THE IGAC/SPARC CHEMISTRY-CLIMATE MODEL INITIATIVE – CCMI

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CCMI co-chairs, on behalf of the CCMI Scientific Steering Committee

Our objectives

The CCMI Mission Statement:

The Chemistry Climate Model Initiative (CCMI) seeks to improve our understanding of the role of chemistry-climate interactions within the Earth system in the past, the present and in future projections. CCMI, supported by Future Earth's IGAC and the WCRP's SPARC projects, advances these goals by providing a forum for coordinated inter-model comparisons and analysis with observations, encouraging the dissemination of innovative ideas for chemistry-climate research and building a strong and inclusive global science community.

SCIENTIFIC STEERING COMMITTEE

Co-Chairs CCMI:

David Plummer	(ECC Canada, CA)
Michaela Hegglin	(University of Reading, UK)
Bryan Duncan	(NASA Goddard, US)

CCMI Scientific Steering Committee (SSC):

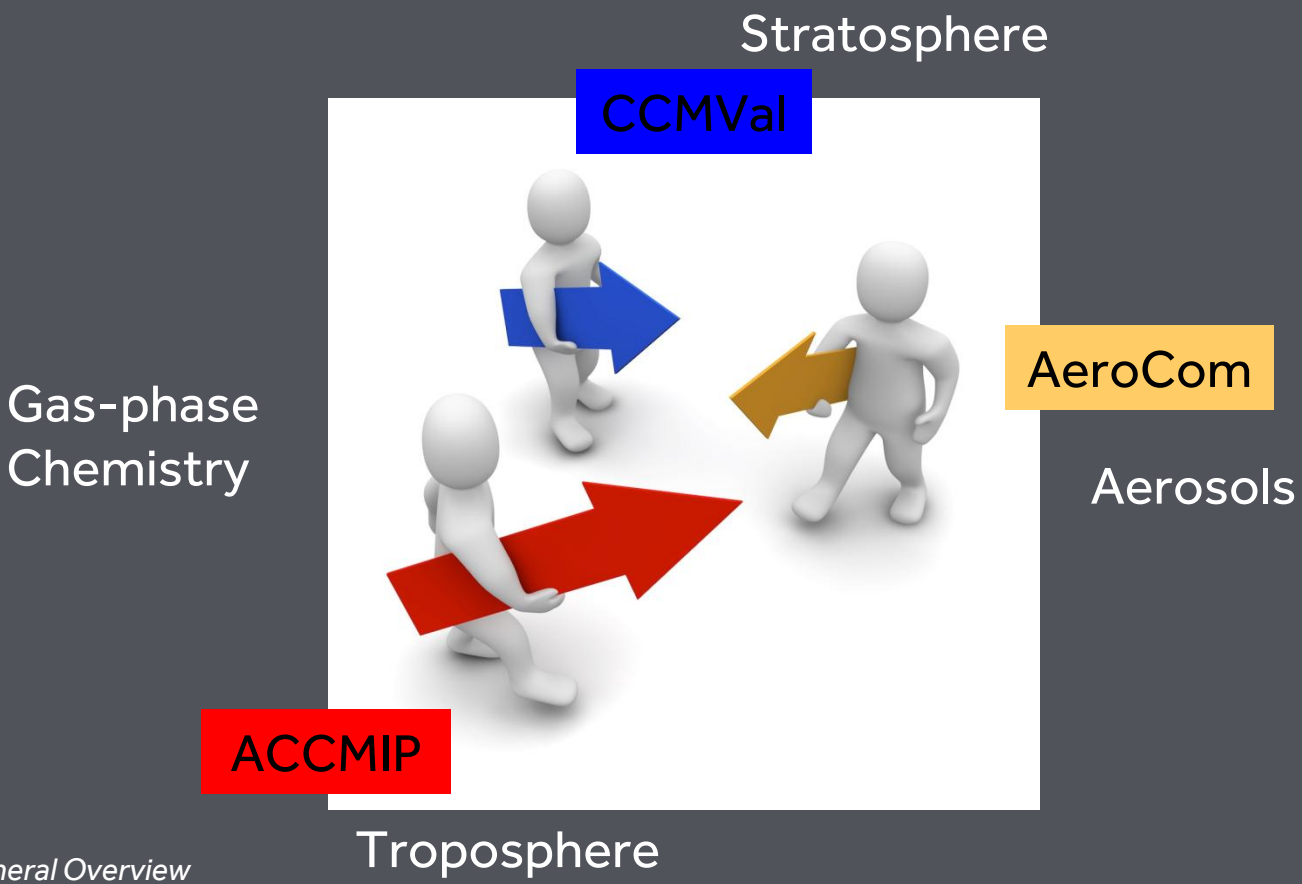
Thomas Birner	(dynamical processes, UTLS; US)
Arlene Fiore	(tropospheric chemistry and climate; US)
Andrew Gettelman	(clouds, UTLS; US)
Béatrice Josse	(chemistry-transport models; France)
Jean-Francois Lamarque	(CCM tropospheric modeller, AerChemMIP; US)
Olaf Morgenstern	(chemistry-climate modelling; New Zealand)
Gunnar Myhre	(aerosols, radiative forcing, Norway)
Tatsuya Nagashima	(chemistry climate interactions, air quality; Japan)
Clara Orbe	(atmospheric chemistry and transport; US)
Seok-Woo Son	(chemistry-climate modelling, atmospheric dynamics; South Korea)
Amos Tai	(biosphere-atmosphere coupling, ILEAPS, Hong Kong)
Paul Young	(tropospheric and stratospheric chemistry, TOAR; UK)

Liaisons:

Martyn Chipperfield and Doug Kinnison	(WMO Scientific Assessment of Ozone Depletion)
Martin Dameris	(SPARC Temperature Initiative)
Jessica Neu, Chiara Cagnazzo	(ACAM)
Björn-Martin Sinnhuber	(NDACC)

WHAT IS ccmi ?

- A joint Future Earth IGAC – WCRP SPARC activity.
- A merger of CCMVal and ACCMIP, aiming also at a stronger coordination with AeroCom.



GOALS OF CCMI

- Coordination of international chemistry-climate modeling efforts, covering questions on climate, air quality, and the ozone layer and interactions between them.
  - Key aspect is community (and where possible capacity building).
  - Key focus is to promote 'interdisciplinary' work (between modeling and observational communities, dynamicists and chemists).
- Foster the development of observation-based process-oriented diagnostics and benchmarking for model evaluation.
  - Contribute to the understanding of chemistry-climate processes.
  - Improve the representation of these processes in global models.
  - Facilitate and improve the use of observations.
- Provide simulations & analysis for process studies, understanding of the past, and investigation of future long-term changes in contribution to upcoming assessments (WMO/UNEP ozone assessment, AerChemMIP/CMIP6, IPCC).

OUTSTANDING SCIENCE QUESTIONS

- How well do global CCMs capture the *observed interannual variability and long-term trends* in tropospheric and stratospheric constituents?
  - Do we understand the observed record of *stratospheric ozone*? (Montreal Protocol)
  - Do we understand the observed record of *tropospheric ozone*? (AQ regulations)
  - How well do we understand the budget, variability, and trends of tropospheric *OH*?
  - How can we use observations to gain a process-based understanding of chemistry-climate interactions
- How have changes in atmospheric forcings impacted chemical composition and chemistry-climate coupling over the last 30 to 50 years?
  - Changes in *natural climate forcings* (Sun, volcanoes);
  - Changes in *greenhouse gases, ODSs*, and *ozone and aerosol precursor emissions*;
  - Changes in *other Earth System components (biosphere, oceans)*.
- What are the interactions between climate and air quality, with links to health, agriculture, and vegetation?

SIMULATIONS

- Reference simulations:

Name of Reference Simulation	Period	Greenhouse Gases	ODSs	SSTs/SICs	Background & Volcanic Aerosol	Solar Variability	VSLS	QBO	Ozone and Aerosol Precursors
REF-C1	**Transient simulation 1960-2010** Appropriate spin up prior to 1960	**OBS** GHG used for CMIP5 simulations, updated until 2010.	**OBS** (WMO, 2011)	**OBS** HadISST1	**OBS** Surface Area Density data (SAD)	**OBS** Spectrally resolved irradiance data, Proton ionization, Ap	**YES**	**OBS or internally generated**	**OBS** Based on Lamarque *et al.* (2010), but annual emissions
REF-C1SD (nudged for CCMs, or CTMs)	**Transient simulation 1980-2010**	**OBS** Same as **REF-C1**	**OBS** Same as **REF-C1**	**OBS** Consistent with met. reanalysis	**OBS** Same as **REF-C1**	**OBS** Same as **REF-C1**	Same as **REF-C1**	Same as **REF-C1**	**OBS** Same as **REF-C1**
REF-C2	**Transient simulation 1960-2100** 10-year spin up prior to 1960	**OBS to 2005 then RCP 6.0 (Masui *et al.*, 2011)**	**OBS + A1 scenario from WMO (2011)**	**Modeled SSTs**	**OBS** Background SAD	**YES** Spectrally resolved irradiance data, Proton ionization, Ap	**YES**	**YES**	**Same as REF-C1 until 2000 + RCP 6.0 scenario in the future**

- Scenario simulations: 1960-2010:

Name of Sensitivity Simulation	
SEN-C1-Emis	SEN-C1-fEmis
SEN-C1SD-Emis	SEN-C1SD-fEmis
	SEN-C1-SSI

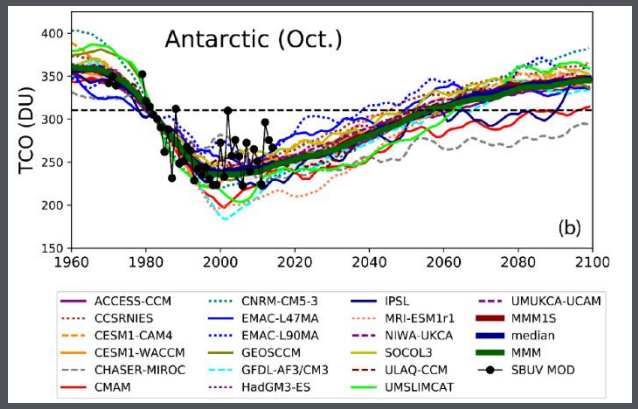
1960-2100:

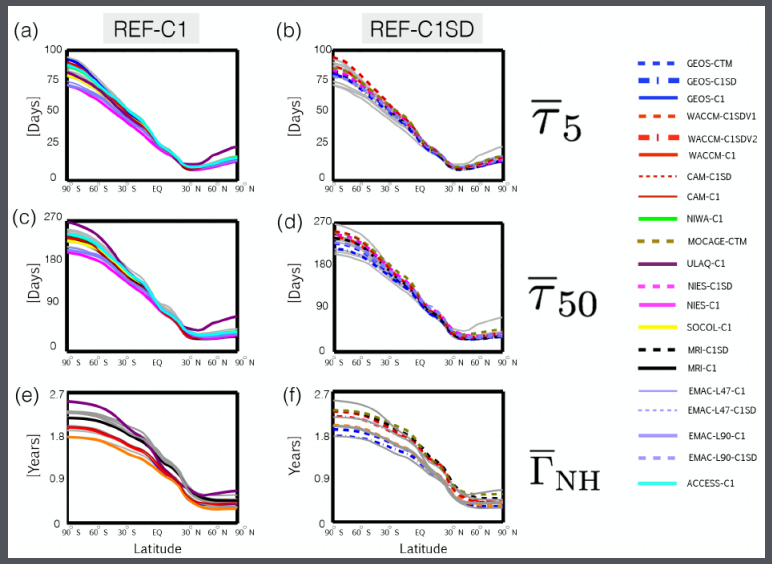
SEN-C2-RCP2.6	SEN-C2-fODS	SEN-C2-fEmis
SEN-C2-RCP4.5	SEN-C2-fODS2000	SEN-C2-GeoMIP
SEN-C2-RCP8.5	SEN-C2-fGHG	SEN-C2-SolarTrend

Eyring et al., *SPARC Newsletter, January 2013*

ANALYSIS PHASE OF CCMI-1

- 19 papers accepted in the ACP/GMD/AMT/ESSD special issue and a further five in other journals
  - Reference paper for model overview: Morgenstern et al. (2017)
  - Contribution to revised ozone recovery dates for WMO/UNEP 2018 Ozone Assessment: Dhomse et al. (2018)





- Investigation of transport timescales in the troposphere in the free-running and Specified Dynamics simulations: Orbe et al. (2018)

- Many analyses are still on-going

ACHIEVEMENTS

- Phase One is winding down
  - Beginning with Davos (mid-2012) we have had a series of workshops to define the experiments and data request, refine science questions and present analyses of the CCMI-1 simulations (Toulouse, mid-2017)
    - Typically 100 – 150 attendees
  - Around 20 reference and scenario simulations covering the 1960-2010 or 1960-2100 periods have been performed by up to 21 chemistry-climate and chemistry-transport models.
  - Special issue ACP/GMD/AMT/ESSD on CCMI is still open and analyses are continuing
  - Contribution to WMO assessment.
  - CCMI and AeroCom have jointly defined AerChemMIP in support of CMIP6.
  - Simulations for CMIP6 are defined and data request prepared.
  - Simulations are now being prepared by modeling centers.
  - **Please consider applying analyses / research questions / understandings developed during CCMI-1 to AerChemMIP**
- CCMI Phase two is gearing up

Considerations for a CCMI phase two

- Lessons from Phase 1

  - Tension between desire for large number of simulations / specialized diagnostics / outputs and the capacity of modelling groups
    - Very few outputs of hourly surface ozone in CCMI-1
    - Rapid decrease in number of models for scenario simulations
      - Nearly 40 REF-C1, C2 simulations but < 5 for SEN-C1
  - Idealized tracers have proven to be amazingly useful
    - Stratospheric Age of air
    - Now tracers for strat-trop exchange / tropospheric transport
  - One challenge we did not make much progress on is how to directly compare models with satellites / aircraft
    - Specialized outputs versus large high frequency outputs
    - Is a MIP the best place for this type of comparison?
  - The data archive is a challenge
    - ESGF versus a centralized repository
    - BADC/CEDA was not always easy, but it did make CCMI-1 possible

Considerations for a CCMI phase two

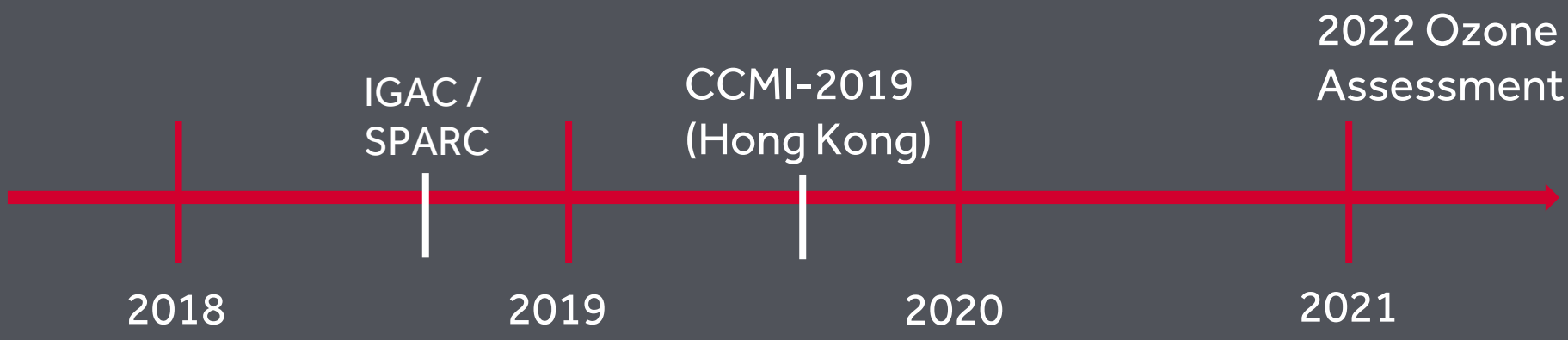
- AerChemMIP currently underway
  - Massive effort across the CCM community
  - Particular requirements for participation (coupled to an ocean, DECK simulation) means not all of the CCMI community participates
  - How does the transition of CMIP to a more 'continuous evolution' mode affect other model evaluation activities like CCMI
- 2022 WMO/UNEP Ozone Assessment is not far away
  - Revised ODS scenarios available (CCMI-1 used WMO-2010) and SSPs
  - CFC-11 report
  - Revised extra-terrestrial solar flux for CMIP6
    - NRLSSI (CCMI-1) and SOLARIS now much closer through UV
  - Not clear how much models will have 'evolved'

ccmi phase two

- CCMI is the 'front door' to the international CCM/CTM community

- Interested researchers will propose projects that address particular scientific questions
  - Various ideas have already been (informally) discussed
    - Geoengineering, Tropospheric OH, …
  - Now is the time to start making concrete plans
    - Formation of formal working groups needs to start
    - Specification of simulations, forcing data and requested variables
  - After IGAC/SPARC you will be hearing more on how this process will evolve

Formulating CCMI phase two



- We will work with the CCMI community to set up working groups and define experiments in the lead up to the 2019 workshop
  - The 2019 Workshop will be where we review the results that have come out of Phase 1 and finalize plans for Phase 2

LINKS TO OTHER COMMUNITIES

- Other activities within WCRP SPARC.
  - DAWG (reanalyses), ACAM (Asian monsoon), ATC (stratospheric temperature and composition trends)
- WMO ozone assessment.
- AeroCom.
  - Combined contribution to CMIP6.
- Observation communities.
  - NDACC, GRUAN
  - GAW (also via GAW Model Application SAG)
  - National and international space agencies.
- Intention to reach out more to Future Earth Activities via working groups.
  - TOAR, ILEAPS, AMIGO …
- CCMI can be seen as a front door to the international CCM/CTM community that is open to interested researchers to propose projects