



SPARC

Stratosphere-troposphere Processes And their Role in Climate

Susann Tegtmeier
GEOMAR, Kiel, Germany

Michaela I. Hegglin
University of Reading, UK



SPARC

- Promotes research on how chemical and physical processes in the atmosphere interact with climate variability and change.
- Historically concentrated on the role of the stratosphere in climate, but now includes foci throughout the atmosphere.

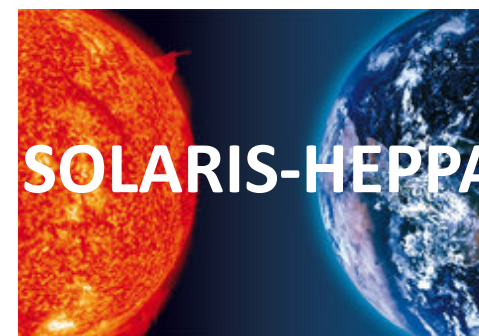
Upcoming new SPARC Implementation Plan (post 2015)

- Theme 1. Atmospheric Dynamics and Predictability
- Theme 2. Chemistry and Climate
- **Theme 3. Long-term Records for Climate Understanding**

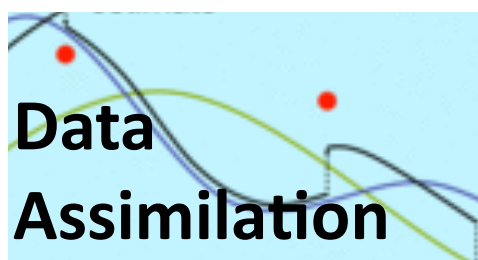
Theme 3. Long-term Records for Climate Understanding

- Guide construction, quality control, analysis, and interpretation of CDRs that require international cooperation (e.g., merging ground-based, remote-sensing, in-situ, and spaced-based)
- Achieve traceability of original measurements and their uncertainties to internationally accepted calibration standards
- Feedback to data providers by articulating the evolving needs of SPARC for the construction of CDRs
- Promote the collection of CDR metadata (data set versioning, use of digital object identifiers (DOIs), availability through long-term archives, and peer-reviewed publication)

Theme 3. Long-term Records for Climate Understanding



**Water vapour
(WAVAS)**



**Ozone
(SI²N)**

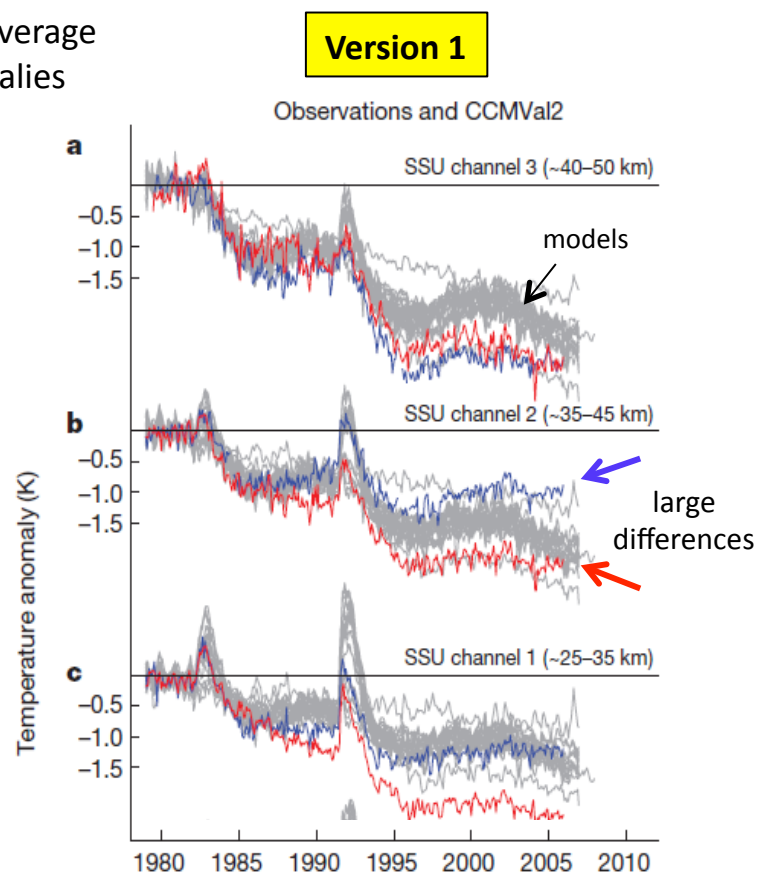
**Temperature
trends**

**Trace gases
(SDI)**

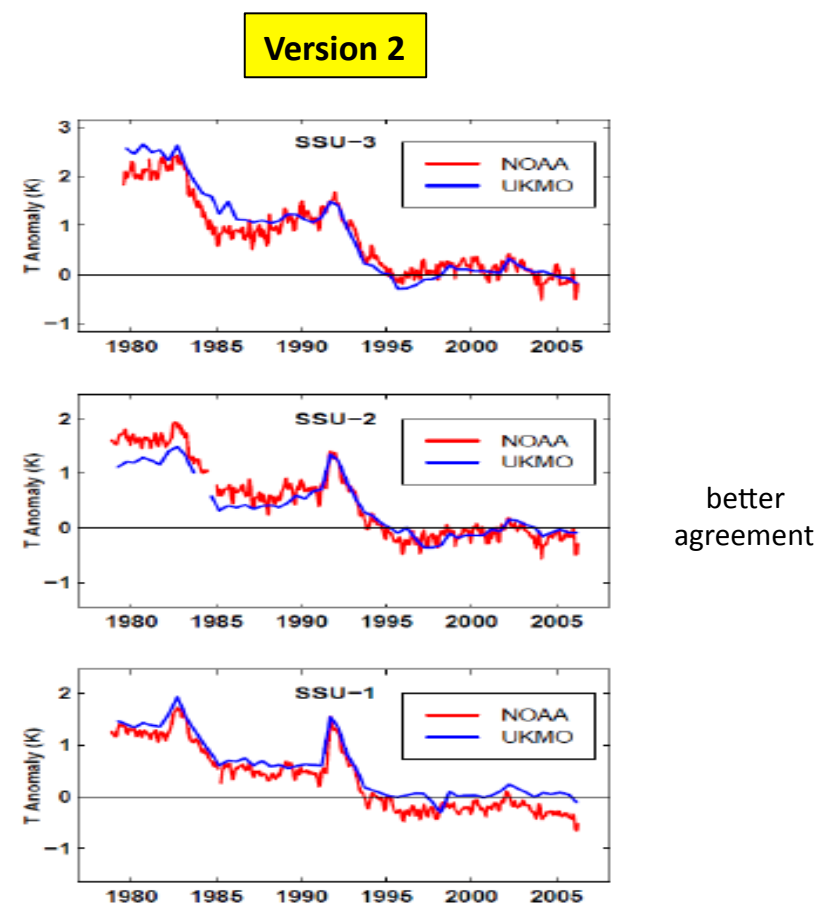
SPARC temperature trends activity

New, revised versions of SSU climate data records
 (only long-term temp. data for middle + upper stratosphere)

global average anomalies



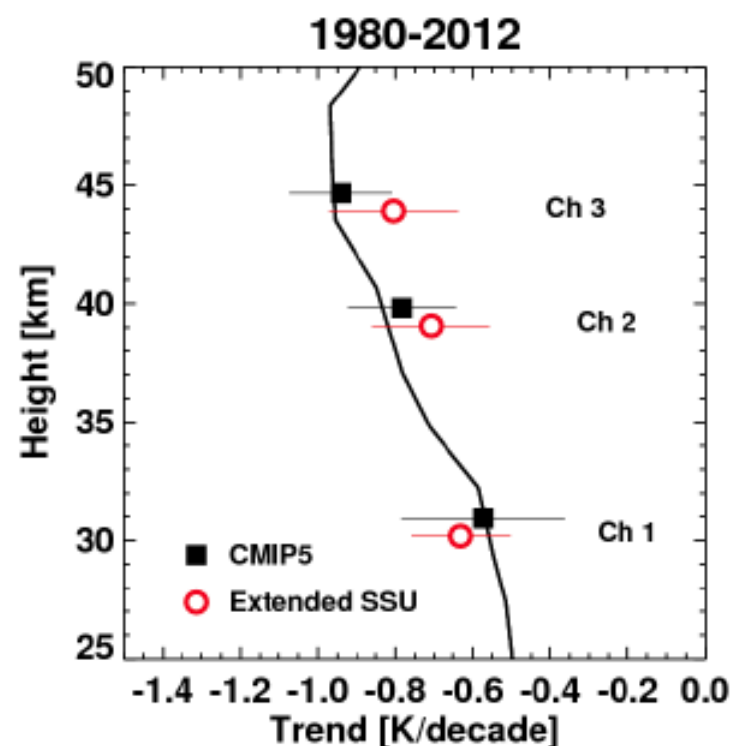
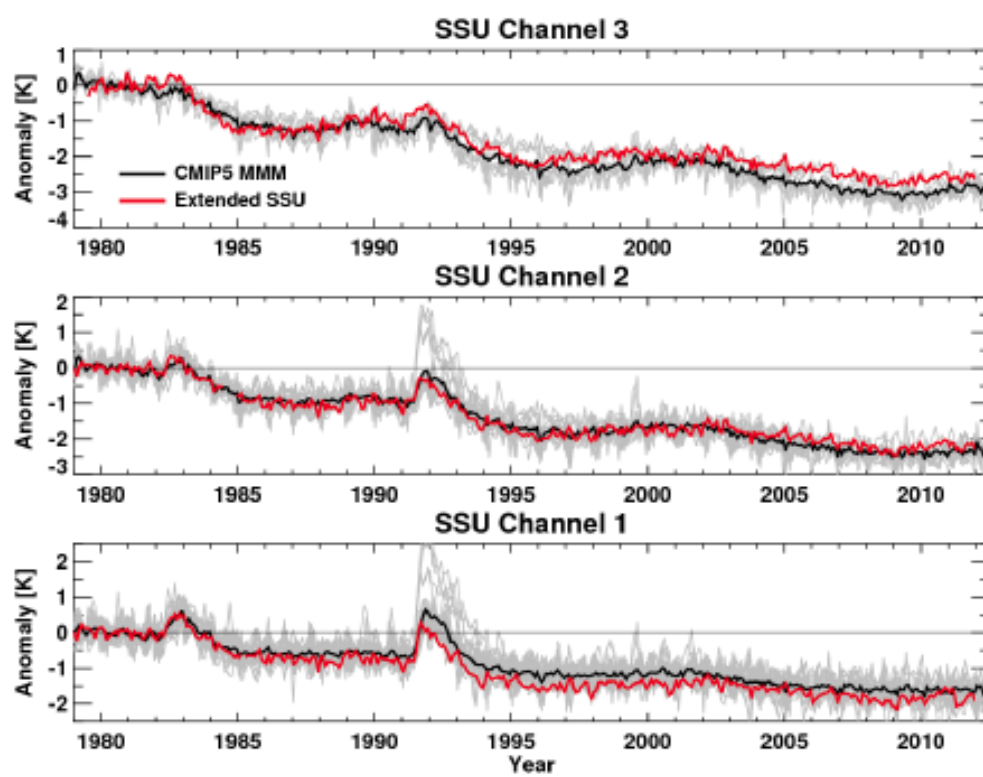
Thompson et al 2012



Seidel et al 2015

Output of ESA-SPARC SPIN

- It is important to extend the SSU record, however the AMSU weighting functions are different
- Using a new merging method (based on limb measurements as a transfer function between SSU and AMSU), the extended SSU record shows excellent agreement with the CMIP5 model mean and trends over 1980-2012.

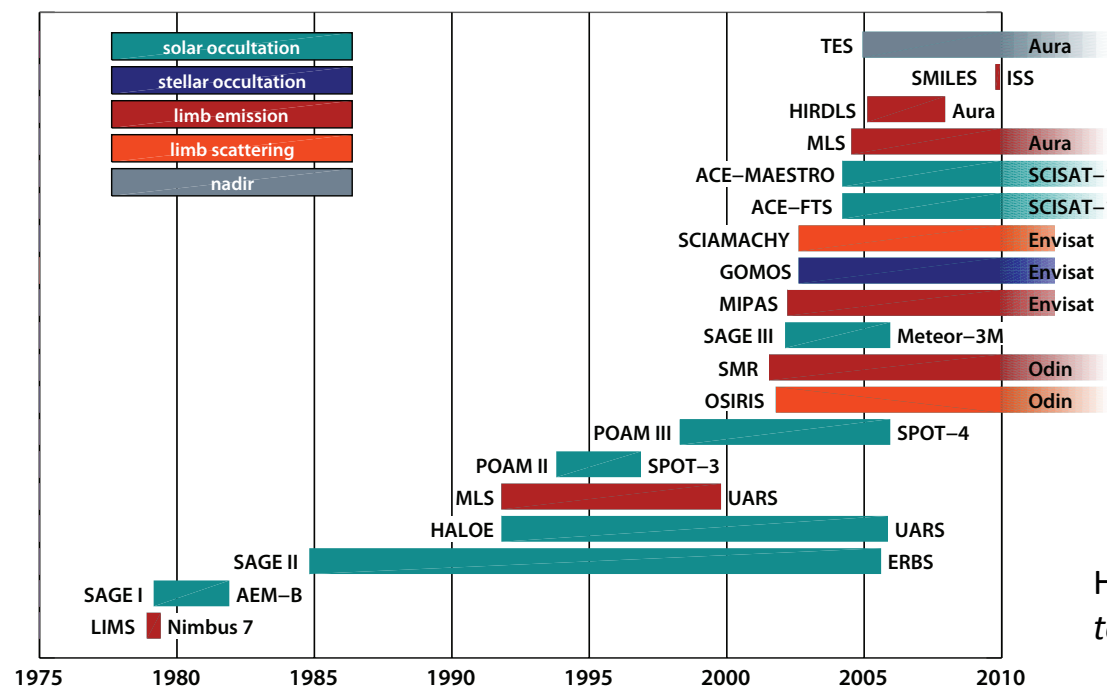


SPARC Data Initiative

- Comprehensive quality assessment of zonal monthly means of 25 chemical trace gases and aerosol from international set of satellite limb observations, introducing a new ‘top-down’ approach to data validation for climate purposes.

Key principles:

- Leadership independent from data providers
- Team members with specialized knowledge (instrument & data analysis)
- Compilation of datasets and archiving in data centre
- Regular team meetings



Hegglin et al.,
to be submitted



- Compare all reanalysis datasets for various key diagnostics and understand what causes the differences
- Provide guidance on the appropriate use of reanalysis products
- Establishing collaborative links between the reanalysis centres and the SPARC community
- 2015: first report covering the basic chapters (description of reanalysis, dynamical variables, ozone, water vapour)
- 2018: full report including advanced chapters

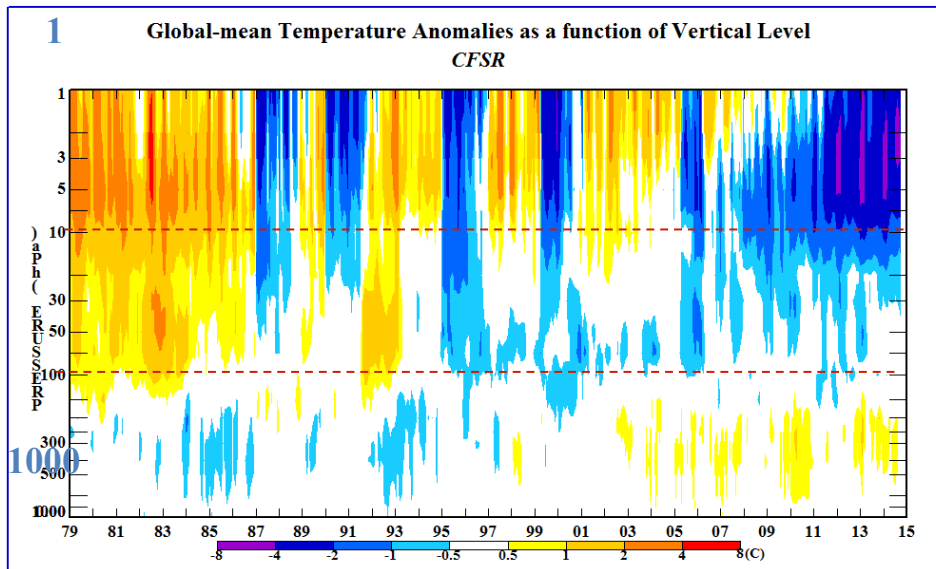
S-RIP common grid files

- First versions of the files have been produced recently
- Based on the ana4mips data
- Full time period for each reanalysis and a common time period (1979-2013)
- 2.5° lat/lon grid or 2.5 zonal mean
- Pressure levels: 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2, 1, .7, .5, .3, .1
- Data will be available through the BADC
- Water vapor and ozone from reanalyses CFSR, ERA-I, JRA-25, JRA-55, MERRA (can be extended to other variables)

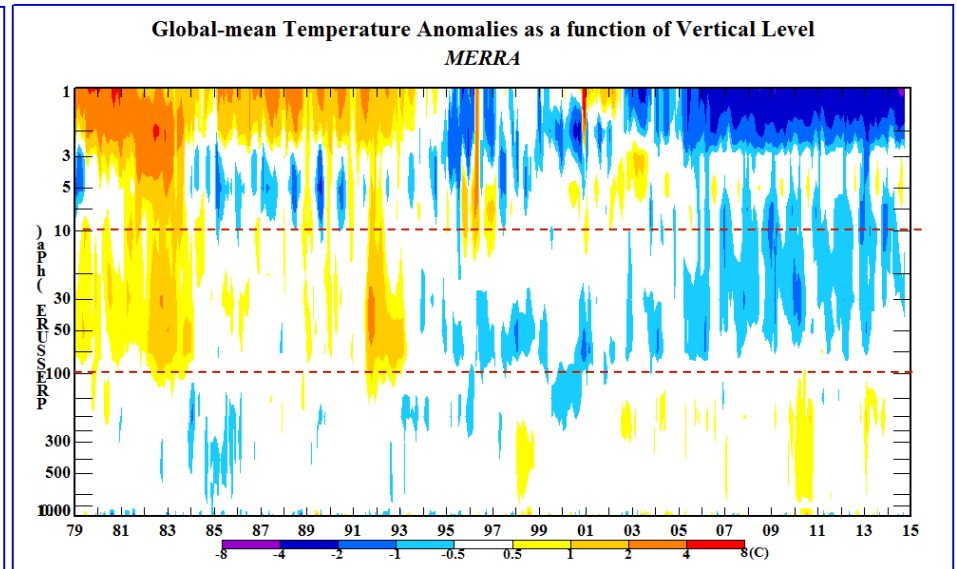
Global Mean Temperature Anomaly (1979-2014)



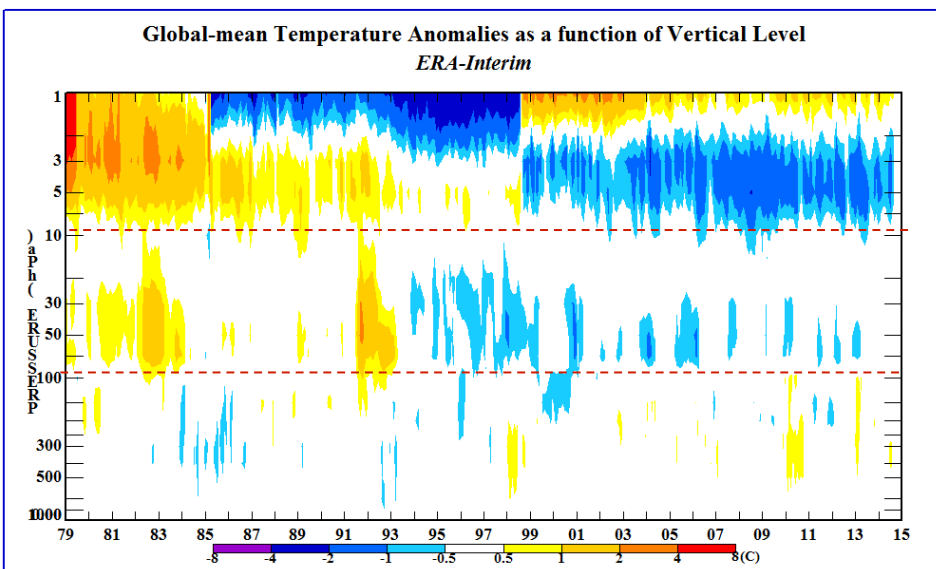
CFSR



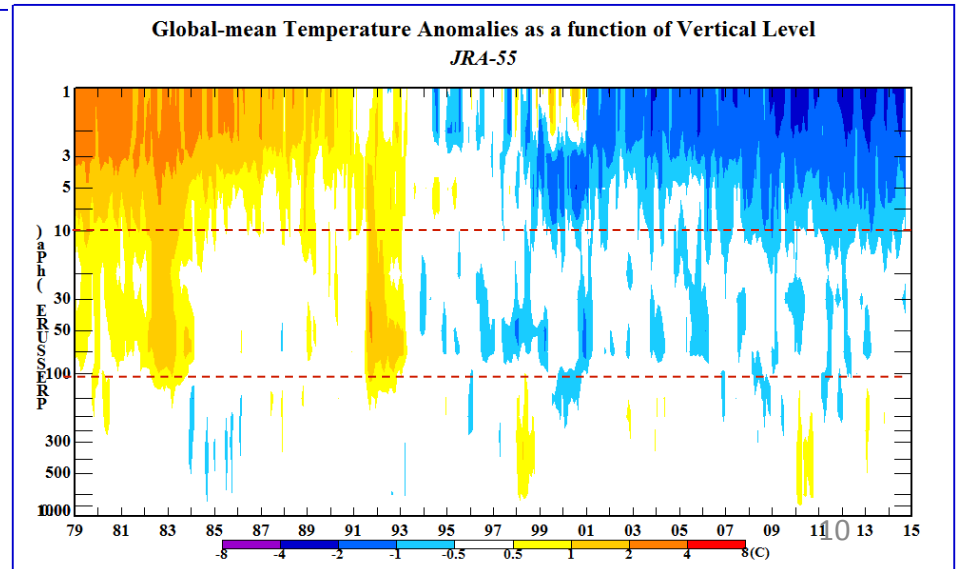
MERRA



ERA-Interim



JRA-55





Future gap in vertically resolved global measurements of stratospheric chemical species (and temperature)

Limb satellites provide **vertically resolved** information with **good global coverage** of many atmospheric constituents and temperature between 5–140 km.

Problem: There is expected to be a gap after current satellites fail!

Current status:

Lost: SAGE-II (1982-2004), HALOE (1991-2004), GOMOS, MIPAS, SCIAMACHY (2002-2012), HIRDLS (2004-2007)

Working but well over lifetime: OSIRIS, SMR (2001), MLS (2004), ACE-FTS & ACE-MAESTRO (2003), Calipso CALIOP Lidar (2006)

New: NPP (2012, has OMPS limb limited to O₃ and aerosol below 60 km)
JPSS-2 (2021) currently will have OMPS-limb (JPSS-1 will not have OMPS-limb)
SAGE-III (2016) limited duration mission, focused on low and middle latitudes

No agencies have current plans for vertical profiling of stratospheric trace gases.

Gap problem – what can SPARC do about it?

- 1) Pointing out the community's needs to space agencies, CEOS, GCOS?
- 2) Capture existing knowledge of current and recent instruments, retrievals and data sets before this knowledge is lost

→ SPARC Data Initiative

- 3) Paper on the subject is being prepared at the moment
 - Suggested title: "A Future Gap in Satellite Constituent Measurements"
 - Planned to submit to EOS

SPARC Data Needs - Summary

Overall

1. Continued improvement in meteorological reanalyses and past records
2. Continuation of existing core measurements – real funding pressure

Specific

- *Lack of planned satellite observations (esp. limb) of UTS composition*
- Need up-to-date AMSU and merged SSU-AMSU climate data records
- Reanalysis diagnostics needed for momentum budget studies
- Need for more reference-quality global & long-term observations, particularly for reanalysis intercomparisons
- No planned continuation of mesospheric radiance for temperatures
- 44 year stratospheric aerosol record at Laramie may stop
- Need for quick response field campaigns after volcanic eruptions
- Data sharing is a challenge in the 'Asian Monsoon region'

- **ADDITIONAL SLIDES**
 - SPARC Data Center
 - SPARC Data Initiative

SPARC Data Center



- Hosted by Centre for Environmental Data Archival, UK
 - Interim ftp server <ftp://sparc-ftp1.ceda.ac.uk/>
 - Web portal at SPARC website
<http://www.sparc-climate.org/data-center/>
- Data Sets
 - SPARC Data Initiative Trace Gas Climatologies
 - US High Vertical Resolution Radiosonde Data (Gravity Wave Activity)
 - Transitioning to direct access from NDIS
 - SPARC International Polar Year
 - Active user list
- Legacy Data Sets
 - SPARC Reference Climatology
 - Stratospheric Aspects of Climate Forcing
 - GCM Reality Intercomparison Project for SPARC (GRIPS)
 - Tropical Tropopause Climatologies
 - Assessment of Stratospheric Aerosol Properties (ASAP)
 - Water Vapour Assessment (WAVAS)
 - Small Organic Peroxy Radicals
 - Rocketsonde
 - Quantum Yields for the Production of O(¹D)

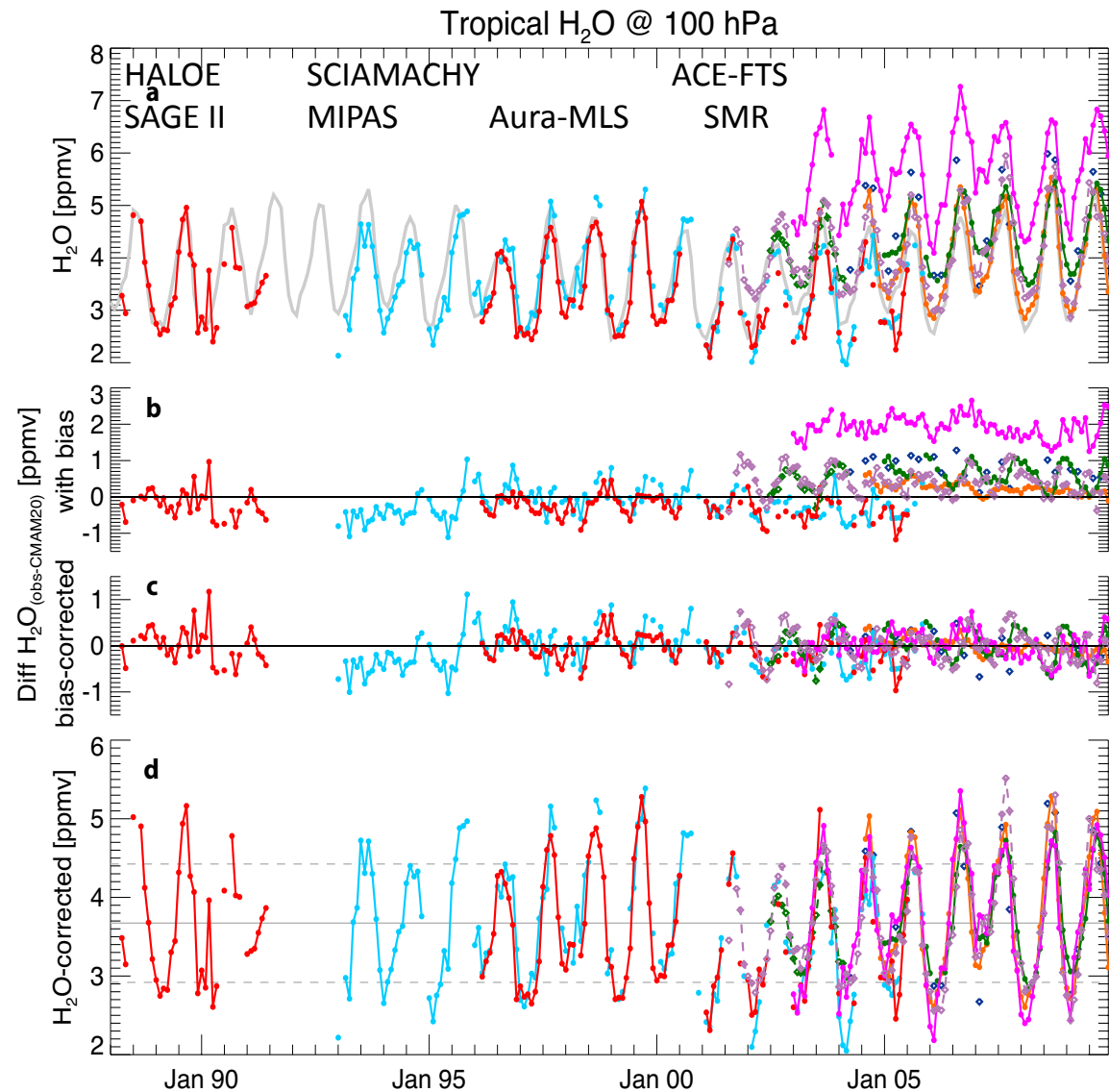


BADC support for the SPARC Data Centre

- BADC provides collaborative work-spaces which are separate from the archive
- BADC has, for several years, been supporting SPARC climate model evaluation and inter-comparison projects
- Data Published through BADC (CCMVal phase 1/2, CCMI-1)

NEW MERGING APPROACH

- CMAM30 (gray) compares well with SAGE II and HALOE between 1996-2001.
- Arguably the best performing period for these instruments.
- Determine the offsets with respect to CMAM30.
- Bias-correct the data records relative to MLS, using CMAM30 as transfer function.
- Result: homogenized time series of stratospheric water vapour, which can be merged.



IMPROVEMENT IN MERGING

- Tropical water vapour and temperature anomalies (scaled with respect to their interannual variability) show a strong correlation.
- Residuals (differences between the scaled variables) mostly fluctuate around zero.
- Direct merge of the HALOE + MLS records (red) exhibits a substantial offset/drift in comparison with the merged SDI record!
- Difference has implications for forcing of surface climate (Solomon et al., *Science* 2010)

