



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



# Sub-Seasonal to Seasonal (S2S) Prediction Project Report for WCRP JSC-39

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# SUB-SEASONAL TO SEASONAL PREDICTION

RESEARCH IMPLEMENTATION PLAN

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



- 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.*



World Meteorological Organization  
Weather · Climate · Water





# S2S Membership



## Steering Group

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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.

# Sub-seasonal to Seasonal (S2S) Prediction Project

Sub-Projects

Teleconnections

Madden-Julian Oscillation

Monsoons

Africa

Extremes

Verification and Products

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)

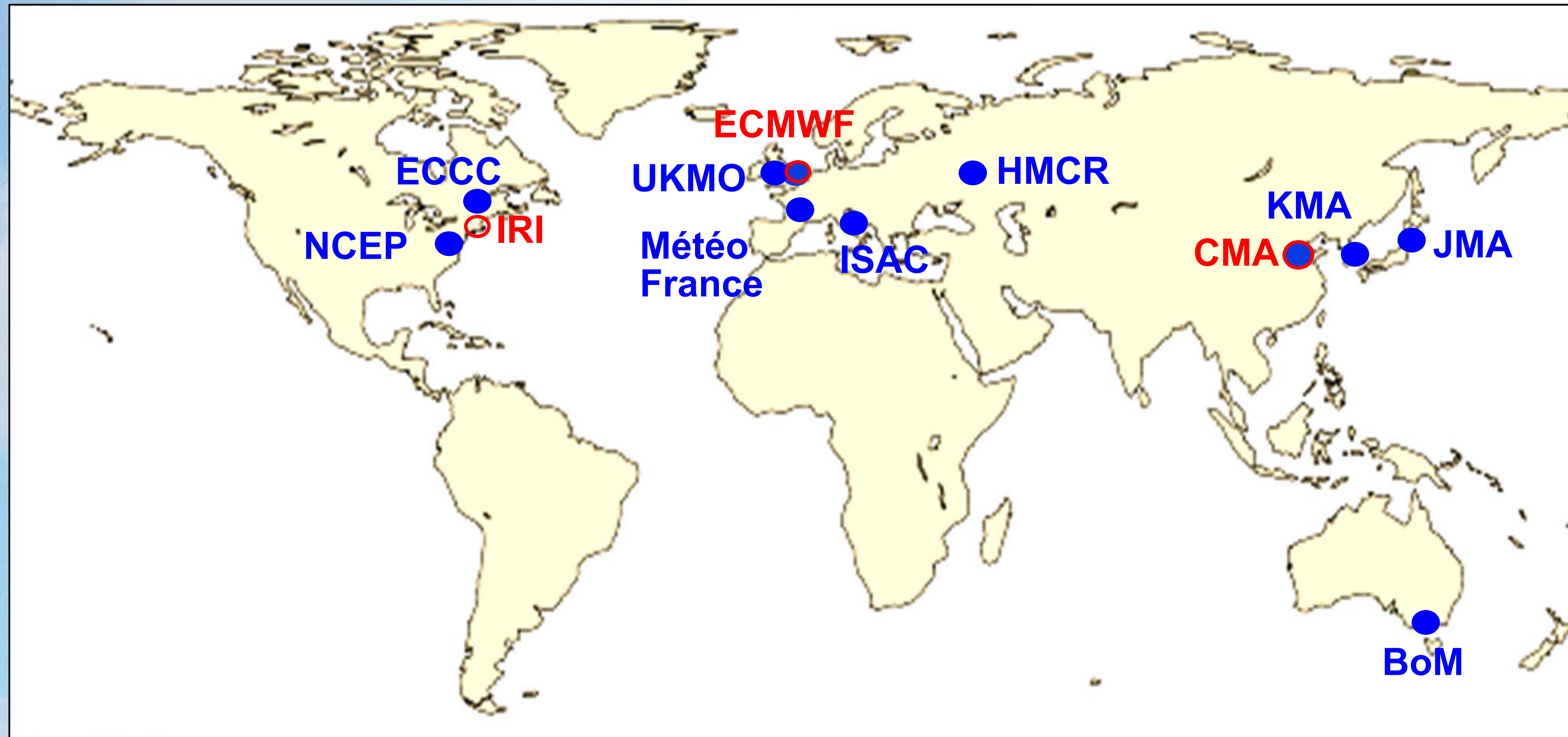
S2S Database



# Contributing Centres to S2S database

● Data provider (11)

○ Archiving centre (3)





# S2S Models

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

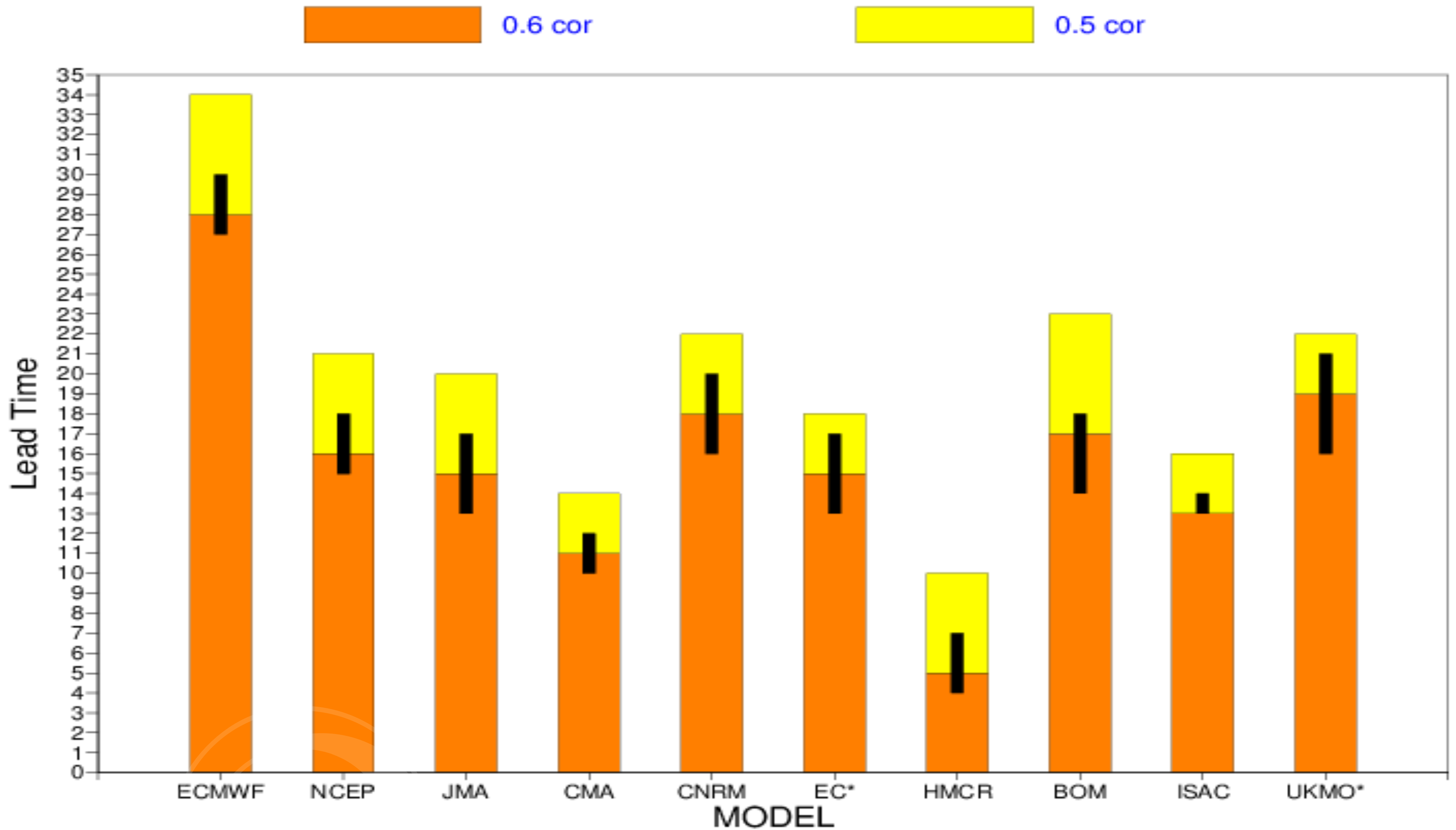
see [s2sprediction.net](http://s2sprediction.net) for details and to access data

Currently 70 Tbytes

**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**

# MJO Forecast Horizon now reaches up to 30 days ahead

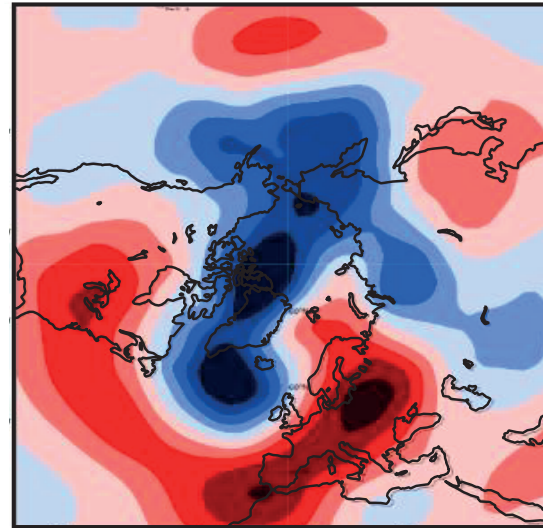
MJO Bivariate Correlation  
S2S REFORECASTS 1999-2010





# Biases in MJO Teleconnections (S2S re-forecasts)

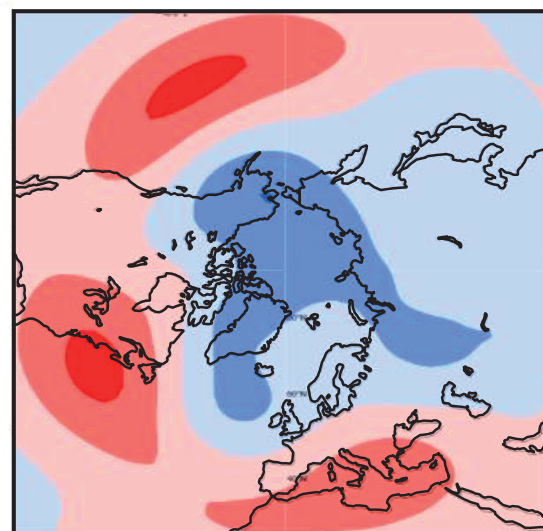
EI 0.48



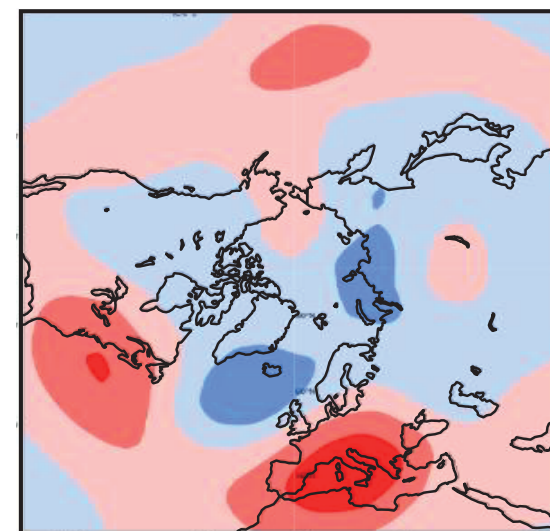
Z500 anomalies 10 days after an MJO in Phase 3

NAO Index: mean=0, std=1.02

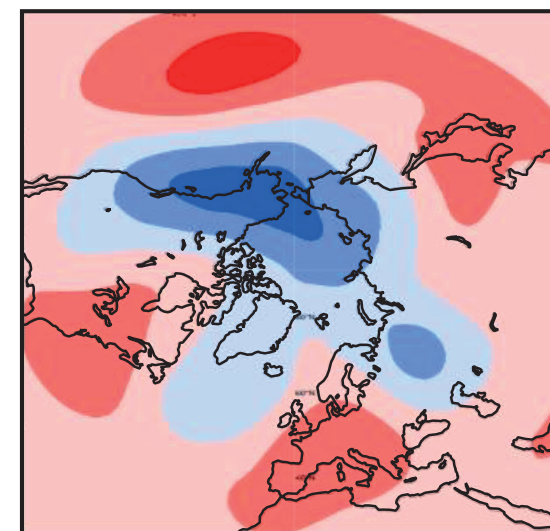
BoM 0.15



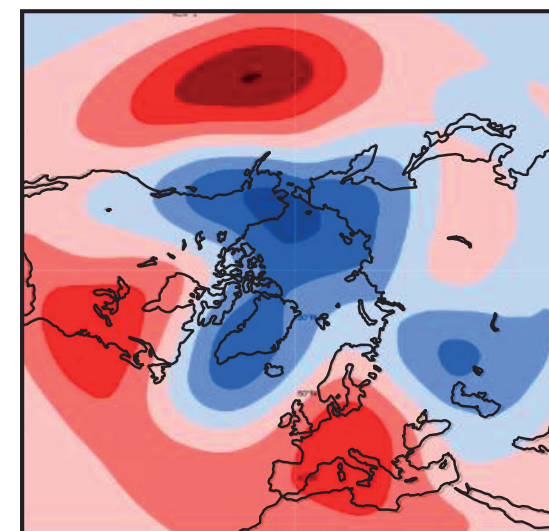
CMA 0.14



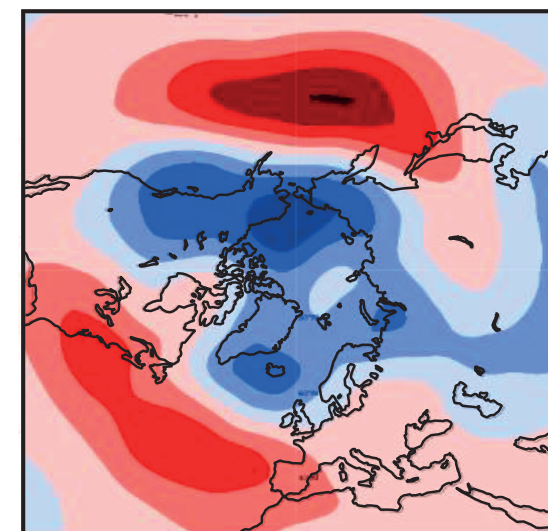
HMCR 0.13



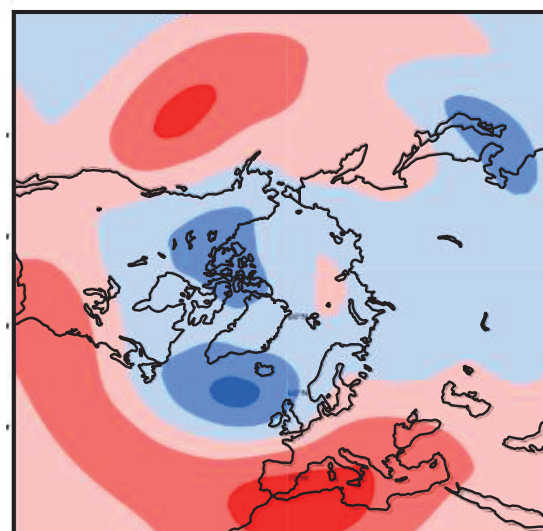
NCEP 0.32



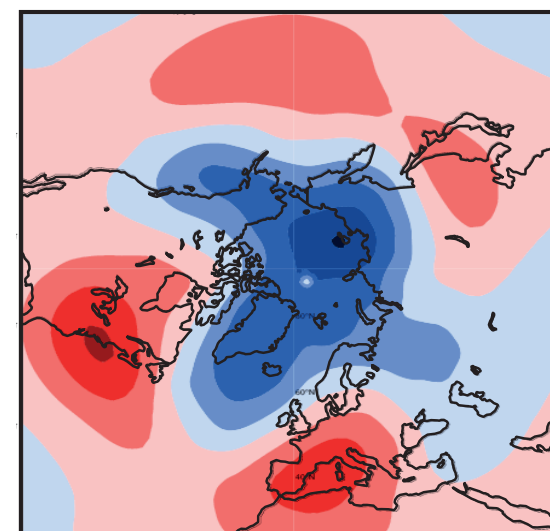
ISAC 0.25



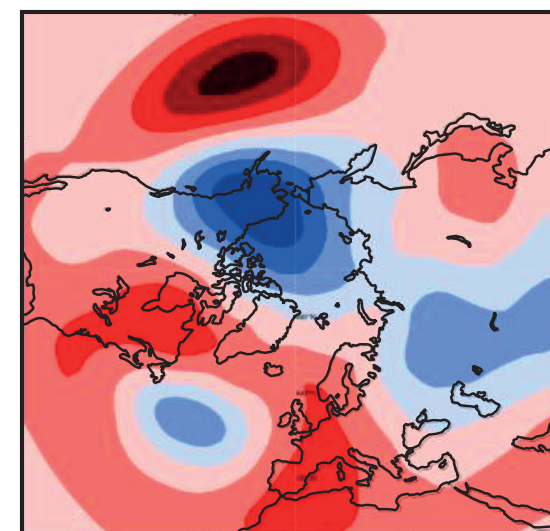
CNRM 0.15



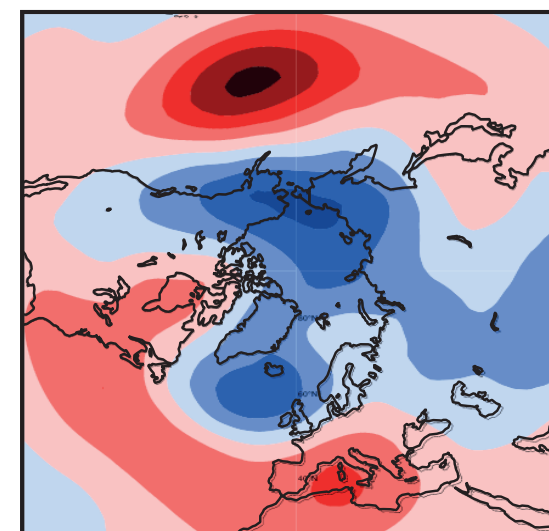
UKMO 0.29



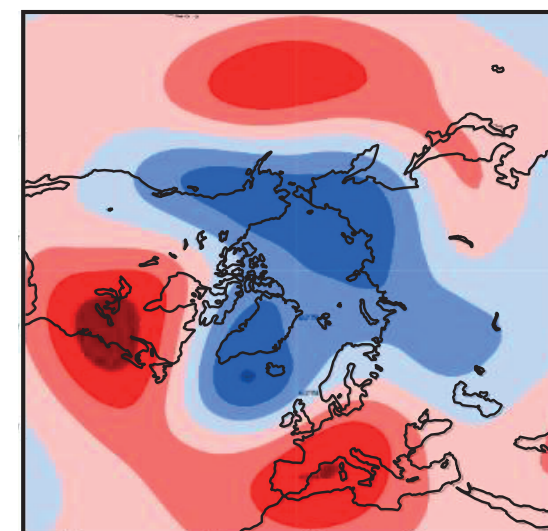
JMA 0.22



ECCC 0.21



ECMWF 0.31



<-40m

-40m - -30

-30m - -20

-20m - -10

-10m - 0

0 - 10

10 - 20

20 - 30

30 - 40

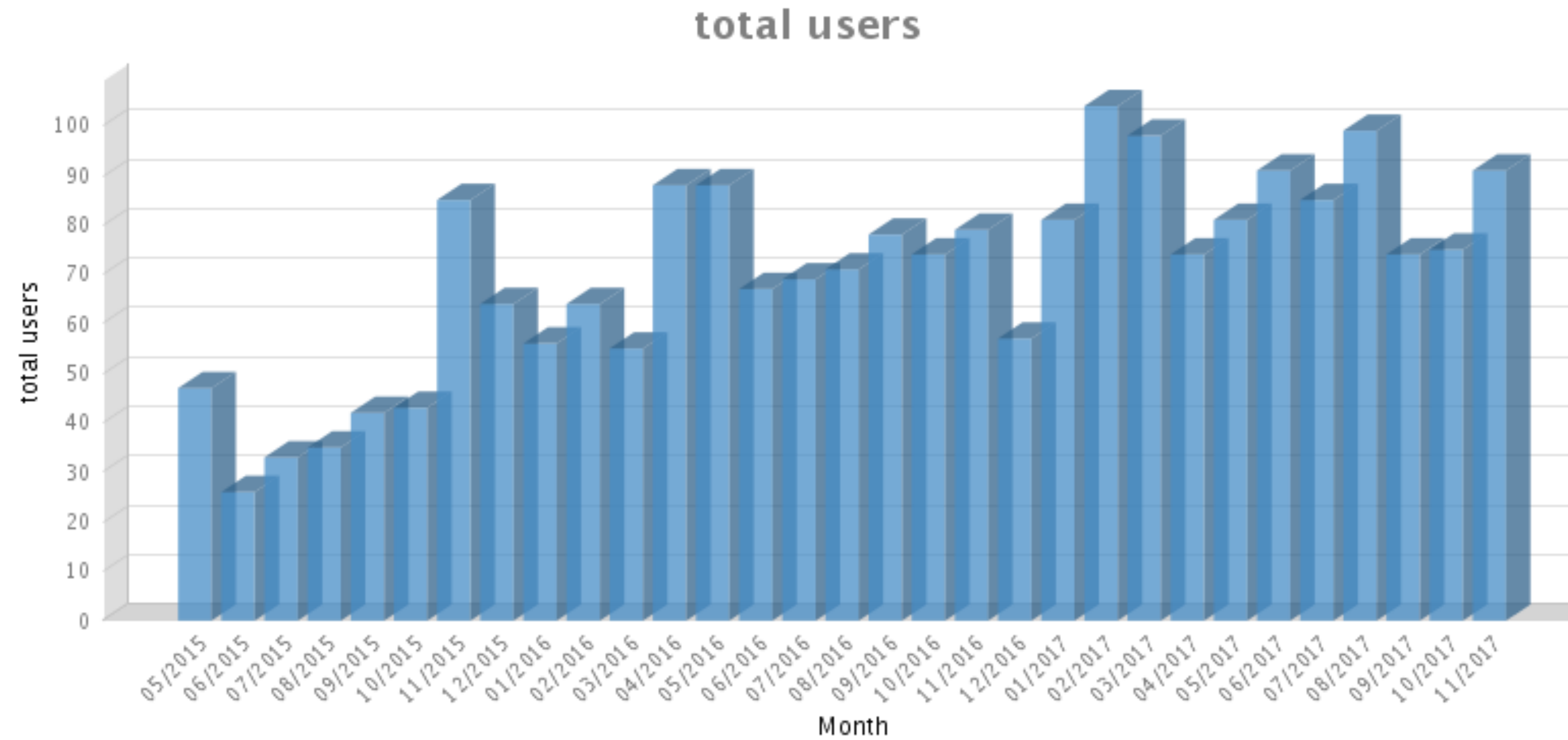
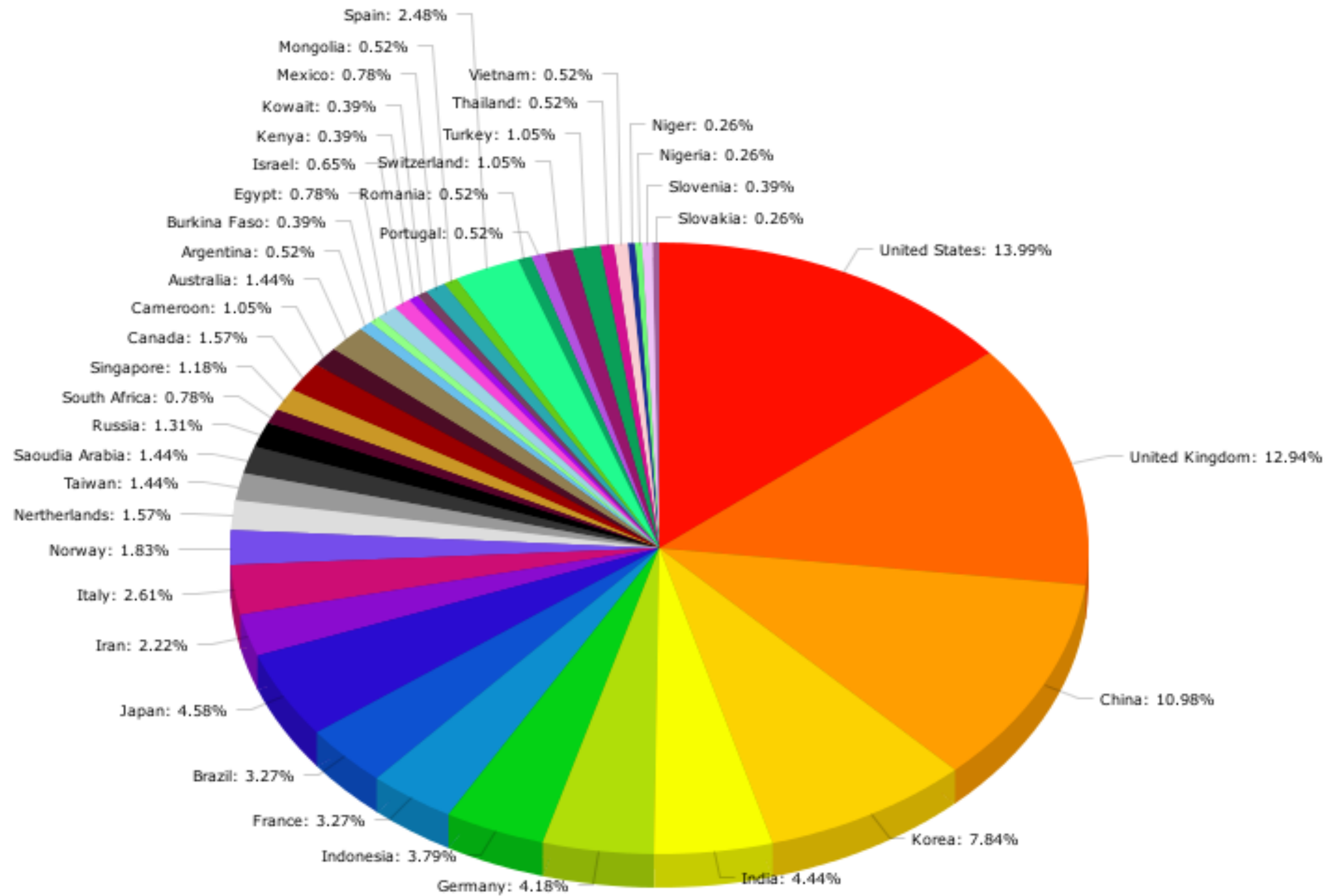
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# Increasing use of the S2S database

by end of 2017:

- 848 registered users from 88 countries at ECMWF
- 222 register users mostly from China at CMA





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

(November 2013–December 2017)

Proposal submitted for 5-year extension 2018-2023 (S2S Phase 2) for approval by the WMO EC in June 2018. Already approved by WWRP SC and WWRP JSC.

## S2S Phase 2 plans:

- **S2S Database enhancement** – ocean variables, more surface variables 4xdaily, additional models (eg IMD)
- **New research foci** (sub-projects) – **MJO** prediction and teleconnections; roles of **Ocean and sea ice, Land surface, Stratosphere, Atmospheric composition** and **Ensemble generation**.
- **Enhancing operational infrastructure, user applications & real-time pilot experiment**

# New S2S research foci

- **MJO prediction and Teleconnections:** incl. high impact weather in the tropics/subtropics
- **Land Initialization and Configuration:** observing system impact on land initialization/S2S forecasts; land/atmosphere processes in S2S models; land surface impacts on extremes
- **Ocean and Sea Ice Initialization and Configuration:** role of ocean-atmosphere coupling on S2S; sea ice process simulation, initialization, prediction; **S2S marine prediction** (eg storm surge, fisheries & coral bleaching)
- **Ensemble Generation:** burst vs lagged ensembles; impacts of random and systematic errors on forecast spread; potential benefits of stochastic parameterization; benchmark of spread-error relationship
- **Atmospheric Composition:** impact of prognostic aerosols on S2S forecasts; level of complexity needed; predictability of aerosols (e.g. dust) & potential forecast value for applications
- **Stratosphere:** role of vertical coupling, stratospheric systematic errors, and impact of quality of stratospheric initial conditions



# Enhancing operational infrastructure & user applications

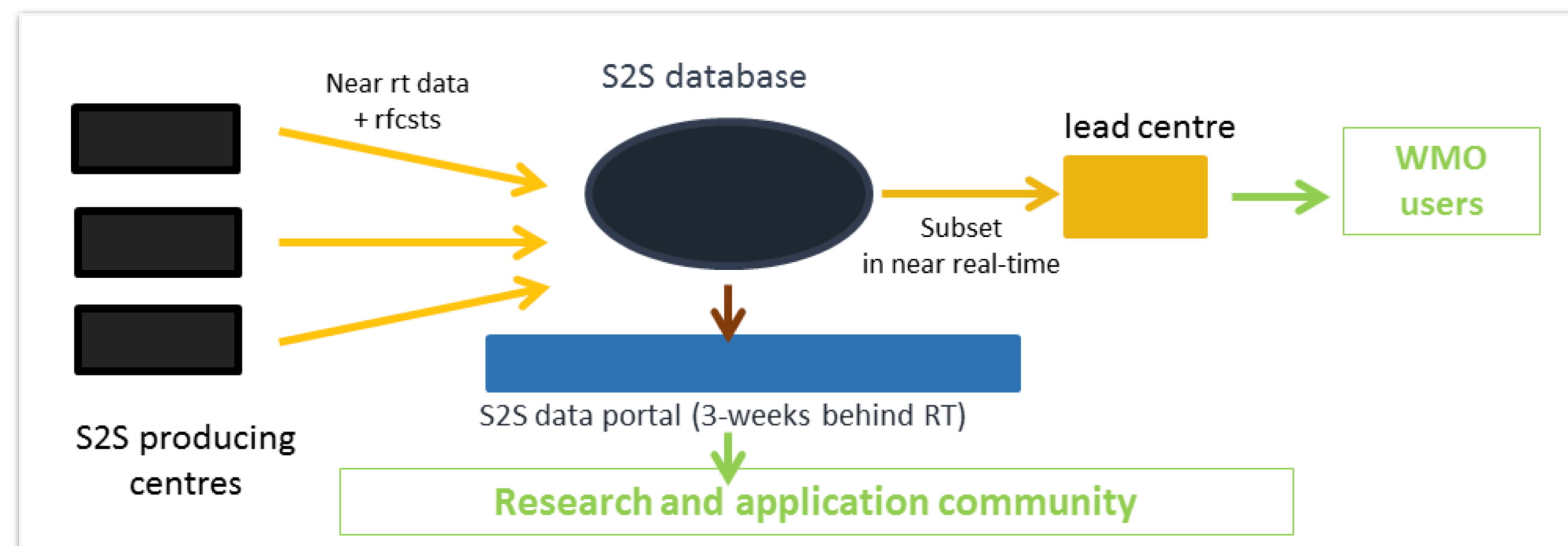
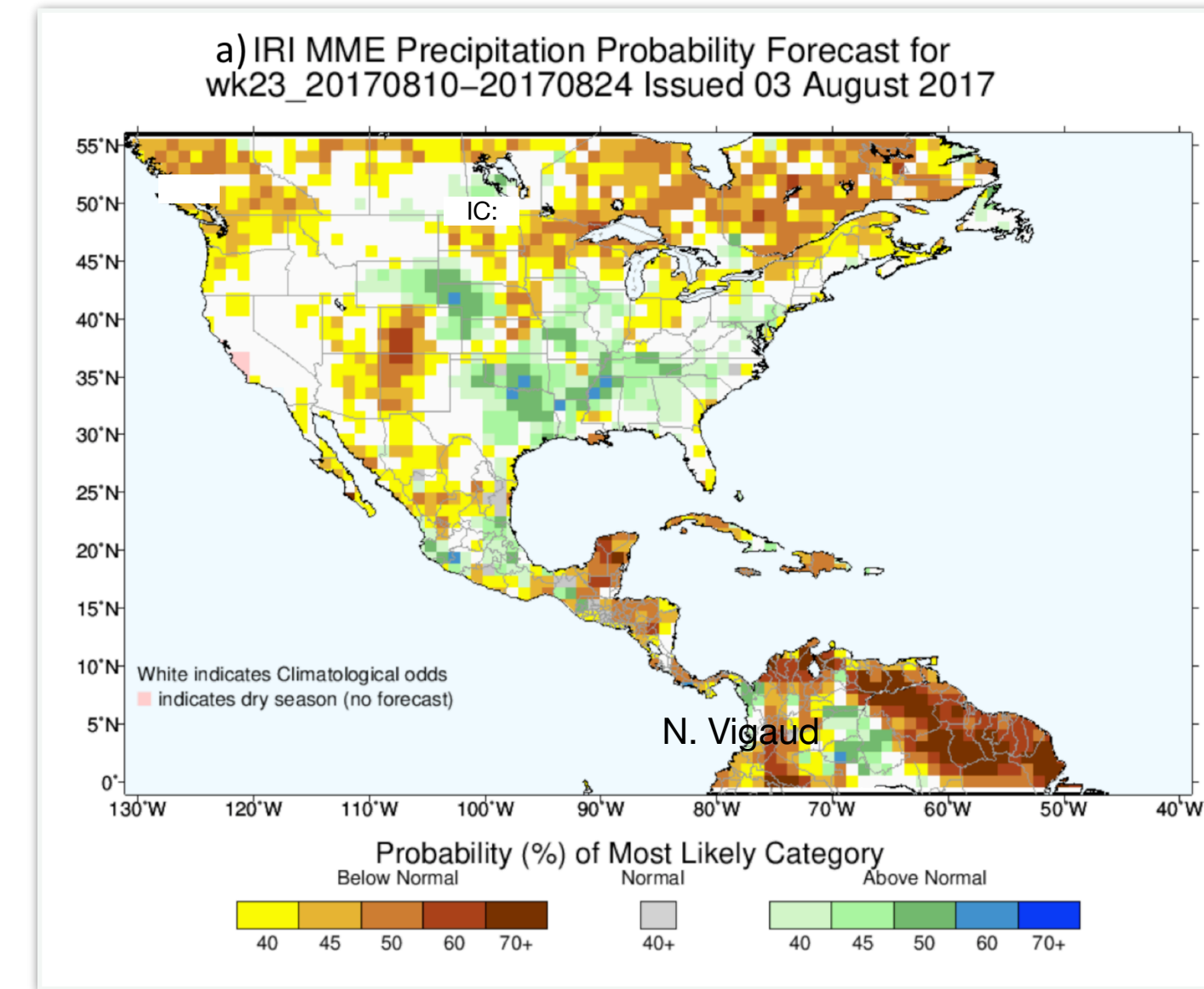
- **Research to Operations (R2O) and S2S Forecast and Verification Products Development:**

- 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



# S2S-WCRP Linkages

- **WGSIP**: collaborations on **tropical-extratropical teleconnections**, impact of **snow initialisation** on S2S forecasts (SNOWGLACE), and analysis of **initial transients and model drift** [Long-Range Forecast Transient Intercomparison Project (LRFTIP)]
- WGSIP linkage also via **WMO Lead Centre** for Long-Range Forecast Multi-Model Ensemble (LC-LRFMME) – expanding from seasonal to include the subseasonal scale.
- **SPARC/SNAP** leads analysis of **stratospheric processes** in the S2S models.
- **WGNE/MJO-TF**: common activities on MJO prediction and teleconnections.
- WMO's **Regional Climate Outlook Forums** (RCOFs) – increasing interest in S2S
- WCRP **GC on Extremes**: S2S predictions of extremes for attribution and early warning.



# WCRP Strategic Plan Links with S2S

- **SP Overarching Objectives:** S2S goals to improve forecast skill & understanding, uptake by operational centres and exploitation by the applications communities (incl GFCS) – contribute esp. to O2 & 4
- **SP Emphases:**
  - S2S Phase II Research Foci on ocean, sea-ice, land, stratosphere, aerosols, map to E1-4
  - R2O aspects incl forecast MME/calibration contributes to E5 on “regions”
  - Planned S2S real-time applications program contributes to E0 on sustainable dev through early warning-early action
- **SP Imperatives:**
  - Partnership with WWRP
  - Data Infrastructure is a cornerstone of S2S
  - S2S is an example of “seamlessness” across weather/climate “boundary”
  - Education: S2S has co-organized 7 training courses in developing countries

# Opportunities & Needs

- The S2S has grown rapidly over the last 5 years, helped by the availability of new forecast databases (S2S, NOAA SubX) that complement existing ones (TIGGE for weather forecasts, NMME and CHFP for seasonal forecasts, and CMIP), to provide a much more complete set of model archives across time scales.
- The S2S database has no WCRP/WWRP/WMO funding. ECMWF is facing difficulties with sustaining it.
- There is a need to make access across these easier to both the research and applications-development communities, as well as to provide forecasts in real time where possible. IRI Data Library archive has archived much of S2S database, but funding is lacking to sustain it.
- More collaboration with WCRP would greatly benefit S2S (Objectives, Emphases, Imperatives): The pan-WCRP modeling meeting in Exeter in 2017 was very valuable and making such meetings a priority for support in the future would be helpful.
- S2S is supported by a Trust Fund administered by WMO – could largely only support SG meetings, and minimally the program of S2S training courses in developing countries.