



Image credit: Yungian Zhu

This impressive illustration shows the volcanic eruption of Hunga Tonga–Hunga Ha’apai of January 2022, and was created by Yungian Zhu. She is one of the co-authors of the new SPARC activity that examines impacts of this eruption. An Introduction to this new activity can be found on page 10.

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30th SPARC SSG Meeting : The New Strategy

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On 8, 10, and 16th November 2022, the SPARC SSG and activity leads met online for the 30th session of the SPARC SSG. The annual meeting covered the reporting by the activities, SPARC business updates, and updates from partner projects, as well as a long session about the future structure of SPARC.

Activity updates

The meeting started with summaries of the activity reports, given by members of the SSG. In her summary, **Sophie Szopa** informed the group about the progress of the CCMi, SNAP, and SSiRC activities. SSiRC has been very active in investigating the effects of the Hunga Tonga-Hunga Ha'apai eruption in 2022 through their Volres Activity while continuing work on the ISA-MIP and the Data Rescue initiative. They recently changed leadership with Larry Thomason and Stefanie Kremser stepping down and succeeded by Anja Schmidt, Landon Rieger, and Marc von Hobe. CCMi and SNAP also had a successful year with a number of published papers and progress in model comparison setups and data collection. Both have been working with CEDA to archive data from their projects. All activities are planning workshops in 2023, SNAP planning theirs in collaboration with DynVar.

Very good cross-collaboration exists between the trends activities *i.e.*, ATC, LOTUS, HEPPA-SOLARIS, and OCTAV-UTLS, as presented by **Viktoria Sofieva**. They also have many well-established connections outside of SPARC (*i.e.* GAW, IGAC TOAR 2, the satellite community, other WCRP homes and light house activities), as well as to other SPARC activities, who collaborate on topics such as data availability, uncertainties, model scenarios, and others. The activities reached a number of individual milestones through the publication and/or continued preparation of important community papers. LOTUS also contributed to the 2022 WMO/UNEP Ozone assessment with important input to Chapter 3, and through the work of the activity members acting as chapter lead authors. ATC also contrib-

uted to a number of important reports and assessments, including IPCC 2021, and State of the Climate in 2021 published in BAMS. Furthermore, the activities continued to upload data to their data bases and use their models for scientific assessments. SOALRIS-HEPPA is currently reassessing the CMIP6 solar forcing recommendations as a preparative step towards CMIP7. All four activities held workshops and meetings last year and are planning to continue their scientific works, with LOTUS currently formulating a science plan for their next phase. ATC and SOLARIS-HEPPA are changing their leadership, with ATC currently looking for a new co-lead to work with Andrea Steiner, and SOLARIS HEPPA announcing that Katja Matthes is rotating off, and Wenjuan Huo will lead the activity together with Bernd Funke.

Wen Chen summarized the activity reports of TUNER, FISAPS, ACAM, and SATIO-TCS, informing the SSG that progress has been made by publishing papers, and connecting better to other communities; *i.e.* instrument groups starting to use the TUNER error reporting standards, and including even more high-resolution radiosonde data in the FISAPS data base. ACAM has produced a large number of papers using data from the StratoClim campaign, and has held a fully virtual training school in June 2022. The next ACAM training school and workshop is currently planned for June 2023 in Bangladesh. FISAPS is also planning a workshop in September 2023 in Boulder, USA, and TUNER also plans an in-person meeting in spring 2023. SATIO-TCS is currently struggling to keep the activity running, and would like to continue their scientific work as part of another thematically fitting SPARC activity.

In the final summary, **Takeshi Horinouchi**, showed that S-RIP, QBOi, DynVar, and Gravity Waves also made progress through published papers and successful workshops in 2022. Most notably, the S-RIP final report was fully published in 2022. QBOi published a large review paper on QBO research since Baldwin et al. 2001.

Gravity Waves has a new ISSI Team, starting in 2023, and will also look into the Hunga Tonga-Hunga Ha'apai eruption, and *DynVar* and *QBOi* also continued their works with good progress. *QBOi* will finally hold an in-person workshop again in 2023, after postponing the *QBO@60* celebration for two years in a row, and meetings are also planned by the other activities.

Partner projects

While most of the other WCRP core projects sent a short presentation that was available from the meeting webpage, the co-chairs invited representatives from the two new WCRP core projects to present their plans and current state of the project. **Bruce Hewitson** introduced the Regional Information for Society (*RiFS*) project, which has clear links to the My Climate Risk Light House Activity (*LHA*), and will take on the science going into the *LHA*. *RiFS* will also bring the connection between the regional hubs established by the *LHA* and the fundamental science in WCRP.

A primary goal of the Earth System Modelling and Observations (*ESMO*) project (**Susann Tegtmeier**), is to establish and enhance better connections, and to coordinate where there are gaps, especially in observations. It is also seen as a possible new home for the science from the *S2S* project, though it is not yet clear, what science will happen.

Alexey Karpechko presented on behalf of the *CLIVAR* project, for which good opportunities to collaborate were seen by all SSG meeting participants. *S-RIP* is among the interested activities, but overall it was found that it would be a good idea to have a SPARC representative at *CLIVAR* to ensure further collaborations between SPARC activities and *CLIVAR*.

Collaboration was also discussed with **Louisa Emmons**, who introduced the *IGAC* project. The largest potential was seen for the *IGAC TOAR* project. It was found, that while there has been a history of hesitancy in expanding activities to avoid stepping on other's feet, it seems to have shifted to a more open environment for collaborations on both sides. The consensus is that there is only one atmosphere, so there should be more joint activities between SPARC and *IGAC*.

The co-chairs also gave a brief summary on the current developments in the WCRP Light House Activities

(still in the process of forming, and some not even having met in person) and task teams, to which the SPARC IPO knows all contact points. There is a lot of room for collaborations, and there are SPARC representatives involved in all of the activities - the Academy is the only exception, and a representative will be appointed, as soon as possible. Following the update on the WCRP Task Teams, there was a brief discussion on possible activities investigating climate intervention. There is slow progress on implementing activities on this topic in WCRP, who - while not wanting to be prescriptive - wants to work on it. There is basic science on the methods missing, e.g. laboratory experiments, and this is where SPARC can come in. If SPARC forms an activity, and states the importance of the topic, that will help local groups/laboratories to find financing.

Proposed new SPARC activities

The second session was completely dedicated to the future of SPARC. After re-visiting a few topics from Session I, there was a discussion on possible future topics to be worked on in SPARC. During discussions the topic of a possible activity on the hydrogen-based economy came up, which could be interesting for various groups in SPARC, as it touches on water vapour in the stratosphere as well as methane in the troposphere. *CCMi* has thought about this in the early 2000s, and was asked to consider re-activating the topic.

A second topic SPARC wants to take on in a short-term activity is a coordinated approach to the Hunga Tonga-Hunga Ha'apai eruption assessment, which is interesting for many SPARC activities (*i.e.*, *SSiRC*, gravity waves, and others), already involved in current scientific work. The results could be a potential contribution to the 2026 Ozone Assessment, and it was found that the collection and assessment of observations and model results are crucial to this project. This could be the first "limited-term cross-activity focused project" (LTFCF), defined in the new SPARC strategy as: "*short-term (<1 year) cross-Activity projects that address specific and focused emerging research needs in a timely manner. The topics could include specific events of interest [...] or policy-relevant matters (e.g., illegal CFC-II emissions). There will be an accelerated process for launching LTFCFs. [...] Proposals may come from anyone in the atmospheric science community via a short statement of interest to the SPARC Steering Group. Open calls should be made when establishing membership of LTFCFs.*"

Future SPARC structure

The new strategy was formulated over a long process during the last two years, after consultation with the strategy task team, the community, and the SPARC SSG. It is ready to be launched after a further round of discussions with the SSG in January, during which the implementation of the new structure will be in focus. The following summarizes the strategy (blue quotes), as well as the discussions during the SSG meeting.

The discussions on the three activity collaboration groups (ACGs) were relatively brief. The new strategy states: *“The core business of ACGs will be to informally report on current and planned work in Activities, discuss areas of mutual interest/cooperation, and identify opportunities to contribute to the Assessments Coordination Panel and the Partnerships and Outreach Advisory Panels.”*

The purpose of the ACGs is to provide fora for more frequent interactions amongst activities, with a clear focus on science. ACGs may propose topics for LTCFs to the Steering Group. They will be organized

around three themes (see Figure 1):

- *Processes relating to atmospheric composition to improve understanding of fundamental climate processes, including those related to atmospheric chemistry, radiation and dynamics.*
- *Processes related to variability and trends across timescales, including research related to atmospheric and climate prediction, and occurrence and attribution of extreme events.*
- *Processes related to atmospheric dynamics focused on leveraging observations, reanalyses, models, and innovative analysis and attribution methods to demonstrate new understanding of the climate system, its changes and drivers*

ACGs will be supported by the IPO. While it is clear that each ACG will have at least one SSG member in the lead, who would be responsible for reporting back to the SSG and co-chairs on ACG meetings, it is not yet decided who else will be on the panels, and how they will be organized.

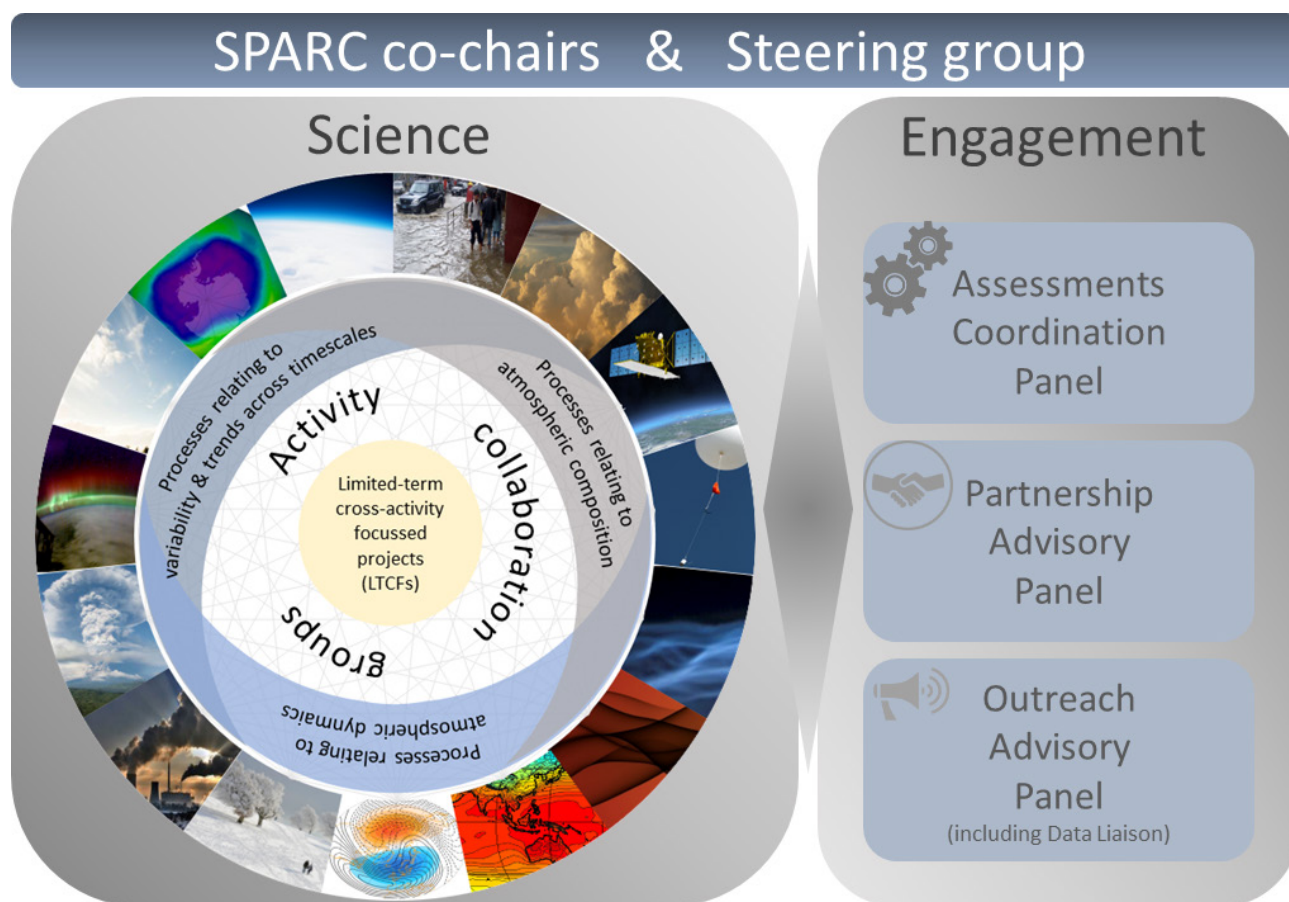


Figure 1: New structure of the project: Activities will be organised in Activity Coordination Groups, which oversee the science and coordinate activities and workshops in their respective themes. The panels will coordinate SPARC science output and necessary science activities with outside projects, maintain, strengthen, and induce partnerships, and coordinate outreach activities, including data storage and availability.

SPARC's new strategy: VISION

To continue building our scientific understanding of the atmosphere, illuminating the dynamical, physical, chemical and radiative processes, and their connections to the climate system and the health of our planet. SPARC recognizes the need to demonstrate societal benefits from science.

It is a clear opportunity to have ECS involved, who can drive the ACGs. The ACGs should not be top-down but rather bottom-up in terms of who wants to contribute to which ACG, and the way of operation might actually be different for individual ACGs to ensure it to be run in a way that is useful to the group, instead of just being a new formalised bureaucracy to the existing activities organised under the ACG. This can be in form of meetings but other communication tools are also welcome (e.g., Slack, google, etc.). The ACGs need clear terms of reference to work by, for which community input is welcome. Some of the existing activities may evolve into one of the ACGs (while making sure that the scientific work will still be continued), or some individual activities may be merged and populate an ACG, to coordinate work towards assessments (e.g., trends activities). SSG meeting participants agreed that the final ACGs must properly represent the scope of SPARC work and bring in ECS, and also that panel members should have limited terms (as in GEWEX/CLIVAR panels) to ensure active contributions.

Regarding the *Advisory and Coordination Panels*, it was discussed that the Assessment Coordination Panel probably mostly touches the trends activities. The strategy defines that the panel *“will unite scientists from the SPARC community who are supporting international assessments. This panel will provide a forum to share best practices, identify synergies and complementarity from across SPARC contributions, and support the delivery of content in a timely manner. Where individual contacts have not yet been established, the Assessment Coordination Panel will provide a point of contact for external Assessment coordinators to seek expertise from the SPARC community. It will also act as a focal point for supporting the SPARC community to deliver timely and relevant evidence to scientific assessments. The Panel will also monitor the contributions of the SPARC community to other assessments such as IPCC reports and associated impacts. The panel will also advise on what assessments SPARC could lead after consultation with the*

community.” In the SSG meeting discussions it was stated that the panel should coordinate timelines of assessments to ensure work can be published and made available on time: model input for trend analysis needs to be created well ahead of deadlines so good work can be done in time for the assessment deadlines. Through the panel the output of SPARC should be also coordinated, meaning that handling of errors, output format, etc, are unified for all outputs. Furthermore, it is important for the panel to interact with the groups outside of SPARC, i.e., IPCC, Ozone Assessments, and others, which will need to be reflected in the composition and/or subgroups of the panel.

The Partnership Advisory Panel is introduced in the strategy as: *“comprising external representatives from organisations, groups and other projects with whom SPARC wishes to collaborate, partner, and engage. The Panel will take strategic leadership of the connections between SPARC and other groups, focusing on opportunities, synergies, and co-benefits. The purpose is to ensure that SPARC is well connected with the network of other groups and organisations who have complementary remits.”*

SPARC's new strategy: MISSION

Atmospheric and climate sciences are increasingly becoming a focus of decision-making across policy, research, and industry, and of interest to the public. SPARC supports the scientific and user/policy communities in addressing science questions relevant to our changing planet. SPARC takes on the mission of building the atmospheric science community's strengths in four key areas:

- 1) critical analyses and reviews of emerging scientific topics for international assessments;
- 2) cross/transdisciplinary science projects that connects researchers across borders and domains, linking atmospheric science to other Earth system science;
- 3) community development and capacity building of international and early/mid-career scientists with development opportunities to participate in and lead projects;
- 4) publicity and outreach for the atmospheric sciences to building an informed public and inspiring a new generation of climate scientists.

It was discussed, that partnerships are often event-based, and that regional ambassadors could/should be coordinated with the My Climate Risk Light House, the WCRP Regional Focal Points, and the YESS network.

These will probably also be involved with the Outreach Advisory Panel, *“whose remit will be to take strategic responsibility for SPARC’s outreach and engagement, capacity building, training, and open science. [...] The Panel should enable a longer-term strategic oversight of SPARC and identify opportunities for shared best practice, elevated impact, and the development of new initiatives. SPARC will appoint Regional Ambassadors across the world who will engage with local communities and stakeholders, identify their needs, and communicate research results. They will work with local organisations that are active in outreach, e.g. universities, and support their work.”* During discussions, the existing capacity building plan, developed by the Zurich IPO, was mentioned, which lost momentum with the Office moved to DLR. While many individual activities in SPARC do great work towards capacity development, it will be important to regain momentum and better coordinate the efforts both within SPARC, as well as with WCRP activities. Further, the organisation of online resources will be a responsibility of this panel, together with the IPO.

Finally, the activities themselves will be reviewed, as well as the mechanisms to start and sunset SPARC activities. In the past, renewal of activities has become a common habit, with ten of the currently 15 existing activities being more than eight years old. Also, activities have increasingly tended to move through the ages (phase I, phase 2, ..., phase N). The different nature of the activities leads to very different ways of defining milestones: it is hard to “end” networking-oriented activities like DynVar, while at the same time, there is a need for a meeting the continued need of science contributing to assessments (e.g. trends). This has led to the fact that there has not been a call for new activities for some time; however, bottom-up evolution is key for the success of the project. Moving forward, it is necessary to reflect on: Why would someone propose an activity? What would they gain? There is only a small amount of financial support, but the prestige of SPARC endorsement, and access to a wide community are definitive strengths.

A process for reviewing and approving activities needs to be defined, which needs to leave room for bottom-up development, but allow for evaluation. As a start, all activities will be asked to review themselves and define a plan for the next 4 years. One question will be what the activity could not (have) achieve(d) without being part of SPARC. There might be activities, which evolve to projects on their own in the future, making room for new activities and projects within SPARC.

ECS discussions

Session two ended with some time for discussions on ECS involvement, for which activities could nominate participants. The discussion was held in a form of a panel discussion, led by **Federico Serva**. The other panel members were: **Blanca Ayarzagüena**, **Mohamadou A. Diallo**, **Corinna Kloss**, **Robert Reichert**, **Prashant Singh**, and **Tobias Spiegl**. Their ideas and needs were brought to the table during the session, and include the need to collect points for the CV that help with securing a long-term position. To increase their visibility, and help building up skills, it would be desirable to have ECS visibly contributing to meetings (including their organisation) and promote ECS-lead community papers. Further, they can use a mentoring program not only to broaden their networks, but also to get help with funding strategies. At the same time, it was highlighted, that one great strength of SPARC is the easy access to “stars” of the scientific field. Outreach ideas from the ECS include a [SPARC job platform](#), a SPARC podcast about new publications, webinars to promote research (organized by activities), possibly even a YouTube channel and/or Ted-Talk series. The panel members also pointed out, that it would be useful to create an ECS hub (forum or wiki) to exchange knowledge, data, manuscripts and get organized. One idea was to share resources and legacy data in easy-to-use formats for hackathons and similar, to revive interest in them (e.g. radiosonde data). It was pointed out that there is a WhatsApp group founded by Alison Ming, and that the YESS community (**Shipra Jain**) is willing to provide a connection to the YESS self-learning groups. Finally, the panel members agreed that ECSs have to make strategic decisions where to invest time to hopefully benefit through continued funding, as they have to split their time between doing their science and being involved in projects and building their networks.

SPARC internal business

The final session was reserved for continued discussions (included in the summaries above), and internal business. The office update included the termination of the current IPO in 2023, since the Agreement with DLR will not be extended again. A call for a new host has been published through WCRP and is reprinted on page 9 in this Newsletter. The new IPO will start operation in January 2024. Further, the office update (**Mareike Heckl**) also included a review of the past year, in which a few staff changes occurred with Stefanie Kremsler leaving her position as stand-in for Mareike Heckl after the General Assembly. The organisation of this event was the main task for the office this year, and was completed successfully. Besides that, the S-RIP report was finalised and published, and other regular tasks were carried out continuously, including regular update-calls with the other WCRP IPOs, reporting tasks, and budget control.

The 2022 budget was not fully used, due to some SPARC workshops being postponed to 2023, and the SSG meeting organized in a virtual format, again. A successful proposal to carry over unused funds will allow for planning a slightly larger budget in 2023 than in the previous year, which will be spent on a number of in-person workshops that are planned after the COVID-19 restrictions have finally lifted, and on advertising the new SPARC structure. Further, it will be one goal to hold an in-person SSG meeting again, which will also aid collaborations.

In the WCRP update, **Hindumathi Palanisamy** talked about the new WCRP implementation plan being moving forward, with new structures (LHAs, Task Teams, Rifs, ESMO projects; see above) moving forward. Hindumathi also reminded the SSG members about the JSC meeting in July 2022, for which meeting notes are available at: <https://www.wcrp-climate.org/WCRP-publications/2022/JSC-43-Report-Final-c.pdf> New JSC member nominations are aiting approval from the co-sponsors. The project liaisons will be discussed after approval. She also advertised the

upcoming Open Science Conference in Rwanda in 2023 (see page 32).

The session closed with an overview talk about the recent SPARC General Assembly at three hubs, given by **Andrew Charlton-Perez**. The Assembly was seen as a success and it could be shown that there was a significant reduction in CO₂ emissions, compared to an in-person event at only one location. For further details and summary of scientific contributions, see the article on page 17.

In the closed session, the leadership discussed recent changes in the SPARC SSG, with the SSG members **Don Wuebbles** and **Michael Prather** stepping down during 2022. The SSG decided to propose **Jadwiga Richter** (NCAR, USA), and Prof. **Qiang Fu** (Univ. of Washington, USA) as immediate successors, which was approved by the WCRP JSC in the following week. Further discussions about implementing the new structure will be picked up in another SSG-only online meeting in January 2023.

PS from Stefanie

As I'm leaving the SPARC IPO after stepping in for Mareike for the past year. I wanted to take this opportunity to thank you all for your support and making it such a fun and memorable experience. I've thoroughly enjoyed working with all of you over the past year. Thank you all for your patience at the beginning while I was still finding the ropes and navigating my way around the different aspects of this role.

Special thanks to Hindumathi for her great support over the past year - it has been a pleasure to work with you.

I wish SPARC all the best in implementing their new strategy and furthering connections with the communities across the world. SPARC is an important core project in aiding all the further science that needs to be done. Keep up the great work, and continue connecting with each other and sharing your knowledge :)

Thank you all for being such a supportive group, and all the best.



Personal reflections on the outlook for SPARC

As we start 2023, we've taken the opportunity to reflect on the wonderful achievements of SPARC in its 30th anniversary year and to look forward to the exciting developments ahead. We were impressed by the way the SPARC community was reinvigorated last year as in-person meetings became possible for the first time since early 2020. We learned that online meetings can connect us across the globe from the comfort of our sofas, but also that substantial intellectual benefits come from face-to-face discussion and debate. These principles were at the heart of the 7th SPARC General Assembly in October 2022. A small group of innovators were already considering a multi-hub meeting prior to the pandemic as a way of reducing the carbon footprint of the meeting. The good and bad experiences of hybrid meetings in the last few years provided guidance that allowed an ambitious and successful Assembly. The co-chairs fully embraced this spirit and were distributed: Karen in Boulder, Amanda in Reading, and Seok-Woo as an online participant. It was fantastic to see all of the excellent science being generated by the SPARC community and to welcome members new and old, online and in person, to join in with the meeting. It was particularly exciting to have a large number of early career scientists involved and helping to organize special activities. The organising committee, chaired by Andrew Charlton-Perez and supported by hub leads Yaga Richter and Jose Santos, did a fantastic job. We thank all the organisers for bringing the General Assembly to life and enabling us to reflect on the pros and cons of a multi-hub meeting.

The online SSG meeting in November enabled planning for the implementation stage of the SPARC Strategy. We are establishing the new panels with the SSG

and will be making calls for membership this spring. We hope you will be keen to get involved. The co-chairs and SSG took on board the community feedback about SPARC's name and have submitted a letter to the JSC which we will communicate to you as soon as possible.

The call to host the SPARC International Project Office is out and we look forward to liaising with your organisations to find a new home for SPARC starting 2024. If your institution may be interested to host, please get in touch with the SPARC International Project Office. We hope that you are all looking forward to the many SPARC workshops planned this year. The WCRP Open Science Conference in Kigali in October will provide the opportunity to present SPARC's work on the wider WCRP stage – we hope to see some of you there.

Amanda, Karen and Seok-Woo



*SPARC co-chairs
Seok-Woo Son,
Amanda Maycock
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Call for proposals to host the International Project Office of SPARC

WCRP is delighted to open a call for proposals to host a dedicated project office in support to one of WCRP's core projects: the Stratosphere-troposphere Processes And their Role in Climate (SPARC).

SPARC is the focal point for climate science related to the atmosphere within WCRP. Atmospheric and climate sciences are increasingly a focus of decision-making across policy, research, and industry, and of wide interest to the general public. In its 30-year (1992-2022) history, SPARC's activities have generated a wealth of cutting-edge research and valuable datasets. SPARC has a major role in key international scientific assessment reports, including the WMO/UNEP Ozone Assessment Reports which are requested by the Parties of the Montreal Protocol and its Amendments. SPARC is moving forward with an ambitious new strategic plan from 2023, which will further advance those achievements by taking a leadership role at the forefront of international atmospheric science research. All SPARC efforts are part of WCRP's activities and embedded in its overarching WCRP Science and Implementation Plan.

Benefits to the Host Institution

The Host Institution will significantly benefit from hosting the SPARC IPO by having a close interaction with this critical domain of research. It will serve as a great opportunity for the host to help deliver the exciting new goals of SPARC to the international community. In addition, the host institution will have the benefit of:

- enhancing their international profile through clear identification with the WCRP international community,
- underscoring the commitment of the national research community for international cooperation,
- association and participation with a range of international meetings, workshops, and regional activities,
- collaboration with other networks including those of early career scientists,
- contributing to the well-established links that the engagement of scientists from the host institute has already established through international research projects to the global community of climate researchers.

- career development for early career scientists in connecting them with the international research community and involvement in SPARC activities and outreach panel,
- playing an important role in refining and implementing WCRP's new strategy.

Further, development of an active scientific partnership between SPARC and scientists at the Host Institution is encouraged, with the aim of increased international exposure and additional scientific publications.

Hosting the SPARC International Project Office (IPO)

The primary function of the SPARC IPO is to provide management support to planning and implementation of WCRP atmospheric research priorities. It ensures both appropriate international coordination between different groups within SPARC, atmospheric research activities, and scientists as well as collaboration and liaison with other international programmes. More specifically, the IPO's role will be to support SPARC's work in close cooperation with the SPARC co-chairs and SSG, the WCRP leadership, and the WCRP Secretariat.

The SPARC IPO will consist of a Director and 2 additional project staff including a dedicated communications expert. To support the vision, mission and activities related to SPARC, the Host Institution is expected to provide the funds required to support and run the IPO from its inception. The Host institution will work jointly with WCRP's Joint Scientific Committee (JSC), the WCRP Secretariat and SPARC co-chairs to establish an administrative plan that will ensure that the appropriate governance is in place, including required IPO lines of authority, and management and reporting policies.

To download the full call visit wcrp-climate.org.

The deadline for proposals is **15 April 2022**.

Communication and enquiries related to this call

All communication, material and enquiries regarding this call shall be directed in English to Hindumathi Palanisamy (hpalanisamy@wmo.int) in the WCRP Secretariat.

Announcement of a new SPARC Hunga-Tonga stratospheric impacts activity

Yunqian Zhu^{1,2}, Graham Mann³, Paul A. Newman³, Bill Randel⁵.

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Introduction of the Project

SPARC is establishing a new activity to examine impacts of the Hunga Tonga–Hunga Ha’apai (HTHH) eruption of January 2022. HTHH was the most explosive volcanic eruption in the satellite era, and the water-rich plume presents an opportunity to understand the impacts on the stratosphere of a large magnitude explosive phreatomagmatic eruption. The wide range of satellite observations of the early stratospheric plume and its global dispersion will provide measurements to evaluate a range of models for their capabilities to represent stratospheric chemistry, aerosol and dynamics, in this case where both water vapor and aerosol are influencing radiative balances and stratospheric ozone.

There are numerous HTHH eruption observa-

tional and modeling studies that have been published, preprints of submitted papers, and new research in early stages. As the dispersed volcanic cloud continues to evolve and its impacts emerge, additional papers will be published. Because of the number and broad range of studies of the HTHH emissions and impacts, a SPARC limited-term cross-activity focused project is being organized to provide a forum for community discussions and synthesis, and to coordinate multi-model assessments. During this 3-year HTHH SPARC activity, the team will co-ordinate research activities and aim to write a special Hunga-Tonga impacts report for publication in late-2025. The report will directly feed into the upcoming 2026 UNEP/ WMO Scientific Assessment of Ozone Depletion report, providing a benchmark synthesis of the impacts from the eruption. Interested scientists in the broader research community are welcomed to be involved in this activity.



Figure 2: Illustration by Yunqian Zhu showing the eruption of an underwater volcano just as the one of Hunga Tonga–Hunga Ha’apai on January 2022, being the most explosive volcanic eruption in the satellite era.

This SPARC activity will not only document HTHH evolution and impacts but will also include the definition of a set of coordinated multi-model experiments for the report. The activity will coordinate with existing community modelling activities to define potential modelling contributions to each chapter of the report. The report's chapters will present consensus findings across both observational and modeling activities spanning a range of timescales and provide synthesized information for policy makers. This assessment will lead to greater model preparedness for future water-rich major eruptions, test eruption plume advection, provide benchmark datasets to test chemistry-climate and interactive stratospheric aerosol models, and provide relevant constraints on impacts from hypothesized stratospheric geoengineering.

Existing SPARC activities such as SSiRC, CCMI and S-RIP are already engaged with HTHH-related studies and will feed into this HTHH activity. The report leads will coordinate with these other SPARC activities, will approach several groups external to SPARC, including Coupled Model Intercomparison Project Phase 6 (CMIP6), Past Global Changes Project (PAGES) and International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), and will recruit and convene a team comprising both experienced scientists and early career researchers from a range of relevant disciplines for assessing new HTHH findings.

Plans

We are pleased to announce our 1st On-line open meeting in May 2023 (precise dates TBD). Details will be posted on SPARC HTHH activity website and publicized across the community. The meeting is open to all interested scientists. The meeting will discuss collaborations and exchange information on the Hunga Tonga observation, campaign and simulation plans as an international collaborative effort. The tentative 3-year HTHH activity schedule will also be discussed and posted on the SPARC HTHH activity website.

The final HTHH SPARC Report: Initial chapters will document the stratosphere aerosol and ozone layer impacts in 2022, and analyze Antarctic ozone

hole impacts expected also in 2023 and 2024, along with water vapor impacts via the upper atmosphere likely to continue into 2024 and 2025. This HTHH community assessment spans multiple research topics but is focused on the following two science themes: A) Plume evolution, dispersion and large-scale transport; B) Impacts on and feedback from the earth system. Potential chapters include: Initial plume dispersion (first week); Evolution of the volcanic cloud & its meridional dispersion; HTHH effects on stratospheric temperatures, dynamics, and transport; HTHH effects on ozone and stratospheric chemistry; upper stratosphere to mesosphere effects & H₂O transport in the deep Brewer-Dobson circulation branch; and the radiative and surface/tropospheric climate impacts of the eruption.

Proposed Activity Schedule

2022

Nov: HTHH activity begun

2023

Jan: Outline 1st circulated for comments

May: 1st On-line open meeting

Jun: Model simulations specified

Jun: Outline 2nd draft completed

Aug: Recruit chapter lead authors

Dec: AGU special session on HTHH
(side meeting with chapter leads)

2024

Feb: Model simulations complete, output submitted & begin analysis

Feb: Chapter authors selected by chapter leads finalized

May: Model analysis completed

Jun: In-person open meeting

Jul: Outline 3rd order draft finalized by chapter authors

Sep: 1st draft completed & sent out for external review

Nov: Reviews due, revisions begin

2025

Feb: 2nd draft completed & reviewed by Editors and chapter Leads

May: 3rd draft completed

Jul: Writing of the Executive Summary, revisions added to 3rd draft

Sep: Final chapter submission

Dec: Report Delivered

Planning and Proposal for Phase 2 of the SPARC-Reanalysis Intercomparison Project (S-RIP)

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The first phase of the SPARC-Reanalysis Intercomparison Project (S-RIP) culminated with the publication of the S-RIP final report in January 2022 (SPARC, 2022). In addition to overview chapters on “Temperatures and Winds” and “Ozone and Water Vapour”, the report contained seven chapters summarising intercomparisons of process-oriented diagnostics for reanalyses that were available for sufficient time before completion of the report; these chapters covered major processes in the upper troposphere through the middle atmosphere (illustrated in Figure 3) comprising: the Brewer-Dobson Circulation, Extratropical Stratosphere-Troposphere Coupling, Extratropical Upper Troposphere and Lower Stratosphere, Tropical Tropopause Layer, Quasi-Biennial Oscillation, Polar Processes, and Upper Stratosphere and Lower Mesosphere. Many of the results summarised in these chapters were also reported in the peer-reviewed literature, including 53 (at this writing) papers in the [ACP/ESSD S-RIP Special Issue](#). Broad conclusions and recommendations from S-RIP include:

- More recent reanalyses generally outperform earlier products, with some earlier reanalyses (e.g., NCEP-NCAR R1 and NCEP-DOE R2) being deprecated as unsuitable for most diagnostics.
- Conventional-input and pre-satellite (i.e., before 1979) reanalyses are useful for many diagnostics but should be carefully validated against full-input satellite era products.
- All reanalyses show temporal discontinuities; trends and climate shifts identified in reanalysis products should be carefully validated and justified.
- Reanalysis products on model levels should be used for all studies when sharp vertical gradients or fine-scale vertical features are involved.
- Several quantities are handled and reported differently by different reanalyses.

And, most critically for looking forward, studies rely-

ing on reanalysis products should use multiple reanalyses whenever possible. If there is a single most critical lesson we have learned from S-RIP it is that the need for systematic reanalysis intercomparisons is ongoing. S-RIP has also been extremely successful in fostering communications between users and providers / developers of reanalyses – which is critical not only to ensuring that reanalysis products are used appropriately but also to continuing the cycle of improving reanalyses. It is because of the great success of S-RIP that a new phase of this activity is clearly needed. As the first phase of S-RIP was concluding, we therefore began planning and gathering input for a new phase of this SPARC activity. Below, we summarise planning activities to date and present a proposal for S-RIP Phase 2 (S-RIP2).

S-RIP Phase 2 Planning Meetings

In addition to polling current S-RIP participants (particularly chapter co-leads for the S-RIP report) and soliciting input in S-RIP overview talks in the past couple of years, three 1 - 2 hour sessions were organised in fall 2022 in time zones friendly to the Americas (hybrid side meeting during the SPARC General Assembly), Asia (online, 10 Nov 2022, 4 - 5UTC), and Europe (online, 10 Nov 2022, 13 - 14UTC). These inquiries and meetings included a summary of S-RIP so far, updates on new products from the reanalysis centres (see below for further information), and discussion of ideas for S-RIP Phase 2. The sections below give an overview of S-RIP2 plans based on the synthesis of these discussions.

S-RIP Phase 2 Proposal – Organisation & Structure

The consensus of input from the discussions mentioned above reflects the belief that the large amount of time spent in preparing a report like SPARC (2022) might be better spent on conducting studies, enhancing communications on shorter timescales through online activities, building an enhanced web presence, and providing summary reports annually (or more often, if needed) on published papers and new results.

Therefore, we plan to organise S-RIP2 around “focus topics” rather than “chapters”, with the organisation of these being similar to that of the chapters for the S-RIP report, that is, 2 - 3 topical co-leads who entrain numerous participants as contributors and coordinate efforts and foster communications among people focusing on those topics. Several chapters of the S-RIP Report were co-led by one senior scientist and one early career scientist (ECS), and we hope to continue this model in S-RIP2 by building topical leadership teams containing senior scientists and ECS.

S-RIP leadership will continue to be organised with a few activity co-leads coordinating the topical co-leads and taking the lead on communications with the SPARC office, organising workshops and seminars, providing regular “S-RIP News” reports, and in general coordinating all activities of the S-RIP community. Currently, Jonathon Wright is expected to be an ongoing project co-lead for Phase 2, with Masatomo Fujiwara and Gloria Manney gradually (likely over a period of up to a few years) phasing out their leadership roles as additional new co-leads are entrained. Because the scope of S-RIP2 will be even larger than that of the first phase, we anticipate a more formal division of responsibilities among the co-leads; for example, overseeing tasks such as communications with the S-RIP community, overseeing development and maintenance of web-based activities, coordinating between linked/overlapping focus topics, and coordinating joint work with other SPARC activities are some of the tasks that may be assigned to different co-leads for primary responsibility to spread the workload. As this new phase of S-RIP develops, we may find that more than three co-leads are ideal.

A particular focus of S-RIP2 will be an enhanced online presence; based on the discussions so far this may include:

- Detailed information on the reanalysis systems and models, such as that in Chapter 2 of SPARC (2022), will be moved online. This will allow us to provide much more complete information and to update/add information on new reanalyses quickly.

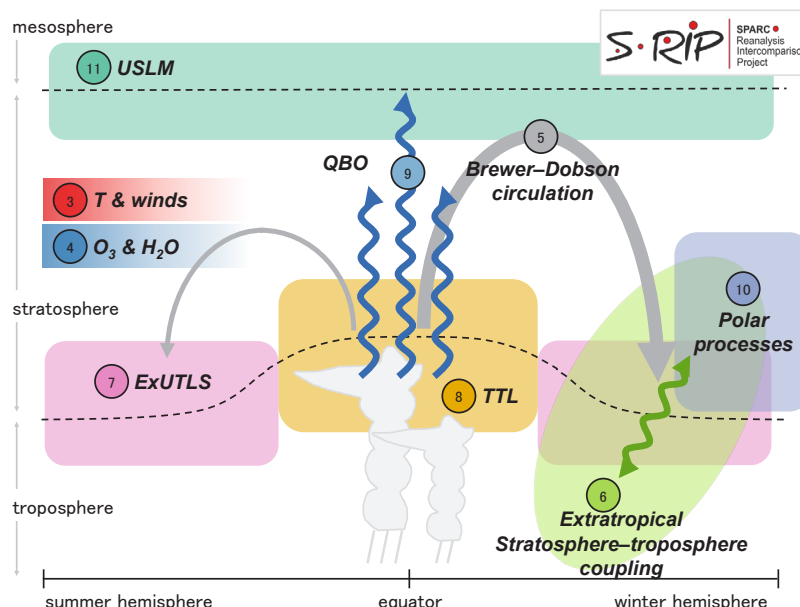


Figure 3: Schematic illustration of S-RIP Final report chapters, showing the processes and regions covered in Chapters 5 through 11. Other chapters include the Introduction (Chap. 1), Description of the Reanalysis Systems (Chap. 2), and Synthesis Summary (Chap. 12). From Figure 1.1 of SPARC (2022)

- In addition to linking to the special issue papers, the website will feature highlights of recently published S-RIP2-related papers (including those in the special issue and in other journals).
- We plan to organise regular webinars, with a wide variety of topics including talks on recent papers, discussions/panels on general S-RIP2 planning and progress, talks describing new or upcoming reanalysis systems, talks by/discussions with representatives of related SPARC activities, etc.
- To further define what our “web-base” should look like, we will be forming a task team to develop a detailed plan.

Because we are not working towards a single final report, the journal special issue for S-RIP2 (as well as peer-reviewed papers in other journals) will be one of the primary sources of detailed information on intercomparison studies and an organising focus for the activity. The [ACP](#) and [WCD](#) (with ESSD expected to be added) special issue “The SPARC Reanalysis Intercomparison Project (S-RIP) Phase 2” opened for submissions on 1 January 2023.

Because there are continually studies being submitted/published focusing on new reanalysis evaluations and intercomparisons, we have opened this special issue in advance of ramping up all activities for S-RIP2, and expect to see submissions during the transition to the new phase.

Table 1: Examples of global reanalysis systems to be evaluated in S-RIP Phase 2

Reanalysis System	Period	Source	Focus	Grid
JRA-3Q	1947–	Japan (JMA)	global atmosphere	40km, 0.01hPa top
CRA-40	1979–2018	China (CMA)	global atmosphere	34km, 0.27hPa top
R2IC	1998–2025	USA (NASA)	global atmosphere	25km, 0.01hPa top
CORe (ensemble, conventional observations)	1950–	USA (NOAA)	global atmosphere	70km, 0.2hPa top
CAFE60 (ensemble)	1960–	Australia (CSIRO)	global atmosphere + ocean	200km, ~3hPa top

Table 2: Examples of chemical reanalysis systems to be evaluated in S-RIP Phase 2

Reanalysis	Period	Source	Focus	Grid
CAMS-EAC4	2003–	ECMWF	whole atmosphere	0.75deg, 60L
BRAM2	2004–2019	BIRA-IASB	stratosphere/UTLS	2.5x3.75deg, 37L
M2_SCREAM	2004–	NASA/GMAO	stratosphere/UTLS	~50km, 72L
TCR2	2005–2019	NASA/JPL	troposphere	1.1deg, 32L
R2IC-CHEM	1998–2025	NASA/GMAO	whole atmosphere	25km, 72L

S-RIP Phase 2 Proposal – Reanalyses

Most of the reanalysis centres whose products were evaluated in S-RIP have new reanalyses that have started production. ECMWF's ERA5 reanalysis became available late in the process of the first phase of S-RIP, so only a small subset of the diagnostics were evaluated for ERA5. Thus, one focus of S-RIP2 will be to fully evaluate ERA5. This will be especially informative for diagnostics (e.g., for the UTLS, gravity waves, and mixing processes) of smaller (sub-synoptic or fine vertical scale) processes given the improved resolution (horizontal, vertical, and temporal) of ERA5 over the previous generation of reanalyses. Table 1 lists several of the other global reanalyses that are either in production or starting production very soon that will be evaluated in S-RIP2.

Chemical reanalyses have become much more mature since the start of S-RIP, and there are now several that are publicly available and widely used. One new

focus of S-RIP2 will thus be evaluation of these and other upcoming chemical reanalyses. Table 2 lists several of the current chemical reanalyses and those starting production soon that will be evaluated in S-RIP2; the current CAMS-EAC4, BRAM2, TCR-2, and M2-SCREAM reanalyses are described by Inness *et al.* (2019), Errera *et al.* (2019), Miyazaki *et al.* (2020), and Wargan *et al.* (2023), respectively. We also plan to evaluate other planned chemical reanalyses as they become available. In particular, BRAM2 and TCR-2 were run using ERA-Interim for the meteorological fields, and thus end with August 2019 when ERA-Interim was discontinued. The groups producing both of these plan new versions to (along with other improvements) be driven with ERA5.

In addition to these reanalyses, there is currently much work on very high-resolution regional reanalyses for studying sub-mesoscale to synoptic-scale processes in greater detail. As more regional reanalyses become available, systematic evaluation and intercomparison of these will become important, as will comparison with global reanalyses to understand how adequate or inadequate the global

reanalyses' representation of these smaller scale processes is.

As in the first phase, in S-RIP2 we will produce systematic documentation for all the reanalyses evaluated; moving this to an online platform for S-RIP2 will allow us to link in more comprehensive information on features of the reanalyses that may be of interest for specific diagnostics, and will facilitate maintaining “living” documentation that can be updated in near real time.

S-RIP Phase 2 Proposal – Continuing and New Focus Topics

All of the S-RIP report chapters evaluating process-oriented diagnostics (Chapters 5 through 11 described above) focus on topics for which evaluation of new and upcoming reanalyses will be critical to inform scientific studies. Most immediately, as noted above, ERA5 has not been fully evaluated for most of these diagnostics because of the timing of its release with respect to the schedule for completing the S-RIP Report.

Many of those chapters (as well as Chapter 4, Overview of Ozone and Water Vapour) evaluated diagnostics for which it will be helpful to include the chemical reanalyses, including Chapter 5 (BDC), Chapter 7 (ExUTLS), Chapter 8 (TTL), and Chapter 10 (Polar Processes). In addition, several new focus topics have been proposed and are expected to be included in S-RIP2. A partial list of topics to be included follows, with notes on relationships to S-RIP Report chapters:

- **Stratospheric Polar Vortex:** This topic would build on Chapter 10 of the S-RIP Report but also include diagnostics related to the general evolution of the stratospheric polar vortex (dynamics) and wintertime polar transport in relation to the vortex throughout the stratosphere.
- **Stratosphere-troposphere coupling and teleconnections:** This would build on Chapters 6 and 9 of the S-RIP report and has links to DynVar and SATIO-TCS. There are also many new areas of study related to teleconnections involving stratospheric pathways, e.g., interplay of tropospheric and stratospheric pathways for ENSO and MJO (e.g., Lee *et al.*, 2019; Domeisen *et al.*, 2020; and references therein).
- **Representations of Tropospheric Circulations, Surface Climate/Weather Extremes, and their UTLS and Middle Atmosphere Connections:** There is much recent work exploring the connections of the middle atmosphere and UTLS circulation to extreme weather events at the surface, so a focus on reanalysis representation of such events (e.g., cold air outbreaks and regional variations in the triggers for these; extreme heat events such as the Pacific Northwest heat dome in 2021; extreme precipitation events). Several recent papers have compared reanalysis representation of aspects of tropospheric circulation including low level winds near Antarctica (Caton Harrison *et al.*, 2022), decadal variability of Rossby wave packets (Fragkoulidis, 2022), and signatures of heat waves in Rossby wave spectra (Strigunova *et al.*, 2022). This focus area also has links to DynVar and SNAP.
- **Upper stratosphere / lower mesosphere:** This will extend Chapter 11 of the S-RIP Report. For that report, there were few reanalyses available that provided data much beyond the stratopause (only MERRA and MERRA-2 had tops extending as high as 0.01hPa), but many of the new and forthcoming reanalyses (including ERA5) have higher tops, which will allow more comprehensive evaluation of representation of this region in reanalyses.
- **Stratospheric and UTLS composition:** This builds on Chapters 4, 7, 8, and 10 of the S-RIP report, and has links to CCMI, OCTAV-UTLS, and LOTUS.
- **Monsoon Circulations:** This would expand Chapter 8.8 (Asian Summer Monsoon) of the S-RIP Report to evaluate many important diagnostics and relationships related to the Asian summer monsoon, and also explore diagnostics of other monsoon circulations including the North American monsoon, Australian monsoon, and South American monsoon. This topic has links to ACAM and AeroCom.
- **Brewer-Dobson circulation variability and change:** This would build on Chapter 5 of the S-RIP Report.
- **Gravity Waves:** When S-RIP began, few reanalyses had the resolution or sophistication of parameterizations to make detailed evaluation and comparison of representation of gravity waves a priority. Since that time, some reanalyses (especially ERA5) have sufficiently fine resolution to resolve some gravity waves. Thus, the time has come for a comprehensive evaluation of reanalysis representation of gravity waves.
- **Evaluations of reanalysis uses, misuses, and recommendations for model evaluation:** While this is not a topic on specific atmospheric diagnostics, one of the critical roles of S-RIP was, and of S-RIP2 will be, to provide recommendations for appropriate use of reanalyses for the diagnostics in the topical focus areas, including noting reanalyses that are not generally recommended for scientific use (e.g., the deprecation of NCEP-R1 and NCEP-R2 in SPARC, 2022). Because of the increasing scope of S-RIP2, having a team within the activity that focuses on tools, methods, and recommendations will facilitate fulfilment of this role. One activity planned for this topic is to evaluate and apply the Earth System Model Evaluation Tool (ESMValTool) (Weigel *et al.*, 2021, and references therein).

A particular aim of the open-source ESMValTool is to raise the standards for model evaluation by providing well documented source code, scientific background documentation of the diagnostics and metrics included, as well as a detailed description of the technical infrastructure. The motivations for developing and deploying this type of tool apply equally well to evaluation of reanalyses as they do to Earth system models.

It will be obvious that there is a good deal of overlap between many of the topics listed above, as is inevitable since the physical system we are evaluating the representation of (the Earth's atmosphere) is a single coupled system. As plans for S-RIP2 mature, we may thus find that different divisions between focus areas make sense, or that some topics are so large that they will need to be split into multiple focus areas. In addition, one of the responsibilities of one or more S-RIP co-leads will be to oversee coordination of overlapping chapters. Most of the topics listed above will benefit from the evaluation of chemical reanalyses proposed for S-RIP2.

Summary

We have presented above a summary of our planning efforts and discussions for Phase 2 of the S-RIP Activity.

As part of this proposal, we encourage people to contact us with ideas for additional topics, for extension or specific analyses related to the topics listed above, and/or to express interest in participating in (including co-leading) any of the topics or other activities (e.g., the web-base task team) mentioned above.

Acknowledgments

We thank all of the participants in the recent hybrid and online S-RIP Phase 2 planning meetings, and the chapter co-leads from S-RIP Phase 1 who have provided input for S-RIP2 planning.

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Report on the multi-hub 7th SPARC General Assembly

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Introduction

DATES:

24 - 28 October 2023

CHAIRS:

Andrew Charlton-Perez (University of Reading, UK), Jadwiga Richter (NCAR, USA), Jose Santos (CLIVAR IPO, China)

ORGANIZING COMMITTEE:

Inna Polichtchouk (ECMWF, UK), Tim Stockdale (ECMWF, UK), Elizabeth Faircloth (UCAR/NCAR, USA), Krzysztof Wargan (NASA, USA), Sabrina Zechlau (DLR, Germany), Stefanie Kremser (Bodeker Scientific, NZ), Victoria Breeze (NOAA ERB)

MEETING VENUE:

**ECMWF, Reading, UK
NCAR, Boulder, USA
FIO, Qingdao, China**

NUMBER OF PARTICIPANTS: 415

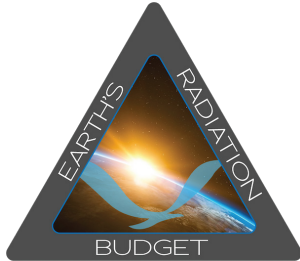
EVENT WEBSITE:

<https://research.reading.ac.uk/sparc-ga2022/>

The 7th SPARC General Assembly (GA) was held in three locations – the European Centre for Medium Range Weather Forecasts (ECMWF, Reading, UK), the National Center for Atmospheric Research (NCAR, Boulder, USA) and the First Institute for Oceanography (FIO, Qingdao, China) from 24-28 October 2022, in the year marking the 30th anniversary of SPARC. The novel multi-hub approach was motivated by the aspiration to reduce the carbon footprint of large international conferences by providing to the participants the opportunity to attend the closest hub and avoid long-haul flights. The multi-hub approach had a measurable impact. Julia Danzer and Stefanie Hölbling from the Wegener Centre for Climate and Global Change at the University of Graz estimated the total carbon footprint of the conference from the travel to be 223 tCO₂-eq. This is a factor of 2-4 smaller than the footprint would be if the conference was exclusively organized in one of the three hubs. Assuming the same number of the attendees, the footprint of a single-hub GA would be between 511 tCO₂-eq and 906 tCO₂-eq depending on the location. There is currently an article in preparation that explains in more detail the calculations behind the carbon footprint numbers which has been submitted at the end of 2022.

The idea of a multi-hub SPARC conference can be dated back to a side meeting held at the Joint DynVar/SNAP workshop in Madrid, October 2019 (Saggioro et al. SPARC Newsletter #54) where a group of enthusiastic scientists met and discussed options to reduce the carbon footprint of SPARC/WCRP workshops. The pandemic started just a few months after the Madrid workshop, moving essentially all communications online, providing a proof-of-concept for virtual meeting technologies.

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Nevertheless, the implementation of the multi-hub idea required thorough planning, intense communication, and regular meetings (of course held online!) between the organizing committee including the chair Andrew Charlton-Perez and SPARC IPO's Stefanie Kremser, as well as the co-chairs Yaga Richter and Jose Santos during the year preceding the Assembly.

SPARC General Assemblies are regular events organized every 4 to 6 years. They are aimed at summarizing the progress of SPARC-related science and identify gaps in the knowledge. They provide an excellent opportunity for the researchers to share their results with the colleagues from the whole SPARC community, to widen their networks and to get inspiration for novel ideas without which the progress in science is not possible. The 7th GA was attended by 415 participants, of which 118 attended in Boulder, 101 in Reading, 34 in Qingdao and 162 online. The oral presentations were organized in 14 sessions jointly held between two hubs at a time with talks presented in both locations. The format allowed presentations nearly around the clock, with one hub's closing in the local evening corresponding to the third hub's opening in the local morning. Recording allowed watching the presentations by all attendees at their convenience. Over 260 posters were presented during the week at the three hubs, as well as online, allowing remote interactions with the presenters.

The GA scientific program included six themes which covered the core topics of SPARC as well as provided discussion about past achievements of SPARC and the emerging areas around which the future SPARC science can be built on:

1. New ways of viewing the atmosphere through observations and re-analyses.
2. New understanding of atmospheric composition and variability.
3. Coupling between climate, radiation, and dynamics.
4. How do dynamical processes shape climate variability and trends?
5. Climate prediction from sub-seasonal to decades.
6. Past and future of SPARC.

At the beginning of the Assembly, **Detlef Stammer**, the WCRP joint science chair outlined the strategic plan and lighthouse activities of the WCRP and how they can help to guide research within the SPARC community and facilitate the development and sharing of climate knowledge. The lighthouse activities are intended to be cross-disciplinary and he encouraged SPARC to collaborate with the other WCRP projects to answer critical questions about the climate system. Stammer also advertised the upcoming WCRP Open Science in Kigali in October 2023 (see page 32) highlighting opportunities for SPARC to contribute to conference's program.

New ways of viewing the atmosphere through observations and re-analyses.

The theme had two invited presentations, eight contributing talks and 82 posters that covered existing and future satellite observations and other available observational technologies, and development and evaluation of the re-analyses products.

An overview of global space-based middle atmospheric measurements with sensors using different techniques of making observations was presented by invited speaker **Michelle Santee**, who referred to the past few decades as “a golden age for space-based middle atmospheric research”. The availability of different sensors from multiple satellite platforms allowed studies of many exceptional events that had impacts on chemistry and dynamics of the stratosphere including recent examples such as the Hunga Tonga eruption, Australian New Year’s pyroCb plume and the Quasi-Biennial Oscillation (QBO) disruptions. Describing the role of the MLS measurements for tracking stratospheric changes, Santee closed her talk by emphasizing on the importance of continued global space-based atmospheric composition measurements. One topic that will require further satellite observations is the impact of wildfires on stratospheric chlorine activation and ozone loss as was argued in the talk by **Peidong Wang**. The future of the satellite observations was discussed by **Bjorn-Martin Sinnhuber** who introduced the Changing-Atmosphere Infra-Red Tomography Explorer (CAIRT) selected by the European Space Agency (ESA) as one of four candidates instruments for the upcoming Earth Explorer II satellite mission. CAIRT will be the first instrument that used limb-sounder with imaging Fourier-transform infrared technique. CAIRT can cover a longer range of altitudes (5 to 115 km), measuring temperature, long-lived trace gases, stratospheric sulfur, aerosols and allowing estimation of atmospheric gravity waves parameters.

Other discussed observational techniques included passive microwave ground-based radiometers for stratospheric and mesospheric ozone monitoring presented by **Eric Sauvageat**, and the STRATE-OLE-2 multiple balloon measurements in the tropical tropopause layer with particle measurements resolving structures not visible by satellites, presented by **Damien Heron**.

Evaluation of re-analyses was presented in an invited

talk by **Masatomo Fujiwara** who reviewed the SPARC Reanalysis Intercomparison Project (S-RIP), focusing on key findings from each of the 12 chapters of the S-RIP Report published in January 2022. Fujiwara offered key findings and recommendations common to all chapters, including the optimistic note that more recent versions of reanalyses outperform earlier products from the same reanalysis center. Cautionary notes concerned spurious trends due to discontinuities in the types of assimilated data. Fujiwara called for new contributors, particularly early career scientists, to Phase 2 of S-RIP, which plans to evaluate new reanalyses including chemical re-analyses, and extend the number of diagnostics. Production and evaluation of the next generation of reanalyses was discussed by **Laura Ciasto** who presented an evaluation of NCEP Conventional Observational Reanalysis (CORE) aimed to replace the older NCEP re-analyse data set. Combining re-analyse products with trajectory models was discussed in a talk by **Warren Smith** who used a trajectory model to analyze convective transport pathways and time scales. Working with the FU-Berlin timeseries of the equatorial stratospheric winds, **Susann Tegtmeier** found that the long-term variability in QBO amplitude was affected by the seasonality of the easterly wind onset. Finally, **Chris Kruse** introduced a novel approach to diagnose stratospheric convective gravity waves by combining data from mosaic weather radar with a high-resolution Weather Research & Forecasting Model (WRF) outputs and neural networks.

New understanding of atmospheric composition and variability

This theme had two invited talks, seven contributing talks, and 62 posters. The ozone research was a topic of several talks discussing highlights of the upcoming WMO/UNEP Scientific Assessments of Ozone Depletion 2022. The other presentations in this theme covered processes in the Upper Troposphere/Lower Stratosphere (UTLS) region, impacts of the recent Hunga Tonga eruption and Asian monsoon on atmospheric composition.

In an invited talk **Martyn Chipperfield** discussed recent chemistry climate model (CCM) studies on stratospheric ozone recovery. He showed that ozone depleting substances have not decreased as fast as predicted, and that there is a large model spread in the magnitude of the Antarctic ozone depletion despite a good understanding of the processes.

CCMs show that the recovery of ozone is dependent on climate change, with higher emission scenarios speeding up ozone recovery. The recovery of the upper stratosphere ozone and a continuing decrease of the lower stratospheric ozone was discussed by **Yajuan Li**, who pointed out that the lower stratospheric trend is not well reproduced by the models. **Birgit Hassler** showed that there is an almost statistically significant signal that ozone is recovering in global mean, with trends strongest in the Southern Hemisphere. Hassler also highlighted emerging issues in ozone trend analysis, including difficulties with accounting for impacts by bushfires and volcanic eruptions, and the impending loss of global observations due to satellite decommissions.

Two presentations addressed the chemical composition in the UTLS region. **Luis Millan** (invited presenter) showed how different definitions of the tropopause influence our understanding of structure and composition of UTLS where uncertainties in the ozone trends are higher than elsewhere. This work is a part of the SPARC activity OCTAV-UTLS which promotes the combination of the satellite, aircraft, balloon and ground-based data sets and use of dynamical coordinates to understand UTLS variability. Uncertainty in our understanding of UTLS regions were further illustrated by **Michael Prather** who advocated the need to use nitrous oxide (N_2O) measurements and modelling to estimate ozone flux to the troposphere.

The impacts of the Hunga Tonga volcanic eruption on 15 January 2022 that destroyed an island in the south Pacific Ocean were also discussed. **Holger Vömel**'s talk highlighted the unprecedented amount of water vapor injected into the stratosphere during the eruption, which was the highest ever based on the available record. The injected water vapor led to a strong radiative cooling effect in the stratosphere. The unprecedented impacts of the Hunga-Tonga eruption are clearly seen in observations from the SAGE III/ISS instrument presented by **Kevin Leavor**. In addition to the influx of water vapor, large increases in the lower stratospheric ozone and a decrease in nitrogen dioxide (NO_2) and a large increase in the aerosol extinction coefficient around 25 km were observed.

Another important topic, the chemical composition of the Asian Monsoon, was discussed in talks by **Jun Zhang** and **Sören Johansson**. Zhang used newly developed MUlti-Scale Infrastructure for Chemis-

try & Aerosols (MUSICA) with more detail representation of pollutants concentrations in UTLS due to chemistry, convection and resolved transport. The results highlighted the role played by small-scale convective uplift, the large-scale circulation and eddy shedding on chemical composition of the Asian Summer Monsoon. Finally, **Johansson** evaluated the ammonia in the Copernicus Atmosphere Monitoring Service (CAMS) reanalysis and forecast model using aircraft-based Gimbal Limb Observer for Radiance Imaging of the Atmosphere (Gloria) measurements.

Coupling between climate, radiation, and dynamics

This theme has four invited and nine contributing talks and 45 posters, covering observations and analysis of the Asian Summer Monsoon dynamics and their role in transporting air pollutants, overshooting convection, response of the Arctic sea ice to stratospheric ozone changes, dynamics and long-term changes of storm activities and challenges associated with geoengineering.

The Asian Summer Monsoon rainfall affects a large population in South Asia. In his invited talk **Tianjun Zhou** discussed its historical decadal variability and near-term projected changes and showed that they are dominated by the Interdecadal Pacific Oscillation (IPO) with a smaller modulation by the external forcing. Thus, improving near-future predictions of IPO could help to reduce the uncertainties in the projected changes in the monsoon rainfall. At subseasonal to interannual timescales, the monsoon rainfall is modulated by the El Niño, tropical volcanoes, and extratropical stratospheric intrusions as was discussed in an invited talk by **Suvarna Fadnavis**. These modulations are seen as changes in the Asian Tropopause Aerosol Layer (ATAL) and the summer monsoon convection. The COVID-19 lockdown, through reducing Asian pollutants and enhancing monsoon convection, led to an increase in monsoon rainfall. Besides the large-scale monsoon convection, there are extratropical overshooting convection events that transport tropospheric air masses to the stratosphere. **Kenneth Bowman** provided an overview of the science questions, concept, and data access of NASA's Dynamics and Chemistry Of The Summer Stratosphere (DCOTSS) mission aimed at investigating the impacts of such overshooting convections on the summer stratosphere.

The stratosphere-troposphere coupling at high latitudes was the topic of the presentation by **Jiankai Zhang** who attributed a part of the Arctic sea ice reduction to the stratospheric ozone depletion that affected tropospheric dynamics, cloud longwave radiation and surface albedo feedbacks. An interdecadal variability in the high-latitude stratosphere-troposphere coupling was discussed by **Dingzhu Hu** who showed that the linkage between the stratospheric Arctic vortex (SAV) and Arctic Oscillation (AO) changed around the 2000s. Switching to the Southern Hemisphere, **Tiffany Shaw** presented an analysis of storminess which is presently stronger in the Southern Hemisphere than in the Northern Hemisphere and this asymmetry is projected to continue in the future.

In her invited talk, **Hella Garny** presented a broad overview of how changes in ozone and carbon dioxide (CO₂) concentrations feedback to climate and circulation. Garny concluded that the coupling between ozone and circulation damps circulation response to greenhouse gas forcing including changes in the Brewer-Dobson Circulation (BDC), delay in vortex breakdown, and shifts of the tropospheric jet. The effect of BDC acceleration on the surface warming and the equilibrium climate sensitivity was highlighted in the talk by **Diego Jimenez-de-la-Cuesta**. **Gabriel Chiodo** reviewed the stratospheric composition feedbacks on climate change including changes in the ozone layer due to CO₂ increase, the influence of the stratospheric water vapor on the circulation response to global warming and the connection between Arctic ozone and surface climate. **Pasquale Sellitto** discusses the radiative forcing of Australian fires 2019-2020 and the Hunga Tonga volcanic eruption in 2022 in terms of top-of-the-atmosphere and surface imbalances and their in-plume localized heating/cooling.



Figure 4: Participants of the SPARC General Assembly at the Asia Hub in Qingdao at FIO Institute.



Figure 5: Participants of the SPARC General Assembly at the Europe Hub in Reading at ECMWF.



Figure 6: Participants of the SPARC General Assembly at the Americas Hub in Boulder at NCAR.

Zhenya Song discussed progress in climate modelling, in particular demonstrating a reduction in model biases related to incorporation of the ocean surface wave model into FIO-ESM.

Geoengineering is seen as a potential remedy for the negative impacts caused by climate change. **John Moore**, an invited speaker, explained how the long timescales involved in decarbonising the atmosphere have led to the increasing acceptance of geoengineering. He presented a few geoengineering model simulations involving stratospheric aerosols injections that showed fewer Atlantic storm surges and reduced flood levels. The possibility of using stratospheric aerosols in the high latitudes to prevent permafrost melting was highlighted. Policy-relevant simulations of climate intervention and challenges associated with geoengineering were further discussed in **Mari Tye's** talk.

How do dynamical processes shape climate variability and trends?

This theme had two invited and eight contributing talks and 45 posters, addressing progress in understanding and modelling of a wide range of processes, from QBO and stratosphere-troposphere coupling to Pacific Decadal Oscillation and ozone-climate interactions. The session was opened by an invited talk given by **Isla Simpson**, who focused on constraining projected changes in the large-scale atmospheric circulation in model ensembles via use of emergent constraints. Simpson argued that if an emergent constraint is robust across Climate Model Intercomparison Projects (CMIP5 and CMIP6) and there is an understood mechanism behind it, it offers the potential to constrain the uncertainty in simulated future projections. Three examples of emergent constraints applied to reduce uncertainty in the Southern Hemispheric jet, North American stationary waves and the Arctic stratospheric polar vortex were considered. The other invited speaker, **Eun-Pa Lim**, focused on understanding of the variability and impacts of the Southern Hemisphere stratosphere-troposphere coupling. Lim argued that the Southern Hemisphere stratospheric polar vortex variability is a key driver of the tropospheric Southern Annular Mode (SAM) that cause significant anomalies in surface regional weather and climate conditions, wildfire risks, ocean circulations, ocean CO₂ uptake, marine biology, and Antarctic sea-ice extent. How changes in the Southern Hemispheric circulation will affect future climate was

discussed by **Julia Midlin** who used a storylines approach to analyze the combined effect of ozone depletion and greenhouse gas increase on the polar vortex breakdown and on the tropospheric climate using CMIP6 and CMIP5 models.

The QBO was the topic of **Jadwiga Richter's** presentation who assessed the progress in QBO modelling between CMIP5 and CMIP6 models and noticed that, while the number of QBO-resolving models has remarkably increased in the last model generations, there was no progress in terms of QBO biases. Similarly, **William Seviour**, who showed that climate models simulate too few polar vortex splits in the Northern Hemisphere winter stratosphere in comparison to vortex displacements, did not find improvements from CMIP5 to CMIP6 models.

Important insights into atmospheric dynamics can be obtained from specifically designed model experiments. New work clarified the role of the topographic effects from Eurasia and North America on the occurrence of the continental Cold Air Outbreaks (**Yueyue Yu**), the dynamics of Indian Ocean teleconnections into the Southern Hemisphere during austral winter (**Zoe Gillett**), and the role of the stratospheric water vapor in contrasting stratospheric polar vortex response to Pacific Decadal variability between interannual (vortex weakening) and decadal (vortex strengthening) timescales (**Melissa Seabrook**). Other talks in this theme analyzed the spatial structure of the wintertime Arctic Oscillation (AO) in re-analyses and climate models (**Wen Chen**) and observed long-term changes in the atmospheric circulation considered as trends in frequency of short-term patterns in the meridional mass circulation (**Irina Rudeva**).

Climate prediction from sub-seasonal to decades.

This theme had two invited and seven talks and 32 posters. The role of the stratosphere in tropospheric predictability both in the tropics and in the extratropics was an overarching topic in most presentations.

Peter Hitchcock (invited talk) began by motivating the need for a multi-model controlled experiment to assess and quantify the potential skill arising from Sudden Stratospheric Warmings (SSWs), which is limited by existing databases.

Such an experiment which involves data contributions from 13 different models from around the world, primarily using zonally-symmetric stratospheric nudging to ascertain the contribution of the stratosphere to extreme weather following Arctic SSWs in 2018 and 2019 and the unusual Antarctic SSW in 2019. The project consists of four core working groups who will analyze the model output – which will be made available for community use on the Centre for Environmental Data Analysis (CEDA) archive in the next few months. Continuing the theme of large collaborative projects, **Zachary Lawrence** reported on key outcomes from the first stage of the SNAP (Stratospheric Network for the Assessment of Predictability) biases project that looks into model biases in operational forecast systems, including those from the sub-seasonal to seasonal prediction (S2S) database. An overarching result was the better representation of the stratosphere in ‘high top’ models, particularly with regard to eddy heat flux. Most models were found to exhibit a global-mean warm stratosphere bias and underestimate SSW frequency. Looking into predictability of tropospheric response to individual weak polar vortex events, **Daniela Domeisen** argued that it’s the tropospheric state that determines the timing, existence, and sign of the response.

The presentations also addressed two-way tropical-extratropical interactions. **Tianjiao Ma** discussed QBO impacts on the Pacific subtropical jet and showed that the QBO has a direct influence on the surface air temperature in East Asia, specifically East Asia Winter Monsoon, via a subtropical route. In turn, **Shunsuke Noguchi** investigated the Antarctic minor SSW in September 2019 and showed an influence of the SSW on

the enhancement in the tropical convective noting that the southern area of the Asian monsoon region was particularly sensitive to the induced deep cumulus convections.



Figure 7: Postersession at ECMWF (Europe Hub).



Figure 8: Presentations at NCAR (Americas Hub).



Figure 9: Combined session and discussions between Asia and Europe Hub.

Understanding relationships between observed phenomena forms the basis of our knowledge of the Nature. **Marlene Kretschmer's** invited talk focused on the importance of causal data analysis in the interpretation of observed statistical associations exemplified by her current research towards causal understanding of the sources of predictability. The causal analysis approach allowed her to demonstrate that the influences of the polar vortex and Madden-Julian Oscillation (MJO) on precipitation in Europe are modulated by the QBO and El Niño/Southern Oscillation (ENSO). The causal analysis was further discussed by **Jonas Spaeth** who looked at the influence of the stratosphere on the AO using the large number of simulated SSWs from S2S model hindcasts. According to Spaeth, about a half of negative AO extremes occurring after SSWs could be attributed to the SSW with a smaller role of SSW during El Niño than La Niña. The last presentation in this theme was given by **Eniola Olaniyan**, who discussed the evaluation of S2S rainfall/monsoon forecasts over West Africa, paying attention to whether the verification was dependent on the observational dataset and the verification metric used. Olaniyan's presentation placed focus on real-time forecaster's needs, providing an example of where research can contribute to society-relevant practices.

Past and future of SPARC

To celebrate the 30th anniversary of SPARC, a special session featuring five invited talks that bridged the past and the future of SPARC science was organized. Three distinguished researchers, who played important role in SPARC's development, gave their vision of how SPARC succeeded during its 30-year history. The historical overview was opened by **Marv Geller** who was one of the first SPARC co-chairs from 1992 until 2002, together with Marie-Lise Chanin. Geller gave an overview of SPARC's activities since its official beginning in 1992 quoting the importance of support given by SPARC to WMO/UNEP Ozone Assessments. Scientific highlights during the first SPARC years included the combination of global ozone profiles from the remote sensing (SAGE I/II, Umkehr) and ozonesondes published in the 1st SPARC report in 1998, and the impact that SPARC has made in understanding global stratospheric temperature trends. In turn, **Shigeo Yoden** who served as SPARC's SSG member during 1999-2005 focused on Stratosphere-Troposphere Dynamical Coupling in the Tropics and influence of QBO on global monsoon systems. Yoden discussed the differences in monsoon precipitation

during different phases of QBO in boreal and austral summer and its links with the Walker circulation. The reasons for SPARC's success were further discussed by **Ted Shepherd** who served as SPARC's co-chair during 2007-2012. Shepherd sees the keys to SPARC's success in the focus on important research gaps, the identification of outcomes which would not happen without SPARC, and its non-hierarchical structure open to fresh talent and operating as a vivid community with a bottom-up spirit through all years. As an example of the work which would be undone without SPARC, Shepherd cited several seminal review papers produced by the SPARC community.

The future of SPARC was addressed in two invited presentations discussing novel analysis tools and perspectives for earth system modelling. **Elizabeth Barnes** gave a presentation on the ability of machine learning algorithms in the detection, prediction and scientific discoveries from the vast amount of data. She demonstrated how the artificial intelligence techniques can sift through vast amounts of climate data and push the bounds of science. She concluded that extracting the robust indicator patterns of climate change and identifying earth system states can lead to improved predictions weeks-to-years in advance. Looking from the climate modeller's perspective, **Irina Sandu** presented "Destination Earth", a cooperative project of ECMWF, the European Space Agency (ESA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), aiming at developing two "digital twins" of Earth, embedded in a broader innovative framework of modeling and data management. Sandu, who leads the project, laid out key components of Destination Earth. It is planned to provide the infrastructure to access and process the data additional to a flexible "digital twin engine", a service allowing customized experiments. Key components are the two digital twins, one optimized for lead times of few days, the other for multi-decadal applications. Both shall be global, storm-resolving and more realistic earth system models.

SPARC strategy plan discussion

During the GA, a discussion of SPARC strategy plan led by SPARC's co-chairs was organized. The discussion started with a presentation by SPARC's co-chair **Amanda Maycock**. She presented an overview of the plans for changes that have been triggered by interactions with WCRP/WMO administration who note that SPARC does not sufficiently promote its achievements.

While traditional structure of SPARC around bottom-up driven activity proposals is largely supported by the community, the new strategical plan also includes creation of cross-cutting panels that would foster interactions between Scientific Steering Group (SSG) and activities (see also report on XX), as well as interactions between SPARC and other WCRP/WMO endeavors such as the Intergovernmental Panel for Climate Change (IPCC) and WMO/UNEP Ozone Assessments. Well-defined criteria for activity initialization, progress and sunseting are planned to be implemented. The co-chairs stressed that the bottom-up approach for activity initialization and selection will remain as this is essential part of how SPARC operates. The needs for SPARC to expand and embrace more of atmospheric science, including changing the name to reflect SPARC's whole-atmosphere approach, was also discussed. It was noted that expansion and merging with other organizations and groups, especially well-established ones, has both challenges and opportunities. To continue building on SPARC's success, it is important to keep SPARC's identity and continue developing its unique expertise, rather than trying to replicate the work that is already done elsewhere.

Dedicated ECR events at each hub and online

Several events targeted at early career researchers (ECR) were organized at the SPARC GA. At the Reading hub the events were organized by Alison Ming, Elio Campitelli, Annelize Ven Niekerk and Julia Mindlin. At the Boulder hub, the activities were organised by Christopher Maloney, Ren Smith, Sean Davis, and Salauddin Mohammad. At the Qingdao hub, the events were organized by Li Li, Qian Zhao, Wenjun Lv, Yan Wang and Xuewei Diao, and chaired by Shizhu Wang.

At Reading, the first event was a mentoring lunch where several senior scientists were happy to offer advice on varied topics ranging from grant writing, teaching, to work life balance. This was followed by a pizza and board gaming evening which was very well attended (40 people). This provided an excellent opportunity for many to meet others in their field for the first time in an informal setting. Good feedback from the attendees was received.

For the ECR events at the Americas Hub, we hosted an ECR mentor lunch on Tuesday as well as a social gathering on Thursday evening. At the Tuesday lunch

event, many distinguished scientists graciously volunteered as mentors and spread themselves out in a cafeteria setting to interact with ECRs. On Thursday, ECRs gathered at the Rayback Collective in Boulder for an evening of food trucks, craft beer and casual conversation. There was strong ECR turnout at both events, and they served as a strong catalyst for networking throughout the SPARC GA.

At Qingdao, each attendee was invited to talk about their research and propose its link with the UN Ocean Decade. Also, the ECRs had a heated discussion on fund raising and gaining visibility for their own work. Consensus was reached that an active participation in academic conference is extremely important for ECRs to share ideas and gain feedbacks. A number of senior scientists attended the discussion and offered advices to the ECRs.

The final ECR activity was to gather votes on the talks and posters and to offer prizes to the best talk and best poster presentation at each hub. Over 400 votes were cast across the three hubs by both attendees and assigned judges. The winners of the best talk and best poster at each hub are presented on page 26. All winners will receive a certificate as well as a warming stripes pin and tote bag.

ECR activities were strongly supported by the YESS community who put forward volunteers to help with the organizations, which is greatly acknowledged.

Acknowledgements

We would like to thank all host institutions (ECMWF, NCAR, FIO) for providing their venue and support throughout the SPARC GA. Special thanks goes to our sponsors providing travel support to ECRs and scientists from the Global South, thereby enabling them to attend the SPARC GA. We are very grateful to our sponsors for their support in putting together this meeting. We would also like to thank the local organising committees, the scientific organising committee, and the chair/co-chairs of the organising committees in putting together such a great SPARC GA. Thank you for all your help and support.

Reference

SPARC, 2019: SPARC Newsletter No. 54, July 2019, 40 pp., available at <http://www.sparc-climate.org/publications/newsletter>.

7th SPARC General Assembly ECR awards for best oral and best poster presentation

Overall, 20 ECRs presented their latest research results in an oral presentation, and 161 ECRs presented their results in a poster (online or in person at one of the hubs). During the duration of the SPARC GA, everyone attending the GA was invited to judge the ECRs presentations. Over 400 votes were cast across the three hubs by both attendees and assigned judges. We are delighted to announce the winners of the Early Career Presentation awards in this newsletter. In keeping with the multi-hub nature of the meeting, we awarded prizes for best oral and best poster presentation at each of our three hubs.

We asked each of the award winners to introduce themselves and give a short description of their work.

Congratulation to everyone!

Best oral presentation Asia:



Jiankai Zhang (Lanzhou University)

“Responses of Arctic sea ice to stratospheric ozone depletion “

“We revealed that the extreme Arctic stratospheric ozone loss could significantly reduce the sea ice concentration and the sea ice thickness over the Kara Sea, Laptev Sea and East Siberian Sea from spring to summer. This study highlights the need for realistic representation of stratosphere-troposphere interactions in order to accurately predict Arctic sea ice loss.”

Best poster presentation, Asia:



Feiyang Wang (College of Oceanography, Hohai University)

“Influence of stratospheric polar vortex on the tropical convection related to MJO “

“The western Pacific region is particularly noteworthy when investigating the exact responses of tropical convection to Northern Hemisphere extreme stratospheric polar vortex events. Significant enhancement of convective activity over the western Pacific is clearly observed after the weak vortex events, while opposite responses to strong vortex events can also be expected.”

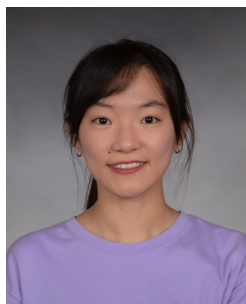
Best oral presentation, Americas:



Peidong Wang (Massachusetts Institute of Technology)

“Chlorine processing after the 2020 Australian wildfire “

“We used satellite data to study the temperature-dependent chlorine activation on the wildfire particles in the stratosphere after the 2020 Australian wildfire.”

Best poster presentation, Americas:
Xinyue Wang (National Centre for Atmospheric Science)
“Stratospheric Responses to the Hunga Tonga Volcanic Eruption “

“The Hunga Tonga-Hunga Ha’apai (HTHH) volcanic eruption in January 2022 injected extreme amounts of water vapor and a moderate amount of the aerosol precursor into the Southern Hemisphere (SH) stratosphere. Our work demonstrates that the HTHH volcanic eruption changed stratospheric temperatures and circulation and caused SH midlatitude and polar ozone losses.”

Best oral presentation, Europe:
Jonas Spaeth (Ludwig-Maximilians-University Munich)
“Predictors of Arctic Oscillation Variability as Revealed by Subseasonal-to-Seasonal Forecasts “

“Sudden stratospheric warmings can cause subsequent weather extremes at the surface. By leveraging a large ensemble of S2S forecasts, we estimate that about one quarter of tropospheric large-scale circulation extremes may be attributable to preceding stratospheric extremes.”

Best poster presentation, Europe:
Irina Statnaia (Finnish Meteorological Institute (FMI), Helsinki Finland)
“Factors affecting sub-seasonal forecast skill of Northern Eurasian cold spells “

“The work presented quantifies the enhanced predictability of extreme cold events over Northern Eurasia arising from the downward influence of the stratosphere on the surface weather. The predicted probability of cold spells that take place after a weakening of the stratospheric polar vortex is systematically higher at lead times 2–4 weeks than that in the cases with a strong stratospheric vortex.”

Best poster presentation, Europe:
Philipp Breul (Imperial College London)
“Revisiting the wintertime emergent constraint of the Southern Hemispheric midlatitude jet response to global warming “

“We revisit a previously identified strong correlation between zonal-mean jet latitude and future jet shift in austral winter. We demonstrate that zonal asymmetries are the ultimate cause of the relationship, and argue that it cannot constrain future wind changes.”

Acknowledgements

We would like to thank Alison Ming for the organisation and putting together the material and voting forms for the awards. We would also like to thank all the judges for taking the time to provide feedback on the ECR presentations. Thank you for your support!

Report on International Workshop on Technical and Scientific Aspects of Lidar Remote sensing of the Atmosphere (ITSLRA-2022)

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DATES:

13-15 July 2022

ORGANIZING COMMITTEE:

SCIENTIFIC ORGANISING COMMITTEE:

Dr.M.Roja Raman, Dr. M. Venkat Ratnam, Prof. S. Vijaya Bhaskara Rao, Dr. Wei Nai Chen, Dr. B. Sheela Rani, Dr. Anoop Kumar Mishra, Dr. Jagabandu Panda, and Dr. Sanjay Kumar Mehta.

LOCAL ORGANISING COMMITTEE:

Dr. K. Nagamani, Dr.PrabhuDassBattavari, Dr. S. Packiyalakshmi, Dr.Marykutty Abraham, Dr. P. Mohana, Dr. P. M. VelMurugan and Dr. Suhail Meer.

MEETING VENUE:



S A T H Y A B A M A

INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University)

Accredited with "A" Grade by NAAC | Approved by AICTE



Center for Remote Sensing and Geoinformatics

Sathyabama Institute of Science and Technology

Dr Jeppiaar Nagar, Rajiv Gandhi Salai

Chennai-600 119, INDIA.



**INDIAN SOCIETY OF REMOTE SENSING –
CHENNAI CHAPTER**

The first of its kind in India, a focused international workshop on Technical and Scientific Aspects of Lidar Remote sensing of the Atmosphere (ITSLRA-2022) was held during 13-15 July 2022 at Sathyabama Institute of Science and Technology, Chennai, India, in association with Indian Society of Remote sensing, Chennai chapter. The workshop was sponsored by the Science and Engineering Research Board (SERB), Department of Science and Technology, Government of India, and partially supported by TSI Instruments India Limited, Bangalore, India.

Background

The Light Detection and Ranging (LIDAR) instrument has been a versatile active remote sensing tool to measure and monitor atmospheric aerosols, clouds, and composition at high temporal and vertical resolutions. With the advancement of better-quality laser sources and the invention of the latest optical and optoelectronic components, more sophisticated lidar systems have been designed and developed globally in the recent decade. Despite several commercial advanced lidar systems available for profiling various atmospheric changes, the end users are not well aware of the system setup and thus require training on basic troubleshooting in case of system malfunctioning. In addition, the lidar inversion algorithms to retrieve usable parameters have been challenging due to several assumptions. This international workshop aimed at bringing the LIDAR community together, from the expert system developer to the end user, and at exchanging both technological and scientific knowledge base among all. This workshop mainly covered technological developments and applications of different lidars probing the atmospheric structure and composition right from the surface up to about 100 km of the atmospheric column. The operational challenges during different weather conditions and geographical locations and remedies to face the challenges were also discussed. This also covered expert talks on Lidar retrieval algorithms, the latest scientific findings, and operational challenges and remedies. This workshop was aimed to ignite young professionals to start working on indigenous Lidar system development as a part of the Make in India initiative.

NUMBER OF PARTICIPANTS:**95 (25 ONLINE AND 70 OFFLINE)****CONTACT:****ksanjaym@gmail.com****ramansvu@gmail.com****SPONSORS:**

Science and Engineering Research Board (SERB)
Department of Science and Technology (DST)
Govt. of India, New Delhi.

At the end of the workshop, participants took home a detailed knowledge of the Lidar technique and applications.

- Overview of Lidar Remote sensing - Technological advancements and Applications
- Technological aspects of Elastic and Inelastic Lidars
- Doppler wind lidar
- Metallic Lidars (Na, K, Fe Lidars)
- DIAL ozone lidar
- Pure Rotational Raman temperature Lidar
- CALIPSO technical details and scientific applications
- AEOLUS technical details and scientific applications
- Airborne and Ship borne Lidar observations
- Lidar inversion algorithms
- Application of Lidar remote sensing for Aerosol and cloud observations. Boundary layer measurements, Middle atmospheric temperature structure and cirrus measurements.
- Application of Lidar Remote sensing for weather and climate monitoring.



Figure 10: Figure : Participants at the Three days international workshop on Technical and Scientific aspects of Lidar Remote sensing of the atmosphere (ITSLRA- 2022) held at Sathyabama Institute of Science and Technology, Chennai, India during 13-15 July 2022.



Figure 11: Workshop activities left to right release of the Lecture notes and abstracts disc, Exchanging MoU, Participants during inaugural day.

The International workshop ITSLRA accommodated 95 registered participants from India and five countries abroad. It included 20 invited speakers from India and abroad who are top-level scientists dealing with different types of atmospheric Lidars. About 60% of the participants were Ph.D. scholars and young professionals who participated in the workshop. The presentations from early career scientists and students were made after the invited talks and examined by a panel of experts. The best two presentations were awarded a citation. The workshop was conducted in a hybrid mode, and some Indian and international speakers delivered their talks online. To facilitate two-way live communication, advanced audio-visual equipment was arranged, through which all the participants were able to have live discussions with the speakers.

Introductory talks and LIDAR basics

The workshop started with a formal inaugural function on 13 July 2022, with a presidential address by **Dr. B. Sheela Rani**, Director (Research), SIST, and program highlights presented by the convenor, **Dr. M. Roja Raman**, SIST. The chief guests of the inauguration, **Prof. S. Vijaya Bhaskara Rao**, Director, UGC-SVU Center for MST Radar Appli-

cations, **S V University**, Tirupati, India, and **Prof. A. Jayaraman**, Former Director, National Atmospheric Research Laboratory (NARL), Gadanki, India and **Dr. M. Venkat Ratnam**, Scientist, NARL, Gadanki, India addressed the gathering and released the disc of Lecture notes and abstracts. Further, a formal memorandum of understanding (MoU) was signed between the Centre for remote sensing and Geoinformatics, Sathyabama Institute of Science and Technology, Chennai, India, and the UGC-SVU Center for MST Radar Applications, S V University, Tirupati, India, for combined intensive field measurements using the suite of instruments including a micro pulse lidar. Later, **Dr. Jean Paul Vernier**, Senior Research Scientist, NASA Langley Research Center, USA, presented the inaugural talk on the application of space-borne lidar, CALIPSO, for monitoring the Asian tropopause aerosol layer (ATAL) during the Asian monsoon season.

Following the inaugural talk, **Prof. A. Jayaraman** gave an introductory talk on the theory and principle of Lidar remote sensing brief overview of different lidar systems for atmospheric profiling and climate monitoring. This talk gave a promising start-up for the students new to the field of Lidar remote sensing.

Following this, **Dr. Guangyao Dai**, Ocean University of China, China, delivered his talk online on the inter-comparison of space-borne wind lidar Aeolus and ground-based coherent Doppler lidar network over China and their scientific applications. This has substantially advanced the technology of space-borne and ground-based Doppler wind lidar.

In the afternoon session, **Dr. Veerabuthiran**, Defence Research, and Development Organisation (DRDO), India, explained the utilization of Lidar technology for defense applications and delivered a talk on the Lidar technology for remote detection of chem-bio agents. Further, **Dr. K. Raghunath**, NARL, Gadanki, India, gave a talk on the technology development and applications of DIAL Ozone Lidar and Doppler Wind Lidar at NARL, Gadanki, India. Followed by this, **Dr. Viktor Zharkov**, Centre of Laser Sounding of the Atmosphere Institute of Atmospheric Optics, Tomsk, Russia, remotely presented on Lidar technique for the simultaneous determination of temperature and humidity of the atmosphere using the vibrational-rotational and pure rotational Raman spectra. Finally, **Prof. Sivakumar Venkatraman**, University of KwaZulu-NATAL, South Africa, talked about developing various Lidar systems in South Africa and their potential applications for atmospheric profiling in a remote presentation.

Regional applications of LIDAR technology

On Day 2, in the morning session, **Dr. Wei Nai Chen**, Lidar Remote sensing Laboratory, RCEC, Academia Sinica, Taiwan, delivered a talk on the Application of LiDAR in environmental monitoring in Taiwan. Later, **Dr. M. Venkat Ratnam**, NARL, Gadanki, India, gave an overview of two decades of Rayleigh and Mie lidar observations from Gadanki: Highlights on Tropical Cirrus clouds, Aerosols, and Middle Atmospheric Temperatures. In addition, **Prof. Som Kumar Sharma**, Physical Research Laboratory, Ahmadabad, India, also showed the application of lidar to explore the Earth's Lower and Middle Atmosphere. Followed by this, **Dr. G. Pandithurai**, Indian Institute of Tropical Meteorology, Pune, India, and **Dr. Ravi Kiran**, NARL, Gadanki, India, presented applications of Lidar remote sensing for aerosol-cloud interaction. In the afternoon session, **Dr. P Vishnu Prasanth**, Mohan Babu University, Tirupati, India gave a talk on Sodium Lidar technology and applications Air of pollution lidar, followed by **Dr. B L Madhavan**, NARL, Gadanki, India,

who showed results from an air pollution horizontal scanning lidar. Later, **Dr. Harish Gadhavi**, Physical Research Laboratory, Ahmadabad, India, gave a comprehensive talk on LIDAR algorithms for aerosol extinction retrieval that provided detailed information and assumptions on lidar data processing.

Ground-based lidar applications and ECS talks

Day 3 started with an excellent talk by **Prof. A. Konoshonkin**, V.E. Zuev Institute of Atmospheric Optics, Russia, on the perspective of scanning polarization lidars for retrieving the orientation properties of atmospheric aerosol and ice crystals. Later, **Dr. Sanjay K. Mehta**, SRMIST, Chennai, India, showed first-time lidar observations of Boundary layer processes over the coastal station Chennai using MPL observations. Followed by that, **Dr. Puna Ram Sinha**, Indian Institute of Space Science and Technology, Thiruvananthapuram, India, gave a detailed talk on Ground- and space-based lidar observation of lower and upper tropospheric aerosols: Technical challenges and future prospective.

In the afternoon session, the participants presented their talks on their recent works on lidar remote sensing, and the expert panel members and other participants were actively involved in the discussion and suggested modifications to upgrade the scientific content in their presented works. Out of the participant presentations, the three best presentations were selected by consolidating the recommendations made by the expert panel members.

Finally, a formal valedictory ceremony was organized on 15 July 2022 to discuss the workshop outcomes and future action plans. Feedback from the participants and the invited speakers was received, and most of the participants and invited speakers wished for such a focused lidar workshop should happen yearly in India. Later, the best presentation certificates and the participation certificates to all the physically attended participants were presented by **Dr. B. Sheela Rani**, Director (Research), Sathyabama Institute of Science and Technology, Chennai, India, and the workshop was concluded.

Acknowledgments

We acknowledge support from DST-SERB, Govt of India, TSI instruments India Ltd., and Sathyabama Institute of Science and Technology to organize this workshop.

WCRP Open Science Conference 2023

ADVANCING CLIMATE SCIENCE FOR A SUSTAINABLE FUTURE

Abstract submission is now open for the World Climate Research Programme (WCRP) Open Science Conference (OSC), which will be held in Rwanda from 23-27 October 2023. With a hybrid (in-person and online) format, the conference will bring together international climate researchers, practitioners, and policy makers.

The focus of the conference is 'Advancing Climate Science for a sustainable future', with three conference themes that bring together 40 sessions and over 40 poster clusters. The three themes are:

- *'Advances in Climate Research'*: Showcasing progress and future challenges in understanding Earth's climate system. Sessions include climate processes; gaps identified by IPCC; energy, water and carbon cycles; climate modelling, observations and model-data fusion.
- *'Human Interactions with Climate'*: Analyzing key drivers and impacts of climate change, identifying risks to human and ecosystem health. Sessions include climate extremes and associated risks and impacts; water availability, food, ecosystems, health and cities in a changing climate.

- *'Co-produced Climate Services and Solutions'*: Connecting scientific knowledge, planning, decision-making and policy processes. Sessions include near-term regional and climate change information for adaptation and mitigation; climate scenarios; climate intervention research.

The full list of sessions and poster clusters is available on the website. A limited amount of [financial support](#) will be available to support deserving delegates who are nearly to mid-career researchers or from low to lower-middle income countries. Planning is also underway for [dedicated early and mid-career researcher events](#) on 22 and 28 October 2023. Abstract submission and requests for financial assistance close on **28 February 2023**.

Registrations for the conference will open early 2023

We warmly invite you to join us in Rwanda to discuss together and find ways forward for some of the critical challenges that we face under a changing climate.

WCRP OSC Website: <https://wcrp-osc2023.org>



A 3-day workshop on Research Using High Vertical-Resolution Radiosonde Data will be held at the NCAR Foothills Laboratory August 30, 31, and September 1, 2023. The motivation for this workshop is the great increase in High Vertical Resolution Radiosonde Data (HVRRD) for research purposes that has recently become available. Figure 12 shows the initial availability of HVRRD when SPARC initially made those data available through the SPARC Data Center in 1999.

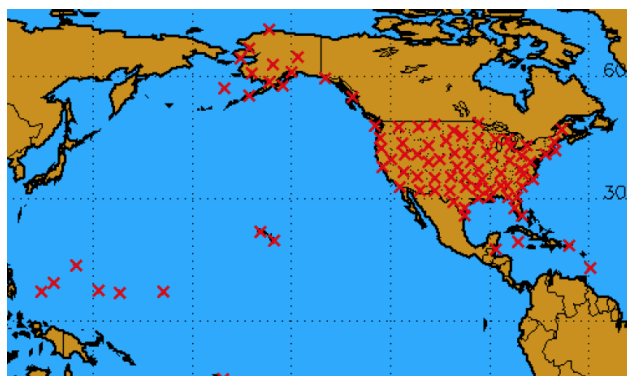


Figure 12: 93 stations with US HVRRD at 6-second resolution available in 1999.

These data were initially available at 6-second sampling intervals, which corresponds to an approximate 30 m vertical resolution, but later data were available at 1-second intervals, which corresponds to an approximate 5 m vertical resolution (assuming a balloon rise rate of 5 m/s). A large number of publications on gravity waves, tropopause configuration, boundary layer depths, and turbulence by researchers in many different countries were based on analysis of these data.

The situation has now changed, as is obvious by looking at Figure 13, which shows radiosonde data availability in October, 2022. Now, HVRRD are available for all the world's continents, and numbered 454 stations in that month. It should be noted that the dark-blue filled-in circles have vertical resolutions comparable to the US HVRRD shown in Figure 12. Note that Figure 12 indicated that 93 radiosonde stations had 6-second data over the United States, the Caribbean, and over the Pacific. Figure 13, on the other hand, indicates that there are 454 radiosonde stations from which 1-second data was available, and those data were available from all continents as well from a number of island stations during the month of October, 2022. Details on those data have been given in [SPARC Newsletter No 56, January 2021](#) and in the October, 2022 SPARC eNews Bulletin. The efforts of Bruce Ingleyby of ECMWF and Xungang Yin of NCEI were essential in making these data available.

Many publications have appeared that used the US HVRRD

data. The authors of those publications have been from the United States, China, Germany, Korea, and other nations. The upcoming workshop in Boulder will have three main purposes. The first is to encourage analysis of the more global HVRRD that have now become available to see which of the conclusions from the analysis of the US HVRRD are true globally and which are not. Also, we seek regional analyses that yield new information on atmospheric fine structures.

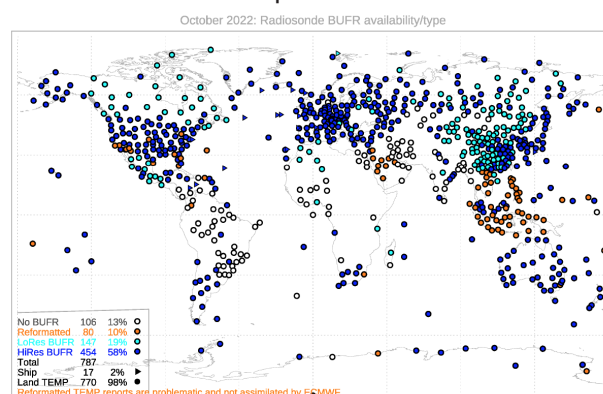


Figure 13: Map showing the global availability of HVRRD during the month of October, 2022.

The second purpose is to look into synergistic research opportunities using GPS occultation data and HVRRD. GPS radio occultation data yields information on relatively fine vertical-scale structures in the atmosphere, though not as fine as HVRRD. On the other hand, GPS radio occultation data have much more extensive global coverage, which will be explored in more depth during the workshop.

Finally, the third goal of the workshop is to look into synergistic studies using HVRRD and aircraft measurements of turbulence, since studies of atmospheric turbulence and its effects on aviation have long been an active topic of research, as well as application by the aviation community.

We also solicit contributions that use radar data together with HVRRD.

The scientific organizing committee is composed of Marvin A Geller (Marvin.Geller@sunysb.edu), Hye-Yeong Chun (chunhy@yonsei.ac.kr), Thomas Birner (thomas.birner@physik.uni-muenchen.de), William Randel (randel@ucar.edu), and Robert Sharman (sharman@ucar.edu). A registration website for this workshop may be found at (<https://cpaess.ucar.edu/meetings/fisaps-workshop-research-using-high-vertical-resolution-radiosonde-data>). Because of financial support for this workshop by the US National Science Foundation, no registration fee is required. A request to give limited support for the workshop attendance of young scientists as well as those from developing nations is pending.

SPARC meetings**28 February - 3 March 2023**

OCTAV-UTLS ISSI Team meeting
Bern, Switzerland (invitation only)

27 - 31 March, 2023

Workshop on the QBO, including its teleconnections and couplings to atmospheric composition, and general developments in wave-mean-flow processes in the atmosphere
Oxford, United Kingdom

18 - 20 April 2023

TUNER meeting
Karlsruhe, Germany

22 - 26 May 2023

LOTUS side-meeting @ LIMB workshop
Brussels, Belgium

06 - 07 June 2023

5th ACAM Training School
Dhaka, Bangladesh

08 - 09 June 2023

5th ACAM Workshop
Dhaka, Bangladesh

30 August - 01 September 2023

FISAPS meeting
Boulder, CO, USA

09 - 13 October 2023

DynVar/SNAP joint meeting on: "The Role of Atmospheric Dynamics for Climate and Extremes"
Munich, Germany

SPARC related meetings**07 - 09 March 2023**

Safe Landing Climates Lighthouse Activity Meeting
London, United Kingdom

16 - 21 April 2023

5th Symposium of the Committee on Space Research (COSPAR): Space Science with Small Satellites "COSPAR 2023"
Singapore

08 - 11 May 2023

44th Session of the Joint Scientific Committee
Brussels, Belgium (invitation only)

05 - 16 June 2023

SOLAS Summer School 2023
Cape Verde

03 - 07 July 2023

WWRP/WCRP S2S SUMMIT 2023. Advancing Sub-seasonal to Seasonal Predictions and their Applications
Reading, United Kingdom

11 - 20 July 2023

IUGG 2023
Berlin, Germany

30 July - 04 August 2023

Asia Oceania Geosciences Society Annual Meeting
Singapore

23 - 27 October 2023

WCRP Open Science Conference
Kigali, Rwanda

Find more meetings at: www.sparc-climate.org/meetings

Publication details**Editing**

Sabrina Zechlau & Mareike Heckl

Design & layout

Brigitte Ziegele & Sabrina Zechlau

Distribution & print (on demand)

DLR - IPA, Oberpfaffenhofen

ISSN 1245-4680

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