Analysis of model outputs at selected grid points : focus to West Africa

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Document the ECUCLIPSE CFMIP models behaviour over West-Africa (AMIP simulations)
Studying in more details the cloud parameterisation answer depending of the geographical location or seasonal cycle

EUCLIPSE WP3 meeting – Toulouse 5-6 April 2012

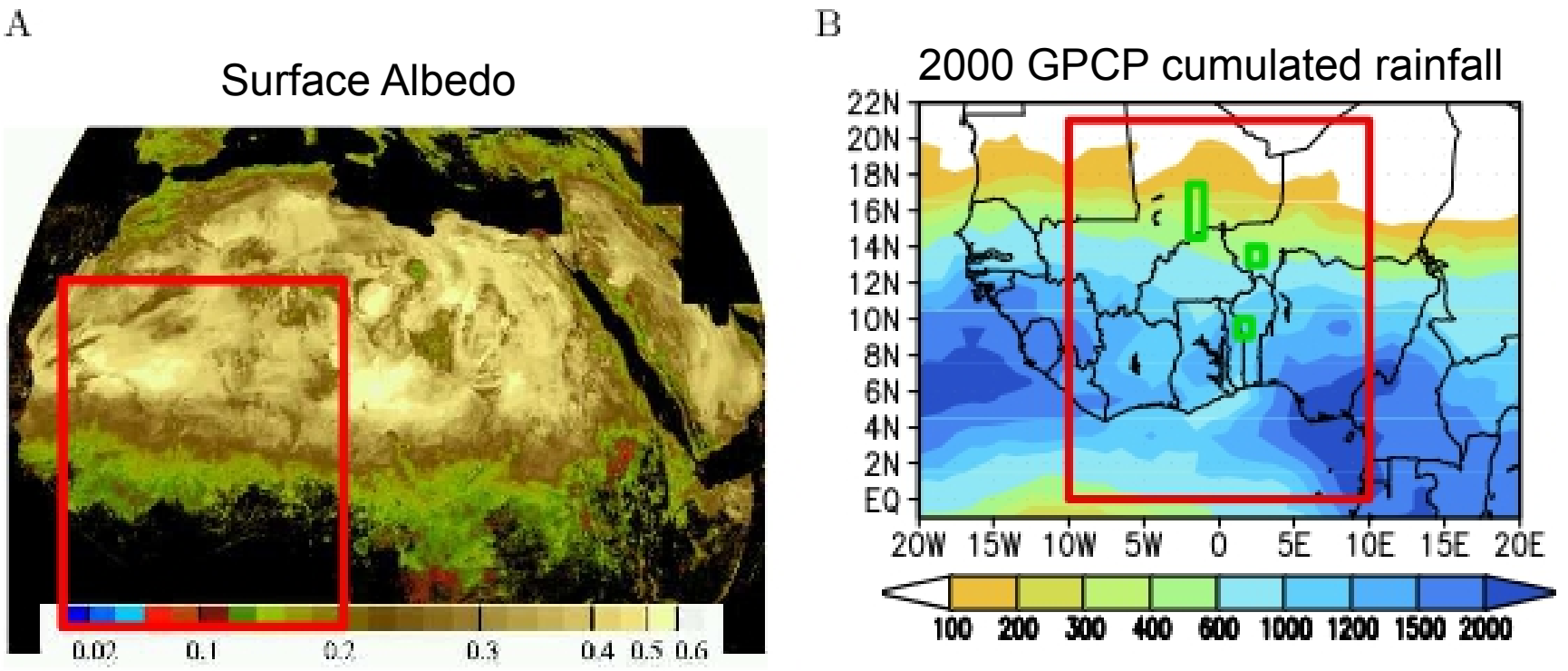


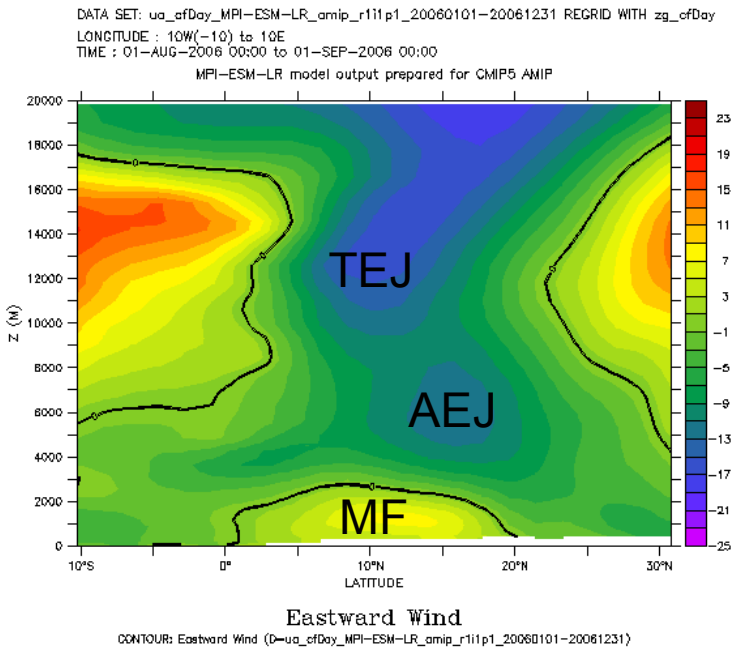
FIG. 1. A satellite-based image of West African surface albedo (A) (source EUMETSAT/GEM, http://www-gem.jrc.it/stars/albedo.htm) and GPCP cumulated rainfall (B) for the year 2000 (mm). The red rectangle

Hourdin et al. 2009

West Africa = one of largest land mass in the Tropics
Strong meridional structure in albedo and vegetation
Sharp transition for precipitation in the Sahel region – strongly correlated with the meridonal structure
Analyse model simulations in a latitude-altitude cross-section by averaging outputs between 10W and 10E

Dynamical view of mature African Monsoon

MPI-ESM-LR



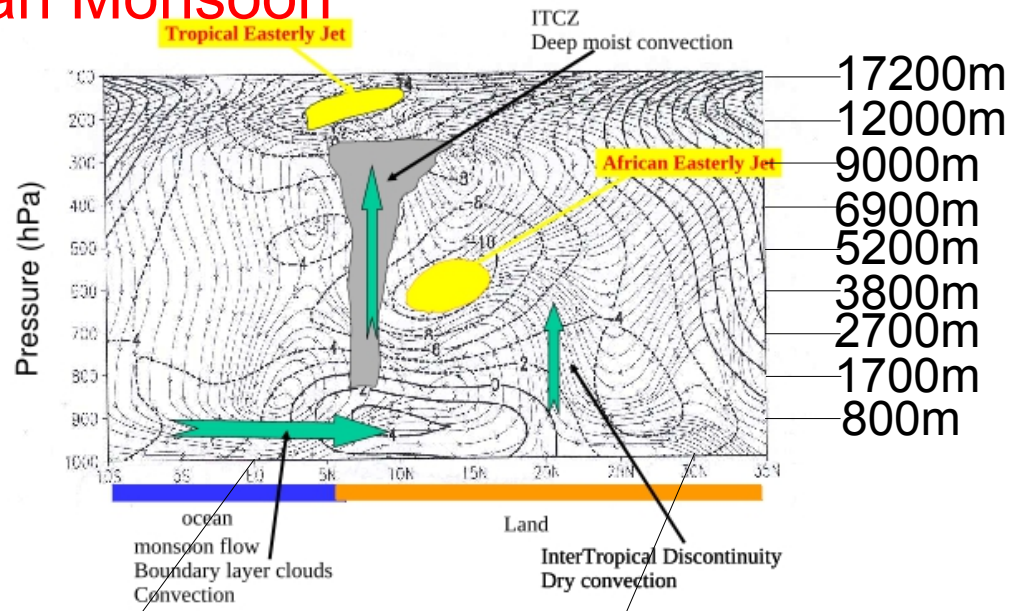
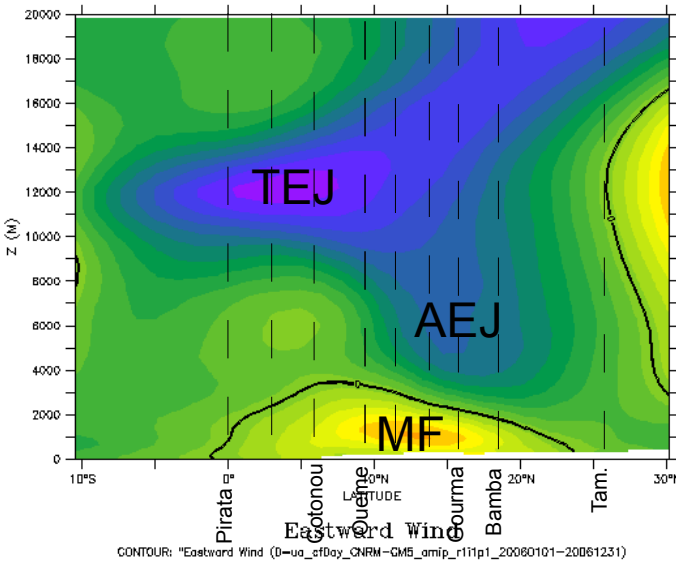


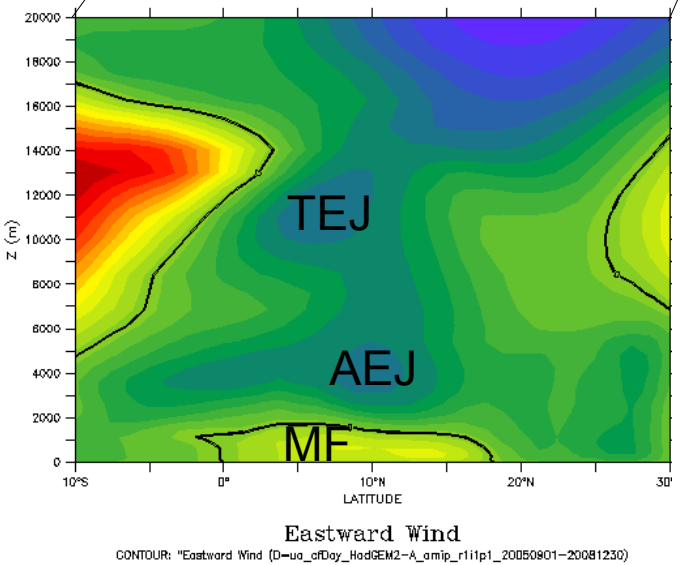
FIG. 2. Mean meridional circulation (stream lines) and associated mean zonal wind (m s^{-1}, contours). Mean JAS conditions are from the NCEP reanalyses.

Hourdin et al. 2009

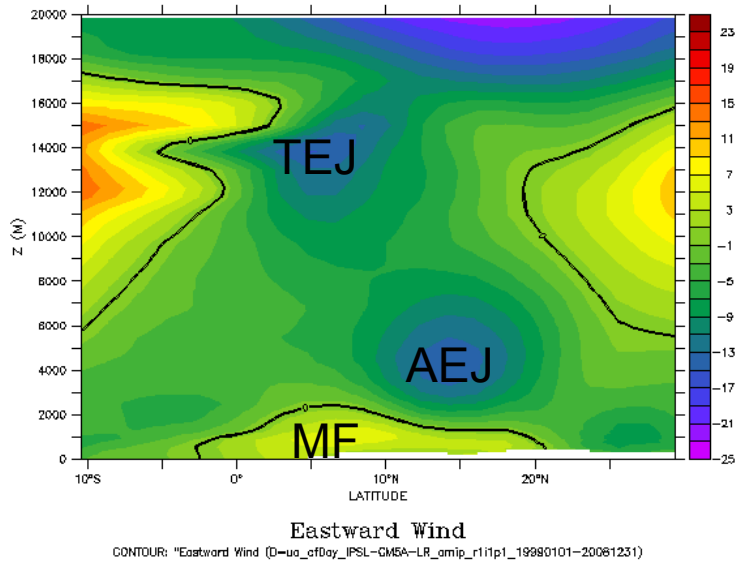
CNRM-CM5



HadGEM2-A

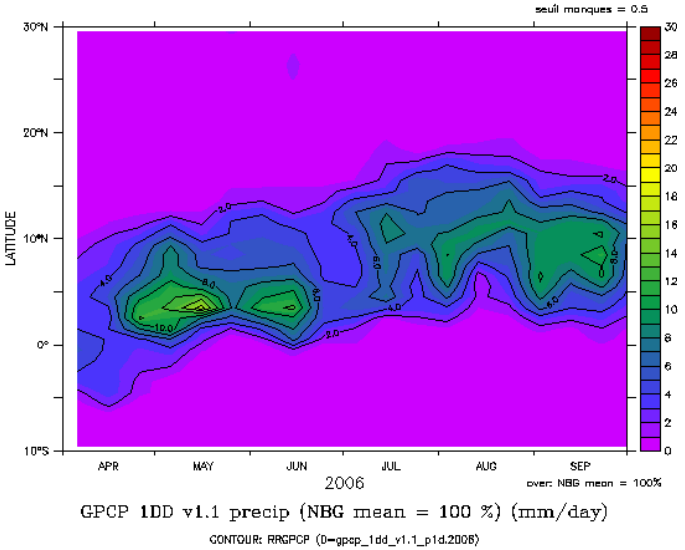


IPSL-CM5-LR

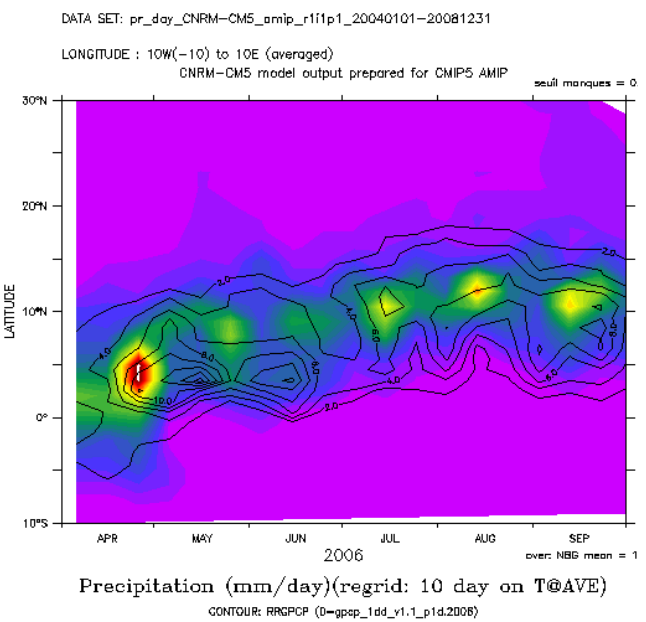


Rain

GPCP



CNRM-CM5



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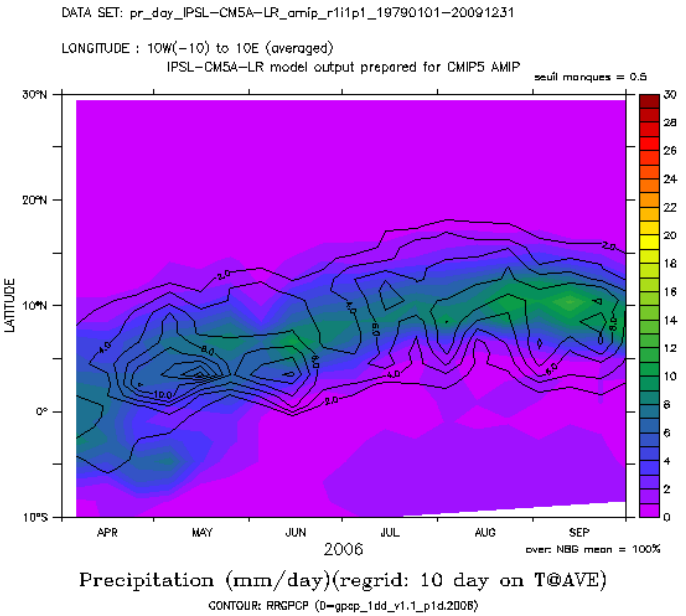
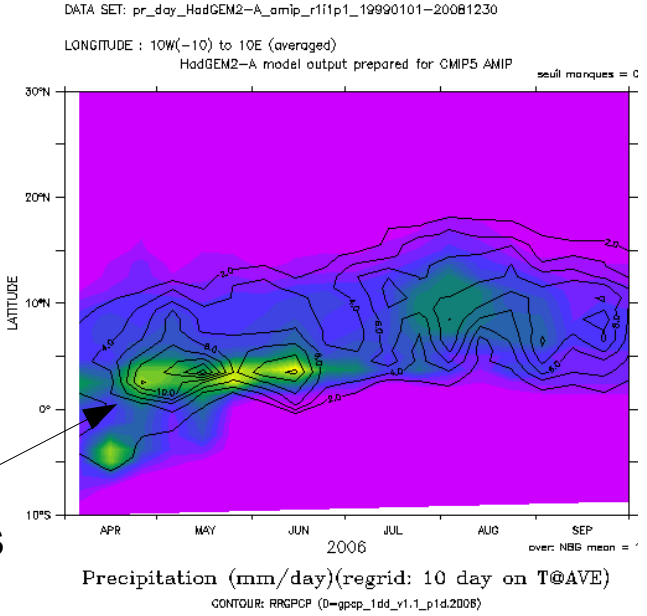
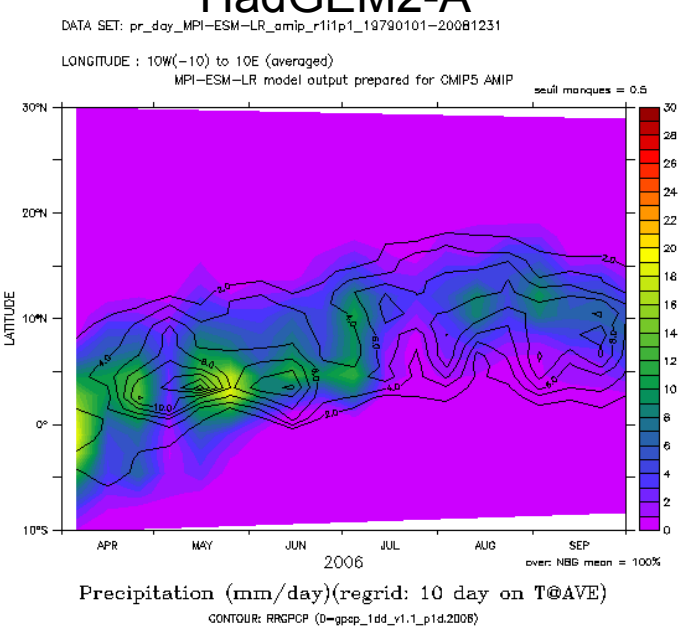


MPI-ESM-LR



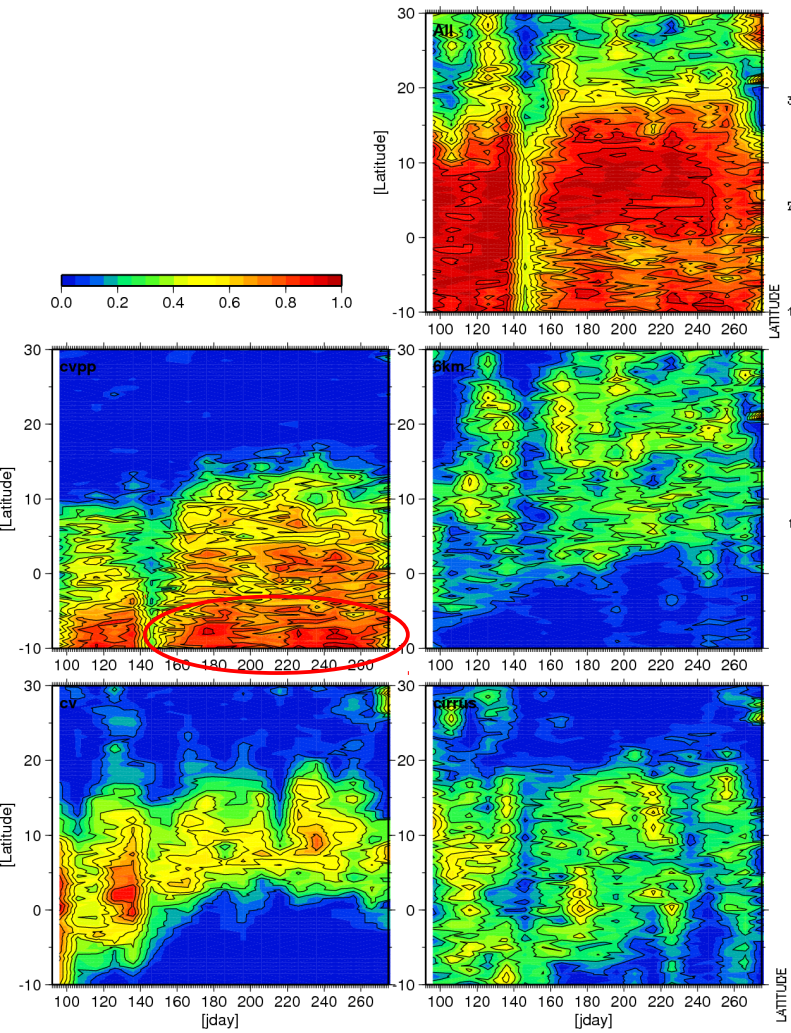
HadGEM2-A



Reasonable dynamical and rain feature in the models

GPCP contours

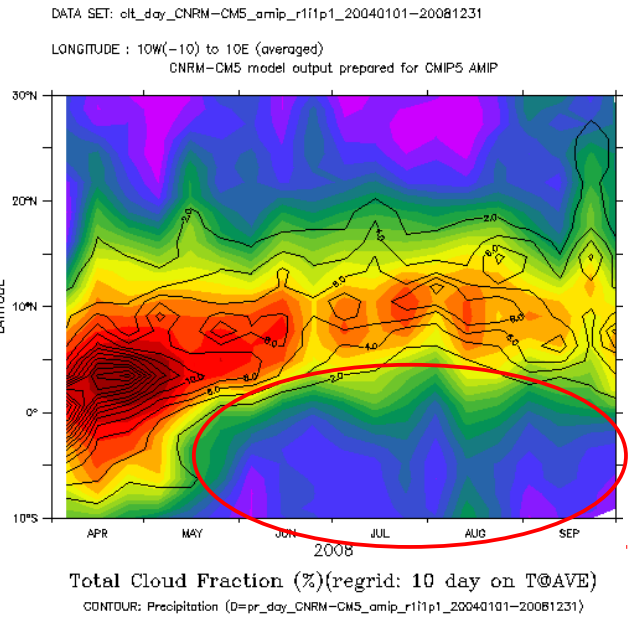
Cloud



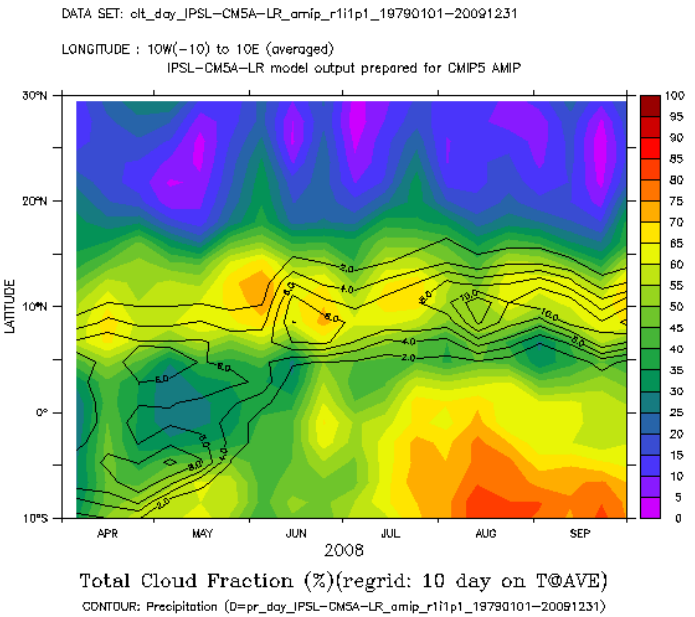
Cloud occurrence by type from CloudSat/CALIPSO

Clt

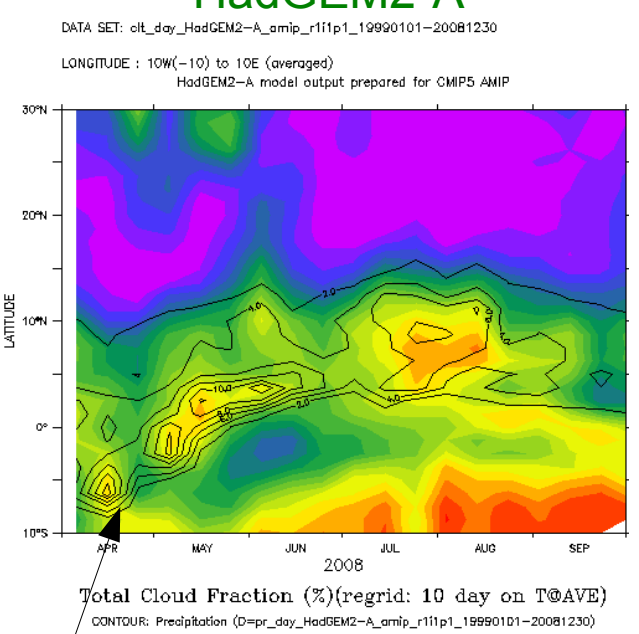
CNRM-CM5



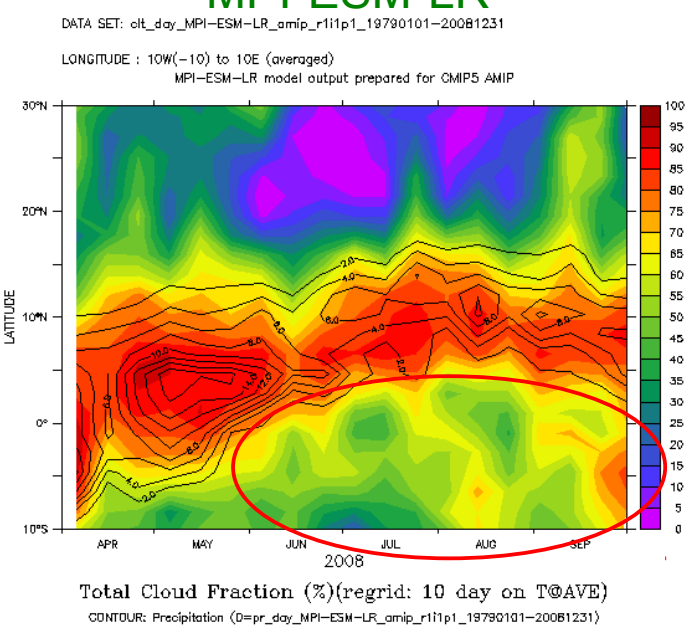
IPSL-CM5-LR



HadGEM2-A



MPI-ESM-LR

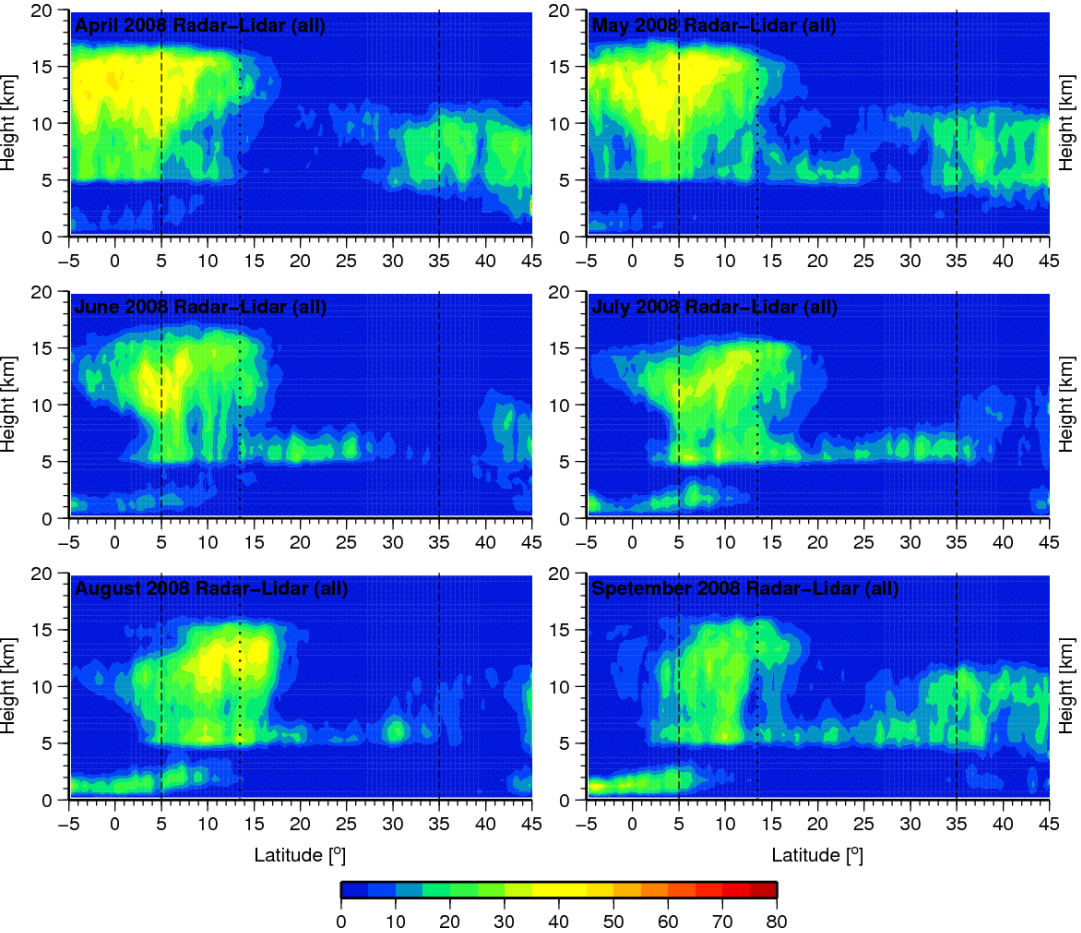


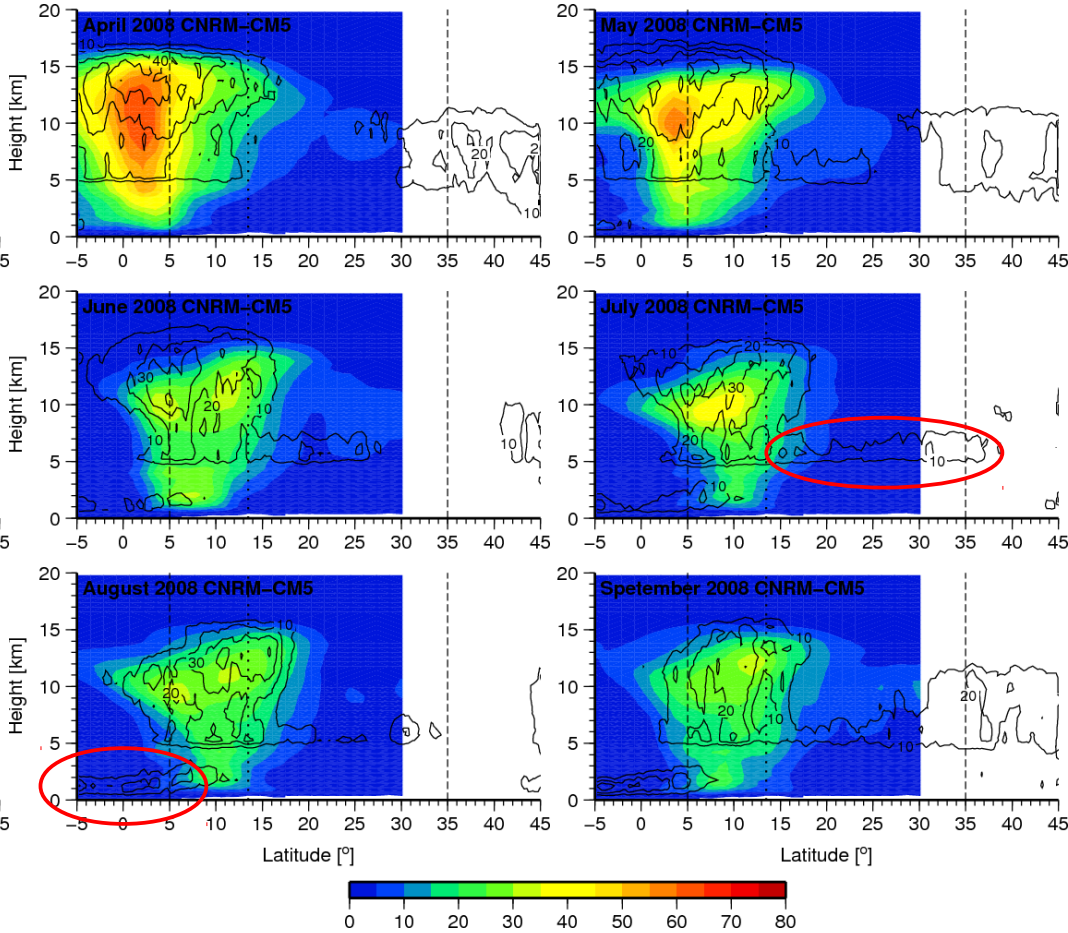
Model rain

Cloud fraction in latitude/altitude section

CloudSat/CALIPSO

CNRM-CM5

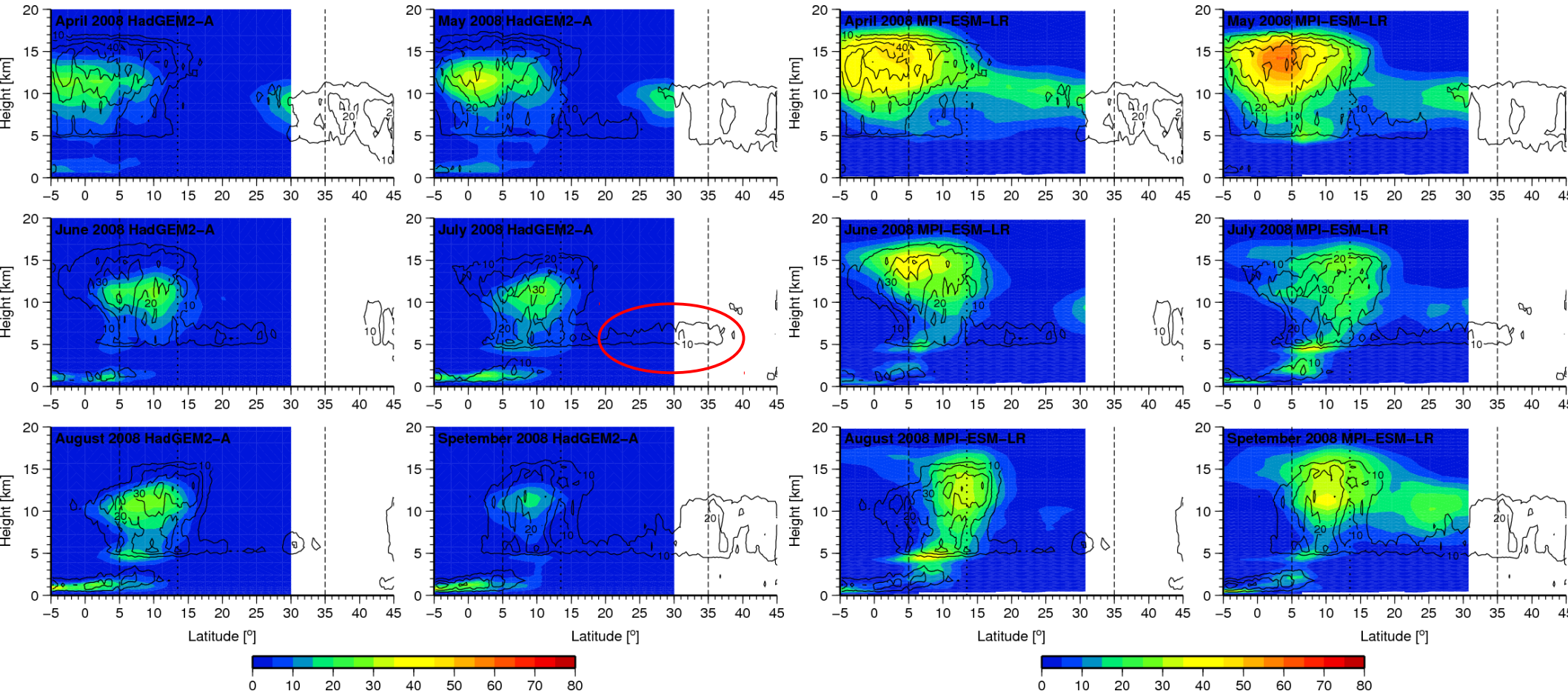




Cv activity a bit too north
Relatively good seasonal cycle for monsoon
Miss Mid-level and Sc over the ocean

HadGEM2-A

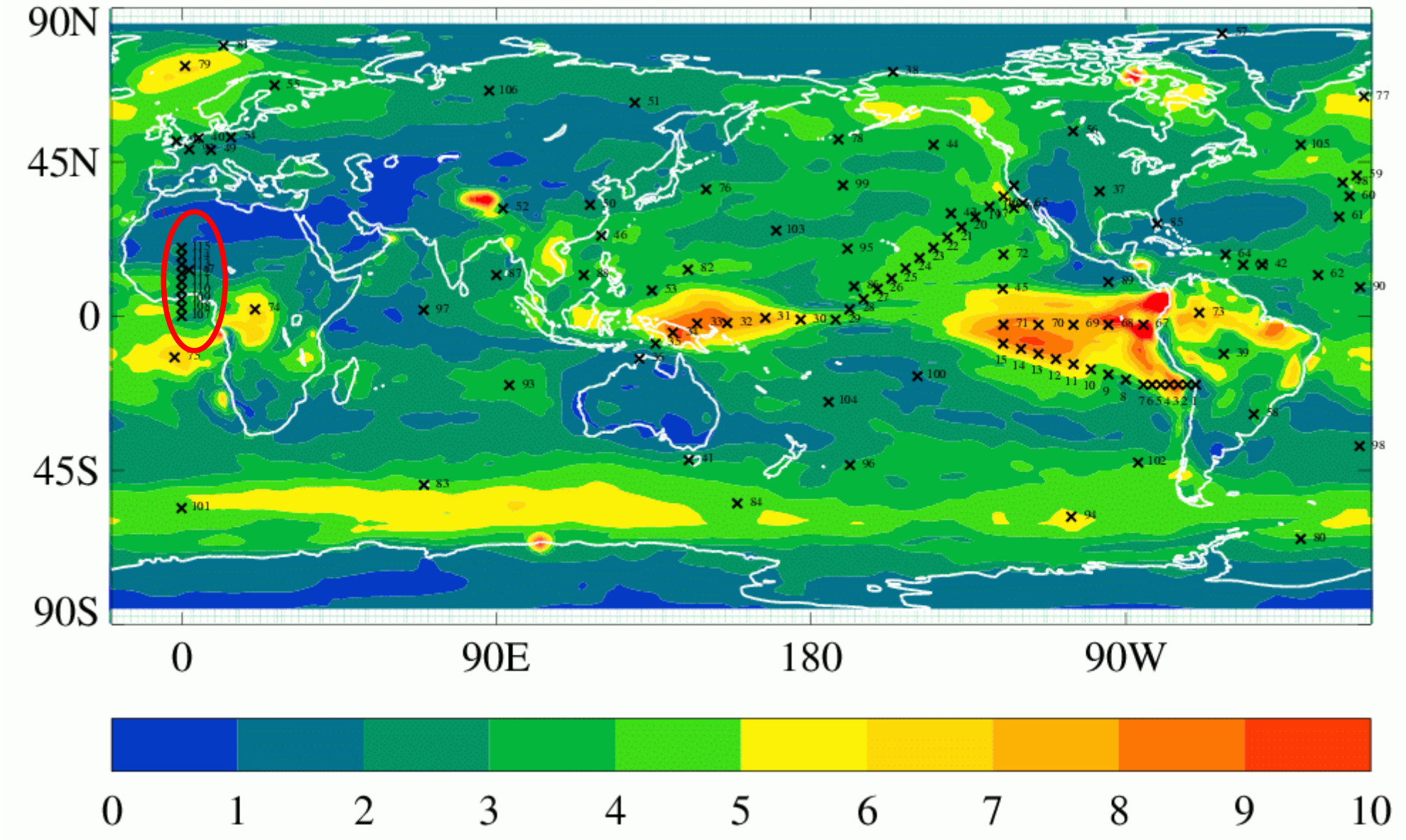
MPI-ESM-LR



Relatively good northward propagation of the monsoon
Misses cirrus and mid-level clouds

- May not include precipitating hydrometeor (i.e. Snow), not seen by RT codes
- compensating effects may occur : too thin clouds too often = too deep cloud not enough often

119 selected CMIP5 sites



We will mainly look at Niamey profiles because of the AMF

Cloud frequency of occurrence seasonal cycle

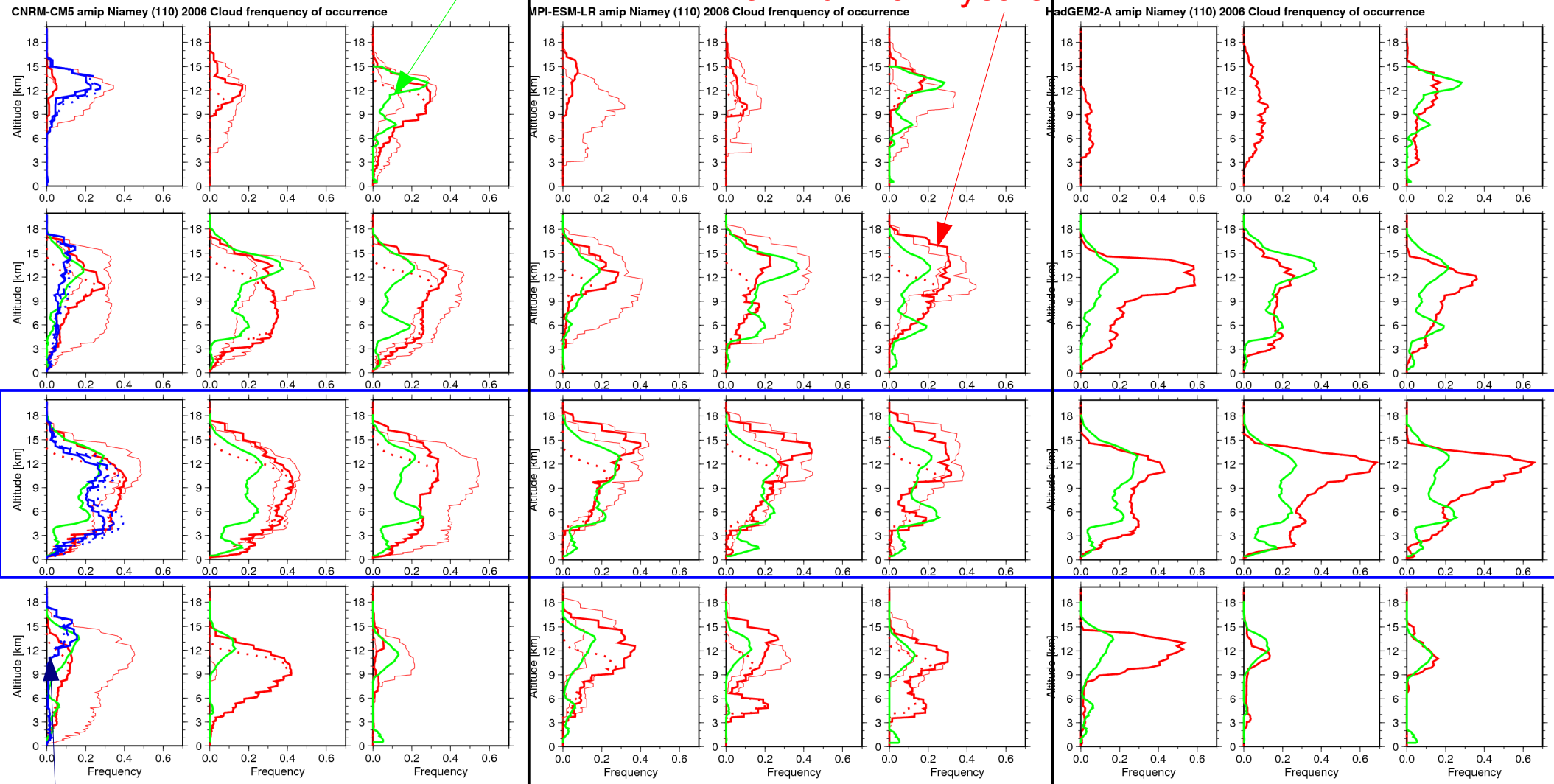
CNRM-CM5

MPI-ESM-LR

HadGEM2-A

AMF radar-lidar data

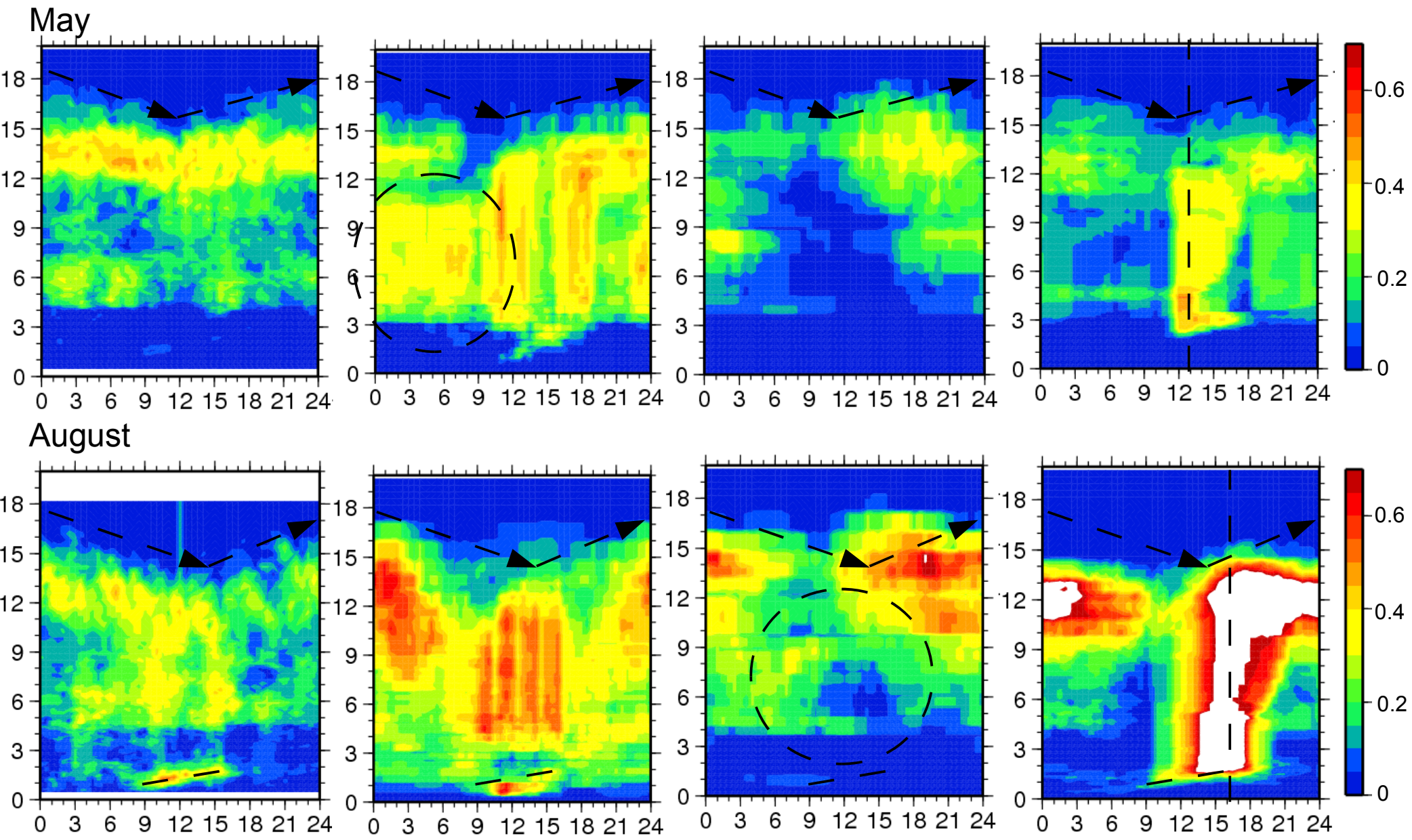
AMIP data
with minimum and
maximum for 4 years



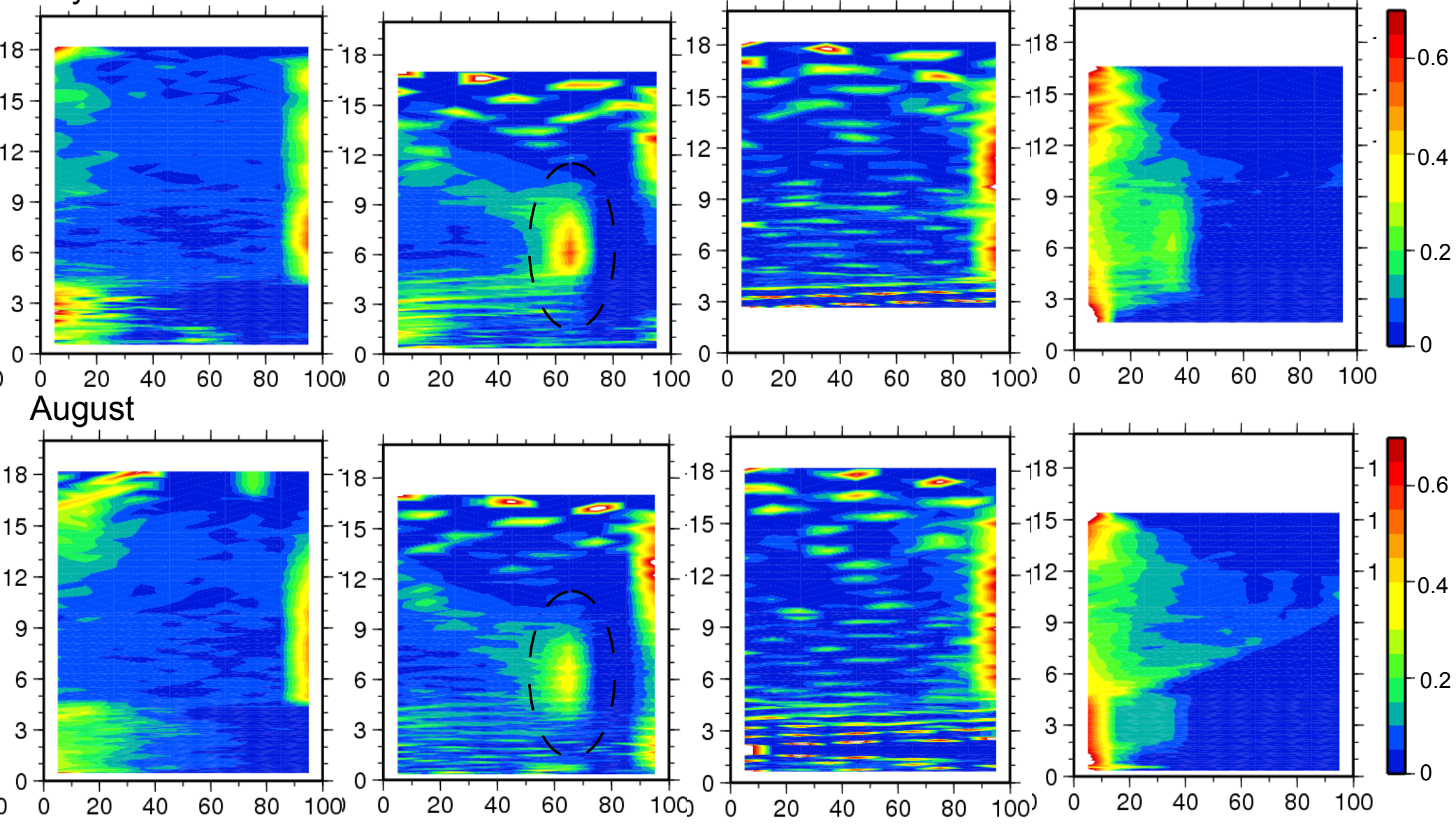
Tamip 12->42/36->66/60->90

Monsoon:Tri-modal occurrences / generally not obtained in the models (respective magnitude)

Cloud frequency of occurrence diurnal cycle



Cloud fraction distribution



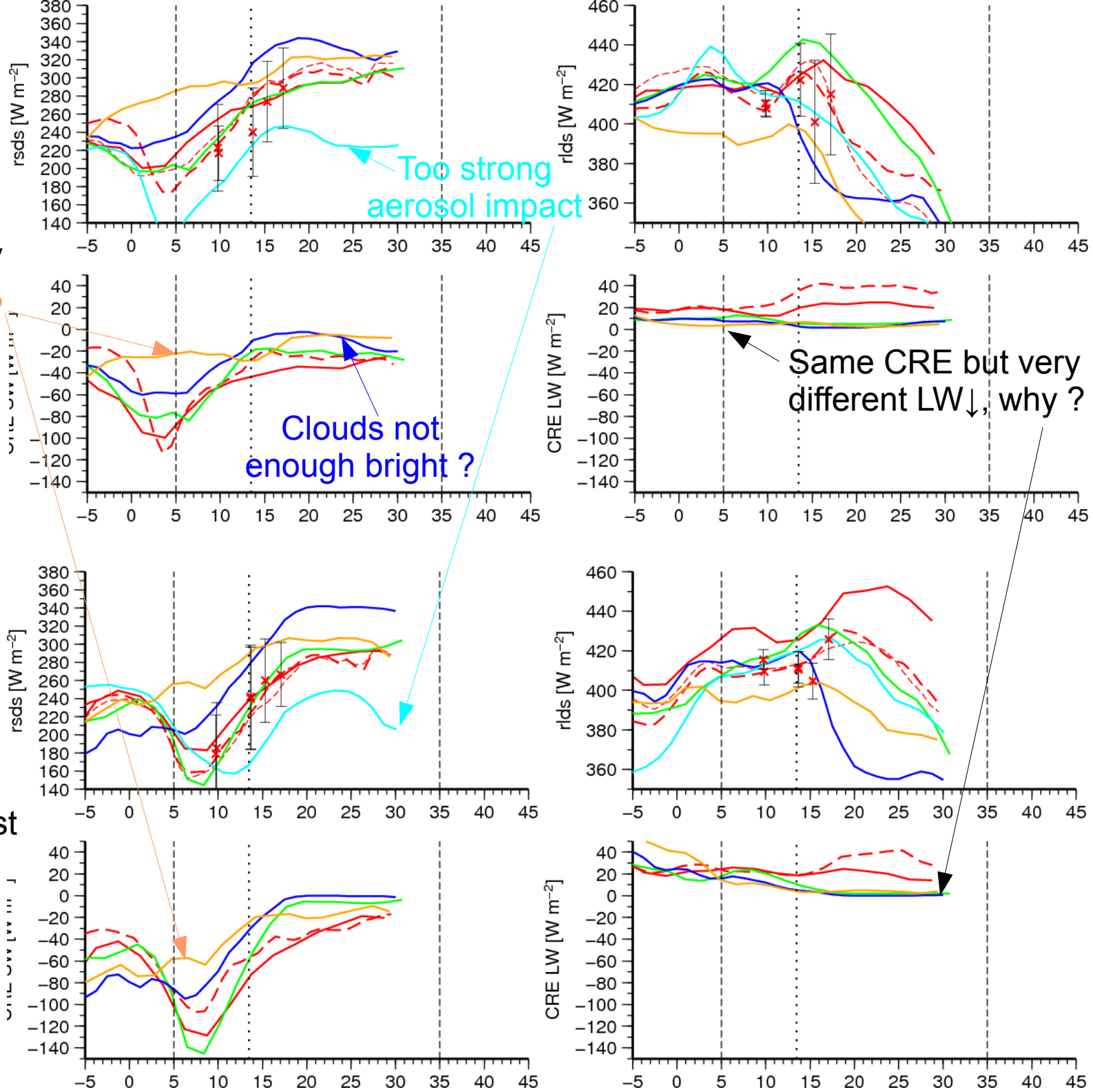
High level clouds more broken during dry season

Fixed value for CF at mid-levels

All or nothing CF

Broken clouds at all levels

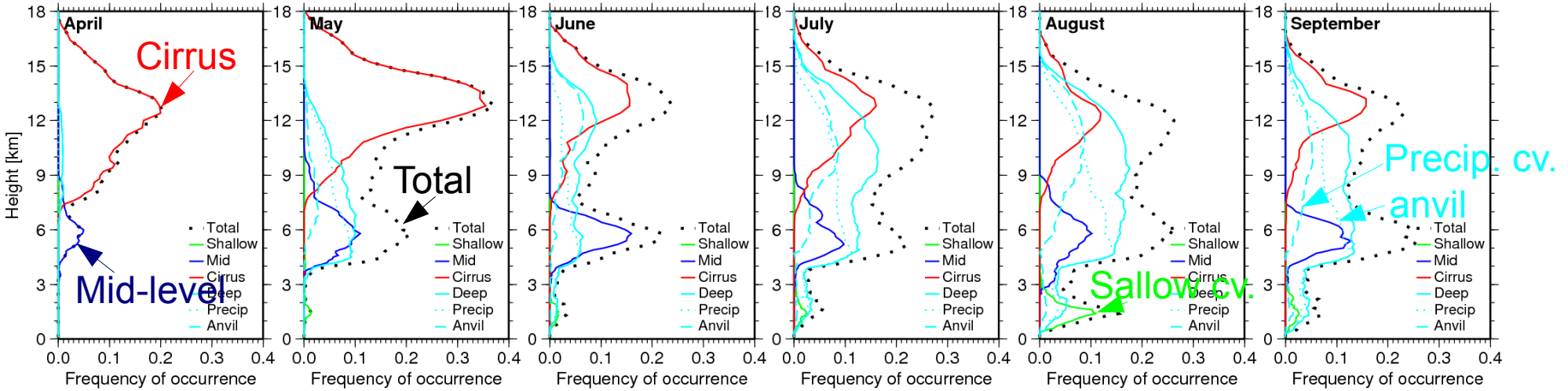
Surface incoming radiation and CRE



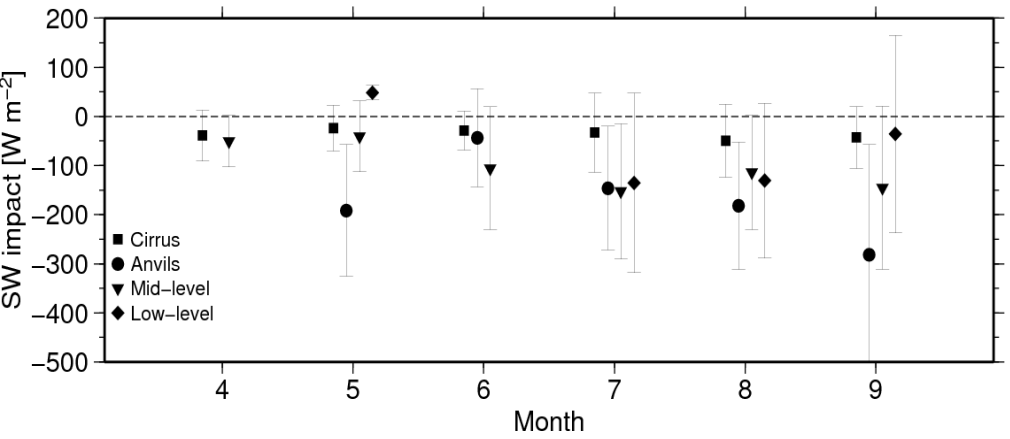
Data (ISCCP, SRB, surf.)
MPI-ESM-LR
HadGEM2-A
CNRM-CM5
IPSL-CM5A-LR

Need « clean » radiation to discriminate between aerosol impact and thermodynamics

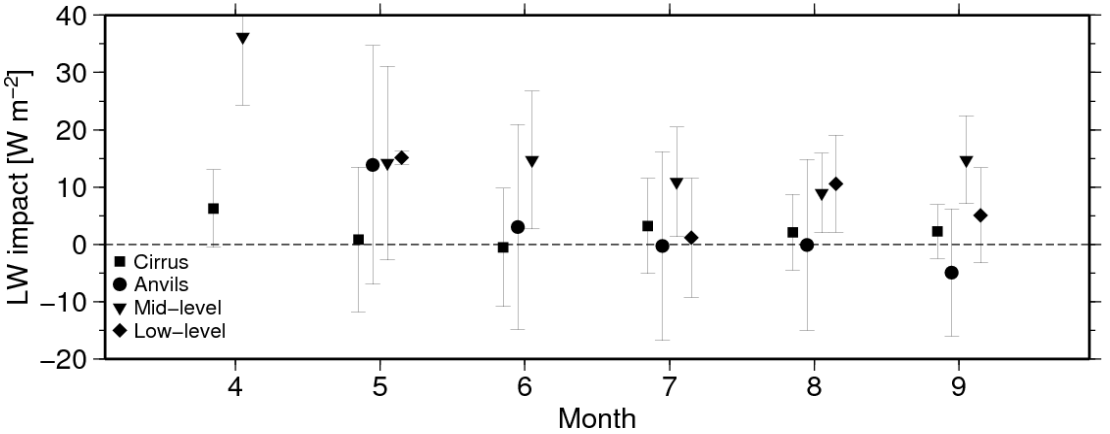
Surface CRE in the data



SW

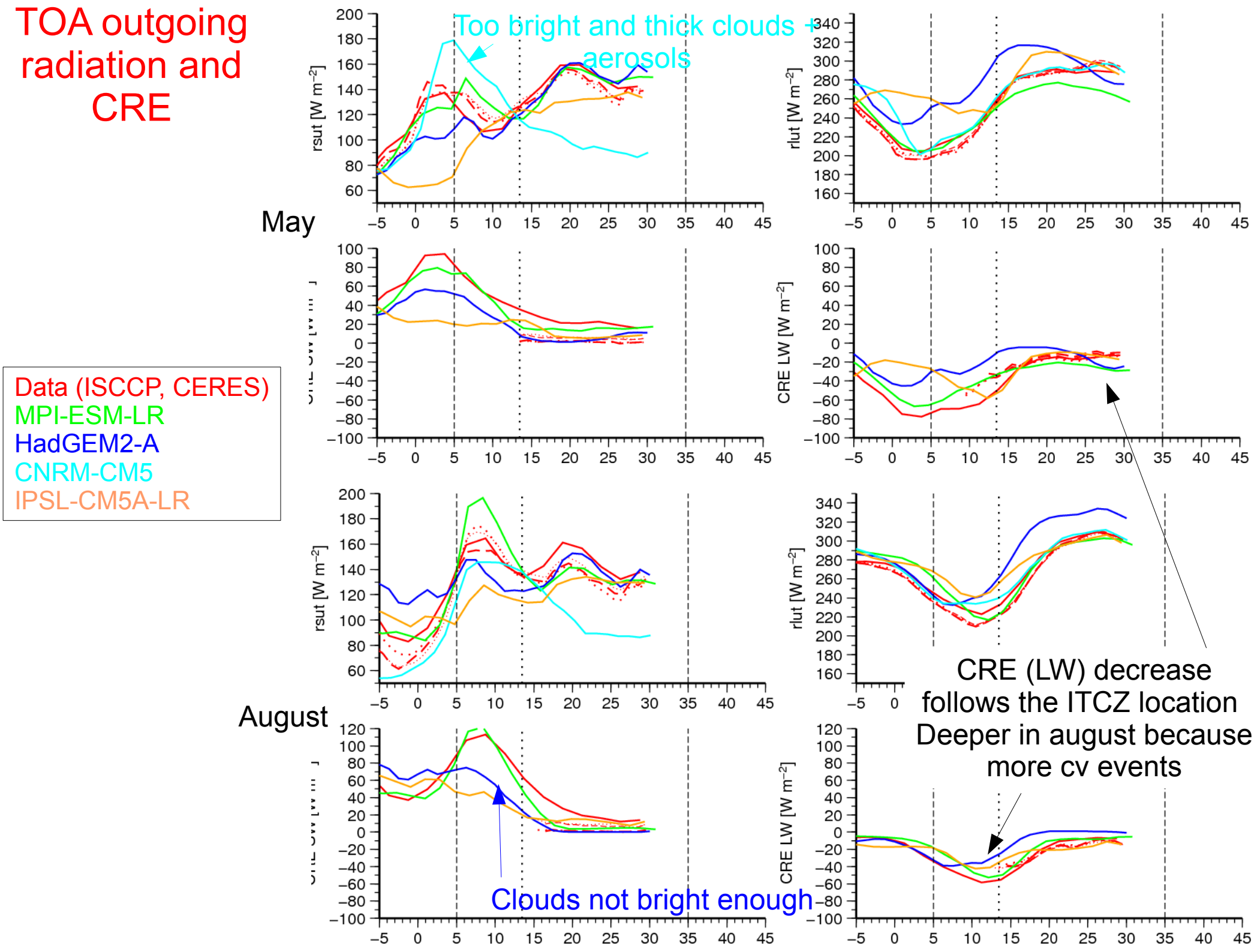


LW



Need to identify in the model, the various cloud types : other clouds type largely contributes to CRE !

TOA outgoing radiation and CRE



Summary

- All the models display the broad African Monsoon general features (dynamics, Monsoon jump, precipitations)
-Large differences exist in term of cloud cover, even if the main cloud area moves well northward

When zooming to the sites:
- Compensating effects between occurrence and cloud fraction.
    Very different answers of the cloud parameterizations (CF distributions)
    Some models (CNRM, Had) with clouds near all the time but with low CF
    Difficulty in generating low levels clouds

- Very different SW and LW incoming at the surface leading to the same CRE in the LW (why ?) but not in the SW (brightness/occurrence ?)

Future work

- Systematically extend the documentation to all the EUCLIPSE models and all the African points (changes along the transect = different forcing conditions (thermo, surface...))
- Include more data in the transect comparisons => spread (precip, TOA, ...)
- Quantify the model CRE by cloud types by classifying the model cloud profiles
- Improve the quantification of the CRE in the observations (for all the African points) by using radiative transfer calculations (Olivier Geoffroy)