Aircraft Measurements of the Atmosphere and the Upper Ocean During DYNAMO Using NOAA P-3

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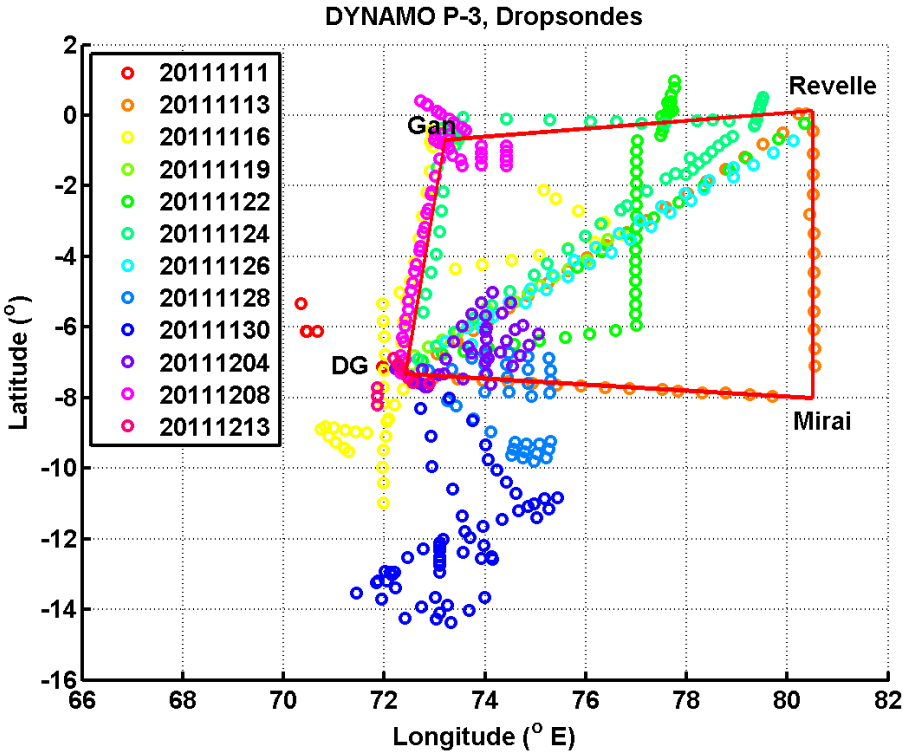
Topics of Discussion

- the overall variability of the atmospheric boundary layer and the upper ocean seen from NOAA P-3 expendable measurements
- the impact of convection on the atmospheric boundary layer and upper ocean
- Characteristics of air-sea temperature difference
- Evolution of SST and air-sea temperature difference through different phases of MJO

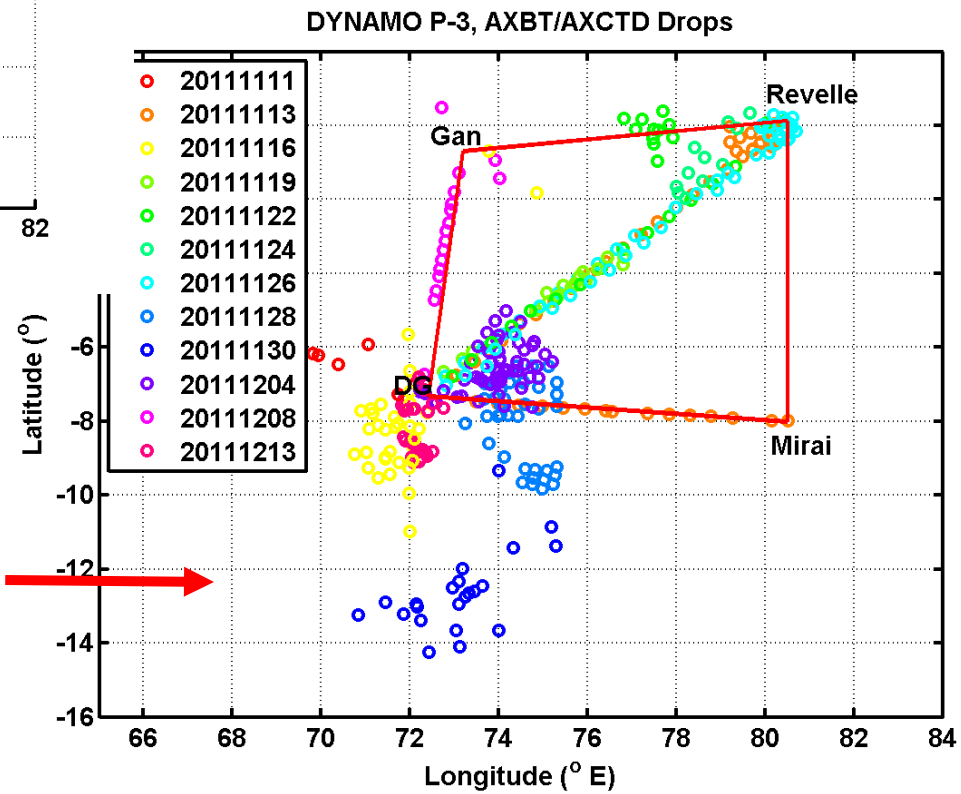
NOAA P-3 for DYNAMO

Flight level *in situ* and remote sensors:	Navigational parameters
	Pressure, temperature, and water vapor
	Mean winds and turbulence
	Cloud physics
	Sea surface temperature
	Radiation
Radars:	Lower fuselage C-band research radar (cloud survey)
	Tail X-band Doppler radar (radial velocity and reflectivity)
Expendables:	GPS dropwindsonde (PTU and derived vertical velocity)
	AXBT (water temperature)
	AXCTD (water temperature and salinity)
Others:	Scanning wave lidar (surface topo)
	SST imagery (SST variability)

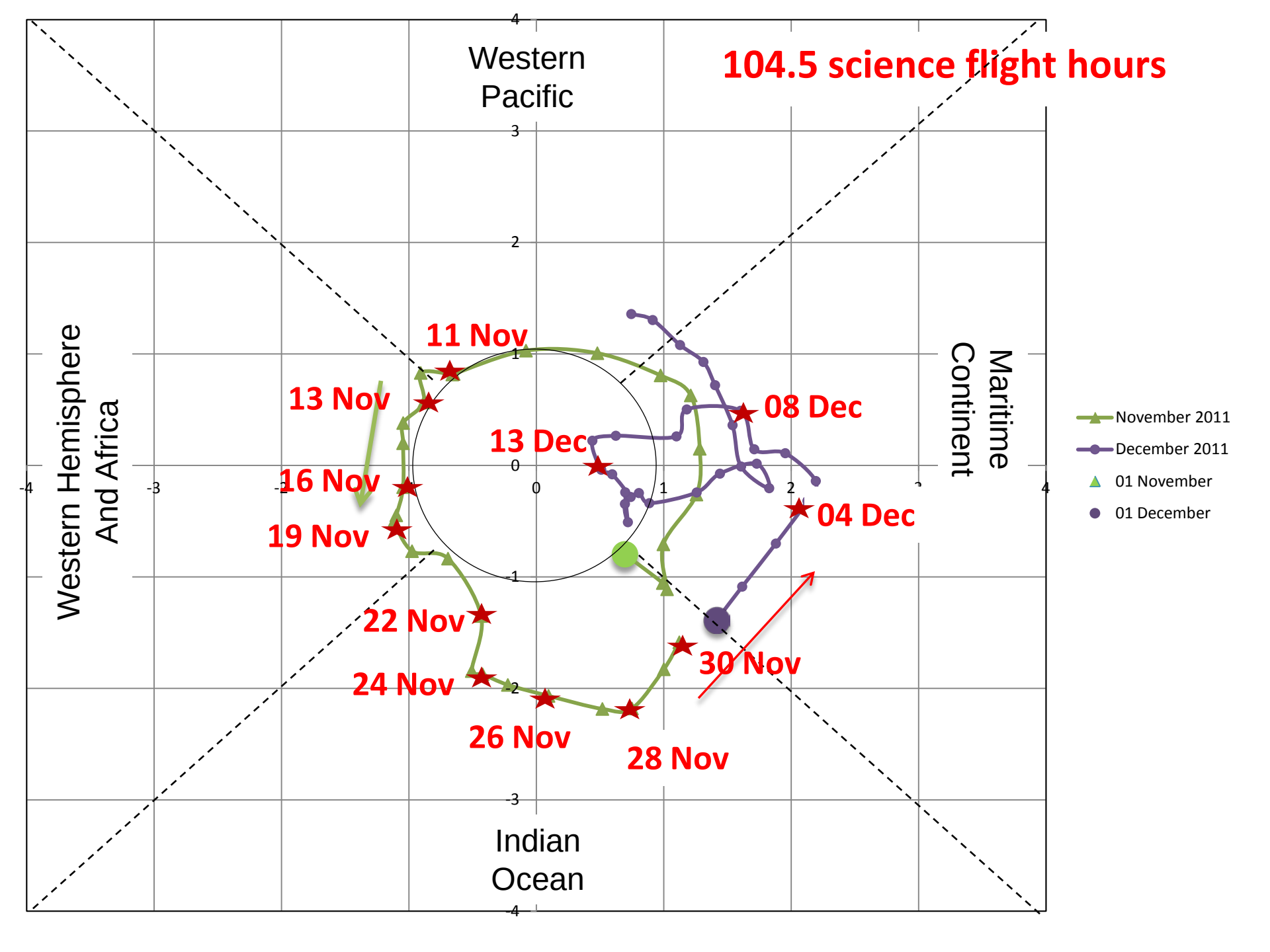
DYNAMO Expendables

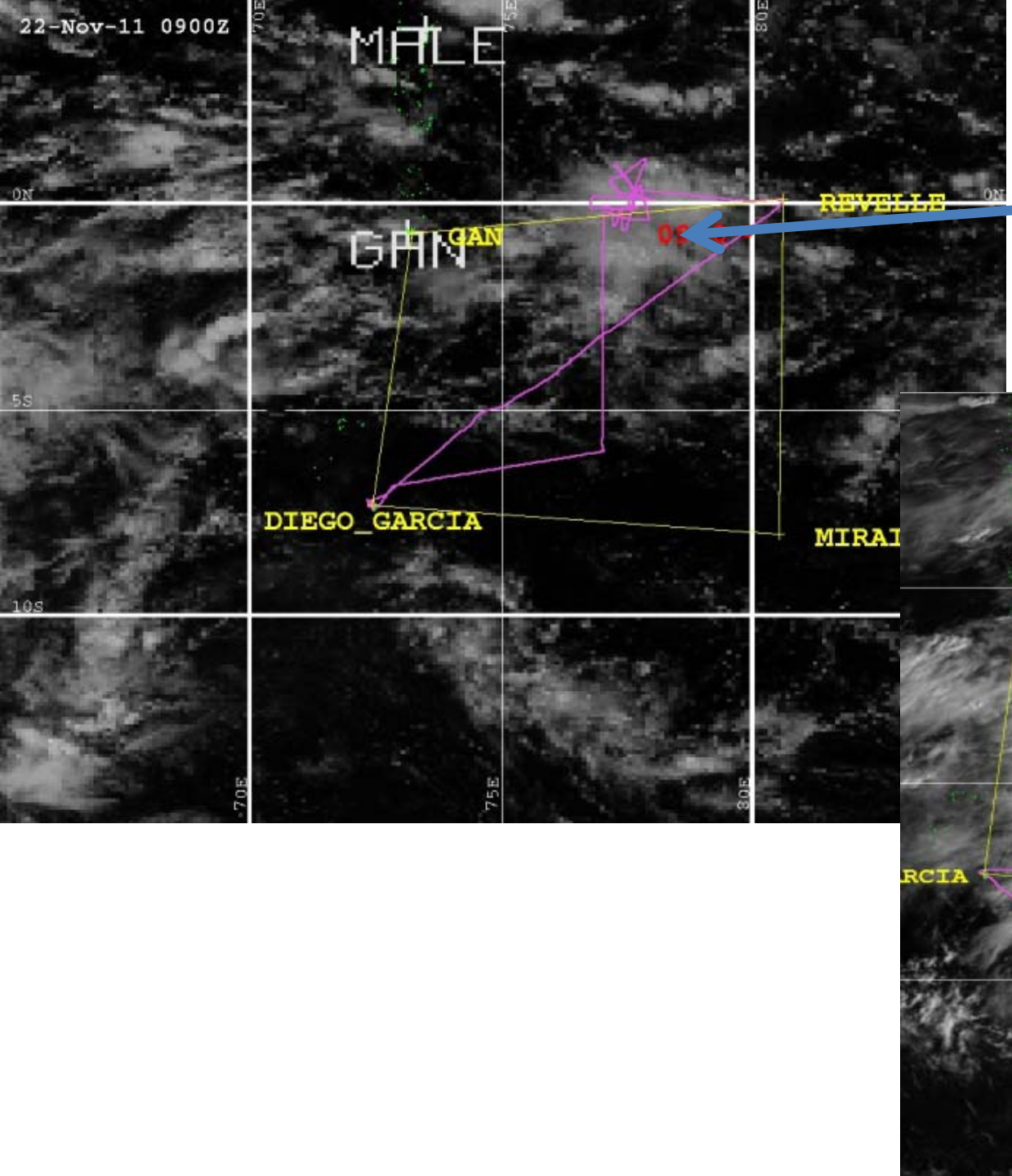


Dropsonde locations
(482 drops, 468 profiles)

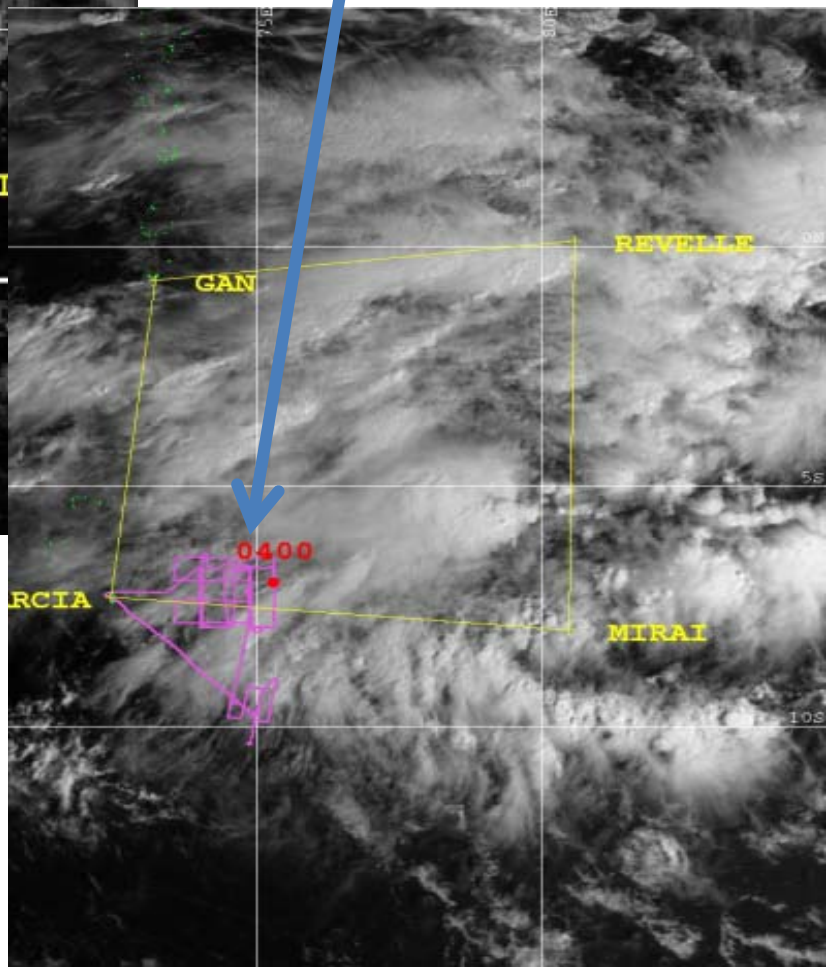


AXBT/AXCTD locations
(316 AXBTs, 289 BT profiles
114 AXCTDs, 106 CTD profiles)


104.5 science flight hours
Western Pacific
Western Hemisphere And Africa
Maritime Continent
Indian Ocean
11 Nov
13 Nov
16 Nov
19 Nov
22 Nov
24 Nov
26 Nov
28 Nov
30 Nov
13 Dec
08 Dec
04 Dec
November 2011
December 2011
01 November
01 December

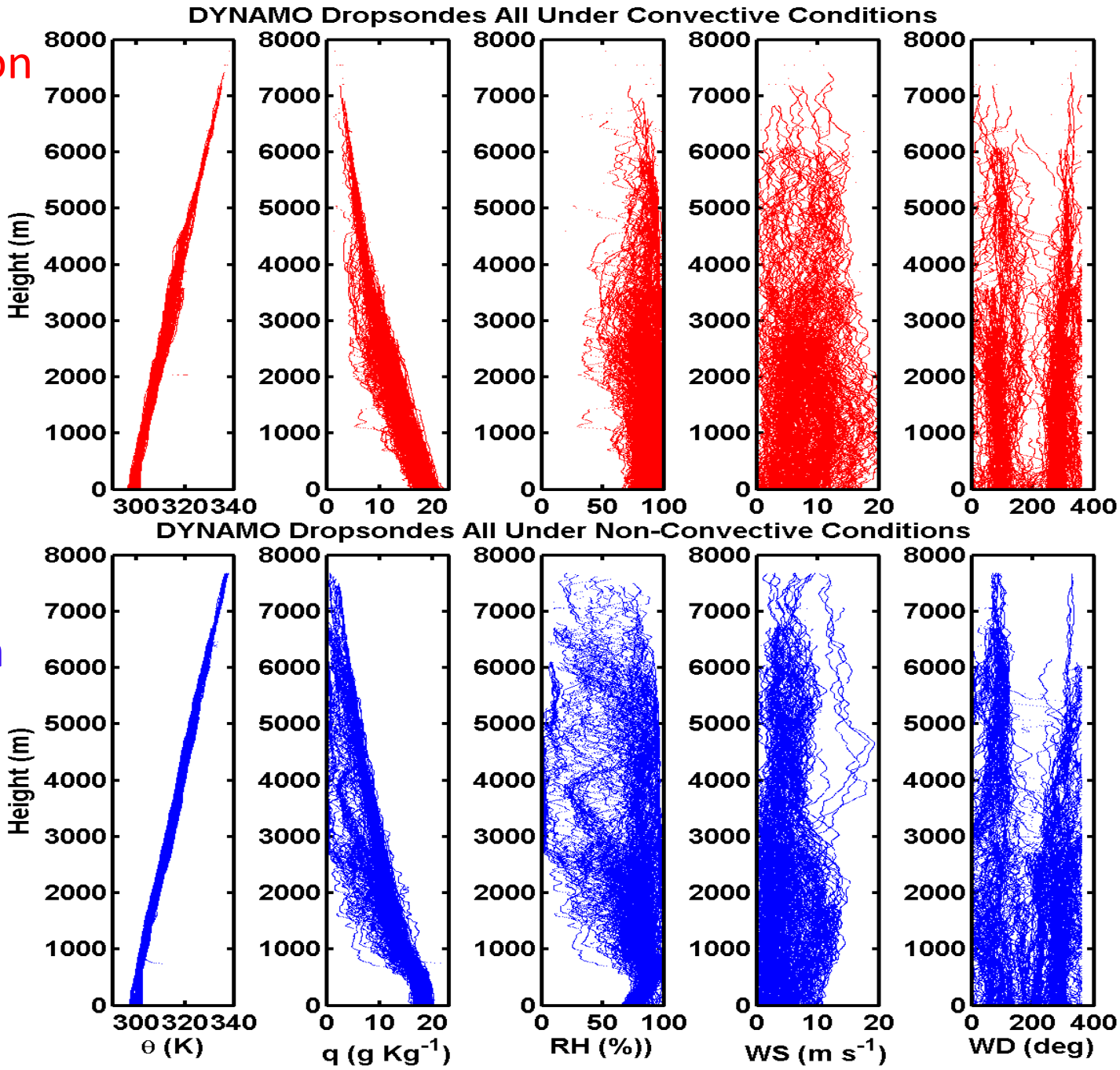


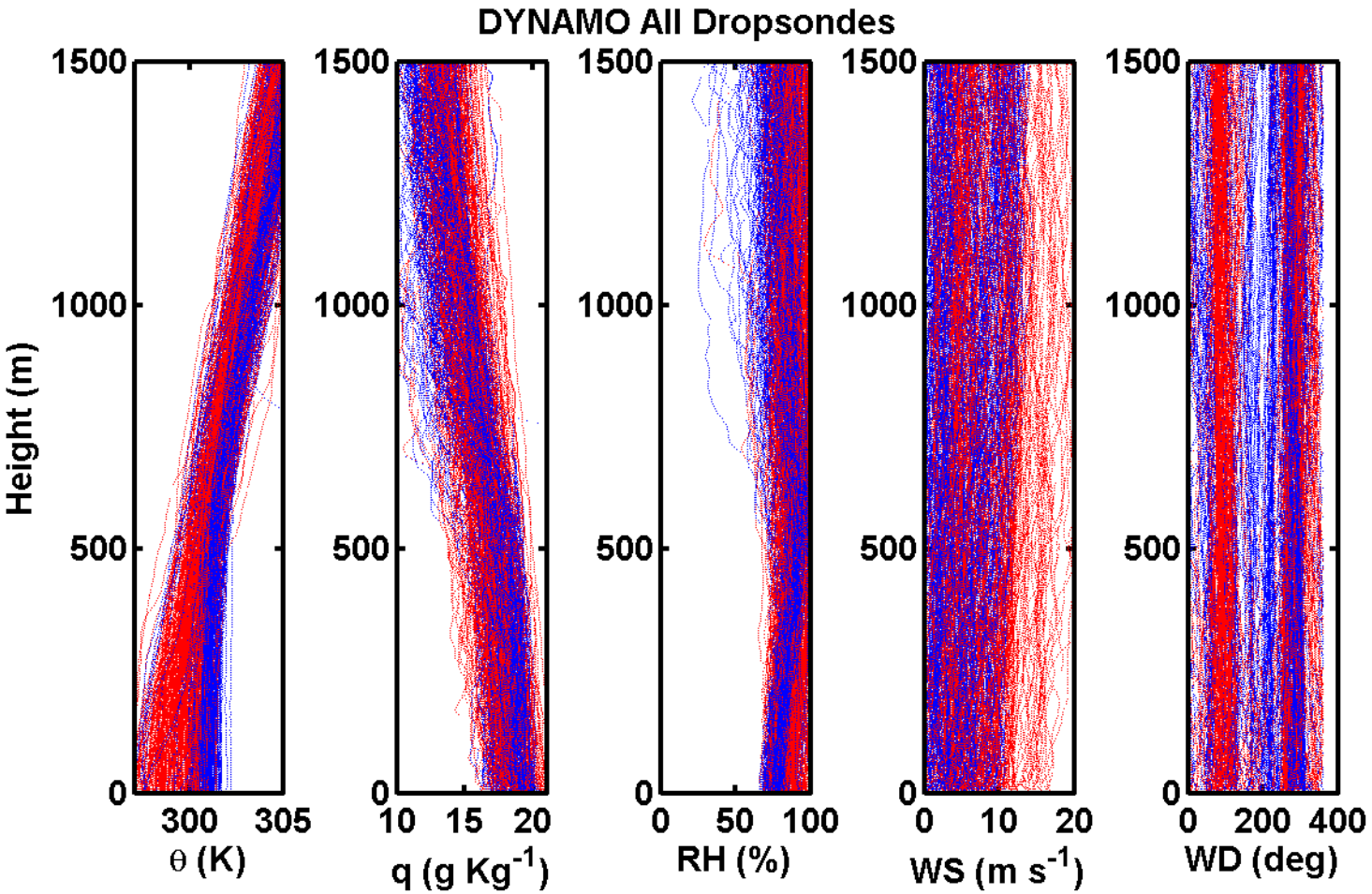
Convective Region



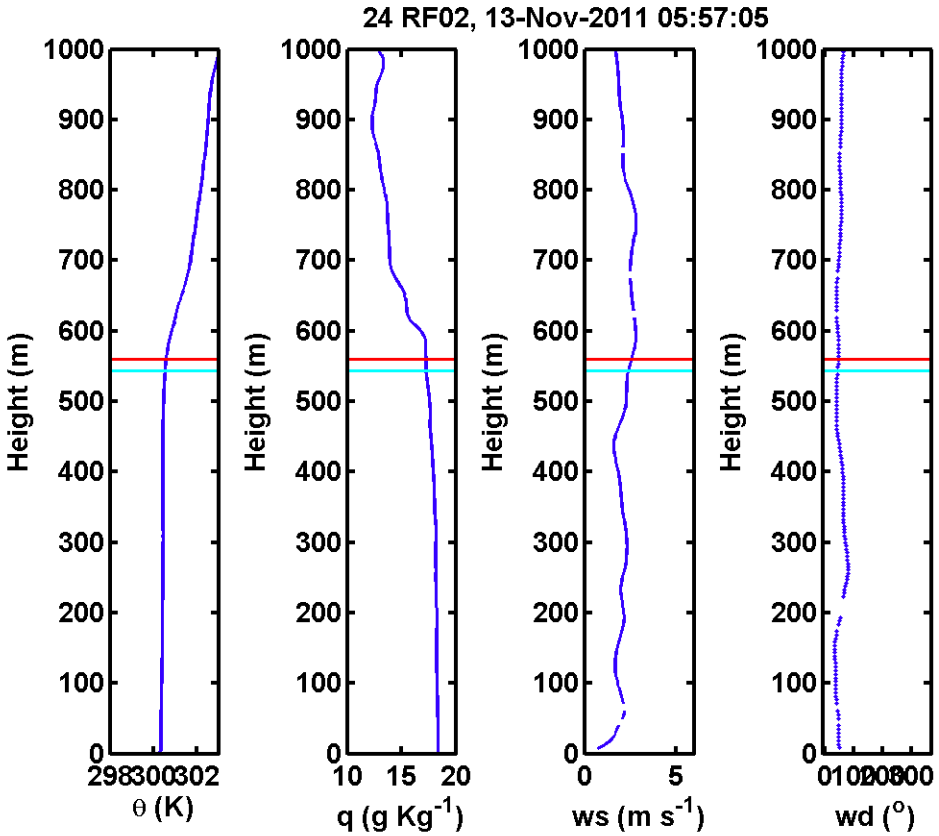
Convection

Non
-convection



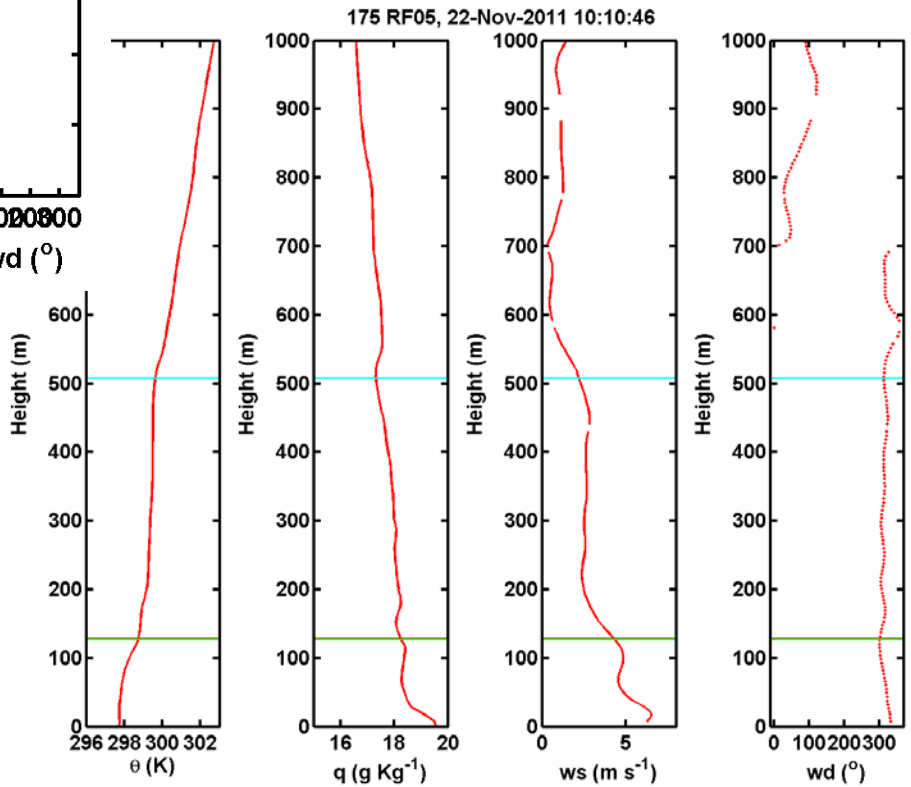


- Well-mixed boundary layer height s ~ 600 m in non-convective environment
- Low-level stable stratification up to several hundred meters under convection and cold pool with temperature difference of ~ 5 K or less
- Saturated below cloud layer under convection, boundary RH ~65-85% in lower 300 meters in non-convection locations



Single layered structure

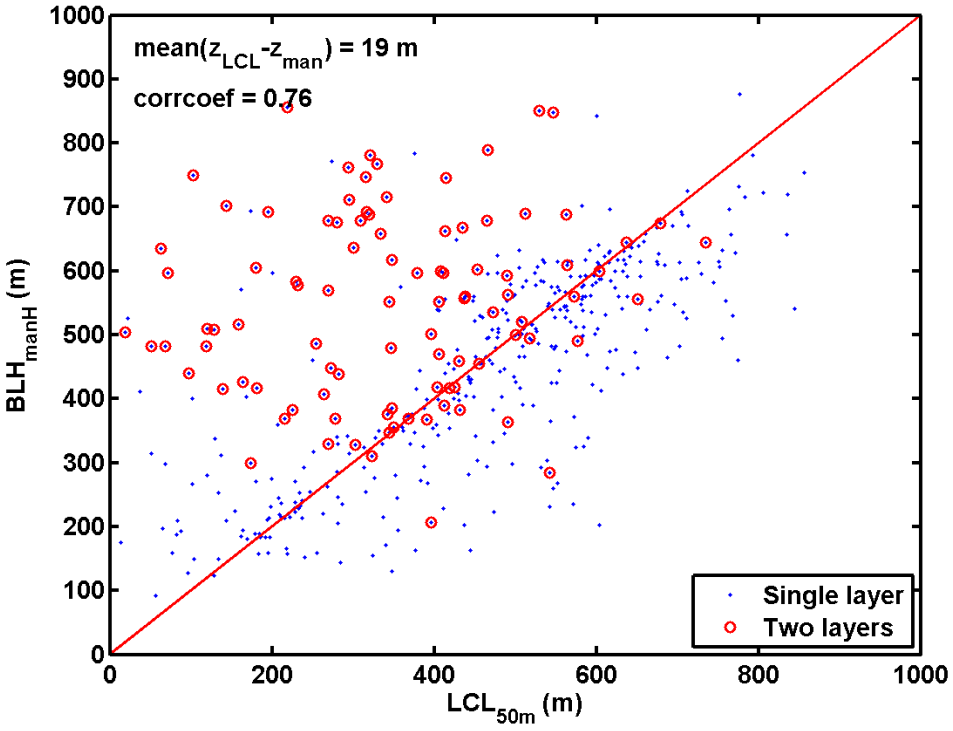
Two-layered structure

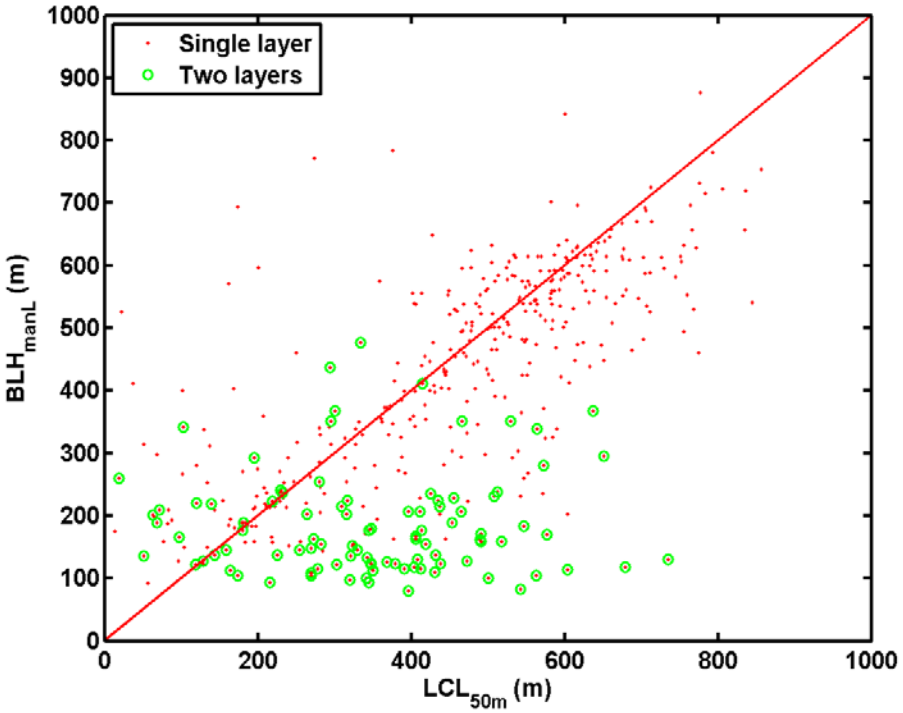


71 out of 253 convection soundings (28%) have two layer

71 out of 96 soundings with two layers are under convective conditions (74%)

Boundary Layer Height vs LCL

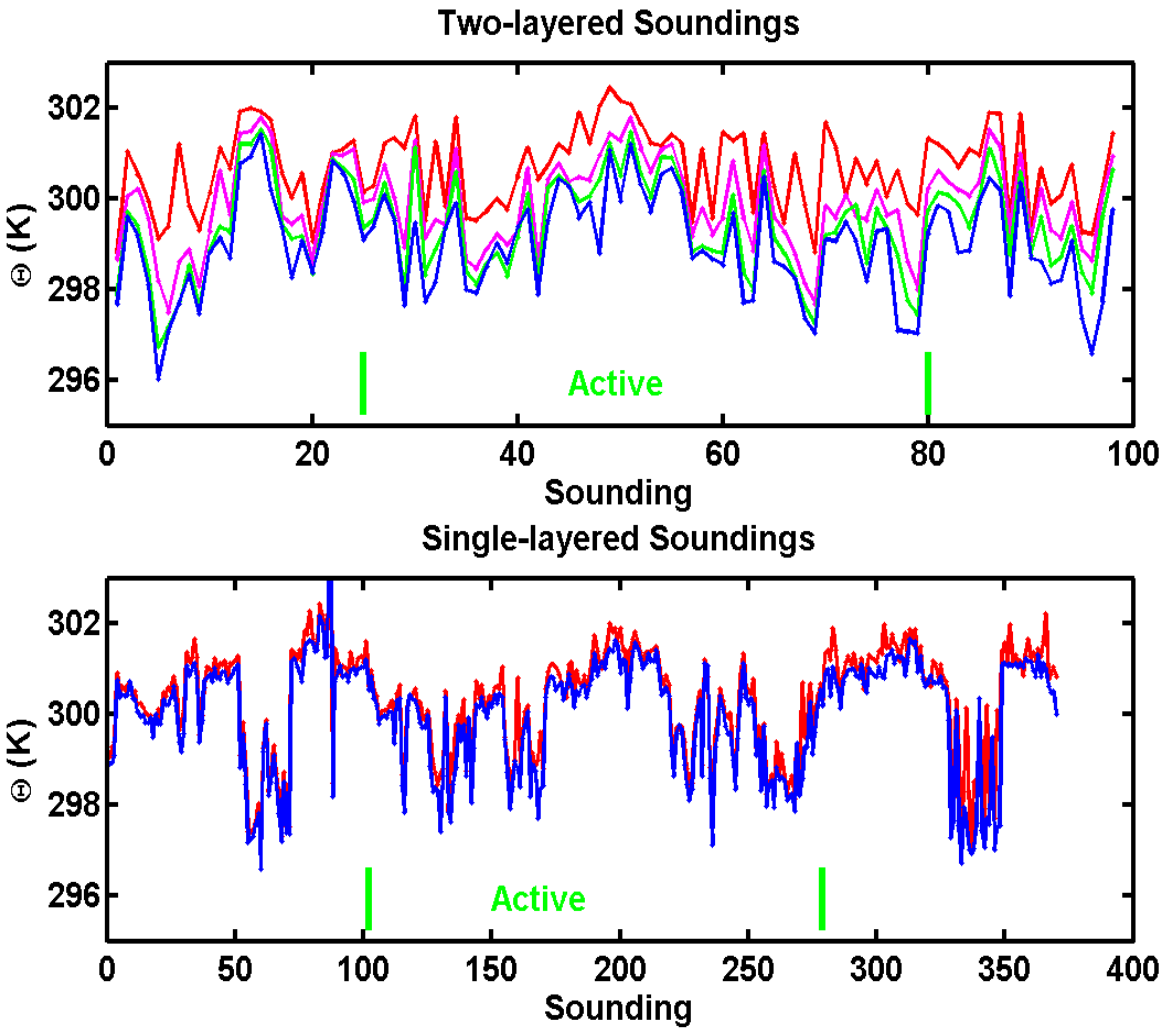


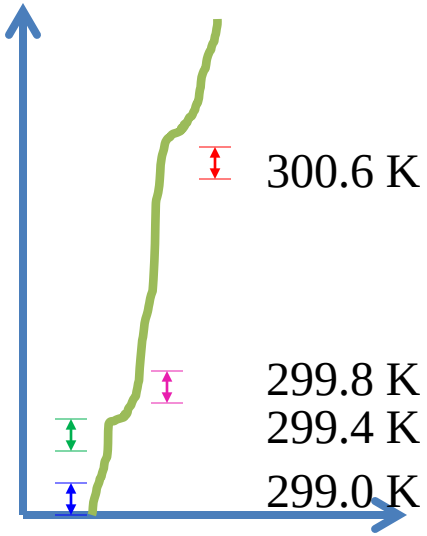


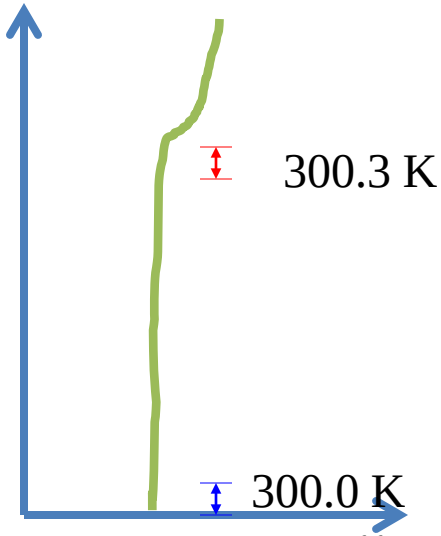
Two-layered structures not related to surface processes

LCL is a good BLH indicator in undisturbed boundary layer

Atmospheric Boundary Layers

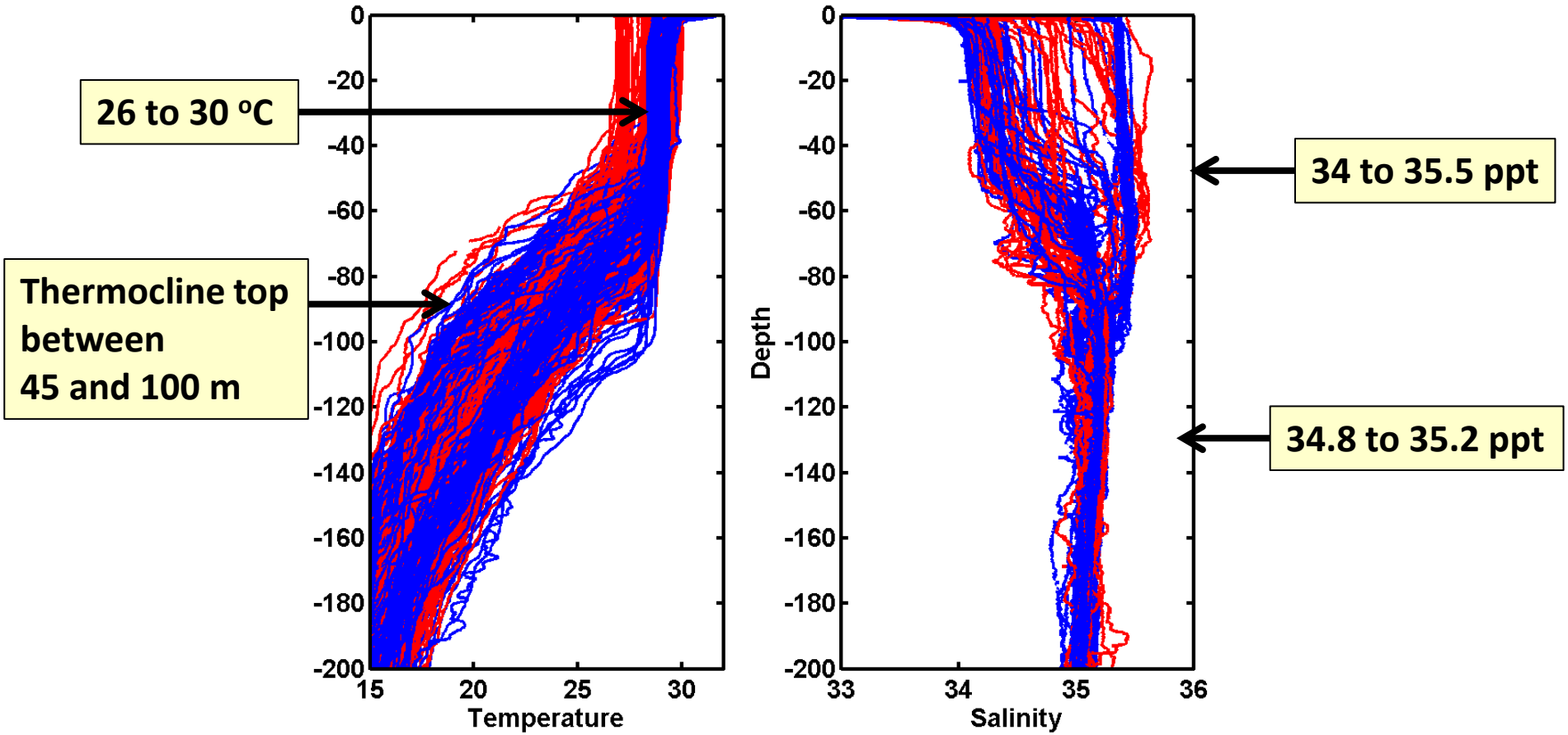




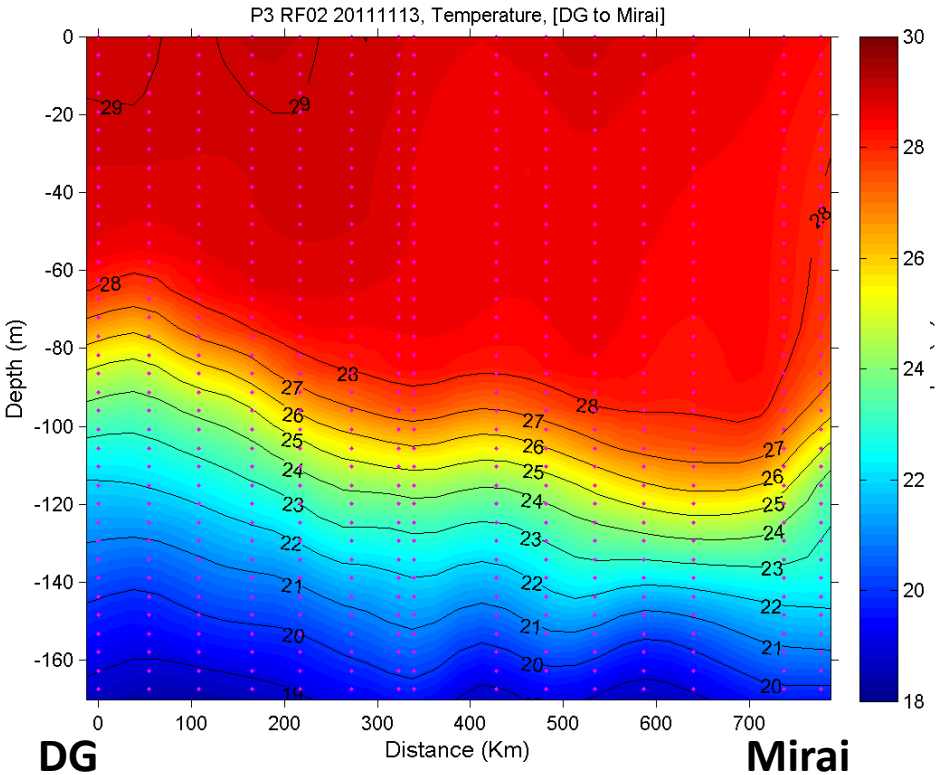


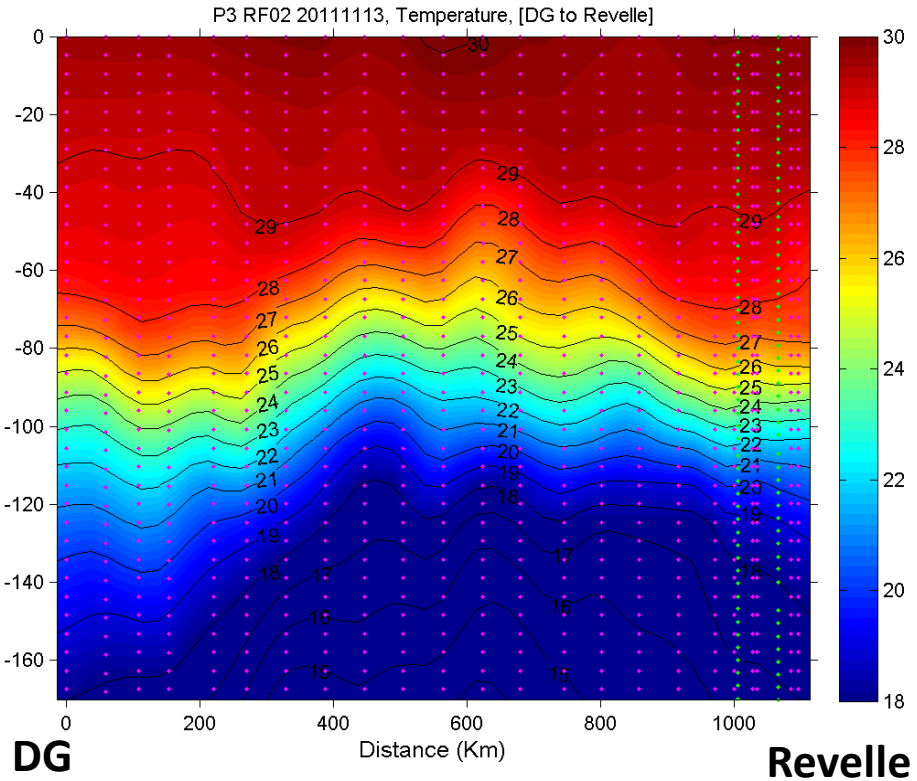
Upper Ocean Characteristics

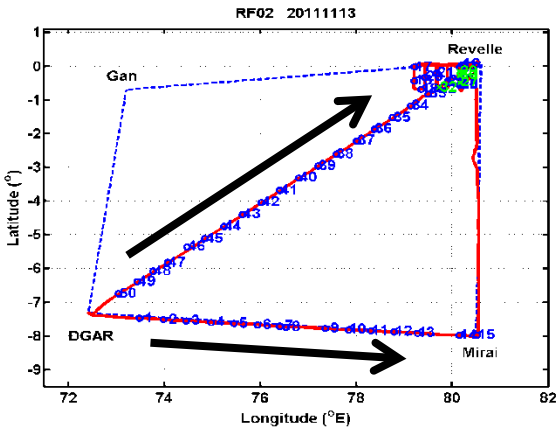
Seen from AXBT/AXCTD Measurements



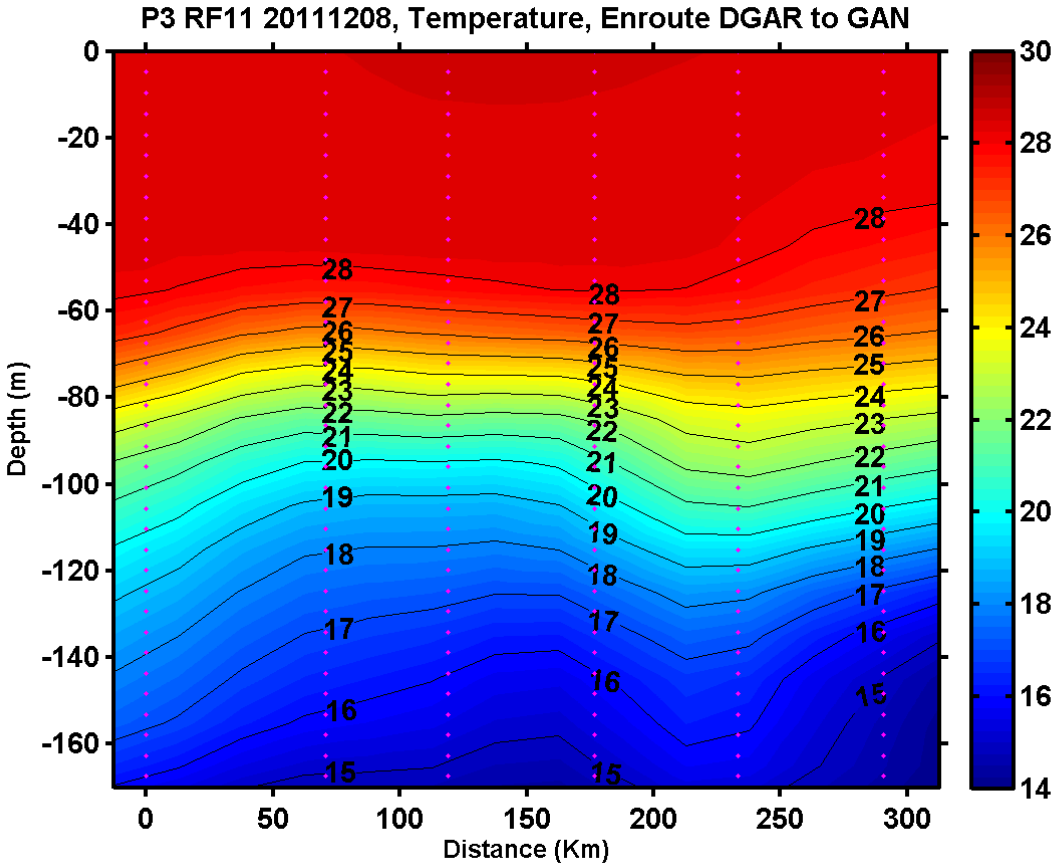
Large Scale Variability



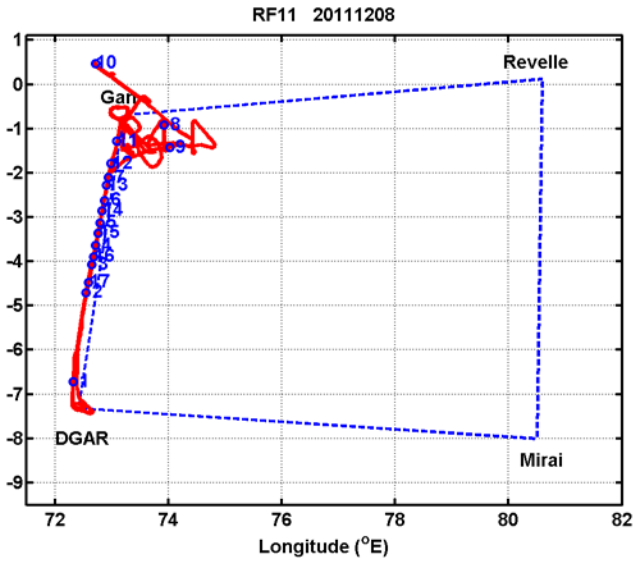




Large Scale Variability

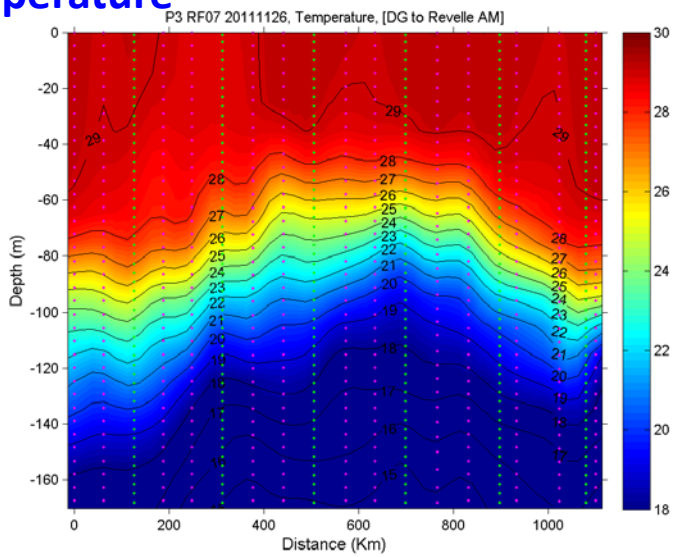


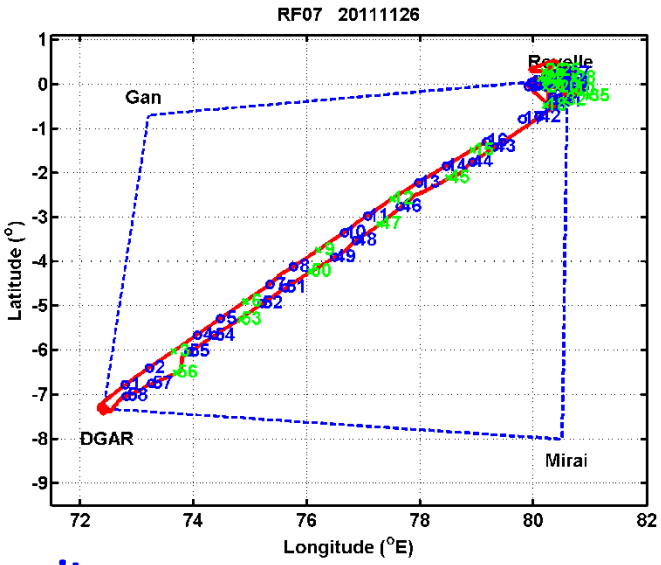
Vertical Cross –Section of Temperature going from Diego Garcia to Gan



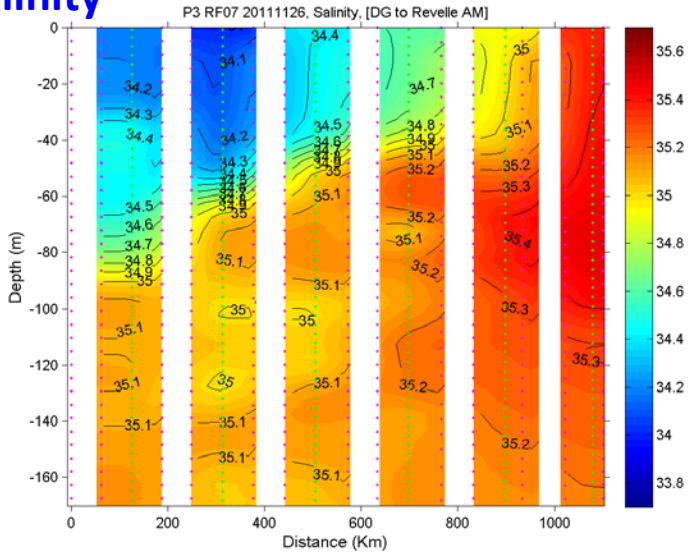
Large Scale Variability

Temperature

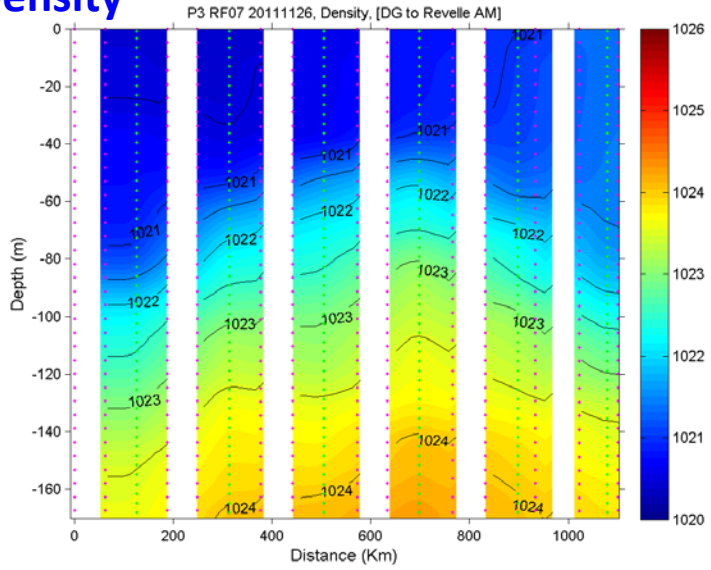




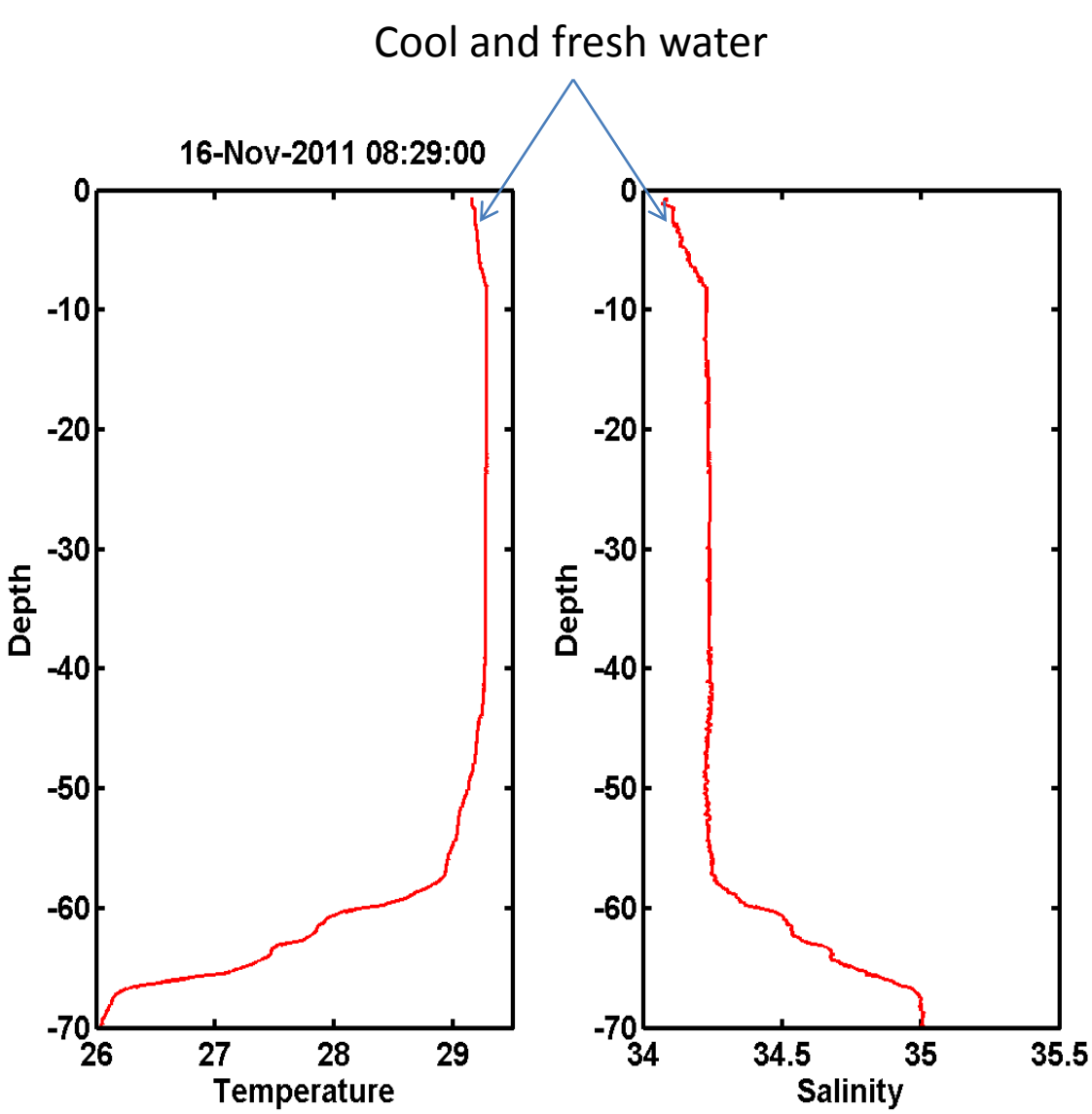
Salinity

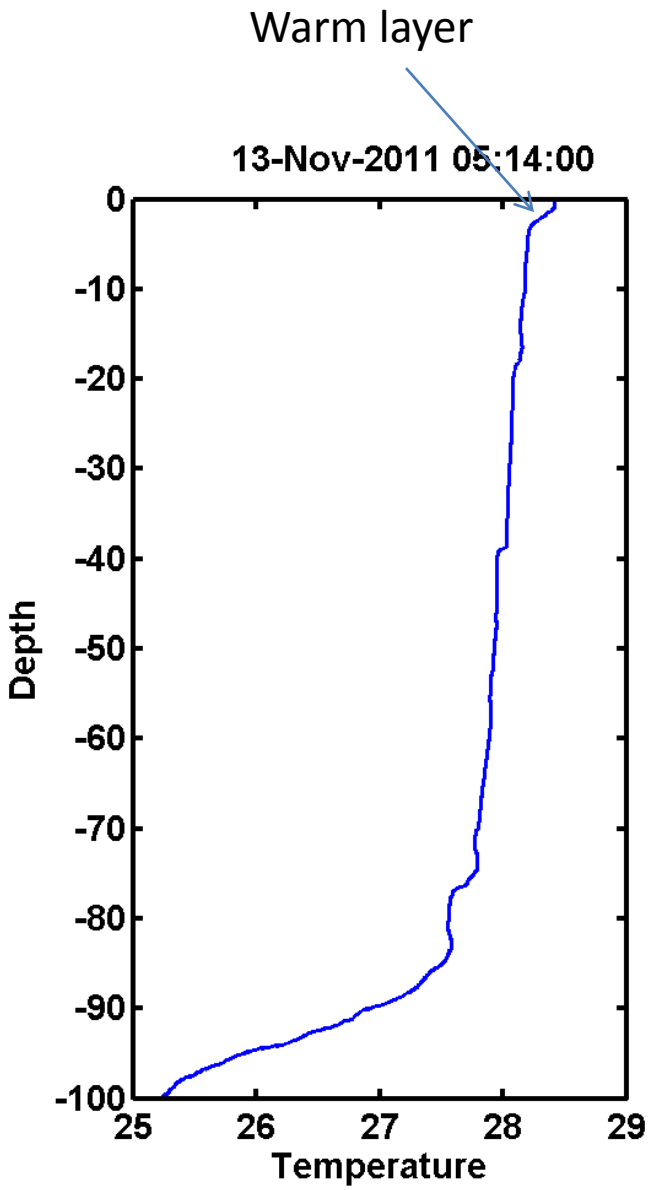


Density



Upper Ocean Thermo Stratification





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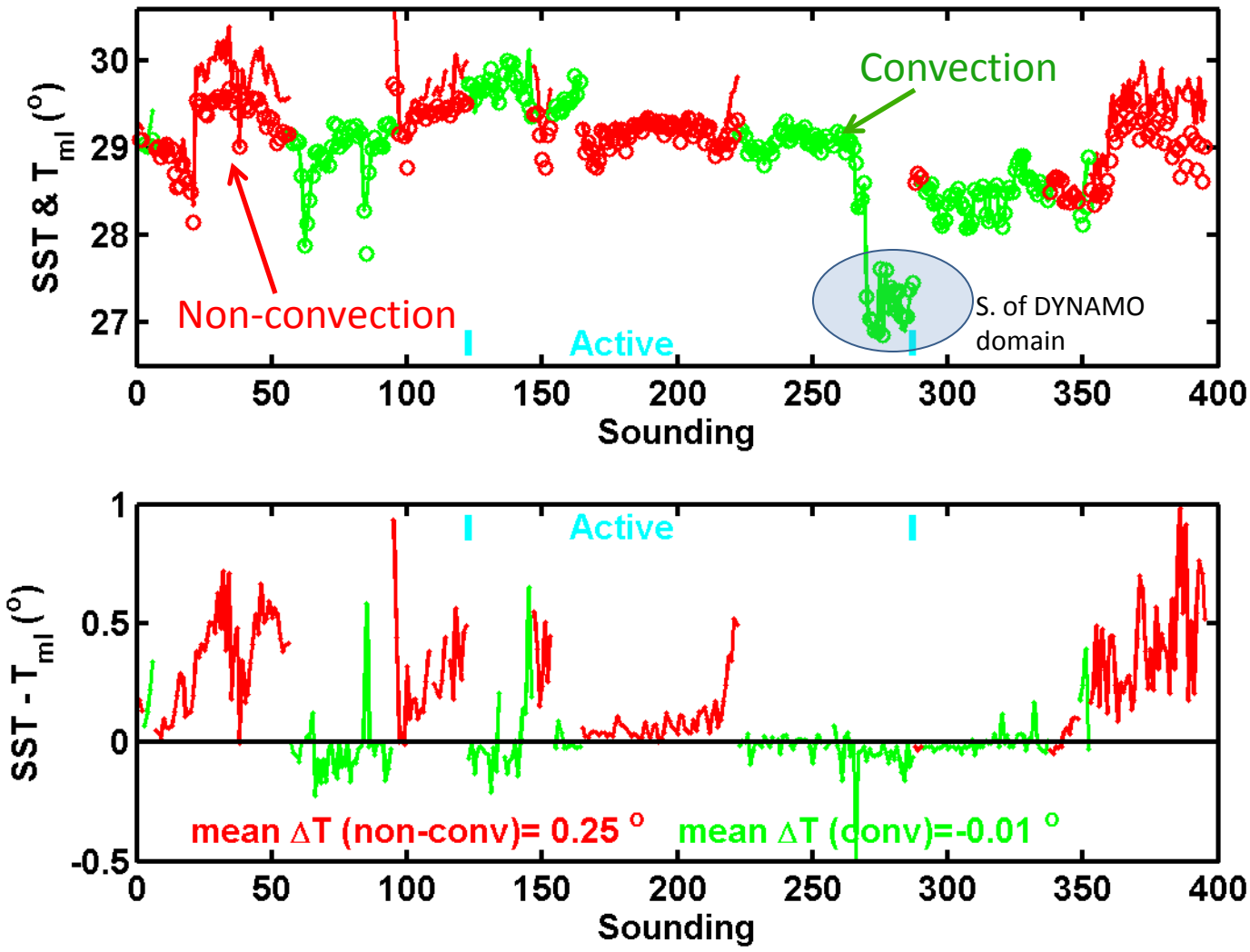
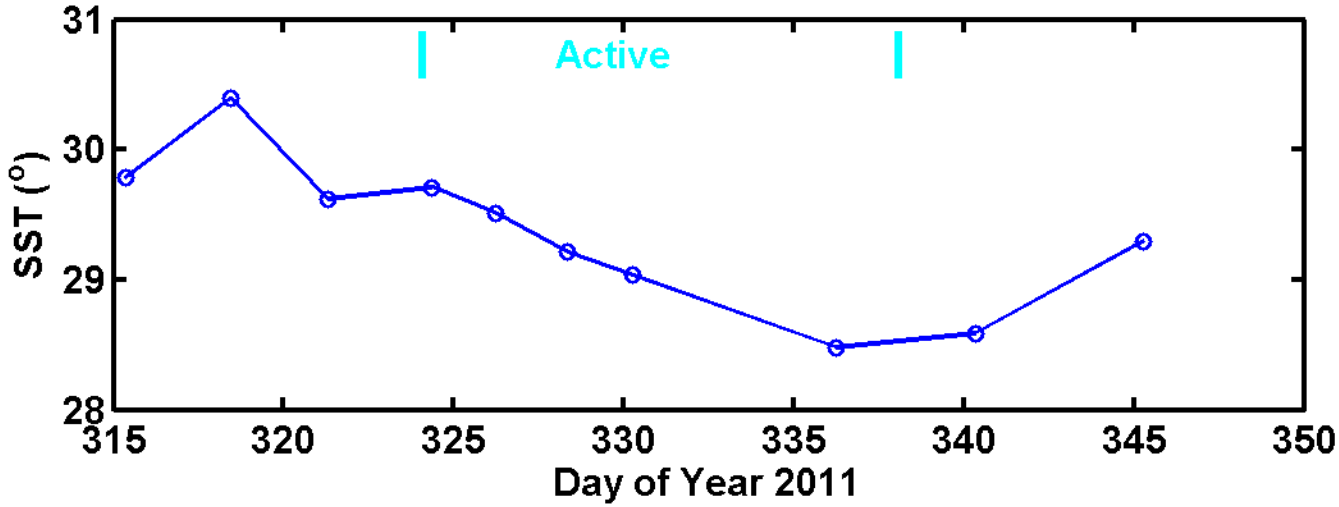
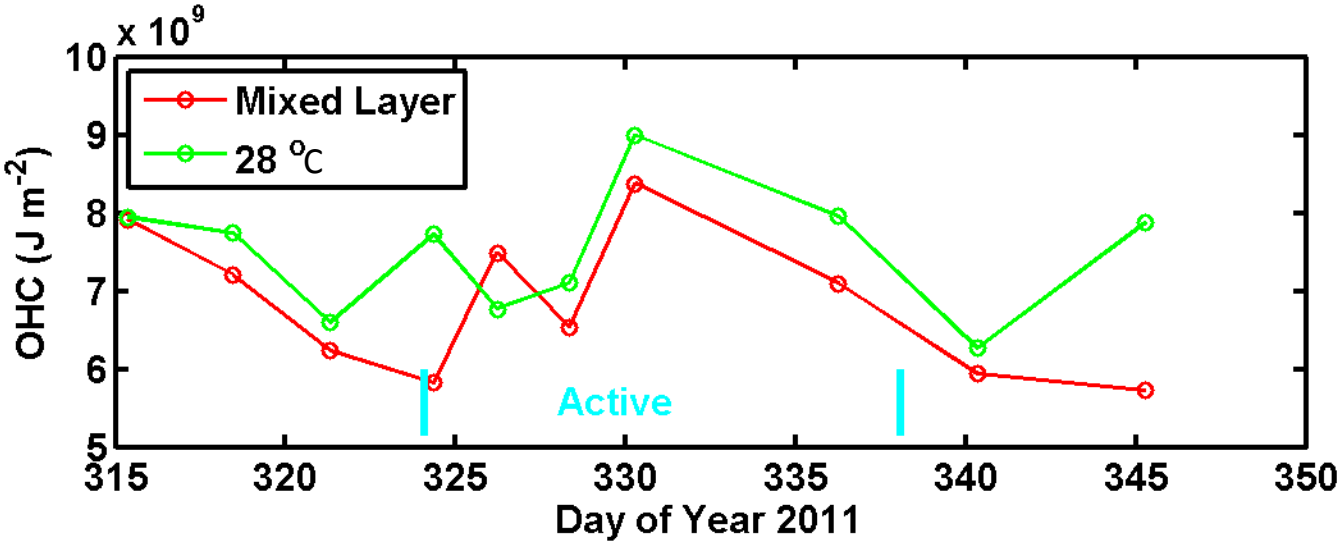


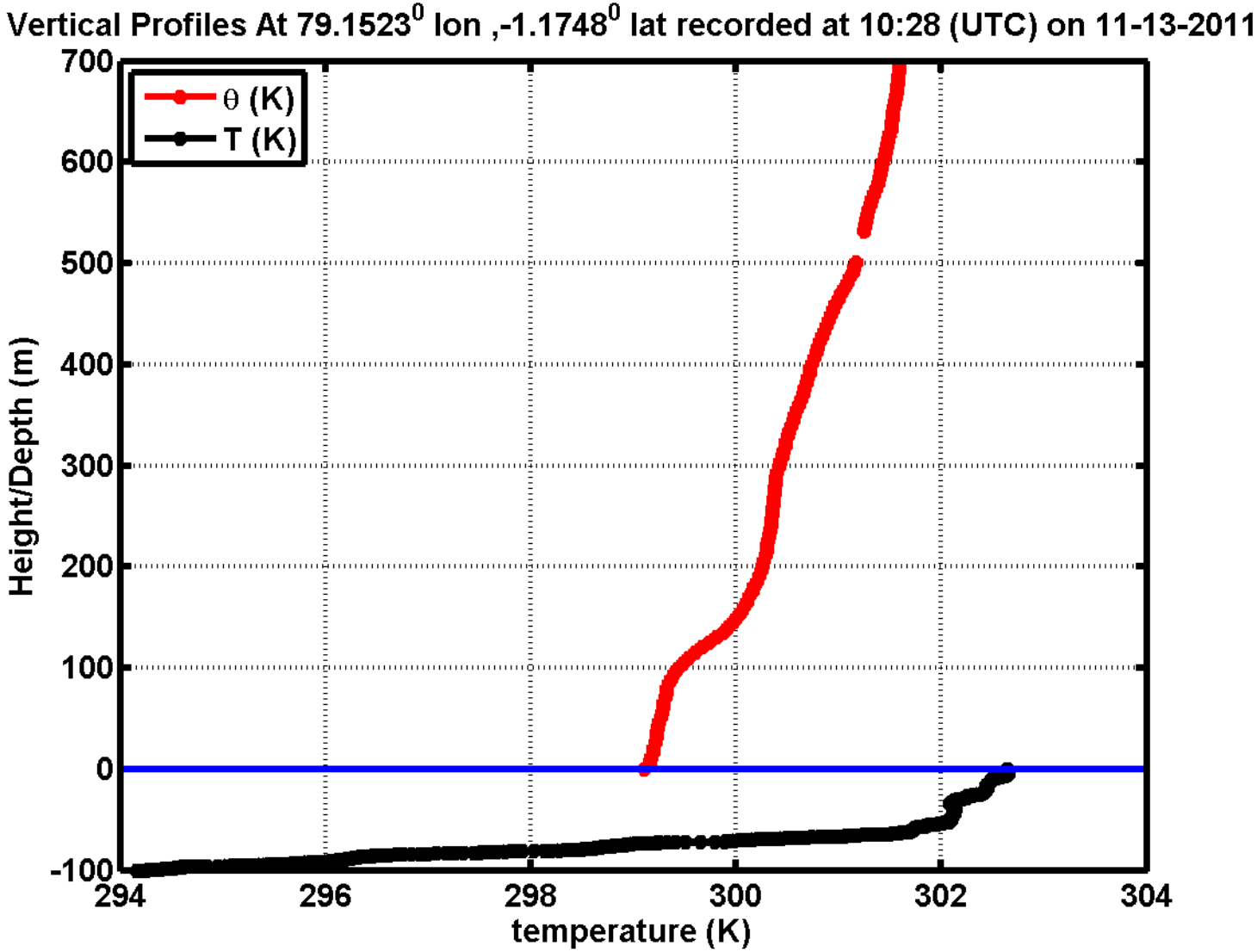
SST and OHC, DYNAMO Domain Average



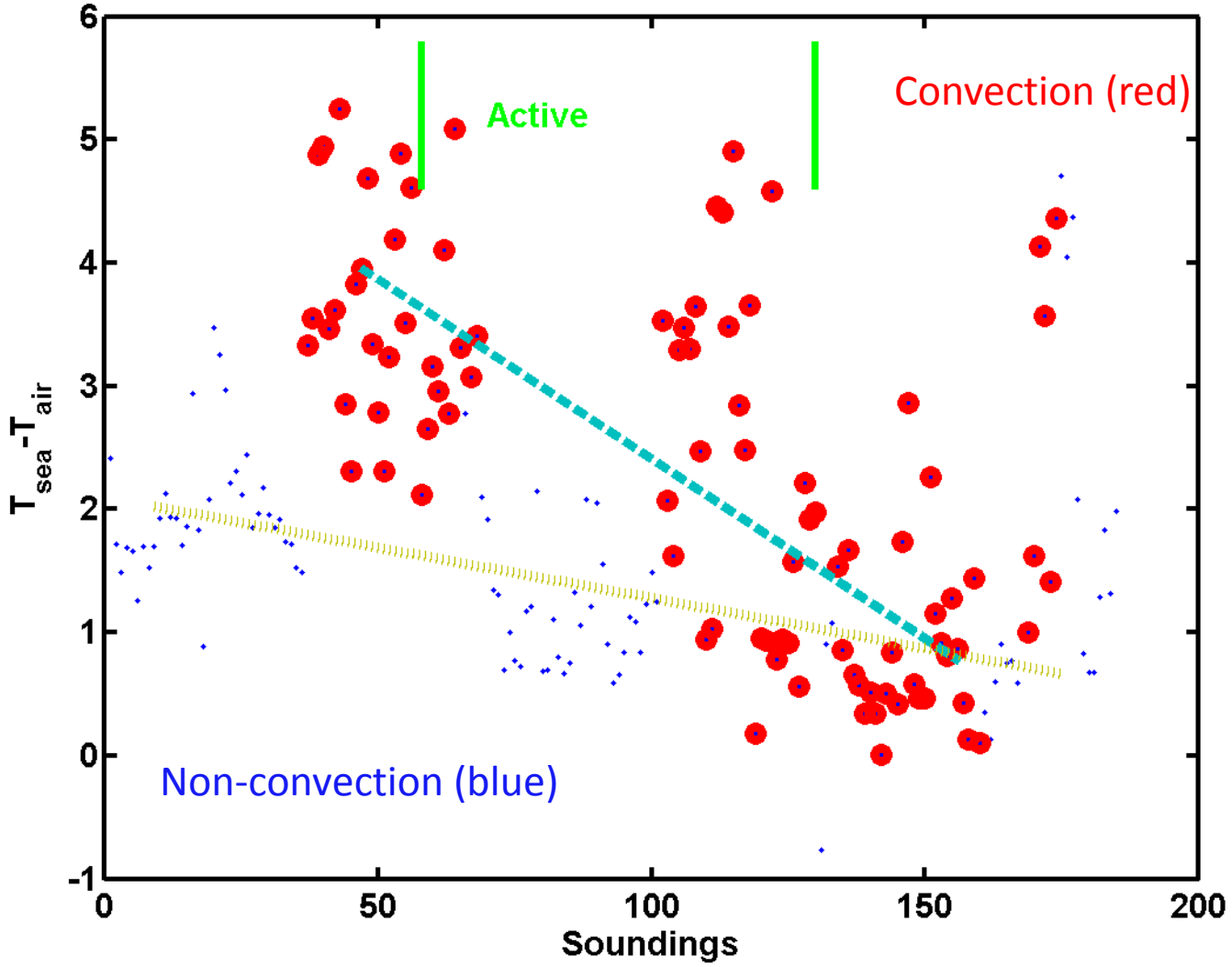


Preliminary results!!

Dropsonde –AXBT/AXCTD Pairs



Air-Sea Temperature Difference



Preliminary results!!

Conclusions

DYNAMO expendable measurements based on the NOAA P-3 revealed:

- two-layered vs single-layered atmospheric boundary layer structure. Near surface temperature in convective region that averages to 1 K cooler and decoupled from sea surface
- cooler ocean surface under convective conditions and a warm thin layer in non-convective region. Stronger thermo-stratification of the upper ocean in the pre- and post- active phase of MJO
- daily domain averaged SST shows high SST before MJO active phase and to a minimum at the end of the active phase. Upper ocean heat content seems to show opposite trend
- Largest air-sea difference seen in the convective conditions in pre-MJO phase. Air-sea temperature difference in both convective and non-convective conditions decrease through the MJO phases.

Important Note:

- The results here are preliminary, will be re-visited once final data QC for AXBT/AXCTD data are completed.
- Further work planned for physical explanations for the observed variability
- Welcome collaborations with the atmosphere/ocean modeling community for a full understanding of the physical processes