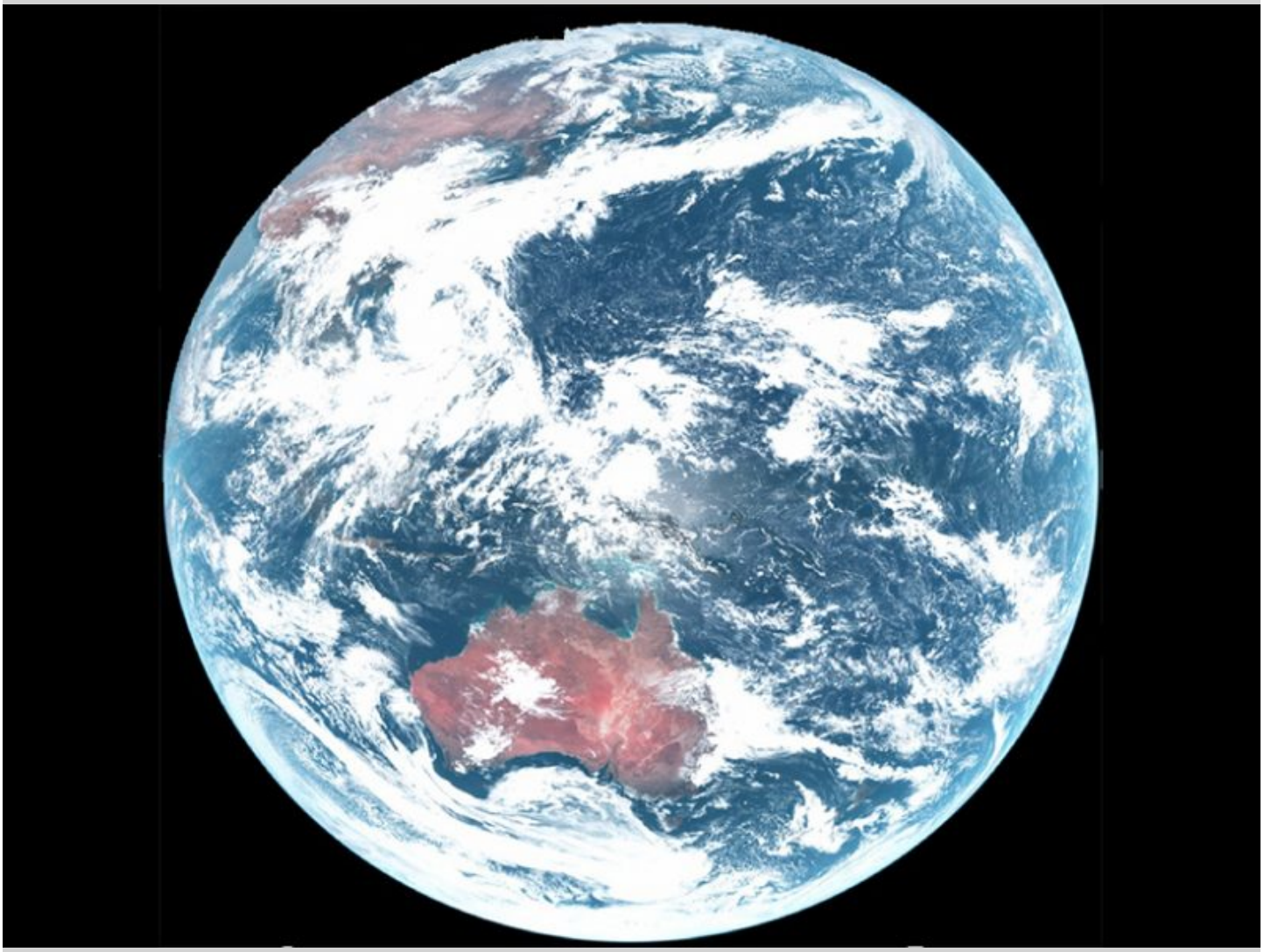
The Stratosphere and Its Role in Tropical Teleconnections

Joint SPARC Dynamics and Observations Workshop; Kyoto, Japan, 9–14 October 2017



A Madden-Julian Oscillation, a type of moving weather disturbance, strengthens over the island nations of Southeast Asia. The Japan Meteorological Agency GMS Himawari 8 satellite obtained this true-color image on the final day of a joint workshop on tropical teleconnections, 14 October 2017, 0200 Universal Time. Credit: Japan Meteorological Agency

By Scott Osprey, Marvin Geller, and Shigeo Yoden 17 May 2018

Organized large-scale weather events such as El Niño, the monsoons, and the Madden-Julian Oscillation (http://www.bom.gov.au/climate/about/?bookmark=mjo) (MJO) regularly affect billions of people living around the tropics. Understanding the response of these events to climate change and reducing impact uncertainty at a regional level is a pressing concern.

By working to reduce uncertainty in the small-scale processes underlying large-scale weather patterns, we are better placed to know how climate events will evolve in the future.

Traditional approaches toward gaining this understanding have involved picking apart large-scale weather patterns to reveal the driving processes underlying them. By working to reduce uncertainty in these underlying small-scale processes, their feedbacks, and pathways of action (teleconnections (https://eos.org/editors-vox/tropical-teleconnections)) and by using the right observations and models, we are better placed to know how climate events will evolve in the future.

The participants in three activities within the World Climate Research Programme's (WCRP (https://www.wcrp-climate.org/)) Stratosphere-Troposphere Processes and their Role in Climate (SPARC (http://www.sparc-climate.org/)) project organized and held a joint meeting (http://www-mete.kugi.kyoto-u.ac.jp/SPARCjws2017/index.html) in Japan last year to tackle outstanding questions of tropical teleconnections. The activities represented at this joint meeting were the Quasi-Biennial Oscillation Initiative (QBOi (http://www.sparc-climate.org/activities/quasi-biennial-oscillation/)), Stratospheric and Tropospheric Influences on Tropical Convective Systems (SATIO-TCS (http://www.sparc-climate.org/activities/emerging-activities/#c1880)), and Fine Scale Atmospheric Processes and Structures (FISAPS (http://www.sparc-climate.org/activities/fine-scale-processes/)). This

meeting, which took the form of a workshop, attracted 74 researchers from 13 countries, and it focused on identifying tropical teleconnections linking the stratosphere and climate phenomena elsewhere.

Upcoming observational campaigns will help in assessing how turbulence may affect air travel.

The workshop was arranged around several themes. One session highlighted the potential for extending skillful MJO forecasts by exploiting the predictability of slowly varying winds in the tropical stratosphere (e.g., the quasi-biennial oscillation (https://eos.org/meeting-reports/modeling-the-stratospheres-heartbeat) (QBO)). Links between these slowly varying winds and the MJO, especially from December to February, are associated with equatorial waves in the stratosphere, which are best observed using high vertical resolution radio occultation (http://www.cosmic.ucar.edu/ro.html) and balloon data. These links underscore the importance of identifying those waves driving the winds in the tropical stratosphere and in creating turbulence below.

Upcoming observational campaigns, highlighted by the forthcoming Strateole-2 (https://strateole2.cnes.fr/en/strateole-2-0) superpressure balloon campaign (https://eos.org/project-updates/around-the-world-in-84-days), will help to constrain estimates of waves and moisture entering the stratosphere. One of the many practical applications includes assessing how turbulence may affect air travel.

A Madden-Julian Oscillation is an aggregation of convection and convection-related clouds that extends over a continental scale. Cumulonimbus clouds, like the one shown here, are often linked with updrafts and rainfall linked to strong convection. Credit: Earth Science and Remote Sensing Unit (https://eol.jsc.nasa.gov/esrs/), NASA Johnson Space Center (ISS017E013853)

One session at the workshop addressed how well climate models capture a QBO and its response to idealized climate forcing and models' abilities to capture disruptions (https://www.ncbi.nlm.nih.gov/pubmed/27608666) similar to that seen during early 2016. Evidence is mounting that current climate models' simulations of QBOs are not robust in their response to climate forcing. This shortcoming is linked to a lack of physical feedbacks and limitations in the representation of small-scale processes and chemistry.

The final plenary session looked at the traditional coupling of the tropics to higher latitudes, with an emphasis on stratospheric pathways. Reports showed a similar lack of consistency for simulations of teleconnections across models, especially for teleconnections expected near the surface. Participants agreed that further progress is needed to better understand and ameliorate these model differences.

One positive outcome from the meeting was participants' enthusiastic support for future joint science workshops tackling common challenges. Another outcome was for wider consultation on additional model diagnostics that will be included in future model initiatives, such as those proposed for QBOi (http://users.ox.ac.uk/~astr0092/Experiments.html#widget2). Specifically, model diagnostics relevant to the MJO and El Niño–Southern Oscillation highlight future directions for pursuing joint science common to the groups. Planning is currently underway for a model experiment whose design and diagnostics are overseen by a cross-member working group. Full details of the workshop are found in the *SPARC Newsletter (http://www.sparc-climate.org/wp-content/uploads/sites/5/2018/02/SPARCnewsletterFeb2018_small-2.pdf)*.

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