



Multi-week prediction of South-East Asia rainfall variability during boreal summer in CFSv2

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Motivation

The screenshot shows the Central Weather Bureau (CWB) website interface. The main content area is titled 'Cloud & Rain' and features a weather map of Taiwan with various weather icons. A large orange arrow points from the map area towards the 'Long-term Weather Outlook' section on the right. The 'Long-term Weather Outlook' section is titled '中央氣象局月長期天氣展望' and includes a release date of September 12, 2014, and a forecast period from September 13 to October 10, 2014. It contains several paragraphs of text and a table for 'Average Temperature and Precipitation Probability Forecast (Unit: %)'.

中央氣象局月長期天氣展望

發布日期：民國103年9月12日
 有效期間：自民國103年9月13日至 103年10月10日
 下次預定發布日期：民國103年9月19日

一、未來 1 個月長期天氣展望

未來兩週溫度不易偏低，第1週期初受鋒面接近影響，東半部及北部山區有局部短暫陣雨，西半部午後亦有局部短暫雷陣雨；期中受颱風外圍雲系影響，各地有局部短暫陣雨；期末南部有局部短暫陣雨，午後中部以北及東北地區有局部短暫雷陣雨。第2週臺灣附近水氣較多，各地降雨機率較高，唯近期第2週模式預報準確性較低，不確定性較大。

第 1 週：平均氣溫預測，第1週西半部以「低於」氣候正常值的機率最小，東部代表站以「接近」氣候正常值的機率最大。雨量預測，各地以「接近」氣候正常值的機率最大。

第 2 週：平均氣溫、雨量預測，第2週各地以「接近」氣候正常值的機率最大。

第 1~4 週：1個月之展望，平均氣溫及累積雨量各地以「接近」氣候正常值的機率最大。

二、平均氣溫與雨量機率預報(單位：%)

| 氣候 | 氣溫 | 雨量 |
|----|----|----|
| 高於 | | |
| 接近 | | |
| 低於 | | |

最新消息 **新聞稿** **政府資訊公開**

09/15 本局五分山雷達站因執行雷達半年保養與雷達更新，自2014年09月16日08時30分至 2014年09月17日17時30分停止觀測。

09/05 本局訂於本(103)年9月16日至18日(星期二至四)，在國際會議廳及310等會議室舉辦「103年天氣分析與預報研討會」，歡迎踴躍參加，相關活動訊息請至研討會網址 <http://photino.cwb.gov.tw/conf/> 參閱。(為響應環保，請自備環保水杯)



中央氣象局月長期天氣展望

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一、未來 1 個月長期天氣展望

未來兩週溫度不易偏低，第1週期初受鋒面接近影響，東半部及北部山區有局部短暫陣雨，西半部午後亦有局部短暫雷陣雨；期中受颱風外圍雲系影響，各地有局部短暫陣雨；期末南部有局部短暫陣雨，午後中部以北及東北部地區有局部短暫雷陣雨。第2週臺灣附近水氣較多，各地降雨機率較高，唯近期第2週模式預報準確性

二、平均氣溫與雨量機率預報(單位：%)

第 1 週：平均氣溫預測，第1週西半部以「低於」氣候正常值的機率最大。雨量預測，各地以

第 2 週：平均氣溫、雨量預測，第2週各地以「

第 1~4 週：1個月之展望，平均氣溫及累積雨量

| 氣溫預報 | 第1週 (9月13日~9月19日) | 第2週 (9月20日~9月26日) | 第1~4週 (9月13日~10月10日) | 雨量預報 | 第1週 (9月13日~9月19日) | 第2週 (9月20日~9月26日) | 第1~4週 (9月13日~10月10日) |
|------|----------------------|----------------------|-------------------------|------|----------------------|----------------------|-------------------------|
| | 偏低 正常 偏高 | 偏低 正常 偏高 | 偏低 正常 偏高 | | 偏少 正常 偏多 | 偏少 正常 偏多 | 偏少 正常 偏多 |
| 北部 | 0 : 60 : 40 | 10 : 50 : 40 | 10 : 50 : 40 | 北部 | 30 : 60 : 10 | 10 : 60 : 30 | 20 : 50 : 30 |
| 中部 | 0 : 60 : 40 | 10 : 50 : 40 | 10 : 60 : 30 | 中部 | 30 : 60 : 10 | 10 : 60 : 30 | 20 : 50 : 30 |
| 南部 | 0 : 60 : 40 | 10 : 50 : 40 | 10 : 60 : 30 | 南部 | 20 : 60 : 20 | 10 : 60 : 30 | 20 : 50 : 30 |
| 東部 | 20 : 60 : 20 | 10 : 50 : 40 | 20 : 50 : 30 | 東部 | 10 : 60 : 30 | 10 : 60 : 30 | 20 : 50 : 30 |

§ 北部、中部、南部及東部分別以臺北、臺中、高雄及花蓮為參考氣象站。

三、平均氣溫與雨量氣候正常值範圍(氣溫單位：℃、雨量單位：毫米)

| 氣溫 | 第1週 (9月13日~9月19日) | 第2週 (9月20日~9月26日) | 第1~4週 (9月13日~10月10日) | 雨量 | 第1週 (9月13日~9月19日) | 第2週 (9月20日~9月26日) | 第1~4週 (9月13日~10月10日) |
|----|----------------------|----------------------|-------------------------|----|----------------------|----------------------|-------------------------|
| 北部 | 26.5~28.6 | 25.7~27.2 | 25.9~27.0 | 北部 | 7.2~90.4 | 9.7~99.4 | 98.7~288.5 |
| 中部 | 26.9~28.2 | 26.7~27.5 | 26.4~27.2 | 中部 | 0.4~34.0 | 0.4~23.0 | 15.0~82.4 |
| 南部 | 27.8~28.6 | 27.4~28.2 | 27.5~28.0 | 南部 | 4.0~44.3 | 3.0~39.8 | 46.5~149.5 |
| 東部 | 26.5~27.4 | 25.7~26.6 | 25.7~26.4 | 東部 | 19.3~101.0 | 12.7~131.9 | 181.0~494.9 |

§ 北部、中部、南部及東部分別以臺北、臺中、高雄及花蓮為參考氣象站。

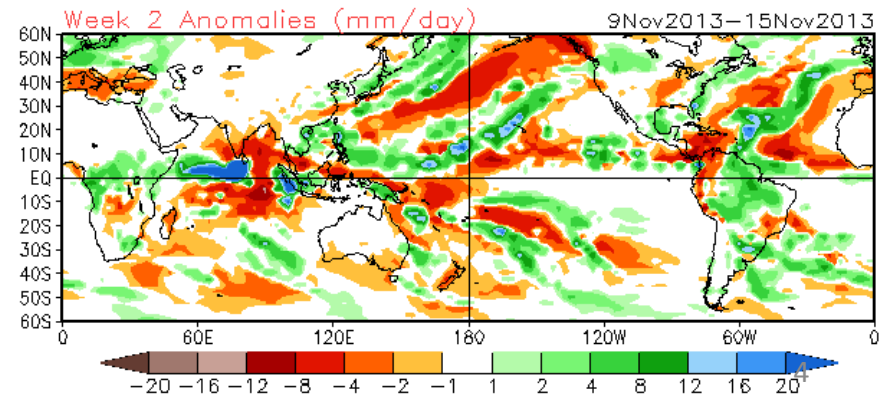
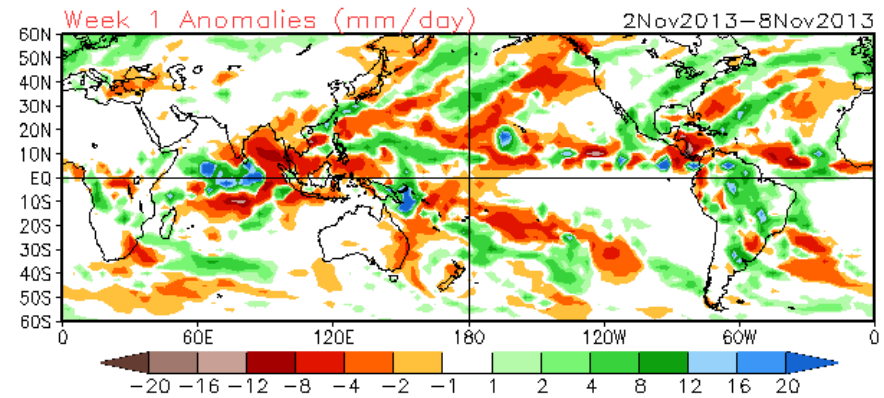
http://www.cwb.gov.tw/V7e/forecast/long/long_month.htm

Guidance

| | Statistical model | Dynamical model |
|-----------------|-------------------------------|---|
| Weekly Forecast | Regression*2 Analog MOS | NCEP/GEFS、CFSv2 NAEFS JMA/EPS CWB、EC、NCEP、JMA... |

CFSv2 forecast is there.
But how good is it?

CFSv2 Weeks 1 & 2 Precipitation
16 Member Ensemble Mean Forecast from 01Nov2013



Objectives

- Assess prediction of the sub-monthly variability in South-East Asia during boreal summer in the National Centers for Environmental Prediction (NCEP) Climate Forecast System version 2 (CFSv2).
- Investigate the dependence of the prediction skill on the ISO (MJO/BSISO) activity

South-East Asia

Studying Domain: South-East Asia(10°S-30°N; 60°E-150°E)

Boreal Summer:01May~30Sep



Data

✓ **Observation** (1May~30SEP from 1999 to 2012)

I. Precipitation: CMORPH (CPC MORPHing technique)

- Regridded from 0.25x0.25 degree to 2.5x2.5 degree
- Saved data between 30°S and 30°N to focus on the South-East Asia

II. U850, Z500: CFSR (Climate Forecast System Reanalysis)

✓ **Forecast**

I. Precipitation , U850, Z500: CFSV2

- Four 45-day Hindcasts runs from every 00, 06, 12, and 18UTC cycles
- Daily Climatological mean is calculated as 4-members average

Anomalies

Total:

$$O'_{TOT}(x, y, yr, d) = O - O_{clm}$$

- X:10°S-30°N
- Y:60°E-150°E
- d:01May~30Sep
- Yr:1999~2012
- l:1-44
- Z:wk1-wk6

Inter-annual:

$$O'_{IA}(x, y, yr, d) = Ave (O'_{TOT}, d-45:d+45)$$

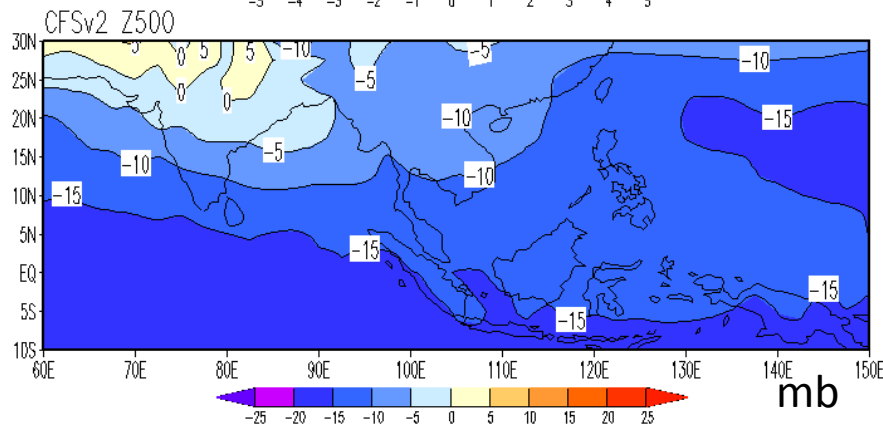
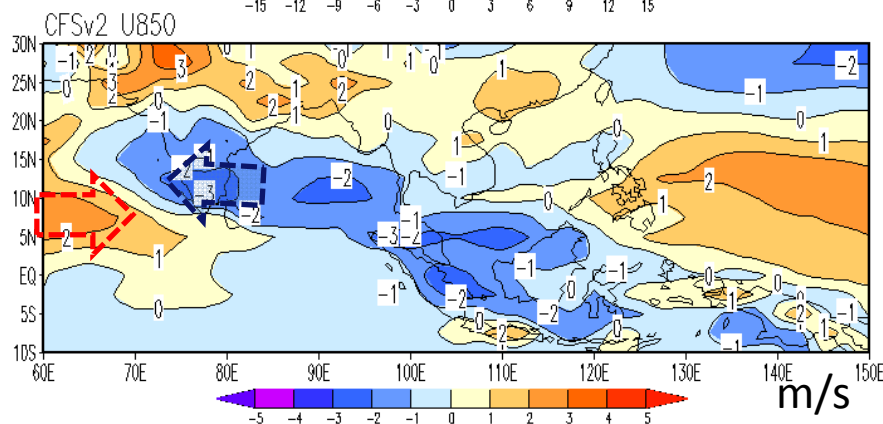
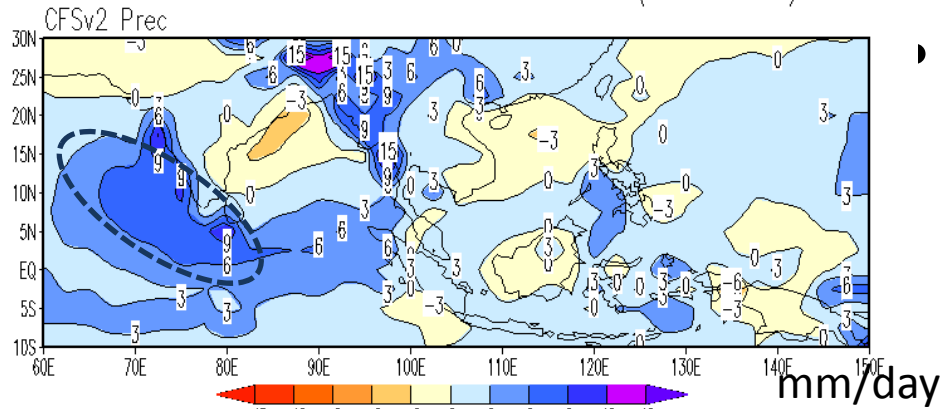
Intra-seasonal:

$$O'_{IS}(x, y, yr, d) = O'_{TOT} - O'_{IA}$$

i) Prediction Bias

4 Weeks Average of Bias

CFSv2 Rainfall U850 Z500 Bias (wk1-wk4)



• Precipitation:

- Dry Bias: South China Sea and western Bay of Bengal
- Wet Bias: Eastern Arabian Sea , west India, west Burma, Burma Sea

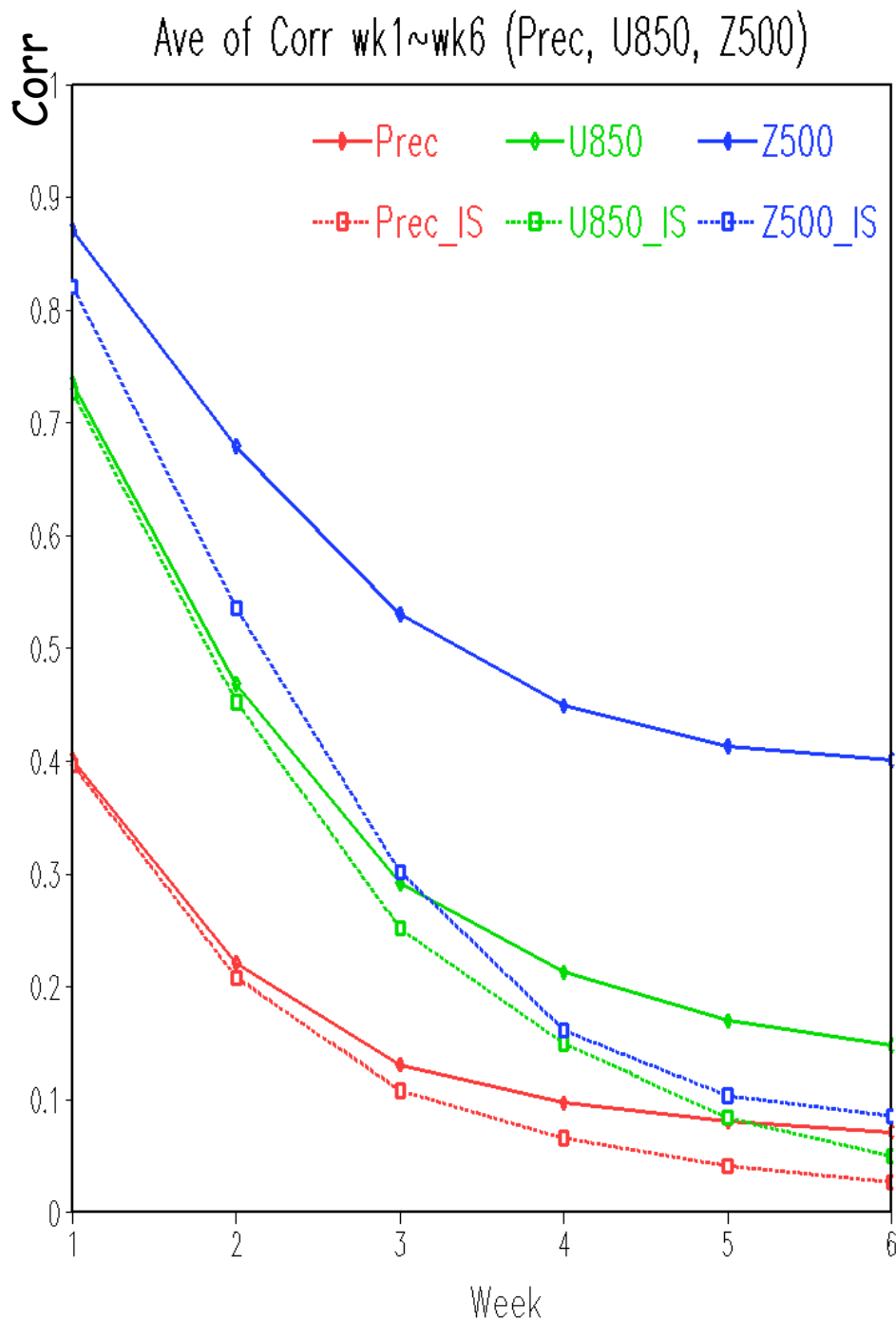
• U850:

- The easterly wind bias exists south of the Bay of Bengal, southern Indian and eastern Arabian Sea and westerly wind bias to the west, consistent with precipitation bias.

• Z500:

- A negative bias in most part of the region, corresponding to an atmosphere that is too cold bias.

ii) Prediction Skill



Spatial average of temporal anomaly correlation coefficient (ACC) of total and intraseasonal anomalies

- When the lead time increases, the correlation decreases dramatically especially the first three weeks.
- The skill for total Z500 anomalies is higher than that for U850 and rainfall.
- The differences in ACC skill between total anomalies and intraseasonal anomalies increase with lead time

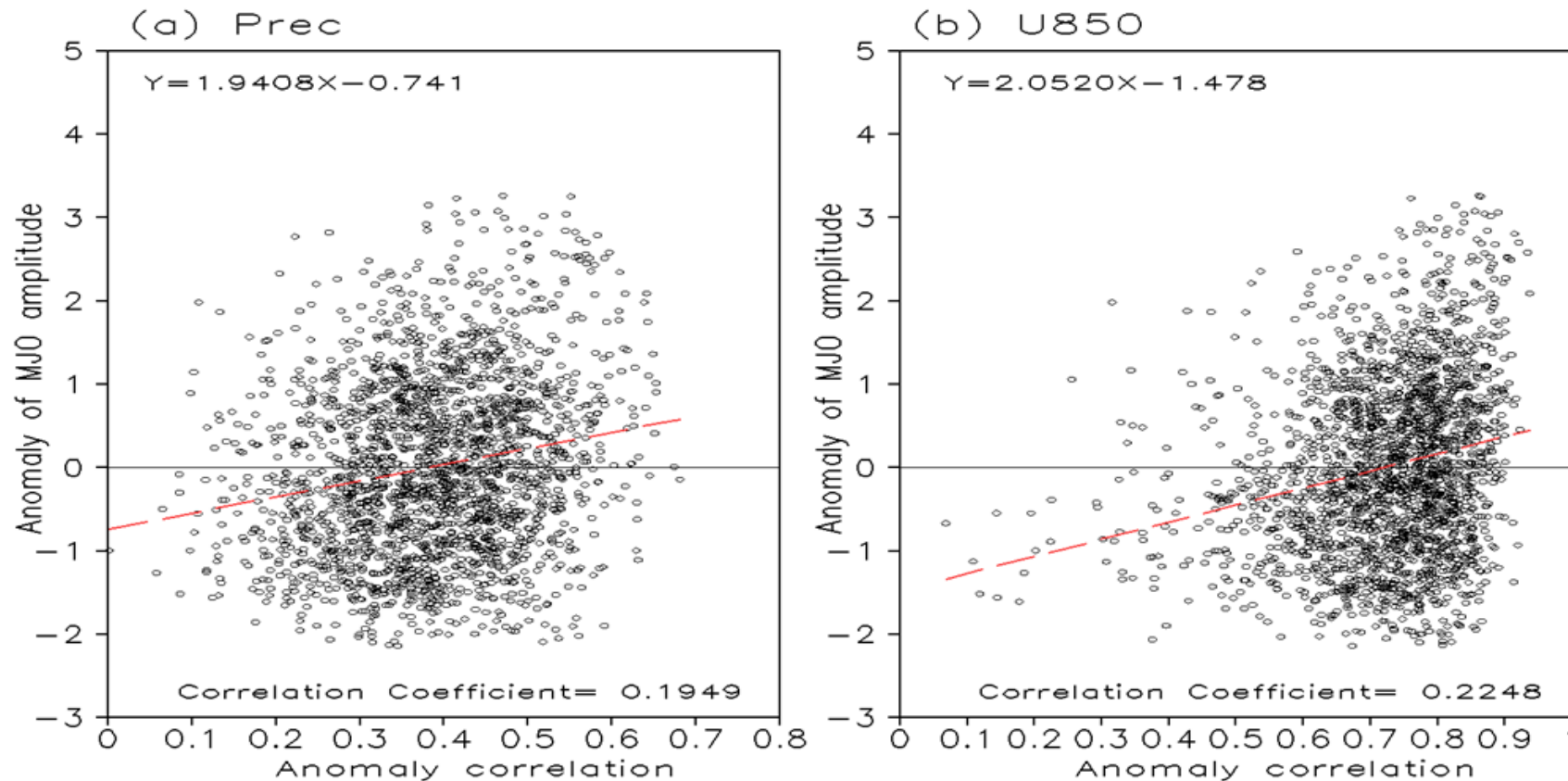
iii) Dependence on MJO/BSISO

Madden-Julian Oscillation (MJO)

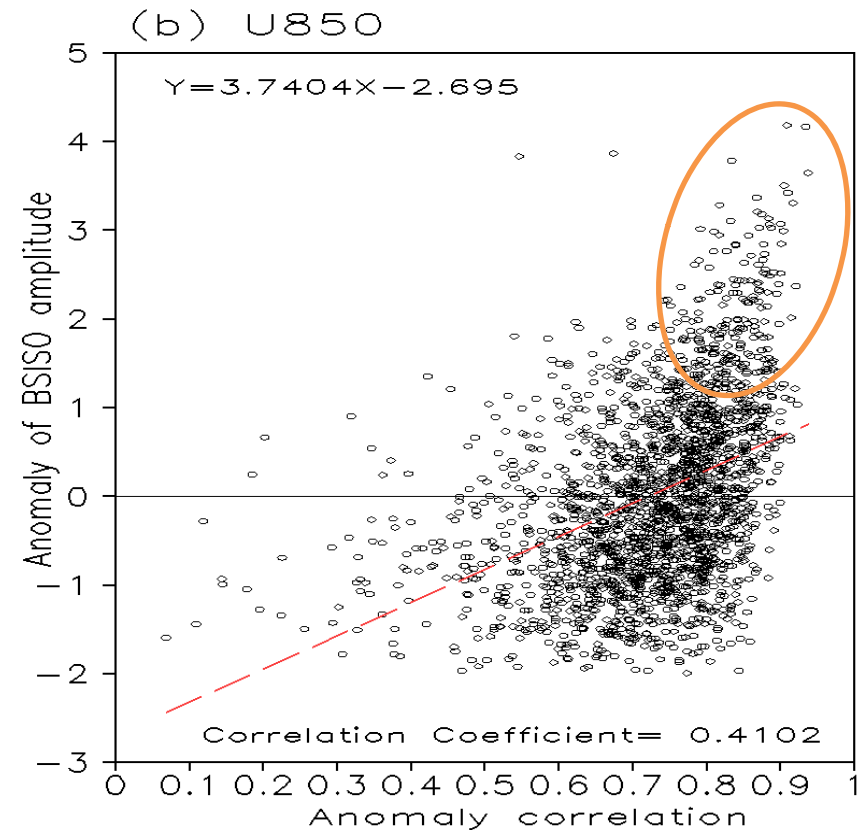
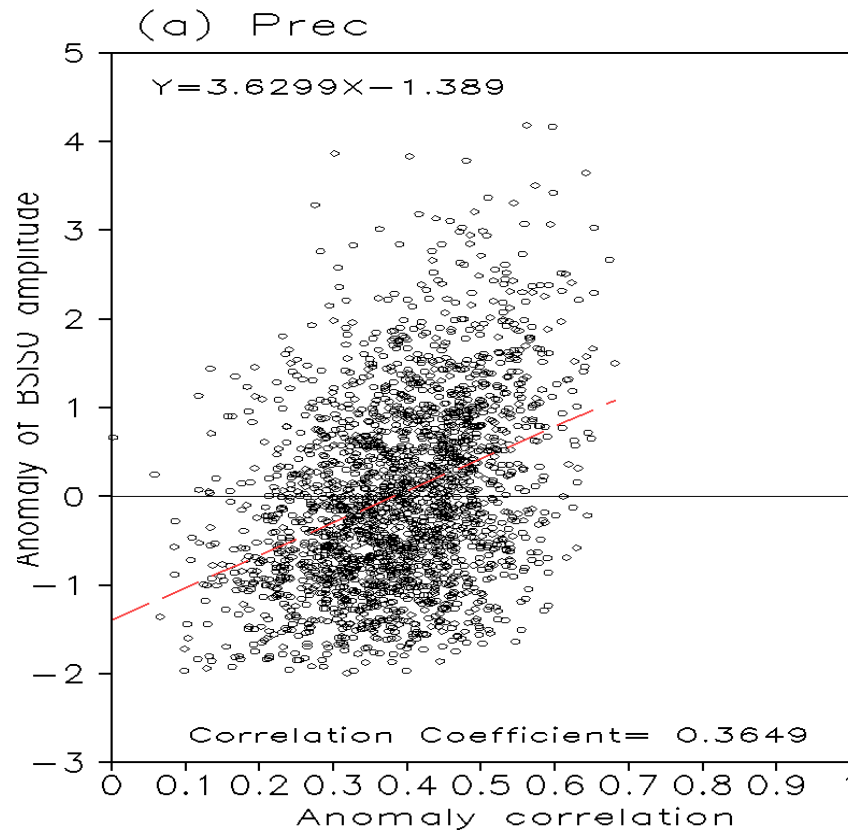
Boreal Summer Intraseasonal Oscillation (BSISO)

Wheeler and Hendon 2004; Lee et al. 2013

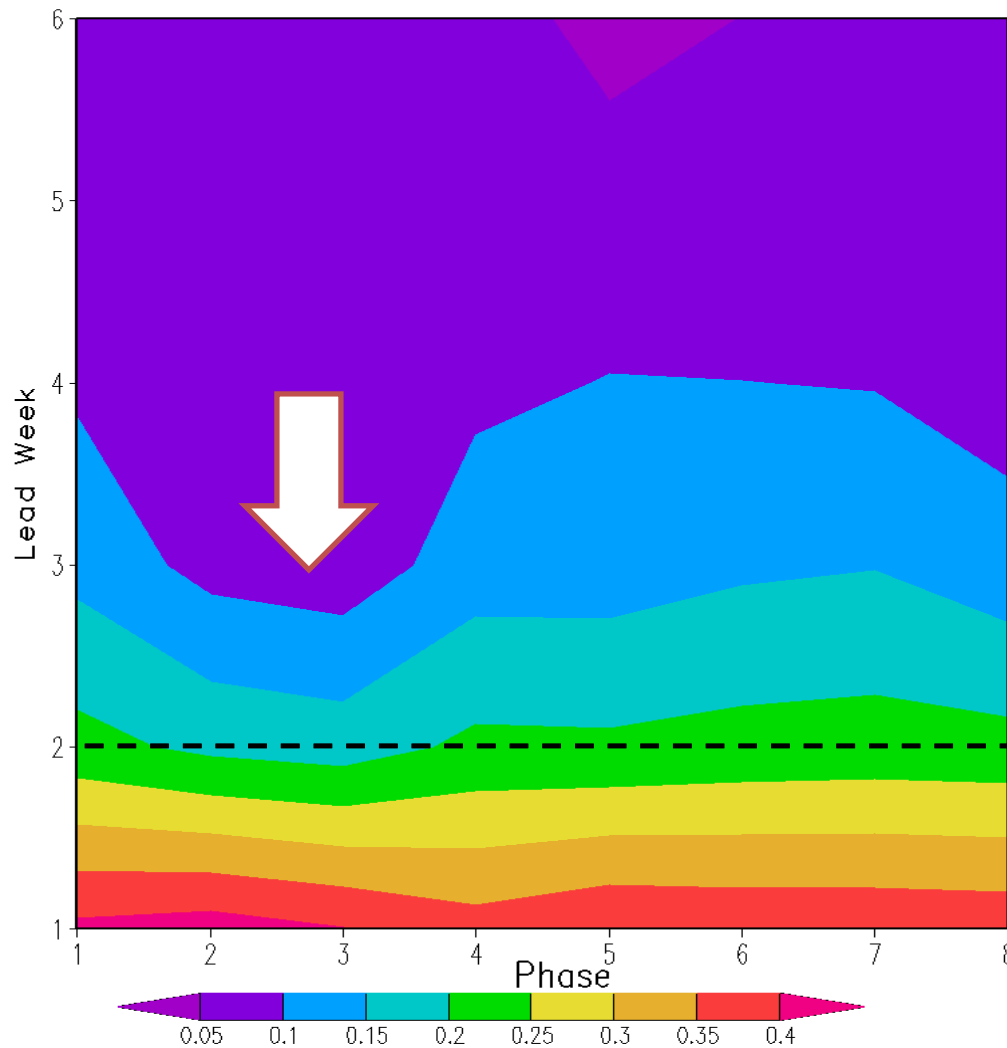
Relationship of the IS prediction skill & MJO Amplitude



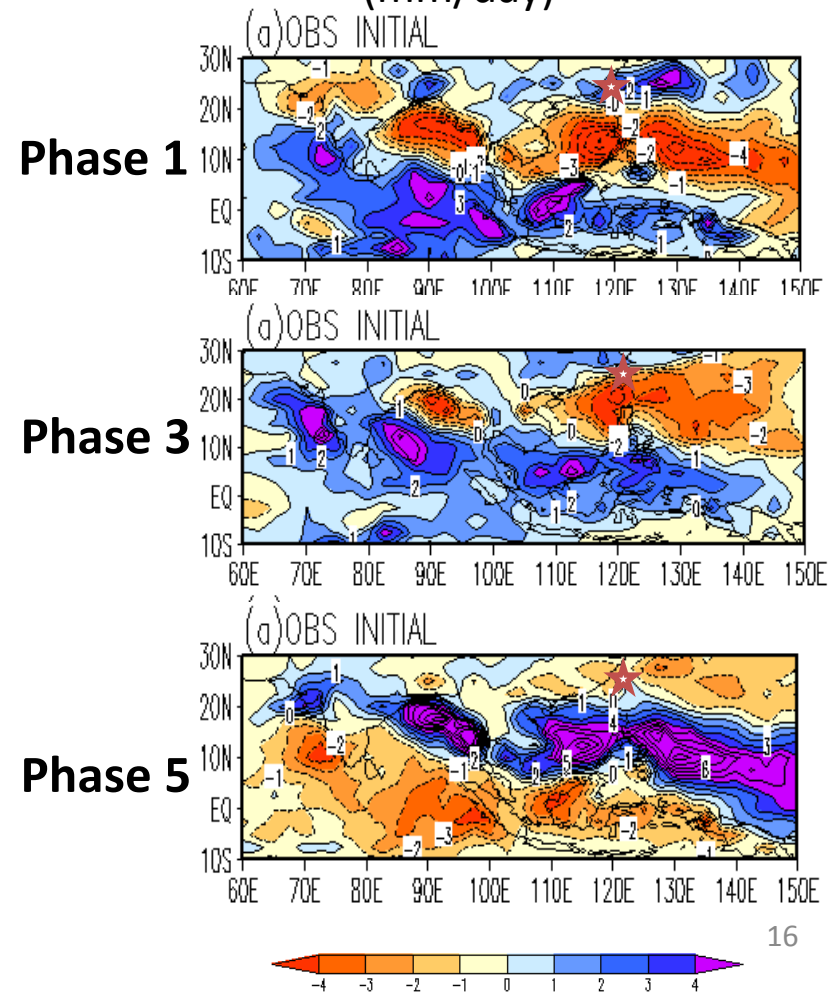
Relationship of the IS prediction skill & BSISO Amplitude



ACC of precipitation as a function of target week and initial BSISO phase



Composite observation anomalies (mm/day)





Summary

- We analyze several aspects of sub-monthly prediction skill of the NCEP CFSv2 model, including
 - 1) provide an overall evaluation of the CFSv2 in multi-week prediction
 - 2) diagnose the prediction skill of the total anomalies versus that of intraseasonal anomalies
 - 3) examine the dependence of the prediction on the activity of intraseasonal leading modes.
- The result provides forecasters with guidance on how real-time forecast from CFSv2 can be used in one month outlook decision-making.

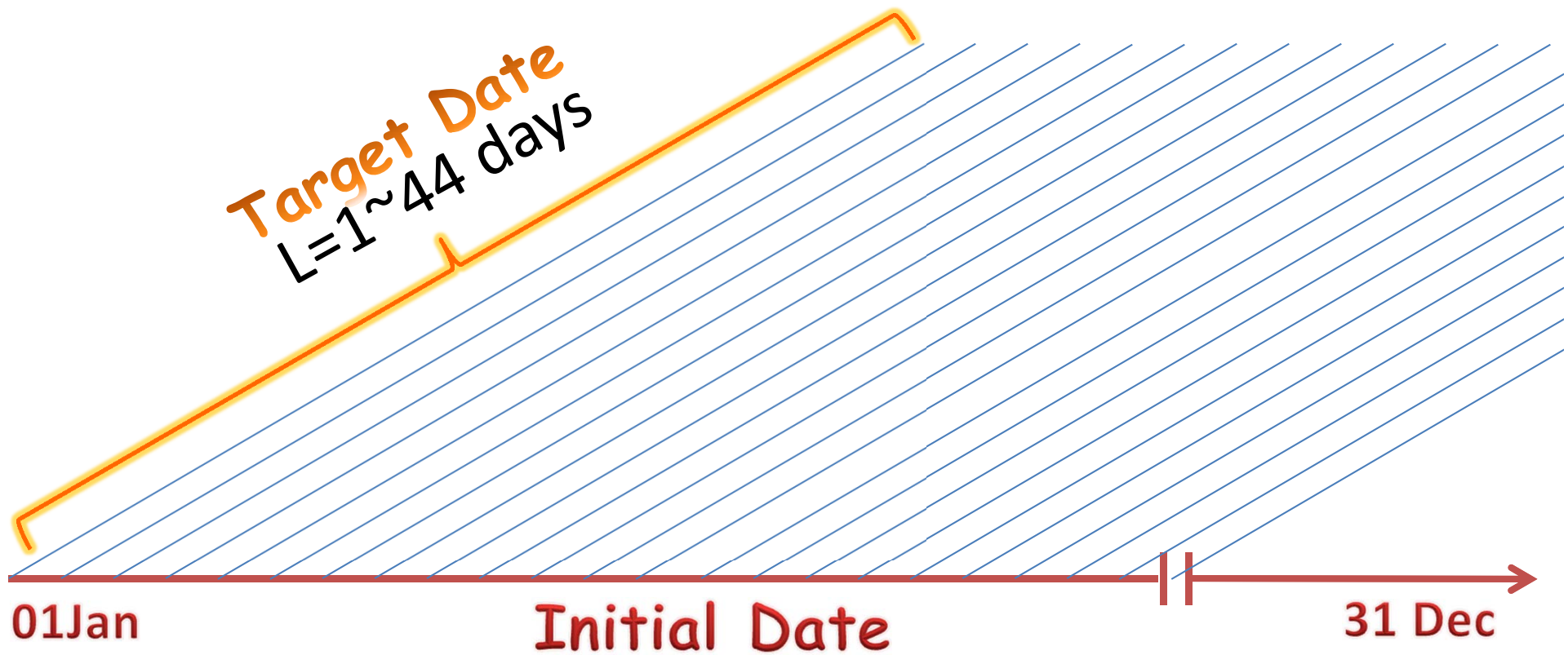
| Index | RMM | BSISO | New BSISO |
|-----------|--|---|--|
| Reference | Wheeler and Hendon 2004 | Kikuchi et al. 2011 | Lee et al. 2013 |
| Method | Multiple EOF | Extended EOF | Multiple EOF |
| Variable | OLR, U200, U850 | OLR | OLR, U850 |
| Domain | Meridionally averaged over 15°S~15°N | 30°S~30°N | 10°S~40°N, 40°~160°E |
| Period | Whole year | DJF, JJA | May-Sep |
| Filter | <ul style="list-style-type: none"> ❖ Removed first 3 harmonics ❖ Subtracted linear regression of ENSO ❖ Subtracted last 120 days mean | <p>Research :</p> <ul style="list-style-type: none"> ❖ Lanczos band-pass filter with cut-off periods 25-90 days and 139 weights. <p>Real time :</p> <ul style="list-style-type: none"> ❖ Removed first 3 harmonics ❖ Subtracted last 40 days mean ❖ 5 day tapered running mean. | <ul style="list-style-type: none"> ❖ Removed first 3 harmonics ❖ Subtracted last 120 days mean |

X:10°S-30°N; Y:60°E-150°E
 d:01May~30Sep
 Yr:1999~2012
 l:1-44
 Z:wk1-wk6

Anomalies

| | Observation | Forecast |
|---|---|---|
| Raw Data | $O(x,y,yr,d)$ | $F(x,y,yr,d,l)$ |
| Daily-Mean Climatology (1999~2012) | $O_c(x,y,d)$ 1) Average of $O(x,y,yr,d)$ 2) Annual mean + 4 harmonics | $F_c(x,y,d,l)$ 1) average of $F(x,y,yr,d,l)$ 2) Annual mean + 4 harmonics |
| Daily-mean anomaly | Raw anomaly: $O'_{TOT}(x,y,yr,d) = O - O_c$ Interannual: $O'_{IA}(x,y,yr,d) = \text{ave}(O'_{TOT}, d-45:d+45)$ Intraseasonal: $O'_{IS}(x,y,yr,d) = O'_{TOT} - O'_{IA}$ | Raw anomaly: $F'_{TOT}(x,y,yr,d,l) = F - F_c$ Interannual: $F'_{IA}(x,y,yr,d,l) = \text{ave}(F'_{TOT}, d-45:d+45)$ Intraseasonal: $F'_{IS}(x,y,yr,d,l) = F'_{TOT} - F'_{IA}$ |
| Weekly-mean anomaly | $O'_{TOTw}(x,y,yr,d) = \text{ave}(O'_{TOT}, d+0:d+6)$ $O'_{ISw}(x,y,yr,d) = \text{ave}(O'_{IS}, d+0:d+6)$ | $F'_{TOTw}(x,y,yr,d,1) = \text{ave}(F'_{TOT}, l+1:l+7)$ $F'_{ISw}(x,y,yr,d,1) = \text{ave}(F'_{IS}, l+1:l+7)$ $F'_{TOTw}(x,y,yr,d,2) = \text{ave}(F'_{TOT}, l+8:l+14)$ $F'_{ISw}(x,y,yr,d,2) = \text{ave}(F'_{IS}, l+8:l+14)$ $F'_{TOTw}(x,y,yr,d,6) = \text{ave}(F'_{TOT}, l+36:l+42)$ $F'_{ISw}(x,y,yr,d,6) = \text{ave}(F'_{IS}, l+36:l+42)$ |

CFSv2 Forecast Data



CFSv2 Forecast data

