. Antarctic Program (USAP) Weather Support (clouds important for aircraft!)**
- **Collaborators: NCAR and OSU BPCRC**



- **Powers et al. (2012) A decade of Antarctic science through AMPS. BAMS, 93, 1699-1712.**
- **http://www.mmm.ucar.edu/rt/amps**

NCAR

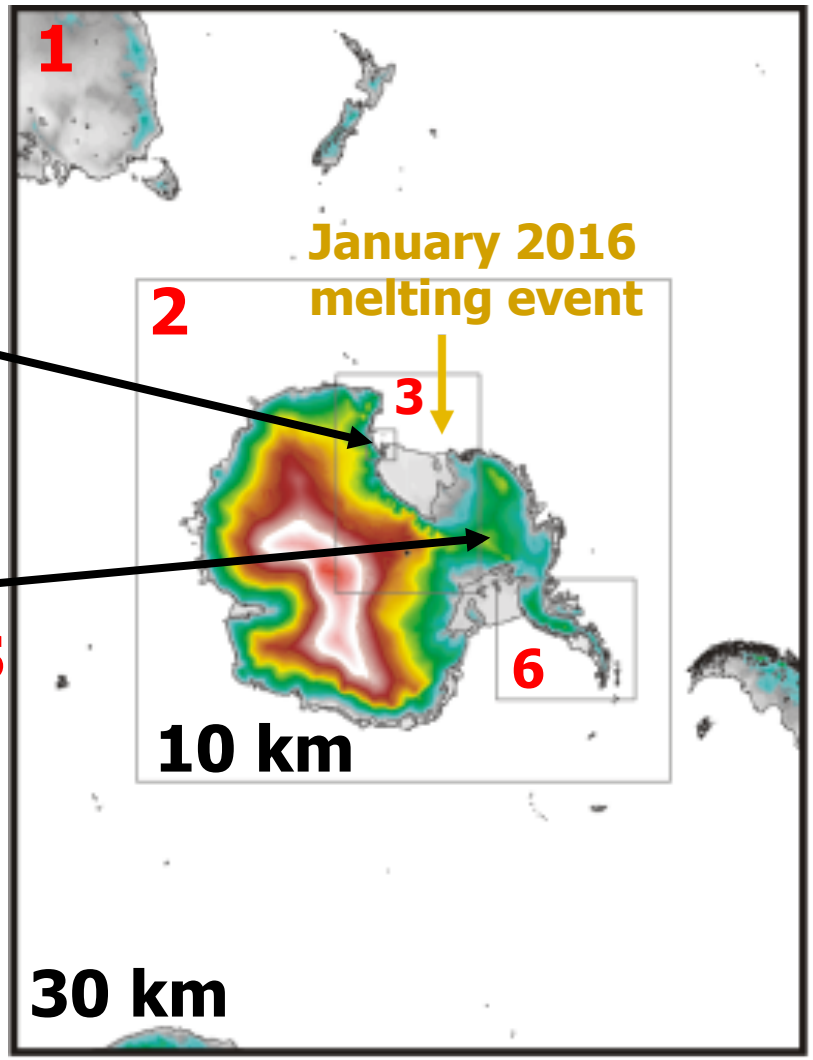
National Science Foundation NSF

AMPS GRIDS

NCAR

McMurdo
Use grid 4 (1.1 km)

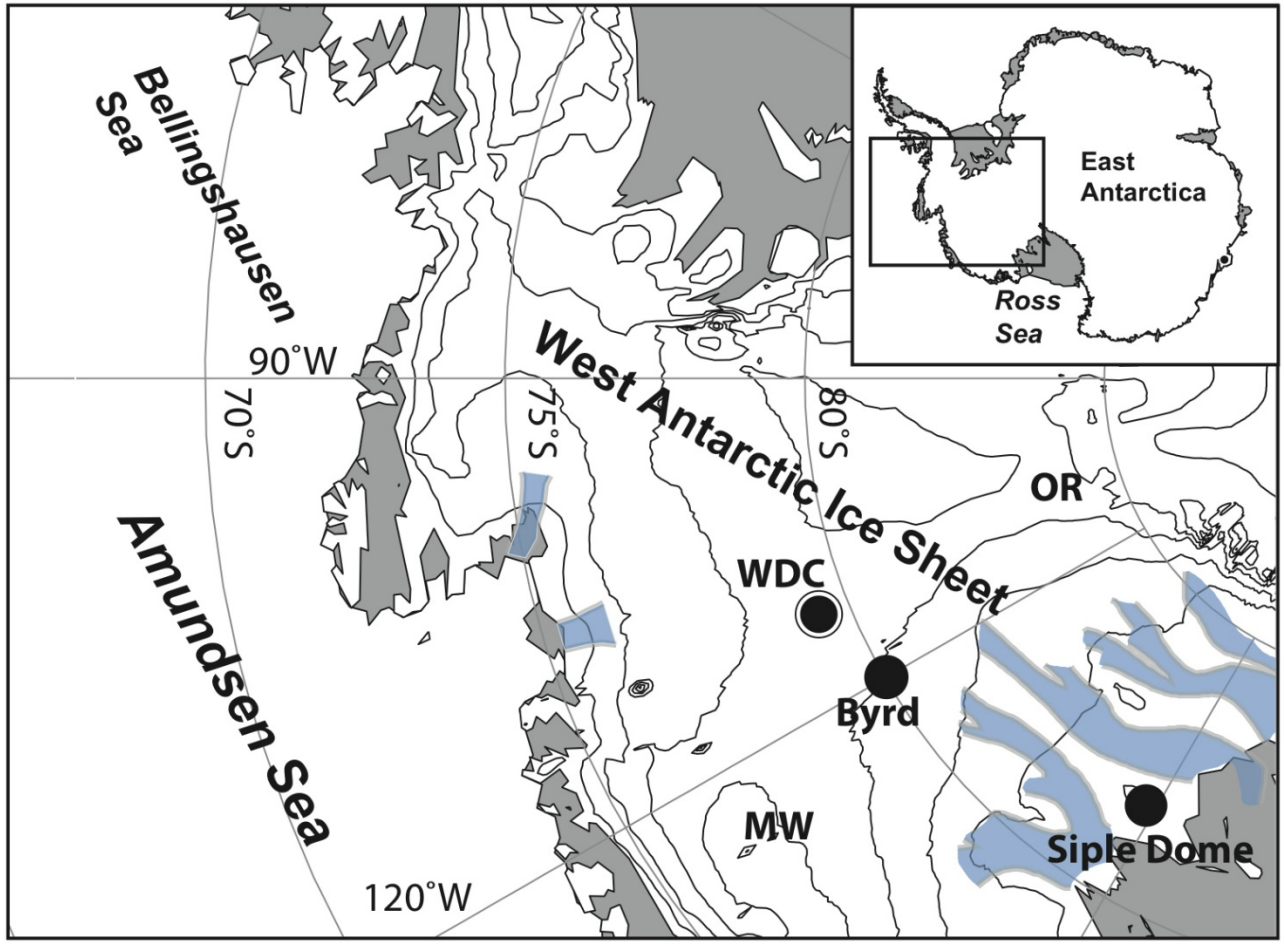
Use AMPS grid 2 (10 km) for WAIS evaluation



Use December 2015 and January 2016 AMPS forecasts and WAIS observations

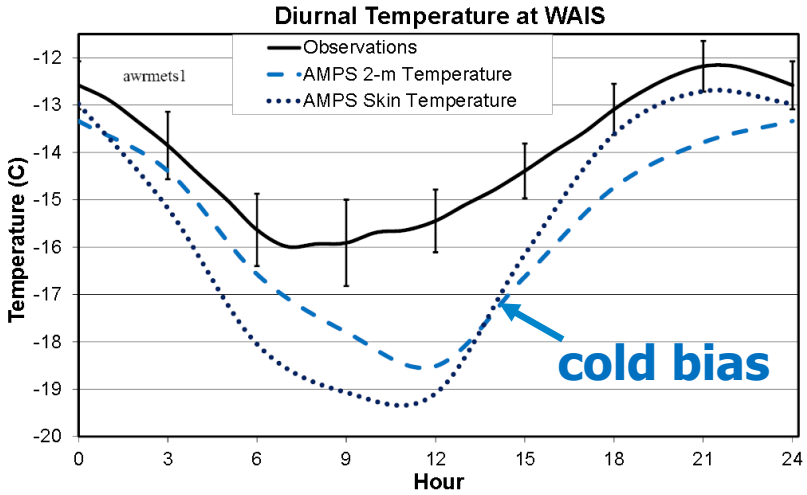
National Science Foundation

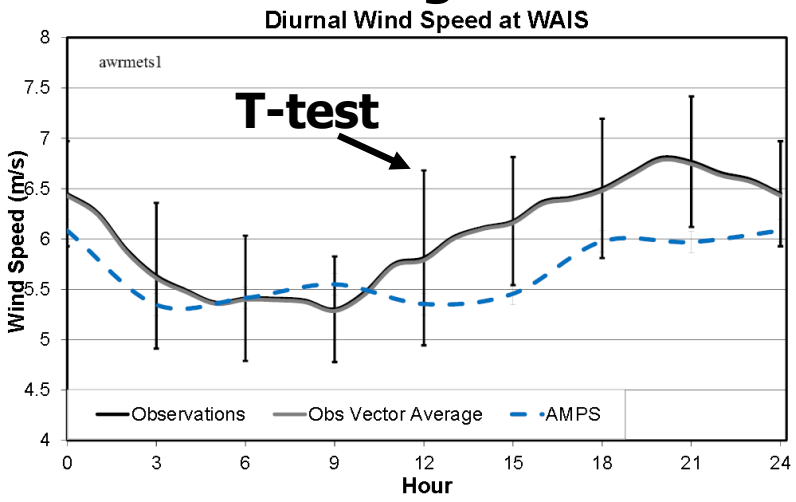
AMPS WAIS Divide Results



Average diurnal cycles for WAIS observations and AMPS forecasts during Dec. 2015 and Jan. 2016

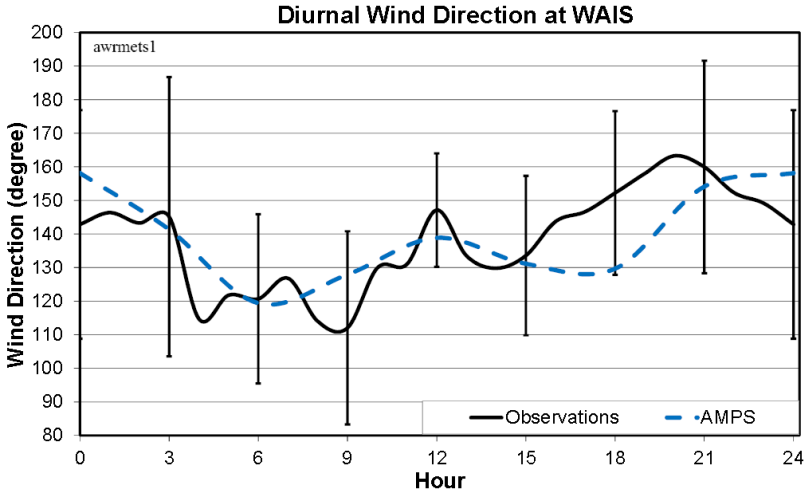
Bars show 95% confidence differences according to the t-test

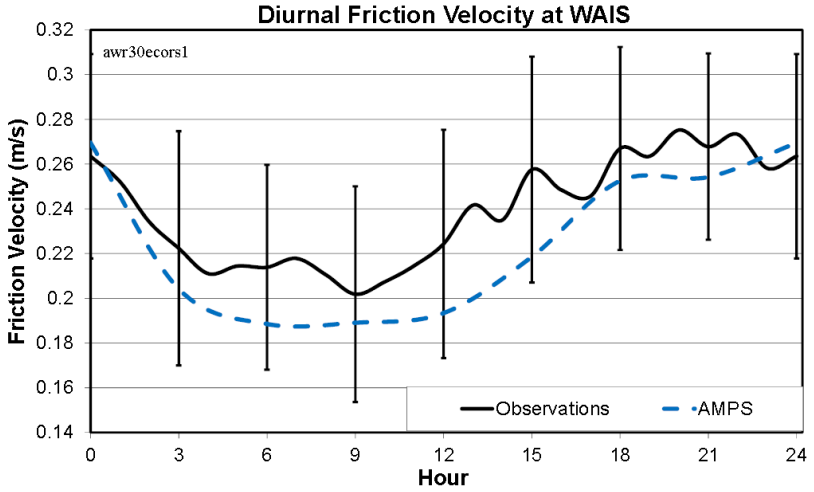




2-m temperature difference is statistically significant for most hours

10-m wind field appears reasonable

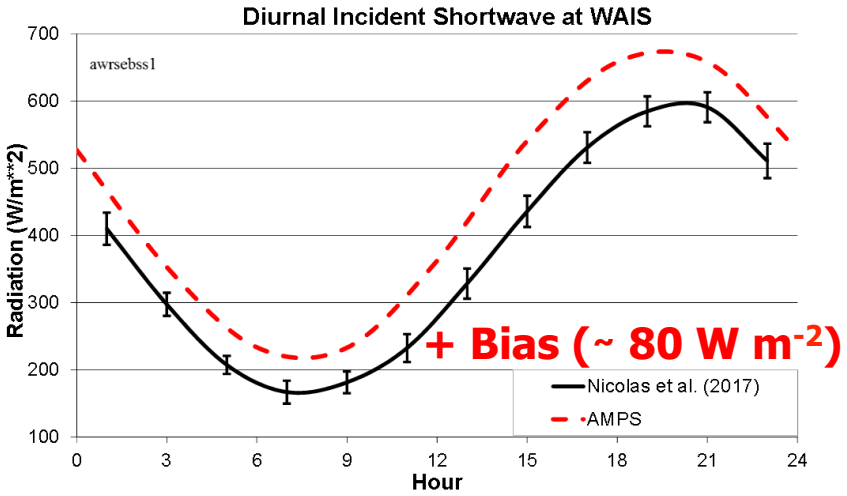


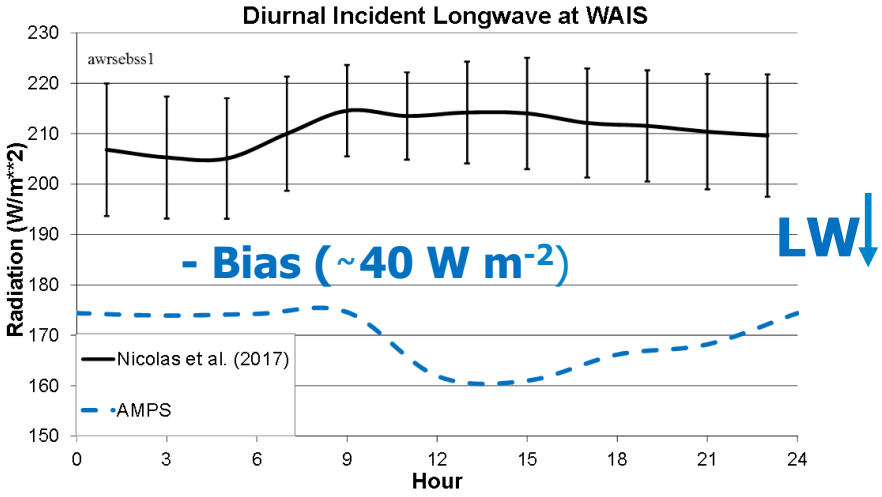


Energy balance can impact West Antarctic ice melt

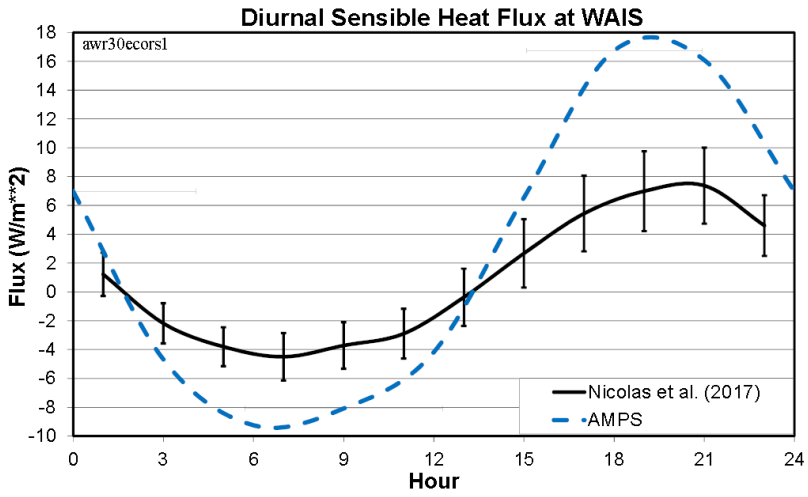
Surface Energy Balance: Excess shortwave and deficit in longwave → Cloud deficit?

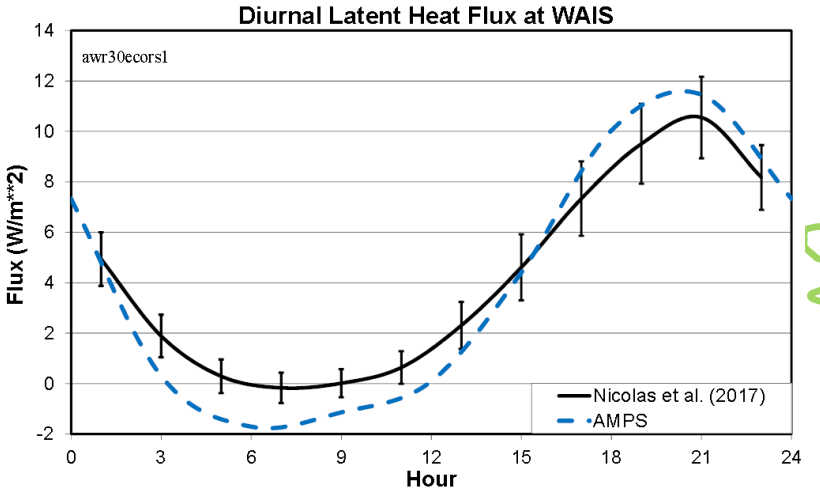
SW↓





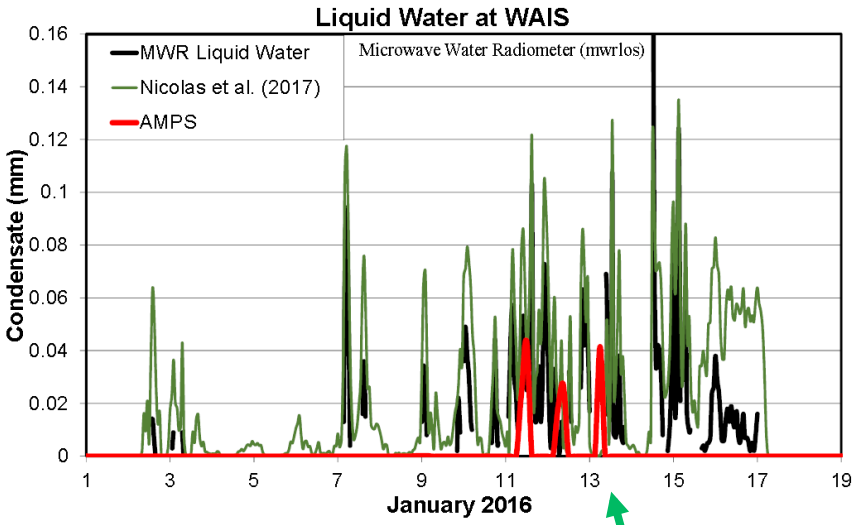
LW↓

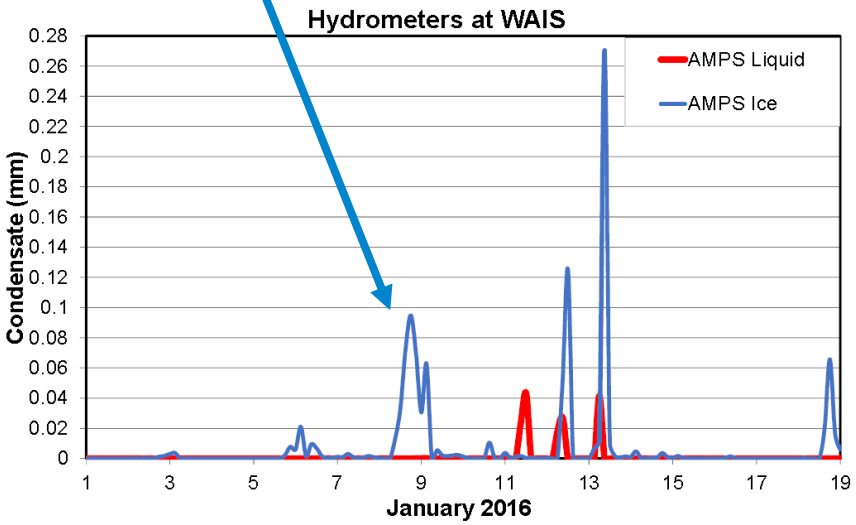




Radiation field can impact sensible and latent heat fluxes at WAIS

AMPS simulates more ice condensate than liquid condensate

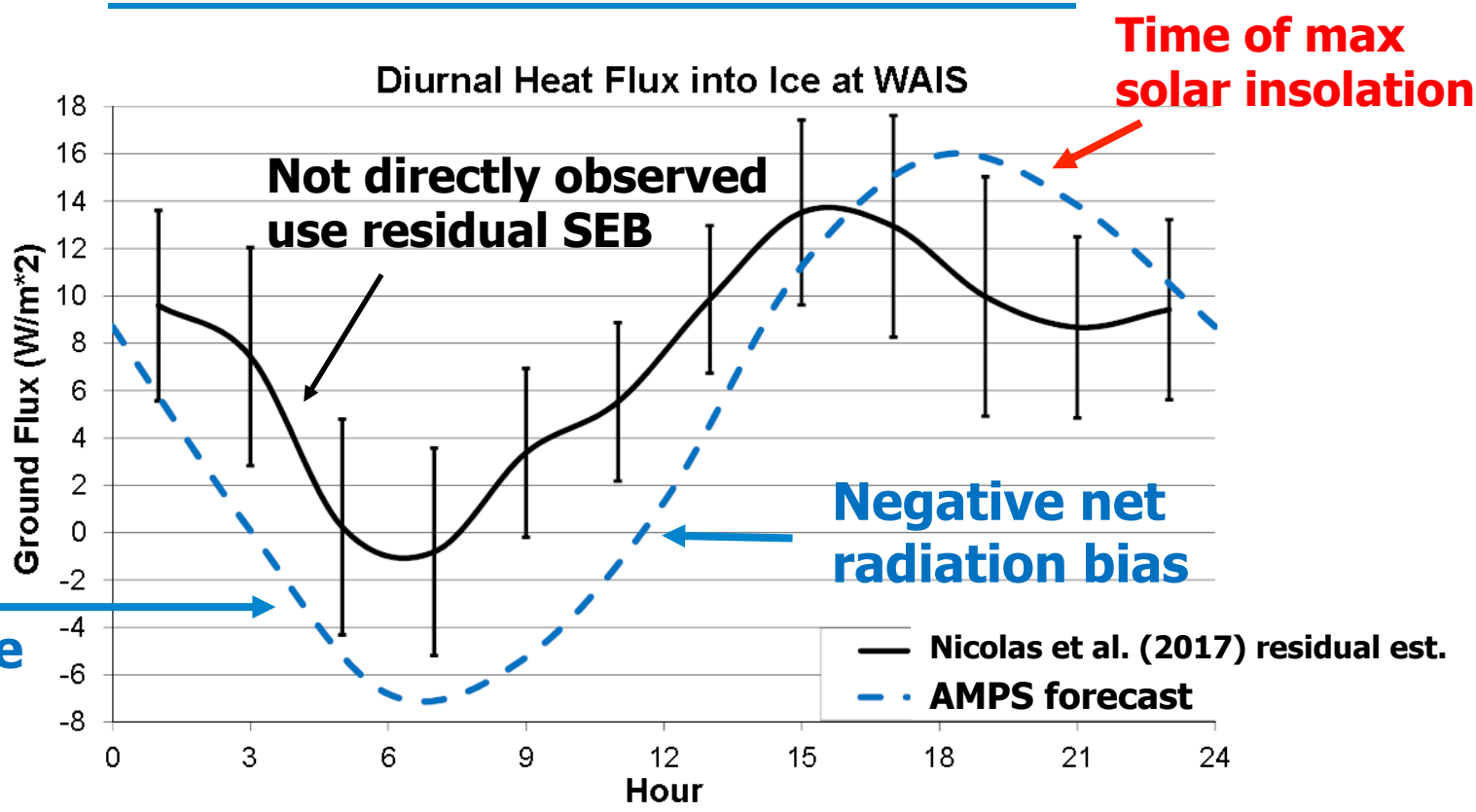




Observations indicate insufficient AMPS liquid water at WAIS.

Contributes to LW and SW bias.

Negative bias of 2.6 W m^{-2} for heat flux into WAIS ice



Impacts calculation of melting/surface energy/mass balance for West Antarctica

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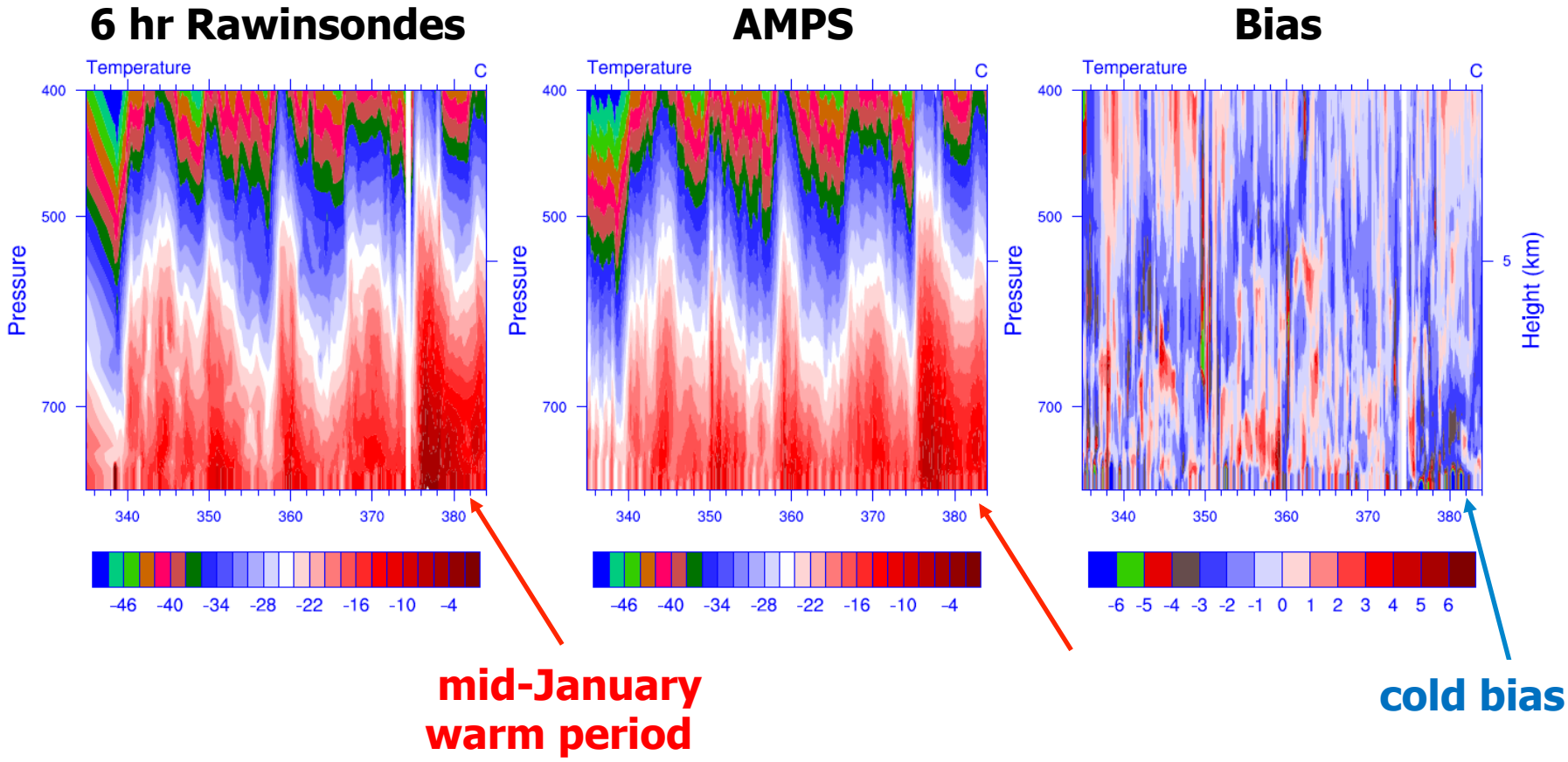
Temperature (°C)

Time-Pressure for December and January



AMPS underrepresents the mid-January warm period associated with melting

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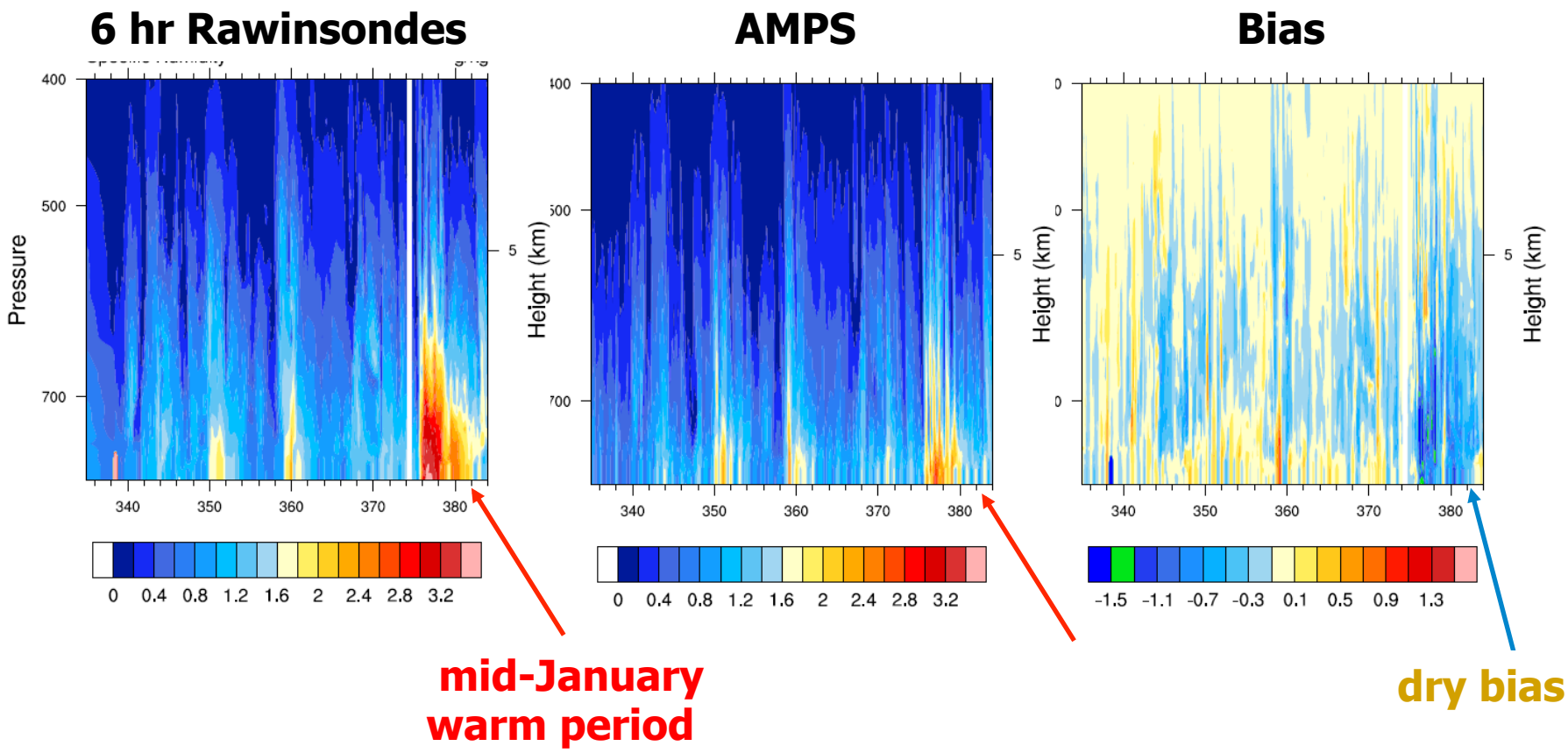
Specific Humidity (g kg^{-1})

Time-Pressure for December and January



AMPS underrepresents the surge in water vapor during the mid-January warm period

Summary of Preliminary AWARE Findings for AMPS at WAIS

Liquid water deficit in AMPS clouds with WRF single-moment 5-class microphysics

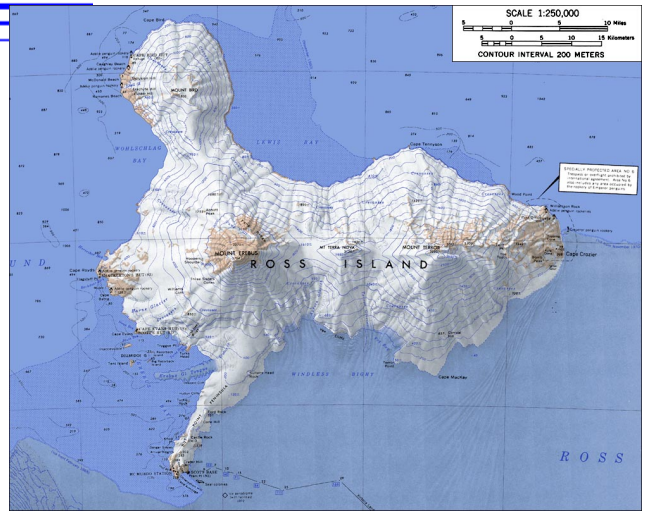
Positive incident SW bias and strong negative incident LW bias combine to a negative net radiation bias

Cold bias at most hours, especially time of minimum temperature

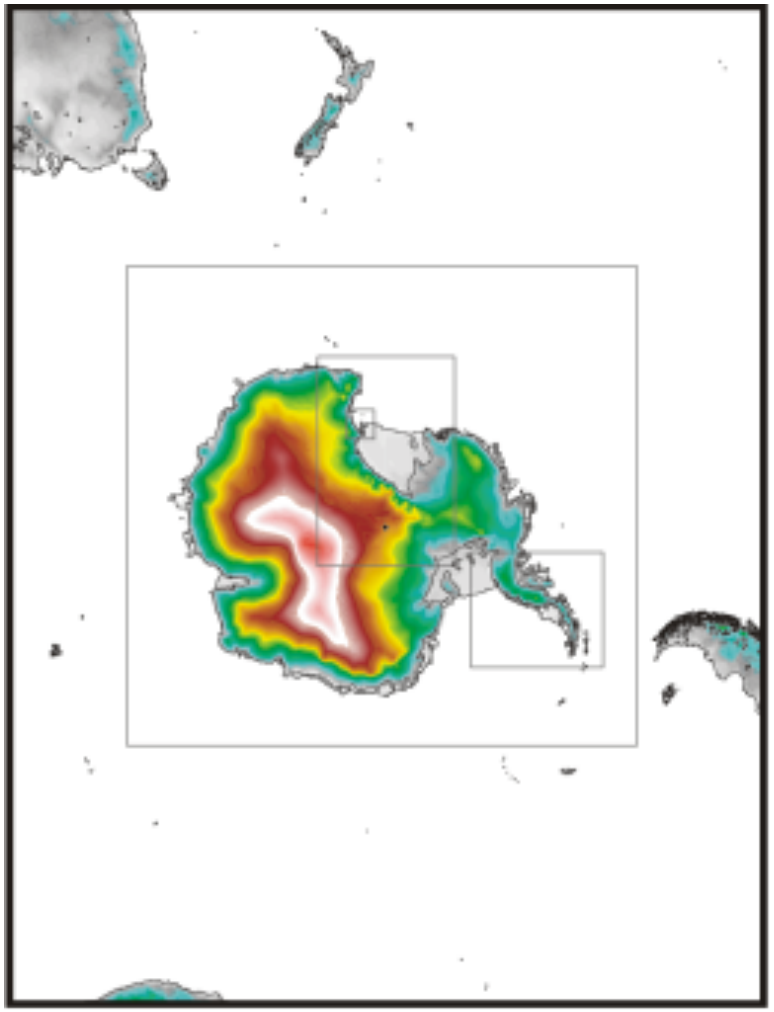
Negative bias of heat flux into Antarctic ice at WAIS

Need to fix multiple things (surface albedo, clouds) for proper surface energy balance

Clouds are critical for improving AMPS



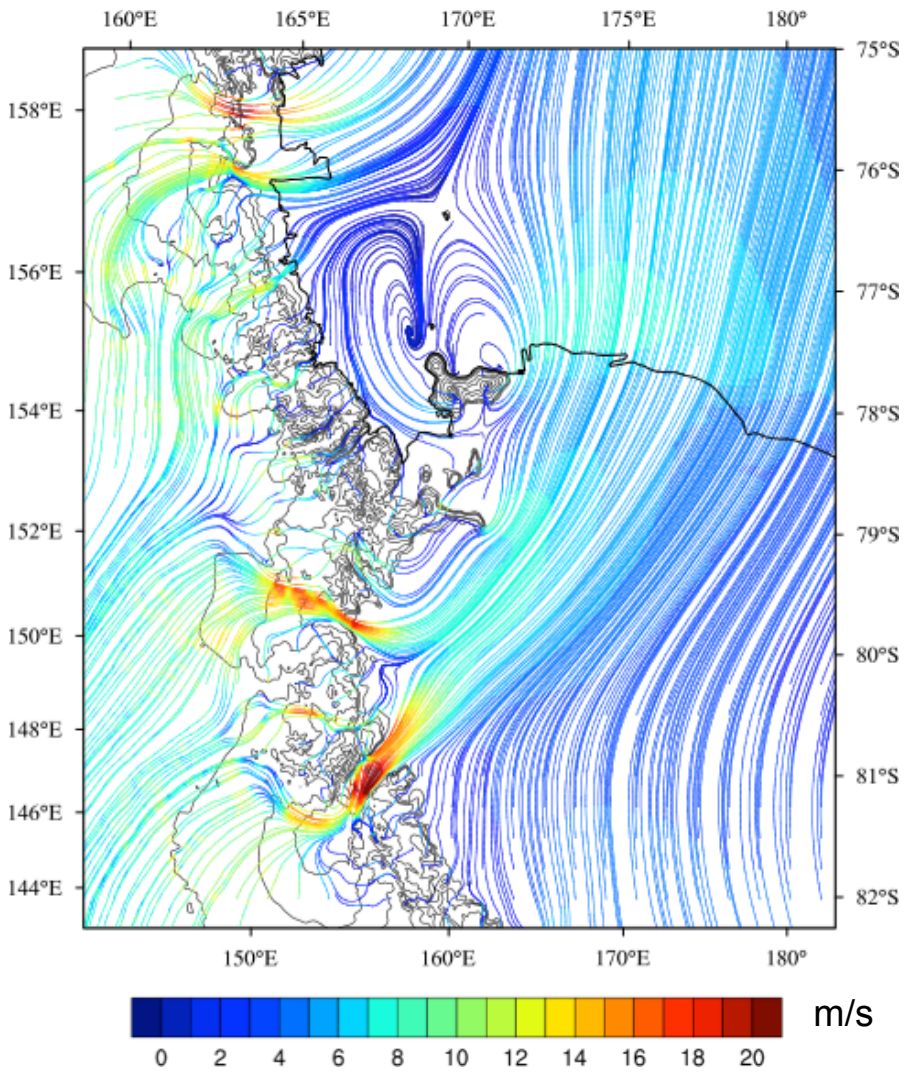
AMPS McMurdo Results



Example of AMPS high-resolution climatology

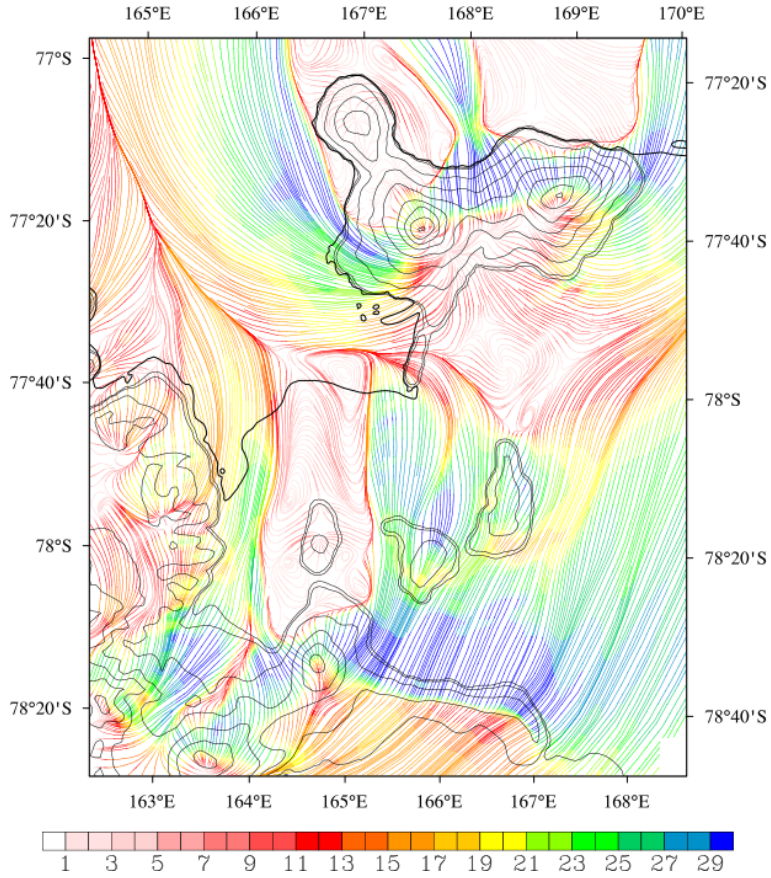
2015 annual mean 10m wind field over the Ross Island area from AMPS 1.1km domain

Complex air flows impacting the AWARE observation site at the southern tip of Hut Point Peninsula due to strong topographic forcing.

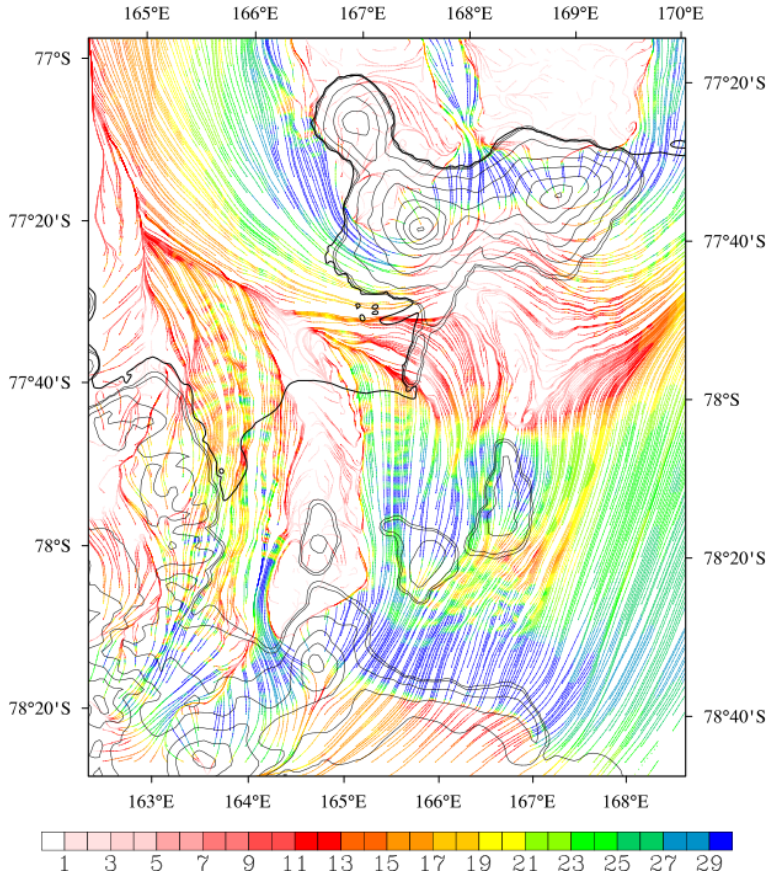


AMPS downscaling: 1.1km → 330m
High wind speed ex. – lots of waves appear

AMPS 1.1km @ 12 UTC 20 Aug 2014

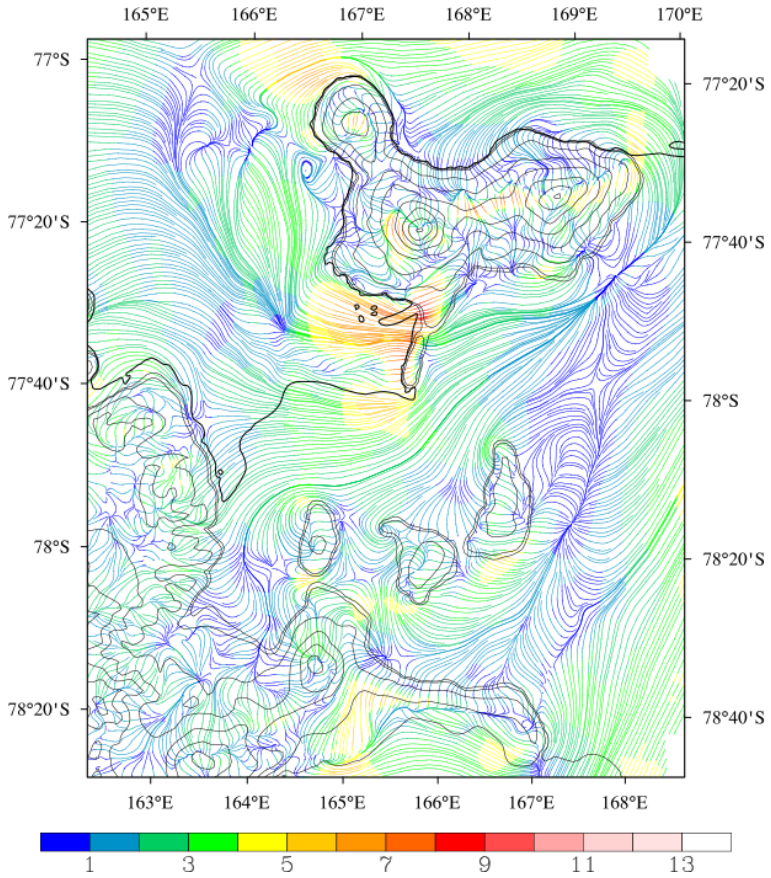


AMPS-NDOWN 330m @ 12 UTC 20 Aug 2014

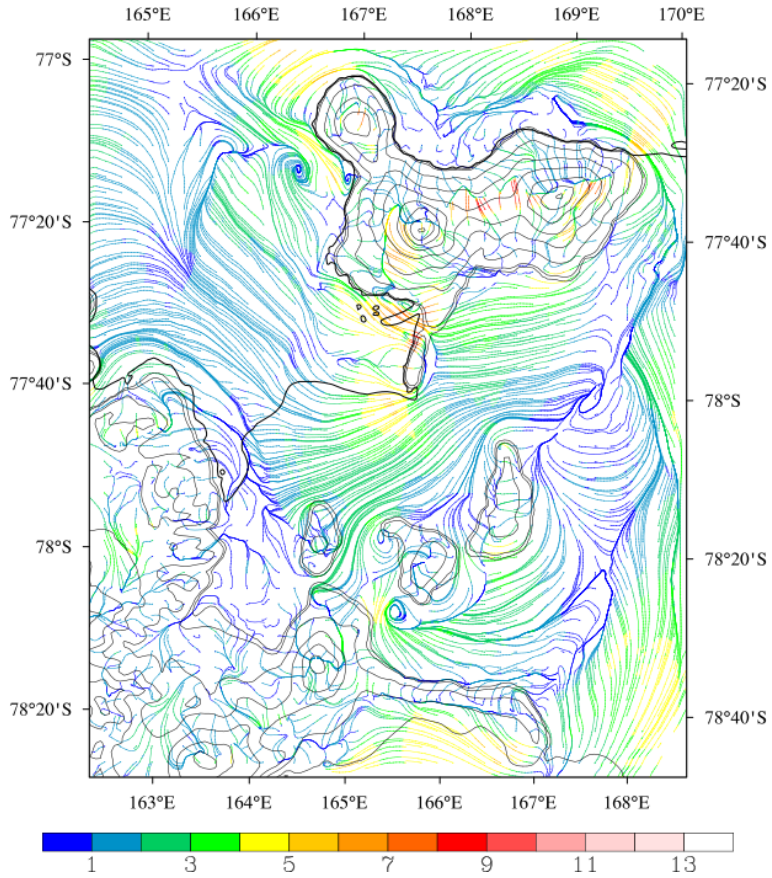


AMPS downscaling: 1.1km → 330m
Low wind speed ex. – more differences

AMPS 1.1km @ 00 UTC 19 Jan 2016



AMPS-NDOWN 330m @ 00 UTC 19 Jan 2016



(Reversed high wind speed color scale)

Plans for AWARE

- Continue evaluation of AMPS for WAIS
- Polar WRF 3.9.1 simulations
  - Morrison microphysics (widely used in Arctic)
  - Thompson-Eidhammer microphysics (aerosol aware)
  - Morrison – Milbrandt microphysics (new)
- Polar WRF 3.9.1 sensitivity tests
  - alter microphysics
- Journal article on AMPS for WAIS
- McMurdo Evaluation