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Request of input from core activities to the

44th Session of the WCRP Joint Scientific Committee (JSC)

8-11 May 2023

Report to the WCRP Joint Scientific Committee

SPARC

1. Highlights achieved since JSC-43

- **SPARC 7th General Assembly** 24-28 October 2022 using an **innovative hybrid multi-hub model** to reduce the carbon footprint of the meeting. The Assembly was attended by a total of 415 participants (162 online and 252 in-person). Estimated total carbon footprint from travel: 223 tCO2-eq (→ factor of 2-4 smaller than using single hub).
- **SPARC Report No. 10**: SPARC Reanalysis Intercomparison Project (S-RIP) Final Report (2022)
- Many SPARC activities have directly or indirectly contributed to the **2022 WMO/UNEP Ozone Assessment Report**
- Contributions to the **BAMS Report "State of the Climate in 2021"** (ATC activity provided results for tropospheric temperature trends)
- Contributions to collabor. effort on updating **the Earth heat inventory** (update on the atmospheric heat content)
- **Review paper** on Gravity Wave Science (covering observations, wave-resolving models, parameterisations, and theory; in submission to BAMS)
- **Review paper**: update on QBO research in the 20 years since Baldwin et al. 2001, particularly on QBO modelling and forward-looking perspectives on research needed to address knowledge gaps pertaining to the QBO
- **Community paper** on "Quantifying stratospheric biases and identifying their potential sources in subseasonal forecast systems" (Part I of the SNAP community project on stratospheric biases in S2S forecast systems)
- **Community paper** on "Stratospheric Nudging And Predictable Surface Impacts (SNAPSI): a protocol for investigating the role of stratospheric polar vortex disturbances in subseasonal to seasonal forecasts." from the SNAP activity
- **Community paper** on "Northern Hemisphere Stratosphere-Troposphere Circulation Change in CMIP6 Models. Part 1: Inter-Model Spread and Scenario Sensitivity." (by the SPARC DynVar community)
- Many publications in various journals (see appendix), including **special issues** lead by SPARC activities:
  - The TUNER Special Issue of Atmospheric Measurement Techniques (AMS): 12 papers (March 2023)
  - The Exceptional Arctic Stratospheric Polar Vortex in 2019/2020: Causes and Consequences Climate (Geophysical Research letters Special issue): 29 papers (March 2023)
  - Atmospheric ozone and related species in the early 2020s: latest results and trends (ACP/AMT inter-journal SI): 27 published papers (March 2023)
  - The inter-journal special issue on "The SPARC Reanalysis Intercomparison Project (S-RIP)" in Atmospheric Chemistry and Physics (ACP) and Earth System Science Data (ESSD): 53 published papers (more S-RIP publications listed here: https://s-rip.github.io/pubs/intercomp.html)
  - QJRMS QBOi Special Section
- Modelling experiments to contribute to the work of the CCMi, QBOi, and SNAP activities, among others.
- SSiRC Activity involvement in the assessments of the impacts of the Hunga Tonga Volcano through VolRes Activity
- International instrument teams work towards error reporting TUNER-compliant and publish those results
- SPARC activities have started again to organize in-person workshops, which are taking place during 2023, and will bring together the community in various meeting places on various continents throughout the year.

2. Planned science initiatives and major events *(next 3 to 5 years)*

- The **SPARC Strategic Plan 2022-2030** has been approved by the SSG and presented to the SPARC community at the General Assembly. We are now moving to the implementation phase which will be a strong focus for SPARC in 2023 and 2024, establishing the new project structure.
  - As part of its new Strategic Plan, SPARC is continuing its efforts to include more tropospheric science. All current activities will be asked to submit refreshed science plans and objectives for the next 4 years that will be approved by the SSG.
- SPARC started a new **3-year Hunga-Tonga activity** with the objective of publishing a SPARC Special Report on the HTHH eruption ahead of the 2026 WMO/UNEP Ozone Assessment Report. The activity will focus an international effort to synthesise studies in the published literature for the broader community and to coordinate multi-model assessments.
- LOTUS submitted a proposal to **extend LOTUS to Phase 3**. The goal is to prepare trend analyses of observations and models for the 2026 WMO/UNEP Ozone Assessment. Three main goals for the next few years are:
  - Collectively explore above research topics concurrently with the goal to publish the results in peer-reviewed journals, possibly as part of a special issue in AMT/ACP
  - Coordinate with other relevant SPARC activities to prepare and collect ozone, temperature, and GHG records for trend analyses
  - Provide trend results in agreement with the schedule of the 2026 WMO/UNEP Ozone Assessment
- **S-RIP** is entering **phase two** of the project. This phase is expected to take five years, and to be centered around a new multi-journal special issue in Atmospheric Chemistry and Physics (ACP), Weather and Climate Dynamics (WCD), and Earth System Science Data (ESSD). Goals of the new phase include:
  - Full evaluation of ERA5, other recently completed reanalyses (e.g., CRA-40), and upcoming reanalyses (e.g., JRA-3Q)
  - Extension of existing diagnostics and topic areas
  - New diagnostics in new areas (as proposed and coordinated within the community (e.g., stratosphere-troposphere coupling, Asian monsoon, atmospheric composition)
- A number of SPARC activities are preparing **work on topics relevant to the upcoming 2026 WMO/UNEP Ozone Assessment** (LOTUS, OCTAV-UTLS, CCMi, …) including:
  - updated projections of ozone, including recovery of stratospheric ozone
  - effects of Stratospheric Aerosol Intervention (SAI) on stratospheric ozone
  - The **new SPARC Assessments coordination panel** will work to keep track of upcoming assessments, their timelines and input needs, and coordinate and streamline SAPRC output for those assessments.
- New coordinated experiments to **address outstanding science questions related to the QBO**. The four working groups to tackle these are:
  - Vertical resolution and other model sensitivities related to QBO biases
  - QBO-MJO connections
  - QBO predictability using hindcasts (e.g. predictability of QBO disruptions)
  - Stratospheric aerosol effects on the QBO (geoengineering / volcanic eruptions)
- Work on the **reassessment of the CMIP6 solar forcing recommendations** as preparative step towards **CMIP7** has been started within the SOLARIS-HEPPA activity. This work includes analysis of solar influence in CMIP 6 simulations. A new white paper will be published, soon. It contains several proposed additions to the forcing data used in models. Further, a preliminary version of the revised historical dataset is planned to be made available by end of 2023. Final release of the CMIP7 solar forcing is planned for early 2025.
- **Scientific Assessment of wildfires** in various SPARC activities
- A number of **Review/community papers** are planned to be published by various SAPRC activities within the next 5 years
- creating **forcing datasets for CMIP7 simulations** (solar forcing, ozone forcing datasets)
- Yearly in-person SPARC workshops and training schools (e.g. ACAM training schools in 2025 and 2027), including **the next General Assembly** in 2026 - 2028

3. Active or planed collaborations with other Core Projects, Lighthouse Activities etc.

- SPARC is continuing efforts to connect to the **GEWEX/CLIVAR Monsoon Panel**. We anticipate to establish permanent liaisons through the new ACAM activity leads in 2023. Both sides are very interested in establishing closer relationships. Current connection through Alexey Karpechko (Panel member and DynVar co-lead)
- ATC continues good collaborations with **WCRP core projects** involved in the work on the Earth's heat inventory and via the Task Team on Energy and Budget Cycles
- Gravity Waves has some interaction with **GEWEX**, on the role of gravity waves relative to clouds. Contacts with the UTCC PROES activity, coordinated by Claudia Stubenrauch and Graeme Stephens have been made, with participation to some of their meetings.
- Jonathon Wright attended the **CLIVAR** Workshop on Future Earth System Reanalysis as an S-RIP representative and intends to maintain communication with this working group.
- **CLIVAR** and **ESMO** may benefit from the experience and expertise from phase 1 of the S-RIP activity in push toward coupled Earth system reanalyses. During their next phase, S-RIP also intends to adopt and adapt climate model evaluation tools, such as **ESMValTool**, that are widely used within the **CMIP** community.
- Various SPARC activities have interest or already established links to **ESMO**:
  - QBOi aims to improve QBO modelling. This is related to all the modelling & prediction groups (WGCM, WGSIPS, WGNE) contained under ESMO.
  - SNAP would like to be involved in ESMO through continued S2S activities
  - Masatomo Fujiwara is S-RIP liaison with the **WCRP TIRA**, which is now within ESMO.
  - S-RIP and SSiRC are also interested in collaborating with ESMO
- Since some of the **LHA** have not yet established their way of working, many SPARC activities are asking how they can **start collaborations**:
  - Most SPARC Activities express interest and/or links to the **EPESC LHA**:
    - Gravity Waves: connection of stratospheric dynamics to predictions on multiple timescales
    - LOTUS assesses the efficacy of models via comparisons with observations and trend analyses. Discrepancies between observations and models detract from the ability to make accurate forecasts / predictions that are at the core of WCRP LHAs.
    - QBOi: analysis of predictability related to the QBO in the LESFMIP5 experiments (QBO as source of predictability through accurate representation).
    - Further interested SPARC Activities: CCMi, DynVar, OCTAV-UTLS, SSiRC
  - DynVar hopes to connect to the new WCRP lighthouses in terms of **climate risk** for extreme events.
  - The **Digital Earths LHA:**
    - Gravity Waves: high-resolution modelling and machine learning parameterization methods are beneficial for both the GW activity (information on gravity waves) and for the modelling community (realism of the processes described at these newly available resolutions).
    - Analysis of high-resolution simulations can shed light on the forcing of the QBO, particularly its easterly phase. Any available data from such models would be a valuable resource for QBOi.
    - SSiRC would like to contribute through looking at the stratospheric aerosol layer as a key component of the climate system.
    - Two SNAP affiliated scientists (Andrea Laing and Daniela Domeisen) are on the planning committee for the Digital Earths high-resolution modelling group
- Already established links to the **EPESC LHA**:
  - ATC has good connection to EPESC through appointed SSG member Andrea Steiner
  - One of the QBOi coordinators (Scott Osprey) is on the SSG of the EPESC lighthouse activity and co-lead of their WG2 (Integrated Attribution, Prediction and Projection).
  - Several DynVar committee members are members of the EPESC WG2; helping to design case studies for investigating decadal predictability, in particular advising on cases where SPARC expertise on stratosphere-troposphere coupling is most relevant.
  - SNAP co-chairs Chaim Garfinkel and Amy Butler are both members of the new WCRP EPESC WG2.
  - SOLARIS-HEPPA collaborates with the EPESC WG2 (Liaison: Bernd Funke, WG2 member).
- SOLARIS-HEPPA activity lead Bernd Funke is a member of the **WCRP Climate forcing Task Team**

3a. Requests for the WCRP Academy to support your training activities?

- SSiRC has always been keen to engage young researchers as well as researchers from underrepresented regions of the world wherever possible. In that context, SSiRC hopes to be able to contribute to as well as benefit from the WCRP academy.
- The **SPARC Outreach Advisory Panel** will be charged with developing new initiatives for training and development of ECRs within SPARC. They will also have oversight on the transfer and impact of SPARC science beyond the realm of blue skies research. It may well be useful for the Outreach Advisory Panel to establish contact with the WCRP Academy, perhaps by co-opting an Academy representative onto the panel.
- Overall SPARC hopes to benefit from exchange of experience as well as availability of platforms & tools supported by the Academy LHA.

4. Partnerships with projects outside WCRP

- As part of its new Strategic Plan, SPARC will establish a new Partnerships Panel as a dedicated forum to review and plan SPARC's engagement with other WCRP groups (CPs, LHAs) and with projects external to WCRP. The ToRs including Panel membership are being developed this spring.
- SPARC activities continue close collaborations with **IGAC**:
    - ACAM collaboration with IGAC activities including MANGO and MAP-AQ
    - CCMi collaborate with the ROSTEES working group under the Tropospheric Ozone Assessment Report (TOAR) activity of IGAC
    - LOTUS collaborates with the IGAC TOAR activity to interpret changes in tropospheric ozone that contribute to the total ozone changes.
    - An OCTAV-UTLS representative attends the IGAC TOAR-2 meetings.
- ACAM: collaboration with **ACCLIP** on the regional and global impact of the Asian summer monsoon
- ACAM: collaboration with the **NASA ASIA-AQ** field experiment in 2026
- Gravity Waves is exploring the use of Machine Learning. Part of this important endeavour is supported by an international project, **DataWave**, of the **Virtual Earth Scientific Research Institute**, involving several groups in the community.
- LOTUS & OCTAV UTLS activities collaborate with the **WMO GAW** and **NDACC** by using the ground-based ozone (and other) records for trend analyses. Some PIs of ground-based records are members of the LOTUS activity.
- LOTUS also collaborates with the satellite community including **NASA, ESA, NOAA**, and **EUMETSAT** that provide combined long-term ozone records.
- SOLARIS-HEPPA is strongly interacting with **SCOSTEP** within its new **PRESTO** Science Programme.
- With the expected inclusion of chemical and aerosol reanalyses in phase 2 of the S-RIP activity, they have established lines of communication with both the Chemical Reanalysis Focus Working Group of the Tropospheric Ozone Assessment, Phase II (**TOAR-II**) and the **AeroCom** activity, and intend to share resources and tools as the activity progresses.
- With respect to research on the tropospheric OCS budget, SSiRC collaborates with **COSANOVA**, a community of researchers that use atmospheric measurements of carbonyl sulfide and other emerging methods in ecosystem science.
- SSiRC seek improving connectivity to the ice core community perhaps through the International Partnership in Ice Core Sciences (**IPICS**). Also, improved communications with organisations like the International Association of Volcanology and Chemistry of the Earth's Interior (**IAVCEI**) and Past Global Changes/Volcanic Impacts on Climate and Society(**PAGES/VICS**).
- The Hunga Tonga initiative invites scientists from any program and affiliation; the report will provide a review of science happening within as well as outside of WCRP. They will approach several groups external to SPARC, including CMIP6, **PAGES** and **IAVCEI**
- SPARC is cooperating well with **CEDA** for long-term storage of data from various SPARC activities

***5. Issues and challenges**:*

- SPARC has recently submitted its **New Strategy** for approval by the JSC, and has already started implementing the new structures mentioned in the document, which will facilitate communication within and towards the outside of the project.
- SPARC has proposed to **change the name of the core project to APARC** (Atmospheric Processes And their Role in Climate)
- SPARC is writing **new guidelines on activity proposals**, requesting a definite timeline to enable reviewing activities after that time has expired. Activities will end at a point where the community is well-established and able to sustain itself without support from SPARC, to be able to make room for new activities.
- SPARC is **initiating a round of reviewing it current activities** and considering to summarize some into a single activity, and possibly sunsetting a few of the "older" existing activities. Work being done by those activities might continue under a different umbrella within SPARC.
- The **legacy of the S2S project** in WCRP is currently not clear. Currently, S2S is part of ESMO, which currently strongly leans towards decadal prediction. SPARC strongly recommends ESMO to include the S2S project within its scope. We think there is much to be gained from including a range of timescales especially in the context of stratosphere-troposphere coupling and extremes, where the underlying mechanisms occur on the scales of days to weeks. SPARC activities are interested to keep collaborating with the project and stay involved in the future.
- The challenge of **data storage** is ever present and growing with increasingly larger data files from model output from high-resolution simulations
  - Currently, some SPARC activities archive data at CEDA (UK), which has been an exceptionally valuable and adequate resource so far. However, as we are not sure of the limits of this service, any information on other potential available data archiving & dissemination services would be valuable.
- SPARC modelling activities experience **difficulties motivating model centers to participate** in their projects due to workload the centers are experiencing.
- **Computational resources** required to do SPARC science is expected to become **more expensive** in the future, which could cause financial budget concerns for SPARC groups and scientists.
- SPARC activities repeatedly ask for **support to submit publications in open source journals** (3-5 kCHF per publication). Currently this is not supported by WCRP, but it would be much appreciated.
- WCRP providing a **platform for abstract submission / registration** to workshops would be very beneficial for both, WCRP for corporate identity purposes, and the core projects for potentially saving on workshop costs.
- The **current political situation** makes **paying out travel support** very hard in some cases. Currently, the SPARC IPO in Germany is not allowed to pay support towards China or any Russian citizen (no matter where they live or who they work for). In these cases, we can work with WCRP in these cases to still be able to provide travel support. However, the process of using two different ways of making payments and having to react to getting information late makes the whole process complicated and puts a larger burden of work both on the IPO and the WCRP secretariat. Another part of the story is that the IPO has helped with **international communication** between U.S. employees and Chinese employees by forwarding emails, since those parties were not allowed to directly talk to each other. This hinders the collaborative international approach WCRP and its core projects stand for. Would an official statement from WCRP do anything to make working internationally easier?

Appendix: List of Publications

Appendix: List of Publications from SPARC activities (non-exhaustive)

Abalos, M., N. Calvo, S. Benito, H. Garny, S. Hardiman, P.Lin and CMIP6 coauthors, 2021: The Brewer-Dobson circulation in CMIP6 models, Atmos. Chem. Phys., 21, 13571–13591.

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