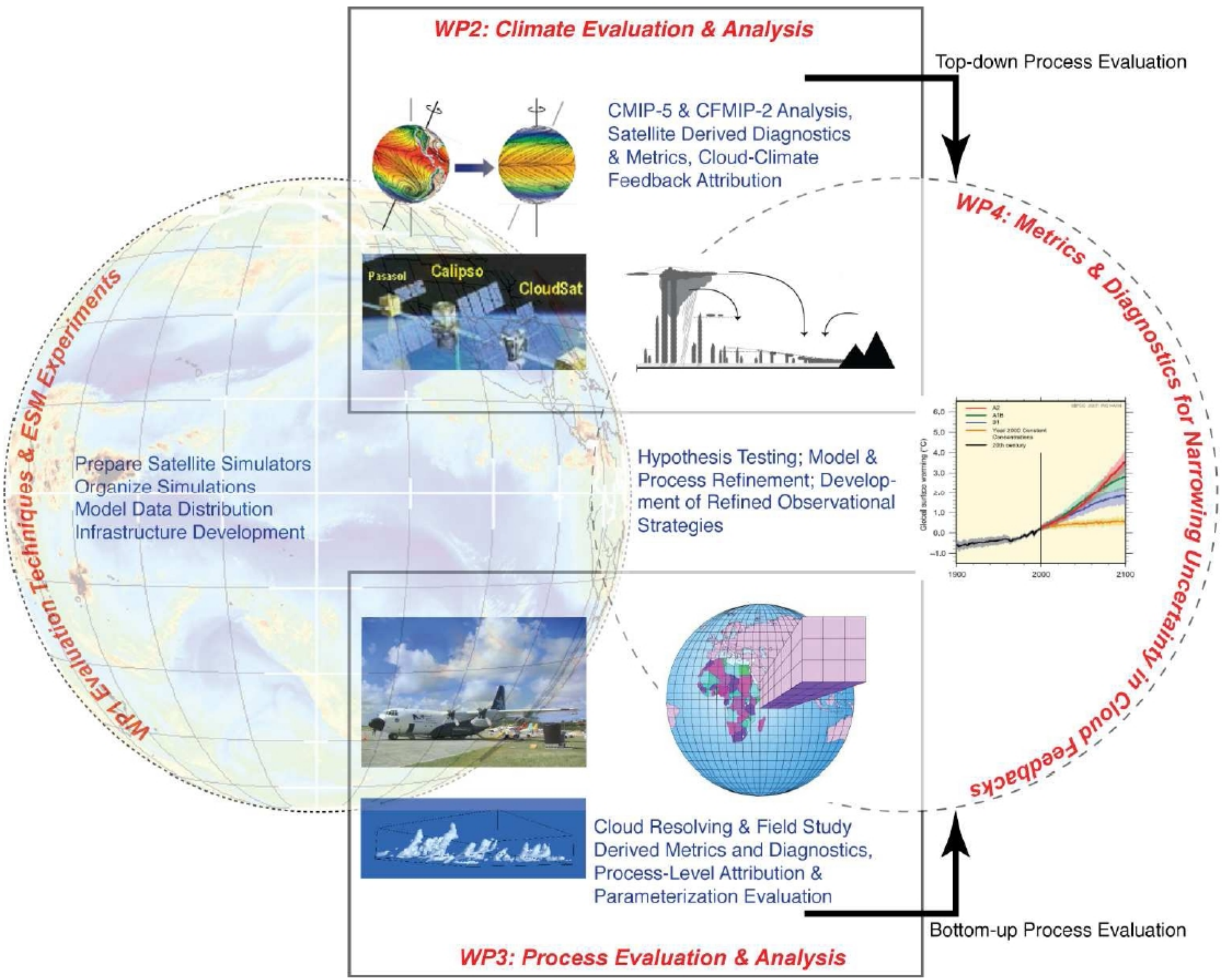
EUCLIPSE WP2
Climate Model Evaluation and Analysis



EUCLIPSE WP2
Climate Model Evaluation and Analysis

Objectives

- *To evaluate the simulation of clouds, precipitation and radiation by climate and weather prediction models*, point out systematic and compensating errors, and develop cloud metrics.
- *To investigate whether and how the simulation of cloud and moist processes influences the simulation of the current climate*, in particular the mean tropical precipitation and large-scale circulation, the tropical variability at intra-seasonal and inter-annual timescales, and the simulation of temperature extremes over Europe.
- *To quantify and to interpret the inter-model spread of climate sensitivity estimates and of the cloud and precipitation responses to climate change predicted by ESMs*, to identify the regions, the cloud regimes and the meteorological conditions primarily responsible for this spread, and to explore the mechanisms that control this response in the different models.

<u>Key words :</u>

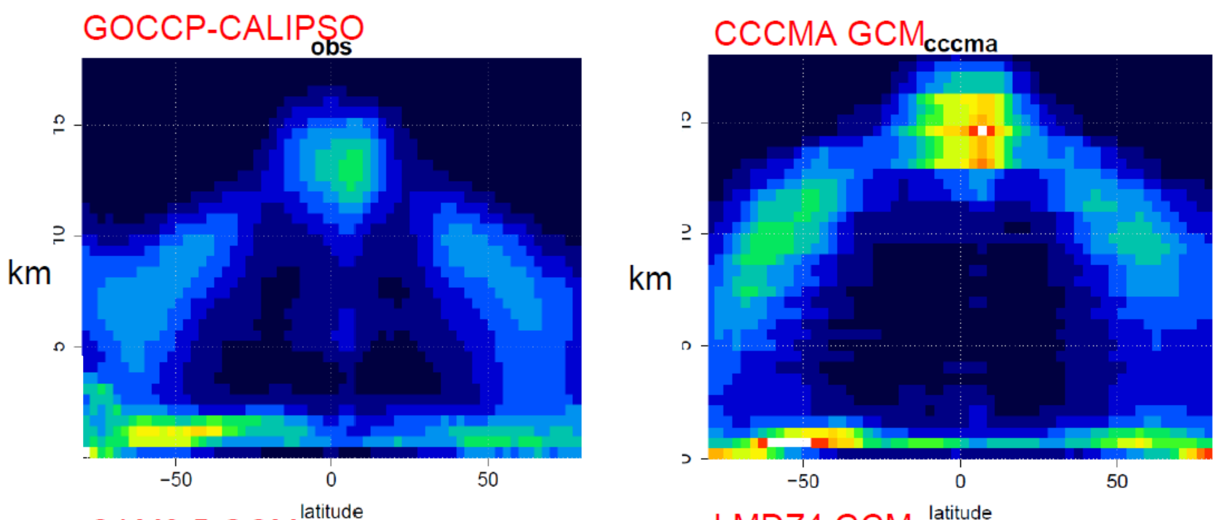
→ model evaluation

→ better understanding the role of cloud processes in current climate

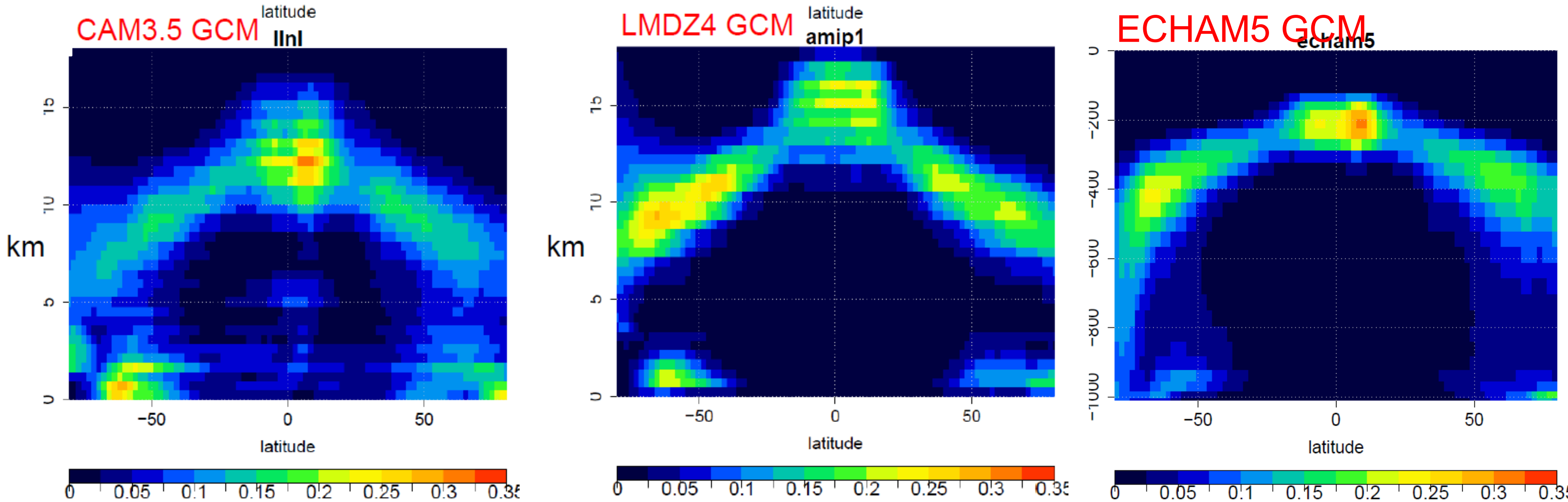
→ interpretation of climate change uncertainties

Task 2.1: Apply observational and process-oriented diagnostics defined in WP1 and define metrics to evaluate the representation of clouds, precipitation and radiation by ESMs

Task 2.1.1: *Evaluate the tri-dimensional distribution of clouds simulated by climate models* by comparing COSP outputs with satellite observations from passive (ISCCP, PARASOL, MODIS, AVHRR) and active (CALIPSO, CloudSat) instruments. Point out systematic errors in the simulation of clouds and radiation (from the Tropics to the Arctic), and unravel compensating errors (e.g. between the predicted cloud fraction and cloud optical thickness) in the simulation of top-of-atmosphere radiative fluxes.

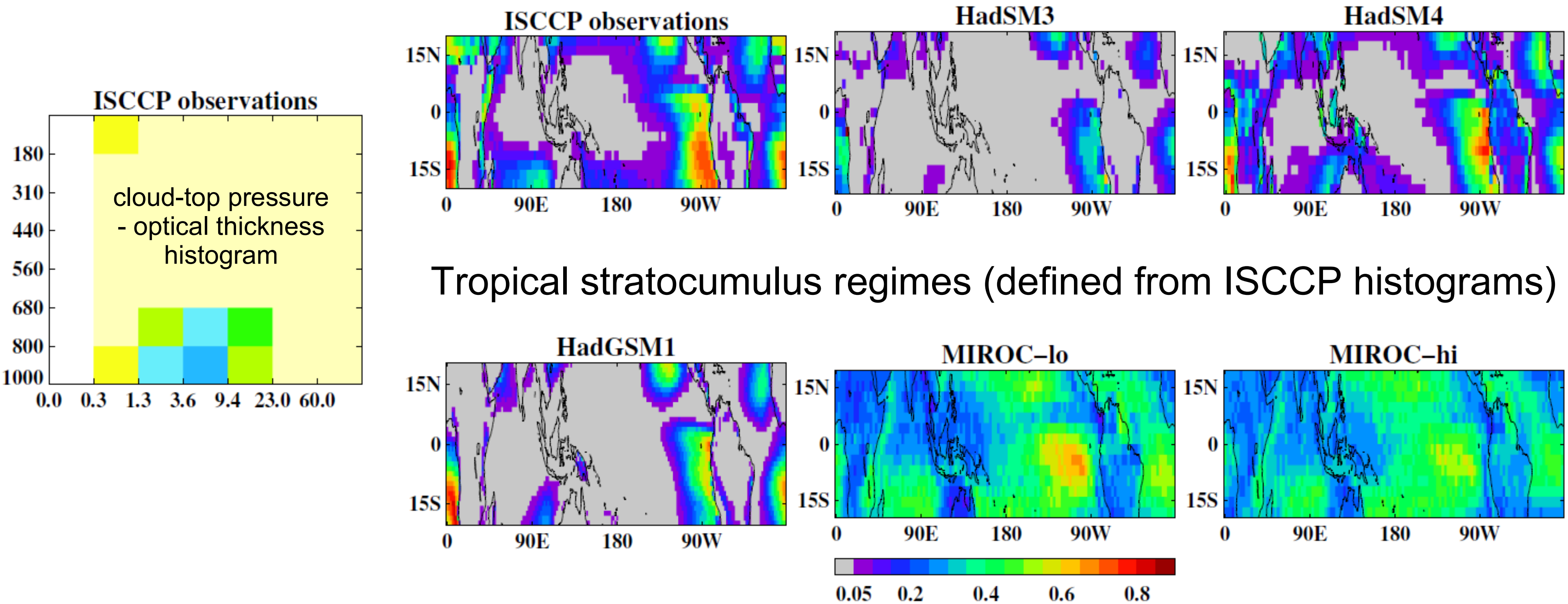


Preliminary comparison of CALIPSO simulator outputs from COSP



Task 2.1: Apply observational and process-oriented diagnostics defined in WP1 and define metrics to evaluate the representation of clouds, precipitation and radiation by ESMs

Task 2.1.2: *Use compositing and clustering techniques to evaluate the ability of GCMs to simulate the precipitation and the radiative impact associated with specific cloud types and dynamical regimes.* Relate the GCM's errors in the simulation of specific cloud types to the deficiencies pointed out at the process-level.



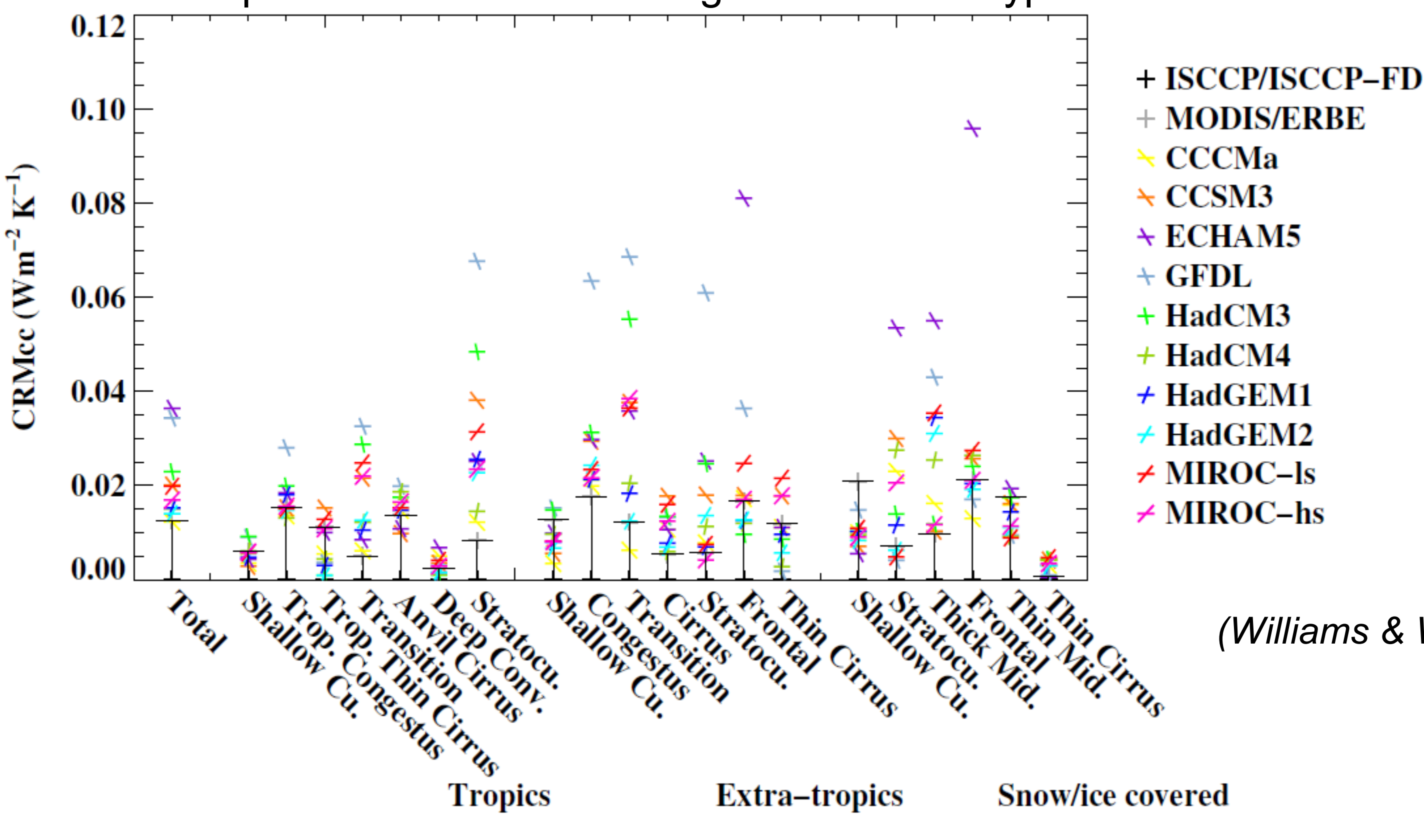
(Williams & Tselioudis 2007)

Task 2.1.3: *Evaluate cloud-aerosol-radiation interactions* by using COSP and MODIS satellite data, and by comparing observed and simulated statistical relationships between aerosol concentration, cloud properties, and top-of-the-atmosphere radiation for individual regions, cloud types and dynamical regimes.

Task 2.1: Apply observational and process-oriented diagnostics defined in WP1 and define metrics to evaluate the representation of clouds, precipitation and radiation by ESMs

Task 2.1.4: *Develop a set of metrics that synthesise the ability of climate and weather prediction models to simulation of clouds, precipitation and radiation.* First apply existing state-of-the-art metrics to CMIP5 simulations. Then develop new metrics based on the diagnostics developed in Tasks 2.1.1 and 2.1.2.

Example of cloud metrics using ISCCP cloud types



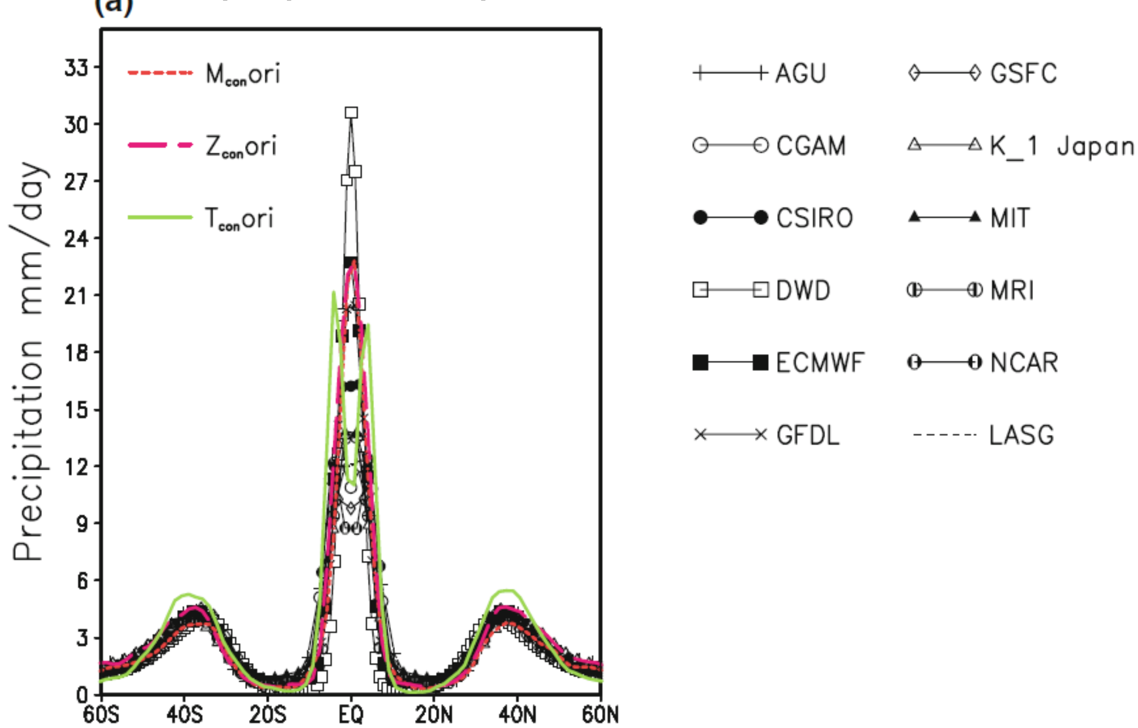
(Williams & Webb 2008)

Task 2.1.5: *Integration of data analysis workflows with respect to cloud processes into the WDCC infrastructure.* In addition to exiting CMIP-5 data metrics data diagnostics which will be developed within EUCLIPSE will be inferred with respect to integration into the standard data processing workflows of WDCC.

Task 2.2: Examine the influence of the representation of cloud and moist processes in the simulation of a few prominent features of the current climate

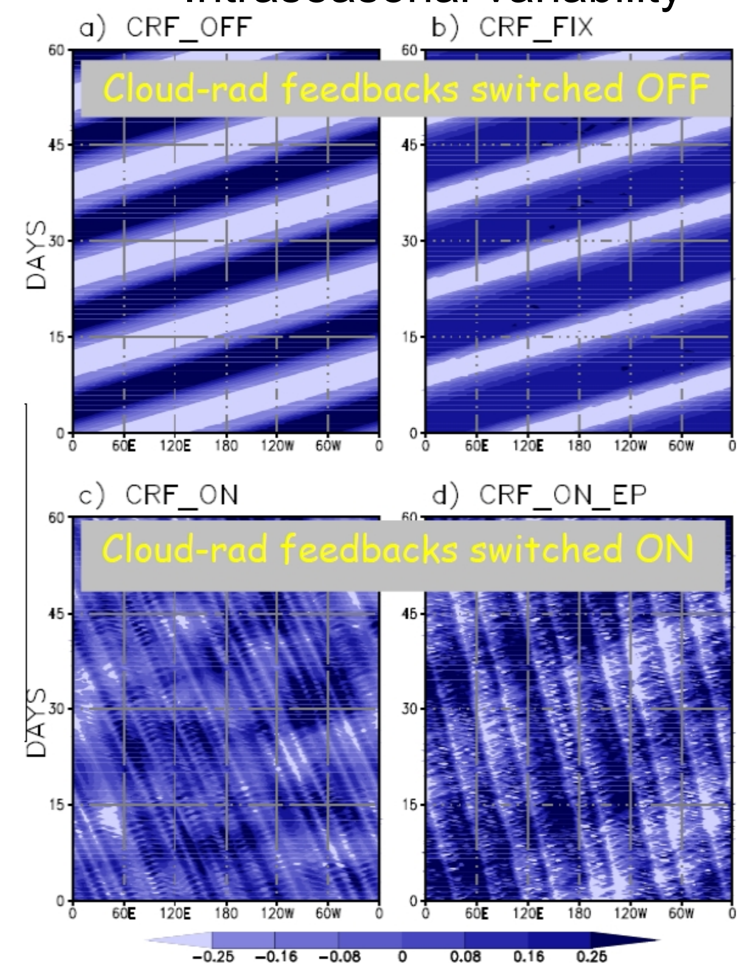
Task 2.2.1: *Role of cloud and moist processes in the simulation of the ITCZ and in tropical intra-seasonal variability (MJO):* Use the set of metrics recently developed by CLIVAR to assess the ability of GCMs to simulate the observed characteristics of the MJO in different CMIP5 simulations (coupled, atmospheric, aquaplanet); Relate the ability of GCMs to simulate a single or double ITCZ and intra-seasonal variability to their ability to simulate convection-humidity feedbacks, cloud-radiation feedbacks, the transition between dry and moist precipitating regimes and the stratiform or convective types of precipitation.

Precipitation in aquaplanet expts



(Liu et al. 2010)

Intraseasonal variability

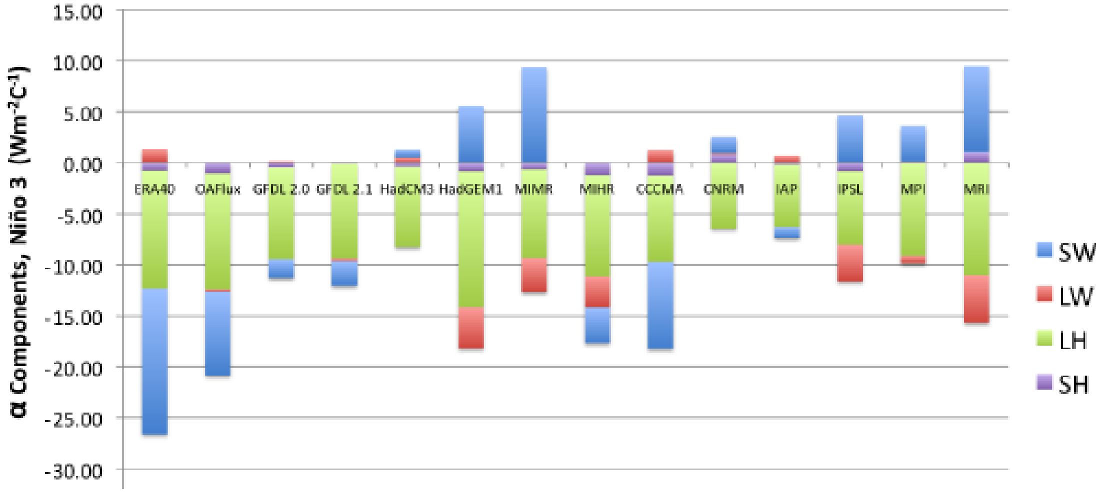


(Zurovac-Jevtic et al. 2006)

Task 2.2: Examine the influence of the representation of cloud and moist processes in the simulation of a few prominent features of the current climate

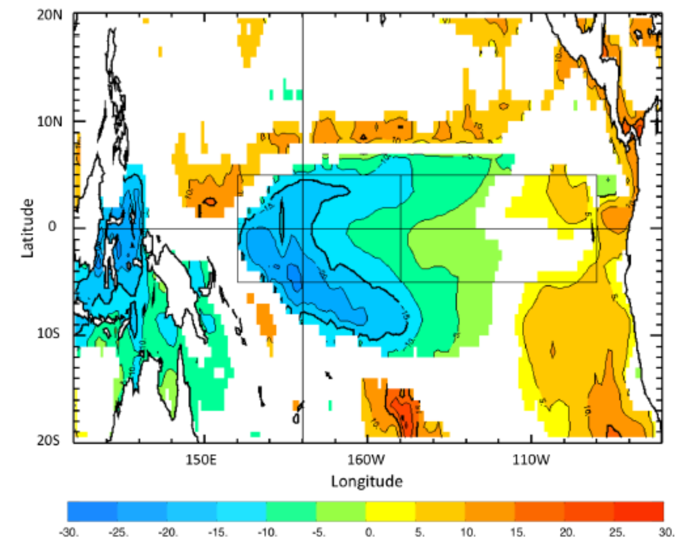
Task 2.2.2: *Role of cloud and moist processes in the simulation of tropical inter-annual variability (ENSO):* Use the set of metrics recently developed by CLIVAR to assess the ability of GCMs to simulate the observed characteristics of ENSO in CMIP5 simulations; Apply process-based diagnostics of the dynamical and heat flux feedbacks involved in ENSO to understand the diversity of ENSO behaviour among models, and relate the heat-flux feedbacks simulated by models to the simulation of clouds, convection and radiation and their interaction with SST.

Heat Flux feedback in ENSO



(Lloyd et al. 2009)

SW component of the heat flux feedback



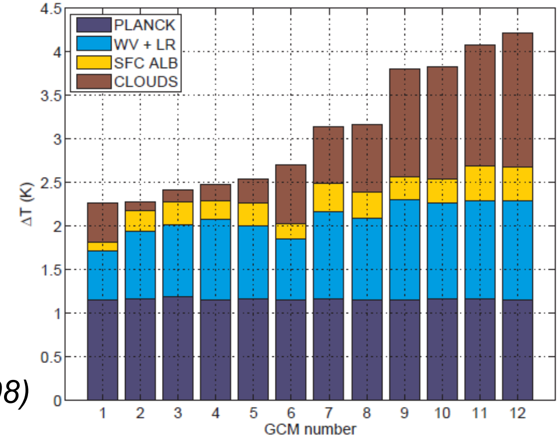
Task 2.2.3: *Role of cloud processes in the simulation of temperature extremes over Europe:* Assess the ability of GCMs to simulate heat waves and cold spells over Europe, analyse the occurrence of temperature extremes as a function of weather regimes, and use the ISCCP simulator to diagnose the cloud variability associated with these regimes; Compare the performance of GCMs in AMIP simulations where the large-scale circulation is predicted by the model or nudged by ERA-interim analyses; Infer the relative roles of large-scale dynamics, cloud variations and regional processes such as land surface hydrology in the simulation of temperature extremes over Europe.

Task 2.3: Quantify, analyse and interpret the diversity of cloud-radiative feedbacks and precipitation responses produced by climate models in climate change simulation

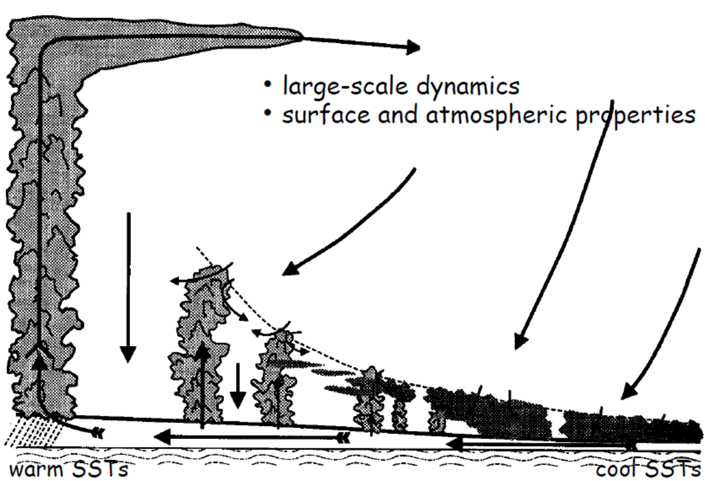
Task 2.3.1: *Diagnose the different climate feedbacks* associated with clouds, water vapour, temperature lapse rate, surface albedo and the carbon cycle and quantify the contribution of each feedback to the inter-model spread of climate sensitivity estimates; Compare this spread of current (CMIP5) models with that of the previous generation of climate models (CMIP3). Quantify the spread of temperature, precipitation and cloud responses to climate change at the regional scale.

Decomposition of climate sensitivity into Planck response and feedbacks

(Dufresne & Bony 2008)



Task 2.3.2: *Identify the processes, the cloud types or environmental situations that are primary responsible for the spread of the global cloud and precipitation responses.* Determine whether the response of low-level clouds is still an important contributor to the spread of climate sensitivity estimates in CMIP5 models.



EUCLIPSE WP2
"Evaluation and Analysis of Climate Simulations"

Exciting work in perspective !

Interaction with WP3 :

→ process-evaluation for specific cloud types and specific locations

→ CGILS (comparison of the response of PBL clouds in LES and in SCMs)

Interaction with WP4 :

→ test ideas about cloud feedback mechanisms

→ use observational constraints to revise uncertainty bounds of climate sensitivity

Timeline :

→ WP2 will officially start in March 2011 (mth 13)

→ strong contribution to CMIP5 analysis

→ strong input to the IPCC AR5 WG1 ("Clouds and aerosols chapter")

(papers to be submitted by the end of Jul 2012, accepted by Mar 2013)

→ contribution to WCRP/CMIP5 review papers ?


Thank You !

Deliverables (brief description and month of delivery)

Associated with Task 1:
D2.1: Report on evaluations of clouds, radiation and precipitation simulated by climate models using COSP, clustering and compositing techniques developed in WP1 and satellite observations (Month 30).

D2.2: Report on the evaluation of cloud-aerosols-radiation interactions in ESMs (Month 30).

D2.3: Design and application of a set of metrics that synthesises the ability of climate and weather prediction models to simulate clouds, precipitation and radiation (Month 36).

Associated with Task 2:
D2.4: Report on the ability of models to simulate the ITCZ, the intra-seasonal and inter-annual variability of the tropical atmosphere, and temperature extremes over Europe using a new set of diagnostics (Month 24).

D2.5: Report on the influence of the representation of cloud and moist processes in models (based on D1.4, D2.3 and WP3) on the simulation of the ITCZ, MJO and ENSO, and temperature extremes over Europe (Month 48).

Associated with Task 3:
D2.6: Report on the diagnostic of the climate feedbacks produced by the different models in some CMIP5 simulations; Report on the global and regional spreads of feedbacks and of cloud and precipitation responses to climate change; and their comparison with estimates from the CMIP3 models (Month 24).

D2.7: Report on the identification of the processes or cloud types most responsible for the spread in climate change cloud feedbacks and precipitation responses (Month 36).

D2.8: Report on the interpretation of the spread of cloud and precipitation responses among models, in interaction with WP3 and WP4 (Month 48).