Understanding climate information from APCC

October 15, 2018

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What does APEC Climte Center do?

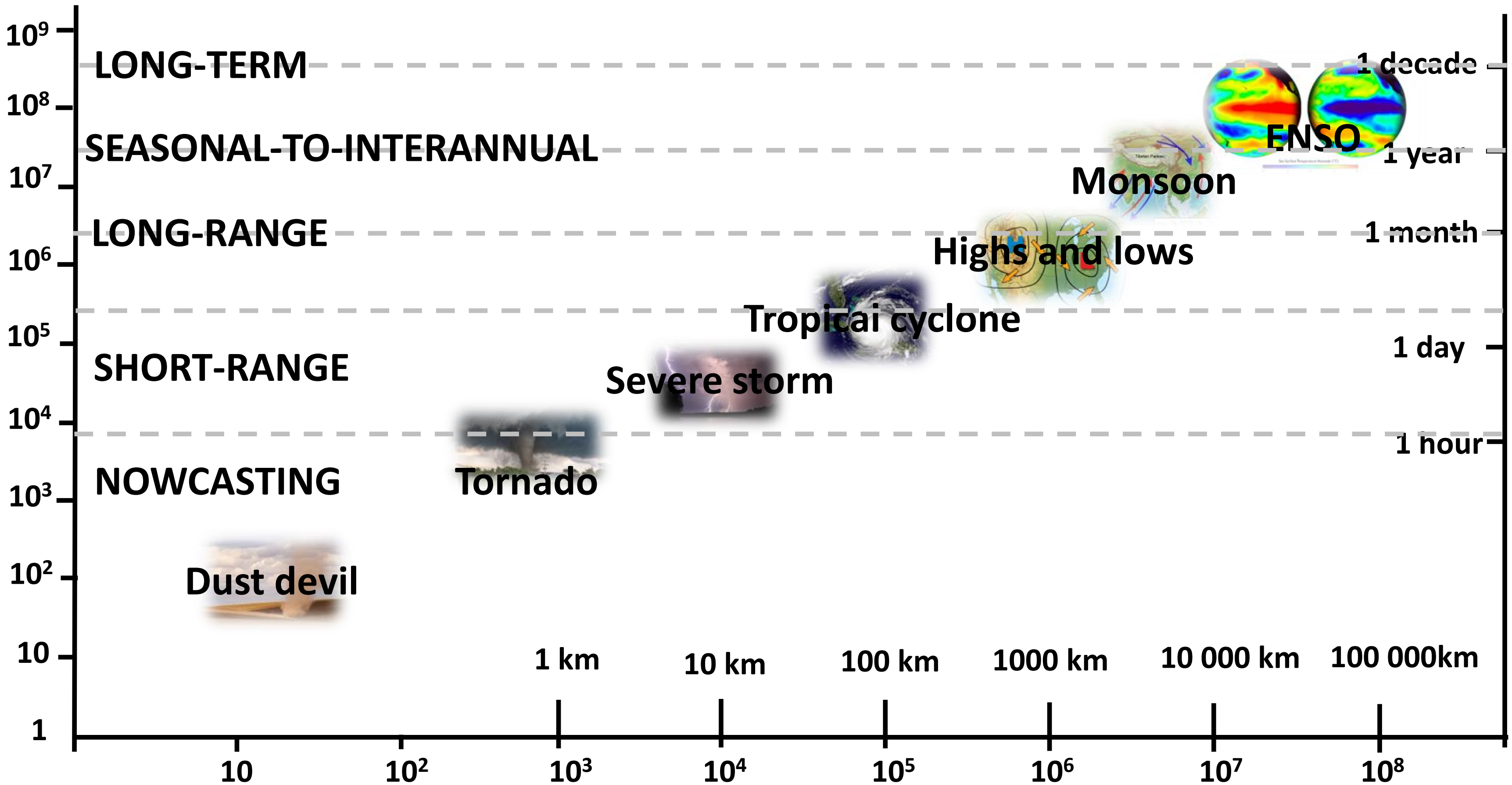
- Established in 2005 as a climate prediction center during the 13th APEC Leaders' Meeting in Busan, South Korea
- Aim: enhance socio-economic wellbeing of APEC countries using climate informati on

MISSION

Use climate science and its applications to contribute to safer, more prosperous, and more resilient communities through four interrelated themes:

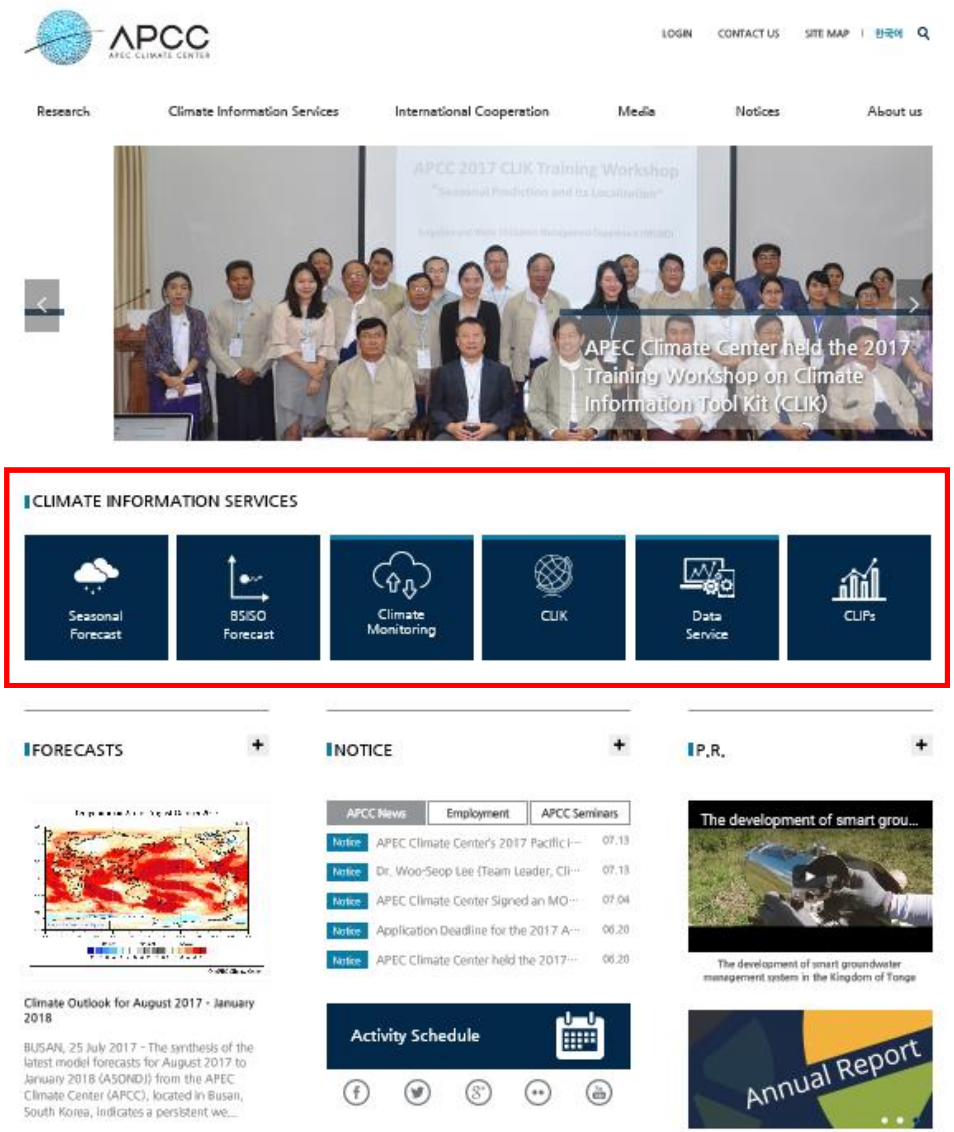
- Climate Prediction
- Climate Information Services
- Interdisciplinary Research
- International Cooperation

Spatial and temporal scale



(Adapted from: J.W., Zillman, WMO Bulletin 48 (2) April 1999)

What does APEC Climte Center do?



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http://www.apcc21.org

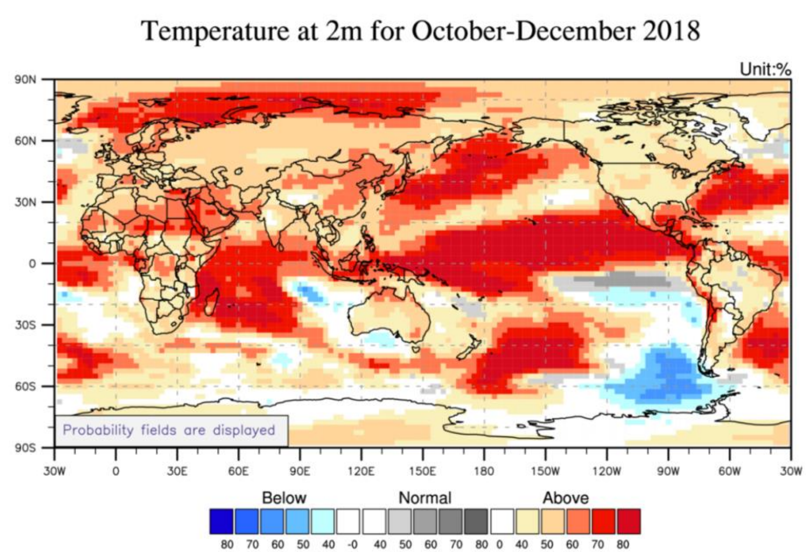
What does APEC Climte Center do?

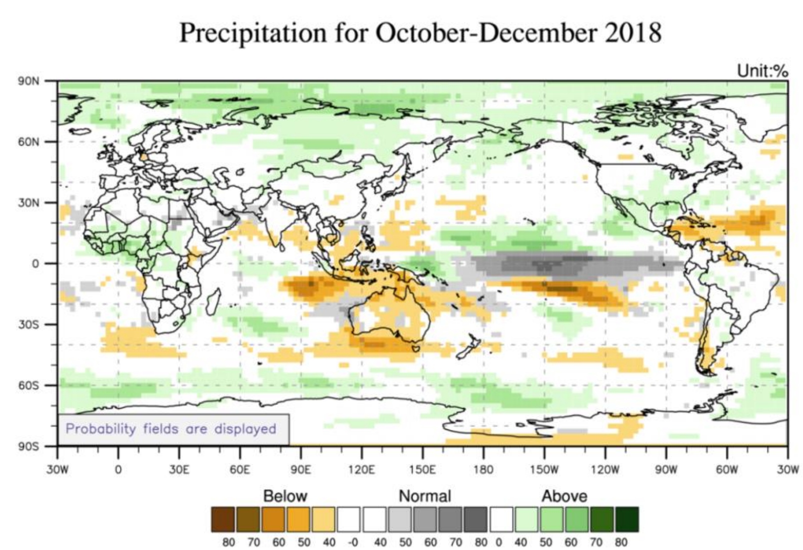
CLIMATE INFORMATION SERVICES

- Seasonal Forecast
- BSISO Forecast
- Climate Monitoring
- CLIK
- Data Service
- CLIPs

- Information about the "climate" that can be expected in the coming months

Forecast for October-December 2018

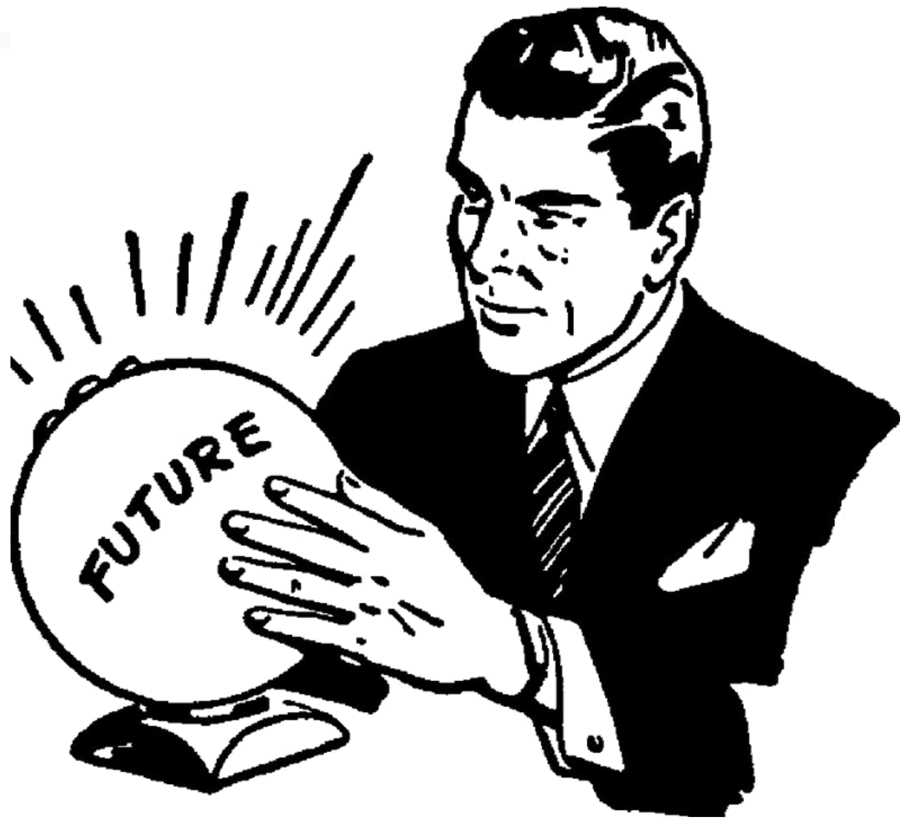




Seasonal forecast:
Temperature and Precipitation Outlook (Oct–Dec 2018)

Strongly enhanced probability for above normal temperatures is predicted for the eastern Arctic Ocean, Bering Sea, tropical North Pacific, northern North Pacific, central South Pacific, equatorial and subtropical Atlantic, and the western and central Indian Ocean. **Enhanced probability for above normal temperatures is expected for** the Arctic, Antarctic, Eurasia, Africa, eastern and northern Australia, Gulf of Mexico, Caribbean Sea, Central America (excluding northern Mexico), and northern Chile. A tendency for above normal temperatures is predicted for North and South America. **Enhanced probability for below normal temperatures is predicted for** the southeastern South Pacific and the eastern Indian Ocean. A tendency for below normal temperatures is expected for the eastern subtropical South Pacific and the Great Australian Bight. **Enhanced probability for near normal temperatures is predicted for** the eastern off-equatorial South Pacific. A tendency for near normal temperatures is expected for the northern North Atlantic and the Coral Sea. **Enhanced probability for above normal precipitation is predicted for** the eastern Arctic Ocean, central off-equatorial North Pacific, and West Africa. **A tendency for above normal precipitation is expected for** the Arctic, Antarctic Ocean, Bering Sea, eastern and central Russia, Mongolia, Alaska, northern Canada, eastern USA, Mexico, and the Gulf of Mexico. **Enhanced probability for below normal precipitation is predicted for** the central off-equatorial South Pacific, off-equatorial North Atlantic, Caribbean Sea, eastern Indian Ocean, and the Great Australian Bight. **A tendency for below normal precipitation is expected for** the Arabian Sea, Bay of Bengal, South China and Philippine Seas, Australia, the Coral Sea, and the seas surrounded by Indonesia and Australia. **Strongly enhanced probability for near normal precipitation is predicted for** the central equatorial Pacific. Enhanced probability for near normal precipitation is expected for the equatorial belt of the Pacific. **A tendency for near normal precipitation is predicted for** some parts of the eastern Indian Ocean near western Australia.

How do we predict?



Seasonal forecast: Method

	Statistical prediction	Dynamical prediction
	▪ Use observed relationship of climate system to predict future	▪ Based on physical laws of the climate system
Pros	▪ Simple ▪ Cheap	▪ Nonlinearity can be considered. ▪ Spatiotemporally coherent variables.
Cons	▪ Stationarity – climate is changing. ▪ Limited data	▪ Complicated & expensive ▪ Not real – biased & need correction.

Seasonal forecast: Statistical prediction

- Use past observational record and statistical methods

(0) Climatology (use 30 year average as a baseline)

$$x(t+1) = \bar{x}$$

(1) Persistence (Assume that future will be same as it is now)

$$x(t+1) = x(t)$$

(2) Regression (The most popular method and many variations)

$$x(t+1) = ax(t) + b$$

Anomalies (deviation) vs Climatology (mean)

Climatology:

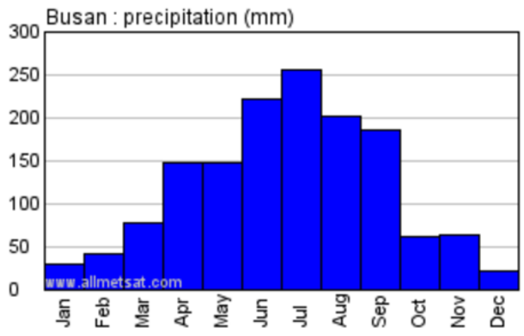
1. total mean of all data over the observing record - for instance 20 years of a particular data product.
2. a monthly climatology, which would be the monthly mean over the years in the observing record

Seasonal forecast: Statistical prediction

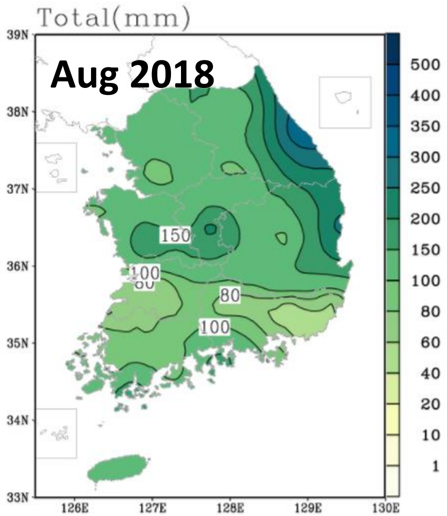
- Predict rainfall in Busan for coming December

(0) Climatology (use 30 year average as a baseline)
(1) Persistence (Assume that future will be same as it is now)
(2) Regression (The most popular method and many variations)

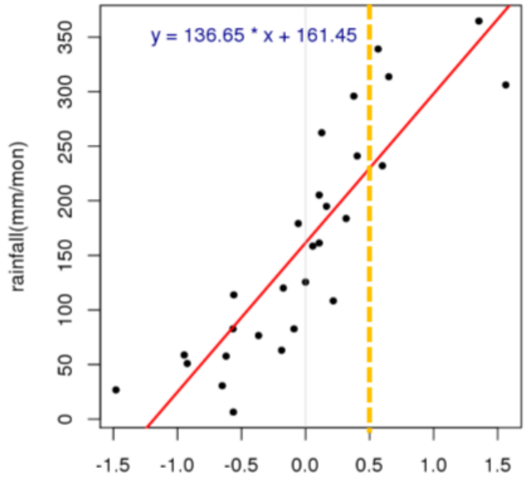
(0)



(1)



(2)

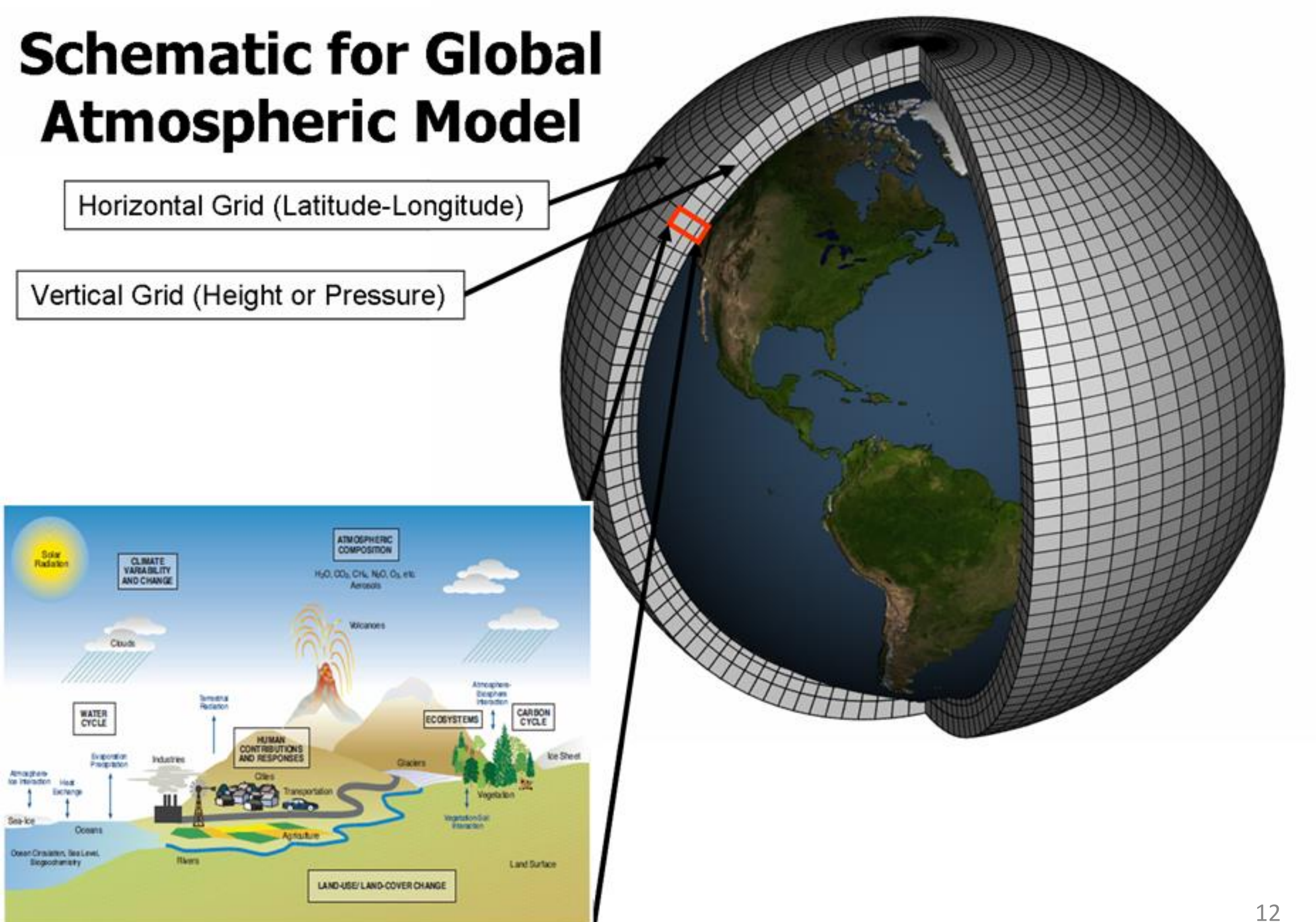


Seasonal forecast: Dynamical prediction

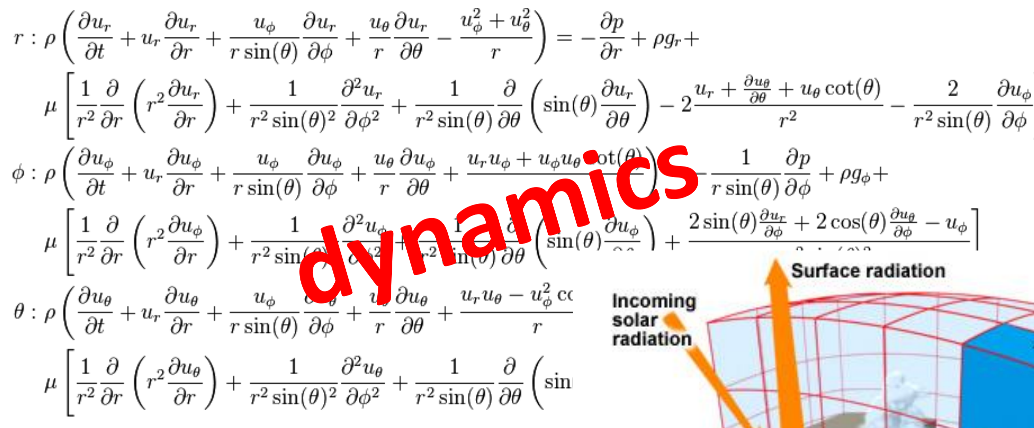
- Use GCM : Global Climate Model

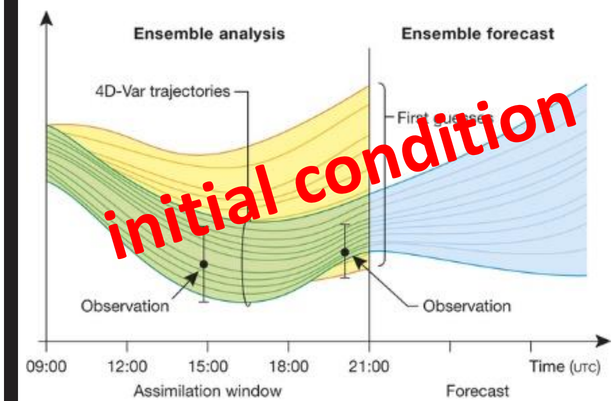
Atmosphere
Ocean
Sea-Ice
Land surface
Chemistry
Biosphere

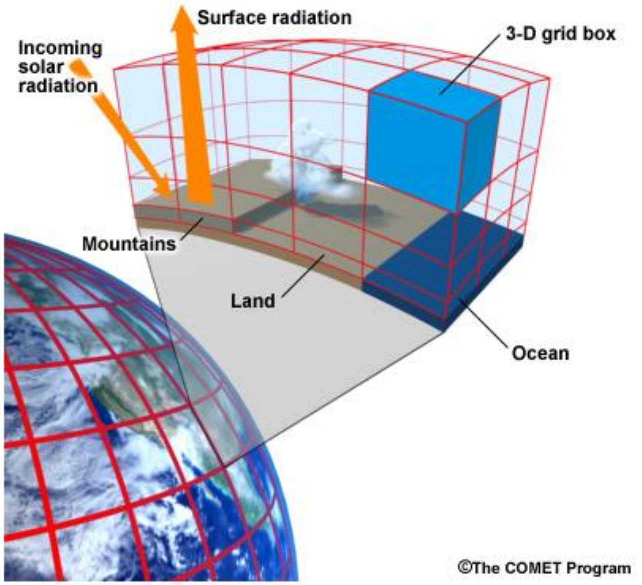
Seasonal forecast: Dynamical prediction

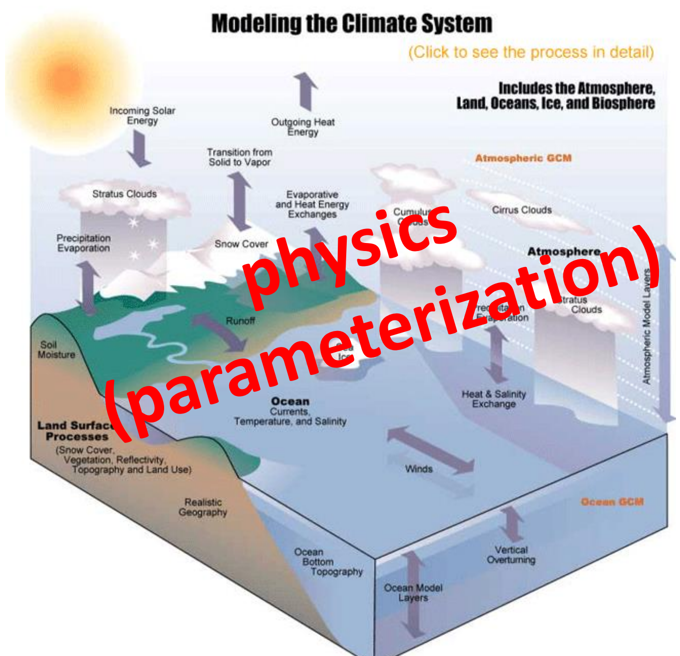


Seasonal forecast: Dynamical prediction









Which approach does APCC take for Seasonal forecast:? Multi-model ensemble (use many GCMs)

APCC
APEC CLIMATE CENTER

Seasonal forecast: Predictability

- Prediction: Action of forecast
- Prediction skill: Model (or human) capability of making forecast
- Predictability: Characteristics of Nature – How fast two states of the system would departure from each other in time

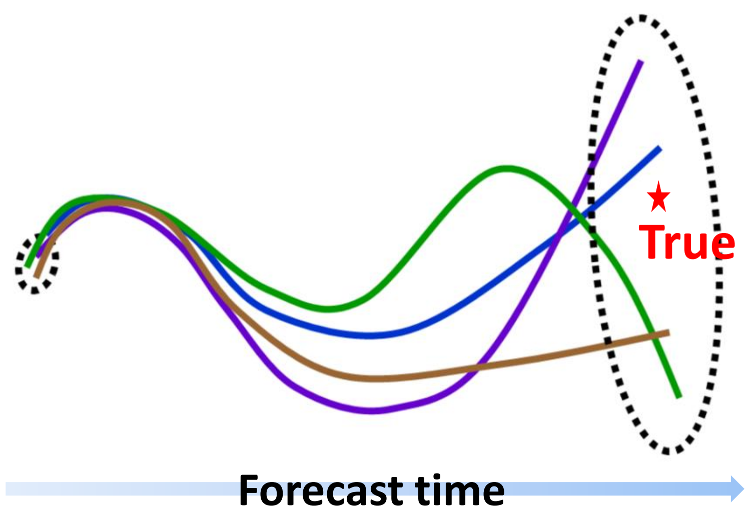
Lead time(τ)	***1. Temperature of this room tomorrow*** ***2. Temperature of this room in 30days later*** ***3. Temperature of this room in 30years later***
Location	***1. Temperature of Seoul (Korea)*** ***2. Temperature of Jakarta (Indonesia)*** ***3. Temperature of Villa Las Estrellas (Antarctica)***
Physical variables	***1. Temperature*** ***2. rainfall*** ***3. wind speed***

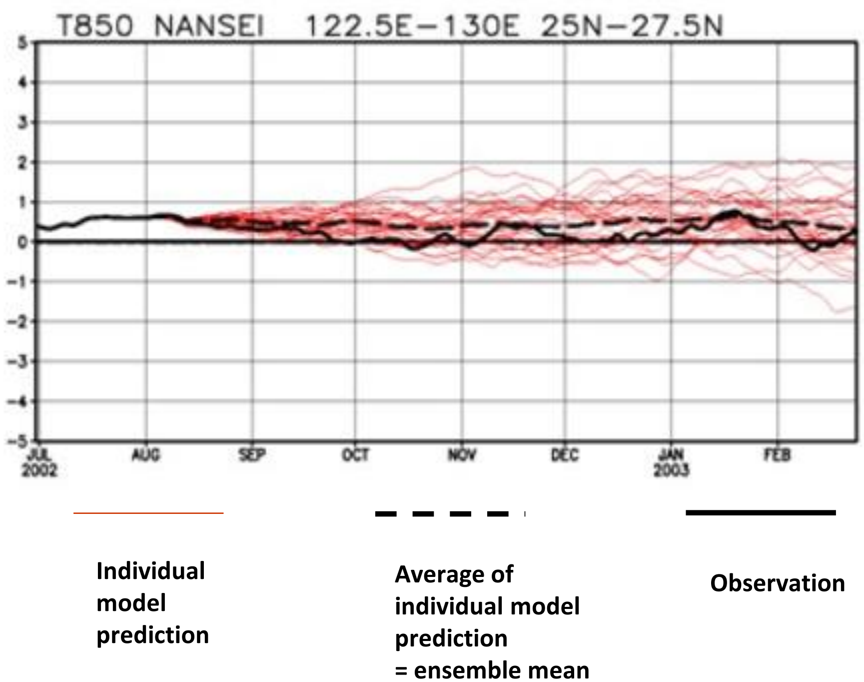
Trying to reach potential predictability with state-of-art prediction system

Seasonal forecast: Multi-model ensemble

- Averaging across a number of models
- To reduce noise by averaging large ensemble members

(The Earth's atmosphere is chaotic, and GCM is not perfect)

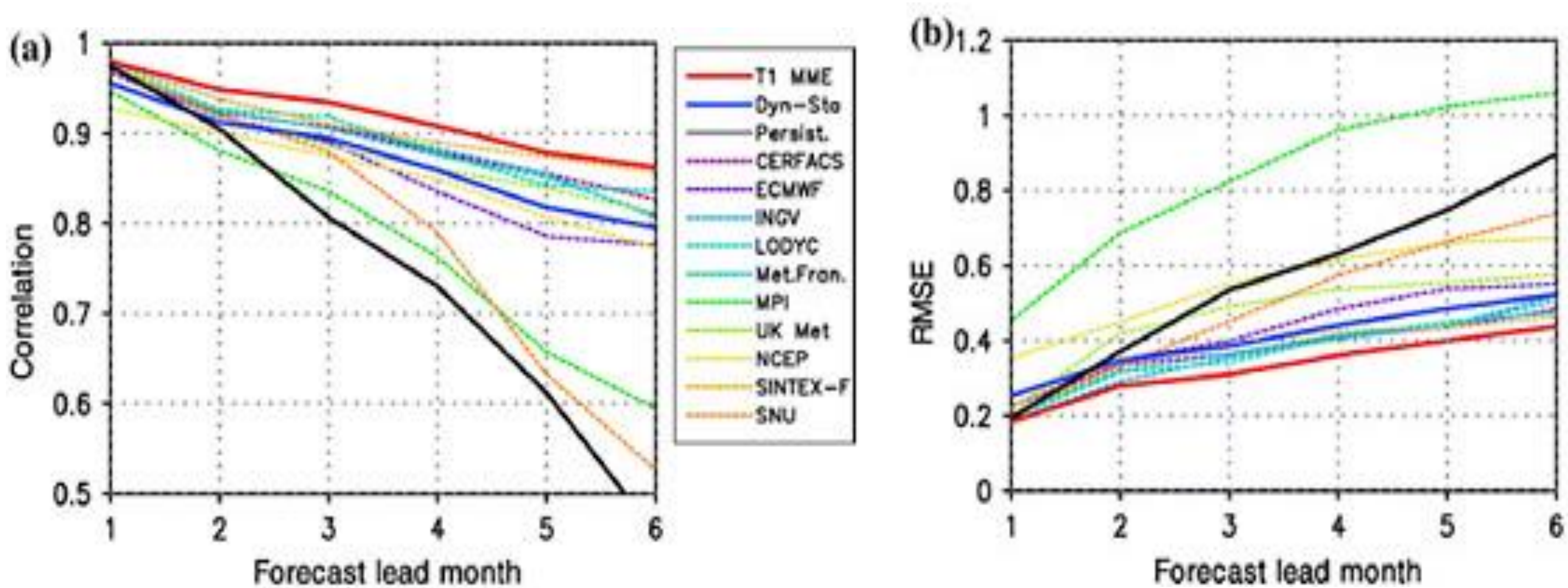




Seasonal forecast: Multi-model ensemble

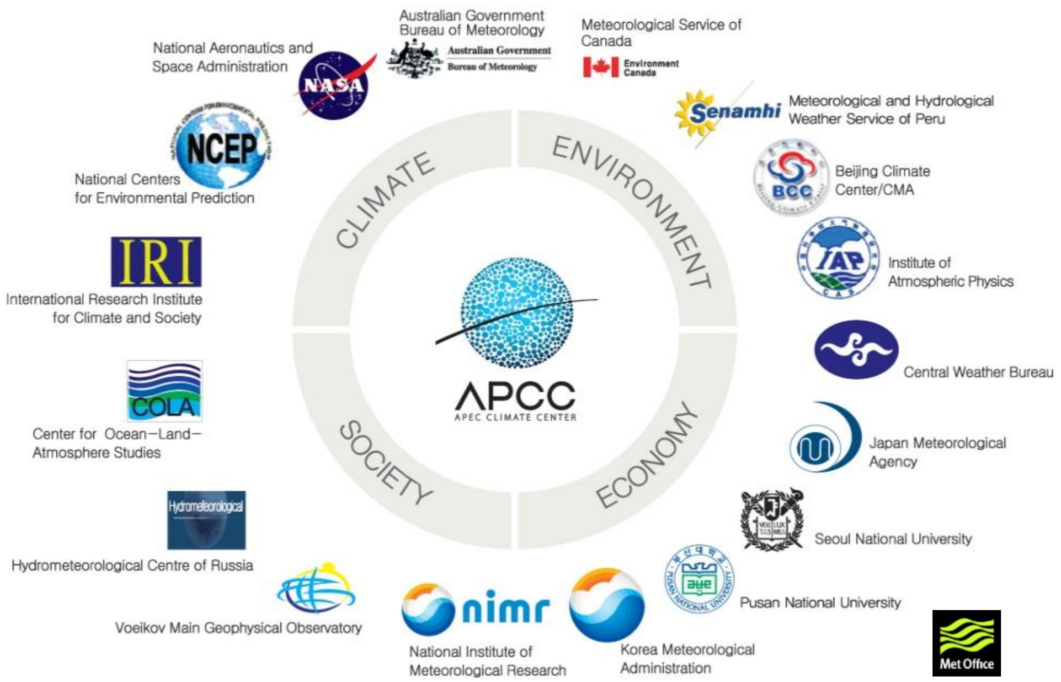
An example of a MME outperforming individual modesl in forecasting

(Jin et al. (2008)



Seasonal forecast: Multi-model ensemble

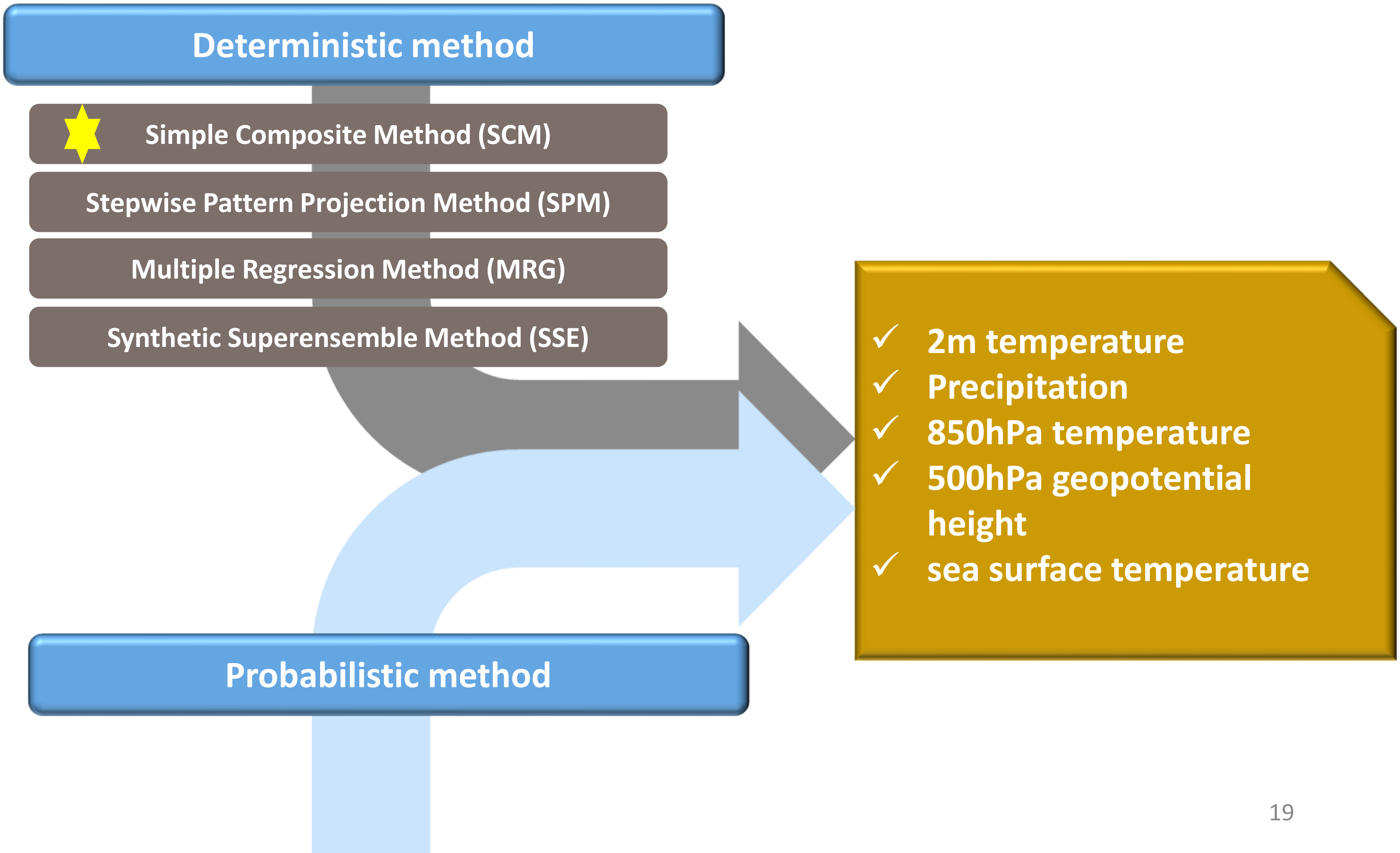
- **Collect Global climate forecast data from 17 institutes and disseminate MME forecast**



Graphical products	APCC website: apcc21.org
Digital products	APCC Data Service System website (ADSS): adss.apcc21.org

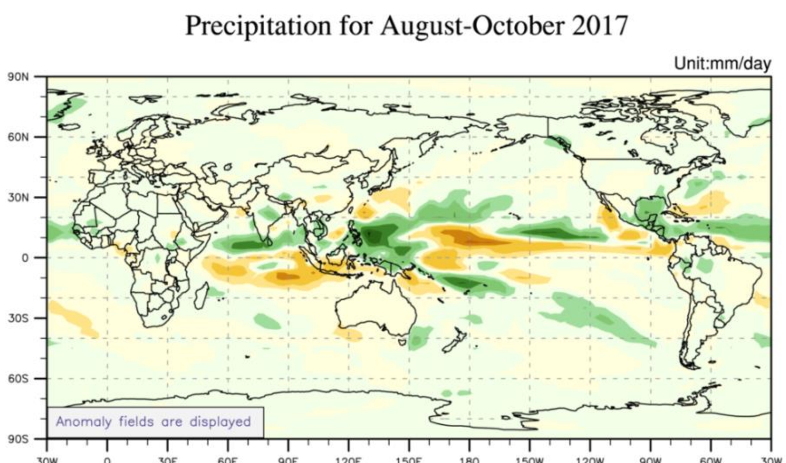
Seasonal forecast: Multi-model ensemble

- **Methodology of the APCC MME Prediction System (Min et al. 2014)**

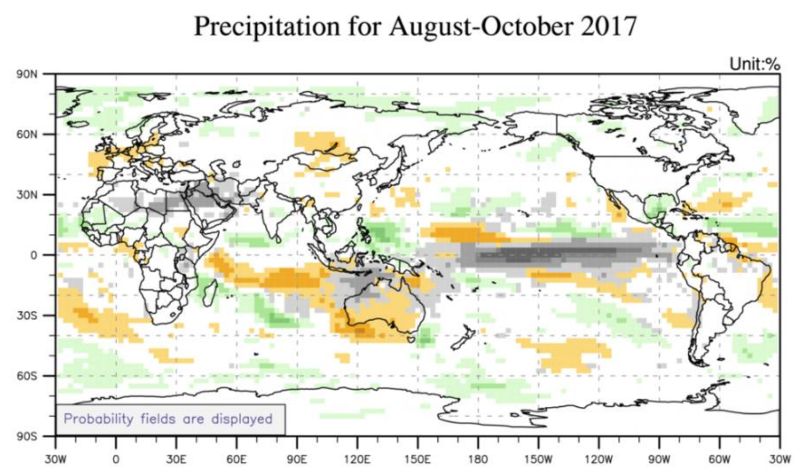


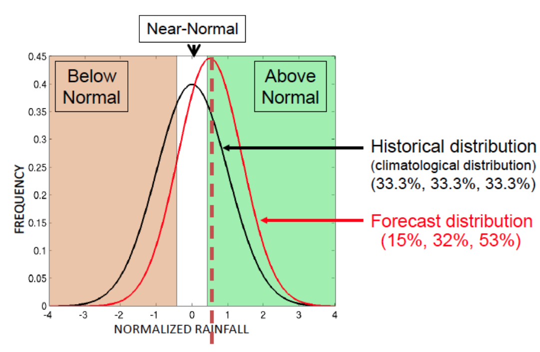
Seasonal forecast: Multi-model ensemble

Deterministic



Probabilistic





Map showing probility of rainfall falling in one of three categories (with respect to climatology)
: BN vs NN vs AN

How good are they?

What makes a good forecast?

1. **Consistency**
2. **Quality**
3. **Value**

(Murphy AH 1993; Wea. Forecasting 8, 281)

Verification for Deterministic MME method

Anomaly Correlation Coefficient	Root Mean Square Error

Verification for Probabilistic MME method

Reliability Diagram	Relative Operating Characteristics Curve	Heidke Skill Score	Ranked Probability Skill Score

How good are they?

Verification for Deterministic MME method

Anomaly Correlation Coefficient	Root Mean Square Error

$$ACC = \frac{1}{n}\sum_{i=1}^{n}\frac{(x_i - \bar{x})}{\sigma_x}\frac{(y_i - \bar{y})}{\sigma_y}$$

-1 ≤ ACC ≤ 1, ACC = 1 best score

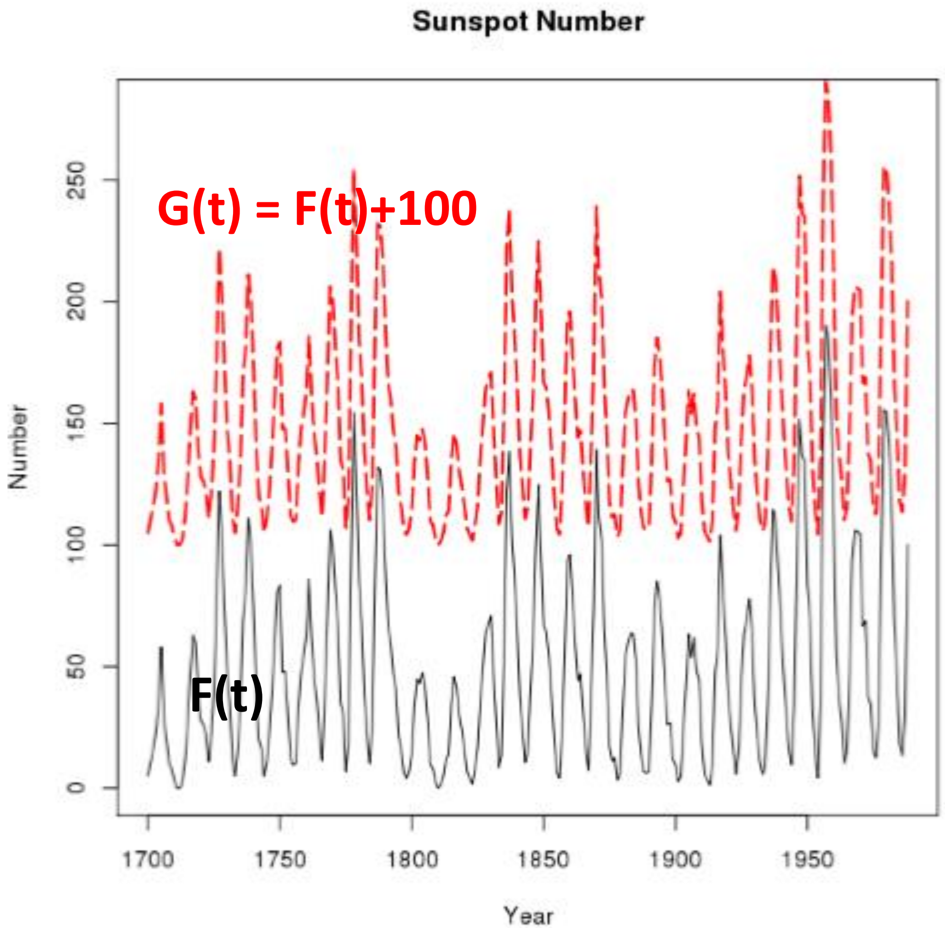
$$RMSE = \sqrt{\frac{1}{N}\sum(y_i - o_i)^2}$$

The smaller, the better

How good are they?

Verification for Deterministic MME method

Anomaly Correlation Coefficient	Root Mean Square Error



Correlation coefficient?
RMSE?

How good are they?

Verification for Probabilistic MME method

Reliability Diagram	Relative Operating Characteristics Curve	Heidke Skill Score	Ranked Probability Skill Score

		Observed		
		Yes	No	Total
Forecast	Yes	a = hits	b = false alarms	$a+b$ = forecast yes
	No	c = misses	d = correct negatives	$c+d$ = forecast no
	Total	$a+c$ = observed yes	$b+d$ = observed no	$a+b+c+d$ = total

$$\mathrm{HSS} = \frac{\mathrm{FC} - \mathrm{FC}_{\mathrm{random}}}{\mathrm{FC}_{\mathrm{perfect}} - \mathrm{FC}_{\mathrm{random}}}$$

FC: Fraction correct = fraction of hits (a/N) + fraction of correct negatives (d/N)

$\mathrm{FC}_{\mathrm{random}}$: random forecast

$$\mathrm{FC}_{\mathrm{random}} = \left(\frac{a+b}{N}\right)\left(\frac{a+c}{N}\right) + \left(\frac{c+d}{N}\right)\left(\frac{b+d}{N}\right)$$

Yes *f* Yes *o* No *f* No*o*

Fraction of hits **Fraction of correct negatives**

HSS = 1 perfect forecast

HSS = 0 forecast as good as random

HSS = worse than random

$\mathrm{FC}_{\mathrm{perfect}}$ = 1

How good are they?

Verification for Probabilistic MME method

Reliability Diagram	Relative Operating Characteristics Curve	Heidke Skill Score	Ranked Probability Skill Score

- Ranked probability score (RPS): squared probability error

$$RPS = \frac{1}{ncat-1}\sum_{icat=1}^{ncat}(Pcumfct_{icat} - Pcumobs_{icat})^2$$

icat: category number (1.below normal, 2.near normal, 3.above normal)
ncat: number of categories

Ex) 0.20/0.35/0.45 (fcst:below/near/above) vs (0.0/0.0/1.0)
RPS = 1/(3-1)x{$(0.20-0.0)^2$+$(0.55-0.0)^2$+$(1.00-1.00)^2$)}=0.17125

- Ranked probability skill score (RPSS)

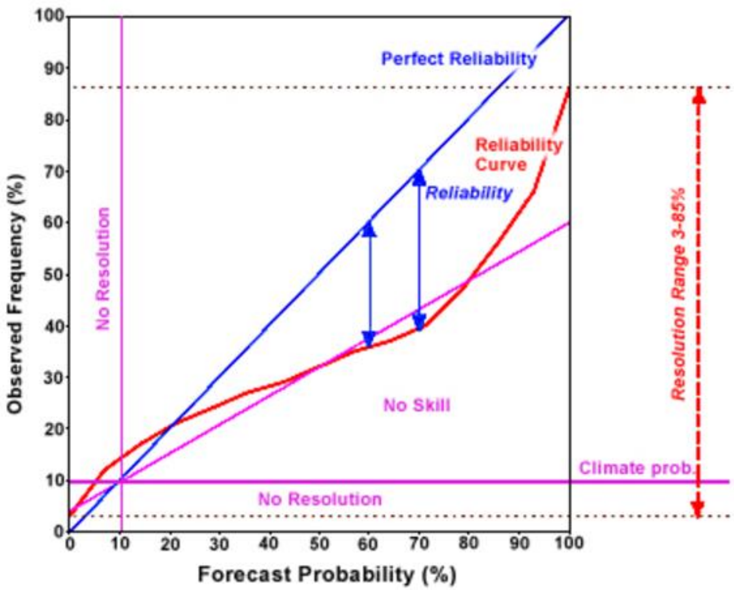
$$RPSS = 1 - \frac{RPS_{fct}}{RPS_{cli}}$$

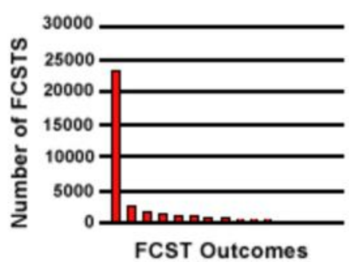
RPSS > 0 : Better than climatology
RPSS = 1 : skill equal to climatology
RPSS < 0: Worse than climatology

How good are they?

Verification for Probabilistic MME method

Reliability Diagram	Relative Operating Characteristics Curve	Heidke Skill Score	Ranked Probability Skill Score

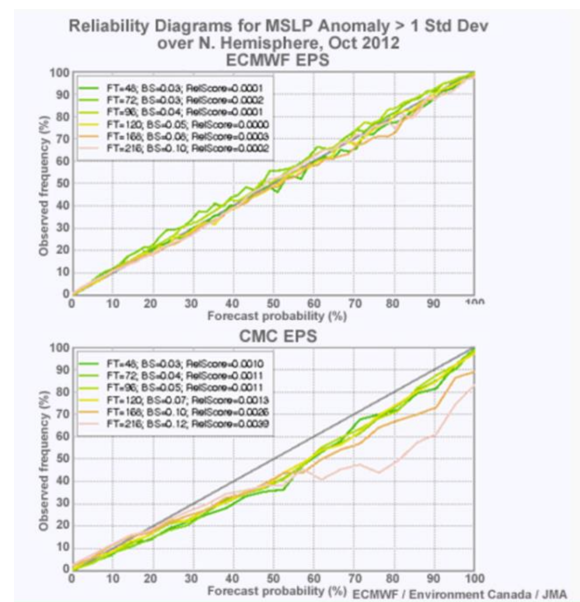




Reliability diagram for 3-day lead time ensembles for January 1996. Forecast probablilites are based on observed frequencies associated with the same number of ensemble members falling in a particular bin during 1-20 December 1995.

NCEP

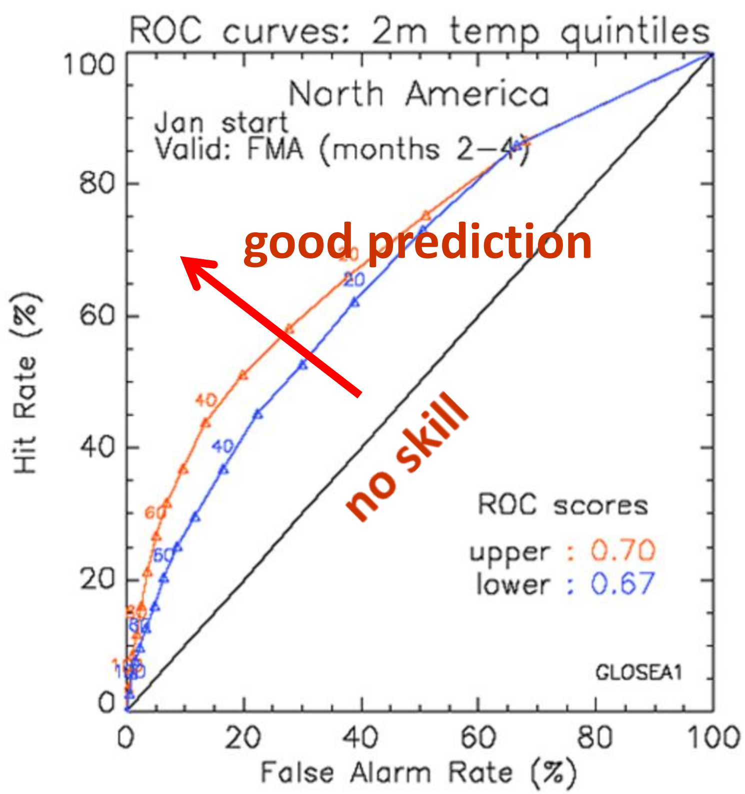
- Forecast probability versus the observed frequency
- For a perfectly reliable ensemble, the two should match, yielding a straight line from the lower-left corner to upper-right corner



How good are they?

Verification for Probabilistic MME method

Reliability Diagram	Relative Operating Characteristics Curve	Heidke Skill Score	Ranked Probability Skill Score



- Information on the hit rates and false alarm rates

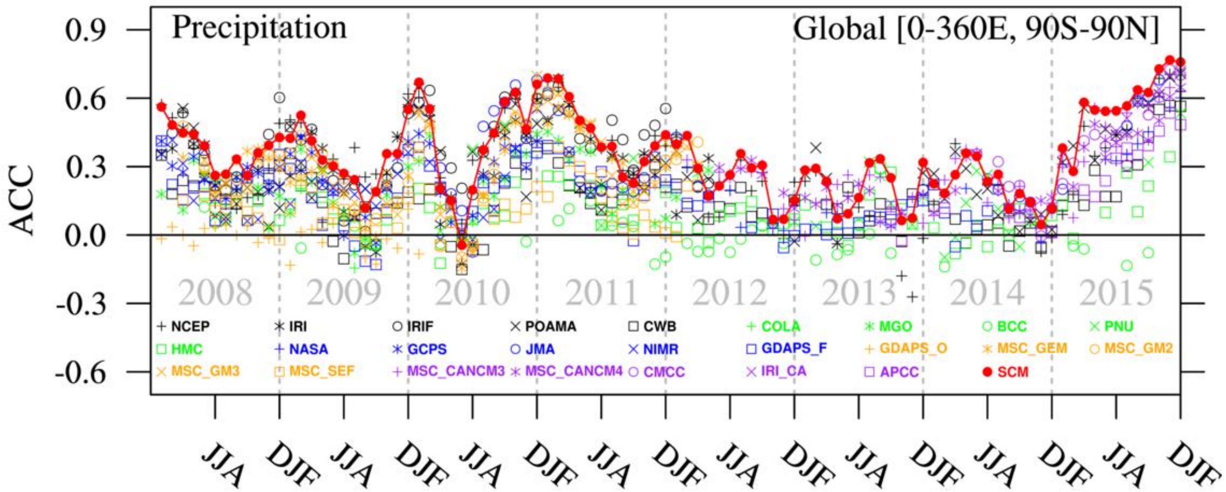
hit rate: the number of times the event was forecast (with probability above a certain threshold) and later observed to occur
false alarm rate: the number of times the event was forecast but did not occur

		Observed		
		Yes	No	Total
Forecast	Yes	*a* = hits	*b* = false alarms	*a* + *b* = forecast yes
	No	*c* = misses	*d* = correct negatives	*c* + *d* = forecast no
	Total	*a* + *c* = observed yes	*b* + *d* = observed no	*a* + *b* + *c* + *d* = total

http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/user-guide/interpret-roc

How good are they?

- APCC operational forecast



	APCC	WMOLC	ECMWF	NCEP	UKMO	JMA
AN	0.569457	0.541897	0.535531	0.52996	0.528975	0.531497
NN	0.520962	0.521424	0.537661	0.519823	0.524022	0.514656
BN	0.567702	0.533777	0.516511	0.535767	0.516994	0.534244

Realtime rainfall forcast for last 4 years (12-15)
ROC score : Perfect = 1, Meaningless(no skill) =0.5,

How good are they?

Clim Dyn
DOI 10.1007/s00382-017-3576-2

CrossMark

Skill of real-time operational forecasts with the APCC multi-model ensemble prediction system during the period 2008–2015

Young-Mi Min[1] · Vladimir N. Kryjov[1] · Sang Myeong Oh[1] · Hyun-Ju Lee[1]

- The skill of the APCC forecasts strongly depends on seasons and regions that it is higher for the tropics and boreal winter than for the extratropics and boreal summer
- forecast skill for precipitation is more seasonally and regionally dependent than that for temperature
- The skill of both temperature and precipitation forecasts strongly depends upon the ENSO strength. (the highest forecast skill noted in 2015/2016 boreal winter is associated with the strong forcing of an extreme El Nino event)

What else does APCC provide?

CLIMATE INFORMATION SERVICES

- Seasonal Forecast
- BSISO Forecast
- Climate Monitoring
- CLIK
- Data Service
- CLIPs

ADSS APCC Data Service System

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The APEC Climate Center Data Service System was developed for real-time climate monitoring and provision of digital data service to APEC member economies. This system underscores the role of APCC in playing an important role as a hub of climate data and services in the region. The main objective of the ADSS is to provide a comprehensive set of models and observational climate data to various researchers and users to establish a scientific basis for climate prediction. ADSS also aims to monitor climate information using near real-time in-situ observation and prediction data in a standardized and accessible format for various users.

What else does APCC provide?

DataSet	Areal Coverage	Grid Size	Time Step	Access	Source	Requirements
APCC-MME(6-MON)	Global	2.5×2.5(degree)	Monthly	About FTP OpeNDAP	APCC	Login
APCC-MME(3-MON)	Global	2.5×2.5(degree)	Monthly	About FTP OpeNDAP	APCC	Login
INDIVIDUAL-MODEL(6-MON)	Global	2.5×2.5(degree)	Monthly	About FTP OpeNDAP	APCC	Login
INDIVIDUAL-MODEL(3-MON)	Global	2.5×2.5(degree)	Monthly	About FTP OpeNDAP	APCC	Login
CORDEX-SEA25	Regional	25km	Daily	About FTP OpeNDAP	APCC	
CORDEX-SEA50	Regional	50km	Daily	About FTP OpeNDAP	APCC	
Clipped CMIP5	National level (22 Countries)	Depending on GCMs	Daily	About FTP OpeNDAP	ESGF	
IRI_DATA_LIBRARY	Global	2.5×2.5(degree)	Various	About Link	IRI	
NCEP	Global	2.5×2.5(degree)	Daily	About FTP OpeNDAP	NOAA	
NCEP-SFC	Global	2.5×2.5(degree)	Daily	About FTP OpeNDAP	NOAA	
NOAA-OLR	Global	2.5×2.5(degree)	Daily	About FTP OpeNDAP	NOAA	
TMI	Global	2.5×2.5(degree)	Daily	About FTP OpeNDAP	REMSS	
QUICKSCAT	Global	0.25×0.25(degree)	Daily	About FTP OpeNDAP	REMSS	
GPCP	Global	1.0×1.0(degree)	Daily	About FTP OpeNDAP	NASA	
GHCN	Global	5.0×5.0(degree)	Monthly	About FTP OpeNDAP	NOAA	
UD	Global	0.5×0.5(degree)	Monthly	About FTP OpeNDAP	University of Delaware	

Seasonal forecast data

Climate change scenario data

Observed data

What else does APCC provide?

Climate change scenario data

- **Coupled Model Intercomparison Project (CMIP) Phase 5**

20 climate modeling groups from around the world involved to

1) Assess the mechanisms responsible for model differences in poorly understood feedbacks associated with the carbon cycle and with clouds
2) Examine climate “predictability” and exploring the ability of models to predict climate on decadal time scales
3) Determine why similarly forced models produce a range of responses

Realistic scenarios of climate forcing for both historical, paleoclimate and future scenarios

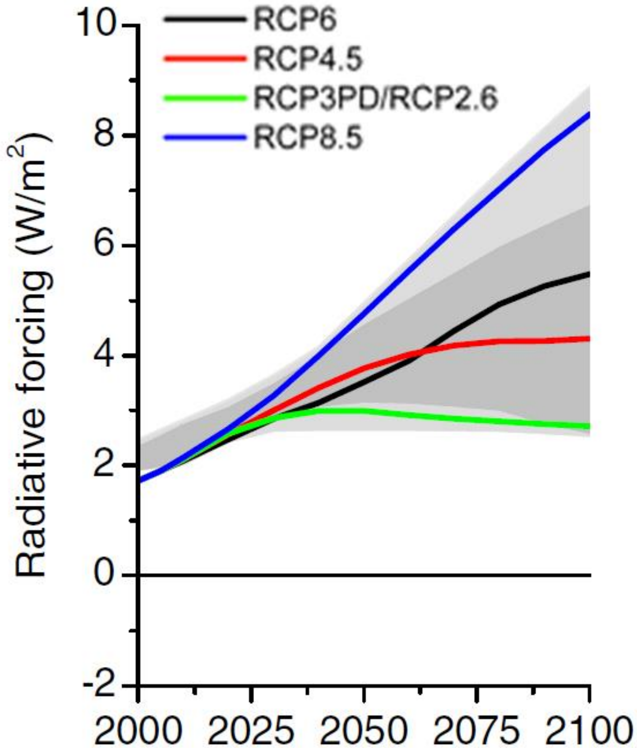
Provide simulations for assessment in the Assessment Report (AR)5 of IPCC (Intergovernmental Panel on Climate Change)

What else does APCC provide?

Climate change scenario data

Coupled Model Intercomparison Project (CMIP) Phase 5

Representative Concentration Pathways (RCPs) scenarios



Source: IPCC

RCPs	Description
RCP8.5	Rising radiative forcing pathway leading to 8.5 W/m2 in 2100.
RCP6.0	Stabilization without overshoot pathway to 6 W/m2 at stabiliz ation after 2100
RCP4.5	Stabilization without overshoot pathway to 4.5 W/m2 at stabi lization after 2100
RCP2.6	Peak in radiative forcing at ~ 3 W/m2 before 2100 and decline

Total radiative forcing

cumulative measure of human emissions of GHGs from all sources expressed in Watts per square meter

What else does APCC provide?

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CORDEX-SEA25	Regional	25km	Daily	About FTP OpeNDAP	APCC	
CORDEX-SEA50	Regional	50km	Daily	About FTP OpeNDAP	APCC	
Clipped CMIP5	National level (22 Countries)	Depending on GCMs	Daily	About FTP OpeNDAP	ESGF	

National level data based on clipped CMIP5 data (29 GCMs)

Scenarios	Countries	Variables
Historical RCP4.5 RCP8.5	Bangladesh, Burma,Chile,Cuba, Egypt,Ethiopia, Federated States of Micronesia, India, Indonesia, Kenya, Malaysia, Marshall Islands, Mongolia, Nepal, Philippines, Pakistan, Samoa, Tanzania, Thailand, Tonga, Vietnam, Zambia	Precipitation, max/min temperature, wind speed, relative humidity, solar radiation

What else?

CLIMATE INFORMATION SERVICES

- Current Climate Conditions
  - Climate Highlight
  - Climate Indices
  - Global Drought / Flood Monitoring

Pacific SST	Atlantic SST	Atmosphere	Monsoon	Index Forecast

Slowly (w.r.t. atmosphere) varying ocean, land surface, sea ice conditions may provide some predictable signals...

Assume you want to predict X = Xsignal + Xnoise

Signal >> Noise : more predictable

Signal << Noise : less predictable

Monsoon

- Most of the world's population live in monsoon regions
- While the global monsoon system responds to net heating on planetary scales, the evolution of the regional monsoons depends on the distribution of land and ocean as well as SST gradients and topography.

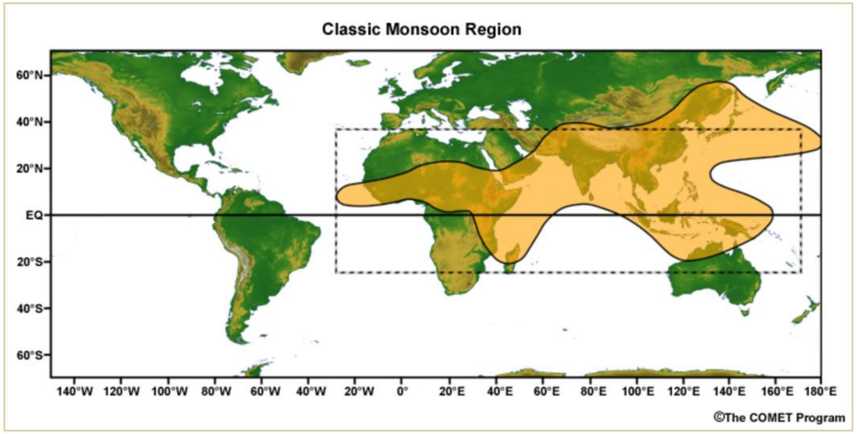
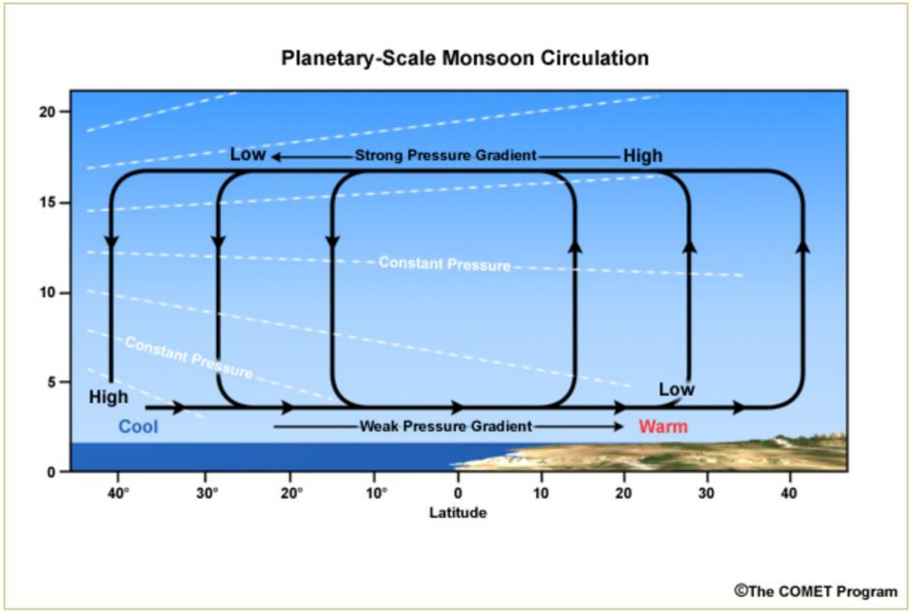
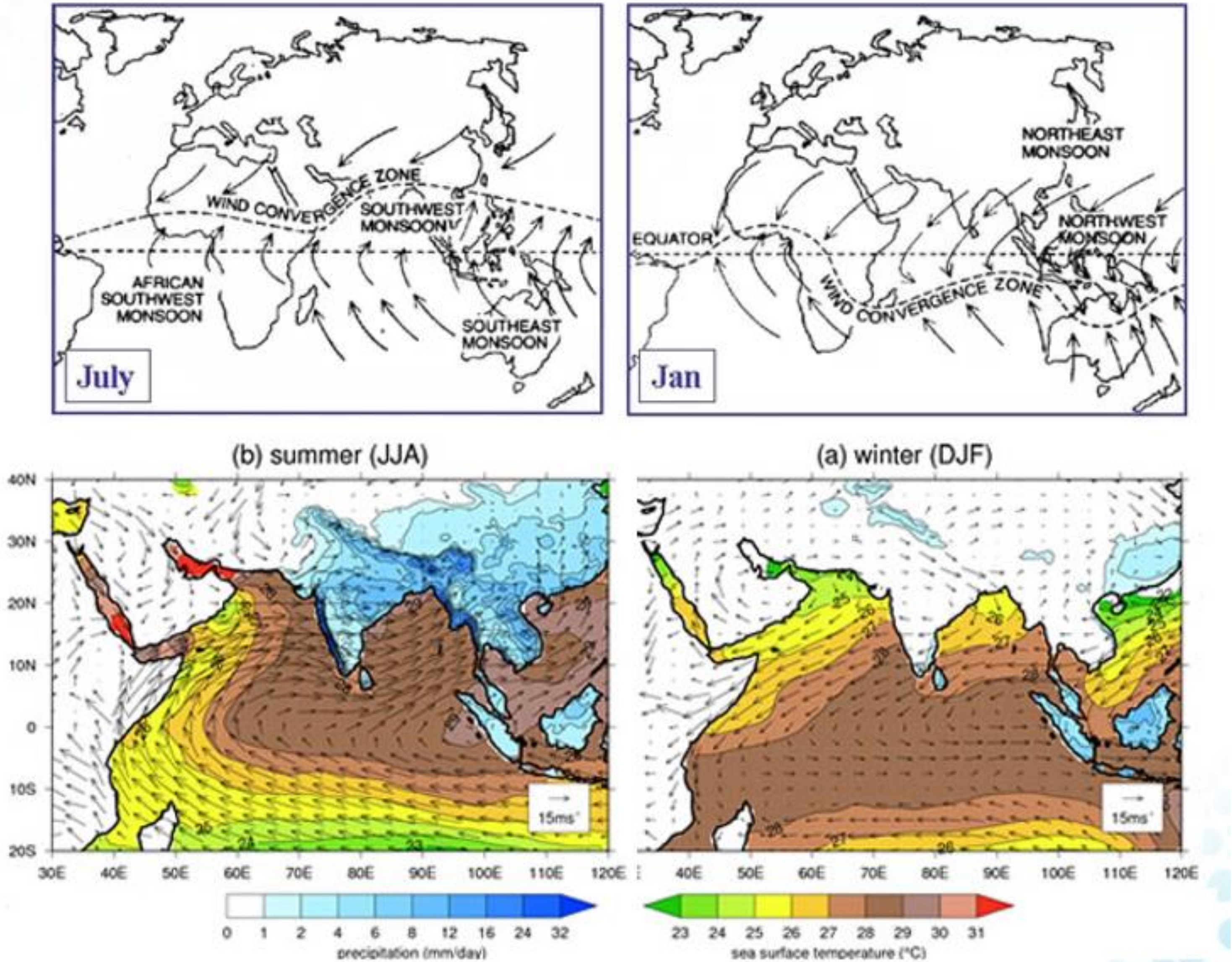


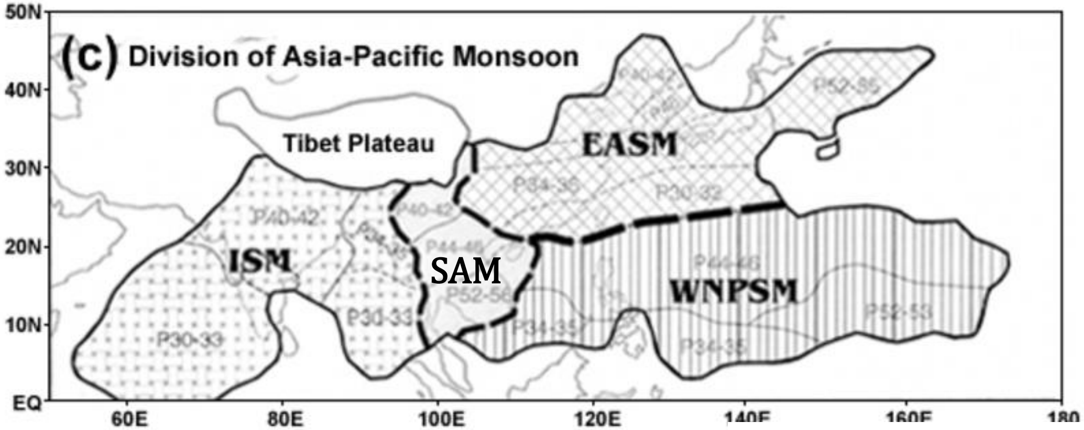
Fig. 3.29. The monsoon regions as defined by Ramage (1971).



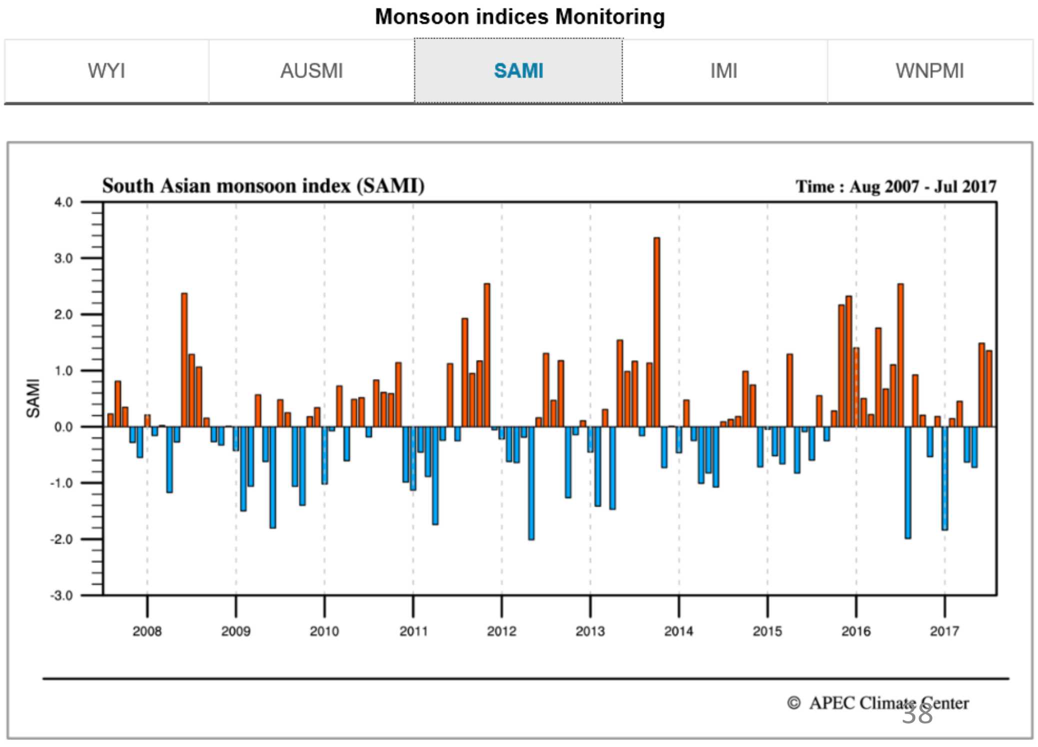
Monsoon


July
WIND CONVERGENCE ZONE
SOUTHWEST MONSOON
AFRICAN SOUTHWEST MONSOON
SOUTHEAST MONSOON
Jan
NORTHEAST MONSOON
NORTHWEST MONSOON
EQUATOR
WIND CONVERGENCE ZONE
(b) summer (JJA)
(a) winter (DJF)
40N
30N
20N
10N
0
10S
20S
30E 40E 50E 60E 70E 80E 90E 100E 110E 120E
15ms⁻¹
0 1 2 4 6 8 12 16 24 32
precipitation (mm/day)
23 24 25 26 27 28 29 30 31
sea surface temperature (°C)

Monsoon



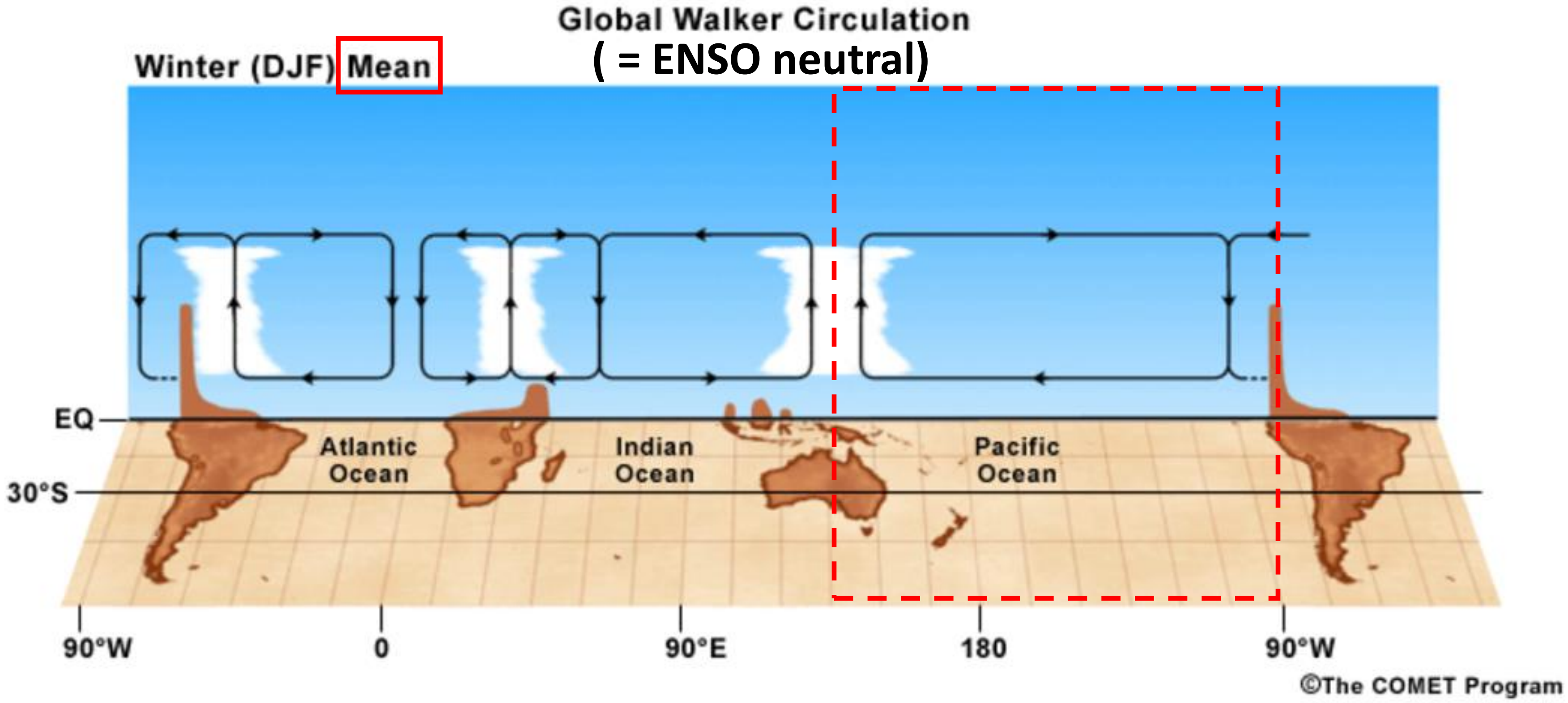
(c) Division of Asia-Pacific Monsoon
Tibet Plateau
EASM
ISM
SAM
WNPSM
50N
40N
30N
20N
10N
EQ
60E
80E
100E
120E
140E
160E
180



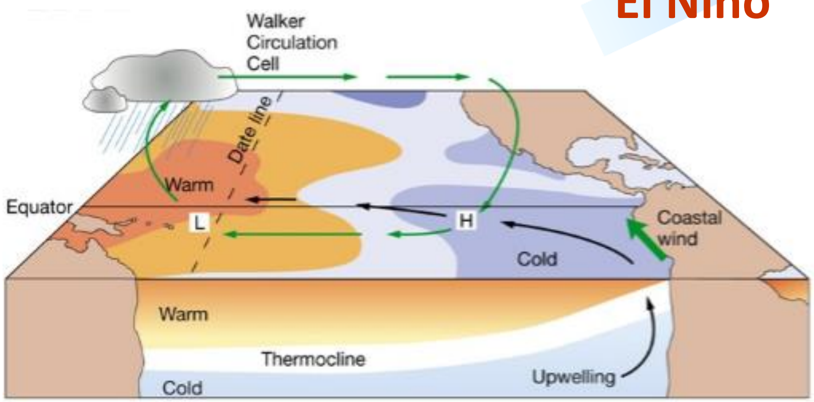
Monsoon indices Monitoring
WYI
AUSMI
SAMI
IMI
WNPMI
South Asian monsoon index (SAMI)
Time : Aug 2007 - Jul 2017
SAMI
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
© APEC Climate Center

ENSO

- El Nino Southern Oscillation: the biggest signal on the globe
- Strong couplings between the ocean and atmosphere
- Interannual times scale occurs in the tropical Pacific
- Has three states: El Nino vs La Nina vs Neutral
- Perturbing Walker circulation



ENSO



(a) Normal conditions

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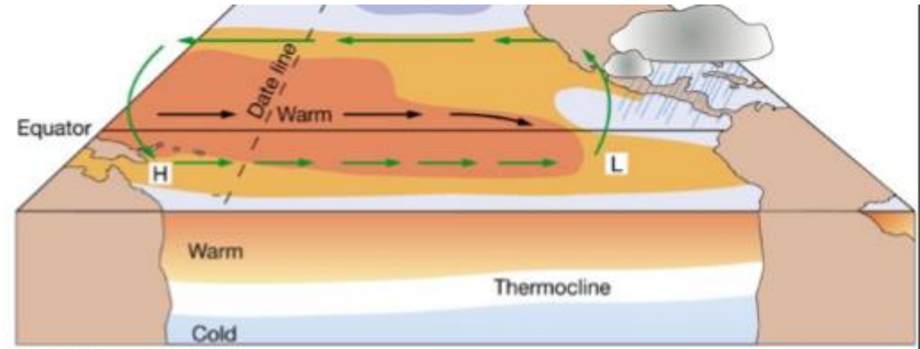
Normal

El Nino



(b) El Niño conditions

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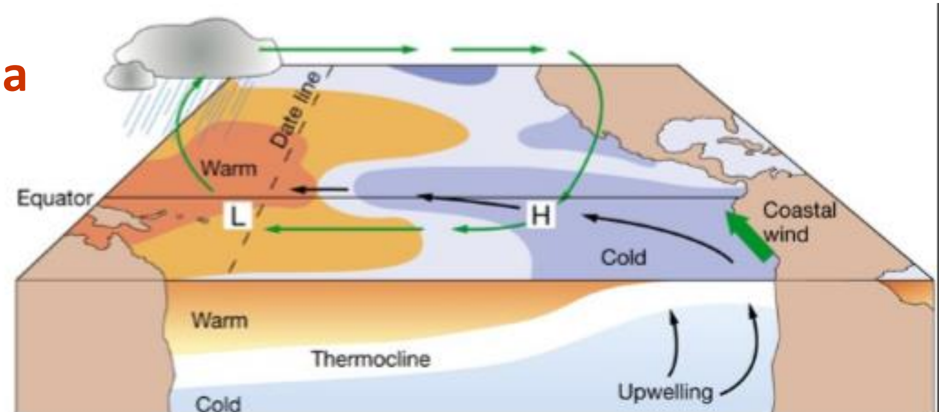
La Nina



(c) La Niña conditions

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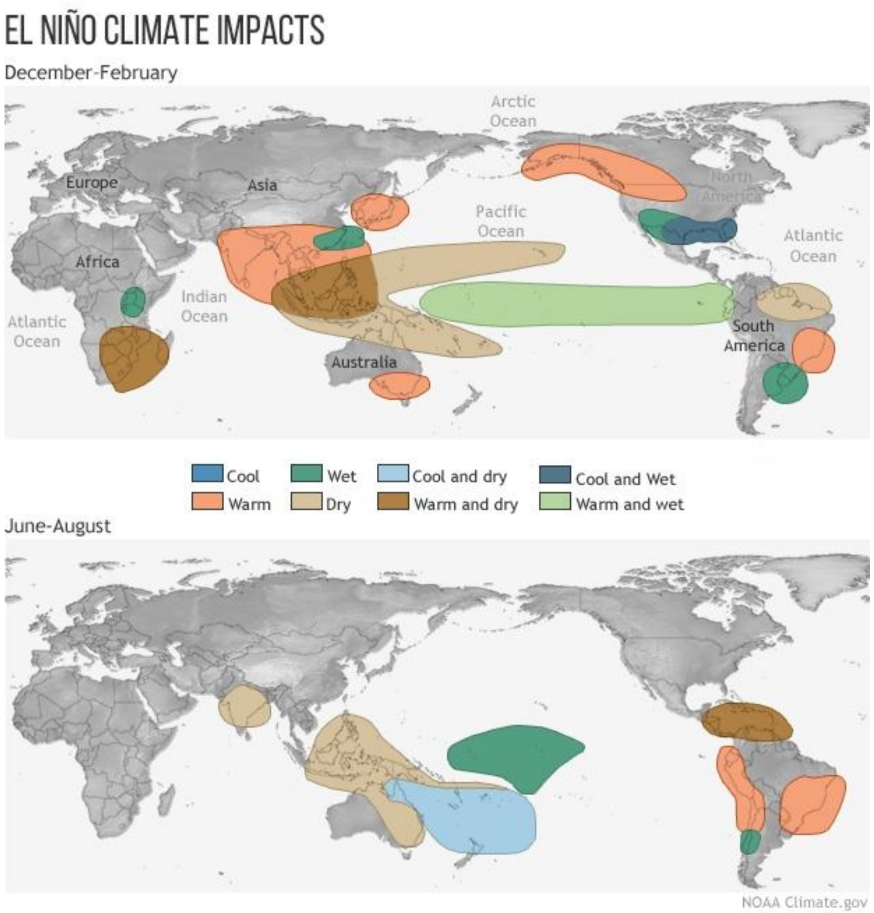
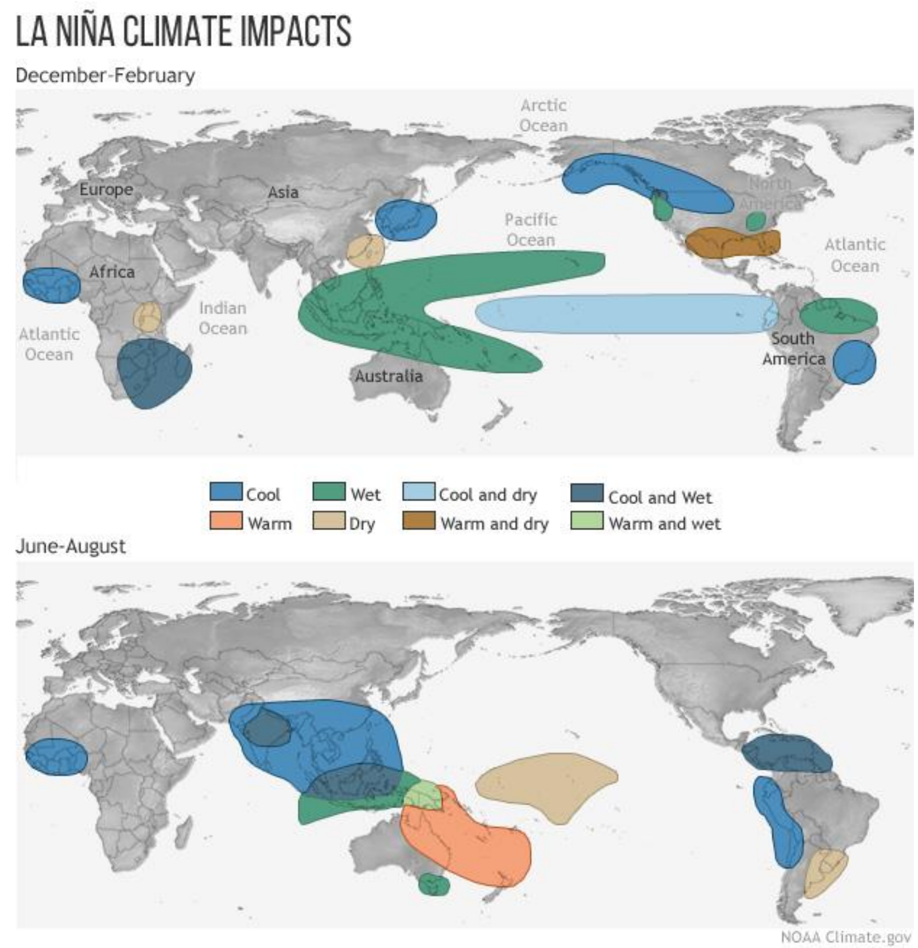
Easterlies: wind blowing from the east
* Think about New Yorker, Parisian

ENSO

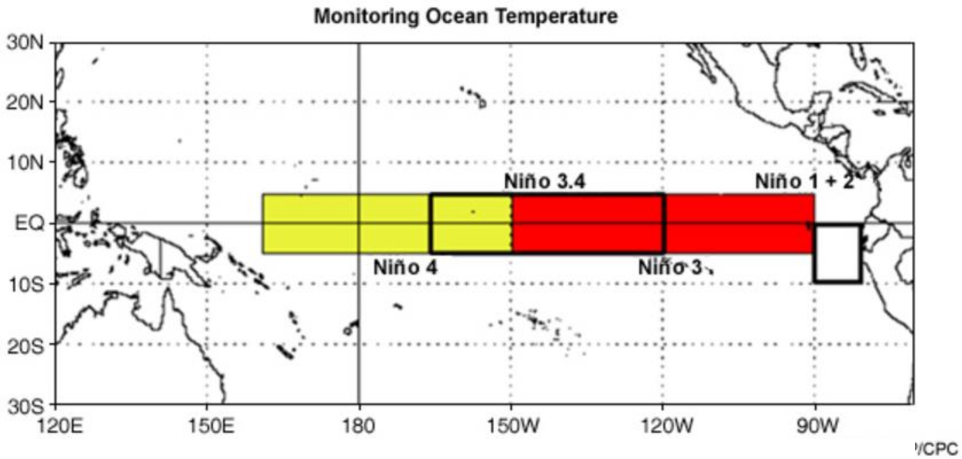
- Why do we care ENSO?

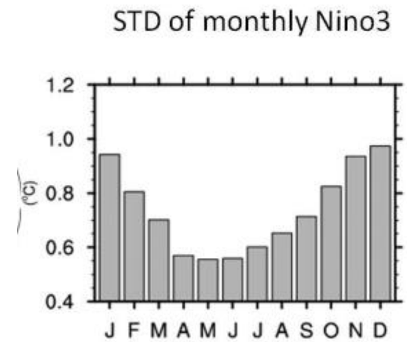


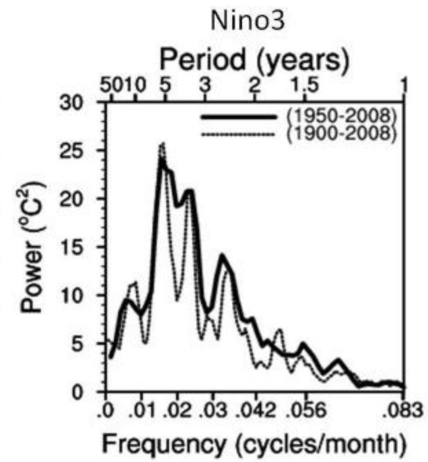


ENSO

- ENSO monitoring

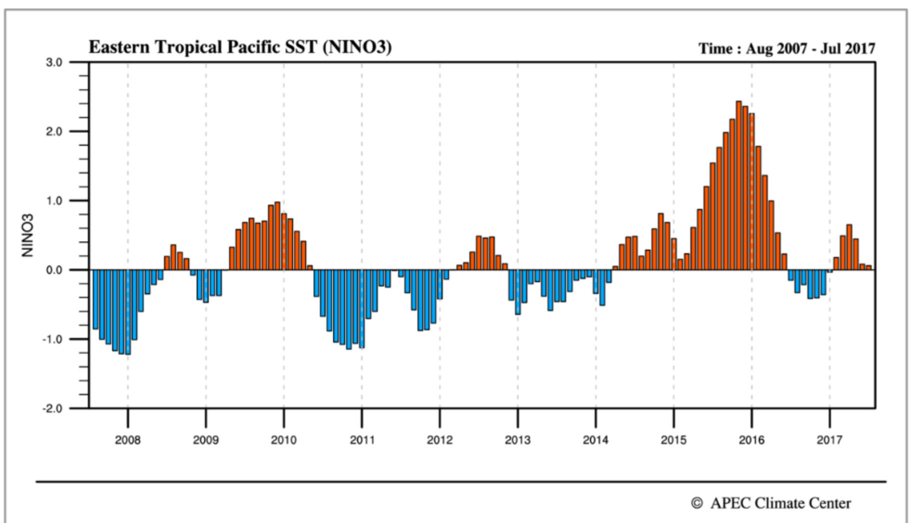






Pacific SST indices Monitoring

NINO1+2	NINO3	NINO3.4	NINO4	ONI	TNI	PACWARM	EOFPAC	EMI

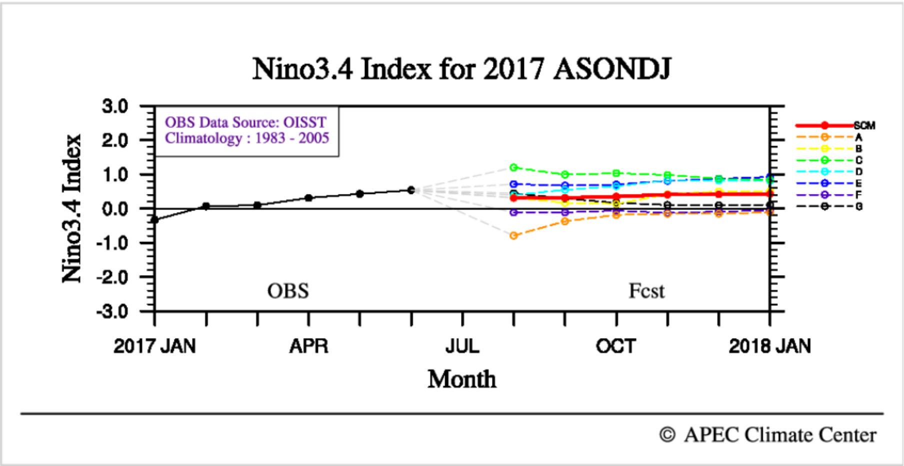


El Niño and La Niña events tend to develop during the period Apr-Jun and they

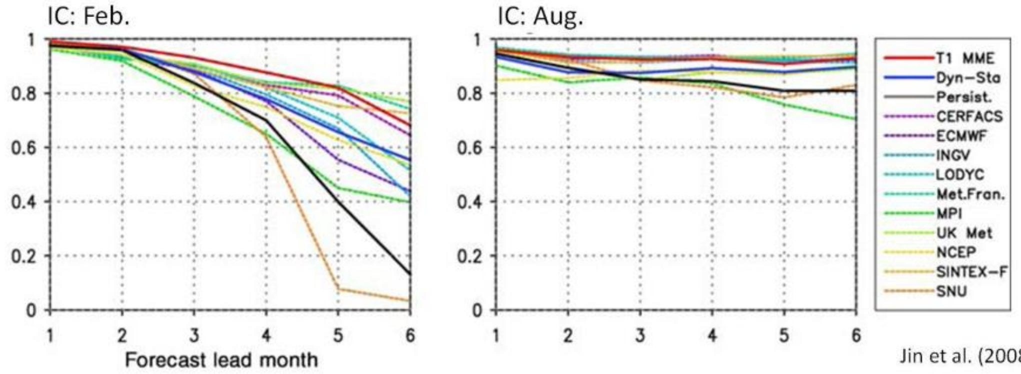
- Tend to reach their maximum strength during October - February
- Typically persist for 9-12 months, though occasionally persisting for up to 2 years
- Typically recur every 2 to 7 years

ENSO

- ENSO prediction



- The skill of both temperature and precipitation forecasts strongly depends upon the ENSO strength (Min et al., 2017)



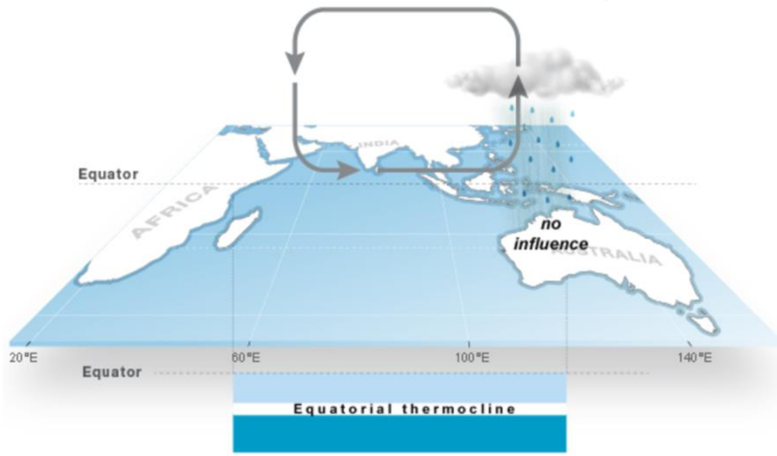
Jin et al. (2008)

- ENSO can be predicted even 6 months ahead
- ENSO forecast is difficut from Feb-Apr, called the

"spring predictability barrier"

IOD

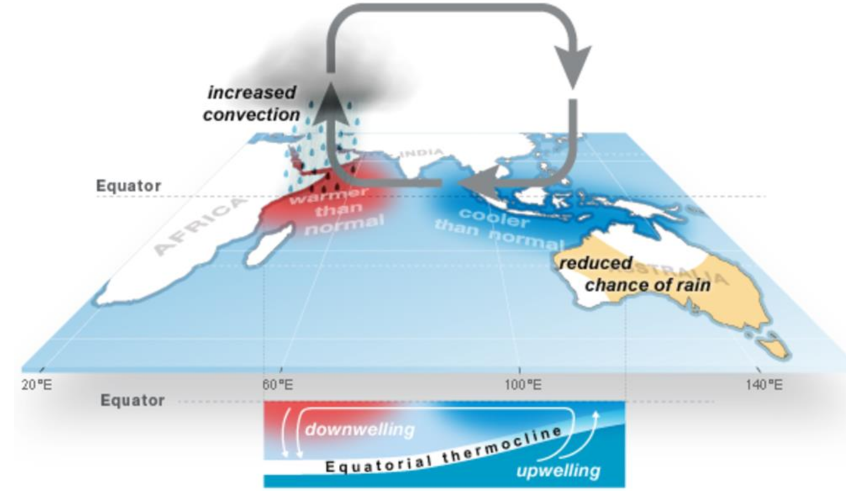
- Indian Ocean Dipole



Indian Ocean Dipole (IOD): **Neutral phase**

© Commonwealth of Australia 2013.

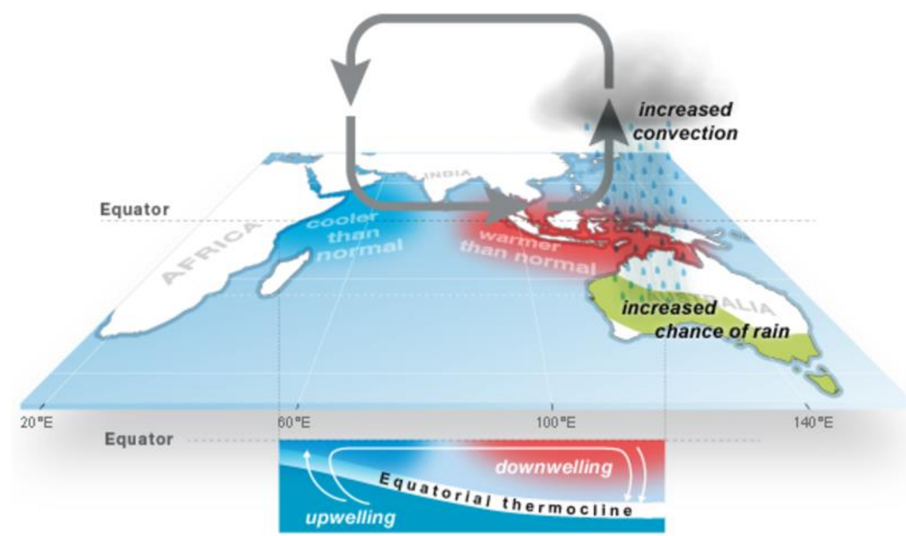
Positve



Indian Ocean Dipole (IOD): **Positive phase**

© Commonwealth of Australia 2013.

Negative

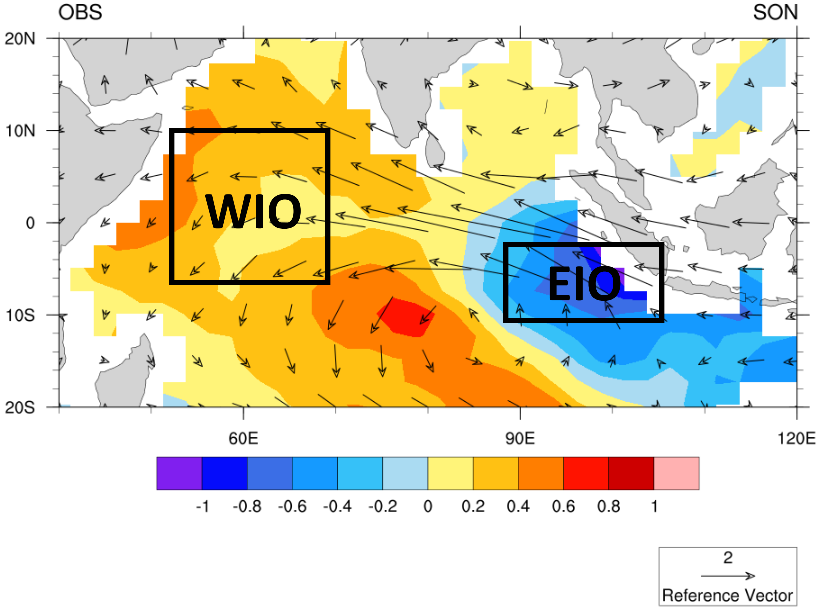


Indian Ocean Dipole (IOD): **Negative phase**

© Commonwealth of Australia 2013.

IOD

- IOD develops rapidly in boreal summer and reaches its mature phase in October
- IOD tends to have a biennial tendency, that is, the zonal wind and SST gradient anomalies change the sign from one year to the following year (i.e., A negative IOD usually follows a positive IOD)
- Co-evolution of El Nino (La Nina) with positive (negative) IOD
- Dipole Mode Index
  = SST_{WIO}-SST_{EIO}

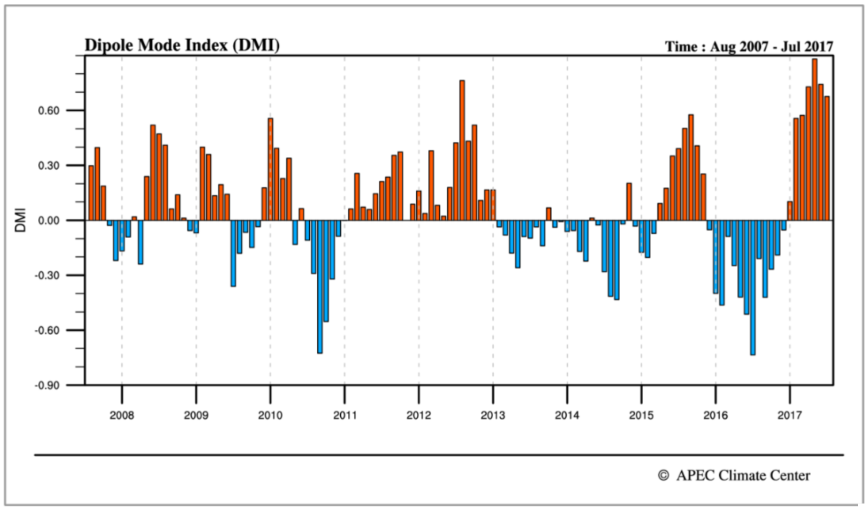


IOD

- Dipole Mode Index = SSTWIO-SSTEIO

Indian & Atlantic SST indices Monitoring

TNA	TSA	ATLTRI	DMI



Monitoring

Forecast

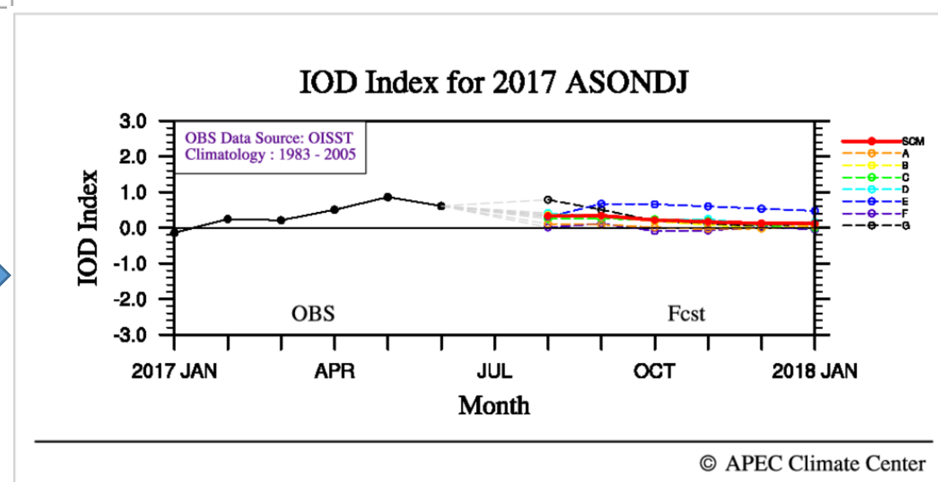
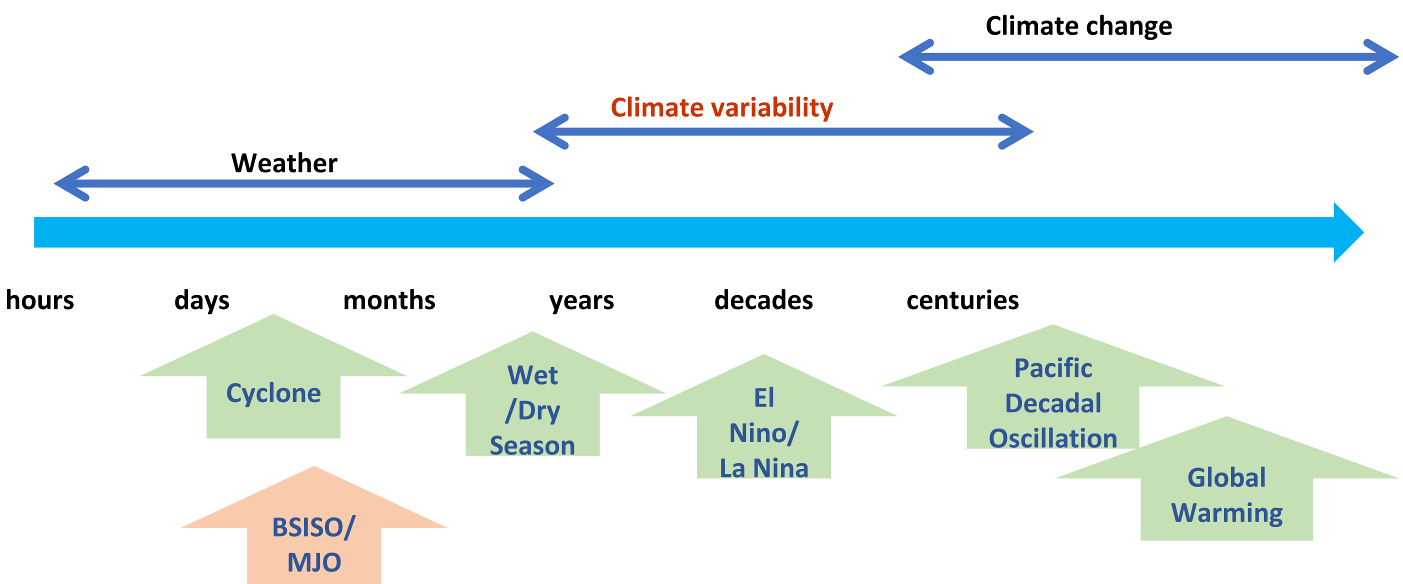


Fig. 2. Predicted Indian Ocean Dipole mode index (IODMI) from individual models (A, B, C, D, E, F and G) and the SCM.

Last but not least

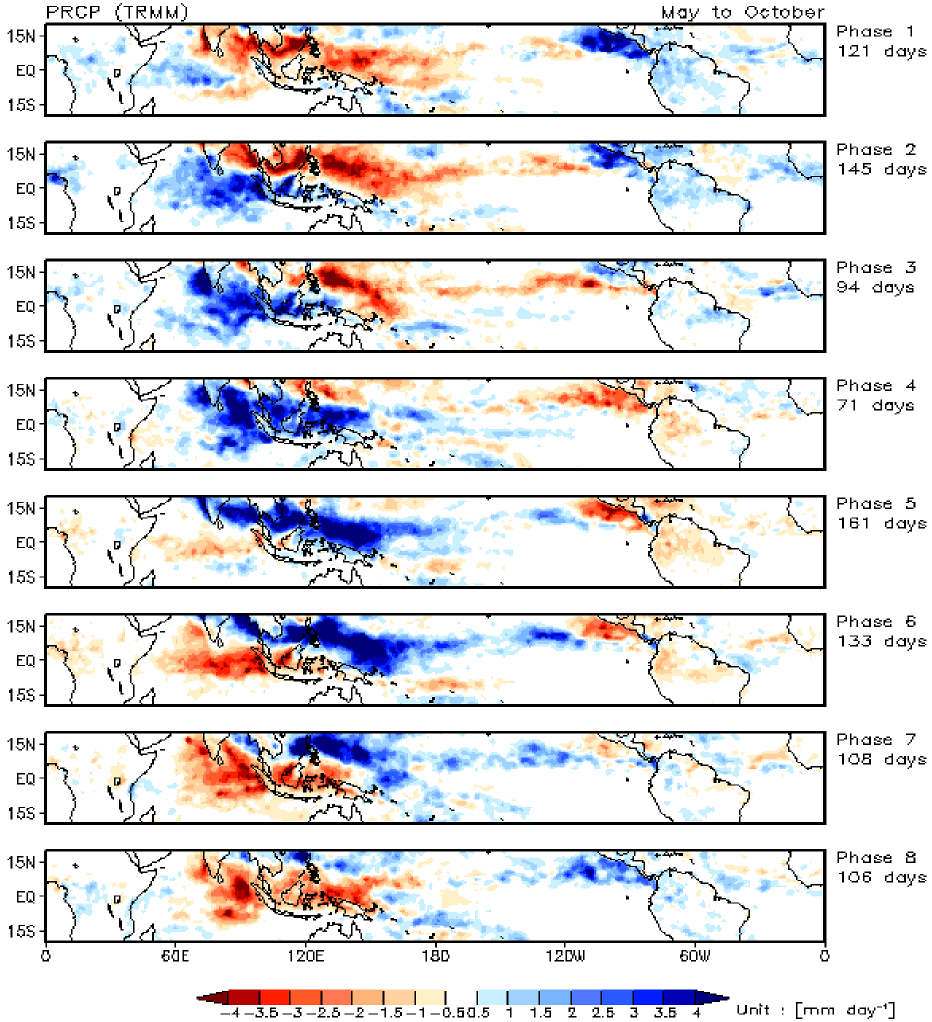
- Don’t forget our BSISO forecast!

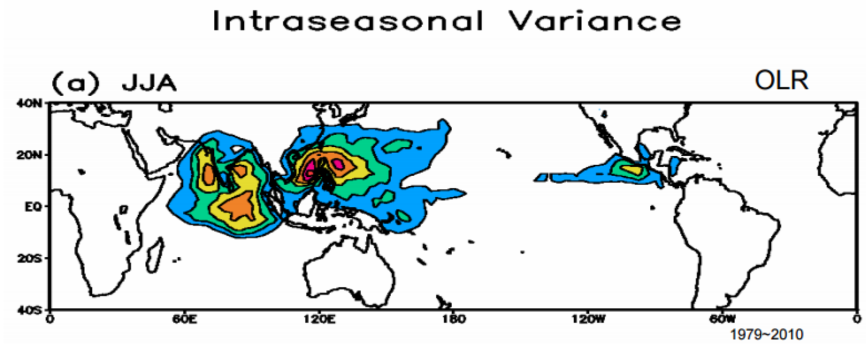
- Boreal Summer **Intraseasonal** Oscillation (2 weeks upto a season = *subseasonal*)



BSISO

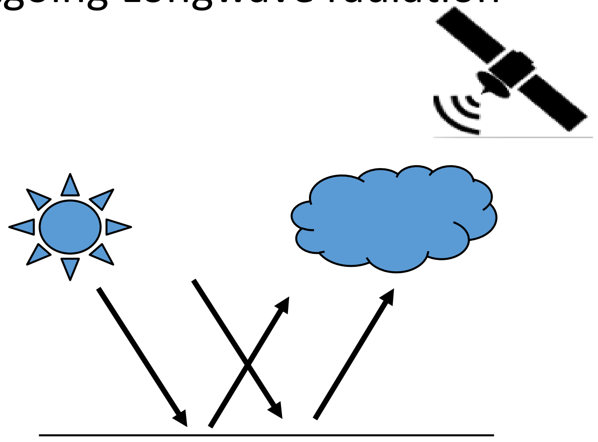
BSISO Life cycle composite



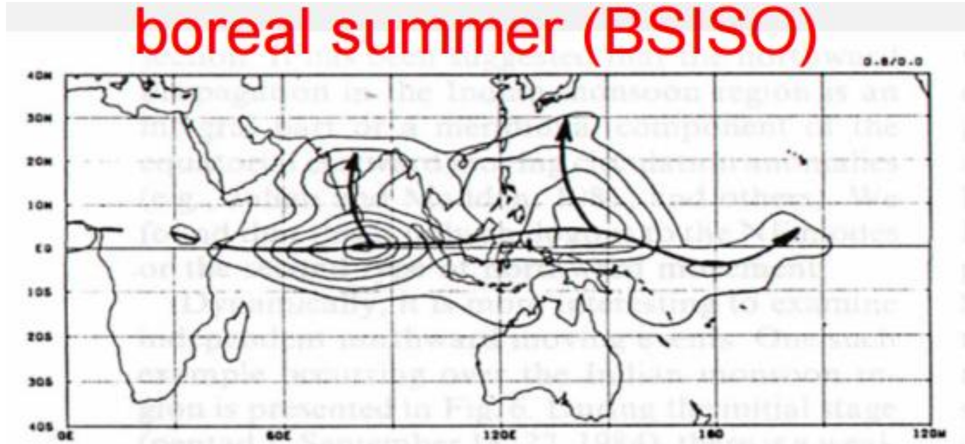


❖ Intraseasonal: 2 weeks upto a season (20-90 days)

❖ OLR: Outgoing Longwave radiation



BSISO

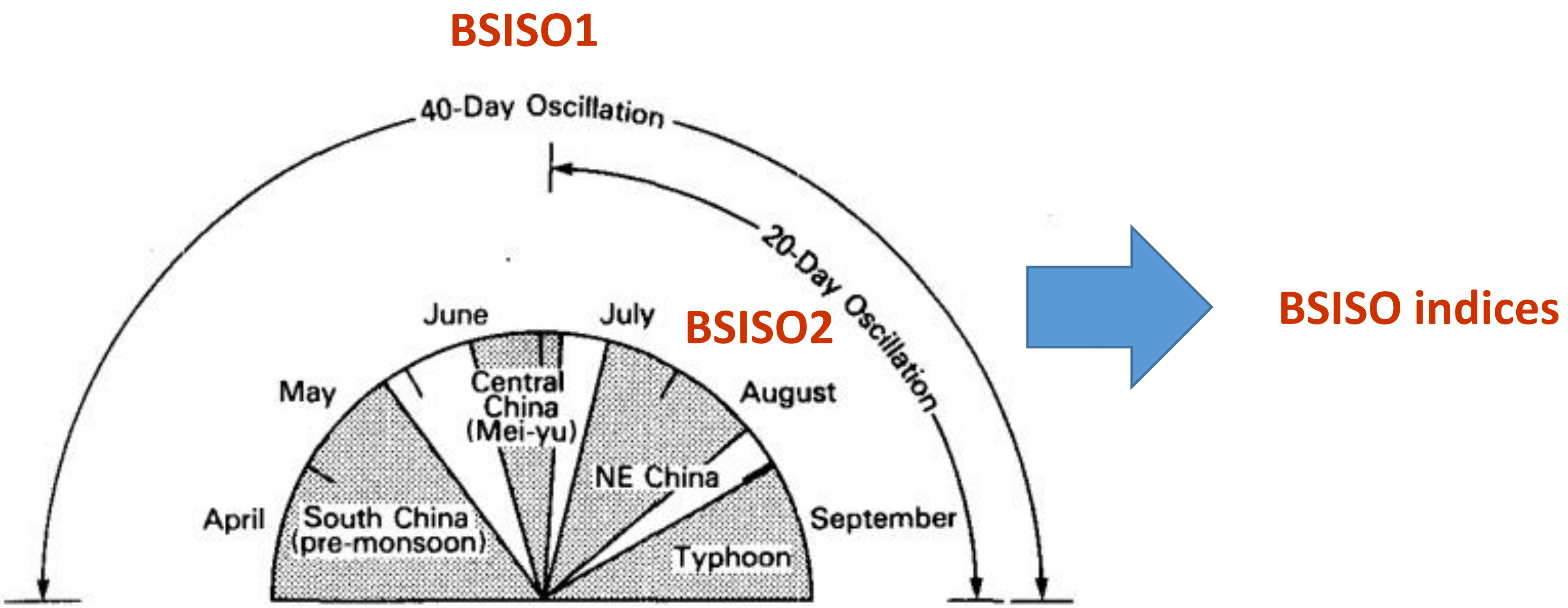


Wang and Rui 1990

- In northern summer, signal maximizes in the northern Indian Ocean and South China Sea.
- Propagation is both northward and eastward.
- **Northward propagation is related to the onset/break of Asia Monsoon**

BSISO

- Two modes of BSISO

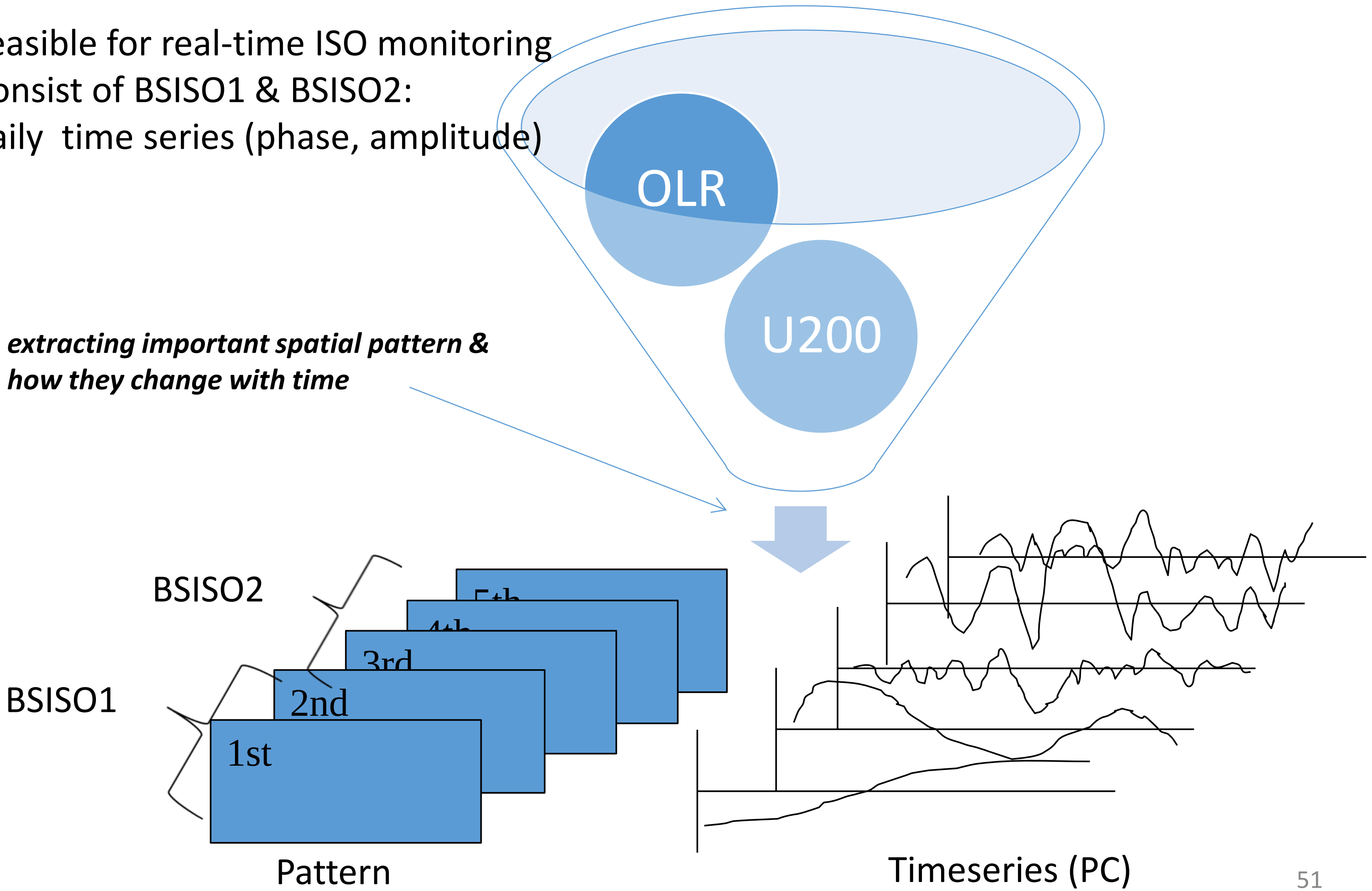


Lau et al (1988) found that the 40-day & 20-day Oscillations are related to rainfall fluctuations over East Asia.

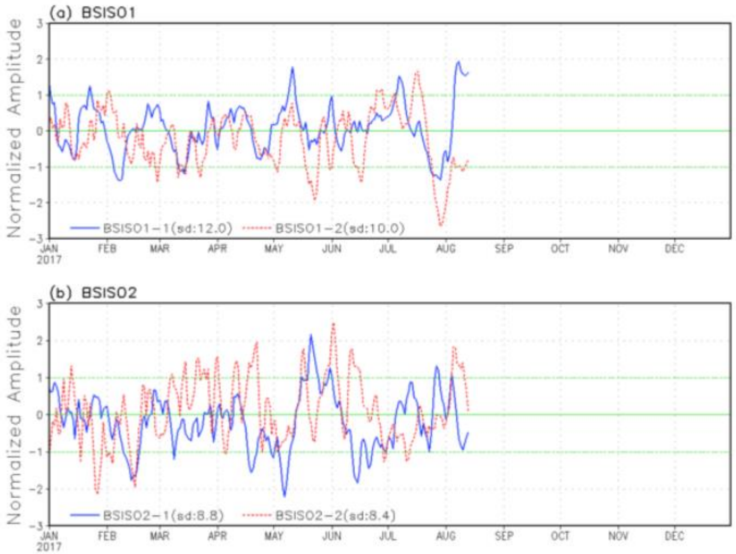
BSISO

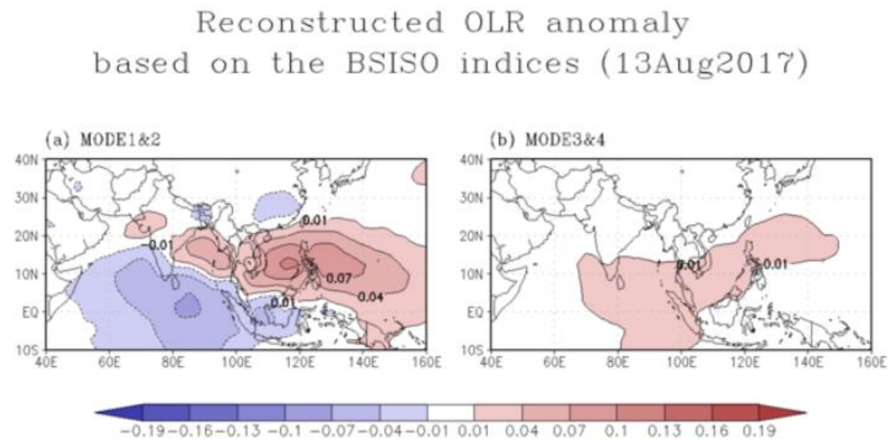
- BSISO indices: Multivariate EOF (A statistcal tool)

Feasible for real-time ISO monitoring
Consist of BSISO1 & BSISO2:
daily time series (phase, amplitude)

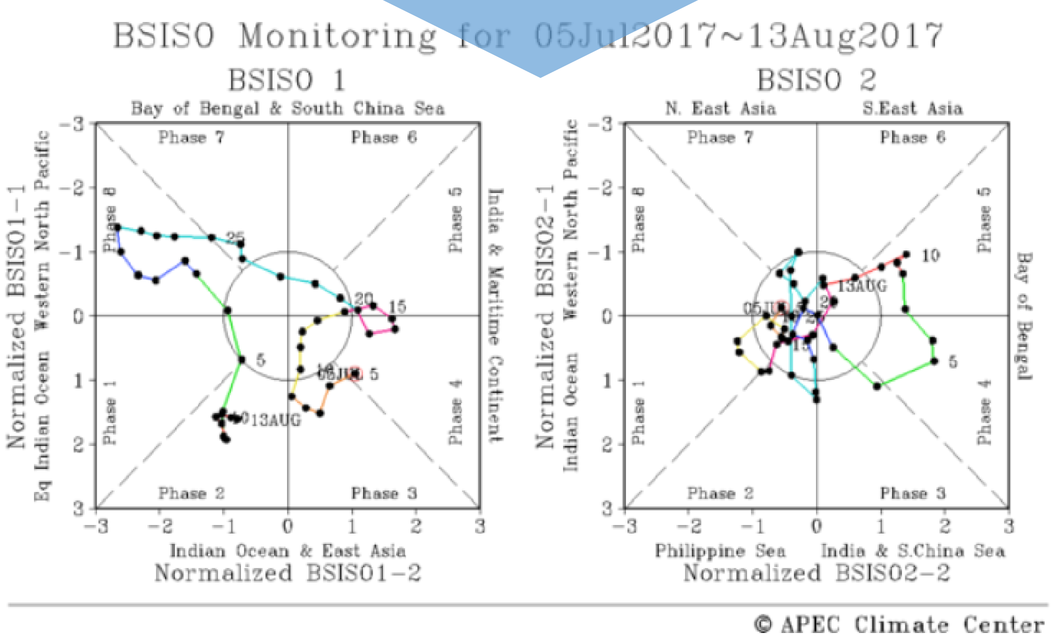


BSISO



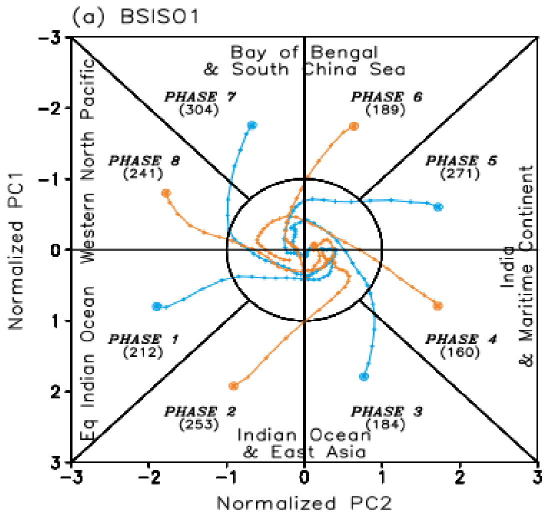


Monitoring

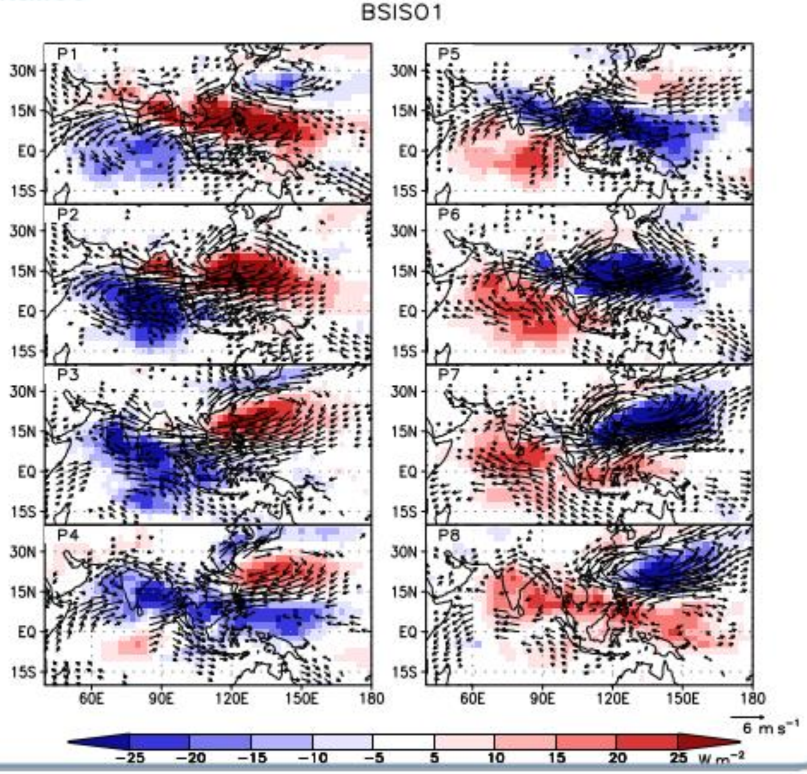


BSISO1

- Consists of EOF1 and EOF2
- Represent canonical northward and northeastward propagating ISO
- Periods of 30-60 days



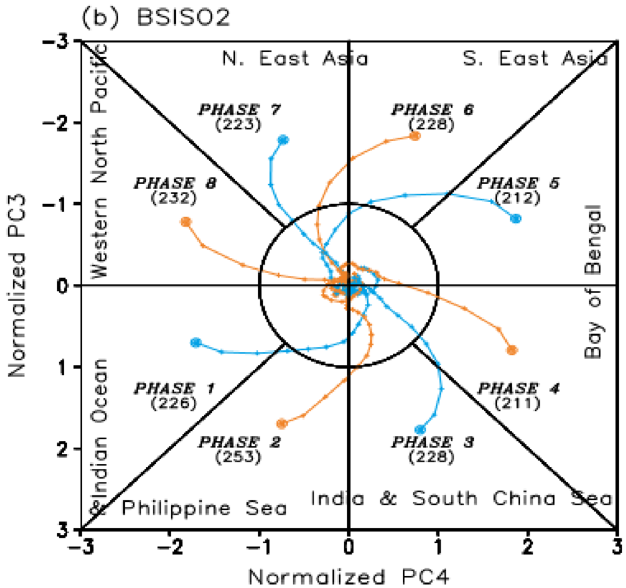
Life cycle composite of OLR (shading) and 850-hPa wind anomalies

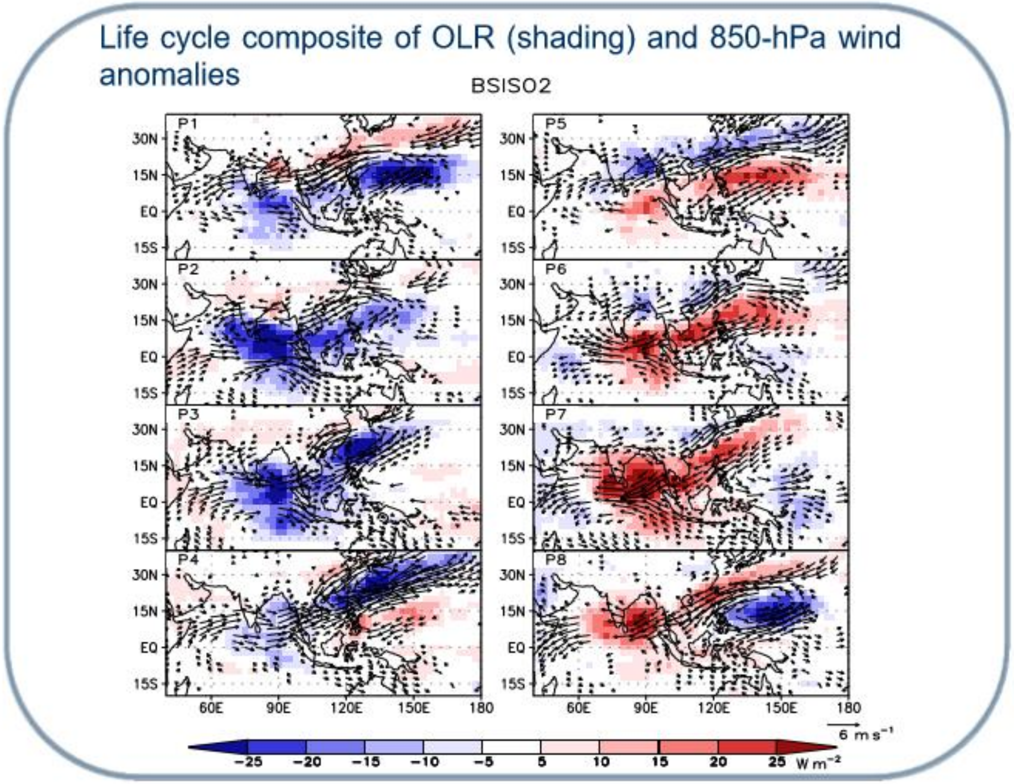


Lee et al (2013)

BSISO2

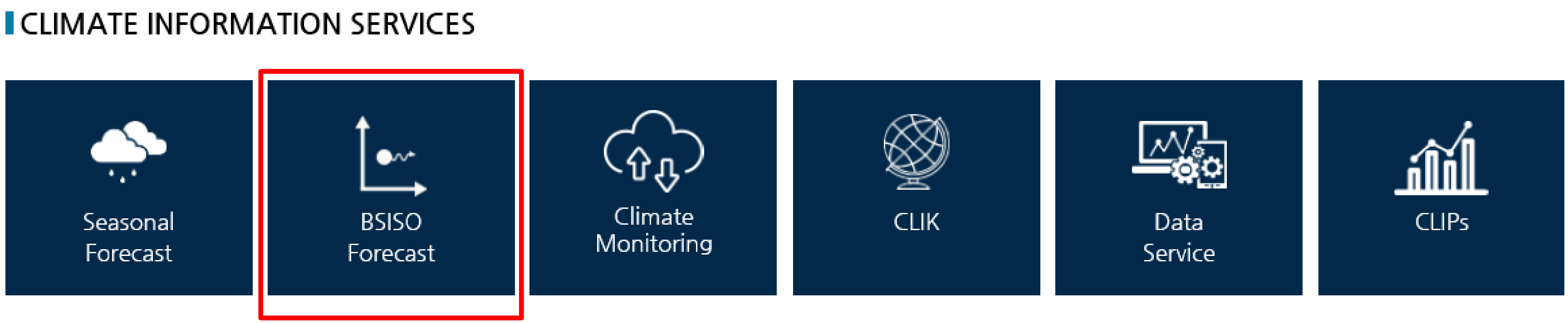
- Consists of EOF3 and EOF4
- Represent northward/northwestward propagating variability
- Periods of 10-30 days





Lee et al (2013)

BSISO forecast



Forecast

Monitoring

Methodology

- The BSISO forecast activity has been initiated in 2013 with the goal of improving our ability to understand and forecast the BSISO based on numerical models
- The forecast is updated everyday with the latest information and is available from May to October

BSISO forecast

- **Participating models**

Institute	Model	Ensemble Size	Forecast Period	Update frequency	Resolution
NCEP	Climate Forecast System	4	40 days	Once a day	T126 L64
	Global Forecast System	1	16 days	Once a day	T574, T190 L64
Australia	POAMA 2.4 multi-week model	33	40 days	Twice per week	T47 L17
ECMWF	ECMWF Ensemble Prediction System	51	32 days	Twice per week	T639, T319 L62
Taiwan CWB	*CWB EPS T119*	*1*	*40 days*	*Every 5 days*	T119 L30

BSISO forecast

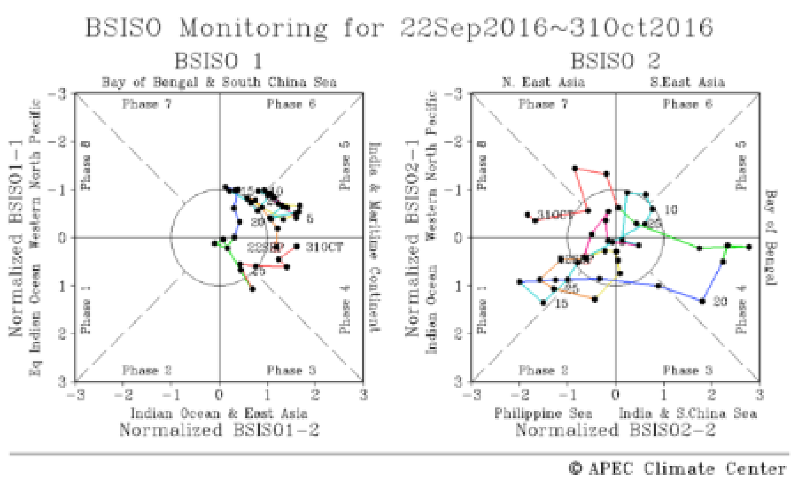
- **Monitoring**

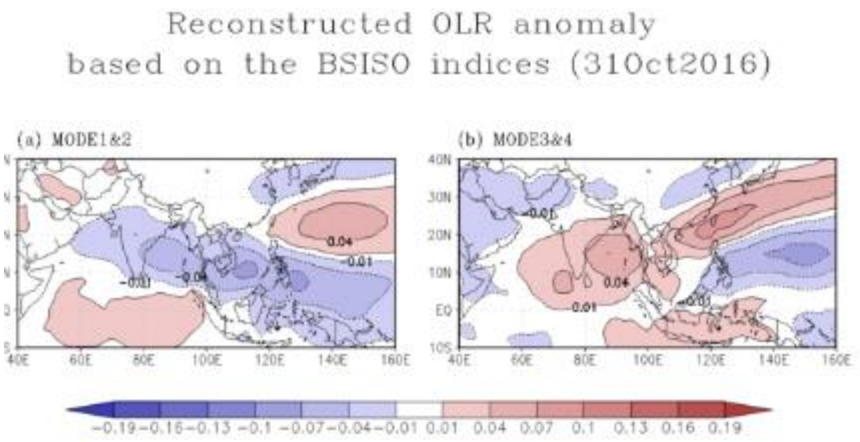
▸ Home > Climate Information Service > BSISO Forecast > **Monitoring**

Monitoring

Welcome to the Boreal Summer Intraseasonal Oscillation (BSISO) monitoring website. The BSISO, one of the dominant phenomena over the Asian summer monsoon region, is characterized by northward/northeastward propagation over the Indian summer monsoon region and northward/northwestward propagation over the Western North Pacific-East Asian region, including equatorial eastward propagation. This monitoring information is available from May to October.

Text file of Normalized Time Series for the BSISO1 and BSISO2 index





BSISO forecast

- **Monitoring**

▸ Home > Climate Information Service > BSISO Forecast > **Monitoring**

Monitoring

Welcome to the Boreal Summer Intraseasonal Oscillation (BSISO) monitoring website. The BSISO, one of the dominant phenomena over the Asian summer monsoon region, is characterized by northward/northeastward propagation over the Indian summer monsoon region and northward/northwestward propagation over the Western North Pacific-East Asian region, including equatorial eastward propagation. This monitoring information is available from May to October.

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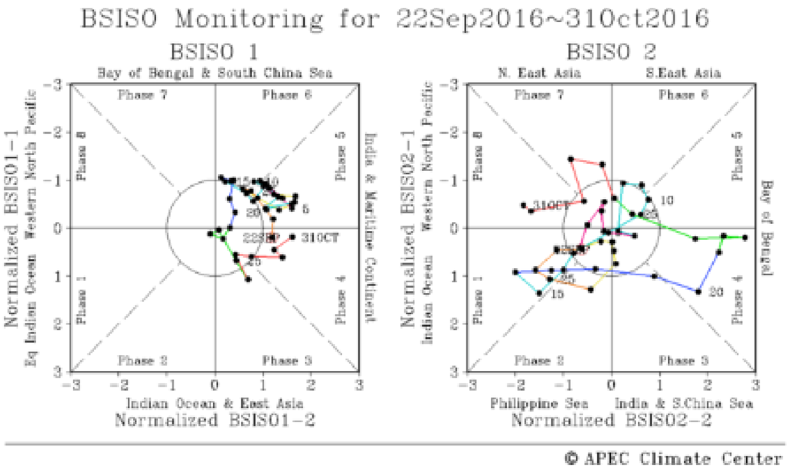
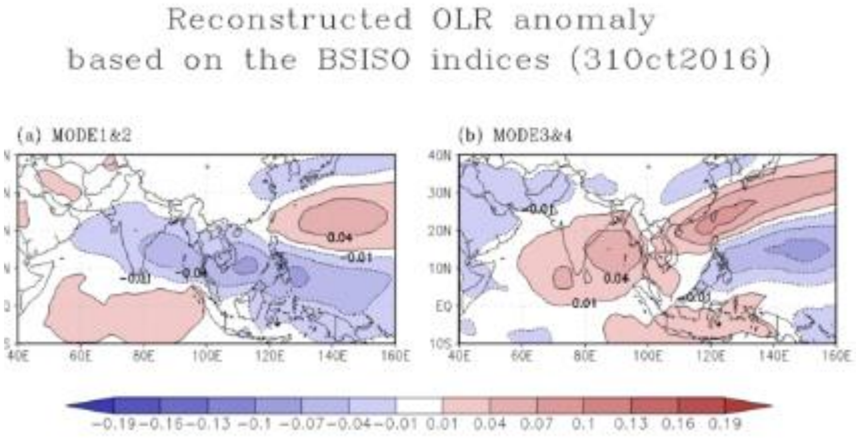




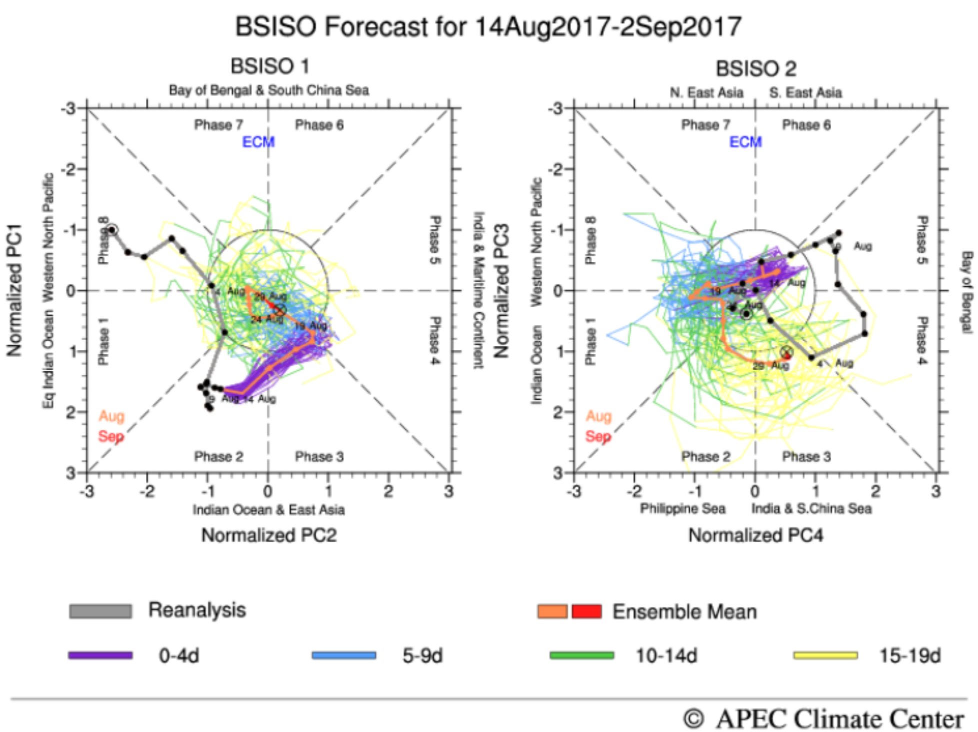
BSISO forecast

- **Forecast**

Phase Diagram | Spatial OLR Anomalies | Heavy Rainfall Probability | Verification | Participation

Phase Plots of BSISO Index Forecasts

BOM | CFS | GFS | **ECM** | CWB

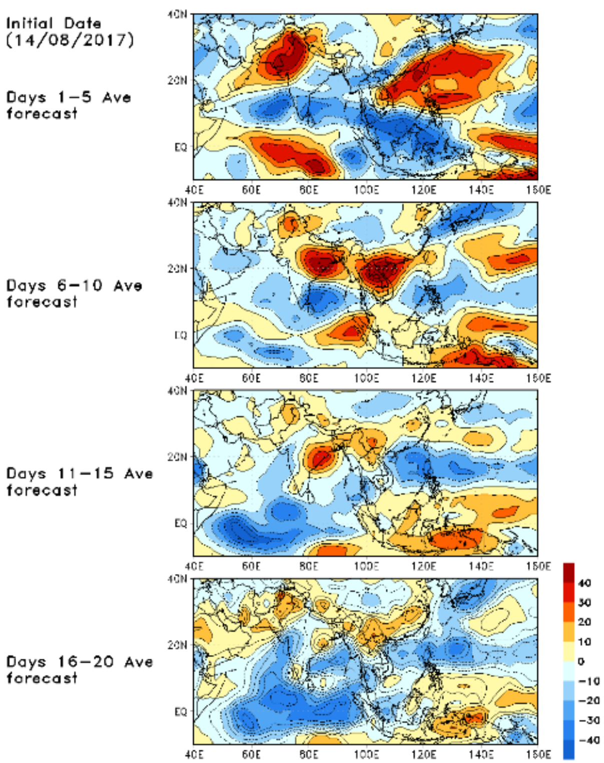


BSISO forecast

- **Forecast**

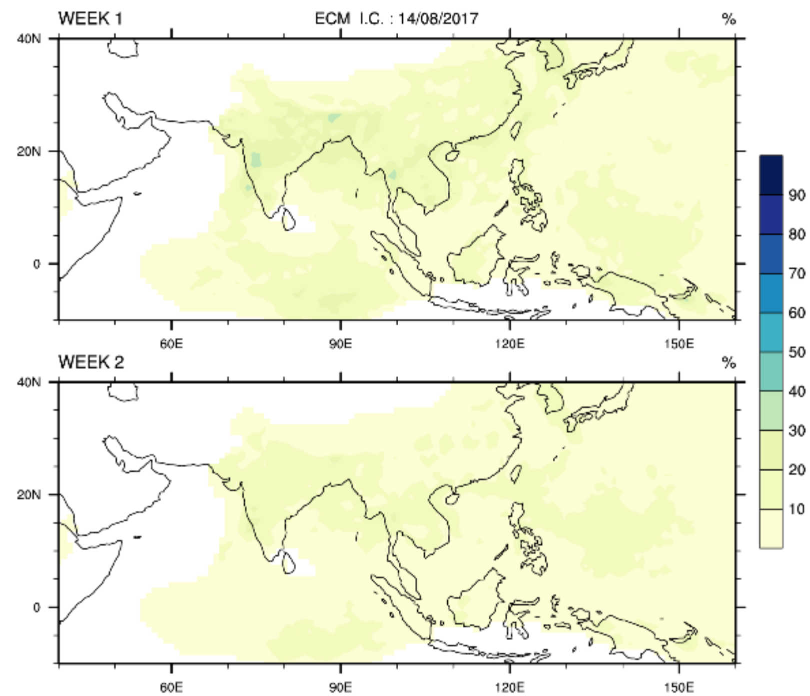
Phase Diagram	Spatial OLR Anomalies	Heavy Rainfall Probability	Verification	Participation

BOM	CFS	GFS	ECM	CWB



BOM	CFS	GFS	ECM	CWB

Probability of heavy rainfall determined by predicted BSISO



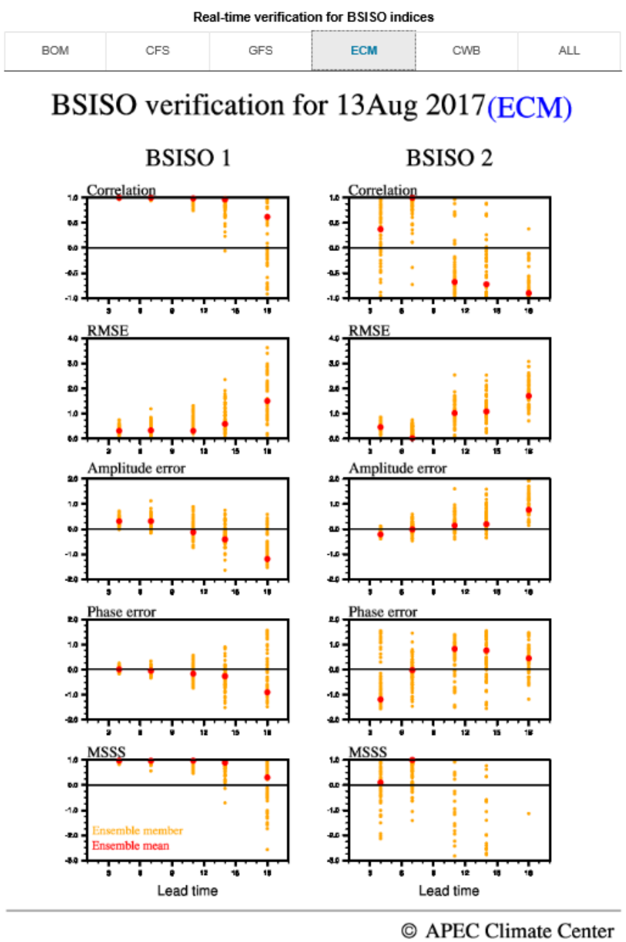
Probability of occurrence for heavy rainfall event as defined by daily rainfall exceeding the 90th percentiles value (22.6 mm/day) for Aug. during 1981-2010.

© APEC Climate Center

BSISO forecast

- **Forecast**

Phase Diagram	Spatial OLR Anomalies	Heavy Rainfall Probability	Verification	Participation



- **Correlation coefficient**

Perfect score: 1

Skill in forecasting the phase of the BSISO

- **Root Mean Square Error (RMSE)**

Perfect score: 0

Errors in both phase & amplitude

- **Phase amplitude**

Perfect score: 0

Relative amplitude difference btw observation and forecast

Postive: forecast amplitude is larger than the observed

- **Phase error**

Perfect score: 0

Positive: phase speed of the forecast is faster than that of the observation

- **Mean square skill score (MSSS)**

Perfect score: 1

Relative level of skill of forecast compared to a climatological forecast that predict no BSISO signal

Kim (2014) APCC Research report


THANK YOU
APEC
Climate
Center