Intra seasonal Variability of West African Monsoon:
A precipitable Water perspective

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METEO FRANCE
Toujours un temps d'avance

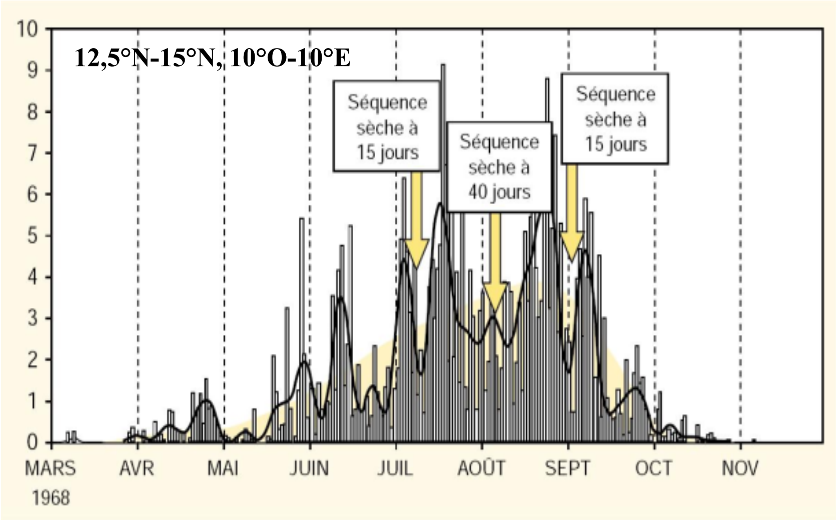
AMMA

cnrs
dépasser les frontières
INSU
Observer & comprendre

Introduction & Motivations

From ……..Sultan and Janicot 2004

1968 rainfall over Sahel



- Crops
- Farming
- Water
- Health

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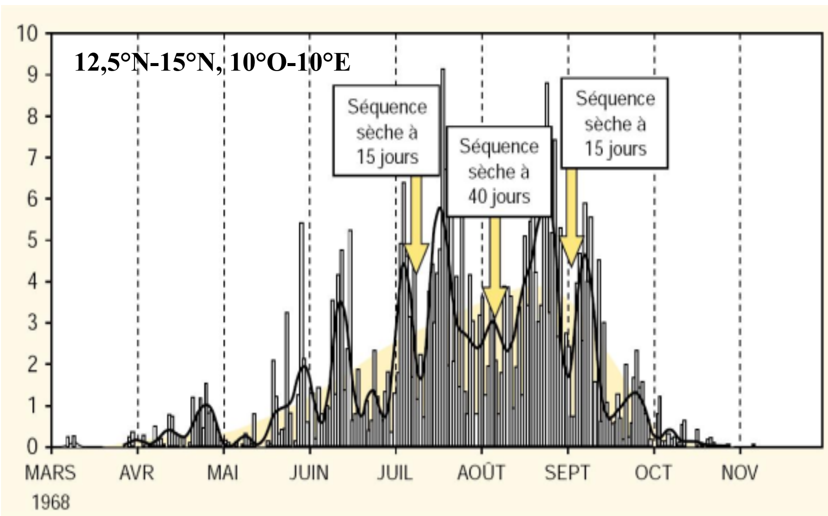

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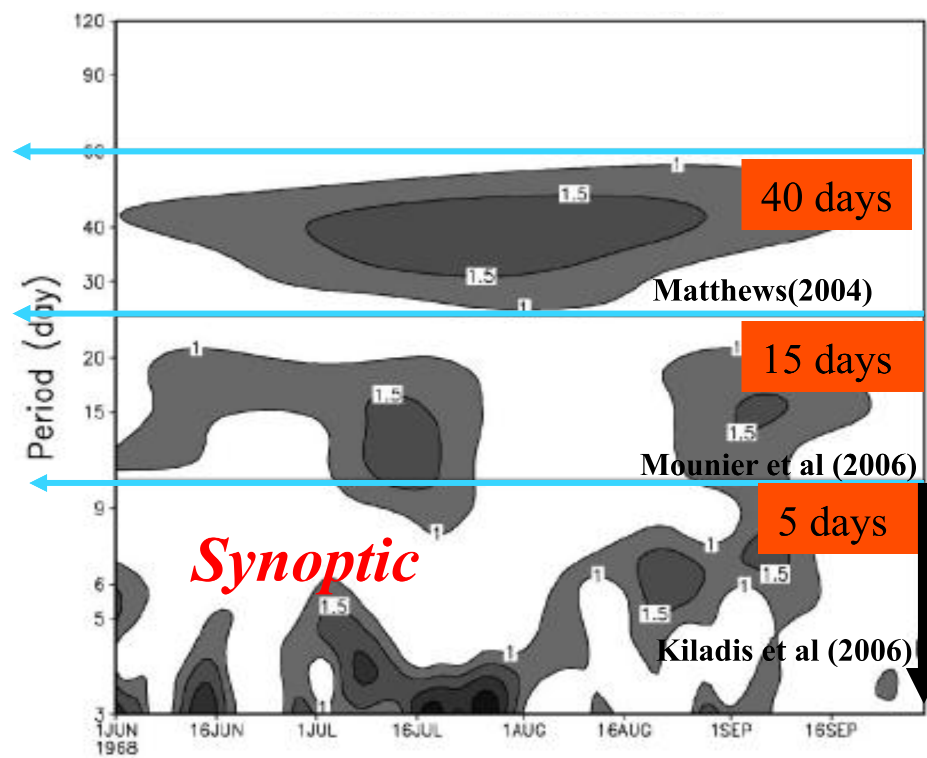
- Major progresses during the last decade in documenting and understanding the African IntraSeasonal Variability (ISV)

→ 3 main scales



Wavelet Analysis on 1968 Rainfall

Introduction & Motivations

From ……..Sultan and Janicot 2004 ???

1968 rainfall over Sahel

- Major progresses during the last decade in

Some questions still remain about:

➢ Interactions between dynamics and convection within such Intra seasonal disturbances,

➢ Variables which could link both dynamics and convection

➢ The potential of predictibility associated with these scales *(Talk by R. Roehrig)*

- Water
- Health

Wavelet Analysis on 1968 Rainfall

Introduction & Motivations

***Precipitable water*:**

$$PW = \frac{1}{g}\int_{ps}^{0} q\,dp$$

- Deep convection is sensitive to both lower and high free tropospheric water vapor

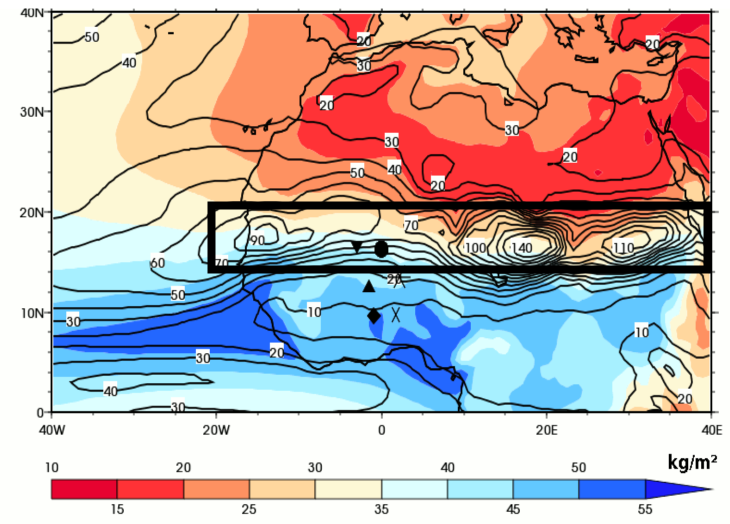
- Rainfall sharp increase is controlled by a threshold value of PW (over ocean)

- PW is less intermittent, has longer autocorrelation time than rainfall (or OLR).

- PW is a limiting factor for rainfall over the Sahel

- PW as a good predictor of the monsoon onset: talk by Ousmane this morning

ERAI JJAS mean and Variance over 1989-2007



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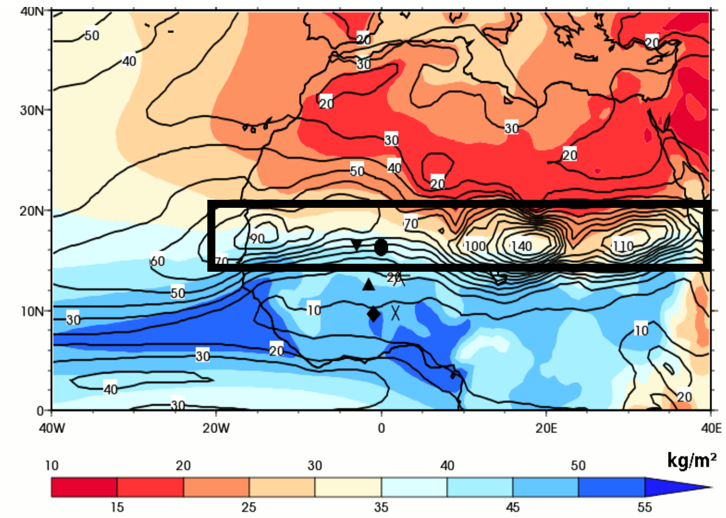
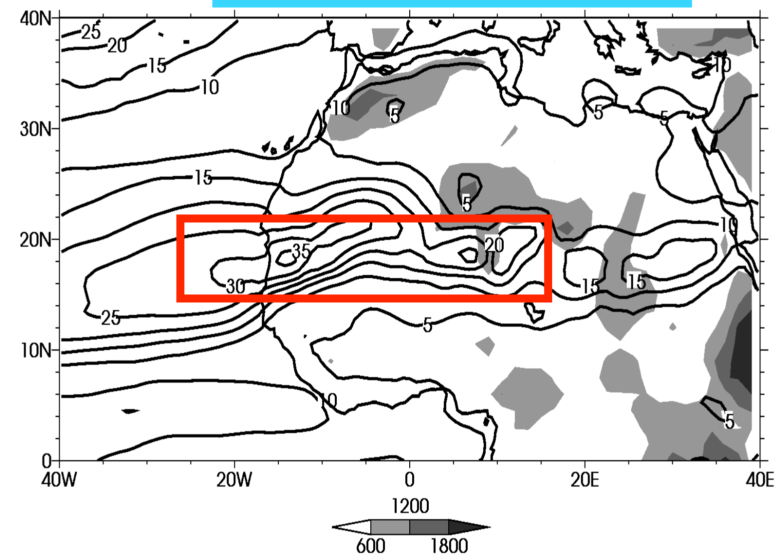


Var < 10 days



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Objective:

Analyse the synoptic variability over West Africa and relate it to that of precipitation

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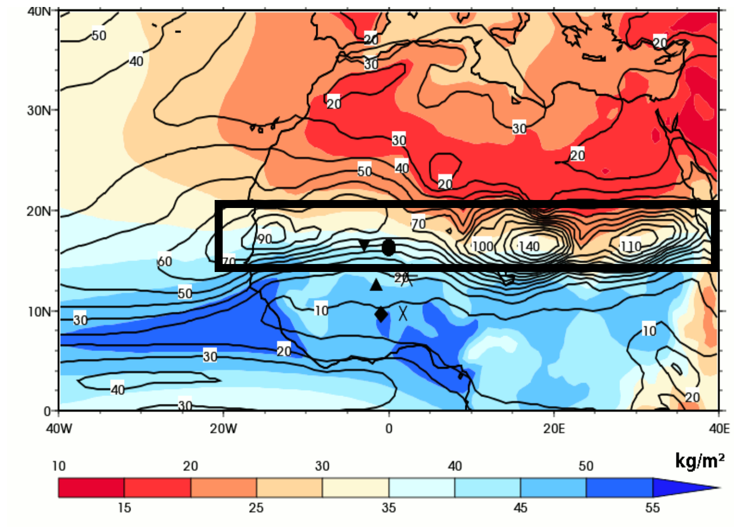

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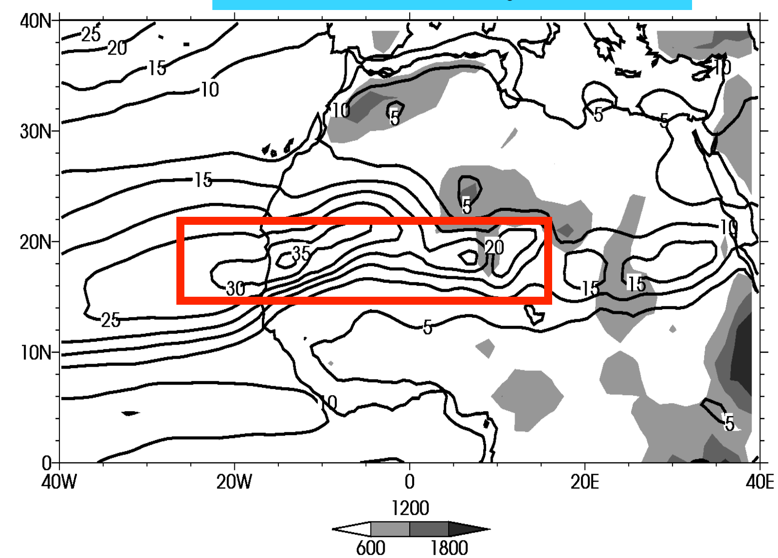
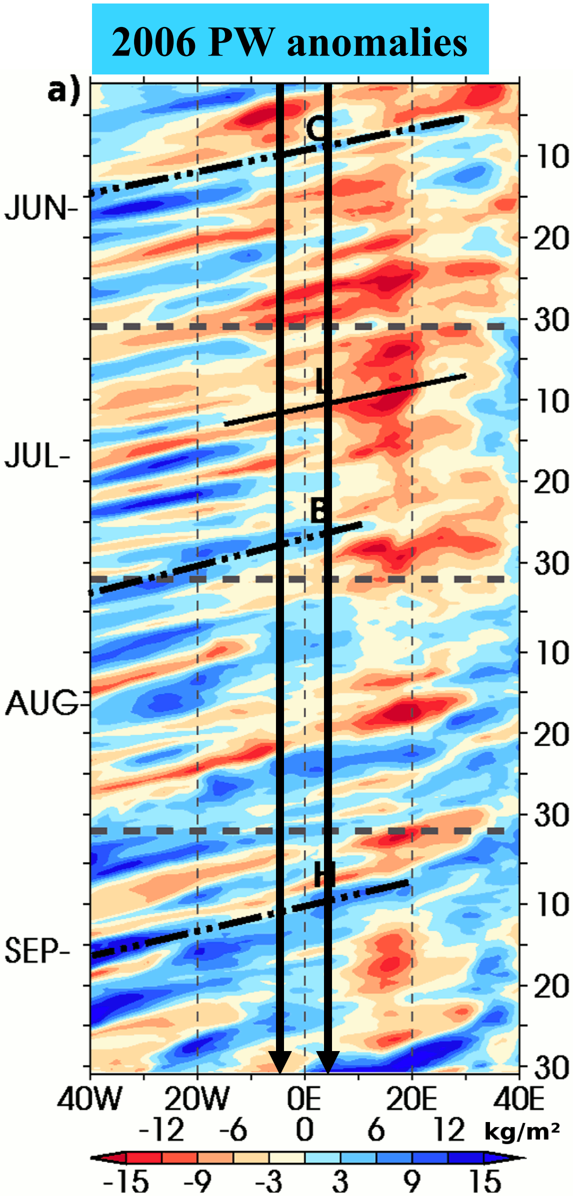
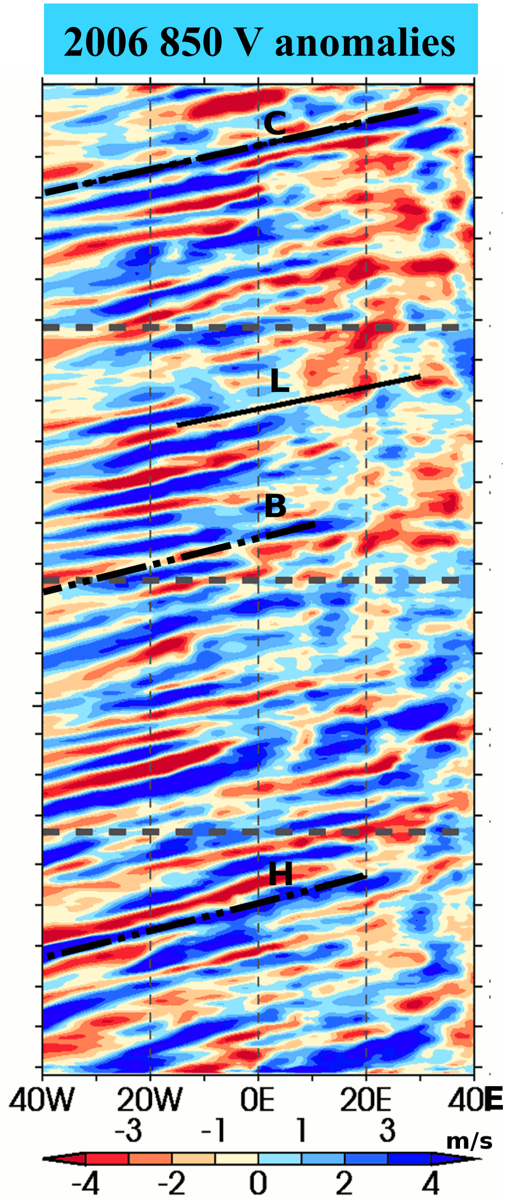


Outline

- 2. Synoptic variability of PW
- 3. Moisture Composite budget
- 4. Conclusion

2. Synoptic variability of PW: *Illustration*





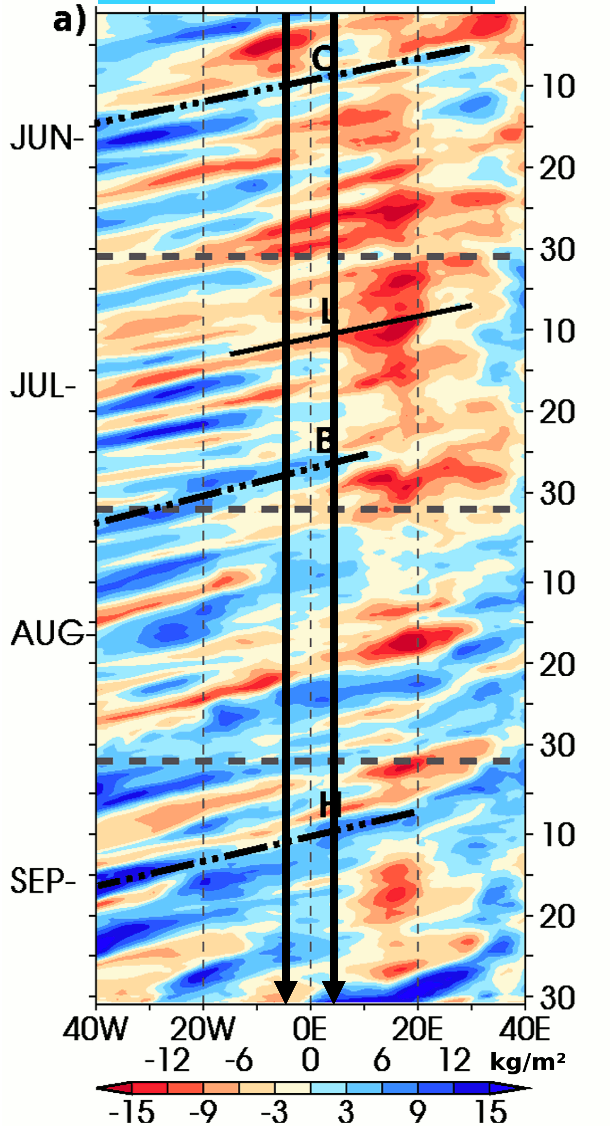
→ Better correlated with V-850 hPa

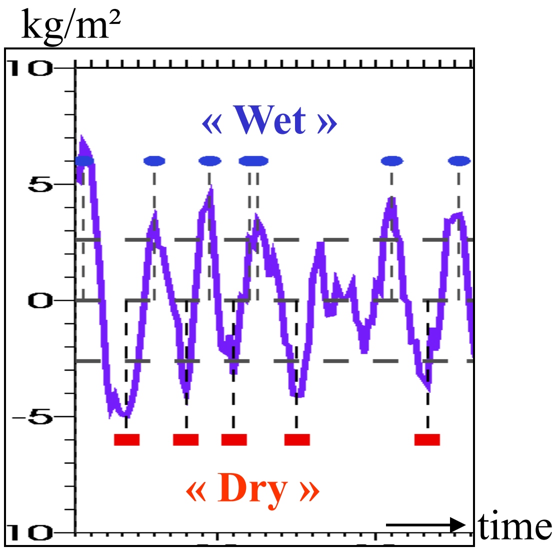
→ Strong link with the mid-level trough activity

→ AEW induced patterns?

2. Synoptic variability of PW: *Illustration*

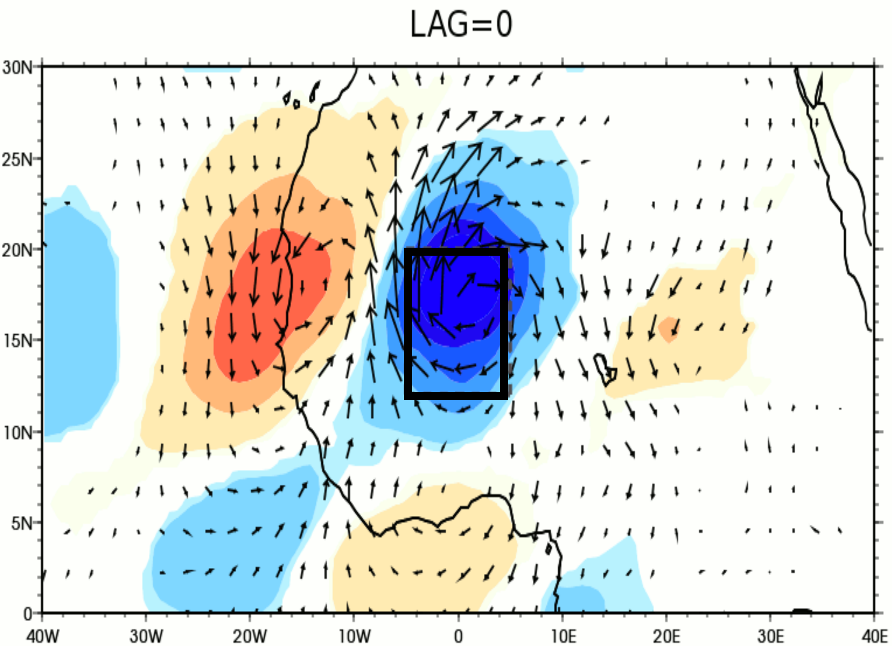
2006 PW anomalies

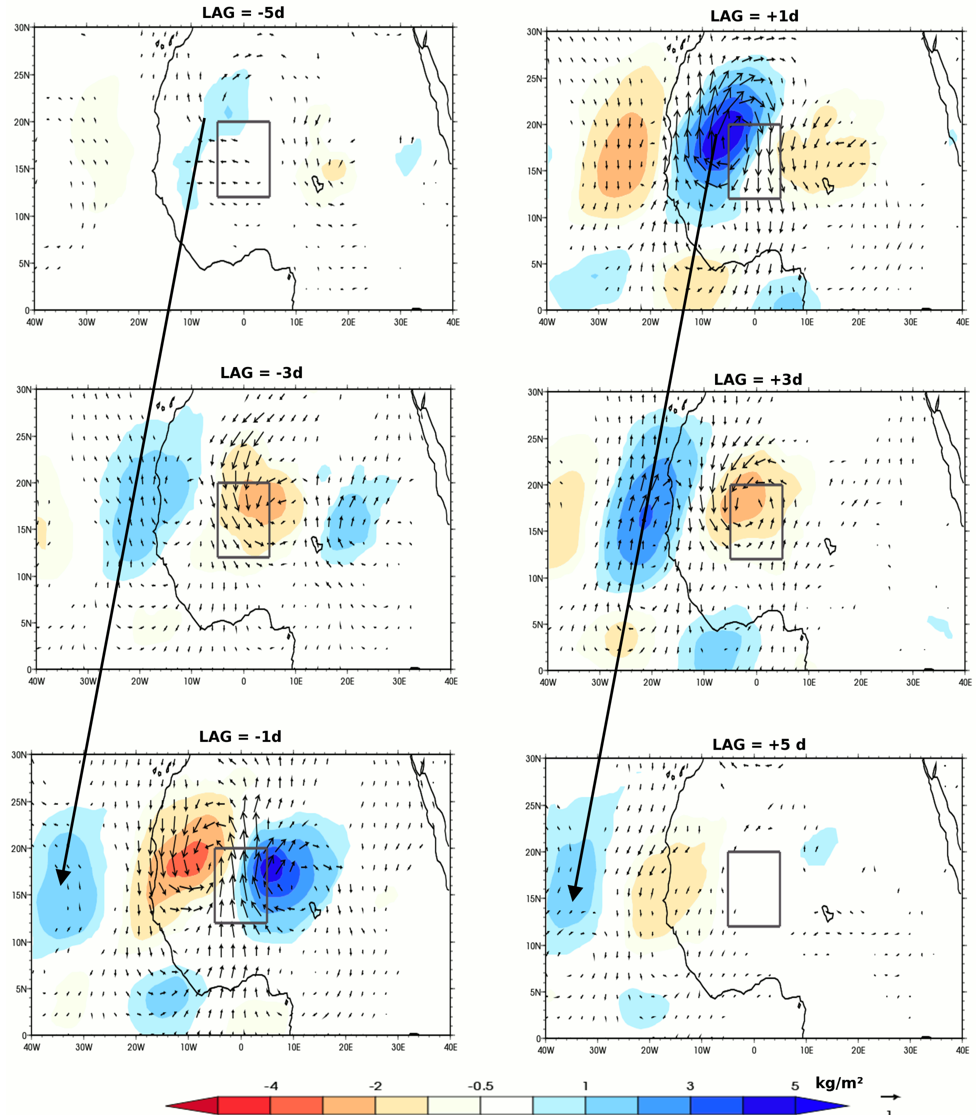




2. Synoptic variability of PW: Composite of «wet events»

PW and 925 Wind





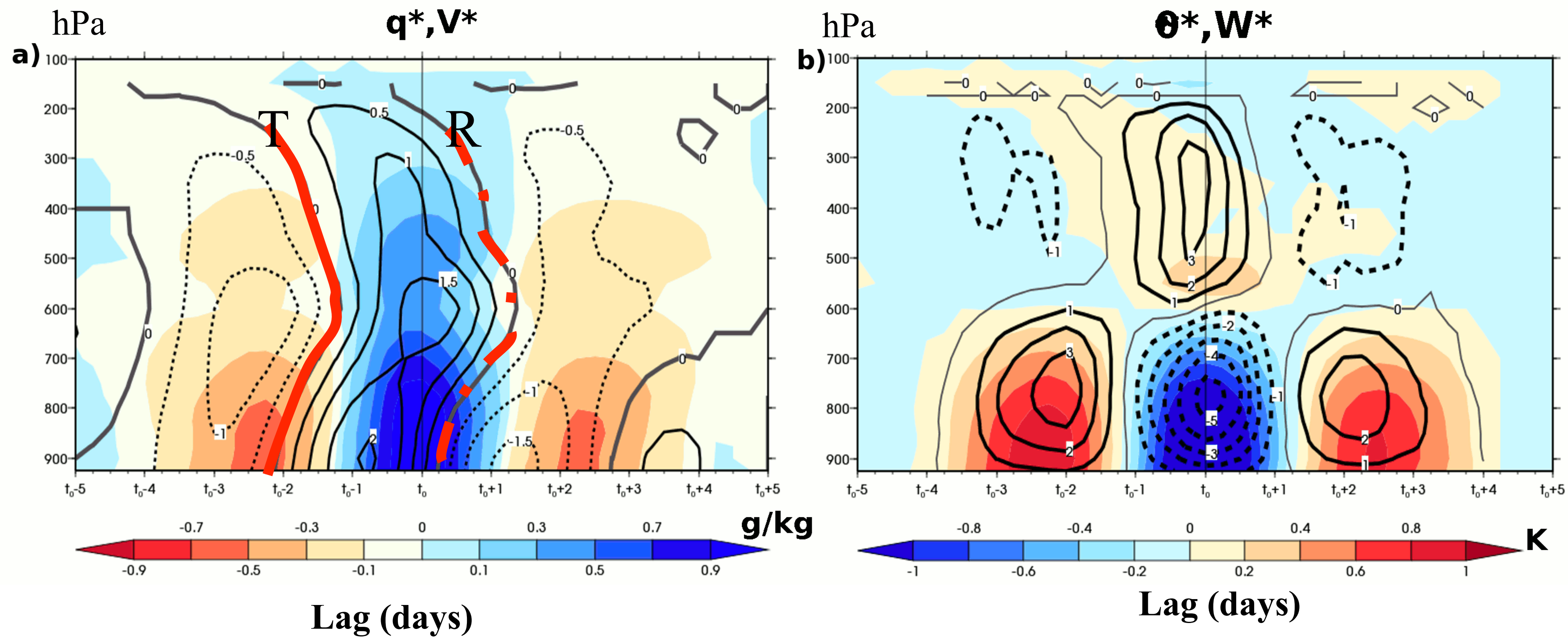
→ Frequent, strong and westward growing events

→ Consistent structure of low level wind

→ AEW characteristics: ~ 9 m s^{-1} westward propagating, 3800 km wavelength

2. Synoptic variability of PW: Composite of «wet events»

Height-Lag profiles:



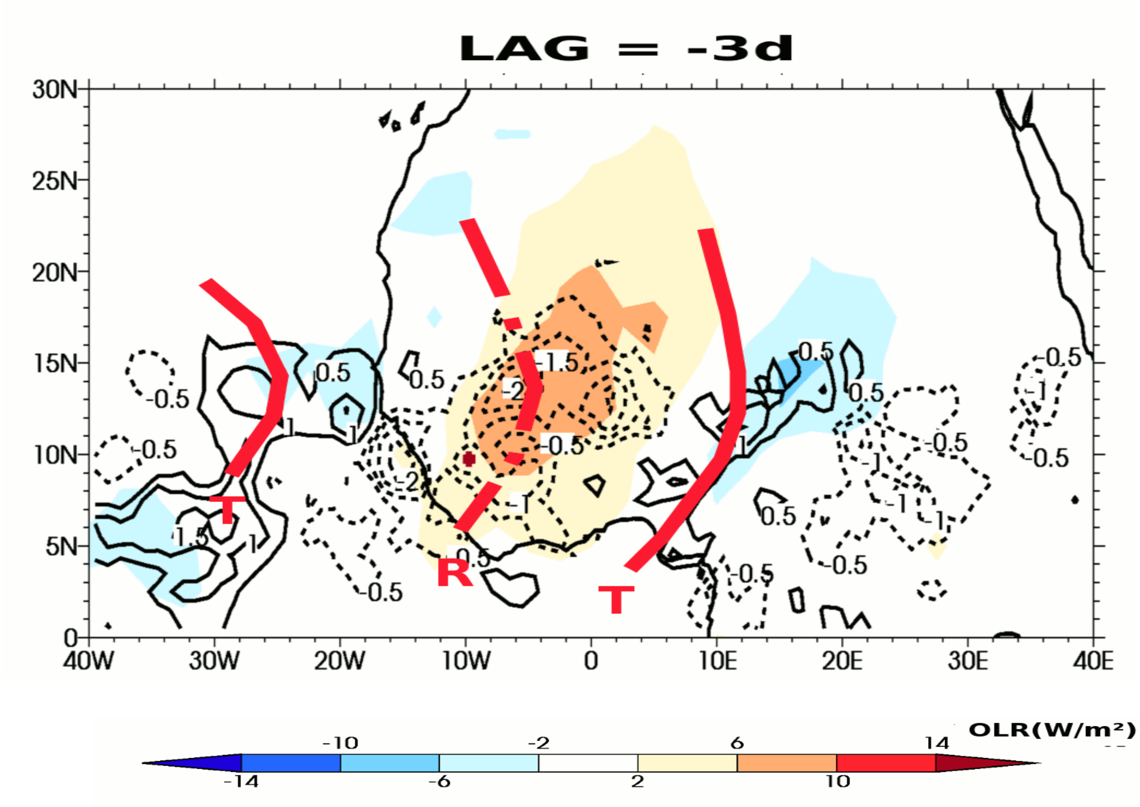
✓ Vertical structures are consistent with those found for AEWs

✓ The PW strong events are driven by a particular coupling between mid and low level circulation associated with AEW.

2. Synoptic variability of PW: link with Convection

GPCP-rainfall (black Contours),

NOAA-olr (colours),



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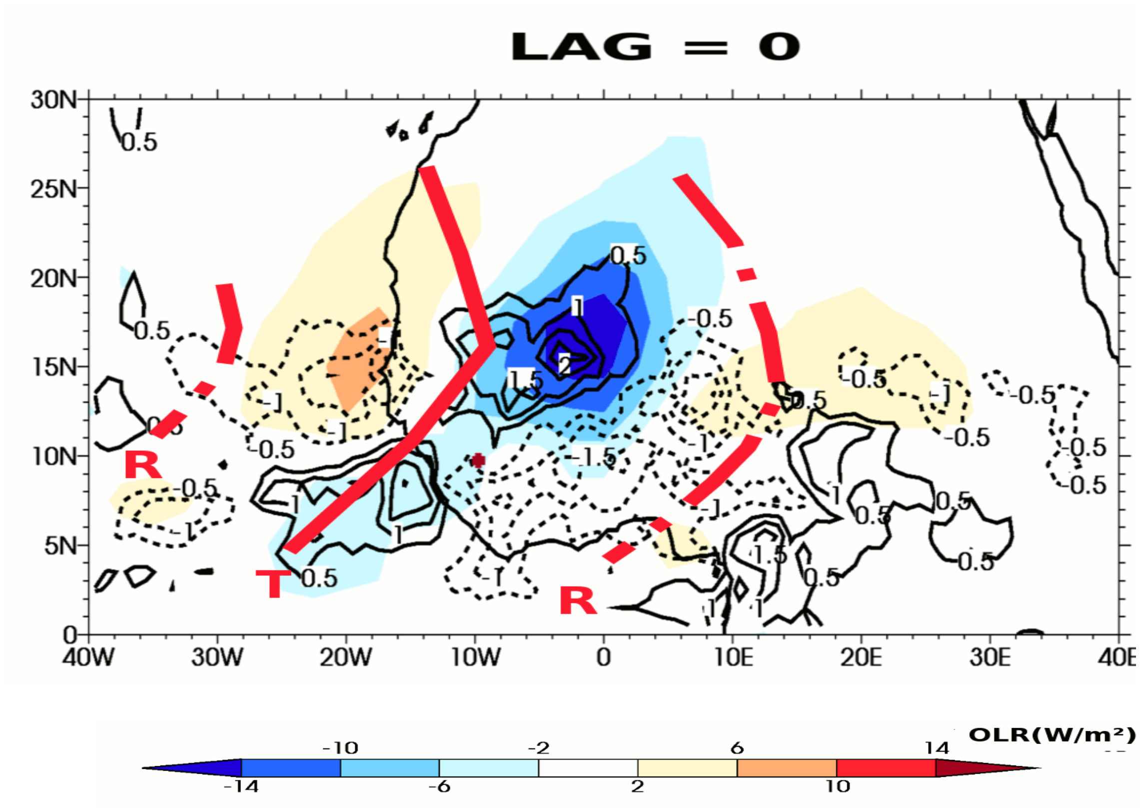

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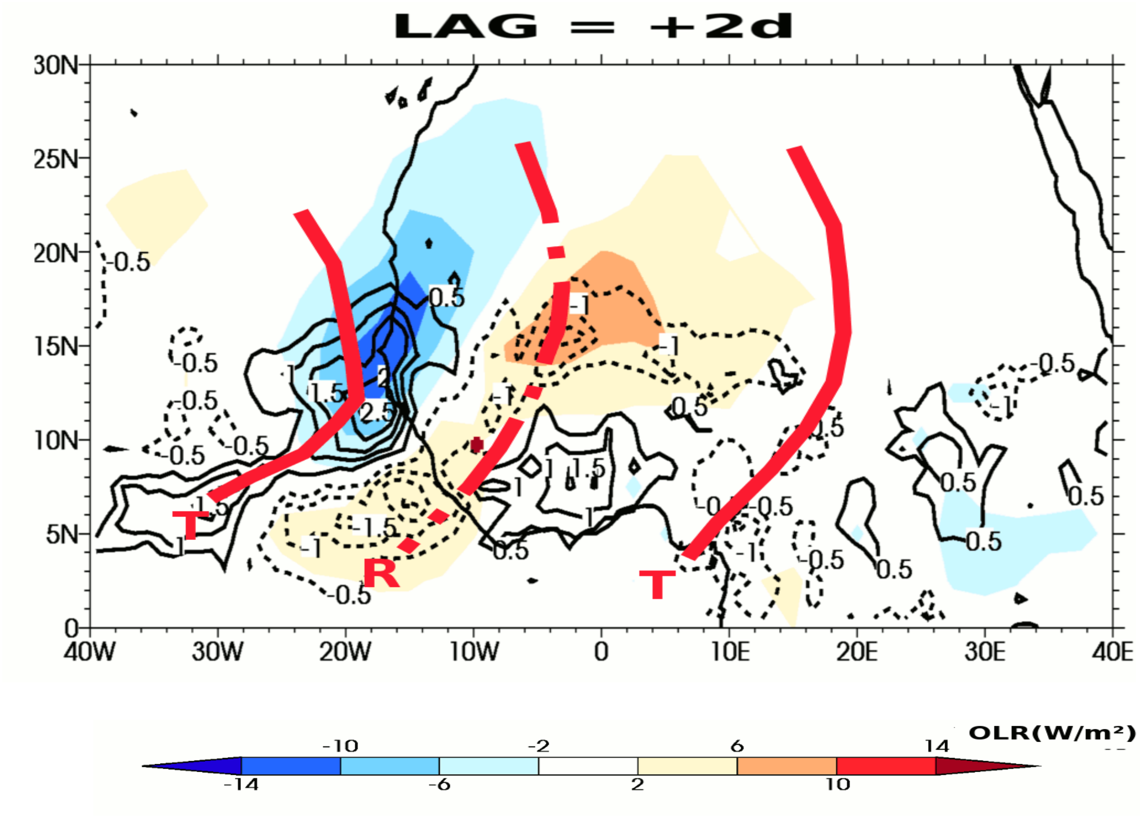
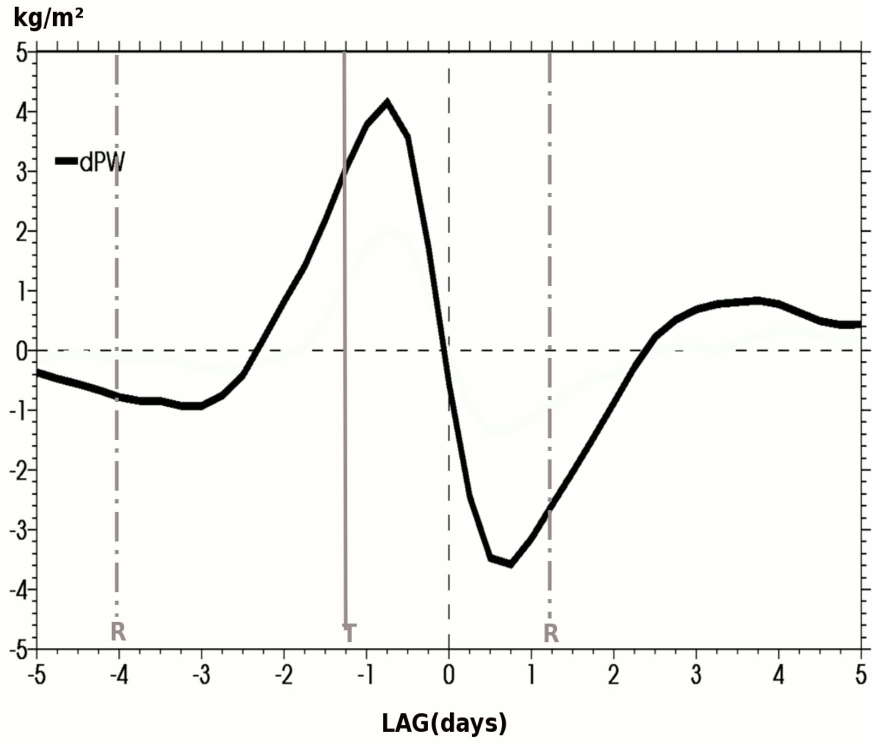


3. Moisture Composite budget

[redacted]

$$\frac{\partial PWV^*}{\partial t} = A_x^* + A_y^* + A_z^* + E^* - P^* + CLSR^* \quad (7)$$



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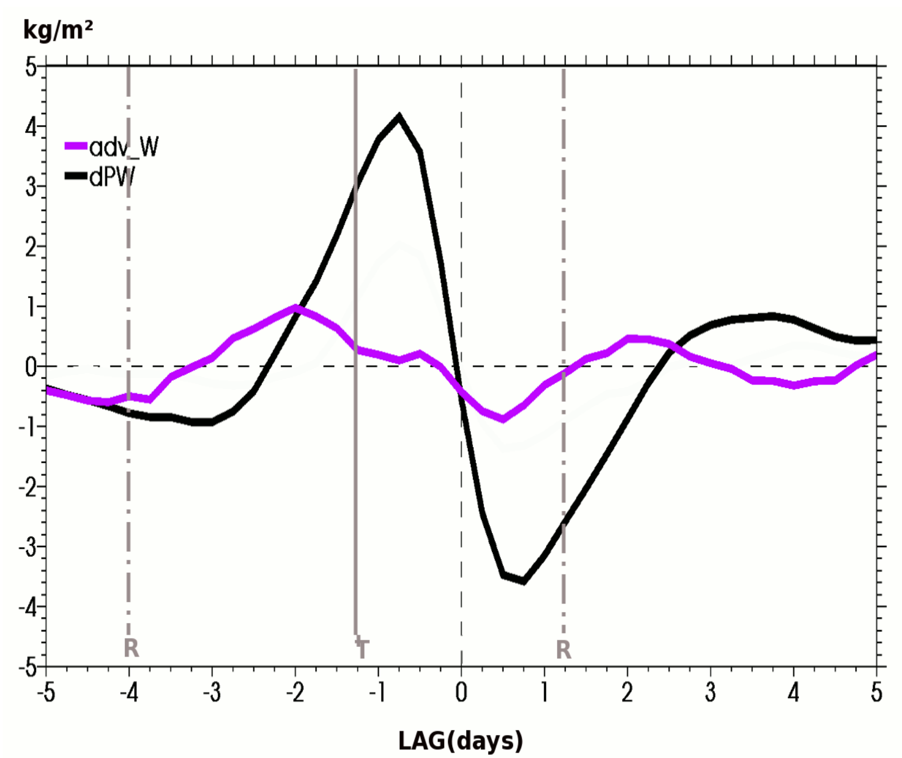

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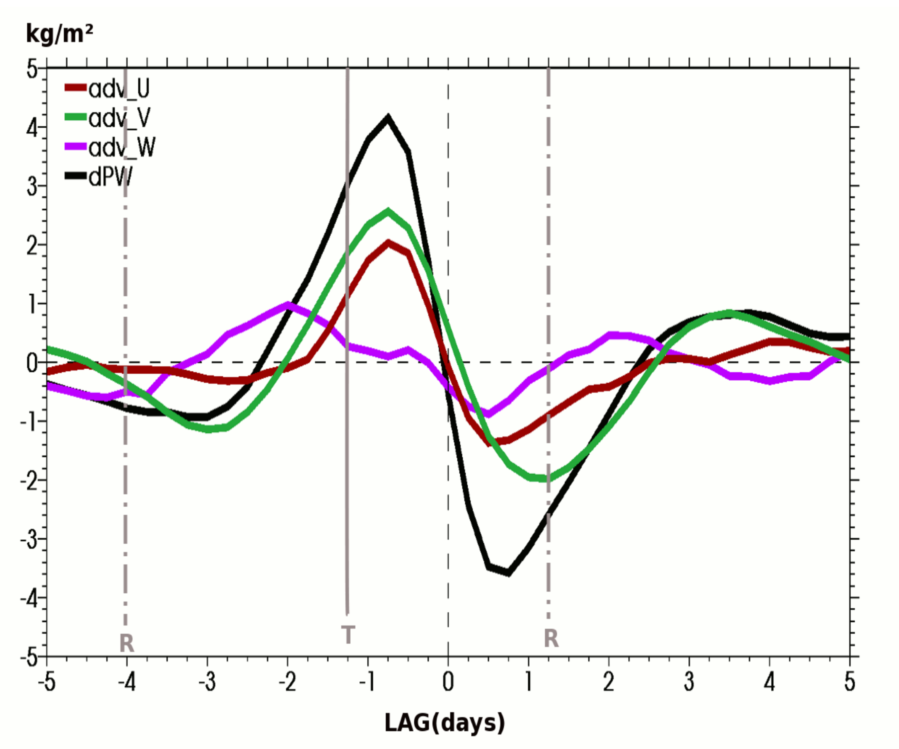

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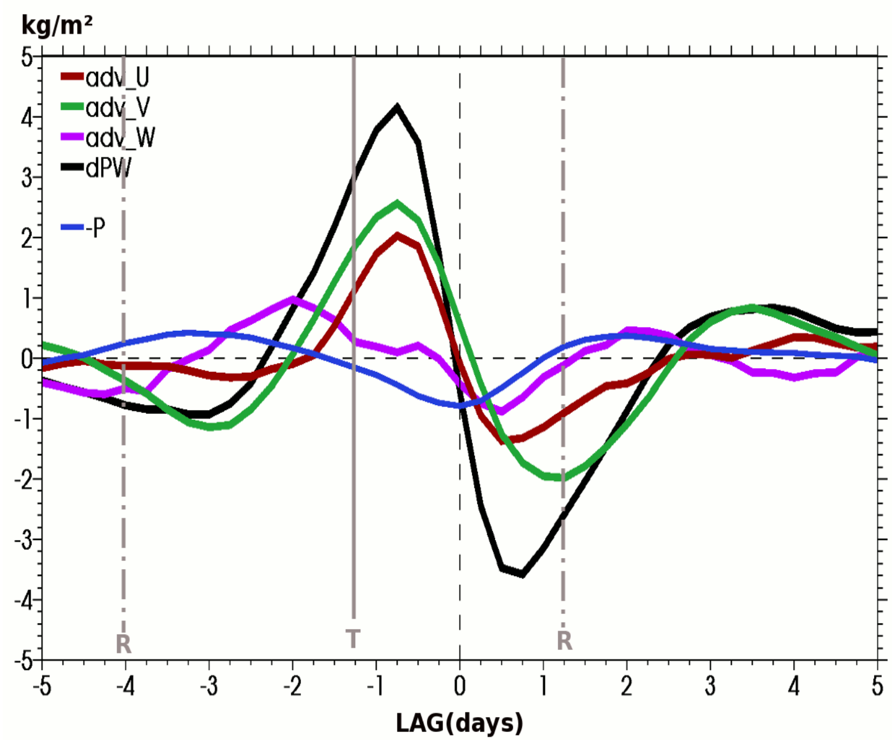

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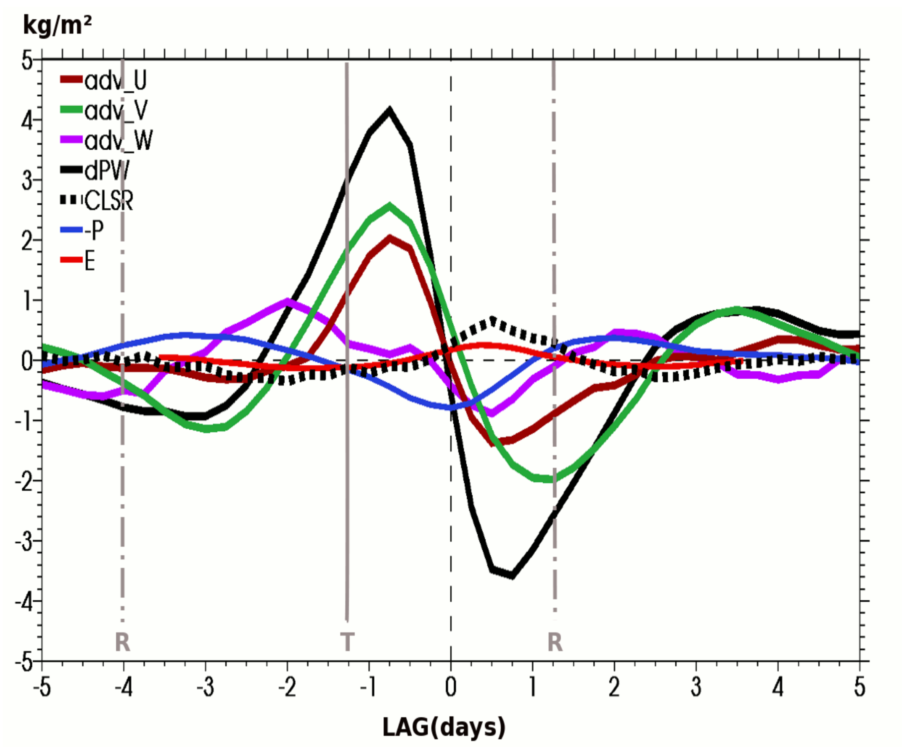


→ Vertical advection (A^*_z) is a precursor

→ Horizontal advections ($A^*_{y,z}$) play a major role particularly at low levels after the trough

→ Precipitation start near the max of PW tendency in the northerly flow

→Small closure (CLSR)

4. Conclusion

- PW variability has been documented at different time scales: synoptic scales are dominant over the Western Sahel while longer periods scales dominate the Eastern part
- Composites analysis highlights a moist perspective of african easterly waves with westward propagative « wet » and « dry » signals.
- Such « events », frequent and strong, show a strong link with convective activity.
- The budget analysis gives insight into the PW signature of AEW: Importance of low-level advection
- PW indices as application to the synoptic weather monitoring : see our website at http://isv.sedoo.fr/

Other results (not shown):

- A linear adiabatic approach of PW anomalies provides a realistic propagation speed of PW anomalies once generated.

Current work:

- However the growing of these anomalies involves some diabatic processes which will be diagnosed in future work.


Questions???
THANK YOU

Adiabatic Linear approach of PW equation

$$\frac{\partial q^*}{\partial t} = -\overline{u}\frac{\partial q^*}{\partial x} - v^*\frac{\partial \overline{q}}{\partial y} - w^*\frac{\partial \overline{q}}{\partial z}$$

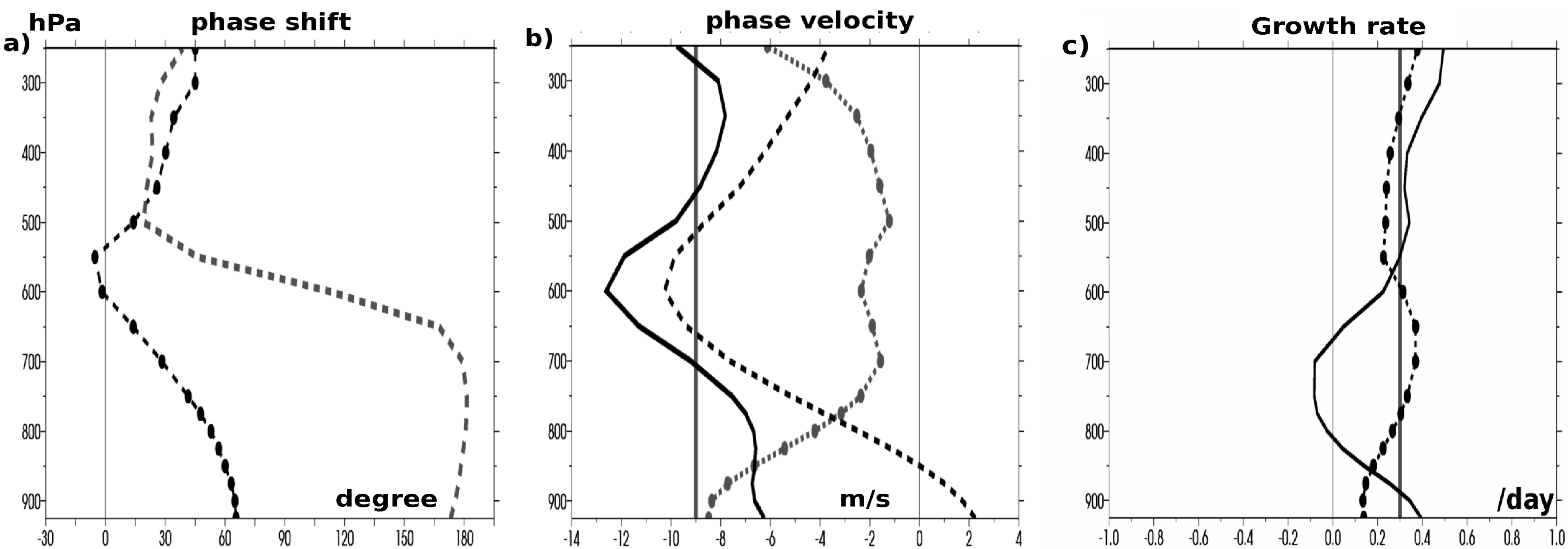
$$q^* = \hat{q}^* e^{i(kx-\omega t)}$$

$$v^* = \hat{v}^* e^{i(kx-\omega t+\phi_v)}$$

$$w^* = \hat{w}^* e^{i(kx-\omega t+\phi_w)}$$

$$U_\varphi = \overline{u} - \frac{1}{k\hat{q}^*}\left(\hat{A}_y \sin\phi_v + \hat{A}_z \sin\phi_w\right)$$

$$G_r = \frac{1}{\hat{q}^*}\left(\hat{A}_y \cos\phi_v + \hat{A}_z \cos\phi_w\right)$$



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$$\Rightarrow$$

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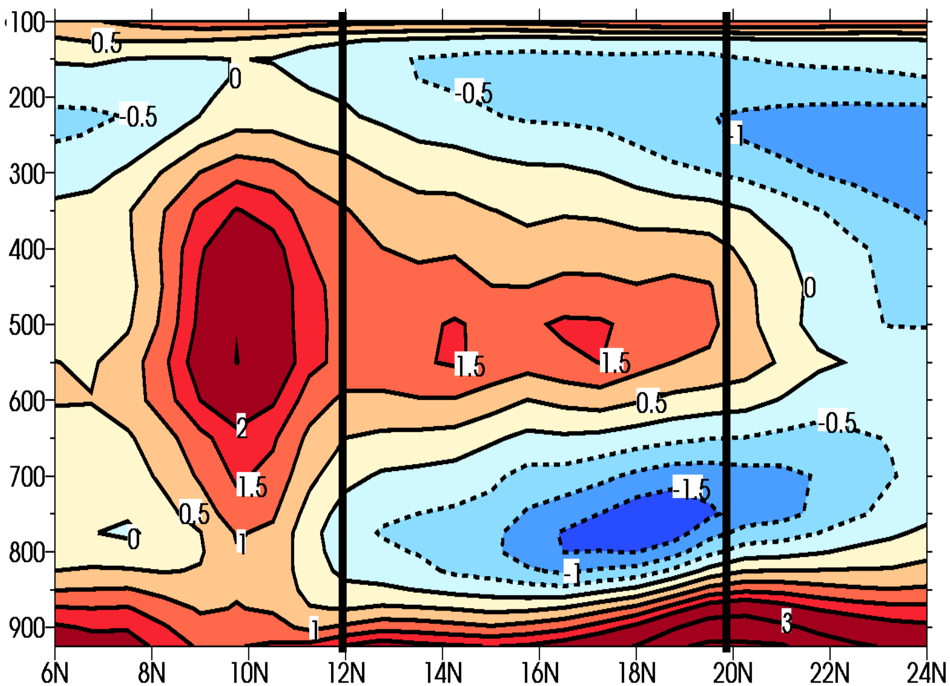
Mean+composite at t0 Lat-Lev profile of Residual of THETA



Mean+composite at t0 Lat-Lev profile of Residual of Humidity