S2S updates

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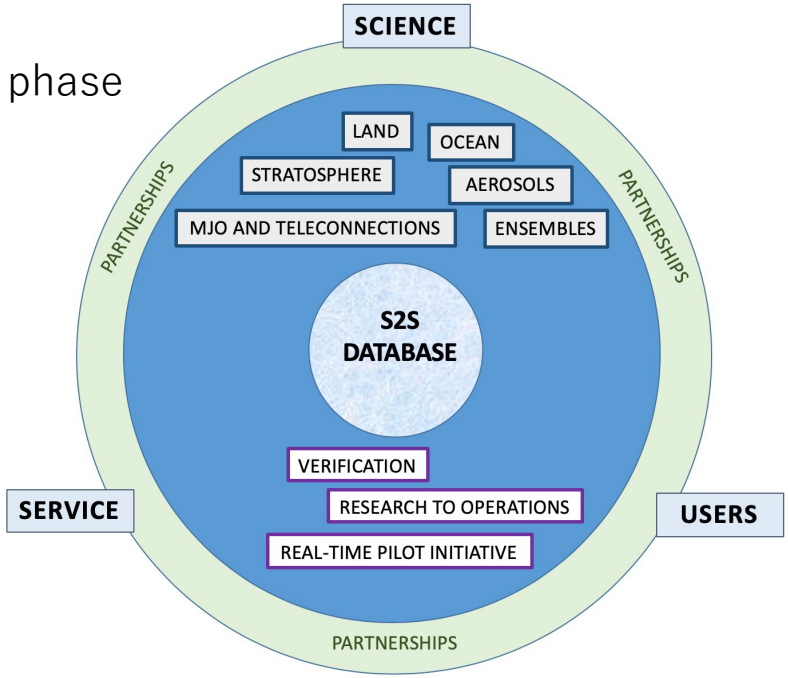
With inputs from S2S SG members

The WWRP/WCRP S2S Project

The S2S Project started 2013 and is now in its second phase (2019-2023)

- WWRP: S2S is one of the 3 core projects
- WCRP: S2S is under ESMO
- Co-chairs: Frederic Vitart, Andrew Robertson
- International Coordination Office hosted by APCC.
- Contribution to S2S trust fund from Australia, Canada, UK and Germany.
- S2S webpage: http://s2sprediction.net/

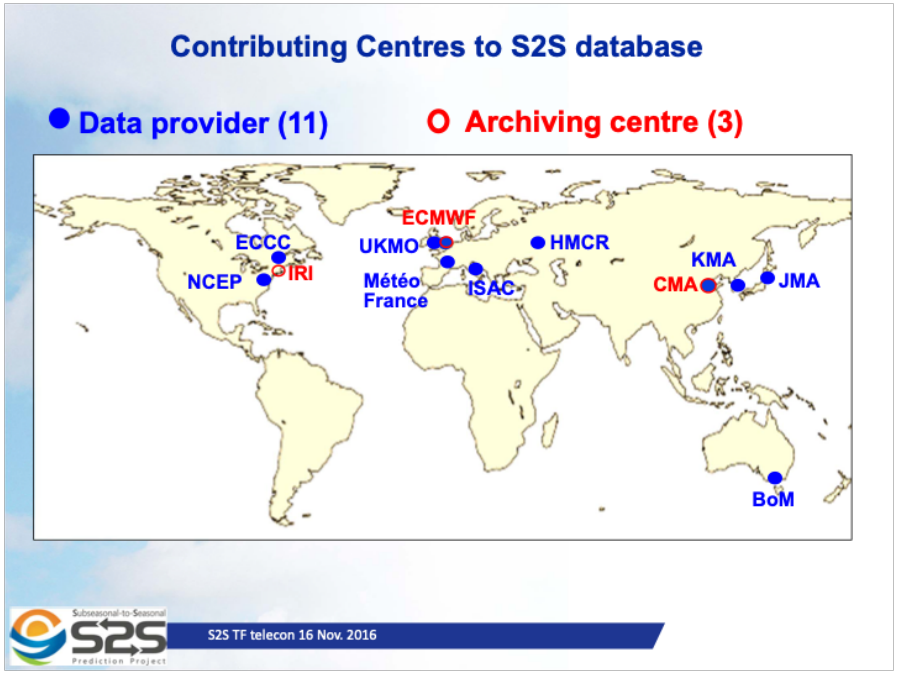


WMO OMM

The WWRP/WCRP S2S Database

Daily 3-week behind real-time forecasts since January 2015 + re-forecasts

- 11 models currently available
- Same grid (1.5 degree) / GRIB2 format
- About 80 variables available, including 3D variables on 10 pressure levels
- Hosted at ECMWF, CMA and IRI
- 10 ocean variables have been recently added
- 1 new model added (Chinese Academy of Science) – Work is ongoing to add NASAGMAO and IITM
- > 250 publications



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WWRP/WCRP S2S in new WCRP strategy

Core Projects and Research Communities

- Climate and Cryosphere (CliC)
- Global Energy and Water Exchanges (GEWEX)
- Climate and Ocean Variability, Predictability and Change (CLIVAR)
- Stratosphere-troposphere Processes And their Role in Climate (SPARC)
- *Earth System Modelling and Observations (ESMO)*
- *Regional Information for Society (RIfS)*

- Explaining and Predicting Earth System Change
- My Climate Risk "Extremes"
- Safe Landing Climates
- Digital Earths
- WCRP Academy

Lighthouse Activities

There are many commonalities, both in science and modeling as well as in the development of services, between S2S and WGSIP.

The S2S Real Time Pilot Initiative

- Started November 2019 & will continue until end October 2022 *(includes 1-year extension recently approved)*
- Goals:
  - Identify what is needed to make S2S forecasts usable, how this varies by sector/ organisation/experience
  - Understand how projects engage with users, how this relates to pull-through/demand
  - Develop understanding of the S2S forecast value chain & the needs for end-to-end user applications
  - Development of best practice guidelines and/or recommendations to enhance pull-through & sustainability

- Approach
  - 16 co-development projects
  - 3 sets of questionnaires: April/May 2020, Winter 2020/2021, Autumn 2021

Sectors:
- Water
- Energy
- Health
- Agriculture/food security
- Disaster risk reduction

Countries/regions:
- Senegal
- Ethiopia
- Bangladesh
- Guatemala
- Columbia
- Ghana
- Kenya
- Nigeria
- Singapore
- USA
- Europe
- Asia & Pacific
- Global

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S2S AI/ML Challenge

- The WMO Research Board has identified Artificial Intelligence (AI) as a key research topic in weather and climate science for the upcoming years
- A competition has been organized to encourage the use of AI tools to extract valuable information from the S2S database.
- **Can purely empirical forecasts beat S2S systems?**
- **Can AI/ML methods improve S2S system forecasts by better calibration/multi-model?** ensemble methods?
- Hosted by Swiss Data Science Center at ETH Zürich, with ECMWF support through the new European Weather Cloud for data access and some CPU time
- A contractor has been hired by WMO
- Timeline: July 2021 – Feb 2022
- **All codes and forecasts will be made open source after the end of the competition to foster community learning on AI/ML methods for S2S**
- Small monetary prizes from WMO

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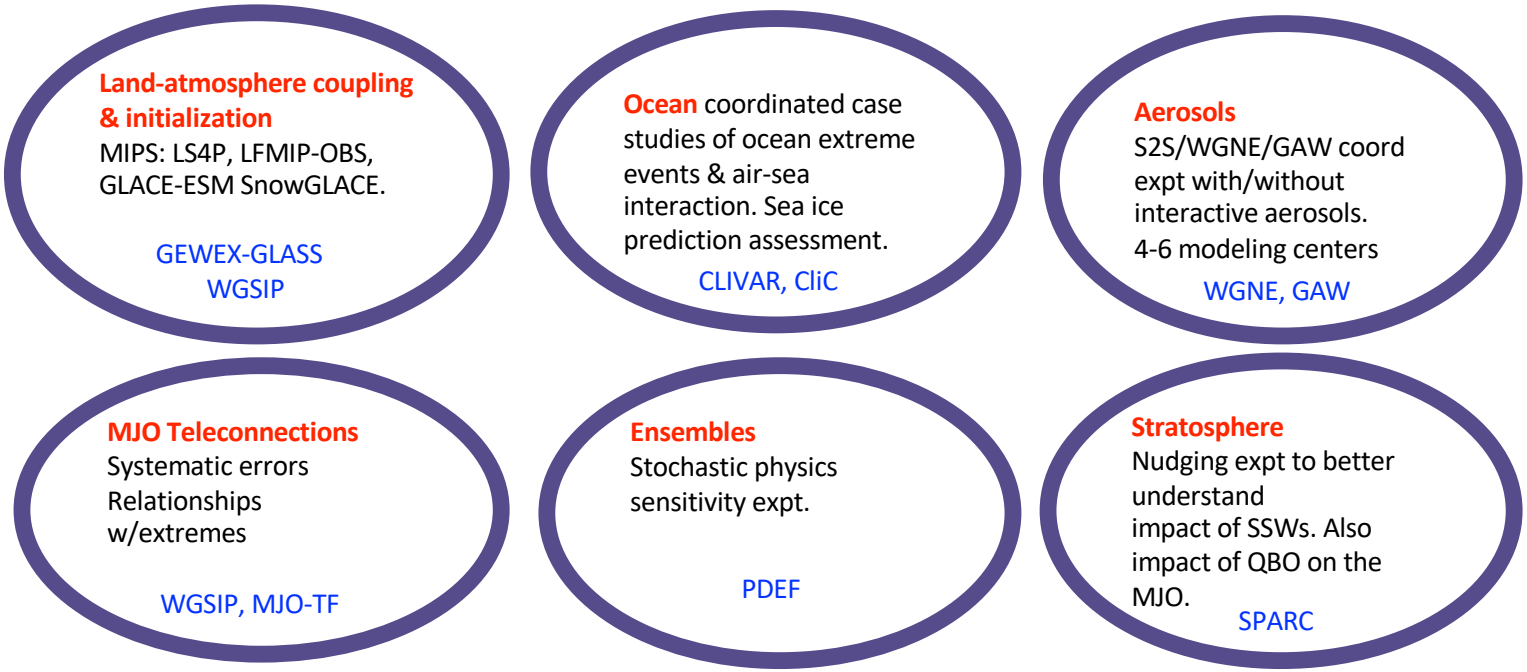
Sub-project updates



- **Stratosphere subproject** (Daniela Domeisen)
- **Applications subproject** new! (Chris White)
- **Ocean subproject** (Charlotte Demott)
- **Aerosol subproject** (Andrea Molod)
- **Ensembles** (Yuhei Takaya)
- **MJO/Teleconnections** (Cristiana Stan)
- **Land** (Paul Dirmeyer)
- **R2O** (Caio Coelho)

New S2S Regional Activity wikis

Establishment of GPC-SSF & LC-MMESSF has been approved at EC-73.

WMO ET-CSISO activity on developing the Guidance Document on calibration of sub-seasonal to seasonal prediction for national-level operations.

Science sub-project activities

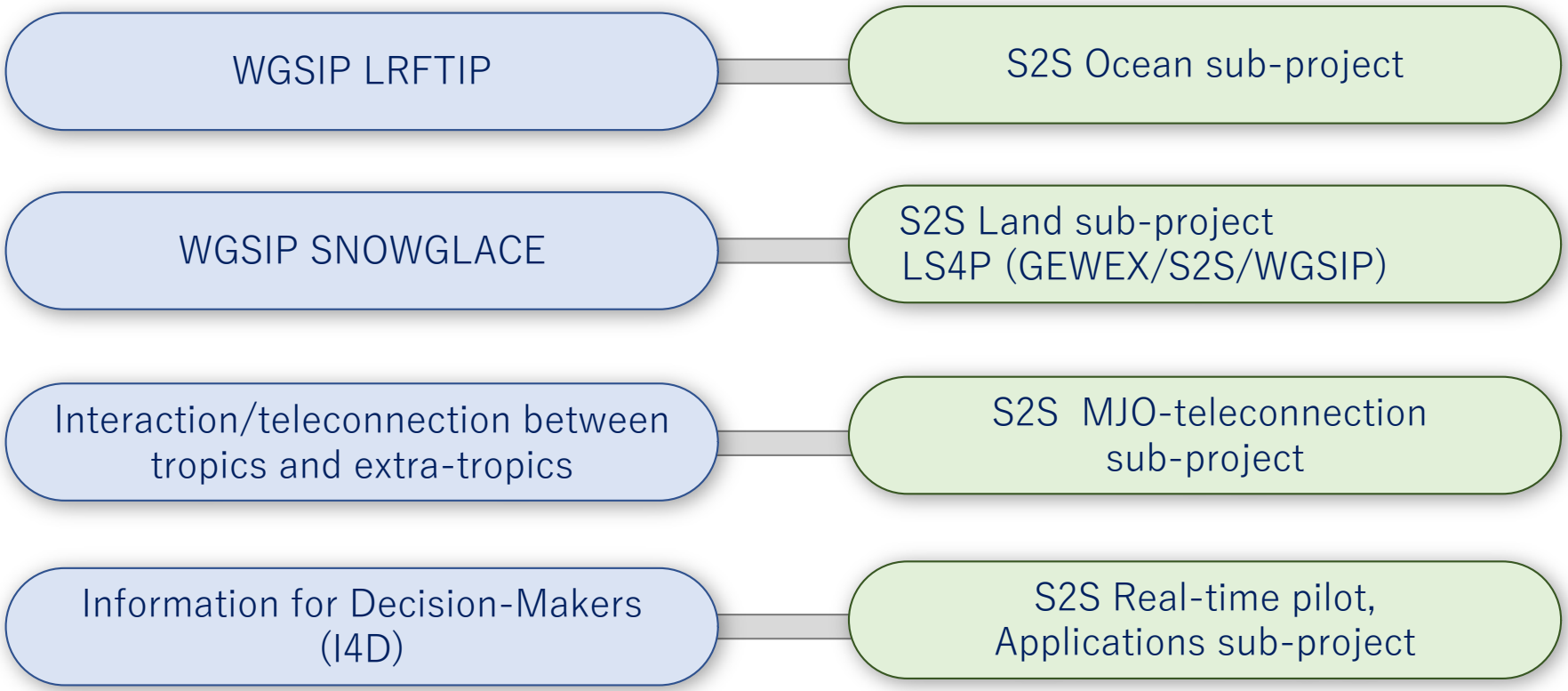
Coordinated experiments:

- Evaluating the Impact of Aerosols on NWP and Subseasonal Prediction (WGNE-S2S-GAW Coordinated experiment)
- Coordinated experiment to better understand stratosphere-troposphere interaction in NWP and climate models (Collaboration with SPARC/SNAP)
- Ocean observing system experiments to better understand the impact of ocean observations on sub-seasonal forecasts

Community papers:

- Sudden stratospheric warming prediction and impact on the troposphere (2 papers, Domeisen et al, 2020)
- Diagnosing MJO teleconnections in S2S models (Stan et al. 2021, submitted to BAMS).
- S2S ocean forecasting (DeMott et al., submitted to EOS)

Connections between WGSIP and S2S

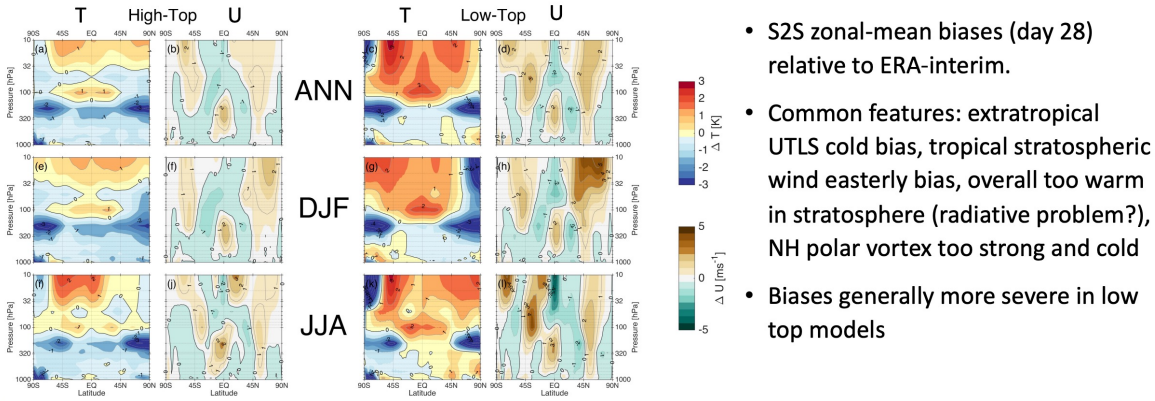


Stratosphere sub-project

(Led by D. Domeisen - Link with SPARC/SNAP)

1. Stratosphere-troposphere biases in S2S models

• Activity led by Zachary Lawrence (NOAA/CIRES) to quantify stratospheric biases in the S2S models and their relationship to skill.
• Current status: two papers in prep; analysis for paper #1 completed, paper draft underway.



- S2S zonal-mean biases (day 28) relative to ERA-interim.
- Common features: extratropical UTLS cold bias, tropical stratospheric wind easterly bias, overall too warm in stratosphere (radiative problem?), NH polar vortex too strong and cold
- Biases generally more severe in low top models

2. Stratospheric nudging and predictable surface impacts (SNAPSI)

• Activity led by Peter Hitchcock (NOAA/CIRES) for investigating the role of the polar stratosphere in sub-seasonal forecasts using nudging experiments. The basic experimental design proposes to focus on the evolution of several specific events as case studies. Experimental protocol to be submitted to GMD – 10 modelling centres are participating

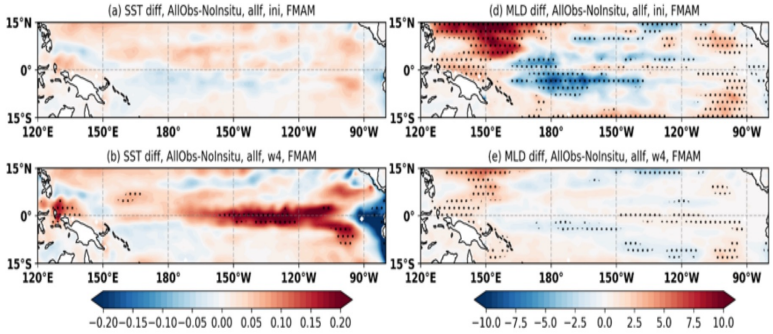
Ocean sub-project (Led by C. DeMott)

1. Tropical Pacific OSEs

Magdelena Balmaseda
Frederic Vitart
Beena Balan Sarojini
(ECMWF)

Aneesh Subramanian
Kris Karnauskas
Ho-Hsuan Wei
(CU Boulder)

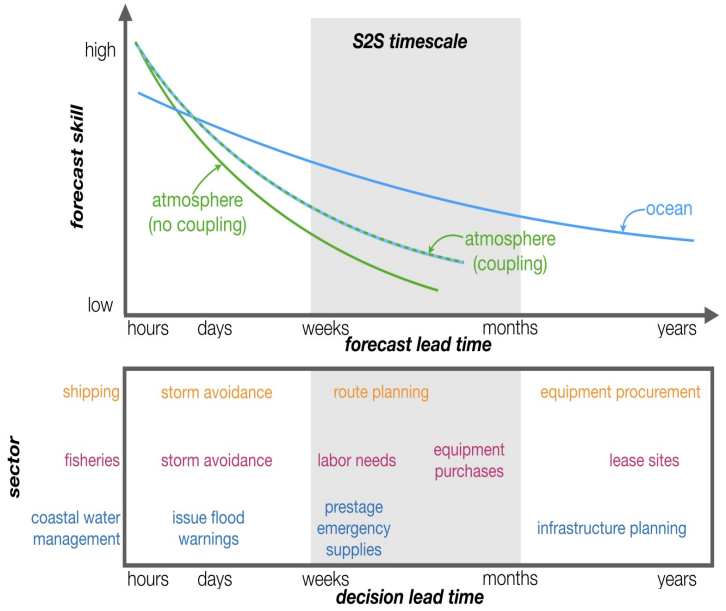
Charlotte DeMott
(CSU)



take home message:
AllObs vs NoInSitu improves SST forecast skill but not MLD forecast skill

2. Promoting S2S ocean output

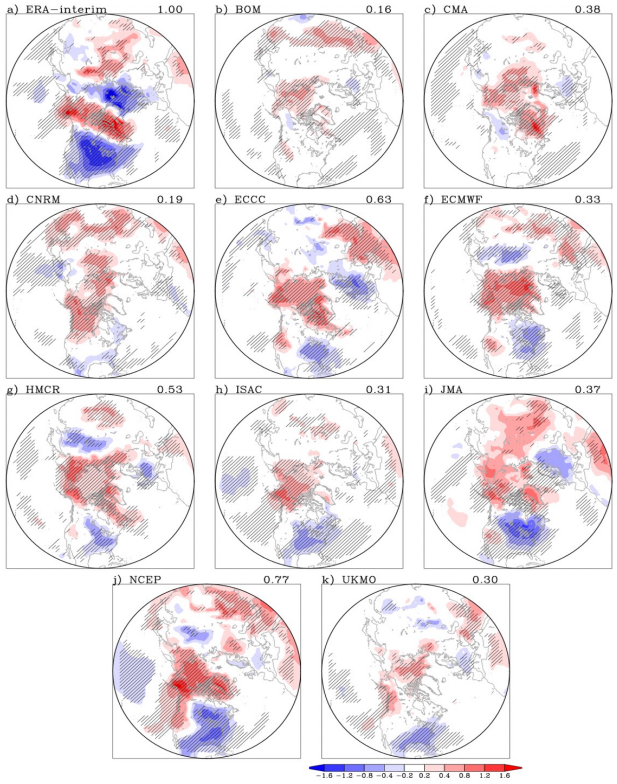
- Eos article: *The Benefits of Ocean Weather Forecasting*
  - DeMott, Muñoz, Roberts, Spillman, Vitart
  - a "climate services" approach to motivating analysis of S2S output



MJO-teleconnection sub-project (Led by C. Stan)

Community paper on MJO teleconnection diagnostics applied to S2S models (Stan et al., submitted to BAMS)

Most of the diagnostics are process-based.



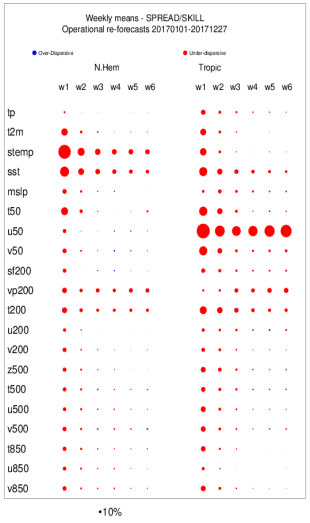
Composite of 2mtm anomalies following an MJO in phase 6-7

Ensemble sub-project (Led by Y. Takaya)

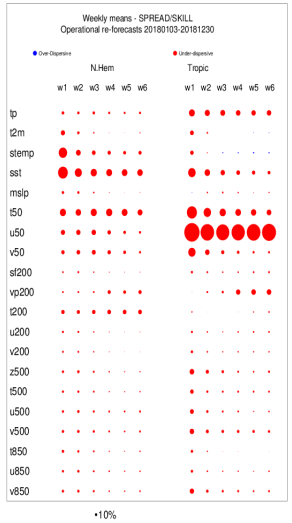
Benchmarking a spread-error relationship

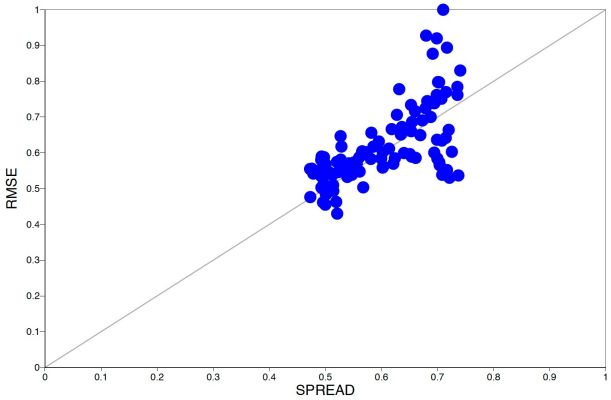
Can we forecast the forecast skill from the S2S ensemble prediction?
→ Yes, to some extent (in ECMWF model).

Reforecasts produced in 2018
Verification against ERA interim



Reforecasts produced in 2018
Verification against ERA5





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→ Yes, to some extent (in ECMWF model).

Opportunities going forward: S2S-related events

- **S2S AI/ML Challenge** (Aaron Spring)
  There are 43 registrations, 160 template forks, 57 private template forks, and 5 teams submitted. The submission deadline is 31st October. A conference-style online session with the top four submissions is planned for mid-January 2022, and the prizes will be announced in early February 2022.
- **Workshops**
  S2S session at AGU 2021 – 13-17 Dec 2021
  S2S session at EGU 2022 (3-8 April 2022),
  S2S session at AOGS 2022 (14-19 August 2022),
  Seventh WMO International Workshop on Monsoon (IWM-7) (23-26 March 2022),
  abstract deadline extended to 31 Nov.,
  Real-time Pilot Project Workshop (Q1-2 2022),
  WWRP Symposium 24 Aug – 2 Sept 2022.
- **Training activities**
  IWM-7 training workshop (1-12 November 2021).
  Latin America/Caribbean training in 2022 (TBD),
  S2S-SEA Workshop series (Singapore, TBD),
  NCAR ASP in person training event (?).
  Real-time Pilot Workshop (TBD ?)