KMA-APCC-CNU updates for dynamical seasonal climate prediction

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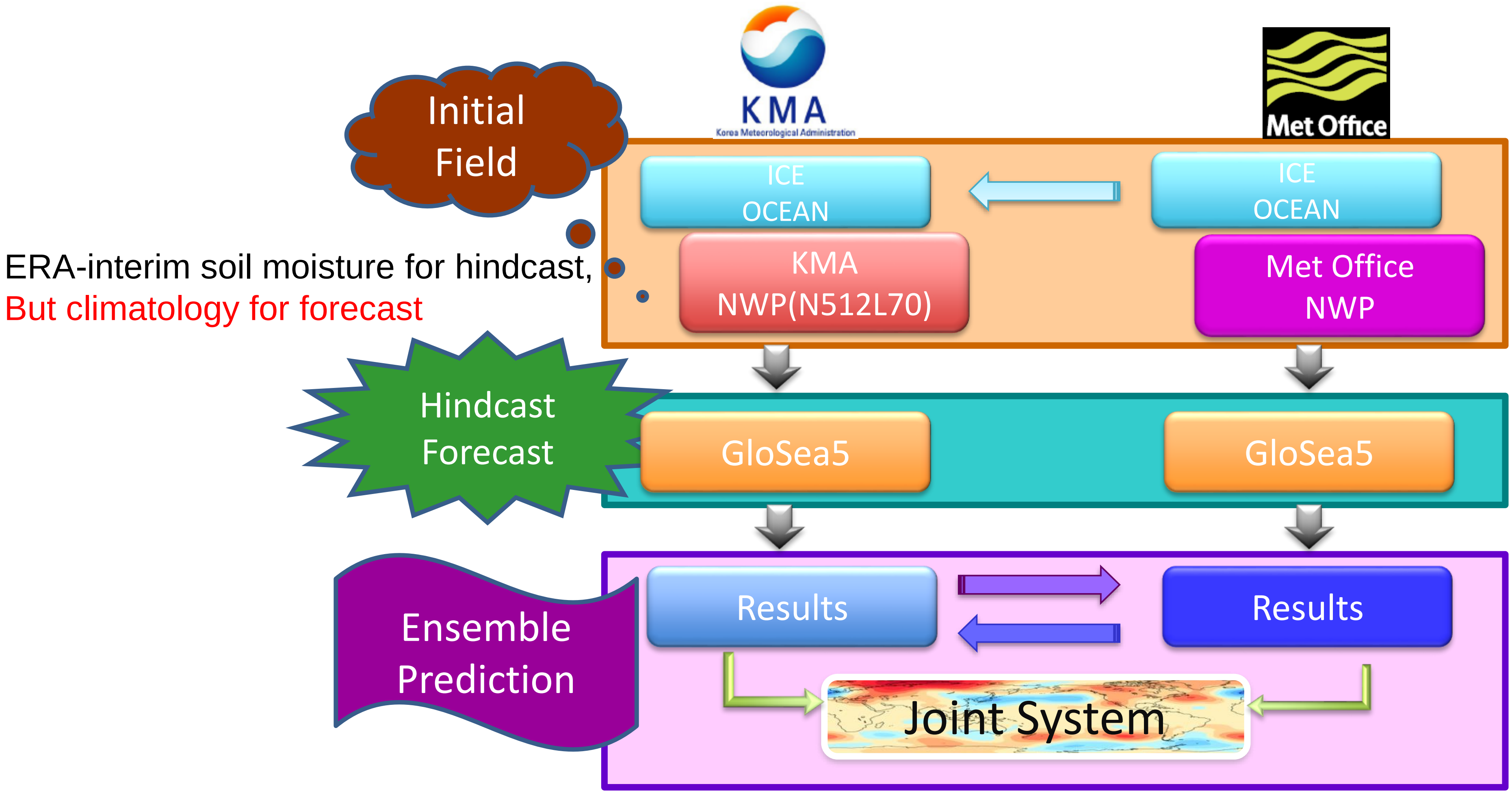
I. Soil moisture initialization for KMA operational seasonal forecast (CNU-UNIST team)

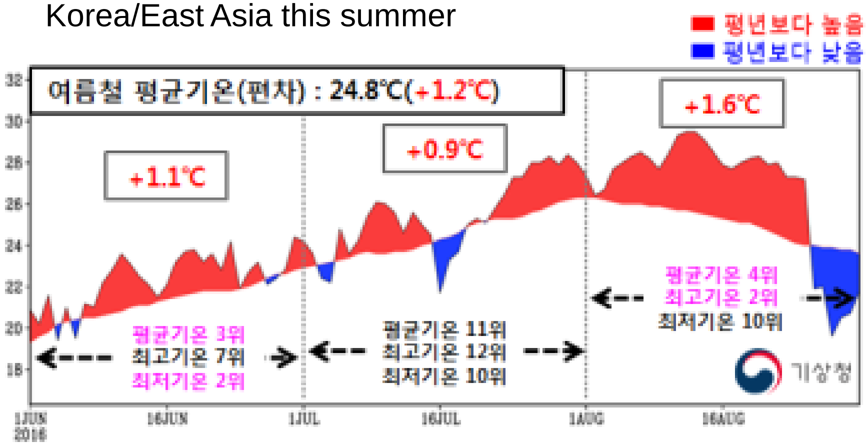
KMA-Met Office Joint Seasonal Forecasting System

KMA: the same configuration with Met Offices. Only, initial condition of weather model is different

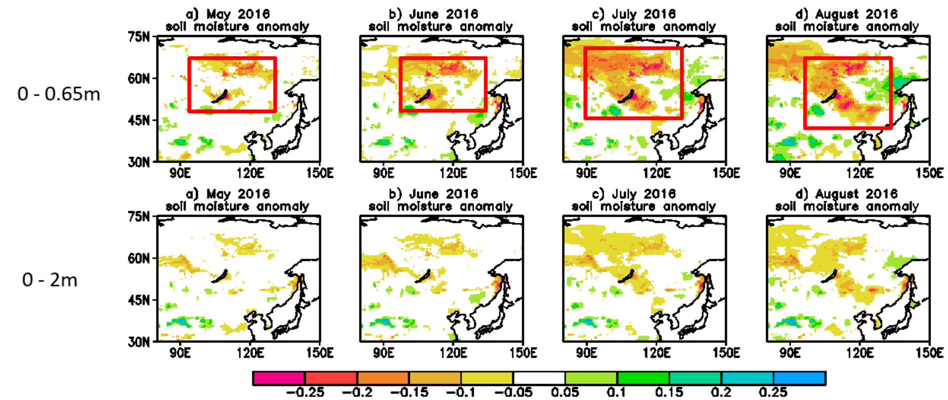


2016 summer heatwave in Korea/East Asia

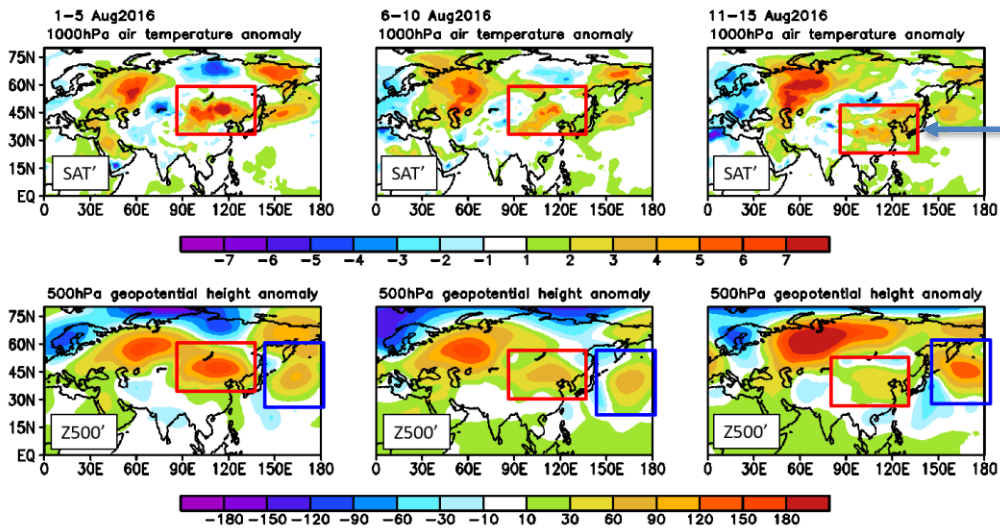
Nearly 1-month long heatwave in Korea/East Asia this summer



Dry condition from spring (JULES-JRA55 soil moisture)

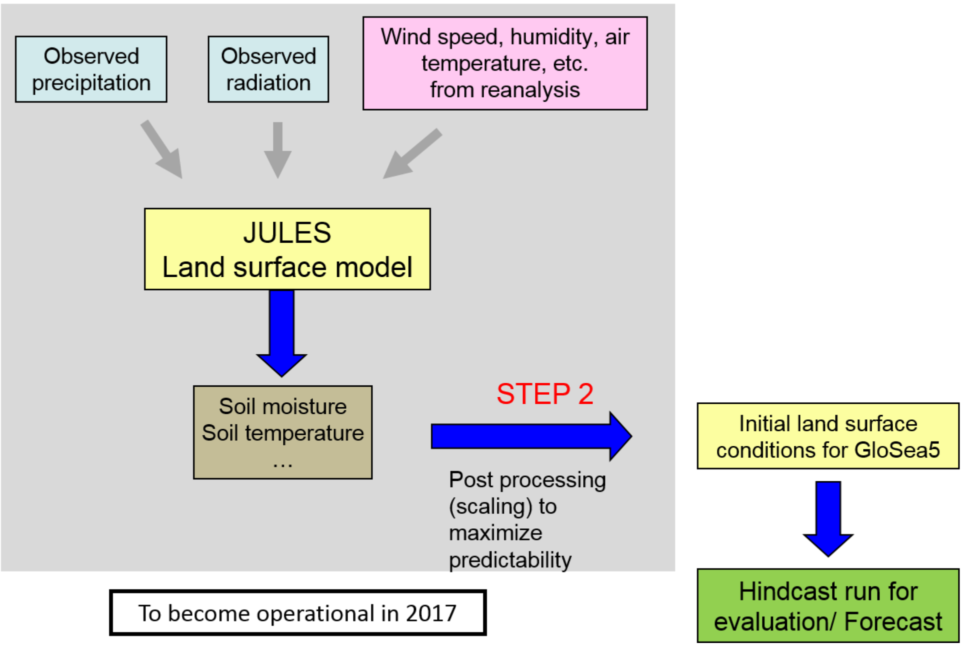


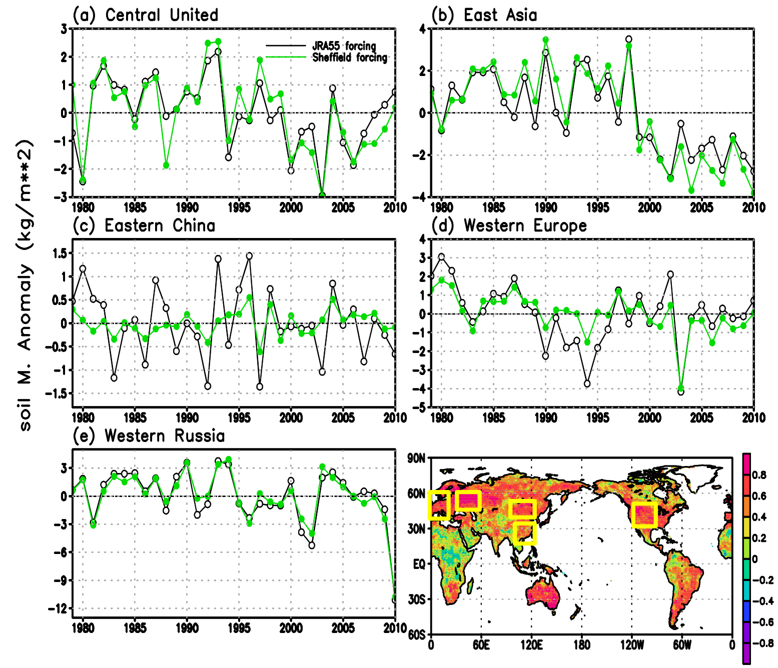
Soil wetness anomaly



Dry condition – atmospheric high pressure system led such a mega heatwave

Soil moisture initialization from offline JULES(GloSea5's LSM) run



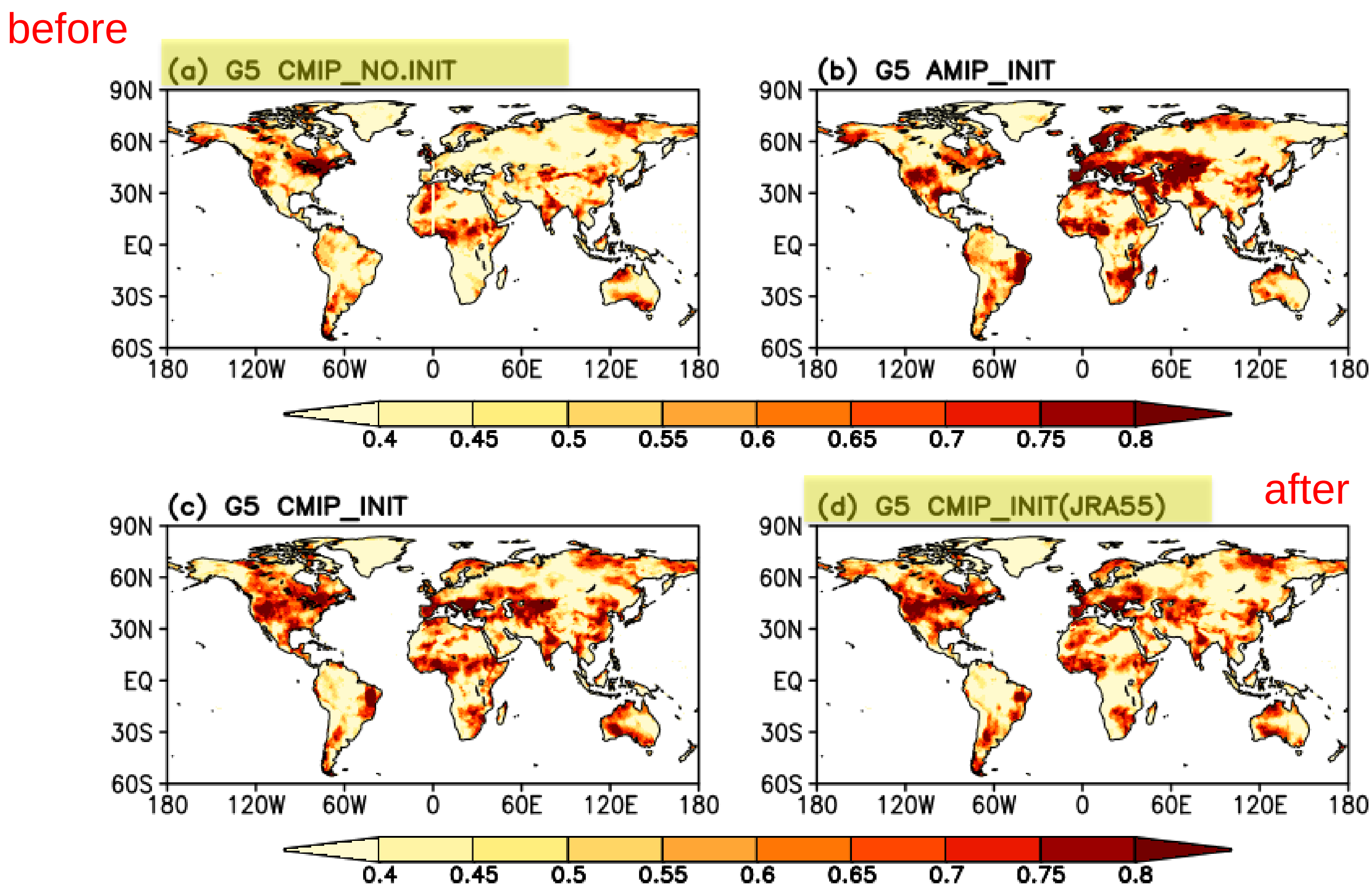


JULES-JRA55 soil moisture is quite consistent with JULES-observation soil moisture

- Atmospheric forcing's from JRA-55 reanalysis
- Precipitation is adjusted to meet observed monthly precipitation
- Scaling of soil moisture in considering bias between JULES and GloSea5
- Hindcast was performed to examine the impact on skill

Skill (*R*) comparison: GloSea5 hindcast

1~30 days mean Tsfc forecast skill (R) for 1996~2009

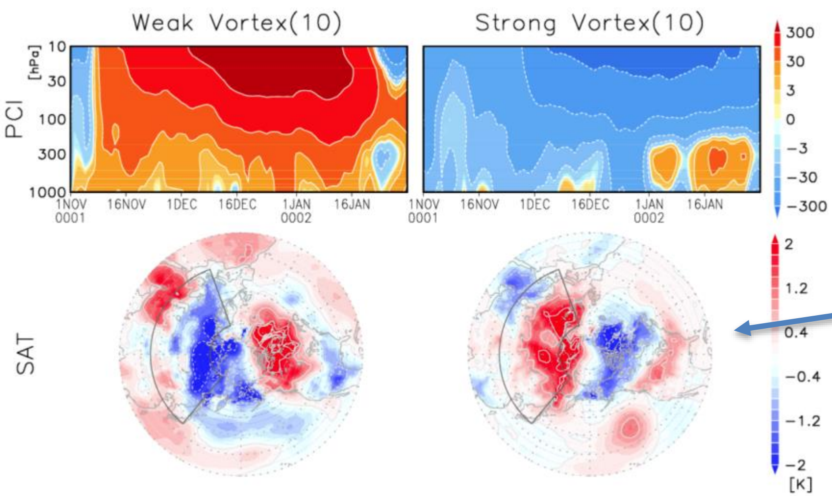


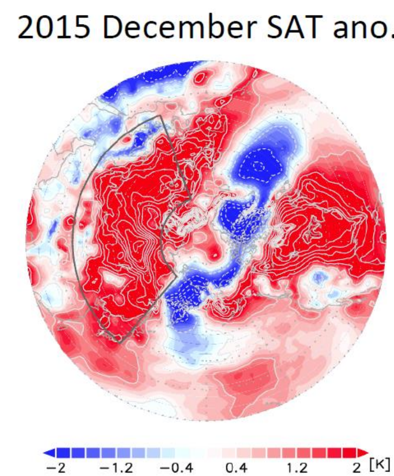
II. KMA/NIMS-SNU: stratospheric influences on dynamical climate prediction for East Asia

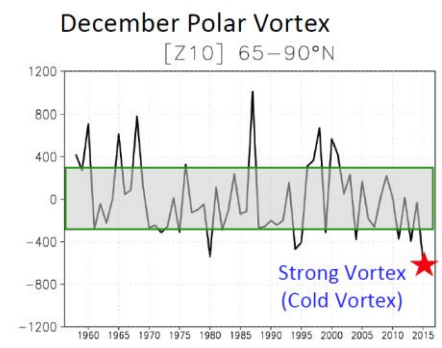
Polar Vortex

There is a strong correlation between polar vortex and Eurasian temperature

Anomalously warm Dec 2015
Was associated with strong polar vortex





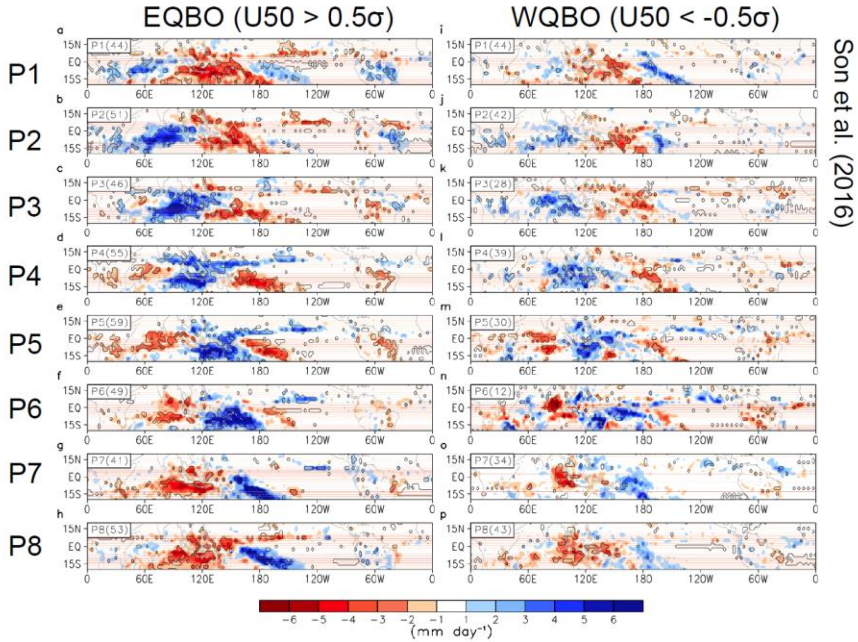


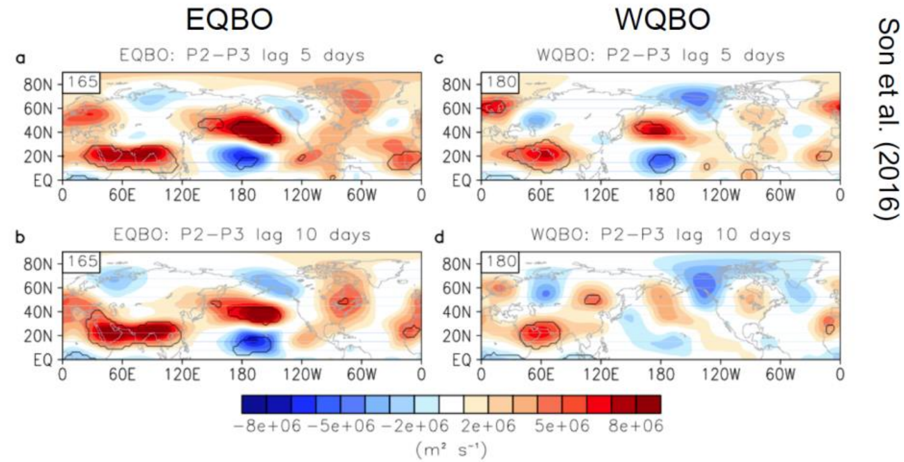
Work led by SNU: prof S.-W. Son, KMA/NIMS: Dr. H.-S. Kang

II. KMA/NIMS-SNU: stratospheric influences on dynamical climate prediction for East Asia

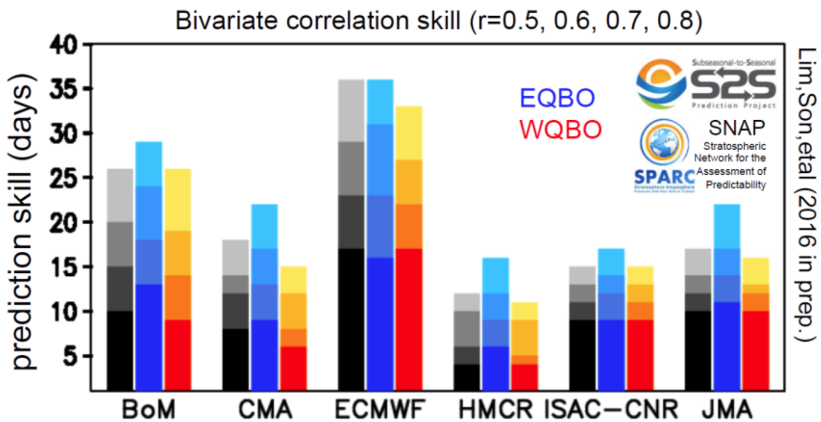
QBO (Quasi-Biennial Oscillation)

MJO signal strengthened during easterly phase of QBO





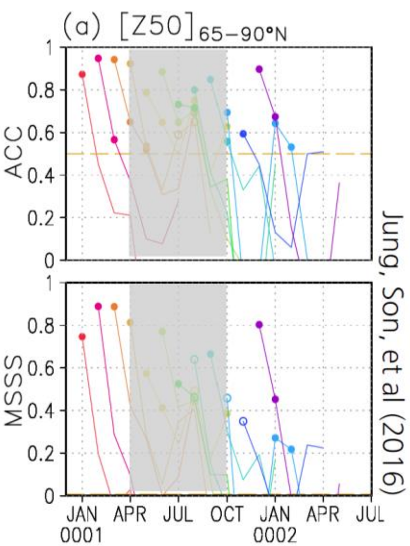
MJO-extratropic teleconnection is strengthened during easterly phase of MJO

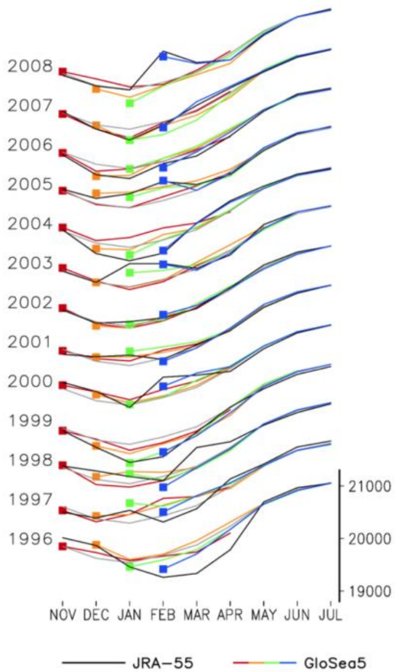


Higher MJO prediction skill during EQBO

II. Skill of polar vortex and QBO in GloSea5 forecast

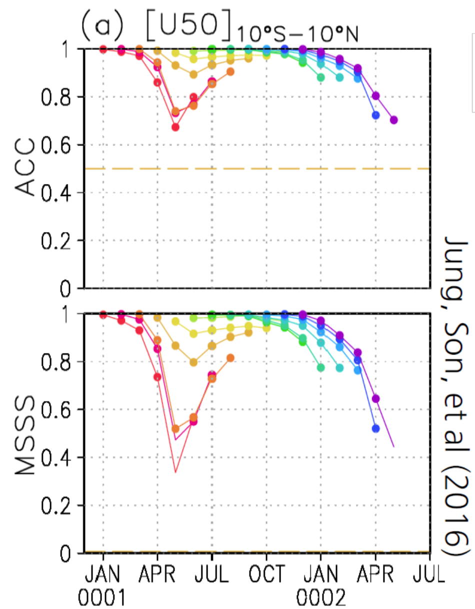
Polar vortex

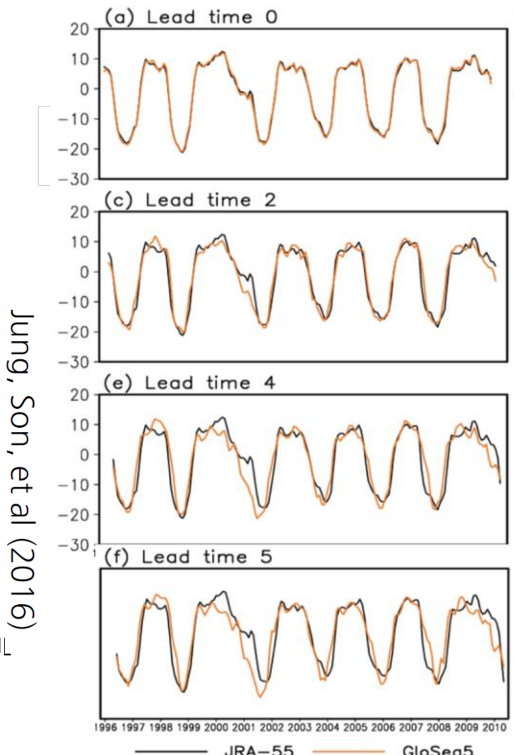




Polar vortex: 1-2 month predictable

QBO





Polar vortex: predictable more than 6 months

Two factors will be utilized for winter seasonal climate prediction by KMA (dynamical-statistical)

III. updates for APCC

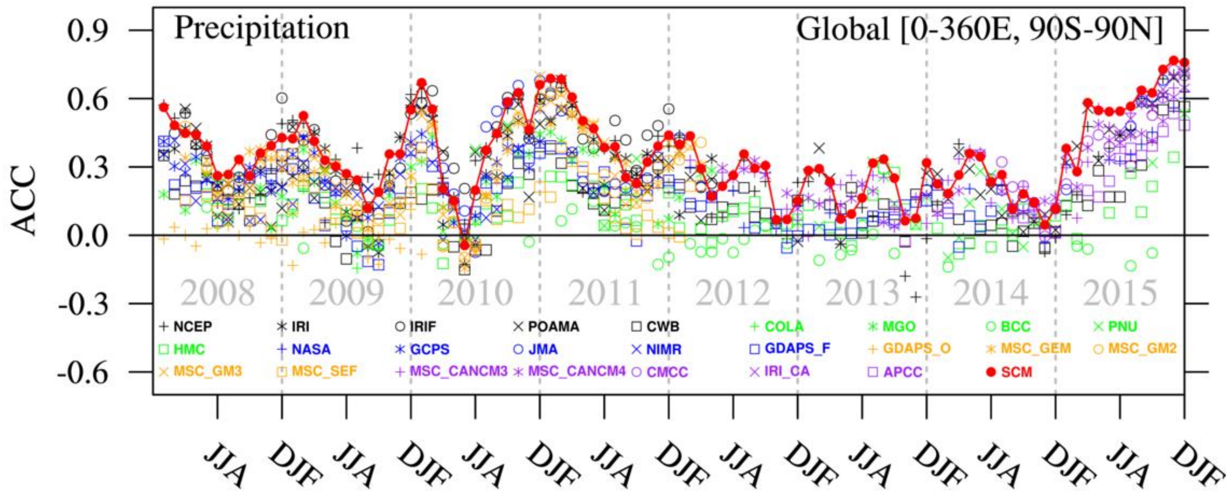
APCC

APEC CLIMATE CENTER

DMME: SCM Forecast (2008JFM-2015DJF)

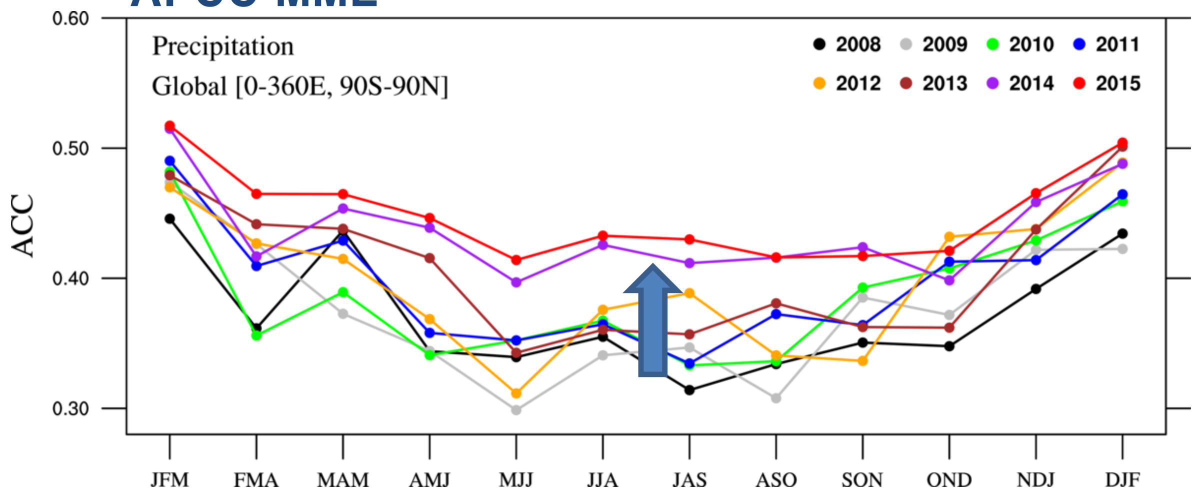
SCM: Simple Composite MME (Multi-Model Ensemble)

Improvements of prediction skill



Real time forecast

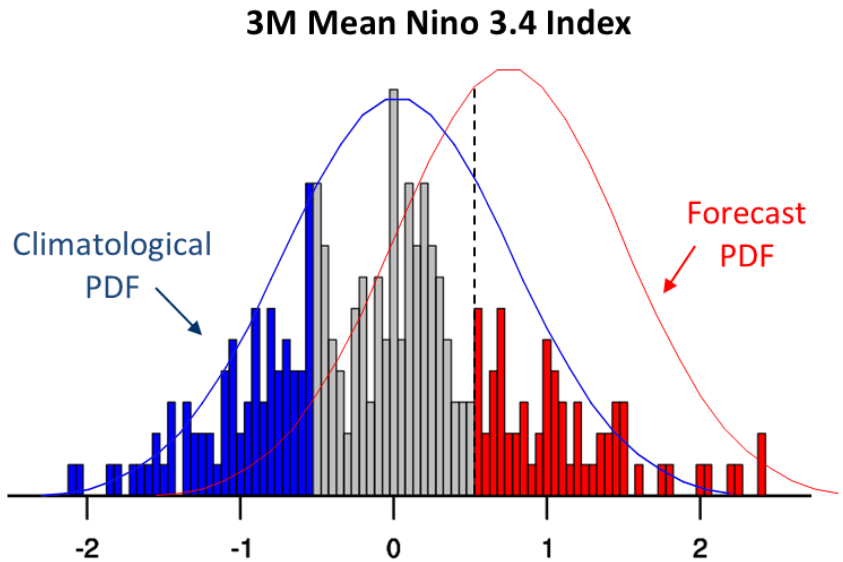
APCC MME

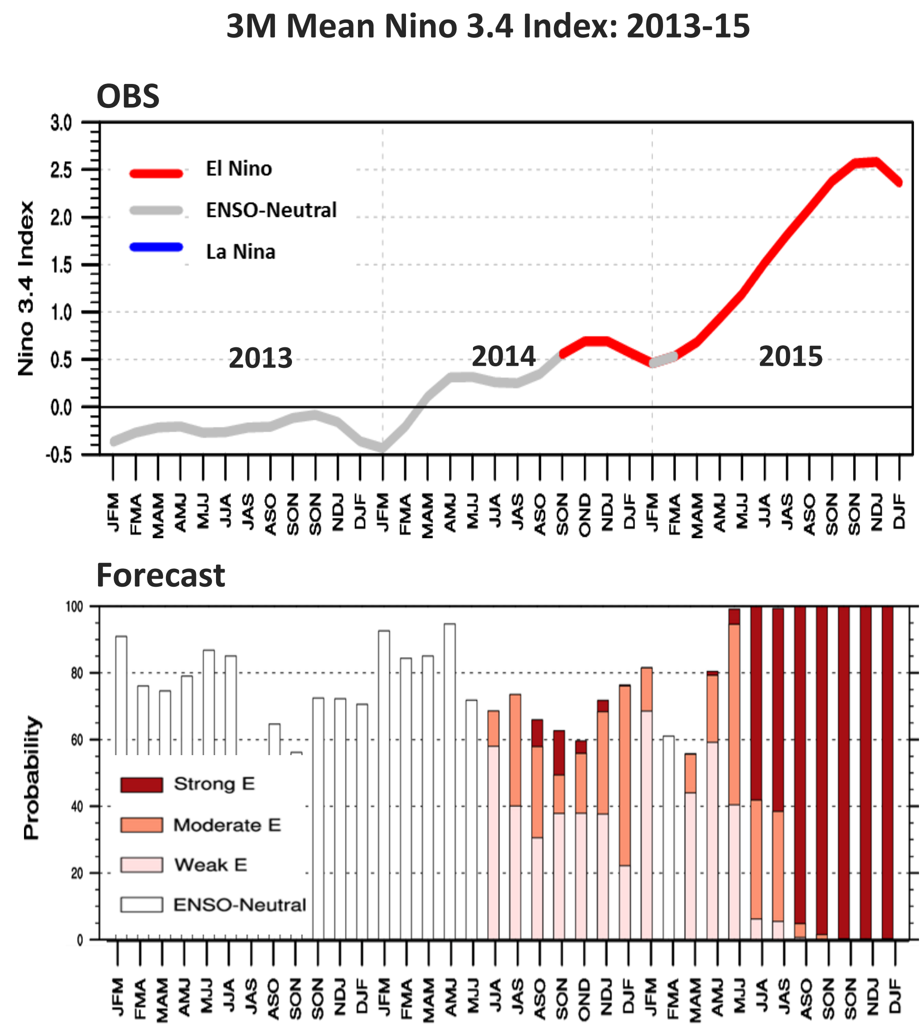


Hindcast skill of each year's MME

The skill of forecasts has continuously increased.
- SCM MME outperforms individual models

Experimental: Prob. ENSO Category & Strength Forecast

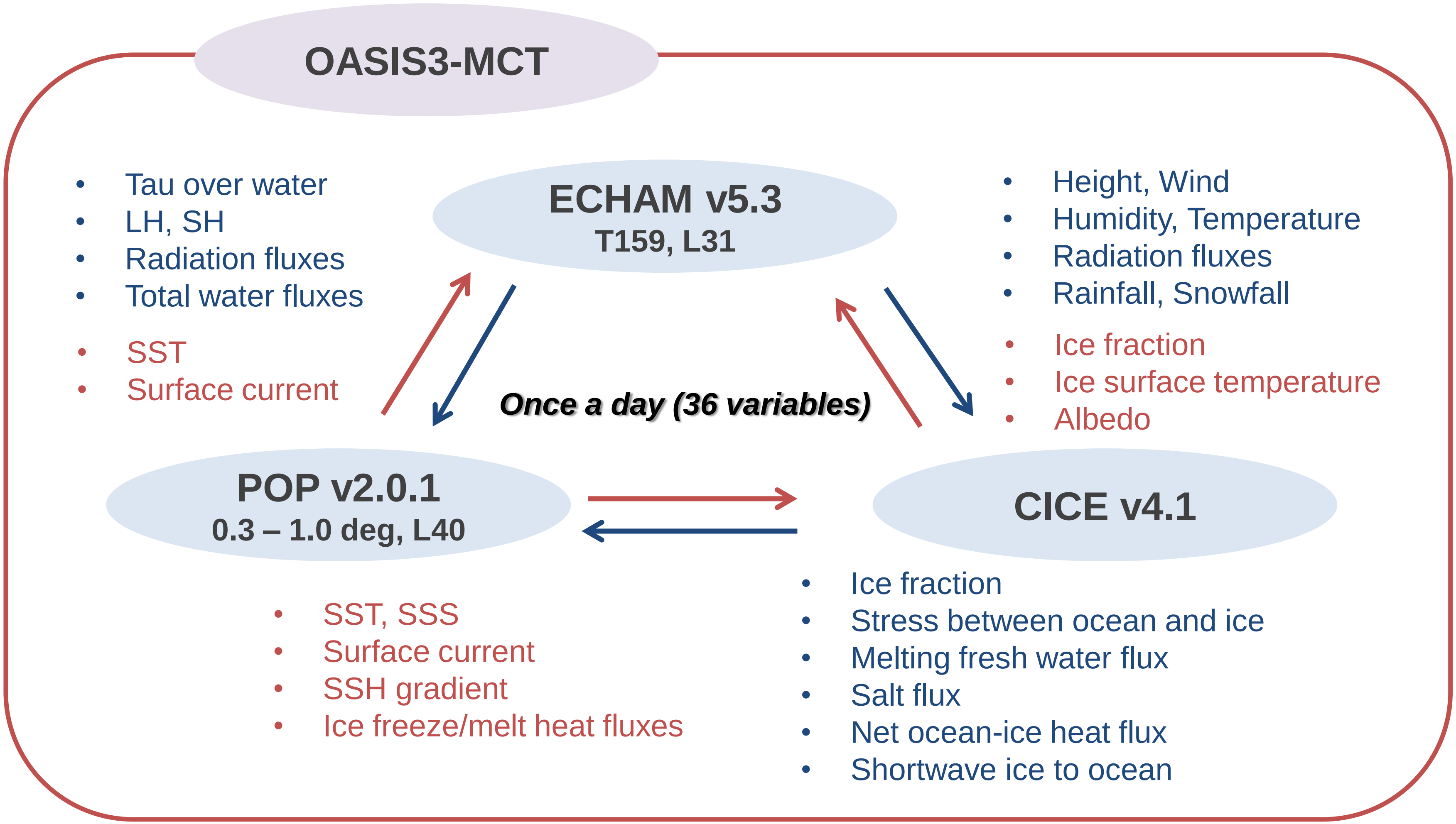




- Definition: based on 3-month mean Nino 3.4 index (+1.5°C /+1.0°C /+0.5/-0.5°C/-1.0°C /-1.5°C : Strong/Moderate/Weak El Nino/La Nina)
- Parametric estimator using a Gaussian fitting method for categorical probabilities
- Simple composite of the individual model's probabilities with equal weightings

To become fully operational in 2017

Development of in-house seasonal forecast model
: Seamless Coupled Prediction System (SCoPS)



Development of in-house seasonal forecast model

: Seamless Coupled Prediction System (SCoPS)

Integrated Atmosphere-Ocean Initialization Scheme

3-D Atmospheric Initialization + **Ensemble Adjustment Kalman Filter (EAKF)**

↑ **CFSR atmosphere variable**

↑ **XBT & ARGO ocean variable**

Hindcast Simulation

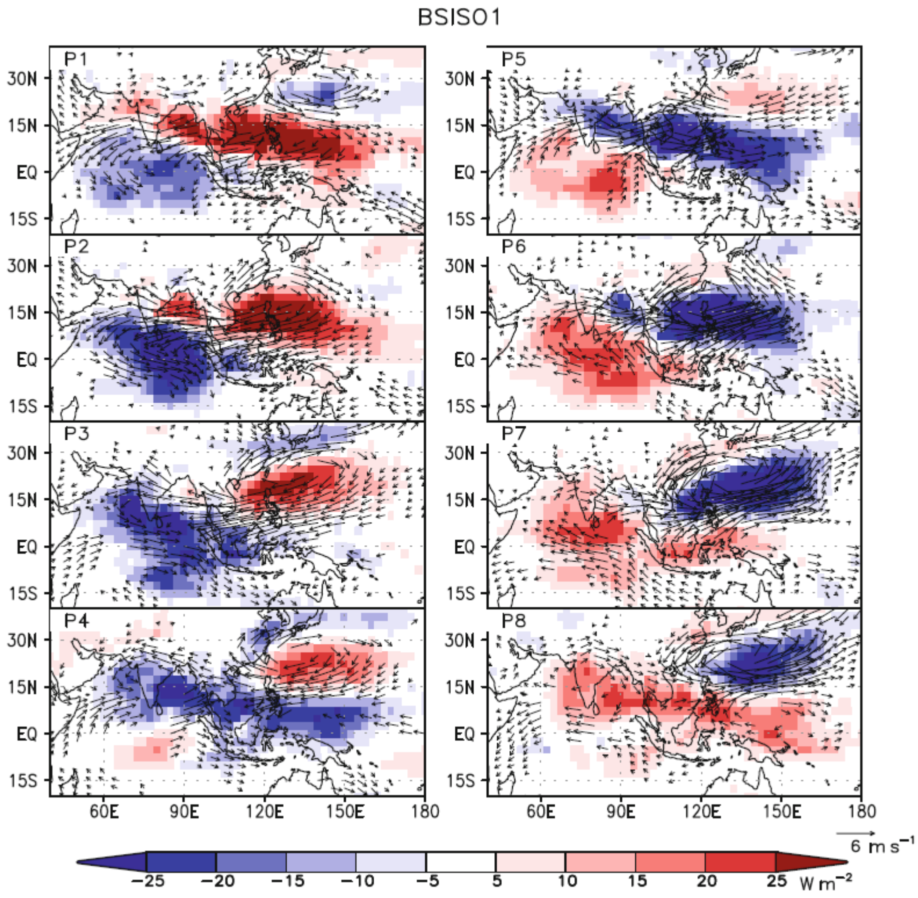
- Total Ensemble members : 10
- Time lagged forecasting with perturbation ensemble spread by EAKF
- ATM/OCN/ICE ICs: the 1^{st}, 5^{th} of every month (5 perturbation initial data)
- Hindcast period: 1982-2014 (33 years) / Forecast period: 2015-present
- 7month integration

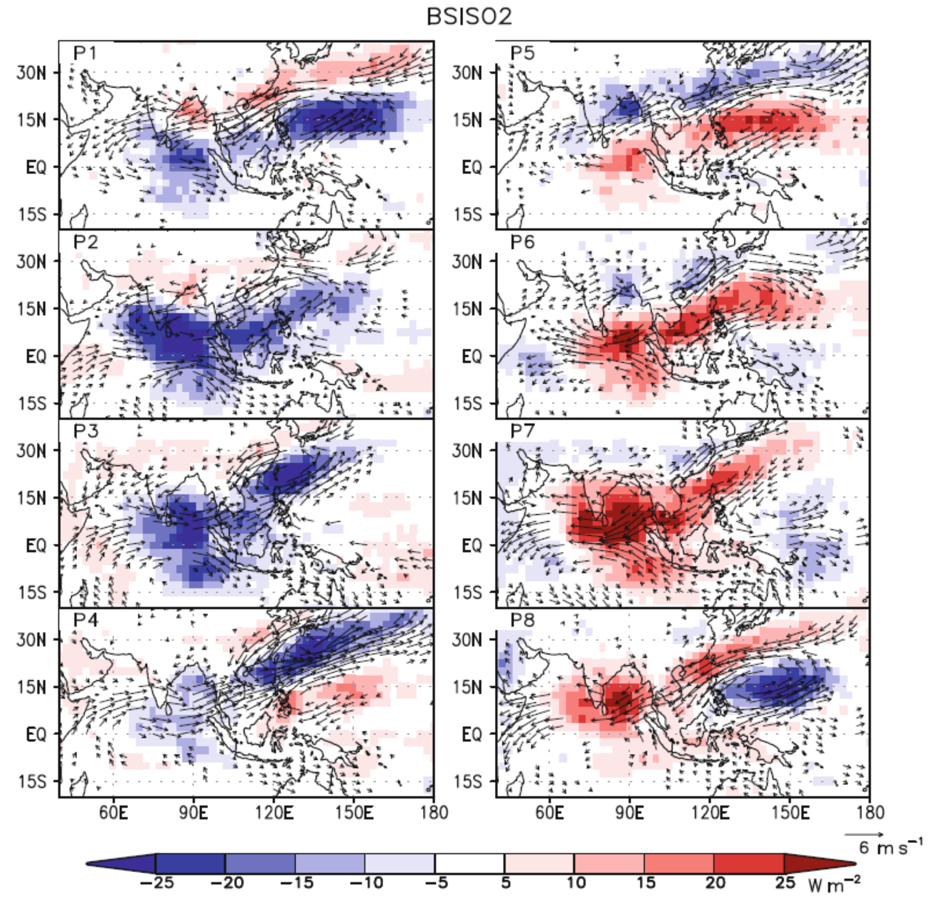
Multi Model Subseasonal forecast of BSISO

(Boreal Summer Intraseasonal Oscillation)

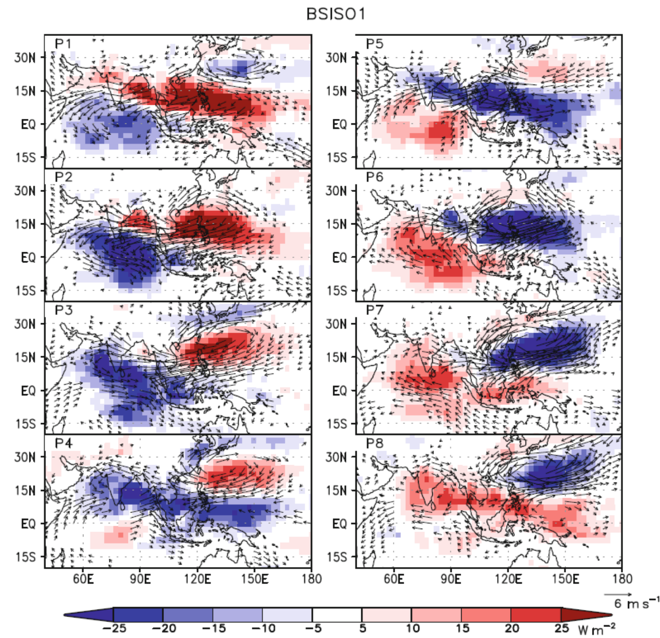
The canonical northward propagating component

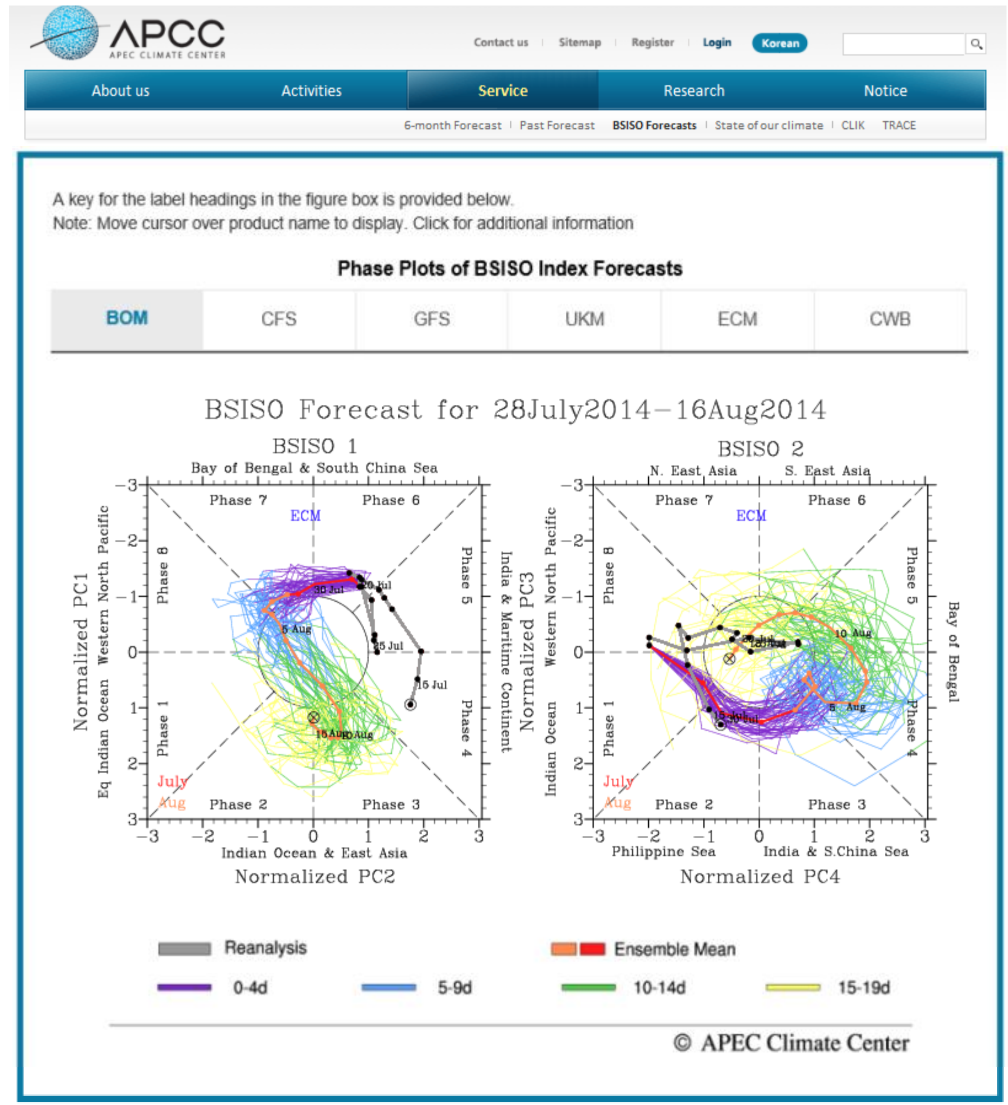
The AMS pre-monsoon and onset component





Multi Model Subseasonal forecast (from July 2013)
: BSISO (Boreal Summer Intraseasonal Oscillation, Lee et al. 2013)

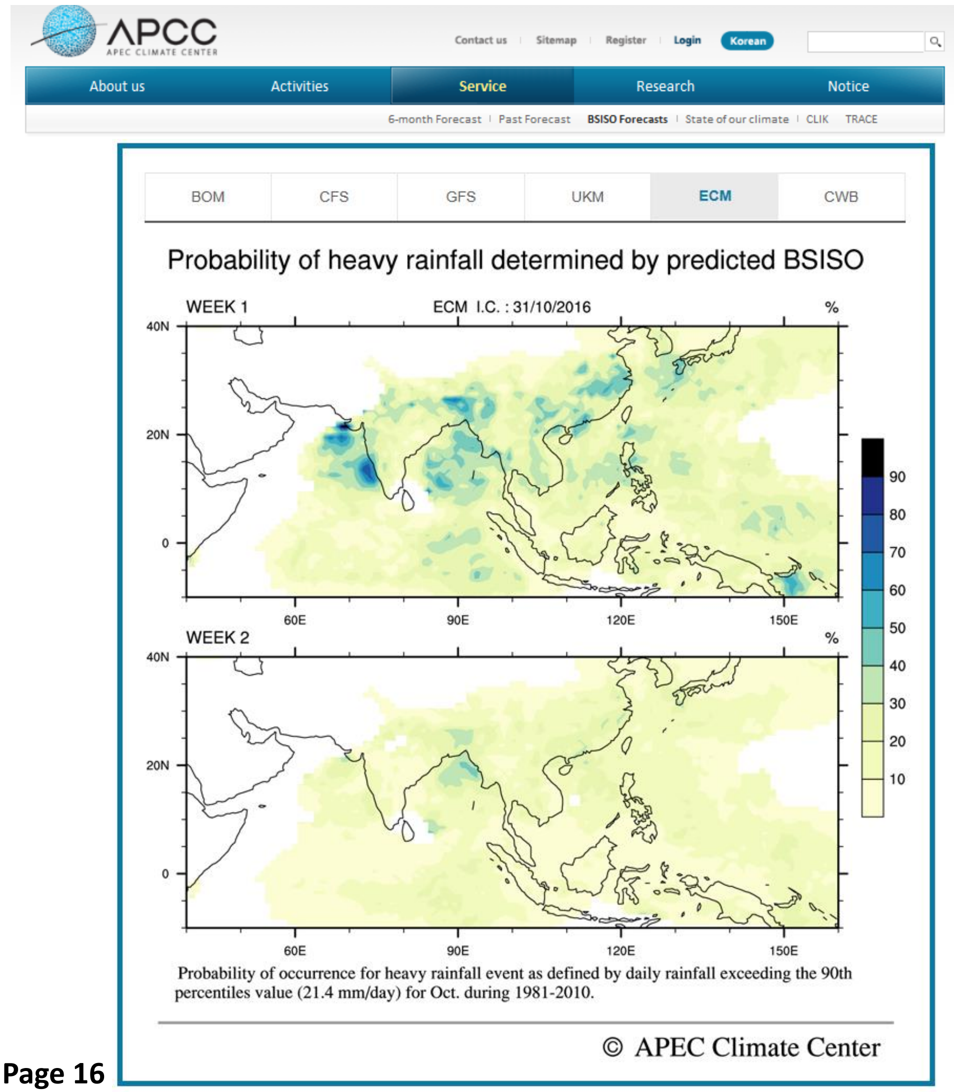




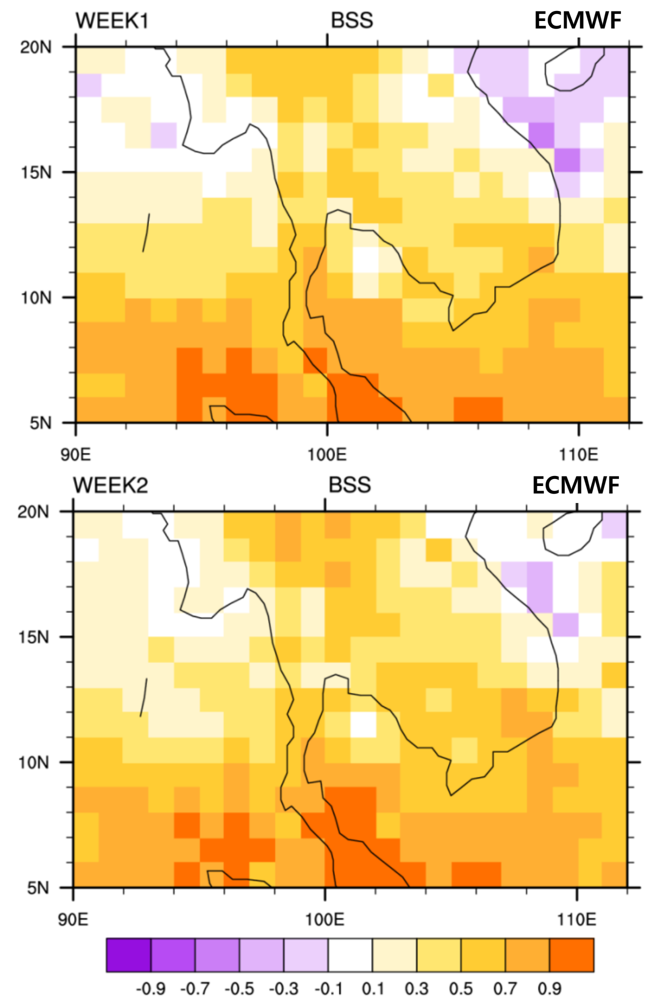
- Participating models

NCEP	CFS
	GFS
BoM	POAMA
ECMWF	EPS
UKMO	MOGREPS-15
CWB	CWB EPS T119

Multi Model Subseasonal forecast (from July 2013)
: User friendly information from BSISO forecast



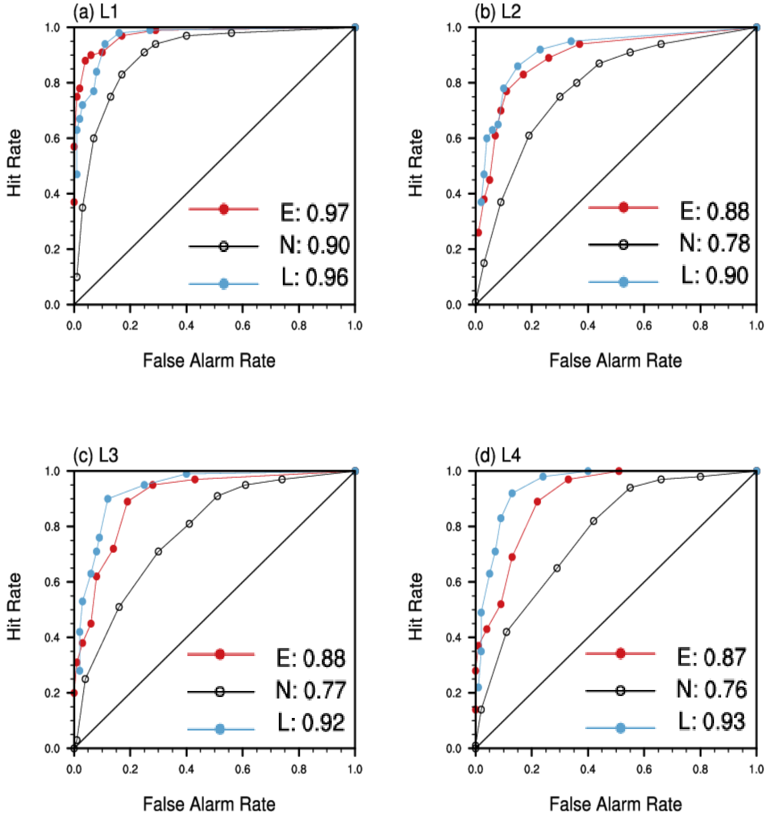
Heavy Rainfall Probability Forecast (left) and its Skill Assessment over Mekong river basin (right)



Thanks!

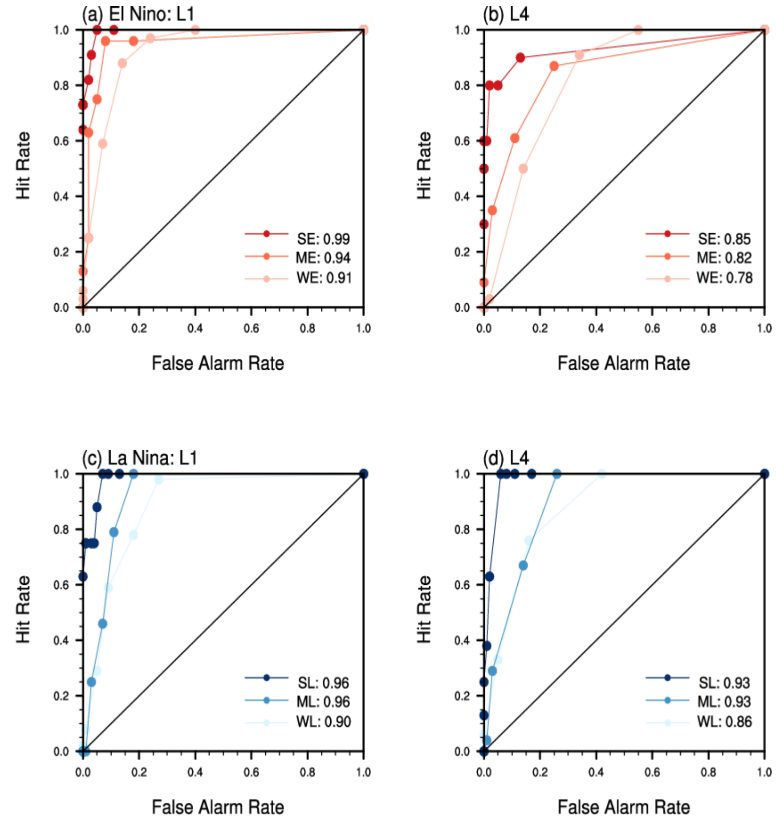
Experimental: Forecast skill for ENSO Category

ENSO Category Forecast: 1983-2005, All seasons



- ***E***: *El Nino*
- ***N***: *ENSO-neutral*
- ***L***: *La Nina*

ENSO Intensity Forecast: 1983-2005, All seasons

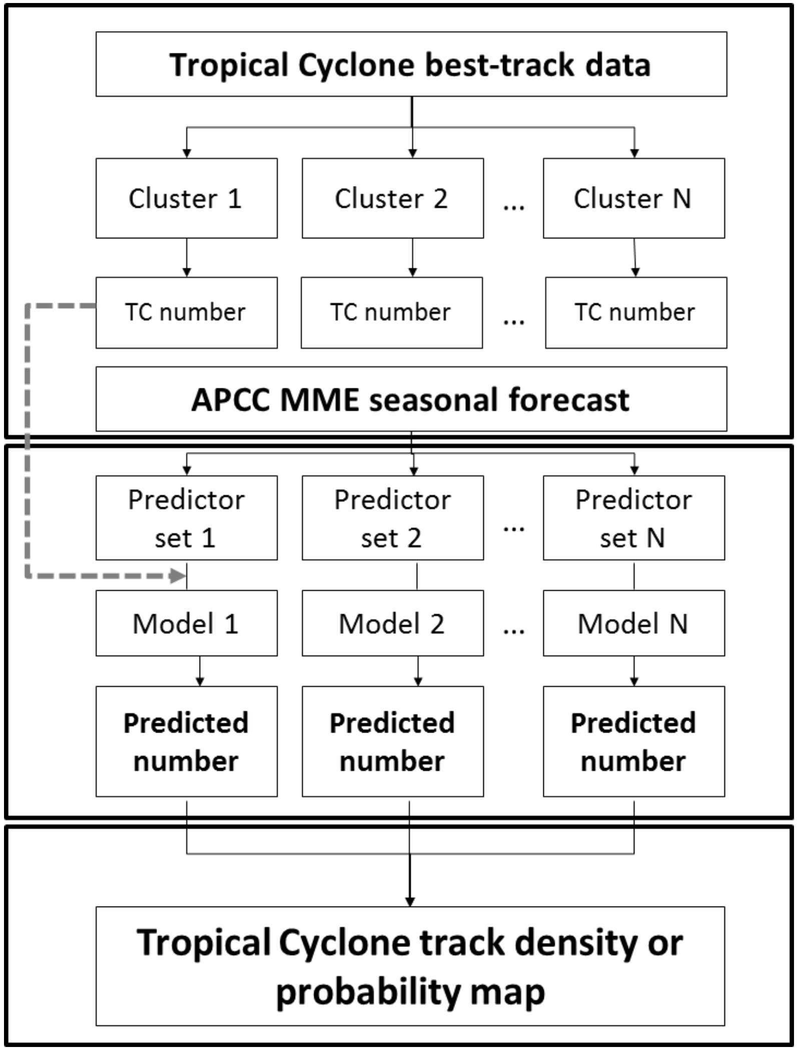


- ***SE***: *Strong El Nino*
- ***ME***: *Moderate El Nino*
- ***WE***: *Weak El Nino*

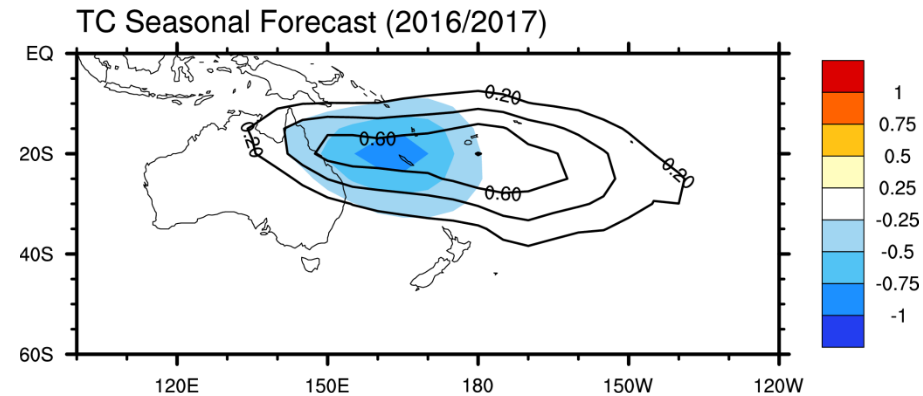
- ***SL*** *: Strong La Nina*
- ***ML***: *Moderate La Nina*
- ***WL***: *Weak La Nina*

To become operational in 2017

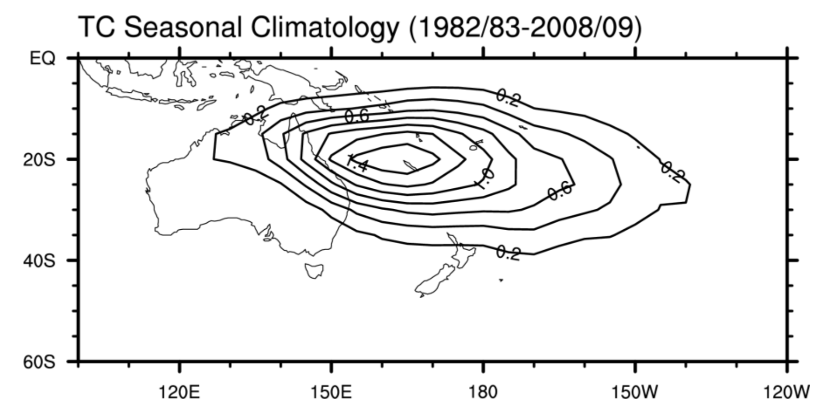
Seasonal Tropical Cyclone Forecast
: South Pacific Ocean



2016-17 seasonal TCs track density forecast



Contour: Seasonal TC track density in each grid
Shaded: Anomaly compared to the climatology



Predictability of East Asian Winter Monsoon (EAWM) in APCC MME Forecast System

Selection of EAWM Index

Predictability of EAWM in climate models

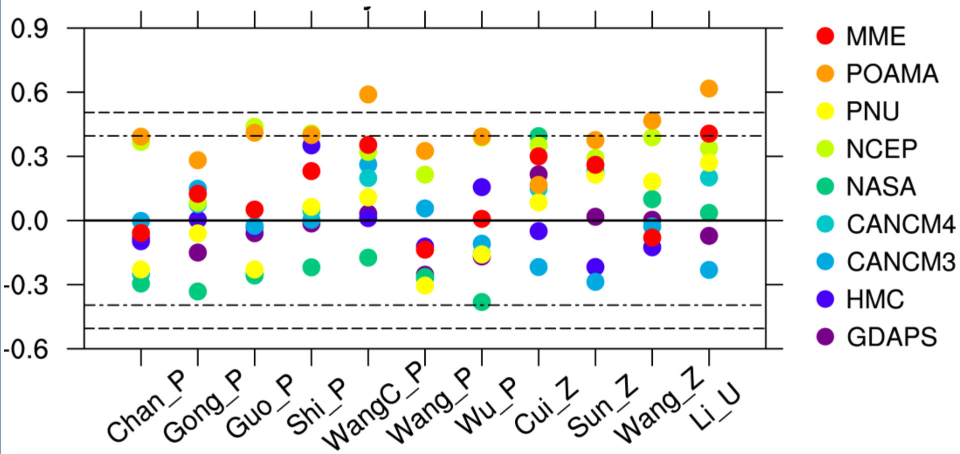


Fig 1. The temporal correlation coefficients between the observed and simulated normalized DJF-mean EAWM indices for the period 1983-2007. Dashed lines denote the threshold values for the 95% and 99% significance levels.

Representability of the T2m ano. related to EAWM

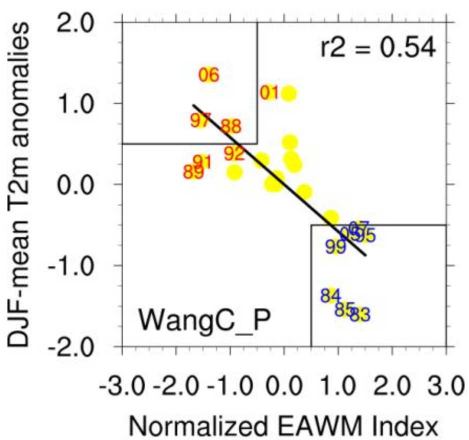


Fig 2. Scatter plots of the normalized EAWM index vs DJF-mean surface temperature anomalies averaged over East Asia (100-145° E, 20-50° N) for the period 1983-2007 based on the EAWM index defined by Wang and Chen (2014). The strong (weak) EAWM year with cold (warm) winter defined in Table 3 is shown at the lower right (left) corner with blue (red) characters of each plot

Prediction skill of EAWM Index

Prediction skill in hindcasts

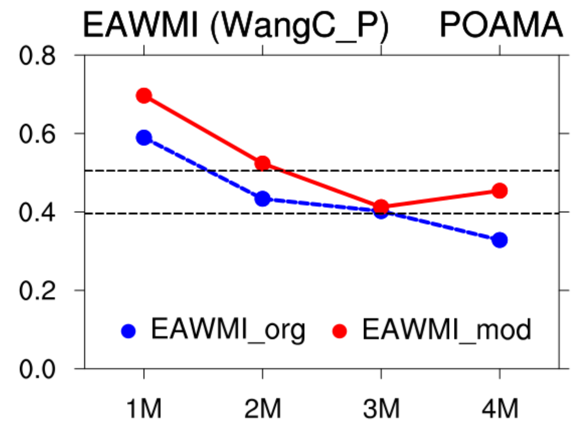
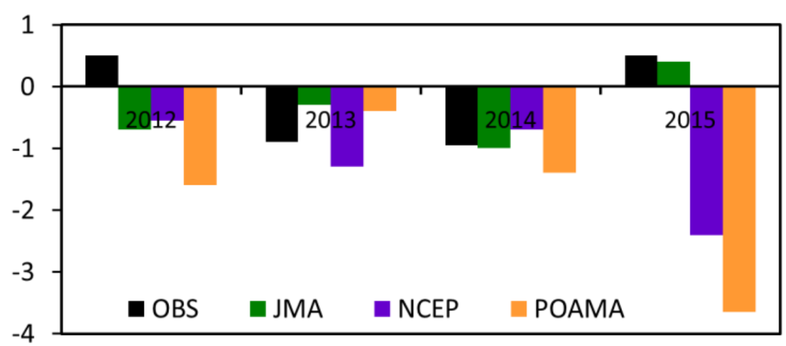


Fig 3. Correlation coefficients between observed and simulated indices from POAMA for different lead months. Red solid line and blue dotted line indicate original and modified index, respectively.

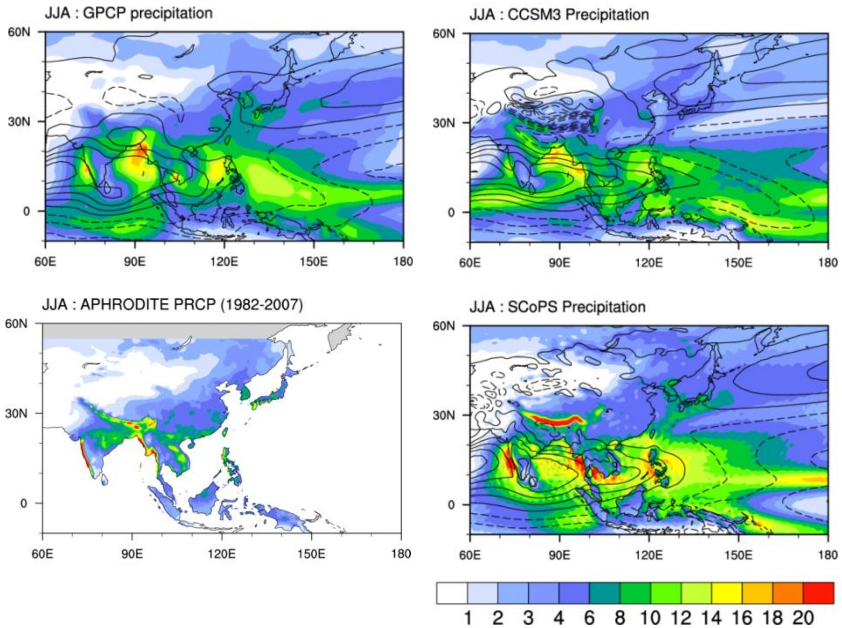
Prediction skill in real-time forecasts

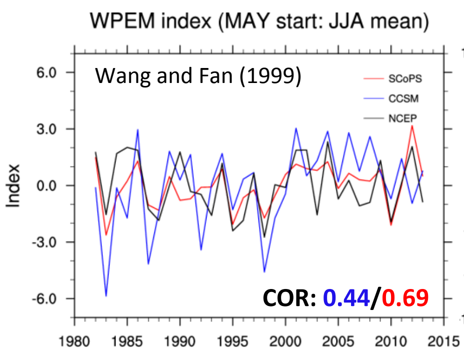


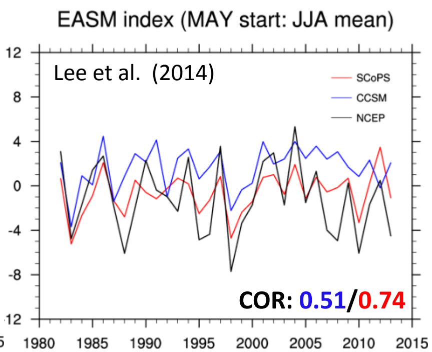
Model hindcast period : 1983-2006
Model forecast period : 2012-2015

Development of in-house seasonal forecast model
: Seamless Coupled Prediction System (SCoPS)

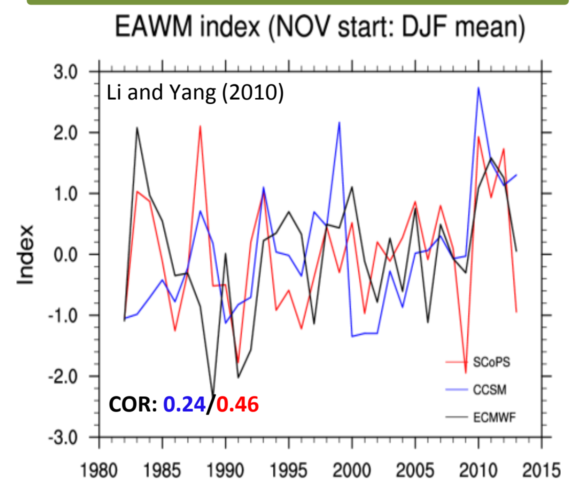
East Asian Summer Monsoon

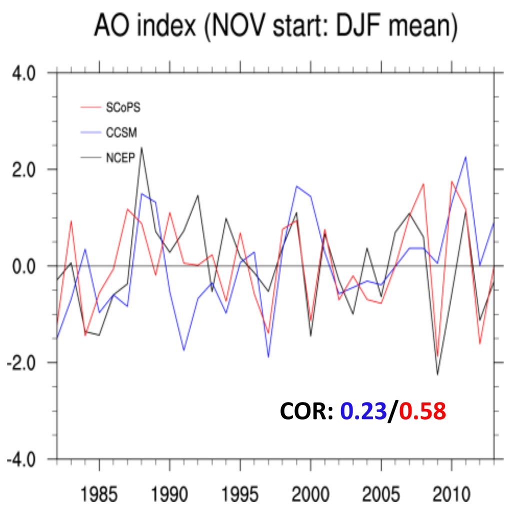






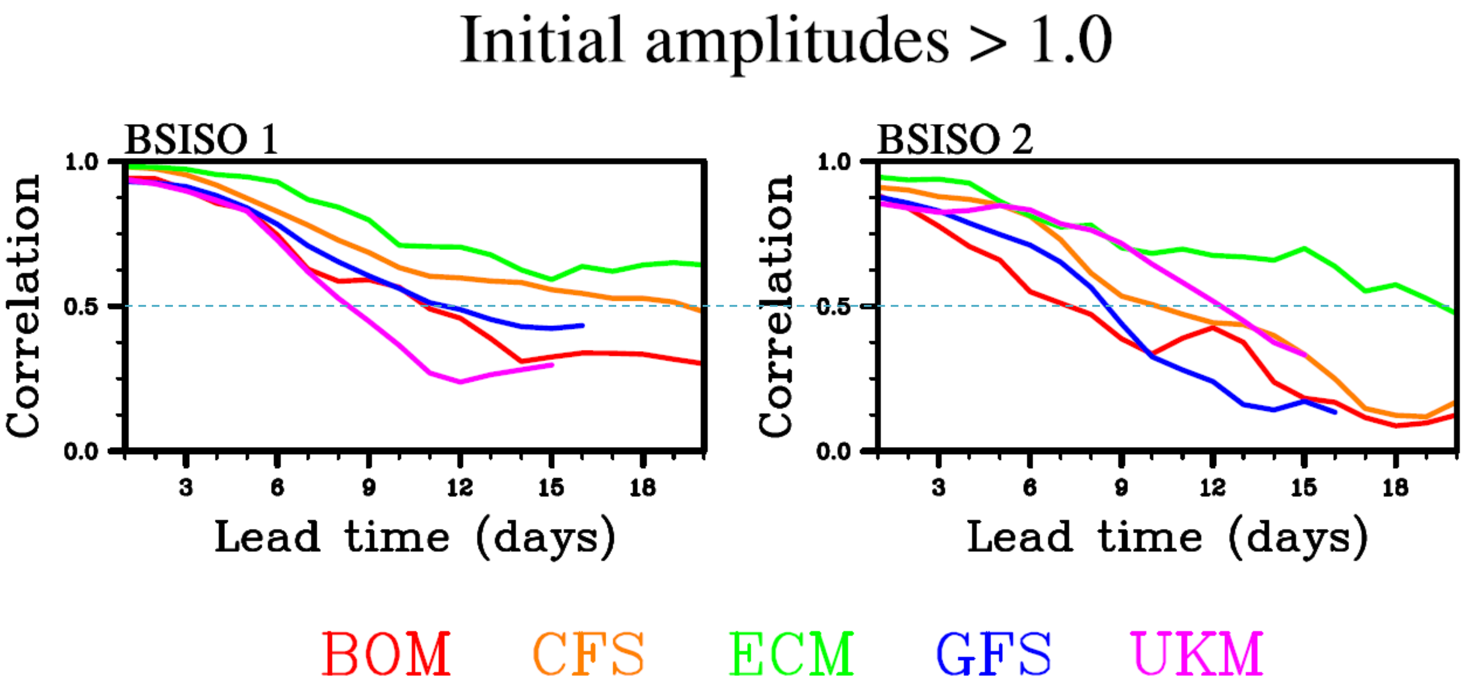
East Asian Winter Monsoon





SCoPS predicts EASM and EAWM related circulation better than APCC CCSM3

Skill assessment for BSISO real-time forecast

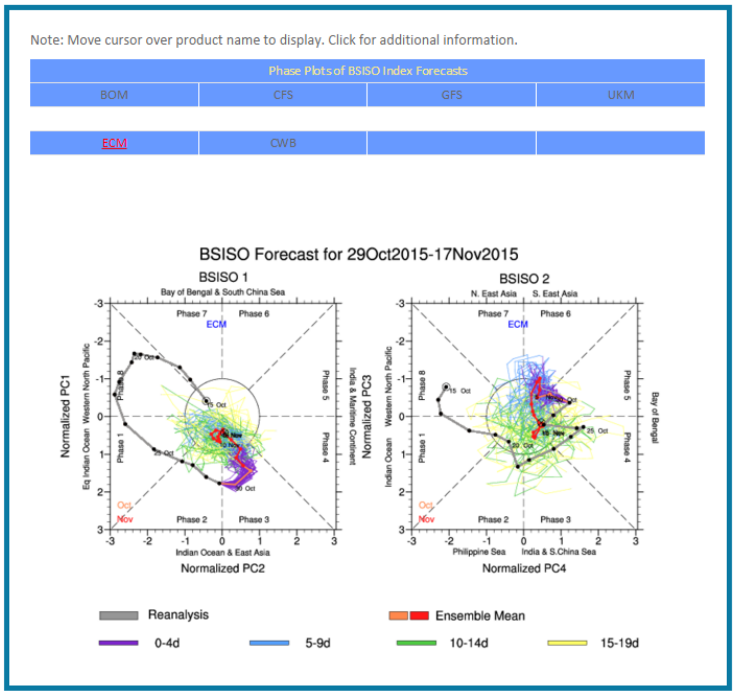


- ECMWF produces skillful BSISO1 forecasts up to a lead time of close to 30 days, while the same level of skill in other models extends only to a lead time of about 10 days.

- Predictable period of BSISO2 is about 8 ~ 20 days.

Multi Model Subseasonal forecast (from July 2013)
: Possible application of BSISO forecast

BSISO forecasts service



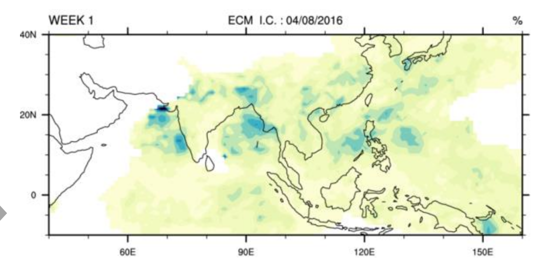
YEAR	DAY	BSISO1	BSISO2	B1phs	B2phs
2015	262	0.395	0.734	P3	P6
2015	263	0.154	0.753	P3	P6
2015	264	0.190	0.223	P3	P6
2015	265	0.600	0.833	P3	P6

:

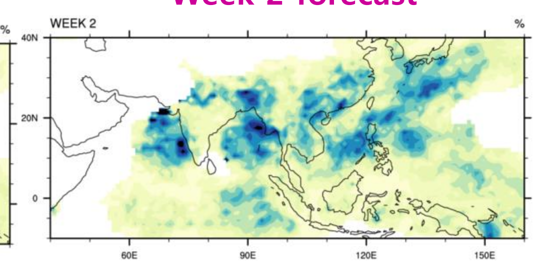
BSISO index = *f (Amplitude, Phase)*

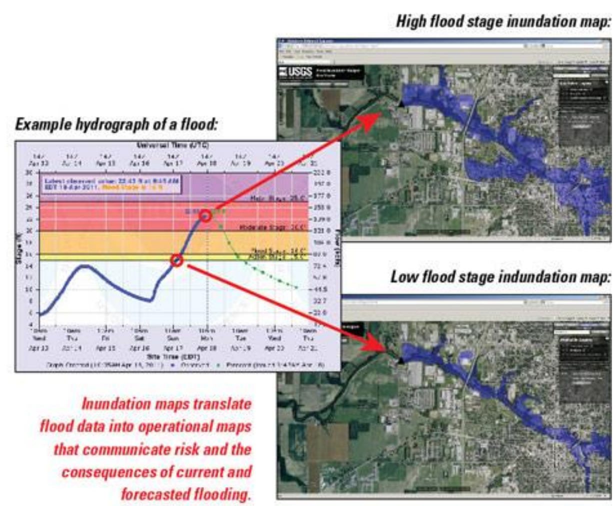
Probability forecast of heavy rainfall estimated by BSISO forecasts

Week-1 forecast



Week-2 forecast





Flood Inundation Mapping