The West African Monsoon and its socio-economical impacts

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The West African Monsoon Region

- Strong meridional Land-Surface gradients
- Land-ocean-atmosphere system
Rainfall Variability in West Africa

- Strong interannual to decadal variability.
- Long period of drought conditions from 70’s, just at the independence from colonialism.

Impacts
- Direct (water resources, pasture, agriculture, power production…)
- Indirect (rural to urban immigration, health problem, Increase of food importation…)

Séries chronologiques des déficits annuels de pluviométrie (bleu) et de ruissellement (rouge) pour le fleuve Niger, à Malanville

Time-series of annual rainfall deficit (blue) and annual runoff deficit (red) for the Niger river, at Malanville
Rainfall: intraseasonnal variability

- The seasonal accumulated rainfall is the integration of small-scale rainfall events: MCS:90% in sahelian rainfall (Laurent et al 1998)

- Dry years characterized by lower frequency of convective events, their average magnitude remaining unchanged (Lebarbé et al 2002)

- Monsoon onset arrives in two peaks with abrupt shift from guinean to soudano-sahelian region (Sultan and Janicot 2000, lebarbé et al 2002)
Rainfall: intraseasonnnaal variability (2)

- Seasonnal rainfall characterized by dry spells.
- Short dry spells more frequent in the core of the rainy season: important for planning desherbing, fertilizing
- Long dry spells more frequent at the begining and the end,
- Real or false monsoon onset
Agriculture application concerns 70% of people over the Sahel

- Variability of crop production does not depend only on variability of accumulated seasonal rainfall
- It depends also on the date of sowing and on the availability of water requirements of the crop (see Sivakumar 1992, Diop, 2000)

Note that they are other factors which contribute positively or negatively to ensure a good water supply of the plant (e.g. soil characteristics, human parameters, fertilizing)
Issues

- Prediction of the monsoon onset in relation to the date of sowing
- Prediction of dry spells in relation to water requirements of the crop. For a given stage of development, prediction that sufficient rain will \textit{or not} occur within 7, 10, 15 days to meet water requirements of the crop.

Decision making

- Date of sowing
- Alternative solution as supplementary irrigation
The WAM System: land-ocean-atmosphere with many interacting scales

Interactions between main atmospheric features over West Africa

From Redelsperger, Diongue,…(2002) QJRMS

Can we forecast accurately the WAM system?
Prediction of the WAM System

Modelling study
With a NH high resolution model, two-way gridnesting (Méso-NH), it has been possible:

- To reproduce the life cycle of a sahelian squall line considering convective scale and larger scale
- Good agreement with observations
- Structure 2D and 3D
  (Diongue et al, 2002)

Perspective on operational numerical prediction resolving explicitly the convection
Analysis and Forecast the WAM system

NWP

JET 2000 campaign over West Africa
25-30 August 2000
http://www.env.leeds.ac.uk/JET2000
Thorncroft et al 2003 in BAMS

Assimilation in real time of extra data by ECMWF model and the Unified Model of the UK Met. Office

- Improvement of the AEJ structure and intensity and the boundary layer humidity
- Even without the inclusion of extra data the representation of the AEJ is quite good BUT the 5-day and 10-day forecast exhibit strong departure from analysis and observation.
…Analysis and Forecast the WAM system

Data denial experiment
with ECMWF IFS:T511/L60, 4D-Var
On 28th
Analysis on 23th 5 day Forecast
Analysis on 23th ➔ Analysis with
 ➔ no satellite data
Analysis on 23th Analysis with
 ➔ no synop data
Analysis on 23th Analysis with
 ➔ no upper-air data
Analysis on 23th Analysis with
 ➔ no wind information

Synop and TEMP observations on 28th
Analysis and Forecast the WAM system

- Radiosonde data dominates the model analysis despite their few number
- Removing one source of information: not sufficient to degrade the AEJ to the level of the 5-day forecast.

(Tompkins, Dioungue-Niang, Parker and Thorncroft, 2005)
Concluding remarks

- The variability of the West African Monsoon system has a high social and economical impact.
- For many applications (e.g. agriculture), there is a high need of subseasonal information (short and medium range).
  - Define and Implement relevant monitoring systems.
  - Conduct more numerical studies to define prediction strategies.
  - To integrate research outcomes and operational products in decision making
Perspectives

- Through AMMA (African Monsson Multidisciplinary Analysis)

- International scientific Programme for West Africa with SOP field campaign in 2006

- African network for AMMA: AMMANET
  WP: Tools-Methods-Demonstration/NWP

- Through THORPEX which interest can be summarized as « improving predictions of high impact weather on 1-day to 14-day timescale for benefit of society and economy »

See Chris Thorncroft talk on Friday