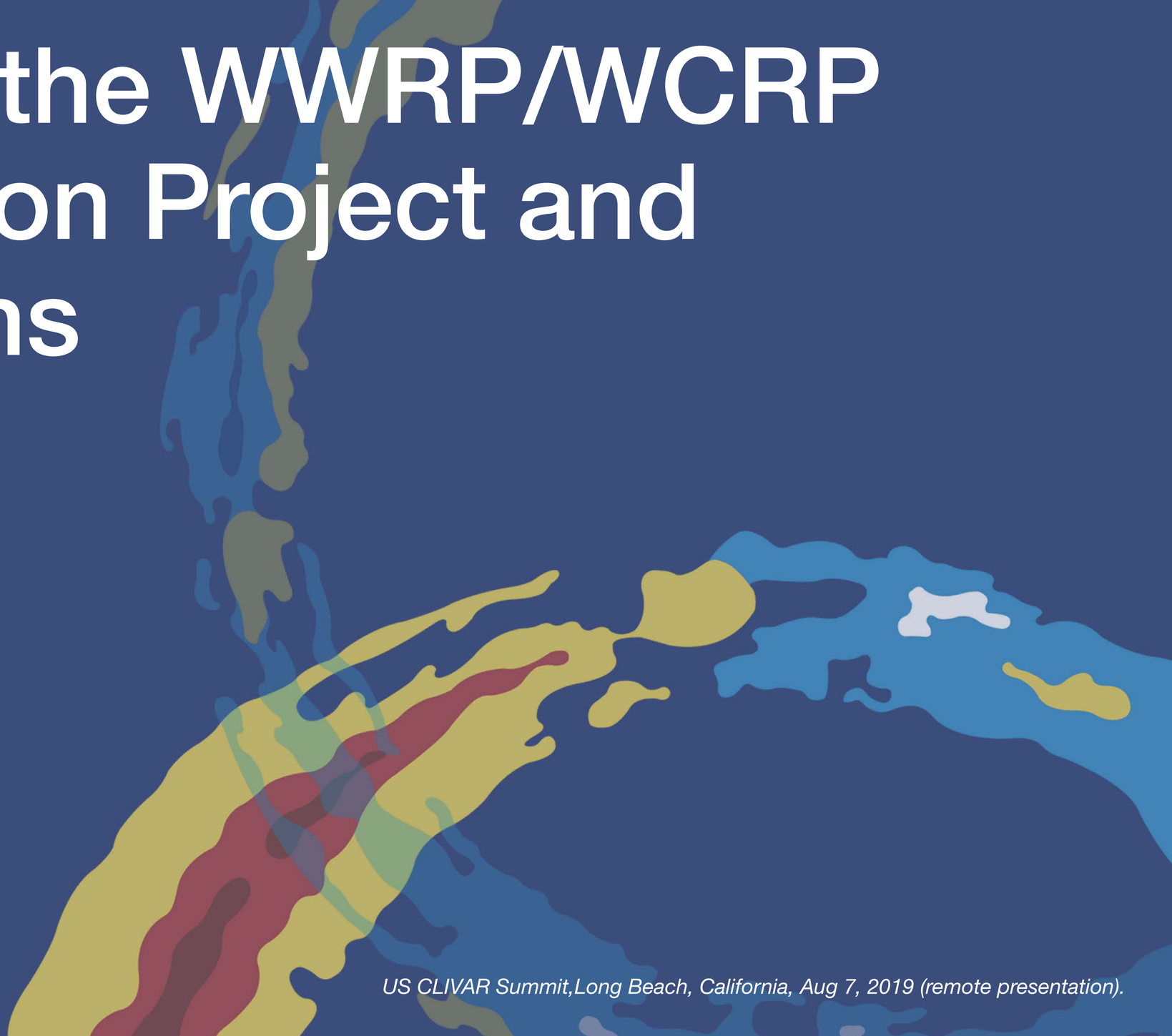
Overview of the WWRP/WCRP S2S Prediction Project and Phase II Plans

Andrew W Robertson, IRI
Frederic Vitart, ECMWF



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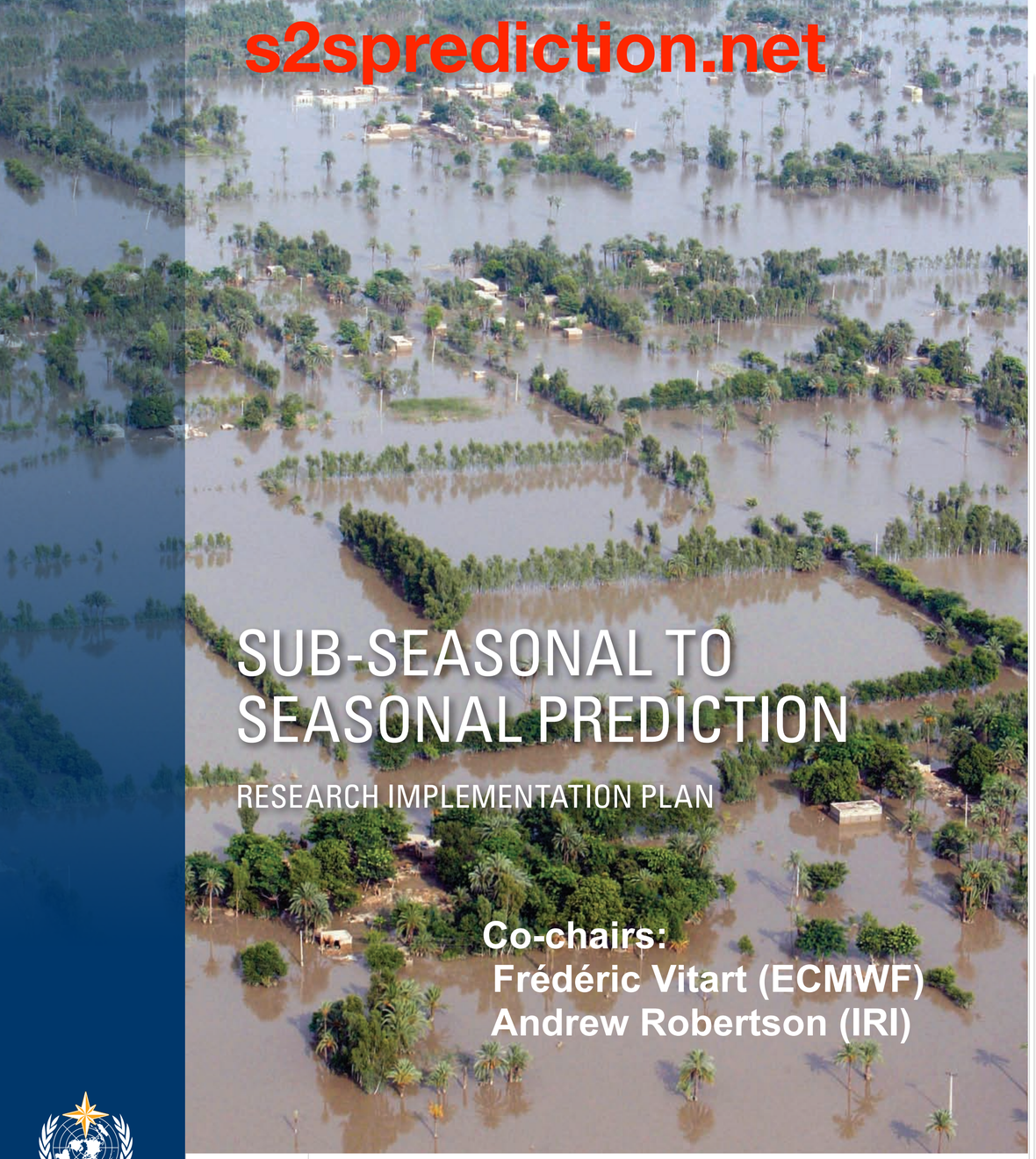
US CLIVAR Summit,Long Beach, California, Aug 7, 2019 (remote presentation).



World Meteorological Organization
Weather · Climate · Water

WWRP World Weather Research Programme

WCRP World Climate Research Programme

THORPEX A World Weather Research Programme

Subseasonal-to-Seasonal S2S Prediction Project

- 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 hosted by KMA.

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

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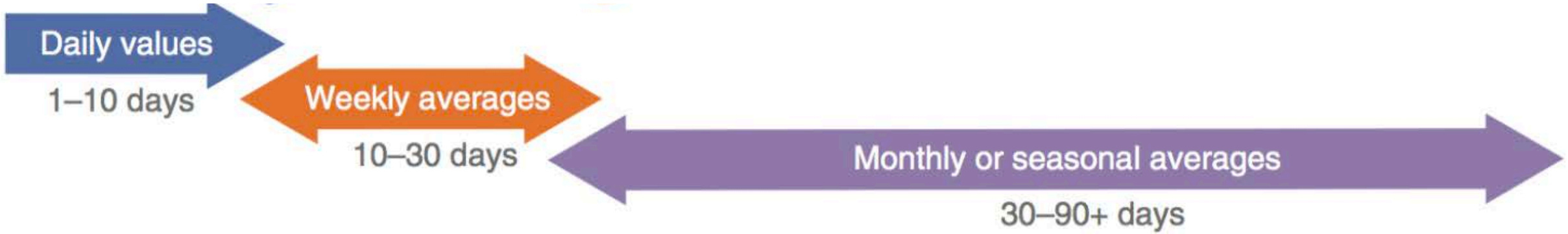
S2S Predictability

Weather:
Initial Value Problem
(e.g., baroclinic waves)

S2S:
Mixed
Initial Value (e.g. MJO) and Boundary Value Problem
(e.g. Soil moisture, snow cover/snow pack, sea ice, SST)

Climate:
Boundary Value Problem
(e.g. ENSO SST anomalies, atmos composition)



TIME AVERAGING

Predictability of the Second Kind (Lorenz, 1975)

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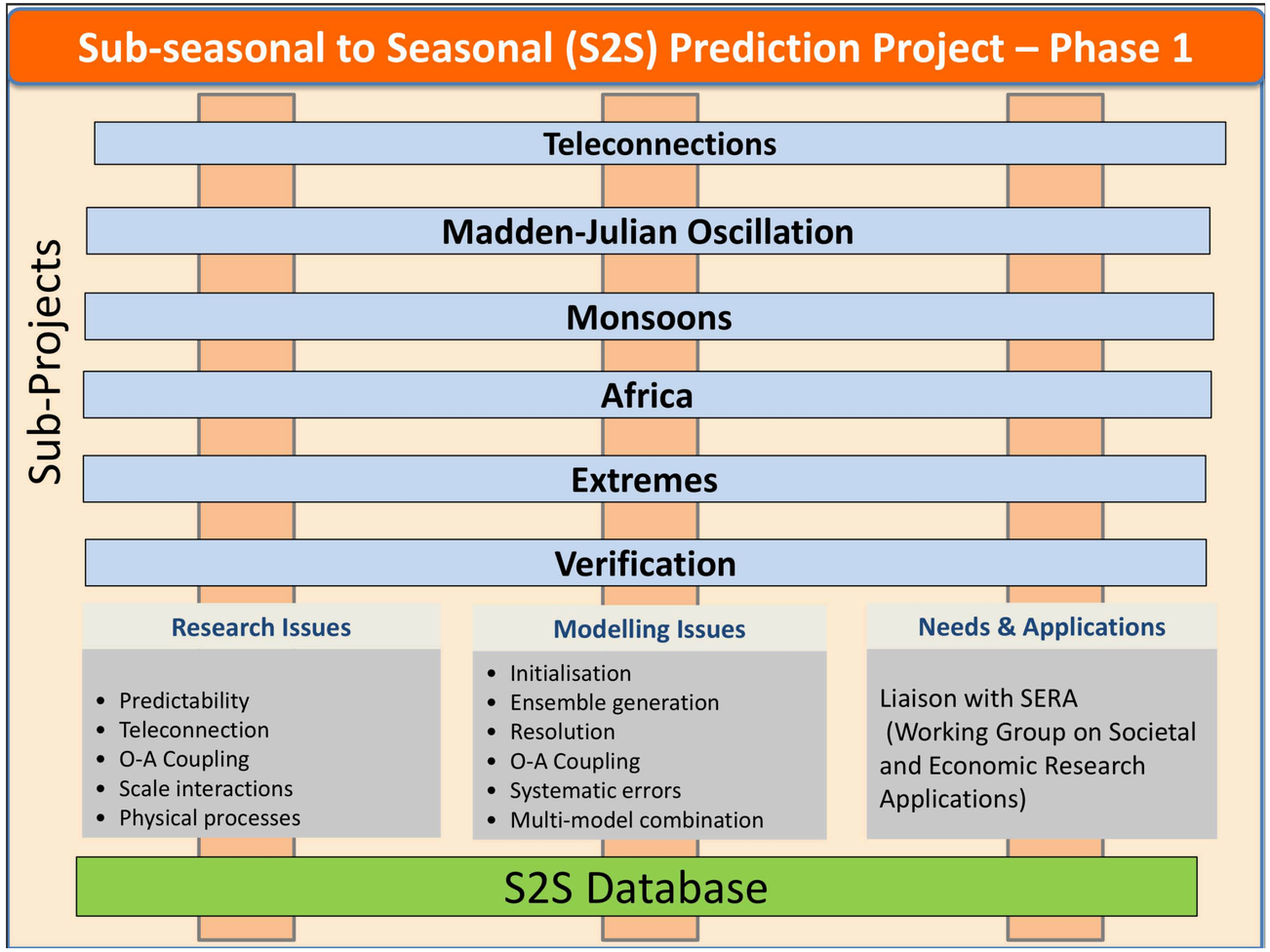
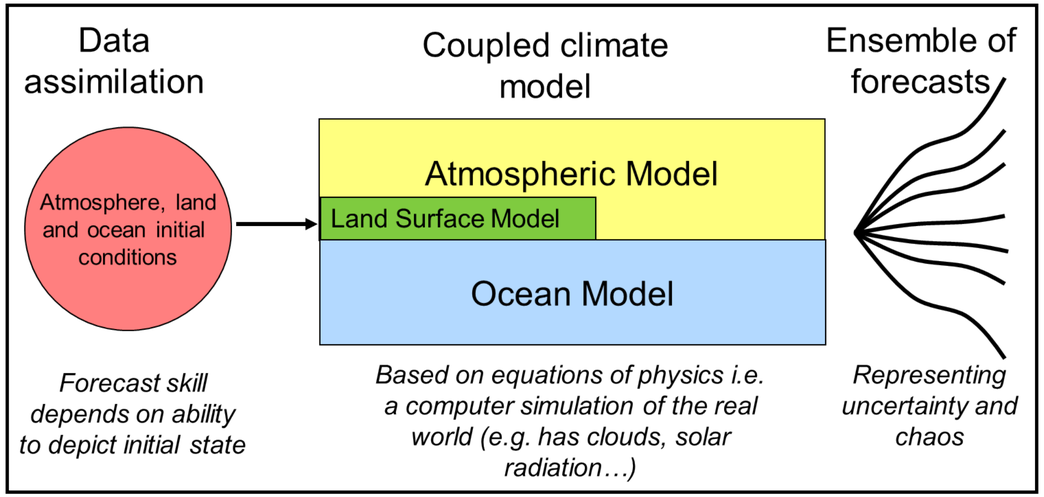
S2S Phase I: 2014–2018



Subseasonal Ensemble Prediction Systems from 11 Forecasting Centres



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

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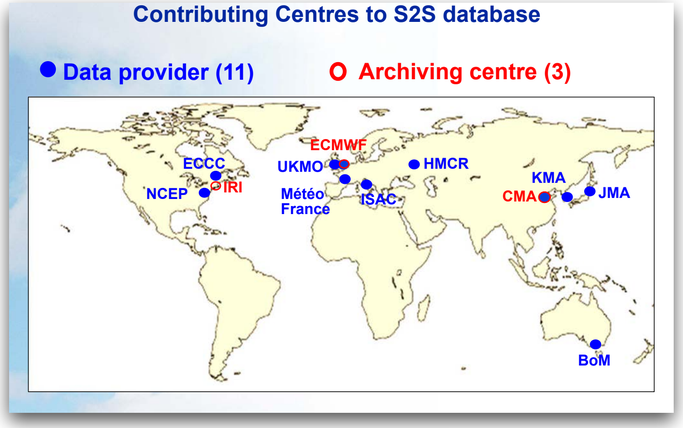
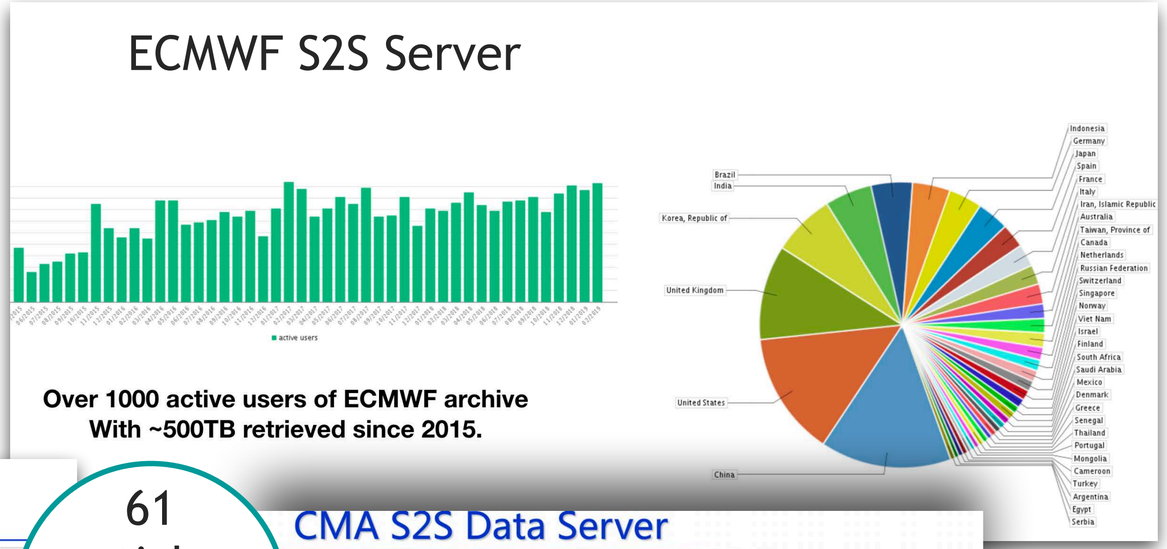
The S2S Database



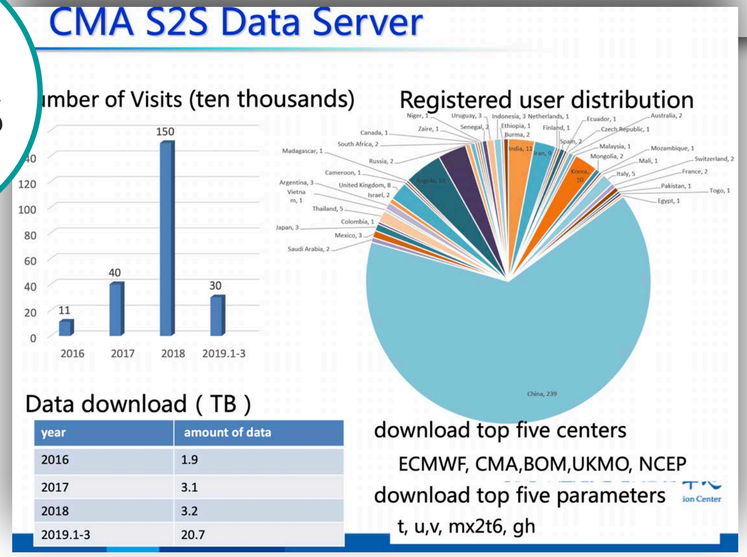


S2S Database Models

	Forecasts				Hindcasts			
Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rf
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3
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						
JMA (rjtd)	d 0-33	TI479/TI319L						
KMA (rksl)	d 0-60	N216L85						
NCEP (kwbc)	d 0-44	T126L64						
UKMO (egrr)	d 0-60	N216L85						

Forecasts available 3 week
Currently ~70 Tbytes

61 articles using S2S DB



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

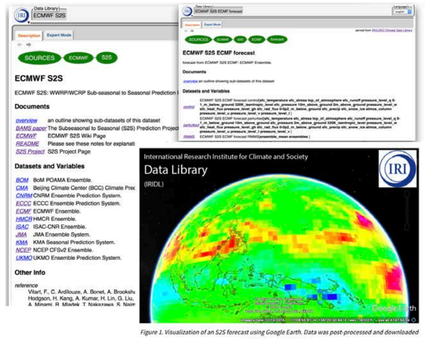


Figure 1. Visualization of an S2S forecast using Google Earth. Data was post-processed and downloaded from the IRI Data Library.

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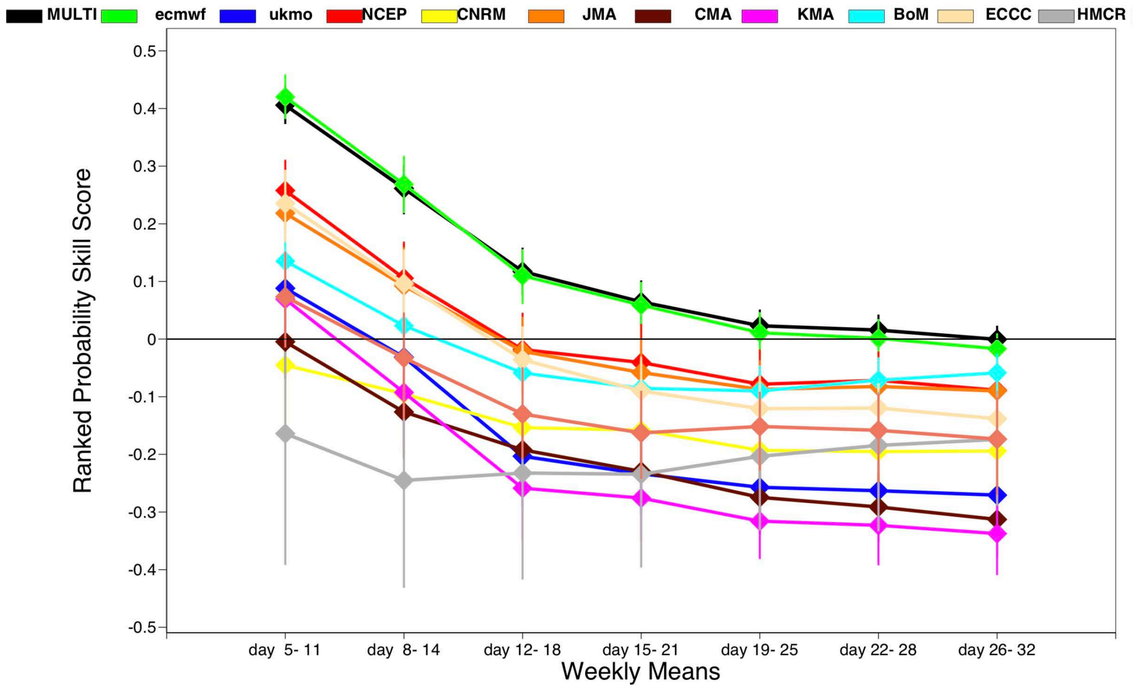
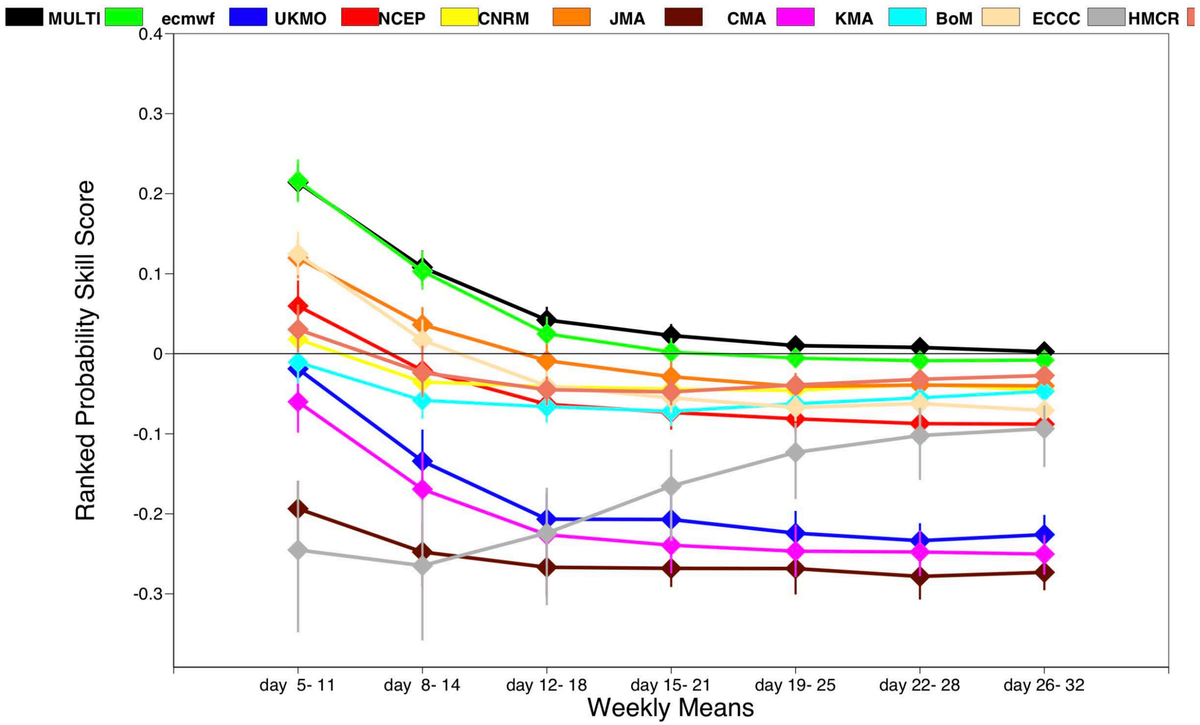
Sub-seasonal Forecast Skill

**RPSS of Weekly averages for Northern Extratropics Landpoints,
June 2017 – November 2018, vs ERA-Interim**

Temperature 2m



Precipitation



F. Vitart

- some multi-model skill up to 3 weeks ahead

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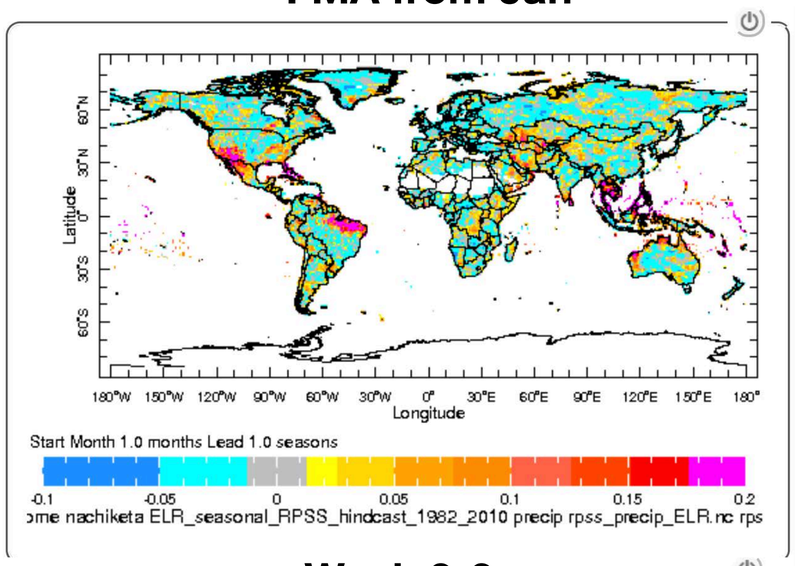
How do Subseasonal and Seasonal forecast skills compare?

Seasonal Skill

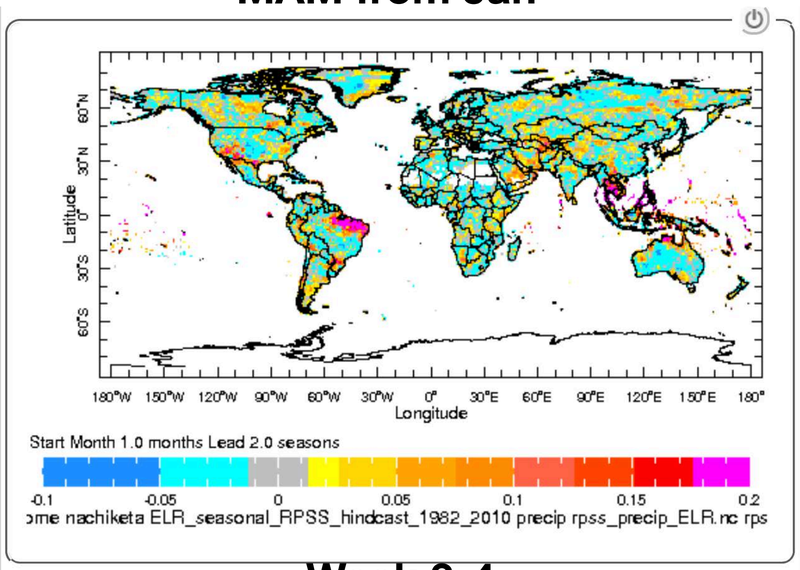
Subseasonal Skill

Precipitation Forecasts issued in January

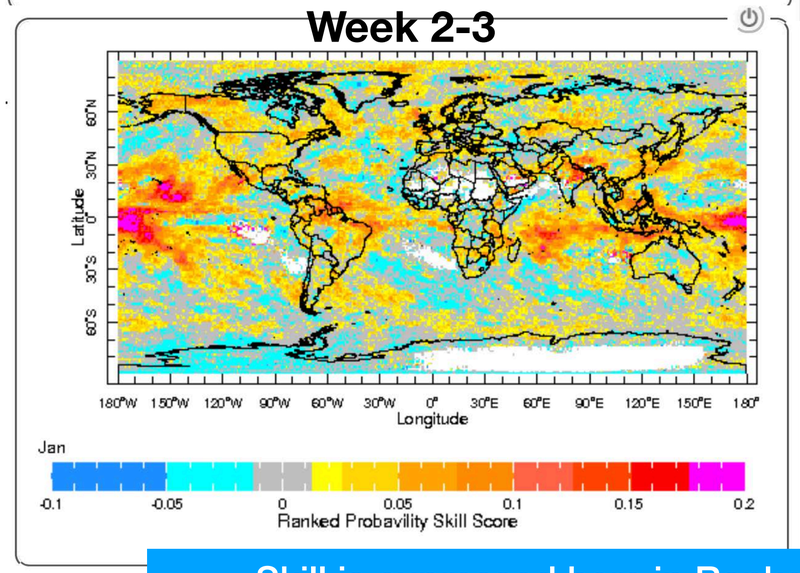
FMA from Jan



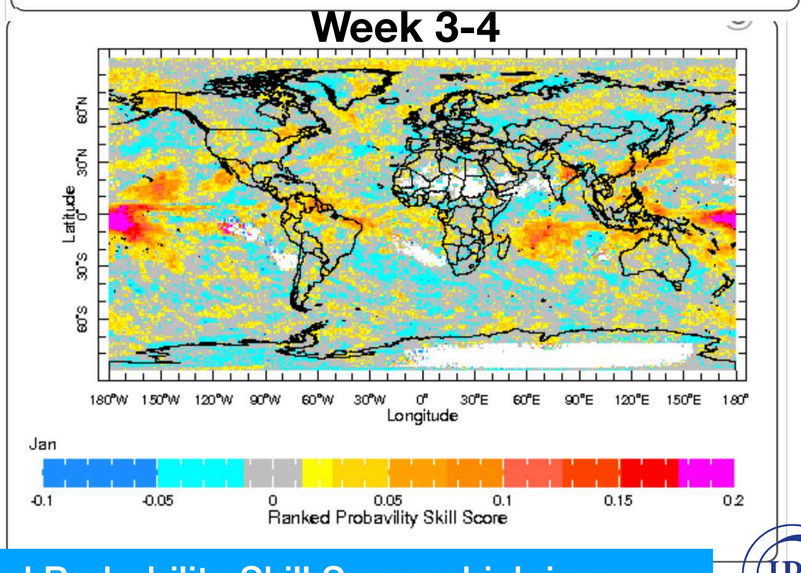
MAM from Jan



Week 2-3



Week 3-4



Subseasonal forecasts are skillful over broader areas than seasonal ones, but skill-maxima are lower

Skill is expressed here in Ranked Probability Skill Score which is a multi-category generalization of the Brier Skill Score

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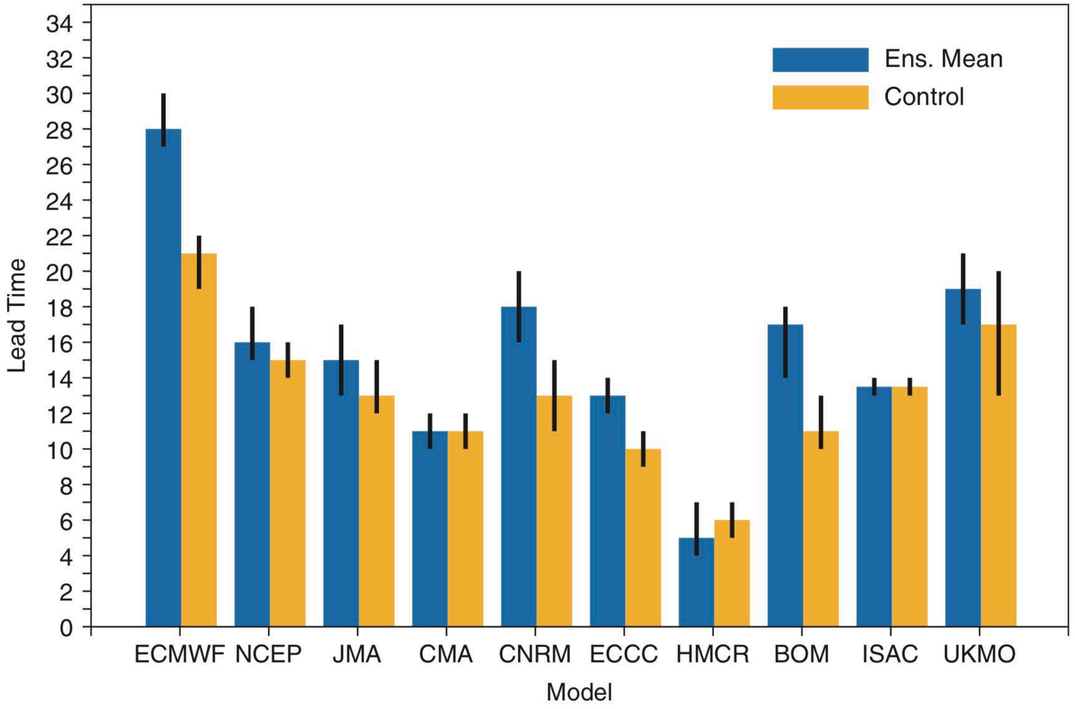
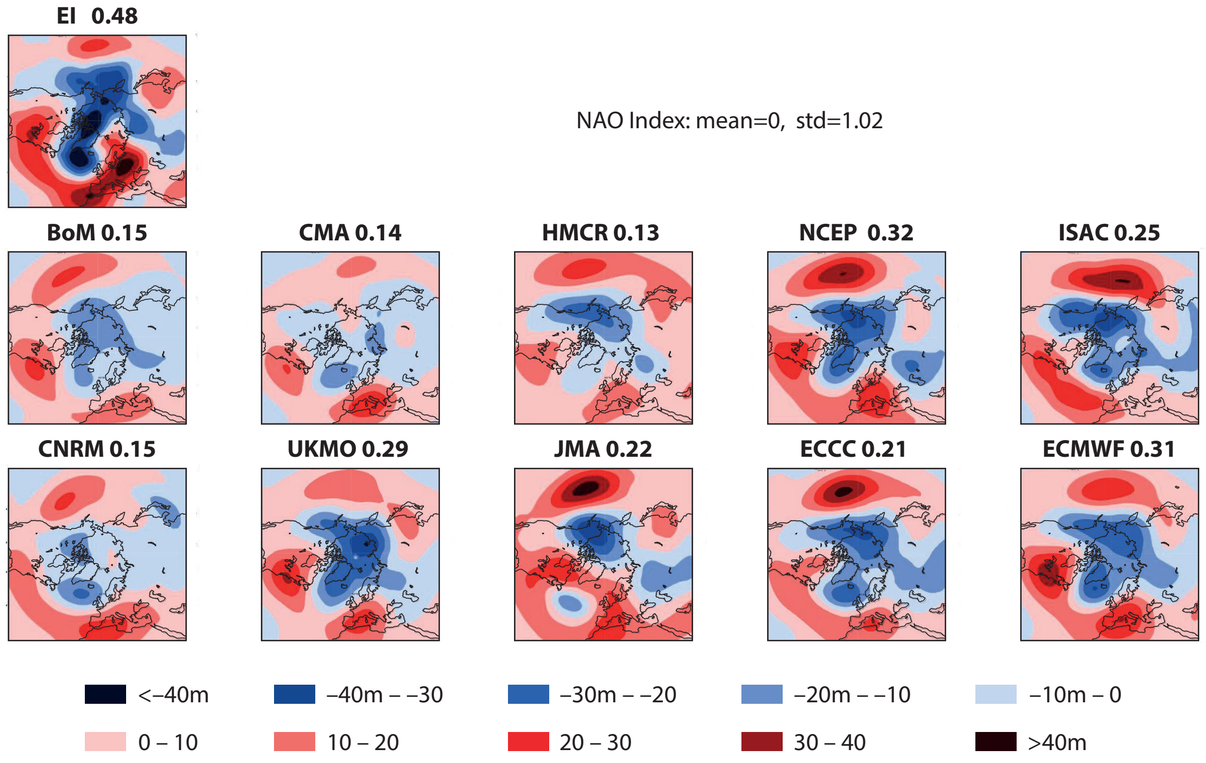
MJO Prediction

Forecast Lead Time When MJO Index Skill Reaches 0.6



Vitart (2017)

Z500 anomalies 10 days after an MJO in Phase 3



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

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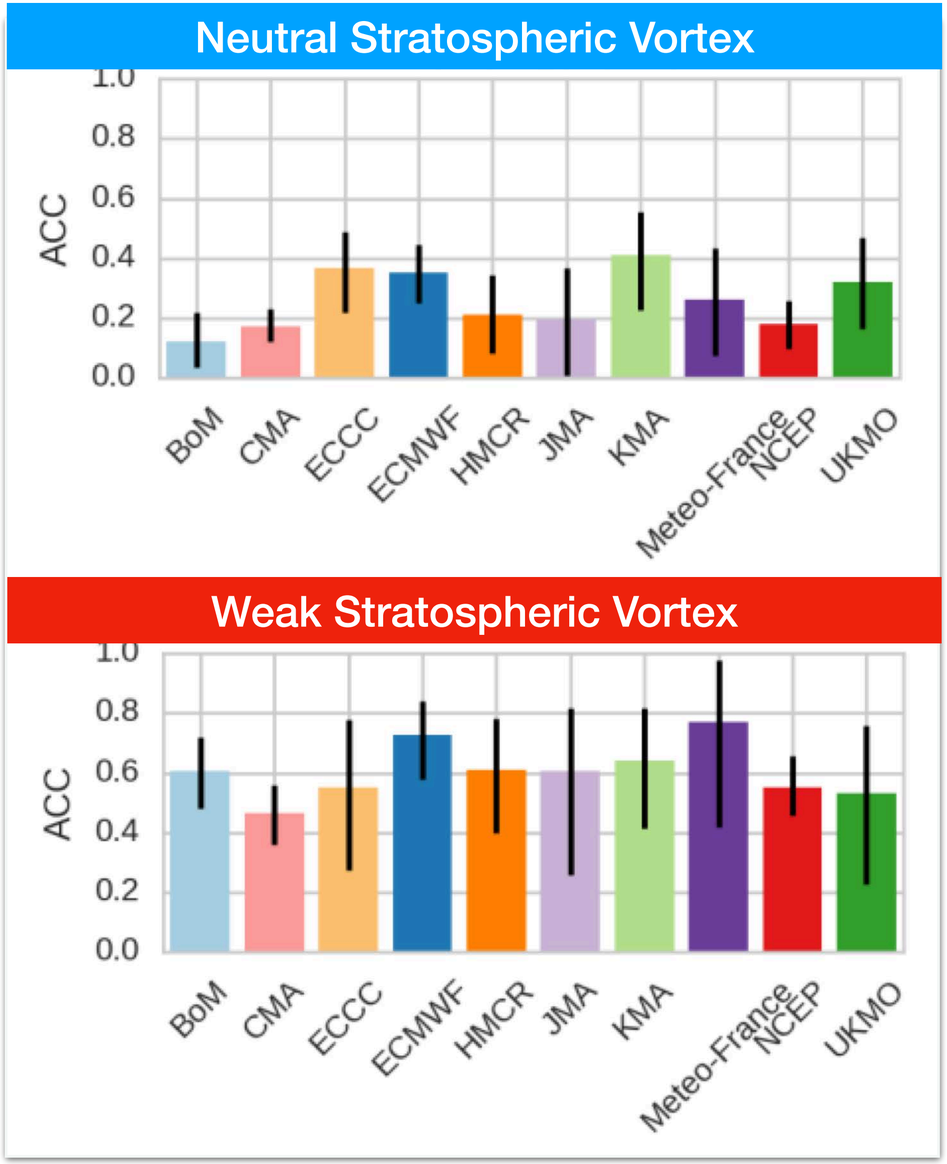
Stratospheric Polar Vortex Events



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

- For most models, skill is higher following weak vortex conditions.
- Similar results are found following strong vortex conditions.

SPARC-SNAP

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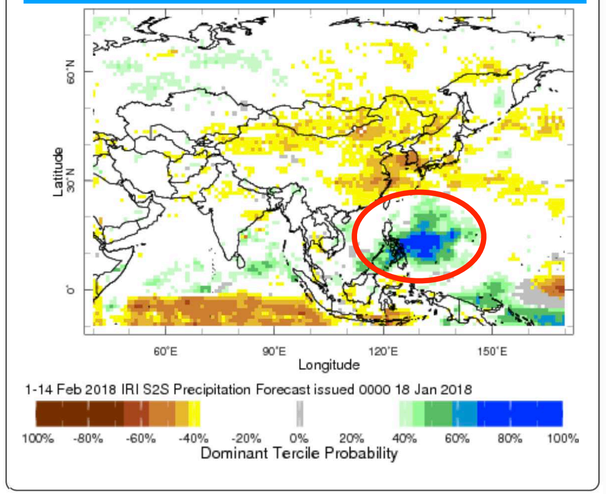
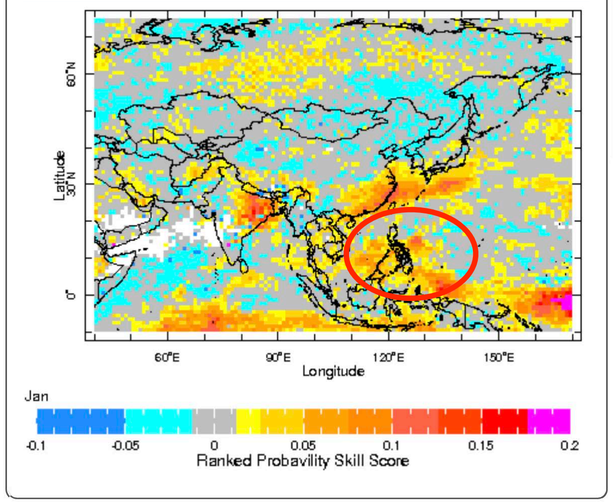
Calibrated S2S Forecast Product Development [R2O]

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?

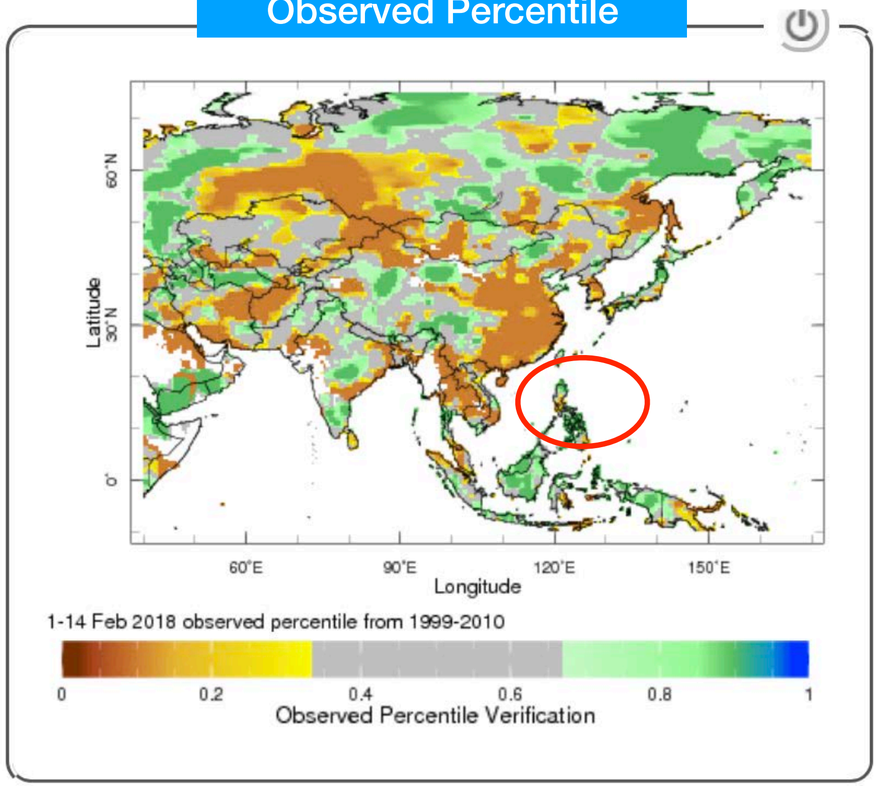
Week 3–4 Forecast



Probabilistic Skill



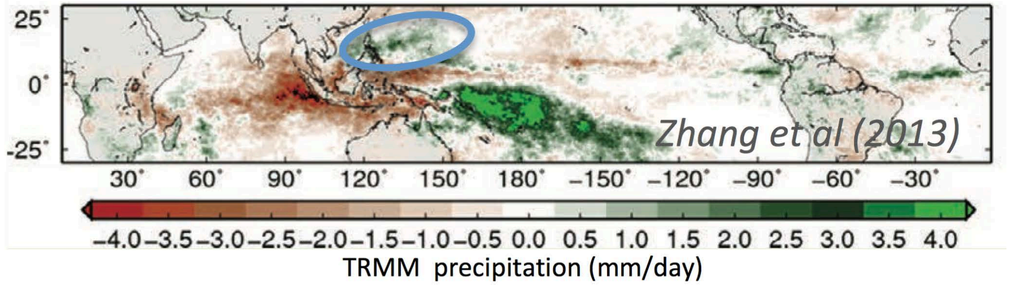
Observed Percentile



- Probabilistic multi-model calibrated forecasts show skill
- MJO often plays a role analogous to ENSO in seasonal forecasting

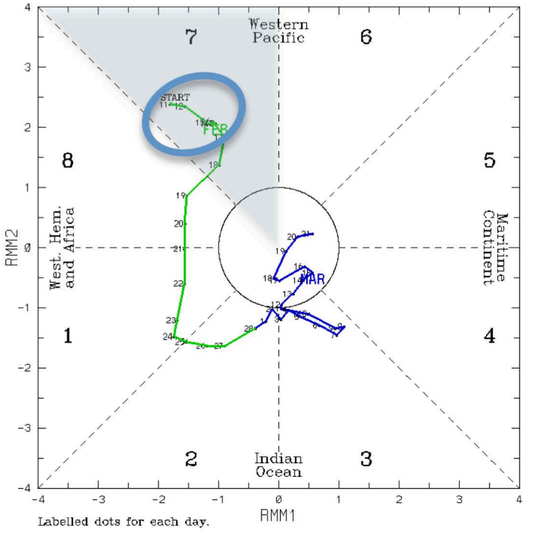
MJO Impacts

MJO phase 7 precipitation anomalies (1998-2012 baseline)



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

N. Vigaud, IRI



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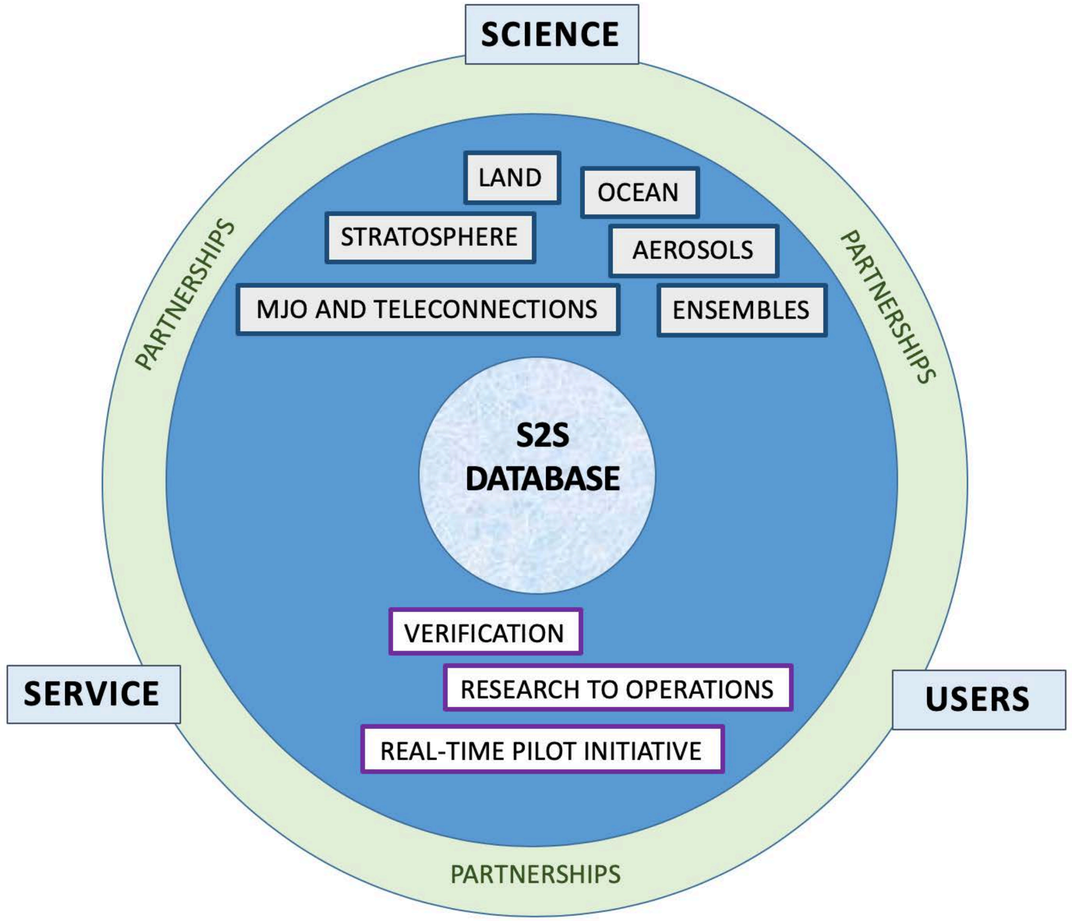
S2S Phase II: 2019–2023



Science

New research foci on improving S2S forecasts and understanding

Research-Operations Applications Dev.

New activities to demonstrate S2S forecast applications value and improve operational infrastructure

Data Infrastructure

Enhance S2S Database

Ocean variables, more surface variables 4xdaily, additional models (eg IMD)

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Phase II Science Subprojects

Land-atmosphere coupling & initialization
MIPS: LS4P, LFMIP-OBS, GLACE-ESM SnowGLACE.
GEWEX-GASS
WGSIP

Ocean
coordinated case studies of ocean extreme events & air-sea interaction. Sea ice prediction assessment.
CLIVAR, CliC

Aerosols
S2S/WGNE coord expt with/without interactive aerosols.
4-6 modeling centers
WGNE, GAW

MJO Teleconnections
Systematic errors
Relationships w/ extremes
WGSIP, WWRP

Impact of the ocean obs system
on S2S forecasts: data denial expts (eg XBT, ARGO T/S profiles)
ECMWF, JMA

Stratosphere
Nudging expts to better understand impact of SSWs. Also impact of QBO on the MJO.
SPARC

Ensembles
Stochastic physics sensitivity expt.
WGNE, PDEF
DAOS

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Phase II Focus on R-O & Applications

Research-Operations

- Develop criteria for GPCs.
- Work with WMO Lead Centre for long-range forecasts on real-time MME product
- Recommend verification scores, MME methods, calibration, product development research

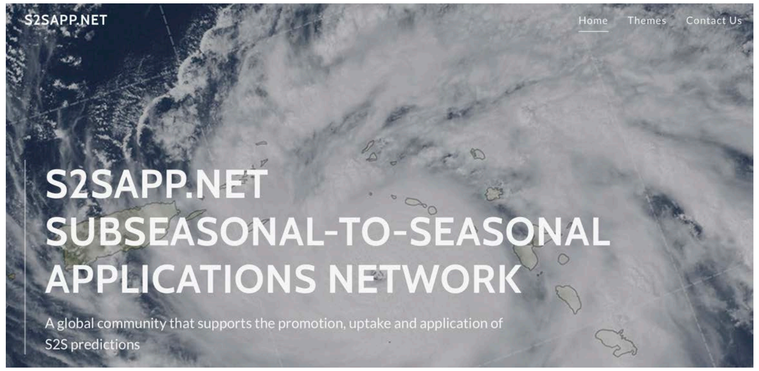
WMO, JWGFV

Real-Time Forecast Pilot Expt.

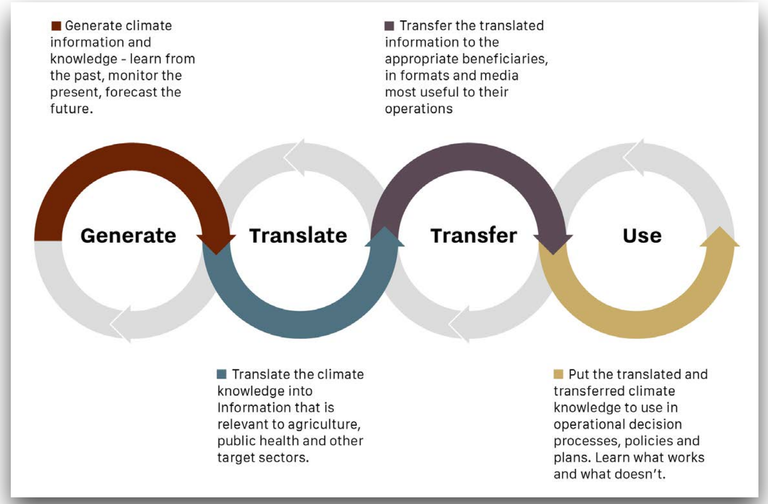
Real-time access for applications demonstrations. 2-years,
18 projects under dev:
What? S2S forecasts for agriculture, water resources, energy, health, DRM (Floods, drought, TCs) Sea Ice,
Where? Africa, SE Asia, Amazonia, Western US, Europe, S America

WWRP SERA

S2S Applications Network



Toward Climate Services



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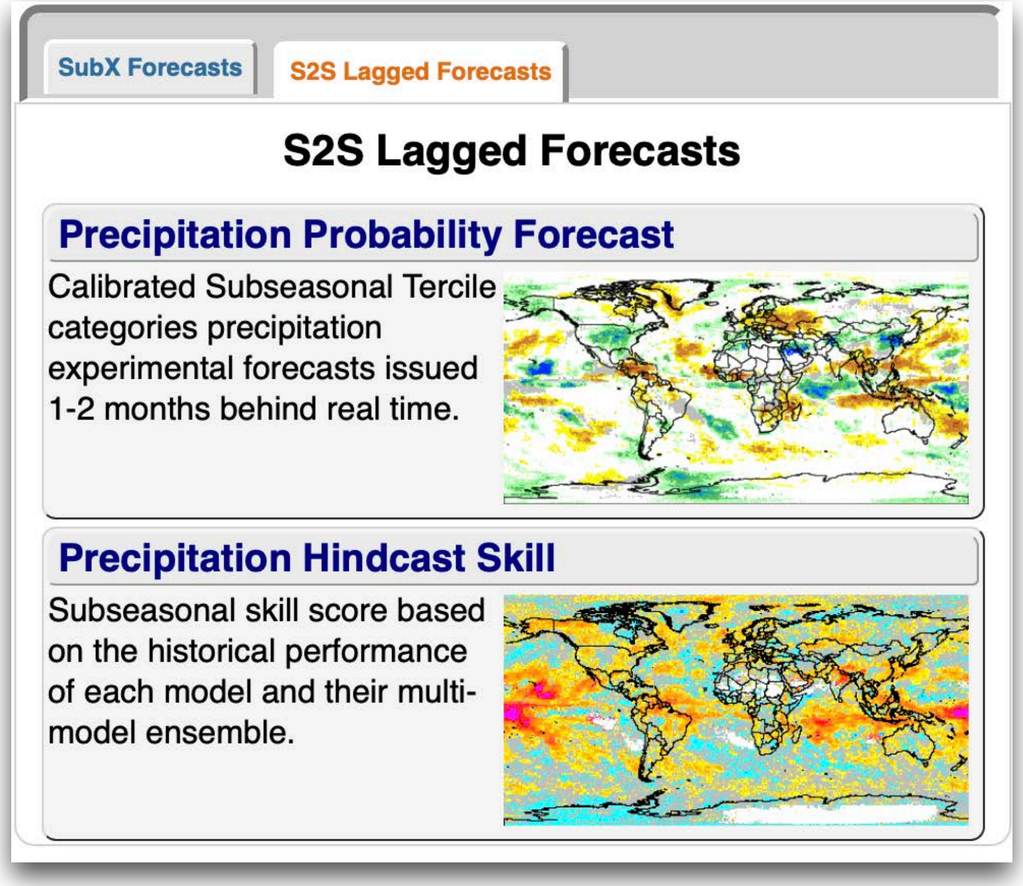
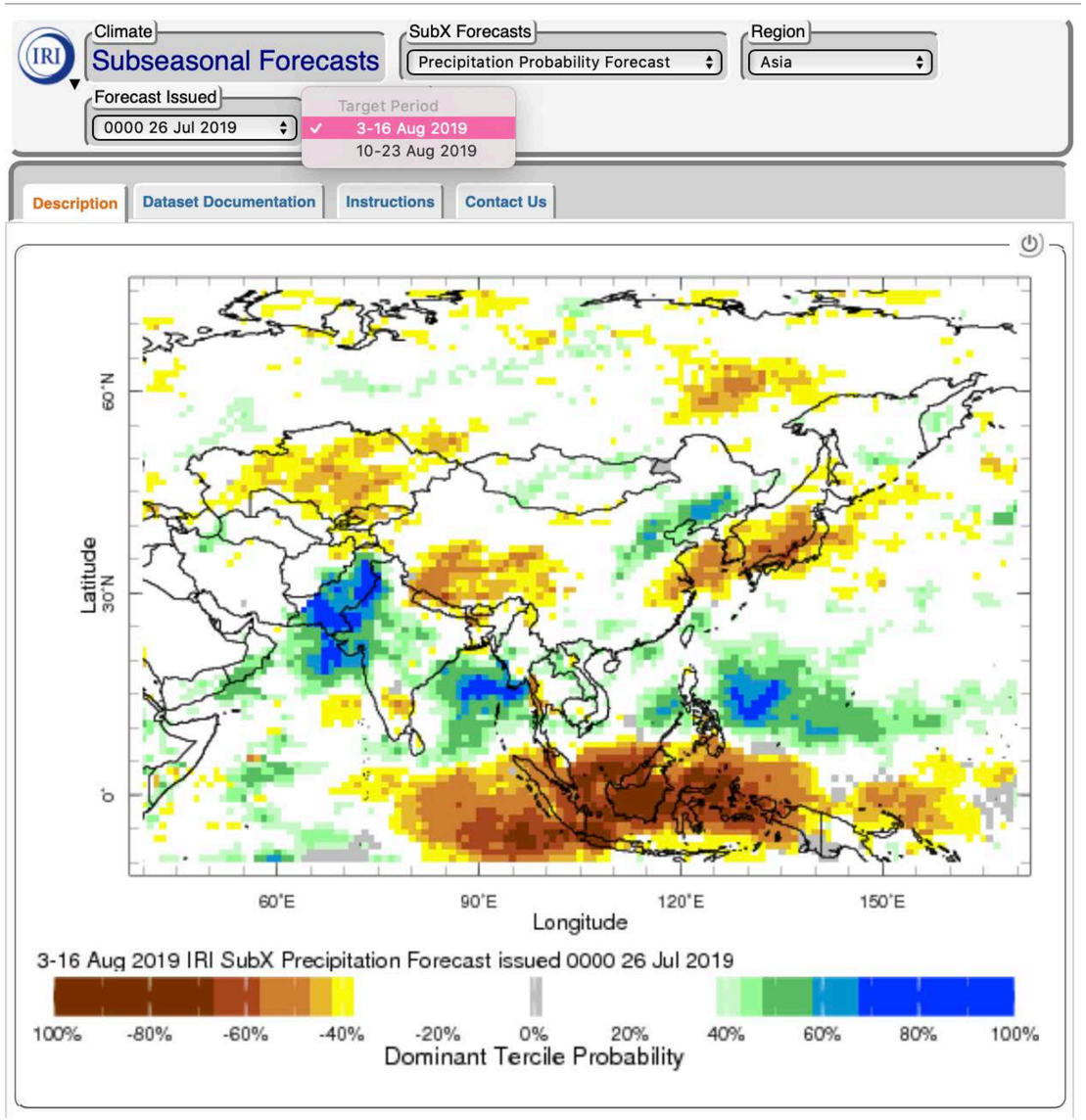
IRI Subseasonal Forecast Maprooms

Lagged S2S, every ~month



Real Time SubX, every Friday



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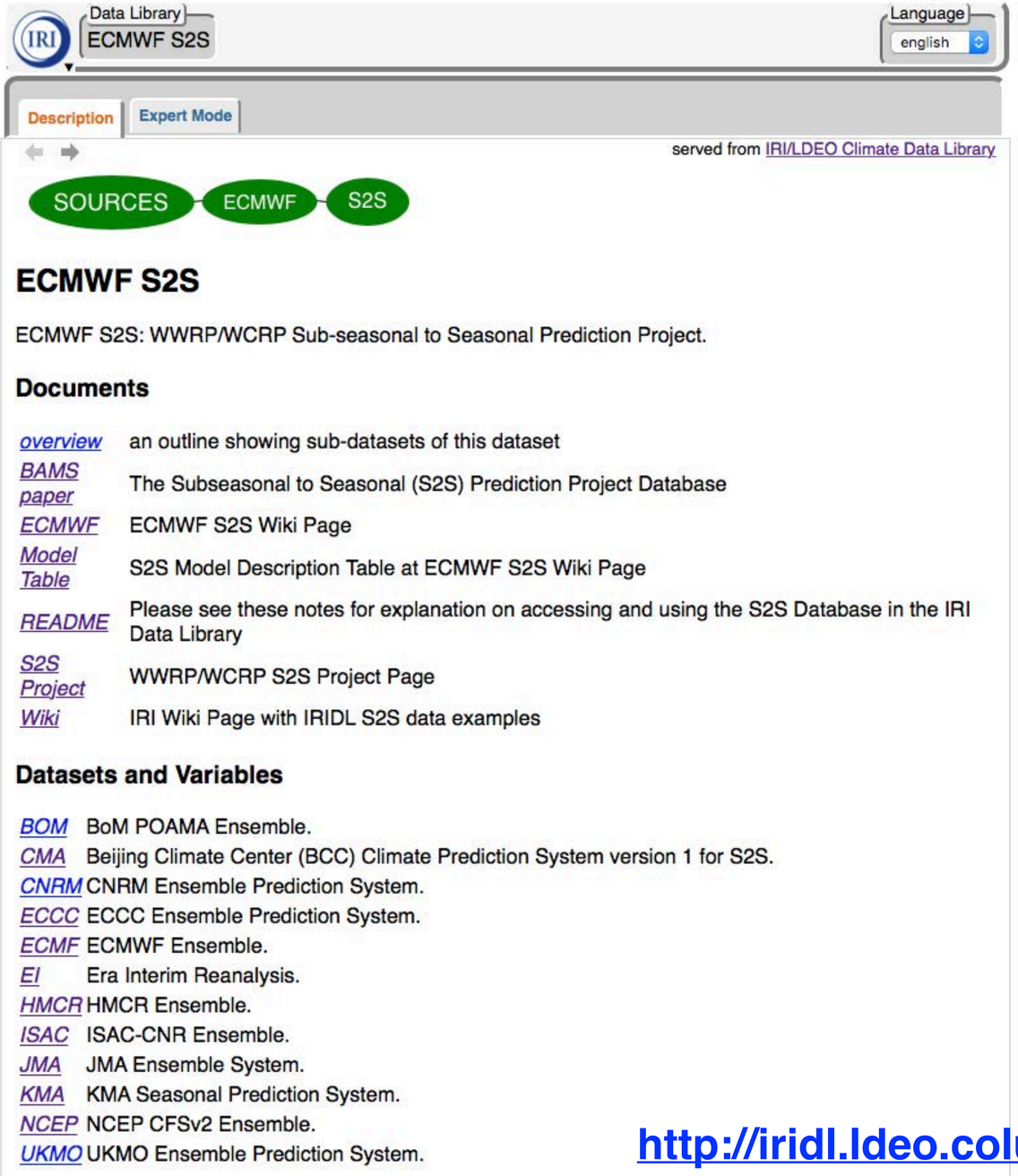
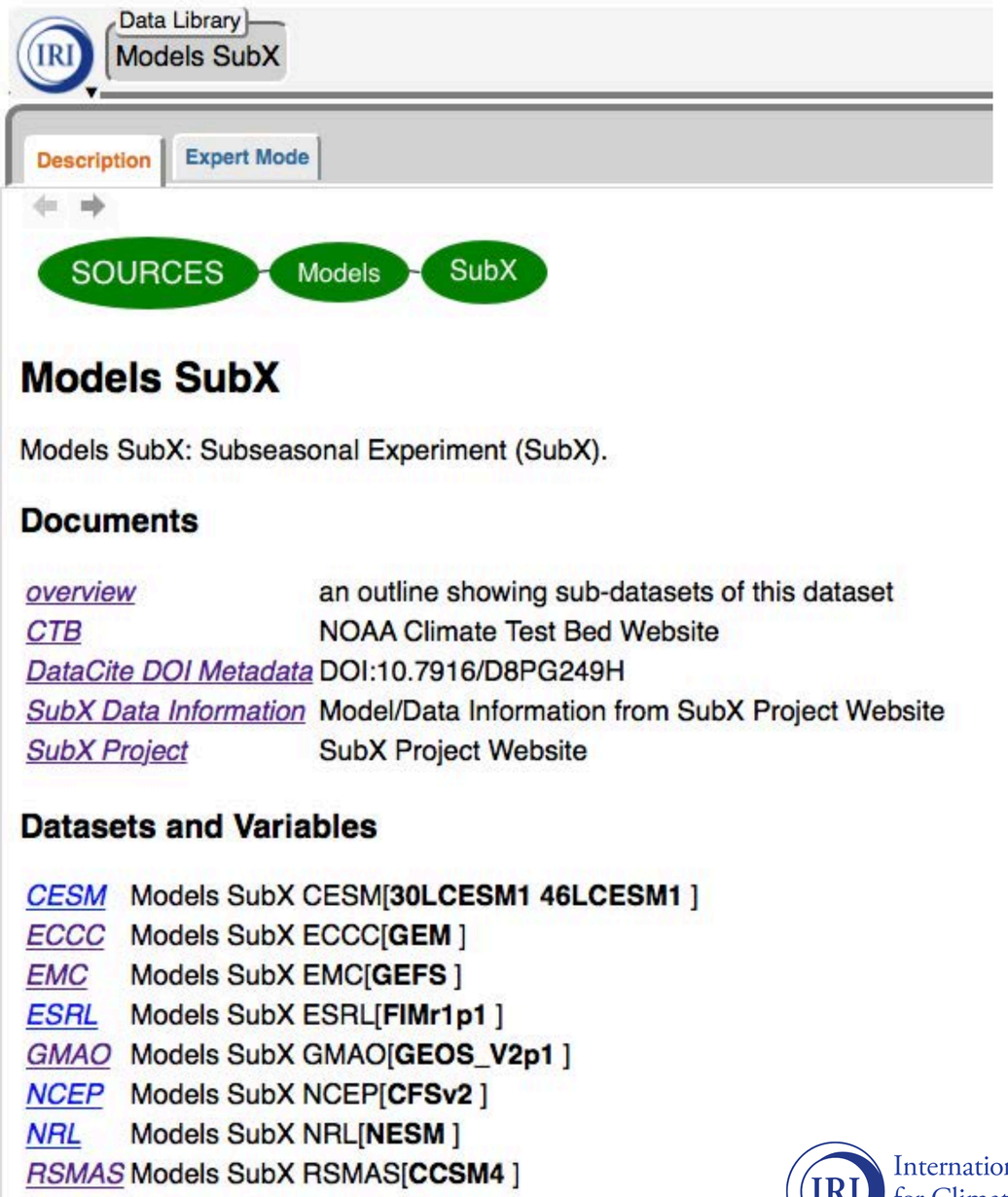
http://iridl.ldeo.columbia.edu

S2S and SubX databases in IRI Data Library





http://iridl.ldeo.columbia.edu

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Summary

s2sprediction.net

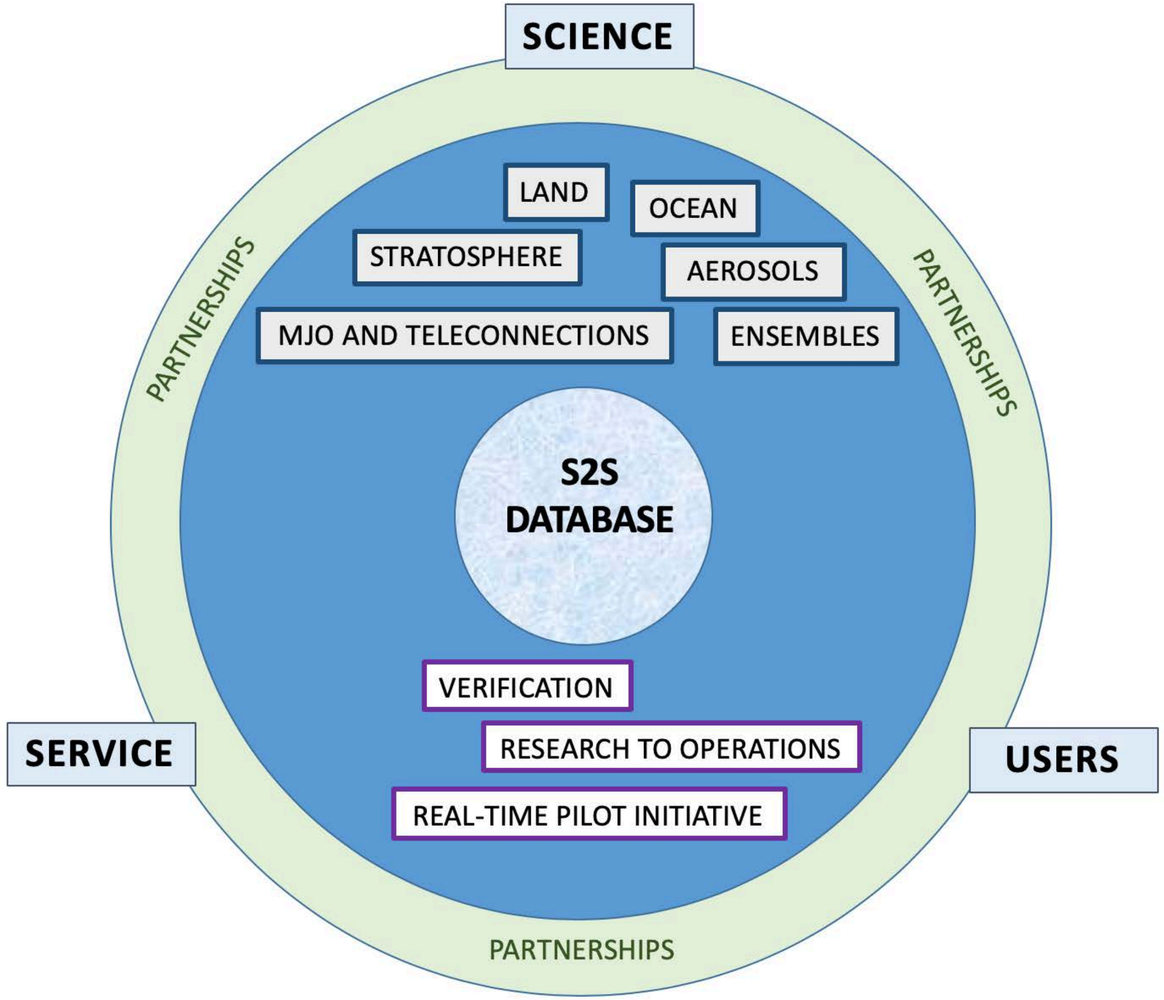
- S2S is still an emerging area of research, improving forecast capabilities and product development – bringing together weather and climate communities toward more “seamless” prediction across scales, as well as researchers/forecasters/users.

- Creation of multi-model NMME, S2S and SubX databases 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 is real-time and demonstrates the value of multi-model combination to enhance skill.



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