

# Update on CCMVal Work

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# What is CCMVal?

- Chemistry-Climate Model Validation exercise.
- Organized under the auspices of the Stratospheric Processes And their Role in Climate (SPARC), a project of WCRP.
- CCMVal activities have contributed directly to the evaluation of chemistry-climate models (CCMs) for the 2007 UNEP/WMO Scientific Assessment of Ozone Depletion.
  - Eyring, V., *et al.*, Assessment of coupled chemistry-climate models: Evaluation of dynamics, transport, and ozone, *J. Geophys. Res.*, 112, D16303, doi:10.1029/2006JD008332, 2007.
  - Eyring, V., *et al.*, Multi-model projections of ozone recovery in the 21<sup>st</sup> century, *J. Geophys. Res.*, 112, D16303, doi:10.1029/2006JD008332, 2007.
  - Garcia, R.R., *et al.*, Simulations of secular trends in the middle atmosphere, 1950-2003, *J. Geophys. Res.*, 112, D09301, doi:10.1029/2006JD007485, 2007.

# SPARC's 2009 CCMVal Report

- 3<sup>rd</sup> CCMVal Workshop (Leeds, UK, June 2007): 80 members of the atmospheric and climate communities attended from Europe, North America, Japan, and New Zealand.
- The attendees included representatives from nearly all the major stratospheric CCM groups (~20 groups)
- **Agenda:** <http://www.see.leeds.ac.uk/ccmval2007>
- **GOALS:**
  - To discuss recent advances in model development and the methodology to diagnose them.
  - To prepare for the 2009 SPARC Report on the Evaluation of Chemistry Climate Models.
- **Webpage:** <http://www.pa.op.dlr.de/CCMVal/>



# 2009 SPARC Report

- The aim is to provide a comprehensive evaluation of the ability of CCMs to represent:
  - stratosphere ozone layer;
  - stratospheric climate;
  - climate variability, and;
  - the coupled ozone climate response to natural and anthropogenic forcing.
- The report will be based on the diagnostic metrics developed within SPARC CCMVal and will be completed in time to provide support to the 2010 WMO/UNEP Ozone Assessment.

# 2009 SPARC Report Continued...

The report will be divided up into two parts.

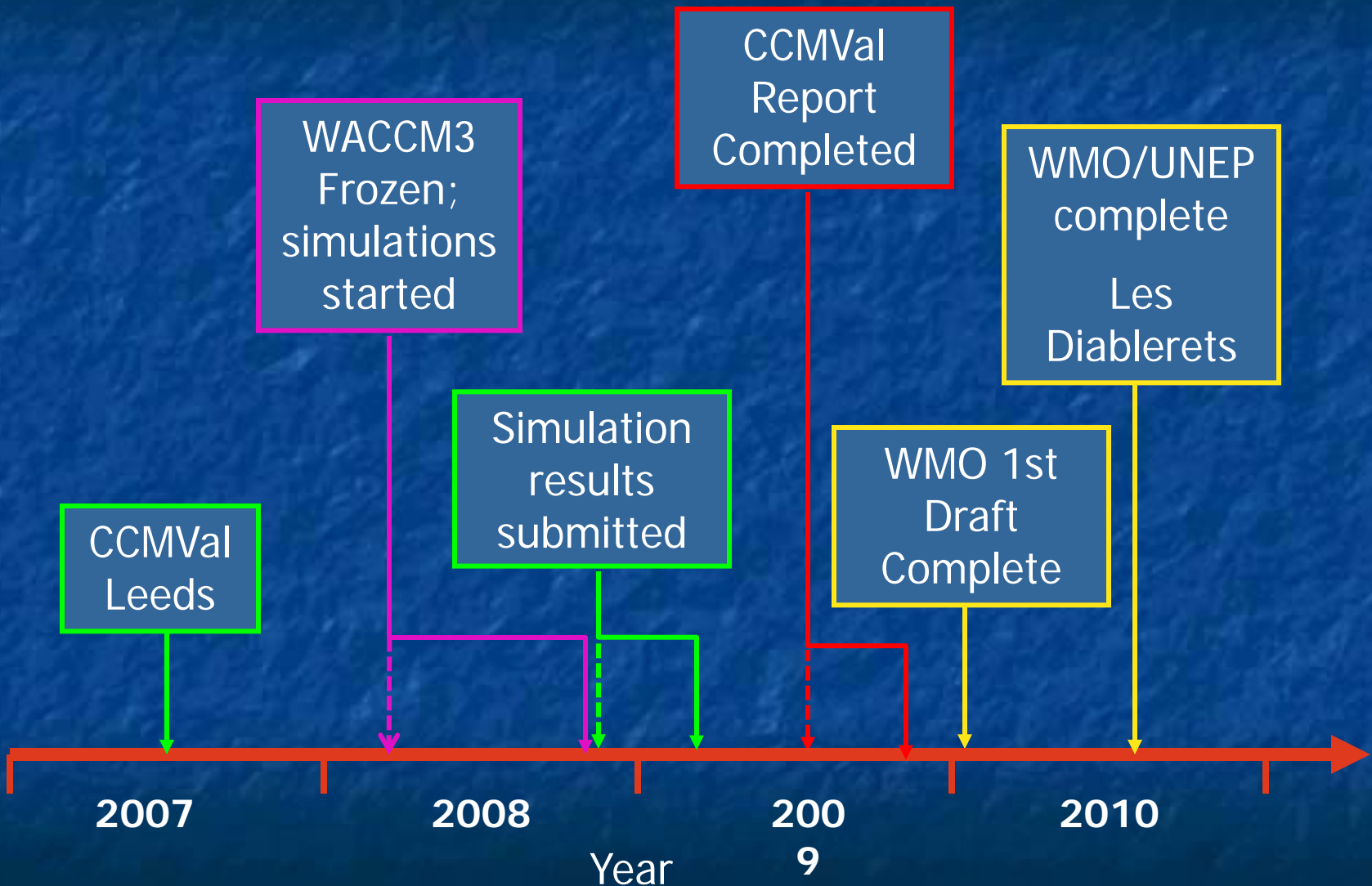
- Part A will evaluate how well the CCMs perform as measured by the CCMVal diagnostics set, under present-day conditions, for:
  - Radiation
  - Dynamics
  - Transport
  - Stratospheric Chemistry and Microphysics
  - Upper Troposphere and Lower Stratosphere
- Part A will also examine long-termed changes of the key processes in the past and future, e.g., changes in the Brewer-Dobson circulation, PSC frequency, SSWs, etc...)

# SPARC Report Continued...

- Part B will examine the coupled ozone climate response to natural and anthropogenic forcings.
  - The chapter on **natural variability** will evaluate how well CCMs represent the effects of various sources of natural variability (e.g., QBO, volcanic, solar, ENSO) on stratospheric dynamics, radiation, chemistry and transport.
  - The chapter on **long-term projections of stratospheric ozone** will focus on simulated long-term changes in ozone (related back to PART-A).
  - There is also a chapter on the **effect of the stratosphere on the troposphere**.



# Timeline



# Reference Simulations

## REF0:

- **TYPE:** Time-slice simulation for conditions typical of **year 2000**.
- **PURPOSE:** To facilitate the comparison of model output against constituent observations from various high-quality datasets, for a period of high chlorine loading and peak ozone loss. (Essentially a present-day baseline simulation.)

## REF1:

- **TYPE:** Transient simulation **1960-present**.
- **PURPOSE:** To reproduce the well-observed period of the past 35 years during which ozone depletion is well recorded. All forcings taken from observations.

## REF2:

- **TYPE:** Transient simulation **1960-2100**.
- **PURPOSE:** An internally consistent simulation from past to future. The objective is to produce best estimates of the future ozone-climate change. REF2 only includes anthropogenic forcing. External natural variability (e.g., SSTs and volcanic eruptions) is not considered.



# Reference Simulations: Specifications

SCN	Period	GHGs	Ozone Depletion Subs.	SSTs/SICs	Sulfate SAD	Solar Variability	QBO	Ozone and Aerosol Precursors
REF0	Time-slice; year 2000.	Fixed at 2000	Fixed at 2000	OBS 1995-2004 HadISST1	OBS Year 2000.	OBS Avg over 1-solar cycle	Only internally generated	OBS RETRO 1998-2000 mean
REF1	Transient 1960-2006	OBS	OBS	OBS HadISST1	OBS (SPARC Report)	OBS Spectral resolved Irradiance data (Lean)	OBS or internally generate	OBS Extended RETRO dataset
REF2	Transient 1960-2100	OBS + A1b-med	OBS + adjusted A1 (WMO-07)	Modeled SSTs	OBS Year 2000	NO	Only internally generated	Same as REF1 until 2000 + adj IIASA scn through 2100

Ozone and Aerosol Precursors:

**REF0,1:** CO, NMVOC, NO<sub>x</sub>, and SO<sub>x</sub> from 1960-2000 are available from the RETRO project (Schultz et al., 2007). REF2: uses the adjusted IIASA scn through 2100 (M. Amann and P. Rafai, pers. comm., 2007)

# Sensitivity Simulations

## CTL0:

- **TYPE:** Is a time-slice experiment for conditions equivalent to the year 1960.
- **PURPOSE:** Designed to establish a baseline control simulation for the reference and sensitivity simulations. The objective is to provide a statistical characteristic of the internal variability of the CCMs prior to major perturbations of the ozone layer.

## SCN1:

- **TYPE:** Is a transient experiment 1960-present.
- **PURPOSE:** Simulates enhanced  $\text{BrO}_y$ . Identical to REF1 except additional ~5 pptv source of VSL organic bromine is included (i.e.,  $\text{CH}_2\text{Br}_2$ ).

## SCN2a:

- **TYPE:** Is a transient experiment 1960-2100.
- **PURPOSE:** Same as REF2, except uses SRES A2 for GHGs. SSTs/SIC are consistent with AOGCMS and ESMs.

# Sensitivity Simulations Continued...

## SCN2b:

- **TYPE:** Transient experiment **1960-2100**. Same as REF2, **except halogens are fixed at 1960 levels**. GHGs are the same as REF2.
- **PURPOSE:** To address the effect of halogens on stratospheric ozone and climate. This simulation will assist in refining the definition of “full ozone recovery”.

## SCN2c:

- **TYPE:** Transient experiment **1960-2100**. Same as REF2, **except GHGs are fixed at 1960 levels**. Halogens are the same as REF2.
- **PURPOSE:** To study the nonlinearity of the atmospheric response to ozone depletion/recovery and climate change, e.g., what would be the impact of halogens on the atmosphere in the absence of climate change. Described as a No Climate Change (NCC) simulation.

## SCN2d:

- **TYPE:** Transient experiment **1960-2100**. Same as REF2, **including natural forcings and QBO**.
- **PURPOSE:** To address the impact of ‘realistic’ natural variability on the REF2 simulations, for which natural variability is underestimated.



SCN	Period	GHGs	Ozone Depletion Subs.	SSTs	Sulfate SAD	Solar Variability	QBO	Ozone and Aerosol Precursors
CNT0	Time-slice; year 1960. 1870 AOGCM	Fixed at 1960	Fixed at 1960	OBS 1955-1964 HadISST1	OBS Year 1979.	OBS Avg over 1-cycle	Only internally generated	OBS RETRO 1960-1962
SCN1 en-BrOY	Transient 1960-2006	OBS	Same REF1+ VSL BrOY	OBS HadISST1	OBS (SPAR C Report)	OBS Spectral resolved	OBS or internally generate	OBS Extended RETRO
SCN2a GHGs	Transient 2000-2100	OBS+ A2 scenario	OBS + adjusted A1 (WMO-07)	Modeled SST (A2 Scenario)	OBS (SPAR C Report)	OBS Spectral resolved Irradiance	OBS or internally generate	Same as REF1 until 2000 + consistent with A2
SCN2b Fixed halogens	Transient 1960-2100	OBS + A1b-med	Fixed Halogen scenario	Modeled SSTs	OBS Year 2000	NO	Only internally generated	Same as REF2
SCN2c NCC	Transient 1960-2100	Fixed at 1960 GHGs	OBS+ adjusted A1 (WMO-07)	Modeled SSTs	OBS Year 2000	NO	Only internally generated	Same as REF2
SCN2d Nat forcing, QBO	Transient 1960-2100	OBS + A1b-med	OBS+ adjusted A1 (WMO-07)	Modeled SSTs	OBS (REF1)	OBS repeating in future	OBS repeating in future	Same as REF2

# WACCM3 Simulation Priorities (early 2009)

Priority	Scenario	Period	# real.	Comments	Yes/No
1	REF1	1960-2006	3	Obs SST/SICs	Yes
1	SCN2d	1870-2100	3	Fully Coupled	Yes
1	CNT0	1870	1	Time-slice	Yes
1	REF0	2000	1	Time-slice	Yes
1	SCN1	1960-2006	1	En-BrOY	Yes
2	SCN1*	1960-2006	1	En-BrOY+NMHC	maybe
2	Scn2c	1960-2100	1	NCC	maybe
0	REF2	1960-2100	—	Limited forcings	No
0	SCN2a	1960-2100	—	SRES A2	No
0	Scn2b	1960-2100	—	Fixed Halogens	No

# WACCM3 Simulation Priorities (now)

Priority	Scenario	Period	# real.	Comments	Yes/No
1	REF1	1960-2006	3 (3)	Obs SST/SICs	Yes
1	SCN2d	1870-2100	3 ?*	Fully Coupled	Yes No*
1	CNT0	1870	1 (0)	Time-slice	Yes
1	REF0	2000	1 (1)	Time-slice	Yes
1	SCN1	1960-2006	1 (0)	En-BrOY	Yes
2	SCN1*	1960-2006	1 (0)	En-BrOY+NMHC	maybe
2	Scn2c	1960-2100	1 (0)	NCC	maybe
0 1	REF2	1960-2100	3 (2)	Limited forcings	No Yes
0	SCN2a	1960-2100	—	SRES A2	No
0	Scn2b	1960-2100	—	Fixed Halogens	No

\*Will do at least 1 run eventually, but not in time for CCMVal; will substitute at least 1 run of REF2



# Useful References...

## Simulations

- Eyring, V., M. P. Chipperfield, M. A. Giorgetta, D. E. Kinnison, E. Manzini, K. Matthes, P. A. Newman, S. Pawson, T. G. Shepherd, and D. W. Waugh, Overview of the New CCMVal reference and sensitivity simulations in support of upcoming Ozone and Climate Assessments and the Planned SPARC CCMVal Report, SPARC Newsletter, n°30, January, p. 20, 2008.

## CCMVal Report

- Eyring, V., A. Gettelman, N. Harris, S. Pawson, T. Shepherd, D. Waugh, H. Akiyoshi, N. Butchart, M. Chipperfield, M. Dameris, D. Fahey, P. Forster, P. Newman, M. Rex, R. Salawitch, B. Santer, Report on the 3rd SPARC CCMVal Workshop, SPARC Newsletter, n°30, January, p. 17, 2008.