Motivation

Vegetation changes driven by climate on decadal scales or by anthropogenic land use at continental scales can modulate the extent and the amount of West African monsoon rainfall [1,2]. However, the effect of natural year-to-year changes of vegetation (Fig. 1) on rainfall and the related operating processes in that region has received less attention.

Study area and method

Experimental set-up

Weather Research and Forecasting model:
- 7 km horizontal resolution
- August-September 2009/2010
- Dynamic and static land surface description
- Inter-annual change: $\Delta Y = 2010-2009$

Reduction of internal model variability

Four-member ensembles per year:
perturbed initial conditions (-0.1, -2, -3 days).

The result are sixteen different $\Delta Y$.

Removal of the large-scale signal

DYN: satellite-derived ALB (monthly), LAI and VF (10-day) + new land-use map
CLIM: WRF default parameters with fixed annual cycle + standard tables [5]

Vegetation-induced surface signal from DYN and CLIM ensemble means:
$\Delta Y_{\text{Dyn}} = \Delta Y_{\text{Dyn}} + \Delta Y_{\text{Clim}}$

The atmospheric footprint of vegetation

Vegetation induced circulations

(a,b) Convergence (divergence) of moist air over higher (lower) temperatures. Higher (lower) PBL heights favour (inhibit) the initiation of deep convection in the afternoon

Different behaviour during night and day

(c,d) Decrease (increase) of rainy hours over regions with higher (lower) VF during the day and vice-versa during the night.

Observed feedback

Signal only detectable in Sahel

Observed correlation between precipitation and vegetation changes (~0.2) captured with DYN.
- not explained by large-scales (CLIM ~0.08)

Dominance of the monsoon dynamics inhibits signal detection in Sudanian Zone; no correlation in WRF. The observed correlations of ~0.15 represent the precipitation-vegetation feedback only.

Conclusions

Precipitation-vegetation correlation peaks with a time-lag of one month with implications for seasonal predictions (Fig. 1)

The modelled feedback corresponds to preceding studies in the region [3,4] (Fig. 3):
- vegetation breeze: negative feedback
- enhancement of mature convective systems during the night: positive feedback

Biggest potential for model improvement at the northern and southern extent of the monsoon rainbland or drier months (Fig. 4)

Need for analysis methods based on observations without the need to remove a large-scale signal

References


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