



気象庁

Japan Meteorological Agency

TCC seminar,  
16:20–18:00, 25 November 2019,  
Tokyo, Japan

# Introduction and operation of iTacs

- Interactive Tool for Analysis of the Climate System -

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Japan Meteorological Agency

# Contents

## 1. What's iTacs?

## 2. Basic operations -Horizontal map-

- ❑ Access to iTacs
- ❑ Basic operating procedure
- ❑ Longitude-latitude map
- ❑ Multiple data

## 3. Basic operations -Other kinds of maps-

- ❑ Vertical and latitude/longitude profile
- ❑ Cross section diagram

## 4. Statistical Analysis in iTacs

- ❑ Introduction
- ❑ Correlation / Regression Analysis
- ❑ Composite Analysis

## 5. Other Advanced operations

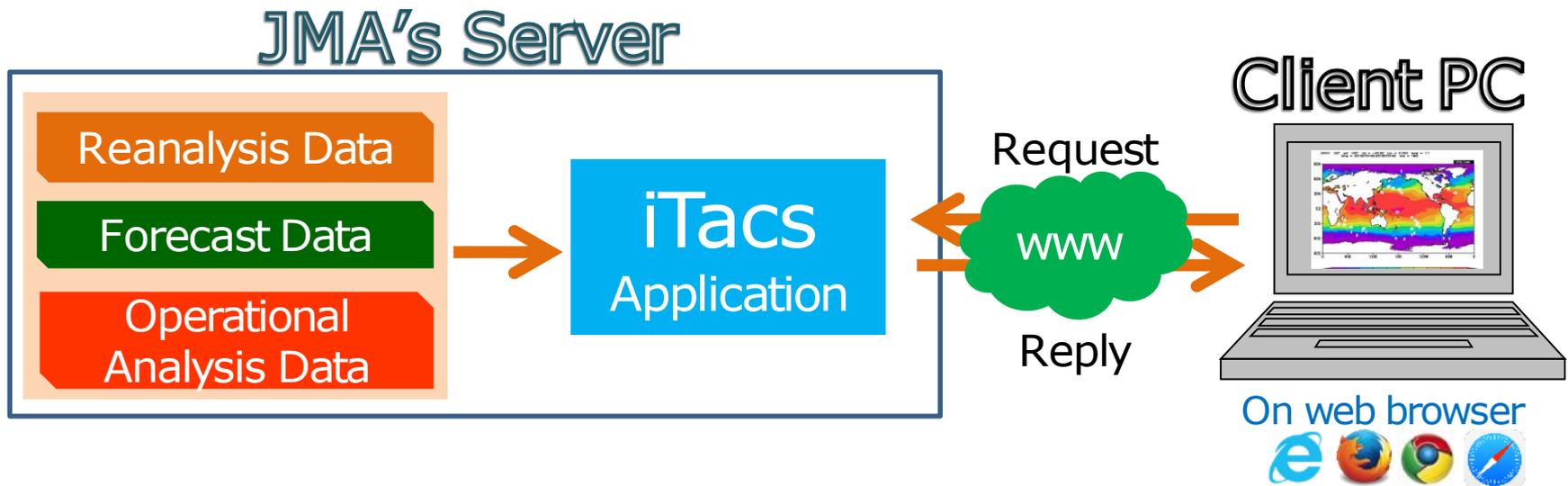
- ❑ Data download
- ❑ User data input

Basic  
25 Nov.

Advanced  
26 Nov.

# What's iTacs?

- iTacs stands for “Interactive Tool for Analysis of the Climate System”.
- Available on web browsers through Graphical User Interface (GUI) with personal IDs.
- Only NMHS staff can use iTacs.
- No additional software or plug-ins are required in user's client PCs.



# Available dataset and period

## Atmospheric analysis dataset

JRA-55	1958~	The Japanese 55-year Reanalysis
SAT	1979*~	NOAA's outgoing longwave radiation (OLR)

\*full available period. Actually data is available from 1974 but is missing between 1978/3/17-12/31.

## Oceanographic analysis dataset

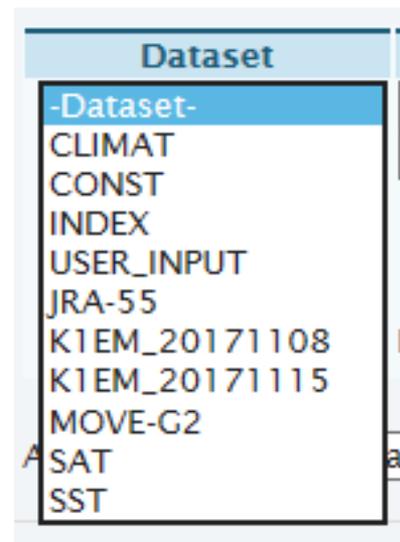
SST	1891~	Sea surface temperature (COBE-SST)
MOVE-G2	1958~	Data assimilation by MOVE/MRI.COM-G2

## Forecast dataset

JMA's one-month prediction model output

## Other dataset

INDEX	ENSO index (NINO.3 etc.)
CLIMAT	Monthly CLIMAT reports
USER-INPUT	Text data input by user

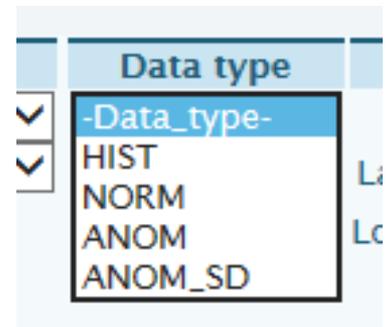


A screenshot of a software interface showing a list of datasets. The list is titled "Dataset" and includes the following items: -Dataset-, CLIMAT, CONST, INDEX, USER\_INPUT, JRA-55, K1EM\_20171108, K1EM\_20171115, MOVE-G2, SAT, and SST. The list is displayed in a window with a light blue header and a white background.

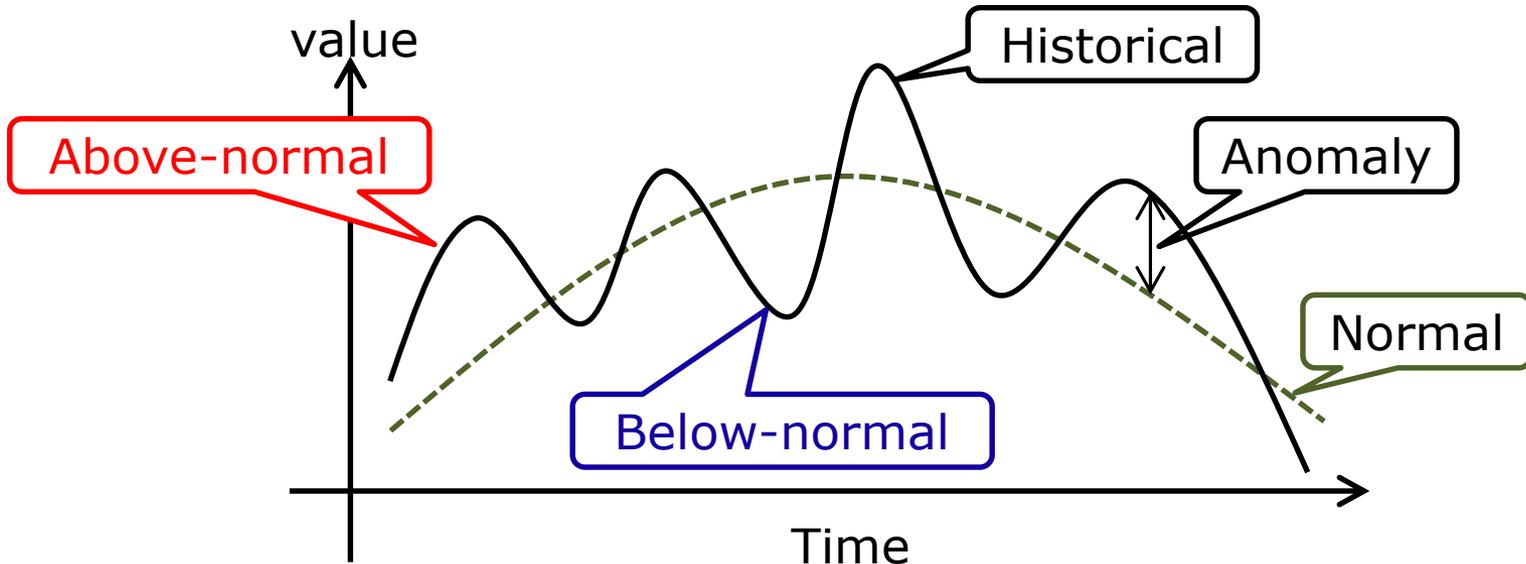
Dataset
-Dataset-
CLIMAT
CONST
INDEX
USER_INPUT
JRA-55
K1EM_20171108
K1EM_20171115
MOVE-G2
SAT
SST

# Available data type

- Various data types are available to perform climate diagnosis.

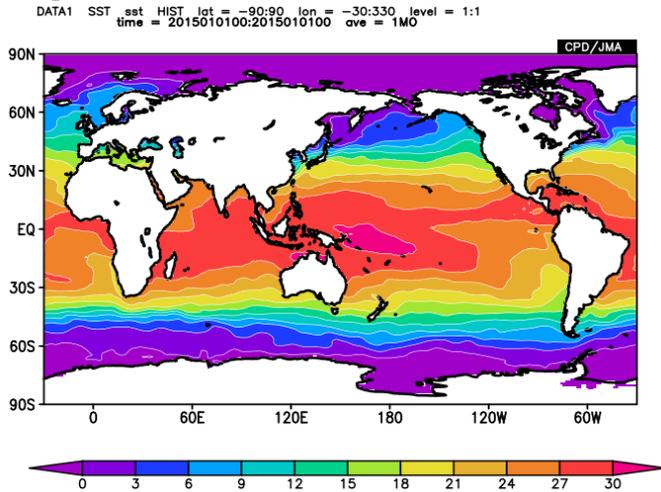


<b>HIST</b>	Historical actual analysis or observation data
<b>NORM</b>	Climatological normal data (averaged from 1981 to 2010)
<b>ANOM</b>	Anomaly data (difference from the climatological normal)

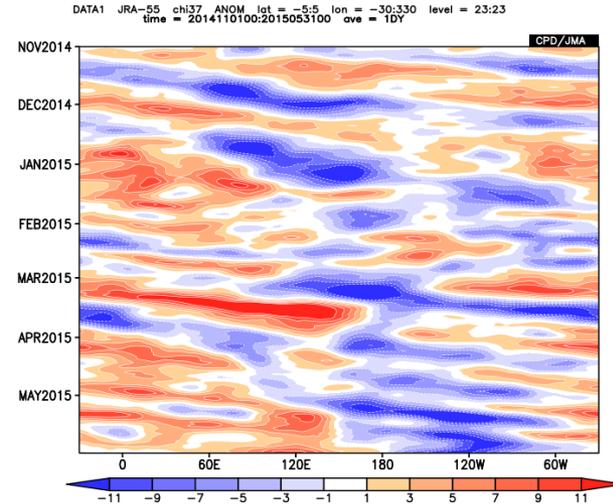


# Samples of charts

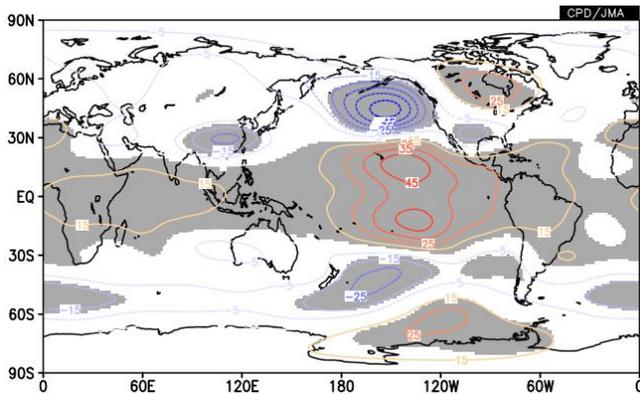
- Various types of charts and statistical analyses are available on iTacs.



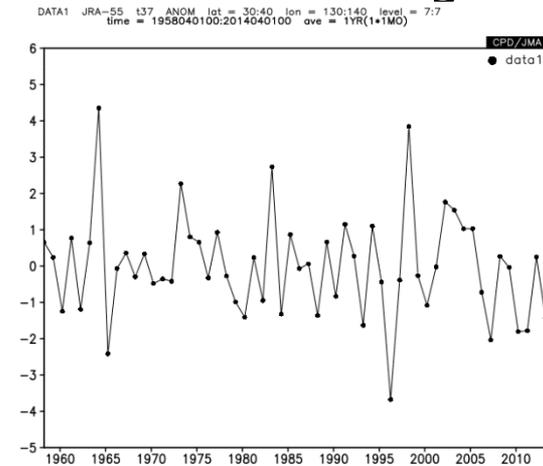
2-dimensional map



Cross section diagram



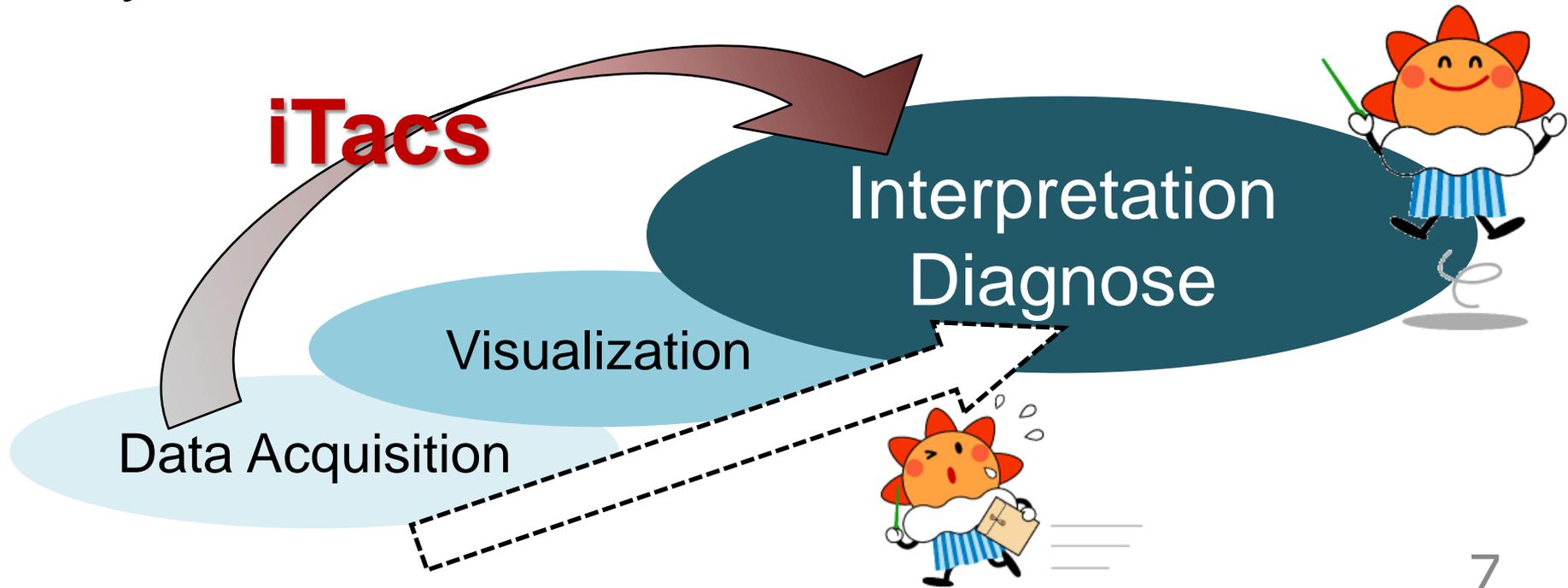
Regression/Correlation  
and significance-test



Time series graph

# Advantages of iTacs

- iTacs is one of the most useful tools developed by JMA to perform climate analysis and will strongly help you in climate monitoring.
- Use of iTacs costs less time to visualize the data, more time to make interpretation of the climate system.



# Contents

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- ❑ Longitude-latitude map
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## 3. Basic operations -Other kinds of maps-

- ❑ Vertical and latitude/longitude profile
- ❑ Cross section diagram

# Access to iTacs

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

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

The image shows a sequence of steps for accessing iTacs from the TCC website:

- Entrance:** The TCC website homepage. The 'Main Products' section contains an icon for iTacs, which is highlighted with a red box.
- iTacs Login:** A login form with fields for 'User Name:' and 'Password:', and a 'Login' button. A yellow arrow points from the iTacs icon to this form.
- iTacs:** The iTacs data analysis interface. A yellow arrow points from the login form to this interface. The interface includes a 'Data 1' section with a table for selecting parameters:

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels T (Temperature) [C]	HST	ASIA Lat: 10 Lon: 30	550hPa Ave	MONTHLY Ave Year-to-year	RANGE 2014 1
			190 Ave		Time filter 2014 3	

# Basic operating procedure (1)

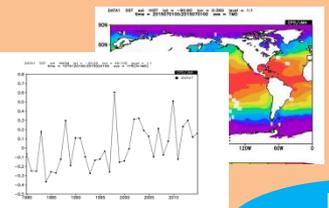
Select Analysis or Forecast dataset

Setting Data parameters

Setting Graphic Options

Data Submit

Draw map



Data download

User Information Logout Reload Help

User ID: XXXX

Analysis Dataset Forecast Dataset

Analysis Dataset

Select parameters Graphic Options

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	HIST	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter	RANGE 2011 - 2013 3 - 5

Vector  SD  
Derivative:  lon  lat

Analysis method: -Analysis method-

Use parameter code

Analysis Data Submit

Parameters for data setting  
-Dataset, Element, Data type

Chronological parameters  
-Time unit, Showing period

Geophysical parameters  
-Area, Level

Analysis method setting  
-DATA1\_DATA2, SUBTRACT, REGRESSION\_COEFFICIENT etc.

In some cases, Data2 setting needed.

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	HIST	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter	RANGE 2011 - 2013 3 - 5

Vector  SD  
Derivative:  lon  lat

Analysis method: DATA1\_DATA2

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	HIST	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	1	MONTHLY Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter	RANGE 2015 - 2015 1 - 1

Use parameter code

# Basic operating procedure (2)

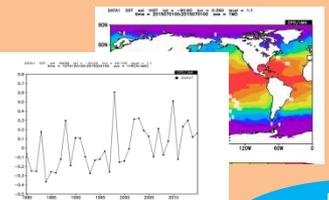
Select Analysis or Forecast dataset

Setting Data parameters

Setting Graphic Options

Data Submit

Draw map



Data download

Select this tab

Graphic Options  
-Contour, Shade, Color Bar, Axes

Select parameters **Graphic Options**

**Graphic Options**

Colorizing: COLOR  
Drawing: SHADE  
Image Format: png  
Font: default  
Color Table: Rainbow

Show Contour Labels  
 Show Color Bar  
 Set Contour Parameters for data1  
interval: min: max:  
 Set Contour Parameters for data2  
interval: min: max:  
 Set Vector size: [inch] value: skip: 1

Polar Stereographic: North pole  
 Logarithmic Coordinates  
 Reverse the Axes  
 Flip the X-axis  
 Flip the Y-axis  
 No Scale Labels  
 Draw Credit Inside  
 Apply All Pics  
picture size %

Detailed Options for Image

Checking here, additional field for detailed options will appear.

Analysis Data Submit

Detailed Options for Image x  
-Graphics, Axis, Map

Detailed Options for Image 1

For Image 1: lower layer apply apply Default

About Graphics

contour Style: default Color: rainbow  
label  format: thickness: 1 size: 0.09 skip interval:  
contour line thickness: 3  
levels: color:  
thin contour:   
not to draw: -:

marker type: closed circle  
line style: solid color: black thickness: 6  
grid style: none color: orange  
vector label  vector head size:  
define rainbow color:  
color bar portrait  X: Y: scale: 1.0

About Axis

About Map

For Image 1 apply

# 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.**

☑ Detailed Options for Image 1

For Image 1 | Lower layer | apply | apply Default

### About Graphics

contour Style: default | Color: rainbow

label  format: | thickness: 1 | size: 0.09 | skip interval: |

contour line thickness: 3

levels: | color: |

thin contour:  |

not to draw: | - |

marker type: closed circle

line style: solid | color: black | thickness: 6

grid style: none | color: orange

vector label  vector head size: |

define rainbow color: |

color bar portrait  X: | Y: | scale: 1.0

### About Axis

### About Map

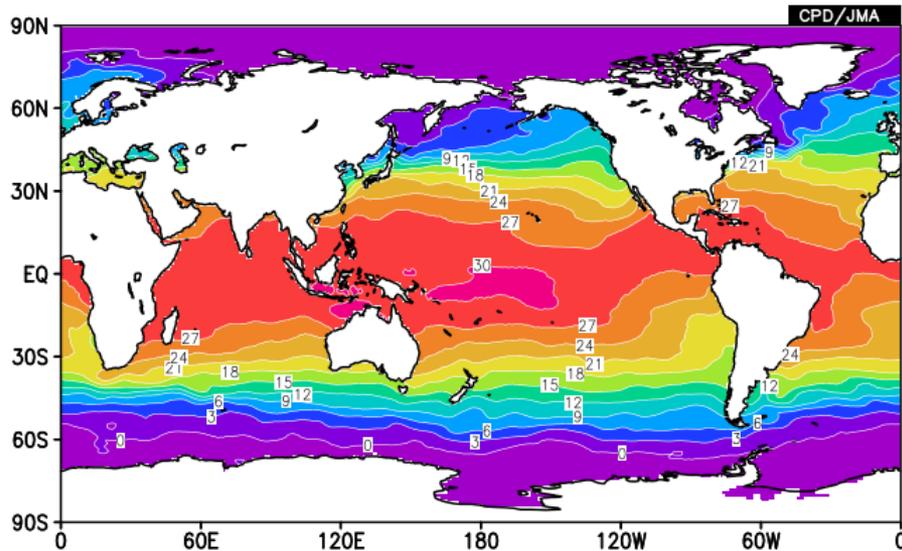
For Image 1 | apply

# Longitude-latitude map (1)

- Let's draw monthly mean sea surface temperature (SST) and its anomaly in December 2015.

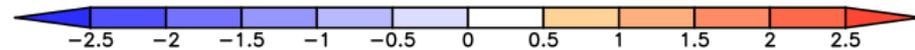
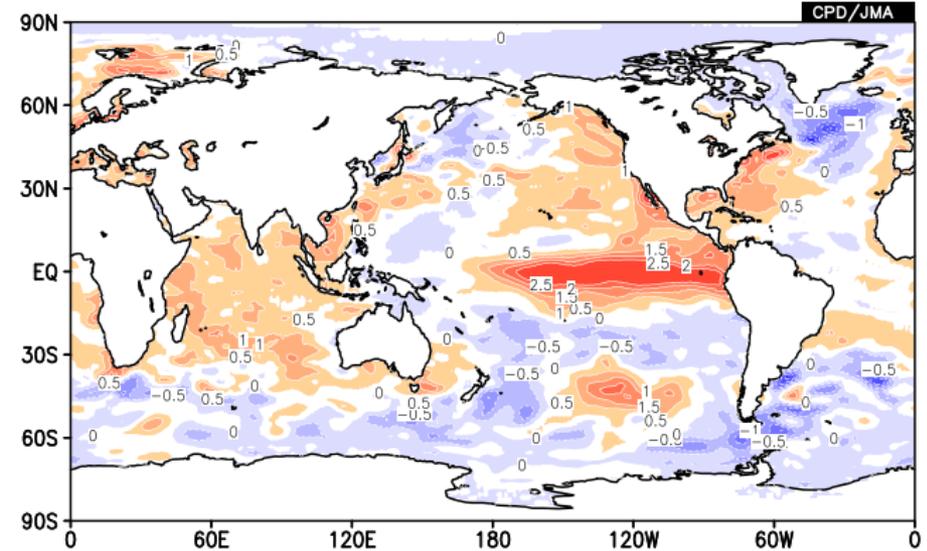
## SST

DATA1 SST\_sst HIST lat = -90:90 lon = 0:360 level = 1:1  
time = 2015120100:2015120100 ave = 1MO



## SST anomaly

DATA1 SST\_sst ANOM lat = -90:90 lon = 0:360 level = 1:1  
time = 2015120100:2015120100 ave = 1MO



# Longitude-latitude map (2)

Dataset	Element	Data type	Area
SST	Sea Surface Data	HIST	ALL
	Temperature (SST) [C]		Lat: -90 - 90 Ave <input type="checkbox"/>
	-element2-		- 360 Ave <input type="checkbox"/>
	Temperature (SST) [C.Deg.]		
	Ice concentration (ice=1 no_ice=0) [fraction]		

Derivative:  lon  lat

Analysis method: -Analysis method-

1. Select "SST" in the "dataset" field.

- Various datasets are available;  
JRA-55, SST, MOVE-G2, 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)

**Data 1**

Dataset	Element	Data type	Area	Level	Time unit
SST	Sea Surface Data	HIST	ALL	1	MONTHLY
	Temperature (SST) [C	-Data_type-	Lat: -90 - 90 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year
	<input type="checkbox"/> Vector <input type="checkbox"/> SD	HIST	Lon: 0 - 360 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat	NORM			
		ANOM			
		ANOM_SD			

Analysis method: -Analysis method-

## 3. Select "HIST" for "Data type" .

Available options are as follows:

- HIST : Historical actual analysis or observation data.
- NORM : Climatological normal.
- ANOM : Anomaly data.
- ANOM\_SD : Anomaly data normalized by their standard deviations, indicative of significance for the anomaly.

# Longitude-latitude map (4)

Data type	Area	Level	Time unit	Showing period
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	RANGE 2015 12 2015 12

Only "1" level in this case

## 4. Select "ALL" for "Area".

- You can change the longitude/latitude range more precisely with setting boxes.

## 5. Select "1" for "Level".

- Options in the "Level" menu will change depending on your selection of "element".

# Longitude-latitude map (5)

Data type	Area	Level	Time unit	Showing period
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	RANGE 2015 12 2015 12

## 6. Select "MONTHLY" for "Time unit".

- There are several styles for range selection: **DAILY**, **PENTAD DAY**, **MONTHLY** and **ANNUAL**

## 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).

# Longitude-latitude map (6)

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

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	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	RANGE 2015 12 2015 12

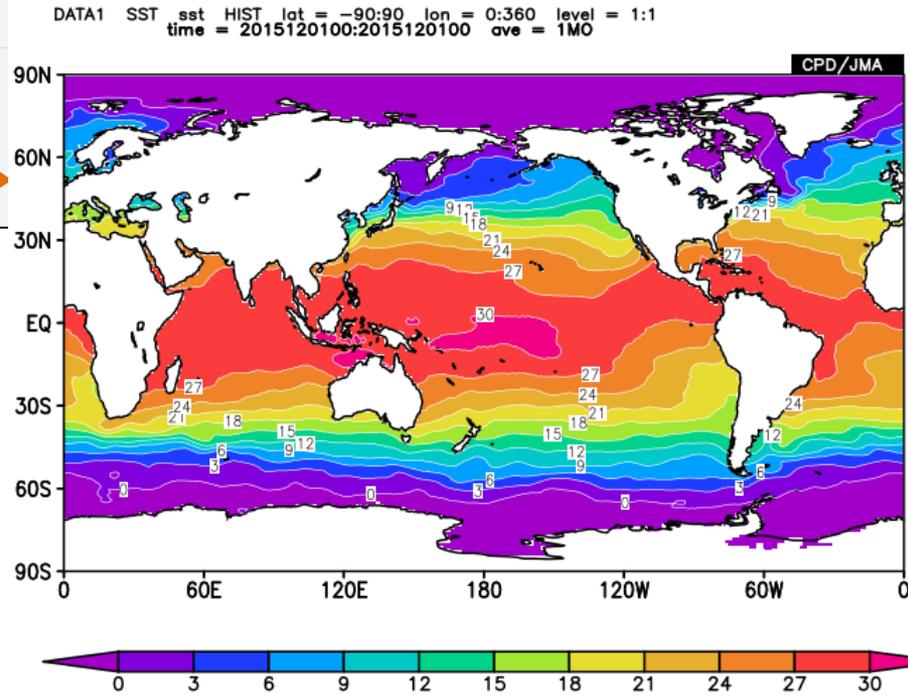
Vector  SD  
Derivative:  lon  lat

Method: -Analysis method-

Parameter code

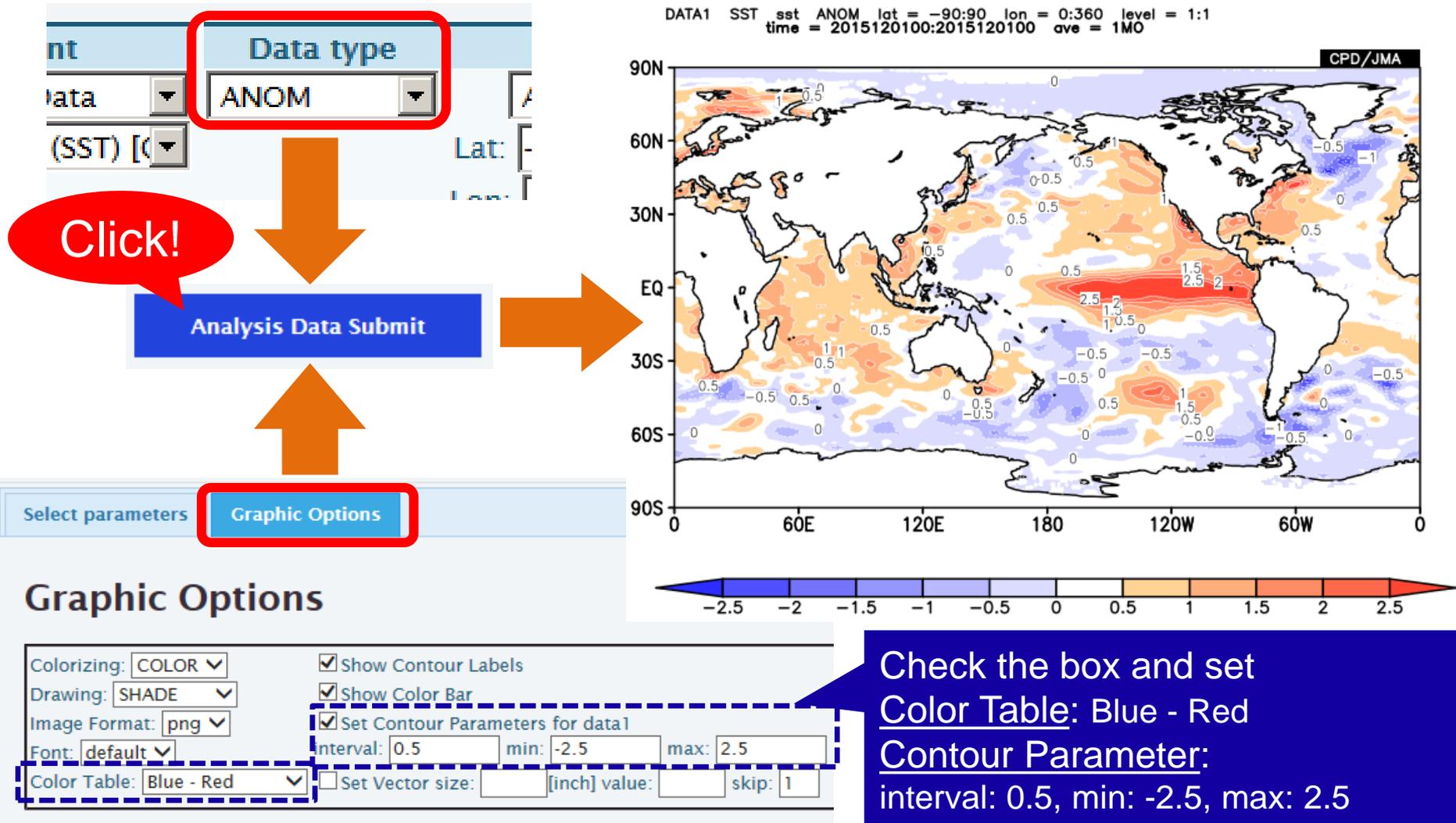
Click!

Analysis Data Submit



# Longitude-latitude map (7)

- You can also draw anomaly charts by selecting "ANOM" for "Data type".



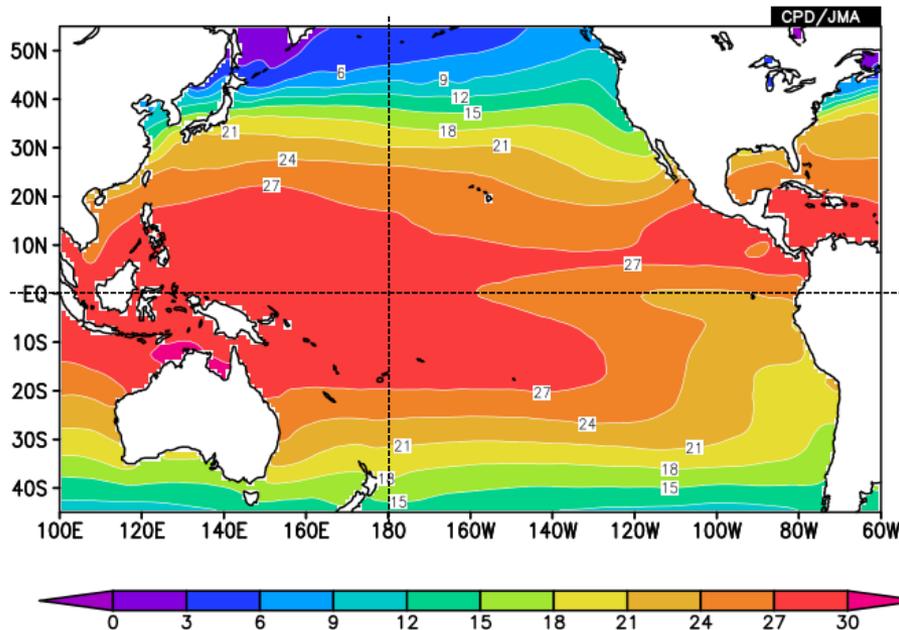
# Topics: El Niño event

- In winter 2015/16, SST exhibited positive anomaly over the central to eastern equatorial Pacific and negative anomalies over the western tropical Pacific, indicating the occurrence of El Niño event.

## SST in December 2015

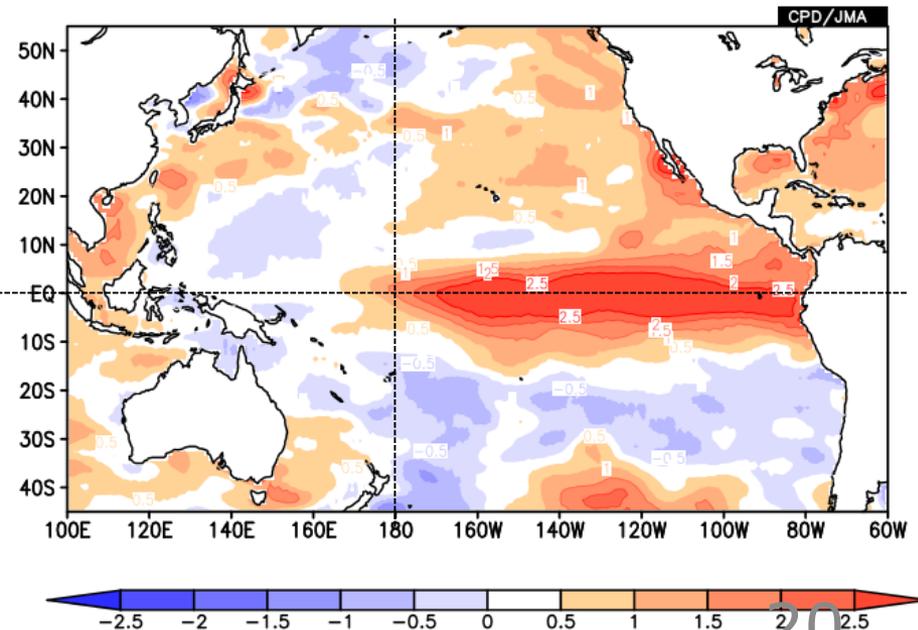
- Normal -

DATA1 SST\_sst NORM lat = -45:55 lon = 100:300 level = 1:1  
time = 2015120100:2015120100 ave = 1MO



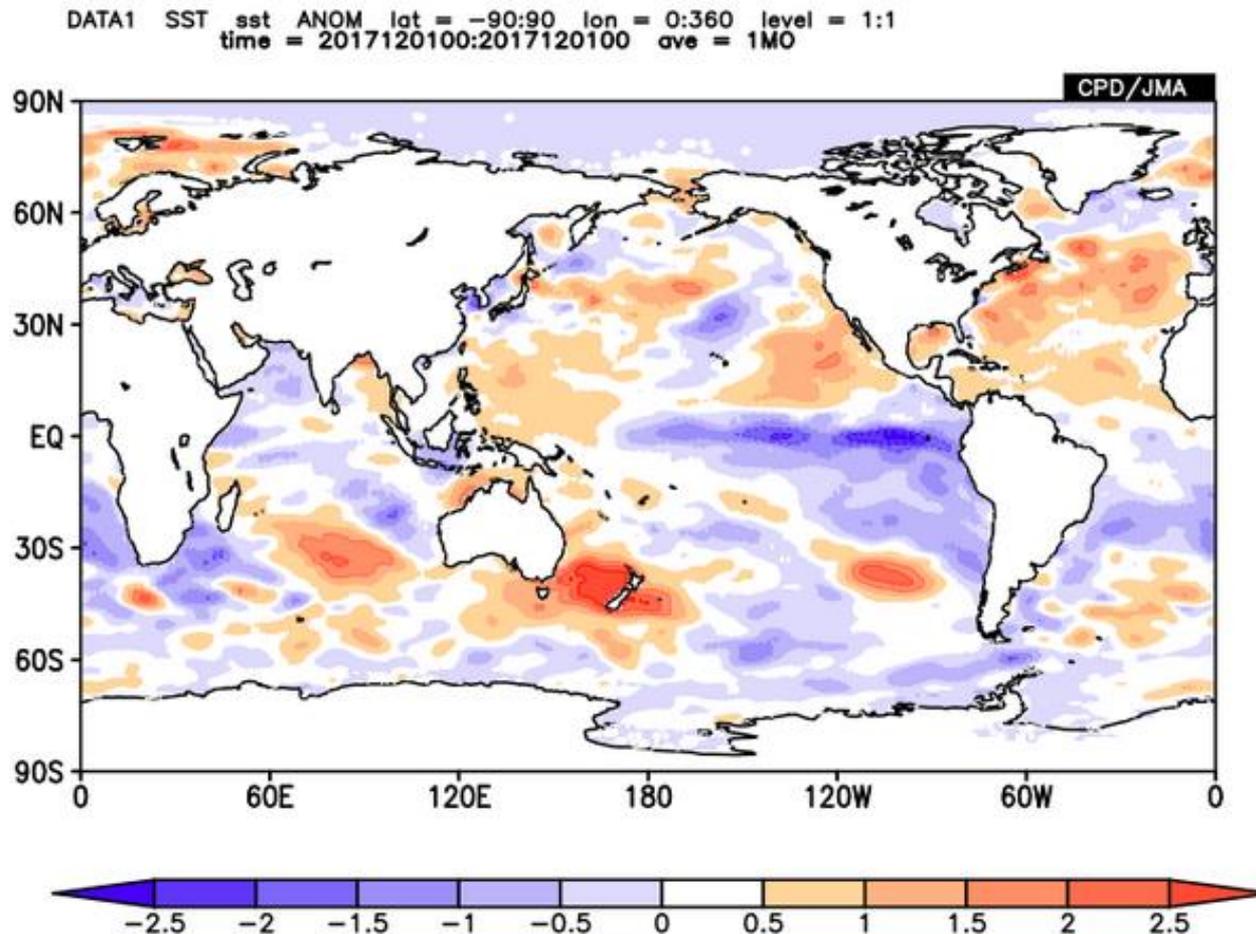
- Anomaly -

DATA1 SST\_sst ANOM lat = -45:55 lon = 100:300 level = 1:1  
time = 2015120100:2015120100 ave = 1MO



# Exercise (1)

- Let's chart monthly **sea surface temperature** (SST) anomaly in **December 2017**.



Showing period

RANGE ▾

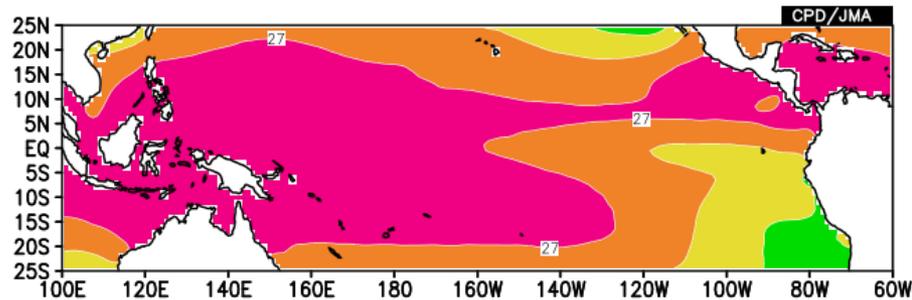
2017 ▾	12 ▾
2017 ▾	12 ▾

# Topics: El Niño Southern Oscillation (ENSO)

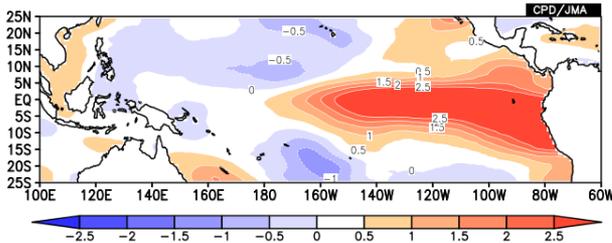
- The occurrence of El Niño and La Niña events (ENSO) modulate zonal contrast of SST in the equatorial Pacific.

## Normal SST

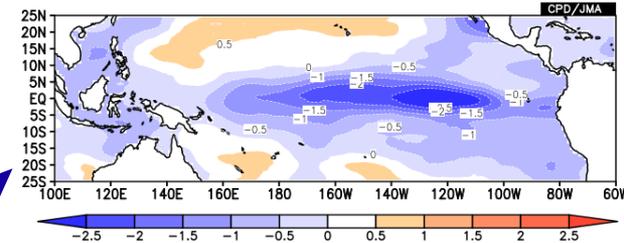
DATA1 SST\_sst NORM lat = -25:25 lon = 100:300 level = 1:1  
time = 1988120100:1988120100 ave = 1MO



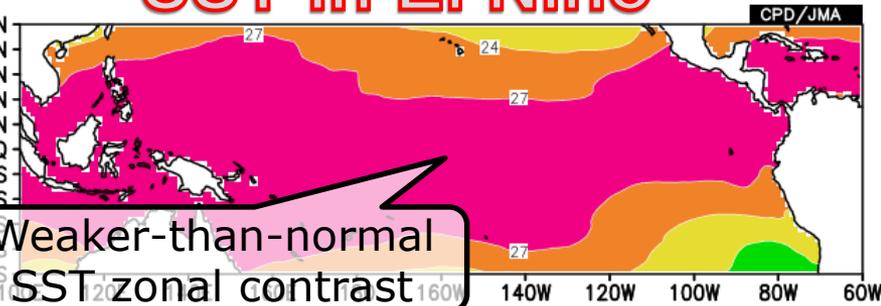
DATA1 SST\_sst ANOM lat = -25:25 lon = 100:300 level = 1:1  
time = 1997120100:1997120100 ave = 1MO



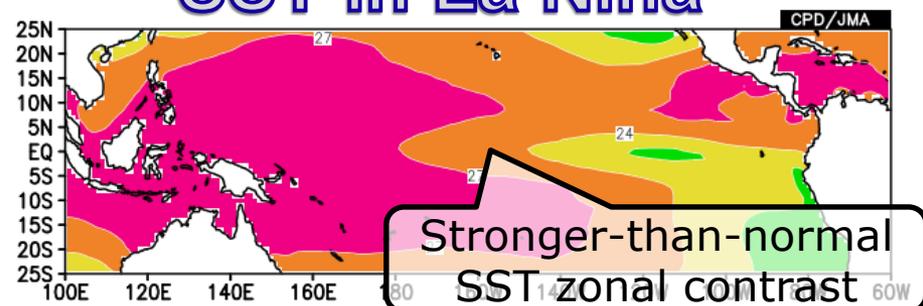
DATA1 SST\_sst ANOM lat = -25:25 lon = 100:300 level = 1:1  
time = 1988120100:1988120100 ave = 1MO



## SST in El Niño



## SST in La Niña



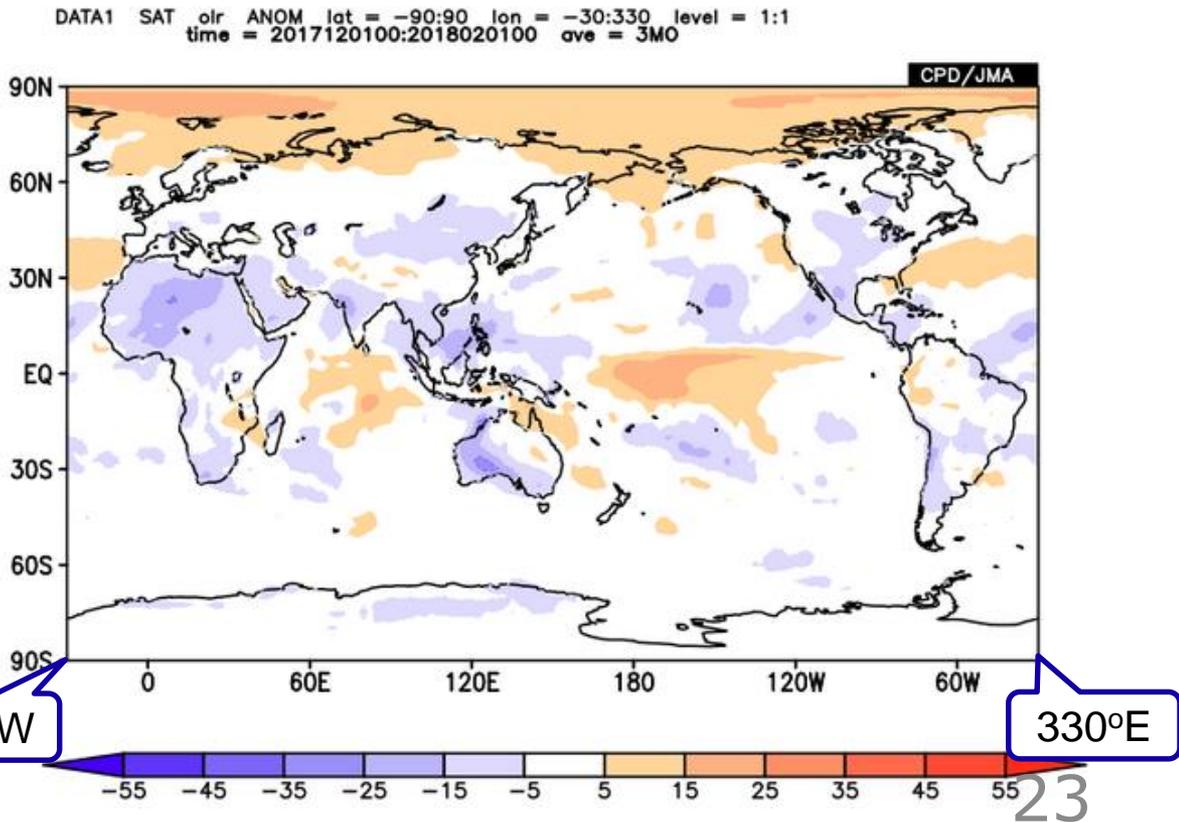
# Exercise (2)

- Show OLR anomaly averaged over the period from December 2017 to February 2018 as shown below.

La Niña event was observed during this period.

- Dataset "SAT" is available to draw the OLR.

- Please try to set longitude range from 30°W to 330°E not to split areas in Africa and Europe.
- Adjust contour parameters (see color bar of the figure)
- Select "Blue-Red" for "Color Table"



# Answers to Exercise (2)

## Analysis Dataset

Select parameters | Graphic Options

### Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m <sup>2</sup> ]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>		MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2017 12 2018 2

Vector  SD  
Derivative:  lon  lat

Lat : -90 – 90  
(90S) (90N)  
Lon: -30 – 330  
(30W) (330E)

## Graphic Options

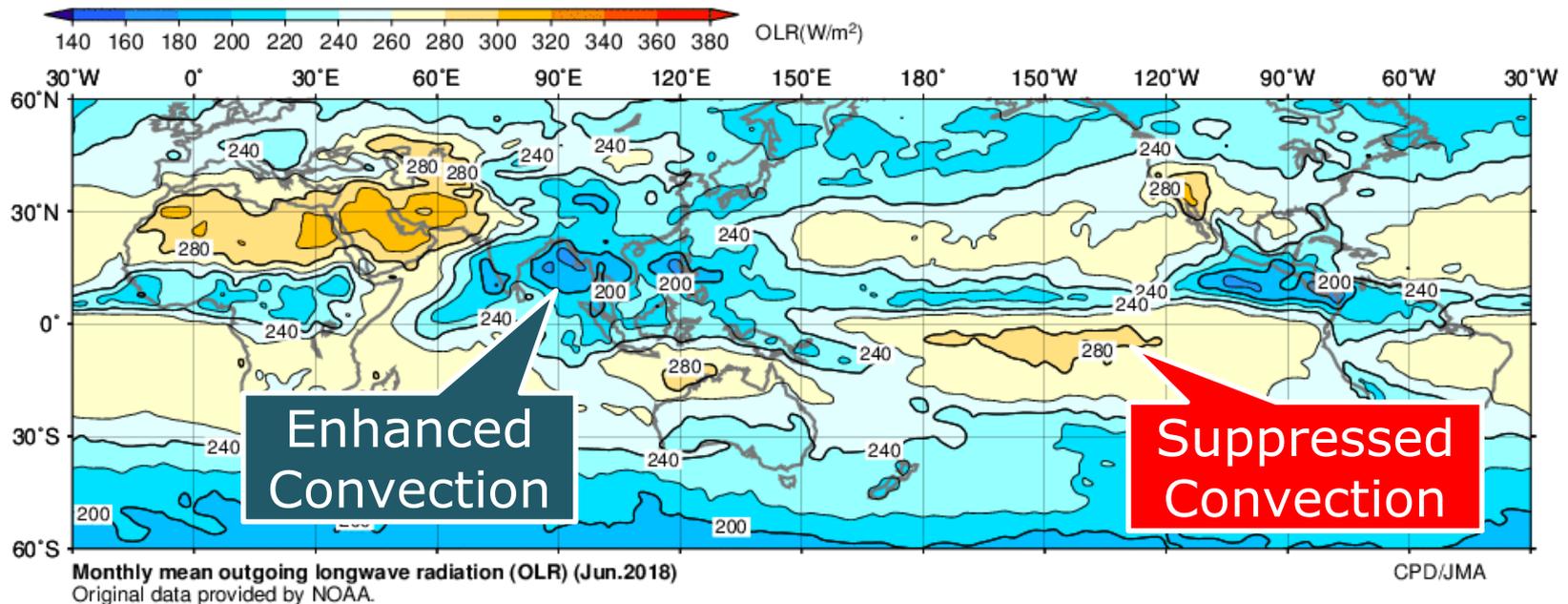
Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	<input type="checkbox"/> Polar Stereographic: North pole	<input type="checkbox"/> No Scale Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar	<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> 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: 10 min: -55 max: 55	<input type="checkbox"/> Flip the X-axis <input type="checkbox"/> Flip the Y-axis	picture size %
Color Table: Blue - Red	<input type="checkbox"/> Set Vector size: [inch] value: 1	<input type="checkbox"/> No Caption	

Select "Blue-Red" color table.

Set these boxes as follows  
interval: 10, min: -55, max: 55

# Tips: Outgoing Longwave Radiation (OLR)

- OLR is an index representing brightness temperature observed from space.
- Take note: In the tropics,
  - Lower OLR – Cooler temp. seen from space
    - Top of cumulonimbus – Active convection
  - Higher OLR – Warmer temp. seen from space
    - Near the earth surface – Suppressed convection



# Topics: Anomalous convective activity associated with the El Niño event

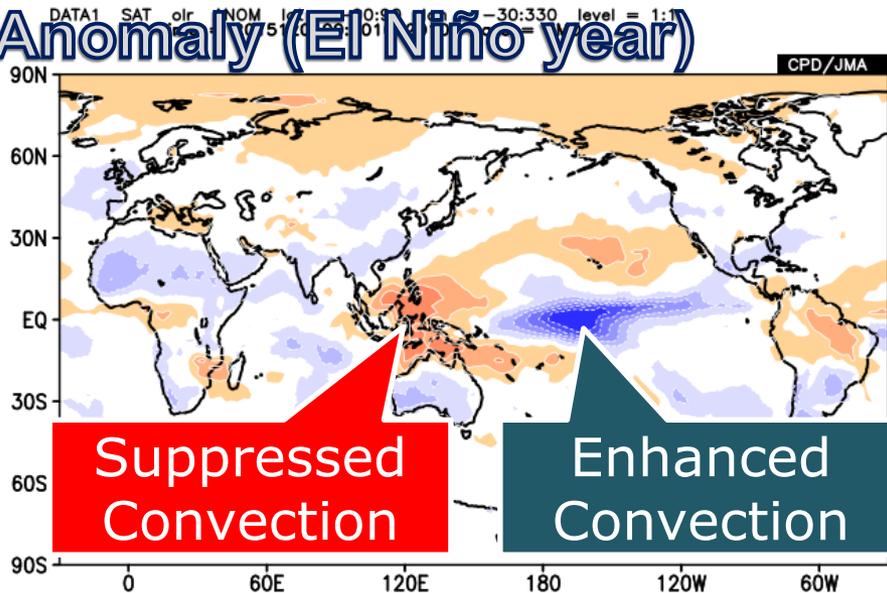
- During El Niño events, enhanced (suppressed) convective activity is statistically seen over the central to eastern (western) equatorial Pacific.
- Opposite pattern is seen during La Niña events

DJF mean OLR in 2015/2016

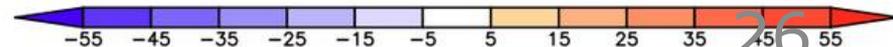
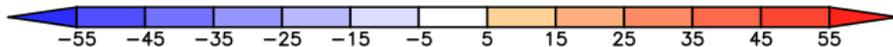
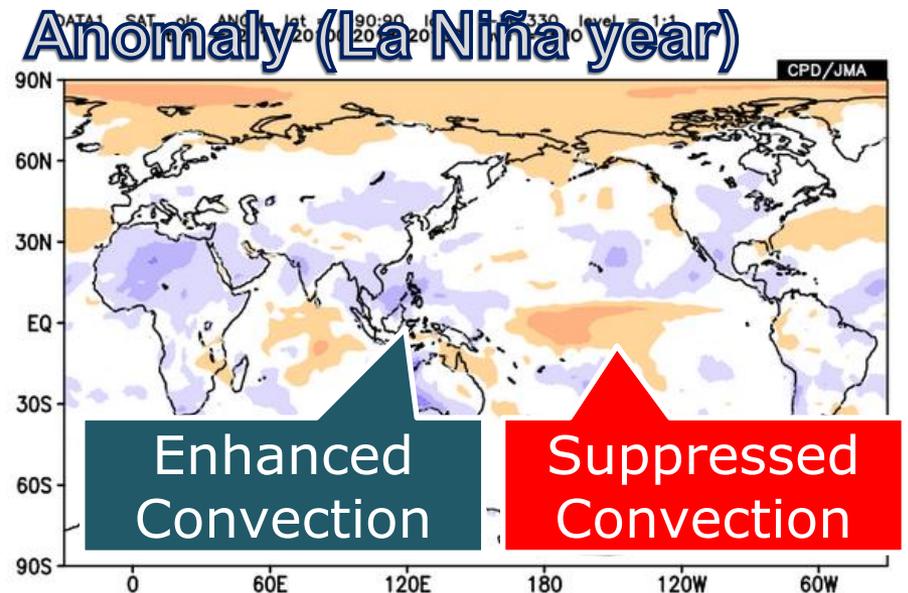
DJF mean OLR in 2017/2018

\*Answer of Exercise (2)

Anomaly (El Niño year)

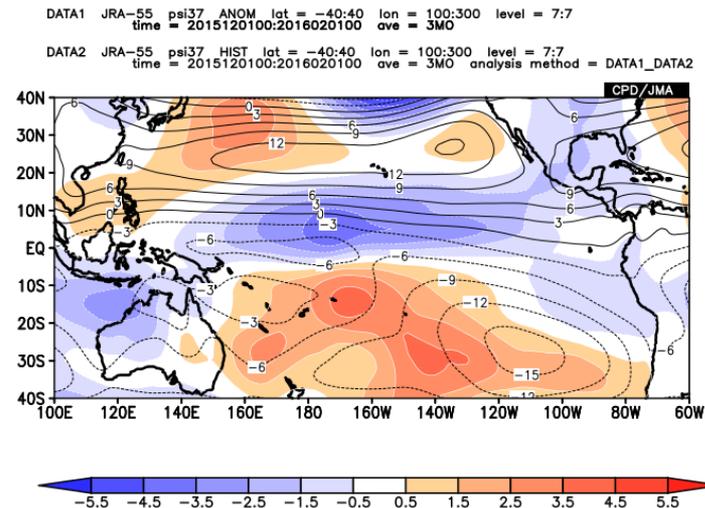
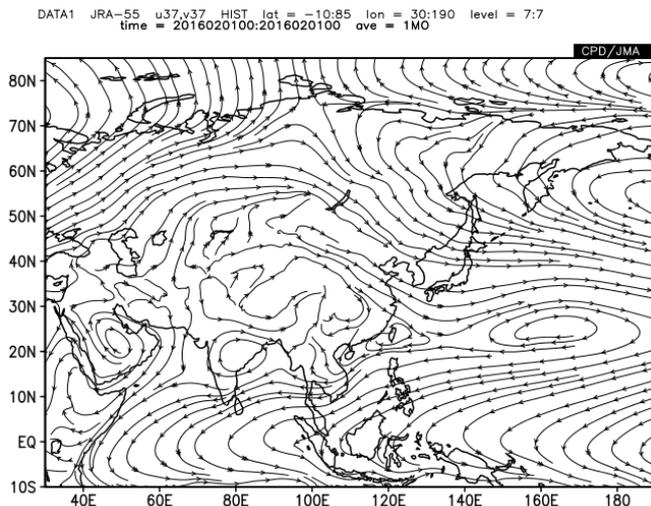


Anomaly (La Niña year)



# Multiple Data

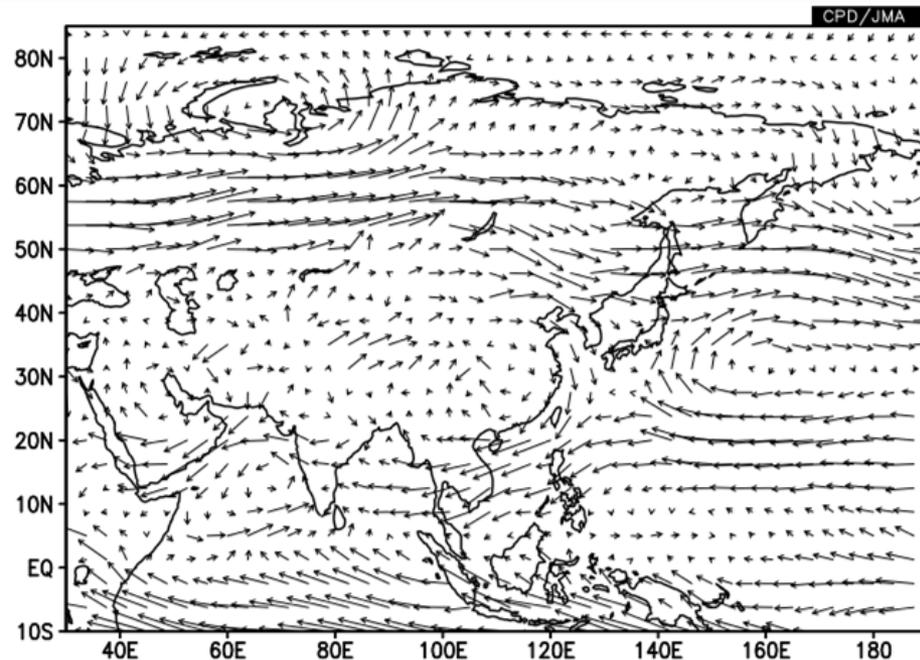
- iTacs can hundle multiple data with methods like these:
  - **Vector** or **Stream-line**: Map vectors or stream lines.
  - **DATA1\_DATA2**: Overlay two kinds of elements on one map at the same time.
    - Contour lines are overlaid on a shaded map.
  - **SUBTRACT**: Map the difference of two data.
    - This function is mainly used to show time variation or the difference between two levels.



# Vectors (1)

- A vector map is available to see flow or flux.
  - For example, set U and V to see blowing wind.
  - Barbs are not available. (Barb:  and 

850-hPa wind  
vector in October  
2019



# Vectors (2)

The image shows two screenshots of a software interface. The left screenshot shows the 'Dataset' dropdown set to 'JRA-55' and the 'Element' dropdown set to 'U (Zonal Wind) [m/s]'. A red box highlights the 'Vector' checkbox, which is checked, with a red callout bubble containing the text 'Check!'. The right screenshot shows the 'Element' dropdown set to 'V (Meridional Wind) [m/s]'. A red box highlights the 'V (Meridional Wind) [m/s]' dropdown, with an orange callout bubble above it containing the text 'X-component' and a green callout bubble below it containing the text 'Y-component'. A yellow arrow points from the left screenshot to the right one. A pink callout bubble at the bottom contains the text 'Another boxes will appear'.

Dataset: JRA-55, Element: Pressure Levels, U (Zonal Wind) [m/s]

Vector  SD  
Derivative:  lon  lat

Dataset: JRA-55, Element: Pressure Levels, U (Zonal Wind) [m/s]

Pressure Levels, V (Meridional Wind) [m/s]

x:   Stream line  
 Vector  SD

Check!

Another boxes will appear

X-component

Y-component

The image shows a 'Graphic Options' panel. The 'Set Vector size' checkbox is checked and highlighted with a red box. The 'value' field is set to 20 and the 'skip' field is set to 3. Other options include 'Colorizing: COLOR', 'Drawing: SHADE', 'Image Format: png', 'Font: default', 'Color Table: Blue - Red', 'Show Contour Labels', 'Show Color Bar', 'Set Contour Parameters for data1', 'Polar Stereographic: North pole', 'Logarithmic Coordinates', 'Reverse the Axes', 'Flip the X-axis', 'Flip the Y-axis', and 'No Caption'.

Graphic Options

Colorizing: COLOR, Drawing: SHADE, Image Format: png, Font: default, Color Table: Blue - Red

Set Vector size: 1 [inch] value: 20 skip: 3

Show Contour Labels,  Show Color Bar,  Set Contour Parameters for data1

Polar Stereographic: North pole,  Logarithmic Coordinates,  Reverse the Axes,  Flip the X-axis,  Flip the Y-axis,  No Caption

Customize setting in these boxes to change the vector size and interval.

# Stream lines

- Drawing stream lines

Data1

Dataset	Element
JRA-55	Pressure Levels
	U (Zonal Wind) [m/s]
	Pressure Levels
	V (Meridional Wind)
x:	<input checked="" type="checkbox"/> Stream line
	<input checked="" type="checkbox"/> Vector <input type="checkbox"/> SD

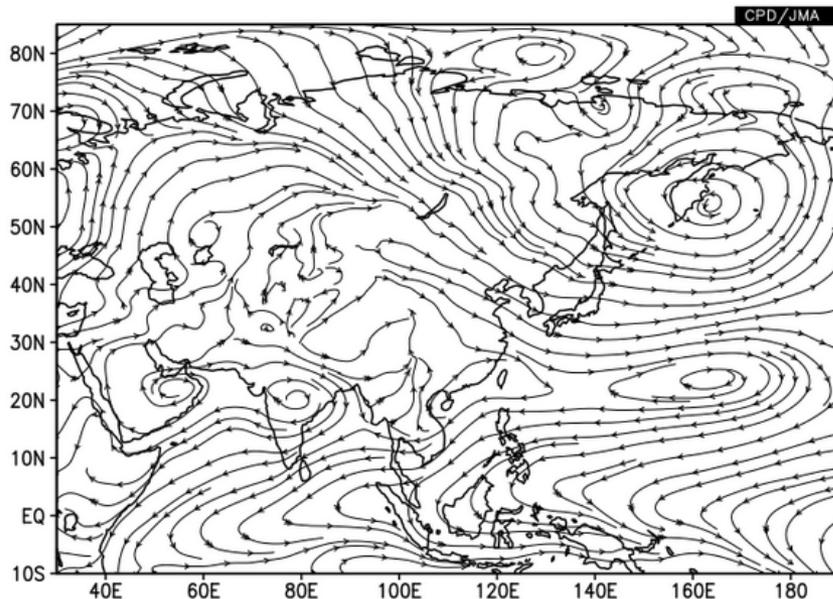
Check

Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1
Font: default	interval: <input type="text"/> min: <input type="text"/> max: <input type="text"/>
Color Table: Rainbow	<input type="checkbox"/> Set Vector size: 1 [inch] value: 15 skip: 5

Uncheck

DATA1 JRA-55 u37.v37 HIST lat = -10:85 lon = 30:190 level = 7:7  
time = 2018020100:2018020100 ave = 1YR(1\*1MO)



When you draw streamlines, the skip value must be "1". It is easier and safer to just uncheck the vector options box.

# DATA1\_DATA2 : Overlaying two data (1)

- The Data1 is mapped as shading, and Data2 is mapped as contours.

\*As an exception, Data2 is mapped as shading when Data1 is mapped as the type of vector or streamline.

1

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels $\psi$ (Stream Function)	ANOM	ALL Lat: -40 - 40 Ave <input type="checkbox"/> Lon: 100 - 300 Ave <input type="checkbox"/>	850hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2018 12 2019 2

Vector  SD  
Derivative:  lon  lat

Analysis method: DATA1\_DATA2

2

3

**Data2**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels $\psi$ (Stream Function)	HIST	ALL Lat: -40 - 40 Ave <input type="checkbox"/> Lon: 100 - 300 Ave <input type="checkbox"/>	850hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2018 12 2019 2

SD

This area will appear after selecting "DATA1\_DATA2".

- Set the "Data1" field.
- Select "DATA1\_DATA2" in the "Analysis method" box.
- Set the "Data2" field and submit.

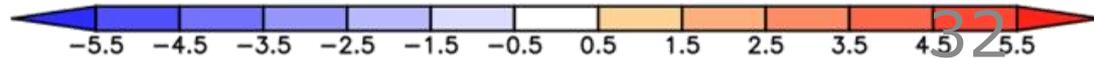
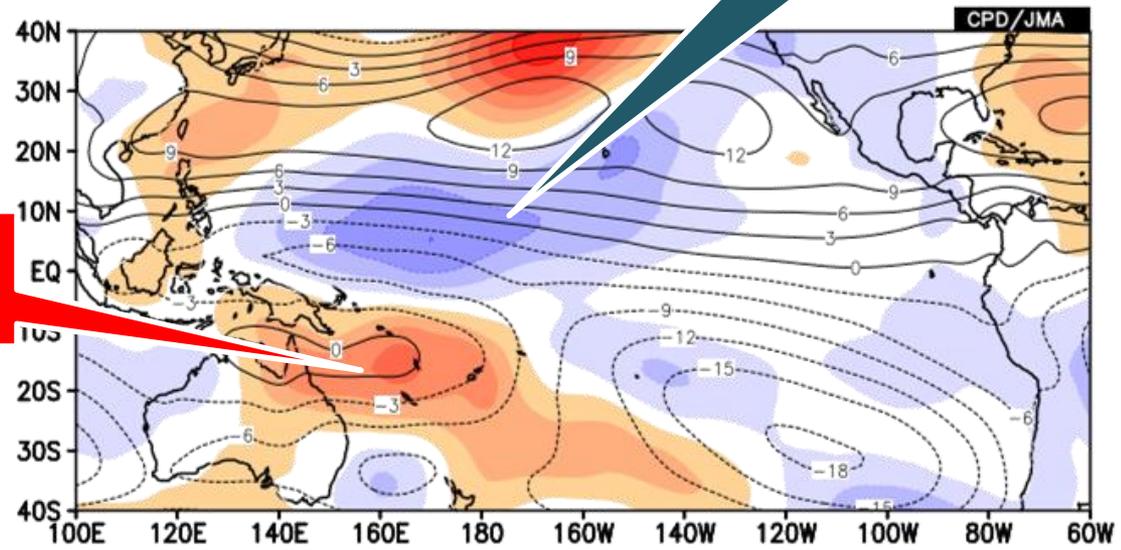
# DATA1\_DATA2 : Overlaying two data (2)

- The stream function (Data2) is mapped as contour, and its anomalies (Data1) is mapped as shading.

Stream Function at  
850 hPa in DJF  
2018/19

Anti-cyclonic  
anomalies

Cyclonic  
anomalies



# SUBTRACT : Data1 minus Data2

The value of “Data1 minus Data2” will be mapped.

1. Set the “Data1” (the base data) .
2. Select “SUBTRACT” in the “analysis method” box.
3. Set the “Data2” field and submit.

**1 Data1**

Dataset	Element	Showing period
SST	Sea Surface Data	RANGE
	Temperature (SST) [C	2019 10
		2019 10

Vector  SD  
Derivative:  lon  lat

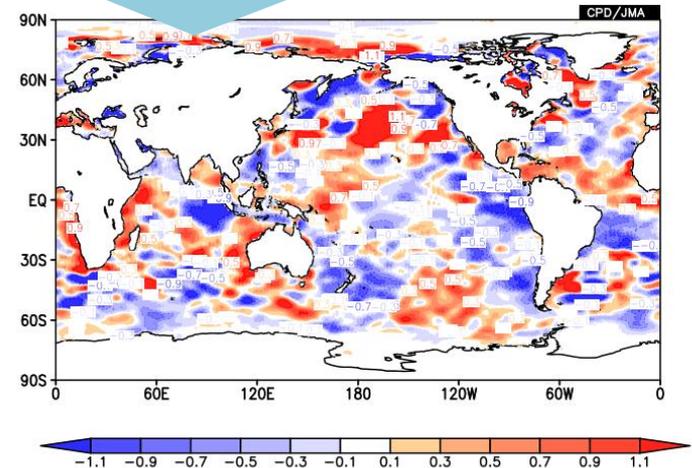
**2 Analysis method: SUBTRACT**

**3 Data2**

Dataset	Element	Showing period
SST	Sea Surface Data	RANGE
	Temperature (SST) [C	2019 6
		2019 6

SD

SST anomaly difference between Jun. and Oct. 2019.



Data1 minus Data2 is mapped (In this case, October minus Jun).

# Multiple Data

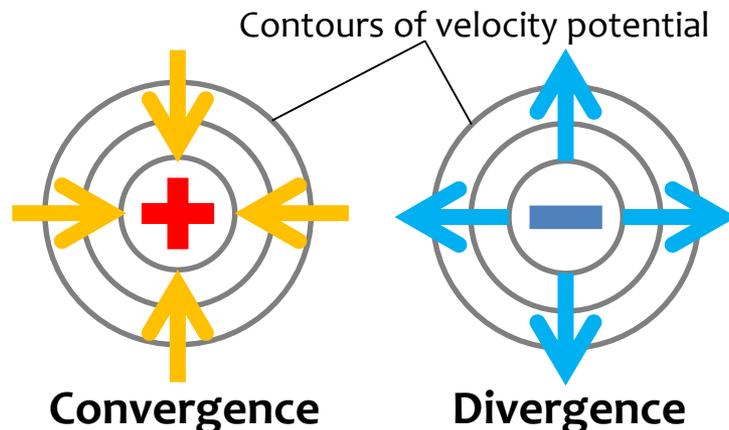
- In a similar way, users can also perform the four basic arithmetic operations of two data by using the corresponding analysis method.

Analysis method	Mapped value	Usage example
<b>ADD</b>	Addition ("Data1" plus "Data2")	—
<b>SUBTRACT</b>	Difference ("Data1" minus "Data2")	Time difference, vertical shear.
<b>MULTIPLY</b>	Multiplication ("Data1" times "Data2")	—
<b>DIVIDE</b>	Division ("Data1" divided by "Data2")	Precipitation ratios ("HIST" divided by "NORM").

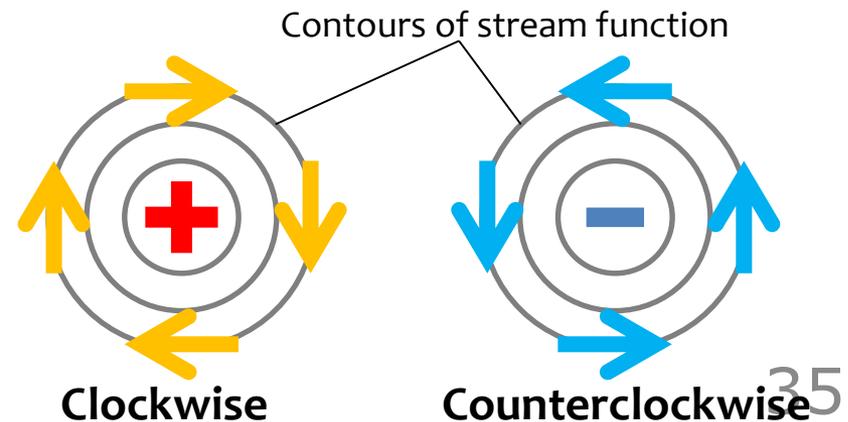
# Tips: Velocity Potential and Stream Function

- **Wind fields = Divergent winds + Rotational winds**
  - Under an assumption of perfect fluid (i.e. no viscosity).
- **Divergent winds =  $\nabla\chi$ , where  $\chi$  is Velocity potential**
  - Divergent wind blows in the upgradient direction of  $\chi$ .
- **Rotational winds =  $\mathbf{k} \times \nabla\psi$ , where  $\psi$  is Stream function ( $\mathbf{k}$  is a unit vector in vertical direction)**
  - Rotational wind blows parallel to the contours of  $\psi$ , with low value to the left, regardless of which hemisphere you think.
  - Air flow around a local  $\psi$  maximum (i.e. clockwise ) corresponds to anti-cyclonic rotation in the N.H. and cyclonic rotation in the S.H.

## Velocity potential (divergent winds)



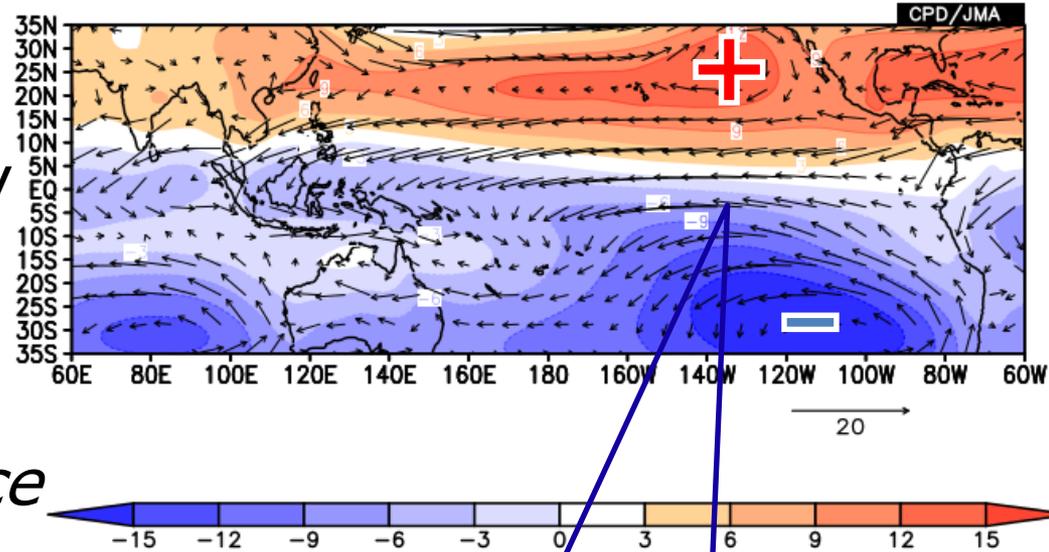
## Stream function (rotational winds)



# Tips: Stream function ( $\psi$ )

Note:

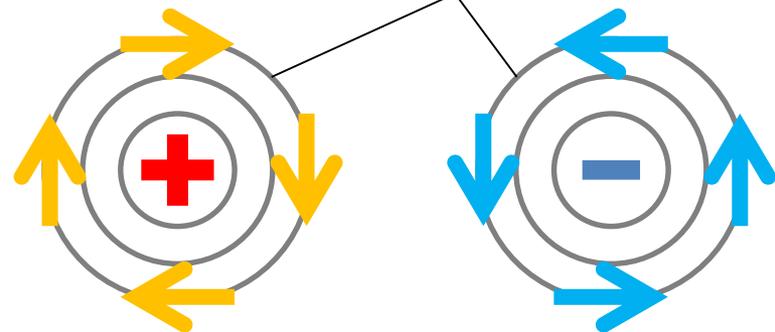
- Wind vectors are nearly parallel to the  $\psi$  lines.
- **Clockwise circulations** around the **local maximum of  $\psi$** , and *vice versa*.
  - $\langle ! \rangle$  Positive  $\psi$  values don't always mean clockwise circulations. You should see  $\psi$ 's maximum/minimum rather than the value itself.
- The gradient of  $\psi$  corresponds to the rotational wind speed.



Prevailing Trade winds

**Stream function (rotational winds)**

Contours of stream function



Clockwise

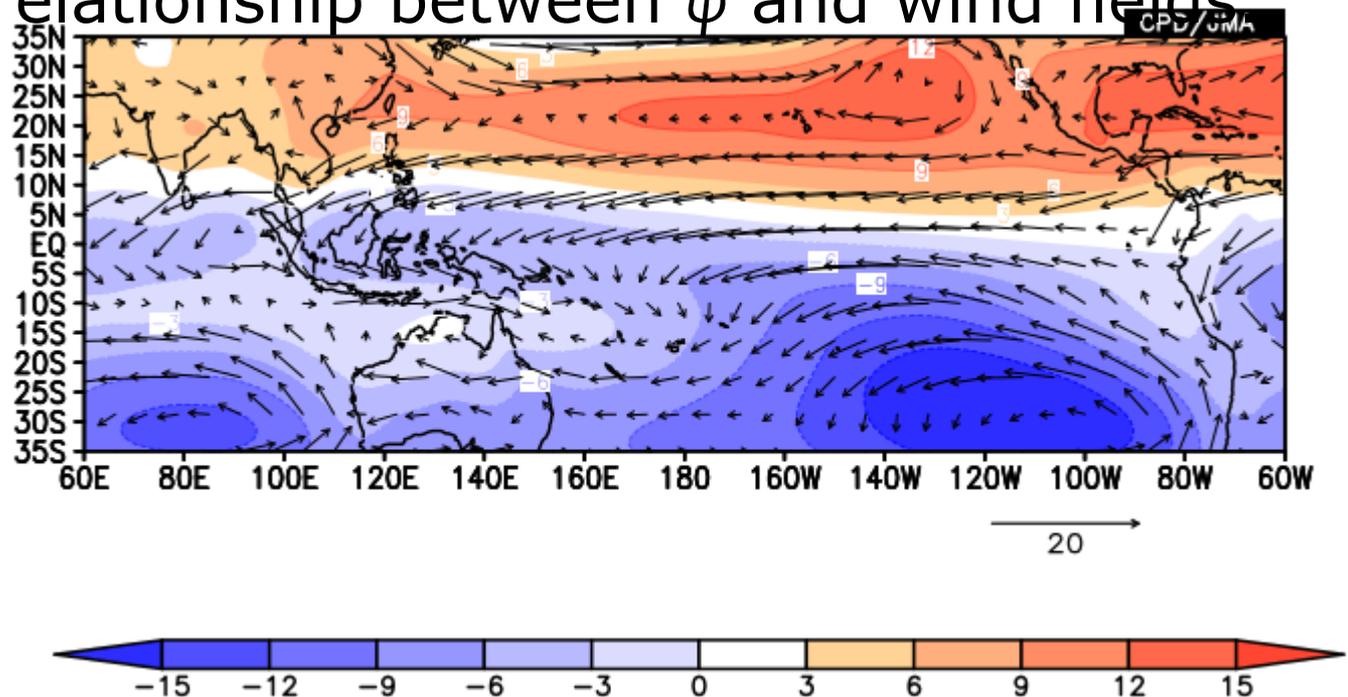
Counterclockwise

# Exercise (3)

- Let's see the climatological mean stream function ( $\psi$ ) and wind vector at 850hPa for January.
  - Stream function ( $\psi$ ) is used for diagnosing large-scale non-divergent ( i.e. rotational) wind fields.
  - Check the relationship between  $\psi$  and wind fields

Hint 1: This is a vector and shading plot. A setting for vector is only available for data1, not data2.

Hint 2: When you draw climatological normal fields, you don't care about year setting (any year is OK).



# Answers to Exercise (3)

Vector variables must be set as "Data 1". Set parameters for U and V.

## Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	850hPa	MONTHLY	RANGE
	U (Zonal Wind) [m/s]		Lat: -35 - 35 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2015 1
	V (Meridional Wind)		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 1
	Pressure Levels					
	V (Meridional Wind)					
	x: <input type="text"/>					
	<input type="checkbox"/> Stream line					
	<input checked="" type="checkbox"/> Vector <input type="checkbox"/> SD					
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat					

Analysis method: DATA1\_DATA2

Set parameter for  $\psi$  data in "Data2" field.

## Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	850hPa	MONTHLY	RANGE
	$\psi$ (Stream Function)		Lat: -35 - 35 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2015 1
	<input type="checkbox"/> SD		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 1

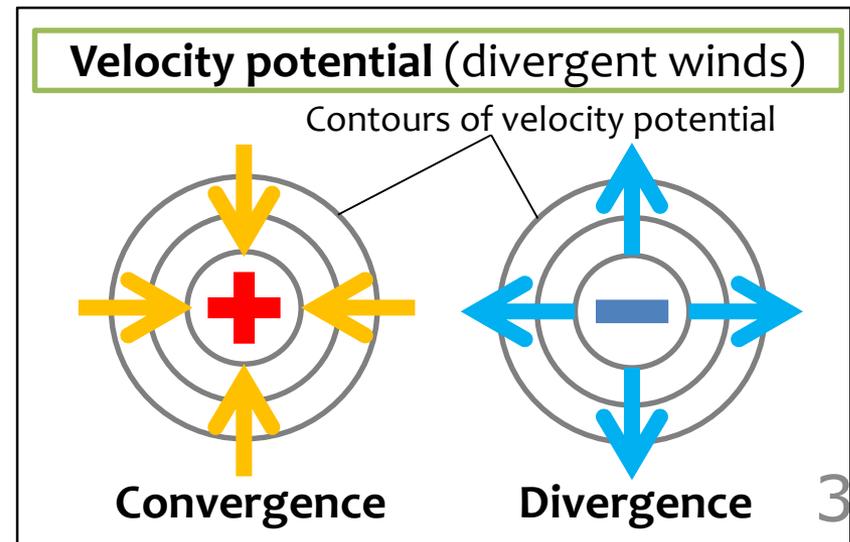
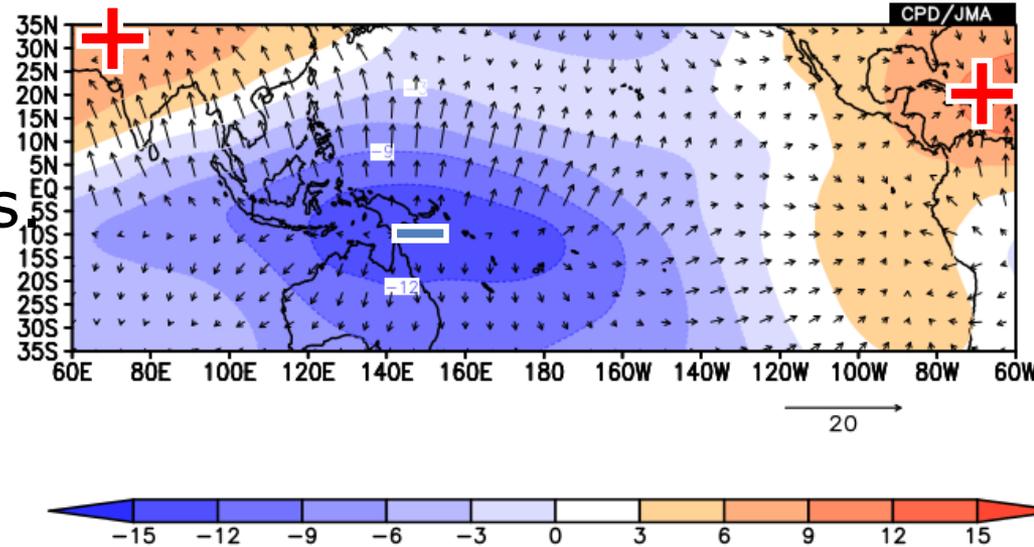
## Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	Set parameters for shading and vector		<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar			<input type="checkbox"/> Draw Credit Inside	
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1	interval: <input type="text"/> min: <input type="text"/> max: <input type="text"/>	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Flip the X-axis	<input type="checkbox"/> Flip the Y-axis
Font: default	<input checked="" type="checkbox"/> Set Contour Parameters for data2	interval: 3 min: -15 max: 15	<input type="checkbox"/> No Caption	<input type="checkbox"/> Apply All Pics	picture size <input type="text"/> %
Color Table: Blue - Red	<input checked="" type="checkbox"/> Set Vector size: 1 [inch] value: 20 skip: 5				

# Tips: Velocity potential ( $\chi$ )

Note:

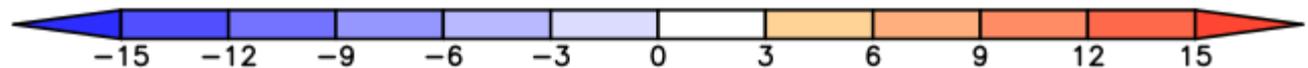
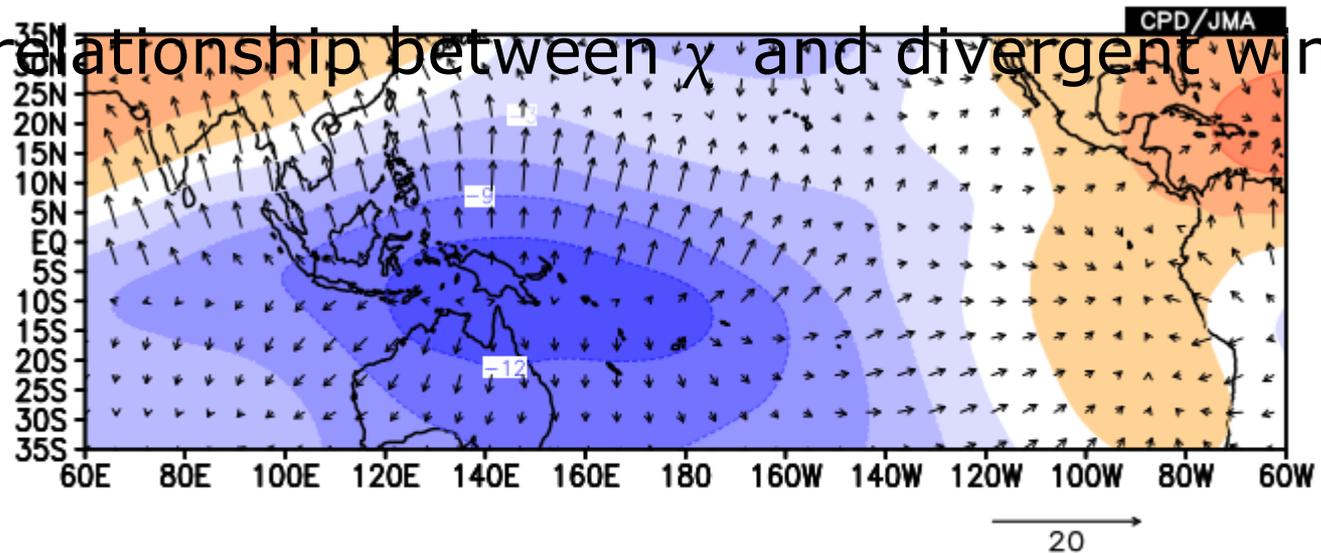
- Divergent wind vectors are normal to the  $\chi$  lines
- **Divergent winds** around the **local minimum of  $\chi$** , and *vice versa*.
  - **<!** Negative  $\chi$  values don't always mean divergent winds. You should see  $\chi$ 's maximum/minimum rather than the  $\chi$  value itself.
- The gradient of  $\chi$  corresponds to the divergent wind speed.



# Exercise (4)

- Let's see the climatological mean velocity potential ( $\chi$ ) and divergent wind vectors at 200hPa for January.
  - Velocity potential ( $\chi$ ) is used for diagnosing large-scale divergent wind fields. In the tropics, those divergent winds are associated with convection.
  - Check the relationship between  $\chi$  and divergent wind fields.

Hint:  
To draw divergent  
wind vectors, select  
"Udiv" and "Vdiv"  
from pressure-level  
data of JRA-55.



# Answers to Exercise (4)

Vector variables must be set as "Data 1". Set parameters for divU and divV.

## Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	200hPa	MONTHLY	RANGE
	Udiv (Zonal Diverger		Lat: -35 - 35 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2015 1
	Pressure Levels		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 1
	Vdiv (Meridional Divi					
	x: <input type="text"/>					
	<input type="checkbox"/> Stream line					
	<input checked="" type="checkbox"/> Vector <input type="checkbox"/> SD					
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat					

Analysis method: DATA1\_DATA2

Set parameter for  $\chi$  data in "Data2" field.

## Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	200hPa	MONTHLY	RANGE
	$\chi$ (Velocity Potential)		Lat: -35 - 35 Ave <input type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2015 1
	<input type="checkbox"/> SD		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 1

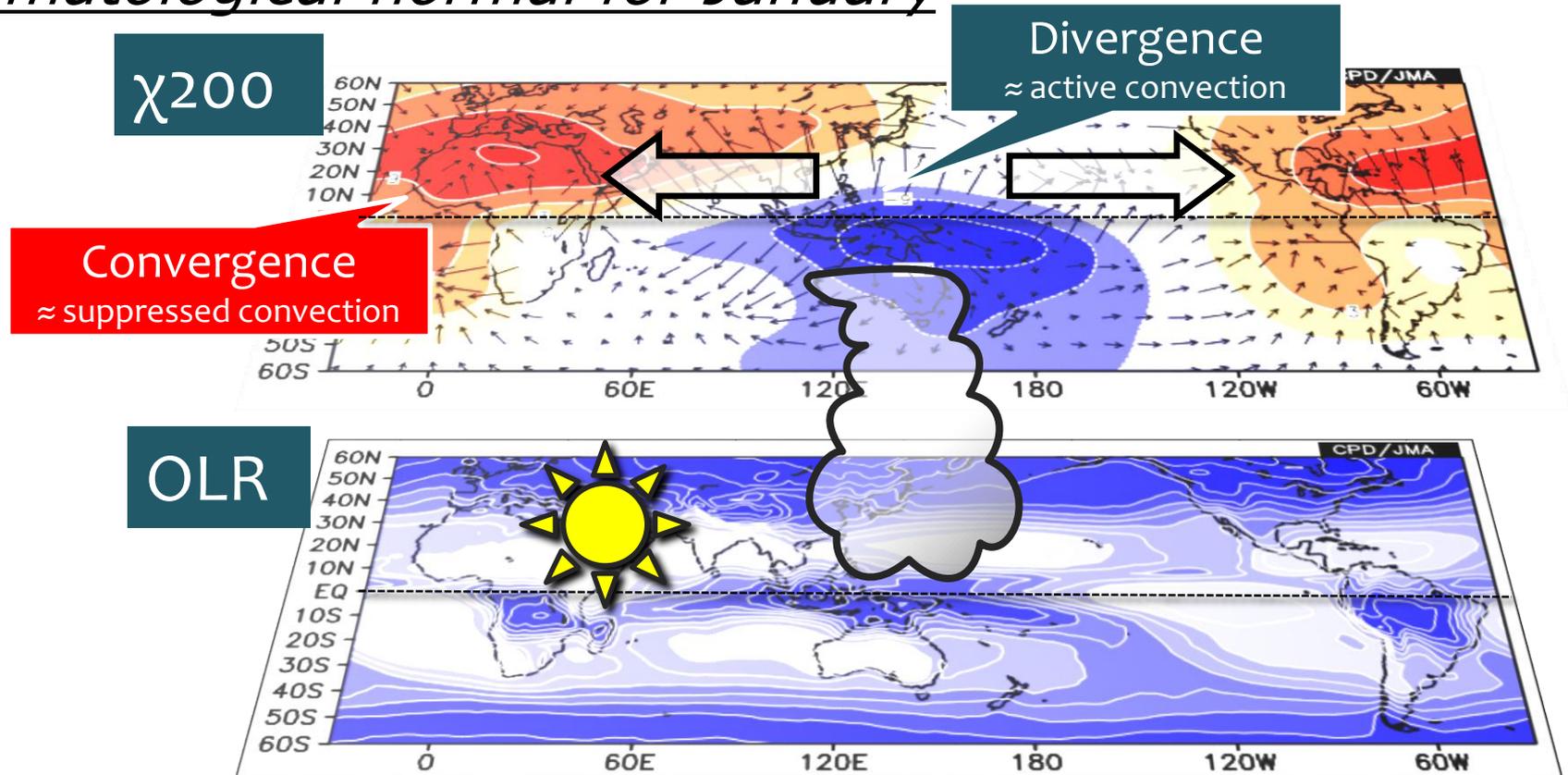
## Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	Set parameters for shading and vector		<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar			<input type="checkbox"/> Draw Credit Inside	
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1	interval: <input type="text"/> min: <input type="text"/> max: <input type="text"/>	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Flip the X-axis	<input type="checkbox"/> Flip the Y-axis
Font: default	<input checked="" type="checkbox"/> Set Contour Parameters for data2	interval: 3 min: -15 max: 15	<input type="checkbox"/> No Caption	<input type="checkbox"/> Apply All Pics	picture size <input type="text"/> %
Color Table: Blue - Red	<input checked="" type="checkbox"/> Set Vector size: 1 [inch] value: 20 skip: 5				

# Topics: Tropical Convection and Divergence

- In the tropics, upper-level divergence (i.e., the minimum of  $\chi$ ) is associated with deep convection.
- Active convection over the Maritime continent.

## Climatological normal for January

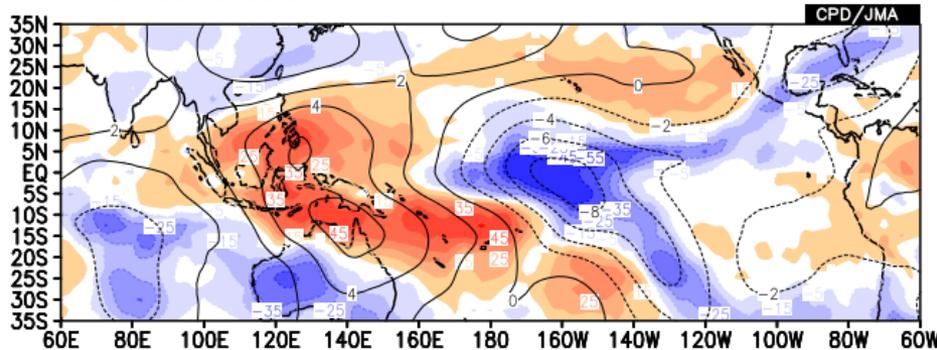


# Exercise (5)

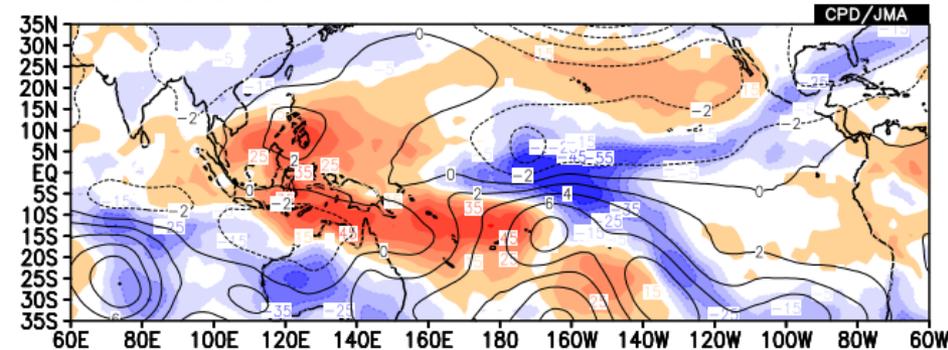
El Niño event was observed during this period.

- Make anomalies map for January 2016.
  - [Left]  $\chi_{200}$  (contour) and OLR (shade)
  - [Right]  $\psi_{850}$  (contour) and OLR (shade)

$\chi_{200}$  (contour) and OLR (shade)



$\psi_{850}$  (contour) and OLR (shade)



Where are upper-level divergence/convergence anomalies?

How about their relationship with OLR anomalies?

What circulation anomalies is collocated with those OLR anomalies?

# Answers of Exercise (5)

Data1

Left

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m <sup>2</sup> ]	ANOM	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 1 2016 1

Vector  SD  
Derivative:  lon  lat

Analysis method: DATA1\_DATA2

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels χ (Velocity Potential)	ANOM	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	200hPa	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 1 2016 1

SD

## Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1
Font: default	interval: 10 min: -55 max: 55
Color Table: Blue - Red	<input type="checkbox"/> Set Contour Parameters for data2
	interval: min: max:
	<input type="checkbox"/> Set Vector size: [inch] value: skip:

# Answers of Exercise (5)

Data1

Right

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m <sup>2</sup> ]	ANOM	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 1 2016 1

Vector  SD  
Derivative:  lon  lat

Analysis method: DATA1\_DATA2

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels ψ (Stream Function)	ANOM	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	850hPa	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 1 2016 1

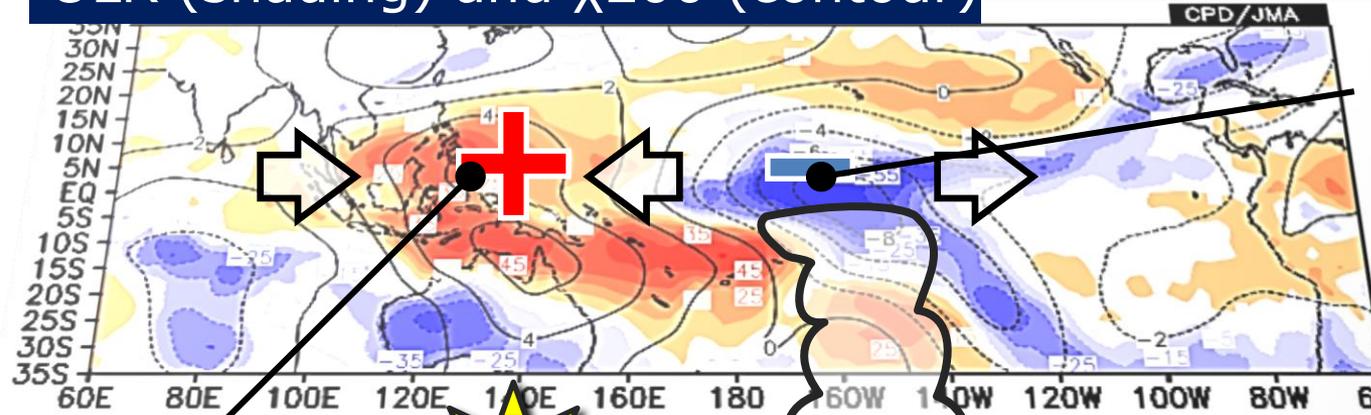
SD

Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1
Font: default	interval: 10 min: -55 max: 55
Color Table: Blue - Red	<input type="checkbox"/> Set Contour Parameters for data2
	interval: min: max:
	<input type="checkbox"/> Set Vector size: [inch] value: skip:

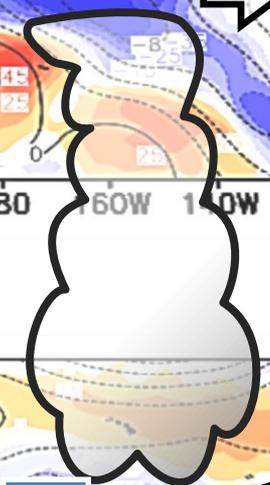
# Topics: Anomalies associated with El Nino

OLR (shading) and  $\chi_{200}$  (contour)



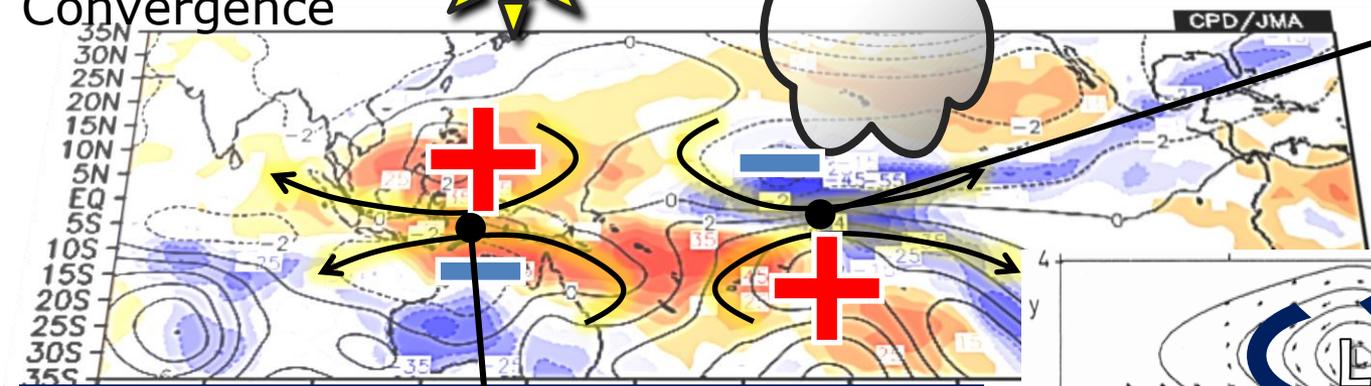
Upper-level Divergence

Upper-level Convergence

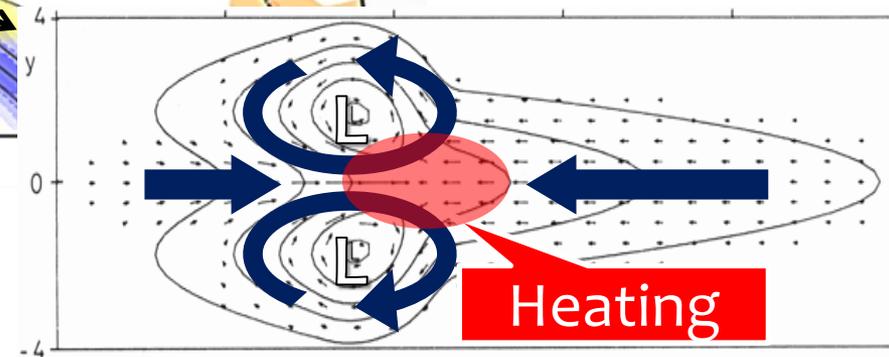


Cyclonic circulation anomalies straddling the equator  
(Negative anomalies in N.H. -> cyclonic  
Positive anomalies in S.H. -> cyclonic)

OLR (shading) and  $\psi_{850}$  (contour)



Anti-cyclonic circulation anomalies straddling the equator



Matsuno-Gill response (Gill, 1980) 46

# Contents

## 1. What's iTacs?

## 2. Basic operations –Horizontal map-

- ❑ Access to iTacs
- ❑ Basic operating procedure
- ❑ Longitude-latitude map
- ❑ Multiple data

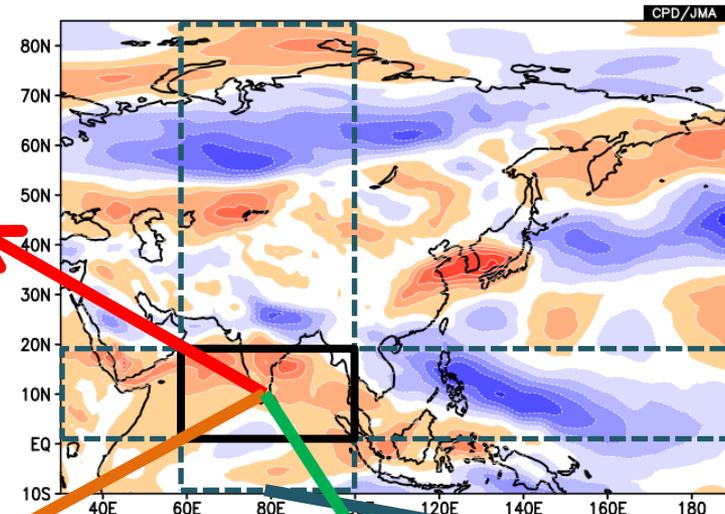
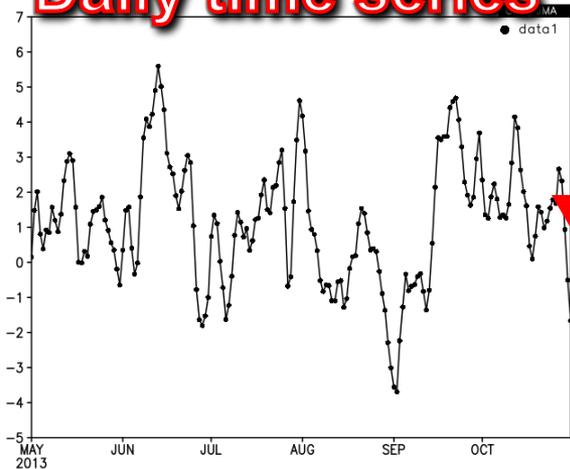
## 3. Basic operations –Other kinds of maps-

- ❑ Vertical and latitude/longitude profile
- ❑ Cross section diagram

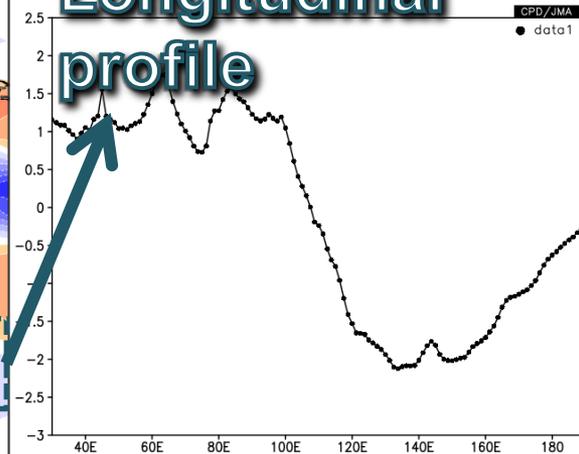
# Line graph & Cross section diagram

- Time series and profile graph are useful to see the variability or spatial structure simply.

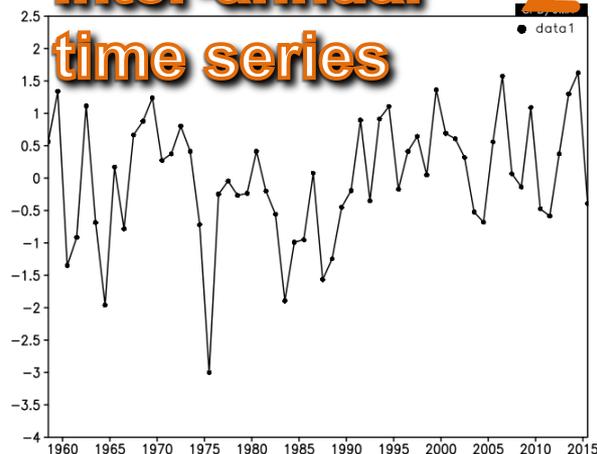
**Daily time series**



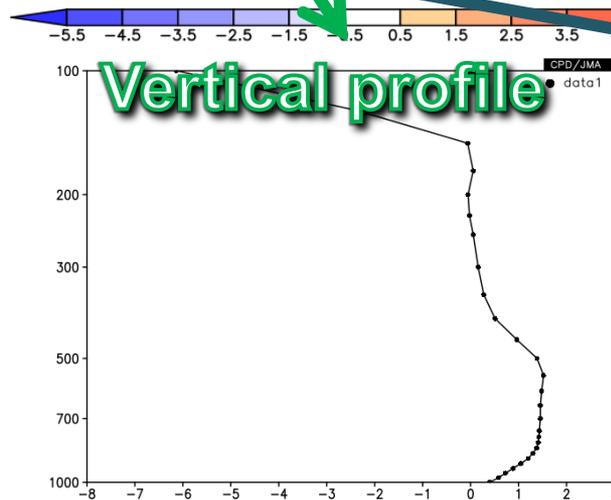
**Longitudinal profile**



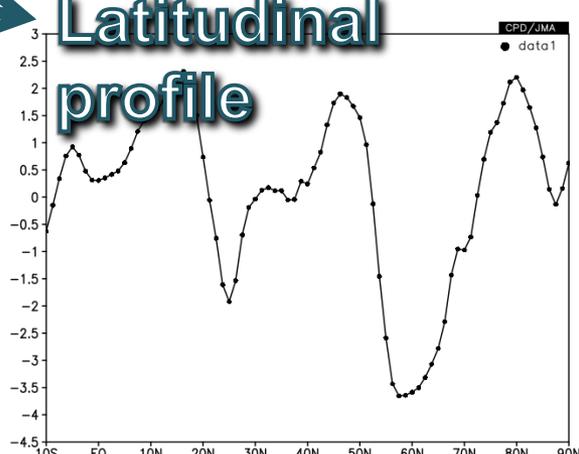
**Inter-annual time series**



**Vertical profile**



**Latitudinal profile**



# Daily timeseries

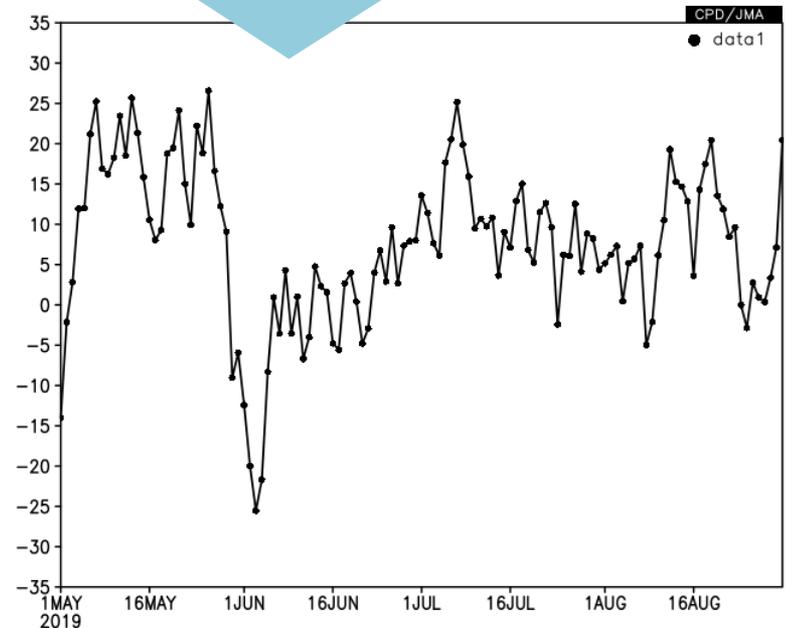
**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m <sup>2</sup> ]	ANOM	ALL		DAILY	RANGE
			Lat: -10 - 10	Ave <input checked="" type="checkbox"/>	<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2019 5 1
			Lon: 90 - 150	Ave <input checked="" type="checkbox"/>	<input type="checkbox"/> Time filter	2019 8 31

Vector  SD  
Derivative:  lon  lat

1. Select OLR anomalies for element boxes.
2. Select 10°S–10°N, 90°–150°E for “Area” box.
  - The area covers the Maritime continent.
  - Check “Ave” boxes.
3. Select “DAILY” for time unit, and showing period
  - Showing period: 1 May 2019 – 31 Aug. 2019.

Daily timeseries of OLR anomalies



- Similarly, you can draw monthly or annual timeseries by setting “Time unit”.

# Inter-annual timeseries

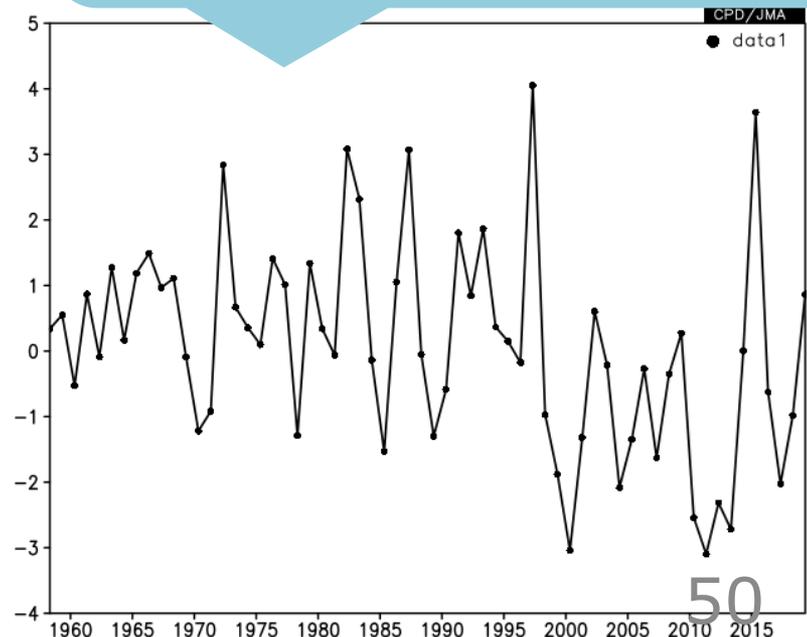
**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels χ (Velocity Potential)	ANOM	ALL Lat: -10 - 10 Ave <input checked="" type="checkbox"/> Lon: 90 - 150 Ave <input checked="" type="checkbox"/>	200hPa 200hPa	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1958 - 2019 5 - 8

Vector  SD  
Derivative:  lon  lat

1. Select 200-hPa velocity potential anomalies for element boxes.
2. Select 10°S–10°N, 90°–150°E for “Area” box.
  - The area covers the Maritime continent.
  - Check “Ave” boxes.
3. Select “MONTHLY” for time unit, and showing period
  - Check “Year-to-year”.
  - Showing period: 1958 – 2019, 5 – 8.

Inter-annual timeseries of 4-month (May – August) mean 200-hPa velocity potential anomalies



# Vertical and lat/longitude profile

- Vertical profile

Area		Level	Time unit	Showing period	
ASIA		1000hPa	MONTHLY	RANGE	
Lat: 25	- 35	1hPa	<input type="checkbox"/> Ave	<input type="checkbox"/> Year-to-year	2019
Lon: 120	- 130		<input type="checkbox"/> Time filter		7
	<input checked="" type="checkbox"/> Ave				2019
	<input checked="" type="checkbox"/> Ave				7

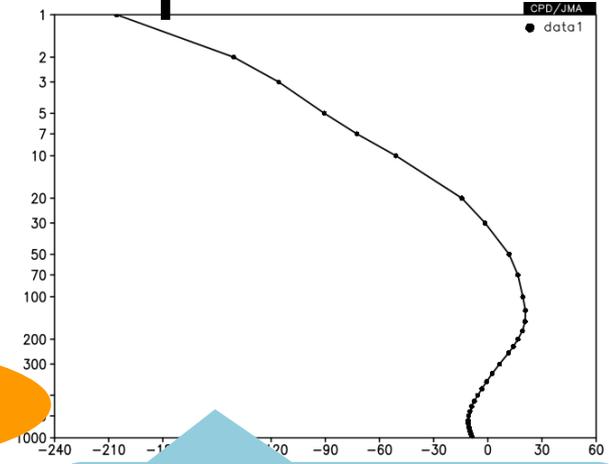
Select bottom and top level

Check (Regional mean)

Set a specific period

“Logarithmic Coordinates” option is recommended in vertical profile graph.

<input type="checkbox"/> Polar Stereographic:	Normal
<input checked="" type="checkbox"/> Logarithmic Coordinates	



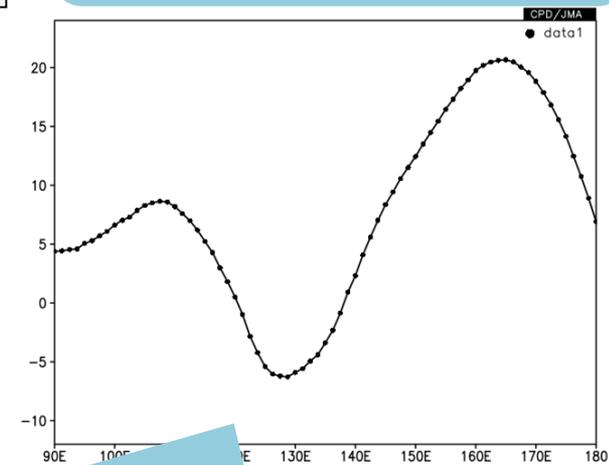
Height anomalies averaged over 25°–35°N, 120°–130°E

- Lat/Longitude profile

Area		Level	Time unit	Showing period	
ASIA		500hPa	MONTHLY	RANGE	
Lat: 25	- 35	500hPa	<input checked="" type="checkbox"/> Ave	<input type="checkbox"/> Year-to-year	2019
Lon: 90	- 180		<input type="checkbox"/> Time filter		6
	<input type="checkbox"/> Ave				2019
					7

Check either “Ave” boxes (latitudinal or longitudinal mean)

Select a specific level and period



Longitude profile of 500-hPa height anomalies over 25°–35°N



# Vertical cross section

- Latitude-height cross section

**Data 1**

Dataset	Element	Data type	Level	Time unit	Showing period
JRA-55	Pressure Levels ω (Pressure Vertical)	NORM	ALL Lat: -60 - 60 Ave <input type="checkbox"/> Lon: 90 - 150 Ave <input checked="" type="checkbox"/>	1000hPa 100hPa MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 6 2016 8

Input southern and northern border

Set a specific period

Input western and eastern border and check "Ave" box.

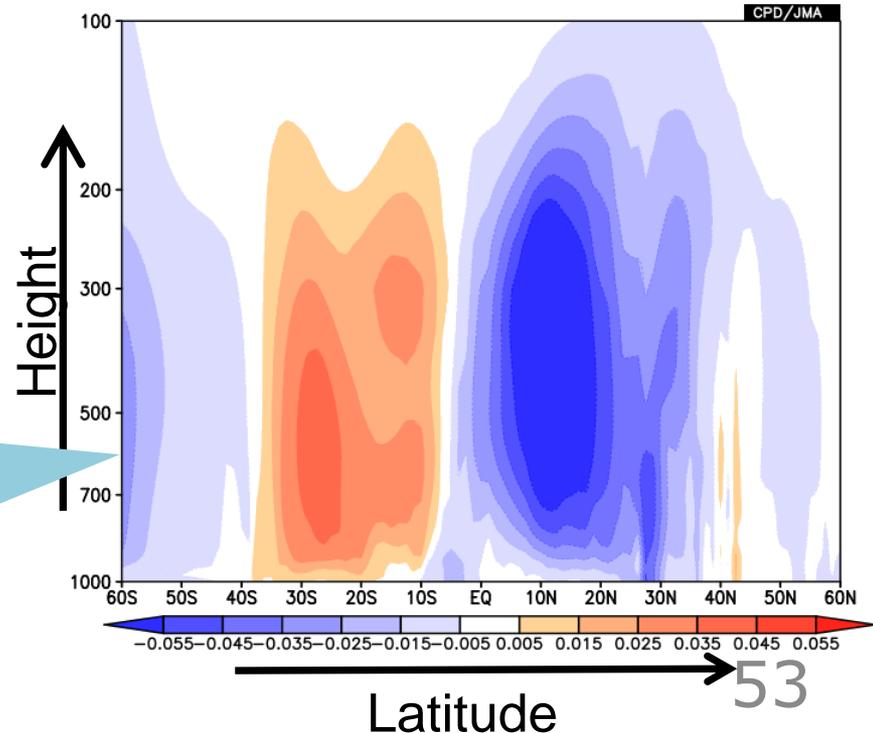
Set bottom and top level

Polar Stereographic: North p  
 Logarithmic Coordinates

"Logarithmic Coordinates" is recommended to draw vertical profiles.

Latitude-height cross section of normal pressure vertical velocity averaged between 90°E and 150°E in summer 2016

DATA1 JRA-55 omg37 NORM lat = -60:60 lon = 90:150 level = 1:27  
time = 2016060100:2016080100 ave = 3MO



# Time cross section

- Longitude-time cross section

**Data1**

5°S–5°N averaged

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels χ (Velocity Potential)	ANOM	ALL Lat: -5 - 5 Ave <input checked="" type="checkbox"/> lon: 0 - 360 Ave <input type="checkbox"/>	200hPa	DAILY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2019 6 1 2019 8 31

200-hPa

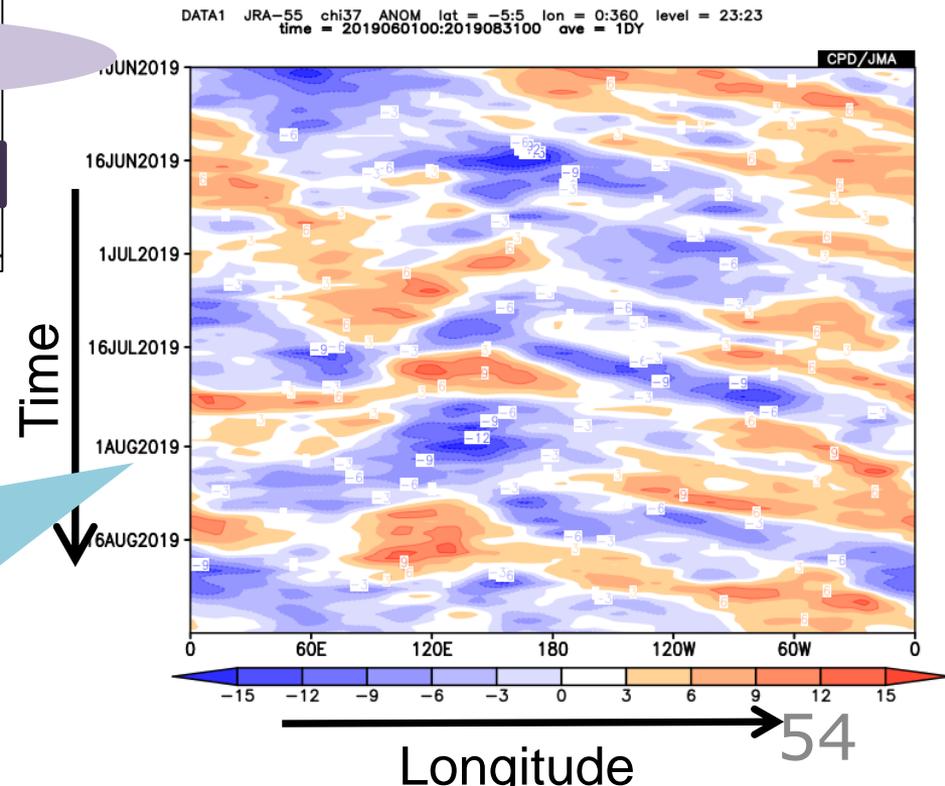
**Graphic Options**

Contour interval:3

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1
Font: default	Interval: 3 min: -15 max: 15
Color Table: Blue - Red	<input type="checkbox"/> Set Vector size: [inch] value: skip: 1

Blue-Red colored shading

Longitude-time cross section of 200-hPa velocity potential anomalies averaged over 5°S – 5°N from 1 Jun to 31 August 2019.

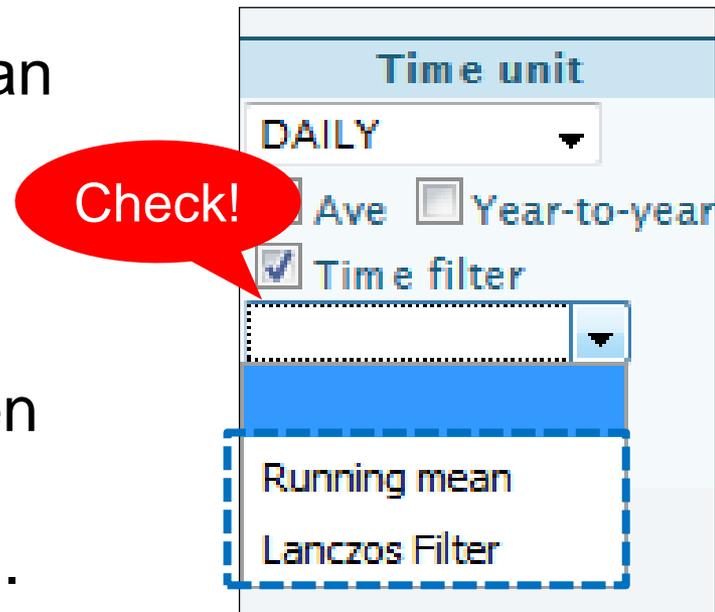


# Time filter

- Time filter should be used to create a time series image in the climate analysis.
- Climatological events are emphasized by a time filter, because it can remove high frequency variations.

Checking “Time filter” box, you can select two types of the time-filter.

- ❑ Running mean: Smooth the original data simply.
- ❑ Lanczos filter: Pick up the given period component and mean them based on Duchon (1979).



# Time cross section

- Running mean longitude-time cross section

**Data1**

5°S–5°N averaged

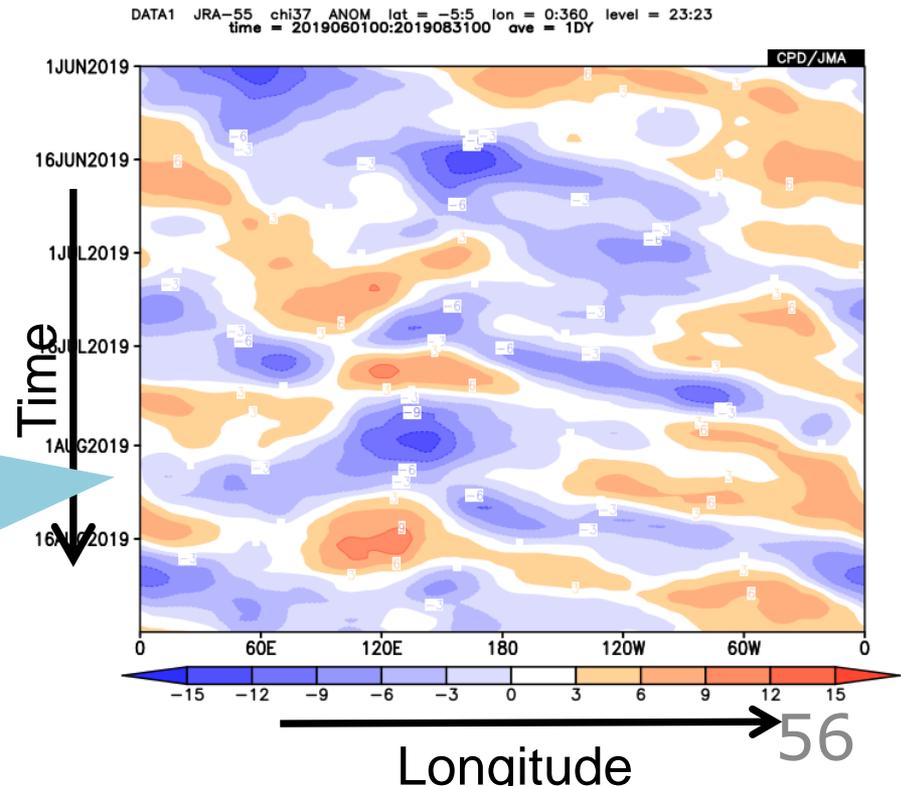
Dataset	Element	Data type	Level	Time unit	Showing period
JRA-55	Pressure Levels χ (Velocity Potential)	ANOM	ALL Lat: -5 - 5 Ave <input checked="" type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	200hPa 200hPa	DAILY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter Running mean mean period 5
					RANGE 2019 6 1 2019 8 31

200-hPa

- Select 5°S–5°N mean 200-hPa velocity potential anomalies.
- Set 5-day running mean in “Time unit” box.

Note: Graphical setting is the same as that in slide 54.

Longitude-time cross section of 5-day running mean 200-hPa velocity potential anomalies averaged over 5°S–5°N from 1 Jun to 31 August 2019.



# Running mean daily timeseries

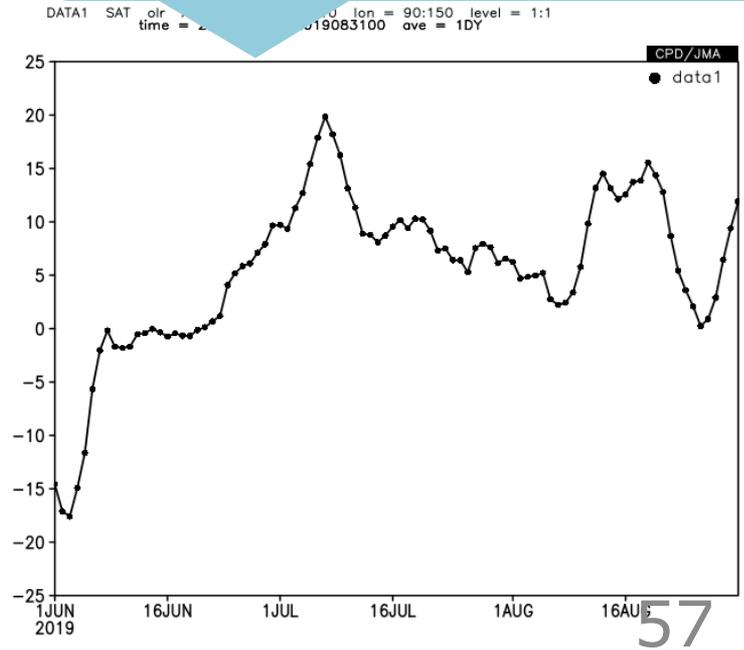
**1** Dataset: SAT, Element: OLR [W/m<sup>2</sup>], Data type: ANOM

**2** Area: ASIA, Lat: -10 to 10, Ave , Lon: 90 to 150, Ave

**3** Time unit: DAILY, Time filter: Running mean, mean period: 5

1. Select OLR anomalies for element boxes.
2. Select 10°S–10°N, 90°–150°E for “Area” box.
  - Check “Ave” boxes.
3. Select “DAILY” for time unit, and showing period.
  - Showing period: 1 Jun. 2019 – 31 Aug. 2019.
  - Check “Time filter” in time unit box, and select “Running mean” and “5(day)” in “mean period” box.

5-day running mean daily timeseries of OLR anomalies



# Exercise (3)

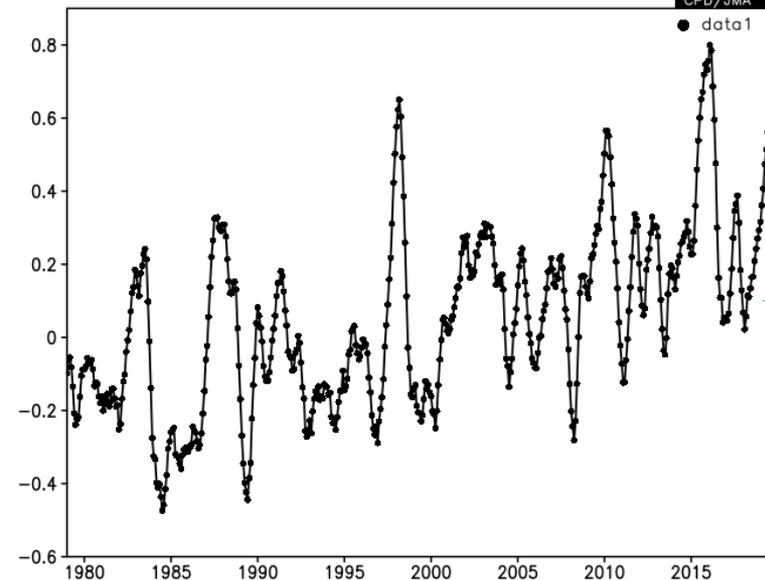
- Show a time series of 5-month running mean monthly SST anomalies averaged over the Indian Ocean (20°S–20°N, 40°–100°E) from January 1979 to July 2019.



DATA1 SST\_sst ANOM lat = -20:20 lon = 40:100 level = 1:1  
time = 1979010100:2019070100 ave = 1MO

CPD/JMA

● data1



Monthly timeseries of 5-month running mean SST anomalies averaged over the Indian Ocean

# Answers to Exercise (3)

**Data1**

SST anomalies

Don't forget to check!

Area average in the Indian Ocean

5-month running mean from Jan. 1979 to Jul. 2019

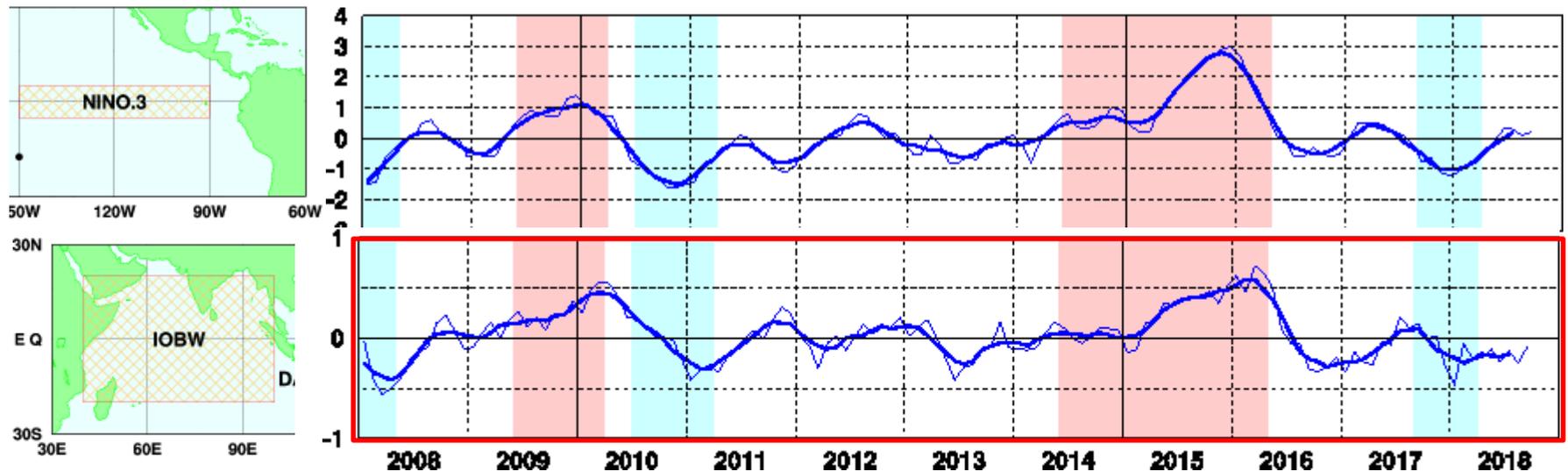
Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C	ANOM	ALL Lat: -20 - 20 Ave <input checked="" type="checkbox"/> Lon: 40 - 100 Ave <input checked="" type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter Running mean mean period 5	RANGE 1979 1 2019 7

Vector  SD  
Derivative:  lon  lat

Analysis method: -Analysis method-

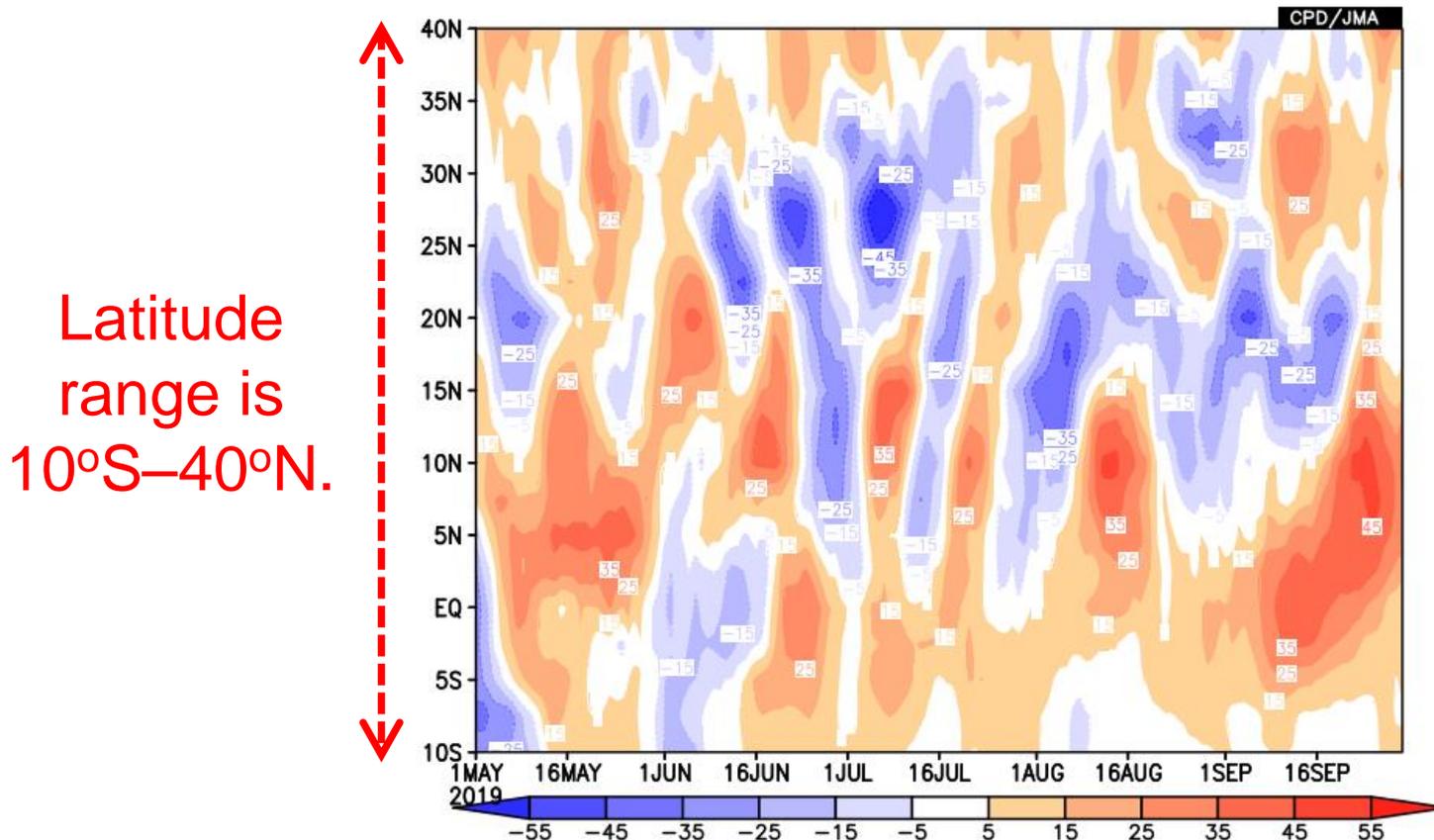
# Topics: Tropical Indian Ocean (IOBW)

- which are identified by SST fluctuations from the central to the eastern equatorial Pacific (NINO.3), are widely-known and
- In addition to El Niño/La Niña events, the tropical Indian Ocean (IOBW) may also have significantly affect climate conditions around the world. JMA surveyed the IOBW indice to monitor its impacts.



# Exercise (5)

- Show a time-latitude cross section of 7-day running mean OLR anomalies averaged over 115°–135°E from 1 May to 30 September 2019.



# Answers to Exercise (5)

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m <sup>2</sup> ]	ANOM	ALL Lat: -10 - 40 Ave <input type="checkbox"/> Lon: 115 - 135 Ave <input checked="" type="checkbox"/>	1	DAILY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter Running mean mean period 7	RANGE 2019 5 1 2019 9 30

OLR anomalies

115°–135°E mean  
from 10°S to 40°N

7-day running mean from 1  
May to 30 Sep. 2019

**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 interval: 10 min: -55 max: 55	<input checked="" type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Apply All Pics
Font: default	<input type="checkbox"/> Set Vector size: [inch] value: skip: 1	<input type="checkbox"/> Flip the X-axis <input checked="" type="checkbox"/> Flip the Y-axis	picture size %
Color Table: Blue - Red		<input type="checkbox"/> No Captions	

Contour interval: 10

Blue-Red colored  
shading

To adjust axis setting, check  
“Reverse the Axes” and “Flip  
the Y-axis”.

This lecture will be continued to the lecture of

# Advanced operation of iTacs

See you tomorrow!



# Operation of iTacs (advanced)

- Interactive Tool for Analysis of the Climate System -

Shunya Wakamatsu & Atsushi Minami  
& Staff Members of Tokyo Climate  
Center

Tokyo Climate Center  
Japan Meteorological Agency

# Contents

## 4. Statistical Analysis in iTacs

- Introduction
- Correlation / Regression Analysis
- Composite Analysis

## 5. Other Advanced operations

- Data download
- User data input

# Statistical Analysis in iTacs

- Various statistical analysis methods are available.
  - Correlation/Regression analysis
  - Composite analysis
  - Single/multi EOF, SVD analysis
  - FFT analysis
  - Wavelet analysis
- They can be powerful and helpful for understanding our climate system. Of course, statistics is also necessary for seasonal forecast.



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

# Contents

## 4. Statistical Analysis in iTacs

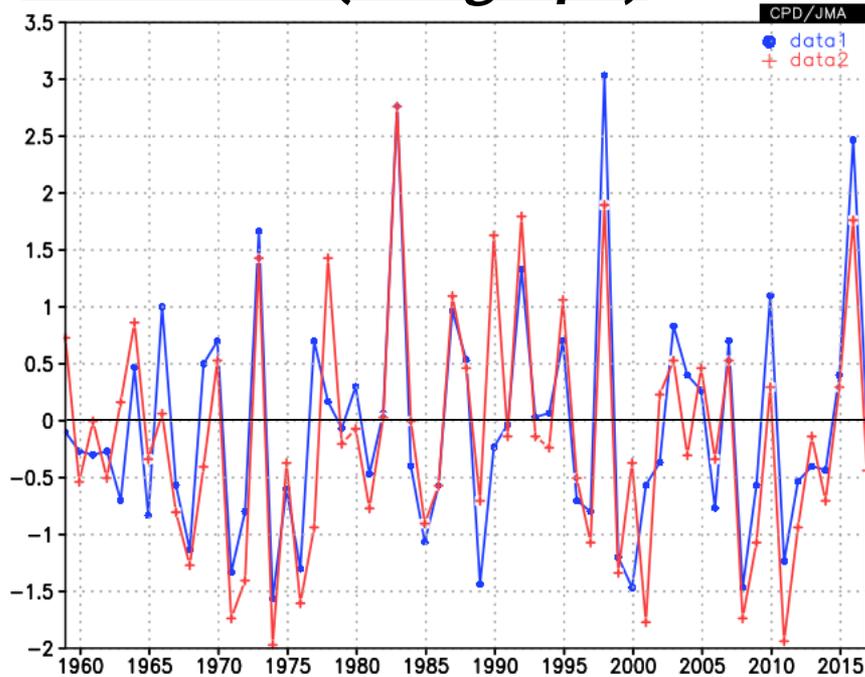
- ❑ Introduction
- ❑ Correlation / Regression Analysis
- ❑ Composite Analysis

## 5. Other Advanced operations

- ❑ Data download
- ❑ User data input

# Tips: Correlation analysis

## Time series (line graph)



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

**Blue: NINO.3 SST anomaly**

(Positive: El Nino-like, Negative: La Nina-like)

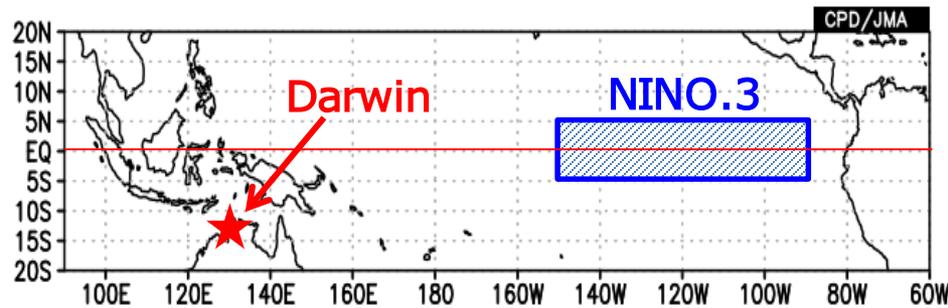
**Red: SLP anomaly at Darwin**

12.5S,130.8E

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

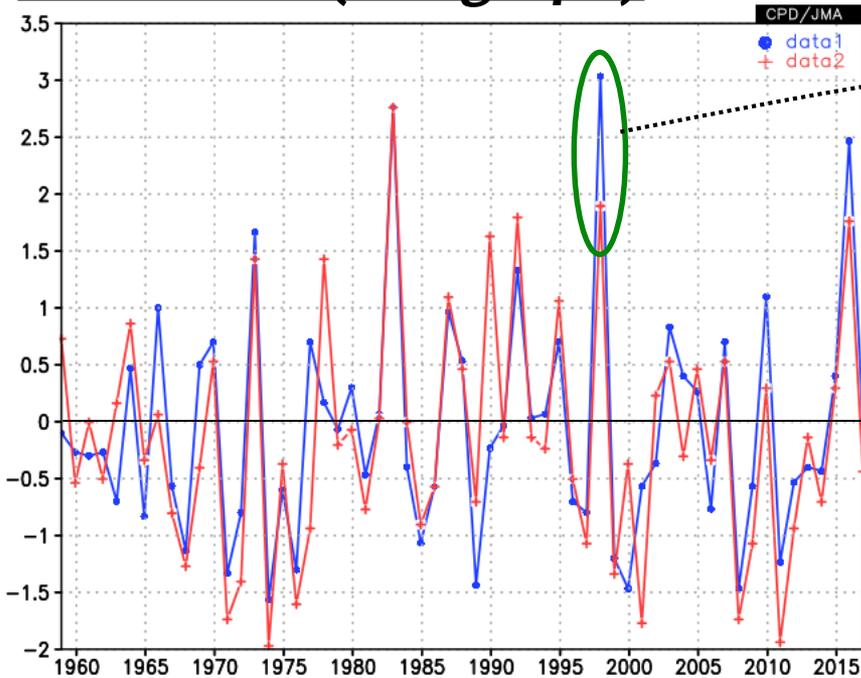
Next step is...,

**How can we evaluate the relationship objectively and quantitatively?**

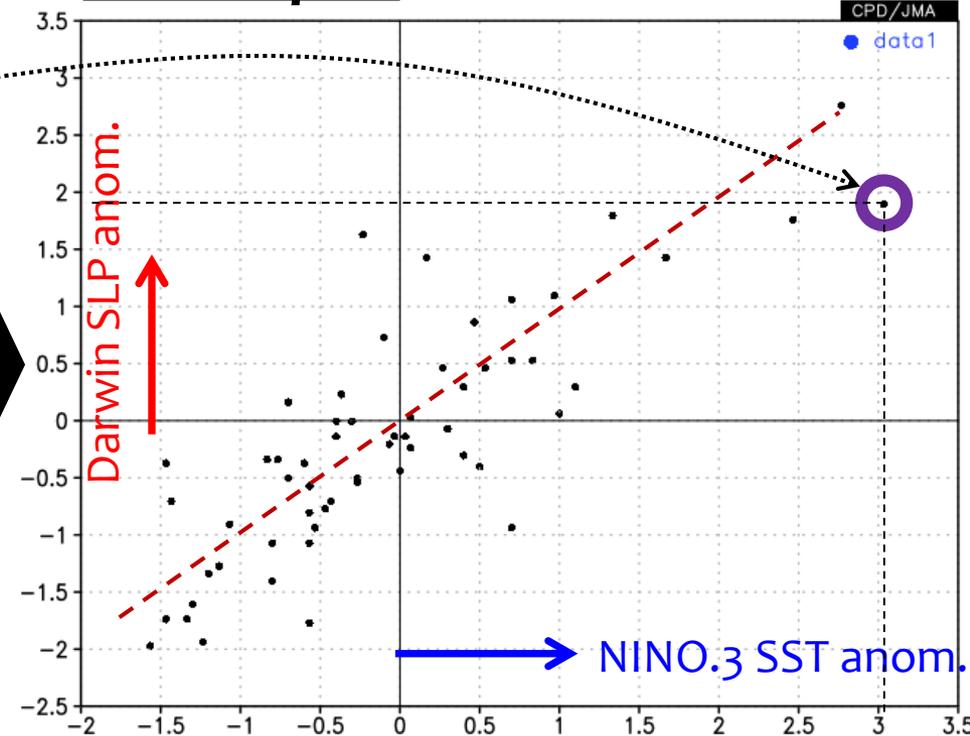


# Tips: Correlation analysis

## Time series (line graph)



## Scatter plot

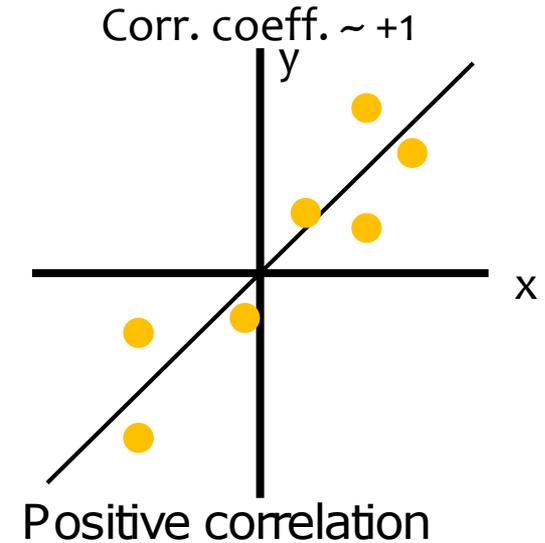
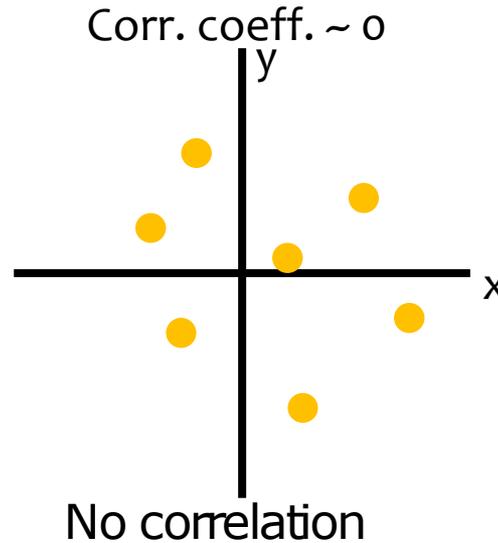
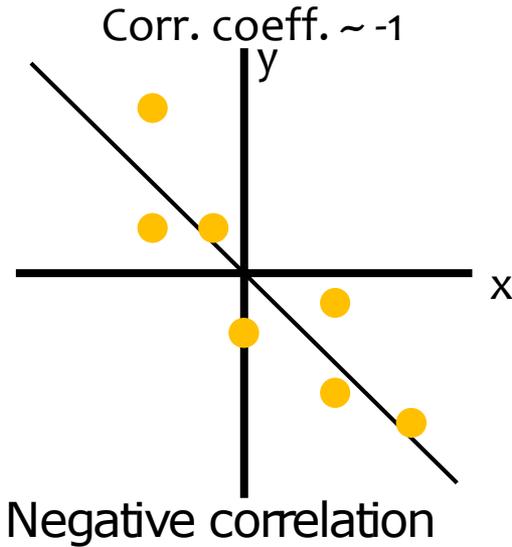


If we link **each pair** of NINO.3 SST and Darwin's SLP values to **a point** on a x-y map, we can clearly see a linear relation between them. We can evaluate the relationship with **correlation coefficients**.

**Correlation coefficient: How close they have a linear relationship**

# 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 (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 btwn X and Y.....,

$$X \rightarrow Y$$

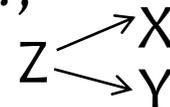
X causes Y

$$Y \rightarrow X$$

Y causes X



Feedback



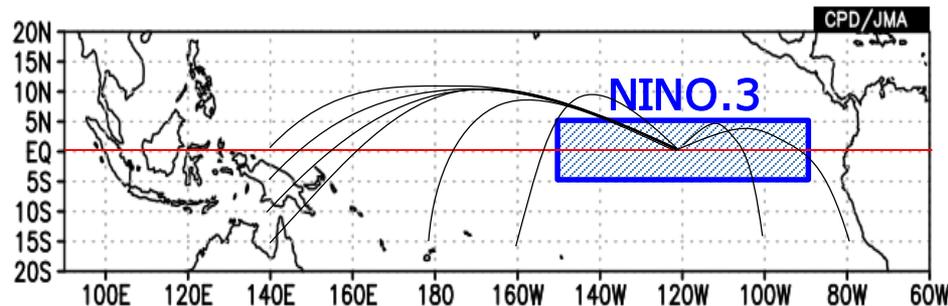
Unknown Z causes both X and Y



# Correlation Analysis (1)

- We confirmed that there is a strong positive correlation between **NINO.3 SST anomalies** and **Darwin sea level pressure (SLP) anomalies**.

Question: How about another station's SLP? Rather, how about **every grid points** throughout the world?



**Evaluating the correlation coefficients** between **NINO.3 SST** and **SLP at every grid points** and 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 1958/1959 to 2018/2019.

# Correlation Analysis (2)

- Setting "Data1" and "Data2".

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Surface SLP (Sea Level Presst	ANOM	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 1958 - 2018 12 - 2

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

This setting means DJF average from 1958/1959 (December 1958 to February 1959) to 2018/2019 (December 2018 to February 2019). 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	ANOM	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year	0 YEAR	95%(two side)

"Data2" lags set period behind "Data1".

Select options indicate confidence level indicated by t-testing.

# Correlation Analysis (3)

- Setting Graphic Options.

Set "Drawing"  
"CONTOUR" to shade  
the grids exceeding  
confidence level.

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

**Graphic Options**

Colorizing: COLOR ▾

**Drawing: CONTOUR ▾**

Image Format: png ▾

Color Table: Blue - Red ▾

Show Contour Labels

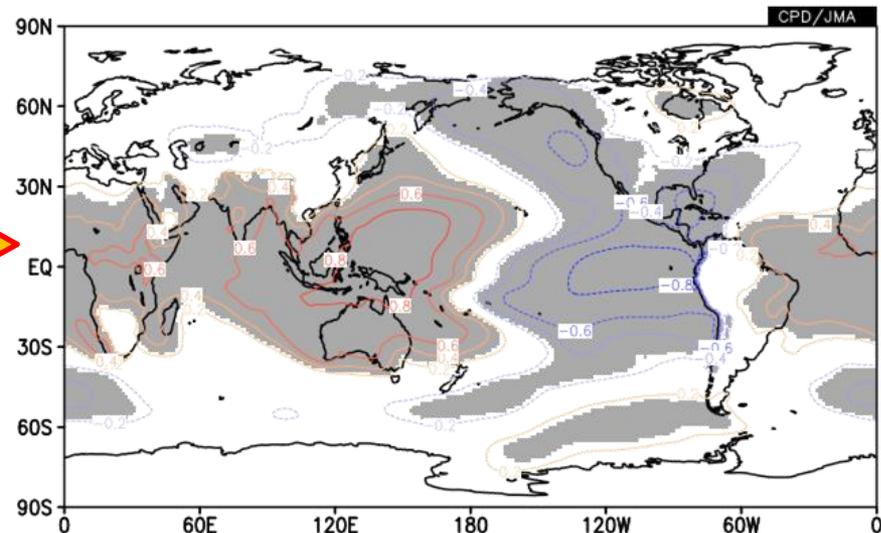
Show Color Bar

Set Contour Parameters for data1

Interval: 0.2    min: -1    max: 1

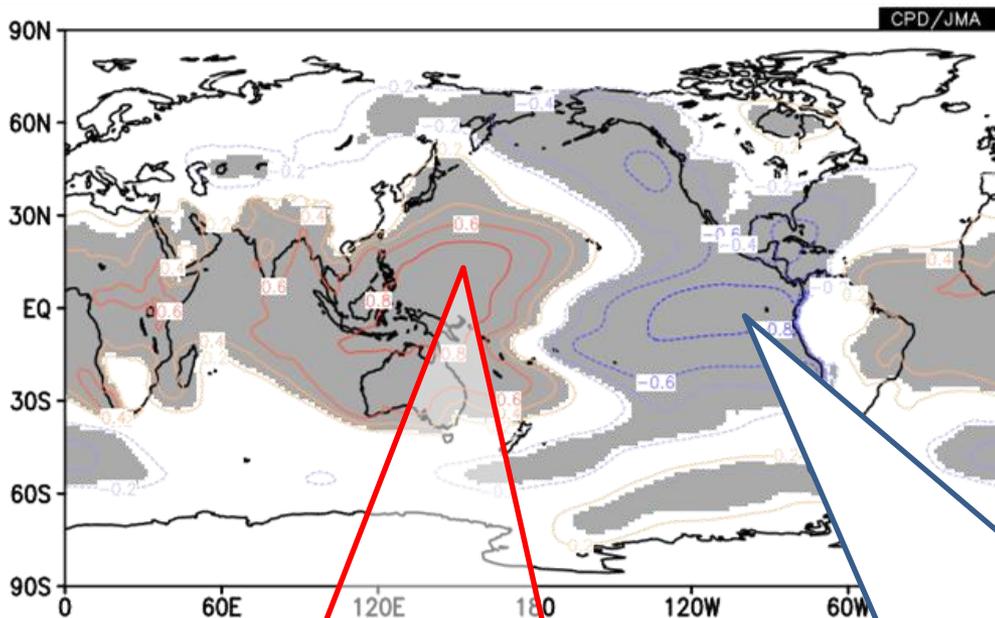
Set Vector size: [ ] [inch] value: [ ] skip: 1

**Don't forget!**



# Correlation Analysis (4)

Correlation coefficient between NINO.3 index and SLP in DJF from 1958/59 to 2018/19.



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.

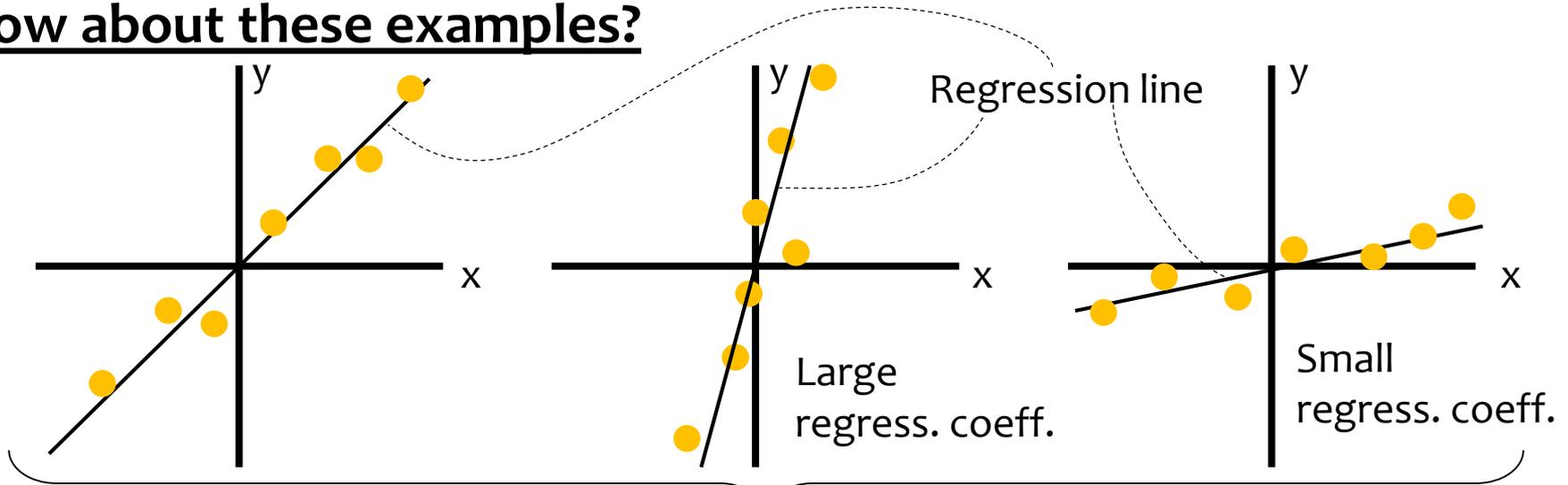
The red contours indicate positive values of correlation coefficients. Simply stated, **positive** (**negative**) SLP anomalies during **El Niño** (**La Niña**).

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**).

# 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.**

# 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 1958/1959 to 2018/2019.
- For a regression analysis, "Data1" is a responsible (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.

# Regression Analysis (2)

- Setting "Data1" and "Data2".

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Surface SLP (Sea Level Pressu	ANOM	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 1958 - 2018 12 - 2

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

This setting means DJF average from 1958/1959 (December 1958 to February 1959) to 2018/2019 (December 2018 to February 2019). Consider the setting for year and month separately.

analysis method: REGRESSION\_COEFFICIENT

**Data2**

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

Select "REGRESSION\_COEFFICIENT".

"Data2" lags set period behind "Data1".

Select options indicate confidence level indicated by t-testing.

# Regression Analysis (3)

- Setting Graphic Options.

Set "Drawing"  
"CONTOUR" to shade  
the grids exceeding  
confidence level.

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

**Graphic Options**

Colorizing: COLOR ▾

**Drawing: CONTOUR ▾**

Image Format: png ▾

Font: default ▾

Color Table: Blue - Red ▾

Show Contour Labels

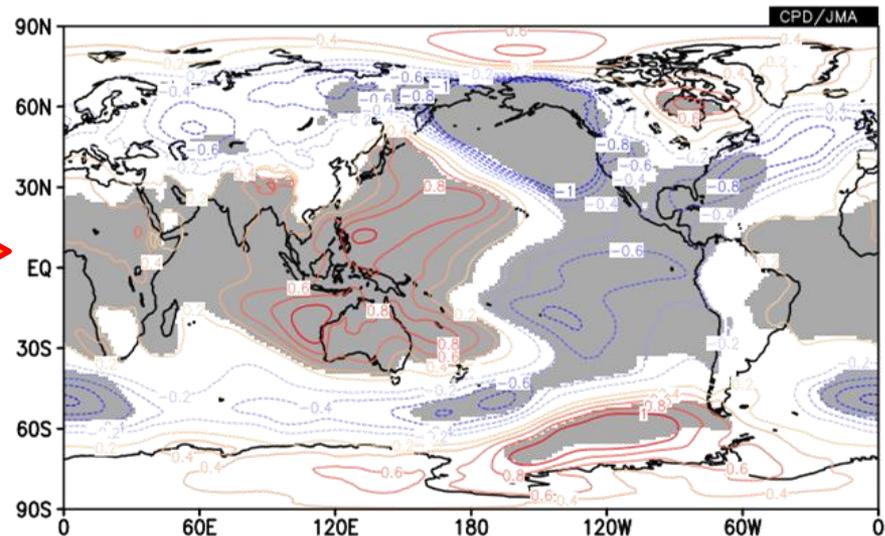
Show Color Bar

Set Contour Parameters for data1

interval: 0.2 min: -1 max: 1

Set Vector size: [ ] [inch] value: [ ] skip: 1

**Don't forget!**



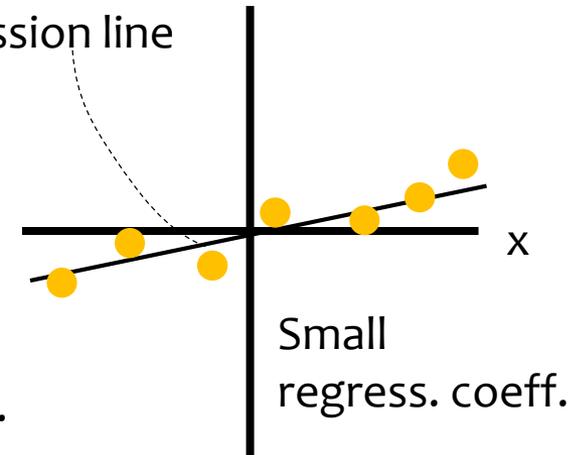
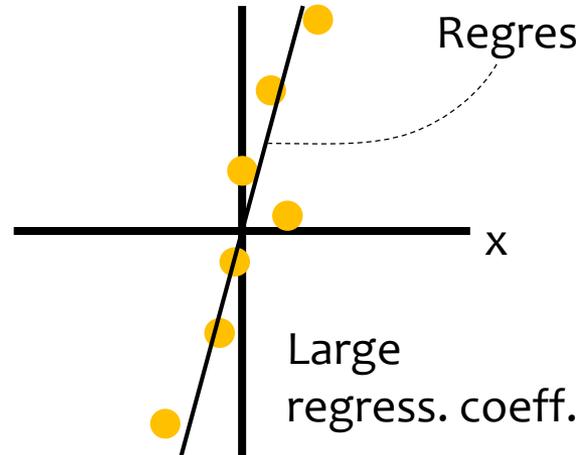
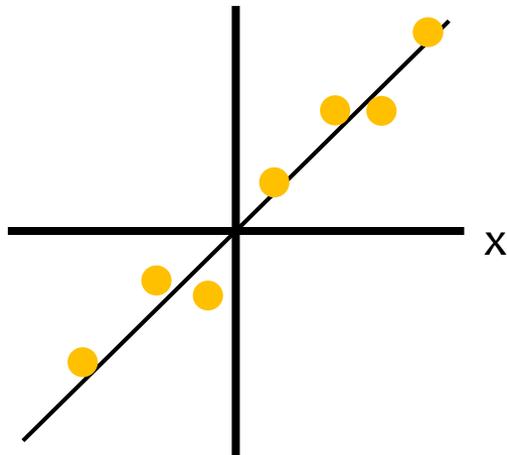
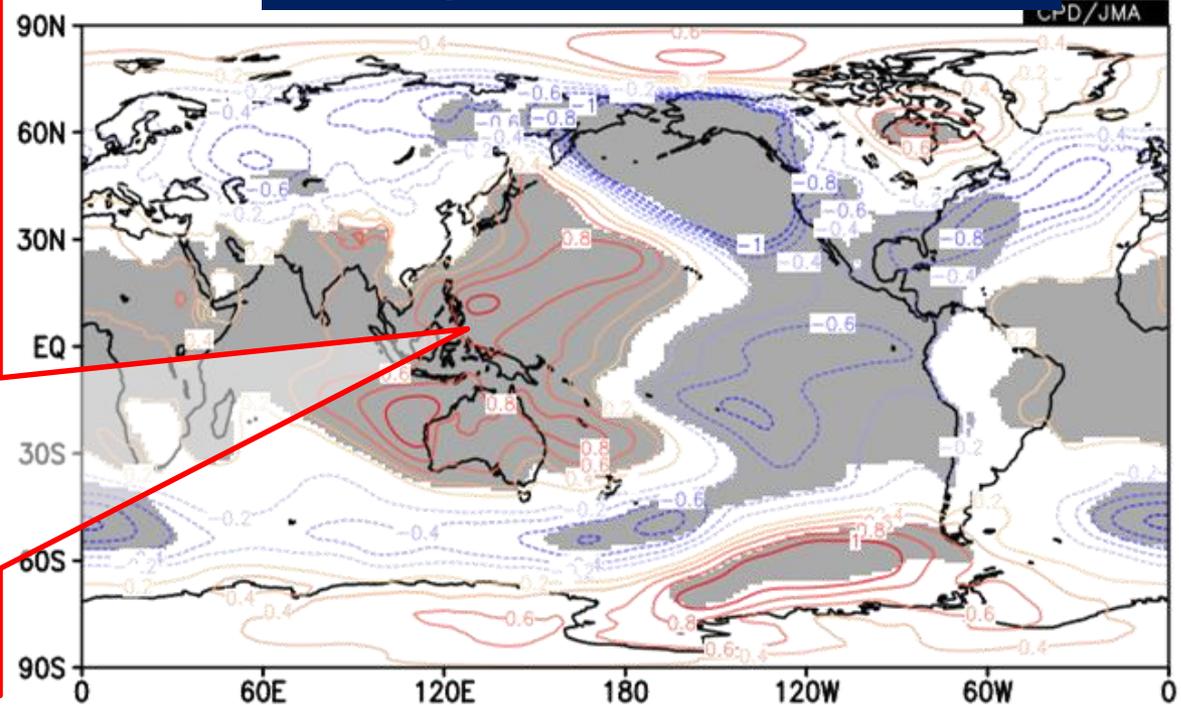
# Regression Analysis (4)

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.

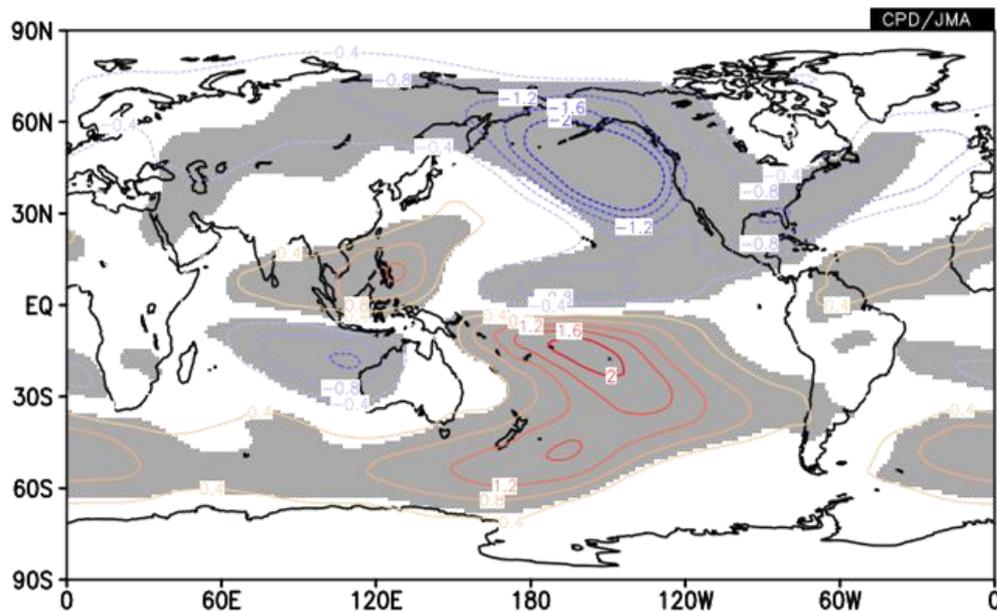
Recall that regression coefficients are the slope of regression lines,  $\Delta y/\Delta x$ . In this case, x is NINO.3 SST index and y is SLP.

SLP regressed onto NINO.3 SST



# Exercises (6)

- Make a regression coefficients map of 850hPa stream function ( $\psi_{850}$ ) anomalies onto NINO.3 SST anomalies for DJF.
  - Set the statistical period from 1958/59 to 2018/19.
  - Stream function can be found in Dataset of "JRA-55", Element of "Pressure Levels".
  - NINO.3 is defined as the area in 5°S–5°N,150°–90°W.
  - Set the confidence level **95% (two side)**.



# Answers to Exercises (6)

## Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels $\psi$ (Stream Function)	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	850hPa	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1958 - 2018 12 - 2

Don't forget!

Select "REGRESSION COEFFICIENT"

Analysis method: REGRESSION\_COEFFICIENT

Set "showing period" DJF from 1958/59 to 2018/19.

## Data2

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

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

## Graphic Options

Colorizing: COLOR	<input type="checkbox"/> Show Contour Labels
Drawing: CONTOUR	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1
Font: default	interval: 0.4 min: -2 max: 2
Color Table: Blue - Red	<input type="checkbox"/> Set Vector size: [ ] [inch] value: [ ] skip: 1

Don't forget!



# Contents

## 4. Statistical Analysis in iTacs

- ❑ Introduction
- ❑ Regression / Correlation Analysis
- ❑ **Composite Analysis**

## 5. Other Advanced operations

- ❑ Data download
- ❑ User data input

# Composite analysis (1)

- **Composite analysis:** To collect many samples matching given conditions (e.g., El Nino condition) and do statistical analysis of them (e.g., taking an average). It is a kind of conditional sampling.

## Example

Full set of data

1958
1959
1960
1961
1962
•
•
•
2017
2018
2019

Designated Condition  
(eg. SSTA in NINO.3 > 0.5 °C)

Subset of data

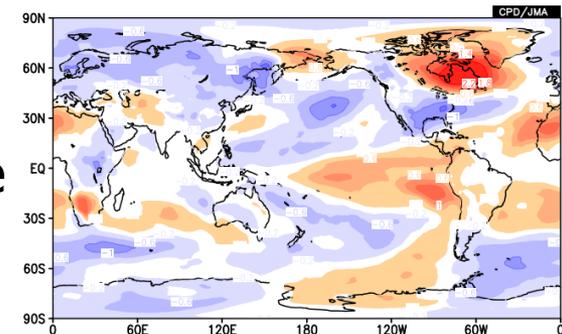
Pick out  
years  
matching  
a given  
condition

1965
•
•
1997
2002
2009
2015
2018

Average

*By composite analysis..., we can get common characteristics associated with a given condition.*

Composite map



# Composite analysis (2)

Let's make a composite map of 850-hPa zonal wind when NINO.3 SST anomalies for DJF  $> 0.5$  (i.e. El Nino -like condition).

1. Set the "Data1".
2. Select "COMPOSITE" in the "analysis method" box.
3. Set the "Data2" (give a composite condition).

1 **Data1** Select the compositing element

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels U (Zonal Wind) [m/s]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	850hPa	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> filter	RANGE 1958 - 2018 12 - 2

Vector  SD  
Derivative:  lon  lat

Check "Year-to-year"

2 Analysis method: COMPOSITE

**Data2**

3

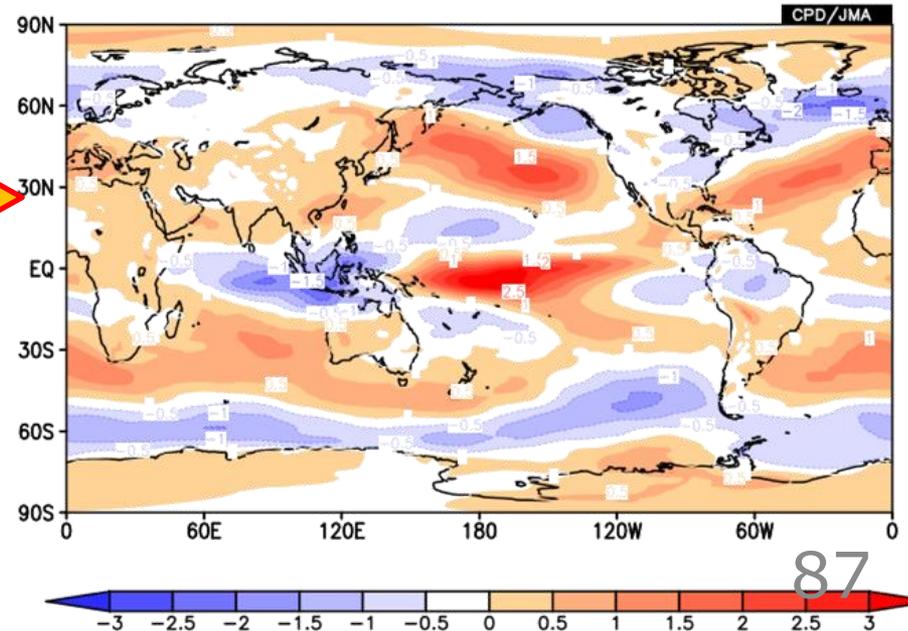
Dataset	Element	Data type	Time unit
INDEX	NINO.3 <input type="checkbox"/> SD	ANOM $>$ 0.5	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter

# Composite analysis (3)

Let's make a composite map of 850-hPa zonal wind when NINO.3 SST anomalies for DJF > 0.5.

### Graphic Options

Colorizing: COLOR ▾	<input checked="" type="checkbox"/> Show Contour Labels
<b>Drawing: SHADE ▾</b>	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png ▾	<input checked="" type="checkbox"/> Set Contour Parameters for data 1
Font: default ▾	interval: 0.5 min: -3 max: 3
Color Table: Blue - Red ▾	<input type="checkbox"/> Set Vector size: [ ] [inch] value: [ ] skip: 1

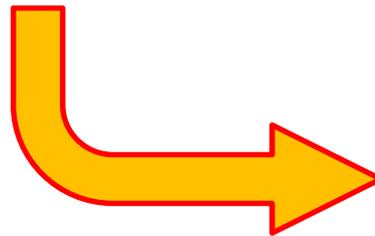


# Composite analysis (4): "Another Way"

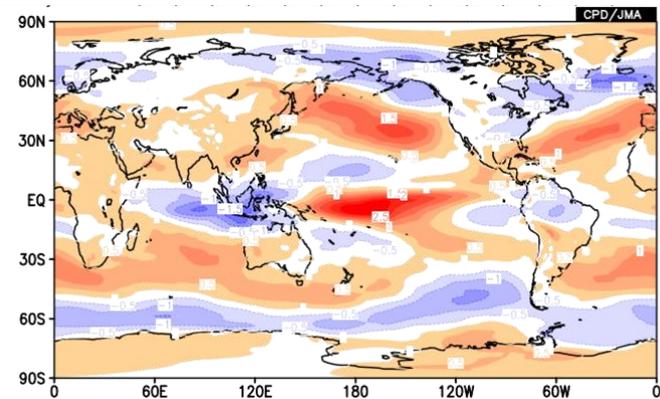
- If you know already target years for compositing, you do not have to use "COMPOSITE" method. Select "YEARS" and input the years and months in "Showing period".

Check "Ave" and "Year-to-year"

Input the target years and/or months

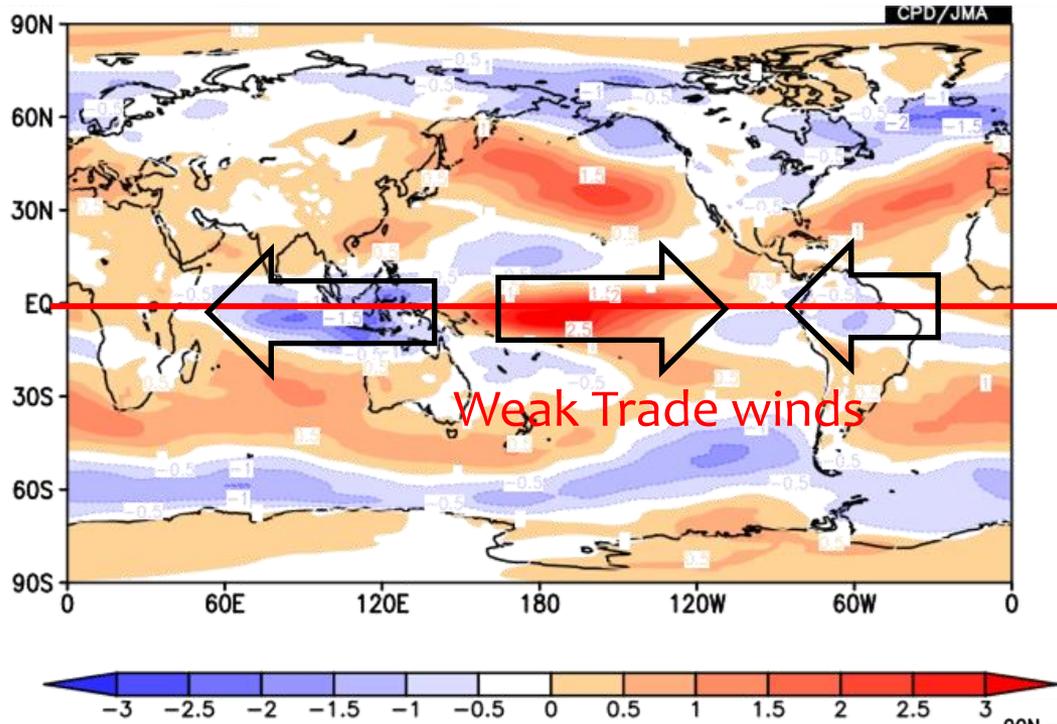


Composite of 850hPa westerly anomalies.



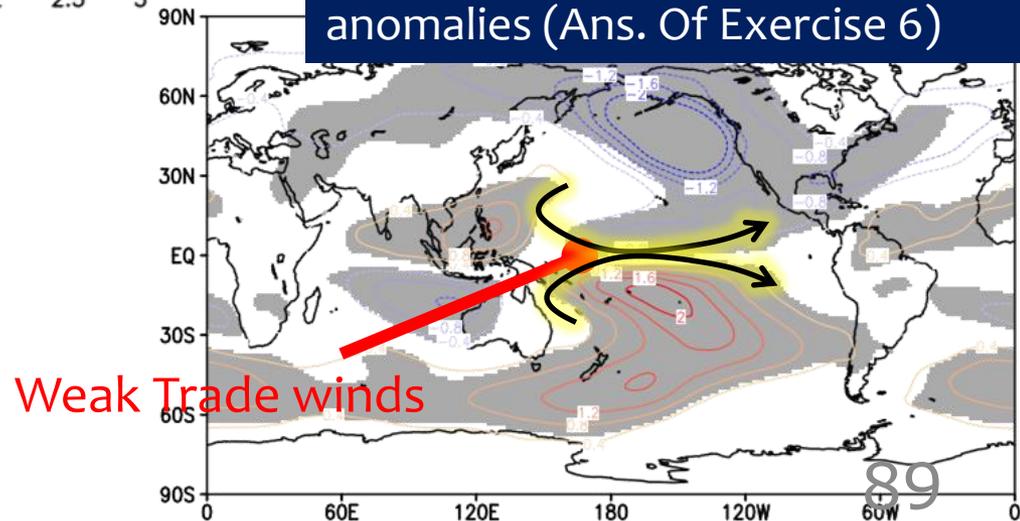
We can get same figure!! 88

# Topics: Typical Anomalies associated with El Niño



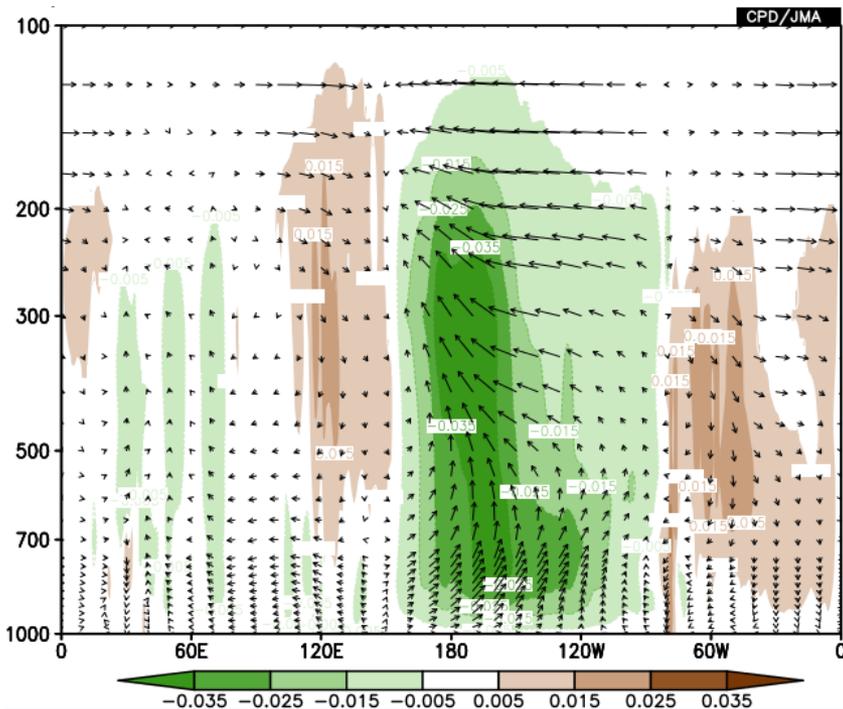
Of course the composite result is consistent with the corr. coeff. map we made just before.

Reg. Coeff.  $\psi_{850}$  onto NINO.3 SST anomalies (Ans. Of Exercise 6)



# Exercise (7)

- Make a composite map of longitude-height cross section of zonal/vertical wind anomaly vector and vertical wind anomaly (shading) averaged from 5°S to 5°N for El Niño-like condition DJF.
  - The El Niño-like condition years are **1965, 1969, 1972, 1976, 1982, 1986, 1987, 1991, 1994, 1997, 2002, 2006, 2009, 2015, 2018** where El Niño-like condition means NINO.3 SST anomalies  $> 0.5$ .



- Try to adjust vector scale and skip interval to improve the visibility of the figure.
- Be aware of the direction of  $\omega$  [Pa/s] vector. It can be inverted
- Select "Green-Brown" for "Color Table".

Composite of wind anomalies along the equator in DJF during El Niño years.

# Answers to Exercise (7)

## Data1

Dataset	Element	Data type
JRA-55	Pressure Levels	ANOM
	U (Zonal Wind) [m/s]	

x: -100

Stream line

Vector  SD

U and omega anomalies

Make y bigger and inverse

Area	Level	Time unit
ALL	1000hPa	MONTHLY
Lat: -5 - 5 Ave <input checked="" type="checkbox"/>	100hPa	<input checked="" type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year
Lon: 0 - 360 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter

Showing period			
YEARS			
input years directly (comma-separated or space-separated)			
1965,1969,1972,1976,1982,1986,1987,1991,1994,1997,2002,2006,2009,2015,2018			
12	-	2	

Analysis method: DATA1\_DATA2

## Data2

Dataset	Element	Data type
JRA-55	Pressure Levels	ANOM
	$\omega$ (Pressure Vertical)	

Area	Level	Time unit
ALL	1000hPa	MONTHLY
Lat: -5 - 5 Ave <input checked="" type="checkbox"/>	100hPa	<input checked="" type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year
Lon: 0 - 360 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter

Showing period			
YEARS			
input years directly (comma-separated or space-separated)			
1965,1969,1972,1976,1982,1986,1987,1991,1994,1997,2002,2006,2009,2015,2018			
12	-	2	

## Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1
Font: default	interval: min: max:
Color Table: Green - Brown	<input checked="" type="checkbox"/> Set Contour Parameters for data2
	interval: 0.01 min: -0.035 max: 0.035
	<input checked="" type="checkbox"/> Set Vector size: 1 [inch] value: 20 skip: 8

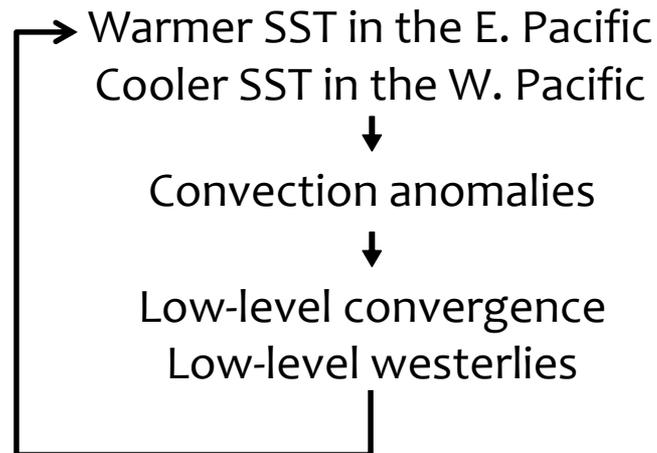
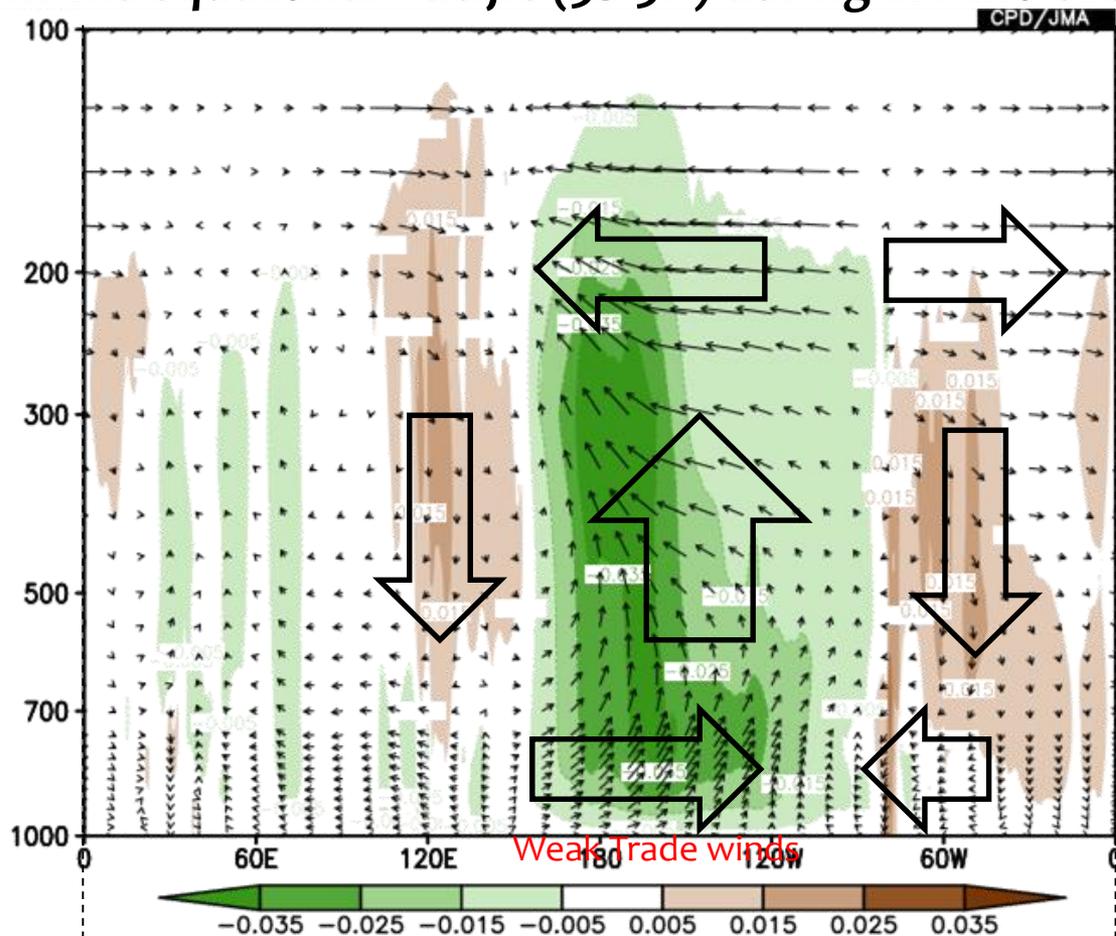
Logarithmic Coordinates

Green-Brown

Dec. thru Feb. during El Niño-like years

# Topics: Ocean-Atmosphere Coupled System

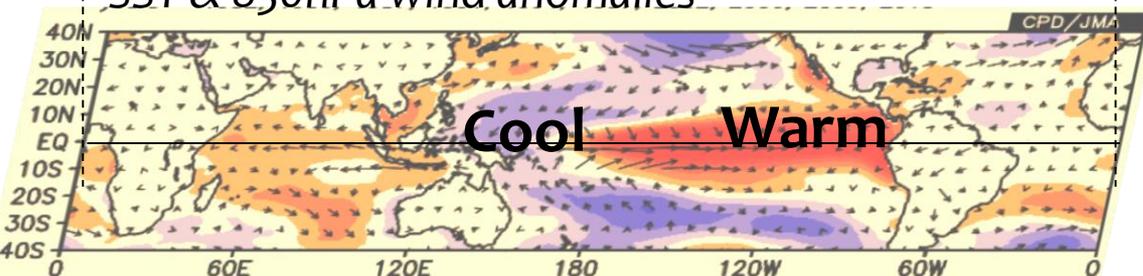
In the equatorial Pacific (5S-5N) during El Niño events.....,



Actually, the induced low-level westerlies can enhance SST anomalies in turn (this is oceanic dynamics).

This is referred to as the **Bjerknes Feedback** (but we cannot say what the initial trigger is).

El Niño/La Niña is an **Ocean-Atmosphere coupled phenomenon!**



# Contents

## 4. Statistical Analysis in iTacs

- ❑ Introduction
- ❑ Regression / Correlation Analysis
- ❑ Composite Analysis

## 5. Other Advanced operations

- ❑ Data download
- ❑ User data input



# Using user input data (1)

- The 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-55 can be created by this function.
- There are two ways for inputting data.
  - **UPLOAD\_TXT** : Data are given by an uploaded text file.
  - **INPUT\_DATA** : Data are directly input to the box.

## Sample text file

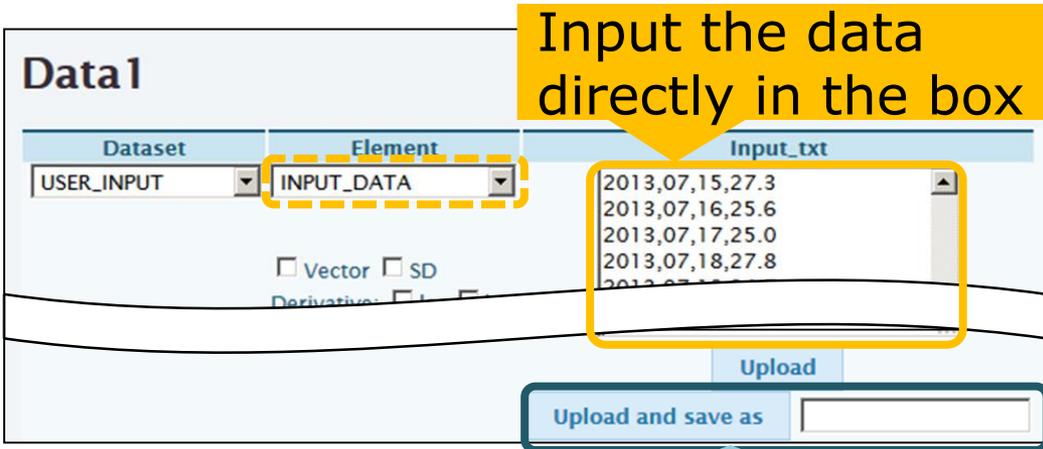
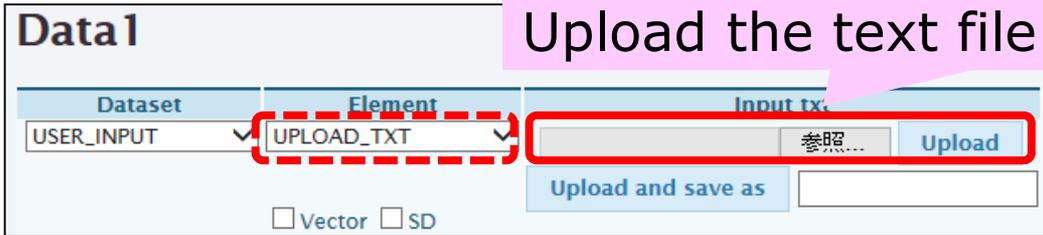
```
#Daily temperature
#undef = 9999
#element = Daily Ts
2013,07,01,23.6
2013,07,02,24.3
2013,07,03,24.5
2013,07,04,9999
2013,07,05,27.4
2013,07,06,28.9
```

## <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.

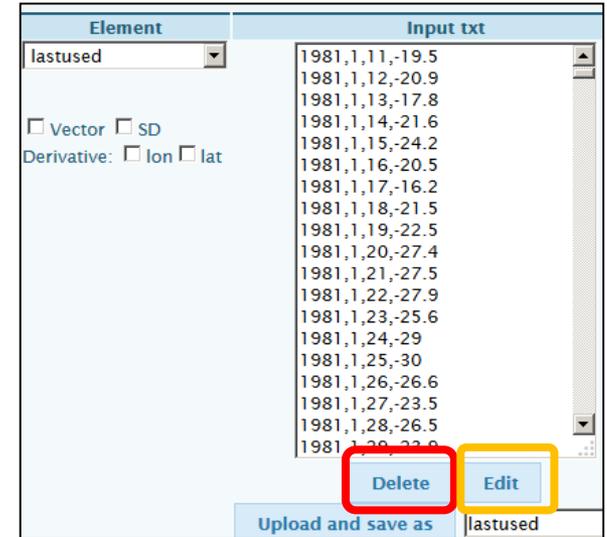
# Using user input data (2)

- 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.

- 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

Don't forget!

# To learn more about iTacs

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

❑ Tutorial: <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 SST anomalies
- ▶ 500-hPa height and anomalies
- ▶ Time-longitude cross section of 200-hPa velocity potential
- ▶ 925-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](#)  
[Graphic Option](#) - [Detailed Options for Image x](#) | [number of grid points for dataset](#) | [format for USER INPUT](#) [color bar sample](#)

### Dataset

データセットを選択します。選択したデータセットによって「element」が変化します。

USER\_INPUTを用いたユーザー作成データの利用について

USER\_INPUTを選択すると、ユーザーが用意したデータを取り込んで描画することが出来ます。データをテキストファイルで用意する場合は、「element2」で「UPLOAD\_TXT」を選択します。その後「UPLOAD\_TXT」でファイルを選択して、uploadボタンを押すと、データを取り込む事が出来ます。

直接iTacsにデータを打ち込む場合は、「element2」でINPUT DATAを選択します。その後「input.txt」にデータを打ち込み、uploadボタンを押すと、データを取り込む事が出来ます。

USER\_INPUTのフォーマットに関しては[こちら](#)を参照してください。

Select the "Dataset" pull-down menu. JRA-55, SST and a variety of other datasets are available.

Using "USER INPUT"

Any time series data can be uploaded and used. There are two ways to set data.

- UPLOAD\_TXT: Data come from an uploaded text file.
- INPUT\_DATA: Data are directly entered in the box.

See [format for USER INPUT](#).

### Element

データ要素を選択します。

要素が多い場合、大きなカテゴリとしてelement1、そのカテゴリ内で詳細な要素をelement2としています。

Vectorボックスをチェックすると、2つめのプルダウンリストが表示され、ベクトルを描くことができます。その際、X方向は上のプルダウンリスト、Y方向は下のプルダウンリストとなります。さらに、Stream lineボックスをチェックすると、流線を描くことができます。

また、「x」の欄にあるテキストボックスに任意の数字を入れることにより、Yの値にその指定した数をかけた値を表示します。

SDボックスをチェックすると表示期間での指定要素の標準偏差を描画します。Vector機能とSD機能は同時には使えません。

Derivativeの、lonボックスにチェックを入れると東西微分、latボックスにチェックを入れると南北微分値を描画します。

Select "element1" or "element2". Available choices will be shown in each pull-down menu depending on the dataset selected.

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.

The value in the "x" box is the multiple scale of the coefficient for the Y component. The default setting is 1.0.

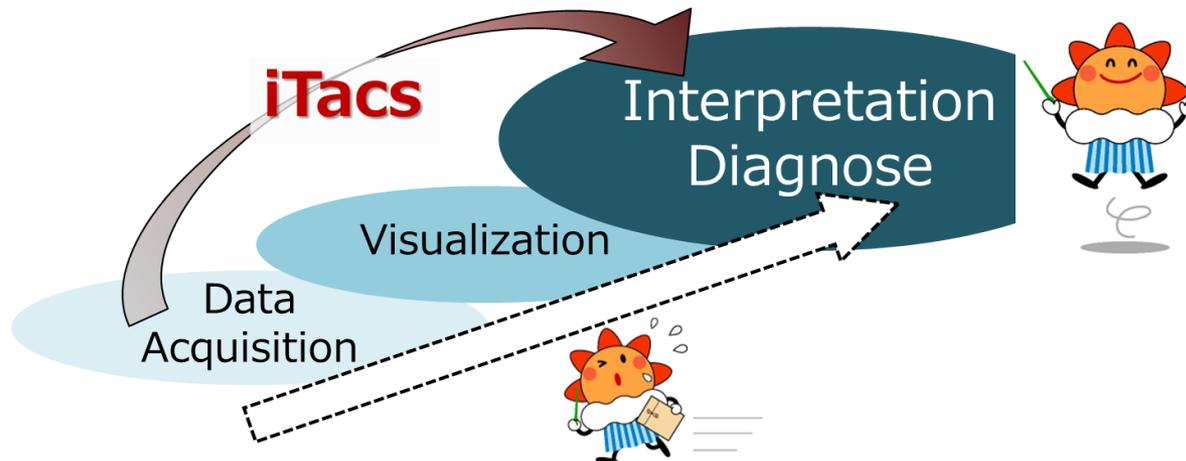
If the "SD" box is checked, a standard deviation map is provided to show the variability of the selected element. The "SD" and "Vector" boxes cannot be set at the same time.

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.

# Thank you for your attention!

If you are interested or have any questions, please feel free to contact us.

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



# References

- Duchon, 1979: Lanczos Filtering in One and Two Dimensions, *J. Applied Met.*, **18**, 1016-1022.
- Gill, 1980: Some simple solutions for heat-induced tropical circulation. *Q.J.R. Meteorol. Soc.*, **106**: 447–462.
- Ishii et al., 2005: Objective Analyses of Sea-Surface Temperature and Marine Meteorological Variables for the 20th Century using ICOADS and the Kobe Collection. *Int. J. Climatol.*, **25**, 865-879.
- Kobayashi et al., 2015: The JRA-55 Reanalysis: General Specifications and Basic Characteristics. *J. Meteorol. Soc. Japan*, **93**, 5-48.
- Toyoda et al., 2013: Improved Analysis of Seasonal-Interannual Fields Using a Global Ocean Data Assimilation System, *Theoretical and Applied Mechanics Japan*, **61**, 31-48.



# Supplement

# Contour parameter and color table

- Changing **intervals for contour/shading**, you can easily see the above- and below-normal SST areas.

① Click  
“Graphic  
Options”

③ Checking  
this box

② Select “Blue - Red”

Click!

Analysis Data Submit

Graphic Options

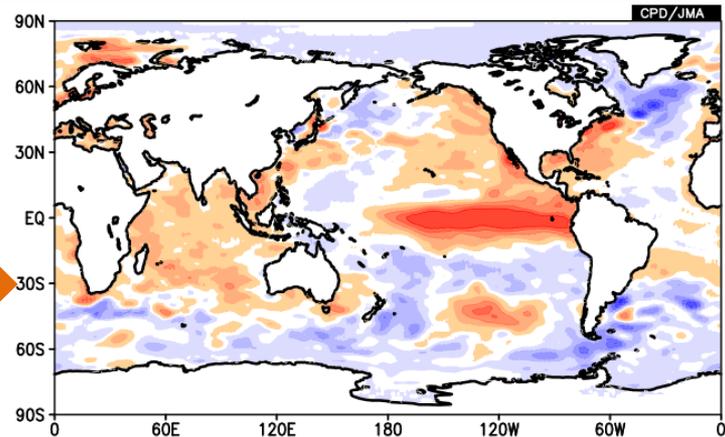
## Graphic Options

g: COLOR ▾  
SHADE ▾  
Font: default ▾  
Color Table: Blue - Red ▾

Show Contour Labels  
 Show Color Bar  
 Set Contour Parameters for data1  
interval: 0.5 min: -2.5 max: 2.5  
 Set Vector size: [ ] [inch] value: [ ] skip: 1

Polar Stereog  
 Logarithmic C  
 Reverse the A  
 Flip the X-axi  
 No Caption

④ Set these boxes as  
follows  
interval: 0.5, min: -2.5, max: 2.5



-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5

# Area setting (1)

**Data1**

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	HIST	ALL	1	MONTHLY	RANGE
			Lat: -90 - 90 Lon: 0 - 360		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2015 7
					<input type="checkbox"/> Time filter	2015 7

Vector  SD  
Derivative:  lon  lat

**Southern border**

**Northern border**

Data type	Area	Level
	ALL	1
Lat: -45 - 55		
Lon: 100 - 300		

**Western border**

**Eastern border**

Available options are as follows:

- **ALL**
  - **ASIA**
  - **Tropical Pacific**
  - **Tropics**
  - **Indian Pacific**
- etc.

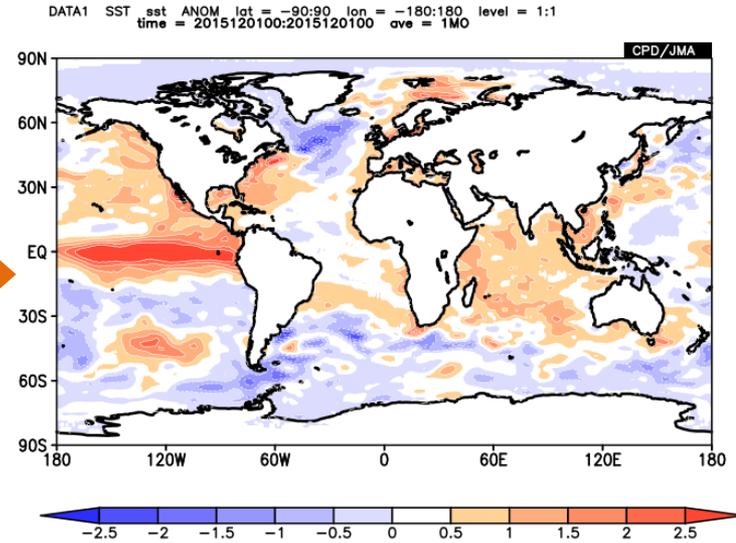
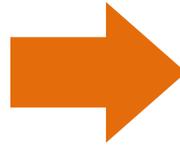
Setting boxes will appear in the “Area” field and after selection for more precise area adjustment.

# Area setting (2)

- Shift the area

Lat : -90 – 90  
(90S) (90N)

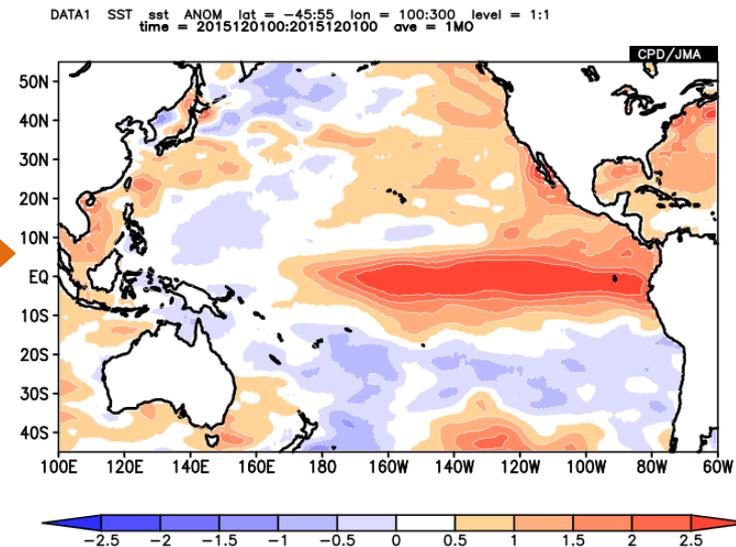
Lon: -180 – 180  
(180W) (180E)



- Change the area

Lat : -45 – 55  
(45S) (55N)

Lon: 100 – 300  
(100E) (300E=60W)



You can adjust zonal and meridional range by setting “Lat” and “Lon” parameters in the “Area” field.

# 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

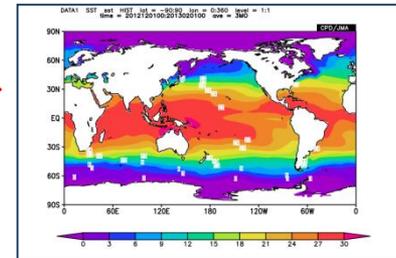
Time unit	Showing period
MONTHLY	RANGE
<input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2012 12
Time filter	2013 2

Check!

Start month

End month

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



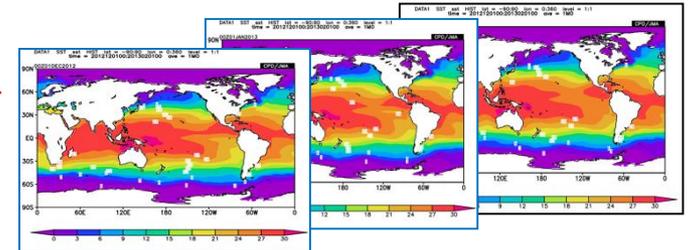
Time unit	Showing period
MONTHLY	RANGE
<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2012 12
Time filter	2013 2

Uncheck

Start month

End month

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



prev next animation stop reset

# Time setting (2)

- Setting for a specific period of each year.

Target years

<Calendar>											
2010	J	F	M	M	J	J	A	S	O	N	D
2011	J	F	M	M	J	J	A	S	O	N	D
2012	J	F	M	M	J	J	A	S	O	N	D
2013	J	F	M	M	J	J	A	S	O	N	D

Target period

Check  
"Year-to-year"

Time unit: MONTHLY

Showing period: RANGE

Ave  Year-to-year

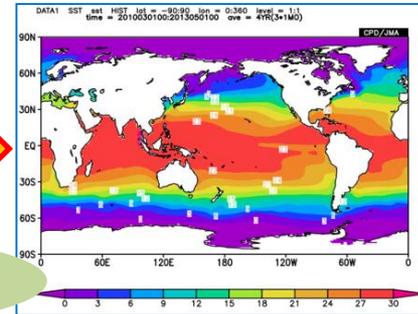
2010 - 2013

3 - 5

Time filter

Target years

One 4-year-MAM averaged map



MAM 2010  
MAM 2011  
MAM 2012  
MAM 2013

averaged

Check!

Target period

Check!

Time unit: MONTHLY

Showing period: RANGE

Ave  Year-to-year

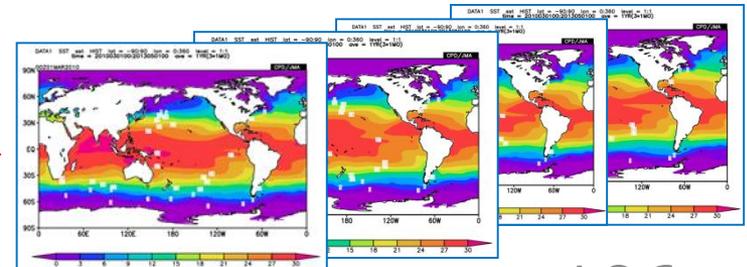
2010 - 2013

3 - 5

Time filter

Target years

Four MAM averaged maps  
MAM 2010, MAM 2011, MAM 2012, MAM 2013



Uncheck

Target period

# Standard deviation map

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

**Data 1**

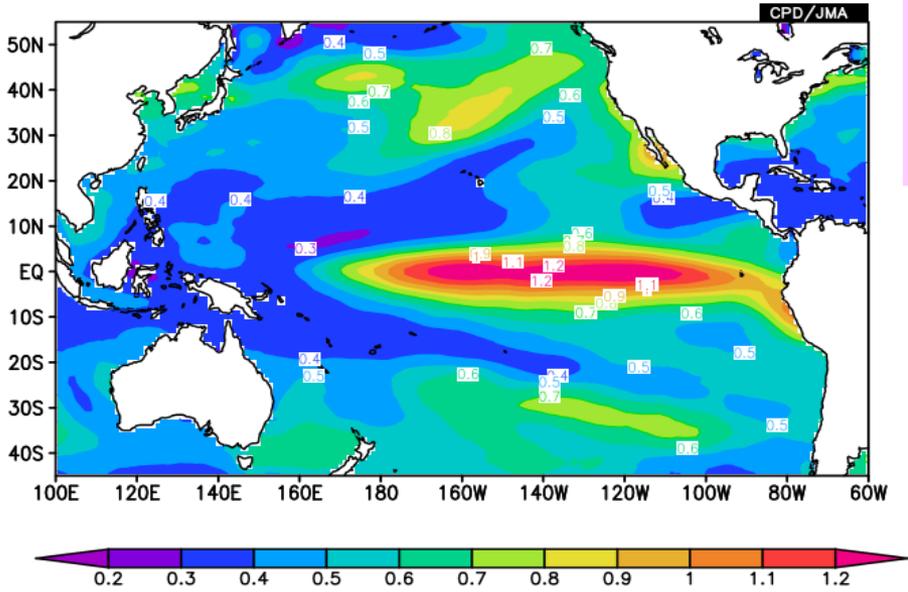
Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	HIST	ALL Lat: -45 - 55 Ave <input type="checkbox"/> Lon: 100 - 300 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1958 - 2015 12 - 2
<input type="checkbox"/> Vector <input checked="" type="checkbox"/> SD		Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat				

Check!

SD

Ave  Year-to-year

DATA1 SST\_sst HIST lat = -45:55 lon = 100:300 level = 1:1  
time = 1958120100:2016020100 ave = 58YR(3+1MO)



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

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

# Detailed Options

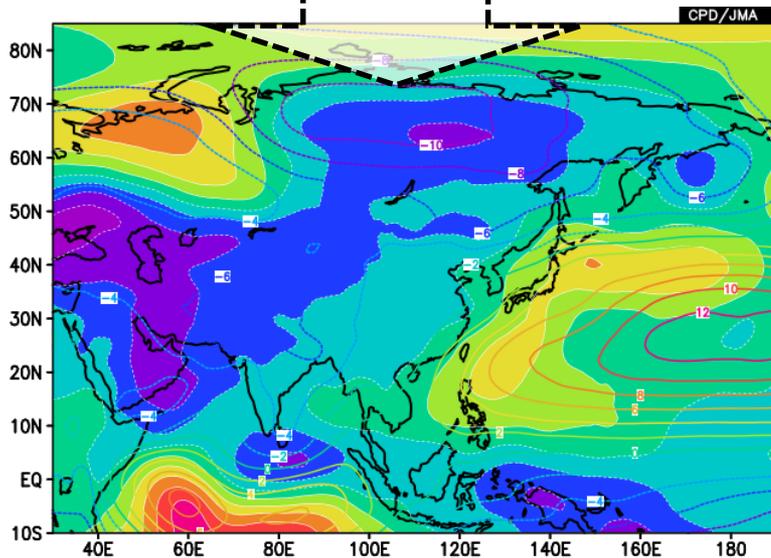
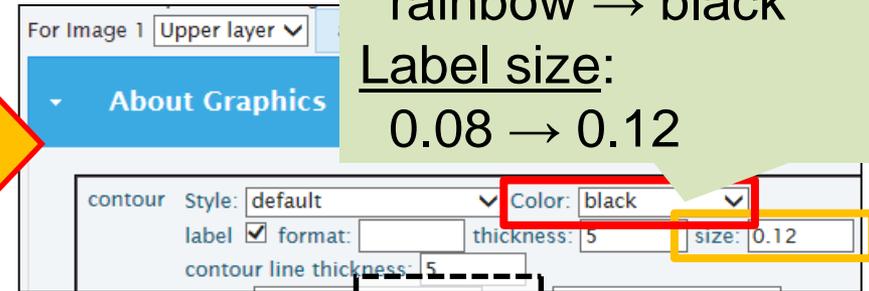
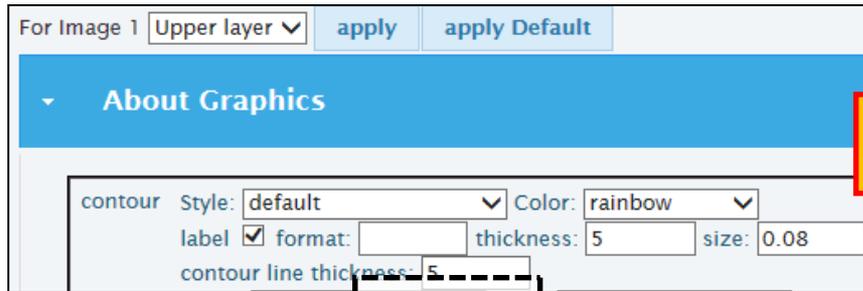
• There are a lot of visual options to create maps.

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

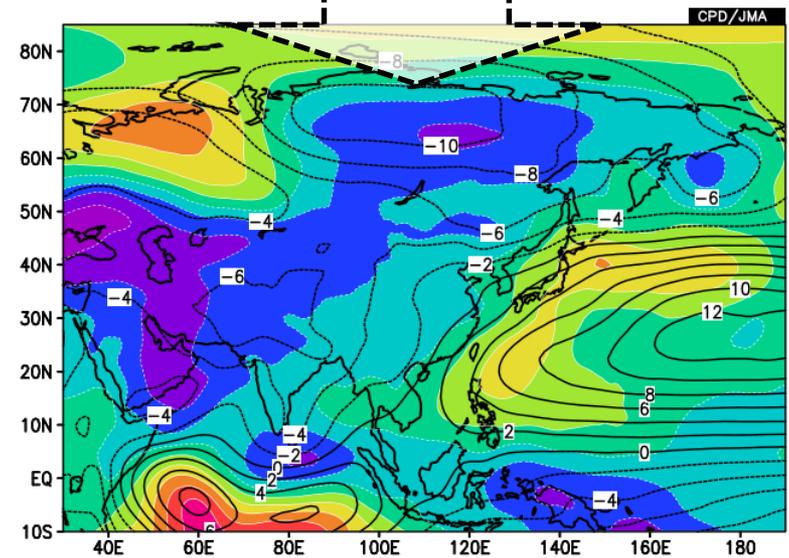
The image shows two panels from a software interface. The left panel, titled 'Graphic Options', has a sub-tab 'Graphic Options' selected. It contains various settings for map visualization, including 'Colorizing: COLOR', 'Drawing: SHADE', 'Image Format: png', 'Font: default', and 'Color Table: Rainbow'. There are also checkboxes for 'Show Contour Labels', 'Show Color Bar', and 'Set Contour Parameters for data1' and 'data2'. A checkbox at the bottom left is labeled 'Detailed Options for Image 1'. A red box highlights this checkbox, and a red arrow points from it to the right panel. A red speech bubble with the text 'Check!' is positioned near the checkbox. The right panel, titled 'Detailed Options for Image 1', is expanded and shows various settings for 'Image 1' (Lower layer). It includes sections for 'About Graphics', 'About Axis', and 'About Map'. The 'About Graphics' section contains detailed settings for contours, markers, and grid lines, such as 'Style: default', 'Color: rainbow', 'label format', 'thickness: 1', 'size: 0.09', 'skip interval', 'contour line thickness: 3', 'levels', 'color', 'thin contour', 'not to draw', 'marker type: closed circle', 'line style: solid', 'color: black', 'thickness: 6', 'grid style: none', 'color: orange', 'vector label', 'vector head size', 'define rainbow color', and 'color bar portrait'. The 'About Axis' and 'About Map' sections are partially visible. At the bottom of the right panel, there is a 'For Image 1' label and an 'apply' button. The page number '108' is located at the bottom right corner.

# About Graphics: Contour color and label

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



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

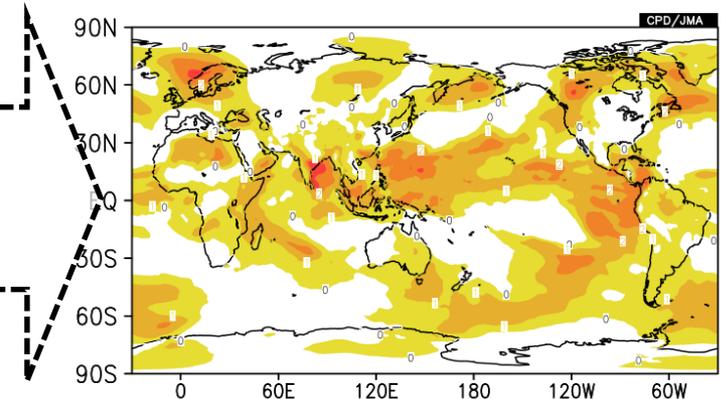
About Graphics

ontour Style: default Color: rainbow

label  format: thickness: size:

contour line thickness: 3

levels: 0,1,2,3 color: 0,7,12,8,2

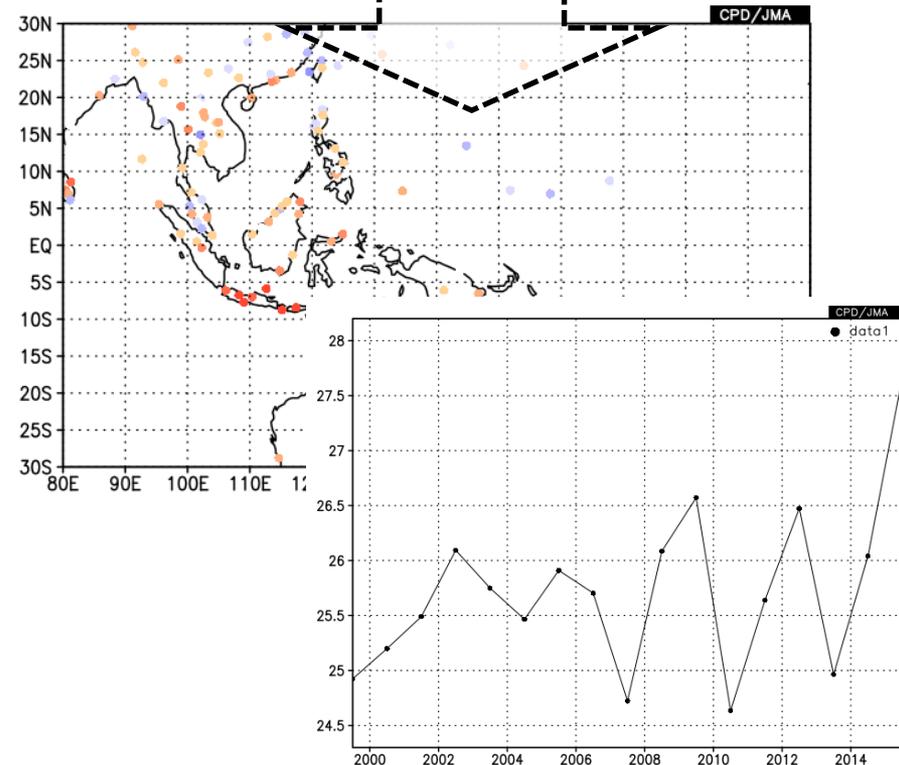
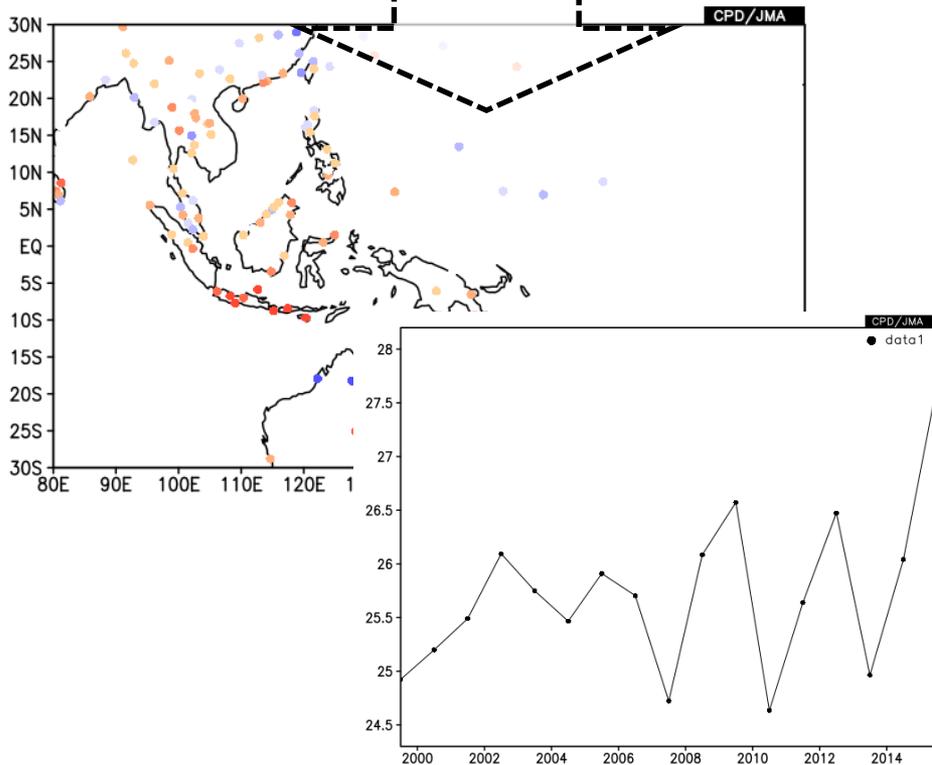
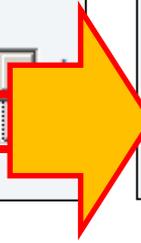


For example, the color setting like the right map is more suitable to focus on the positive value.

# About Graphics: grid style

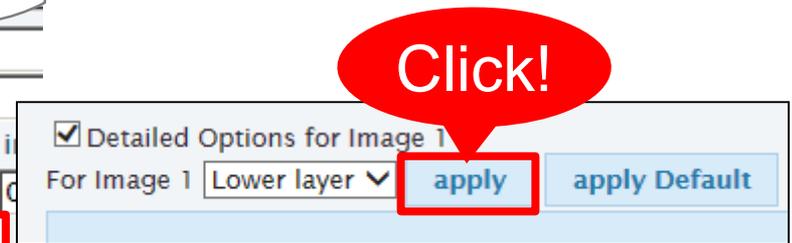
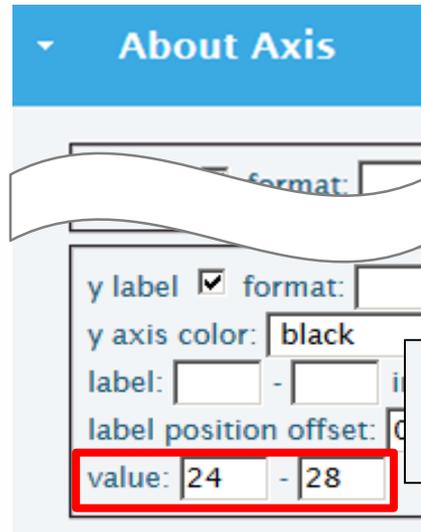
marker type: closed circle  
line style: solid color: black  
**grid style: none color: rainbow**  
vector label  vector head size:

marker type: closed circle  
line style: solid color: black  
**grid style: dotted color: black**  
vector label  vector head size:

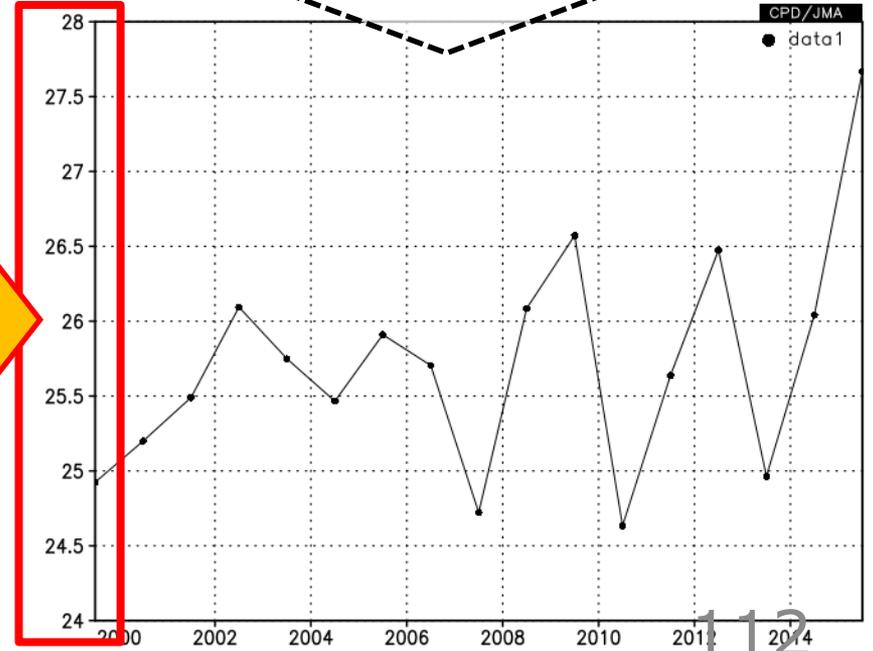
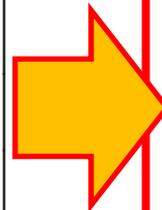
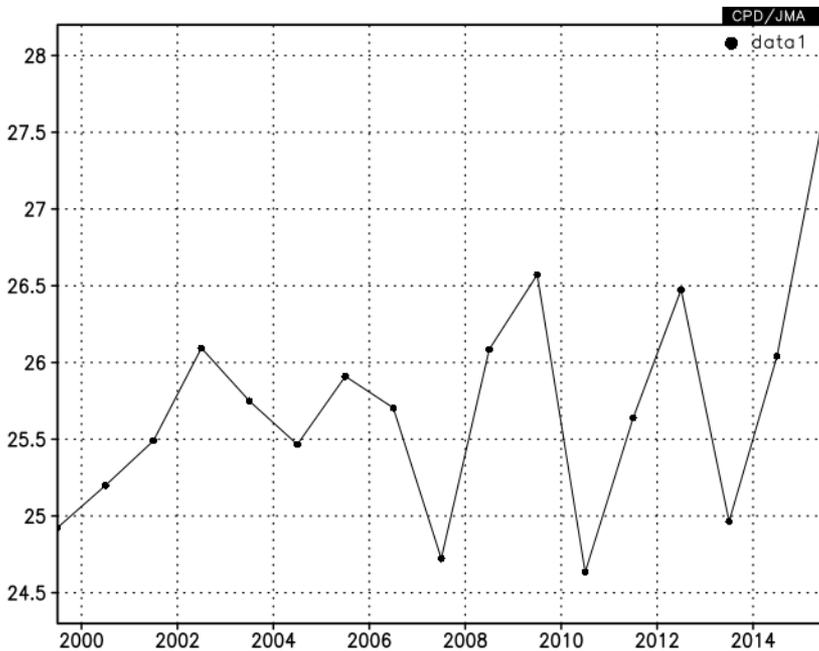


The grid line in the panel like the right map is available.

# About Axis: value

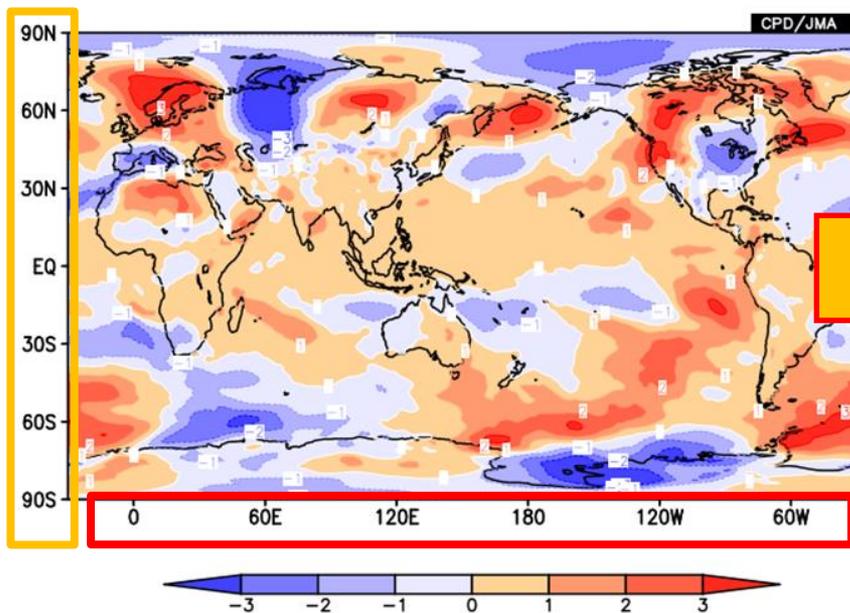


Default

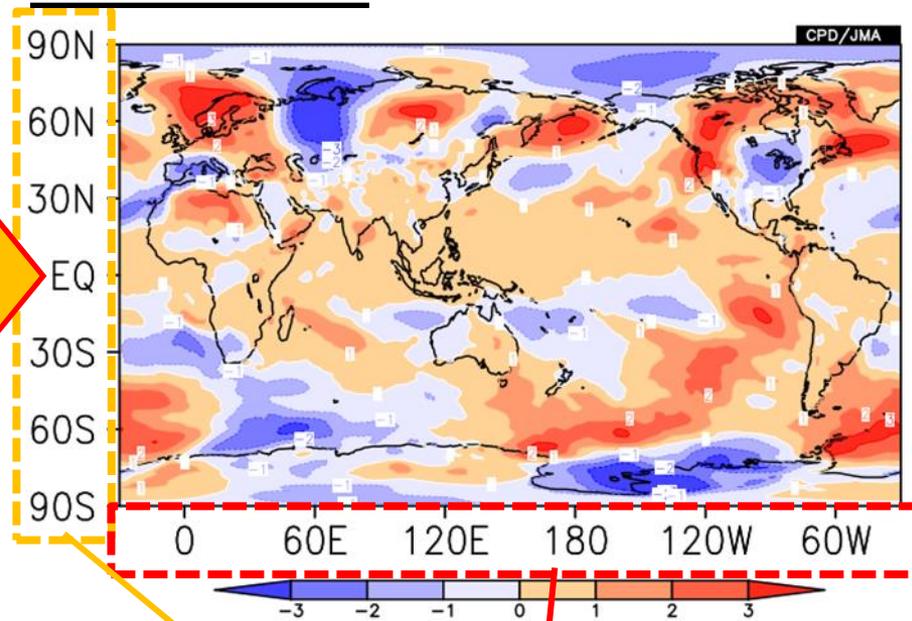


# About Axis: Label size

Default size



Label size: 0.3



The label size is customizable in the “About Axis” box.

**About Axis**

x label  format:  title:   
x axis color: black  thickness: 5  size: 0.3  
label:  -  interval:  levels:   
label position offset: 0  side: bottom   
value:  -

y label  format:  title:   
y axis color: black  thickness: 5  size: 0.3  
label:  -  interval:  levels:   
label position offset: 0  side: left   
value:  -

# About Map

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

**About Map**

map  quality **lowres**

coast line  
style: solid color: black thickness:

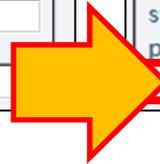
political boundaries (valid in 'mres' and 'hires')  
style: none color: black thickness:

**About Map**

map  quality **hires**

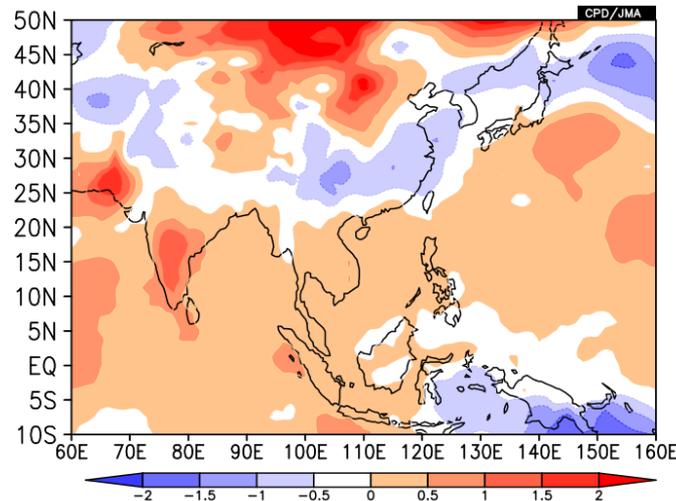
coast line  
style: solid color: black thickness: **10**

political boundaries (valid in 'mres' and 'hires')  
style: solid color: dark-blue thickness:



DATA1 JRA-55 t37 ANOM lat = -10.50 lon = 60.160 level = 7:7  
time = 2015080100:2015080100 ave = 1MO

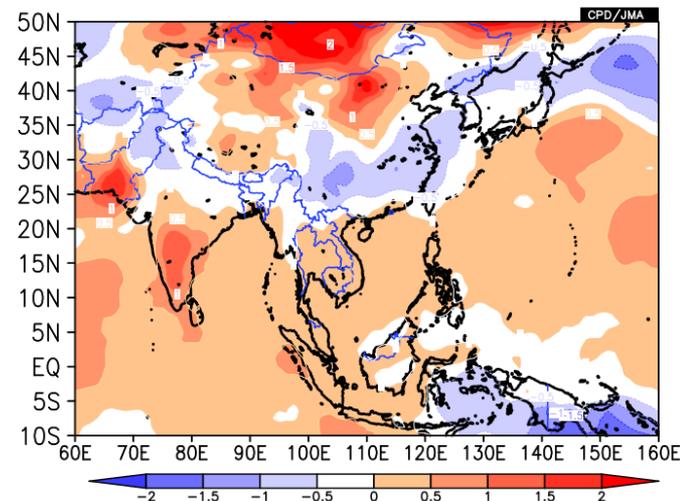
DATA1 JRA-55 t37 ANOM lat = -10.50 lon = 60.160 level = 7:7  
time = 2015080100:2015080100 ave = 1MO



**lowres:**  
low resolution

**mres:**  
middle resolution

**hires:**  
high resolution



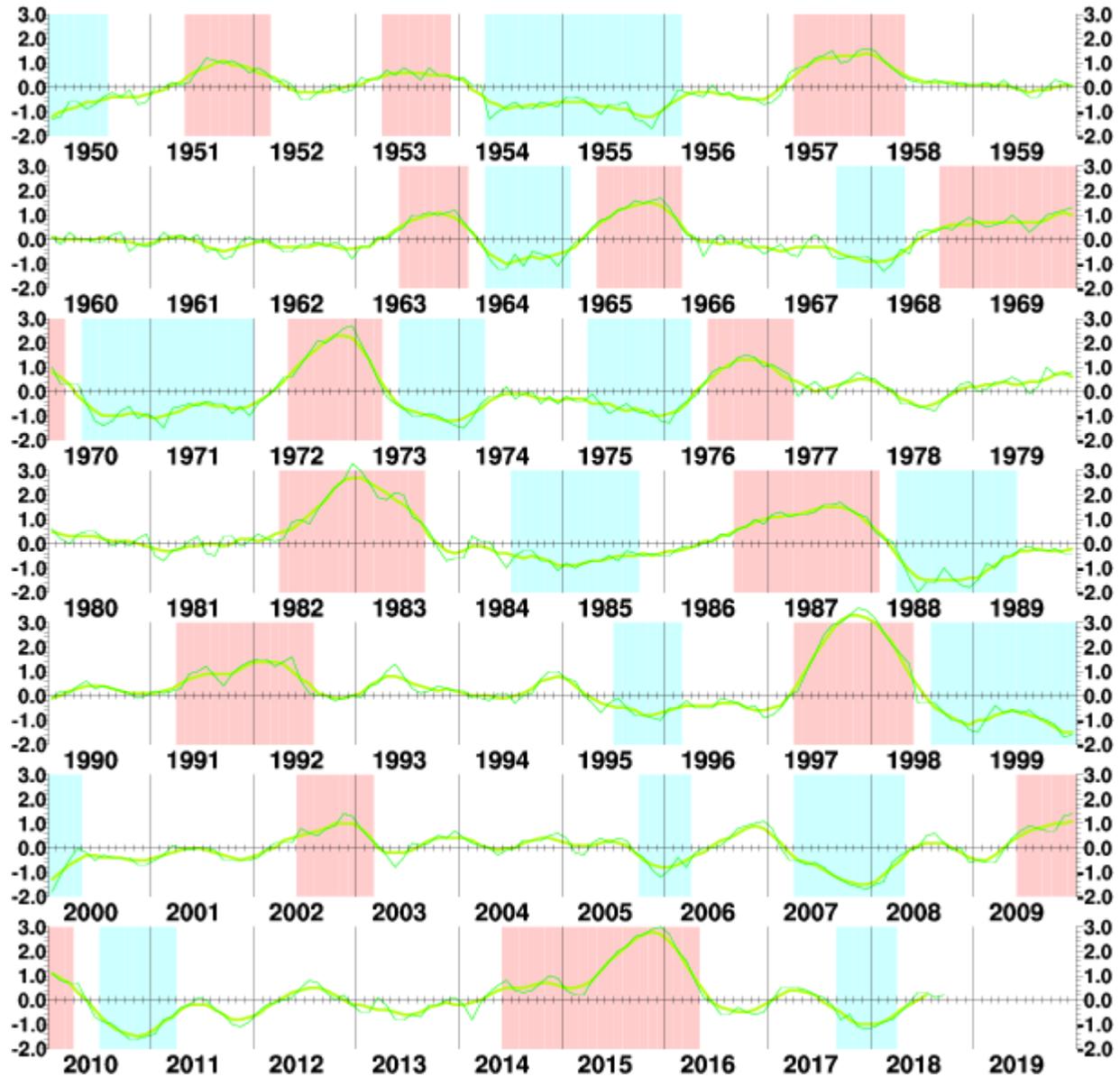
Quality must be set “mres” or “hires” to show political boundaries.

# 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.**



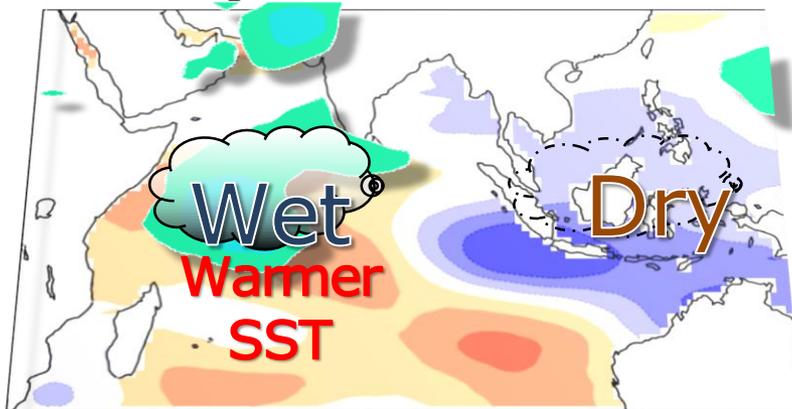
# SST Deviation at NINO.3 (5S-5N,150W-90W)



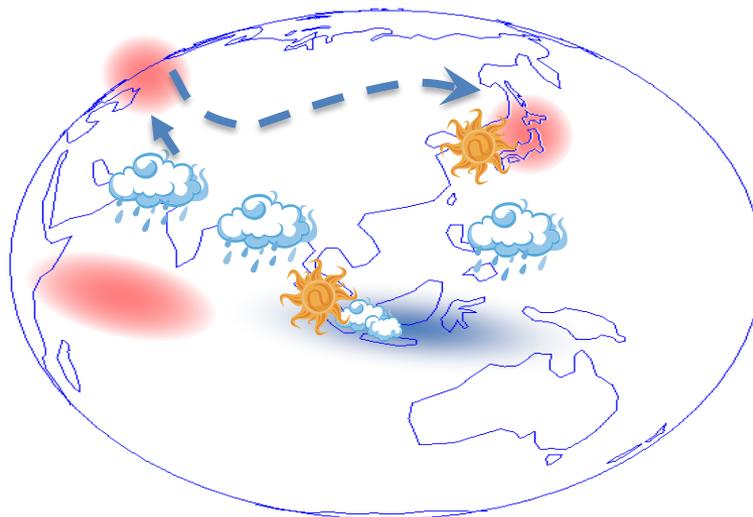
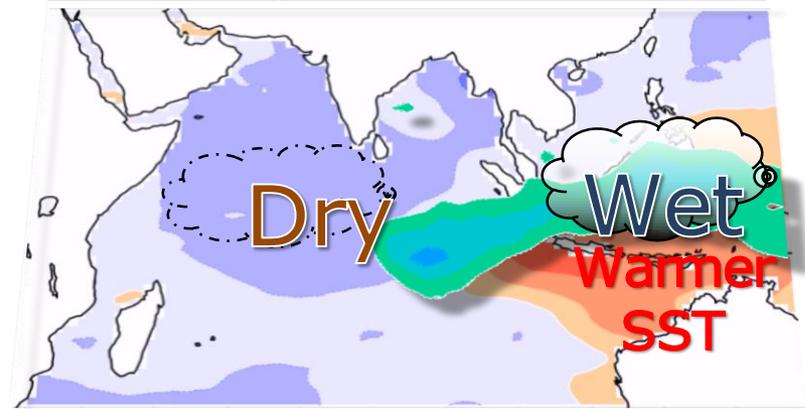
# Topics: Indian Ocean Dipole

- The Indian Ocean Dipole (IOD) is a coupled ocean-atmosphere climate mode, found by Saji et al. (1999).
- IOD is mainly seen during summer and autumn.

positive IOD event



negative IOD event

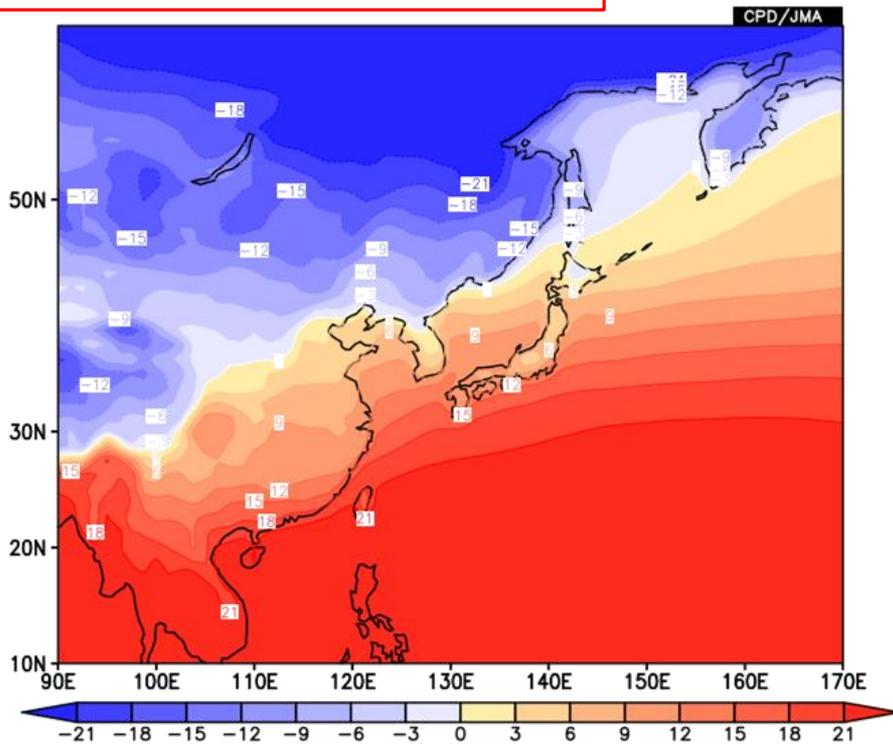


It is said that IOD can affect the atmospheric fields outside the Indian Ocean including Japan.

# Integrated Exercise (1)

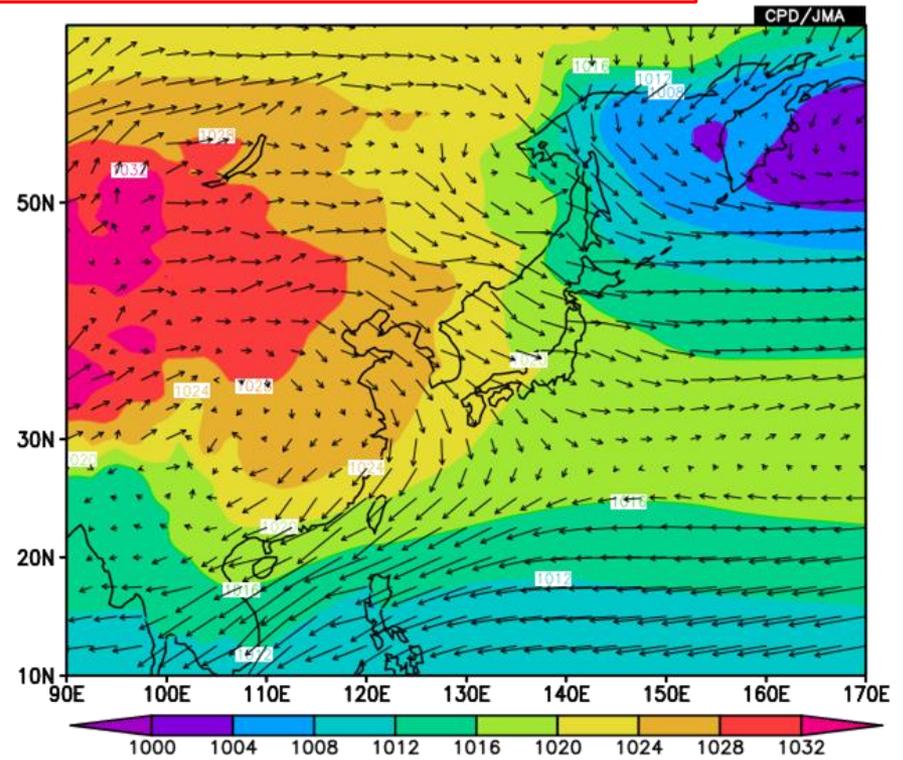
- Check the normal fields around your country with iTacs. These are examples focusing on Japan.

Normal of surface temp.  
(25 – 29 Nov.)



\* Here, "Normal" means climatological normal averaged from 1981 to 2010.

Normal of 925hPa wind and SLP  
(25 – 29 Nov.)



The example of drawing vectors with shade can be found in Exercise (3).

# Integrated Exercise (2)

- Let's see the climatological mean OLR and wind vector at 925 hPa for your country. These are examples focusing on Indonesia.

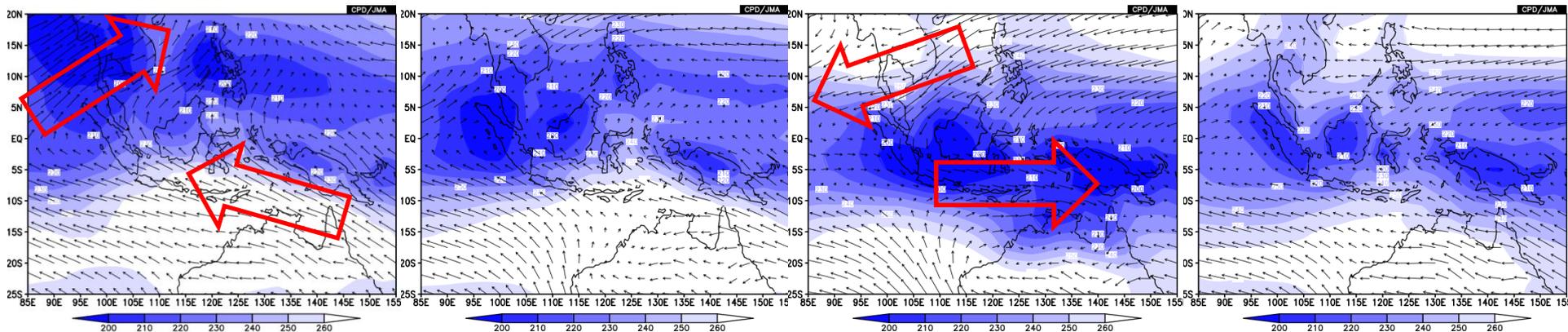
925hPa Wind & OLR (NORM)

Summer (JJA)

Autumn (SON)

Winter (DJF)

Spring (MAM)



Dry season (JJAS)

Rainy season (DJFM)

Typhoon season (SOND)

# Integrated Exercise (3)

- Let's make a correlation map between monthly OLR anomaly on your country and global SST anomaly for a specific calendar month(s). Set the period as appropriate.
- **In this exercise, please use USER\_INPUT for Data2.**
- Set the confidence level **95% (two side)**.

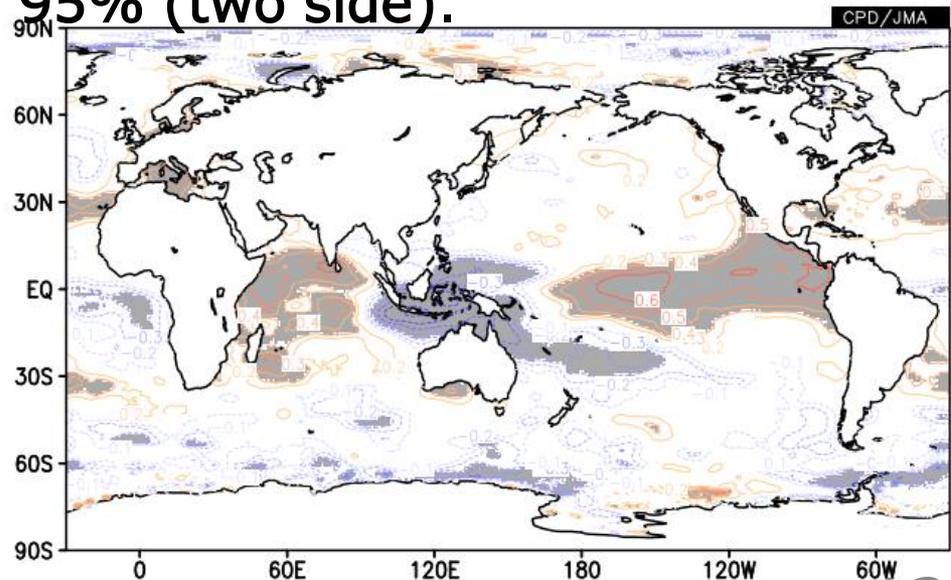
[Example]

OLR:

10S-EQ, 100E-120E

Month: Sep.

Period: 1979 –  
2018



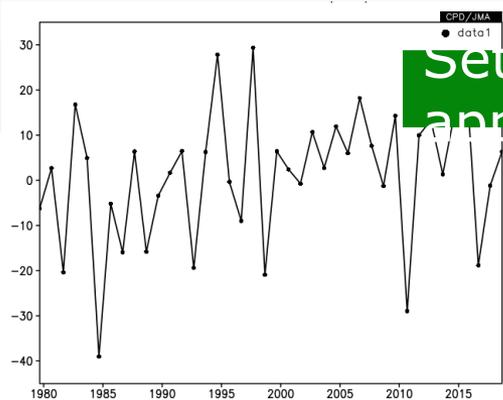
# Answers to Integrated Exercise (3)

## Data 1

Dataset: SAT, Element: OLR [W/m<sup>2</sup>], Data type: ANOM, Area: ALL, Level: 1, Unit: MONTHLY, Showing period: RANGE (1979-2018)

Don't forget!

Set the period as appropriate



Download text zip file

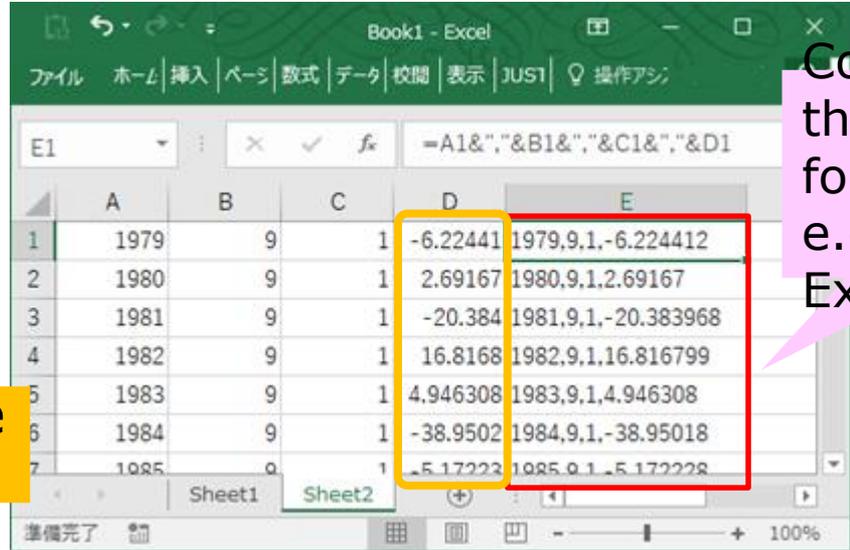
Download data (ctl file and 4byte data)

data\_set : SAT  
 element : olr

ni = 1 ni = 1 nk = 1 nt = 40

-6.224412  
 2.691670  
 -20.383968  
 16.816799  
 4.946308  
 -38.950180

Use these values



Convert to the iTacs format. e.g. with Excel.

# Answers to Integrated Exercise (3)

## Data1

Dataset: SST, Element: Sea Surface Data, Temperature (SST) [C], Data type: ANOM, Area: ALL, Level: 1, Time unit: MONTHLY, Showing period: RANGE 1979 - 2018, 9 - 9.

Analysis method: CORRELATION\_COEFFICIENT

**Don't forget!**

**Set the same period.**

## Data2

Dataset: USER\_INPUT, Element: lastused, Input\_txt: 1979,9,1,-6.224412, 1980,9,1,2.69167, 1981,9,1,-20.383968, 1982,9,1,16.816799, 1983,9,1,4.946308, 1984,9,1,-38.95018, 1985,9,1,-5.172228, 1986,9,1,-15.945408, 1987,9,1,6.399723, 1988,9,1,-15.794648, 1989,9,1,-3.417346, 1990,9,1,1.671012, 1991,9,1,6.450326, 1992,9,1,-19.403618, 1993,9,1,6.262841, 1994,9,1,27.788681, 1995,9,1,-0.340281, 1996,9,1,-8.95012, 1997,9,1,29.372099.

Time unit: MONTHLY, Lag: 0, Significance: 95%(two side).

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

# Answers to Integrated Exercise

(3)

- Setting Graphic Options.

Set "Drawing"  
"CONTOUR" to shade  
the grids exceeding  
confidence level.

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

## Graphic Options

Colorizing: COLOR  Show Contour Labels

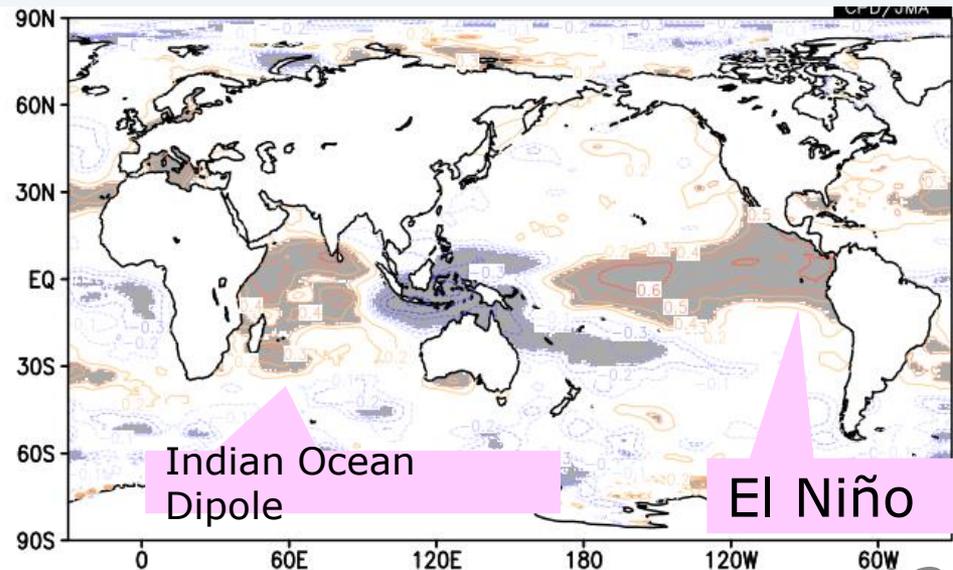
Drawing: CONTOUR  Show Color Bar

Image Format: png  Set Contour Parameters for data1

interval: 0.1 min: -1 max: 1

Color Table: Blue - Red  Set Vector size: 1 [inch] value: 20 skip: 8

Don't forget!



# Integrated Exercise (4)

- Let's make a regression map between some local element (e.g. temp., OLR, ...) on your country and some global element (e.g.  $\psi_{200}$ ,  $\psi_{850}$ ,  $\chi_{200}$ , SST, ...) for a specific calendar month(s). Set the period as appropriate.
- Set the confidence level 95% (two side).

# Model Answers to Integrated Exercise (4)

- These are regression maps against the OLR anomaly (10S-EQ, 100E-120E) during dry season (JJAS) of 1979-2018.

