Introduction and Operation of iTacs

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1. What's iTacs?

iTacs stands for "Interactive Tool for Analysis of the Climate System". It is available on web browsers such as Internet Explorer, Firefox through Graphical User Interface (GUI) with no additional software or plug-ins. National Meteorological and Hydrological Services (NMHSs) can use it with personal IDs.

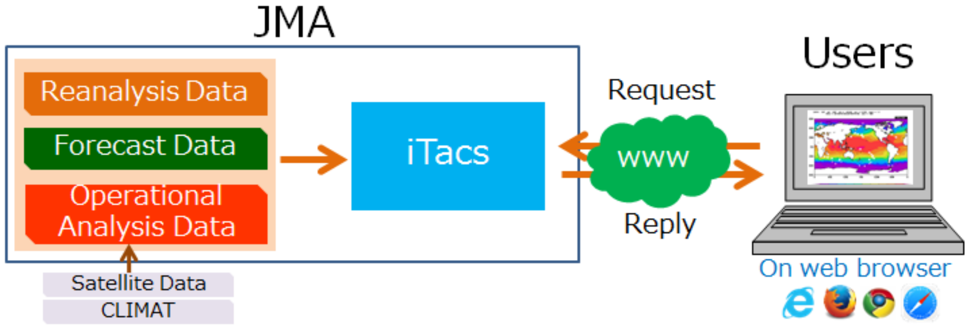


Fig.1 Schematic diagram for iTacs

iTacs is built on JMA servers and various types of dataset are saved in the system. Your client PC can access and use it via internet. 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.

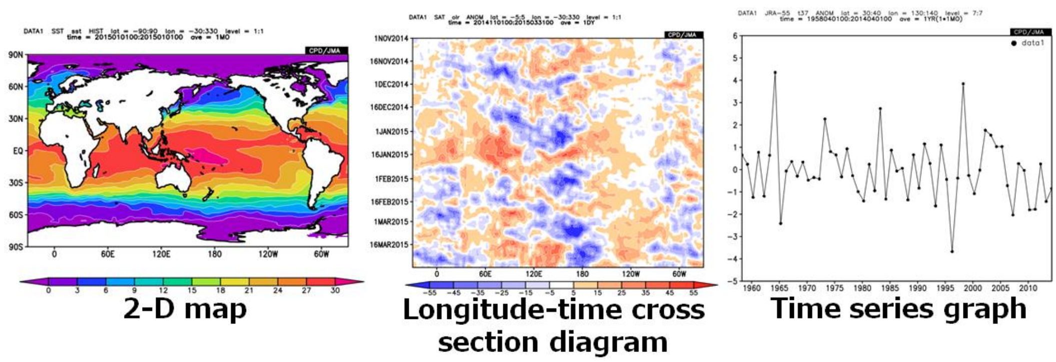


Fig.2 Various types of charts available on iTacs

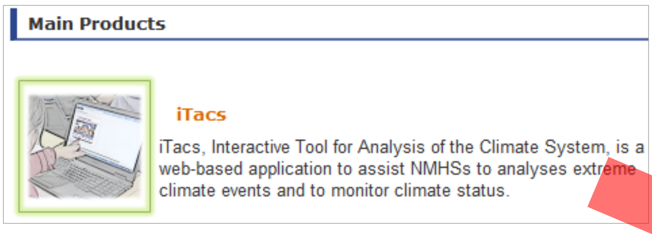
2. Application for using iTacs

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 are interested to use the iTacs, access the following URL for the application.

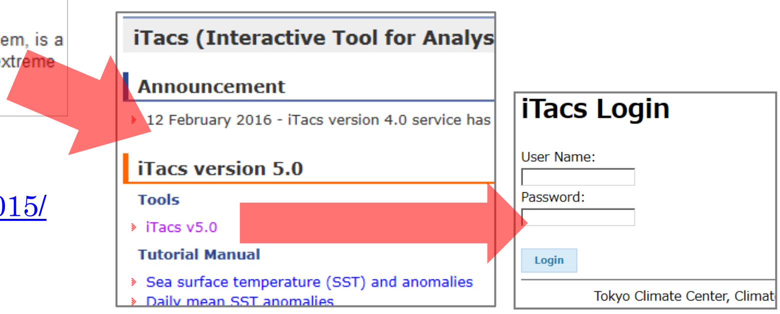
iTacs: https://extreme.kishou.go.jp/tool/itacs-tcc2015/

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 applying to TCC (tcc@met.kishou.go.jp) by e-mail completely filling the items. JMA will examine applications and, if the application is accepted, issue ID and password.

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



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



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

Fig.3 Access to iTacs

3. Basic operations

If you input ID and password provided on the iTacs login page, you will see 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.

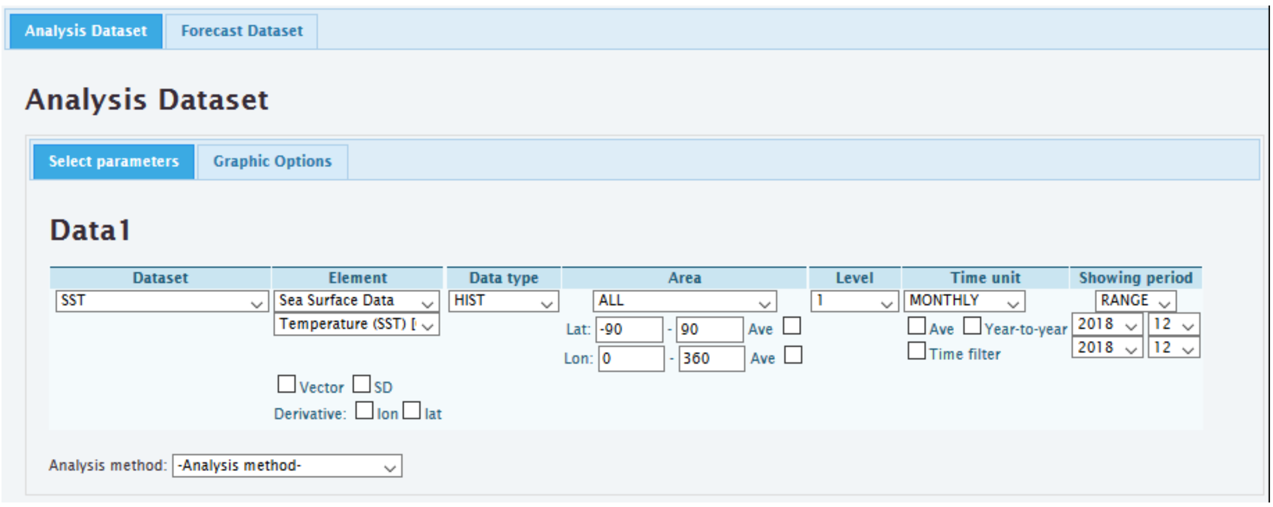


Fig.4 Main display of iTacs

3.1. Longitude-latitude map

As a starter, let's chart monthly sea surface temperature (SST) map in December 2018. 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 (90ºS – 90ºN, 0º – 360ºE).
- Level: 1 (Surface data).
- Time unit: MONTHLY.
- Showing period: RANGE, 2018 – 12 (December 2018) for both upper and lower boxes.

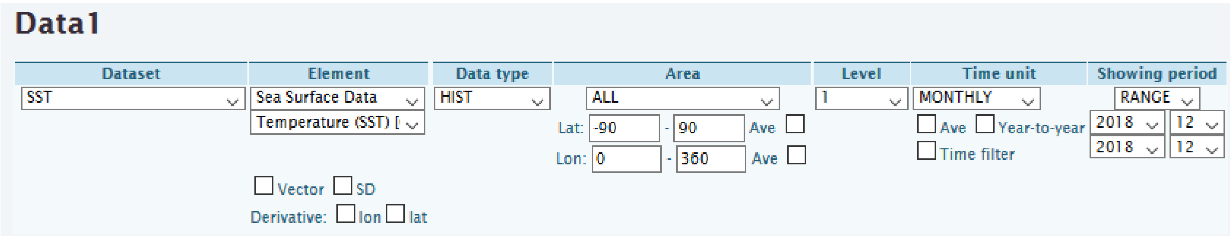


Fig.5a Parameter setting on iTacs to draw SST map in December 2018

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

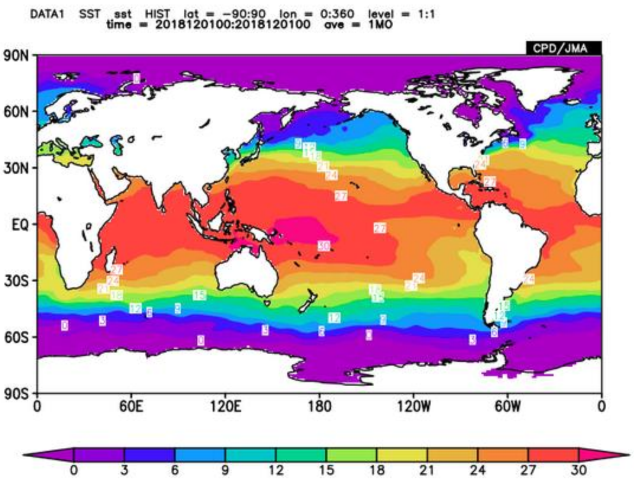


Fig.5b Image of SST in December 2018 created by the setting shown in Fig.5a

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.

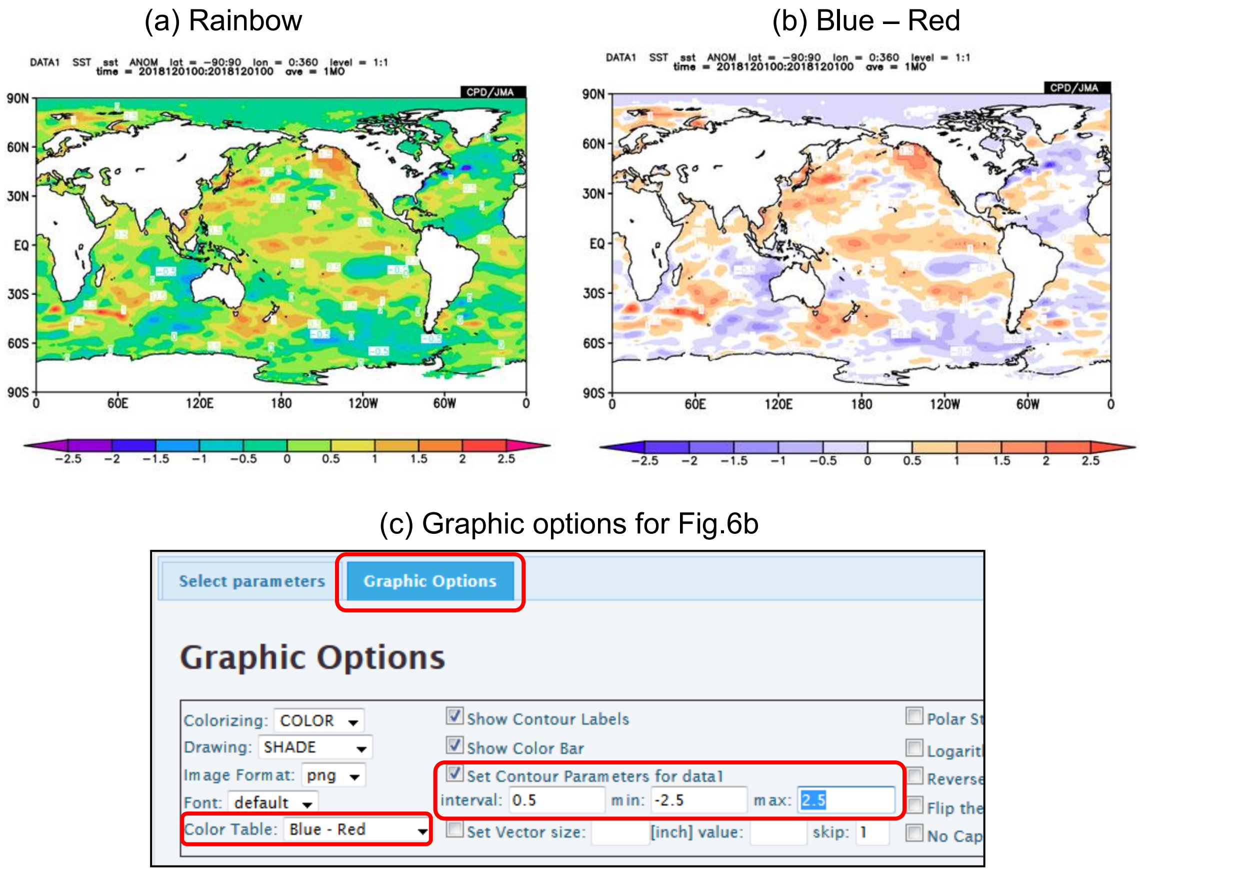


Fig.6 SST anomalies in December 2018 with (a) the color table “Rainbow” (default setting), (b) “Blue–Red” and (c) Graphic options of the contour setting for (b)

You can adjust zonal and meridional range 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).

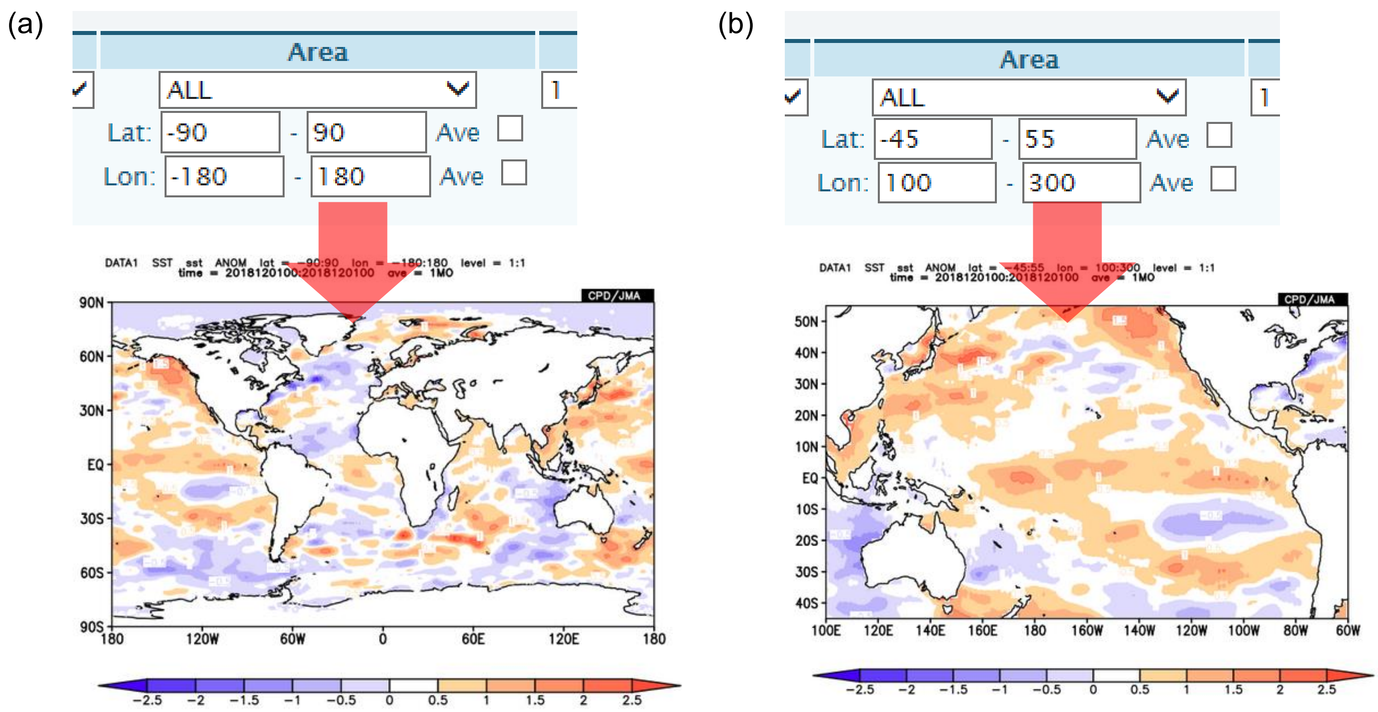


Fig.7 Example of area setting on iTacs

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 850-hPa wind filed in December 2018 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).

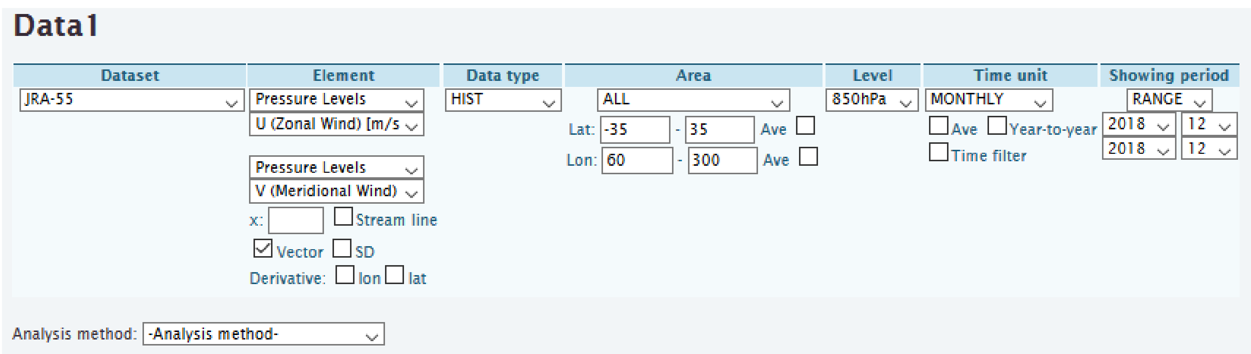
- Data1
  - Dataset: JRA-55.
  - Element: Pressure Levels → U (Zonal Wind) and V (Meridional Wind). Check the "Vector" box to set the second component.
  - Data type: HIST.
  - Area: Lat: -35 – 35, Lon: 60 – 300 (35°S – 35°N, 60°E – 60°W).
  - Level: 850 hPa.
  - Time unit: MONTHLY
  - Showing period: RANGE, 2018 – 12 for both upper and 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).

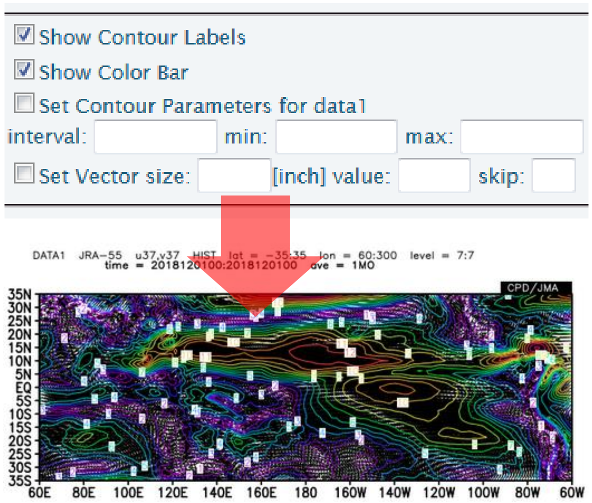
- Graphic Options
  - Set Vector size: 1 [inch] value: 20 skip: 5

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)



(b)



(c)

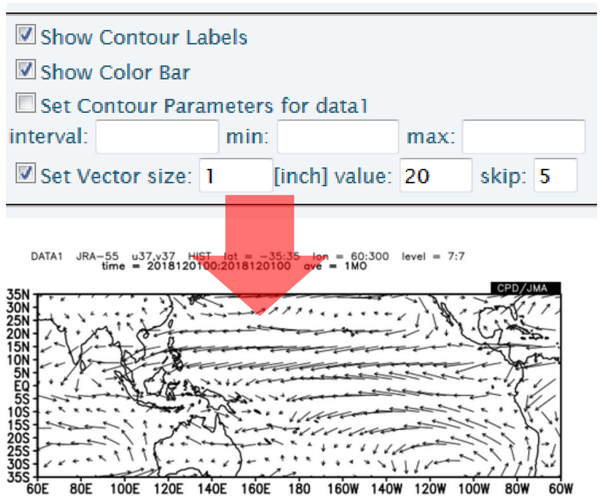


Fig.8 Parameter settings for making 850 hPa wind vectors for December 2018 and their corresponding maps

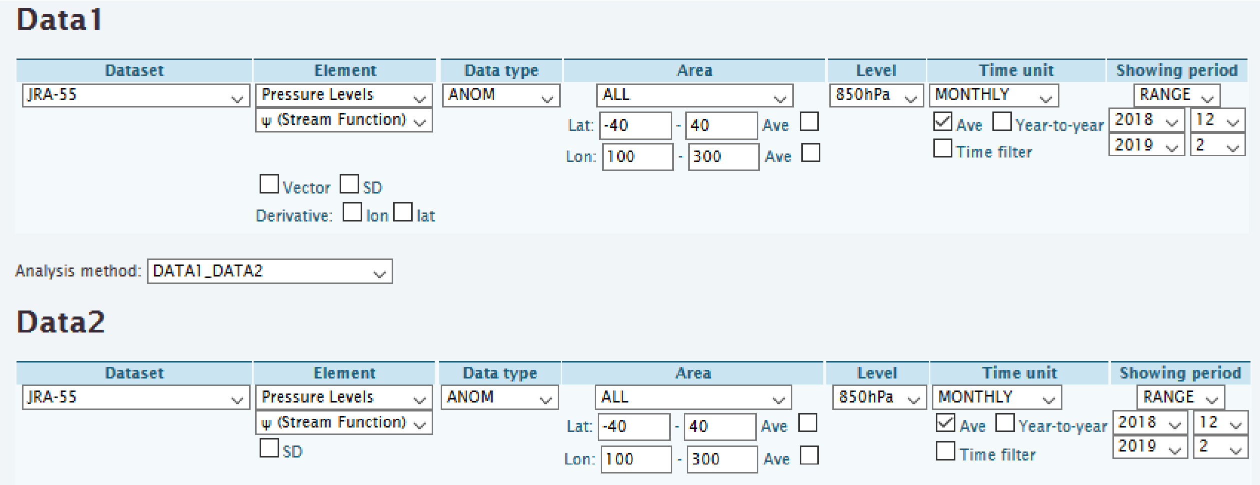
3.3. Overlaying two data

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 850-hPa stream function and its anomalies from December 2018 to February 2019 on a map. Set parameters on “Data1” and “Data2” box as shown below (See also Fig.9a).

- Data1
  - Dataset: JRA-55.
  - Element: Pressure Levels → ψ (Stream Function).
  - Data type: ANOM.
  - Area: Lat: -40 – 40, Lon: 100 – 300 (40°S – 40°N, 100°E – 60°W).
  - Level: 850 hPa.
  - Time unit: MONTHLY, check “Ave” box to calculate three-month mean.
  - Showing period: RANGE, 2018 – 12 for upper box and 2019 – 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:-5.5, max:5.5.



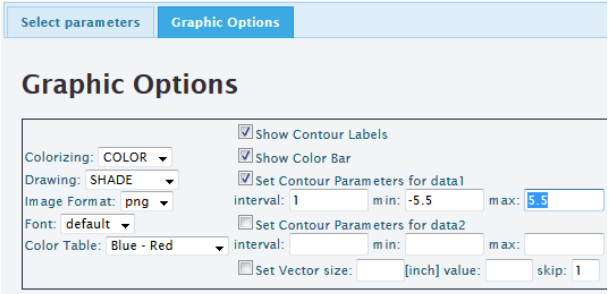


Fig.9a Parameter setting and graphic options to draw 850-hPa stream function and its anomalies map in DJF 2018/2019

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

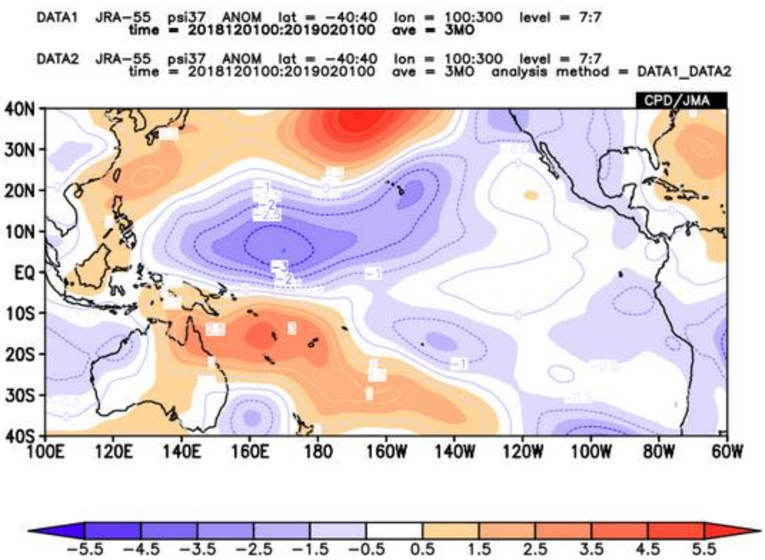


Fig.9b Image of 850-hPa stream function in DJF 2018/2019 created by the setting shown in Fig.9a

The Data1 will be mapped as shading, and Data2 is mapped as contour lines. As an exception, Data2 is mapped as shading when Data1 is mapped as the type of vector or streamline (not shown in this textbook).

3.4. Mapping the difference of two data

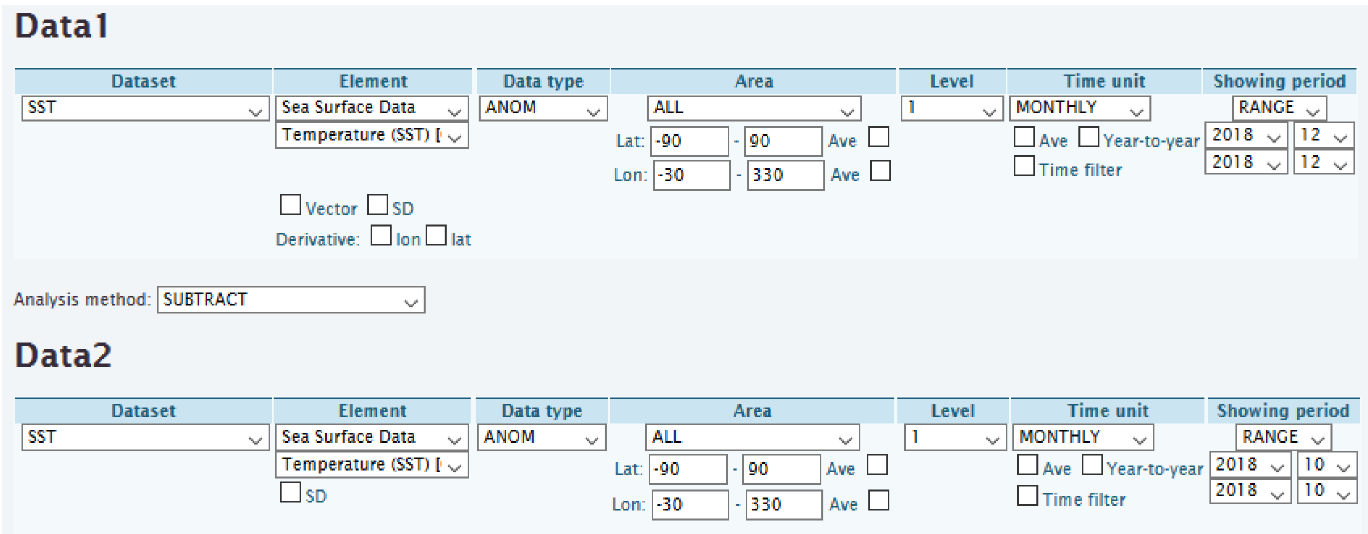
Users can calculate and map the difference of two data by using "SUBTRACT" analysis method. Let's chart monthly SST anomaly change from October to December 2018. Set parameters on "Data1" and "Data2" box as shown below (See also Fig.10a).

- 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, 2018 – 12 for both upper and lower boxes.

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

- Data2
  - Showing period: RANGE, 2018 – 10 for both upper and lower boxes.
  - Other parameters are the same as Data1.
- Graphic Options
  - 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.



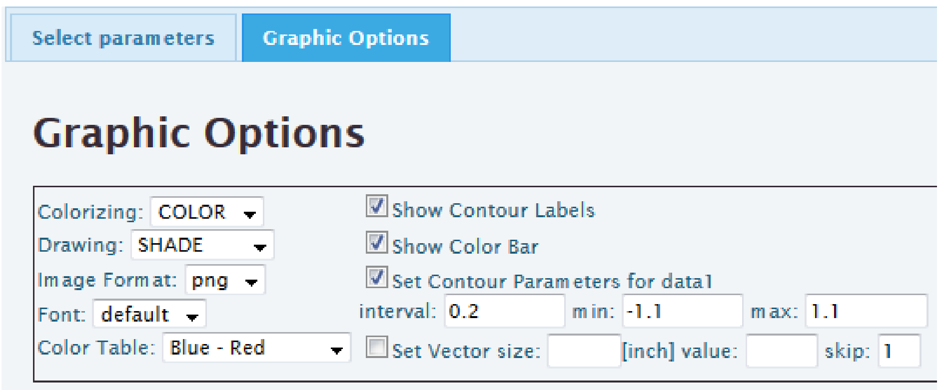


Fig.10a Parameter setting and graphic options to draw monthly SST anomaly difference between October and December 2018

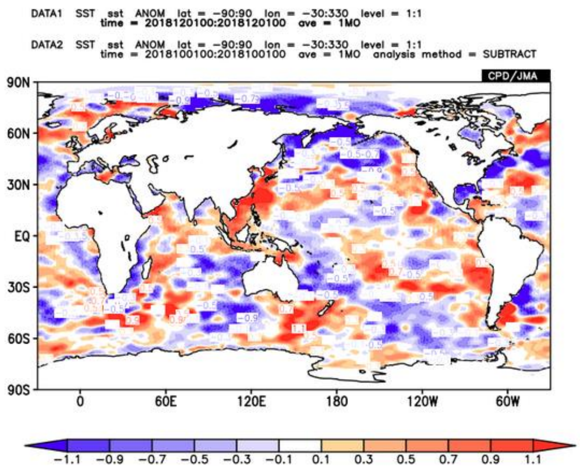


Fig.10b Image of SST anomaly change from October to December 2018 created by the setting shown in Fig.10a

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. Advanced operations

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.

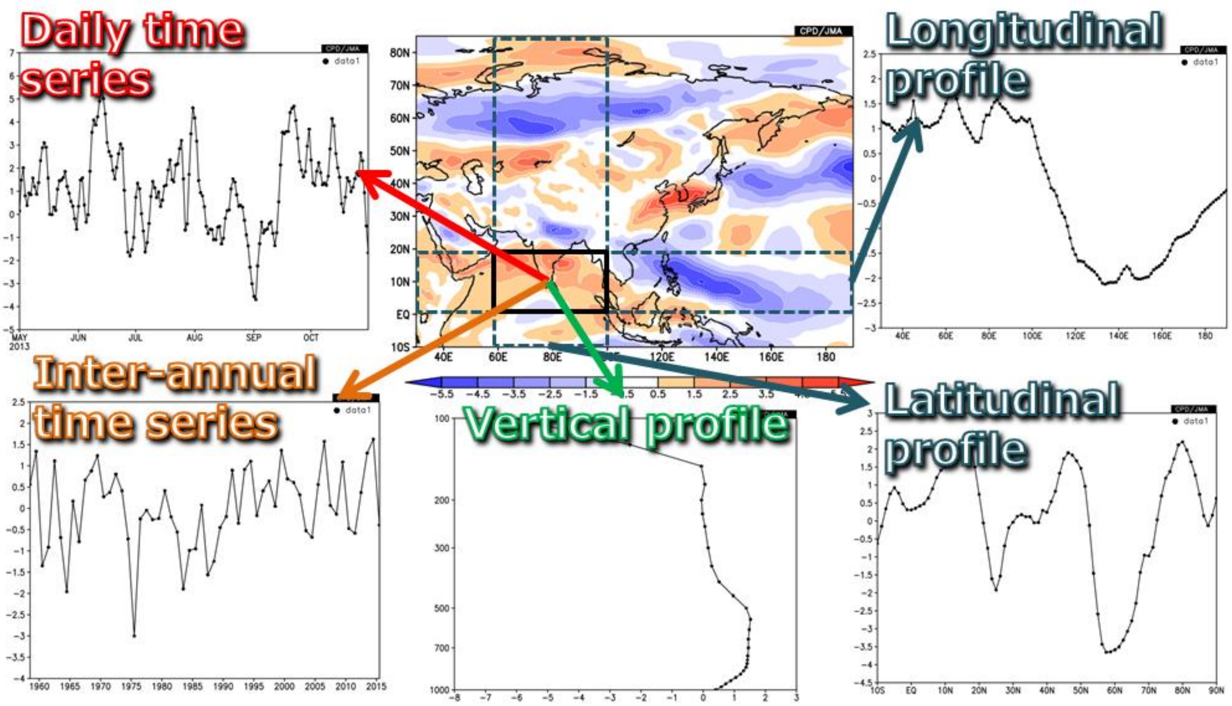


Fig.11 Example of time-series graphs available on iTacs

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: 2019 – 5 – 1 (from 1 May 2019),
  - Lower box: 2019 – 8 – 31 (to 31 August 2019).

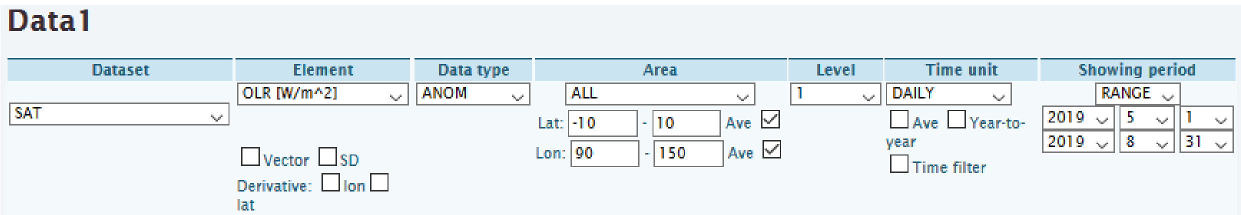


Fig.12a Parameter setting on iTacs to draw time-series of OLR anomalies from 1 May to 31 August 2019

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

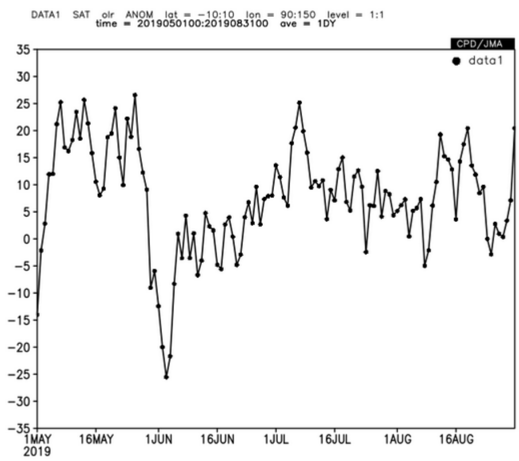


Fig.12b Daily time-series of OLR anomalies created by the setting shown in Fig.12a

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.12b, 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: 2010 – 2019, Month: 5 – 8 (MJJA mean from 2010 to 2019).

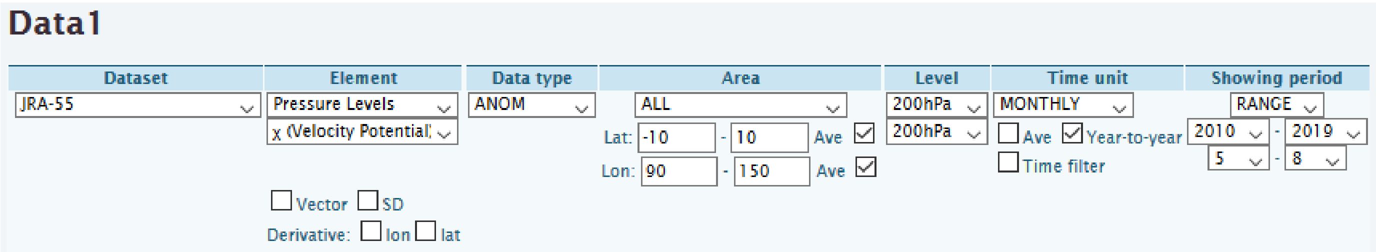


Fig.13a Parameter setting on iTacs to draw inter-annual time-series of four-month (May – August) averaged 200-hPa velocity potential anomalies over and around the Maritime Continent from 2010 to 2019

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

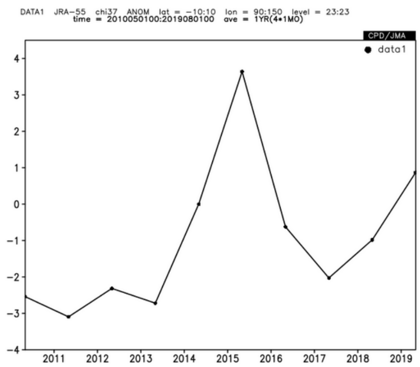


Fig.13b Inter-annual time-series of 200-hPa velocity potential anomalies created by the setting shown in Fig.13a

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 – 10 hPa.

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

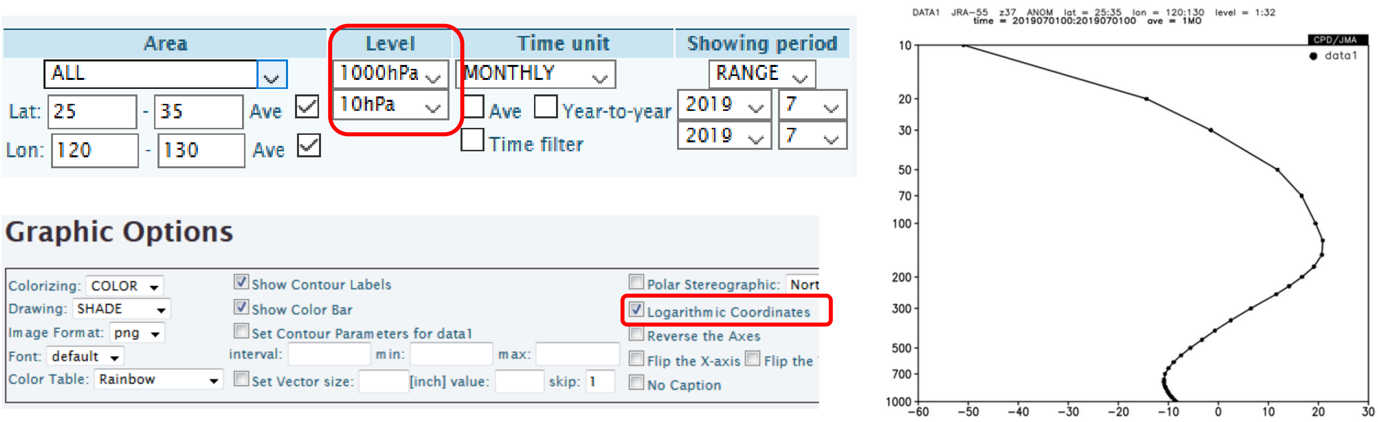


Fig.14 Example of parameter setting and the figure to draw a vertical profile of height anomalies

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.

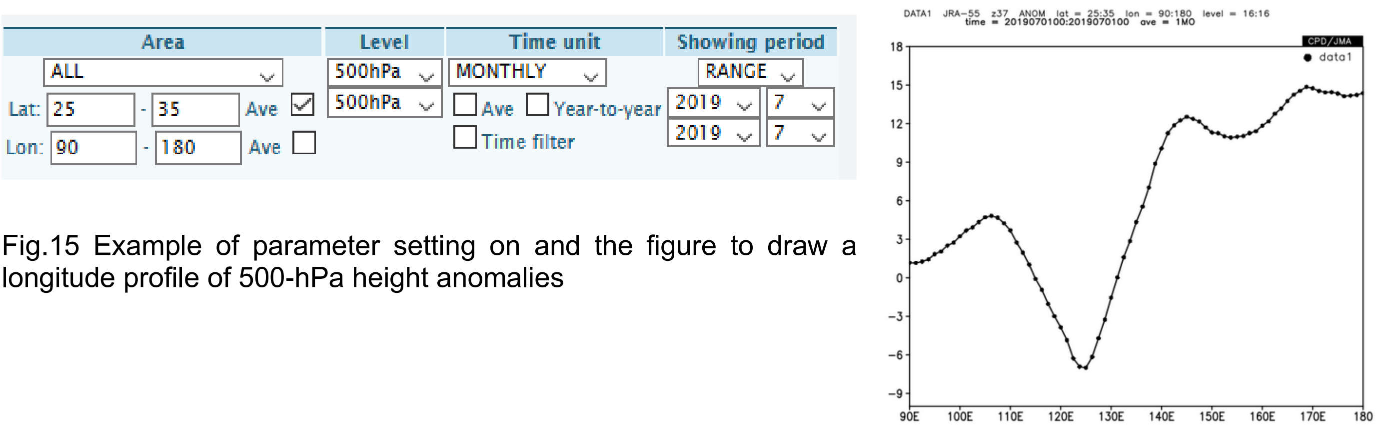


Fig.15 Example of parameter setting on and the figure to draw a longitude profile of 500-hPa height anomalies

4.3. Cross section diagram

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

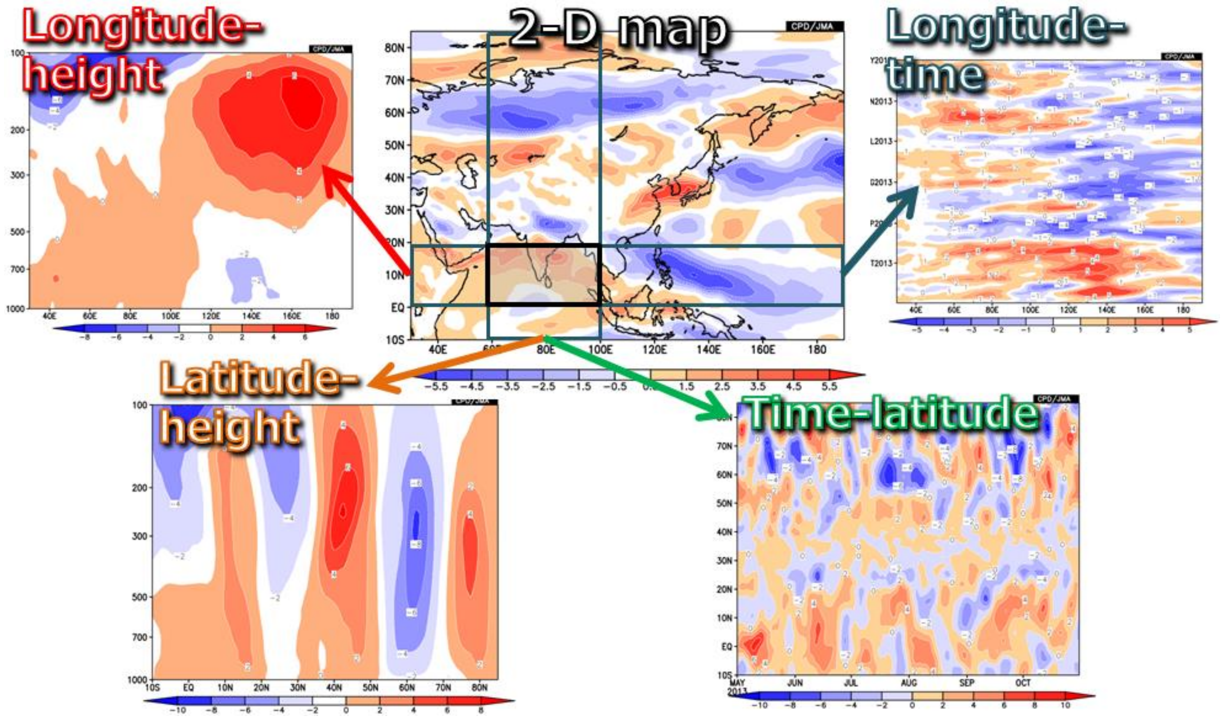


Fig.16 Example of cross section diagrams available on iTacs

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.

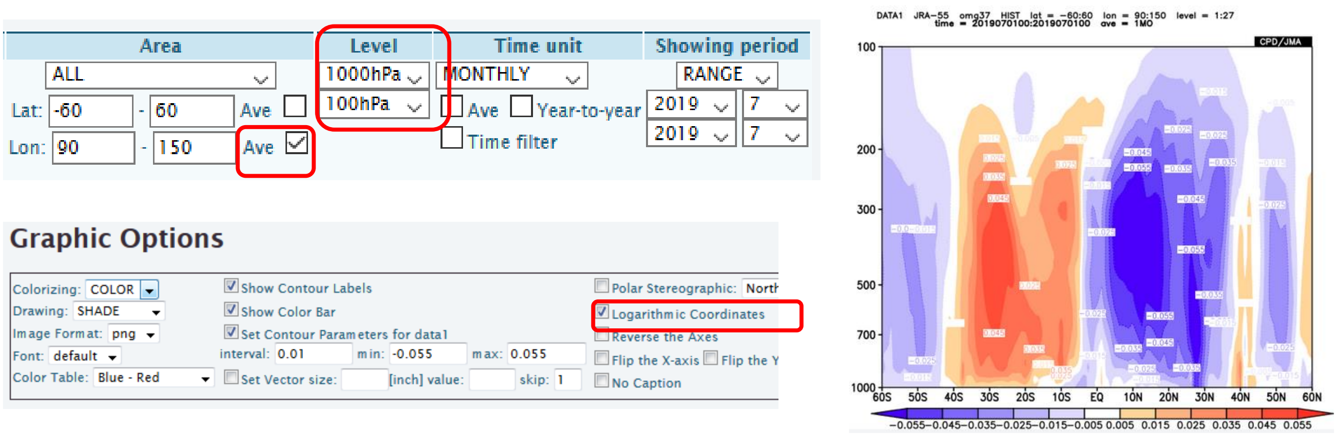
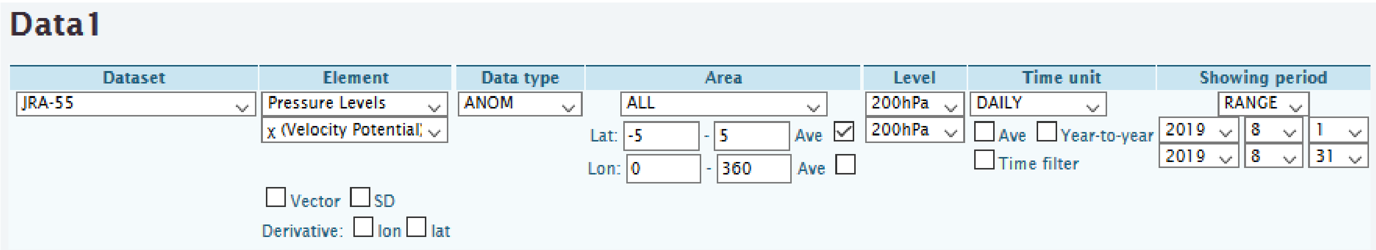


Fig.17 Example of parameter setting and the figure to draw a vertical cross section of normal pressure vertical velocity

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: 2019 – 8 – 1 (from 1 August 2019),
  - Lower box: 2019 – 8 – 31 (to 31 August 2019).
- <u>Graphic Options</u>
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:3, min:-15, max:15.



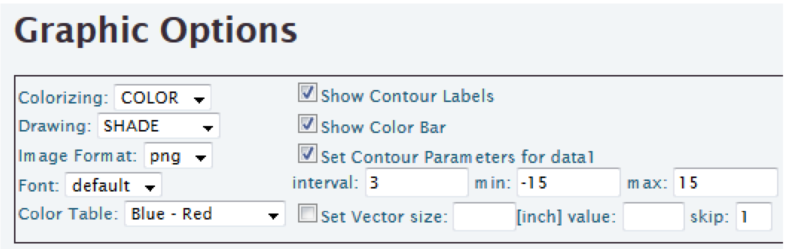


Fig.18a Parameter setting and graphic options to draw a longitude-time cross section of 5°S – 5°N mean 200-hPa velocity potential anomalies during the period from 1 August to 31 August 2019

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

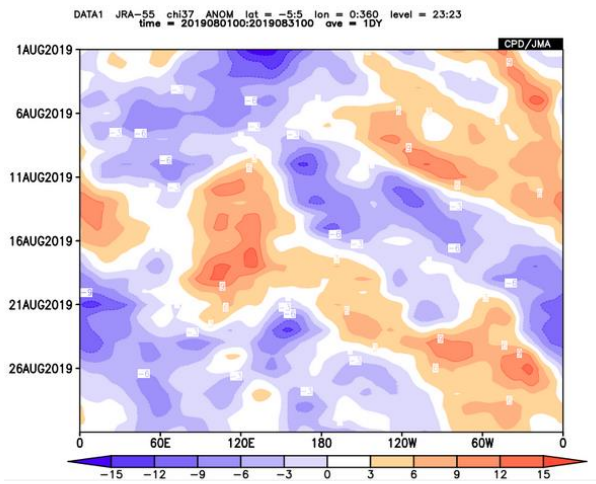


Fig.18b Longitude-time cross section diagram (it is a so-called “Hovmöller diagram”) created by the setting shown in Fig.18a

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).

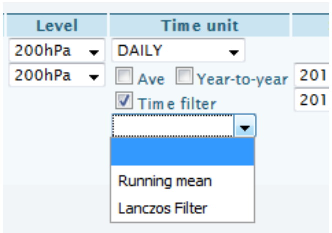


Fig.19 Two types of time filtering function on iTacs

Using "Running mean" function, users can make smoothed time-series graphs as shown in Fig.20a.

- 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.

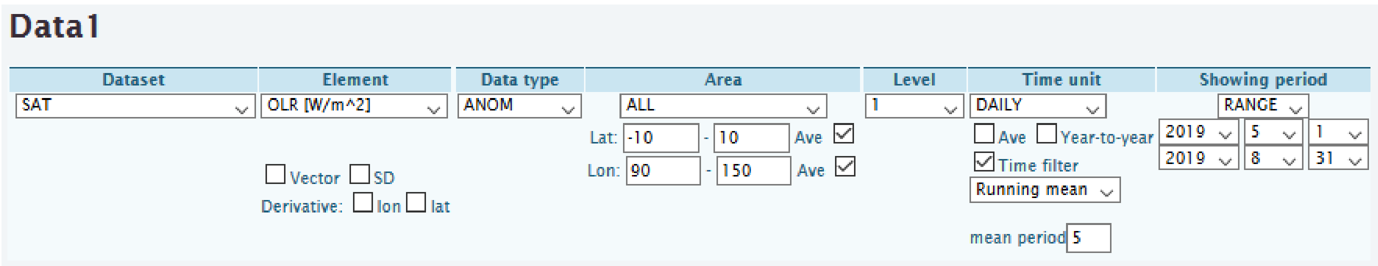


Fig.20a As for Fig.12a, but parameter setting for 5-day running mean

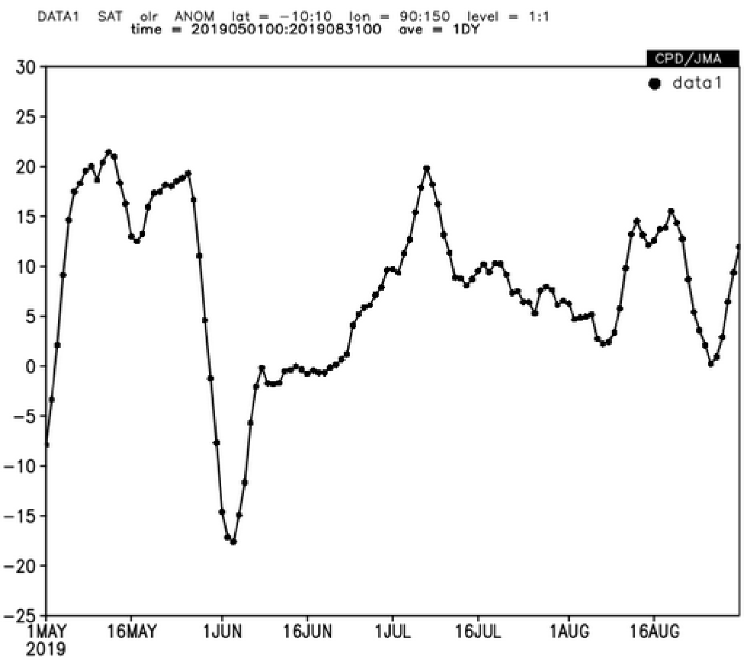


Fig.20b As for Fig.12b, but smoothed by 5-day running mean created by the setting shown in Fig.20a

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.

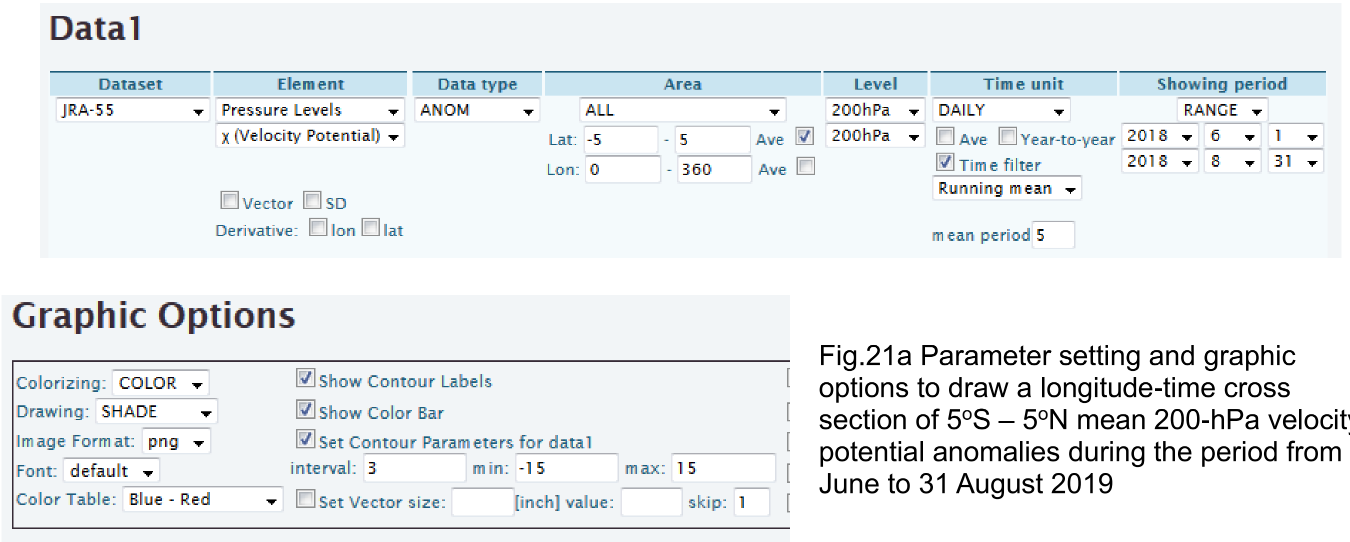


Fig.21a Parameter setting and graphic options to draw a longitude-time cross section of 5°S – 5°N mean 200-hPa velocity potential anomalies during the period from 1 June to 31 August 2019

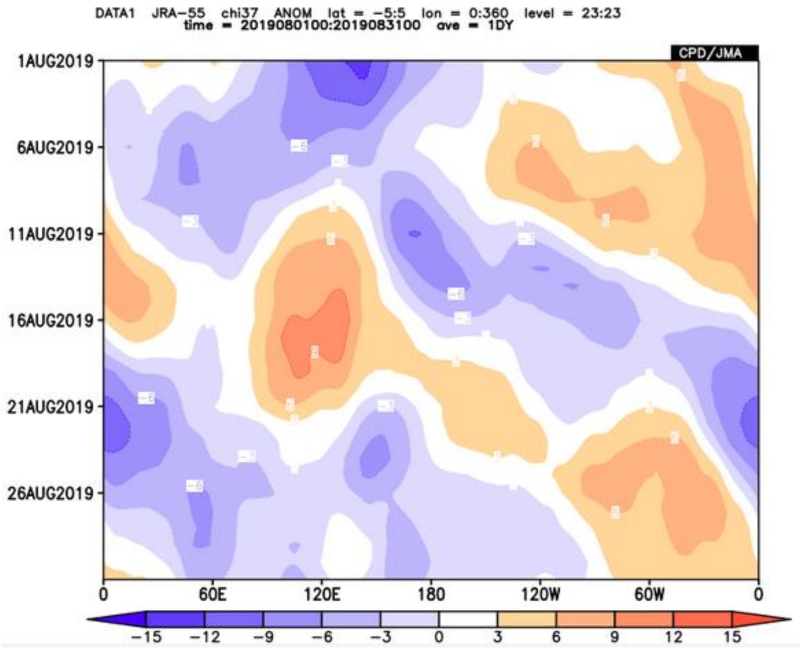


Fig.21b Same as Fig.18b, but smoothed by 5-day running mean created by the setting shown in Fig.21a

5. Statistical Analysis

Following statistical analyses are available on iTacs.

- Regression/correlation analysis.
- Composite analysis.
- Single/multi EOF, Singular Value Decomposition (SVD) analysis.
- Fast Fourier Transform (FFT) analysis.
- Wavelet analysis

These methods can be powerful to consider and understand climate system. However, it should be noted that their statistical results don't always mean the existence of physical system or structures in targeted data, because statistics is just a matter of mathematics. We need physical interpretation after statistical analysis.

In this text, regression/correlation analysis and composite analysis are described. These methods are frequently used to analyze the relationships between two data like temperature in a region and ENSO.

5.1. Regression and Correlation analysis

Regression and correlation analysis are often used to examine the circulation pattern related to the focused one-dimensional time-series. Correlation coefficient means the degree of the correlation (that's to say, how close they have a linear relationship), and the regression coefficient means the gradient of the regression line.

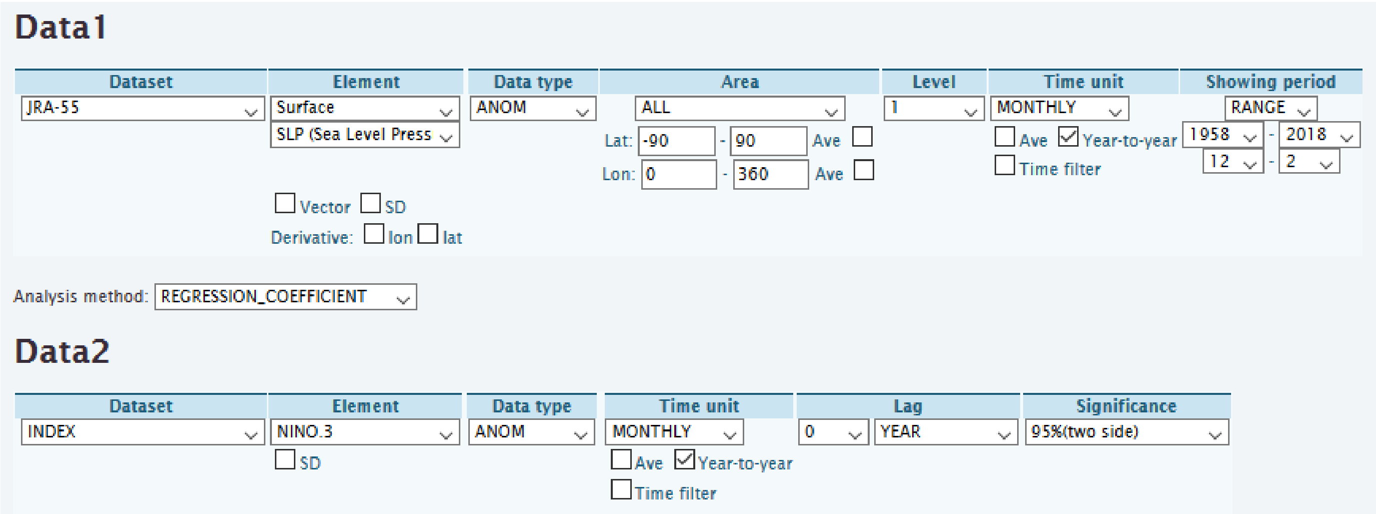
As an example, let's make a regression coefficient map of sea level pressure (SLP) anomaly onto NINO.3 SST index for boreal winter (December to February) mean from 1958/1959 to 2018/2019. Set parameters on "Data1" box as shown below.

- Data1
  - Dataset: JRA-55.
  - Element: Surface → SLP (Sea Level Pressure).
  - Data type: ANOM.
  - Area: Lat: -90 – 90, Lon: 0 – 360.
  - Level: 1.
  - Time unit: MONTHLY, Check "Year-to-year" box in regression or correlation analysis.
  - Showing period: RANGE, 1958 – 2018 for upper box and 12 – 2 for lower box.

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

- Data2
  - Dataset: INDEX.
  - Element: NINO.3.
  - Data type: ANOM.
  - Time unit: MONTHLY, Check "Year-to-year" box in regression or correlation analysis.
  - Lag: 0 YEAR. (In this example, simultaneous regression is calculated)
  - Significance: 95% two side. (significance test using student's t-test)

- Graphic Options
  - Drawing:CONTOUR
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:0.2, min:-1, max:1.



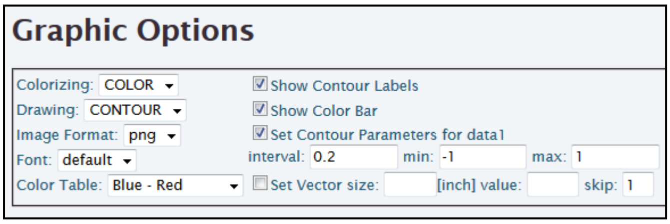


Fig. 22a Parameter setting and graphic options to draw regression coefficient and significance of SLP onto NINO.3 index for DJF 1958/1959 to 2018/2019

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

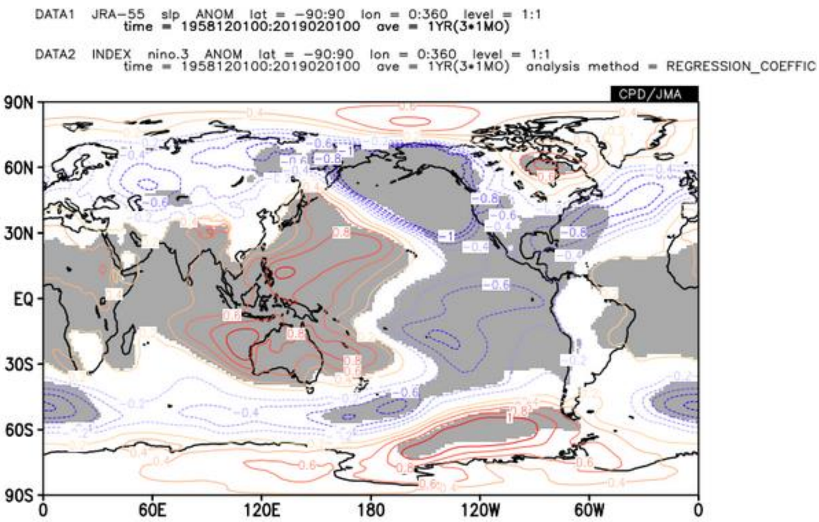


Fig. 22b Regression coefficient of SLP onto NINO.3 index for DJF 1958/1959 to 2018/2019 created by the setting shown in Fig. 22a. Statistical significance 95% or higher is also indicated by gray shading.

The regression coefficient will be mapped as contour, and the area where regression coefficient is significant at a given (in this case, 95%) confidence level is marked as gray shading.

Correlation analysis can be done by almost the same process but select “CORRELATION_COEFFICIENT” from the “Analysis method” box.

5.2. Composite analysis

Users can calculate and map the composite data by using "COMPOSITE" analysis method. Let's make a composite map of 3-month mean zonal wind anomaly at 850hPa for December-January-February when SST anomaly in NINO.3 region was larger than +0.5. In this time, target period is from 1958/1959 to 2018/2019. Set parameters on "Data1" and "Data2" box as shown below (See also Fig.9a).

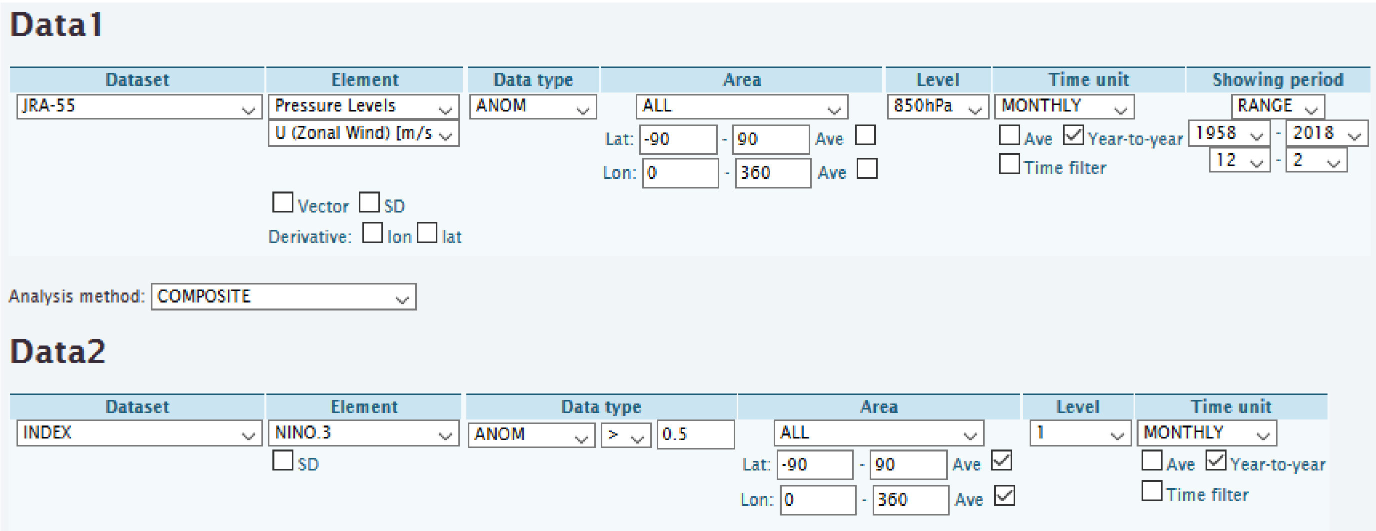
- Data1
  - Dataset: JRA-55.
  - Element: Pressure Levels → U (Zonal Wind).
  - Data type: ANOM.
  - Area: Lat: -90 – 90, Lon: 0 – 360 (90°S – 90°N, 0° – 360°E).
  - Level: 850hPa.
  - Time unit: MONTHLY, Check "Year-to-year" box.
  - Showing period: RANGE, 1958 – 2018 for upper box and 12 – 2 for lower box.

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

- Data2
  - Dataset: INDEX
  - Element: NINO.3
  - Data type: ANOM. > 0.5
  - Area: Lat: -90 – 90, Lon: 0 – 360.
    - Check "Ave" box in both "Lat" and "Lon" fields to calculate area-averaged value. Actually, any area is OK in this case because INDEX depends on only time.
  - Level: 1
  - Time unit: MONTHLY, Check "Year-to-year" box.

- Graphic Options
  - Drawing: SHADE
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:0.5, min:-3, max:3.

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



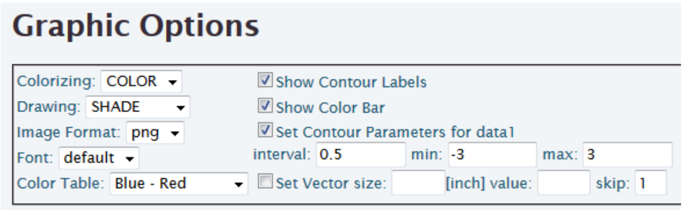


Fig. 23a Parameter setting and graphic options to draw the composite map of 3-month mean zonal wind anomaly for December-January-February when SST anomaly in NINO.3 region was larger than +0.5.

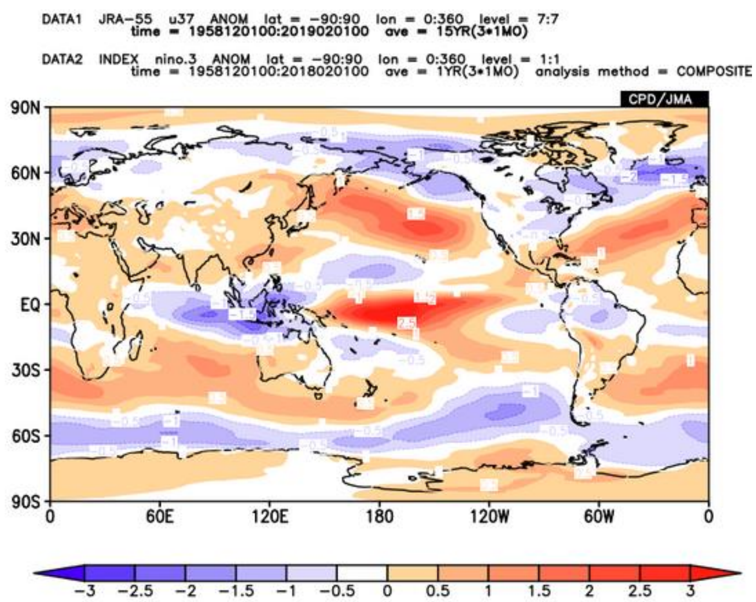


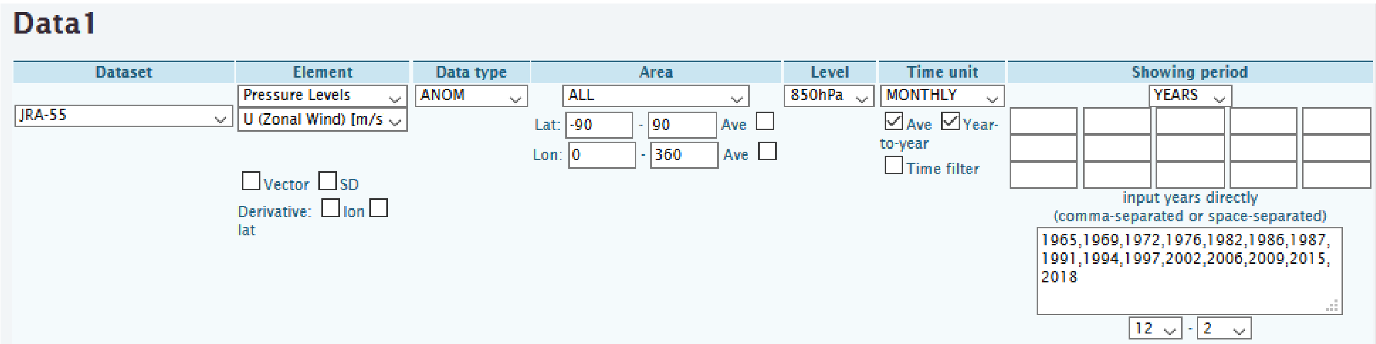
Fig. 23b Composite map of zonal wind anomaly at 850hPa in DJF created by the setting shown in Fig. 23a

If you know the compositing years already, you can make composite maps by another way. As an example, let's make the same figure as Fig. 23b again but by the different method.

- <u>Data1</u>
  - Dataset: JRA-55.
  - Element: Pressure Levels →U (Zonal Wind).
  - Data type: ANOM.
  - Area: Lat: -90 – 90, Lon: 0 – 360 (90°S – 90°N, 0° – 360°E).
  - Level: 850hPa.
  - Time unit: MONTHLY, Check "Ave" and "Year-to-year" box.
  - Showing period: YEARS. Input following years in each small box or in large box with comma-separated or space-separated format.
    - 1965,1969,1972,1976,1982,1986,1987,1991,1994,1997,2002,2006,2009,2015,2018
    - Select 12 for the left box and 2 for the right box.

- <u>Graphic Options</u>
  - Drawing: SHADE
  - Color Table: Blue – Red.
  - Set Contour Parameters for data1: interval:0.5, min:-3, max:3.

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



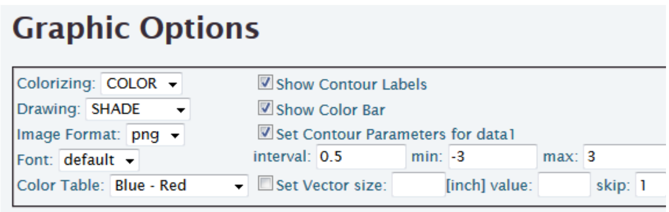


Fig. 24 Parameter setting and graphic options to draw the composite map of 3-month mean zonal wind anomaly for December-January-February when SST anomaly in NINO.3 region was larger than +0.5. This is another way for making Fig. 23b.

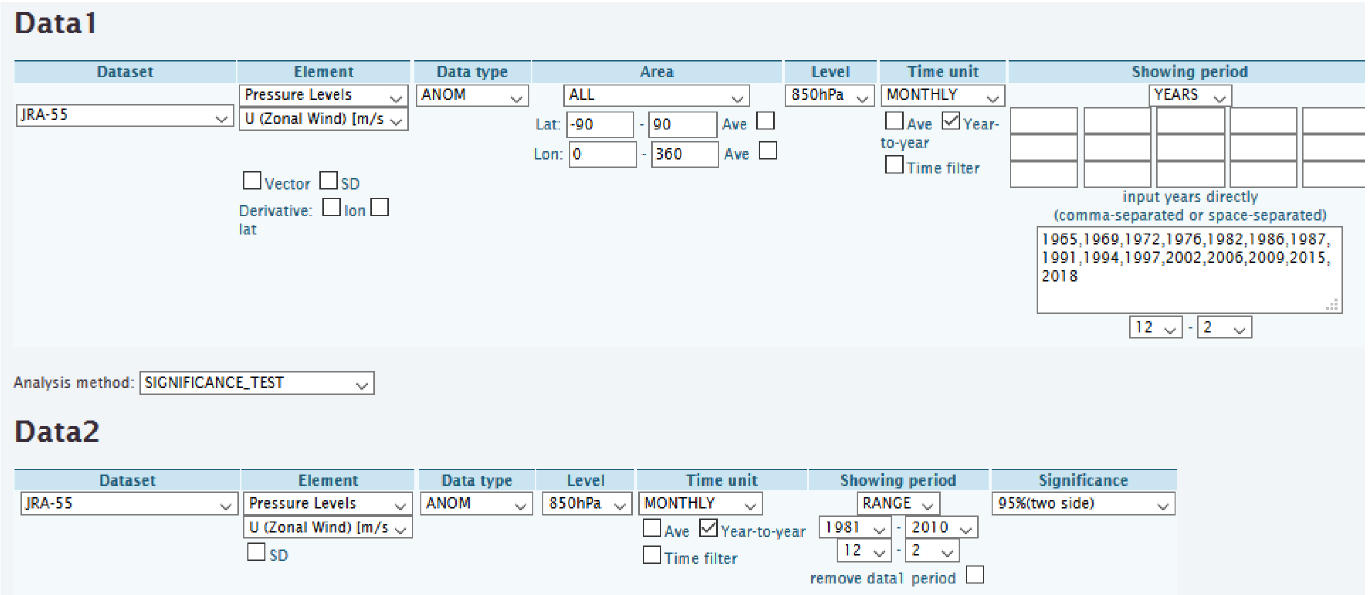
If you want to draw composite map using anomaly relative to default (1981-2010 mean) climatology, significance of the composite anomaly can be drawn using "SIGNIFICANCE_TEST" analysis.

- Data1
  - Time unit: MONTHLY, Check "Year-to-year" box. Uncheck "Ave" box.
  - Other parameters are the same as previous example.

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

- Data2
  - Showing period: RANGE, 1981 – 2010 for upper box and 12 – 2 for lower box.
  - Significance: 95% (two side).
  - Other parameters are the same as Data1.
- Graphic Options
  - Drawing:CONTOUR
  - Other parameters are the same as previous example.

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



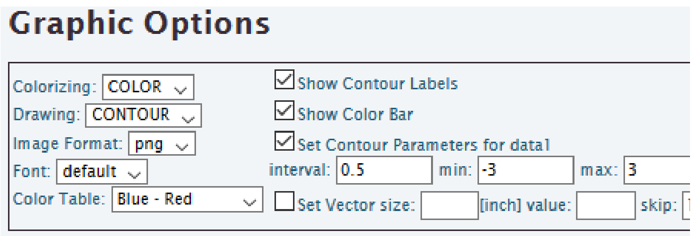


Fig. 25a Another way for making Fig. 23b with significance of the composite anomaly.

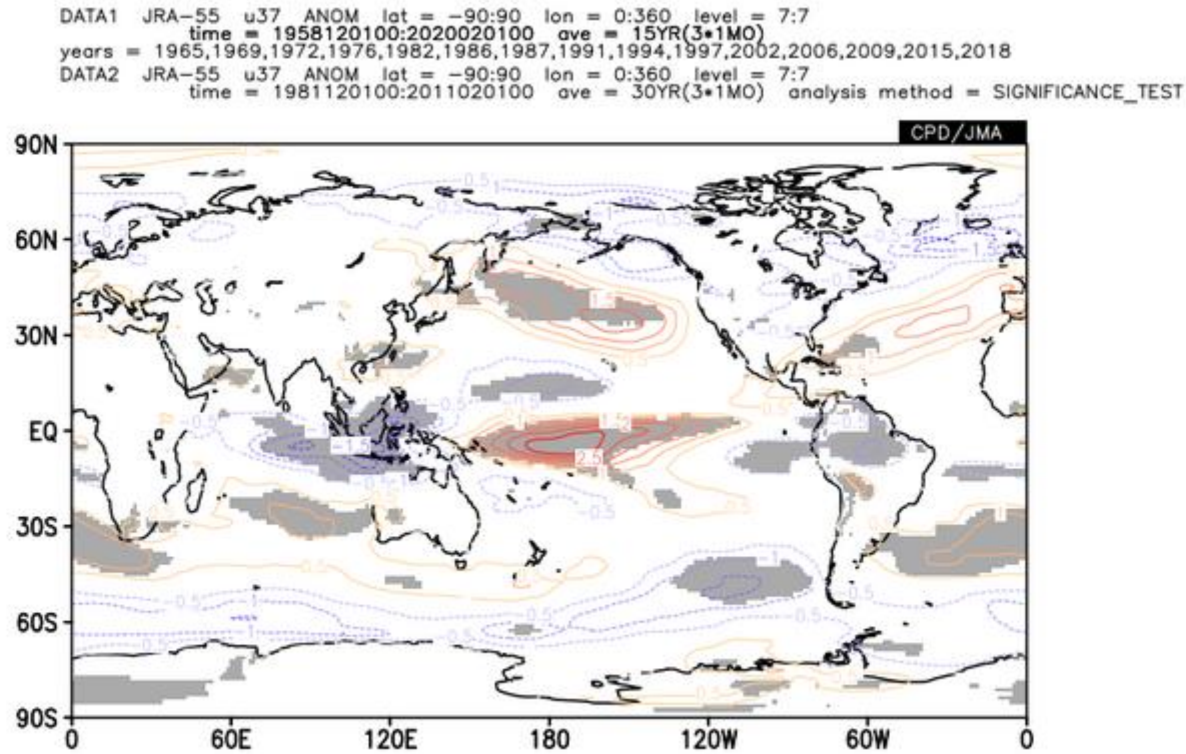


Fig. 25b Image of stream function anomaly at 850hPa composite for post-El Niño July with 95% confidence level marked by gray shading created by the setting shown in Fig. 25a

CAUTION: In “SIGNIFICANCE_TEST” analysis, “DATA1” is composited, not “difference between DATA1 and DATA2”. Therefore, if you want to draw composite map of deviation relative to reference value except default climatology (1981-2010 average), this method cannot be used. For example, if you change the period of DATA2 to “1971-7 to 2000-7” in the above example, the contour would indicate the composite of anomaly (relative to 1981-2010 climatology) and gray shading would indicate the significance of deviation relative to 1971-2000 average, and the figure might be misleading.

6. Other Functions

6.1. Data download

Users can download data as a zip compressed file with a plain text and GrADS format (control file and data file) to create a map. If you need to download data, please click "Download text zip file" or "Download data (ctl file and 4-byte-binary data)" at the bottom of the iTacs window.

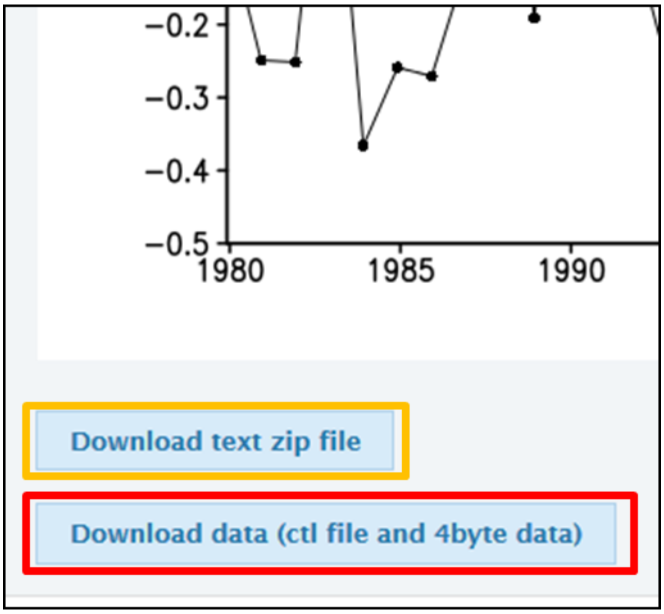


Fig. 26 Screenshot of banners for download data from iTacs.

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6.2. Using user input data

Time series data made by individual users can be used in a dataset name "USER_INPUT". Using this function, a correlation or regression coefficient map between single station data or user's original index and another dataset like JRA-55 can be created, for example.

There are two ways to set data, which can be selected in element name.

- UPLOAD_TXT : Data are given by an uploaded text file.
- INPUT_DATA : Data are directly input to the box.

Input data must be consists of one element, separated by comma and given by specified format as "year, month, day, value". In case of monthly data, "day" is always given as "1". Similarly, in case of annual data, "month" and "day" are always given as "1".

Sentences beginning with "#" have special meanings as below. Other sentences beginning with "#" is taken as comments and not used in analysis.

- "#undef =" : Definition of missing data (default is -9999). For example, "#undef=-9999"
- "#element =" : Data name used to save them on the server. For example, "#element=Daily Ts"

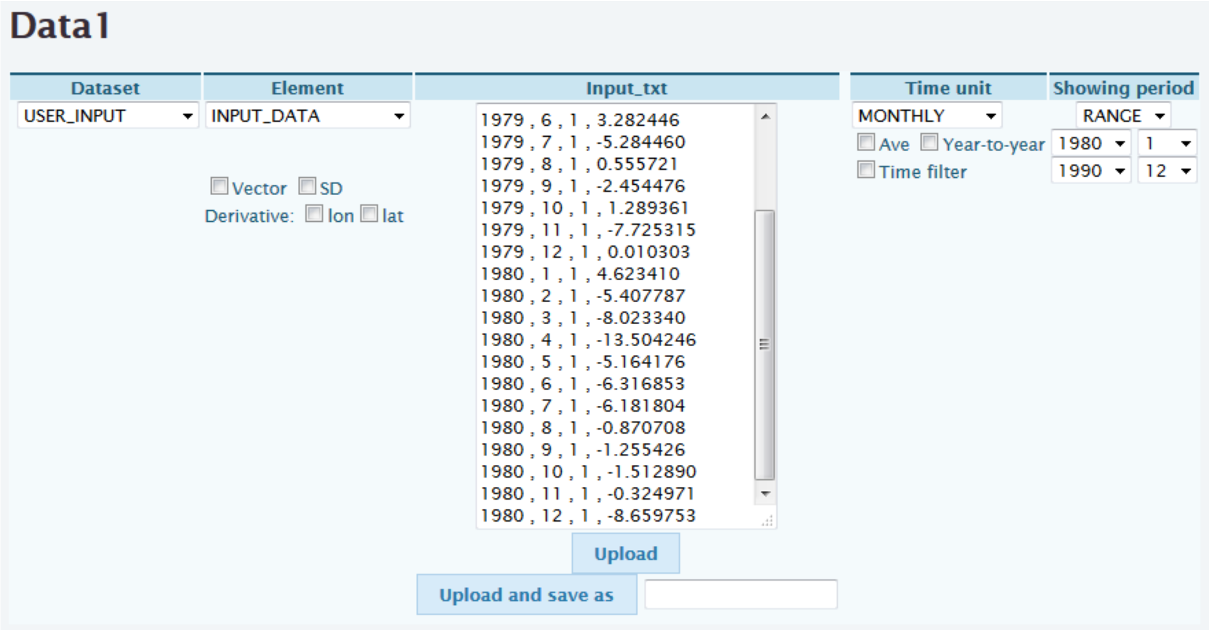

Fig. 27 A screen image when monthly time series data is input with “INPUT_DATA”.

References

- ✓ Duchon, C. E., 1979: Lanczos Filtering in One and Two Dimensions, *J. Applied Met.*, **18**, 1016-1022.
- ✓ Ishii, M., A. Shouji, S. Sugimoto, and T. Matsumoto, 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, S., Y. Ota, Y. Harada, A. Ebita, M. Moriya, H. Onoda, K. Onogi, H. Kamahori, C. Kobayashi, H. Endo, K. Miyaoka, and K. Takahashi, 2015: The JRA-55 Reanalysis: General Specifications and Basic Characteristics. *J. Meteorol. Soc. Japan*, **93**, 5-48.
- ✓ Toyoda, T., Y. Fujii, T. Yasuda, N. Usui, T. Iwao, T. Kuragano, and M. Kamachi, 2013: Improved Analysis of Seasonal-Interannual Fields Using a Global Ocean Data Assimilation System, *Theoretical and Applied Mechanics Japan*, **61**, 31-48.

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
		KE (Kinetic energy of high-frequency variation)	m^2/s^2
	Flux	Wvf-x (Zonal water vapor flux)	kg/kg m/s
		Wvf-y (Meridional water vapor flux)	kg/kg m/s
		Div-wvf (Divergence of water vapor flux)	kg/kg/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
		Wss (Surface horizontal wind speed)	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
		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
		Zonal wind	m/s
		Meridional wind	m/s
	Surface	Surface temperature	ºC
		Surface pressure	hPa
		Rain	mm/day