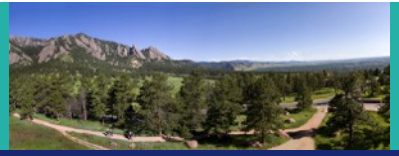
International Conferences on Subseasonal to Decadal Prediction

17 - 21 September 2018 | NCAR, Boulder, CO, USA

WCRP World Climate Research Programme

WWRP WORLD WEATHER RESEARCH PROGRAMME



Overarching Objectives

Fundamental understanding of processes and cycles of the Earth System

Improving Predictions and Quantifying Uncertainties

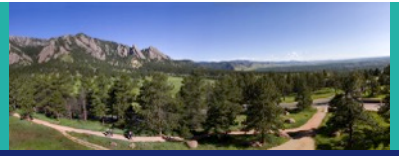
Constraining Projections and Identifying Sensitivities

Connecting Climate Science to Decisions

Bedrock Science (Emphases)

Tools and Capabilities (Imperatives)

Partnerships



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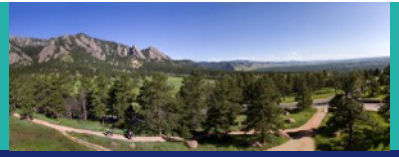
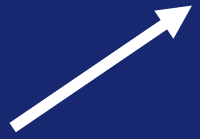
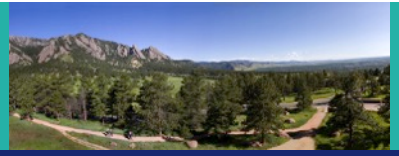




The happy seamless family



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Subseasonal-to-Seasonal S2S Prediction Project

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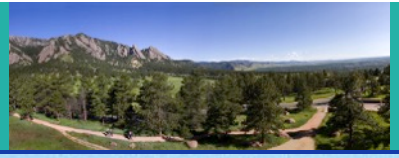

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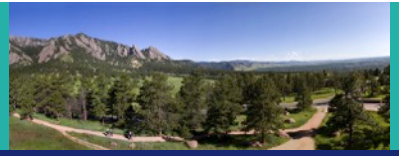
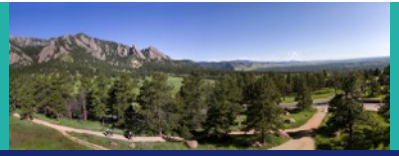


Many thanks to:

- Security, food and beverage staff
- On-site support: Kristan Uhlenbrock, Teresa Foster, Jeff Becker, Dawn Mullaly, Ryan Johnson, Elisabeth Maroon, Tammy Kepple, Kelvin Tavarez, Reed Summers, Bret Batterman, Tyler Scherpenseel, Daphne Van
- Session chairs and rapporteurs
- Organizing Committee: Mike Patterson, Heidi Allen, Melanie Russ, Catherine Michaut
- Executive Committee: Andrew Robertson, Arun Kumar, Caio Coelho, Paco Doblas-Reyes, Bill Merryfield, Doug Smith
- Frederic Vitart (Co-chair of EC)
- Gokhan Danabasoglu (Co-chair of EC and OC)



International Conferences on Subseasonal to Decadal Prediction

Second International Conference on Subseasonal to Seasonal Prediction (S2S) and Second International Conference on Seasonal to Decadal Prediction (S2D)

Daily news

Day 1: Over 300 scientists gather to discuss subseasonal to decadal weather and climate predictions

Boulder, CO – Walter Orr, the first president of the University Corporation for Atmospheric Research (UCAR) and the founder of the National Center for Atmospheric Research (NCAR), was known for saying science in support of society

WCRP World Climate Research Programme

WWRP World Weather Research Programme

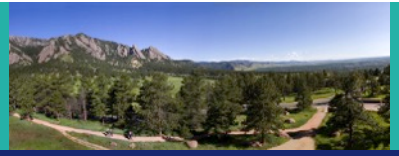
Daily News

Day 2: A look at modeling and forecast challenges and advancementsDay 2: A look at modeling and forecast challenges and advancements

For the second day of meetings, participants learned about modeling issues, ensemble predictions, and forecast information available from the subseasonal to decadal timescales. The concurrent sessions continued for both the S2S and S2D topics; below are some highlights.

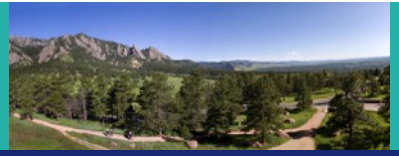
Read more

Day 1: Over 300 scientists gather to discuss subseasonal to decadal weather and climate predictions



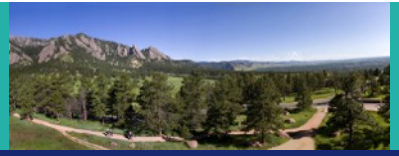
Objectives of the Conferences

- Bring together scientists, producers, and users who are at the forefront of S2S and S2D prediction and related research, development, and application areas to foster the exchange of information and knowledge between the communities towards more seamless subseasonal to decadal predictions;
- Highlight the current level of progress and accomplishments in S2S and S2D predictions;
- Identify challenges for transitioning S2S and S2D prediction research efforts into operations;
- Review current abilities to make skillful predictions on timescales of interest;
- Identify new initiatives, collaborations, and emerging science questions



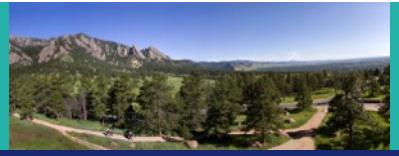
Expected Outcomes

- A key outcome of the conference is the interaction and information exchange that it will facilitate both within the respective S2S and S2D communities and, importantly, across these two communities;
- It will foster inclusion and integration in the S2S and S2D communities of researchers from developing countries as well as of early career scientists;
- A specific goal is to publish an article, summarizing major outcomes, accomplishments, challenges, and future directions with further details provided in a meeting report issued by WCRP.



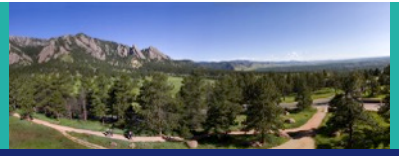
The S2S and S2D communities share very similar, if not identical, scientific and technical challenges. These common challenges include:

- forecast initialization and ensemble generation
- initialization shock and drift
- understanding the onset of model systematic errors
- bias correction, calibration, and skill assessment
- model resolution
- atmosphere-ocean coupling
- linking research, operations, and users



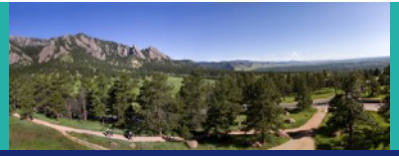
Session summaries:
A1 – Mechanisms of S2S predictability

- **Sub-seasonal forecast skill** of many extra-tropical phenomena has a dependency on the amplitude and/or phase of the MJO.
- **Good representation of the basic state** is required for teleconnections between the MJO and North Atlantic to be correct.
- Increasing evidence of **time scale interactions**: MJO teleconnections modulated by ENSO, QBO/SSW, QBO/tropical convection….
- **The stratosphere** is a valuable source of predictability on S2S timescales. However, models used for S2S forecast still have issues capturing stratosphere processes and stratosphere-troposphere interaction.
- The possible role of **sea ice** as a source of S2S predictability needs more research attention.
- **Oceanic mesoscale eddies** (oceanic weather) affect surface height and boundary layer height. Non-linear impact on humidity/precipitation and storm track.
- **Land surface parameterization** is the sweet spot of S2S prediction



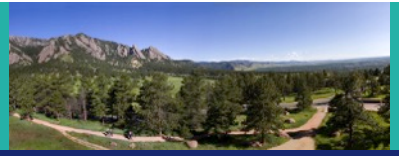
Session summaries:
A2 – Modelling issues in S2D prediction

- Some operational centers are moving towards a unified, coupled forecast system that can work across timescales from days (or shorter) to seasons (or longer)
- **Low-order empirical models** can provide valuable insight into S2S predictability and can be used as benchmarks for operational forecasts.
- **Stochastic physics** can help improve sub-seasonal forecasts
- **Resource tradeoffs** have to be made regarding complexity, resolution, and ensemble size of S2S forecasts. There was some debate about whether high-resolution models are necessary for S2S predictions.
- **Ensemble generation** has not yet been optimized for subseasonal forecasts. MJO sub-seasonal forecasts tend to be strongly under-dispersive.



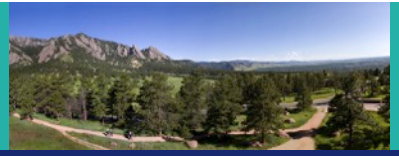
Session summaries:
A3 – S2S ensemble predictions and forecast information

- **Forecast verification, calibration**: Approaches used to calibrate seasonal forecasts (CCA, BJP) are being tested on subseasonal forecasts using models in the S2S and SubX databases. For S2S verification/calibration there are tradeoffs in using hindcasts for particular target weeks versus pooling over a season.
- **Multimodel ensembling** is shown to have higher skills than individual models.
- **Weather regime analysis and teleconnection patterns** provide a bridge between large-scale sources of predictability and impacts such as surface temperatures, heat/cold waves, and atmospheric rivers.



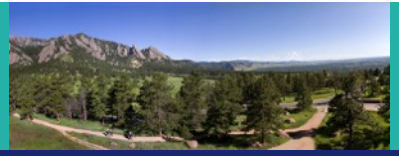
Session summaries:
A4 – S2S forecasts for decision making

- ***User needs:*** Co-production with applications/sector scientists/stakeholders and users underlined as critical to demonstrate value in specific sectorial settings. This includes forecast statistical post-processing to link to user-relevant variables such as streamflow.
- **Applications of real-time S2S forecasts** are being developed separately in different sectors: the S2S4E project in the energy sector, the quasi-operational excessive heat outlook system in the health sector, and the S2S hydrologic prediction in the water management sectors.
- **S2S forecasts in real time** are needed, but not provided by S2S database.
- **Applicability of S2S forecasts** depends on prediction skill, which strongly depends on the target-user variable. Further case studies and evaluation are needed from the applications context.



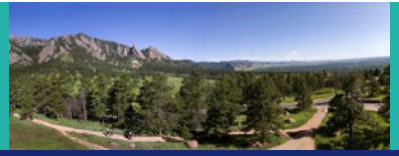
S2D Summary / Outcomes

- S/N paradox seen in many aspects of predictions, widespread on decadal time scales. However nature of model deficiencies still elusive: for NAO, too weak teleconnection signals, too short synoptic regime persistence, or? But also seen in European summer and multi-year Sahel rainfall → multiple causes?
- Reasons to be optimistic about decadal prediction skill:
  - large ensembles → encouraging additional signs of skill, including for rainfall over land
  - skill is useful to users, regardless of whether from forcing or internal variability
  - previous approaches to assess impacts of initialization have been sub-optimal
  - new approaches (verifying differences from forced evolution , random walk approach) more powerful → clearer skill improvements including for rainfall, circulation
  - long-range skill (e.g. for 2-year La Niña) most evident when predicting from existing climate anomaly (El Niño, N Atl sub-polar gyre); harder to predict onset in N Atl



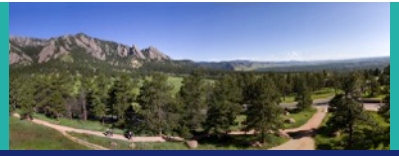
S2D Summary / Outcomes

- Still challenging to detect clear role of multi-annual to multi-decadal internal variability, although new evidence of multi-decadal internal variability source in Southern Ocean could explain recent circum-Antarctic cooling and sea ice increase
- Improved understanding of teleconnections (ENSO, AMO, CGT)
- Improved understanding of model errors/biases/shocks, + approaches for reducing them (flux correction, supermodel, statistical/dynamical, EDF, mode initialisation, calibration, vegetation, soil)
- Other aspects of Earth system including land variables, extremes, wildfire, sea ice, ocean BGC are increasingly being assessed and appear to be skillful, although verification can be issue
- Increasing attention to addressing needs of users in fisheries, water resources…



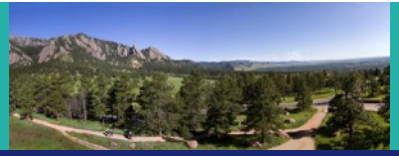
S2D Summary / Outcomes

- What is (are) the cause(s) of the S/N paradox?
- How can we use S2D information to improve models, and how should we use our knowledge of existing errors to make the best forecasts?
- What are the roles of internal variability and external forcing, and how will they change in future?
- How can we provide maximum benefit to society? – user engagement, generation of new products, communication of uncertainties, …



Some discussion topics towards a way forward:

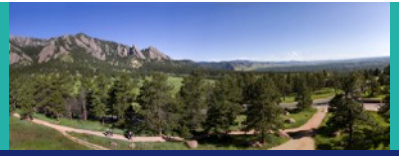
- Adverse impacts of persistent model biases on predictability / prediction skill
- Much more work needed in process understanding
- Mixed messages on prediction skill with high-resolution modeling efforts
- Improved skill with land initialization
- For most applications, an ensemble size of > 10 is needed



- The 2nd Operational Climate Prediction (OCP-2) workshop was held in May 2018 in Barcelona.

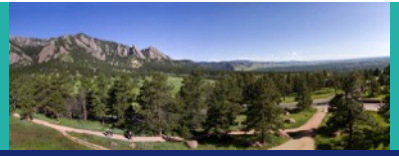
- An outcome of the OCP-2 is to develop a position paper that highlights the research needs from operations, particularly, research for the development of

  - Operational prediction systems,
  - Product development and communication of forecasts, and
  - Verification strategies for forecasts.



The proposed paper from OCP-2 can

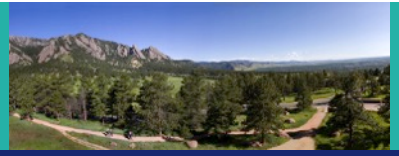
- Either be combined with the outstanding research issues from the S2D conference, or
- Could be part of a set of two complementary papers – one on the outcome of OCP-2 on research requirements from the perspective of advancing extended-range operational forecasts and the other as the outstanding research issues from the S2D conference.
- A journal like BAMS would be the preferred venue.



Examples of many research issues from operations revolve around having guidance on "what matters" to realize prediction skill, e.g.,

- Ensemble generation techniques,
- Length of hindcast period,
- Requirements in the consistency of initial conditions across hindcasts and forecasts in different components of prediction system,
- Burst vs. lagged ensembles and optimal lagged ensemble,
- Quantifying routine assessments of current state of prediction systems and their evolution.

Such guidance is critically needed to nudge operational centers to adopt relatively uniform forecast configuration practices.



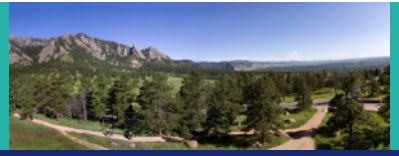
Some S2S/S2D outcomes that could guide operations

(Emphasized in combined paper *or* points of cross-reference in complementary papers)

Ensemble size: the ensemble size above which diminishing returns occur for further improvement of skill can be very large where the predictable signal is weak or unrealistically small in the model ("signal to noise paradox")

- NAO prediction
- CESM Decadal Prediction Large Ensemble: 40 ensemble members → precipitation skill over land

Quantifying routine assessments of current state of prediction systems and their evolution: more sensitive test are available for detecting skill differences between system versions than often are currently applied



Some S2S/S2D outcomes that could guide operations (2)

(Emphasized in combined paper *or* points of cross-reference in complementary papers)

Beyond seasonal or subseasonal mean temperature and precipitation

- models are showing skill in predicting **additional variables** relevant for decision making (snow, sea ice, ocean conditions including biogeochemistry…), and extremes (hurricane activity, extreme deciles…) although statistical forecasts still can be hard to beat
- **co-design** is key to developing tailored forecast information relevant to decision making by forecast users
- increasing demand is likely for **daily data** from seasonal forecasts (sector-specific tailored products, sea ice advance & retreat dates, …)