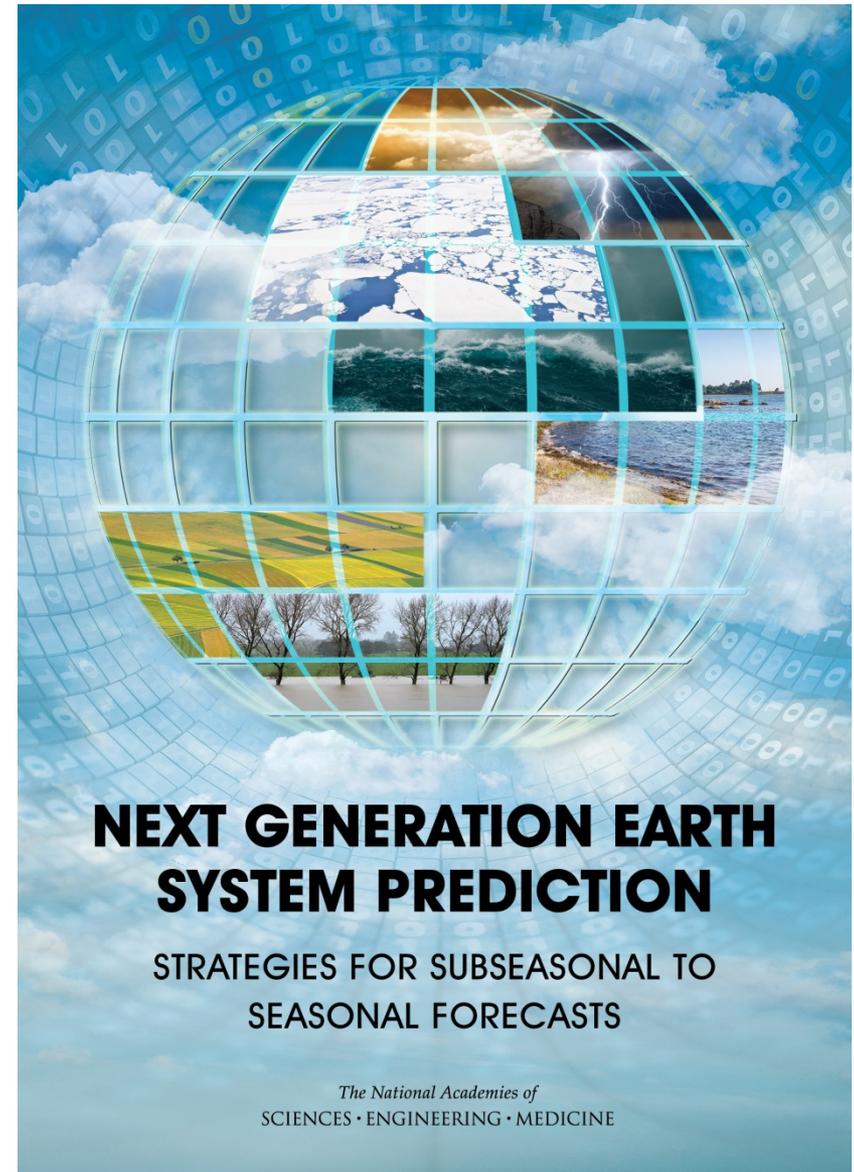


# Next Generation Earth System Prediction: Strategies for Subseasonal to Seasonal Forecasts

Presented by  
Duane Waliser  
JPL/Caltech/NASA

**On Behalf of the S2S  
Study Committee**



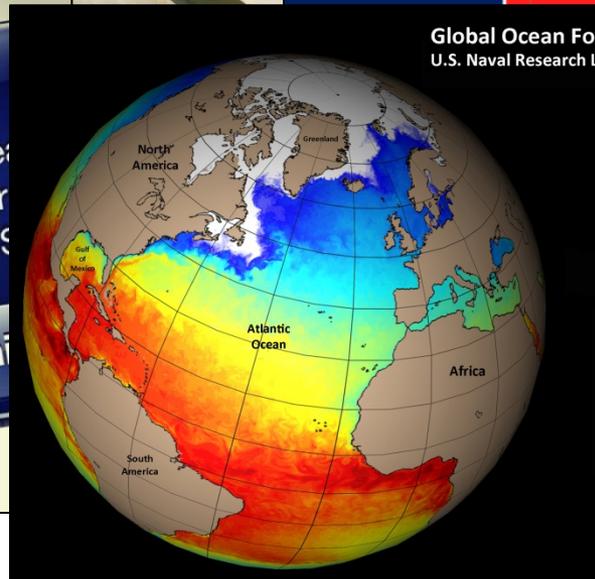
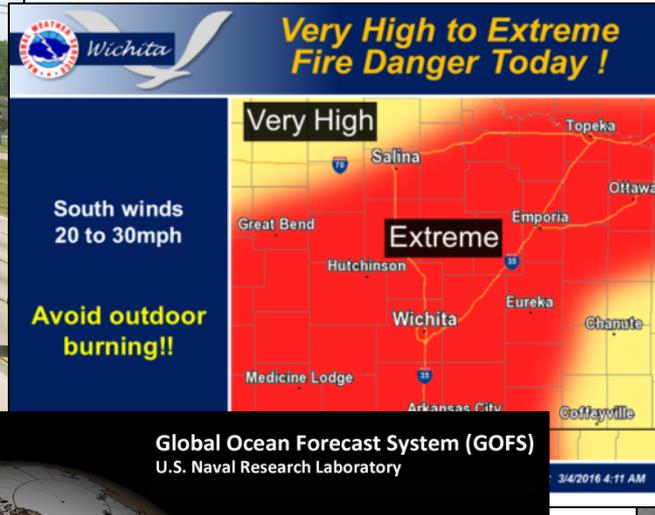
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# Weather, Water, and Climate Forecasts are Vital to Decision Making

Businesses

Governments

Individuals



# Forecast Timescales

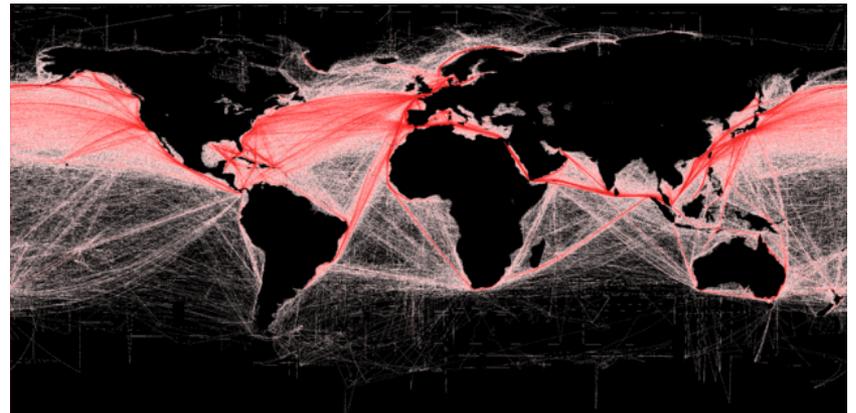
- Weather 0-14 Days
- **Subseasonal 2-12 Weeks**
- **Seasonal 3-12 Months**
- Interannual 1 year - Decade
- Climate Decades - Centuries



**Subseasonal  
to Seasonal  
(S2S)  
2 weeks -12  
months**

# What if Longer-Range Forecasts Were More Skillful and Widely Used?

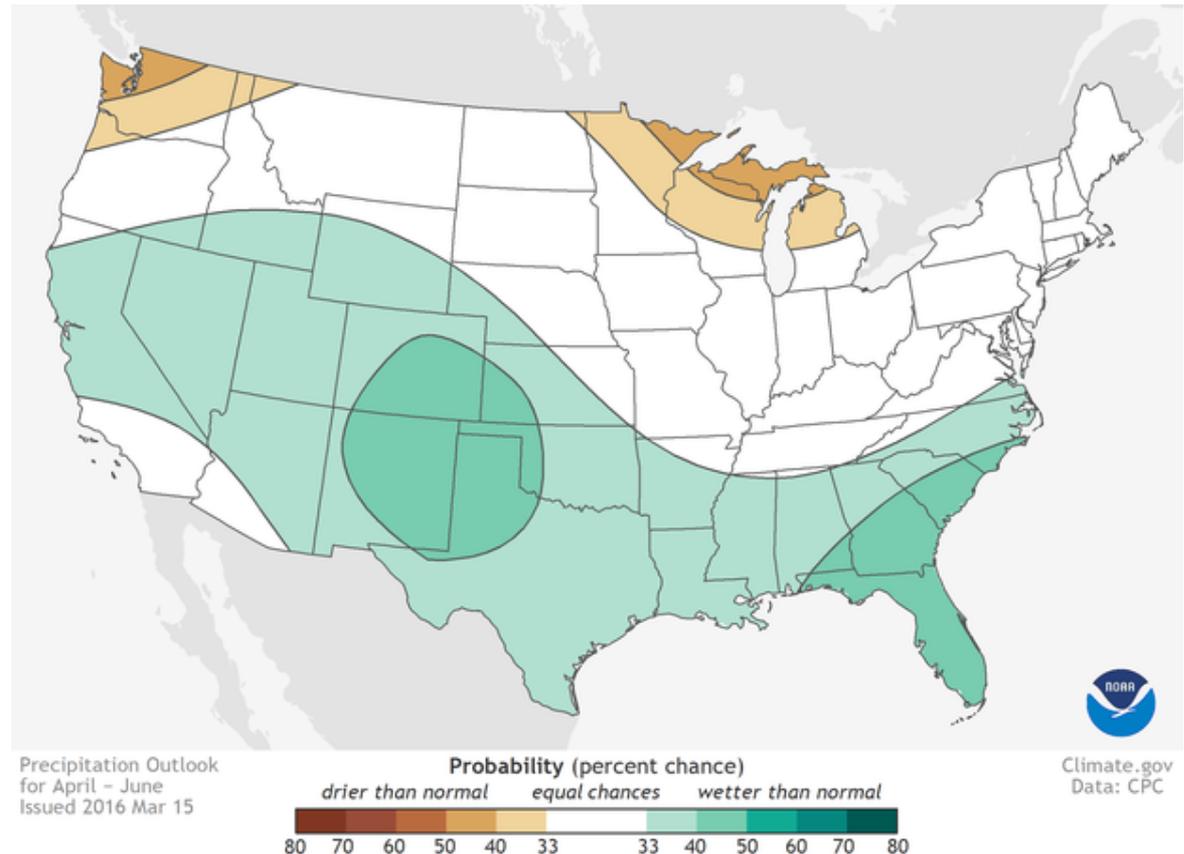
- Many decisions must be made in the space between weather forecasts and climate projections
- Improving S2S forecasts would benefit many sectors of society
- Will improve planning and preparation to help save lives, protect property, increase economic vitality



# Current State of S2S Forecasting

S2S forecasts are increasingly used in agriculture, energy, and water resource management—but more engagement with users in other sectors will increase use

Precipitation Outlook for April–June 2016  
Issued March 15, 2016



# Current State of S2S Forecasting

Scientific knowledge gap, gaps in observations and modeling, and limited computational capacity currently limit accuracy of S2S forecasts

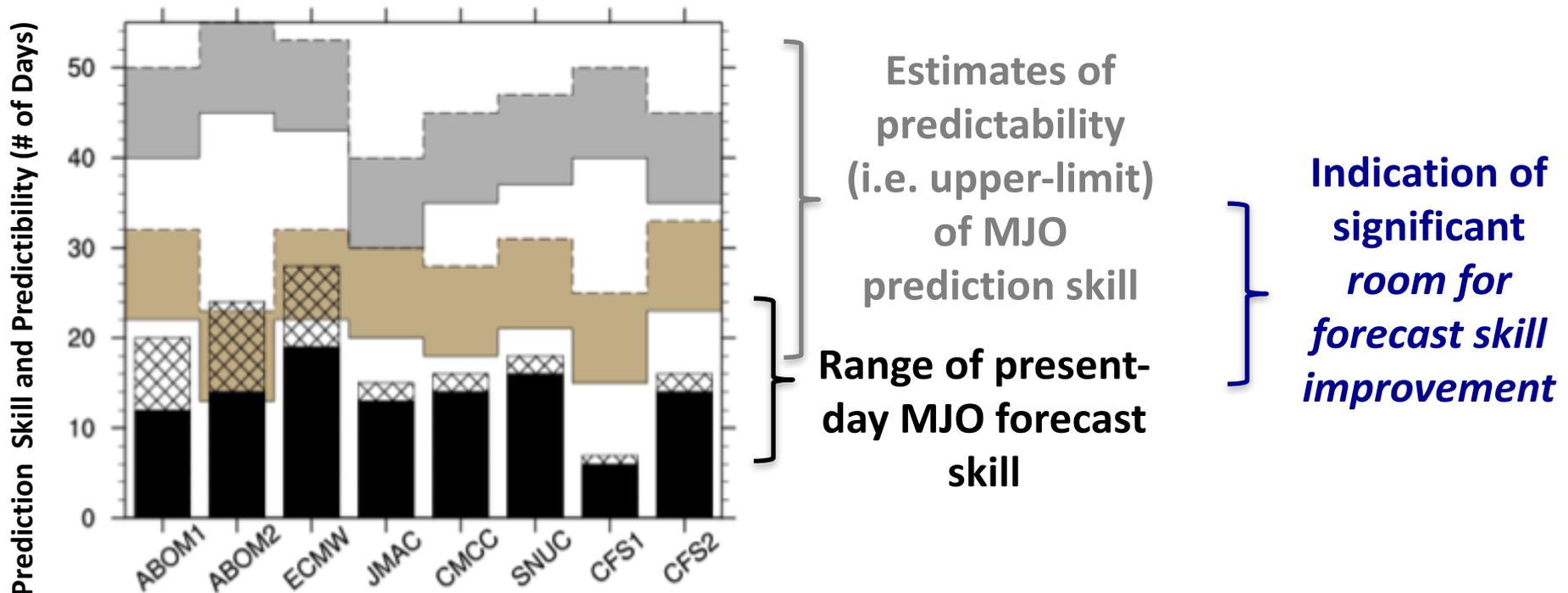


Figure 4.2

Neena et al., *J. Climate*, 2014

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# Why This Study?

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- Sponsored by Office of Naval Research, Heising-Simons Foundation, NASA, and NAS Arthur L. Day Fund

## Task:

- To describe a strategy to increase the nation's capacity for S2S forecasting
- To develop a 10 year scientific research agenda to accelerate progress

# Committee Roster

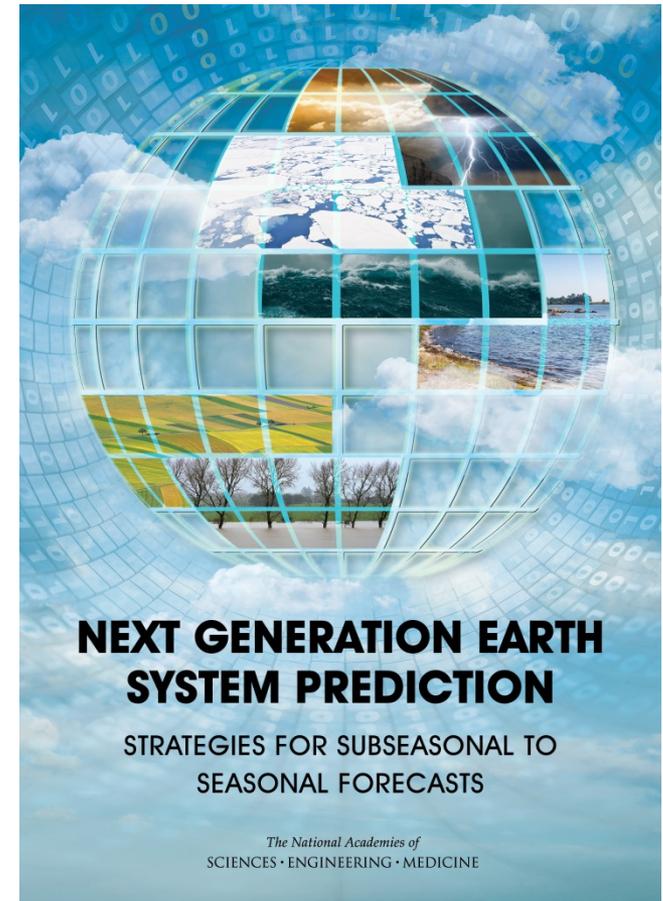
- **Raymond J. Ban (Chair)**, Ban and Associates, LLC
- **Cecilia Bitz**, University of Washington
- **Andy Brown**, UK Met Office
- **Eric Chassignet**, Florida State University
- **John A. Dutton**, Prescient Weather, Ltd.
- **Robert Hallberg**, NOAA Geophysical Fluid Dynamics Laboratory
- **Anke Kamrath**, National Center for Atmospheric Research
- **Daryl Kleist**, University of Maryland, College Park
- **Pierre F.J. Lermusiaux**, Massachusetts Institute of Technology
- **Hai Lin**, Environment Canada
- **Laura Myers**, University of Alabama
- **Julie Pullen**, Stevens Institute of Technology
- **Scott Sandgathe**, University of Washington
- **Mark Shafer**, The University of Oklahoma
- **Duane Waliser**, Jet Propulsion Laboratory
- **Chidong Zhang**, University of Miami

Committee held five in-person meetings, spoke with dozens of researchers and users  
Report reviewed by 12 outside experts

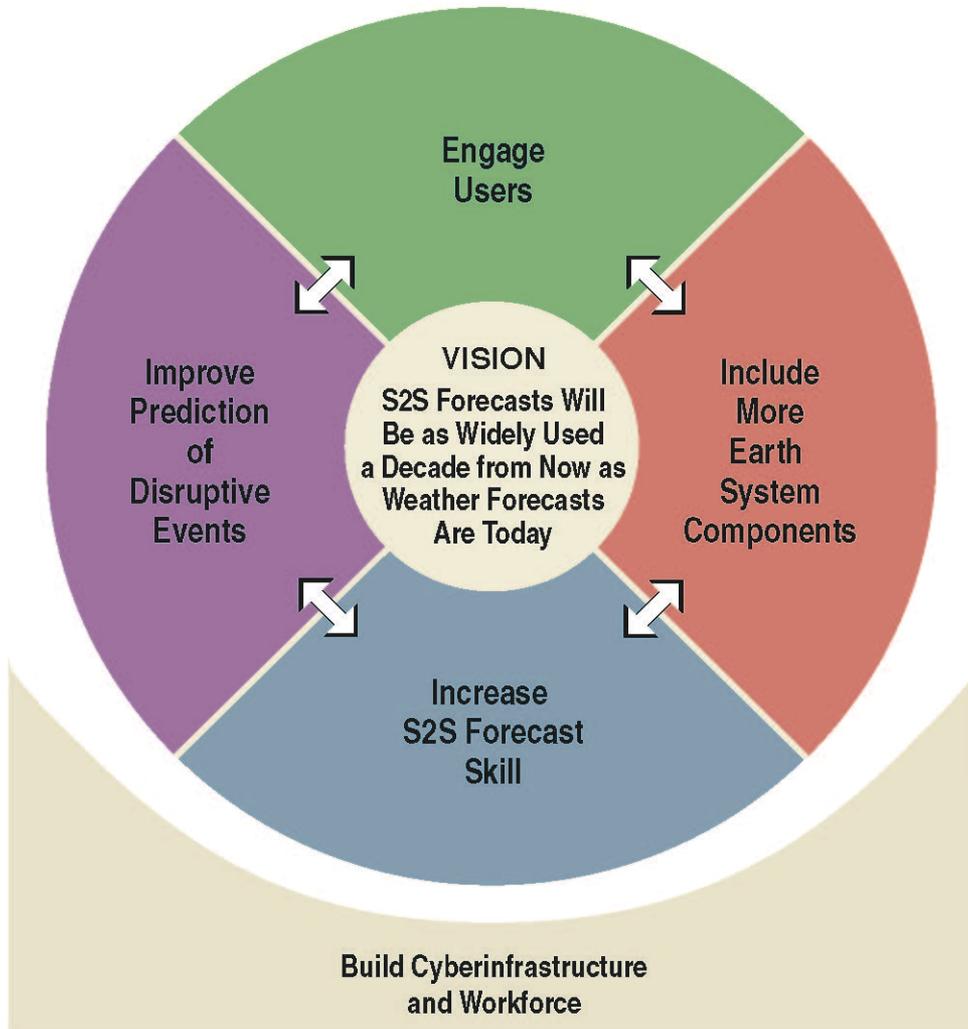
# The Committee's Vision

**S2S forecasts will be as widely used a decade from now as weather forecasts are today**

- Fulfilling this vision will take sustained effort and investment



# Fulfilling the Vision: Research Strategies



1. Engage Users
2. Increase S2S Forecast Skill
3. Improve Prediction of Disruptive Events
4. Include More Earth System Components

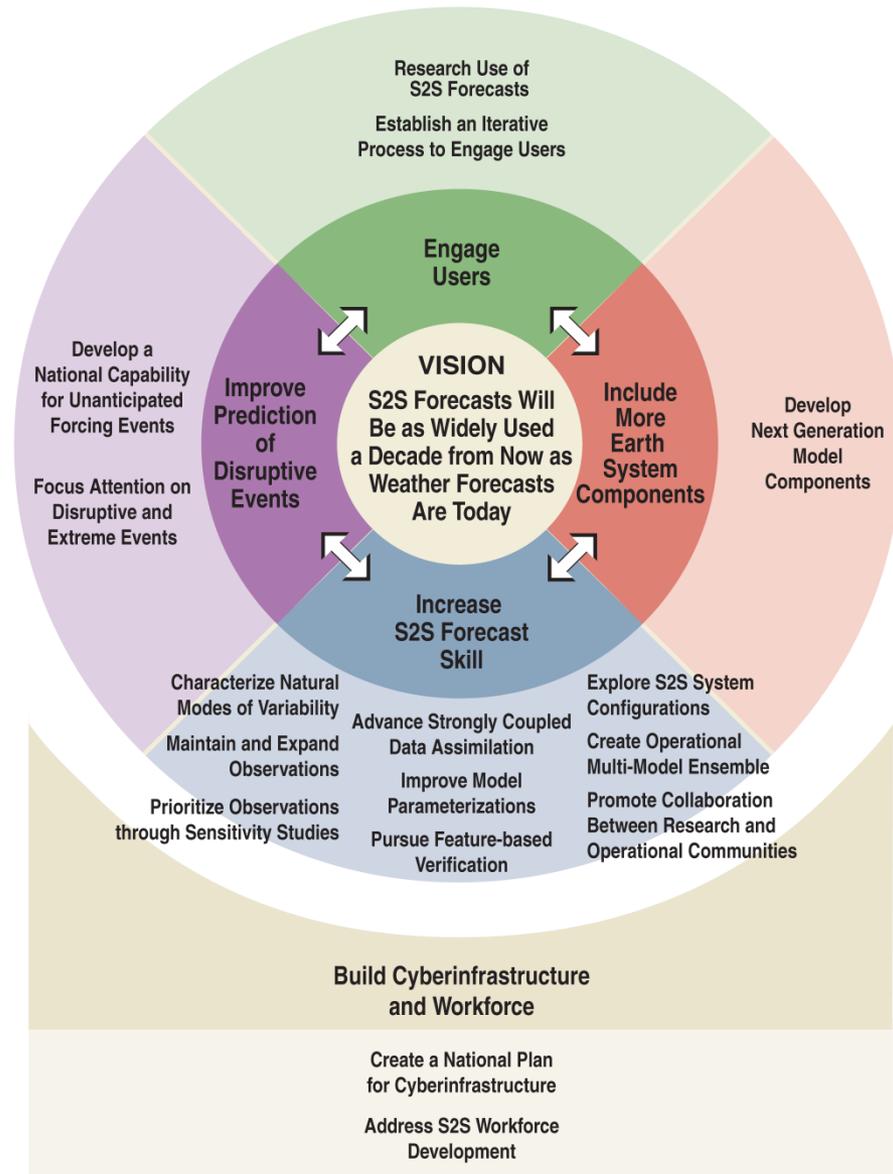
# Example: Recommendation A

- More detailed actions listed under each recommendation
- Tables (S.1 and 8.1) give further guidance

Recommendation	Research Strategies	Basic Research	Applied Research/ Operational	Benefits Likely in the Short Term	May Need New Initiative	International Collab. Critical
<b>Chapter 3</b>						
<b>A: Develop a body of social science research that leads to more comprehensive and systematic understanding of the use and barriers to use of seasonal and subseasonal Earth system predictions.</b>	1, 4	■ — ■		■		
Characterize current and potential users of S2S forecasts and their decision-making contexts, and identify key commonalities and differences in needs (e.g., variables, temporal and spatial scale, lead times, and forecast skill) across multiple sectors.	1, 4		■	■		
Promote social and behavioral science research on the use of probabilistic forecast information.	1	■		■		
Create opportunities to share knowledge and practices among researchers working to improve the use of predictions across weather, subseasonal, and seasonal timescales.	1	■ — ■		■		

# Bringing It All Together

- Vision and research agenda are bold
- **S2S forecasts will be as widely used a decade from now as weather forecasts are today**
- Fulfilling this vision will take sustained effort and investment



# ***The Sub-seasonal to Seasonal (S2S) Prediction Project***

**“Bridging the gap between weather and climate”**

**Co-chairs:  
Frédéric Vitart (ECMWF)  
Andrew Robertson (IRI)**

# Mission Statement

---

- “To improve forecast skill and understanding on the sub-seasonal to seasonal timescale with special emphasis on high-impact weather events”
- “To promote the initiative’s uptake by operational centres and exploitation by the applications community”
- “To capitalize on the expertise of the weather and climate research communities to address issues of importance to the Global Framework for Climate Services”

One of 3 Post-THORPEX Projects: S2S, HiW, PPP

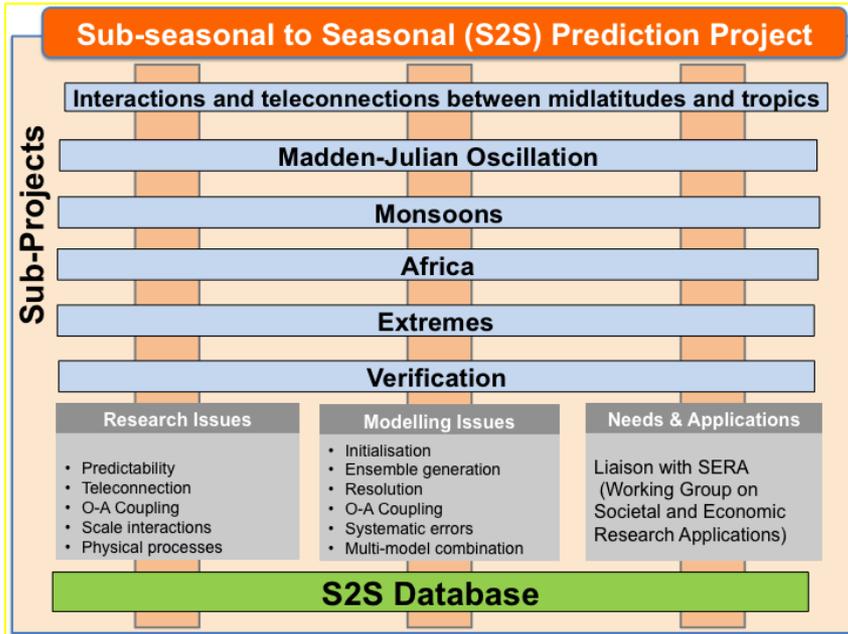
# Subseasonal Forecast Database

WCRP-WWRP S2S Project

S2sprediction.net



## International Program for S2S Research



## S2S Database

	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
<b>ECMWF</b>	D 0-46	T639/319L91	51	2/week	On the fly	Past 20y	2/weekly	11
<b>UKMO</b>	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
<b>NCEP</b>	D 0-44	N126L64	4	4/daily	Fix	1999-2010	4/daily	1
<b>EC</b>	D 0-32	0.6x0.6L40	21	weekly	On the fly	1995-2014	weekly	4
<b>CAWCR</b>	D 0-60	T47L17	33	weekly	Fix	1981-2013	6/month	33
<b>JMA</b>	D 0-34	T319L60	25	2/weekly	Fix	1981-2010	3/month	5
<b>KMA</b>	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
<b>CMA</b>	D 0-45	T106L40	4	daily	Fix	1886-2014	daily	4
<b>CNRM</b>	D 0-32	T255L91	51	Weekly	Fix	1993-2014	2/monthly	15
<b>CNR-ISAC</b>	D 0-32	0.75x0.56 L54	40	weekly	Fix	1981-2010	6/month	1
<b>HMCR</b>	D 0-63	1.1x1.4 L28	20	weekly	Fix	1981-2010	weekly	10



# S2S Project Website



Subseasonal-to-Seasonal  
**S2S**  
Prediction Project

About S2S ▾ News ▾ Documents ▾ Sub-projects Database ▾ Products ▾ Meetings ▾ People ▾ Links Site Map

## THE SUBSEASONAL TO SEASONAL (S2S) PREDICTION PROJECT DATABASE

F. VITART, C. ARDILOUZE, A. BONET, A. BROOKSHAW, M. CHEN, C. CODOREAN, M. DÉQUÉ, L. FERRANTI, E. FUCILE, M. FUENTES, H. HENDON, J. HODGSON, H.-S. KANG, A. KUMAR, H. LIN, G. LIU, X. LIU, P. MALGUZZI, I. MALLAS, M. MANOUSSAKIS, D. MASTRANGELO, C. MACLACHLAN, P. MCLEAN, A. MINAMI, R. MLADEK, T. NAKAZAWA, S. NAJM, Y. NIE, M. RIXEN, A. W. ROBERTSON, P. RUTI, C. SUN, Y. TAKAYA, M. TOLSTYKH, F. VENUTI, D. WALISER, S. WOOLNOUGH, T. WU, D.-J. WON, H. XIAO, R. ZARIPOV, AND L. ZHANG

A database containing subseasonal to seasonal forecasts from 11 operational centers is available to the research community and will help advance our understanding of predictability at the subseasonal to seasonal time range.

### Sub-projects' Wiki

- Wiki page for Teleconnections**  
(Contact : [Hai Lin](#))
- Wiki page for Madden-Julian Oscillation (MJO)**  
(Contact : [Duane Waliser](#))
- Wiki page for Monsoons**  
(Contact : [Harry Hendon](#))
- Wiki page for Africa**  
(Contact : [Richard Graham](#))
- Wiki page for Extremes**  
(Contact : [Frederic Vitart](#))
- Wiki page for Verification and Products**  
(Contact : [Caio Coelho](#))

S2S News   Upcoming Events   News Letter   FAQs

### Regional S2S Activity: A New Spanish-language web portal "Portal Experimental MONITOREO Y PRONOSTICO DEL CLIMA"

This Spanish-language web portal is developed in collaboration with CLIMAR (<http://www.cima.fcen.uba.ar/climar.php>) and CLIMAX (<http://www.climax-sa.org/>) at CIMA. It includes weekly CFSv2 sub seasonal forecasts in real time as well as circulation diagnostics for southern South America.

The purpose of the portal is to accelerate the knowledge of the personnel of Meteorological Service as well as of agencies in southern South America related with water and other sectors, such as agriculture, about the climate characteristics at subseasonal scales and the interpretation, and the use of tools for monitoring and prediction. More details can be found at

### S2S Database

ECMWF   CMA

- The result of "S2S User Survey 2017"**  
Updated: 2017-05-25 05:27
- Charts of S2S Products/Indices are now available**  
Updated: 2016-09-22 00:41
- S2S Database Paper will come soon on BAMS**  
Updated: 2016-08-28 17:25
- Now 9 centres S2S data available!**  
Updated: 2016-01-13 22:16
- CMA S2S Data Portal is Open!**

## Mission

The main goal of the proposed WWRP/THORPEX/ WCRP joint research project is to improve forecast skill and understanding on the subseasonal to seasonal timescale, and promote its uptake by operational centres and exploitation by the applications community. Specific attention will be paid to the risk of extreme weather, including tropical cyclones, droughts, floods, heat waves and the waxing and waning of monsoon precipitation. Work will be guided by a steering group that will work in conjunction with appropriate WMO bodies and other relevant structures.

## Reports & Publications

- Spanish version of the S2S project overview
- Applications of S2S Forecasts: From Disaster Early Warning to Early Action
- Report on subseasonal MME in LC-LRFMME
- (Early Release) The Sub-seasonal to Seasonal Prediction (S2S) Project Database
- WMO Publication, 2015: Seamless Prediction of the Earth System: from minutes to months
- Andrew W. Robertson, Arun Kumar, Malaquias Pena, and Frederic Vitart, 2015: Improving and Promoting Subseasonal to Seasonal Prediction. BAMS, 96, ES49-ES53.

# Program Status

- Initial 5 year period ends fall of 2018
- Recently conducted a user survey of how to expand/improve products, objectives, etc.
- Proposal for 2<sup>nd</sup> 5 year period being developed now.
  
- Note