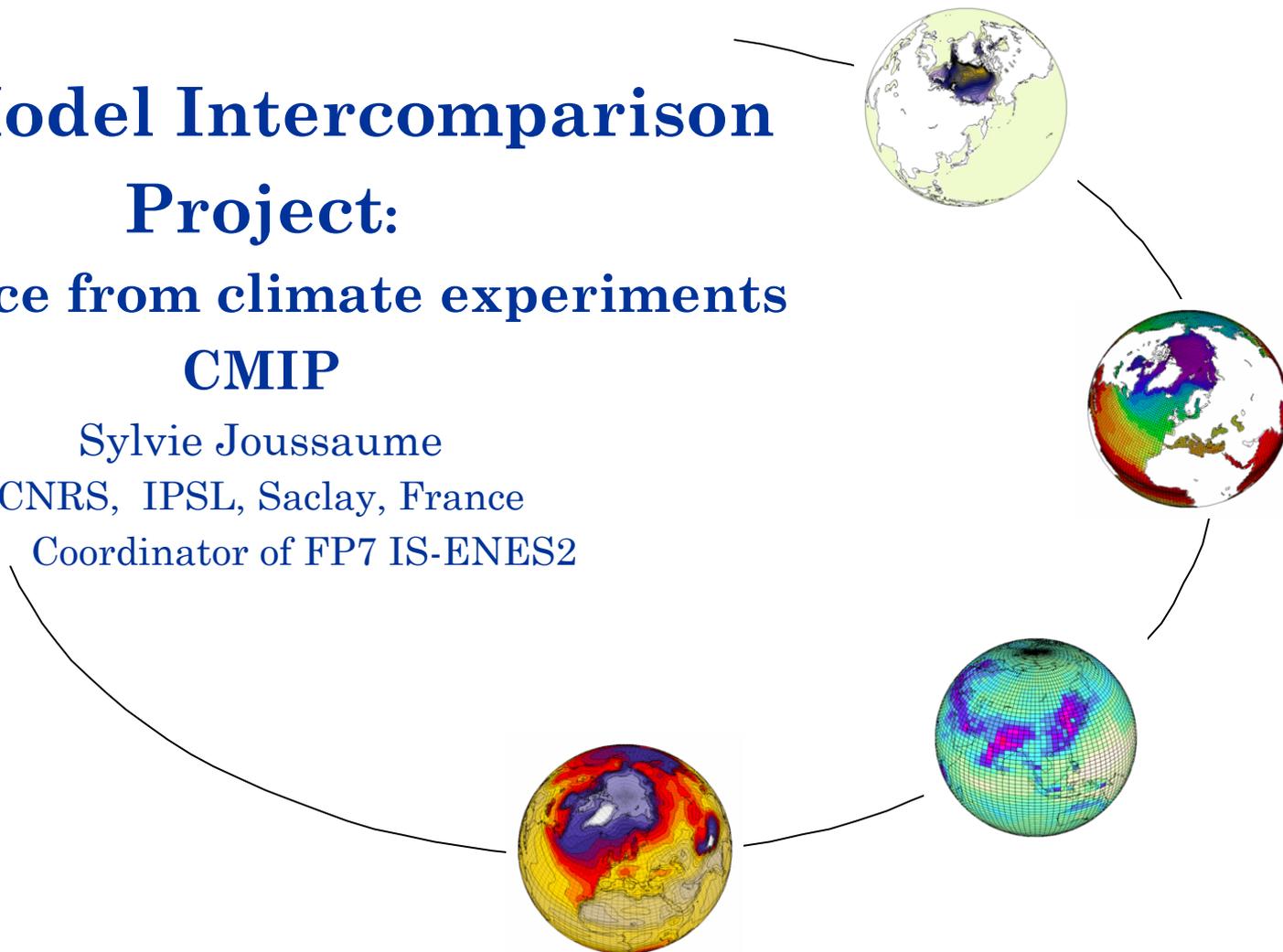




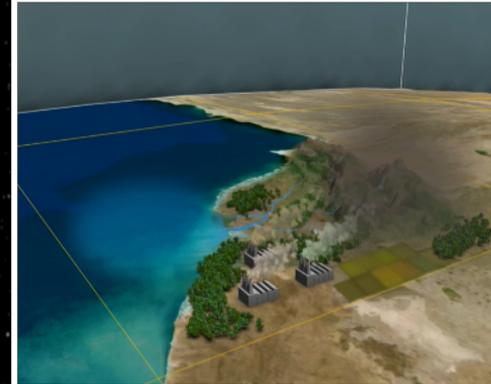
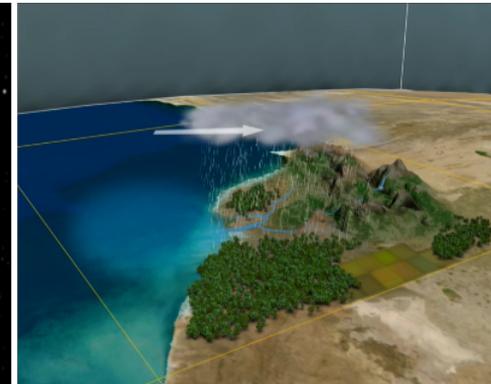
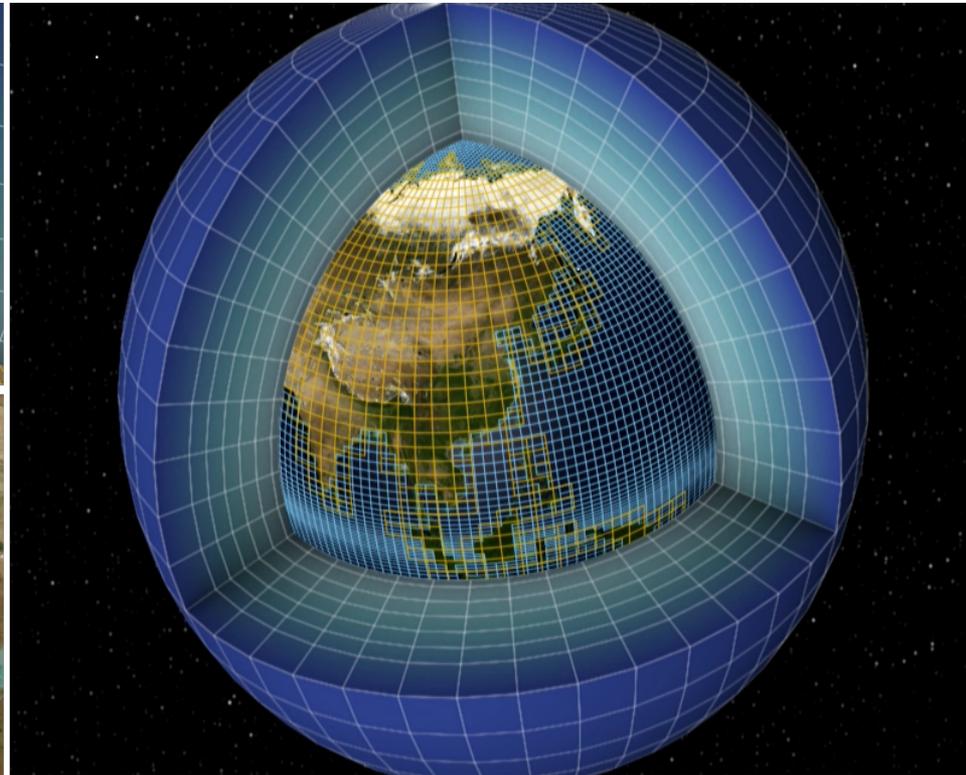
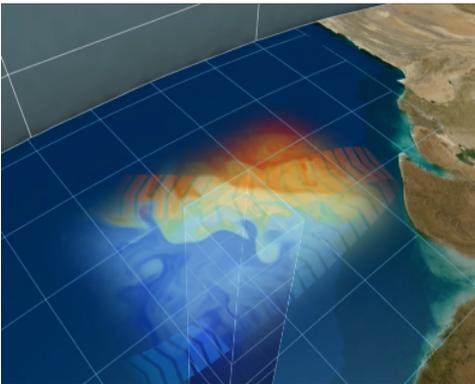
Data Model Intercomparison Project: Experience from climate experiments CMIP

Sylvie Joussaume
CNRS, IPSL, Saclay, France
Coordinator of FP7 IS-ENES2



Modelling the Earth's climate system

Understand & Predict
Climate Variability and Changes



Atmospheric Model Intercomparison Project

A vision

End of 1980s-beginning of 90s

AMIPI: 1990-1996

Larry Gates (BAMS, 1992)

Need for a systematic and comprehensive intercomparison of atmospheric climate models

Recommendation WCRP (1989)

**Under Working Group on Numerical Experiments
(WMO/WCRP)**

A leading team: PCMDI (USA)

Program for Climate model Diagnosis and Intercomparison

Contribution to IPCC Assessment Reports 2 (1996)

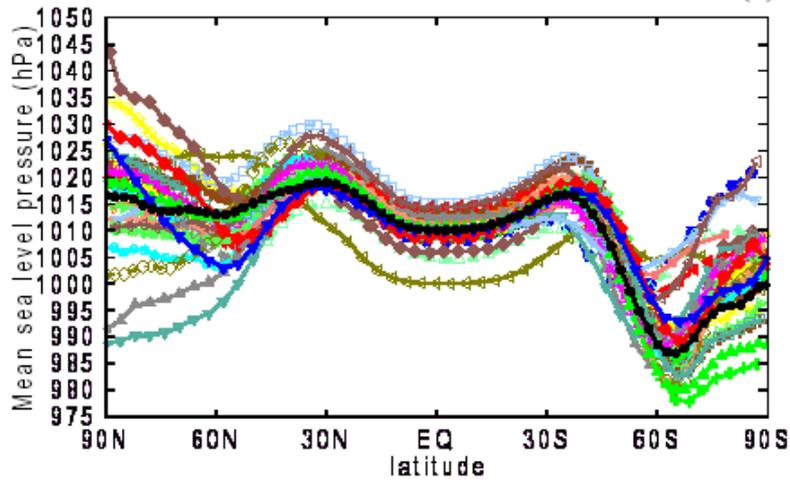
Start of a new approach: MIPs

Paleoclimate Modelling Intercomparison Project: 2nd MIP

Atmospheric Modeling Intercomparison Project *Gates et al. (1998)*

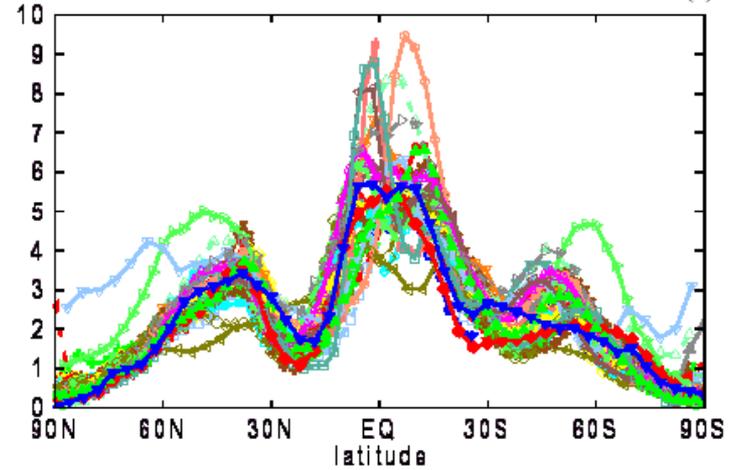
Sea level pressure

(a)



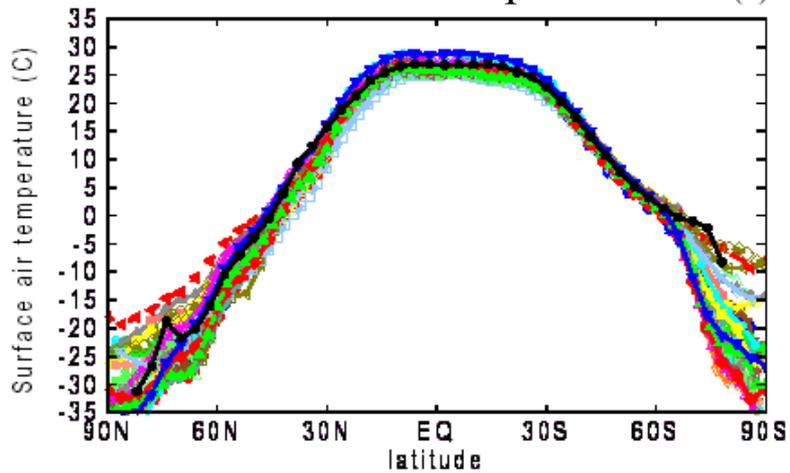
Precipitation

(c)



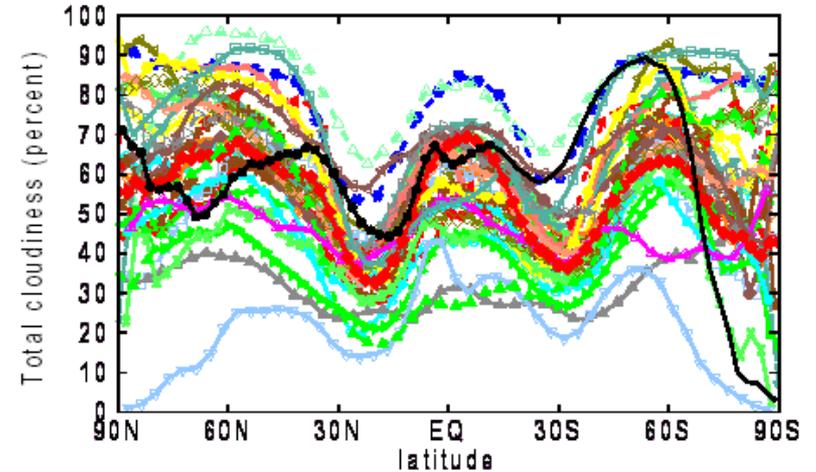
Surface air temperature

(b)



Cloudiness

(b)



DFJ 1979-1988

Coupled Model Intercomparison Project

1995 WCRP creation of the Working Group on Coupled Modelling

Foster the development and review of coupled models

CMIP Launched in 1995 - Mainly control runs

CMIP2: Launched in 1997 – Idealised experiment 1%/year increased CO₂

0.5 TB - Data accessible only on subproject basis - IPCC TAR (2001)

CMIP3: more realistic past (20th) and future simulations (scenarios) - **IPCC AR4 (2007)**

36 TB of data at PCMDI – open and free non commercial

Limitations: different model versions for CMIP and other MIPs (eg Paleoclimates PMIP)

CMIP5 (2008-2013): consistent set for all experiments - **IPCC AR5 (2013)**

1.8 PB of data – ESGF – open data (very few closed for non commercial)

Difficulties: all experiments with same model version / very heavy

CMIP6 (2014-2019) common core simulations and more independent MIPs

IPCC AR6 (2020)

New approach: Allows a better involvement of the community in the design

CMIP "Coupled Model Intercomparison Project"

Phase 5 – CMIP5



Evaluate / Understand / Projections
 basis for IPCC Assessments
 Inform mitigation & adaptation policies

CMIP5 (2008-2013)

3400 simulated yrs up to > 12000 yrs

50 expts up to > 160 expts

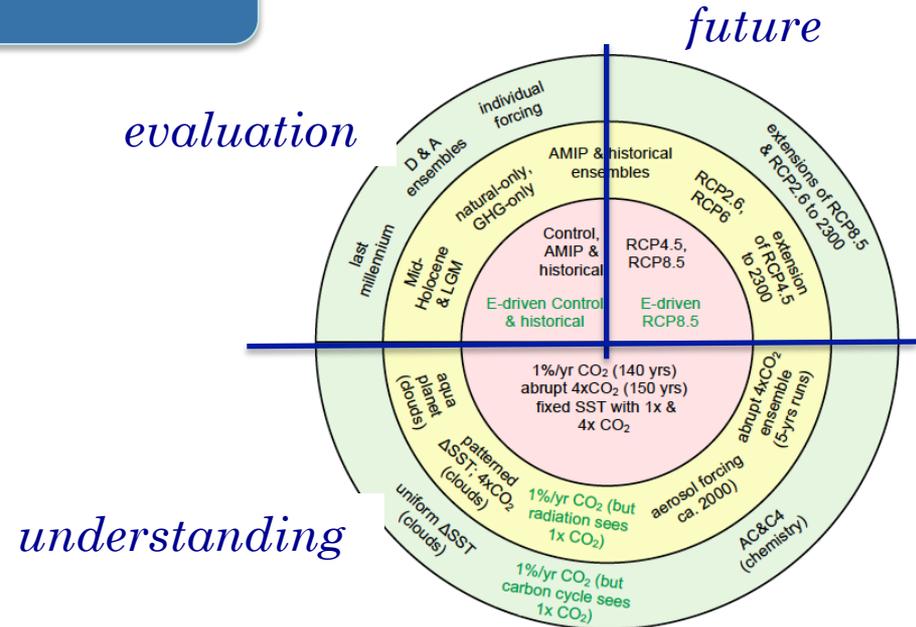
2000 Tbytes (CMIP3: 36)

28 modelling groups / **7 in Europe**
 61 models / 17 in Europe

> 1000 publications (ca 300/yr)

Used for Regional coordinated expts
CORDEX

IPCC AR5



Near-term experiments
 (10-30 years)

Long-term experiments
 (century)

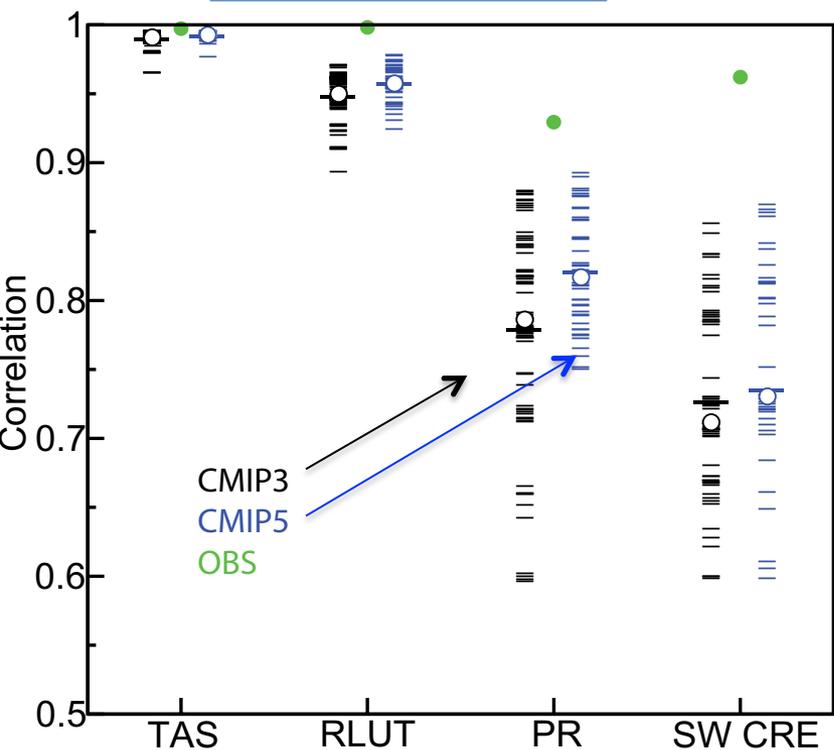
CMIP5 Evaluate / Understand / Projections

IPCC AR5



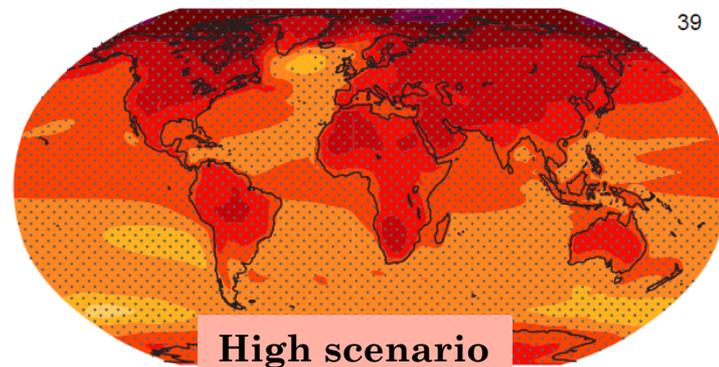
Projections

Evaluate



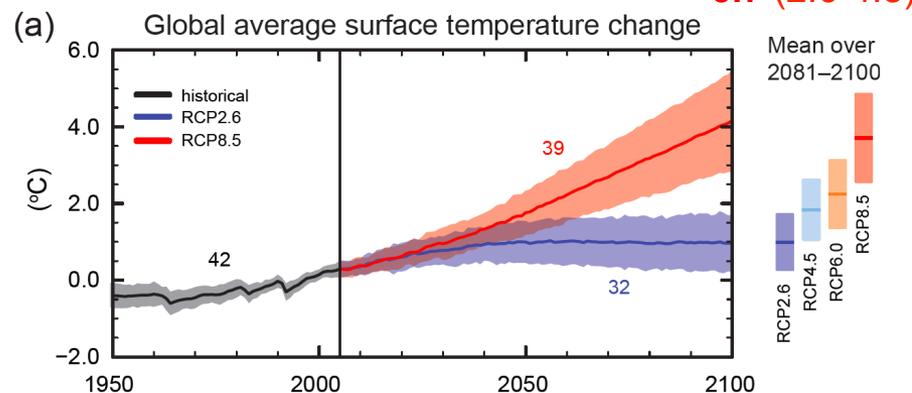
(2081-2100) minus (1986-2005)

39

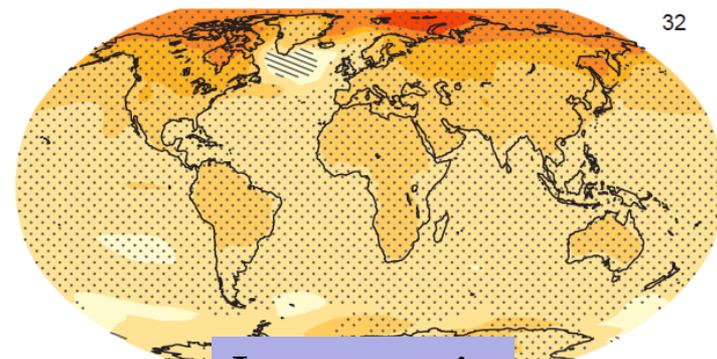


High scenario

3.7 (2.6-4.8)

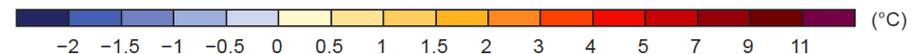


32



Low scenario

1.0 (0.3-1.7)

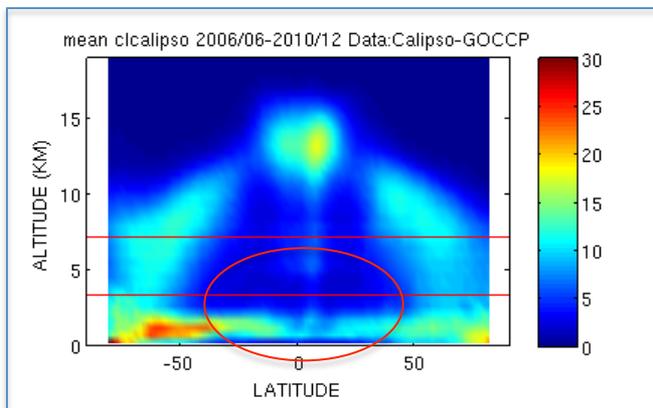


Surface air temperature Precipitation

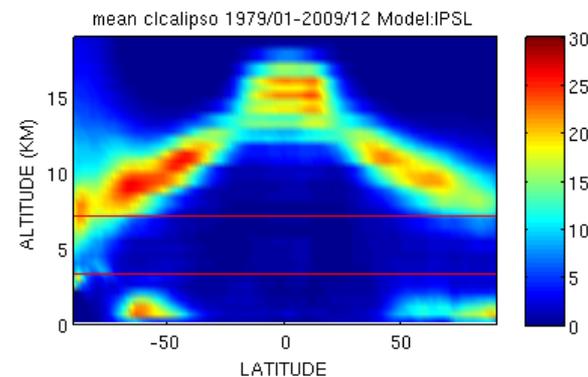
LW outgoing radiation SW cloud radiative effect

Obs4MIP: Observations for Model Intercomparison Projects

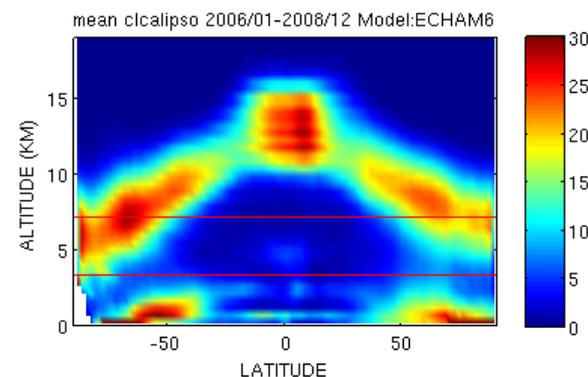
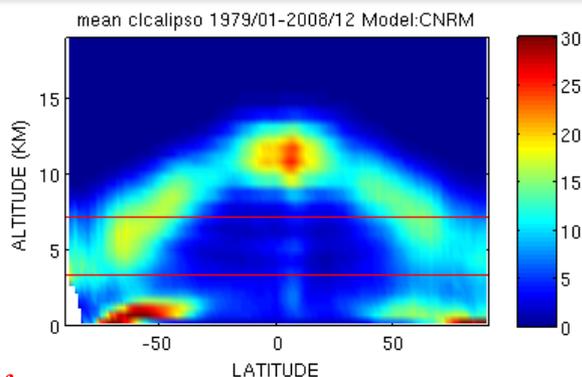
Observations
CALIPSO-GOCCP



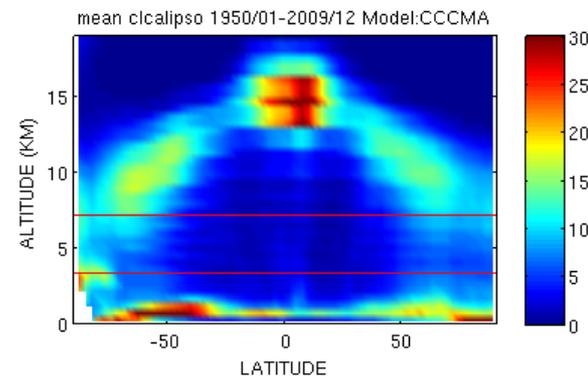
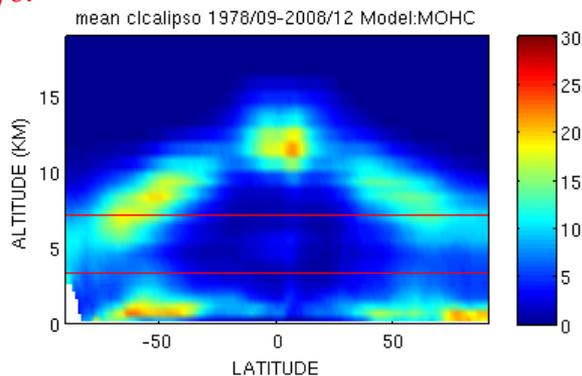
Models



Models



*Cesana and Chepfer
GRL, 2012*



Status of CMIP5 experiments

28 modelling groups
61 models

1 Canada

CCCma	CanAM4 CanCM4 CanESM2
NSF-DOE-NCAR	CESM1(BGC) CESM1(CAM5) CESM1(CAM5.1, FV2) CESM1(FAST CHEM) CESM1(WACCM)
NCAR	CCSM4
NOAA GFDL	GFDL-CM2.1 GFDL-CM3 GFDL-ESM2G GFDL-ESM2M GFDL-HIRAM-C180 GFDL-HIRAM-C360
NASA GMAO	GEOS-5
NASA GISS	GISS-E2-H GISS-E2-H-CC GISS-E2-R GISS-E2-R-CC
COLA & NCEP	CFSv2-2011

6 USA

1 Brazil (with UK)

NCC	NorESM1-M NorESM1-ME
MPI-M	MPI-ESM-LR MPI-ESM-MR MPI-ESM-P
MOHC (with INPE)	HadCM3 Hadcm3Q HadGEM2-A HadGEM2-CC HadGEM2-ES
EC-EARTH	EC-EARTH
IPSL	IPSL-CM5A-LR IPSL-CM5A-MR IPSL-CM5B-LR
CNRM-CERFACS	CNRM-CM5 CNRS-CM5-2
CMCC	CMCC-CESM CMCC-CM CMCC-CMS
INM	INM-CM4

1 Russia

4 Japan

2 Australia

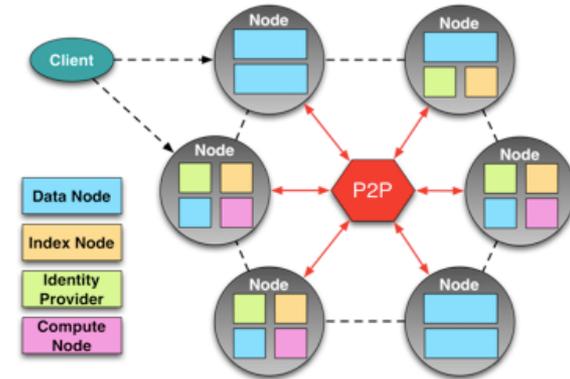
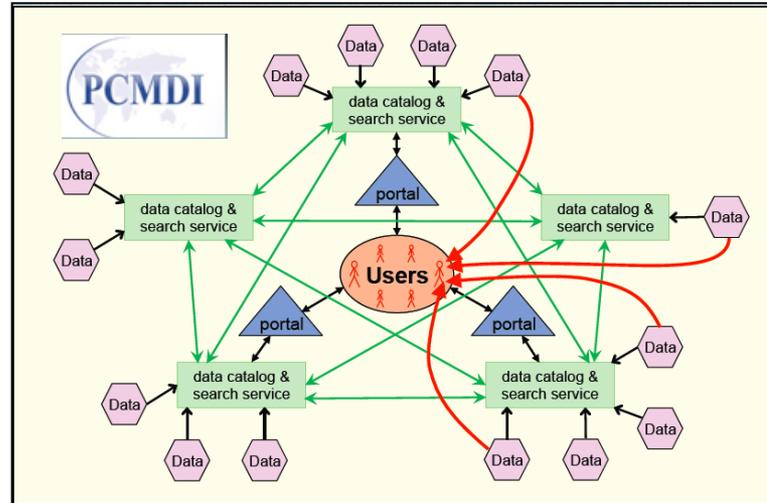
7 in Europe



5 China / 1 Korea

LASG-IAP	FGOALS-g1 FGOALS-s2
LASG-CESS	FGOALS-g2
GCESS	BNU-ESM
FIO	FIO-ESM
BCC	BCC-CSM1.1(m) BCC-CSM1.1
NIMR/KMA	HadGEM2-AO
NICAM	NICAM.09
MRI	MRI-AGCM3.2H MRI-AGCM3.2S MRI-CGCM3 MRI-ESM1
MIROC	MIROC-ESM MIROC-ESM-CHEM
MIROC	MIROC4h MIROC5
CSIRO-QCCCE	CSIRO-Mk3.6.0
CSIRO-BOM	ACCESS1.0 ACCESS1.3

A common infrastructure distributed database & standards



Open source software

International, Community led : GO-ESSP, WIP
Multi-agencies support: *DOE, NOAA, NASA, IS-ENES, NCI*
Most often: project base

Adoption of common standards

Data: structure, format, metadata, vocabulary
Document Model/experiments (**ES-DOC**)

Standardization enables/facilitates

Analysis using uniform methods
Unique identification of files
Sharing of data across the ESGF network

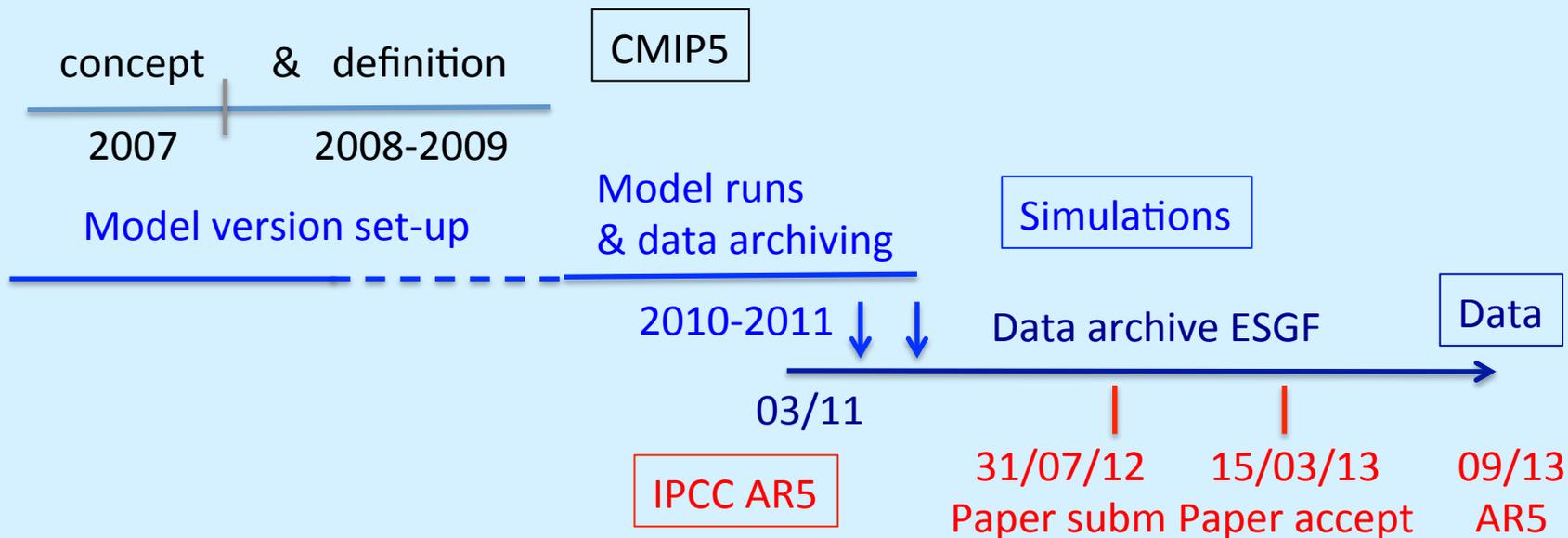
Ref: from Doutriaux and Taylor, 12/2014

At the limit of what can be done

Coupled Model Intercomparison Project – CMIP5

IPCC: A policy incentive but also a strong timing

CMIP5/AR5 cycle



Coupled Model Intercomparison Project Phase 6

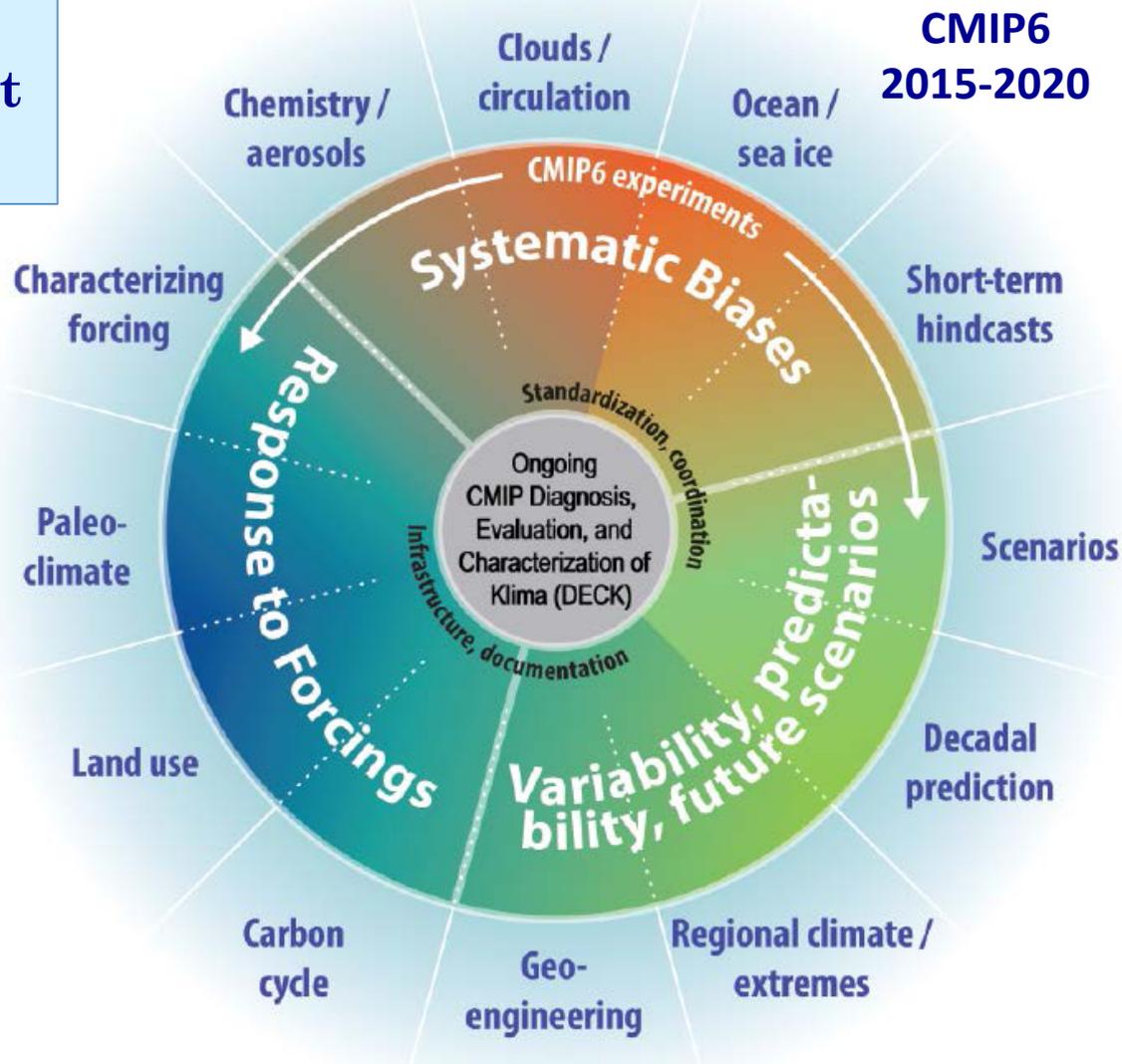


Working Group on Coupled Models

International coordinated numerical experiments

**Evaluate
Understand
Projections**

basis for IPCC Assessments
Inform mitigation & adaptation policies



Meehl et al., EOS, 2014

WCRP Grand Challenges: (1) Clouds, circulation and climate sensitivity, (2) Changes in cryosphere, (3) Climate extremes, (4) Regional climate information, (5) Regional sea-level rise, and (6) Water availability, plus an additional theme on “Biogeochemical forcings and feedbacks”

Large range of users

From climate research to
climate impact studies & climate services

Examples

Climate Impact research

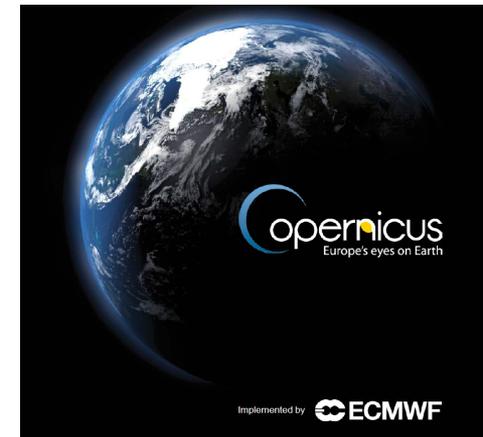
Platform to
Explore data
Perform computation
Access documentation & guidance



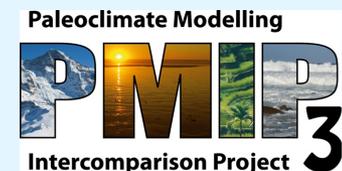
IS-ENES Climate4impact Portal
<http://Climate4impact.eu>



Copernicus Climate Change Service



Paleoclimate data
Used by Paleoecology



CMIP

A strong added value for climate research

Common basis for :

Model evaluation

Understanding

Future climate (IPCC)

Science driven but strong link with policy

But also felt as a constraint by the community

Organisation: bottom-up approach (WCRP/WGCM)

Define standards (data and metadata)

Including list of output variables (climate and users)

Quite heavy & in evolution

Challenges for ICT

At the limit of what is possible (HPC, data)

Still heavy to use

Need to ease analyses / evaluation

Issue of integrating with other data sources
(observations, reanalyses)

Need recognise long-term research infrastructure

Missing international funding

Serving society : challenge of climate services

Serving impact research and climate services (data requests)

Ease access/use for a non specialist community

How to integrate socio-economic data