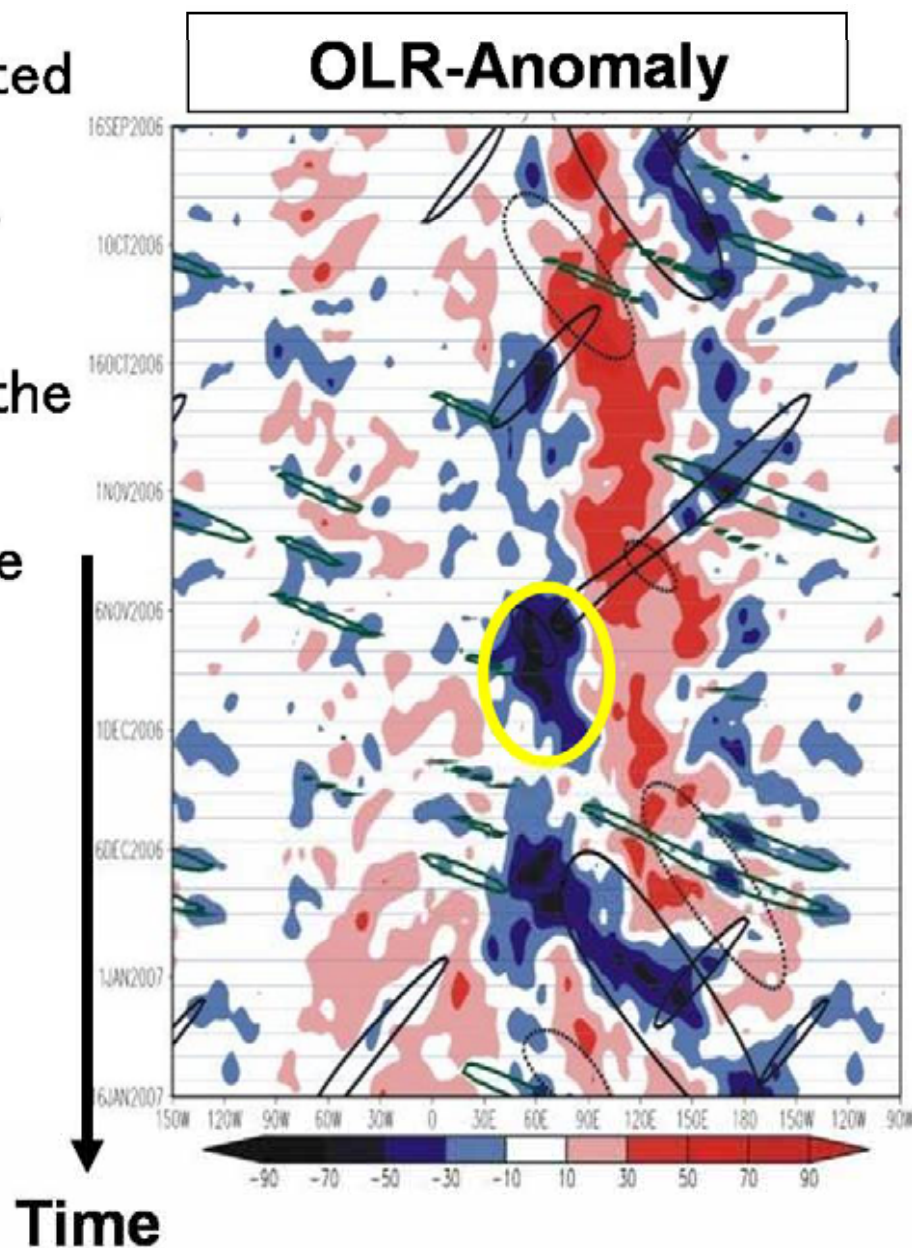


# 3 Kelvin-Type disturbances observed from October to December in 2006

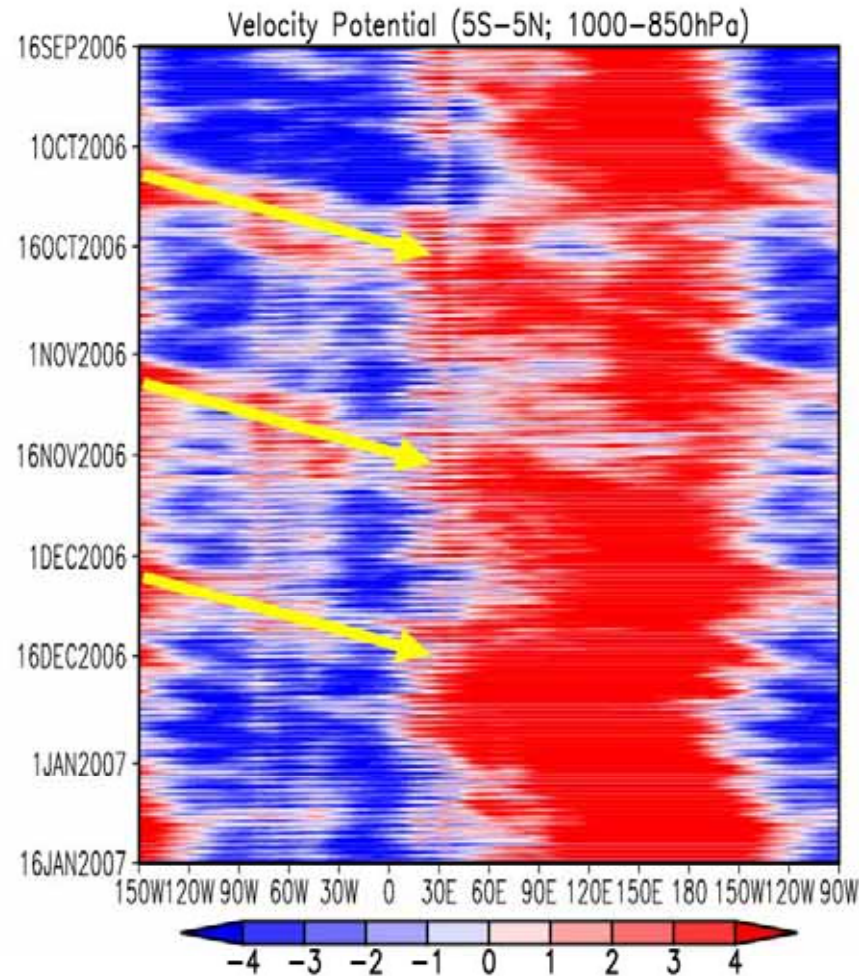
Kazuaki Yasunaga  
(IORGC/JAMSTEC)

# Background

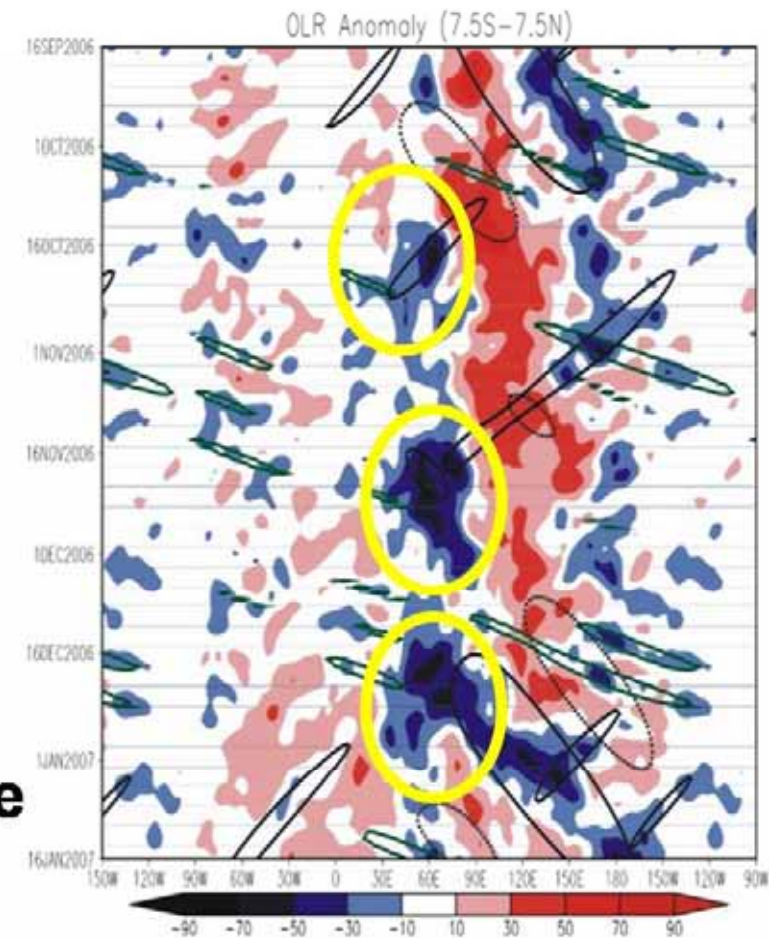
- MISMO: Field experiment conducted in the central equatorial Indian Ocean during October–December 2006
- MJO onset was observed during the MISMO.
- Focus: Influence of the large scale motion
- Data:
  - Dynamical fields : JCDAS (Japan Meteorological Agency Climat Data Assimilation System)
  - Precipitable water: SSM/I
  - Cloud: OLR, Global-TBB



## Low-level Velocity Potential



## OLR-Anomaly

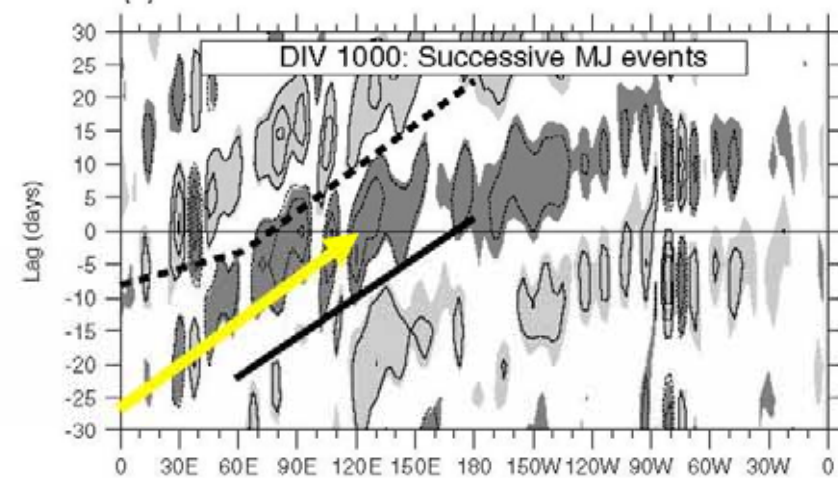


- VP shows clear **eastward-propagating** signal.
- Positive VP indicates the large-scale convergence.
- The positive VP propagates into the Indian Ocean **3 times**.
- Convective activity is enhanced, when the positive VP arrives.

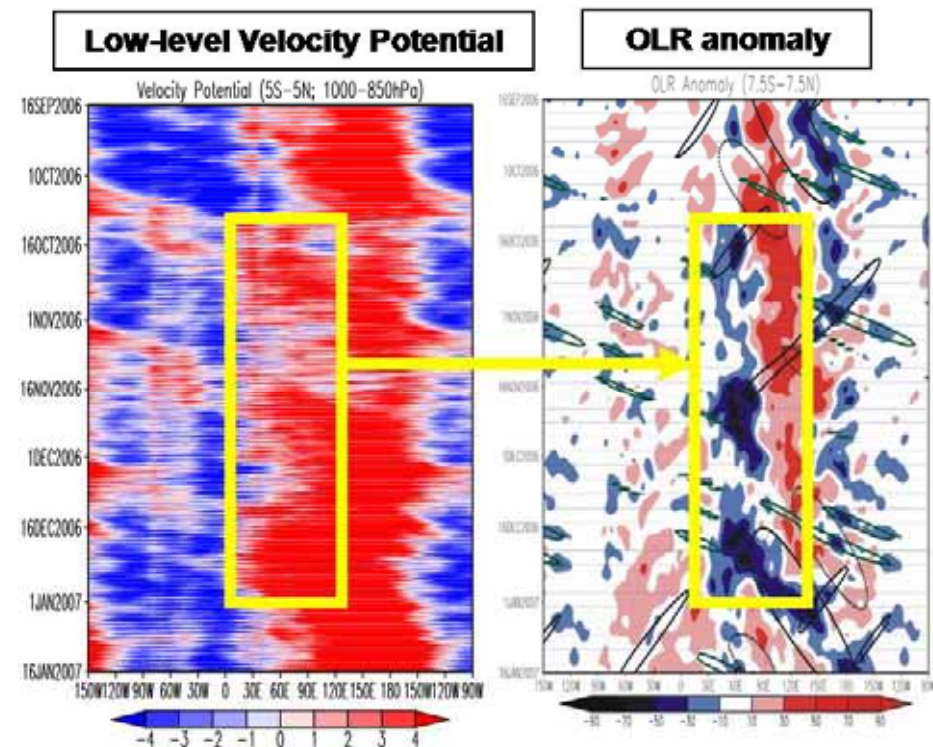


# Motivation

- Several investigations point out that eastward-propagating low-level convergence is critical to start a MJO.
- **MJO did not necessarily develop**, although the arrival of the positive VP promotes the development of cloud cluster over the Indian ocean.
- Question
  - **What is the further requirement to MJO onset and development?**
- The comparison among the 3 case will give us an insight into MJO-onset and development over the Indian Ocean.
- The phase relationship and vertical structure indicate that the eastward-propagating VPs are associated with the **Kelvin-type disturbance**.



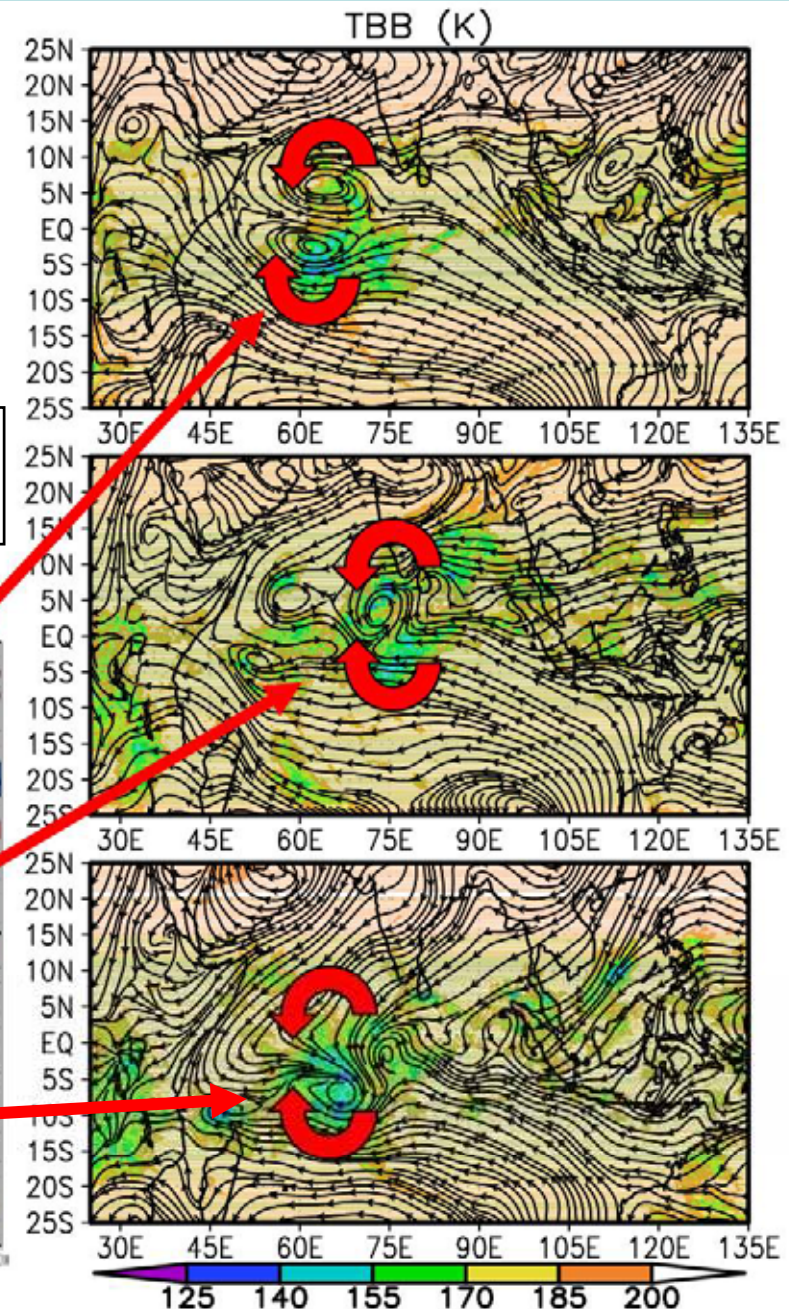
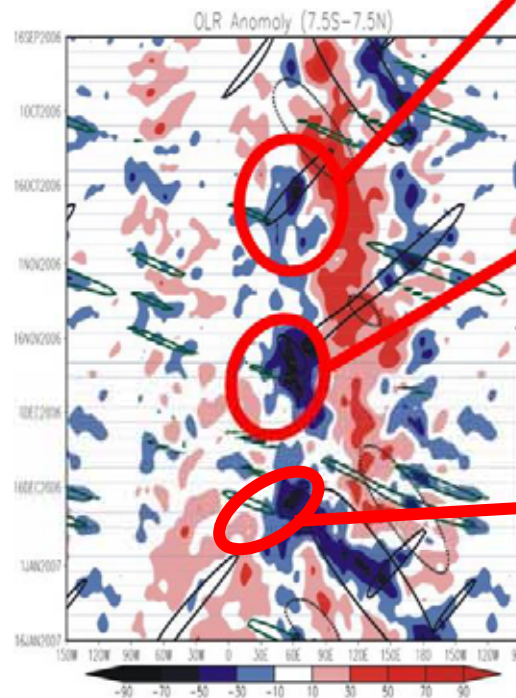
Matthews (2008, Q.J.R. Meteorol. Soc.)



# Rossby-wave-type disturbances

- In the all 3 cases, twin vortex developed over the western Indian Ocean.
- The vortex propagated or broke out over the Indian Ocean?

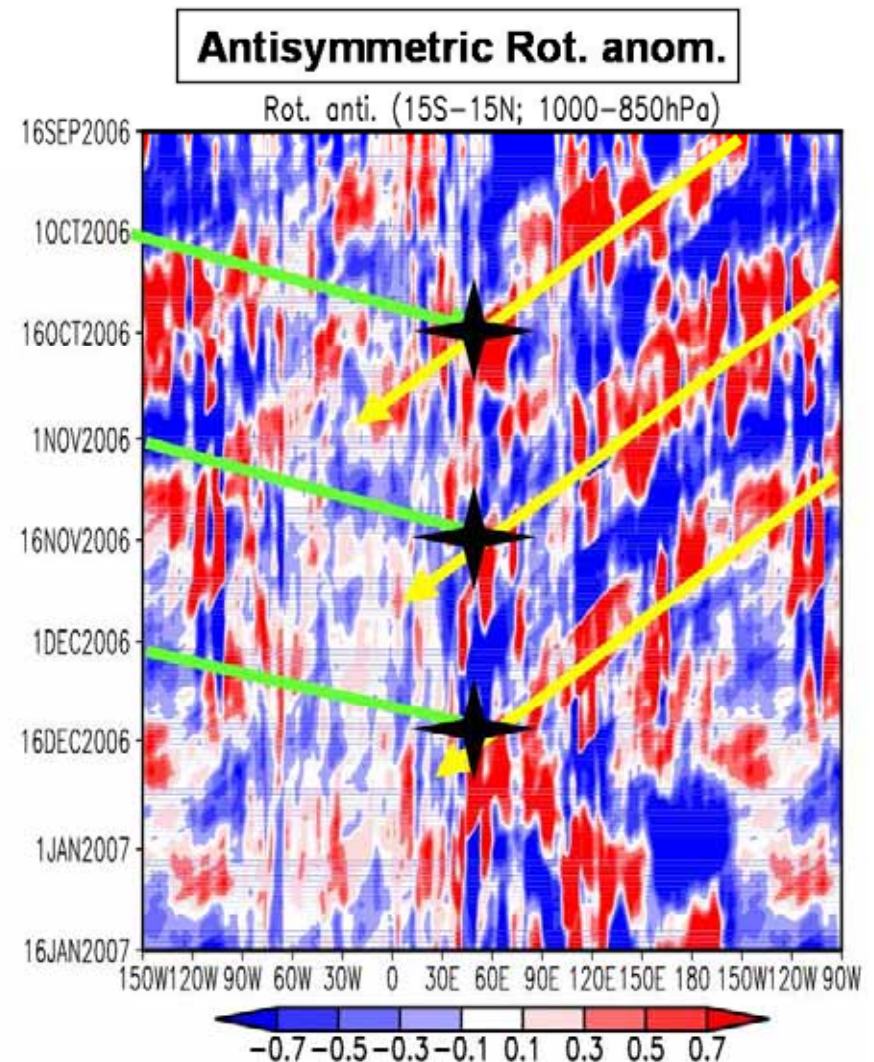
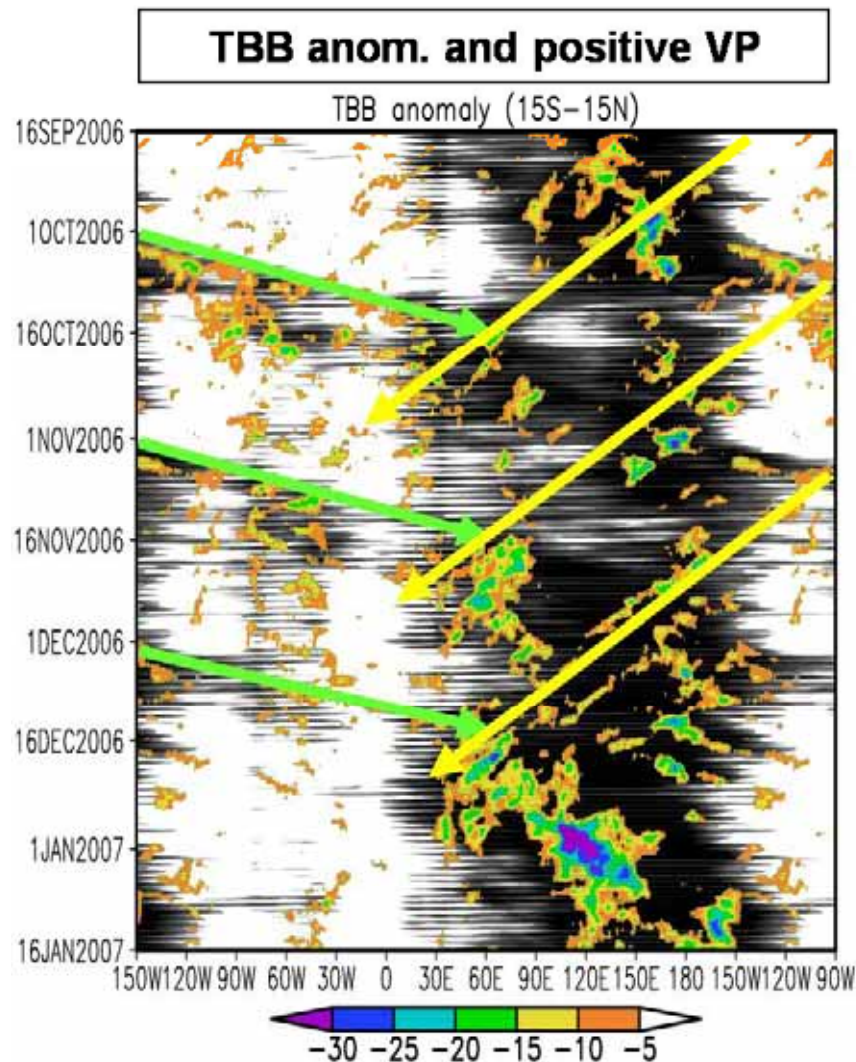
Snapshot of the cloud cluster in the each case





# Westward-propagating signal of vorticity

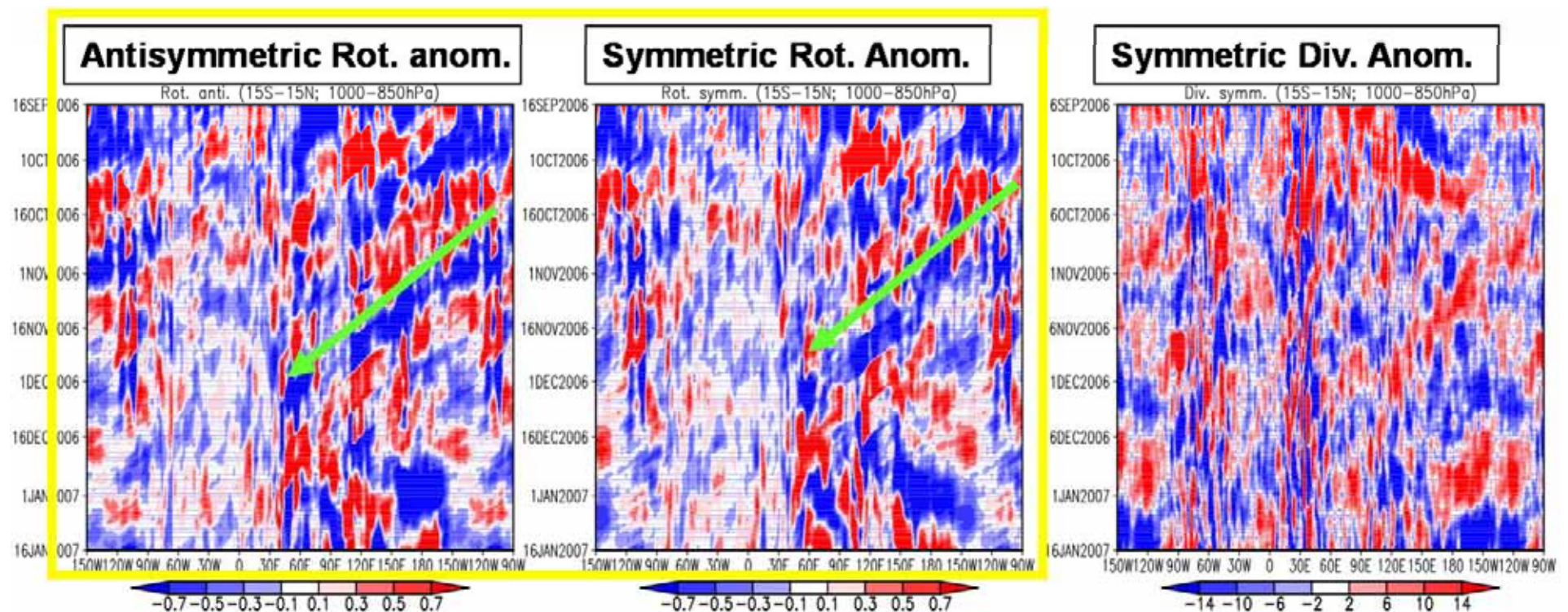
- Vorticity shows the clear westward-propagating signal.
- Cloud clusters developed at the intersection of the eastward-propagating VP and westward-propagating Vor.





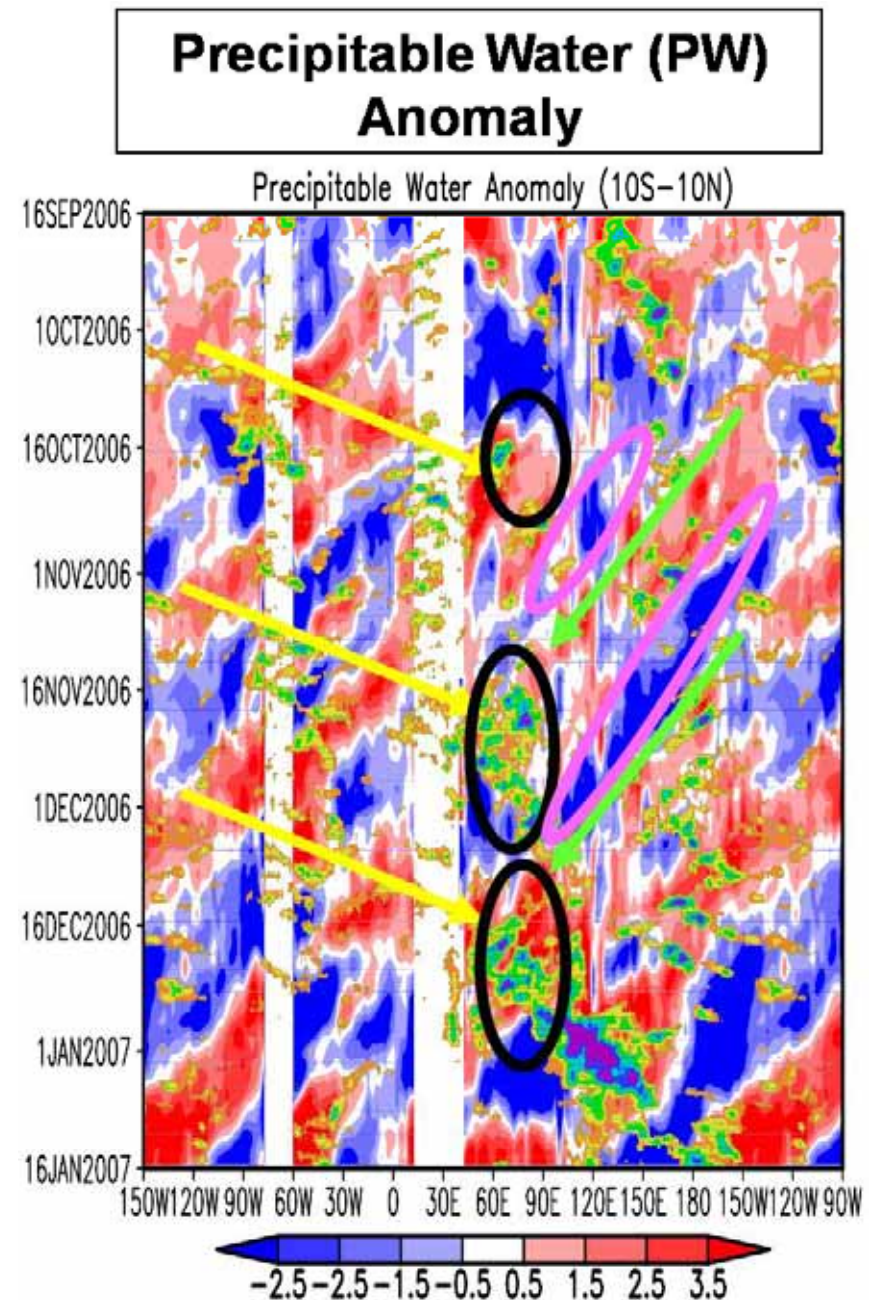
## W.-P. Vor. is associated with the Equatorial Rossby wave ?

- Westward-propagating signal is clearer in the rotation field than the divergence field.
- Westward-propagating signal is more distinct in the symmetric field than the antisymmetric field.
- Propagation speeds is about 5 degrees per day.
- The signal is associated with the equatorial Rossby wave ?



# Westward-propagating signal of PW

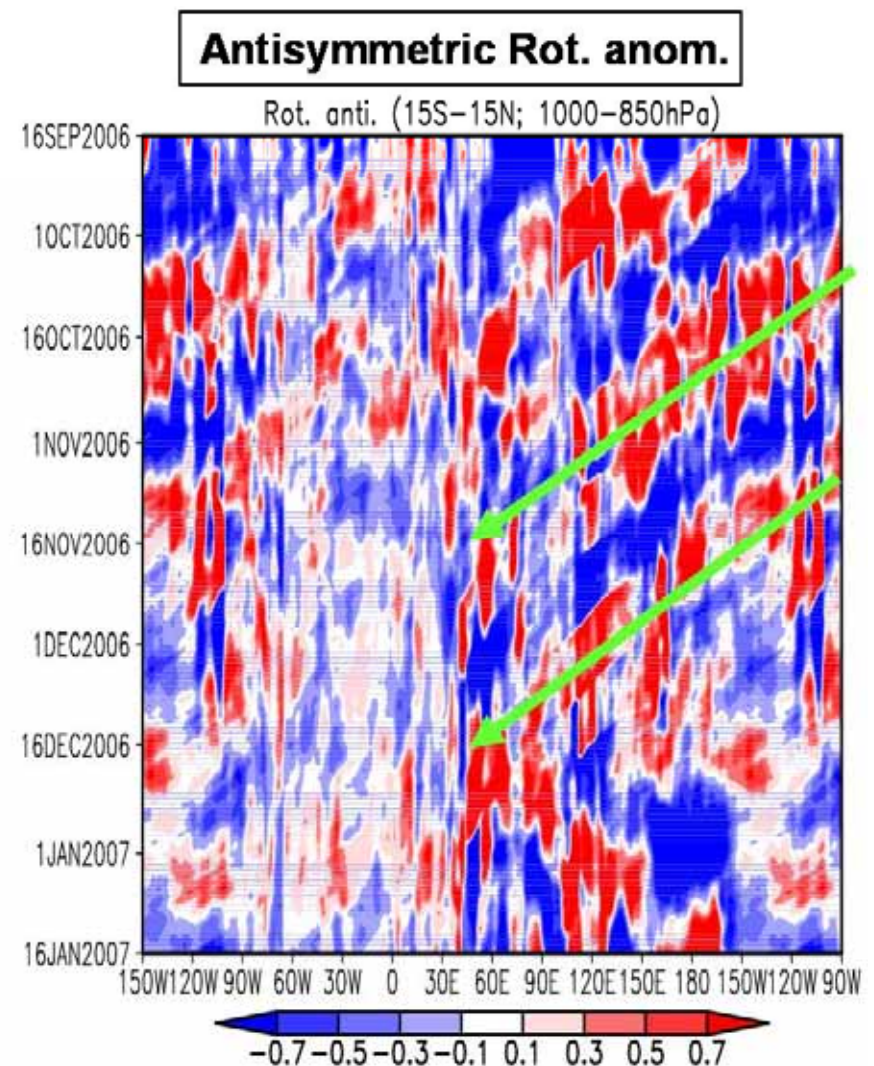
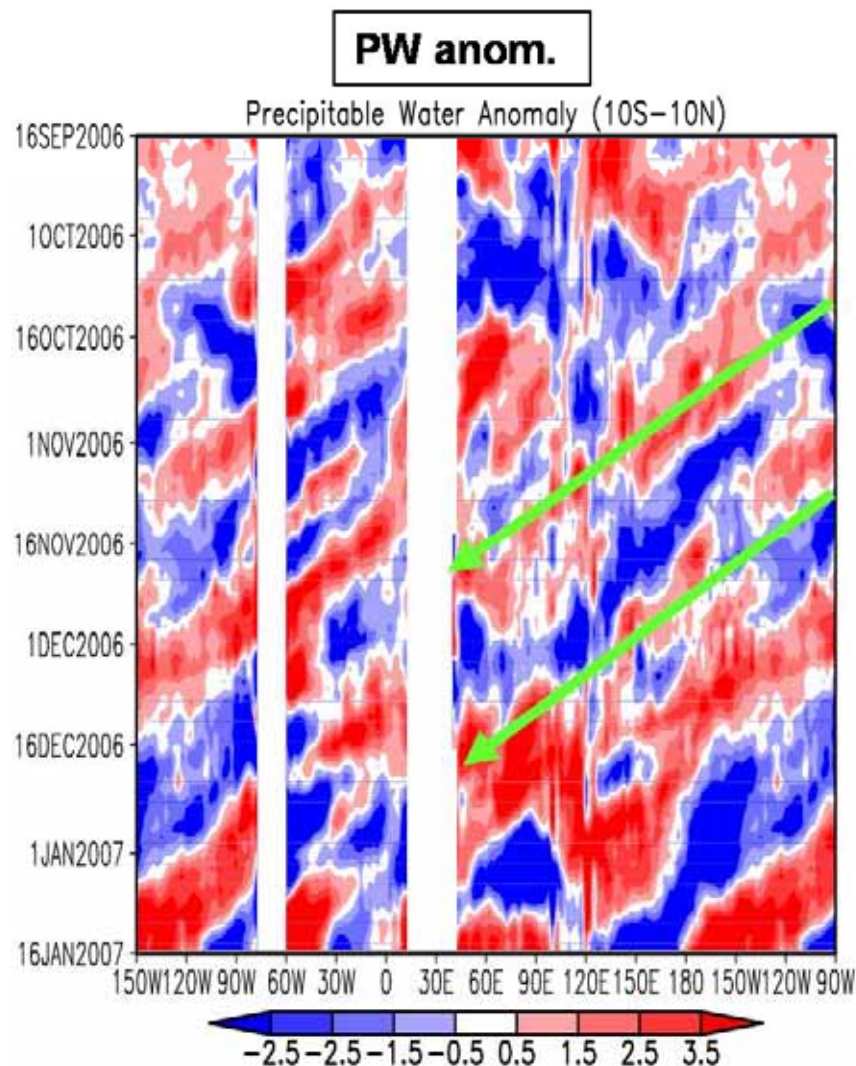
- Water vapor is one of the important factors to the convection activity.
- Associated with the positive VP, PW propagates **eastward in the western hemisphere**.
- **Westward propagating signal is clear in the eastern hemisphere.**
- Positive PW coincides with the convectively active area.
- The **westward-propagating PWs precondition the MJOs** in Nov and Dec, and enhance the convection at the intersection.
- There is no preconditioning signal in Oct.
- **Negative PW inhibits the convection and stop the MJO around the maritime-continent in Nov.**





# Relationship between PW and antisymmetric Vor.

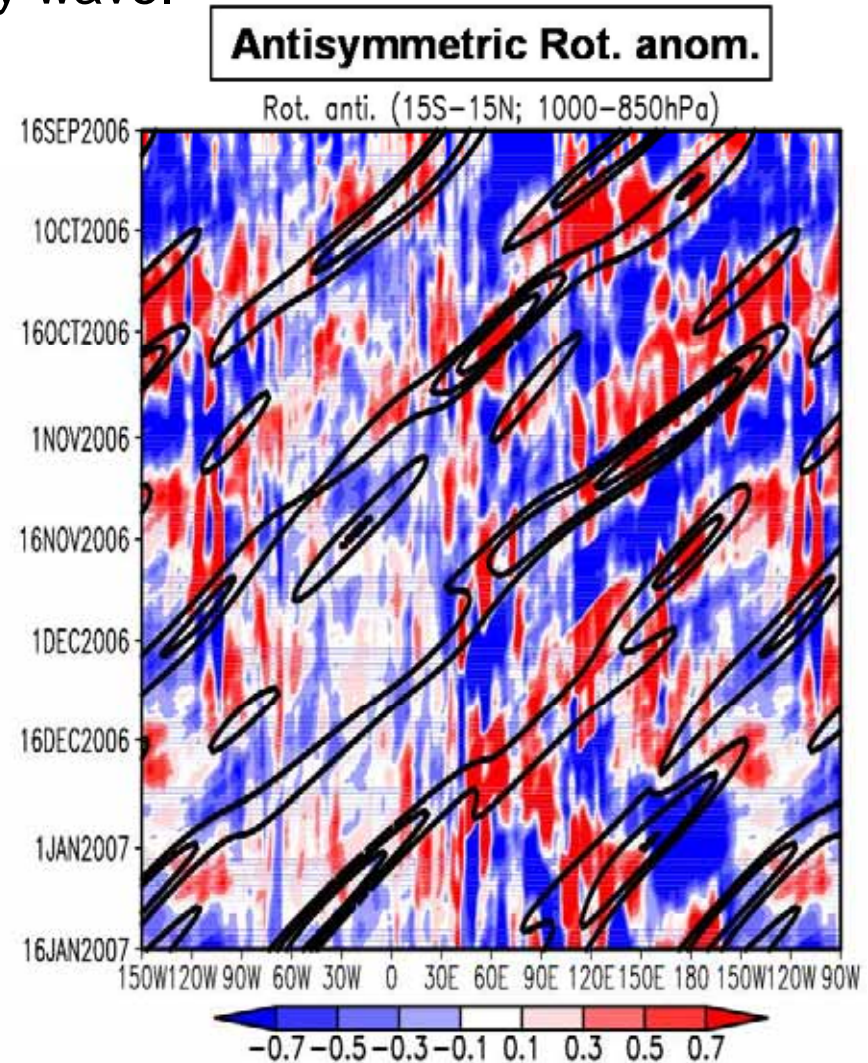
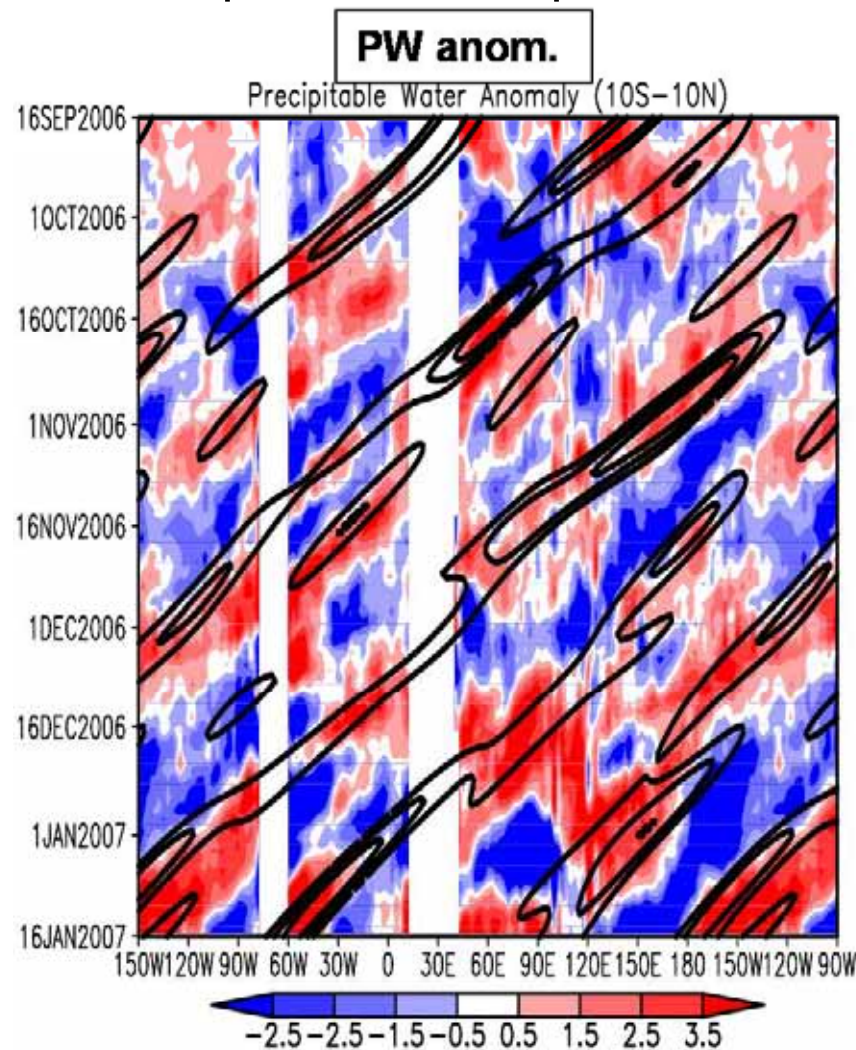
- Propagation speed of the PW is approximately equal to that of the vorticity.
- Both fields are controlled by the same wave ?





# Mode-filtered OLR anomaly

- OLR anomaly associated with the equatorial Rossby wave agree with the positive signals of PW and rotation.
- This result also supports that the westward-propagating signals correspond to the equatorial Rossby wave.





# Summary

- The positive VP propagates into the Indian Ocean 3 times.
- Convective activity is enhanced, when the positive VP arrives.
- **MJO did not necessarily develop**, although the arrival of the positive VP promotes the development of cloud cluster over the Indian ocean.
- 1<sup>st</sup> arrival of positive VP
  - The cloud cluster (Not MJO) developed at the intersection of the positive Vor. and VP.
  - No preconditioning by the westward-propagating wave
- 2<sup>nd</sup> arrival of positive VP
  - The cloud cluster (MJO) developed at the intersection of the positive Vor. and VP.
  - Preconditioning by the westward-propagating wave
  - Negative PW anomaly and MJO meet around the maritime-continent, and MJO stops there.
- 3<sup>rd</sup> arrival of positive VP
  - The cloud cluster (MJO) developed at the intersection of the positive Vor. and VP.
  - Preconditioning by the westward-propagating wave
  - Negative PW anomaly and MJO do not meet until the MJO propagates around the date line.
- PW and vorticity associated with the equatorial Rossby wave are important to the MJO onset and development.