Atmospheric Chemistry and Climate
- Session Introduction -

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WCRP
World Climate Research Programme

Key questions arising from the 2006 WMO/UNEP Ozone Assessment

(I) How will stratospheric ozone and other constituents evolve?

- What's the role of ozone depletion substances (ODSs) versus naturally variability (volcanoes, solar cycle, QBO etc)?
- What's the role of climate change?

(II) How will changes in stratospheric composition affect climate?

- What is the role of ozone in climate simulations?
- What is the role of interactive chemistry in climate simuations?

(III) What is the role of stratospheric variability on tropospheric ozone?

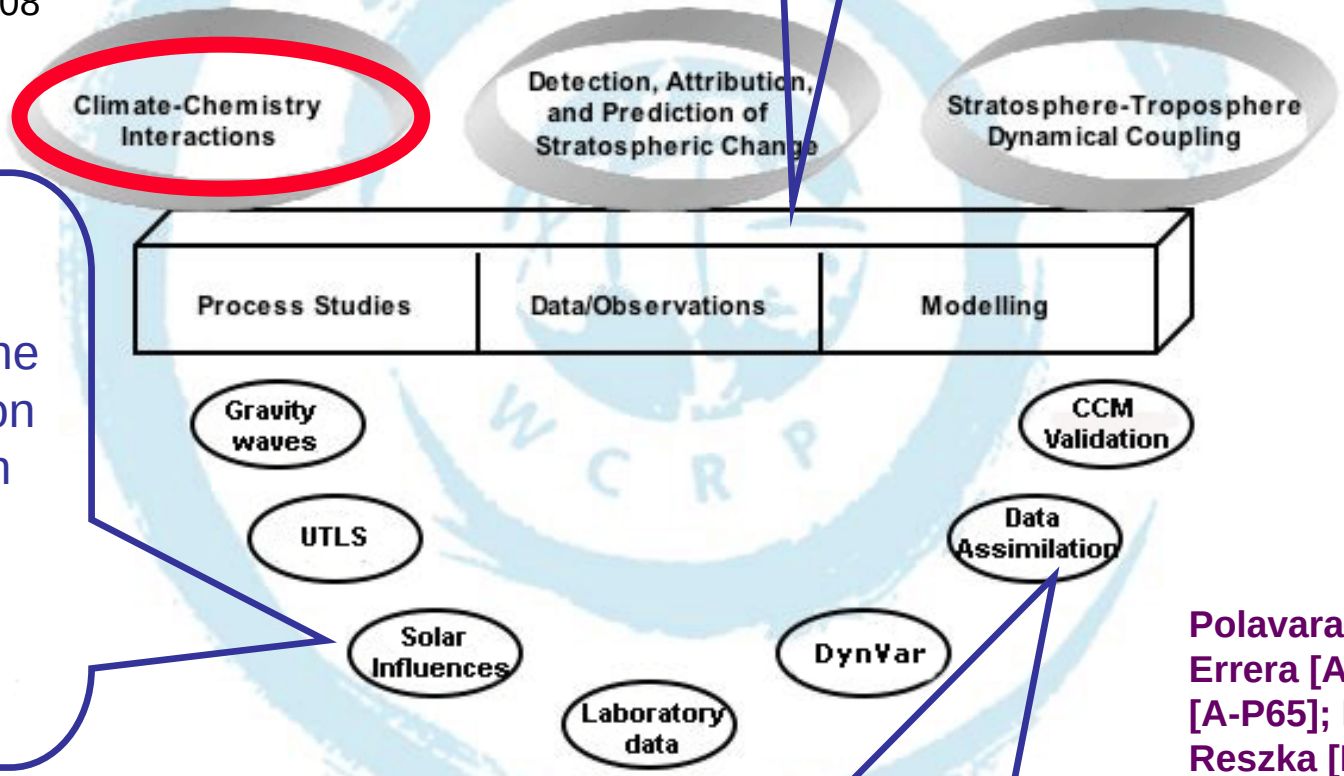
see also Shepherd & Randel, SPARC Newsletter no29, 2007

Matthes; Hood [Talk]; Baumgaertner [C-P7]; Kubin [C-P49]; Marchand [C-P61]; Rozanov [C-P81]; Yamashita [C-P110]

Austin et al., JGR, 2008

SPARC Data Initiative

Burrows; Rodriguez [Talk]; Atlas [C-P4]; Brohede [C-P12]; Clain [C-P18]; Douglass [C-P21]; McDermid [C-P63]; Schoeberl [C-P88] Tukiainen [C-P100]; Walker [C-P112]

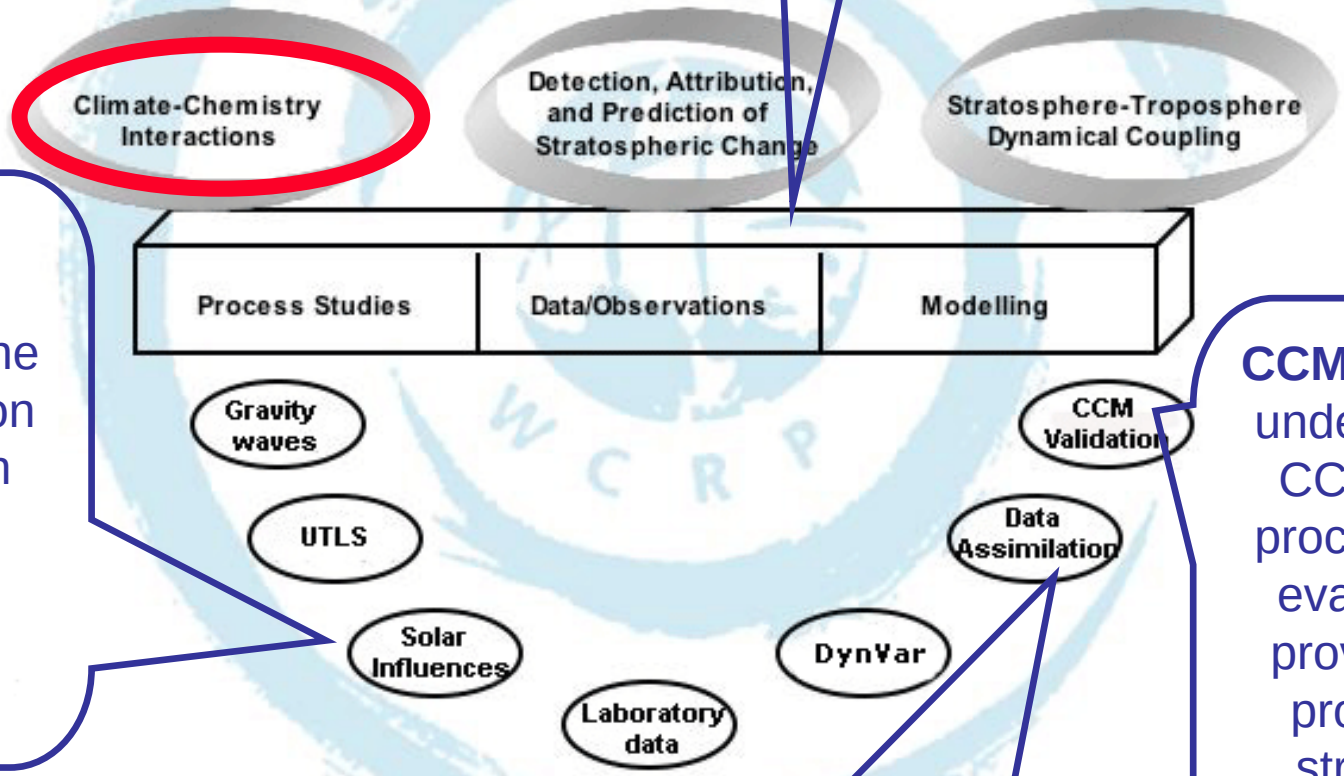


SOLARIS: Modeling and understanding the solar influence on climate through stratospheric chemical and dynamical processes.

SPARC Data Assimilation Group

Polavarapu [Talk]; Errera [A-P34]; Lahoz [A-P65]; Ren [A-P87]; Reszka [P88]; Sekiyama [A-P91]; Yudin [A-P113]; Jackson [A-P35]; Murtagh [A-P61]

SPARC Data Initiative

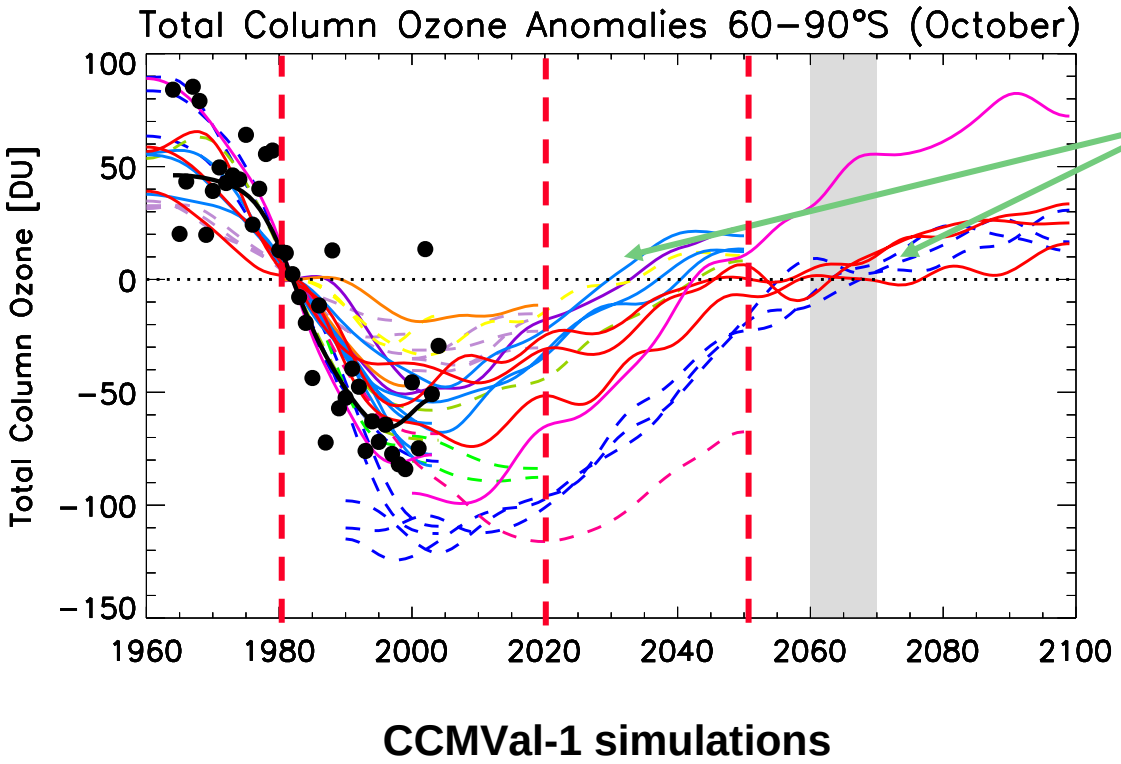


SOLARIS: Modeling and understanding the solar influence on climate through stratospheric chemical and dynamical processes.

CCMVal: Improve understanding of CCMs through process-oriented evaluation and provide reliable projections of stratospheric ozone and its impact on climate

SPARC Data Assimilation Group

I. How will stratospheric ozone and other constituents evolve?



CCMVal-1 simulations

- AMTRAC
- CCSRNIES
- CMAM
- E39C
- GEOSCCM
- MAECHAM4CHEM
- MRI
- SOCOL
- ULAQ
- UMSLIMCAT
- WACCM
- Observations

There are substantial differences in the **date at which Cly returns to 1980** values varying from before 2030 to after 2050. There is a similar large variation in the **timing of recovery of Antarctic spring-time column ozone back to 1980 values.**

Talk by Darryn Waugh

Differences in the **length of the simulations**

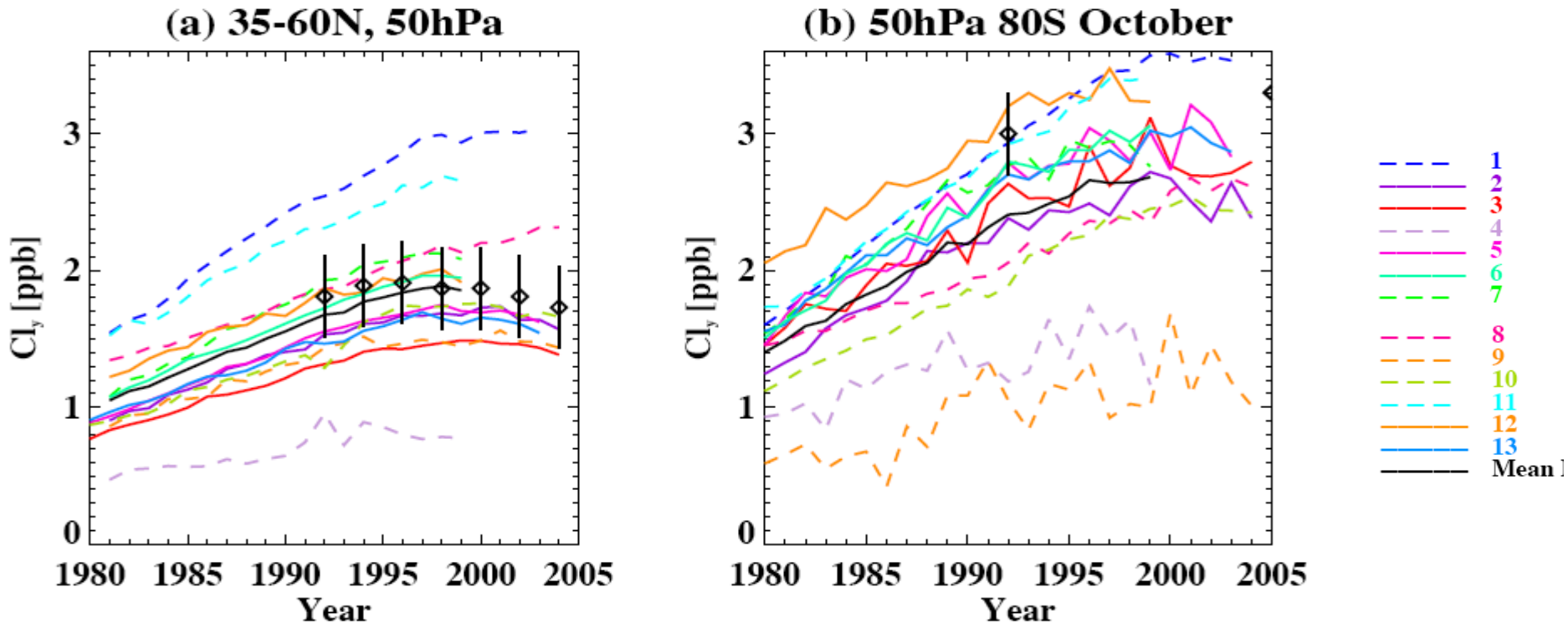
Eyring et al., JGR, 2007

Conclusions from CCMVal-1 model simulations

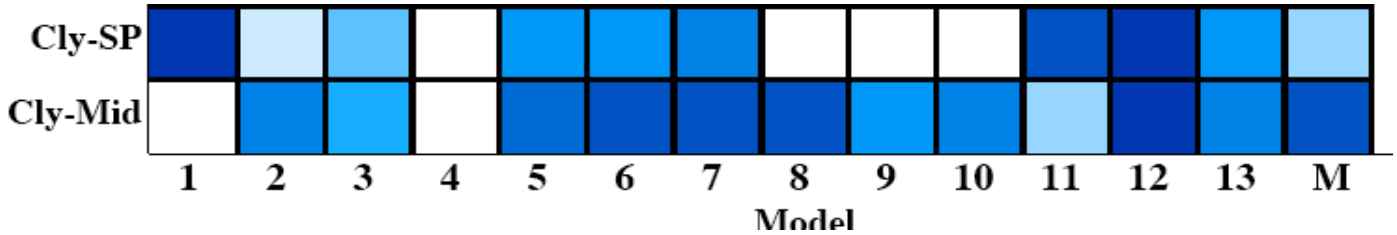
Improve our understanding on representation of key processes in CCMs

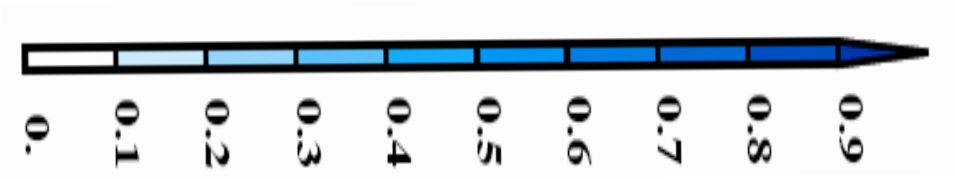
- **Single Model Studies** Akiyoshi [P1]; Austin [B-P4]; Backman [P5]; Baumgaertner [P7]; Bonazzola [P9]; Brühl [P13]; Dameris [P19]; Deckert [A-P31]; Deushi [P20]; Fischer [P34]; Hitchcock [P34]; Kinnison [B-P43]; Li [P56]; Newman Paul [P66]; Palazzi [P70]; Pawson [P71]; Plummer [P74]; Shibata [P90]; Stolarski [P94]
- **Multi-model studies** (CCMVal archive at BADC) Butchart [C-P15]; Huck [C-P37]; Kunze [C-P52]; Oman [C-P69]; Son [C-P91]; Strahan [C-P95]
- **SPARC CCMVal Report** on Evaluation of Chemistry Climate Models (see http://www.pa.op.dlr.de/CCMVal/)
  - Look at radiation & chemistry in addition to transport & dynamics
  - Observations will be key for the success of the report and the report will help identifying observational needs
  - The report will aim to develop quantitative metrics.

Cl_y evolution in the CCMVal-1 REF1 simulations



Grades:



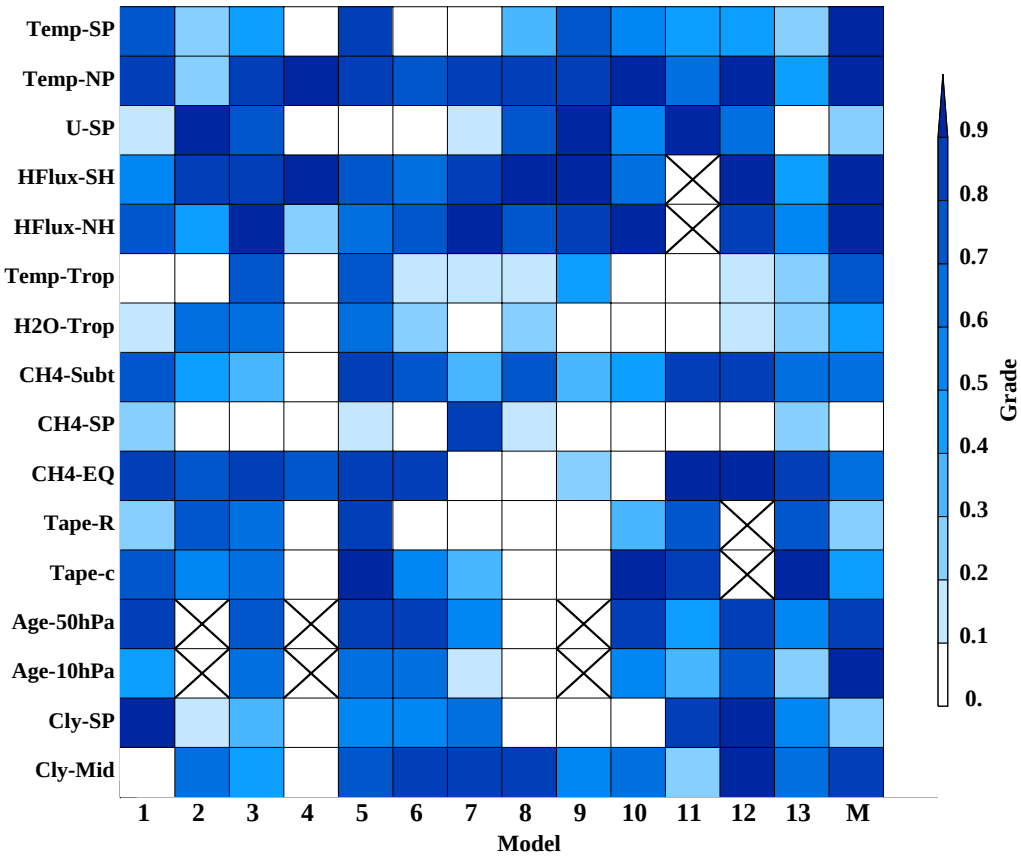


Waugh & Eyring, ACPD, 2008

[P106]

Quantitative Performance Metrics

Waugh & Eyring, ACPD, 2008
based on Eyring et al., JGR, 2006 [P106]



Others: *e.g. Schmittner et al., GRL, 2005; Connolley & Bracegirdle, GRL, 2007; Reichler & Kim, BAMS, 2008; Gleckler et al., JGR, 2008; Pincus et al., JGR, 2008.*

Potential benefits:

- Allow visualization of the model's performance for multiple aspects of the simulations.

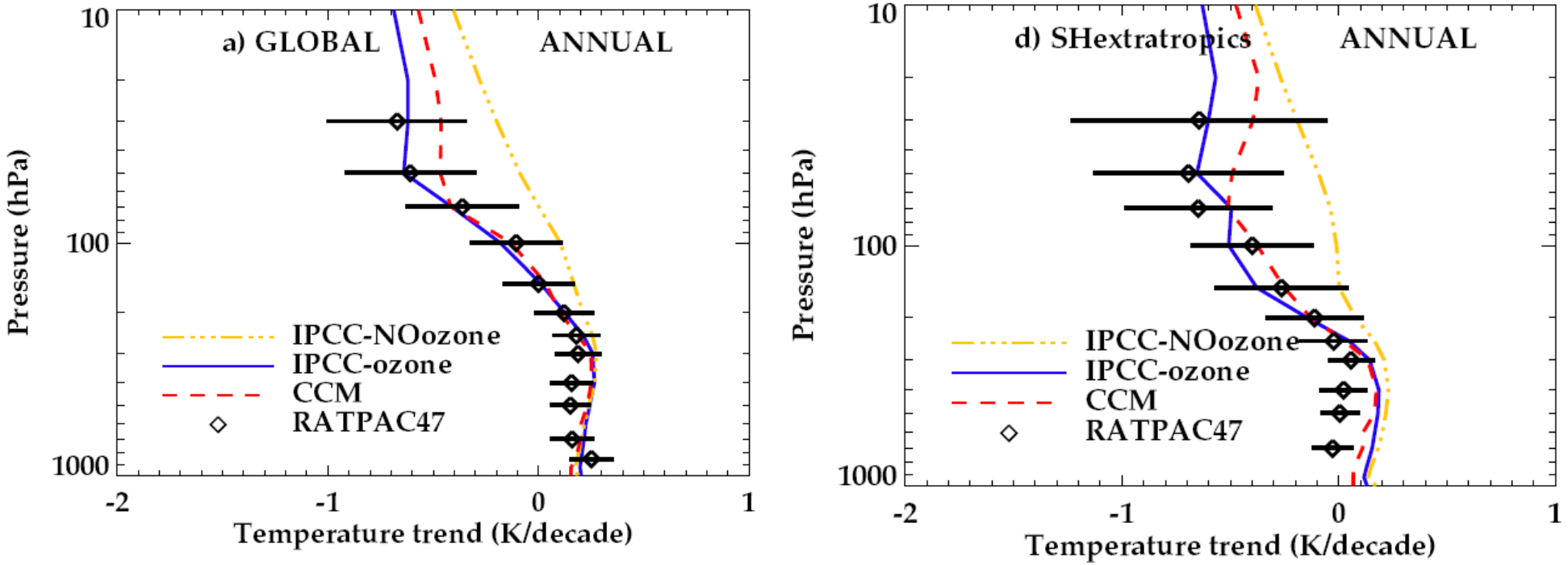
- Allow identification of missing or incompletely modeled processes.

- Enable a quantitative assessment of model improvements for different versions of individual CCMs and for different generations of community-wide CCMs (e.g. CCMVal-1 versus CCMVal-2).

- Make it possible to explore the value of **weighting** the predictions by models based on their abilities to reproduce key processes, and to form a best estimate **(weighted mean)** plus uncertainties that takes into account these differing abilities.

II. Role of Ozone in Future IPCC Simulations

- Comparison of CCM and AR4-AOGCM simulations -



Plot courtesy of Tesfai & Cordero, San Jose State University 1980-2004

Gray; Mathison; Waugh [Talk]

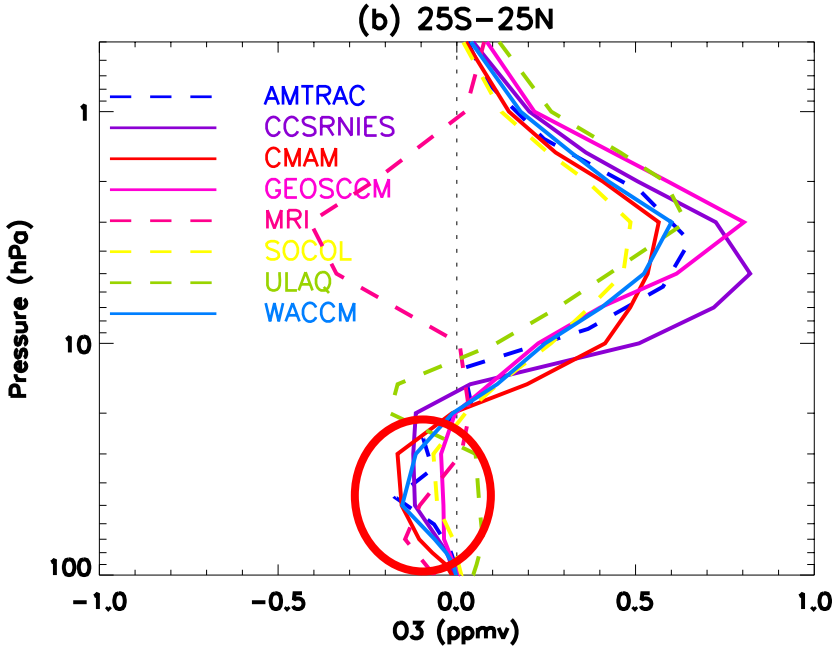
Related CCMVal papers:

Son *et al.,* Tropopause in the 21st century as simulated by CCMs, J. Clim., 2008.

Son *et al.,* Impact of Stratospheric Ozone Recovery on Southern Hemisphere Westerly Jet, Science, 2008

Stratospheric ozone is also affected by climate change, not just by CFCs

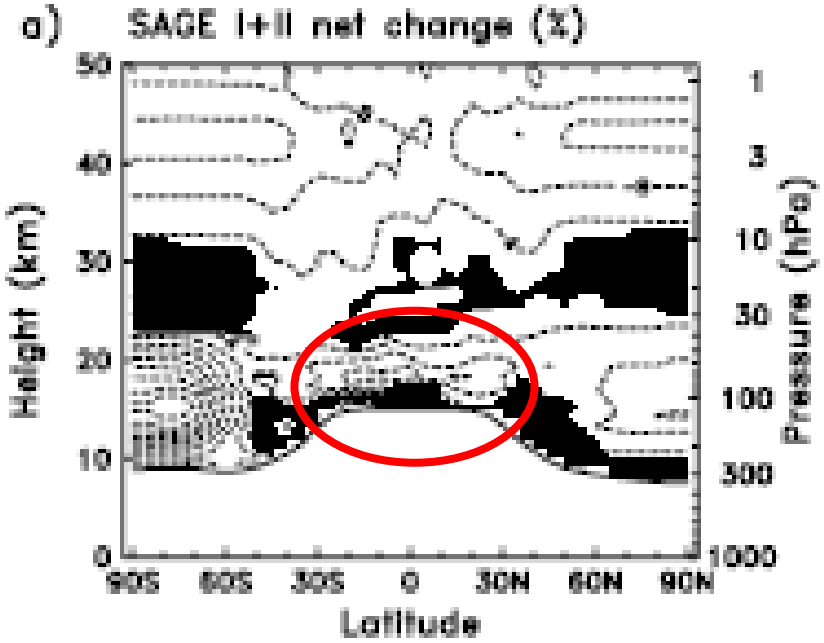
Tropical Ozone 1980s-2040s in the CCMVal-1 models



Increase in US ozone; Decrease in lower stratospheric ozone associated with increased tropical upwelling

from Eyring et al., JGR, 2007

Observed changes over 1979-2005, regressed against EESC



The lower stratospheric tropical ozone decrease is also observed; but it should probably be attributed to climate change, not CFCs (and hence is not expected to reverse)

from Randel & Wu, JGR, 2007

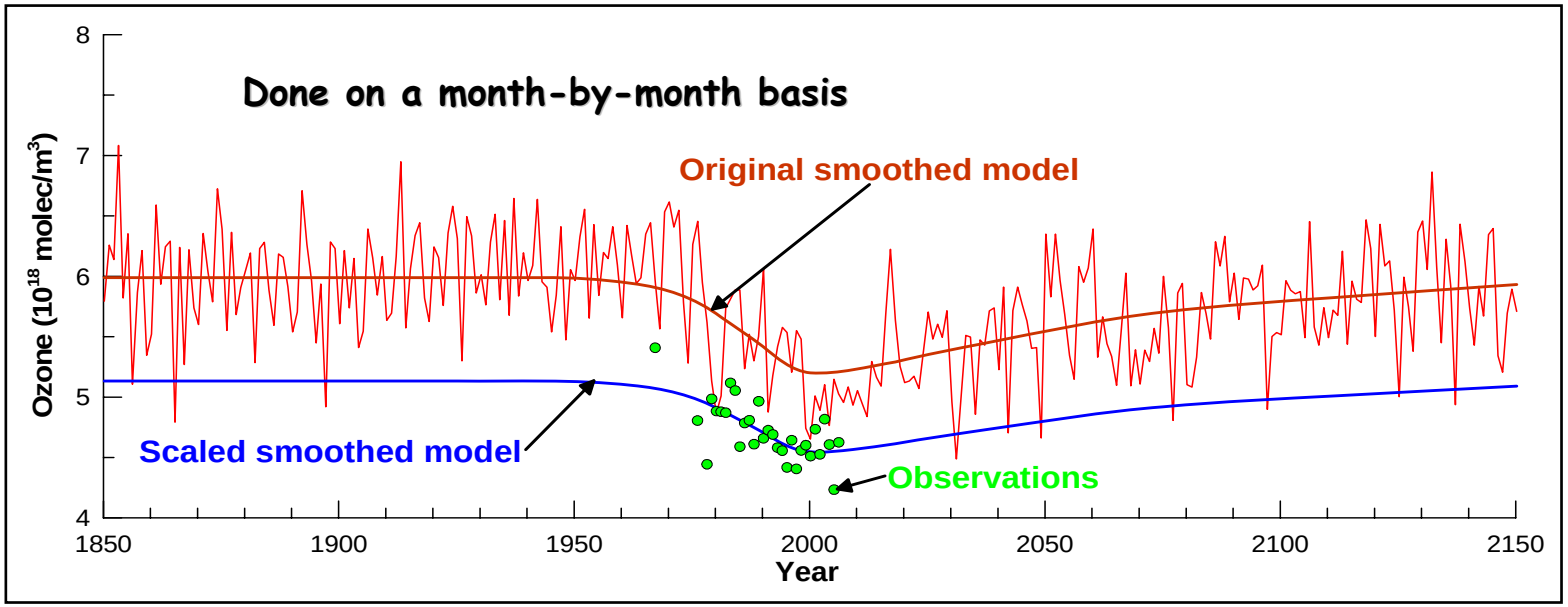
Garcia; Reichler; Scinocca [Talk]; Calvo [A-P11]; Deckert [A-P31]; Austin [B-P1]; Butchart [B-P15]; Oman [C-P69]

SPARC: Provide a consensus ozone database for constraining CMIP5 simulations

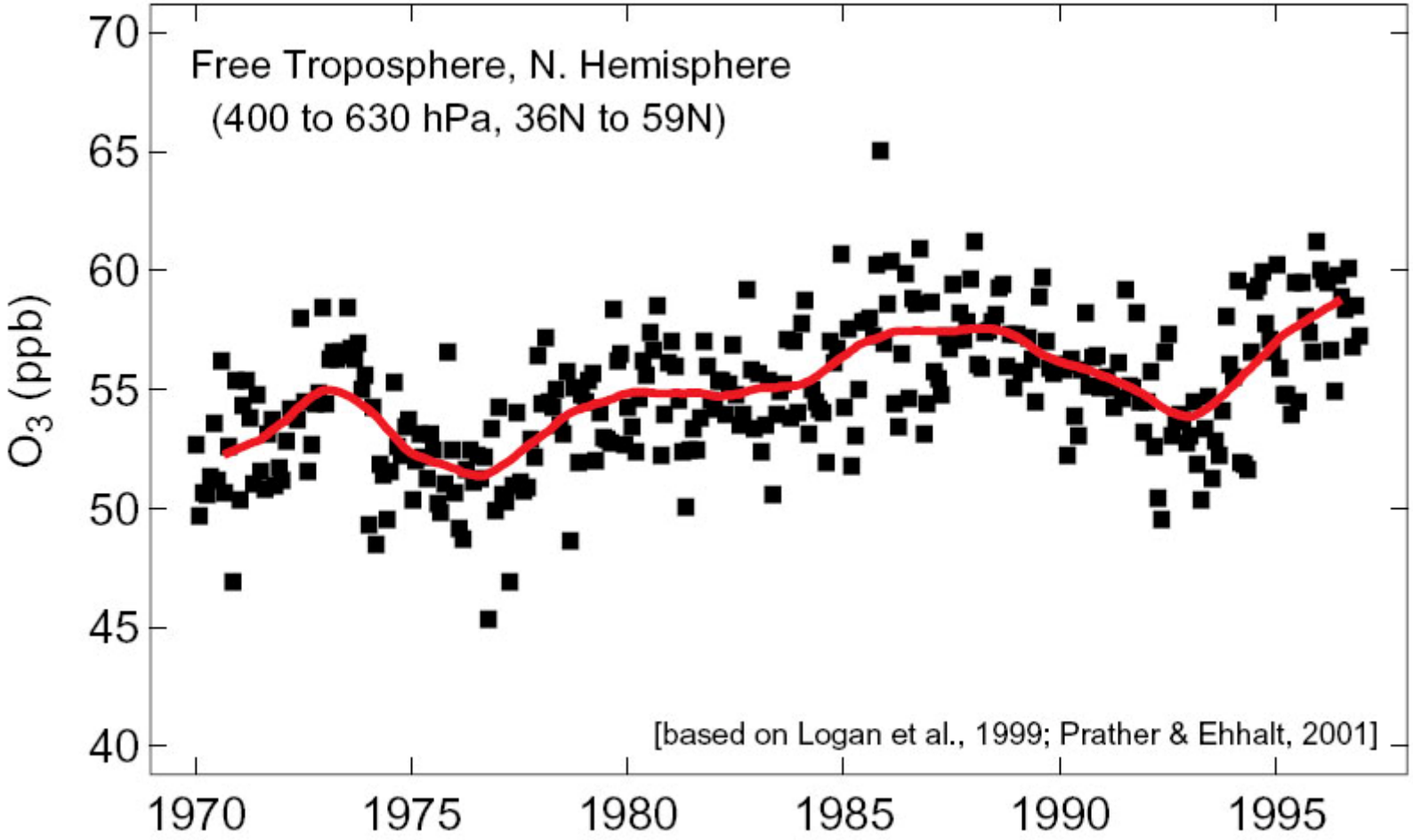
Will be built from **5 observational databases** (initiative lead by G. Bodeker)

1. *The NCAR database (Randel & Wu)*
2. *The NIWA database (Bodeker & Hassler)*
3. *The NASA/NOAA/RAL database (Rosenlof & Gray)*
4. *The NASA/GSFC database (Stolarski and Frith)*
5. *The Environment Canada database (Fioletov and McLinden)*

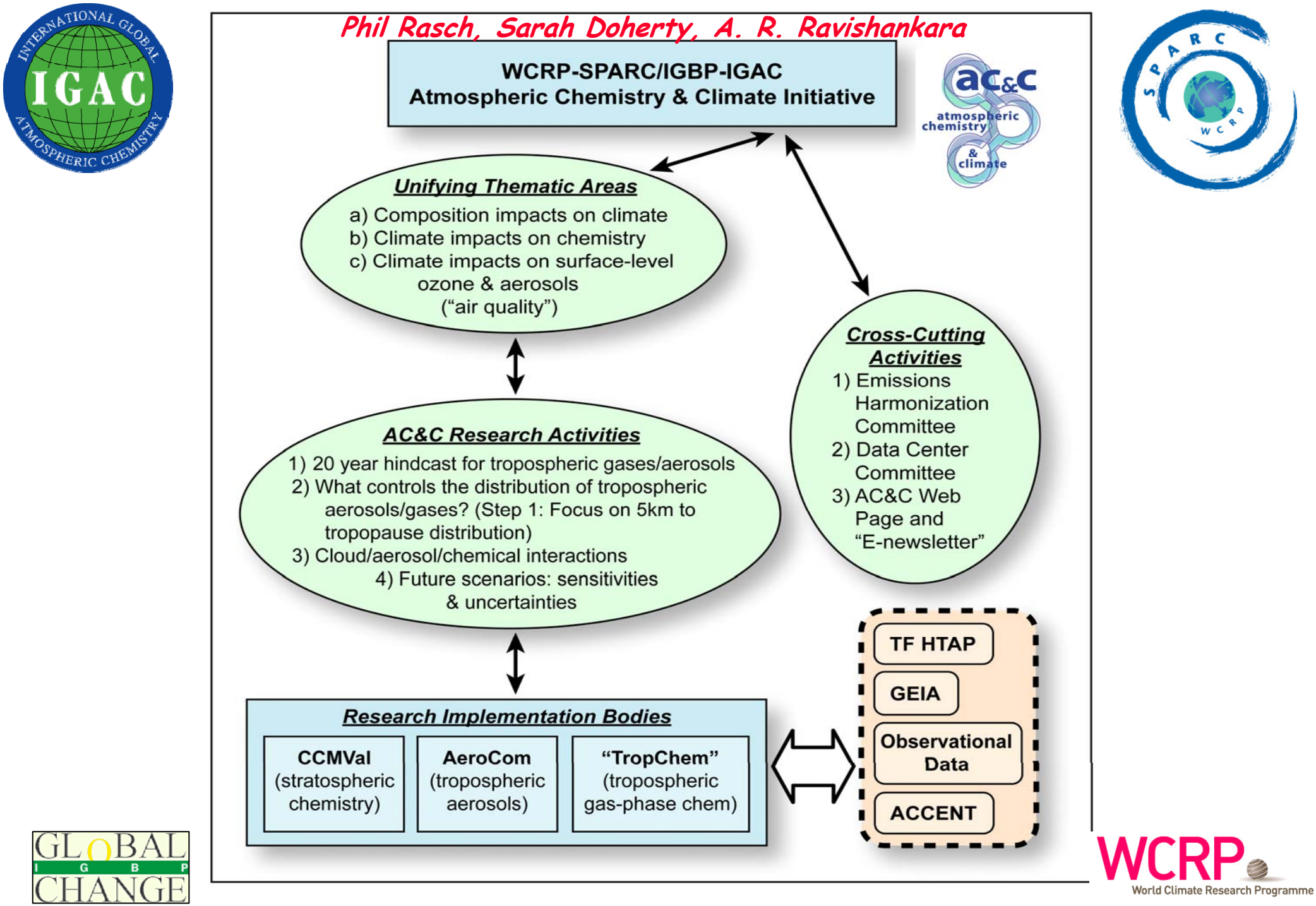
and extended backward based on regression modelling and forward with **CCMVal model output** to produce a 1850-2150 database for CMIP5 simulations



(III) What is the role of stratospheric variability on tropospheric ozone?



Lawrence; Sudo; Neu [Talks]


Phil Rasch, Sarah Doherty, A. R. Ravishankara
WCRP-SPARC/IGBP-IGAC
Atmospheric Chemistry & Climate Initiative
ac&c
atmospheric chemistry & climate
Unifying Thematic Areas
a) Composition impacts on climate
b) Climate impacts on chemistry
c) Climate impacts on surface-level ozone & aerosols ("air quality")
Cross-Cutting Activities
1) Emissions Harmonization Committee
2) Data Center Committee
3) AC&C Web Page and "E-newsletter"
AC&C Research Activities
1) 20 year hindcast for tropospheric gases/aerosols
2) What controls the distribution of tropospheric aerosols/gases? (Step 1: Focus on 5km to tropopause distribution)
3) Cloud/aerosol/chemical interactions
4) Future scenarios: sensitivities & uncertainties
Research Implementation Bodies
CCMVal (stratospheric chemistry)
AeroCom (tropospheric aerosols)
"TropChem" (tropospheric gas-phase chem)
TF HTAP
GEIA
Observational Data
ACCENT

WCRP World Climate Research Programme

Friday, 5 September 2008 Atmospheric Chemistry and Climate

09:15	Effects of Deep Cumulus Convection on Atmospheric Chemistry	Mark Lawrence
09:45	Changes in Tropospheric Chemistry and Their Impacts on Climate	Kengo Sudo
10:15	*Coffee Break*	
Session Chair: Anne Douglass		
10:45	Tropospheric Ozone: The Role of Stratospheric Variability	Jessica Neu
11:00	Improving the Representation of Ozone in the UK Met Office Model	Camilla Mathison
11:15	The Role of Ozone in Future IPCC Simulations	Lesley Gray
11:30	Surface UV Simulations in the 21st Century	Kleareti Tourpali
11:45	Impact of the Mt Pinatubo Eruption on the Hydrological Cycle With Implications for Geoengineering	Claudia Timmreck
12:00	*Lunch Buffet*	
13:00	Poster Session	
Session Chair: David Fahey		
15:30	SPARC Lecture: Projections of Stratospheric Changes and Their Role in Climate	Darryn Waugh
16:30	What Determines Tropical Tropopause Parameters? A Modelling Study with the AMTRAC CCM	Thomas Reichler
16:45	The Sensitivity of Polar Ozone Recovery to Catastrophic Sea-Ice Loss In The Northern Hemisphere	John Scinocca