

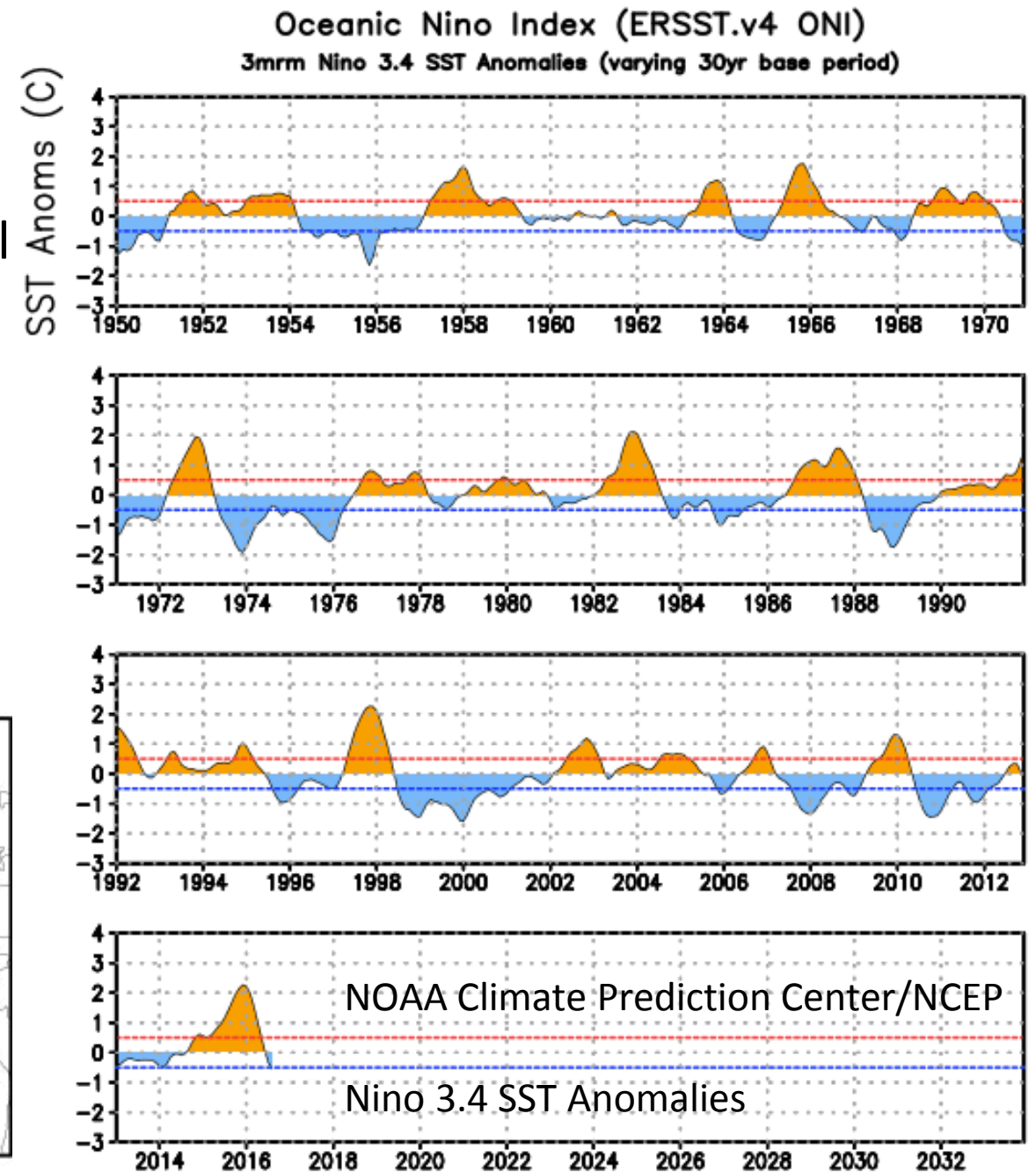
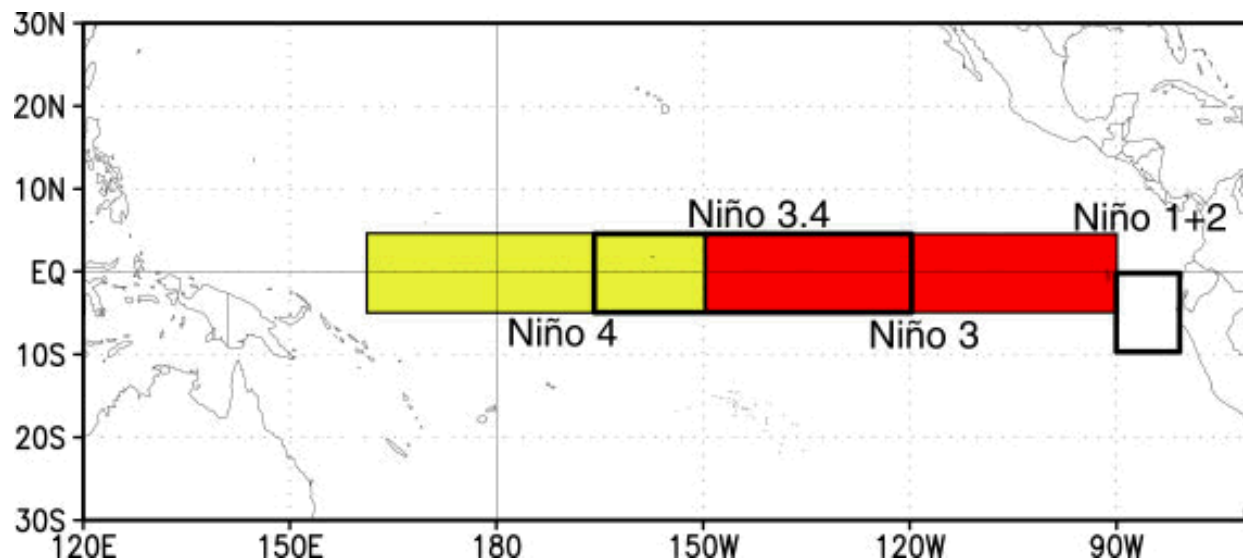
A-Train Observations of the Unusual 2015/2016 El Nino in the Tropical Pacific

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Rosenlof, Mark A. Vaughan, Brian Getzewich, Mark
Schoeberl, Andrew Dessler, Hao Ye

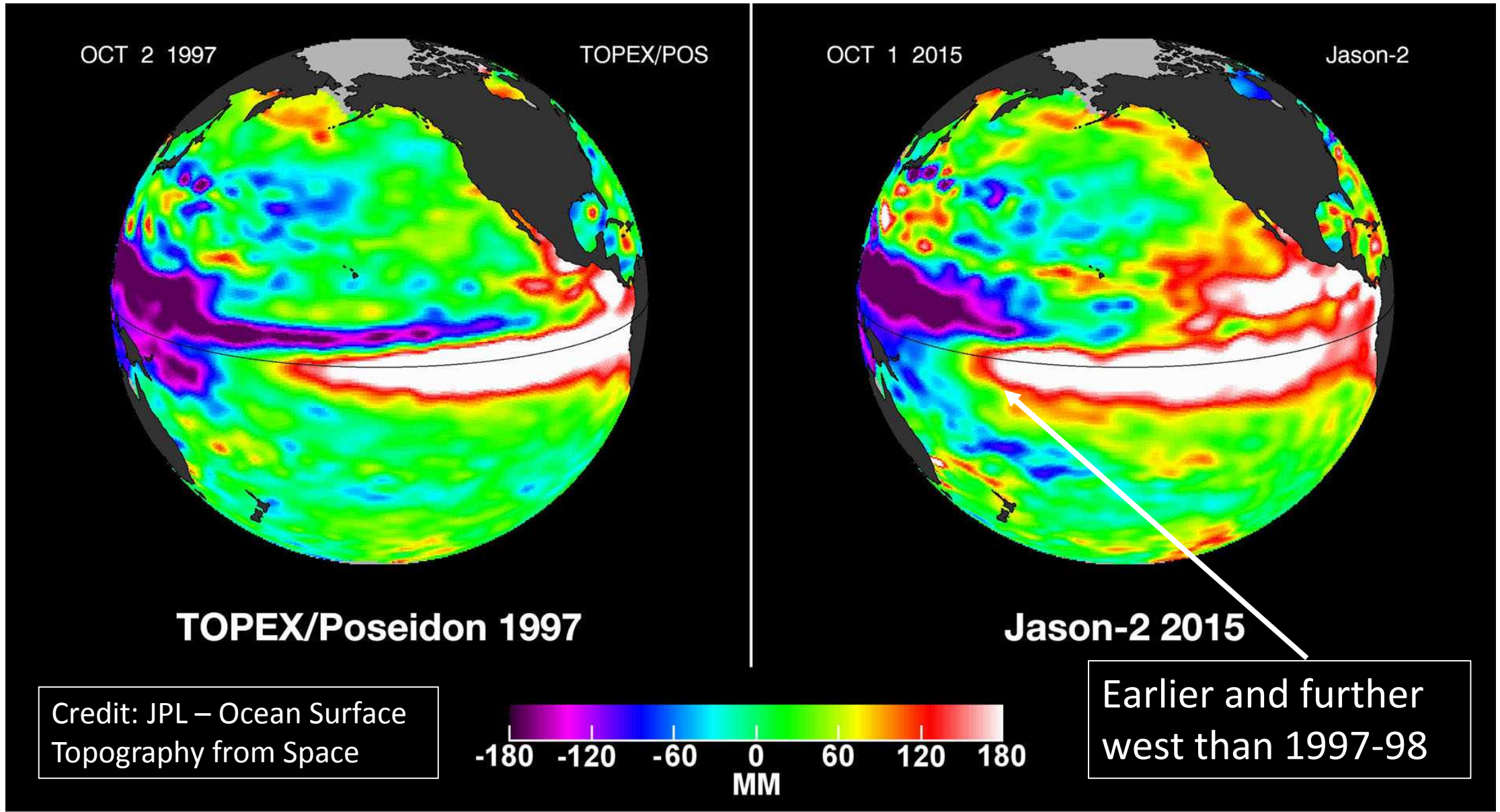
What happened during the winter of 2015/6?

- Anomalous warm SST in the Central Pacific
- Large amount of UT/LS cloud ice in the Central Pacific
- Positive water vapor anomaly in the lower stratosphere
- QBO “reversal”

Are these things are connected?



1997-8 vs 2015-6 El Nino – Radar Altimetry



2015-16 El Nino Perturbations to the QBO Cycle

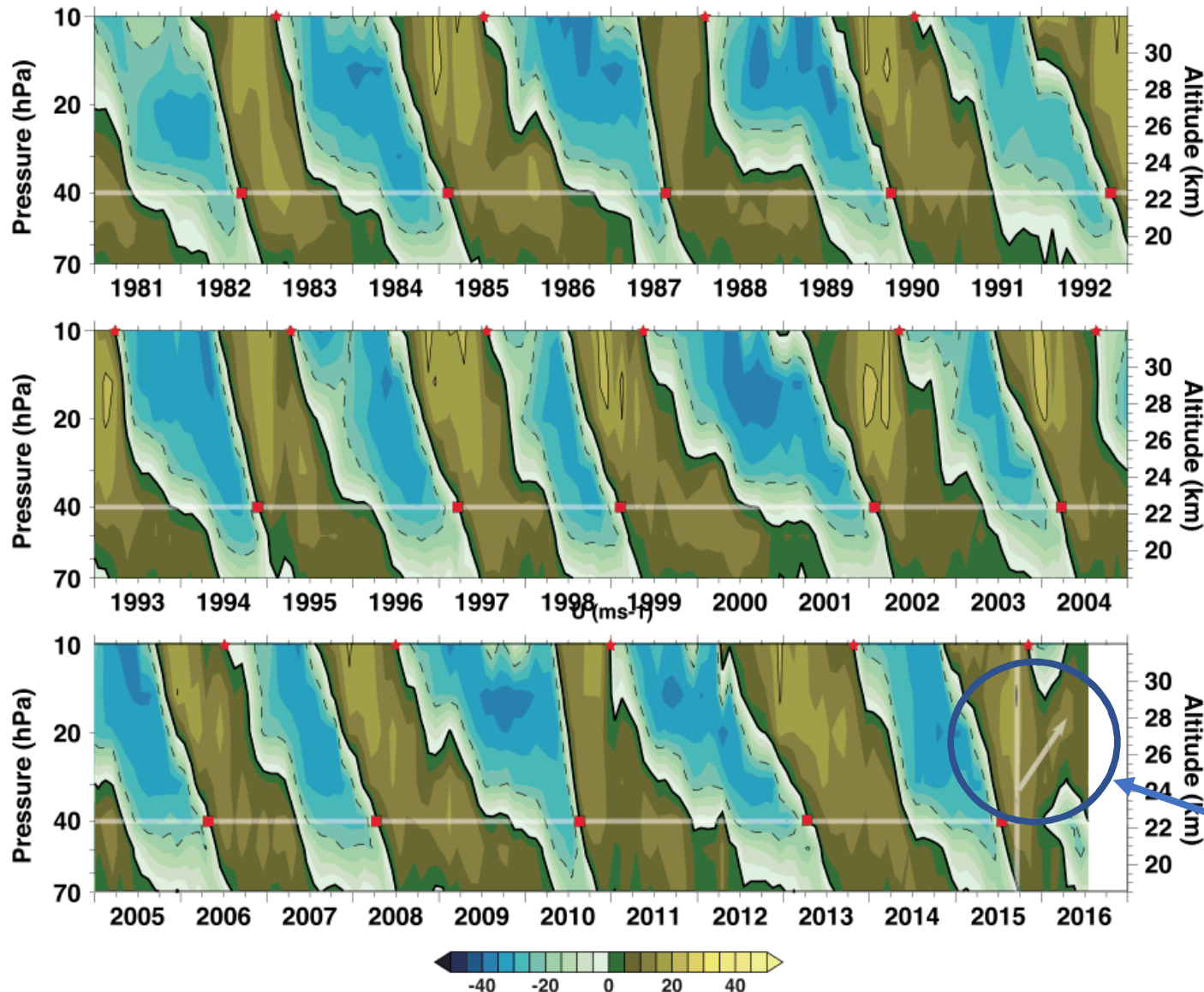


Figure 1 from Newman et al. (2016), GRL:
Stratospheric Wind Direction Time Series

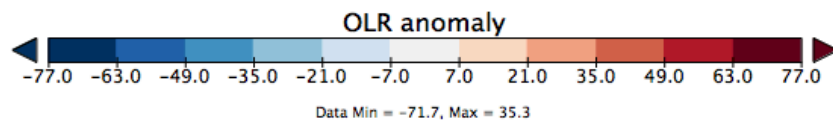
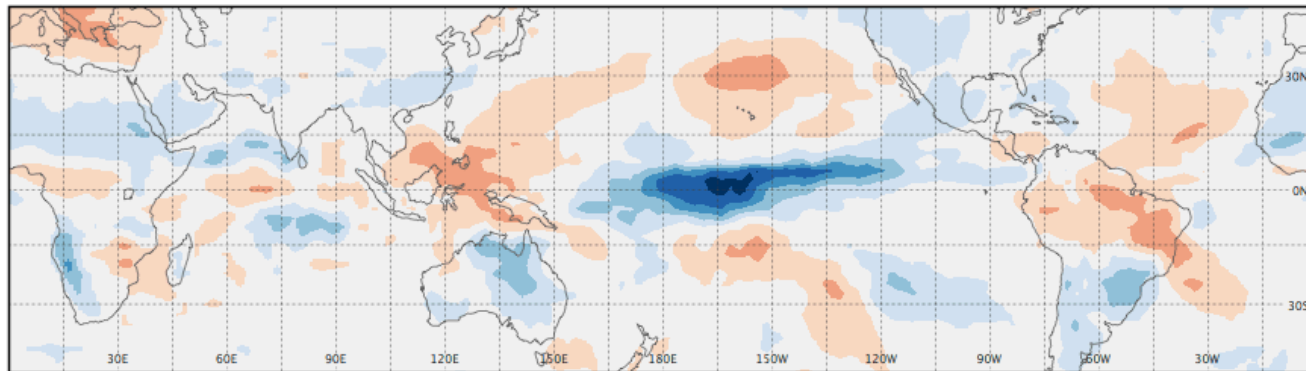
Radiosonde wind profiles suggest there is something significantly odd about the winter of 2015-16 in the stratospheric wind field.

Odd reversal in wind direction at 22-30 km

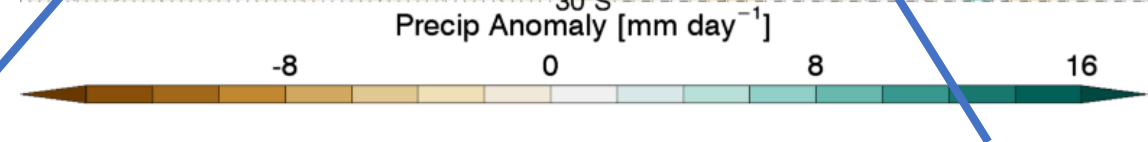
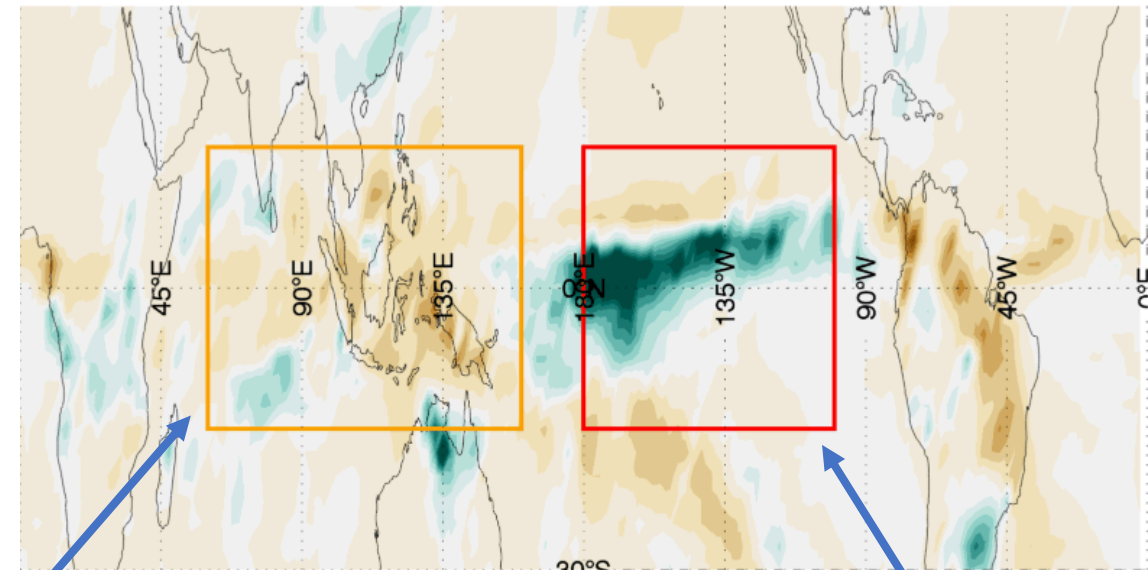
MERRA-2: Large Negative Outgoing Long-Wave and Precipitation Anomalies in December, 2015

Much more convection than usual in the Central Pacific
and less than usual in the Tropical Western Pacific.

outgoing longwave radiation anomaly
2015-12



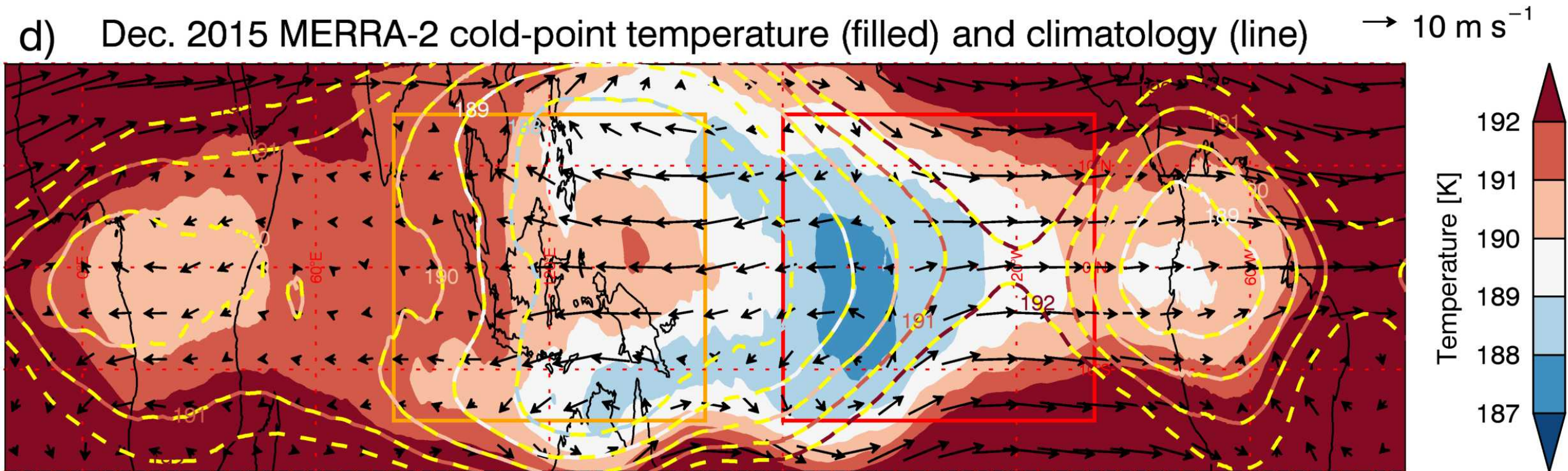
201512 MERRA-2 precipitation anomaly



Tropical Western Pacific
15S – 15N, 60 – 140 E

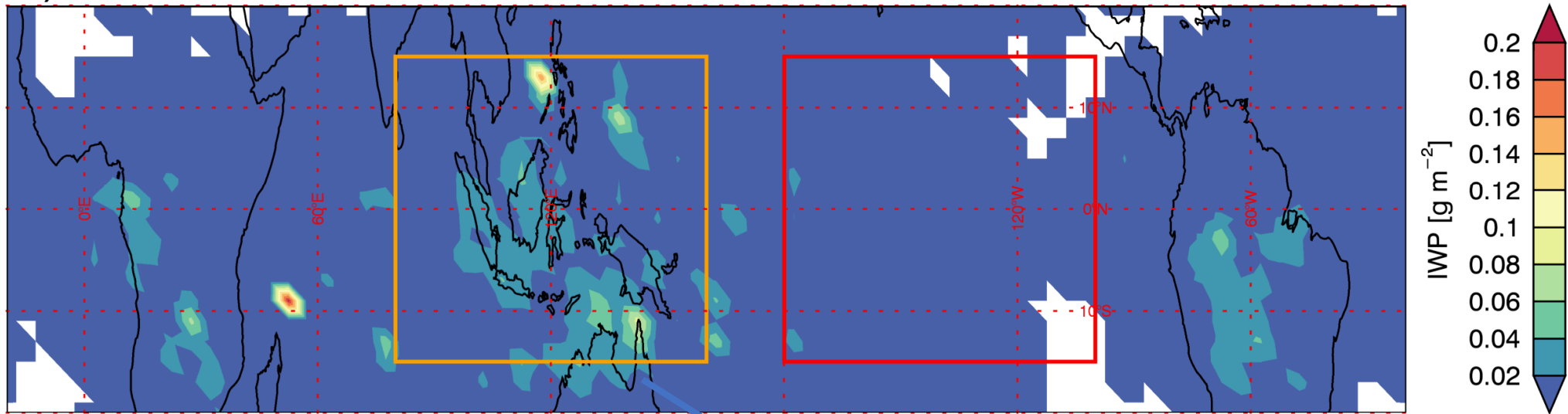
Central Pacific
15S – 15N, 180 – 100 E

Cold-Point Tropopause and Convection: MERRA2 Cold-Point Temperature vs Climatology

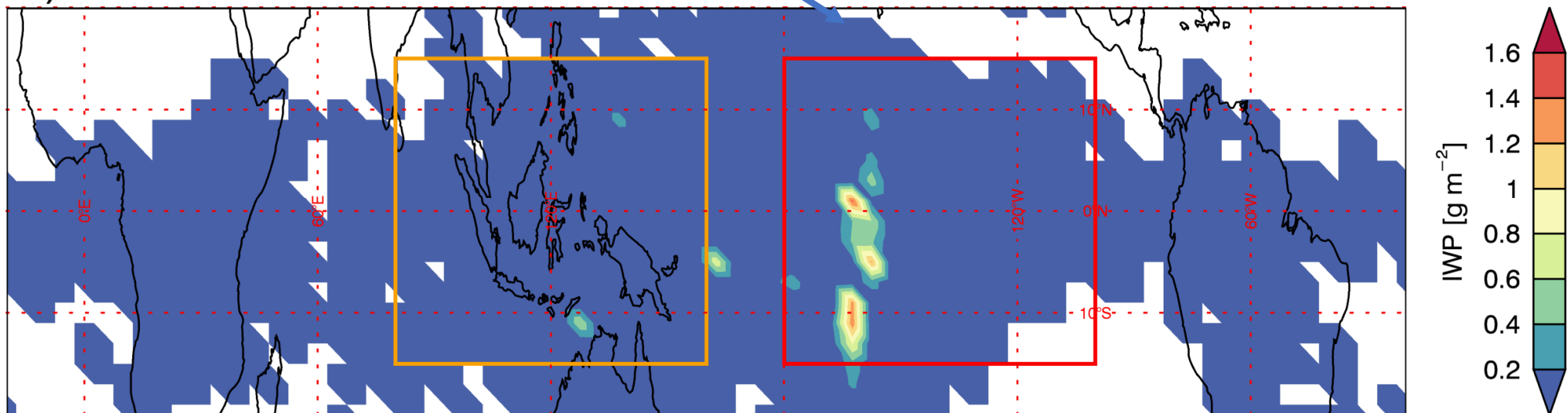


CALIOP Ice water content integrated above the cold-point Tropopause

a) Dec. 2006-2014 CALIOP IWP above cold-point tropopause

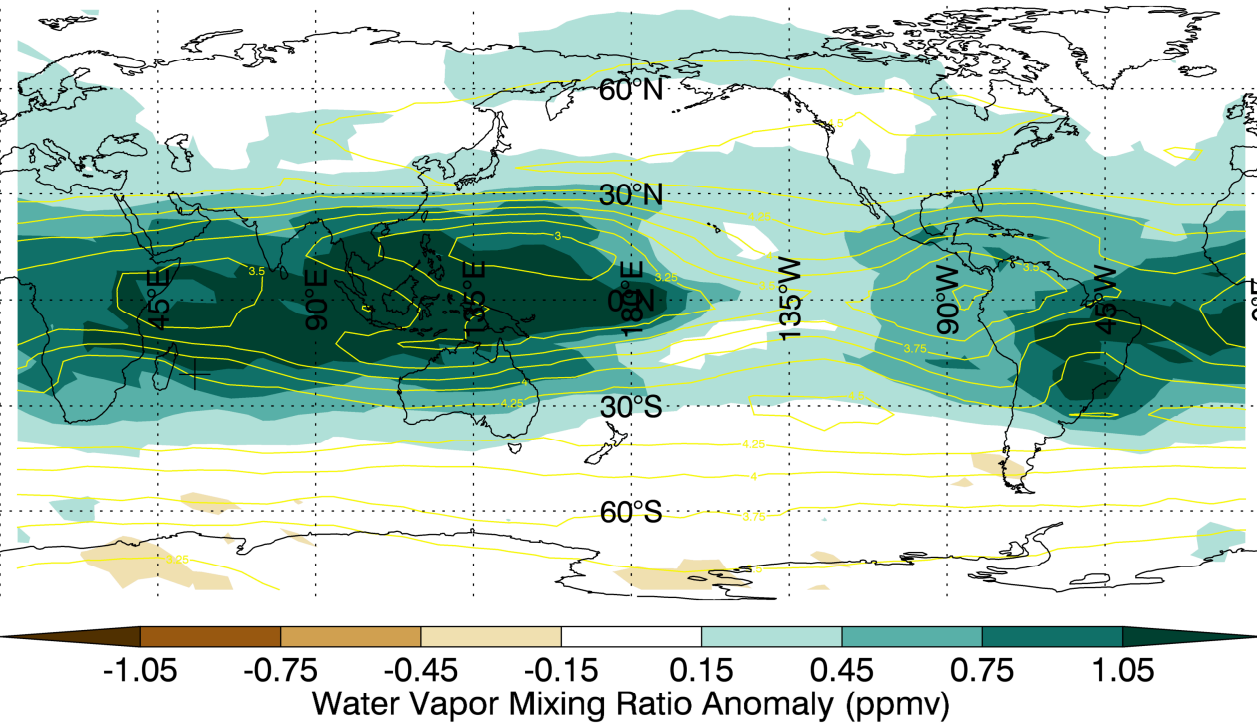


b) Dec. 2015 CALIOP IWP above cold-point tropopause

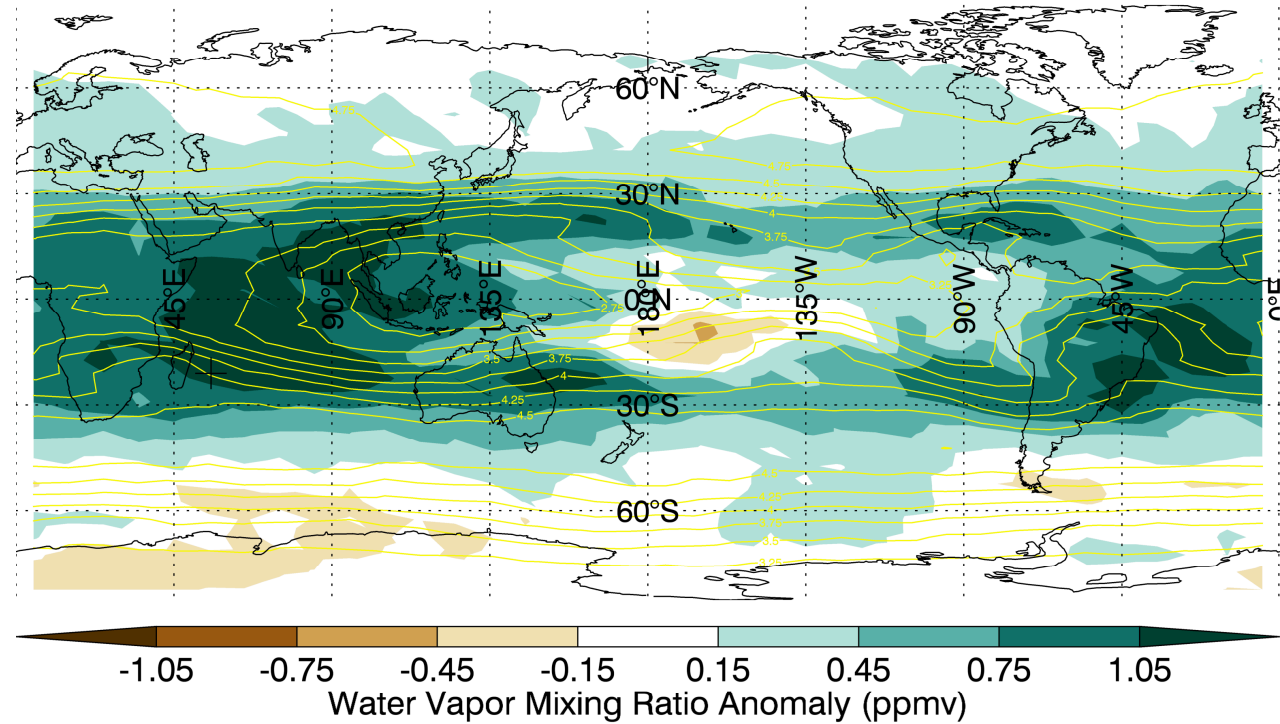


December, 2015 UT/LS Water Vapor Anomaly Observations by MLS at 100 and 82 hPa

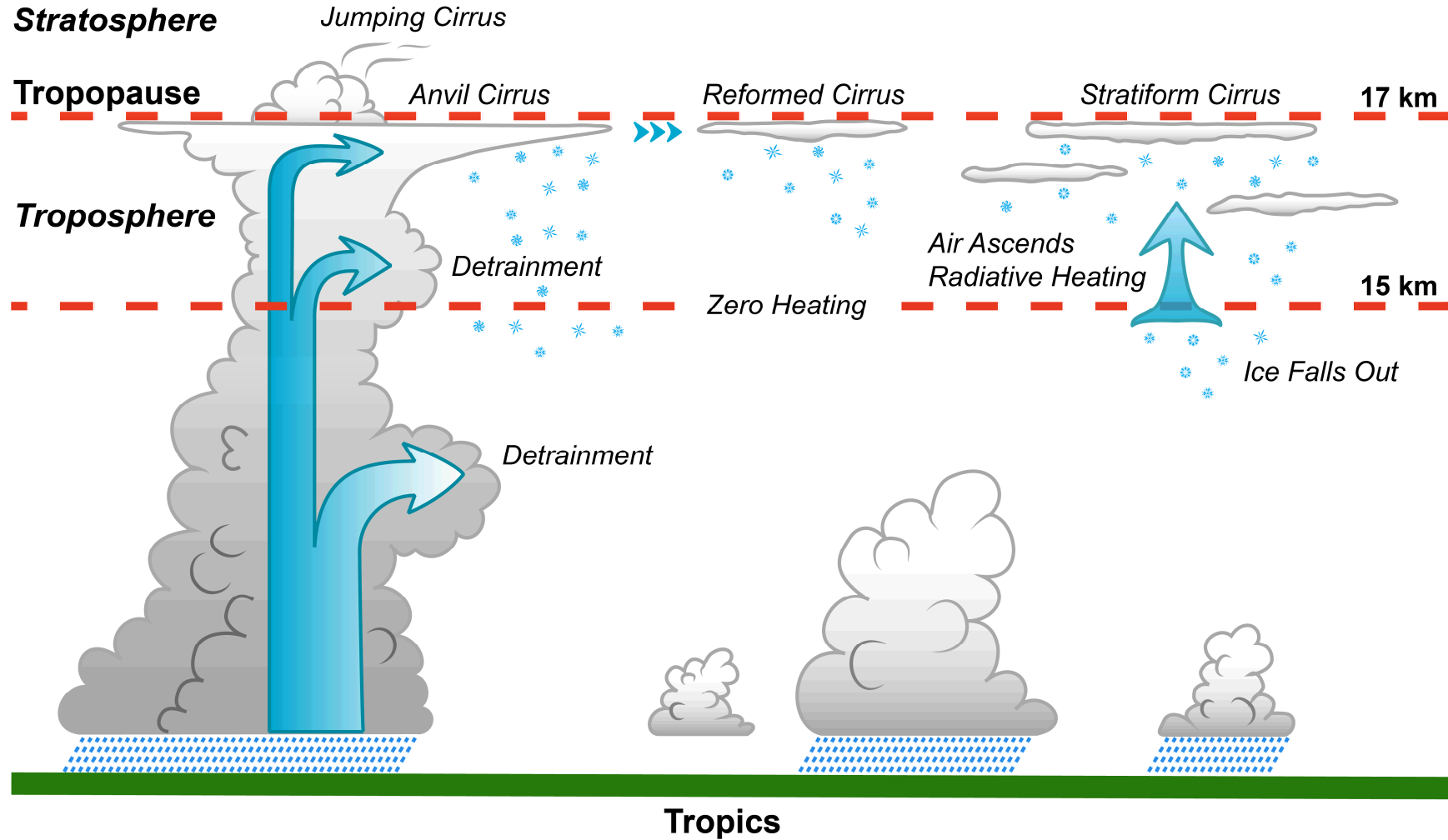
20151201-20151231 H₂O anomaly (82hPa)



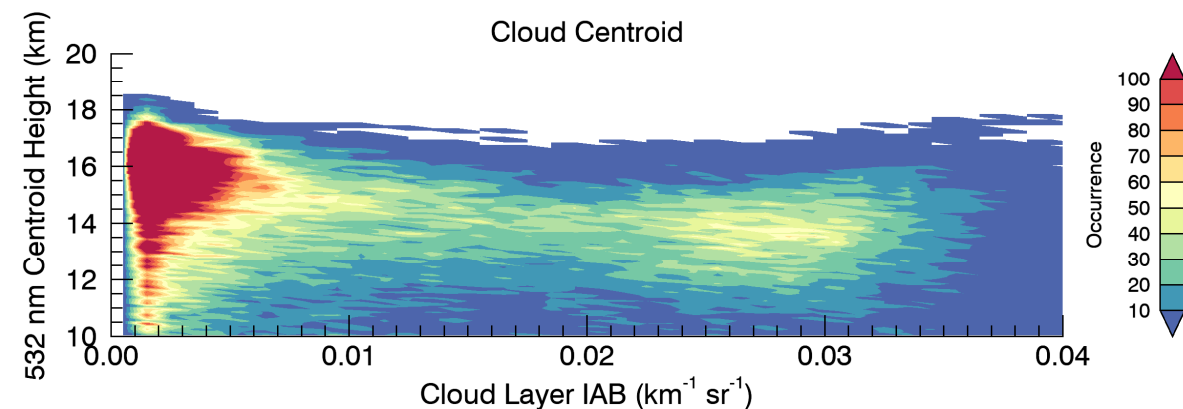
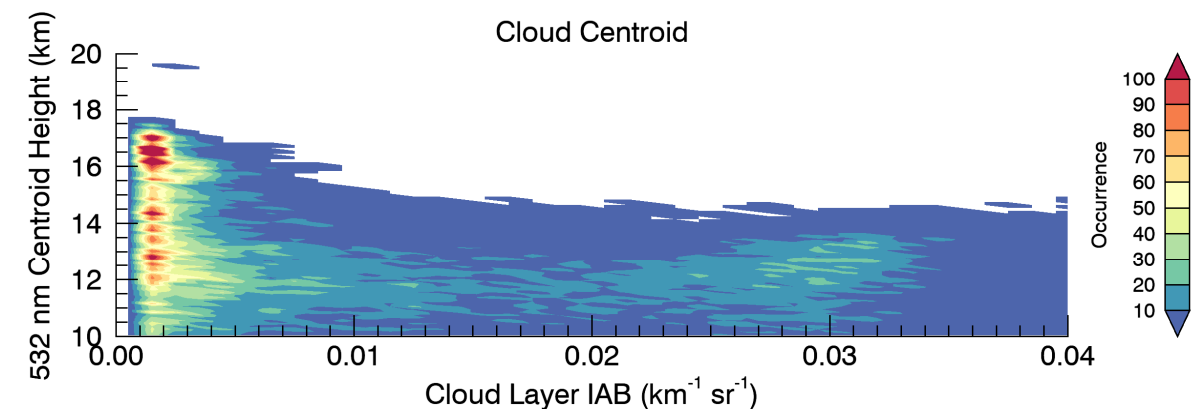
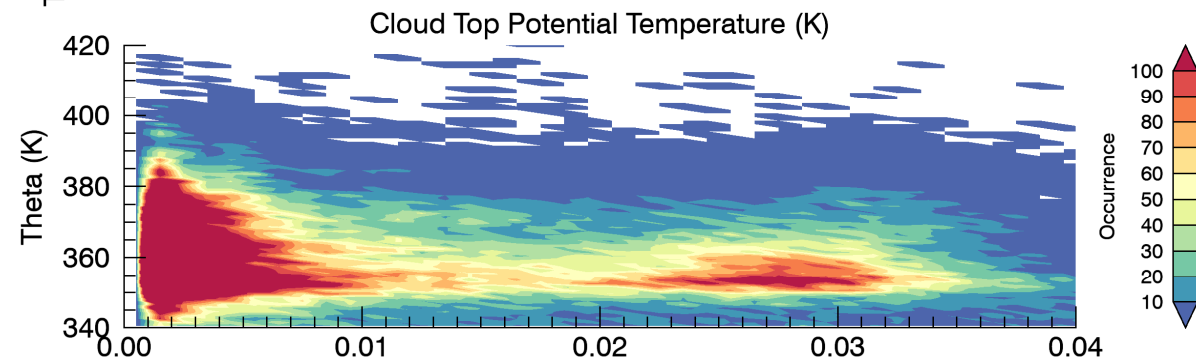
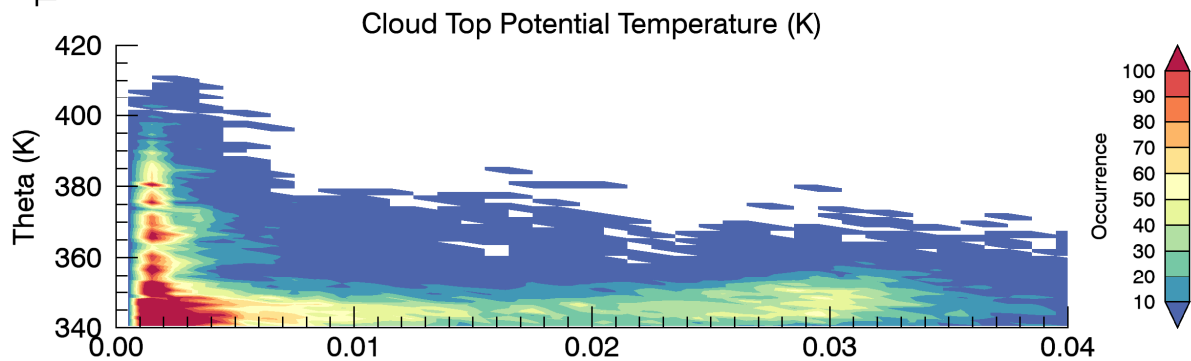
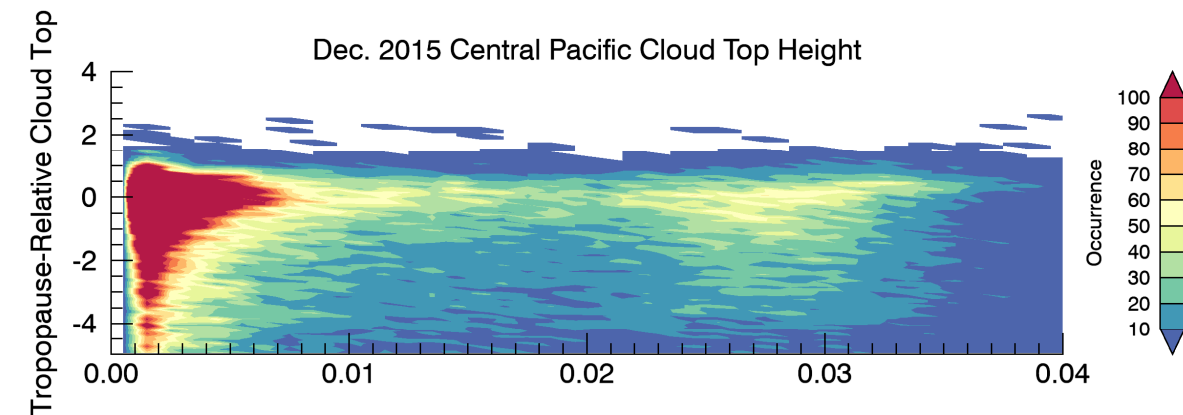
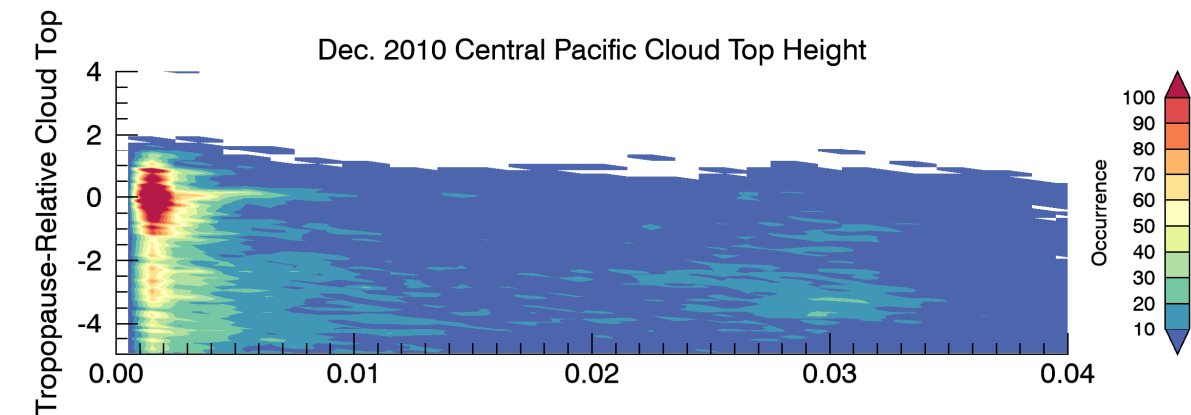
20151201-20151231 H₂O anomaly (100hPa)

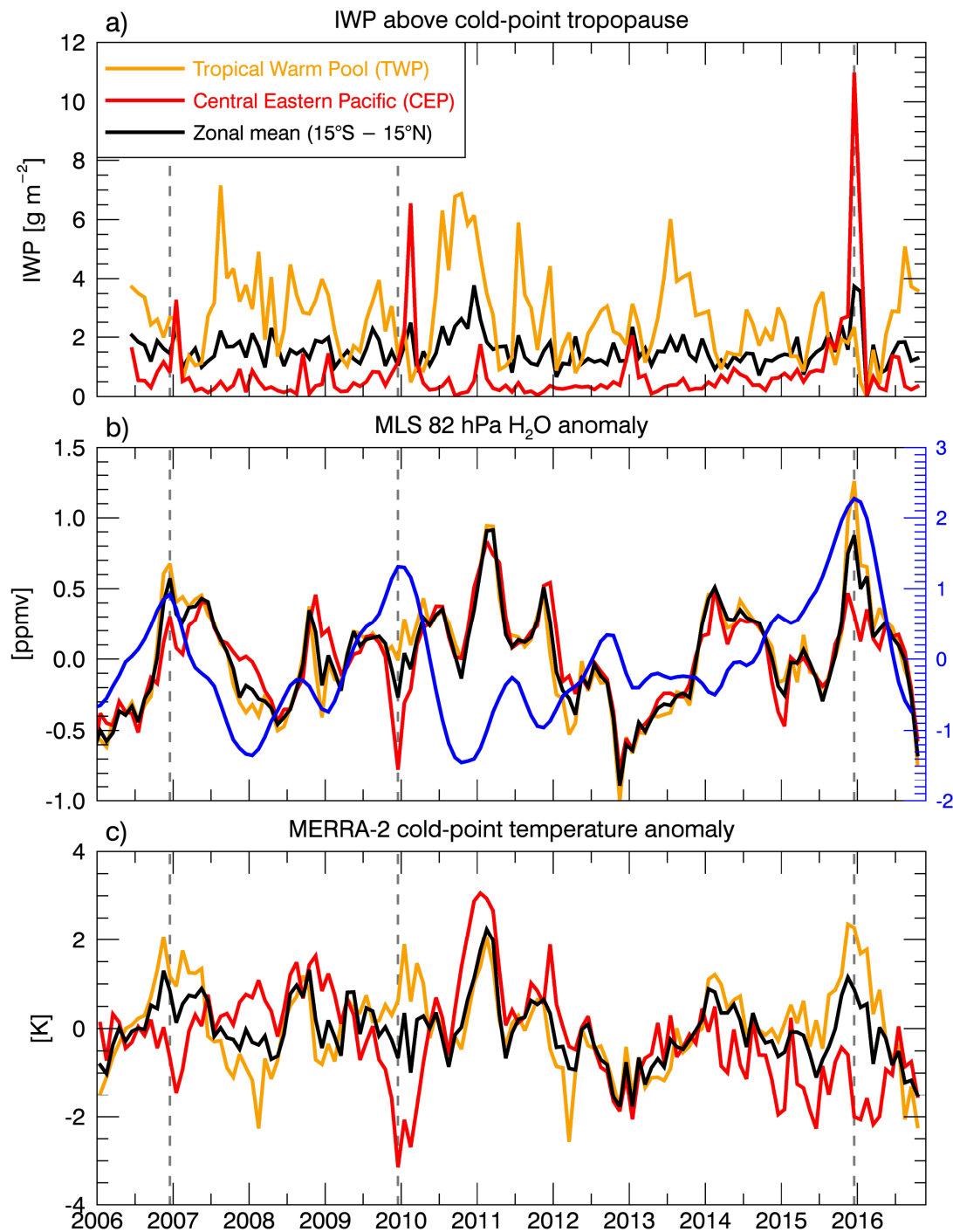


Upper Tropospheric and Lower Stratospheric (UT/LS) Water Cycle



Central Pacific Cloud Tops Observed by CALIOP: Dec. 2010 (La Nina) vs Dec. 2015 (El Nino)





Regional Time Series

A-Train Time Frame (2006 – 2016)

- a) CALIOP ice water path (above the interpolated MERRA-2 cold-point)
- b) MLS 82-hPa water vapor anomaly
- c) MERRA-2 cold-point temperature anomaly

Key:

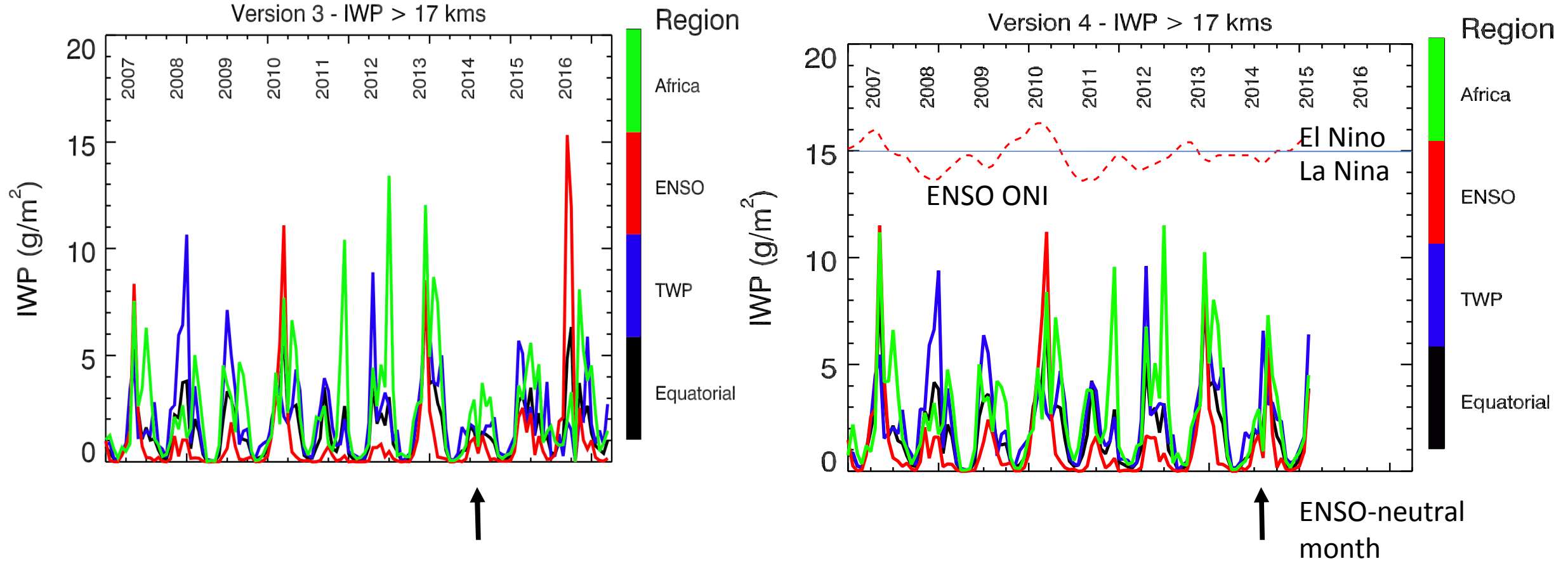
Blue line is the ENSO ONI index
Black lines are the 15S – 15N zonal mean
Red lines are the Central Pacific
Orange lines are the Tropical Warm Pool
(Western Pacific)

Summary

- In the A-Train data record, the 2015-16 El Nino stands out
- A “natural experiment” to see how surface (SST) temperature changes impact the UT/LS
- Observational evidence suggests that there may be large increases in UT/LS cloud ice, lower stratospheric water vapor, as well as changes in local dynamics (temperature structure)
- Convection matters! Non-equilibrium conditions, local perturbations impact the larger scales
- Increasing lower stratospheric water vapor is a positive feedback on surface temperature.

Extras

Inter-annual Variability in Near-Tropopause TTL Ci V3 vs V4.1; Regional Cycles of IWP > 17 km



Compare extinction and IWC distributions for Extinction QC 0&1 (Thin clouds) vs QC 2,16,18 (Thicker clouds) during an ENSO-neutral time period that coincides with ATTREX 2014.