JMA Ensemble Prediction System (EPS) for seasonal prediction

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Outline

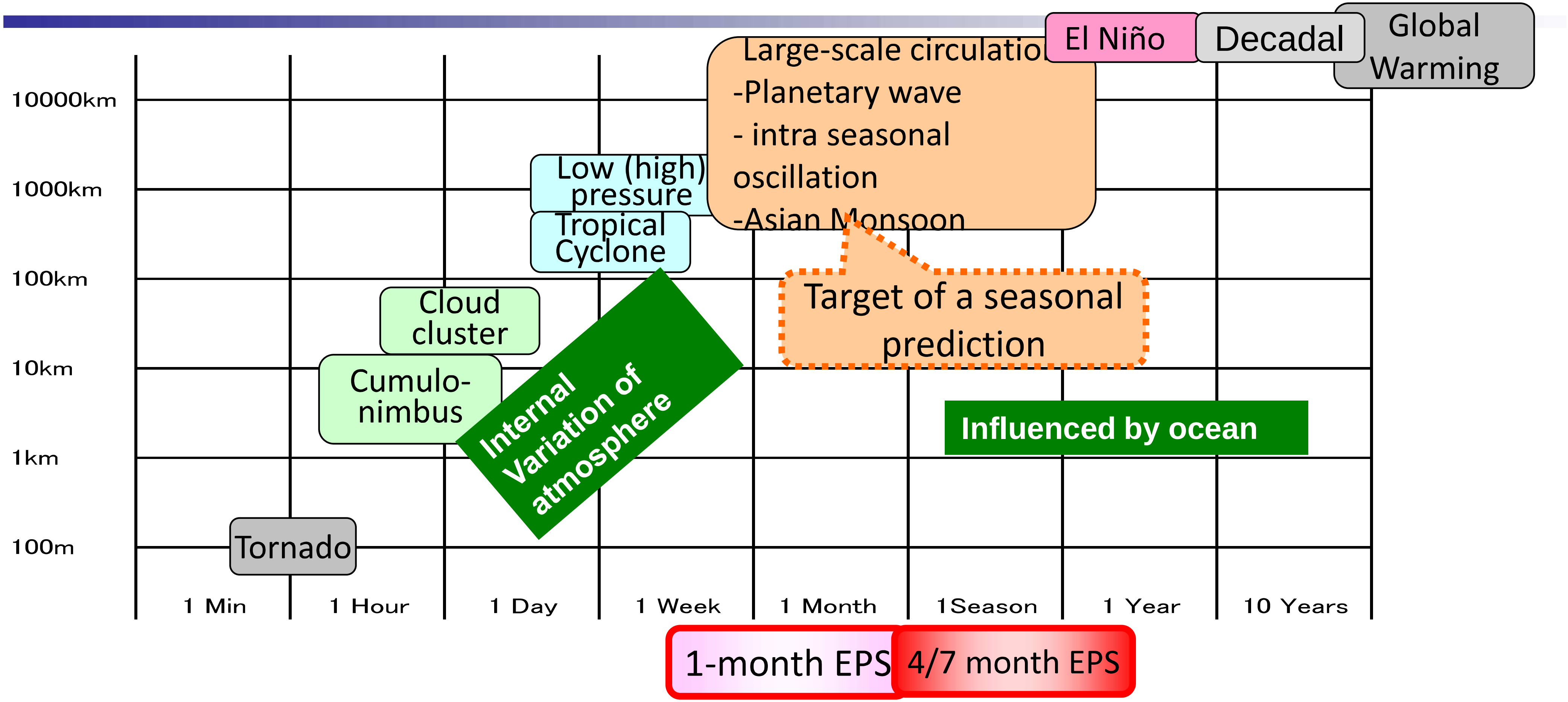
- Introduction
  - Differences between short-range and seasonal forecasting
  - Uncertainty of prediction
  - Concept of an ensemble prediction
  - Predictability
- Outline of the JMA operational EPS
  - Overview of the JMA Ensemble prediction system for seasonal prediction
    - 1-month EPS (Main target of this seminar), 4/7 month EPS
  - Hindcast
  - Prediction skill of the 1-month EPS
- Model products on the TCC website

  (Mainly introduce the product of the 1-month EPS)
- First step guide for usage of the gridded dataset (Grid Point Values; GPVs)
  - Demonstration of downloading and visualizing the gridded dataset

Introduction

- Differences between short-range and seasonal forecasting
- Uncertainty of prediction
- Concept of an ensemble prediction
- Predictability

Classification of atmospheric variations according to spatial and temporal scale



•The main target of seasonal prediction is large-scale circulation of the atmosphere, which is largely affected by oceanic variations.

WMO Classification of meteorological forecasting
(GDPFS Manual)

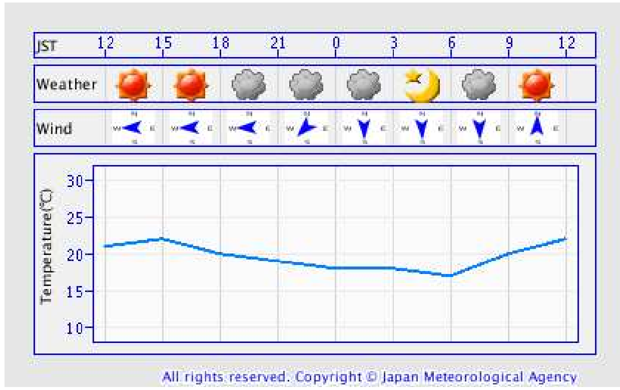
	Forecasting target period
Nowcasting	Up to 2 hours
Very short-range weather forecasting	Up to 12 hours
Short-range forecasting	Beyond 12 hours and up to 72 hours
Medium-range weather forecasting	Beyond 72 hours and up to 240 hours
Extended-range weather forecasting	Beyond 10 days and up to 30 days
Long-range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

Seasonal forecasting

Manual on the Global Data-processing and Forecasting System, Appendix I-4
(http://www.wmo.int/pages/prog/www/DPFS/Manual_GDPFS.html)

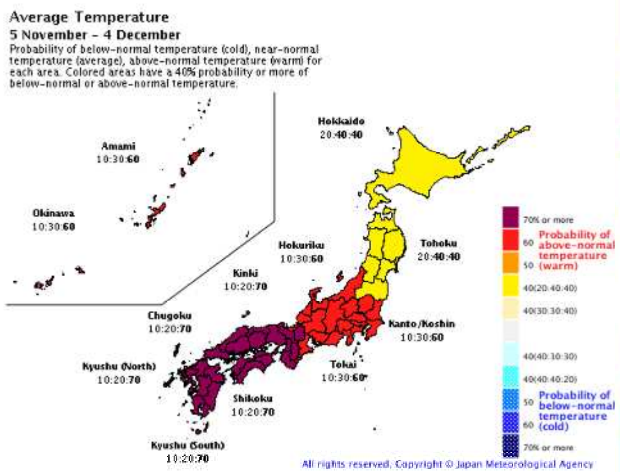
Difference between short-range and seasonal forecasting

- **Short-range prediction** (up to about 1 week) describes weather parameter variation itself. (not deviation, not averaged)



3-hourly forecasts of Tokyo (issued at 11:00 JST, 4 Nov. 2011)

- **Seasonal forecasting** describes averaged weather parameters, expressed as a departure (deviation, variation, anomaly) from climate values for that period.



1-month forecast (issued on 28 Oct. 2011)

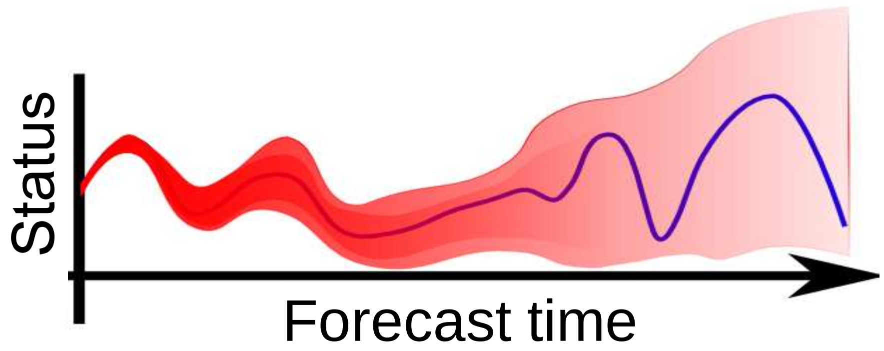
Uncertainty of prediction

- Causes of prediction error
  - Uncertainty of an initial condition
    - limitation of observation data (especially in ocean)
    - observation error
    - Errors in the objective analysis procedure
  - Uncertainty of the boundary conditions

    (ex. SSTs for AGCM)
  - Uncertainty of an NWP model
    - certain limits of resolution
    - Many approximations in the physical processes (Parameterization)

Growth of initial error -> Ensemble prediction

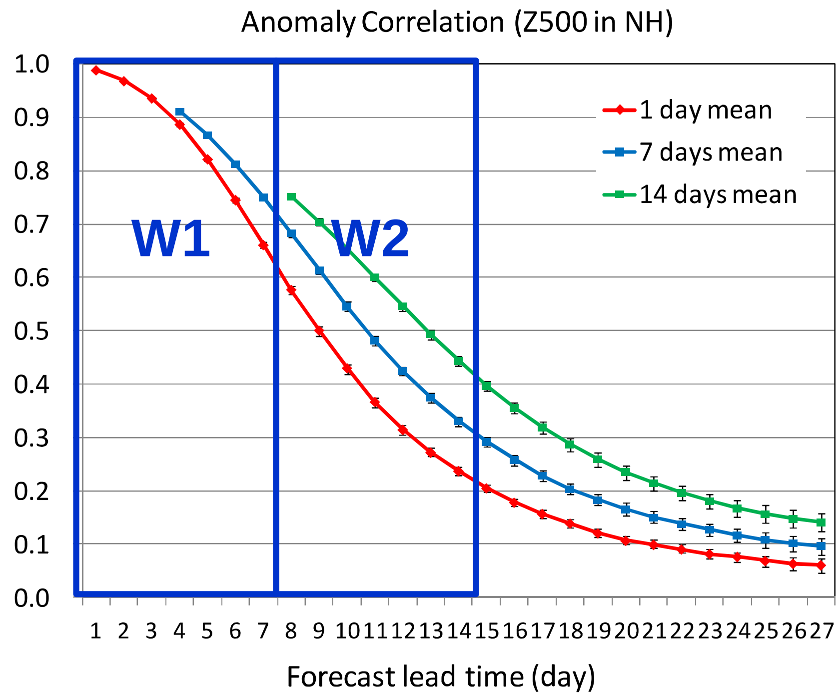
- Errors contained in the initial states rapidly grows in the beginning of the prediction due to chaotic behavior of atmosphere.



- The limit of deterministic forecast is fewer than 2-weeks.

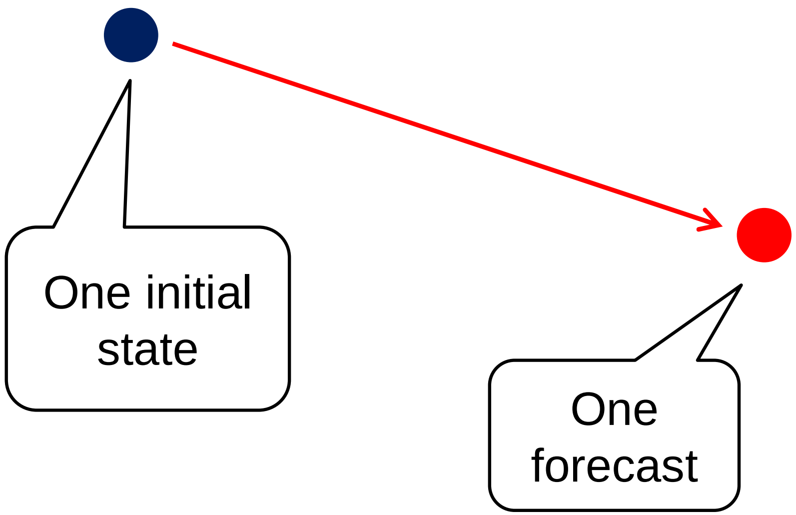
- The necessity of probabilistic forecast for seasonal forecasting

Ensemble prediction is essential for seasonal forecasting



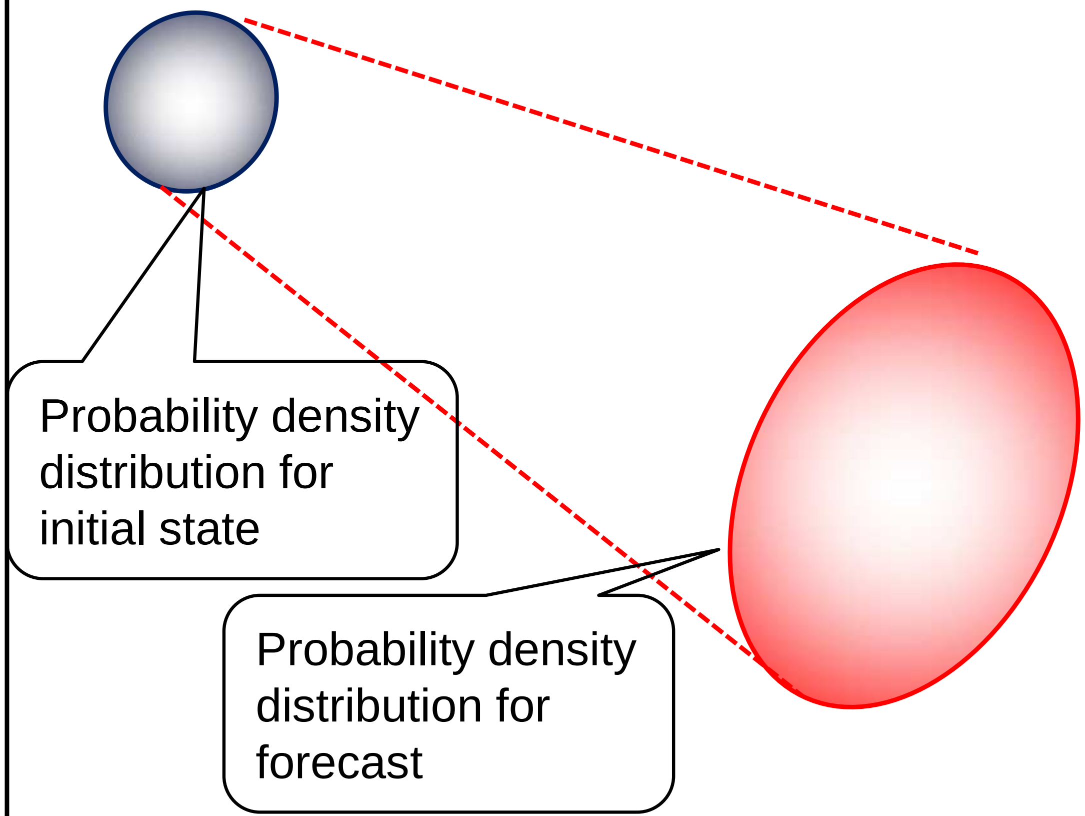
Deterministic and probabilistic forecast

Deterministic forecast



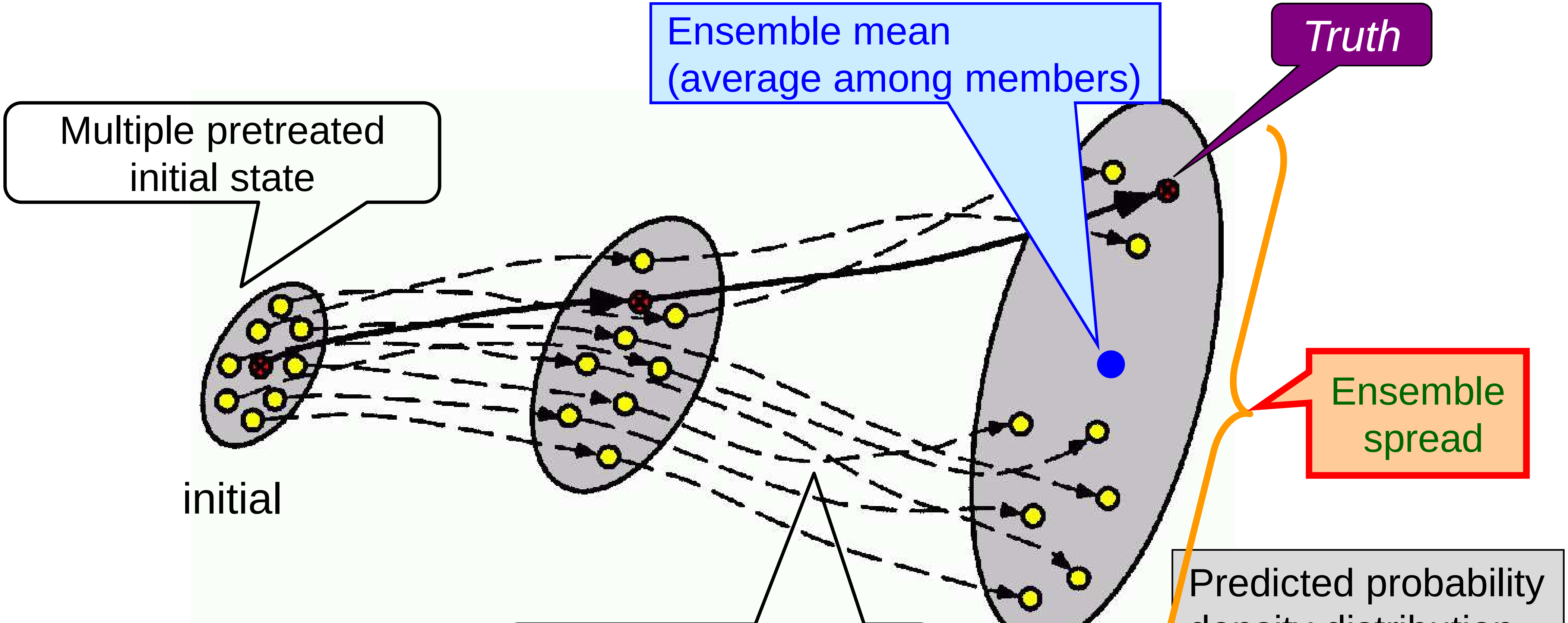
Calculate one forecast using one initial state

Probabilistic forecast



Concept of ensemble prediction

•Initial ensemble prediction
calculating model using slightly different initial condition (perturbation)



Individual prediction is called as "member"

(Reference)
Ensemble mean and Ensemble spread

- Basics of the ensemble prediction statistics
  - Ensemble mean : average of the all member results
  - Ensemble spread :
    - Standard deviation of individual ensemble members members
    - indicate variability of predictions

RMSE of ensemble mean forecast

Spread: $$s = \sqrt{\frac{1}{M}\sum_{i=1}^{m}\left(x_i^m - \bar{x}\right)^2}$$

((Hopefully)) comparable

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(f_i - a_i)^2}$$

x_i: predictions by each member,
$\bar{x}$: ensemble mean

f_i: predictions, a_i: truths

- Idealized ensemble prediction system:
  (error of ensemble mean) = (ensemble spread)

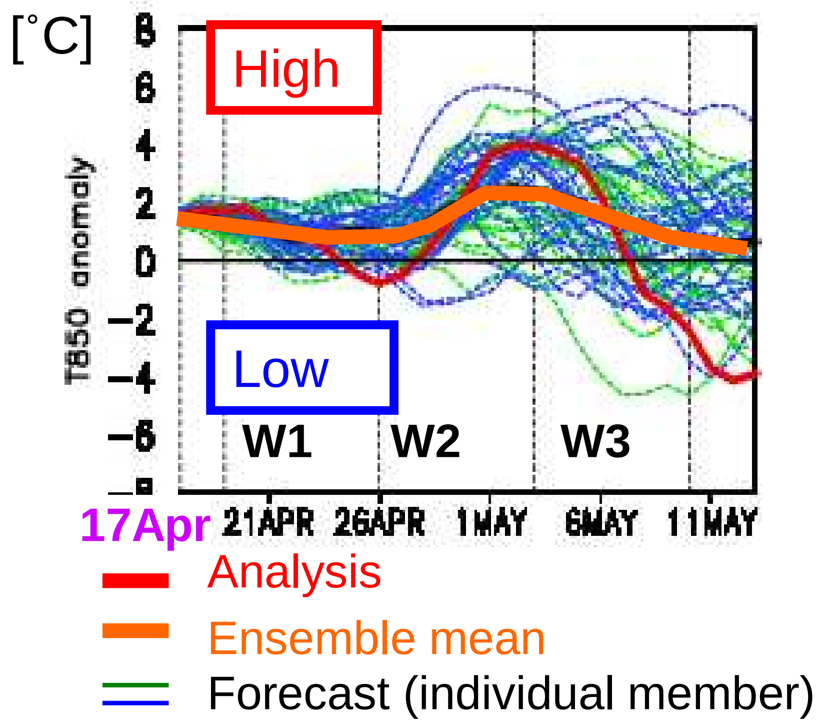
Example of uncertainty of initial condition

- Ensemble mean
  - average of the all member
  - most likely forecast
  - Ensemble mean is better forecast than the individual member forecast.

Statistically (in huge cases), MSE for ensemble mean (E) would be about half of MSE for one member (e), if model and perturbation would be perfect.

T850 anomaly over Eastern Japan

(initial date: 17Apr2008)



$$\langle E^2 \rangle = \left(1 - \frac{N-1}{2N}\right)\langle e^2 \rangle$$

(N is about 50 for typical EPS)

Merits of an ensemble prediction

- Ensemble prediction: Prediction with the multiple member

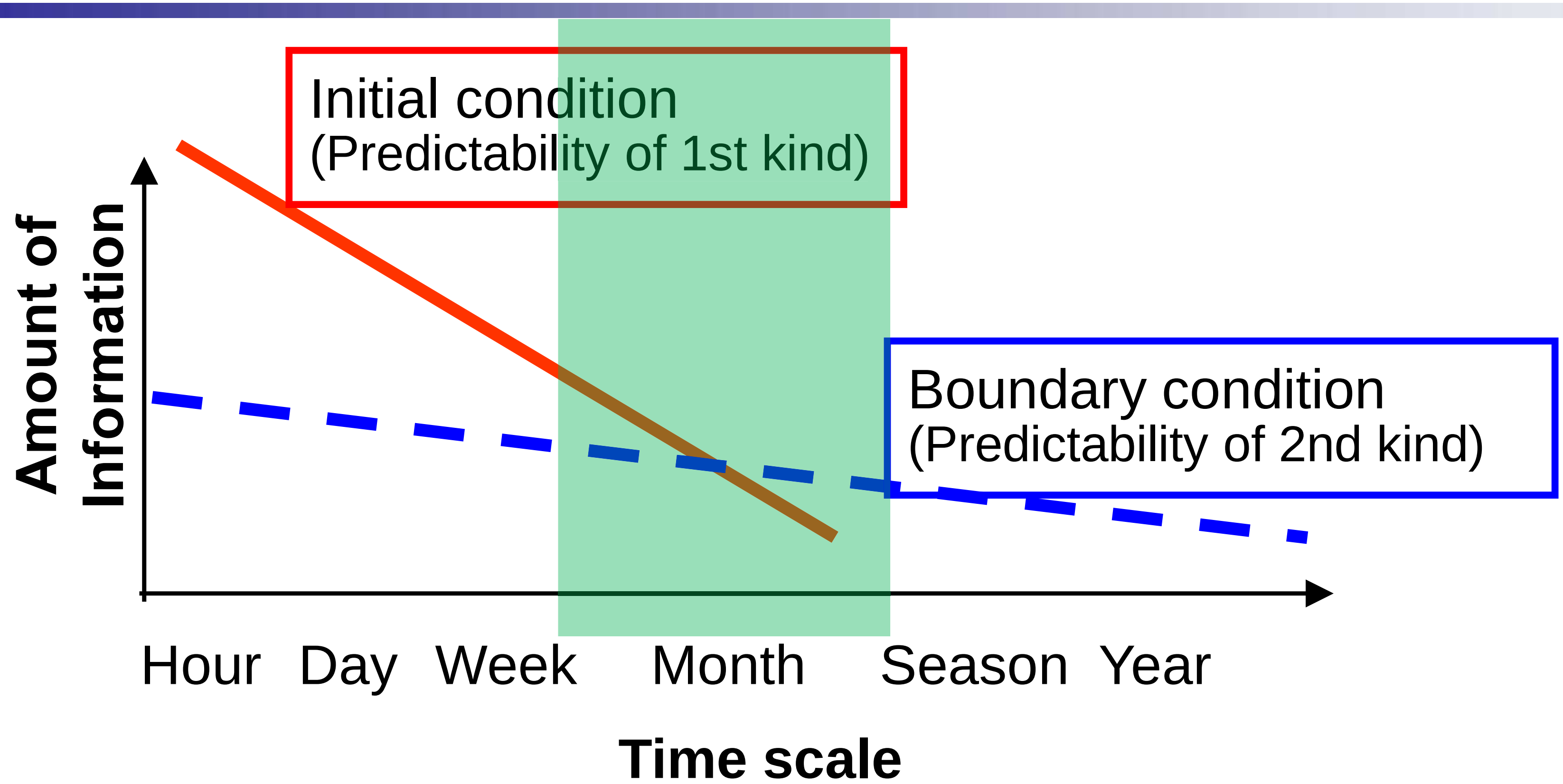
- Ensemble mean: Possible to increase prediction skill comparing with the one member forecast
- Probability density distribution: Possible to predict probability of the targeted phenomena

- (Notice) It is not correct that *"some members might be hit when many members are prepared".*

Two kinds of Predictability

- Predictability came from initial state (predictability of 1st kind)
  - Initial error rapidly grows due to chaotic nature of the atmosphere.
  - Limitation of a deterministic forecasting is about 2-weeks.
- Predictability came from boundary condition (predictability of 2nd kind)
  - As lead time becomes long, deterministic forecasting falls.
    - → Probabilistic forecasting with Ensemble prediction system (EPS)
  - Forcing by boundaries (especially ocean) on atmosphere is "signal" for seasonal forecasting.

Importance of initial and boundary condition



- For shorter range, initial condition is important.
- For longer range, impact of boundary condition become large.
- For one month forecasting, both are important.

Outline of the JMA operational EPS

- Overview of the JMA Ensemble prediction system for seasonal prediction
  - 1-month EPS (Main target of this seminar), 4/7 month EPS
- Hindcast
- Prediction skill of the 1-month EPS

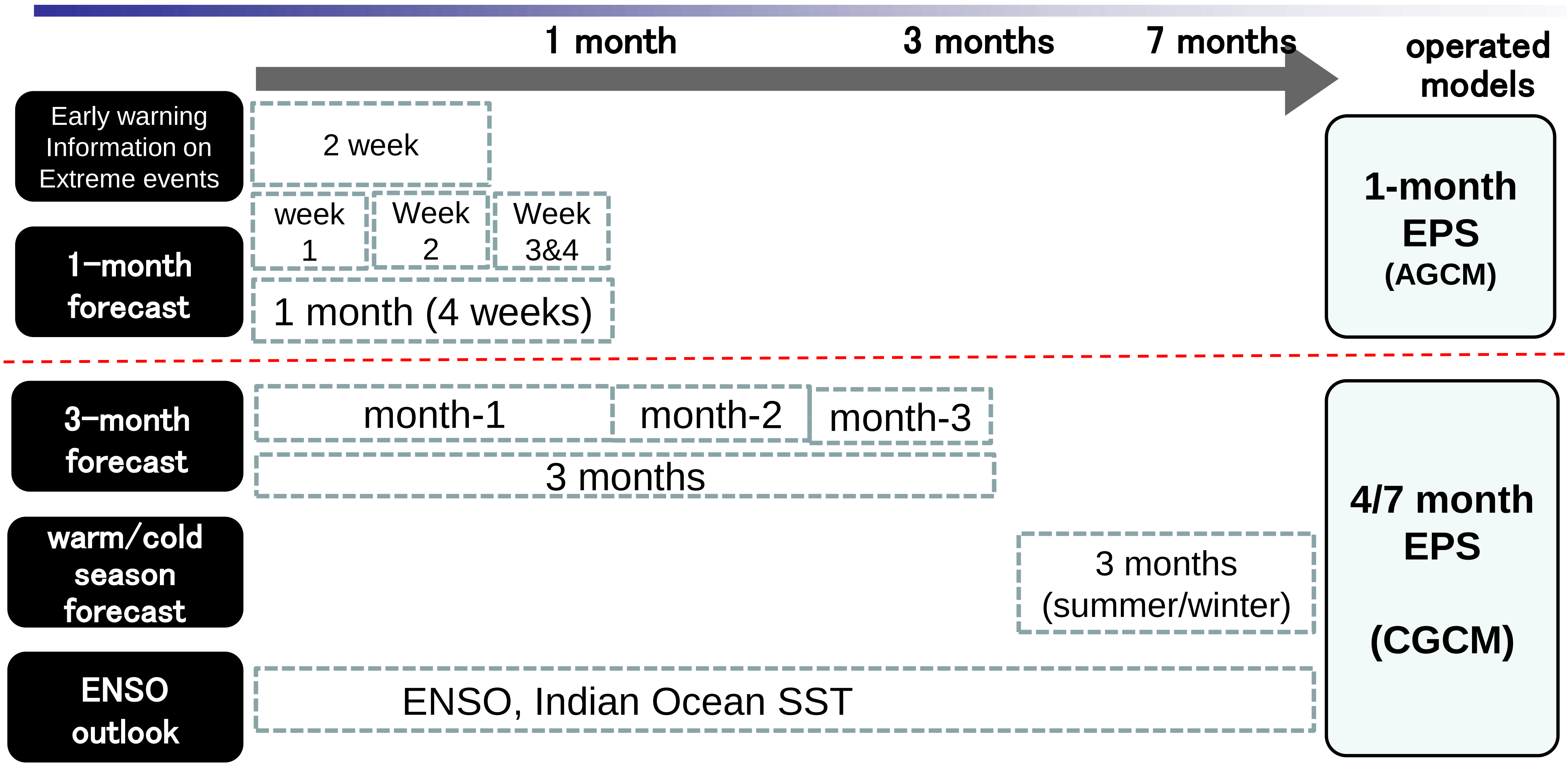
Operational models of JMA

	Main target	Horizontal resolution
Meso-Scale Model (MSM)	•Disaster reduction •Aviation	5km Around Japan
Global Spectral Model (GSM)	•Short-range forecasting	20km Global
Typhoon EPS (TEPS)	•Typhoon forecasting	60km Global
One-week EPS (WEPS)	•One-week forecasting	60km Global
One-month EPS	•Early warning Information on •Extreme events •One-month forecasting	110km Global
4/7-month EPS	•Seasonal forecasting •El Niño outlook	180km Global

Numerical Prediction Division/JMA (MSM, GSM, TEPS, WEPS)

Climate Prediction Division/JMA (One-month EPS, 4/7-month EPS)

Overview of forecasts at CPD/JMA



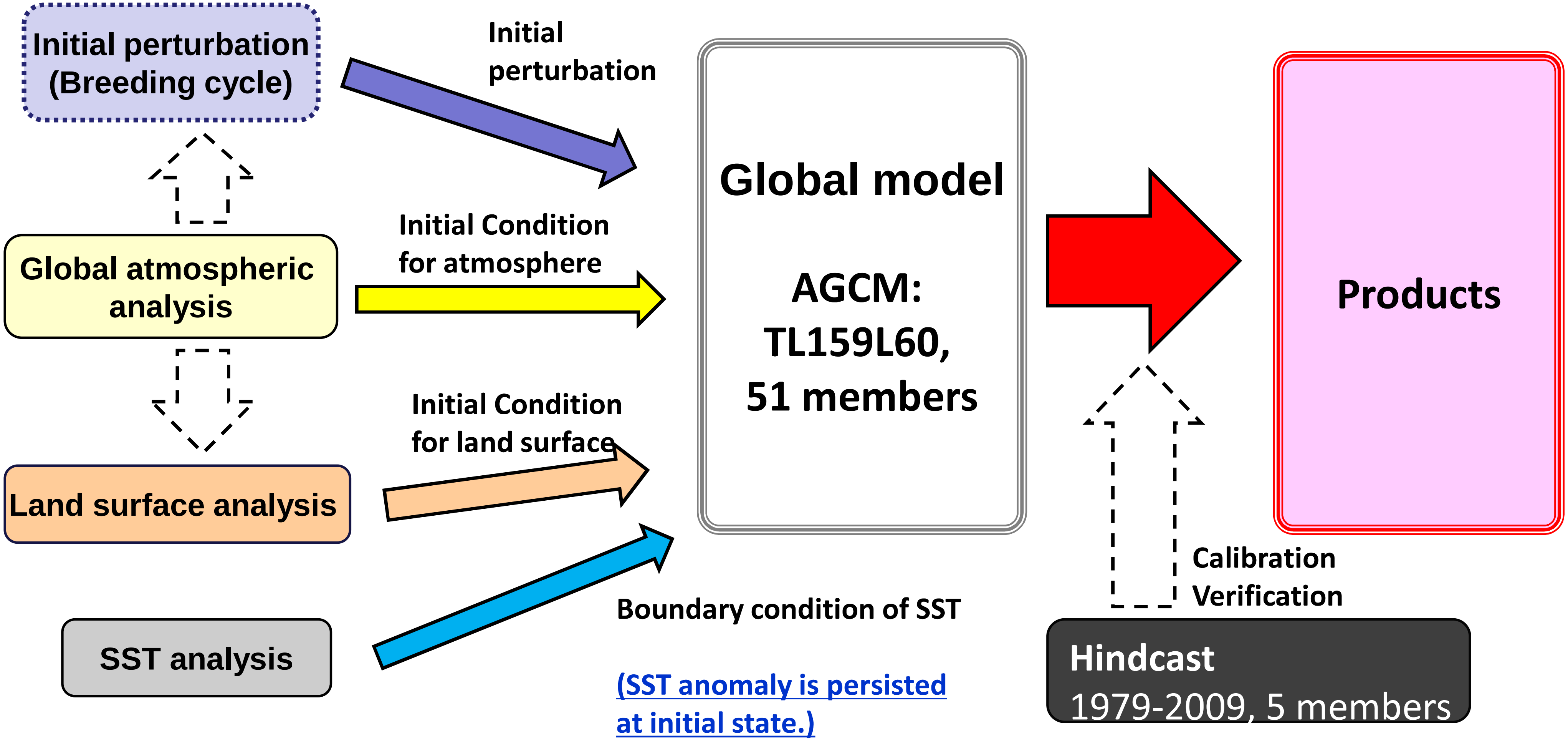
In order to support seasonal forecast, two ensemble prediction systems (EPSs) are operated; 1-month EPS and the 4/7-month EPS

Specifications of seasonal EPSs

Main target of this seminar

	1-month EPS	4/7-month EPS
Model	AGCM	CGCM
Resolution	Horizontal: approx. 110 km (TL159) Vertical: 60 levels (~0.1 hPa)	* Atmospheric component Horizontal: approx. 180 km (TL95) Vertical: 40 levels (~0.4hPa) * Oceanic component Horizontal: 1.0º longitude, 0.3–1.0º latitude (75˚S – 75˚N) Vertical: 50 levels
Forecast range	Up to 34 days	7-month (initial month of Sep., Oct., Feb., Mar., Apr) 4 months (other initial month)
SST	Persisted anomaly	Prognostic variable of CGCM
Sea ice	Climatology	
Ensemble method	Combination of Breeding of Growing Modes (BGM) and Lagged Average Forecast (LAF)	
Ensemble size	50 (25 BGMs & 2 days with 1-day LAF)	51 (9 BGMs & 6 days with 5-day LAF)
Frequency of operation	Every Wednesday and Thursday	Every 5 days
Frequency of model product creation	Once a week Every Friday	Once a month Around the 20th (no later than the 22nd) of every month

One-month EPS



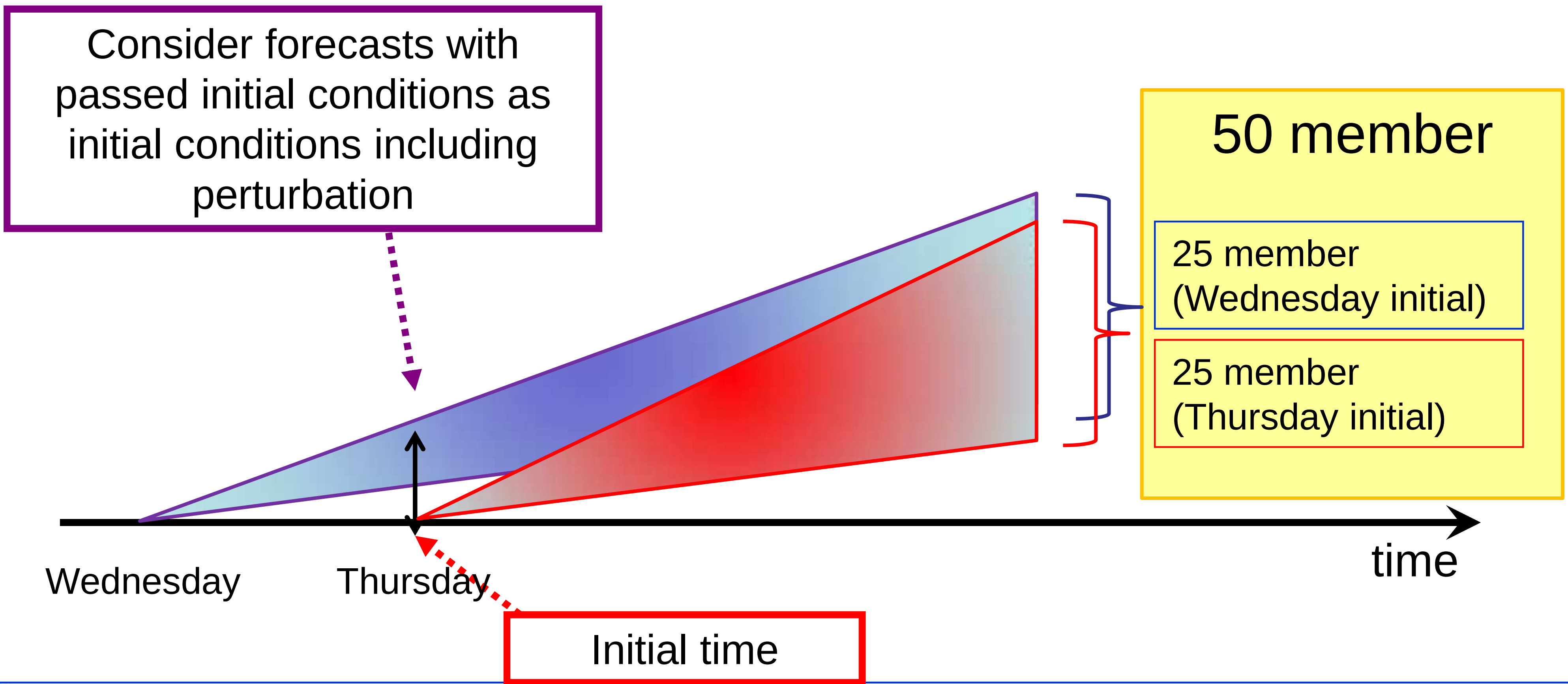
For more details;
http://ds.data.jma.go.jp/tcc/tcc/products/model/outline/index.html
http://www.jma.go.jp/jma/jma-eng/jma-center/nwp/nwp-top.htm

(Reference) LAF method

LAF (Lagged Averaged Forecasting) method:

The past forecasts with the earlier analyses are included in the ensemble

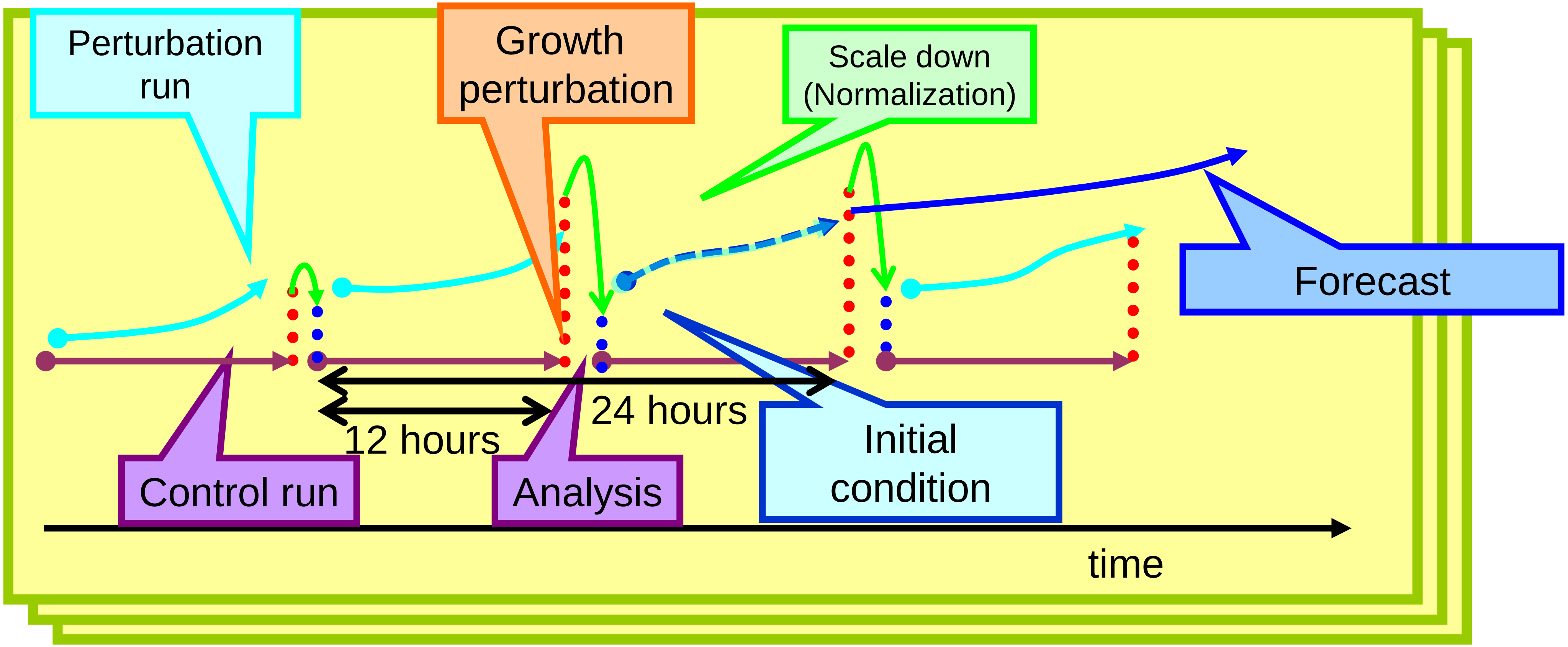
Example; 1-month EPS



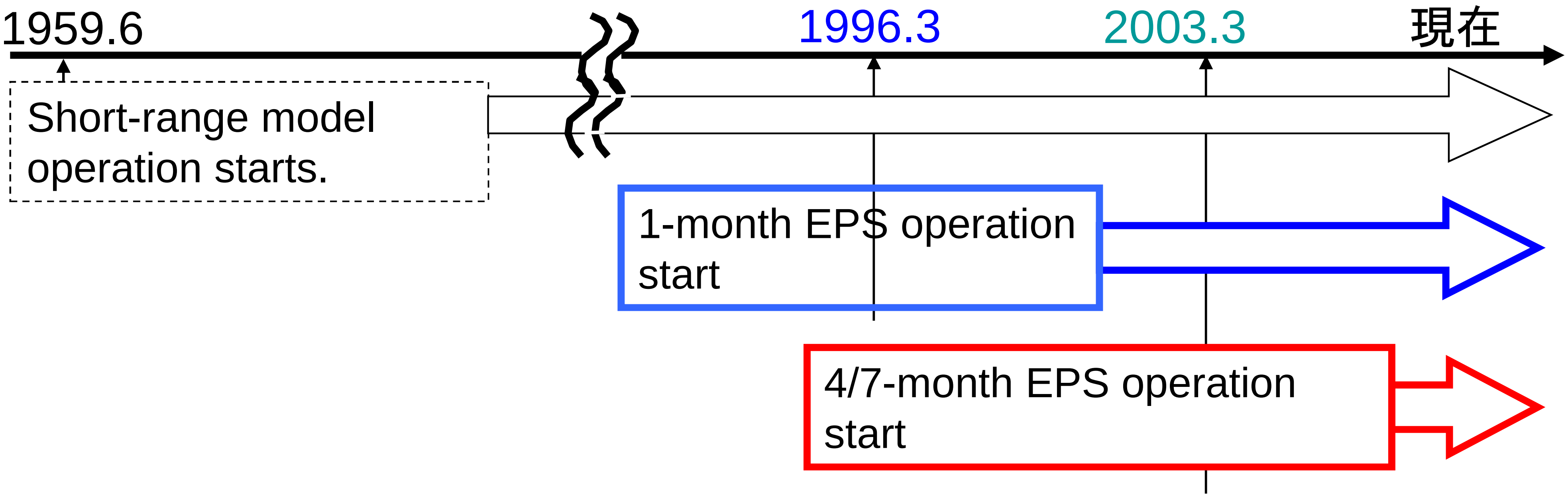
(Reference) BGM method(Breeding cycle)

Toth, Z. and E. Kalnay, 1997: Ensemble forecasting at NCEP and the breeding method. Mon. Wea. Rev., 125, 3297-3319.

- Prepare initial perturbations, which is slightly different with analysis field.
- Perturbations are based on forecast error of very short-range (e.g. 12 hours)



History of the seasonal EPSs at JMA



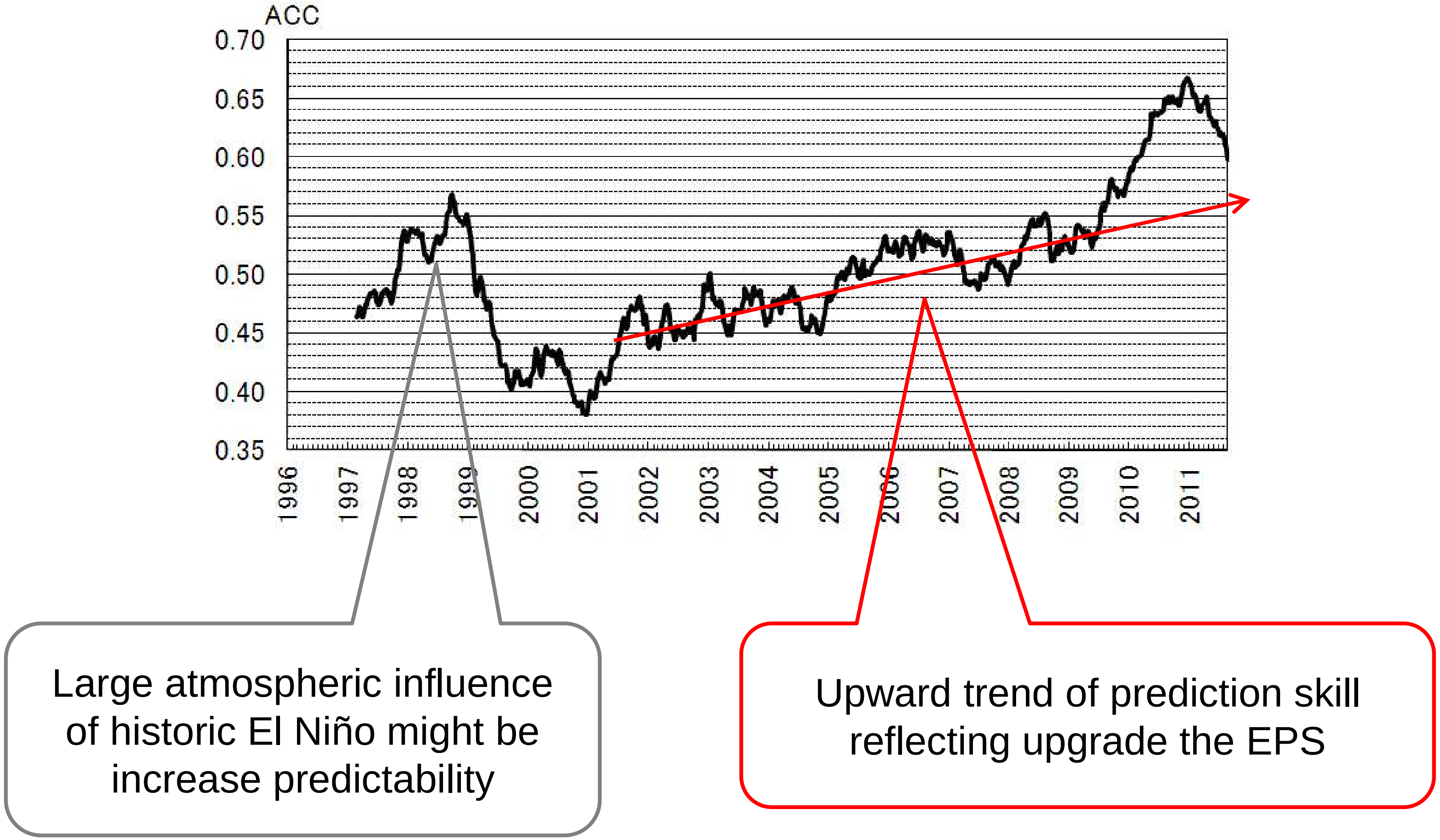
Seasonal EPSs does not have a long history.

	Mar 1996	Mar 2001	Mar 2003	Mar 2006	Sep 2007	Mar 2008	Feb 2010
1-month EPS	T63L30M10	T106L40M26	→	TL159L40M50	→	TL159L60M50	→
4/7 month EPS			T63L40M31	TL95L40M31	TL95L40M51	→	Introduction of CGCM

AGCM CGCM

Improvement of prediction skill of the 1-month EPS

Anomaly correlation of Z500 over NH
(4-week average, 1 year (52-weeks) running mean)



Hindcast

- **Hindcast** (= behind + forecast)
  : A set of systematic forecast experiments for past cases

- Object of hindcast
  - to understand prediction skill
  - to calculate the model statistics for applied product
    - Systematic bias, Model climate

  Essential for seasonal forecasting!

- Difficulty
  - Huge computing resources
    - Specifications (e.g., ensemble size, calculation frequency) of hindcast needs must be limited than those of operational system forecasts

Specifications of the 1-month EPS hindcast

	Hindcast	Operational system
Ensemble size	5 (5 BGMs, not using LAF)	50 (25 BGMs & 2 days with 1-day LAF)
Forecast range	Initial date + 33 days	2, 3, 4,...31, 32 days from the later initial date (Thursday)
Initial date	10th, 20th, end of month	Every Wednesday and Thursday
Target period	1979 – 2009	---

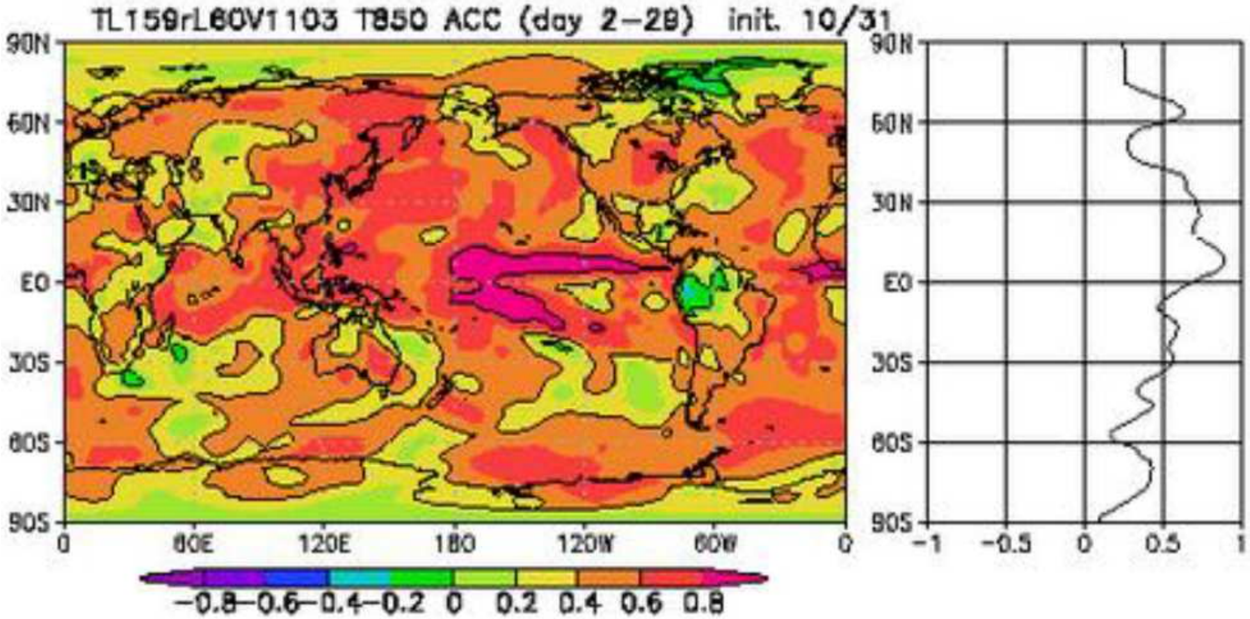
Although the specifications of the hindcast is limited, huge computing resources are required.

- 36(initial date) * 31(years) * 5(member) = 5580 (forecast runs)

Anomaly correlation for T850 of 4-week forecast (1-month EPS hindcast)

Initial date: 31 Oct

T850



•Anomaly correlation is high in the tropics reflecting tropical ocean variability.

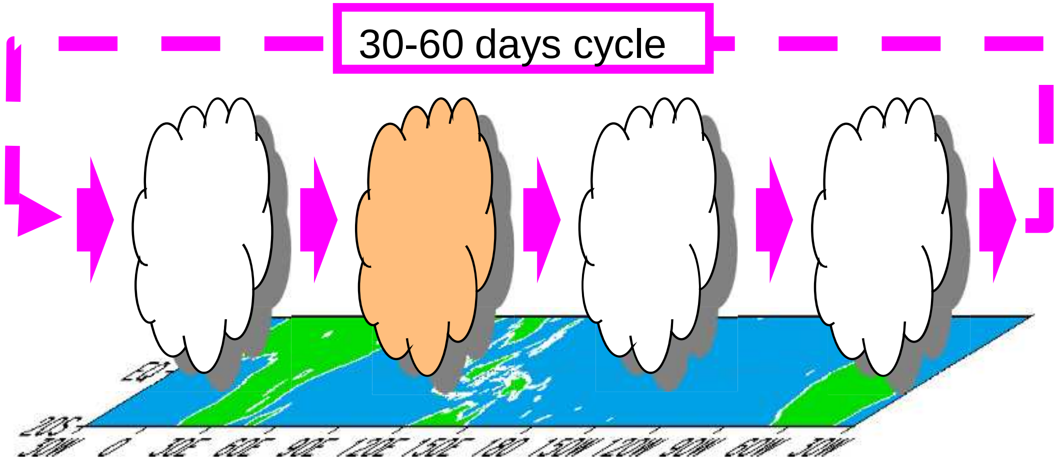
•In the mid-high latitudes, anomaly correlation is small due to dominant of the atmospheric internal variability.

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/hindcast/1mE/tro_acor.html

(Reference) MJO (Madden Julian Oscillation)

(Details are referred to the lecture by analysis unit.)

- Propagate eastward in tropics
- Wave number = 1
- Period = about 30-60 days
- Often monitor with anomaly fields of OLR and/or velocity potential
- Often affect the mid-latitudes



Phase of MJO (winter)

Wheeler and Hendon 2004, MWR, 132, 1917-1932.

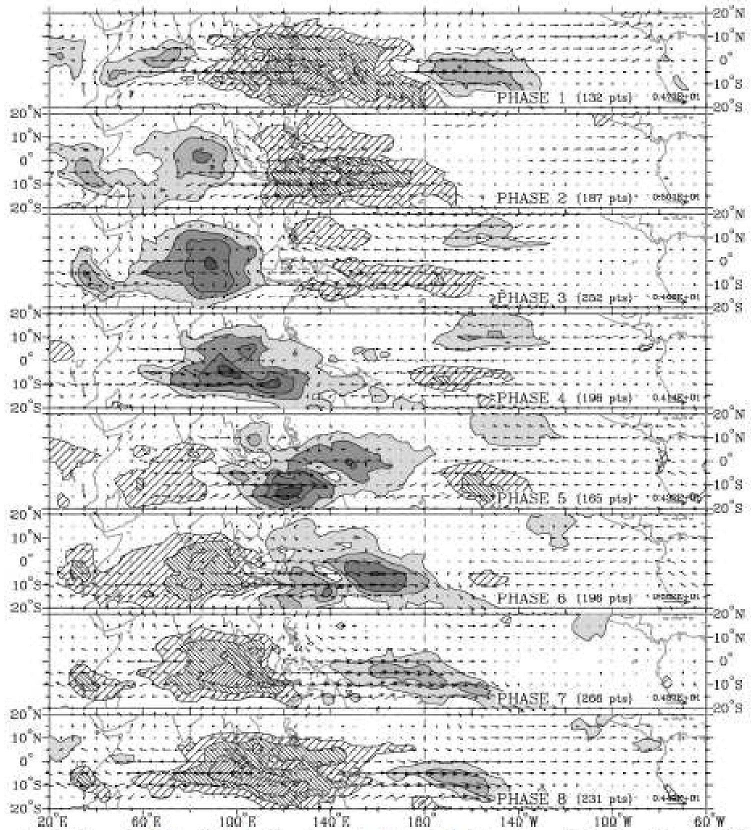


FIG. 8. DJF composite OLR* and 850-hPa wind vector anomalies. Shading levels denote OLR anomalies less than −7.5, −15, −22.5, and −30 W m⁻², respectively, and hatching levels denote OLR anomalies greater than 7.5, 15, and 22.5 W m⁻², respectively. Black arrows indicate wind anomalies that are statistically significant at the 99% level, based on their local standard deviation and the Student's t test. The magnitude of the largest vector is shown on the bottom right, and the number of days (points) falling within each phase category is given.

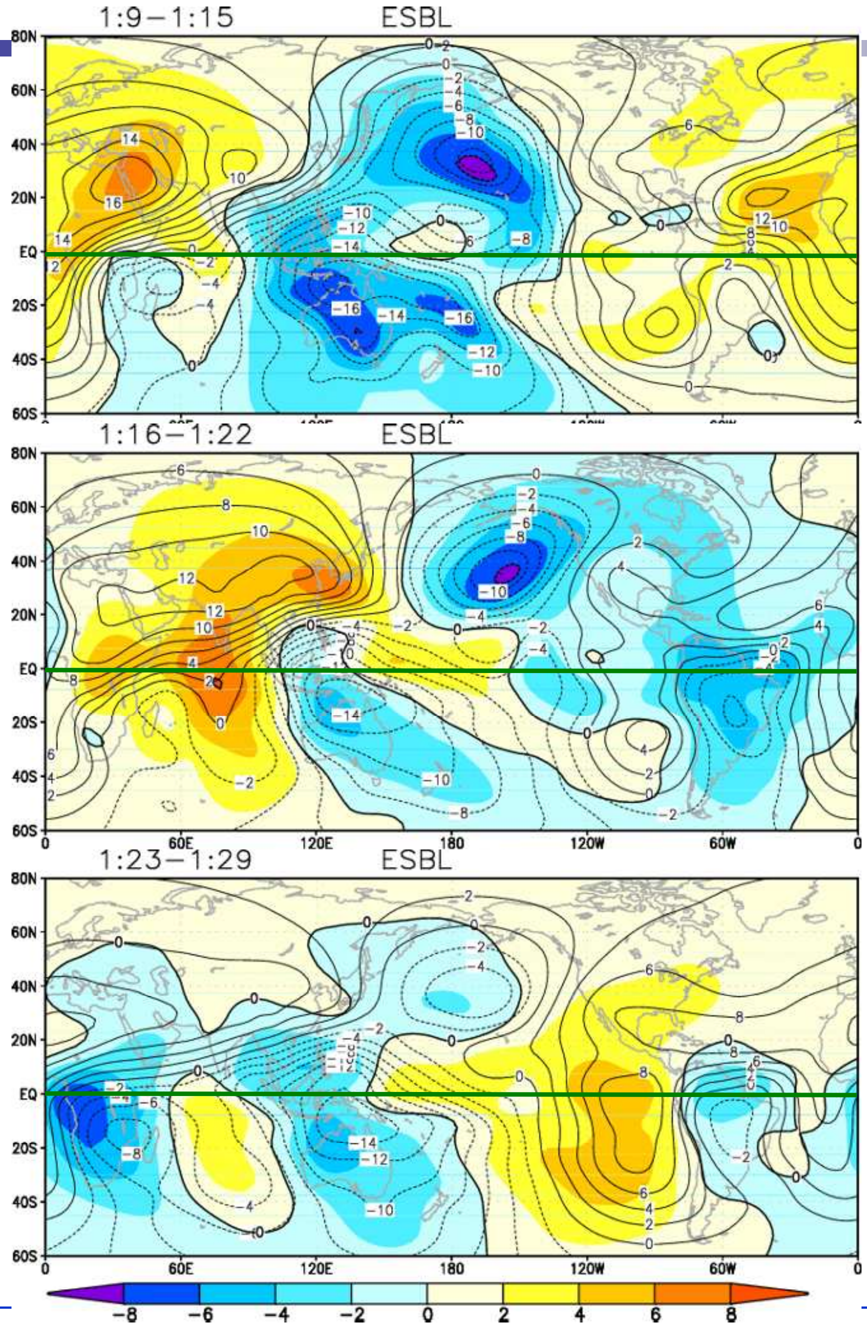
Vector: 850hPa Wind anomaly
Shading: OLR anomaly

Example of MJO seen in the operational 1-month EPS

Initial date: 30Dec2010

Region of activated convection:

Week-1



Maritime continent

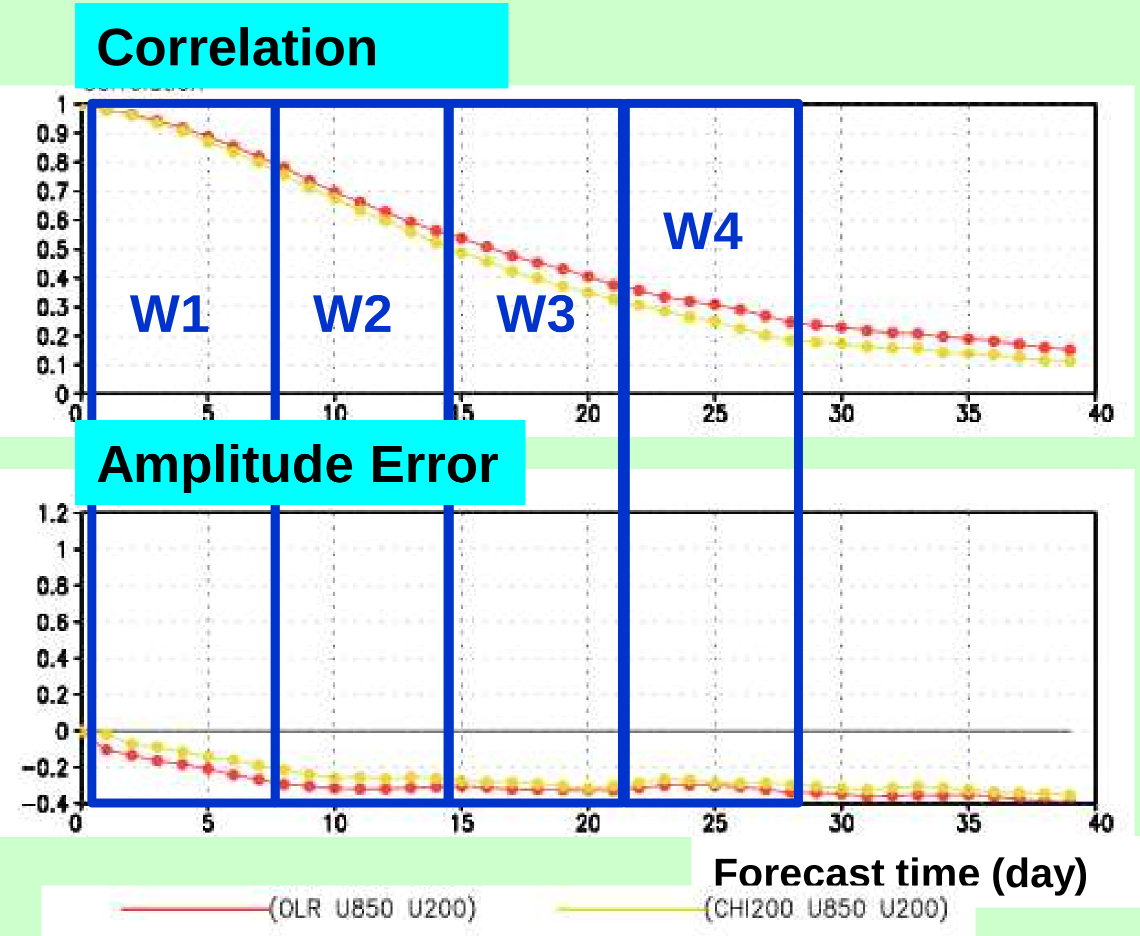
Week-2

Eastern Pacific

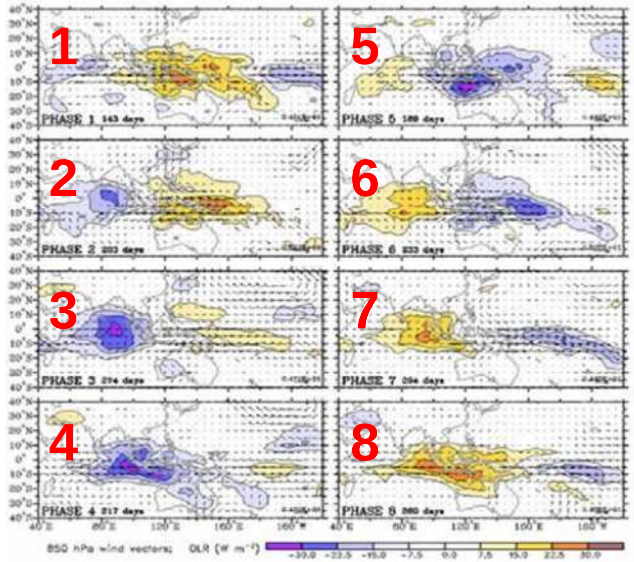
Week-3

Africa

Prediction skill of MJO index (hindcast of the 1-month EPS)



(Reference) Phase of MJO
Wheeler and Hendon (2004)



- Prediction skill of MJO is about 2-3 weeks.
- Weak bias of MJO is found in the JMA's model.

Verified by Matsueda-san (Numerical prediction unit/ CPD/JMA)
(Please refer to the presentation on 10 Nov.)

Lead-time dependency of prediction skill over tropics (200hPa velocity potential)

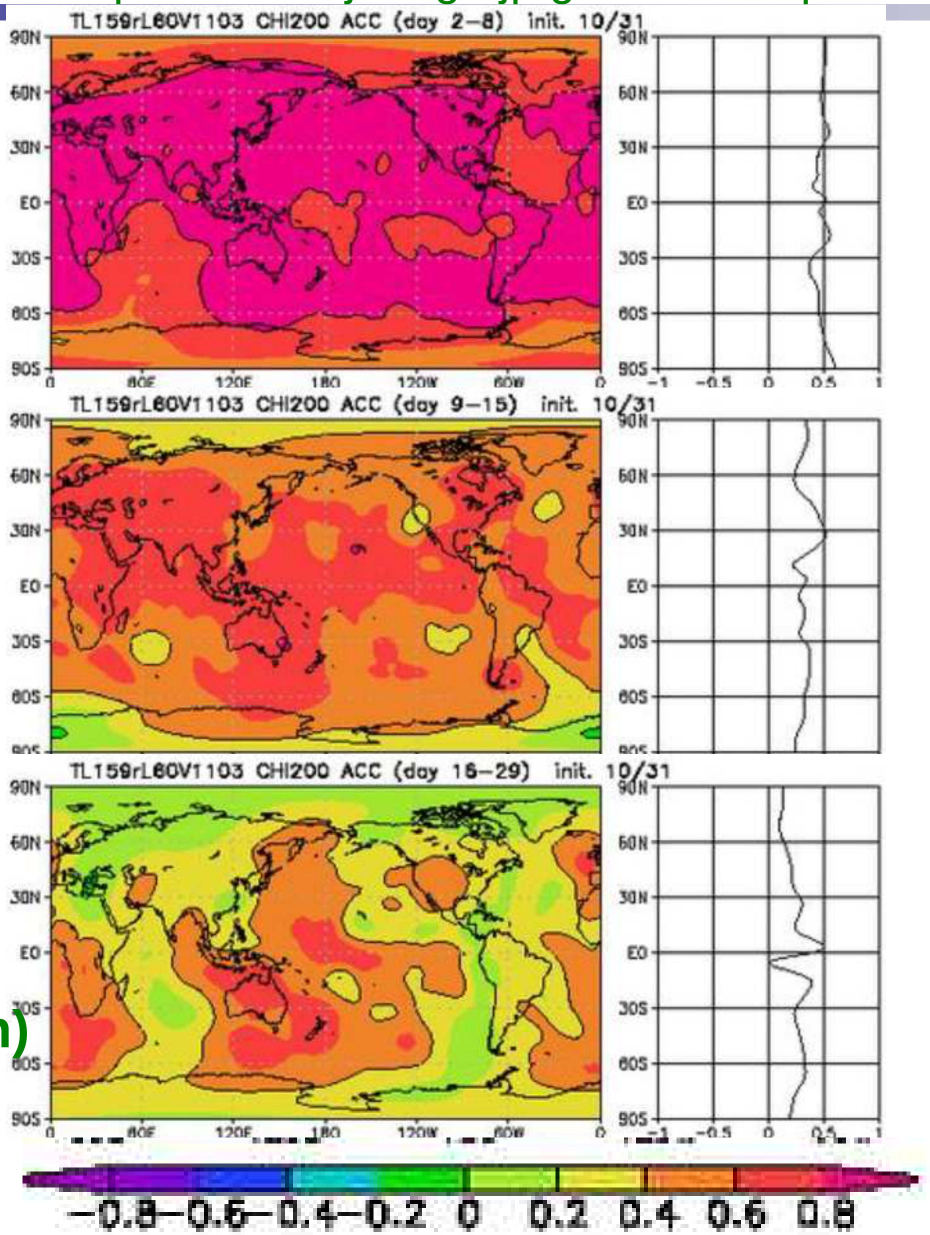
http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/hindcast/1mE/tro_acor.html

Initial date: 31 Oct

Week-1

Week-2

Week-3,4 (2-weeks mean)



After week-3, prediction skill clearly decreases.

Example of the operational JMA 1-month EPS (Comparison between Analysis and Forecast)

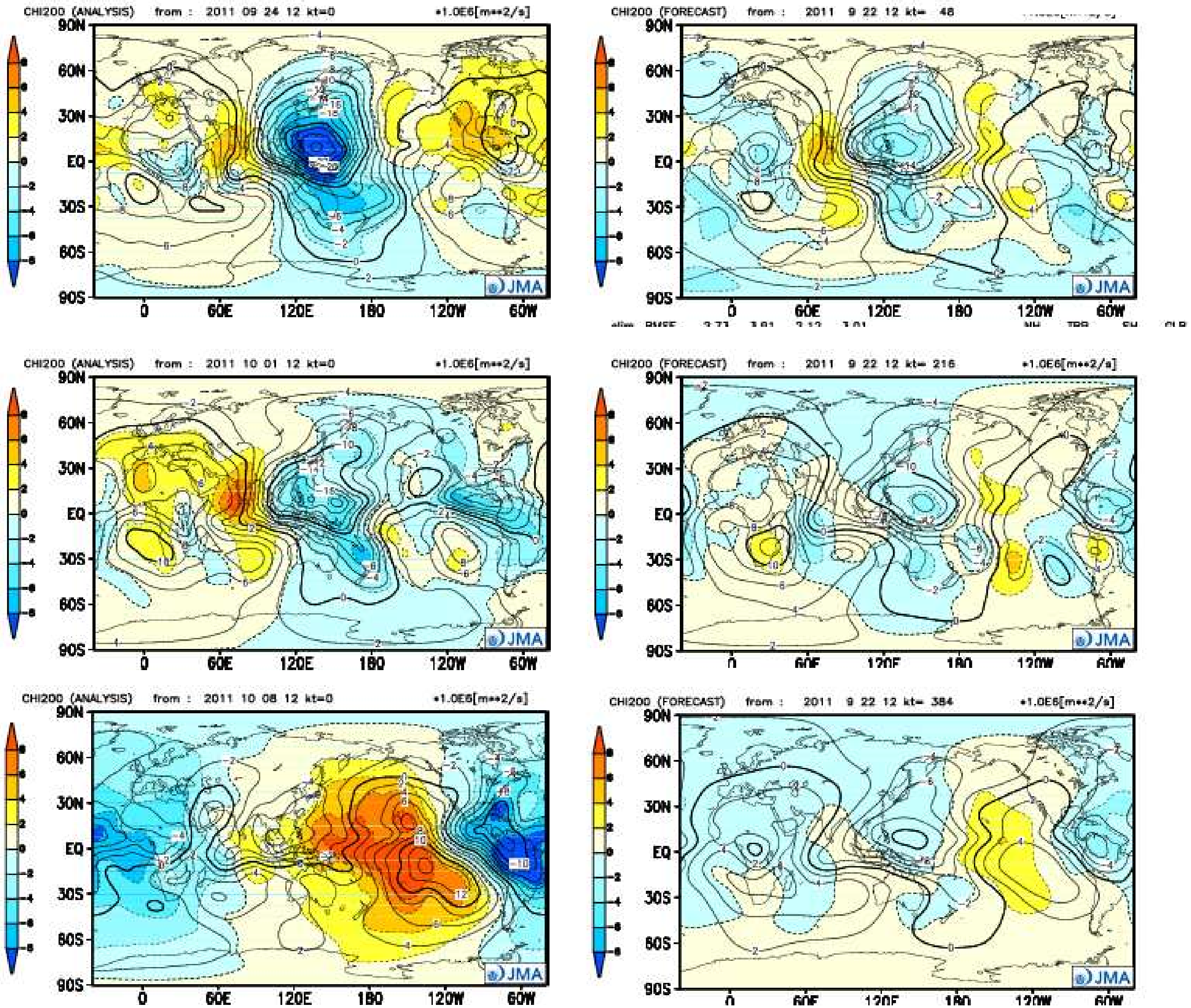
http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/verif/1mE/vrfmap/week/zpcmap.php

Analysis **Forecast** **Initial date: 22 Sep 2011**

Week-1

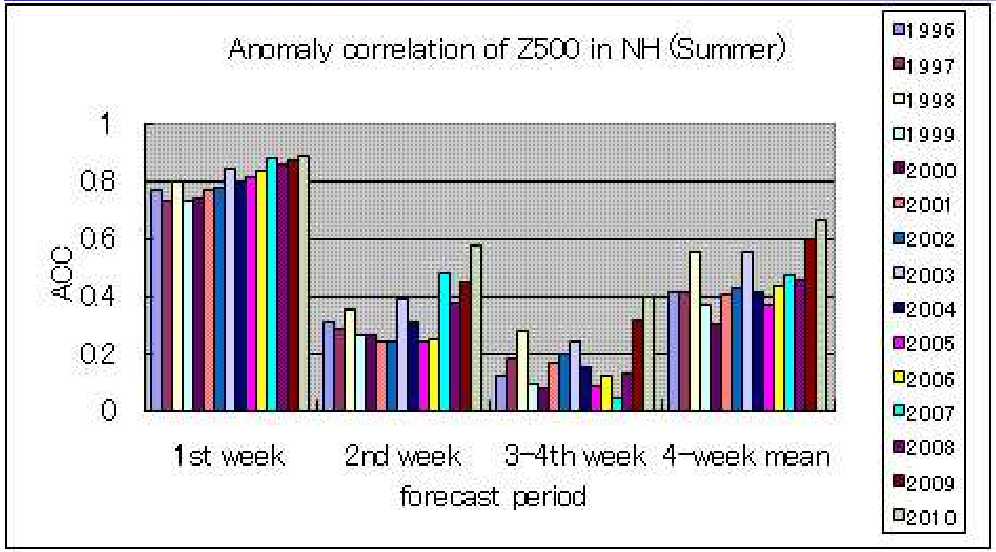
Week-2

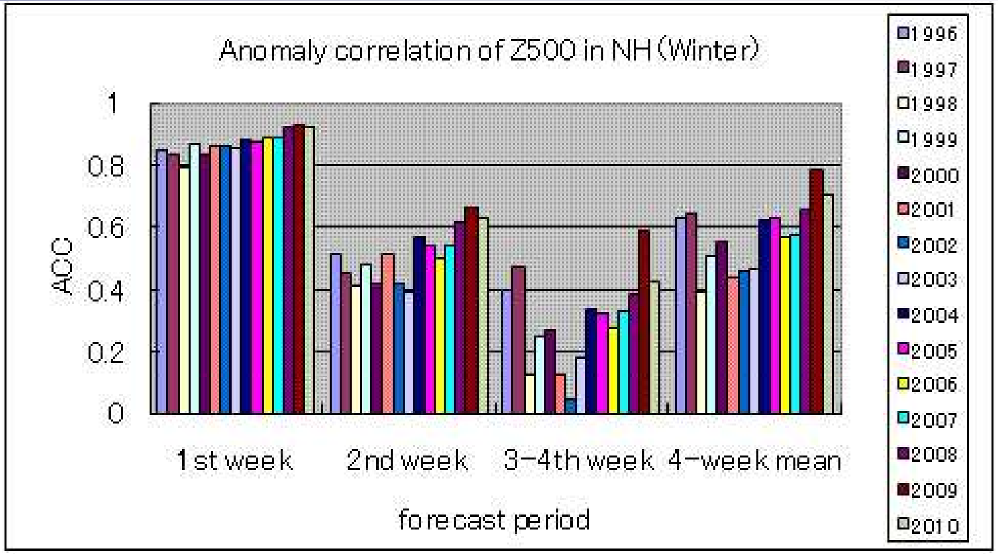
Week-3,4



- Phase of MJO is reasonably predicted in this case.
- However, amplitude of MJO become small, as forecast time increases.

Anomaly correlation for Z500 over NH (operational 1-month EPS)





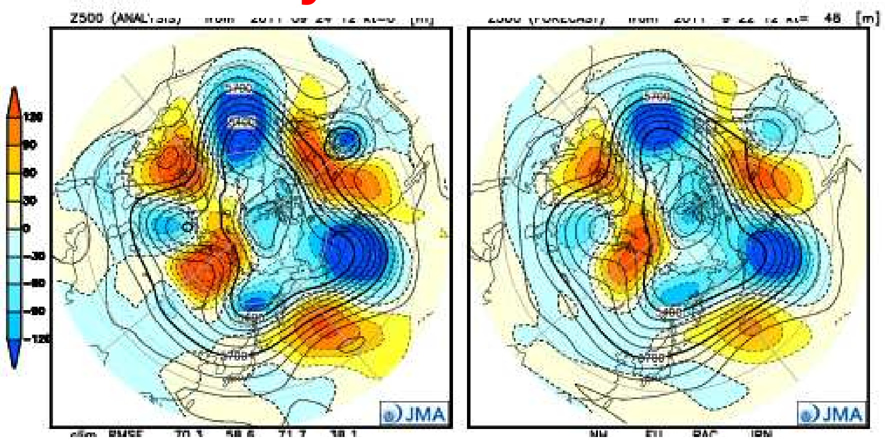
- In general, predictability over mid-high latitudes associating with westerlies is about 2-week.

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/verif/1mE/2010/2010_e.html

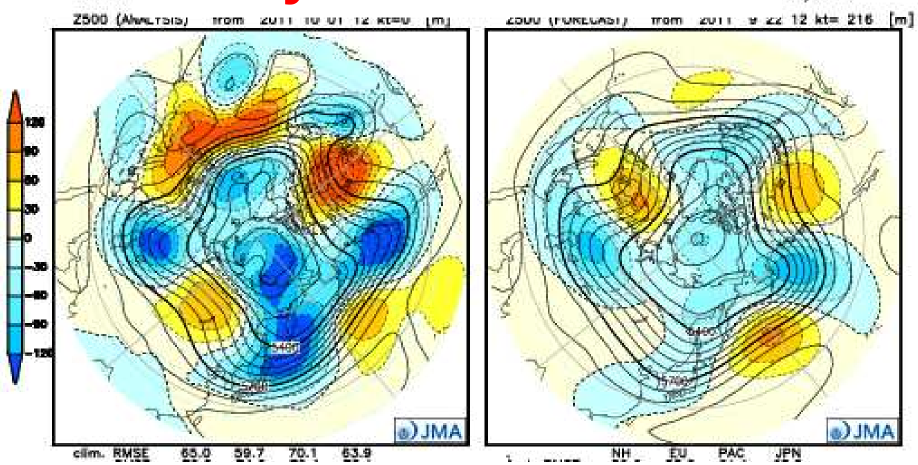
Example of the operational JMA 1-month EPS (Comparison between Analysis and Forecast)

Initial date: 22 Sep 2011

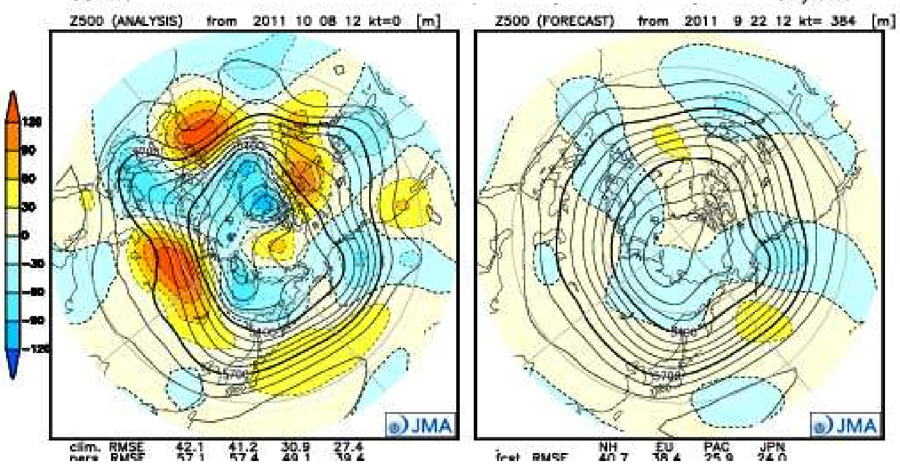
Week-1 **Analysis** **Forecast**



Week-2 **Analysis** **Forecast**



Week-3,4 **Analysis** **Forecast**



After week-3,4, prediction error becomes large.

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/verif/1mE/vrfmap/week/pztmap.php

Model products on the TCC website

Products available on TCC website

- Forecast Maps
  - Ensemble mean forecasts
- Calibrated probabilistic forecasts
- Verification charts
  - Real-time
  - Hindcast
- Gridded dataset (Grid Point Values; GPVs)

Map

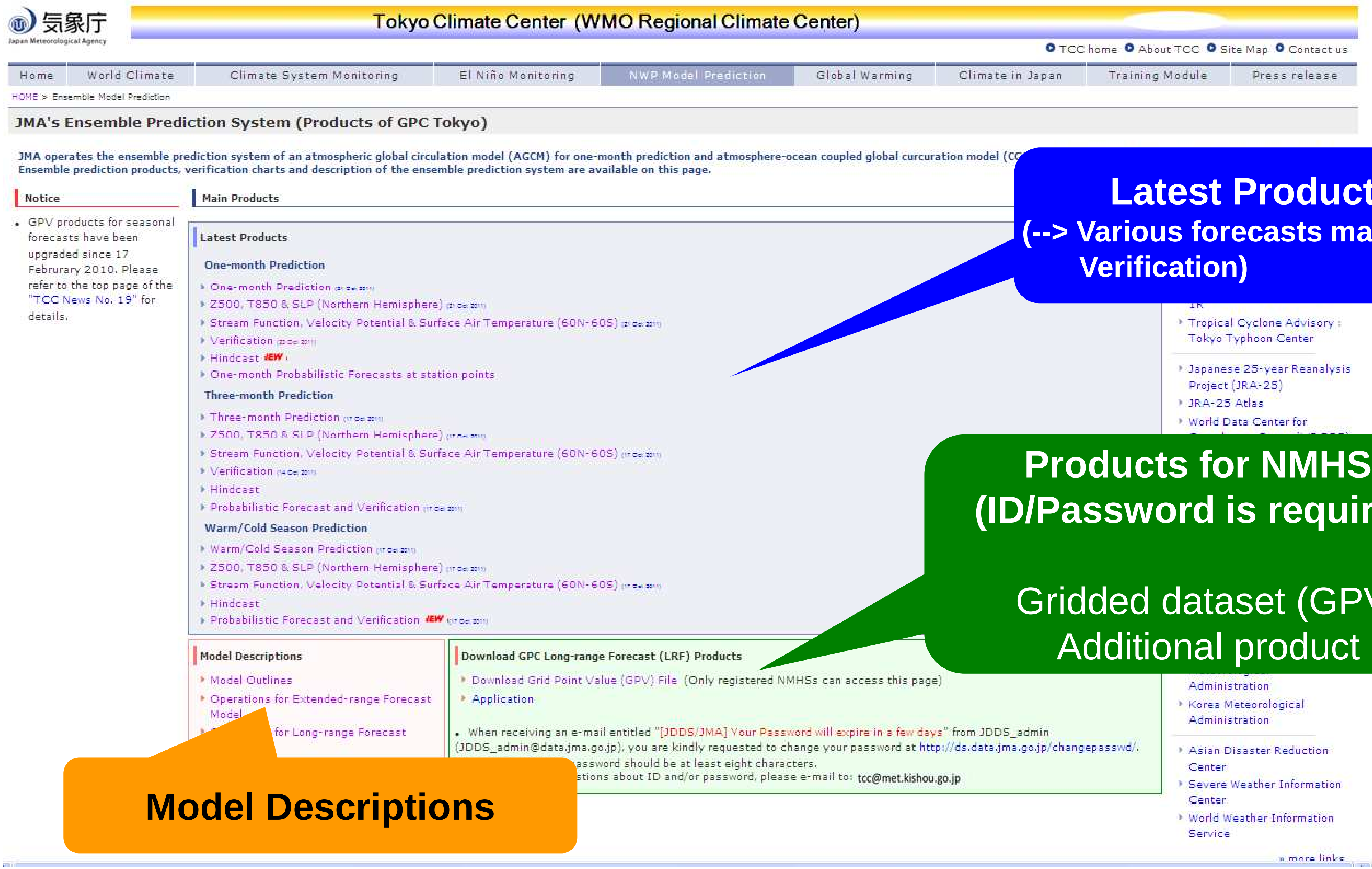
Gridded dataset

TCC Website

(http://ds.data.jma.go.jp/gmd/tcc/tcc/index.html)

“NWP Model Prediction” on TCC Website

(http://ds.data.jma.go.jp/gmd/tcc/tcc/index.html)



Latest Products
(--> Various forecasts maps Verification)

Products for NMHSs
(ID/Password is required.)

Gridded dataset (GPV)
Additional product

Model Descriptions

(Note)
Some products are required UID.

- Some products are required UID.
  - For Application; http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/Application.html

  - Gridded dataset (Grid Point Values, GPVs)
  - The other additional products
    - animation maps of 1-month EPS
    - Predicted indices by 4/7 month EPS for statistical downscaling

“Latest Product” of 1-month EPS

Latest Products

1-month EPS

One-month Prediction

- One-month Prediction (21 Oct 2011)
- Z500, T850 & SLP (Northern Hemisphere) (21 Oct 2011)
- Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (21 Oct 2011)

Forecast maps

- Verification (23 Oct 2011)

Verification (Real-time)

- Hindcast NEW

Verification (Hindcast)

- One-month Probabilistic Forecasts at station points

Calibrated probabilistic forecasts

Three-month Prediction

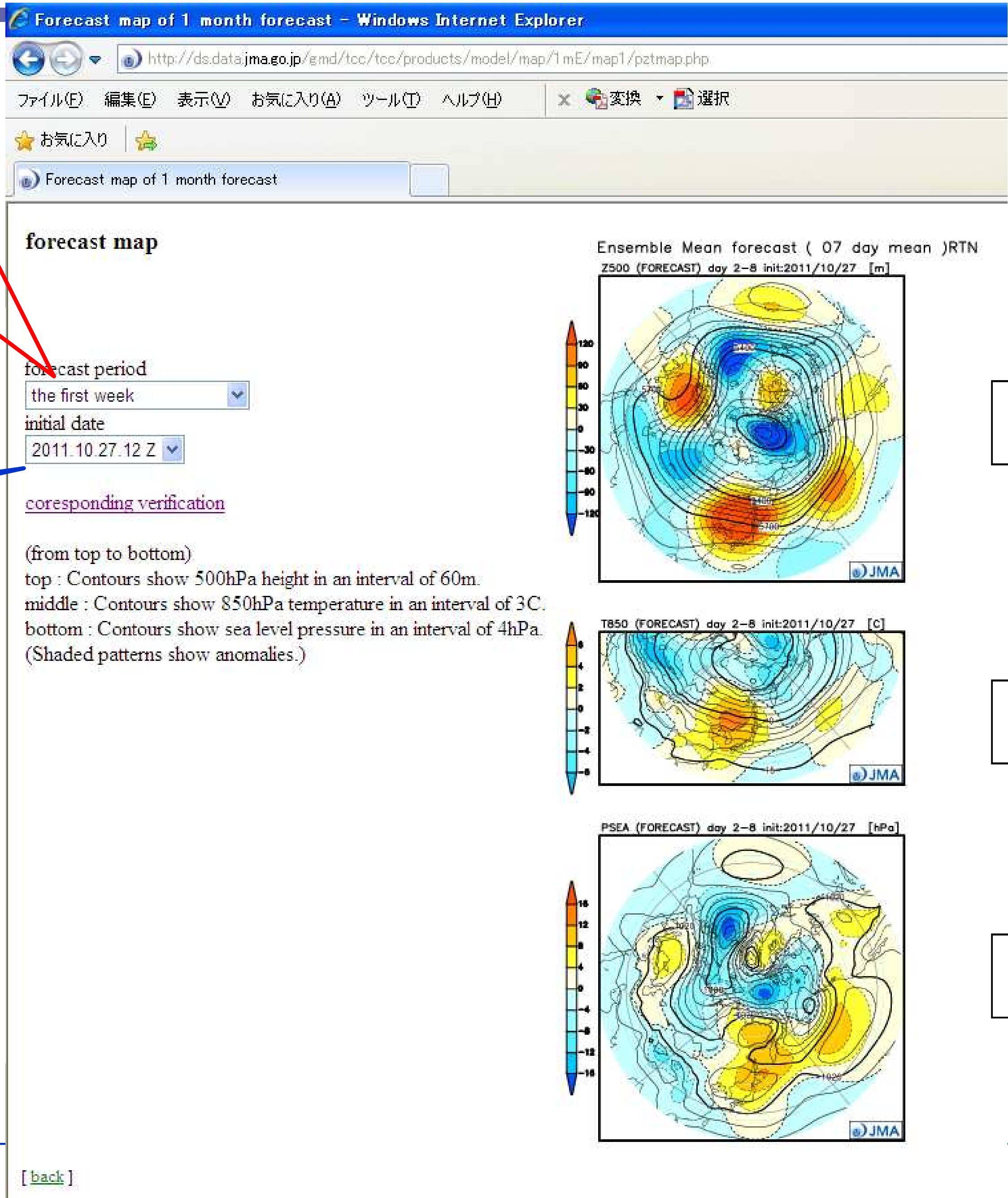
- Three-month Prediction (17 Oct 2011)

Forecast map (Ensemble mean, NH map)

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/map/1mE/map1/pztmap.php

Forecast Period
- •W-1, W-2
- •W,3-4 (2-weeks mean)
- •W1-4 (4-weeks mean)

Initial date



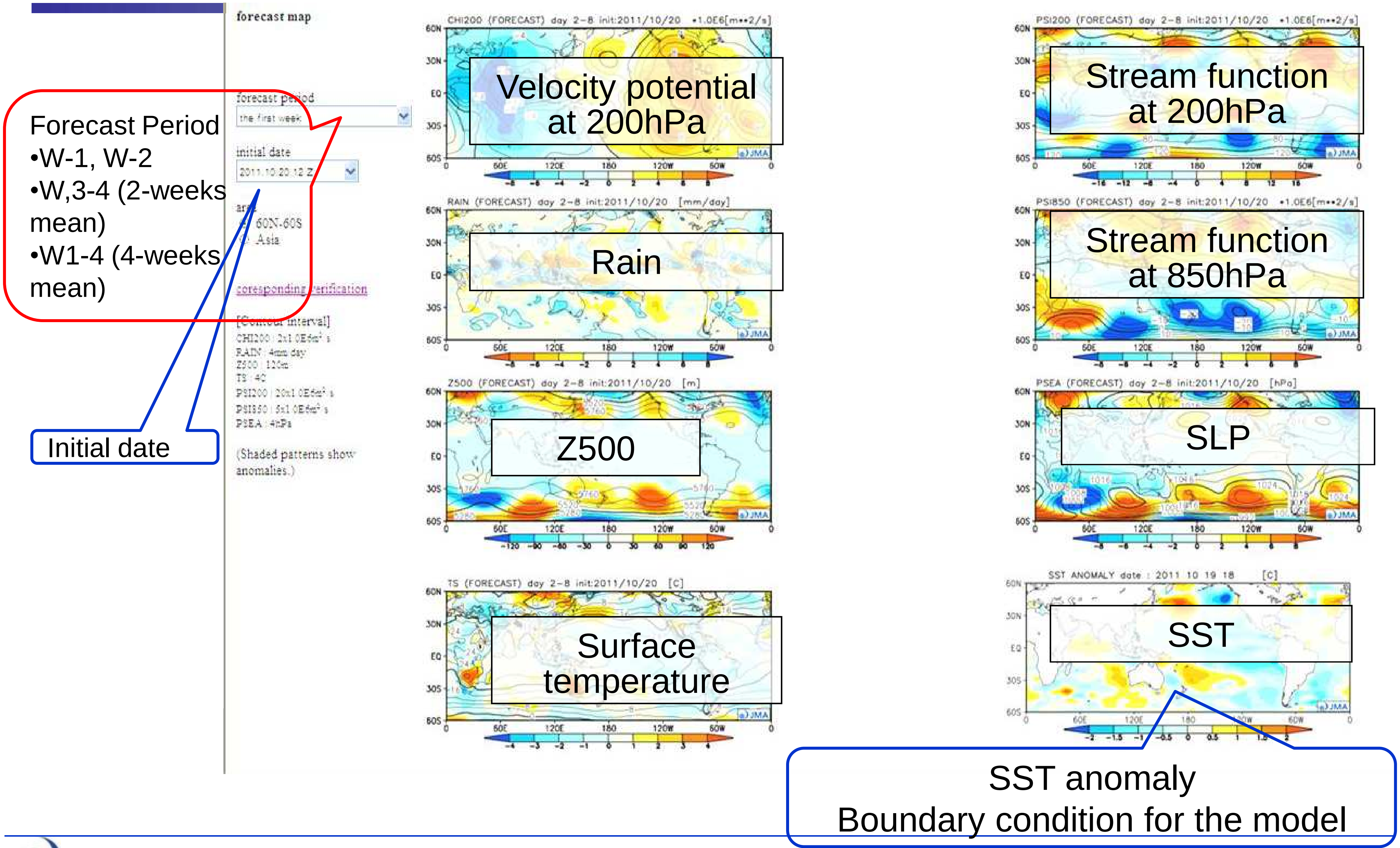
Z500

T850

SLP

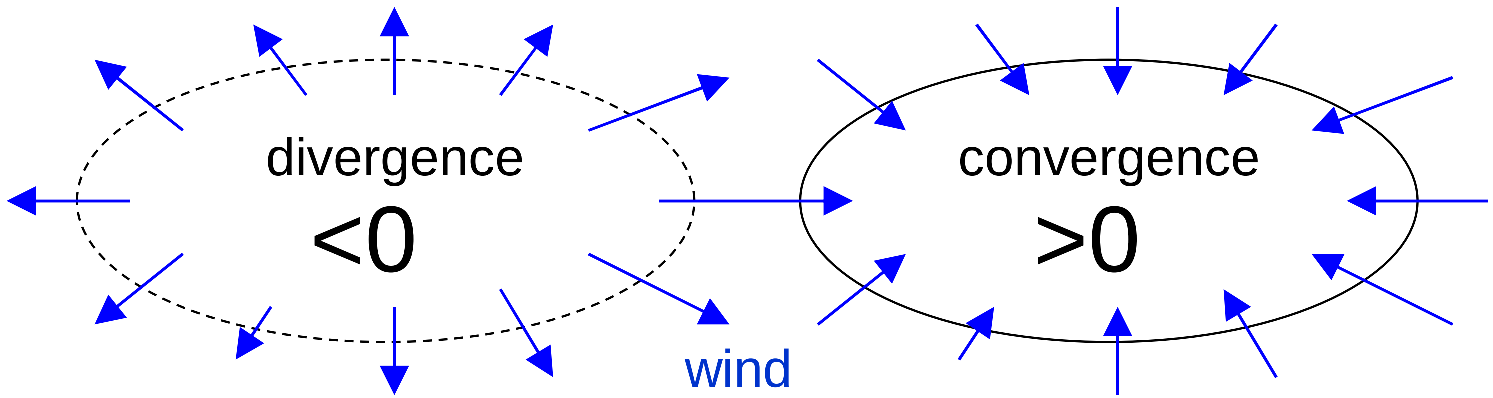
Forecast map (Ensemble mean, Tropics map)

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/map/1mE/map1/zpcmap.php



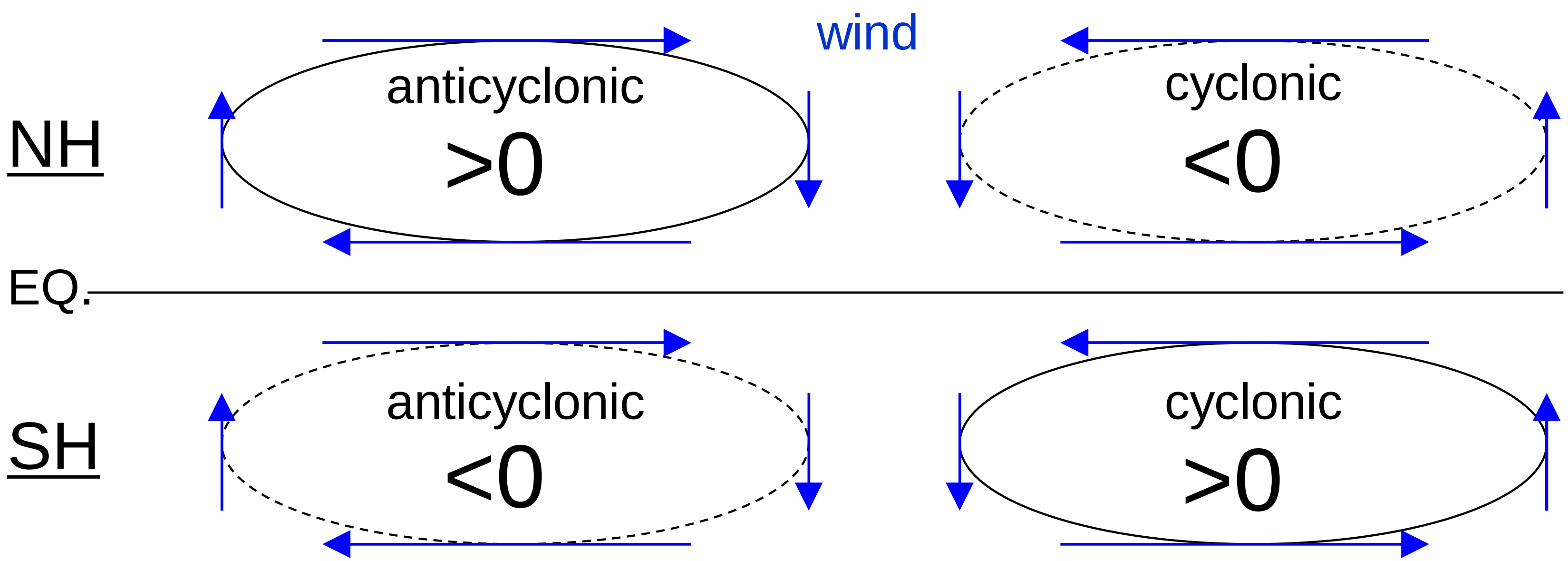
(Reference) Velocity potential (CHI)

- A velocity potential (hereafter CHI) indicates a large scale divergence or convergence.
- The maximum (minimum) portions of positive (negative) velocity potential indicate centers of large scale convergence (divergence).
- At the upper troposphere (e.g. 200hPa), divergence is considered to be related to an active convective area.



(Reference) Stream function (PSI)

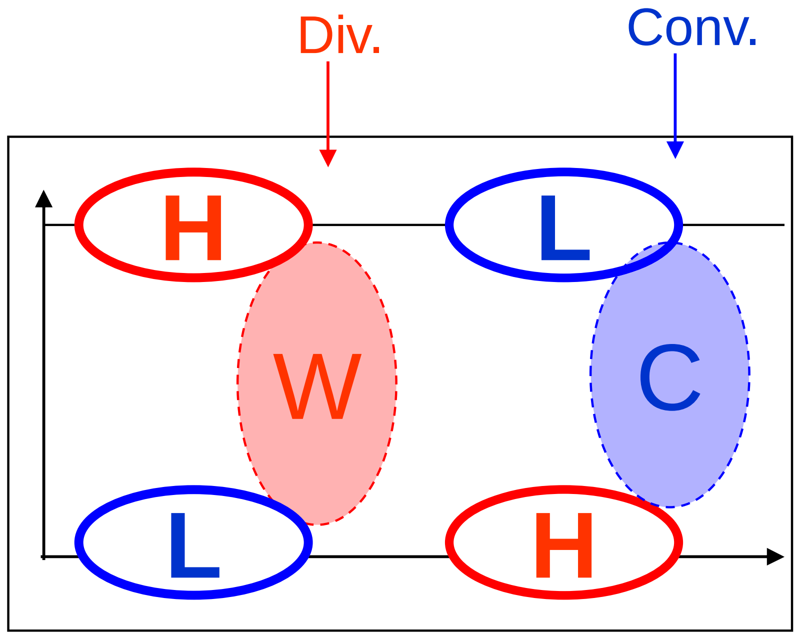
- A stream function (hereafter PSI) is an indicator for non-divergent winds.
- In an area with an anticyclonic circulation, the stream function is positive (negative) in the northern (southern) hemisphere.

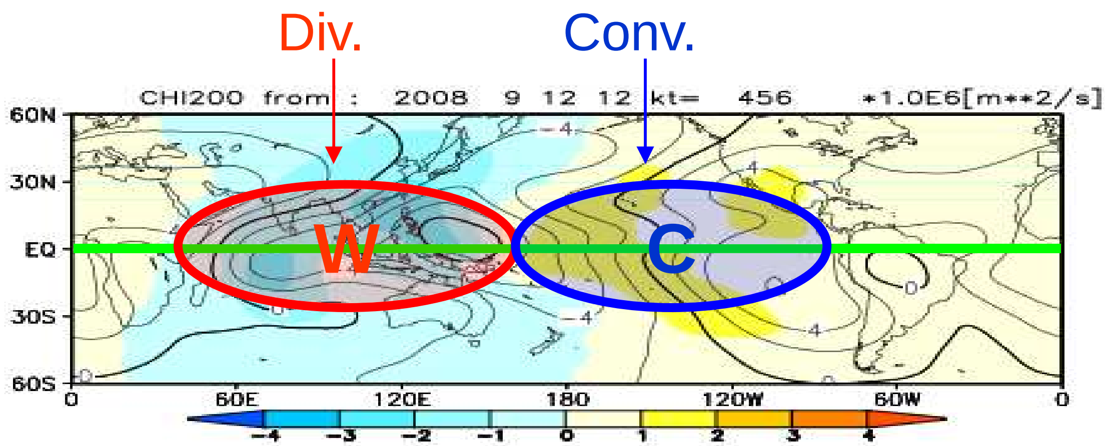


(Reference) Response of circulation anomaly to large-scale convection

Upper troposphere

Lower troposphere





1-month EPS animation (Experimental product)

- New product , “**1-month Animation**”, begin to create in Nov. 2011.
- Predicted fields for each lead time is continuously referred in order to understand variation processes of predicted fields.

- Notice

Currently, this product is not identical with the forecast maps and the gridded datasets (GPVs).

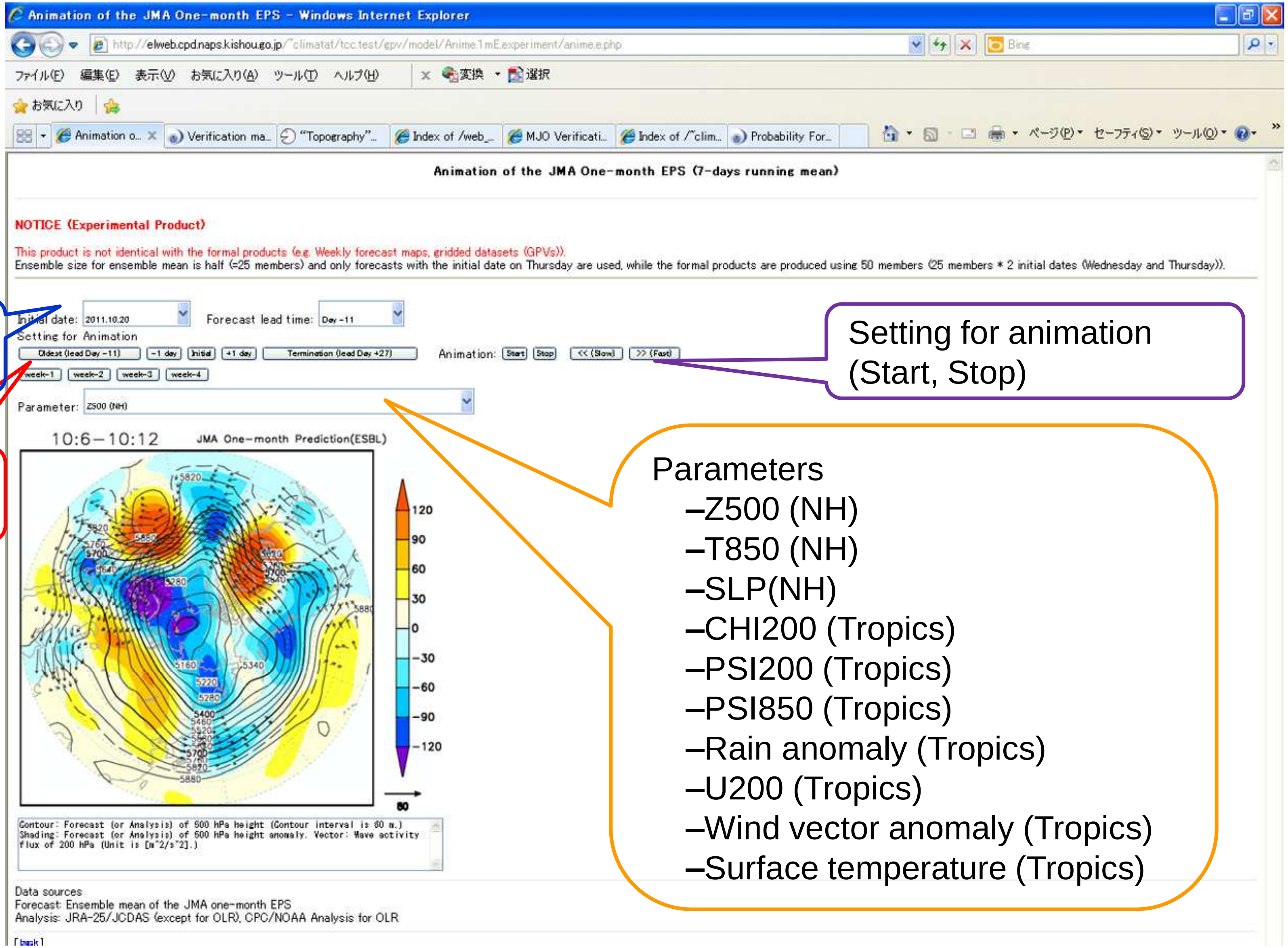
  - Ensemble size for ensemble mean is half (=25 members).
  - forecasts with the initial date on Thursday only are used, while the formal products are produced using 50 members (25 members * 2 initial dates (Wednesday and Thursday)).

ID/ Password are required.

1-month EPS animation (Experimental product)

http://ds.data.jma.go.jp/gmd/tcc/tcc/gpv/model/Anime.1mE.experiment/anime.e.php

ID/ Password are required.

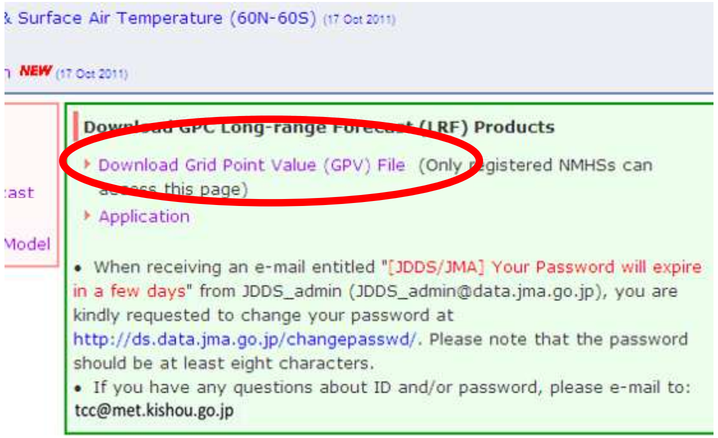


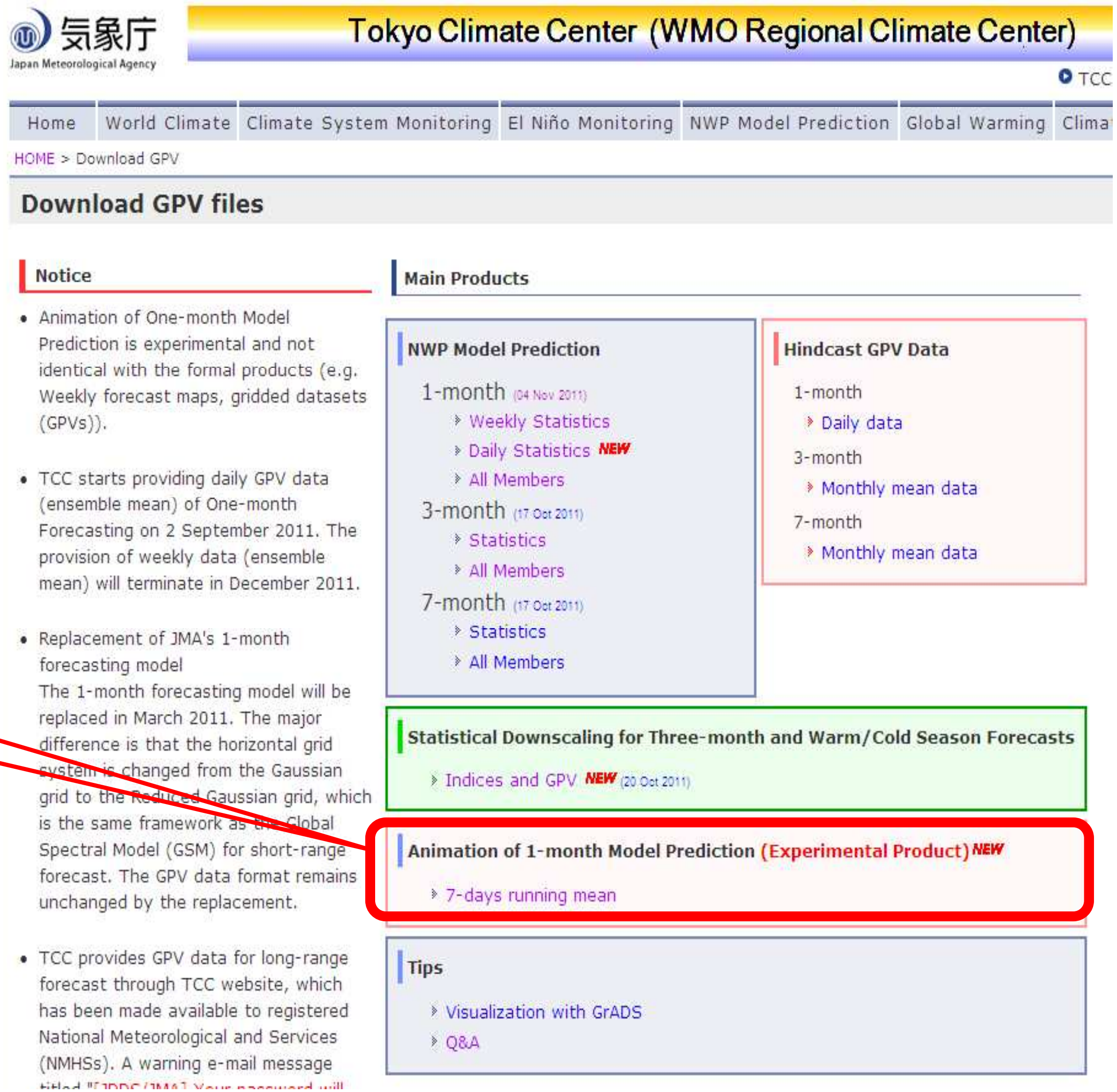
Initial date

Forecast Period

Setting for animation (Start, Stop)

Parameters
- –Z500 (NH)
- –T850 (NH)
- –SLP(NH)
- –CHI200 (Tropics)
- –PSI200 (Tropics)
- –PSI850 (Tropics)
- –Rain anomaly (Tropics)
- –U200 (Tropics)
- –Wind vector anomaly (Tropics)
- –Surface temperature (Tropics)



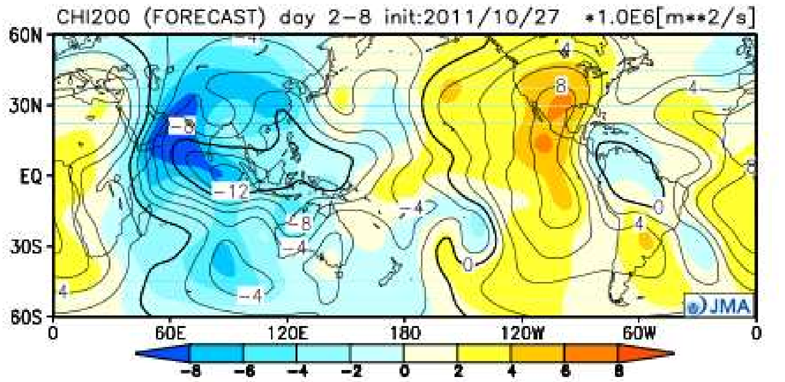


1-month EPS animation

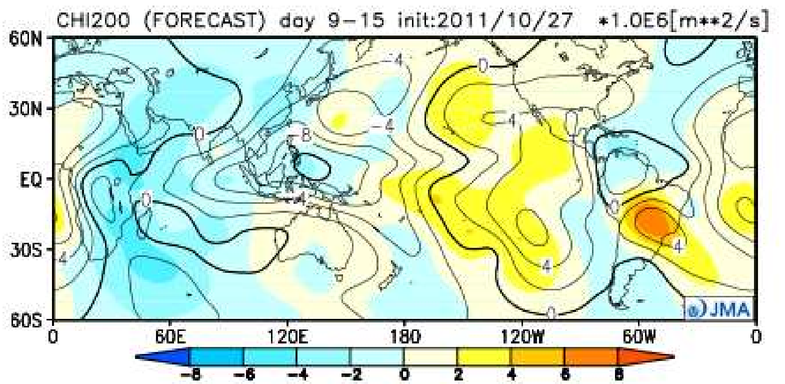
CHI200 anomaly in the forecast map (Tropical map)

Initial date: 27 Oct 2011

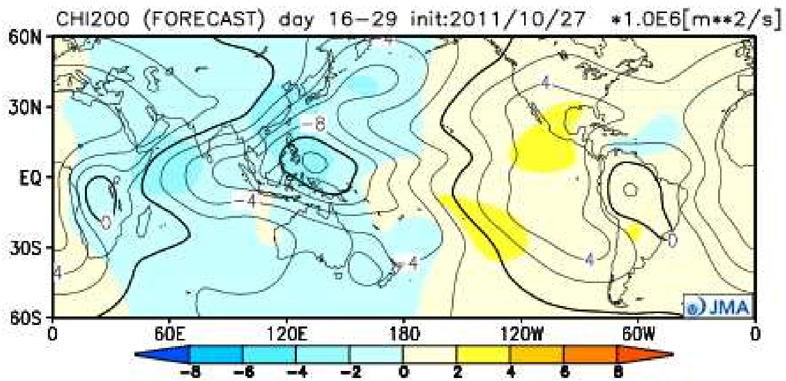
Week-1



Week-2

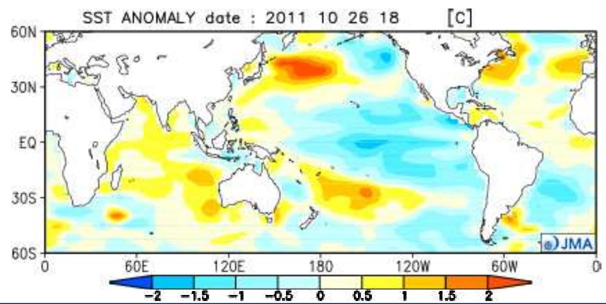


Week-3 and 4
(2-weeks mean)



- Propagation of MJO becomes unclear and active convection predicted the Indian Ocean, where SST anomaly is positive.

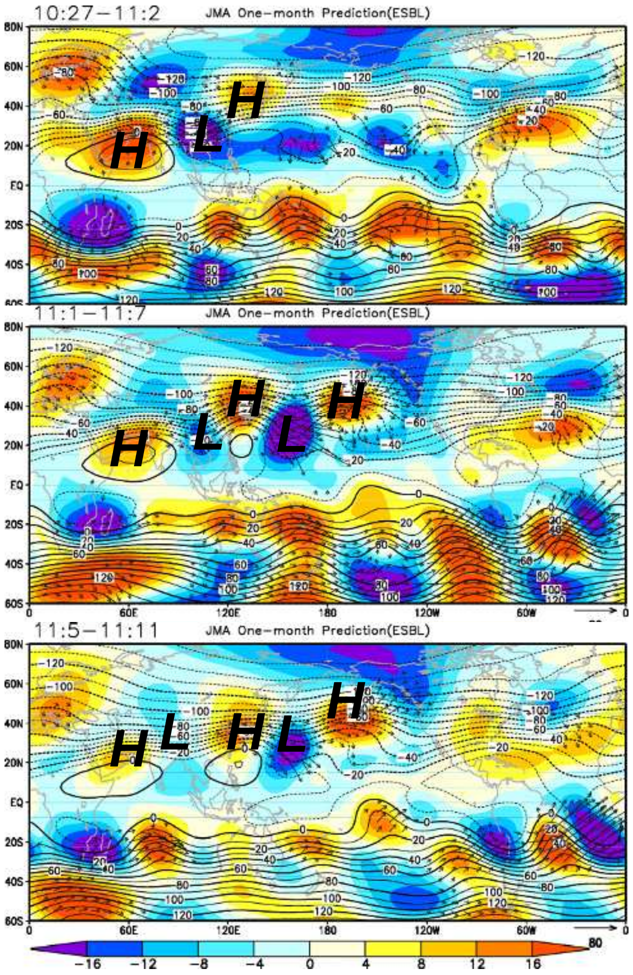
SST anomaly as boundary condition
(constant during forecast period)



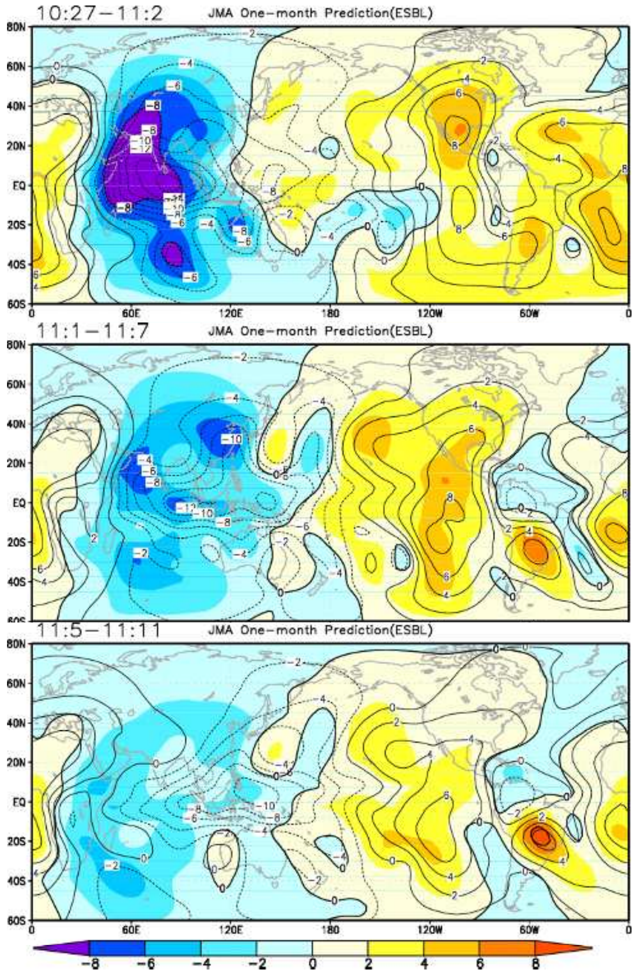
Influence of activated convection over Indian Ocean (Animation map)

Initial date: 27 Oct 2011

PSI200



CHI200

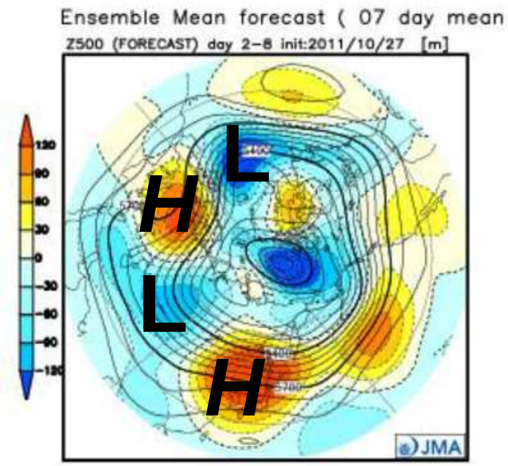


- Anti-cyclonic anomaly of 200hPa stream function (PSI200) is predicted over the Arabian Sea, reflecting with activated convection over Indian Ocean (CHI200).
- Propagation of Rossby wave packet along sub-tropical jet is found in subtropics over Asia.
  - Amplify “L” and “H” anomalies.

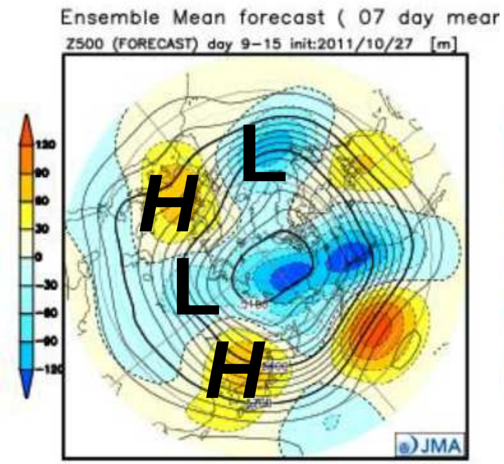
Z500 anomaly in the forecast map (NH map)

Initial date: 27 Oct 2011

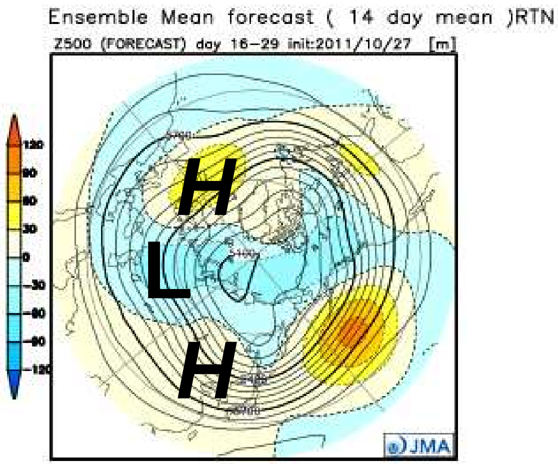
Week-1



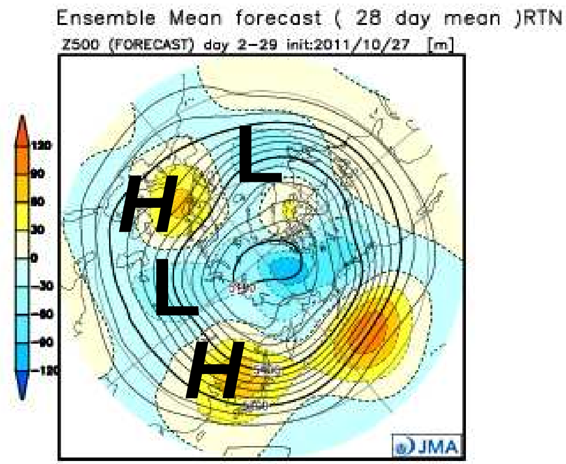
Week-2



Week-3 and 4



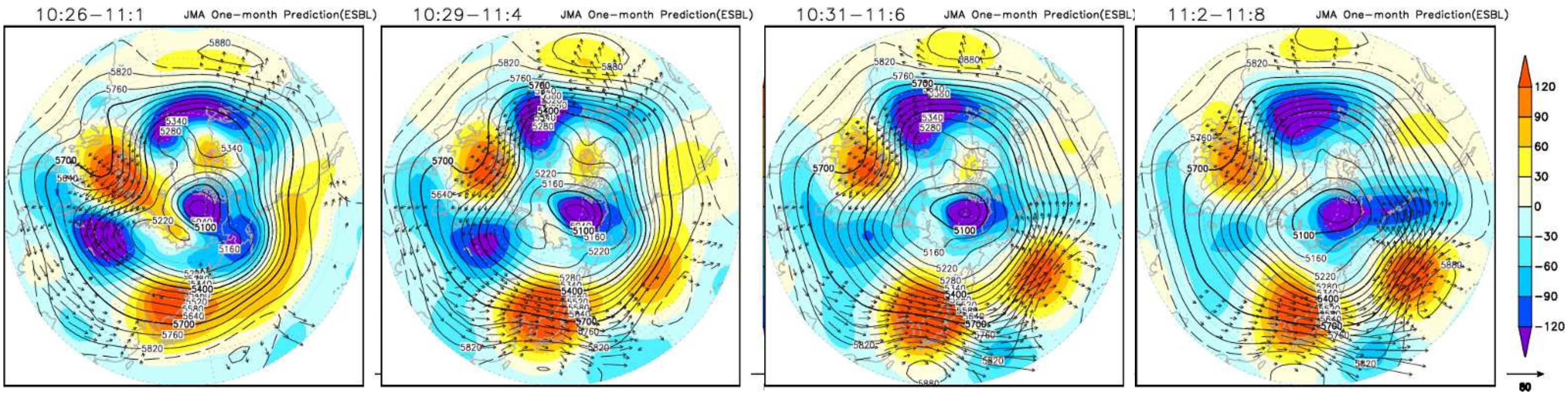
Week-1 to 4 (4 weeks average)



Z500 anomaly (NH map)

Initial: 27 Oct 2011

Initial date: 27 Oct 2011



- Propagation of Rossby wave packets along both polar- and subtropical jet stream are found.
- Those enhances positive anomaly of PSI200 over east Asia from the end of Oct. to the beginning of Nov.

Verification (Real-time)

http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/verif/1mE/index.html

Verification of one month forecast

Maps

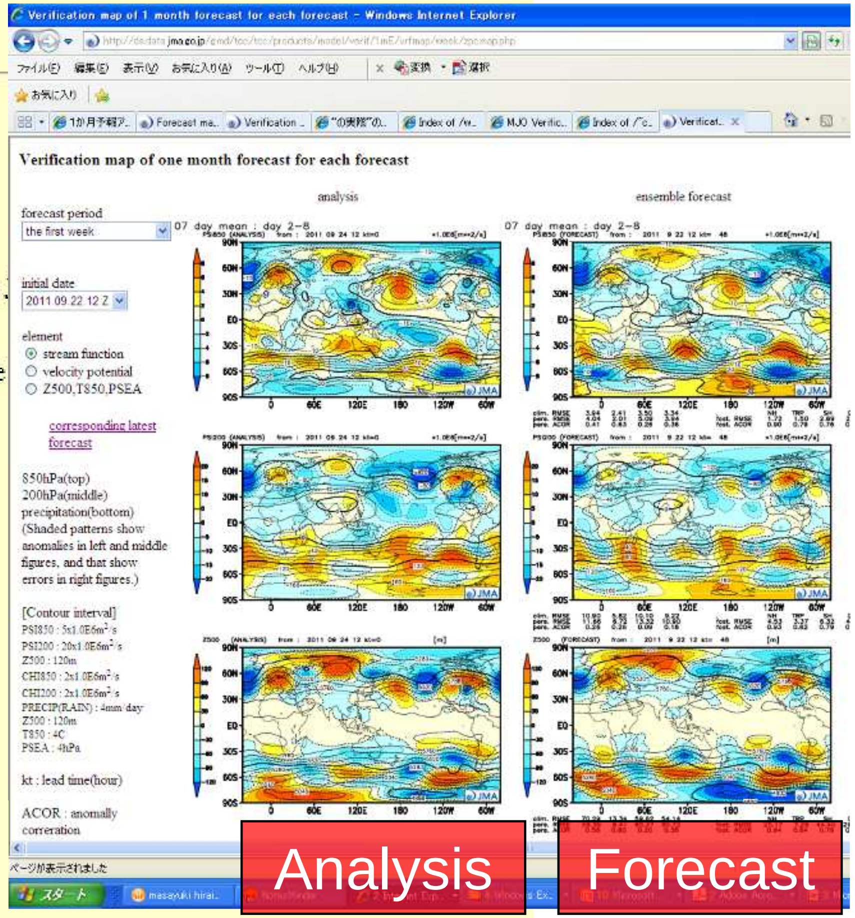
- Error maps for every forecast (updated every week)
    - Z500, T850 and PSEA
      * Systemtic error is removed.(Bias based on hindcast from 1979 to 2009.)
      After the initial date was May. 19 2011, Climatological normals were calculated with
    - Stream Function and Velocity Potential
      * Model normals based on hindcast from 1979 to 2009. Climatological normals were
- Reliability diagrams for each season
- ROC curves for each season

Scores

- Score in each season
- Score in each year

Summary of verification in 2001
Summary of verification in 2002
Summary of verification in 2003
Summary of verification in 2004
Summary of verification in 2005
Summary of verification in 2006
Summary of verification in 2007
Summary of verification in 2008
Summary of verification in 2009
Summary of verification in 2010

Summarized real-time verification scores



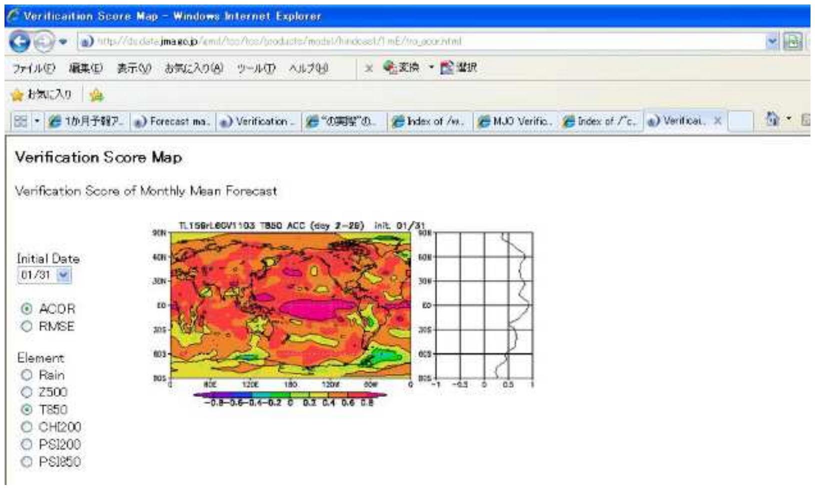
Verification (Hindcast)

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

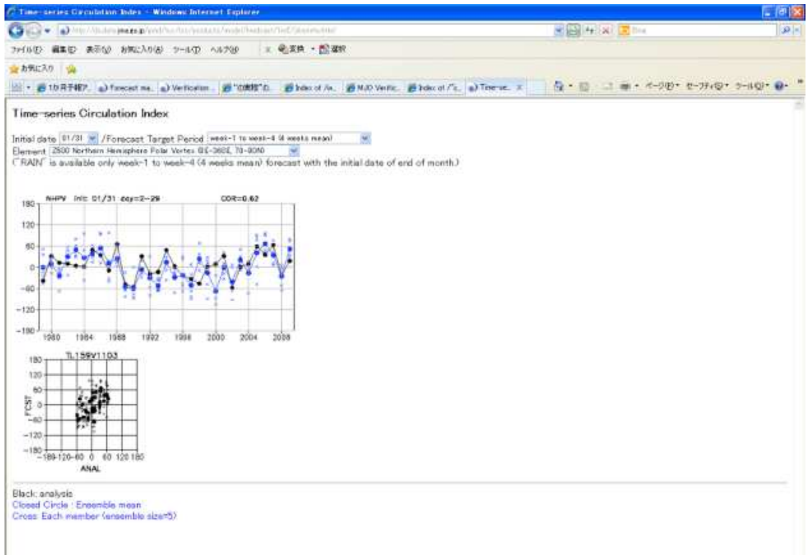

Verifications of One-month EPS fr

- Time-series Circulation Index
- Verification Score Maps
  - Variables to be Assessed: RAIN, Z500, T850, CHI200, PSI200, PSI850
  - Diagonostic Measures:
    - Anomaly Correation(ACOR)
    - Root Mean Squred Error(RMSE)

Score map (Anomaly correlation)



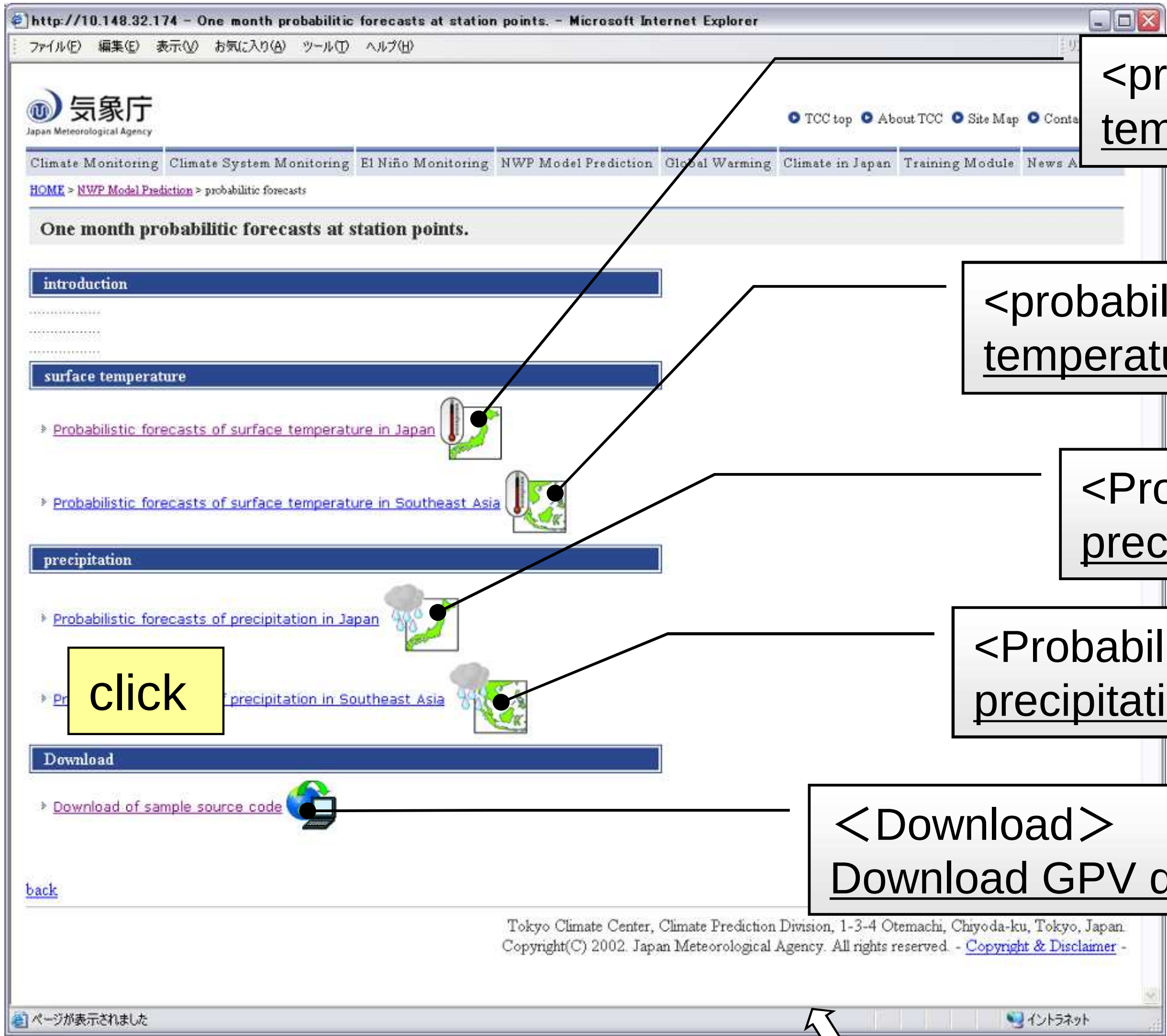
Score of index



Calibrated probabilistic forecasts

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

Top page



<probabilistic forecast map in Japan>
temperature

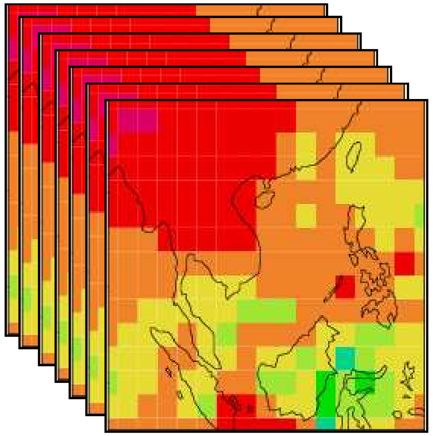
<probabilistic forecast map in Southeast Asia>
temperature

<Probabilistic forecast map in Japan>
precipitation

<Probabilistic forecast map in Southeast Asia>
precipitation

＜Download＞
Download GPV data and sample program download

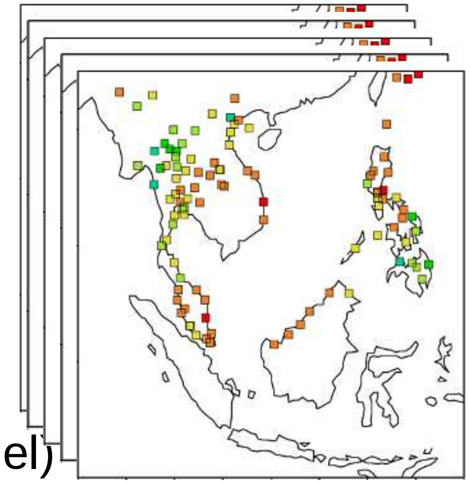
Probabilistic one-month forecast system



Direct model output

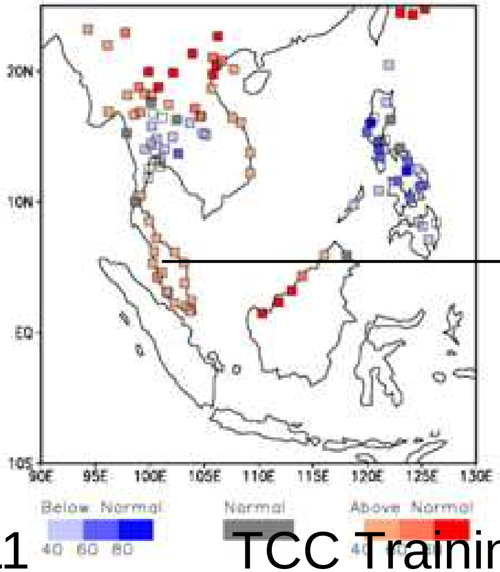
50 members result
- –T(surface) or Rain
- –Wind 850 hPa
- –MJO index
- –NINO.3 SST (boundary condition for model)
- –Topography (constant)

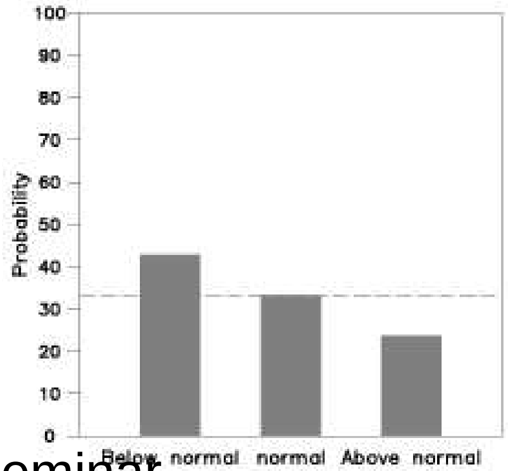
Statistical downscale



Downscale to station data

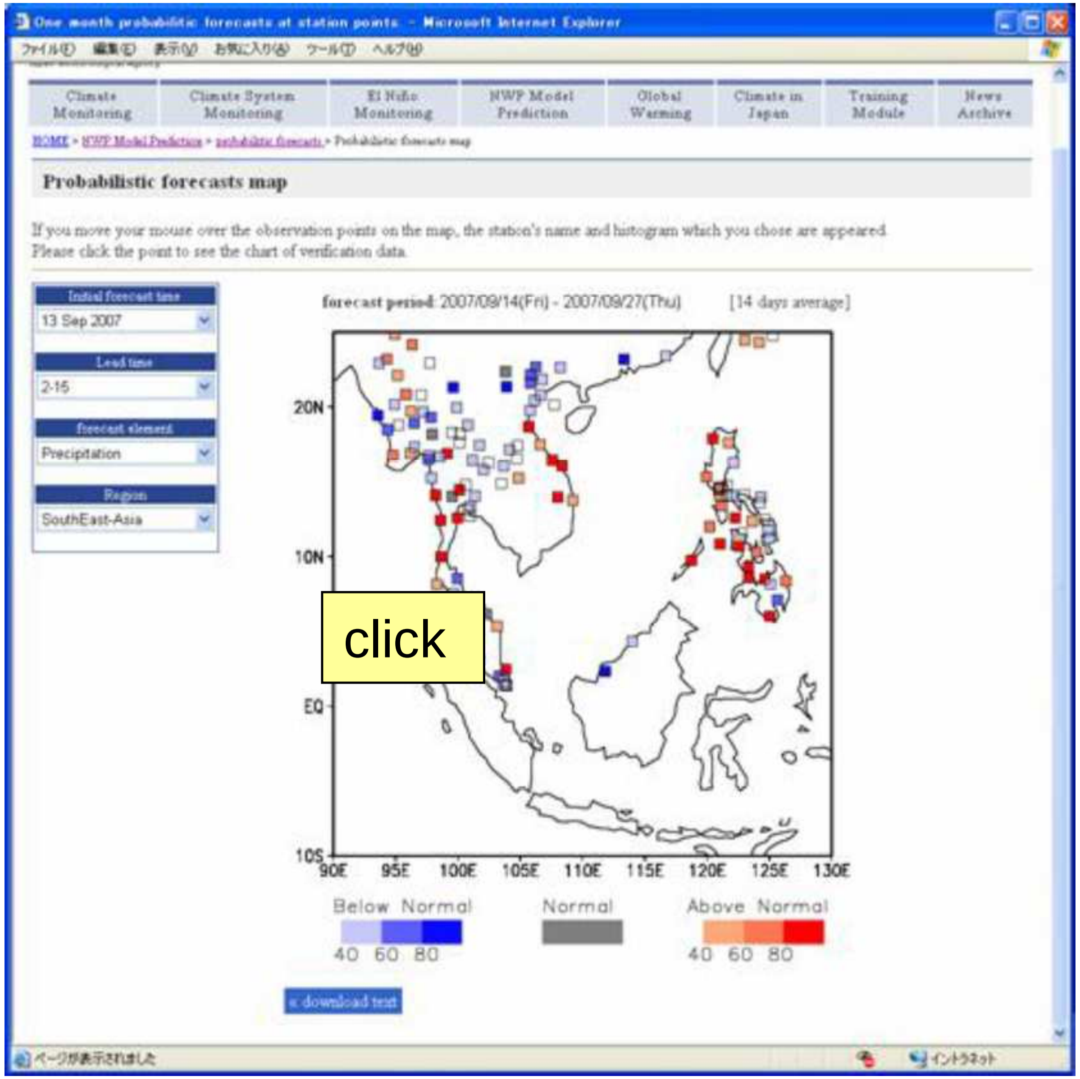
Create probability charts





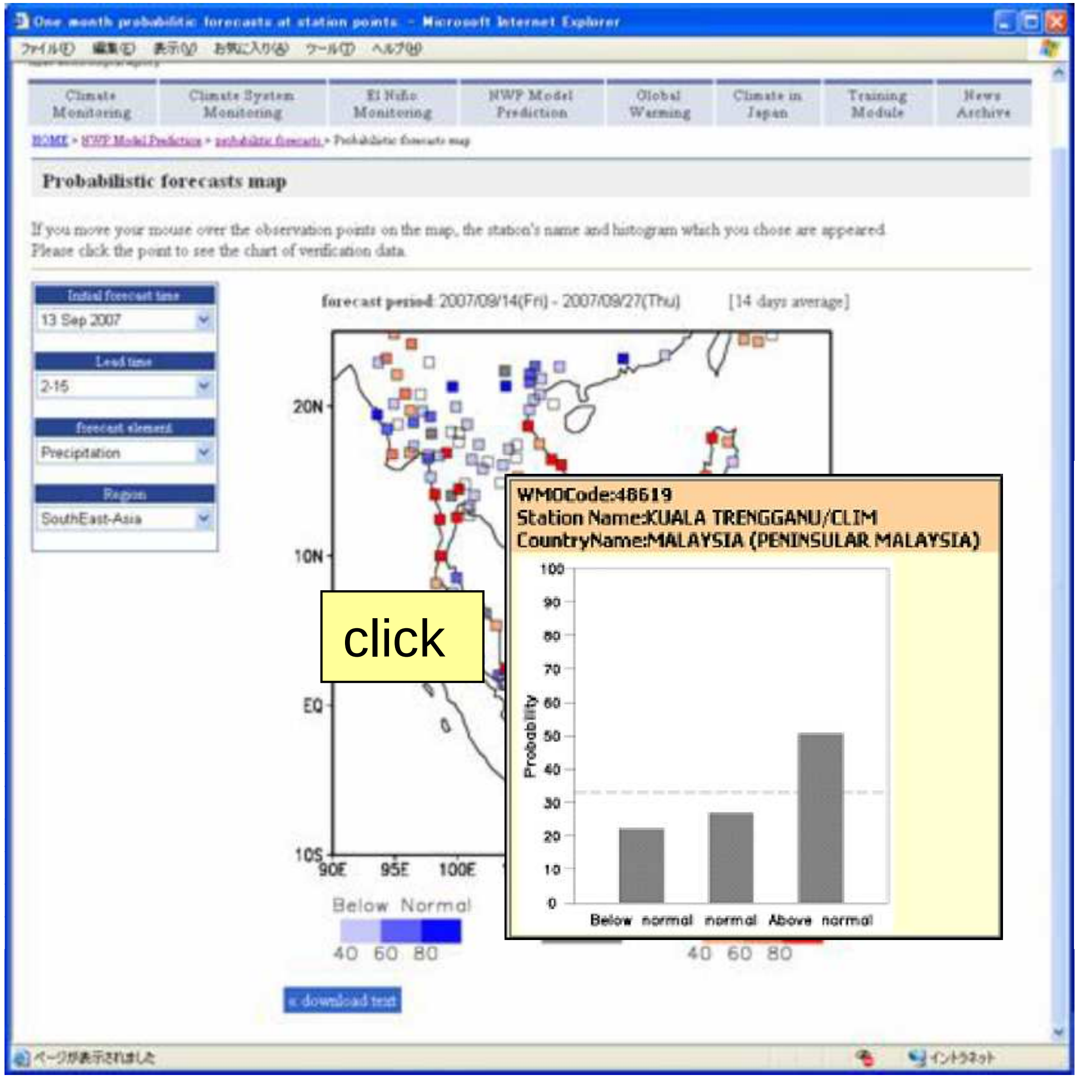
TCC Training Seminar 7 November 2011

Web page of probabilistic one-month forecast Probability map page



- Forecast Period
  - Day 2-8, 3-9, 4-10, ..., 23-29 (7-days average)
- Parameter
  - Surface temperature
  - Precipitation

Web page of probabilistic one-month forecast Probability map page



- Forecast Period
  - Day 2-8, 3-9, 4-10, ..., 23-29 (7-days average)
- Parameter
  - Surface temperature
  - Precipitation

“Latest Product” of 4/7-month EPS

Three-month Prediction

4-month EPS

- Three-month Prediction (17 Oct 2011)
- Z500, T850 & SLP (Northern Hemisphere) (17 Oct 2011)
- Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (17 Oct 2011)

Forecast maps

- Verification (14 Oct 2011)

Verification (Real-time)

- Hindcast

Verification (Hindcast)

- Probabilistic Forecast and Verification (17 Oct 2011)

Calibrated probabilistic forecasts

Warm/Cold Season Prediction

7-month EPS

- Warm/Cold Season Prediction (17 Oct 2011)
- Z500, T850 & SLP (Northern Hemisphere) (17 Oct 2011)
- Stream Function, Velocity Potential & Surface Air Temperature (60N-60S) (17 Oct 2011)

Forecast maps

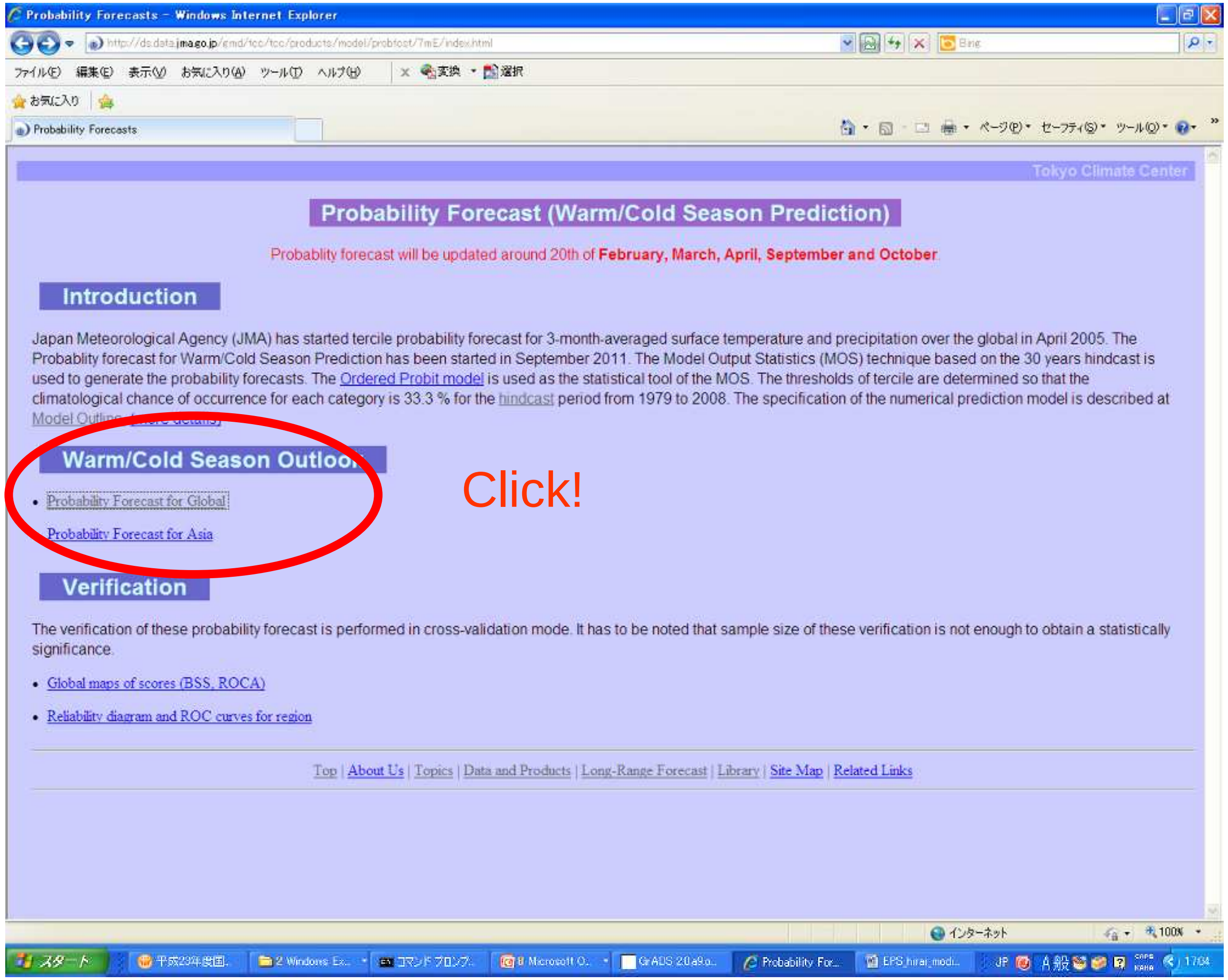
- Hindcast
- Probabilistic Forecast and Verification NEW (17 Oct 2011)

Calibrated probabilistic forecasts

Probabilistic forecast of 4/7 month EPS

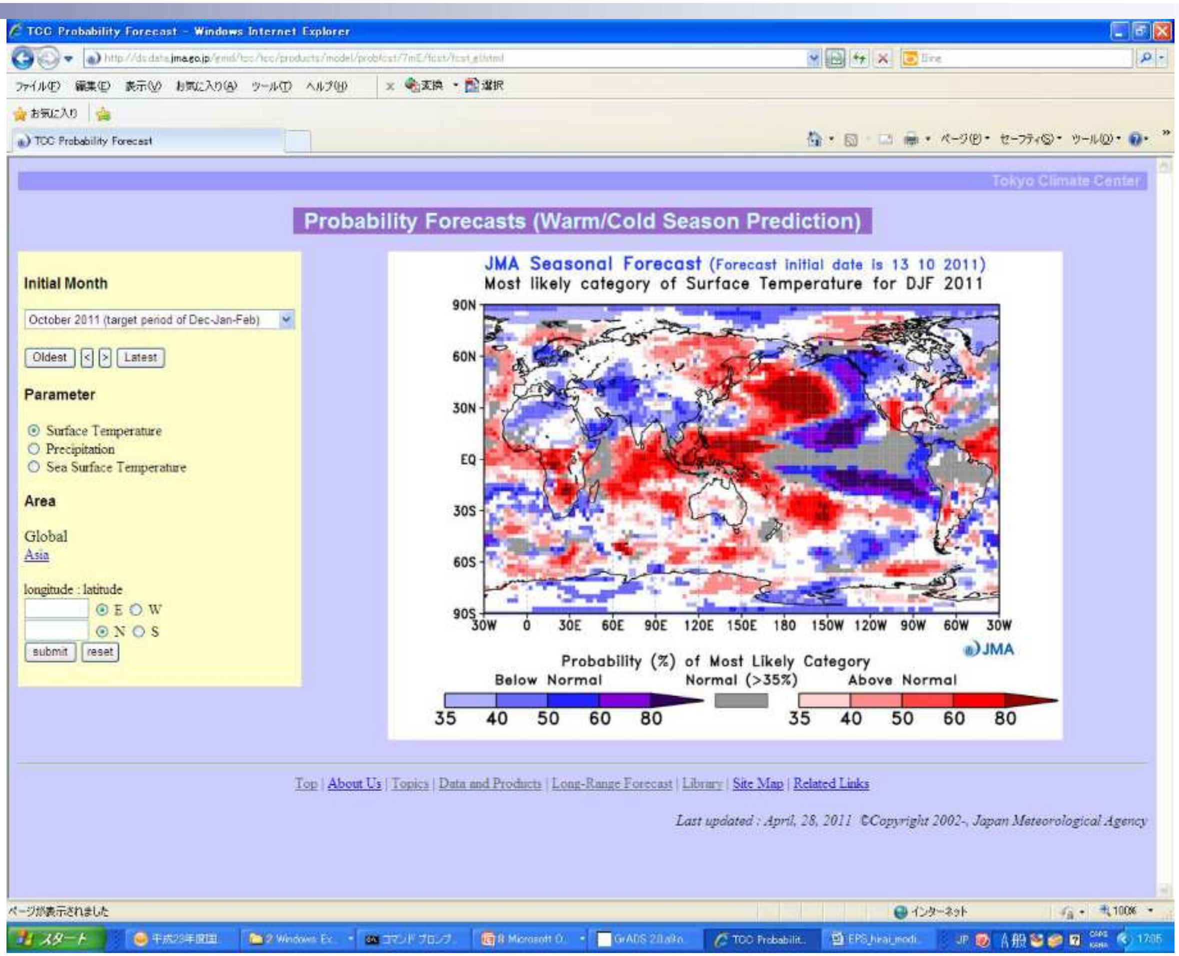
http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/probfcst/4mE/index.html
http://ds.data.jma.go.jp/gmd/tcc/tcc/products/model/probfcst/7mE/index.html

- Tercile probability forecasts for 3-month-averaged surface temperature, precipitation and sea surface temperature based on MOS technique (Model Output Statistics), that is one of the statistical downscaling technique.
- Probability forecast will be updated **around 20th every month**.



Probabilistic forecast of 4/7 month EPS

- Forecast Period
  - –Once a month
  - –Three month average
- Parameter
  - –Surface temperature
  - –Precipitation
  - –Sea Surface Temperature
- Area
  - –Global
  - –Asia



Shading denotes the probability of most likely category.

Gridded dataset (Grid Point Values; GPVs)

http://ds.data.jma.go.jp/gmd/tcc/tcc/gpv/index.html

ID/ Password are required.

- 1-month EPS
  - Operational system data
    - Daily data on statistics (ensemble mean and anomaly)
    - Daily data on individual ensemble members
  - Hindcast data
    - Daily data on individual ensemble members
- 4/7 month EPS
  - Operational system data
    - Monthly data on ensemble statistics (ensemble mean, anomaly and spread)
    - Monthly data on individual ensemble members (forecast and anomaly)
  - Hindcast data
    - Monthly data on individual ensemble members (forecast and anomaly)

- For more details, please refer to the text of this seminar (WORD file).

First step guide for usage of the gridded dataset (Grid Point Values; GPVs)

- Download the gridded dataset
- Viewer: Grid Analysis and Display System (GrADS) from COLA/IGES

Example:

Ensemble mean data of 1-month EPS (using Windows PC)

In case of Linux machine, please refer to the document (Item 4; Using Grid Point Value Data Provided on the TCC Website)

Processes

(1) Preparation

- Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
Ensemble mean data of 1-month EPS
Initial date: 27 Oct 2011
Element: Z500 and its anomaly

(2) Download the gridded dataset (GPV)

(3) Conversion of TCC-GRIB files into **GrADS data file** using wgrib2

(4) Edit the **GrADS control file**

(5) Visualization using GrADS

Flow chart for handling gridded dataset

Step-(1)

Grib2 (1 month, 3 months)

on TCC Website

Step-(2)

(Download)

Internet

Grib2 (1 month, 3 months)

Step-(3)

(Convert using wgrib2)

Binary (GrADS data format)

Step-(4), (5)

(Visualization)

Processes

(1) Preparation

- Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
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(2) Download the gridded dataset (GPV)

(3) Conversion of TCC-GRIB files into GrADS data file using wgrib2

(4) Edit the GrADS control file

(5) Visualization using GrADS

Preparation
Install tools (OpenGrADS)

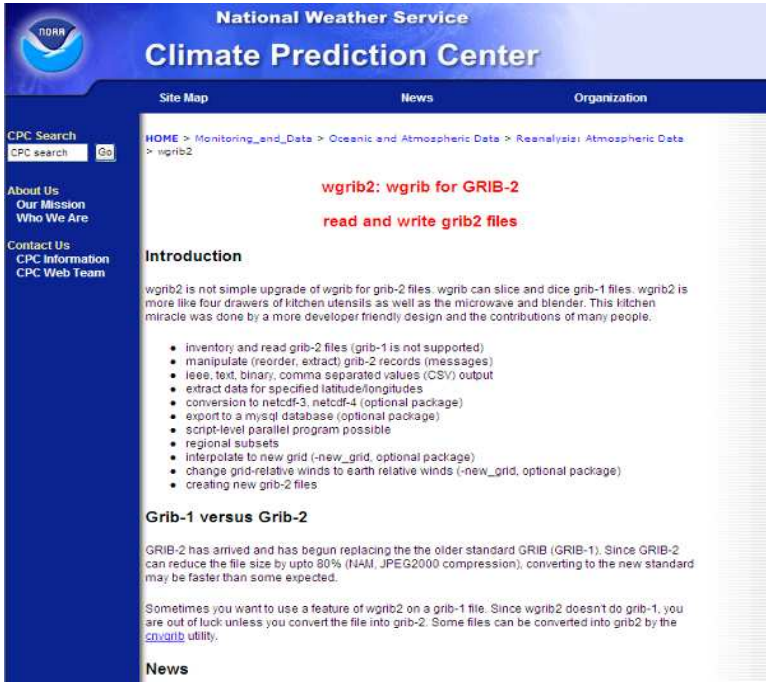
- COLA/IGES in the US provides a Windows version of GrADS.
- US-based company SourceForge, Inc. has developed and provides an extension version of GrADS based on the original GrADS program from COLA/IGES called "OpenGrADS".

- For download of "OpenGrADS"...
  - **visit to http://sourceforge.net/projects/opengrads/**.
  - Click on the banner "**Download"** and save the file to the desired directory.

Preparation
Install tools (Wgrib2)

- All grid point data on the TCC website are provided in GRIB2 format.
- To handle or decode the GRIB2 files, the program “wgrib2” is useful.

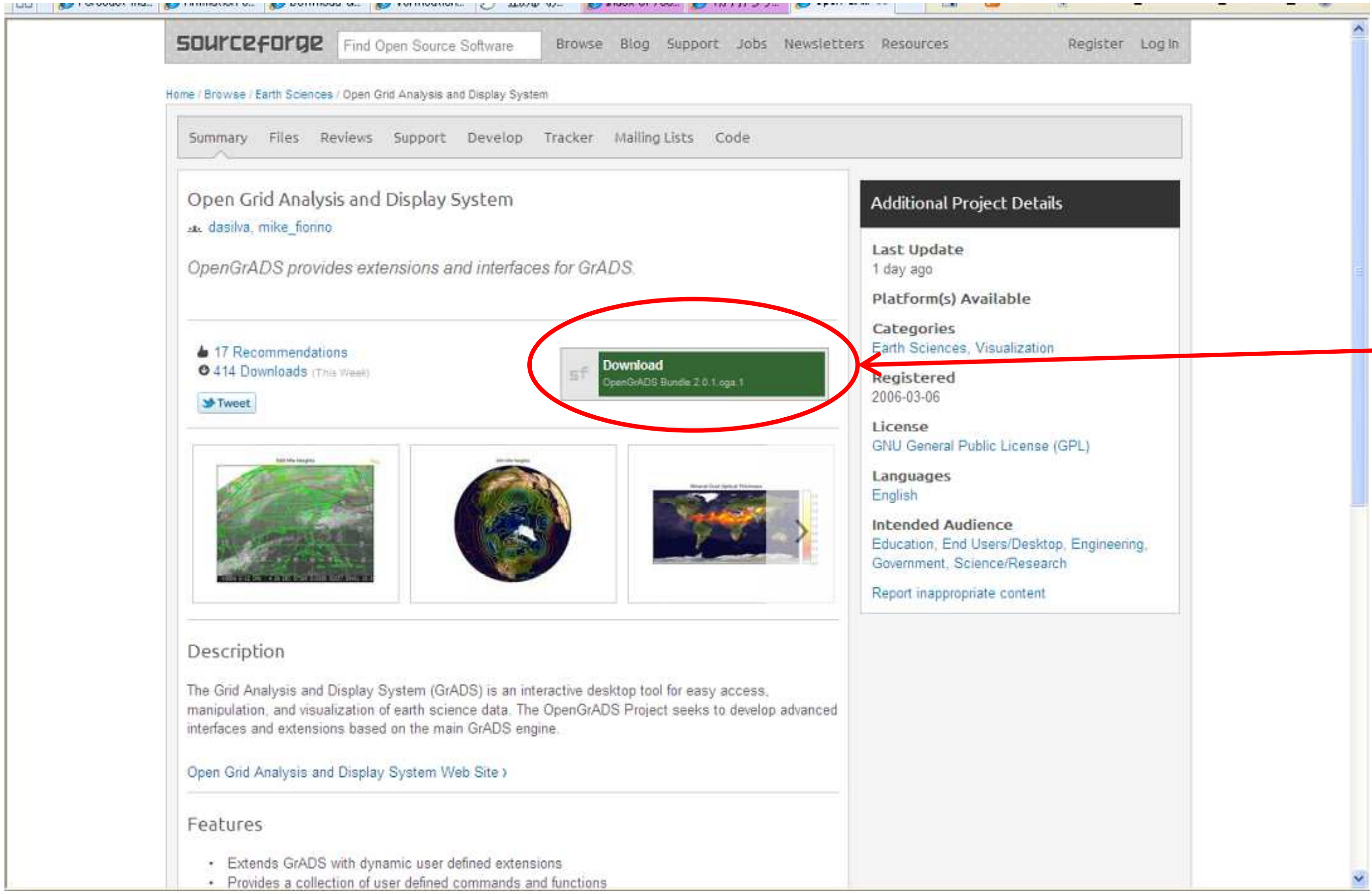
Download page of wgrib2;
http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/



- For Windows, as wgrib2 is also packaged with OpenGrADS, there is no need to install wgrib2 separately as there is for Linux.

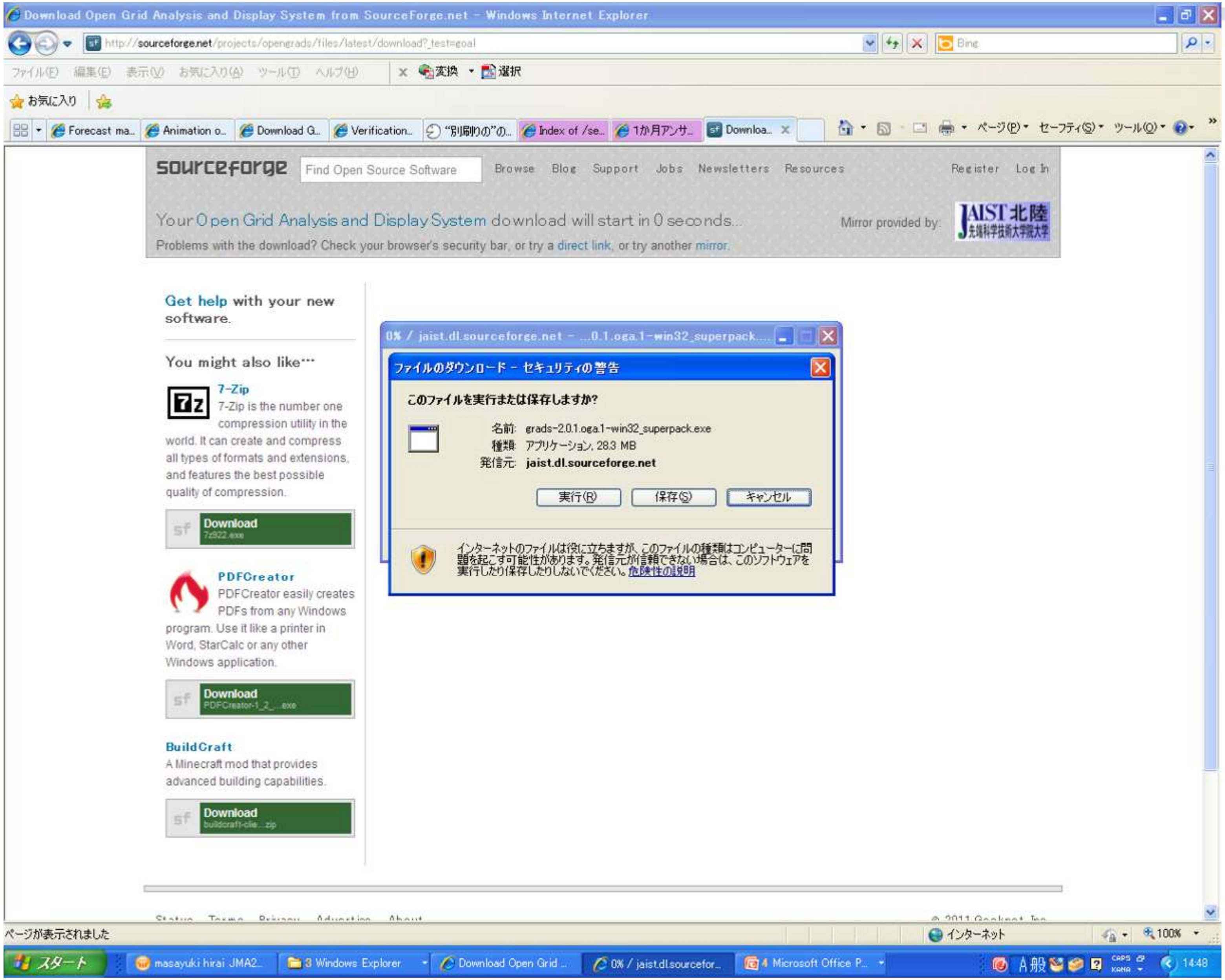
Download of OpenGrADS (1)
(Top page of OpenGrADS)

http://sourceforge.net/projects/opengrads/

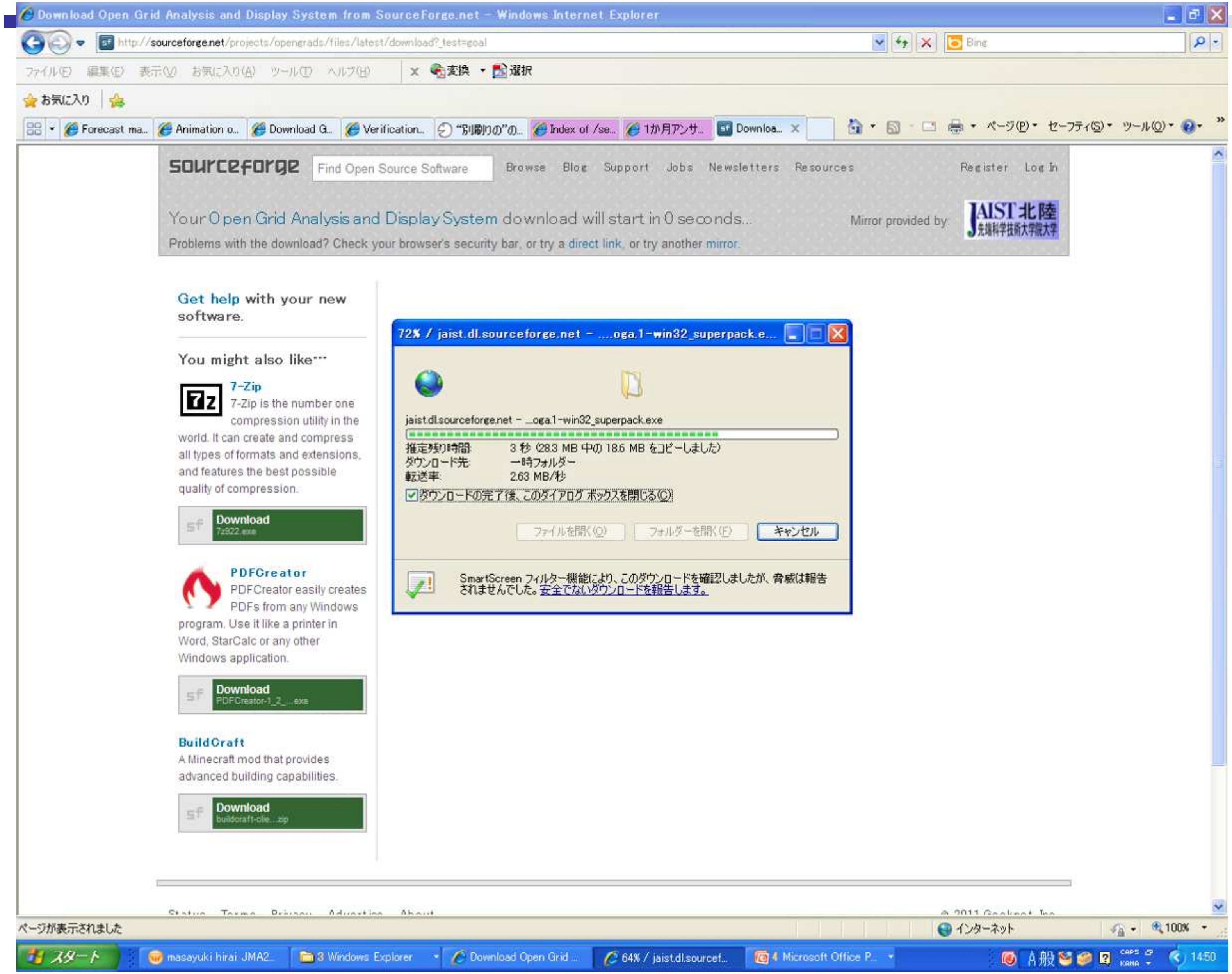


Download for install of OpenGrADS

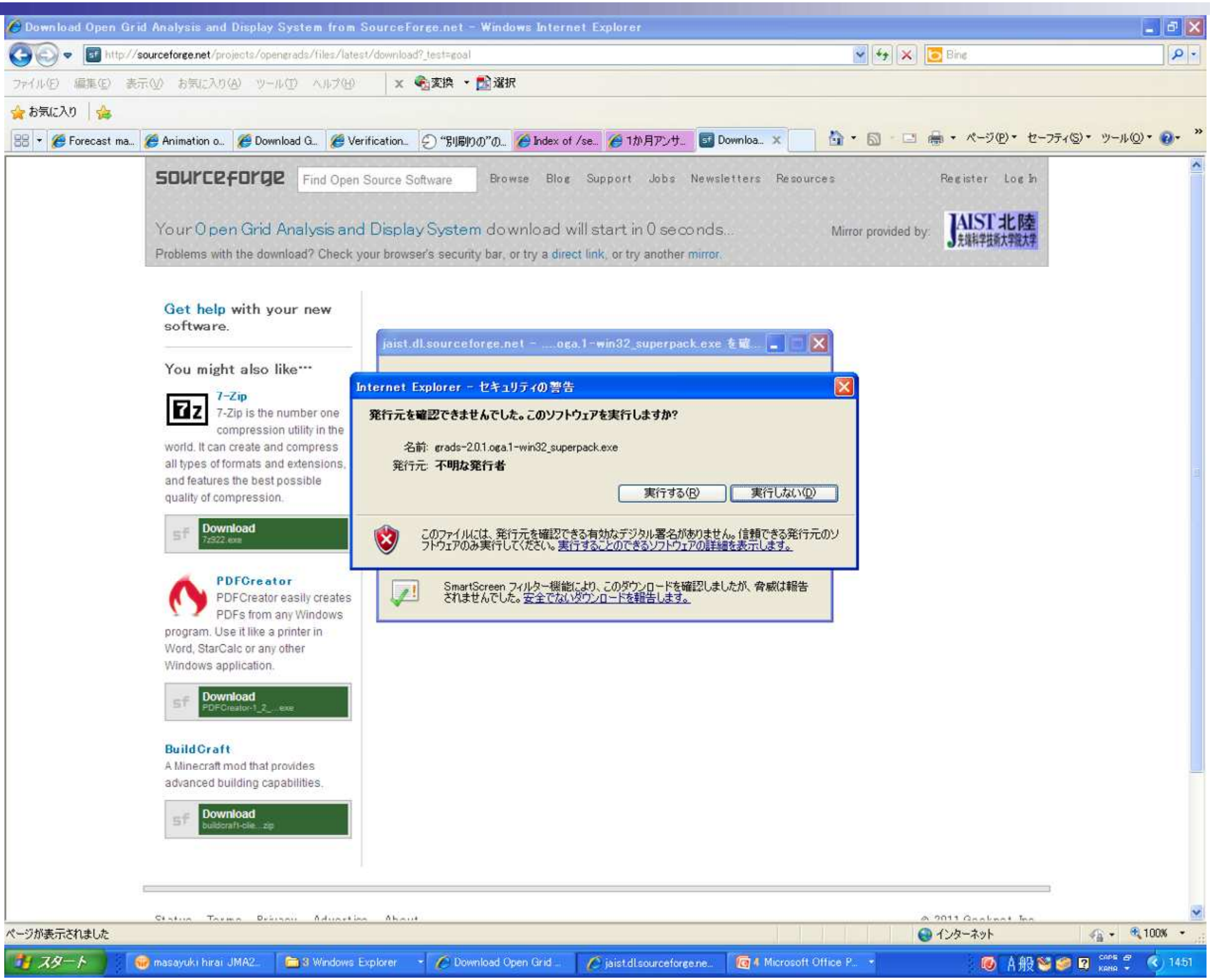
Download of OpenGrADS (2)
(Start of download)



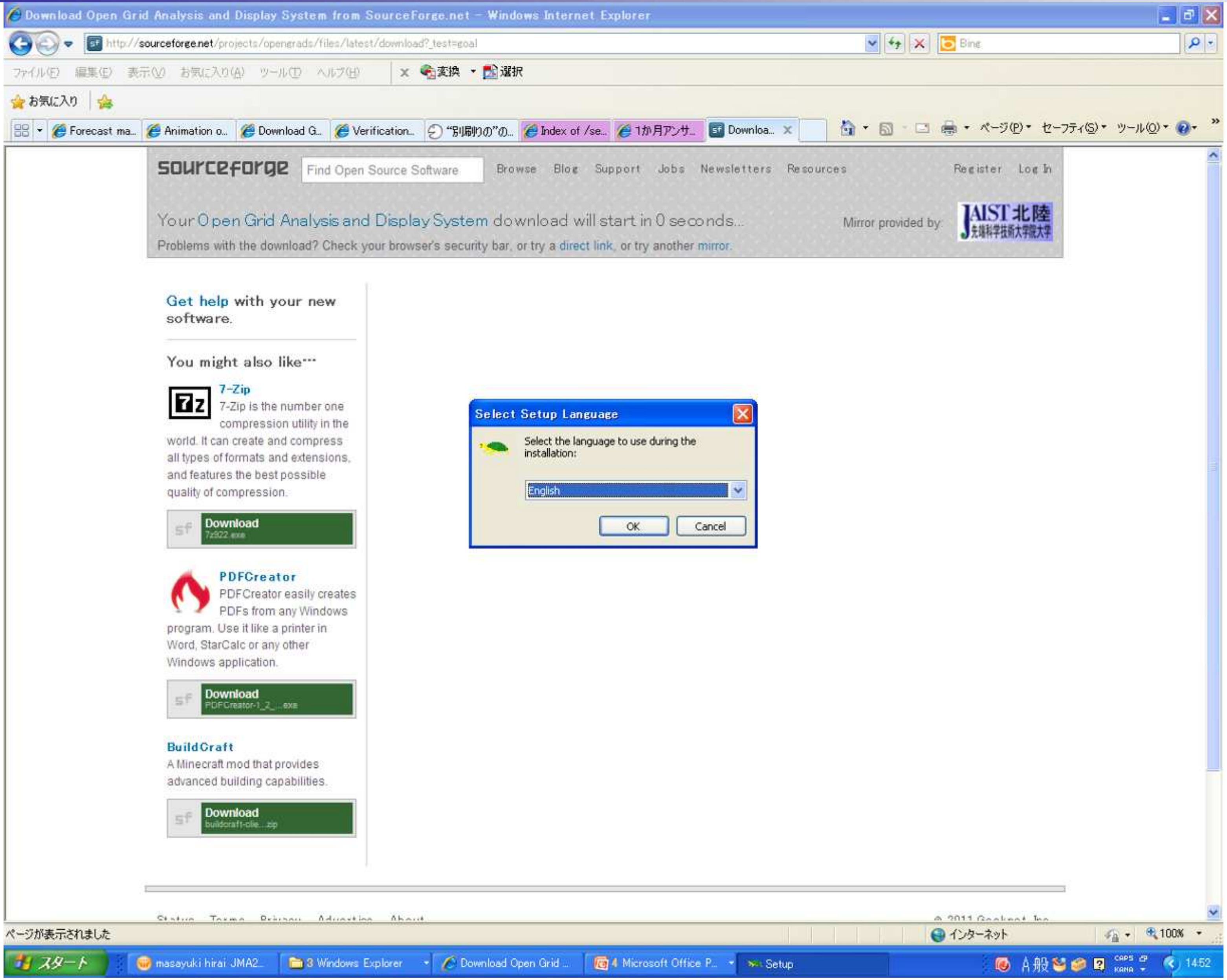
Download of OpenGrADS (3)
(download (underway))



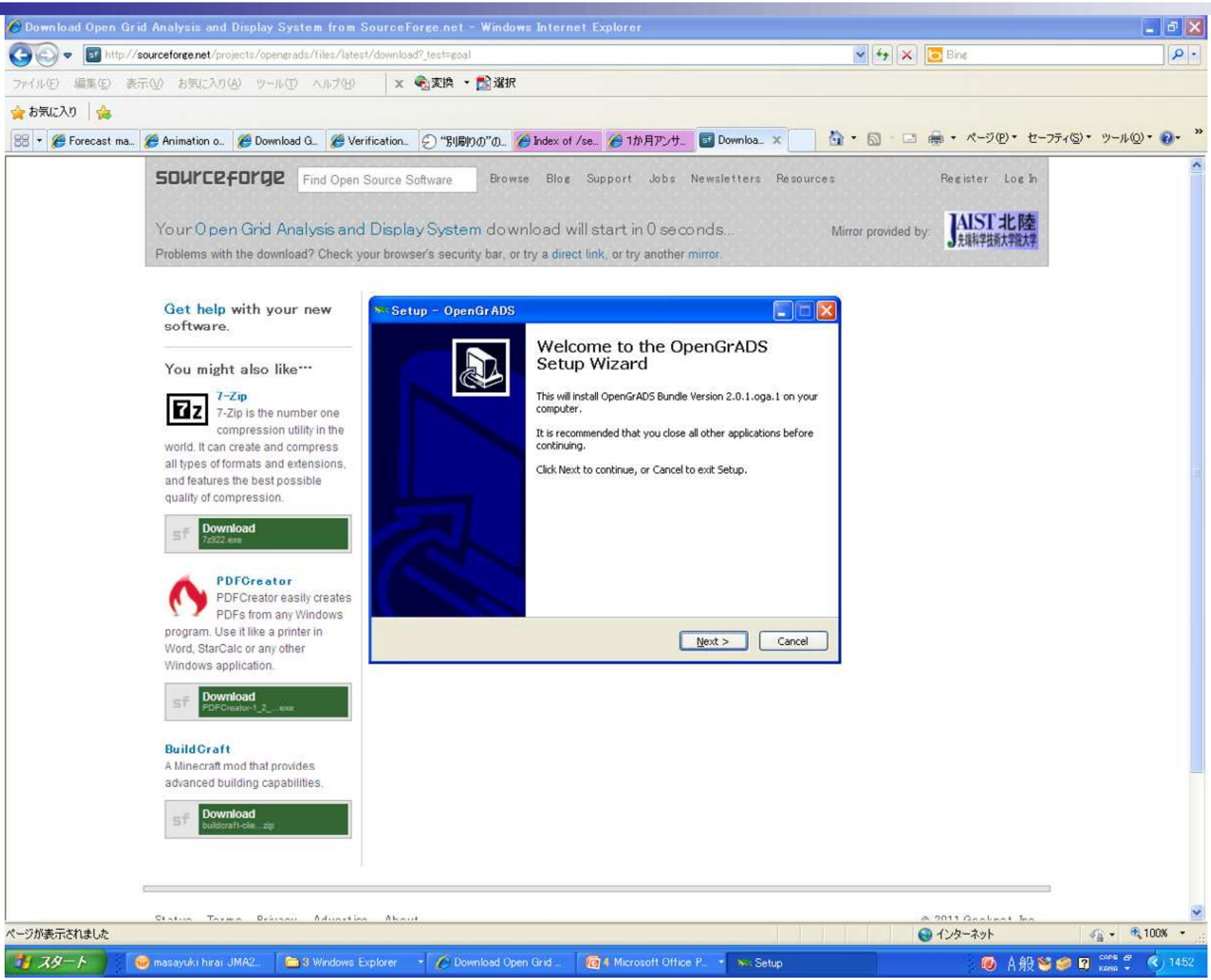
Download of OpenGrADS (3) (Confirmation screen of install)



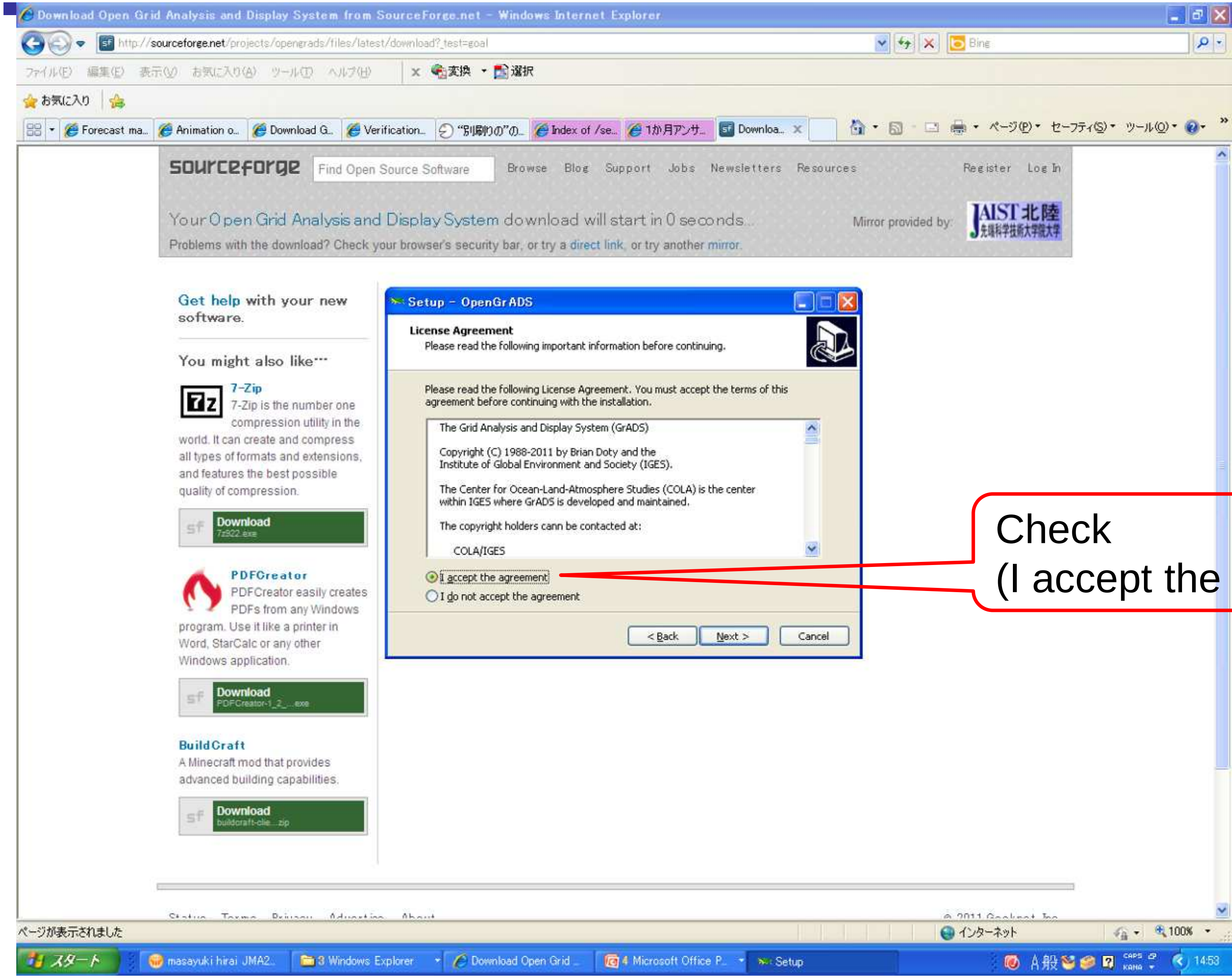
Download of OpenGrADS (3)
(Install (selecting language))



Download of OpenGrADS (3)
(Start setup wizard screen for install)

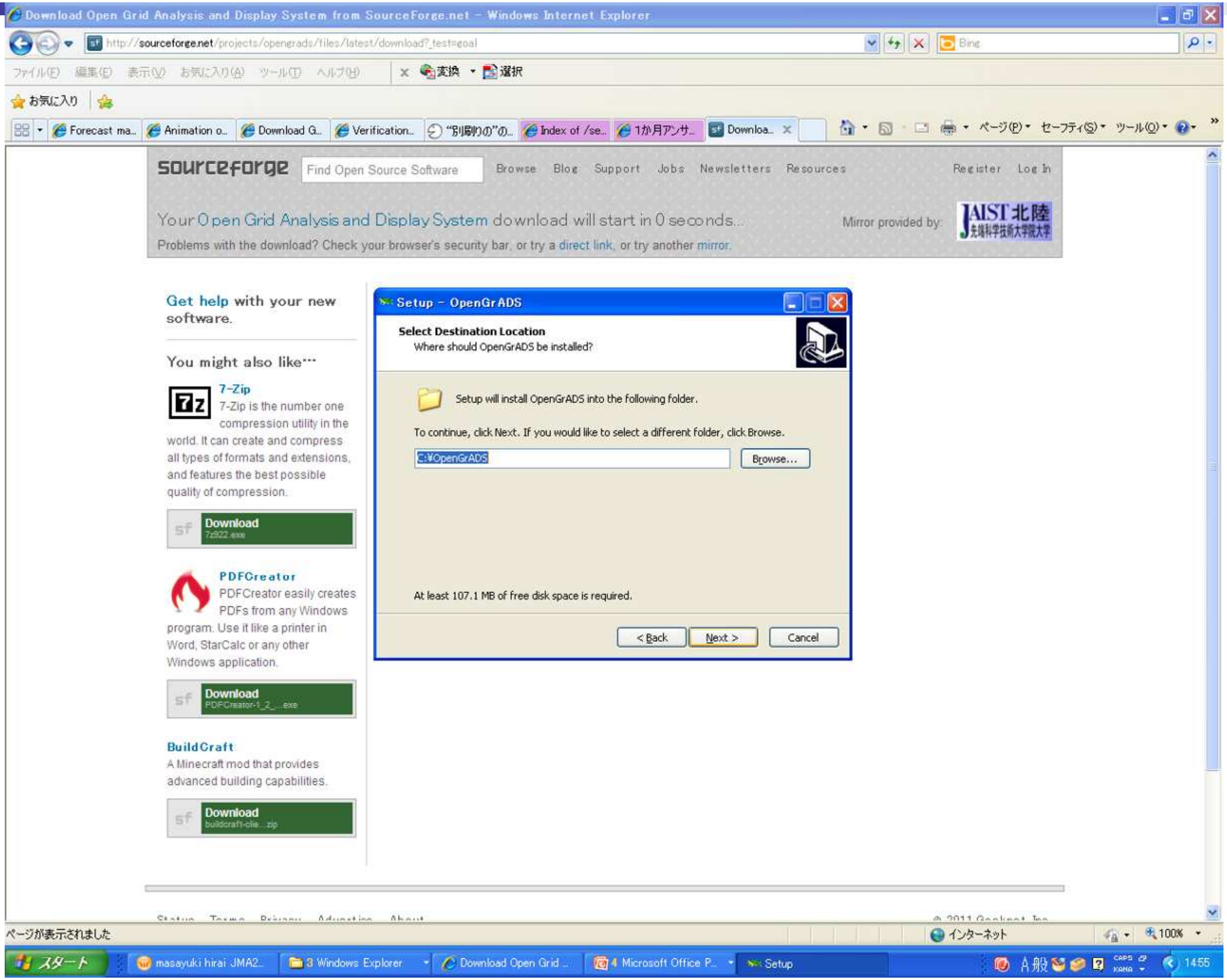


Download of OpenGrADS (3)
(License agreement for install)

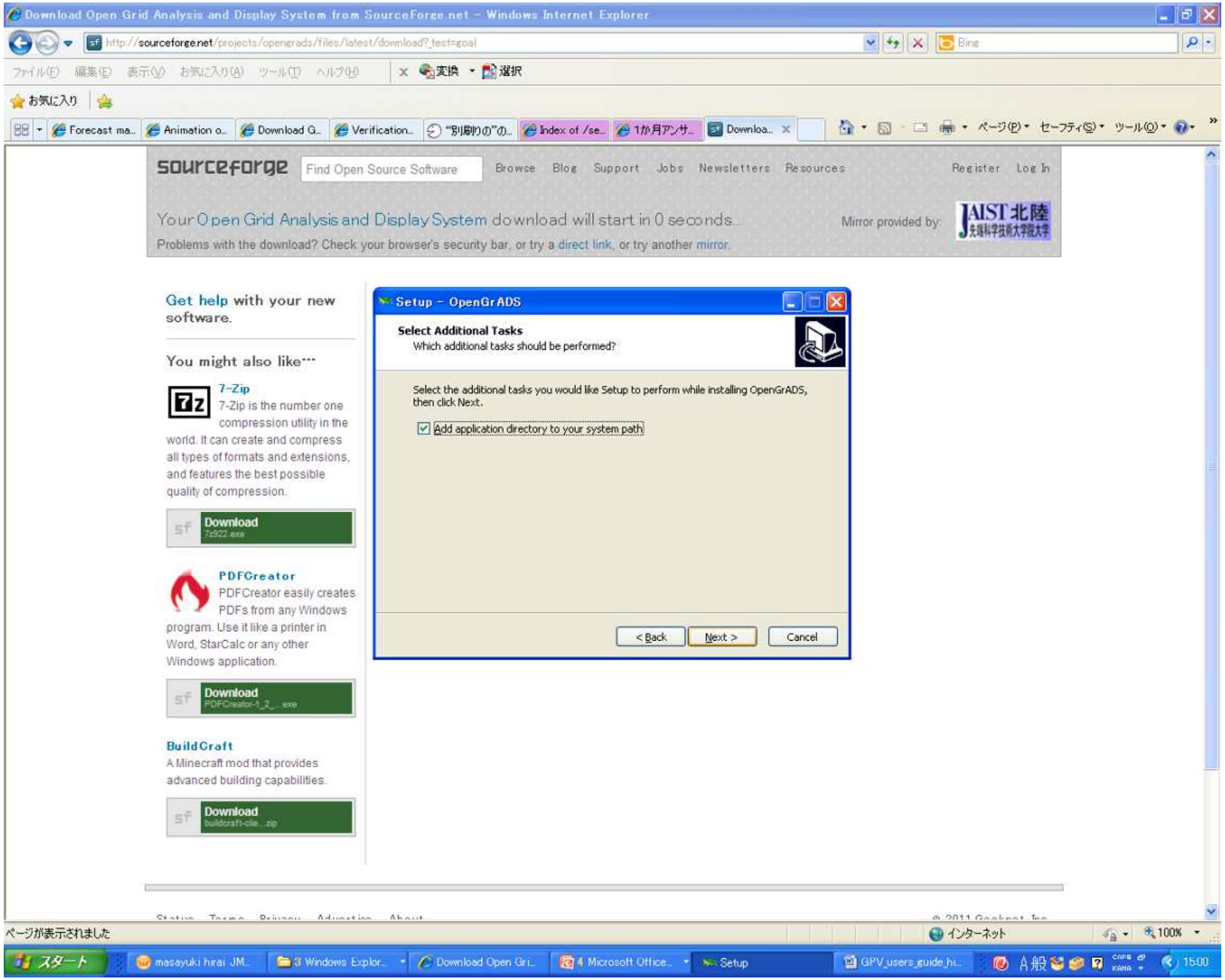


Check
(I accept the agreement)

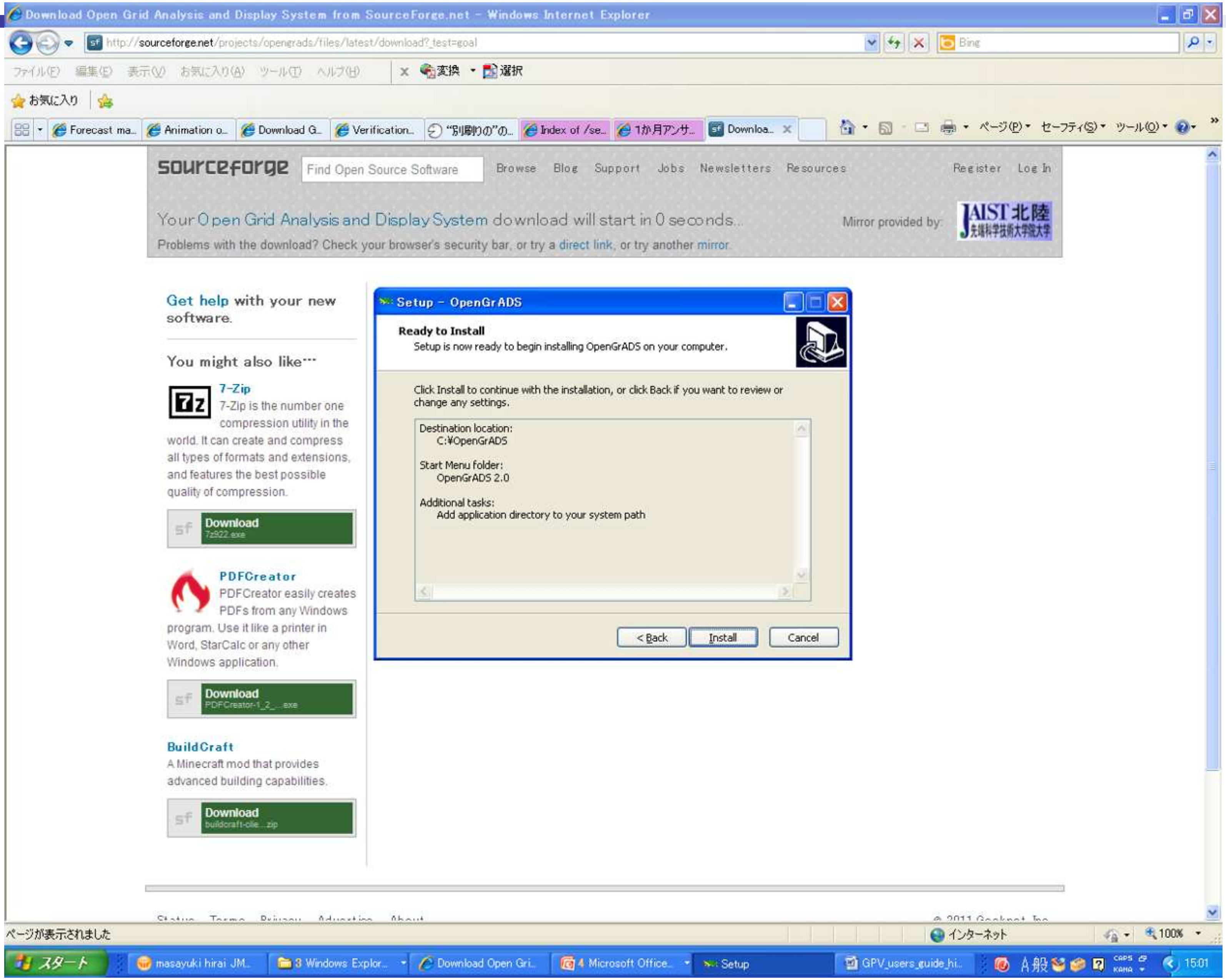
Download of OpenGrADS (3) (Folder name for install)



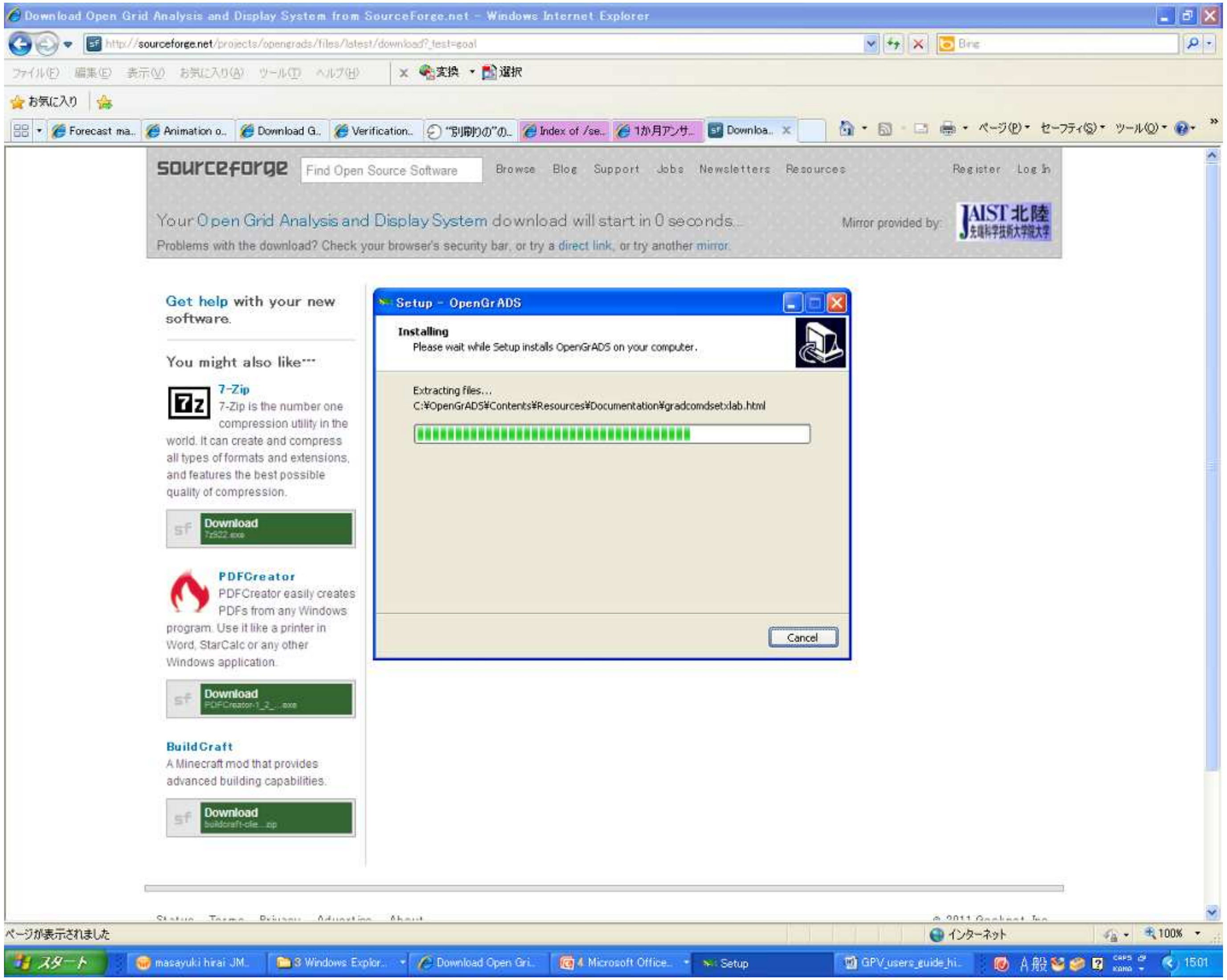
Download of OpenGrADS (3)
(Add path to the system path)



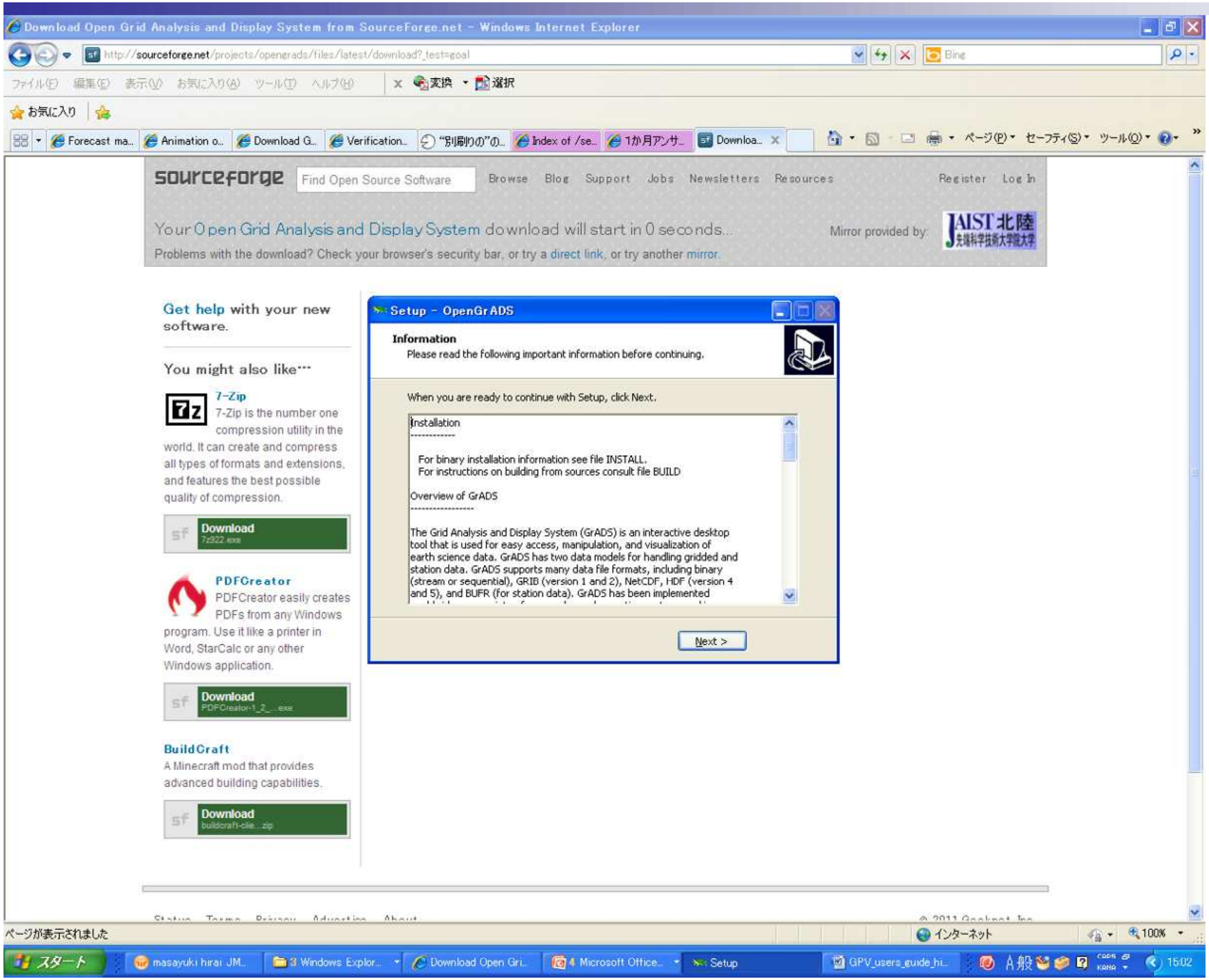
Download of OpenGrADS (3)
(Ready to install)



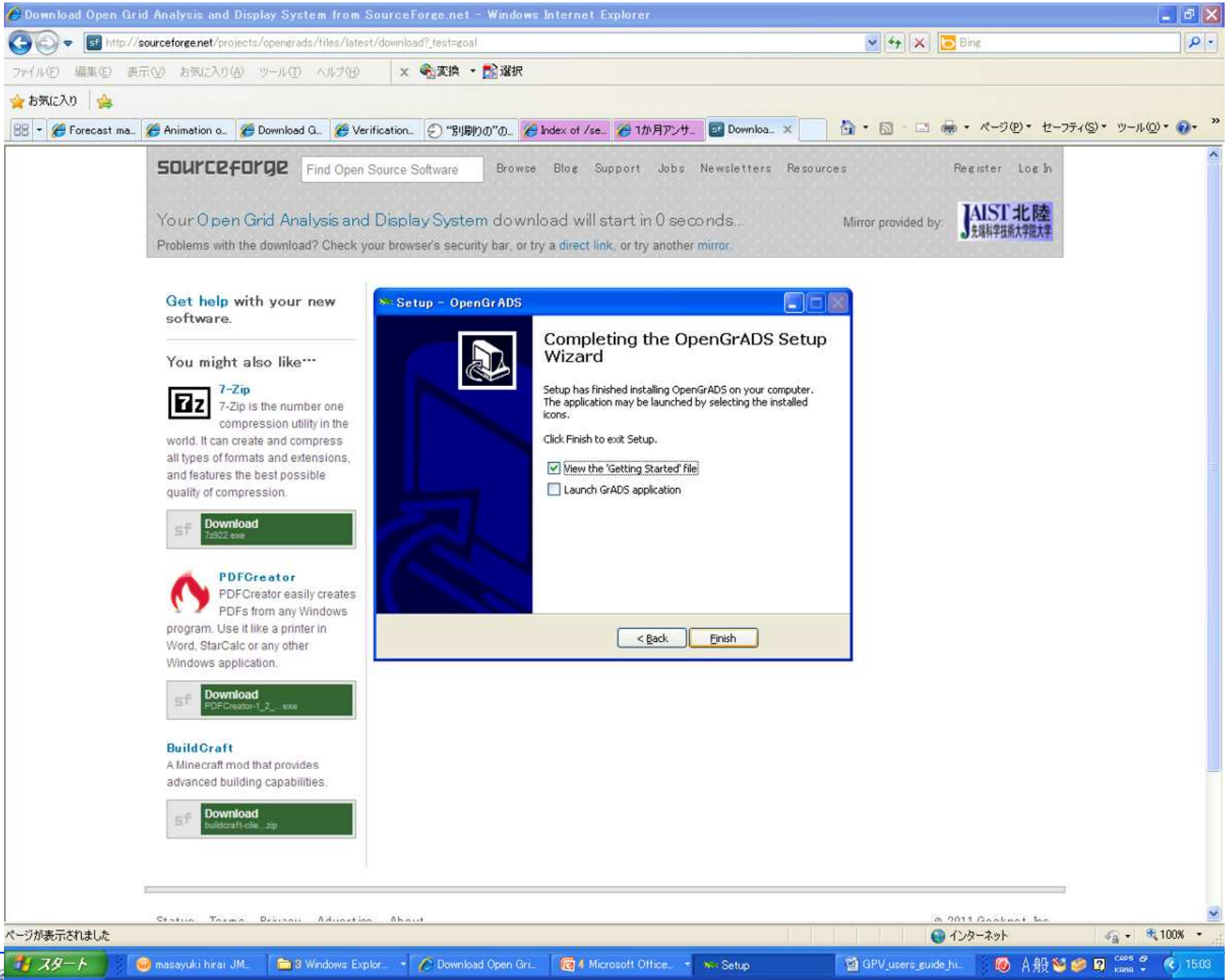
Download of OpenGrADS (3)
(Install (underway))



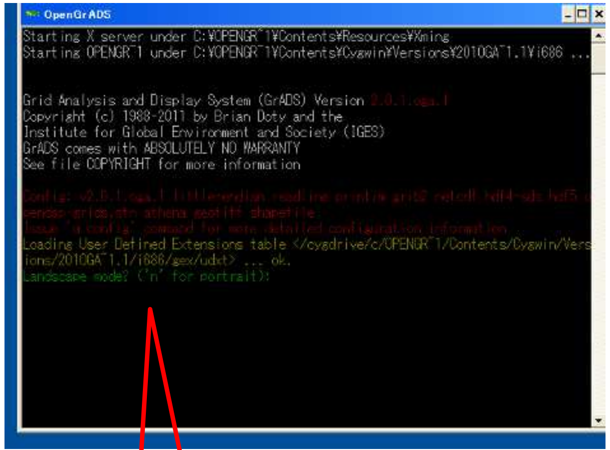
Download of OpenGrADS (3)
(Information of Grads displays.)

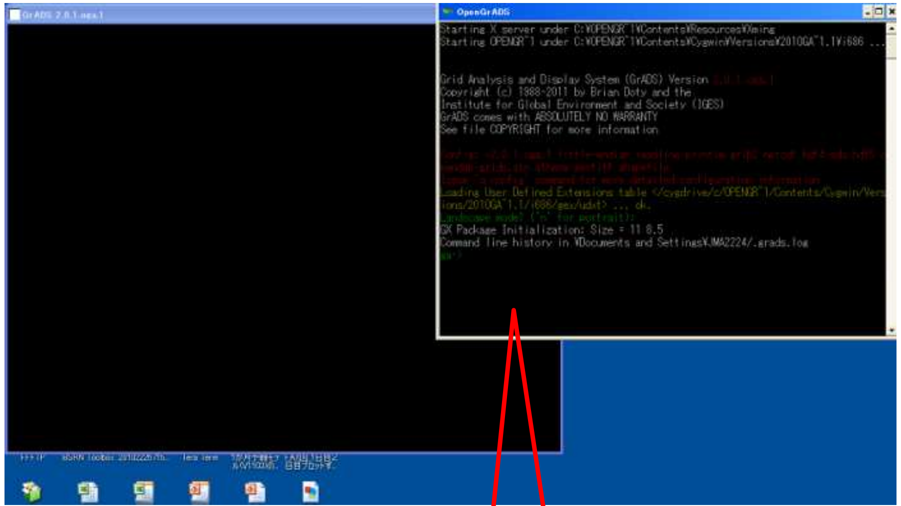


Download of OpenGrADS (3)
(Install finishes.)



Start-up of GrADS





CLICK
(OpenGrADS)

Opening message of GrADS

Push "Return" key

Two windows open.

Input command "quit" for exit GrADS.

Processes

(1) Preparation

– Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
Ensemble mean data of 1-month EPS
Initial date: 27 Oct 2011
Element: Z500 and its anomaly

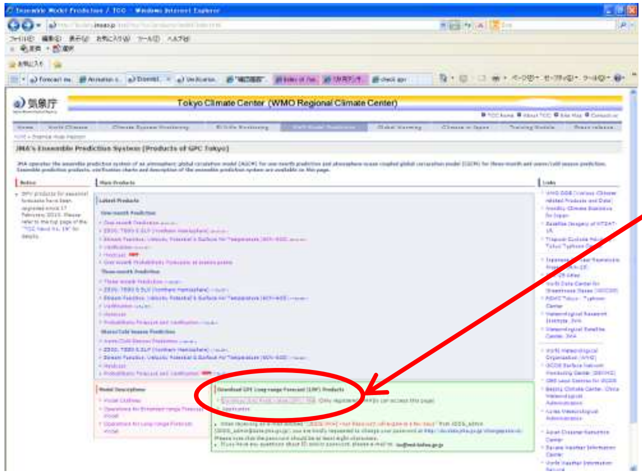
(2) Download the gridded dataset (GPV)

(3) Conversion of TCC-GRIB files into GrADS data file using wgrib2

(4) Edit the GrADS control file

(5) Visualization using GrADS

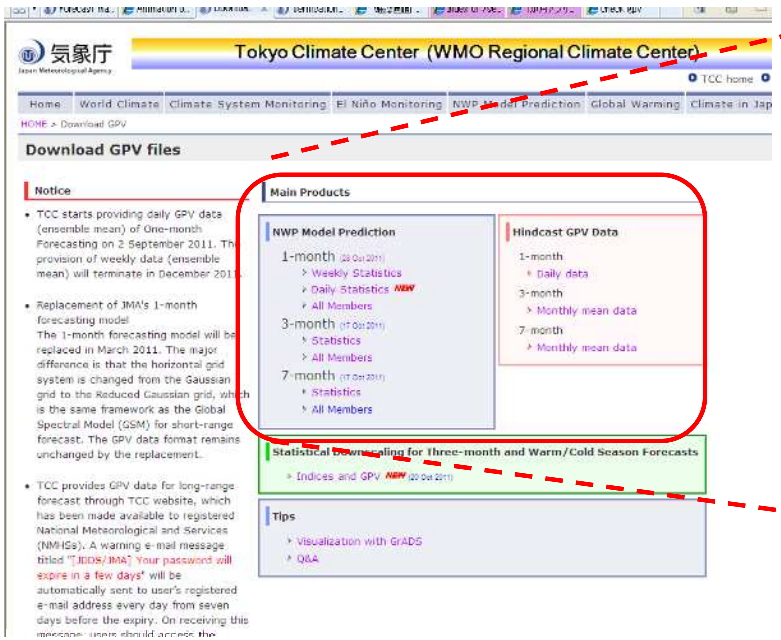
Download page of the gridded datasets

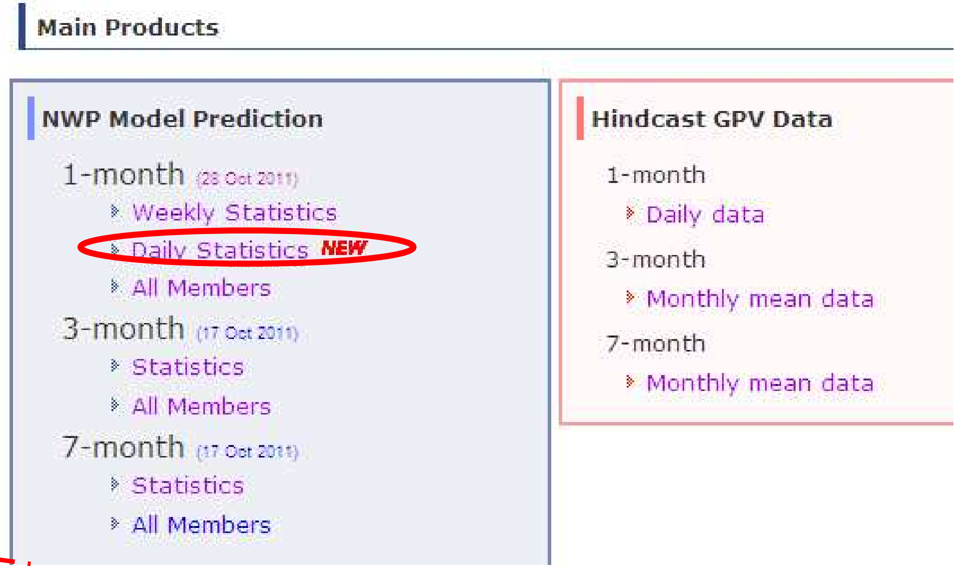


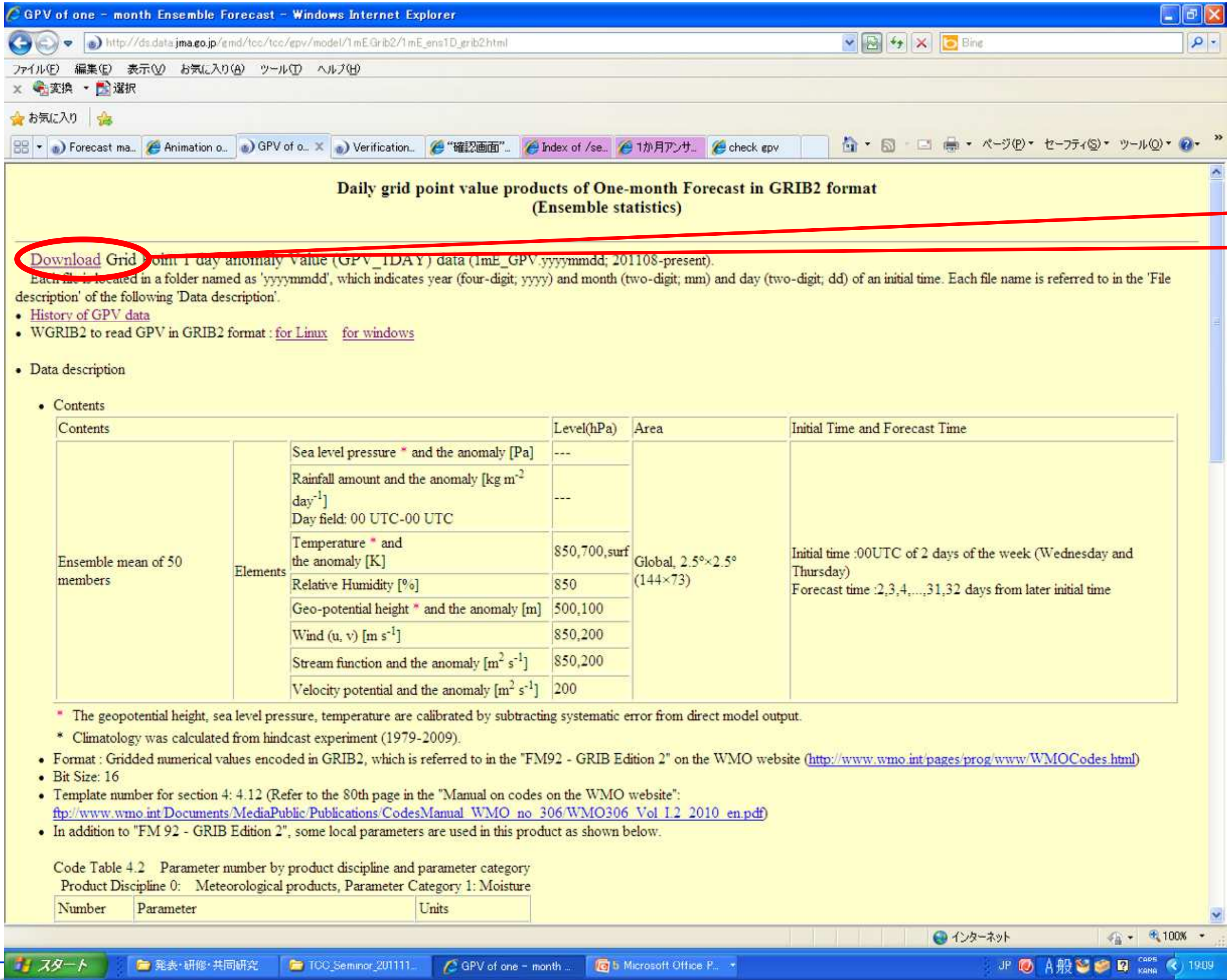
Download Grid Point Value (GPV)

(Only registered NMHSs can access this page)

NWP Model Prediction
"1-month/ Daily Statistics" are
referred in this case.







GPV of one - month Ensemble Forecast - Windows Internet Explorer

http://ds.data.jma.go.jp/gmd/tcc/tcc/gpv/model/1mEGrib2/1mE_ens1D_grib2.html

Daily grid point value products of One-month Forecast in GRIB2 format (Ensemble statistics)

Download Grid point 1 day anomaly Value (GPV_1DAY) data (1mE_GPV.yyyymmdd; 201108-present).

Each file is located in a folder named as 'yyyymmdd', which indicates year (four-digit; yyyy) and month (two-digit; mm) and day (two-digit; dd) of an initial time. Each file name is referred to in the 'File description' of the following 'Data description'.

- History of GPV data
- WGRIB2 to read GPV in GRIB2 format : for Linux for windows
- Data description
  - Contents

Contents			Level(hPa)	Area	Initial Time and Forecast Time
Ensemble mean of 50 members	Elements	Sea level pressure * and the anomaly [Pa]	---	Global, 2.5°×2.5° (144×73)	Initial time :00UTC of 2 days of the week (Wednesday and Thursday) Forecast time :2,3,4,...,31,32 days from later initial time
		Rainfall amount and the anomaly [kg m^{-2} day^{-1}] Day field: 00 UTC-00 UTC	---		
		Temperature * and the anomaly [K]	850,700,surf		
		Relative Humidity [%]	850		
		Geo-potential height * and the anomaly [m]	500,100		
		Wind (u, v) [m s^{-1}]	850,200		
		Stream function and the anomaly [m^2 s^{-1}]	850,200		
		Velocity potential and the anomaly [m^2 s^{-1}]	200		

* The geopotential height, sea level pressure, temperature are calibrated by subtracting systematic error from direct model output.

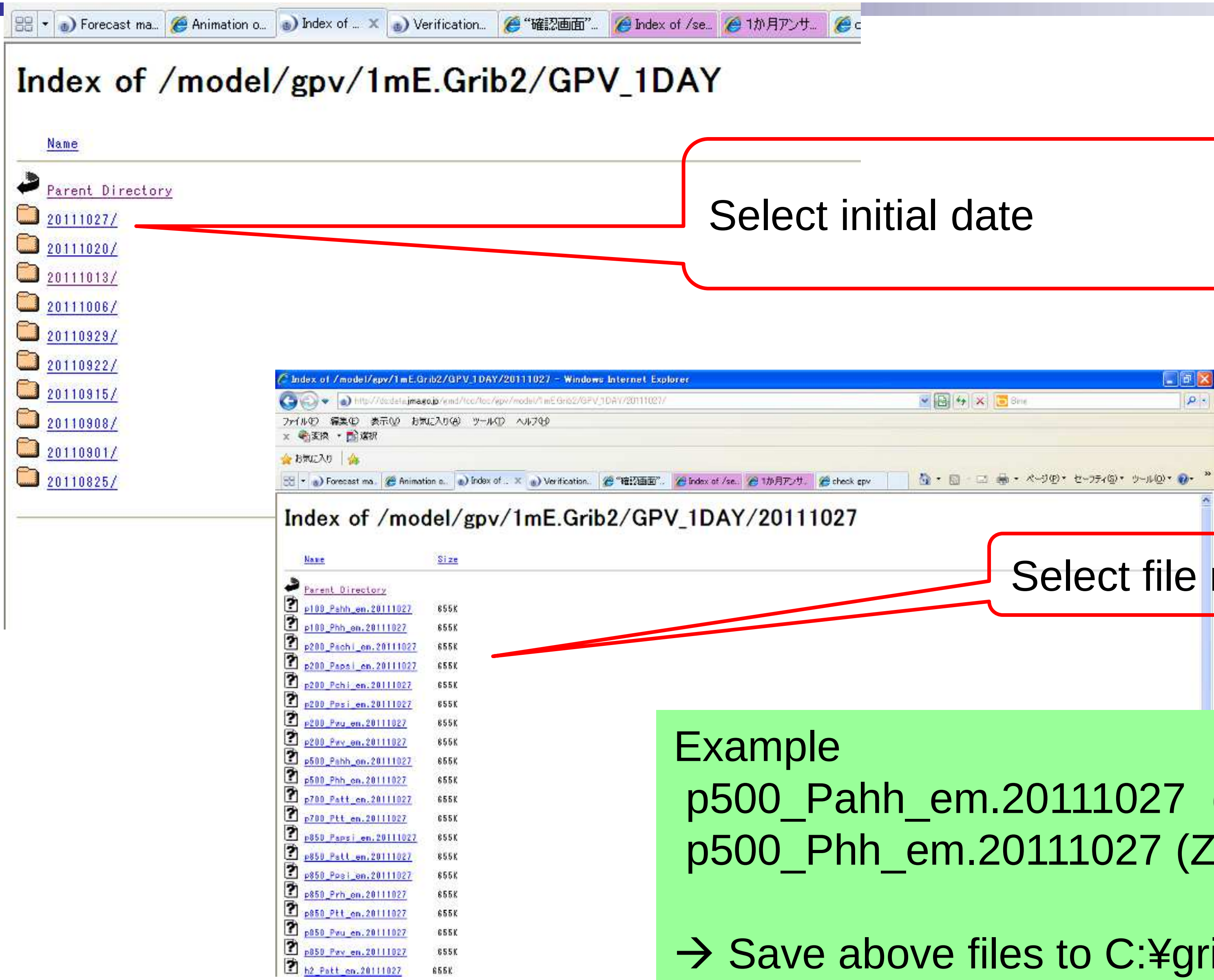
* Climatology was calculated from hindcast experiment (1979-2009).

- Format : Gridded numerical values encoded in GRIB2, which is referred to in the "FM92 - GRIB Edition 2" on the WMO website (http://www.wmo.int/pages/prog/www/WMOCodes.html)
- Bit Size: 16
- Template number for section 4: 4.12 (Refer to the 80th page in the "Manual on codes on the WMO website": ftp://www.wmo.int/Documents/MediaPublic/Publications/CodesManual_WMO_no_306/WMO306_Vol_I.2_2010_en.pdf)
- In addition to "FM 92 - GRIB Edition 2", some local parameters are used in this product as shown below.

Code Table 4.2 Parameter number by product discipline and parameter category
Product Discipline 0: Meteorological products, Parameter Category 1: Moisture

Number	Parameter	Units

"Download"

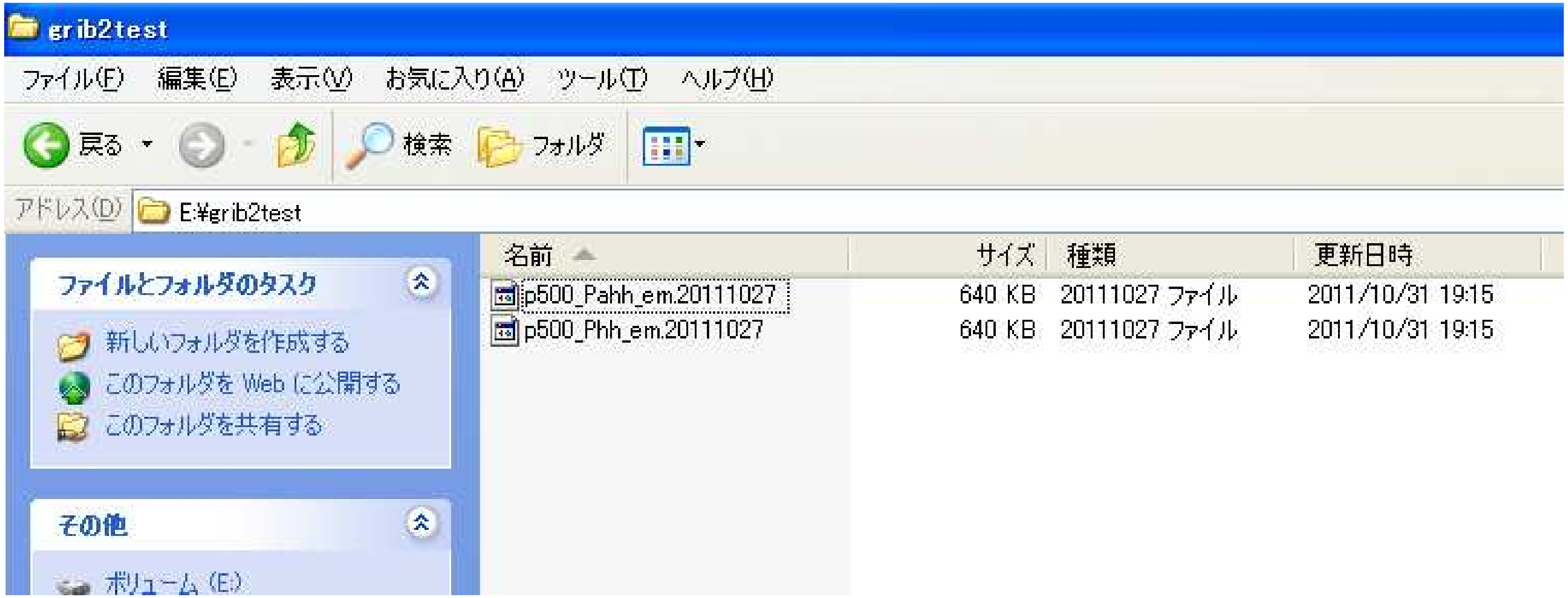


Select initial date

Select file name

Example
p500_Pahh_em.20111027 (Z500 anomaly)
p500_Phh_em.20111027 (Z500)

→ Save above files to C:¥grib2test



- p500_Pahh_em.20111027 (Z500 anomaly)
- p500_Phh_em.20111027 (Z500)

Save above files to C:¥grib2test

Processes

(1) Preparation

- Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
Ensemble mean data of 1-month EPS
Initial date: 27 Oct 2011
Element: Z500 and its anomaly

(2) Download the gridded dataset (GPV)

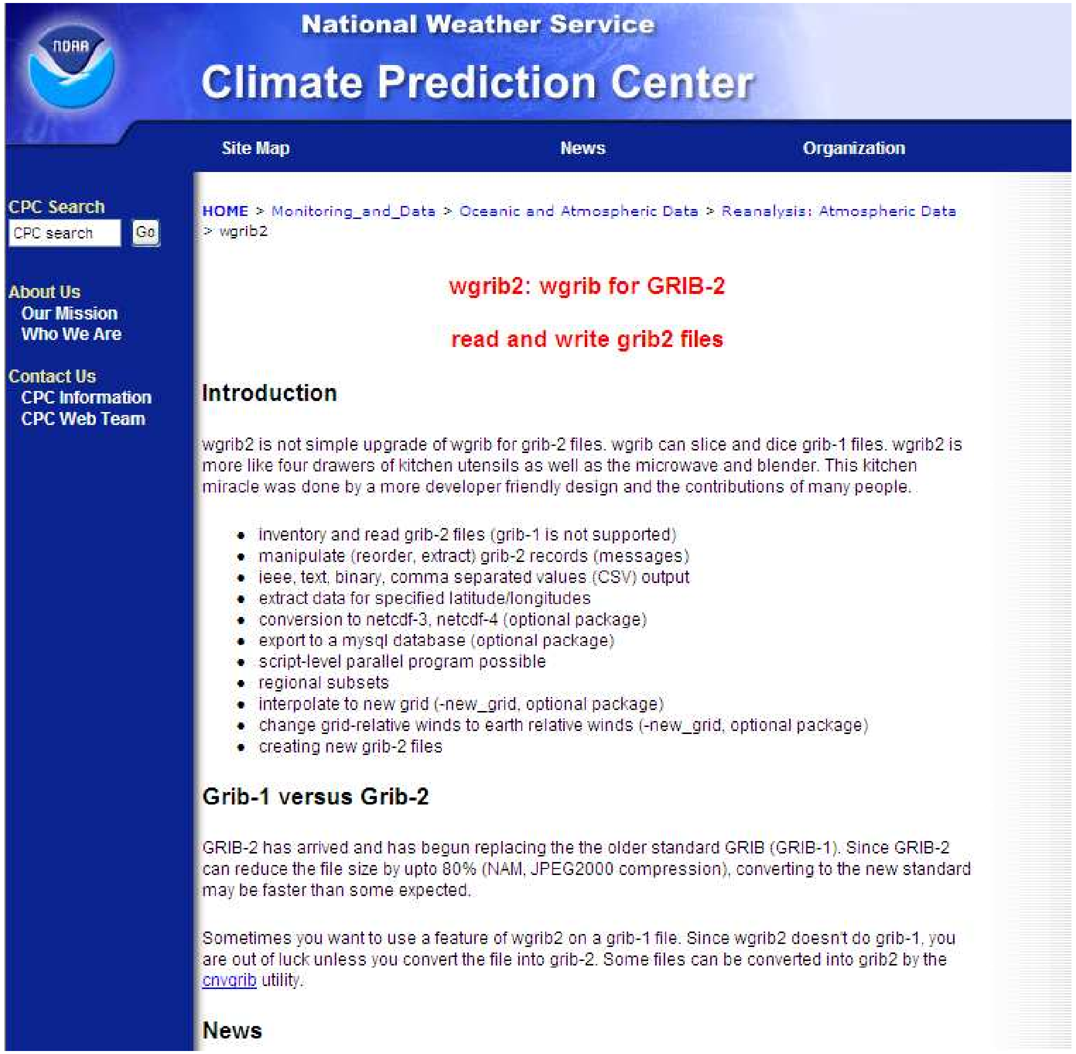
(3) Conversion of TCC-GRIB files into GrADS data file using wgrib2

(4) Edit the GrADS control file

(5) Visualization using GrADS

Conversion from GRIB2 to GrADS data file using wgrib2

http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/


National Weather Service
Climate Prediction Center

Site Map | News | Organization

CPC Search
CPC search [Go]

About Us
Our Mission
Who We Are

Contact Us
CPC Information
CPC Web Team

HOME > Monitoring_and_Data > Oceanic and Atmospheric Data > Reanalysis: Atmospheric Data > wgrib2

wgrib2: wgrib for GRIB-2

read and write grib2 files

Introduction

wgrib2 is not simple upgrade of wgrib for grib-2 files. wgrib can slice and dice grib-1 files. wgrib2 is more like four drawers of kitchen utensils as well as the microwave and blender. This kitchen miracle was done by a more developer friendly design and the contributions of many people.

- inventory and read grib-2 files (grib-1 is not supported)
- manipulate (reorder, extract) grib-2 records (messages)
- ieee, text, binary, comma separated values (CSV) output
- extract data for specified latitude/longitudes
- conversion to netcdf-3, netcdf-4 (optional package)
- export to a mysql database (optional package)
- script-level parallel program possible
- regional subsets
- interpolate to new grid (-new_grid, optional package)
- change grid-relative winds to earth relative winds (-new_grid, optional package)
- creating new grib-2 files

Grib-1 versus Grib-2

GRIB-2 has arrived and has begun replacing the the older standard GRIB (GRIB-1). Since GRIB-2 can reduce the file size by upto 80% (NAM, JPEG2000 compression), converting to the new standard may be faster than some expected.

Sometimes you want to use a feature of wgrib2 on a grib-1 file. Since wgrib2 doesn't do grib-1, you are out of luck unless you convert the file into grib-2. Some files can be converted into grib2 by the cnvgrib utility.

News

- All gridded dataset (GPV) on the TCC website are provided in GRIB2 format.

- To handle the GRIB2 files, the program “wgrib2” is useful.

For referring to wgrib2 options

- wgrib2 (-h)

```
C:¥>wgrib2
wgrib2 v0.1.7.8e 2/2009 Wesley Ebisuzaki, Jaakko Hyvätti, Kristian Nilssen, Karl Pfeiffer, Manfred Schwarb, Arlindo da
Silva, Niklas Sondell, Sergey Varlamov
 -0xSec           inv  X     Hex dump of section X (0..8)
 -MM              inv        month
 -N_ens           inv        number of ensemble members
 -RT              inv        Reference Time
 -Sec0            inv        contents of section0
 -Sec3            inv        contents of section 3 (Grid Definition Section)
 -Sec4            inv        Sec 4 values (Product definition section)
 -Sec5            inv        Sec 5 values (Data representation section)
 -Sec6            inv        show bit-map section
 -Sec_len         inv        length of various grib sections
 -T               inv        time YYYYMMDDHHMMSS
 -V               inv        diagnostic output
 -VT              inv        verf time = reference_time + forecast_time (YYYYMMDDHHMMSS)
 -YY              inv        year
 -bitmap          inv        bitmap mode
 -center          inv        center
 -ctl_ens         inv        ens info for grads
 -ctl_inv         inv        ctl inventory dump (for g2ctl/GrADS)
 -disc            inv        discipline (code table 0.0)
 -domain          inv        max limit for n/s/e/w
 -ens             inv        ensemble information
 -ftime           inv        forecast time
 -grid            inv        grid definition
 -ij              inv  X Y   value of field at grid(X,Y) X=1,...,nx Y=1,...,ny
 -ijlat           inv  X Y   lat,lon and grid value at grid(X,Y) X=1,...,nx Y=1,...,ny
 -ilat            inv  X     lat,lon and grid value at Xth grid point, X=1,...,npnts
```

also referred on the wgrib2 website.
http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/

Survey girb2 file

- wgrib2 (grib2 file)

```
cd /d C:¥grib2test
C:¥grib2test>wgrib2 p500_Pahh_em.20111027

1.1:0:d=2011102700:var discipline=0 master_table=4 parmcat=3 parm=9:500
mb:2 day-(2 day+24 hour ave@6 hour fcst,missing=0:ens-mean
1.2:0:d=2011102700:var discipline=0 master_table=4 parmcat=3 parm=9:500
mb:3 day-(3 day+24 hour ave@6 hour fcst,missing=0:ens-mean
1.3:0:d=2011102700:var discipline=0 master_table=4 parmcat=3 parm=9:500
mb:4 day-(4 day+24 hour ave@6 hour fcst,missing=0:ens-mean


1.30:0:d=2011102700:var discipline=0 master_table=4 parmcat=3 parm=9:500
mb:31 day-(31 day+24 hour ave@6 hour fcst,missing=0:ens-mean
1.31:0:d=2011102700:var discipline=0 master_table=4 parmcat=3 parm=9:500
mb:32 day-(32 day+24 hour ave@6 hour fcst,missing=0:ens-mean
```

- Initial date is 27 Oct 2011 (2011102700).
- 31 records are included.

Record-1; Day-2

Record-2; Day-3

Record-3; Day-4

...

Record-30; Day-31

Record-31; Day-32

Convert girb2 to binary

- **wgrib2 (*grib2_file*) -no_header -bin (*output_file*)**

```
wgrib2 p500_Phh_em.20111027  -no_header -bin z500.dat
wgrib2 p500_Pahh_em.20111027  -no_header -bin z500_anomaly.dat
```

```
C:¥grib2test>ls -l
total 3832
-rwx------ 1 USERID mkgroup  654709 2011-10-31 19:15 p500_Pahh_em.20111027
-rwx------ 1 USERID mkgroup  654709 2011-10-31 19:15 p500_Phh_em.20111027
-rwx------ 1 USERID mkgroup 1303488 2011-10-31 19:34 z500.dat
-rwx------ 1 USERID mkgroup 1303488 2011-10-31 19:34 z500_anomaly.dat
```

GRIB2

GrADS data (created using wgrib2)

Processes

(1) Preparation

- Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
Ensemble mean data of 1-month EPS
Initial date: 27 Oct 2011
Element: Z500 and its anomaly

(2) Download the gridded dataset (GPV)

(3) Conversion of TCC-GRIB files into GrADS data file using wgrib2

(4) Edit the GrADS control file

(5) Visualization using GrADS

Basic format of the GrADS control file

```
dset ^${ grads data filename }
undef (UNDEF value)9.999e+20
xdef (num. of grids along X-axis) linear   (start) (increment)
ydef (num. of grids along Y-axis) linear   (start) (increment)
zdef   (num. of vertical levels) levels  (list of levels)
tdef   (num. of time steps) linear   (starting time) (increment)
vars   (num. of parameters)
(parameter_name)      0   0  (remarks)
endvars
```

C:¥grib2test¥z500.ctl

```
dset ^z500.dat
undef 9.999e+20
xdef 144 linear    0 2.5
ydef  73 linear  -90 2.5
zdef   1 levels   500
tdef   7 linear   29Oct2011 1dy
vars   1
z500   0   0  z500
endvars
```

C:¥grib2test¥z500_anomaly.ctl

```
dset ^z500_anomaly.dat
undef 9.999e+20
xdef 144 linear    0 2.5
ydef  73 linear  -90 2.5
zdef   1 levels   500
tdef   7 linear   29Oct2011 1dy
vars   1
z500   0   0  z500
endvars
```

Processes

(1) Preparation

- Installing the tools
  - GrADS (Viewer)
  - Wgrib2 (encoder)

Example:
Ensemble mean data of 1-month EPS
Initial date: 27 Oct 2011
Element: Z500 and its anomaly

(2) Download the gridded dataset (GPV)

(3) Conversion of TCC-GRIB files into GrADS data file using wgrib2

(4) Edit the GrADS control file

(5) Visualization using GrADS

Visualization (1)
Startup GrADS on the “Command Prompt”

C:¥grib2test>grads

```
Starting X server under C:¥OPENGR~1¥Contents¥Resources¥Xming
Starting grads under C:¥OPENGR~1¥Contents¥Cygwin¥Versions¥20A9OG~1.1¥i686 ...

Grid Analysis and Display System (GrADS) Version 2.0.a9.oga.1
Copyright (c) 1988-2010 by Brian Doty and the
Institute for Global Environment and Society (IGES)
GrADS comes with ABSOLUTELY NO WARRANTY
See file COPYRIGHT for more information

Config: v2.0.a9.oga.1 little-endian readline printim grib2 netcdf hdf4-sds hdf5 opendap-grids,stn athena geotiff shapefile
Issue 'q config' command for more detailed configuration information Loading User Defined Extensions table
</cygdrive/c/OPENGR~1/Contents/Cygwin/Versions/20A9OG~1.1/i686/gex/udxt> ... ok.
Landscape mode? ('n' for portrait):
GX Package Initialization: Size = 11 8.5
cygwin warning:
  MS-DOS style path detected: ¥Documents and Settings¥JMA2224/.Xauthority
  Preferred POSIX equivalent is: /cygdrive/e/Documents and Settings/JMA2224/.Xauthority
  CYGWIN environment variable option "nodosfilewarning" turns off this warning.
  Consult the user's guide for more details about POSIX paths:
    http://cygwin.com/cygwin-ug-net/using.html#using-pathnames
ga->
```

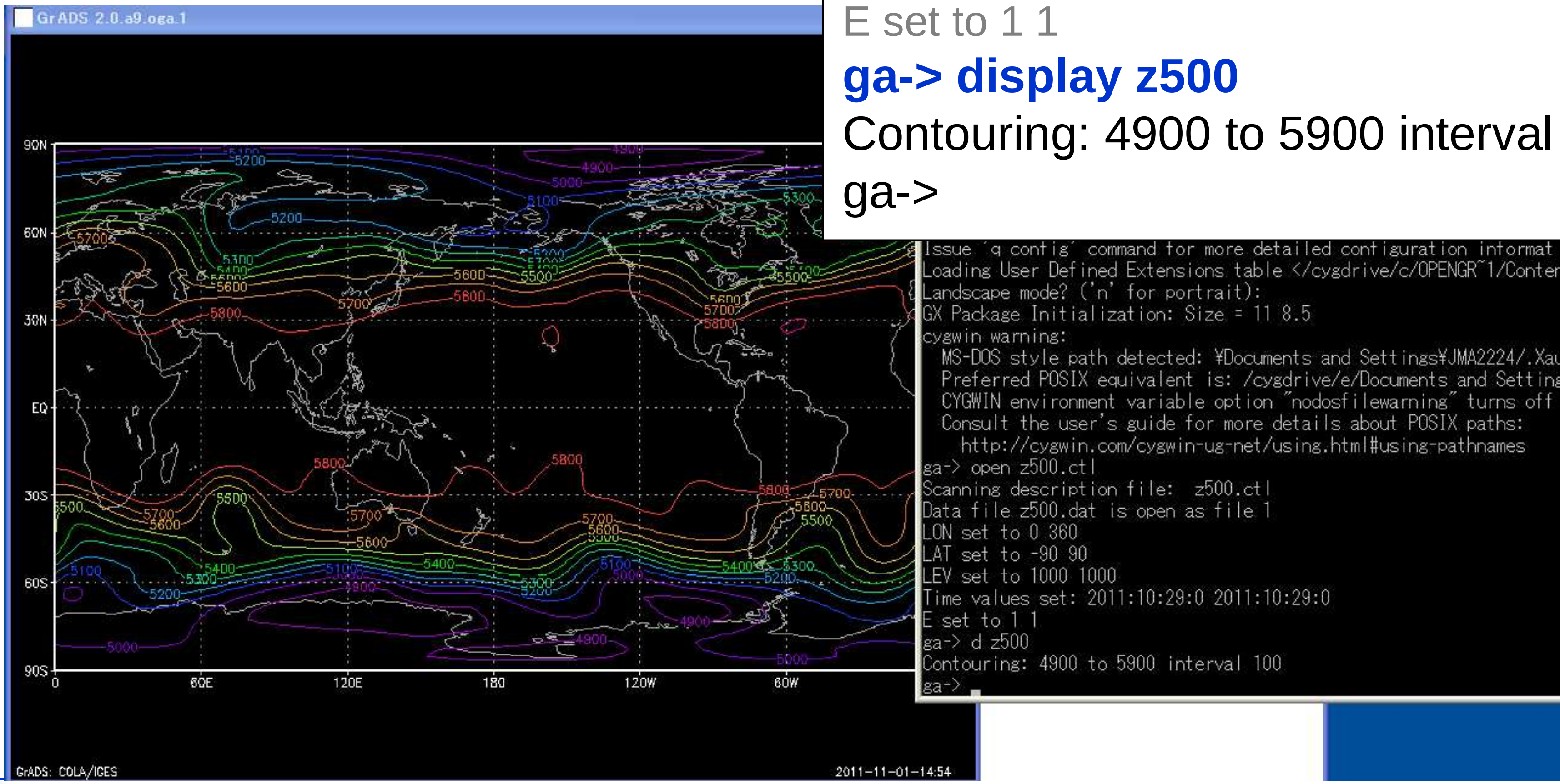
“Return” key

Waiting for command input

Visualization (2)
Open the grads control file

- open {grads control file}

ga-> **open z500.ctl**
Scanning description file: z500.ctl
Data file z500.dat is open as file 1
LON set to 0 360
LAT set to -90 90
LEV set to 1000 1000
Time values set: 2011:10:29:0 2011:10:29:0
E set to 1 1
ga-> display z500
Contouring: 4900 to 5900 interval 100
ga->



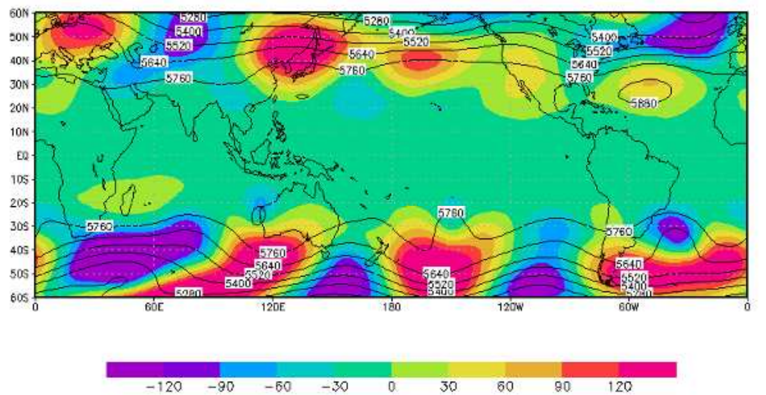
Visualization (3)
Draw week-1 forecast of Z500 and its anomaly

```
open z500.ctl
open z500_anomaly.ctl
```
} Open files

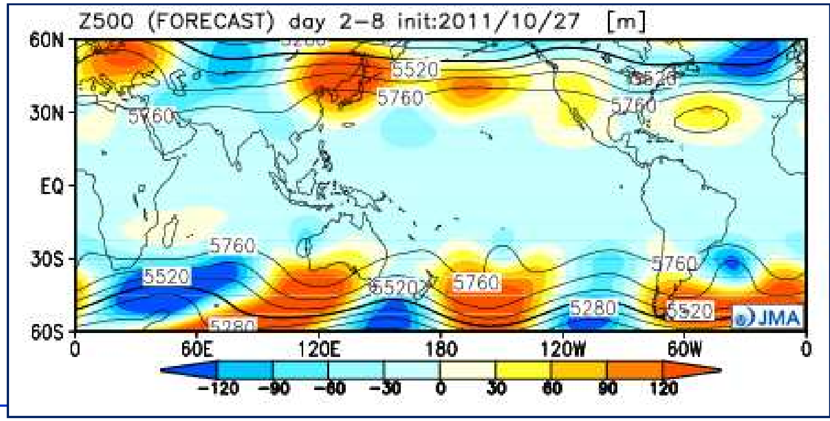
```
set gxout shaded
set clevs -120 -90 -60 -30 0 30 60 90 120
display ave(z500.2,t=1,t=7)
run cbar.gs
```
} Shading for z500 anomaly

```
set gxout contour
set cint 120
display ave(z500.1,t=1,t=7)
```
} contour for Z500

```
printim testimg.png white
```
→ output image file (png format)

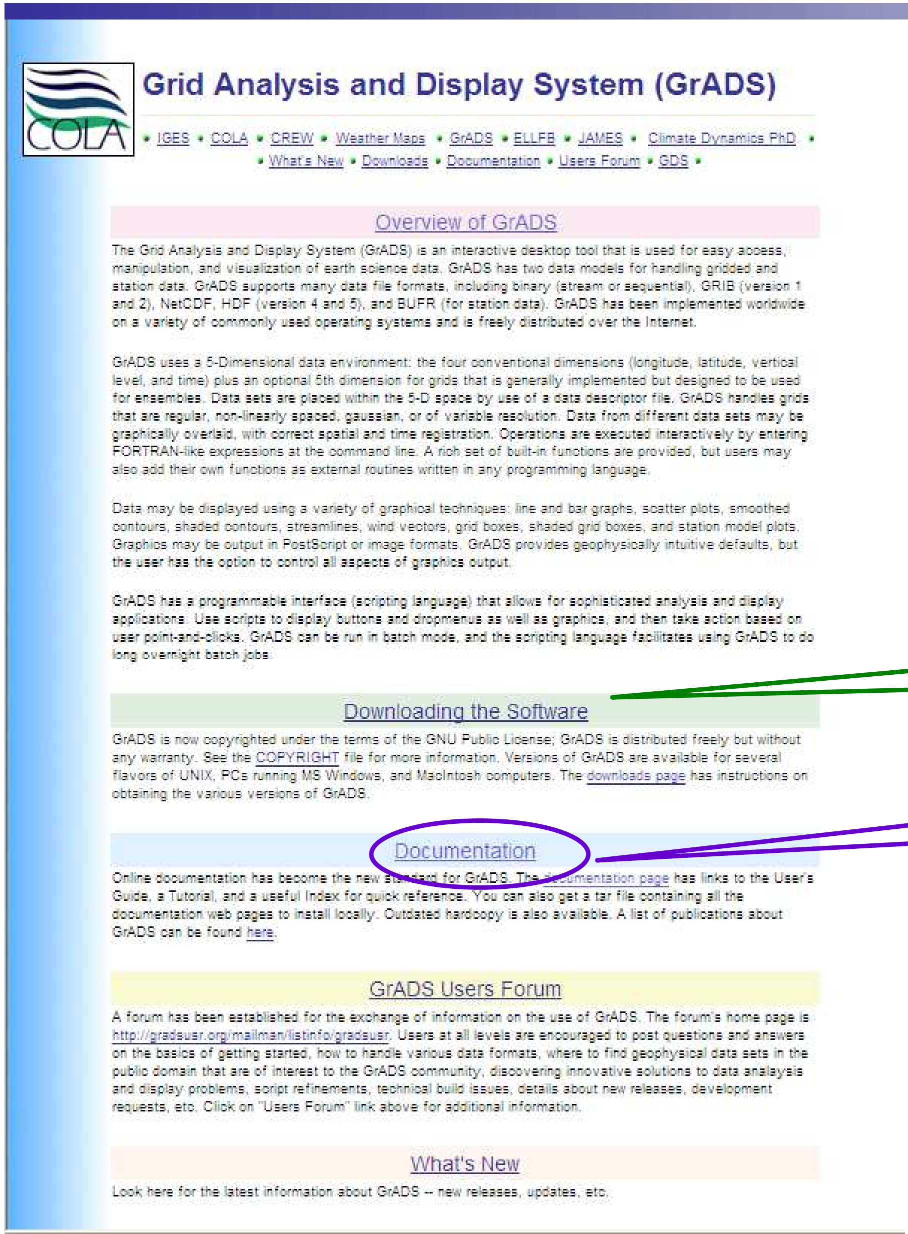


Forecast map on the TCC-web



For more details about GrADS...

http://www.iges.org/grads/



Grid Analysis and Display System (GrADS)

• IGES • COLA • CREW • Weather Maps • GrADS • ELLFB • JAMES • Climate Dynamics PhD •
• What's New • Downloads • Documentation • Users Forum • GDS •

Overview of GrADS

The Grid Analysis and Display System (GrADS) is an interactive desktop tool that is used for easy access, manipulation, and visualization of earth science data. GrADS has two data models for handling gridded and station data. GrADS supports many data file formats, including binary (stream or sequential), GRIB (version 1 and 2), NetCDF, HDF (version 4 and 5), and BUFR (for station data). GrADS has been implemented worldwide on a variety of commonly used operating systems and is freely distributed over the Internet.

GrADS uses a 5-Dimensional data environment: the four conventional dimensions (longitude, latitude, vertical level, and time) plus an optional 5th dimension for grids that is generally implemented but designed to be used for ensembles. Data sets are placed within the 5-D space by use of a data descriptor file. GrADS handles grids that are regular, non-linearly spaced, gaussian, or of variable resolution. Data from different data sets may be graphically overlaid, with correct spatial and time registration. Operations are executed interactively by entering FORTRAN-like expressions at the command line. A rich set of built-in functions are provided, but users may also add their own functions as external routines written in any programming language.

Data may be displayed using a variety of graphical techniques: line and bar graphs, scatter plots, smoothed contours, shaded contours, streamlines, wind vectors, grid boxes, shaded grid boxes, and station model plots. Graphics may be output in PostScript or image formats. GrADS provides geophysically intuitive defaults, but the user has the option to control all aspects of graphics output.

GrADS has a programmable interface (scripting language) that allows for sophisticated analysis and display applications. Use scripts to display buttons and dropmenus as well as graphics, and then take action based on user point-and-clicks. GrADS can be run in batch mode, and the scripting language facilitates using GrADS to do long overnight batch jobs.

Downloading the Software

GrADS is now copyrighted under the terms of the GNU Public License; GrADS is distributed freely but without any warranty. See the COPYRIGHT file for more information. Versions of GrADS are available for several flavors of UNIX, PCs running MS Windows, and MacIntosh computers. The downloads page has instructions on obtaining the various versions of GrADS.

Documentation

Online documentation has become the new standard for GrADS. The documentation page has links to the User's Guide, a Tutorial, and a useful Index for quick reference. You can also get a tar file containing all the documentation web pages to install locally. Outdated hardcopy is also available. A list of publications about GrADS can be found here.

GrADS Users Forum

A forum has been established for the exchange of information on the use of GrADS. The forum's home page is http://gradsusr.org/mailman/listinfo/gradsusr. Users at all levels are encouraged to post questions and answers on the basics of getting started, how to handle various data formats, where to find geophysical data sets in the public domain that are of interest to the GrADS community, discovering innovative solutions to data analaysis and display problems, script refinements, technical build issues, details about new releases, development requests, etc. Click on "Users Forum" link above for additional information.

What's New

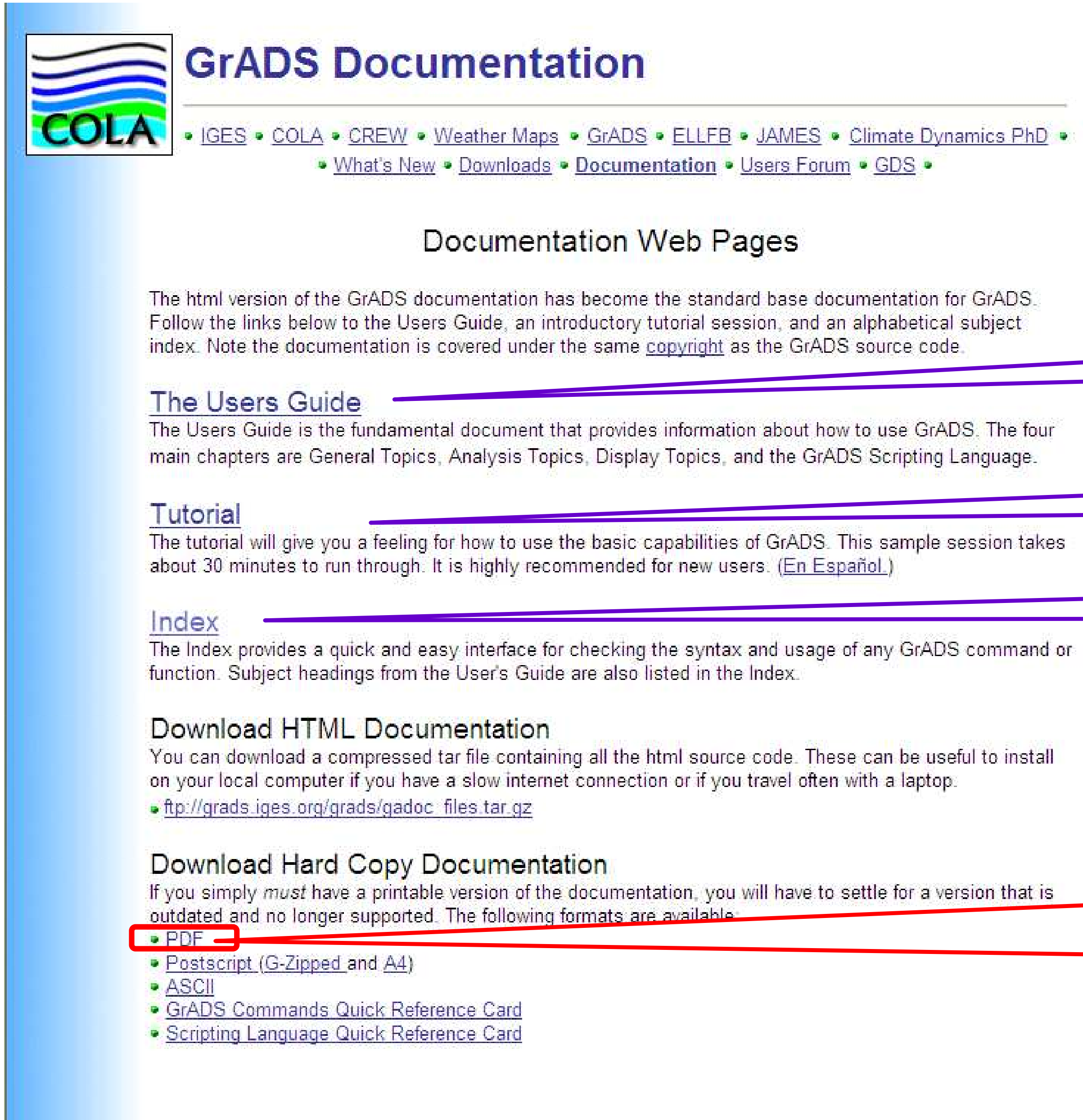
Look here for the latest information about GrADS -- new releases, updates, etc.

Download GrADS (for Linux machine)

Documentation

GrADS documentation page

http://www.iges.org/grads/gadoc/



GrADS Documentation

• IGES • COLA • CREW • Weather Maps • GrADS • ELLFB • JAMES • Climate Dynamics PhD •
• What's New • Downloads • **Documentation** • Users Forum • GDS •

Documentation Web Pages

The html version of the GrADS documentation has become the standard base documentation for GrADS. Follow the links below to the Users Guide, an introductory tutorial session, and an alphabetical subject index. Note the documentation is covered under the same copyright as the GrADS source code.

The Users Guide
The Users Guide is the fundamental document that provides information about how to use GrADS. The four main chapters are General Topics, Analysis Topics, Display Topics, and the GrADS Scripting Language.

Tutorial
The tutorial will give you a feeling for how to use the basic capabilities of GrADS. This sample session takes about 30 minutes to run through. It is highly recommended for new users. (En Español)

Index
The Index provides a quick and easy interface for checking the syntax and usage of any GrADS command or function. Subject headings from the User's Guide are also listed in the Index.

Download HTML Documentation
You can download a compressed tar file containing all the html source code. These can be useful to install on your local computer if you have a slow internet connection or if you travel often with a laptop.
- ftp://grads.iges.org/grads/gadoc_files.tar.gz

Download Hard Copy Documentation
If you simply *must* have a printable version of the documentation, you will have to settle for a version that is outdated and no longer supported. The following formats are available:
- PDF
- Postscript (G-Zipped and A4)
- ASCII
- GrADS Commands Quick Reference Card
- Scripting Language Quick Reference Card

Users guide

Tutorial

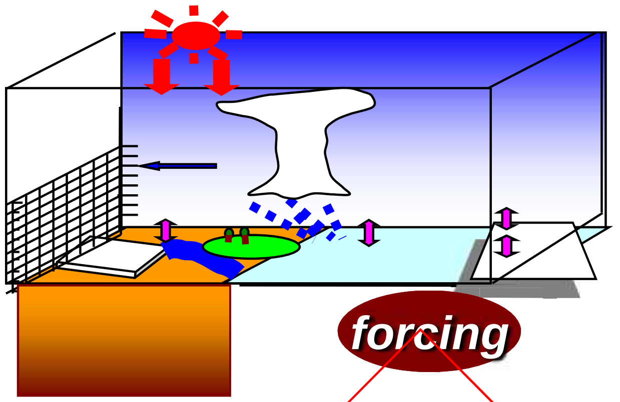
Index of command

Document (PDF file) helpful! (though apply to GrADS ver. 1.5)

Backup

Implementation of CGCM to the 4/7 month EPS in Feb 2010

(Old) AGCM

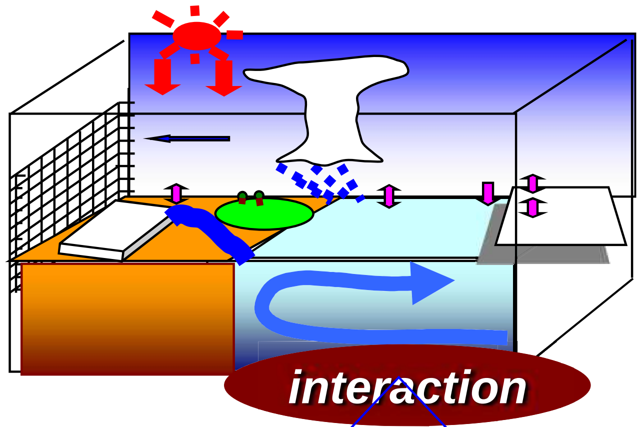


Prescribed SST
(Persistent anomaly + statistics based on ENSO prediction)

Boundary condition for AGCM

Two-tier

(New) CGCM



Coupling atmosphere-ocean models

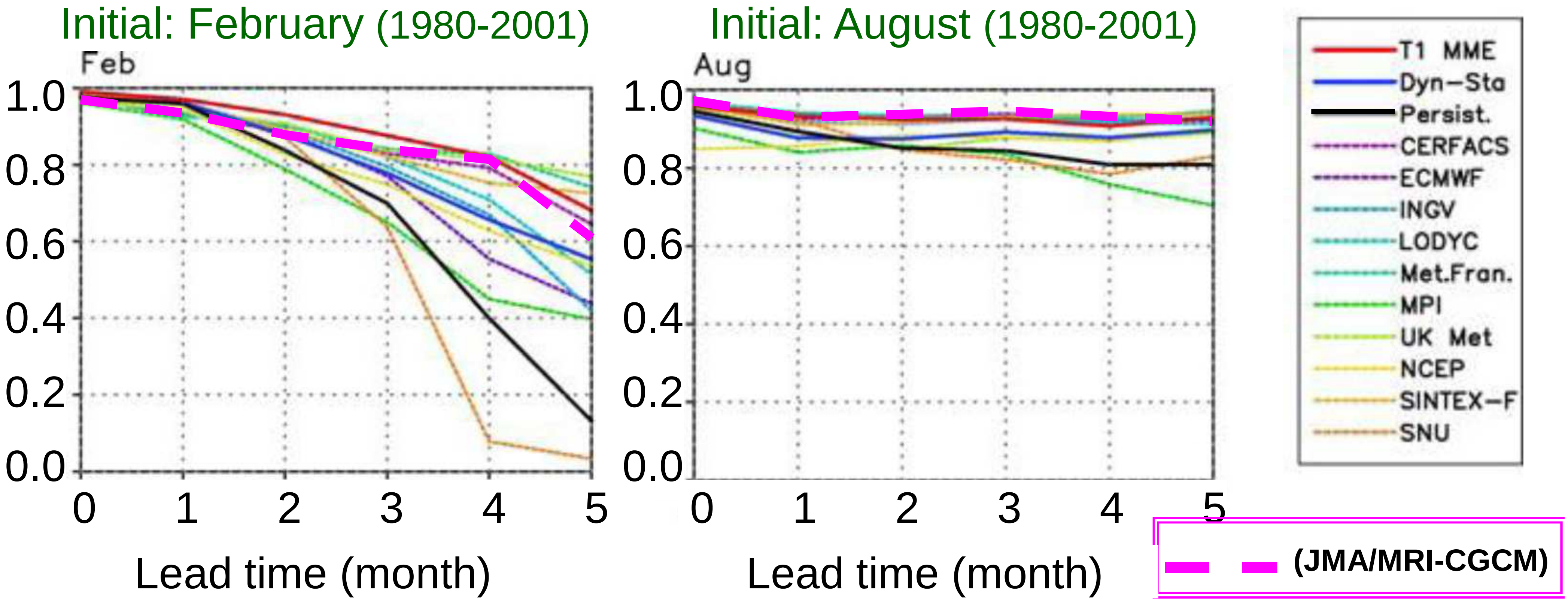
↓

interaction between atmosphere and ocean is considered

One-tier

NINO.3.4 SST ACC: dependency on lead time

(quote from Fig. 8 of Jin et al. 2008)



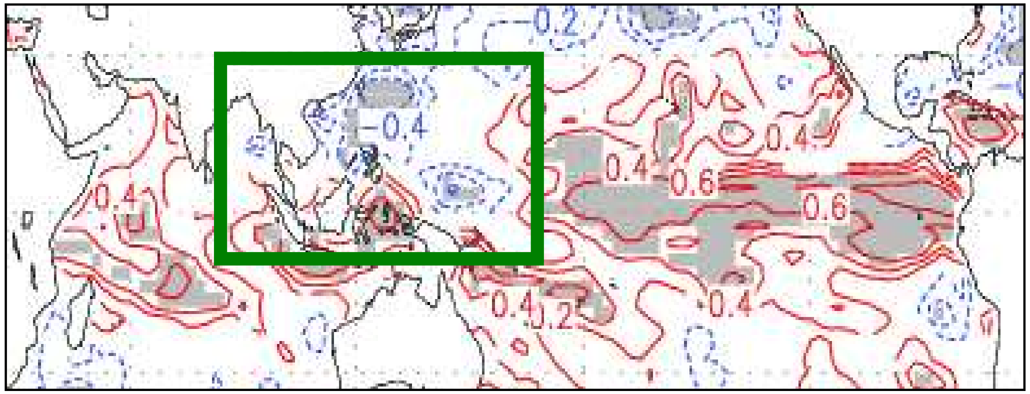
NINO.3.4 region: 120W-170W, 5S- 5N

Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean–atmosphere models. Clim. Dyn., **31**, 647–666.

TCC Training Seminar 7 November 2011

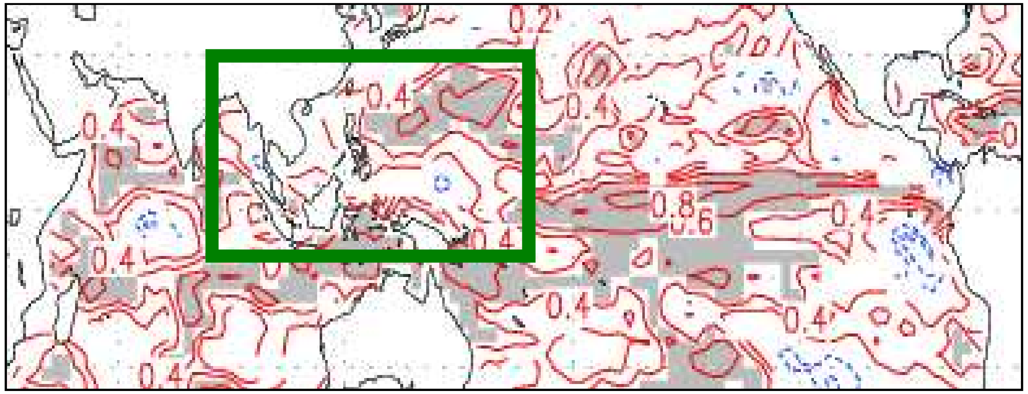
Importance of air to sea interactions

Analysis

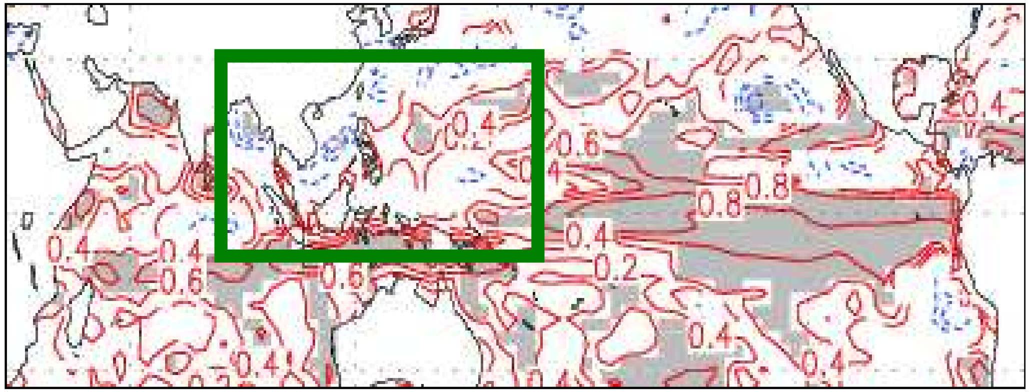


Correlation coefficient between precipitation and SST in JJA. (initial month: May)

AGCM



CGCM

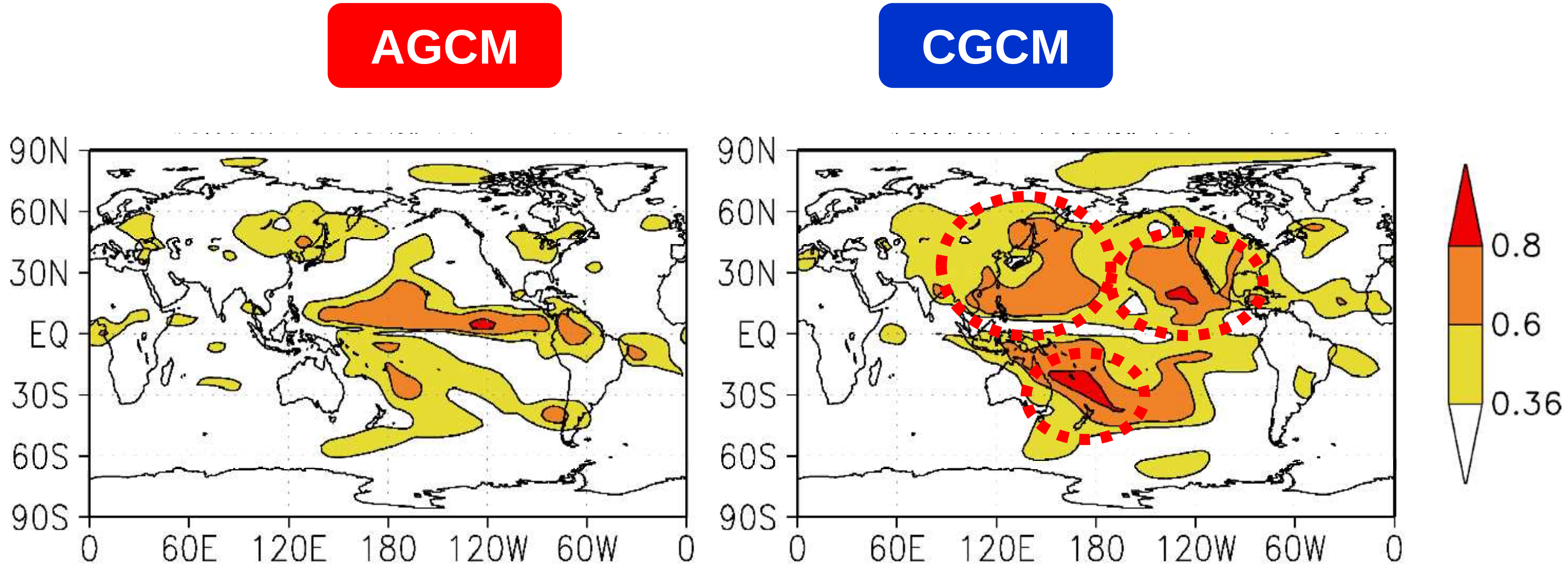


CGCM reduces the overestimated positive correlation coefficient in the Western North Pacific.

TCC Training Seminar 7 November 2011

Improvement of large-scale circulation using CGCM

Anomaly Correlation of 850 hPa stream function in JJA
(initial month: Feb)



Improvement circulation fields in tropics

Specifications of the 1-month EPS hindcast

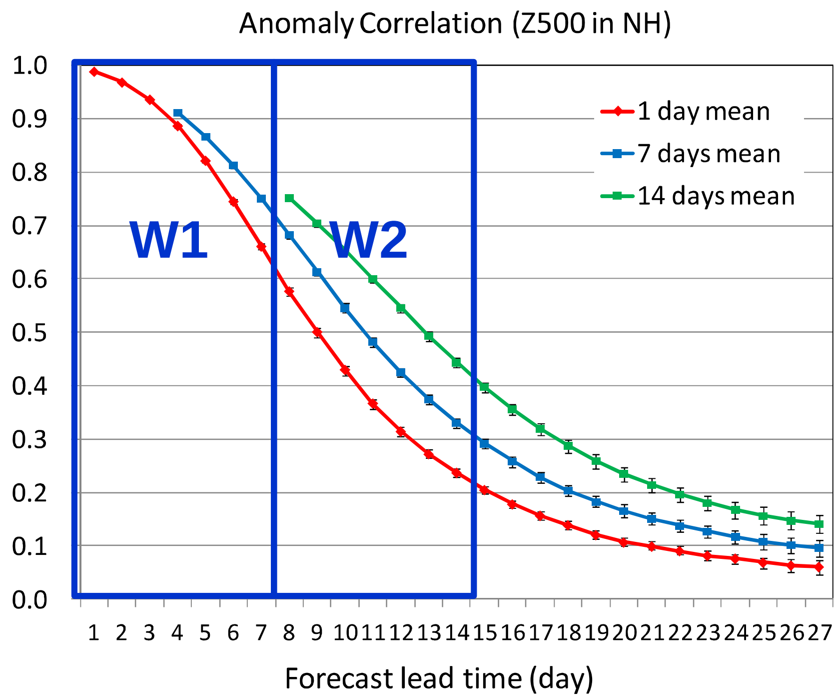
	Hindcast	Operational system
Ensemble size	5 (5 BGM)	51 (9 BGMs & 6 days with 5-day LAF)
Forecast range	Lead time from 0 to 6 months as shown in the correspondence table below	(4-month EPS) Lead time from 1 to 3 as shown in the correspondence table below (7-month EPS) DJF (initial month of Oct.) JJA (initial months of Feb., Mar. and Apr.)
Initial date	24 initial dates a year (1st Jan., 16th Jan., 15th Feb., 2nd Mar., 17th Mar.,... 2nd Dec. and 17th Dec.	Once a month
Target period of hindcast	1979 – 2008	–

Correspondence between lead times (months) and initial dates

Initial date \ Target month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1-Jan, 17-Dec	0	1	2	3	4	5	6					
31-Jan, 16-Jan		0	1	2	3	4	5	6				
2-Mar, 15-Feb			0	1	2	3	4	5	6			
1-Apr, 17-Mar				0	1	2	3	4	5	6		
1-May, 16-Apr					0	1	2	3	4	5	6	
31-May, 16-May						0	1	2	3	4	5	6
30-Jun, 15-Jun	6						0	1	2	3	4	5
30-Jul, 15-Jul	5	6						0	1	2	3	4
29-Aug, 14-Aug	4	5	6						0	1	2	3
28-Sep, 13-Sep	3	4	5	6						0	1	2
28-Oct, 13-Oct	2	3	4	5	6						0	1
2-Dec, 17-Nov	1	2	3	4	5	6						0

Average length dependency of prediction skill

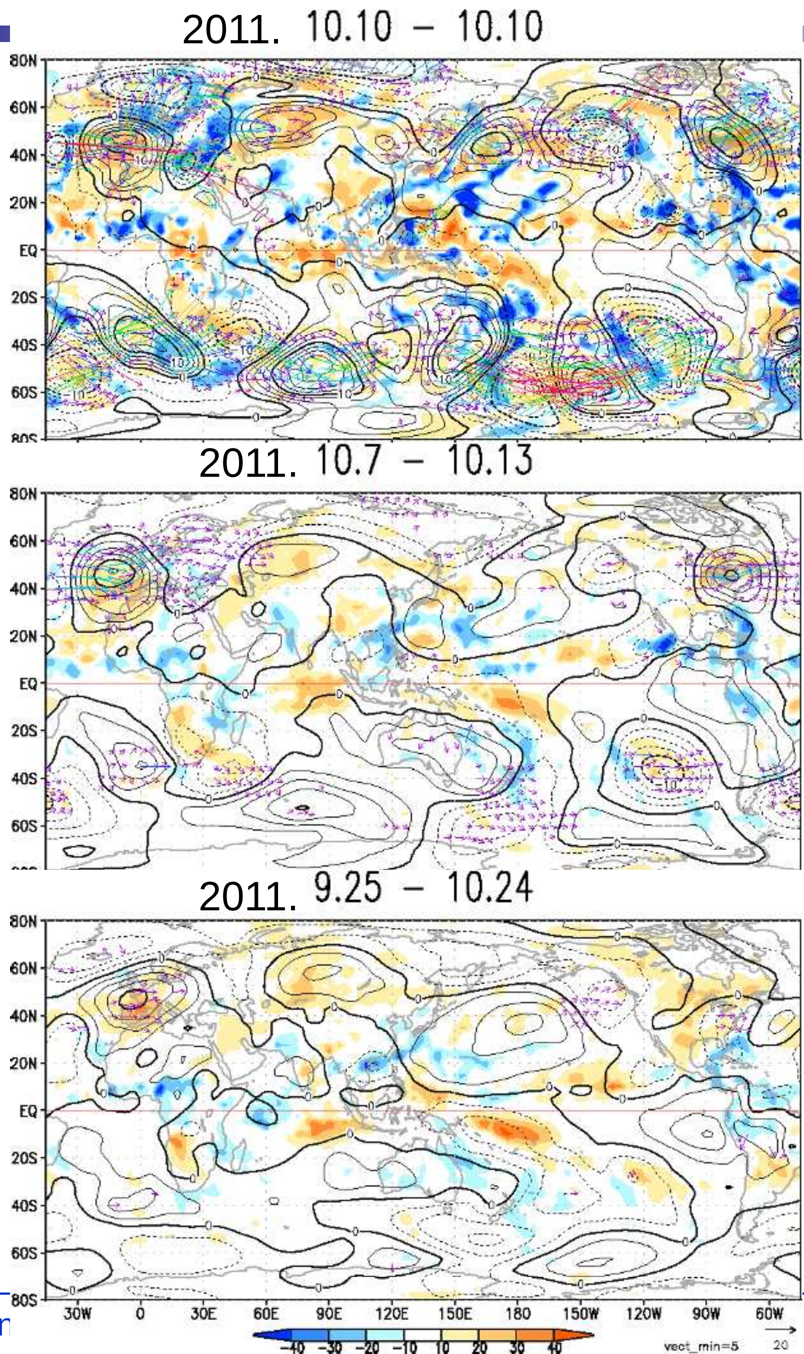
- As average length is taken longer, decreasing rate of prediction skill is more gradually.)
-> seasonal forecasting does not target daily variations. (ex. 1-month EPS of JMA targets 7-days average field .)



(Example) Difference by time average

Small
Short

Large
Long



1-day average

7-day average

30-day average

850hPa stream function
anomaly (analysis)