

# WWRP/WCRP

## The sub-seasonal to seasonal (S2S) Prediction Project

Co-chairs: Frédéric Vitart and Andrew Robertson

Presented by Caio Coelho

at the

NOAA-USAID 11<sup>th</sup> International Training Workshop

Climate Variability and Predictions (11ITWCVP),

Second Symposium on the Variability and

Predictability of the Global Climate System,

Ankara, Turkey, *15 – 22 April, 2019*



WMO OMM

World Meteorological Organization

Organisation météorologique mondiale

# S2S project: A large community effort

## Steering Group

### • Co-chairs

- Frederic Vitart, ECMWF, UK  
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- Andrew Robertson, IRI, USA  
e-mail: [awr@iri.columbia.edu](mailto:awr@iri.columbia.edu)

### • Members

- Harry Hendon, CAWCR, Australia  
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### • Ex-Officio Members

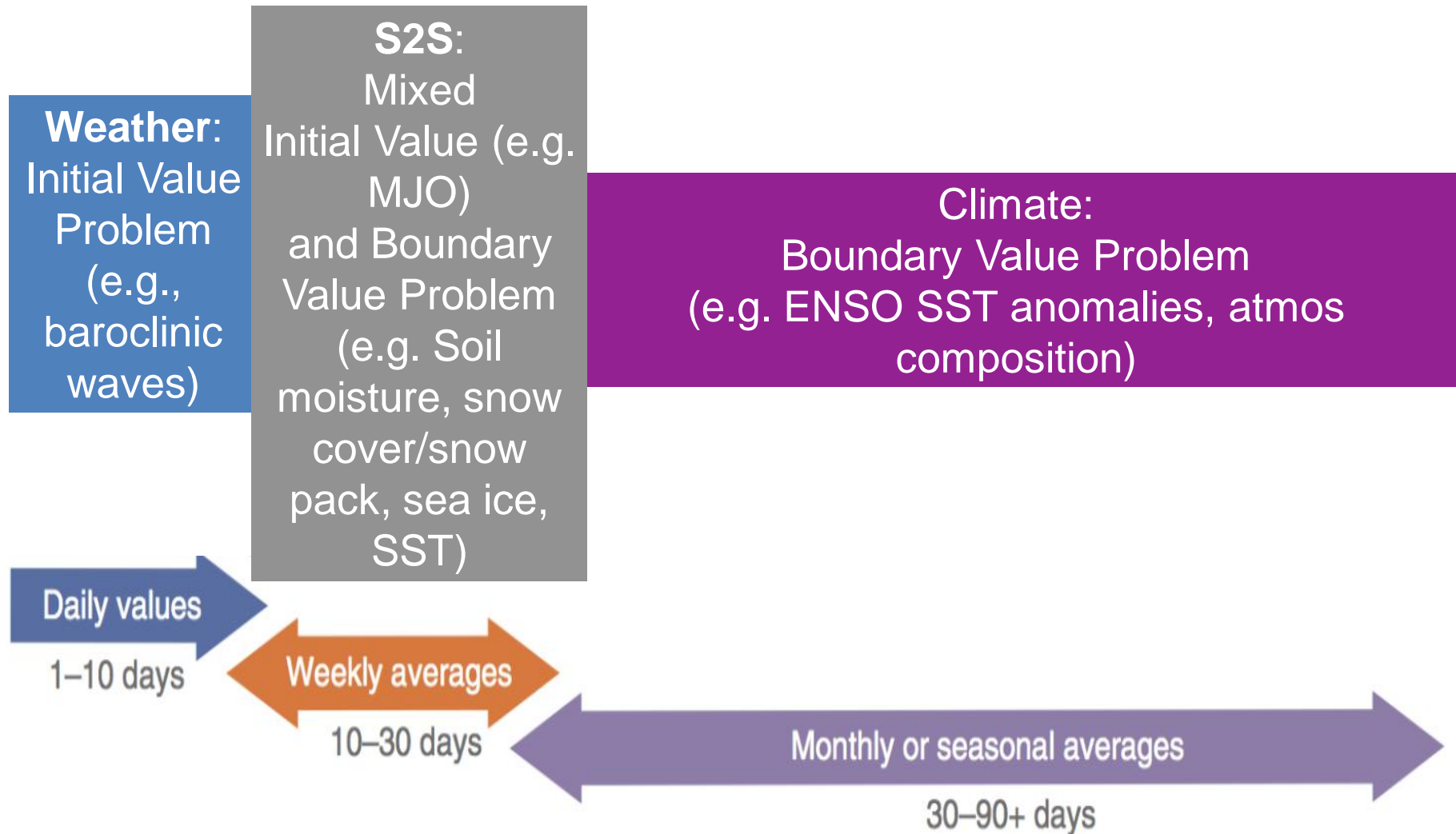
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- Paolo Ruti, WMO, WWRP  
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- Michel Rixen, WMO, WCRP  
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## Liaison Group

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- In-Sik Kang, SNU, WCRP Joint Scientific Committee (JSC), Korea  
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- Caio Coelho, CPTEC, Joint Working Group on Forecast Verification Research (JWGFVR), Brazil  
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The role of the Liaison Group is to ensure a good interaction and collaboration between the Steering Group and other Working Groups and activities.

# S2S: A mixed predictability problem

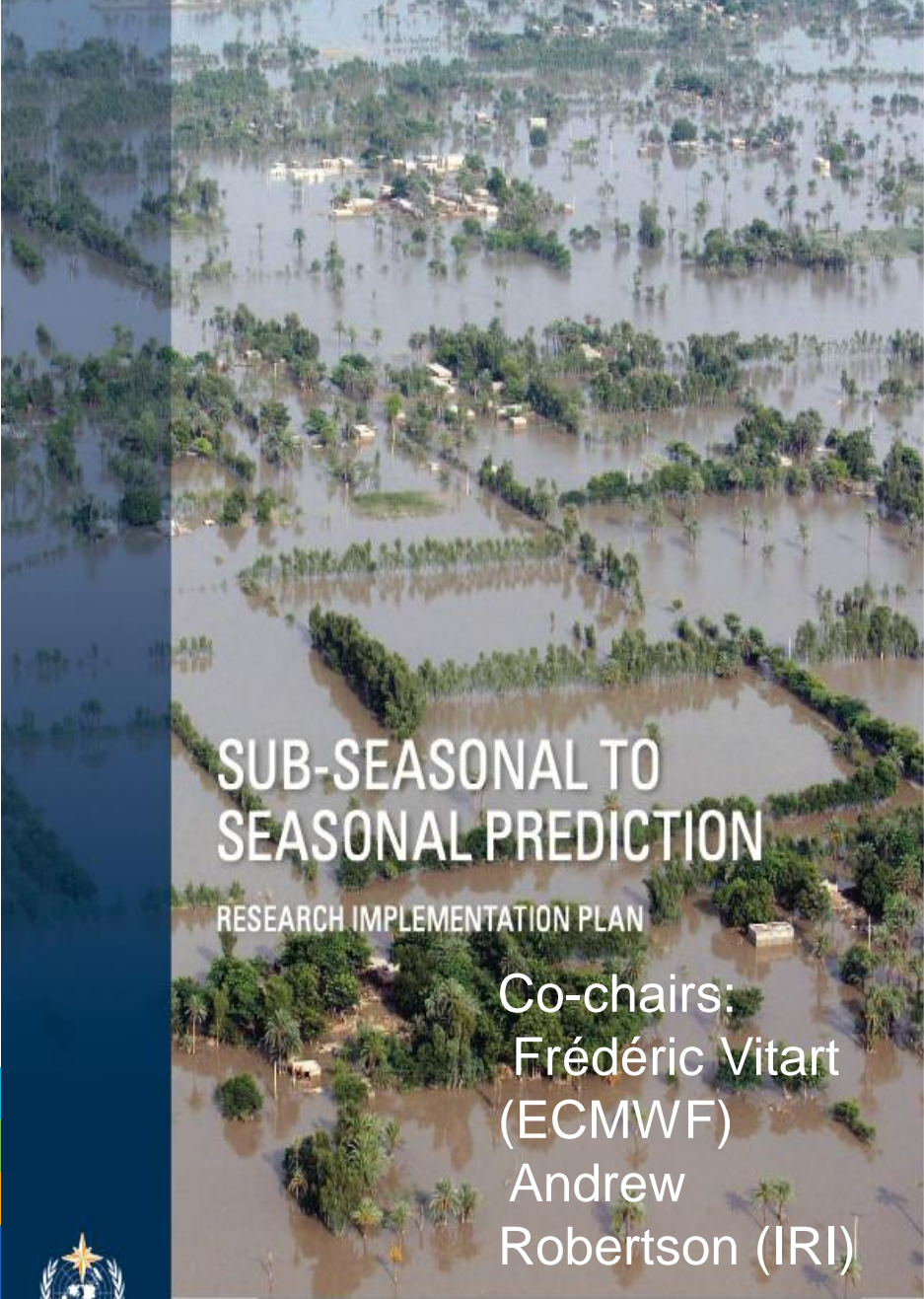


## TIME AVERAGING

Predictability of the Second Kind (Lorenz, 1975)







# SUB-SEASONAL TO SEASONAL PREDICTION

RESEARCH IMPLEMENTATION PLAN

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



## Goals:

- Improve forecast skill and understanding on the sub-seasonal to seasonal timescale with special emphasis on high-impact weather events
- Promote the initiative's uptake by operational centres and exploitation by the applications community
- Capitalize on the expertise of the weather and climate research communities to address issues of importance to the Global Framework for Climate Services

*The S2S Database, hosted by ECMWF and CMA, went online in May 2015.*

*International Coordination Office (ICO) hosted by KMA.*

*Trust fund: Contributions from Australia, Canada, UK and Germany*

*The project focuses on the forecast range between 2 weeks and a season.*



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

Sub-Projects

**Teleconnections** (*C. Stan and H. Lin*)

**Madden-Julian Oscillation** (*D. Waliser and S. Woolnough*)

**Monsoons** (*H. Hendon*)

**Africa** (*A. Robertson and R. Graham*)

**Extremes** (*F. Vitart*)

**Verification and Products** (*C. Coelho*)

### Research Issues

- Predictability
- Teleconnection
- O-A Coupling
- Scale interactions
- Physical processes

### Modelling Issues

- Initialisation
- Ensemble generation
- Resolution
- O-A Coupling
- Systematic errors
- Multi-model combination

### Needs & Applications

Liaison with SERA  
(Working Group on Societal  
and Economic Research  
Applications)

**S2S Database**



# Where to find information about the S2S project

The screenshot displays the S2S Prediction Project website. At the top left is the logo for the Subseasonal-to-Seasonal (S2S) Prediction Project. A navigation bar contains the following items: About S2S, News, Documents, Sub-projects, Database, Products, Meetings, People, Links, and Site Map. The main content area features a large image of a document titled "WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S) Phase II Proposal" (November 2018–December 2023), with logos for WWRP, WCRP, and the World Meteorological Organization. To the right of this image is a list of links to Wiki pages for various topics: Teleconnections (Contact: Hai Lin), Madden-Julian Oscillation (MJO) (Contact: Duane Waliser), Monsoons (Contact: Harry Hendon), Africa (Contact: Richard Graham), Extremes (Contact: Frederic Vitart), and Verification and Products (Contact: Caio Coelho). Below the main content are two columns of news. The left column has tabs for "S2S News", "Upcoming Events", "News Letter", and "FAQs". It lists two events: the "16th AOGS Annual Meeting on S2S Forecasts and Applications, 28 Jul – 2 Aug 2019, Singapore" and the "27th IUGG General Assemble on S2S Prediction, 8-18 Jul 2019, Montreal, Canada". The right column is titled "S2S Database" and includes filters for "ECMWF", "CMA", and "IRI/LDEO Data Lib". It lists three updates: "The result of 'S2S User Survey 2017'", "Charts of S2S Products/Indices are now available", and "S2S Database Paper will come soon on BAMS".

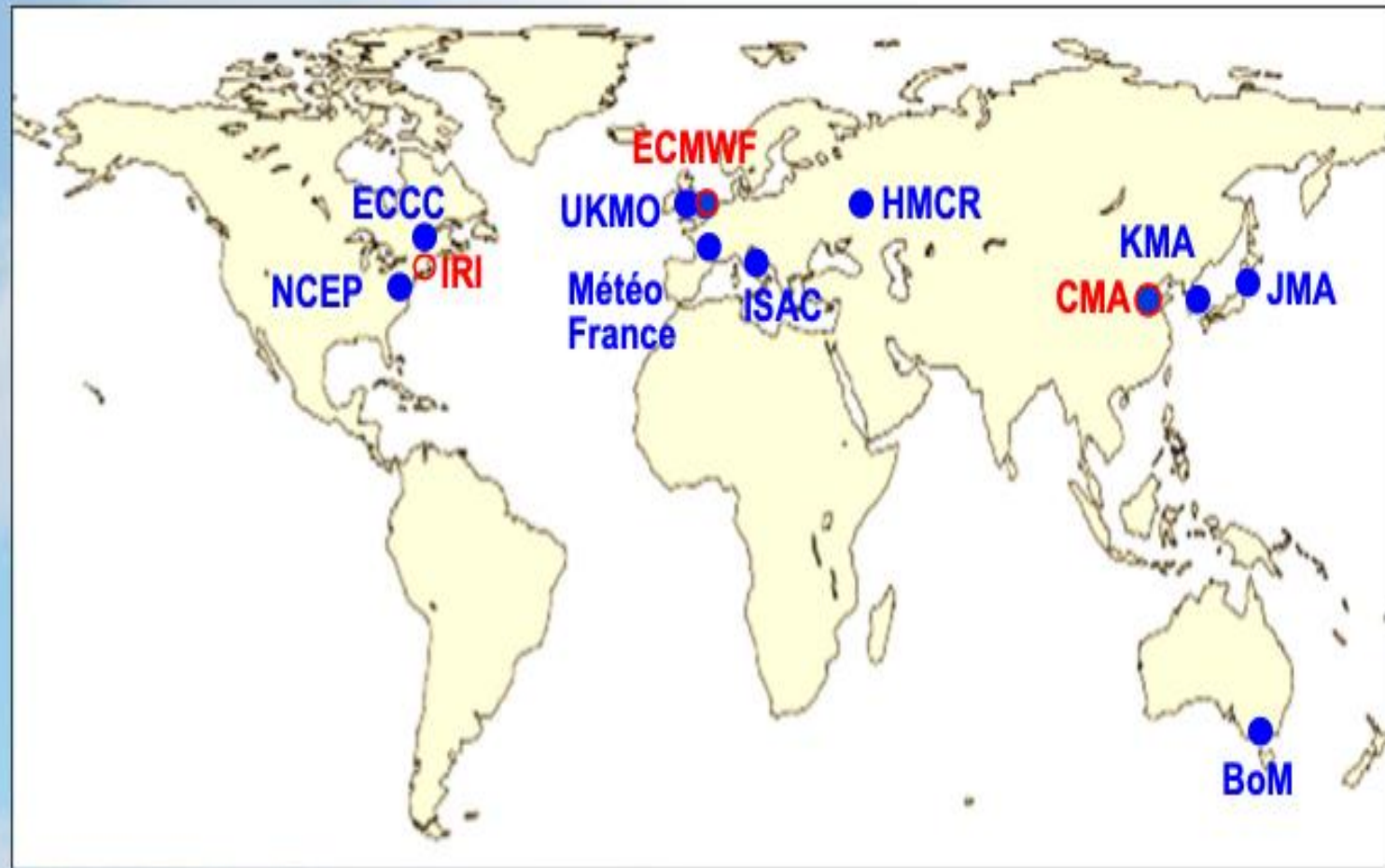
The S2S project web portal  
<http://s2sprediction.net>



# Contributing Centres to S2S database

● Data provider (11)

○ Archiving centre (3)



- **Daily 3-week behind real-time forecasts + re-forecasts**
- **11 models currently available**
- **Same grid (1.5 degree) / format**
- **More than 80 variables available**
- **A major legacy of the S2S project phase I**



# S2S Database Models

## Forecasts

## Hindcasts

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	day	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

Forecasts available 3 weeks behind real time, on 1.5-deg grid

Currently ~70 Tbytes



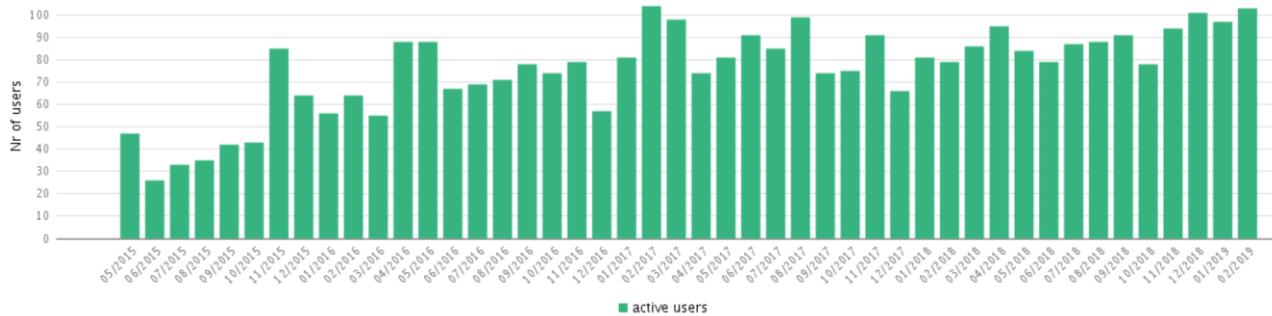
# S2S Model Components

<b>Models</b>	<b>Ocean coupling</b>	<b>Active Sea Ice</b>
<b>ECMWF</b>	<b>YES</b>	<b>YES</b>
<b>UKMO</b>	<b>YES</b>	<b>YES</b>
<b>NCEP</b>	<b>YES</b>	<b>YES</b>
<b>ECCC</b>	<b>NO</b>	<b>NO</b>
<b>BoM</b>	<b>YES</b>	<b>Planned</b>
<b>JMA</b>	<b>NO</b>	<b>NO</b>
<b>KMA</b>	<b>YES</b>	<b>YES</b>
<b>CMA</b>	<b>YES</b>	<b>YES</b>
<b>CNRM</b>	<b>YES</b>	<b>YES</b>
<b>ISA-CNR</b>	<b>YES</b>	<b>NO</b>
<b>HMCR</b>	<b>NO</b>	<b>NO</b>



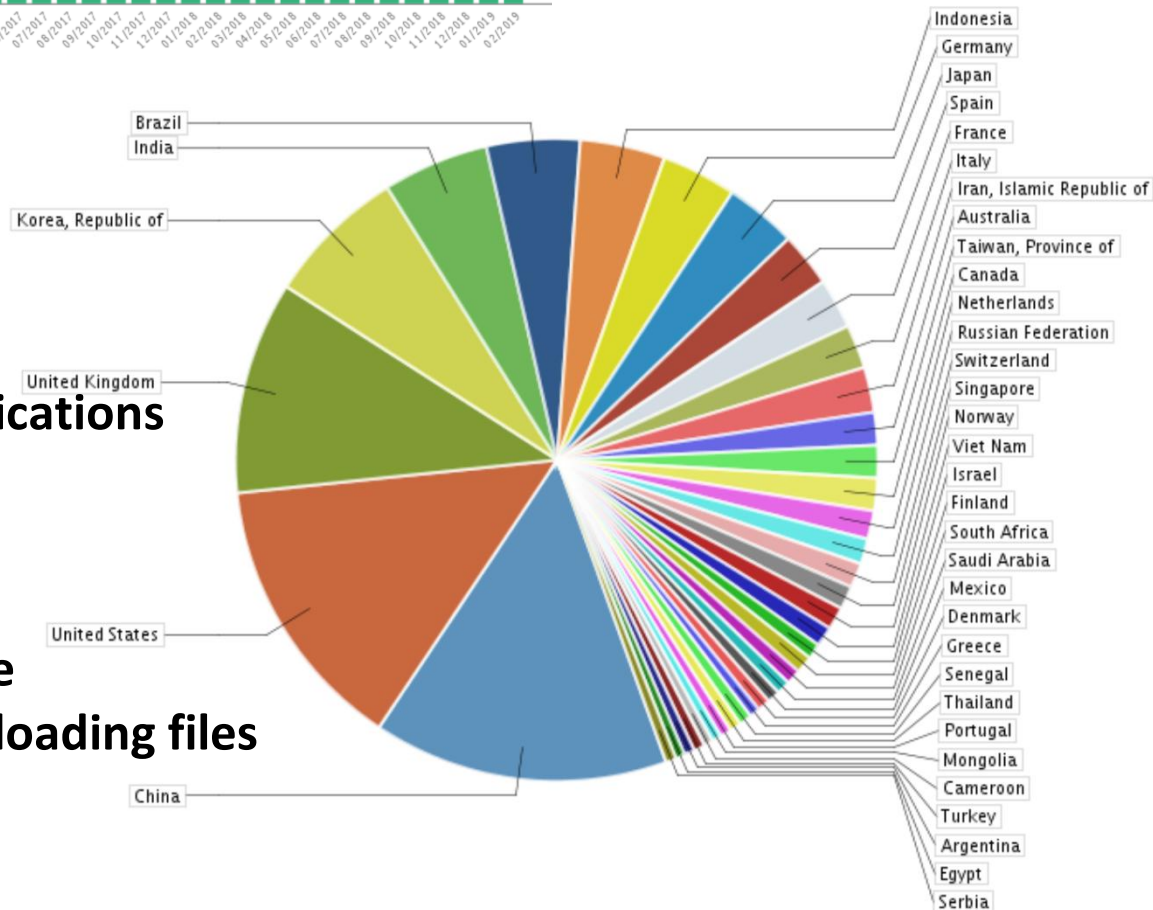
# Use of the S2S database at ECMWF

<https://apps.ecmwf.int/datasets/data/s2s>



- Over 1000 active users of ECMWF archive from 92 countries
- ~500TB retrieved since 2015.
- So far ~ 61 peer-reviewed publications making use of S2S database

Also available a webAPI interface with Python capability for downloading files



# CMA S2S data service

s2s.cma.cn

## Data download:

- Data download amount

year	amount of data
2015	0.3TB
2016	1.9TB
2017	3.1TB
2018 (Jan~Aug)	2.4TB

Total : 7.7 TB

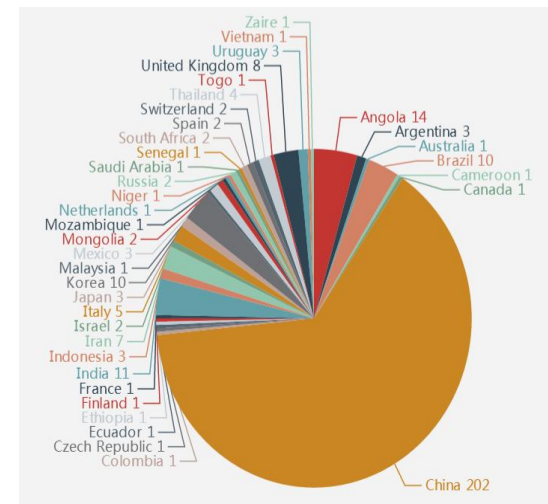
- User preference

download top five centers

NCEP, ECMWF, CMA, UKMO , JMA

download top five parameters

t, 2t, tp, gh, wind (V-velocity , U-velocity)





# Progress report: S2S data at CMA

## Data Library Statistics for ECMWF S2S Data

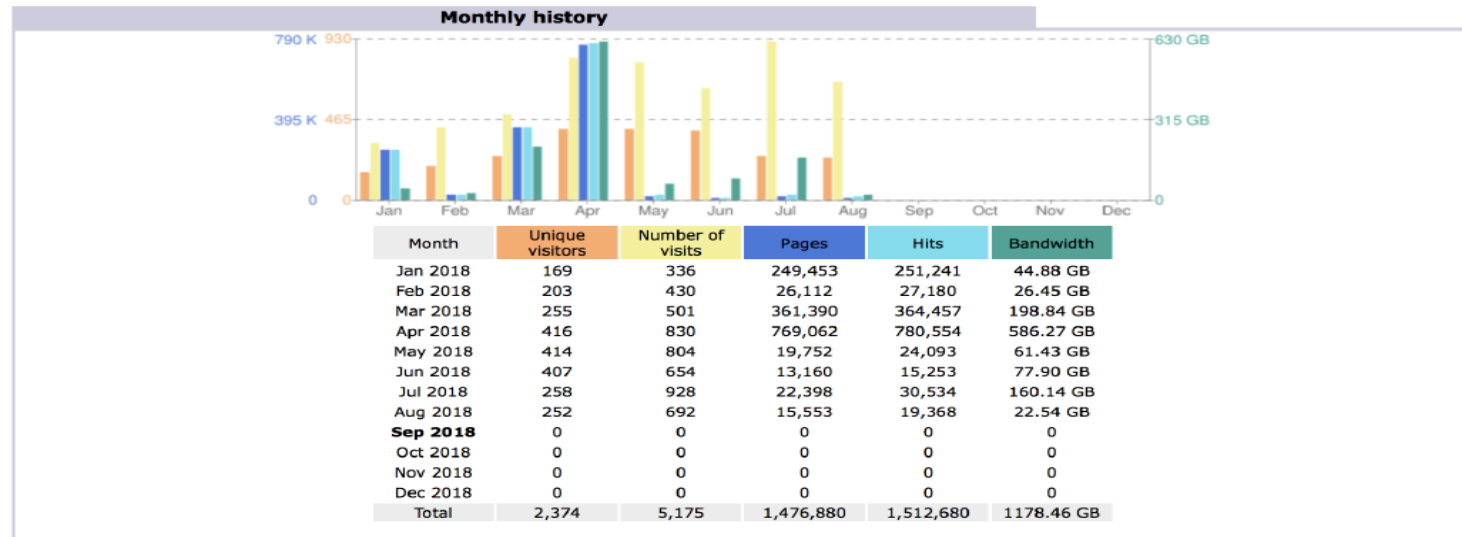
**Last Update:** 04 Sep 2018 - 18:03

**Reported period:** - Year - 2018 OK



Summary					
<b>Reported period</b>	Year 2018				
<b>First visit</b>	01 Jan 2018 - 10:54				
<b>Last visit</b>	31 Aug 2018 - 20:26				
	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Viewed traffic *	<= 2,374 Exact value not available in "Year" view	5,175 (2.17 visits/visitor)	1,476,880 (285.38 Pages/Visit)	1,512,680 (292.3 Hits/Visit)	1178.46 GB (238782.55 KB/Visit)
Not viewed traffic *			124,058	126,860	218.18 GB

\* Not viewed traffic includes traffic generated by robots, worms, or replies with special HTTP status codes.



**69 TB (Sept 2018)**  
**174 registered users (Aug 2018)**



S2S Database

Data Portal (ECMWF) >

Data Portal (CMA)

IRI/LDEO Data Lib >

Model Description

Other databases >

**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

## 16th AOGS Annual Meeting on S2S Forecasts and Applications, 28 Jul – 2 Aug 2019, Singapore

16th AOGS Annual Meeting

(AS36) Subseasonal to Seasonal Forecasts and Applications,

28 Jul – 2 Aug 2019, Singapore

<http://www.asiaoceania.org/aogs2019/>

Updated: 2019-02-11 03:16

## 27th IUGG General Assemble on S2S Prediction, 8-18 Jul 2019,

S2S Database

ECMWF ▾

CMA

IRI/LDEO Data Lib ▾

The result of 'S2S Datasets MJO RMMS(ftp) 17'

Updated: 2018-04-1

**Charts of S2S Products/Indices are now available**

Updated: 2016-09-22 04:41

**S2S Database Paper will come soon on BAMS**

Updated: 2016-08-28 21:25

**Now 9 centres S2S data available!**

Updated: 2016-01-14 04:16

# S2S Database in IRI Data Library

- Over 2/3 of the S2S database is archived at IRI, including MJO indices
- Kept up to date
- Allows server-side and “lazy” computation to analyze the data according to user requests (eg weekly averaged anomalies of ensemble means, EOFs ...)
- Good for low-bandwidth situations
- OpenDAP
- Includes RMM indices

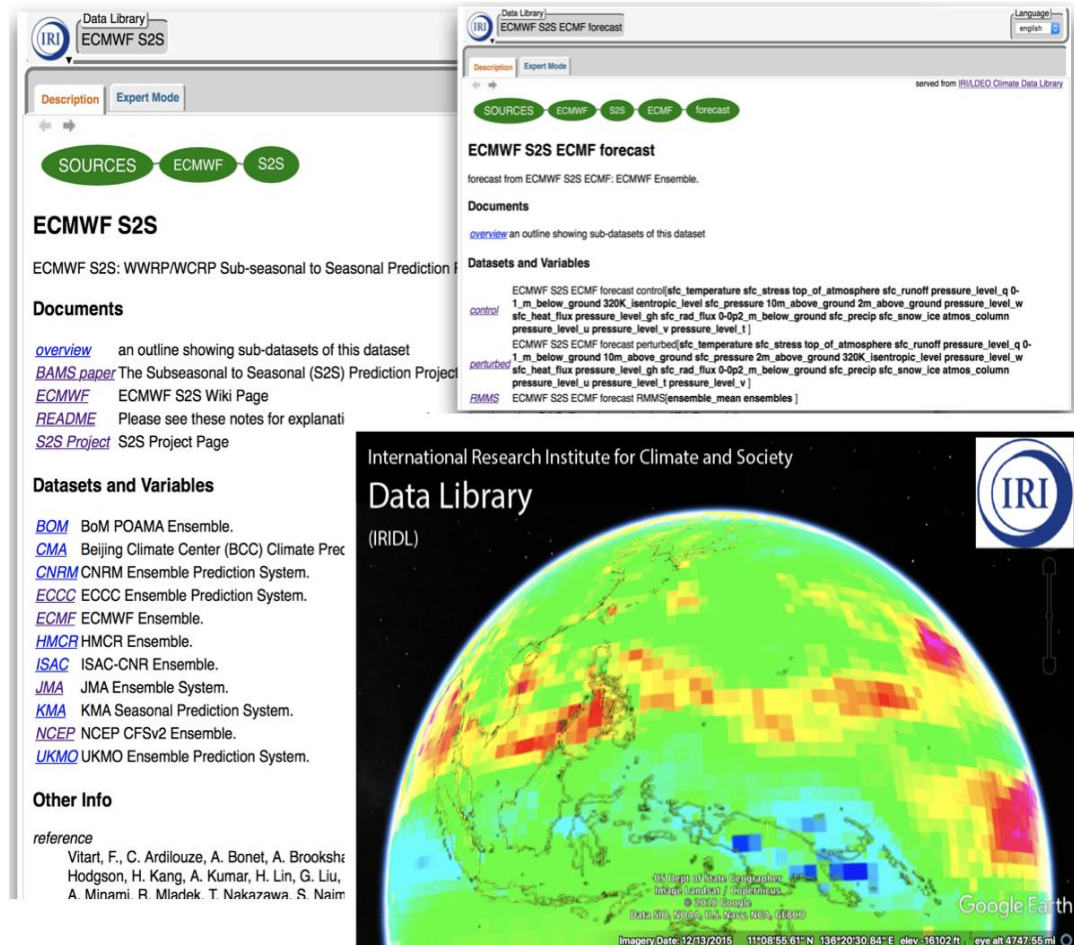


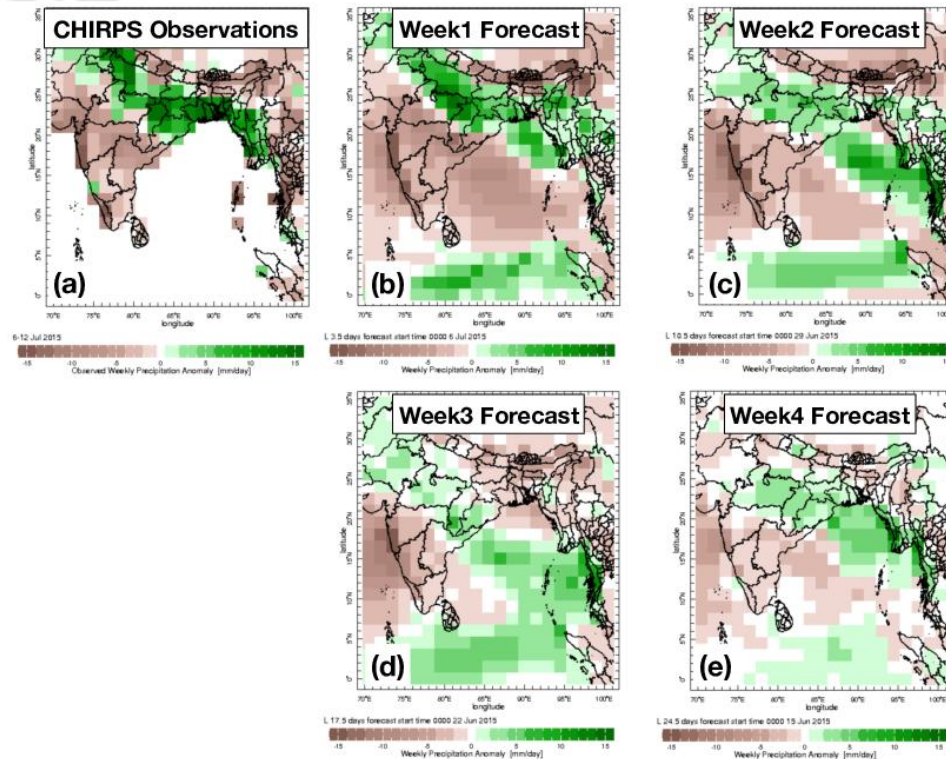
Figure 1. Visualization of an S2S forecast using Google Earth. Data was post-processed and downloaded from the IRI Data Library.





- Large subset of the S2S database available from the IRI Data library
- Online map-room for visualization of weekly fields and anomalies

## *Weekly precipitation anomalies (mm/day) for July 6-12 2015*





# IRI Subseasonal Forecast Maprooms

Lagged S2S, every ~month

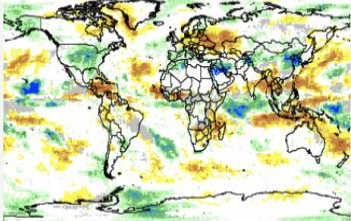
Real Time SubX, every Friday

**SubX Forecasts**   **S2S Lagged Forecasts**

## S2S Lagged Forecasts

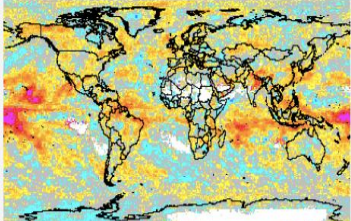
**Precipitation Probability Forecast**

Calibrated Subseasonal Tercile categories precipitation experimental forecasts issued 1-2 months behind real time.



**Precipitation Hindcast Skill**

Subseasonal skill score based on the historical performance of each model and their multi-model ensemble.

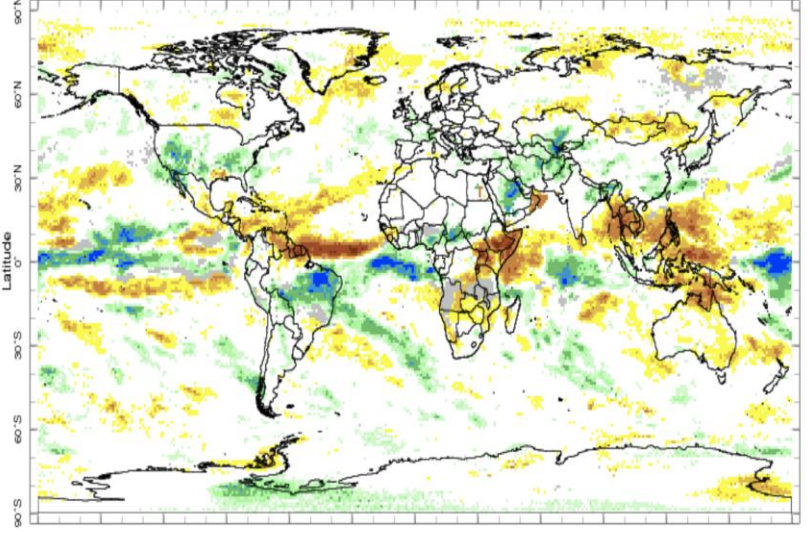


Climate   SubX Forecasts   Region   Forecast Issued

IRI   Subseasonal Forecasts   Precipitation Probability Forecast   Global   0000 5 Apr 2019

Target Period  
✓ 13-26 Apr 2019  
20 Apr 2019 - 3 May 2019

Description   Dataset Documentation   Instructions   Contact Us



13-26 Apr 2019 IRI SubX Precipitation Forecast issued 0000 5 Apr 2019

100%   -80%   -60%   -40%   -20%   0%   20%   40%   60%   80%   100%

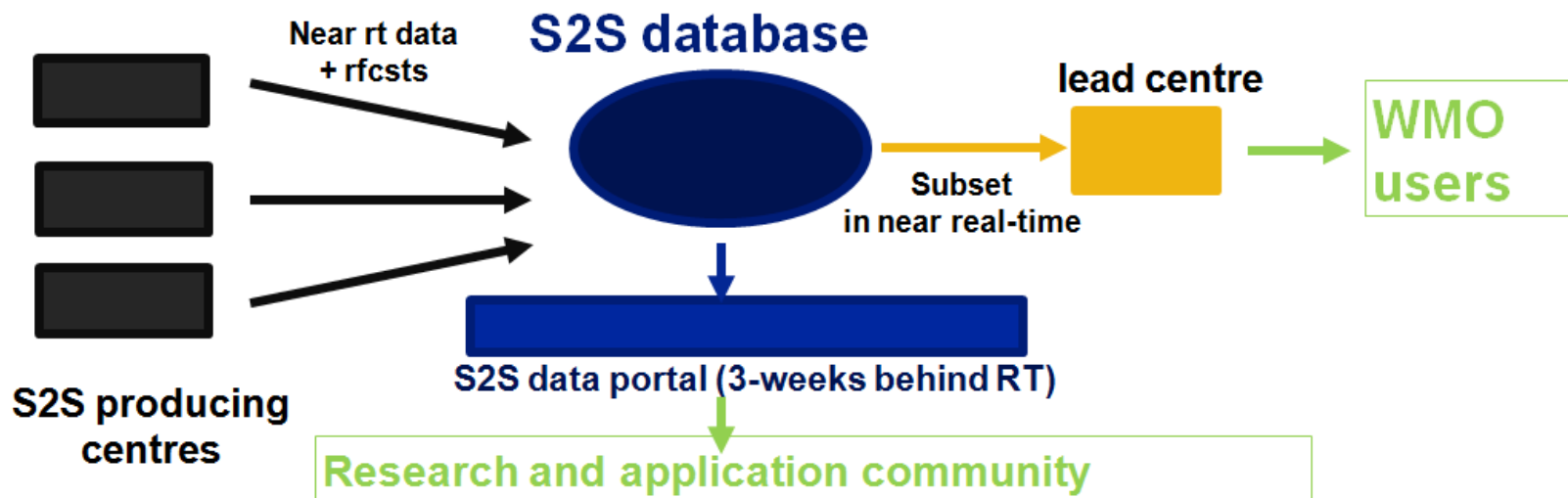
Dominant Tercile Probability

### Precipitation Probability Forecast

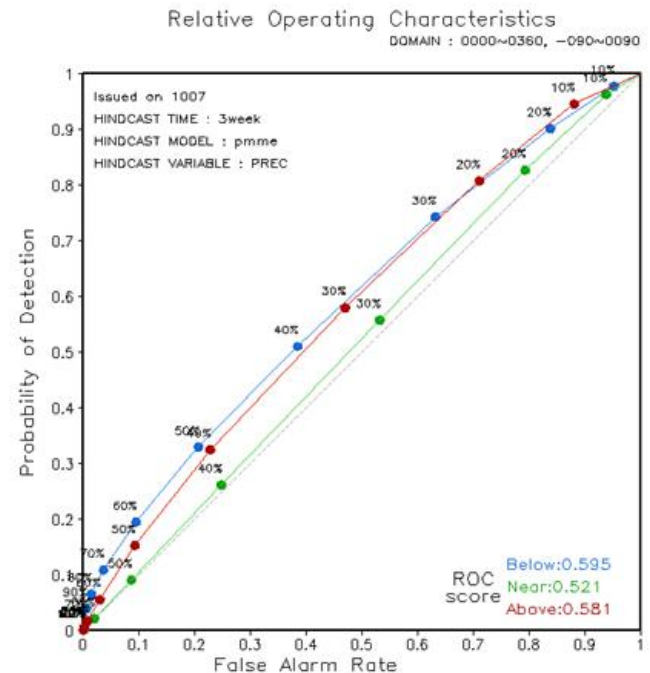
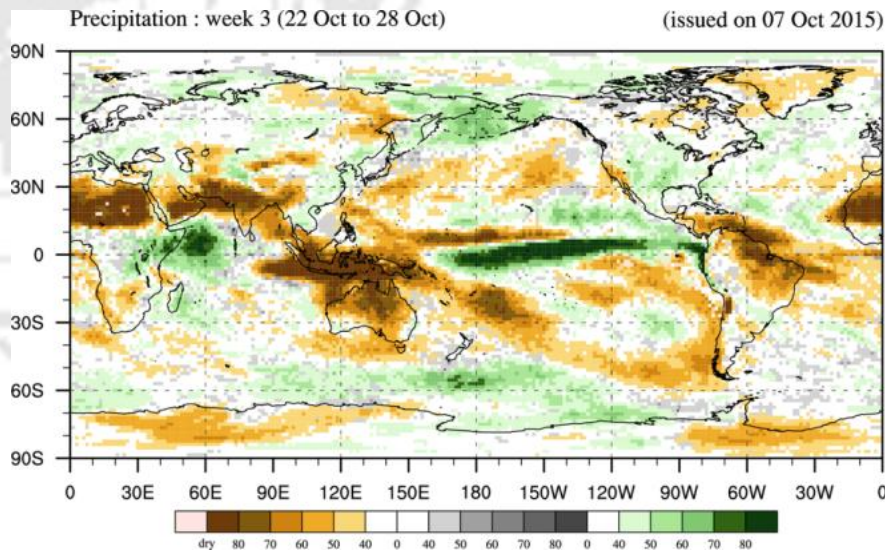
# S2S Linkage with WMO Operational Arm

A major goal of S2S is to support WMO Commission for Basic Systems (CBS) operational sub-seasonal activities

- S2S predictability research is linked to development infrastructure and procedure for operational sub-seasonal prediction under CBS.
- The S2S database is used to provide real-time data to CBS.



- **Prototype for real-time provision of MME S2S forecasts by WMO LC-LRFMME**
- **Variables:** SST, T2m, precipitation, u200, v200, u850, and OLR
- **Participating Models:** ECMWF, UKMO, JMA, NCEP/CPC, KMA
- Needs to be formalized by CBS





# S2S database near-real time products

- ECMWF: <http://www.ecmwf.int/en/research/projects/s2s/charts/s2s/>
- “S2S Museum” at University of Tsukuba, Japan (Mio Matsueda) [http://gpvjma.ccs.hpcc.jp/S2S/S2S\\_SICmap.html](http://gpvjma.ccs.hpcc.jp/S2S/S2S_SICmap.html)

## S2S NAO index forecasts

Updated every day with a 21-day delay!  
The latest initial date is 20180219.

Initial time:

Year:Month

Day

Definition of leading mode is [here](#)

Initial days of forecasts:

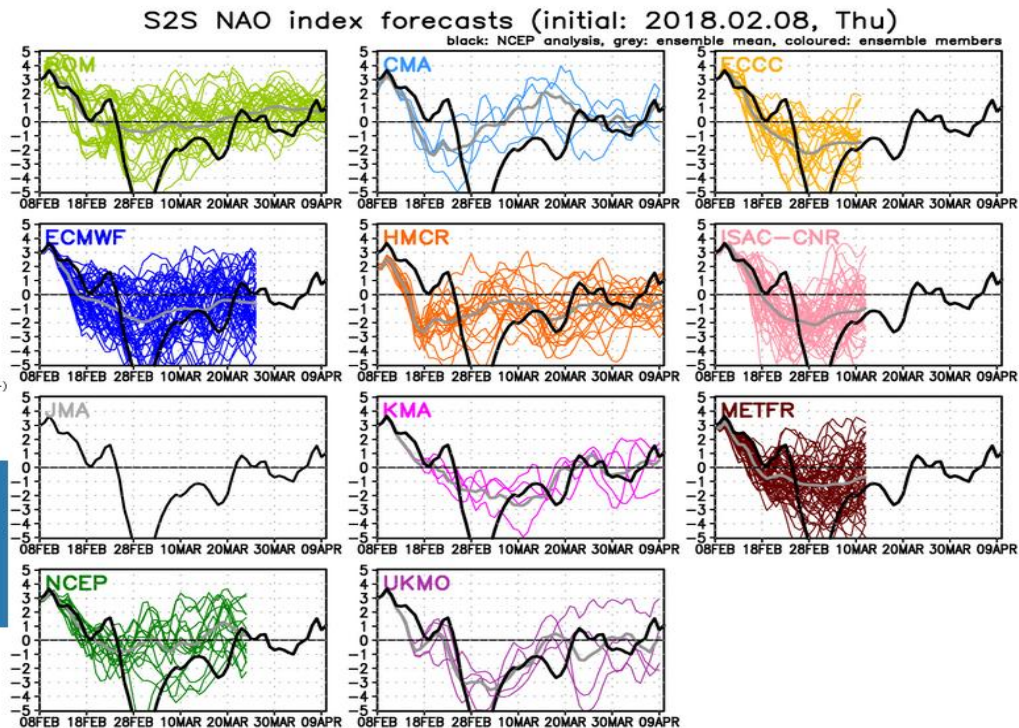
centre	Sun	Mon	Tue	Wed	Thu	Fri	Sat
BolM							
CMA							
ECMWF							
ECCC							
HMCR *1							
ISAC-CNR *2							
JMA *3							
KMA							
METFR *4							
NCEP							
UKMO							

\*1 HMCR: Wed (-31 May 2017); Thu (08 Jun. 2017-)  
\*2 ISAC-CNR: Mon (-10 Jan. 2017); Thu (19 Jan. 2017-)  
\*3 JMA: Tue, Wed (-15 Mar. 2017); Wed (22 Mar. 2017-)  
\*4 METFR: 1st of each month (-Feb 2018), Thu (Mar. 2017-)

[Go to the S2S Museum \(top\)](#)



## NAO Index – 8 Feb 2018 start date





# **A few research highlights from S2S phase I**



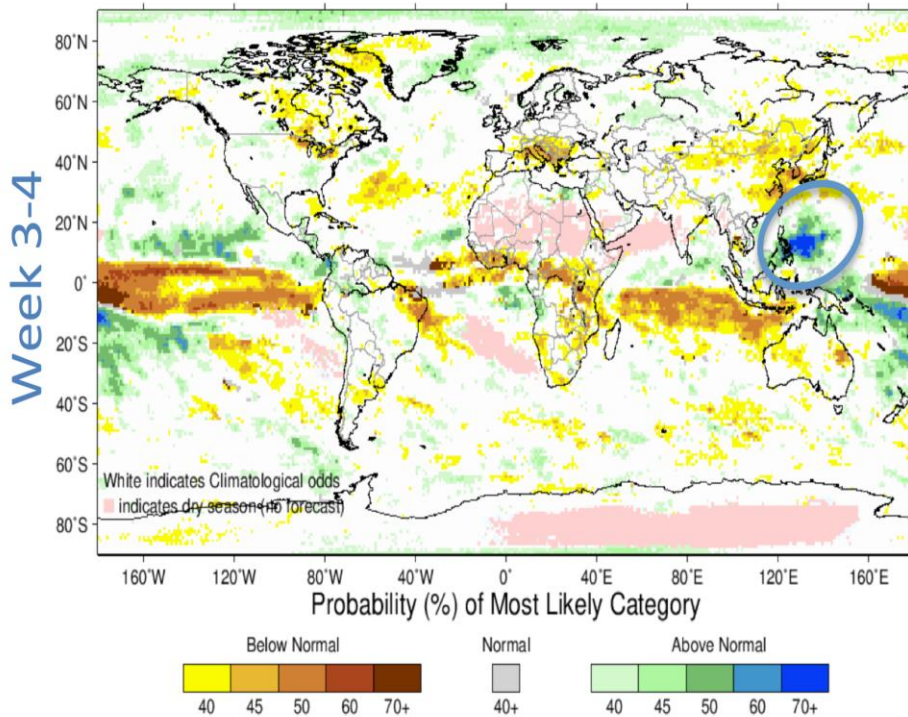
WMO OMM

# Calibrated S2S Forecast Product

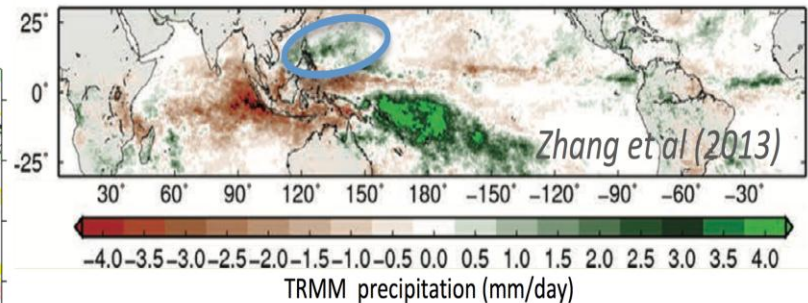
## Development

On Feb 13–15 2018, Tropical cyclone Basyang/Sanba hit the Philippines (150,000 affected & 50,000 displaced)  
Could it be predicted 3–4 weeks ahead?

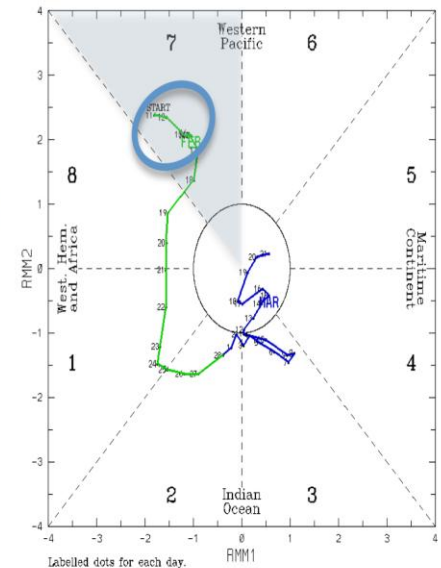
Experimental Precipitation Probability Forecast for 20180208–20180215,  
Issued on 18 January 2018



MJO phase 7 precipitation anomalies (1998-2012 baseline)



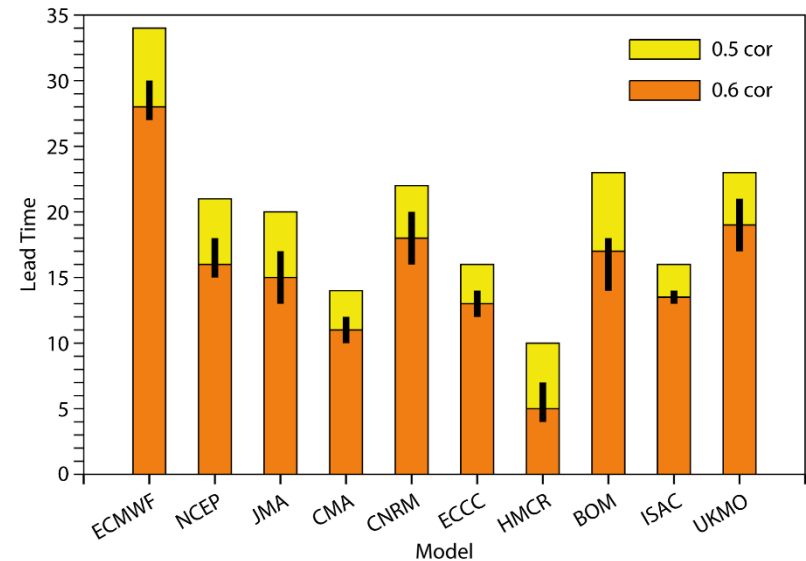
Skill relationship  
to **strong MJO**  
activity in phase 7



N. Vigaud, IRI

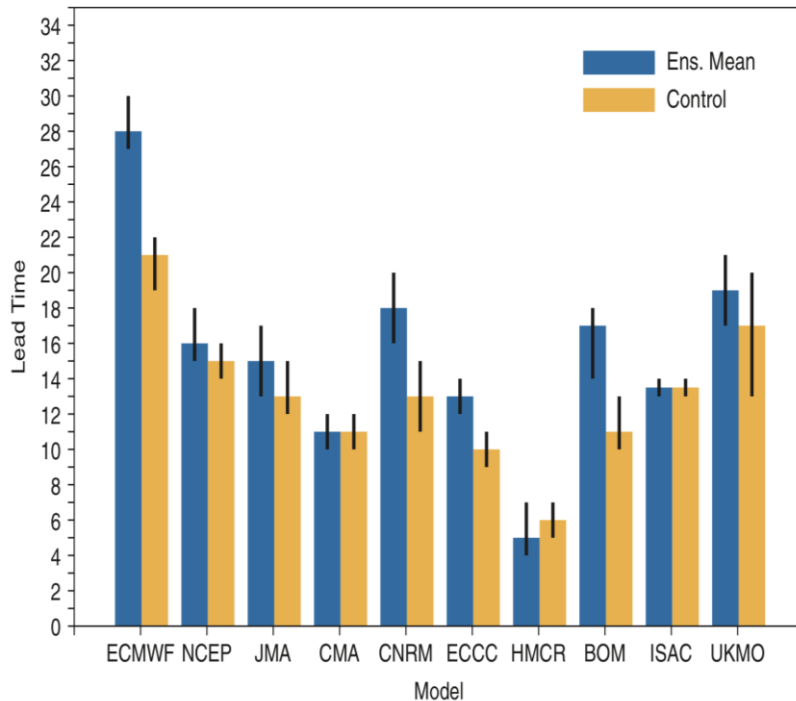
# Madden Julian Oscillation

- 6 of the S2S models have skill (bivariate correlation  $> 0.5$ ) at 20-day lead
- S2S models have a weaker and slower MJO than analyses
- MJO teleconnections too weak in the Euro-Atlantic sector

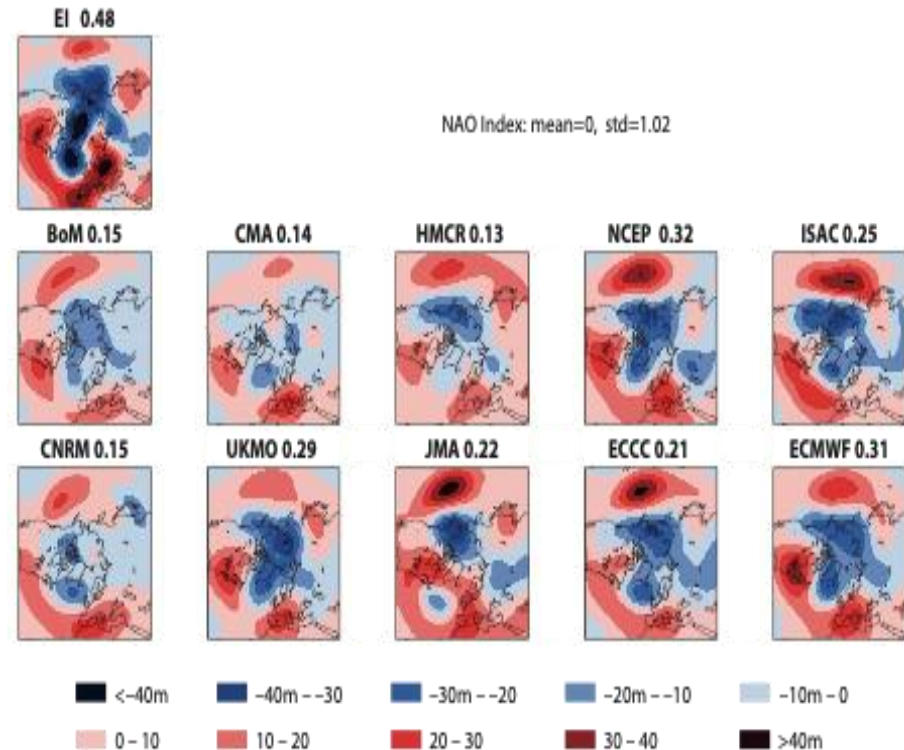


# MJO Prediction

Forecast Lead Time When MJO Index Skill Reaches 0.6



Z500 anomalies 10 days after an MJO in Phase 3

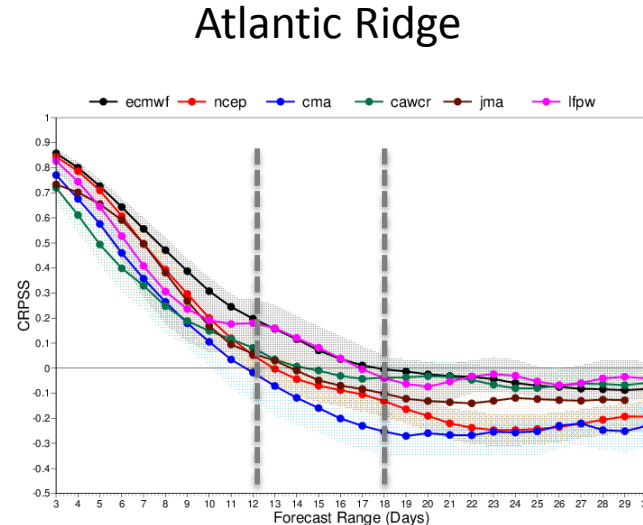
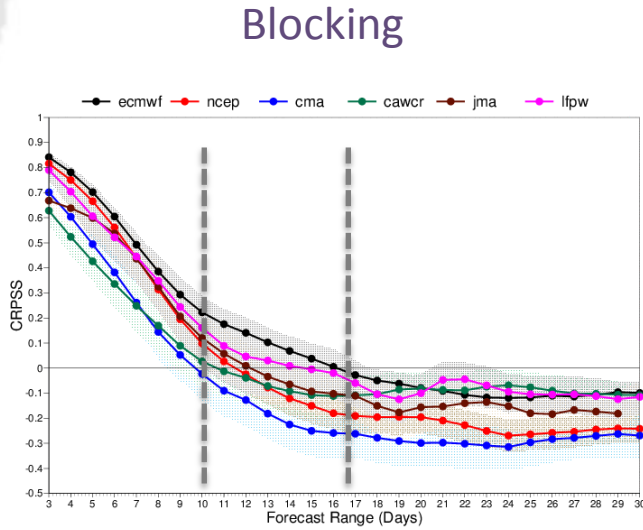
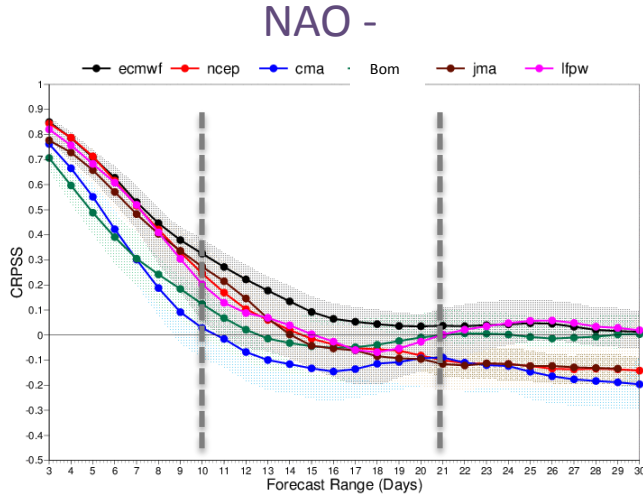
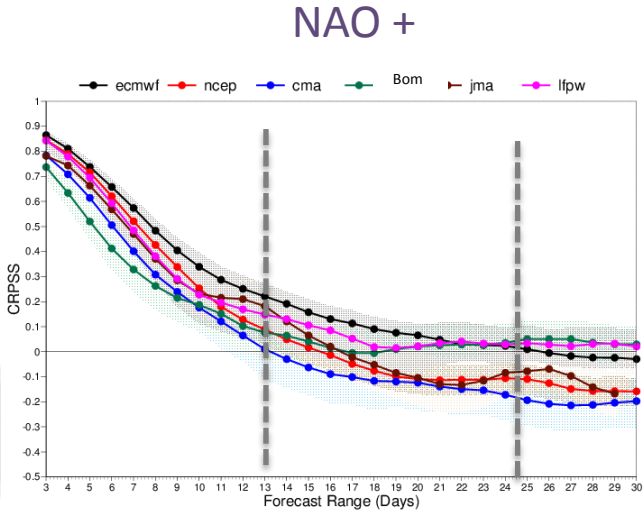


- Big recent improvements in MJO prediction skill
- MJO Teleconnections still show serious biases



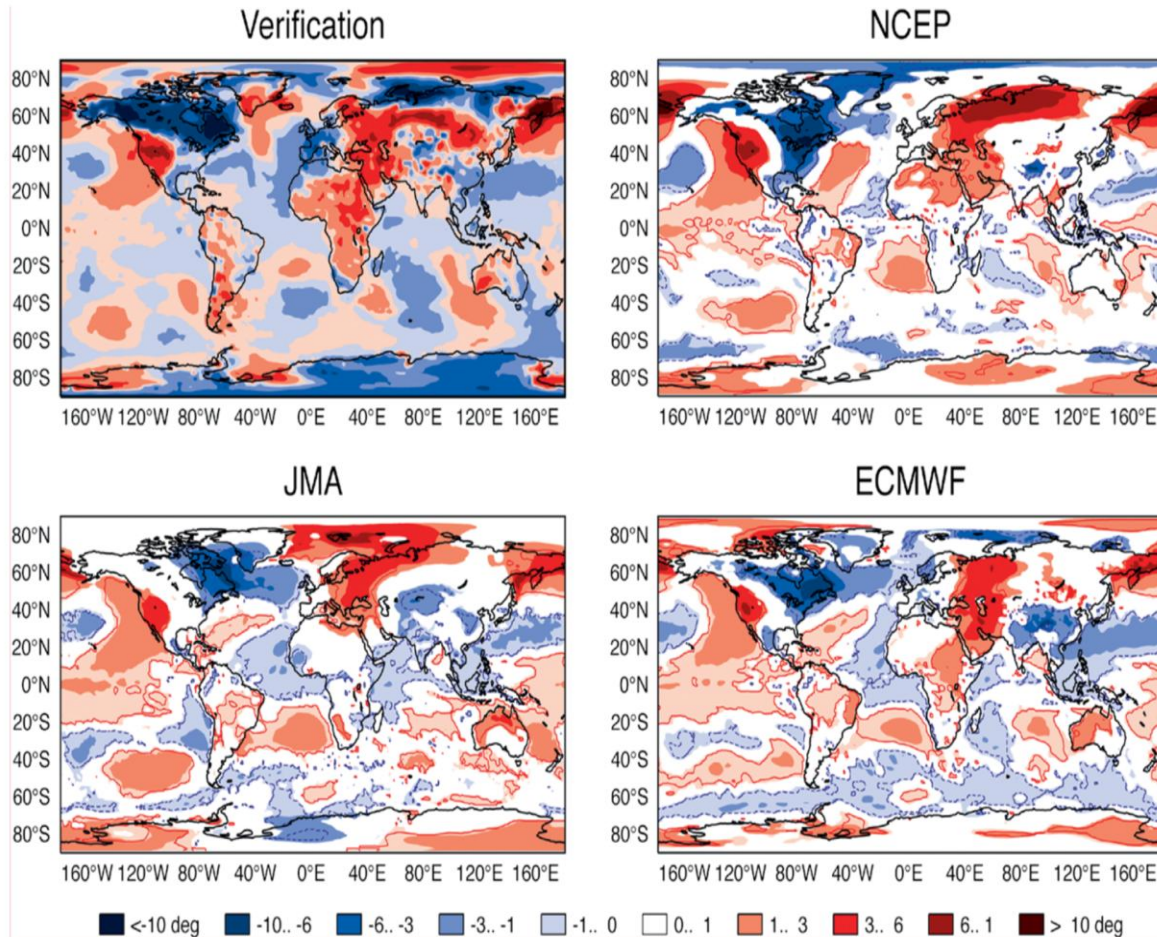
# Euro-Atlantic Weather Regimes

Predictive skill up to about 3 weeks for NAO+ and NAO- and up to about 16 days for the other weather regimes.



# Multi-model forecast comparisons

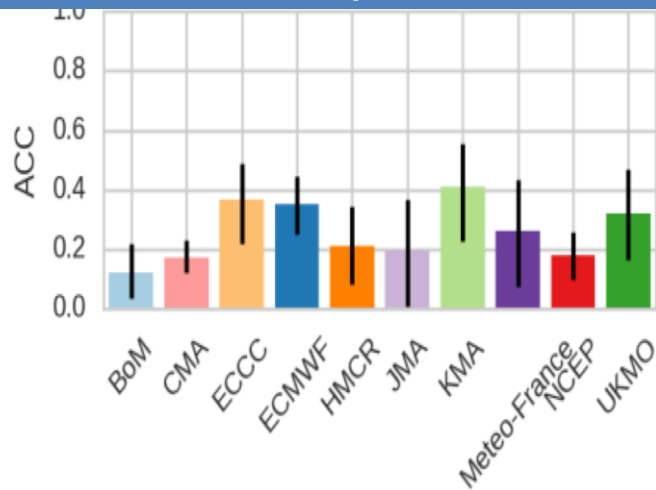
Temperature Forecasts for week from 2 to 8 Feb (Days 12–18) issued 22 Jan 2015



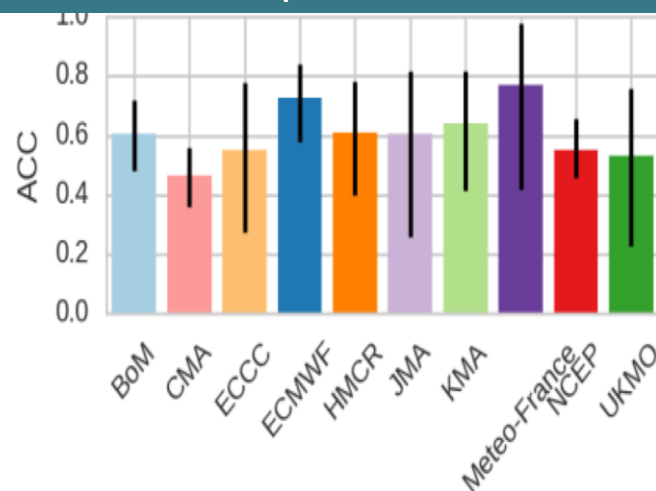
The cold event in the northeastern United States and Canada in early February 2015 was well predicted 11 days in advance

# Stratospheric Polar Vortex Events

## Neutral Stratospheric Vortex



## Weak Stratospheric Vortex



Prediction quality of the 1000 hPa Northern Annular Mode for week 3 in the S2S models

- For most models, performance is higher following weak vortex conditions.

- Similar results are found following strong vortex conditions.

**SPARC: Stratosphere-troposphere processes and their role in climate**  
**SNAP: Stratospheric Network for the Assessment of Predictability**



# S2S book: Another legacy of the S2S Prediction project Phase I

## SUB-SEASONAL TO SEASONAL PREDICTION

Robertson  
Vitart



The Gap Between Weather and Climate Forecasting

Edited By  
Andrew W. Robertson and Frederic Vitart

### Key Features

- Offers chapters from leading experts in subseasonal to seasonal (S2S) science, forecasting, and applications.
- Provides a one-stop shop for graduate students, academic and applied researchers, and practitioners in an emerging and interdisciplinary field.
- Gives a synthesis of the state of S2S science, with sections on sources of predictability, modeling, and forecasting, and through application examples, enables prospective users of S2S forecasts to quickly grasp the potential for using them in their own decision setting.
- Includes a broad set of topics and illustrated with graphic examples that powerfully illustrate the interdisciplinary linkages.

*Sub-Seasonal-to-Seasonal Prediction: The Gap Between Weather and Climate Forecasting* is an ideal reference for researchers and practitioners across the range of disciplines involved in the science, modeling, forecasting, and applications of this new frontier in subseasonal-to-seasonal (S2S) prediction. This reference provides an accessible yet rigorous introduction to the scientific principles of S2S prediction and the sources of S2S predictability, through the unique challenges of numerical simulation and forecasting with state-of-the-art modeling codes and supercomputers. Additional topics include the prospects for developing applications to trigger early-action decisions to lessen weather catastrophes, minimize costly damage, and optimize operator decisions in such scenarios as today's complex, multisourced power generation from renewable and traditional sources.

*Subseasonal-to-Seasonal Prediction: The Gap Between Weather and Climate Forecasting* consists of a set of chapters solicited from leading experts in the fields of S2S predictability science, numerical modeling, operational forecasting, and developing application sectors. The introduction and conclusion, written by the coeditors, discuss historical perspective, unique synthesis and prospects, and emerging opportunities in this exciting, complex, and interdisciplinary field.

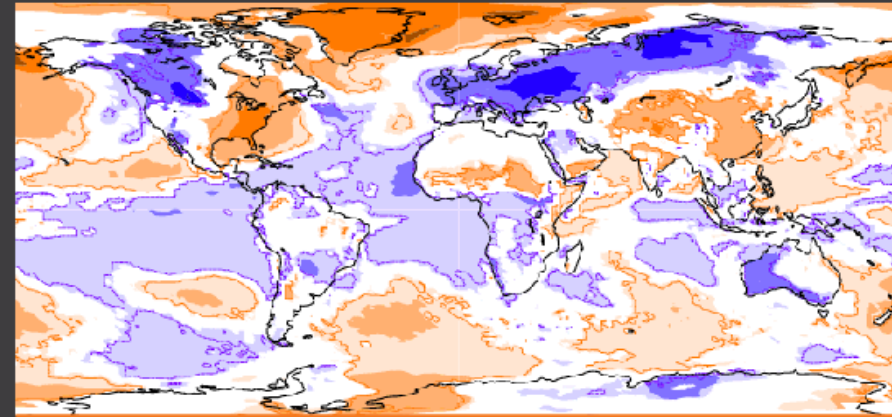


[elsevier.com/books-and-journals](http://elsevier.com/books-and-journals)



## SUB-SEASONAL TO SEASONAL PREDICTION

The Gap Between Weather and Climate Forecasting



SUB-SEASONAL TO SEASONAL PREDICTION

Edited by  
Andrew W. Robertson | Frédéric Vitart

Contains 22 chapters on S2S sources of predictability, modelling, forecasting, and applications.  
**585 pages!**



## WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S) Phase I Final Report

(November 2013–December 2017)

# S2S Phase II: Gap Analysis

- To inform future plans, a questionnaire was circulated to research, modelling, operational & applications communities for feedback.
- Frequently mentioned gaps: land-surface processes and initialization; ensemble generation, perturbation methods and stochastic physics; coupled data assimilation, role of the ocean and sea ice; stratospheric processes; and understanding model systematic errors and error growth.
- Need for more convenient and faster access to popular suites of variables, including ensemble means, model climatologies, indices, and map displays;
  - need for multi-model calibrated forecast product development;
  - desire for more extensive re-forecast sets (number of years and ensemble members) for verification and forecast calibration,
  - encouraging centres to harmonize re-forecasts;
  - request for more ocean data including 3D fields,
  - increased model horizontal and temporal resolution; and desire for real-time access.

# Barriers to S2S Forecast Uptake: Stakeholder Mini-Survey

For the applications/service/donors/wider stakeholder audience, a set of 8 semi-structured interviews was carried out by **SERA**. The interviewees were stakeholders in agriculture (Australia, Uruguay), energy (Uruguay), transport (Canada), water management (Canada, USA), bushfire management (Australia), and humanitarian aid (global and Peru).

They generally agreed that while the potential benefits of skilful S2S forecasts are high, several barriers hinder their realization, namely:

- Lack of accuracy/poor skill - high level of accuracy is required for many types of decision-making;
- Lack of post-processing - need for statistical post-processing techniques to calibrate forecast for reliable probabilities;
- Lack of forecast verification: request that forecasts always be provided with verification information;
- Lack of stability in forecast model output: instability/persistence of the rainfall in the forecasts prevented the use of the forecast, or they became reliable only close to the actual event;
- Challenges in interpretation of probabilities - a large share of users struggle to interpret probabilities and can have low expertise in risk management.

## REPORT ON THE USE, POTENTIAL BENEFITS AND DEVELOPMENT NEEDS OF S2S INFORMATION:

### PREPARED FOR WMO S2S PROJECT PHASE II

Report prepared by the WMO SERA working group

#### Contributors:

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## WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S) Phase II Proposal

(November 2018–December 2023)

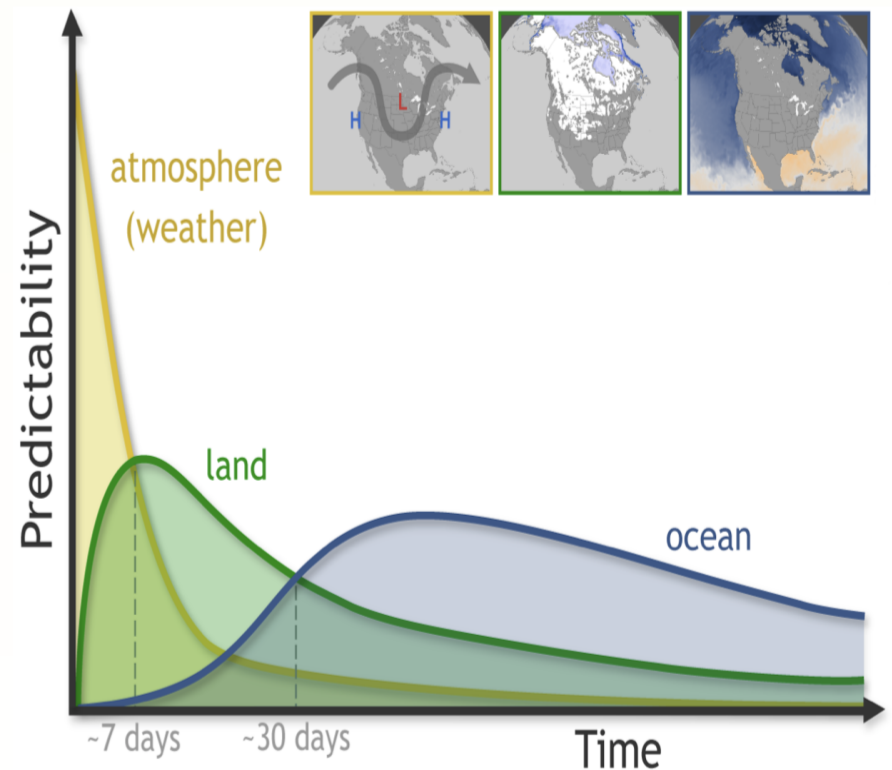
## S2S Phase 2 plans (2019-2023):

### Focused on:

- **S2S Database enhancement** – ocean variables, more surface variables 4xdaily, additional models, derived products (e.g. model climatology)
- **New research foci** (sub-projects):  
**MJO** prediction and teleconnections; roles of initialization and processes in **ocean, sea ice and land surface, stratosphere, atmospheric composition** (aerosols) and **ensemble generation**
- **Enhancing operational infrastructure, user applications & real-time pilot experiment**

# Land in the S2S Phase II Plans

- Phase II questions posed:
  1. What is the impact of the observing system on land initialization and S2S forecasts?
  2. How well are the coupled land/atmosphere processes represented in S2S models?
  3. How might anomalies in land surface states contribute to extremes?







## Goals of the Project

This project aims to improve our understanding about the following questions:

- What are the current capabilities of NWP models to predict aerosols on S2S time scales?
- What are the current capabilities of NWP models to simulate aerosol impacts on weather and sub-seasonal prediction?
- Are the S2S air quality forecasts useful for impacts purposes?

2 Coordinated experiments:

- 72h forecasts with limited area models – Dust in Egypt, Smoke in Brazil and S. Africa (field Campaign)
- S2S re-forecasts for dust (Spring) and biomass burning

*Possible partners: ECMWF, NASA, NOAA, JMA, CMA, UKMO*

*Links with WMO/GAW*



# Enhancing operational infrastructure & user applications

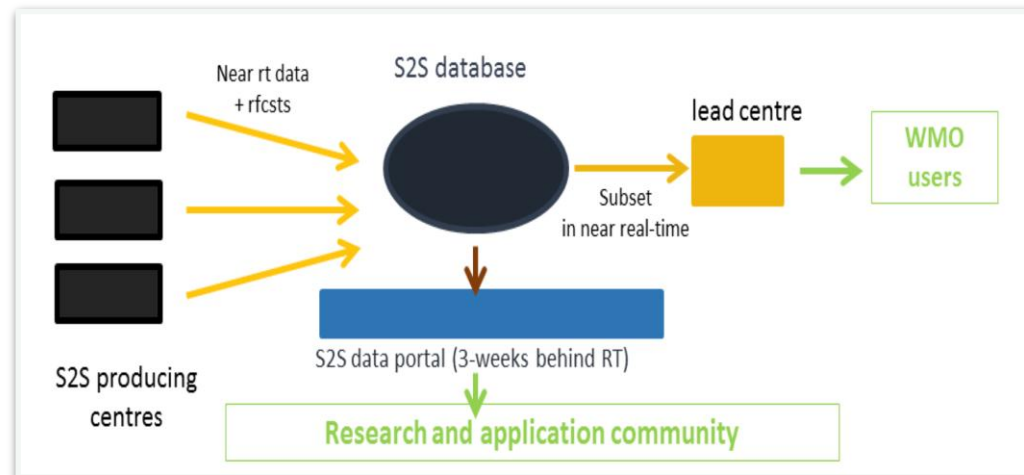
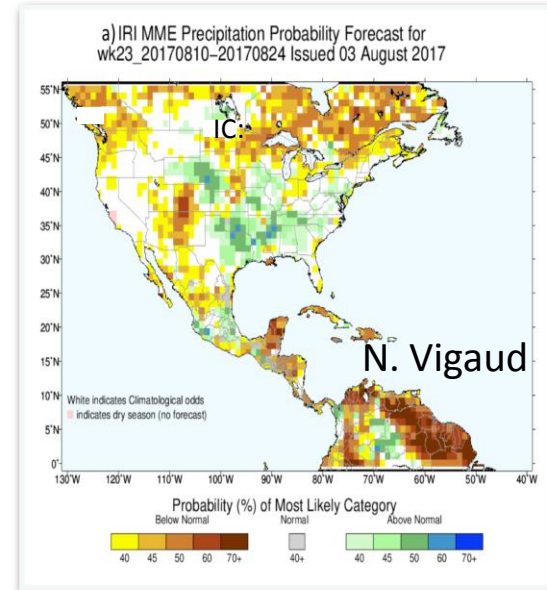
- **Research to Operations (R2O) and S2S Forecast and Verification Products Development:**

- Methodologies for forecast calibration, multi-model combination, verification, and forecast formats (e.g. probability of threshold exceedance)

- Recommendations for operational centres to harmonize their real-time and re-forecast set-ups

- Assist WMO develop operational criteria for Global Producing Centers for S2S Predictions, and data exchange standards for S2S hindcasts/real-time forecasts for WMO Lead Centre

- **Establish a real-time forecast pilot program** for S2S applications of 1–2 years duration, with goal of demonstrating S2S forecast value using real-time S2S forecasts



# Training

- **10-14 July 2017, Paraguay: First South American School on Sub-Seasonal Predictability and Prediction (WMO, WCRP, WWRP, IRI, CPTEC/INPE, UBA)**
- **16-20 July 2018, Ecuador: 10<sup>th</sup> International Training Workshop on Climate Variability and Prediction (CIFEN, USAID, NOAA, WMO, CPTEC/INPE, UBA)**
- **13-17 August 2018, Singapore: Capacity Building Programme in S2S Prediction for Southeast Asia -ASEAN2 (ASMC, WCRP, IRI, RIMES, UN-ESCAP)**
- **3-7 December 2018, Guatemala: Central American and Caribbean Workshop on Sub-Seasonal Predictability of the Mid-Summer Drought (IRI, ICTP, UNESCO, CIAT/CCAFS)**
- **15-26 April 2019, Ankara: 11<sup>th</sup> International Training Workshop on Climate Variability and Prediction (TSMS, USAID, NOAA, WMO, ECMWF, TMD, CPTEC/INPE, UBA)**
- **3<sup>rd</sup> S2S training for ASEAN in Singapore in July 2019**
- **Training workshop in Nov 2019, likely in KMA (Jeju). Focus on E Asia built on several previous APCC S2S trainings.**
- **Summer School (2020) at NCAR**

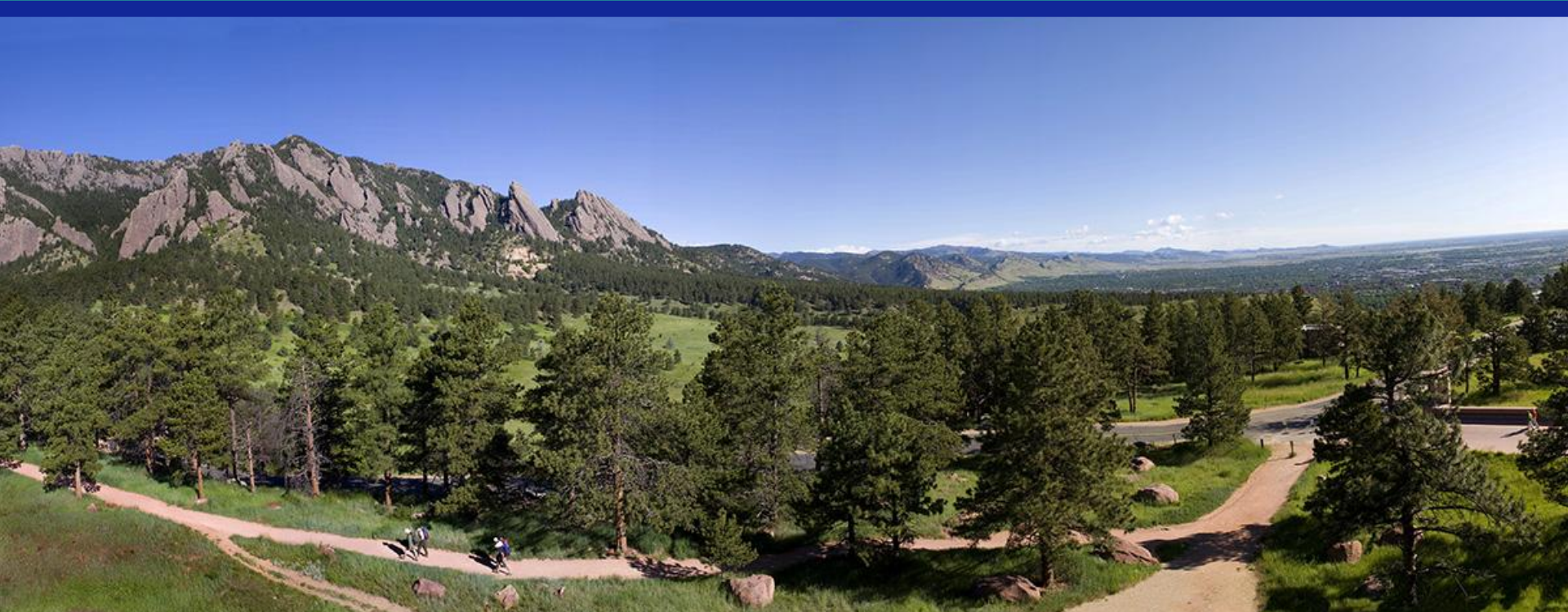


# Conferences/Workshops

- International S2S conference (Sep 2018), NCAR
- AGU session on S2S (Dec 2018) - More than 70 abstracts - 3 sessions
- TIGGE-S2S workshop at ECMWF (April 2019)
- EGU session on S2S (April 2019)
- IUGG/IAMAS meeting in Montreal (July 2019)
- AGU session on S2S (Dec 2019): Two session proposals (on science & application-related topics)



# International Conferences on Subseasonal to Decadal Prediction



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



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



<https://www.wcrp-climate.org/s2s-s2d-2018-home>

- 347 Participants
- 224 Poster Presentations
- 144 Oral Presentations
- 92 Early Career Scientists
- 38 Countries
- Hundreds of remote users

## Some highlights from the S2S conference:

- 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.
- Some operational centres 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.
- Multimodel ensembling shown to have higher skill 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.
- S2S forecasts in real-time are needed for application research, 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 application context.



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

ECMWF, Reading, 2-5 April 2019

To bring together the users and data providers of the TIGGE and S2S databases around the following themes:

- *Database technical development*
- *Predictability and Dynamics*
- *Prediction and Verification*
- *Multi-Model approaches to prediction*
- *Application Studies*

WORKSHOP ON 2-5 APRIL 2019

Predictability, dynamics  
and applications research  
using the TIGGE and S2S  
ensembles



# Summary

- S2S is still an emerging area of research, improving forecast capabilities and product development – bringing together weather and climate communities toward more “seamless” prediction across scales, as well as researchers/forecasters/users.
- Creation of multi-model databases (S2S, SubX) has accelerated development.
- Second 5-year phase of WWRP/WCRP S2S Project research foci on ocean and sea ice, land surface, stratosphere, atmospheric composition, and ensemble generation – started Jan 2019.
- New S2S R2O focus on forecast and verification products development. An S2S “real-time pilot” will enable real-time demonstrations across a spectrum of applications & GFCS sectors.
- SubX project in U.S. is real-time and demonstrates the value of multi-model combination to enhance prediction performance.



# Thank you for your attention



WMO OMM

World Meteorological Organization  
Organisation météorologique mondiale