# ANNUAL CYCLE OF CLOUD AND AEROSOL RADIATIVE EFFECTS OVER WEST AFRICA
## *OBSERVATIONALLY - BASED ESTIMATIONS*


**F. GUICHARD*, O. GEOFFROY and D. BOUNIOL**

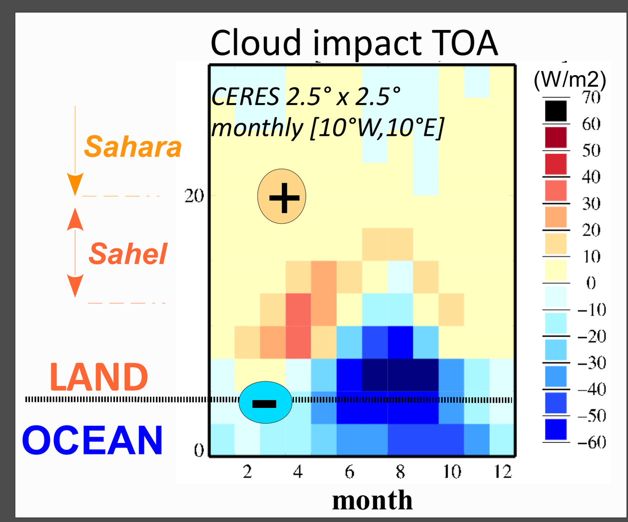
** francoise.guichard@.meteo.fr   CNRM-GAME (CNRS and Météo-France)*


## CONTEXT AND OBJECTIVES

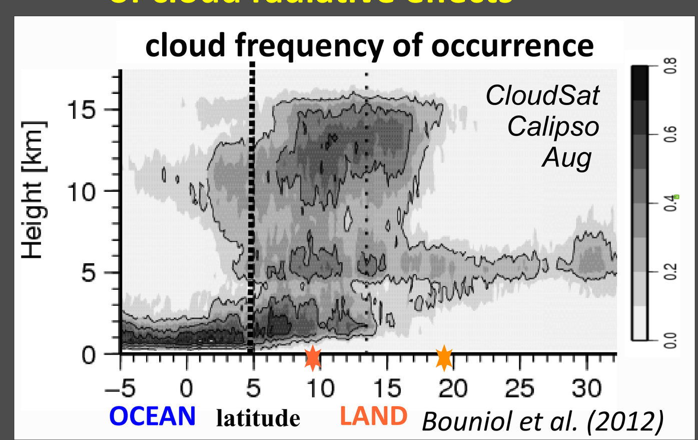
Major errors in the modelling of radiative flux in West Africa, in CMIP5 simulations (Roehrig et al. 2013) and (re)analyses.

These errors are linked to surface, aerosols, and cloud processes. and they largely affect the energetics and dynamics of the monsoon

**Objective** : estimate and analyse cloud radiative impact throughout the year in West Africa based on observations, which also provide a ground-based reference for models




well defined latitudinal structure of cloud radiative effects




Linked to distinct observed cloud types

## DATA AND METHOD

**Radiative fluxes data**

*ARM & GERB* (Slingo et al., JGR 2009)
*AMMA-CATCH* (J. Hydrol 2009)
**Surface** : Δt = 1, 15 or 30 min
**TOA** : Δt = 15 min

**Radiative transfert model**

**RRTM** (*Iacono et al, 2008*) **Inputs**

- Greenhouse gazes : RRTM climatology
- **Water vapour** & **temperature profiles**: radiosondes & ECMWF analysis
  radiosondes: 4 to 8 per day
  ECMWF analysis : 4 per day
- **Aerosols** : Aeronet, AOD,SSA, AP  Δt < 1h
- **Albedo** : surface data & LSA-SAF
- **Surface temperature** from LW surface flux

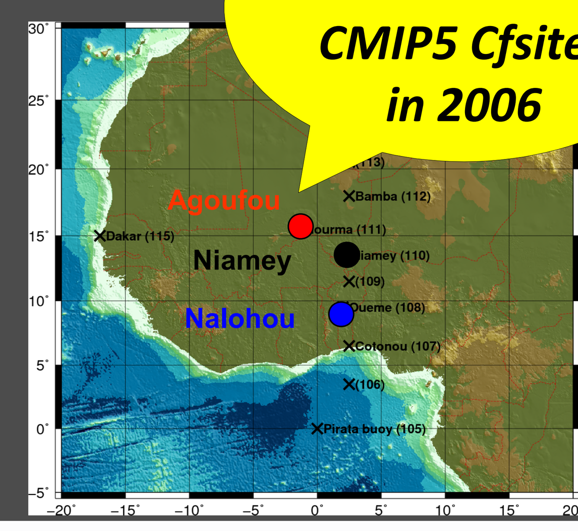
*data from AMMA , ARM , AMMA-CATCH*

**Radiatives fluxes estimates**
Clear sky and Clean sky
LW and SW TOA and Surface

**Cloud Radiative Effect (CRE)**
CRE : RAD (obs) – Rad_clear (computed)
+ estimate of aerosol radiative effect
LW and SW  Δt ~ 30 min

*OTHER DATASETS: **cloud masks**, AMF radar, lidar*
***precipitable water** GPS, **precipitation** local data*

**Focus on 3 contrasted sites**
***CMIP5 Cfsites in 2006***




**Agoufou: Central Sahel, annual precipitation ~ *350 mm*** (Guichard et al. 2009)

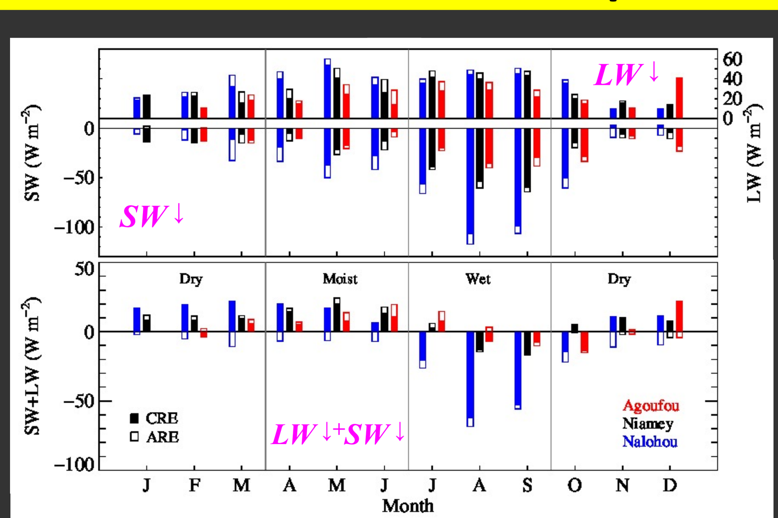
**Niamey: Southern Sahel, annual rainfall ~ 600 mm** (Slingo et al. 2009)

**Nalohou: Soudanian zone, annual rainfall ~ 1100 mm** (Mamadou et al. 2014)

## OBSERVATIONALLY-BASED RESULTS

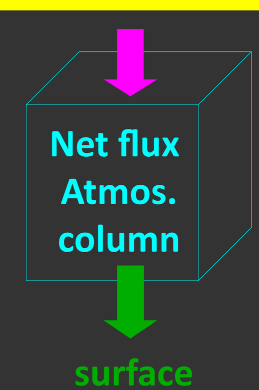
*Geoffroy et al. (2015)*

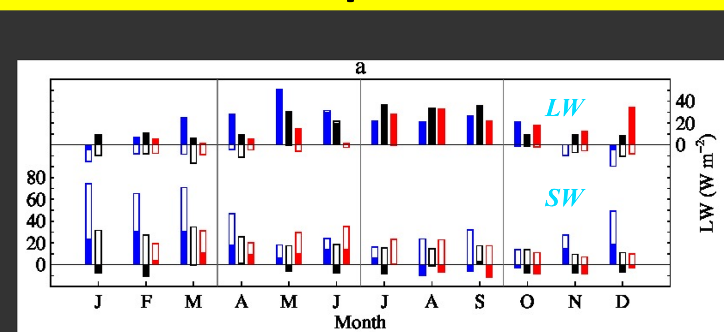
### Cloud & aerosol radiative impacts: TOA




- compensations LW-SW, but major LW effect in the Sahel
- consistency with latitudinal gradient at regional scale: negative in the South, positive in the North

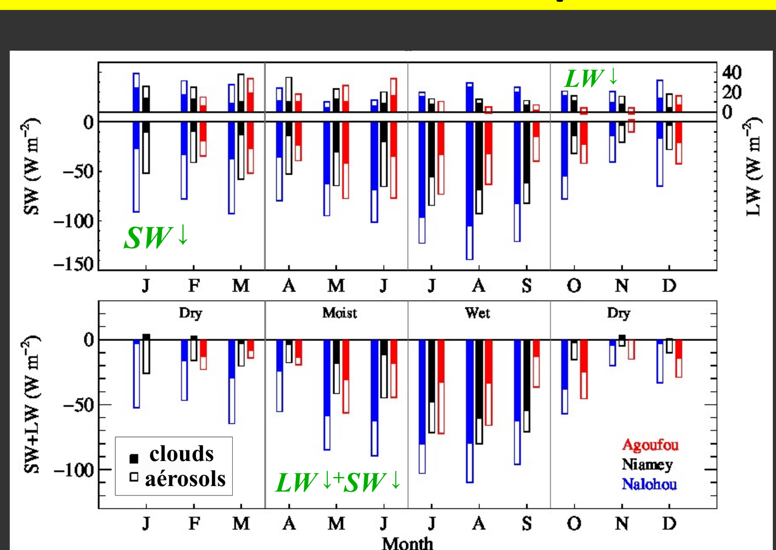
### Cloud & aerosol radiative impacts: ATMOSPHERE



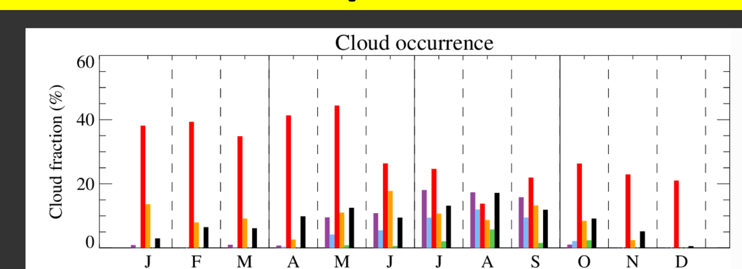

- cloud impact mostly in the LW
- aerosol impact mostly in the SW
- Consistent with and extend the results of Slingo et al. (2009)

### Cloud & aerosol radiative impacts: SURFACE

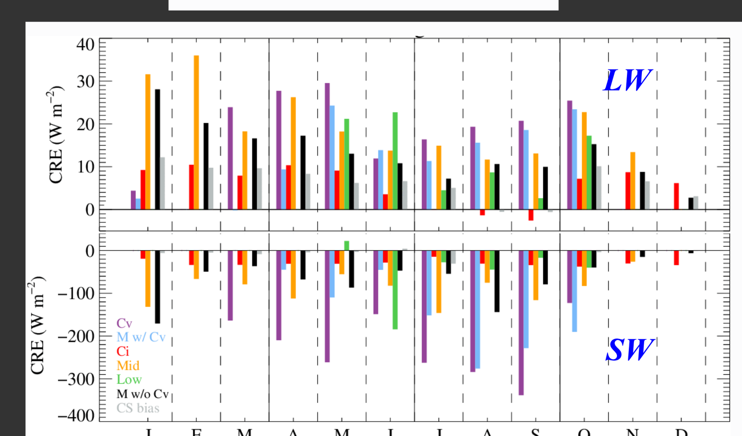



- SW dominates, but LW important during dry season
- SW+LW: clouds (aerosols) impact dominate during the monsoon (dry season)

### Cloud radiative impact: BY CLOUD TYPE



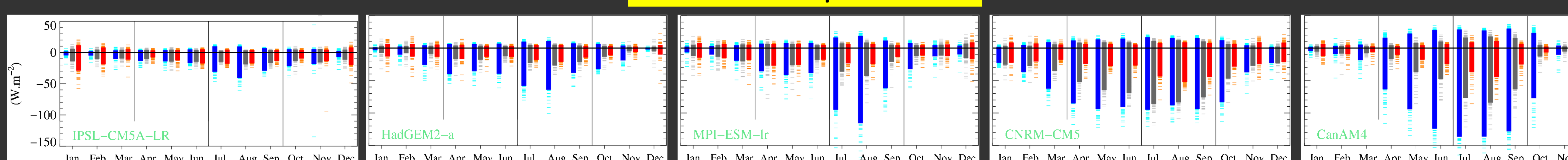

low-level clouds
mid-level clouds
high-level clouds (cirrus)
multi-level clouds without Cv
deep convective clouds (Cv)
multi-level clouds with Cv



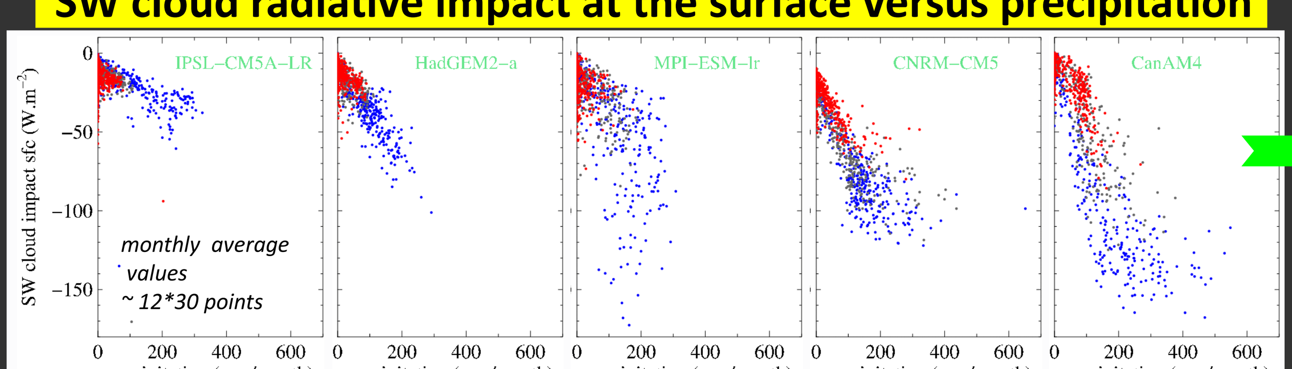

- occurrence of cirrus and mid-level clouds all year long
- SW surface: impact of deep convective clouds dominates
- LW surface: large impact of mid-level clouds

## RESULTS FROM CMIP5 AMIP runs

### Cloud radiative impact: SURFACE




### SW cloud radiative impact at the surface versus precipitation

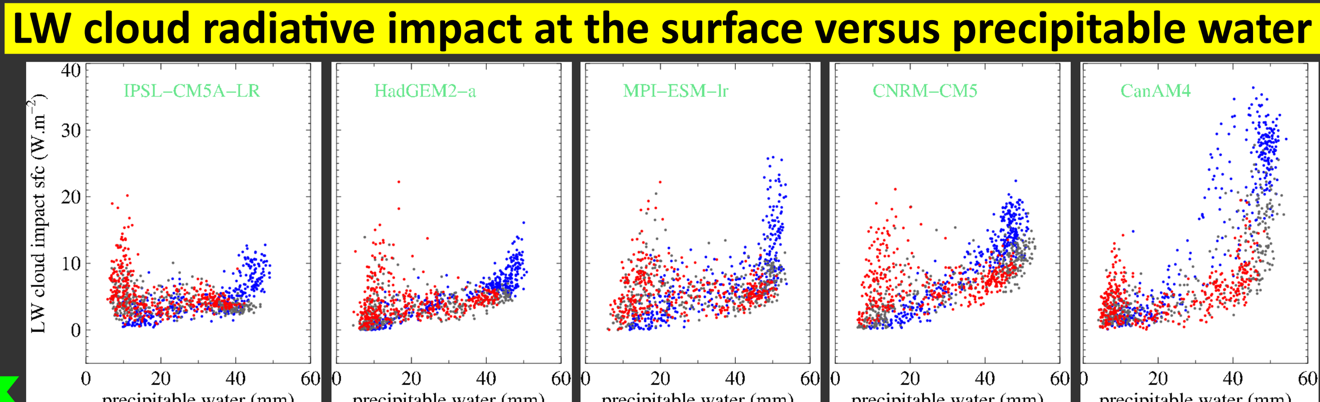



very large spread, with relative errors ~ 100 %

precipitation only partly accounts for differences in SW

distinct coupling of cloud LW radiative impact with atmospheric water possibly related to differences in aerosols and diurnal cycle of cloud cover

### LW cloud radiative impact at the surface versus precipitable water




**NEXT STEP** more analyses of cloud radiative impact as a function of cloud type in observations and climate runs, design of physically-based diagnostics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