SPARC
Stratosphere-troposphere Processes And their Role in Climate

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SPARC

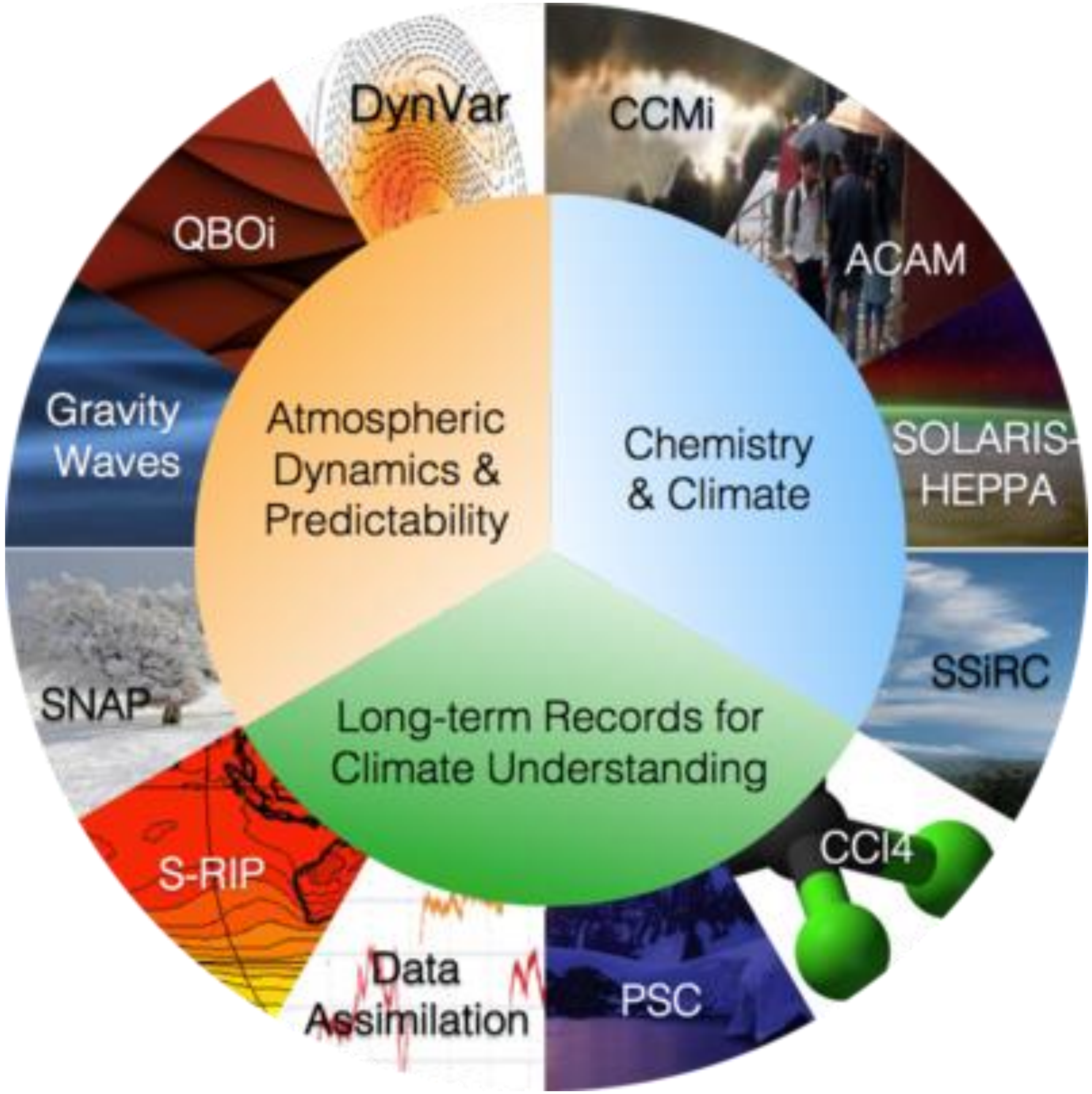
- Promotes research on how chemical and physical processes in the atmosphere interact with climate variability and change.
- Historically concentrated on the role of the stratosphere in climate, but now includes foci throughout the atmosphere.

SPARC Implementation Plan

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

SPARC Theme:
Long-term Records for Climate Understanding

- Vertically and spatially resolved trends in SPARC-relevant ECVs?
  - Which species and state variables are needed, and with what resolution, frequency, and uncertainty?
  - Requirements on observing programme (uncertainties and sampling regimens) for reliable trend detection?
- Is the atmosphere (chemistry and dynamics) evolving in a way that is consistent with our understanding?
- Temporal evolution of global and regional forcing (natural and anthropogenic) of the climate system?
- Do current observations test our knowledge of atmospheric composition and dynamics? Which observations would provide more robust tests?



Ending activities:

Data Initiative

SI^{2}N Ozone trends

Temperature trends

Water vapour (WAVAS)

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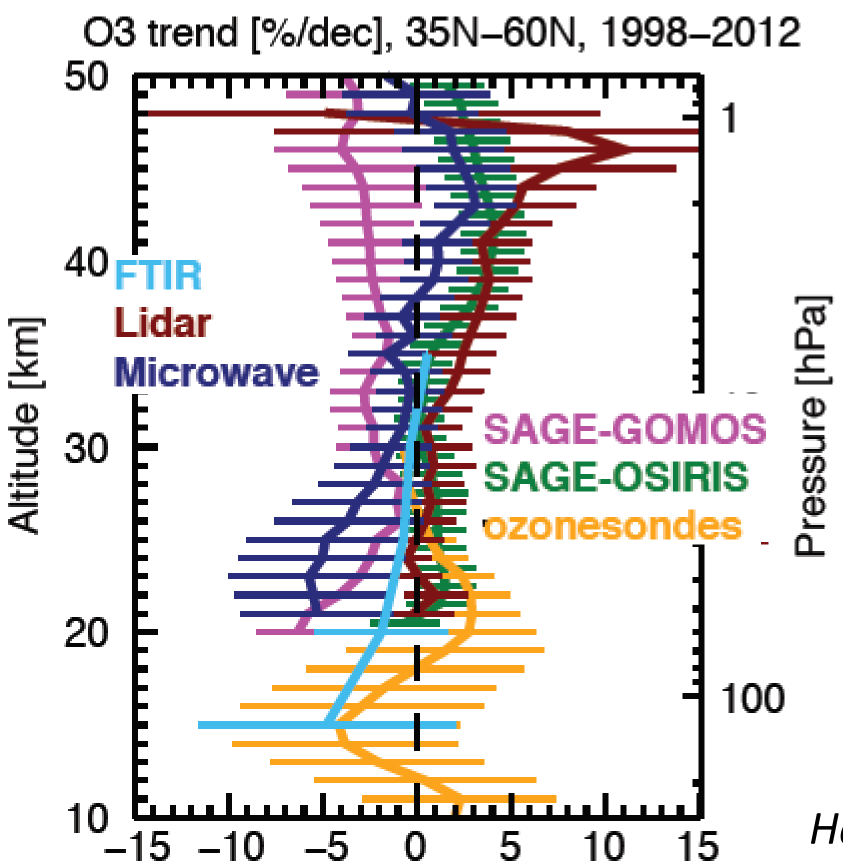
SI^2N - Trends in the vertical distribution of ozone

- Ground-based and satellite measurements of ozone profiles
- Quantify trend and uncertainties of individual measurement systems and combined data sets



Harris et al., 2015

All systems measure the same atmosphere, but trends are very different!

→ Reducing uncertainties is important

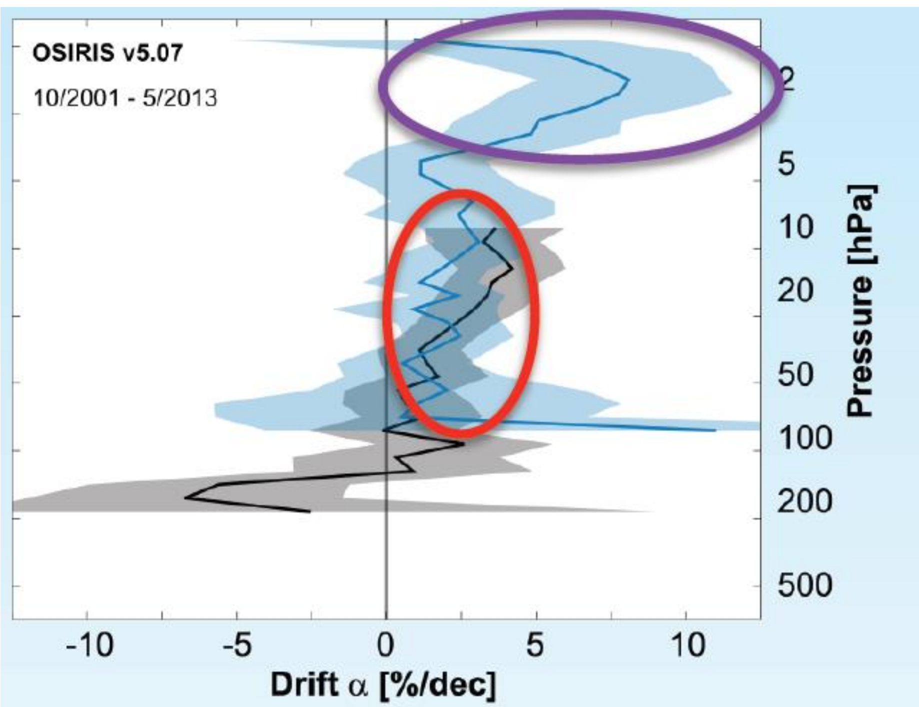
→ Need methodologies for merging multiple data sets (uncertainties propagated rigorously)

→ Drifts of satellite measurements need to be quantified

SI^2N - Trends in the vertical distribution of ozone

High-quality ground-based instruments are critical to quantify the quality and relative stability of satellite measurements

Drift detection threshold of about 2-4% per decade from ground-based networks

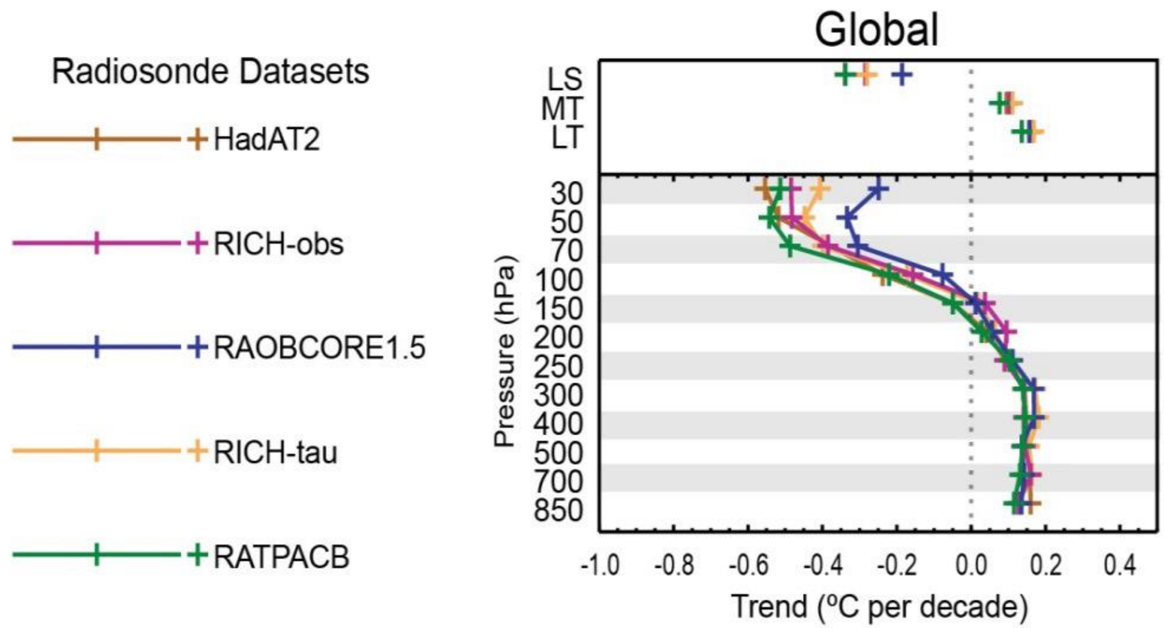


1. Continuation of observations at stations with long-term records, especially lidar stations and ozonesondes
2. Improved homogeneity across the ground networks, e.g. O3S-DQA for ozonesonde, GRUAN …
3. Observations in tropics and Southern mid-latitudes

Hubert et al., AMTD, 2015

Stratospheric Temperature Trends Activity

- Recent focus: analysis of the Stratospheric Sounding Unit (SSU)
- Understanding discrepancies between SSU data processed by Met Office and NOAA (some differences remain)
- Basic agreement in trends, but uncertainties on trend rates in Upper Troposphere/Lower stratosphere



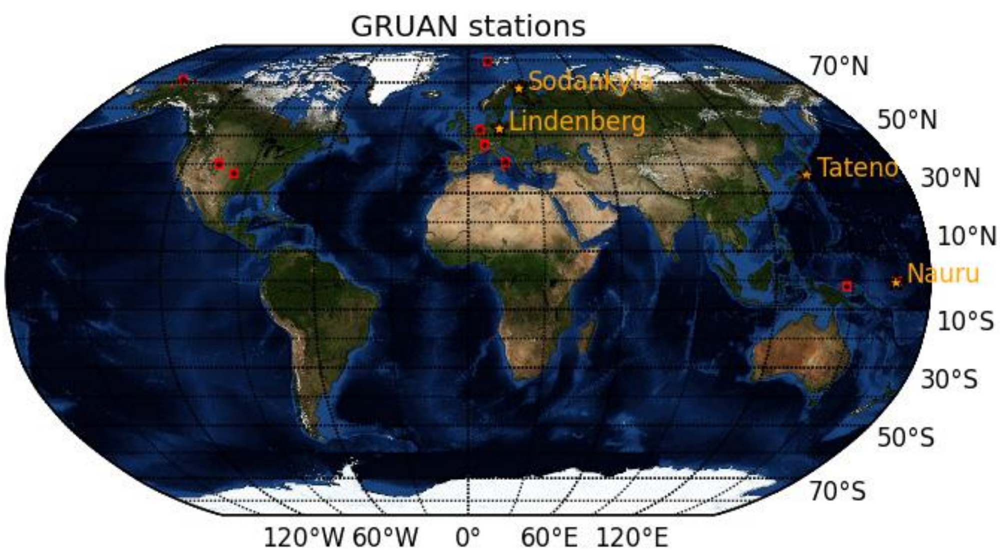
Temperature trends from radiosonde and AMSU observations for 1979–2012 (IPCC, 2013)

Relaunch: Atmospheric Temperature Changes activity

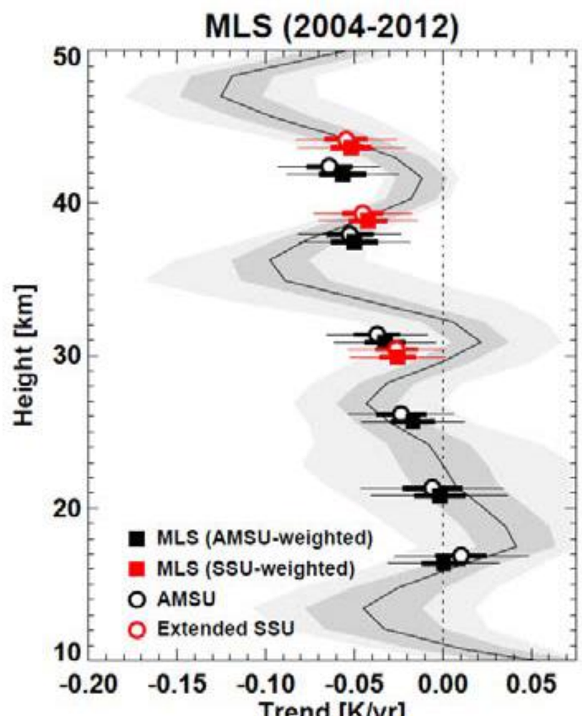
1) Atmospheric temperature variability, trends, and uncertainties

Inclusion of emerging novel observational records

- GPS radio occultation (stability, GCOS climate monitoring targets)
- Limb-viewing instruments with high vertical resolution
- GRUAN radiosondes



Merged and extended SSU



McLandress et al., 2015

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Relaunch: Atmospheric Temperature Changes activity

2) Role of composition in atmospheric temperature changes

Synthesize understanding of composition and temperature changes

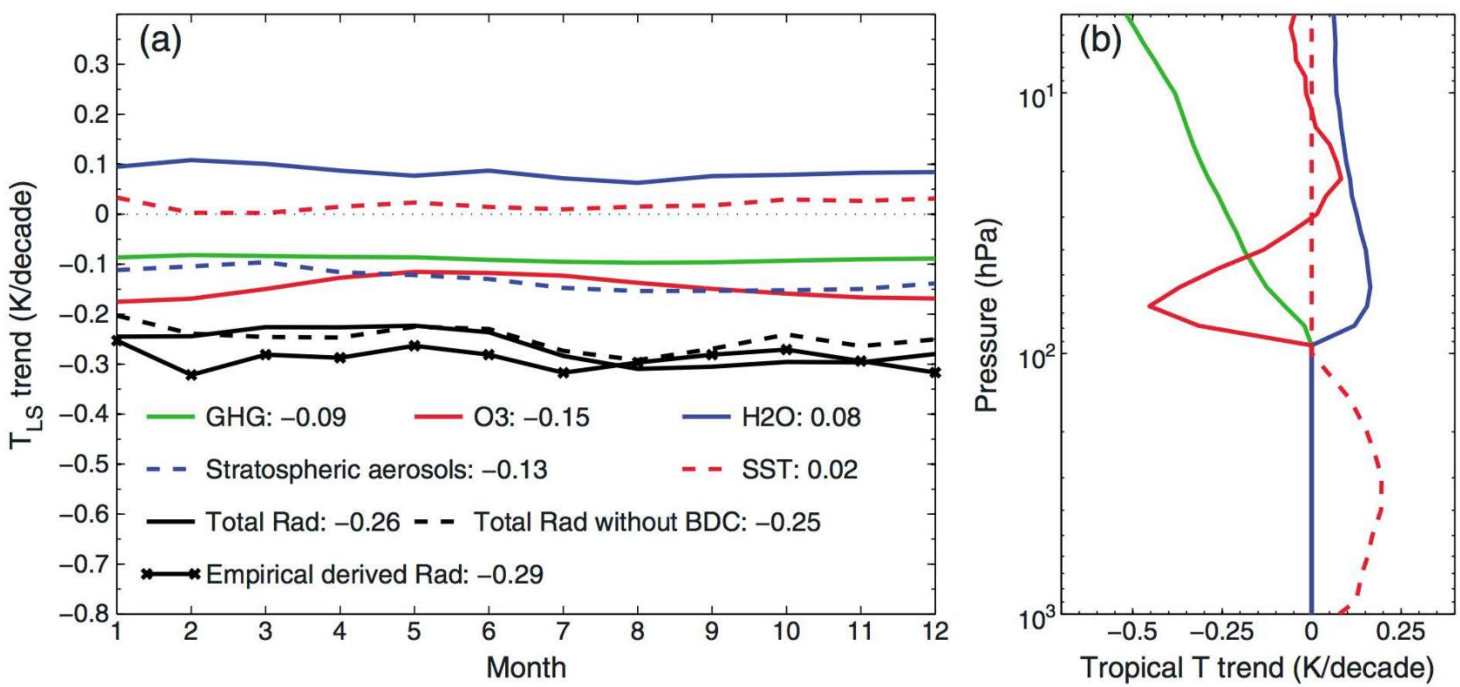
SI²N Ozone trends

Temperature trends

SSIRC (stratospheric aerosol)

Water vapour

Radiative contribution to observed temperature changes



Fu et al., 2015

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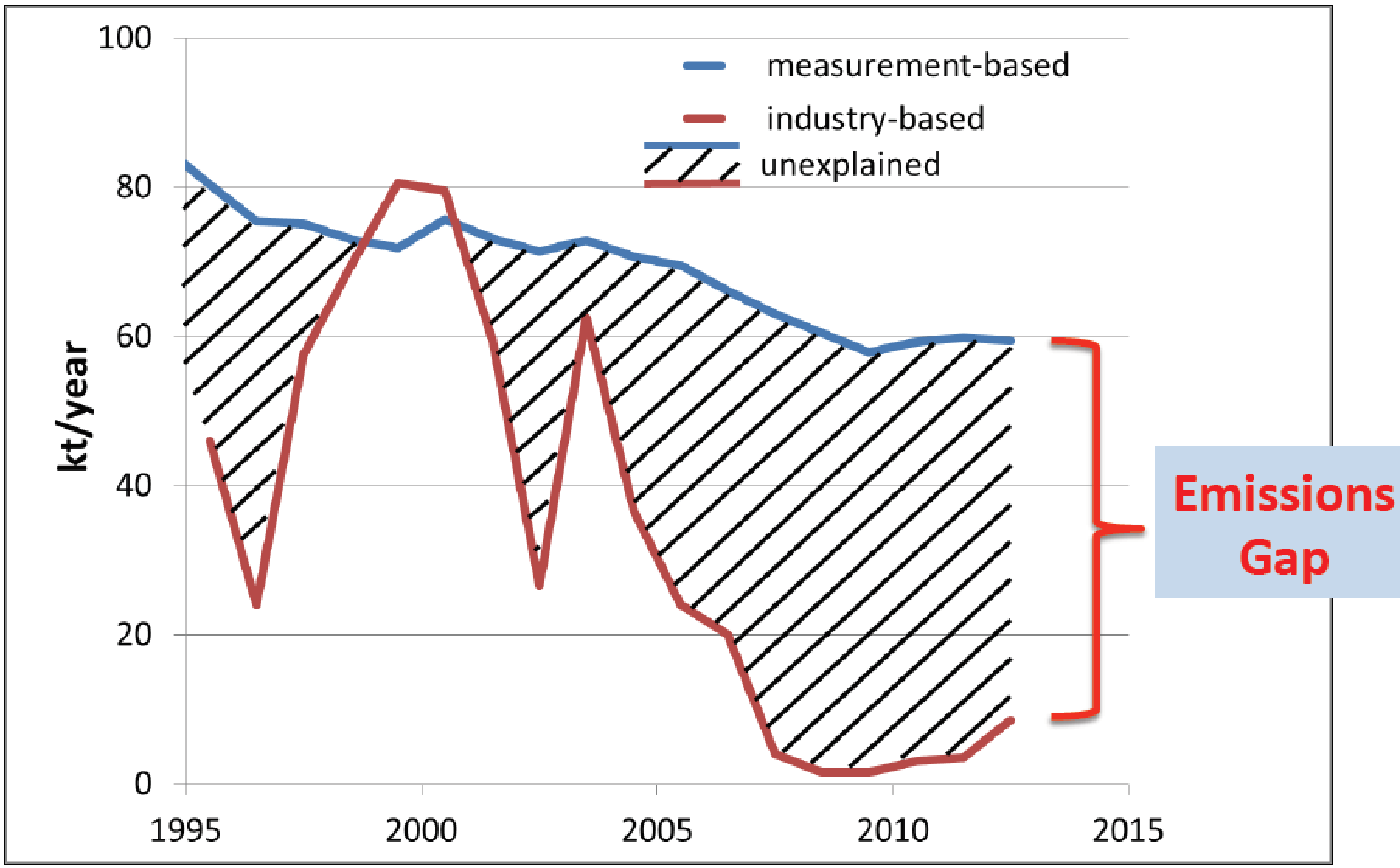
Mystery of Carbon Tetrachloride (CCl_4)

The budget of CCl_4 cannot be balanced between the top-down and bottom-up emission estimates



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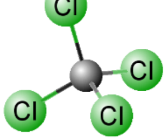
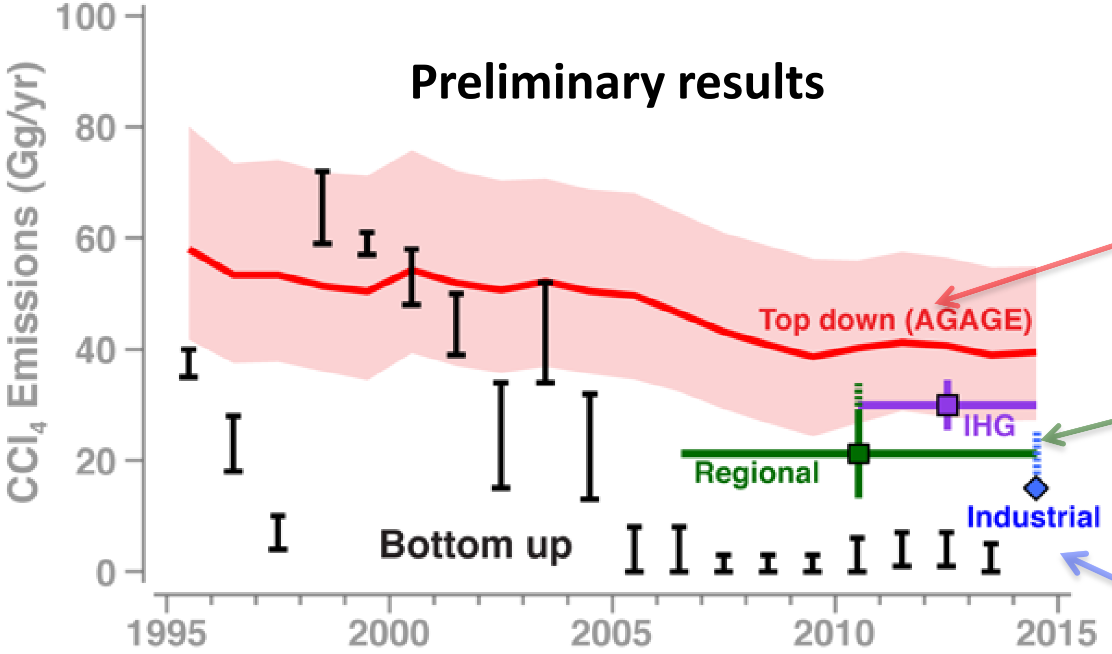


SPARC 2016 CCl_4 report: Collaborative effort Liang, Newman, Reimann and 40+ scientists and industrial experts world-wide.



A new CCl_4 lifetime with improved ocean and soil lifetimes

Improved top-down emissions

- New lifetime-based global emissions from NOAA and AGAGE observations
- Emissions from three major industrial regions: **US**, **E. Asia**, and **W. Europe**

Improved bottom-up emissions

- New industrial emissions

The new lifetime and observation-based analysis lead to an improved top-down emissions estimate. **These new estimates have significantly closed the CCl_4 budget gap from the original 30-70 Gg yr^{-1} to 15 Gg yr^{-1}**

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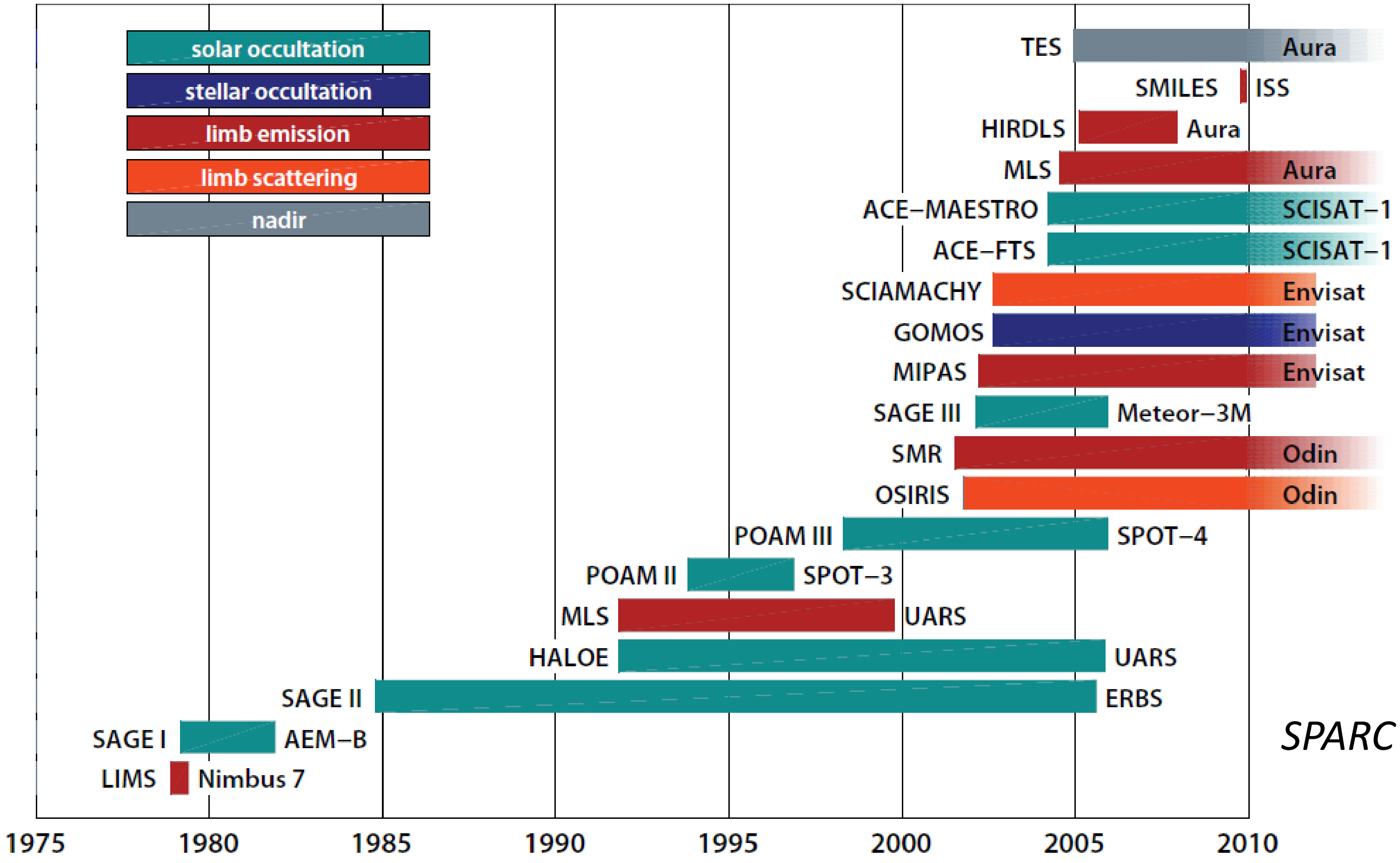
SPARC Data Initiative on stratospheric composition

Comprehensive quality assessment of 25 chemical trace gases and aerosol from satellite limb observations



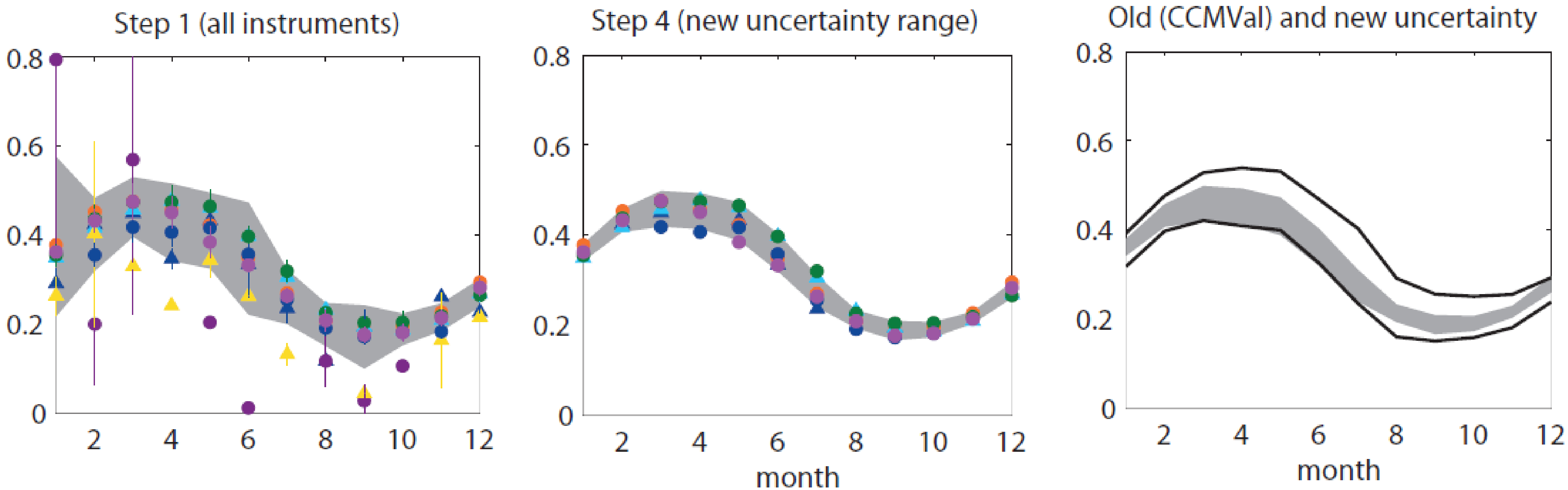
SPARC Report No. 7, 2016

SPARC Data Initiative on stratospheric composition

Improved diagnostics for model evaluations

- Based on all satellite data sets appropriate subset is selected
- New observation mean values and uncertainty range
- Input for Chemistry Climate model inter-comparisons

Ozone seasonal cycle 40°N-60°N, 200 hPa



SPARC Data Initiative is ending, but …

Ideas for a new emerging SPARC activity on UTLS composition, observations and trends

GAW, SPARC and NDACC **’Upper troposphere/lower stratosphere (UTLS) Observation Workshop’**

- Assessing availability and quality of chemical composition measurements in the UTLS from multiple instrument platforms“
- WMO Headquarters, Geneva, 24-27 May 2016
- Bring together experimentalists (satellite, aircraft, balloon, and ground-based), data analysts, and UTLS experts
- Main focus on water vapour and ozone, but also extend to other trace gases, aerosol and clouds

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.

Lack of planned satellite limb observations of UTS composition

1) **One page on a consolidated view on the lack of satellite limb sounders and the issues arising for SPARC science.**

WDAC GCOS ESA/EUMETSAT

ET-SAT (Expert Team on Satellite Systems)
CGMS –WGIII (Coordination Group for Meteorological Satellites)

2) **Contribution to the Decadal Survey for Earth Science and Applications from Space**

- from the National Academies of Sciences, Engineering, and Medicine
- submitted from the SPARC Data Initiative and from the SPARC Data Assimilation group

3) **Contribution to the GCOS conference on Global Climate Observation: the Road to the Future**

S·RIP | SPARC Reanalysis Intercomparison Project

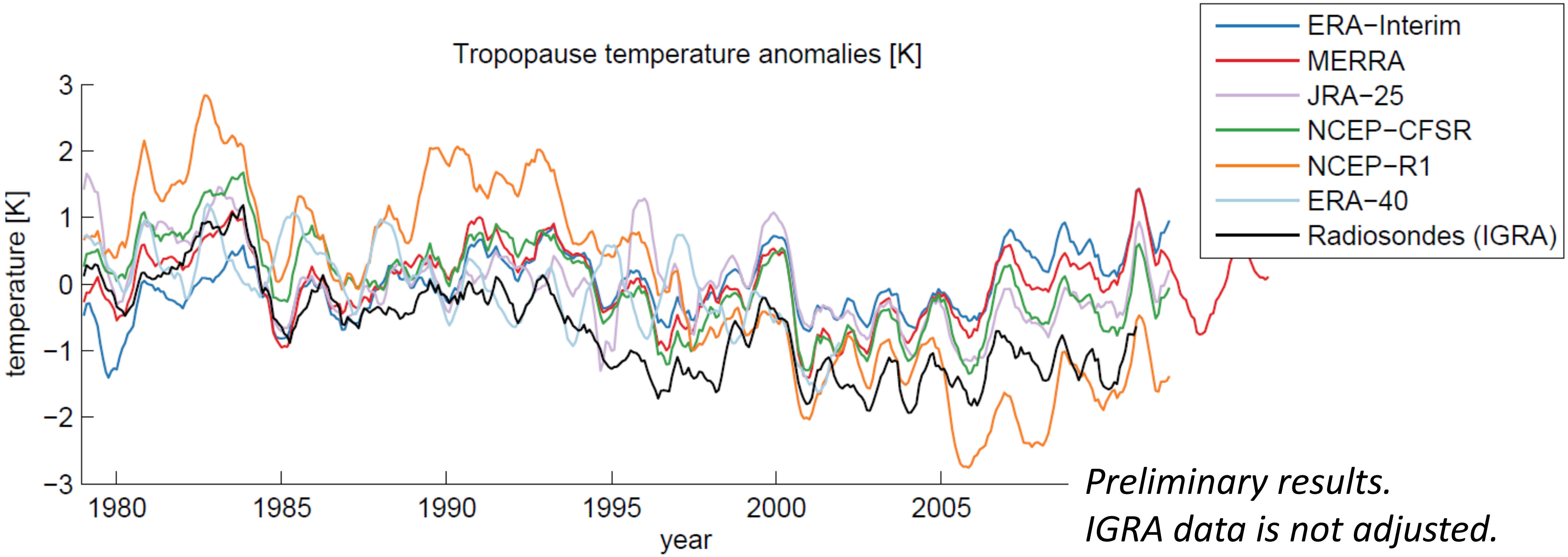
Goals

(1) To create a **communication platform** between the SPARC community and the reanalysis centres

(2) To better **understand reanalysis products** and to contribute to future reanalysis improvements

(3) To document the results of the reanalysis intercomparison in peer reviewed papers and **two SPARC S-RIP reports**.

Reanalysis Centre	Products	Contacts for S-RIP
ECMWF	ERA-40, ERA-Interim, ERA-20C (and ERA-20CM), [ERA5]	Rossana Dragani
JMA (& CRIEPI)	JRA-25/JCDAS, JRA-55 (and JRA-55C, JRA-55AMIP)	Kazutoshi Onogi & Yayoi Harada
NASA	MERRA, MERRA-2	Steven Pawson
NOAA NCEP	NCEP/NCAR (R-1), NCEP/DOE (R-2), NCEP-CFSR	Wesley Ebisuzaki & Craig Long
NOAA & Univ. Colorado	20CR (v2c)	Gilbert Compo & Jeffrey S. Whitaker



Preliminary results.
IGRA data is not adjusted.

Chapters 1-4: Basic chapters
2016 report

Chapters 5-11: Advanced chapters
2018 report

Outline Plan for S-RIP Report

	Chapter Title	Chapter Co-leads
1	Introduction	Fujiwara & WG members
2	Description of the Reanalysis Systems	Masatomo Fujiwara, Craig Long
3	Climatology and Interannual Variability of Dynamical Variables	Craig Long, Masatomo Fujiwara
4	Climatology and Interannual Variability of Ozone and Water Vapour	Michaela Hegglin, Sean Davis
5	Brewer-Dobson Circulation	Thomas Birner, Beatriz Monge-Sanz
6	Stratosphere-Troposphere Coupling	Edwin Gerber, Patrick Martineau
7	Extratropical UTLS	Cameron Homeyer, Gloria Manney
8	Tropical Tropopause Layler	Susann Tegtmeier, Kirstin Krüger
9	QBO and Tropical Variability	James Anstey, Lesley Gray
10	Polar Processes	Michelle Santee, Alyn Lambert, Gloria Manney
11	Upper Strato. Lower Mesosphere	Lynn Harvey
12	Synthesis Summary	Fujiwara & WG members

SPARC Data needs and requirements

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 (MERRA example)
- Need for more reference-quality global & long-term observations, particularly for reanalysis intercomparisons
- No planned continuation of mesospheric radiance for temperatures
- Need for quick response field campaigns after volcanic eruptions
- Data sharing is a challenge in the 'Asian Monsoon region'