SPARC activities related to WDAC

IGAC/SPARC Chemistry-Climate Model Initiative (CCMI)

SPARC Gravity Wave Activity

and

SPARC Data Initiative

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ccmi
chemistry-climate model initiative

The IGAC/SPARC Chemistry-Climate Model Initiative

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

IGAC

SPARC Stratosphere-troposphere Processes And their Role in Climate

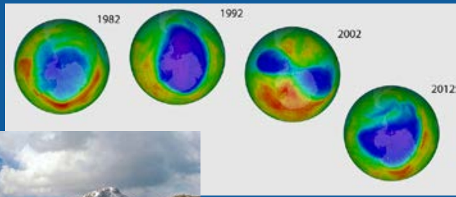
WCRP World Climate Research Programme

Co-chairs:

Michaela I. Hegglin (University of Reading, *UK*)

Jean-Francois Lamarque (NCAR, *USA*)

Formerly: Veronika Eyring (DLR; now *CMIP chair*)



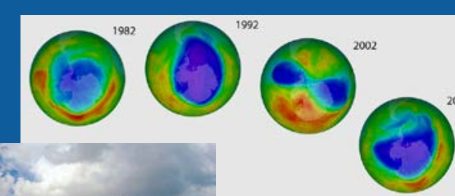
www.met.reading.ac.uk/ccmi/

Who is ccmi?

University of Reading

IGAC/SPARC CCMI workshop Boulder 2013

Over 150 participants worldwide including chemistry-climate modelers, experimentalists (satellite, aircraft, and ground-based observations), and data analysts focusing on chemistry-climate interactions.



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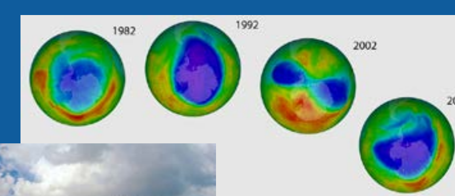
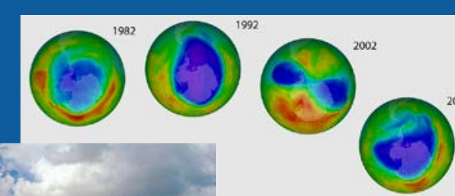
Background

- Increasingly, the chemistry and dynamics of the stratosphere and troposphere (and also a coupled ocean) are being modeled as a single entity in global models.
  - Modelling centres around the world now start to merge these CCMs with Earth System models
- In order to test their performance and to gain confidence in their predictions, these comprehensive models need to be challenged by new observations and model intercomparisons.




Goals

- Better understand the role of chemistry-climate interactions, and quantify their impact on climate, air quality, and the ozone layer.
- Contribute to the understanding and improve representation of chemistry-climate processes in global models.
- Facilitate and improve the comparison between models and observations. Use ESG (Earth System Grid)
- Provide and coordinate simulations & analysis for process studies, understanding of the past, and investigation of future long-term changes in support of upcoming assessments (WMO, IPCC).

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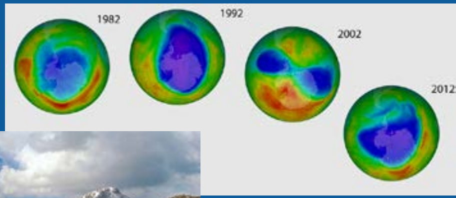
Scientific Challenges

- How well does the current generation of global chemistry-climate models capture the observed interannual variability in atmospheric composition?
  - To what extent do tropospheric and stratospheric satellite observations constrain constituent variability over the last 10-15 years? (see science example next slide)
- How have changes in aerosol loading impacted oxidative capacity of the troposphere over the last 30 to 50 years?
- How well do we understand the budget of tropospheric OH?
- How have changes in atmospheric forcings impacted chemical composition and chemistry over the last 30 to 50 years? These forcings include:
  - changes in climate forcing (ocean, Sun,…) with resulting impacts on temperature, meteorology, and water vapour, extending to stratosphere-troposphere and ocean- or land surface-atmosphere exchange,
  - changes in ozone and aerosol precursor emissions,
  - changes in land cover, and
  - changes in ODSs.

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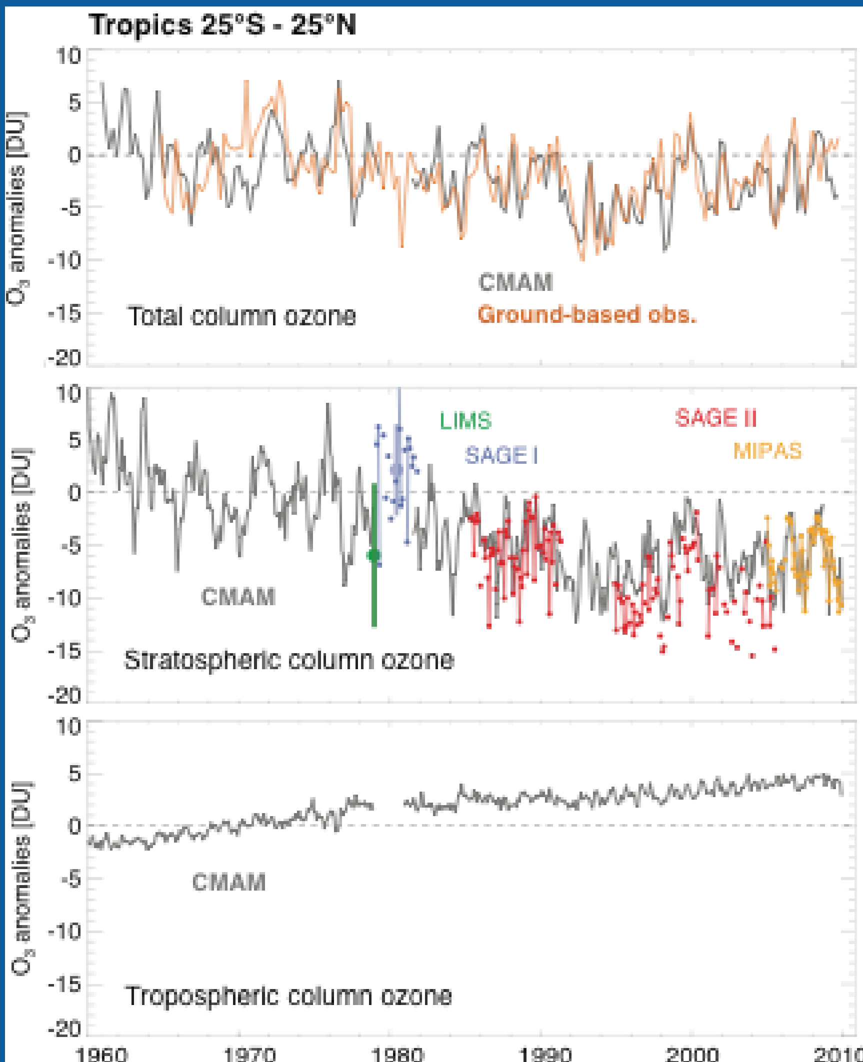
Why did tropical total column ozone show no negative trend despite known ozone depletion?

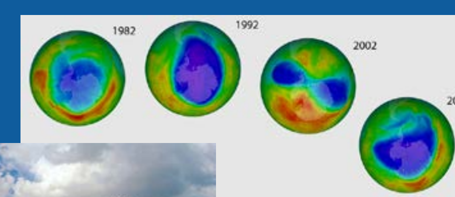


A combined model–measurement approach reconciles the apparent discrepancy between observational records of total column and stratospheric ozone:

The stratospheric ozone loss is partially offset by tropospheric increases!

The SPARC Data Initiative climatologies provided crucial vertical information needed to resolve the puzzle!

Adapted from
Shepherd et al.,
Nature Geoscience,
in press



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Summary

- CCMI is aiming at the process-oriented evaluation of chemistry-climate models to help improve model processes and gain confidence in their predictions of air pollution, the ozone layer, and their interactions with climate.
- Interdisciplinary collaboration between modelers, experimentalists and data analysts will be crucial to define representative diagnostics (and metrics) for the key physical and chemical processes that define the response of the atmosphere to climate change.
- Observational data are becoming an integral part of CCMI (e.g., obs4MIP). However, the evaluation of model performance depends crucially on data quality. This needs ongoing evaluation efforts!
- Where WDAC can help:
    1. Create support for and facilitate future observational and model data assessments.
    2. More specifically, create focus on (re-)defining and extending historical emission data bases and assessment of their uncertainties. These should include also information on surface fluxes (especially from natural sources of methane, N_2O) and deposition (i.e., ozone, reactive nitrogens)

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SPARC gravity wave activity

Co-chaired by

M. J. Alexander (NWRA, USA)
and K. Sato (U Tokyo, Japan)

Importance of global circulation in the stratosphere and mesosphere on the surface climate

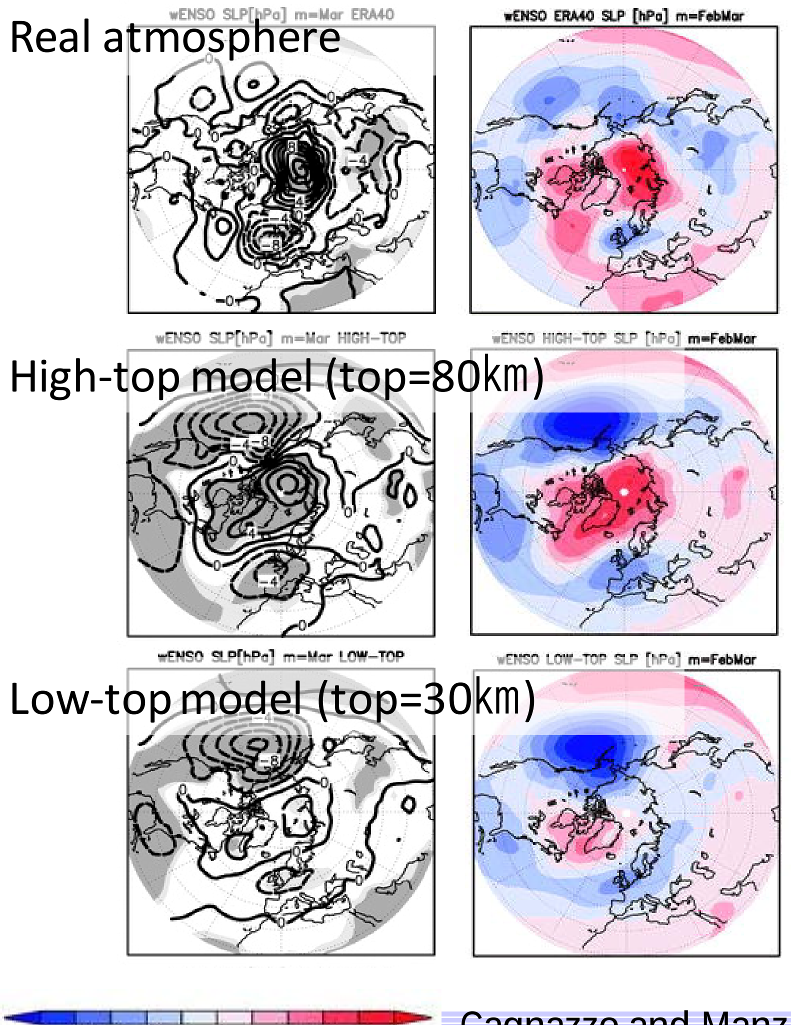
Arctic response to El Nino

Ps | Ts

Real atmosphere

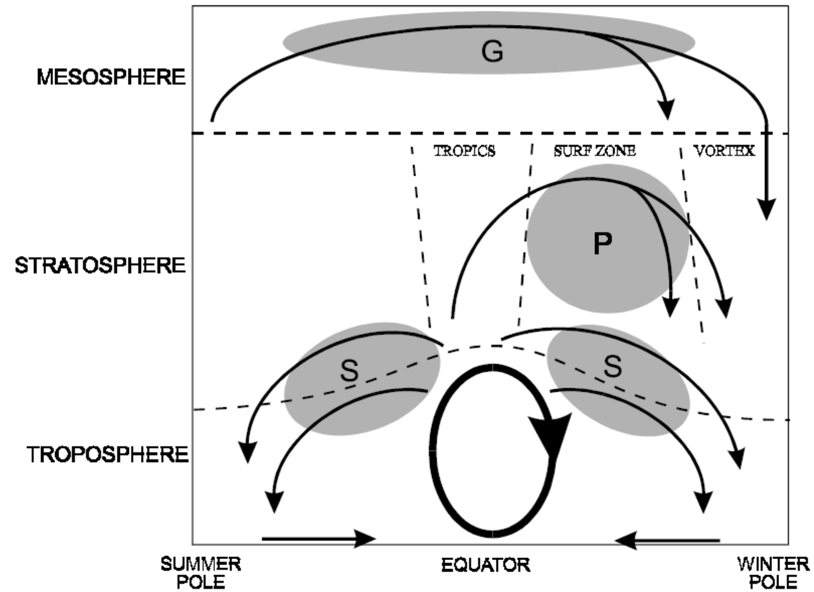
High-top model (top=80km)

Low-top model (top=30km)



Cagnazzo and Manzini (J. Climate, 2009)

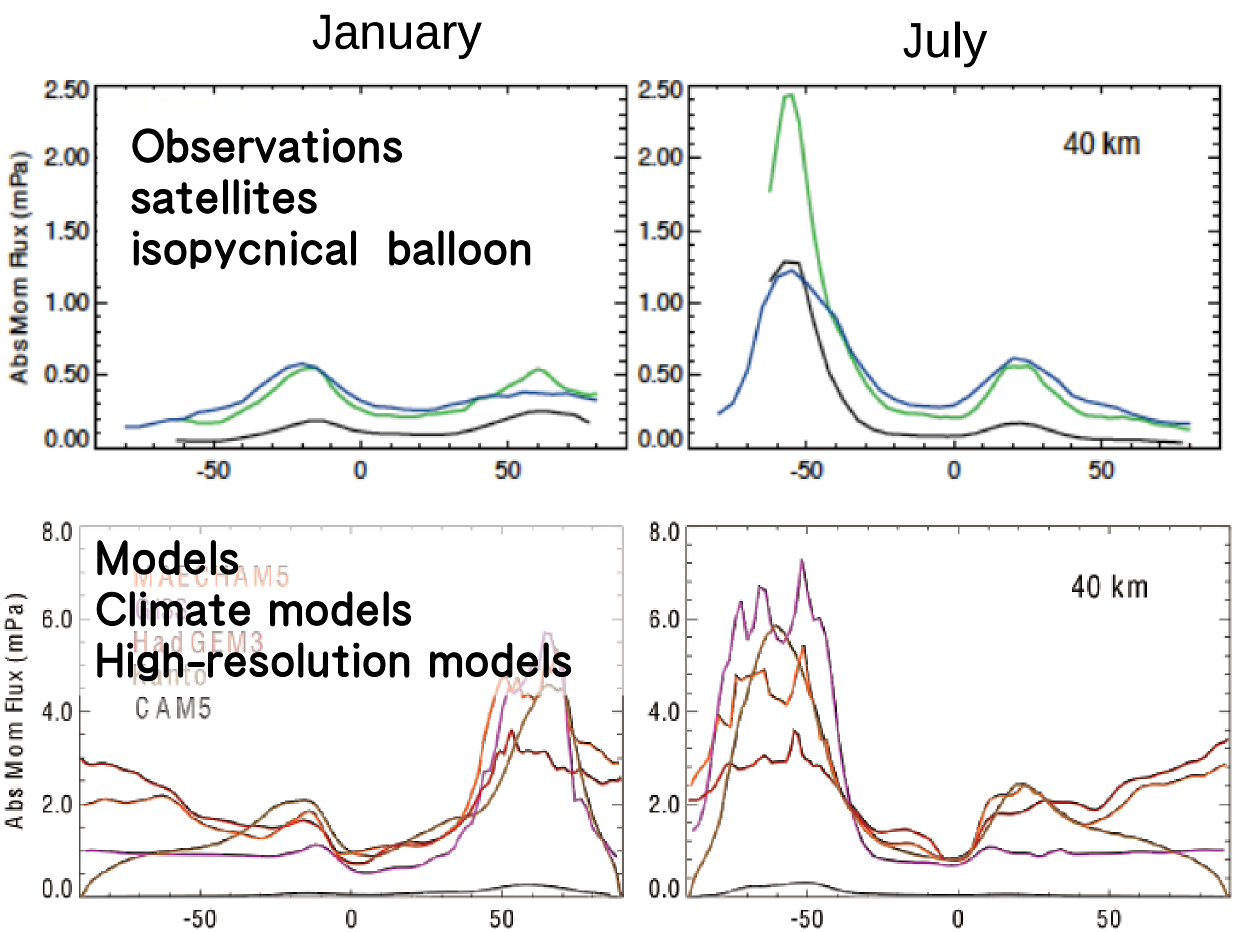
Plumb (JMSJ, 2002)



Stratosphere-mesosphere circulation is mainly wave-driven and determines

- Mass flux (stratosphere-troposphere exchange)
- Distribution of the mass (i.e. surface pressure) and minor constituents (chemistry and radiation)
- Distribution of temperature through geostrophic and hydrostatic balances

SPARC gravity wave activity



Geller et al. (J. Climate, 2013)

Some significant difference btwn observation and GW-parameterizaton (ISSI gravity wave team, led by J. Alexander)

There is a link of SPARC gravity wave activity with Working Group on Numerical Experimentation (WGNE) on surface momentum fluxes.

The SPARC Data Initiative

Michaela I Hegglin (*University of Reading, UK*) & Susann Tegtmeier (*GEOMAR, Kiel, GE*)
(Co-leads)

Objectives

First comprehensive inter-comparison of 18 different **limb** satellite instruments from NASA, JAXA, CSA, ESA, and other national space agencies, evaluating 25 different chemical trace gases and aerosol.

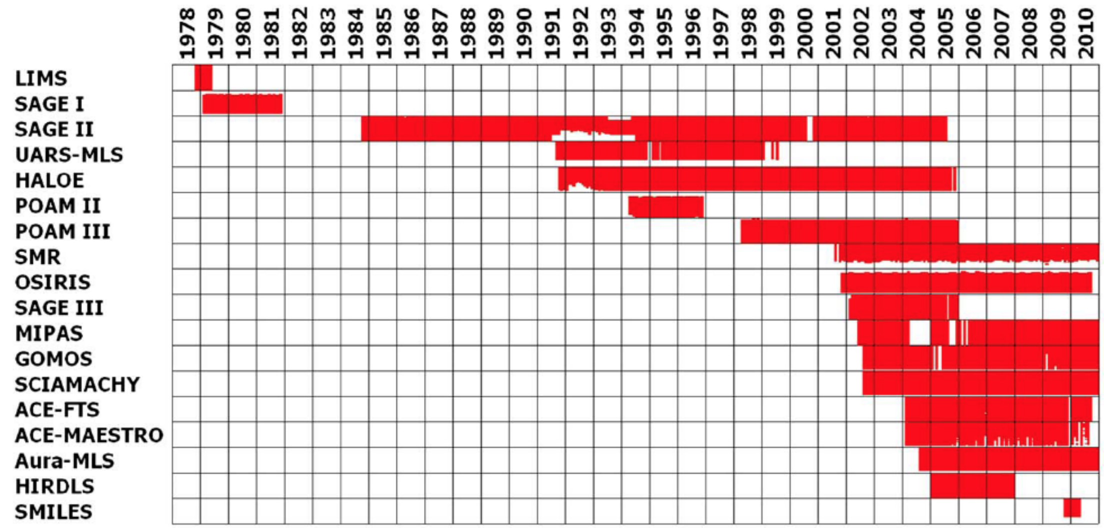
- Summarize information and knowledge of instruments, and highlight differences between derived datasets
- Provide guidance to space agencies about required improvements and future observations
- **Peer-reviewed SPARC report** and journal publications

	O_3	H_2O	CH_4	N_2O	CCl_3F	CCl_2F_2	CO	HF	SF_6	NO	NO_2	NO_x	HNO_3	HNO_4	N_2O_5	$ClONO_2$	NO_y	HCl	ClO	HOCl	BrO	OH	HO_2	CH_2O	CH_3CN	aerosol
ACE-FTS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x		
Aura-MLS	x	x		x			x						x					x	x	x		x	x			
GOMOS	x										x															x
HALOE	x	x	x					x		x	x	x						x								
HIRDLS	x				x	x					x		x													
LIMS	x	x									x		x													
MAESTRO	x																									
MIPAS	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x				x		
OSIRIS	x										x	x_d					x_m				x					x
POAM II	x										x															x
POAM III	x	x									x															x
SAGE I	x																									
SAGE II	x	x									x															x
SAGE III	x	x									x															x
SCIAMACHY	x	x									x	x_d									x					x
SMILES	x												x					x	x	x	x		x		x	
Odin/SMR	x	x		x			x			x			x				x_m		x				x_{lc}			
TES	x_t						x_t																			
UARS-MLS	x	x											x						x							

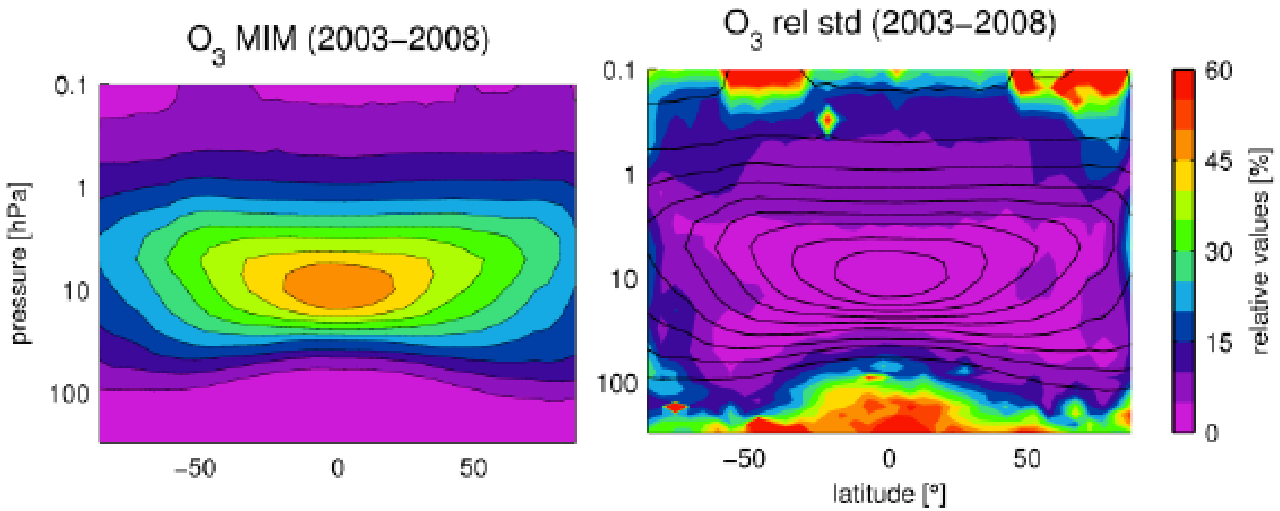
Example ozone evaluations

Tegtmeier et al., JGR 2013

Assessment of available data sets: Only OSIRIS, SMR, ACE-FTS and Aura-MLS are still up and running, however, all of these are already past their expected instrument lifetimes!



Assessment of data quality: New knowledge of inter-instrument differences and of the atmospheric mean state of ozone and its uncertainty (defined as the inter-instrument spread).



Summary

Importance of intercomparison project

Knowledge of quality of different satellite data sets is crucial to improve different applications:

- Tracer scenario validation (Montreal Protocol, Cl_y)
- Model validation projects (CCMI, IPCC)
- Trend analyses (e.g., stratospheric water vapour, ozone, temperature)
- Empirical studies of stratospheric climate and variability

WCRP support highly appreciated!

- Financial support to hold several team meetings was crucial to the success of the activity
- Also, provided framework (SPARC) that guaranteed international buy-in to the activity.

Questions/Issues:

- Identification of looming gap in vertically resolved (1-3 km) stratospheric observations. Where does the stratospheric community get its information from beyond 2020 ?!

Other important SPARC topics related to WDAC3

1. The need of the SPARC stratospheric temperature activity for a merged middle and upper stratosphere using SSU (Stratospheric Sounding Unit ended in 2005)+AMSU (Advanced Microwave Sounding Unit ongoing) time series. See activity of SASBE (Site Atmospheric State Best Estimate) also.
2. The role that SPARC can play as a facilitator to bring observations, made through organizations with close connections to SPARC e.g. NDACC, GRUAN, GAW, for use in model validation through obs4MIPs.
3. The completion of the recent SPARC-ESA initiative (SPIN) and the work that was done within SPIN regarding data measurement requirements.
4. SPARC serving the IPCC 6th assessment report by (hopefully) providing the ozone boundary conditions for the CMIP6 simulations.
5. The relocation of the SPARC Data Centre to BADC.
6. CCMI intends to use the ESG (Earth System Grid) for distributing the new CCMI simulations.
7. Maybe raise the development of the ESM diagnostic tool that has evolved out of the CCMVal diagnostic tool led by Andrew Gettelman.
8. The wrap up of SI2N and the SPARC Data Initiative.