Variability of the West African Monsoon: an integrated view of the SHL and the AEW processes

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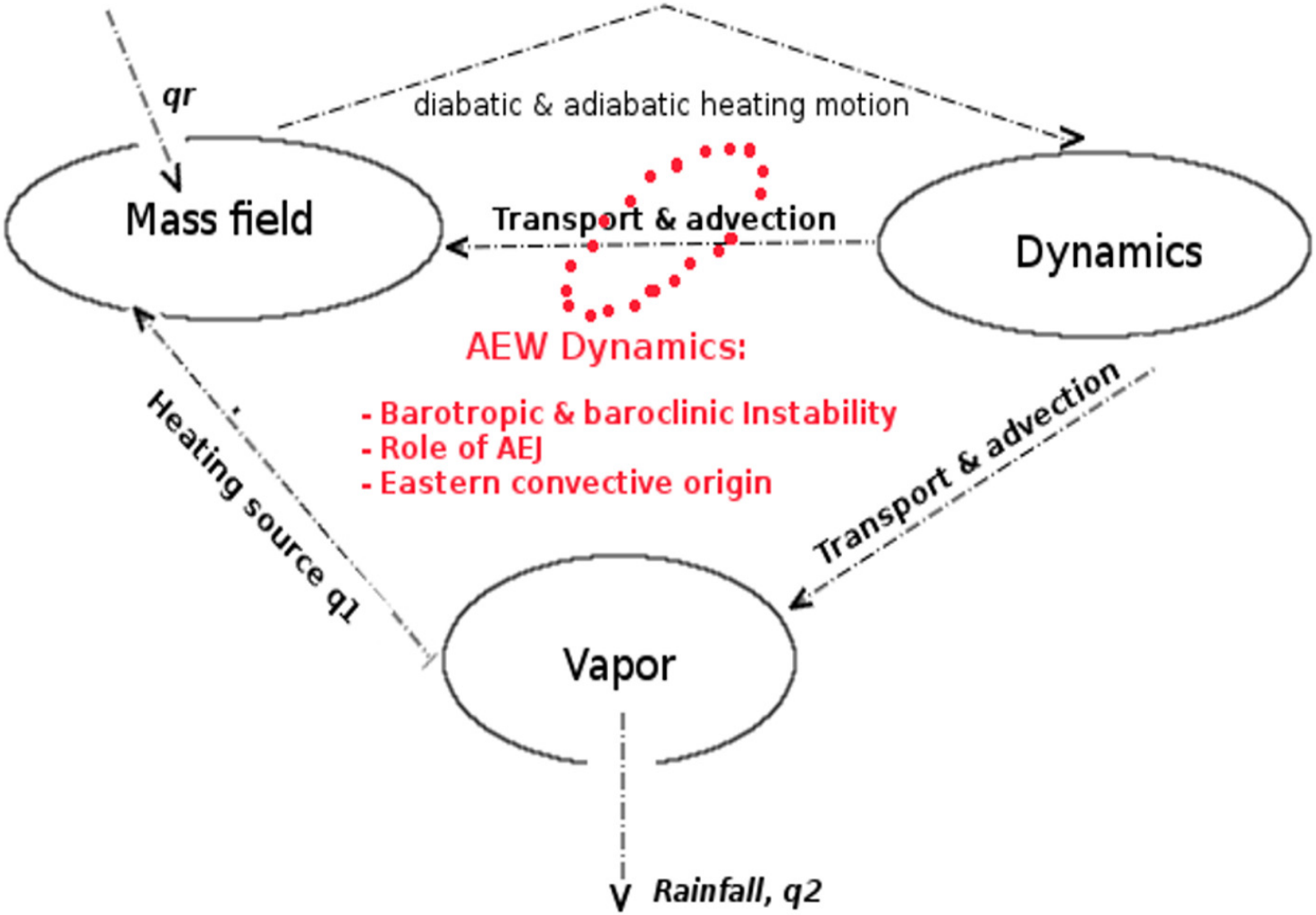
3-Dimensionnal Approach



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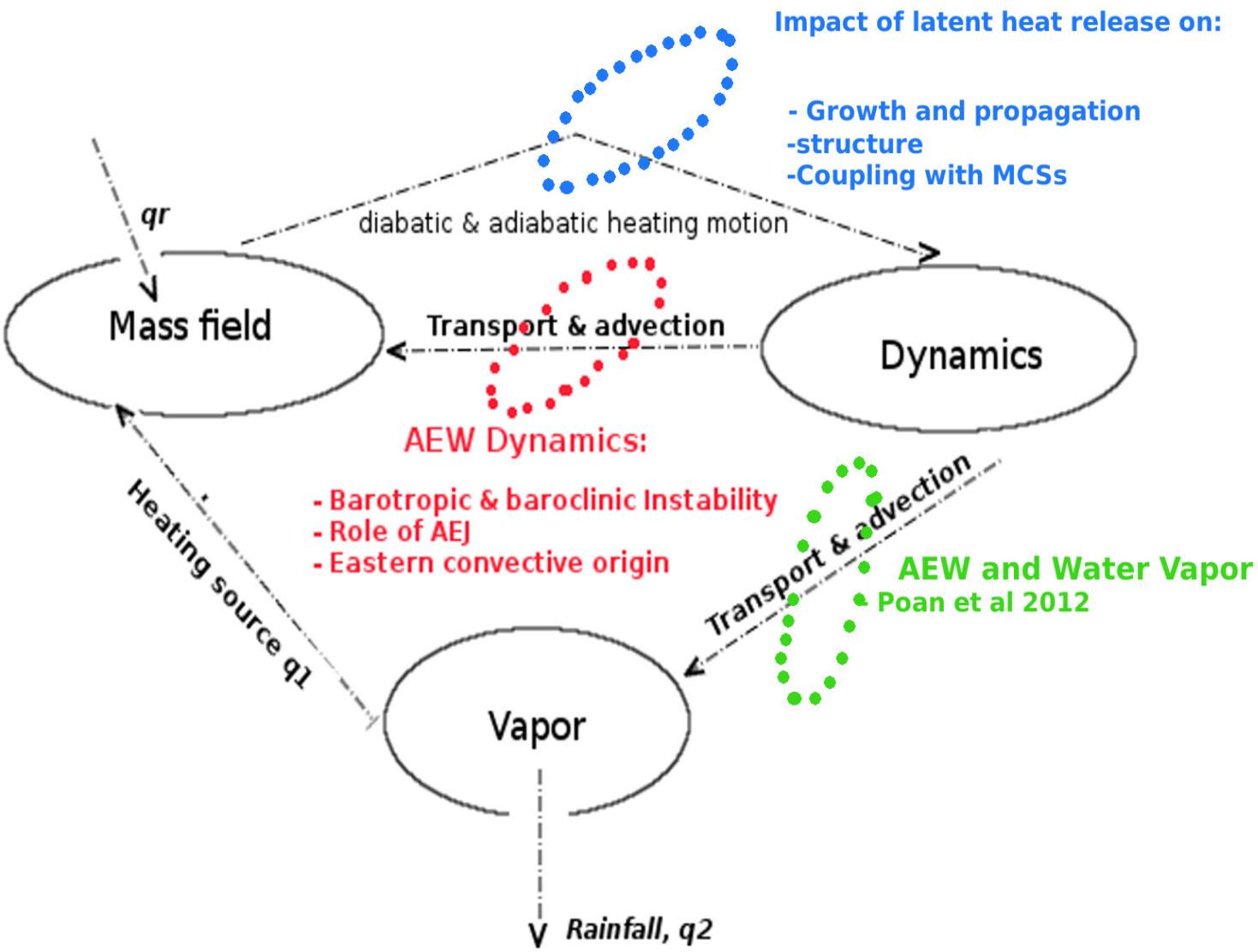

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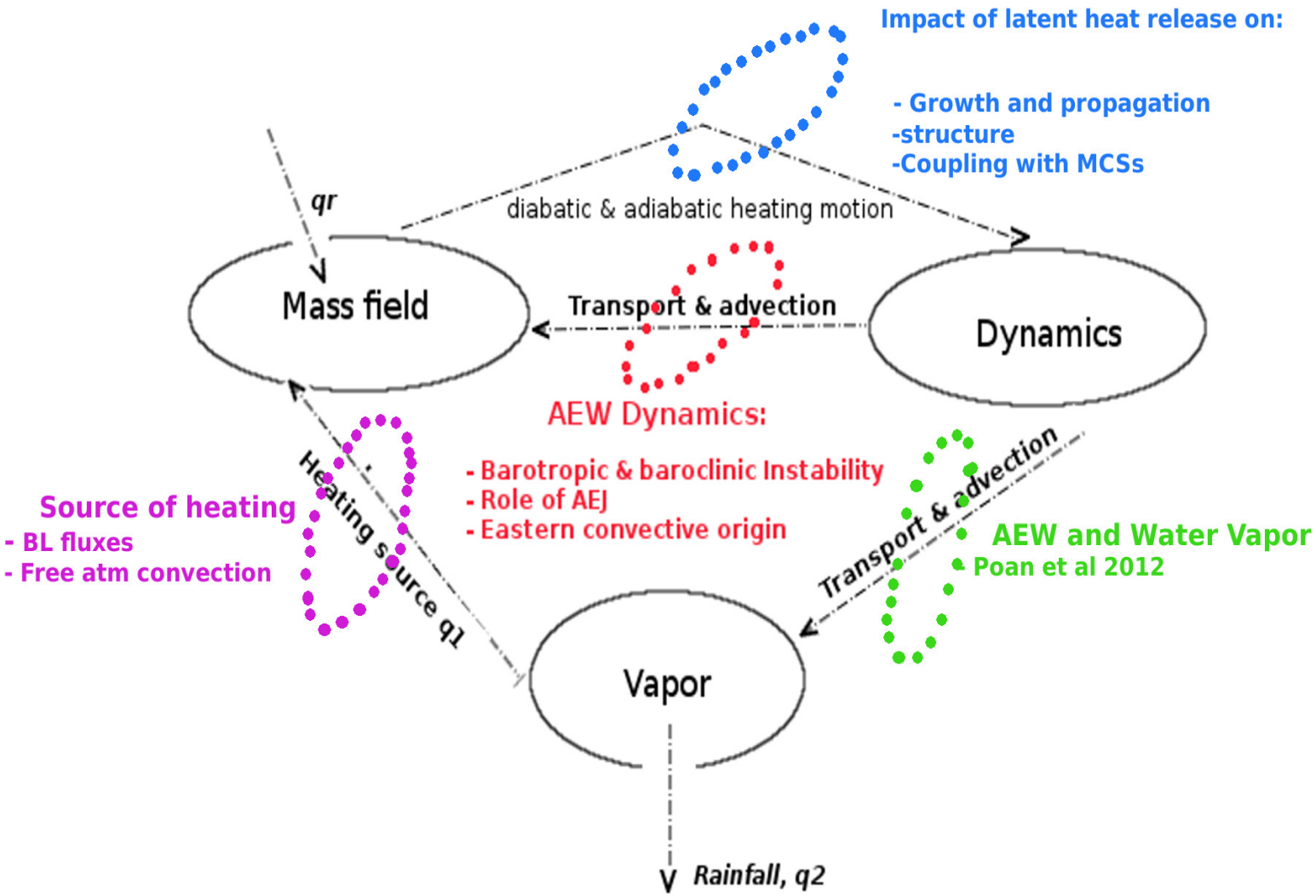

Main goals

- The mechanisms inside each box

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- The interactions between the different boxes

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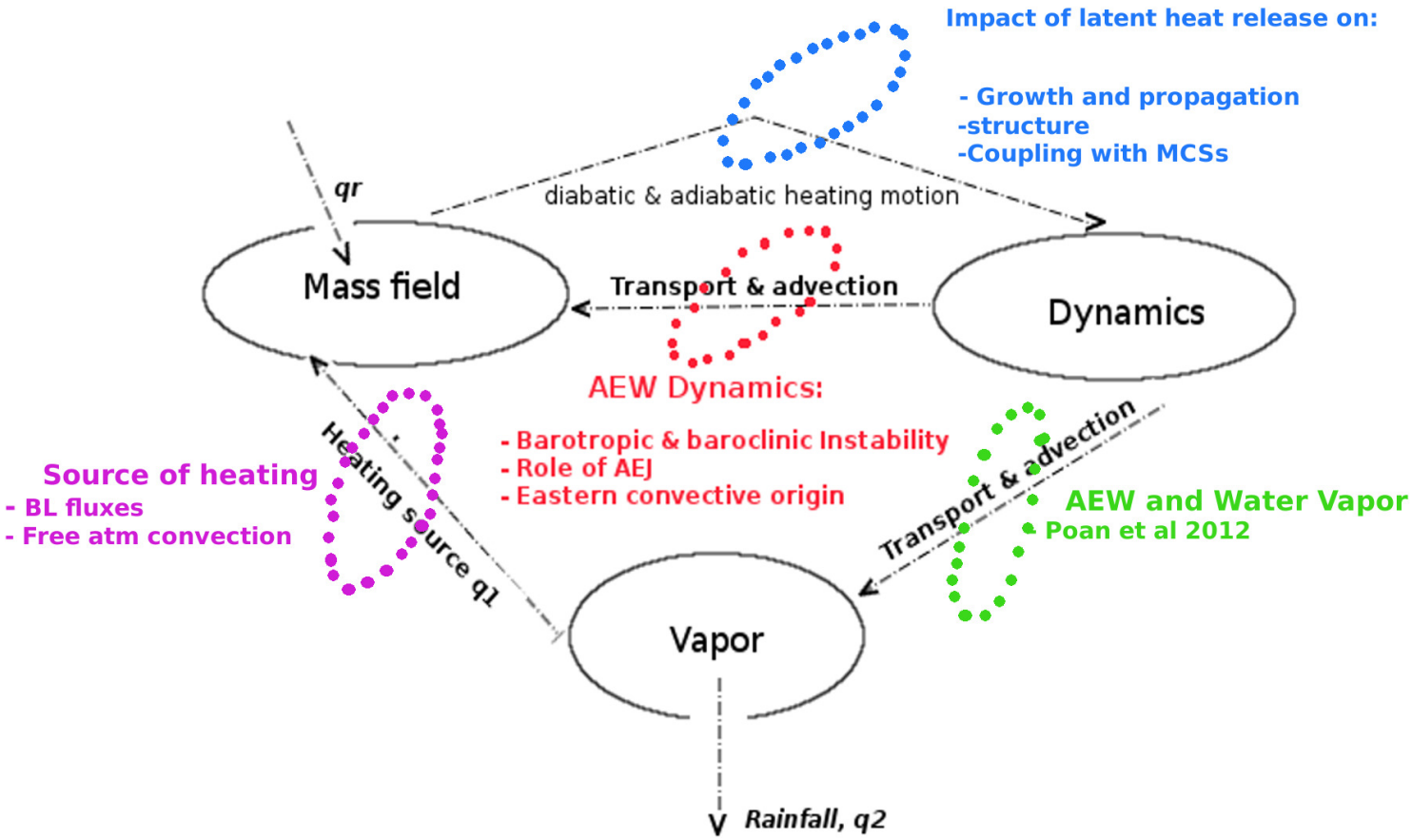
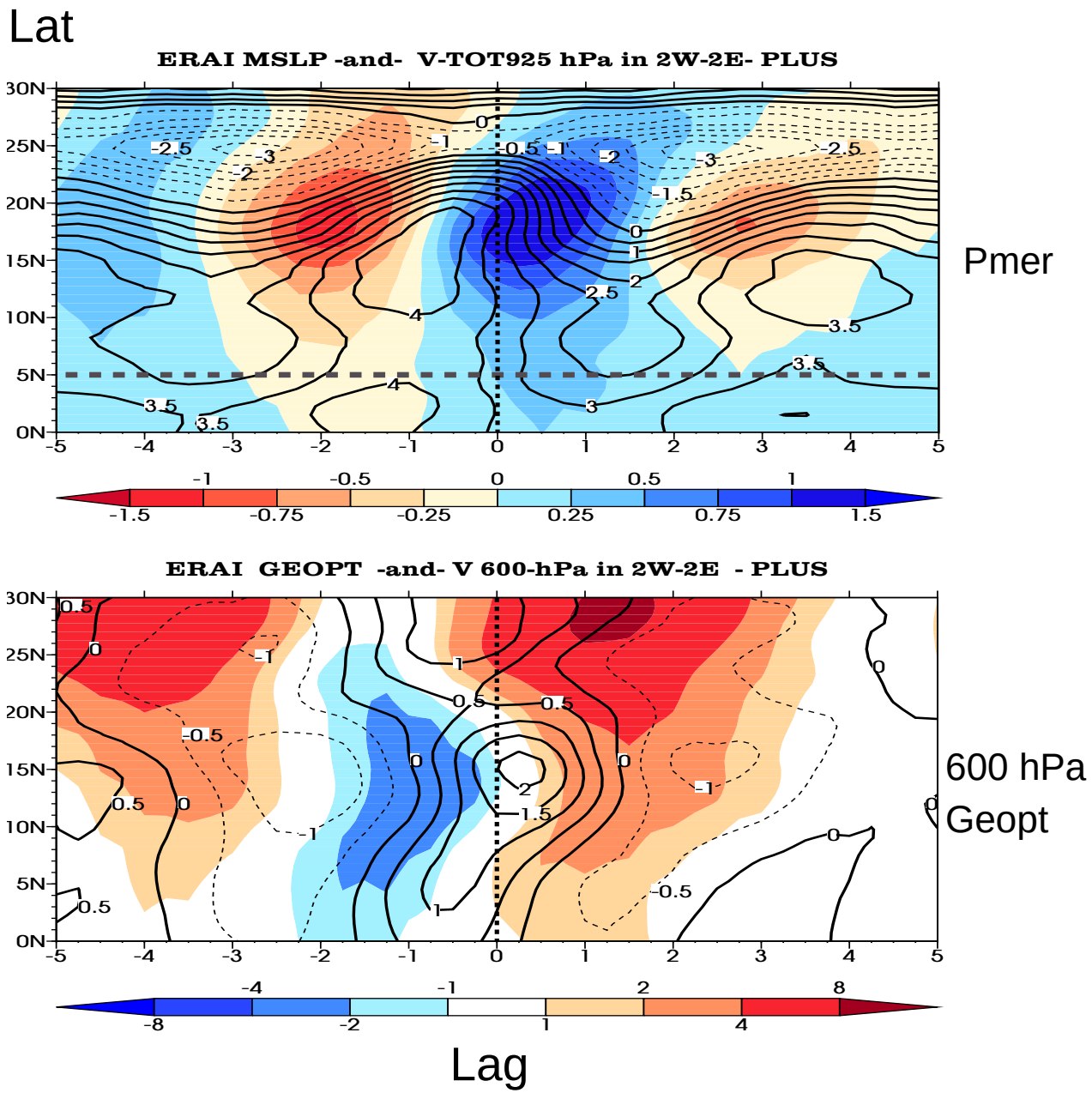
- The mechanisms inside each box
- The interactions between the different boxes
- A consistent scheme of the global physics

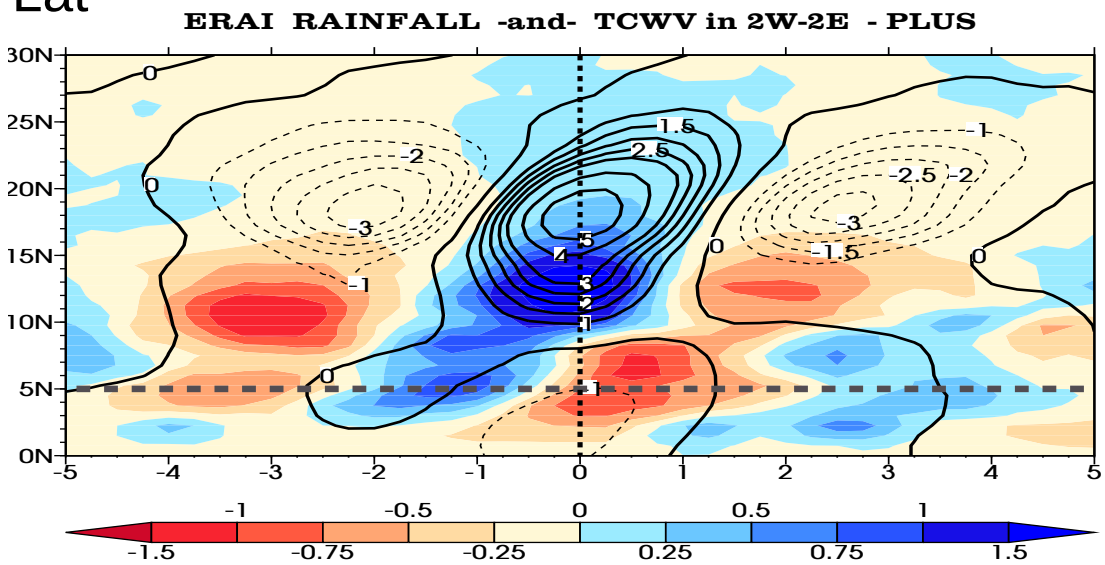


Latitude-Time Evolution of Mass Field

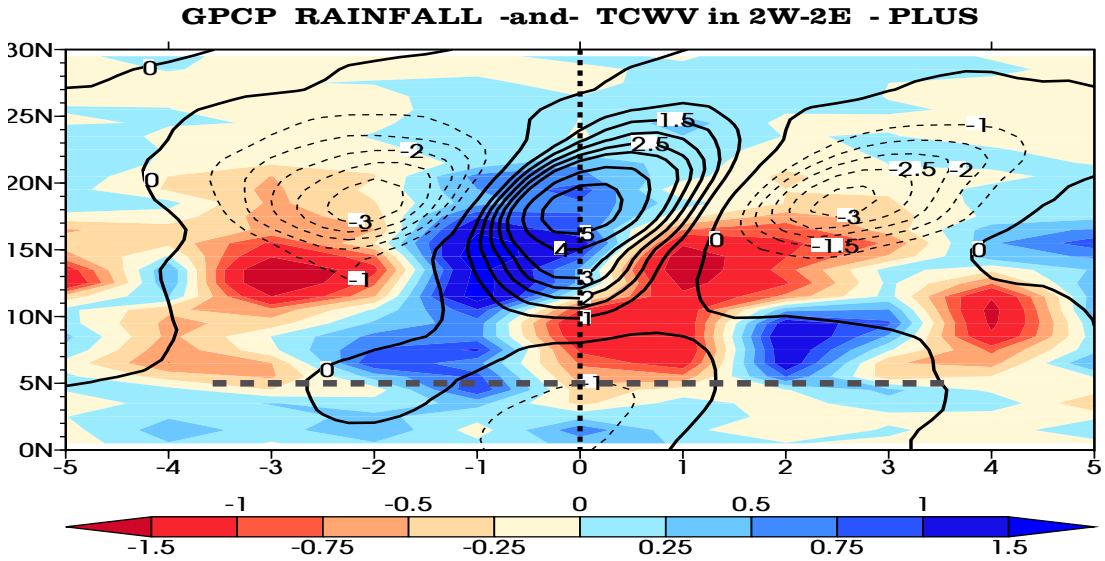


Latitude-Time Evolution of Rainfall

Lat



ERAI



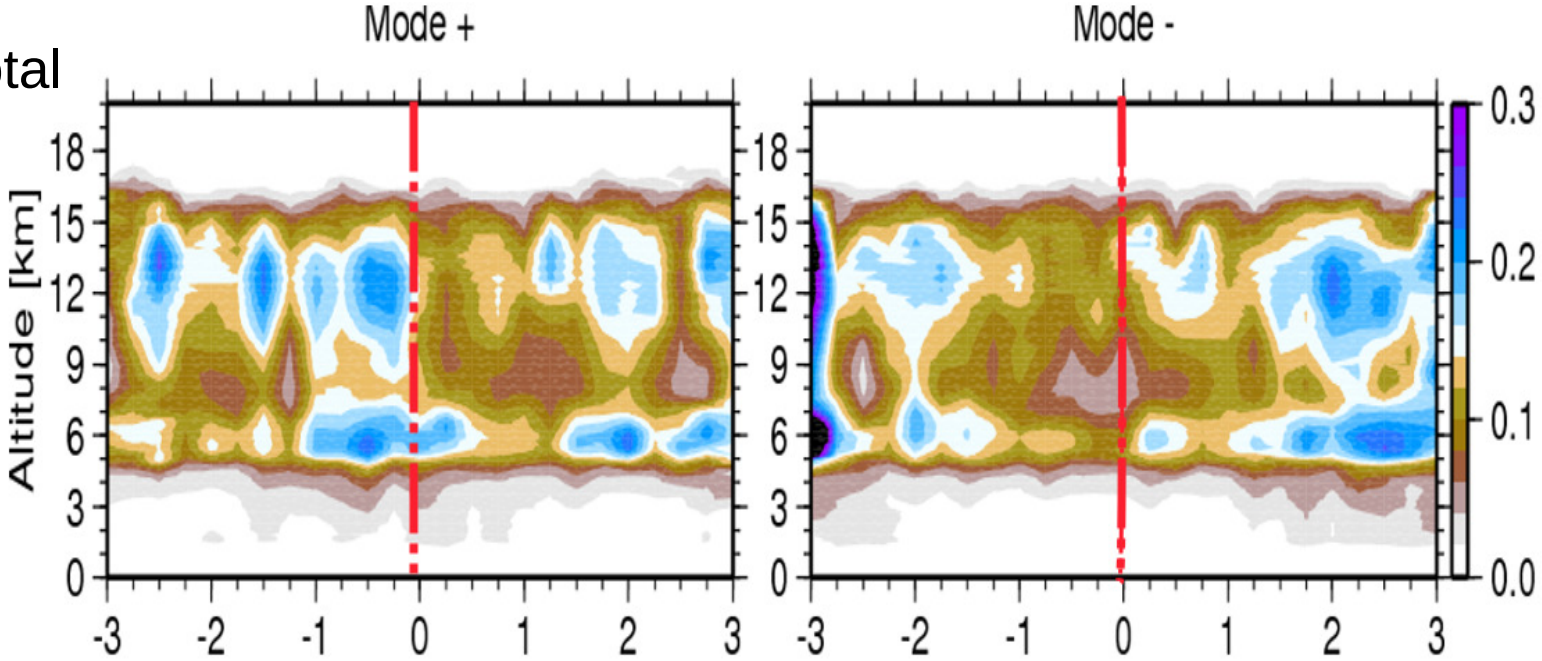
GPCP

Lag

From cloud observations

Cloud Fraction

Total



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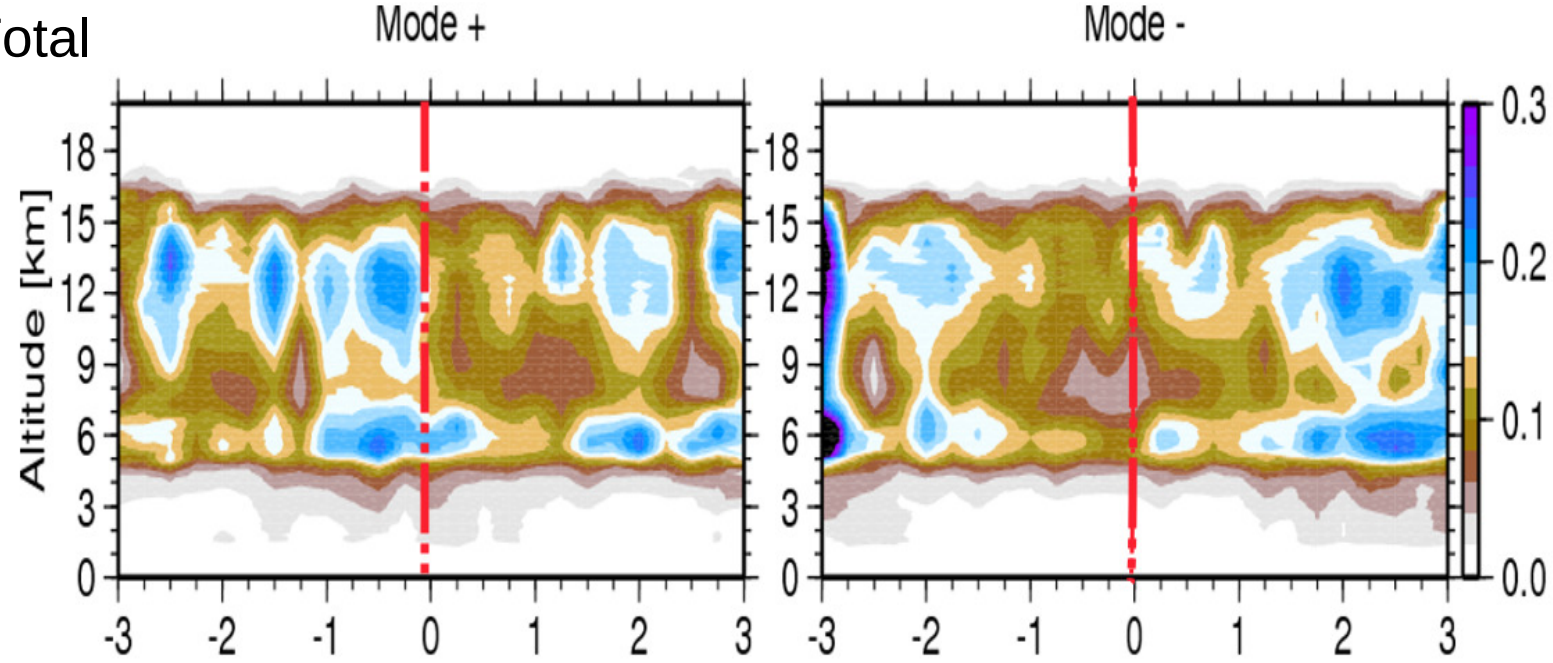
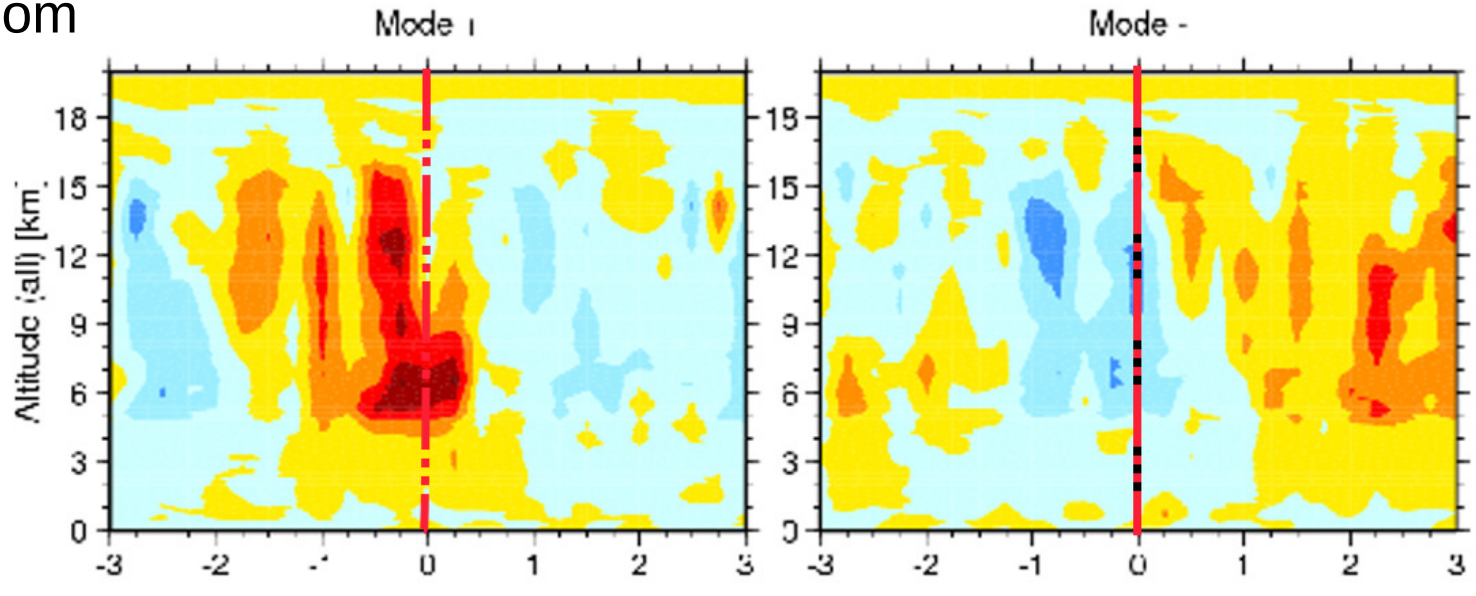


Lag

Anom



Diabatic Processes: Equations and Notations

Following Yanai et al 1973:

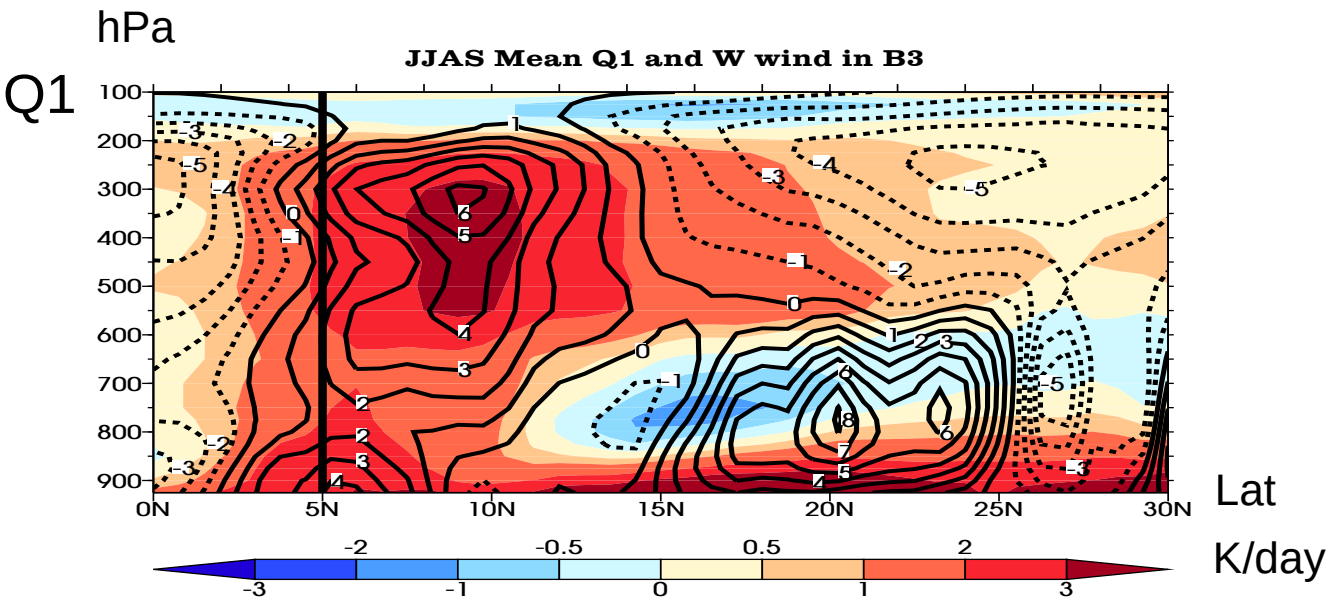
$$Q_1 = \frac{d\theta}{dt} = Q_R + L(c - e) - \frac{\partial s'\omega'}{\partial p}$$

$$Q_2 = -L\frac{dq}{dt} = L(c - e) + L\frac{\partial q'\omega'}{\partial p}$$

Two ways to diagnose Q_1 and Q_2:

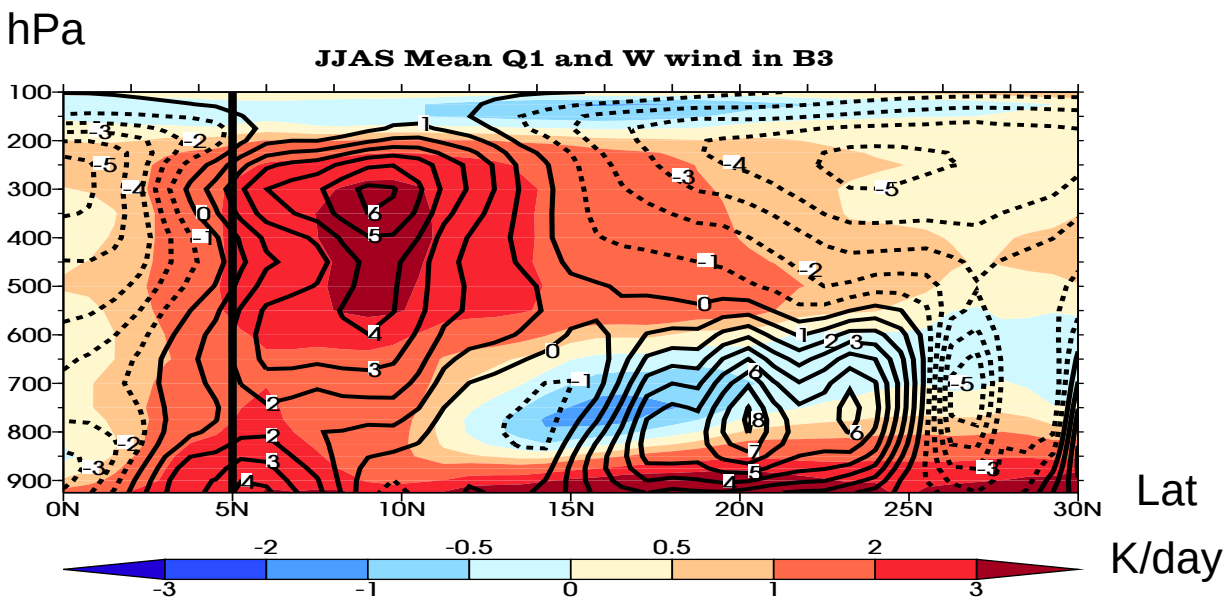
- Using The Tendency terms due to Physics in ERAinterim Reanalysis
- Computing Q_1 and Q_2 as Residuals from the equations

The JJAS mean Structure

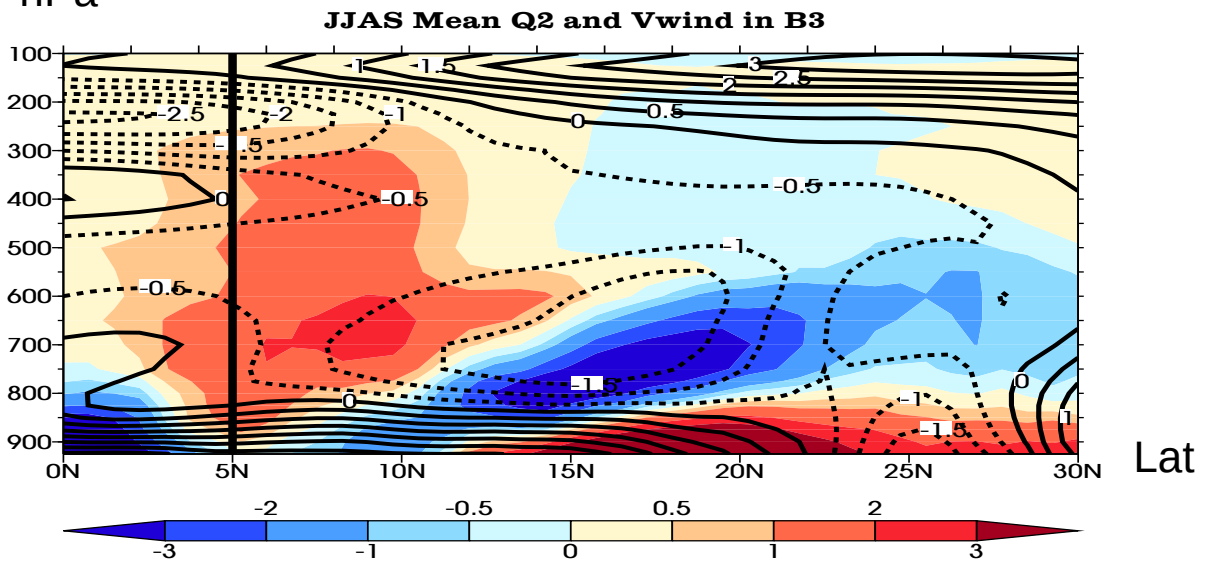


The JJAS mean Structure

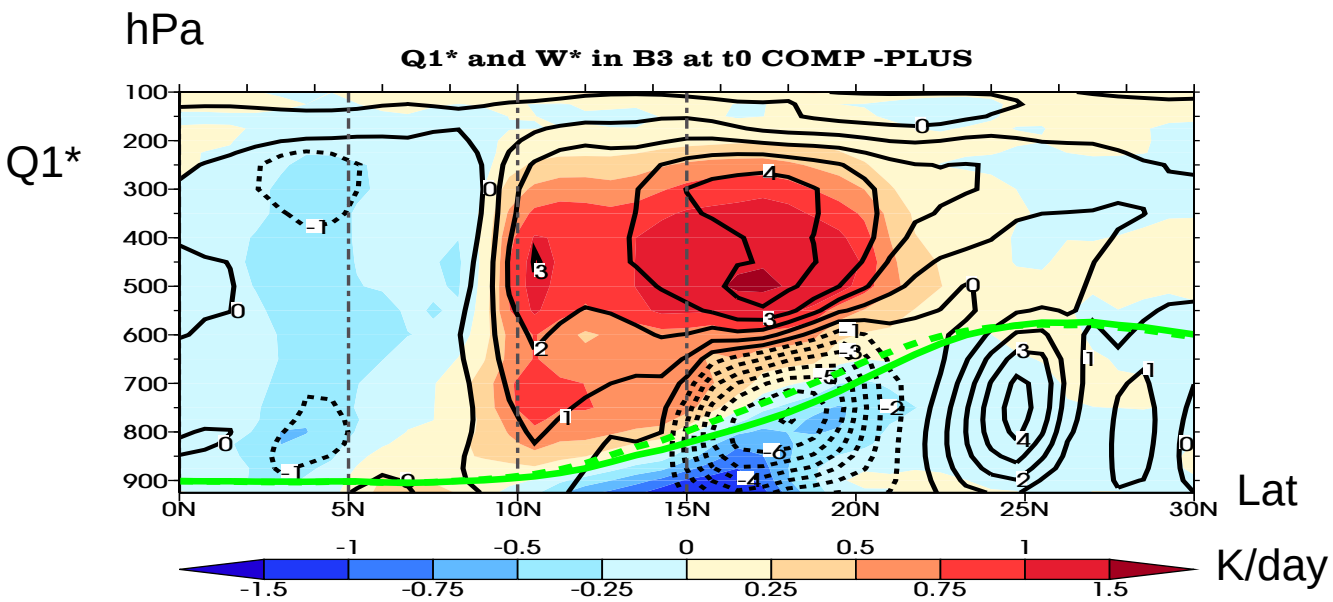
Q1



Q2



Composite of Q_1^* and Q_2^* at t_0: "Wet Event"



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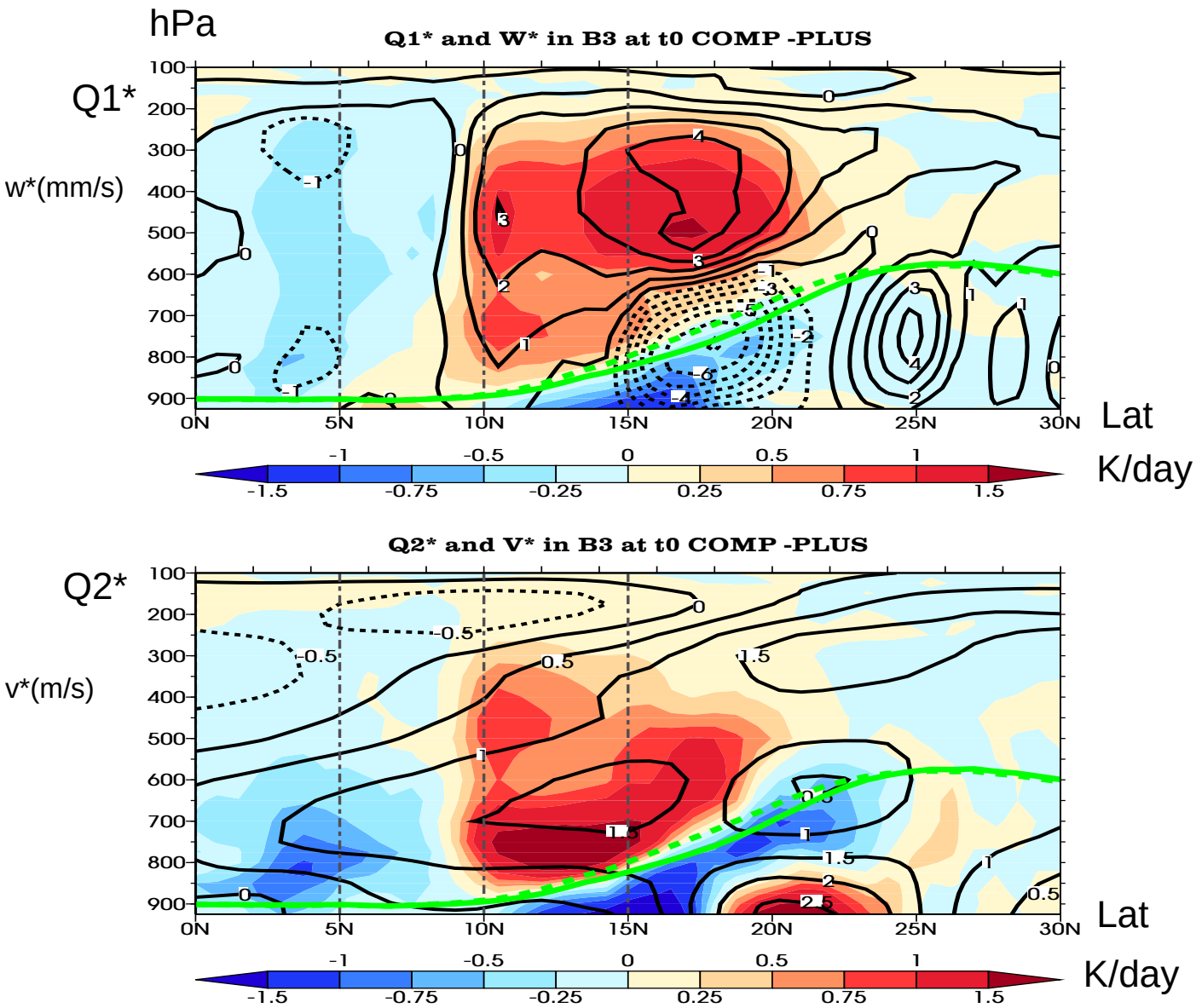
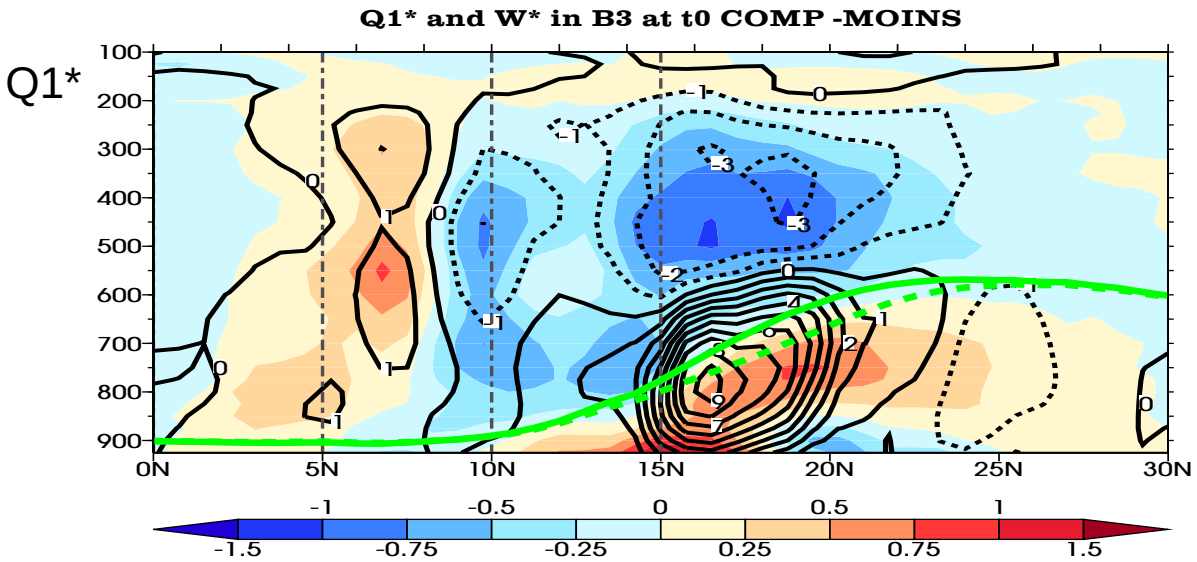
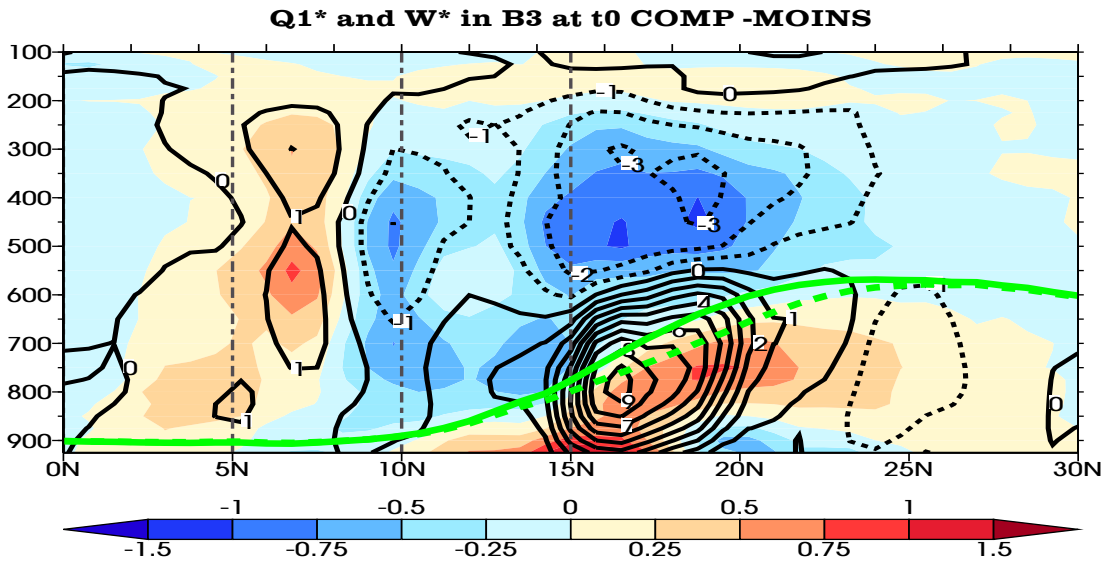


Composite of Q_1^* and Q_2^* at t_0: "Dry Event"

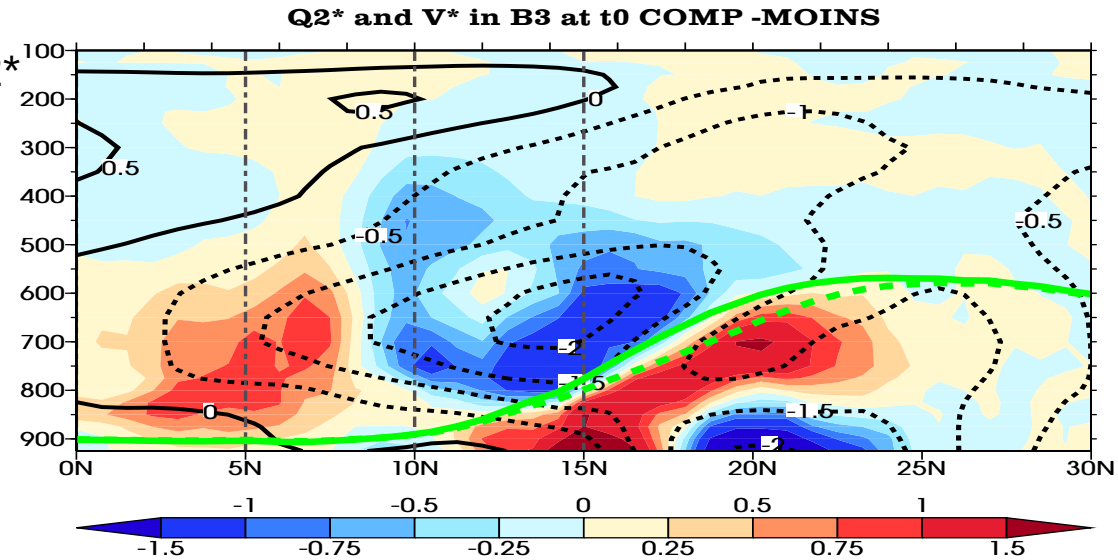


Composite of Q_1^* and Q_2^* at t_0: "Dry Event"

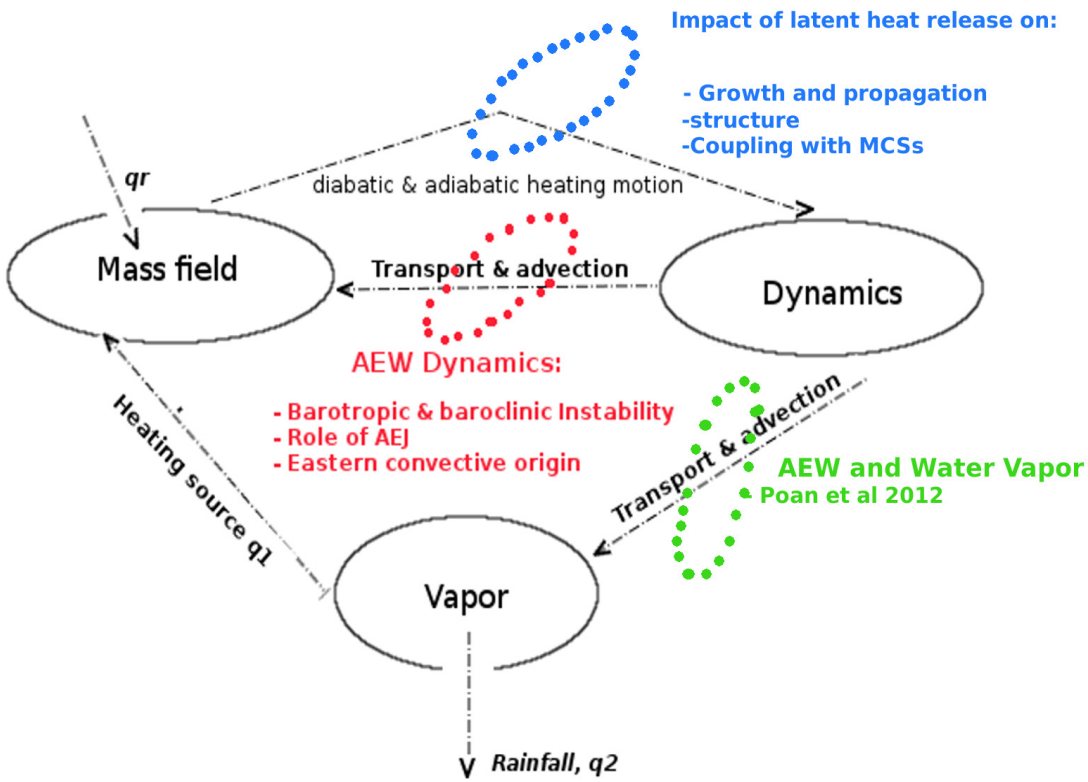
Q1*



Q2*

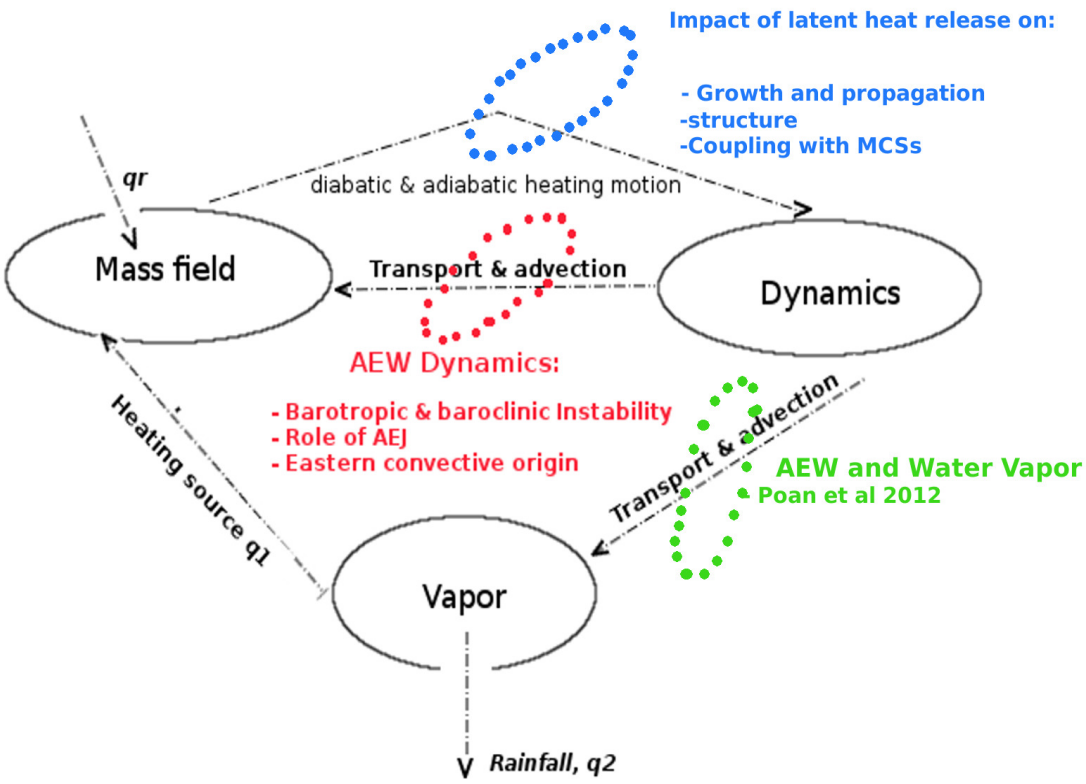


The Mass and Dynamics Fields Loop



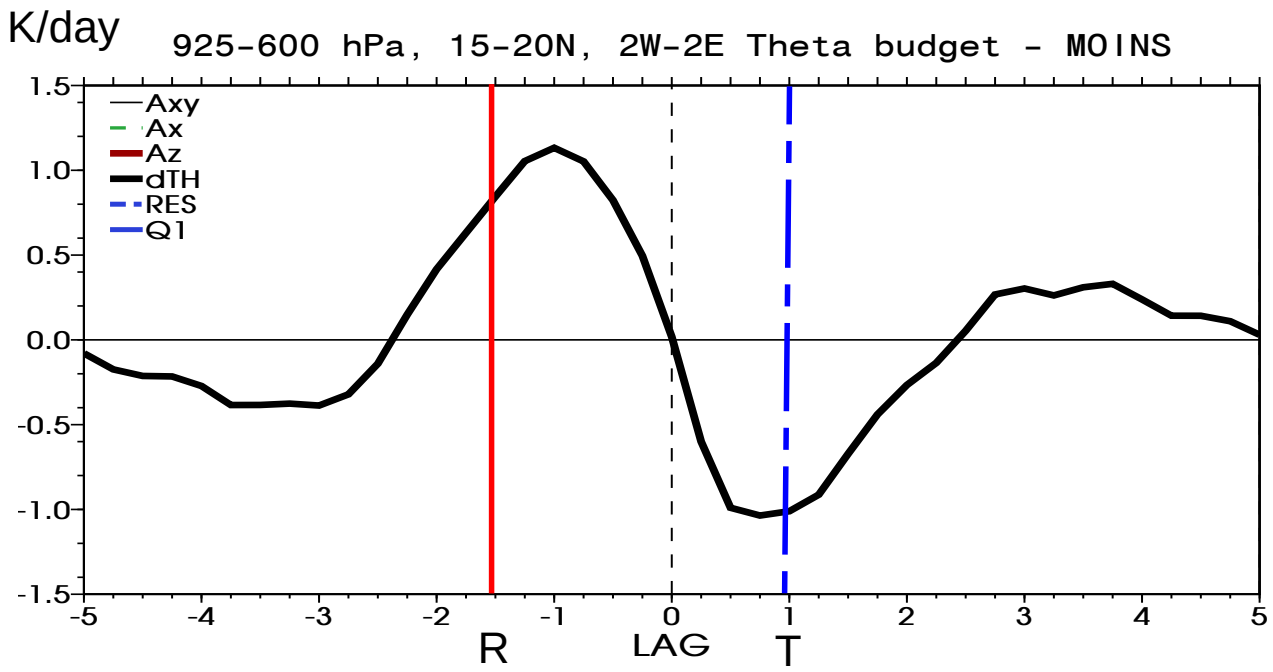
1. Transport of Mass Field: Key Role of the Saharan Heat Low

The Mass and Dynamics Fields Loop



1. Transport of Mass Field: Key Role of the Saharan Heat Low
2. Mass feedback on circulation: Importance of Latent Heat Release

The SHL Contruction: Temperature Budget



Budget in the SHL layer: 925-600 hPa in 2W-2E, 15-20N, During a DRY EVENT

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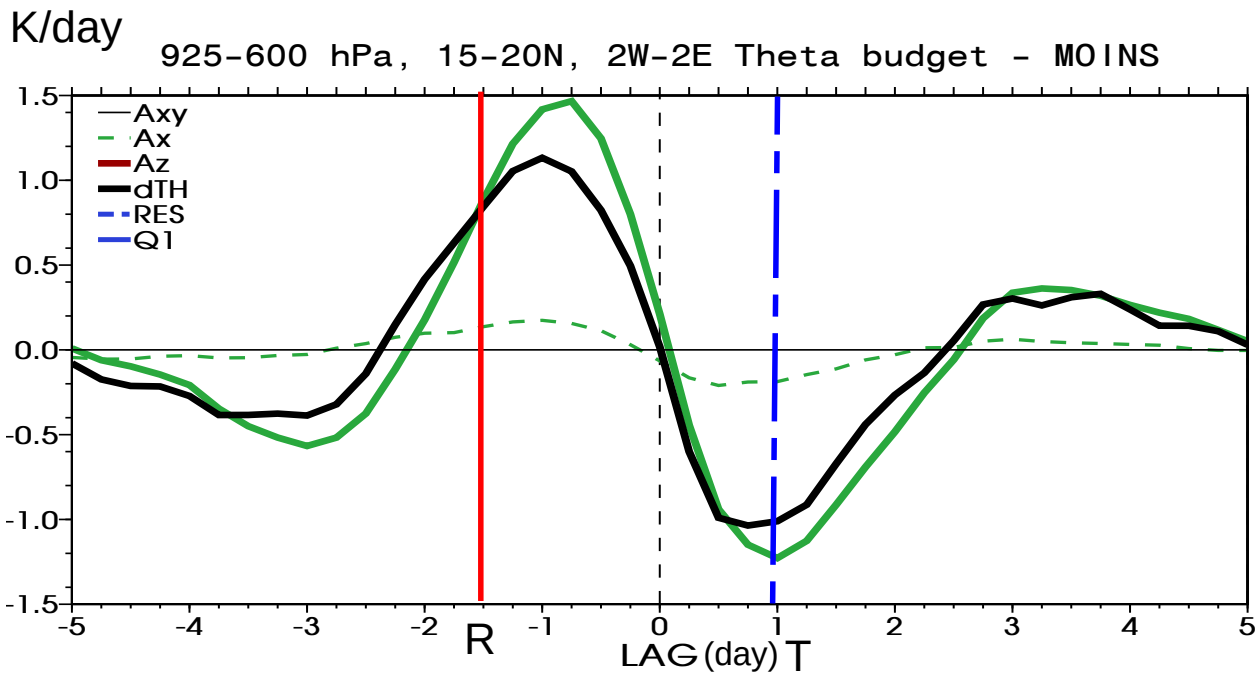

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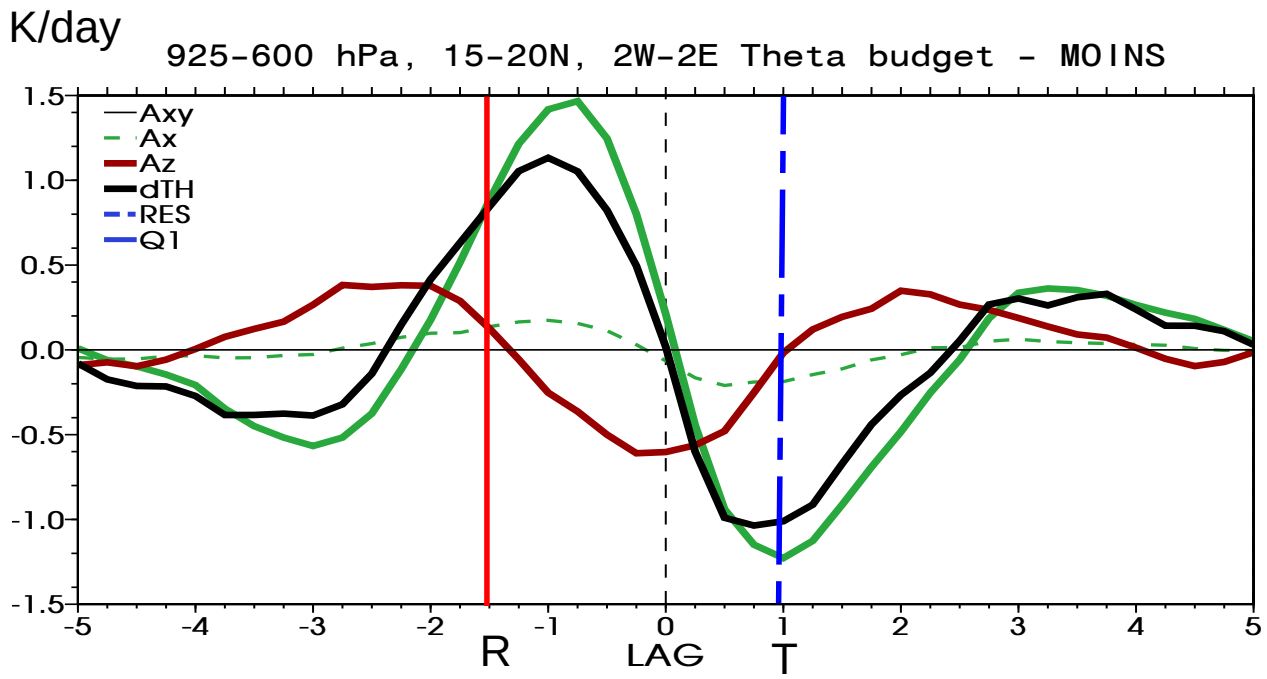

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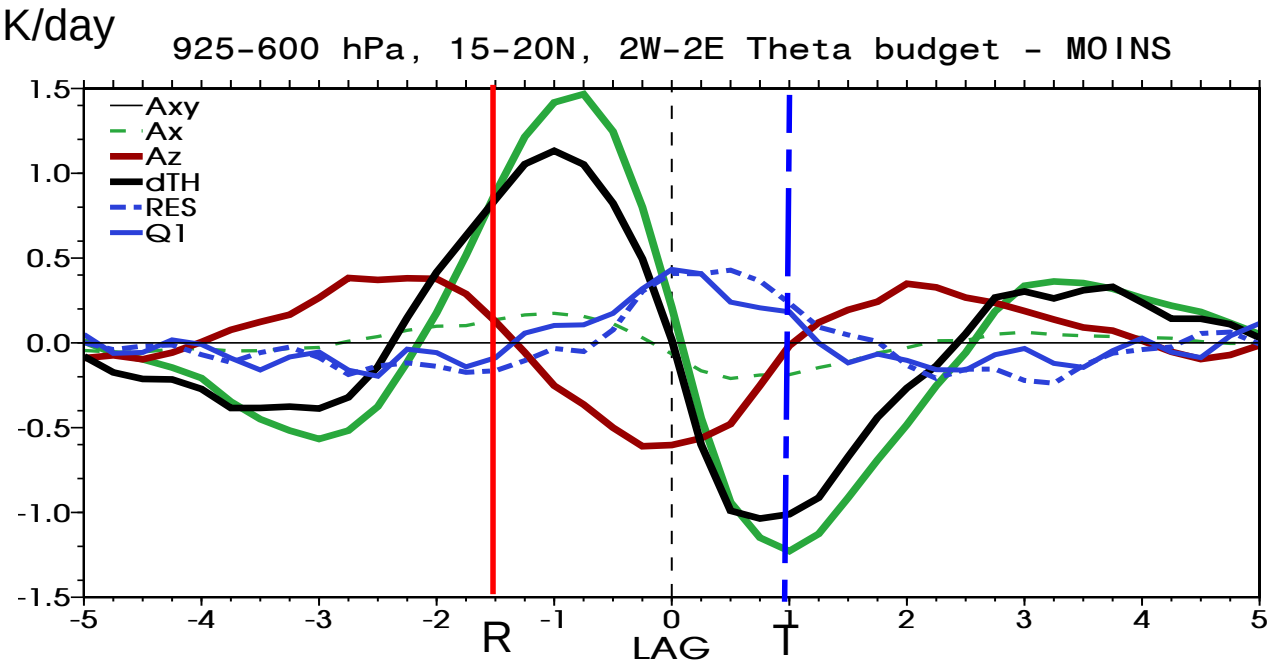

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Mass Feedback: The Q vector Approach, Equations

The adiabatic Q vector is given by the equation (Kiladis et al 2006.)

$$Q_{adiab} = (Q_{x0}, Q_{y0}) = \frac{R_a}{p}\left(\frac{\partial v^*}{\partial x} \cdot \frac{\partial T_m}{\partial y}, \frac{\partial v^*}{\partial y} \cdot \frac{\partial T_m}{\partial y}\right)$$

The diabatic Q_{diab} vector is given by the equation:

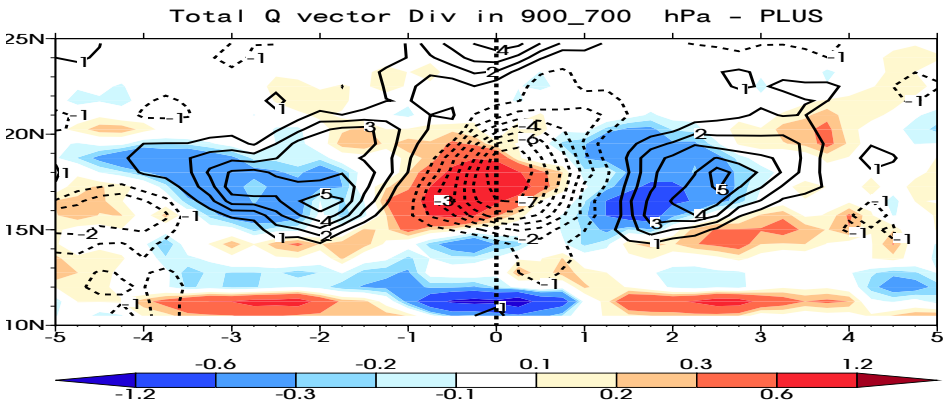
$$Q_{diab} = (Q_{x1}, Q_{y1}) = \frac{R_a}{p}\left(\frac{\partial Q_{1ERA}}{\partial x}, \frac{\partial Q_{1ERA}}{\partial y}\right)$$

where Q_{1ERA} is the latent heat source provided in ERAI Reanalysis.

Following Hoskins et al. 1978, the Divergence of Q_{adiab} is proportional to the vertical velocity.

Latitude-Time Structure: 900-700 hPa

Total Q vector Divergence



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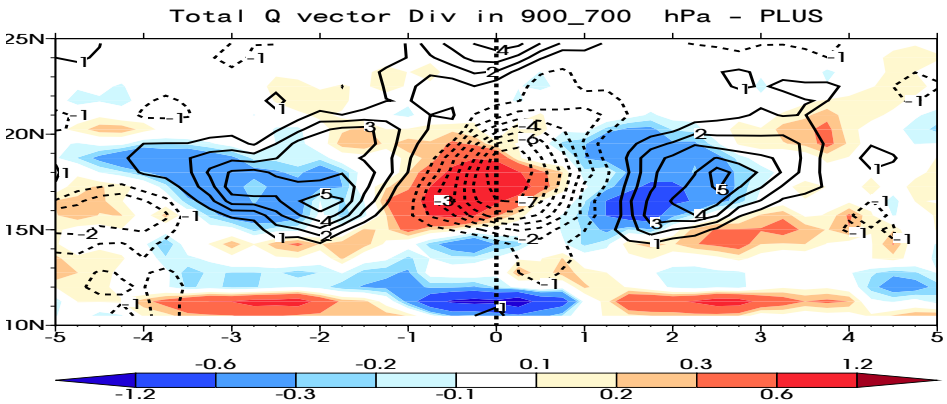

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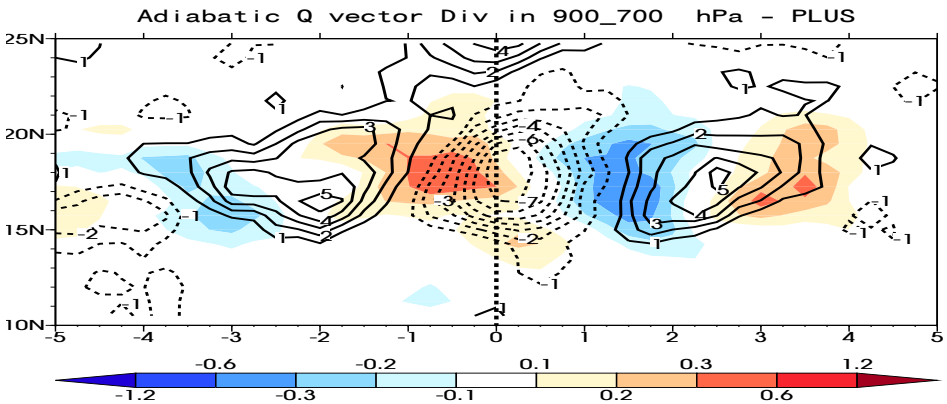

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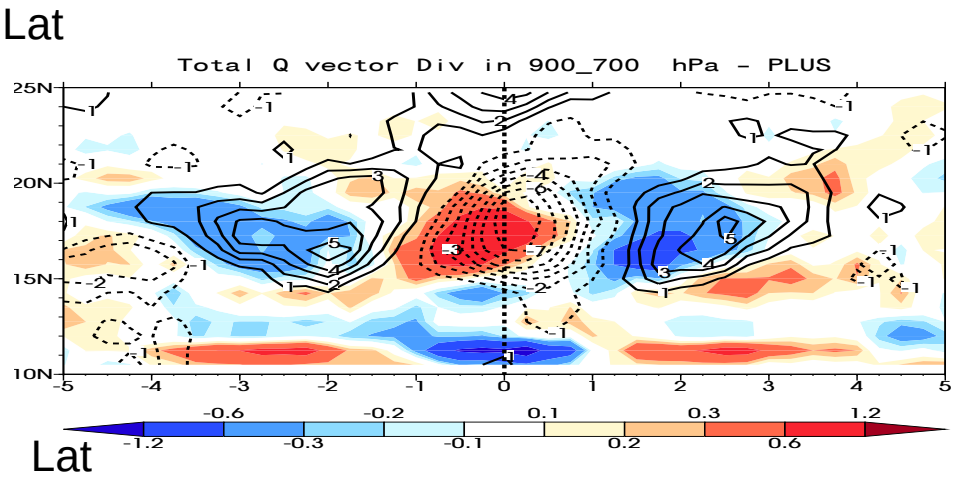

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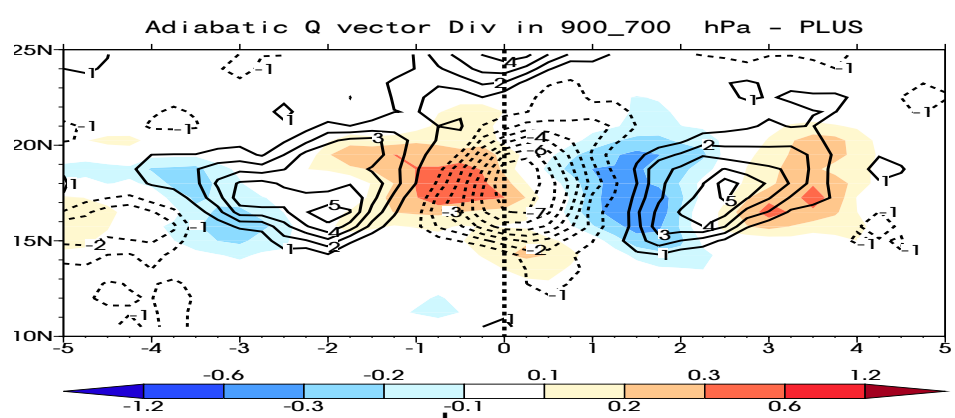

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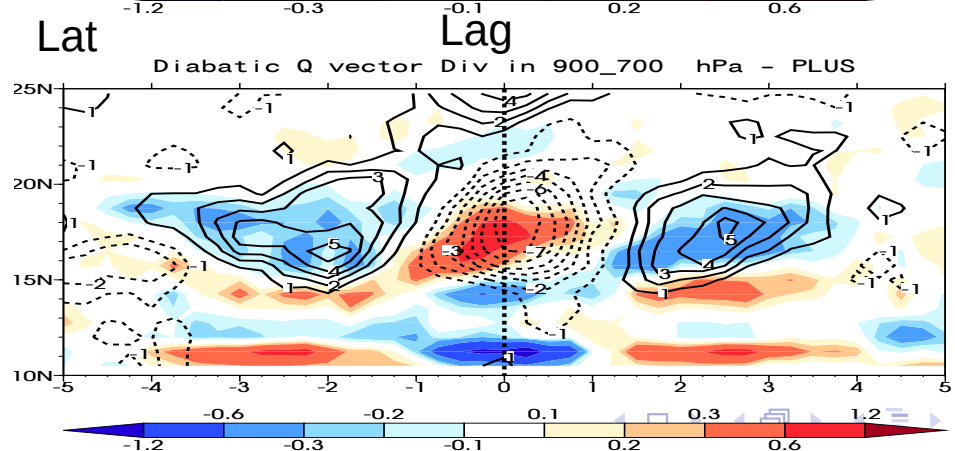
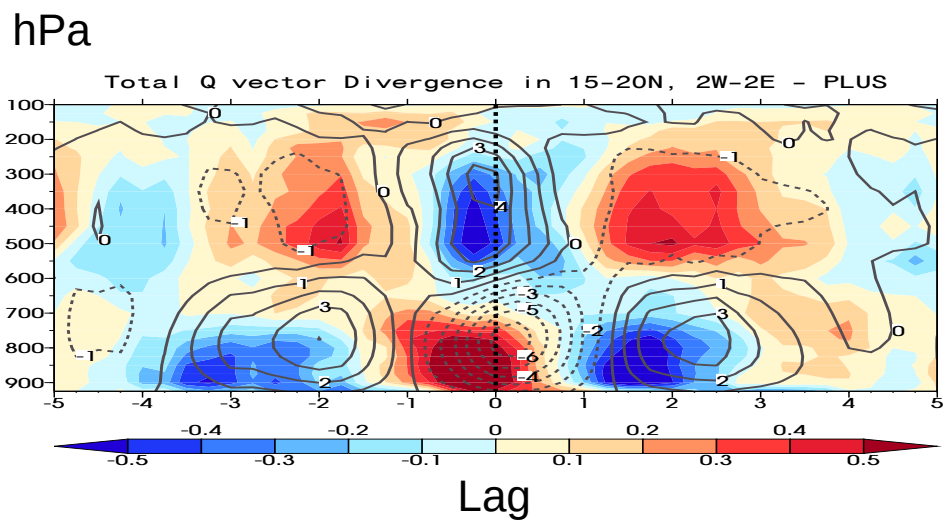


Height-Time Profiles: Box 15-20N, 2W-2E

Total Q vector Divergence



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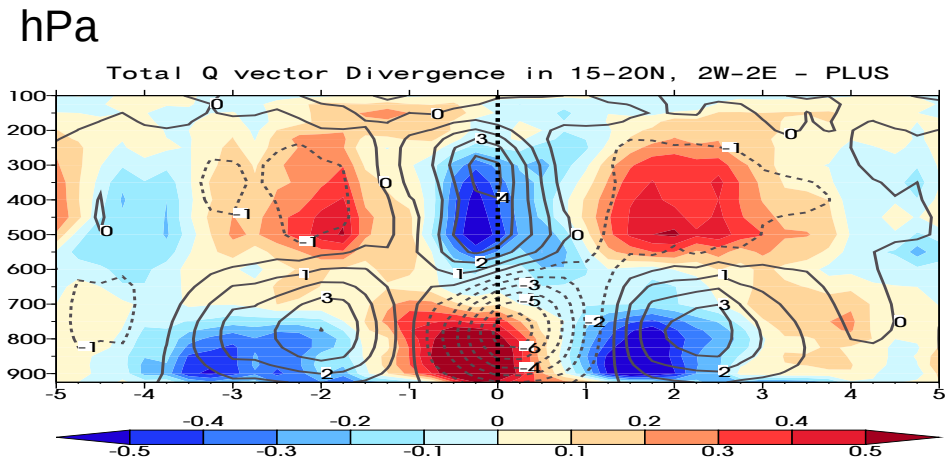

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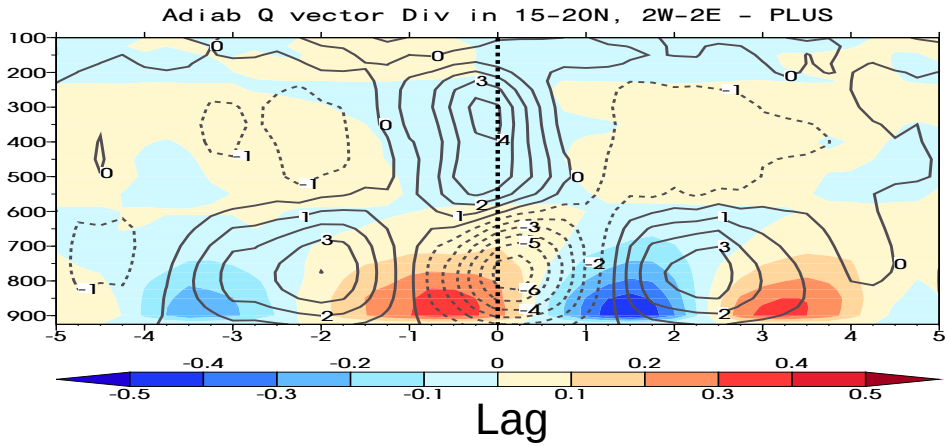

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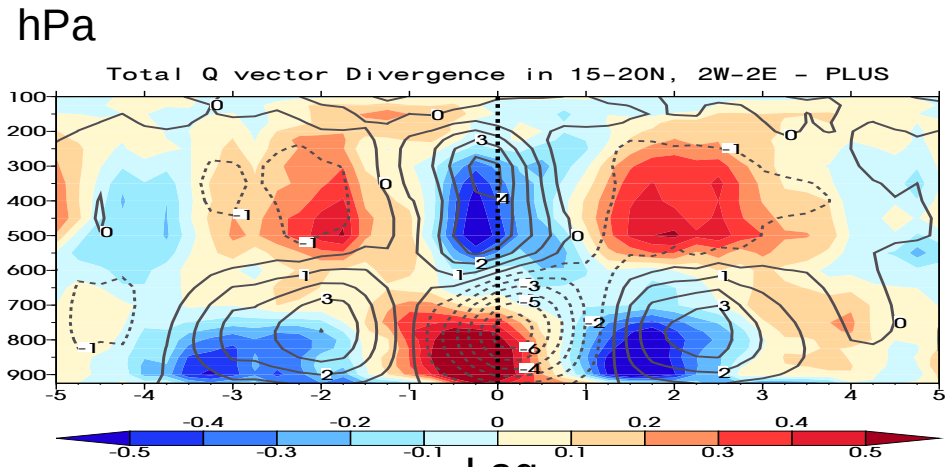

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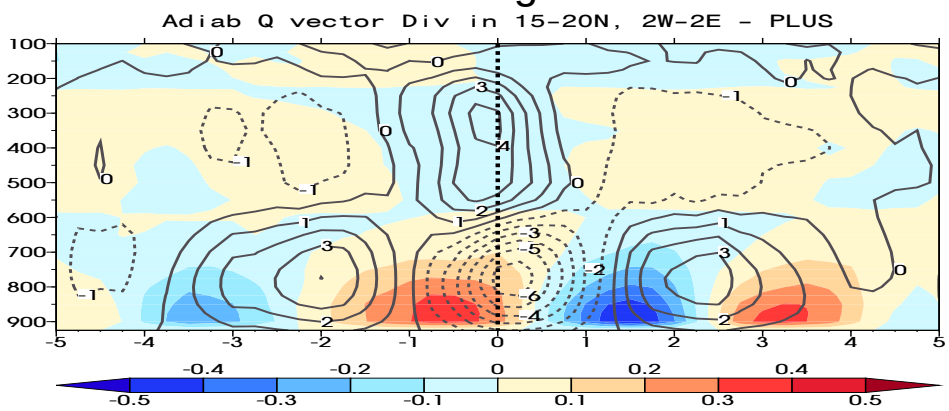

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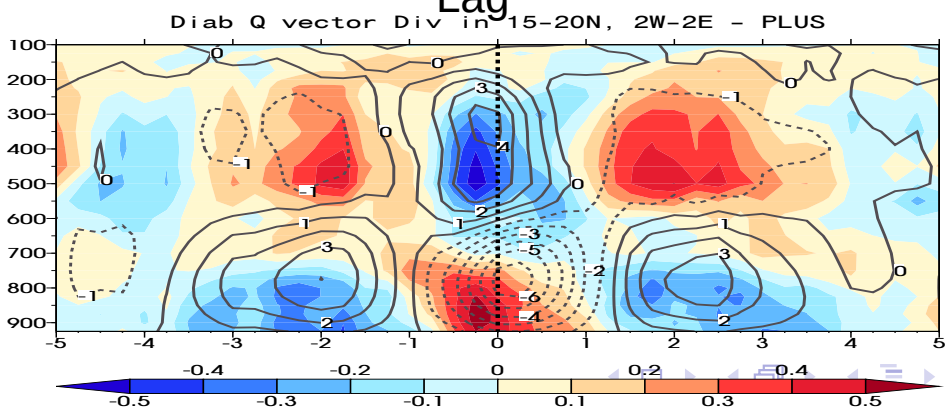

Conclusions and Perspectives

- Many interactions to take into account: The 3-Dimensional Approach
- AEW is not only a zonal cell: There is a strong meridional activity through the SHL modulation – A Momentum Bugdet would help to quantify the "intrinsic " role of the HL
- We show here how mass and dynamics play together through different processes: Qualitative approach of Q Vectors
- A second step is to couple the Vapor field which is the tank of convection energy