気象庁
Japan Meteorological Agency

TCC Training Seminar, 29 January 2024, 17:00-18:00

Basic Operation of iTacs

- Interactive Tool for Analysis of the Climate System -

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Tokyo Climate Center
Japan Meteorological Agency

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   - Longitude-latitude map
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   - Time series graph
   - Data download
   - User data input

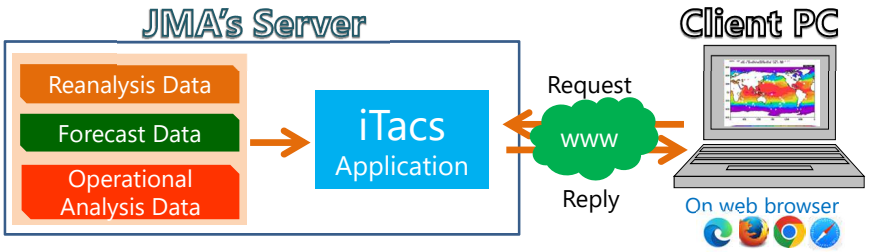
29 January (today)

3. Advanced operations
   - Statistical analysis on iTacs
   - Correlation / Regression Analysis
   - Relationship with Observation Data

30 January (tomorrow)

What's iTacs?

- A web application developed by TCC/JMA for climate data visualization and analysis
- iTacs stands for "Interactive Tool for Analysis of the Climate System".
- Available on web browsers through Graphical User Interface (GUI) with personal IDs.
- No additional software or plug-in is required on user's client PCs.
- Only NMHS staff can use iTacs.



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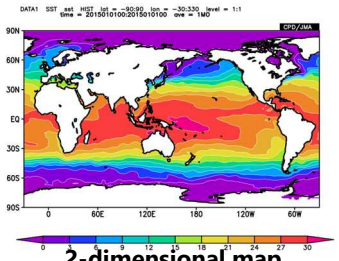
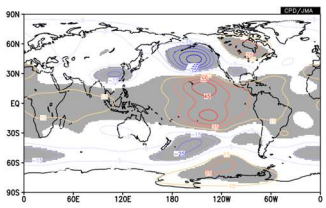
Examples

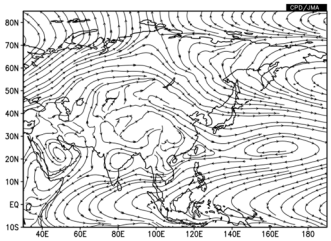
- Various types of charts and statistical analyses are available on iTacs.



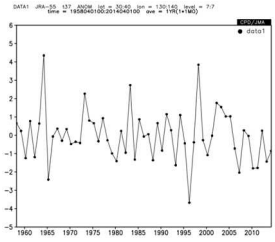
2-dimensional map



Regression/Correlation and significance-test



Streamline or Vector map



Time series graph

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Available dataset and its period

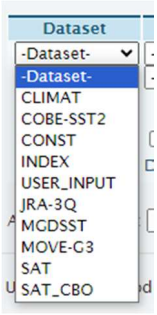
Atmospheric analysis dataset		
JRA-3Q*1	1947.9 -	Japanese Reanalysis for Three Quarters of a Century to diagnose atmospheric circulation in past period
SAT_CBO	1991.1 -	NOAA/CPC blended outgoing longwave radiation (OLR) to infer tropical convective activities

Oceanographic analysis dataset		
MGDSST*2	1982 -	Merged satellite and in-situ data Global Daily SST
MOVE-G3	1947.9 -	Ocean Data Assimilation (MOVE/MRI.COM-G3)

Forecast dataset
JMA's one-month prediction model output

Other dataset	
INDEX	Monitoring index of ENSO and IOD
USER-INPUT	Text data input by user

*1: Kosaka et al. (2024), *2: Kurihara et al. (2006)



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Available elements in JRA-3Q dataset

- Various elements to diagnose atmospheric circulation are available in JRA-3Q dataset.

Dataset	Element		Unit
JRA-3Q	Pressure Levels	χ (Velocity potential)	10^6 m^2/s
		ω (Pressure vertical velocity)	Pa/s
		ψ (Stream function)	10^6 m^2/s
		q (Specific humidity)	kg/kg
		T (Temperature)	°C
		U (Zonal wind)	m/s
		V (Meridional wind)	m/s
		Ws (Horizonal Wind Speed)	m/s
		γ (Geopotential height)	gpm
	Surface	SLP (Sea level pressure)	hPa
		qs (Surface specific humidity)	kg/kg
		Ts (Surface temperature)	°C
		Us (Surface zonal wind)	m/s
		Vs (Surface meridional wind)	m/s
		Wss (Surface horizontal wind speed)	m/s
		Tprat (Surface total precipitation)	mm/day

https://extreme.kishou.go.jp/tool/itacs-tcc2015/elements.html

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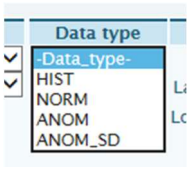
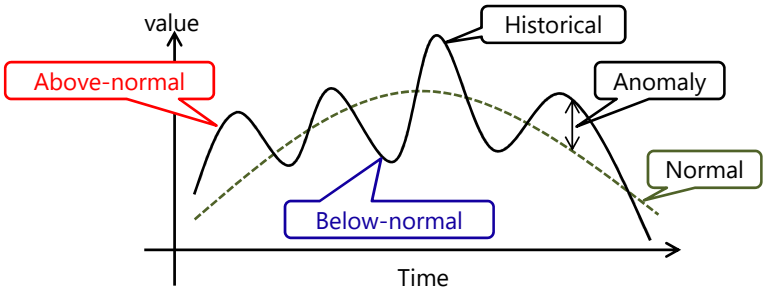
Available data type



- Several data types are available for climate analysis.

HIST	Historical actual analysis or observation data
NORM	Climatological normal data (30-year average from 1991 to 2020)
ANOM	Anomaly data (deviation from the climatological normal, i.e. **HIST** minus **NORM**)



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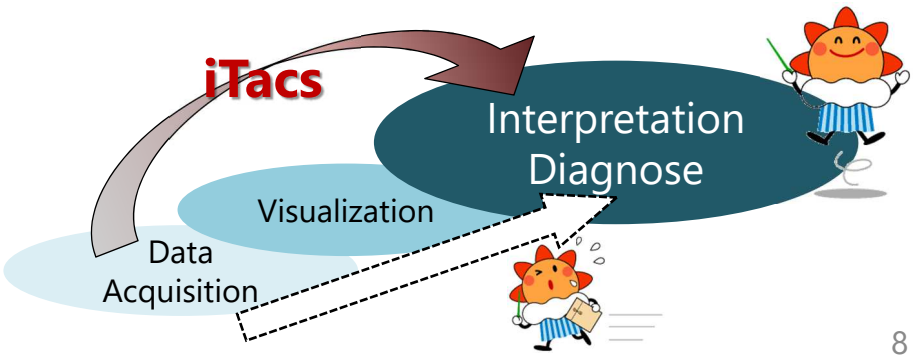
Advantages of iTacs

- ***Less time for data processing, more time to interpretation of the climate system*.**
- iTacs will strongly help your work about climate analysis and the related statistical analysis.



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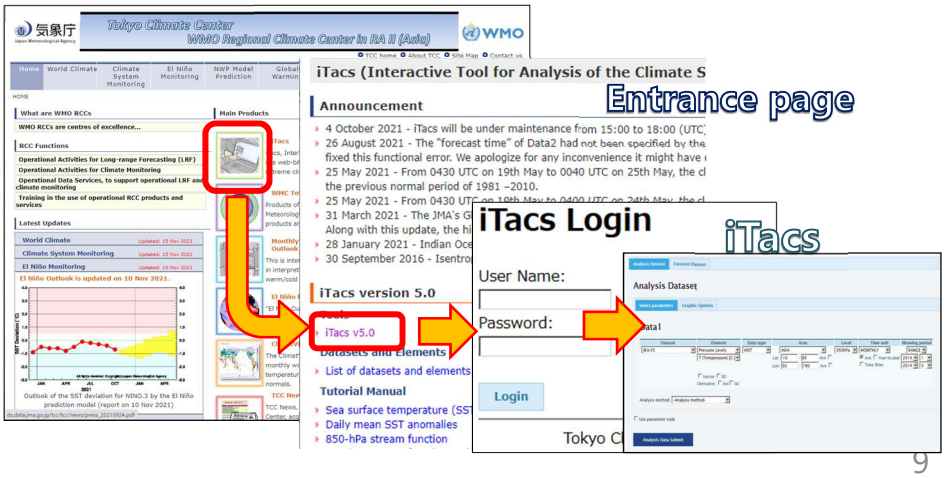
Access to iTacs

- Registered users can access iTacs from the Tokyo Climate Center (TCC) website.

TCC website (https://www.data.jma.go.jp/tcc/tcc/index.html)



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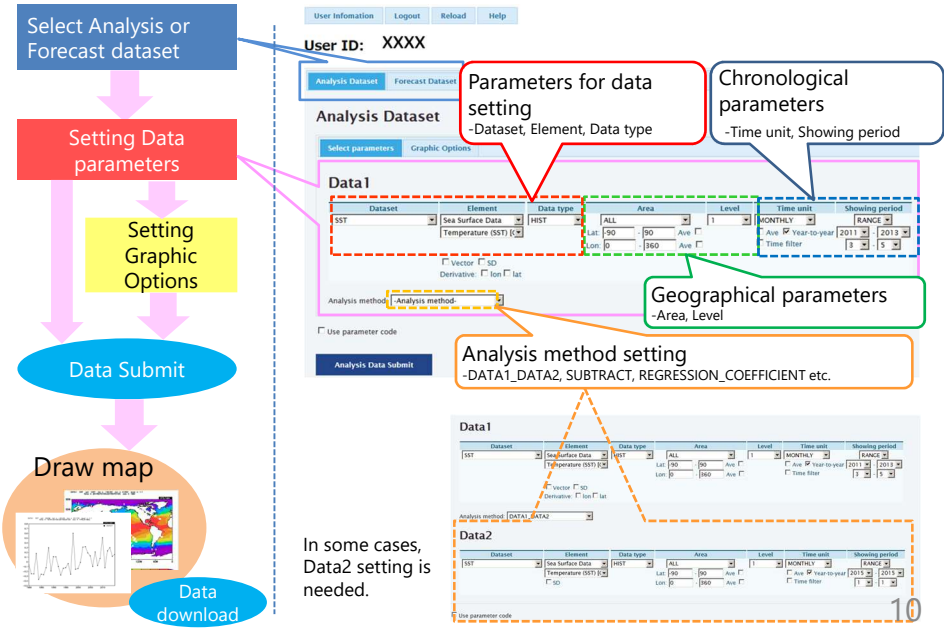
Basic operating procedure (1)



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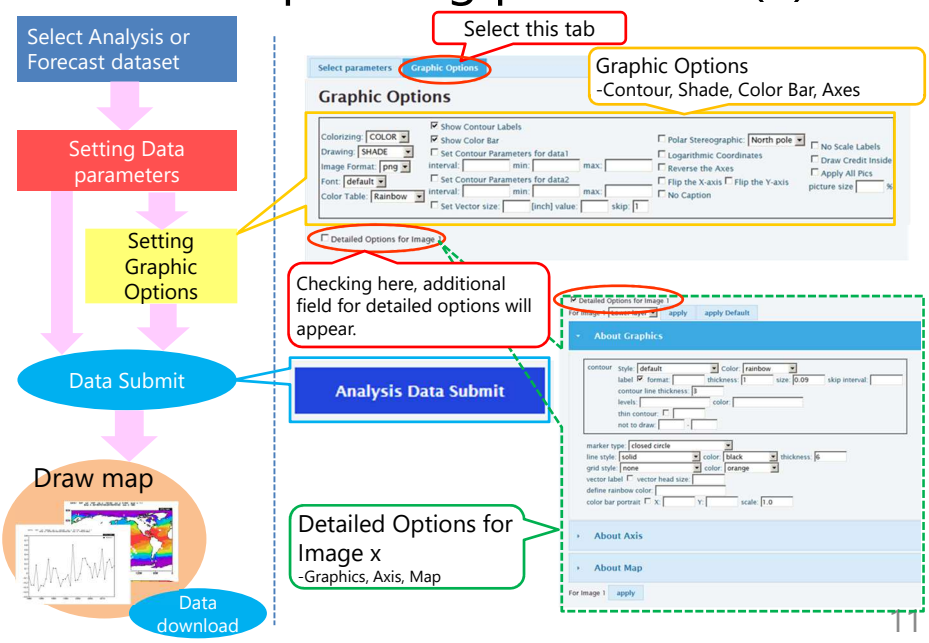
Basic operating procedure (2)



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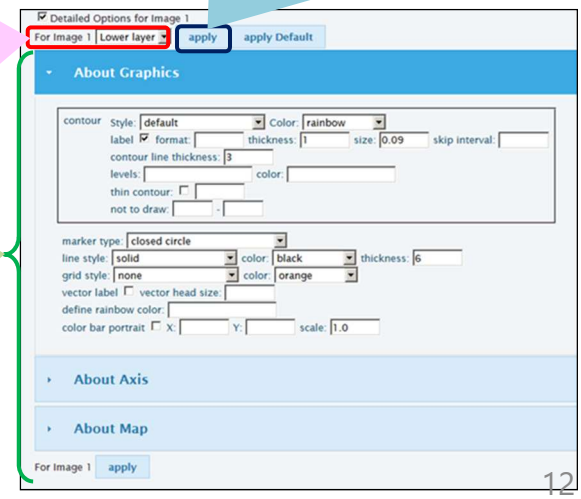
Basic operating procedure (3)

1. Select target
Lower layer: Data1
Upper layer: Data2
In case of vector map
Lower layer: Data2
Upper layer: Data1

2. Set options
Set contour style, color, thickness, etc.

3. Apply the settings
Click the "apply" button before clicking the "Submit" button.



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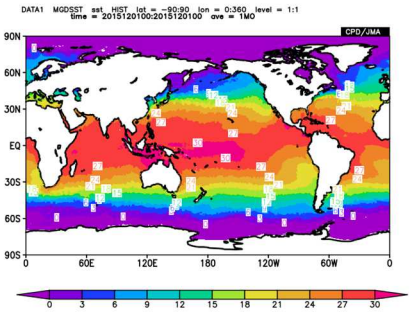
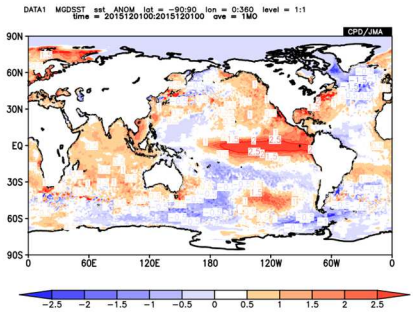
Longitude-latitude map (1)

- Example: Monthly mean sea surface temperature (MGDSST) and its anomaly maps for December 2015.

SST

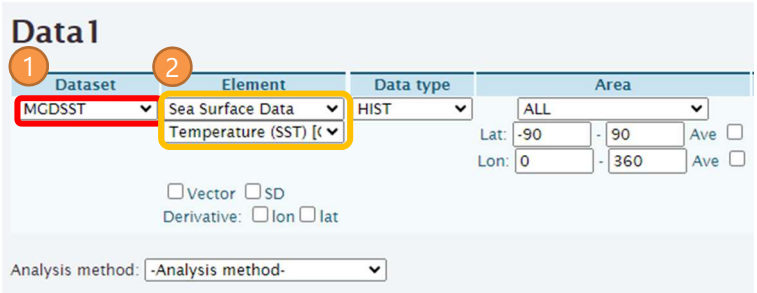


SST anomaly



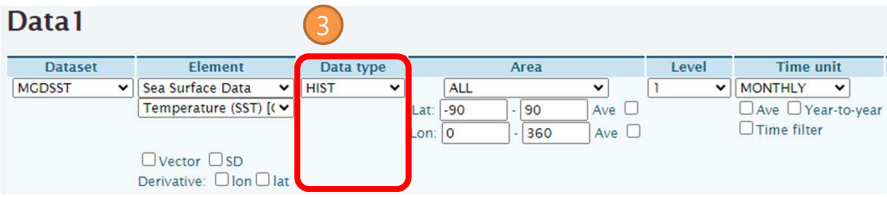
Anomaly = Deviation from the climatological normal

Longitude-latitude map (2)



1. Select "MGDSST" in the "dataset" field.
   - Various datasets are available;
     JRA-3Q, MGDSST, MOVE-G3, CLIMAT, INDEX, USER-INPUT etc.
2. Select "Sea Surface Data" for "element1" and "Temperature" for "element2".
   - Available elements will be shown in a pull-down menu.

Longitude-latitude map (3)



3. Select "HIST" for "Data type" .
   Available options are as follows:
   - **HIST** : Historical actual analysis or observation data
   - **NORM** : Climatological normal
   - **ANOM** : Anomaly (deviation from climatological normal)
   - **ANOM_SD** : Anomaly normalized by its standard deviations of interannual variability during a 30-year period from 1991 to 2020, indicative of significance for the anomaly.

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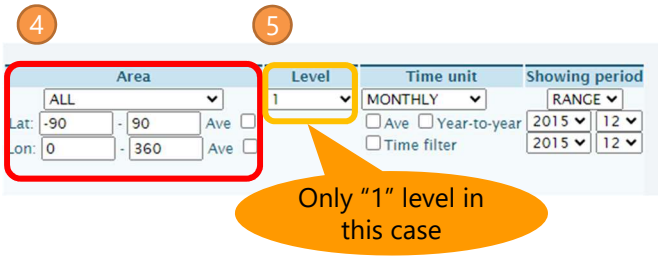
Longitude-latitude map (4)



4. Select "ALL" for "Area".
   - You can change the longitude/latitude range with setting boxes.
5. Select "1" for "Level".
   - Options in the "Level" menu will change depending on your selection of "element".

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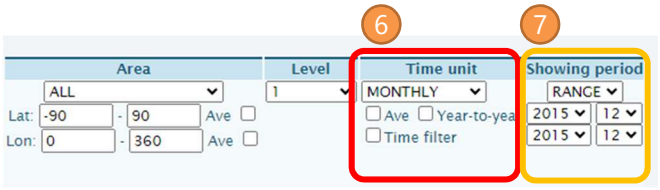
Longitude-latitude map (5)



6. Select "MONTHLY" for "Time unit".
   - There are several styles for range selection: **DAILY, PENTAD DAY** (only for SST and MOVE-G2)**, MONTHLY** and **ANNUAL**
   - This seminar mainly uses **MONTHLY** dataset to verify seasonal forecasting.
7. Select "RANGE" for "Showing period" and "2015 12", for both upper and lower boxes (left box: year, right box: month).

   Available options are as follows:
   - **RANGE**: Setting the start and end points of the targeted time period.
   - **YEARS**: Setting individual years.
   - **INDEX**: Setting a SST index border to pick up years (e.g. NINO.3).

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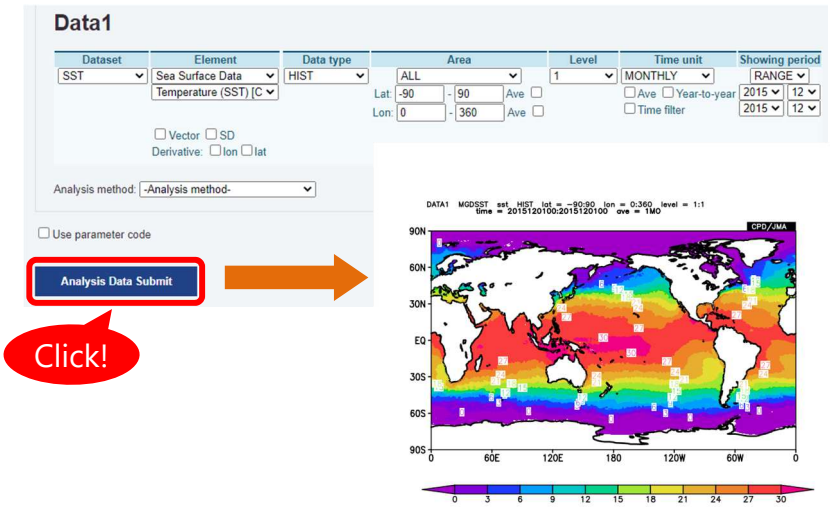
Longitude-latitude map (6)

Finally, click the "Analysis Data Submit" button and the image will be displayed.



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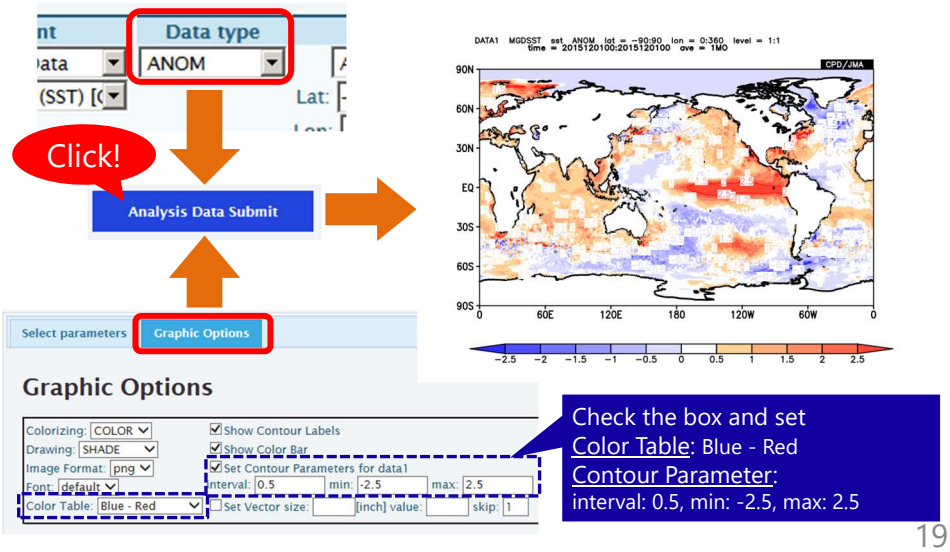
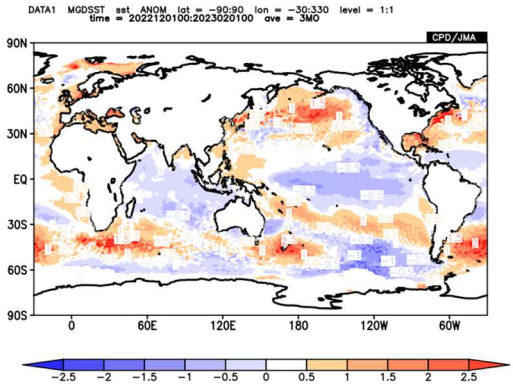
Longitude-latitude map (7)

- You can make anomaly maps by selecting “ANOM” for “Data type”.

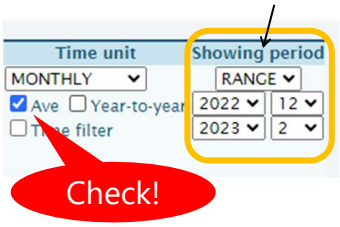


Exercise (1)

- Let’s make a three-month-mean sea surface temperature (MGDSST) anomaly map. The averaging period is from December 2022 to February 2023.

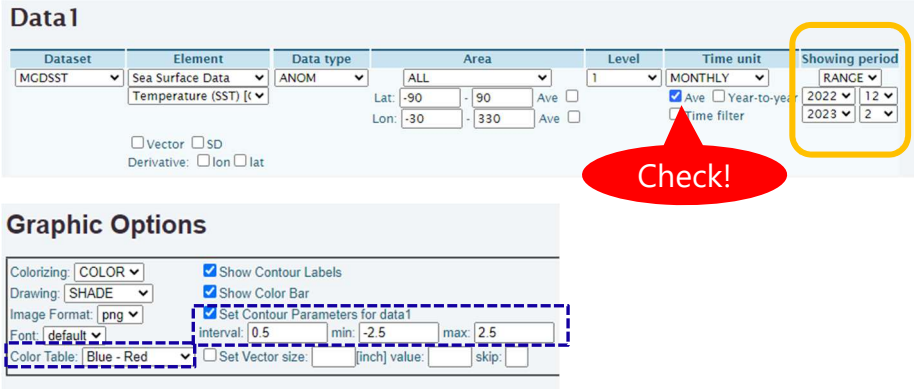


Upper: Start of Period
Bottom: End of Period



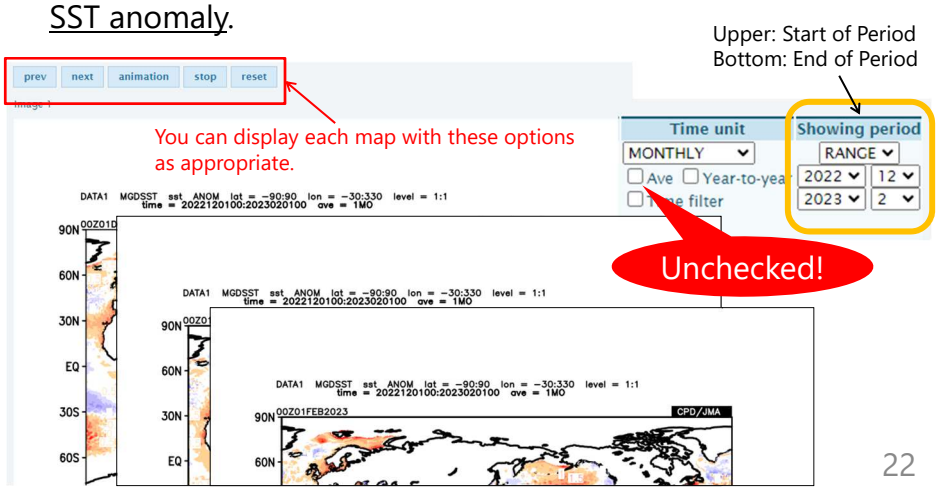
If you don’t check the “Ave” box, you will get **THREE** maps of **MONTHLY** SST anomaly for December 2022, January 2023, and February 2023. If you have time, please try it!

Answer to Exercise (1)



Tips

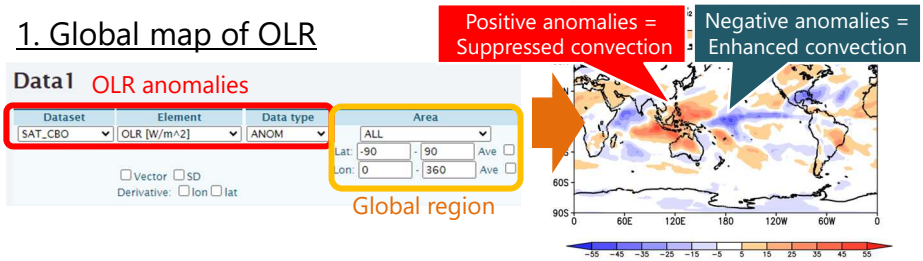
- If you don't check the "Ave" box in "Time unit", you will get three maps of monthly SST anomaly for December, January, February 2022/2023, not one map of three-month-mean SST anomaly.



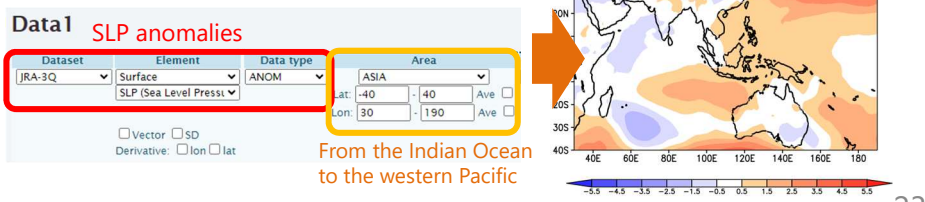
Longitude-latitude map (8)

- Using "SAT_CBO" and "JRA-3Q" dataset, you can also make regional maps of OLR and atmospheric circulation.

1. Global map of OLR



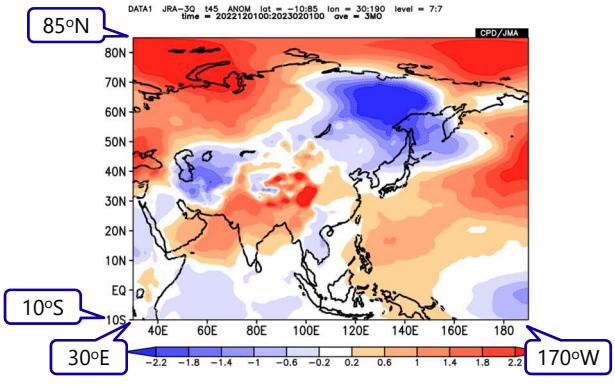
2. Sea-level pressure (SLP) in Indo-Pacific region



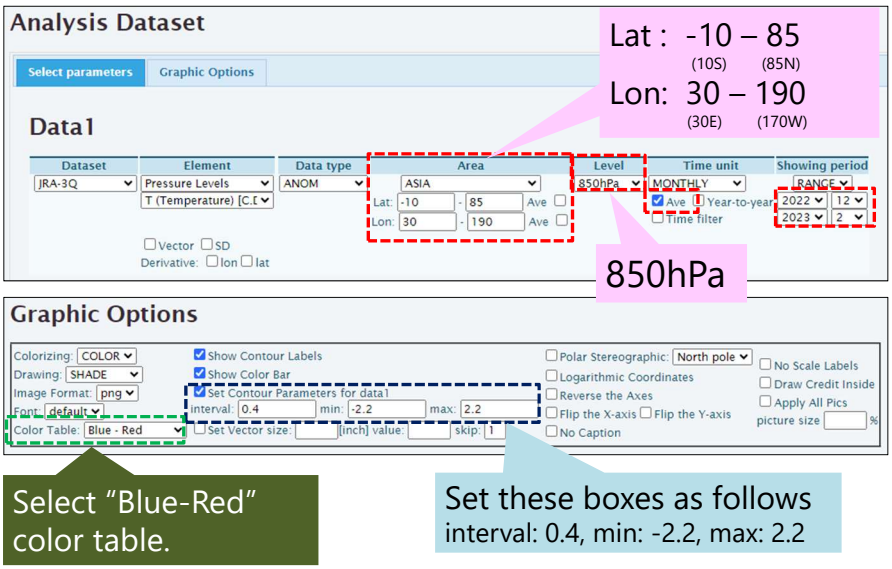
Exercise (2)

- Let's make 850hPa temperature anomaly map averaged from December 2022 to February 2023.
- Dataset "**JRA-3Q**" is available to draw temperature on a pressure level.

◆ Hints to make this map
- Longitudinal and latitudinal range are 30°E–170°W, 10°S–85°N.
- Temperature is a pressure-level element. Set "Level" the pressure level.
- Adjust contour parameters (see color bar of the figure)
- Select "Blue-Red" for "Color Table"



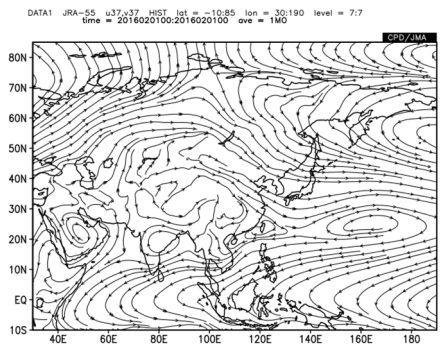
Answer: Exercise (2)



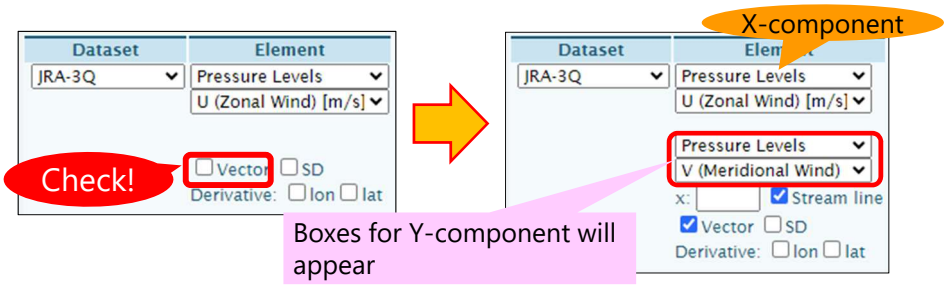
Stream-line map (1)

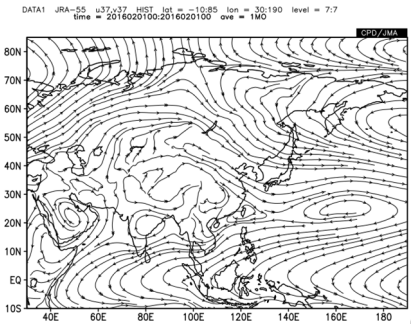
- A stream-line map derived from two kinds of elements is available to see flow or flux.
  - For example, set U and V to see wind fields.
  - Barbs are not available. (Barb: and)

Example of stream line at 850-hPa



Stream-line map (2)





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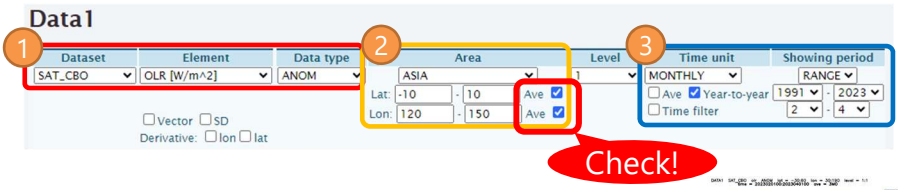
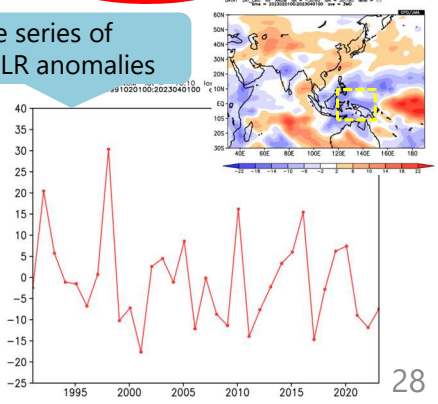
Inter-annual time series (1)

- Time series graph is useful to see the time variation.



Inter-annual time series of area-averaged OLR anomalies



1. Select OLR anomalies.
2. Select 10°S–10°N, 120–150°E
   Check "Ave" boxes.
3. Select "MONTHLY" for time unit, and showing period
   - Check "Year-to-year".
   - Showing period: 1991 – 2023, 2 – 4 (Feb. – Apr.)

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Tips: Year-to-year

Case 1

Picking up June-July-August three-month means from each year.

2013 J F M A M J J A S O N D
2014 J F M A M J J A S O N D
2015 J F M A M J J A S O N D
2016 J F M A M J J A S O N D

Case 2

Picking up December-January-February three-month means from each year.

2013 J F M A M J J A S O N D **2014** J F M ...
2014 J F M A M J J A S O N D **2015** J F M ...
2015 J F M A M J J A S O N D **2016** J F M ...
2016 J F M A M J J A S O N D **2017** J F M ...

↑ Apparently the end of period is February 2016 and three DJFs (2013/14, 2014/15 and 2015/16) are picked up, but actually the end of period is February 2017 and four DJFs (2013/14, 2014/15, 2015/16 and 2016/17) are picked up.
In other words, you should specify years of the start date of each period you pick up.

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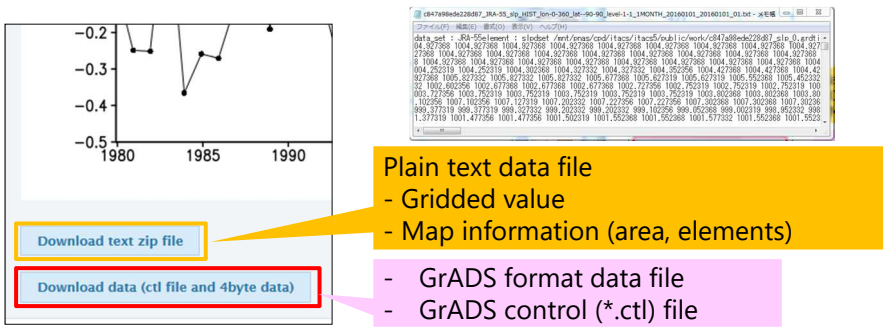
Data download

- Users can download the data used to create a map.
- A plain text file and GrADS format files (control file and data file) are available.



(GrADS official website; https://cola.gmu.edu/grads/)
(GrADS tutorial on TCC;
https://www.data.jma.go.jp/tcc/tcc/products/model/tips/tutorial.html)

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Using user input data (1)

- Time series data made by individual users is available in a dataset name "USER_INPUT".
  - The data must be **one-dimensional**.
  - For example, a correlation or regression coefficient map between single station data or user's original index and another dataset like JRA-3Q can be created by this function.
- There are two ways for inputting data.
  - **UPLOAD_TXT** : Data are given by an csv file.
  - **INPUT_DATA** : Data are directly input to the box.

Sample csv file

```
#Daily temperature
#undef = 9999
#element = Daily Ts
2013,07,01,23.6
2013,07,02,24.3
2013,07,03,24.5
2013,07,04,9999
2013,07,05,27.4
2013,07,06,28.9
```

<CSV Data format>

- **Data must be separated by commas** and must be given by specified format as "**year, month, day, value**". In case of monthly data, "day"s are always given as "1".
- Sentences beginning with "#" have special meanings.
  - # : Comment (except for two cases shown below).
  - #undef = : Definition of missing data (default is -9999).
  - #element = : Data name used to save them on the server.

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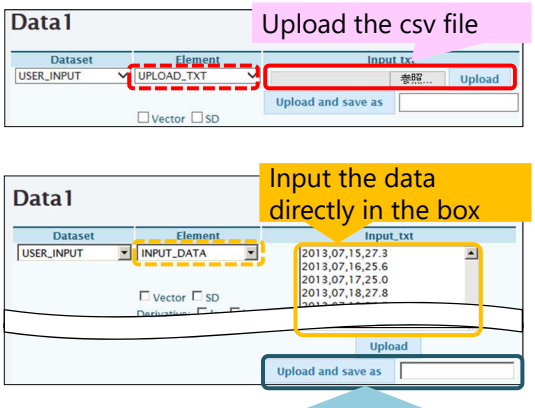
Using user input data (2)

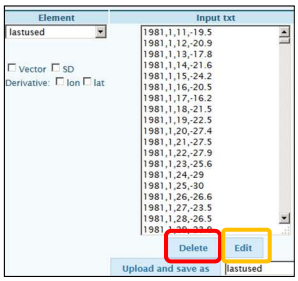
- Upload/input the data



Input the name to save them on the server, and click the "upload and save as" button. Blank spaces are not allowed in the file name.

Don't forget!

- Control the uploaded data



- Select the data name and click "Delete" button to delete the data from the server.
- Click "Edit" button to edit the data in the box.

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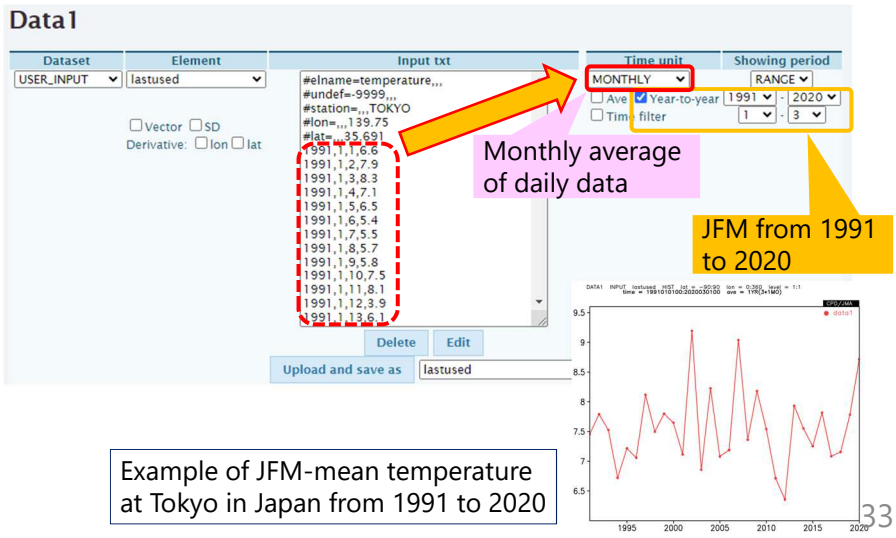
Using user input data (3)

- Daily and monthly averages of input daily data are calculated in iTacs.

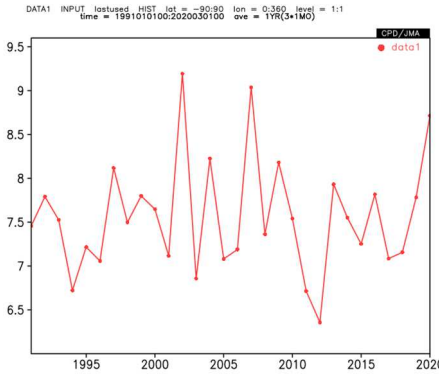


Example of JFM-mean temperature at Tokyo in Japan from 1991 to 2020

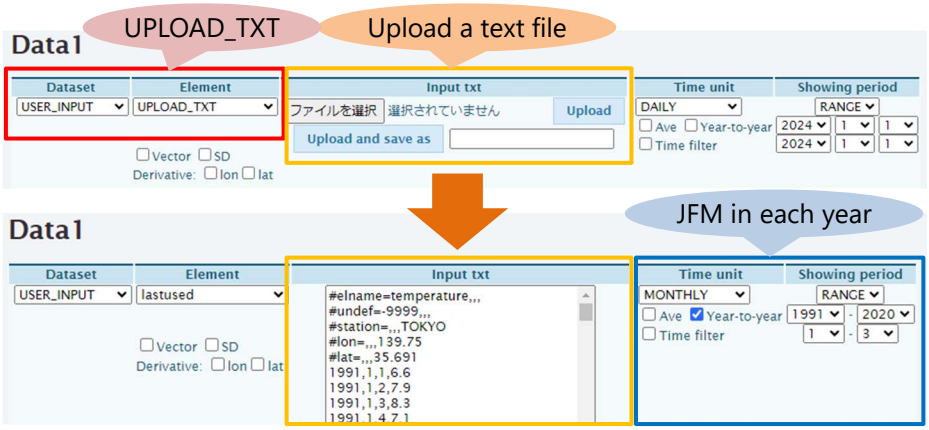
Exercise (3)

- Make an inter-annual time series of January–March mean observed temperatures in observation stations of your countries from 1991 to 2020.
  - Although the period to draw is recommended to be set from 1991 to 2020, it can be adjusted due to missing of observation.

Example of JFM-mean temperature at Tokyo in Japan from 1991 to 2020



Sample Answers to Exercise (3)



気象庁
Japan Meteorological Agency

TCC Training Seminar, 30 January 2024, 14:00-15:30

Advanced Operation of iTacs

- Interactive Tool for Analysis of the Climate System -

Takemura Kazuto
& Staff Members of Tokyo Climate Center

Tokyo Climate Center
Japan Meteorological Agency

Statistical Analysis on iTacs (1)

- Various statistical analysis methods are available.
  - Correlation and Regression analysis
  - Composite analysis

  etc.
- They can be powerful and helpful to understand statistical relationship with oceanographic and atmospheric circulation. Statistics is also necessary for seasonal forecasting.

⚠ *Keep in mind that statistical results **DO NOT ALWAYS** give us the physical nature of the target phenomena. Statistics is just a matter of mathematics. We need **physical interpretation** after statistical analysis.*

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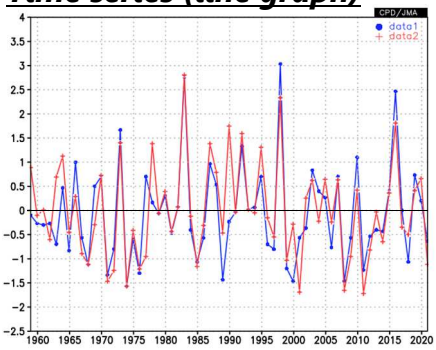
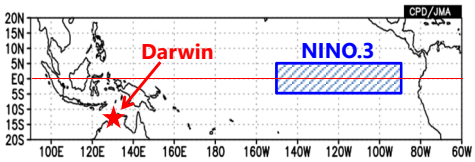
Tips: Correlation analysis

Time series (line graph)





For Dec.-Feb. (DJF) 3-month mean,

Blue: NINO.3 SST anomaly
(Positive: El Nino-like, Negative: La Nina-like)

Red: SLP anomaly at Darwin

When NINO.3 SST anomalies are positive, SLP anomalies at Darwin tend to be positive.

Next step is…,
How can we evaluate the relationship objectively and quantitatively?

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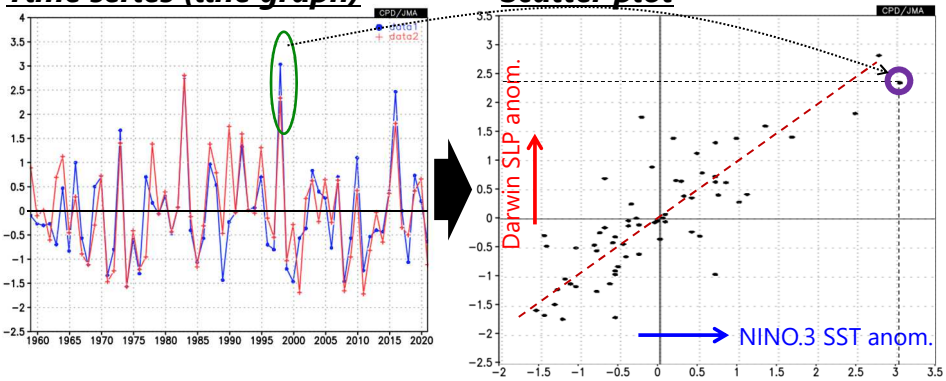
Tips: Correlation analysis

Time series (line graph) ***Scatter plot***



Considering mapping **each pair** of NINO.3 SST and Darwin's SLP values onto **a point** on a x-y map, we can clearly see a **linear relation** between them. We can evaluate the relationship with the **correlation coefficient**, which implies **how close they have a linear relationship.**

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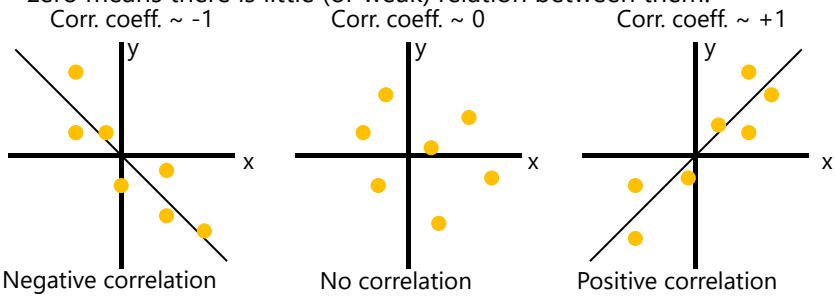
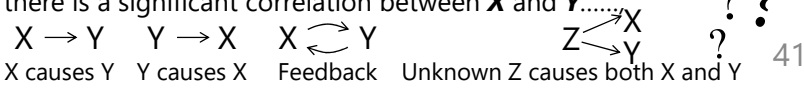
Tips: Correlation analysis

- **Correlation coefficient: How close they have a linear relationship**
  - Correlation coefficient values are between -1 and +1.
  - The value close to +1 (or -1) means there is a clear positive (or negative) linear relationship between the targeted data pair, and the value around zero means there is little (or weak) relation between them.



Correlation does not imply causality!

If there is a significant correlation between ***X*** and ***Y***.....



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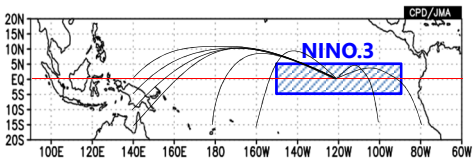
Correlation Analysis (1)

- We have just confirmed positive correlation between NINO.3 SST anomalies and Darwin sea level pressure (SLP) anomalies.

*<u>Next Question</u>: How about for other weather stations? Rather, how about for **every grid points** throughout the world?*



***Evaluating the correlation coefficients** between NINO.3 SST and SLP at every grid points. Then **mapping** each value on each grid.*

- Let's make a correlation map between three-month mean sea level pressure (SLP) and SST anomaly in NINO.3 for DJF from 1991/1992 to 2020/2021.

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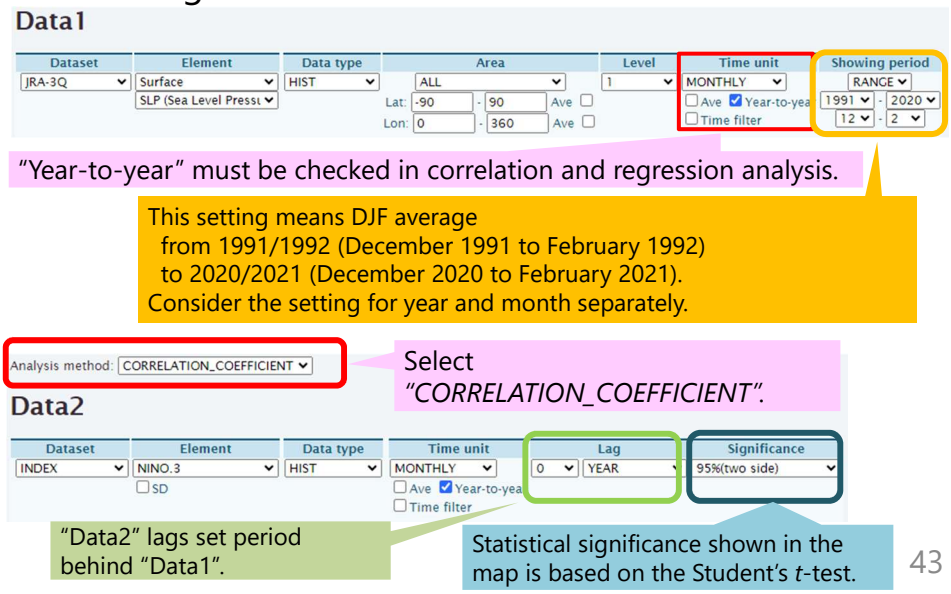
Correlation Analysis (2)

- Setting “Data1” and “Data2”.



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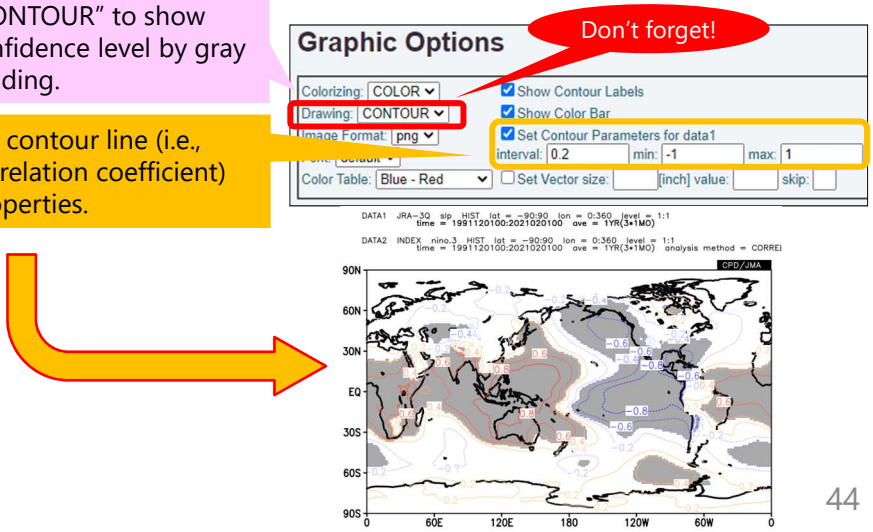
Correlation Analysis (3)

- Setting Graphic Options.

Set “Drawing”
“CONTOUR” to show
confidence level by gray
shading.

Set contour line (i.e.,
correlation coefficient)
properties.



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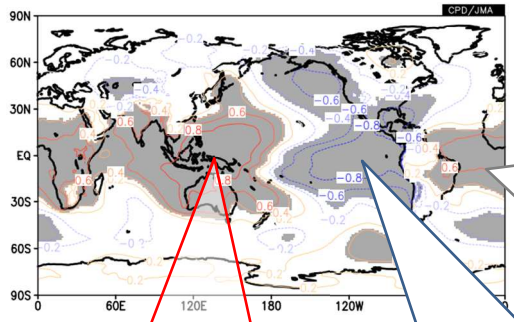
Correlation Analysis (4)

Correlation coefficient between NINO.3 index and SLP in DJF from 1991/92 to 2020/21.



The gray shading indicates a 95% confidence level as indicated by t-testing. In other words, **their relationships are robust**.

SLPs tend to increase associated with positive NINO.3.
The red contours indicate positive values of correlation coefficients.
Simply stated, **positive** (**negative**) SLP anomalies during **El Niño** (**La Niña**).

SLPs tend to decrease associated with positive NINO.3.
The blue contours indicate negative values of correlation coefficients.
Simply stated, **positive** (**negative**) SLP anomalies during **La Niña** (**El Niño**).

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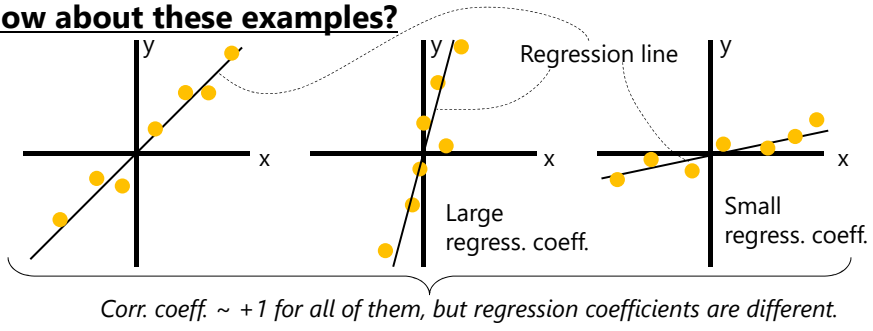
Tips: Regression analysis

How about these examples?



Corr. coeff. ~ +1 for all of them, but regression coefficients are different.

- All of these examples have strong positive linear relationships.
- We also use regression coefficients to evaluate their relationship.

(Linear) Regression coefficient: The slope of a regression line

Since the slope is given by $\Delta y/\Delta x$, regression coefficients mean **how much the variable *y* changes when the variable *x* changes**.

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Regression Analysis (1)

- Let's make a regression map of three-month mean sea level pressure (SLP) onto SST anomaly in NINO.3 for DJF from 1991/1992 to 2020/2021.

- For a regression analysis, "Data1" is a response (dependent or y-axis) variable, and "Data2" is an explanatory (independent or x-axis) variable.
- In this case, "Data1" is SLP and "Data2" is SST anomaly in NINO.3.

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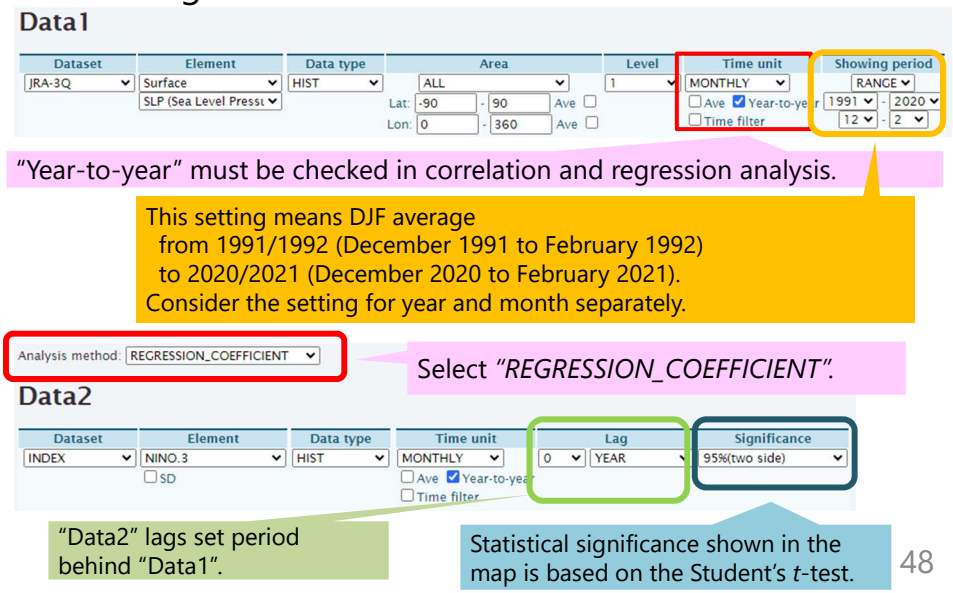
Regression Analysis (2)

- Setting "Data1" and "Data2".



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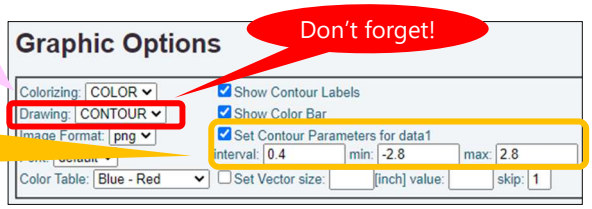
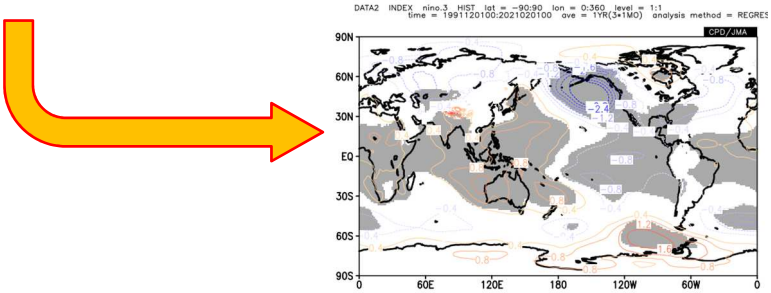
Regression Analysis (3)

- Setting Graphic Options.

Set "Drawing" "CONTOUR" to show confidence level by gray shading.

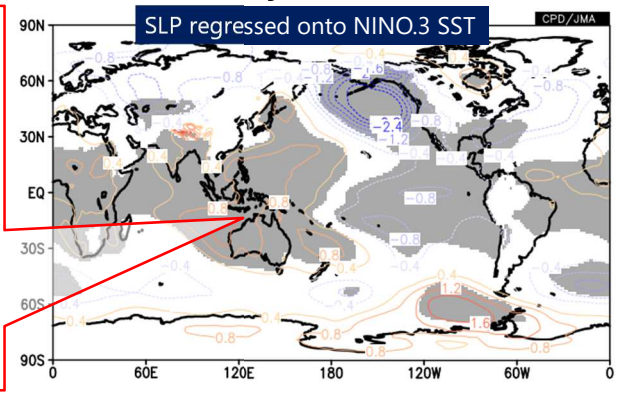
Set contour line (i.e., regression coefficient) properties.

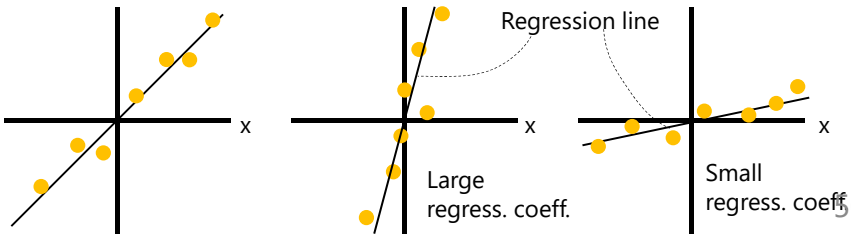




Regression Analysis (4)

This regression coefficient is +0.8.
This means SLP tends to be +0.8hPa higher than normal here when NINO.3 SST index is +1.0 higher than normal.
Recall that regression coefficients are the slope of regression lines, $\Delta y/\Delta x$. In this case, x is NINO.3 SST index and y is SLP.

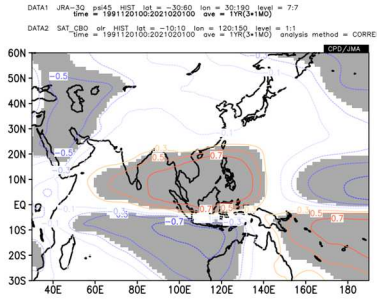




Exercise (4)

- Make a correlation coefficient map of 850hPa stream function (ψ850) onto OLR averaged over [10°S–10°N, 120–150°E] for DJF.
  - Set the statistical period from 1991/92 to 2020/21.
  - Stream function can be found in Dataset of "**JRA-3Q**", Element of "**Pressure Levels**".
  - Set the confidence level **95% (two side)**.
  - Set the drawing area **in and around your countries**.

Regression coefficient of ψ850 onto area-averaged OLR



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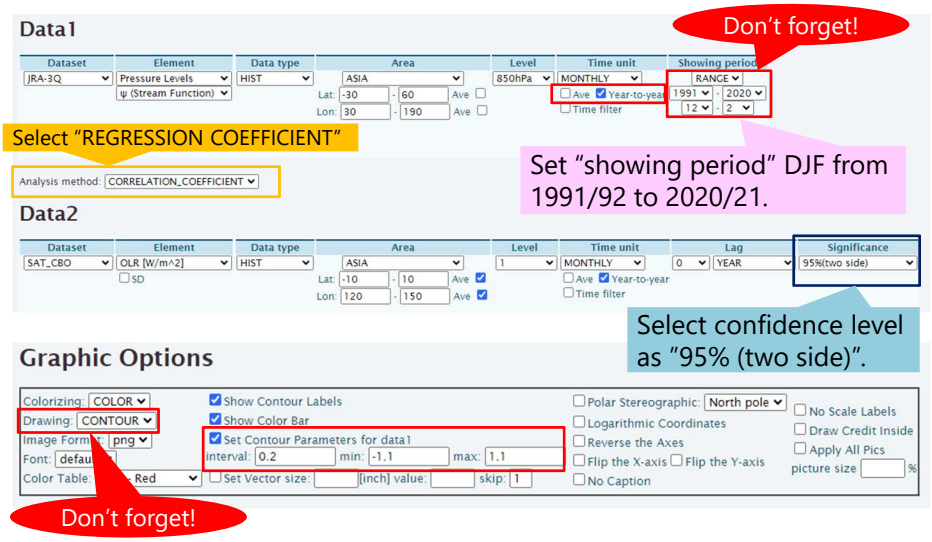
Answers to Exercise (4)



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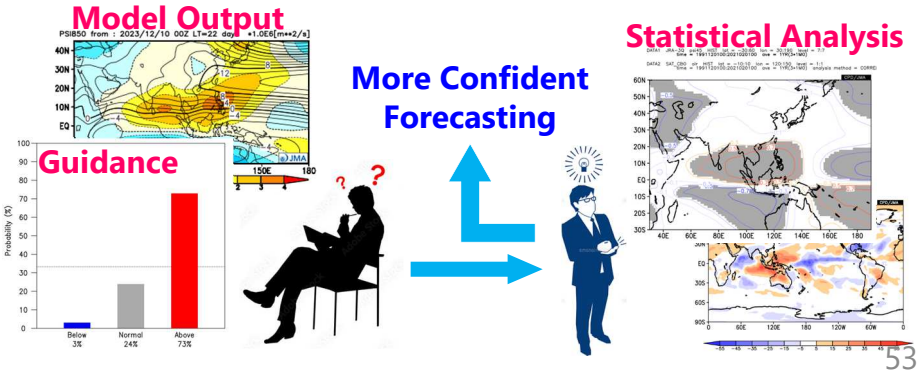
Statistical Analysis on iTacs (2)

- Correlation analysis is useful to understand a relationship between observation in your country and oceanographic and atmospheric circulation.
- It will be powerful tool for interpretation of output of seasonal forecast model and the guidance.



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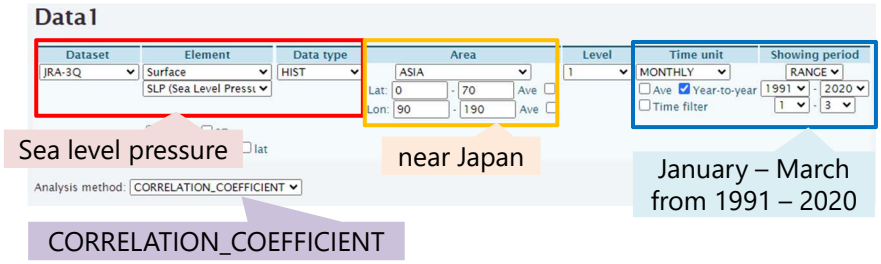
Relationship with Observation Data (1)

- Let's make a correlation coefficient map between **sea level pressure** near Japan and **observed temperature** in Tokyo/Japan for JFM from 1991 to 2020.
- Setting **SLP** in "Data1", and selecting "CORRELATION_COEFFICIENT" as analysis method.



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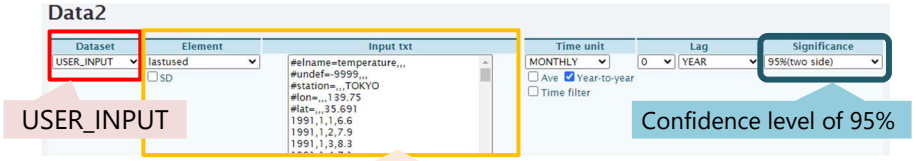
Relationship with Observation Data (2)

- Setting **observed temperature** in "Data2" utilizing "USER_INPUT" function.

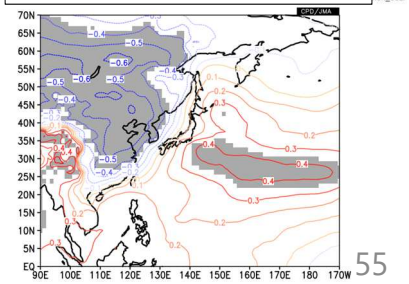


USER_INPUT

Confidence level of 95%

Upload text file of observed temperature

Correlation between SLP and observed temperature in Tokyo



- In case of above-normal temperature in Tokyo, SLP tends to increase (decrease) to the east (west) of Japan, corresponding to weaker than normal winter Asian monsoon (northwesterly wind).

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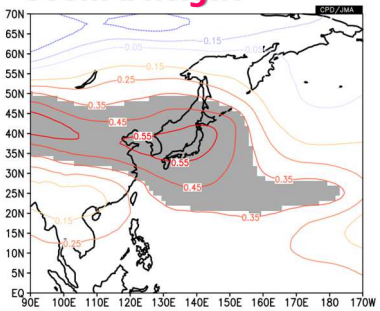
Relationship with Observation Data (3)

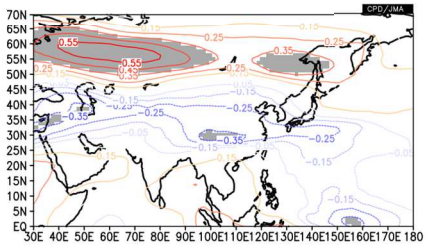
- Making maps of correlation coefficients for various elements will provide us further understanding circulation characteristics and thus the basis of seasonal forecasting.

Correlation coefficients with observed temperature in Tokyo

500hPa height



200hPa zonal wind



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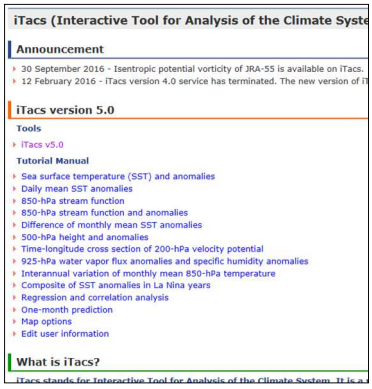
Integrated Exercise (5)

- Let's make correlation coefficient maps with observation data averaged from February to April (FMA) in your country, and make dynamical interpretation of the results.
  - Elements to calculate the correlation coefficient are optional.
  - Set text file of observation data as the observation data.
  - Although the statistical period is recommended to be set from 1991 to 2020, it can be adjusted due to missing of observation.

To learn more about iTacs

- Online help page and tutorial manual are available on the iTacs website.

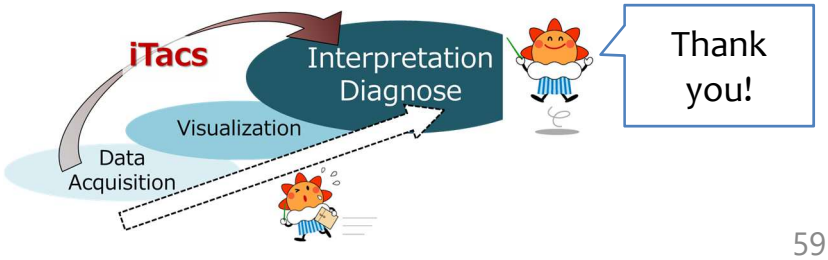
- Tutorials: https://extreme.kishou.go.jp/tool/itacs-tcc2015/
- Help page: https://extreme.kishou.go.jp/itacs5/assets/help.html



Thank you for your attention!

If you need more iTacs accounts or have any questions, please feel free to contact us.

- TCC Web Site: https://www.data.jma.go.jp/tcc/tcc/index.html
- TCC E-mail: tcc[at]met.kishou.go.jp



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- Gill, 1980: Some simple solutions for heat-induced tropical circulation. *Q.J.R. Meteorol. Soc*., **106**: 447–462.
- Hirahara, S., M. Ishii, and Y. Fukuda, 2014: Centennial-scale sea surface temperature analysis and its uncertainty. *J. Climate*, **27**, 57-75.
- Kosaka Y., S. Kobayashi, Y. Harada, C. Kobayashi, H. Naoe, K. Yoshimoto, M. Harada, N. Goto, J. Chiba, K. Miyaoka, R. Sekiguchi, M. Deushi, H. Kamahori, T. Nakaegawa, T. Y. Tanaka, T. Tokuhiro, Y. Sato, Y. Matsushita, K. Onogi, 2024: The JRA-3Q Reanalysis. *J. Meteor. Soc. Japan*, **102**. EOR.
- Kurihara, Y., T. Sakurai, and T. Kuragano, 2006: Global daily sea surface temperature analysis using data from satellite microwave radiometer, satellite infrared radiometer and in-situ observations. *Weather Service Bulletin*, **73**, Special issue, s1-s18 (in Japanese).
- Saji, N. H., B. N. Goswami, P. N. Vinayachandran, and T. Yamagata (1999), A dipole mode in the tropical Indian Ocean. *Nature*, **401**, 360-363.
- WMO 2019: WMO Statement on the State of the Global Climate in 2018, World Meteorological Organization (WMO).

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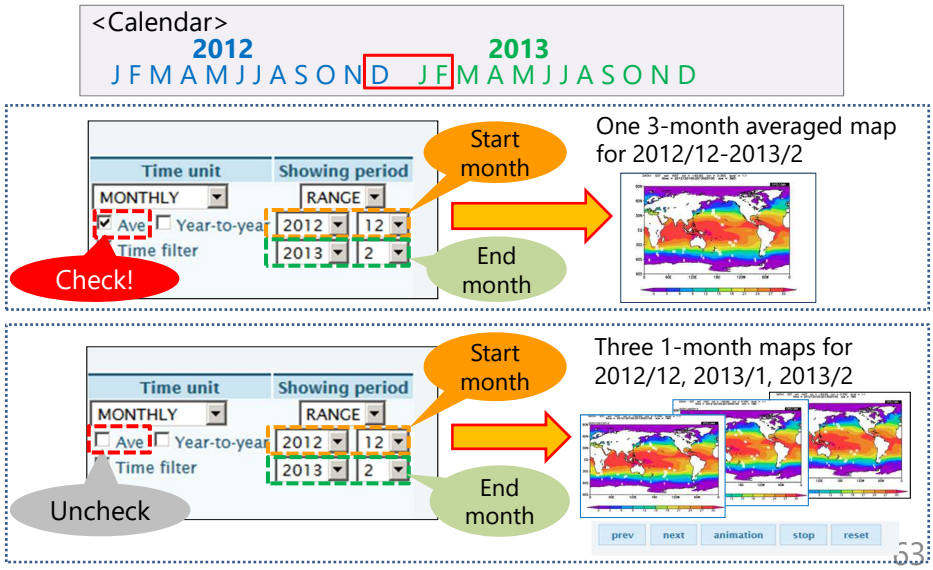
Supplement

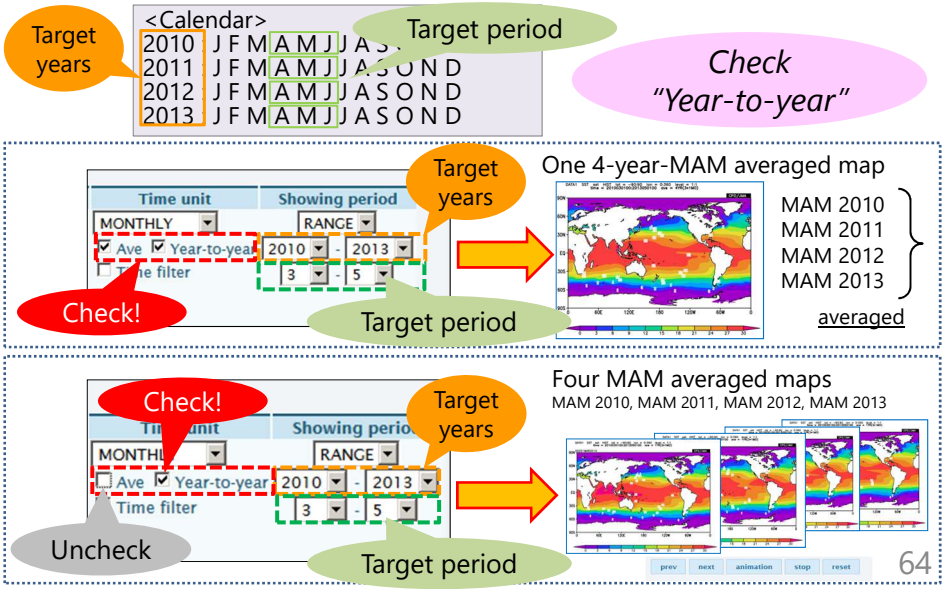
Time setting (1)

- Setting for **a consecutive period**.



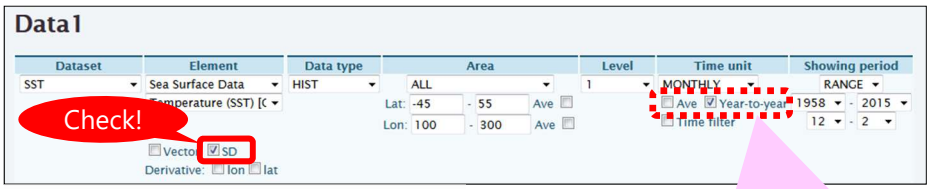
Time setting (2)

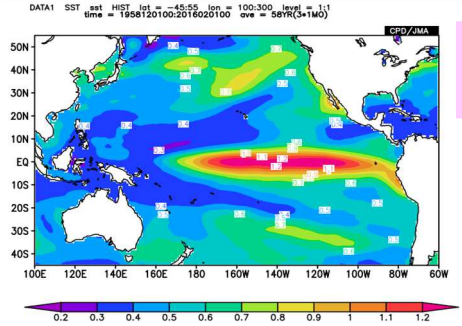
- Setting for **a specific period of each year**.



Standard deviation map

- A standard deviation map is available to see the variability of the selected element over the selected period.





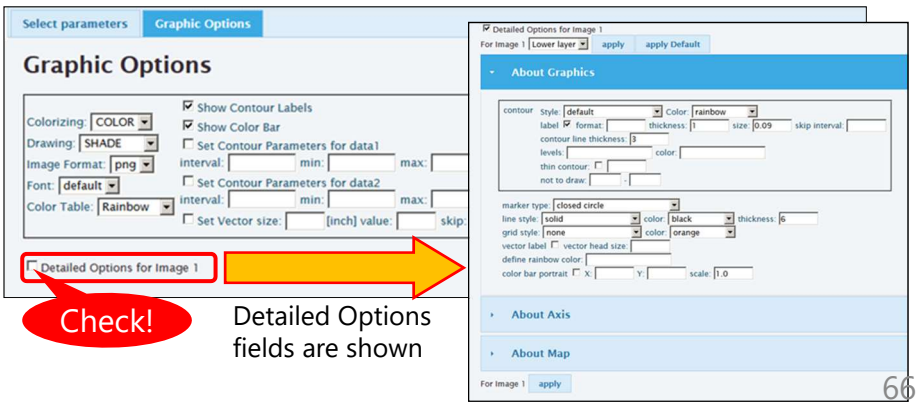
For standard deviation, don't check "Ave" box.

The standard deviation of DJF averaged SST from 1958/59 to 2015/16.

Detailed Options

・There are a lot of visual options to create maps.

- Contour : Color, thickness, style, label etc.
- Axis : Color, interval, style and others.
- Map : Color, resolution, style and others.



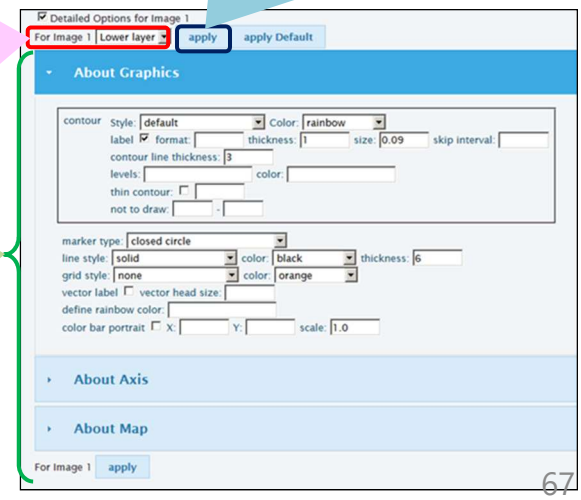
Detailed Options fields are shown

Procedure of setting detailed options

1. Select target
Lower layer: Data1
Upper layer: Data2
In the case of vector map
Lower layer: Data2
Upper layer: Data1

2. Set options
Set contour style, color, thickness, etc.

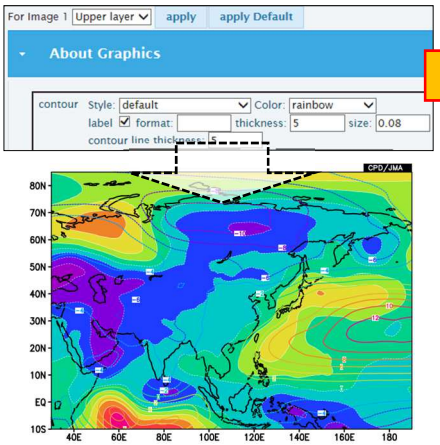
3. Apply the settings
Click the "apply" button before "Analysis Data Submit".

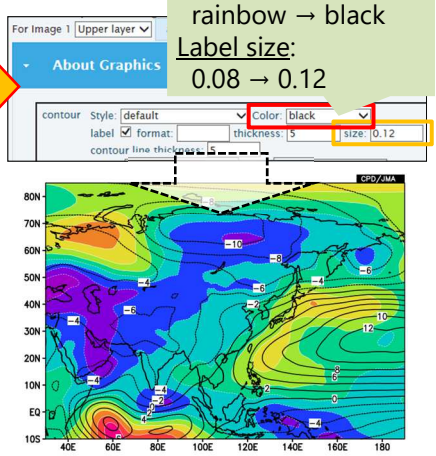


About Graphics: Contour color and label

- After selecting the layer, set color and label to change contour properties.

Color:
rainbow → black
Label size:
0.08 → 0.12





It's hard to see contours and its label because its color is similar to shade color.

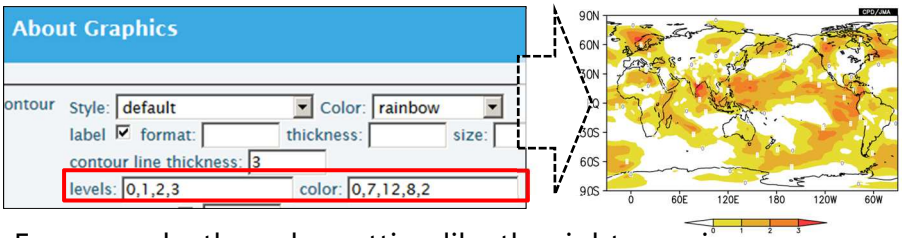
The problems are cleared.

About Graphics: Color table

- Set levels and colors separated by comma in the boxes to define the color table by yourself. The color numbers are defined as the right table.

e.g.) levels:-2,-1,0,1,2
color: 4,11,5,7,12,2

white	0
black	1
red	2
green	3
dark blue	4
light blue	5
magenta	6
yellow	7
orange	8
purple	9
yellow green	10
medium blue	11
dark yellow	12
aqua	13
dark purple	14
gray	15



For example, the color setting like the right map is more suitable to focus on the positive value.

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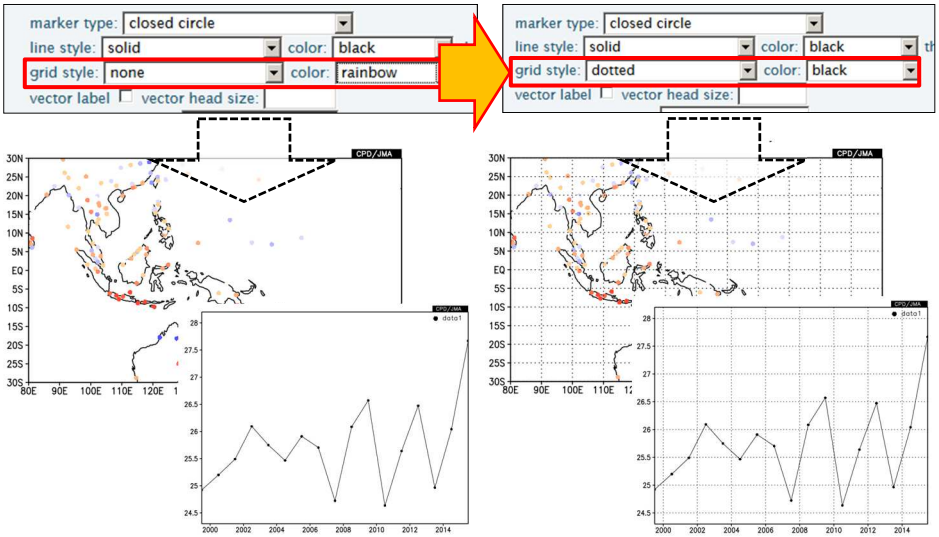
About Graphics: grid style



The grid line in the panel like the right map is available.

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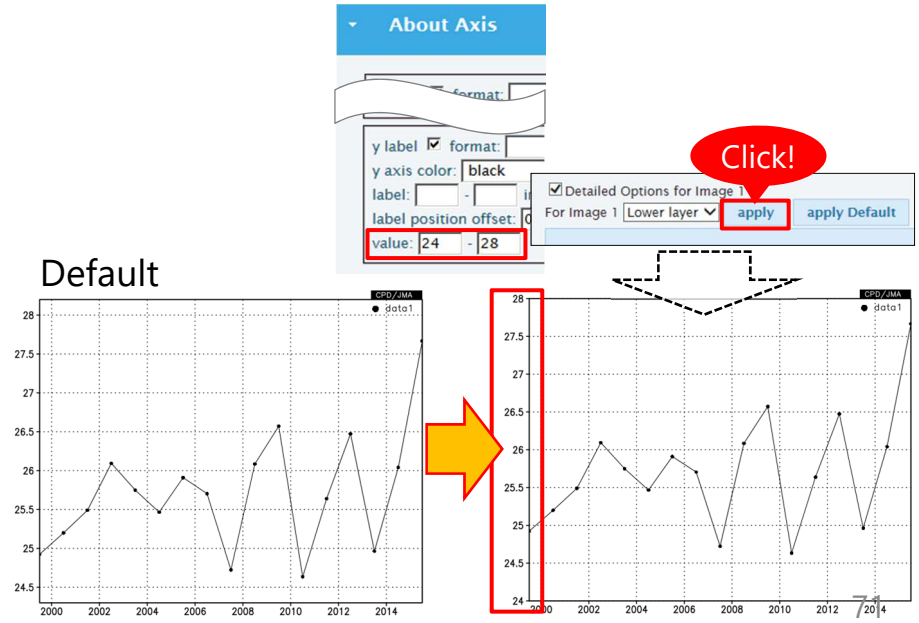
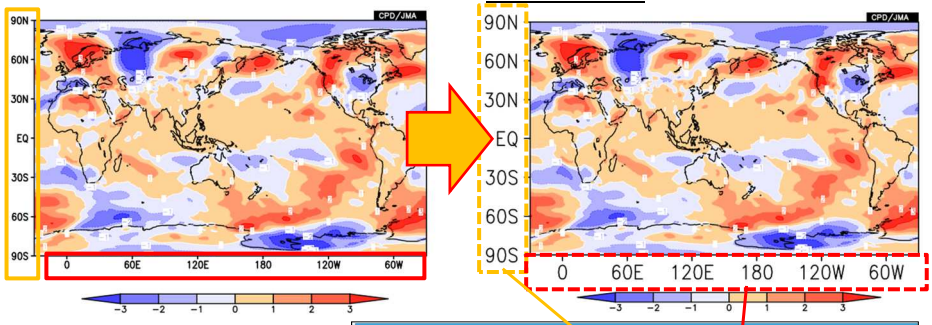
About Axis: value



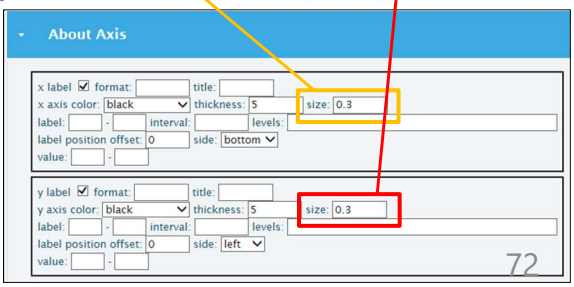
About Axis: Label size

Default size

Label size: 0.3

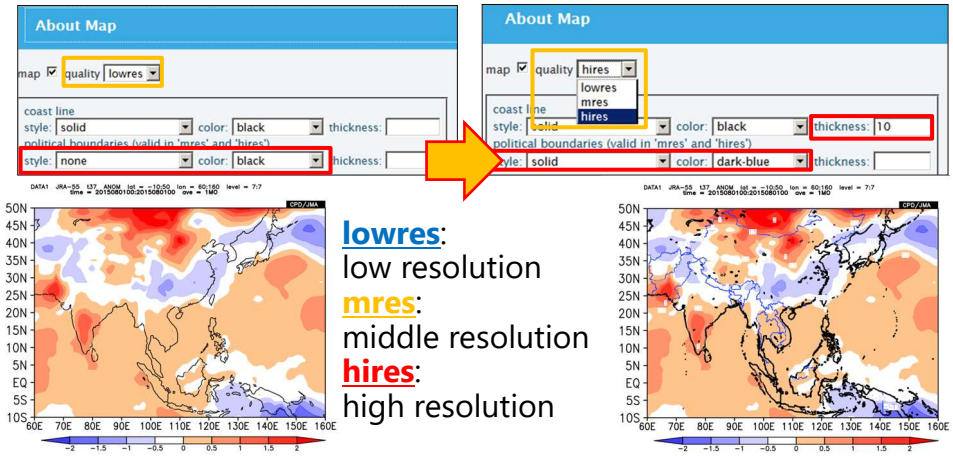


The label size is customizable in the "About Axis" box.



About Map

- Map resolution, political boundaries are customizable in the “About Map” box.



lowres: low resolution
mres: middle resolution
hires: high resolution

Quality must be set “mres” or “hires” to show political boundaries.

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Notice about detailed options

- In iTacs, **the detailed options’ settings are always saved per individual user IDs.**
  - If several people share the same iTacs ID and one of them changes some of detailed options, the changes will **influence the other people’s use** of course.
  - Users **must explicitly set** detailed options again by themselves **to return to the default settings**.
  - Unlike the other settings such as element, period, analysis method, they **cannot be shared by user parameter code**.

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