Development and testing of a multi-model ensemble prediction system for sub-monthly forecasts

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Objectives

- Quantify the sub-monthly hindcast skill of the CFSv2 and selected other individual models over the U.S. in terms of: gridded fields of precipitation and temperature, as well as atmospheric indices such as the NAO and PNA; lead time and averaging range, including weekly averages in weeks 2–4; deterministic and probabilistic forecast skill metrics; and diagnostics of predictability.

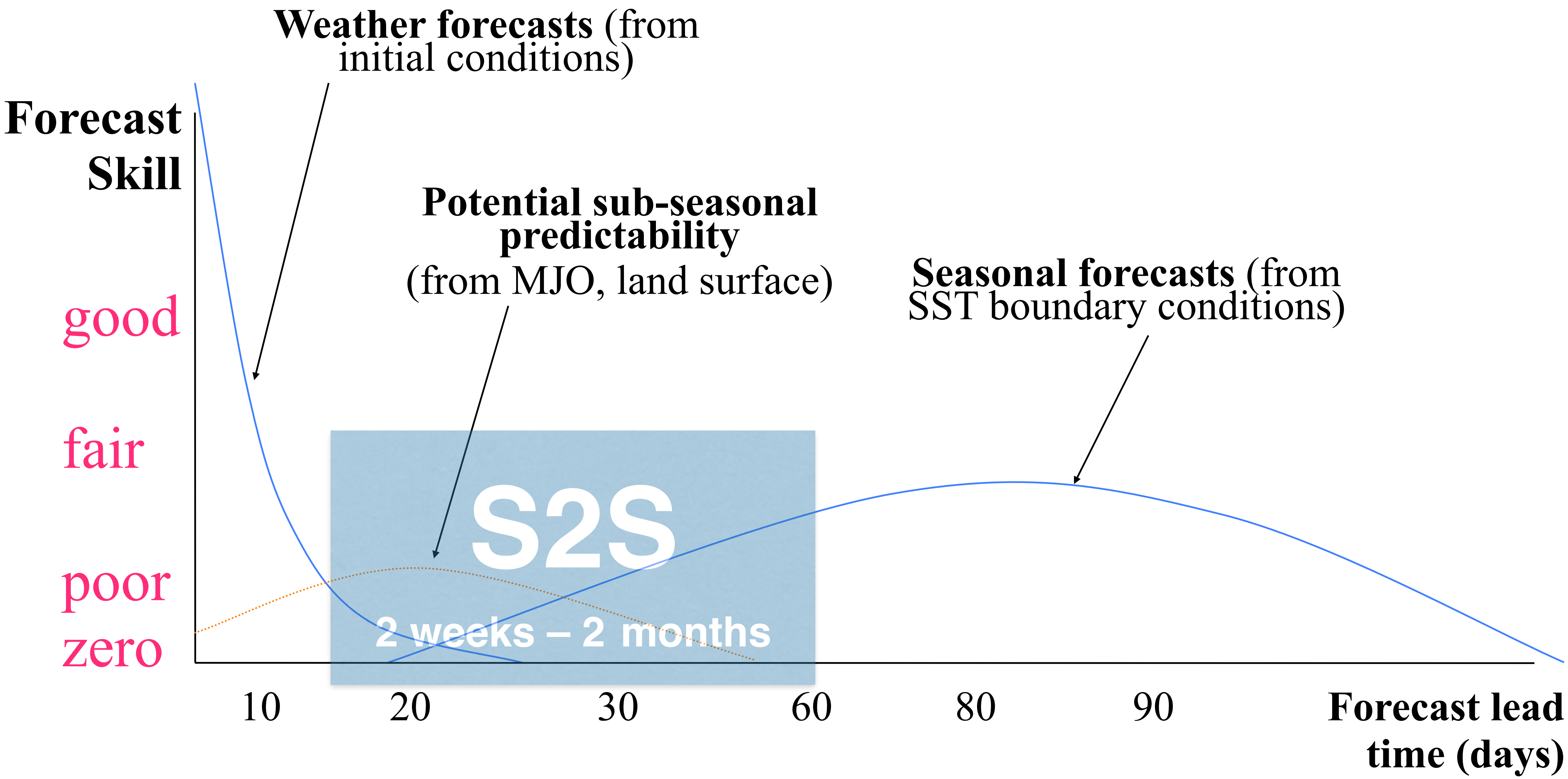
- Develop the methodology and evaluate the benefit of including an additional 1–3 models in a multi-model ensemble, with focus over the U.S.

- Improve physical understanding of sub-monthly predictability over the U.S.

- Establish the applicability of MME methods developed for seasonal forecasts to the sub-monthly scale.

- (Implement a real-time S2S MME at CPC, built using the most skillful and models that are available to CPC in real time.)

Forecast Lead Times



Evaluation of Submonthly Precipitation Forecast Skill from Global Ensemble Prediction Systems

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ABSTRACT

The prediction skill of precipitation at submonthly time scales during the boreal summer season is investigated based on hindcasts from three global ensemble prediction systems (EPSs). The results, analyzed for lead times up to 4 weeks, indicate encouraging correlation skill over some regions, particularly over the Maritime Continent and the equatorial Pacific and Atlantic Oceans. The hindcasts from all three models correspond to high prediction skill over the first week compared to the following three weeks. The ECMWF forecast system tends to yield higher prediction skill than the other two systems, in terms of both correlation and mean squared skill score. However, all three systems are found to exhibit large conditional biases in the tropics, highlighted using the mean squared skill score.

The sources of submonthly predictability are examined in the ECMWF hindcasts over the Maritime Continent in three typical years of contrasting ENSO phase, with a focus on the combined impact of the intraseasonal MJO and interannual ENSO. Rainfall variations over Borneo in the ENSO-neutral year are found to correspond well with the dominant MJO phase. The contribution of ENSO becomes substantial in the two ENSO years, but the MJO impact can become dominant when the MJO occurs in phases 2–3 during El Niño or in phases 5–6 during the La Niña year. These results support the concept that ‘‘windows of opportunity’’ of high forecast skill exist as a function of ENSO and the MJO in certain locations and seasons, which may lead to subseasonal-to-seasonal forecasts of substantial societal value in the future.

3 models, boreal summer, weekly precipitation

Model	Grid Resolution	Ensemble	Frequency	# of Starts	Period
JMA	144 x 73	5	3/month	13	1979–2008
CFSv2	384 x 190	4	5-day	25	1982–2010
ECMWF	360 x 181	5	weekly	18	1992–2009

- Weekly averages were constructed from the GCM daily output, and CMAP pentad data

- Ensemble sizes are small so skill measures restricted to deterministic measures

- Hindcast frequency differ – MME not possible

Skill metrics

- Correlation of anomalies (CORA)
  – between the EPS ensemble mean and CMAP
  – lead-dependent EPS weekly climo is subtracted
  – weekly averages (week 1 = days 1–7, week2 = 8–14, week 3 = days 15–21), week 4 = days 22–28)
  – all available start dates, 1992–2008 (17 yrs)

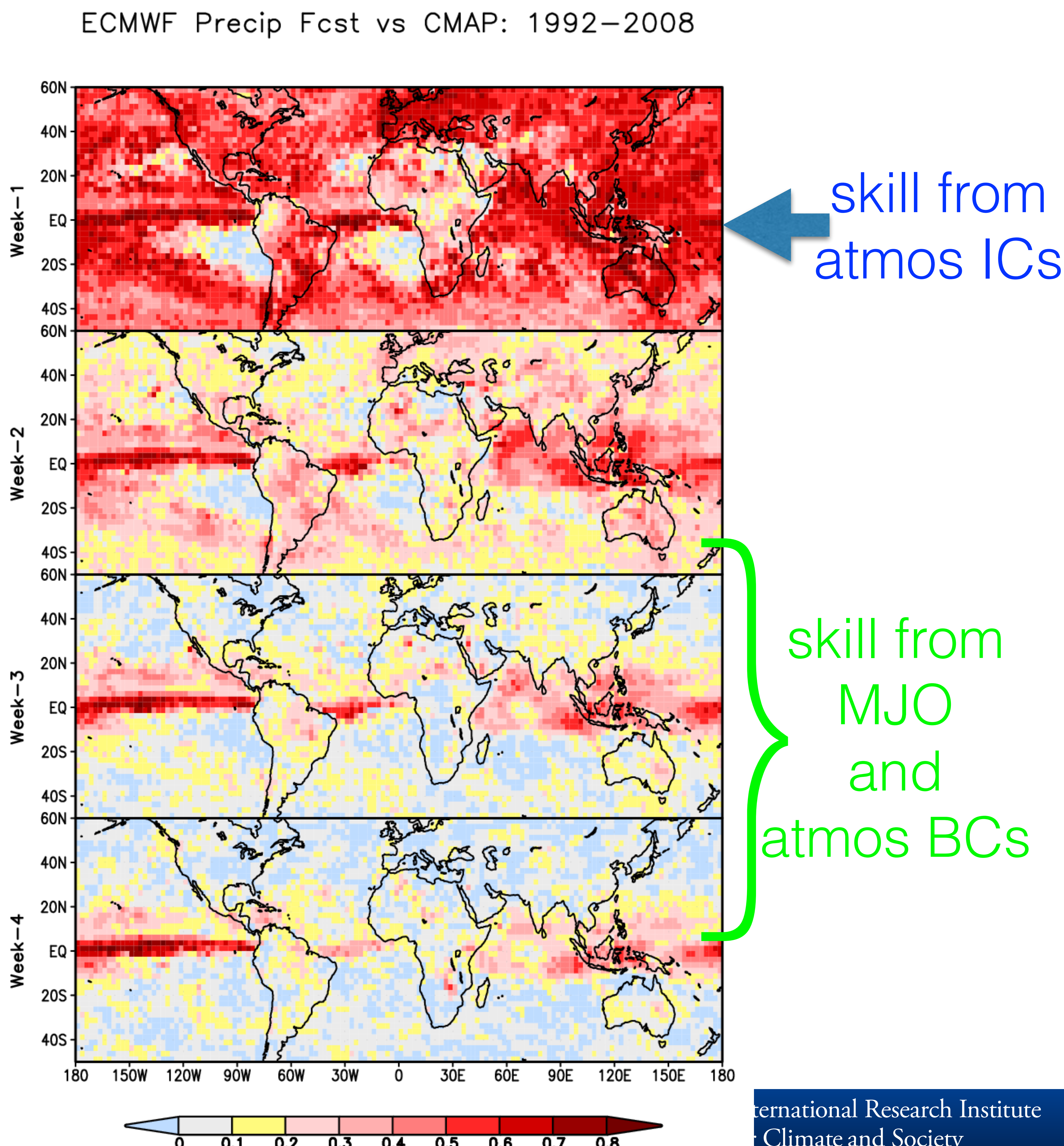
- Mean Squared Skill Score (MSSS)

  $\text{MSSS} = (\text{CORA})^2 + b^2$

ECMWF Sub-monthly forecast skill

Weekly average precip

Jun–Aug anomaly correlation skill



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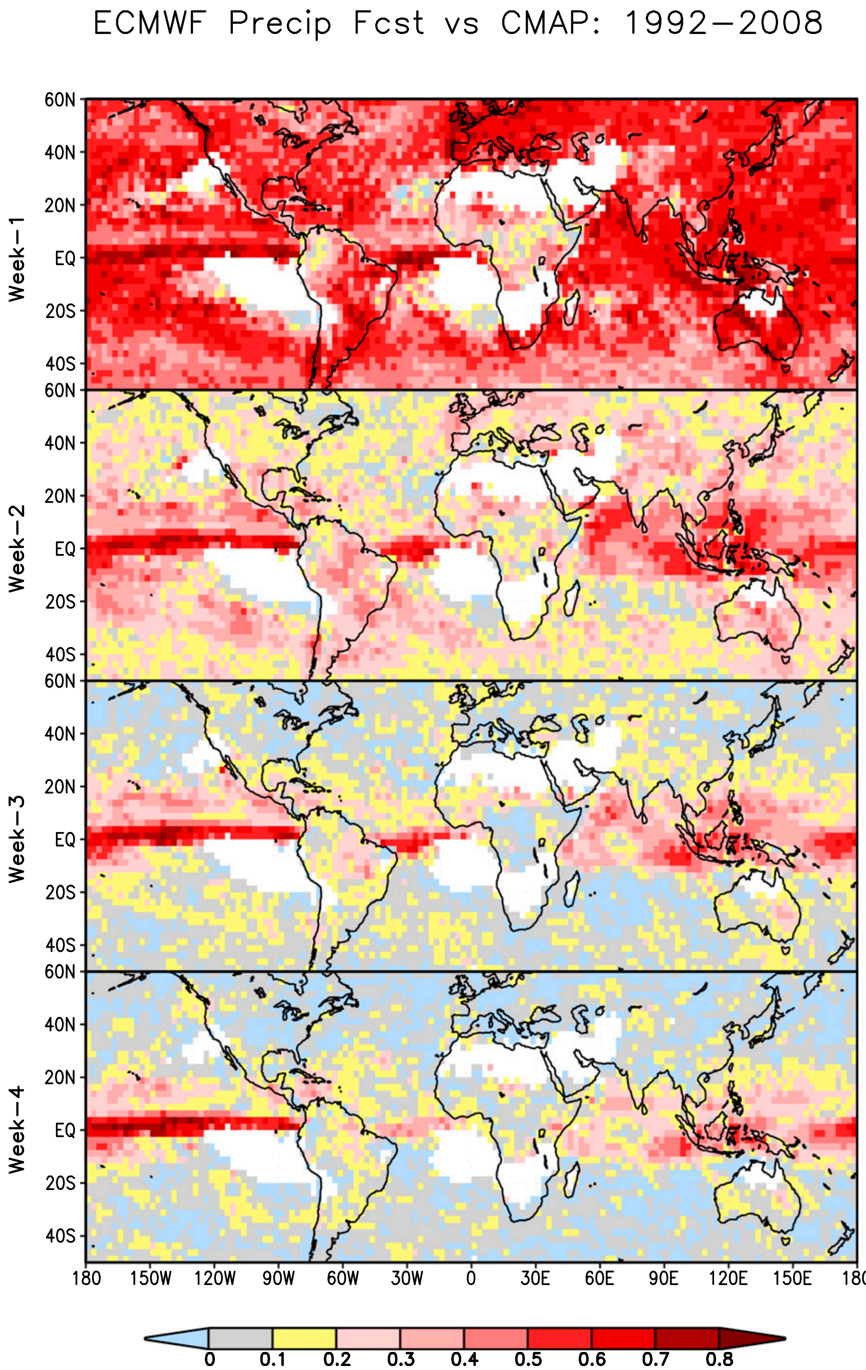
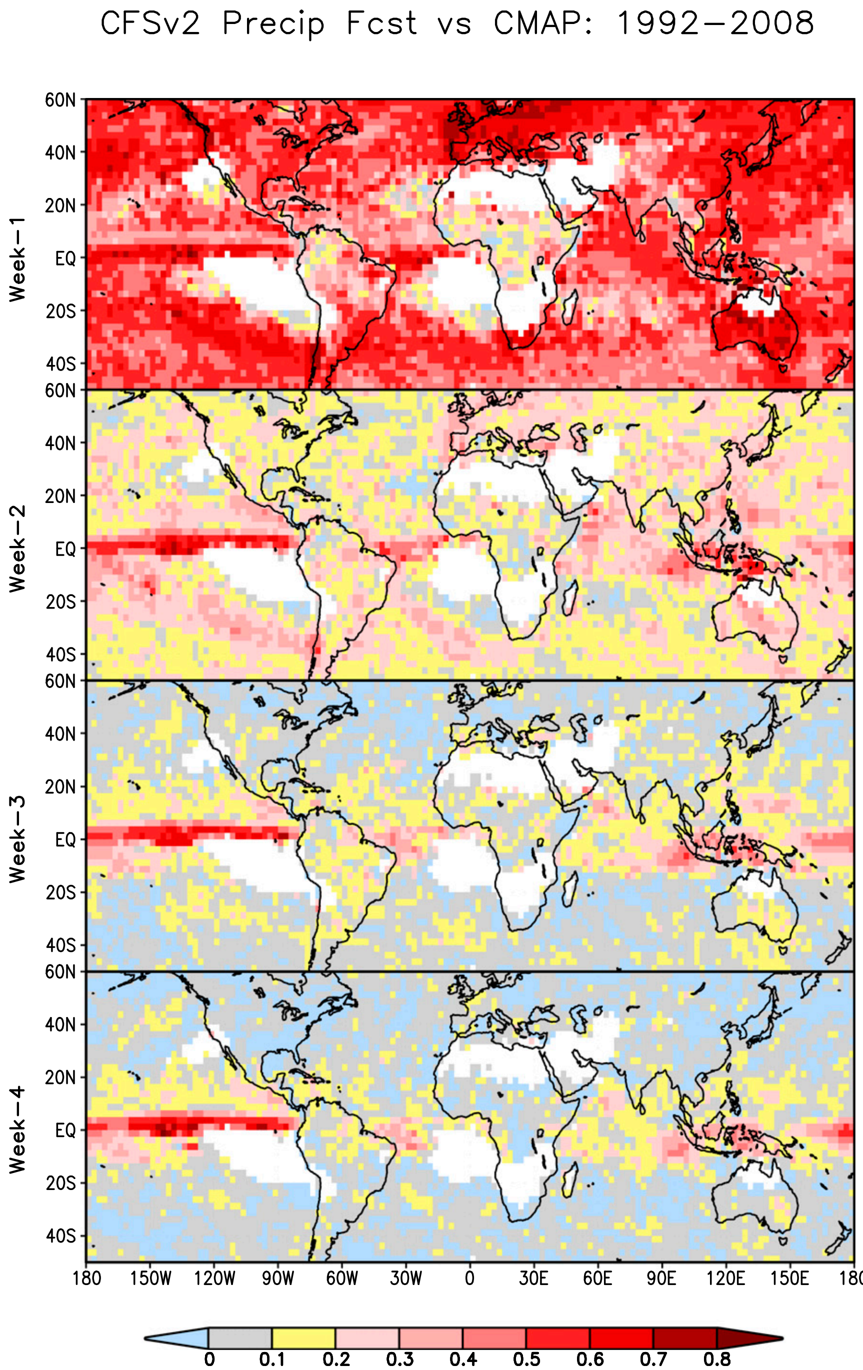
Anomaly correlation skill of weekly precipitation

ECMWF



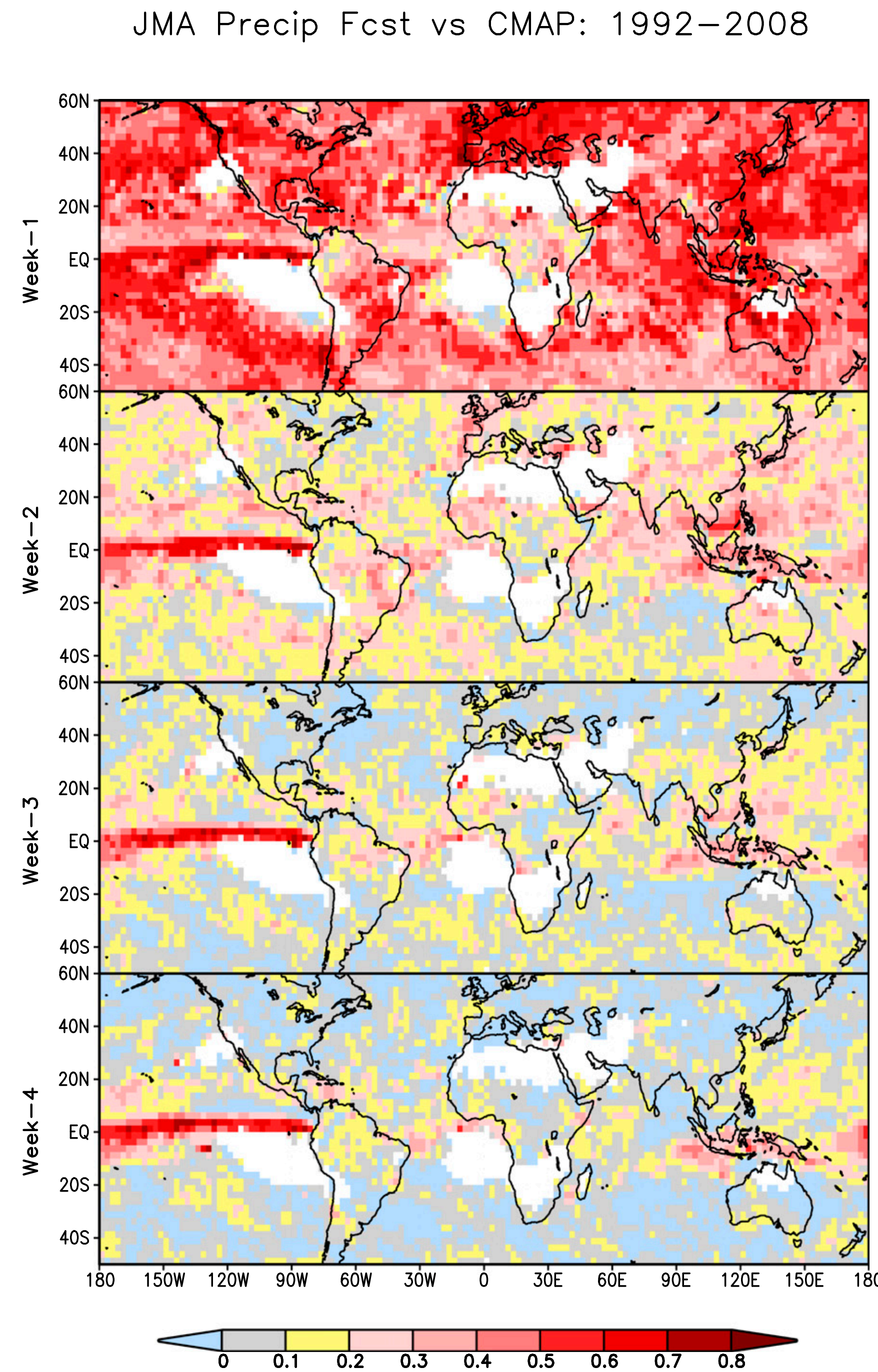
T255, coupled after day 9

CFSv2



T126, coupled

JMA



T159, persisted SST

MSSS: ECMWF Precip Fcst vs CMAP: 1992–2008

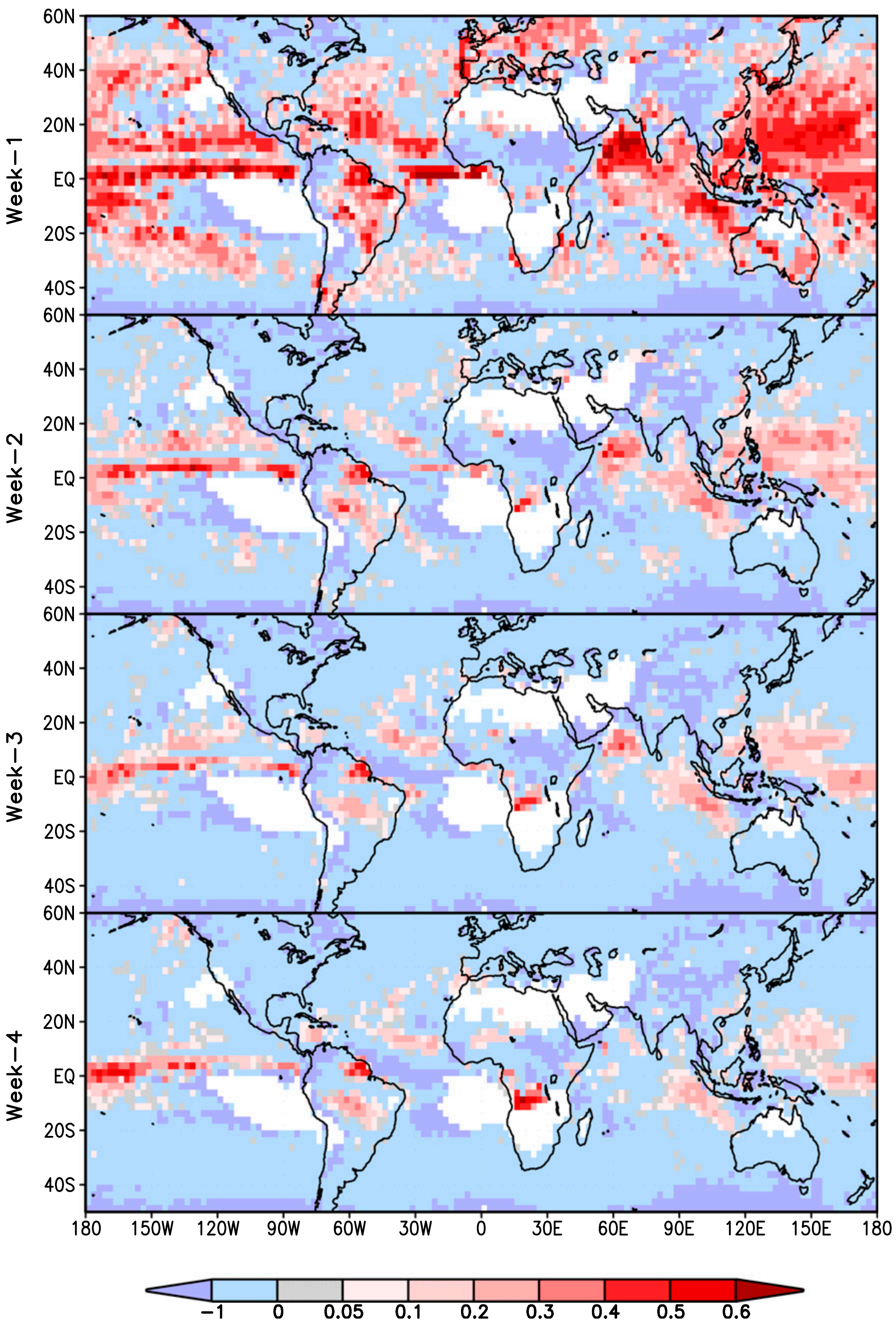
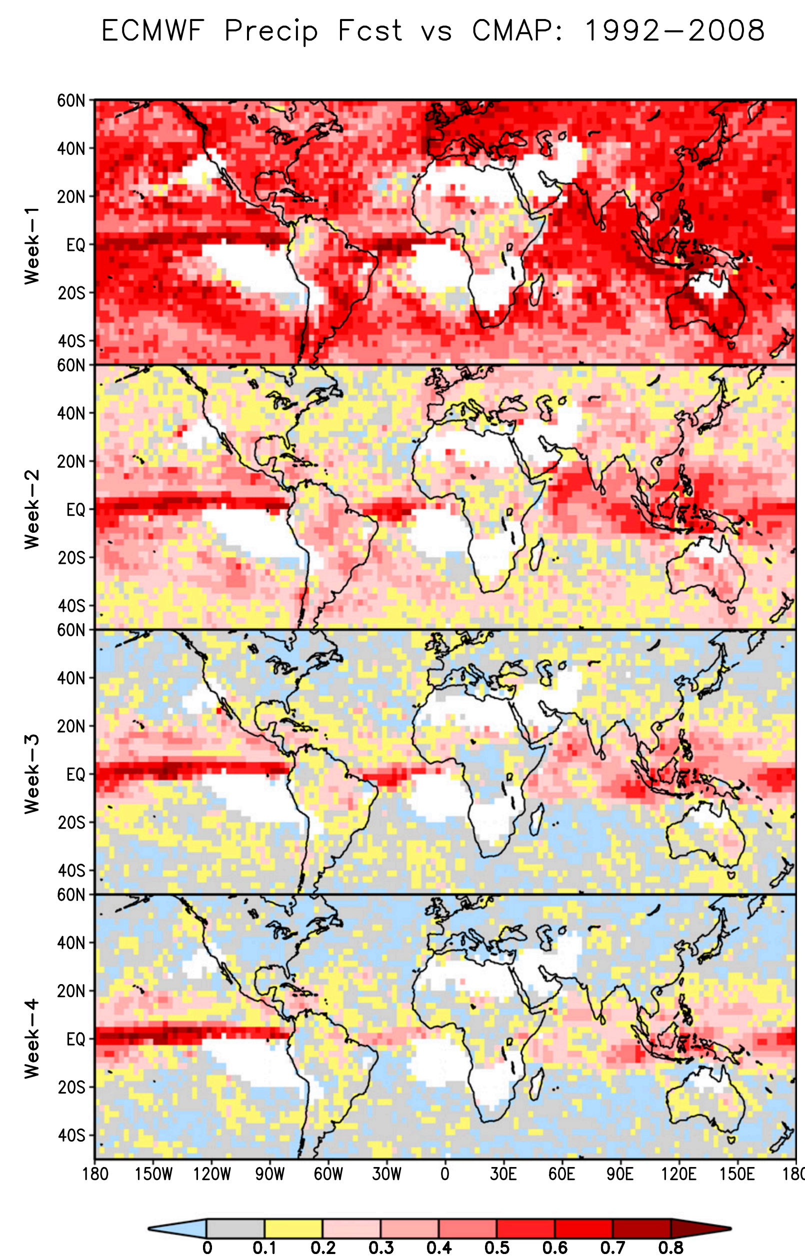


FIG. 15. Mean square skill score (MSSS) between ECMWF precipitation hindcast and CMAP rainfall data over weeks 1–4.

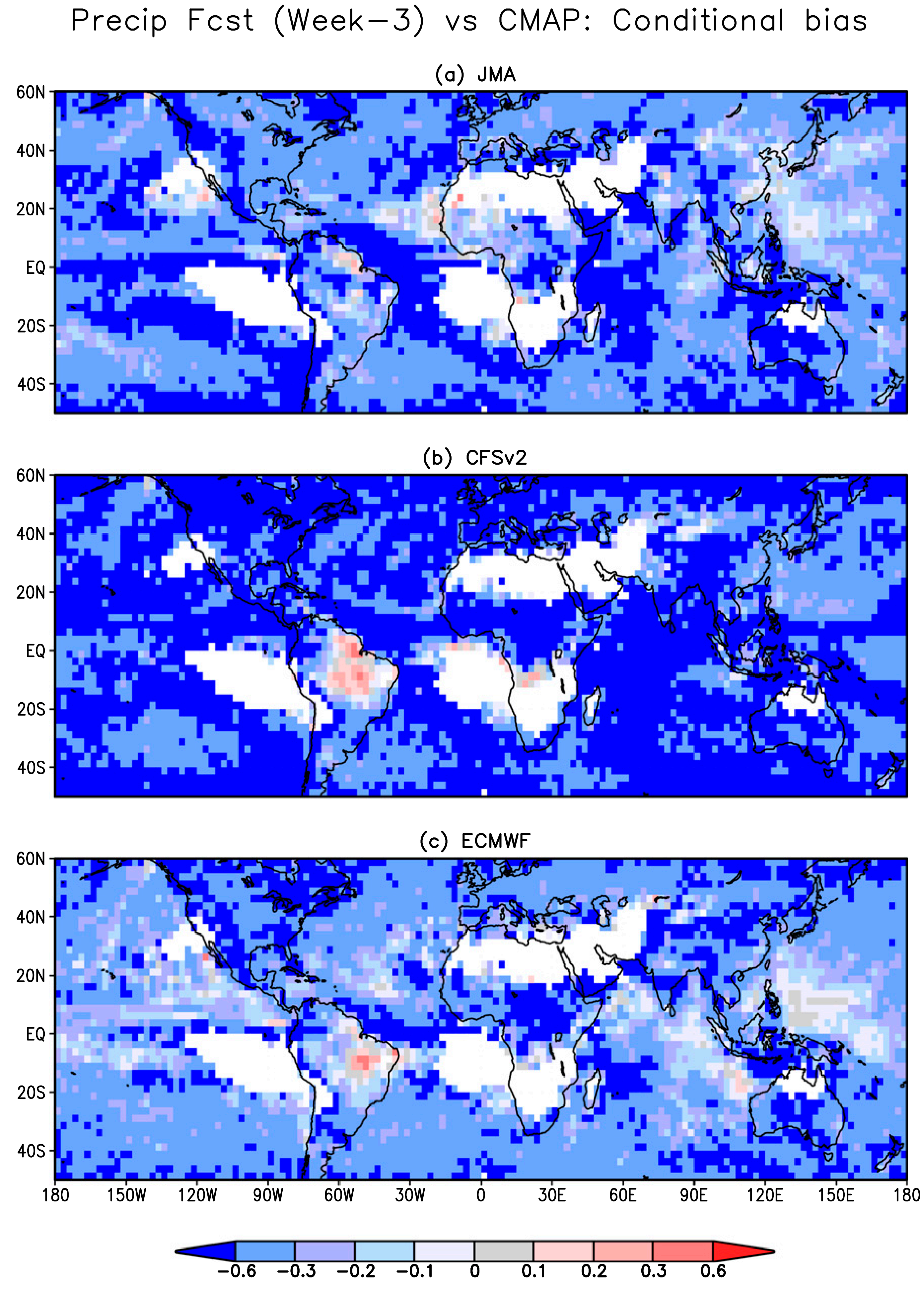
Mean Squared Skill Score



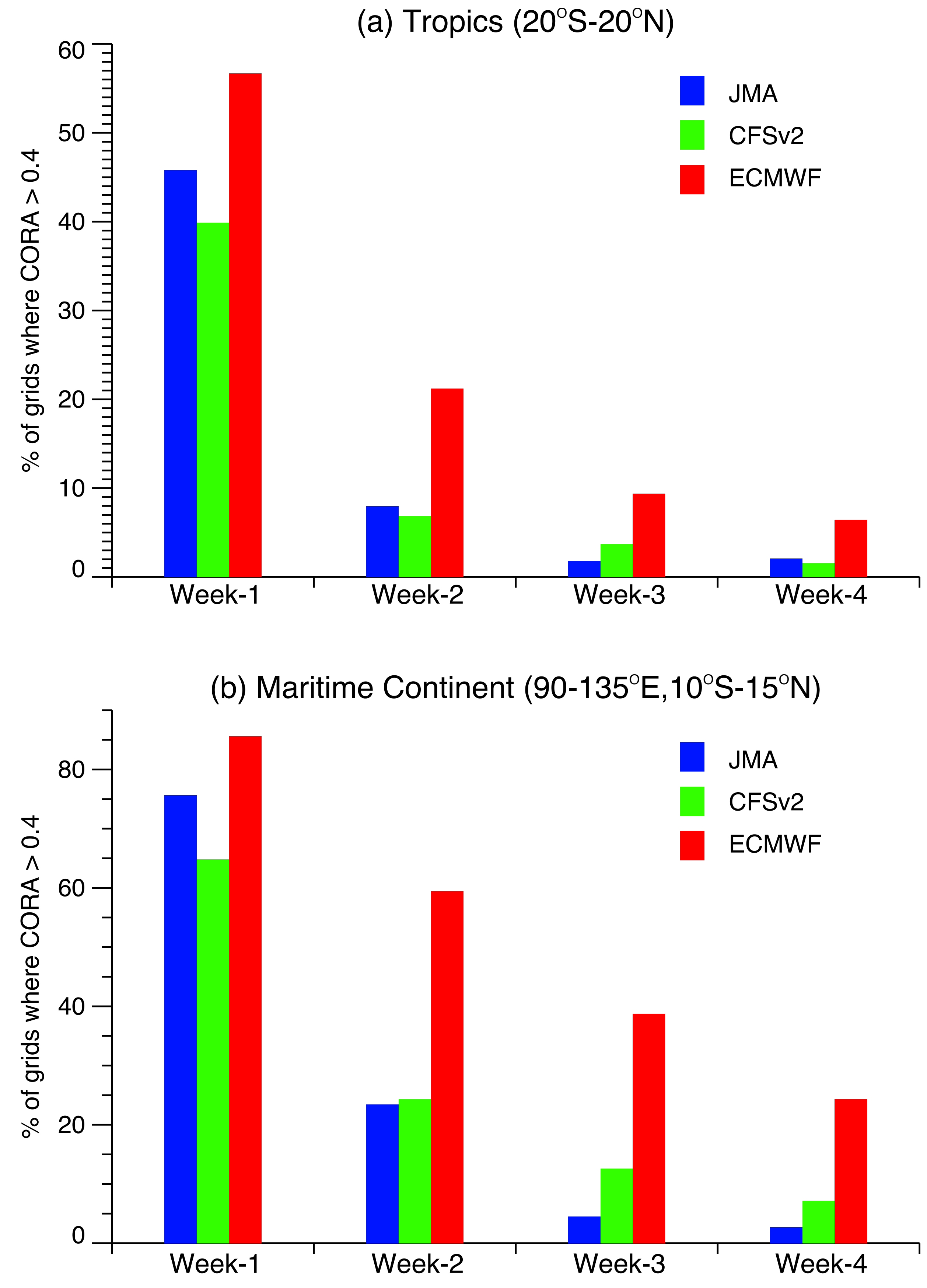
$$MSSS = (CORA)^2 + b^2$$

Conditional Bias

CORA – s_h/s_o



Spatial averages of Correlation of Anomalies for 3 GCMs



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Skill for ENSO Years

Weekly average precip

Jun–Aug anomaly correlation skill

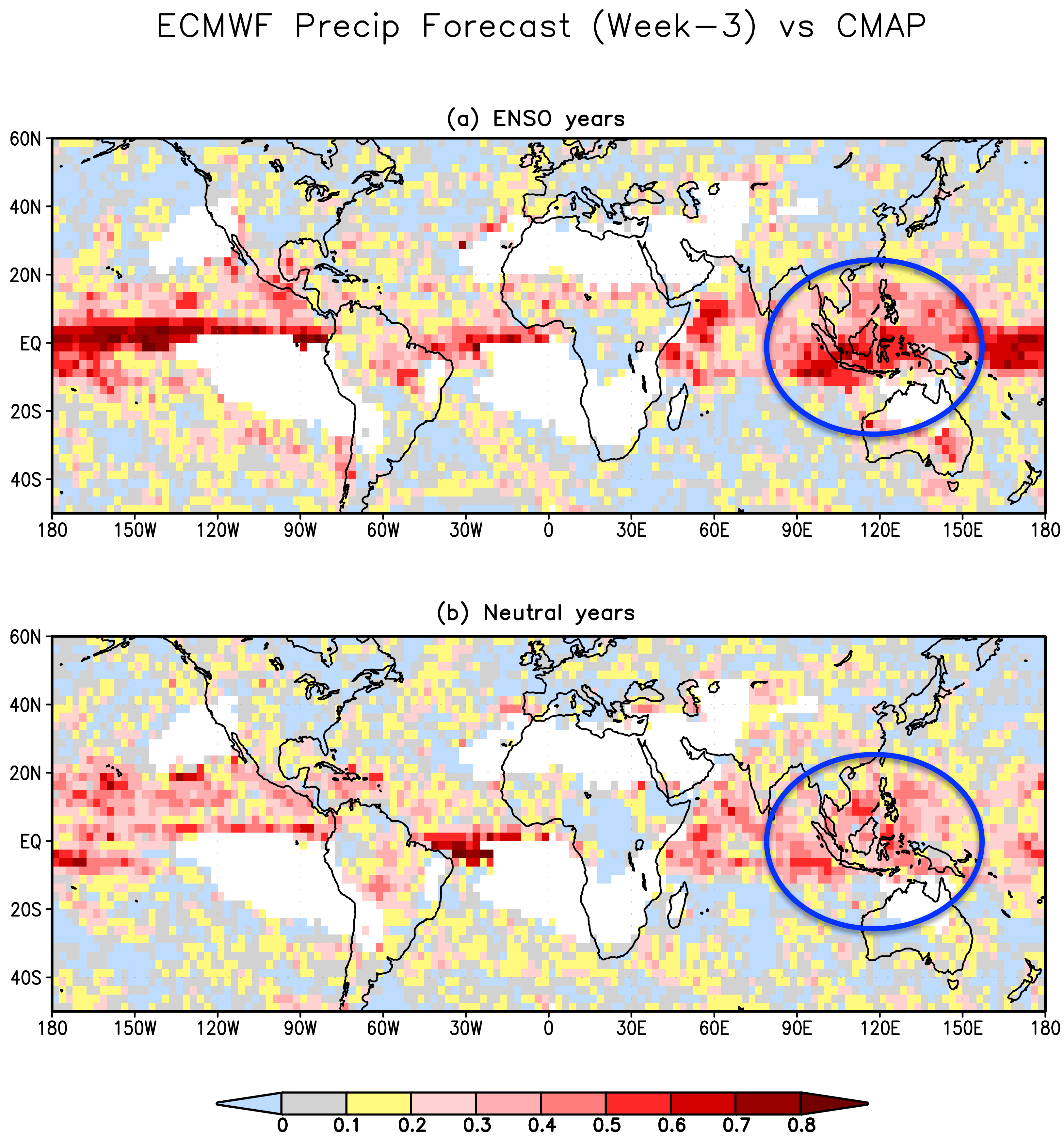
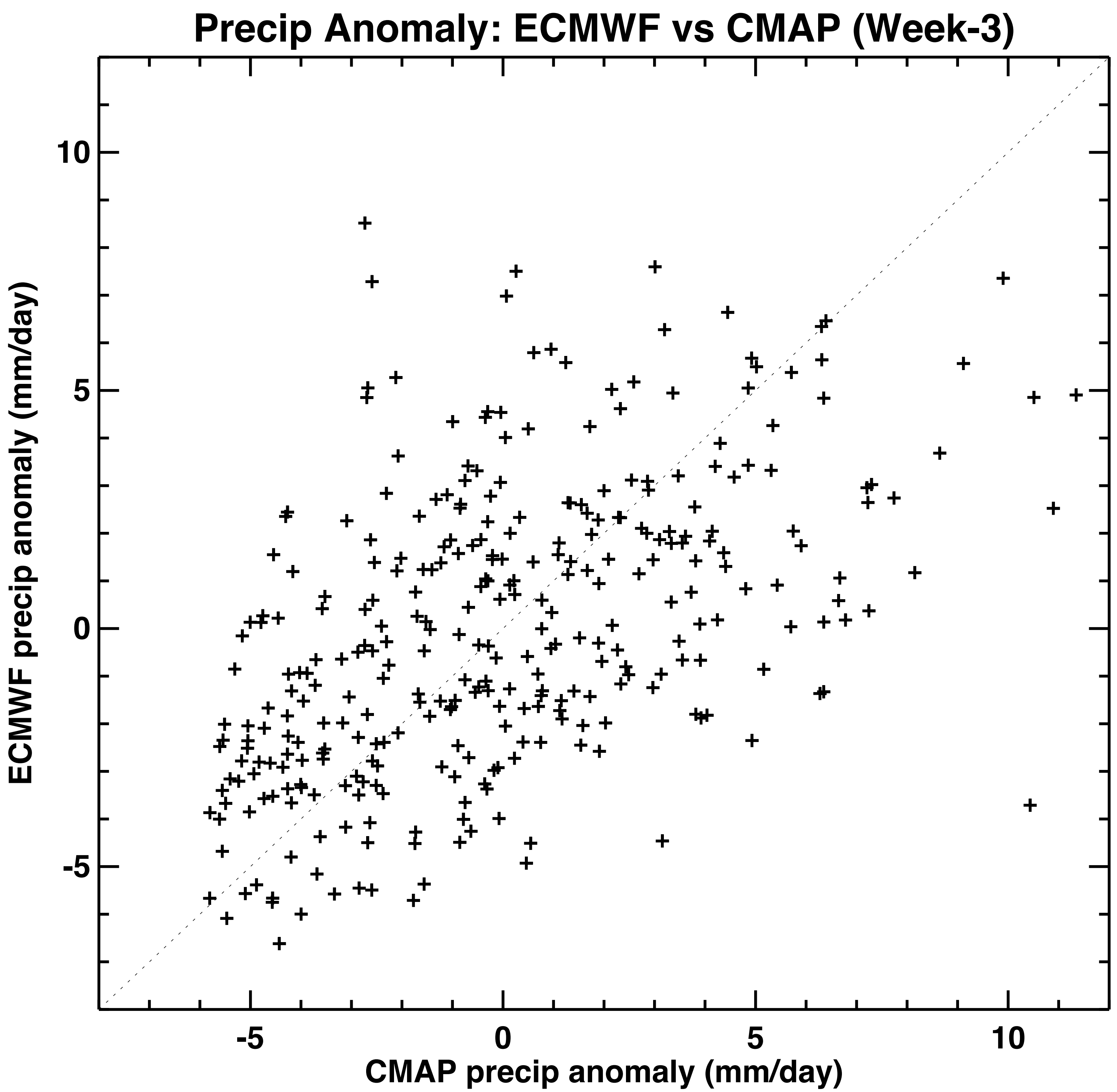


Figure 6: Correlation of anomalies between ECMWF lead-3 preci[...]

start dates) and CAMP observation during (a) 5 ENSO years: 1[...]

ECMWF Performance over Borneo (Boreal summer)



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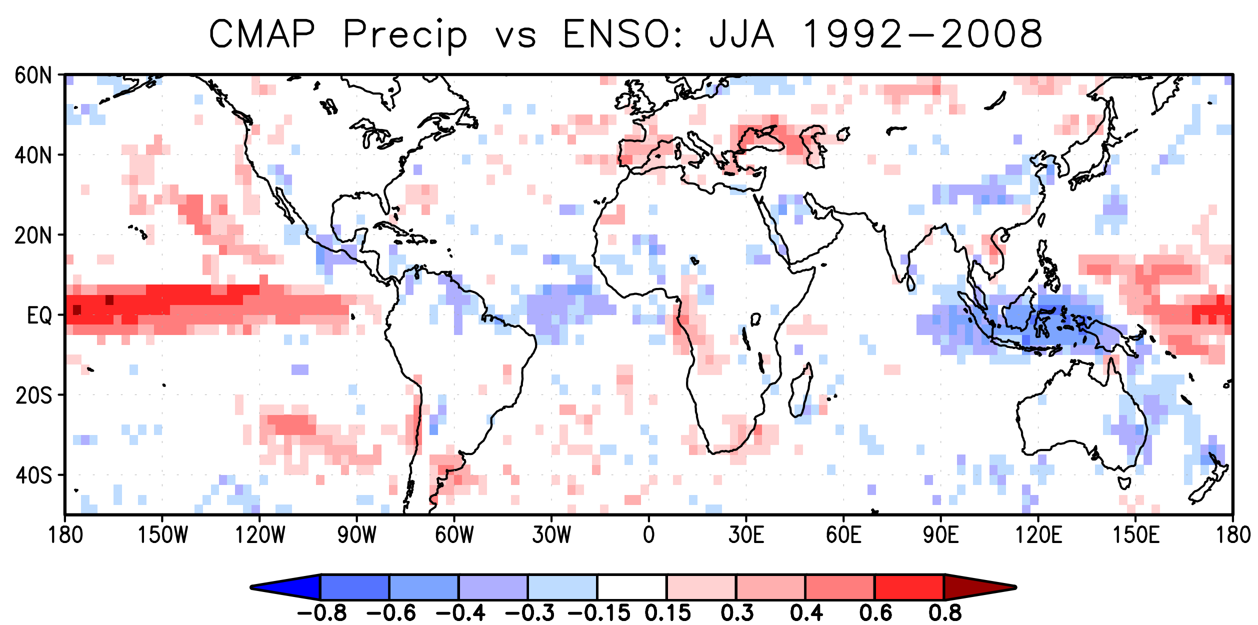
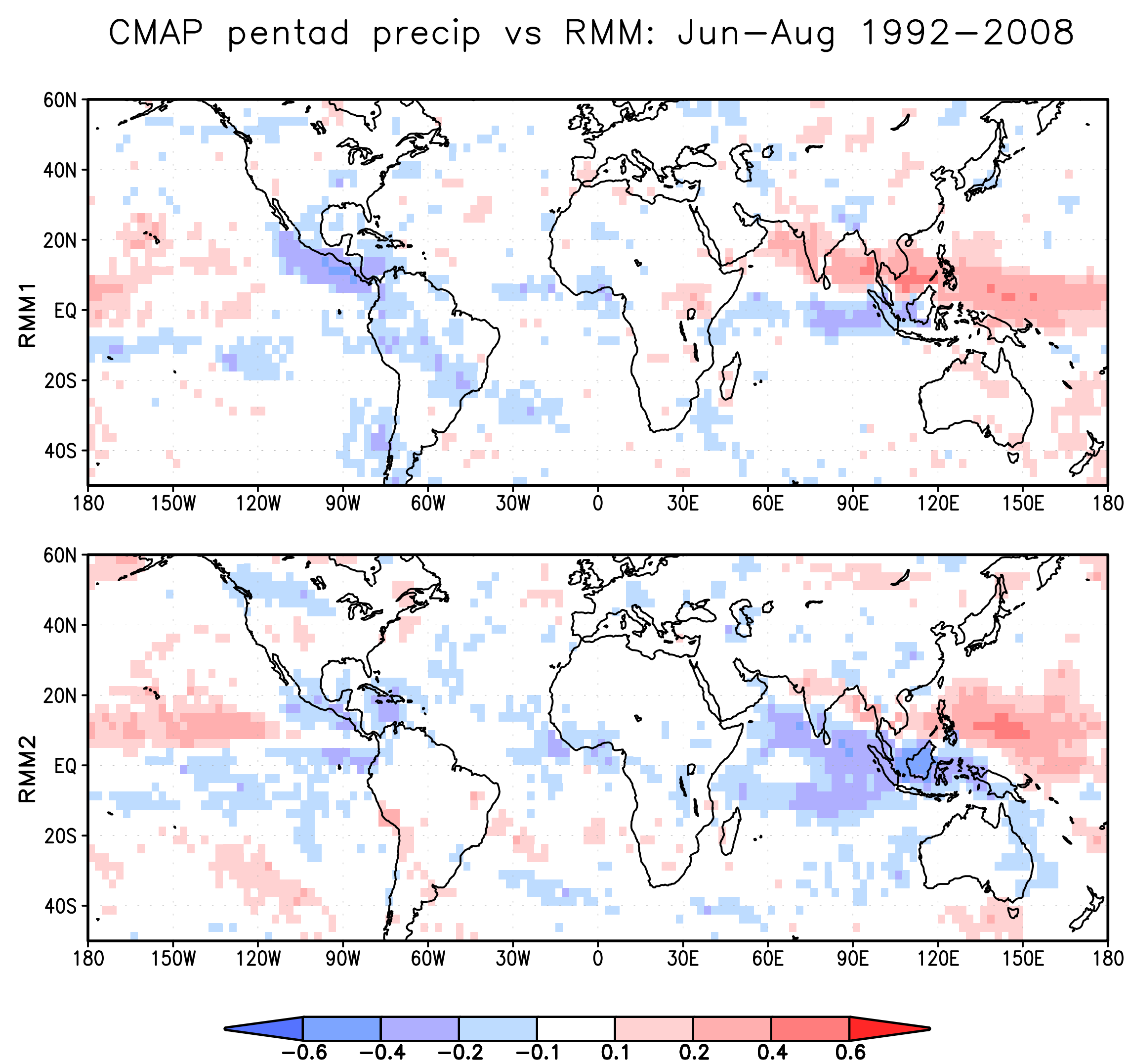
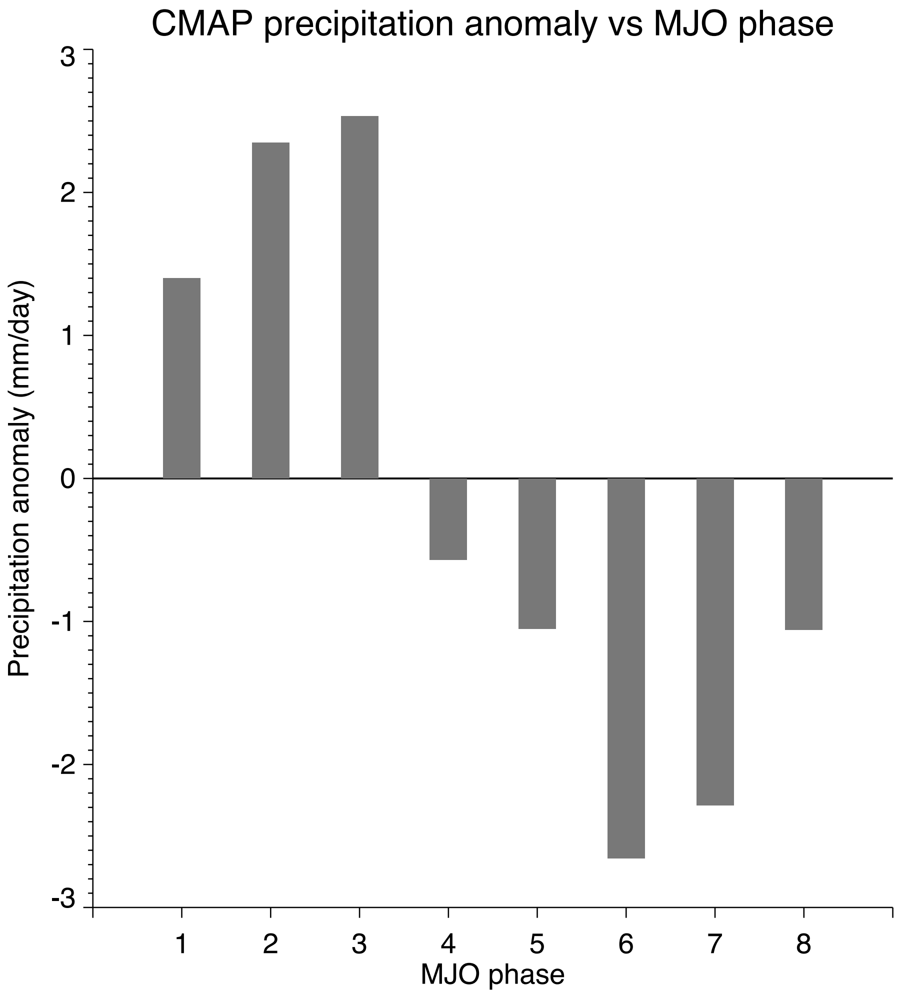
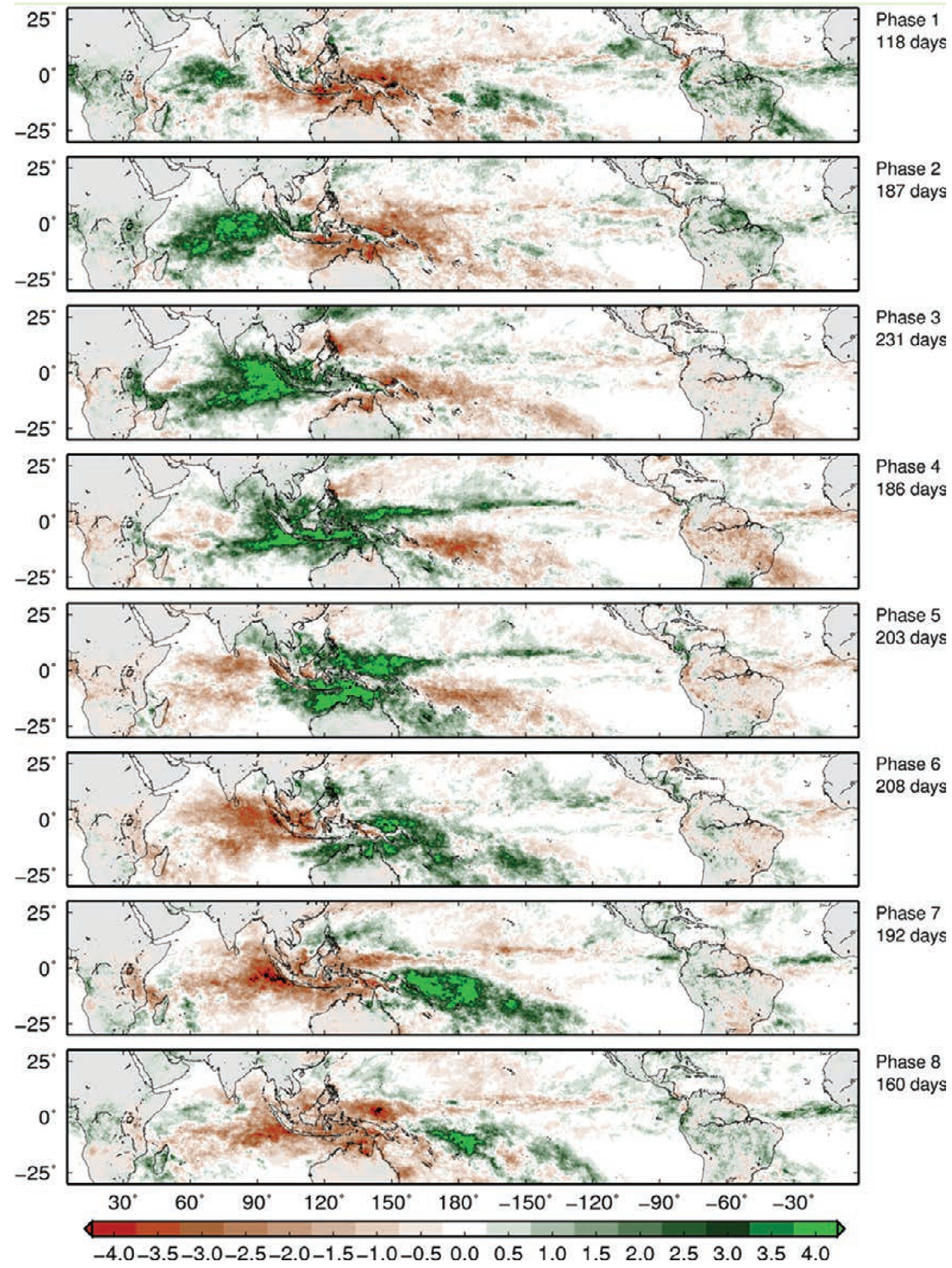
ENSO & MJO Signals during boreal summer



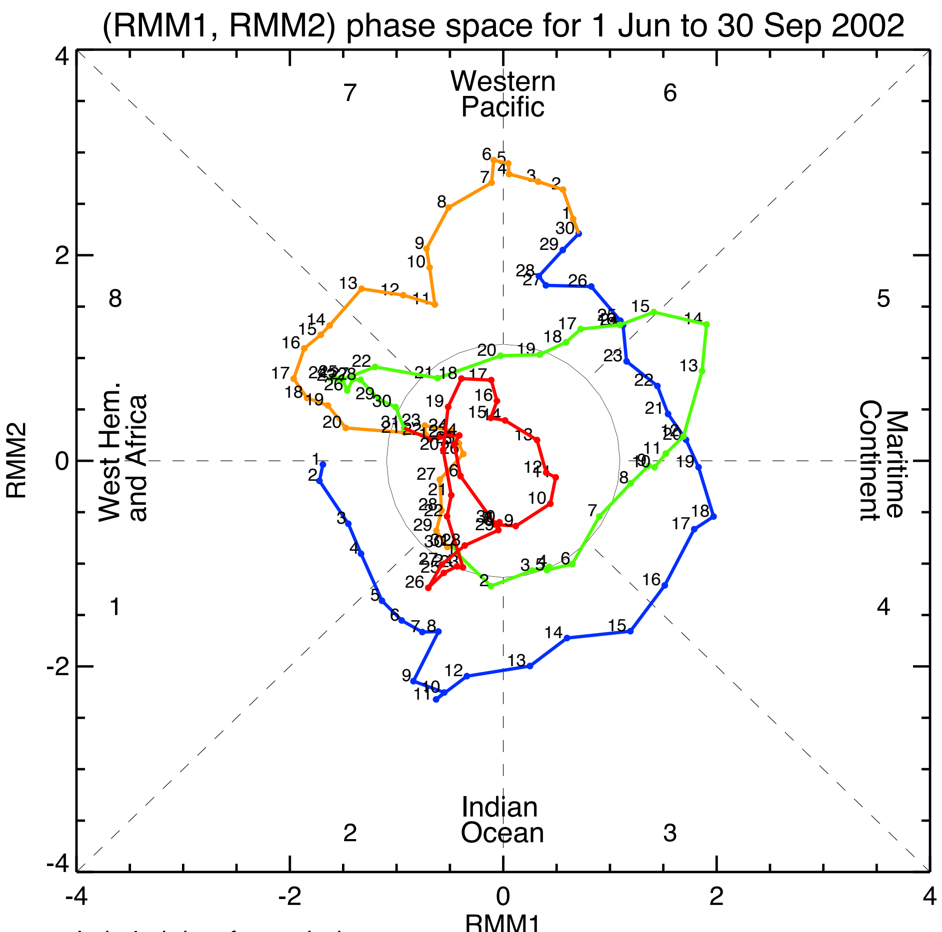


Borneo Precipitation vs MJO Phase

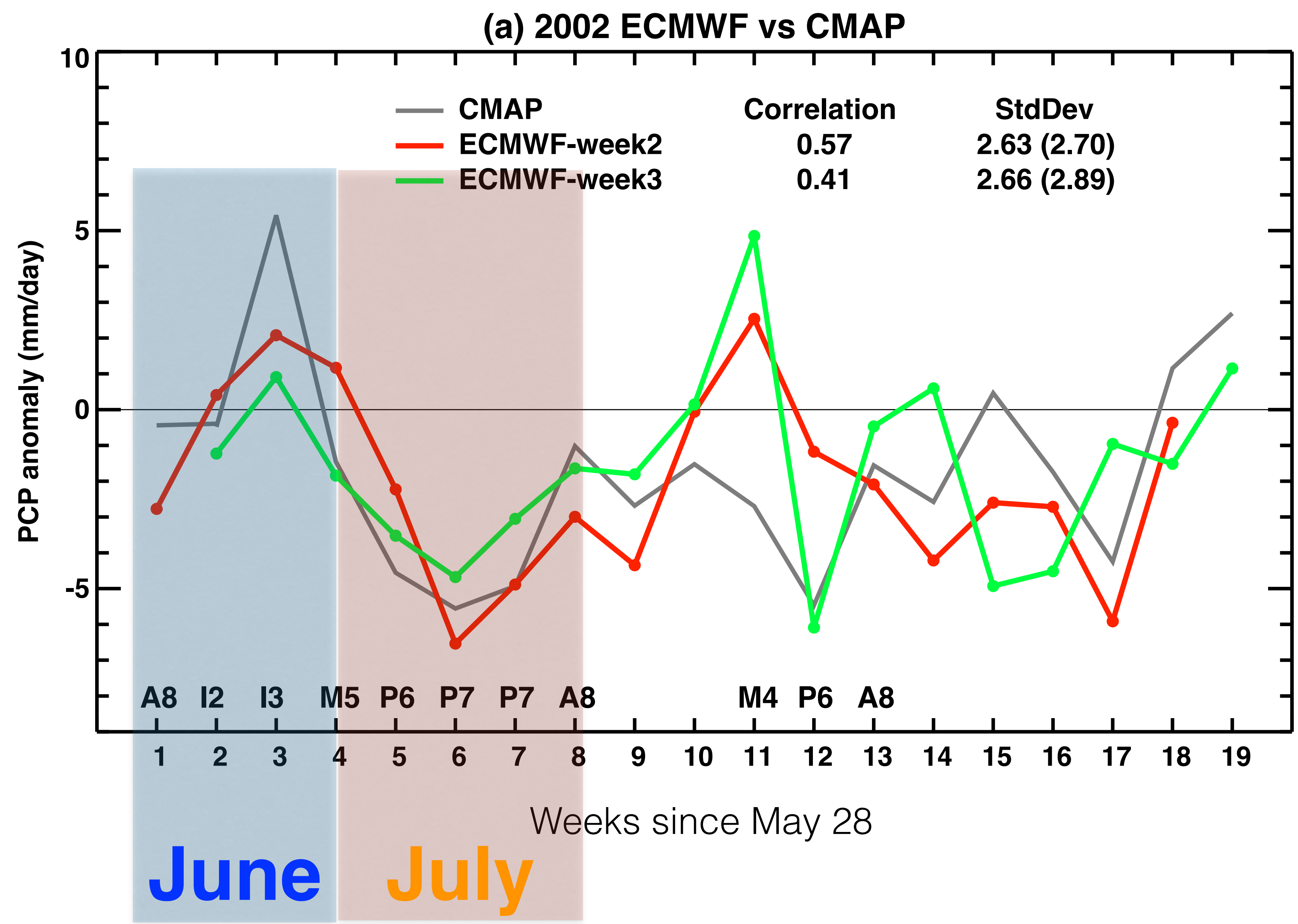




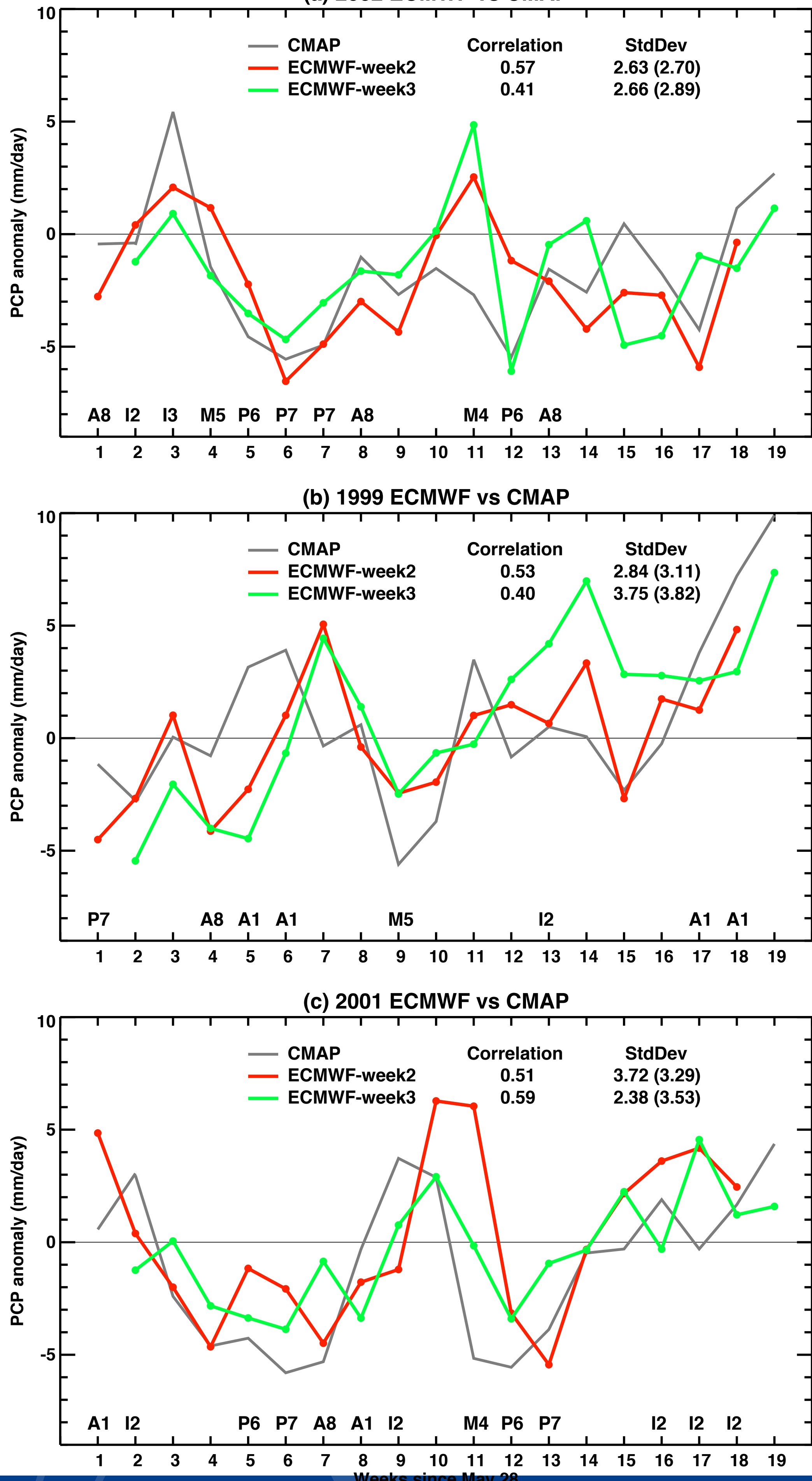
ECMWF Performance over Borneo

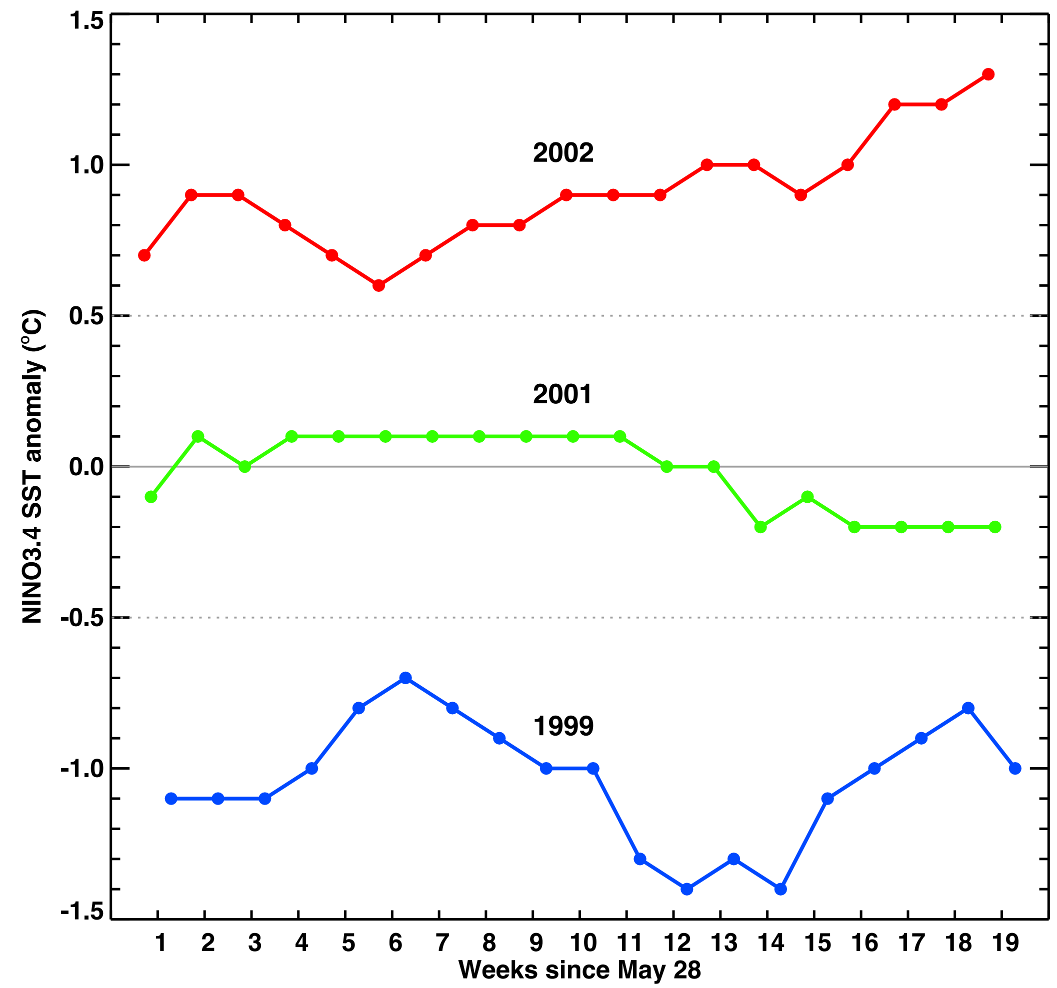


Labeled dots for each day.
Blue for Jun, orange for Jul, green for Aug, and red for Sep.



ECMWF Performance over Borneo





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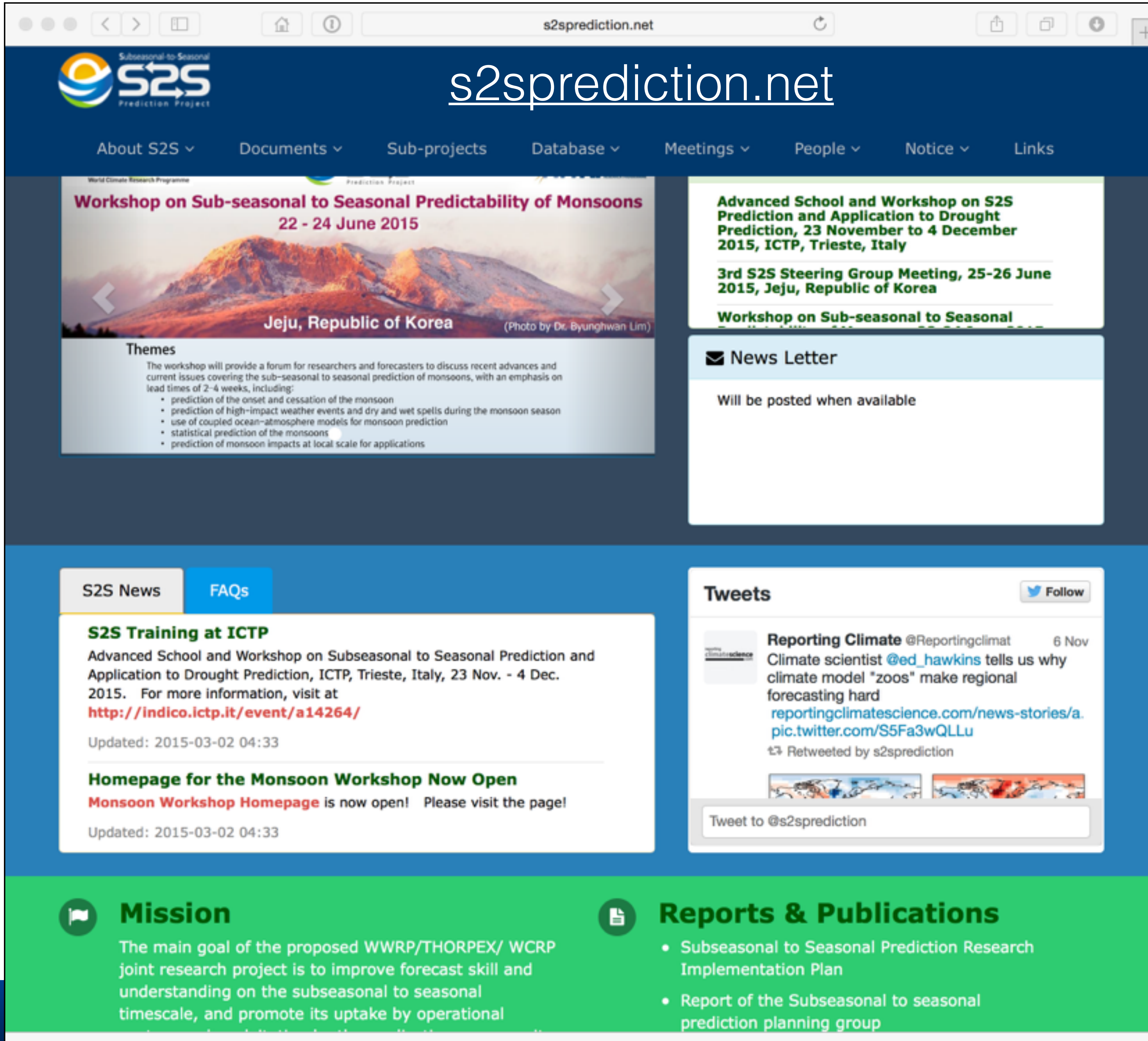
s2sprediction.net
Subseasonal-to-Seasonal S2S Prediction Project
s2sprediction.net
About S2S
Documents
Sub-projects
Database
Meetings
People
Notice
Links
Workshop on Sub-seasonal to Seasonal Predictability of Monsoons
22 - 24 June 2015
Jeju, Republic of Korea
(Photo by Dr. Byunghwan Lim)
Themes
The workshop will provide a forum for researchers and forecasters to discuss recent advances and current issues covering the sub-seasonal to seasonal prediction of monsoons, with an emphasis on lead times of 2-4 weeks, including:
• prediction of the onset and cessation of the monsoon
• prediction of high-impact weather events and dry and wet spells during the monsoon season
• use of coupled ocean-atmosphere models for monsoon prediction
• statistical prediction of the monsoons
• prediction of monsoon impacts at local scale for applications
Advanced School and Workshop on S2S Prediction and Application to Drought Prediction, 23 November to 4 December 2015, ICTP, Trieste, Italy
3rd S2S Steering Group Meeting, 25-26 June 2015, Jeju, Republic of Korea
Workshop on Sub-seasonal to Seasonal
News Letter
Will be posted when available
S2S News
FAQs
S2S Training at ICTP
Advanced School and Workshop on Subseasonal to Seasonal Prediction and Application to Drought Prediction, ICTP, Trieste, Italy, 23 Nov. - 4 Dec. 2015. For more information, visit at
http://indico.ictp.it/event/a14264/
Updated: 2015-03-02 04:33
Homepage for the Monsoon Workshop Now Open
Monsoon Workshop Homepage is now open! Please visit the page!
Updated: 2015-03-02 04:33
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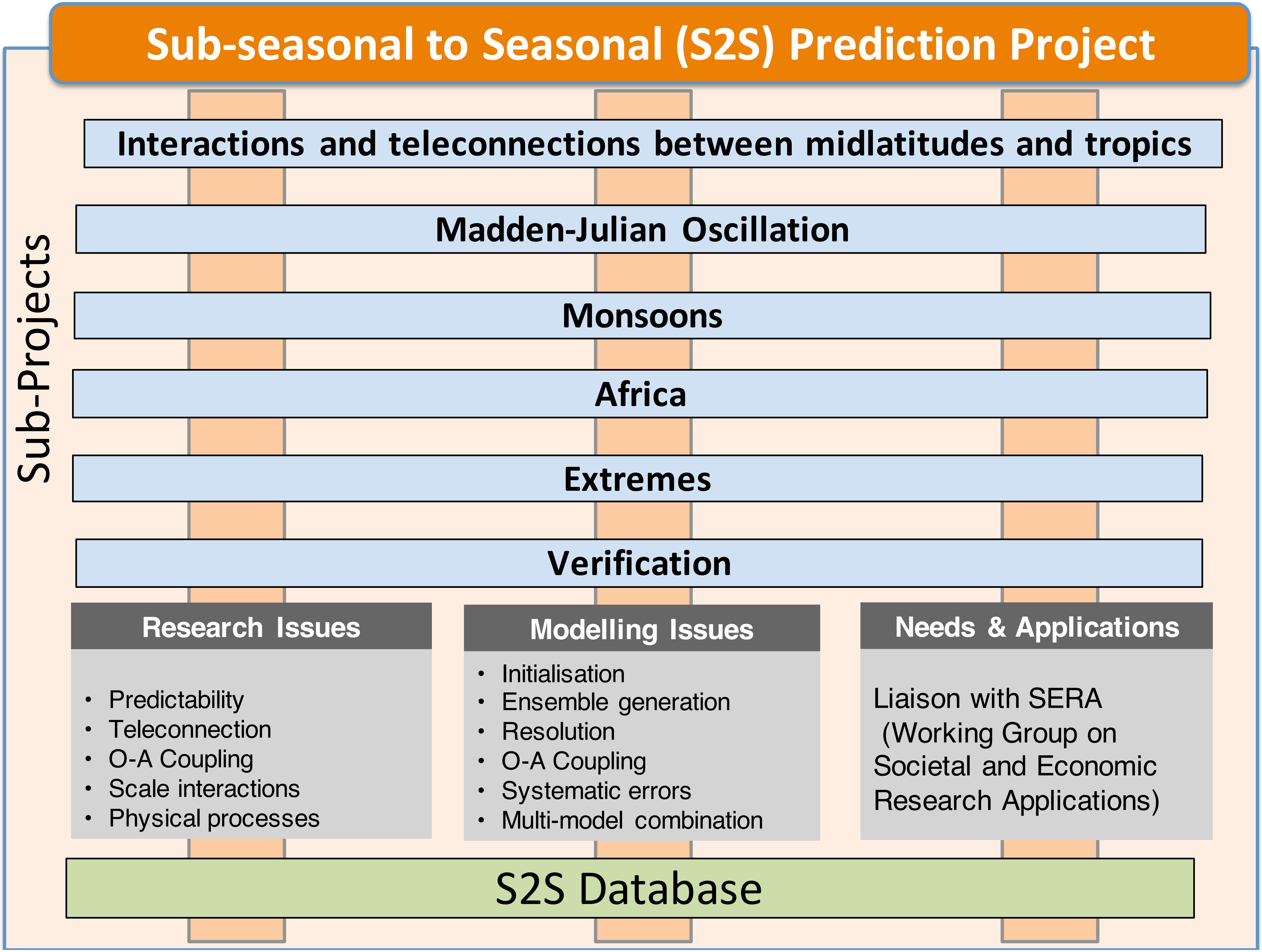
Retweeted by s2sprediction
Tweet to @s2sprediction
Mission
The main goal of the proposed WWRP/THORPEX/ WCRP joint research project is to improve forecast skill and understanding on the subseasonal to seasonal timescale, and promote its uptake by operational
Reports & Publications
• Subseasonal to Seasonal Prediction Research Implementation Plan
• Report of the Subseasonal to seasonal prediction planning group



Sub-seasonal to Seasonal (S2S) Prediction Project
Sub-Projects
Interactions and teleconnections between midlatitudes and tropics
Madden-Julian Oscillation
Monsoons
Africa
Extremes
Verification
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

S2S partners

	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
ECMWF	D 0-32	T639/319L91	51	2/week	On the fly	Past 18y	2/weekly	11
UKMO	D 0-60	N96L85	4	daily	On the fly	1989-2003	4/month	3
NCEP	D 0-45	N126L64	4	4/daily	Fix	1999-2010	4/daily	1
EC	D 0-35	0.6x0.6L40	21	weekly	On the fly	Past 15y	weekly	4
CAWCR	D 0-60	T47L17	33	weekly	Fix	1981-2013	6/month	33
JMA	D 0-34	T159L60	50	weekly	Fix	1979-2009	3/month	5
KMA	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
CMA	D 0-45	T106L40	4	daily	Fix	1992-now	daily	4
Met.Fr	D 0-60	T127L31	51	monthly	Fix	1981-2005	monthly	11
CNR	D 0-32	0.75x0.56 L54	40	weekly	Fix	1981-2010	6/month	1
HMCR	D 0-63	1.1x1.4 L28	20	weekly	Fix	1981-2010	weekly	10

Workplan

Year 1:

1. **Downloading of datasets from NCEP and S2S database**
2. **Evaluation of skill of individual models;**
3. **Predictability diagnostics using individual models;**
4. Development of MME methodology;
5. Publication on individual models.

Year 2:

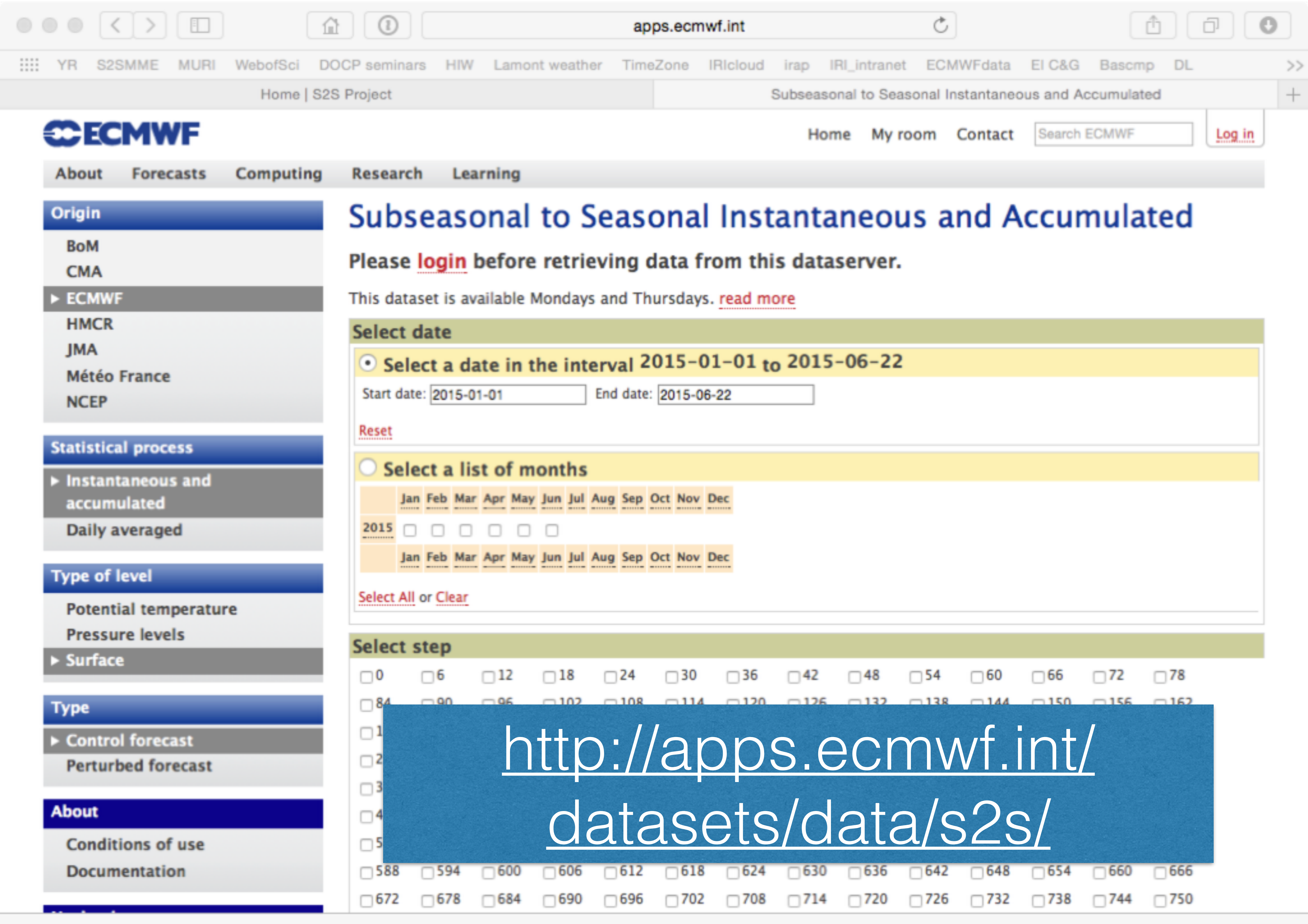
6. Further development and testing of MME methodology;
7. Evaluation of skill of multi- model combinations;
8. Predictability diagnostics of MMEs;
9. Porting of MME methodology to NCEP;
10. Publication on MME.

Models

Created by Richard Mladek, last modified by Frederic Vitart about 13 hours ago

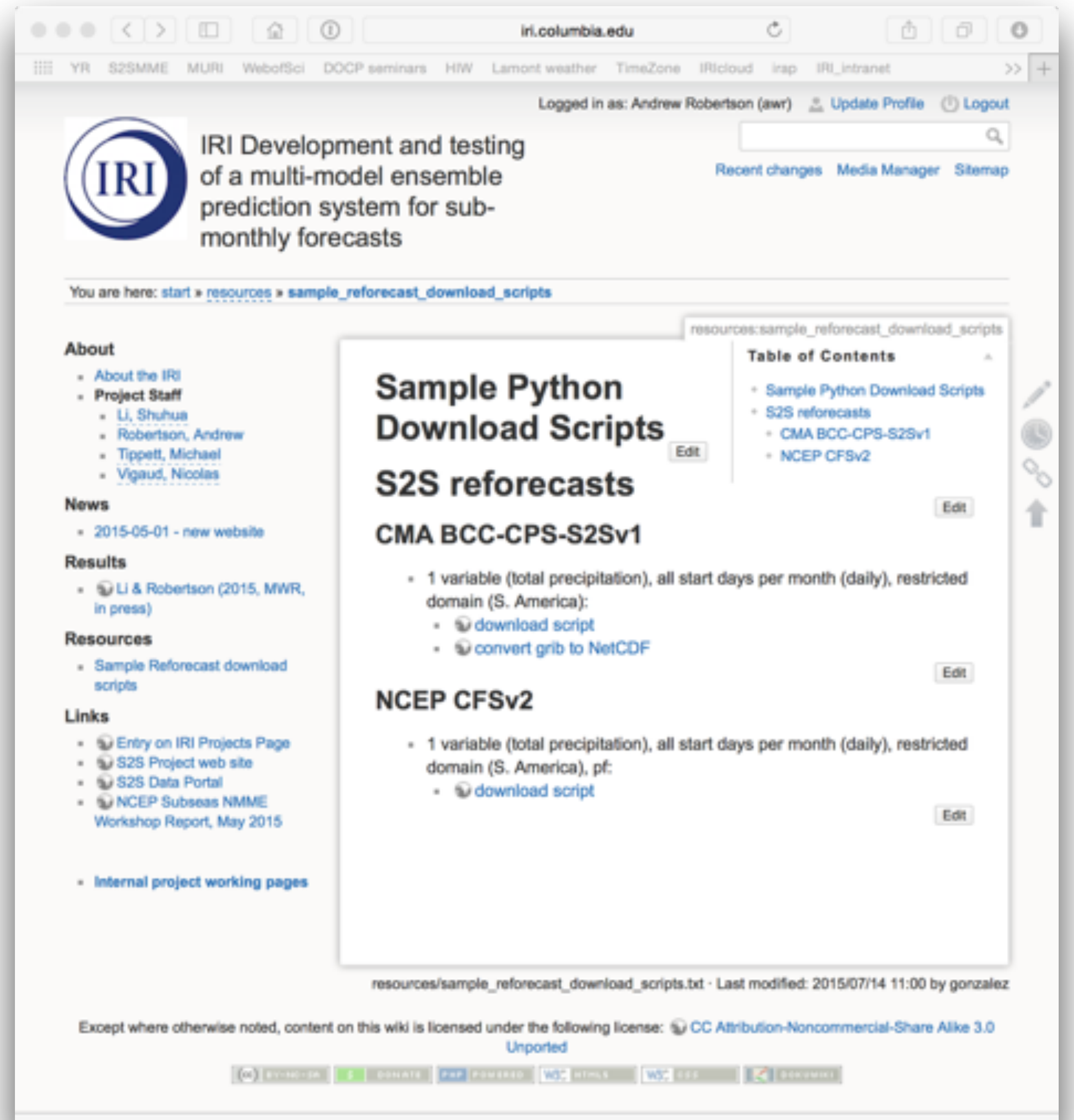
This table shows the centres that provide data to this project together with the **latest** configuration of their systems. Follow the link of each Data Prov
of retrievals.

Status on 1st July 2015	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-60	T47L17	33	2/week	fix	1981-2010	6/month	33
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-April 2014	daily	4
EC (cwao)	d 0-35	0.6x0.6 L40	21	weekly	on the fly	past 15y	weekly	4
ECMWF (ecmf)	d 0-46	T639/319 L62	51	2/week	on the fly	past 20 years	2/week	11
ISAC-CNR (isac)	d 0-32	0.75x0.56 L54	40	weekly	fix	1981-2010	6/month	1
HMCR (rums)	d 0-63	1.1x1.4 L28	20	weekly	fix	1985-2010	weekly	10
JMA (rjtd)	d 0-34	T319L60	25	2/week	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1996-2009	4/month	3
Meteo-France (lfpw)	d 0-60	T255L91	51	monthly	fix	1993-2014	monthly	15
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	day	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1996-2009	4/month	3



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

Data Download




```python
#!/usr/bin/env python

import calendar
year_list=range(1999,2015)
month_list=range(1,13)
month_name_list=["01","02","03","04","05","06","07",
"08","09","10","11","12"]


for dy in year_list:
     for dm in month_list:

          end_day=calendar.monthrange(dy, dm)[1]


          string="";
          date_range=[str(dy), month_name_list[dm-1],
"01/to/", str(dy),
month_name_list[dm-1],str(end_day)];
          file_name=[ "NCEP_SAm_pf_reforecast_tp_",
str(dy),"_", str(dm), ".grib"];

          from ecmwfapi import ECMWFDataServer
          server = ECMWFDataServer()
          server.retrieve({
                   "class": "s2",
                   "dataset": "s2s",
                   "hdate":  string.join(date_range),
                   "date": "2011-03-01",
                   "expver": "prod",
                   "levtype": "sfc",
                   "origin": "kwbc",
                   "param": "tp",
                   "step": "24/to/1056/by/24",
                   "stream": "enfh",
                   "target": string.join(file_name),
                   "area": "20/-90/-60/-30",
                   "time": "00",
                       "number":"1/2/3",
                   "type": "pf",
              })
```