Stratospheric Processes And their Role in Climate (SPARC)

Co-chairs: Ted Shepherd (Univ. of Reading), Greg Bodeker (Bodeker Scientific)

SPARC Office Director: Johannes Staehelin (ETH Zürich)

Other SPARC Office staff: Fiona Tummon, Anke Witten and Carolin Arndt Foppa (ETH Zürich), Diane Pendlebury (Univ. of Toronto)

WCRP Liaison: Vladimir Ryabinin

Objectives and Approach

- *SPARC facilitates research and highlights to the climate research and NWP communities the importance of stratospheric and upper tropospheric processes in the climate system*

- The scientific goals of SPARC are currently encapsulated within three main themes:
  - Detection, attribution, and prediction of stratospheric change
  - Chemistry–climate interactions
  - Stratosphere–troposphere dynamical coupling

SPARC works by:

- Being responsive to the need for scientific input to international scientific assessments for the benefit of WCRP, WMO/UNEP Ozone Assessment, IPCC, and space agencies
- Identifying manageable activities where coordination at an international level can make a difference and can lead to a significant added value – seek emerging talent
- Having clear deliverables for each activity, such as peer-reviewed reports and scientific reviews, which summarise the state of knowledge and identify gaps and research needs
- Anticipating, facilitating and stimulating new directions for research to address emerging issues

SPARC vehicles include:

- SPARC Newsletter (365 citations in the Web of Science)
- SPARC Reports (240 citations in the Web of Science)
- Refereed review papers (most recently, a QJRMS 2010 paper on gravity waves led by Joan Alexander)
- Papers from SPARC activities (e.g. Pawson et al. 2000; Ramaswamy et al. 2001; Randel et al. 2009; Eyring et al. 2006, 2007; dozens of CCMVal papers)
- Interdisciplinary workshops to cross boundaries
- Working groups, e.g. data assimilation
- General Assemblies (normally every 4 years)
  - *Last one was in Bologna in 2008, next will be in 2014*

Metrics of success

- The response of the scientific community to any particular activity, judged by its level of commitment to and engagement in the activity
- The response of national agencies to SPARC activities
- Clear outcomes or deliverables, the existence of a well-defined timeline for each activity, and the ability to meet that timeline
- Production of new data sets, and the extent of their use
- Production of peer-reviewed scientific reports or journal publications, and the extent of their use

Metrics of success, continued

- Quality of the SPARC Newsletter, judged both informally and through citations to it in the peer-reviewed literature
- Impact of SPARC activities on scientific assessments, the WMO/UNEP Ozone Assessment being of particular importance for SPARC
- Contribution to capacity development, involvement of developing nations in SPARC activities
- SPARC being approached to deliver research
- Engagement of end-users

Main Activities and Accomplishments over the Past Year

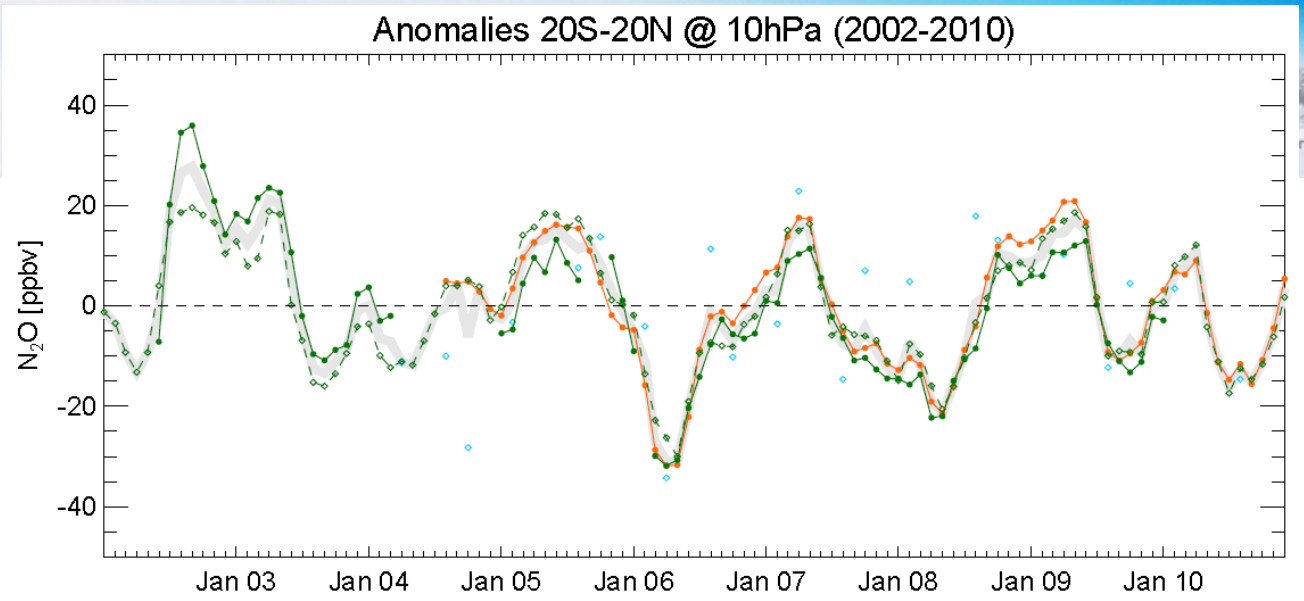
SPARC Data Initiative: Evaluation of stratospheric trace gas and aerosol climatologies from satellites

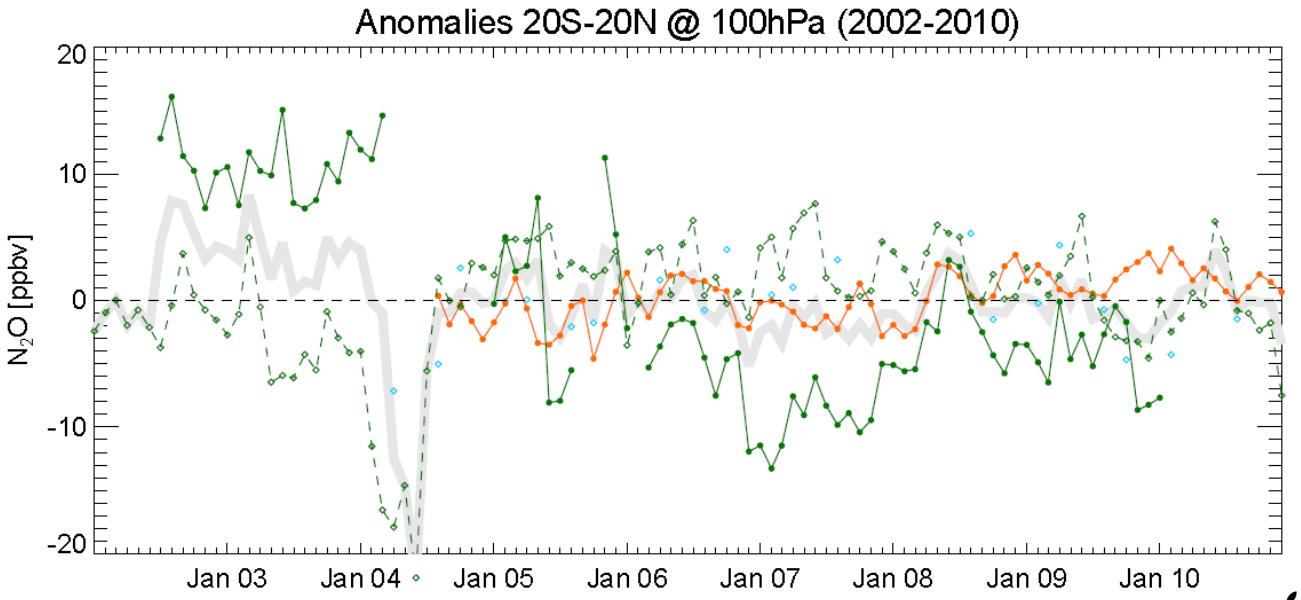
	O_3	H_2O	CH_4	N_2O	CCl_3F	CCl_2F_2	CO	HF	SF_6	NO	NO_2	NO_x	HNO_3	HNO_4	N_2O_5	$ClONO_2$	NO_y	HCl	ClO	HOCl	BrO	OH	HO_2	CH_2O	CH_3CN	aerosol
ACE-FTS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x		
Aura-MLS	x	x		x			x						x					x	x	x		x	x			
GOMOS	x										x															x
HALOE	x	x	x					x		x	x	x						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							

Leads: Michaela Hegglin (Reading) and Susann Tegtmeier (Kiel)

N_2O interannual variability, 2002-2010

Time series of deseasonalized N_2O for 20S–20N at 100 and 10 hPa



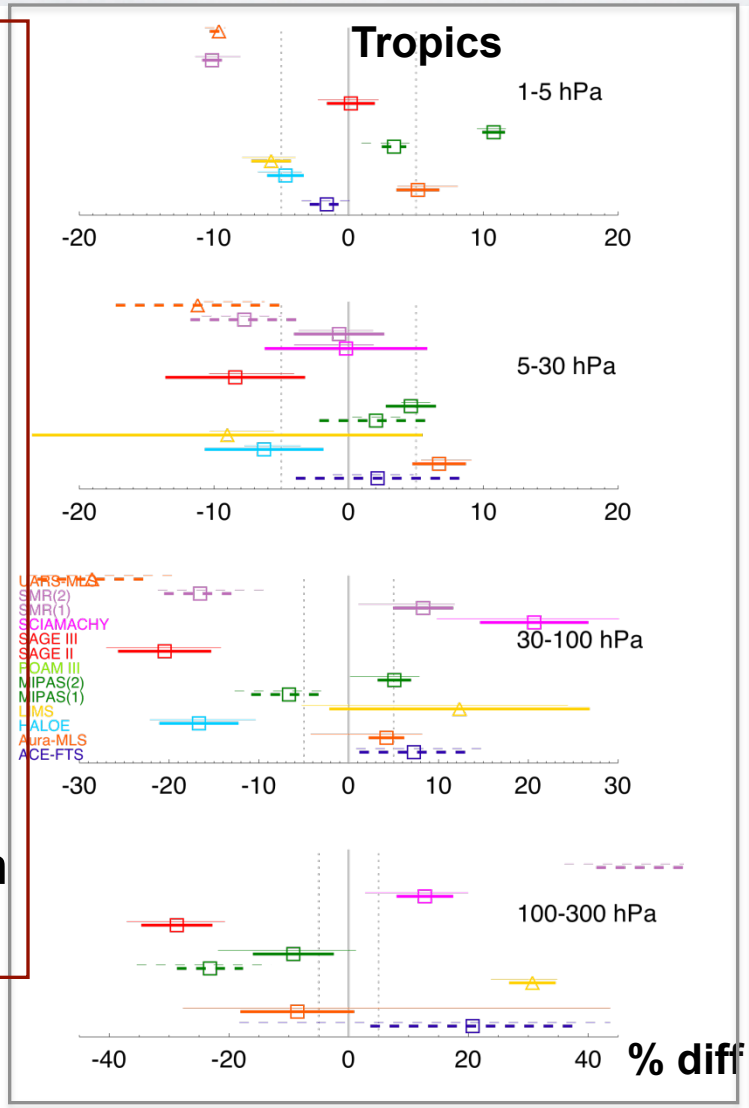


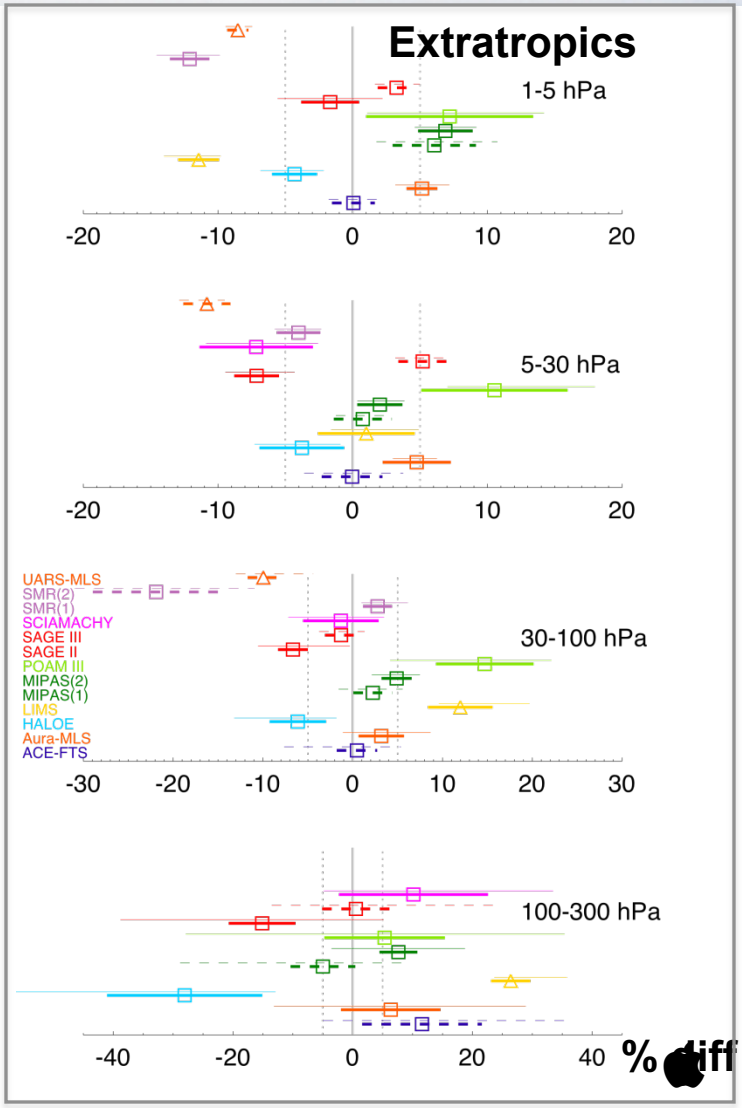
Instruments agree well at 10 hPa, displaying a strong QBO signal, but do not capture the interannual variability at 100 hPa coherently

H_2O uncertainty summary, 2003-2008

Climatological evaluations of H_2O are generally within ±10% of the multi-instrument mean, but discrepancies are larger in the UTLS and the tropics

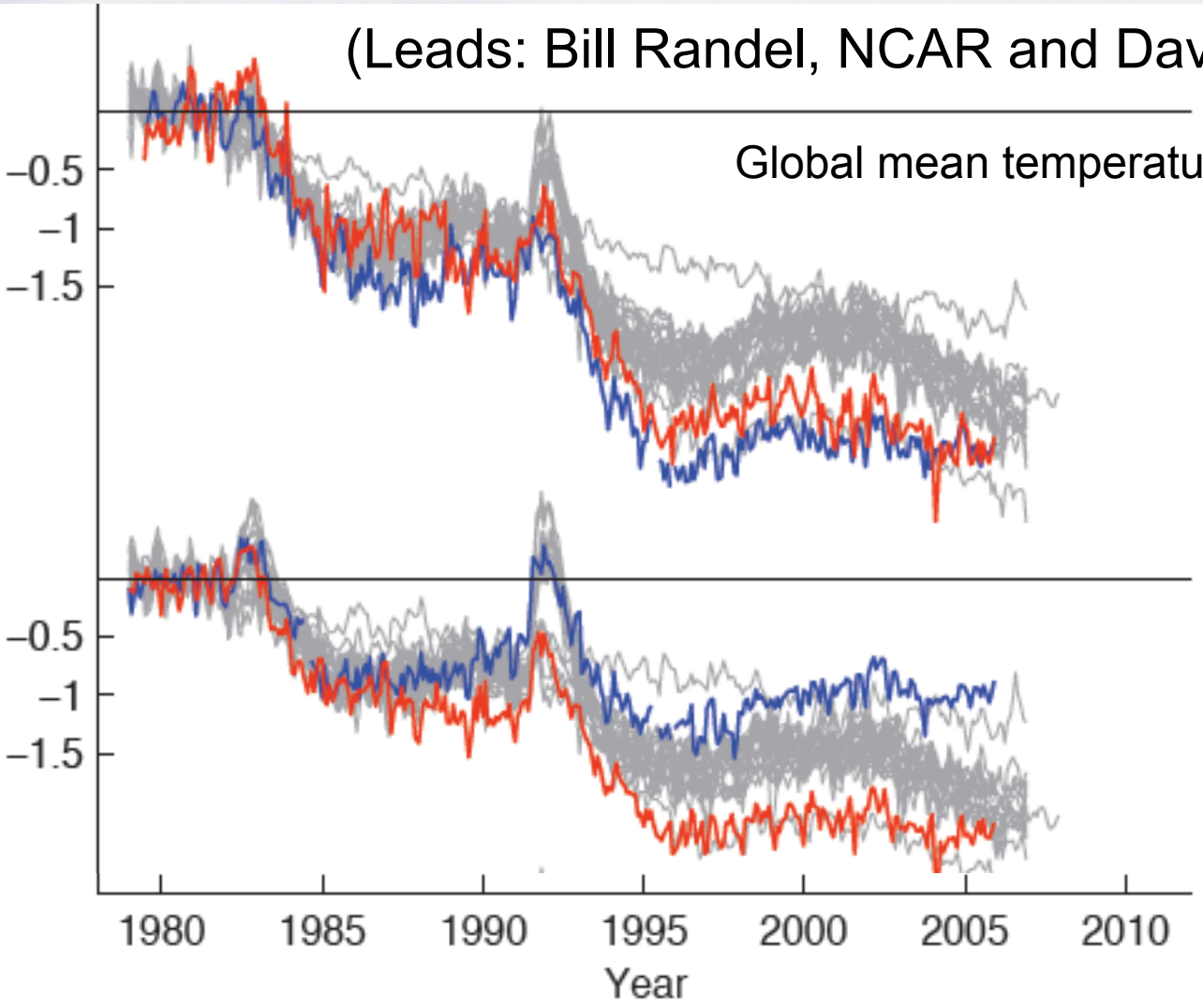
Need better characterization of obs errors!





SPARC Temperature Trends Activity: Evaluation of new NOAA SSU data products

(Leads: Bill Randel, NCAR and Dave Thompson, CSU)

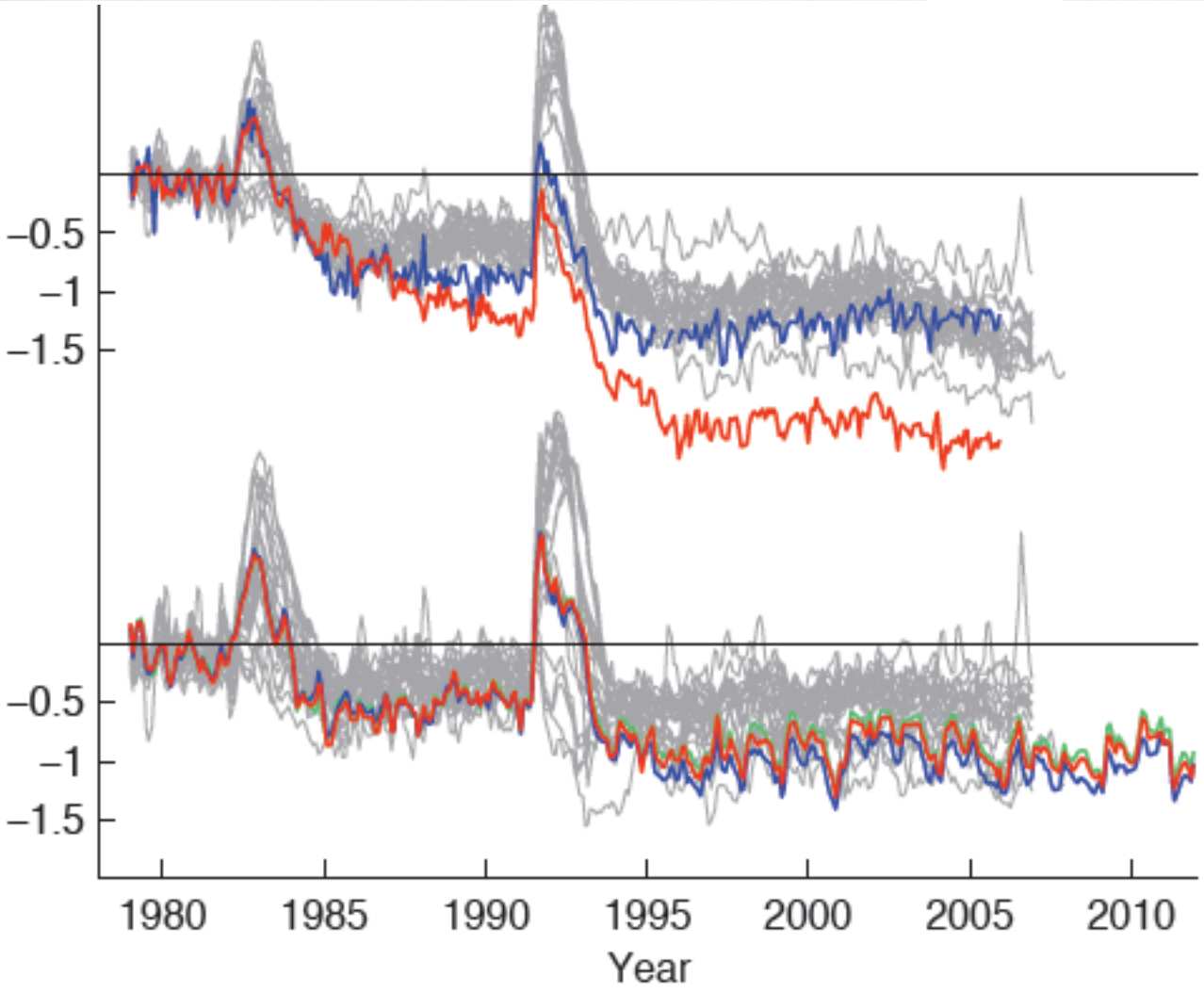


SSU Ch. 3 (~40-50 km)
NOAA and Met. Office

Gray indicates CCMVal models, using appropriate weighting functions

SSU Ch. 2 (~35-45 km)
NOAA and Met. Office

Global temperature anomalies, lower stratosphere



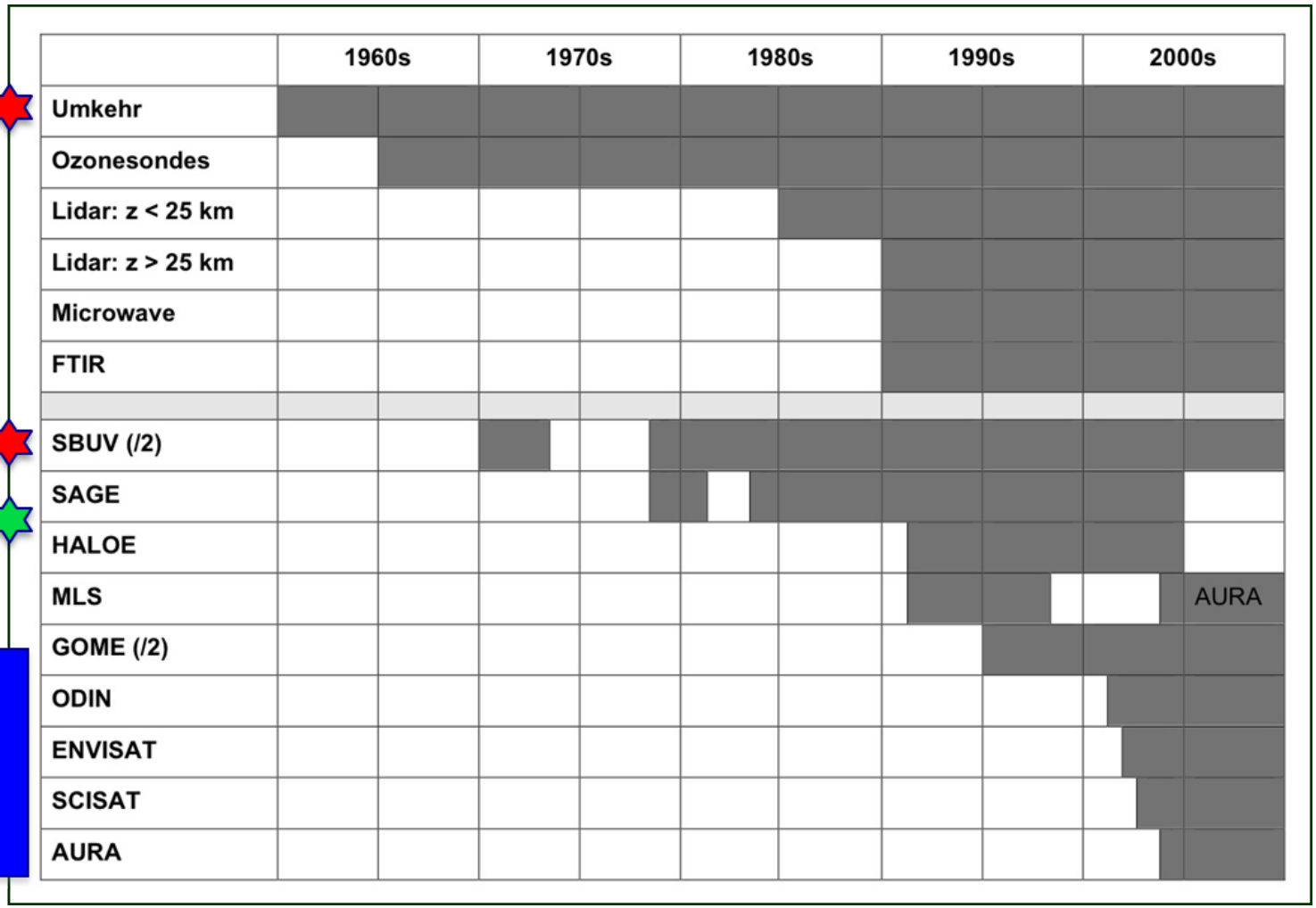
Gray indicates CCMVal models, using appropriate weighting functions

SSU Ch. 1 (~25-35 km)
NOAA and Met. Office

MSU Ch. 4 (~15-20 km)
NOAA, RSS, and UAH

Initiative on changes in the vertical distribution of ozone

(Lead: Neil Harris, U Cambridge)



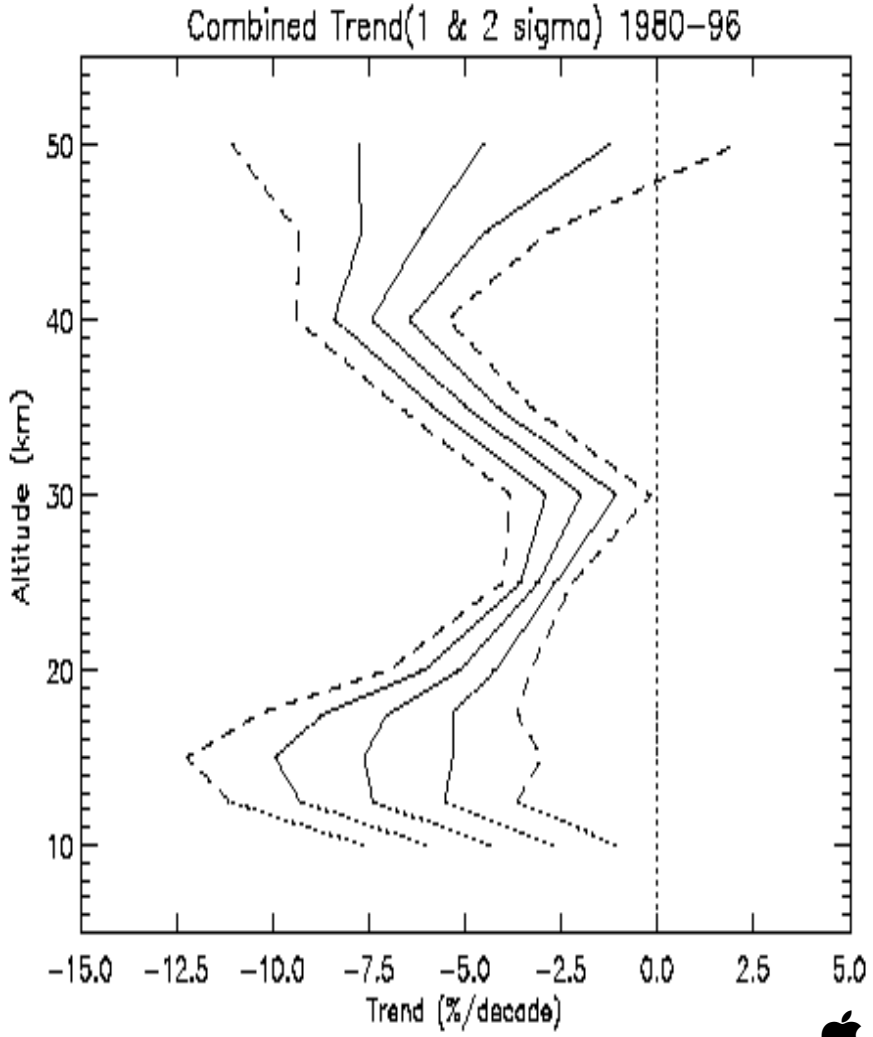
A SPARC activity specifically established to meet the needs of a client, i.e. the WMO/UNEP ozone assessment

A collaborative initiative with IGACO, IO_3C and NDACC

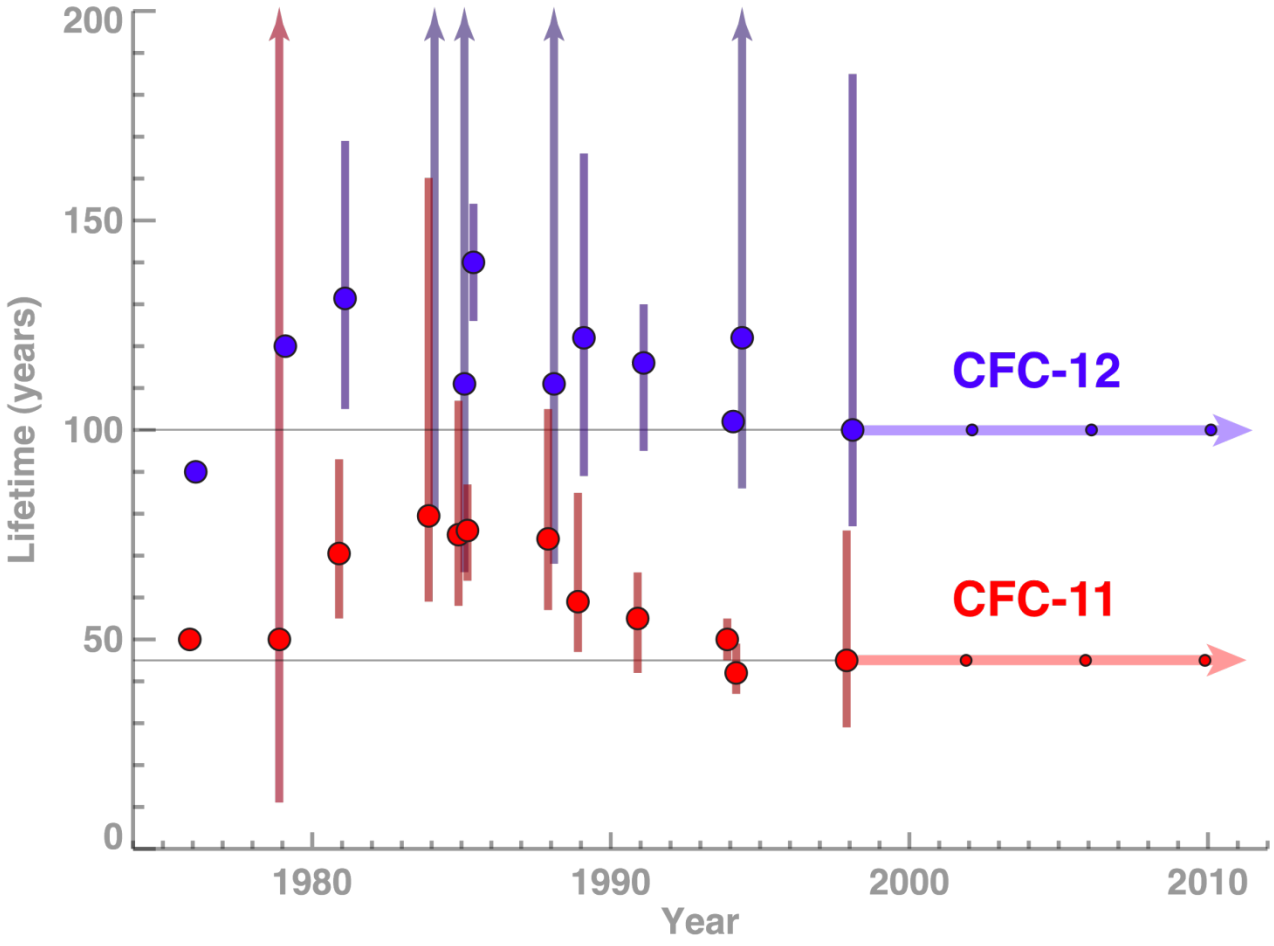
A focus on ozone needs for climate studies

Initiative on changes in the vertical distribution of ozone

- Assess and extend current knowledge and understanding of the vertical distribution of ozone
- Update the ‘iconic’ figure that describes in the most accessible way how ozone has changed over the past 50 years
- Many historical databases reworked
- Much new activity on how best to merge databases
- SPARC connects data providers to data users (at the policy level) through appropriate channels, i.e. WMO/UNEP ozone assessments.
- Special journal issue including 3 overview papers

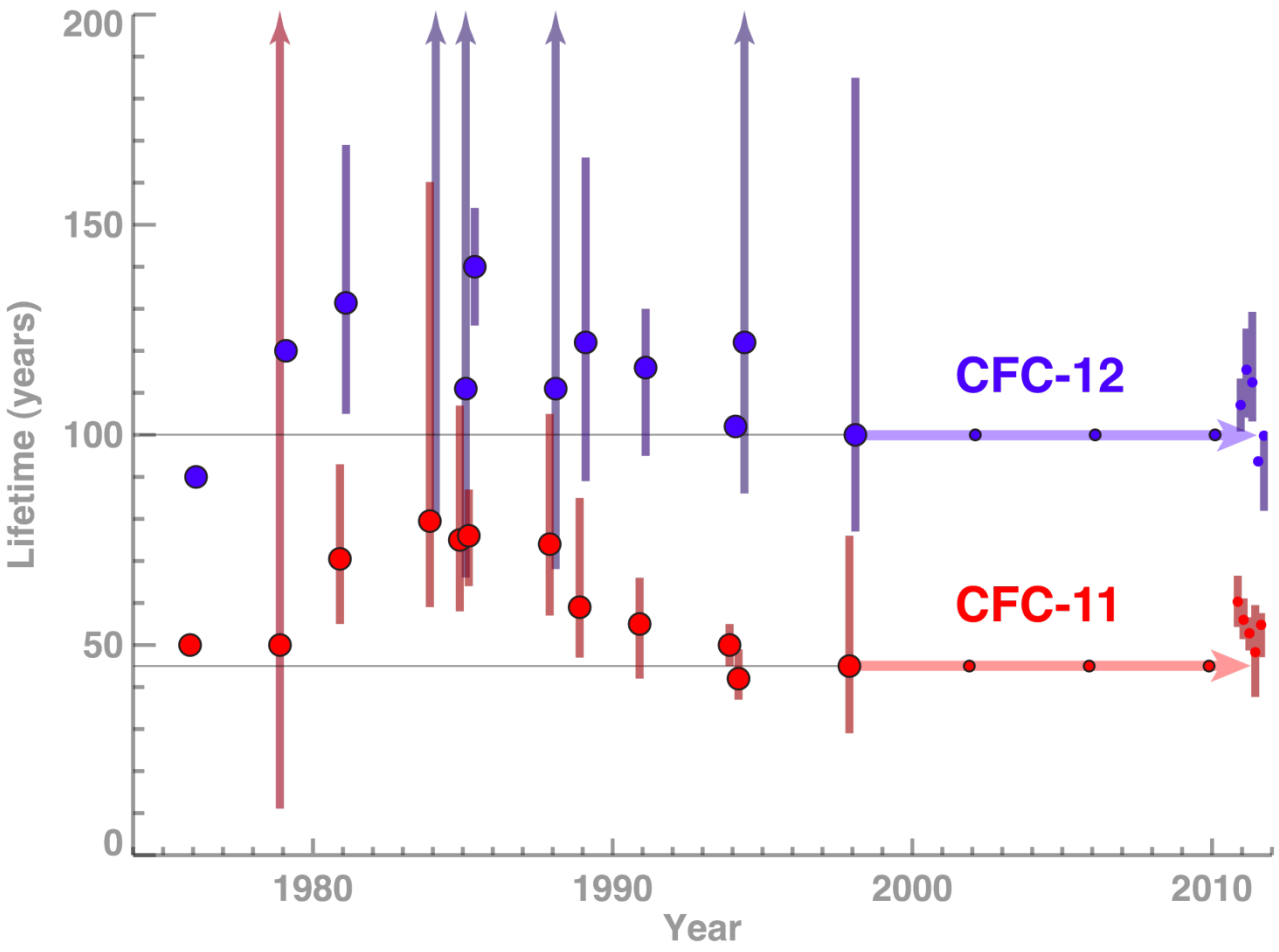


Lifetimes evaluation
(Lead: Paul Newman, NASA)



- Again a response to the needs of the policy community: the 2010 WMO/UNEP ozone assessment highlighted the need for revision of lifetimes of some important ODSs (e.g. CFC-11)
- First re-evaluation of ODS lifetimes since 1998 and first in-depth adjustment since 1994
- Re-evaluation essential for budget closure

Lifetimes evaluation

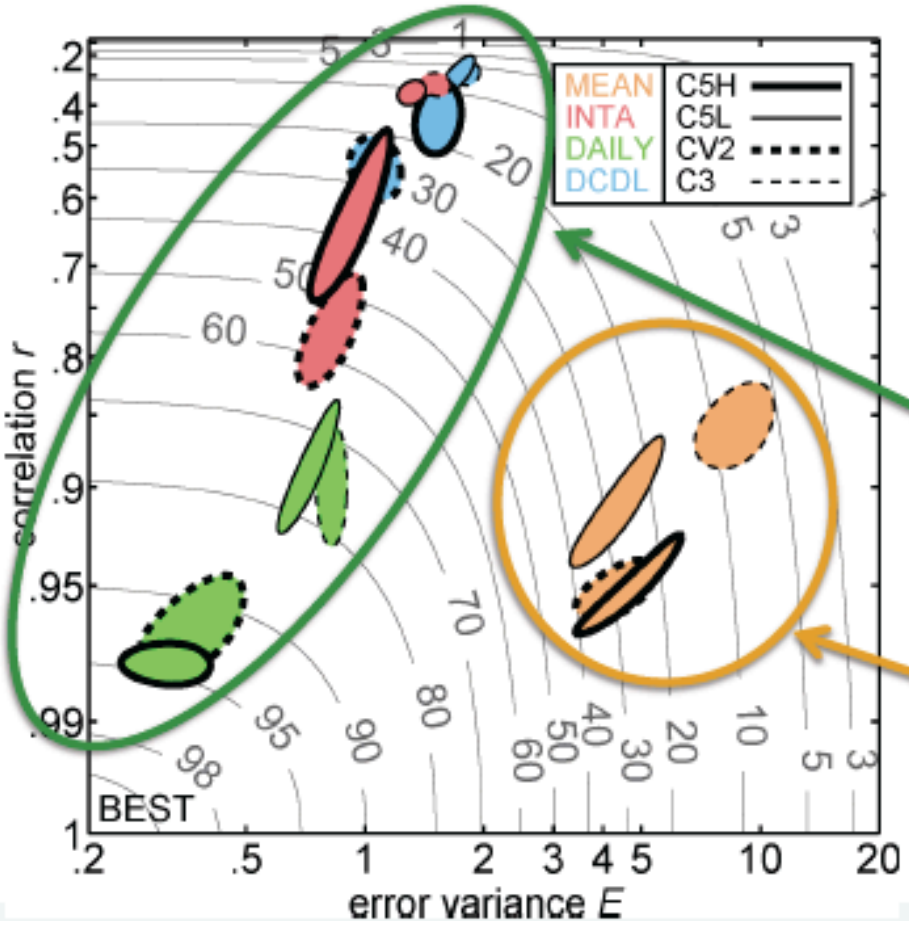


- New estimates tend to be higher than old values
- Scatter is much smaller but somewhat inconsistent for CFC-12
- Uncertainties of lifetimes have been significantly reduced via a re-evaluation of the photochemical data
- First draft of report has been completed and will be submitted for peer review in September 2012

DynVar (Dynamical Variability)

(Lead: Elisa Manzini, MPI-Hamburg)

- Modelling the stratosphere in the CMIP5 models (skill)



Climate and Variability of the stratosphere. Charlton-Perez et al. (submitted to JGR 2012):

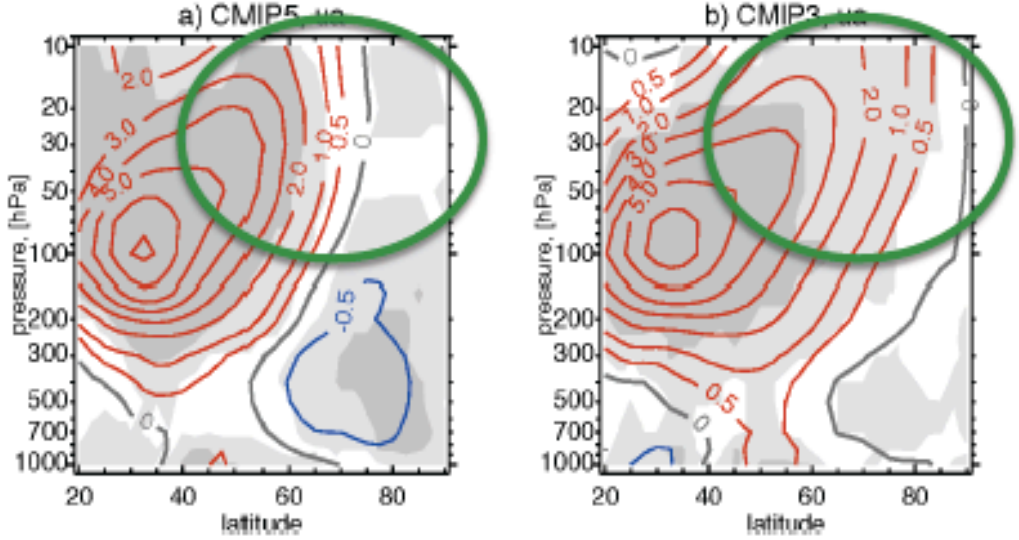
Assessing performance in the stratosphere (90S-90N, 100-10 hPa)

Stratospheric variability at all time scales is better simulated in the CMIP5 models with tops above the stratopause

Mean flow better simulated in the CMIP5 than CMIP3 models

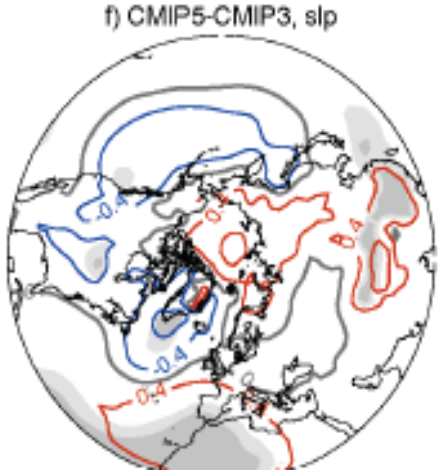
DynVar (Dynamical Variability)

- Arctic wintertime response to CO_2 increase in CMIP5



DJF response to 1%CO_2 increase:

New in CMIP5 wrt CMIP3: negative zonal wind response at high latitudes => The stratospheric polar vortex expands



Difference CMIP5 minus CMIP3 in response:

Positive SLP in the Arctic
=> Consistent with downward influence of negative zonal wind response (Scaife et al CD 2012, Karpechko and Manzini JGR 2012)

Gravity-wave activity
(Lead: Joan Alexander, NWRA, Boulder)

- New ISSI activity recently approved

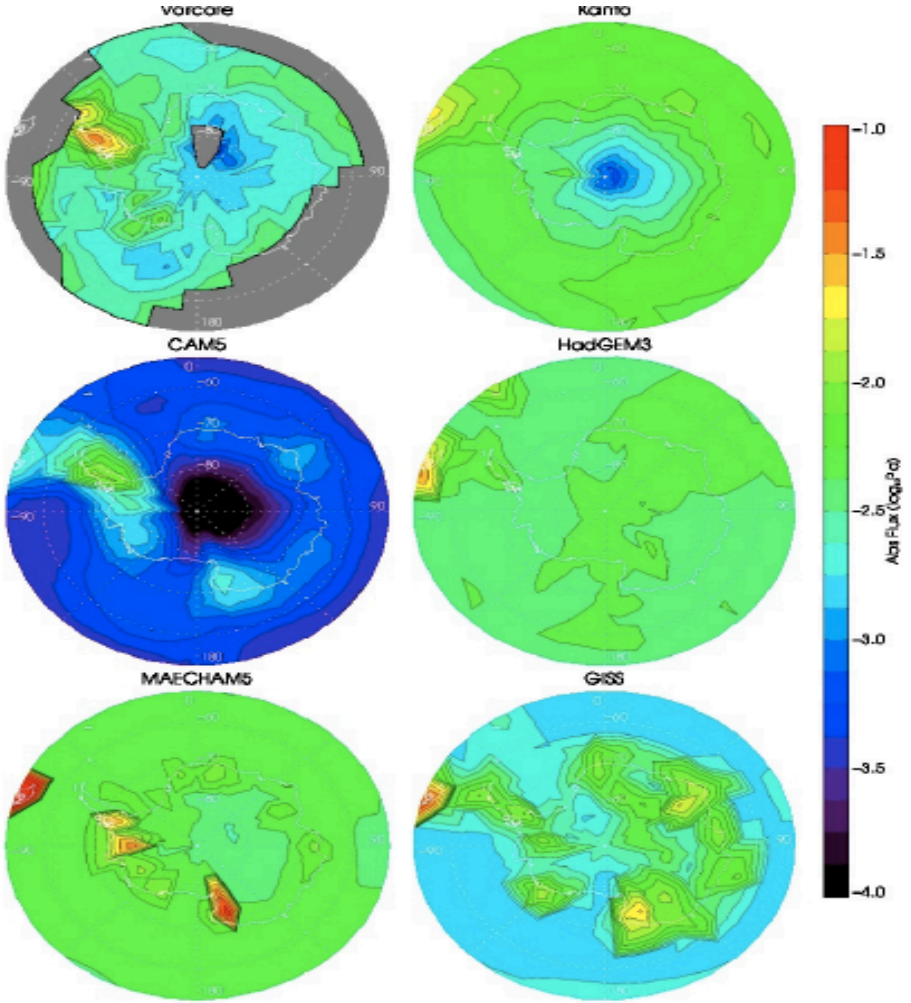
South Pole

Total Absolute Flux
October 2005
at 20km

Model comparisons to Vorcore super-pressure balloon observations.

- Parameterized mountain wave plus non-orographic wave fluxes (HadGEM3, MAECHAM5, GISS) have similar magnitude to Vorcore, but fluxes over the pole are unrealistically high.

- High-resolution models (Kanto and CAM5) are under-resolving important mountain wave fluxes.



First results, from group paper to be submitted to JClim soon (Geller et al.)

New and Emerging Activities

SPARC Reanalysis/analysis Intercomparison Project (S-RIP)

- Lead: Masatomo Fujiwara (Hokkaido U)
- Emerged from SPARC Data Assimilation Working Group
- Will compare stratospheric and upper tropospheric aspects of the many newly available reanalysis products, as a guide to users
- Goal is to produce a peer-reviewed SPARC Report in 3-5 years
  - Will be a major update on SPARC Report No. 3 (2002)
- Activity will have a strong link to the reanalysis centres, to provide feedback

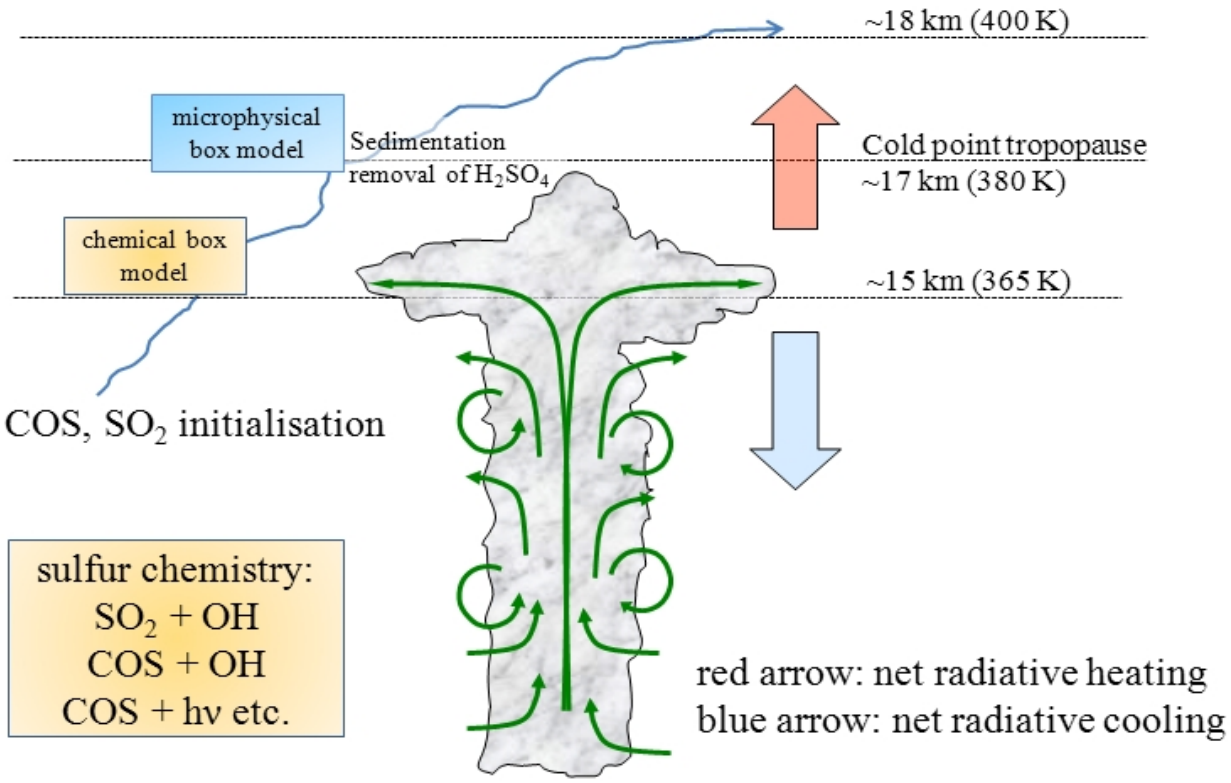
Stratospheric Network on Assessment of Predictability (SNAP)

- Lead: Andrew Charlton-Perez (Reading U)
- Also emerged from Data Assimilation Working Group
  - Jointly endorsed by WGNE
- Coordination funded by NERC, based at Univ of Reading
- Plan is to:
  - Define an international intercomparison experiment on stratospheric predictability
  - Facilitate a crowd-sourced analysis of the results
  - Discuss the results in an open workshop
  - Produce a peer-reviewed synthesis SPARC Report based on the results of the intercomparison

SSiRC – Stratospheric Sulfur and its Role in Climate

(Lead: Markus Rex, AWI Potsdam)

What processes maintain the stratospheric aerosol layer during volcanically quiescent periods and what role does this aerosol layer play in climate?



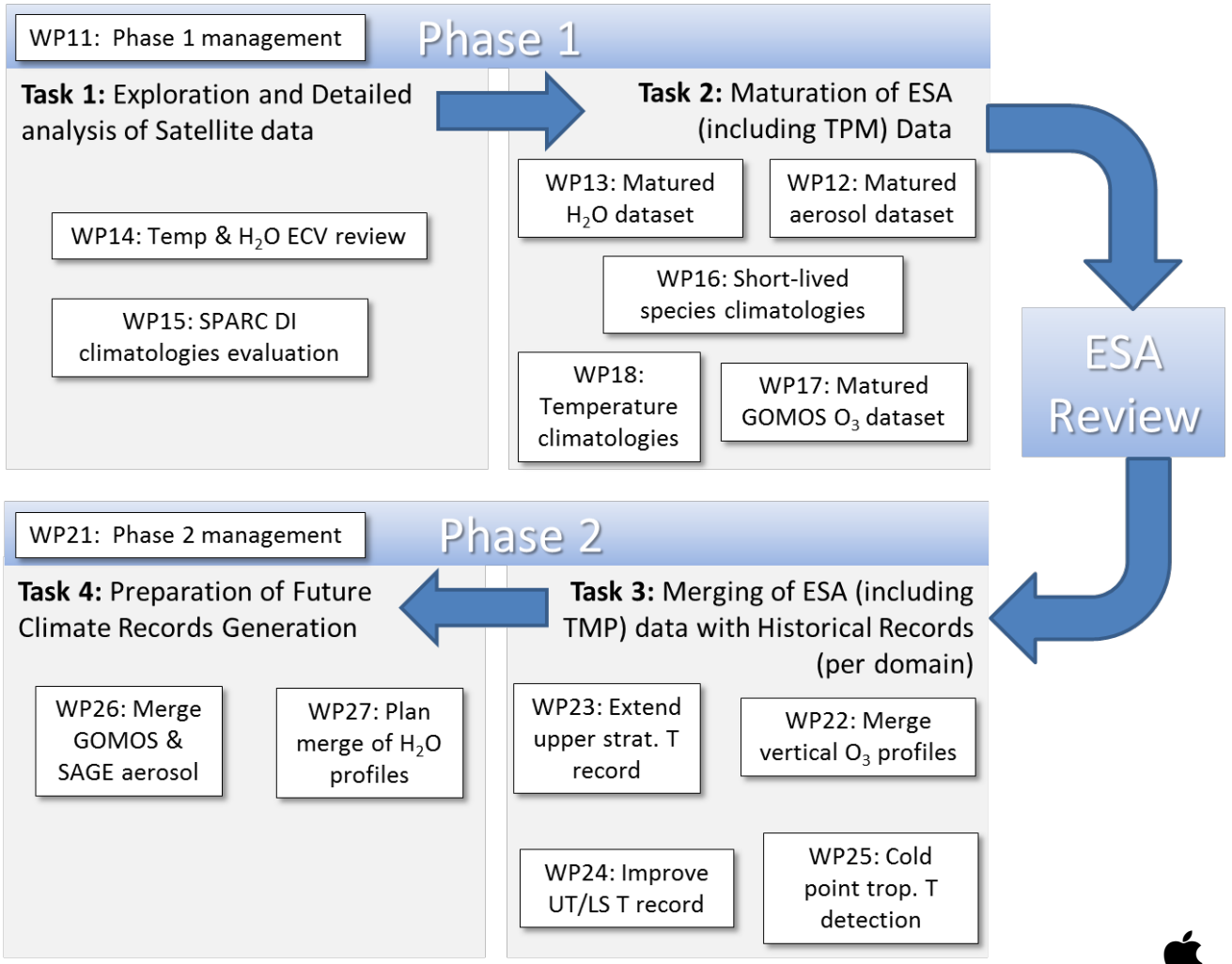
- Supports SPARC's new focus on radiative forcing.
- Need for interactive stratospheric sulfate aerosols in climate models.
- Links to GEWEX, CLIVAR, IGAC and SOLAS.
- Some connection to geoengineering.

- Strong focus on measurements and data usage.

The ESA-SPARC initiative (SPIN)

To do list:

- Improve the quality of existing measurements
- Make new climate data records
- SPARC responding to clients' needs
- Links to ESA funded Ozone_CCI and Aerosol_CCI
- ESA phase 1 review will include SPARC data requirements discussion…



SPARC Data Requirements Initiative

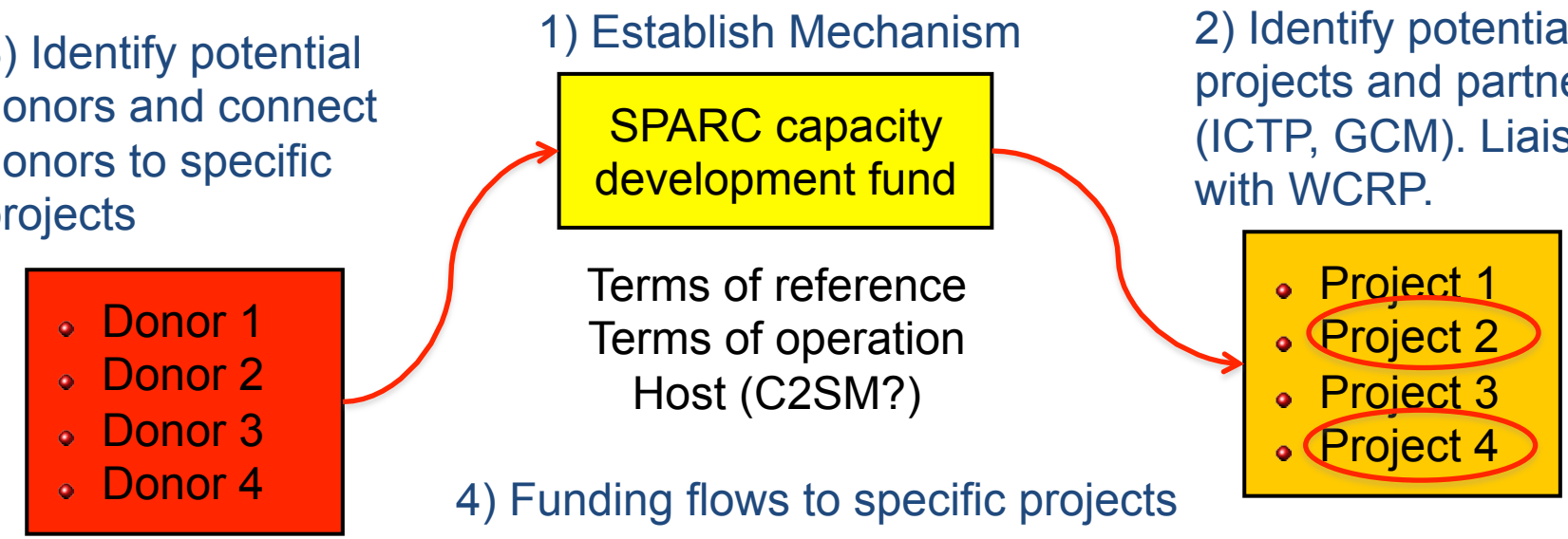
The goal is to develop material that will:

- Make explicit the kind and quality of measurements needed to support SPARC activities - focus on existing data (reprocessing) and on long-term data needs. Measurement requirements should be traceable to big science questions, SPARC imperatives, WCRP Grand Challenges.
- Provide coordinated input to the WDAC, GCOS (updating GCOS requirements), CEOS, space agencies, funding agencies – build relationships with users
- Allow SPARC to rapidly respond to requests from funding agencies concerning SPARC measurement needs and priorities - SPARC is a **data consumer**
- Stimulate greater use and improvement of observational products by SPARC activities
- Support key existing long-term measurement programmes by quantitatively assessing the consequences of losing existing measurement systems (OSSEs) – quantitatively assess **data utility**

Capacity Development

(Lead: Roseanne Diab, Academy. Sci., SA)

- If SPARC is to provide regionally tailored climate services, then regional engagement of the research community is essential
- If that capacity is not available, SPARC needs to actively identify where that is the case, where that presents an impediment to delivery of climate services, and then work to develop regional capacity



Interaction with IGAC

- Joint IGAC-SPARC workshop on *Chemistry-Climate Modelling and Evaluation* held in Davos (May 2012)
  - Led by Veronika Eyring (DLR) and Jean-Francois Lamarque (NCAR); 130 participants from 16 countries
- Community-driven; reviewed current state of science, identified key metrics for model evaluation
  - White Paper will be completed by end of the summer
- Recommended establishment of a joint IGAC-SPARC *Chemistry-Climate Modelling Initiative* (CCMI), incorporating existing elements (CCMVal, ACC-MIP, hindcasts), to integrate future activities in this area
  - Will effectively replace IGAC-SPARC AC&C
  - Links with AeroCom will be arm's length

WCRP Polar Climate Predictability Initiative

- Planning meeting was held in Toronto (April 2012), joint with IASC-Atmosphere (~30 participants)
- Outcome:
  - There are important problems to work on
  - There is a community wanting to move forward
  - There is good cooperation with relevant partners (WWRP PPP, IASC, SCAR)
    - Clear role for WCRP: global perspective, global modelling
  - Predictability is not just about the initial-value problem
  - Most people are interested in both poles
- Produced the beginnings of a draft implementation plan (still in very rough form)

Frontier Questions

- Why are the climates at the two poles changing so differently to each other (with the Arctic changing rapidly, and the Antarctic unevenly), and to global climate?
- Why is the rate of Arctic change at the edge of (or beyond) the distribution of model estimates, with observations on average exceeding the model rate of change? And why is the situation essentially the opposite in the Antarctic?
- What does high latitude climate change mean for lower latitudes?
- Do the ongoing amplified changes in the Arctic have an influence on extremes in the Arctic?
- How predictable is Arctic climate?
- Is the stability of ice sheets changing? What is the probability of catastrophic ice sheet breakdown in the next few decades?

Imperatives

- Reconstruct past climate variations (100+ years)
- Improve reanalysis products for the high latitudes
  - Ocean as well as atmosphere, work towards coupled
- Design optimised sustained observational networks
  - Need for public sharing of data
- Improve the climate models that are used for simulating past and future polar climate
  - Improve process parameterizations
- Assess model performance and inform new model development
  - Assess how much confidence we can place in models
- Define proper use of models to answer frontier questions
- Improve prediction

Suggested Implementation Mechanisms

- A sequence of actions to form a community on Antarctic climate processes, centred on the question of how the jets and non-zonal circulation couple to the rest of the system in the SH
- Synthesis workshop focused on Antarctic climate and its change, as represented in data records, reanalyses and CMIP models
- Workshop to determine the best estimate and uncertainty of old Arctic data
- Workshop to construct metrics that can be used to assess models
- Workshop (with special collection or single consensus paper) to synthesize the polar performance in CMIP5 analysis
- Workshop to assess, understand, and improve predictability experiments (involve WGSIP and YOPP)
- Special session or paper collection to debate Arctic-midlatitude connectivity (linkage with IASC and WWRP)

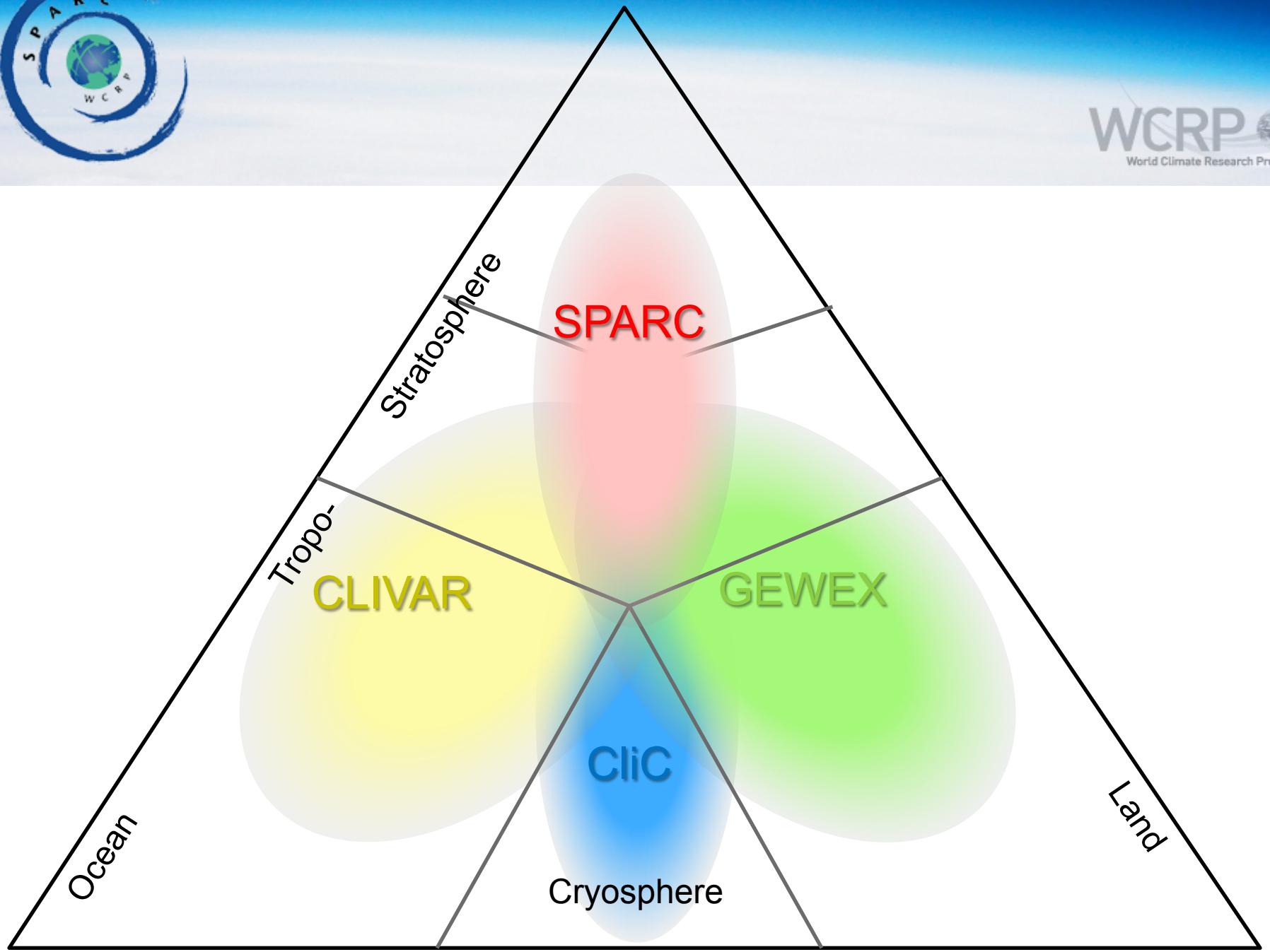
The Way Ahead

- Recommend forming a limited-lifetime PCPI SSG
  - Charge: develop an Implementation Plan and move ahead with specific, targeted activities ranging from focused workshops to coordinated efforts of up to 2-3 years' duration
  - Secretariat support available from SPARC IPO (Dr. Diane Pendlebury, funded by the Canadian Space Agency): will need continued JPS support
- Initiative can be an 'incubator' to generate community research efforts that could be adopted, in the longer term, by more permanent components of the WCRP or of partner organizations
- Whilst good liaison with partner organizations is important, this activity will fail if the SSG consists only of 'representatives'
  - Needs to have a core group of champions who will move it forward

Programmatic Context

- WMO EC-PORS is promoting a Global Integrated Polar Prediction System (GIPPS)
  - Is expected to address three time scales: from weather time scales to a season; from seasons to decades; and centuries
  - WWRP PPP and WCRP PCPI will collectively address this range of time scales
- Falls within broader emerging International Polar Initiative, which seeks to preserve the legacy of IPY
- Within WCRP, the PCPI will contribute to the Grand Challenge on provision of regional climate information
- PCPI will need to have good synergy with IASC and SCAR (but in my view should be kept informal, e.g. joint workshops)

The Future of SPARC


Stratosphere
SPARC
Tropo-
CLIVAR
GEWEX
CliC
Ocean
Land
Cryosphere

Perspective from the Open Science Conference

- SPARC has always been *interdisciplinary*: an equal focus on dynamics and chemistry
- SPARC has always had a strong focus on *deliverables* (e.g. peer-reviewed SPARC Reports) and *user needs* (e.g. WMO/UNEP Ozone Assessment, and space agencies)
- SPARC's activities are evolving naturally to develop a greater emphasis on stratosphere-troposphere coupling, as this is where the science is headed ("one atmosphere")
  - Challenge 1: people do not live in the free atmosphere!
  - Challenge 2: to keep the 'culture' of SPARC as scope expands

Imperatives

- *Improve the models*: through model-measurement comparison
- *Improve the use of (imperfect) model information*: through model assessment and diagnostic analysis
- *Improve the reanalyses:* through assessment of the products
- *Improve the observational record:* through assessment of the products and development of climate data records

- *Serving user needs* (feed into assessments; for climate services, we would expect to mainly work through the various WCRP working groups)

WCRP Grand Challenges

- *Provision of skillful future climate information on **regional** scales; sea-level rise; and water availability*

  Atmospheric circulation effects, through the WCRP working groups (including WGRC)

- ***Cryosphere** response to climate change*

  Through the Polar Climate Predictability Initiative

- *Interactions of clouds, aerosols, precipitation, and radiation and their contributions to **climate sensitivity***

  Through chemistry, upper tropospheric water vapour, sulfate aerosol microphysics; link with IGAC; through SPARC participation in WGCM

- *Science underpinning the prediction and attribution of **extreme events***

  Through DynVar

SPARC name change discussion

To cut a long story short, the SPARC community is converging on:

- Keeping the SPARC acronym
- Changing what it stands for (Stratosphere-troposphere Processes And their Role in Climate)
- Redesigning the logo to highlight that SPARC's focus now extends to include those tropospheric process that are relevant to stratosphere-troposphere interactions.

How did we come to this position?

- A web-based blog discussion was initiated on 3 August last year.
- 29 postings occurred between then and an SSG meeting in early February.
- Debate was stimulated by very strong arguments being made for a name and acronym change.
- A summary of the debate to date was presented by Thomas Peter at the February SSG meeting and further discussion ensued.

SPARC name change discussion

SSG outcomes

- T-SPARC = Troposphere-Stratosphere Processes and their Role in Climate
- SPARC+ = SPARC and the troposphere
- SPARC™ = SPARC—Troposphere, Mesosphere
- STARC = Stratosphere-Troposphere Processes and their Role in Climate
- SPARCS = Stratosphere-troposphere Processes and their Role in the Climate System
- or only name change but no change of the acronym.

SPARC name change discussion

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- **or only name change but no change of the acronym.**

After the SSG meeting, blog was reopened.

A further 40 additional unique comments were received:

Keep acronym and change name and tag-line: 30
T-SPARC: 6
SPARC™: 1
ASTRICS (Analyzing Stratosphere TRroposphere Interactions in the Climate System): 3

Many highlighted they had always seen SPARC as having had a tropospheric interest.

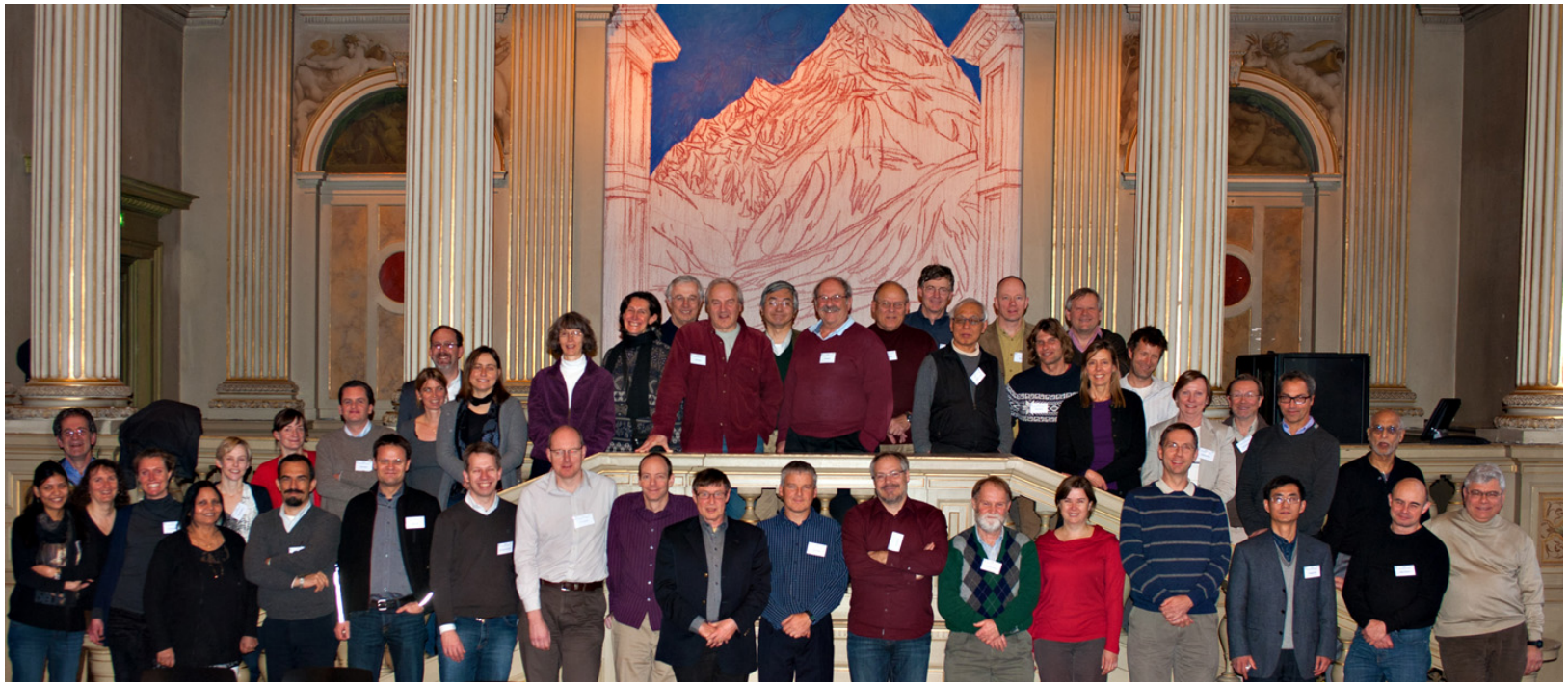
New logo: Community participation in design but ensure that the final product is professional.

Absolute limit: 5 pm on 30 November 2012, propose moving faster

Operational Aspects

SPARC Office now operational at ETH Zürich

- SSG meeting in Zürich (February 2012), celebration of 20th anniversary of SPARC (with booklet) and opening of new SPARC Office



New SPARC website

www.sparc-climate.org

Next SPARC SSG meeting

- Will be hosted by Prof. Carolina Vera at the University of Buenos Aires, November 27-30, 2012
- Will be preceded by a SPARC Regional Workshop, November 26-27
  - One focus will be on SH midlatitude circulation effects of climate change
- Will be immediately followed by a WCRP Workshop on SH ozone depletion and climate change, December 3-7, also in Buenos Aires

N.B. The SPARC SSG meeting in Pune (February 2011) led to the creation of an Indian SPARC programme

SPARC SSG membership

- Ted Shepherd is stepping down as co-Chair at the end of 2012
- Will be replaced by Joan Alexander (NWRA, Boulder)
  - Greg and Joan will develop new SPARC themes and implementation plan for the next phase of SPARC, in line with SPARC's broader mandate
- Recommend continuing to strengthen the tropospheric expertise within SPARC SSG
  - Ted Shepherd ➔ large-scale tropospheric dynamicist
  - Tom Peter ➔ tropospheric global chemistry modeller
  - Masato Shiotani ➔ observations and processes in UTLS

Casting the net wider for SPARC SSG membership

- SPARC members are considered for nomination to the SSG, in part, through their participation in SPARC activities.

So how do we determine the widest possible engagement in SPARC activities?

- The SPARC project office is developing a SPARC members database (web-based but with data privacy ensured)
- Database includes scientific expertise and allows members to flag interest in activities
- Database will be used in future to identify new participants in SPARC activities

2014 SPARC General Assembly

- Queenstown, New Zealand
- 12-17 January 2014
- Millennium and Copthorne Hotels
- Budgeted income has been based on attendance of 300 and budgeted costs on attendance of 400

- In discussions with Jenny Harper from the Air New Zealand Environment Trust to develop novel ideas for carbon offsetting

2014 SPARC General Assembly

- Local company has been established to run the GA
- Professional conference organiser has been contracted (TCC)
- Local organising committee has been established
- Co-chairs of scientific organising committee have been appointed (Veronika Eyring & Adam Scaife)

- Sponsors need to be identified and approached – all sponsorship will be used to subsidize students, early career scientists and scientists from developing countries or countries in transition
- See http://www.sparc2014.org