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futureearth iCACGP IGAC SPARC Stratosphere-troposphere Processes And their Role in Climate WCRP World Climate Research Programme

# CHEMISTRY-CLIMATE MODEL INITIATIVE – CCMI

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

# SCIENTIFIC STEERING COMMITTEE

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Bryan Duncan (NASA Goddard, US) and Michaela Hegglin (University of Reading, UK)

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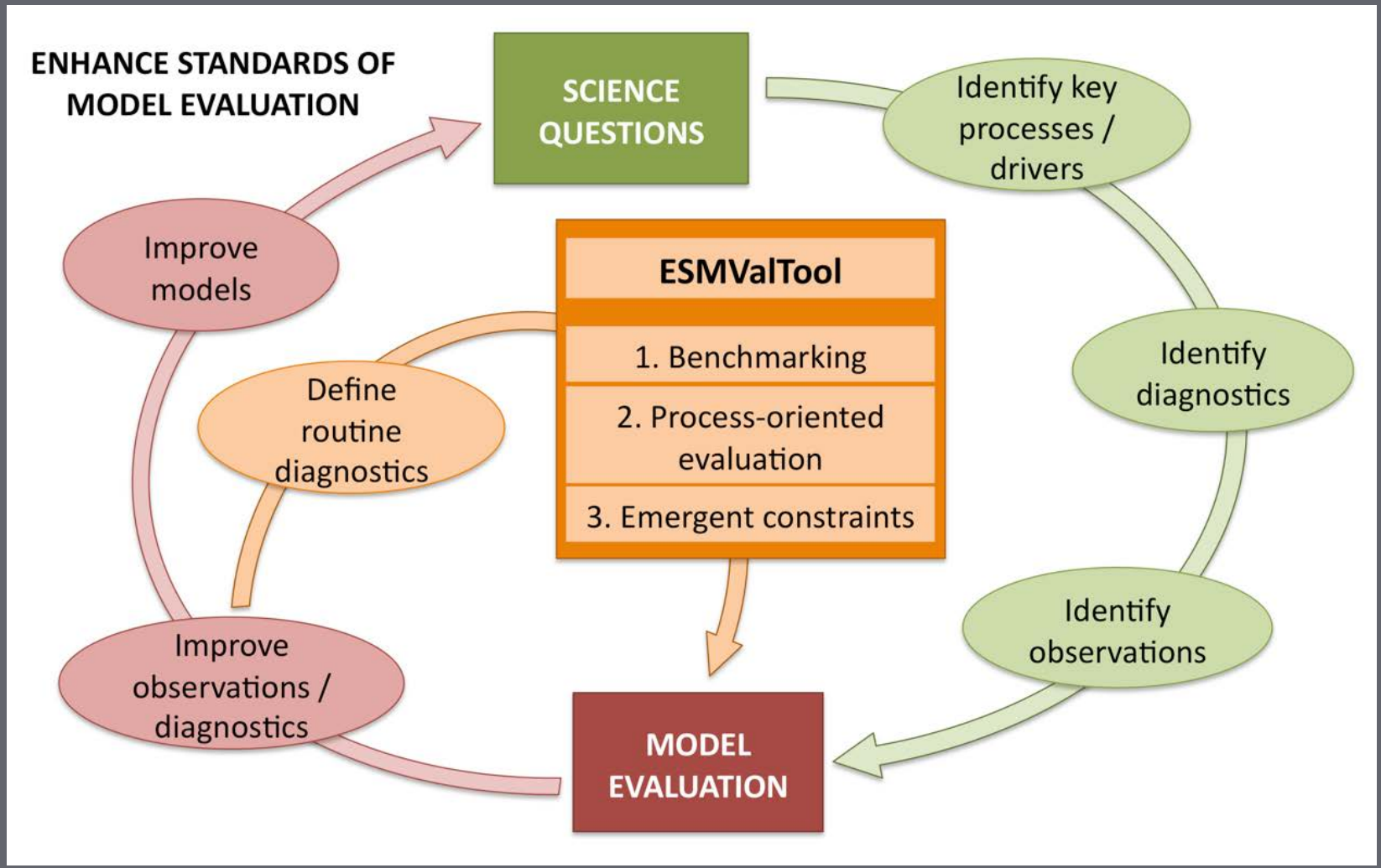
Tom Ryerson (insitu observations for model evaluation; US)
Seok-Woo Son (chemistry-climate modelling, atmospheric dynamics; South Korea)
Paul Young (tropospheric and stratospheric chemistry; UK)

# GOALS OF ccmi

chemistry-climate model initiative

- 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 modelling 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).

# PHASE-1


ENHANCE STANDARDS OF MODEL EVALUATION
SCIENCE QUESTIONS
Identify key processes / drivers
Identify diagnostics
Identify observations
MODEL EVALUATION
Improve observations / diagnostics
Improve models
Define routine diagnostics
ESMValTool
1. Benchmarking
2. Process-oriented evaluation
3. Emergent constraints

# PHASE-2

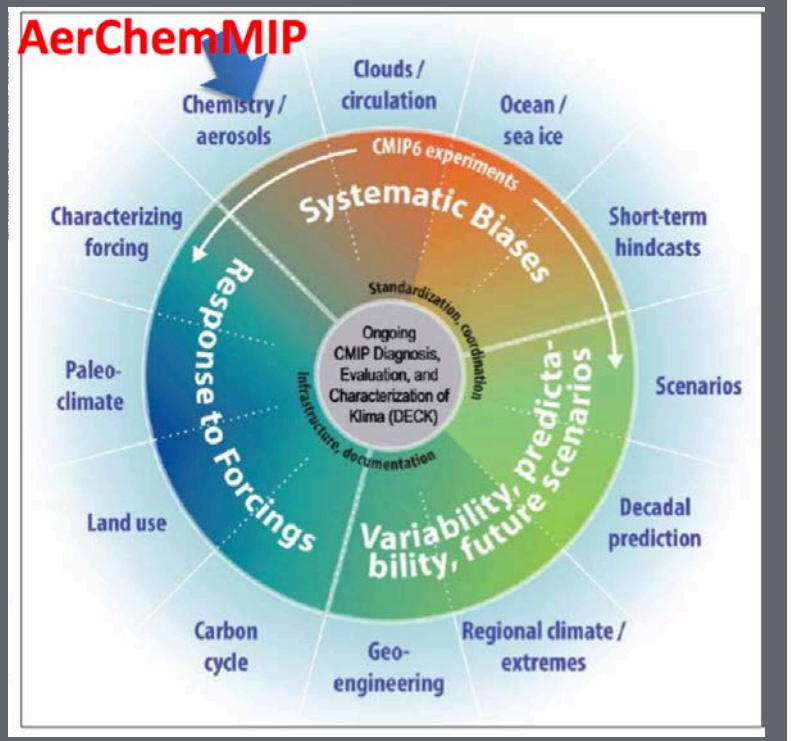
- Original plan: A set of simulations in support of the WMO 2018 report based on the lessons-learned of CCMI-1 by 2016. (*Eyring et al.*, SPARC Newsletter 2013)
- CCMI-1 simulations cover most aspects. Only a few additional simulations are needed:
  - Sen-C2-fCH4 (*Hegglin et al.,* SPARC Newsletter 2016)
  - Sen-C2-fN2O (*Hegglin et al.,* SPARC Newsletter 2016)
  - SEN-C2-CH4-RCP8.5 (most recent WMO request)
- In support of CMIP6: AerChemMIP simulations.
- CCMI-2 will be developed by 2018.
  - Key will be to focus on Earth system processes.
  - Less focused on transient simulations (to save computer time, energy, and money).
  - More focused on time-slices and sensitivity simulations (to foster understanding).
  - Engage other communities (dynamics, HTAP, AeroCom, GAIA)

# AerChemMIP

- Aerosol and Chemistry Model Intercomparison Project in contribution to CMIP6
- Joint CCMI/AeroCom effort.
- Co-leads Bill Collins, Michael Schulz, and Jean-François Lamarque
- Set of specified simulations that answer key questions of CMIP6:

**How does the Earth system respond to forcing?**

1. How have anthropogenic emissions contributed to global RF and affected regional climate over the historical period?
2. How might future policies affect the abundances of NTCFs and their climate impacts?
3. How can uncertainties in historical NTCF emissions be mapped onto pre-industrial to present-day changes?
4. How important are climate feedbacks to natural NTCF emissions, atmospheric composition, and ERF?




- Does not replace, but builds on the process-oriented model evaluations within CCMI

# ACHIEVEMENTS 2016 – I

- CCMI contribution to the planning of AerChemMIP simulations and data request.
- Contribution to AerChemMIP overview paper in GMDD (under revision)

W. J. Collins, J.-F. Lamarque
M. Schulz, O. Boucher, V. Eyring,
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G. Myhre, M. Prather,
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Geosci. Model Dev. Discuss., doi:10.5194/gmd-2016-139, 2016
Manuscript under review for journal Geosci. Model Dev.
Published: 12 July 2016
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Geoscientific Model Development Discussions

**AerChemMIP: Quantifying the effects of chemistry and aerosols in CMIP6**

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**Abstract.** The Aerosol Chemistry Model Intercomparison Project (AerChemMIP) is endorsed by the Coupled-Model Intercomparison Project 6 (CMIP6) and is designed to quantify the climate and air quality impacts of aerosols and chemically-reactive gases. These are specifically near-term climate forcers (NTCFs: tropospheric ozone and aerosols, and their precursors), nitrous oxide and ozone-depleting halocarbons. The aim of AerChemMIP is to answer four scientific questions:
...egenic emissions contributed to global radiative forcing and affected regional climate over the

# ACHIEVEMENTS 2016 – II

- More CCMI phase-1 model simulations have been produced and uploaded to the BADC CCMI data archive (around 80 TB).
- CCMI researchers have begun using these simulations for science evaluations related to climate, air quality and ozone depletion and recovery.
- CCMI has started updating and collating the planned science analyses by various participating modeling groups.
- CCMI has held a side meeting at the 2016 IGAC meeting in Breckenridge, with around 30-40 participants.
- Communication with the CCMI community is being enhanced through quarterly CCMI e-News, which highlight recent developments within CCMI.
- CCMI is improving communication with the CCMI SSG in order to engage them more efficiently in decision making and guidance for CCMI.

# PUBLICATIONS

- AerChemMIP overview paper by Collins et al. (GMDD)

  http://www.geosci-model-dev-discuss.net/gmd-2016-139/

- CCMI phase-1 model overview paper by Morgenstern et al. (GMDD)

  http://www.geosci-model-dev-discuss.net/gmd-2016-199/

- SPARC Newsletter report on 2015 science workshop published by Hegglin et al., see

  http://www.sparc-climate.org/fileadmin/customer/6_Publications/Newsletter_PDF/SPARCnewsletter_Jan2016_Web.pdf

- The CCMI community has started to publish CCMI-related science papers in the CCMI joint special issue of ACP/AMT/GMD

  http://www.geosci-model-dev.net/special_issue10_812.html

# PLANS FOR THE NEXT YEAR – I

- Finalization of CCMI phase-1 simulations and upload to the BADC and ESGF by March 2017.
- Scientific evaluations of the CCMI phase-1 simulations with expected peak in publications in summer 2017 in the joint special issue ACP/ESSD/AMT/GMD.
- Strengthen work in focus groups with key community publications expected:
  - CCMI tropospheric OH and ozone budgets (leads: Bryan Duncan & Arlene Fiore)
  - CCMI specified dynamics simulations (leads: David Plummer & Clara Orbe)
  - CCMI phase-1 overview (leads: CCMI co-chairs)
- CCMI's next workshop in the week 12-17 June 2017 in Toulouse at MeteoFrance.
- 2017 Science Workshop reports in SPARC and IGAC Newsletters, also in EOS.
- Work on new science plan for CCMI phase-2. This will include strengthening links to dynamics community, AeroCom, HTAP, and GAIA.
- Further support AerChemMIP in the coordination of the data request.
- Finalization of CCMI ozone forcing database in support of CMIP6.

# OZONE DATABASE

## Main characteristics

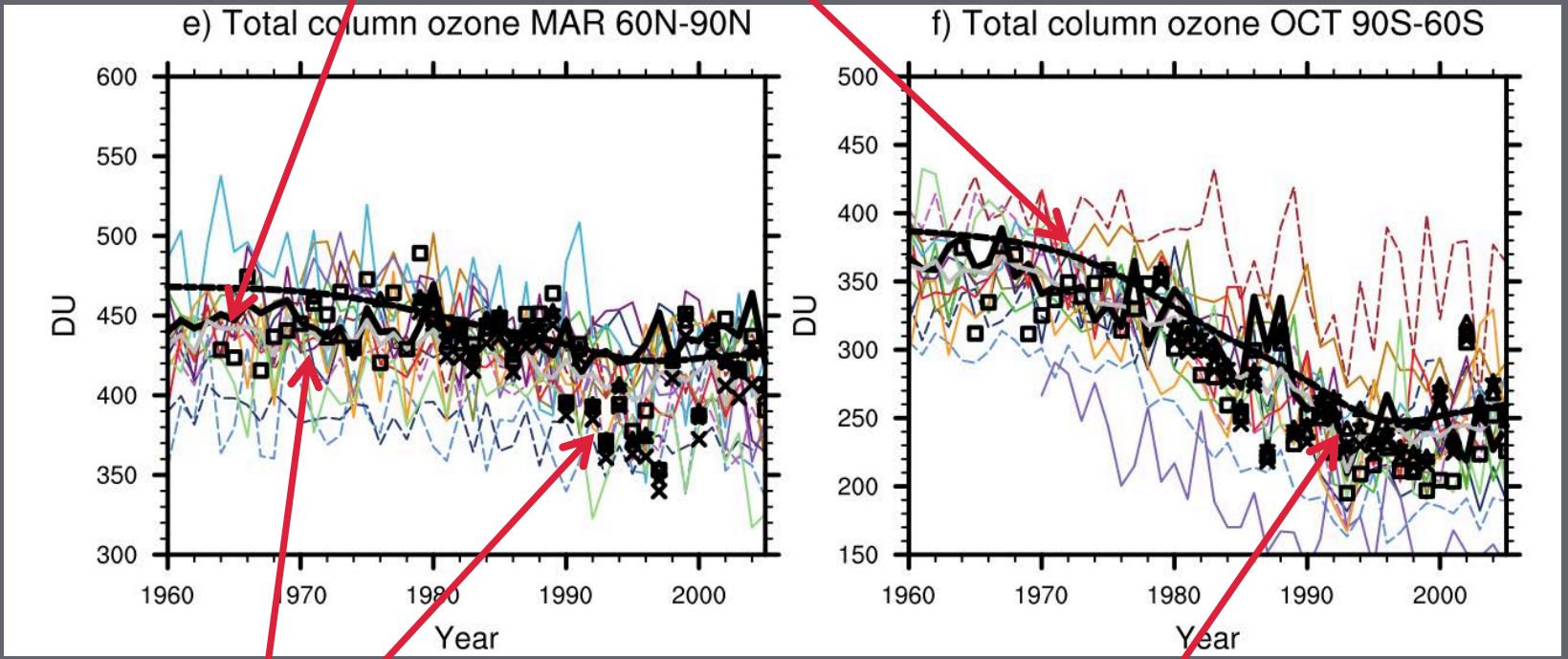
| | |
|---|---|
| Variable name: | vmro3 |
| Unit: | [mole mole$^{-1}$] |
| Spatial domain: | 3D |
| Spatial resolution: | 96x144 latxlon |
| | 66 pressure levels (between 1000 and 0.0001 hPa) |
| Temporal resolution: | monthly means |

## Main differences/advances compared to CMIP5

- Model-based only and not merged to observations, which led to inconsistencies in CMIP5:
  - Antarctic ozone hole was not deep enough in CMIP5
  - There was no ozone recovery at Northern Hemisphere mid-latitudes in CMIP5
- Produced using two well-characterized, stratosphere-troposphere resolving CCMs:
  - Stratospheric ozone distribution now resolved in 3D (not 2D as in CMIP5)
  - Stratosphere-troposphere transition now 'smooth' and without jumps (unlike in CMIP5)
  - Model data in the stratosphere now also into the past (1850-1950).
- Includes modelled year-to-year variability, not smooth 'idealized' fields as in CMIP5.
- Will have RCP2.6/4.5/6.0/8.5 scenarios into the future.

# OZONE DATABASE

Black wiggly solid: CMIP6, black dashed: CMIP5, symbols: obs, colored: CCMVal models




Absolute mean values agree better than in CMIP5, but missing variability including some very low years in NH obs in both CMIP5/6.

Better agreement with obs in SH, improvement again in mean value over CMIP5.

# THANKS TO

- SPARC/WCRP and IGAC for continuous travel support