

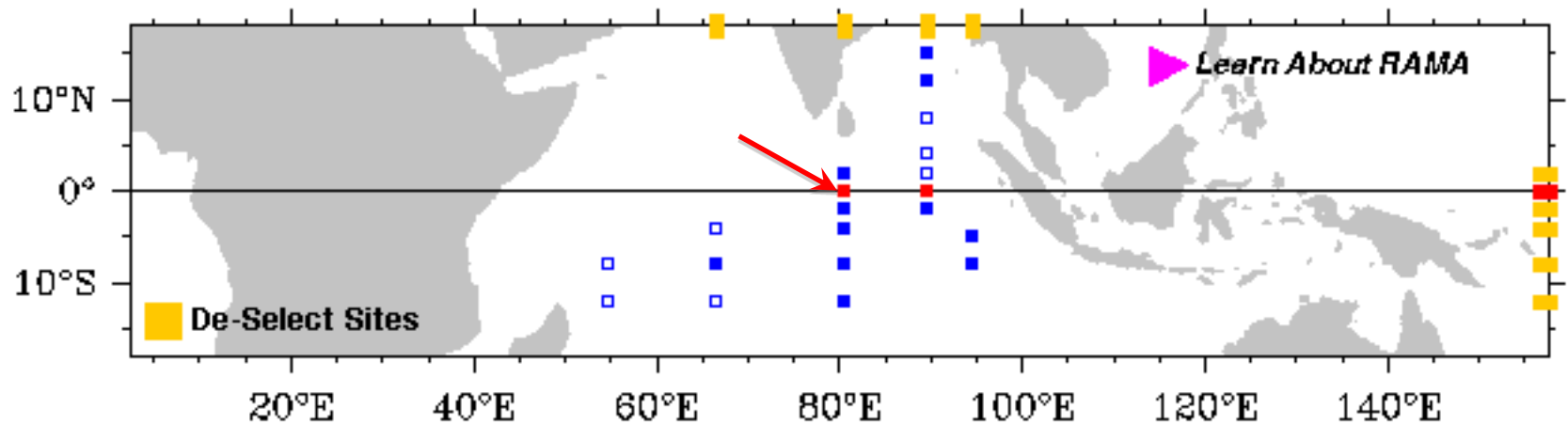
# Water Vapor Measurement

Sondes, Microwave radiometers, GPS

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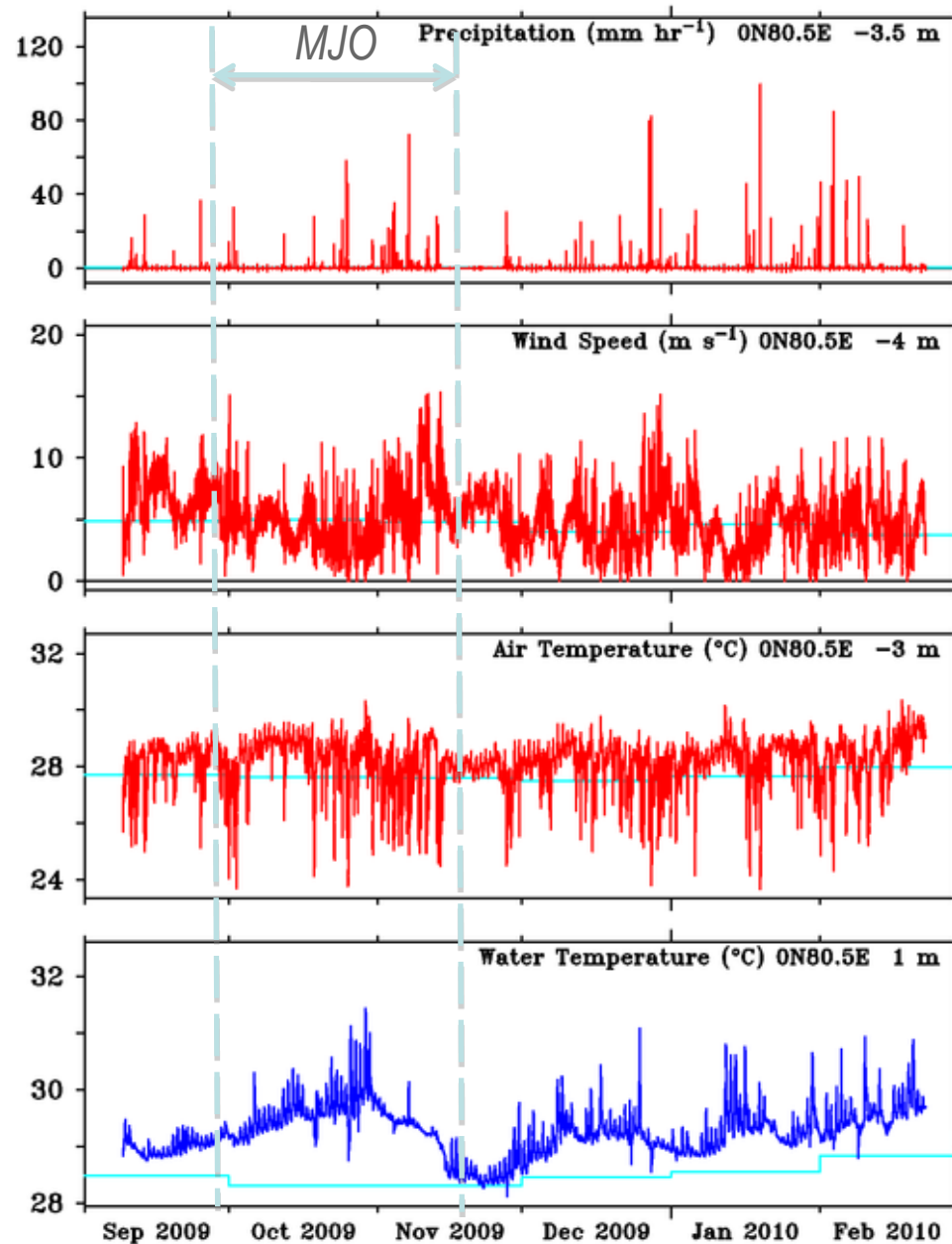
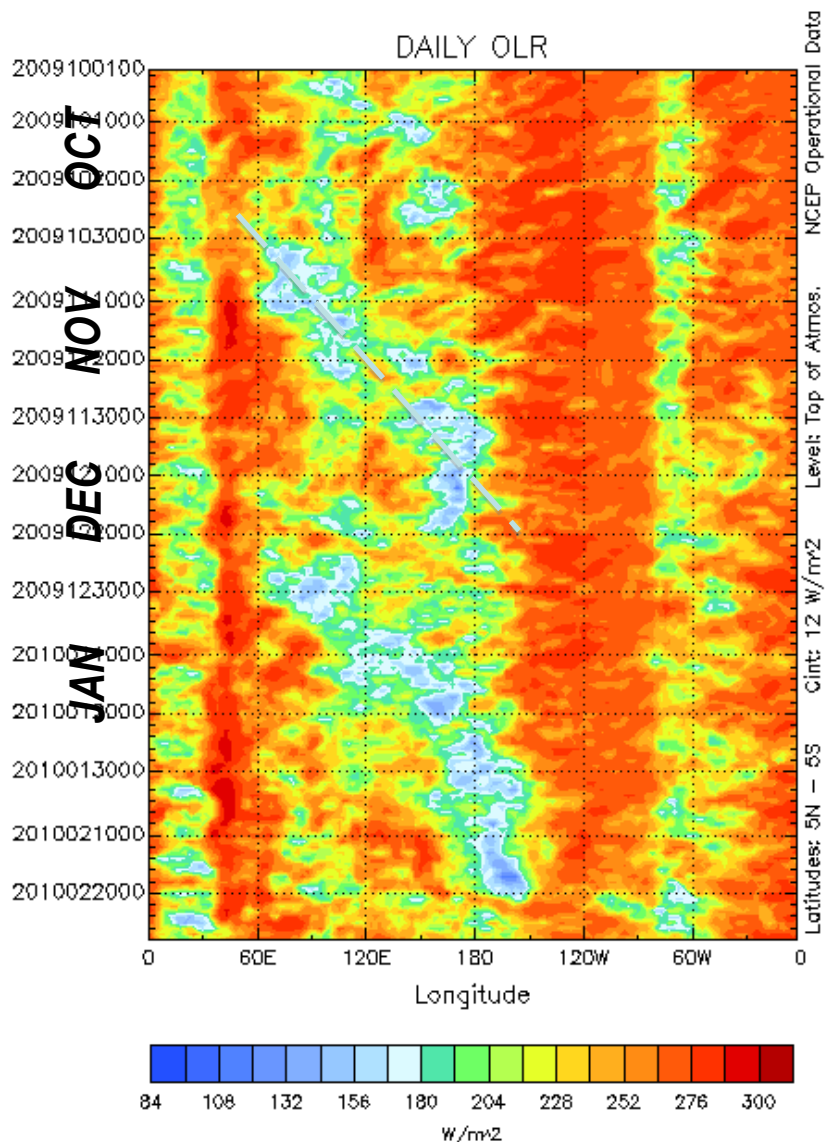
# RAMA Array, courtesy PMEL (as of July 2010)



<http://www.pmel.noaa.gov/tao/disdell/disdell.html>

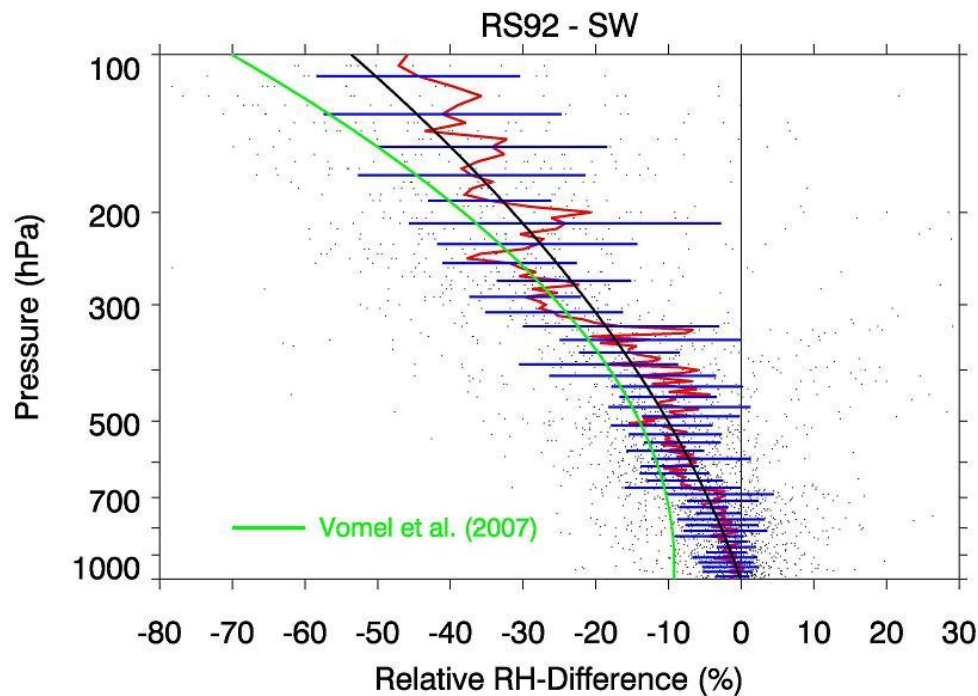
# 10 Minute Data

## October-November 2009 MJO



## Instrument biases

- Reference sondes will be useful in calibrating other sondes
- Vaisala RS 92 sondes used at ARM sites have a daytime dry bias (Vomel et al. 2007, Yoneyama et al. 2008, Cady-Pereira et al. 2008)

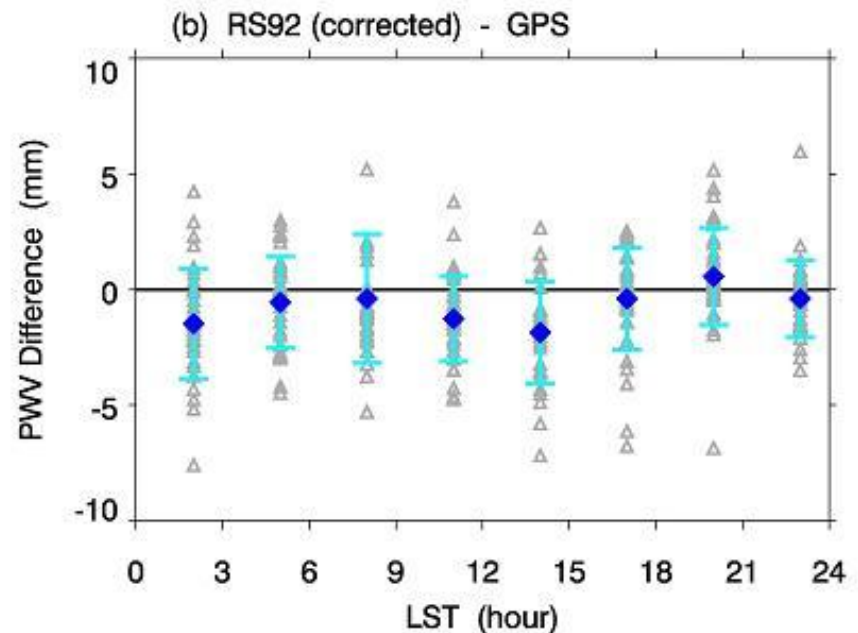
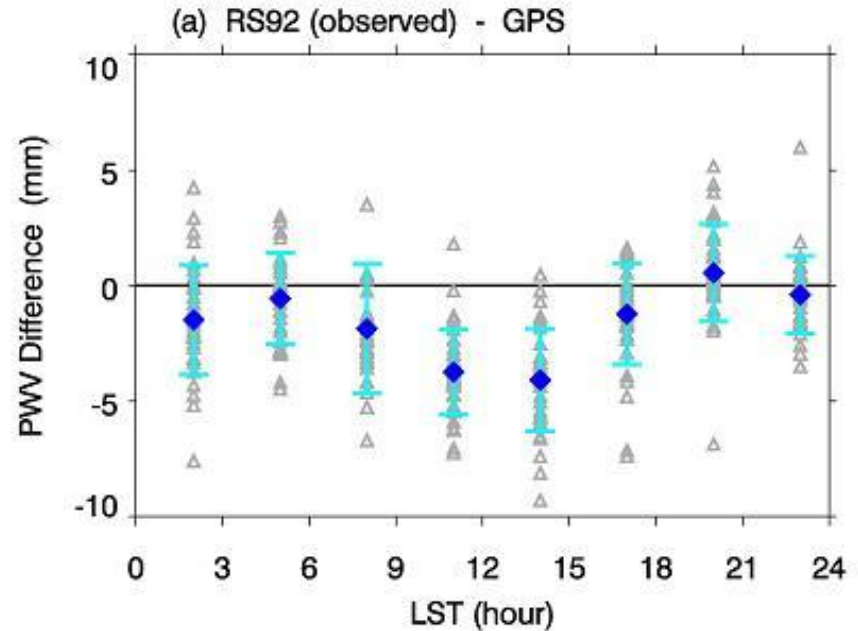


Relative difference between humidity data from RS92 and Snow White (chilled mirror hygrometer) for 14 daytime (near noon) soundings taken during MISMO in 2006 shows significant dry bias in RS92 sondes, especially at upper levels.

Green curve, which is Vomel's correction, is considerably larger at lower levels. However Vomel's study was over land, whereas MISMO was conducted over the Indian Ocean.

## Instrument biases (continued)

- **Collocating ground-based GPS receivers, which measure total column PW, with sonde sites is strongly recommended.** Wang and Zhang (2008) recommend that sonde and GPS sites be within 50 km of each other.
- Using GPS PW data will allow us to better identify and correct the daytime Vaisala RS92 dry bias
- PW difference (sonde - GPS)  $\longrightarrow$  before and after correction in MISMO. Large daytime dry bias is significantly reduced with correction.





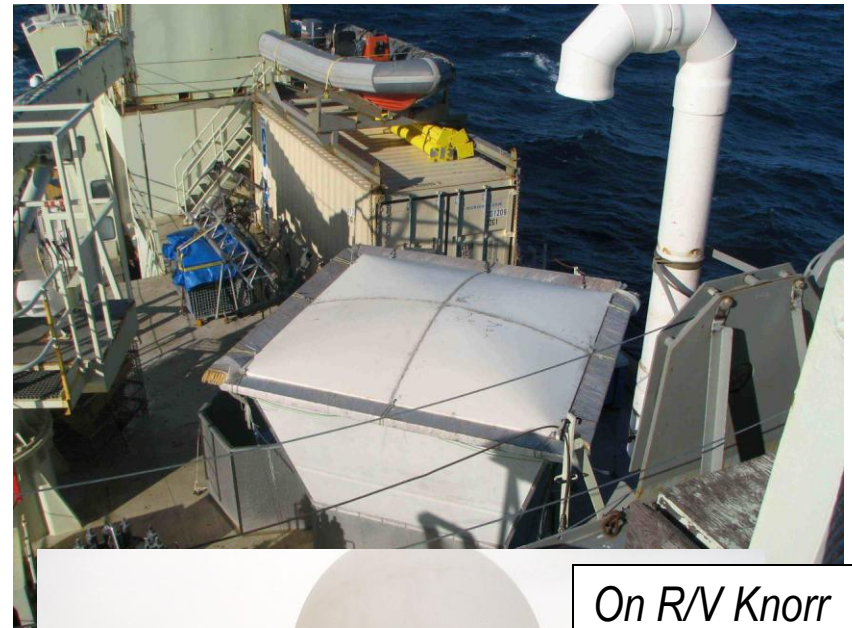
# ISS



NCAR



- Integrated Sounding System
- Wind Profiler (915MHz on stabilizer)
- Radiosondes (Vaisala RS92-SGP)
  - Accurate in lower to mid troposphere (slight dry bias, moist in upper tropo).
  - DYNAMO: 4 - 8 soundings per day
- Surface met. tower (T,RH,P,Wind,Radn)
- Flexibility - add/rm cmpts as needed
- Want to hear from potential users

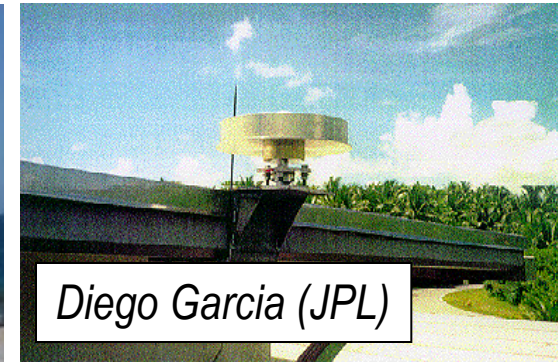


# GPS

Integrated Water Vapor

- Very accurate (down to mms)

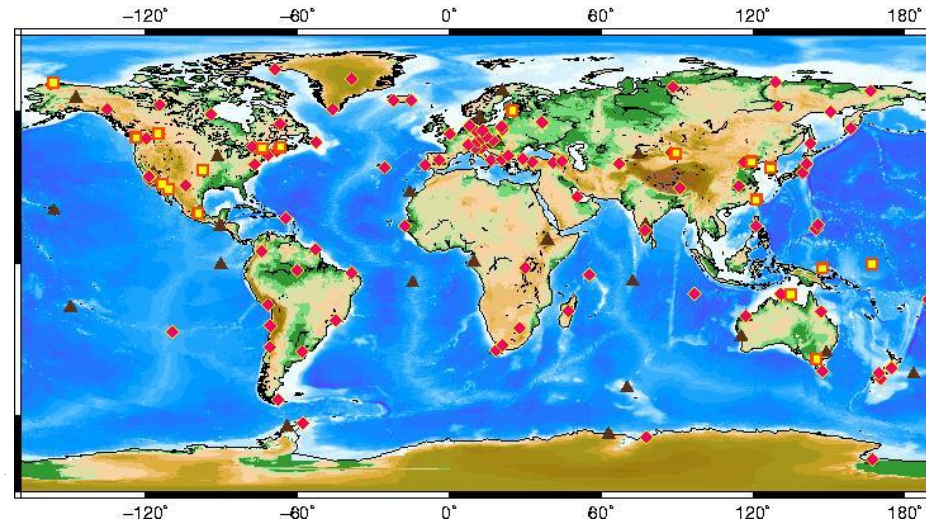
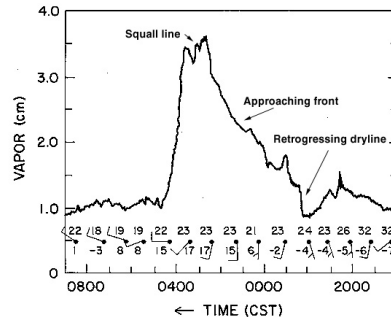
Ship-board deployment possible  
(Requires additional processing)



Integrate into SuomiNet

EOL has 2(+) systems available

Global Sites



# Microwave Radiometer

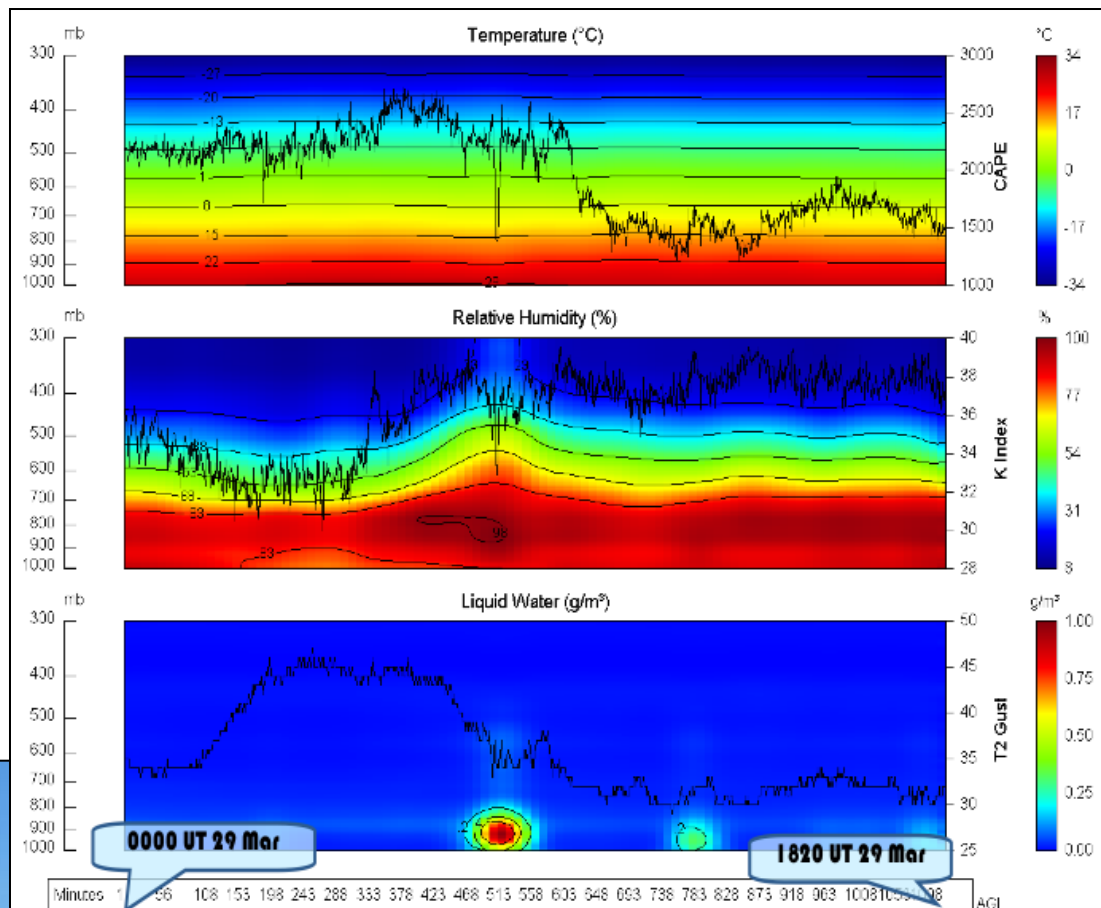
Gives WV and temperature profiles at moderate cost

Low resolu, moderate accuracy but continuous

Easy to setup & maintain  
Ship board possible



Thermodynamic profiler at the India Space Launch Center.

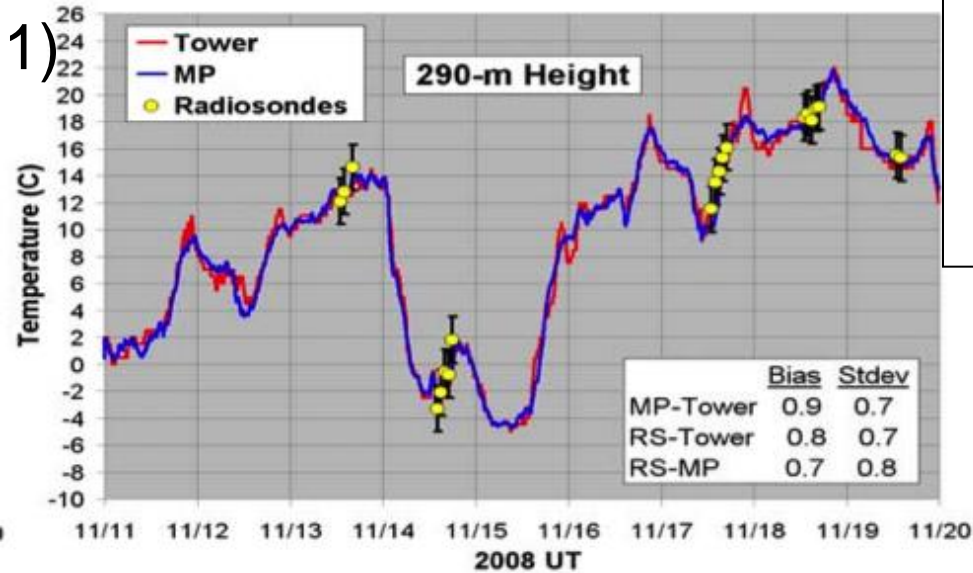


Zenith temperature, relative humidity and liquid profiles to 10 km height, with CAPE, K-index and T2 Gust indices.



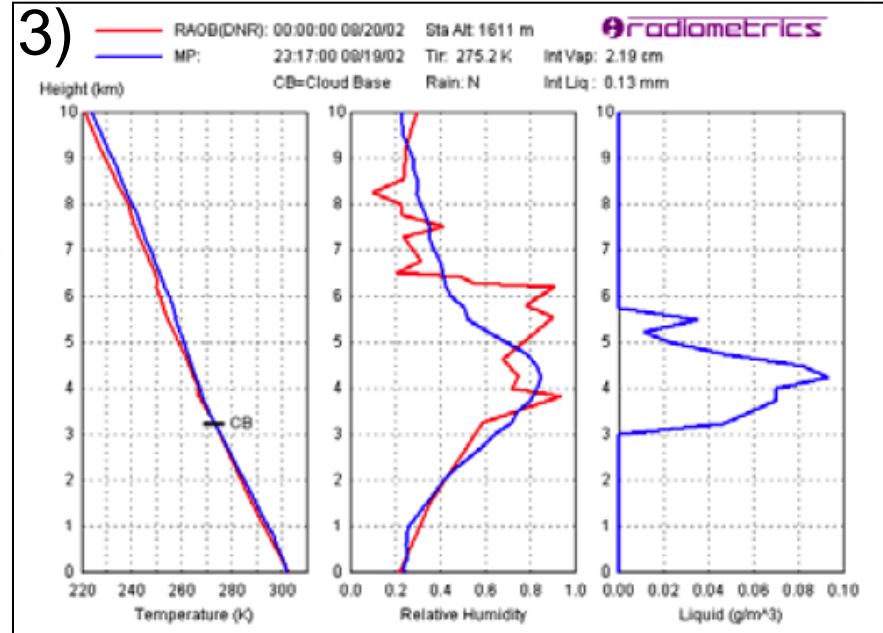
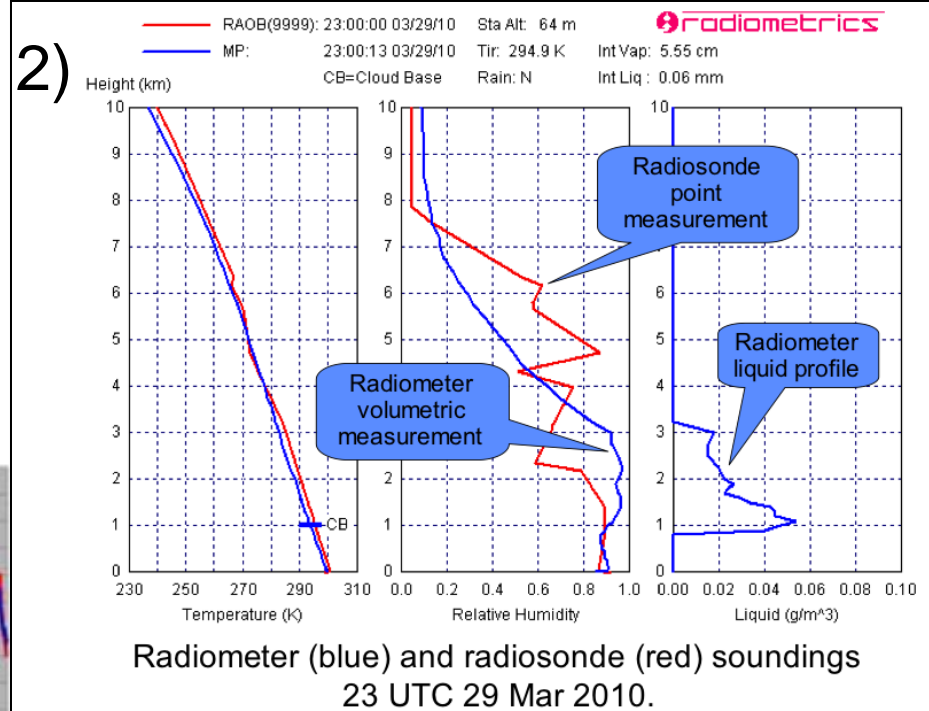
# Radiometer comparisons

1. 9-day time series at BAO tower
2. Sounding at Indian Space Center
3. Sounding in Boulder



ARM Report:

- Errors ~ 2C, 2g/m<sup>3</sup> (compared with sondes)
- Problems resolving gradients
- Vert resolu decreases with altitude (100's of m in BL, km's above)
- Does recommend deployment at their sites.



# Solar Radiation

ISS Solar Radiation Sensors

Eppley PSP (short) & PIR (long)

Shipboard on top of met. mast

Sun Pyranometer proposed  
gives global & diffuse  
sunshine  
no moving parts

Want to hear from potential users



*On-board  
RV Mirai*



*Eppleys  
deployed  
at U. Miami*



*Delta-T SPN-1  
Sunshine  
Pyranometer*