Water Vapor and Ozone in the subtropical upper troposphere

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Introduction

Tropical and subtropical upper troposphere is key region for coupling between composition and climate.

What is the spatial and temporal variability of subtropical UT water and ozone?

What processes control the subtropical tracer distributions?

1. Examine AIRS data for 2002-2006
   (NH winter; daily 1x1 gridded data, Gettelman et al 2006)

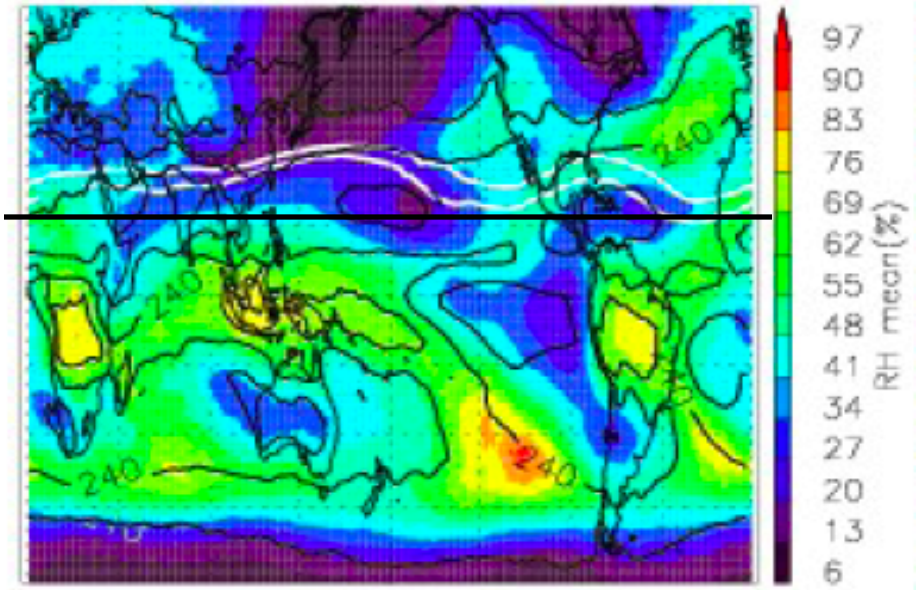
2. Compare AIRS and MLS data
   (Jan-Feb 2006, 215hPa).

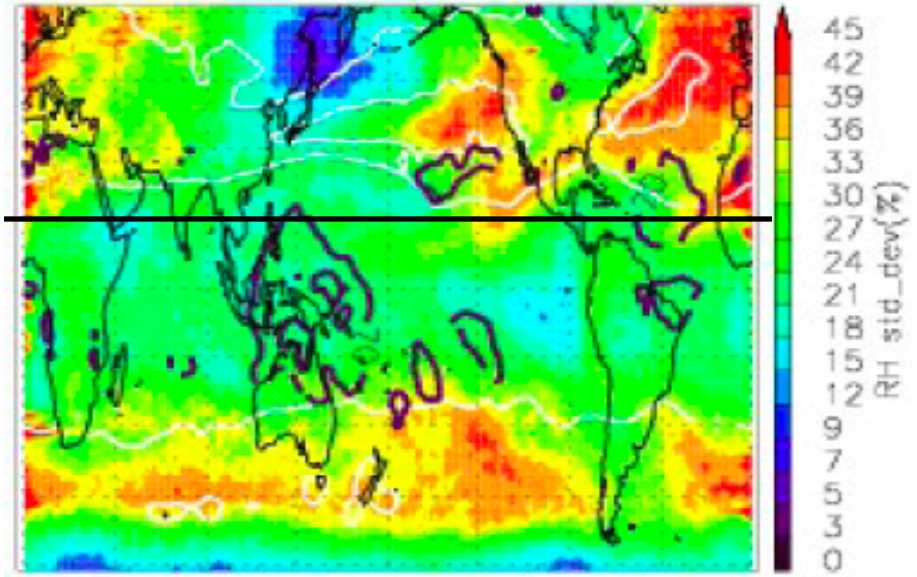
Climatological Relative Humidity (AIRS)

DJF MEAN

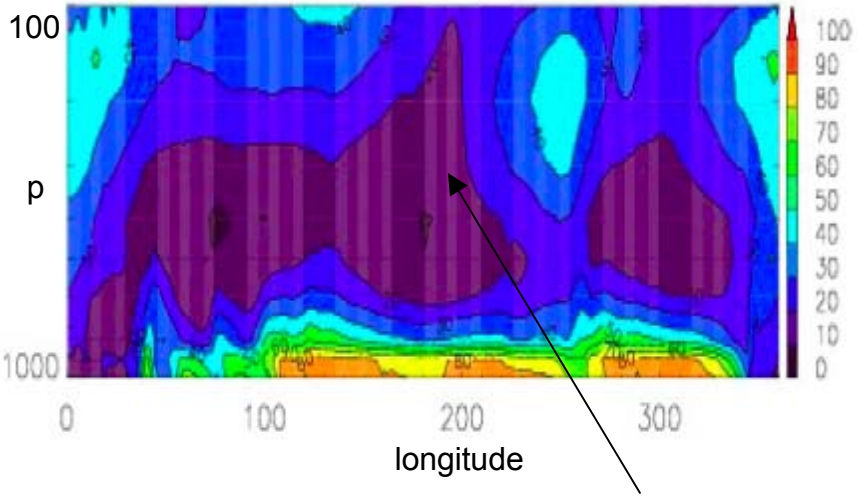
200-250 hPa

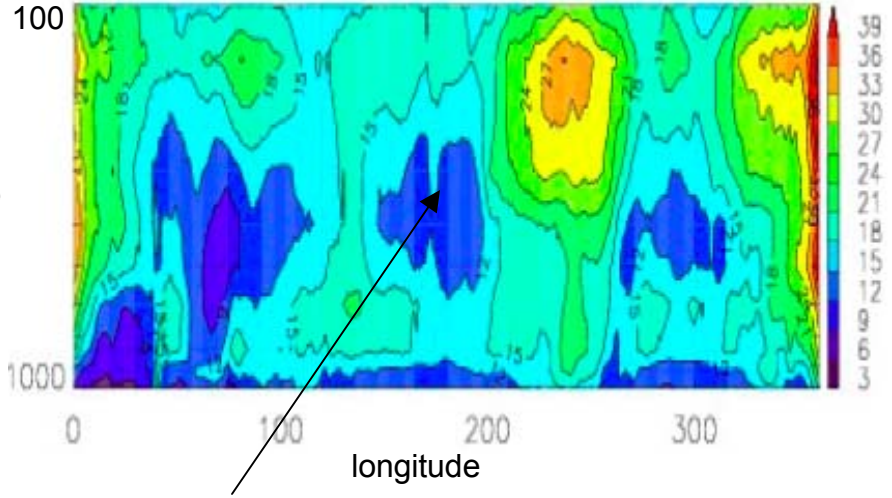
DJF STD DEV.





15-20 N





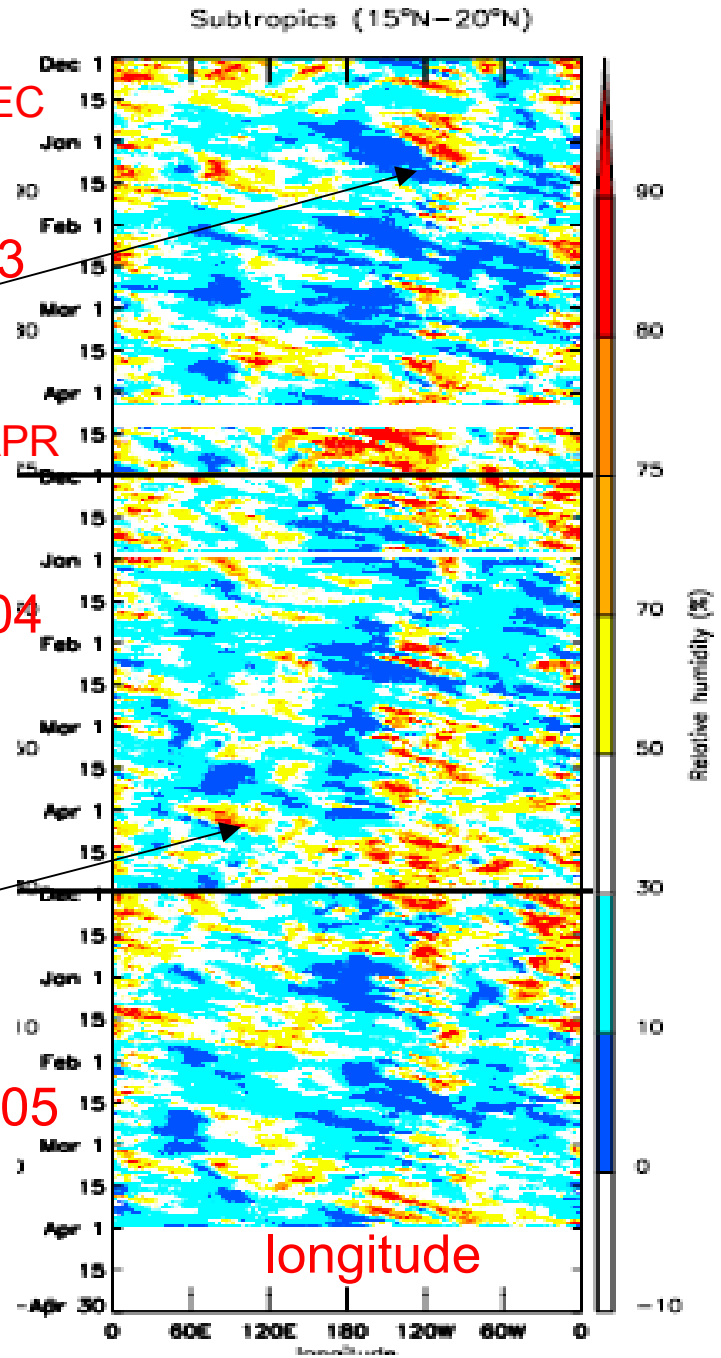
Dry subtropical regions have smallest variability.

Daily Variability of Subtropical UTH

Intermittent high values in Eastern Pacific and Atlantic

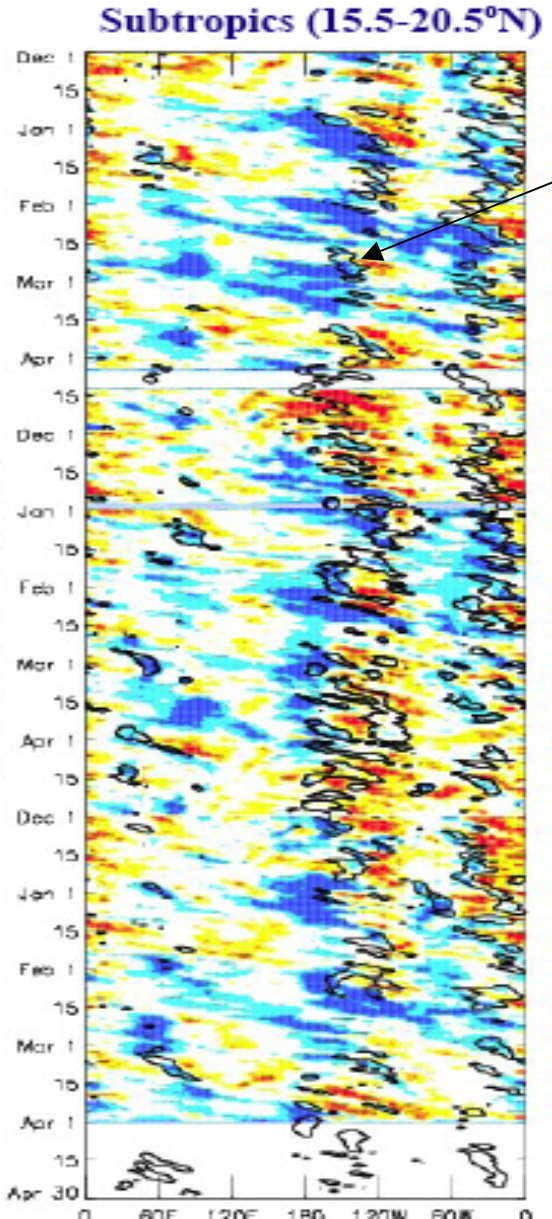
time

Eastward propagating features in Indian Ocean - Western Pacific



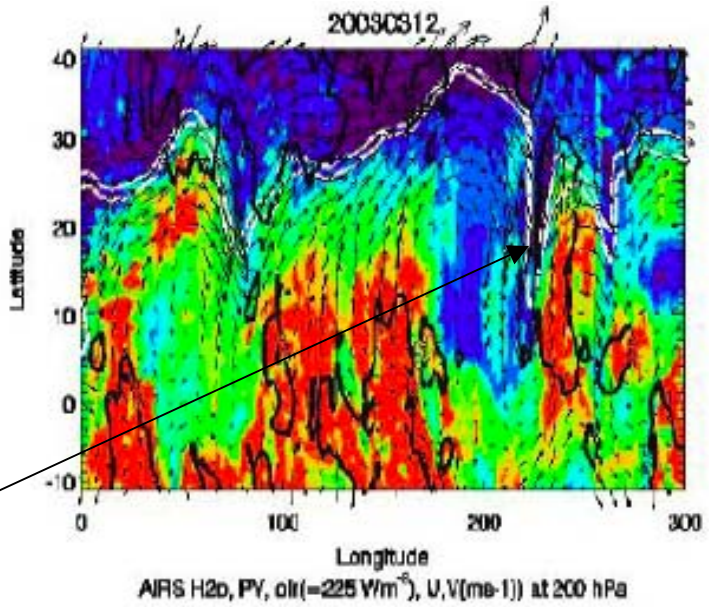
PV Intrusions

Intermittent high values in Eastern Pacific and Atlantic are due to intrusions of high PV air into subtropics

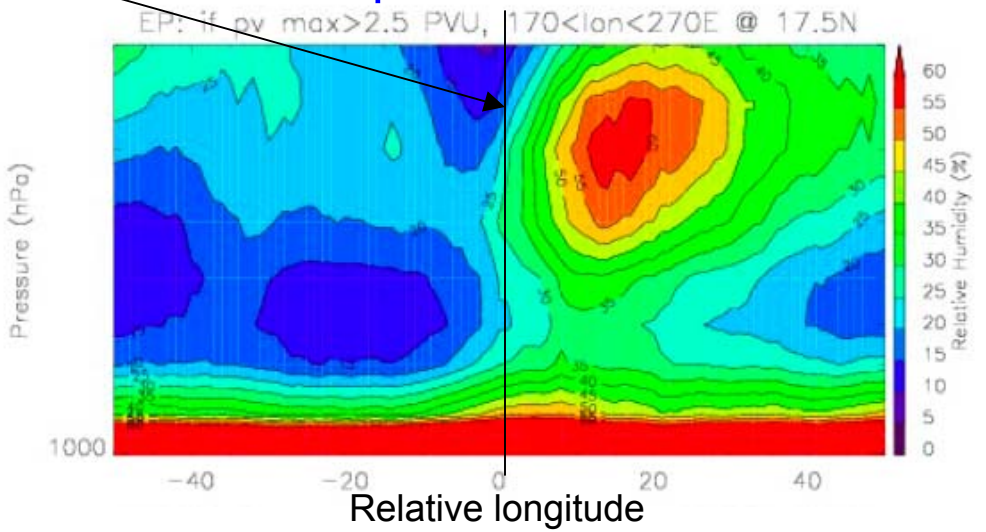


PV > 1.5PVU

Deep convection and high UTH ahead of PV, and low UTH within and behind intrusion. [Waugh 2005]



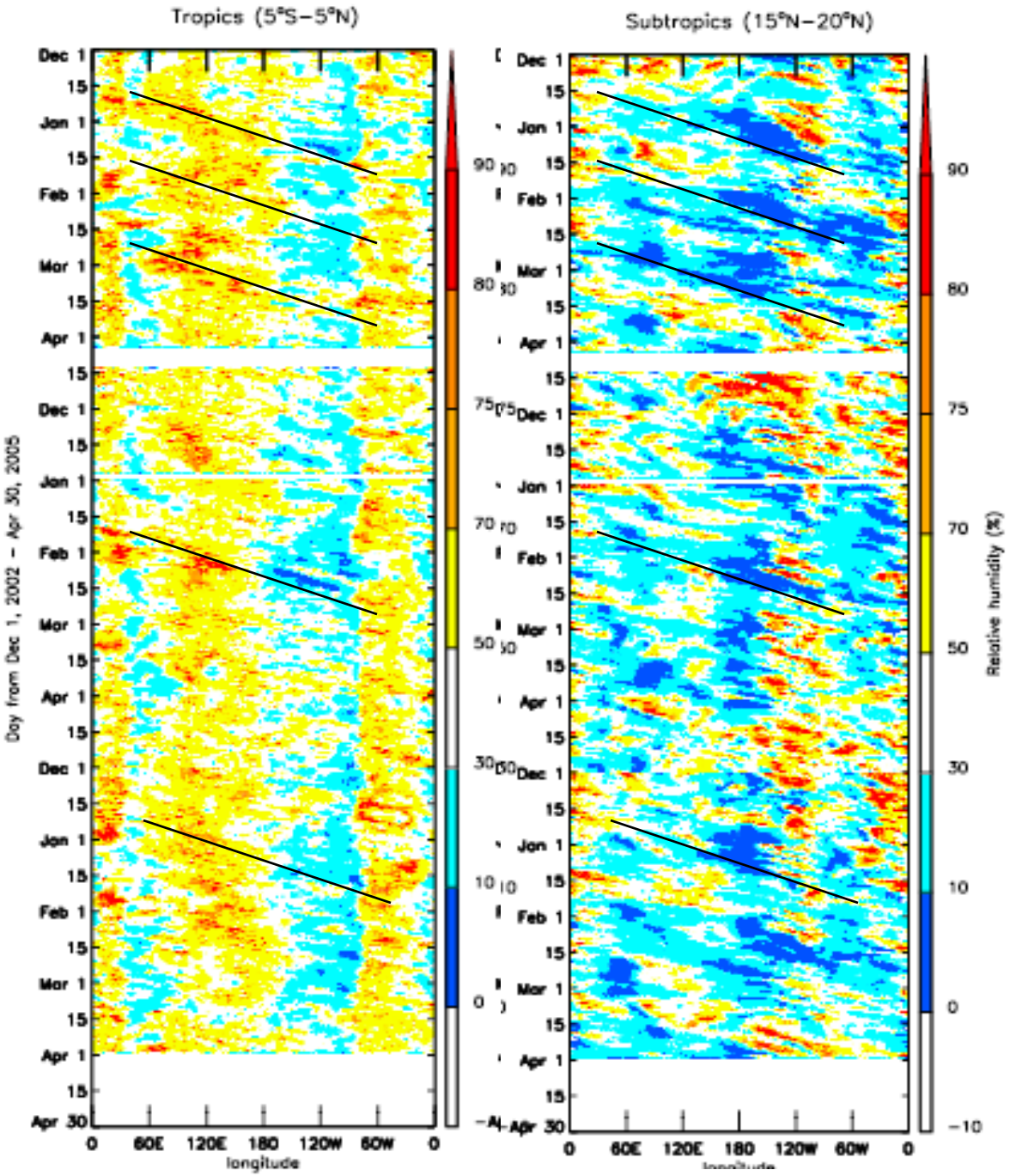
RH composite for Intrusions



Eastward Propagating Features

Eastward propagating features in Indian Ocean - Western Pacific appear both in tropics and subtropics.

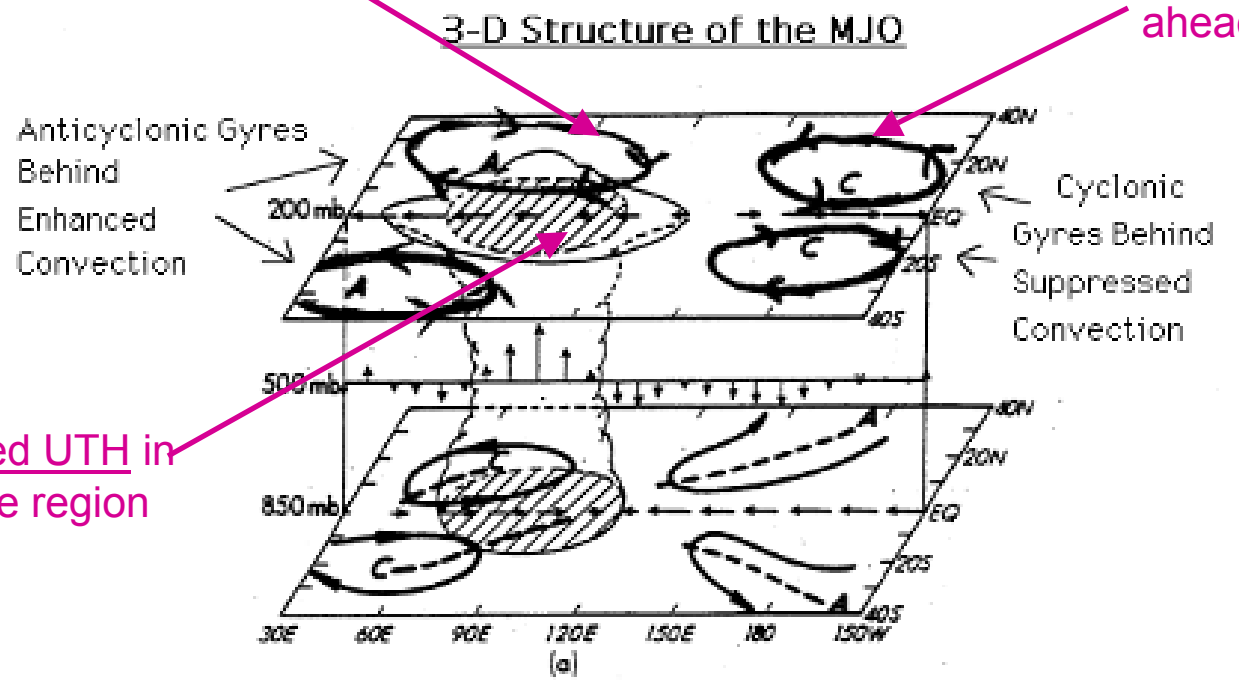
However, tropics and subtropics are out of phase.



MJO Influence on UTH

2. Equatorward flow at leading edge of anticyclones -> reduced subtropical UTH

3. Reduced westerlies -> intrusions more likely -> enhanced subtropical UTH ahead of intrusions.



1. Enhanced UTH in convective region

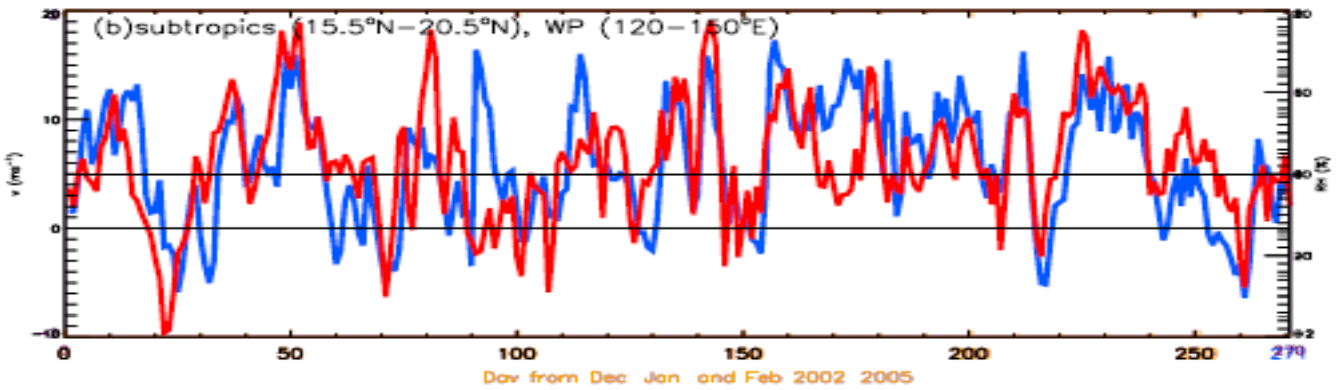
{From Rui and Wong 1990}

1 and 2 -> tropical and subtropical out of phase.

MJO - Subtropical UTH (Western Pacific)

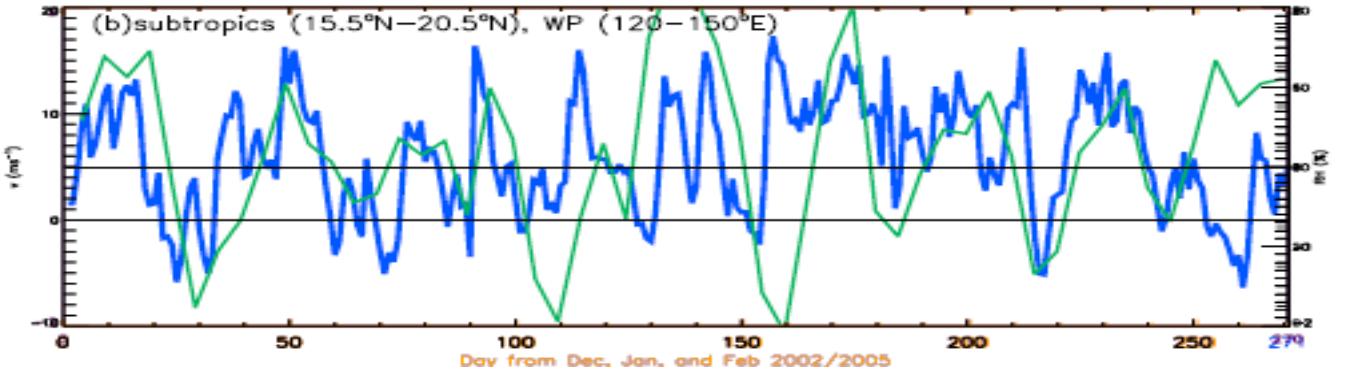
Variability in subtropical western pacific is related to variations in meridional wind

RH v

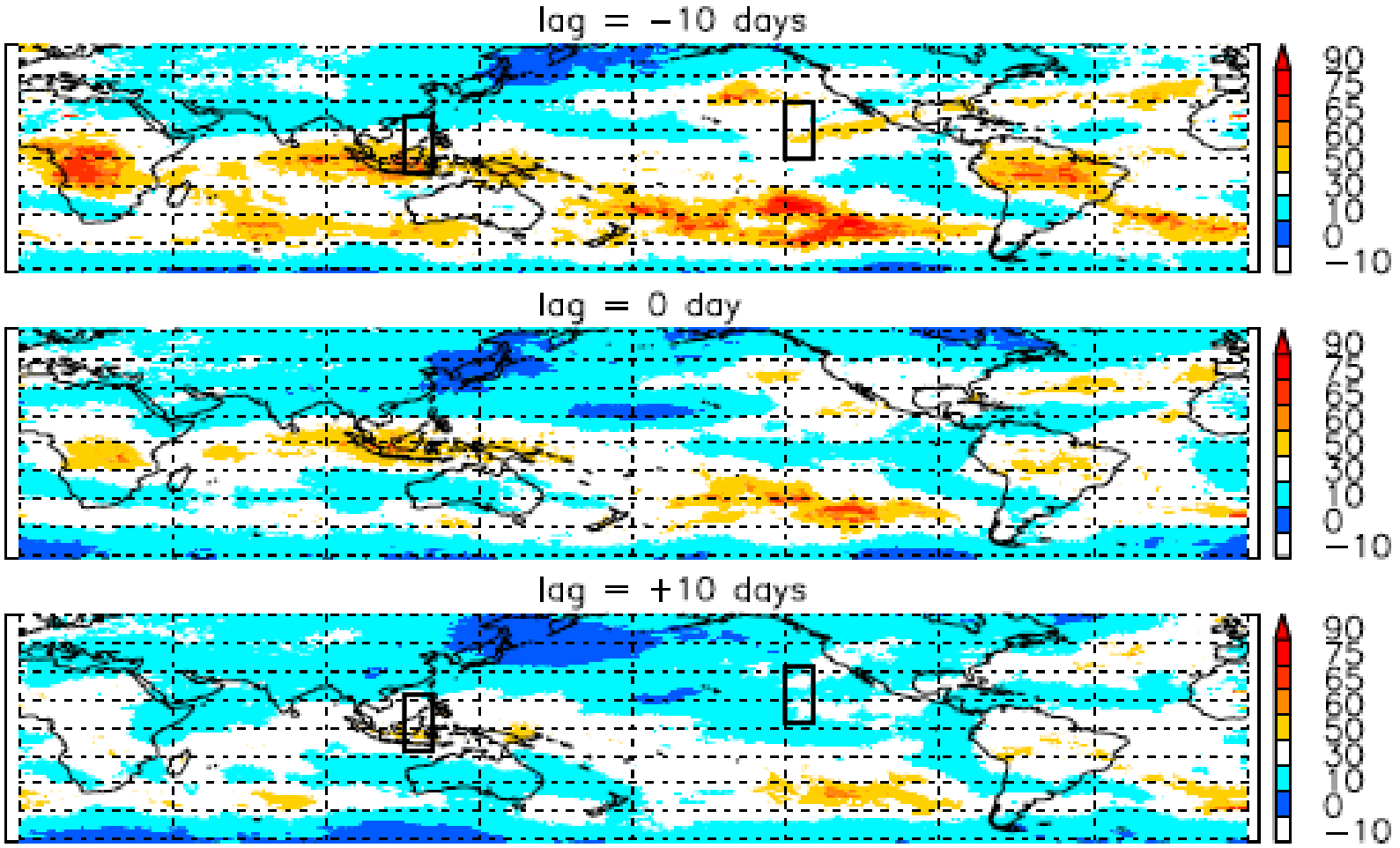


MJO appears to modulate subtropical UTH by modulating the meridional winds.

RH MJO Index



MJO composites of UTH



AIRS - MLS Comparison

Compare

MLS v1.5 215hPa data

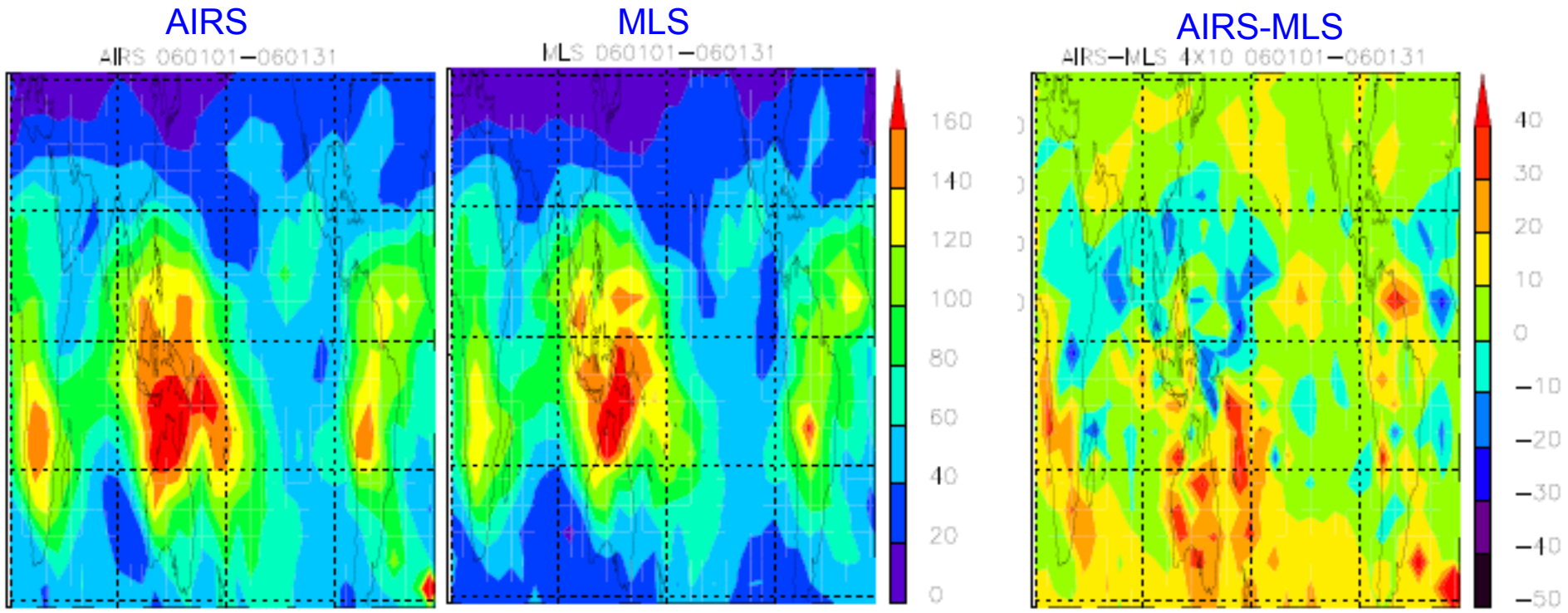
with

AIRS v4.0 200-250hPa 1x1 gridded data,

for Jan-Feb 2006.

Focus on spatial and temporal variability in subtropics.

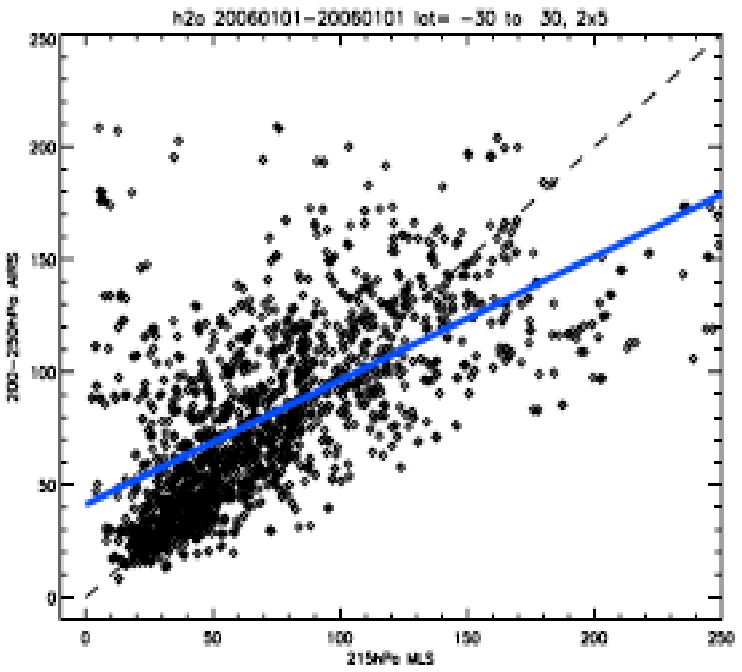
Monthly-mean: MLS, AIRS



Good agreement for monthly-mean UTH
Similar spatial structure and magnitude

Scatter Plots

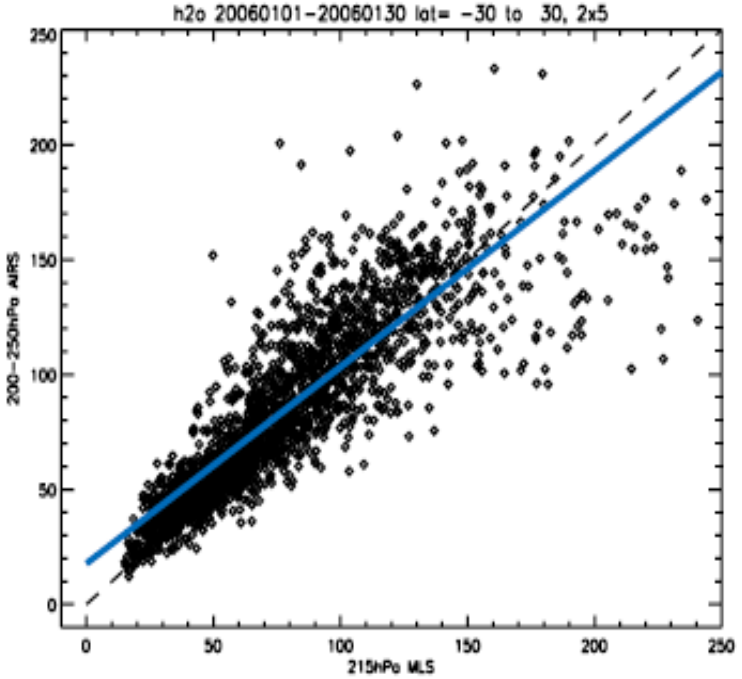
Individual Day (1 Jan 2006)



AIRS

MLS

Monthly-mean values (Jan 2006)



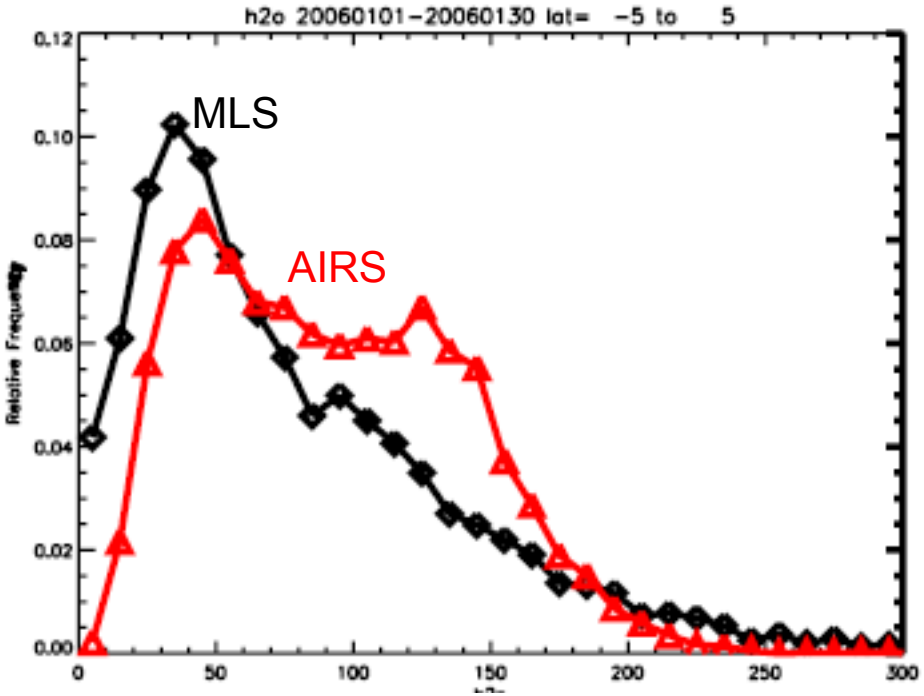
AIRS

MLS

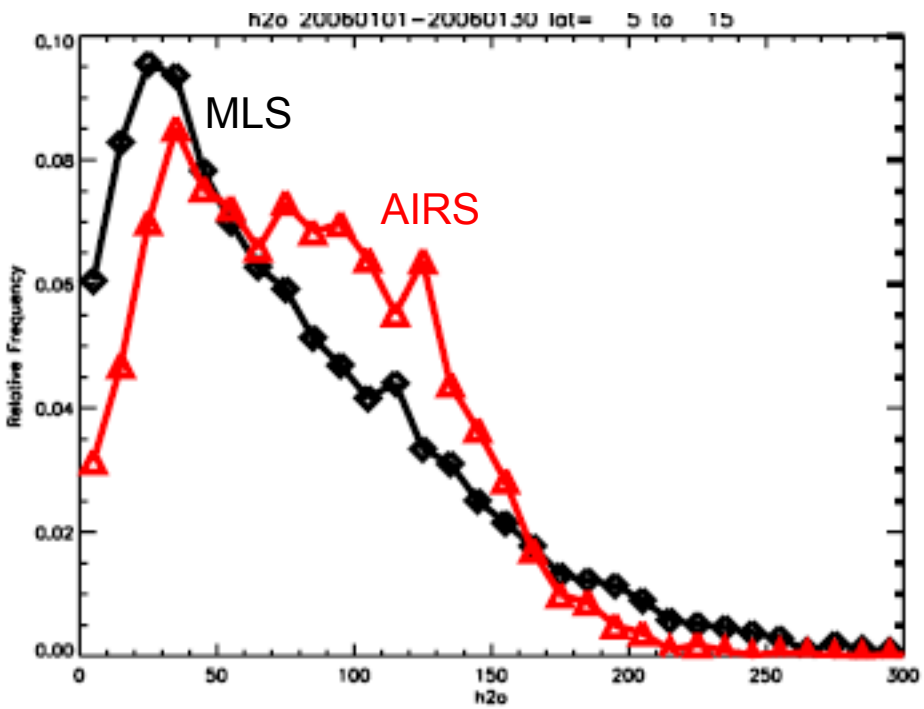
AIRS > MLS for low (MLS) values
AIRS < MLS for high (MLS) values.

PDFs

5S-5N



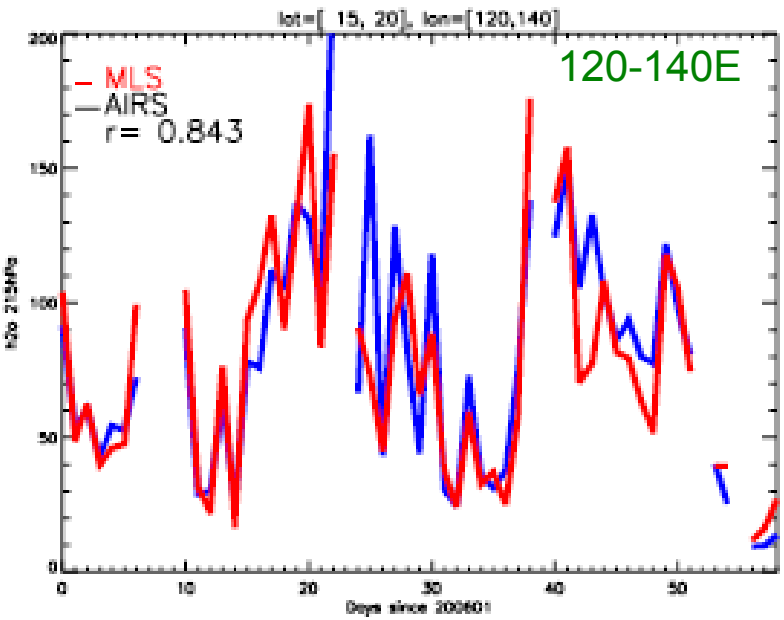
5-15N

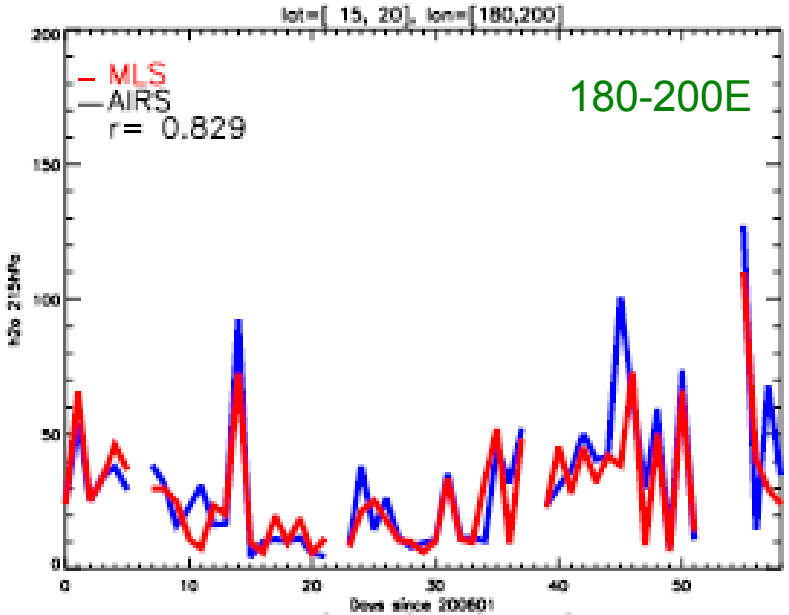


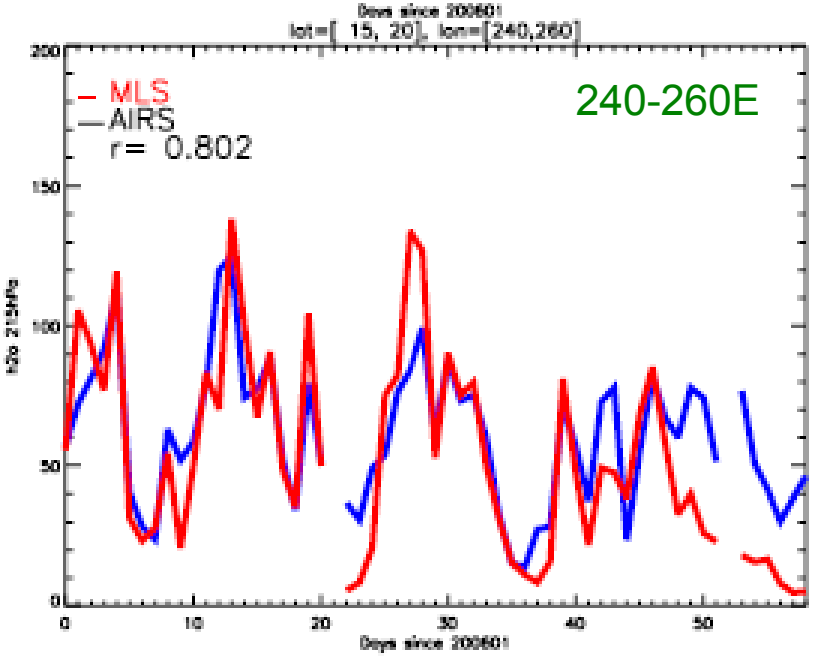
PDFs show more extreme (high and low) values in MLS data.

MLS, AIRS UTH Time series

215hPa, 15-20N







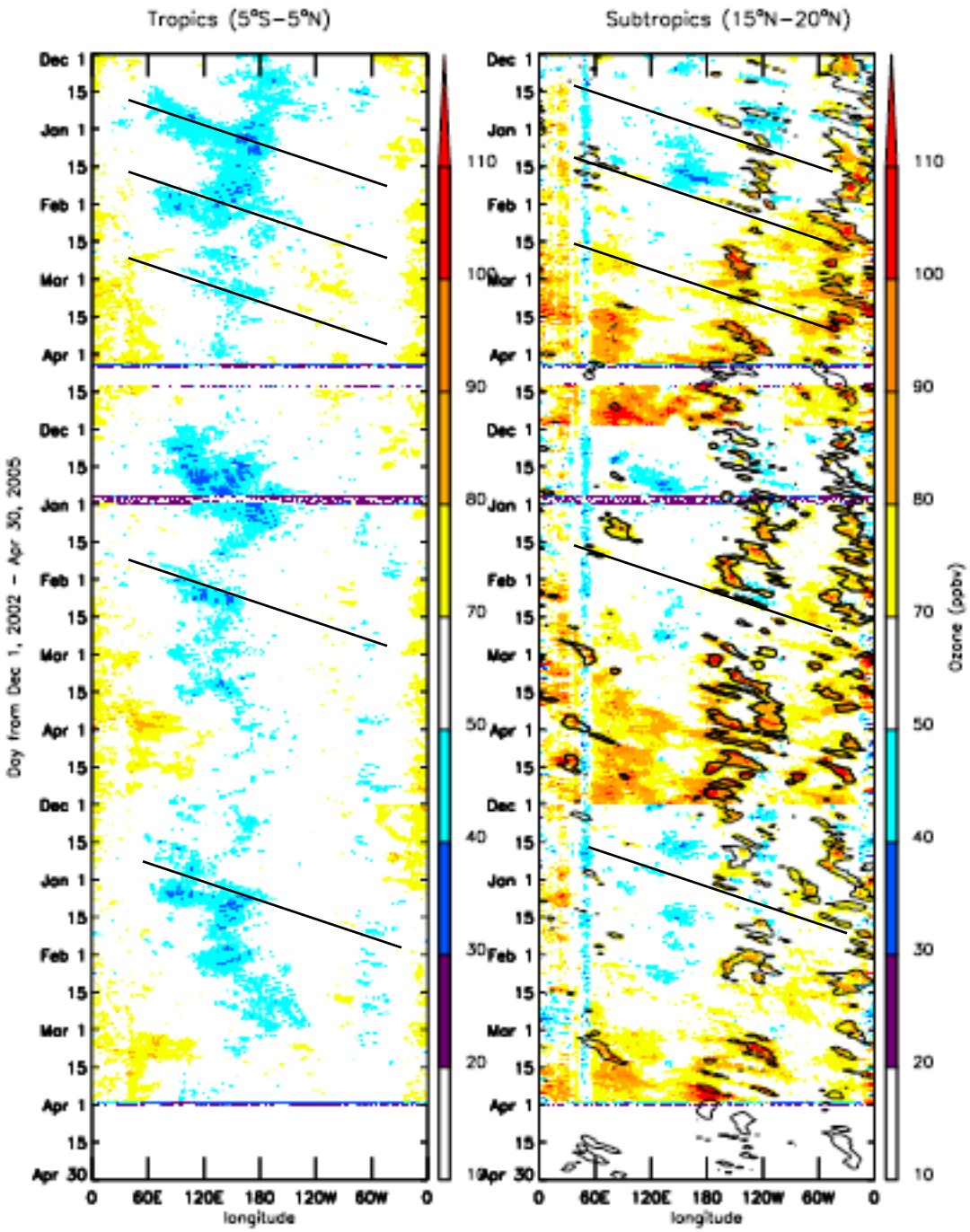
Excellent agreement in temporal variations.

Also agreement in longitudinal variations.

AIRS 200-250hPa Ozone

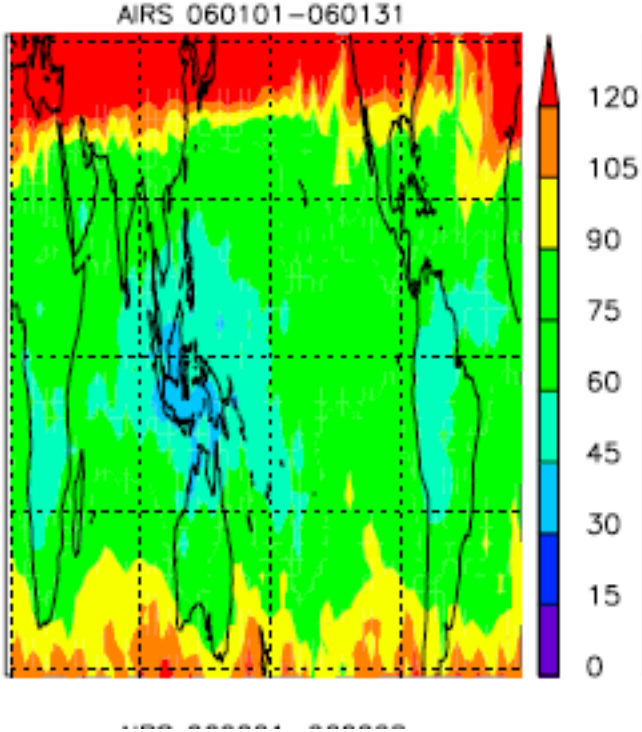
Impacts of intrusions and MJO can be seen in AIRS UT ozone.

However, AIRS ozone has significant bias for low values.

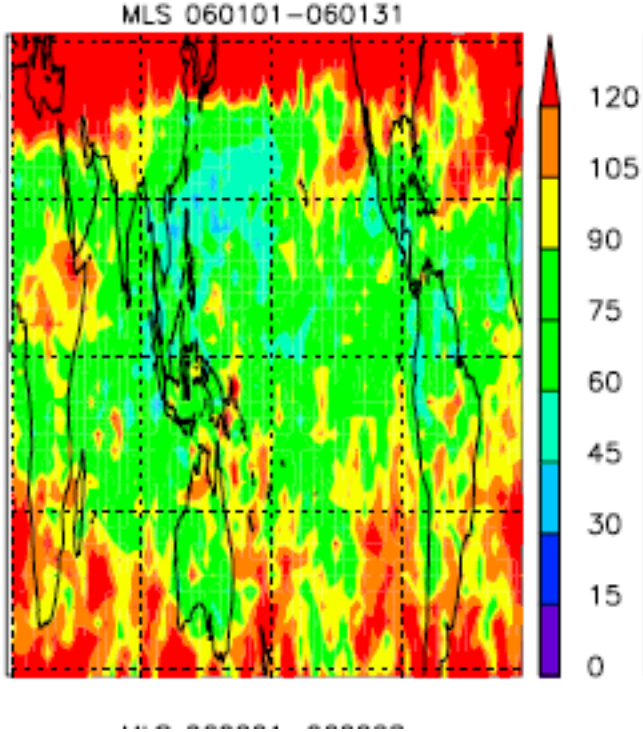


Monthly-mean O3: MLS, AIRS

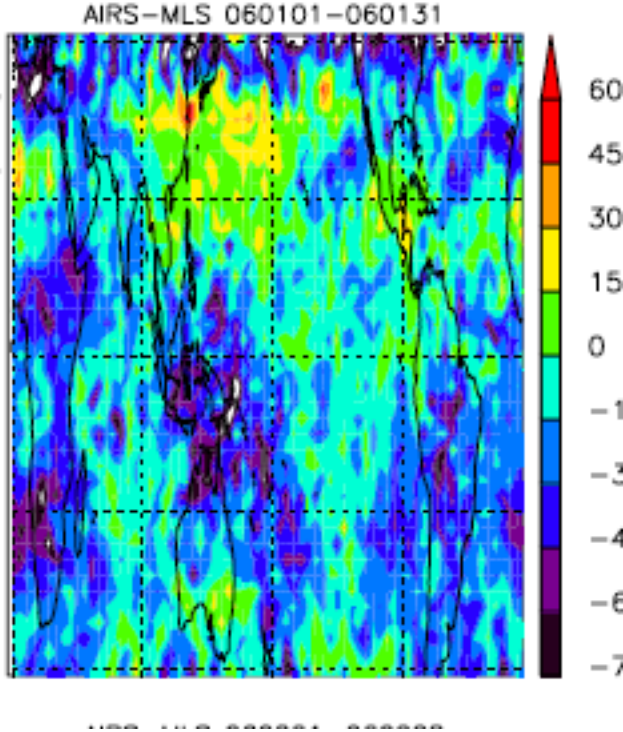
AIRS (200-250hPa)



MLS (215hPa)



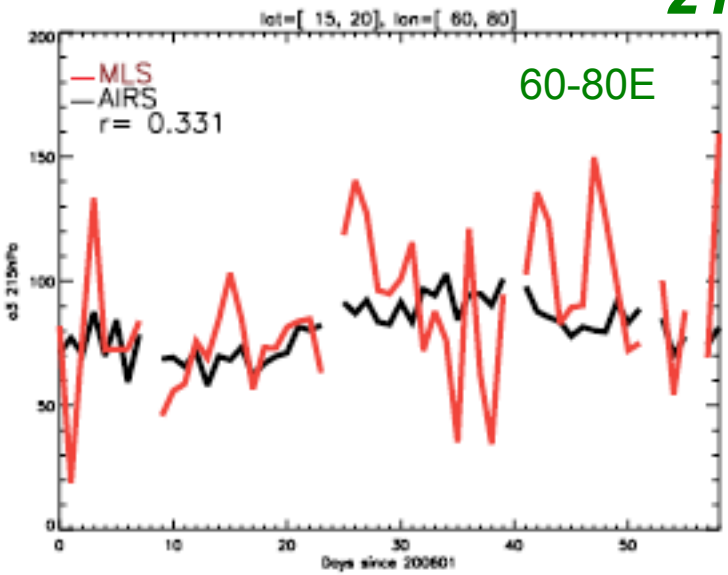
AIRS-MLS

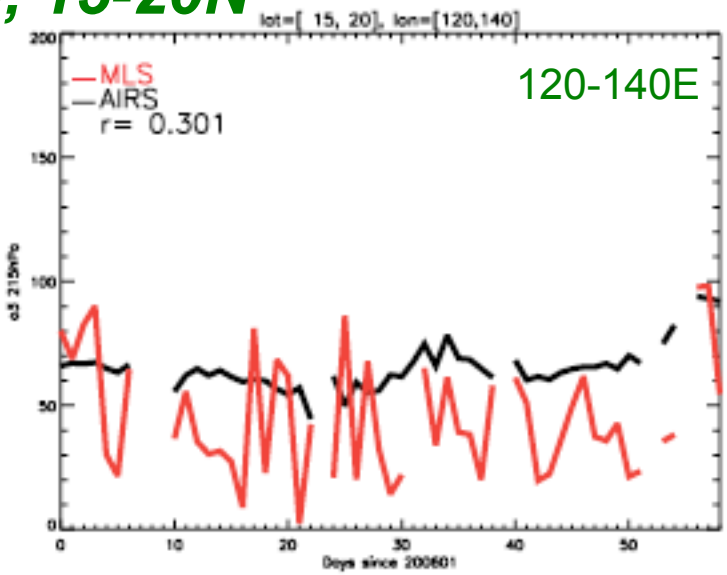


Significant differences between monthly mean fields.

MLS, AIRS Ozone Time Series

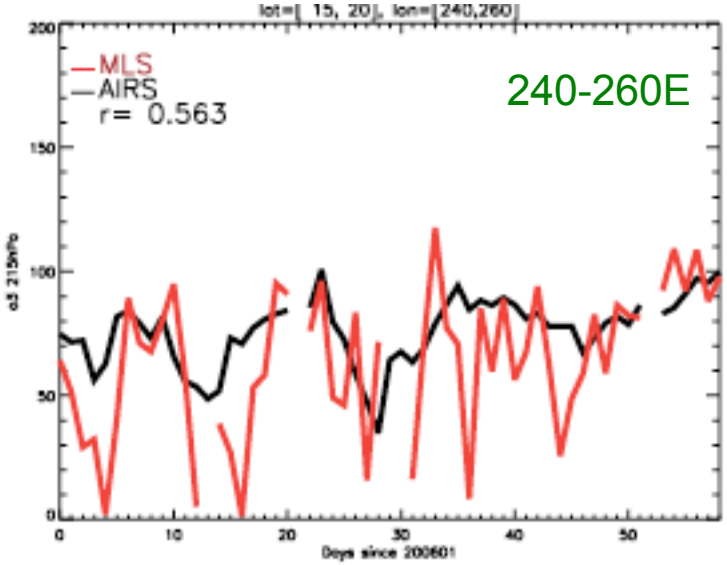
215hPa, 15-20N





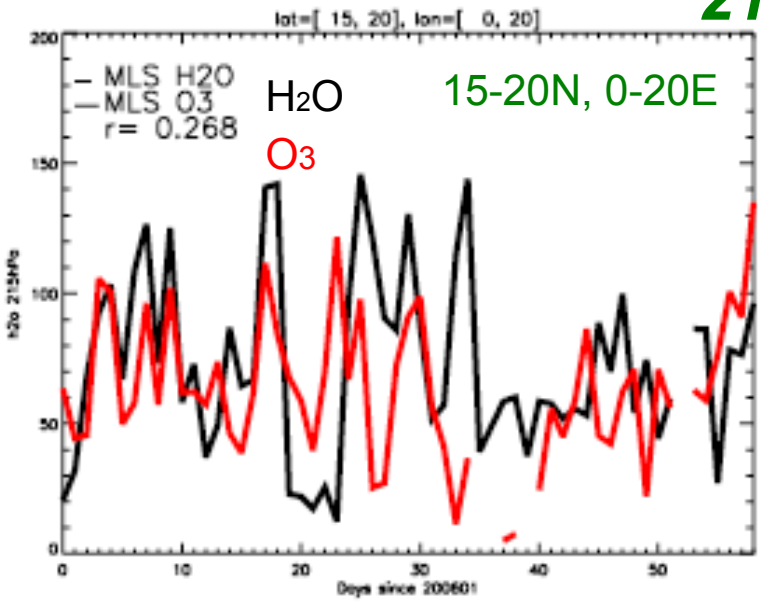
Much larger range and daily variability in MLS.

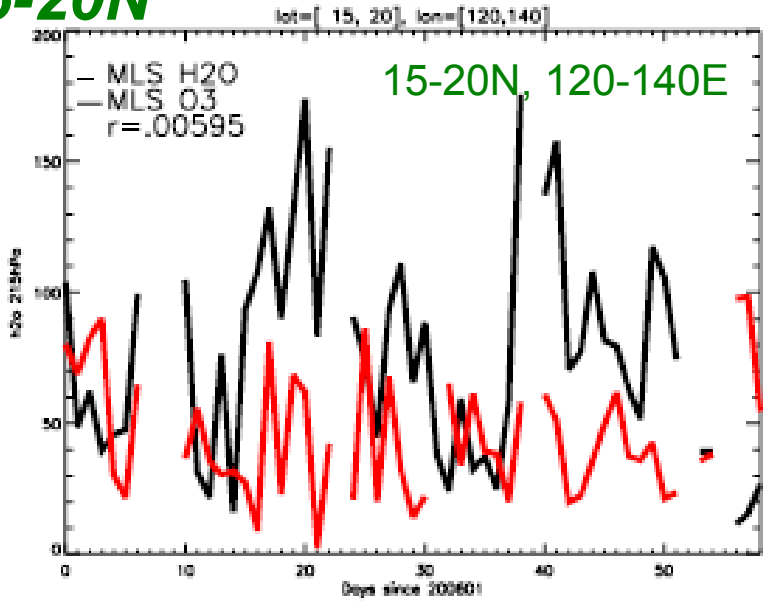
Reasonable correlations between AIRS and MLS.

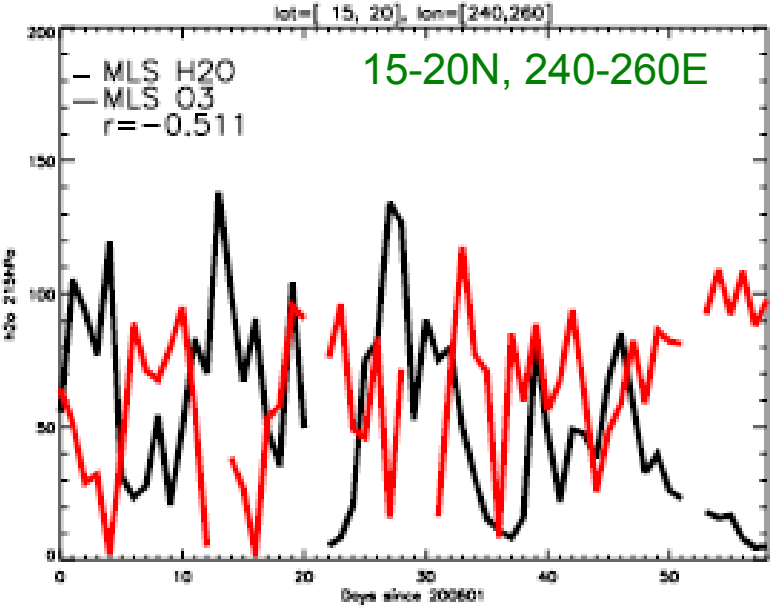


Time series of MLS H_2O and O_3

215hPa, 15-20N







Correlation between O_3 and H_2O variations with longitude.

Anti-correlation in E Pacific, but little correlation in other regions.

Conclusions

- Large longitudinal variations in mean and variability of subtropical UT humidity.

- Related to differences in transport in different regions, e.g., intrusions in EPac and anticyclones in WPac.

- Good agreement between MLS and AIRS 215hPa H_2O, esp. in spatial and temporal variability. Note the case for 215hPa O_3.

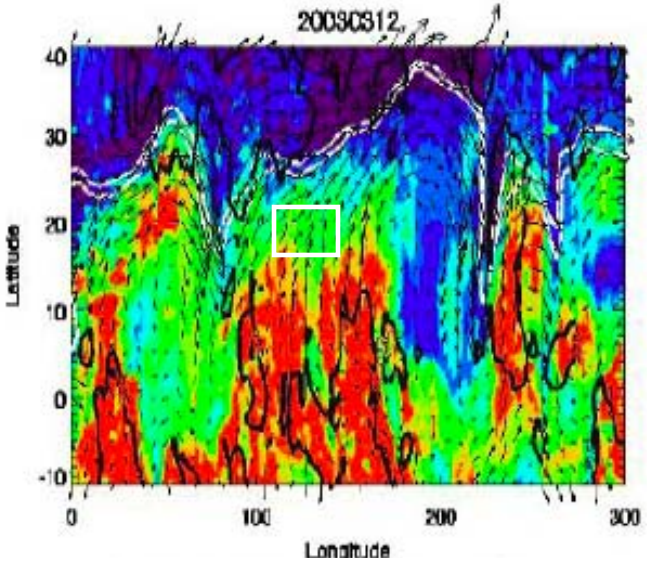
Future Work

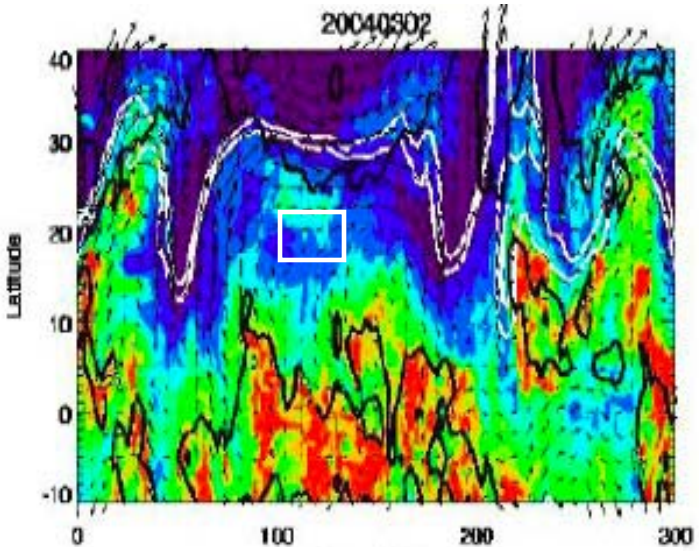
- Complete analysis of MJO in subtropical UTH.

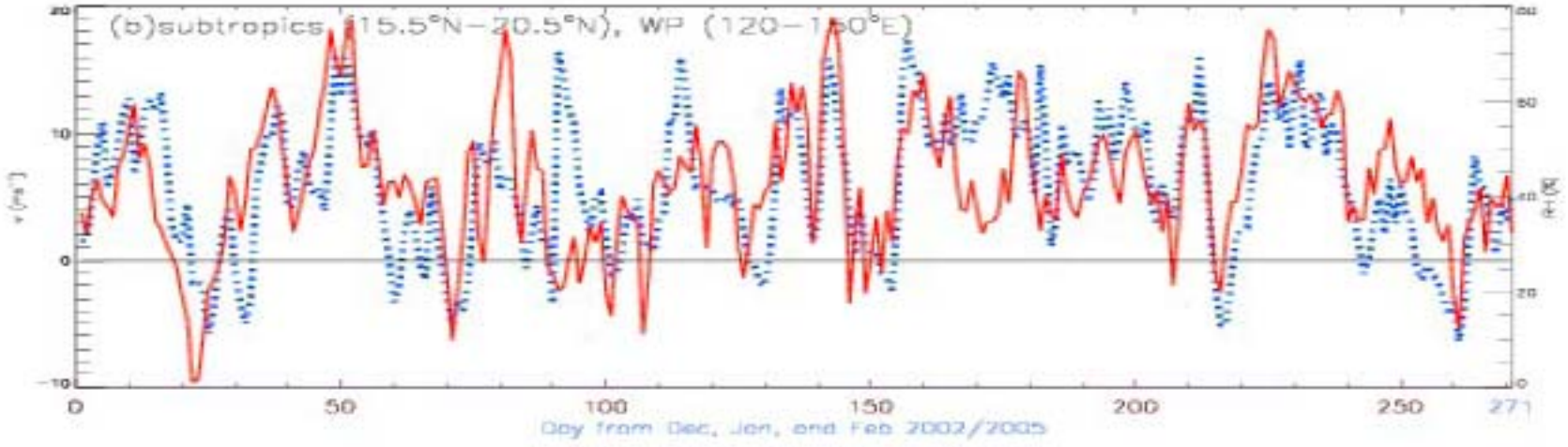
- Further comparisons of MLS and AIRS UTH, including comparisons with trajectory simulations.

- Examine MLS O_3 and CO, and how impacted by intrusions and MJO.

Variability in Western Pacific







Variability in subtropical western pacific not related to intrusion, but variations in meridional wind