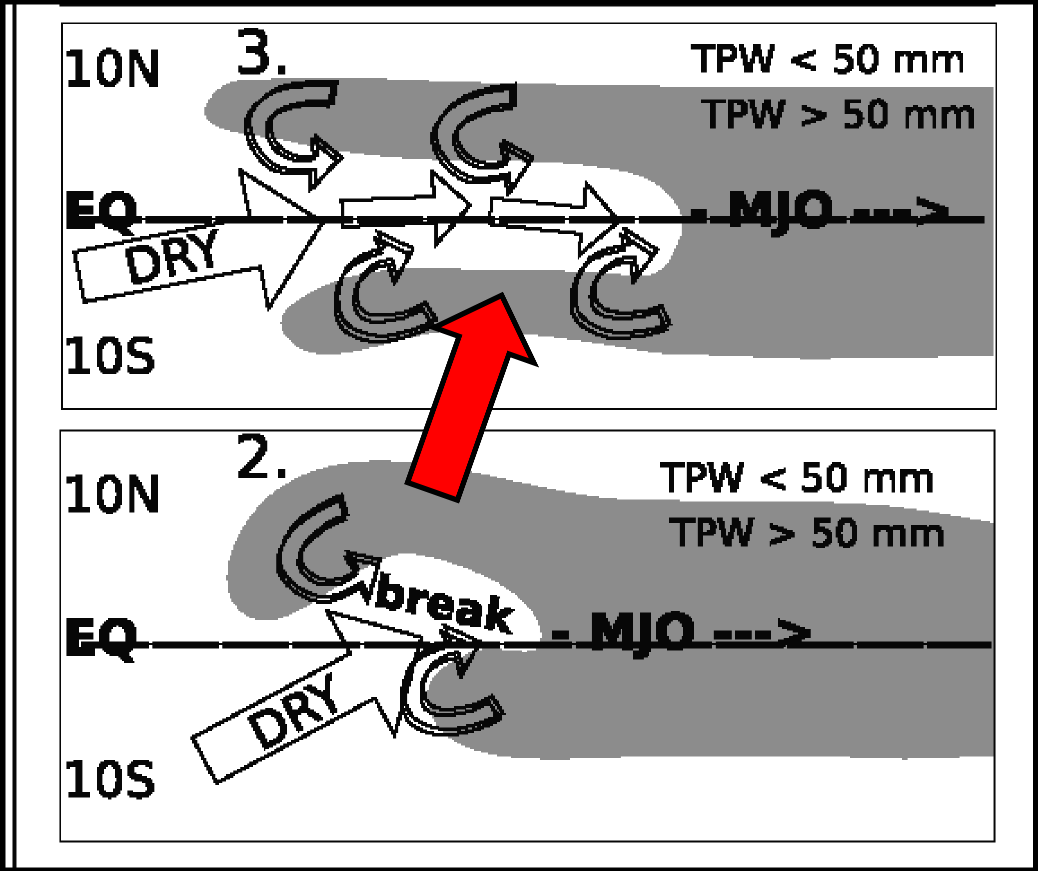
Moisture Advection by Rotational and Divergent Winds Associated with an MJO

Kazu. Yasunaga

(JAMSTEC/Univ. of Toyama)

Importance of horizontal advection of qv

- CINDY/DYNAMO (Kerns and Chen, 2013)



Frequent Intrusion of dry air and synoptic eddies

MJO convection was suppressed by dry-air intrusions, and moved to the east.

Importance of horizontal advection of qv

- Simple linear model (Sobel, and Maloney,2012)

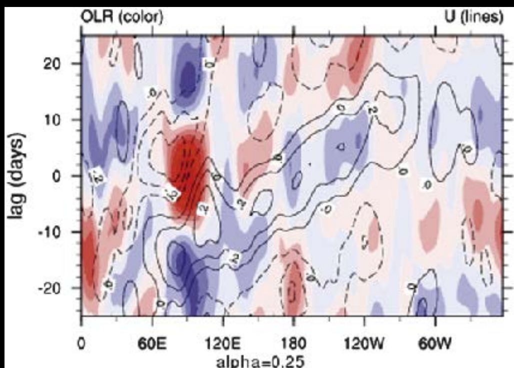
Modulation of synoptic-eddy drying is included in the term (Cu – D).

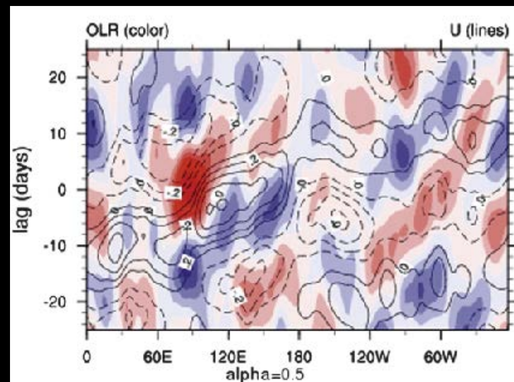
$$\frac{\partial W}{\partial t} + U\frac{\partial W}{\partial x} = -\tilde{M}P + (C_u - D)u - (1-\tilde{M})R + k_w\frac{\partial^2 W}{\partial x^2}. \quad (10)$$

Synoptic-eddy drying contributes to eastward propagation of the MJO.

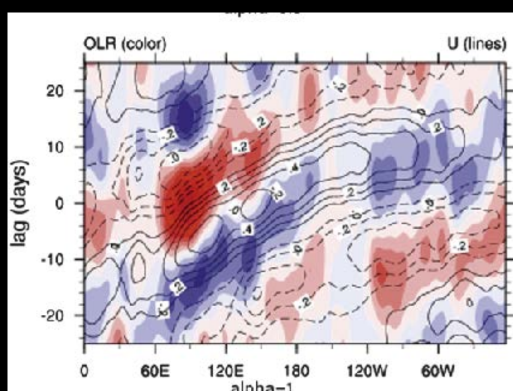
Importance of horizontal advection of qv

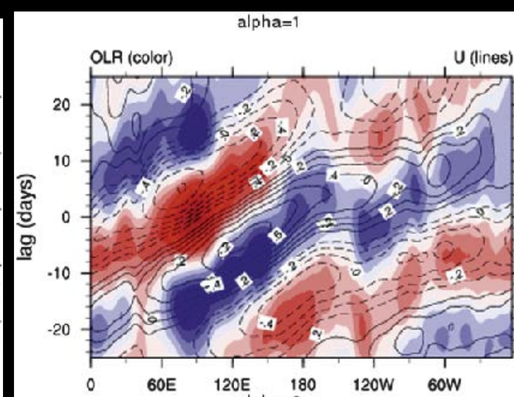
- SPCAM (Pritcharda and Bretherton, 2014)

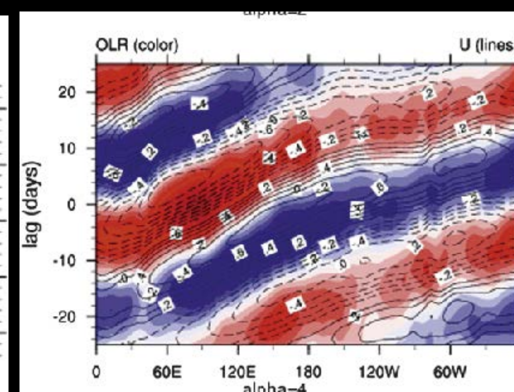




Tropical moisture advection by vorticity anomalies is artificially modulated in a SPCAM.







More rotational

Boosting horizontal moisture advection by tropical vorticity anomalies accelerates and amplifies the simulated MJO.

Decomposition of horizontal velocity

$$-\mathbf{v}\cdot\nabla q_v$$

↓

LF component ISV component HF component

$$-\mathbf{v}^{LF}\cdot\nabla q_v-\mathbf{v}^{ISV}\cdot\nabla q_v-\mathbf{v}^{HF}\cdot\nabla q_v$$

↓

rotational component divergent component

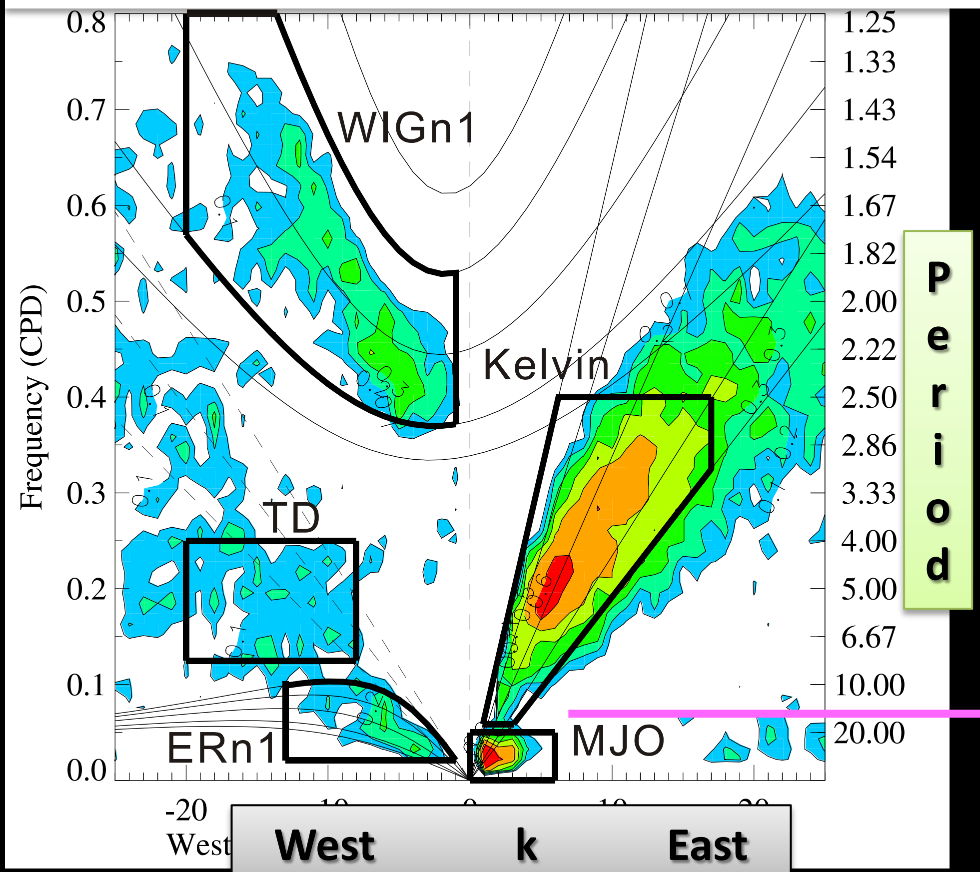
$$-(\mathbf{v}_{\psi}^{LF}+\mathbf{v}_{\psi}^{ISV}+\mathbf{v}_{\psi}^{HF})\cdot\nabla q_v-(\mathbf{v}_{\chi}^{LF}+\mathbf{v}_{\chi}^{ISV}+\mathbf{v}_{\chi}^{HF})\cdot\nabla q_v$$

Each term is evaluated by using reanalysis data (ERA)

Methodology

Linear regression between MJO rainfall anomalies, and moisture advection from a global reanalysis dataset.

Power spectrum of rainfall



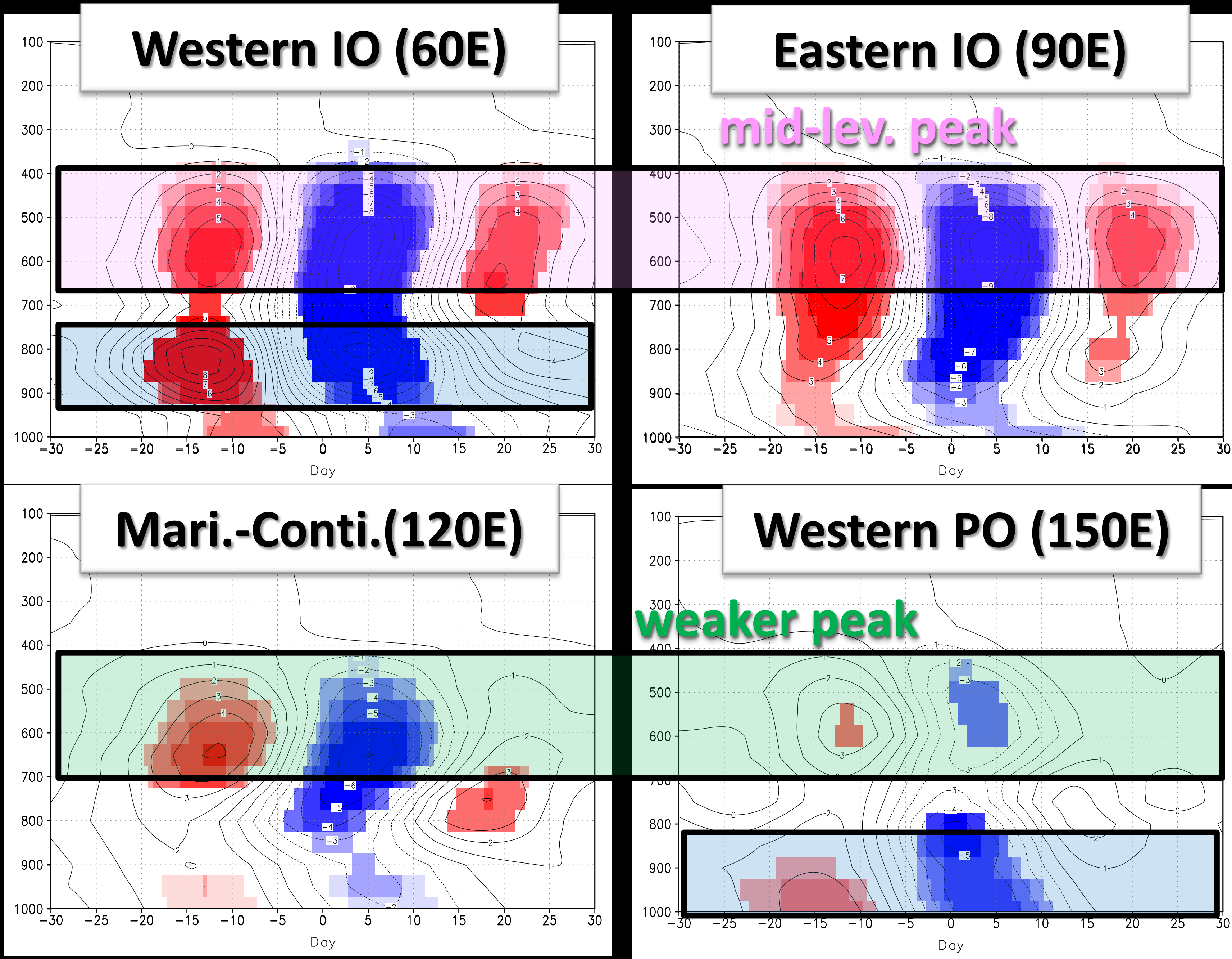
DATA: TRMM-3B42, ERA-Interim

Period: JAN. 1998 to DEC. 2013

MJO rainfall anomalies

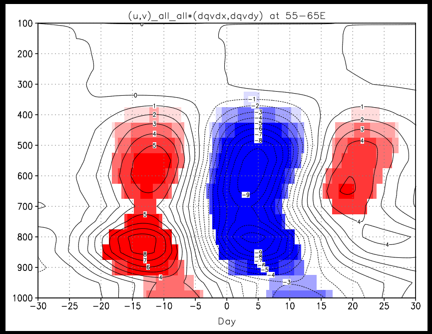
back to a real space from a spectral space

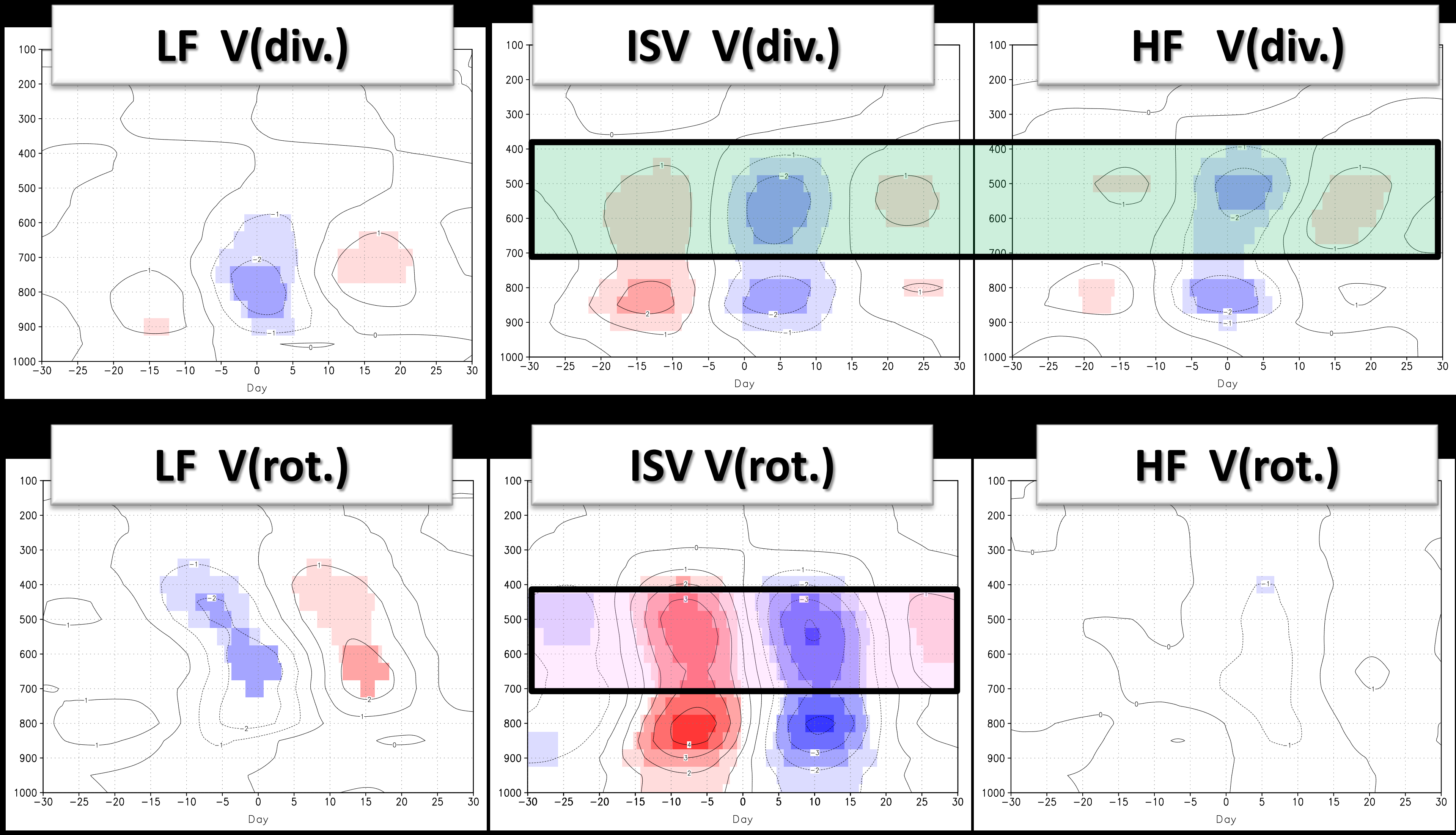
horizontal advection of qv around the Eq.



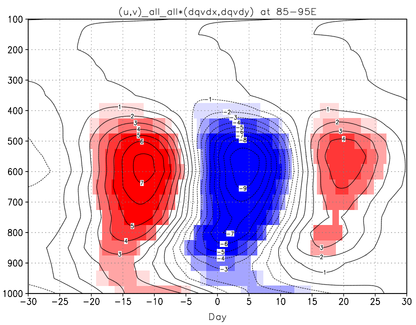
Decomposition of qv adv.

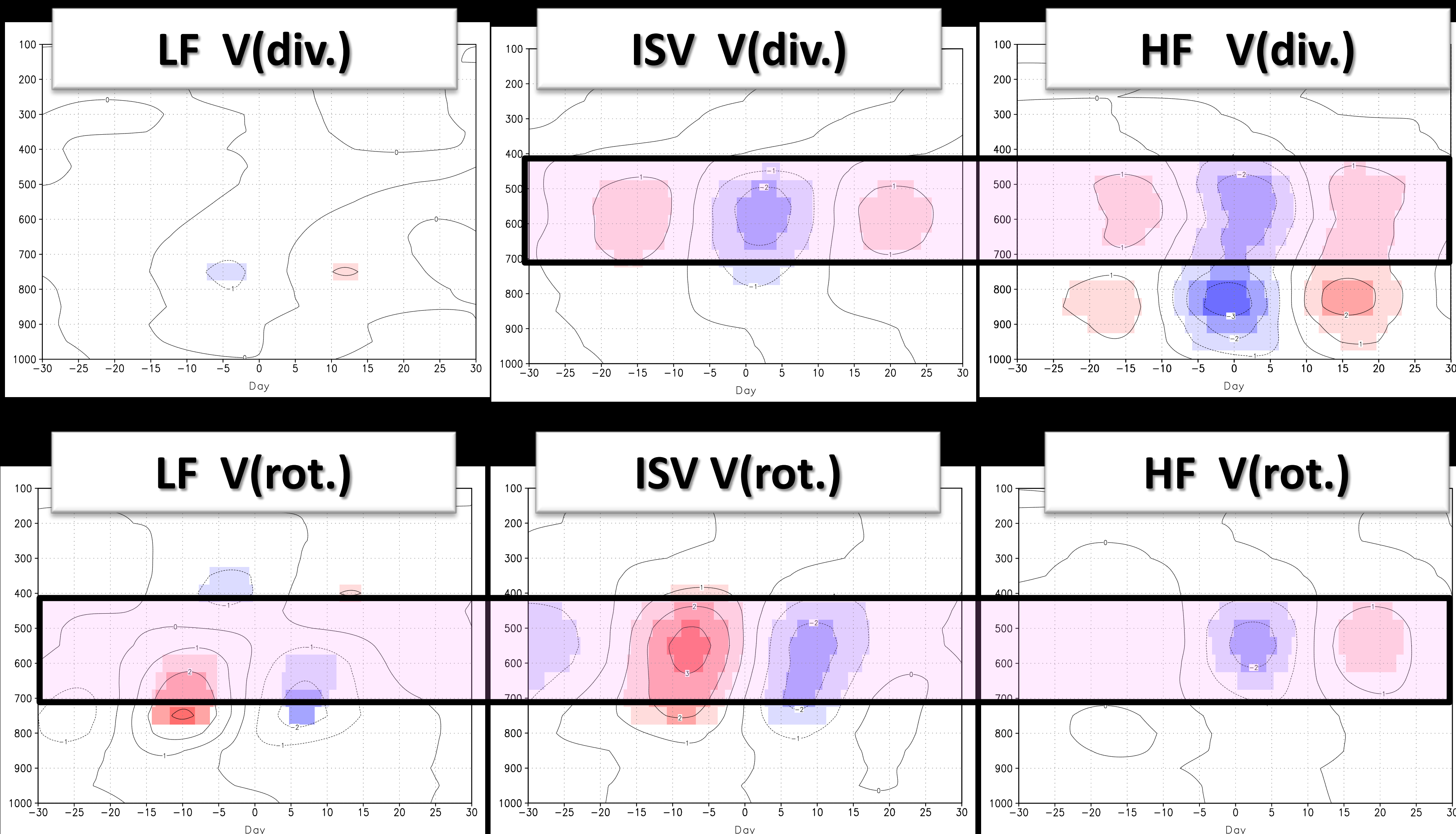
Western Indian Ocean(60E)

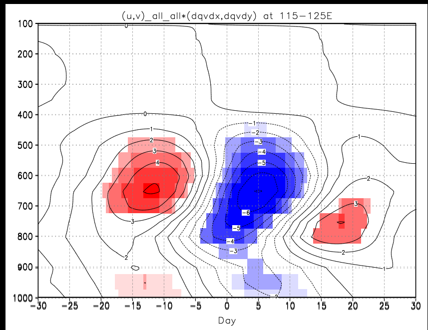




Decomposition of qv adv.
Eastern Indian Ocean(90E)

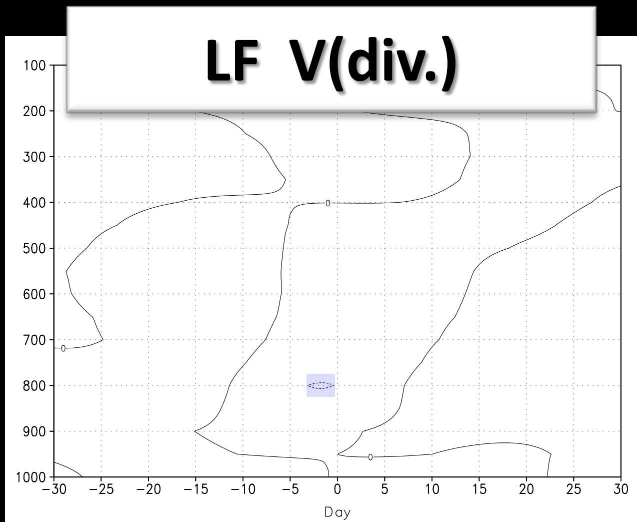


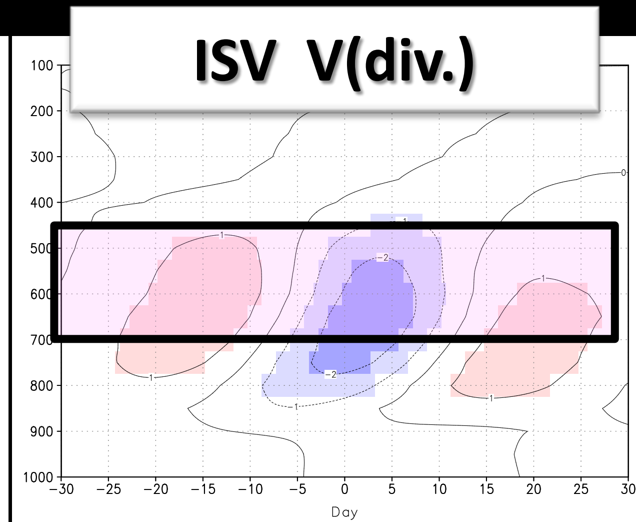


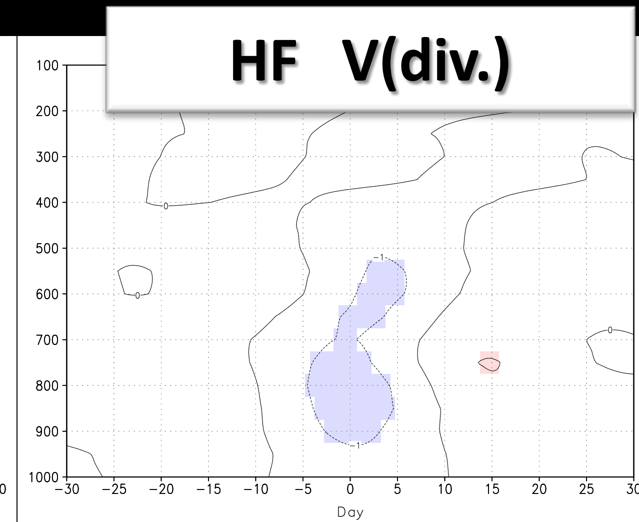


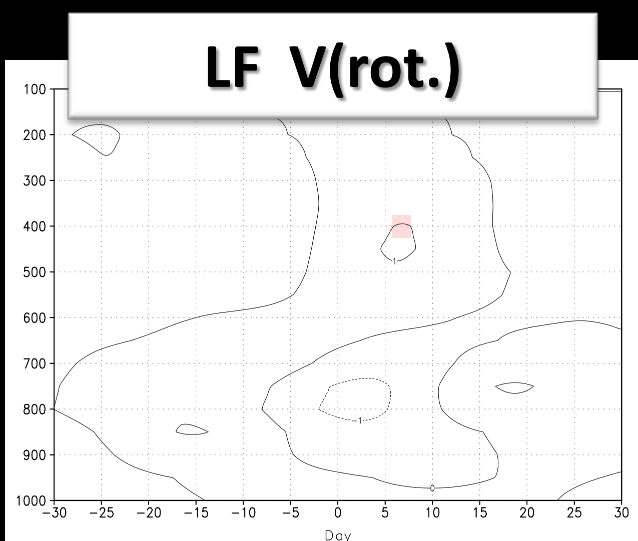
Decomposition of qv adv.

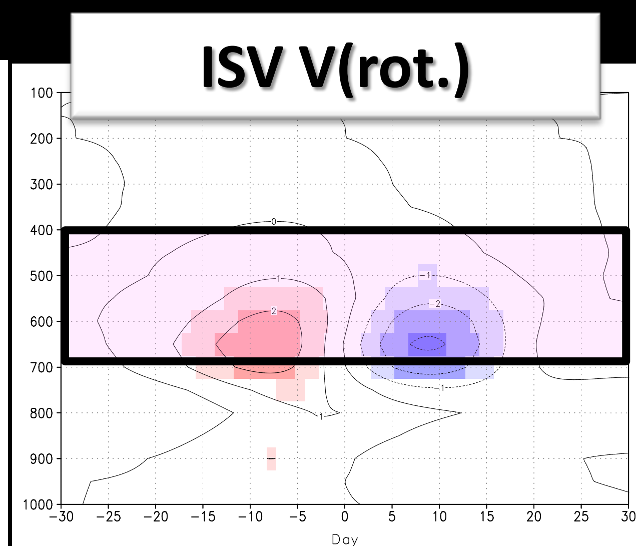
Maritime-Continent (120E)

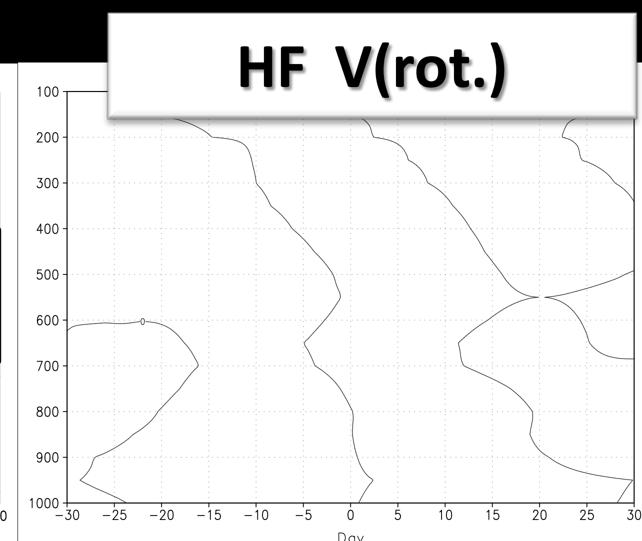


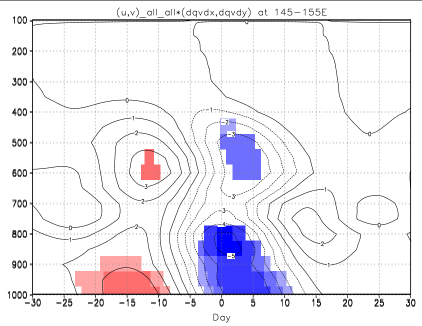






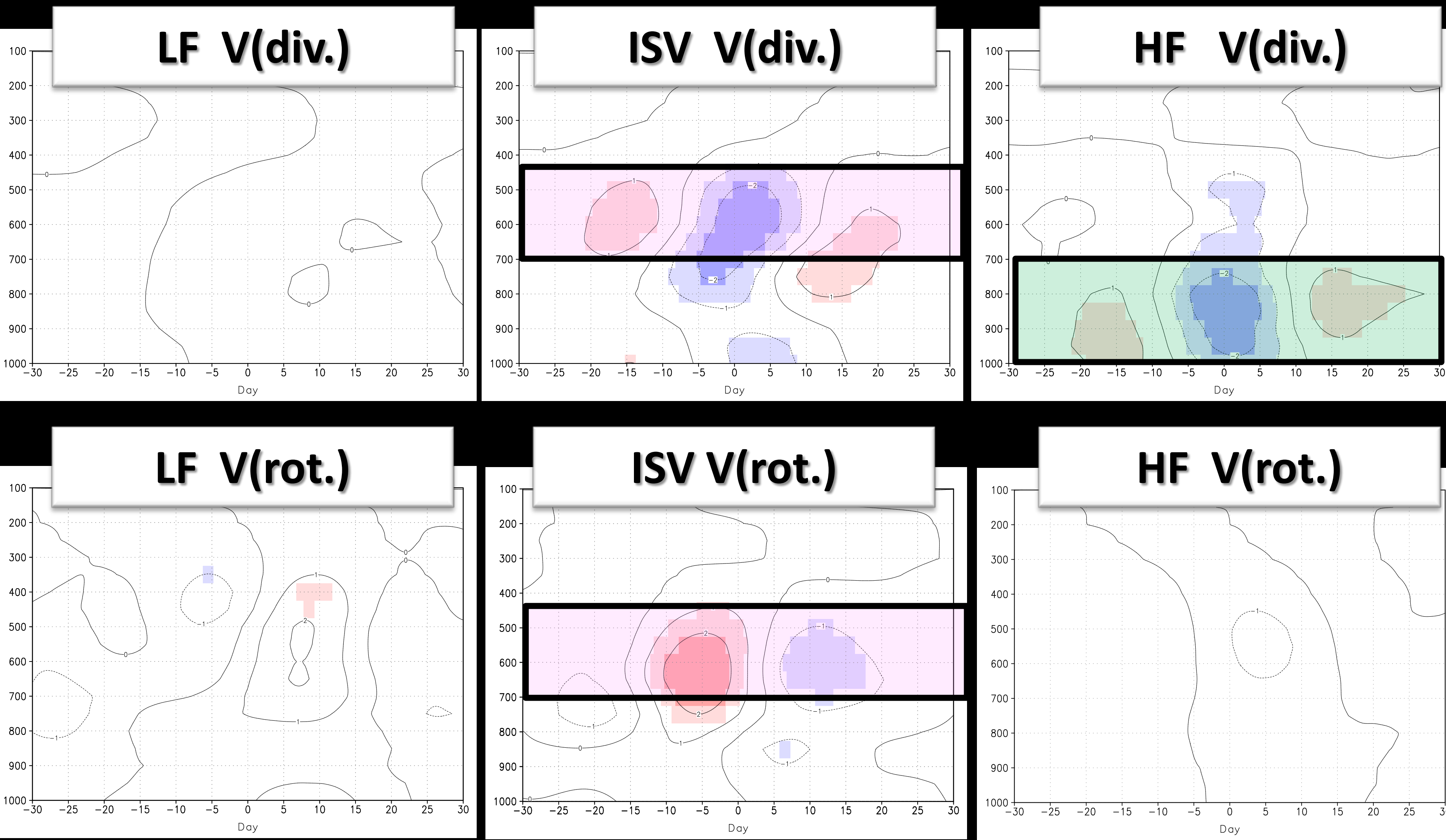




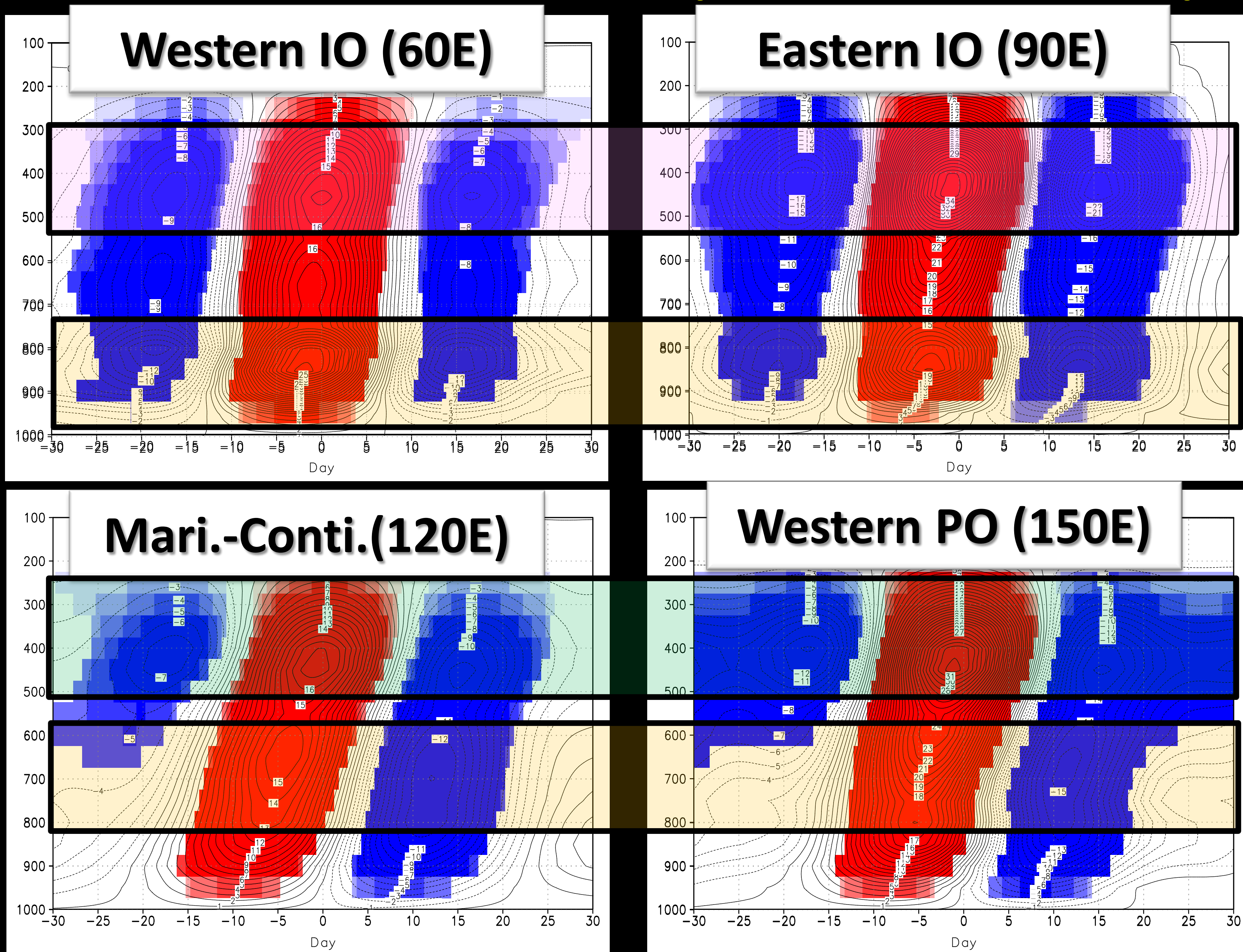


Decomposition of qv adv.

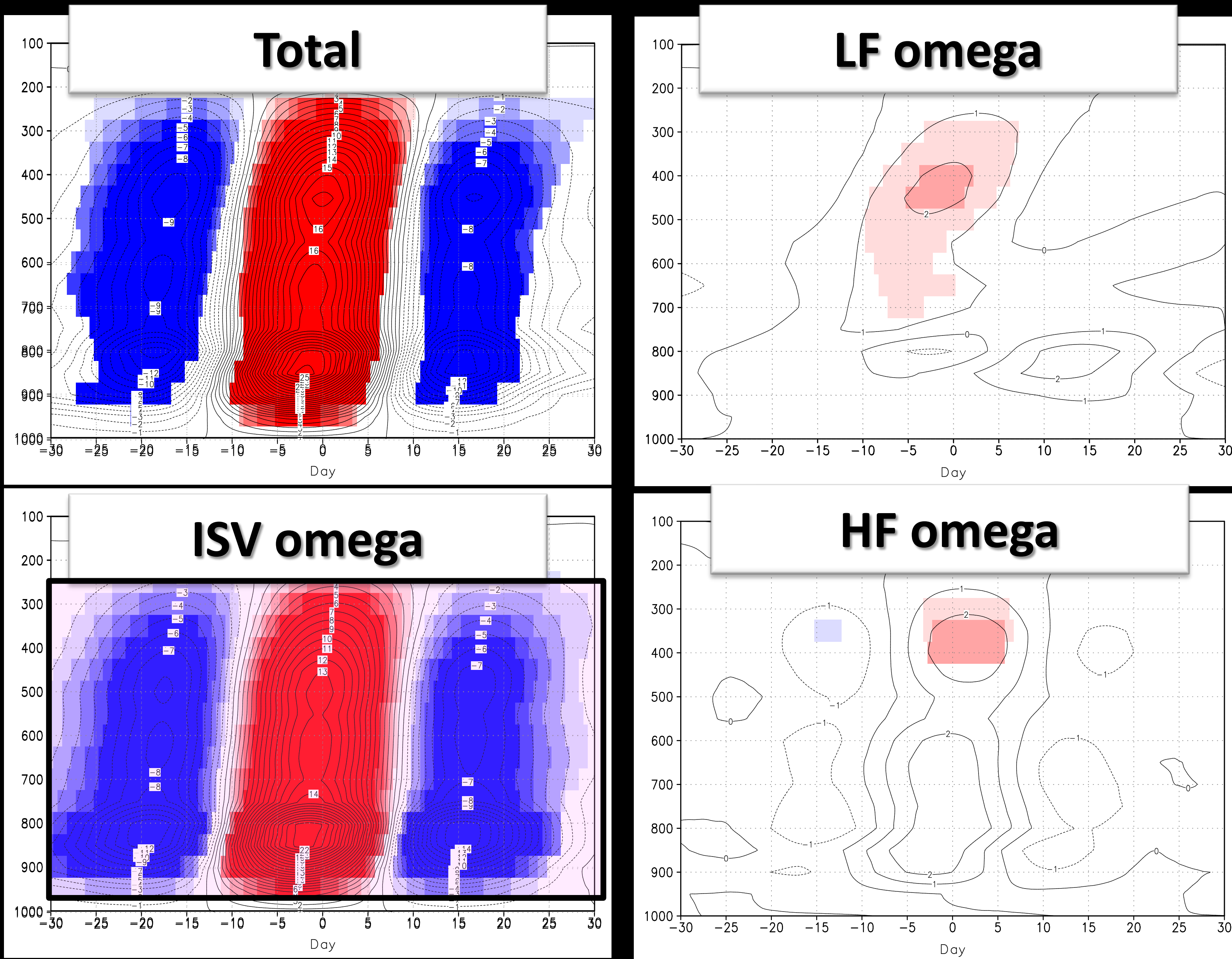
Western Pacific Ocean (150E)



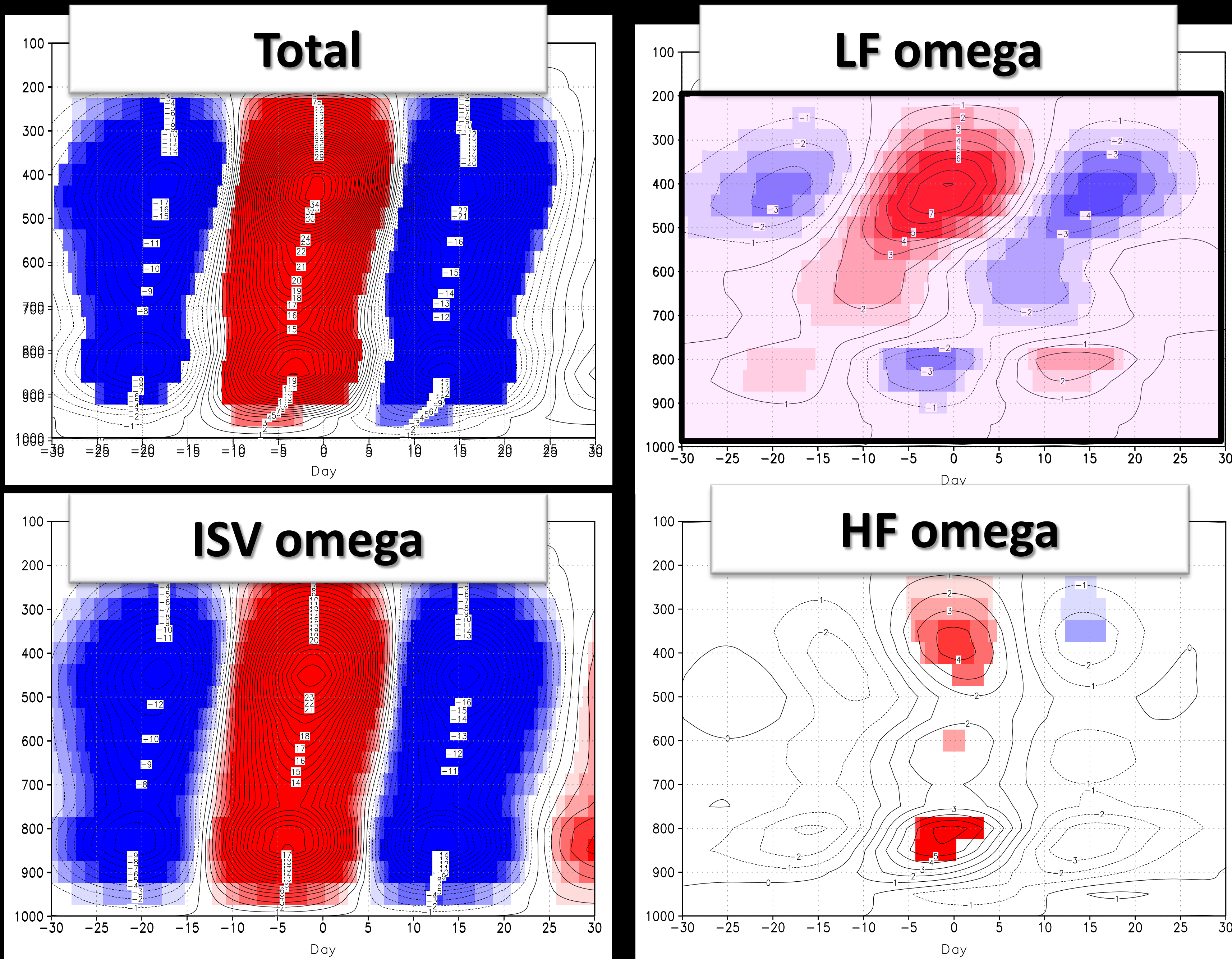
Vertical advection of qv around the Eq.



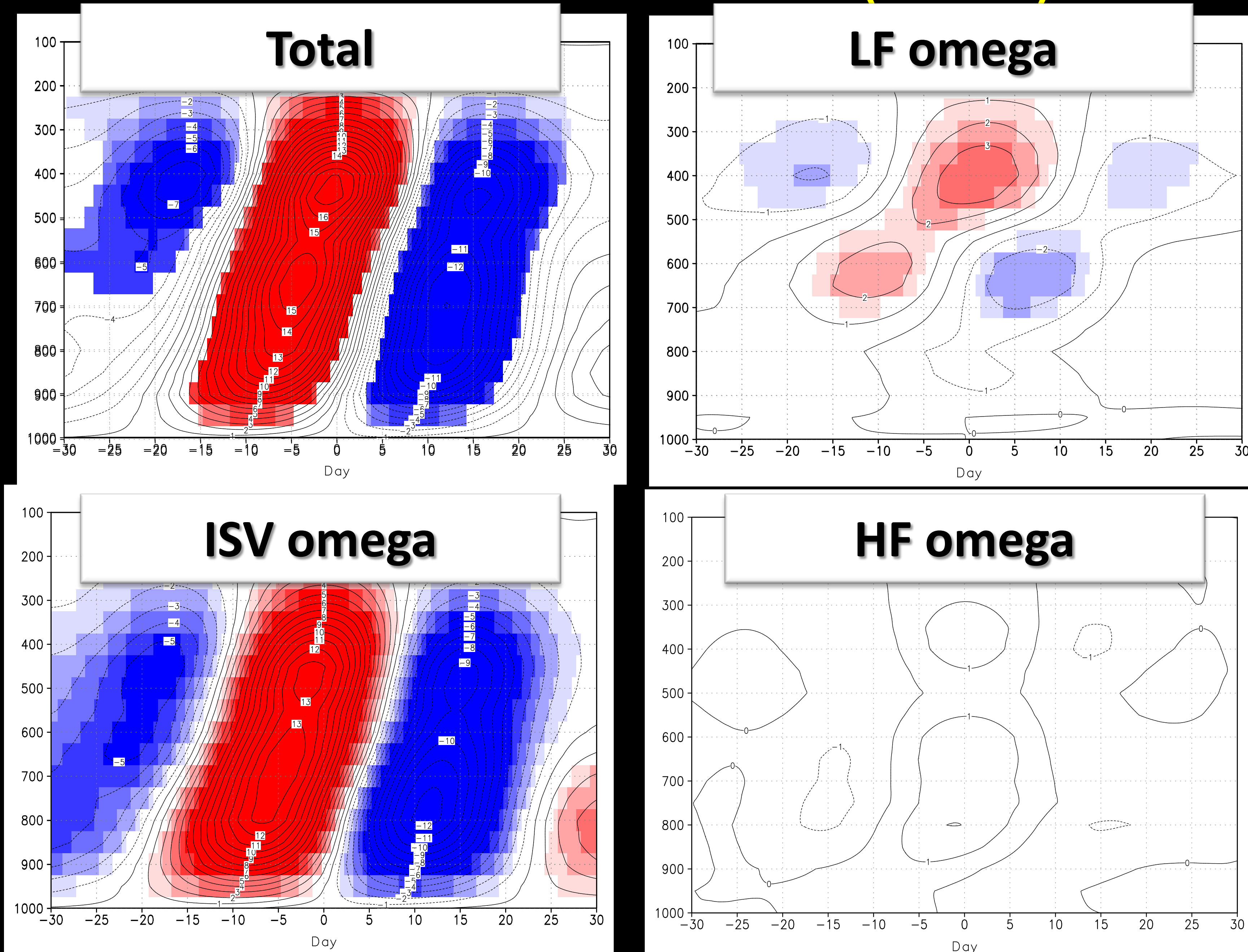
Western Indian Ocean(60E)



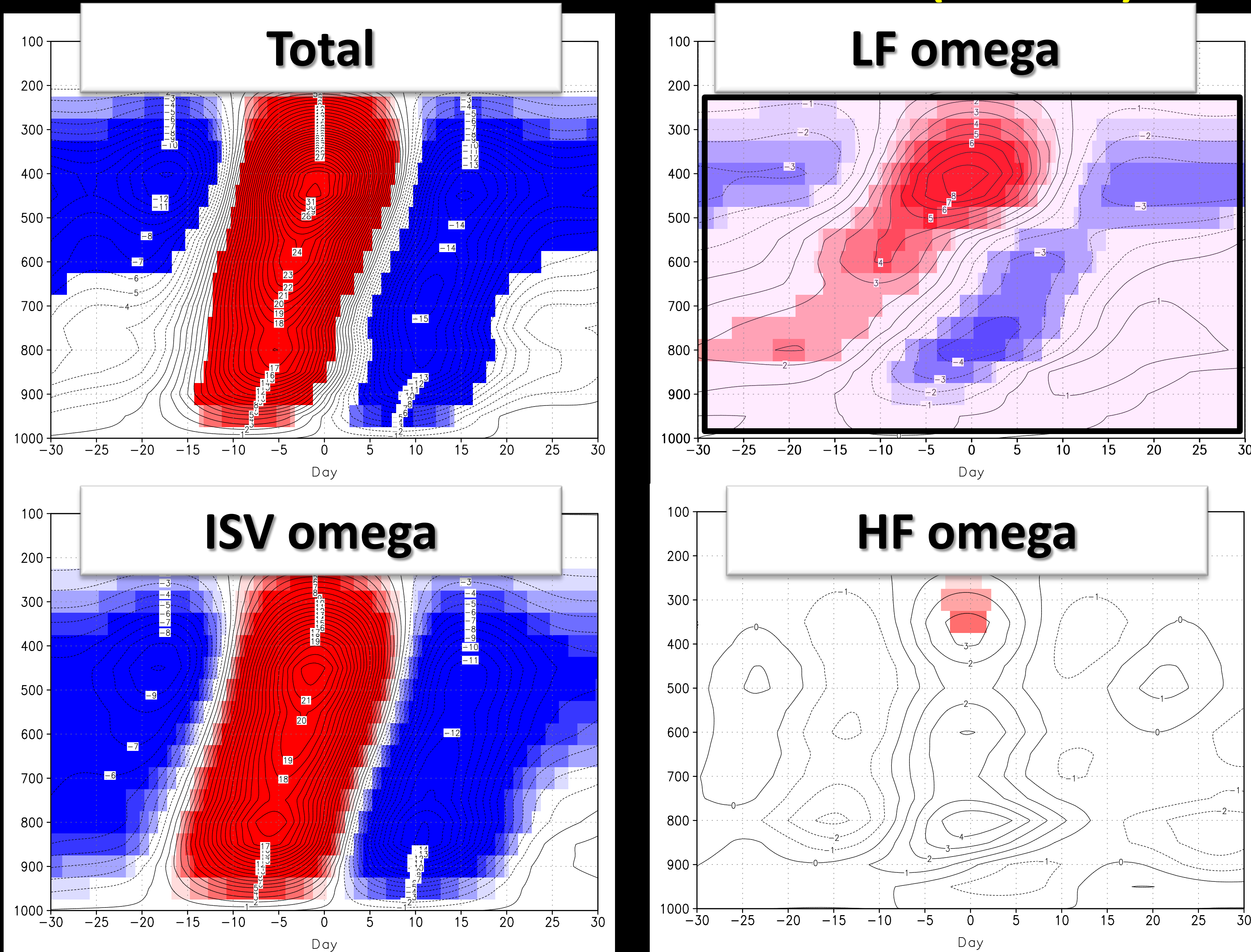
Eastern Indian Ocean(90E)



Maritime-Continent (120E)



Western Pacific Ocean (150E)



Summary(1)

- Horizontal wind -> 3 components (LF, ISV, and HF).
- LF, ISV, and HF components -> rot. and div. components.
- Relative importance of the horizontal advection is evaluated.

- Horizontal advection signals are more dominant over IO.
- Over the Western IO: ISV (rot.) wind
- Over the Eastern IO: all wind , except for LF div. wind.
- Over the maritime-continent: ISV (rot. and div.) winds
- Over the Western PO: ISV and HF (div.) winds

- Relative importance varies from a region to a region.
- Adequate evidence of synoptic eddy drying is not found.

Summary(2)

- Vertical moisture advection is much more important.
- Verticatal wind -> 3 components (LF, ISV, and HF).
- Relative importance of the vertical advection is evaluated.

- Vertical advection of moisture mainly results from ISV winds.
- Over the Eastern IO, and Western PO, LF vertical wind cannot be negligible.

- Environmental upward motion is important for the propagation of an MJO?