# Real-time monitoring and forecast of intraseasonal variability during the 2011 African Monsoon


**R. Roehrig**[1], F. Couvreux[1], E. Poan[1], P. Peyrillé[1], J.-P. Lafore[1], O. Ndiaye[2], A. Diongue-Niang[2], F. Favot[1], J.-L. Boichard[3], L. Fleury[3]

[1] CNRM-GAME, Météo-France/CNRS, Toulouse, France.

[2] ANACIM, Dakar, Sénégal.

[3] OMP, Toulouse, France

METEO FRANCE
Toujours un temps d'avance


cnrs
dépasser les frontières
INSU
Observer & comprendre

# Introduction and Motivation

- Large progress during the last decade in documenting and understanding the African IntraSeasonal Variability (ISV)

- 3 main timescales:

  **25-90 days**:

  – **link to the MJO** (e.g. Matthews 2004, Janicot et al. 2009)

  **10-25 days**:

  – **Quasi-Biweekly Zonal Dipole** (QBZD, Mounier et al. 2008)

  – **Sahelian mode** (Janicot et al. 2010),

  – Variability of the **Saharan Heat Low** and link with midlatitudes (Chauvin et al. 2010, Roehrig et al. 2011)

  **3-10 days**:

  – **African Easterly Waves** (e.g. Kiladis et al. 2006),

  – Synoptic variability of **precipitable water** (Couvreux et al. 2010, Poan et al. 2012),

  – **Kelvin waves** (Mounier et al. 2007).

# Introduction and Motivation

- Large progress during the last decade in documenting and understanding the African IntraSeasonal Variability (ISV)

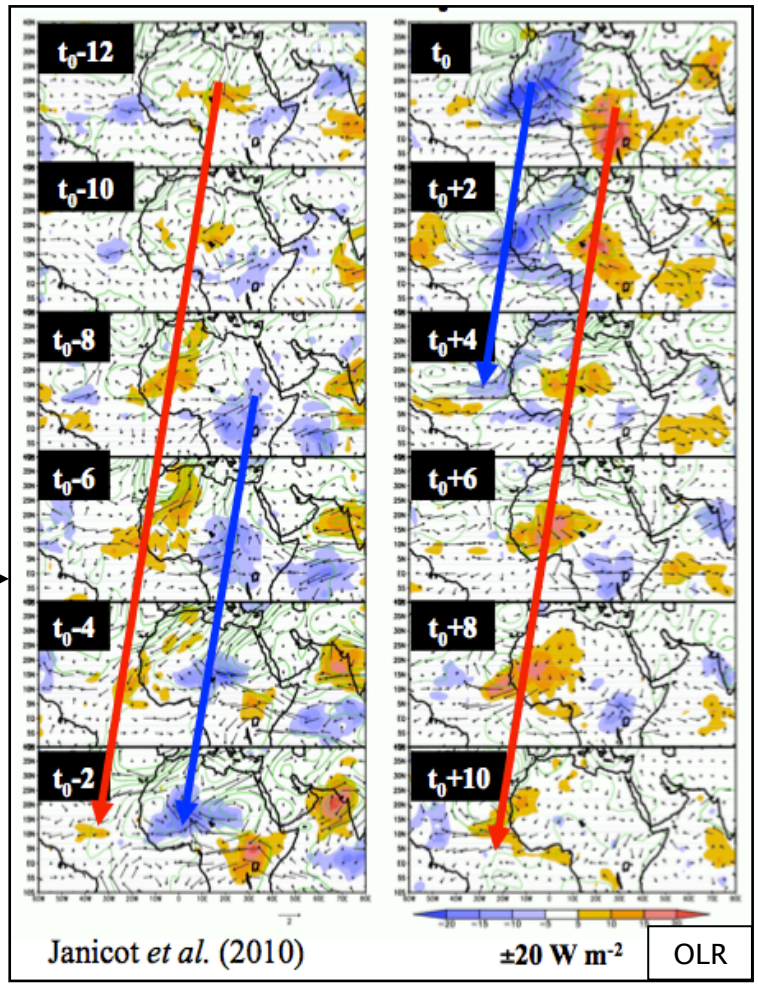
- 3 main timescales:

  25-90 days:
  - **link to the MJO** (e.g. Matthews 2004, Janicot et al. 2009)

  10-25 days:
  - **Quasi-Biweekly Zonal Dipole** (QBZD, Mounier et al. 2008)
  - **Sahelian mode** (Janicot et al. 2010),
  - Variability of the **Saharan Heat Low** and link with midlatitudes (Chauvin et al. 2010, Roehrig et al. 2011)

  3-10 days:
  - **African Easterly Waves** (e.g. Kiladis et al. 2006),
  - Synoptic variability of **precipitable water** (Couvreux et al. 2010, Poan et al. 2012),
  - **Kelvin waves** (Mounier et al. 2007).

10-25 days: **Sahelian mode**



# Introduction and Motivation

- Large progress during the last decade in documenting and understanding the African IntraSeasonal Variability (ISV)

- 3 main timescales:

**Objectives:**

➢ Confront the climatology to the real world;

➢ Investigate the forecast skill of the monsoon ISV, based on our current knowledge

**Approach:**

➢ Address these 2 points through a real-time exercice

  - **African Easterly Waves** (e.g. Kiladis et al. 2006),
  - Synoptic variability of **precipitable water** (Couvreux et al. 2010, Poan et al. 2012),
  - **Kelvin waves** (Mounier et al. 2007).

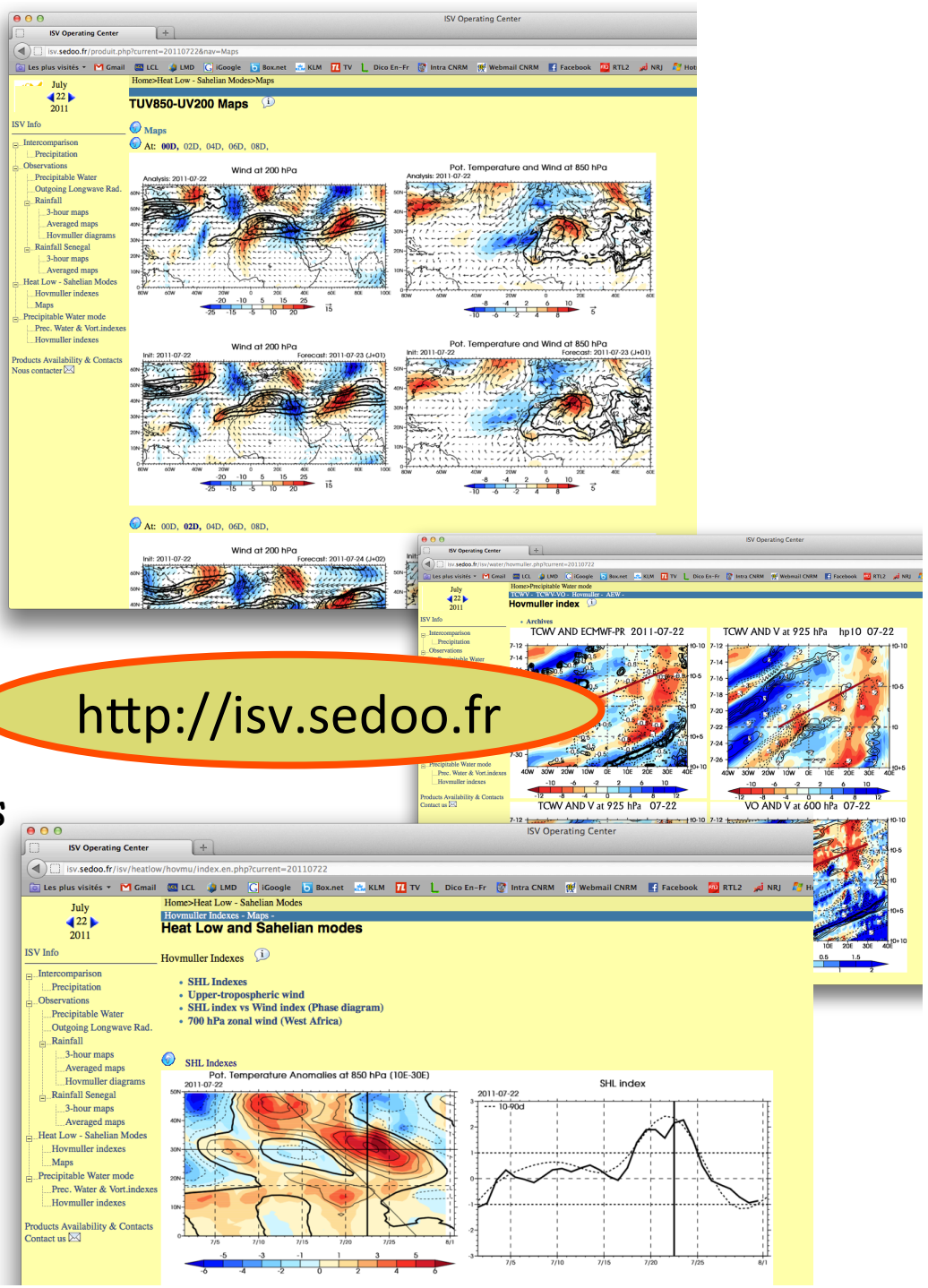
**10-25 days: Sahelian mode**

# Outline

1. Introduction
2. The MISVA project
   - Data and methodology
   - Available products
3. Overview of 2011 season
4. Conclusions

# 2. MISVA

- **MISVA**: Monitoring IntraSeasonal Variability over Africa
- **Collaboration between France & Senegal** with the objective to involve forecasters
- ***A* real-time website**, simple but easily and rapidly evolving, according to the encountered needs and ideas
- Use of websites providing complementary information (broader context)
  - e.g. MJO: Wheeler's website + NCEP
- **Regular briefing & reports** (~2/ week) between Toulouse and Dakar.



# 2.a Data and methodology

**Data:**

- **ECMWF** 6-hourly analyses and forecasts (+10 days)
- Daily satellite **OLR**, with a 2-day delay (NOAA)
- 3-hourly **TRMM precipitation**, with a ~6h delay
- **Observations**: Senegal Rain gauges, soundings

**Methodology:**

- Computation of **seasonal anomalies**, using the mean seasonal cycle derived from ERA-Interim/NOAA OLR/TRMM-3B42
- **Filtering** using forecast data (EC) and zero-padding (as in Wheeler and Weickmann 2001)
- **Indexes of ISV modes** are computed through a spatial projection of (filtered or not) anomalies on their mean climatological (canonical) structure.

# 2.a Data and methodology

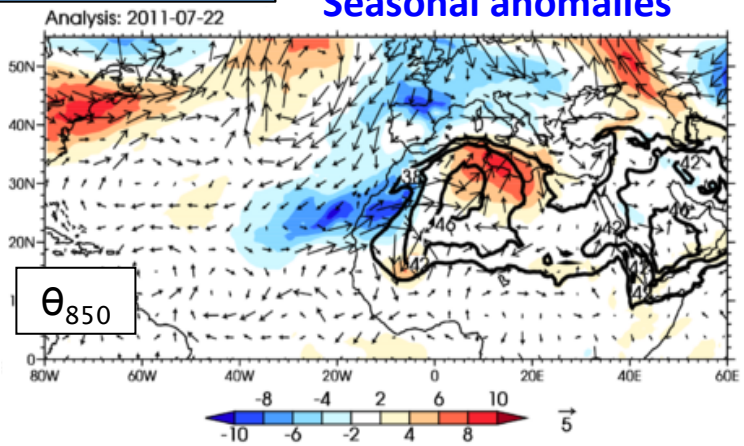
**Data:**

- **ECMWF** 6-hourly analyses and forecasts (+10 days)
- Daily satellite **OLR**, with a 2-day delay (NOAA)
- 3-hourly **TRMM precipitation**, with a ~6h delay
- **Observations**: Senegal Rain gauges, soundings

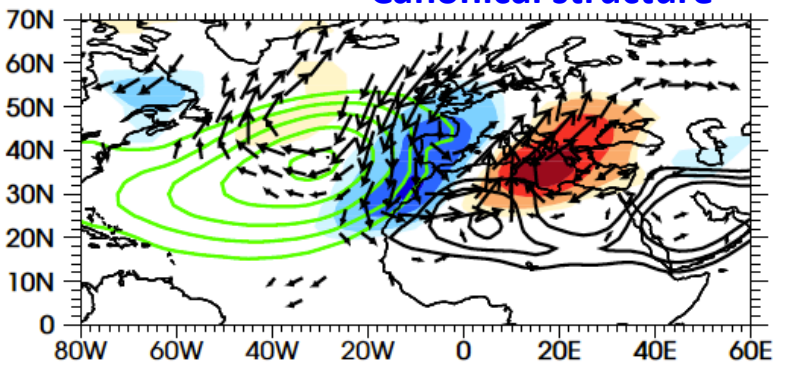
**Methodology:**

- Computation of **seasonal anomalies**, using the mean seasonal cycle derived from ERA-Interim/NOAA OLR/TRMM-3B42
- **Filtering** using forecast data (EC) and zero-padding (as in Wheeler and Weickmann 2001)
- **Indexes of ISV modes** are computed through a spatial projection of (filtered or not) anomalies on their mean climatological (canonical) structure.

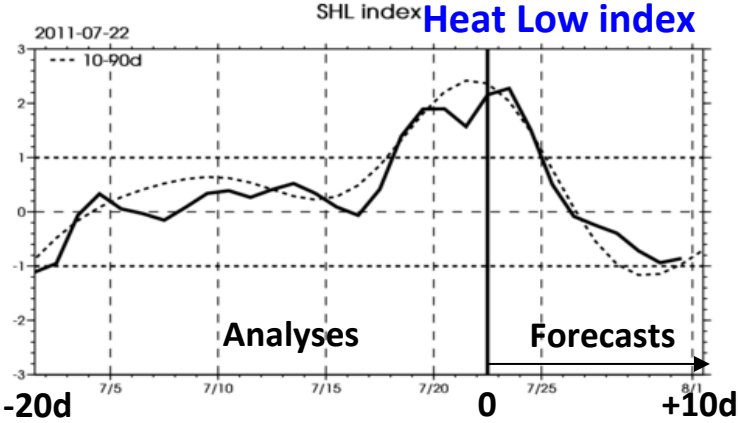
**Seasonal anomalies**




**Canonical structure**



**Heat Low index**



# 2.b Available Products

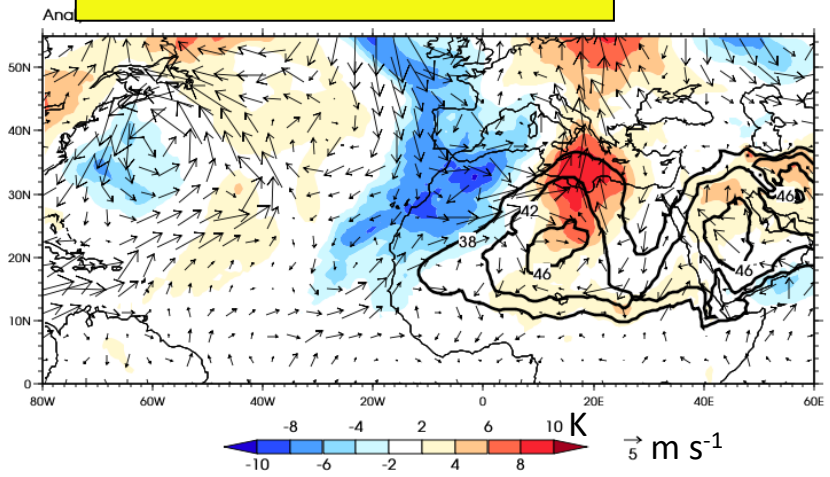
For a start (in 2011) we selected just a few products (maps, indices, hovmüller…)

- **Sahelian mode**
- **QBZD mode**
- **SHL mode**
- **Mid-latitude Rossby waves**
- **Ventilation**
- **Onset**

- **Precipitable Water**
- **AEWs**
- **Precipitation (TRMM & Obs)**

# 3. Overview of 2011 ISV: 10-25-day scale

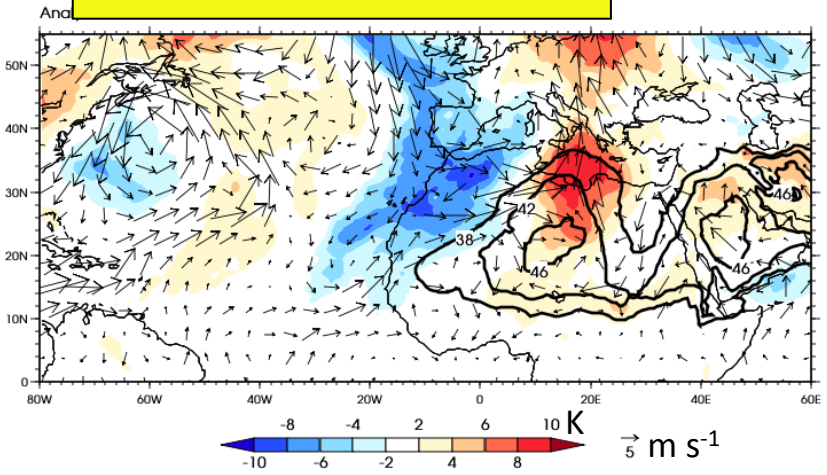
HLE – 7 June



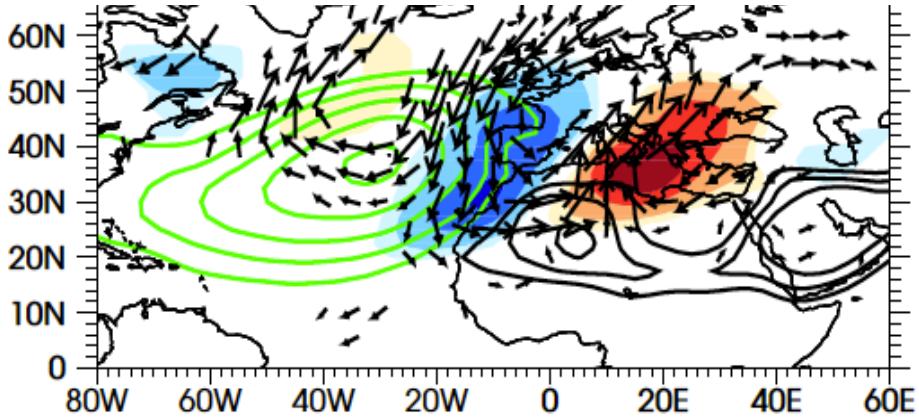

Shading: $\theta_{850}$ anomalies
Black contours: raw $\theta_{850}$
Vectors: wind anomalies at 850 hPa
Green contours: raw sea level pressure

# 3. Overview of 2011 ISV: 10-25-day scale

HLE – 7 June



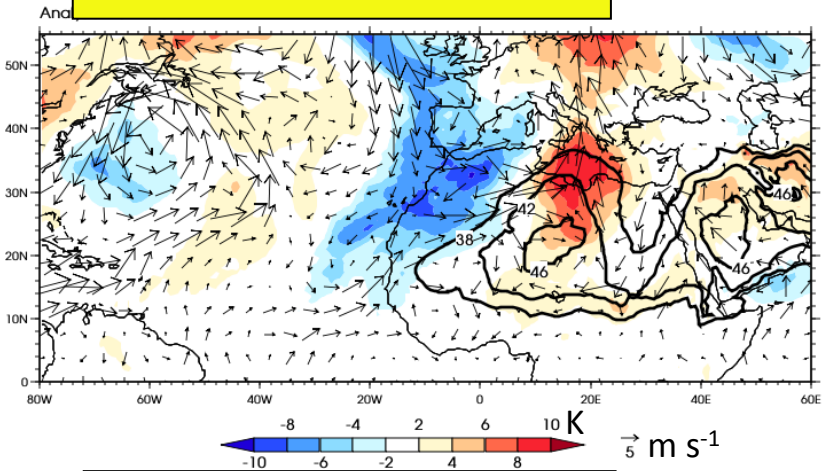

"Canonical" HLE



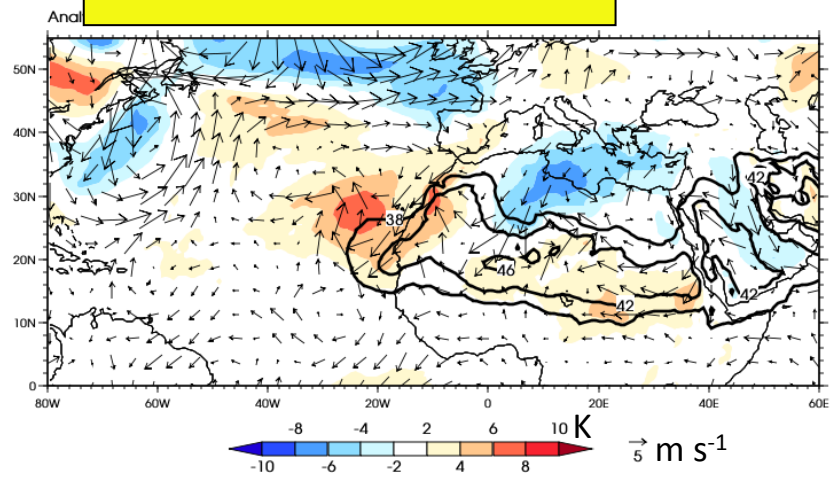

Shading: $\theta_{850}$ anomalies
Black contours: raw $\theta_{850}$
Vectors: wind anomalies at 850 hPa
Green contours: raw sea level pressure

# 3. Overview of 2011 ISV: 10-25-day scale

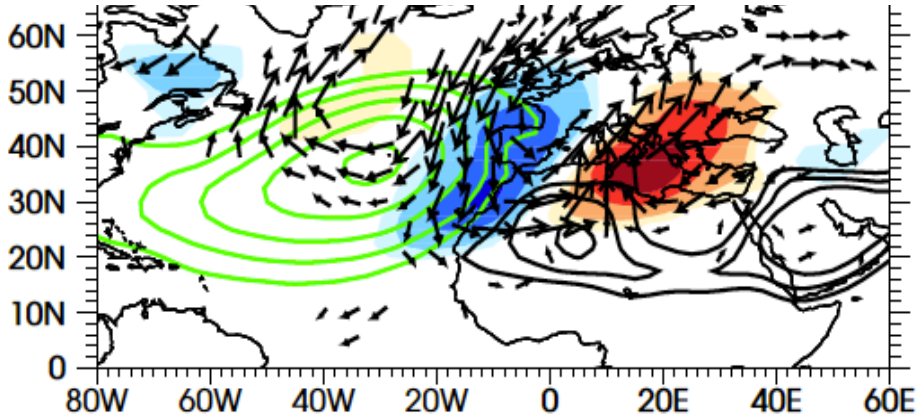
## HLE – 7 June



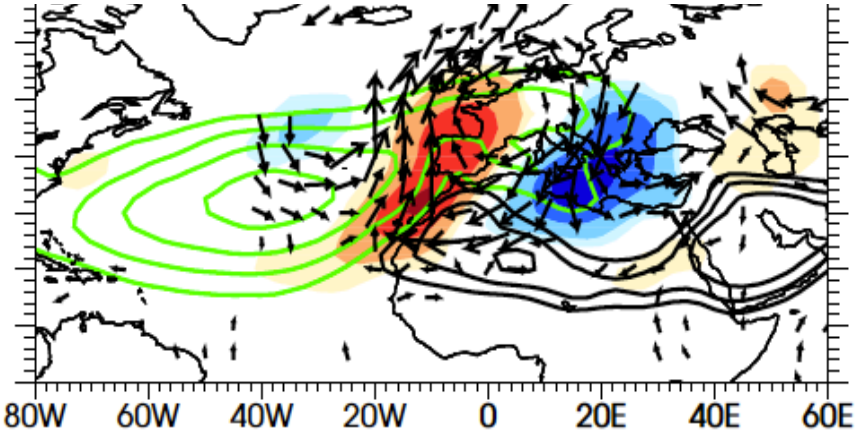

## HLW – 16 June




## "Canonical" HLE




## "Canonical" HLW

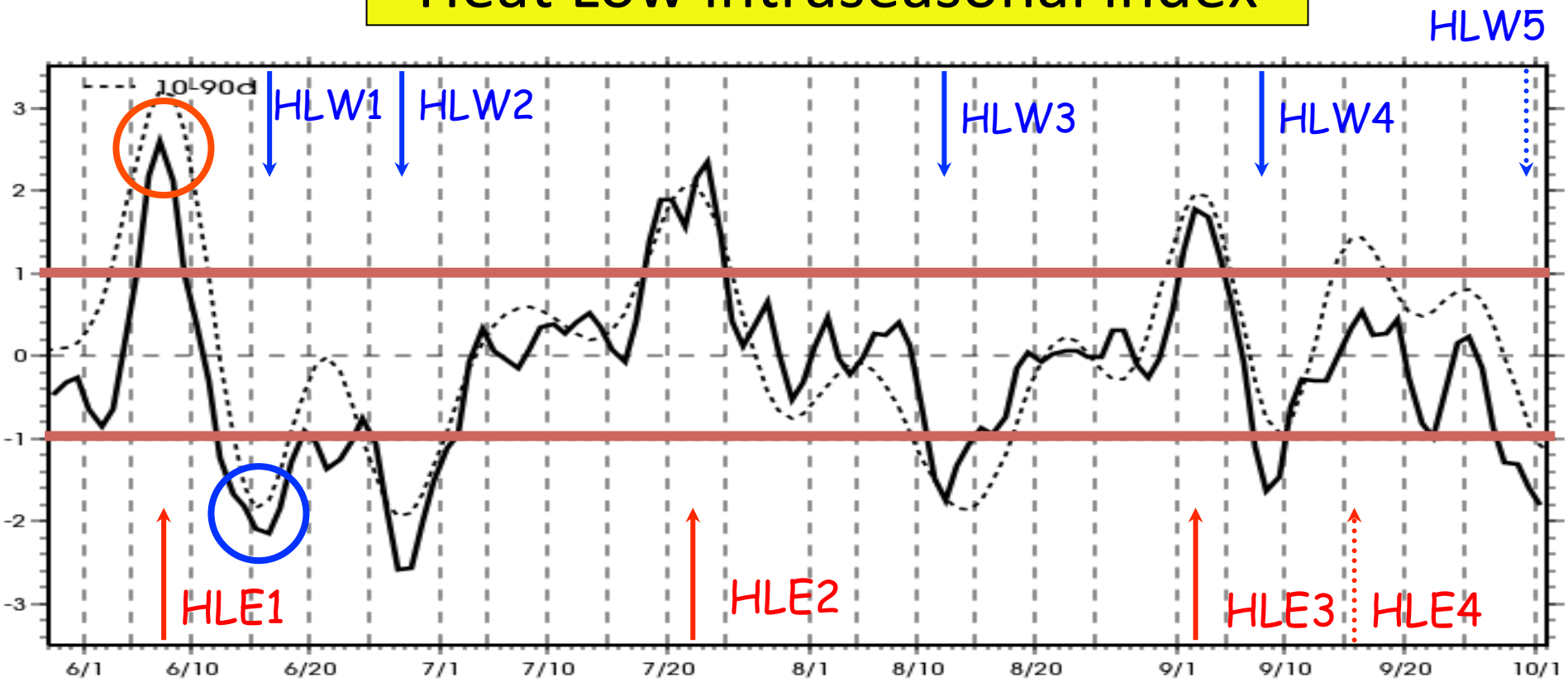



- **High similarities with canonical events: they make sense in the "real world"**

Shading: $\theta_{850}$ anomalies
Black contours: raw $\theta_{850}$
Vectors: wind anomalies at 850 hPa
Green contours: raw sea level pressure

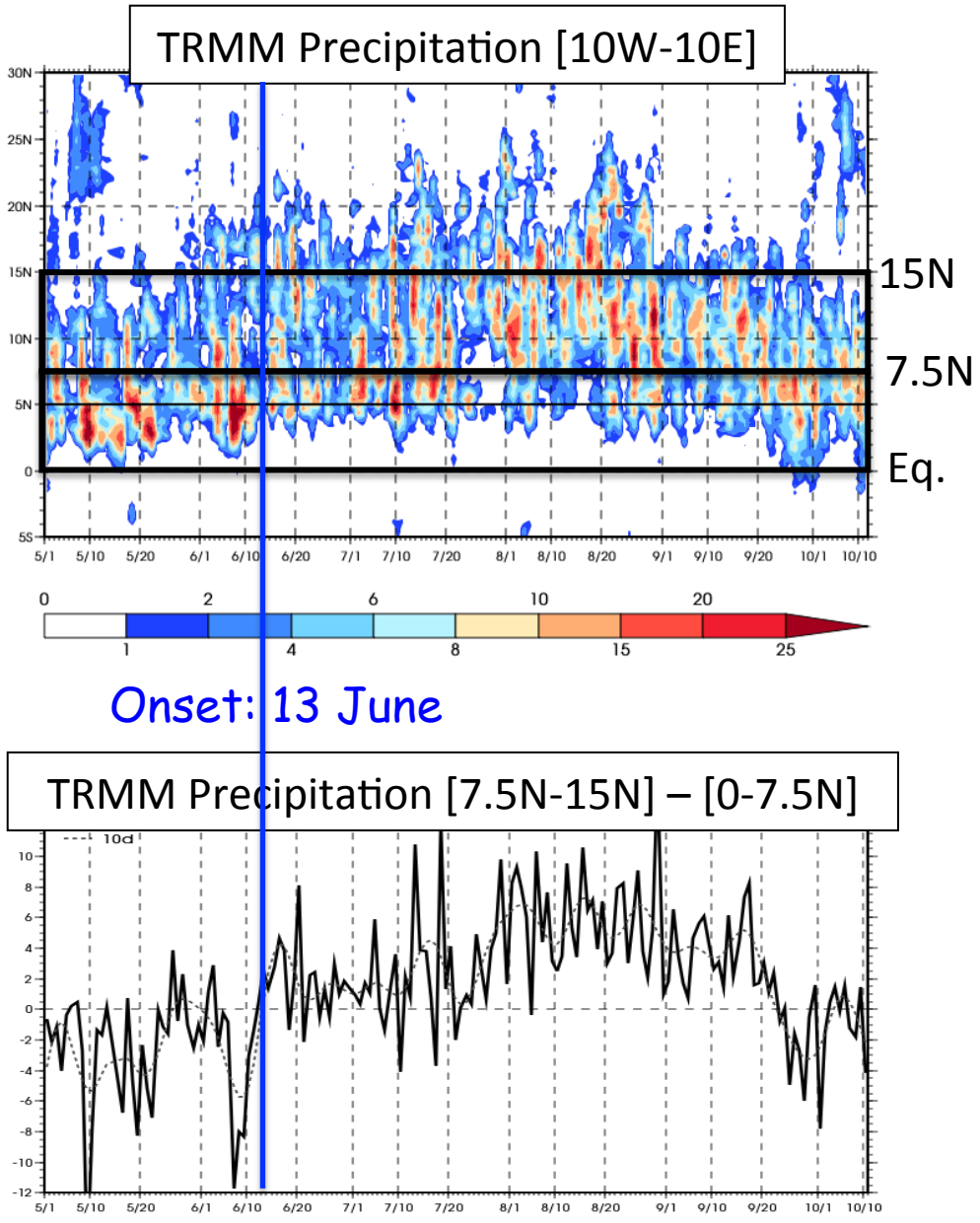
# 3. Overview of 2011 ISV: 10-25-day scale

## Heat Low intraseasonal index

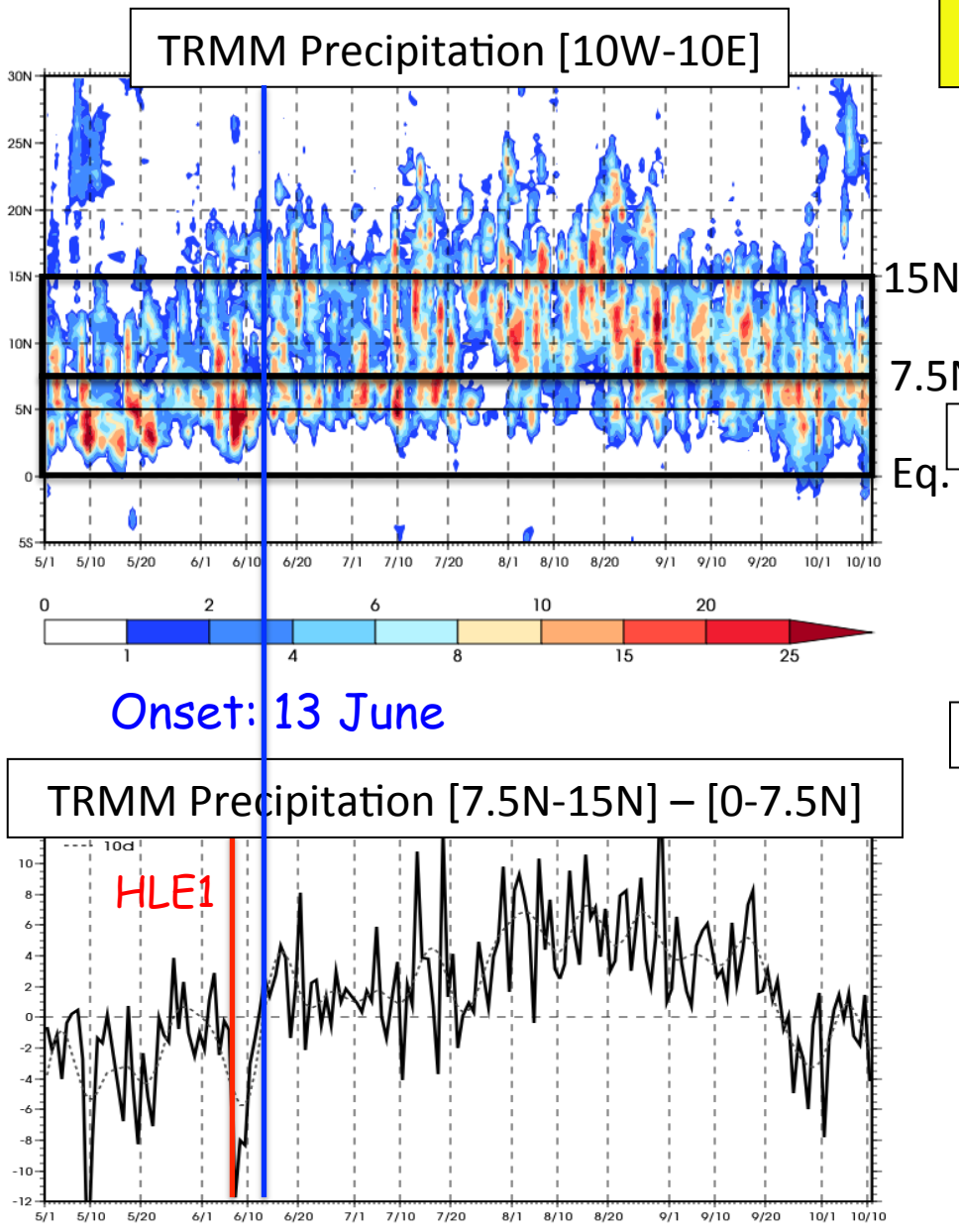



- **3 HLE** events: 5-9 June, 18-24 July, 1-4 Sep
- **4 HLW**: 12-18 June, 25 June-1 July, 10-14 Aug,7-10 Sep
- The season begins with a HLE event, favorable to the monsoon onset (Roehrig et al. 2011)

# 3. Overview of 2011 ISV: Onset



# 3. Overview of 2011 ISV: Onset




## Heat Low and Onset

**HLE event = reduced northeastern ventilation**

↓

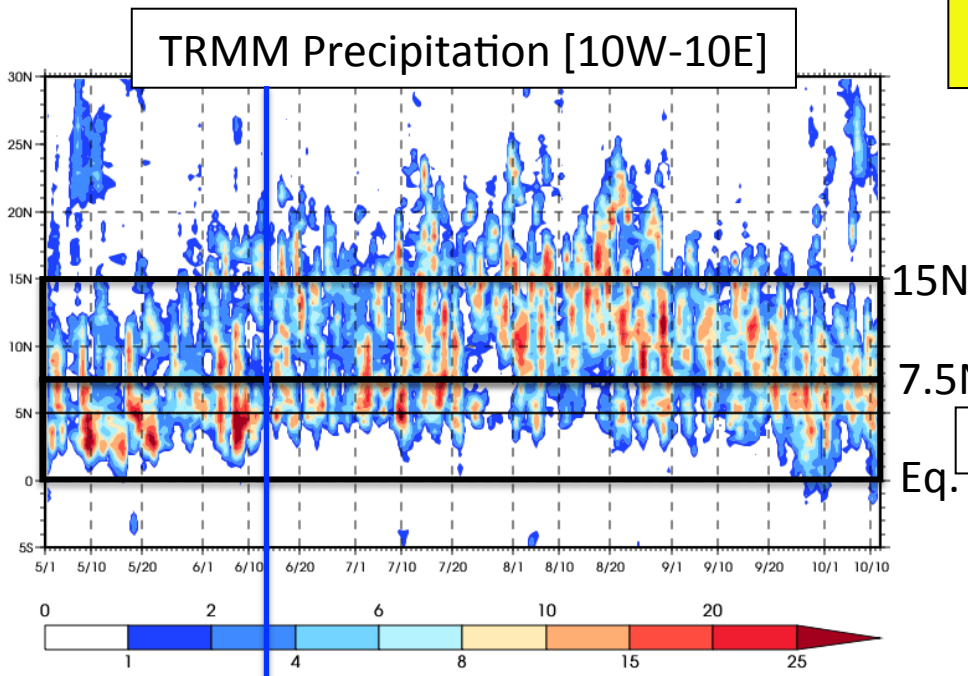
**The heat low can reinforce**

↓

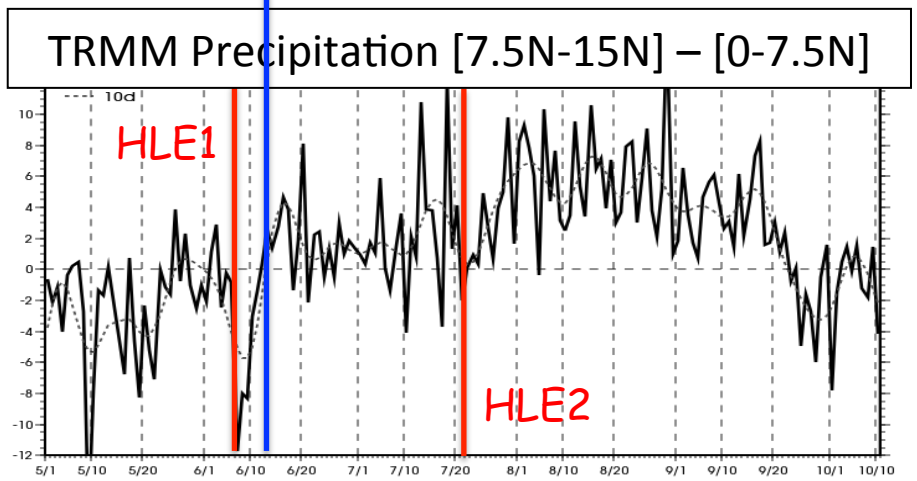
**Favorable to the northward shift of the ITCZ**

Roehrig et al. (2011)

# 3. Overview of 2011 ISV: Onset




Onset: 13 June




## Heat Low and Onset

**HLE event = reduced northeastern ventilation**

↓

**The heat low can reinforce**

↓

**Favorable to the northward shift of the ITCZ**

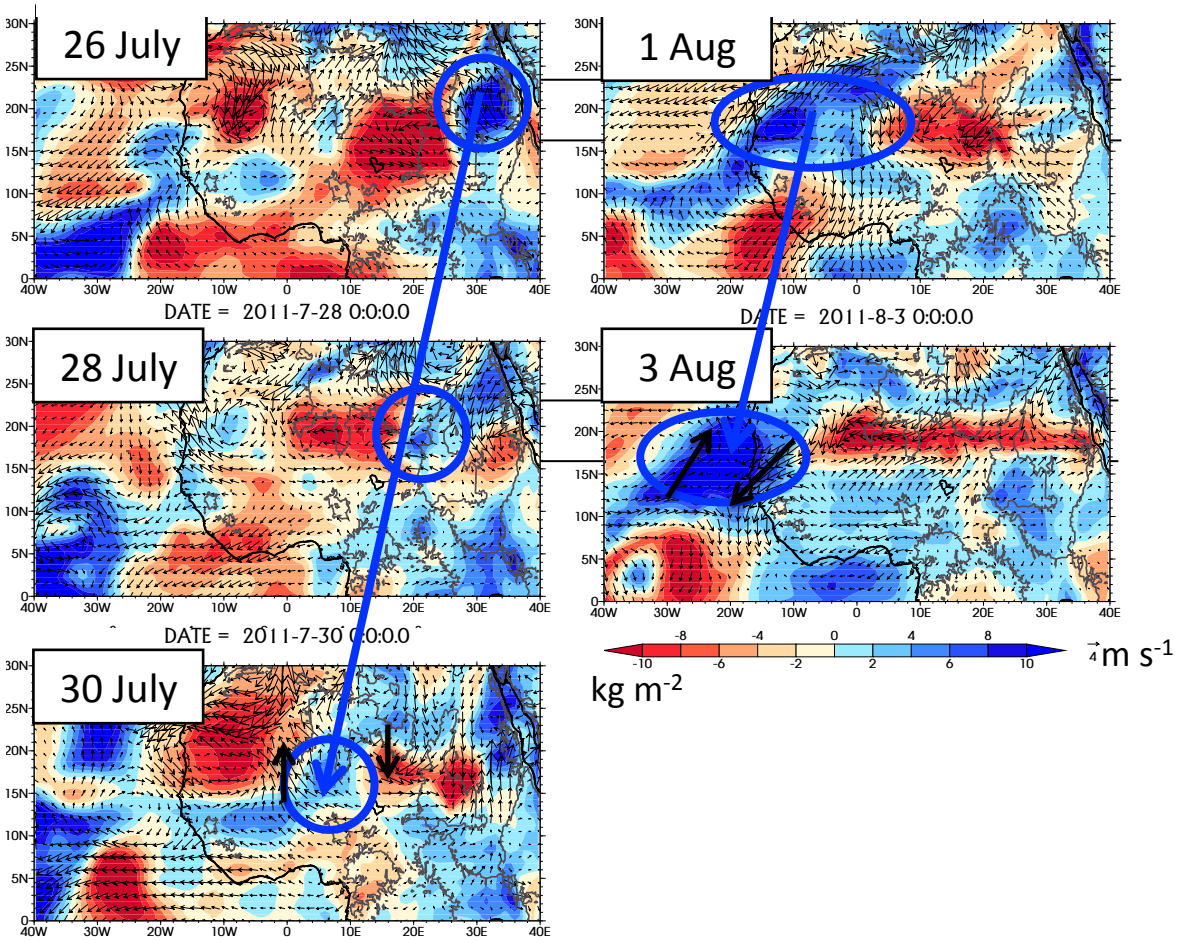
Roehrig et al. (2011)

→ SHL state provides large scale information for monsoon onset or northward surge.

# 3. Overview of 2011 ISV: 1-10-day scale

## Synoptic Variability of Precipitable Water (PW)

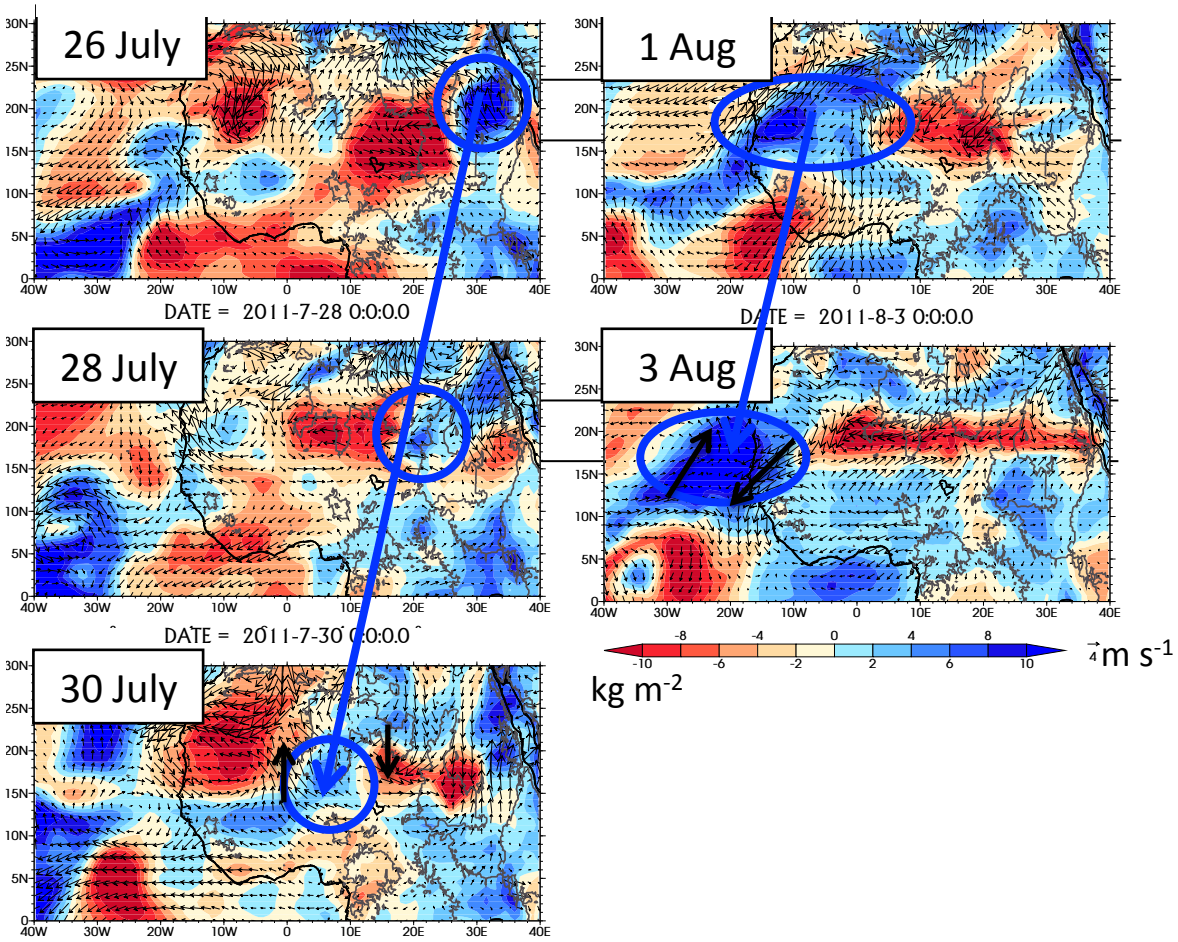
PW anomalies + Wind anomalies at 925 hPa



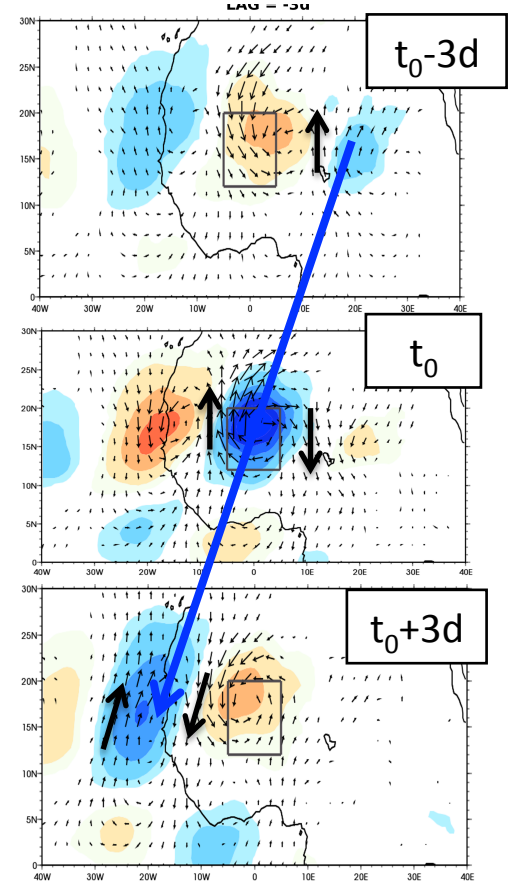
# 3. Overview of 2011 ISV: 1-10-day scale

## Synoptic Variability of Precipitable Water (PW)

PW anomalies + Wind anomalies at 925 hPa




Canonical wet PW synoptic event (Poan et al. 2012)

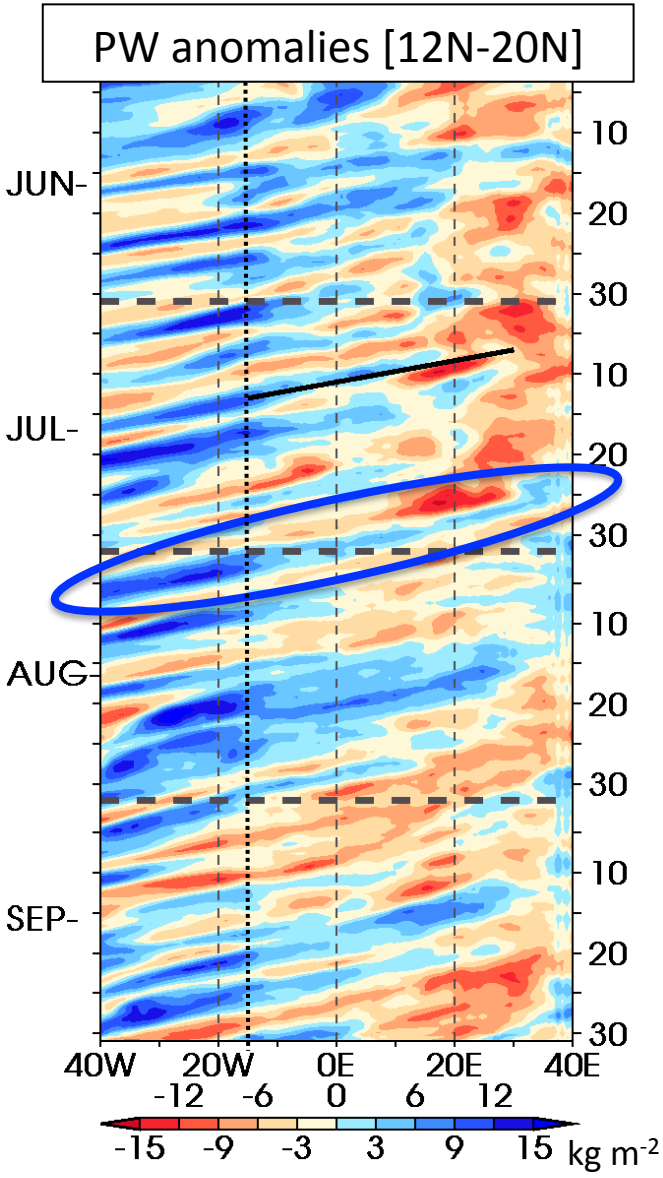



- **High similarities between with the canonical event: In structure, in dynamics: The canonical event makes sense**

# 3. Overview of 2011 ISV: 1-10-day scale

**Synoptic Variability of Precipitable Water (PW)**

- Same characteristics as the canonical mode: frequency, propagation
- Differences between the eastern and the western Sahel structures (as in Poan et al 2012)

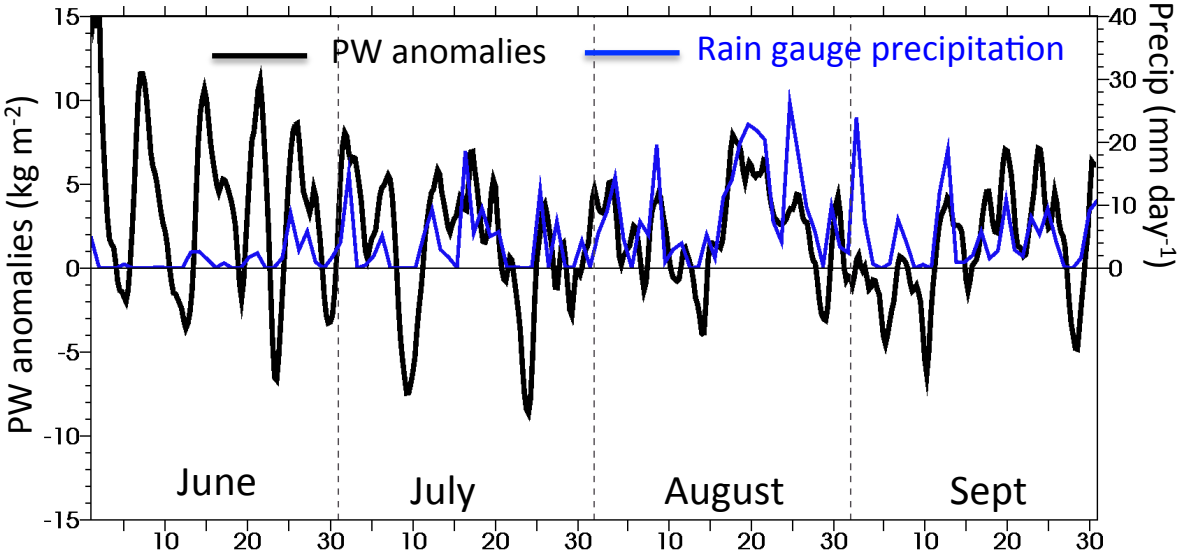


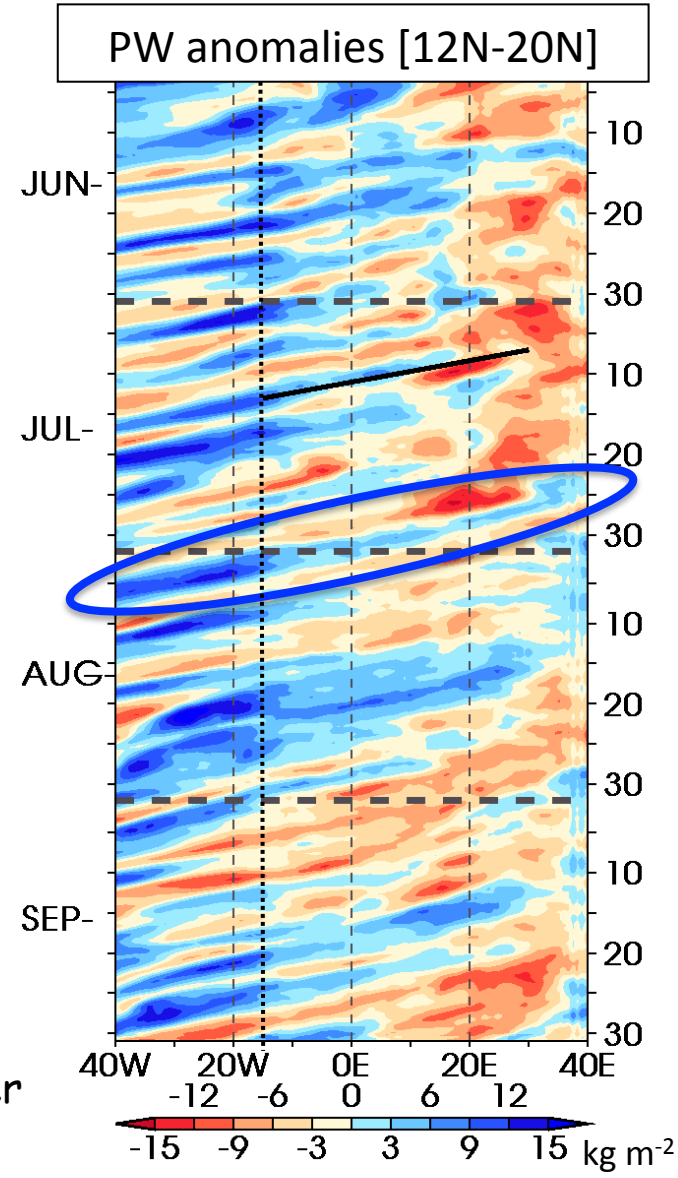
# 3. Overview of 2011 ISV: 1-10-day scale

## Synoptic Variability of Precipitable Water (PW)

- Same characteristics as the canonical mode: frequency, propagation
- Differences between the eastern and the western Sahel structures (as in Poan et al 2012)

## Precipitable Water index and Rainfall: over Senegal




- **High correlation (0.57)** between precipitation and PW over Senegal, especially after the monsoon onset **(0.63)**.
- **High potential** of the PW variable

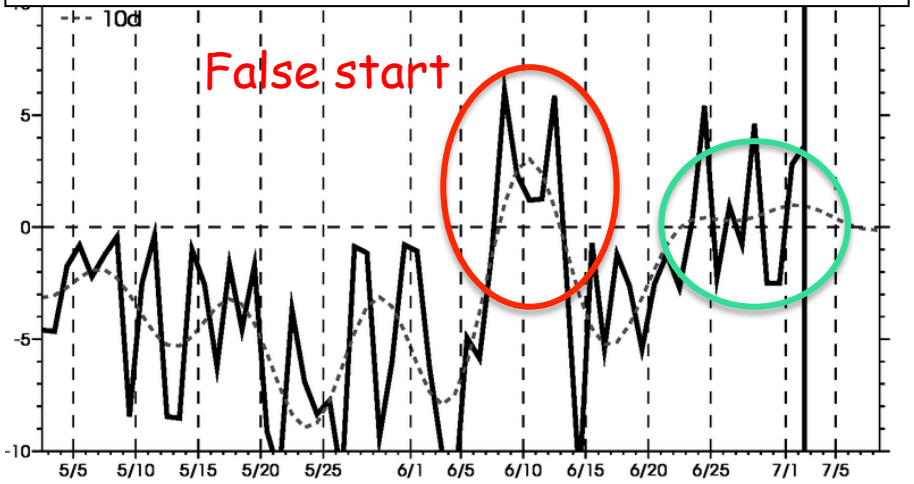
# Conclusions - Perspectives

- **Conclusions**:
  - **10-25 days:**
    - Monitoring of heat low variability provides some large-scale information on the monsoon system. The relationship with the onset seems to work this year
    - The monitoring of the QBZD and Sahelian modes is less obvious (not shown).
  - **Synoptic scales:**
    - PW has a large potential: high predictability, strong relationship with precipitation.

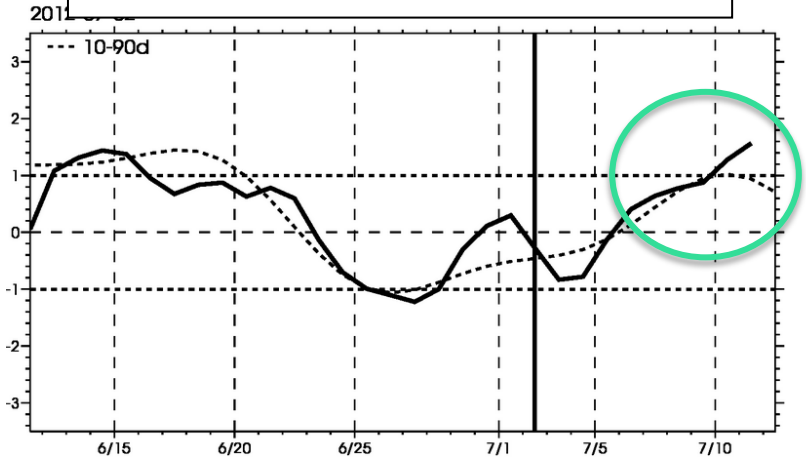
- **Perspectives**:
  - **Quantitative evaluation** of:
    - Diagnostics (e.g., filtering effects)
    - Skills of ECMWF forecasts for different scales (PW, Heat Low…)
  - **This exercise continue this year** with new diagnostics and with higher involvement of Senegalese forecasters

# Beginning of the 2012 season

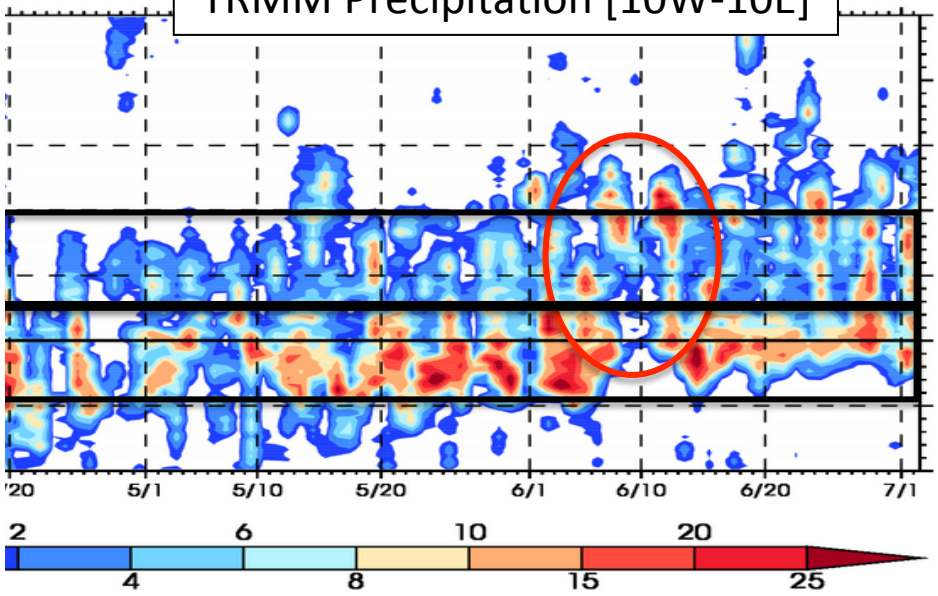
TRMM Precipitation [7.5N-15N] – [0-7.5N]




SHL intraseasonal index

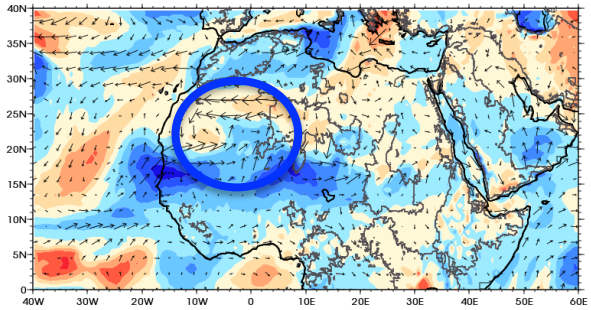



TRMM Precipitation [10W-10E]

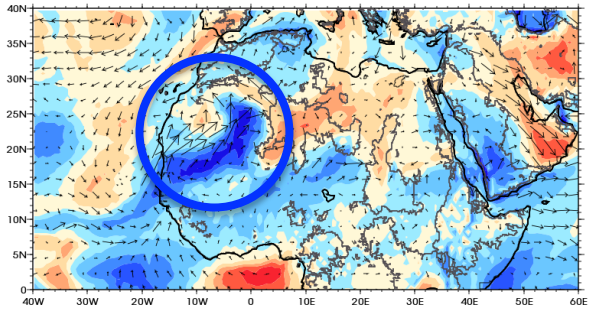


# Beginning of the 2012 season

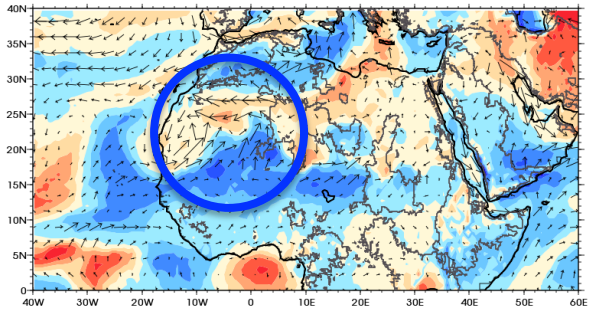
PW and 925 Wnd --> 2012-7-4 0:0:0.0



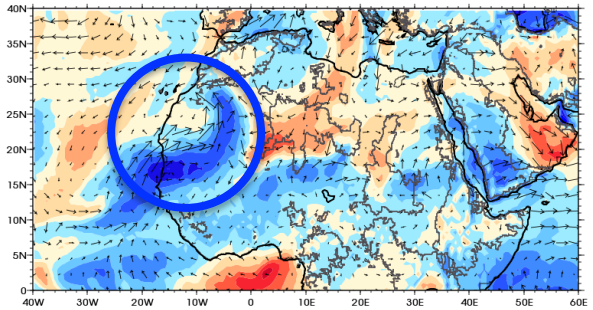

PW and 925 Wnd --> 2012-7-7 0:0:0.0



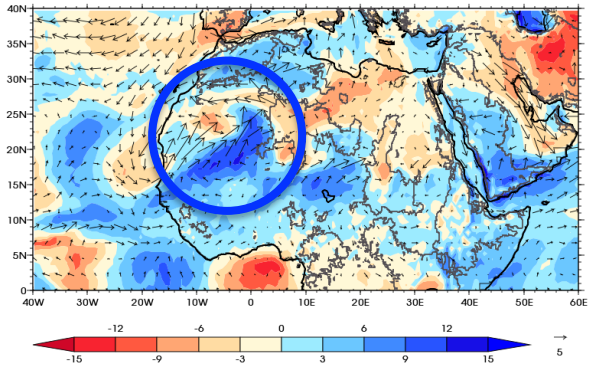

PW and 925 Wnd --> 2012-7-5 0:0:0.0




PW and 925 Wnd --> 2012-7-8 0:0:0.0




PW and 925 Wnd --> 2012-7-6 0:0:0.0




PW and 925 Wnd --> 2012-7-9 0:0:0.0