

# WCRP SPARC (Stratospheric Processes and their Role in Climate) activities related to CMIP5:

Chemistry-Climate Model Validation (CCMVal) Activity  
DynVar (Modelling the Dynamics & Variability of the Stratosphere-Troposphere System)

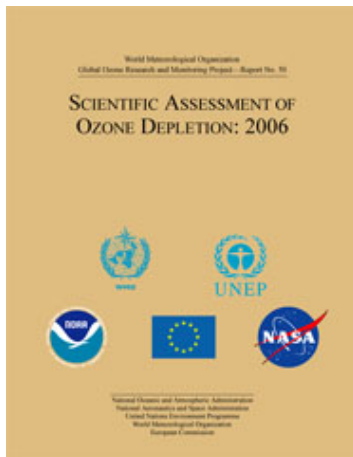
Veronika Eyring

WGCM Meeting, Boulder, 19-21 October 2011

# International Scientific Assessment Reports

Multi-model projections are key components of the regular

## WMO/UNEP Ozone Assessments and IPCC Climate Assessments



- WMO/UNEP (1985)
- WMO/UNEP (1989)
- WMO/UNEP (1991)
- WMO/UNEP (1994)
- WMO/UNEP (1998)
- WMO/UNEP (2002)
- WMO/UNEP (2006) } CCMVal-1
- WMO/UNEP (2010) } CCMVal-2



- IPCC AR1 (1990)
- IPCC AR2 (1997)
- IPCC AR3 (2001)
- IPCC AR4 (2007) } CMIP3
- IPCC AR5 (2013) } CMIP5



**SPARC CCMVal Report (more than 100 authors); extensively peer-reviewed.**

[http://www.atmosp.physics.utoronto.ca/SPARC/CCMVAL\\_FINAL/index.php](http://www.atmosp.physics.utoronto.ca/SPARC/CCMVAL_FINAL/index.php)

- Detailed evaluation of past reference simulations (**REF-B1**)
- Projections of stratospheric ozone and impact on climate (**REF-B2**)

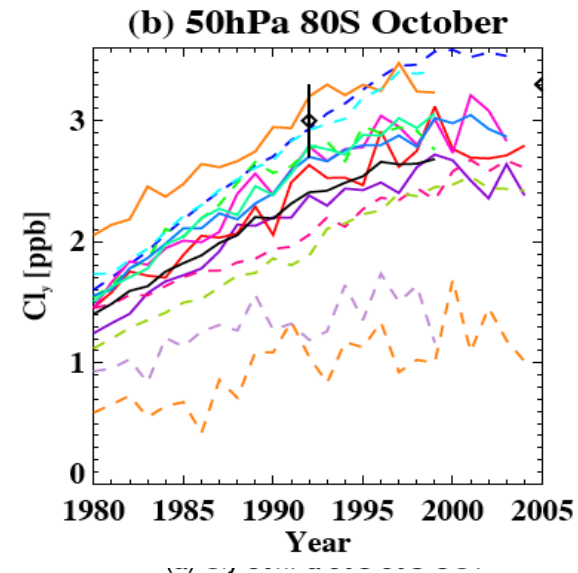
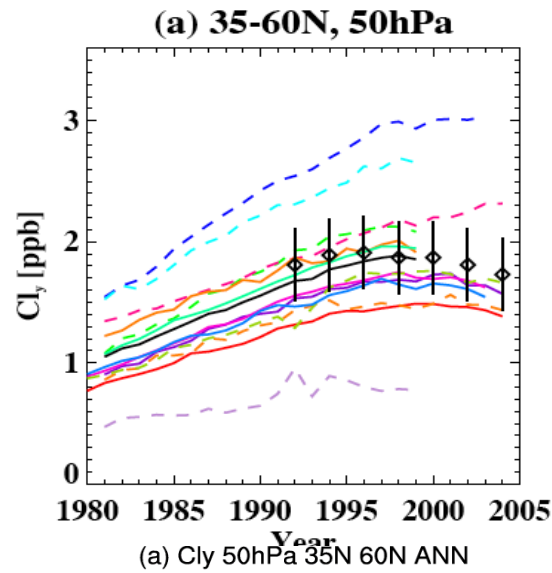
**Many papers published from analysis of the SPARC CCMVal Report in addition**  
=> Synthesis from CCMVal



# CCMVal-1 and CMMVal-2: Inorganic Chlorine ( $Cl_y$ )

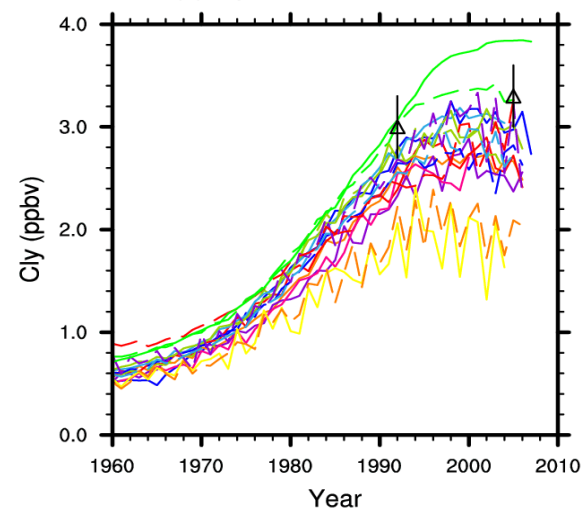
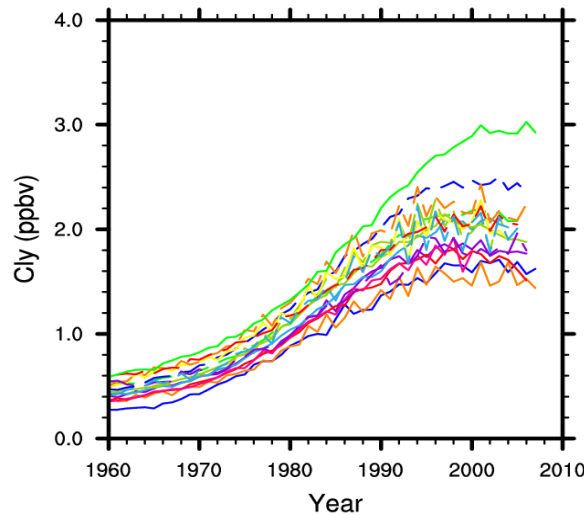


**CCMVal-1**

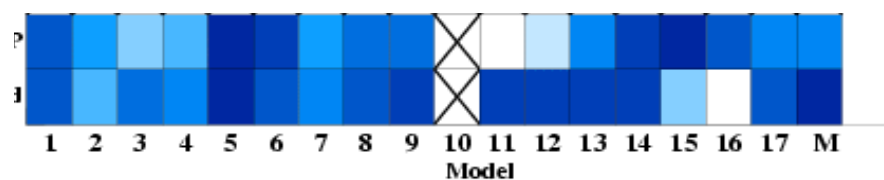
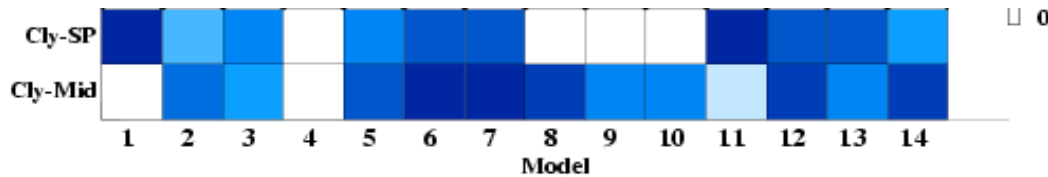


*Waugh & Eyring, ACP, 2008*

**CCMVal-2**



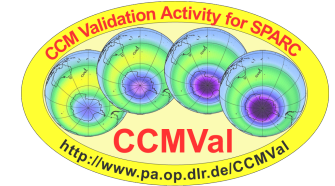
*Chapter 5, SPARC CCMVal (2010)*



# Overall Recommendations SPARC CCMVal 2010 Report (selected)

- **Performance metrics** on a wide suite of diagnostics need to be made as standard practice and calculated routinely by individual model groups and through multi-model comparisons. **Explore weighting the projections**
- **More attention needs to be paid to model development** to address major persistent deficiencies, e.g. the late-spring breakdown of the Antarctic vortex.
- **Development should continue towards comprehensive troposphere-stratosphere CCMs**, which include coupled ocean, tropospheric chemistry, a naturally occurring QBO, spectrally resolved solar irradiance, and a fully resolved stratosphere.
- **Recommendations for Observations:**
  - **Long-term vertically resolved data sets** of constituent observations in the stratosphere are required to assess model behavior (**ozone & other species**)
  - **The current set of GCOS Essential Climate Variables** is not sufficient for process-oriented validation of CCMs.
  - **More global vertically resolved observations** are required, particularly in **the UTLS**. As CCMs evolve towards including tropospheric chemistry, lack of observations in this region will become a major limitation on model validation.
  - **A systematic comparison of existing observations is required** in order to underpin future model evaluation efforts, by providing a more accurate assessment of measurement uncertainties.
  - => **Need a coordinated international “data initiative” to support model intercomparison projects like CCMVal (SPARC Data Report, Obs4MIP)**

# Future CCMVal Activities



- ❑ Further analysis of CCMVal-2 model archive.
- ❑ Further development of the **CCMVal diagnostic tool**
- ❑ Further encourage Model Improvements: Dynamical biases, QBO, ...
- ❑ Further analysis of application of performance metrics (e.g., robustness, weighting).
- ❑ CCM simulations under the RCP scenarios => ozone RF for AR5
- ❑ **"Geoengineering" simulations in support of GeoMIP.**
- ❑ **CCM simulations with coupled ocean.**
- ❑ **CCM simulations with stratospheric & tropospheric chemistry.**
- ❑ Plan and broadly discuss CCMVal-3 (possibly with AC&C hindcast / ACC-MIP, GeoMIP)
- ❑ **CCMVal workshop in 21-23 May 2012** to be held in Davos, Switzerland; strong tropospheric component; *Scientific Organizing Committee*: V. Eyring, A. Fiore, A. Gettelman, J.-F. Lamarque, S. Pawson, T. Shepherd, K. Sudo, and D. Waugh
- ❑ **Followed or joint with IGAC/SPARC global modelling and evaluation workshop 24-25 May** with a strong component on observations for model evaluation.
- ❑ **Synthesis Paper on ozone in CMIP5 simulations compared to CCMVal-2 planned**

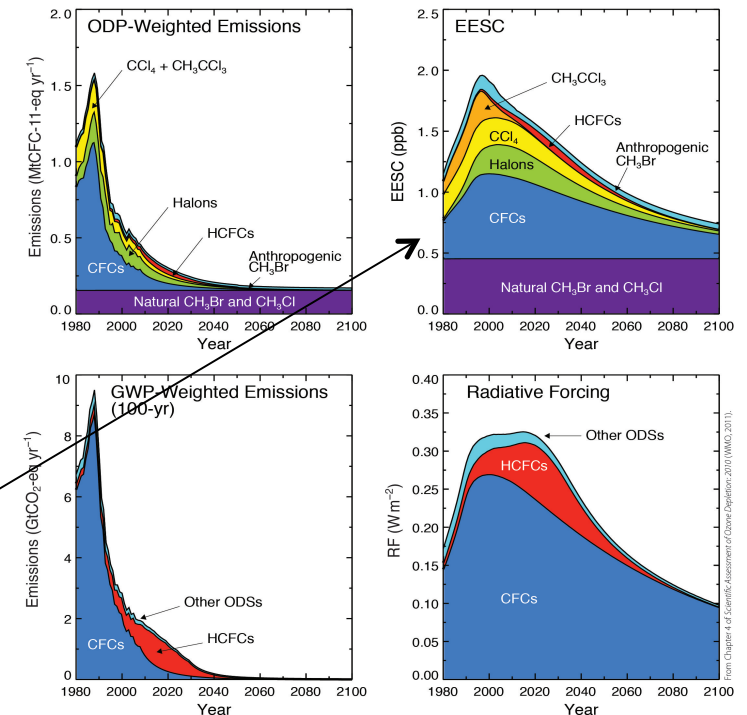


## SPARC Lifetime Assessment

An accurate knowledge of the atmospheric lifetime of gases is essential for predicting the ozone-depletion and climate effects of emissions.

There is currently significant uncertainty in the lifetime of some major ODSs. E.g. Lifetime of CFC-11 likely to be 60 yrs and not 45 yrs (as used in past WMO Assessments). Will change predicted future decay rate.

Through CCMVal global 3-D models have now been evaluated and provide realistic tools for a thorough reassessment of lifetimes.



Institute for Climate and Atmospheric Science  
SCHOOL OF EARTH AND ENVIRONMENT



**UNIVERSITY OF LEEDS**  
**Martyn Chipperfield**

Veronika Eyring, WGCM 2011, Boulder, NCAR, USA

# SPARC DynVar

## Modelling the Dynamics & Variability of the Stratosphere-Troposphere System)

### DynVar Committee Members:

Elisa Manzini (Coordinator),  
Amy Butler, Natalia Calvo,  
Andrew Charlton-Perez,  
Edwin Gerber, Marco  
Giorgetta,  
Adam Scaife, Tiffany Shaw  
and Shingo Watanabe

### Ex-Officio Members:

Judith Perlwitz, Lorenzo  
Polvani and Fabrizio Sassi



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

### Goals:

- Promote coupled atmosphere, ocean, and sea-ice global models with **high vertical resolution and model tops above the stratosphere.**
  - Systematically assess
    - stratospheric **dynamical variability and processes,**
    - **two-way dynamical couplings** between the stratosphere and the troposphere, and
    - their impacts on troposph. and **surface climate predictability**
- > Modelling activity, S-T with emphasis on atm&ocean coupling

### Current focus:

**HIGH - LOW TOP MODELS INTERCOMPARISON WITHIN CMIP5**

### Synthesis Papers on the CMIP5 multi-model ensemble in plan:

(1) Climate and Variability of the stratosphere. Charlton-Perez et al.

- Aim: Analyse the mean climate and variability of the stratosphere as simulated by the CMIP5 set of models.

(2) Surface Climate, Variability and Change in the CMIP5 multi-model ensemble: Role of the stratosphere. Manzini et al.

- AIM: Evaluate the impact of a dynamical stratosphere on surface climate, variability and change by comparing diagnostics from the high top (lid above the stratopause) and low top (lid in the mid-stratosphere) CMIP5 multi-model ensembles.

Veronika Eyring, WGCM 2011, Boulder, NCAR, USA

## High top models participating to CMIP5 so far:

Institute / Group	Model	Atmospheric Resolution	Scenario	Contact
CMCC	CMCC-CMS	T63xL95 top=0.01hPa	RCP4.5	<a href="mailto:chiara.cagnazzo@cmcc.it">chiara.cagnazzo@cmcc.it</a> <a href="mailto:piergiuseppe.fogli@cmcc.it">piergiuseppe.fogli@cmcc.it</a> <a href="mailto:silvio.gualdi@bo.ingv.it">silvio.gualdi@bo.ingv.it</a>
	CMCC-CESM	T31xL39 top=0.01hPa	RCP8.5	
DMI	EC-EARTH	T159xL91 top=0.01hPa	RCP4.5	<a href="mailto:shuting@DMI.dk">shuting@DMI.dk</a> <a href="mailto:boc@DMI.dk">boc@DMI.dk</a>
		T159xL61 top=5hPa		
GEOS	GEOS-5	1°x1.25°xL72 top=0.01hPa	Decadal prediction runs	<a href="mailto:Steven.Pawson-1@nasa.gov">Steven.Pawson-1@nasa.gov</a>
GFDL	CM3	~200kmxL48 top=0.017hPa	All 4 RCPs	<a href="mailto:john.austin@noaa.gov">john.austin@noaa.gov</a> <a href="mailto:leo.j.donner@noaa.gov">leo.j.donner@noaa.gov</a> <a href="mailto:larry.horowitz@noaa.gov">larry.horowitz@noaa.gov</a>
GISS	GISS-E	90x144xL40 top=0.1hPa	All 4 RCPs	<a href="mailto:dshindell@giss.nasa.gov">dshindell@giss.nasa.gov</a>
IPSL	IPSL-CM5	144x143xL39 top=65km	RCP4.5	<a href="mailto:Francois.lott@lmd.jussieu.fr">Francois.lott@lmd.jussieu.fr</a>
Met Office Hadley Center / NCAS	HadGEM2	192x145xL60 top=84km	RCP4.5, RCP8.5	<a href="mailto:neal.butchart@metoffice.gov.uk">neal.butchart@metoffice.gov.uk</a> <a href="mailto:steven.hardiman@metoffice.gov.uk">steven.hardiman@metoffice.gov.uk</a> <a href="mailto:s.osprey@physics.ox.ac.uk">s.osprey@physics.ox.ac.uk</a> <a href="mailto:gray@atm.ox.ac.uk">gray@atm.ox.ac.uk</a>
MPI-M	MPI-ESM	T63xL47 top=0.01hPa T63xL95 top=0.01hPa	RCP4.5, RCP8.5, RCP2.6	<a href="mailto:marco.giorgetta@zmaw.de">marco.giorgetta@zmaw.de</a>
MIROC	MIROC-ESM	T42xL80 Top=85km	All 4 RCPs	<a href="mailto:wnabe@jamstec.go.jp">wnabe@jamstec.go.jp</a> <a href="mailto:kawamiya@jamstec.go.jp">kawamiya@jamstec.go.jp</a> <a href="mailto:nozawa@nies.go.jp">nozawa@nies.go.jp</a>
	MIROC-ESM-CHEM			
MRI	MRI-ESM1	TL95xL48 (320x160) top=0.01hPa	RCP4.5, RCP8.5 RCP8.5	<a href="mailto:kshibata@mri-jma.go.jp">kshibata@mri-jma.go.jp</a>
NCAR	WACCM4	144x96xL66 top=6x10 <sup>-6</sup> hPa~135km	RCP4.5 (RCP8.5, RCP2.6)	<a href="mailto:aksmith@ucar.edu">aksmith@ucar.edu</a> <a href="mailto:rgarcia@ucar.edu">rgarcia@ucar.edu</a> <a href="mailto:marsh@ucar.edu">marsh@ucar.edu</a>



## Contribution to: CMIP5 Analysis Workshop March 2012

In addition to the two synthesis papers .....

.... we are encouraging submissions of **CMIP5 multi-model inter-comparisons** focused on "DynVar topics" (eg, **dynamical stratospheric - tropospheric coupling**) to the CMIP5 Analysis Workshop. Idea discussed at the last CLIVAR SSG, with the intent of entrain stratospheric research into the mainstream events of climate research.

Our understanding (emails passed on to us) is that this is possible, pending that there are indeed such contributions (on "DynVar topics") and that they are accepted.

**Questions:** Criteria of acceptance? Roughly, how many poster presentations on "DynVar topics" can we possibly aim at?

*DynVar slides from Elisa Manzini and Andrew Charlton-Perez*



By: Carolin Arndt | 30 August 2011

## New Blog: Should SPARC change its name?

WCRP requested that SPARC not only focusses on stratospheric research but also on the troposphere.

A blog was set up to give the SPARC community the opportunity to take part in an open discussion about a possible name change for SPARC. Welcome to contribute!

- The WCRP is undergoing an internal restructuring which will see revised mandates for the four core projects to respond to scientific developments since those mandates were originally established — in most cases, around 20 years ago.
  - SPARC is being asked to develop a stronger focus on stratosphere-troposphere coupling. This will involve a stronger engagement with tropospheric processes than has been the case so far.
- CLIVAR and GEWEX are being asked to focus on, respectively, ocean-atmosphere and land-atmosphere coupling, while CliC will continue to focus on cryosphere-climate coupling. Each core project is in the process of determining what this development implies for its programme of activities
- As part of this process, the core projects are also being asked to consider whether a name change might be appropriate, to reflect the revised mandates

## Need for cross-MIPs analyses

1. **Chemistry-Climate Model Validation (CCMVal) Activity**
2. **Atmospheric Chemistry Climate Model Intercomparison Project (ACCMIP)**  
Time-slice experiments to complement CMIP5, e.g.:
  - Documentation of radiative forcing for radiatively active gases and aerosols
  - Sensitivity to IAM on emissions for each RCP

3. **AC&C Hindcast Activity**

Joint IGAC / SPARC workshop May 2012  
Joint activity in the future?

4. **DynVar**
5. **Coupled Model Intercomparison Project (CMIP5)**
  - Models with interactive chemistry (synthesis paper; contributions to CMIP5 workshop)
  - High-top versus low-top models (synthesis papers; contributions to CMIP5 workshop)
6. **GeoMIP**
7. **Obs4MIP**
8. **Input to WGNE / WGCM Metrics Panel**