Making Seasonal Forecast
Introduction to Exercise

UESAWA Daisaku
Senior Forecaster
Japan Meteorological Agency

What we do in the exercise

- We learn **how to make seasonal forecast**
  - **Step by step**
  - **Following the essence of JMA's procedure**
  - Some simplifications
    - We use JMA's CPS3 ensemble model only
      - *cf.* JMA uses also other NWPs for comparison
      - Multi-model ensemble is *NOT* covered in the exercise
    - We use a ready-made simple guidance tool for translating CPS3 ensemble GPVs to probability forecast of temperature and precipitation for stations
      - *cf.* JMA uses a guidance specialized for seasonal forecast over areas in Japan
      - Development of guidance is *NOT* covered in the exercise
  - Forecast Target
    - Temperature and Precipitation at points we choose
    - 3-category probabilities (below-, near-, and above-normal)
    - February-March-April 2024 (3-month mean)

Schedule

Jan 31 (Wed)
- AM: Introduction & Example
- PM: **Exercise**

Feb 1 (Thurs)
- AM: **Exercise (continue)**
- PM: **Presentation**

Feb 2 (Fri)
- AM: **Presentation (continue)**

- Note
  - **TCC staff members always welcome any questions during the exercise**
  - Take your coffee break anytime during the exercise
- Presentation Time: **20 minutes**
  - **Including Q&A session**

Order of presentation: Alphabetical order by country name
Bangladesh, Bhutan, Hong Kong, Indonesia, Lao PDR, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam

3

What we should always keep in mind

- Predictability of seasonal forecast is lower than those of short- and middle-range forecasts (particularly for extra-tropics)
- Seasonal forecast is mainly based on slowly changing global scale phenomena (particularly ENSO)

So when we make a seasonal forecast,

- Take care about **predictability**
  - Global > Local, Low latitude > High latitude, Temperature > Rainfall
- Consider **tropical ocean and atmosphere and their effect** (particularly ENSO)
- Forecast **probabilities** of deviation from normal (i.e. **anomaly**)

4

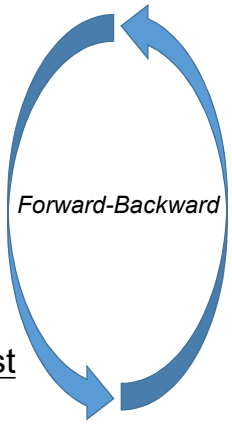
Basic Concept of JMA's seasonal forecast procedure

- Based on the ensemble prediction by atmosphere and ocean coupled model (CPS3)
- Use guidance (statistical post-processing or down-scalling) to translate model output to forecast (probabilities of below-, near-, and above- normal of temperature etc. for areas)
- After **synthesizing** these results, forecasters decide forecast
  - Think carefully about meteorological interpretation of model and guidance prediction
  - Think about how to explain forecast
- Besides probability forecast, JMA provides **explanation of forecast** to users

5

Workflow (JMA's procedure)

1. Check global circulation prediction by CPS3
   ① Tropical ocean, particularly ENSO
   ② Tropical circulation, particularly as response to ENSO
   ③ Extra-tropical circulation (if necessary)
   - Be sure to check prediction skills
2. Check guidance output
   - Be sure to check prediction skills
3. Synthesize model and guidance output to decide forecast
   - Think about how to explain forecast
4. Issue forecast



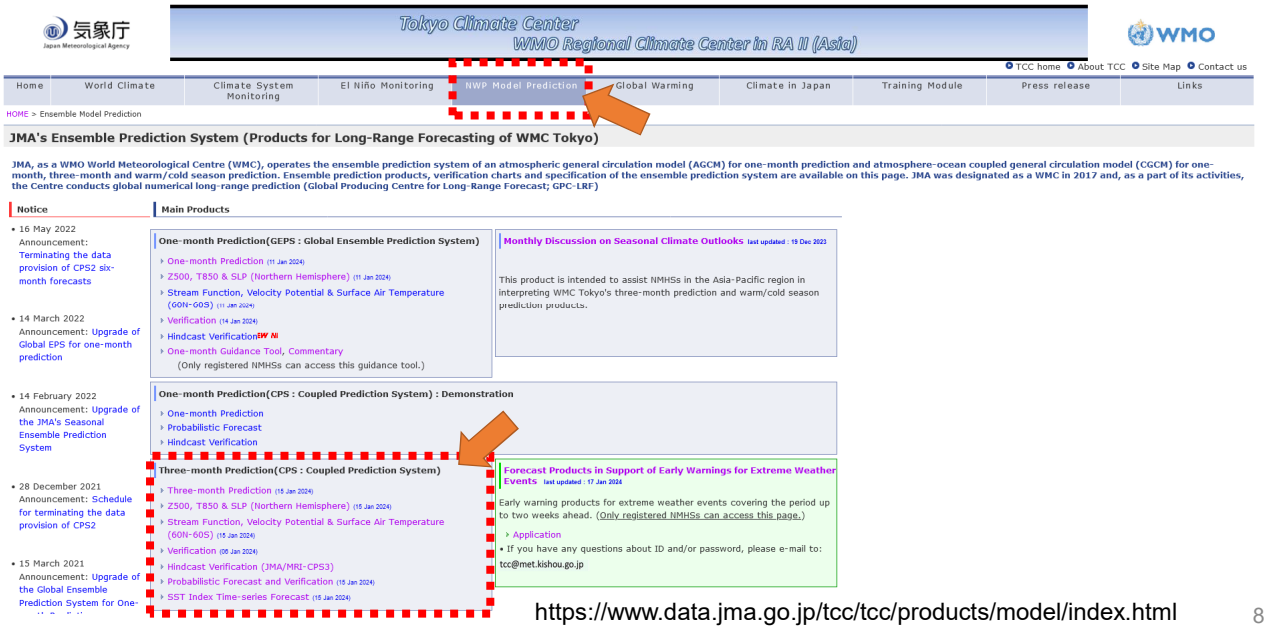
6

Data & Tools for the exercise

- CPS3 prediction
  - https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php
  - https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/pztmap.php
- CPS3 hindcast verification
  - https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/index.html
- El Nino Outlook
  - https://www.data.jma.go.jp/tcc/tcc/products/elnino/outlook.html
- El Nino impact (composite analysis)
  - https://www.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html
- iTacs (registered NMHSs only)
  - https://extreme.kishou.go.jp/tool/itacs-tcc2015/
- Guidance tool (this exercise only)
  - https://extreme.kishou.go.jp/cgi-bin/simple_guidance_3mon/index_3mon.cgi

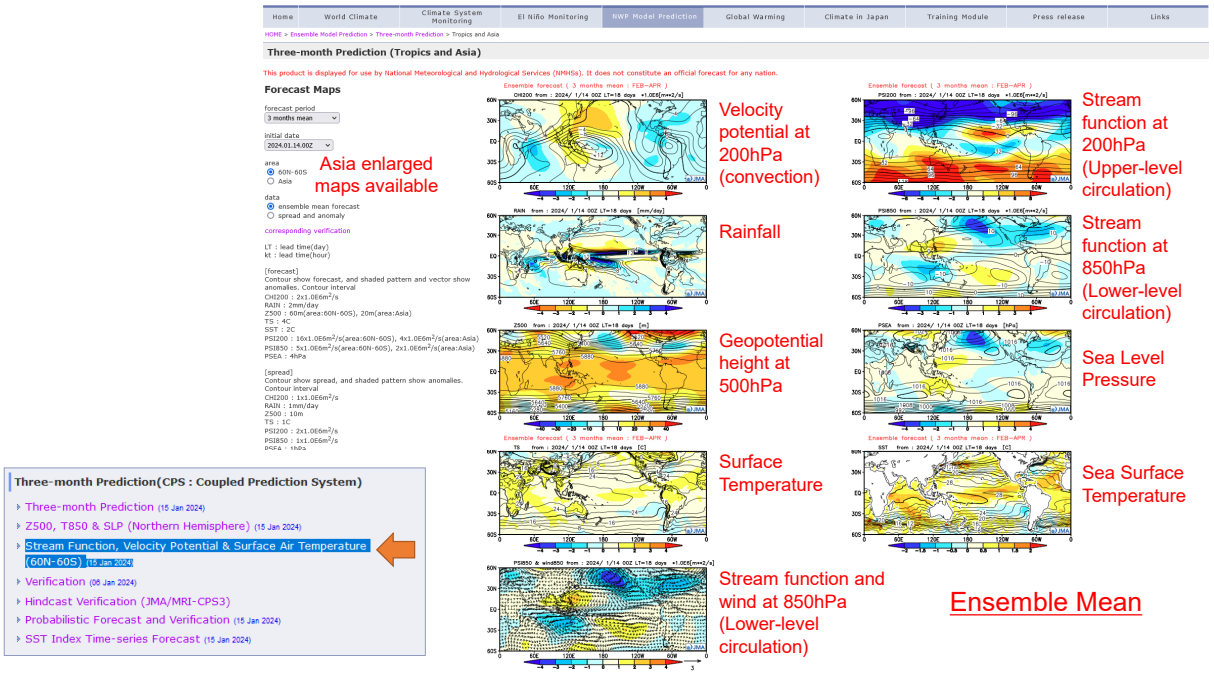
7

CPS3 ensemble prediction on TCC website



https://www.data.jma.go.jp/tcc/tcc/products/model/index.html

8



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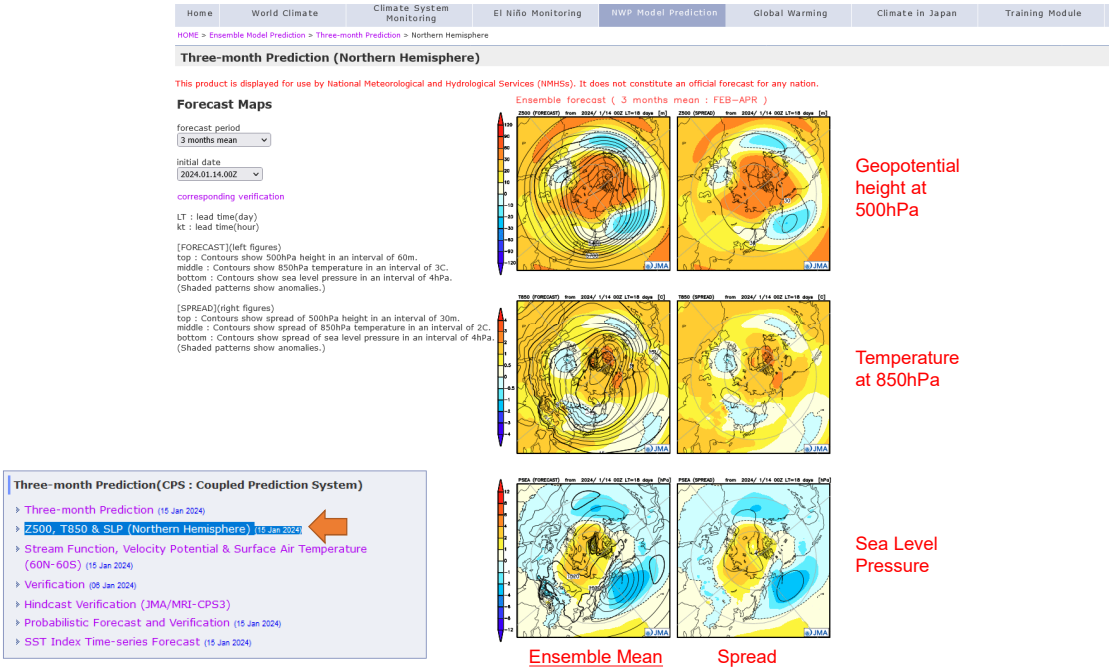
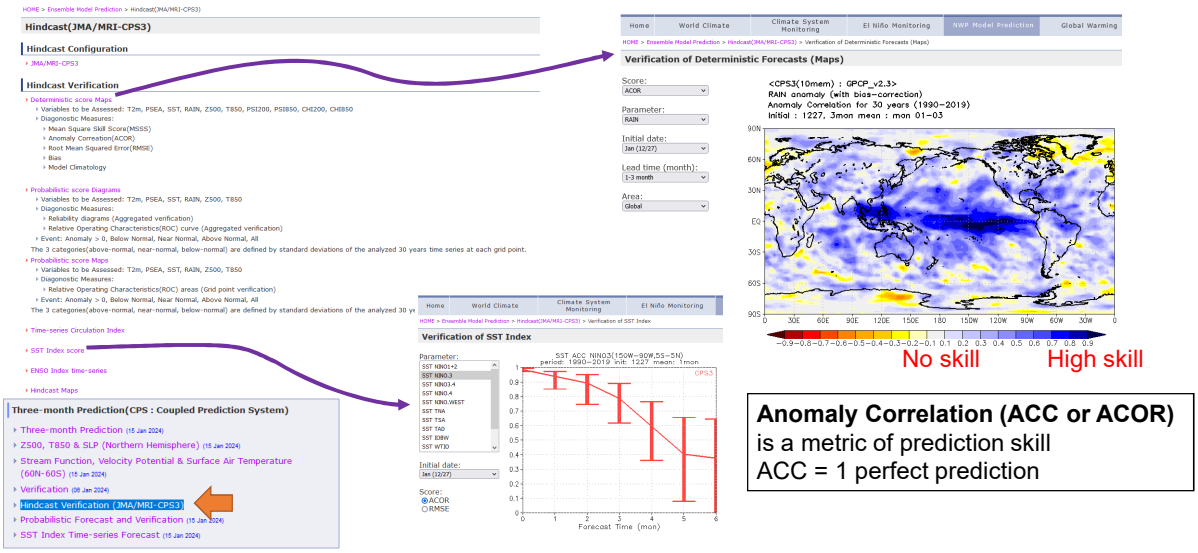


https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/pztmap.php

CPS3 hindcast verification on TCC website

Based on 30-year (1991-2020) hindcast (retrospective forecast)

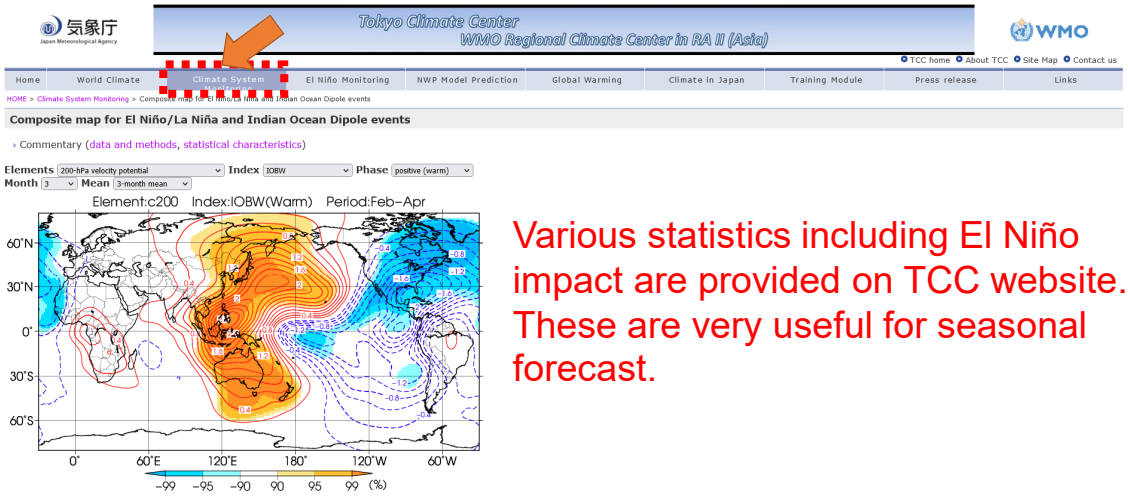


Anomaly Correlation (ACC or ACOR)
is a metric of prediction skill
ACC = 1 perfect prediction

https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/index.html

11

El Niño impact (composite analysis) on TCC website



Various statistics including El Niño impact are provided on TCC website. These are very useful for seasonal forecast.

https://www.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html

12

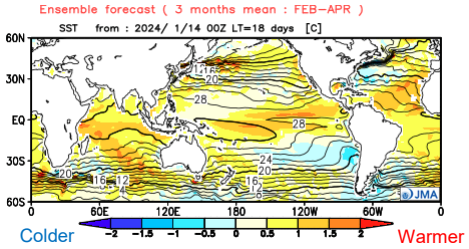
What we should note at each step

1. Check global circulation prediction by CPS3
   - ① Tropical ocean, particularly ENSO
   - ② Tropical circulation, particularly as response to ENSO
   - ③ Extra-tropical circulation (if necessary)
   - • Be sure to check prediction skills
2. Check guidance output
   - • Be sure to check prediction skills
3. Synthesize model and guidance output to decide forecast
   - • Think about how to explain forecast
4. Issue forecast

13

Check Tropical ocean prediction

SST



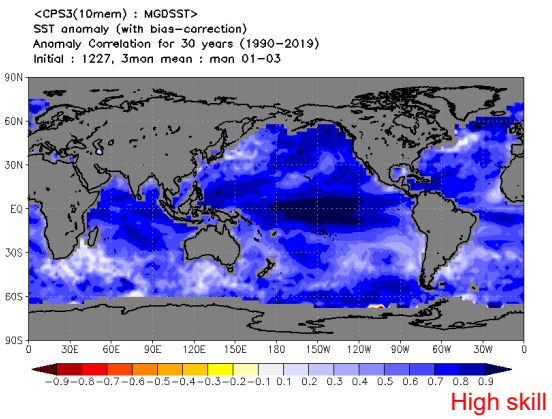
Map is available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php

- Tropical ocean is major climate driver
  - Large impact on climate in the tropics and extra-tropics
- High prediction skill

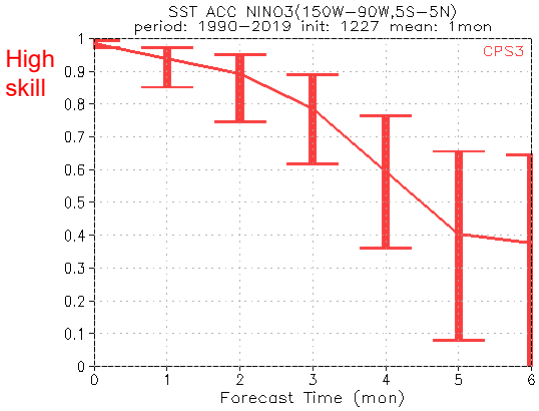
- **POINT: How is tropical ocean predicted?**
  - SST anomaly pattern
  - Pacific
    - ENSO (El Niño/La Niña)
  - Indian Ocean
    - IOBW (as delayed response to ENSO)
    - IOD

14

Tropical ocean prediction skill is high



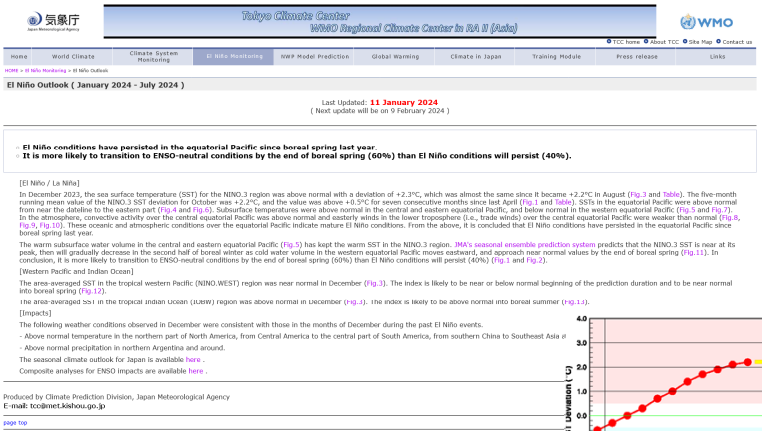
CPS3 Hindcast verification (Map)
https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/svs/deter.html



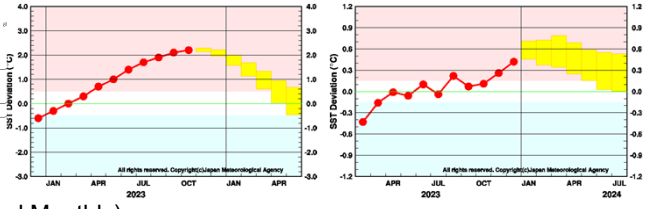
CPS3 Hindcast verification (SST Indices Score)
https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/score/index.html

15

Use TCC El Nino Outlook as a reference



- Current condition
- Outlook
- Explanation and Figures

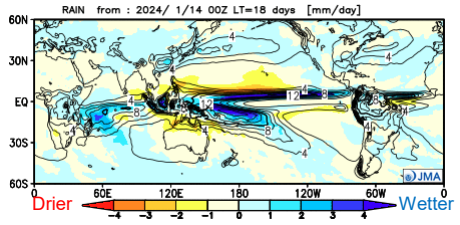


El Nino Outlook is available at TCC website (Updated Monthly)
https://www.data.jma.go.jp/tcc/tcc/products/elnino/outlook.html

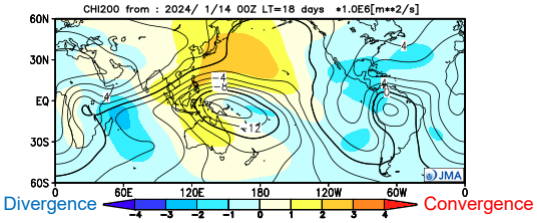
16

Check Tropical convection prediction

RAIN



Velocity potential at 200hPa (CHI200)



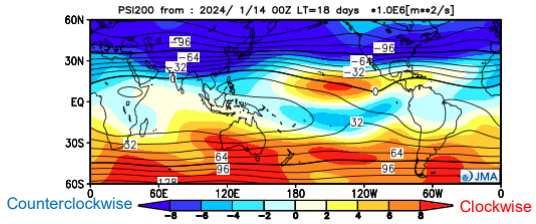
- Tropical ocean drives atmospheric circulation by altering convection pattern
- Tropical convection can be inferred from rainfall and velocity potential

- **POINT: How is tropical convection predicted?**
  - Anomaly pattern
  - Enhanced convection anomaly (Wetter; Divergence anomaly at upper level)
  - Suppressed convection anomaly (Drier; Convergence anomaly at upper level)
  - Does the convection anomaly pattern correspond to SST anomaly pattern by ENSO and/or IOD?

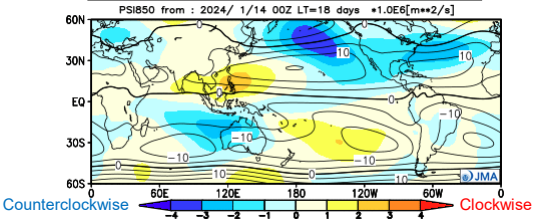
Maps are available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php

Check Tropical circulation prediction

Stream function at 200hPa (PSI200)



Stream function at 850hPa (PSI850)



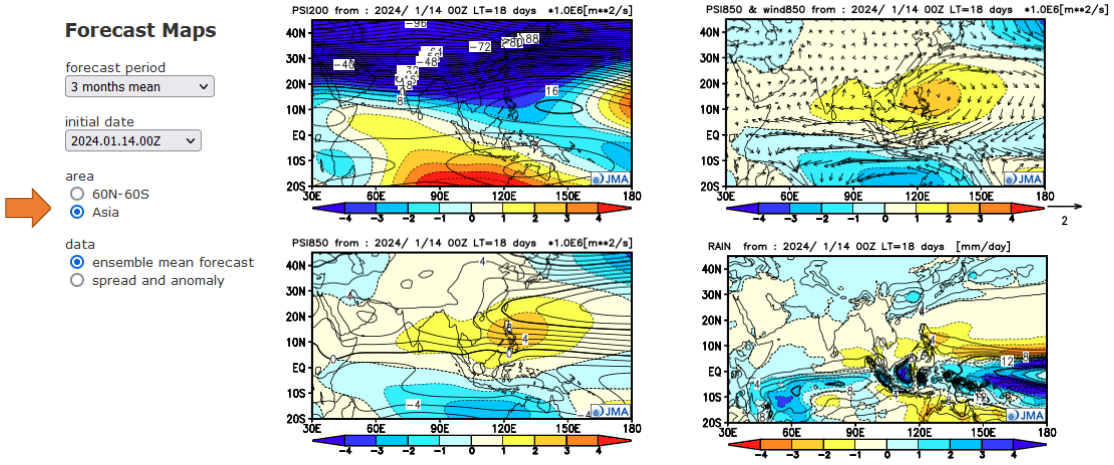
- Atmospheric circulation can be changed by tropical convection anomaly

- **POINT: How is tropical circulation predicted?**
  - Cyclonic/Anti-cyclonic anomaly pattern
    - Corresponds to Low/High pressure anomaly
  - Is the pattern excited by tropical convection anomaly?

- Useful knowledge
  - Tropical convection can excite Rossby waves along subtropical jet
  - Equivalent barotropic Low/High pressure anomaly corresponds to Warm/Cold temperature anomaly
  - Wind anomaly accompanied with Cyclonic/Anti-cyclonic anomaly can cause wetter or drier condition

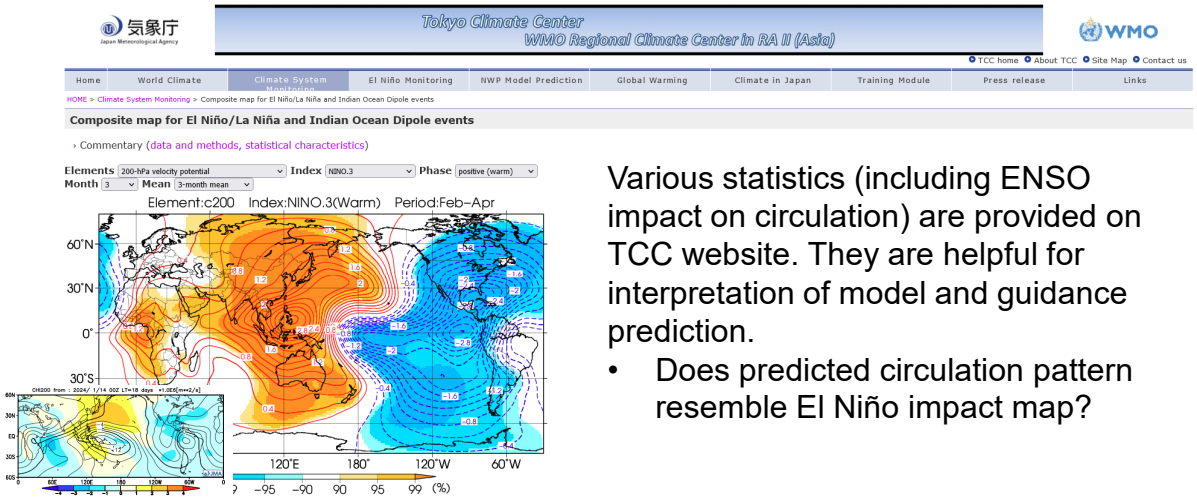
Maps are available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php

Use Asia enlarged CPS3 prediction maps



Maps are available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php

Use statistics as a reference



Various statistics (including ENSO impact on circulation) are provided on TCC website. They are helpful for interpretation of model and guidance prediction.

- Does predicted circulation pattern resemble El Niño impact map?

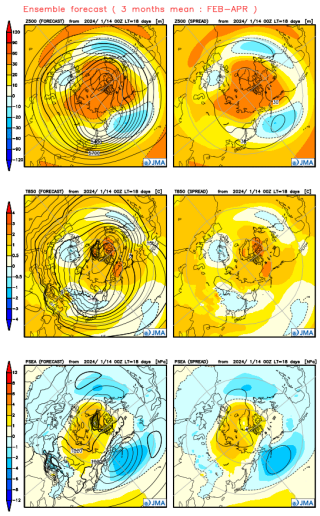
https://www.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html

Check Extra-tropical circulation prediction

Z500

T850

PSEA



- **POINT: How is extra-tropical circulation predicted?**
  - East Asian monsoon
  - Siberian High: Stronger/Weaker than normal
  - Aleutian Low: Stronger/Weaker than normal
- Keep in mind
  - Predictability of extra-tropical circulation is lower than that of tropical circulation

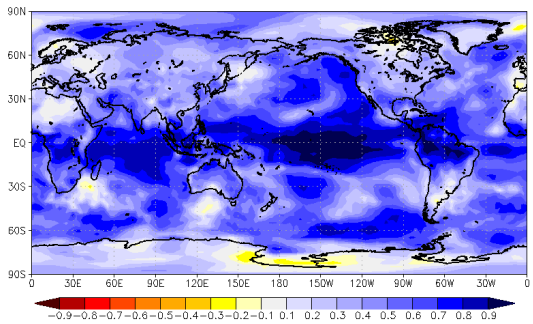
Maps are available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/pztmap.php

Predictability: Extra-tropics < Tropics

For extra-tropics, it is difficult to forecast only based on model prediction 'above the head'
We need to make forecast based on prediction of tropics too

Surface Temperature

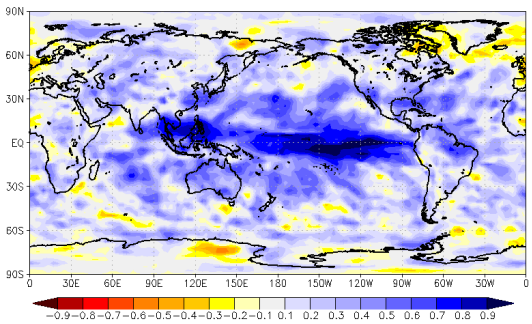
<CPS3(10mem) : JRA-3Q>
TS anomaly (with bias-correction)
Anomaly Correlation for 30 years (1990-2019)
Initial : 1227, 3mon mean : mon 01-03



No skill High skill

Rainfall

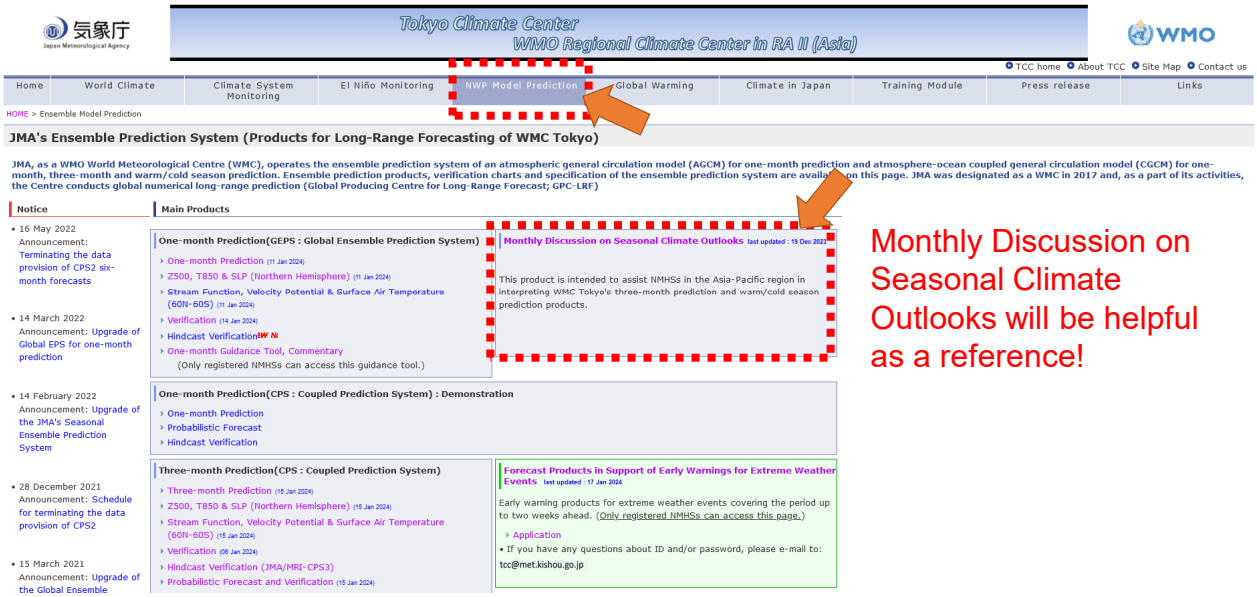
<CPS3(10mem) : GPCP_v2.3>
RAIN anomaly (with bias-correction)
Anomaly Correlation for 30 years (1990-2019)
Initial : 1227, 3mon mean : mon 01-03



No skill High skill

CPS3 Hindcast verification (Map)
https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/svs/deter.html

Optionally Use Monthly Discussion on Seasonal Climate Outlooks as a reference



Monthly Discussion on Seasonal Climate Outlooks will be helpful as a reference!

https://www.data.jma.go.jp/tcc/tcc/products/model/monthly_discussion/latest.pdf

What we should note at each step

1. Check global circulation prediction by CPS3
   - ① Tropical ocean, particularly ENSO
   - ② Tropical circulation, particularly as response to ENSO
   - ③ Extra-tropical circulation (if necessary)
   - Be sure to check prediction skills
2. Check guidance output
   - Be sure to check prediction skills

NOTE: JMA uses its own guidance for the official forecast instead of the guidance tool. However, the points to check are the same.

3. Synthesize model and guidance output to decide forecast
   - Think about how to explain forecast
4. Issue forecast

Guidance tool for this exercise

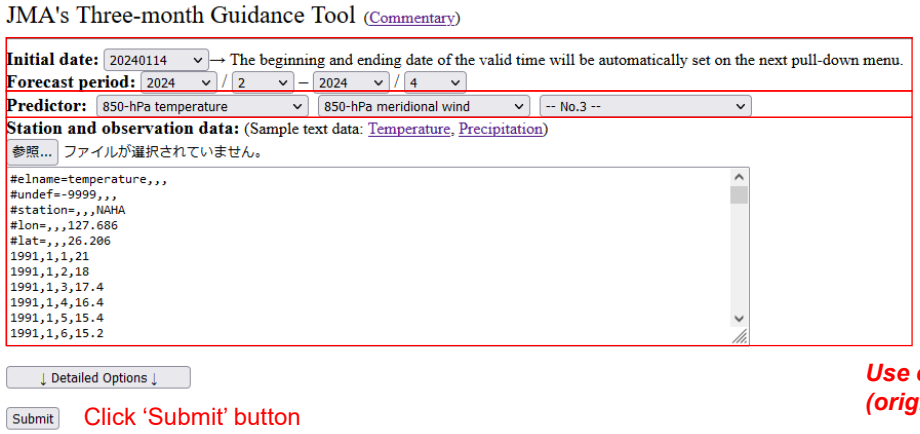
- In the exercise, we use **a guidance tool** for forecasting seasonal temperature and precipitation on stations
  - ① Input csv file (30-year observation of temperature/precipitation at stations)
  - ② Select predictor(s)
  - ③ The tool makes a simple statistical model between observations and CPS3 predictions over 30 years (1991-2020). Then it calculates forecast by entering the CPS3 prediction into the statistical model.
    - 3-category probability forecast (below-, near-, above-normal)
    - Skill scores
- **Assumption of the guidance tool**
  - 'Point' forecast by using single model grid point data (GPV) at the same location
    - *cf.* 'Area' forecast is common for seasonal forecast to increase accuracy
      - ex. JMA uses a guidance specialized for seasonal forecast over areas in Japan
  - Predictor choices are limited
    - The guidance tool should be used only for training purposes
- For details of the guidance tool, see the manual

25

How to use guidance tool

https://extreme.kishou.go.jp/cgi-bin/simple_guidance_3mon/index_3mon.cgi

NOTE: The guidance tool is exclusive to TCC seminar 2024



Determine the settings

Select predictor(s)

Input csv file
(Load csv file)

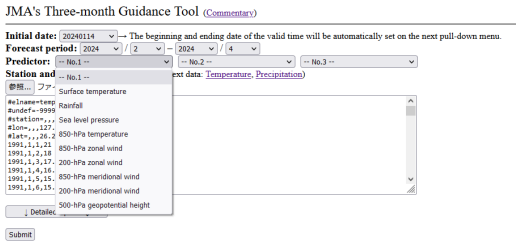
Use corrected csv files (original file name)+JMA

Click 'Submit' button

For any questions about the guidance tool, see the manual or ask TCC staff members

26

How to select predictors of the guidance tool



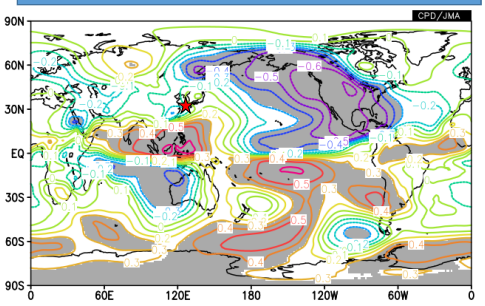
Tips
- We can select multiple predictors (up to 3) but **single predictor may be enough**.
- **DON'T select similar predictors at the same time (ex. surface temperature and 850hPa temperature)**. Inappropriate guidance model can be resulted.

- Select variables that determine temperature/precipitation at the target station
- Temperature
  - Surface temperature or 850hPa temperature is recommended as a first choice
- Precipitation
  - Rainfall is recommended as a first choice
- Use meteorological knowledge!

27

Use diagnostic relationship for choosing guidance tool predictors

Example to find NAHA's precipitation predictor

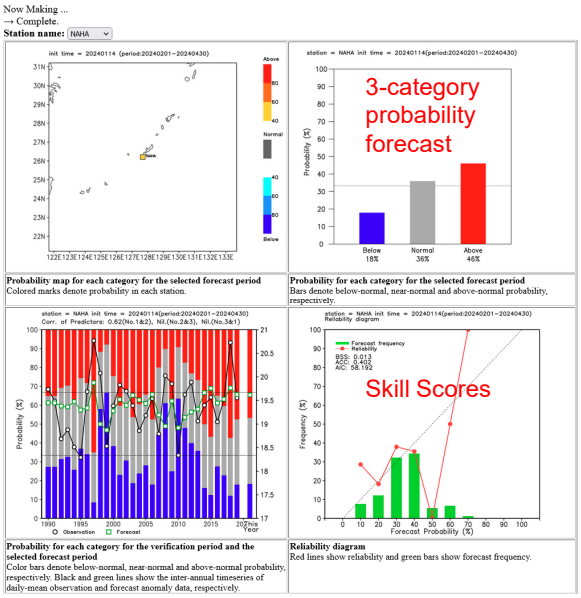


Example
Correlation coefficient map of PSI850 with NAHA's rainfall for FMA 1991-2020. We can see that NAHA's rainfall correlates well with anti-cyclonic anomaly around Philippines. Probably southwesterly anomaly advects humid air into NAHA. Created by using iTacs and NAHA's rainfall observation data.

- To find variables that determine temperature/precipitation at the target station, we can use diagnostic relationship between the station's observation data and atmospheric circulation field
- We can find such relationship using **iTacs**
  - Already learned in iTacs exercise!

28

Check Guidance output



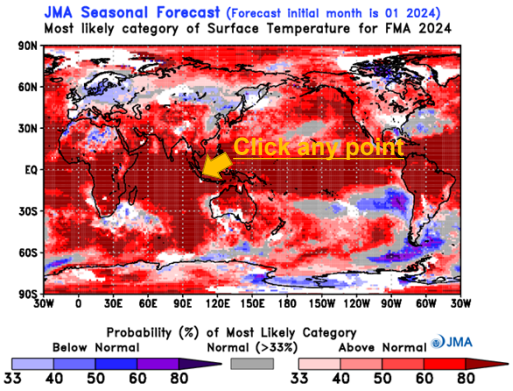
- **POINT: Is forecast as expected?**
  - Reasonable or not
- **POINT: Is skill enough?**
  - BSS > 0 desirable at least
  - Reliability curve close to 45-degree line as possible
- *In the exercise, we can re-select predictors, if the skill is not enough*

Brier Skill Score (BSS) measures the relative skill of the forecast compared to climatology
BSS = 1 perfect skill compared to climatology
BSS = 0 no skill compared to climatology

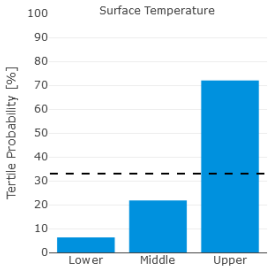
29

Optionally Use TCC probabilistic forecast as a reference

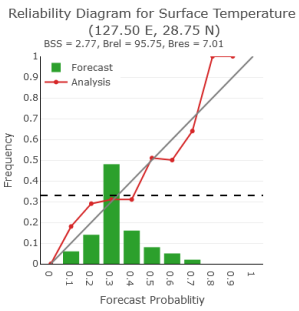
Use of TCC probabilistic forecast is optional in the exercise, but it can be helpful to forecast



Probabilities at any point



Skill scores at any point



TCC probabilistic forecast is publicly available at TCC website
https://www.data.jma.go.jp/tcc/tcc/products/model/probfcst/3-mon/index.html

30

What we should note at each step

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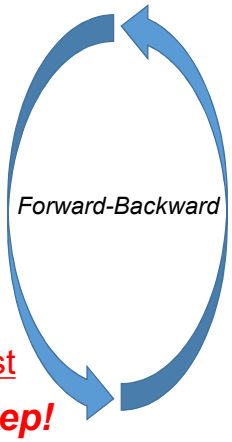
   ③ Extra-tropical circulation (if necessary)
   • Be sure to check prediction skills

2. Check guidance output
   • Be sure to check prediction skills

3. Synthesize model and guidance output to decide forecast
   • Think about how to explain forecast

Most important step!

4. Issue forecast



31

Synthesize all data

• Don't just believe guidance, particularly for precipitation forecast

• **Think about the meteorological reason of guidance output**
• **Think about how to explain forecast**
  • Why is above-normal temperature predicted?
  • Why is above-normal precipitation predicted?
  • Is there any impact of global circulation, particularly by ENSO?

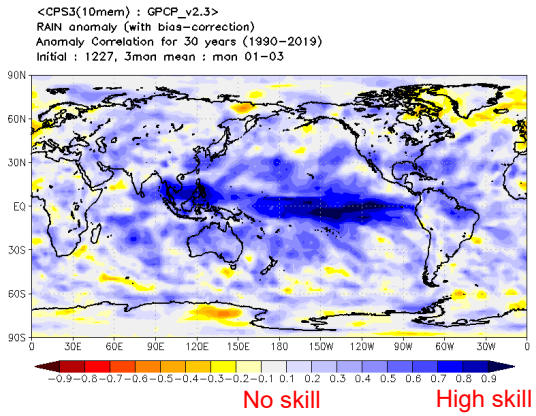
• If necessary, adjust guidance output

• Decide forecast
  • reasonable explanation of forecast is necessary to users

32

Don’t just believe guidance output!

This is especially true for the guidance tool for the exercise because it uses single point data alone, so that small difference in location can cause large difference in forecast.

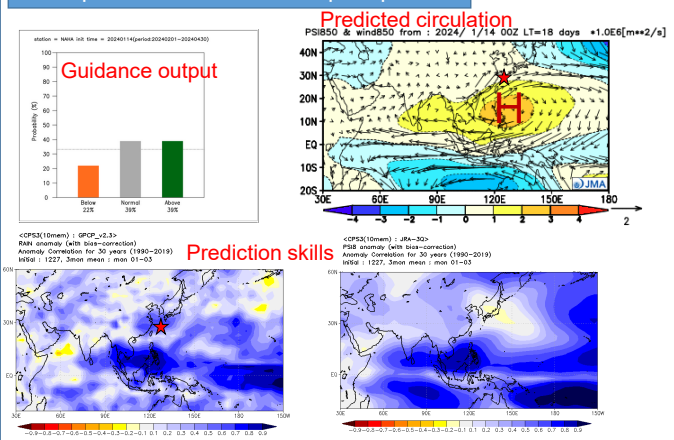


- Don’t make forecast from guidance output alone
  - Particularly for extra-tropics
- Try to explain the guidance result from a meteorological point of view
  - Any connection with tropics?
- So that we can believe model and guidance prediction

CPS3 Hindcast verification (Map)
https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/svs/deter.html

Think about how to explain forecast

Example to forecast NAHA’s precipitation

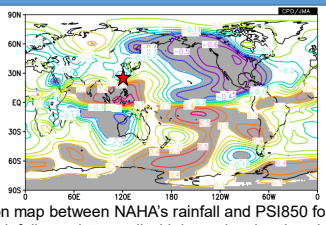


An explanation by a forecaster
Above- or near-normal precipitation for NAHA is predicted by guidance tool. An interpretation is that it’s caused by anti-cyclonic circulation anomaly around Philippines. The anti-cyclonic circulation anomaly may be a response to El Niño, so the prediction skill is high. Above- or near-normal precipitation can be reliable.

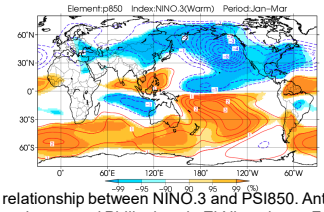
- **POINT: Synthesize all data so as not to contradict**
  - Model predictions
  - Guidance output
  - Prediction skills
  - Diagnostic relationship
- Consider forecast based on tropical phenomena (e.g. ENSO) as possible to increase forecast accuracy
- If necessary, adjust guidance probabilities

Use diagnostic relationship for forecast

Example to forecast NAHA's precipitation



Correlation map between NAHA's rainfall and PSI850 for FMA 1991-2020. NAHA's rainfall correlates well with lower-level anti-cyclonic anomaly around Philippines. Created by using iTacs.



Statistical relationship between NINO.3 and PSI850. Anti-cyclonic anomaly tends to develop around Philippines in El Nino phase. From TCC website at https://www.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html

- For interpretation of model and guidance output, we can use diagnostic relationship between observation and atmospheric circulation
- We can find such relationship using **iTacs**
- We can use also **various statistics provided on TCC website**

35

What we should note at each step

1. Check global circulation prediction by CPS3
   ① Tropical ocean, particularly ENSO
   ② Tropical circulation, particularly as response to ENSO
   ③ Extra-tropical circulation (if necessary)
   - Be sure to check prediction skills
2. Check guidance output
   - Be sure to check prediction skills
3. Synthesize model and guidance output to decide forecast
   - Think about how to explain forecast
4. Issue forecast

36

Forecast

In the exercise, we will consider not only forecast but also explanation of forecast

	Temperature			Precipitation		
	Below Normal	Near Normal	Above Normal	Below Normal	Near Normal	Above Normal
NAHA	10%	30%	**60%**	20%	**40%**	**40%**
(Guidance)	15%	25%	60%	17%	40%	43%

Explanation of forecast

- In response to suppressed convective activities over the Maritime Continent by El Nino, an anti-cyclonic anomalies is expected to develop around the Philippines. Southwesterly wind anomalies will cause hotter and wetter condition around Okinawa Island.
- Consequently, above-normal temperature and above- or near-normal precipitation are expected for NAHA.

37

Schedule (again)

Jan 31 (Wed)
- AM: Introduction & Example
- PM: **Exercise**

Feb 1 (Thurs)
- AM: **Exercise (continue)**
- PM: **Presentation**

Feb 2 (Fri)
- AM: **Presentation (continue)**

- Note
  - **TCC staff members always welcome any questions during the exercise**
  - Take your coffee break anytime during the exercise
  - Presentation Time: **20 minutes**

Order of presentation: Alphabetical order by country name
Bangladesh, Bhutan, Hong Kong, Indonesia, Leo PDR, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam

38

Data & Tools for the exercise (again)

- CPS3 prediction
  - https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php
  - https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/pztmap.php
- CPS3 hindcast verification
  - https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/index.html
- El Nino Outlook
  - https://www.data.jma.go.jp/tcc/tcc/products/elnino/outlook.html
- El Nino impact (composite analysis)
  - https://www.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html
- iTacs (registered NMHSs only)
  - https://extreme.kishou.go.jp/tool/itacs-tcc2015/
- Guidance tool (this exercise only)
  - https://extreme.kishou.go.jp/cgi-bin/simple_guidance_3mon/index_3mon.cgi

39

Exercise Setting

- Forecast Target
  - Target period: **February-March-April 2024 (3-month mean)**
  - Target forecast: **3-category probabilities** (below-, near-, and above-normal) of **Temperature and Precipitation for points**
    - We prepared and brought observation data of forecast points in advance
- Data
  - We use prediction data initialized on January 2024
  - URLs are given (previous slide)

Use corrected csv files (original file name)+JMA

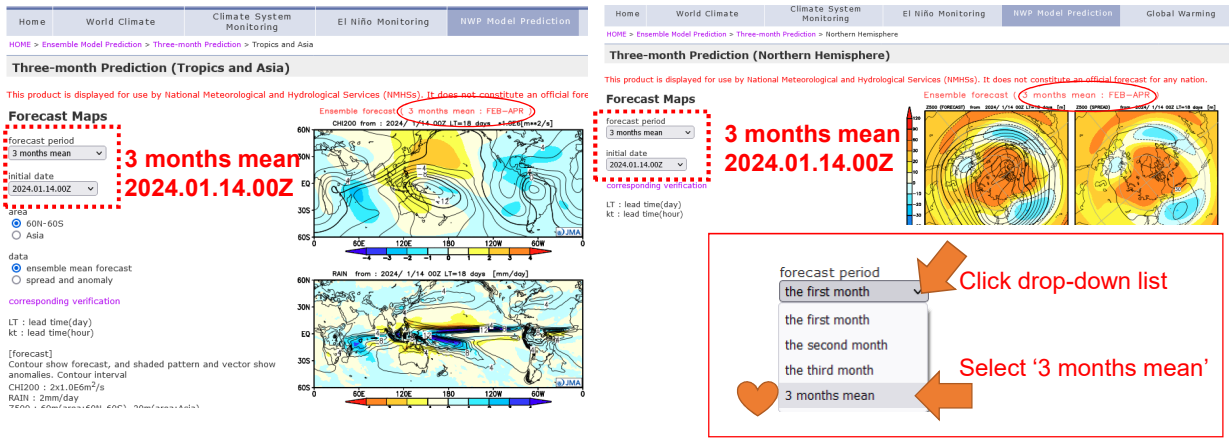
- Presentation
  - **Forecast with explanation** (meteorological interpretation)
  - **20-minute presentation time**

40

Exercise Setting

CPS3 prediction
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/zpcmap.php
https://www.data.jma.go.jp/tcc/tcc/products/model/map/4mE/map1/pztmap.php

CPS3 prediction map on TCC website



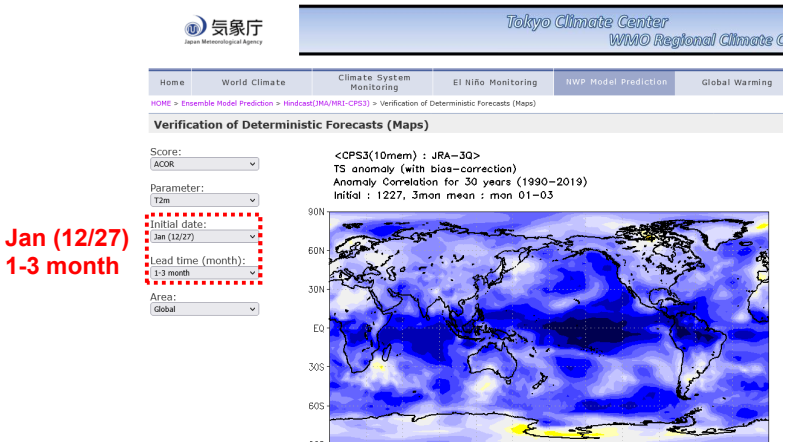
Make sure your settings are correct!

41

Exercise Setting

CPS3 hindcast verification
https://www.data.jma.go.jp/tcc/tcc/products/model/hindcast/CPS3/index.html

CPS3 verification map on TCC website



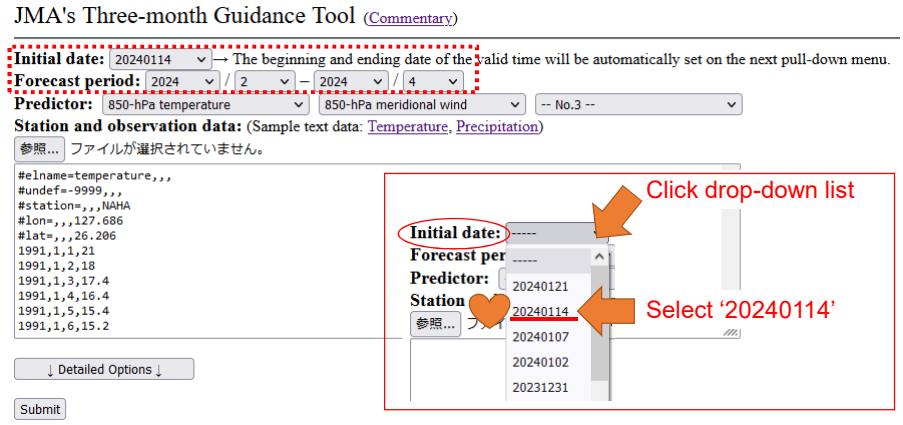
Make sure your settings are correct!

42

Exercise Setting Guidance Tool

Guidance tool (this exercise only)
https://extreme.kishou.go.jp/cgi-bin/simple_guidance_3mon/index_3mon.cgi

20240114
2024 2 – 2024 4



Make sure your settings are correct!

43

Contents of Presentation

- Presentation time is 20 minutes including Q&A session
- About 5-10 pages in order to finish in 20 minutes
- First page
  - Climate of the country
  - Location of forecast target station (point)
- Second page onwards
  - **Explanation of forecast** (Why that forecast?)
- Last page
  - **Forecast with summary of explanation**
- Example is given

44

Tips for exercise

- **Apply what we have already learned in the seminar!**
  - Lecture on seasonal forecast
  - Lectures on ENSO and its impact on seasonal climate
  - Lecture and exercise on iTacs

Maeda-san's lecture is highly relevant.
It shows how we can interpret CPS3 prediction for FMA

- **Start from the guidance tool, if you don't know what to do. Then, think about how to explain the guidance output.**

- **Don't hesitate to ask any questions to TCC staff members!**

- ***Enjoy exercise!***

45