Introduction and Basic Operation of iTacs

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1. What's iTacs?

"iTacs" stands for "Interactive Tool for Analysis of the Climate System". It can be widely used for climate services like climate monitoring, climate researches and of course seasonal forecast. It is available on web browsers such as Internet Explorer, Firefox through Graphical User Interface (GUI) with no additional software or plug-ins. Moreover, you don't have to prepare data by yourself. National Meteorological and Hydrological Services (NMHSs) can use it with personal IDs.

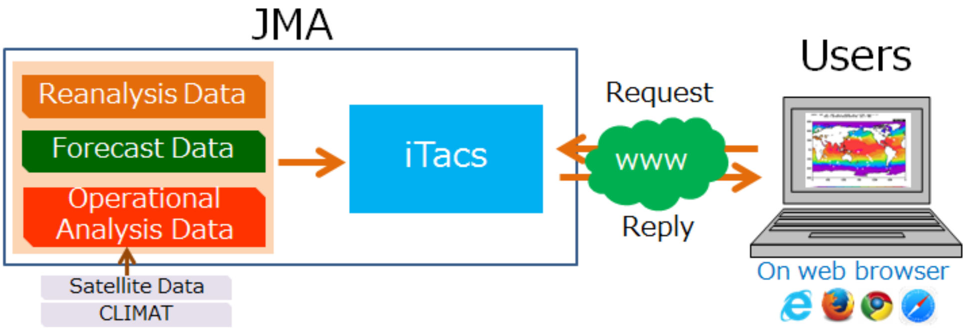


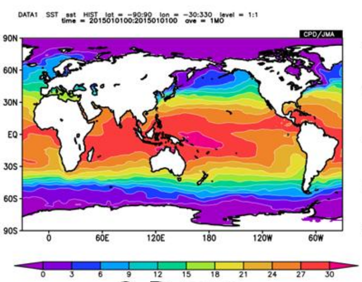
Fig.1 Schematic diagram for iTacs

iTacs is built on JMA servers and various types of dataset are saved in the system. You can access and use it via internet with your client PCs. The Japanese 55-year Reanalysis (JRA-55, Kobayashi et al. 2015) and outgoing longwave radiation (OLR) provided by NOAA can be used for atmospheric analysis. COBE-SST (Ishii et al. 2005) is also available in oceanographic analysis. The detailed elements available on iTacs are listed in APPENDIX.A.

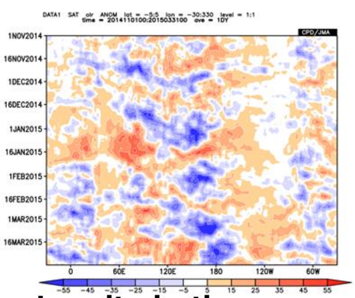
Atmospheric analysis	JRA-55 (Kobayashi et al. 2015)	From 1958 to present
	OLR provided by NOAA	From 1979 to present
Oceanographic analysis	COBE-SST (Ishii et al. 2005)	From 1891 to present
	MOVE/MRI.COM-G2 (Toyoda et al. 2013)	From 1958 to present
Atmospheric forecast	Output of JMA's one-month prediction model	
Others	ENSO monitoring indices, CLIMAT reports, user-input data etc.	

Table.1 Available dataset on iTacs

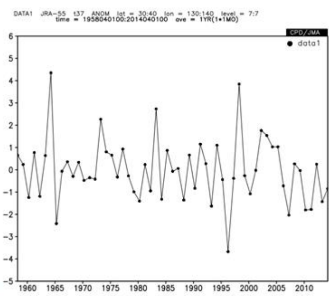
In iTacs, various types of charts such as two-dimensional map, cross section diagram, timeseries graph can be drawn, and some types of statistical analyses such as Empirical Orthogonal Function (EOF) analysis, regression or correlation analyses can be performed. iTacs is one of the most useful tool and will help you to understand climate system.



2-D map



Longitude-time cross section diagram



Time series graph

Fig.2 Various types of charts available on iTacs

2. Application for using iTacs

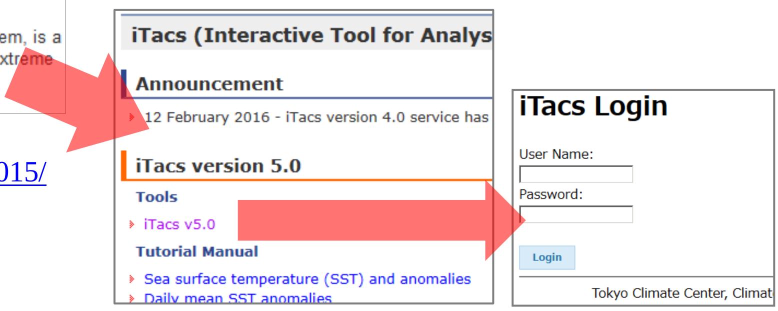
Only registered users can access iTacs at the TCC website. User ID and password are needed to use the iTacs*. JMA permits persons at NMHSs to use the iTacs. If you or your colleagues are interested to use the iTacs, please access the following URL for the application.

iTacs: http://extreme.kishou.go.jp/tool/itacs-tcc2015/

You can see "Requests for iTacs access" section on this web page. Please carefully read the conditions of use and disclaimer. If you agree to them, please apply to TCC (tcc@met.kishou.go.jp) by e-mail completely filling the items. JMA will issue ID and password if the application is accepted.

* ID and password of the seminar participants are already issued.

TCC website: http://ds.data.jma.go.jp/tcc/tcc/index.html



iTacs: http://extreme.kishou.go.jp/tool/itacs-tcc2015/

Fig.3 Access to iTacs

3. Basic operations –Horizontal map-

If you input your ID and password on the iTacs login page, you will see the main display of the iTacs as shown below. The standard procedure for drawing a chart by iTacs is as follows:

- Select dataset, element, and data type.
- Set geophysical parameters: area (longitude and latitude), pressure level or depth.
- Set chronological parameters: average period (e.g., daily, monthly), period to show (e.g., year, month, day).
- Select analysis method (if needed).
- Set graphic parameters (if needed).
- Click a submit button and draw a map.

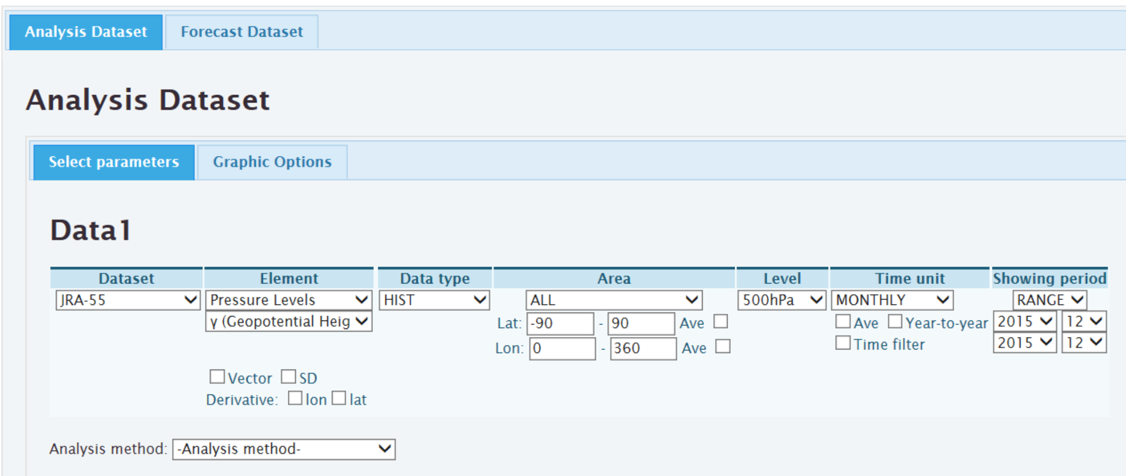


Fig.4 Main display of iTacs

3.1. Longitude-latitude map

As a starter, let's make a monthly sea surface temperature (SST) map in December 2015. Set parameters on "Data1" box as shown below.

- ◆ Dataset: SST (COBE-SST).
- ◆ Element: Sea Surface Data → Temperature (SST).
- ◆ Data type: HIST (historical actual observation or analysis).
- ◆ Area: ALL (90°S – 90°N, 0° – 360°E).
- ◆ Level: 1 (Surface data).
- ◆ Time unit: MONTHLY.
- ◆ Showing period: RANGE, 2015 – 12 (December 2015) for both upper and lower boxes.

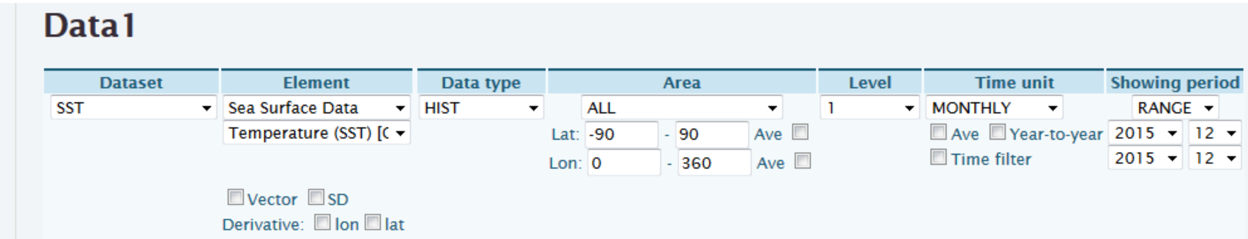


Fig.5a Parameter setting on iTacs to draw SST map in December 2015

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

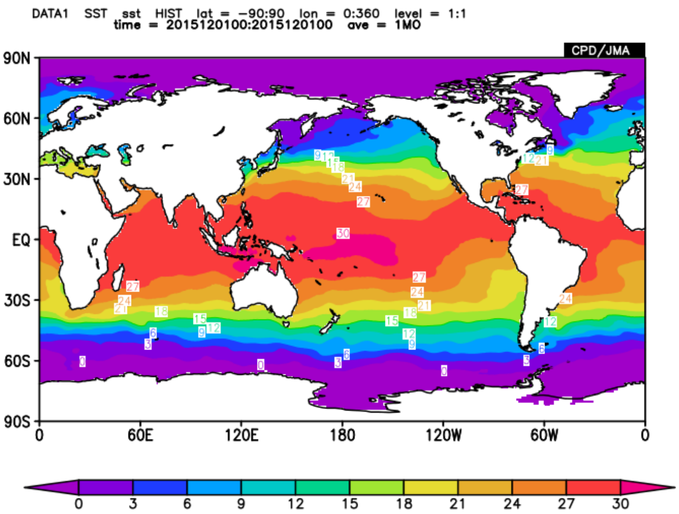


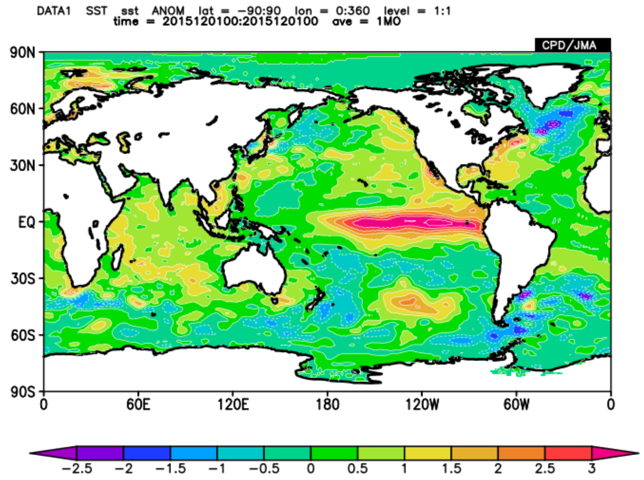
Fig.5b Image of SST in December 2015 created by the setting shown in Fig.5a

You can select the following options in "Data type" pull-down menu.

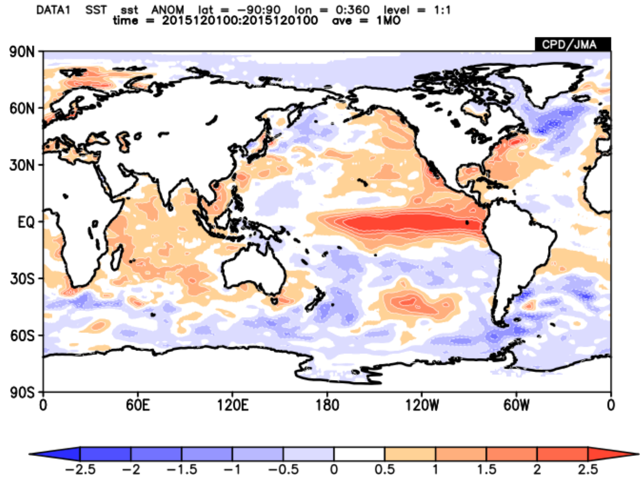
- ◆ HIST: Historical actual analysis or observation data.
- ◆ NORM: Climatological normal data (averaged from 1981 to 2010).
- ◆ ANOM: Anomaly data (HIST minus NORM: difference from the climatological normal)
- ◆ ANOM_SD: Anomaly data normalized by their standard deviations.

Select "ANOM" in "Datatype" box to draw anomalies (Fig.6a). Changing "Color Table" and "Contour Parameters" in “Graphic Options” tab as shown in Fig.6b, it becomes easier to recognize the above- and below-normal SST anomalies.

(a) Rainbow



(b) Blue – Red



(c) Graphic options for Fig.6(b)

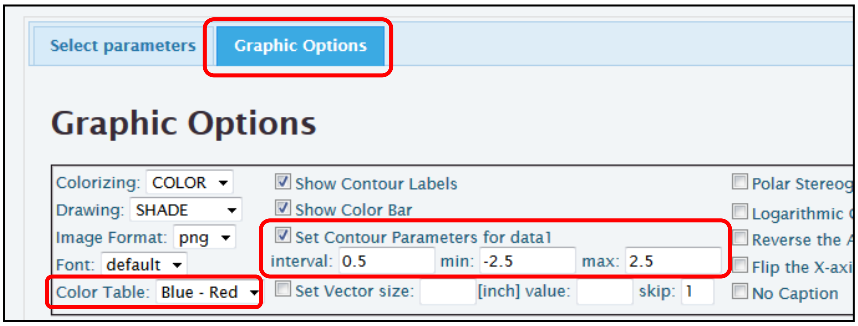
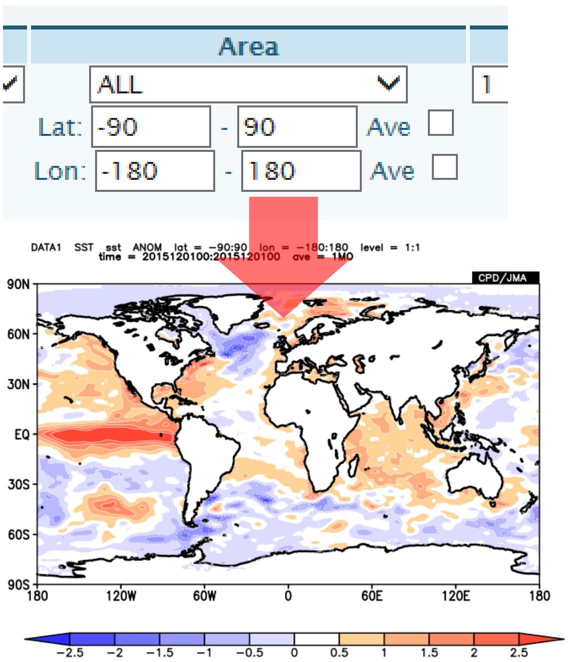


Fig.6 SST anomalies in December 2015 with (a) the color table “Rainbow” (default setting), (b) “Blue–Red” and (c) Graphic options of the contour setting for (b)

You can adjust the area by setting “Lat” and “Lon” parameters in the “Area” field. The negative values of latitude and longitude mean south latitude and west longitude, respectively (See Fig.7).

(a)



(b)

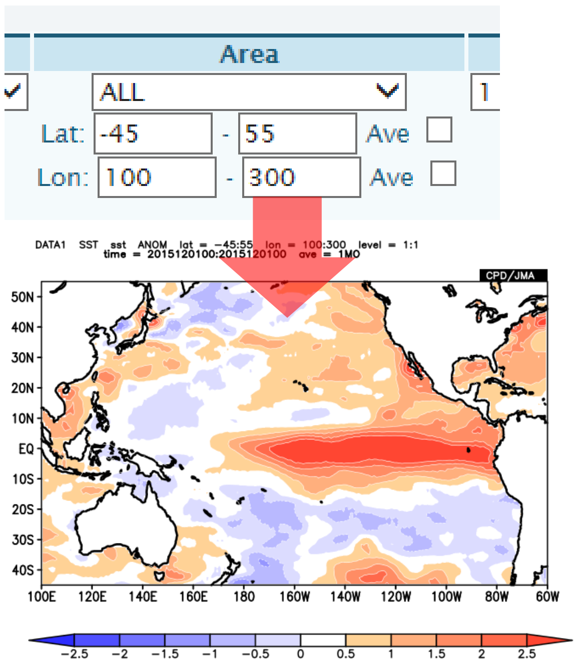


Fig.7 Example of area setting on iTacs

The following options are available in “Showing period” pull-down menu to pick up the time range to show.

- RANGE: Set the start and end points of the targeted time period.
- YEARS: Set individual years.
- INDEX: Pick up years based on a condition of SST index (e.g., NINO.3, IOBW).

3.2. Vector and Stream line

Vector and stream lines maps can be also made with iTacs. Let’s see the 850hPa wind filed in January 2016 by vector map. To draw vectors, please check the “vector” box in the “Element” field. If you check this box, the second element boxes will appear. The first variable is treated as X component, and the second one is treated as Y component, where X and Y means horizontal and vertical direction on the map, respectively. Set parameters as below (see also Fig. 8a).

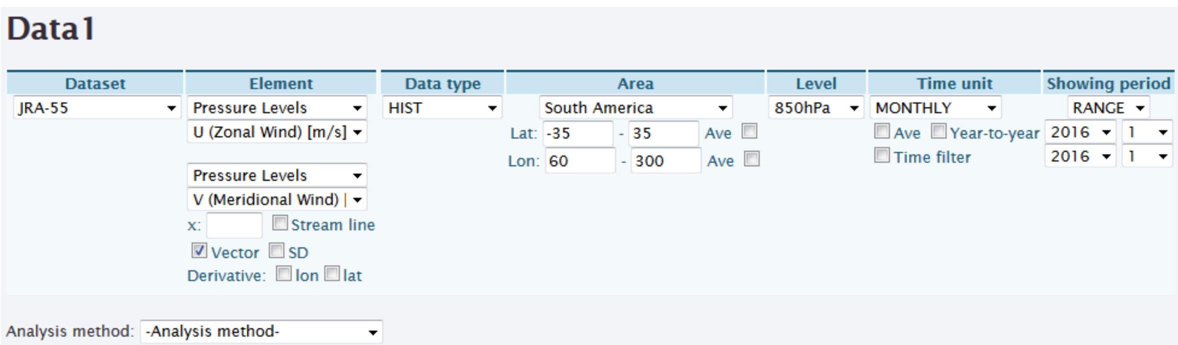
- Data1
  - Dataset: JRA-55.
  - Element: Pressure Levels → U (Zonal Wind) and V (Meridional Wind). Check the “Vector” box to set the second component.
  - Data type: HIST.
  - Area: Lat: -35 – 35, Lon: 60 – 300 (35°S – 35°N, 60°E – 60°W).
  - Level: 850 hPa.
  - Time unit: MONTHLY, check “Ave” box to calculate three-month mean.
  - Showing period: RANGE, 2015 – 12 for upper box and 2016 – 2 for lower box.

Now you can draw the vector map, but it would be better to modify graphical options related to vector. If you don’t, you will get the figure like Fig. 8b, in which vectors are too crowded to see its wind field. Please set the vector size option like this (see also Fig. 8c).

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

This setting means that 1 inch on the map is equivalent to 20 m/s wind and the vectors are displayed on every 5th grid point both in X direction and Y direction. Please try to find appropriate vector size and skip interval.

(a)



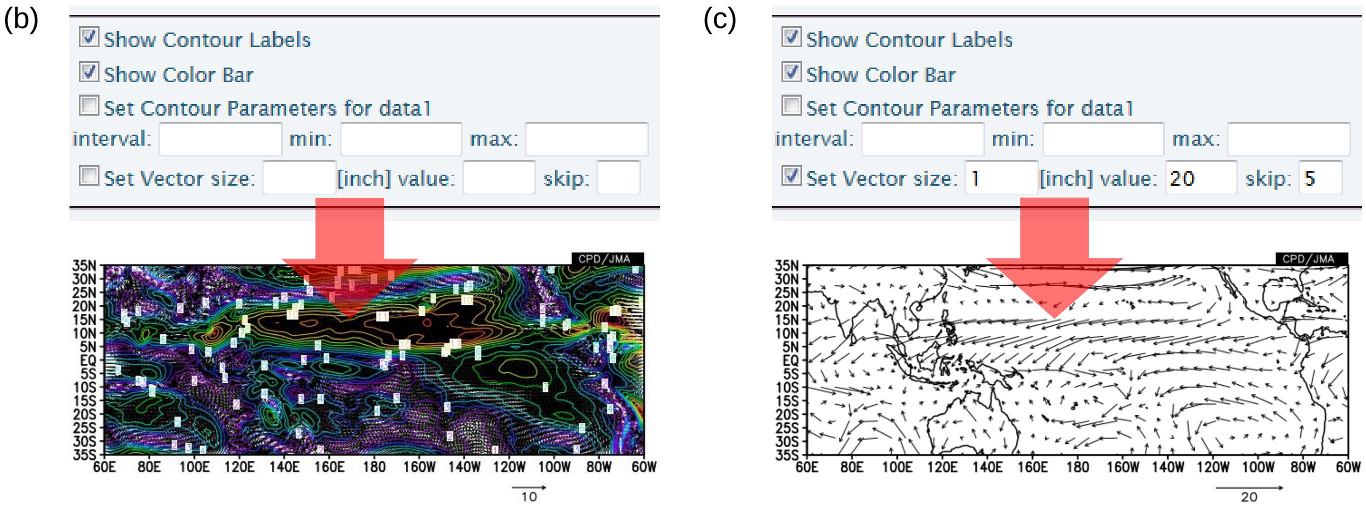


Fig.8 Parameter settings for making 850 hPa wind vectors for January 2016 and their corresponding maps

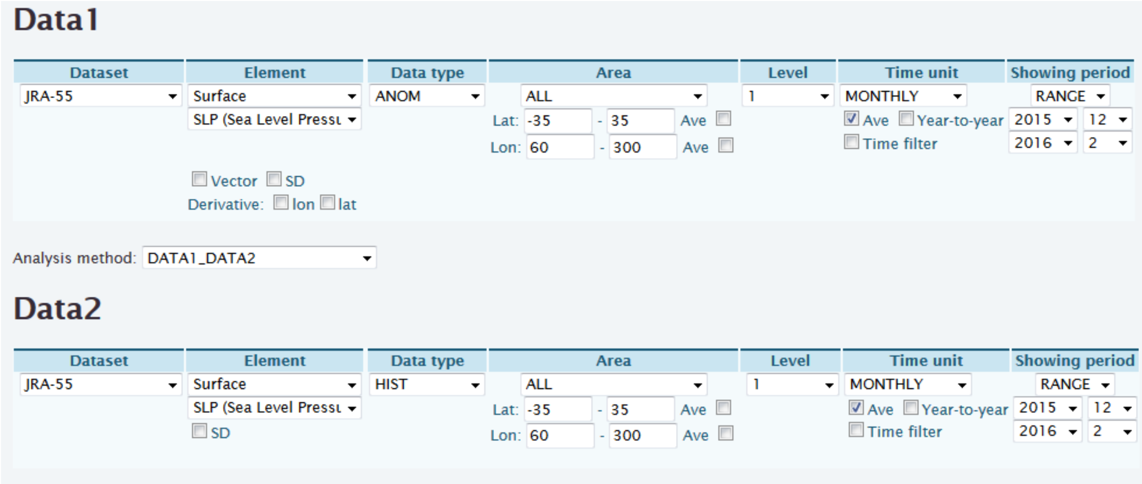
3.3. Overlaying two data

Users can overlay two kinds of elements on the same image by using "DATA1_DATA2" analysis method. Let's chart and superimpose three-month mean sea level prerrusre and its anomalies from December 2015 to February 2016 on a map. Set parameters on "Data1" and "Data2" box as shown below (See also Fig.9a).

- Data1
  - Dataset: JRA-55.
  - Element: Surface → SLP (Sea Level Pressure).
  - Data type: ANOM.
  - Area: Lat: -35 – 35, Lon: 60 – 300 (35^{o}S – 35^{o}N, 60^{o}E – 60^{o}W).
  - Level: 850 hPa.
  - Time unit: MONTHLY, check "Ave" box to calculate three-month mean.
  - Showing period: RANGE, 2015 – 12 for upper box and 2016 – 2 for lower box.

"Data2" box will appear after selecting "DATA1_DATA2" in "Analysis method" pull-down menu.

- Data2
  - Data type: HIST.
  - Other parameters are the same as Data1.
- Graphic Options
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:1, min:-4, max:4.
  - Set Contour Parameters for data2: interval:2, min:1000, max:1020.



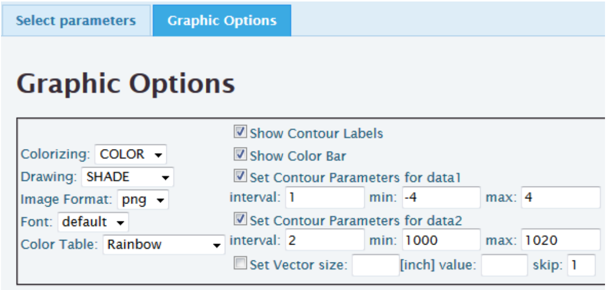


Fig.9a Parameter setting and graphic options to draw sea level pressure and its anomalies map in DJF 2015/2016

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

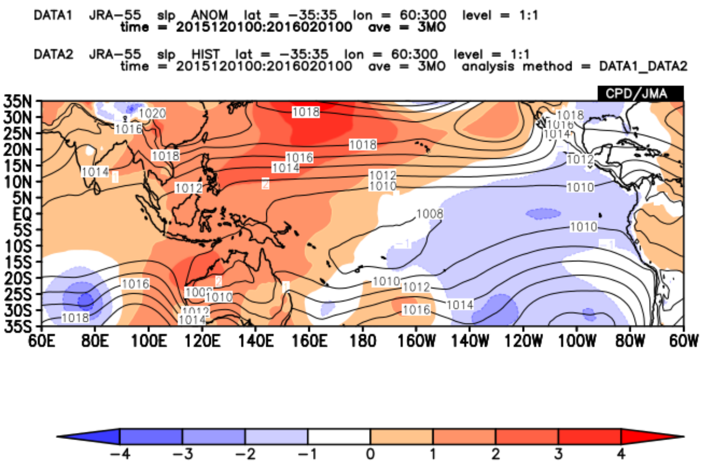


Fig.9b Image of 850-hPa stream function in DJF 2015/2016 created by the setting shown in Fig.8a

Please keep in mind the basic rule for Data1_Data2 that the Data1 is mapped as shading, and Data2 is mapped as contour lines. But as an exception, when you make a vector/stream line map, Data1 must be for vector/stream line and Data2 is mapped as shading or contour lines (not shown in this note).

3.4. Mapping the difference of two data

Users can calculate and map the difference of two data by using "SUBTRACT" analysis method. Let's chart monthly SST anomaly change from October to December 2015. Set parameters on "Data1" and "Data2" box as shown below (See also Fig.10a).

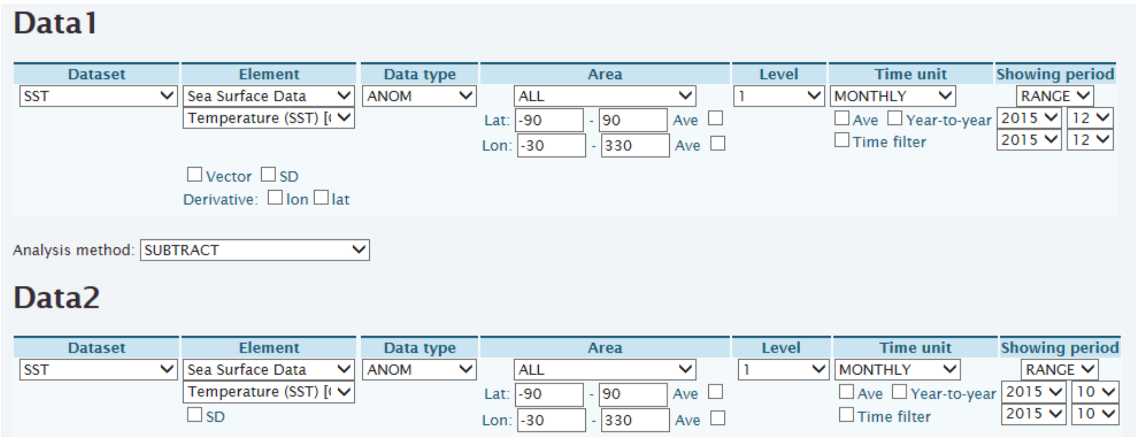
- Data1

- Dataset: SST.
- Element: Sea Surface Data → Temperature (SST).
- Data type: ANOM.
- Area: Lat: -90 – 90, Lon: -30 – 330 (90°S – 90°N, 30°W – 330°E).
- Level: 1.
- Time unit: MONTHLY.
- Showing period: RANGE, 2015 – 12 for both upper and lower boxes.

"Data2" box will be adjustable after selecting "SUBTRACT" in "Analysis method" pull-down menu.

- <u>Data2</u>
  - Showing period: RANGE, 2015 – 10 for both upper and lower boxes.
  - Other parameters are the same as Data1.
- <u>Graphic Options</u>
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:0.2, min:-1.1, max:1.1.

In the setting above, the value of "Data1" minus "Data2" will be calculated and mapped. Click "Analysis Data Submit" button and the image will be displayed.



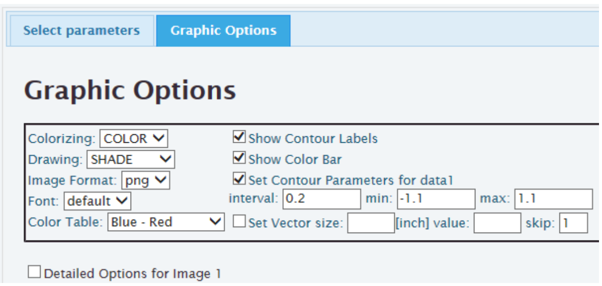


Fig.10a Parameter setting and graphic options to draw monthly SST anomaly difference between October and December 2015

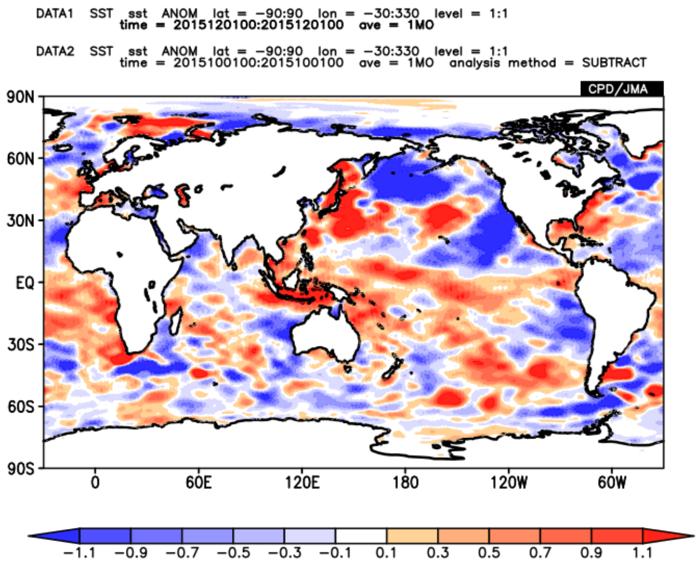


Fig.10b Image of SST anomaly change from October to December 2015 created by the setting shown in Fig.10a

In a similar way, users can also perform the four basic arithmetic operations of two data by using the corresponding analysis method shown in Table.2.

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”).

Table.2 Analysis method of the four basic arithmetic operations on iTacs

4. Basic operations –other kinds of map-

Users can create various types of image such as line graph and cross section diagram (Fig.11). These operations are useful to see the variability or spatial structure simply.

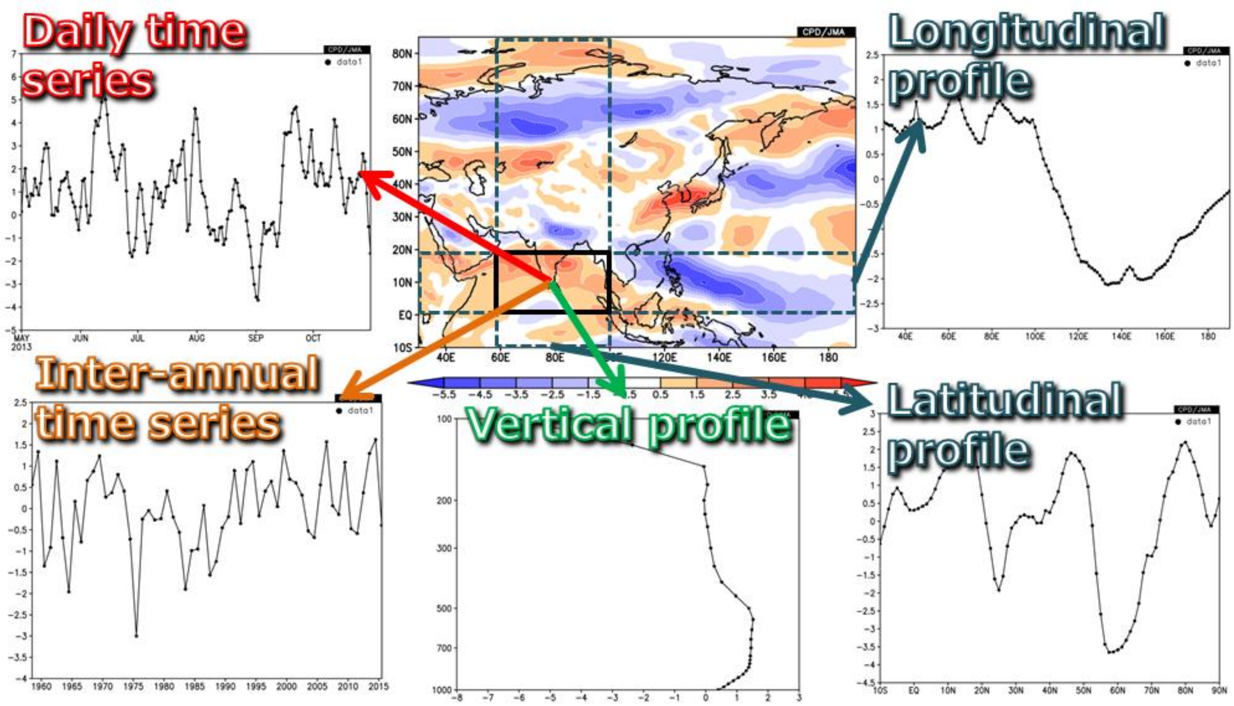


Fig.11 Example of time-series graphs available on iTacs

4.1. Area-averaged time series

Daily, monthly and inter-annual time-series are available by adjusting “Area”, “Level”, “Time unit” and “Showing period”. As an example, let’s chart daily time-series of area-averaged OLR anomalies. Set parameters on “Data1” box as shown below (See also Fig.12a).

- Dataset: SAT (OLR is available by selecting “SAT” in this box).
- Element: OLR [W/m^2].
- Data type: ANOM.
- Area: Lat: -10 – 10, Lon: 90 – 150 (over and around the Maritime Continent).
  - Check “Ave” box in both “Lat” and “Lon” fields to calculate area-averaged value.
- Level: 1 (OLR is surface data).
- Time unit: DAILY.
- Showing period: RANGE,
  - Upper box: 2016 – 5 – 1 (from 1 May 2016),
  - Lower box: 2016 – 8 – 31 (to 31 August 2016).

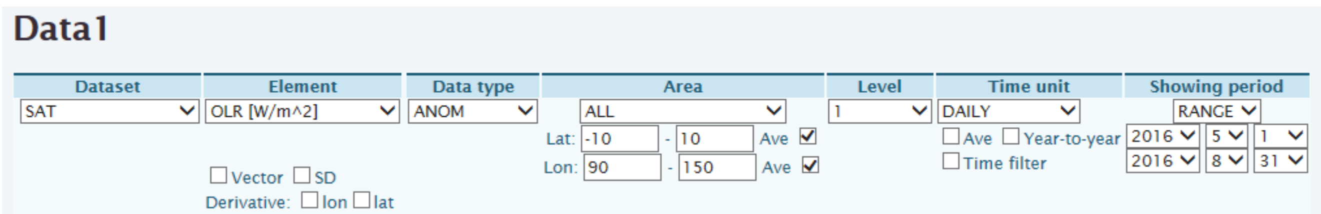


Fig.12a Parameter setting on iTacs to draw time-series of OLR anomalies from 1 May to 31 August 2016

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

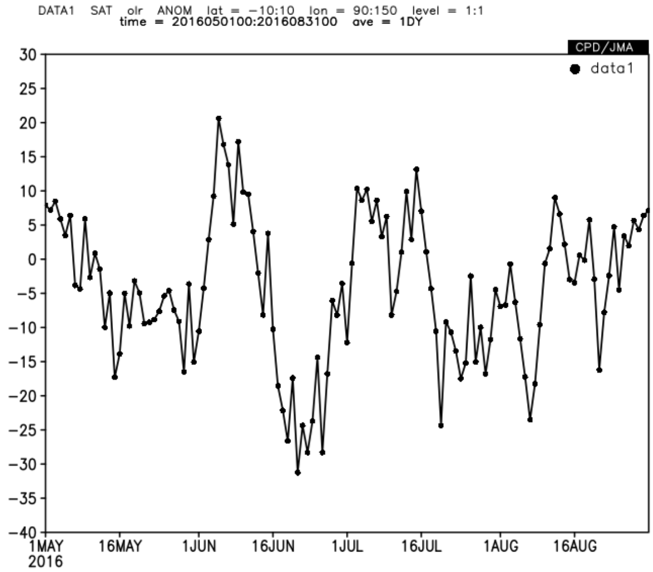


Fig.12b Daily time-series of OLR anomalies created by the setting shown in Fig.11a

OLR is one of the most important indices of tropical convective activities. It can be assumed that lower values of OLR indicate more enhanced convective activities, except for the mid-latitudes in winter season and the high-latitudes. In Fig.11b, negative (positive) anomalies indicate that the convective activities are stronger (weaker) than normal.

Selecting "MONTHLY" in "Time unit" box, users can draw monthly time-series.

Next, let's chart inter-annual time-series of 200-hPa velocity potential anomalies. Set parameters on "Data1" box as shown below (See also Fig. 13a).

- Dataset: JRA-55.
- Element: Pressure Levels → χ (Velocity Potential).
- Data type: ANOM.
- Area: Lat: -10 – 10, Lon: 90 – 150 (over and around the Maritime Continent).
  - Check "Ave" box in both "Lat" and "Lon" fields to calculate area-averaged value.
- Level: 200hPa for both upper and lower boxes.
- Time unit: MONTHLY.
  - Check "Year-to-year" box to calculate inter-annual variabilities.
- Showing period: RANGE, Year: 1958 – 2016, Month: 5 – 8 (MJJA mean from 1958 to 2016).

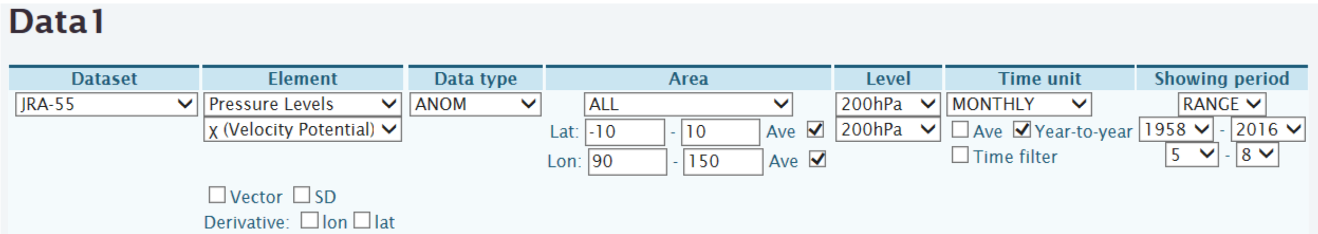


Fig. 13a Parameter setting on iTacs to draw inter-annual time-series of four-month (May – August) averaged 200-hPa velocity potential anomalies over and around the Maritime Continent from 1958 to 2016

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

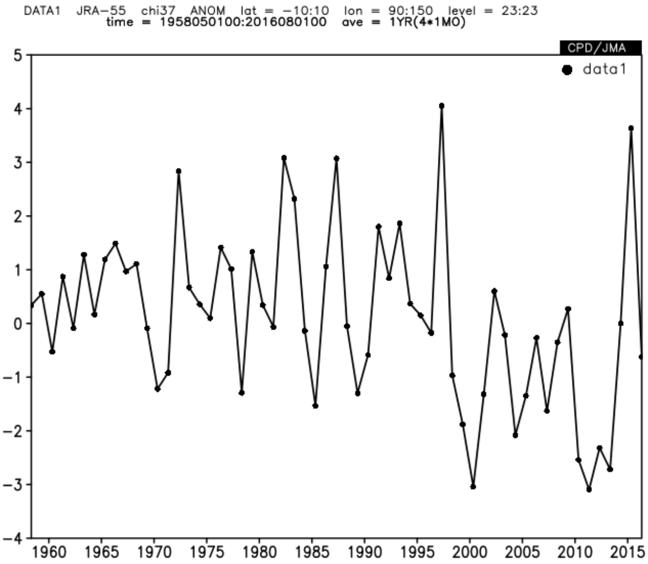


Fig. 13b Inter-annual time-series of 200-hPa velocity potential anomalies created by the setting shown in Fig. 13a

4.2. Vertical and latitude/longitude profile

As with the time-series graph, users can make vertical/horizontal profiles graph by using spatial average functions. Selecting two different levels in "Level" box, users can make the vertical profile of area-averaged elements as shown in Fig.14.

- Area: Check "Ave" in both "Lat" and "Lon" boxes to calculate area-averaged value.
- Level: 1000 hPa – 1 hPa.

Checking "Logarithmic Coordinates" in the Graphic Options is recommended in vertical profile graph for pressure coordinate

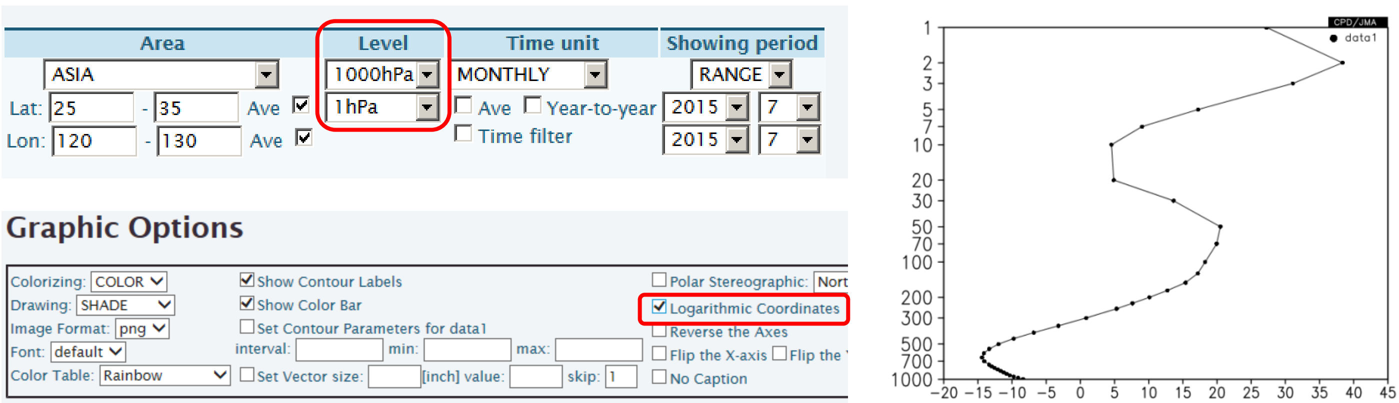
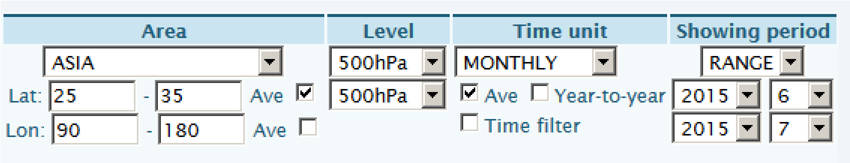


Fig.14 Example of parameter setting and the figure to draw a vertical profile of height anomalies

Checking either "Ave" boxes, users can make the latitude or longitude profile of a specific level. Fig.15 shows an example of the parameter setting for a longitude profile of meridional mean values.

- Area: Check "Ave" box in "Lat" field to calculate zonal averaged values.
- Time unit, Showing period: Select a specific time or time mean.



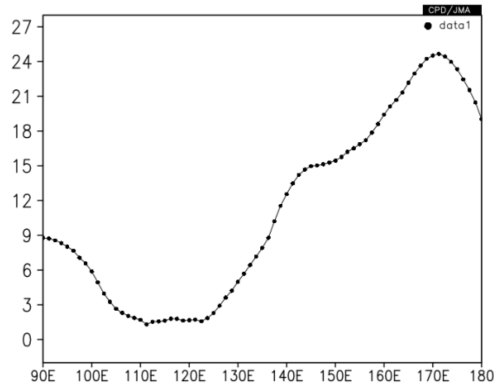


Fig.15 Example of parameter setting on and the figure to draw a longitude profile of 500-hPa height anomalies

4.3. Cross section diagram

Cross section diagram is also useful to see the variability or spatial structure of atmospheric or oceanographic characteristics.

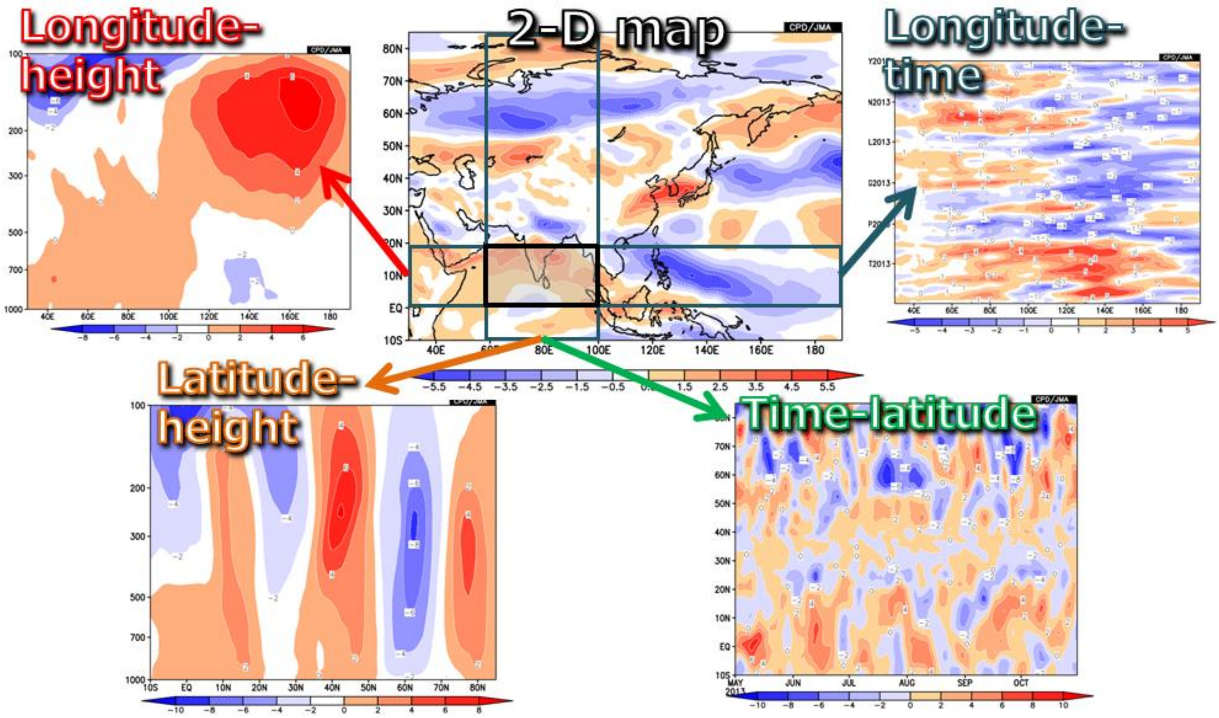


Fig.16 Example of cross section diagrams available on iTacs

Selecting two different levels in “Level” box, users can make the vertical profile of area-averaged elements as shown in Fig.17.

- Area: Check “Ave” box in “Lon” fields to calculate area-averaged value.
- Level: 1000 hPa – 100 hPa.
- Time unit, Showing period: Select a specific time or time mean.

Checking “Logarithmic Coordinates” in the Graphic Options is recommended in vertical profile graph.

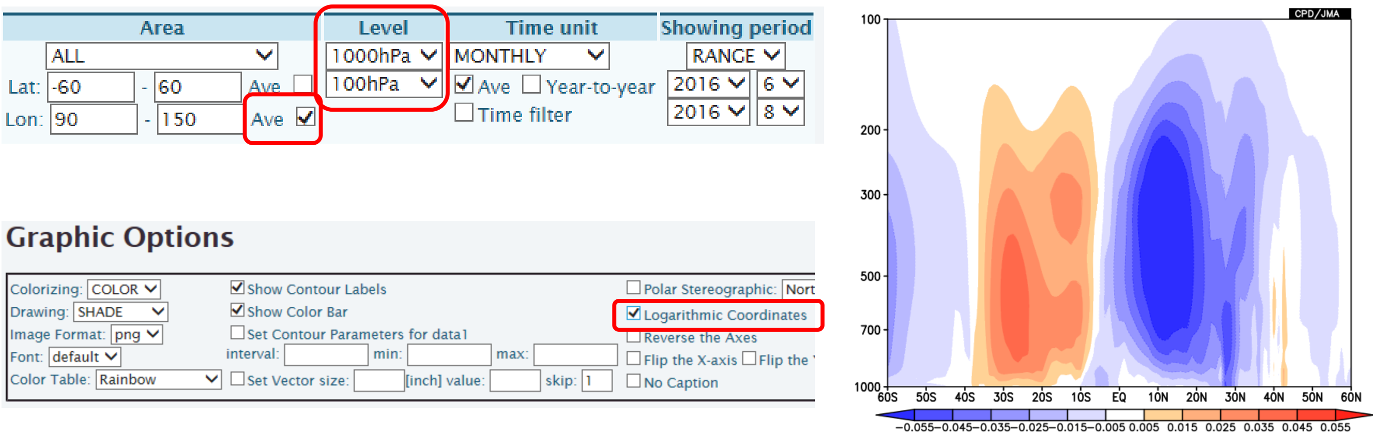


Fig.17 Example of parameter setting and the figure to draw a vertical cross section of normal pressure vertical velocity

Let's chart a longitude-time cross section of meridional mean 200-hPa velocity potential anomalies. Set parameters on "Data1" box as shown below (See also Fig.18a).

- Dataset: JRA-55.
- Element: Pressure Levels → χ (Velocity Potential).
- Data type: ANOM.
- Area: Lat: -5 – 5, Lon: 0 – 360.
  - Check "Ave" box in "Lat" field to calculate meridional mean from 5°S – 5°N.
- Level: 200hPa for both upper and lower boxes.
- Time unit: DAILY.
- Showing period: RANGE,
  - Upper box: 2015 – 5 – 1 (from 1 May 2015),
  - Lower box: 2015 – 10 – 31 (to 31 October 2015).
- Graphic Options
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:3, min:-15, max:15.

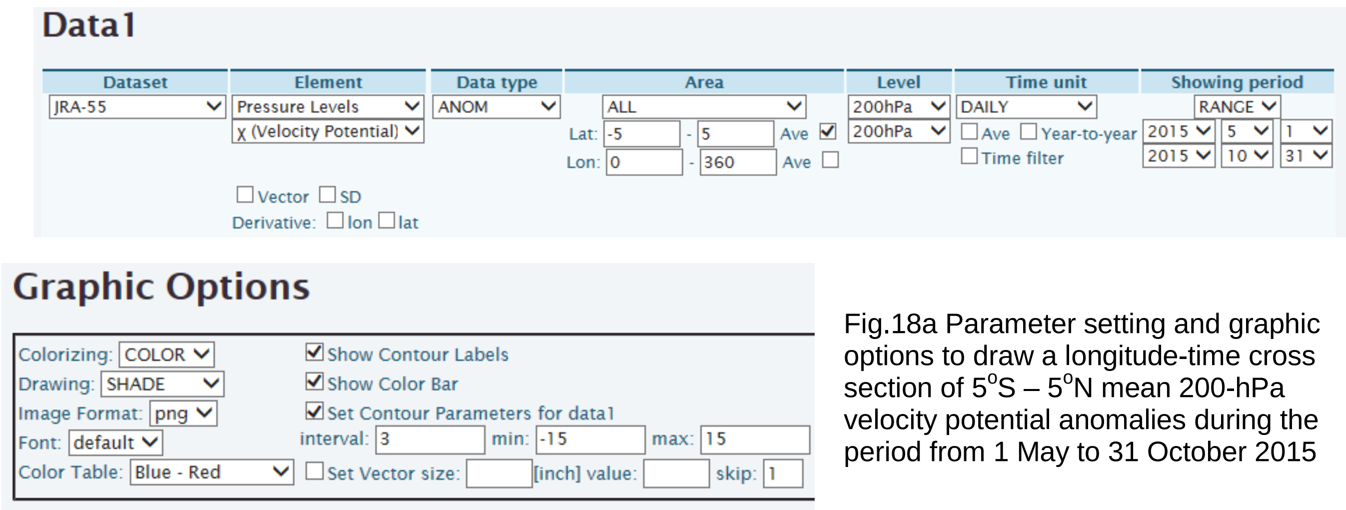


Fig.18a Parameter setting and graphic options to draw a longitude-time cross section of 5°S – 5°N mean 200-hPa velocity potential anomalies during the period from 1 May to 31 October 2015

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

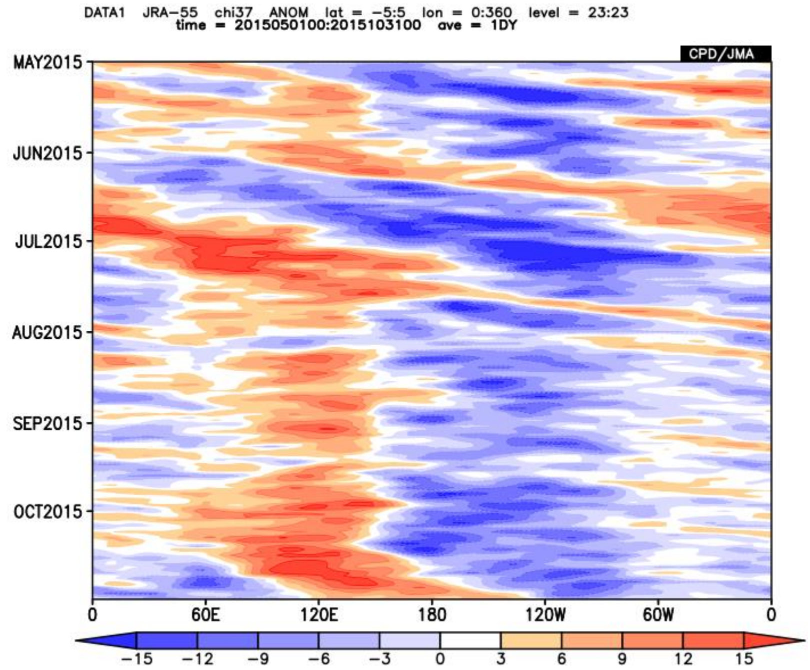


Fig.18b Longitude-time cross section diagram (it is a so-called "Hovmöller diagram") created by the setting shown in Fig.18a

4.4. Time filter

Time filtering is used to create a time-series or time cross section images. It emphasizes climatological variability because it can remove high frequency variations. There are two types of the time filter in iTacs as shown below:

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

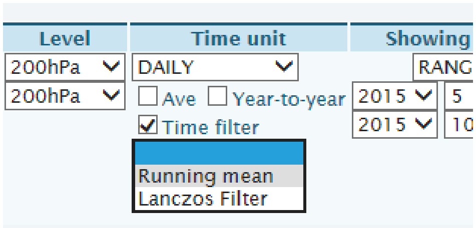


Fig.19 Two types of time filtering function on iTacs

Using "Running mean" function, users can make smoothed time-series graphs as shown in Fig.19a.

- Time unit: DAILY.
  - Check "Time filter" and select "Running mean".
  - Input "5" in mean period (i.e. 5-day running mean).
- Other parameters are the same as Fig.12a.

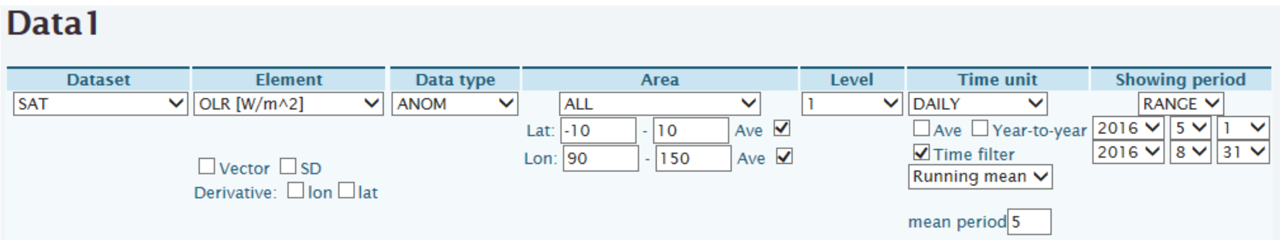


Fig.20a As for Fig.12a, but parameter setting for 5-day running mean

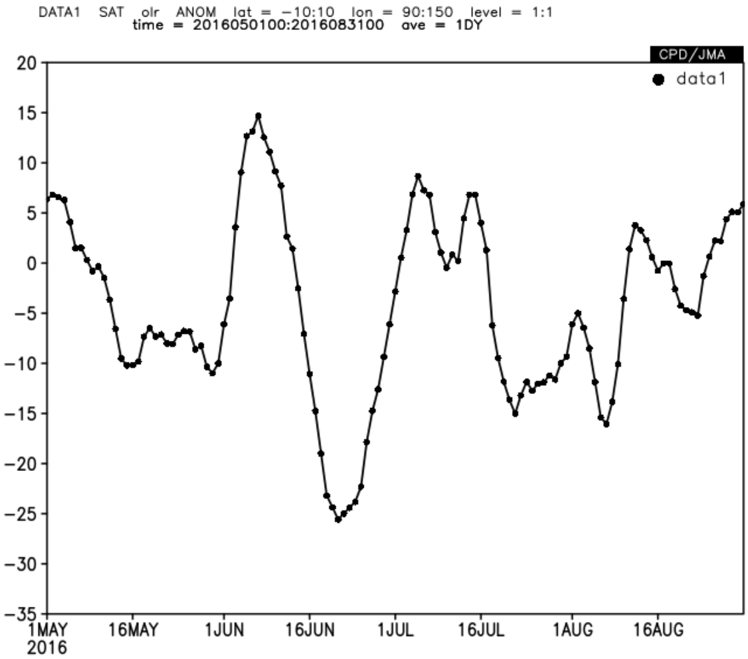
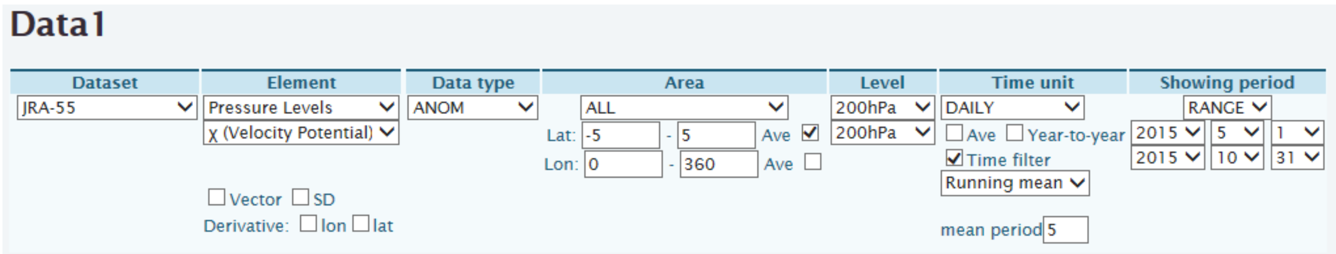


Fig.20b As for Fig.12b, but smoothed by 5-day running mean created by the setting shown in Fig.20a

Smoothed time cross section diagrams are also available by using “Running mean” function as shown in Fig.21a.

- Time unit: DAILY.
  - Check “Time filter” and select “Running mean”.
  - Input “5” in mean period (i.e. 5-day running mean).
- Other parameters are the same as Fig.18a.



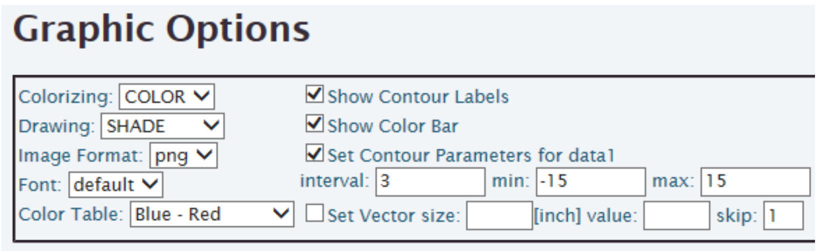


Fig.21a Parameter setting and graphic options to draw a longitude-time cross section of 5°S – 5°N mean 200-hPa velocity potential anomalies during the period from 1 May to 31 October 2015

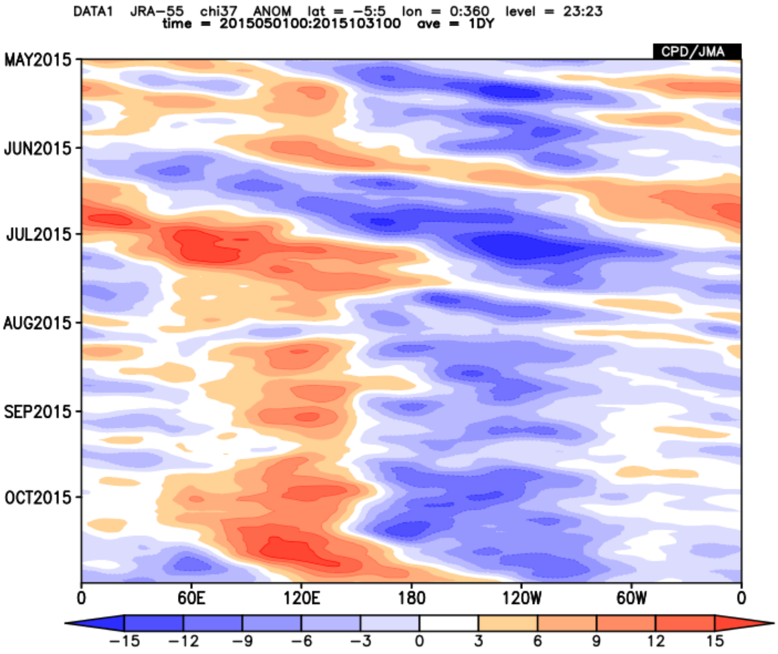


Fig.21b As for Fig.18b, but smoothed by 5-day running mean created by the setting shown in Fig.21a

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APPENDIX.A. Dataset and elements available on iTacs

Table.A1 List of analysis dataset and its elements available on iTacs

Dataset	Element		Unit
JRA-55	Pressure Levels	χ (Velocity potential)	10^6 m^2/s
		Div (Relative divergence)	1/s
		θe (Equivalent potential temperature)	K
		ω (Pressure vertical velocity)	Pa/s
		ψ (Stream function)	10^6 m^2/s
		θ (Potential temperature)	K
		q (Specific humidity)	kg/kg
		T (Temperature)	^oC
		T-Td (Dew point depression)	^oC
		U (Zonal wind)	m/s
		V (Meridional wind)	m/s
		Udiv (Zonal divergence wind)	m/s
		Vdiv (Meridional divergence wind)	m/s
		ζ (Relative vorticity)	1/s
		γ (Geopotential height)	m
	Flux	Wvf-x (Zonal water vapor flux)	kg/kg m/s
		Wvf-y (Meridional water vapor flux)	kg/kg m/s
	Surface	SLP (Sea level pressure)	hPa
		Ps (Surface pressure)	hPa
		qs (Surface specific humidity)	kg/kg
		Ts (Surface temperature)	^oC
		T-Td (Surface 2-m dew point depression)	^oC
		Us (Surface zonal wind)	m/s
		Vs (Surface meridional wind)	m/s
		Tprat (Surface total precipitation)	mm/day
		Latent heat flux (positive: upward)	W/m^2
		Sensible heat flux (positive: upward)	W/m^2
		Solar radiation flux (positive: upward)	W/m^2
		Longwave radiation flux (positive: upward)	W/m^2
		Net heat and radiation flux (positive: upward)	W/m^2
	Isentropic Levels	Potential vorticity	PVU ($10^{-6}K\ m^2kg^{-1}s^{-1}$)
SST	Sea Surface Data	Temperature (SST)	^oC
SAT	OLR		W/m^2
INDEX	NINO.1+2		^oC
	NINO.3		^oC
	NINO.3.4		^oC
	NINO.4		^oC
	NINO.WEST		^oC
	IOBW		^oC

Table.A2 List of forecast dataset and its elements available on iTacs

Dataset	Element		Unit
1MONTH_ENS_MEAN	Pressure Levels	χ (Velocity potential)	10^6 m^2/s
		ψ (Stream function)	10^6 m^2/s
		T (Temperature)	^oC
		T-Td (Dew point depression)	^oC
		U (Zonal wind)	m/s
		V (Meridional wind)	m/s
		γ (Geopotential height)	m
	Surface	SLP (Sea level pressure)	hPa
		Ts (Surface temperature)	^oC
		Rain (Daily Precipitation)	mm/day
1MONTH_HIND	Pressure Levels	Velocity potential	10^6 m^2/s
		Stream function	10^6 m^2/s
		Geopotential height	m
		Relative humidity	%
		Temperature	^oC
		T-Td (Dew point depression)	^oC
		Zonal wind	m/s
		Meridional wind	m/s
	Surface	Surface temperature	^oC
		Surface pressure	hPa
		Rain	mm/day