Subseasonal-to-Seasonal S2S Prediction Project

WWRP World Weather Research Programme

WCRP World Climate Research Programme

Newsletter

In This Issue …

News:

- S2S Real Time Pilot Initiative
- S2S Database new graphics and indices
- WMO S2S 8th SG meeting
- Workshop on predictability, dynamics and applications research using the TIGGE and S2S ensembles
- EGU 2019 S2S session

Special articles:

- S2S4E (S2S for Energy)

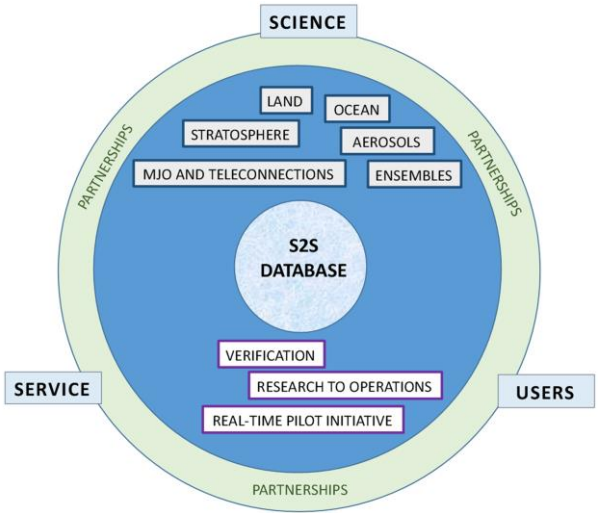
Topics:

1. What is S2S ?

To bridge the gap between medium-range weather forecasts and seasonal forecasts, the World Weather Research Programme (WWRP) and World Climate Research Programme (WCRP) launched a joint research initiative in 2013, the Subseasonal to Seasonal Prediction Project (S2S). The main goal of this project is to improve forecast skill and understanding of the subseasonal to seasonal timescale, and to promote its uptake by operational centres and exploitation by the applications communities.

Phase II of the S2S project began in January 2019 and will continue until 2023. A new set of scientific sub-projects has been developed, as outlined in the sidebar in next pages. Enhancements to the database will be made including access to the S2S ocean and additional models. The second phase will also include new research-to-operations activities and a real-time supplications initiative introduced in this edition of the newsletter.

S2S Phase II Proposal is available at http://s2sprediction.net/file/documents_reports/P2_Pro.pdf



< Schematic of the S2S Phase II >

S2S Real Time Pilot Initiative

Joanne Robbins (UKMO)

A key feature of the S2S Prediction Project's 2nd Phase is the pull through of research to operations and specifically focussed on pull through to meet user needs. The S2S Real Time Pilot Initiative is designed to improve our understanding of how we can effectively pull through our underpinning and growing science capability to better inform the development of user-orientated applications in the S2S time range. The initiative will look to produce best practice guidance on how to make S2S forecast information useful and useable, by working with a select group of projects that have an end user focus.

16 projects will be participating in the S2S Real Time Pilot Initiative which will officially start on 1st November 2019. Participating projects have a wide geographical coverage (North and South America, Asia, Africa, Europe and Oceania) and will interact across a diverse set of sectors (Humanitarian; Agriculture, Forestry and Fishing; Energy; Water; Health; Defence and DRR). Over recent months the S2S Real Time Pilot Team, together with WMO, have solicited support from several Operational Centres who have agreed to lift the 3-week lag on S2S forecast data availability, for those projects participating in the initiative. This will allow the 16 projects to access real time S2S forecasts for a two year period, and develop user-orientated tools focussed on user requirements. We are currently working with the WWRP's Societal and Economic Research Applications (SERA) working group to establish a feedback strategy for the initiative. This is essential so that we can gather information from the projects regarding their user engagement and co-development practices, obtain end user feedback on the tools developed and gather information on the methods used to generate user-orientated applications, the successes and the challenges. Using this information we will be able to generate best practice guidance to support future S2S application work. The feedback strategy will be complete by the end of August 2019 and shared with the projects in early October.

S2S Database new graphics and indices

- New charts showing the prediction of 4 individual Euro-Atlantic weather regimes for each S2S models have been added. They consist of NAO+, NAO-, Atlantic ridge, and Scandinavian blocking. In addition, charts showing the ensemble distribution in the NAO-Blocking phase space have also been added.
  Go to: S2S Homepage > Database > ECMWF > S2S Datasets.

- 3 new indices in addition to MJO RMMS have been newly provided by ECMWF as follows.
  -Tropical cyclone tracks using the ECMWF tracker (available for all real-time forecasts and reforecasts and updated daily)
  -Euro-Atlantic Weather regimes using Dr. Laura Ferranti's code (currently available for real-time forecasts only, but will be extended to re-forecasts)
  -Sudden stratospheric warming index based on 10 hPa wind (currently available for real-time forecasts only, but will be extended to re-forecasts)
  Go to: S2S Homepage > Database > ECMWF > MJO RMMS(ftp)

WMO S2S 8th Steering Group Meeting

The 8th S2S steering group meeting took place before the workshop on predictability, dynamics and applications research using the TIGGE and S2S ensembles on 1-2 April 2019. 25 people, including Steering Group and Liaison Group members, ICO members and several guests, attended the meeting.

They shared opinions about a new strategic plan of WWRP/WCRP, Phase 2 schematic, linkages with other groups, S2S database, OSE experiments, real-time pilot, S2S inputs to WCRP JSC Implementation and Transition meeting, S2S product generation and tools such as ECMWF, S2S museum, IRI Python, and Github, downscaling activities, proposal opportunities relevant to S2S, ICO activity and training course, S2S AppNet, etc. And, there were discussions on the progress of the following 6 sub-projects.

- MJO and teleconnections (Dr. Steve Woolnough & Dr. Cristiana Stan)
- Land (Dr. Paul Dirmeyer)
- Ocean (Dr. Harry Hendon)
- Aerosol (Dr. Frederic Vitart)
- Ensembles (Dr. Yuhei Takaya)
- Stratosphere (Dr. Andrew Charlton Perez)

It was announced that the ECMWF data centre will move to Bologna in Q2 2020, and this will generate a disruption in the availability of the S2S database at ECMWF for at least a few weeks.

2. Six sub-projects in S2S Phase II

The new research Phase II sub-projects will address issues related to sources of predictability, forecast system configureation, and model development. These sub-projects are more oriented towards model experimentation than the Phase I sub-projects which were more about model assessment. Some of the new sub-project research plans will include coordinated experiments and also process studies in coordination with the Working Group on Numerical Experimentation (WGNE).

1. **MJO and teleconnections**: This sub-project focuses on the representation of teleconnections and their modulation in S2S models. Metrics for assessing model teleconnections and diagnosing sources of errors in teleconnections will be applied.

2. **Land**: This sub-project investigates the impact of the observing system on land initialization and S2S forecasts, the representation of the coupled land/ atmosphere processes in S2S models, and contribution of anomalies in land surface states to extremes. It will work in concert with other relevant programs to pool resources and coordinate scientific studies (e.g. GEWEX/GLASS).

3. **Ocean**: This sub-project aims to evaluate the ocean feedbacks which directly influence sub-seasonal variability and prediction skill, the predictability influenced by pre-existing ocean state, the effect of low-frequency variability on S2S predictability, the impact of ocean mean state drift on S2S predictability, mechanisms which affect extreme ocean weather (heat waves) and their predictability.

4. **Aerosol**: This sub-project is a collaboration between S2S, WGNE and GAW. It aims to evaluate the benefit of interactive instead of climatological aerosols on sub-seasonal forecasts through a series of coordinated re-forecast experiment with and without interactive aerosols. The sub-seasonal predictability of aerosols will be assessed as well as their impact on sub-seasonal forecast skill scores.

5. **Ensembles**: This sub-project will study the influence of burst vs lagged ensemble initialization on the forecast spread using S2S database. It will also investigate the impacts of stochastic parameterizations and coupled initial perturbations on the sub-seasonal prediction, review the techniques for coupled initial perturbations which are under development in a few centers (ECMWF, NCEP, BoM, and JMA).

6. **Stratosphere**: This is a joint sub-project between S2S and WCRP/SPARC/SNAP. Its main goals include: developing additional stratospheric diagnostics and investigating the use of DynVarMIP additional diagnostics to S2S models; Coordinating damping experiments to examine the dynamics of downward coupling; Studying the link to tropospheric dynamics.

3. Upcoming events

• **2019 ECMWF annual seminar** (Subseasonal and seasonal forecasting: recent progress and future prospects), *2-5 September 2019, ECMWF.* https://www.ecmwf.int/en/learning/workshops/annual-seminar-2019

• **EMS (Session: UP3.7)**, *9-13 September 2019, Copenhagen, Denmark.* https://meetingorganizer.copernicus.org/EMS2019/session/33719

• **Atmospheric Circulation in a Changing Climate** (A joint DynVarMIP/CMIP6 and SPARC DynVar & SNAP Workshop), *22-25 October 2019, Madrid, Spain*. https://www.sparc-climate.org/meetings/workshop-on-atmospheric-circulation-in-a-changing-climate/

• **Stratospheric predictability and impact on the troposphere,** *18-21 November 2019*, ECMWF. https://www.ecmwf.int/en/learning/workshops/workshop-stratospheric-predictability-impact-troposphere

• **AGU Fall Meeting 2019** (S2S sessions: A003, A120, and GC088), *9-13 December 2019, San Francisco, CA, USA.* https://www2.agu.org/Fall-Meeting/

• **100th AMS Annual Meeting** (S2S project Session: Sub-seasonal to Seasonal Predictions and Predictability: Past Progress and Future Prospects Across the International Community), *12-16 January 2020, Boston, MA.* https://annual.ametsoc.org/index.cfm/2020/

Workshop on predictability, dynamics and applications research using the TIGGE and S2S ensembles

This workshop was held at the ECMWF on 2~5, April, 2018. The workshop attracted about 120 participants representing around 60 organisations from Europe as well as from Australia, Brazil, Canada, China, India, Japan, Korea, Nigeria, Singapore, Taiwan and USA. Due to the conference room capacity, the number of participants had to be limited to 120. This large attendance demonstrates the wide interest of the TIGGE and S2S databases in the research and application communities.

The programme included 44 oral presentations. 45 posters were displayed in the ECMWF Weather Room during the 3 days of the workshop. Working group sessions took place on Thursday 4 April afternoon and Friday 5 April morning. Presentations and recordings as well as the recommendations from the 6 working groups are now available on the workshop web page.

The workshop provided an opportunity to review the main scientific advances in predictability, dynamical process studies and applications of ensemble forecasts across the medium and S2S forecast ranges. The oral presentations were organized around 5 themes:

1. Predictability and Dynamics
2. Database technical development
3. Prediction and verification
4. Multi-model ensemble approaches
5. Ensemble applications research

The first session on Predictability and Dynamics showed how the TIGGE and S2S databases provide important insights into the predictability and impacts of stratospheric sudden warmings, the Madden Julian Oscillation and European weather regimes. The databases are also used to evaluate the impact of QBO on MJO and sudden stratospheric warmings.

In the second session, the technical developments of the TIGGE and S2S databases at ECMWF and CMA were presented. Both report from CMA and ECMWF showed a strong and increasing usage of the databases as well as a large number of scientific publications based on the TIGGE and S2S databases. Several new models may contribute to the TIGGE and S2S databases, including the global ICON_EPS from DWD. The S2S database is also archived at IRI, which provides a maproom and online analysis tool for the S2S database particularly useful for users from developing countries. This session closed with the evaluation of sub-seasonal forecasts from two new models: the Navy Earth System Capability (EPSC) and the new FV3 based GEFS model.

In the third session, several oral presentations discussed the verification of ensemble forecasts. They included a discussion on the use of the Receiver Operating Characteristics (ROC) for ensemble forecast verification and the presentation of a general framework for verifying S2S probabilistic forecasts. A methodology for producing seamless transition from daily to time-averaged forecasts which could be applied to the TIGGE and S2S models was also presented. Several

presentations discussed the prediction of weather regimes for Europe and North America using the S2S database, tropical cyclones using TIGGE, sea-ice cover, stratospheric sudden warmings, precipitation. For instance, it was shown that the prediction skill horizon of sea ice cover exceeds 30 days in some S2S models and that the verification of tropical cyclone in TIGGE demonstrated value in multi-model ensemble forecasts, which led to operational multi-model tropical cyclone forecasts.

Session 4 included several talks demonstrating the benefit of multi-model ensembles for medium-range and extended-range forecasts, as well as frameworks for multi-model ensemble calibration and post-processing.

Finally, Session 5 was dedicated to applications studies using the TIGGE and S2S databases. This session showed several areas where medium-range and S2S predictions could benefit society: energy sector, drought monitoring and prediction, telecommunications, flood alerts, agriculture and so on.

The oral sessions were followed by working group sessions. The participants were divided into 6 working groups around the 5 following themes: database technical development, user-oriented variables, processes and forecasts (2 groups), verification/ calibration and potential value of multi-model ensembles. The working group reports can be found in the workshop main web page.

A growing S2S community meets again at EGU in 2019

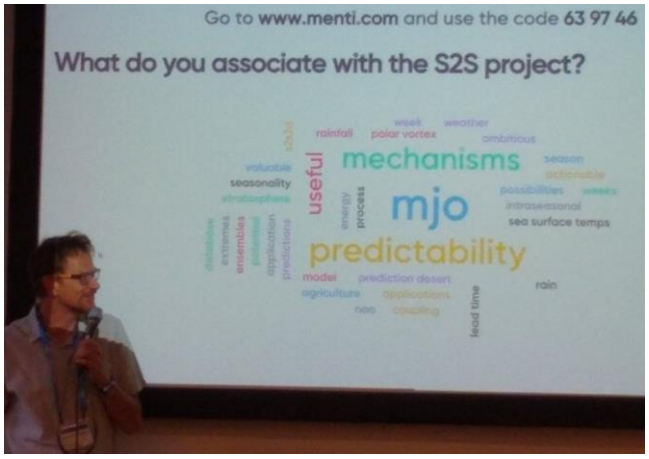
Francesca Di Giuseppe (ECMWF) and Adrian Tompkins (ICTP)

After the good reception in 2018, at the European Geophysical Union (EGU) General Assembly in 2019 organised in Vienna, took place the second edition of a session on sub-seasonal to seasonal prediction "Subseasonal-to-Seasonal (S2S) Prediction: meteorology and impacts". With almost 60 abstracts submitted the event brought together scientist and users to discuss issues related to this scale of predictability. The session was organised over three oral slots, an afternoon poster session and concluded with an enjoyable social dinner.

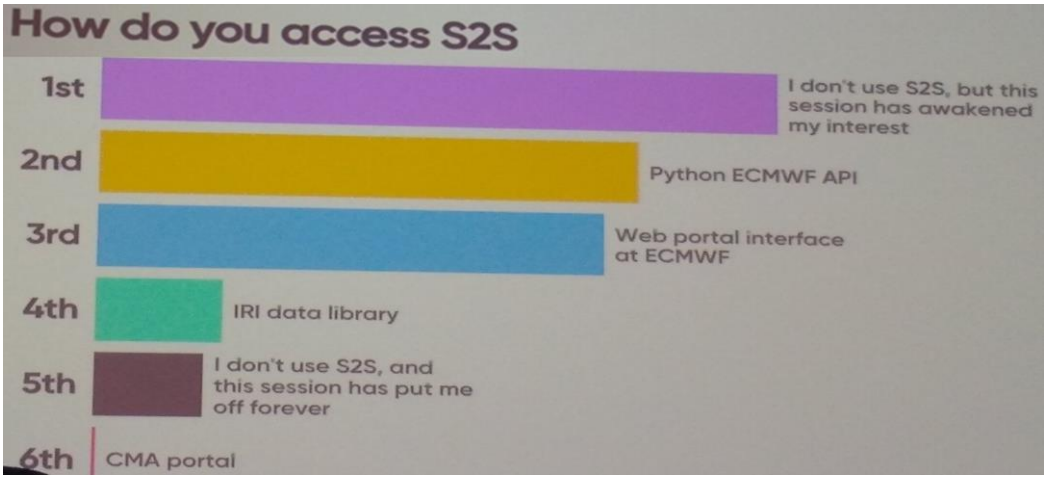
This year we also organised an interactive start to every slots using mentimeter to gather feedback on the S2S program. The first interactive 15 minutes really helped breaking the ice and made the atmosphere very lively.

Contributions focused on phenomena such as - The Madden Julian Oscillation (MJO)- Tropical/Extra-Tropical waves- Stratospheric variability and stratosphere-troposphere coupling - Predictability and skill of atmospheric or surface variables- Transition of weather regimes.

A vast number of contributions regarding impacts studies at the S2S time range were also discussed including the areas of energy, health and agriculture.



<Adrian Tompkins leading the interactive session with a word cloud of keywords from the audience on what they think of when hearing the term S2S>



< Adrian Tompkins showing ways to access of S2S data. Seems like a number of people have been gained interest in the S2S data>

S2S4E (S2S for Energy)

- Customising sub-seasonal and seasonal forecasts for the needs of energy user -

Albert Soret Miravet and Julia Cannata
(Barcelona Supercomputing Center)

The added value of sub-seasonal and seasonal forecasts for the energy sector

The energy industry has traditionally used climatology to anticipate renewable energy sources and electricity demand for situations 15 days or more into the future. However, assuming that future conditions will be similar to average past conditions has several inherent shortcomings. EU-funded S2S4E (Sub-seasonal to Seasonal climate forecasting for Energy) aims to address these shortcomings by demonstrating the potential application of sub-seasonal to seasonal forecasts. These forecasts will enable renewable energy producers and providers, electricity network managers and policy makers to design better informed strategies to: manage resources effectively, anticipate resource effects on markets, plan for maintenance works (especially offshore wind), anticipate cash flow and optimize return on investments, anticipate colder and hotter periods or schedule power plants to reinforce supply (Soret et al. 2019).

The S2S4E process

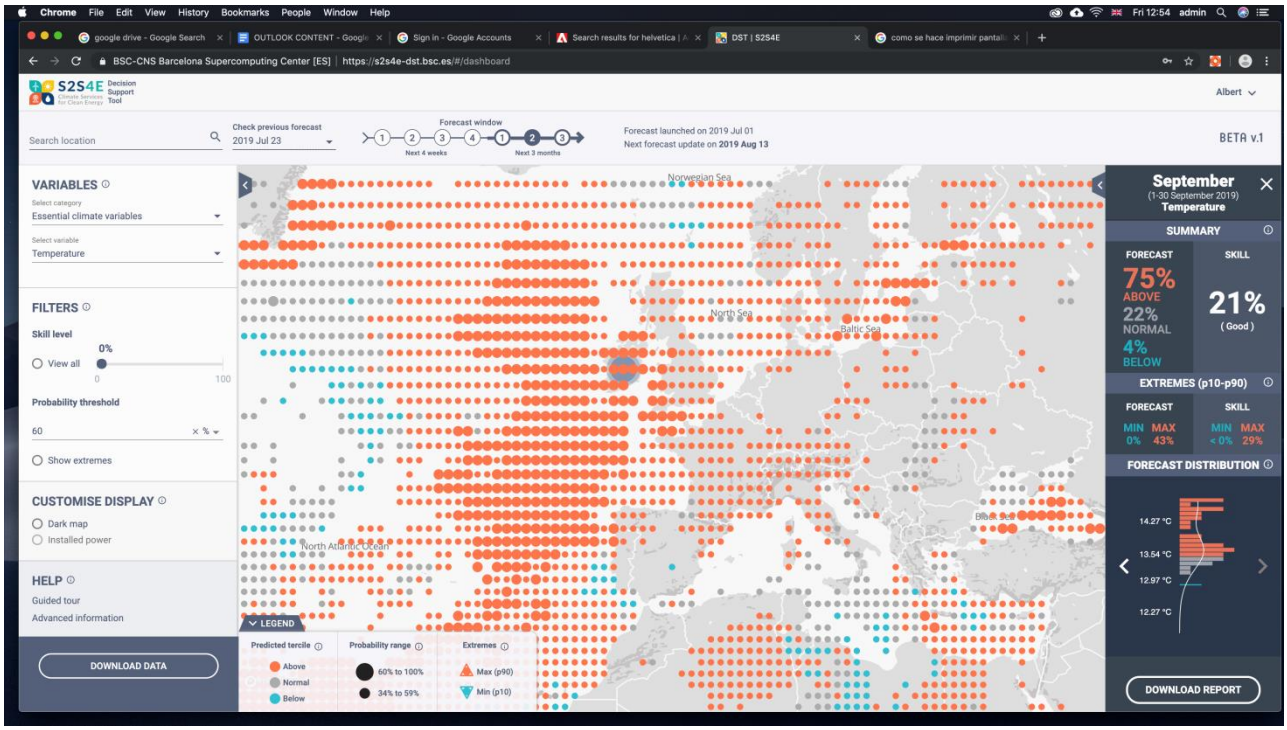
To customise forecasts and ultimately co-create the Decision Support Tool (DST; s2s4e.eu/dst) that would effectively be used and useful to energy users, a two-step process was carried out.

First, S2S4E worked with energy companies to identify relevant case studies of past unusual climate behaviour. These events were analysed with sub-seasonal and seasonal forecasts to evaluate the added value, including the economic benefits, that climate predictions could have provided to energy users in the context of these case studies.

The second major step of S2S4E involved working side-by-side with users to integrate the sub-seasonal and seasonal forecasts into the DST. As a result of this close collaboration between industry and research S2S4E has been able to launch an operational and online tool that provides visually the climate information and customisable features that energy users have indicated would be beneficial.

S2S4E forecasts and its availability

The online DST therefore includes climate information determined to be specifically relevant to renewable energy production -- solar power, hydropower, wind power, and demand. This includes post-processed sub-seasonal (updated every week) and seasonal (updated every month) climate predictions of solar radiation, solar capacity factor, inflows, precipitation, seal level pressure, annual snow max, wind speed, wind speed capacity factor, temperature, maximum and minimum temperature, and electricity demand.



<Forecast available in the S2S4E DST for September 2019 issued July, 15th for temperature showing that in most European regions, temperature will very likely be in the above normal tercile>

In its current version, the DST is integrating ECMWF SEAS5 seasonal forecasts from the Copernicus Climate Data Store and the sub-seasonal predictions of CFSv2 system through NCEP database. S2S4E is one of the projects participating in the real time pilot initiative of S2S, that will allow to make use of S2S models to produce tailored forecasts and to assess their added value continuously in a real business environment with the feedback of the industry partners.

The research behind S2S4E

The development of the project is composed by two complementary research lines. The first research line consists of exploring the frontiers of sub-seasonal and seasonal predictions taking into account user needs. For instance, a majority of climate prediction studies focus on variables such as temperature. However, S2S4E extends its research to other climate variables, such as wind speed. Taking this variable as example, S2S4E has: 1) assessed which global reanalysis best represents winds comparing them with instrumented tall towers (Ramon et al. 2019); 2) characterized European wind speed variability for the whole year using weather regimes computed month by month, addressing the user's need of a service that covers all year, since most studies focus on winter season only. (Cortesi et al. 2019); and 3) investigated the drivers of one of the main wind droughts in the recent years that significantly affected the energy sector (Lledo et al. 2018). The second research line is devoted to transfer this knowledge to the society and ensure the impact and application of the research. For instance, within the context of S2S4E a game has been developed, where users can play with probabilistic information and assess the usefulness of climate predictions, showing that in skillful areas economic benefits are obtained in the long term (Terrado et al. 2019).

Take advantage of the S2S4E DST

Ultimately, the co-generation process of this decision tool has achieved both a closer and stronger engagement with the users as well as enhanced reliability of the DST, to result in a platform which can be used for effective decision-making. To encourage usage of the tool and improve its features, it will be open and freely available until November 2020 in s2s4e.eu/dst.

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S2S ICO at NIMS in Jeju

The S2S International Coordination Office (ICO) is located at the National Institute of Meteorological Sciences (NIMS) of the Korea Meteorological Administration (KMA), in Jeju, Republic of Korea. Dr. Seung-On Hwang started working as an ICO manager on June 19, 2019.