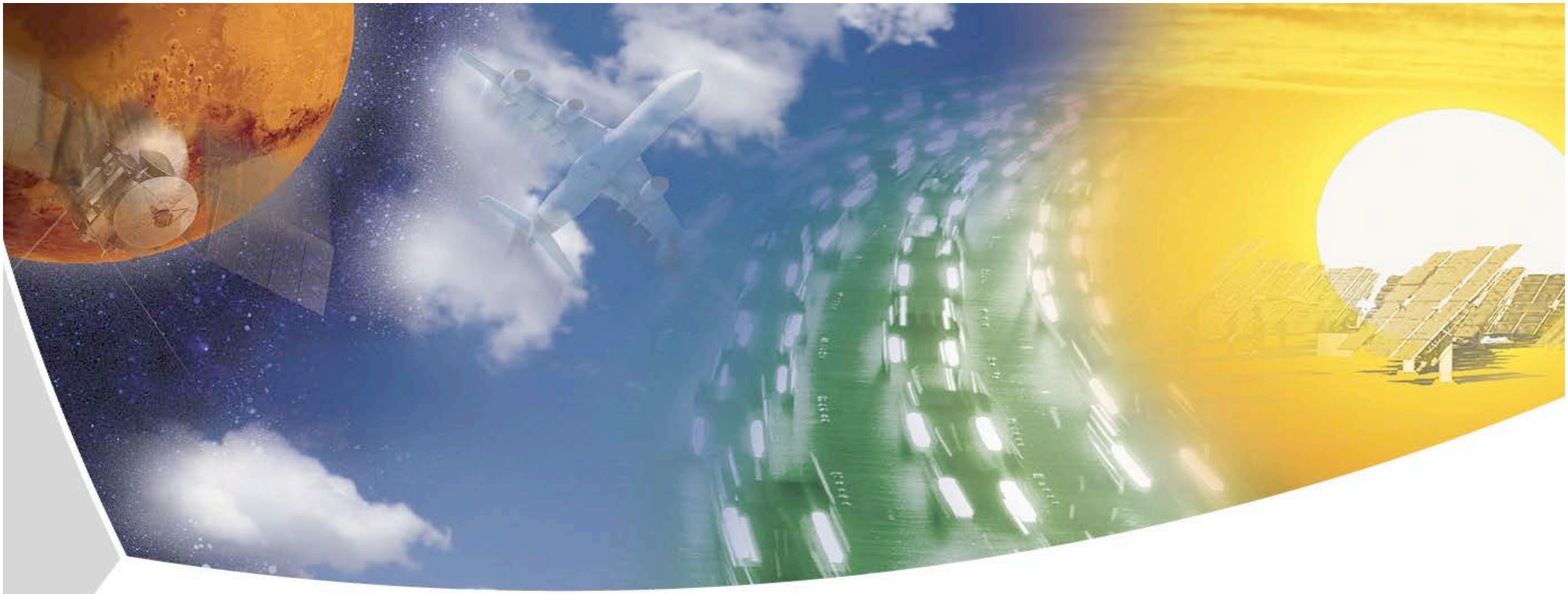


Chemistry-Climate Modeling Activities within WCRP SPARC / IGBP IGAC

Veronika Eyring
DLR, Institut für Physik der Atmosphäre, Germany

16th Session of the Working Group on Coupled Modelling (WGCM)
24 September 2012, Hamburg, Germany

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

Overview

- CMIP5 & Atmospheric Chemistry & Climate MIP (ACCMIP) results
- Workshop IGAC/SPARC Workshop on Global Chemistry-Climate Modeling and Evaluation, Davos, May 2012
- Chemistry-Climate Model Initiative (CCMI): New IGAC / SPARC initiative

Ozone chemistry in CMIP5 simulations

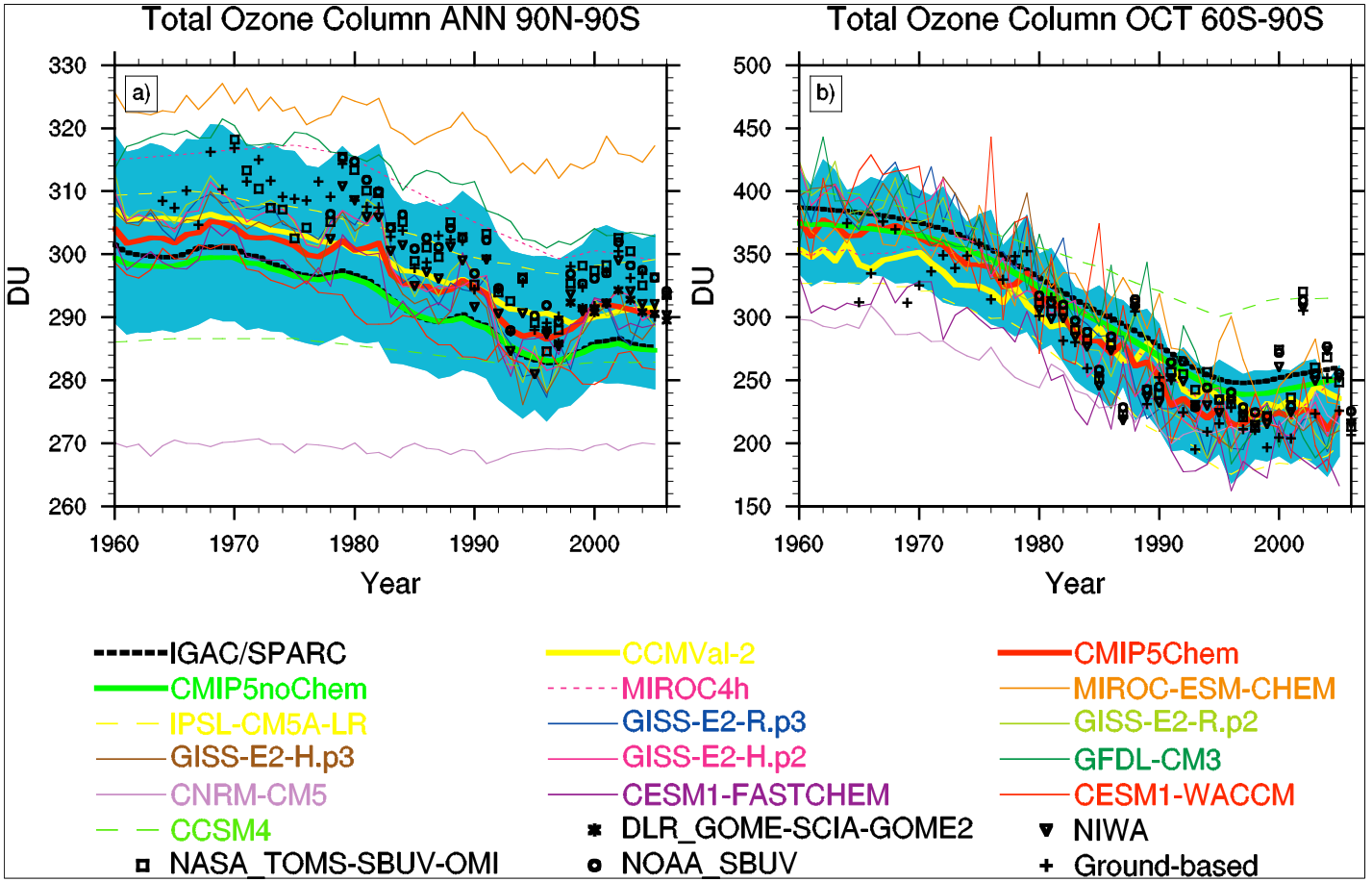
Model	O3 chemistry		Prescribed ozone dataset
	Trop.	Strat.	
ACCESS1 -0	P	P	C[1]
ACCESS1 -3	P	P	C[1]
BCC-CSM1.1	P	P	C[1]
BCC-CSM1.1 -M	P	P	C[1]
BNU-ESM	SO	SO	P[2]
CanAM4	P	P	C_{modB}[4]
CanCM4	P	P	C_{modB}[4]
CanESM2	P	P	C_{modB}[4]
CCSM4	SO	SO	P[2]
CESM1(BGC)	SO	SO	P[2]
CESM1(CAM5)	SO	SO	P[2]
CESM1(FASTCHEM)	I	I	---
CESM1 (WACCM)	I	I	---
CMCC -CM	P	P	C_{modA}[3]
CNRM -CM5	I	I	---
CSIRO -Mk3-6-0	P	P	C[1]
EC-EARTH	P	P	C[1]
FGOALS -g2	P	P	C[1]
FGOALS -s2	P	P	C[1]
FIO -ESM	P	P	C[1]
GFDL-CM3	I	I	---
GFDL-ESM2G	P	P	C[1]
GFDL-ESM2M	P	P	C[1]

Model	O3 chemistry		Prescribed ozone dataset
	Trop.	Strat.	
GISS -E2-H p1	P	P	P[5]
GISS -E2-H p2	I	I	---
GISS -E2-H p3	I	I	---
GISS -E2-R p1	P	P	P[5]
GISS -E2-R p2	I	I	---
GISS -E2-R p3	I	I	---
HadCM3	P	P	C_{modA}[2]
HadGEM2 -CC	P	P	C_{modA}[2]
HadGEM2 -ES	I	P	--- / C_{modA}[2]
HadGEM2 -AO	P	P	C_{modA}[2]
INM -CM4	P	P	C[1]
IPSL -CM5A -LR	SO	SO	P[6]
IPSL -CM5A -MR	SO	SO	P[6]
IPSL -CM5B -LR	SO	SO	P[6]
MIROC -ESM	P	P	P[7]
MIROC -ESM -CHEM	I	I	---
MIROC4h	P	P	P[7]
MIROC5	P	P	P[7]
MPI-ESM-LR	P	P	C_{modA}[2]
MPI-ESM-P	P	P	C_{modA}[2]
MRI-CGCM3	P	P	C[1]
NorESM1 -M	SO	SO	P[2]
NorESM1 -ME	SO	SO	P[2]

CHEM: 18 of 46 CMIP5 models with interactive (I) or semi-offline (SO) chemistry

NOCHEM: 28 of 46 CMIP5 models with prescribed ozone (P), mostly based on the original or a modified version of the Cionni et al. (2011) dataset (C).

Ozone chemistry in CMIP5 simulations



- In contrast to CMIP3, where half of the models prescribed a stratospheric ozone climatology instead of a timeseries, the CMIP5 models all consider past ozone depletion and future ozone recovery, either prescribed or interactive.
- This results in substantial improvements of stratospheric ozone compared to CMIP3, leading to a more realistic representation of the effects of anthropogenic forcings on stratospheric temperatures and subsequent impacts on tropospheric climate.

Eyring et al., JGR, subm., 2012

Atmospheric Chemistry-Climate Model Intercomparison Project (ACCMIP)

Coordinated by Jean-Francois Lamarque and Drew Shindell

Goal of Phase 1 (within AR5 deadline)

- Document & analyze the radiative forcing in CMIP5 simulations
- Evaluate underlying chemistry used for providing concentrations & depositions in CMIP5
- Participating models (output available now, * is CMIP5 model)

1. CCCma (Canada)
2. CICERO (Norway)
3. EMAC-DLR (Germany)
4. GFDL (USA)*
5. GISS (USA)*
6. LSCE (France)*
7. LLNL-NCAR (USA)
8. MeteoFrance (France)
9. NCAR CAM3.5 (USA)*
10. NCAR CAM5.1 (USA)
11. NIES (Japan)*
12. NIWA (New Zealand)
13. UKMO (UK)*
14. UEDI (UK)

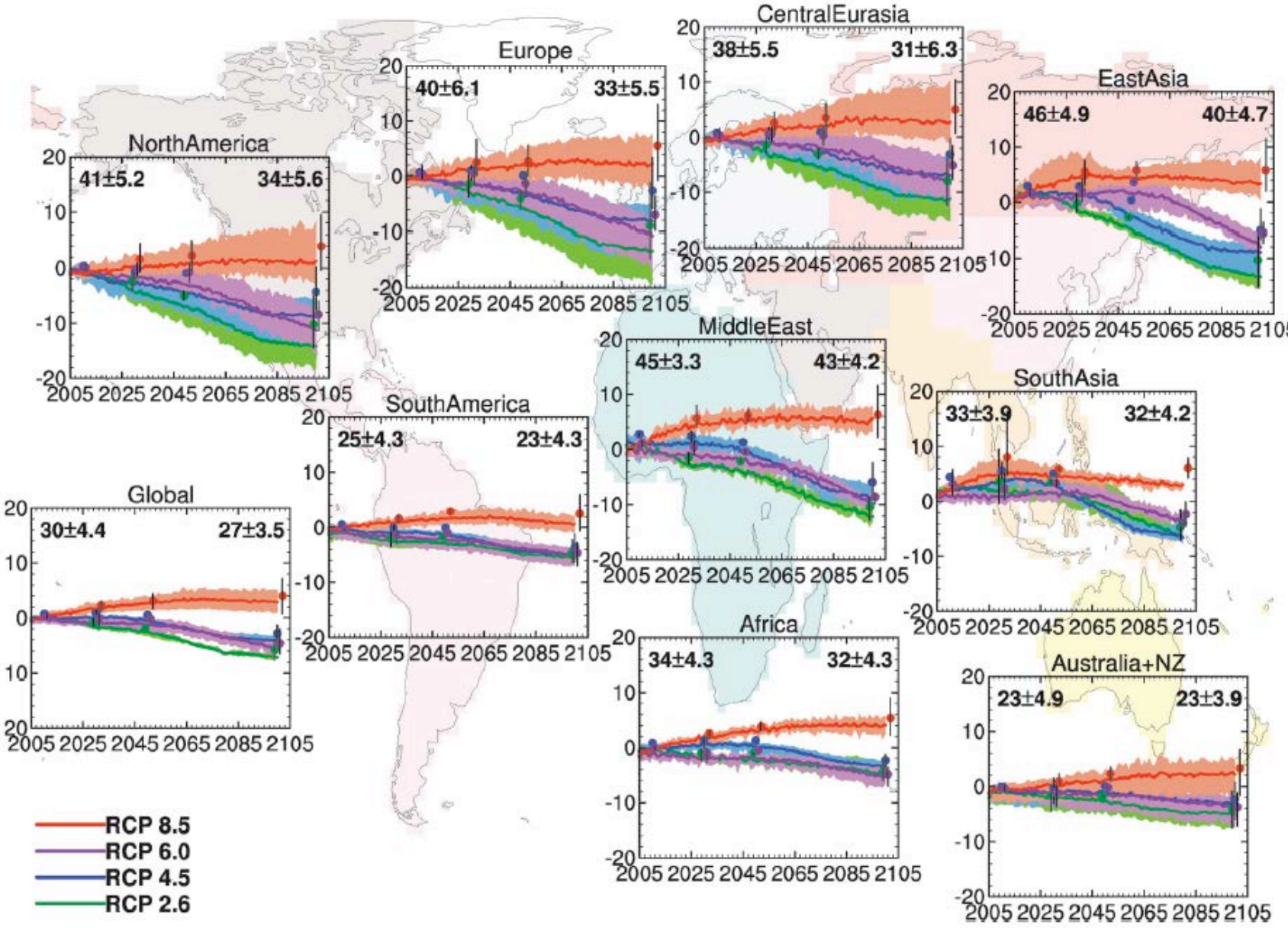
Goal of Phase 2: sensitivity experiments (after AR5 deadline)

Papers submitted (others are in preparation):

- **ACCMIP overview and models**: Lamarque et al., GMDD, 2012.
- **Global air quality and climate,** Fiore et al., Chem Soc Rev, 2012.
- **Ozone budget, time evolution**, Young et al., ACPD, 2012.
- **Observational constraints on ozone RF,** Bowman et al., ACPD, 2012.
- **Ozone RF,** Stevenson et al., ACPD, 2012.
- **Long-term changes in BC (based on ice cores)**, Lee et al., 2012.
- **Aerosol forcing**, Shindell et al., ACPD, 2012.
- **Future oxidation & methane**, Voulgarakis et al., ACPD, 2012

Atmospheric Chemistry-Climate Model Intercomparison Project (ACCMIP)

Changes in annual-mean surface ozone



Fiore et al., Chem Soc Rev, *2012*

Workshop IGAC/SPARC Workshop on Global Chemistry-Climate Modeling and Evaluation, Davos, May 2012

Rationale for the workshop

Background:

(i) Increasingly, the chemistry and dynamics of the stratosphere and troposphere are being modeled as a single entity in global models (and increasingly a coupled ocean).

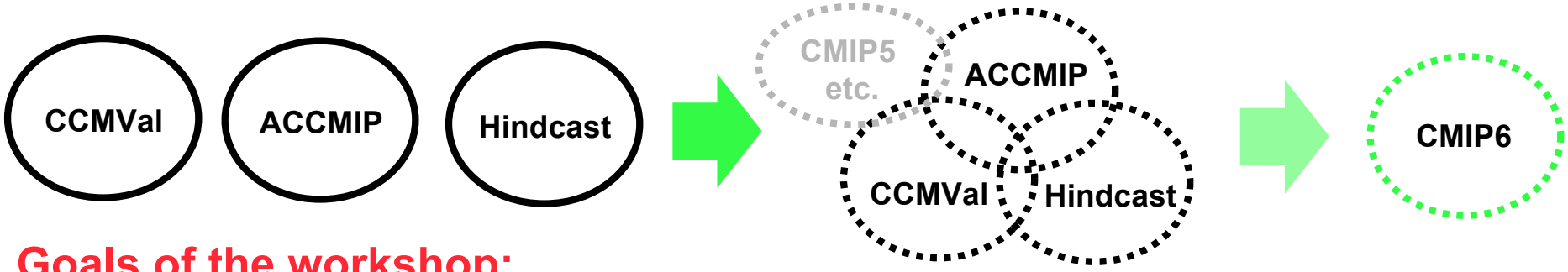
(ii) Tropospheric and stratospheric global chemistry-climate models are continuously being challenged by new observations and model intercomparisons.

(iii) There is a need to better coordinate the previously separate activities addressing these two domains and to assess scientific questions in the context of comprehensive stratosphere-troposphere resolving models with chemistry.

Recommendation from SPARC CCMVal Report:

(i) Development should continue towards comprehensive troposphere-stratosphere CCMs, which include an interactive ocean, tropospheric chemistry, a naturally occurring QBO, spectrally resolved solar irradiance, and a fully resolved stratosphere.

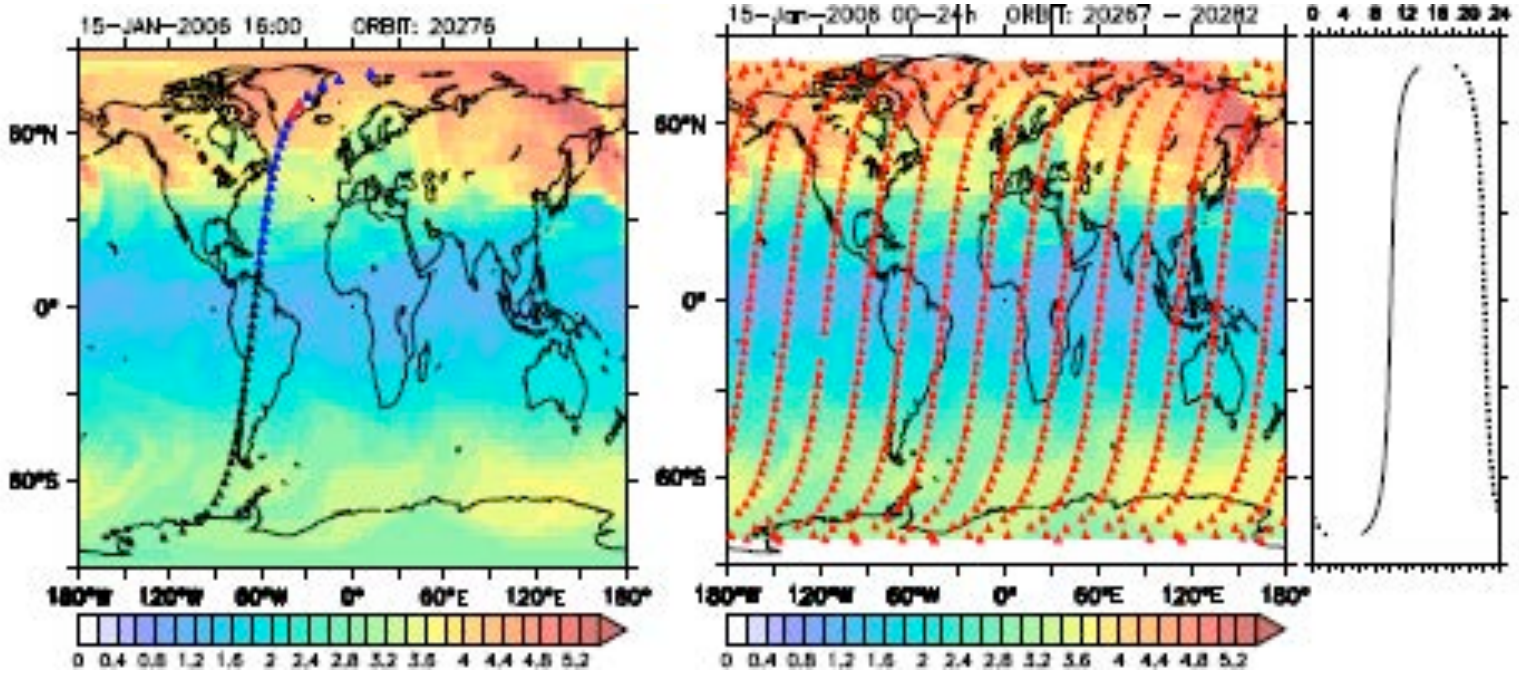
Goals of the Workshop



Goals of the workshop:

1. Improvements in process-oriented evaluation and understanding of CCMs (including extending the CCMVal approach to the troposphere).
2. Identifying observations for model evaluation and new methods for improved comparability between models and observations.
3. Defining community-wide simulations in support of upcoming ozone and climate assessments and for process studies

Example GOAL 2: Improved comparability between models & observations

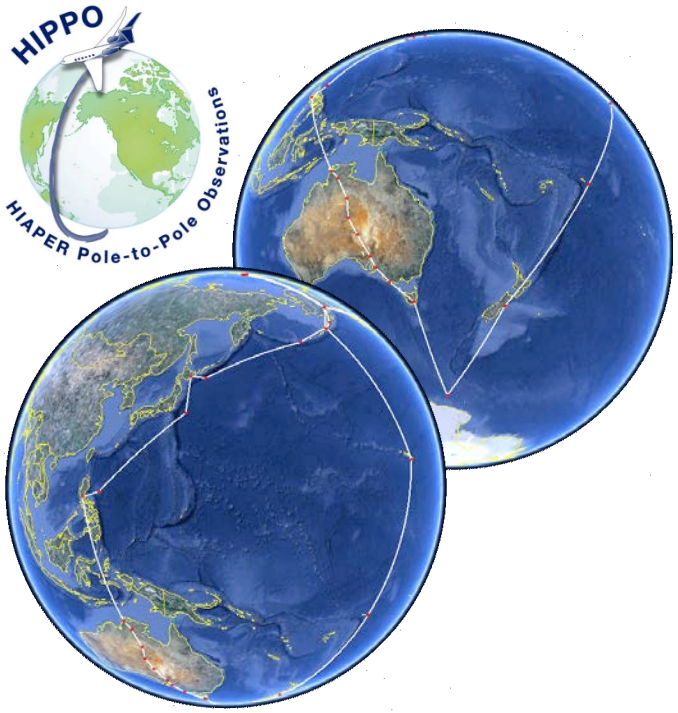


Jöckel et al., GMD, 2010

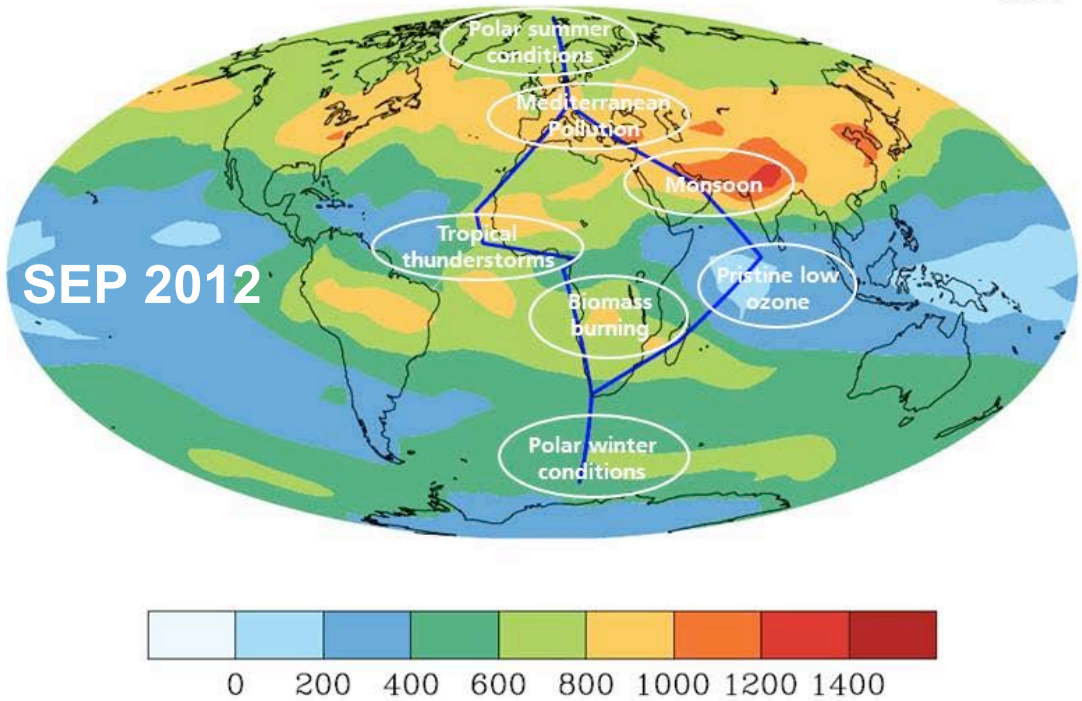
Consider issues like

- Sampling of the model output at the times and locations of the measurements (e.g. satellite simulators)
- Combination of different insitu campaigns into one database with a horizontal grid comparable to that used in CCMs (Emmons et al., 2000).
- Collecting observations in a format similar to the models (e.g., obs4MIP)
  - FORMED AN EXPERT GROUP THAT WILL MOVE THIS FOREWARD (led by Tom Ryerson, NOAA)
  - Released a first version of the CCMVal Diagnostic Tool (Gettelman et al., GMD, 2012)

High-altitude and long-range research aircrafts



HIAPER (High-performance Instrumented Airborne Platform for Environmental Research) Pole-to-Pole Observations (HIPPO) of Carbon Cycle and GHG Study



ESMVal (Earth System Model Validation) High Altitude and LOng Range **(HALO) Mission**
- DLR Project -

IGAC/SPARC Chemistry-Climate Model Initiative (CCMI)

- Clear recommendation from the CCM community to create a joint **IGAC/SPARC Chemistry-Climate Model Initiative (CCMI)** to coordinate future (and to some extent existing) IGAC and SPARC chemistry-climate model evaluation and associated modeling activities.
- CCMI will encompass (or supersede) CCMVal and other MIPs

Moving forward:

- Document summarizing the new community-wide CCMI simulations finalized by Nov 2012.
- White paper summarizing the goals of CCMI, including a more detailed summary of the workshop, will be published in the IGAC and SPARC newsletters in early 2013.
- CCMI website will be created
- BAMS paper on model evaluation planned (similar to CCMVal BAMS paper).
- **Next CCMI workshop: Boulder 13-17 May 2013**

Proposed CCMI Timeline: PHASE 1 and 2