


TCC Training Seminar on 12 November 2018

Global Ensemble Prediction System (EPS) and Products for One-month Forecast



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Contents

- Basic Knowledge
 - **NWP Model and Predictability**
 - Ensemble Prediction and Uncertainty
 - Hindcast
- JMA's Global Ensemble Prediction System
- TCC's Products to support 1-month Forecast

Seasonal forecast issued by JMA (domestic)

Forecast etc.

1 month

3 months

6 months

Daily Forecast

One-week Forecast

EWE*

5-14 days ahead

Every Monday and Thursday

Temp. (very high or very low)
Snowfall (very heavy (in winter))

*EWE:
Early Warning Information on Extreme Weather

One-month Forecast

M1			
W1	W2	W3	W4

Every Thursday

Temp. Precip. Sunshine Snowfall

Three-month Forecast

M123 (3-month average)		
M1	M2	M3

Around 25th of the month



Warm-season Forecast

Around 25th of February



Summer (JJA)

Cold-season Forecast

Around 25th of September



Winter (DJF)

El Niño Outlook

Around 10th of the month

up to 6 months ahead

Seasonal forecast issued by JMA (domestic)

Forecast etc.

1 month

3 months

6 months

Daily Forecast

One-week Forecast

EPS: Ensemble Prediction System

EWE*

Global EPS (AGCM)

5-14 days ahead

Every Monday and Thursday

*EWE: Early Warning Information on Extreme Weather

M1	W1	W2	W3	W4
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Temp. (very light), Snowfall (very heavy), Precip., Sunshine, Snowfall

One-month Forecast

Three-month Forecast

Seasonal EPS (CGCM)

M123 (3-month average)

M1	M2	M3
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Around 25th of the month

Around 25th of February

Summer (JJA)

Around 25th of September

Winter (DJF)

Around 10th of the month

up to 6 months ahead

Warm-season Forecast

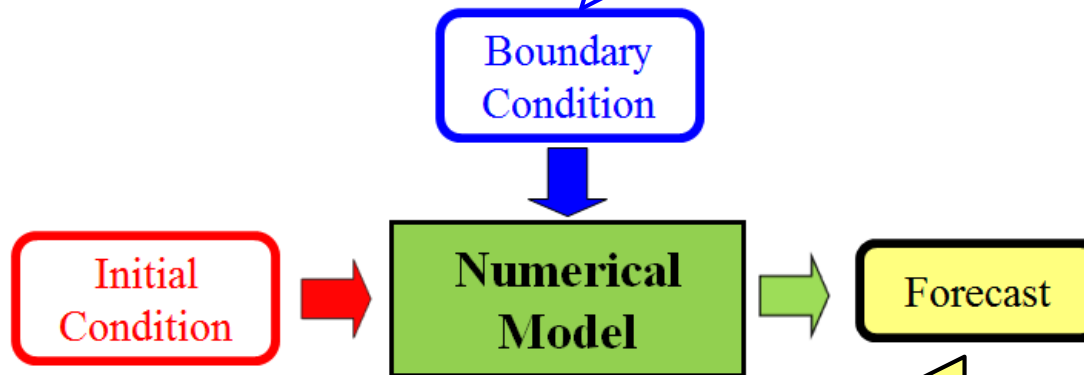
Cold-season Forecast

El Niño Outlook

Numerical Weather Prediction

■ A Simplified Conceptual Chart of “Numerical Prediction”

In this case, boundary conditions mean many kinds of seasonal variable natural factors except atmosphere such as sea surface temperatures (SSTs), sea ices and snow covers. In general, variations of boundary conditions are slower than a variation of atmosphere.



A numerical model is made from many kinds of physical laws and a large number of grids.

If you input an initial atmospheric condition and boundary conditions into a numerical model, you can get to know a future atmospheric condition as an output.

Predictability

■ A Simplified Conceptual Chart of “Predictability”

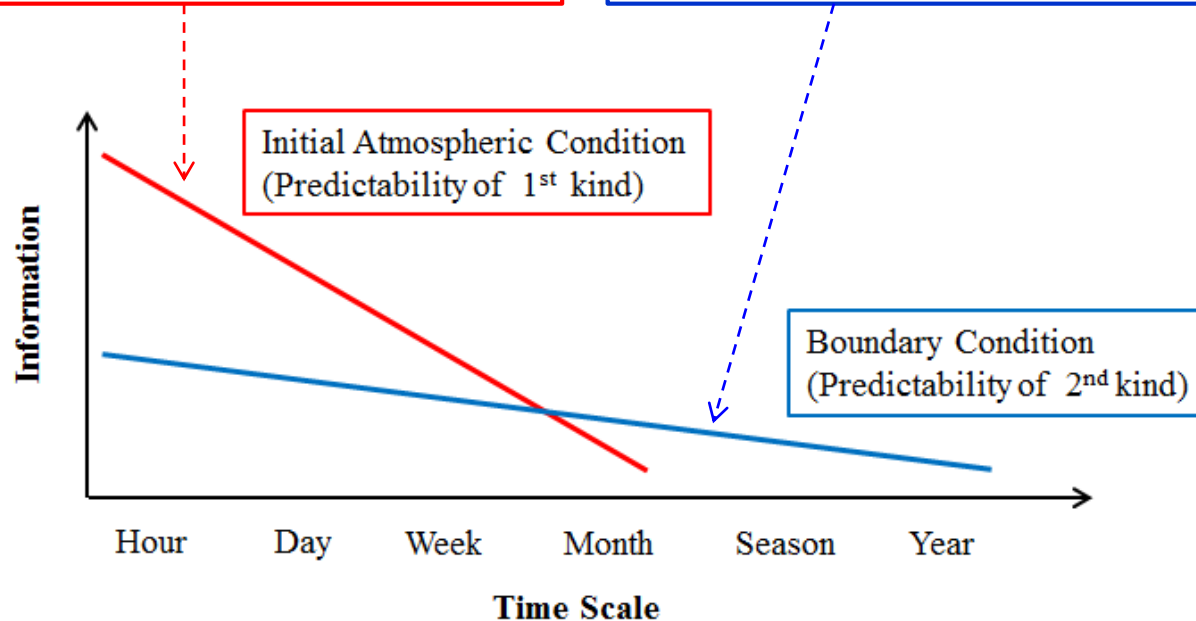
There are mainly 2 types of predictabilities.

■ “Predictability of 1st kind”

depends on an **initial atmospheric condition**. Because a variation of atmosphere is fast, information which an initial atmospheric condition has are lost rapidly.

■ “Predictability of 2nd kind”

depends on **boundary conditions** such as **sea surface temperatures (SSTs), sea ices and snow covers**. Because variations of boundary conditions are slow, they make a long-range forecast possible.



Predictability

■ Temporal and Spatial Scale of Atmospheric Phenomena

■ Short-life and Small-scale Phenomena

(e.g. Tornadoes, Cyclones)

Long-range forecast is impossible,

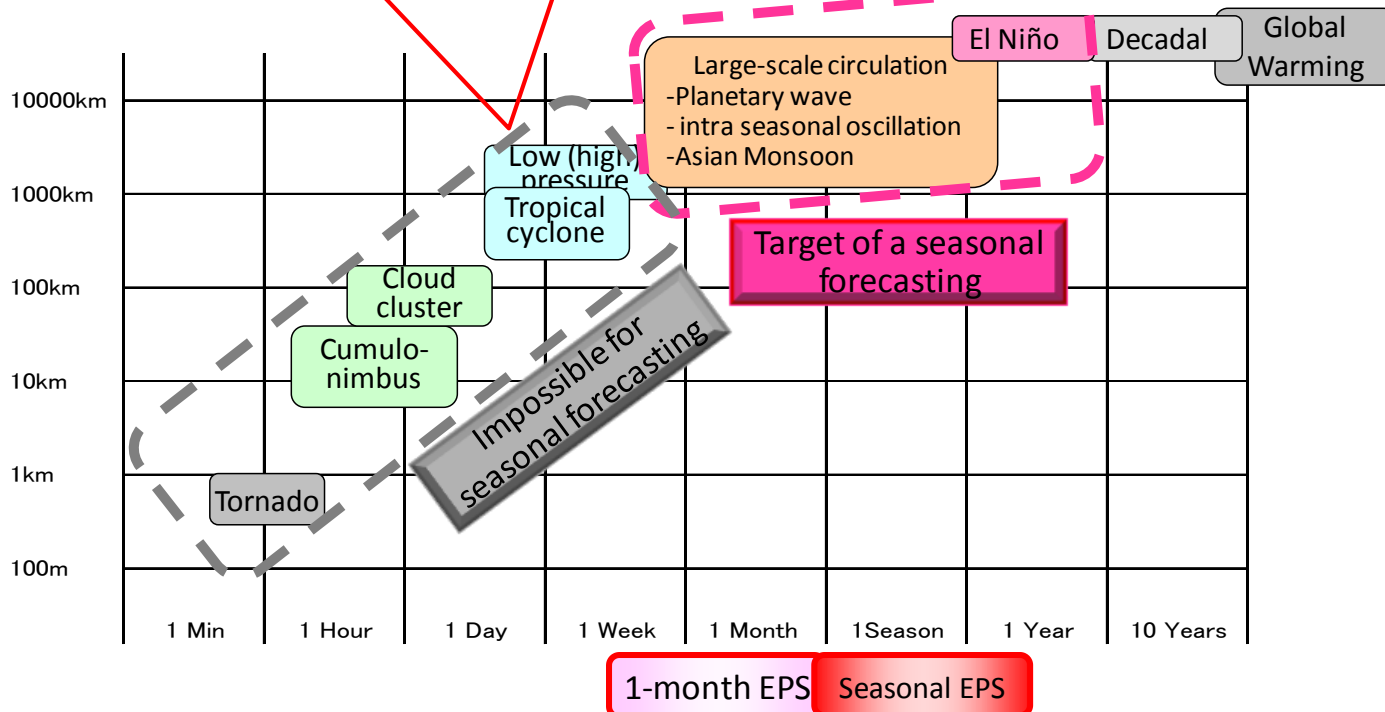
because they are sensitive to an initial atmospheric condition.

■ Long-life and Large-scale Phenomena

(e.g. Seasonal Oscillations, Monsoons)

Long-range forecast is possible,

because they are sensitive to boundary conditions rather than an initial atmospheric condition.



Predictability

■ Potential Predictability derived by SSTs

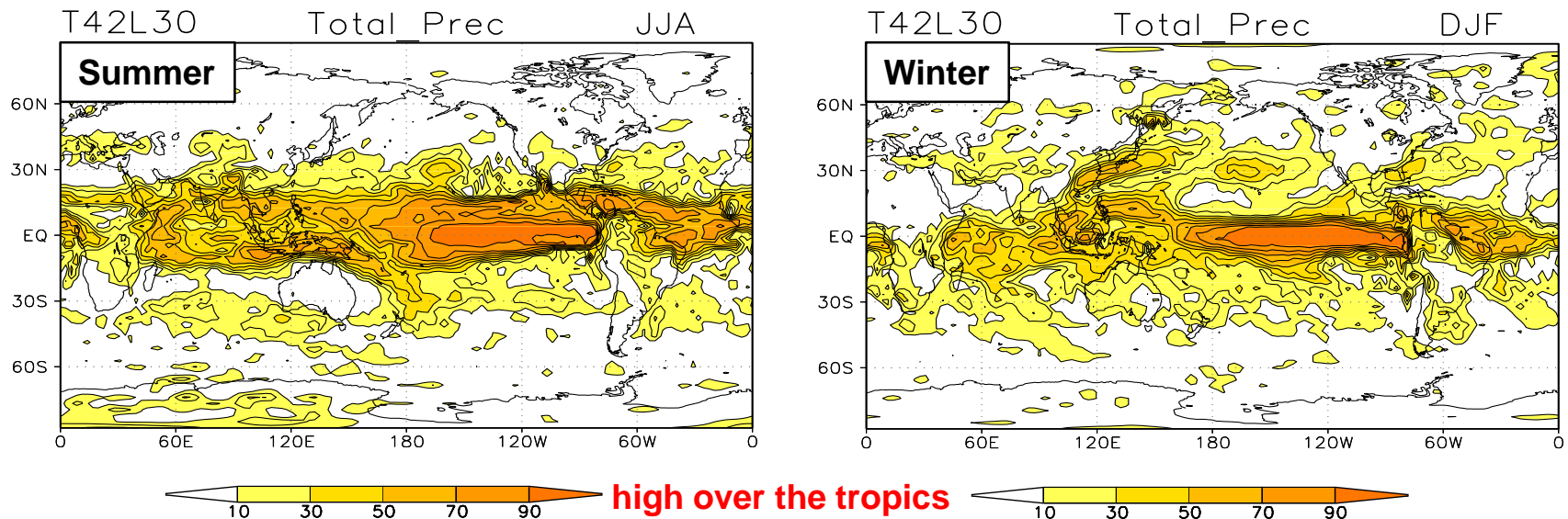
An experiment of giving same SSTs to all ensemble members (9 members, 1979-1993)

Signal: Anomaly of Ensemble Mean

Noise: Ensemble Spread

$$\text{Potential Predictability} = \frac{\text{Signal}}{\text{Signal} + \text{Noise}} \times 100 (\%)$$

Potential Predictability for Seasonal Precipitation derived by SSTs



Sugi, M., R. Kawamura and N. Sato, 1997, J.Meteor.Soc.Japan, 75, 717-736.

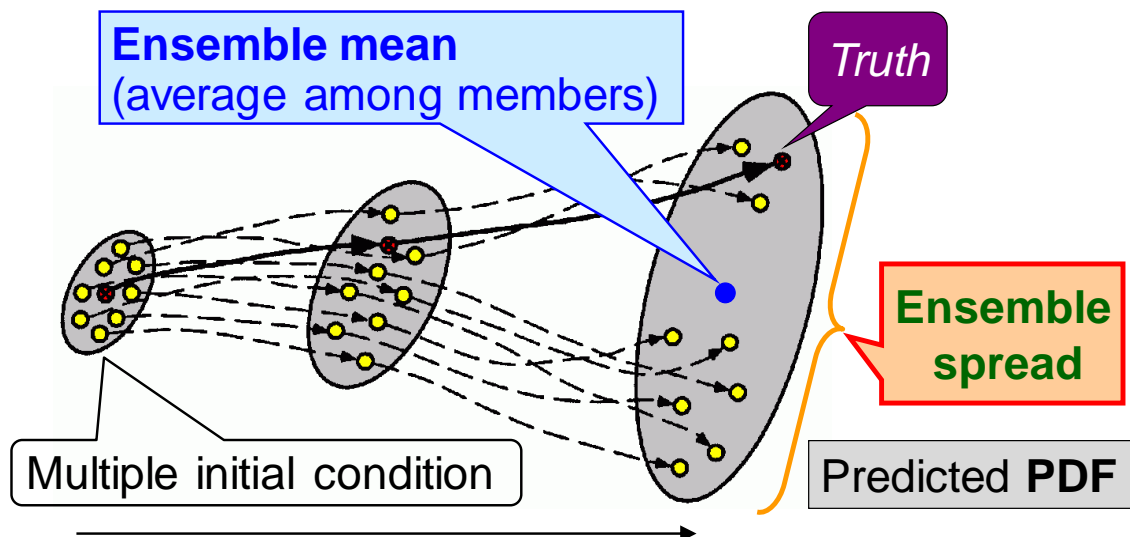
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Uncertainty and Ensemble Prediction

■ A Simplified Conceptual Chart of Ensemble Prediction

Because atmosphere has chaotic nature, a small error in an initial condition grows rapidly. However, it is **impossible to know a perfect initial condition** even with the use of high accurate observations. Therefore, it is **essential to consider uncertainty** when forecasting. **Ensemble prediction makes it possible to estimate uncertainty** caused by initial condition errors with similar calculations from a little bit different multiple initial conditions.



The individual calculation is called “**Ensemble member**” and the standard deviation among all members is called “**Ensemble spread**”.

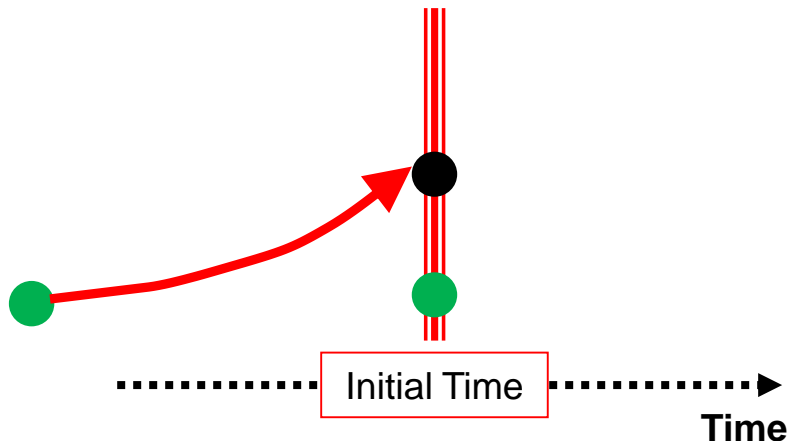
Initial Perturbation

In order to efficiently represent the initial observational error with initial perturbations (multiple initial conditions), the following methods are used.

■ Breeding of Growing Mode (BGM)

The BGM method **finds out the perturbation grew before the initial time** with a forecast and assimilation cycle.

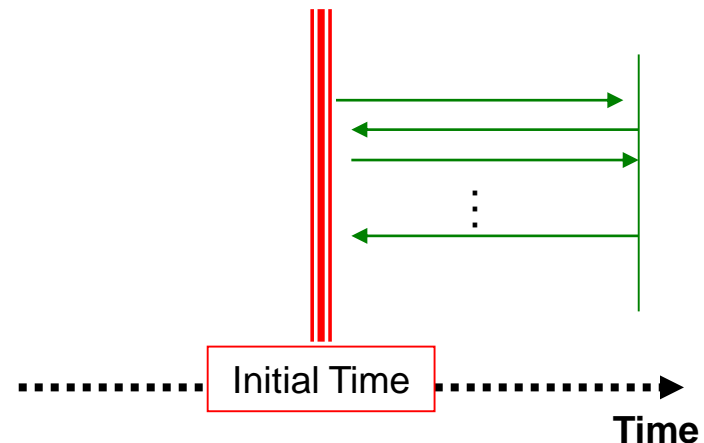
This method is simple but **necessary to keep a forecast and assimilation cycle** even for the time except the initial time.



■ Singular vector (SV)

The SV method **finds out the fastest growing perturbation after the initial time** with the use of a tangent linear model which is obtained by locally linearizing the original nonlinear NWP model and its adjoint model.

This method can find better perturbations, but **requires heavier resources for calculation and development.**



Ensemble Techniques

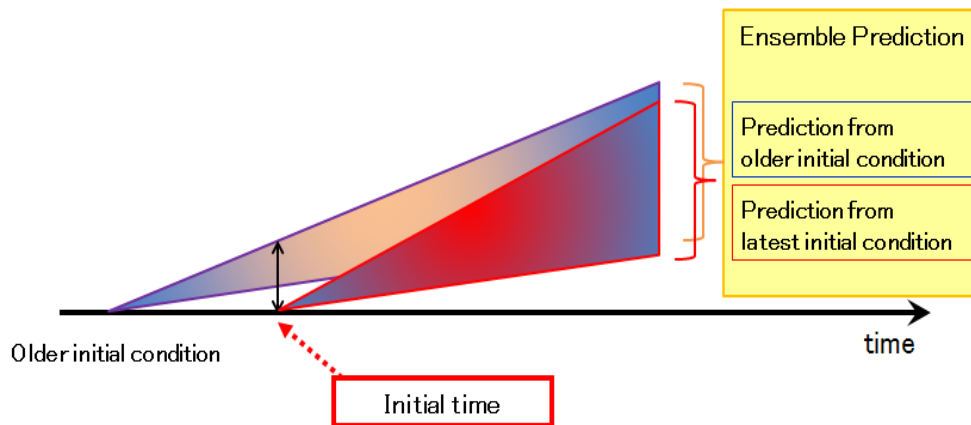
■ LAF

Lagged Average Forecasting (LAF) is one of the ensemble prediction techniques.

Ensemble prediction is **calculated with the combination of predictions from not only latest initial condition but also older initial conditions.**

LAF is easy method for ensemble prediction and make it possible to share computer resources among several days.

However, the accuracy of prediction from older initial conditions is generally worse than that from latest initial conditions.



■ Stochastic Physics Scheme

Uncertainty is caused by imperfection of not only initial conditions but also numerical prediction models. In order to consider uncertainty caused by imperfection of numerical prediction models, **multi-model ensemble (MME) system and stochastic physics scheme are often used.**

MME is an EPS using some different numerical ensemble prediction models.

Stochastic physics scheme is a calculation method which controls some physical calculations with random numbers.

$$\frac{\partial x}{\partial t} = \text{Time variation by dynamical process} + \text{Time variation by parameterization}$$

↑
Random number

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Hindcast

◆ **Hindcast** (= **behind** + **forecast**) ; coined term

Systematic forecast experiments for past cases
performed with the use of the operational EPS.

- Purpose of the hindcast
 - to understand prediction skill
 - to calculate the model statistics (bias, model climate) for creating various products (e.g., forecast maps, numerical guidance)
- Hindcast period is required to be more than 20 years.
- Difficulty
 - In order to calculate a large number of past events, huge computer resources are required.
(Because of limited computer resources, ensemble size and calculation frequency are less than those for operational forecasts in JMA.)

Definition of Bias and Anomaly

■ Bias

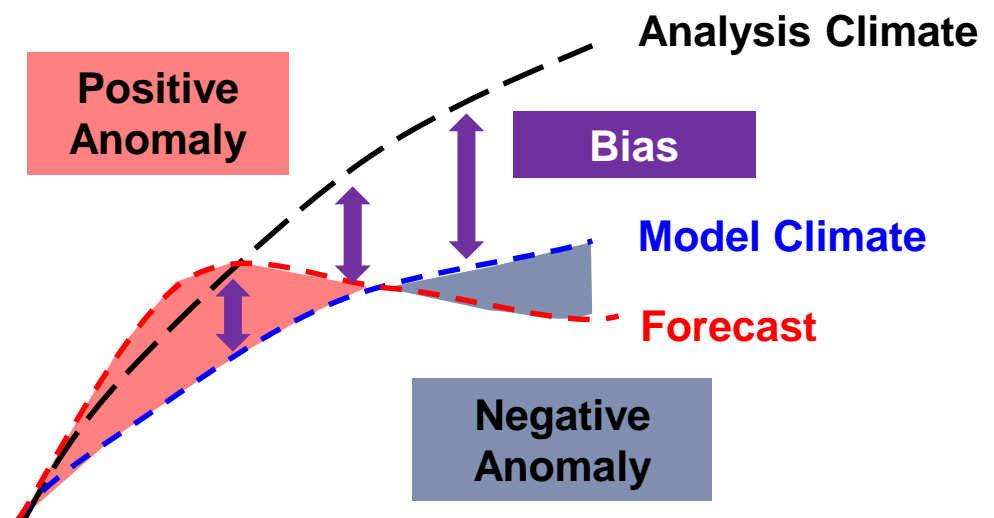
- Bias is systematic errors of the model, calculated as **the difference between model climate and analysis climate**.

■ Anomaly

- Anomaly is calculated as **the difference between model climate and forecast** to reduce the influence from bias.

■ Difficulty

- It is **impossible to adjust the systematic position errors** of jet stream etc.
Therefore, it is **essential to reduce model prediction bias**.



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WMO Forecast Classification

In line with “WMO’s Manual on the Global Data-Processing and Forecasting System”, forecasts are classified by their ranges. **Seasonal forecasting, which is the main topic of TCC seminar, corresponds to extended- and long-range forecasting.** Especially, this TCC seminar focuses on extended-range forecasting.

	Forecasting target period
Nowcasting	Up to 2 hours
Very short-range weather forecasting	Up to 12 hours
Short-range forecasting	Beyond 12 hours and up to 72 hours
Medium-range weather forecasting	Beyond 72 hours and up to 240 hours
Extended-range weather forecasting	Beyond 10 days and up to 30 days
Long-range forecasting	Beyond 30 days up to two years
Climate forecasting	Beyond two years

https://www.wmo.int/pages/prog/www/DPS/Publications/WMO_485_Vol_I.pdf

JMA's Operational Global NWP Models

	Main target	Horizontal resolution
AGCM	Global Spectral Model (GSM)	•Short-range forecast
	Global EPS	•Typhoon forecast
		•One-week forecast
AGCM		•Early warnings for extreme events (Two-week forecast)
		•One-month forecast
CGCM	Seasonal EPS	•3month forecast •Warm/Cold season forecast •El Niño outlook

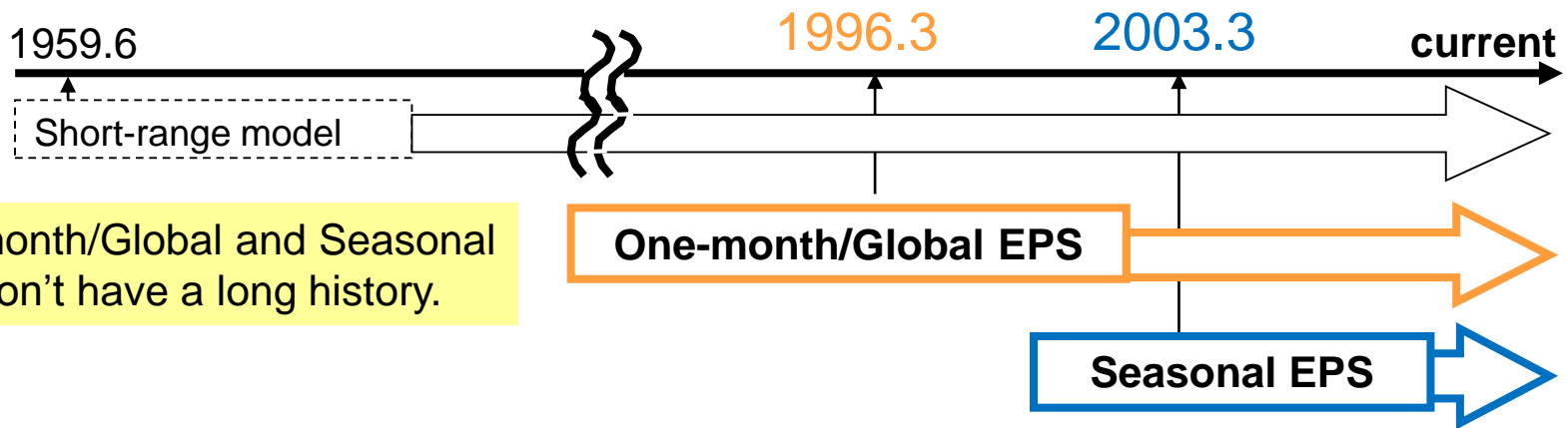
as of Nov.2018

Numerical Prediction Division/JMA

TCC

Climate Prediction Division/JMA

History of EPSs



One-month/Global and Seasonal EPS don't have a long history.

	Mar 1996	Mar 2001	Mar 2003	Mar 2006	Sep 2007	Mar 2008	Feb 2010	Mar 2014	Jun 2015	Mar 2017
One-month/Global EPS	T63 L30 M10	T106 L40 M26		TL159 L40 M50		TL159 L60 M50		TL319 L60 M50		TL479/319 L100 M50
Seasonal EPS			T63 L40 M31	TL95 L40 M31	TL95 L40 M51		TL95 L40 M51		TL159 L60 M51	

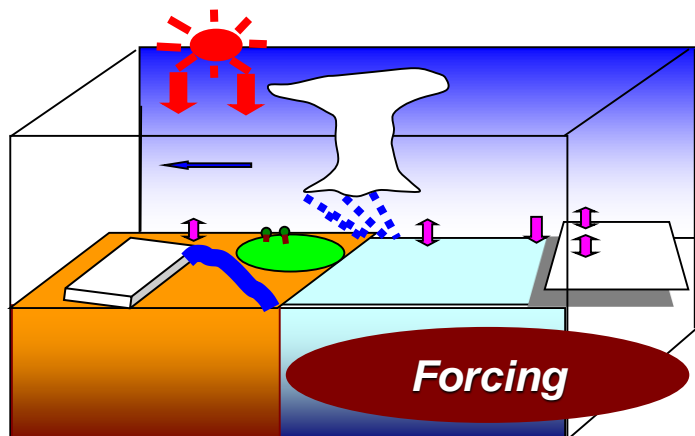
Red: AGCM

Blue: CGCM

Difference between AGCM and CGCM

AGCM

Atmospheric General Circulation Model

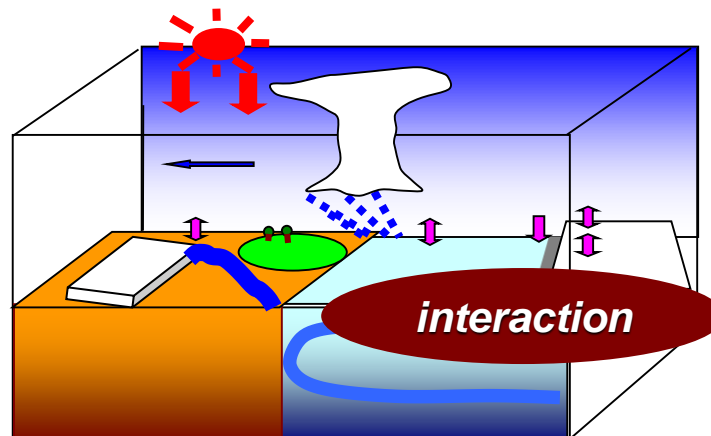


Oceanic conditions are given as a forcing. Prescribed anomalies are used for SST forcing.

Two-tiered method

CGCM

Coupled Ocean-Atmospheric General Circulation Model



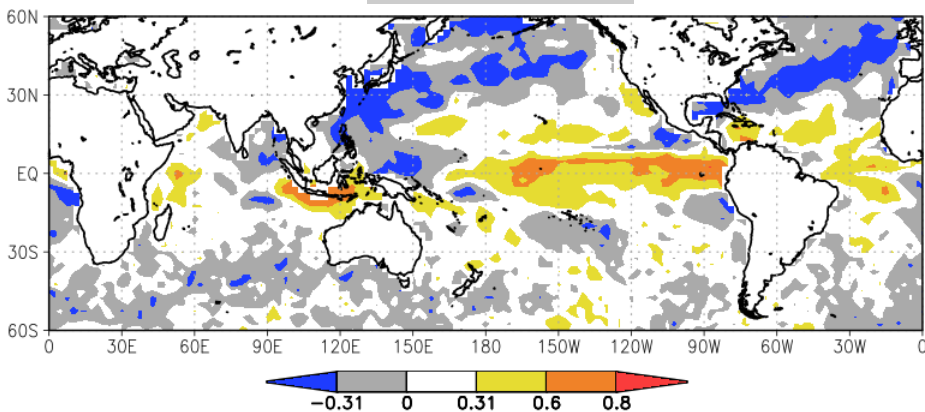
Ocean-atmosphere interaction is considered.

One-tiered method

Difference between AGCM and CGCM

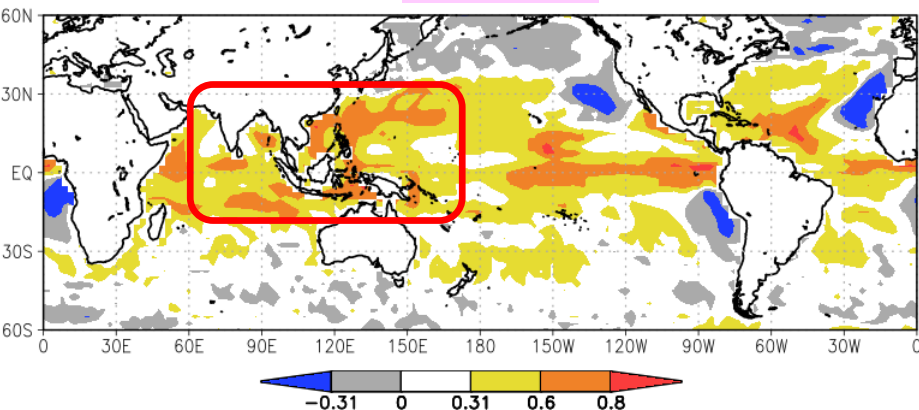
Correlation coefficient between SST and precipitation
in July (Initial date: 30 June, 1979-2010)

Analysis

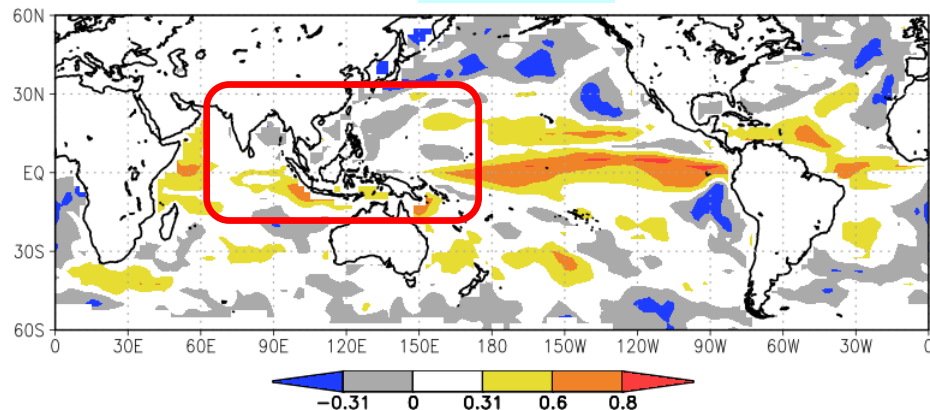


CGCM improves an excess positive correlation between SST and precipitation in tropics, especially over Asian monsoon. CGCM leads to improve prediction skills especially over the tropics, which are affected by tropical oceanic variations.

AGCM



CGCM

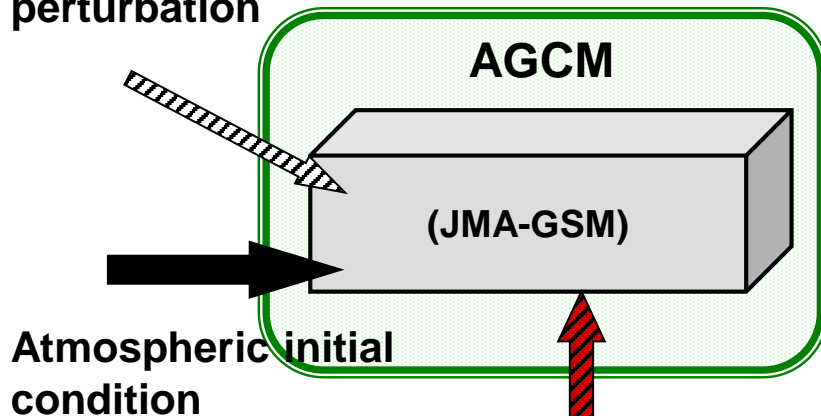


Specification of Global EPS

as of Nov.2018

Global EPS

Atmospheric initial
perturbation



lower boundary
condition

- Prescribed SST perturbation
- Prescribed Sea Ice distribution

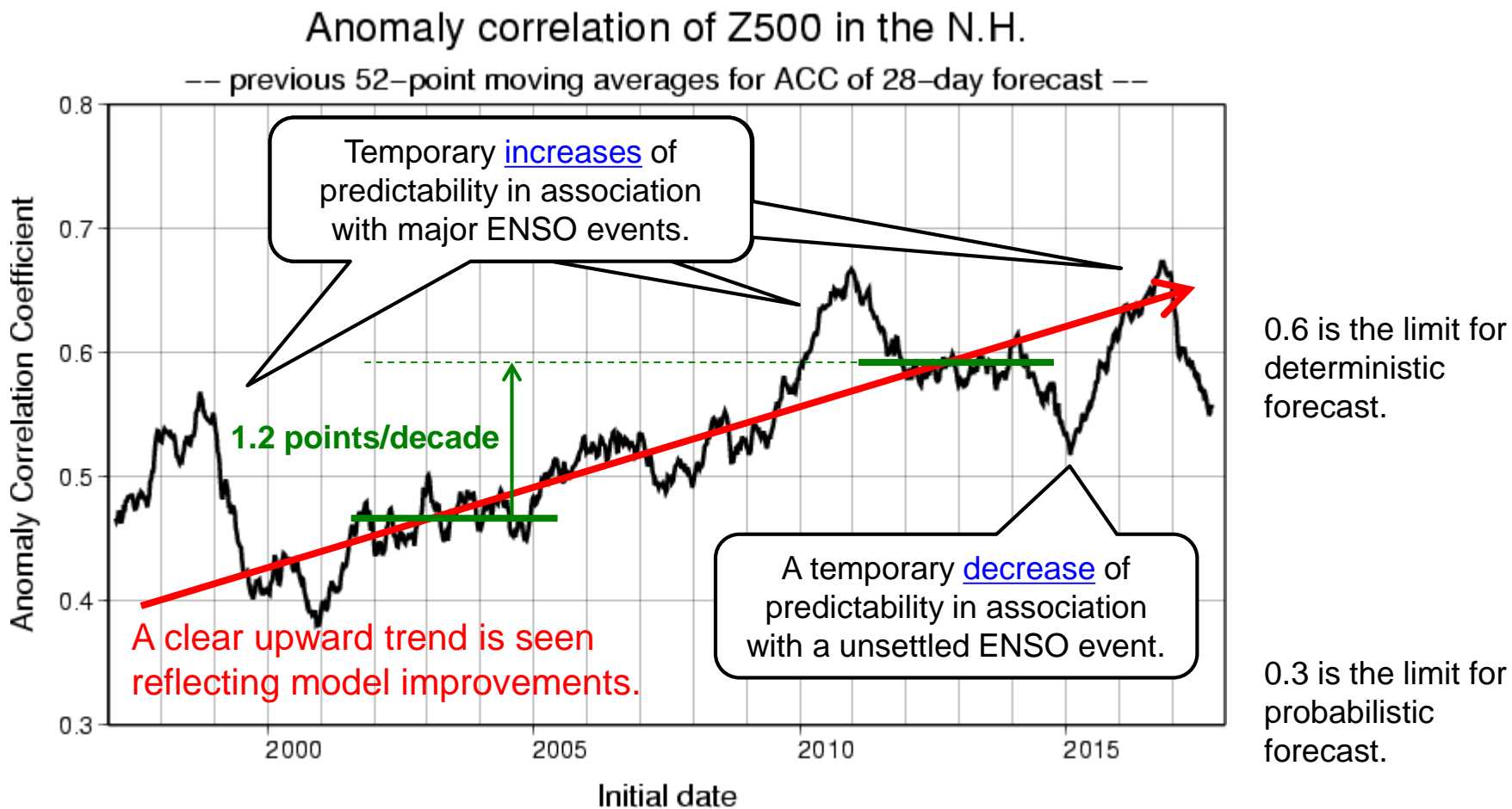
Upgrade	Last: March 2017 Frequently: Every few years
Model	AGCM
Horizontal Resolution	40km (TL479) up to 18 days 55km (TL319) after 18 days
Vertical Resolution	100 levels up to 0.01hPa
Forecast range	Up to 34 days
SST	Prescribed SST perturbation
Sea ice	Prescribed Sea Ice distribution (Sugimoto and Takaya, 2014)
Ensemble method	SV, LAF, LETKF (based on Hunt et al., 2007) Stochastic physics scheme
Ensemble size	50 (13-11 SVs x 4 initial LAFs at 12hour interval)
Freq. of operation	Every Tuesday and Wednesday
Freq. of model product creation	Once a week (Thursday)

Specification of Global EPS Hindcast

	Hindcast	Operational system
Initial Condition	JRA-55 Reanalysis	Global Analysis (Newer System than JRA-55)
Ensemble Size	5 (5 SVs, no using LAF)	50 (13-11 SVs x 4 initial LAFs with 12hour interval)
Forecast range	Initial date +40days	2,3,4,...,31,32days from the latest initial date (Wednesday)
Initial date	3 times per month (10th, 20th, end of month)	4 times per week (00 & 12 UTC on Tuesday and Wednesday)
Target period for hindcast	Available: 1981.1 - 2017.3 Verification: 1981.1 - 2010.12	---

Because of the limited computer resources, ensemble size and frequency of calculation for hindcasts are less than those for operational forecasts.
For the initial date on which no hindcast was performed, virtual hindcast data is created with a linear interpolation method using before and after initial dates on which hindcasts were performed.

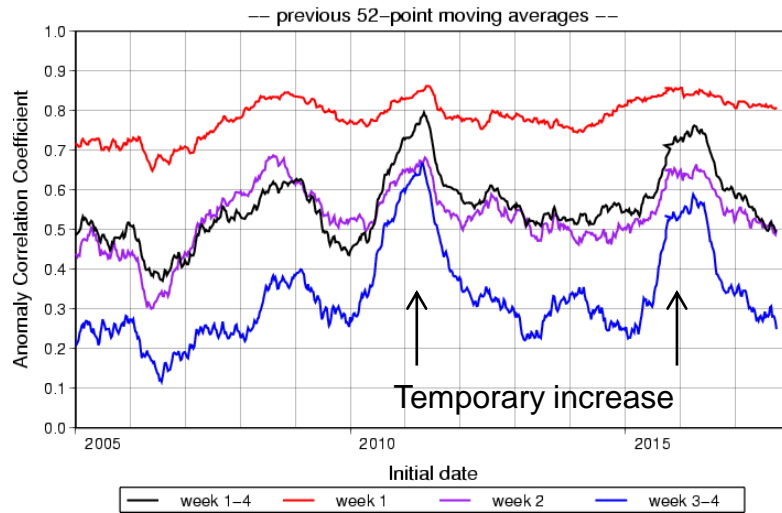
Scores of Operational One-month Prediction



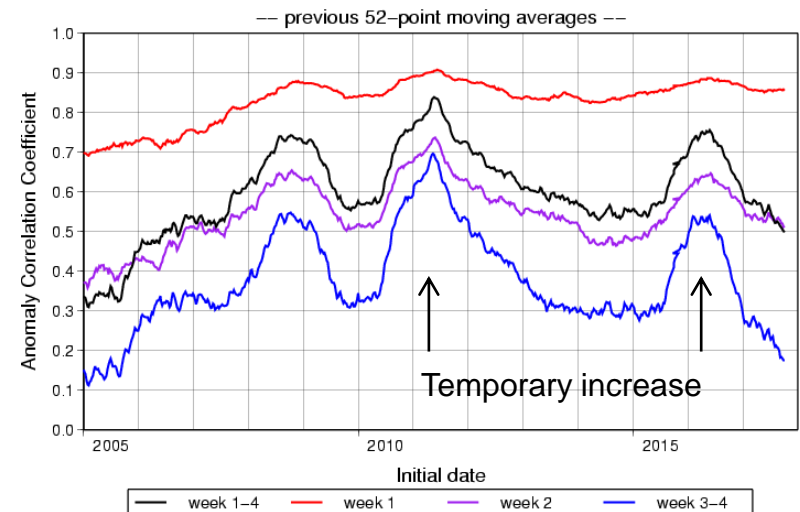
http://ds.data.jma.go.jp/tcc/tcc/products/model/verif/1mE/Map_discussion/ACOR/vrf_map_acc_z500_nh_52wmean.e.html

Scores of Operational One-month Prediction

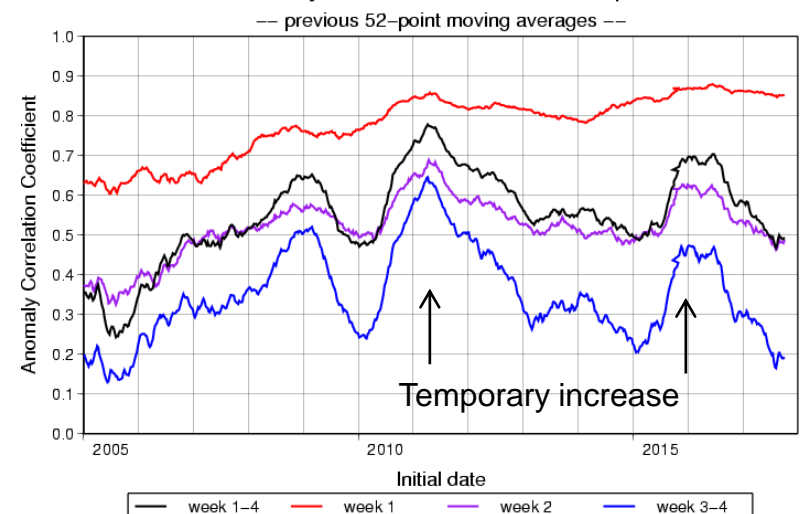
Anomaly correlation of CHI200 tropics



Anomaly correlation of PSI200 tropics



Anomaly correlation of PSI850 tropics



Scores for Tropics.

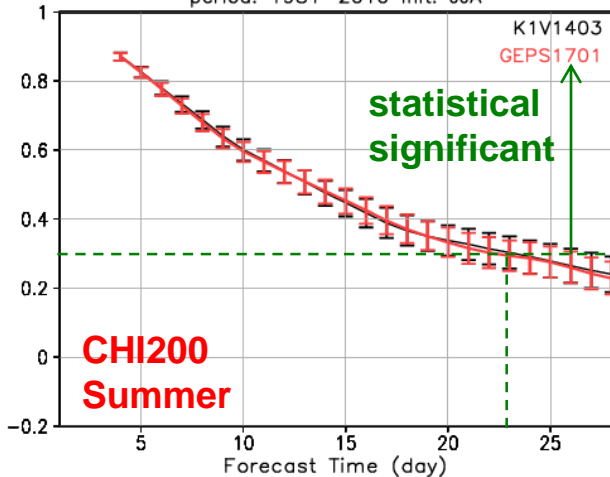
Clear upward trends are seen but scores longer than fortnight forecast are largely influenced by variations of predictabilities in association with ENSO events.

http://ds.data.jma.go.jp/tcc/tcc/products/model/verif/1mE/Map_discussion/ACOR/vrfmap_acc_tr_52wmean.e.html

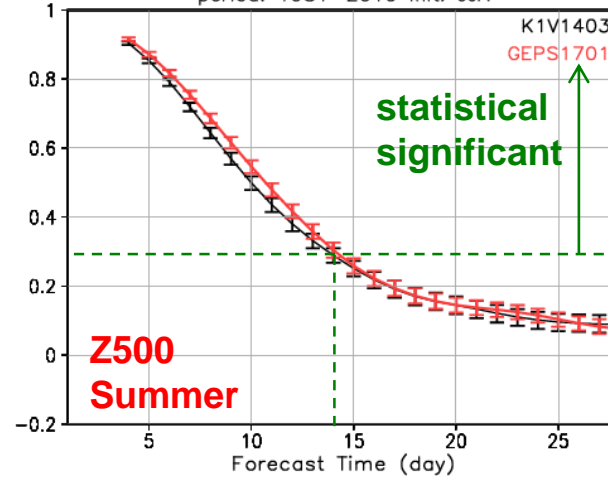
Prediction Skill of One-month EPS

Hindcast experiments for 30 years (1981 – 2010)

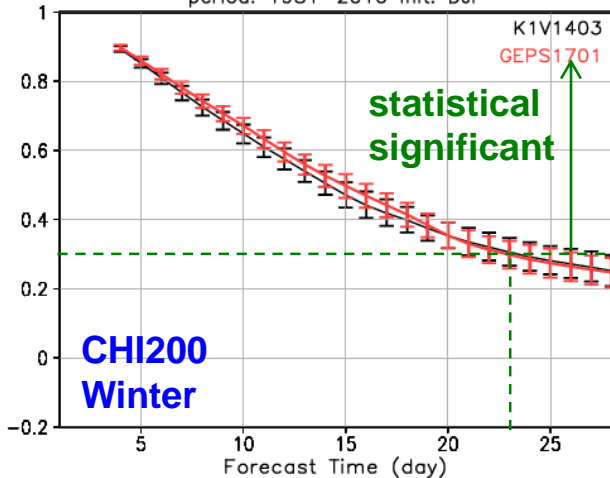
CHI2 ACC Global(90S-90N)
period: 1981-2010 init: JJA



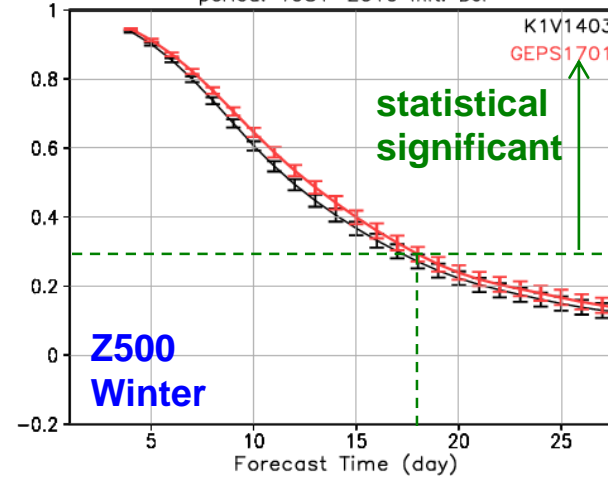
Z500 ACC Global(90S-90N)
period: 1981-2010 init: JJA



CHI2 ACC Global(90S-90N)
period: 1981-2010 init: DJF



Z500 ACC Global(90S-90N)
period: 1981-2010 init: DJF



How many days are predictable for weekly mean forecast by 5-member ensemble?

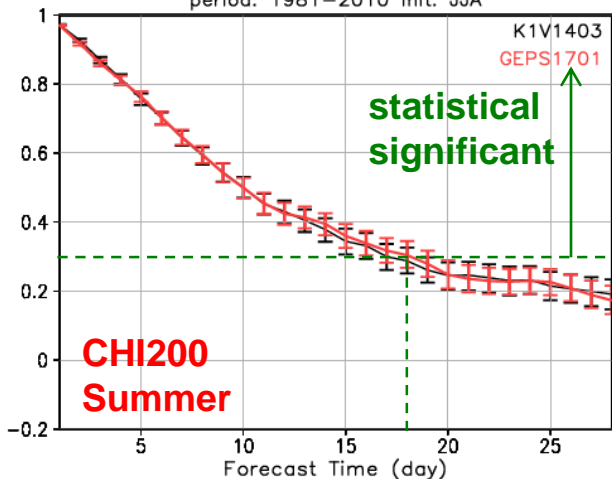
- **CHI200** in the tropics is averagely predictable up to 21-25 days with small seasonal dependency.
- **Z500** in the Northern Hemisphere is averagely predictable up to 14-18 days with large seasonal dependency.

The larger ensemble size is, the higher scores is.

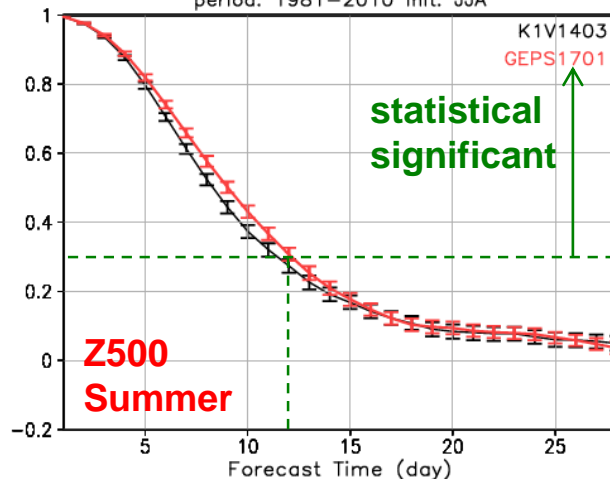
Prediction Skill of One-month EPS

Hindcast experiments for 30 years (1981 – 2010)

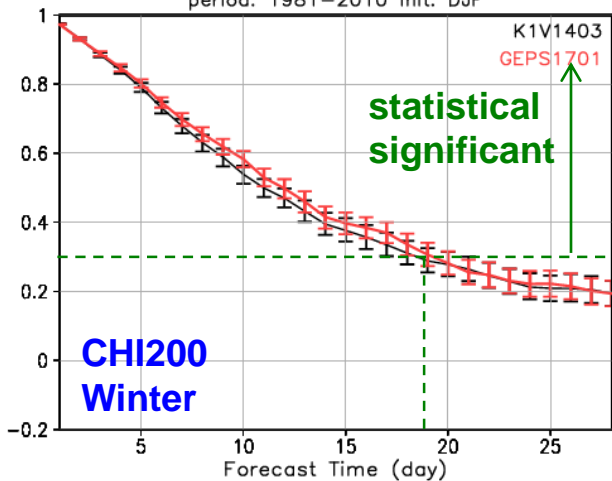
CHI2 ACC Global(90S-90N)
period: 1981-2010 init: JJA



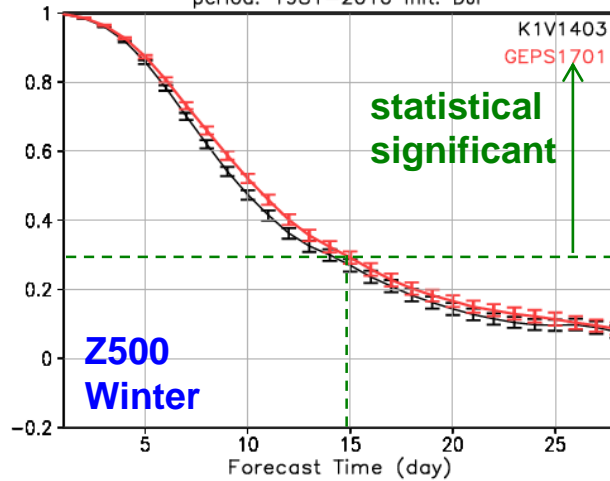
Z500 ACC Global(90S-90N)
period: 1981-2010 init: JJA



CHI2 ACC Global(90S-90N)
period: 1981-2010 init: DJF



Z500 ACC Global(90S-90N)
period: 1981-2010 init: DJF



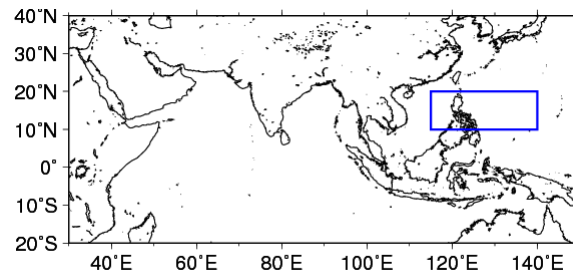
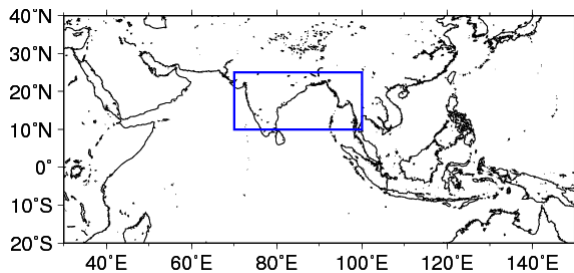
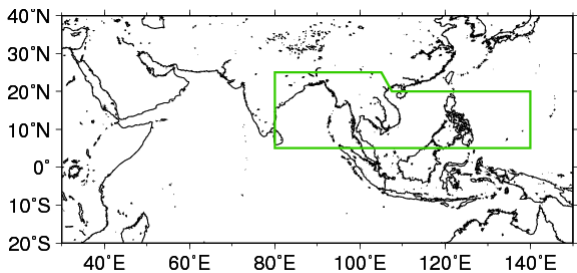
How many days are predictable **for daily forecast** by 5-member ensemble?

- **CHI200** in the tropics is averagely predictable **up to 16-20days** with small seasonal dependency.
- **Z500** in the Northern Hemisphere is averagely predictable **up to 12-15 days** with large seasonal dependency.

Predictable days for daily forecasts are a few days less than that for weekly mean forecasts.

Prediction Skill of One-month EPS for Monsoon Rainfall

Hindcast experiments for 30 years (1981 – 2010)



Initial month	Daily Rainfall Correlation (28day mean)
May	0.46
June	0.09
July	0.38
August	0.30

Initial month	Daily Rainfall Correlation (28day mean)
May	0.48
June	0.05
July	0.31
August	0.14

Initial month	Daily Rainfall Correlation (28day mean)
May	0.33
June	0.49
July	0.28
August	0.48

Skill for onset season is good but those for offset season and for mature season are not good.

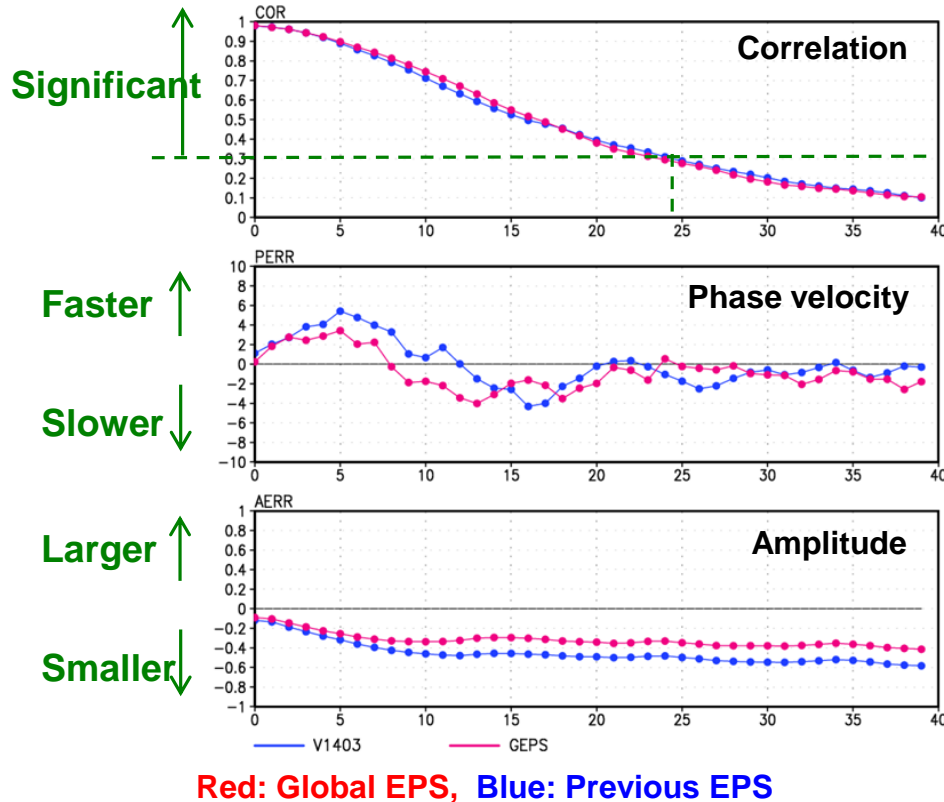
Skill for onset season is good but those for offset season and for mature season are not good.

Skills are largely good through the whole season.

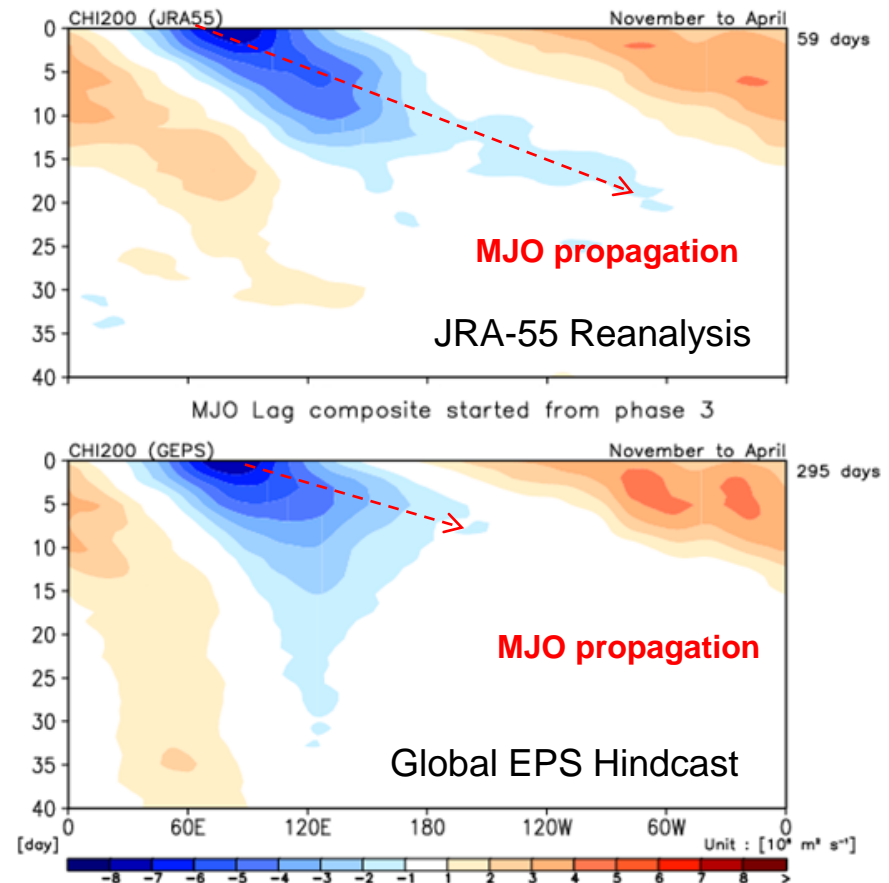
In case of weekly or monthly average rainfall, correlations are higher than daily rainfall. Seasonal oscillations such as MJO and BSISO make a monsoon rainfall forecast difficult.

Verification of Global EPS for MJO

Hindcast experiments for 30 years (1981 – 2010)



MJO is **predictable up to 25 days**. However, **faster phase velocity bias up to 8 days**, **slower phase velocity bias after 8 days** and **smaller amplitude bias** can be seen.



CHI200 Hovmöller diagram from MJO phase 3

Forecast skill beyond 2 weeks: Sub-seasonal to Seasonal (S2S) time-scale

METEOROLOGICAL APPLICATIONS
Meteorol. Appl., 24: 315–325 (2017)
Published online 6 April 2017 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/met.1654

RMetS
Royal Meteorological Society

Review
Potential applications of subseasonal-to-seasonal (S2S) predictions

Christopher J. White,^{a,b*} Henrik Carlsen,^c Andrew W. Robertson,^d Richard J.T. Klein,^e Jeffrey K. Lazo,^f Arun Kumar,^g Frederic Vitart,^h Erin Coughlan de Perez,^{h,i} Andrea J. Ray,^j Virginia Murray,^k Sukaina Bharwani,^l Dave MacLeod,^m Rachel James,ⁿ Lora Fleming,^o Andrew P. Morse,^p Bernd Eggen,^q Richard Graham,^r Erik Kjellström,^s Emily Becker,^t Kathleen V. Pegion,^u Neil J. Holbrook,^v Darryn McEvoy,^w Michael Depledge,^x Sarah Perkins-Kirkpatrick,^y Timothy J. Brown,^z Roger Street,^{aa} Lindsay Topping,^{ab} A. Ramana Murty,^{ac} Indri Hidayat,^{ad} Johannes Lorenz,^{ae} Gede Budiyanto,^{af} Rob Lamb,^{ag}

(a) WEATHER FORECASTS
predictability comes from initial atmospheric conditions

S2S PREDICTIONS
predictability comes from initial atmospheric conditions, monitoring the land/sea/ice conditions, the stratosphere and other sources

SEASONAL OUTLOOKS
predictability comes primarily from sea-surface temperature conditions; accuracy is dependent on ENSO state

The graph plots Forecast Skill (y-axis, from zero to excellent) against Forecast Range (x-axis, from 1-10 days to 30-90+ days). Three curves are shown: a blue curve for 'Daily values' (1-10 days) that starts at 'excellent' and drops to 'poor' by 10 days; an orange curve for 'Weekly averages' (10-30 days) that starts at 'poor' and drops to 'zero' by 30 days; and a purple curve for 'Monthly or seasonal averages' (30-90+ days) that starts at 'fair' and remains above 'poor' even at 90+ days.

FORECAST RANGE
Daily values: 1–10 days
Weekly averages: 10–30 days
Monthly or seasonal averages: 30–90+ days

White et al. (2017)

RMetS
Royal Meteorological Society

The forecast skill horizon
Roberto Buizza* and Martin Leutbecher
European Centre for Medium-Range Weather Forecasts, Reading, UK

*Correspondence to: R. Buizza, ECMWF, Shinfield Park, Reading, RG2 9AX, UK. E-mail: buizza@ecmwf.int

Numerical weather prediction has seen, in the past 25 years, a shift from a ‘deterministic’

The graph plots Skill range (y-axis, from 1 day to 1000 days) against Spatial scale (km) (x-axis, from 1 to 10000 km). A vertical dashed line at approximately 25 km is labeled 'ENS grid spacing'. The area to the left of this line is shaded grey and labeled 'Unresolved'. The area to the right is shaded pink and labeled 'No skill'. Several curves represent different variables: 'Extremes' (red, skill drops to zero by 10 days), 'Rainfall' (orange, skill drops to zero by 10 days), 'Surface fields' (yellow, skill drops to zero by 10 days), 'Upper-level fields' (green, skill drops to zero by 10 days), 'Teleconnection indices' (light blue, skill drops to zero by 10 days), '2-metre temperature, mean sea level pressure' (medium blue, skill drops to zero by 10 days), 'Monthly average sea-surface temperature (e.g. El Niño)' (dark blue, skill drops to zero by 10 days), and 'Monthly average' (black, skill drops to zero by 10 days).

ENS grid spacing

Skill range
1000 days
1 year
1 season
100 days
1 month
10 days
1 day

Spatial scale (km)
1 10 100 1000 10000
From finer to larger scales

Monthly average sea-surface temperature (e.g. El Niño)
Monthly average
2-metre temperature, mean sea level pressure
Teleconnection indices
Upper-level fields
Surface fields
Rainfall
Extremes

<https://www.ecmwf.int/sites/default/files/elibrary/2017/17631-forecast-skill-horizon.pdf>


- “Errors propagate from poorly initialized smaller/faster scales.”
- “Predictive signals propagate from better initialized larger/slowly-evolving scales.”

The Sub-seasonal to Seasonal (S2S) Prediction Project

WWRP 2018 - 4
WCRP Report No. 11/2018

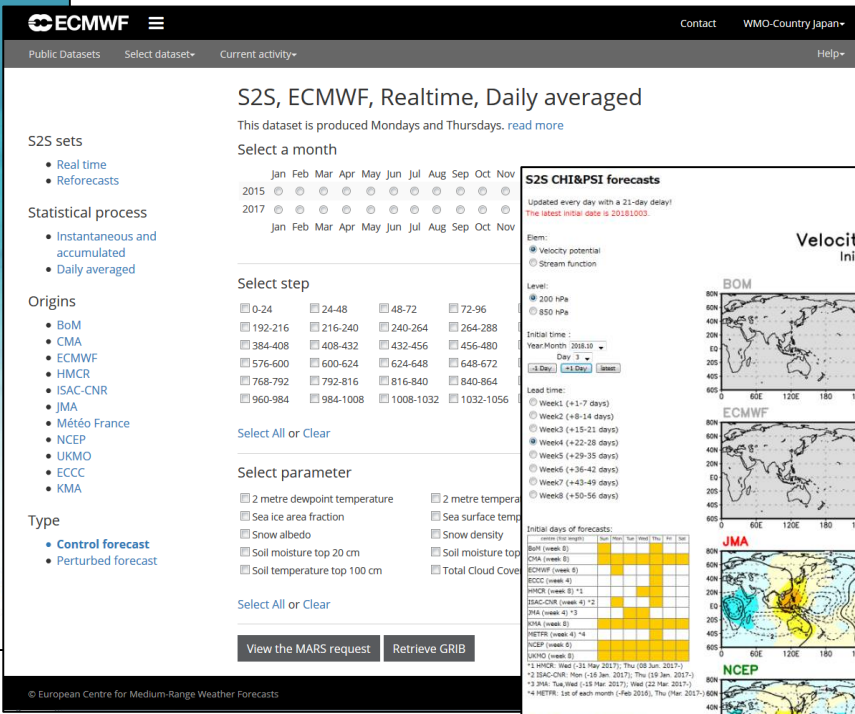
WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S) Phase II Proposal

(November 2018–December 2023)



http://www.s2sprediction.net/file/document_s_reports/WWRP_2018_4_S2S_Phase_II_Proposal.pdf

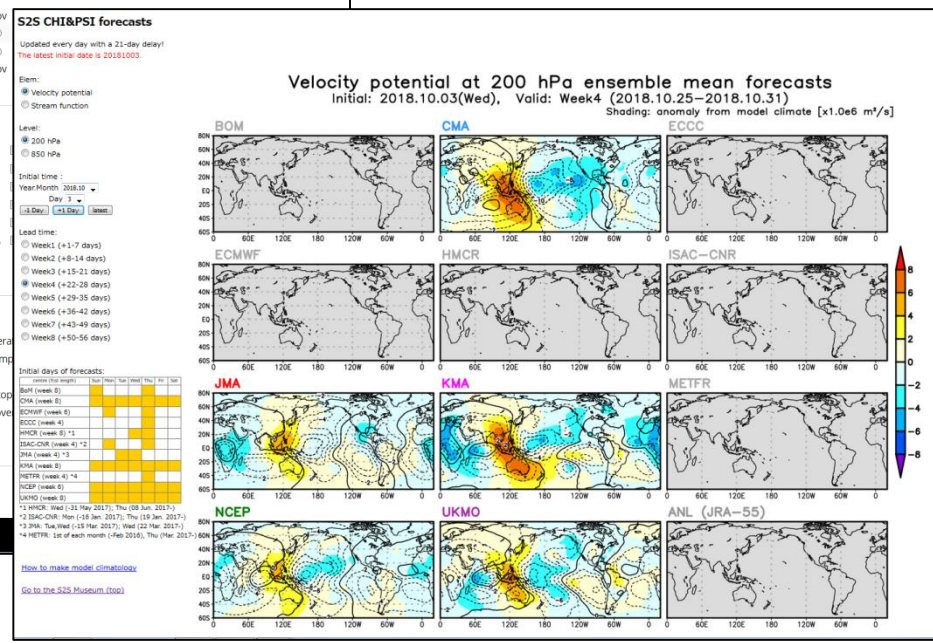
ECMWF Data Server



The screenshot shows the ECMWF Data Server interface. The main heading is "S2S, ECMWF, Realtime, Daily averaged". Below this, there are options to "Select a month" (2015, 2017) and "Select step" (0-24, 24-48, 48-72, 72-96). There are also sections for "Select parameter" and "Select All or Clear". At the bottom, there are buttons for "View the MARS request" and "Retrieve GRIB".

<http://apps.ecmwf.int/datasets/data/s2s/levtype=sfc/type=cf/>

S2S Museum



http://gpvjma.ccs.hpcc.jp/S2S/S2S_CHIPSI.html

- S2S Phase 1 started in Nov. 2013 as 5-year project. The Phase 2 has just started from Nov 2018 (to Dec 2023).
- The data provided from 11 operational centers is freely available with 3-week delay for research and education purposes.

Contents

- Basic Knowledge
 - NWP Model and Predictability
 - Ensemble Prediction and Uncertainty
 - Hindcast
- JMA's Global Ensemble Prediction System
- TCC's Products to support 1-month Forecast

TCC's NWP Model Products

Tokyo Climate Center
WMO Regional Climate Center in RA II (Asia)

Home World Climate Climate System Monitoring El Niño Monitoring **NWP Model Prediction** Global Warming Climate in Japan Training Module Press release Links

HOME

What are WMO RCCs

WMO RCCs are centres of excellence...

RCC Functions

- Operational Activities for Long-range Forecasting
- Operational Activities for Climate Monitoring
- Operational Data Services, to support operational LRF and climate monitoring
- Training in the use of operational RCC products and services

Latest Updates

- World Climate Updated: 16 November 2017
- Climate System Monitoring Updated: 16 November 2017
- El Niño Monitoring Updated: 10 November 2017

El Niño Outlook is updated on 10 November 2017.

Main Products

- iTacs**
iTacs, Interactive Tool for Analysis of the Climate System, is a web-based application to assist NMHSs to analyse extreme climate events and to monitor climate status.
- GPC Tokyo**
Products of long-range forecast from Global Producing Center (GPC) Tokyo are available. These products are based on JMA's ensemble prediction system.
- Monthly Discussion on Seasonal Climate Outlook**
This is intended to assist NMHSs in the Asia-Pacific region in interpreting GPC Tokyo's three-month prediction and warm/cold season prediction products.
- El Niño Monitoring**
"El Niño Outlook" consists of a diagnosis of current condition and prediction of El Niño/Southern Oscillation. This is issued every month around 10th.

What's New **RSS**

- 26 October 2017 NEW**
Announcement: A website for Information Sharing on Climate Services in WMO RA II has been updated.
- 16 October 2017 NEW**
Announcement: The 2016 edition of Climate Change Monitoring Report is now available.
- 30 August 2017 NEW**
TCC News No. 49 (Summer 2017: PDF)
 - Sea Ice in the Sea of Okhotsk in the 2016/2017 Winter Season
 - Kosa (Aeolian dust) Events over Japan in January-June 2017
 - TCC Experts Visit Malaysia

» Previous news
» Press release

Links

Regional Climate Centers

- RA II Regional Climate Center (RCC) Network Homepage
- Beijing Climate Center
- National Climate Centre, Pune **NEW**

Click "NWP Model Prediction" Tab or "GPC Tokyo" Icon on the top page of TCC website.

TCC website

<http://ds.data.jma.go.jp/tcc/tcc/>

TCC's NWP Model Products

NWP products are available smoothly through the NWP Model Products page.

Main Products

One-month Prediction <ul style="list-style-type: none">One-month Prediction (30 Nov 2017)Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017)Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (30 Nov 2017)Verification (03 Dec 2017)Hindcast Verification NEWOne-month Probabilistic Forecasts at station points	Monthly Discussion on Seasonal Climate Outlooks last updated : 24 Nov 2017 <p>This product is intended to assist NMHSs in the Asia-Pacific region in interpreting GPC Tokyo's three-month prediction and warm/cold season prediction products.</p>
Three-month Prediction <ul style="list-style-type: none">Three-month Prediction (12 Nov 2017)Z500, T850 & SLP (Northern Hemisphere) (12 Nov 2017)Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (12 Nov 2017)Verification (06 Dec 2017)Hindcast Verification (JMA/MRI-CPS2)Probabilistic Forecast and Verification (12 Nov 2017)SST Index Time-series Forecast (12 Nov 2017)	Forecast Products in Support of Early Warnings for Extreme Weather Events last updated : 29 Nov 2017 <p>Early warning products for extreme weather events covering the period up to two weeks ahead. (Only registered NMHSs can access this page.)</p> <ul style="list-style-type: none">Application<ul style="list-style-type: none">If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp
Warm/Cold Season Prediction <ul style="list-style-type: none">Warm/Cold Season Prediction (18 Oct 2017)Z500, T850 & SLP (Northern Hemisphere) (18 Oct 2017)Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (18 Oct 2017)Verification (05 Sep 2017)Hindcast Verification (JMA/MRI-CPS2)Probabilistic Forecast and Verification (18 Oct 2017)	Download GPC Long-range Forecast (LRF) Products <ul style="list-style-type: none">Download Gridded data File (Only registered NMHSs can access this page.)Application<ul style="list-style-type: none">If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp
Model Descriptions <ul style="list-style-type: none">Model Outlines NEWOperations for Extended-range Forecast Model NEWOperations for Long-range Forecast Model (JMA/MRI-CPS2)	

One-month Prediction
(Free accessible)

Seasonal Prediction
(Free accessible)

Extreme Weather Prediction
(Authentication is required)

Gridded data
(Authentication is required)

NWP Charts for One-month Prediction

Some NWP charts for tropics are available on the One-month prediction menus.

Select forecast period, initial date and area type on these menu.

- One-month Prediction**
- › One-month Prediction (30 Nov 2017)
 - › Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017)
 - › **Stream Function, Velocity Potential & Surface Air Temperature (60N-60S)** (30 Nov 2017)
 - › Verification (03 Dec 2017)
 - › Hindcast Verification **NEW**
 - › One-month Probabilistic Forecasts at station points

One-month Prediction (Tropics and Asia)

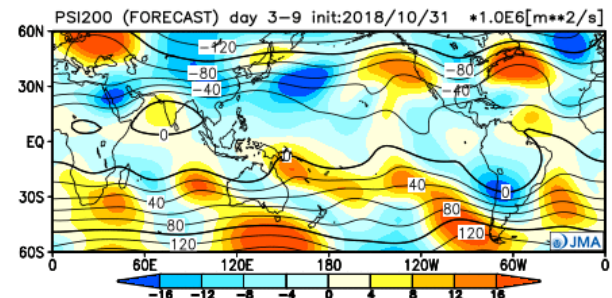
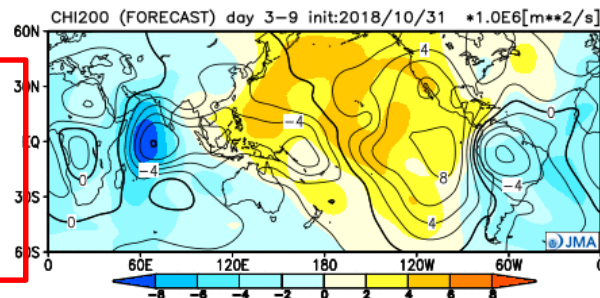
This product is displayed for use by National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any nation.

Forecast Maps

forecast period

initial date

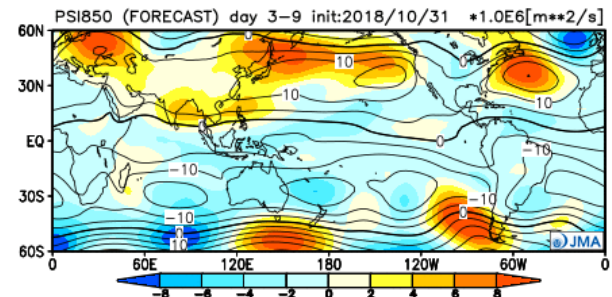
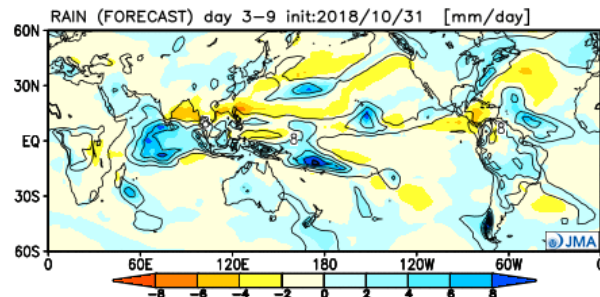
area
 60N-60S
 Asia



corresponding verification

[Contour interval]
 CHI200 : 2x1.0E6m²/s
 RAIN : 4mm/day
 Z500 : 120m
 TS : 4C
 PSI200 : 20x1.0E6m²/s
 PSI850 : 5x1.0E6m²/s
 PSEA : 4hPa

(Shaded patterns show anomalies.)



NWP Charts for One-month Prediction

Some NWP charts for the Northern Hemisphere are available on the One-month prediction menus.

Select forecast period and initial date on these menu.

- One-month Prediction
 - One-month Prediction (30 Nov 2017)
 - Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017)**
 - Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (30 Nov 2017)
 - Verification (03 Dec 2017)
 - Hindcast Verification **NEW**
 - One-month Probabilistic Forecasts at station points

One-month Prediction (Northern Hemisphere)

This product is displayed for use by National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any nation.

Forecast Maps

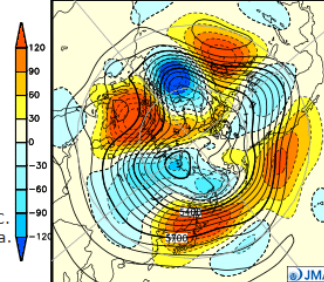
forecast period
the first week

initial date
2018.10.31.12 Z

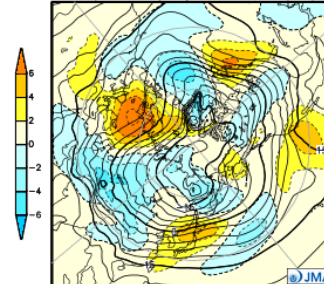
[corresponding verification](#)

(from top to bottom)
top : Contours show 500hPa height in an interval of 60m.
middle : Contours show 850hPa temperature in an interval of 3C.
bottom : Contours show sea level pressure in an interval of 4hPa.
(Shaded patterns show anomalies.)

Ensemble Mean forecast (07 day mean)
Z500 (FORECAST) day 3-9 init:2018/10/31 [m]



T850 (FORECAST) day 3-9 init:2018/10/31 [C]



TCC's NWP Model Products

NWP products are available smoothly through the NWP Model Products page.

Main Products	
<p>One-month Prediction</p> <ul style="list-style-type: none"> › One-month Prediction (30 Nov 2017) › Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017) › Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (30 Nov 2017) › Verification (03 Dec 2017) › Hindcast Verification NEW › One-month Probabilistic Forecasts at station points 	<p>Monthly Discussion on Seasonal Climate Outlooks last updated : 24 Nov 2017</p> <p>This product is intended to assist NMHSs in the Asia-Pacific region in interpreting GPC Tokyo's three-month prediction and warm/cold season prediction products.</p>
<p>Three-month Prediction</p> <ul style="list-style-type: none"> › Three-month Prediction (12 Nov 2017) › Z500, T850 & SLP (Northern Hemisphere) (12 Nov 2017) › Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (12 Nov 2017) › Verification (06 Dec 2017) › Hindcast Verification (JMA/MRI-CPS2) › Probabilistic Forecast and Verification (12 Nov 2017) › SST Index Time-series Forecast (12 Nov 2017) 	<p>Forecast Products in Support of Early Warnings for Extreme Weather Events last updated : 29 Nov 2017</p> <p>Early warning products for extreme weather events covering the period up to two weeks ahead. (Only registered NMHSs can access this page.)</p> <ul style="list-style-type: none"> › Application • If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp
<p>Warm/Cold Season Prediction</p> <ul style="list-style-type: none"> › Warm/Cold Season Prediction (18 Oct 2017) › Z500, T850 & SLP (Northern Hemisphere) (18 Oct 2017) › Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (18 Oct 2017) › Verification (05 Sep 2017) › Hindcast Verification (JMA/MRI-CPS2) › Probabilistic Forecast and Verification (18 Oct 2017) 	<p>Download GPC Long-range Forecast (LRF) Products</p> <ul style="list-style-type: none"> › Download Gridded data File (Only registered NMHSs can access this page.) › Application • If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp
<p>Model Descriptions</p> <ul style="list-style-type: none"> › Model Outlines NEW › Operations for Extended-range Forecast Model NEW › Operations for Long-range Forecast Model (JMA/MRI-CPS2) 	

One-month Prediction
(Free accessible)

Seasonal Prediction
(Free accessible)

Extreme Weather Prediction
(Authentication is required)

Gridded data
(Authentication is required)

GPC Long-range Forecast (LRF) Products

Select “Download Gridded data File” on GPC LRF Products menu.

Some additional charts of One-month Prediction are available here.

Download GPC Long-range Forecast (LRF) Products

- ▶ [Download Gridded data File](#) (Only registered NMHSs can access this page.)
- ▶ [Application](#)

• If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp

Download Gridded Data File

Notice

- 14 March 2017
Announcement: [Launch of the JMA's Global Ensemble Prediction System for one-month prediction](#)
- 17 June 2015
JMA's new Seasonal Ensemble Prediction System (JMA/MRI-CPS2) is implemented. The operational gridded data and indices are available.
- 29 May 2015
JMA's Seasonal Ensemble Prediction System will be upgraded next month. The hindcast gridded data for JMA/MRI-CPS2 is available.

Main Products

- NWP Model Prediction**
 - Global EPS for one-month prediction (31 Oct 2018)
 - ▶ [Daily Statistics](#)
 - ▶ [All Members](#)
 - ▶ [Systematic Errors](#)
 - Seasonal EPS (13 Oct 2018)
 - ▶ [Statistics](#)
 - ▶ [All Members](#)
 - ▶ [Indices](#)
 - ▶ [Systematic Errors](#)
- Hindcast Gridded Data**
 - Global EPS for one-month prediction **NEW**
 - ▶ [Daily data](#)
 - Seasonal EPS
 - ▶ [Monthly mean data](#)
- Animation of One-month Prediction**
 - ▶ [Seven-days running mean](#) (31 Oct 2018)
- Tips**
 - ▶ [Q&A](#)

Additional Charts of One-month Prediction

Click “Seven-days running mean”.

Animation of One-month Prediction

Seven-days running mean (31 Oct 2018)

Select initial date, forecast lead time and parameter on these menu.

Animation for one-month prediction (7-days running mean)

This product is displayed for use by National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any nation.

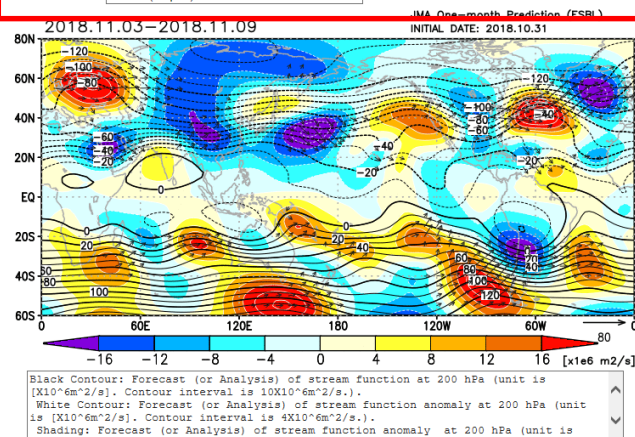
Initial date: 2018.10.31 Forecast lead time: Day+6

Setting for Animation

Oldest (lead Day -11) -1 day Initial +1 day Termination (lead Day +28) Animation: Start Stop << (Slow) >> (Fast)

week-1 week-2 week-3 week-4

Parameter: PSI200 (Tropics)



Data sources

Forecast: Ensemble mean of the Global EPS (One-month EPS before 2017.03.22)

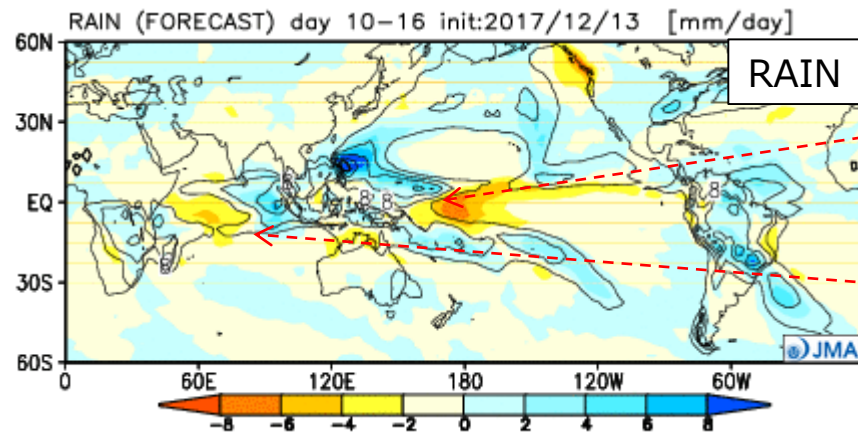
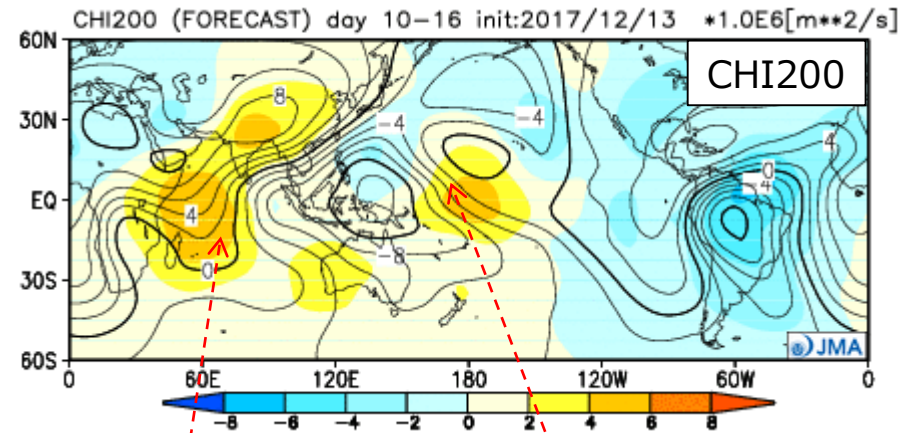
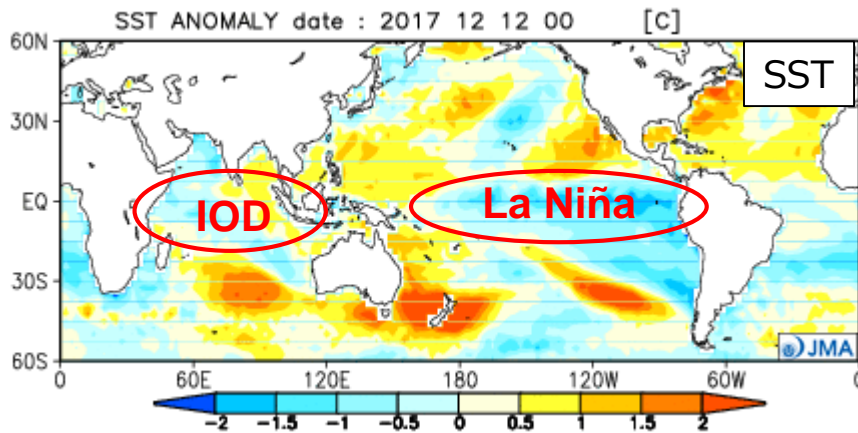
Analysis: JRA-55 (JRA-25/JCDAS before 2014.03.05) (except for OLR), CPC/NOAA Analysis for OLR

This product is identical with the formal products after 13/05/2015.

But it is not identical with the formal products during the experimental period before 06/05/2015 (see the table below).

How to use NWP charts

【Step 1】 Let's check predicted SST conditions and tropical convection fields.



In this case, a response associated with La Niña like SST conditions is clear.

In this case, a response associated with positive IOD like SST conditions can be seen.

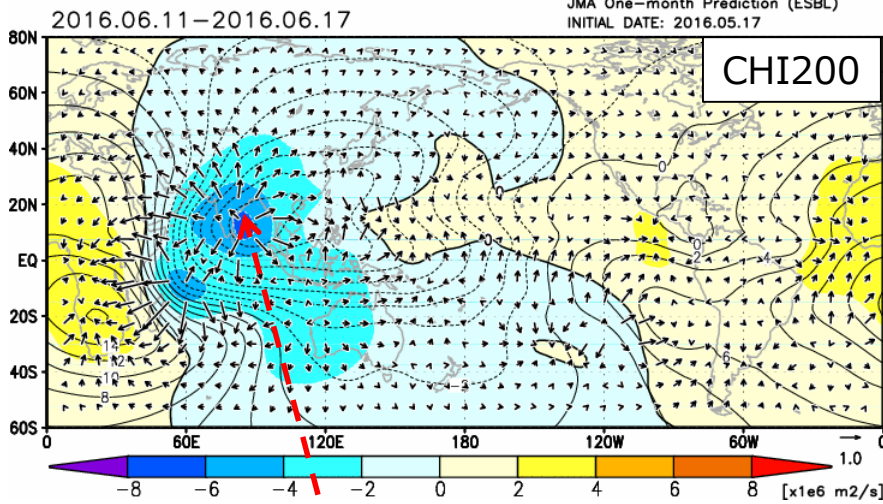
CHI200 (Velocity potential at 200hPa)

- Positive values indicate convergence, and negative values indicate divergence.

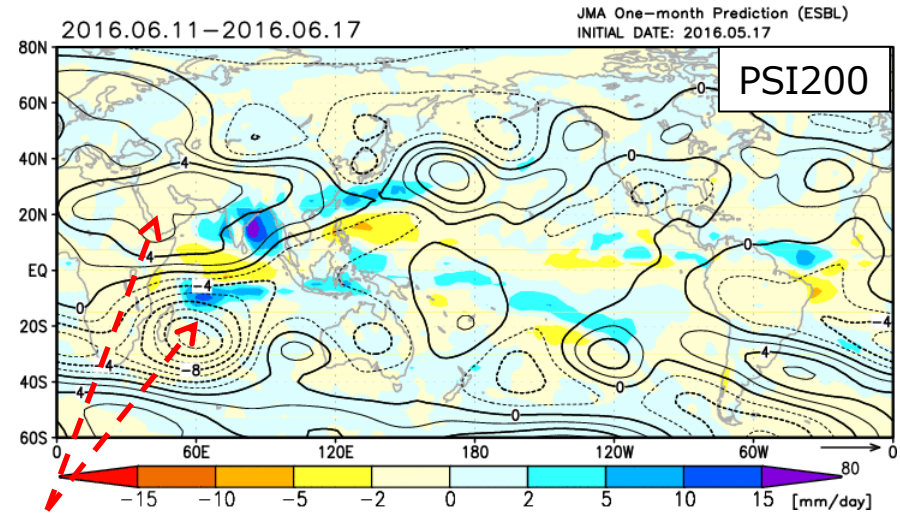
Contours indicate predicted values. Shading indicates anomaly.

How to use NWP charts

[Step 2] Let's check fields responding to the tropical convection.



Active Convection



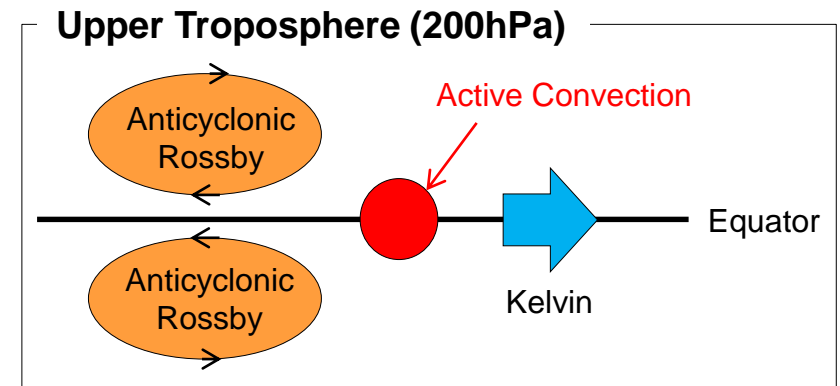
Anticyclonic Rossby response

CHI200 (Velocity potential at 200hPa)

- Positive values indicate convergence, and negative values indicate divergence.

PSI200 (Stream function at 200hPa)

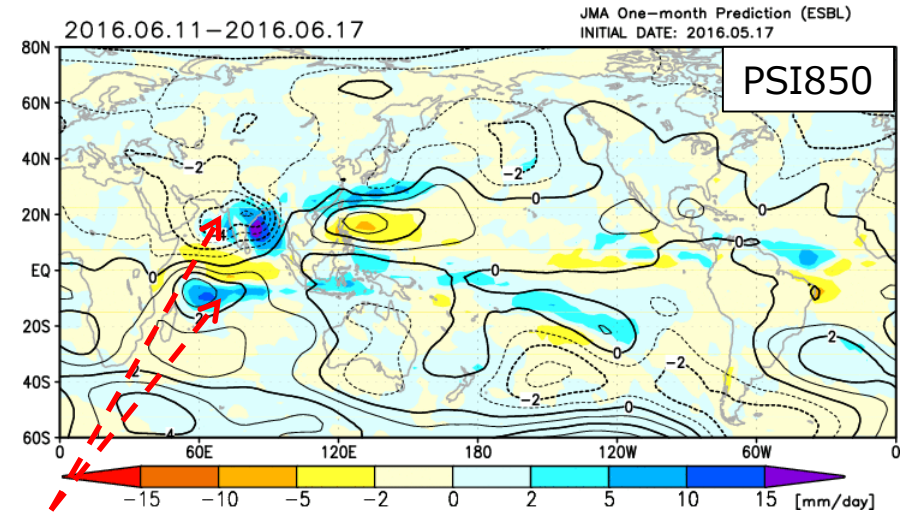
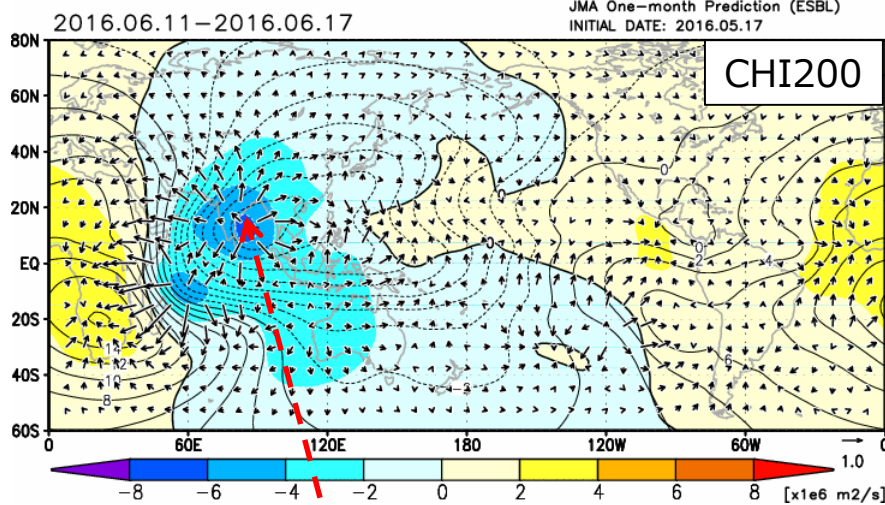
- Positive values indicate anticyclone, and negative values indicate cyclone in Northern Hemisphere.



Typical Response Pattern
(The Matsuno-Gill Response)

How to use NWP charts

[Step 2] Let's check fields responding to the tropical convection.

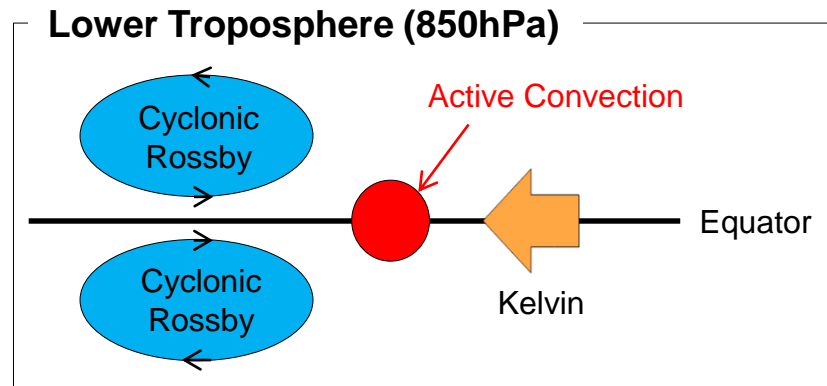


CHI200 (Velocity potential at 200hPa)

- Positive values indicate convergence, and negative values indicate divergence.

PSI850 (Stream function at 850hPa)

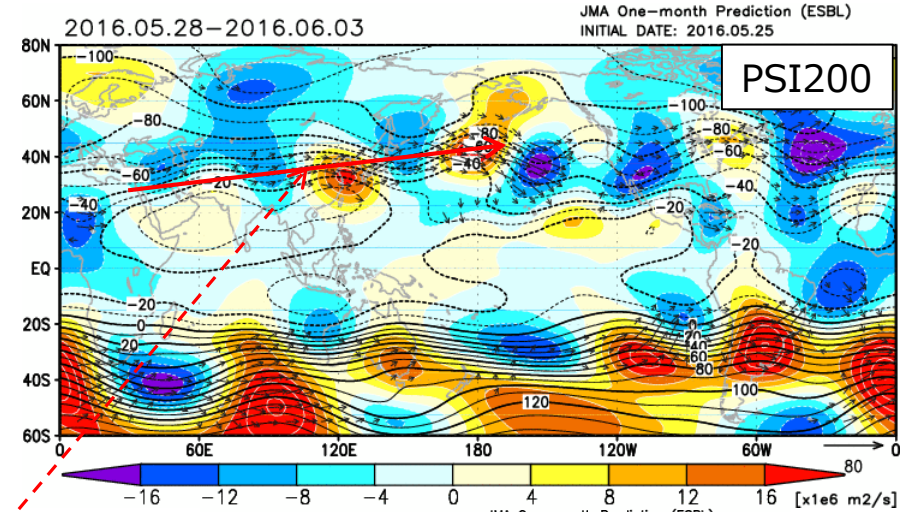
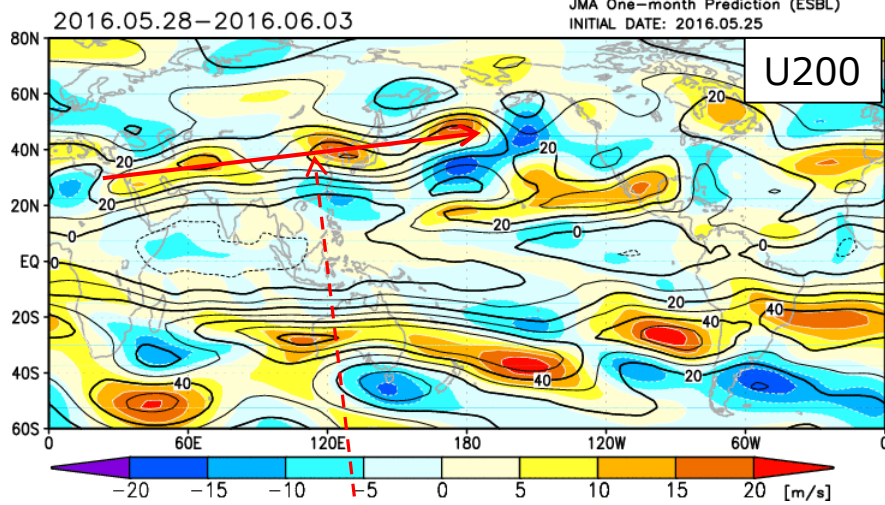
- Positive values indicate anticyclone, and negative values indicate cyclone in Northern Hemisphere.
- Tropical cyclones are sometimes generated in strong cyclonic circulations.



**Typical Response Pattern
(The Matsuno-Gill Response)**

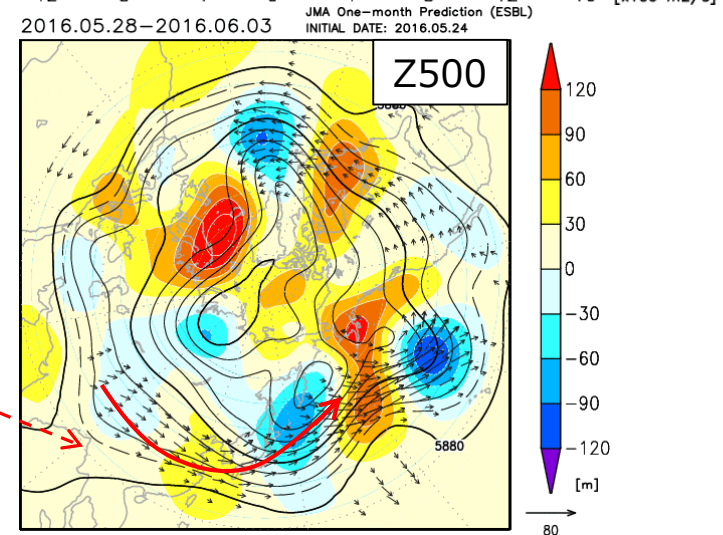
How to use NWP charts

[Step 3] Let's check wave energy propagations along the sub-tropical jet.



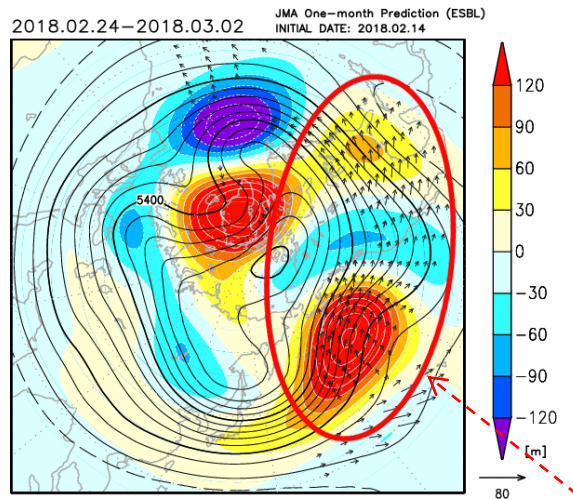
Subtropical Jet

The subtropical jet plays a role of wave guide to propagate the wave energy downward.



How to use NWP charts

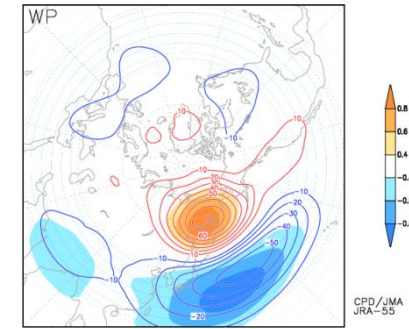
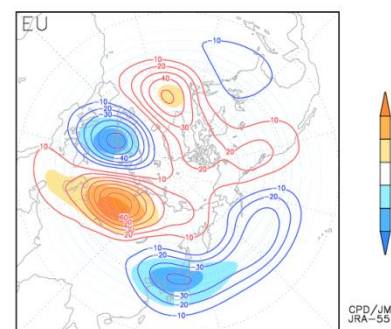
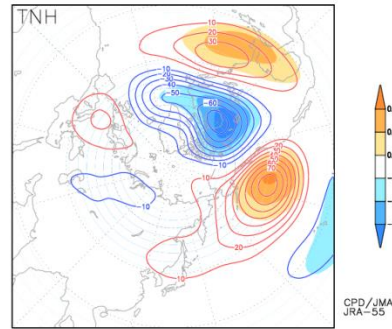
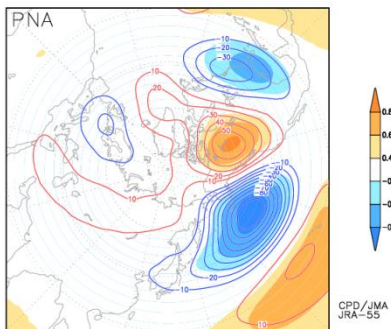
【Step 4】 Let's check teleconnection patterns.



Z500 (i.e. Geopotential Height at 500hPa)

- In general, predictabilities over mid- and high- latitude are small, but teleconnection patterns associated with tropical convection patterns are relatively reliable.
- Positive/Negative Pacific-North America (PNA) pattern and Negative/Positive Tropical-Northern Hemisphere pattern are often seen with El niño/La niña.
- Eurasia(EU) pattern has strong correlation with PNA.
- Western Pacific (WP) pattern has strong correlation with tropical convection over NINO.WEST.

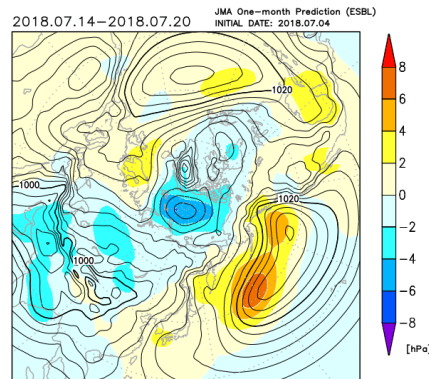
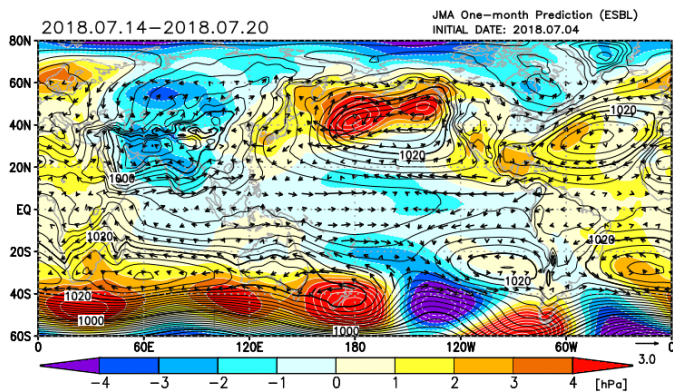
In this case, negative PNA and positive TNH are dominant.



Contours indicate predicted values. Shading indicates anomaly.

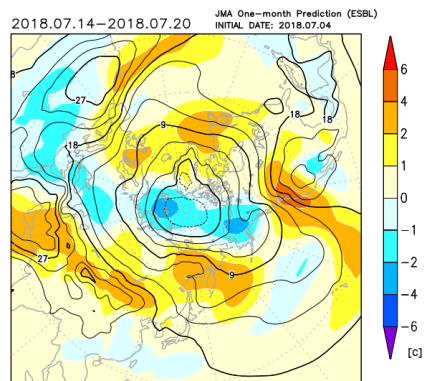
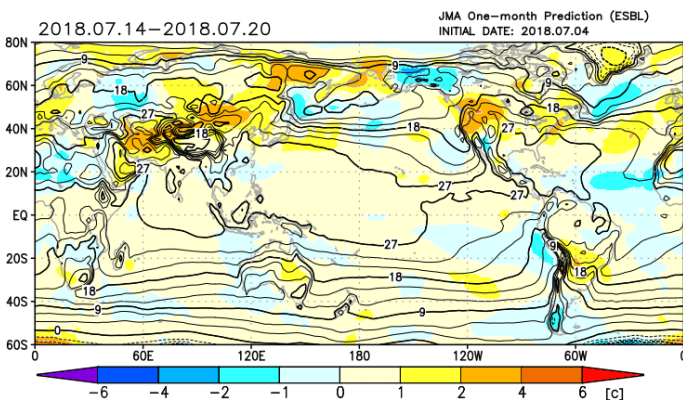
How to use NWP charts

【Step 5】 Let's check the other figures.



PSEA (i.e. Sea Surface Pressure)

Sea Surface Pressure is useful to understand Arctic Oscillation (AO), North Atlantic Oscillation (NAO) and the strength of North Pacific High, Siberian High, Aleutian Low and so on. Both tropical and northern hemisphere maps are available.



Temperature

Model output temperature is necessary to check statistical guidance reliability. If temperature in guidance is different from that in model, you should investigate the reason. A tropical map of surface temperature and a northern hemisphere map of 850hPa temperature are available.

Contours indicate predicted values. Shading indicates anomaly.

Hindcast Verification Charts for One-month forecast

Hindcast verification charts are available on the One-month prediction menus.

One-month Prediction

- › One-month Prediction (30 Nov 2017)
- › Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017)
- › Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (30 Nov 2017)
- › Verification (03 Dec 2017)
- › **Hindcast Verification *NEW***
- › One-month Probabilistic Forecasts at station points

Verifications of Global EPS for one-month prediction using its Hindcast

Hindcast Verification

- › Bias map (Mean error map)
 - › Northern hemisphere map
 - › Global map
 - › Zonal mean map
- › Hindcast maps for every initial date
 - › Northern hemisphere map
 - › Global map
- › Verification score
 - › Time-series Circulation Index
 - › Verification Score Maps
 - › Variables to be Assessed: RAIN, Z500, T850, SLP, CHI200, PSI200, PSI850
 - › Diagnostic Measures:
 - › Anomaly Correlation(ACOR)
 - › Root Mean Squared Error(RMSE)

Specifications of the hindcast

- › Model: JMA-GSM
- › Resolution: TL479L100 (up to 18 days) , TL319L100 (after 18 days)
- › Target period for verification: 1981-2010
- › Ensemble size: 5
- › Initial condition (Atmosphere): JRA-55
- › Initial condition (Land): Land surface values estimated with the land-surface model in the Global EPS using atmospheric forcing from JRA-55

Verification data

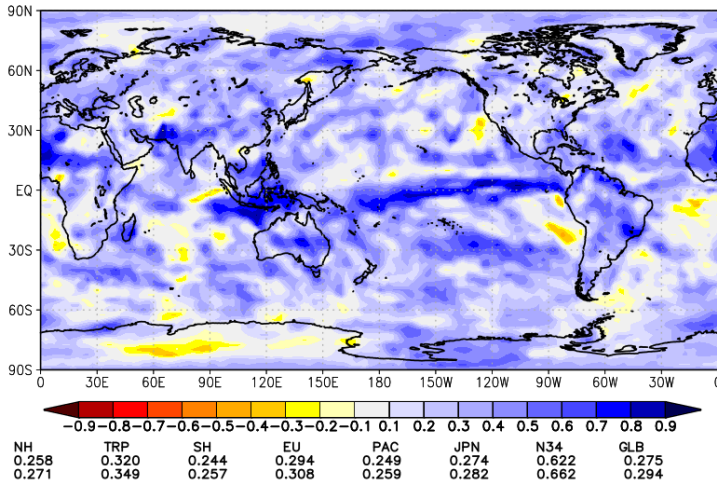
- › Precipitation (RAIN) : GPCP (Global Precipitation Climatology Project) precipitation dataset (version 2.2)
- › Atmospheric Analysis (such as Z500 and T850): JRA-55

[page top](#)

<http://ds.data.jma.go.jp/tcc/tcc/products/model/hindcast/1mE/index.html>

Verification scores for One-month forecast

<GEPS1701(05mem) : GPCP_v2.2>
 RAIN anomaly (with bias-correction)
 Anomaly Correlation for 30 years (1981-2010)
 Initial : 08.31 , 28day mean : day 03-30



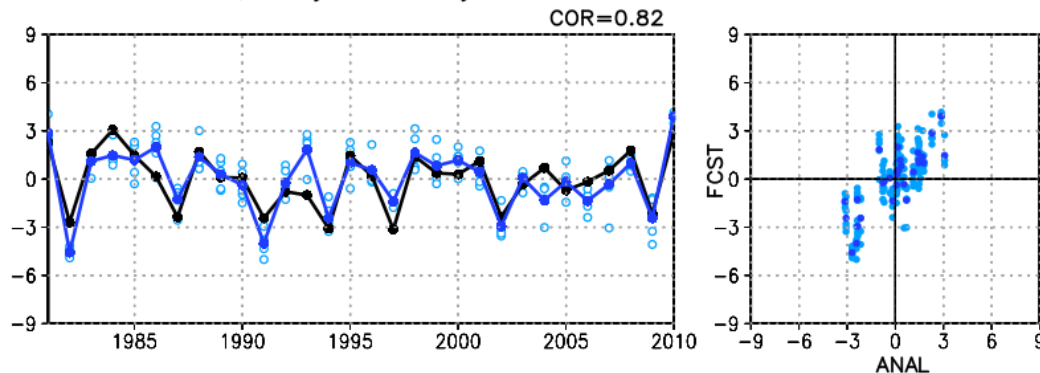
Verification Score Maps

Hindcast score maps are useful to understand the spatial prediction skills. In the low prediction skill region, it is not recommended to use model output directly. Statistical relationships to the high skill region and calibration using past observation should be considered.

Time-series circulation Index

Time-series circulation indexes are useful to understand model predictabilities of various kinds of focal phenomena such as El Niño/La Niña, Indian Ocean Dipole (IOD), monsoon rainfalls and circulations. Higher skill phenomena should be used for explanation of forecast reasons.

<GEPS1701(05mem) : GPCP_v2.2>
 RAIN MC for 30 years (1981-2010)
 Initial : 08.31 , 28day mean : day 03-30



One-month probabilistic forecast at station points

Top page

One month probabilistic for... x +

ds.data.jma.go.jp/tcc/tcc/products/guidancetst/ 検索

よく見るページ Firefox を使いこな... Web スライス ギャ... おすすめサイト JMA K1 EOF

気象庁 Japan Meteorological Agency Tokyo Climate Center WMO Regional Climate Center in RA II (Asia) WMO

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Home World Climate Climate System Monitoring El Niño Monitoring NWP Model Prediction Global Warming Climate in Japan Training Module Press release Links

HOME > NWP Model Prediction > Probabilistic forecasts

One-month probabilistic forecasts at station points

Announcement

28 April 2014

- New forecast maps from 5 March to 9 April 2014 (initial forecast time) are currently available.

21 April 2014

- Forecast maps from 5 March to 9 April 2014 (initial forecast time) are currently not available. New maps will be made available soon.

6 March 2014

- JMA updated its one-month forecast system on 6 March 2014.
 - Provision of probabilistic one-month forecast for Japan was discontinued. Please refer to [official one-month forecast](#).

21 December 2012

- Ensemble mean and standard deviation values have been newly added in the histogram for each forecast station point.
- Forecast station (Hong Kong Observatory) has been newly added.

Introduction

JMA started probabilistic one-month forecast for 7-day averaged surface temperature and 14-day averaged precipitation. The Model Output Statistics (MOS) technique with the 30-year (1981-2010) hindcasts is used to generate the forecasts. The thresholds of three categories (below normal, normal and above normal) are determined so that the climatological chance of occurrence for each category is 33.3% for the period from 1981 to 2010. Model Outline is [here](#).

Surface temperature

- Probabilistic forecasts of surface temperature in Southeast Asia

Precipitation

- Probabilistic forecasts of precipitation in Southeast Asia

Download

- Download of sample source code

- ### One-month Prediction
- One-month Prediction (30 Nov 2017)
 - Z500, T850 & SLP (Northern Hemisphere) (30 Nov 2017)
 - Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (30 Nov 2017)
 - Verification (03 Dec 2017)
 - Hindcast Verification **NEW**
 - One-month Probabilistic Forecasts at station points**

<probabilistic forecast map in Southeast Asia>
temperature

<Probabilistic forecast map in Southeast Asia>
precipitation

One-month probabilistic forecast at station points

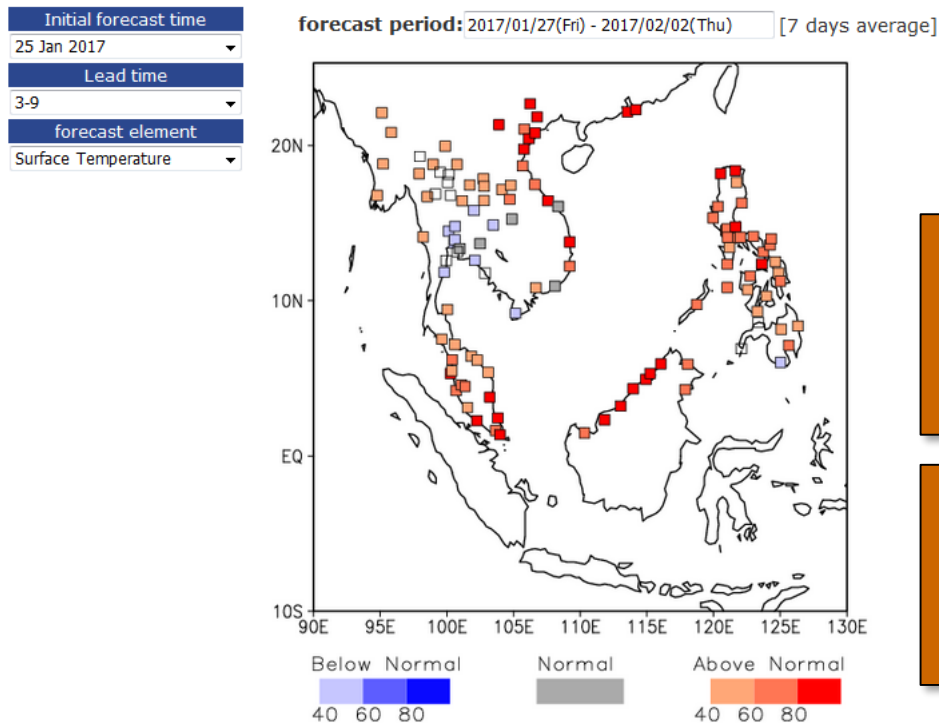
Probability map page

<http://ds.data.jma.go.jp/tcc/tcc/products/guidancetst/>

Probabilistic forecasts map

This product is displayed for use by National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any nation.

If you move your mouse over the observation points on the map, the station's name and histogram which you chose are appeared. Please click the point to see the chart of verification data.



[« download text](#)

Target Element

Surface Temperature (7Day Average)
Precipitation (14Day Average; Power of $\frac{1}{4}$)

Target Event

Below Normal; Normal; Above Normal
(Each Category: 33.3%)

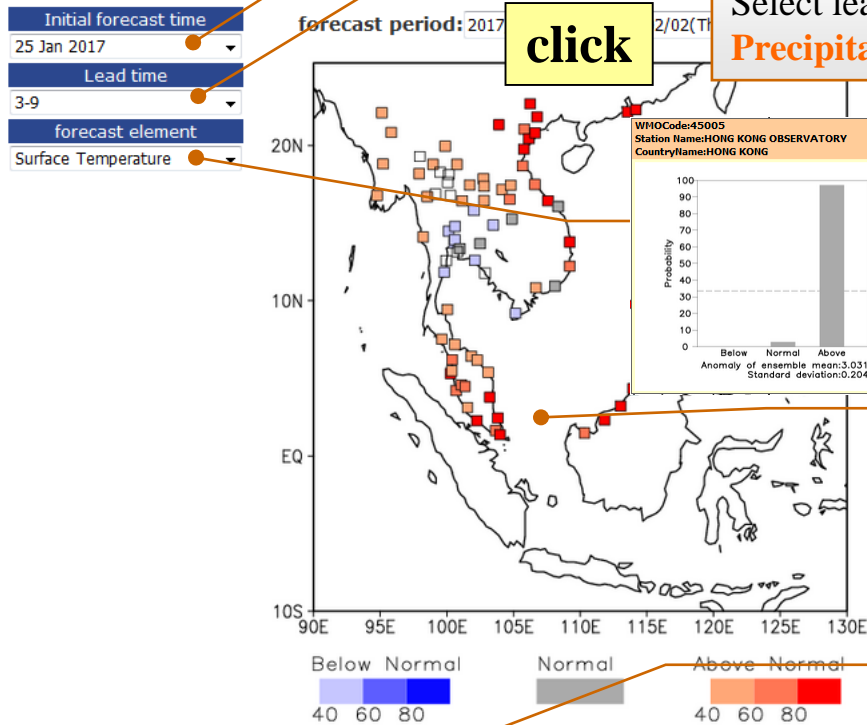
One-month probabilistic forecast at station points

Probability map page

Probabilistic forecasts map

This product is displayed for use by National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any nation.

If you move your mouse over the observation points on the map, the station's information will be displayed. Please click the point to see the chart of verification data.



<initial time>

Select initial forecast date

<lead time>

Select lead time from forecast date.

Precipitation is 14 days averaged data, temperature is 7 days averaged

<Mean & Standard Deviation>

<element>

Select **temperature or precipitation**.

If you change this, lead time is also changed

<stations>

Colors indicate probability.

When mouse point is on a station, **bar graph** is appear.

If you click a station, new window is open, you can see **verification graph** on clicked station.

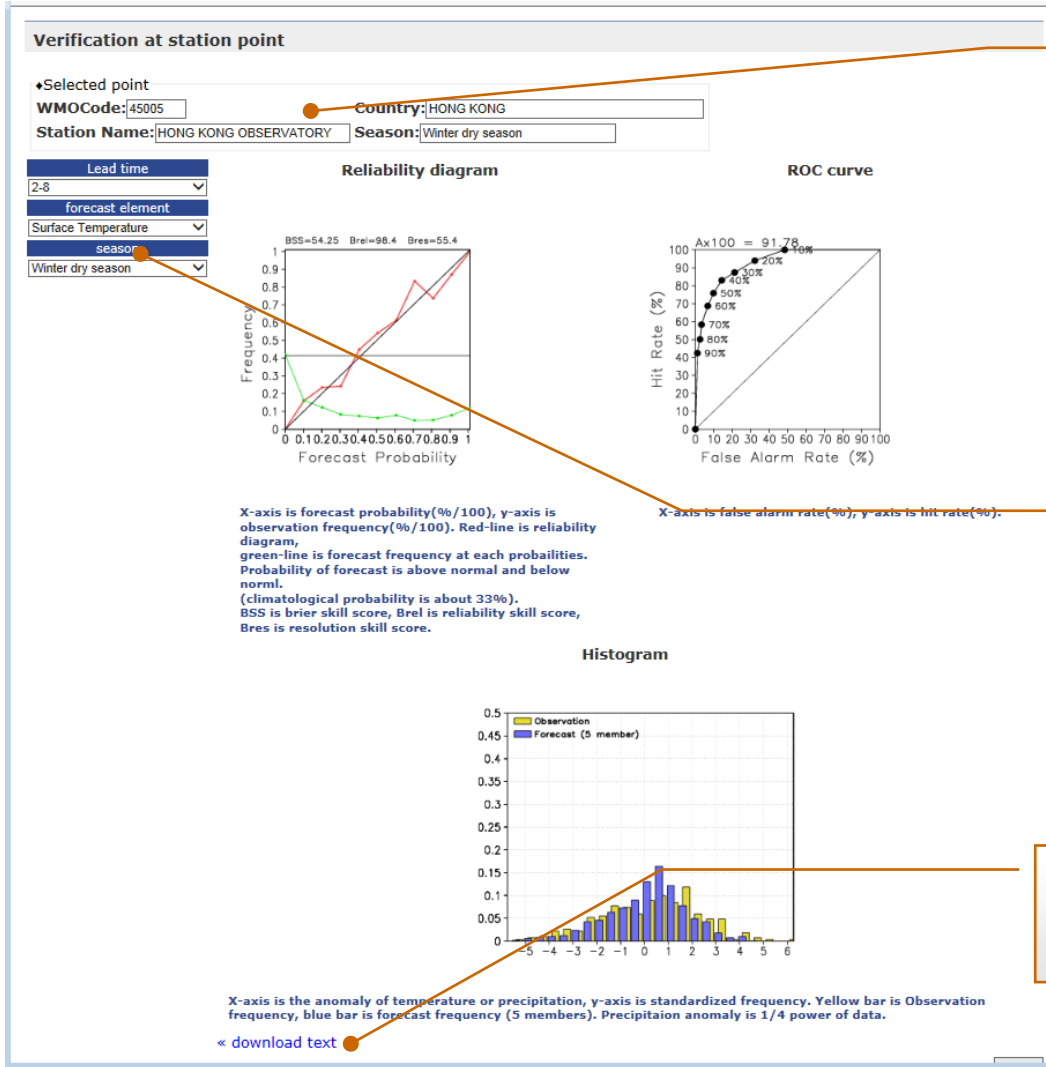
<download>

Download text file written every stations probability.

← download text

<http://ds.data.jma.go.jp/tcc/tcc/products/guidancetst/>

One-month probabilistic forecast at station points



<station information>
 Information of Clicked station

<season>
 Seasons that statistics equation made in.

- winter dry season (Jan-Mar)
- pre-monsoon season (Apr-May)
- summer monsoon season (Jun-Sep)
- post-monsoon season (Oct-Dec)

<download>
 Download text written verification data.

Extreme Forecast Index (EFI) products



Tokyo Climate Center
WMO Regional Climate Center in RA II (Asia)



- Home
- World Climate
- Climate System Monitoring
- El Niño Monitoring
- NWP Model Prediction
- Global Warming
- Climate in Japan
- Training Module
- Press release
- Links

HOME > Ensemble Model Prediction

JMA's Ensemble Prediction System (Products of GPC Tokyo)

JMA operates the ensemble prediction system of an atmospheric global circulation model (AGCM) for one-month prediction and atmosphere-ocean coupled global climate model (AGCM-CO2) for three-month and warm/cold season prediction. Ensemble prediction products, verification charts and description of the ensemble prediction system are available on this page.

Notice	Main Products
<ul style="list-style-type: none"> 28 August 2014 The provision of "Forecast Products in Support of Early Warnings for Extreme Weather Events" started. 25 March 2014 The forecast products for the "Discussion on Seasonal Climate Outlooks" started on a trial basis. 6 March 2014 JMA's one-month forecast model has been upgraded. Please refer to the "TCC News No. 35" for details. 8 May 2013 The model statistics for the forecast products for the warm/cold season were updated on 18 April 2013. The period for the model statistics are changed to 1981-2010. 7 March 2013 Hindcast gridded data were available for the period up to 2009 for one-month forecast and up to 2008 for three-month and warm/cold season forecasts. Recently, hindcast gridded data up to 2010 for one-month, three-month and warm/cold season forecasts have been made available at http://ds.data.jma.go.jp/tcc/tcc/gpv/index.html (available only for registered NMHSs). Gridded data for seasonal forecasts have been made available on the http://ds.data.jma.go.jp/tcc/tcc/products/model/index.html page for details. 	<p>One-month Prediction</p> <ul style="list-style-type: none"> One-month Prediction (27 Nov 2014) Z500, T850 & SLP (Northern Hemisphere) (27 Nov 2014) Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (27 Nov 2014) Verification (8 Nov 2014) Hindcast One-month Probabilistic Forecasts at station points <p>Three-month Prediction</p> <ul style="list-style-type: none"> Three-month Prediction (14 Nov 2014) Z500, T850 & SLP (Northern Hemisphere) (14 Nov 2014) Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (14 Nov 2014) Verification (8 Nov 2014) Hindcast Probabilistic Forecast and Verification (14 Nov 2014) <p>Warm/Cold Season Prediction</p> <ul style="list-style-type: none"> Warm/Cold Season Prediction (15 Oct 2014) Z500, T850 & SLP (Northern Hemisphere) (15 Oct 2014) Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (15 Oct 2014) Verification (24 Sep 2014) Hindcast Probabilistic Forecast and Verification (15 Oct 2014) <p>Model Descriptions</p> <ul style="list-style-type: none"> Model Descriptions Outline Operations for Gridded-range Forecast Model Operations for Long-range Forecast Model
	<p>Monthly Discussion on Seasonal Climate Outlooks (Monitoring & Prediction)</p> <p>Monthly Discussion on Seasonal Climate Outlooks (Monitoring & Prediction) - Trial provision</p> <p>This product is intended to assist NMHSs in the Asia-Pacific region in interpreting GPC Tokyo's three-month prediction products for the warm/cold season prediction products.</p>
	<p>Forecast Products in Support of Early Warnings for Extreme Weather Events</p> <p>Early warning products for extreme weather events covering the period to two weeks ahead. (Only registered NMHSs can access this page.)</p> <ul style="list-style-type: none"> Application If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp
	<p>Download GPC Long-range Forecast (LRF) Products</p> <ul style="list-style-type: none"> Download Gridded data File (Available only for registered NMHSs) Application If you have any questions about ID and/or password, please e-mail to: tcc@met.kishou.go.jp

Latest Products (One-month, Three-month, Warm/Cold season)

NWP Model Prediction

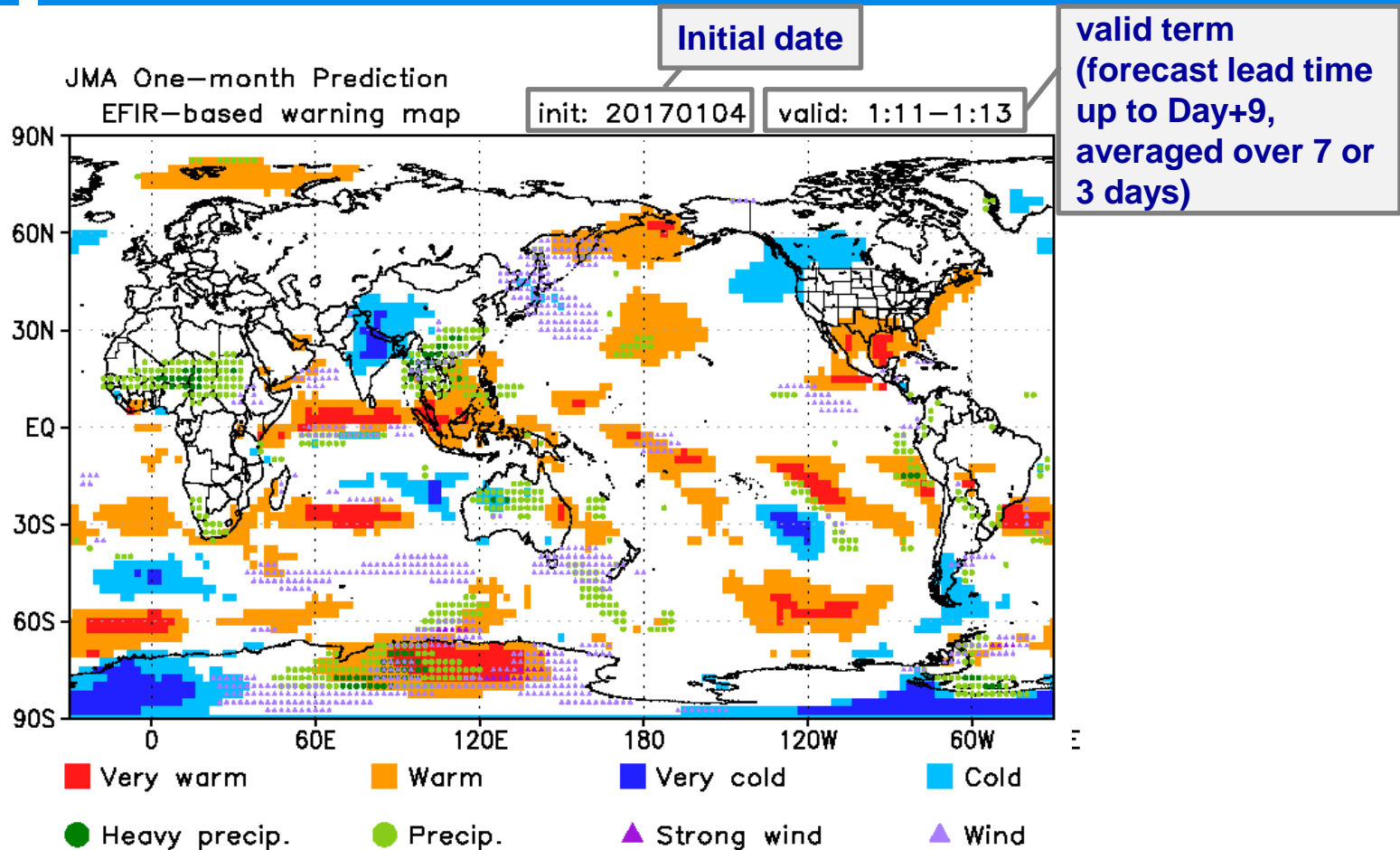
Monthly Discussion on Seasonal Climate Outlooks (Monitoring & Prediction)

Products for Early Warning using EFI

Download GPV (Recent predictions and hindcast)

<http://ds.data.jma.go.jp/tcc/tcc/products/model/index.html>

Extreme weather warning map

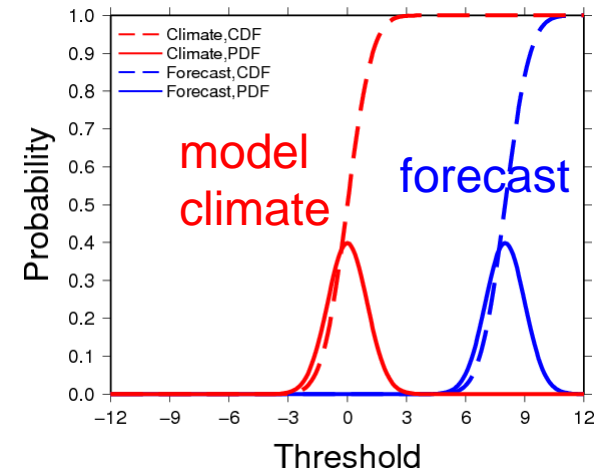
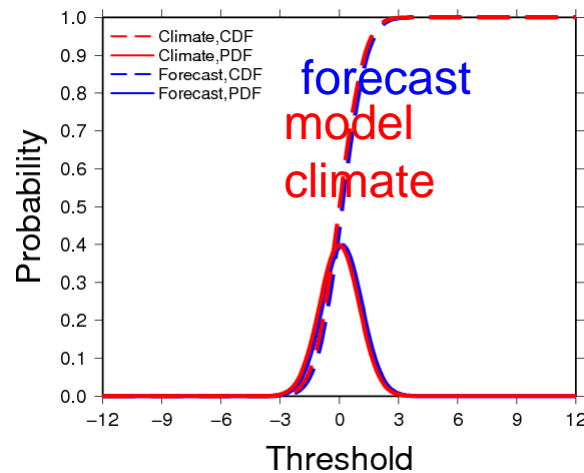
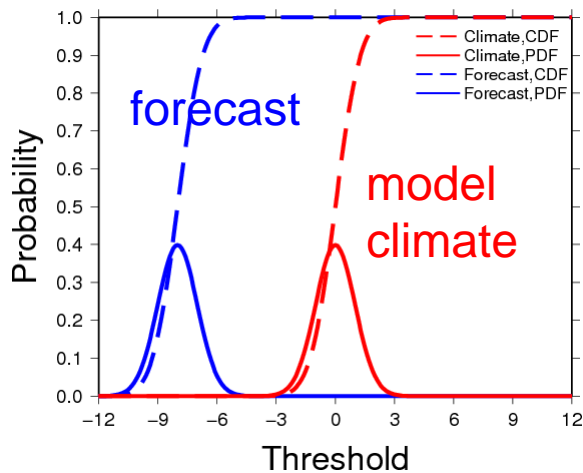


Occurrence probabilities for various extreme events are plotted on one map based on the following EFI thresholds.

Very warm, Very cold, Heavy precip. and Strong wind : $|EFI| \geq 0.8$
 Warm, Cold, Precip. and Wind : $|EFI| \geq 0.5$

The Extreme Forecast Index (EFI)

- The EFI value (from -1 to 1) is computed from the difference between cumulative distribution function (CDF) curves of the real-time **forecast** distribution and **model climate** distribution (Lalurette 2002, 2003).
- Underlying assumption: if a **forecast** is extreme with respect to **model climate**, the real world is also likely to be extreme compared to the real climate

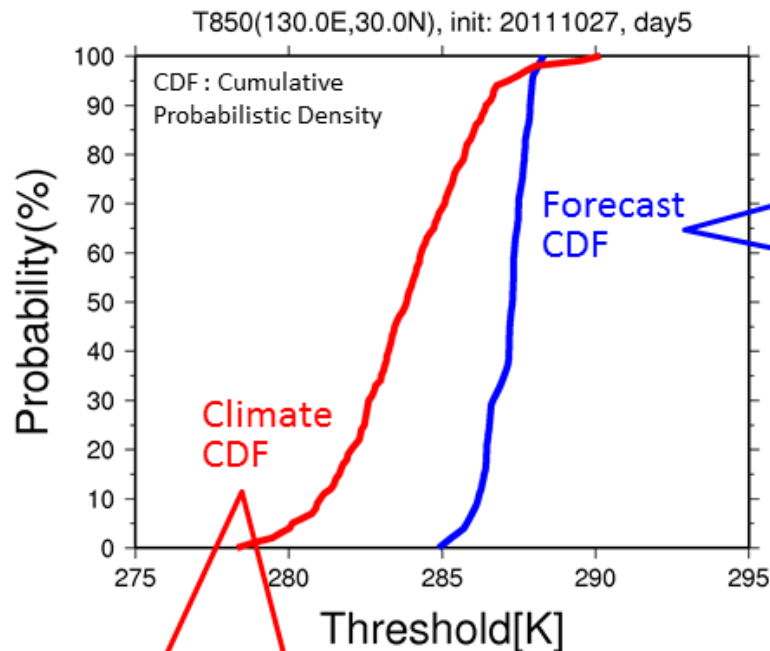


EFI=-1.0 (minimum)
All **forecast** values are below the minimum of **model climate**

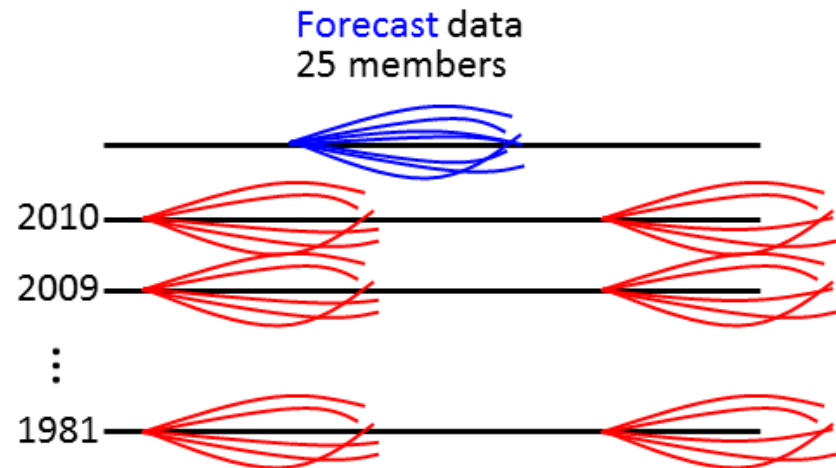
EFI=0
Forecast distribution agrees with **model climate** distribution

EFI=+1.0 (maximum)
All **forecast** values are above the maximum of **model climate**

How to obtain probabilistic distributions



Forecast CDFs (cumulative distribution functions) are produced from JMA's operational One-month EPS (25 members for each initial day).



Climate CDF estimation is based on five-member hindcasts starting with the nearest two initial calendar dates for the one-month EPS initial date.
size : 5-member × 30 years × 2 initials = 300 members

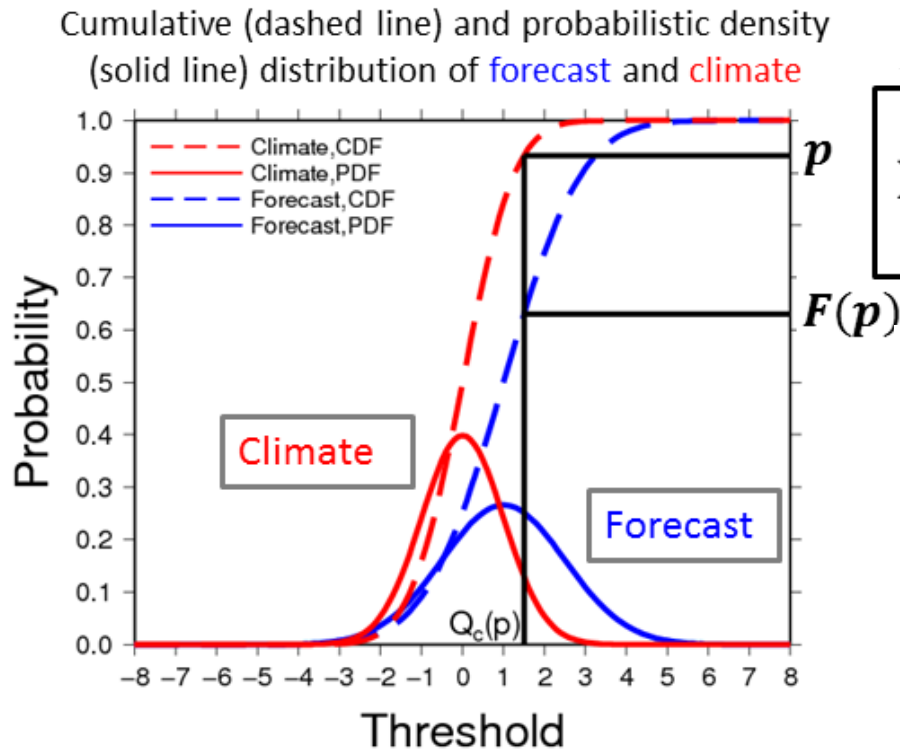
Hindcast data
300 members (5 members × 2 initials × 30 years)

Compare [Forecast FT=O] and [model climate FT=O].

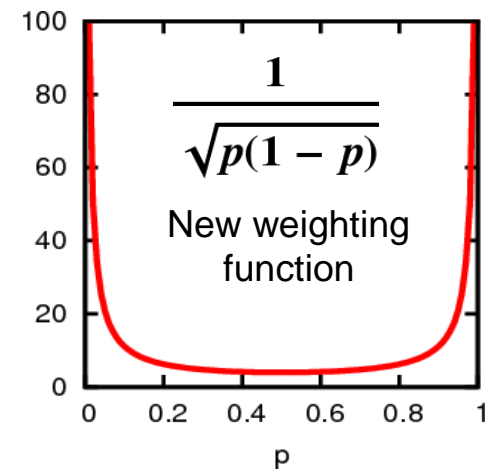


The revised EFI on the JMA's TCC website

- To add more weights in the tails of the probability distributions, the EFI calculation is revised with new weighting function (Zsótér 2006).
- The EFI products on the JMA's TCC website are based on the revised EFI.

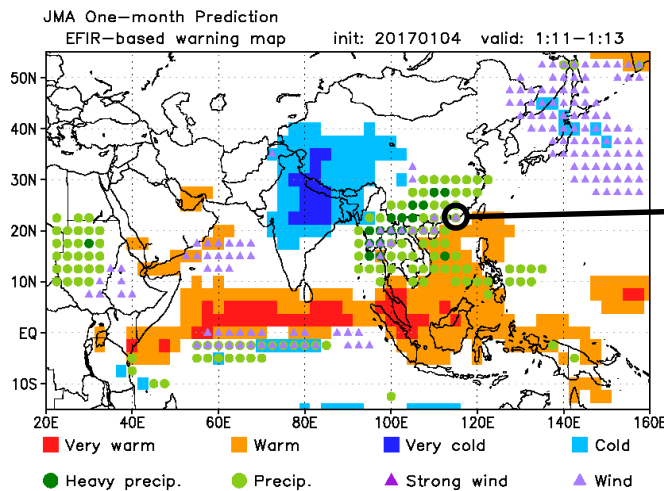


$$EFI_{revised} = \frac{2}{\pi} \int_0^1 \frac{p - F(p)}{\sqrt{p(1-p)}} dp$$



EFI time-series and Meteogram

- Comparing EFI value with PDF is important before issuing warnings or undertaking any action, because the EFI values do not indicate probabilities.



Element
(U850,
Tsurf,
Rain)

Chosen location (2.5° x 2.5° grid)

Initial date

Averaged
days

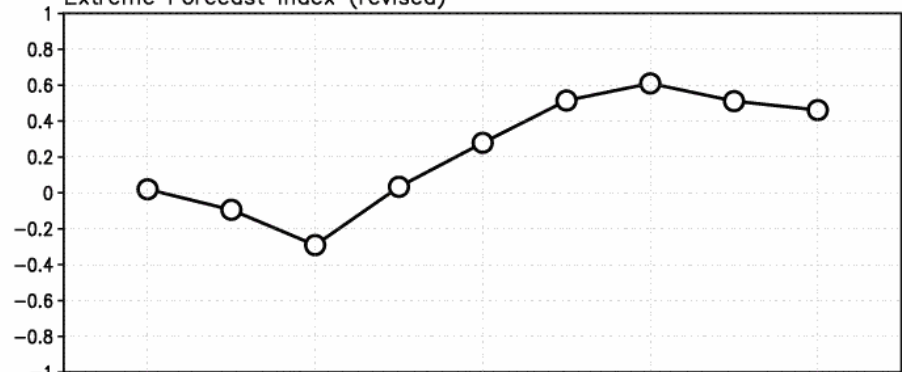
JMA One-month Prediction Meteogram

elm: UA_850

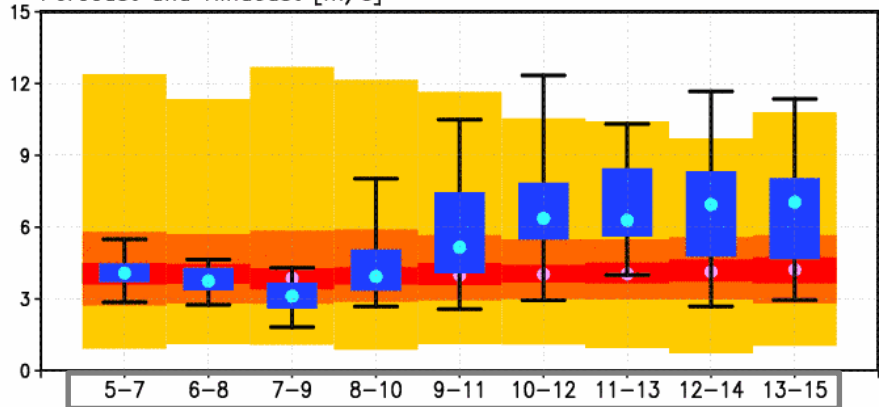
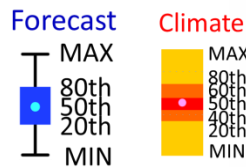
(lon,lat)=(115.0,22.5)

init: 20170104 average(day): 3

Extreme Forecast Index (revised)



Forecast and Hindcast [m/s]

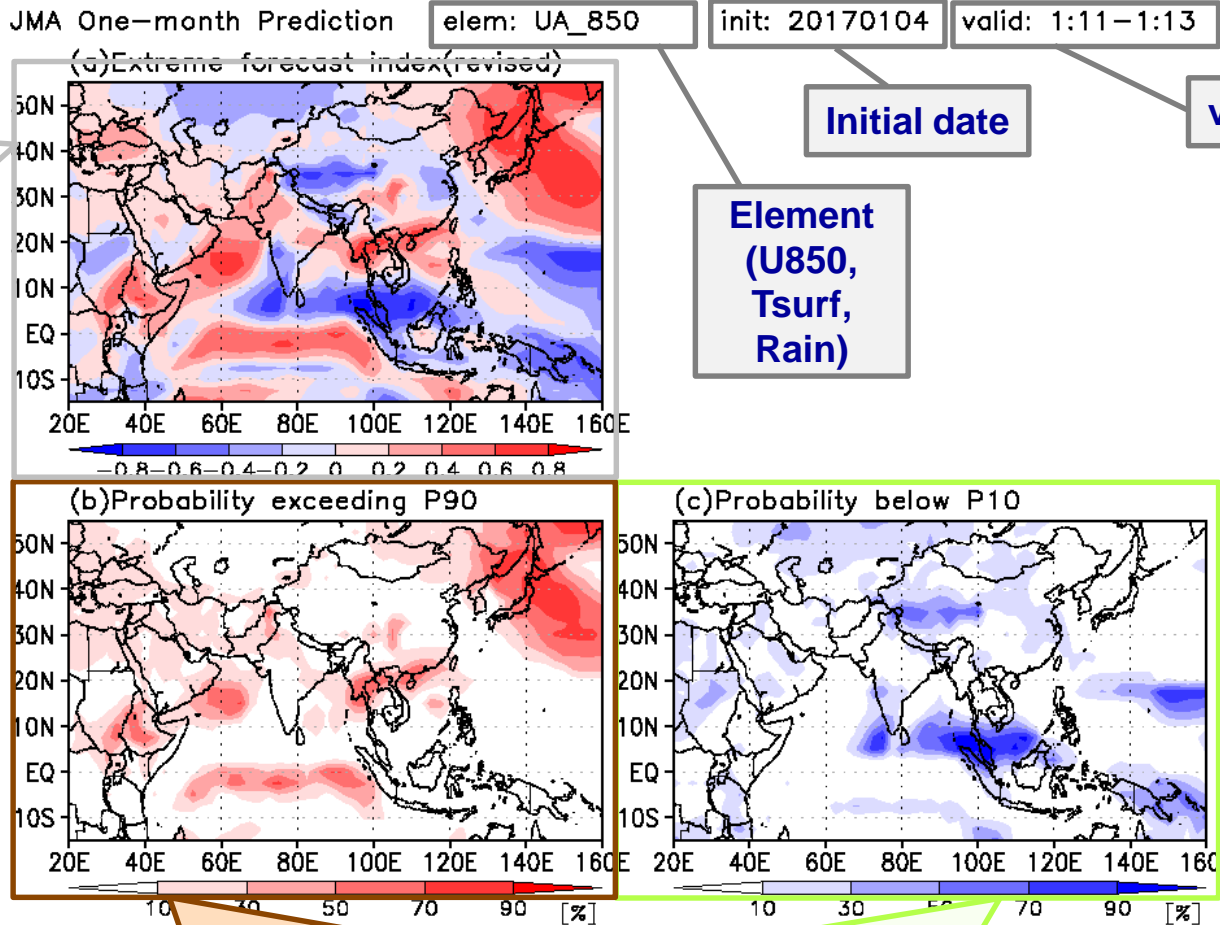


EPS probability distributions of the
forecast (25 members) and the
model climate (300 members)

Valid date

EFI map and probability map

Horizontal map of the revised EFI



Element
(U850,
Tsurf,
Rain)

Initial date

valid term

The fraction of ensemble members that predict a value **above the 90th percentile** of the model climatology to 25 members

The fraction of ensemble members that predict a value **below the 10th percentile** of the model climatology to 25 members

Summaries

■ Predictability

- There are 2 kinds of predictability.
 - Predictability of 1st kind depends on an initial condition.
 - Predictability of 2nd kind depends on boundary conditions.
- Temporal and spatial scales of forecast targets should be considered.

■ Uncertainty

- Because of chaotic nature, it is essential to consider uncertainty.
- Ensemble prediction system (EPS) make it possible to estimate uncertainty.

■ Hindcast

- Hindcast is essential to understand prediction skill and to make model climate.

■ Global EPS

- A high-resolution AGCM is used for extended range forecast (Predictability of 1st kind).
- Seasonal oscillations such as MJO and BSISO make a monsoon rainfall forecast difficult.
- MJO is predictable up to 25 days, but velocity and amplitude bias should be cared.
- Sub-seasonal to seasonal (S2S) prediction project

■ TCC products to support 1-month forecast

- NWP charts
- Verification charts
- Probabilistic products
- Extreme Forecast Index (EFI) products