10-25-day intraseasonal variability of convection over the Sahel: a role of the Saharan Heat Low and midlatitudes

Romain Roehrig[1,3], Fabrice Chauvin[2] and Jean-Philippe Lafore[2]

[1]Laboratoire de Météorologie Dynamique, IPSL, CNRS, Paris, France.

[2] CNRM/Game, Météo-France/CNRS, Toulouse, France

[3] contact: romain.roehrig@lmd.jussieu.fr

1. Introduction

➢ The understanding and forecasting of persistent dry and wet periods of the West African monsoon (WAM), especially those that occur at the intraseasonal time scale, are crucial to improve food management and disaster mitigation in the Sahel region.

➢ Various intraseasonal modes of the WAM convection have been identified in the last 10 years, involving different time scales (e.g., Janicot et al. 2011):

- ➢ The **25-90-day** main mode likely related to the Madden-Julian Oscillation (Matthews 2004).
- ➢ At the **10-25-day** timescale, 2 main intraseasonal modes have been identified:
  - ➢ The **Quasi-Biweekly Zonal Dipole** (Mounier et al. 2008) consists of a quasi-stationnary zonal dipole (Guinean Coast and western equatorial Atlantic).
  - ➢ The **Sahelian mode** (Janicot et al. 2010) corresponds to a westward propagating modulation of the WAM convection.

➢ Recently, a few studies emphasized the possible relationship of the 10-25-day WAM intraseasonal variability with that of the Saharan Heat Low (SHL - Chauvin et al. 2010) or that of the midlatitudes (Vizy and Cook 2009). We build up on these studies to further assess the role of the SHL and midlatitudes in the WAM intraseasonal variability.

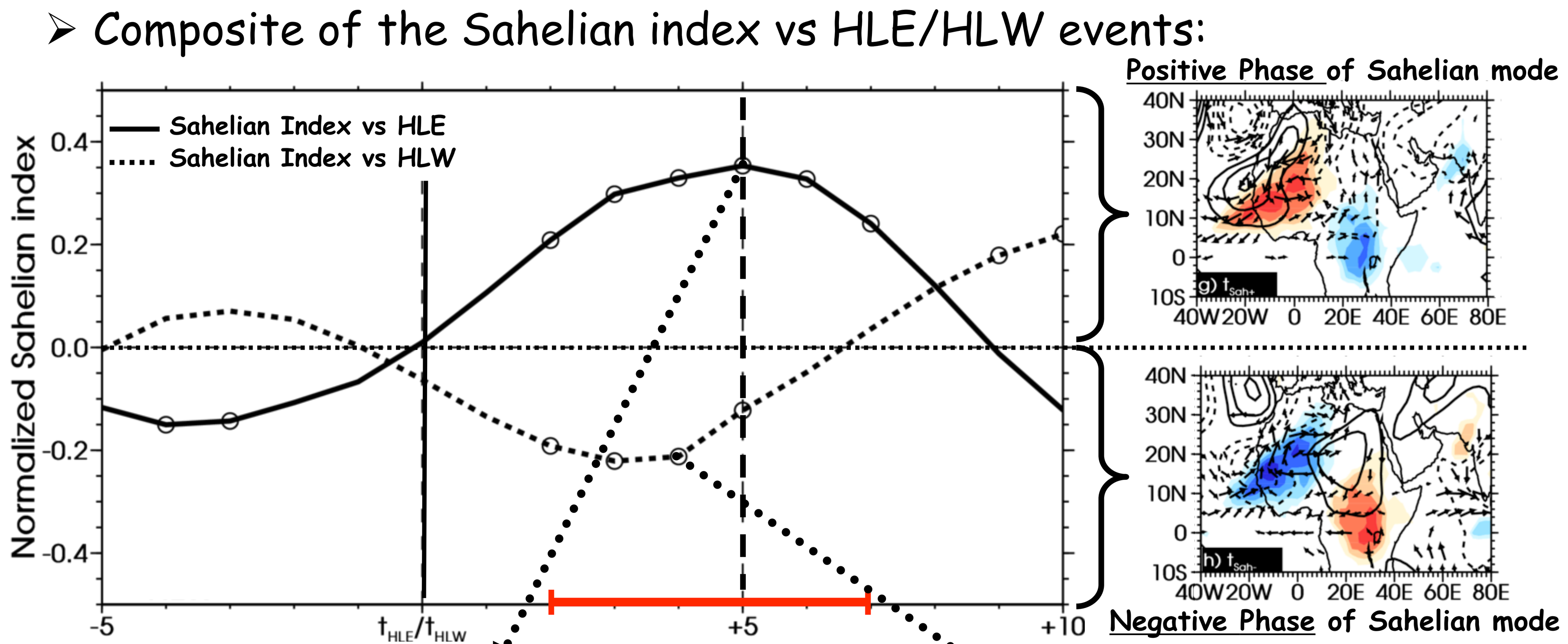
2. Datasets

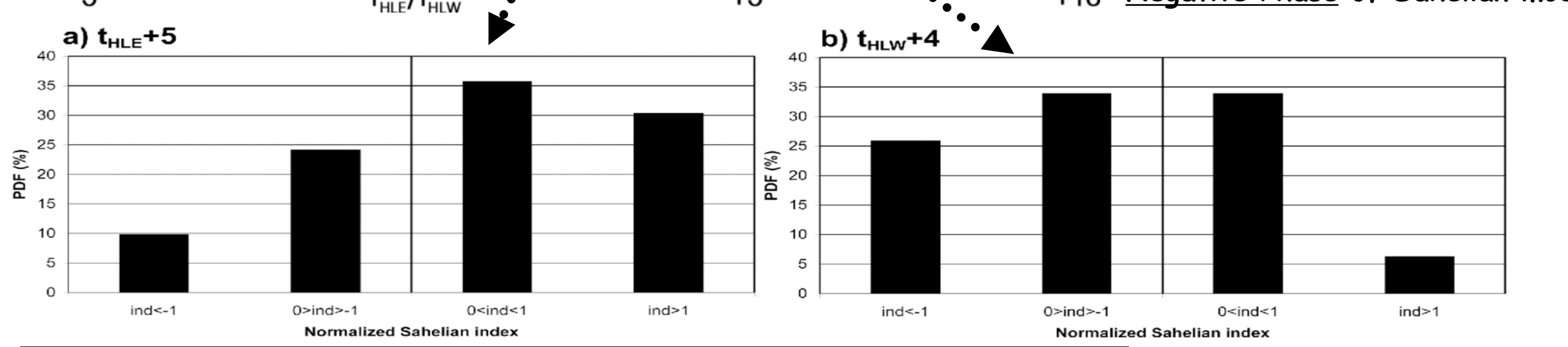
"Observations": daily averages for 1979-2007 JJAS seasons (2.5°x2.5°)

- ➢ **NCEP-DOE AMIP-II** reanalysis (Kanamitsu et al. 2002),
- ➢ **NOAA Outgoing Longwave Radiation** (Liebmann and Smith 1996).

4. Co-occurrences of SHL/Sahelian events

➢ Composite of the Sahelian index vs HLE/HLW events:

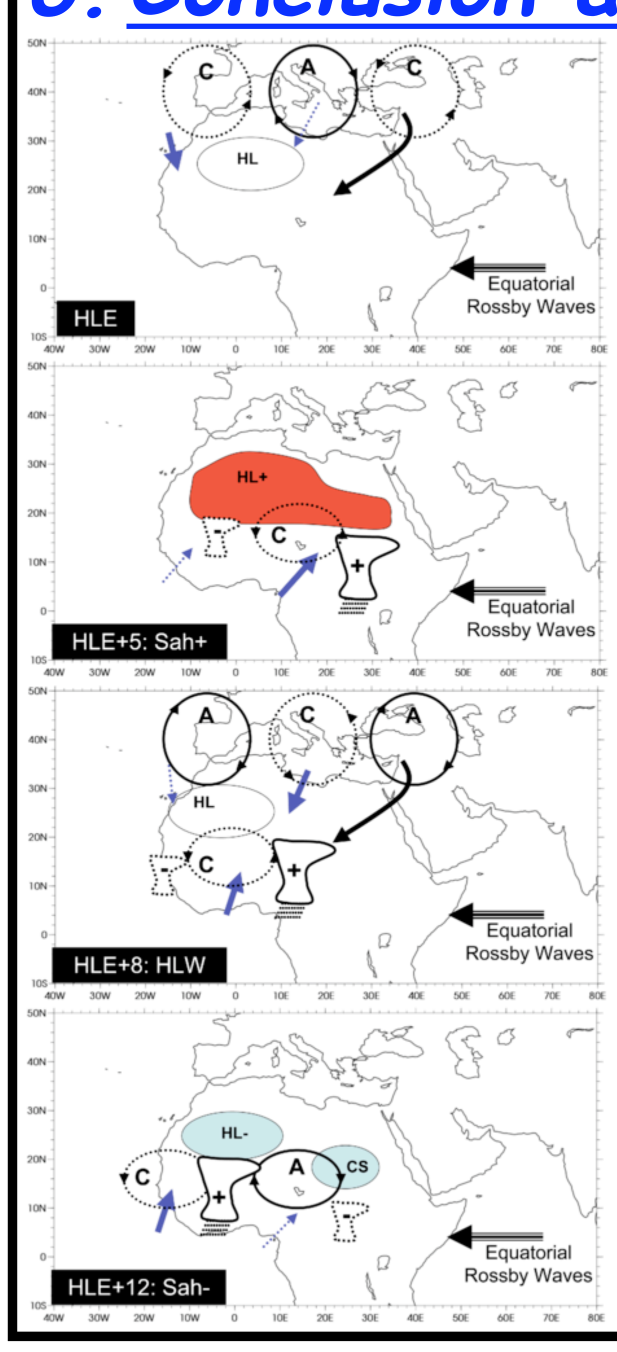




- ➢ 5 days after HLE events, positive phase of the Sahelian mode
- ➢ 4 days after HLW events, negative phase of the Sahelian mode
- ➢ 36% of HLE events followed 2-to-7 days later by a Sah+ event: -> HLE/Sah+ combined events
- ➢ 29% of HLW events followed 2-to-7 days later by a Sah- event: -> HLW/Sah- combined events

From **the set** of Sah+ events, **2 new subsets** are defined: Sah+ events combined with HLE events (1/3) and Sah+ uncombined events (2/3). Idem for Sah-.

6. Conclusion and Perspectives



➢ **Conclusion**:

- A conceptual model for the Sahelian wet and dry sequences, which have an extratropical origin, can be proposed (see on the left).
- This conceptual model covers about 1/3 of Sahelian wet and dry spells, which adds to another 1/3 attributed to equatorial Rossby waves (Janicot et al. 2010).
- These spells have similar spatial structure and evolution, which may reflect the role of specific regional features and processes (orography, land surface…).
- The two origins are likely to interfere in a constructive and destructive manner, leading to high temporal and spatial variability of the Sahelian mode. To better understand the WAM intraseasonal variability, it should be worthwhile to isolate one mechanism from the other.
- More details in **Roehrig et al. (2011)**.

➢ **Perspectives and Future work**:

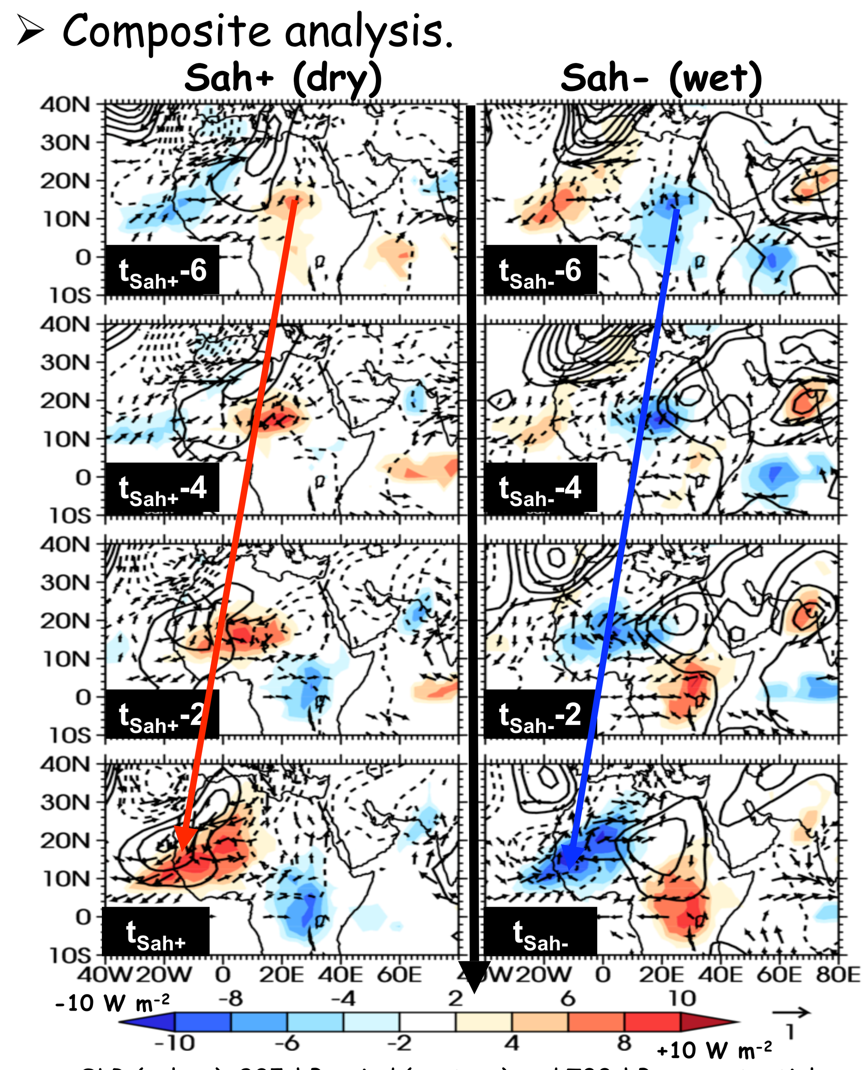
- Idealized modeling studies to better understand the respective role of each mechanism.
- 2 predictors can be computed to help in the forecast of Sahelian break and active events:
  - (i) One for the SHL intraseasonal variability
  - (ii) Another for the equatorial Rossby wave activity
    - -> What predictive skill do they have ?
    - -> How useful are they in a forecast mode ?

3. Background and definitions

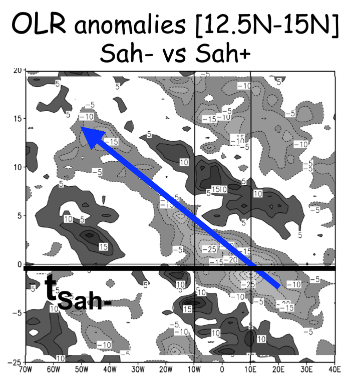
3.a The Sahelian Mode

➢ Principal Component Analysis (PCA) of 10-25-day filtered OLR (Janicot et al. 2011): ~20% of filtered variance.

➢ Composite analysis.



OLR (colors), 925-hPa wind (vectors) and 700-hPa geopotential (contours) anomalies.



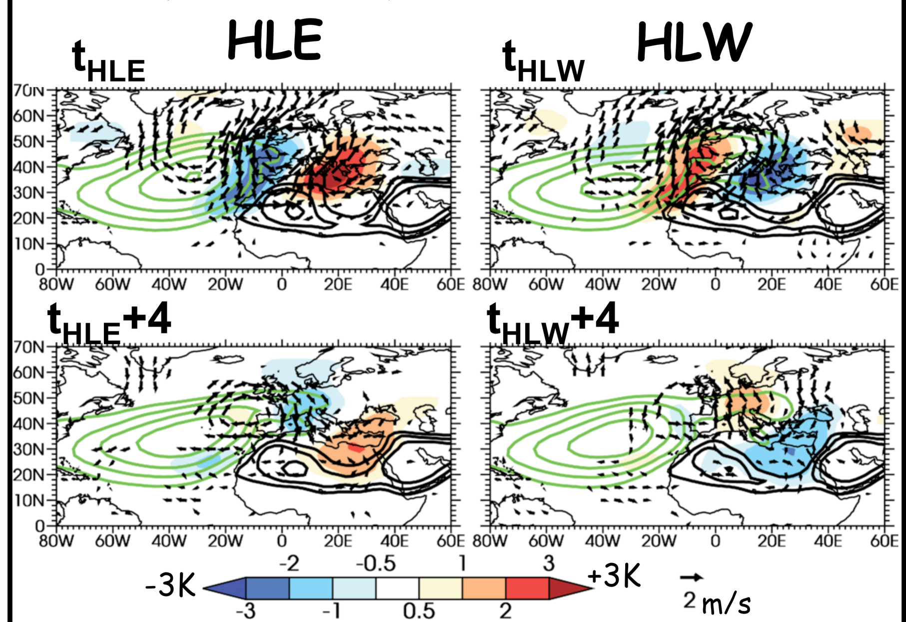
➢ Janicot et al. (2010) related **1/3 of Sah+/Sah- events to Equatorial Rossby waves.**

➢ But also **high extratropical activity** over Europe and the Mediterranean.

3.b The SHL intraseasonal mode

➢ Principal Component Analysis of 10-60-day filtered θ_{850} (Chauvin et al. 2010): ~30% of filtered variance.

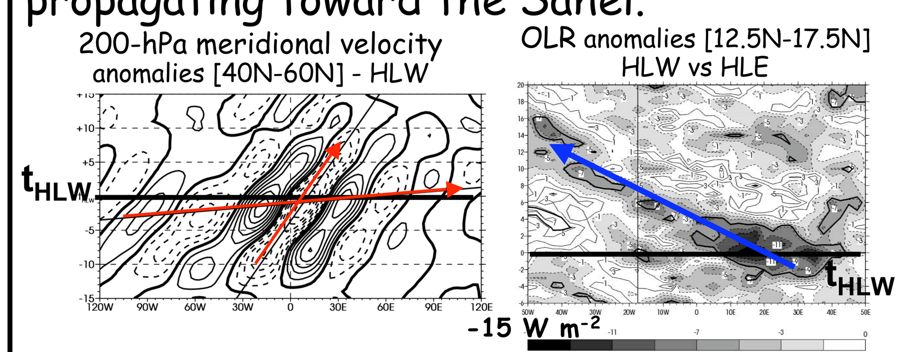
➢ Composite analysis.



θ_{850} anomalies (colors), 850-hPa wind anomalies (vectors) , raw θ_{850} (black contours) and raw mean sea level pressure (green contours).

➢ Modulation of low-level Mediterranean and Atlantic SHL **ventilations.**

➢ HLW: cold surge over Lybia and Egypt propagating toward the Sahel.

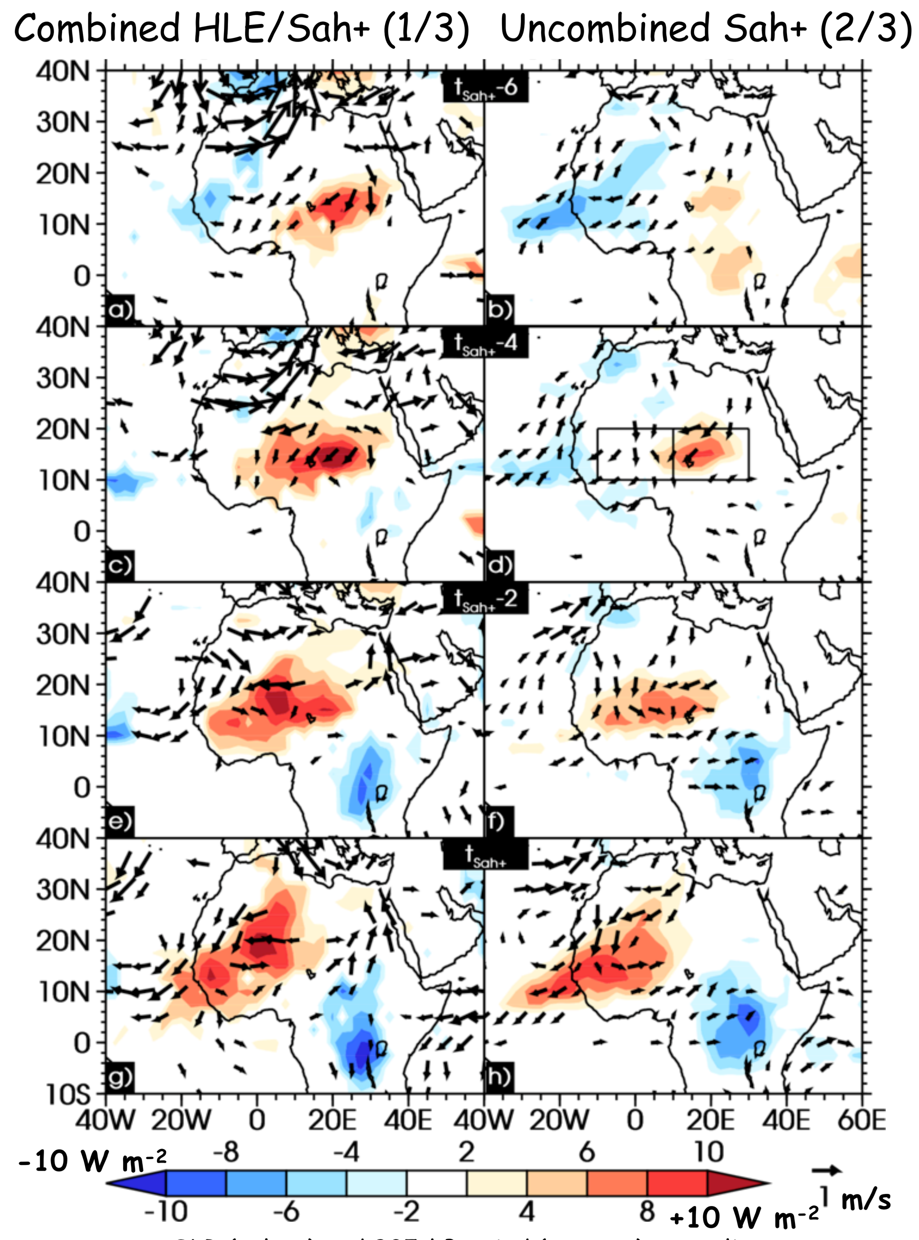


➢ Driven by a quasi-stationnary Rossby wave traveling along the polar and subtropical jets.

➢ Associated with a modulation of convection over the Sahel.

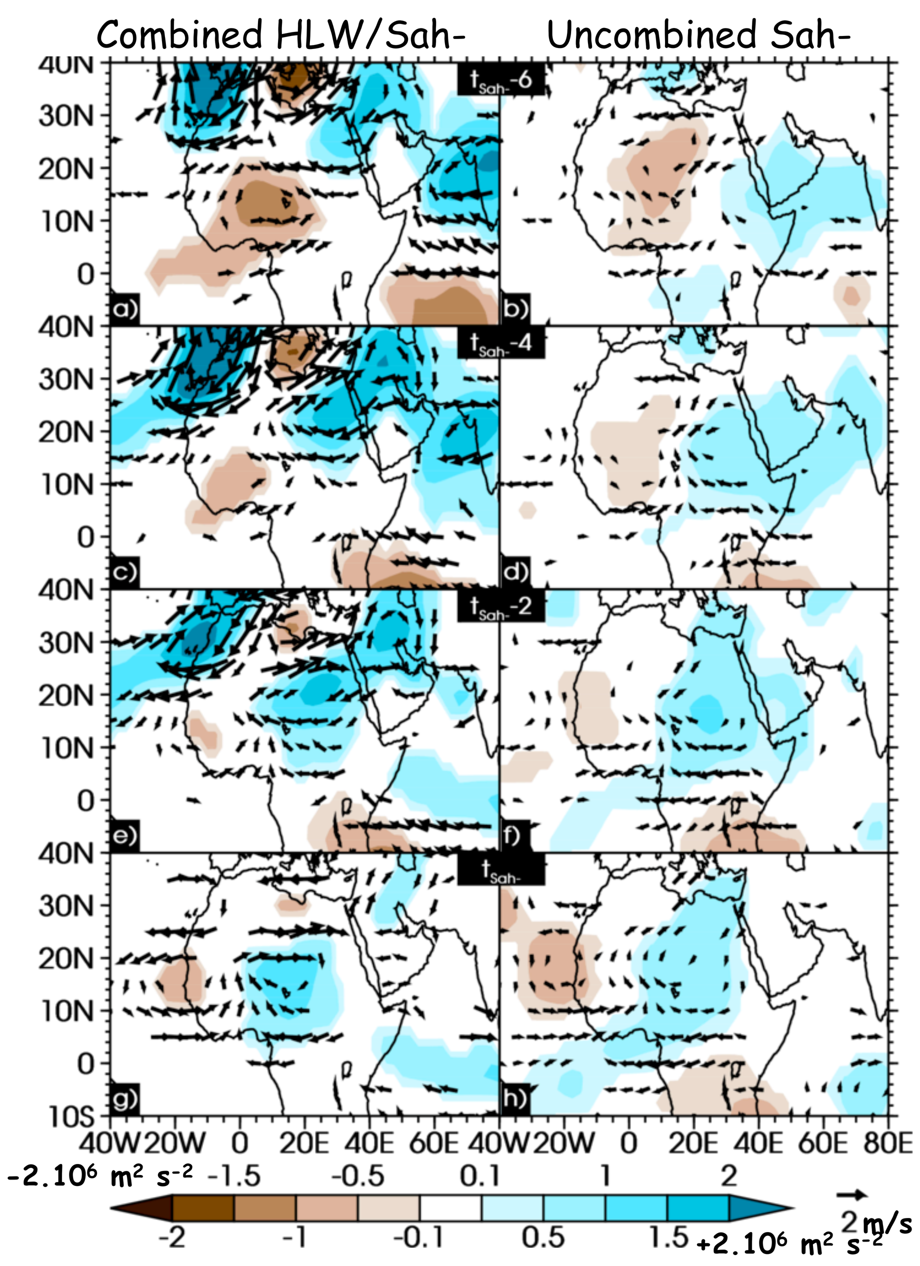
5. Combined SHL and Sahelian events

➢ Composite structure of combined and uncombined Sah+/Sah- are derived to identify significant differences between these two populations.



OLR (colors) and 925-hPa wind (vectors) anomalies.

- ➢ **Combined HLE/Sah+ events**:
  - ➢ The associated **dry spells** over the Sahel are **more intense**, last **longer** (+2 days) and reach a **larger spatial scale**, than those that are uncombined.
  - ➢ These differences between the 2 subsets are **strongly significant**.
- ➢ **Combined HLW/Sah- events**:
  - ➢ No significant difference for convective anomalies of the associated wet spells.
  - ➢ This nonsymmetry suggests nonlinearity.



700-hPa streamfunction (colors) and wind (vectors) anomalies.

- ➢ **Combined HLW/Sah- events**:
  - ▪ The 700-hPa anomalous anticyclonic circulation associated with Sah- events has an extratropical origin.
- ➢ **Uncombined Sah- events**:
  - ▪ well-defined equatorial Rossby wave.
- ➢ **Sah+**: symmetric from Sah-.
- ➢ **2 possible origins** for the dynamical component of the Sahelian mode, which can superpose in a constructive or destructive way.

   -> **Interferences** ?

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