

An introduction to iTacs

- Interactive Tool for Analysis of the Climate System -

Hiroataka Sato
& Staff Members of Tokyo Climate Center

Tokyo Climate Center
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

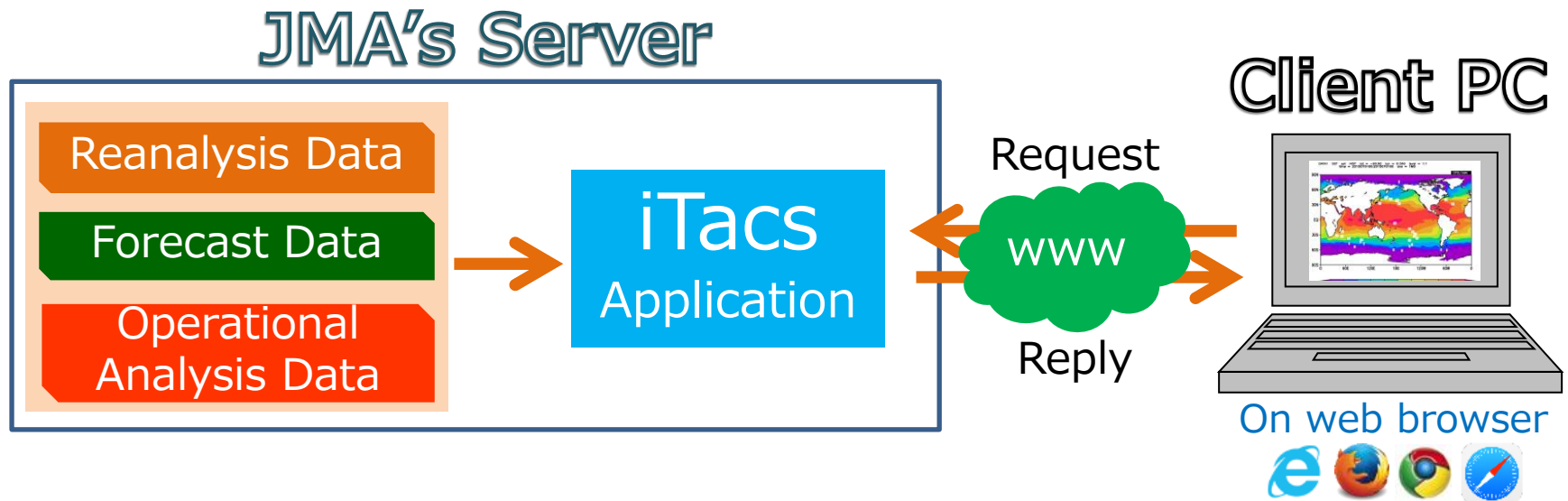
- ❑ Data download
- ❑ User data input

Basic
29 Jan.

Advanced
30 Jan.

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)

Oceanographic analysis dataset

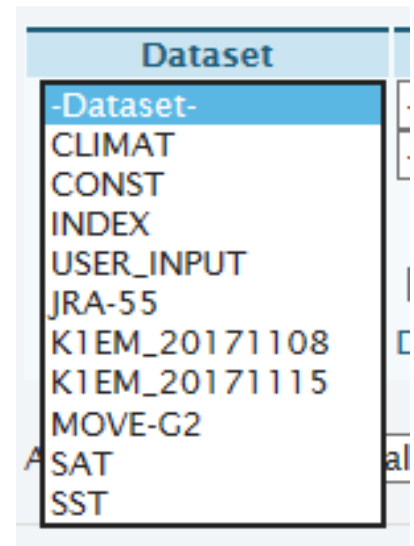
SST	1891~	Sea surface temperature (COBE-SST)
MOVE-G2	1958~	Data assimilation by MOVE/MRI.COM-G2

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

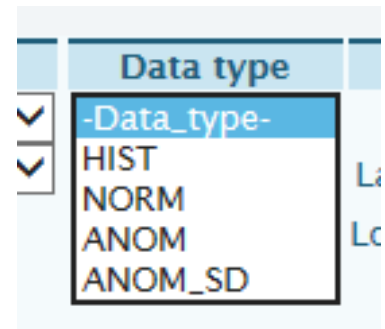


A screenshot of a software interface showing a list of datasets. The list is titled "Dataset" and includes the following items: -Dataset-, CLIMAT, CONST, INDEX, USER_INPUT, JRA-55, K1EM_20171108, K1EM_20171115, MOVE-G2, SAT, and SST. The list is displayed in a light blue box with a white background and a black border.

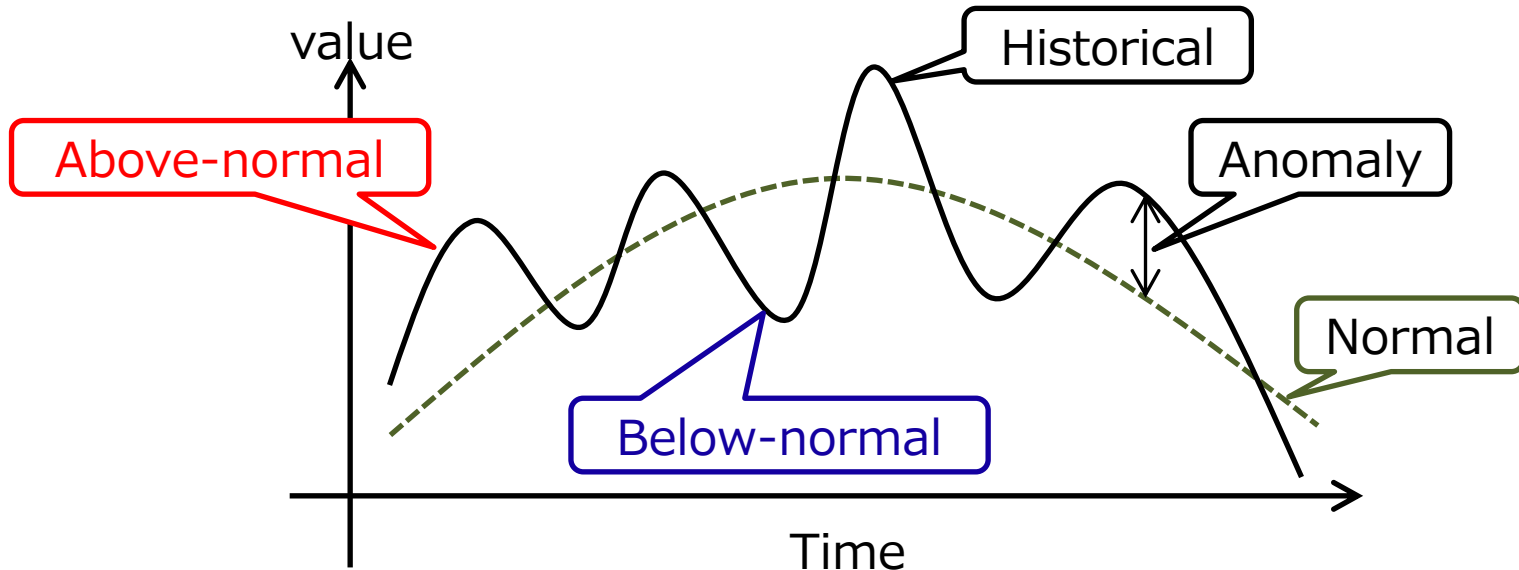
Dataset
-Dataset-
CLIMAT
CONST
INDEX
USER_INPUT
JRA-55
K1EM_20171108
K1EM_20171115
MOVE-G2
SAT
SST

Available data type

- Various data types are available to perform climate diagnosis.

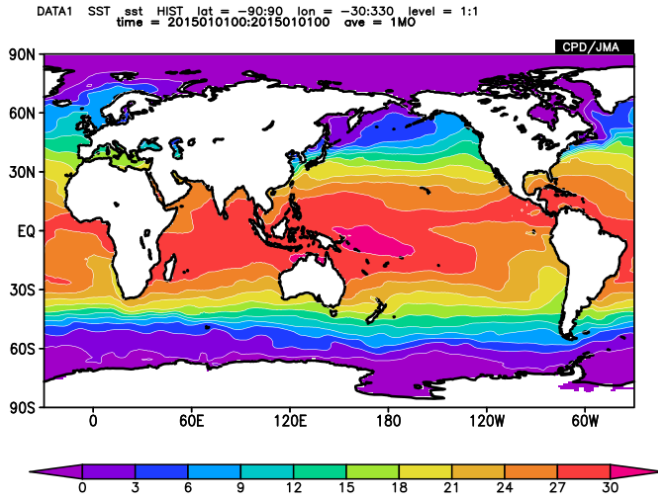


HIST	Historical actual analysis or observation data
NORM	Climatological normal data (averaged from 1981 to 2010)
ANOM	Anomaly data (difference from the climatological normal)

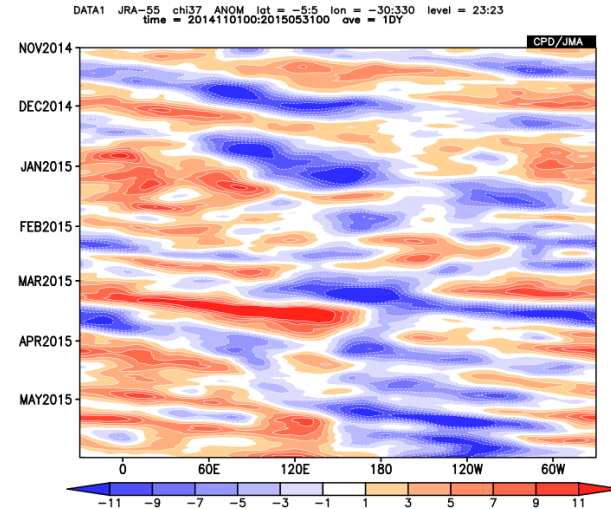


Samples of charts

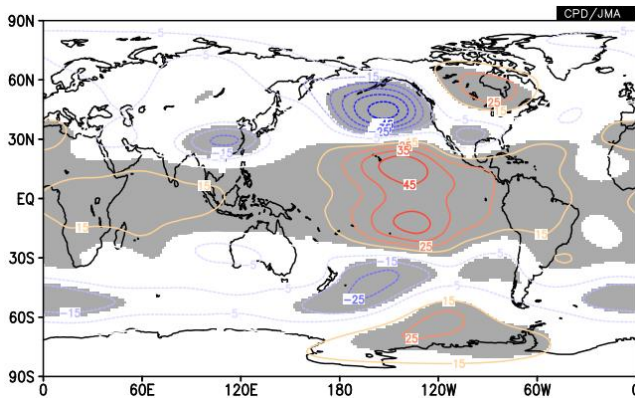
- Various types of charts and statistical analyses are available on iTacs.



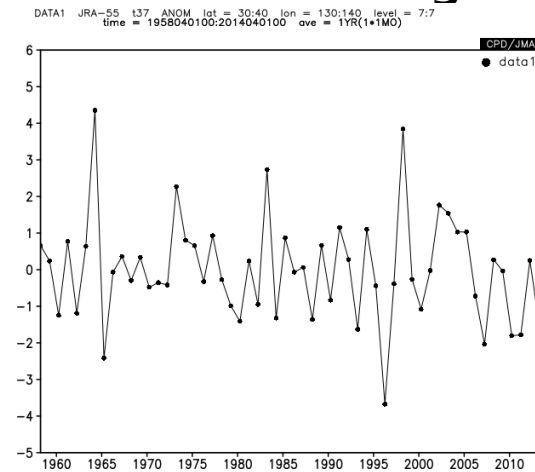
2-dimensional map



Cross section diagram



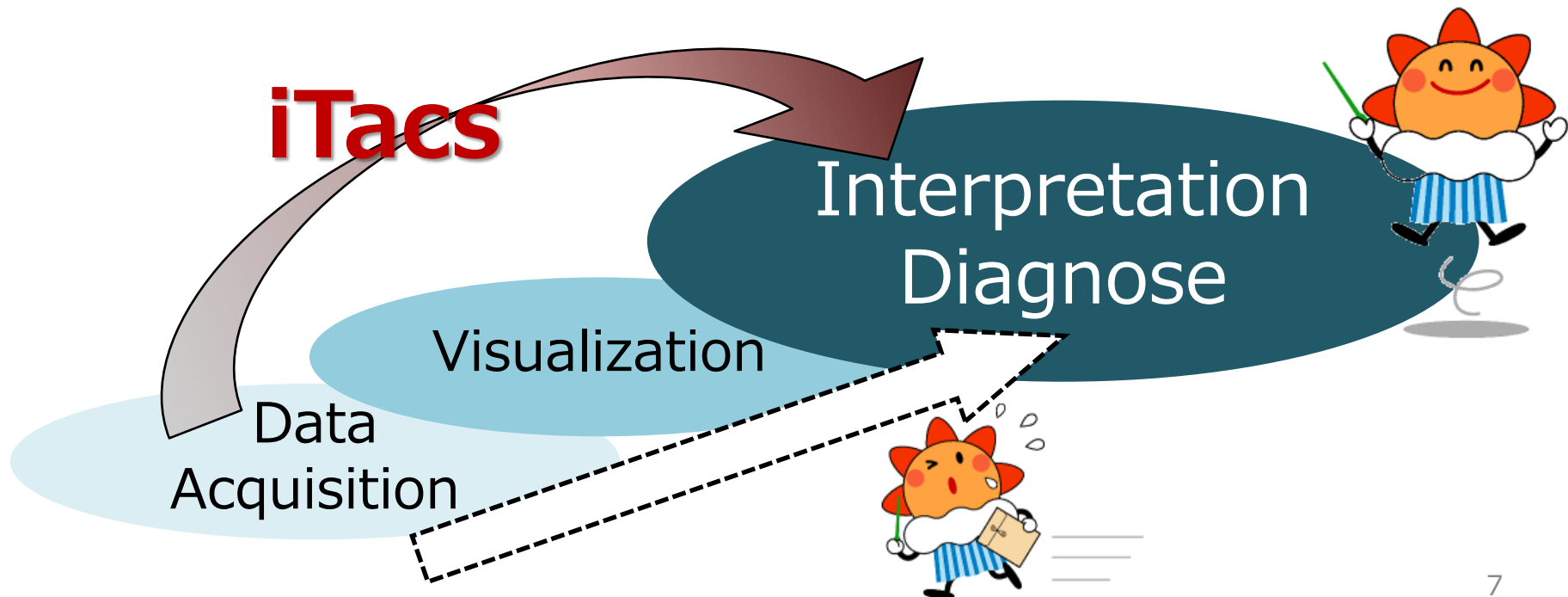
**Regression/Correlation
and significance-test**



Time series graph

Advantages of iTacs

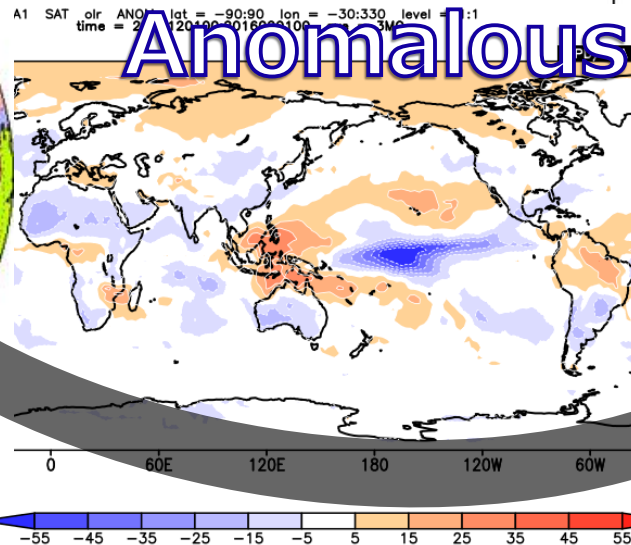
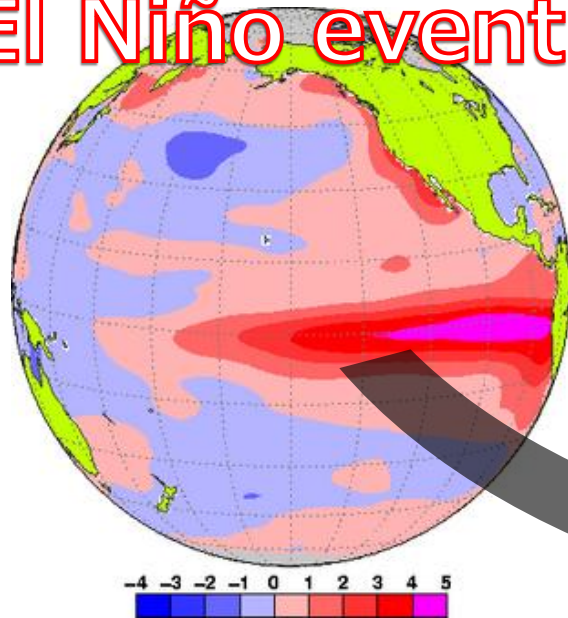
- iTacs is one of the most useful tools provided by TCC/JMA, which is designed for climate analysis and will strongly help your work.
- Use of iTacs costs less time for data handling, more time for interpretation of the climate system!!



Object of this lecture

- This lecture demonstrates and performs some exercises the basic operation of iTacs.
- This class overviews the influence of El Niño events on oceanographic condition and atmospheric circulation by utilizing iTacs.

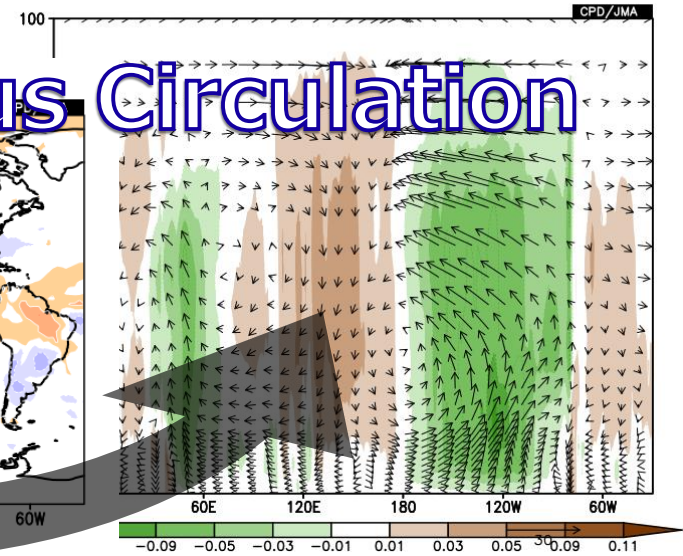
El Niño event



Anomalous Circulation

DATA1 JRA-55 u37,omg37 ANOM lat = -5:5 lon = -30:330 level = 1:27
time = 1997120100:1998020100 ave = 3MO

DATA2 JRA-55 omg37 ANOM lat = -5:5 lon = -30:330 level = 1:27
time = 1997120100:1998020100 ave = 3MO analysis method = DATA1_DATA2



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

Access to iTacs

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

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

Tokyo Climate Center
WMO Regional Climate Center in RA II (Asia)

Home | World Climate | Climate System Monitoring | El Niño Monitoring | NWP Model Prediction | Global Warming | Climate in Japan | Training Module | Press release | Links

Entrance

iTacs (Interactive Tool for Analysis)

Announcement

- 30 September 2016 - Isentropic potential vorticity
- 12 February 2016 - iTacs version 4.0 service has t

iTacs Login

User Name:

Password:

Tools

- iTacs v5.0**
- List of datasets and
- Tutorial Manual
- Sea surface tempera
- Daily mean SST ano
- 850-hPa stream func

iTacs

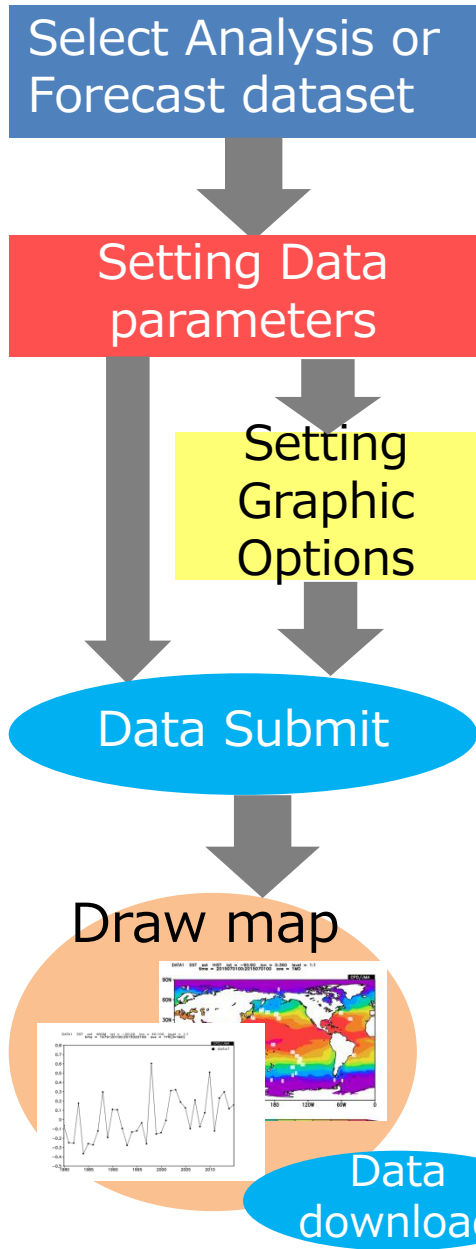
Analysis Dataset

Dataset	Element	Data type	Area	Level	Time unit	Showing period
RA-S5	Pressure Levels	HST	ASIA	850hPa	MONTHLY	RANGE
	(Temperature) [C]		Lat: 10 - 85 Ave		Use Year-to-year	2014 1
			Lon: 30 - 190 Ave		Time filter	2014 3

Analysis method: -Analysis method-

Analysis Data Submit

Basic operating procedure (1)



Analysis Dataset Forecast Dataset

Select parameters Graphic Options

Analysis Dataset

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 checked="" type="checkbox"/> Year-to-year 2011 - 2013 <input type="checkbox"/> Time filter	RANGE 3 - 5

Analysis method: -Analysis method-

Use parameter code

Analysis Data Submit

Dataset parameters

Chronological parameters

Geophysical parameters

Analysis method setting
DATA1_DATA2, SUBTRACT, REGRESSION_COEFFICIENT etc.

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 <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year 2015 - 2015 <input type="checkbox"/> Time filter	RANGE 1 - 1

Use parameter code

“Data2” field will be appeared depending on types of analysis method.

Basic operating procedure (2)

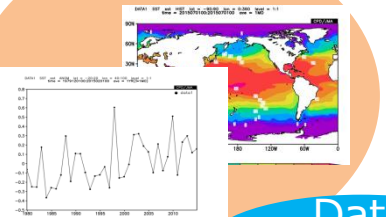
Select Analysis or Forecast dataset

Setting Data parameters

Setting Graphic Options

Data Submit

Draw map



Data download

Select parameters **Graphic Options**

Graphic Options

Colorizing: Show Contour Labels
Drawing: Show Color Bar
Image Format: Set Contour Parameters for data1
Font: interval: min: max:
Color Table: Set Contour Parameters for data2
interval: min: max:
 Set Vector size: [inch] value: skip:

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

Detailed Options for Image 1

Checking here, additional field for detailed options will appear.

Analysis Data Submit

Detailed Options for Image 1
For Image 1

About Graphics

contour Style: Color:
label format: thickness: size: skip interval:
contour line thickness:
levels: color:
thin contour:
not to draw: -

marker type:
line style: color: thickness:
grid style: color:
vector label vector head size:
define rainbow color:
color bar portrait X: Y: scale:

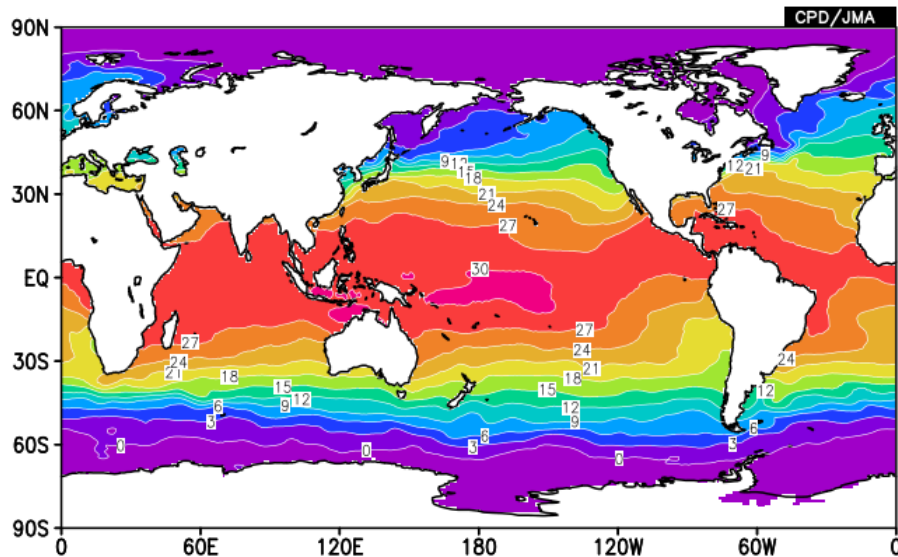
For Image 1

Longitude-latitude map (1)

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

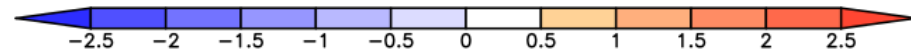
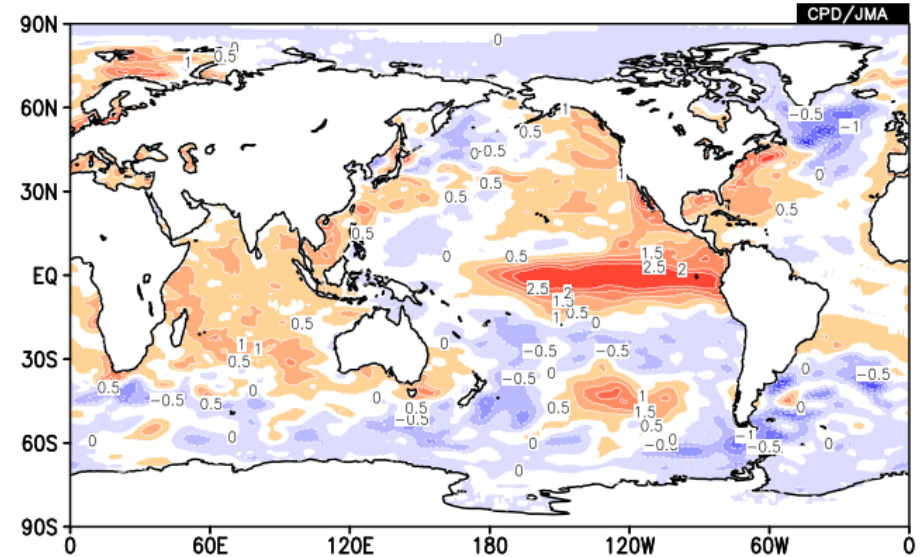
SST

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)

The screenshot shows a configuration window titled "Data 1" with four main columns: Dataset, Element, Data type, and Area. The "Dataset" column has a dropdown menu with "SST" selected, highlighted by a red box and a circled "1". The "Element" column has a dropdown menu with "Sea Surface Data" selected, highlighted by a yellow box and a circled "2". Below "Sea Surface Data", a pull-down menu is open, showing "Temperature (SST) [C" selected (highlighted in blue), "-element2-", "Temperature (SST) [C.Deg.]", and "Ice concentration (ice=1 no_ice=0) [fraction]". The "Data type" column has a dropdown menu with "HIST" selected. The "Area" column has a dropdown menu with "ALL" selected. Below the "Area" dropdown, there are two rows of latitude/longitude ranges: "Lat: -90 - 90" and "Lat: - 360". To the right of these ranges are checkboxes labeled "Ave". At the bottom of the window, there is a field for "Analysis method" with a dropdown menu showing "-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)

The screenshot shows a configuration panel for a map. It includes a 'Data type' dropdown set to 'HIST'. The 'Area' section is highlighted with a red box and contains a dropdown set to 'ALL', latitude input fields from -90 to 90, and longitude input fields from 0 to 360. The 'Level' dropdown is highlighted with a yellow box and set to '1'. The 'Time unit' is set to 'DAILY'. The 'Showing period' is set to 'RANGE' with two rows of year and count dropdowns, both showing '2016' and '1'. An orange callout bubble points to the 'Level' dropdown with the text '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

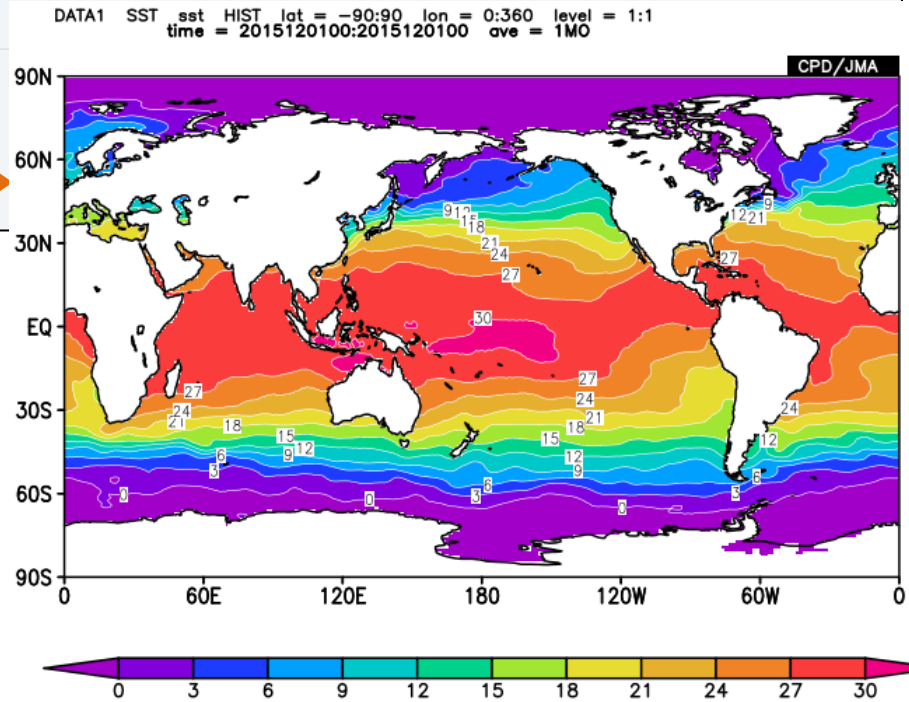
Vector SD
Derivative: lon lat

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".

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

CPD/JMA

90N
60N
30N
EQ
30S
60S
90S

0 60E 120E 180 120W 60W 0

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

Click!

Analysis Data Submit

Select parameters Graphic Options

Graphic Options

Colorizing: COLOR
Drawing: SHADE
Image Format: png
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

Set Color Table: Blue - Red
Contour Parameter:
interval: 0.5, min: -2.5, max: 2.5

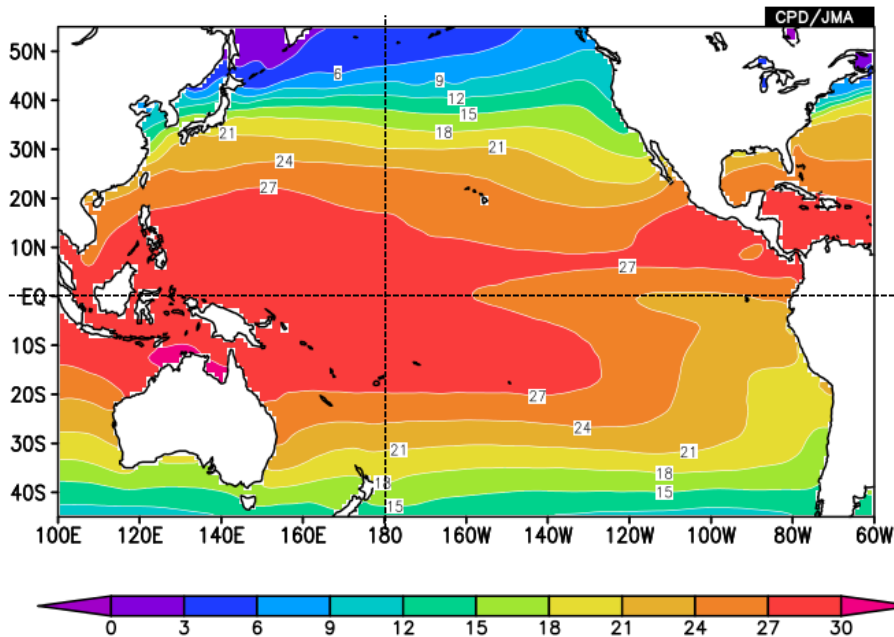
Topics: El Niño event

- 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

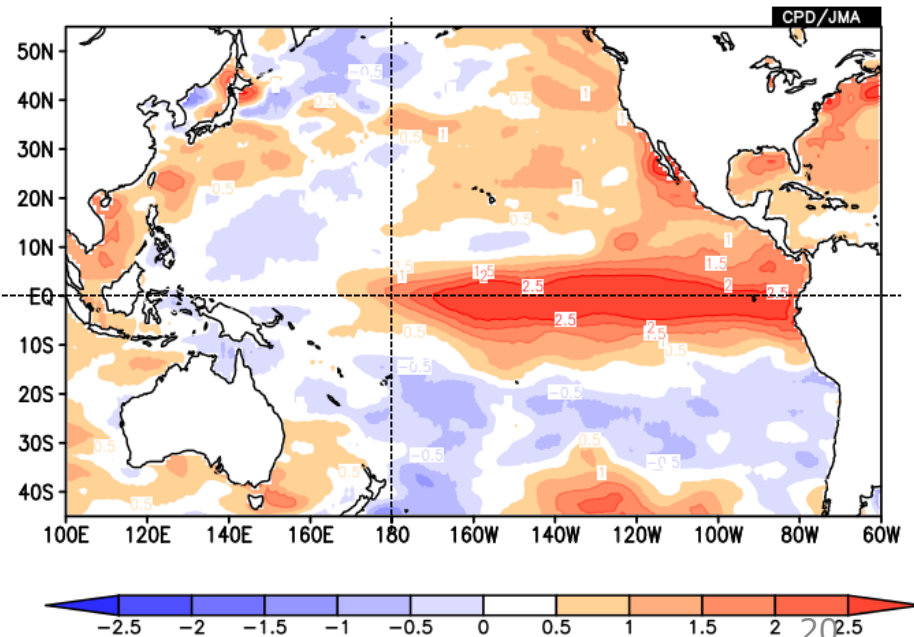
- Normal -

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

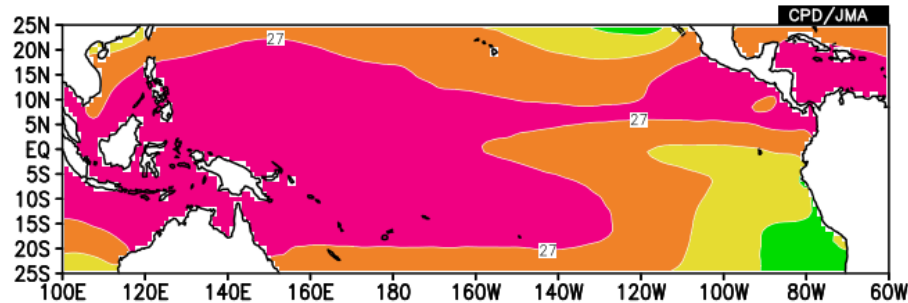


Topics: El Niño Southern Oscillation (ENSO)

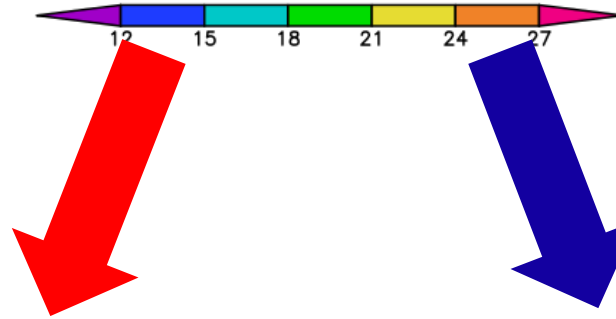
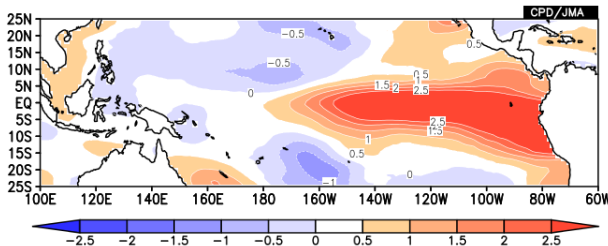
- The occurrence of El Niño and La Niña events (ENSO) modulate zonal contrast of SST in the equatorial Pacific.

Normal SST

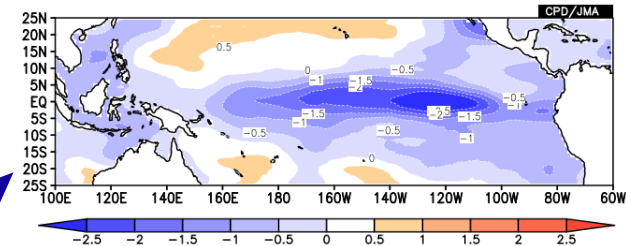
DATA1 SST_sst NORM lat = -25:25 lon = 100:300 level = 1:1
time = 1988120100:1988120100 ave = 1MO



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

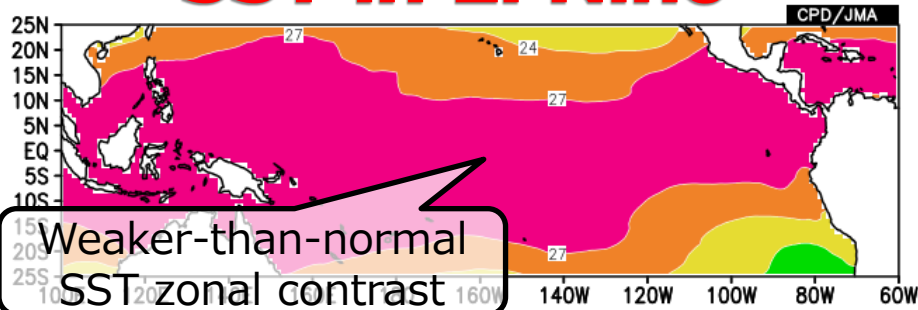


DATA1 SST_sst ANOM lat = -25:25 lon = 100:300 level = 1:1
time = 1988120100:1988120100 ave = 1MO



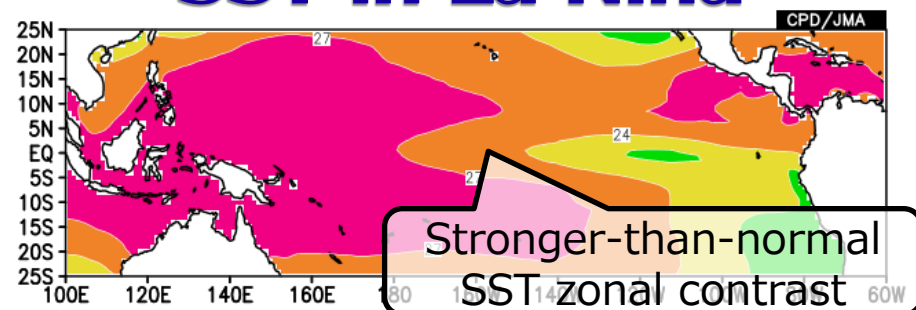
SST in El Niño

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



SST in La Niña

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

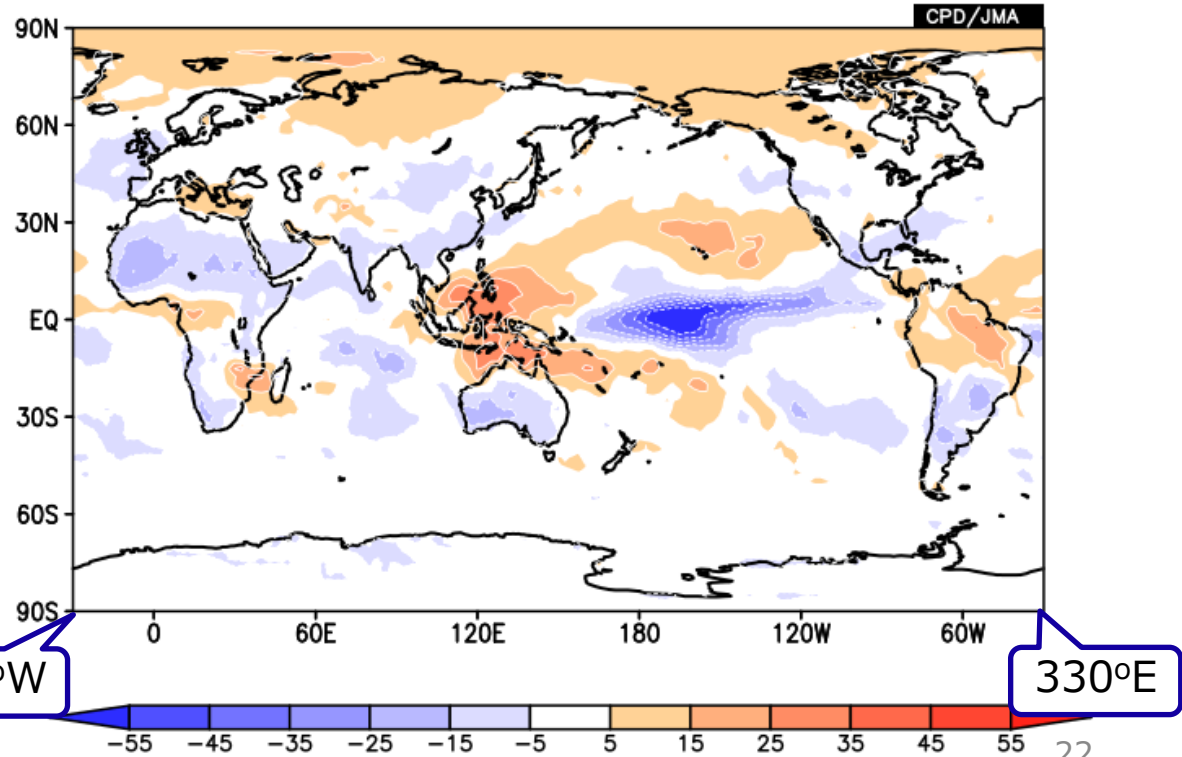


Exercise (1)

- Show OLR anomaly averaged over the period from December 2015 to February 2016 as shown below.
- Dataset "**SAT**" is available to draw the OLR.

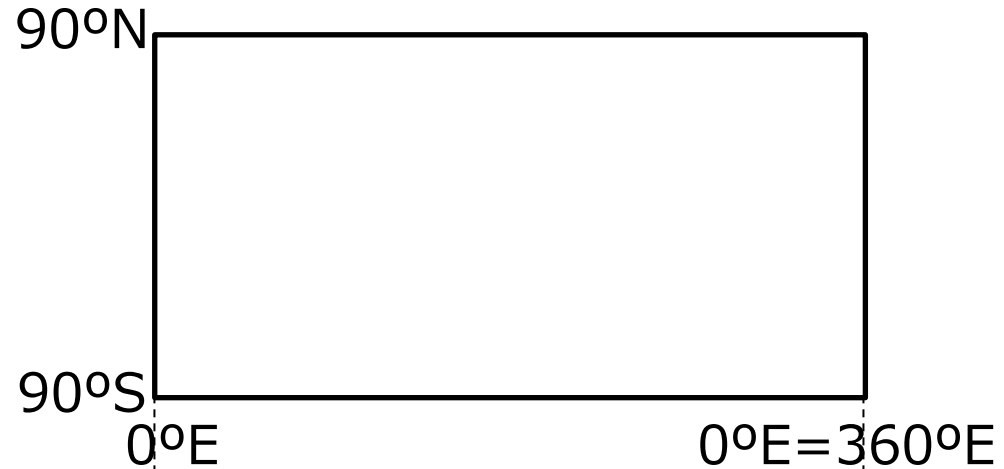
- Please try to set longitude range from 30°W to 330°E not to split areas in Africa and Europe.
- Adjust contour parameters (see color bar of the figure)
- Select "Blue-Red" for "Color Table"

DATA1 SAT_olr ANOM lat = -90:90 lon = -30:330 level = 1:1
time = 2015120100:2016020100 ave = 3MO

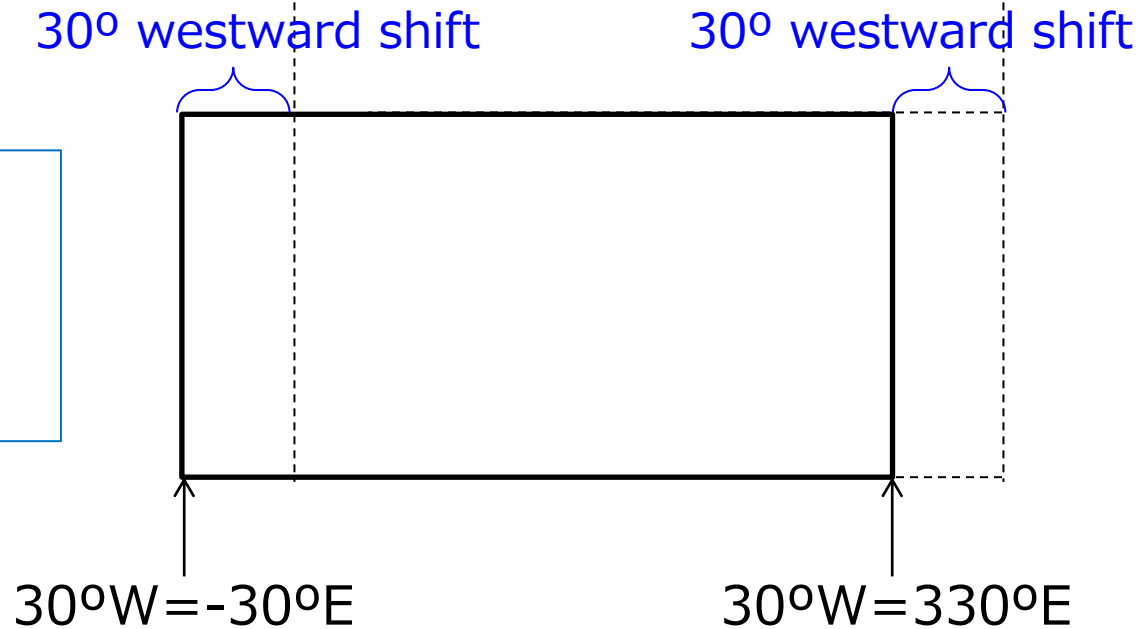


Hint: Area setting

Lat : -90 - 90
(90S) (90N)
Lon: 0 - 360
(0) (0)



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



Answer to Exercise (1)

Analysis Dataset

Select parameters | Graphic Options

Data 1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m ²]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>	1	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2015 12 2016 2

Vector SD
Derivative: lon lat

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

Graphic Options

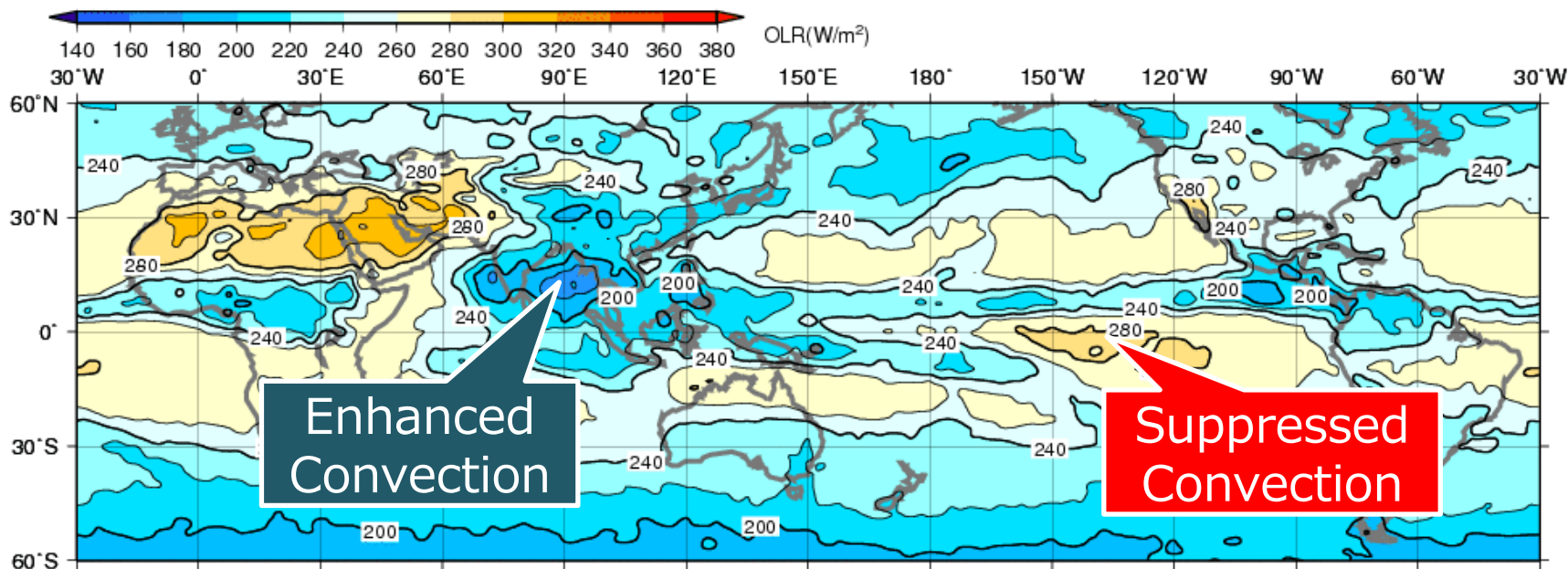
Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	<input type="checkbox"/> Polar Stereographic: North pole	<input type="checkbox"/> No Scale Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar	<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> 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: skip: 1	<input type="checkbox"/> No Caption	

Select "Blue-Red" color table.

Set contour parameters as follows.
interval: 10, min: -55, max: 55

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**



Monthly mean outgoing longwave radiation (OLR) (Jun.2016)
Original data provided by NOAA.

CPD/JMA

http://ds.data.jma.go.jp/tcc/tcc/products/clisys/figures/db_hist_mon_tcc.html

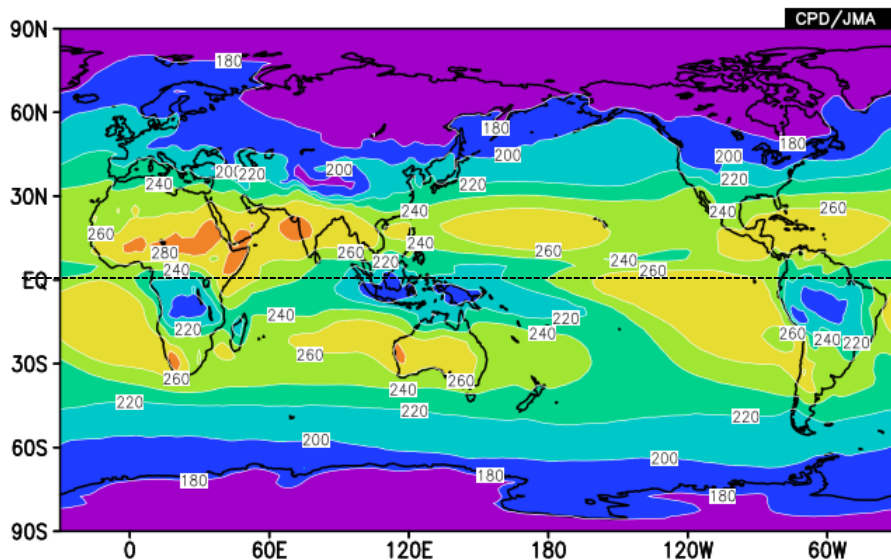
Topics: Anomalous convective activity associated with the El Niño event

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

DJF (Dec, Jan & Feb) mean OLR

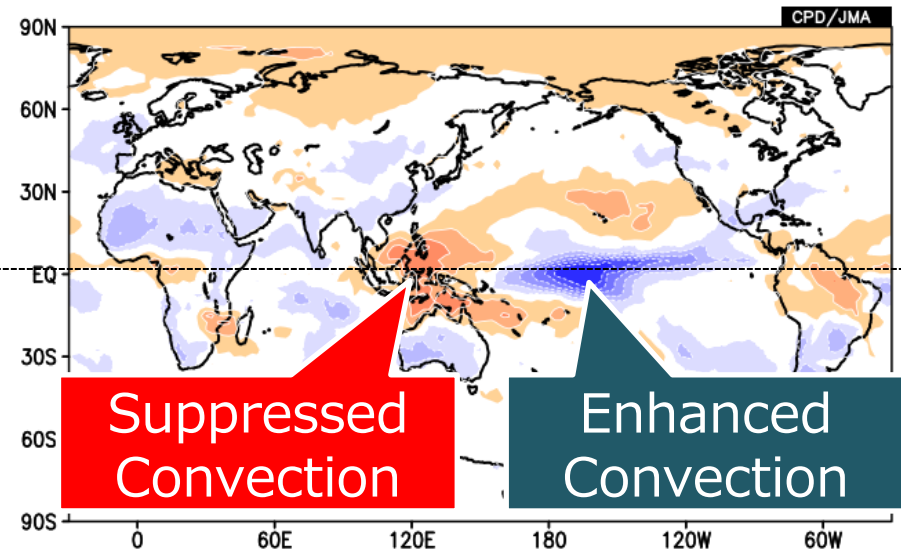
- Normal -

DATA1 SAT_olr NORM lat = -90:90 lon = -30:330 level = 1:1
time = 2015120100:2016020100 ave = 3MO



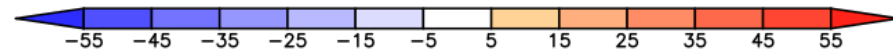
- Anomaly -

DATA1 SAT_olr ANOM lat = -90:90 lon = -30:330 level = 1:1
time = 2015120100:2016020100 ave = 3MO



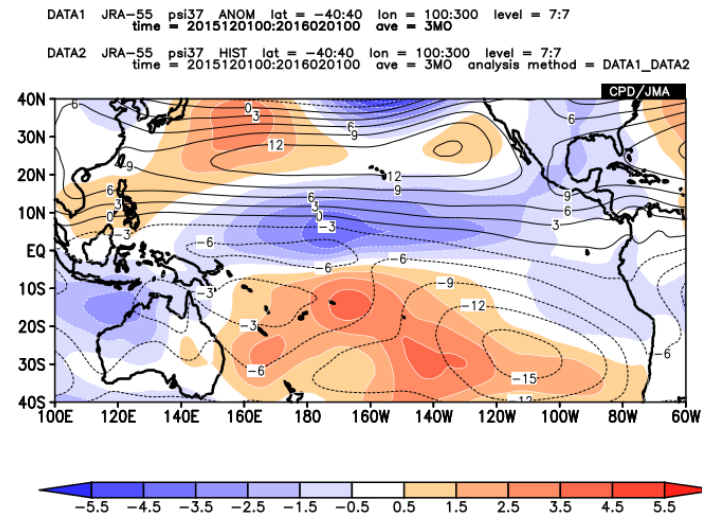
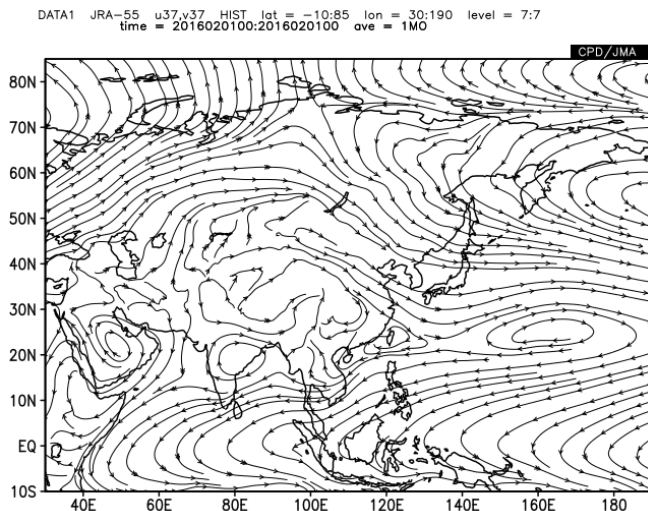
Suppressed
Convection

Enhanced
Convection





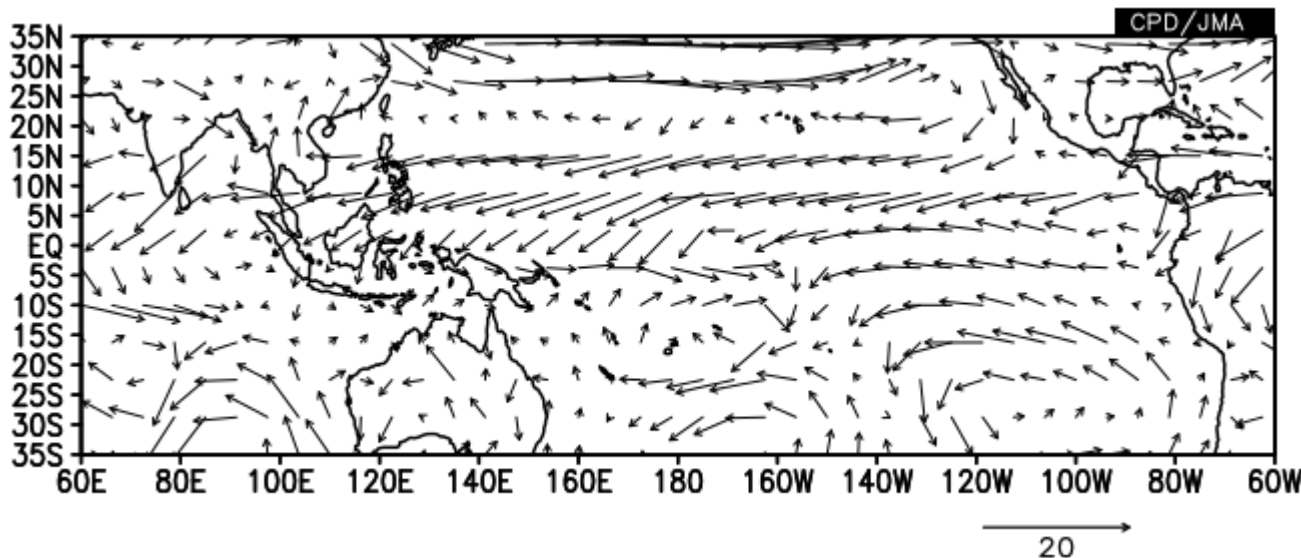
Multiple Data

- **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)

- How to draw vector maps
 - For example, let's make a low-level wind field map step by step.
 - Barbs are not available. (Barb :  and )



Wind vector at
850hPa in
January 2016

Vectors (2)

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	HIST	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 12
	V (Meridional Wind)		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 12
	x: <input type="text"/>					
	<input checked="" type="checkbox"/> Vector					
	<input type="checkbox"/> Stream line					
	<input type="checkbox"/> SD					
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat					

Analysis method: -Analysis method-

Check

X - component

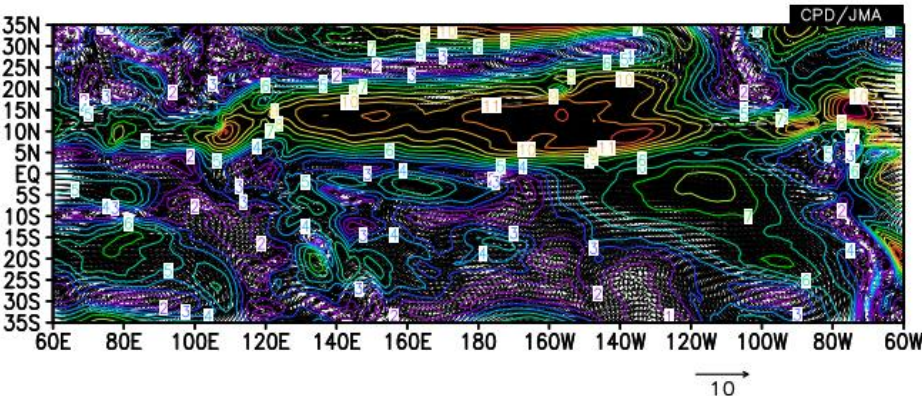
These boxes will appear.

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

Y - component

Submit

DATA1 JRA-55 u37,v37 HIST lat = -35:35 lon = 60:300 level = 7:7
time = 2015120100:2015120100 ave = 1MO



Oops!

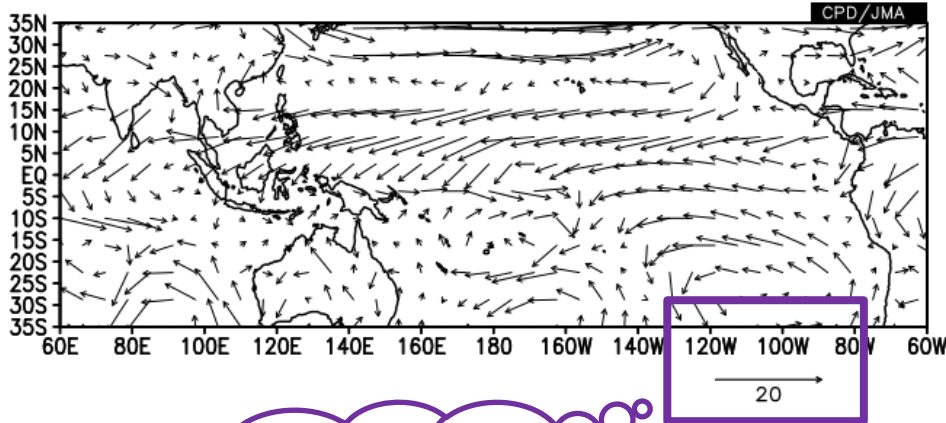
Vectors (3)

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 Vector size: 1 [inch] value: 20 skip: 5

Polar St
North pole
 Logaritl
 Reverse
 Flip the
 No Cap



In this setting,
1 inch
= 20 m/s.

Modify the vector size and its skip interval.

- If you want to make vector size larger, make "size" larger or "value" smaller.
- If vectors are too crowded, you should change "skip" value. In this setting, vectors are drawn at every 5 grids.

Stream lines

- Drawing stream lines

Data 1

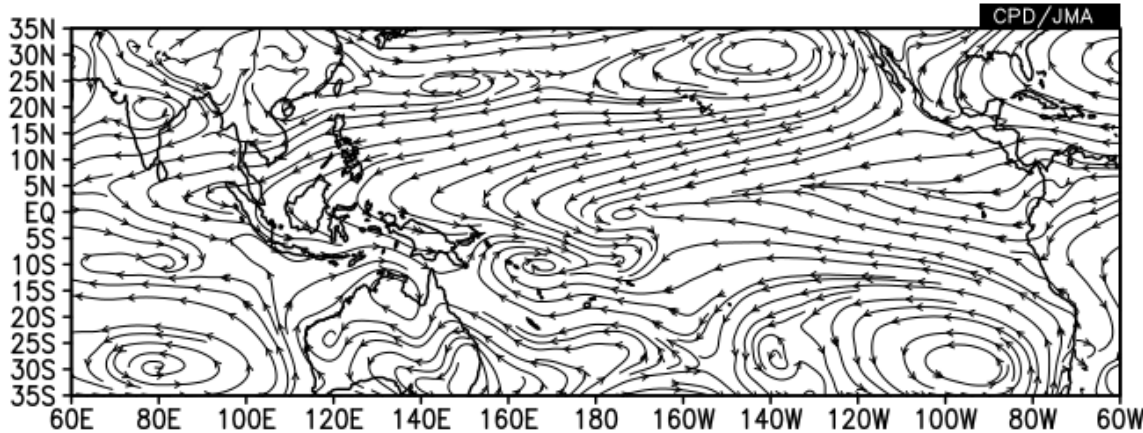
Dataset	Element
JRA-55	Pressure Levels
	U (Zonal Wind) [m/s]
	Pressure Levels
	V (Meridional Wind)
x:	<input checked="" type="checkbox"/> Stream line
	<input checked="" type="checkbox"/> Vector <input type="checkbox"/> SD

Check

Graphic Options

Colorizing: COLOR Show Contour Labels
Drawing: SHADE Show Color Bar
Image Format: png Set Contour Parameters for data1
Font: default interval: min: max:
Color Table: Rainbow Set Vector size: 1 [inch] value: 15 skip: 5

Uncheck



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

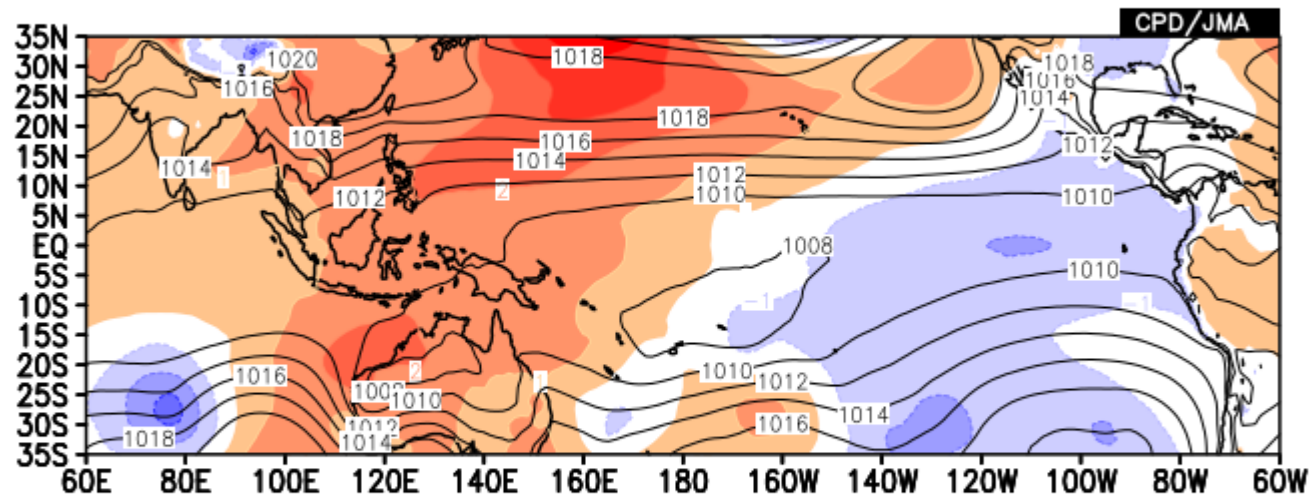
DATA1_DATA2: Overlaying two data

- How to draw two data
- Sea level pressure (contour) and its anomalies (shading).

DATA1 JRA-55 slp ANOM lat = -35:35 lon = 60:300 level = 1:1
time = 2015120100:2016020100 ave = 3MO

DATA2 JRA-55 slp HIST lat = -35:35 lon = 60:300 level = 1:1
time = 2015120100:2016020100 ave = 3MO analysis method = DATA1_DATA2

3-month mean
sea level
pressure and
its anomalies
from Dec.
2015 through
Feb. 2016



DATA1_DATA2: Overlaying two data

Basic Rule: The Data1 for shading (the lower layer) and Data2 for contours (the upper layer).

*As an exception, when you make a vector/stream line map, Data 1 must be for vector/stream line and Data 2 is for shading or contours.

1 Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Surface SLP (Sea Level Presst	ANOM	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	1	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2015 12 2016 2

Vector SD
Derivative: lon lat

Shading

This area will appear after "DATA1_DATA2" is selected.

2

Analysis method: DATA1_DATA2

3

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Surface SLP (Sea Level Presst	HIST	ALL Lat: -35 - 35 Ave <input type="checkbox"/> Lon: 60 - 300 Ave <input type="checkbox"/>	1	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2015 12 2016 2

SD

Contour

1. Set parameters in "Data1" field.
2. Select "DATA1_DATA2" in the "Analysis method" box.
3. Set parameters in "Data2" field and submit.

DATA1_DATA2: Overlaying two data

Graphic Options

4

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

Show Contour Labels
 Show Color Bar

Set Contour Parameters for data1
interval: 1 min: -4 max: 4

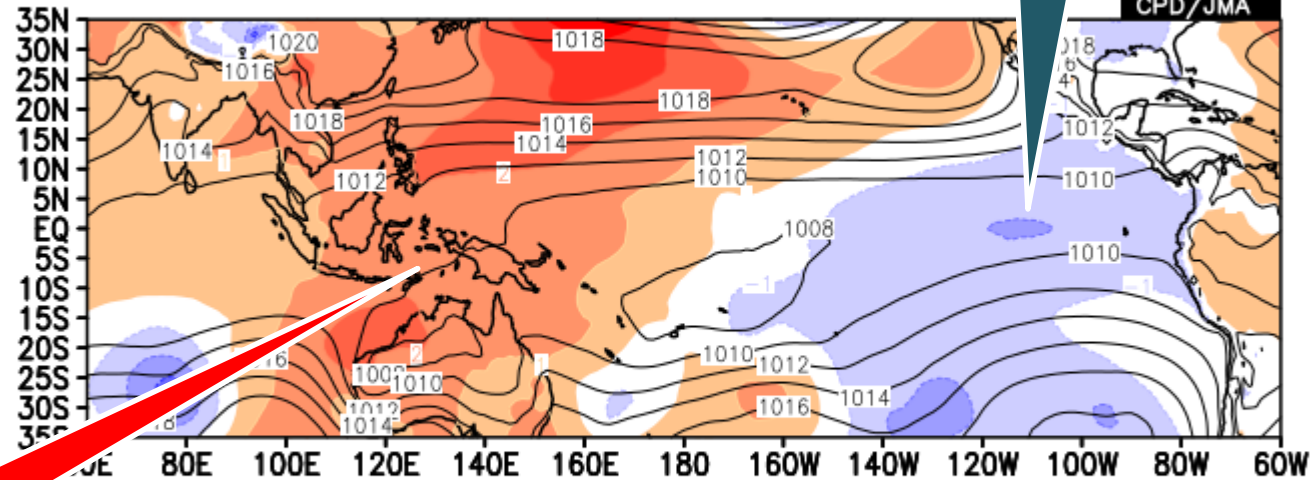
Set Contour Parameters for data2
interval: 2 min: 1000 max: 1020

Set Vector size: 1 [inch] value: 20 skip: 5

60:300 = 1:1
3MO
0:300 le = 1:1
3MO anly s me

= DATA1_DATA2

4. Set Contour parameters for data1 (SLP anomalies) and data2 (SLP).



Anti-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	2015 12
		2015 12

Vector SD

Derivative: lon lat

2

Analysis method: SUBTRACT

3

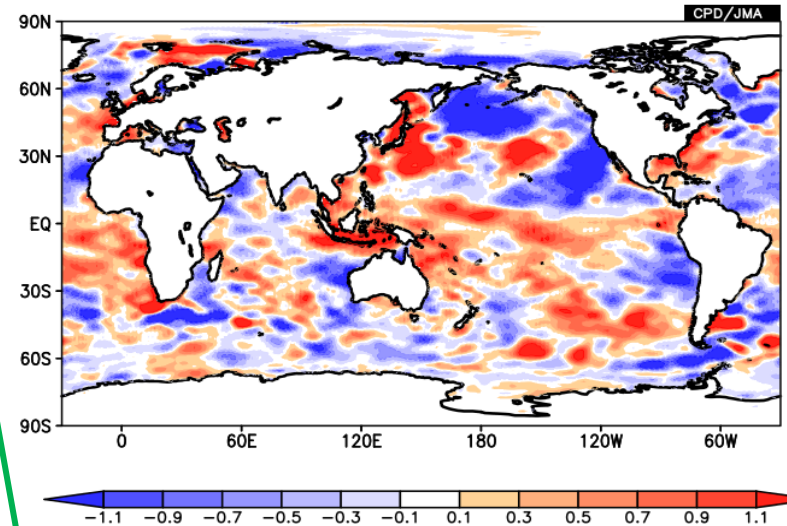
Data2

Dataset	Element	Showing period
SST	Sea Surface Data	RANGE
	Temperature (SST) [C	2015 10
		2015 10

SD

```
DATA1 SST_sst ANOM lat = -90:90 lon = -30:330 level = 1:1
time = 2015120100:2015120100 ave = 1MO

DATA2 SST_sst ANOM lat = -90:90 lon = -30:330 level = 1:1
time = 2015100100:2015100100 ave = 1MO analysis method = SUBTRACT
```



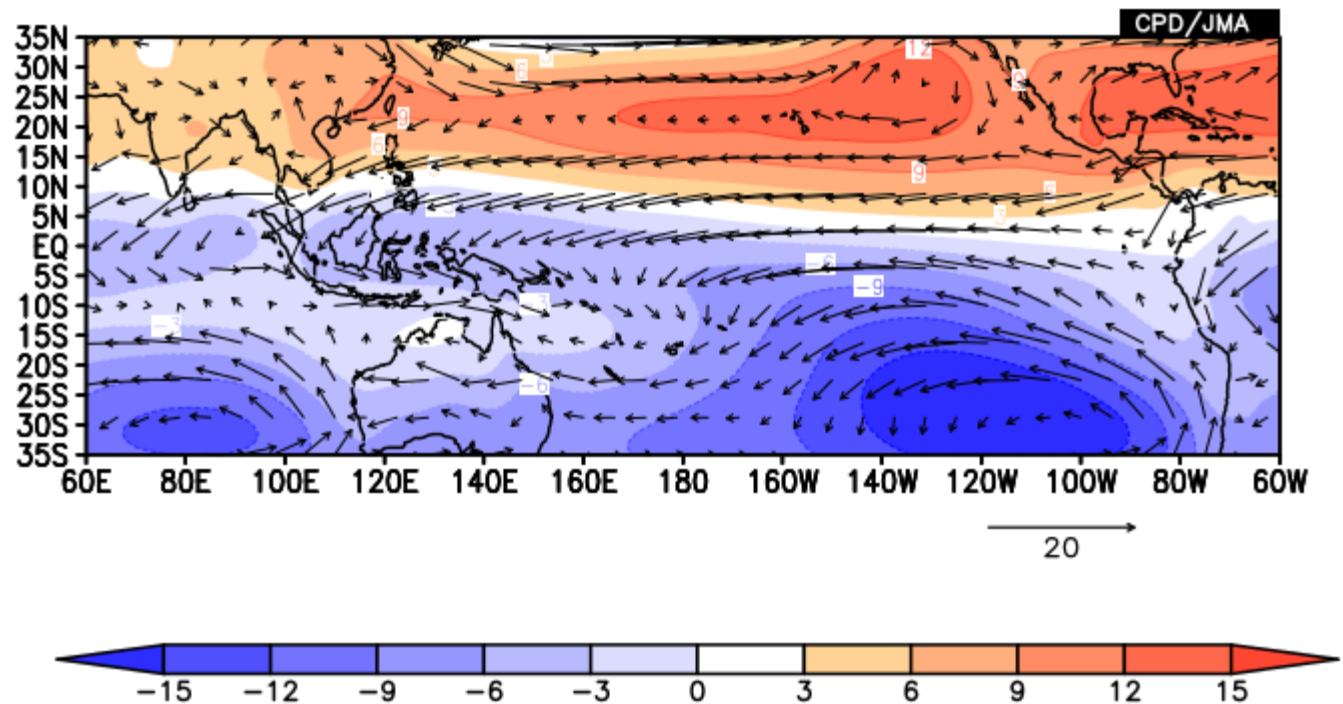
Data1 minus Data2 is mapped (In this case, December minus October).

Exercise (2)

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

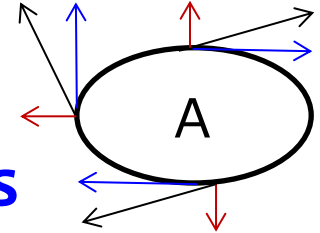
Hint 1: This is a vector and shading plot. In this case, is the data1 vector or shading?

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



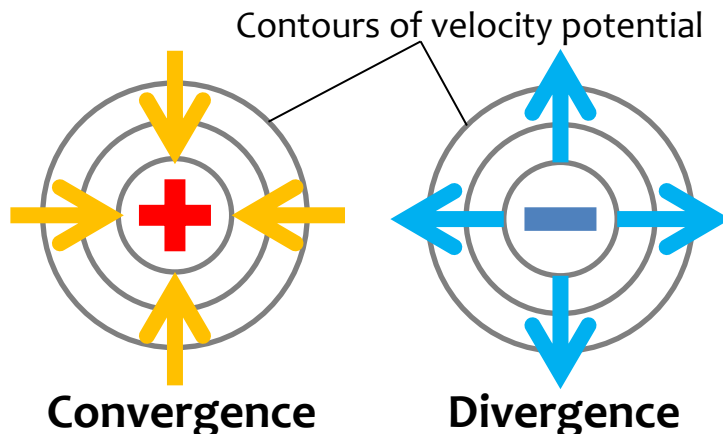
Velocity Potential and Stream Function

- **Wind fields = Divergent winds + Rotational winds**
 - Under an assumption of perfect fluid (i.e. no viscosity).
- **Divergent winds = $\nabla\chi$, where χ is Velocity potential**

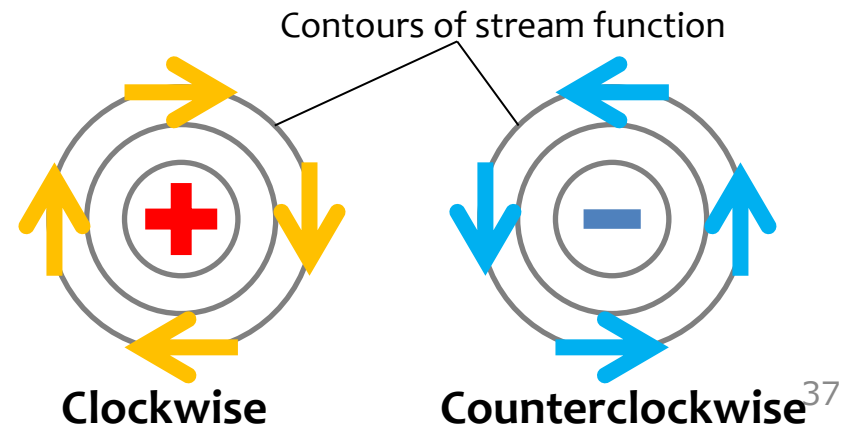


- Divergent wind blows in the upgradient direction of χ .
- **Rotational winds = $\mathbf{k} \times \nabla\psi$, where ψ is Stream function** (\mathbf{k} is a unit vector in vertical direction)
 - Rotational wind blows parallel to the contours of ψ , with low value to the left, regardless of which hemisphere you think.
 - Air flow around a local ψ 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)



Answers to Exercise (2)

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

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	850hPa	MONTHLY	RANGE
	ψ (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

Set parameter for ψ data in "Data2" field.

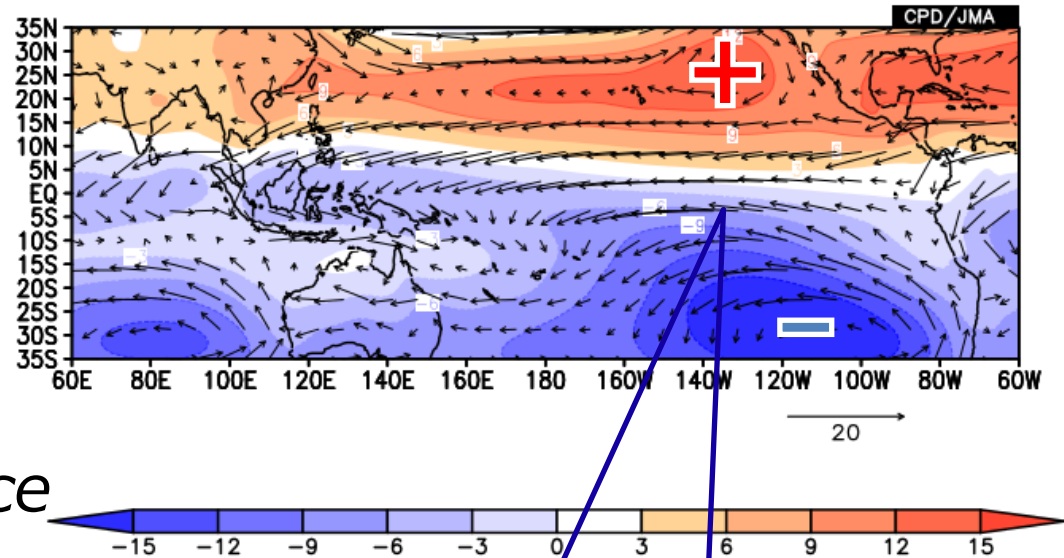
Graphic Options

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"/> Reverse the Axes	<input type="checkbox"/> Draw Credit Inside
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1			<input type="checkbox"/> Flip the X-axis <input type="checkbox"/> Flip the Y-axis	<input type="checkbox"/> Apply All Pics
Font: default	<input checked="" type="checkbox"/> Set Contour Parameters for data2			<input type="checkbox"/> No Caption	picture size <input type="text"/> %
Color Table: Blue - Red	interval: <input type="text"/> min: <input type="text"/> max: <input type="text"/>	<input checked="" type="checkbox"/> Set Vector size: 1 [inch] value: 20 skip: 5			

Tips: Stream function (ψ)

Note:

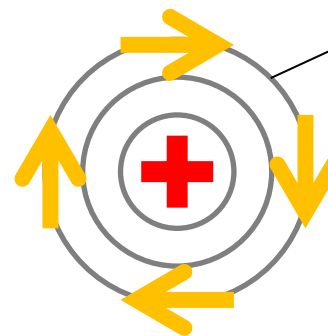
- Wind vectors are nearly parallel to the ψ lines.
- **Clockwise circulations** around the **local maximum of ψ** , and *vice versa*.
 - ψ Positive ψ values don't always mean clockwise circulations. You should see ψ 's maximum/minimum rather than the value itself.
- The magnitude of ψ 's gradient corresponds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



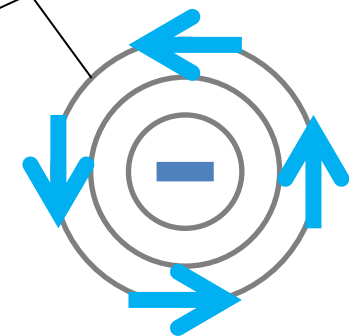
Prevailing Trade winds

Stream function (rotational winds)

Contours of stream function



Clockwise

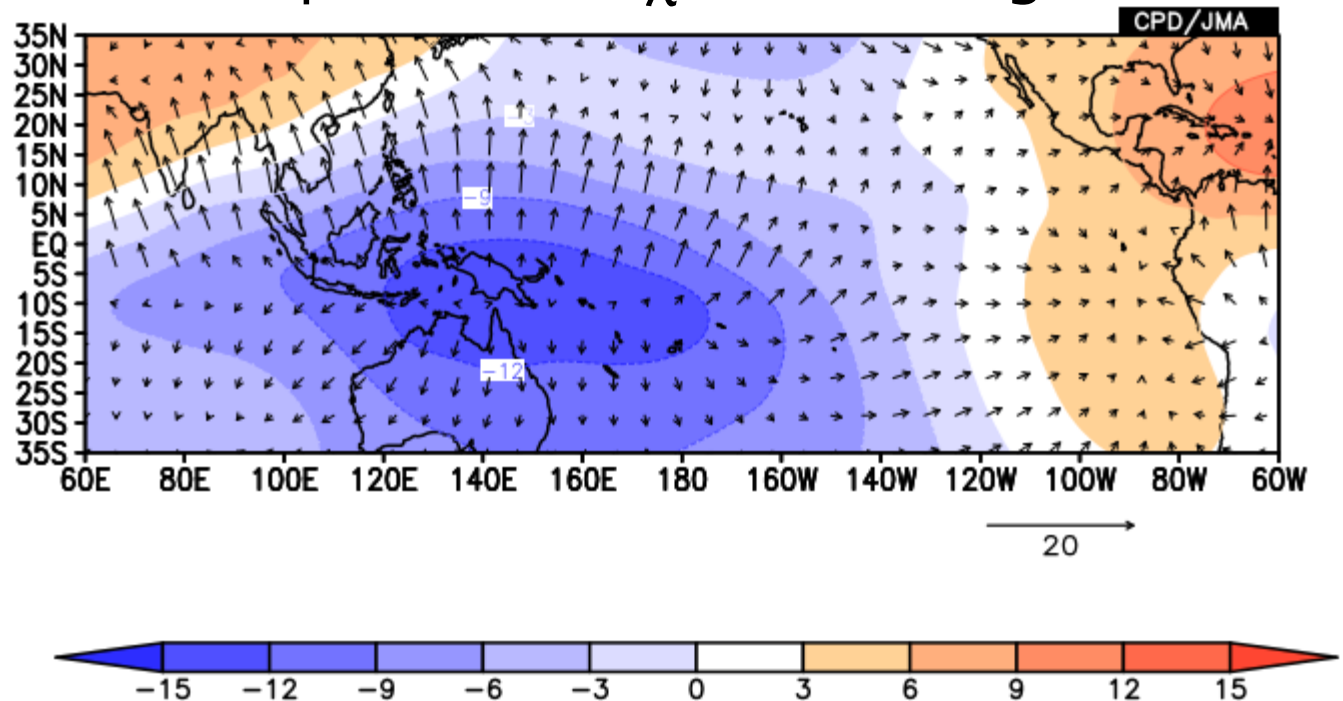


Counterclockwise

Exercise (3)

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

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



Answers to Exercise (3)

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
	Vdiv (Meridional Divi		Lon: 60 - 300 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	2015 1
	Pressure Levels					
	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

Data2

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels	NORM	ALL	200hPa	MONTHLY	RANGE
	χ (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

Set parameter for χ data in "Data2" field.

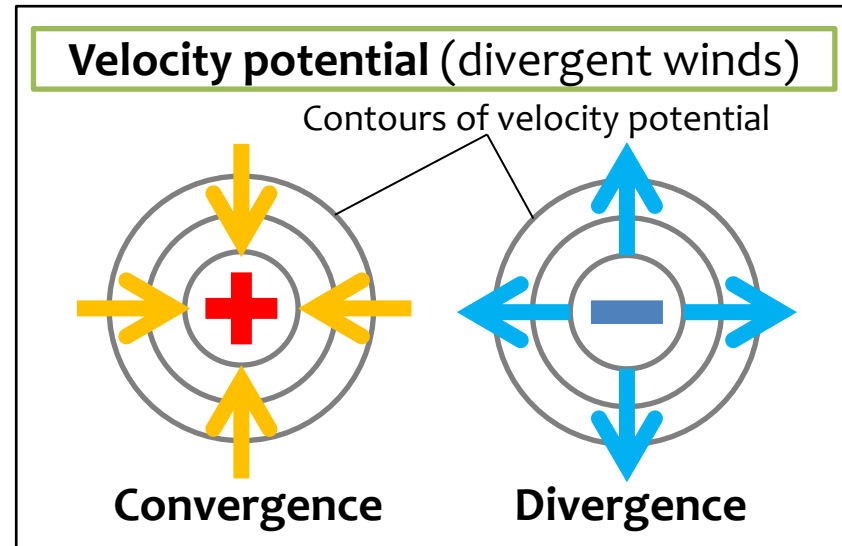
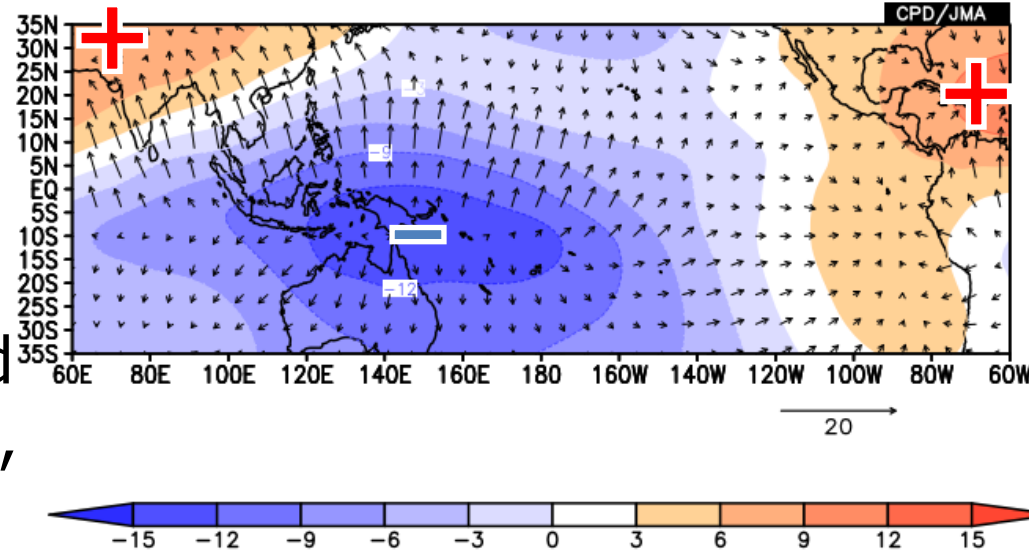
Graphic Options

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"/> Reverse the Axes	<input type="checkbox"/> Draw Credit Inside
Image Format: png	<input type="checkbox"/> Set Contour Parameters for data1		<input type="checkbox"/> Flip the X-axis <input type="checkbox"/> Flip the Y-axis	<input type="checkbox"/> Apply All Pics
Font: default	<input checked="" type="checkbox"/> Set Contour Parameters for data2		<input type="checkbox"/> No Caption	picture size <input type="text"/> %
Color Table: Blue - Red	interval: <input type="text"/> min: <input type="text"/> max: <input type="text"/>	<input checked="" type="checkbox"/> Set Vector size: <input type="text"/> [inch] value: <input type="text"/> skip: <input type="text"/>		

Tips: Velocity potential (χ)

Note:

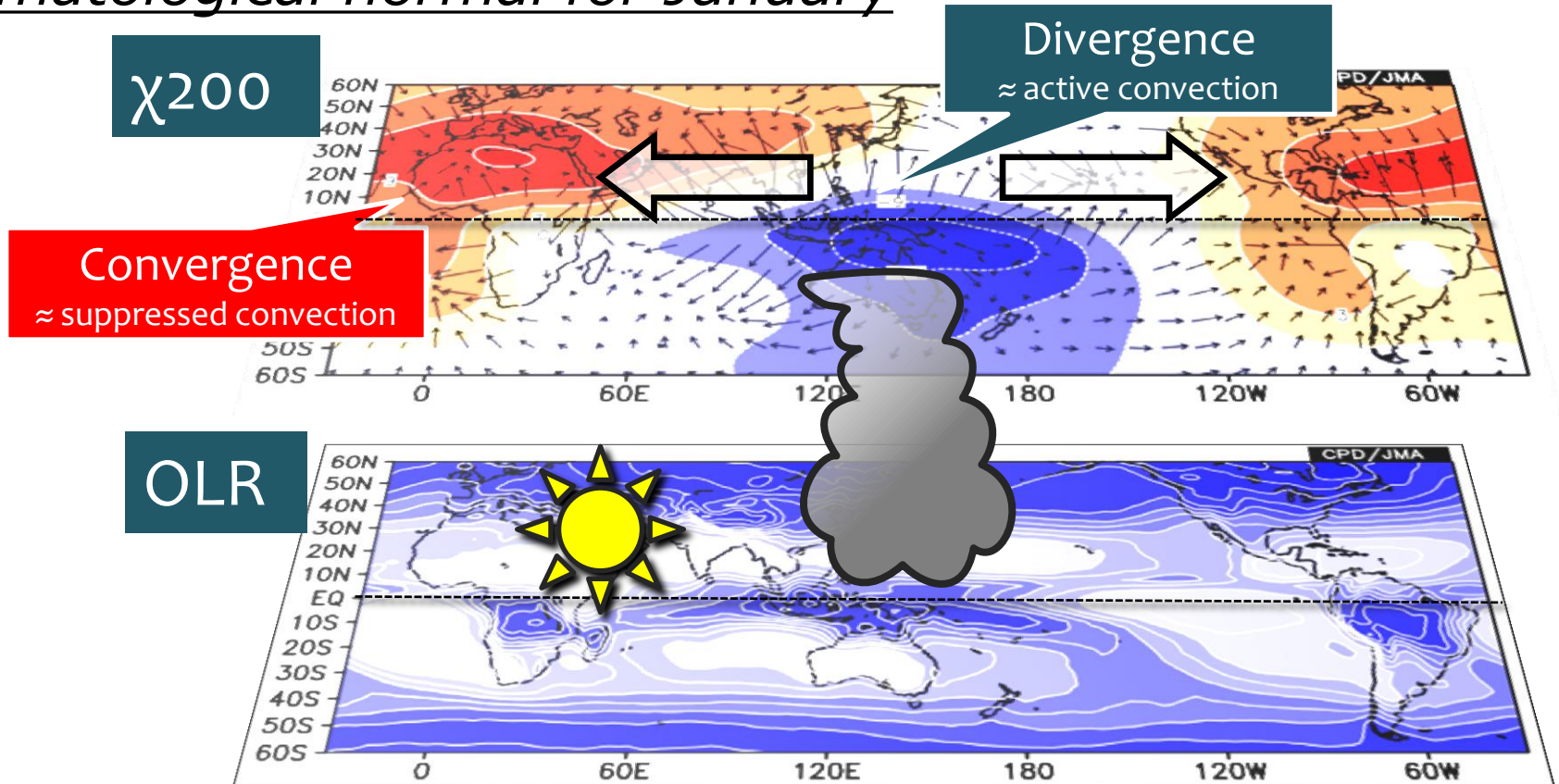
- Divergent wind vectors are perpendicular to the χ lines.
- **Divergent winds** around the **local minimum of χ** , and *vice versa*.
 - $\langle ! \rangle$ Negative χ values don't always mean divergent winds. You should see χ 's maximum/minimum rather than the χ value itself.
- The magnitude of χ 's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



Topics: Tropical Convection and Divergence

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

Climatological normal for January

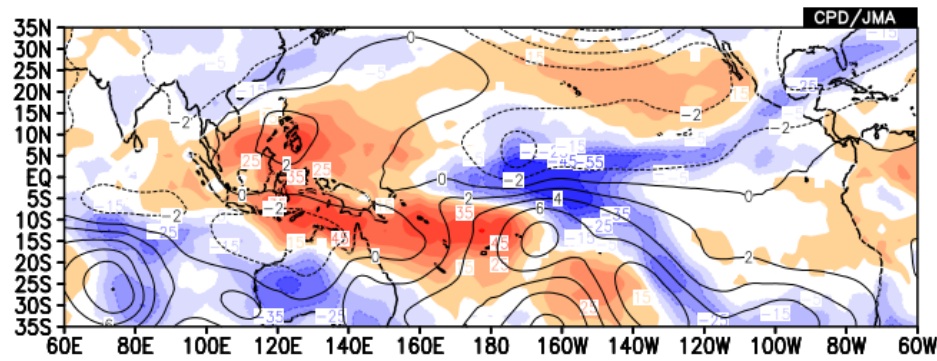
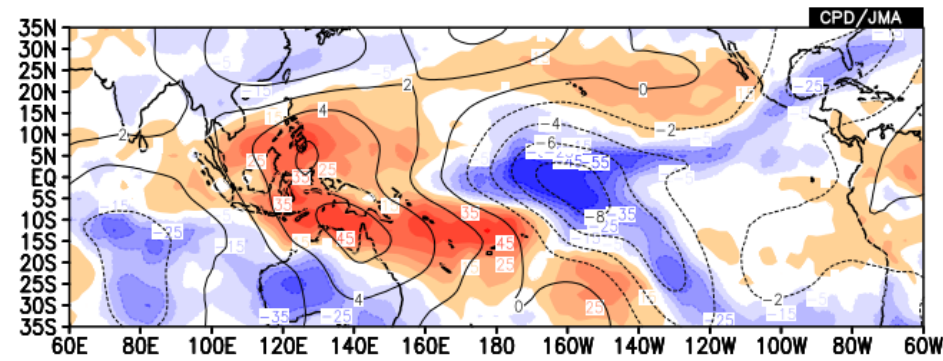


Exercise (4)

- Make anomaly maps for January 2016.
 - [Left] χ_{200} (contour) and OLR (shade)
 - [Right] ψ_{850} (contour) and OLR (shade)

χ_{200} (contour) and OLR (shade)

ψ_{850} (contour) and OLR (shade)



Where is upper-level divergence/convergence anomalies?
How about their relationship with OLR anomalies?
What circulation anomalies is collocated with those OLR anomalies?

Answers of Exercise (4)

Data1

Left

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m ²]	ANOM	ALL	1	MONTHLY	RANGE
		Lat: -35 - 35 Ave <input type="checkbox"/>			<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2016 1
		Lon: 60 - 300 Ave <input type="checkbox"/>			<input type="checkbox"/> Time filter	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	ANOM	ALL	200hPa	MONTHLY	RANGE
		Lat: -35 - 35 Ave <input type="checkbox"/>			<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2016 1
		Lon: 60 - 300 Ave <input type="checkbox"/>			<input type="checkbox"/> Time filter	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 checked="" type="checkbox"/> Set Contour Parameters for data2
	interval: 2 min: -10 max: 10
	<input type="checkbox"/> Set Vector size: [inch] value: skip:

Answers of Exercise (4)

Data1

Right

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m ²]	ANOM	ALL	1	MONTHLY	RANGE
		Lat: -35 - 35 Ave <input type="checkbox"/>			<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2016 1
		Lon: 60 - 300 Ave <input type="checkbox"/>			<input type="checkbox"/> Time filter	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	ANOM	ALL	850hPa	MONTHLY	RANGE
		Lat: -35 - 35 Ave <input type="checkbox"/>			<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2016 1
		Lon: 60 - 300 Ave <input type="checkbox"/>			<input type="checkbox"/> Time filter	2016 1

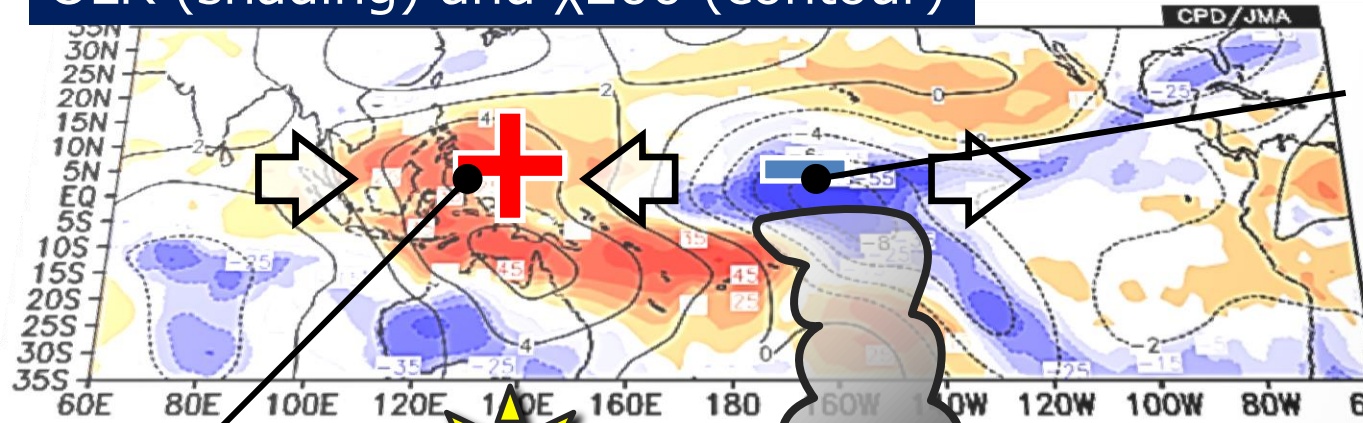
SD

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 checked="" type="checkbox"/> Set Contour Parameters for data2
	interval: 2 min: -10 max: 10
	<input type="checkbox"/> Set Vector size: [inch] value: skip:

Topics: Anomalies associated with El Nino

OLR (shading) and χ_{200} (contour)

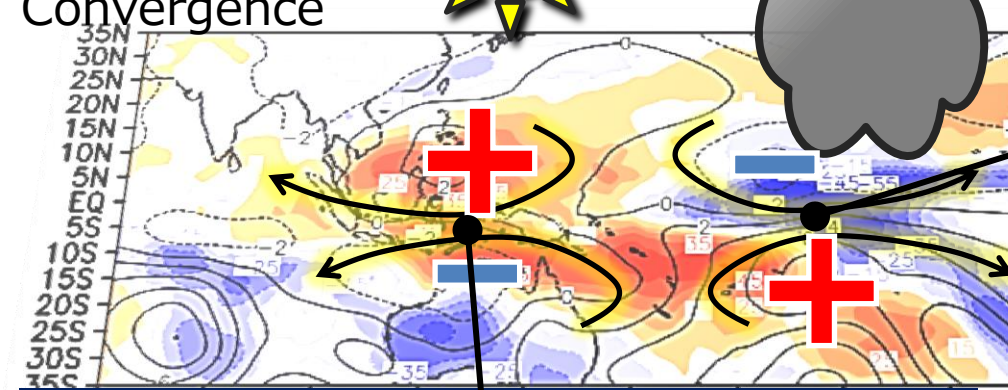


Upper-level Divergence

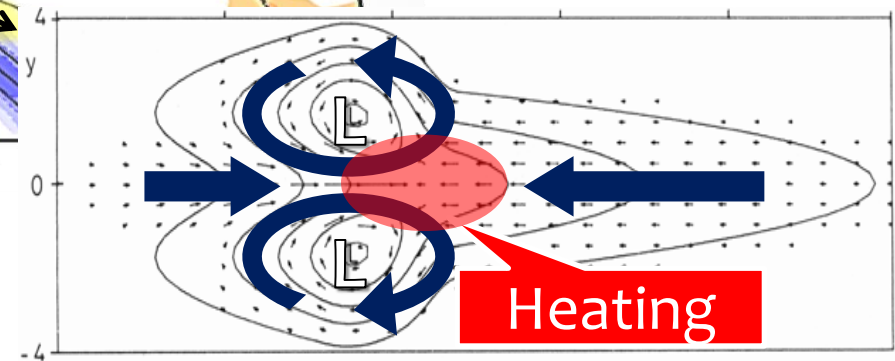
Upper-level Convergence

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

OLR (shading) and ψ_{850} (contour)



Anti-cyclonic circulation anomalies straddling the equator



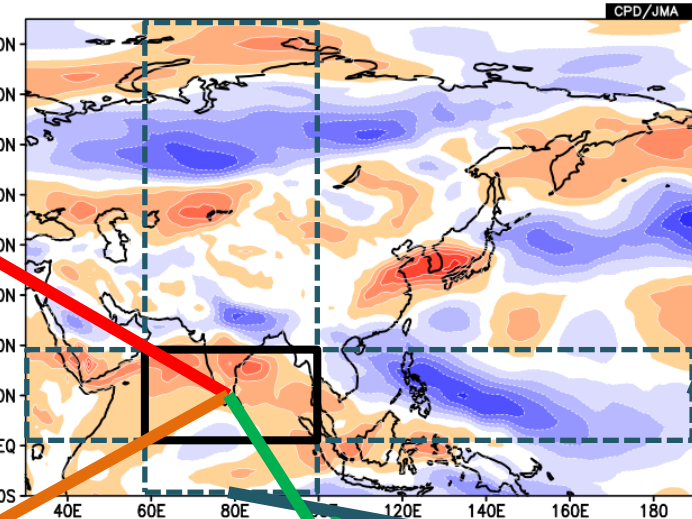
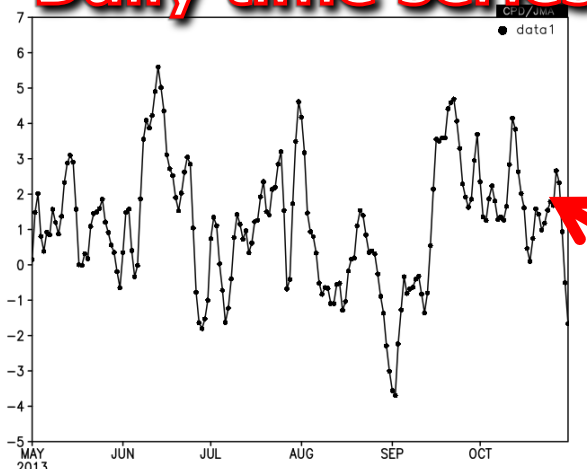
Contents

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

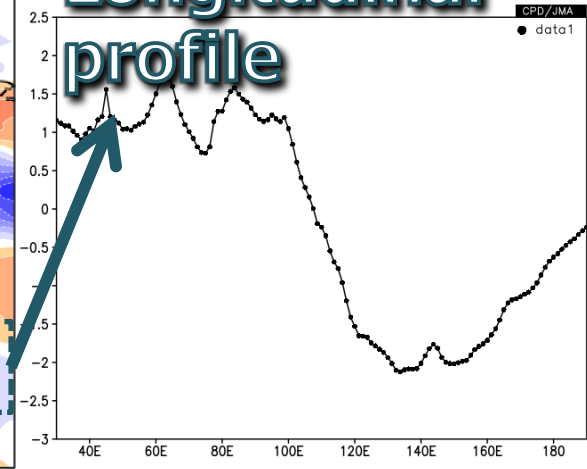
Line graph & Cross section diagram

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

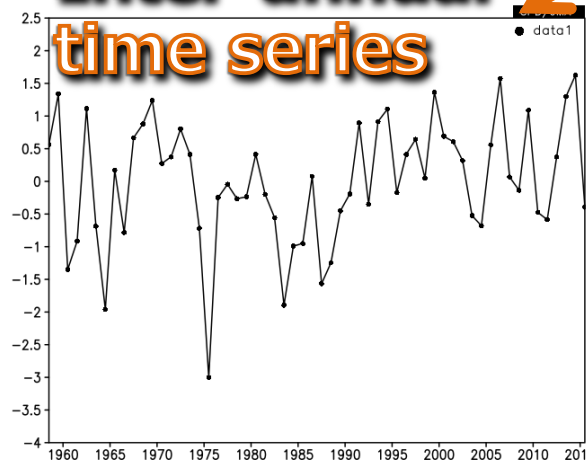
Daily time series



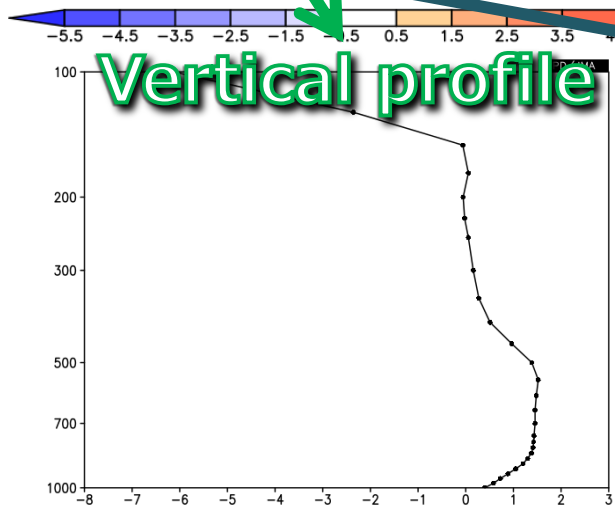
Longitudinal profile



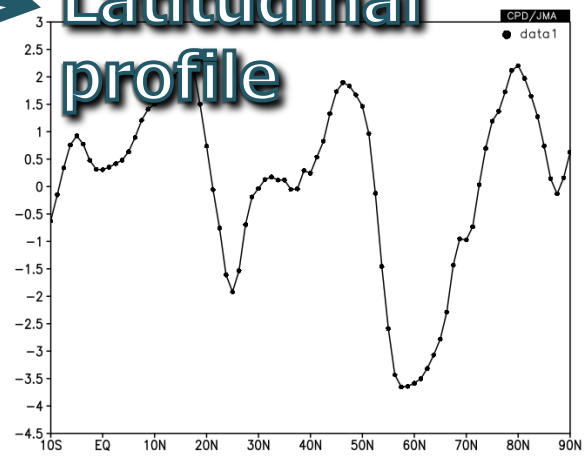
Inter-annual time series



Vertical profile



Latitudinal profile



Vertical and lat/longitude profile

- Vertical profile

Area		Level		Time unit	Showing period	
ASIA		1000hPa	1hPa	MONTHLY	RANGE	
Lat: 25	- 35			<input type="checkbox"/> Ave	2015	7
Lon: 120	- 130			<input type="checkbox"/> Year-to-year	2015	7
				<input type="checkbox"/> Time filter		

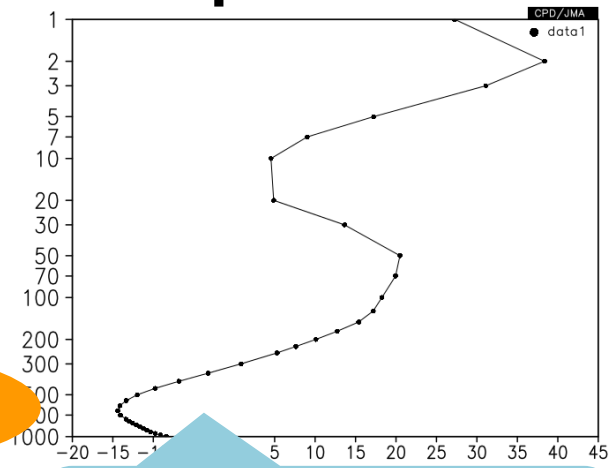
Select bottom and top level

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	



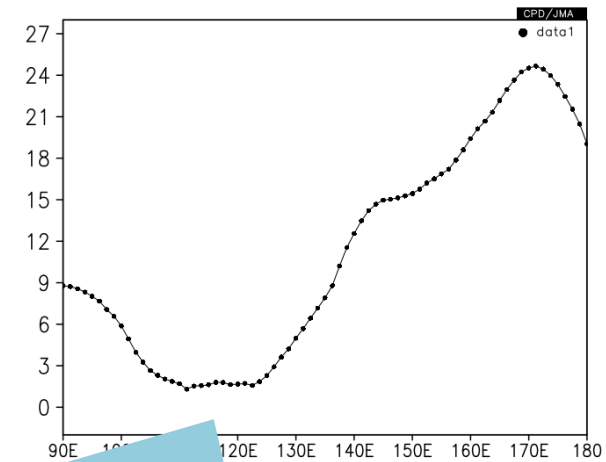
Height anomalies averaged over 25°–35°N, 120°–130°E

- Lat/Longitude profile

Area		Level	Time unit	Showing period	
ASIA		500hPa	MONTHLY	RANGE	
Lat: 25	- 35	500hPa	<input checked="" type="checkbox"/> Ave	2015	6
Lon: 90	- 180		<input type="checkbox"/> Year-to-year	2015	7
			<input type="checkbox"/> Time filter		

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

Select a specific level and period

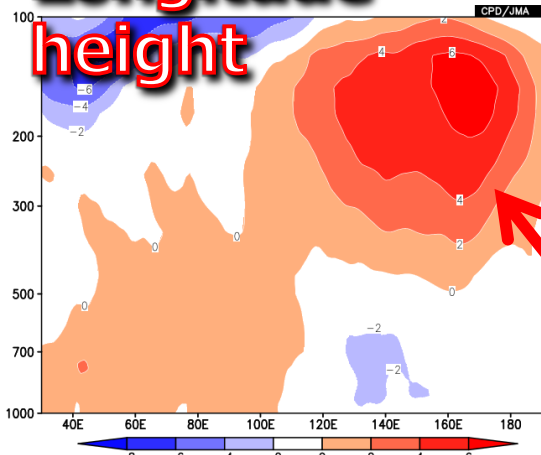


Longitude profile of 500-hPa height anomalies over 25°–35°N

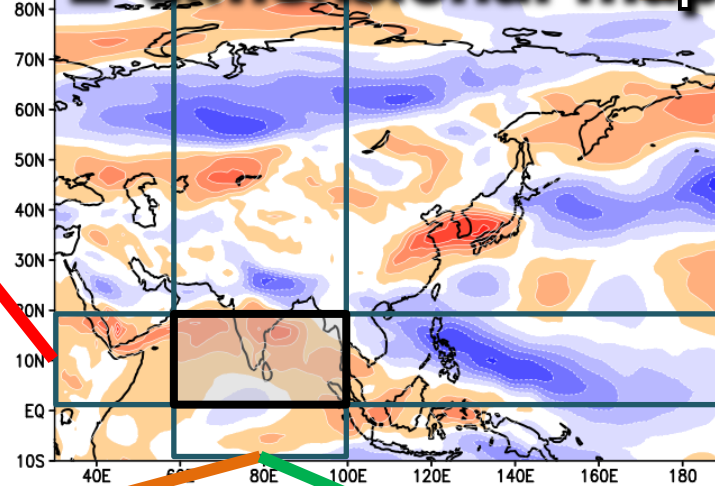
Cross section diagram

- Cross section diagram is also useful to see the variability or spatial structure.

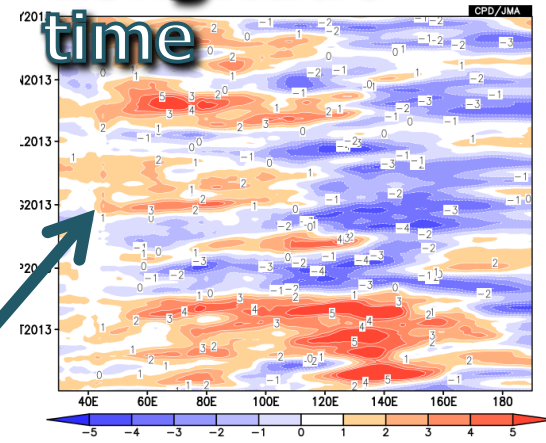
**Longitude-
height**



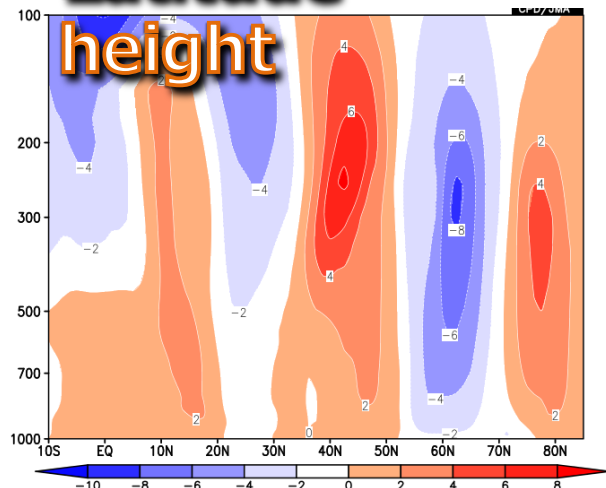
2-dimensional map



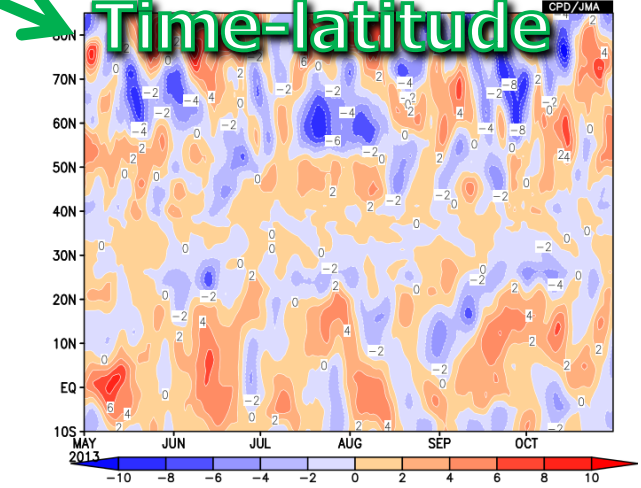
**Longitude-
time**



**Latitude-
height**



Time-latitude



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	MONTHLY	RANGE
			Lat: -60 - 60 Ave <input type="checkbox"/>	1000hPa	2016 6
			Lon: 90 - 150 Ave <input checked="" type="checkbox"/>	100hPa	2016 8
				<input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	
				<input type="checkbox"/> Time filter	

Input southern and northern border

Set a specific period

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

Set bottom and top level

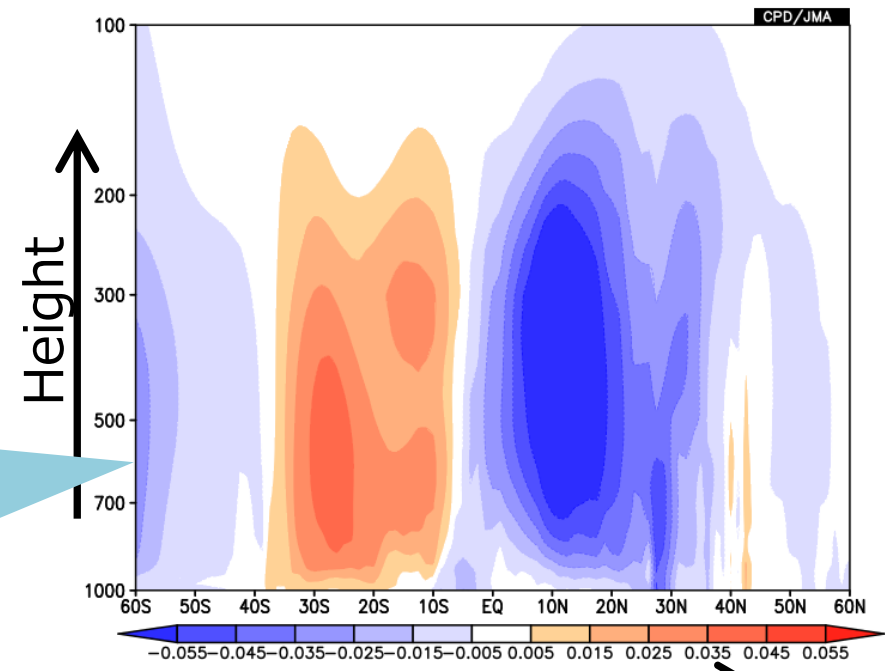
Polar Stereographic: North p

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

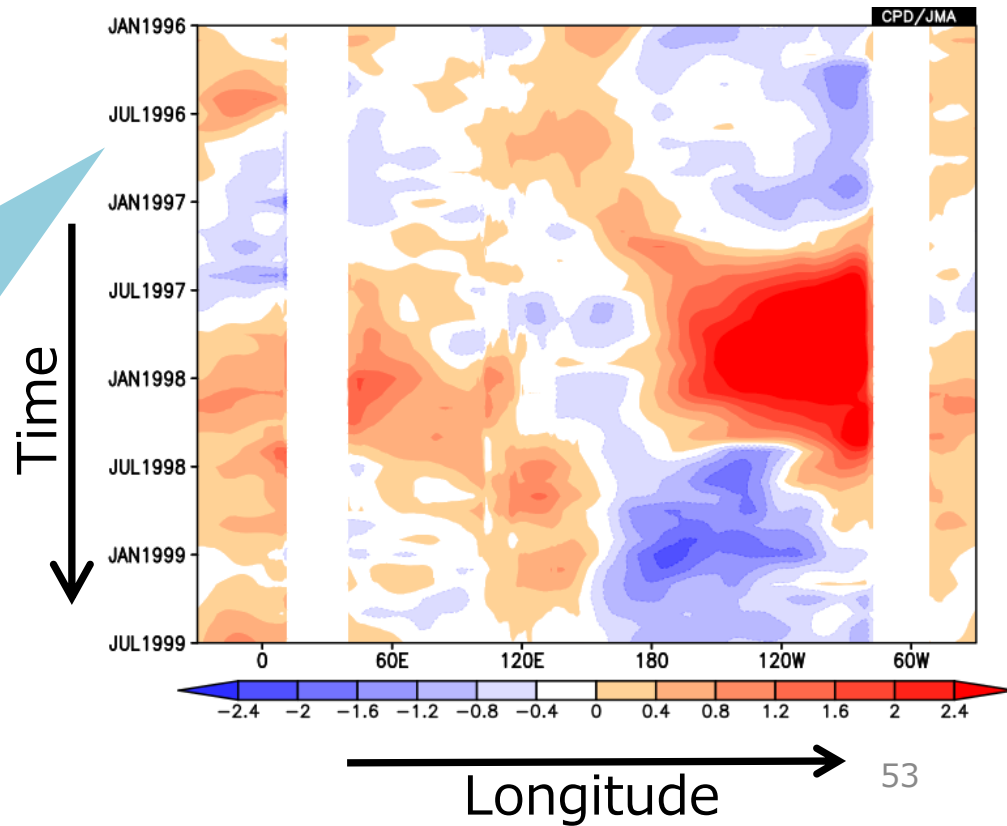
DATA1 JRA-55 omg37 NORM lat = -60:60 lon = 90:150 level = 1:27
time = 2016060100:2016080100 ave = 3MO



Time cross section

- Longitude-time cross section
- To see time evolution and highlight some wave propagation
- Let's see the time evolution of the equatorial SST anomalies associated with the 1997/98 big El Niño event.

Longitude-time cross section of SST anomalies averaged over $5^{\circ}\text{S} - 5^{\circ}\text{N}$ (i.e. along the equator) from January 1996 to July 1999.



Time cross section

Analysis Dataset

Select parameters | Graphic Options

Data1 SST anomalies

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data	ANOM	ALL	1	MONTHLY	RANGE
	Temperature (SST) [C		Lat: -5 - 5 Ave <input checked="" type="checkbox"/>		<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	1996 1
			Lon: -30 - 330 Ave <input type="checkbox"/>		<input type="checkbox"/> Time filter	1999 7

Vector SD
Derivative: lon lat

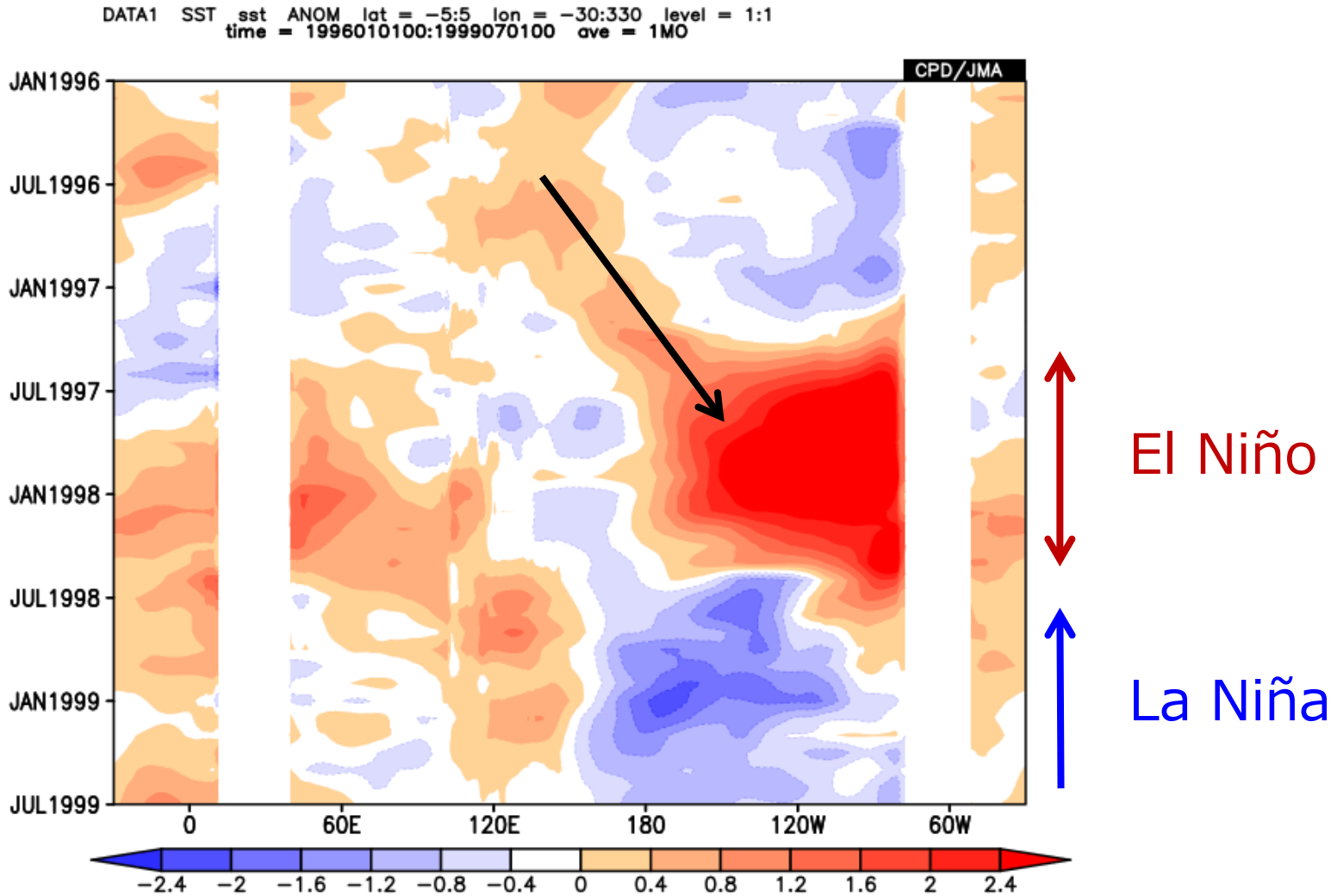
Don't forget to check to perform meridional average!

from Jan. 1996 To Jul. 1999

Graphic Options

Colorizing: COLOR	<input checked="" type="checkbox"/> Show Contour Labels	<input type="checkbox"/> Polar Stereographic: North pole	<input type="checkbox"/> No Scale Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Show Color Bar	<input type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Draw Credit Inside
Image Format: png	<input checked="" type="checkbox"/> Set Contour Parameters for data1	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Apply All Pics
Font: default	interval: 0.4 min: -2.4 max: 2.4	<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: [] skip: 1	<input type="checkbox"/> No Caption	

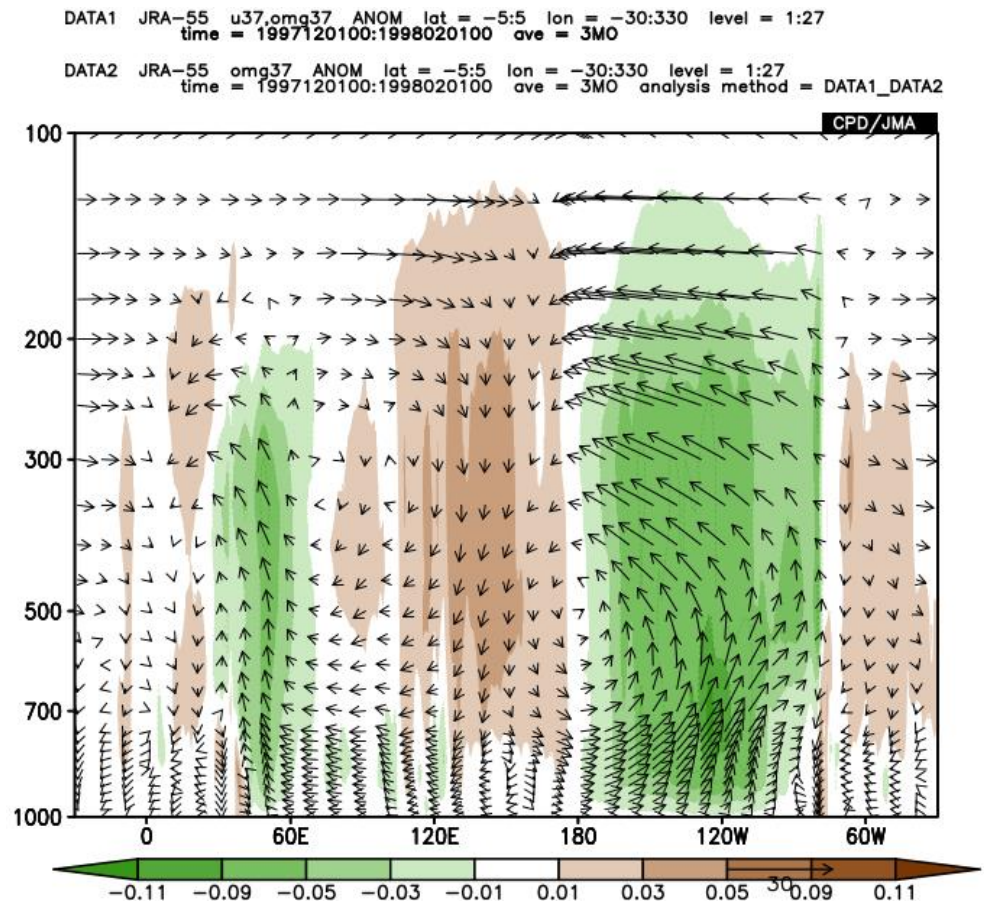
Time cross section



Integrated Exercise (1)

- Show longitude-height cross section of zonal/vertical wind anomaly vector and vertical wind anomaly (shading) averaged from 5°S to 5°N during the period from December 1997 to February 1998.

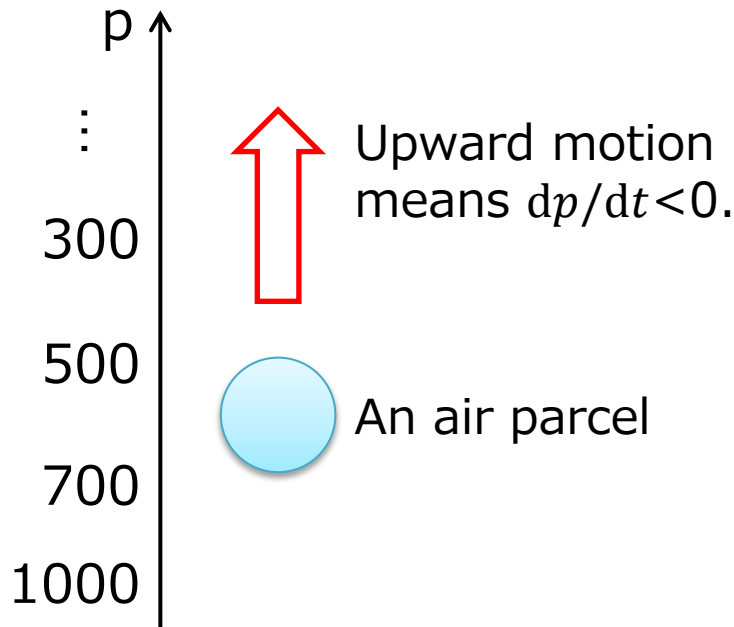
- Try to adjust vector scale and skip interval to improve the visibility of the figure.
- Select logarithmic coordinates for vertical axis.
- Adjust contour parameters (see color bar of the figure).
- Select "Green-Brown" for "Color Table".



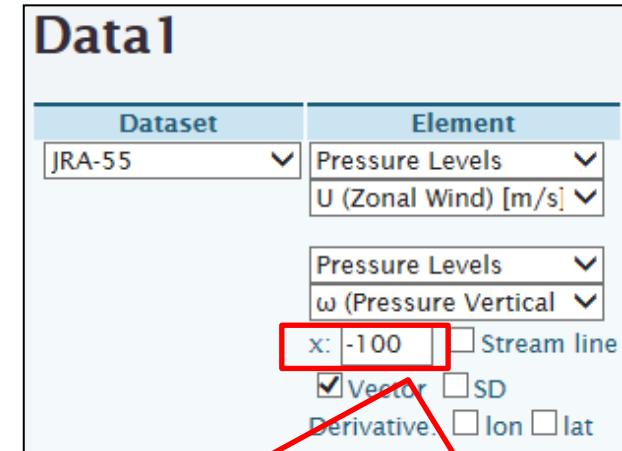
Hint: How to draw vertical motion by vectors

In pressure coordinate data set, vertical motion is given by pressure velocity ω , where $\omega \equiv dp/dt$.

If $\omega < 0$, it means the pressure of an air parcel there becomes lower, which corresponds to upward motion because pressure becomes smaller towards upper levels in general.



In iTacs.....,



This means multiplying the second component by -100. There are two reasons.
#1: **To reverse the vector direction for understanding the true wind direction intuitively.**
#2: To highlight vertical component because omega values are too small compared to meridional winds in general.

Answers to Integrated Exercise (1)

Data1

zonal/vertical
wind anomalies

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels U (Zonal Wind) [m/s]	ANOM	ALL Lat: -5 - 5 Ave <input checked="" type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>	1000hPa 100hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1997 12 1998 2

x: -100 Stream line
 Vector SD
 Derivative: lon lat

5°S – 5°N
average

1000
~100
hPa

Dec. 1997
– Feb. 1998

Analysis method: DATA1_DATA2

Data2

Vertical wind
anomalies

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels ω (Pressure Vertical)	ANOM	ALL Lat: -5 - 5 Ave <input checked="" type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>	1000hPa 100hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1997 12 1998 2

SD

Graphic Options

Set parameters for
contour and vector

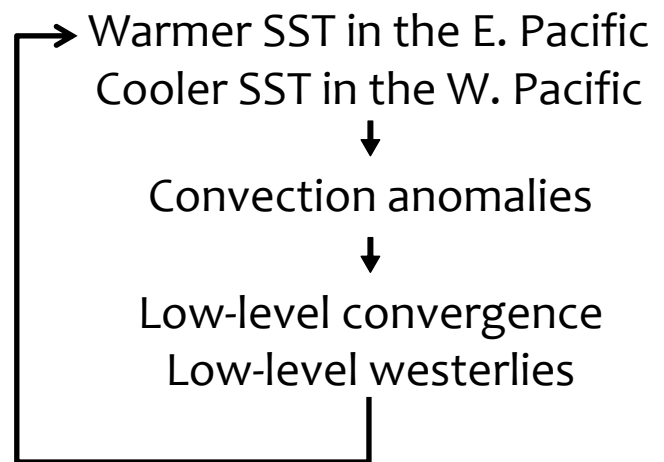
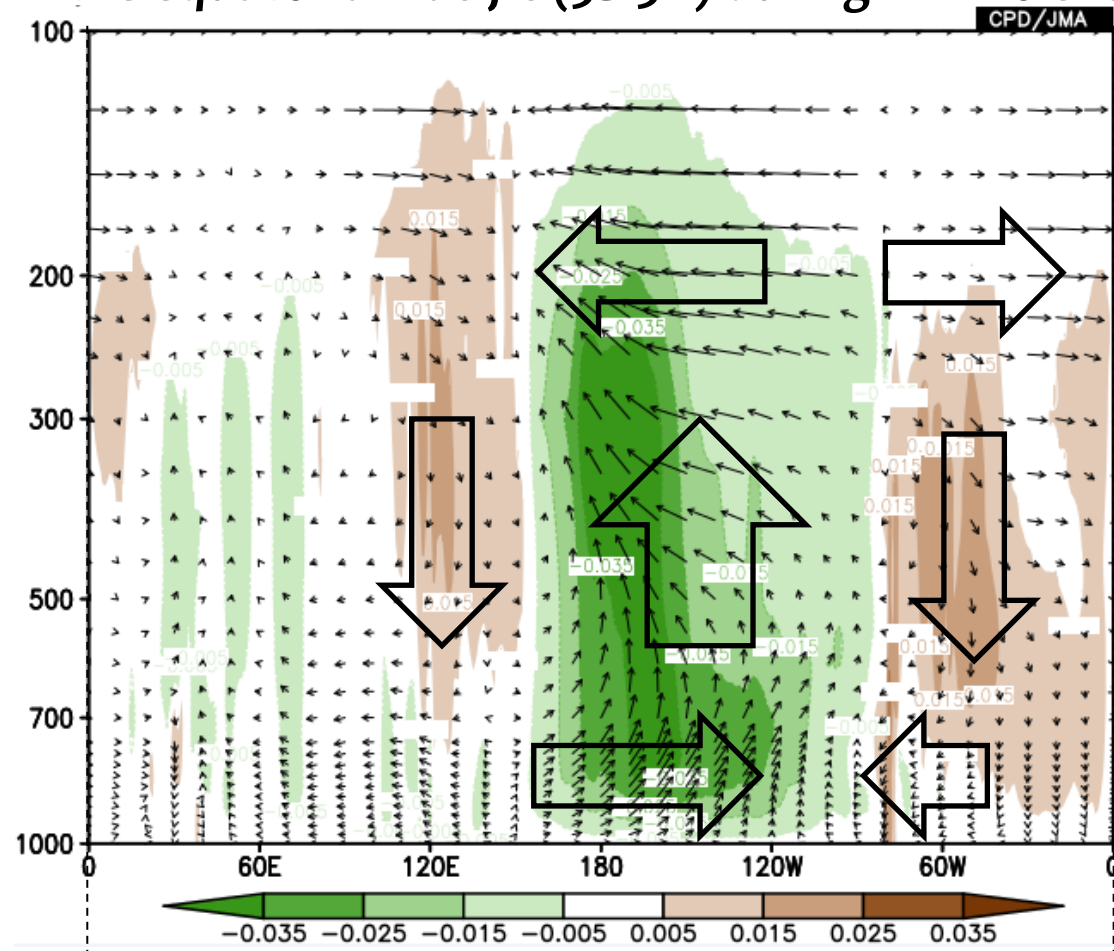
Logarithmic
Coordinates

Colorizing: COLOR	<input checked="" type="checkbox"/> Show	<input type="checkbox"/> Set	interval: min: max:	<input type="checkbox"/> Polar Stereographic	<input type="checkbox"/> North pole	<input type="checkbox"/> No Scale Labels
Drawing: SHADE	<input checked="" type="checkbox"/> Set Contour Parameters for data2	<input checked="" type="checkbox"/> Set Vector size: 1 [inch] value: 30 skip: 8	interval: 0.02 min: -0.11 max: 0.11	<input checked="" type="checkbox"/> Logarithmic Coordinates	<input type="checkbox"/> Reverse the Axes	<input type="checkbox"/> Draw Credit Inside
Image Format: png				<input type="checkbox"/> Flip the X-axis	<input type="checkbox"/> Flip the Y-axis	<input type="checkbox"/> Apply All Pics
Font: default				<input type="checkbox"/> No Caption		picture size %
Color Table: Green - Brown						

Green-Brown

Topics: Ocean-Atmosphere Coupled System

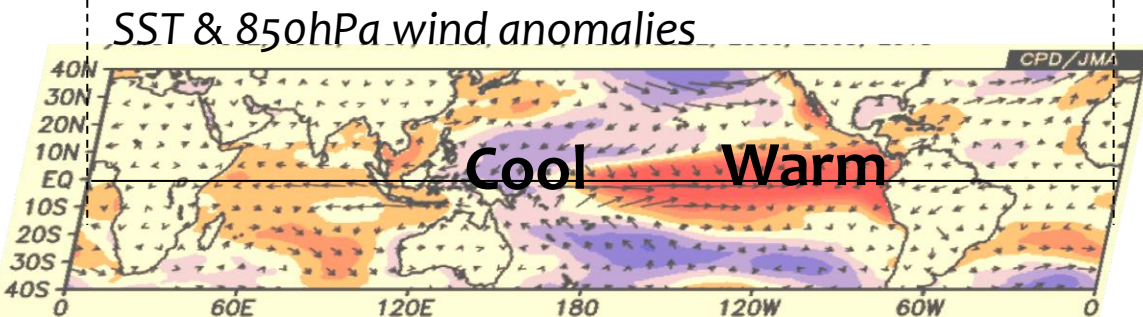
In the equatorial Pacific (5S-5N) during El Niño events.....,



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
- ❑ 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

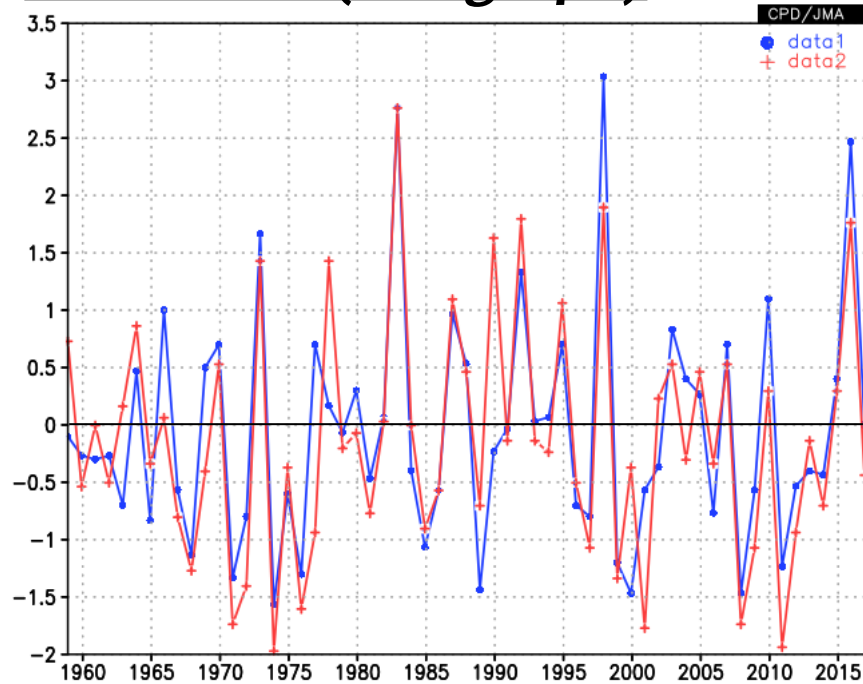
- Introduction
- Correlation / Regression Analysis
- Composite Analysis

5. Other Advanced operations

- Data download
- User data input

Basic Statistics in Brief

Time series (line graph)



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

Blue: NINO.3 SST anomaly

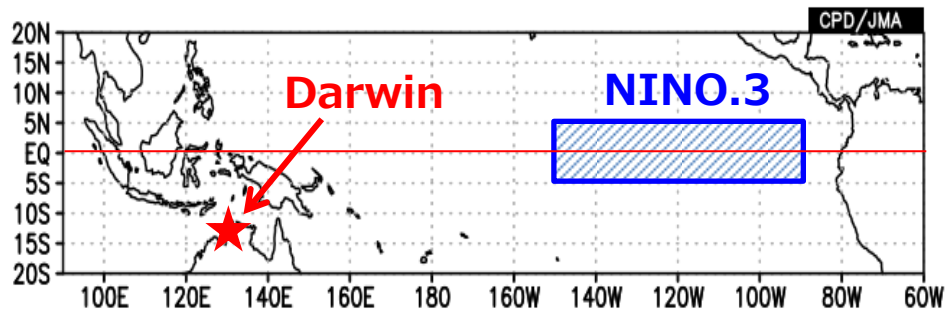
(Positive: El Nino-like, Negative: La Nina-like)

Red: SLP anomaly at Darwin

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

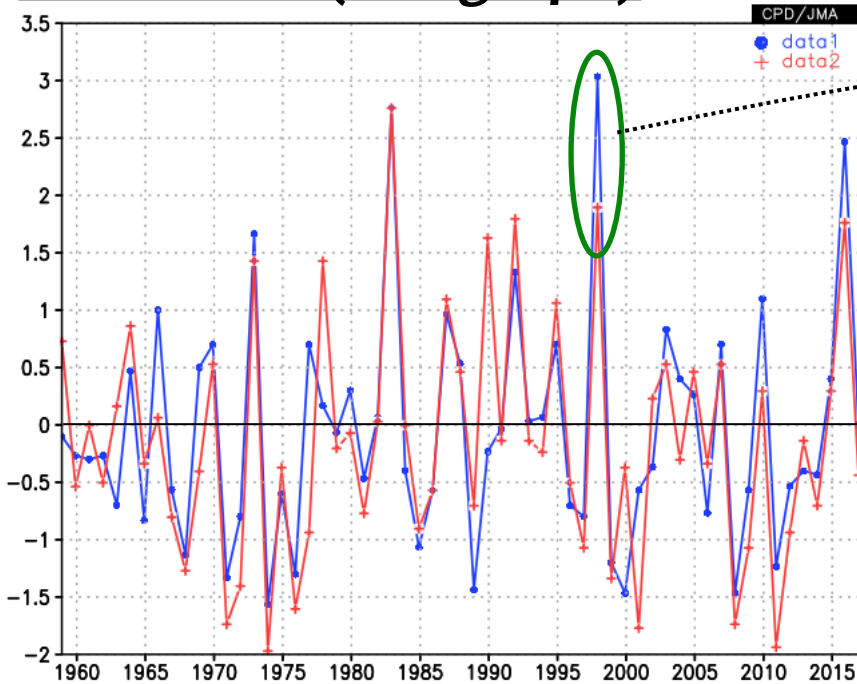
Next step is...,

How can we evaluate the relationship objectively and quantitatively?

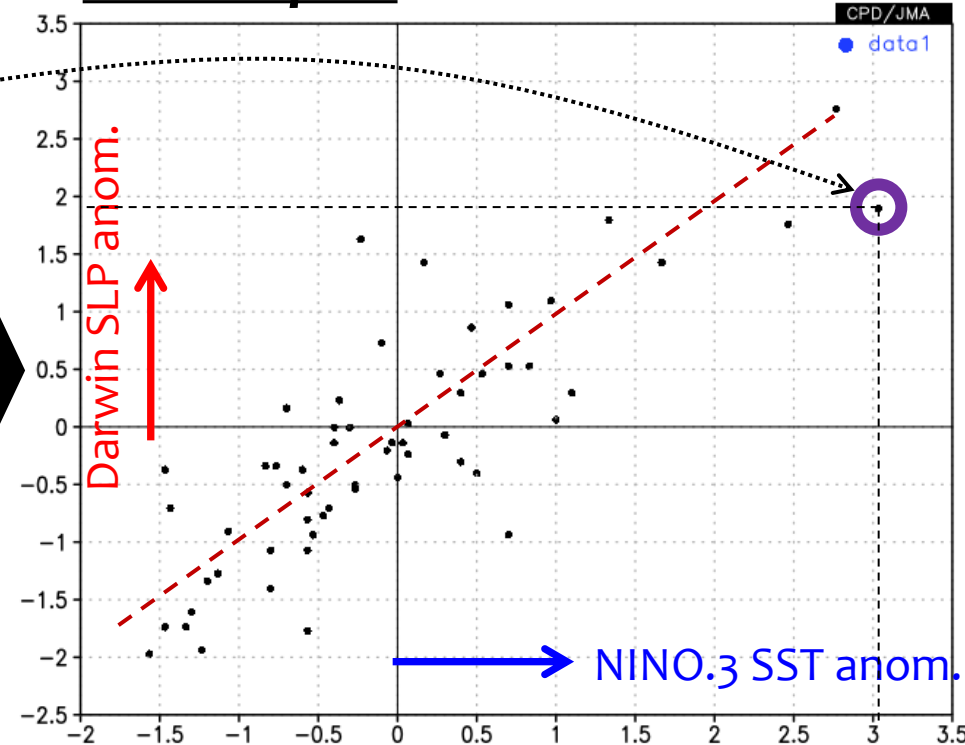


Basic Statistics in Brief

Time series (line graph)



Scatter plot

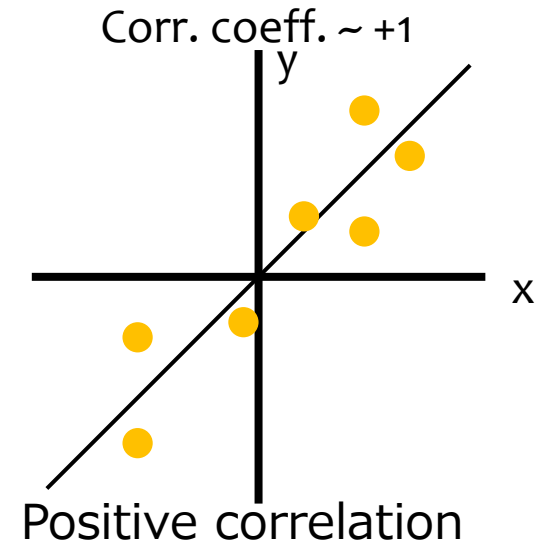
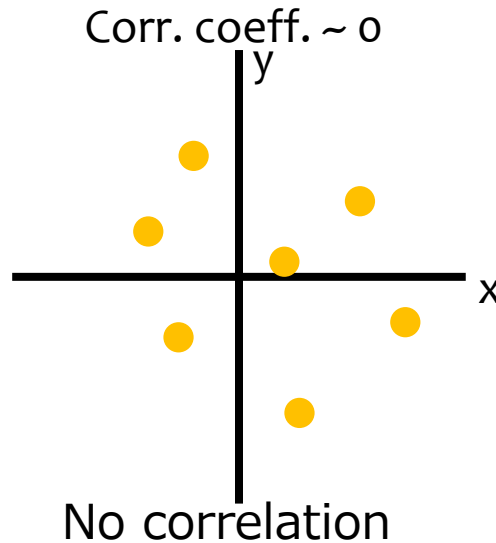
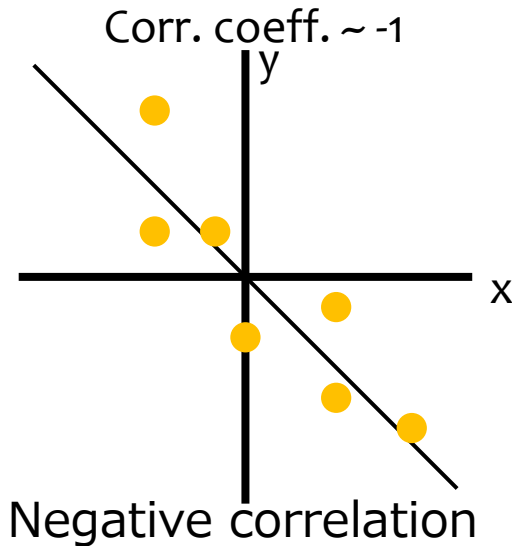


If we link **each pair** of NINO.3 SST and Darwin's SLP values to **a point** on a x-y map, we can clearly see a linear relation between them. We can evaluate the relationship with **correlation coefficients**. In this case, the correlation coefficient is +0.82.

Correlation coefficient: How close they have a linear relationship

Basic Statistics in Brief

- **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

$Y \rightarrow X$

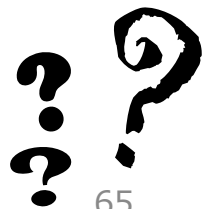
Y causes X

$X \rightleftarrows Y$

Feedback

$Z \rightarrow X$
 $Z \rightarrow Y$

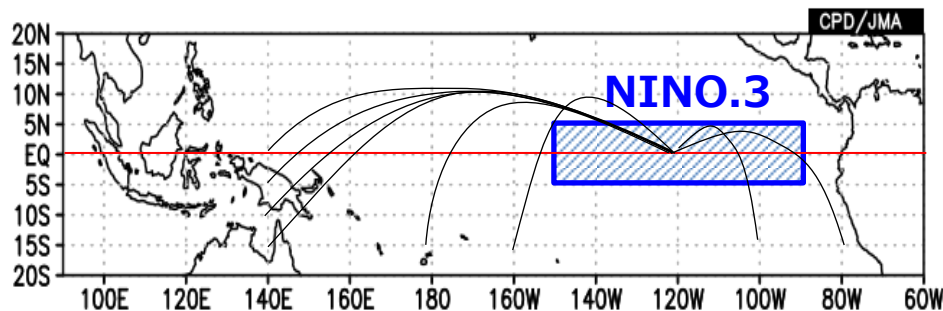
Unknown Z causes both X and Y



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 2016/2017.

Correlation Analysis (2)

- Setting "Data1" and "Data2".

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 - 2016 12 - 2

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

Although the end of the period may appear to be February 2016, this setting means DJF average from 1958/1959 (December 1958 to February 1959) to 2016/2017 (December 2016 to February 2017). 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 <input type="checkbox"/> Time filter	0 YEAR	95%(two side) 67

"Data2" lags set period behind "Data1".

Select options indicate confidence level indicated by t-testing.

Correlation Analysis (3)

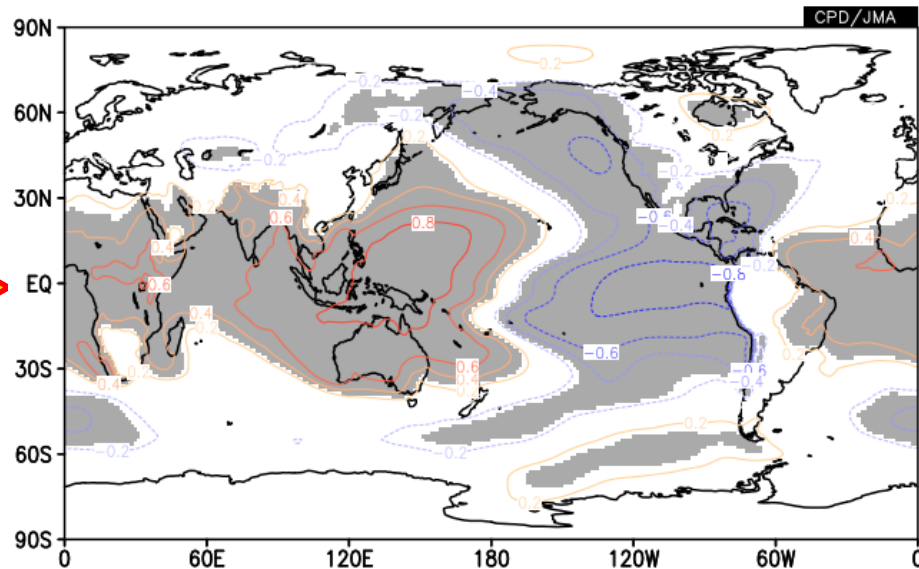
- Setting Graphic Options.

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

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

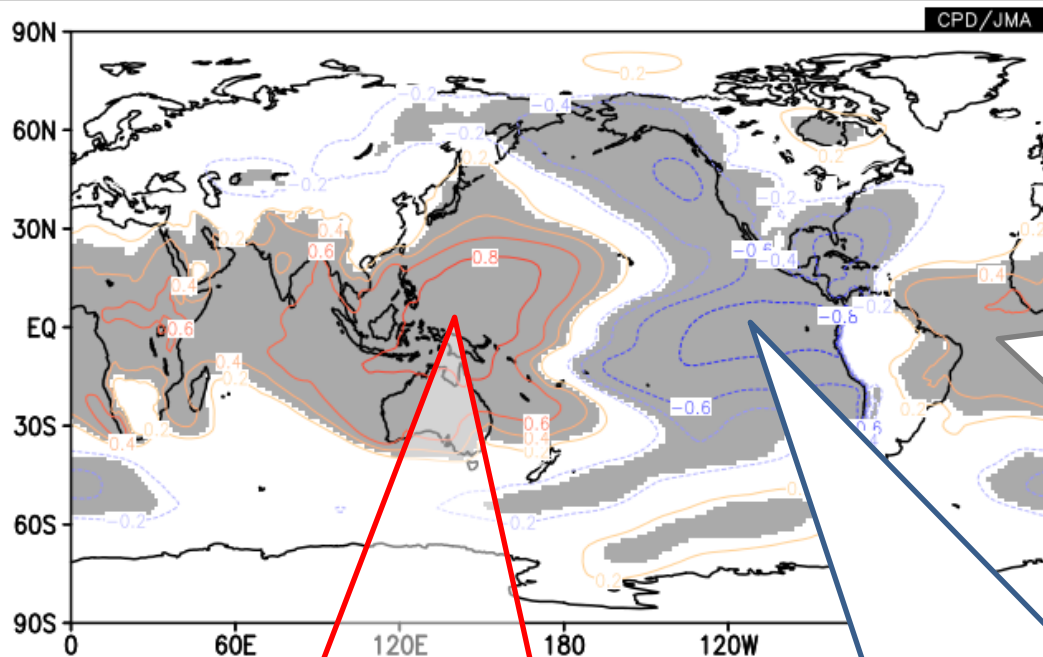
Graphic Options Don't forget!

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: 0.2 min: -1 max: 1
Color Table: Blue - Red	<input type="checkbox"/> Set Vector size: [inch] value: skip: 1



Correlation Analysis (4)

Correlation coefficient between NINO.3 index and SLP in DJF from 1958/59 to 2015/16.



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**).

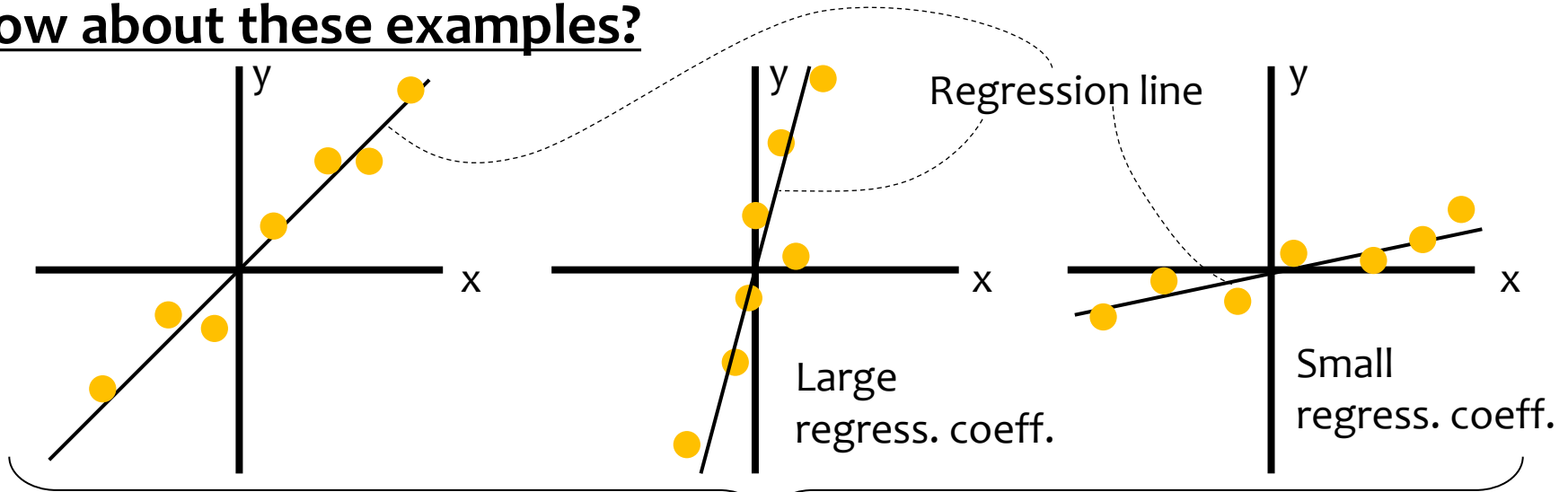
SLPs tend to decrease associated with positive NINO.3.

The blue contours indicate negative values of correlation coefficients.

Simply stated, **positive** (**negative**) SLP anomalies during **La Niña** (**El Niño**). 69

Basic Statistics in Brief

How about these examples?



Corr. coeff. $\sim +1$ for all of them, but regression coefficients are different.

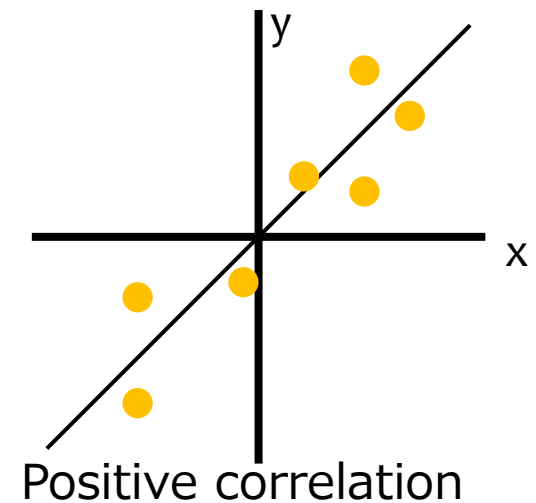
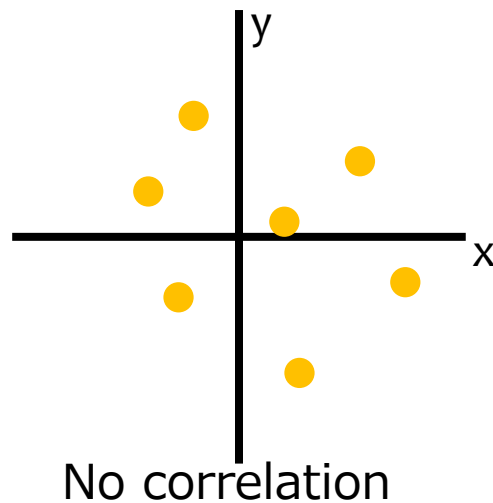
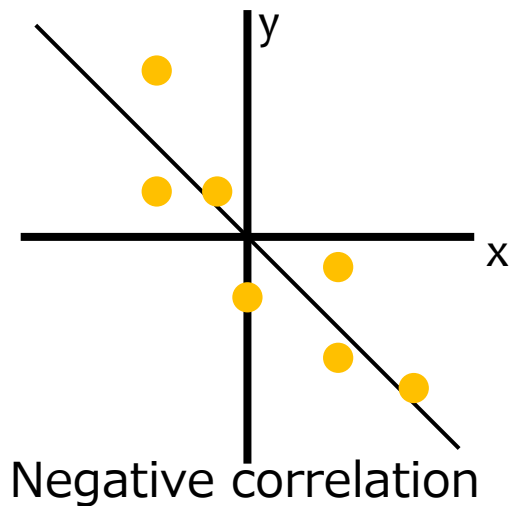
- All of these examples have strong positive linear relationships.
- We also use regression coefficients to evaluate their relationship.

(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.**

Correlation and Regression analysis

- **Correlation coefficient** means the degree of the correlation, and **the regression coefficient** means the gradient of the regression line.
 - Correlation coefficient close to +1 or -1 means there is a clear linear relation between the targeted data pair, and that around zero means there is little (or weak) relation between them.



Regression and correlation analysis are often used to examine the circulation pattern related to the focused one-dimensional time series.

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 2016/2017.
- 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 Press)	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 - 2016 12 - 2

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

Although the end of the range may appear to be February 2016, this setting means DJF average from 1958/1959 (December 1958 to February 1959) to 2016/2017 (December 2016 to February 2017). Consider the setting for year and month separately.

Analysis method: REGRESSION_COEFFICIENT

Select "REGRESSION_COEFFICIENT".

Data2

Dataset	Element	Data type	Time unit	Lag	Significance
INDEX	NINO.3 <input type="checkbox"/> SD	ANOM	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year	0 YEAR	95%(two side) 73

"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 Show Contour Labels

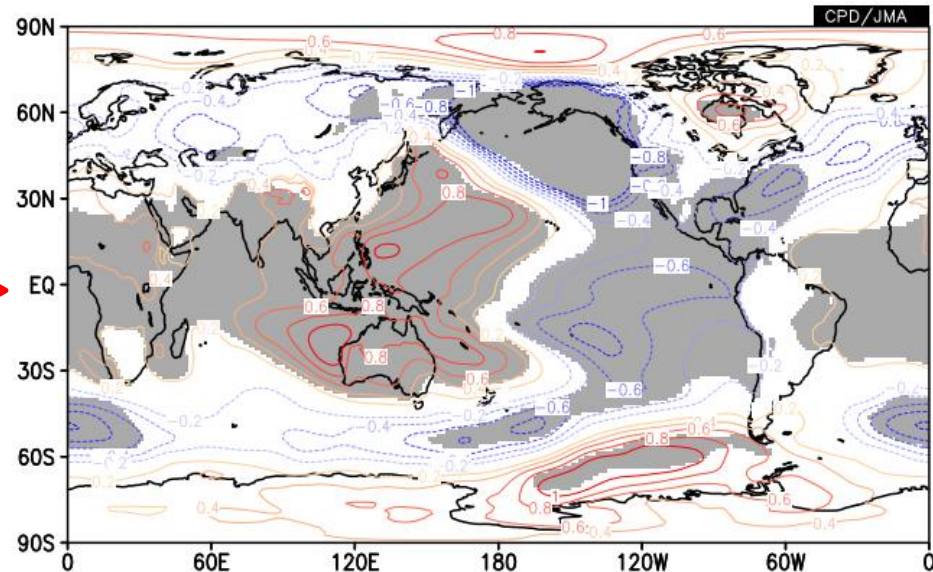
Drawing: CONTOUR Show Color Bar

Image Format: png Set Contour Parameters for data1

Font: default interval: 0.2 min: -1 max: 1

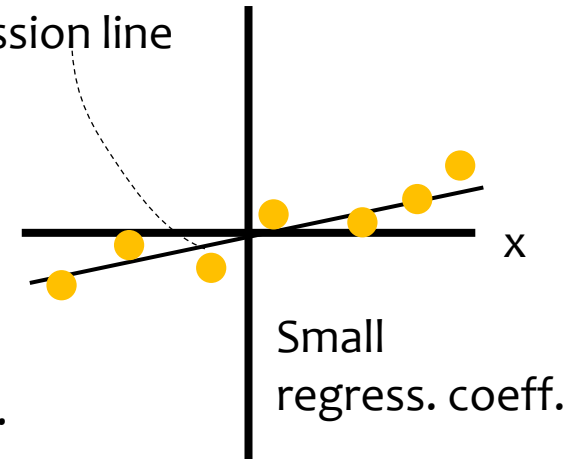
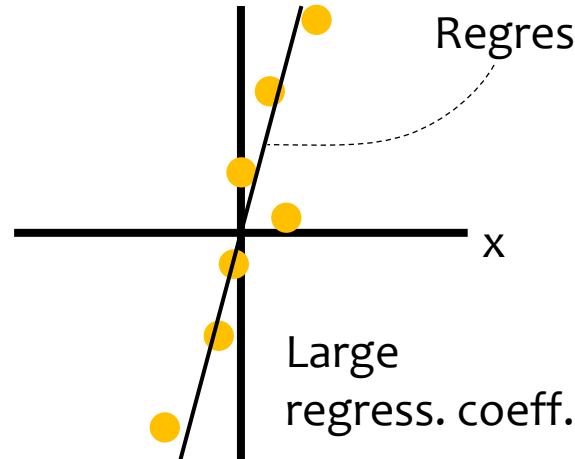
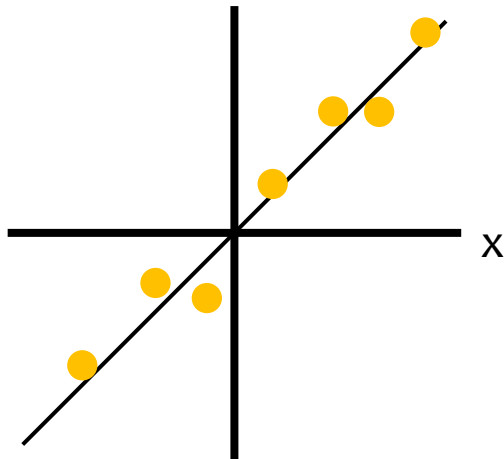
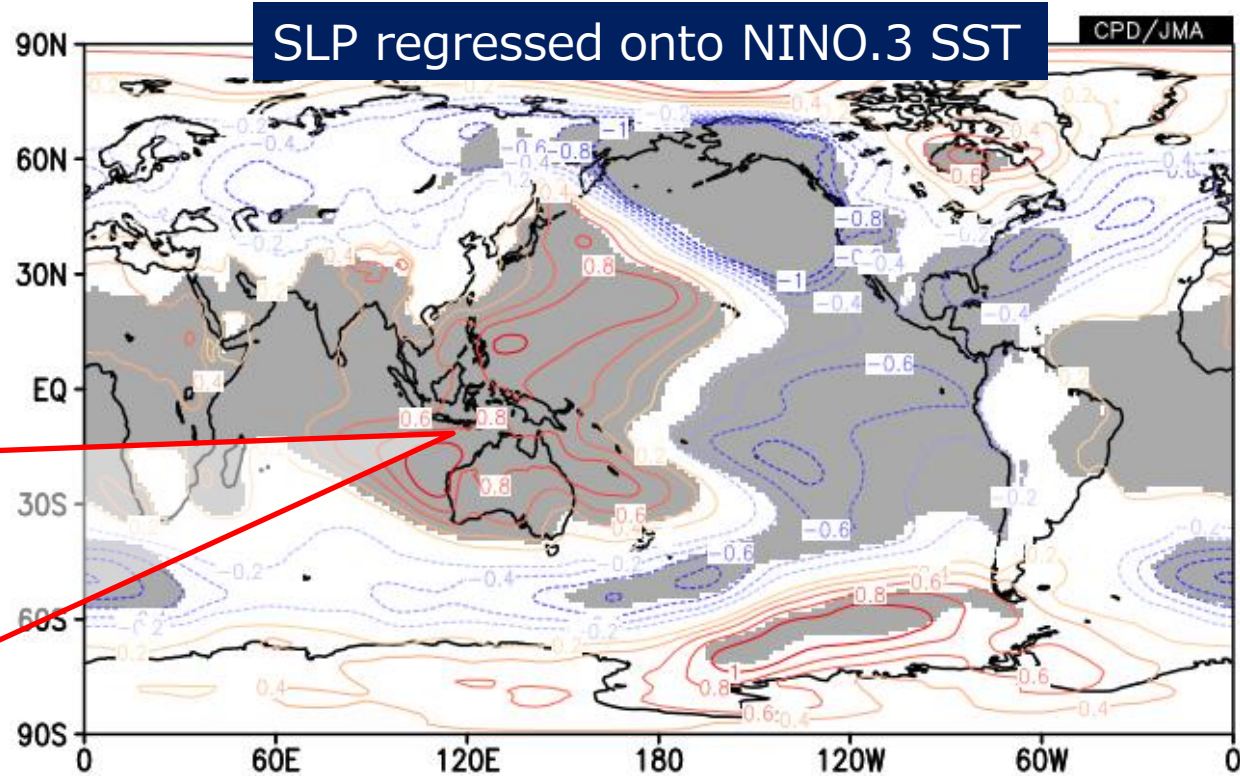
Color Table: Blue - Red Set Vector size: [inch] value: skip: 1

Don't forget!



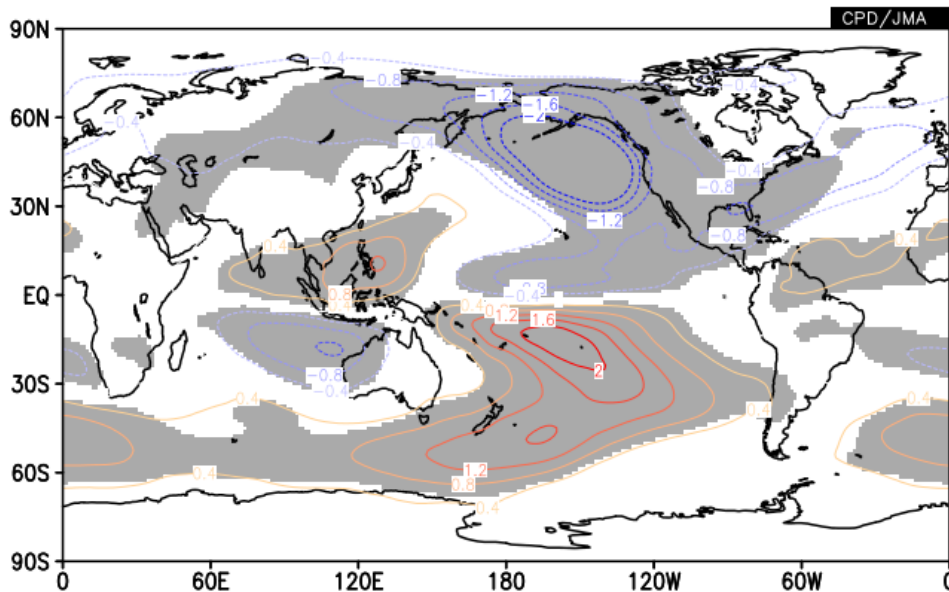
Regression Analysis (4)

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.



Exercises (5)

- Make a regression coefficients map of 850hPa stream function (ψ_{850}) anomalies onto NINO.3 SST anomalies for DJF.
 - Set the statistical period from 1958/59 to 2016/17.
 - 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)**.



Regression coefficient of ψ_{850} onto NINO.3 SST anomalies for DJF.

Can you imagine the circulation pattern?

Answers to Exercises (5)

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels ψ (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 - 2016 12 - 2

Don't forget!

Select "REGRESSION COEFFICIENT"

Analysis method: REGRESSION_COEFFICIENT

Set "showing period" DJF from 1958/59 to 2015/16.

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)".

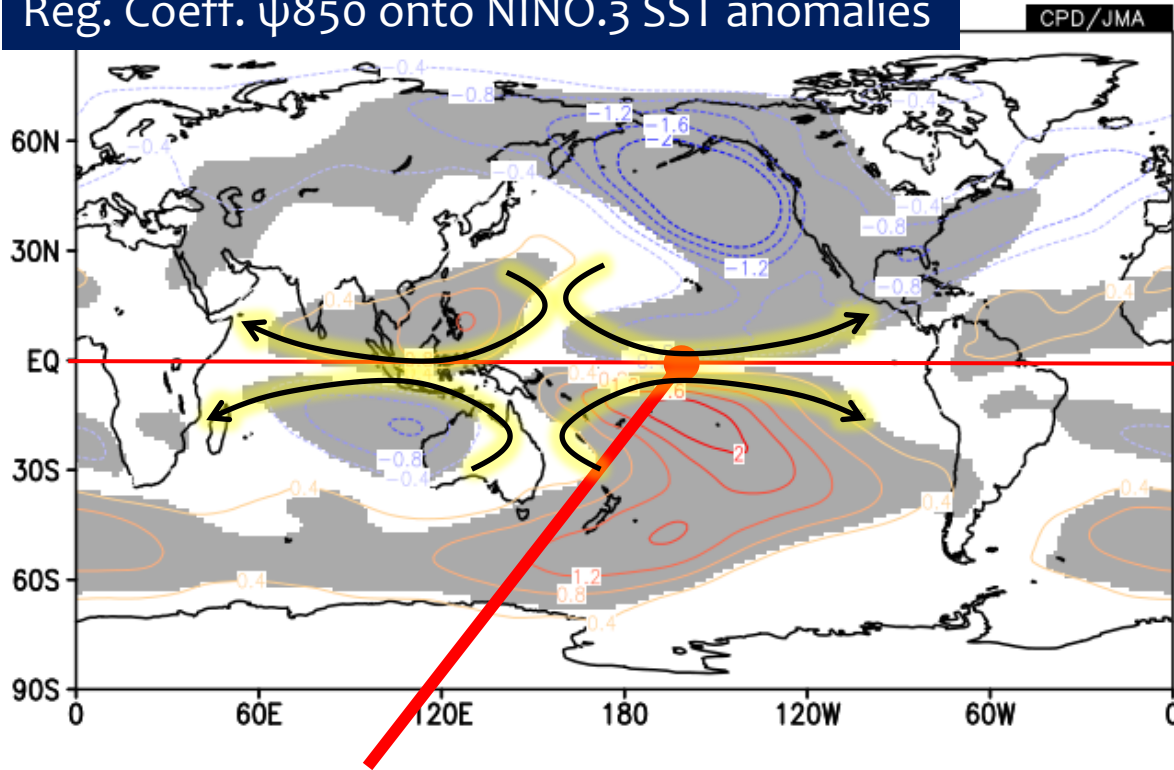
Graphic Options

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

Don't forget!

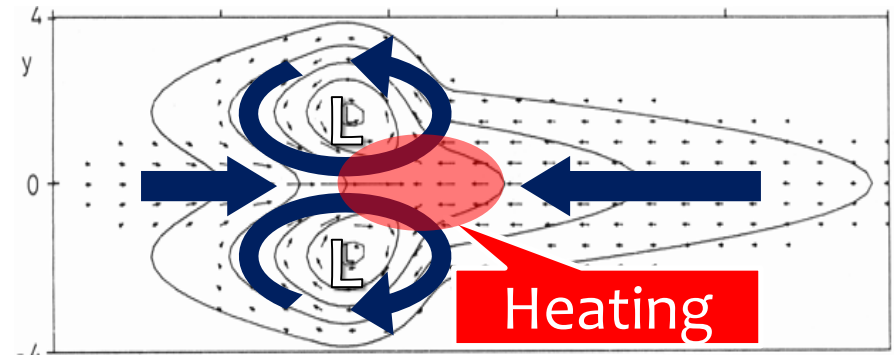
Topics: Typical Anomalies associated with El Niño

Reg. Coeff. ψ_{850} onto NINO.3 SST anomalies



Do you remember the Matsuno-Gill response pattern?

When **El Niño** events occur, **positive** westerly anomaly = **Weak Trade winds**



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
.
.
.
2014
2015
2016

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

Pick out
years
matching
a given
condition

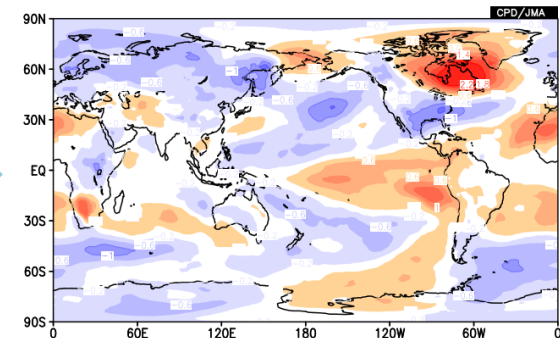
Subset of data

1963
1965
.
.
1997
2002
2009
2015

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"/> Time filter	RANGE 1958 - 2016 12 - 2

Vector SD
Derivative: lon lat

Check "Year-to-year"

2 Analysis method: COMPOSITE

3 **Data2**

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

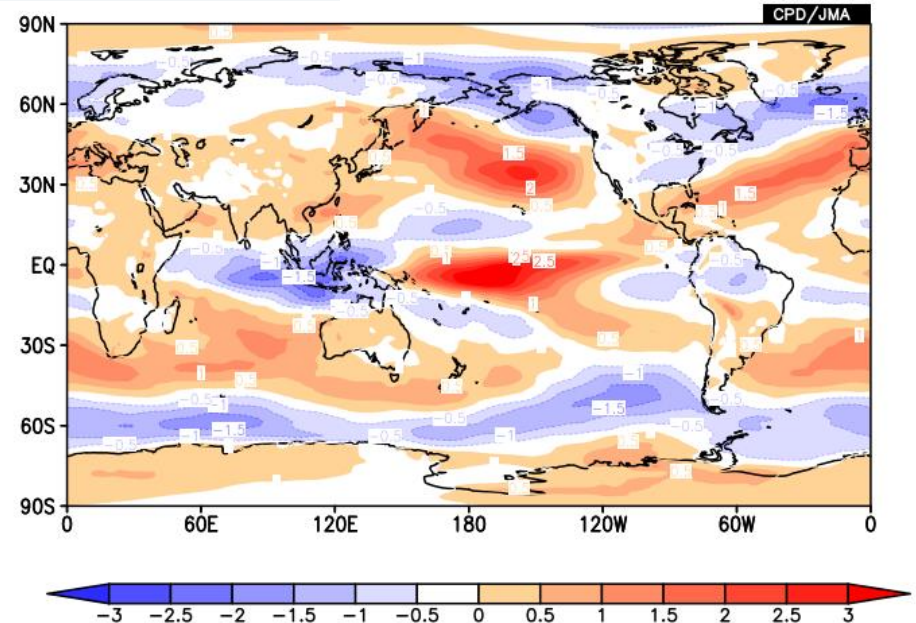
Composite analysis (3)

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

Graphic Options

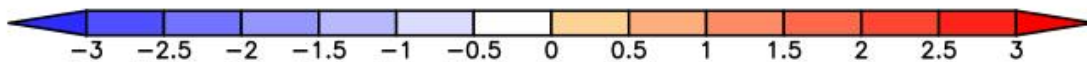
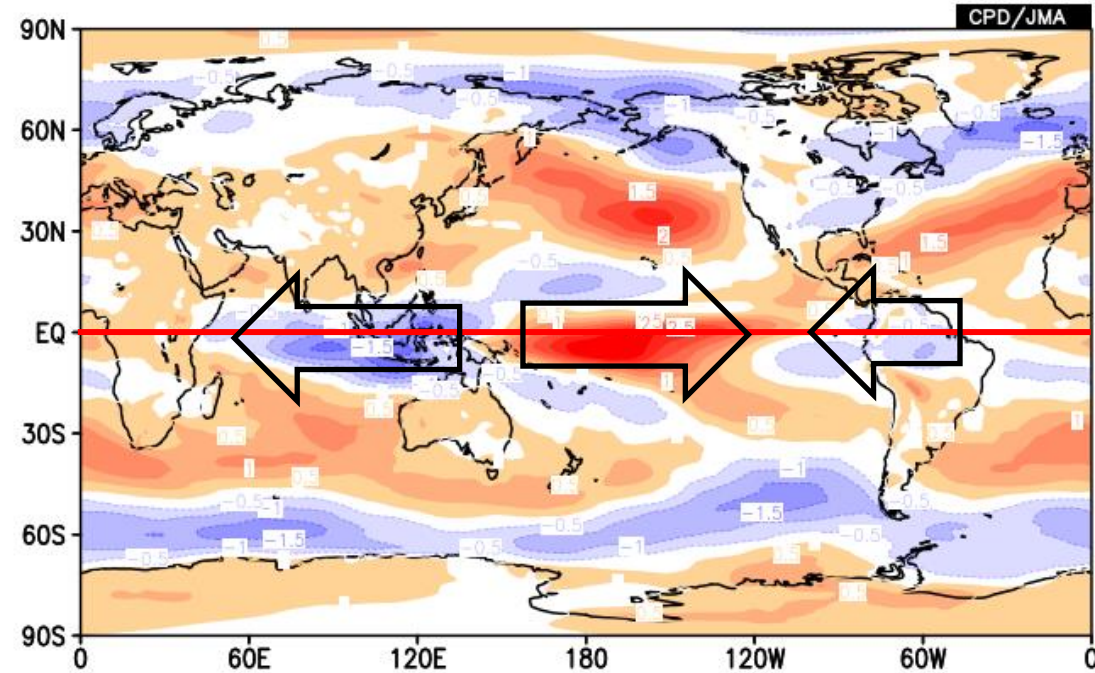
Colorizing: COLOR ▾
Drawing: SHADE ▾
Image Format: png ▾
Font: default ▾
Color Table: Blue - Red ▾

Show Contour Labels
 Show Color Bar
 Set Contour Parameters for data1
interval: 0.5 min: -3 max: 3
 Set Vector size: [inch] value: skip: 1

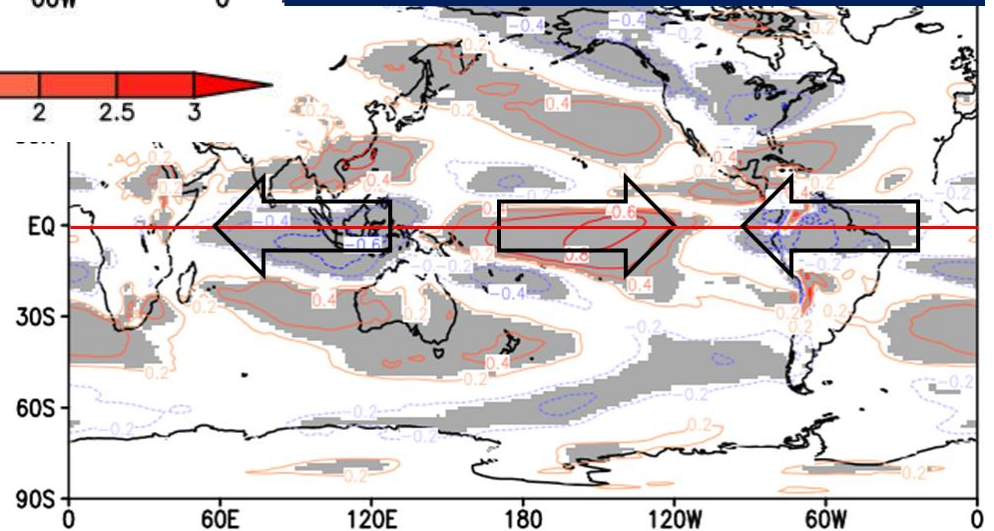


Composite analysis (4)

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



CPD/JMA
Corr. Coeff. u850 & NINO.3 SST anomalies



Composite analysis (5): "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".

Data1

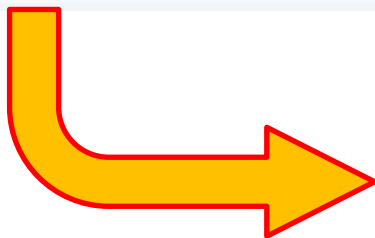
Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels U (Zonal Wind) [m/s]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	850hPa	MONTHLY <input checked="" type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year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

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

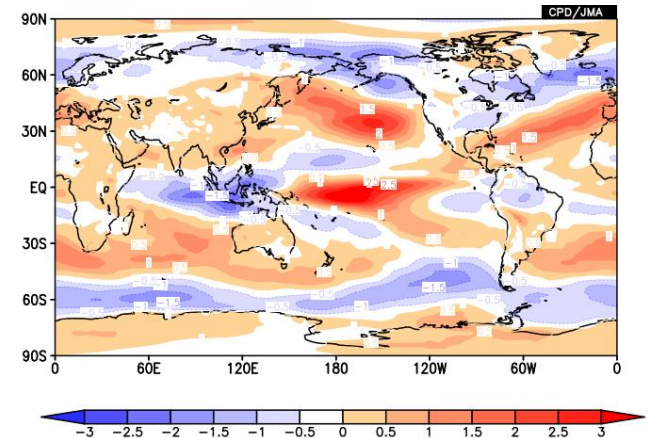
Input the target years and/or months

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

12 - 2



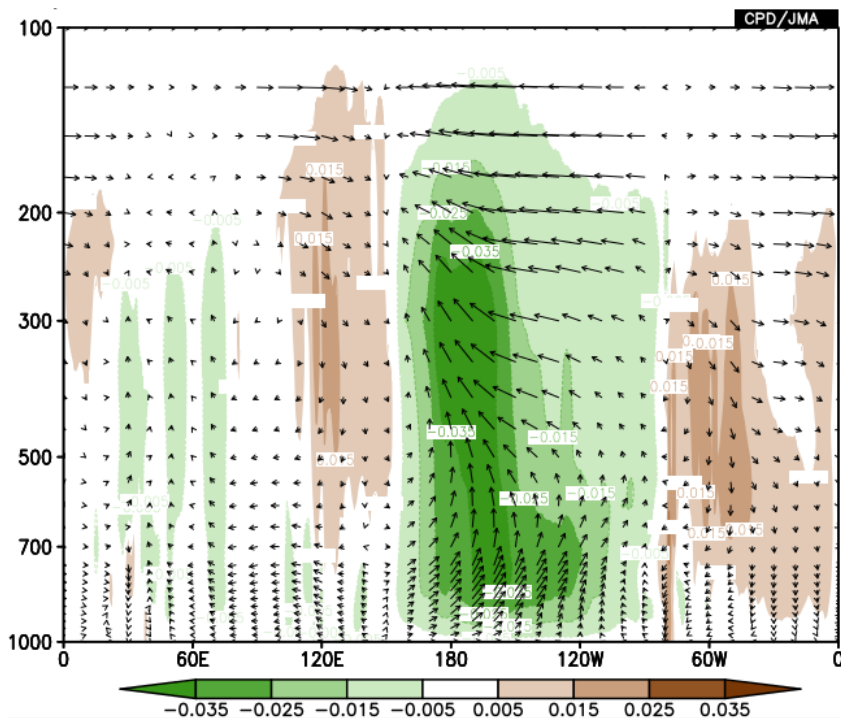
Composite of 850hPa westerly anomalies.



We can get same figure!!

Exercise (6)

- 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**, where El Niño-like condition means NINO.3 SST anomalies > 0.5 .



You can draw multi variable composite maps with “another way”.

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

Answers to Exercise (6)

Data1

Dataset	Element	Data type
JRA-55	Pressure Levels	ANOM
	U (Zonal Wind) [m/s]	
	Pressure Levels	
	ω (Pressure Vertical ')	
	x: -100	<input type="checkbox"/> Stream line
	<input checked="" type="checkbox"/> Vector	<input type="checkbox"/> SD
	Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat	

U and omega anomalies

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

12 - 2

Analysis method: DATA1_DATA2

Data2

Dataset	Element	Data type
JRA-55	Pressure Levels	ANOM
	ω (Pressure Vertical ')	
	<input type="checkbox"/> SD	

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

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

Dec. thru Feb. during El Niño-like years

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

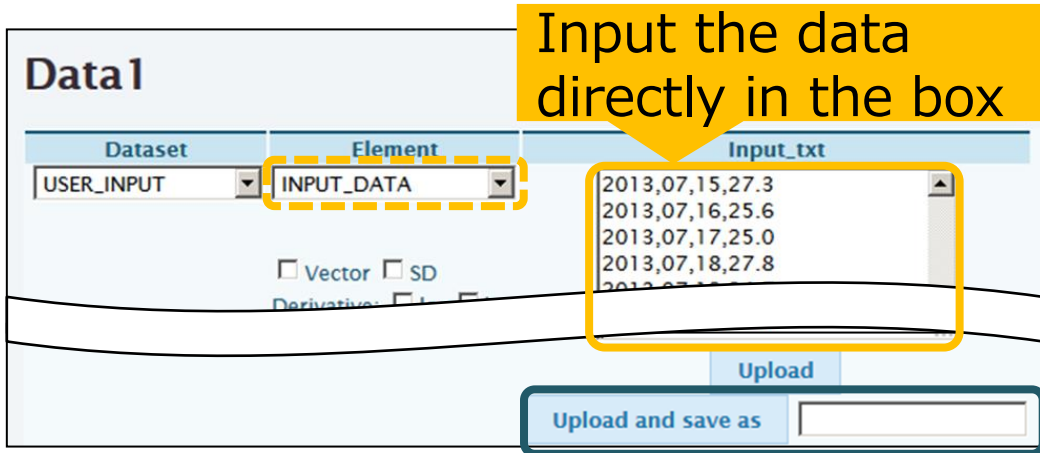
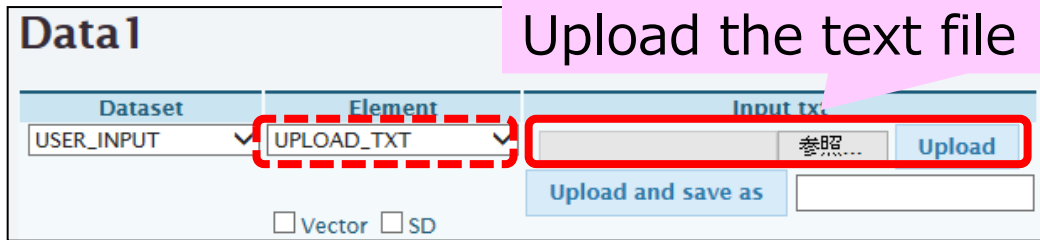
```
#Daily temperature
#undef = 9999
#element = Daily Ts
2013,07,01,23.6
2013,07,02,24.3
2013,07,03,24.5
2013,07,04,9999
2013,07,05,27.4
2013,07,06,28.9
```

<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.

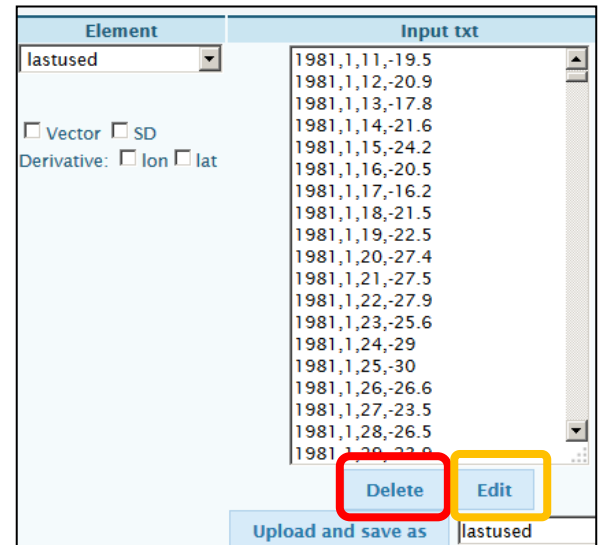
Using user input data (2)

- Upload/input the data



Input the name to save them on the server, and click the "upload and save as" button.

- 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.

Integrated Exercise (2)

- Let's make a correlation map between monthly precipitation data you prepared and global SST anomaly for a specific calendar month(s). Set the period as appropriate.
 - Use "USER_INPUT" method. Set the confidence level **95%** (**two side**).

[Example]

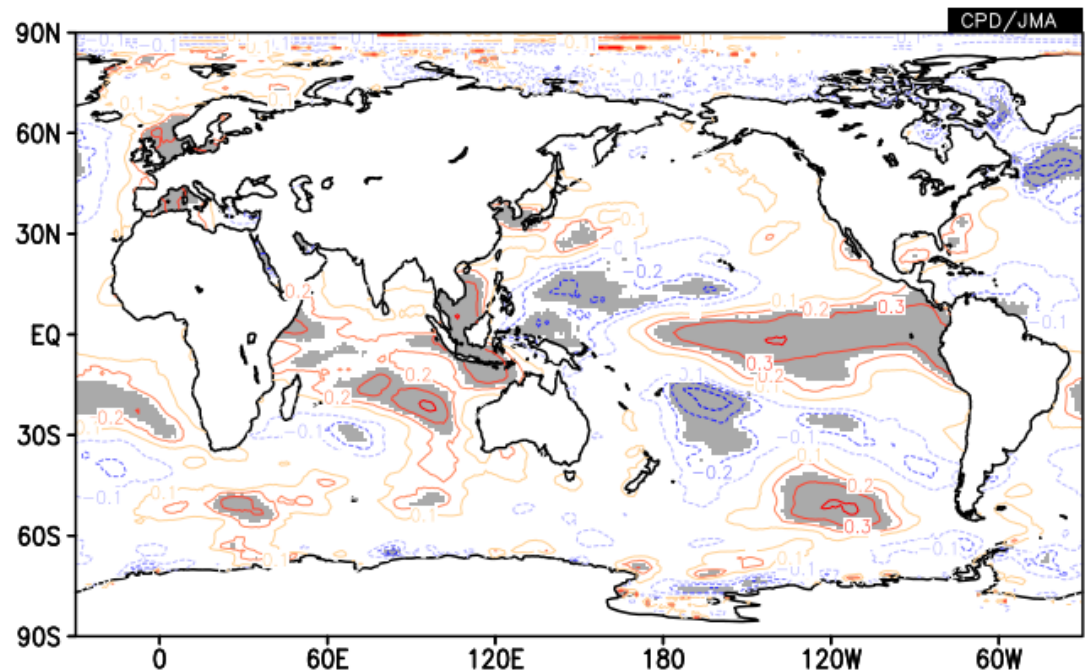
Station:

Hong Kong Observatory

Month: Dec-Feb

Period:

1951/52 – 2016/17



Answers to Integrated Exercise (2)

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SST	Sea Surface Data Temperature (SST) [C]	ANOM	ALL Lat: -90 - 90 Ave <input type="checkbox"/> Lon: -30 - 330 Ave <input type="checkbox"/>	1	MONTHLY <input type="checkbox"/> Ave <input checked="" type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 1951 - 2016 12 - 2

Vector SD
Derivative: lon lat

Analysis method: CORRELATION_COEFFICIENT

Don't forget!

Set the period as appropriate.

Data2

Dataset	Element	Input_txt	Time unit	Lag	Significance
USER_INPUT	INPUT_DATA	<pre>#station=""Hong Kong Observatory"" ... #WMOnumber=45005,... #Precip... 1951,1,1,32.1 1951,2,1,24.4 1951,3,1,96.1 1951,4,1,172.5 1951,5,1,553.8 1951,6,1,560.9 1951,7,1,209.4 1951,8,1,480.5 1951,9,1,69.9 1951,10,1,82.7 1951,11,1,69.6 1951,12,1,12 1952,1,1,23.9 1952,2,1,30.1 1952,3,1,36.4</pre>	MONTHLY	0 YEAR	95%(two side)

SD

Upload

Upload and save as

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

Answers to Integrated Exercise (2)

- Setting Graphic Options.

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

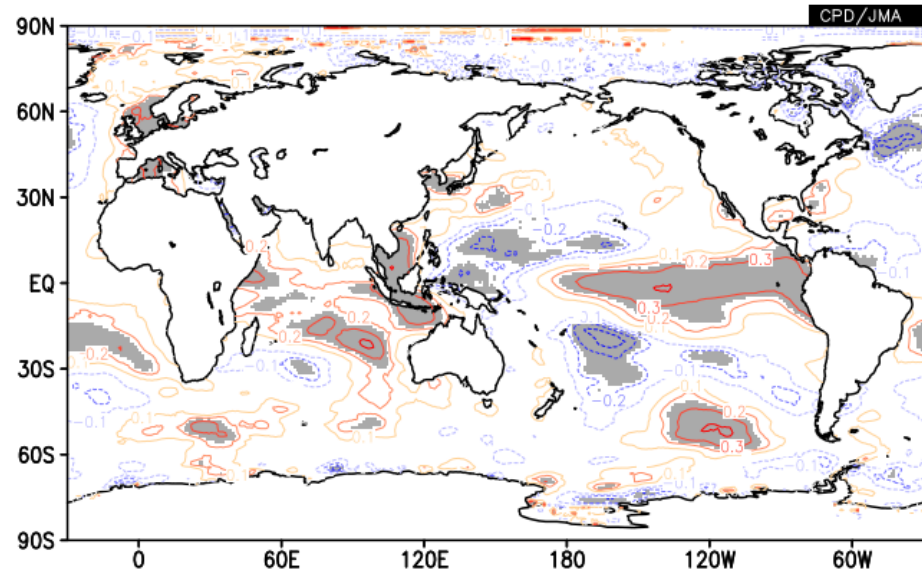
Set contour line (i.e.,
correlation coefficient)
properties.

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: 0.1 min: -0.4 max: 0.4
 Set Vector size: [inch] value: skip: 1

Don't forget!



Further Exercise

- How about other month(s)?
- How about relationships between other variables related to precipitation (like stream function, velocity potential, moisture flux, etc.)?
- How can you explain the relationship you found?
 - It is beyond this lecture.

To learn more about iTacs

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

❑ Tutorial: <http://extreme.kishou.go.jp/tool/itacs-tcc2015/>

❑ Help page: <http://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](#) [color bar sample](#)
[Graphic Option](#) - [Detailed Options for Image x](#) | [number of grid points for dataset](#) | [format for USER INPUT](#)

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できます。データをテキスト形式の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」にデータを行打ち込み、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値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.

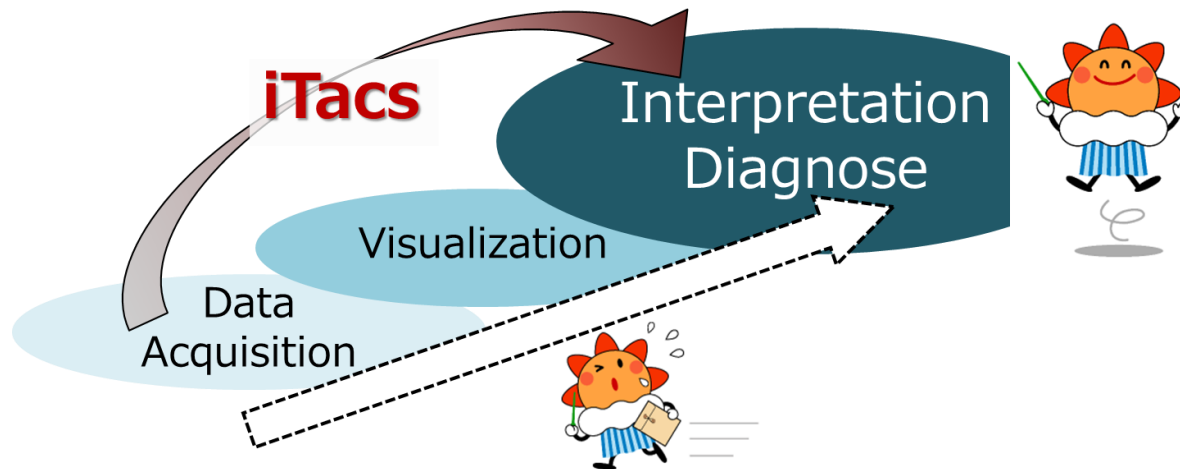
If the "SD" box is checked, a standard deviation map is provided to show the variability of the selected element. The "SD" and "Vector" boxes cannot be set at the same time.

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:
<http://ds.data.jma.go.jp/tcc/tcc/index.html>
- TCC E-mail: [tcc\[at\]met.kishou.go.jp](mailto:tcc@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.

Useful Link

- iTacs
 - <http://extreme.kishou.go.jp/tool/itacs-tcc2015/>
- Analysis charts
 - <http://ds.data.jma.go.jp/tcc/tcc/products/clisys/acmi.html>
- Composite maps for El Niño / La Niña events
 - http://ds.data.jma.go.jp/tcc/tcc/products/clisys/enso_statistics/index.html

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

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

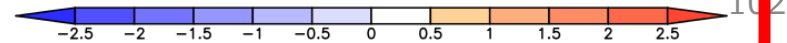
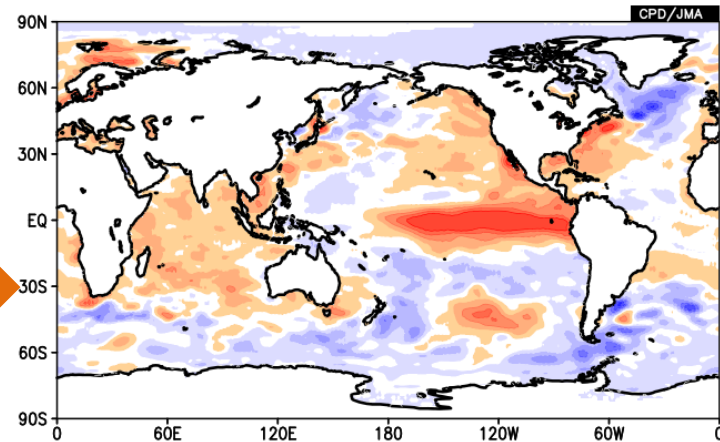
Graphic Options

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
 Reverse the A
 Flip the X-axi
 No Caption



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 <input type="checkbox"/> Time filter	2015 7 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:

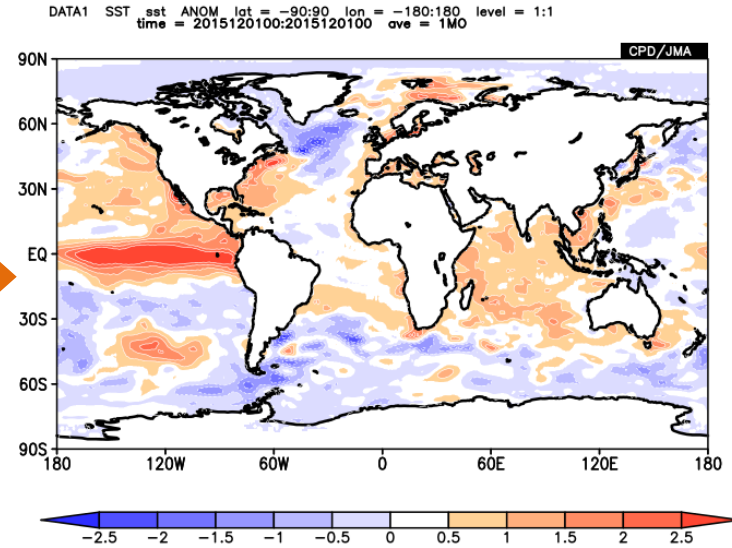
- **ALL**
 - **ASIA**
 - **Tropical Pacific**
 - **Tropics**
 - **Indian Pacific**
- etc.

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

Area setting (2)

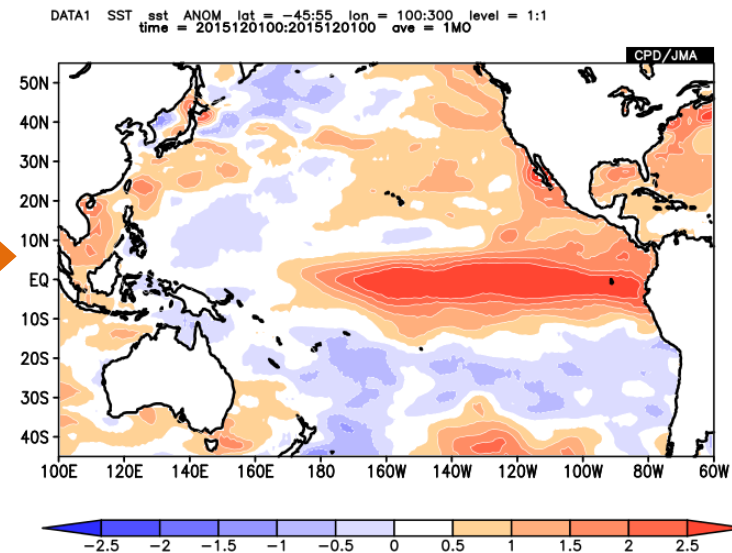
- Shift the area

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 2013
J F M A M J J A S O N D J F M A M J J A S O N D

Time unit: MONTHLY

Showing period: RANGE

Ave Year-to-year

Time filter

2012 12

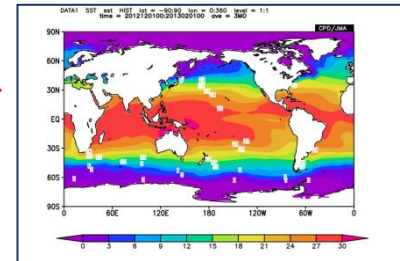
2013 2

Check!

Start month

End month

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



Time unit: MONTHLY

Showing period: RANGE

Ave Year-to-year

Time filter

2012 12

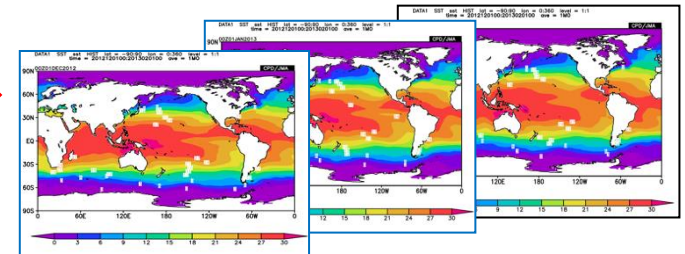
2013 2

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	A	M	J	J	A	S	O	N	D
2011	:	J	F	M	A	M	J	J	A	S	O	N	D
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

Target period

Check "Year-to-year"

Time unit: MONTHLY

Showing period: RANGE

Ave Year-to-year

2010 - 2013

3 - 5

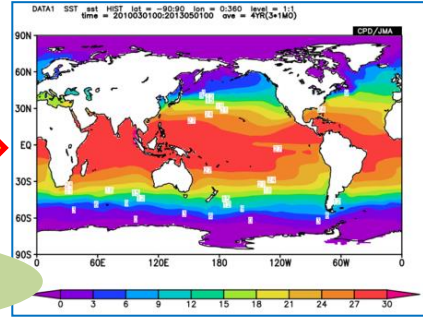
Time filter

Check!

Target years

Target period

One 4-year-MAM averaged map



MAM 2010
MAM 2011
MAM 2012
MAM 2013
} averaged

Check!

Time unit: MONTHLY

Showing period: RANGE

Ave Year-to-year

2010 - 2013

3 - 5

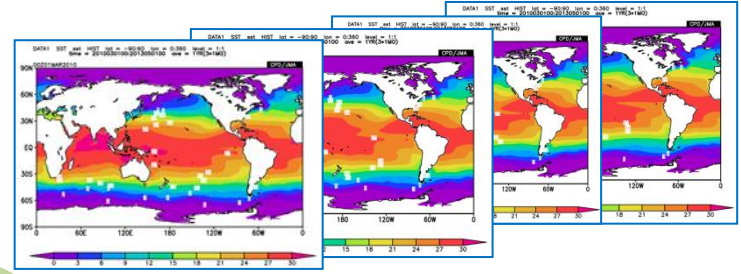
Time filter

Uncheck

Target years

Target period

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



Multiple Data

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

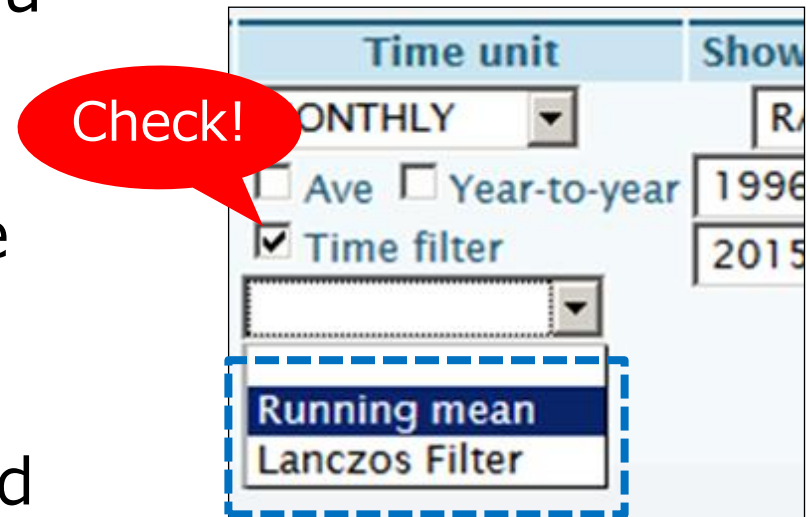
Analysis method	Mapped value	Usage example
ADD	Addition ("Data1" plus "Data2")	–
SUBTRACT	Difference ("Data1" minus "Data2")	Time difference, vertical shear.
MULTIPLY	Multiplication ("Data1" times "Data2")	–
DIVIDE	Division ("Data1" divided by "Data2")	Precipitation ratios ("HIST" divided by "NORM").

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).



Running mean daily timeseries

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m ²]	ANOM	ALL	1	DAILY	RANGE
			Lat: -10 - 10 Ave <input checked="" type="checkbox"/>			
			Lon: 90 - 150 Ave <input checked="" type="checkbox"/>			
<input type="checkbox"/> Vector <input type="checkbox"/> SD						
Derivative: <input type="checkbox"/> lon <input type="checkbox"/> lat						
					<input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year	2016 5 1
					<input checked="" type="checkbox"/> Time filter	2016 8 31
					Running mean	
					mean period 5	

1. Select OLR anomalies for element boxes.

2. Select 10°S–10°N, 90°–150°E for “Area” box.

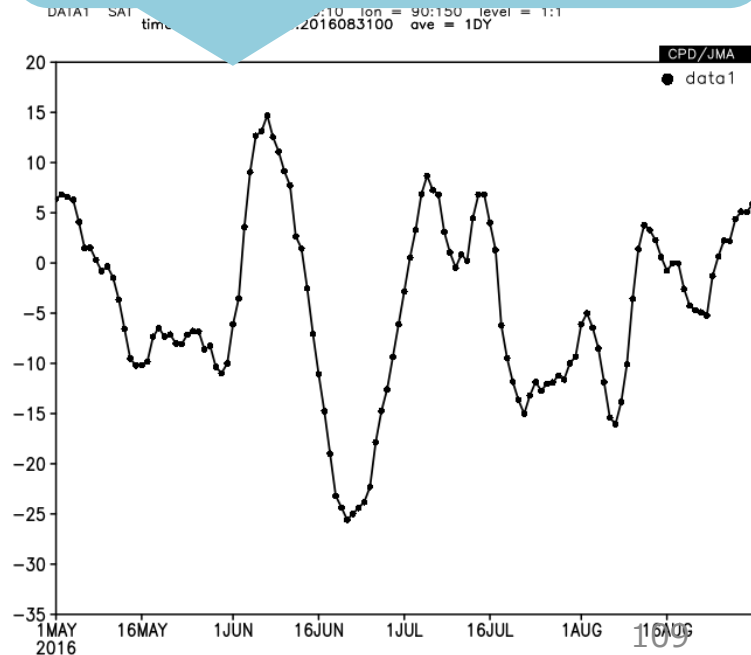
➤ Check “Ave” boxes.

3. Select “DAILY” for time unit, and showing period.

➤ Showing period: 1 May 2016 – 31 Aug. 2016.

➤ 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



Time cross section

- Running mean longitude-time cross section

Data1

5°S–5°N averaged

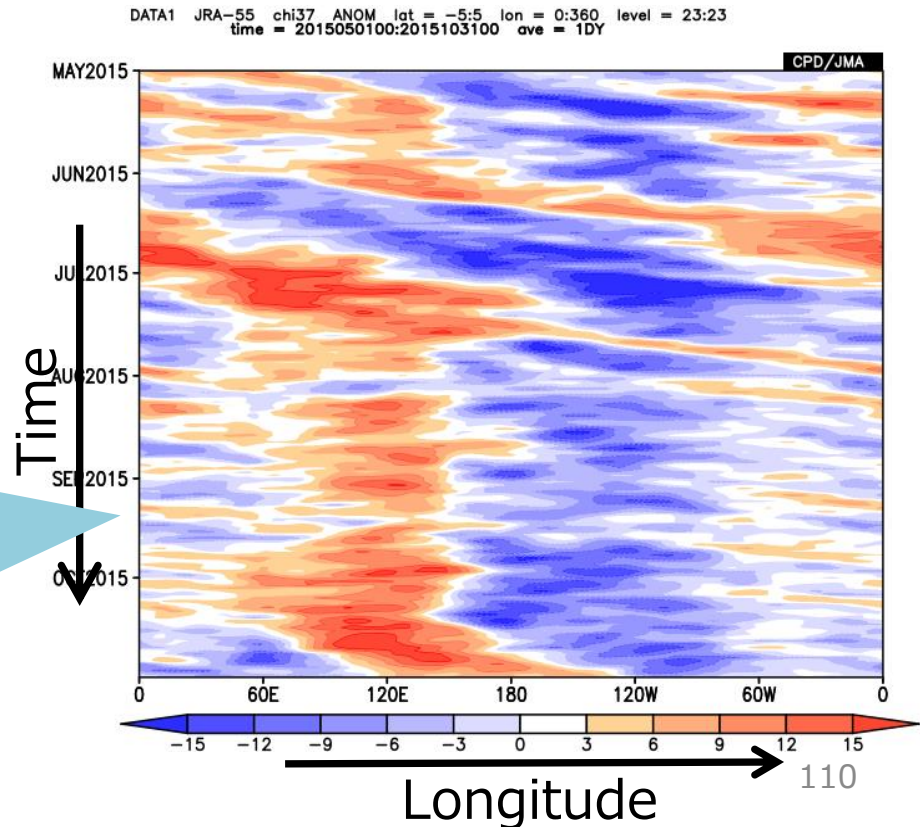
Dataset	Element	Data type	Area	Level	Time unit	Showing period
JRA-55	Pressure Levels χ (Velocity Potential)	ANOM	ALL Lat: -5 - 5 Ave <input checked="" type="checkbox"/> Lon: 0 - 360 Ave <input type="checkbox"/>	200hPa 200hPa	DAILY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input checked="" type="checkbox"/> Time filter Running mean mean period 5	RANGE 2015 5 1 2015 10 31

Vector SD
Derivative: lon lat

200-hPa

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

Longitude-time cross section of 5-day running mean 200-hPa velocity potential anomalies averaged over 5°S–5°N from 1 May to 31 October 2015.



Daily timeseries

Data1

Dataset	Element	Data type	Area	Level	Time unit	Showing period
SAT	OLR [W/m ²]	ANOM	ALL Lat: -10 - 10 Ave <input checked="" type="checkbox"/> Lon: 90 - 150 Ave <input checked="" type="checkbox"/>	1	DAILY <input type="checkbox"/> Ave <input type="checkbox"/> Year-to-year <input type="checkbox"/> Time filter	RANGE 2016 5 1 2016 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.

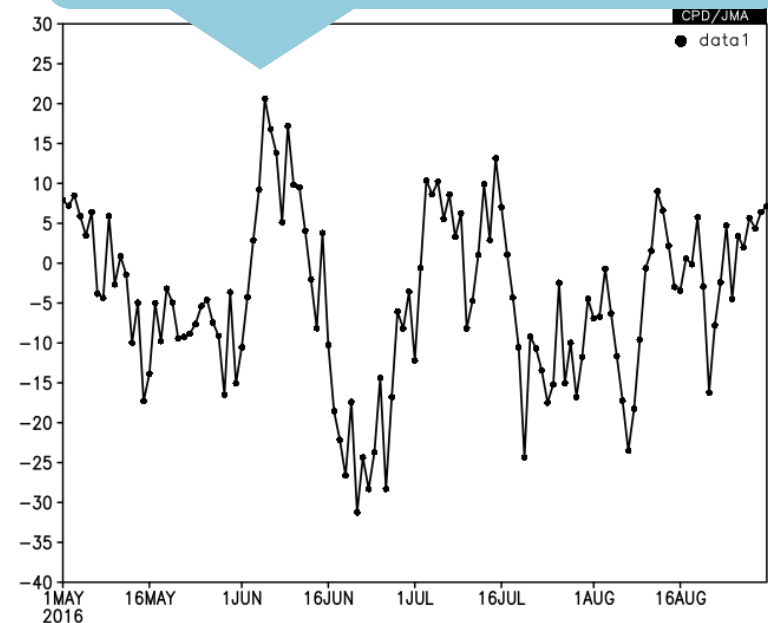
- The area covers the Maritime continent.
- Check “Ave” boxes.

3. Select “DAILY” for time unit, and showing period

- Showing period: 1 May 2016 – 31 Aug. 2016.

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

Daily timeseries of OLR anomalies



Inter-annual timeseries

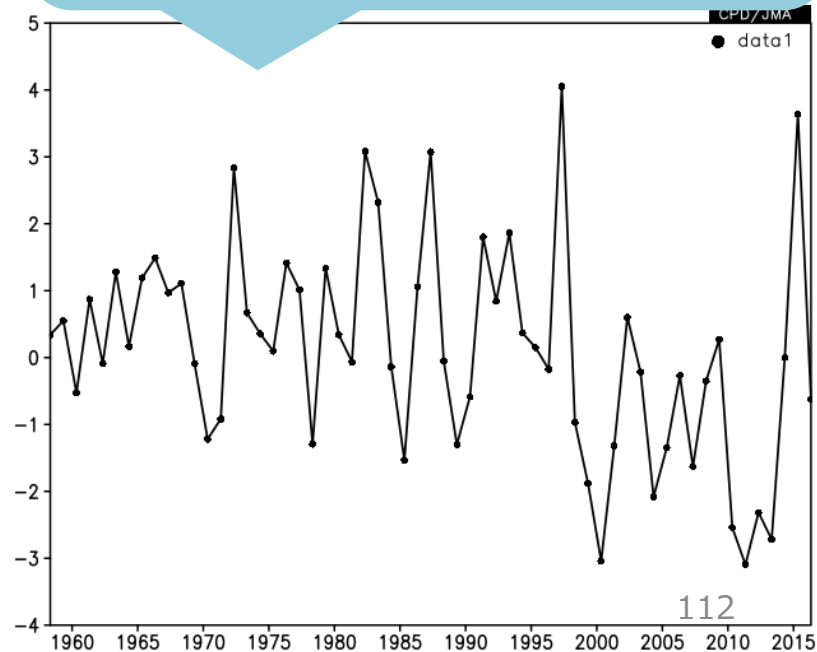
Data1

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 - 2016 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 – 2016, 5 – 8.

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



Standard deviation map

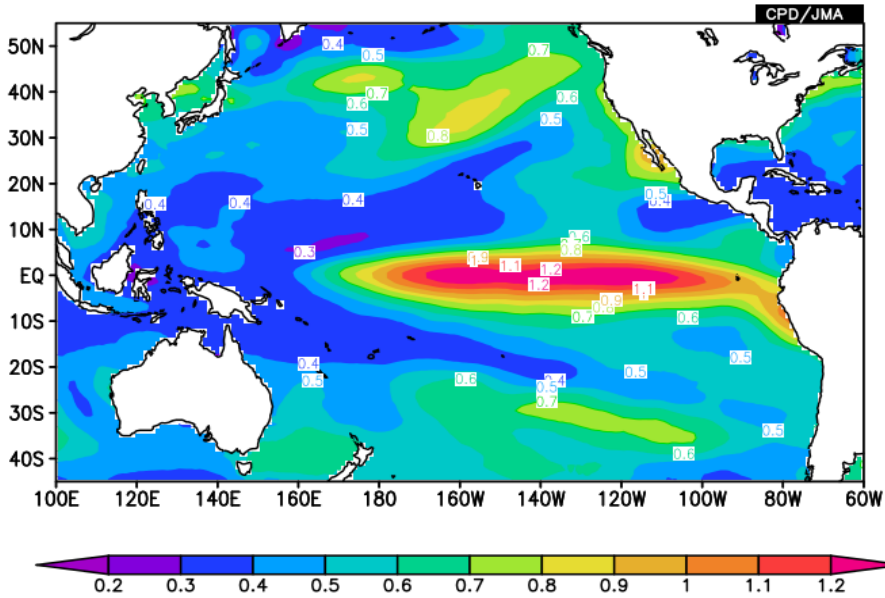
- A standard deviation map is available to see the variability of the selected element over the selected period.

Data1

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

Check!

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 overlapping software windows. The background window is titled 'Graphic Options' and has a 'Select parameters' tab. It contains various settings for map visualization, including 'Colorizing' (set to COLOR), 'Drawing' (set to SHADE), 'Image Format' (set to png), 'Font' (set to default), and 'Color Table' (set to Rainbow). There are also checkboxes for 'Show Contour Labels' and 'Show Color Bar', and input fields for 'interval', 'min', and 'max' values. A red box highlights the checkbox 'Detailed Options for Image 1' at the bottom left of this window. A large yellow arrow points from this checkbox to the foreground window.

The foreground window is titled 'Detailed Options for Image 1' and has a 'Lower layer' dropdown and 'apply' and 'apply Default' buttons. It is divided into sections: 'About Graphics', 'About Axis', and 'About Map'. The 'About Graphics' section is expanded and shows detailed settings for contours, markers, and grid lines. For example, 'contour' settings include 'Style: default', 'Color: rainbow', 'label format: [checked]', 'thickness: 1', 'size: 0.09', 'skip interval: []', 'contour line thickness: 3', 'levels: []', 'color: []', 'thin contour: []', and 'not to draw: []'. Other settings include '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: []' with 'X', 'Y', and 'scale: 1.0' fields.

Check! Detailed Options fields are shown

Procedure of setting detailed options

1. Select target

Lower layer: Data1

Upper layer: Data2

In the case of vector map

Lower layer: Data2

Upper layer: Data1

2. Set options

Set contour style, color, thickness, etc.

3. Apply the settings

Click the "apply" button before "Submit" is clicked.



☑ 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

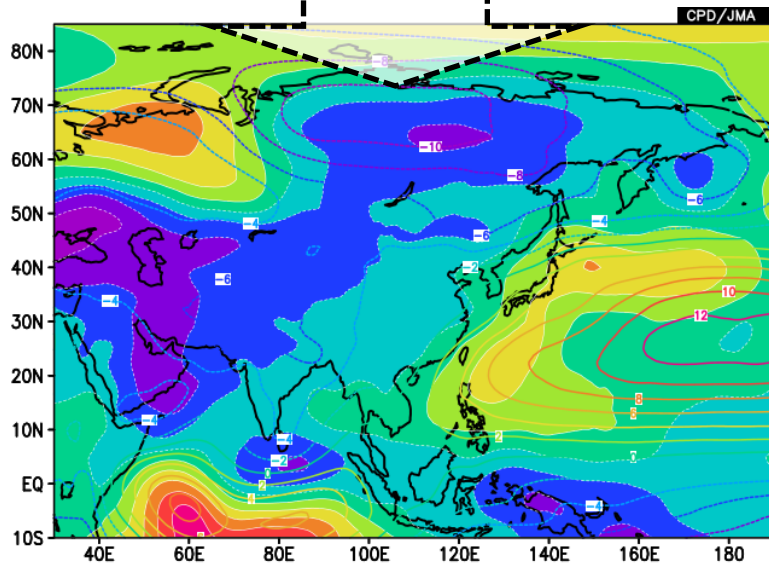
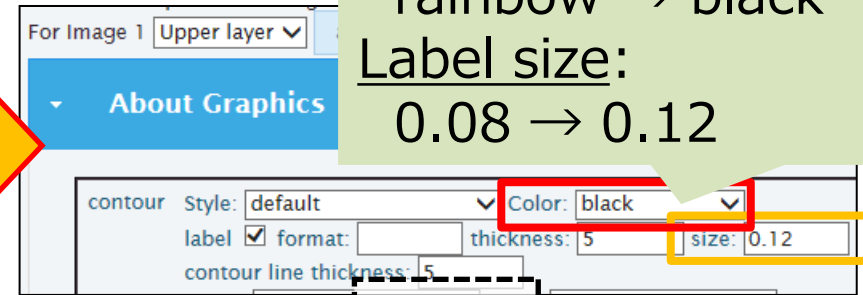
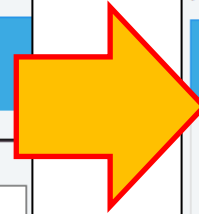
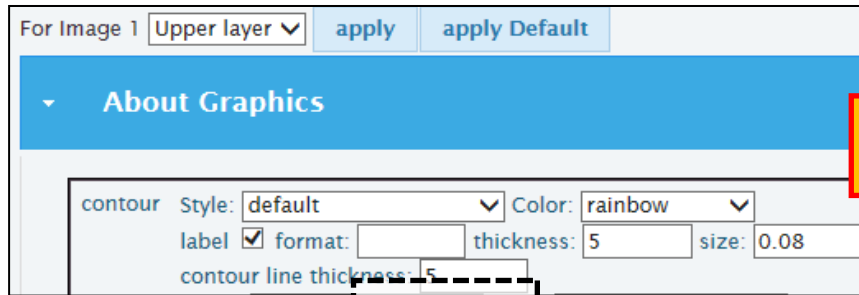
About Map

For Image 1 apply

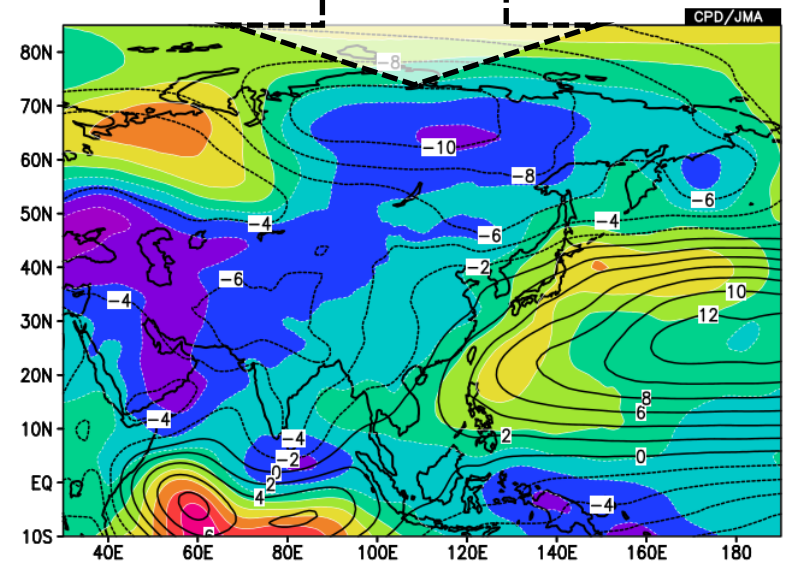
About Graphics: Contour color and label

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

Color:
rainbow → black
Label size:
0.08 → 0.12



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



The problems are cleared.

About Graphics: Color table

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

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



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

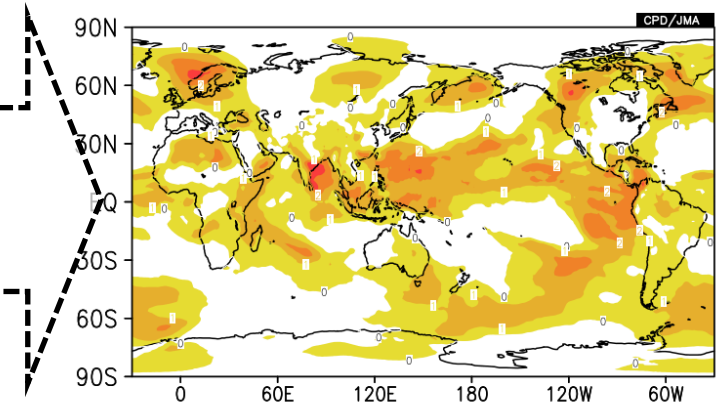
About Graphics

contour Style: default Color: rainbow

label format: thickness: size:

contour line thickness: 3

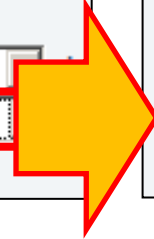
levels: 0,1,2,3 color: 0,7,12,8,2



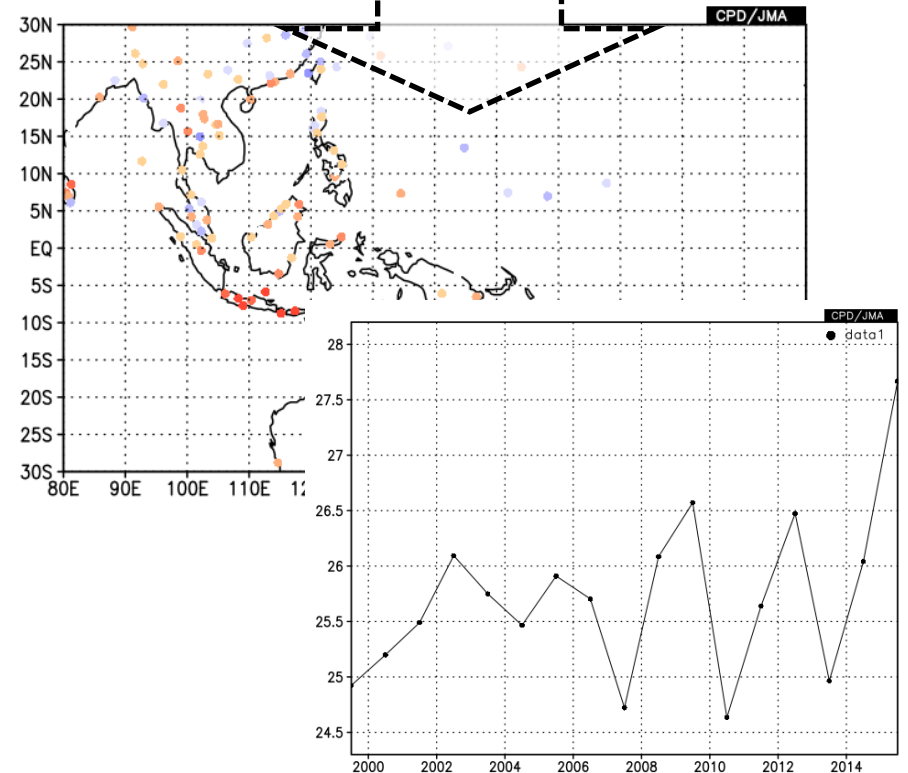
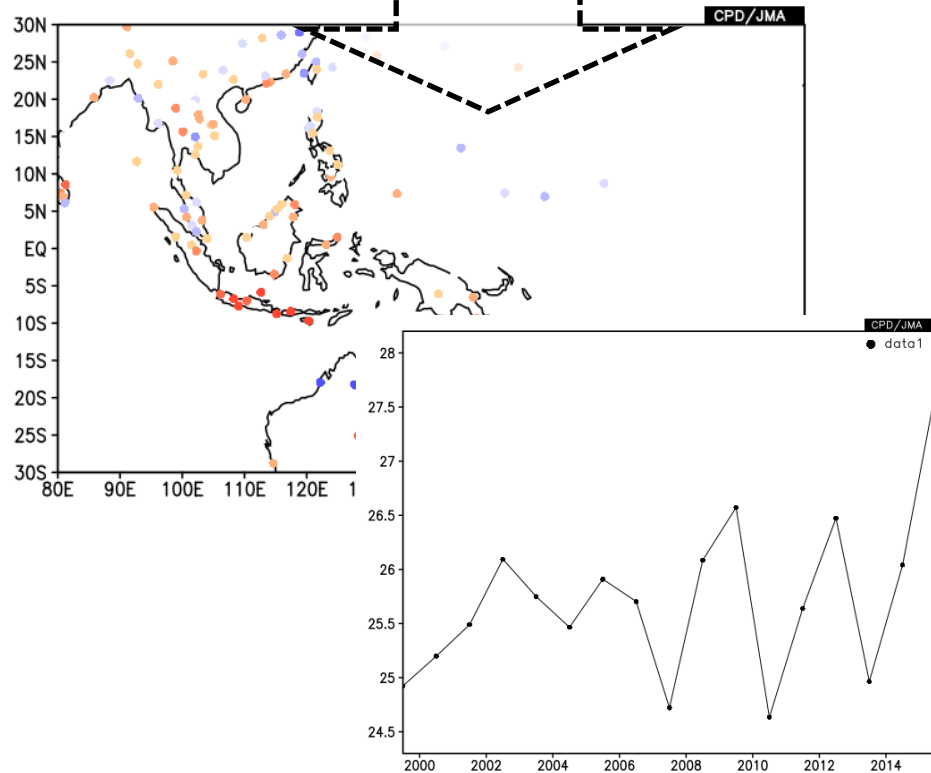
For example, the color setting like the right map is more suitable to focus on the positive value.

About Graphics: grid style

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

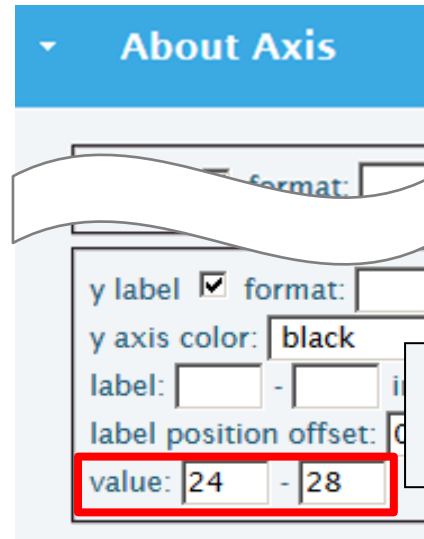


marker type: closed circle
line style: solid color: black
grid style: dotted color: black
vector label vector head size: []

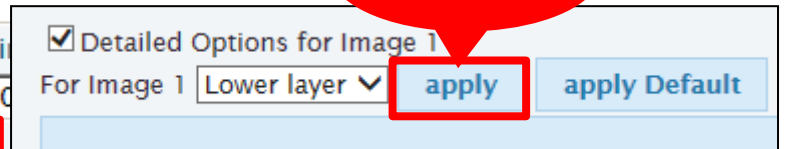


The grid line in the panel like the right map is available.

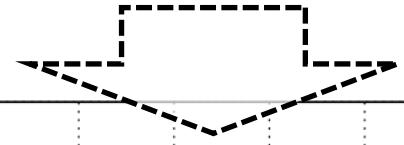
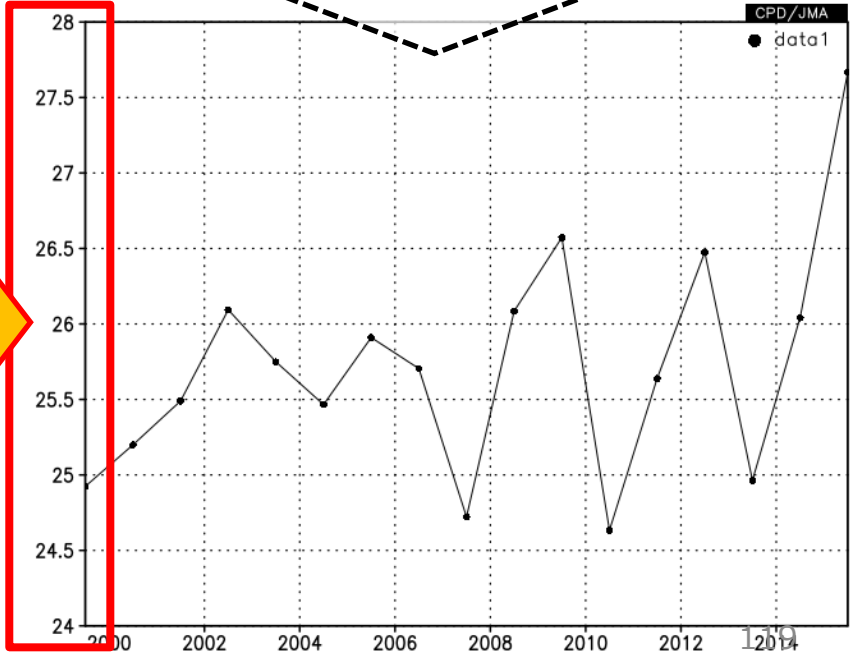
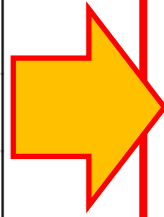
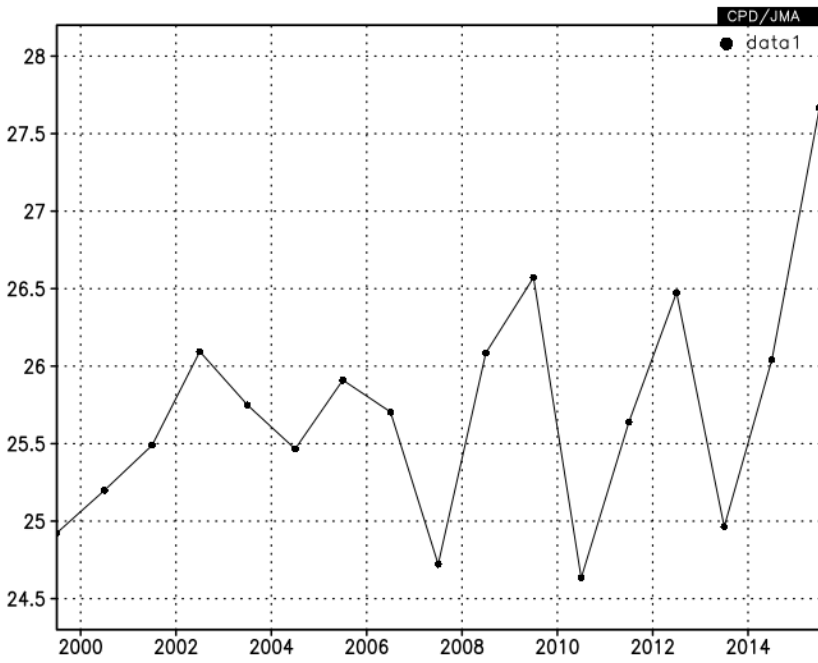
About Axis: value



Click!

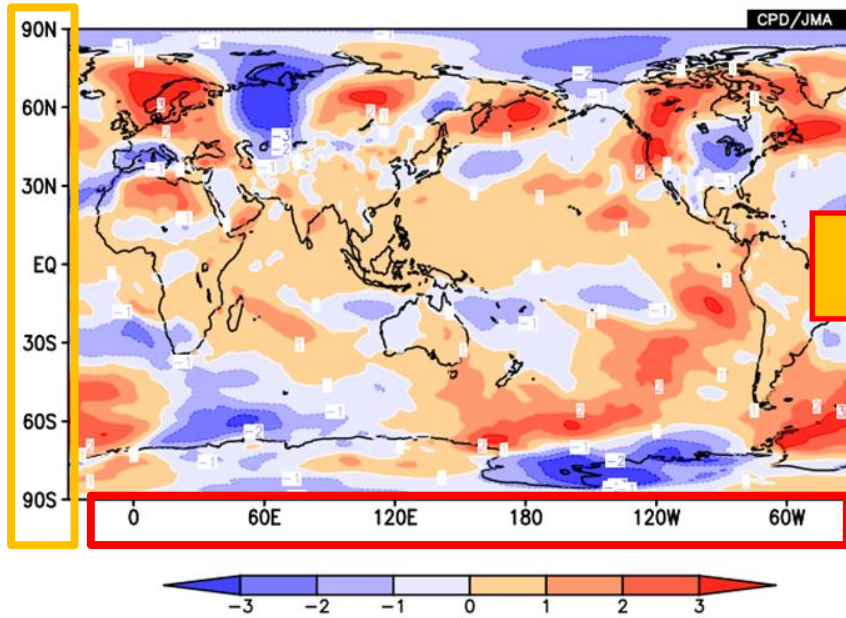


Default

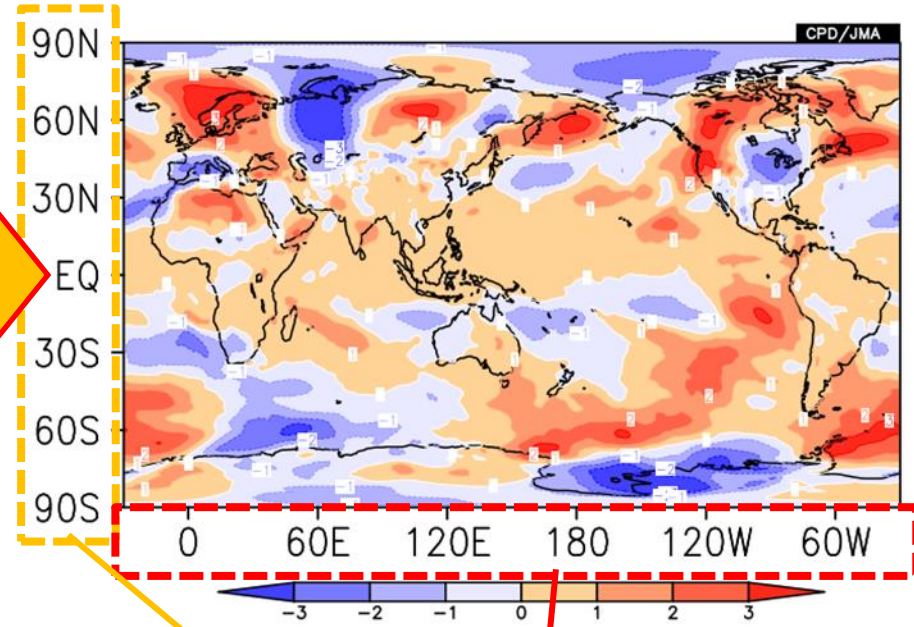


About Axis: Label size

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: -

120

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:

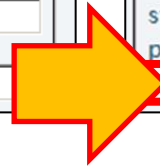
political boundaries (valid in 'mres' and 'hires')
style: none color: black thickness:

About Map

map quality **hires**

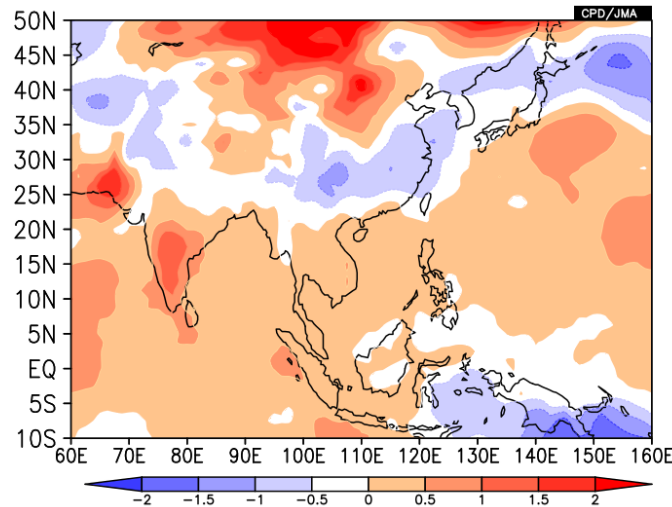
coast line
style: solid color: black thickness: 10

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

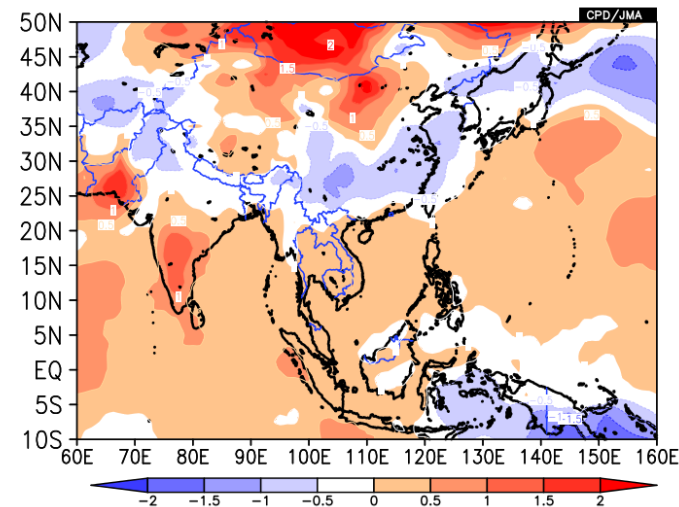


DATA1 JRA-55 t37 ANOM lat = -10:50 lon = 60:160 level = 7:7
time = 2015080100:2015080100 ave = 1MO

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.**