

COSPAR PSW/ISWAT Roadmap Update Pathway; Coordinator: Mario M. Bisi.

The *COSPAR Space Weather Roadmap* is in need of updating approximately every five years as per the *COSPAR PSW* terms of reference. This is also needed for and by the community as a whole so that the roadmap remains current and valid. The scope and coverage of the roadmap can be assessed each time the update period comes around. The original COSPAR Space Weather Roadmap (Schrijver *et al.*, “Understanding space weather to shield society: A global road map for 2015–2025 commissioned by COSPAR and ILWS”, *Advances in Space Research*, Volume 55, Issue 12, Pages 2745-2807, 2015) concentrated solely on scientific needs/gaps and pathways forward. It is expected that the updated Roadmap will include elements of operations and applications as well as the science, but will still be a science-research driven activity overall. In addition, there is a desire to bring in national/international strategies and with the proposed tiered approach to the roadmap, this can quite easily be achieved.

During the COSPAR International Space Weather Action Teams (ISWAT) Inaugural Meeting in February 2020, it was agreed through detailed discussions that the updated space weather roadmap will be more community driven from the bottom up and that the COSPAR ISWAT Initiative will form the backbone for it with sets of papers in layers from the bottom-up as laid out in Figure 1. Subsequent discussions by both ISWAT Moderators and the PSW Members have agreed to this plan in principle with suggestions of needing to provide more hands-on input for the middle tier of papers to ensure nothing is missed and also to bring out the less-science oriented activities, particularly looking at the space-weather impact chains from the Sun to the final effect(s).

For terminology specifically related to the structure of the ISWAT initiative and how teams are grouped into clusters representing key aspects of space weather and the subsequent links to overarching activities and impacts, please take a look here: <https://iswat-cospar.org/> - this is the COSPAR ISWAT website which provides all the relevant information pertaining to the COSPAR ISWAT initiative.

A key point throughout all the envisaged paper layers is to make the distinction between what is wanted and what is possible and why some things needed may not be possible, or at least, may not be possible yet. Avenues on where those ideas are needed to go to become available will also be expected to be covered in the papers in which they are raised in general.

The bottom-level set of papers (original research) will be the COSPAR ISWAT Team-driven/Multi-Team-driven science and technology papers on ISWAT activities with reference and acknowledgement to the original Roadmap and where the next steps are in each niche area/team topic.

The lower-middle-level set of papers (quasi-reviews) will be COSPAR ISWAT Cluster-driven/Cross-Cluster-driven papers (meaning across different key space-weather themes/domains) with additional guided papers by the COSPAR PSW to fill any gaps. These papers would primarily be referring to the bottom-level topical papers on science and technology (as appropriate), consolidating ideas from considerations of scientific and operational/monitoring needs into broader-scale requirements with reference to the original roadmap, and for expected community actions to move things forward in a more broad sense

and/or in more joined-up approaches than at the bottom-level papers. Links into the Space-Weather Impacts and making use of the COSPAR ISWAT Overarching Activities and R2O/O2R concepts can be discussed within these papers too. In addition, this tier could contain papers on national/international strategies, particularly where those strategies tie into the COSPAR PSW goals and activities, and especially where they can show advancement to the COSPAR PSW roadmap and/or points the way forward. In addition, it would be really good if the roadmap could work in sync with such national/international/agency strategies and potentially reflect some of the wider needs/concerns to more-completely tie into society.

The upper-middle-level set of papers (impacts focussed) will tie together the four primary pathways/impact chains. These are akin to the original roadmap but can let the necessary detail “evolve” in each while tying back to the lower-level papers and forming a very strong foundation for the top-level paper. These papers will include the details necessary for R2O-O2R and even operations when pertinent, but will still be founded in the science that links the space-weather phenomena to these impacts. These four impact pathways are: (1) GICs; (2) Communications/Navigation/Radio Propagation; (3) Neutrals and Satellite Drag; and (4) Radiation (all radiation aspects combined together). The ISWAT impacts and science avenues nicely map into these - which are detailed here: <https://iswat-cospar.org/> on the right-hand side, with the exception of Climate. We should also be aware of the potential damage to other areas of science caused by more space-weather infrastructures; for example, more space-weather constellations in Earth orbit causing increased amounts of interference and degradations in signals for ground-based optical and radio astronomers (and these include space-weather applications too).

The top-level, single, consolidated paper (consolidated roadmap) will provide a suitably-concise PSW-/ISWAT-Moderator-led roadmap overview and recommendations paper for science, operations, and monitoring referring down the chains of papers and to the original roadmap. Still needs to be somewhat standalone, but not verbose. The roadmap, as a whole, should stimulate national space-weather investments and pave the way for the most-critical international engagements/activities that are needed globally as well as nationally/locally. Although different countries are at different stages of their planning, as is being discovered by the UN COPUOS Expert Group on Space Weather (EGSW) activities, some of the insights learned there can also be fed into the the more-strategic outcomes/directions of this roadmap, particularly as the vast majority of nations want to learn more about potential space-weather impacts on them, even if they have not even began that journey of discovery as yet.

Thus, the top-level paper will form an executive overview of the two lower-level sets of papers where the more-detailed descriptions of cutting-edge science and technology and their impact will be described. As a collection, the papers will form the Updated COSPAR Space Weather Roadmap - an ISWAT Community-led Roadmap from the bottom-up with key science, validation, old roadmap steps achieved, and where to go next/what’s missing/needed...

In addition to that detailed thus far, an Executive Summary/Overview more open to everyone will need to also be established, again of a similar guise to the original roadmap. This could be a formal paper, a brochure-type paper, or something different still; but it needs to be fully engaging, simple, straightforward, and covering all the key points of the top-level paper as a minimum. This will be a significant challenge, but a necessary one. This is also very useful here for those in the funding agencies and people in high-director-level positions to read in a very concise and straightforward manner.

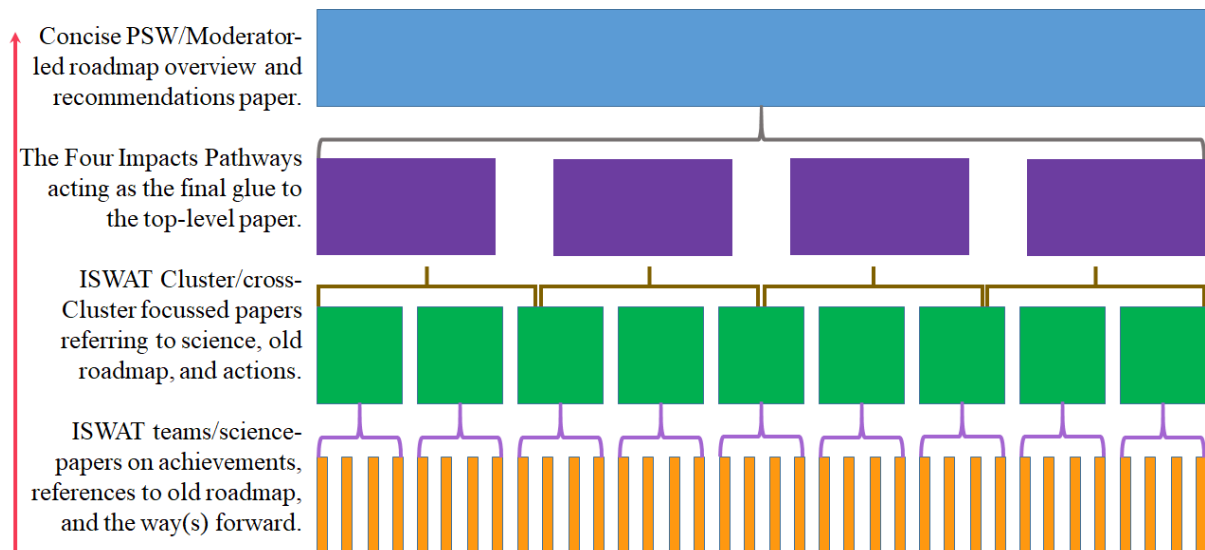


Figure 1. Overview (simplified) diagram of the papers structure forming the Updated COSPAR Space Weather Roadmap.

The papers are expected to be encapsulated in a special edition (to be discussed with the journal) of *Advances in Space Research (ASR)*, COSPAR’s in-house journal. Provisional interest has already been obtained from COSPAR for such an endeavour. Due to the disruption caused by COVID-19, including the postponement of COSPAR 2020 to 2021, the timeline needs to be slipped for the preparations and eventual publication of the COSPAR Space Weather Roadmap Papers, and this is laid out below.

- 23 November 2020 - ONGOING - liaise with COSPAR ASR journal.
- 15 May 2021 - call for notice of intent and advertisement of the approach to the wider community.
- 15 July 2021 - deadline for the notice of intent for each of the orange tier papers.
- 15 August 2021 - deadline for the outlines and author lists of the green and purple tier papers including some details on what will be included in the papers.
- *We will have two separate Special Issues that form the roadmap - awaiting final feedback from the ASR Editors.*
- 13-17 September 2021, 27 September – 1 October - Virtual ISWAT Working Meeting “Toward Community-Driven Living Roadmap”
- 1 October 2021 - finalisation of planning for the purple and blue papers and submission of the necessary NOIs for these.
- 04 October 2021 - expected opening of submissions for both parts.
- 31 January 2022, (28 March 2022 to 01 April 2022 - hybrid ISWAT meeting in Portugal), 30 April 2022, 30 June 2022, and 31 August 2022 - staggered for the paper submissions - in four phases from the bottom level upwards.
- 31 December 2022 - envisaged final possible date for publication.

More details will follow in due course, including the Guest Editor Team information to propose and work with the COPAR ASR journal.

