

Basic Operation of iTacs

- Interactive Tool for Analysis of the Climate System -

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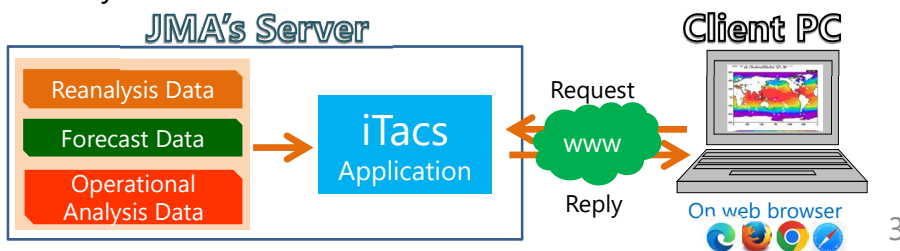
Tokyo Climate Center
Japan Meteorological Agency

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 - Correlation / Regression Analysis
 - Relationship with Observation Data
- } **29 January (today)**
- } **30 January (tomorrow)**

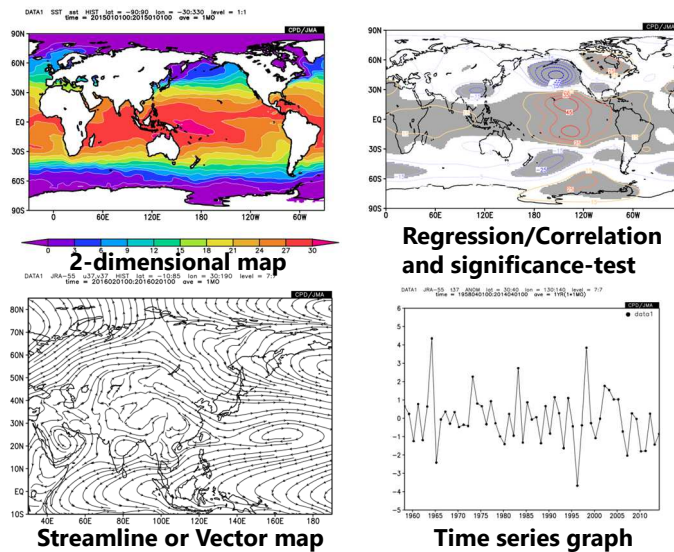
What's iTacs?

- 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.



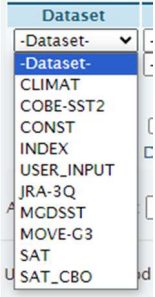
Examples

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



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 (Horizontal 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>

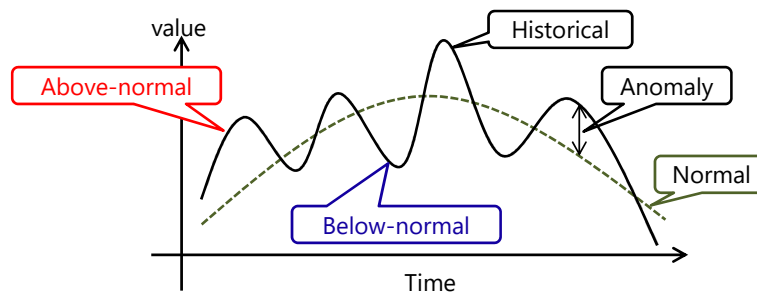
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Available data type

- Several data types are available for climate analysis.

Data type
-Data_type-
HIST
NORM
ANOM
ANOM_SD

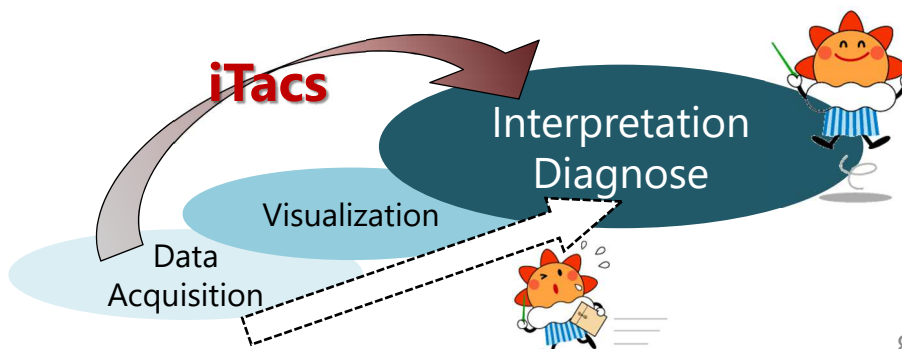
HIST	Historical actual analysis or observation data
NORM	Climatological normal data (30-year average from 1991 to 2020)
ANOM	Anomaly data (deviation from the climatological normal, i.e. HIST minus NORM)



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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.

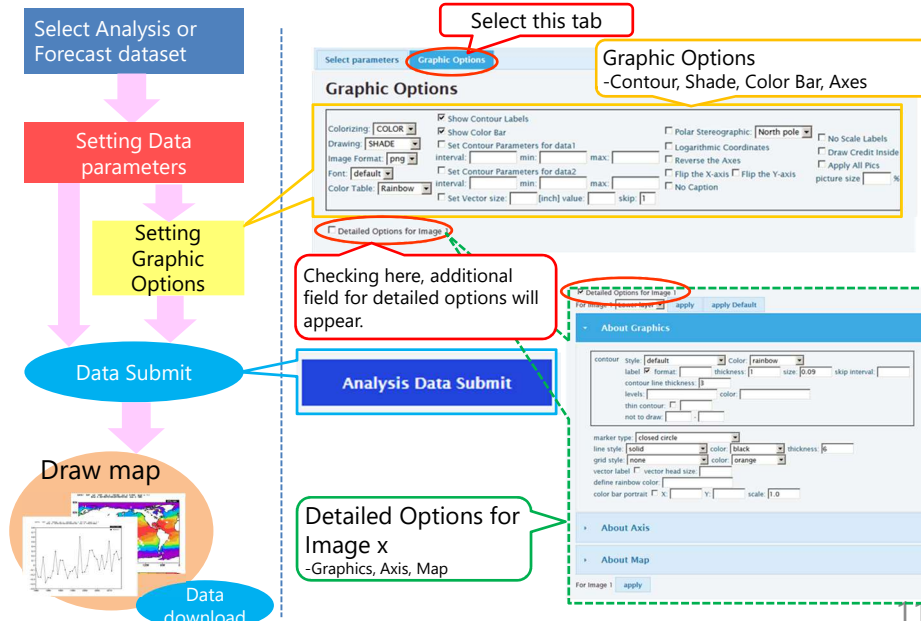
TCC website (<https://www.data.jma.go.jp/tcc/tcc/index.html>)

The screenshot shows the Tokyo Climate Center website. On the left is a navigation menu with categories like 'Home', 'World Climate', 'Climate System', 'El Niño Monitoring', 'NWP Model Prediction', and 'Global Warming'. The main content area is titled 'iTacs (Interactive Tool for Analysis of the Climate 5.0)' and includes an 'Announcement' section with dates and a 'List of datasets and elements' section. A red box highlights the 'iTacs v5.0' link. An arrow points from this link to the 'iTacs Login' page, which has fields for 'User Name' and 'Password' and a 'Login' button. A second arrow points from the login page to the 'iTacs' analysis interface, which shows 'Analysis Dataset' and 'Data1' settings.

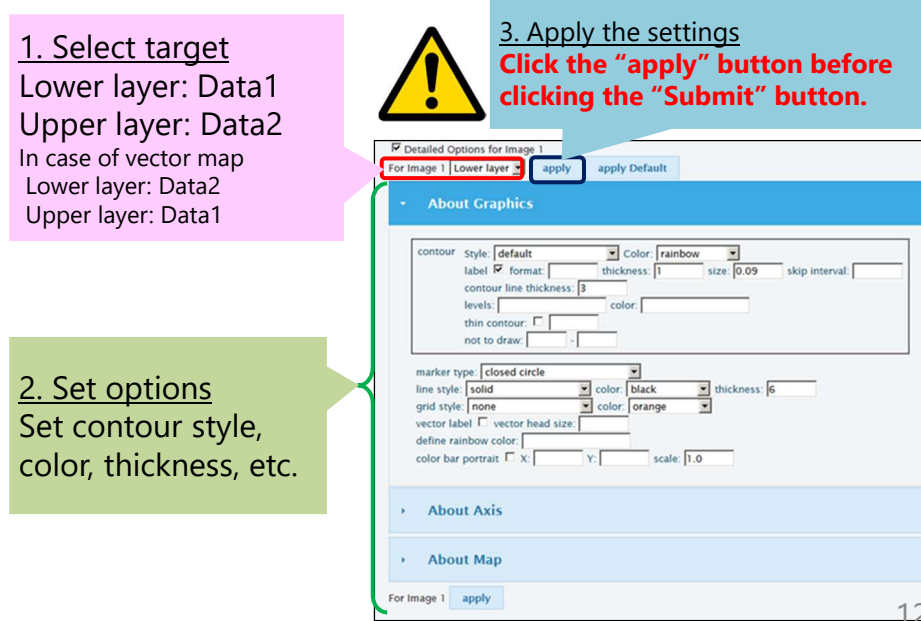
Basic operating procedure (1)

The diagram illustrates the basic operating procedure for iTacs. It consists of a vertical flow of steps on the left, connected to a screenshot of the iTacs interface on the right. The steps are: 'Select Analysis or Forecast dataset' (blue box), 'Setting Data parameters' (red box), 'Setting Graphic Options' (yellow box), 'Data Submit' (blue oval), 'Draw map' (orange oval), and 'Data download' (blue oval). The screenshot shows the 'Analysis Dataset' page with 'Data1' selected. Red and blue callouts point to 'Parameters for data setting' (Dataset, Element, Data type) and 'Chronological parameters' (Time unit, Showing period). A green callout points to 'Geographical parameters' (Area, Level). An orange callout points to 'Analysis method setting' (DATA1_DATA2, SUBTRACT, REGRESSION_COEFFICIENT etc.). A note at the bottom states 'In some cases, Data2 setting is needed.' The number '10' is in the bottom right corner of the screenshot.

Basic operating procedure (2)



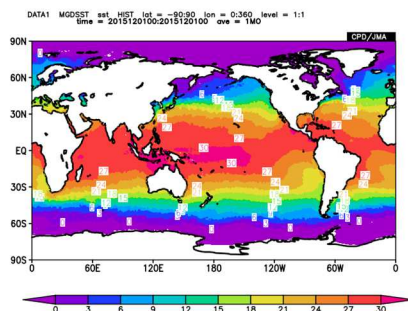
Basic operating procedure (3)



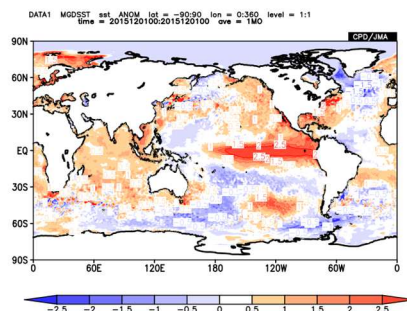
Longitude-latitude map (1)

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

SST



SST anomaly



Anomaly = Deviation from the climatological normal 13

Longitude-latitude map (2)

Data1

1	2		
Dataset	Element	Data type	Area
MGDSST	Sea Surface Data Temperature (SST) [C	HIST	ALL
		Lat: -90 - 90 Ave <input type="checkbox"/>	
		Lon: 0 - 360 Ave <input type="checkbox"/>	
<input type="checkbox"/> Vector <input type="checkbox"/> SD Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat			
Analysis method: -Analysis method-			

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.

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Longitude-latitude map (3)

Data1

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Dataset	Element	Data type	Area	Level	Time unit
MGDSST	Sea Surface Data Temperature (SST) [C	HIST	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter

Vector SD
Derivative: lon lat

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)

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Area	Level	Time unit	Showing period
ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2015 12 2015 12

Only "1" level in this case

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).

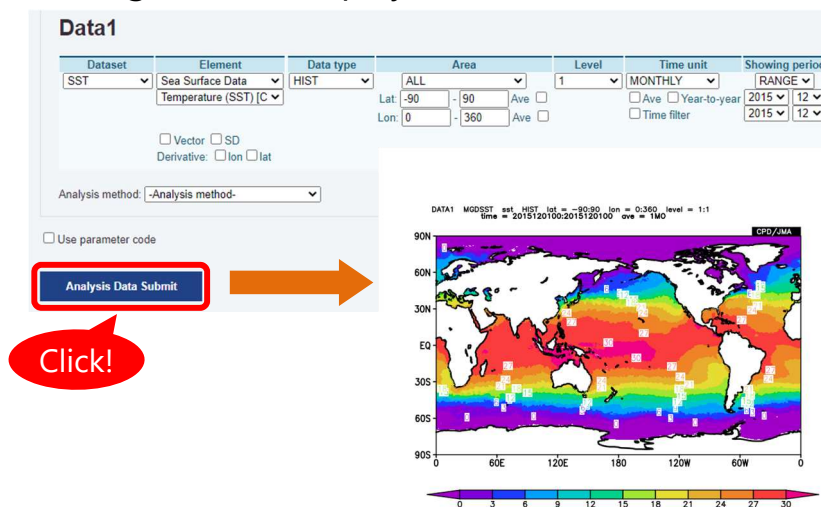
Available options are as follows:

- **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".

Click!

Analysis Data Submit

Select parameters **Graphic Options**

Graphic Options

Coloring: [COLOR] Show Contour Labels
 Drawing: [SHADE] Show Color Bar
 Image Format: [png] Set Contour Parameters for data
 Font: [default] interval: [0.5] min: [-2.5] max: [2.5]
 Color Table: [Blue - Red] Set Vector size: [] [inch] value: [] skip: [1]

Check the box and set
 Color Table: Blue - Red
 Contour Parameter:
 interval: 0.5, min: -2.5, max: 2.5

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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

Time unit: [MONTHLY] Ave Year-to-year Time filter
 Showing period: [RANGE] 2022 12 2023 2

Check!

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!

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Answer to Exercise (1)

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
MGDSST	Sea Surface Data Temperature (SST) [C]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>	1	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2022 12 2023 2

Vector SD
Derivative: lon lat

Graphic Options

Colorizing: COLOR Show Contour Labels
 Drawing: SHADE Show Color Bar
 Image Format: png Set Contour Parameters for data1
 Font: default interval: 0.5 min: -2.5 max: 2.5
 Color Table: Blue - Red Set Vector size: [] [inch] value: [] skip: []

Check!

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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.

Upper: Start of Period
Bottom: End of Period

prev next animation stop reset

You can display each map with these options as appropriate.

Time unit: MONTHLY
 Ave Year-to-year
 Time filter

Showing period: RANGE
2022 12
2023 2

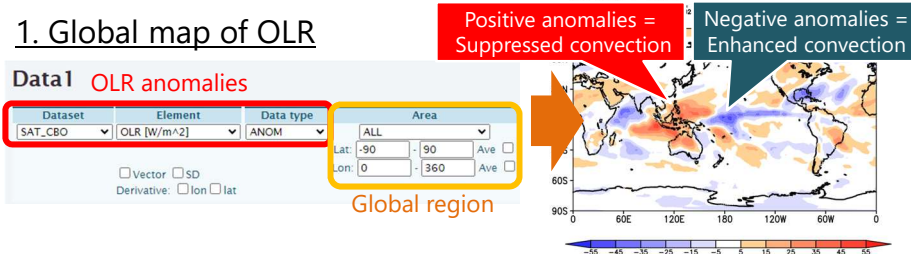
Unchecked!

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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

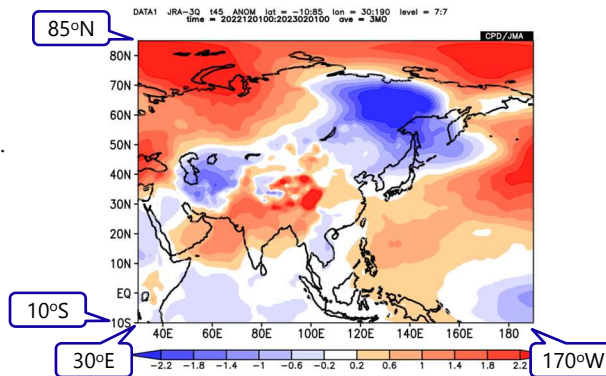


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Exercise (2)

- 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"



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Answer: Exercise (2)

Analysis Dataset

Select parameters
Graphic Options

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-3Q	Pressure Levels T (Temperature) [C.F]	ANOM	ASIA Lat: -10 - 85 Ave <input type="checkbox"/> Lon: 30 - 190 Ave <input type="checkbox"/>	850hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2022 12 2023 2

Vector SD
Derivative: lon lat

Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	<input type="checkbox"/> Polar Stereographic: North pole	<input type="checkbox"/> No Scale Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar	<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Draw Credit Inside
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Apply All Pics
Font: default	Interval: 0.4 min: -2.2 max: 2.2	<input type="checkbox"/> Flip the X-axis	<input type="checkbox"/> Flip the Y-axis
Color Table: Blue - Red	<input type="checkbox"/> Set Vector size: (inch) value: skip: 1	<input type="checkbox"/> No Caption	picture size: %

Lat : -10 – 85
(10S) (85N)

Lon: 30 – 190
(30E) (170W)

850hPa

Select "Blue-Red" color table.

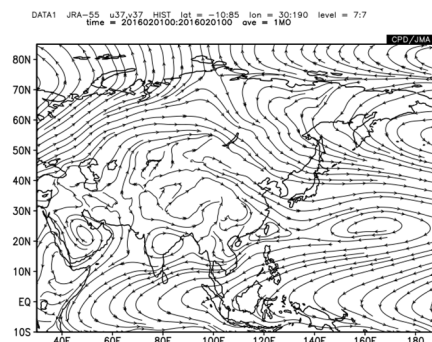
Set these boxes as follows
interval: 0.4, min: -2.2, max: 2.2

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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



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Stream-line map (2)

Dataset	Element
JRA-3Q	Pressure Levels
	U (Zonal Wind) [m/s]

Vector SD
Derivative: lon lat

➔

Dataset	Element
JRA-3Q	Pressure Levels
	U (Zonal Wind) [m/s]
	V (Meridional Wind)

x: Stream line
 Vector SD
Derivative: lon lat

Boxes for Y-component will appear

Area	Level	Time unit	Showing period
ASIA	850hPa	MONTHLY	RANGE
Lat: -10 - 85 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2018 2
Lon: 30 - 190 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2018 2

DATA1 JRA-55 37.37 HST lat = -10.85 lon = 30.190 level = 7.7
time = 2016020100:2016020100 ave = 1M0

Inter-annual time series (1)

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

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT_CBO	OLR [W/m^2]	ANOM	ASIA		MONTHLY	RANGE
			Lat: -10 - 10 Ave <input checked="" type="checkbox"/>		<input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year	1991 - 2023
			Lon: 120 - 150 Ave <input checked="" type="checkbox"/>		<input type="checkbox"/> Time filter	2 - 4

Vector SD
Derivative: lon lat

Check!

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.)

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
```

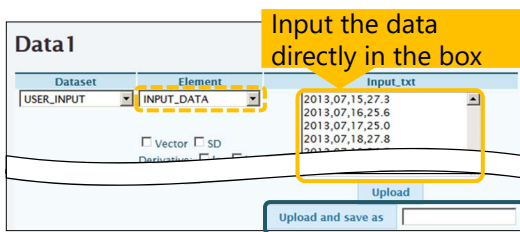
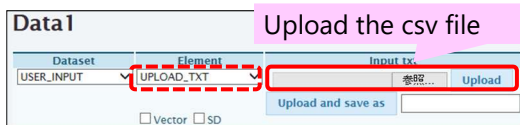
<CSV Data format>

- **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.

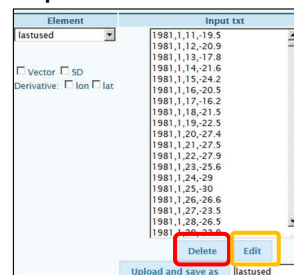
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Using user input data (2)

- Upload/input the data
- Control the uploaded 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.



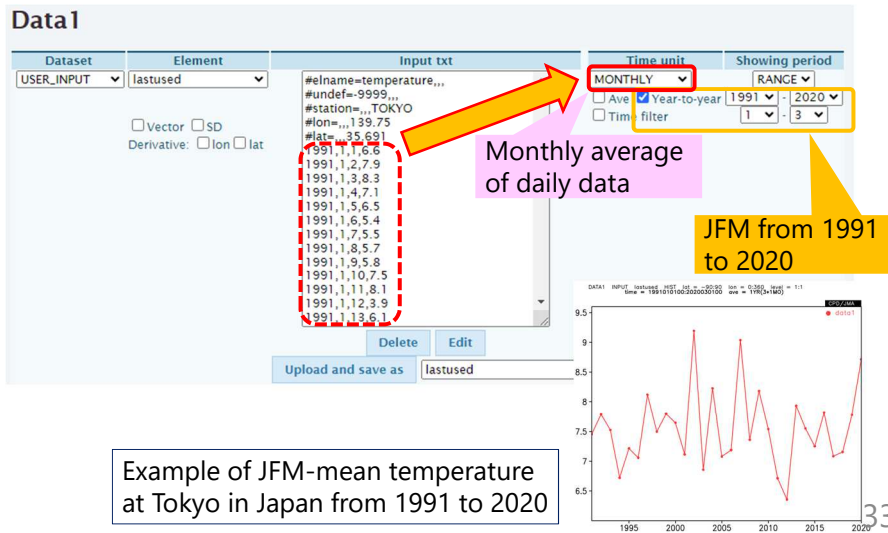
- Select the data name and click "Delete" button to delete the data from the server.
- Click "Edit" button to edit the data in the box.

Don't forget!

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Using user input data (3)

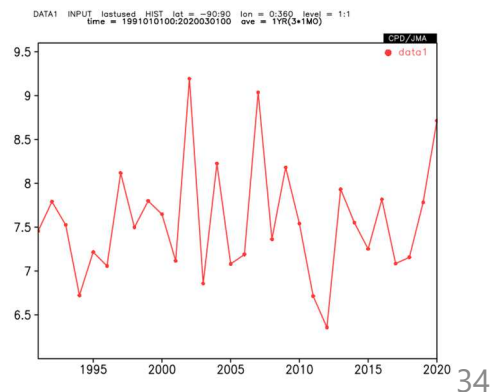
- Daily and monthly averages of input daily data are calculated in iTacs.



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)

UPLOAD_TXT Upload a text file

Data 1

Dataset	Element	Input txt	Time unit	Showing period
USER_INPUT	UPLOAD_TXT	ファイルを選択 選択されていません Upload	DAILY	RANGE
		Upload and save as	<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2024 1 1
	<input type="checkbox"/> Vector <input type="checkbox"/> SD		<input type="checkbox"/> Time filter	2024 1 1
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat			

↓

JFM in each year

Data 1

Dataset	Element	Input txt	Time unit	Showing period
USER_INPUT	lastused	#elname=temperature,, #undef=-9999,, #station=,,TOKYO #lon=,,139.75 #lat=,,35.691 1991,1,1,6.6 1991,1,2,7.9 1991,1,3,8.3 1991,1,4,7.1	MONTHLY	RANGE
	<input type="checkbox"/> Vector <input type="checkbox"/> SD		<input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year	1991 - 2020
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat		<input type="checkbox"/> Time filter	1 - 3

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Advanced Operation of iTacs

- Interactive Tool for Analysis of the Climate System -


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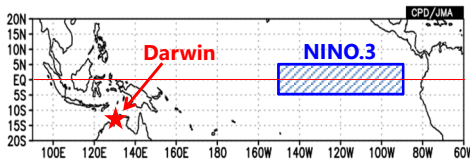
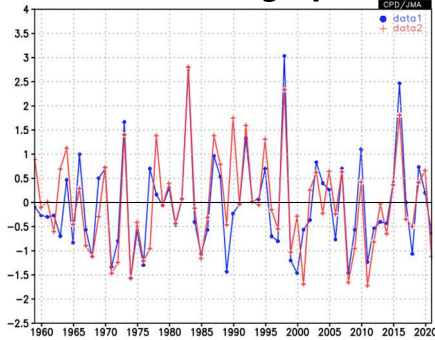
Statistical Analysis on iTacs (1)

- 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.*

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.

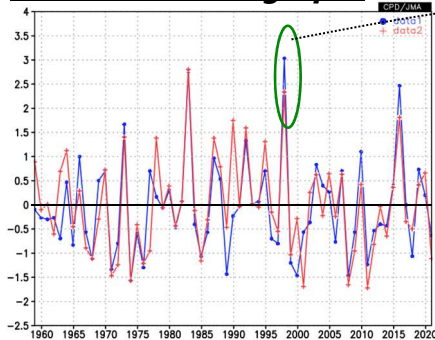
Next step is...

How can we evaluate the relationship objectively and quantitatively?

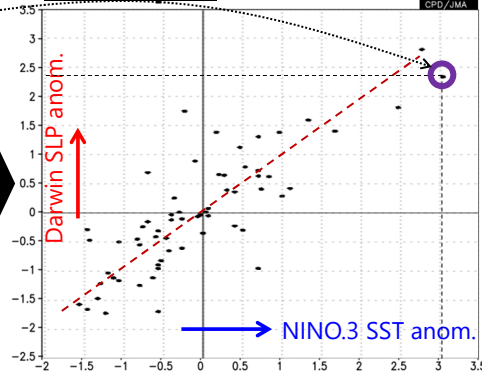
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Tips: Correlation analysis

Time series (line graph)



Scatter plot



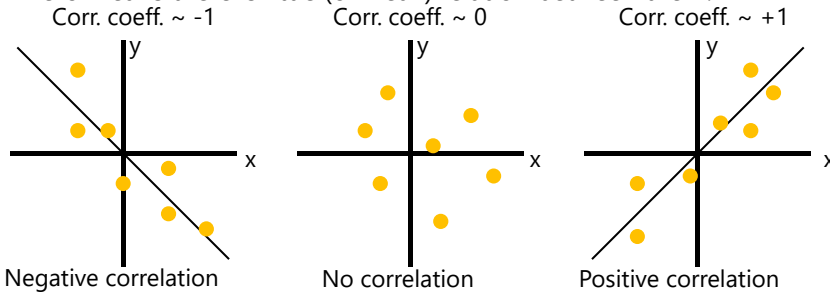
Considering mapping **each pair** of NINO.3 SST and Darwin's SLP values onto **a point** on a x-y map, we can clearly see a **linear relation** between them. We can evaluate the relationship with the **correlation coefficient**, which implies **how close they have a linear relationship**.

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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.



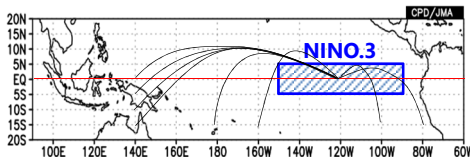
Correlation does not imply causality!

If there is a significant correlation between X and Y
 $X \rightarrow Y$ $Y \rightarrow X$ $X \rightleftarrows Y$ $Z \rightarrow X$ $Z \rightarrow Y$? ?
 X causes Y Y causes X Feedback Unknown Z causes both X and Y ? ? 41

Correlation Analysis (1)

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

*Next Question: 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".

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-3Q	Surface SLP (Sea Level Press)	HIST	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1991 - 2020 12 - 2

"Year-to-year" must be checked in correlation and regression analysis.

This setting means DJF average
from 1991/1992 (December 1991 to February 1992)
to 2020/2021 (December 2020 to February 2021).
Consider the setting for year and month separately.

Analysis method: CORRELATION_COEFFICIENT

Select "CORRELATION_COEFFICIENT".

Data2

Dataset	Element	Data type	Time unit	Lag	Significance
INDEX	NINO.3 <input type="checkbox"/> SD	HIST	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	0 YEAR	95%(two side)

"Data2" lags set period behind "Data1".

Statistical significance shown in the map is based on the Student's *t*-test.

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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.

Graphic Options

Colorizing: COLOR

Drawing: CONTOUR

Image Format: png

Color Table: Blue - Red

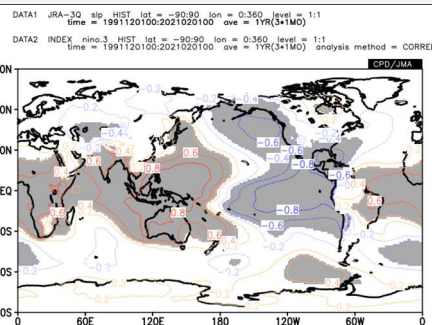
Show Contour Labels

Show Color Bar

Set Contour Parameters for data1
interval: 0.2 min: -1 max: 1

Set Vector size: [] [inch] value: [] skip: []

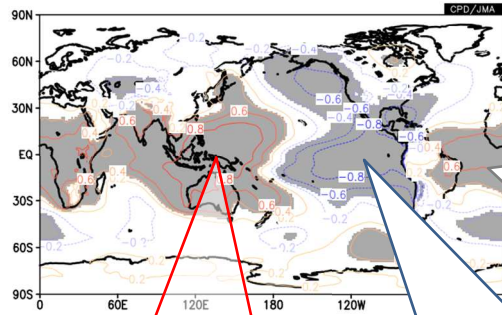
Don't forget!



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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.**

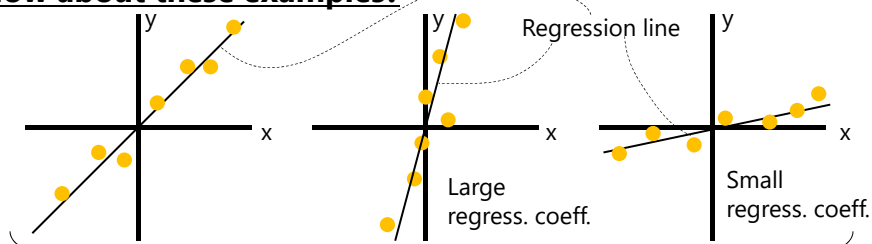
SLPs tend to increase associated with positive NINO.3. The red contours indicate positive values of correlation coefficients. Simply stated, **positive (negative)** SLP anomalies during **El Niño (La Niña)**.

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. $\sim +1$ 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".

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-3Q	Surface SLP (Sea Level Pressi	HIST	ALL	1	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1991 - 2020 12 - 2

"Year-to-year" must be checked in correlation and regression analysis.

This setting means DJF average from 1991/1992 (December 1991 to February 1992) to 2020/2021 (December 2020 to February 2021). Consider the setting for year and month separately.

Analysis method: REGRESSION_COEFFICIENT

Select "REGRESSION_COEFFICIENT".

Data2

Dataset	Element	Data type	Time unit	Lag	Significance
INDEX	NINO.3 <input type="checkbox"/> SD	HIST	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	0 YEAR	95%(two side)

"Data2" lags set period behind "Data1".

Statistical significance shown in the map is based on the Student's *t*-test.

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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.

Graphic Options

Colorizing: COLOR Show Contour Labels

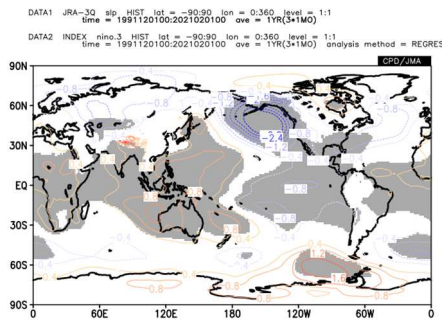
Drawing: CONTOUR Show Color Bar

Image Format: png Set Contour Parameters for data1

Interval: 0.4 min: -2.8 max: 2.8

Color Table: Blue - Red Set Vector size: [inch] value: skip: 1

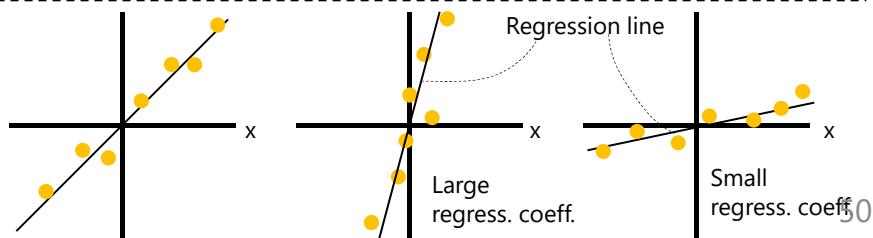
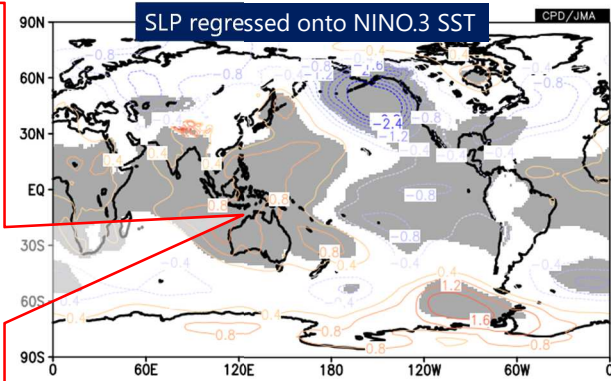
Don't forget!



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Regression Analysis (4)

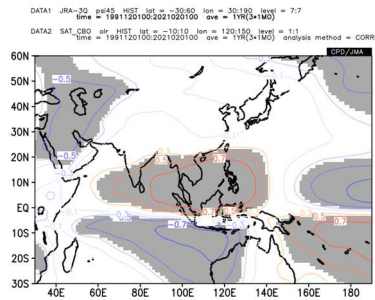
This regression coefficient is +0.8. This means SLP tends to be +0.8hPa higher than normal here when NINO.3 SST index is +1.0 higher than normal. Recall that regression coefficients are the slope of regression lines, $\Delta y/\Delta x$. In this case, x is NINO.3 SST index and y is SLP.



Exercise (4)

- Make a correlation coefficient map of 850hPa stream function (ψ_{850}) 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 ψ_{850} onto area-averaged OLR



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Answers to Exercise (4)

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-3Q	Pressure Levels ψ (Stream Function)	HIST	ASIA Lat: -30 -60 Ave <input type="checkbox"/> Lon: 30 -190 Ave <input type="checkbox"/>	850hPa	MONTHLY	RANGE <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year 1991 - 2020 <input type="checkbox"/> Time filter 12 - 2

Don't forget!

Select "REGRESSION COEFFICIENT"

Analysis method: CORRELATION_COEFFICIENT

Set "showing period" DJF from 1991/92 to 2020/21.

Data2

Dataset	Element	Data type	Area	Level	Time unit	Lag	Significance	
SAT_CBO	OLR [W/m ²] SD	HIST	ASIA Lat: -10 -10 Ave <input checked="" type="checkbox"/> Lon: 120 -150 Ave <input checked="" type="checkbox"/>	1	MONTHLY	0	YEAR <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	95%(two side)

Select confidence level as "95% (two side)".

Graphic Options

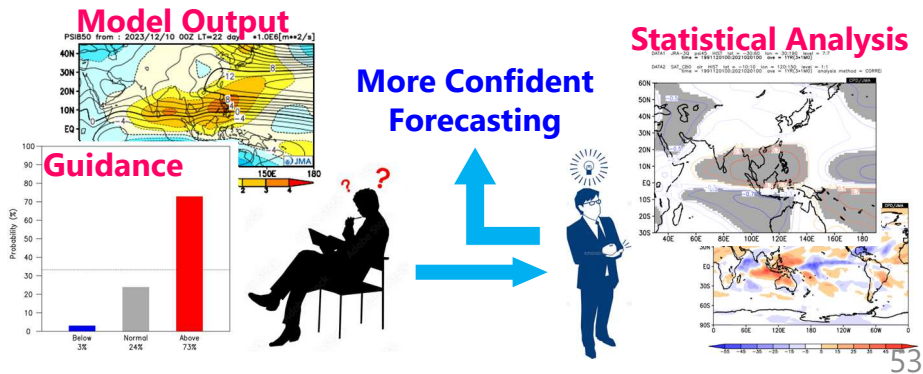
Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	<input type="checkbox"/> Polar Stereographic: North pole	<input type="checkbox"/> No Scale Labels
Drawing: CONTOUR	<input checked="" type="checkbox"/> Show Color Bar	<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Draw Credit Inside
Image Form: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1 interval: 0.2 min: -1.1 max: 1.1	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Apply All Pics picture size: %
Font: default	<input type="checkbox"/> Set Vector size: [inch] value: skip: 1	<input type="checkbox"/> Flip the X-axis <input type="checkbox"/> Flip the Y-axis	<input type="checkbox"/> No Caption

Don't forget!

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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.



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.

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-3Q	Surface SLP (Sea Level Press)	HIST	ASIA Lat: 0 - 70 Ave Lon: 90 - 190 Ave	1	MONTHLY	RANGE Ave <input checked="" type="checkbox"/> Year-to-year 1991 - 2020 Time filter 1 - 3

Sea level pressure lat

near Japan

Analysis method: CORRELATION_COEFFICIENT

CORRELATION_COEFFICIENT

January – March from 1991 – 2020

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Relationship with Observation Data (2)

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

Data2

Dataset	Element	Input txt	Time unit	Lag	Significance
USER_INPUT	lastused	#elname=temperature,... #undef=-9999... #station=, TOKYO #lon=, 139.75 #lat=, 35.691 1991, 1, 1, 6.6 1991, 1, 2, 7.9 1991, 1, 3, 8.3	MONTHLY	0	95%(two side)

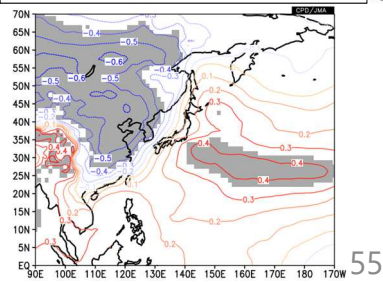
USER_INPUT

Confidence level of 95%

Upload text file of observed temperature

Correlation between SLP and observed temperature in Tokyo

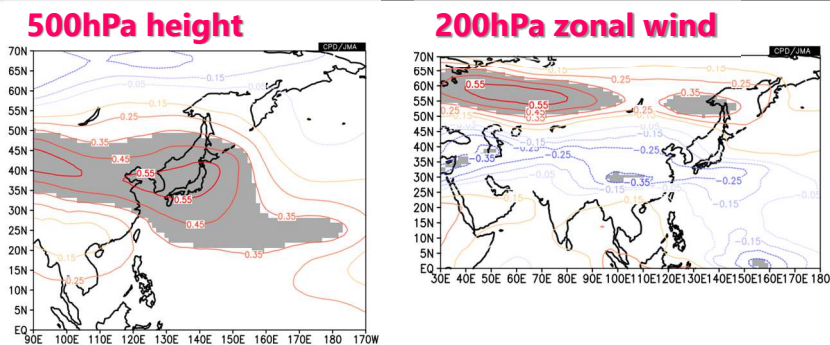
- In case of above-normal temperature in Tokyo, SLP tends to increase (decrease) to the east (west) of Japan, corresponding to weaker than normal winter Asian monsoon (northwesterly wind).



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



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.

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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>

iTacs (Interactive Tool for Analysis of the Climate System)

Announcement

- 30 September 2016 - Isentropic potential vorticity of JRA-55 is available on iTacs.
- 12 February 2016 - iTacs version 4.0 service has terminated. The new version of iTacs is available.

iTacs version 5.0

Tools

- iTacs v5.0
- Tutorial Manual**
 - Sea surface temperature (SST) and anomalies
 - Daily mean SST anomalies
 - 850-hPa stream function
 - 850-hPa stream function and anomalies
 - Difference of monthly mean 850-hPa temperature
 - 500-hPa height and anomalies
 - Time-longitude cross section of 200-hPa velocity potential
 - 825-hPa water vapor flux anomalies and specific humidity anomalies
 - Interannual variation of monthly mean 850-hPa temperature
 - Composite of SST anomalies in La Nina years
 - Regression and correlation analysis
 - One-month prediction
 - Map options
 - Edit user information

What is iTacs?

iTacs stands for Interactive Tool for Analysis of the Climate System. It is a...

Online help for iTacs

top | Select parameters | Dataset | Element | Data type | Area | Level | Average period | Showing period | Analysis method | Color bar sample | Credits/Options | Detailed Options for Users | number of grid points for dataset | format for USER INPUT

Dataset

データセットを選択します。観測データや再分析データが利用可能です。Select the "Dataset" pull-down menu. JRA-55, SST and a variety of other datasets are available.

USER INPUTでは、ユーザーが任意のデータセットを選択することが出来ます。ユーザーが任意の形式のファイルで任意のデータをアップロードしてご利用いただけます。任意のJRA-55, SST, reanalysis, satellite, etc. uploadが可能です。Any time series data can be uploaded and used. There are two ways to set data.

- UPLOAD TEXT: Data come from an uploaded text file.
- INPUT DATA: Data are directly entered in the box.

See [format for USER INPUT](#).

Element

データの要素を選択します。Select "element1" or "element2". Available choices will be shown in each pull-down menu depending on the dataset selected.

要素が少い場合は、次で示すようにelement1, element2を選択する必要があります。To enable vector map drawing, the "Vector" box must be checked. Another pull-down menu is then displayed to allow selection of another element. Select the X and Y components of the vector from the first and second menus, respectively. Stream-line is available except when the map area contains a pole.

また、%の値で任意のスケールに任意の数値を入力することにより、Yの値にその指定した数値をかけた値を表示します。The value in the "%" box is the multiple scale of the coefficient for the Y component. The default setting is 1.0.

SDのチェックボックスは、標準偏差マップの表示を可能にします。Vectorマップの表示を可能にするには、Vectorのチェックボックスをオンにする必要があります。If the "SD" box is checked, a standard deviation map is provided to show the variability of the selected element. The "SD" and "Vector" boxes cannot be set at the same time.

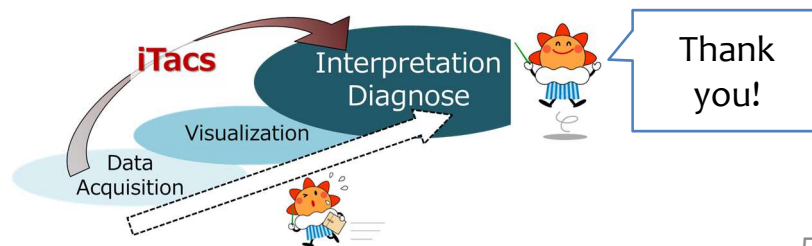
Derivativeのチェックボックスは、任意の数値を入力することにより、Yの値にその指定した数値をかけた値を表示します。A derivative map is also provided to show the derivative (rate of variability or gradient) for the meridional ("lat") or zonal ("lon") direction of the selected element.

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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.
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- 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.
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- 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**.

<Calendar>
 2012 J F M A M J J A S O N D 2013 J F M A M J J A S O N D

Time unit: MONTHLY, Showing period: RANGE

Time filter: Ave, Year-to-year

Start month: 2012, 12; End month: 2013, 2

One 3-month averaged map for 2012/12-2013/2

Time filter: Ave, Year-to-year

Start month: 2012, 12; End month: 2013, 2

Three 1-month maps for 2012/12, 2013/1, 2013/2

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Time setting (2)

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

<Calendar>

Target years: 2010, 2011, 2012, 2013

Target period: MAM

Check "Year-to-year"

Time unit: MONTHLY, Showing period: RANGE

Time filter: Ave, Year-to-year

Target years: 2010 - 2013; Target period: 3 - 5

One 4-year-MAM averaged map

MAM 2010, MAM 2011, MAM 2012, MAM 2013 averaged

Time unit: MONTHLY, Showing period: RANGE

Time filter: Ave, Year-to-year

Target years: 2010 - 2013; Target period: 3 - 5

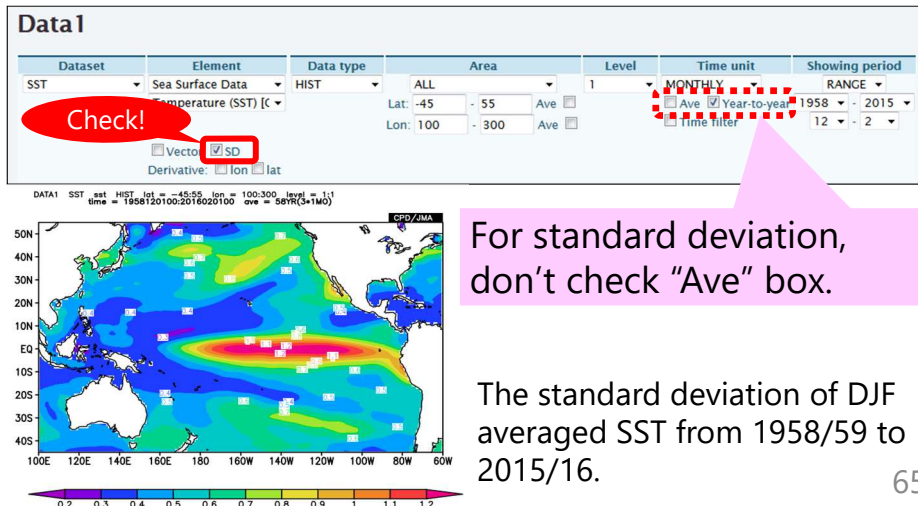
Four MAM averaged maps

MAM 2010, MAM 2011, MAM 2012, MAM 2013

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Standard deviation map

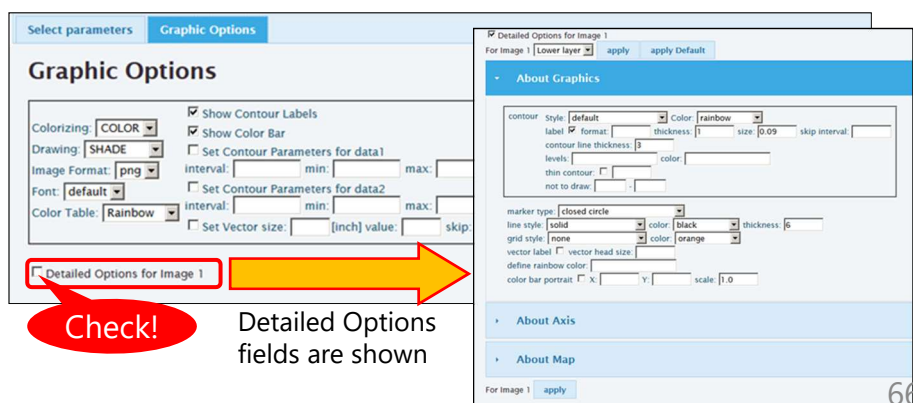
- A standard deviation map is available to see the variability of the selected element over the selected period.



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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.



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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

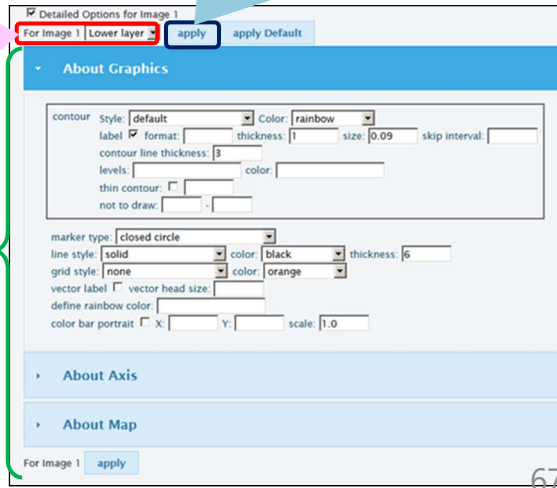


3. Apply the settings

Click the "apply" button before "Analysis Data Submit".

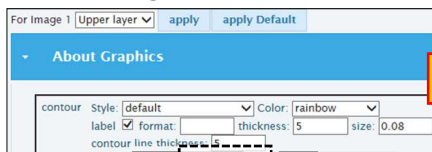
2. Set options

Set contour style, color, thickness, etc.

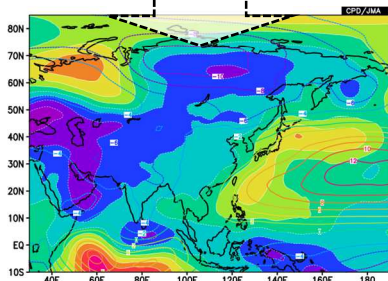
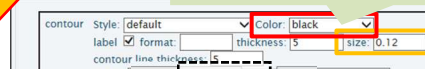


About Graphics: Contour color and label

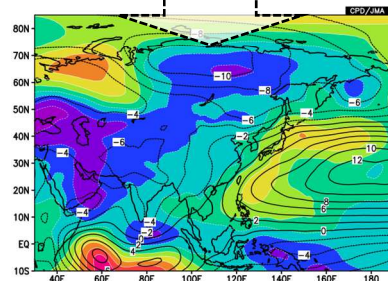
- After selecting the layer, set color and label to change contour properties.



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

About Graphics

contour Style: Color:

label format: thickness: size:

contour line thickness:

levels: color:

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

marker type:

line style: color:

grid style: color:

vector label vector head size:

➔

marker type:

line style: color:

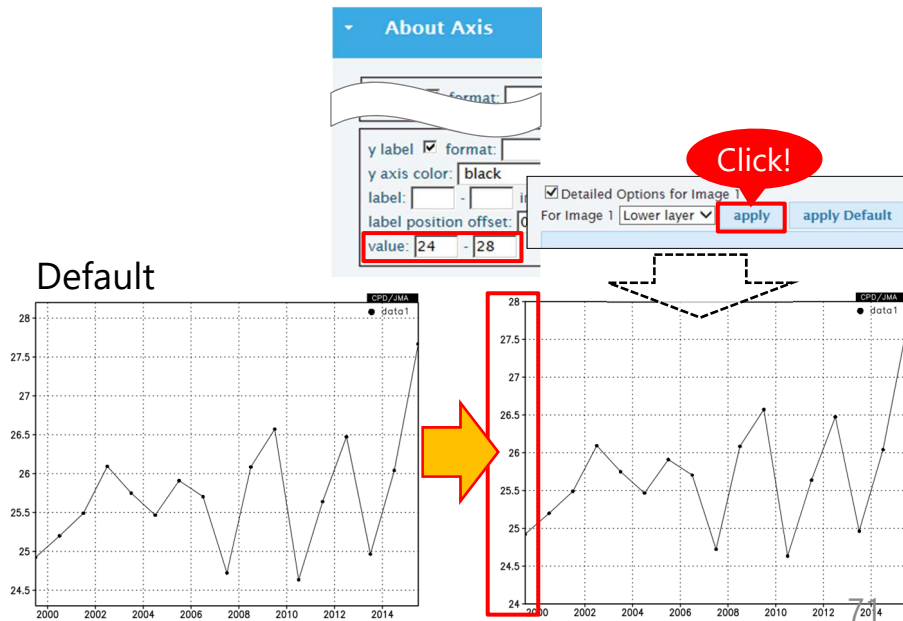
grid style: color:

vector label vector head size:

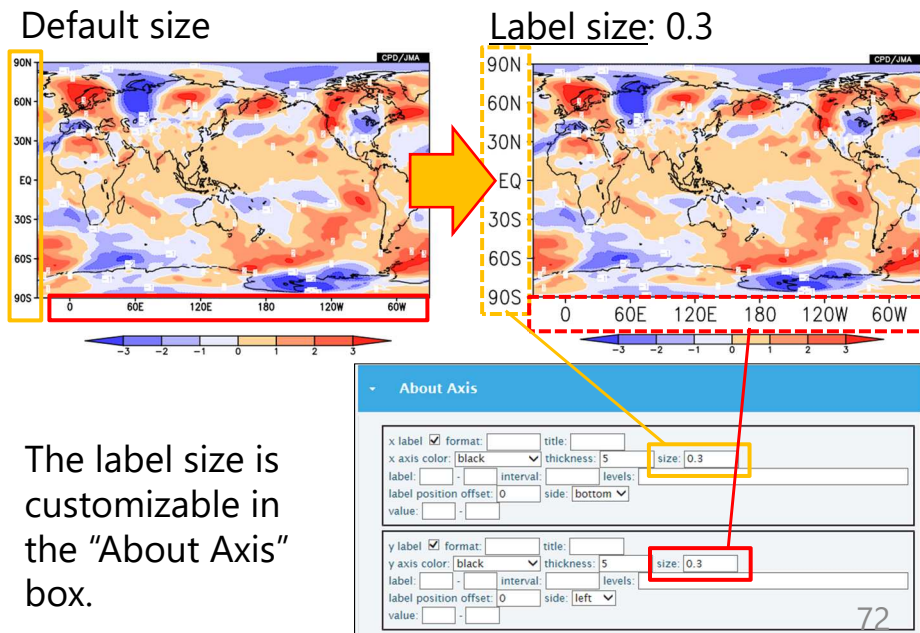
The grid line in the panel like the right map is available.

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About Axis: value



About Axis: Label size



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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