

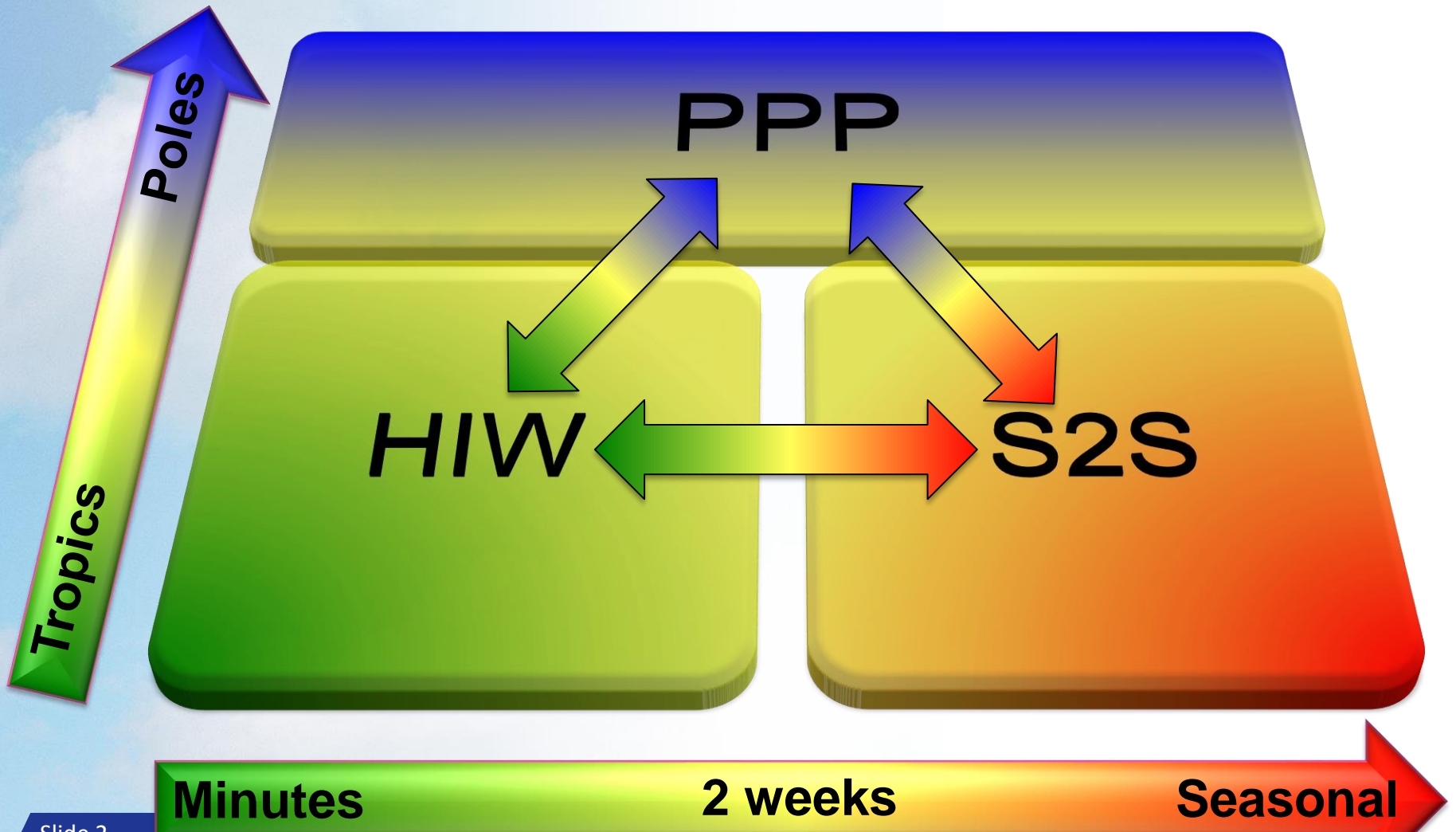


# The Sub-seasonal to Seasonal (S2S) Prediction Project

“Bridging the gap between weather and climate”

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

# WMO/WWRP International Legacy Projects





# Mission Statement

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- “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”

# S2S project

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- 5-year project, started in Nov 2013.
- Project office: KMA/NIMR hosts the project office in Jeju island.
- Trust Fund: Contributions from Australia, USA and UK

# 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

# MJO Subproject

## MJO and Maritime Continent (MC) Interactions: Evaluating State of the Art & Characterizing Shortcomings *In collaboration with the WGNE MJO Task Force*

### Major Objectives:

- Assess current model simulation fidelity and prediction forecast skill over the MC across time scales, with emphasis on the MJO, and identify and rectify model biases.
- What roles do: 1) multi-scale interactions, 2) topography and land-sea contrast, and 3) ocean/land-atmosphere coupling play in the MC-MJO interaction and how do they influence predictability over the MC.

### Modeling Resources to Exploit

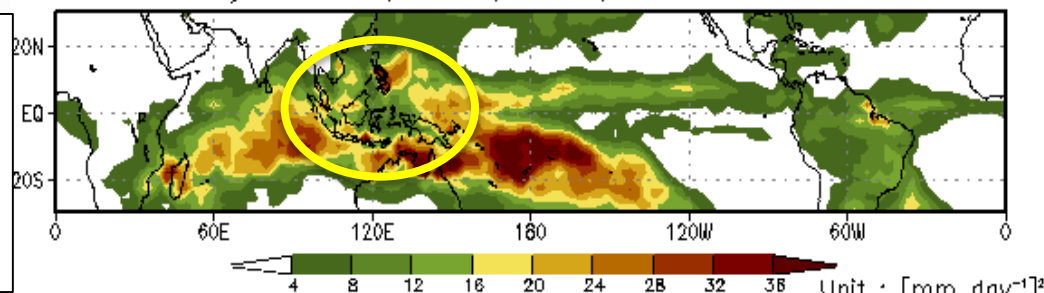
- 1) S2S Database, 2) MJOTF-GASS Multi-Model Exp and 3) ISVHE

### Potential Future Field Campaign

- Year of Maritime Continent (YMC) is a growing multi-nation effort to carry out a field campaign over the MC in 2017 to address objectives such as those above.
- 11-14 April 2016 Workshop for Subproject in Singapore– S2S, MJOTF

**Nexus of 1) land, atmosphere & ocean interactions and 2) multi-scale interactions: diurnal, mesoscale, synoptic, subseasonal, seasonal & interannual.**

20–100 day variance, PRCP, GPCP, Winter



# Extreme weather sub-project

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## Major Objectives:

- Evaluate the predictive skill and predictability of weather regimes and extreme events (droughts, floodings, heat and cold waves)
- Assess the benefit of multi-model forecasting for extreme events
- Improve understanding of the modulation of extreme weather events by climate modes.
- Sub-seasonal prediction of tropical storms
- Case studies selected for the strong societal impact

*A case study already completed: March 2013 cold wave over Europe. Next cases will include intense tropical cyclone Pam and intra-seasonal variability of precipitation over the US west coast during the 2015 El-Niño event.*



## Why was the start to spring 2013 so cold?

April 2013

Professor Julia Slingo,  
Met Office Chief Scientist

### Summary

**March 2013 was the second coldest March in the UK record since 1910, and was associated with a negative phase of the North Atlantic Oscillation. A number of potential drivers may predispose the climate system to a state which accounts for these conditions.**

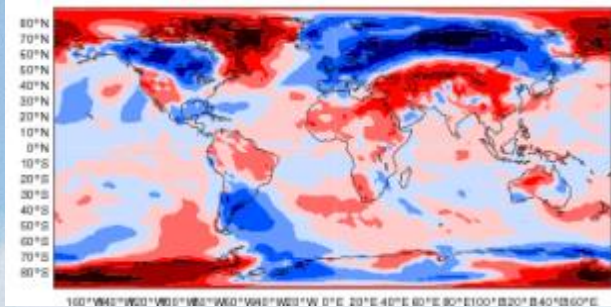
- The cold temperatures were part of a larger-scale weather pattern in the Northern Hemisphere.
- This pattern was associated with the negative phase of the North Atlantic Oscillation, which leads to the prevalence of easterly winds and cold conditions over the UK.
- There are a number of similarities between the climatological context of the March 2013 cold weather and that observed in 1962 (the coldest March on record).
- A number of potential drivers may predispose the climate system to negative NAO states in early spring. These include:
  - weather in the Tropics
  - the Stratosphere
  - conditions in the North Atlantic
  - the state of the Arctic
- These drivers are not necessarily independent, and no single explanation can account for the cold conditions observed.



# 2mtm anomalies 14 Feb day 26-32

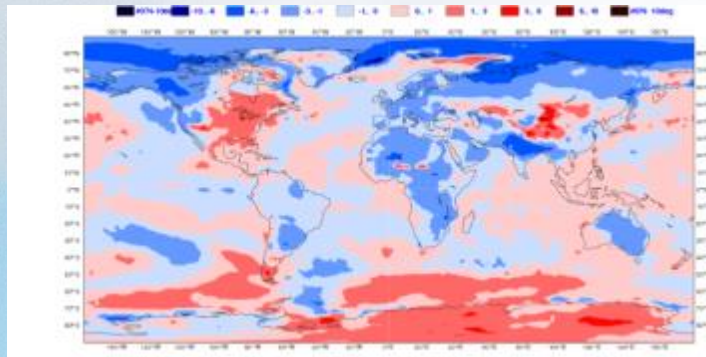
ERA Interim

11 -17 March

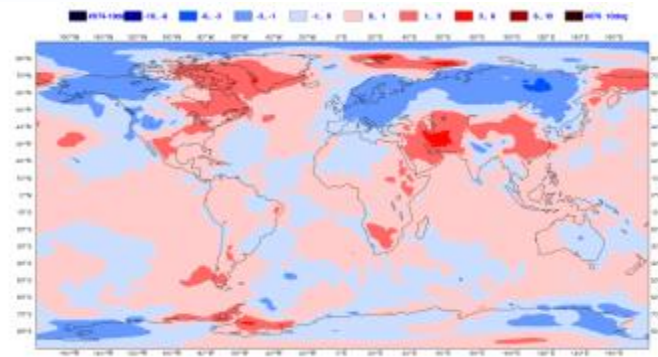


model 1

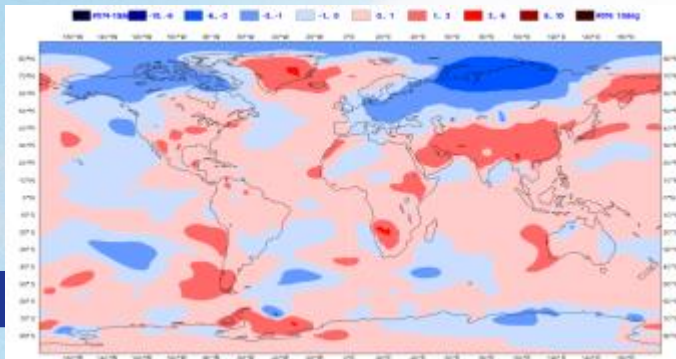
model 2



model 3

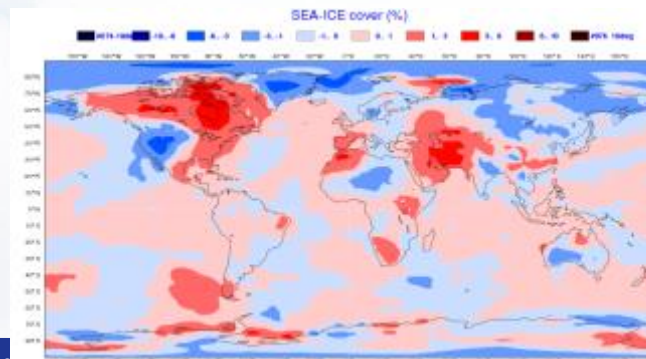
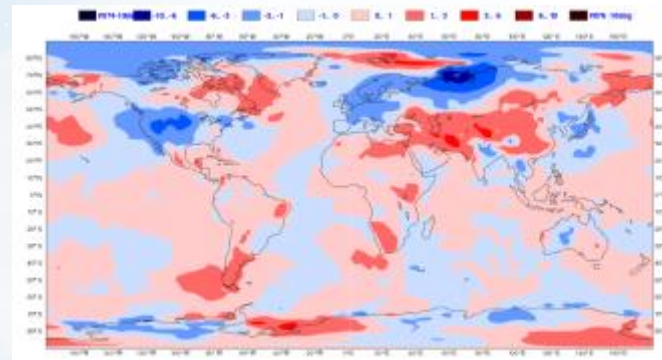
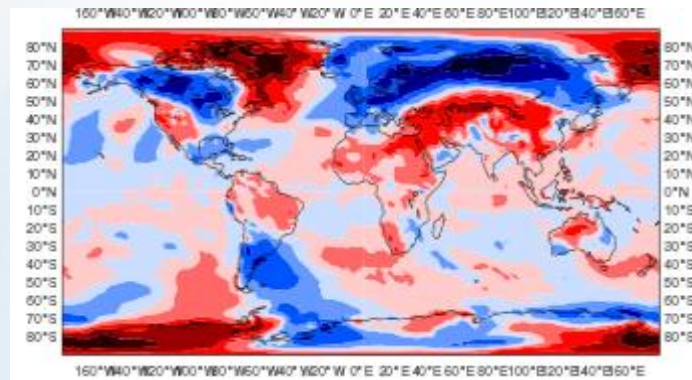
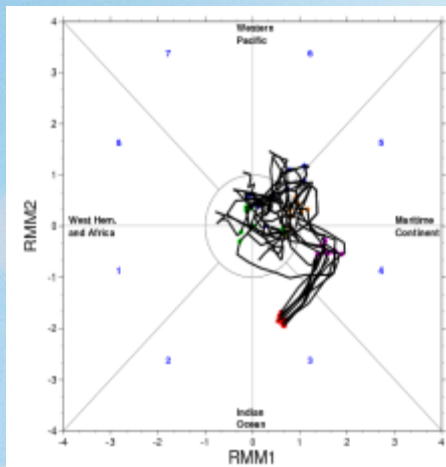
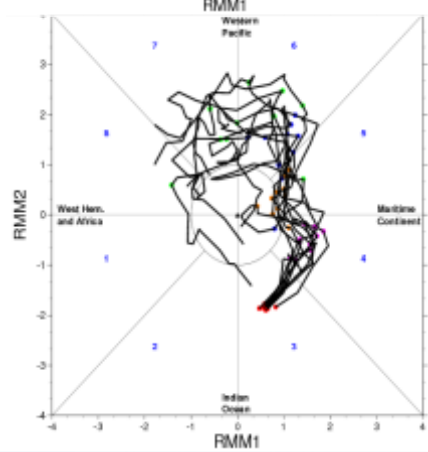
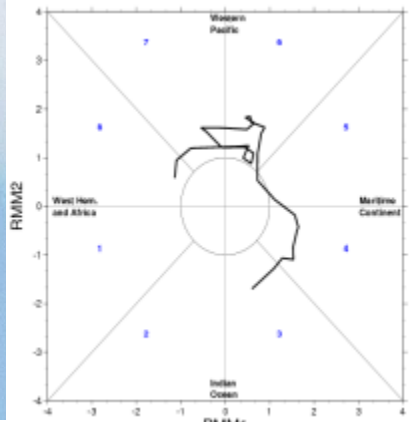


model 4



readi

# Cold March 2013 – 14 Feb 2013 -Day 26-32

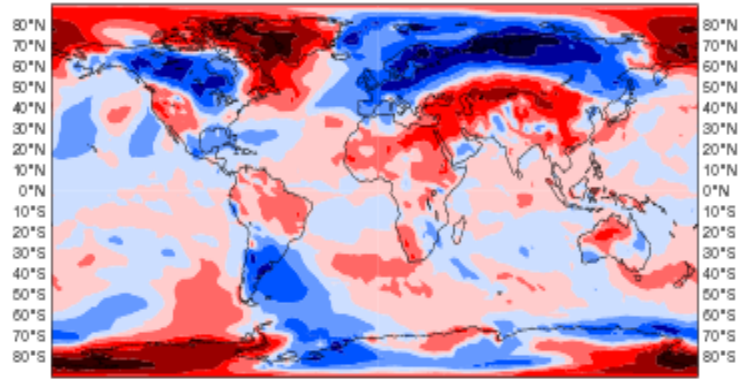


WF sub-season



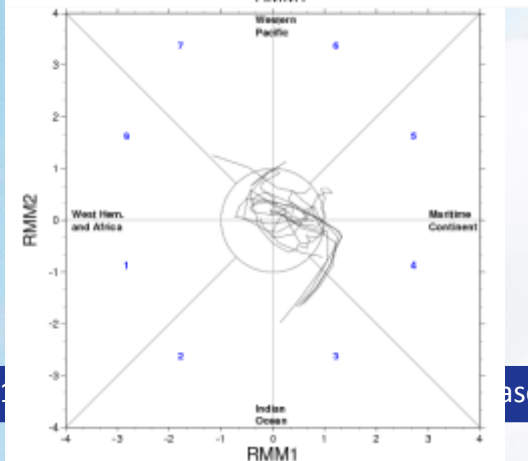
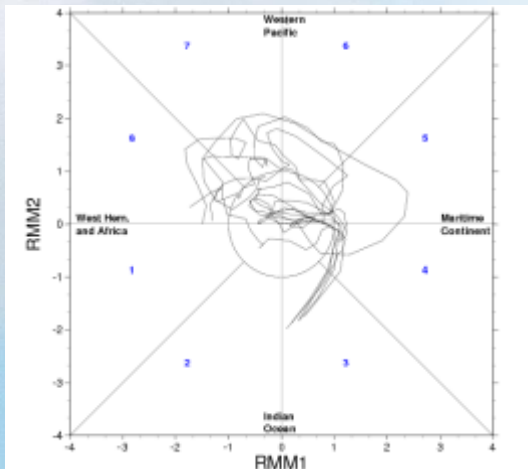
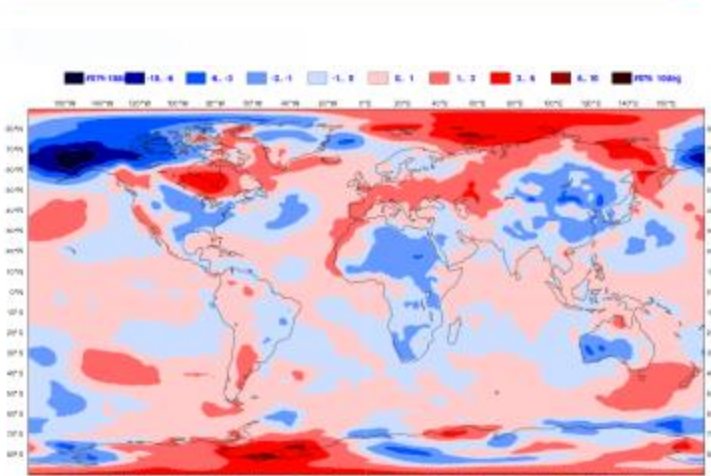
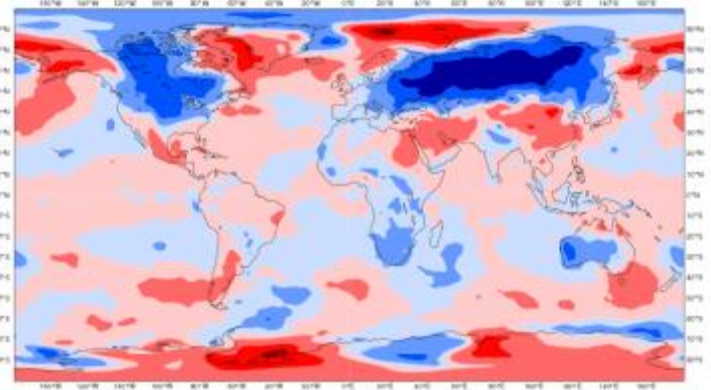
# Cold March 2013 – 14 Feb 2013 -Day 26-32

160°W 140°W 120°W 100°W 80°W 60°W 40°W 20°W 0°E 20°E 40°E 60°E 80°E 100°E 120°E 140°E 160°E



160°W 140°W 120°W 100°W 80°W 60°W 40°W 20°W 0°E 20°E 40°E 60°E 80°E 100°E 120°E 140°E 160°E

■ 17% 15% 14% 13% 12% 11% 10% 9% 8% 7% 6% 5% 4% 3% 2% 1% 0% 1% 2% 3% 4% 5% 6% 7% 8% 9% 10% 11% 12% 13% 14% 15% 16% 17%



# Conferences/Education outreach

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- *Nov 2013: S2S workshop organized by the S2S ICO (Jeju, Republic of Korea)*
- *Dec. 2013: S2S session at AGU conference*
- *Feb 2014: International conference on sub-seasonal to seasonal prediction – NCEP –*
- *Aug. 2014: WWRP Open Science Conference –Montreal, Canada:  
S2S sessions (26 oral presentations in 6 sessions) + white paper*
- *June 2015: 3-day workshop organized by the ICO (Jeju, Republic of Korea) on Sub-seasonal to seasonal predictability of monsoons.*
- *Oct 2014: Training course was co-organized with APCC in Busan (Republic of Korea)*
- **Nov/Dec, 2015: 2 week training course at ICTP (Trieste, Italy) for young scientists from developing countries**
- **Dec 2015: S2S session at AGU conference**
- **11-14 April 2016: S2S/MJO-TF Maritime Continent workshop - Singapore**



# http://s2sprediction.net/



About S2S

News

Documents

Sub-projects

Database

Meetings

People

Links

\*\*\* News \*\*\*

## Reforecast data are now available at the ECMWF S2S Data Portal

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

### Upcoming Events

**AGU Session on Sub-seasonal to Seasonal Prediction of Weather and Climate, 14-18 December 2015, AGU Fall Meeting, San Francisco**

**Advanced School and Workshop on S2S Prediction and Application to Drought Prediction, 23 November to 4 December 2015, ICTP, Trieste, Italy**

**ECMWF Workshop on Sub-seasonal Predictability, 2-5**

### S2S Database

ECMWF CMA

**S2S re-forecast data portal at ECMWF is now available!**

Updated: 2015-10-21 01:40

**Now 7 Centres data available at ECMWF Data Portal (<http://apps.ecmwf.int/datasets/data/s2s/>)**

Updated: 2015-07-08 01:04

S2S News

News Letter

FAQs

weather Open Science Conference (WVOSC-2014), 16-21 August 2014, Montreal, Canada. The manuscript is available in "Reports & Publications" or downloadable from [http://library.wmo.int/pmb\\_ged/wmo\\_1156\\_en.pdf](http://library.wmo.int/pmb_ged/wmo_1156_en.pdf)

Updated: 2015-07-01 09:49

#### New publication on S2S on BAMS

New publication has come on BAMS, American Meteorological Society, entitled "Improving and Promoting Subseasonal to Seasonal Prediction", by A. W. Robertson, A. Kumar, M. Pena, and F. Vitart. You can come to the AMS website at <http://dx.doi.org/10.1175/BAMS-D-14-00139.1> to download the manuscript.

Updated: 2015-06-30 01:57

### Tweets

Follow



**Reporting Climate** @Reportingclimat  
Climate scientist @ed\_hawkins tells us why climate model "zoos" make regional forecasting hard  
[reportingclimatescience.com/news-stories/a...](http://reportingclimatescience.com/news-stories/a...)  
[pic.twitter.com/S5Fa3wQLLu](http://pic.twitter.com/S5Fa3wQLLu)

Retweeted by s2sprediction



Tweet to @s2sprediction



## 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

- Subseasonal to Seasonal Prediction Research Implementation Plan
- 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.
- WMO, 2012, WMO Bulletin, 61 (2), 48pp

# S2S Database

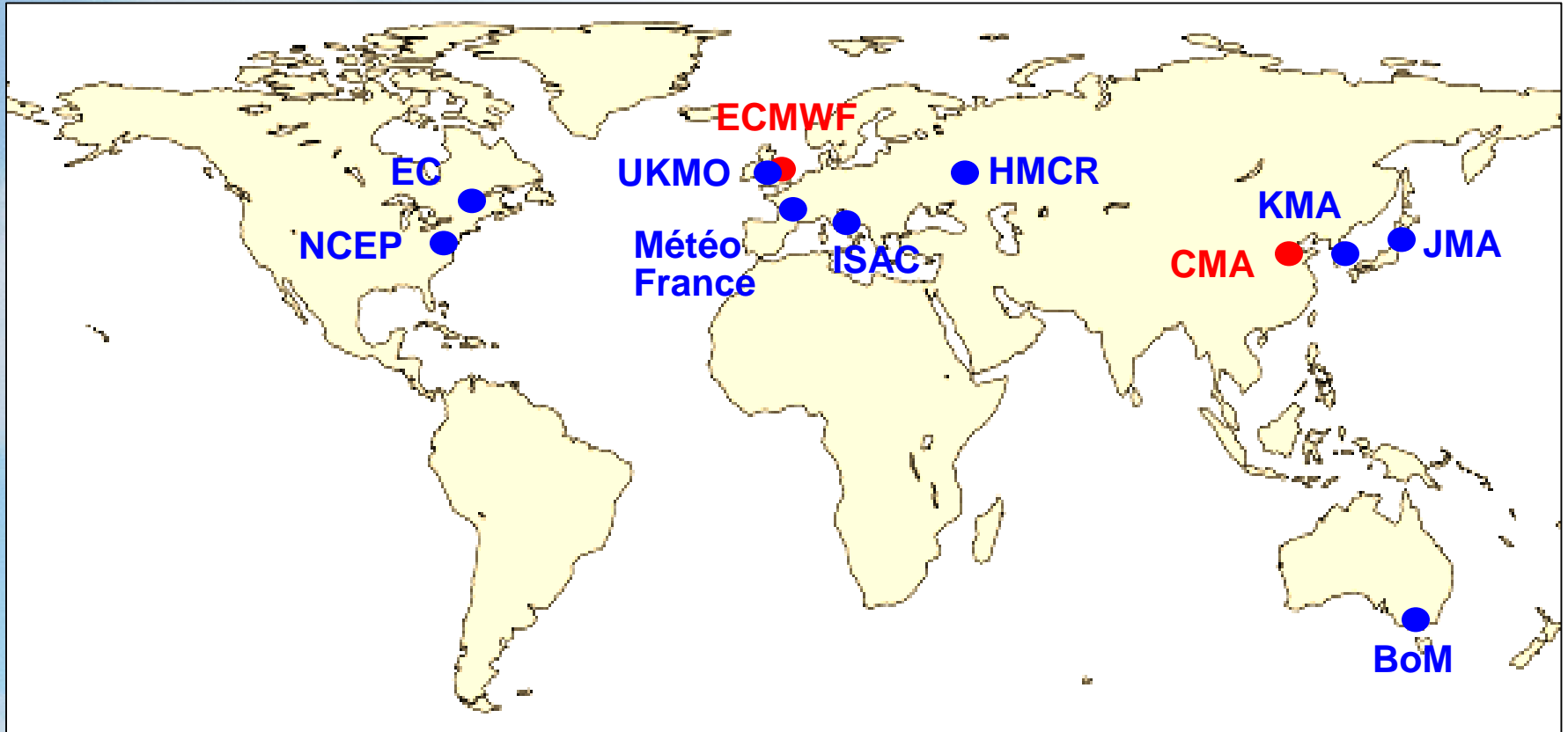
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- Daily real-time forecasts + re-forecasts
- 3 weeks behind real-time
- Common grid (1.5x1.5 degree)
- Variables archived: about 80 variables including ocean variables, stratospheric levels and soil moisture and temperature
- Archived in GRIB2 – NETCDF conversion planned
- Database opened in May 2015, currently data of 7 models available

# Contributing Centres to S2S database

- Data provider (11)

- Archiving centre (2)



# S2S contributions

Institution	Contacts
BoM	H. Hendon, G. Liu
CMA	T. Wu and L. Zhang
EC	Hai Lin
HMCR	M. Tolstykh, R. Zaripov
ECMWF	F. Vitart, M. Fuentes
JMA	Y. Takaya, A. Minami
KMA	H-S. Kang, D-J Won
Météo-France	M. Déqué and C. Ardilouze
UKMO	C. Mclachlan, P. Mclean
NCEP	A. Kumar, M. Chen
CNR-ISAC	P. Malguzzi, D. Mastrangelo

Data archiving at EMCWF: M. Fuentes, F. Vitart, R. Mladek, I. Mallas, M. Manoussakis, S. Najm, A. Bonet, L. Ferranti, E. Fucile, C. Codorean, F. Venuti, C. Sun (CMA)



# S2S Data Portal at ECMWF

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

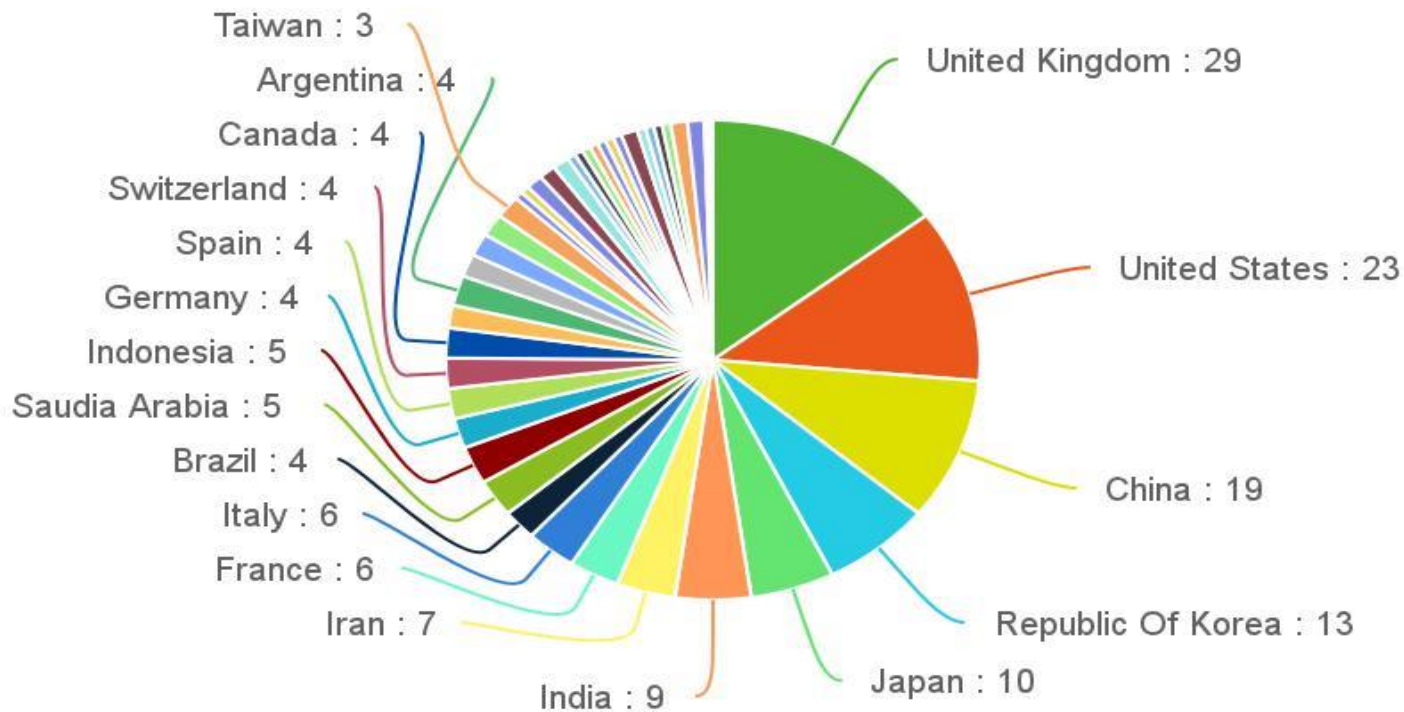
The screenshot displays the S2S Data Portal interface. On the left is a navigation sidebar with the ECMWF logo and menu items: About, Forecasts, Computing, Research, Learning, S2S sets (Real time, Reforecasts), Origin (BoM, CMA, ECMWF, HMCR, JMA, Météo France, NCEP), Statistical process (Real time instantaneous and accumulated, Real time daily averaged), Type of level (Potential temperature, Pressure levels, Surface), Type (Control forecast, Perturbed forecast), About (Conditions of use, Documentation), Navigation (Public Datasets, Job list), and See also... (Access Public Datasets, General FAQ, WebAPI FAQ, Accessing forecasts, GRIB decoder). The main content area is titled 'S2S, Realtime, Instantaneous and Accumulated' and includes a 'Select date' section with a date range from 2015-01-01 to 2015-10-05, a 'Select a list of months' section with a calendar for 2016, a 'Select step' section with a grid of step numbers from 0 to 1002, and a 'Select parameter' section with a list of parameters such as '10 metre U wind component', 'Convective precipitation', 'Land-sea mask', etc.

# S2S Database current status

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- Open access to researchers on 6<sup>th</sup> May
  - Data from seven data providers:
    - ECMWF, NCEP, JMA, BoM, CMA, Météo-France, HMCR
  - Near real-time data from 1<sup>st</sup> January 2015
  - Re-forecast available
- Usage (end of October): about 200 users, 130 000 requests, 25 TBs downloaded
- Plans
  - End of 2015: all 11 Data Providers
  - Add new ocean and sea-ice variables

## S2S usage per country



## S2S partners

<b>Models</b>	<b>Time-range</b>	<b>Freq.</b>	<b>Hcst length</b>	<b>Hcst Freq</b>	<b>Ocean coupling</b>	<b>Active Sea Ice</b>
<b>ECMWF</b>	D 0-46	2/week	Past 20y	2/weekly	<b>YES</b>	<b>Planned</b>
<b>UKMO</b>	D 0-60	daily	1996-2009	4/month	<b>YES</b>	<b>YES</b>
<b>NCEP</b>	D 0-44	4/daily	1999-2010	4/daily	<b>YES</b>	<b>YES</b>
<b>EC</b>	D 0-35	weekly	Past 15y	weekly	NO	NO
<b>BoM</b>	D 0-60	2/weekly	1981-2013	6/month	<b>YES</b>	NO
<b>JMA</b>	D 0-34	weekly	1981-2010	3/month	NO	NO
<b>KMA</b>	D 0-60	daily	1996-2009	4/month	<b>YES</b>	<b>YES</b>
<b>CMA</b>	D 0-45	daily	1992-now	daily	<b>YES</b>	<b>YES</b>
<b>Met.Fr</b>	D 0-60	monthly	1993-2014	monthly	<b>YES</b>	<b>YES</b>
<b>ISAC-CNR</b>	D 0-32	weekly	1981-2010	6/month	NO	NO
<b>HMCR</b>	D 0-63	weekly	1981-2010	weekly	NO	NO

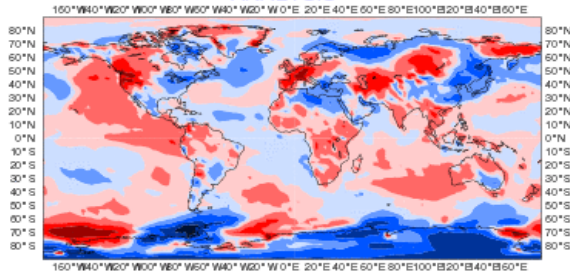


# 2-m temperature anomalies - Day 19-25

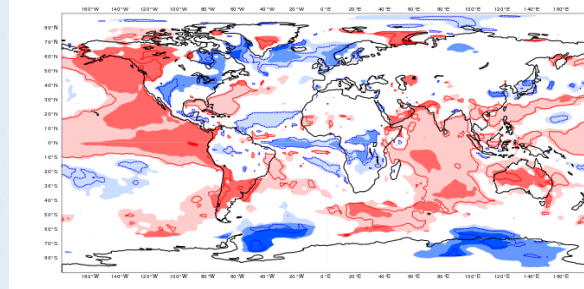
Forecast start date is 11 June 2015

**VERIFICATION**

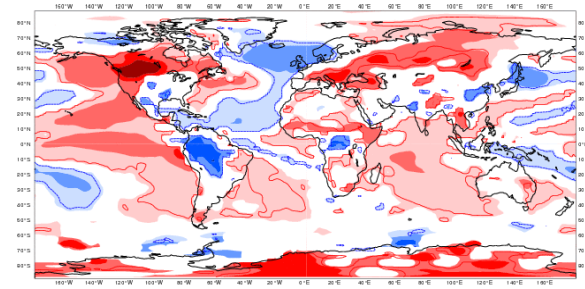
**ANALYSIS**



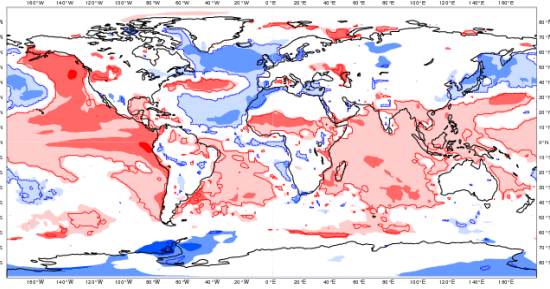
**NCEP**



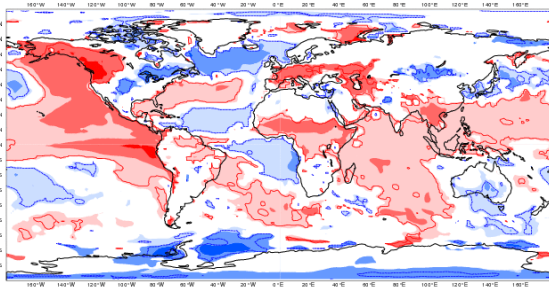
**BoM**



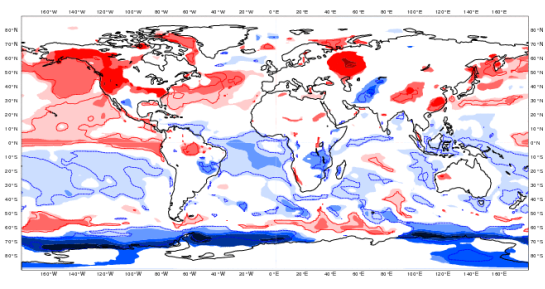
**JMA**



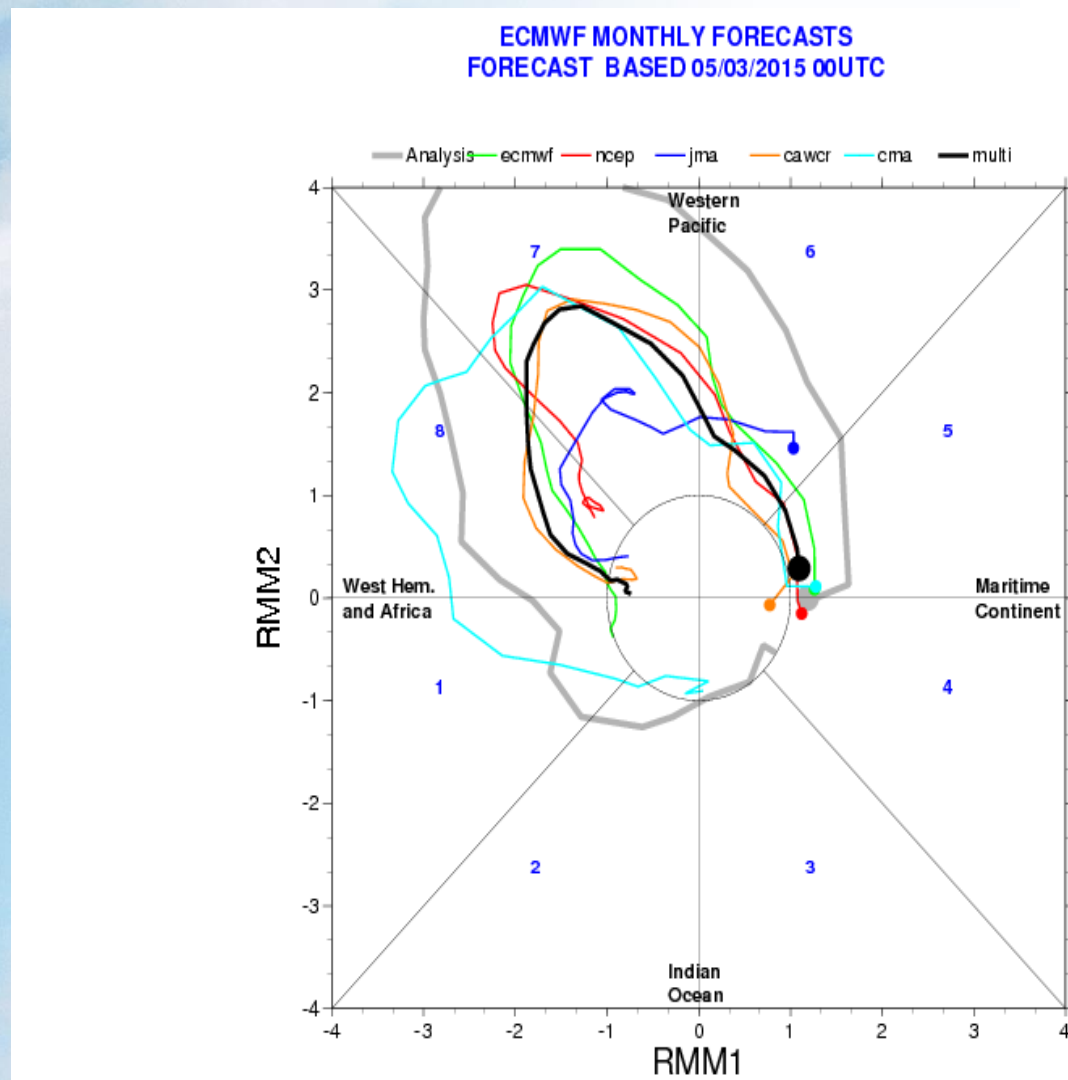
**ECMWF**



**CMA**



# MJO prediction

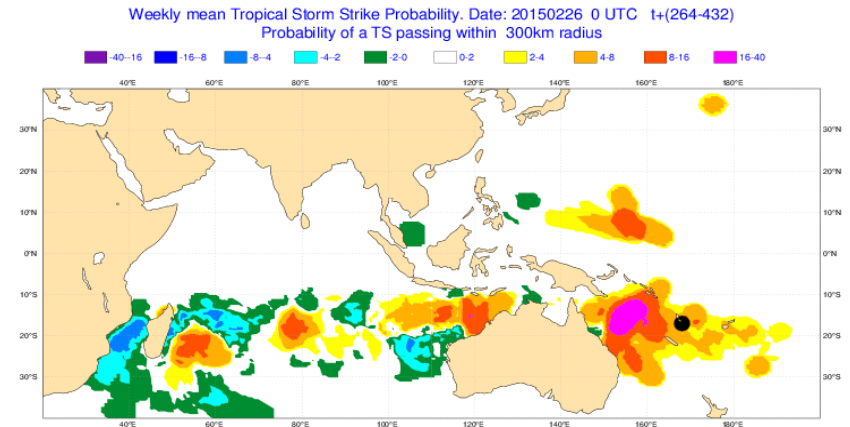
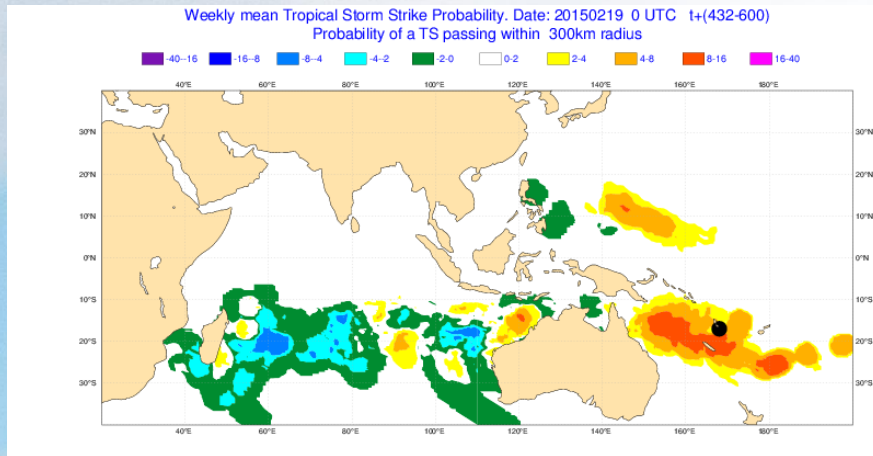


# Tropical Cyclone Pam case study

## Multi-model prediction of TC strike probability anomalies- 9-15 March 2015 (NCEP/ECMWF/BoM/JMA/CMA)

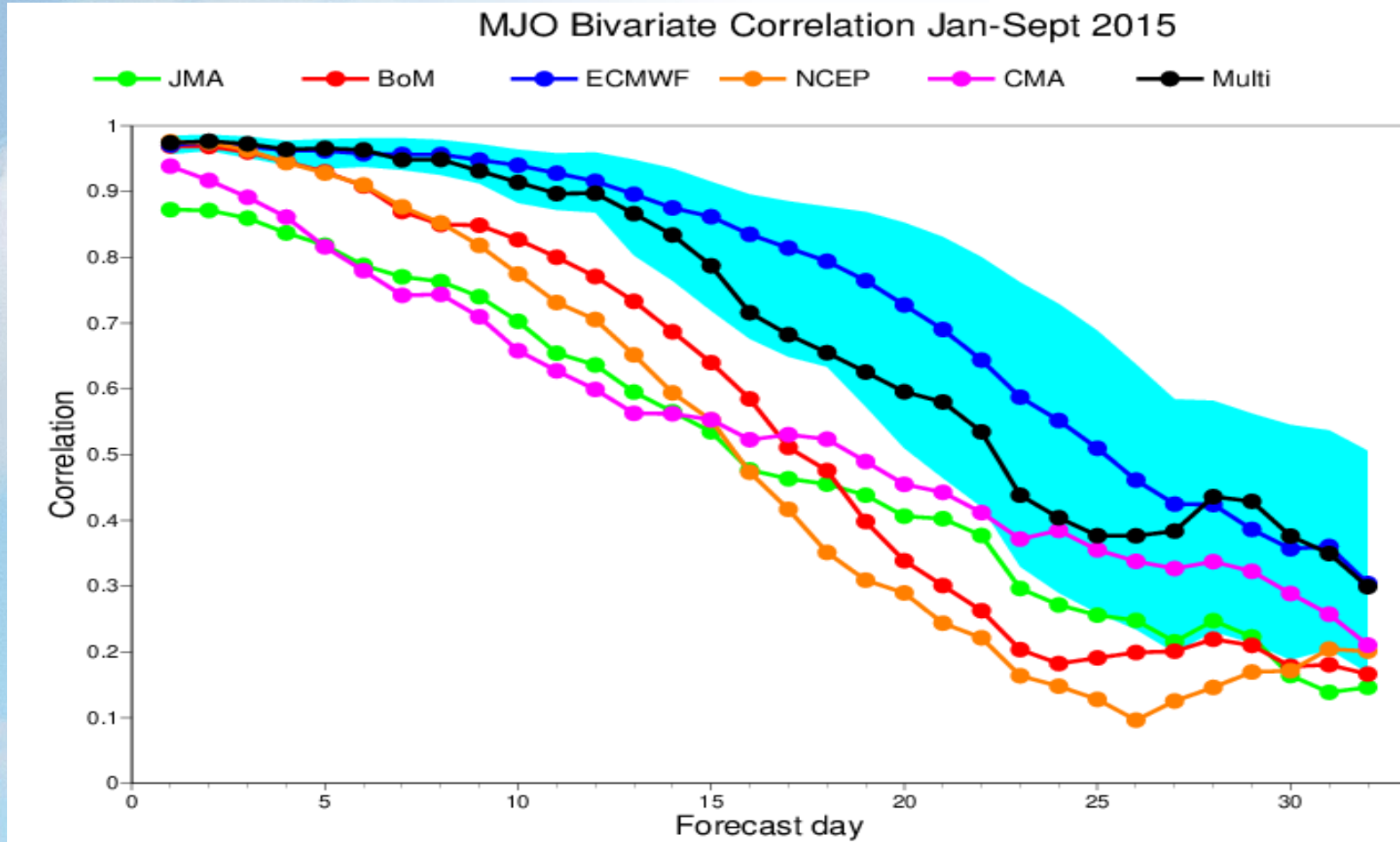
2015/02/19 day 19-25

2015/02/26 day 12-18



# MJO skill scores

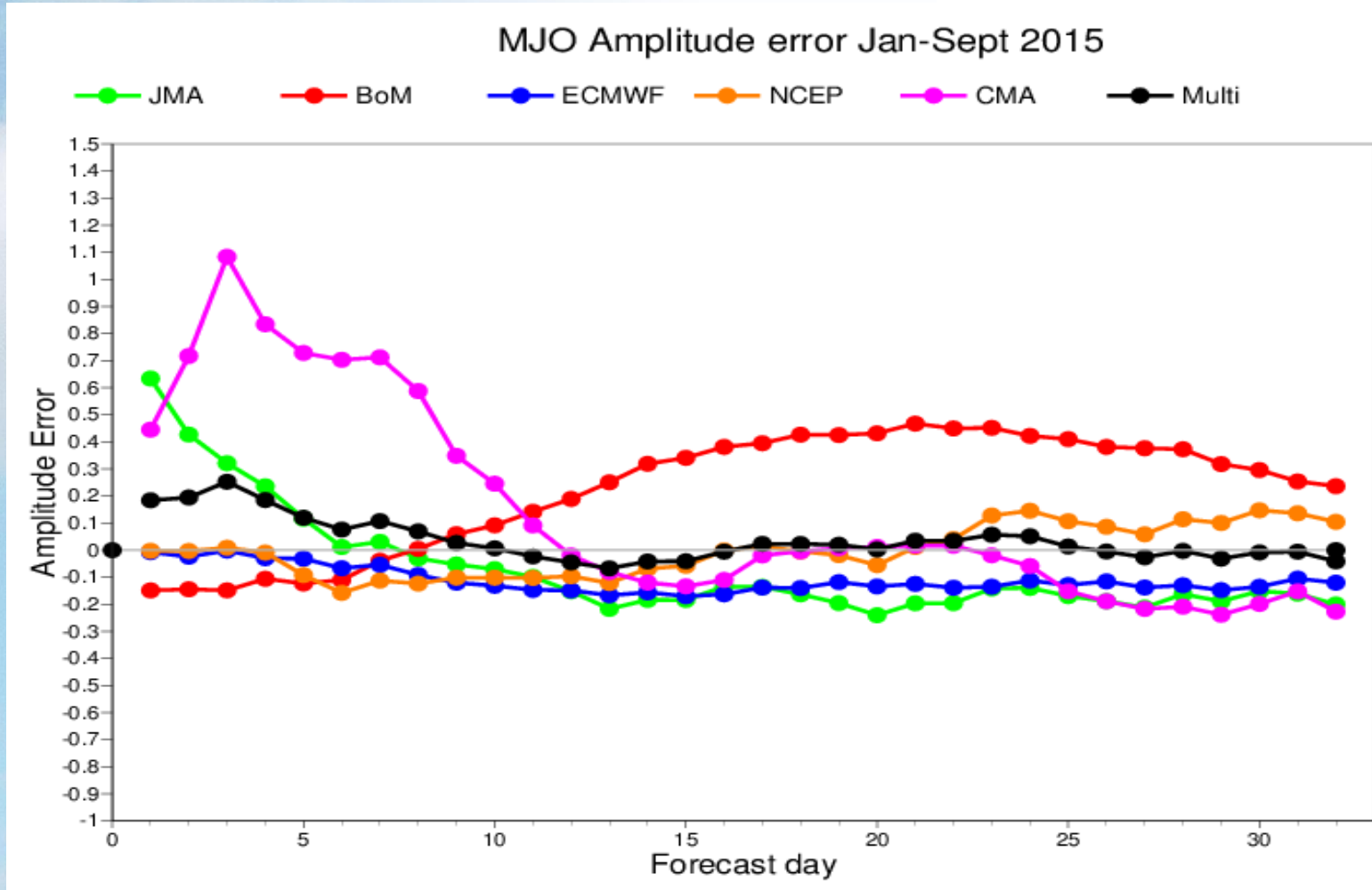
36 start dates





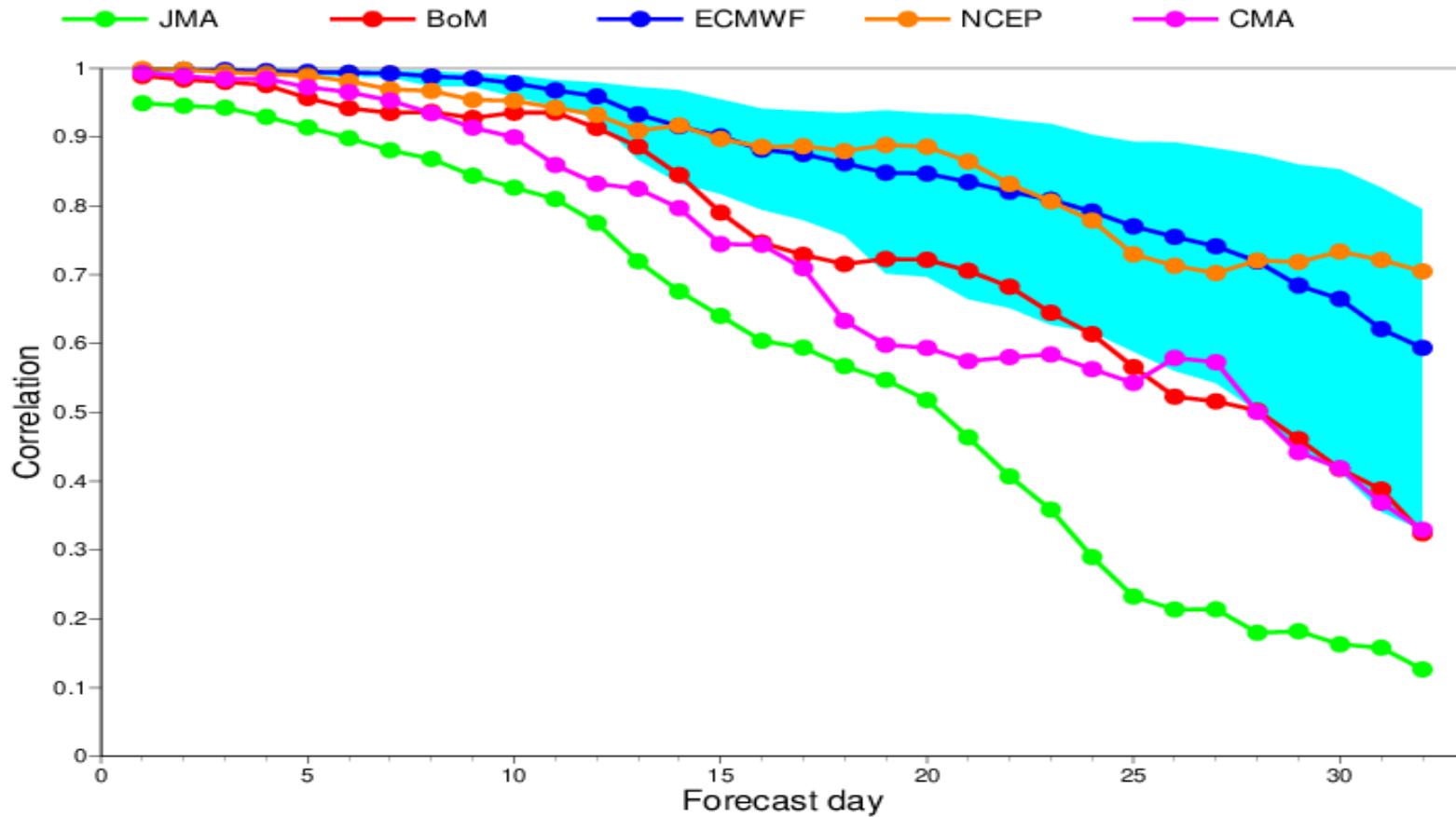
# MJO Amplitude

36 start dates



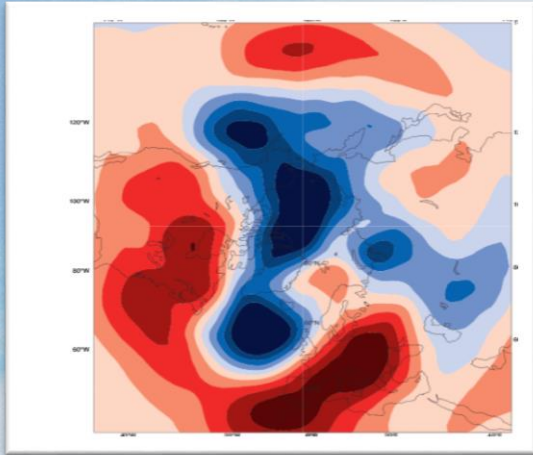
# SSW skill scores

SSW Correlation Jan-May 2015

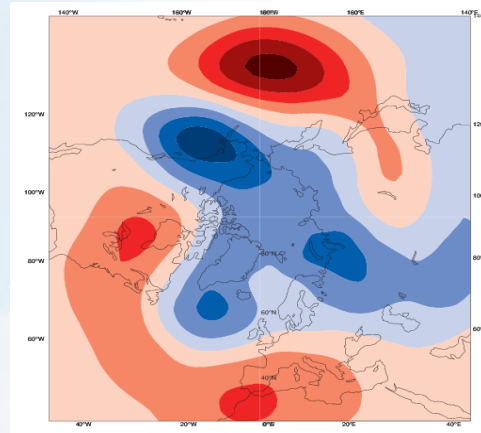


# MJO Teleconnections (S2S re-forecasts)

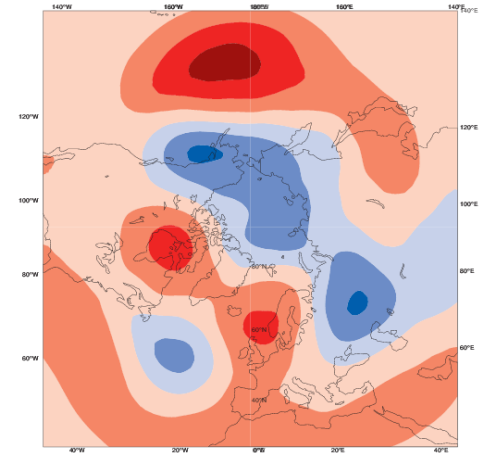
Analysis



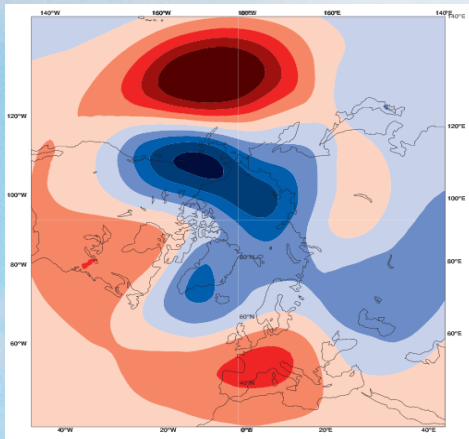
ECMWF



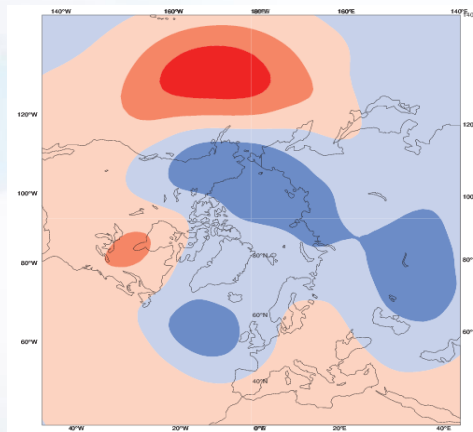
JMA



NCEP



CAWCR



**Z500 anomalies 10 days  
after an MJO in Phase 3**



# Tropical Cyclone Density Anomaly

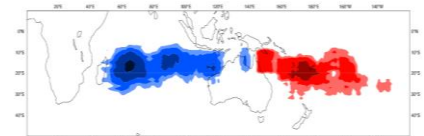
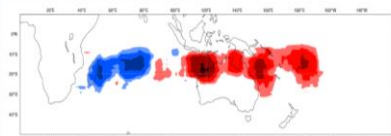
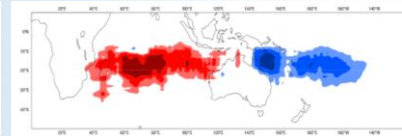
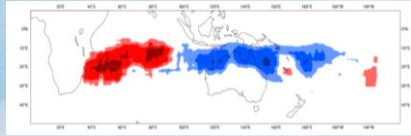
MJO Phase 2-3

MJO Phase 4-5

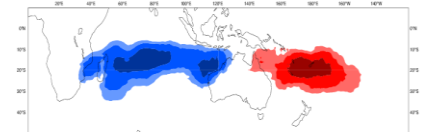
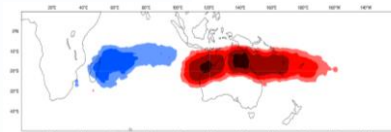
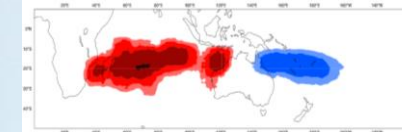
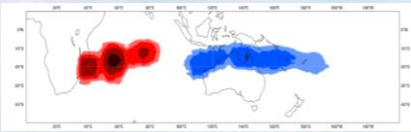
MJO Phase 6-7

MJO Phase 8-1

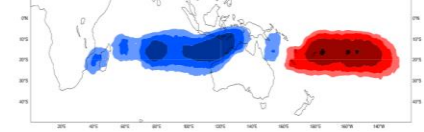
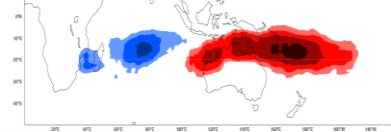
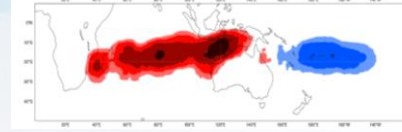
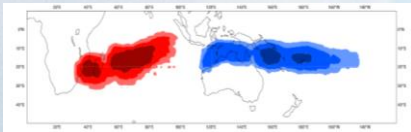
OBS



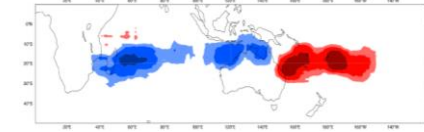
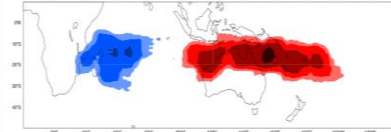
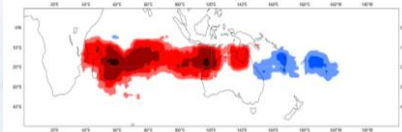
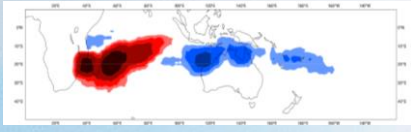
ECMWF



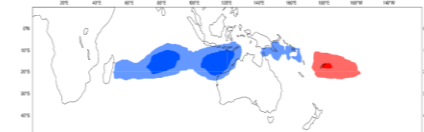
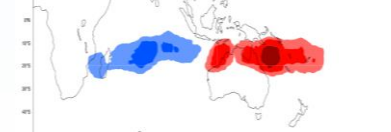
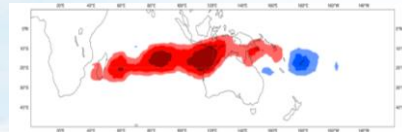
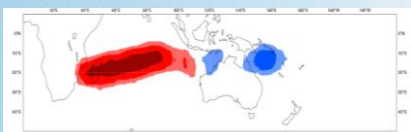
NCEP



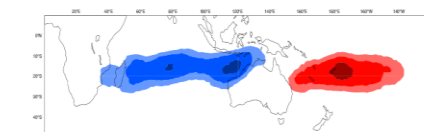
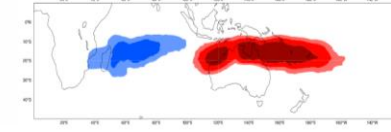
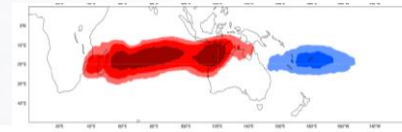
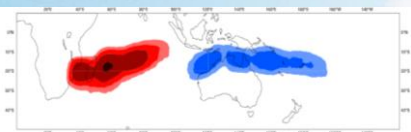
JMA



BoM



Multi



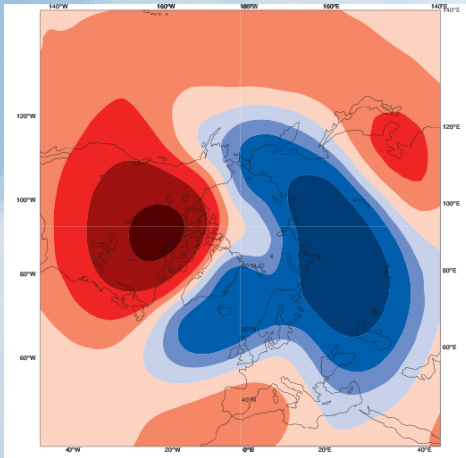


## Summary

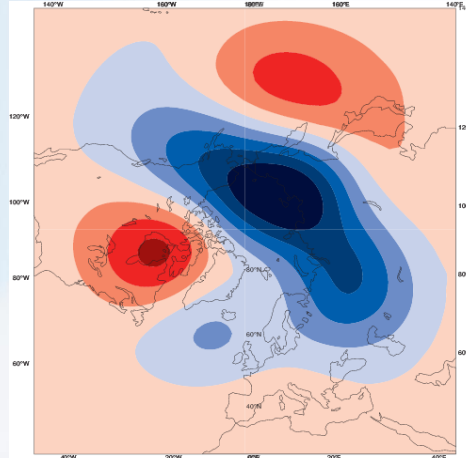
- Sub-seasonal to seasonal is a very important time range which links weather and climate communities
- S2S is one of the three post THORPEX legacy project
- What can S2S do for us?
  - It provides a framework to facilitate international collaboration (S2S database, workshops, coordinated experiments..)
  - It can influence funding agencies
  - Training and promotion of early career scientists

# MJO Teleconnections (S2S re-forecasts)

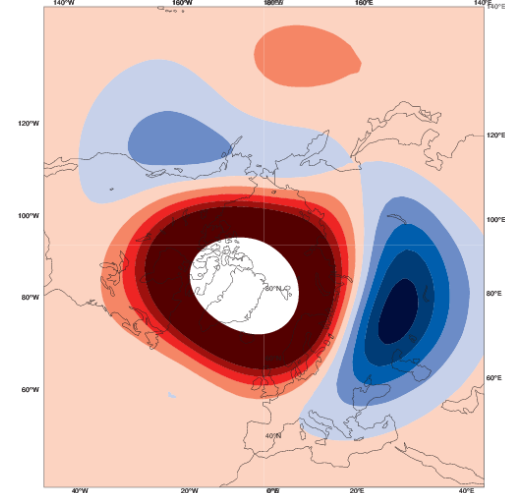
## Analysis



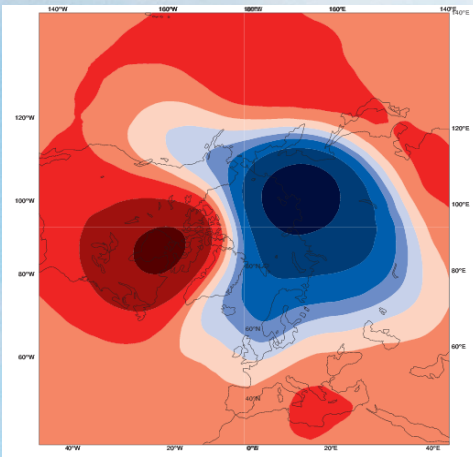
## ECMWF



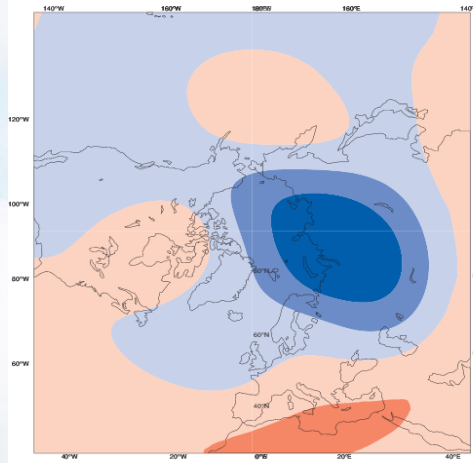
## JMA



## NCEP



## CAWCR



**MJO Teleconnections  
(re-forecasts)**

**Z50 anomalies 10 days  
after an MJO in Phase 3**



# S2S models

	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
<b>ECMWF</b>	<b>D 0-46</b>	<b>T639/319L91</b>	<b>51</b>	<b>2/week</b>	<b>On the fly</b>	<b>Past 20y</b>	<b>2/weekly</b>	<b>11</b>
<b>UKMO</b>	<b>D 0-60</b>	<b>N216L85</b>	<b>4</b>	<b>daily</b>	<b>On the fly</b>	<b>1996-2009</b>	<b>4/month</b>	<b>3</b>
<b>NCEP</b>	<b>D 0-44</b>	<b>N126L64</b>	<b>4</b>	<b>4/daily</b>	<b>Fix</b>	<b>1999-2010</b>	<b>4/daily</b>	<b>1</b>
<b>EC</b>	<b>D 0-35</b>	<b>0.6x0.6L40</b>	<b>21</b>	<b>weekly</b>	<b>On the fly</b>	<b>Past 15y</b>	<b>weekly</b>	<b>4</b>
<b>BoM</b>	<b>D 0-60</b>	<b>T47L17</b>	<b>33</b>	<b>2/weekly</b>	<b>Fix</b>	<b>1981-2013</b>	<b>6/month</b>	<b>33</b>
<b>JMA</b>	<b>D 0-34</b>	<b>T319L60</b>	<b>50</b>	<b>weekly</b>	<b>Fix</b>	<b>1979-2009</b>	<b>3/month</b>	<b>5</b>
<b>KMA</b>	<b>D 0-60</b>	<b>N216L85</b>	<b>4</b>	<b>daily</b>	<b>On the fly</b>	<b>1996-2009</b>	<b>4/month</b>	<b>3</b>
<b>CMA</b>	<b>D 0-45</b>	<b>T106L40</b>	<b>4</b>	<b>daily</b>	<b>Fix</b>	<b>1992-now</b>	<b>daily</b>	<b>4</b>
<b>Met.Fr</b>	<b>D 0-60</b>	<b>T255L91</b>	<b>51</b>	<b>monthly</b>	<b>Fix</b>	<b>1993-2014</b>	<b>monthly</b>	<b>15</b>
<b>ISA-CNR</b>	<b>D 0-32</b>	<b>0.75x0.56 L54</b>	<b>40</b>	<b>weekly</b>	<b>Fix</b>	<b>1981-2010</b>	<b>6/month</b>	<b>1</b>
<b>HMCR</b>	<b>D 0-63</b>	<b>1.1x1.4 L28</b>	<b>20</b>	<b>weekly</b>	<b>Fix</b>	<b>1981-2010</b>	<b>weekly</b>	<b>10</b>