

Intraseasonal Variability of the Tropical Tropopause Derived from COSMIC RO Data

Z. Zeng, S.-P. Ho, S. Sokolovskiy, Y.-H.
Kuo

UCAR-COSMIC Project Office

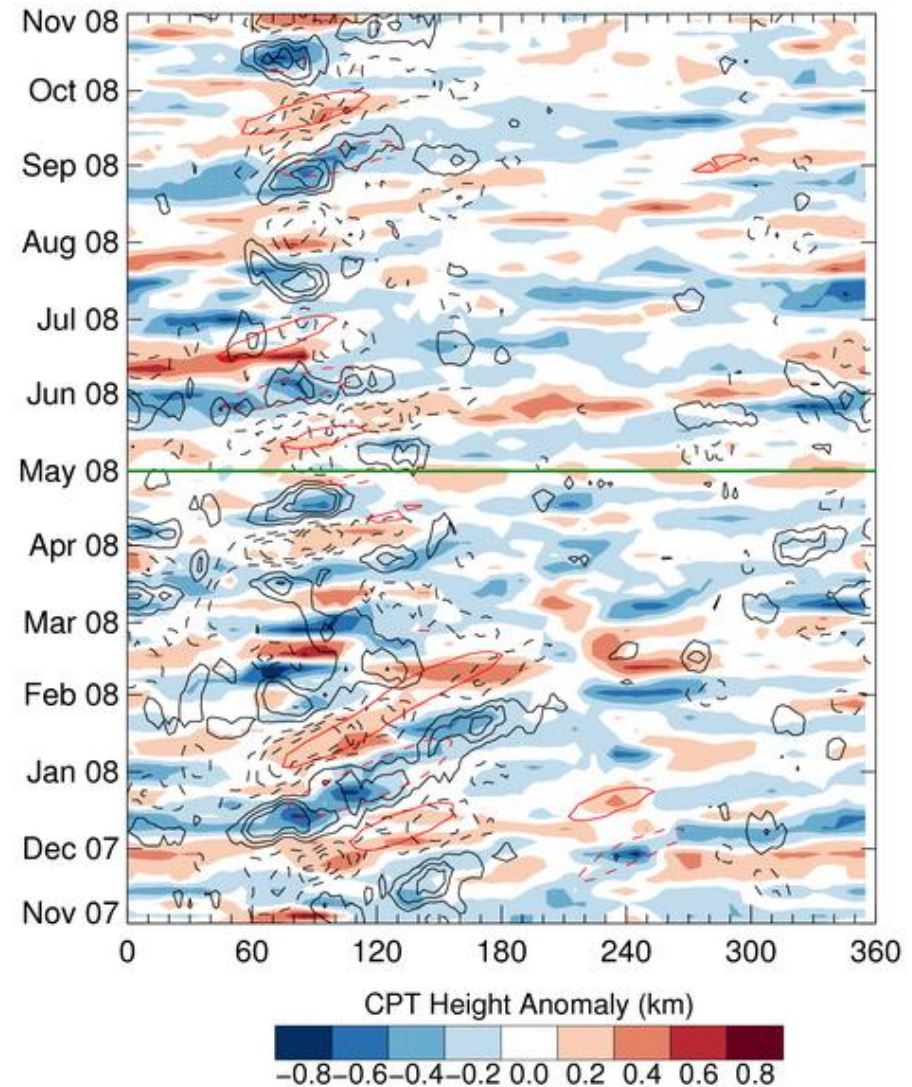
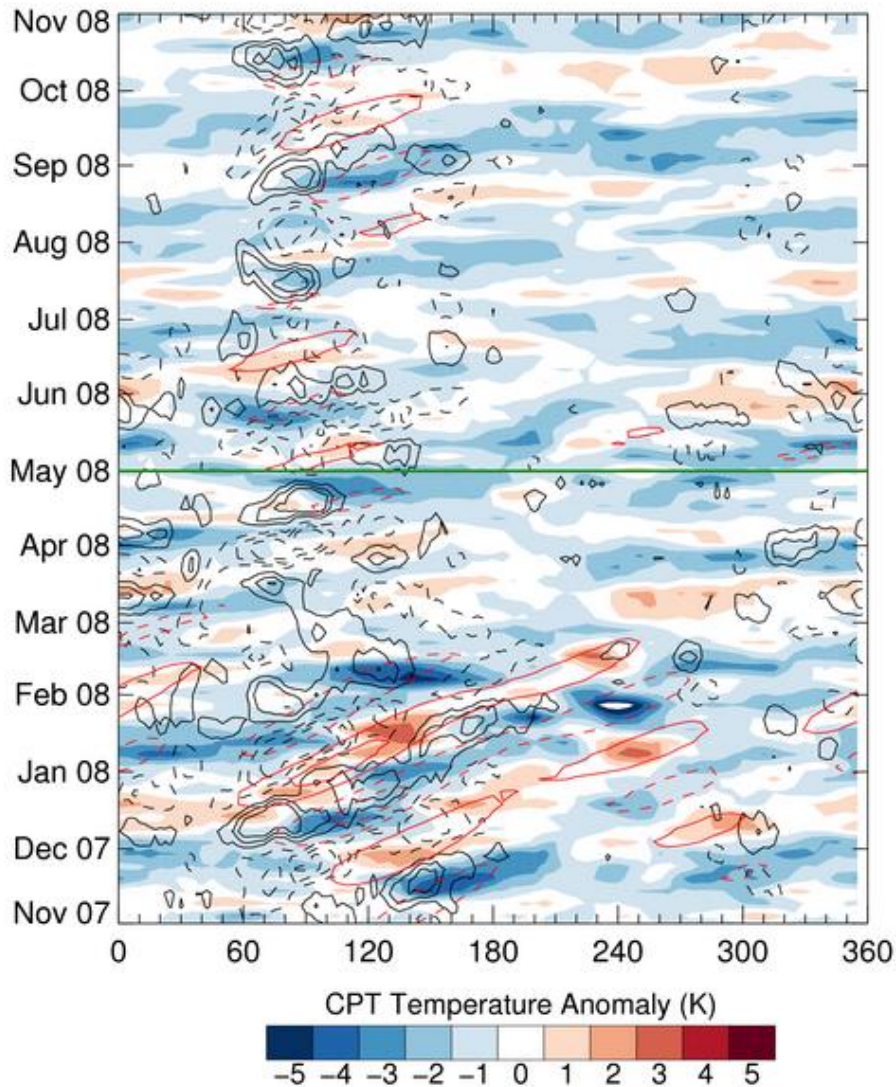
Data Analysis

Dataset: COSMIC RO tropical CPT T and H during 2006-2010;
OLR as a proxy of deep convection;

Analysis Method:

1. All data are first averaged into 5-day $\times$ 20°-lon $\times$ 5°-lat bins.
2. The intraseasonal anomalies (ISA) of the binned data are then generated by removing the climatological seasonal cycle and filtering by a 30- to 90-day bandpass filter.
3. By use of the Wheeler-Hendon index (2004), the ISA is composited into a full cycle by averaging the ISA for each phase of WH index. WH index is decomposed conventionally into eight phases describing the coherent large-scale eastward propagation of MJO convection from the western Indian Ocean to the central Pacific.

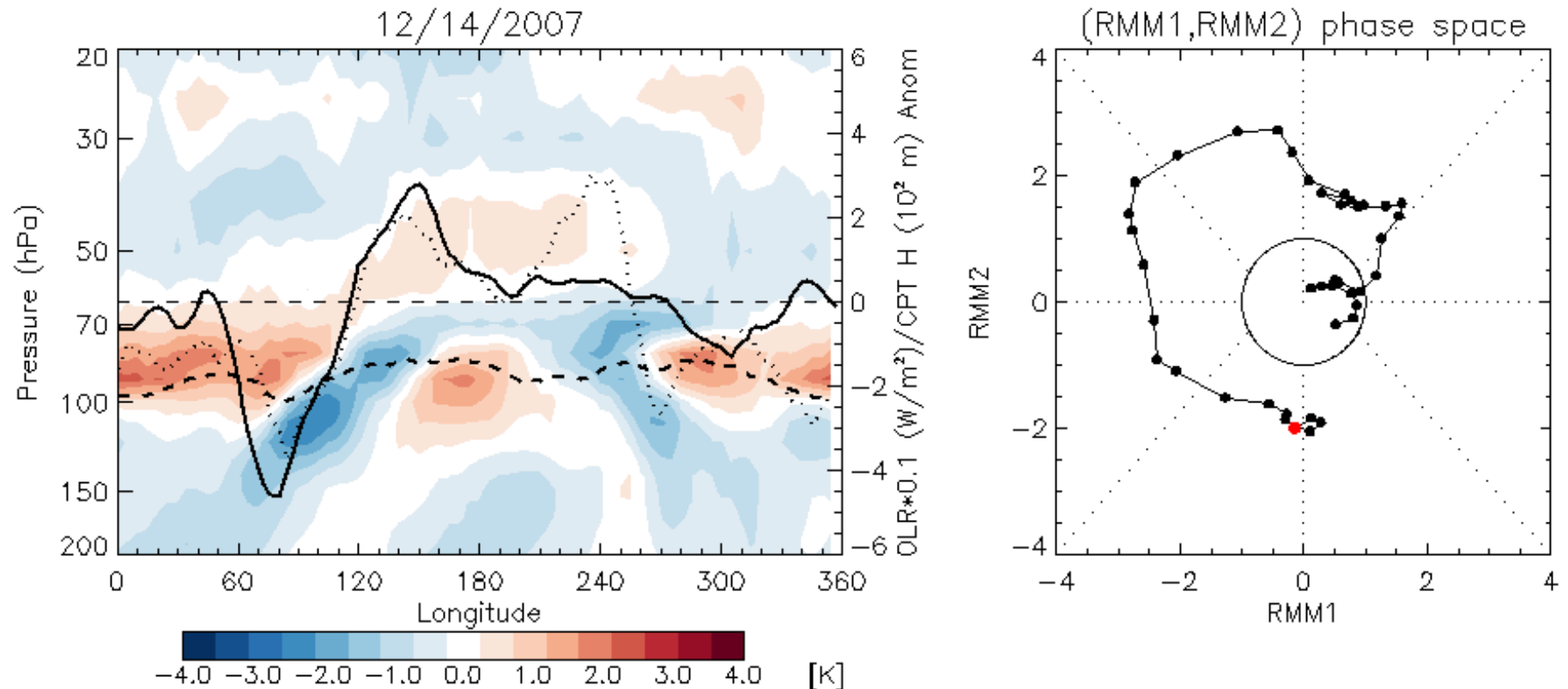
Bandpassed CPT and OLR (30-90 days)



(Shading: CPT anom; red contour: filtered CPT anom; black contour: filtered OLR anom)

Corr. between CPT & OLR with lag; propagation eastward; seasonal difference:

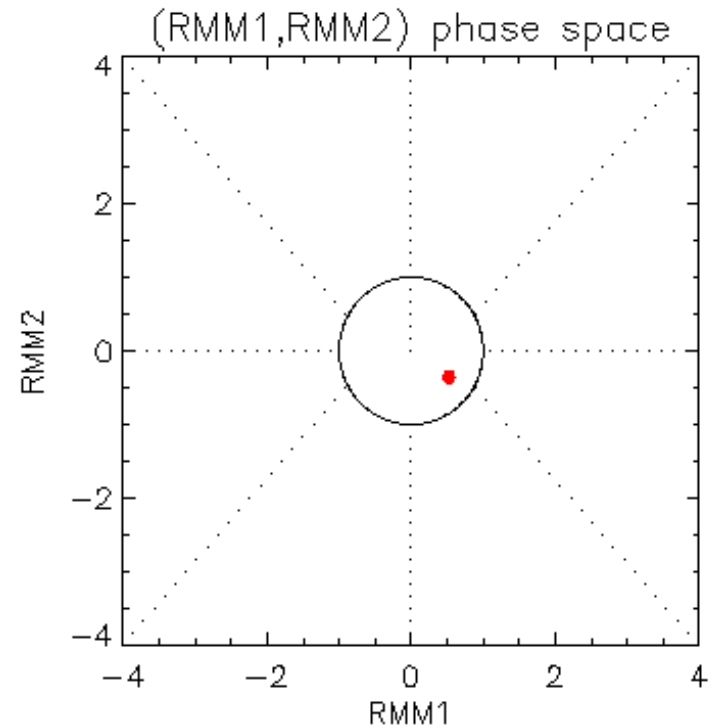
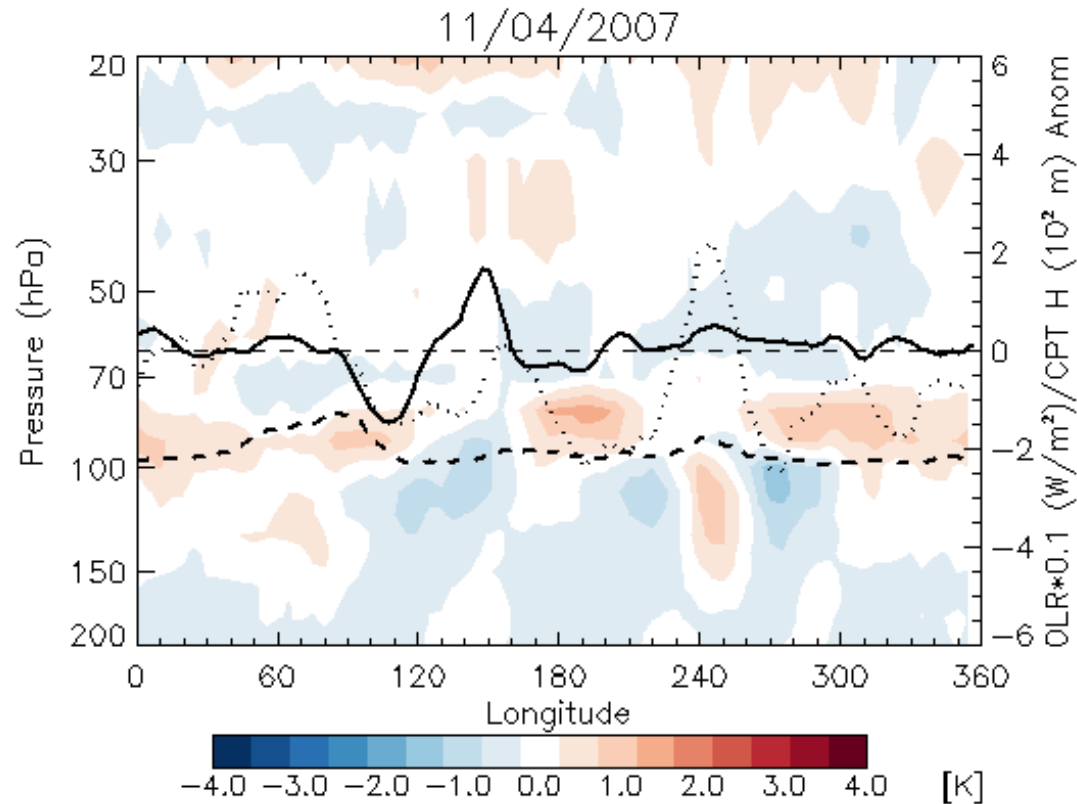
Vertical Structure of ISA near CPT



(shading: T' ; dashed: loc. of CPT; solid: OLR anom; dotted: CPT H')

- Over Indonesian region, eastward tilting Kelvin wave structure near the CPT is associated with the deep convection, with vertical λ of $\sim 5 \text{ km}$.
- CPT T' shows a dipole structure with warm anom over the west of convection and cold anom over the east of convection.
- Enhanced convection locally lowers the CPT H.

Vertical Structure of ISA near CPT



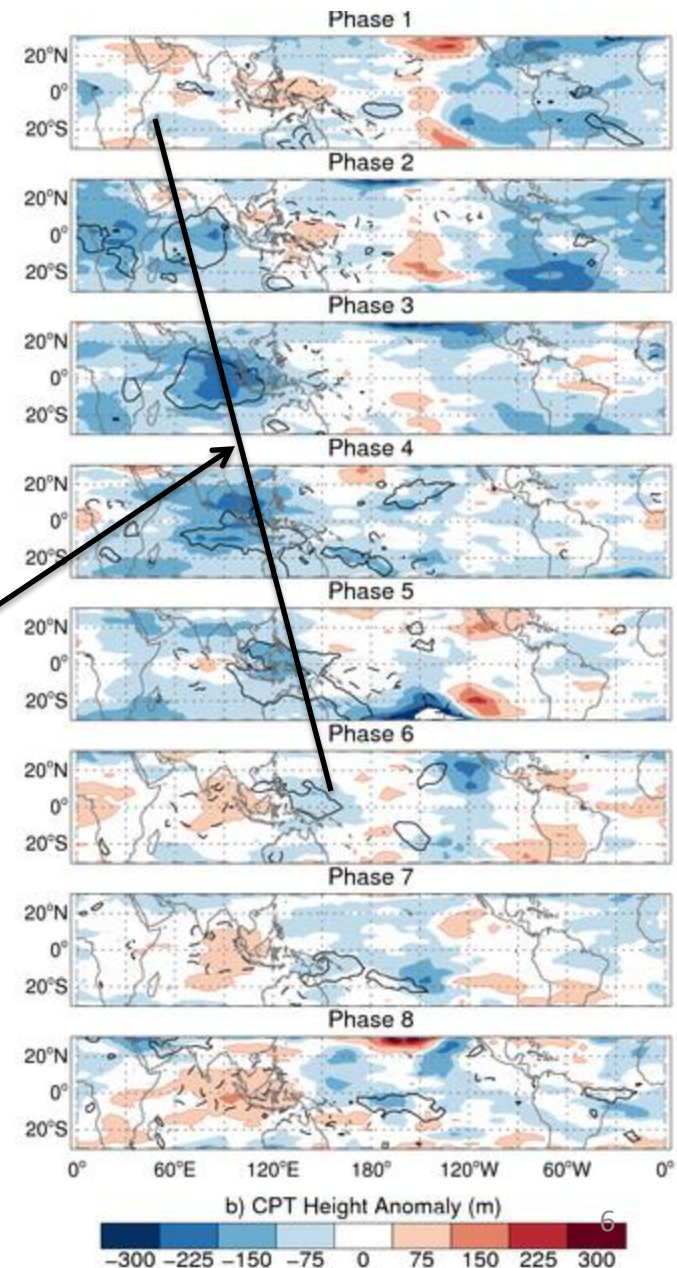
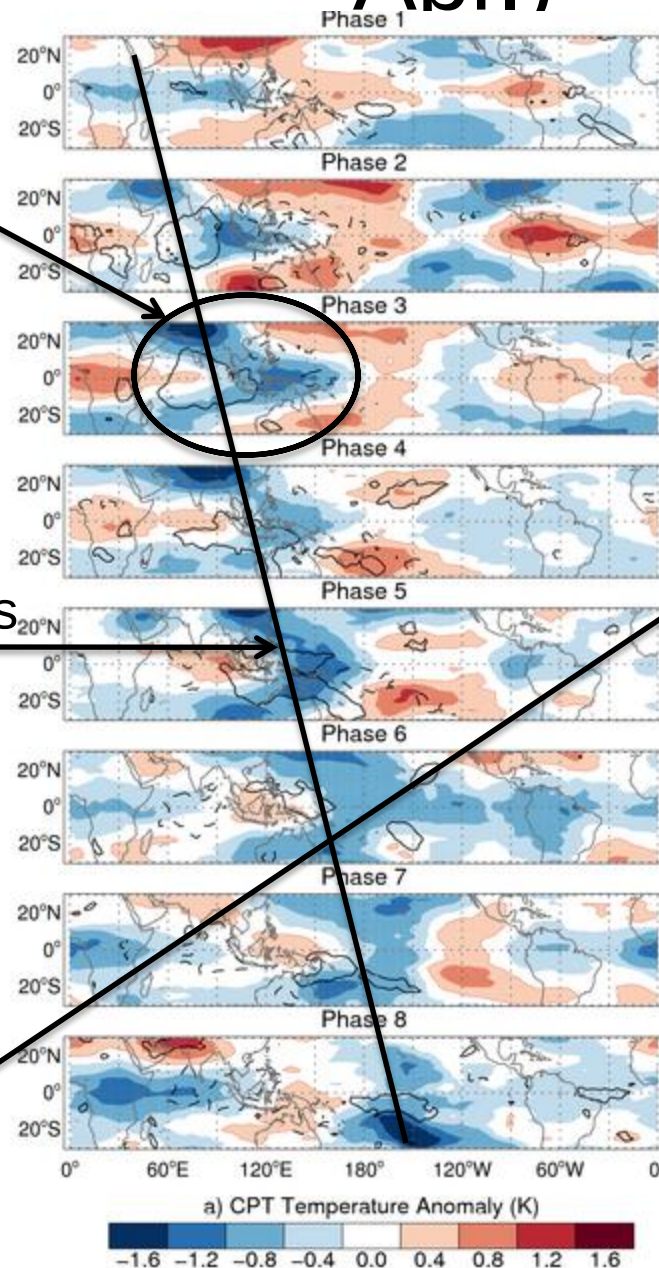
Regardless of the longitudinal position of deep convection, the T' reaches its maximum amplitude over the western Pacific.

Horizontal Structure of CPT (Nov. – Apr.)

Low temperature persist over the eastern tropics of convective center and extend northwest and southwest.

This horse-shaped structure propagates eastward along with the convective center thru. MJO cycle.

Enhanced convection locally lower the CPT H



Horizontal Structure of CPT (May – Oct.)

Horse-shaped structure of T' is not so well pronounced as that during Nov.-Apr.

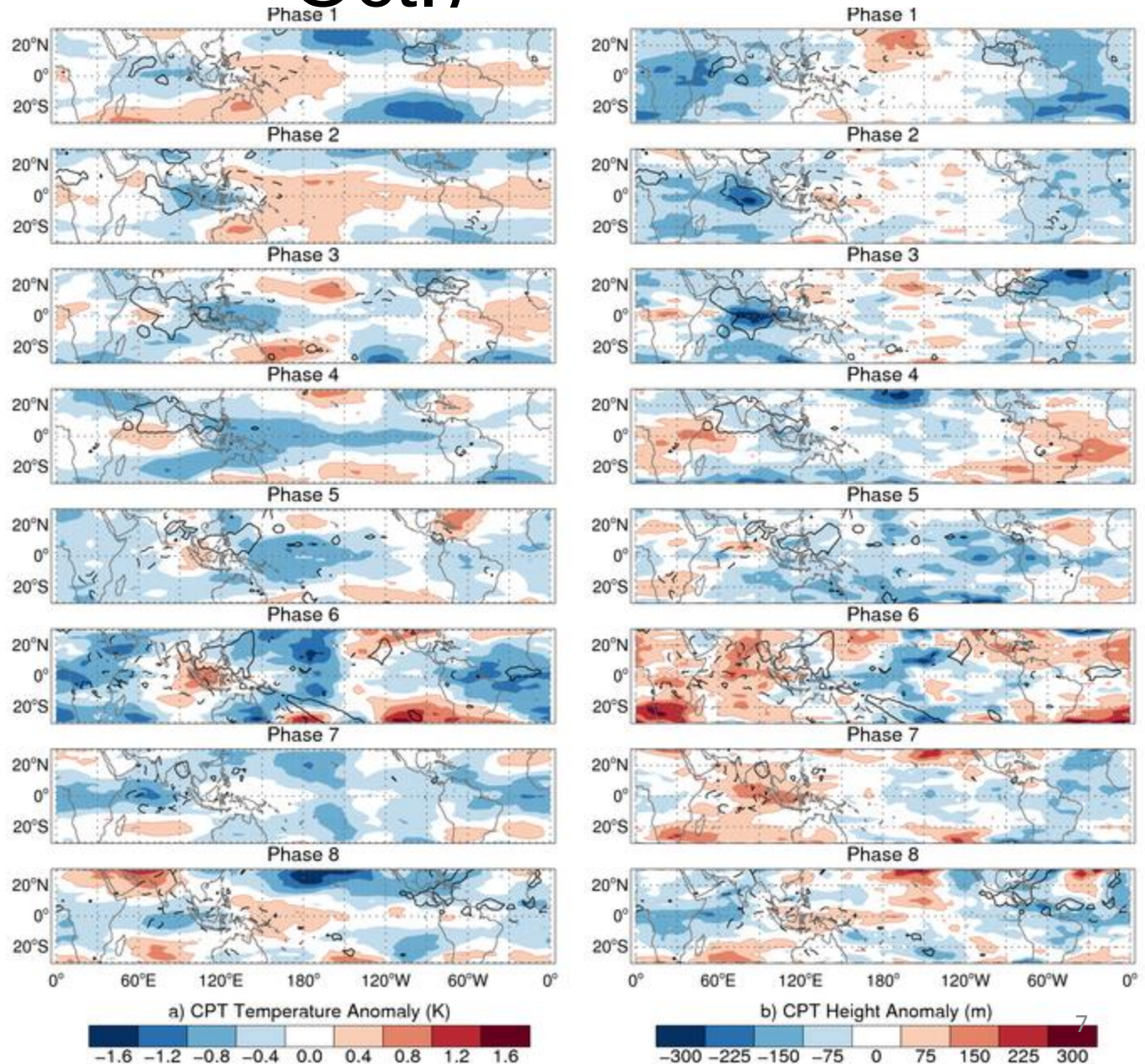


Diagram of Horseshoe-shaped structure

Definition of Indices

Representative of Rossby Response

HSI-R < 0

Low Temperatures

10°N-15°N

Eq.

10°S-15°S

High Temp.

$$\text{HSI-R}(x, t) = \frac{T_N(x, t) + T_S(x, t)}{2} - T_{Eq}(x, t),$$

Representative of Kelvin Response

HSI-K < 0

T_{Eq}

HSI-K > 0

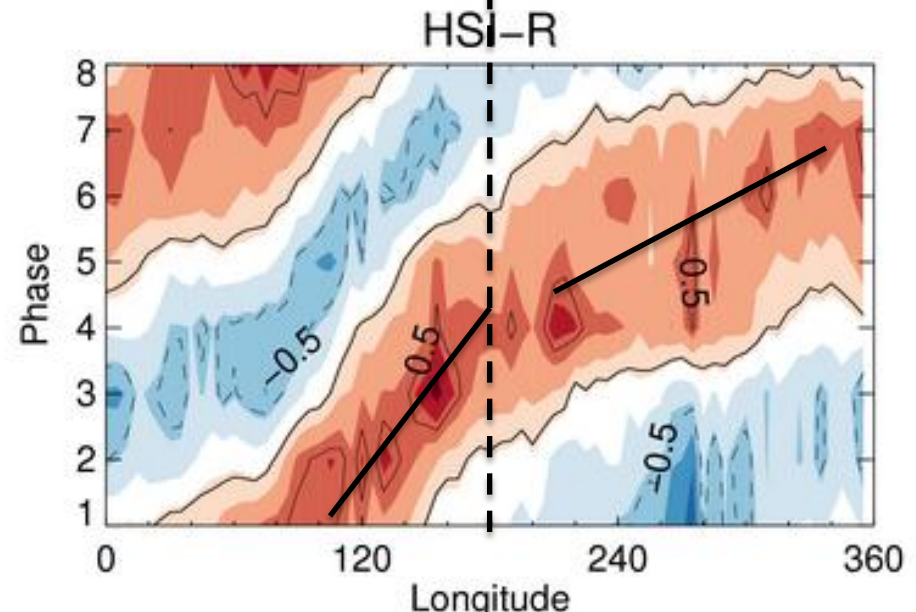
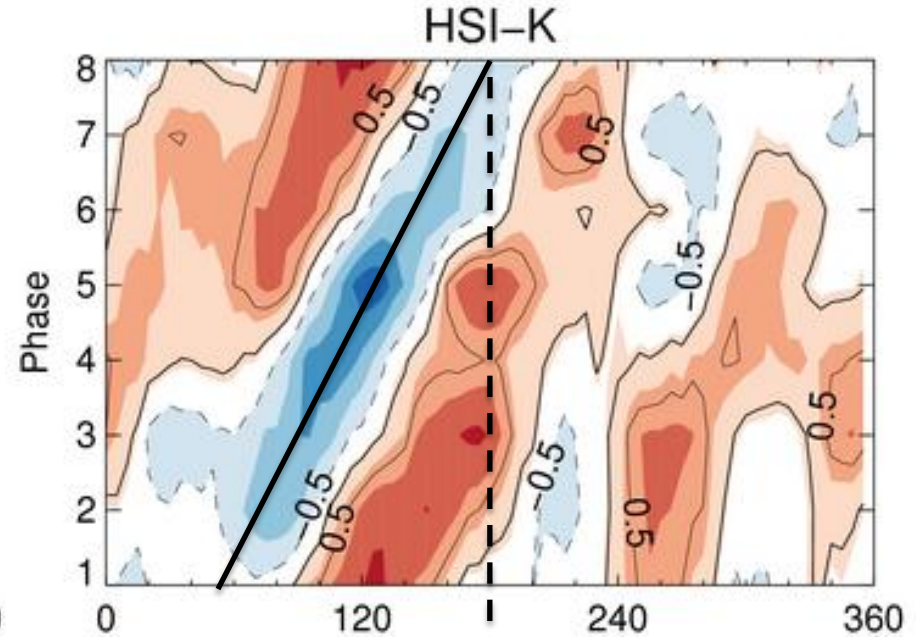
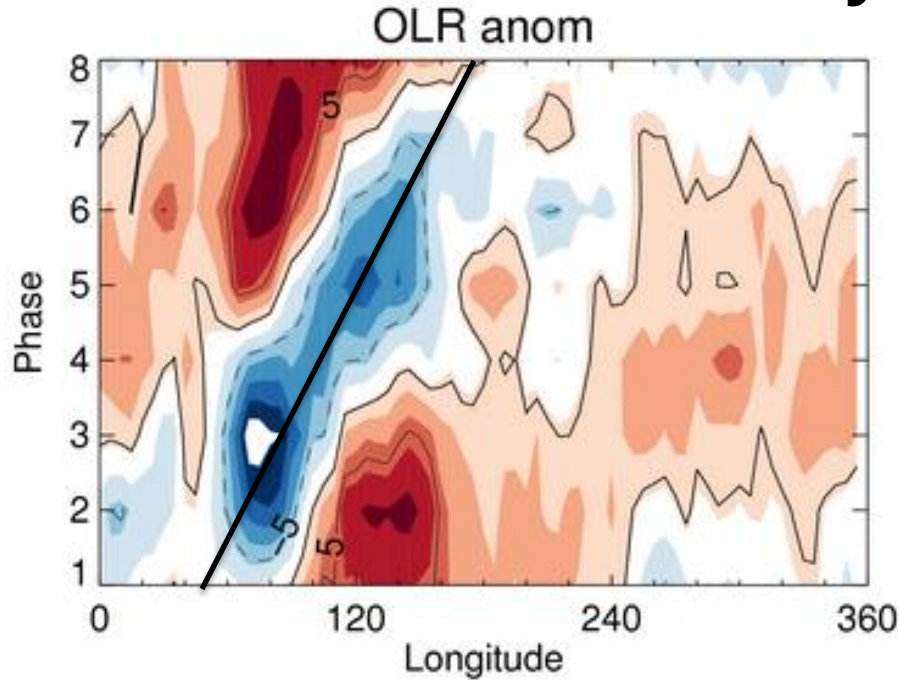
HSI-K > 0

$$\text{HSI-K}(x, t) = T_{Eq}(x + \Delta x/2, t) - T_{Eq}(x - \Delta x/2, t).$$

Longitude

[Nishimoto and Shiotani, JGR2012]

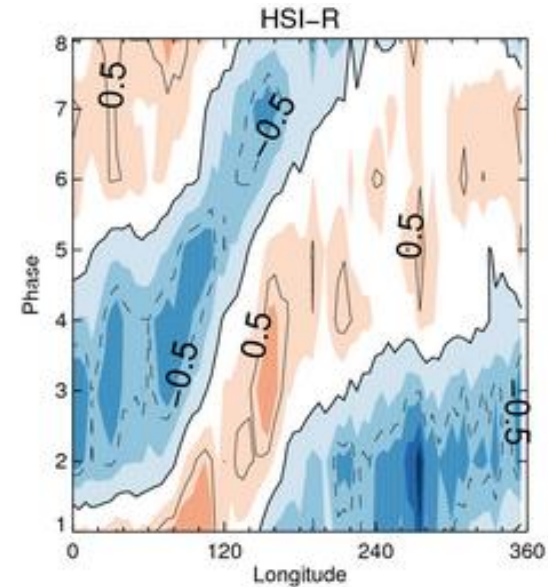
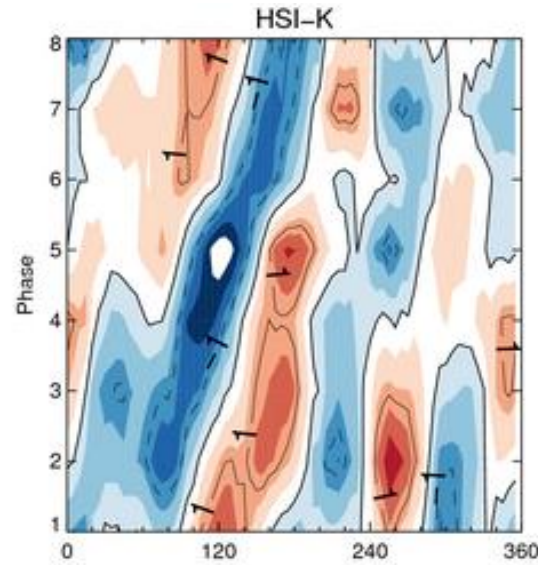
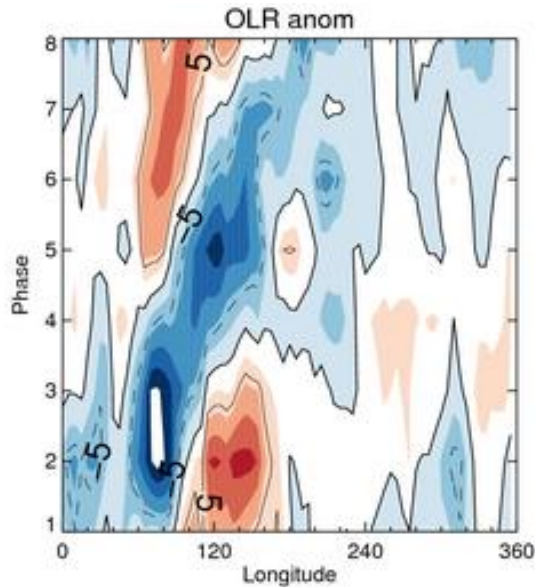
Composite pattern of HSI thru MJO cycle



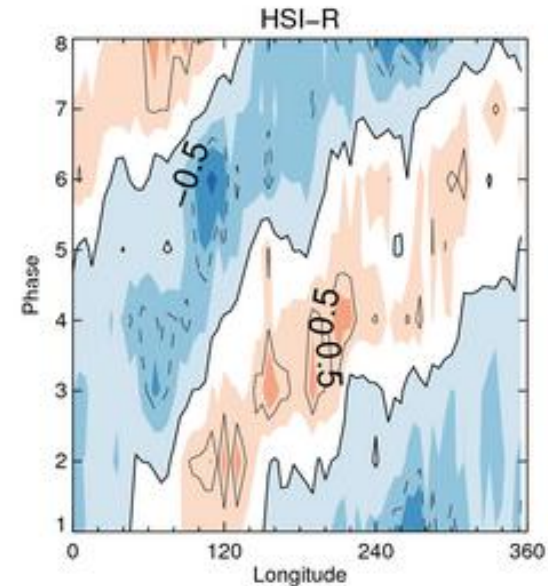
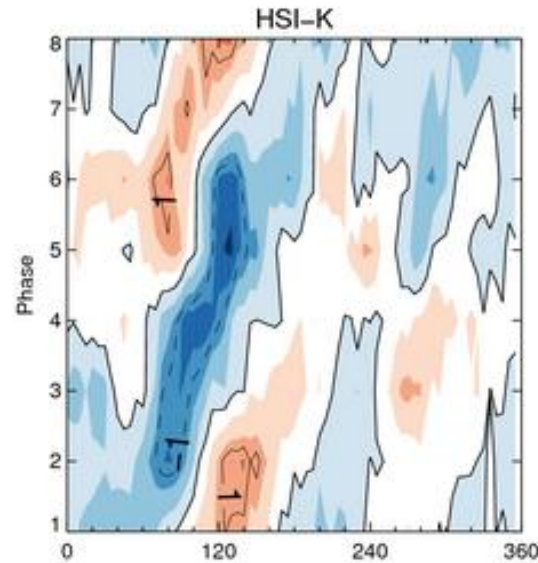
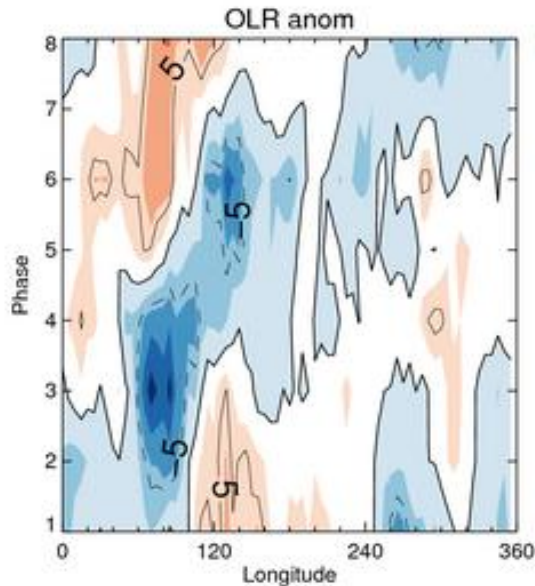
- Close relationship of HSI-K and HSI-R with the OLR anom over the EH;
- Kelvin wave propagates eastward from IO to eastern Pacific, associated with convective activity.
- Rossby wave propagates thru. the whole zonal circle, with faster speed over the EH than over the WH.

Seasonal Variability of CPT T' pattern

Nov.
—
Apr.

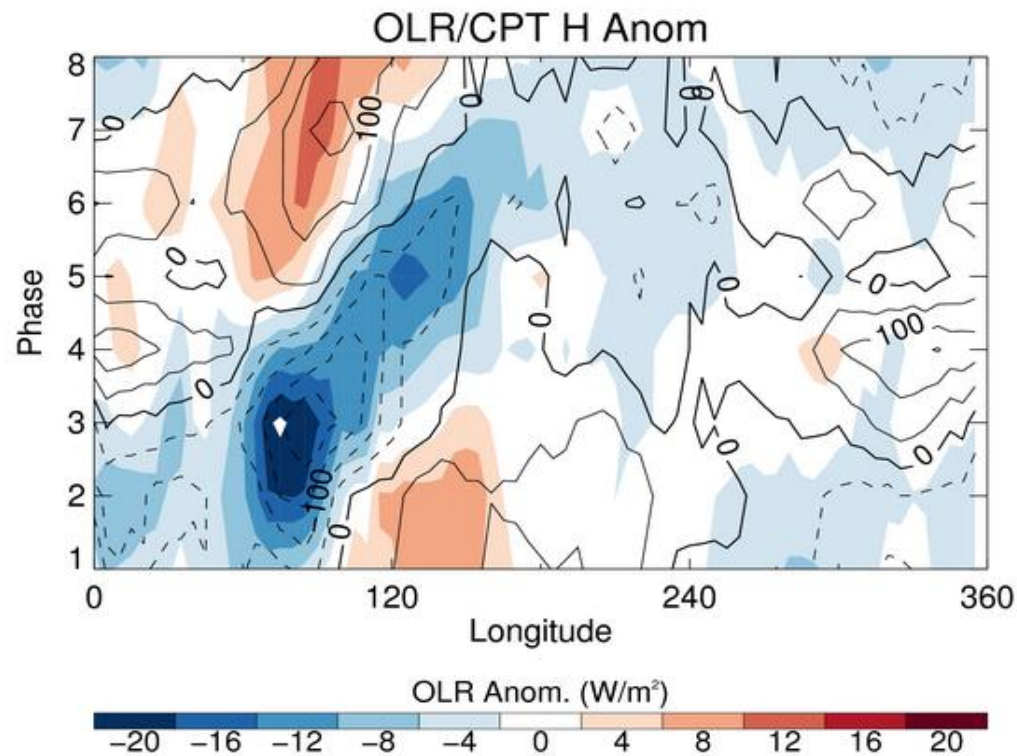


May
—
Oct.



Composited CPT H' pattern

CPT H' is closely associated with the convective activity with 10° longitudinal phase lead.



Summary

- With high vertical resolution and high accuracy of RO data near the tropopause, an unprecedented representation of the IS structure in terms of CPT T' and H' is presented firstly from the observations.
- Deep convection tends to be preceded by negative CPT T' . The interaction between deep convection and large-scale equatorial Kelvin wave yields significant equatorial-trapped anomalies of the CPT. The off-equatorial anomalies are related to the Rossby wave response to the enhanced convection.
- Intensive tropical convection tends to locally lower CPT H . Kelvin wave play a central role in driving CPT H undulations.