"Variability of regional and local climate from inter-annual to decadal scales using simulations from LMDZ"

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The analysis of climate data show that West Africa has been hit by a long dry period to 70 years (Nicholson et al. 2000; and Le Barbé et al. 2002). The consequences of this drought were important on water resources, agriculture and pastoral farming, which are key sectors of the region’s economy. It is therefore necessary to focus on studying climate change impacts at the local level. The general circulation models (GCMs) have been used to simulate climate change and have improved substantially in recent years, raising the hope for better climate prediction on interannual to decadal time scales. They have spatial resolutions of the order of a few hundred miles and find it difficult to study the impacts of climate change at the local level where the need for regional climate models are very high resolution. LMDZ is the second generation of a climate model developed at Laboratoire de Météorologie Dynamique (Sadourny and Laval 1984; Le Treut et al. 1994, 1998). The dynamical equations are discretised on the sphere in a staggered and longitude-latitude Arakawa C-grid. The grid is stretchable (the 2. of LMDZ standing for zoom capability) so that the model can be used for climate studies at both global (Li 1999; Li and Conil 2003) and regional scale (Krinner and Genton 1998; Genton et al. 2002; Zhou and Li 2002; Krinner et al. 2004). In our study, we used three simulations that the difference lies in the spatial resolution: a very coarse resolution (220 km), a finer scale corresponding to the synoptic scale (187 km) and a very fine resolution at 80 km.

I- Objectives

To evaluate the performance of the model on the West Africa and Senegal (Ferlo)

Specific objectives:
- Show the widespread nature of drought
- Study the influence of model resolution on the various climatic parameters in West Africa

Study area: West Africa (regional scale) and Ferlo of Senegal (local)

II- Data and Methodology

I-1 Data


I-2 Model

- Simulation Study: LMDZ with 3 sets of simulation based on three different resolutions:
  - Standard resolution: 96x95 grids points corresponding to 12kmx208km (on by lat)
  - Fine resolution: 144x143 grids points (275kmx138km)

II- Results

1- Surface Temperature

Figure 1: The seasonal cycle of surface temperatures (°C) (1975-1985) over the West Africa.
- Coherence between the areas of maximum simulated and observed temperature
- Overestimation of the Sahel and cold temperatures through the mountainous areas.

2- Precipitation in the Sahel

Figure 2: Rainfall anomalies (Wet minus Dry) over the West Africa.
- Observations and model very close
- Systematic overestimation of the mountainous areas

3- Simulation of the West African monsoon

Figure 3: Hovmöller diagram of rainfall averaged over the period 75-85 (over the band 10W-10E)
- Zonal character of the seasonal rainfall well simulated in West Africa
- Magnitude of the seasonal movement of the ITCZ underestimated on the northern part of West Africa
- Break early monsoon (mid-May) and fast enough with respect to observations.

4- Precipitation in Ferlo

Figure 4: Seasonal cycle of precipitation anomalies in the Ferlo.
- Seasonal cycle fairly well reproduced on all stations
- Shift of the maximum rainfall (Gassane and Louga)

IV. Conclusion

- LMDZ: Tool relevant enough to simulate and analyze climate variability at the regional (West Africa) and local (Ferlo of Senegal)
- Shortcomings of the model
- Need high resolution for impact studies and future projections.

V. Perspectives

- Simulate the climate of the last decades using the LMDZ-ORCHIDE model forcing by SSTs (to assess the part of the decadal variations which may be related to coupling with vegetation)
- Simulations of the related changes of environment and resources (with hydrological, vegetation and crops model)
- Evaluation of the ability of CMIP5 and Cordex simulations to reproduce the observed climate variations over West Africa during the historical period according to the above mentioned criteria
- Provide assessment of the climate change scenarios of IPCC CMIP5 and Cordex exercises in terms of relevance for the modification of crop potential, vegetation biomass and hydrological resources.
- Re-running one atmospheric model (the version of LMDZ which will be optimized for West Africa) on a series of SST changes issued from the various global coupled models available through CMIP5 will be envisaged.

Références bibliographiques


Table 1: Decadal variability of rainfall during the wet phase

<table>
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<tr>
<th>areas</th>
<th>Sahel</th>
<th>Senegal</th>
<th>Ferlo (in Senegal)</th>
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<td>mean/std</td>
<td>Mean</td>
<td>std</td>
<td>Mean</td>
</tr>
<tr>
<td>CRU</td>
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<td>0.79</td>
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<tr>
<td>LMDZ_80km</td>
<td>0.92</td>
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Table 2: Decadal variability of rainfall during the dry phase

<table>
<thead>
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<th>Ferlo (in Senegal)</th>
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<tr>
<td>LMDZ_80km</td>
<td>0.90</td>
<td>0.56</td>
<td>0.71</td>
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Tables 1 and 2 respectively show the decadal variability of rainfall during the wet and dry phase.
- The systematic decreasing in rainfall poorly simulated by the model (about 0.19mm/jour) with respect to CRU data.
- The underestimated is lower in the Ferlo area with the model...