

# Analysis of the AMPS-Polar WRF Boundary Layer at the Alexander Tall Tower! site on the Ross Ice Shelf

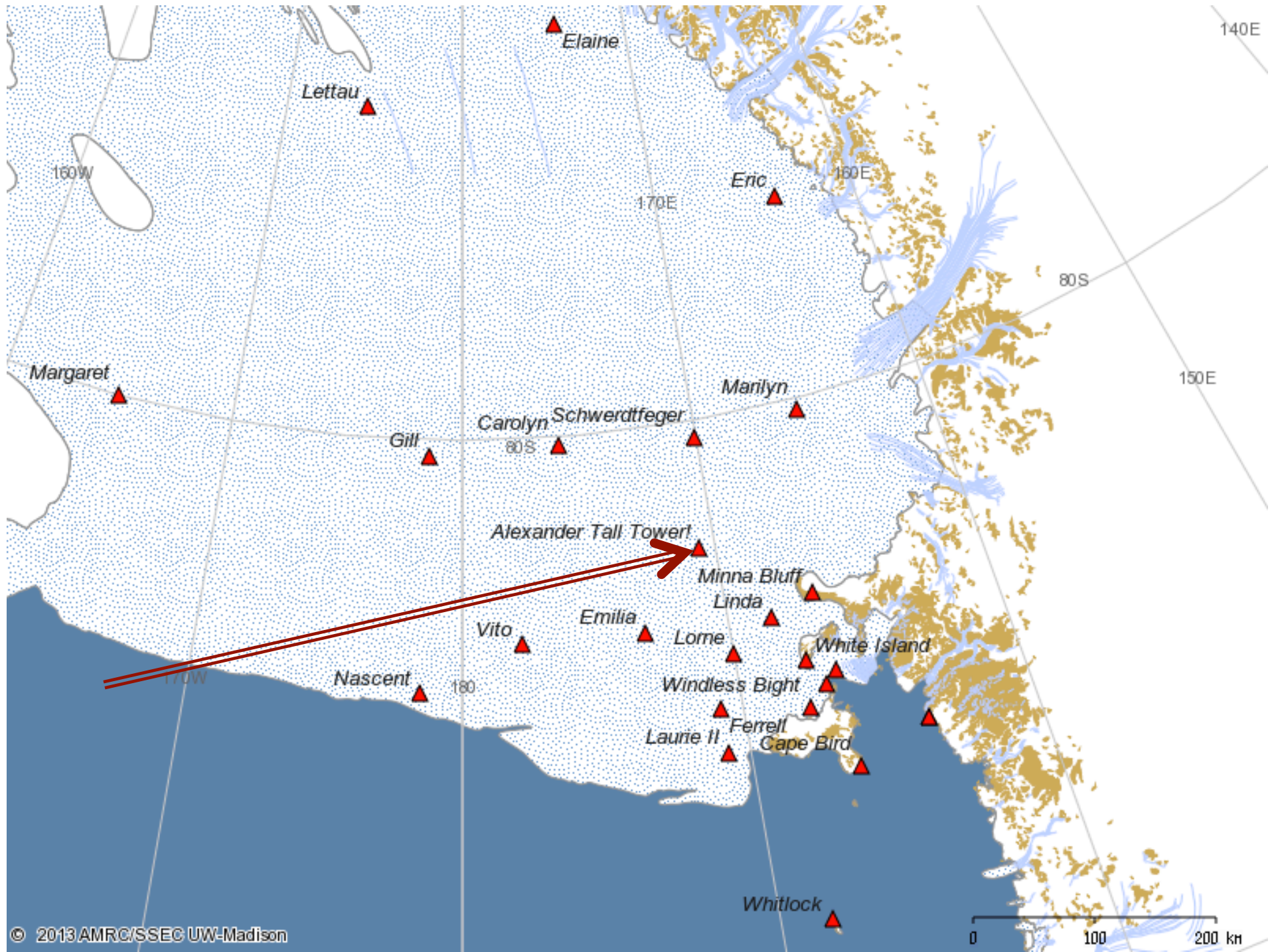
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David H. Bromwich



**THE OHIO STATE UNIVERSITY**

BYRD POLAR AND CLIMATE  
RESEARCH CENTER







## Alexander Tall Tower!

30m: Temp, RH, Wind Speed, Wind Direction, Net Long-wave and Shortwave Radiation

15m: Temp, Wind Speed, Wind Direction

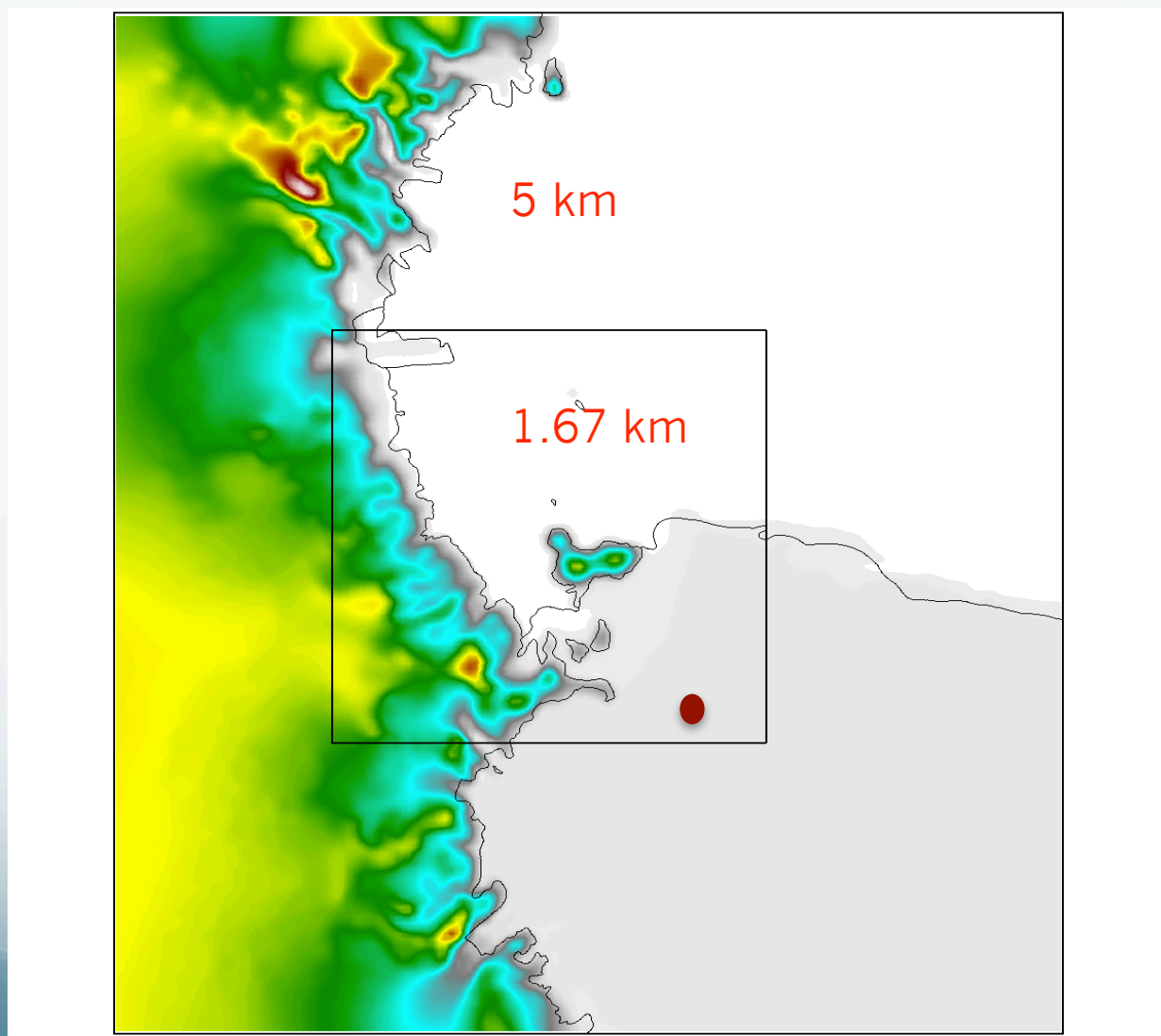
7.5m: Temp, RH, Wind Speed, Wind Direction

4m: Temp, Wind Speed, Wind Direction

2m: Temp, Wind Speed

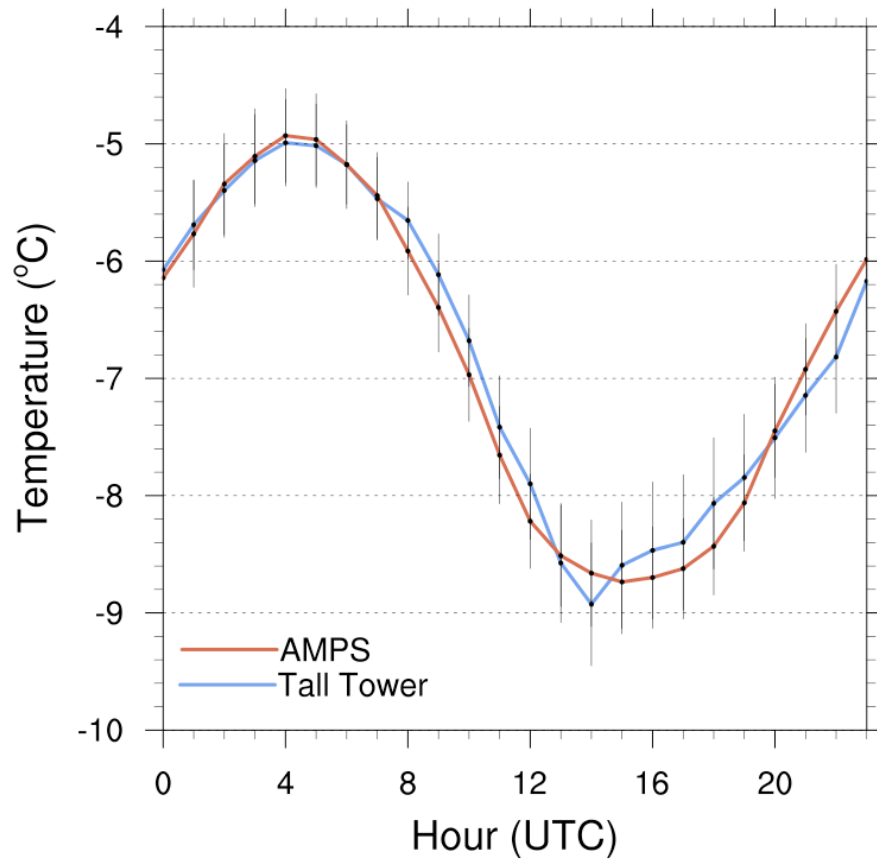
1m: Temp, Wind Speed

# AMPS-Polar WRF Domain 3

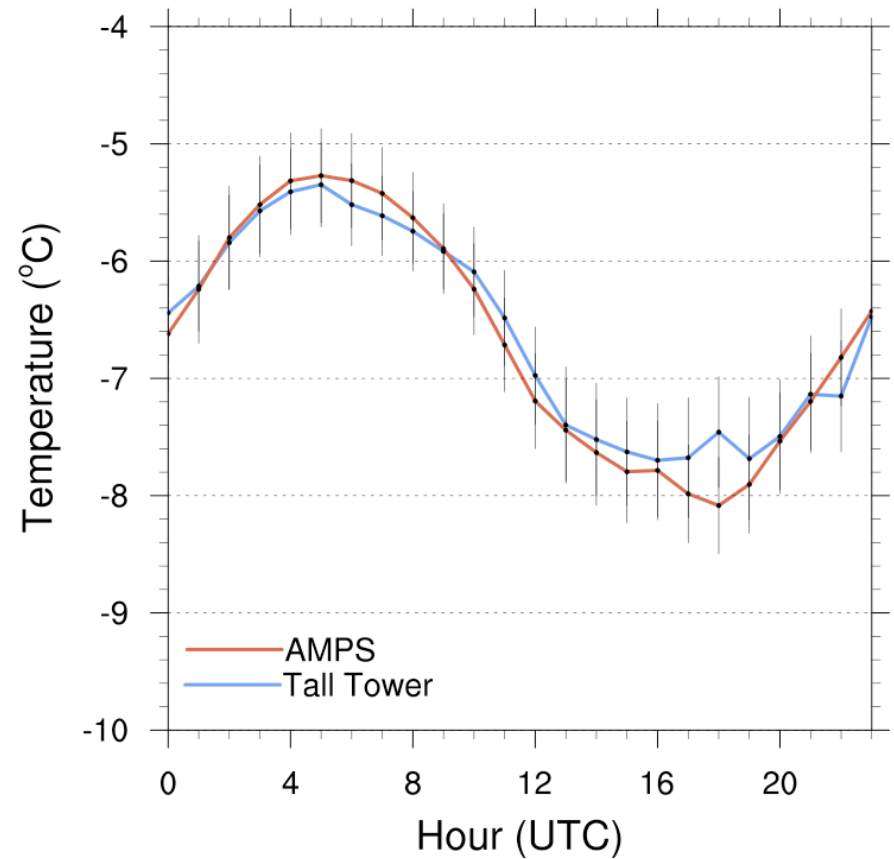


# Diurnal Cycle

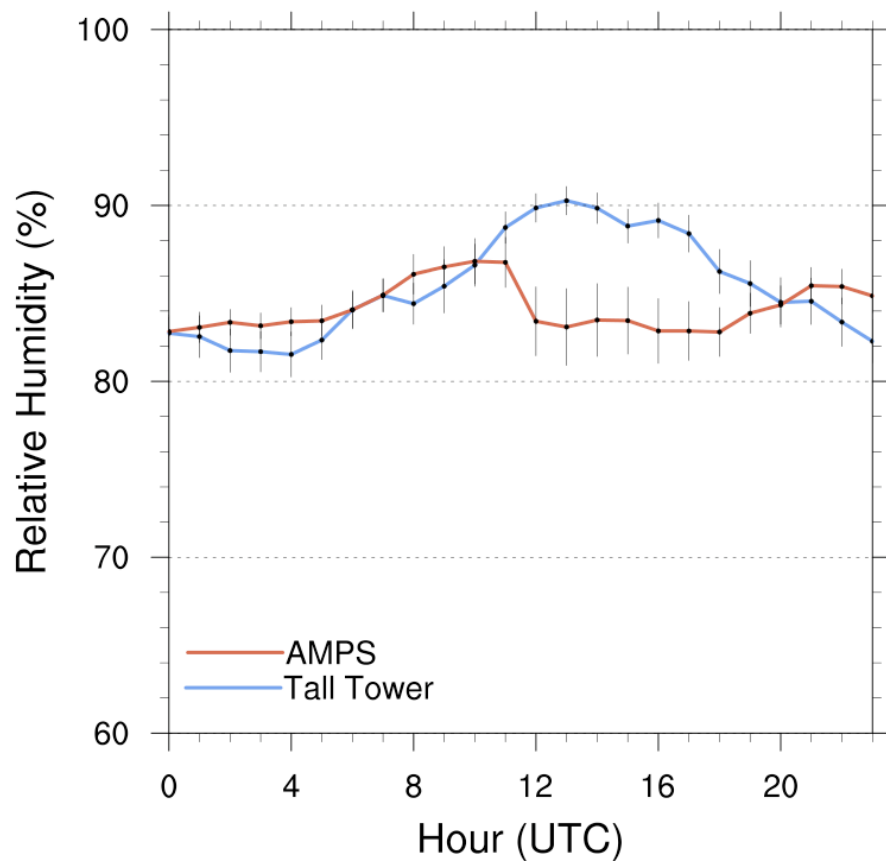
Dec Diurnal 4 m Temperature



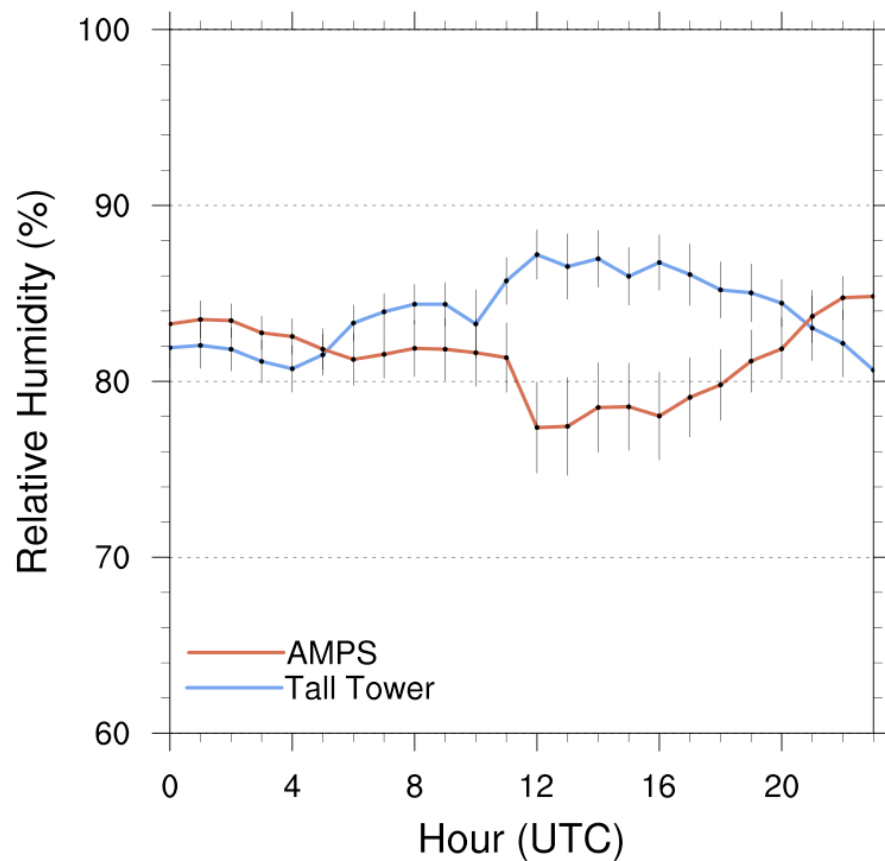
Dec Diurnal 30 m Temperature



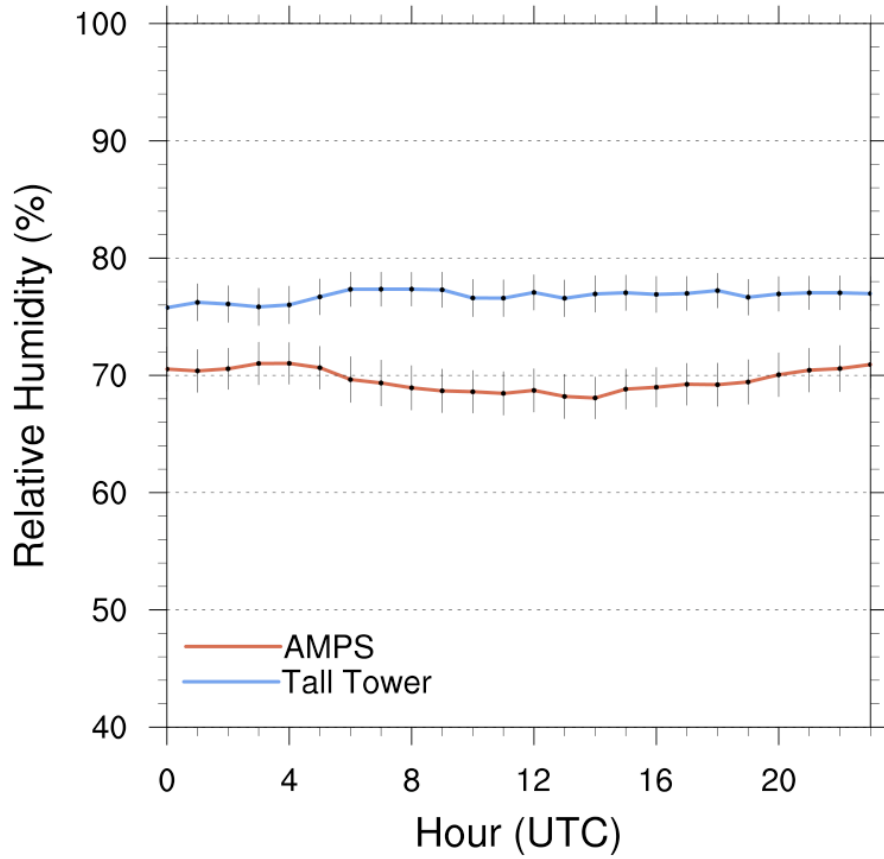
Dec Diurnal 8 m Relative Humidity



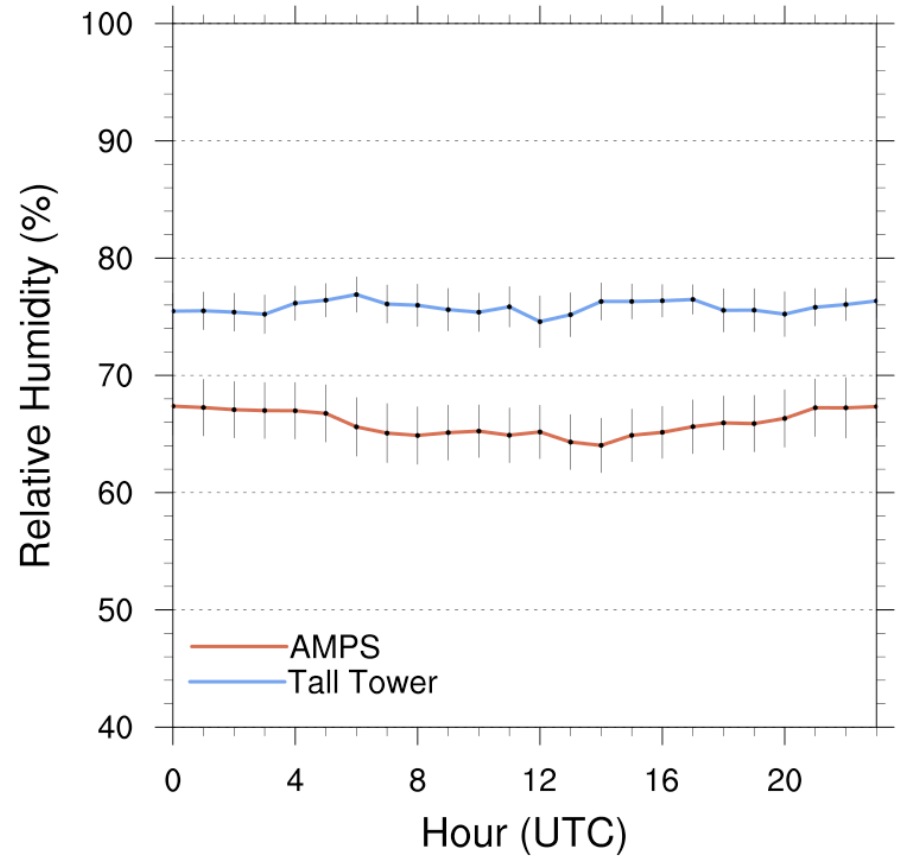
Dec Diurnal 30 m Relative Humidity



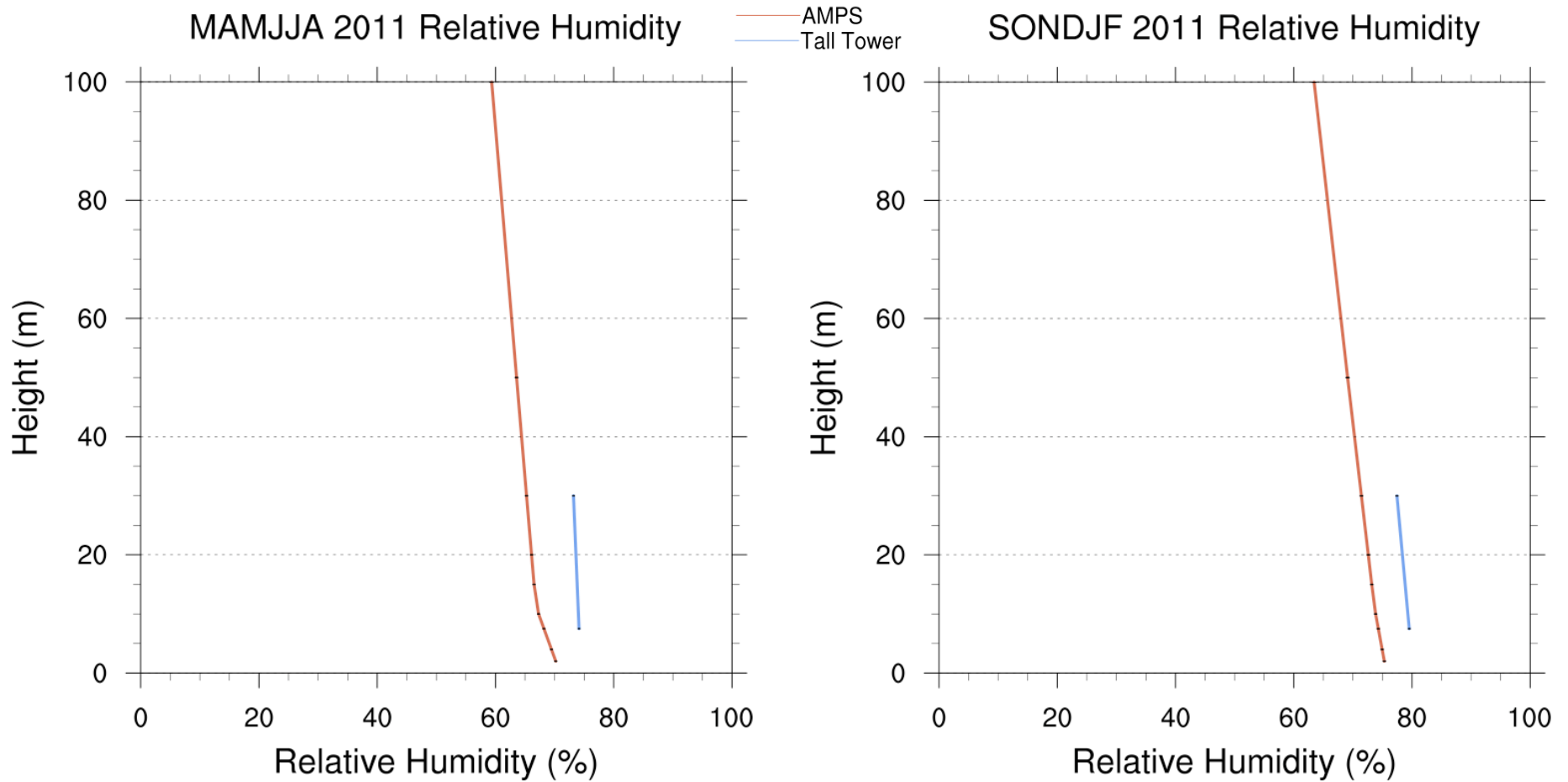
Jul Diurnal 8 m Relative Humidity



Jul Diurnal 30 m Relative Humidity

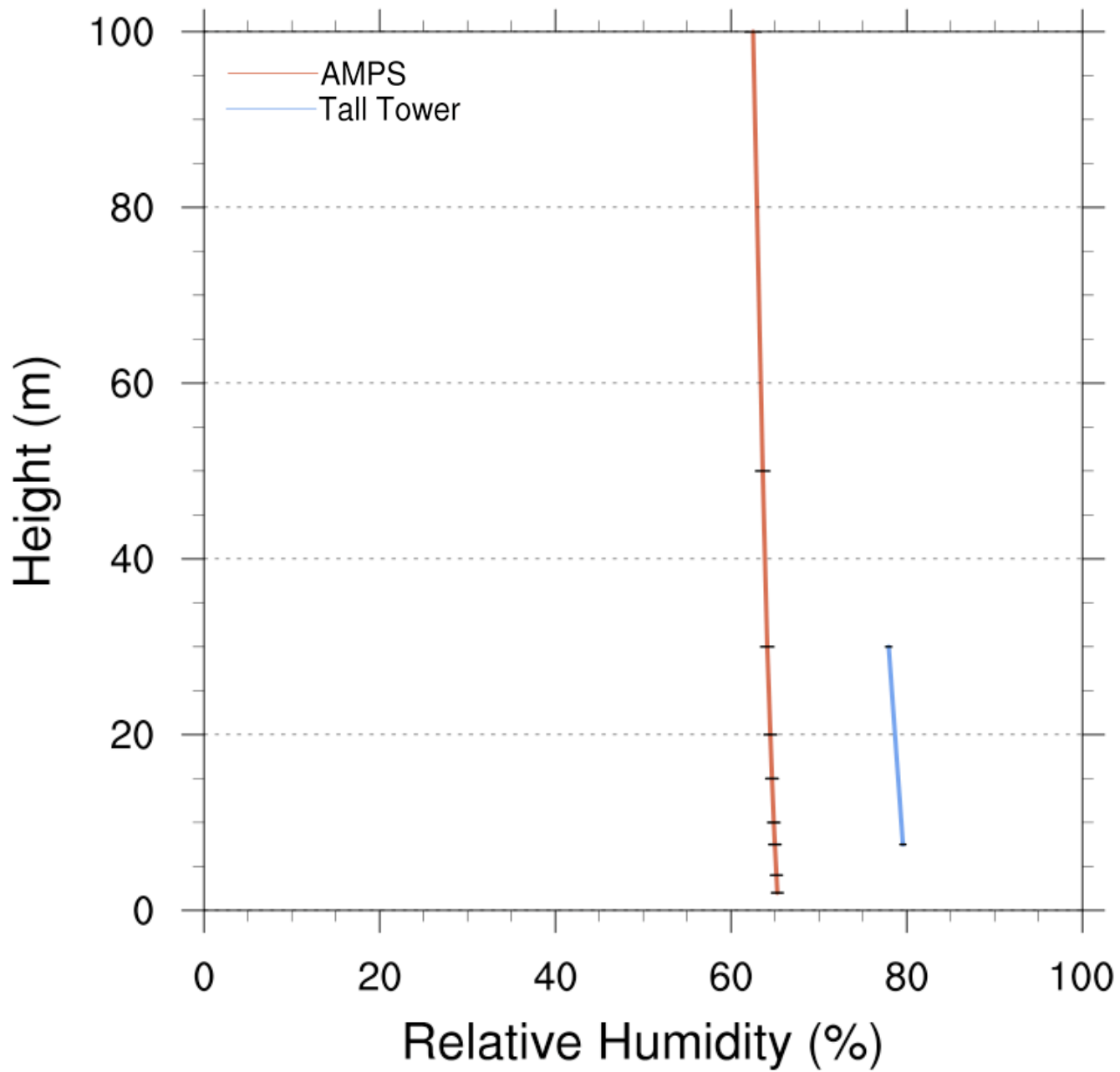


# Seasonal Vertical Averages

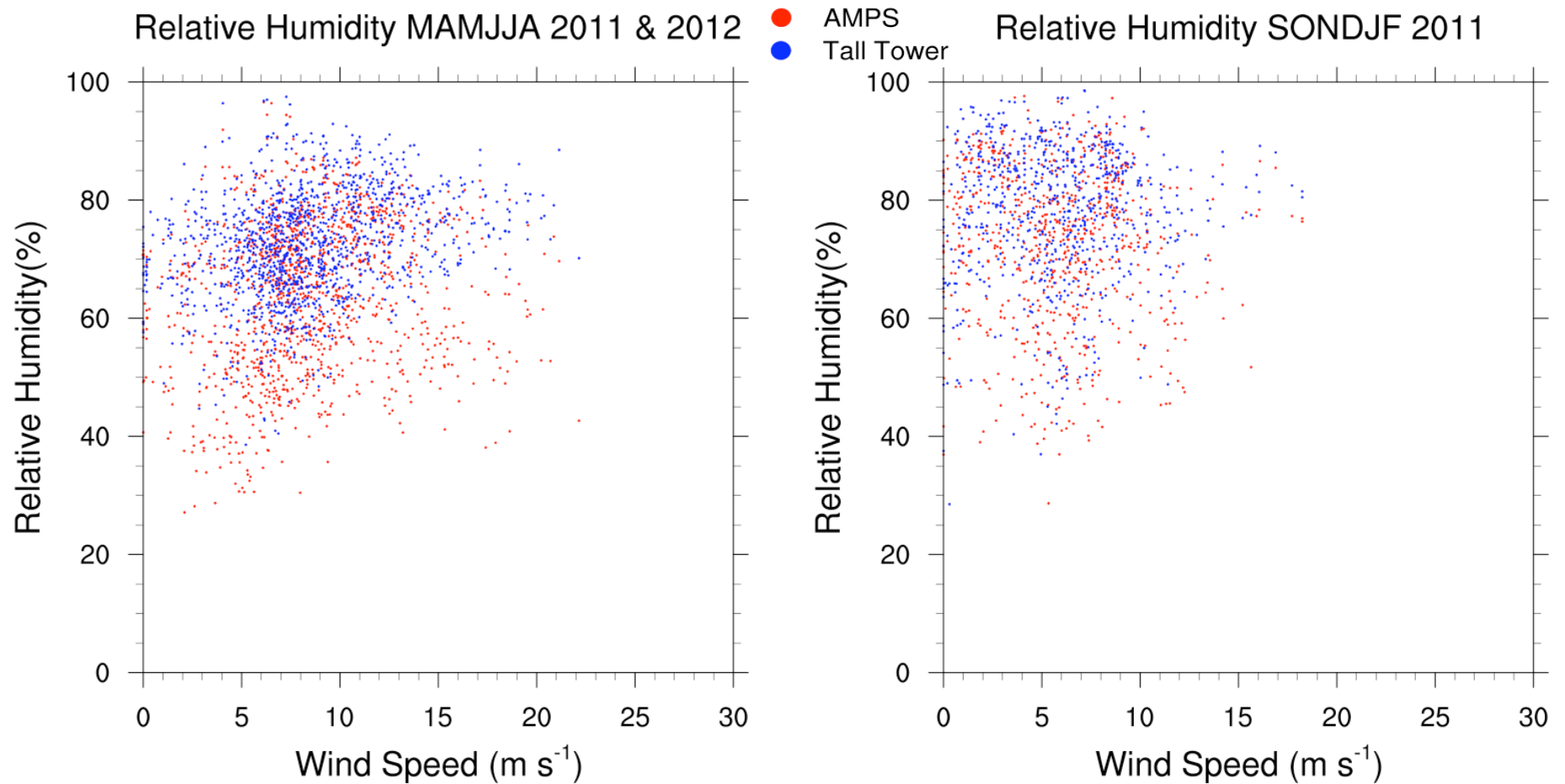




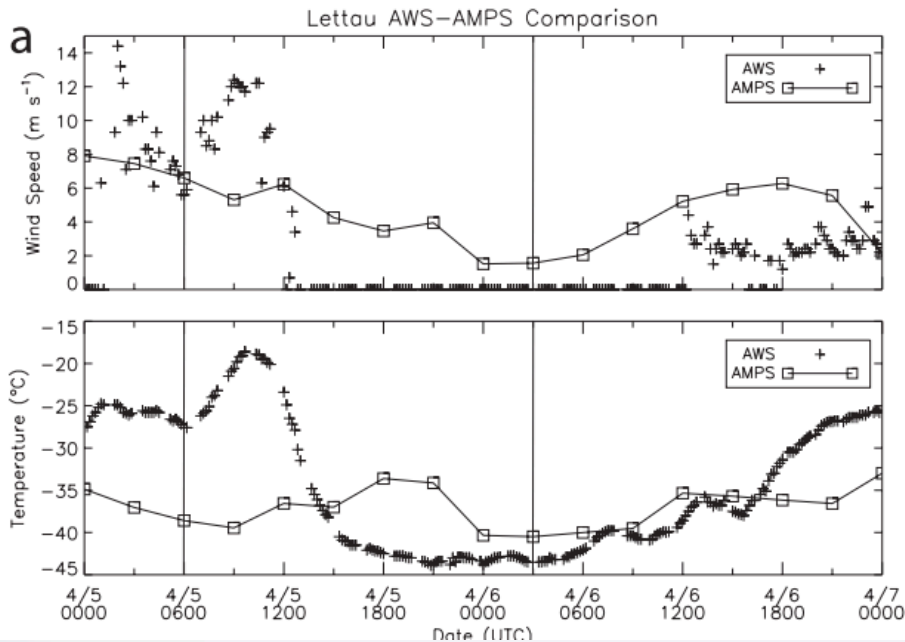
# MAMJJA 2011 Relative Humidity (>15 m s<sup>-1</sup>)



# Relative Humidity/Wind Speed Relationship

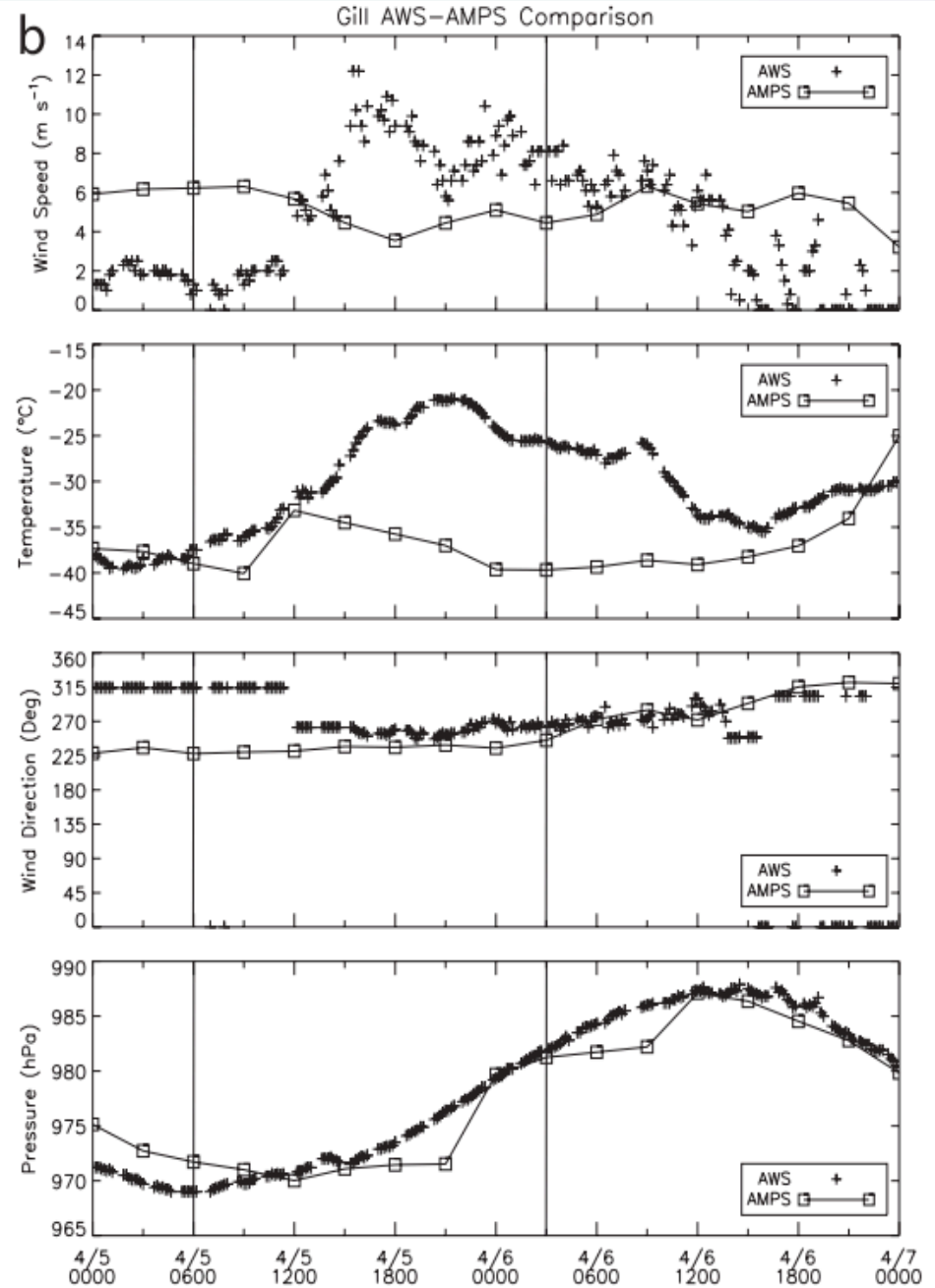


# Stability

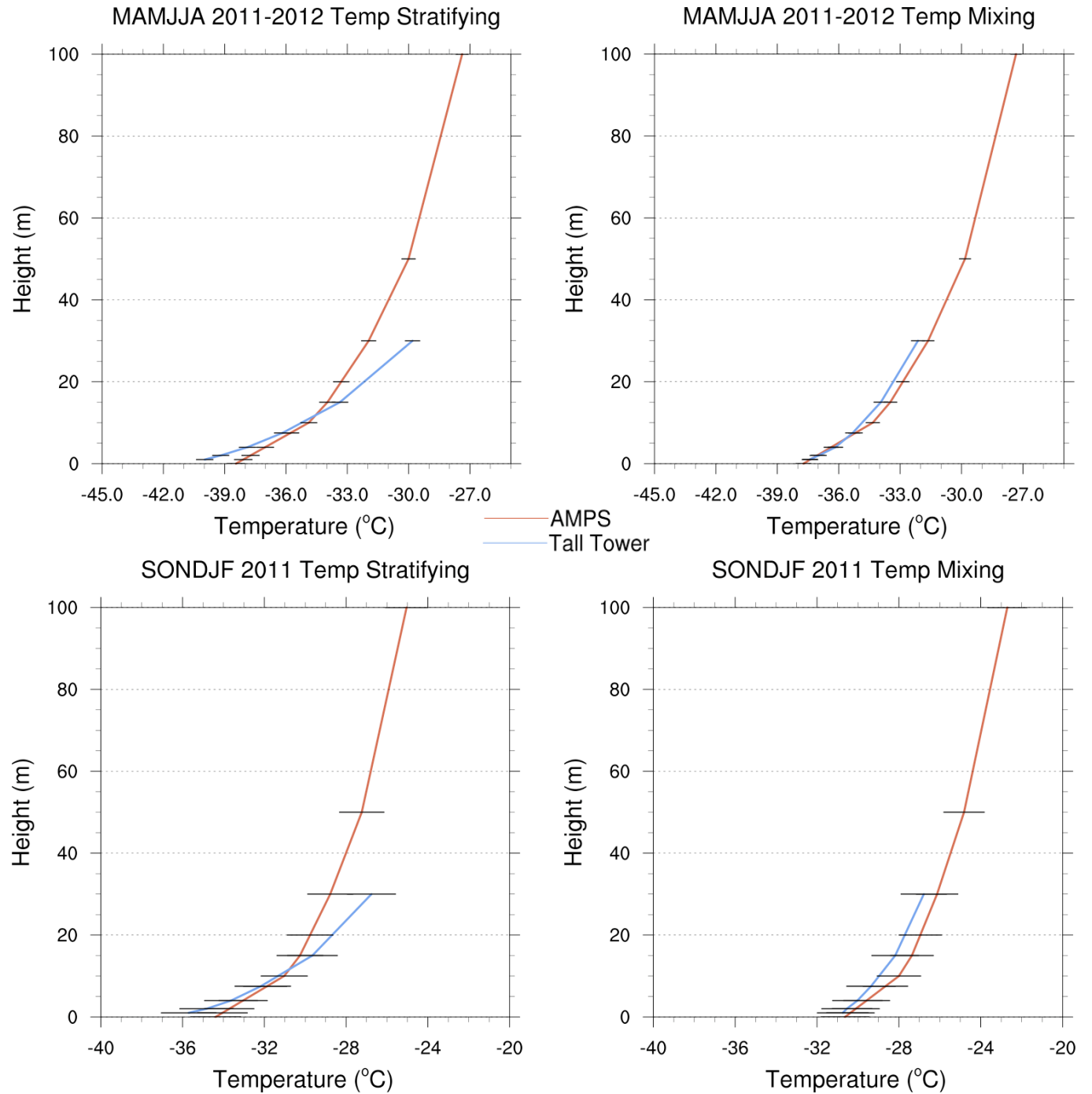


Mellor-Yamada-Janjic (MYJ) PBL scheme may yield unrealistic inversion strengths in moderate ( $\sim 7\text{ms}^{-1}$ ) wind speeds

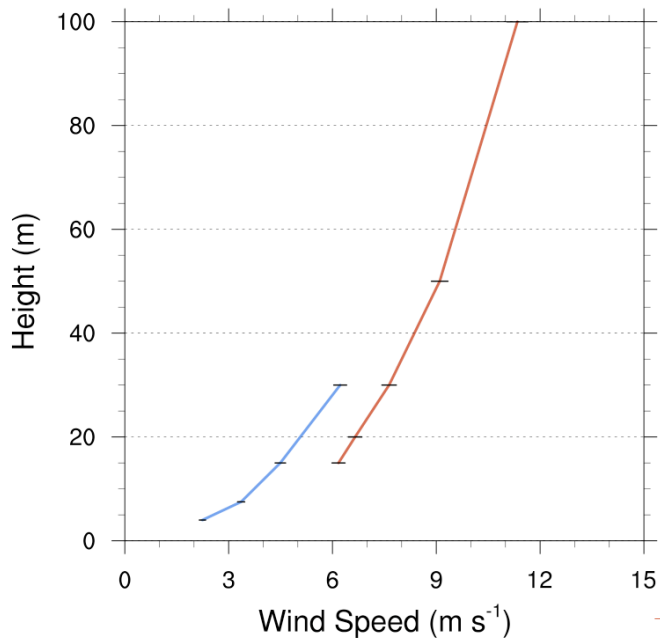
Steinhoff et. al. 2009



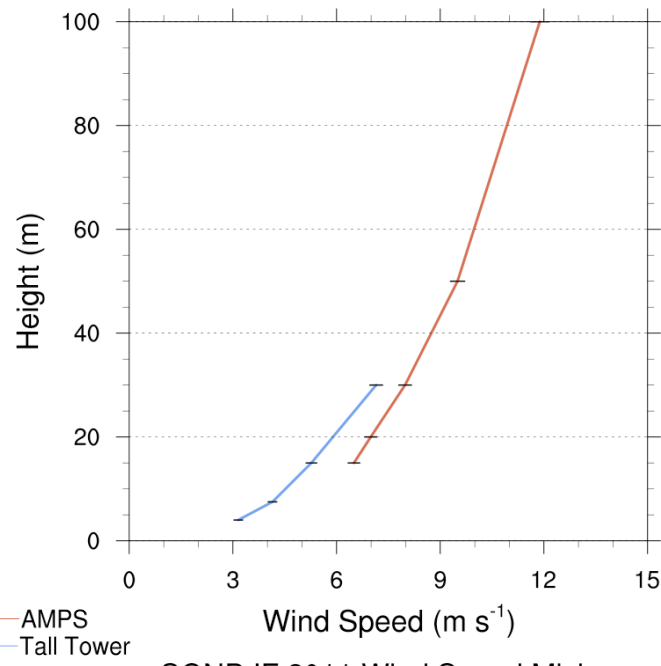
# Stability Transitions



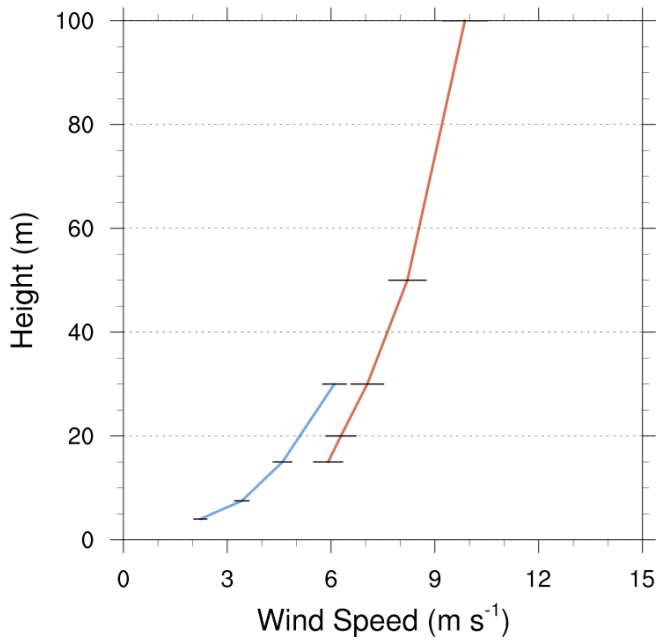
MAMJJA 2011-2012 Wind Speed Stratifying



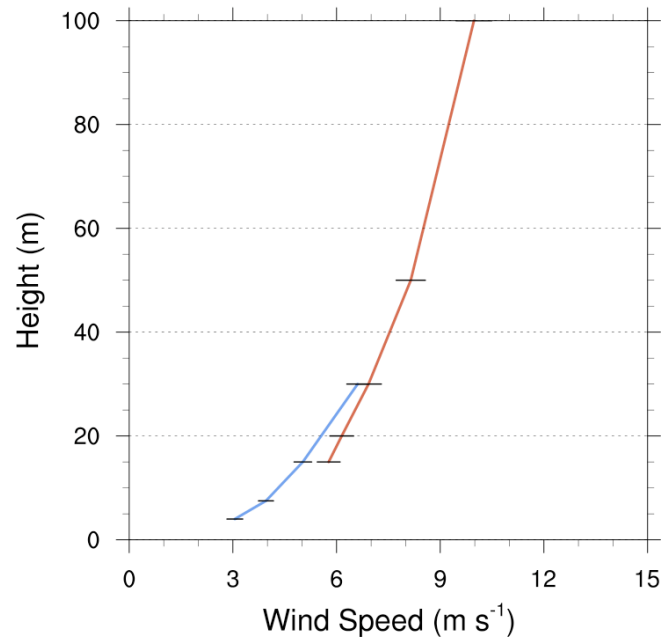
MAMJJA 2011-2012 Wind Speed Mixing



SONDJF 2011 Wind Speed Stratifying

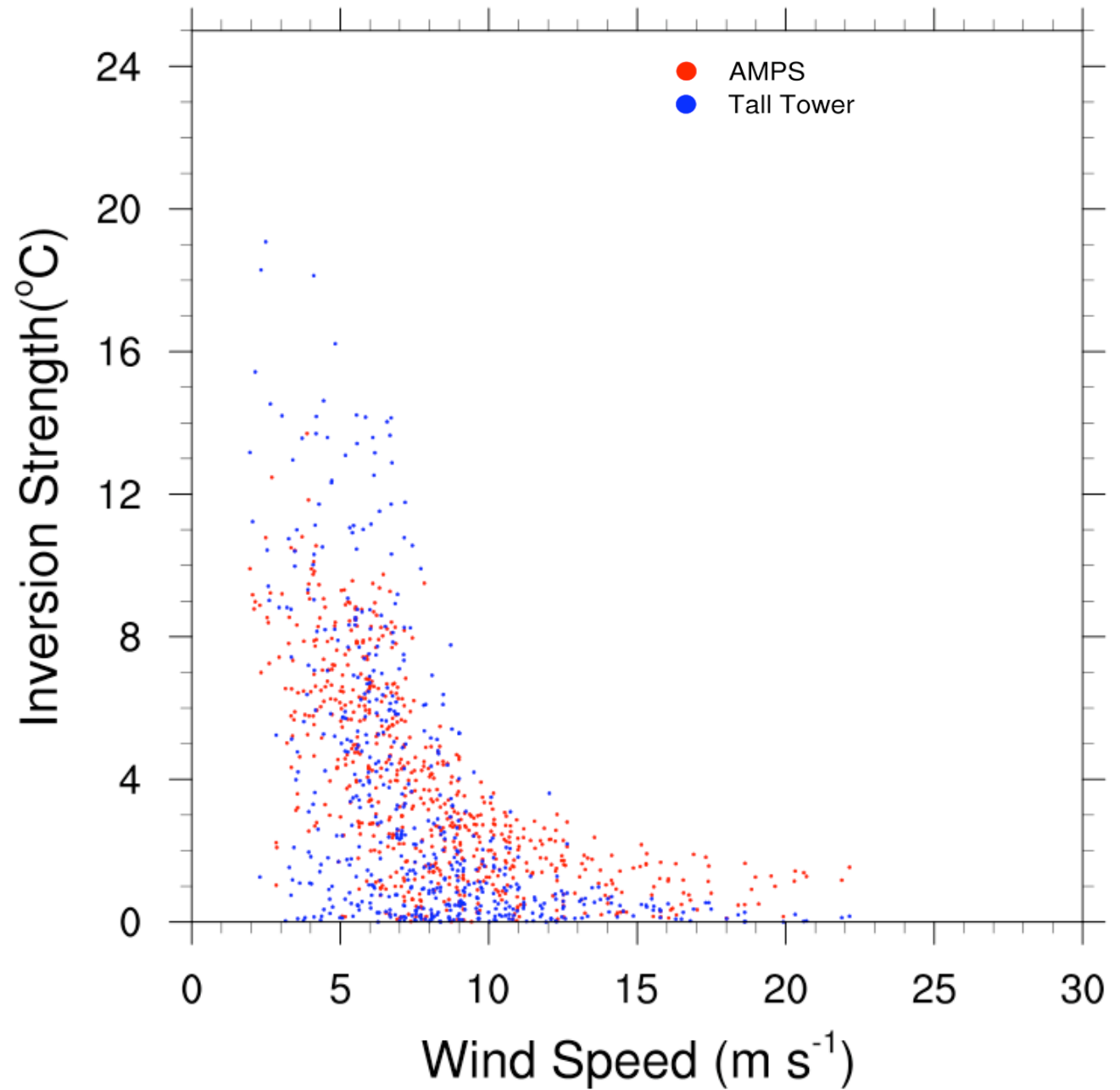


SONDJF 2011 Wind Speed Mixing

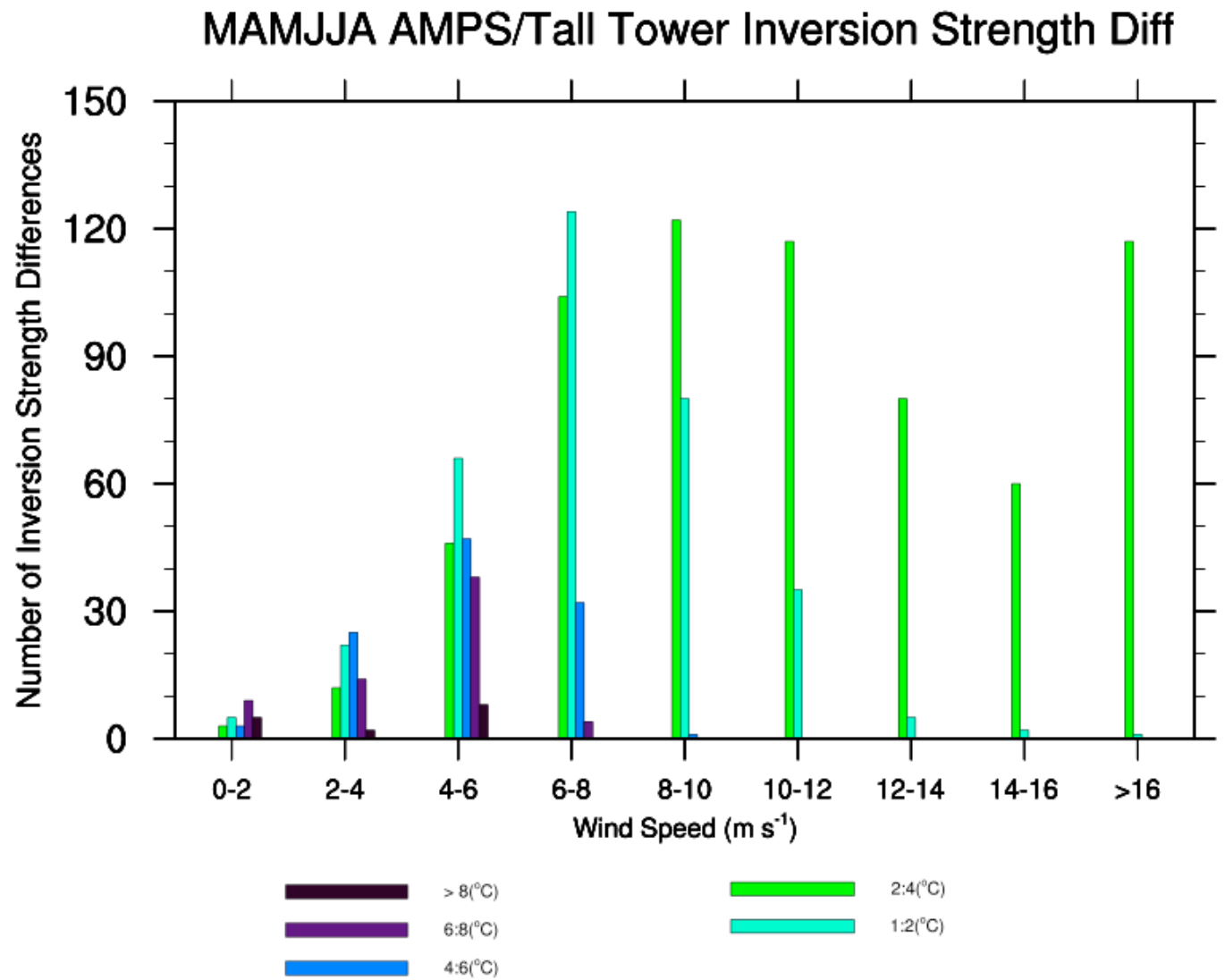


# Inversion Strength/ Wind Speed Relationship

## Inversion Strength MAMJJA 2012

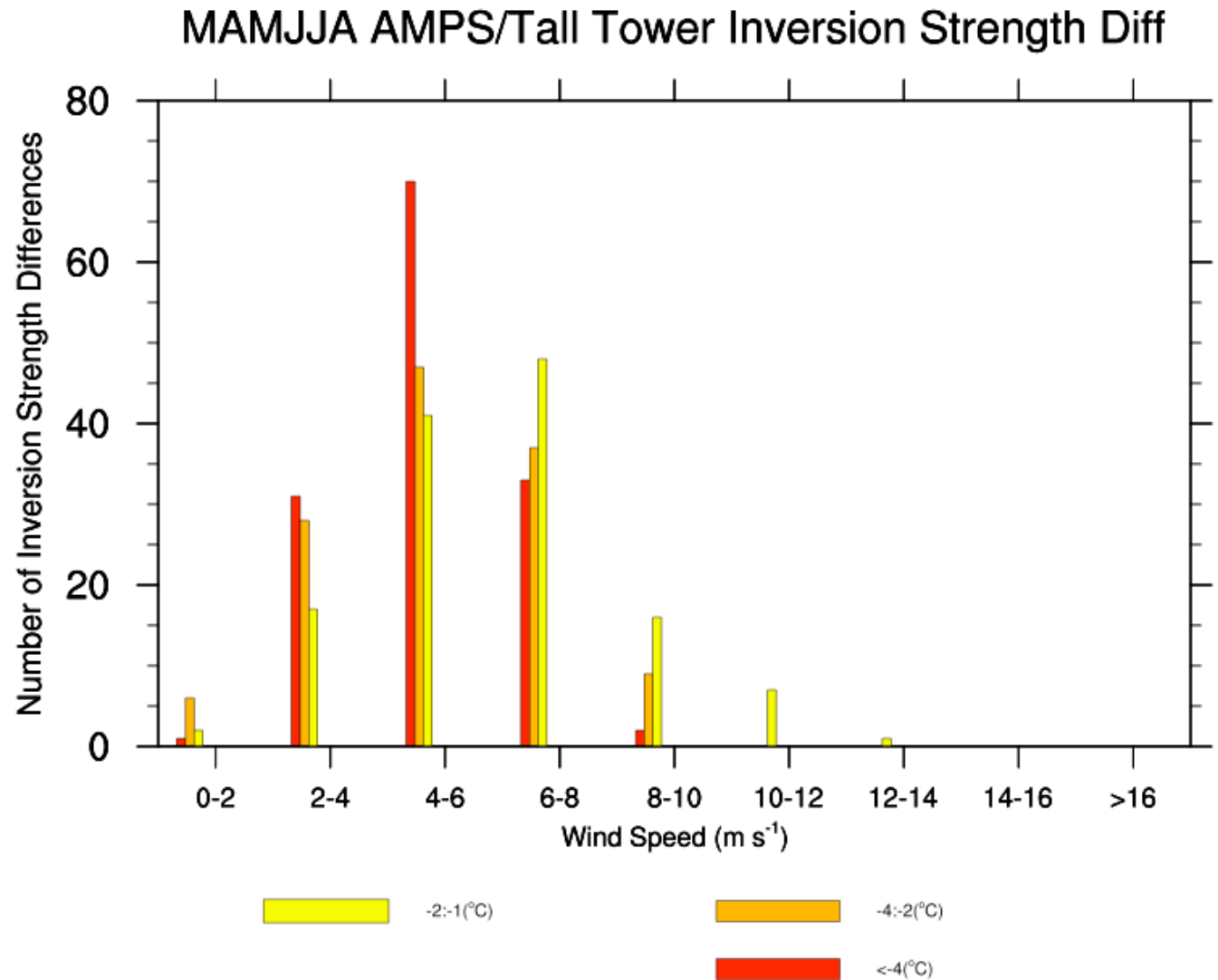


# Positive Histogram



AMPS Inv  $>$  Tower Inv

# Negative Histogram



AMPS Inv < Tower Inv



# SUMO UAV Flights

## Field Campaign

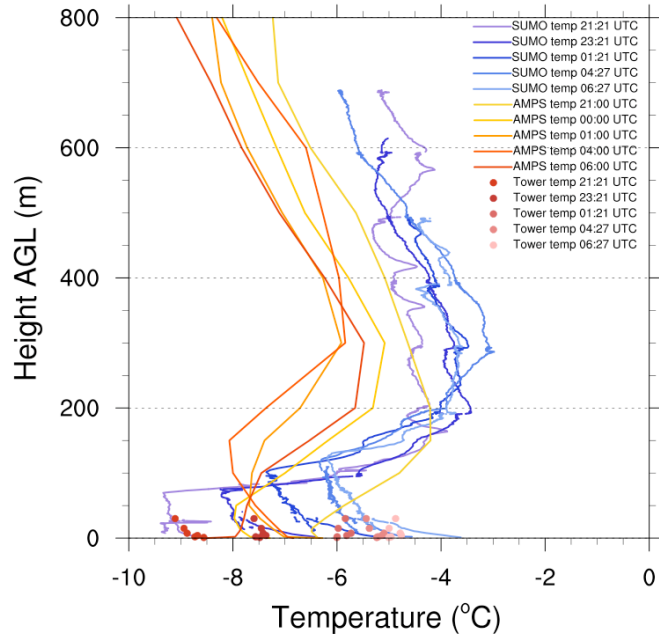
January 13-26, 2014

## Typical Flight

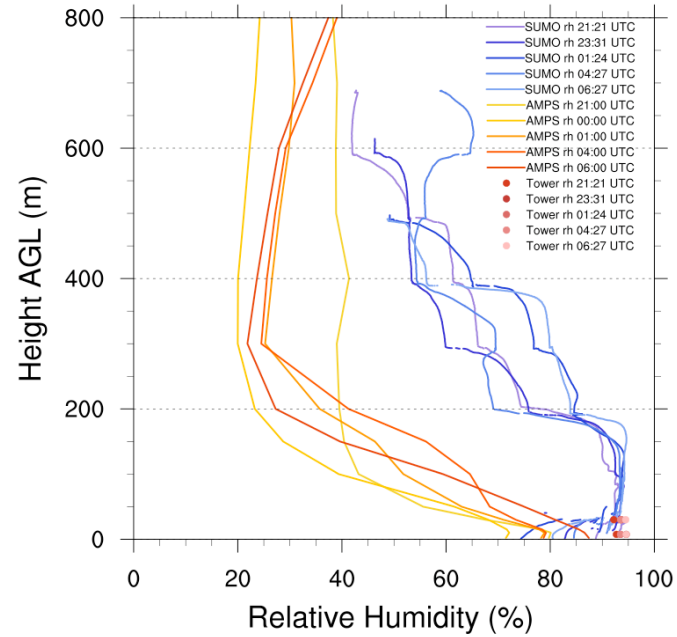
- Calibrate in tent
- Launch
- Climb to ~30m and complete a ~140m diameter circle
- Climb to ~100m and complete a ~140m diameter circle
- Repeat circles for every additional ~100m up to ~800m
- Land



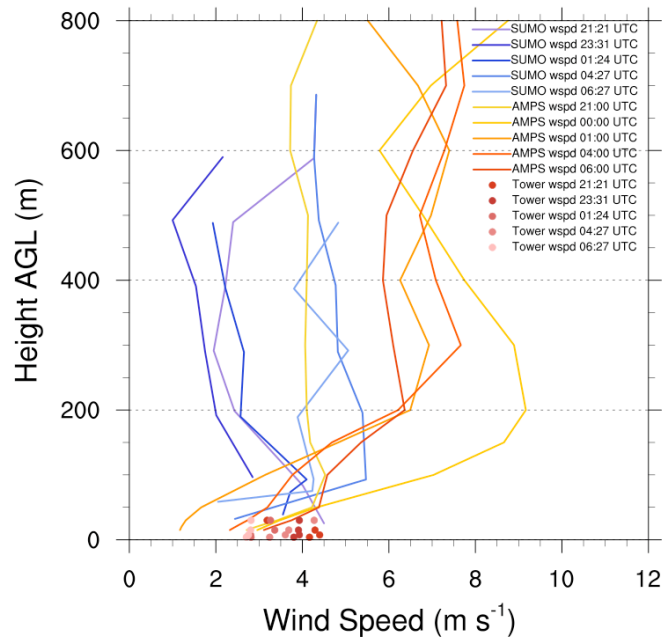
Temperature: 20140123 Flights



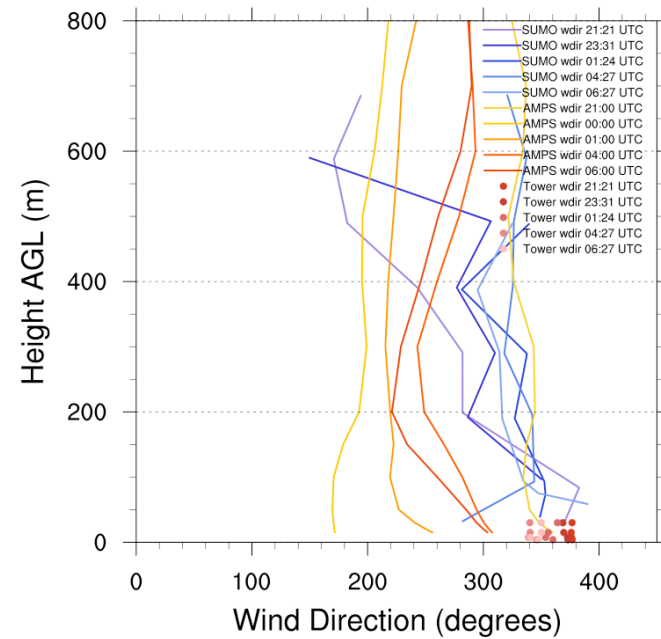
Relative Humidity: 20140123 Flights



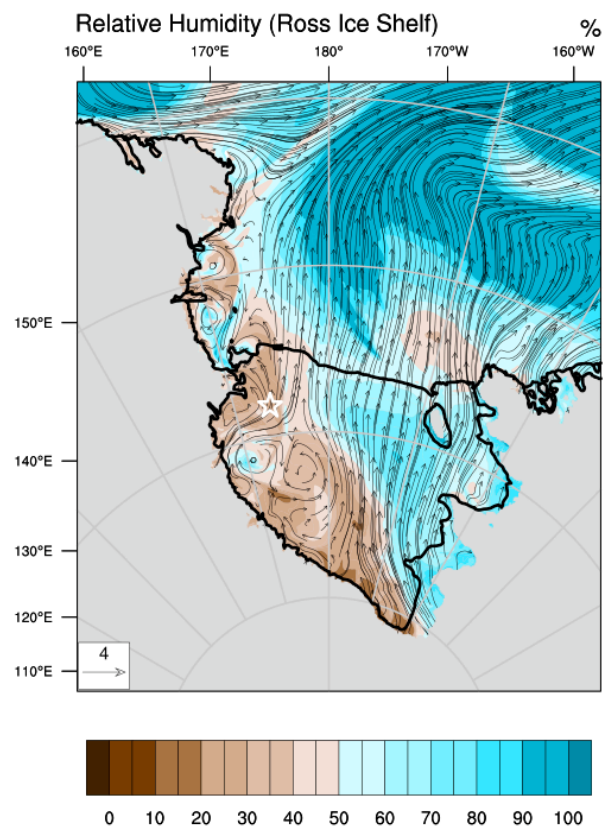
Wind Speed: 20140123 Flights



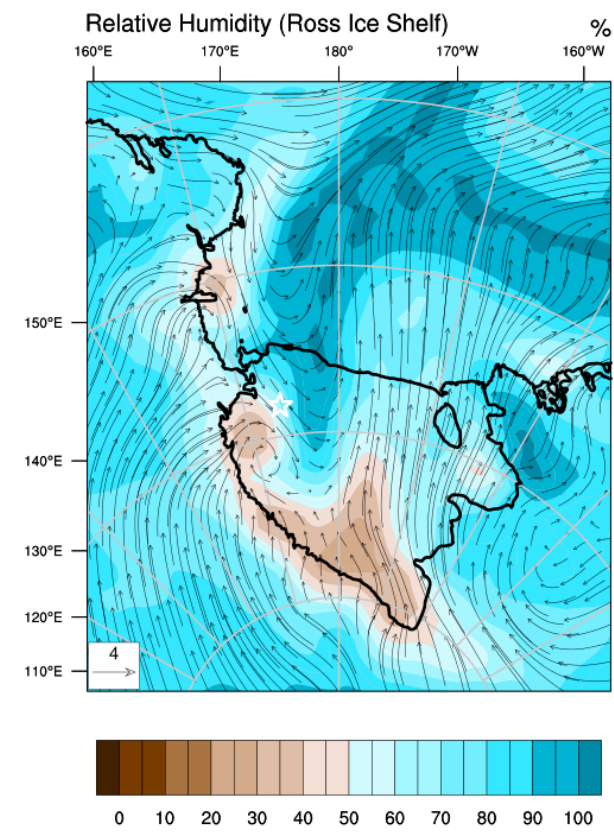
Wind Direction: 20140123 Flights



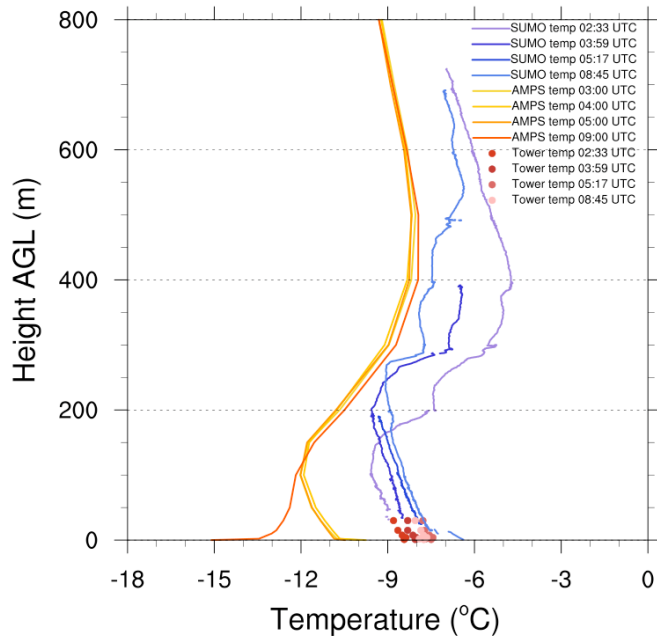
**AMPS 950 mb Relative Humidity and Wind: 01/23/00Z**



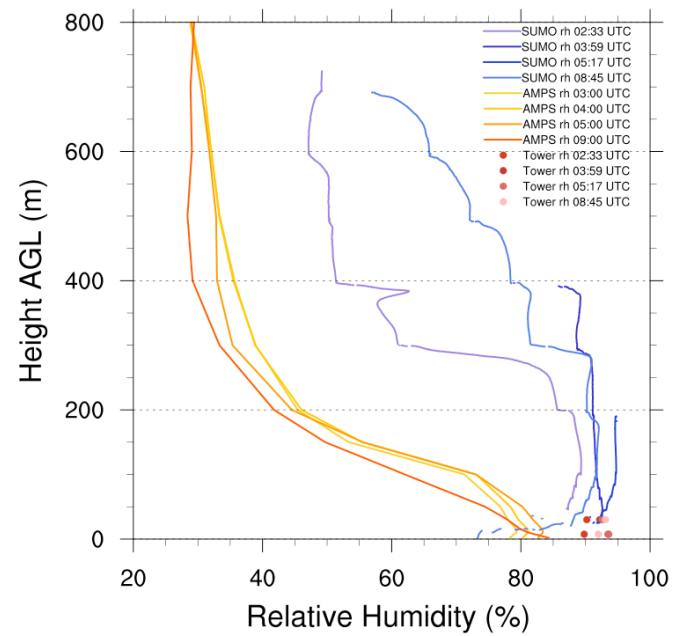
**ERA-Interim 950 mb Relative Humidity and Wind: 01/23/00Z**



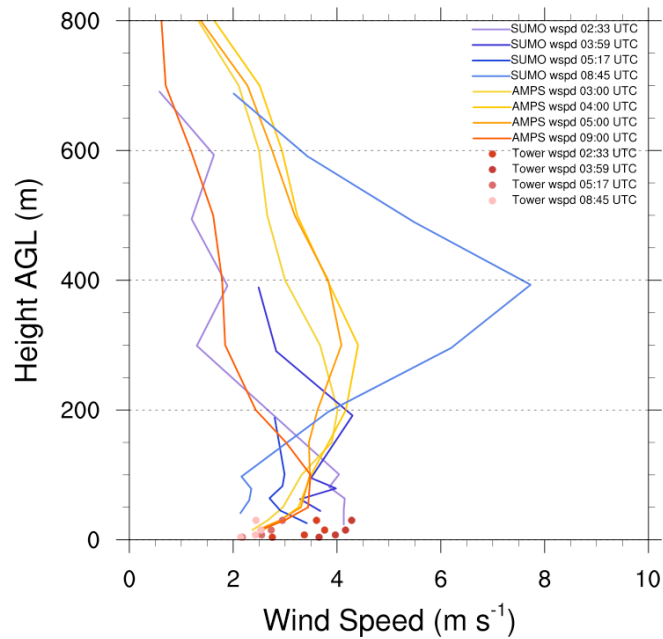
Temperature: 20140124 Afternoon Flights



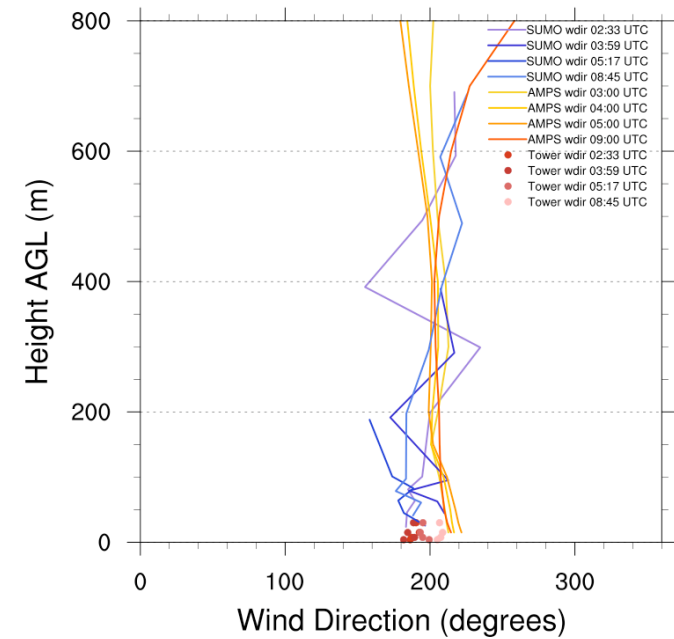
Relative Humidity: 20140124 Afternoon Flights



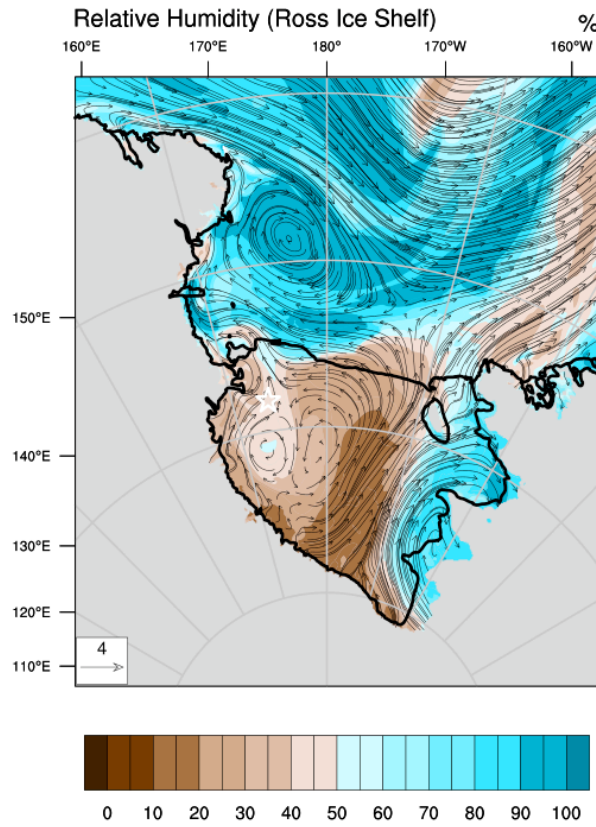
Wind Speed: 20140124 Afternoon Flights



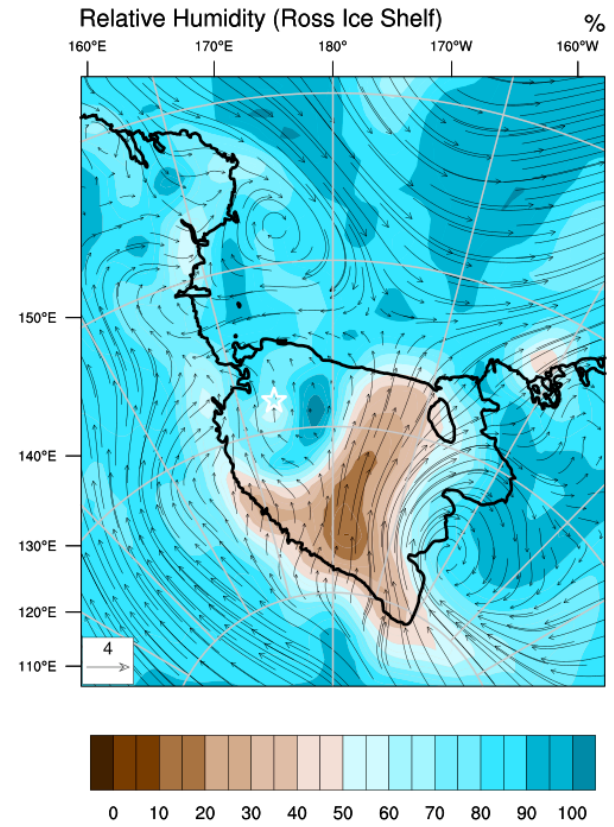
Wind Direction: 20140124 Afternoon Flights



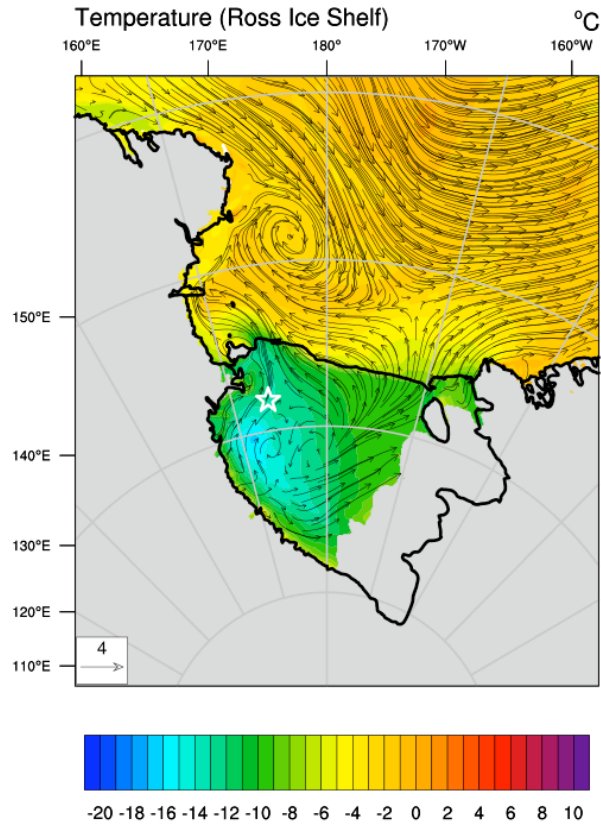
**AMPS 950 mb Relative Humidity and Wind: 01/24/00Z**



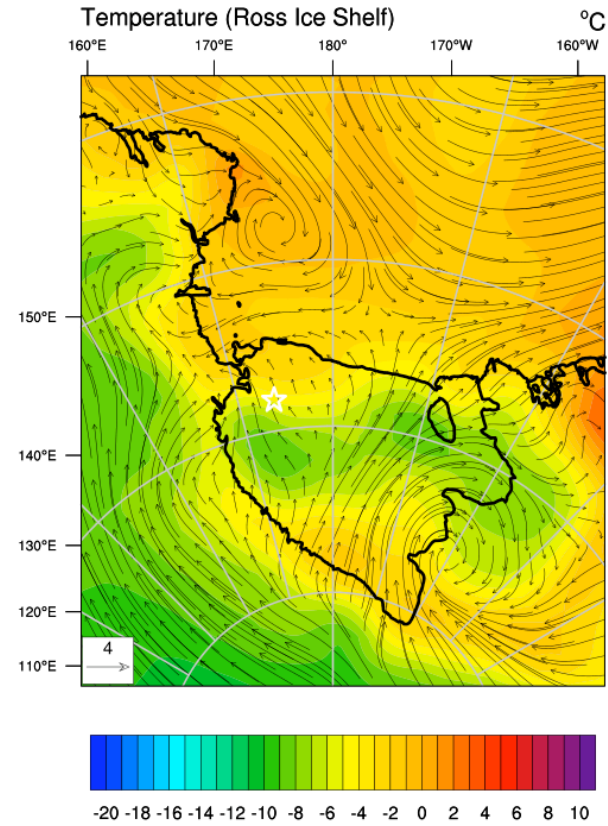
**ERA-Interim 950 mb Relative Humidity and Wind: 01/24/00Z**



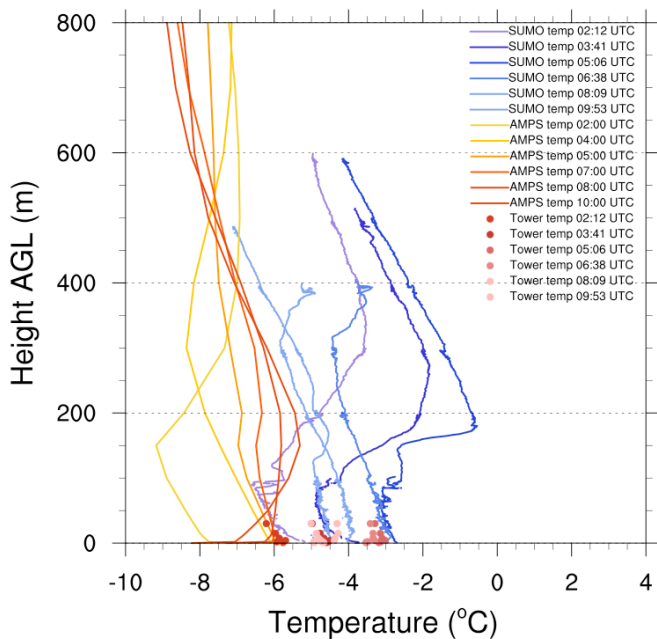
**AMPS 975 mb Temperature and Wind: 01/24/00Z**



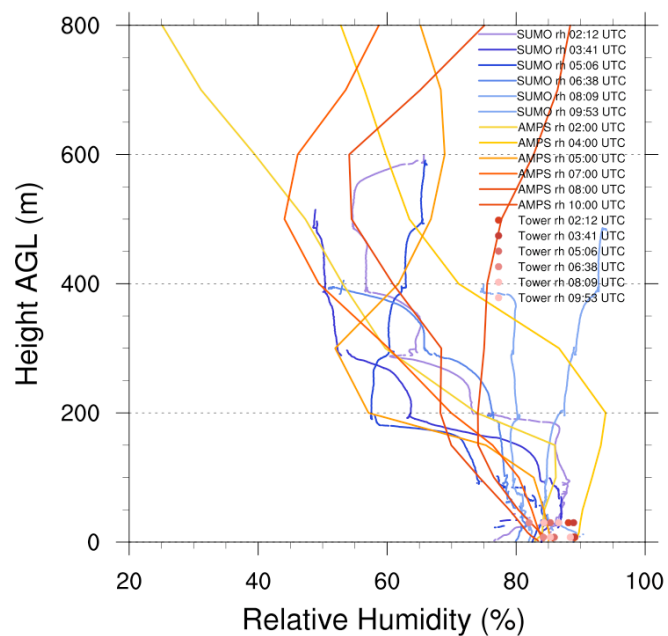
**ERA-Interim 975 mb Temperature and Wind: 01/24/00Z**



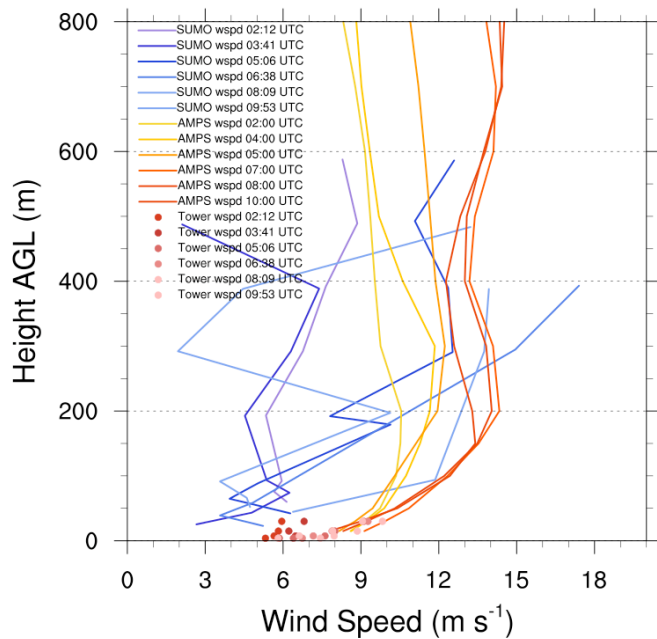
Temperature: 20140121 Afternoon Flights



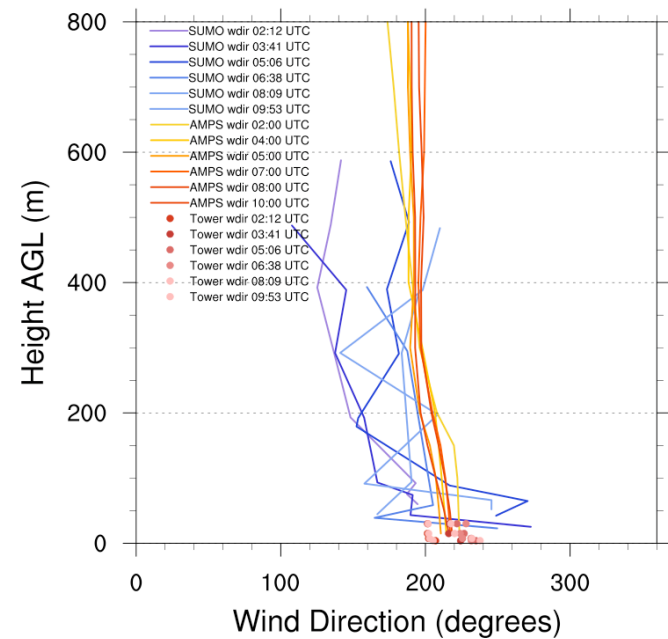
Relative Humidity: 20140121 Afternoon Flights



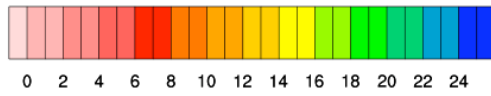
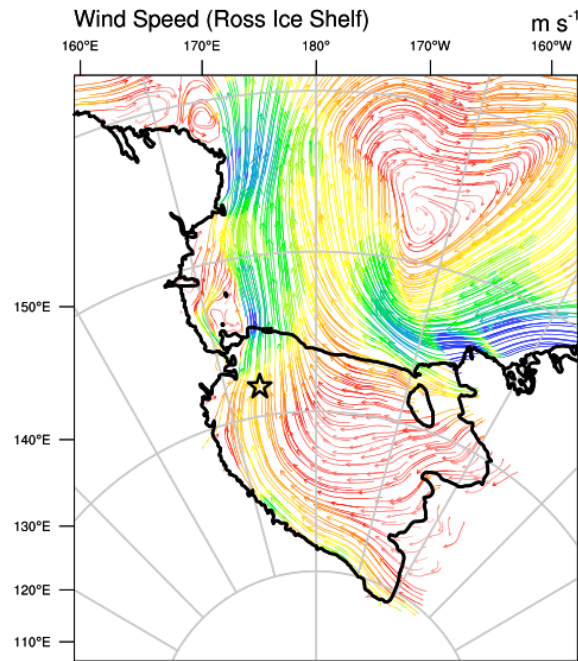
Wind Speed: 20140121 Afternoon Flights



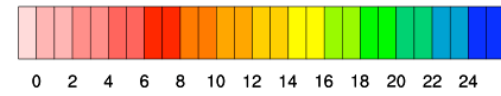
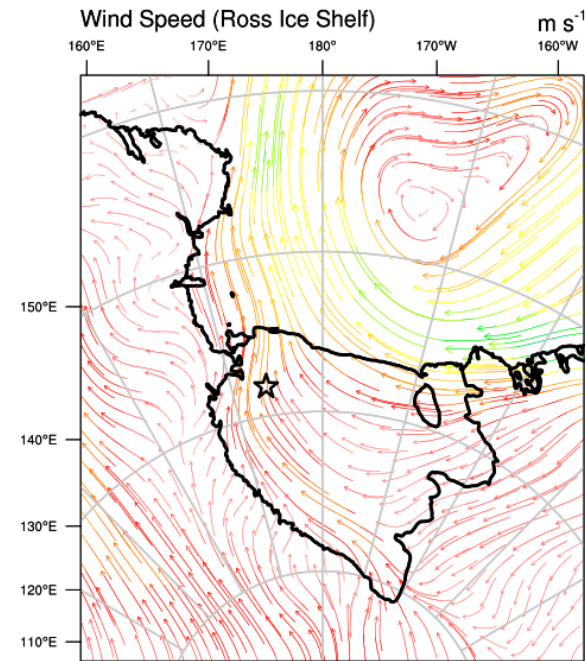
Wind Direction: 20140121 Afternoon Flights



**AMPS 950 mb Wind Speed: 01/21/06Z**

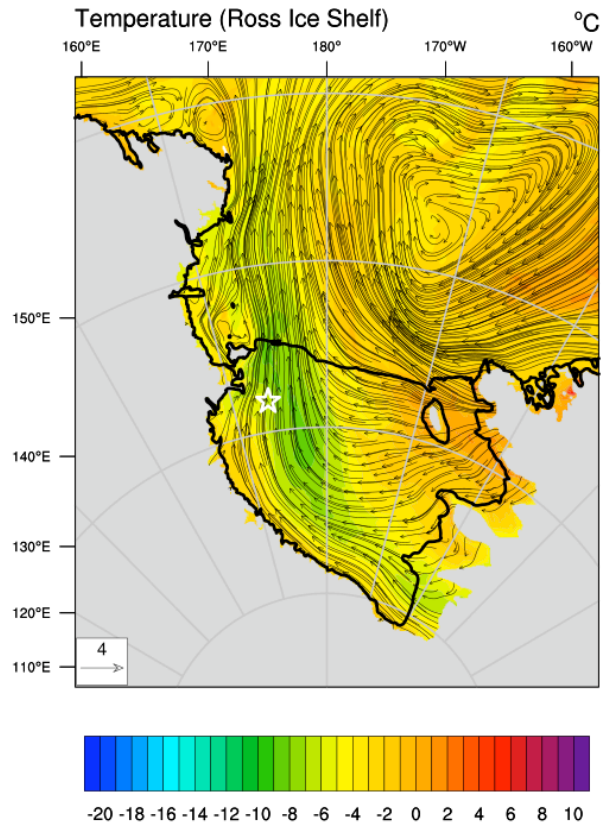


**ERA-Interim 950 mb Wind Speed: 01/21/06Z**

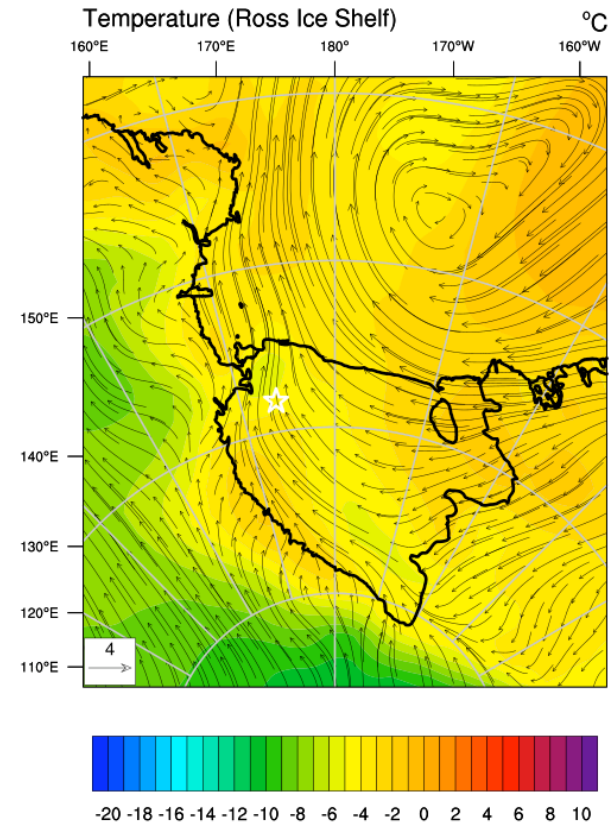




**AMPS 950 mb Temperature and Wind: 01/21/06Z**



**ERA-Interim 950 mb Temperature and Wind: 01/21/06Z**



# Conclusions

- Systematic dry and high wind speed biases in AMPS-Polar WRF
- Wind speed transition range for stability errors is 4-8 m s<sup>-1</sup> from underestimating to overestimating inversion strength
- Four of the six SUMO case study days exhibited dry and high wind speed biases
- SUMO case studies appear to be sampling the persistent dry and high wind biases in AMPS-Polar WRF

# Future Steps

- Run a nested Polar WRF with enhanced vertical resolution to better resolve the sharp observed inversions
- Experiment with different AMPS-Polar WRF configurations to understand the dry bias





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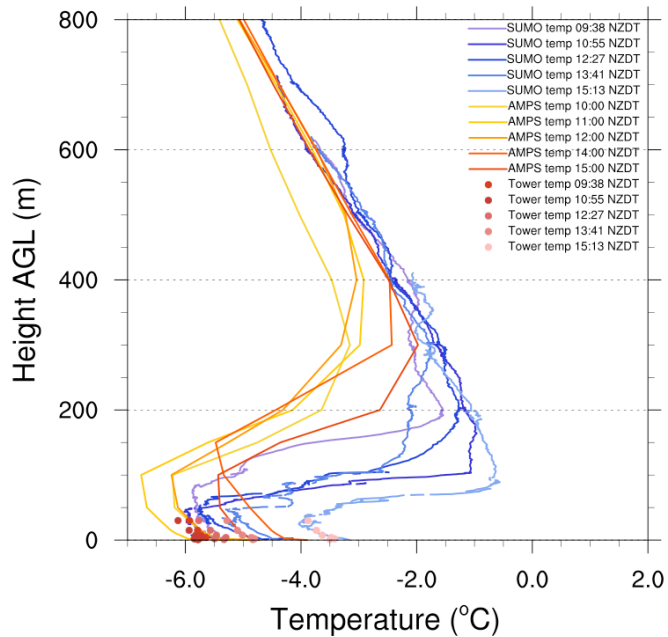
wille.15@osu.edu



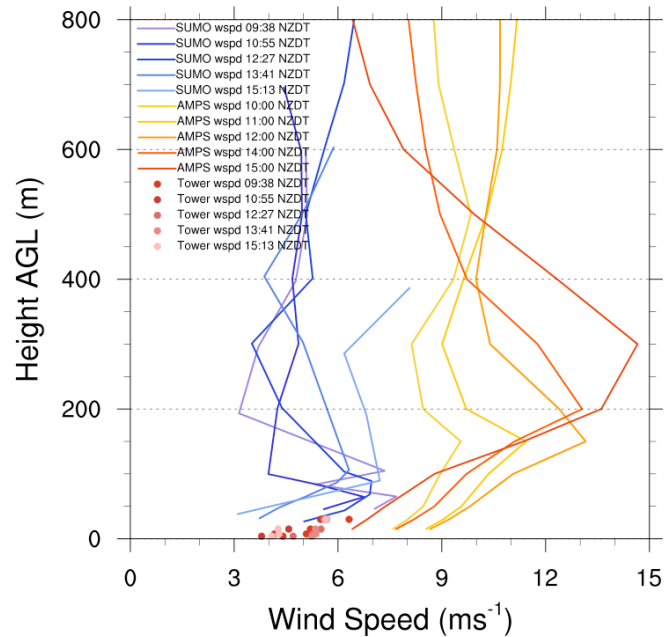
# Additional Works Cited

- Steinhoff, Daniel F., Saptarshi Chaudhuri, David H. Bromwich, 2009: A Case Study of a Ross Ice Shelf Airstream Event: A New Perspective. *Mon. Wea. Rev.*, **137**, doi: 10.1175/2009MWR2880.1, 4030-4046
- Nigro, M. A., J. J. Cassano, 2014: Observations of the summertime boundary layer over the Ross Ice Shelf, Antarctica using SUMO UAVs. *9<sup>th</sup> Antarctic Meteorological Observation, Modeling, & Forecasting Workshop*. Charleston, SC

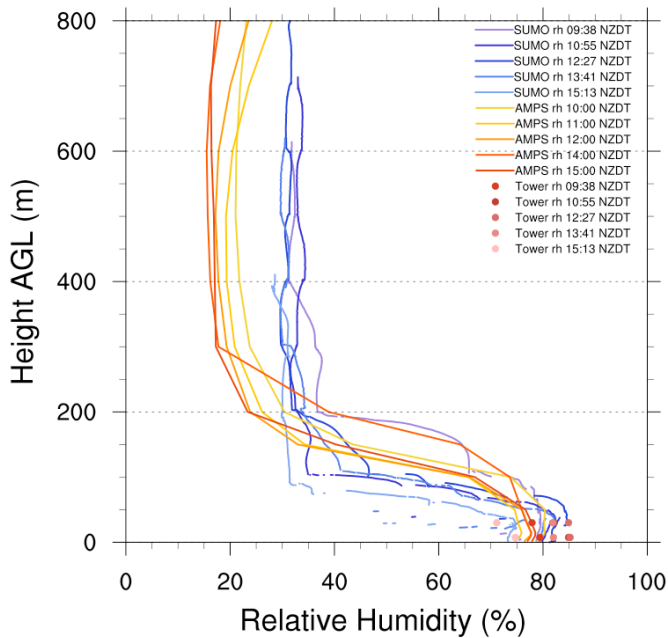
Temperature: 20140119 Flights



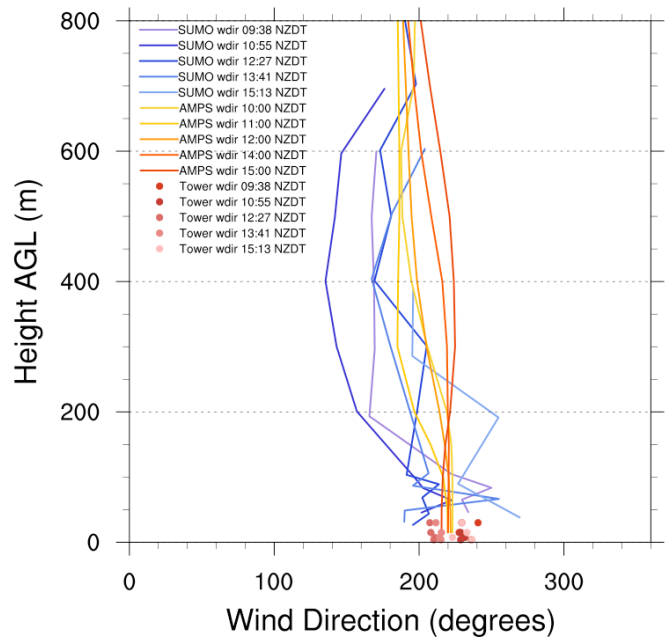
Wind Speed: 20140119 Flights



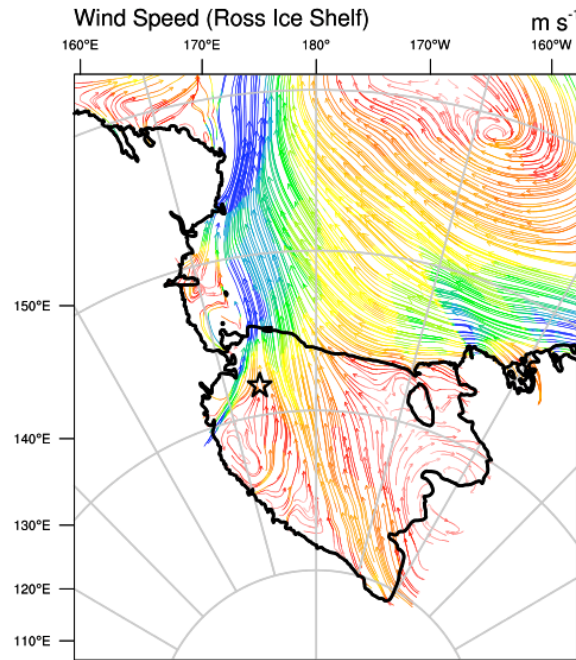
Relative Humidity: 20140119 Flights



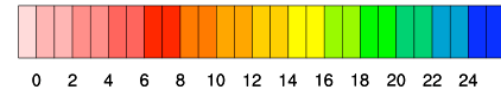
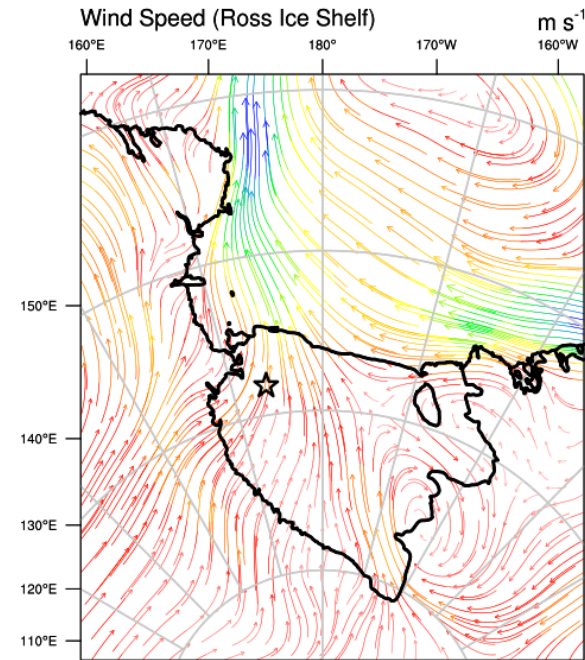
Wind Direction: 20140119 Flights



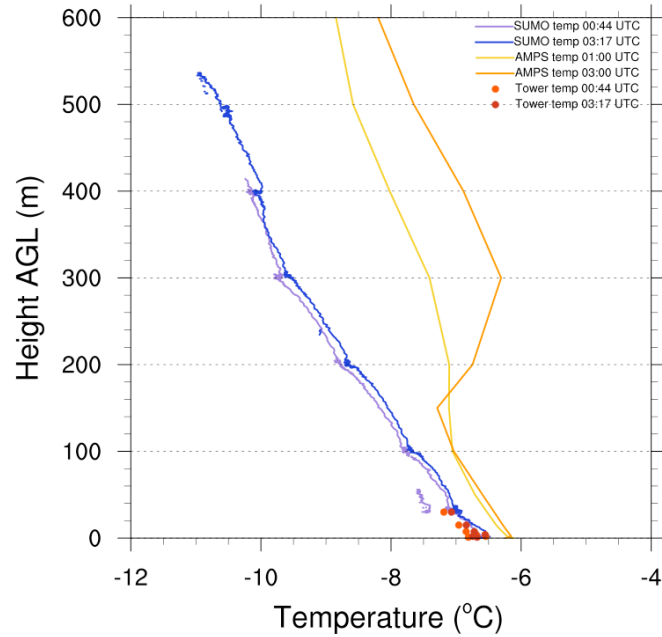
**AMPS 950 mb Wind Speed: 01/19/00Z**



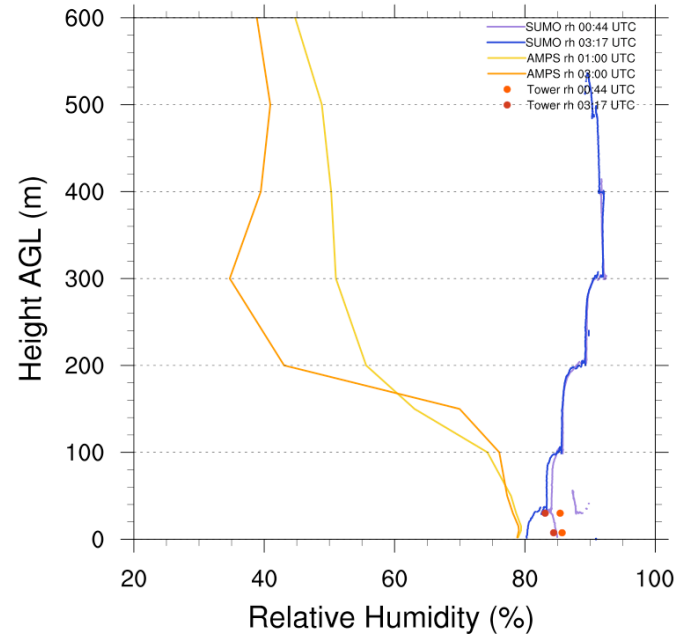
**ERA-Interim 950 mb Wind Speed: 01/19/00Z**



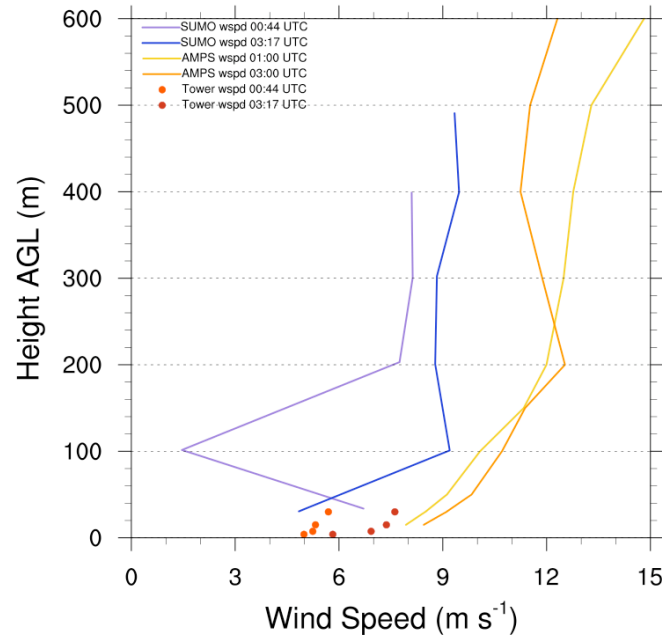
Temperature: 20140116 Flights



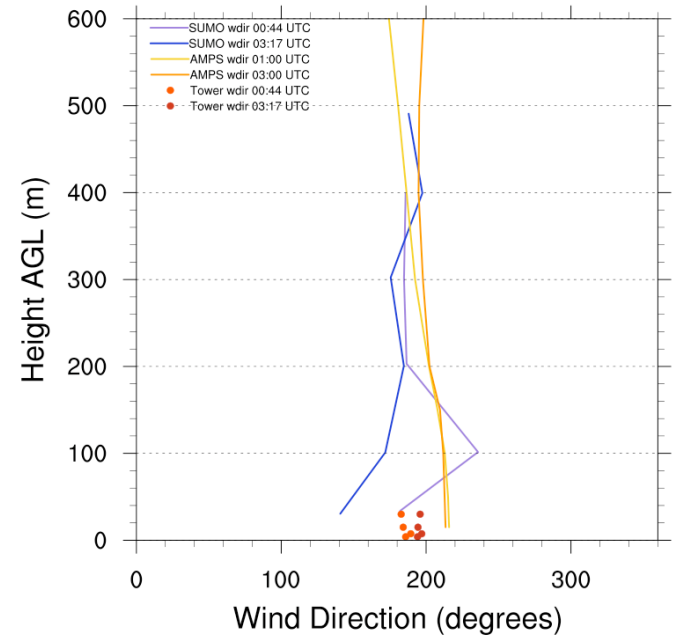
Relative Humidity: 20140116 Flights



Wind Speed: 20140116 Flights

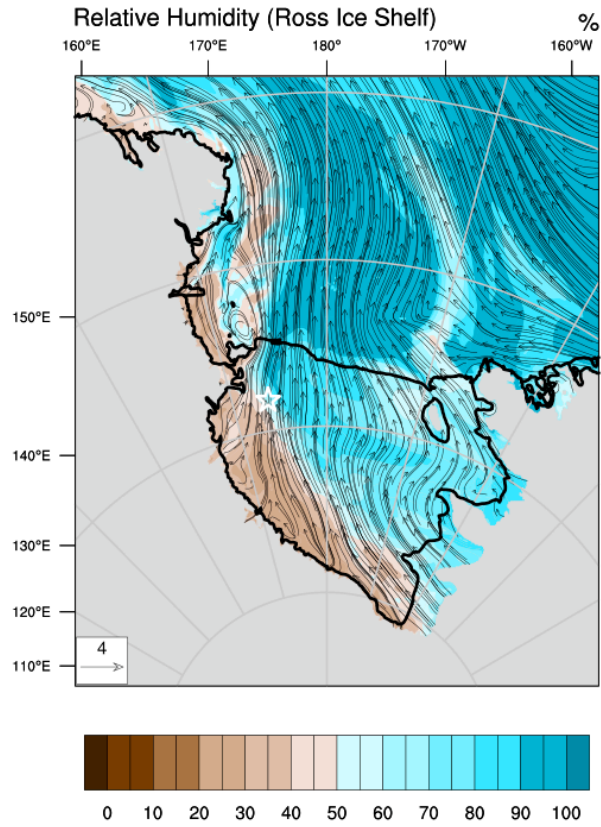


Wind Direction: 20140116 Flights

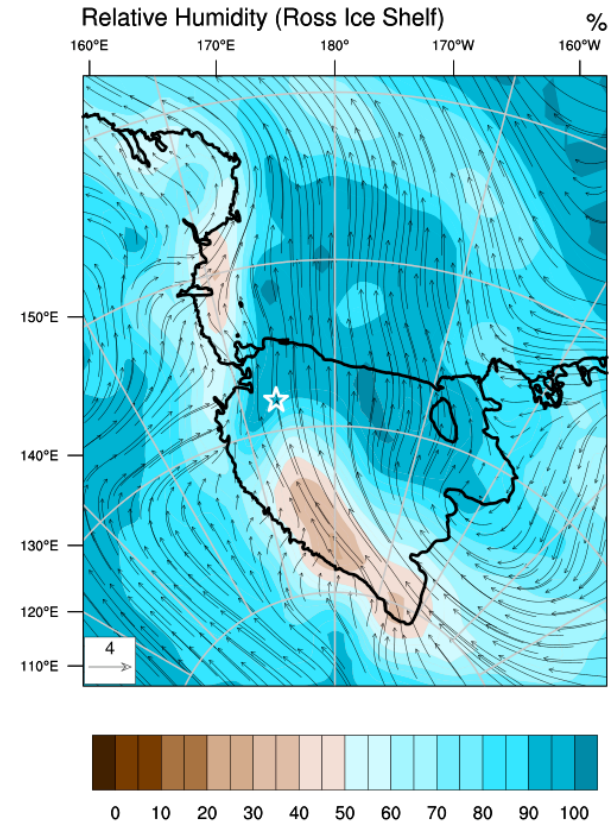




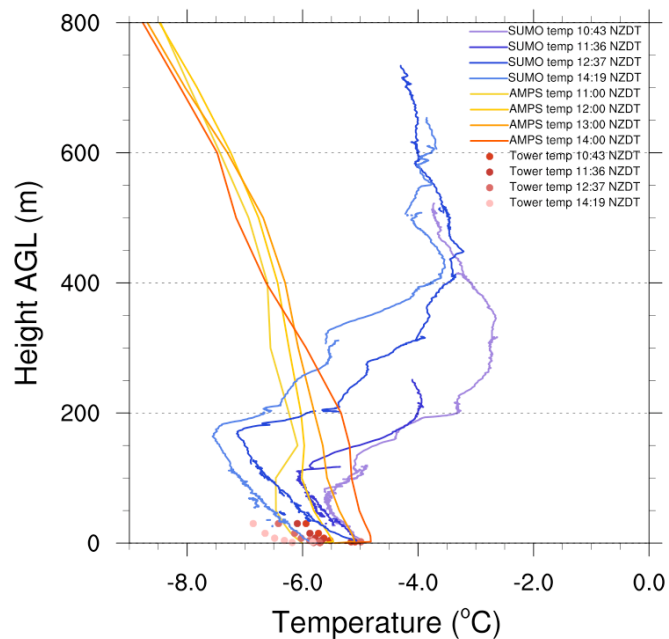
**AMPS 950 mb Relative Humidity and Wind: 01/16/00Z**



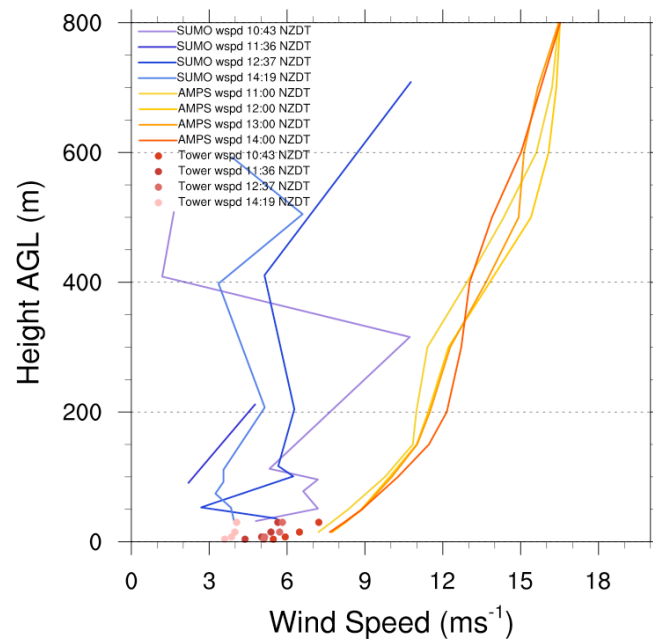
**ERA-Interim 950 mb Relative Humidity and Wind: 01/16/00Z**



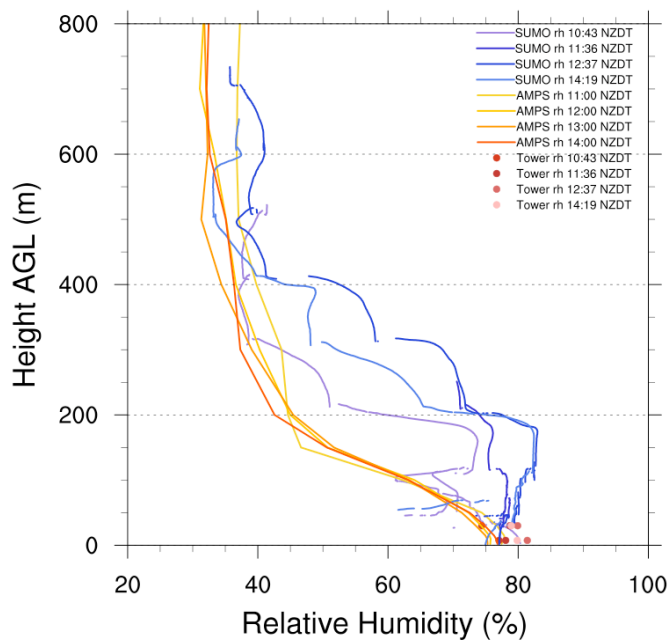
Temperature: 20140117 Flights



Wind Speed: 20140117 Flights



Relative Humidity: 20140117 Flights



Wind Direction: 20140117 Flights

