

Decadal variability of the West African monsoon in CMIP5 control run of two models

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Abstract. We have explored the links between the West African monsoon variability and sea surface temperature (SST) fields at decadal scale in control runs of different versions of IPSL-CM5 model and of CNRM model of the CMIP5 dataset, as a preliminary work on the evaluation of potential decadal predictability of the African monsoon. The predictand variables have been defined from rainfall and atmospheric fields, and predictors as EOF SST fields on the different oceanic basins. Correlation and regression analyses have been performed between predictor and predictand variables. The key time scale and oceanic basins have been identified and their robustness evaluated within the available runs.





Figure 1. Regional index of annual Sahel rainfall anomaly (mm) 1905-2006. The two curves display the uncertainty of this information (kriging standard deviation). Courtesy AGRHYMET.



Figure 2. Bottom right : The 1910-2008 standardized SST GW, AMO and IPO indices are shown in red long dashed, blue solid lines and green short dashed, respectively. Top : July-September average of the associated SST patterns for: (a) the GW, (b) the AMO, (c) and the IPO. The monthly GW, AMO and IPO associated SST patterns were defined as twice the regression of the observed monthly SST onto the 1910-2008 GW, AMO, indices IPO indices, respectively. Units are 0.5 K per standard deviation of the index. Bottom left : Regression of July September precipitation onto the 1910-2002 (c) GW, (d) AMO and (e) IPO indices.

Figure 3. Description of two predictands of rainfall (IMP and IDM) of two models (IPSL and CNRM) : wavelet power spectrum, global wavelet spectrum and correlation with fields of SST, rainfall, zonal wind at 200 hPa and 850 hPa. IMP represents mean of rainfall over the white box, IDM is the first EOF of principal component analysis (PCA) of zonal wind 200 hPa and 850 hPa fields on area [20°W-50°E]x[0°N-15°N].

Fig.1: Precipitation over the Sahel shows pronounced decadal variability characterized in particular over the second half of the 20th century by a negative trend between wet conditions in the 1950s and 1960s to dry ones in the 1970s and 1980s and by a partial recovery since the mid-1980s.

Fig.2: Three SST signals have a significant impact over sub-Saharan Africa: the positive phases of the GW and the IPO lead to drought over the Sahel, while a positive AMO enhances Sahel rainfall. So the lowfrequency evolution of Sahel rainfall can be interpreted as the competition of these three factors.

Fig.3 : Decadal variability is not significant for unfiltered IMP and IDM indices in the control runs. However we filtered these indices to retain periodicities higher than 10 years. Peaks around 15-20 years are highlighted for IMP, up to 30 years for IDM.

Tab.1: Link between IMP and some ocean basins (Mediterranean, Pacific and Tropical Atlantic). These links and basins are depend on the IPSL model versions. However, no significant association was noted with new-physic version of IPSL model and with CNRM model.

Table 1. Synthesis of the regression between the three first modes of principal components analysis of SST performed on each basin (ATL, PAC, IND) and indices IDM and IMP for each control run. Only the modes selected by a selection of stepwise ascending selection are listed in this table.

MODEL	IPSL						CNRM	
Version	Standard version		new-physics		Average resolution			
	IMP	IDM	IMP	IDM	IMP	IDM	IMP	IDM
	Mode 1 MED	Mode 1 PAC			Mode 1 MED			
	Mode 1 ALT				Mode 1 PAC			



Figure 4. The wavelet power spectrum, global wavelet spectrum and regression on SST and rainfall for the selected modes.

Fig.4: Similar periodicities are present for the selected oceanic indices.

Next step:

*It is necessary to study the robustness of the methodology and results relative to the sample size and choice of variables ◆It is also necessary to apply the same methodology to other models of AR5 in order to evaluate and identify the robustness of the links between the West African monsoon dynamics and oceanic basins SST.