

CMIP5 Update

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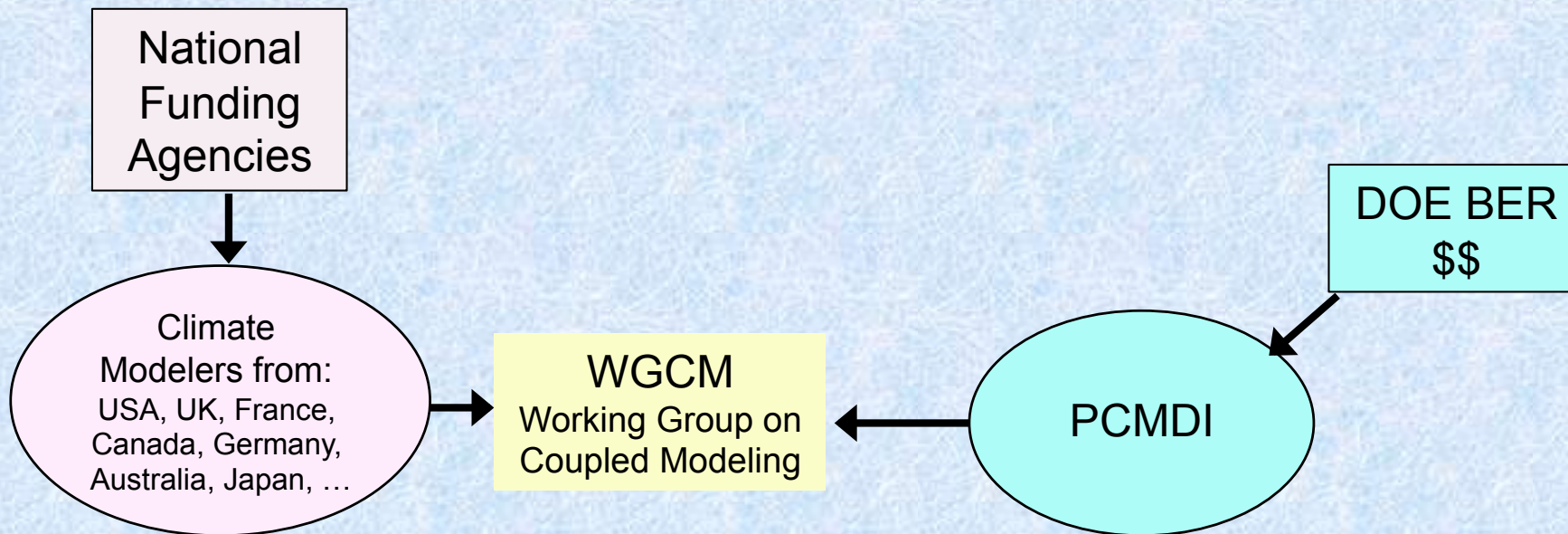
Presented to the joint session of the WGNE and WGCM

Boulder, Colorado
19 October 2011

Outline

- Review of *CMIP5* and differences from *CMIP3*
- Experiments and available model output
- Data delivery
- Observations and *CMIP5*
- *CMIP5* science preview

CMIP: A grass-roots collaborative effort

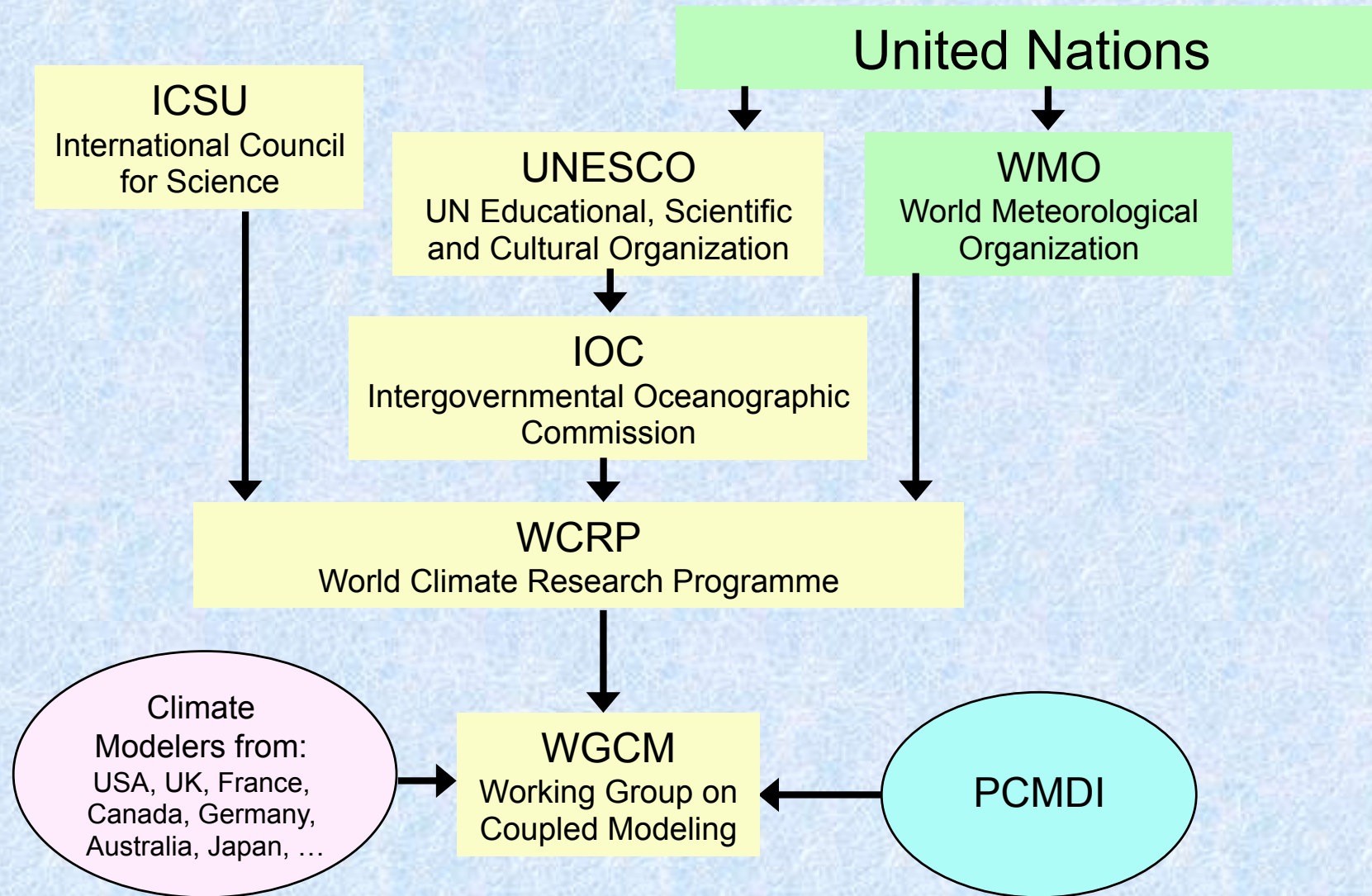


CMIP5 participating groups (23 groups; 50+ models; 17 Oct 2011: 24 models available from 13 centers)

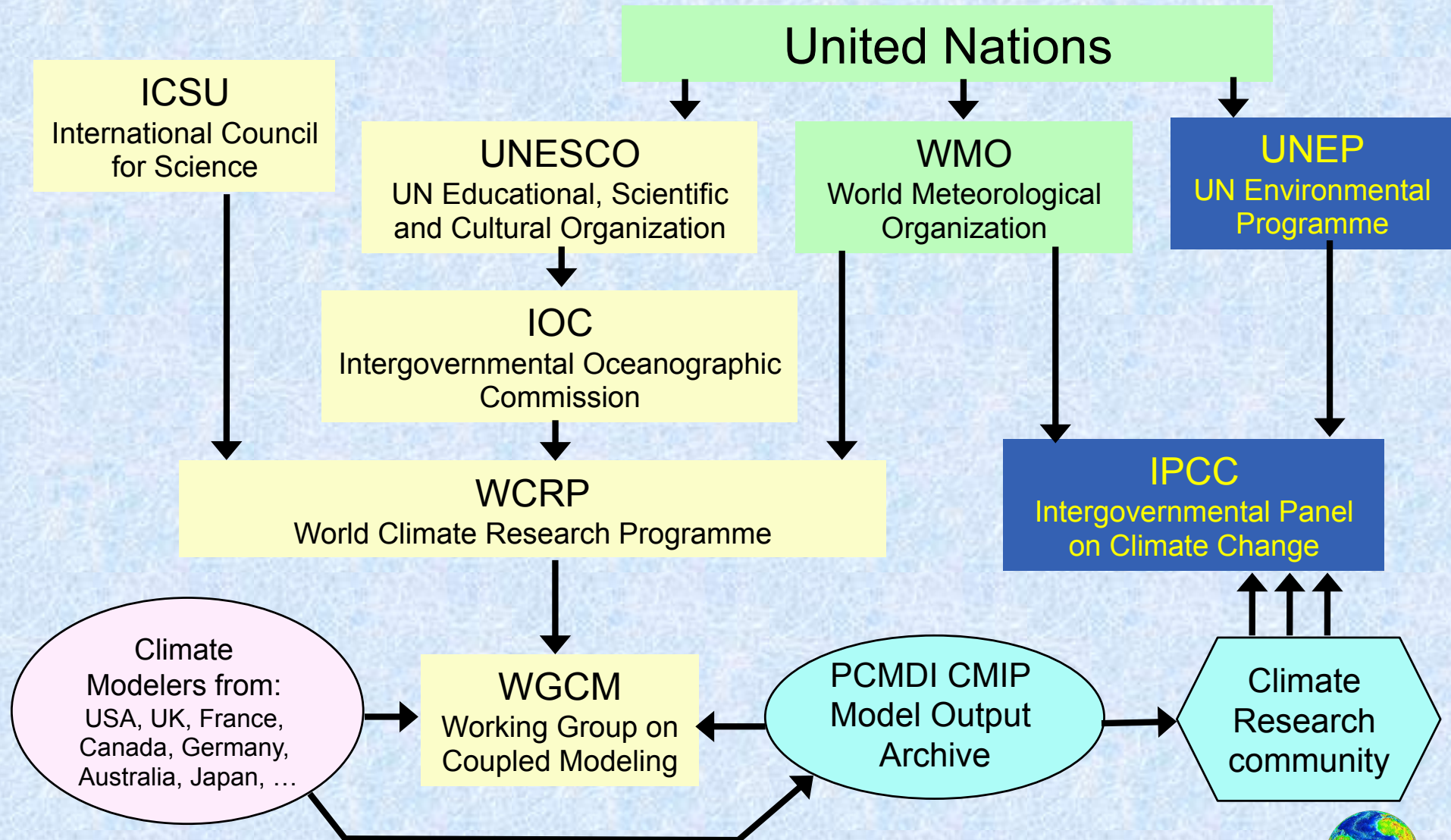
Primary Group	Country	Model
CAWCR	Australia	ACCESS
BCC	China	BCC-CSM1.1
GCESS	China	BNU-ESM
CCCMA	Canada	CanESM2, CanCM4, CanAM4
CCSM	USA	CESM1, CCSM4
RSMAS	USA	CCSM4(RSMAS)
CMCC	Italy	CMCC- CESM, CM, & CMS
CNRM/CERFACS	France	CNRM-CM5
CSIRO/QCCCE	Australia	CSIRO-Mk3.6
EC-EARTH	Europe	EC-EARTH
LASG, IAP	China	FGOALS- G2.0, S2.0 & gl
FIO	China	FIO-ESM
NASA/GMAO	USA	GEOS-5
GFDL	USA	GFDL- HIRAM-C360, HIRAM-C180, CM2.1, CM3, ESM2G, ESM2M
NASA/GISS	USA	GISS- E2-H, E2-H-CC, E2-R, E2-R-CC, E2CS-H, E2CS-R
MOHC	UK	Had CM3, CM3Q, GEM2-ES, GEM2-A, GEM2-CC
NMR/KMA	Korea / UK	HadGEM2-AO
INM	Russia	INM-CM4
IPSL	France	IPSL- CM5A-LR, CM5A-MR, CM5B
MIROC	Japan	MIROC 5, 4m, 4h, ESM, ESM-CHEM
MPI-M	Germany	MPI-ESM- HR, LR
MRI	Japan	MRI- AGCM3.2H, AGCM3.2S, CGCM3, ESM1
NCC	Norway	NorESM1-M, NorESM-ME, NorESM1-L



CMIP: Under the umbrella of an internationally-coordinated research program



IPCC assessments are separate from the international climate research programs



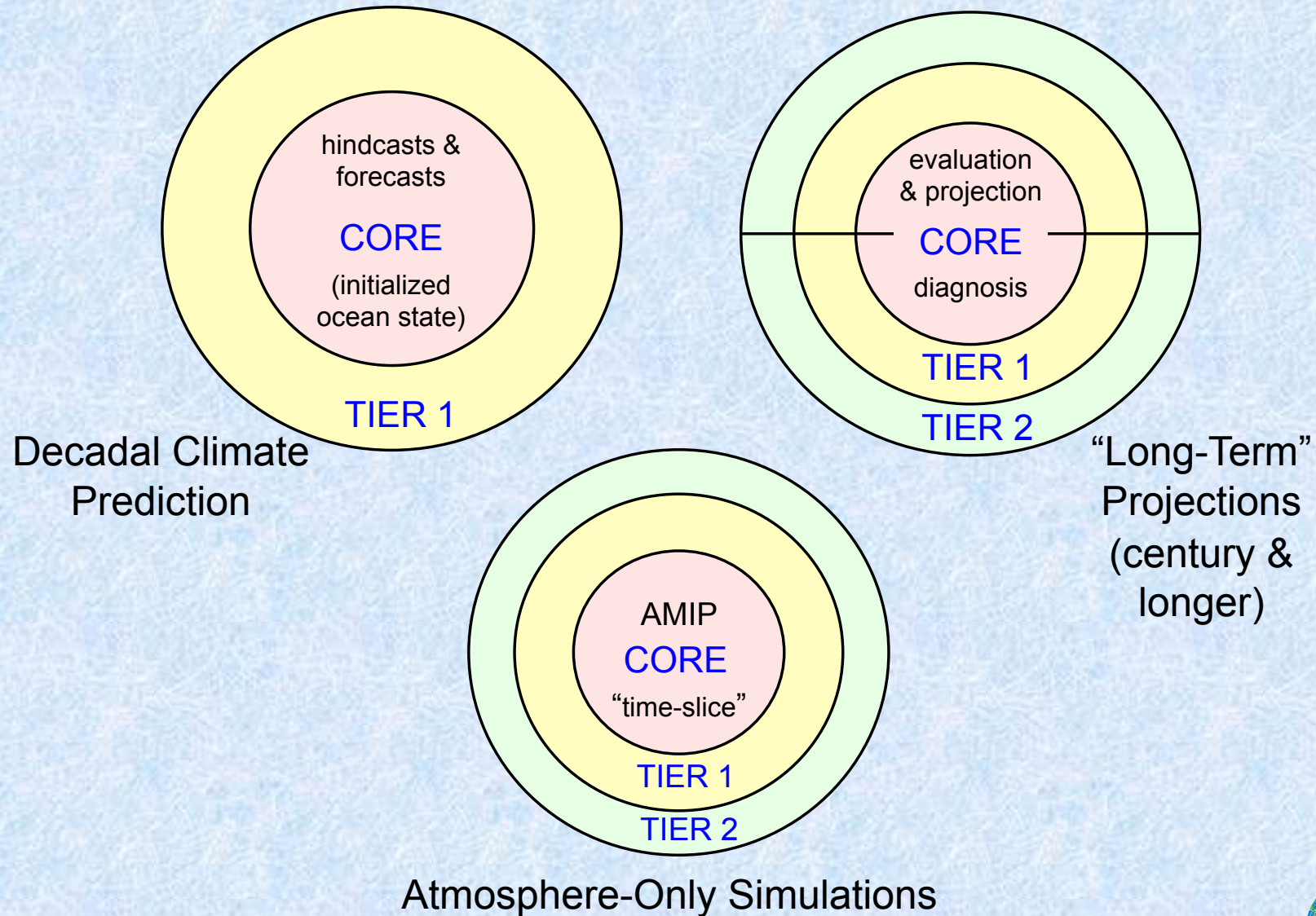
Differences between CMIP3 and CMIP5

- A wider variety of models - ESMs, EMICs, atmosphere-only
- A more ambitious suite of experiments designed to
 - Address a wider variety of questions (e.g., decadal predictability)
 - Meet the needs of a broader community of users
 - Encompass originally independent MIPs into a single MIP that through coordination provides synergistic opportunities for greater scientific understanding
- A more comprehensive set of model output
 - Enabling more complete diagnostic process studies (e.g., clouds)
 - Providing information requested by a wider variety of users (e.g., impact studies)
 - For use in dynamical and empirical downscaling
 - Data volume increase from ~35 TB to ~3000 TB

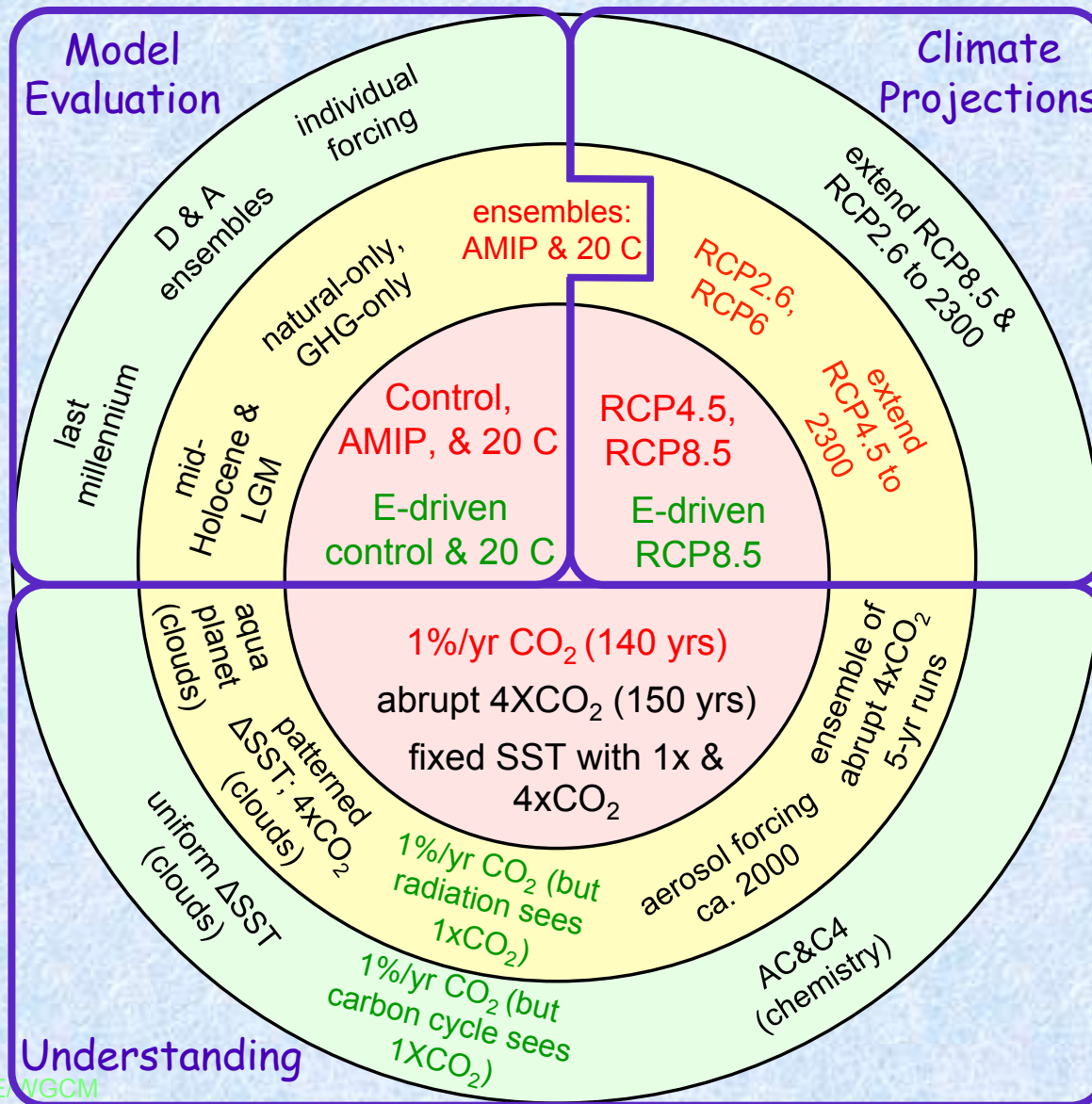
Differences between CMIP3 and CMIP5

- More complete documentation of models/experiments
 - ▶ But the "Metafor" questionnaire has only been completed by a couple of groups
- New strategies for making output accessible to users
- Increased standardization of model output

CMIP5 is organized around three types of simulations



A rich set of CMIP5 experiments, drawn from several predecessor MIPs, focuses on model evaluation, projections, and understanding



Red subset matches the entire CMIP3 experimental suite

Green subset is for coupled carbon-cycle climate models only

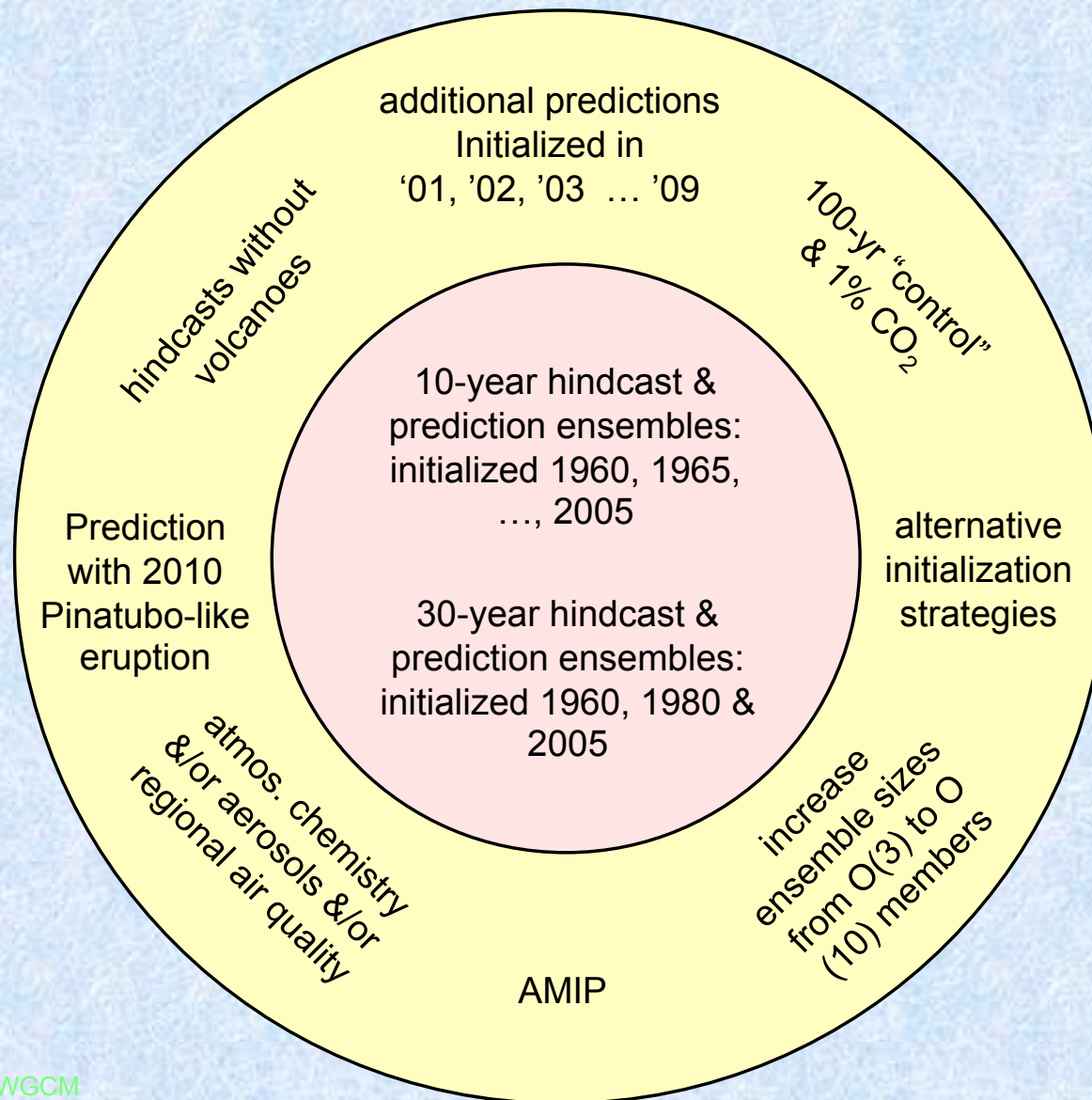
Adapted from Taylor et al., BAMS, 2011

"Long-term" experiments: contributions

** Core simulations* (# available as of 17 Oct 2011)

Experiment(s)	# of models	Experiment(s)	# of models
* Control & historical	35 (14)	Fast adjustment diagnostic	9 (?)
* AMIP	26 (9)	Aerosol forcing	9 (5)
* RCP4.5 & 8.5	29 (15)	*ESM control, historical & RCP8.5	18 (4)
RCP2.6	18 (12)	Carbon cycle feedback isolation	9 (3)
RCP6	13 (10)	Mid-Holocene & LGM	11 (4)
RCP's to year 2300	10 (?)	Millenium	7 (0)
* 1% CO2 increase	28 (11)	CFMIP runs	~8 (~4)
* Fixed SST CO2 forcing diagnosis	16 (8)	D & A runs	15 (8)
* Abrupt 4XCO2 diagnostic	22 (11)		

The new near-term experiments attempt true climate "predictions" by initializing models with observations.



Adapted from Taylor *et al.*, BAMS, 2011

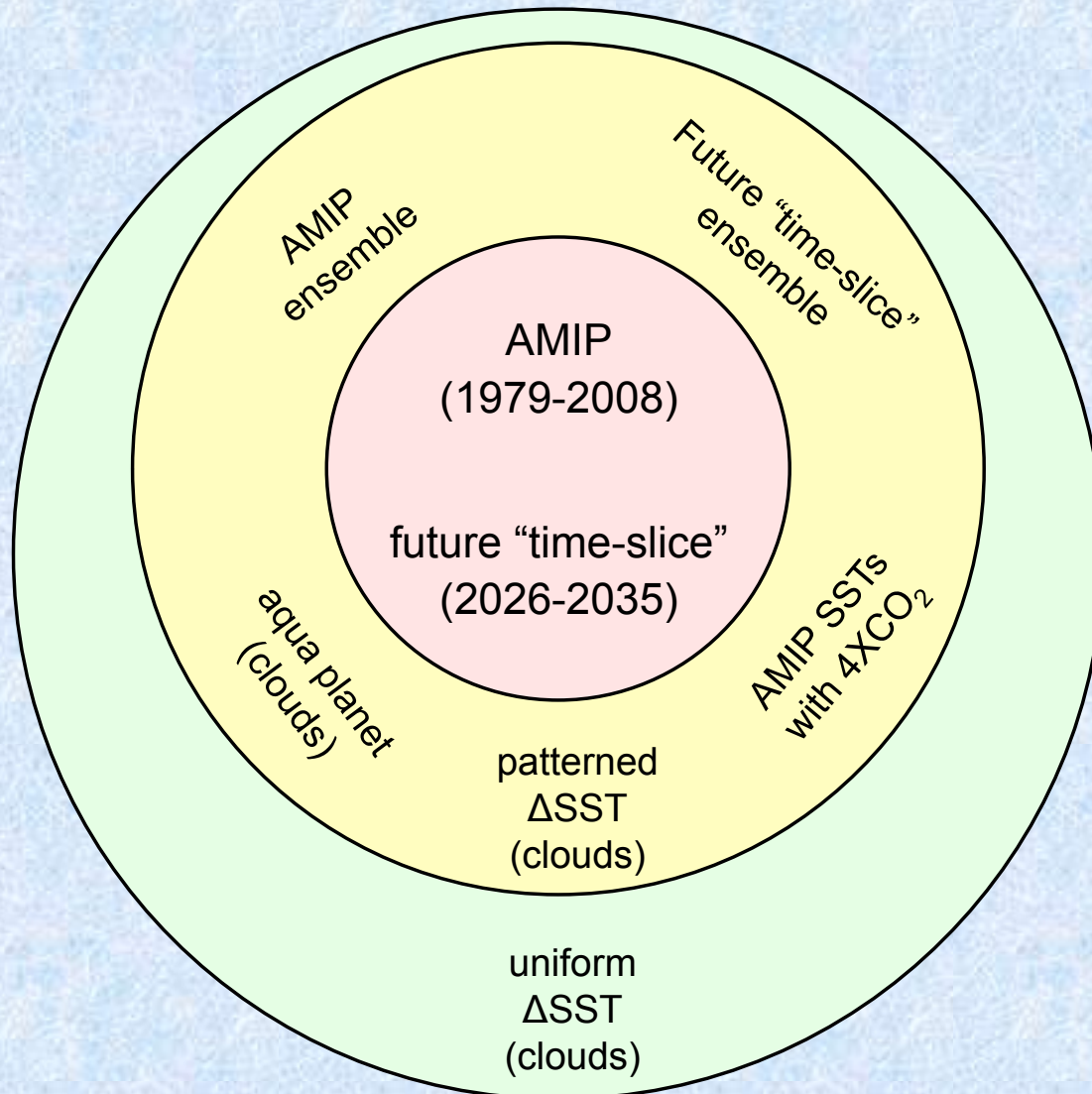


"Decadal" experiments: contributions

** Core simulations simulations (# available as of 17 Oct 2011)*

Experiment(s)	Number of models
*Hindcasts and predictions	18 (6)
AMIP	3 (3)
Volcano-free hindcasts	3 (0)
2010 "Pinatubo-like" eruption	1 (0)
Initialization alternatives	5 (?)
Pre-industrial control	10 (4)
1% CO2 increase	9 (3)

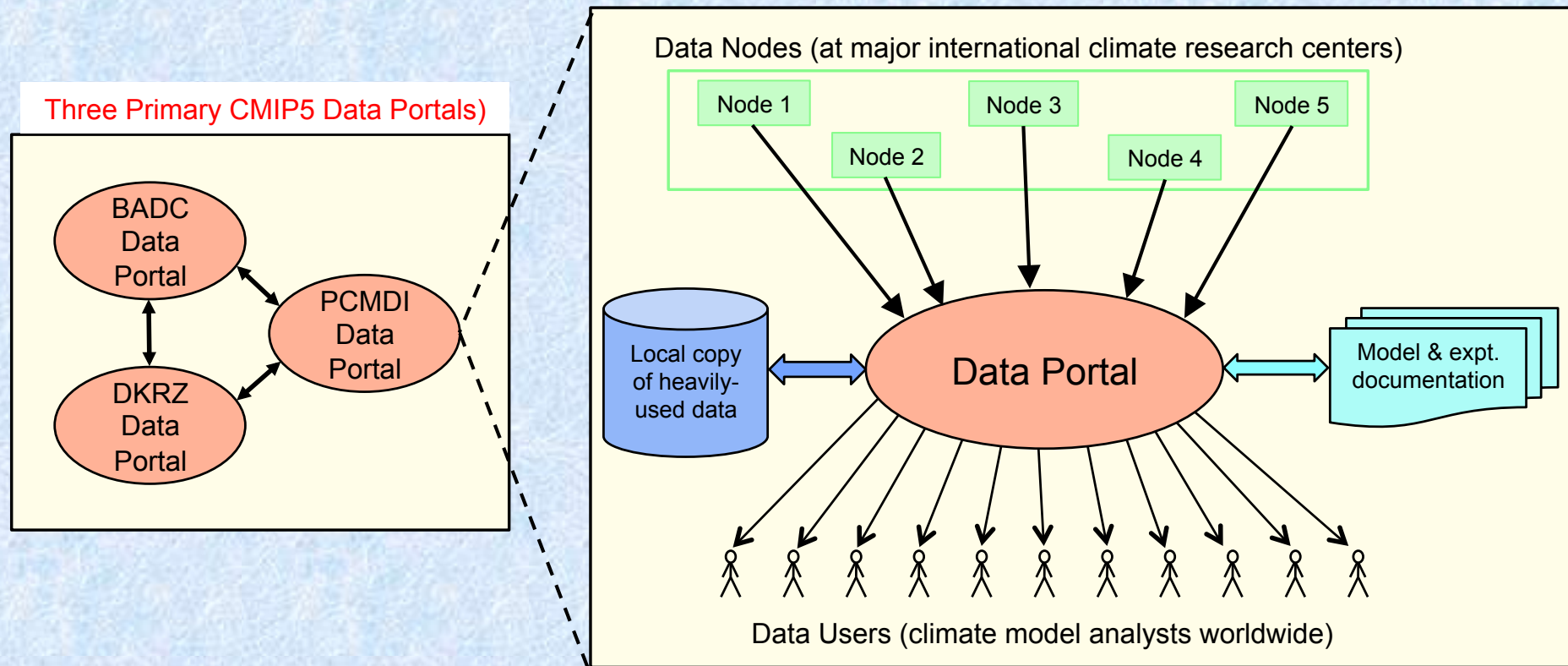
CMIP5 Atmosphere-Only Experiments (targeted for computationally demanding and NWP models)



~14 models plan to do core runs

(10 of these will also do long-term and/or decadal simulations)

PCMDI-led Earth System Grid Federation (ESGF) serves CMIP5 simulation output to analysts worldwide



What does ESGF do for CMIP5?

- For CMIP5, ESGF links together 13 data nodes
- Data holdings expanding from 100's to 1000's of Tbytes
- Serves 100's of users

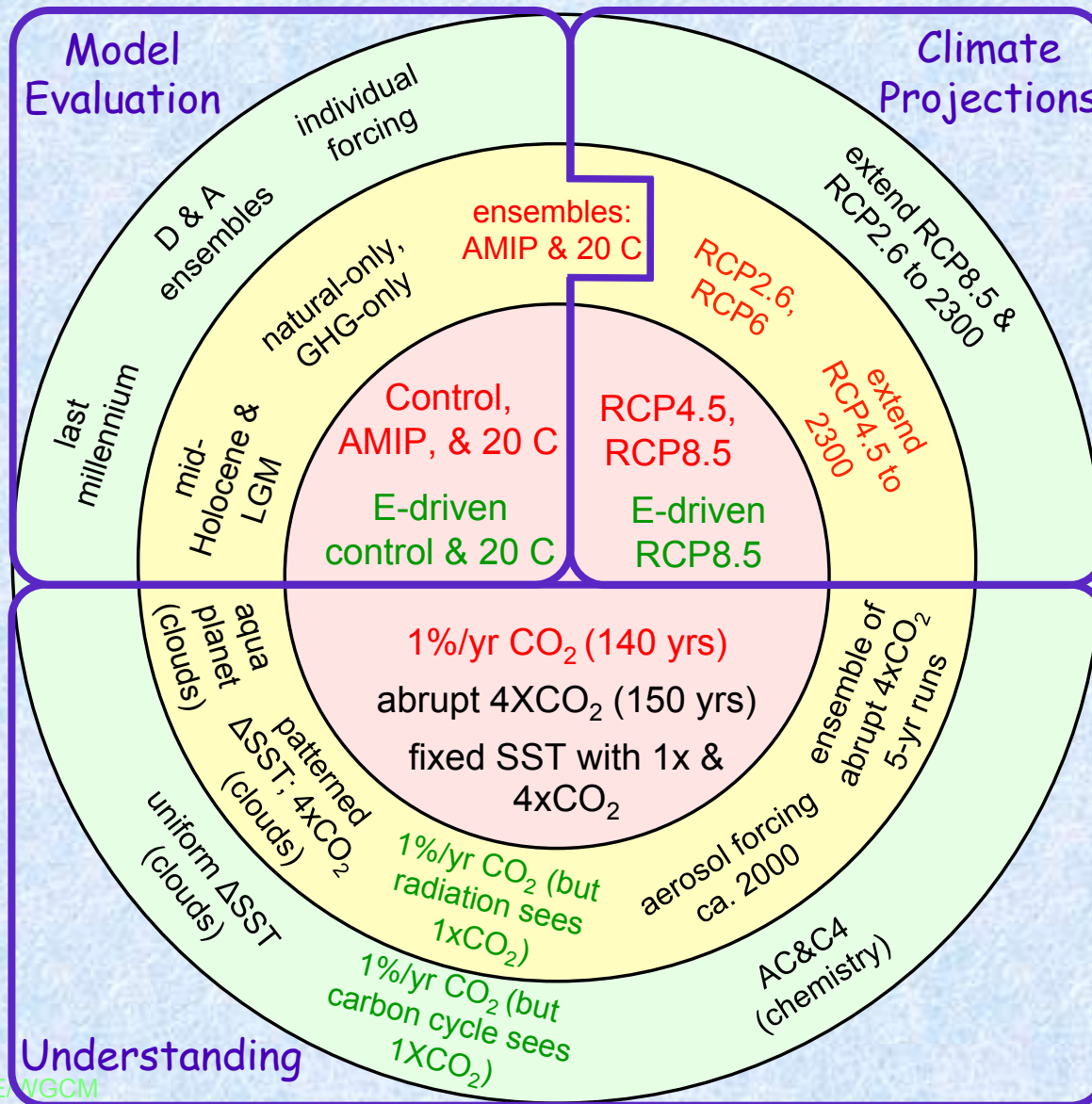
The system is much more complicated than for CMIP3 but has been essential to getting data to users

- Only a small fraction of the nearly 400 Tbytes of data would at this time be available to users under the old system.
- ESGF has received many complaints on difficulties encountered
 - ▶ See next slide
- But also some kudos, at least from a recent meeting of ESA (as reported by M. Juckes)
 - ▶ "the Rolls-Royce of archive systems"
 - ▶ It's "fantastic" that we have got globally distributed data accessible through a single catalog

The system is much more complicated than for CMIP3 and consequently users find it more difficult

- Not yet possible to write scripts to automatically search and download new data as it becomes available
 - ▶▶ But a new capability is currently being tested
- Web search tool is not as reliable as it should be and is slow
 - ▶▶ But a better tool has been developed and is close to being installed
 - ▶▶ Non web-based options have also been developed
- Some data nodes have bandwidth problems slowing downloads
 - ▶▶ But PCMDI is making copies of data (as will other major data centers)
- A number of other annoying issues are being addressed

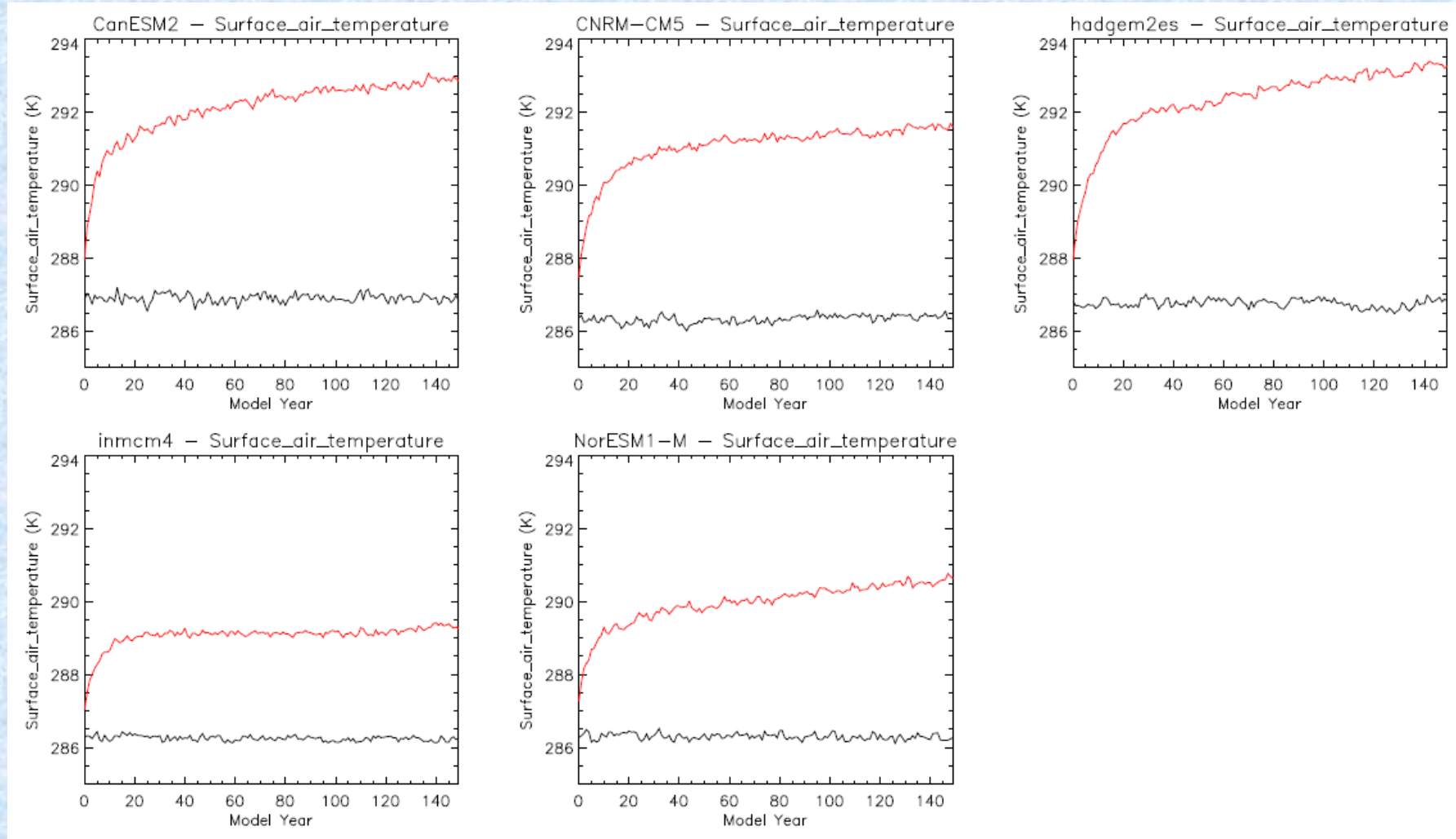
Despite difficulties in retrieving data, users are getting the data they need and CMIP5 research has commenced



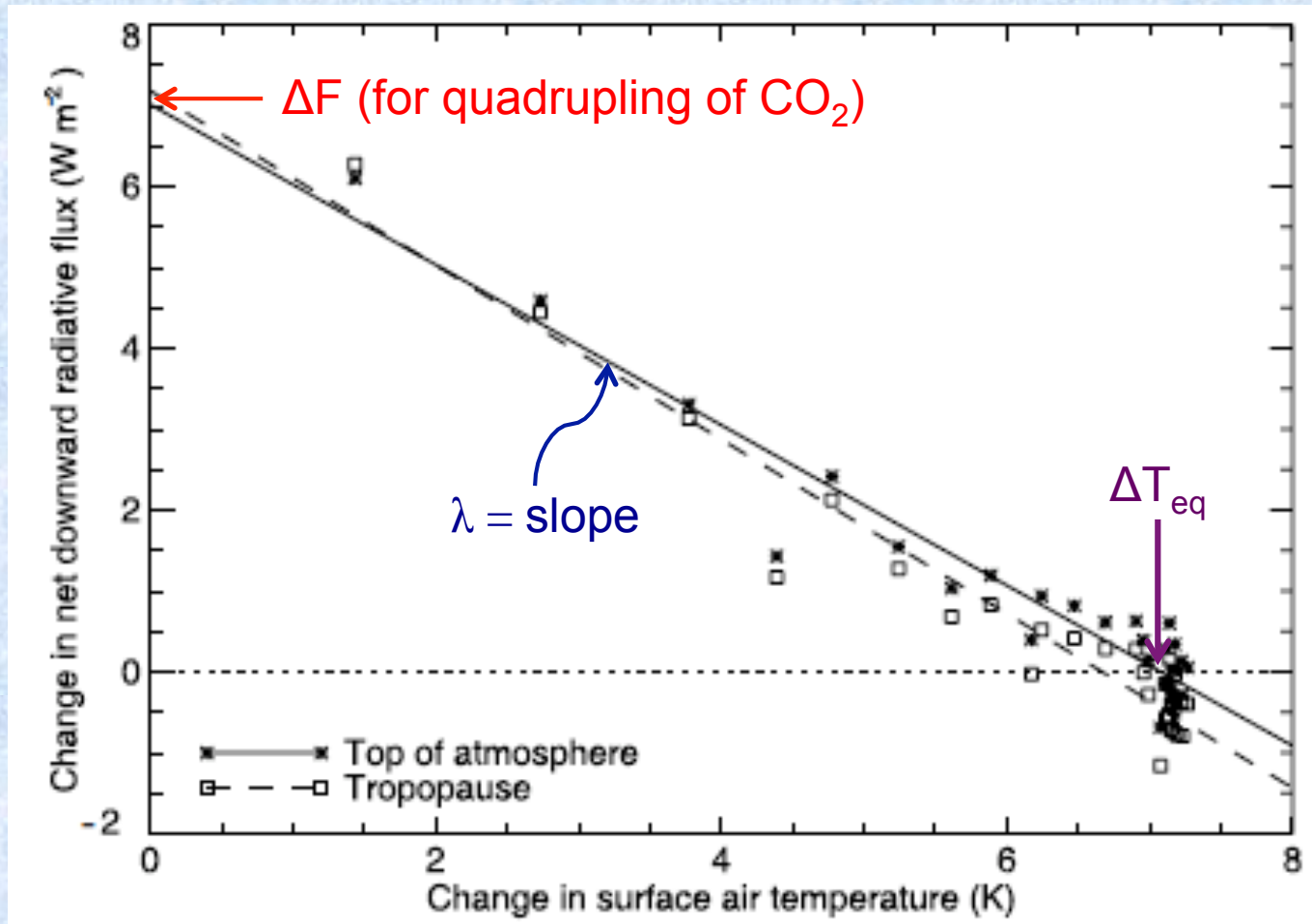
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Response in 5 CMIP5 models to abrupt quadrupling of CO₂

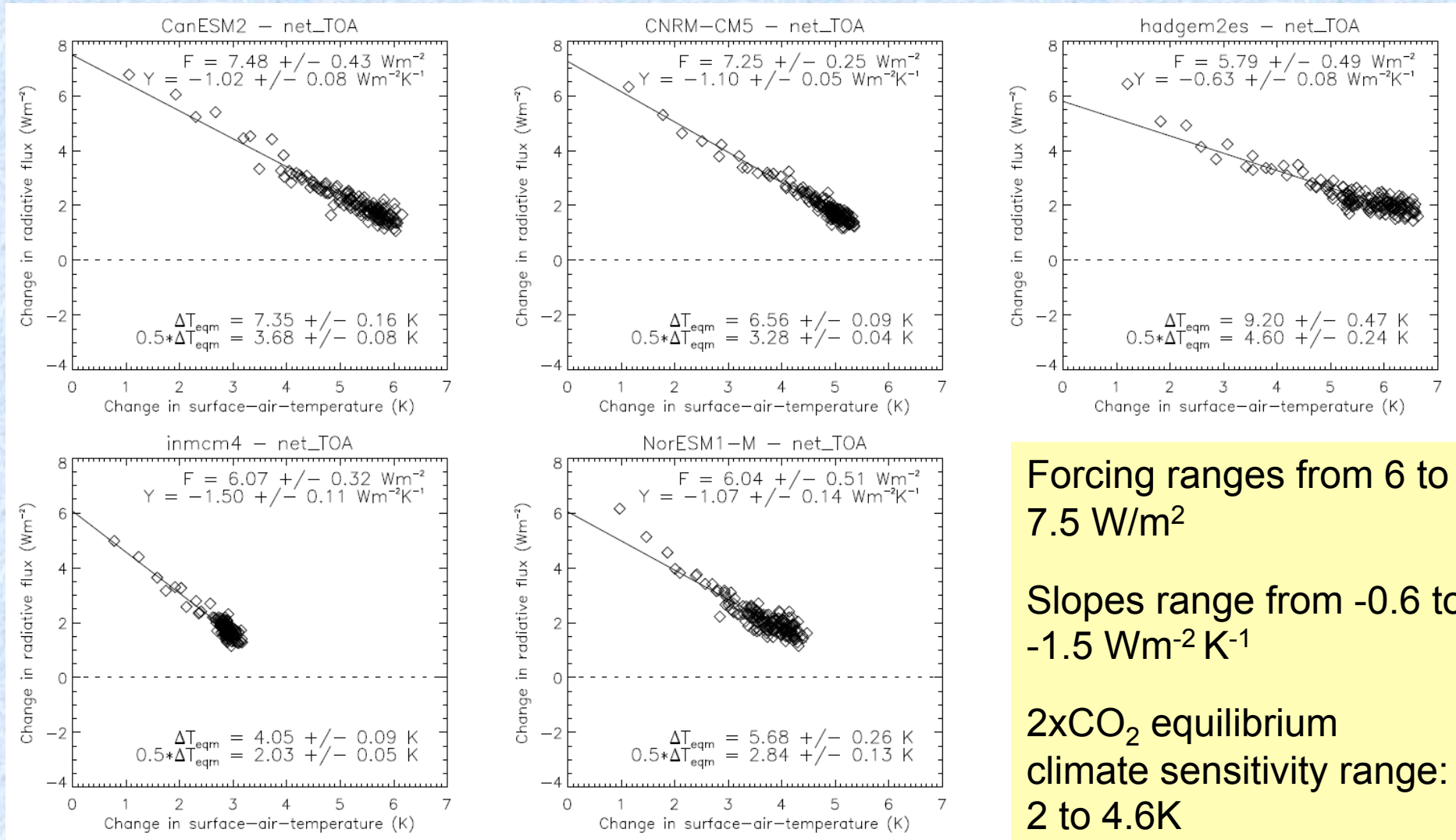


CMIP5 idealized experiments designed to quantify differences in model forcing and global climate sensitivity



Gregory *et al.*, 2004

CMIP5 model results from first 5 available models:



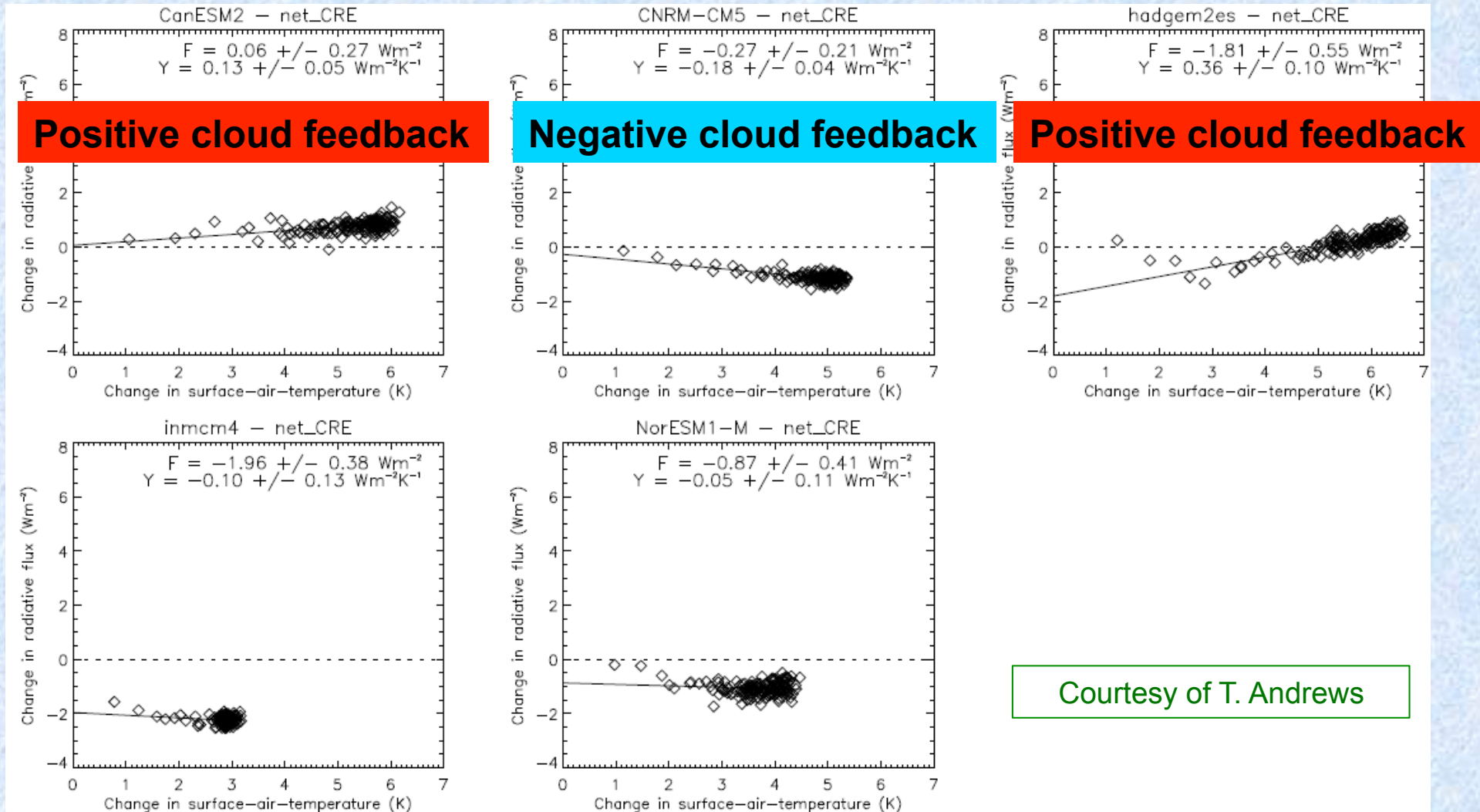
Forcing ranges from 6 to 7.5 W/m²

Slopes range from -0.6 to -1.5 Wm⁻² K⁻¹

2xCO₂ equilibrium climate sensitivity range: 2 to 4.6K



Sign of cloud feedback (actually cloud radiative effect) differs across 5 available models:



Courtesy of T. Andrews

An update with more recent models leads to this table:

AOGCM	Transient Climate Response (K)	Equilibrium Climate Sensitivity (K)
CanESM2	2.3	3.7
CNRM-CM5	2.1	3.3
CSIRO-Mk3-6-0	1.7	4.3
HadGEM2-ES	2.3	4.6
INM-CM4	1.3	2.0
IPSL-CM5A-LR	2.0	4.1
MIROC-ESM	2.3	n.a.
MIROC5	1.6	2.7
MRI-CGCM3	1.6	2.6
NorESM1-M	1.4	2.8

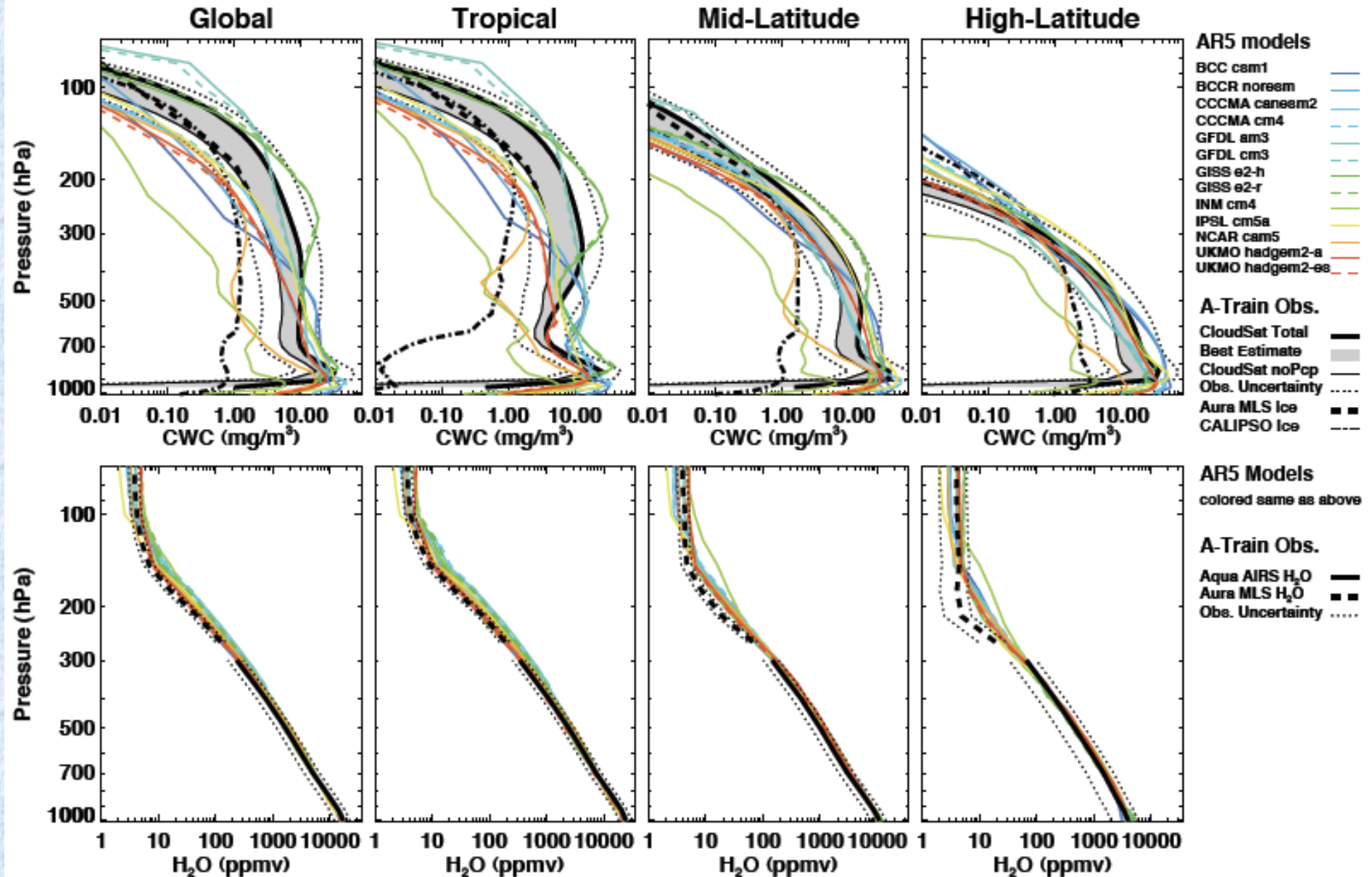
Courtesy of
T. Andrews

Coordinated with CMIP5 is a parallel effort to collect and make available observations

- Promoted by Duane Waliser and others at JPL with cooperation from PCMDI and encouragement by the WGCM
- Short name: Obs4MIPs
- Data written in same structure and format as CMIP5 model output
- Not only satellite data but also ARM data and reanalysis



"Obs4MIPs" is providing datasets useful in evaluating CMIP5 models (preliminary results courtesy of Jonathan Jiang)



CMIP5 timeline

- Late 2013: IPCC AR5 published
- Journal articles accepted - 15 March 2013
- Journal articles submitted - 31 July 2012
- April 2012: Data not already in the CMIP5 archive will probably not be included in publications cited by the AR5
- March 2011: First model output became available to users

Concluding remarks

- CMIP5 is the most complex and comprehensive model intercomparison activity ever attempted
- Many models (approaching half) have made available their model output from at least some of their experiments
- More than 10 times the output of CMIP3 is now available
- The Earth System Grid, used to serve the data from nodes around the world, is working, but needs improvement
- Observational datasets are being developed that will be useful and easy to use in evaluating CMIP5 models
- CMIP5 research results are beginning to appear



CMIP website:
<http://cmip-pcmdi.llnl.gov>
(or search on “CMIP5”)

