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Correlation of sea-surface temperature (SST) with sea-ice concentration (SIC) between Subarea 48.6 and other areas such as Ross Sea, Weddell Sea

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Correlation of Sea Surface Temperature (SST) with Sea Ice Concentration (SIC) between Subarea 486 and other areas such as Ross Sea, Weddell Sea

T. Namba, R. Sarralde,

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Abstract

Since the correlation of SST between Subarea 48.6 and Division 58.4.2 was reported in Namba et al. (WG-SAM-17/10), correlations of SIC between Subareas 48.6 and 88.1 (Ross Sea), Weddell Sea and the Sea off Peru were re-analyzed in this paper. There is some correlation of SIC between Subareas 48.6 and 88.1 with SST data from 2002-2019. In addition, the correlation of SST and SST shifted forward 6 months was analyzed and there was some negative correlation between Subarea 48.6 and the central part of the Pacific ocean. Wider phenomena such as the El Niño Southern Oscillation must influence the correlation.

1. Figure 1 shows the time series (2002-2019) of SST anomaly in 8 areas, namely 1. off Peru, 2. the whole subarea 48.6, 3. research block 48.6-2, 4. RB 48.6-4, 5. RB 48.6-5, 6. the subareas 88.1 and 7. 48.2 and 8. division 58.4.1. The location of the areas with monthly SIC are shown in Figure 1 (bottom right). The two latest "El Niño" events took place from summer in 2014 to spring in 2016 and from autumn in 2018 to spring in 2019, as shown in Figure 1. The SST of the sea off Peru fluctuated with larger amplitudes than other areas in the Antarctic and in the Pacific. There were similar trends of positive spikes both in RB 48.6-5 and in RB 48.6-2 for the last three years. There were also two positive spikes in Subarea 88.1 for the latest three years. There were no SST spikes in division 58.4.1 and subarea 48.2.

2. Data sources of sea surface temperature (SST) anomaly and sea ice concentration (SIC)
   The sea surface temperature (SST) is from the ERDDAP of NOAA (`https://coastwatch.pfeg.noaa.gov/erddap/index.html`). The SIC

is provided by the University of Bremen (https://seaice.uni-bremen.de/sea-ice-concentration/) based on the Advanced Microwave Scanning Radiometer 2 (AMSR2) and analyzed for the ice concentrations. The resolutions of the ice concentration of the AMSR2 are 3125m and 6250m/grid and (https://seaice.uni-bremen.de/data/amsr2/asi_daygrid_swath/s6250/2019/apr/Antarctic/,https://seaice.uni-bremen.de/data/amsr2/asi_daygrid_swath/s3125/2019/apr/Antarctic3125/).T SSTs used in this analysis are extracted with 1 degrees of grids from the center point of 0° ,10° ,20°, etc. in longitude and latitude. For the SICs used in this analysis, the locations used are plotted in figure 1(bottom).

3. Figure 2 shows the charts of SICs from 2014- 2019 both in Subarea 48.6 and 88.1 with SST anomalies. The lowest SICs for the latest 5 years was in the 2017/2018 season. The spatial distributions of SIC both in Subarea 48.6 and 88.1 were very similar to each other for the latest three years. The low of SICs corresponds well with the positive spikes of SST anomalies both in Subarea 48.6 and 88.1.

4. 3. Figure 3 shows the time series of daily SIC (top) and SST (bottom) both in Subarea 48.6 (blue) and 88.1 (light brown) from 2013-2019. Since January 2017 the SICs of Subarea 48.6 and 88.1 both in winter and summer have been lower than in 2016 which corresponds with the charts of SIC in Figure 2. In 2019, the SIC increased. Contrastingly, the SST anomalies have the opposite value to the SIC as the SST is the highest in summer and the lowest in winter. Since January 2017, the SST in Subareas 48.6 and 88.1 both in winter and summer have been higher than 2017. In 2019, the SST has been decreasing unlike the SIC trend. The SST of Subarea 48.6 has been 4~5 °C lower than in 88.1 even though the areas analyzed are almost at the same latitude.

5. Figure 4 shows the correlation between the SST anomalies of Subarea 48.6 and other stations in the world from 2002-2019. The data were sampled over 1° grid at 10 ° intervals in longitude and latitude. The

correlation decreases as the distances between Subarea 48.6 and other areas increases in meridional (East-West) direction, probably because oceanographic and atmospheric phenomena in meridional direction must be more dominant than in zonal (North-West) direction and because of the dominant zonal winds at 50-60° South. There are some correlations of Subareas 88.1 and 88.3 versus Subarea 48.6. The correlation of RB 48.6_5 in the south of the Weddell Sea versus Subarea 48.6 is stronger than RB 48.6_4 of the Southeastern part of Subarea 48.6. It is also reported in a WG -FSA-2019 document that the Subarea RB 48.6_4 is isolated from RB 48.6_5, _3 and _2 with respect to SST.

6. Figure 5 shows the correlation between the SST anomaly of Subarea 48.6 and other areas 6 months shifted forward from 2002-2019. The sampled data were averaged over 1° grid at 10° intervals in longitude and latitude. There is low correlation of stations 6 months shifted forward versus Subarea 48.6 compared to the correlation in Figure 4. Even in meridional direction, there is almost no correlation. On the contrary, there is some correlation between the central part of the Pacific Ocean versus Subarea 48.6. Rather large-scale oscillations such as El Niño Southern Oscillation (ENSO) may influence the correlation.

Conclusions

1. There were similar positive spikes of SST both in Subarea 48.6 and 88.1 for the latest three years which corresponds well with lower SICs. There were no spikes of SST in subarea 48.2 and division 58.4.1. There was a smaller amplitude of oscillation of SST in subarea 48.6 and some other areas in the Antarctic than in the sea off Peru. There were no positive or negative spikes in Subarea 48.2 and division 58.4.1.

2. The SICs of Subareas 48.6 and 88.1 correspond well with each other for the latest three years with low SICs and high SST. There were positive spikes since December 2016 for the latest three years and the spikes in

2019 became smaller.

3. Daily SICs and SST of both subarea 48.6 and 88.1 correspond well to each other as SICs and SSTs are opposite in value. The warmer trend of SST in both subarea 48.6 and 88.1 agrees with the lower SICs for the latest three years but the increase of SST is less pronounced in 2019 while the SIC become higher.

4. There is a positive correlation between Subareas 48.6 and 88.1 and there are more positive correlations along the meridional direction than along zonal direction because of the meridional dominant winds and currents. The correlation between 48.6-4 versus 48.6-3 is low as it is isolated from 48.6-5 and 48.6-3.

5. There is no significant positive or negative correlation of SST between other areas 6 months shifted forward. There seems to be some negative correlation between the SST of central part of the Pacific Ocean. The correlations may relate to larger scale phenomena like El Niño Southern Oscillation.

References

- T. Namba, T. Ichii and T. Okuda, 2017, Correlation of sea-surface temperature in Ross Sea, Weddell Sea and the sea off Peru for the ice analysis,WGFSA-17/08
- T. Namba, R. Sarralde, T. Ichii, T. Okuda, S. Somhlaba and J. Pompert, 2019, Possibility of the prediction for the sea ice concentration(SIC) of research block 5 of the southern part of Subarea 48.6 with sea surface temperature(SST) and SIC difference per day of research block 2 of the northern part, WGFSA-19

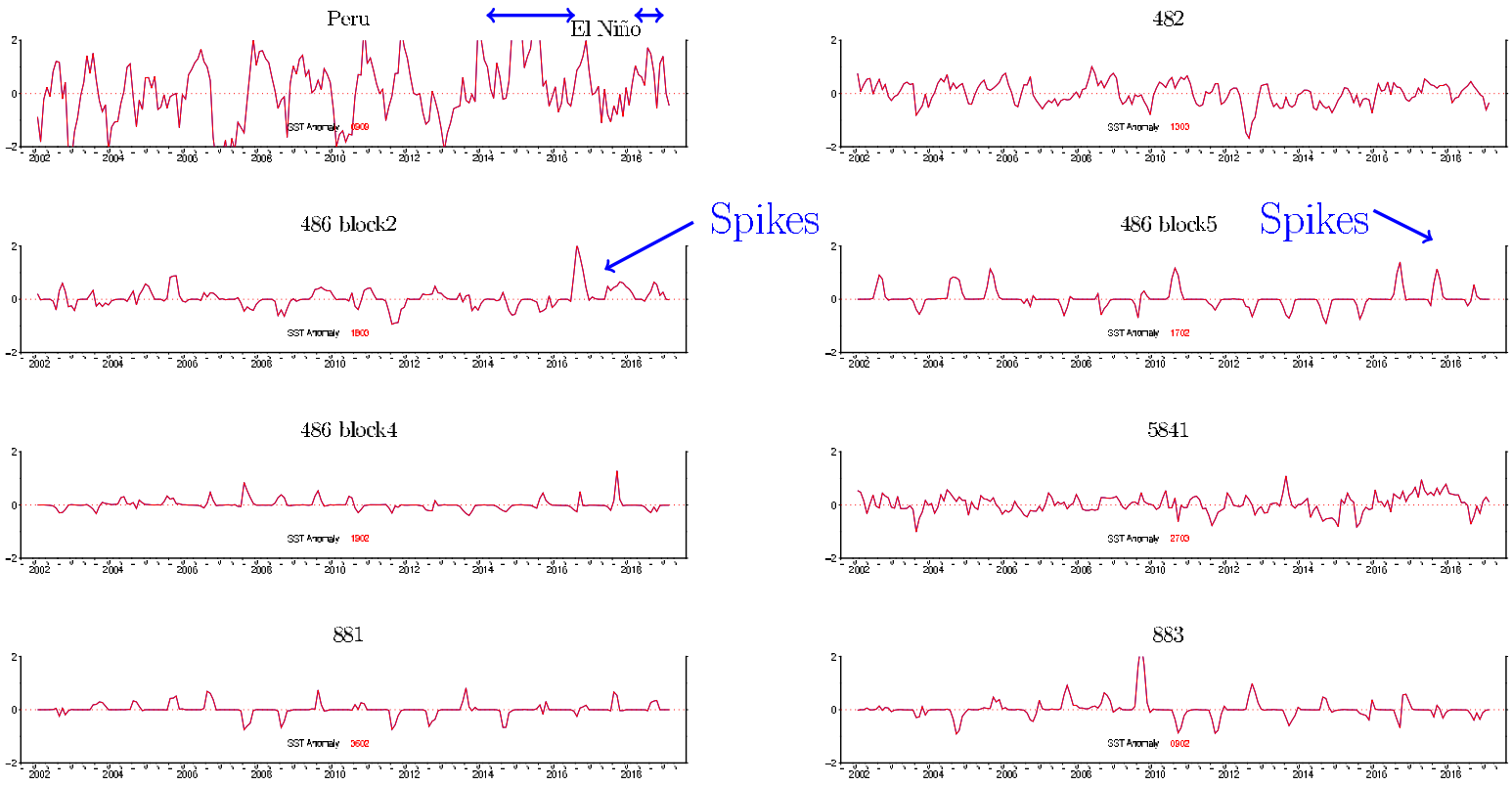
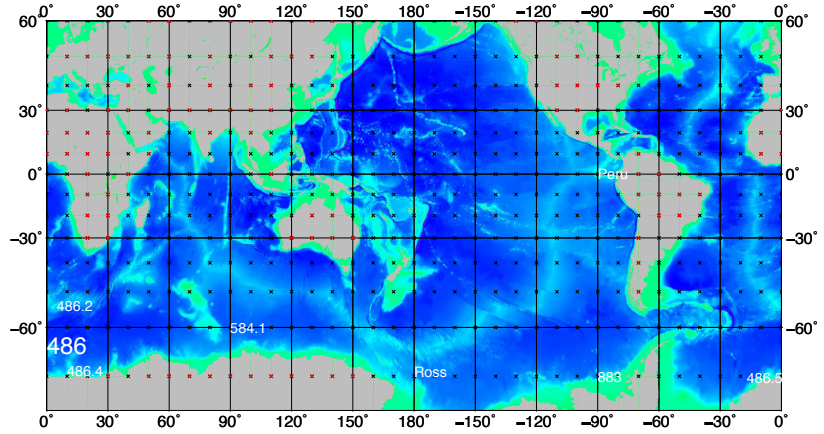


Figure 1. SST anomaly for 2002-2017 in 8 stations such as off Peru, Subarea 48.6, RB 48.6-2, 48.6-5, 88.1,c44.2 Disision 584.1 in the world. Each station is shown in the picture(right). The latest two El Niño events took place for as shown in the figure above.



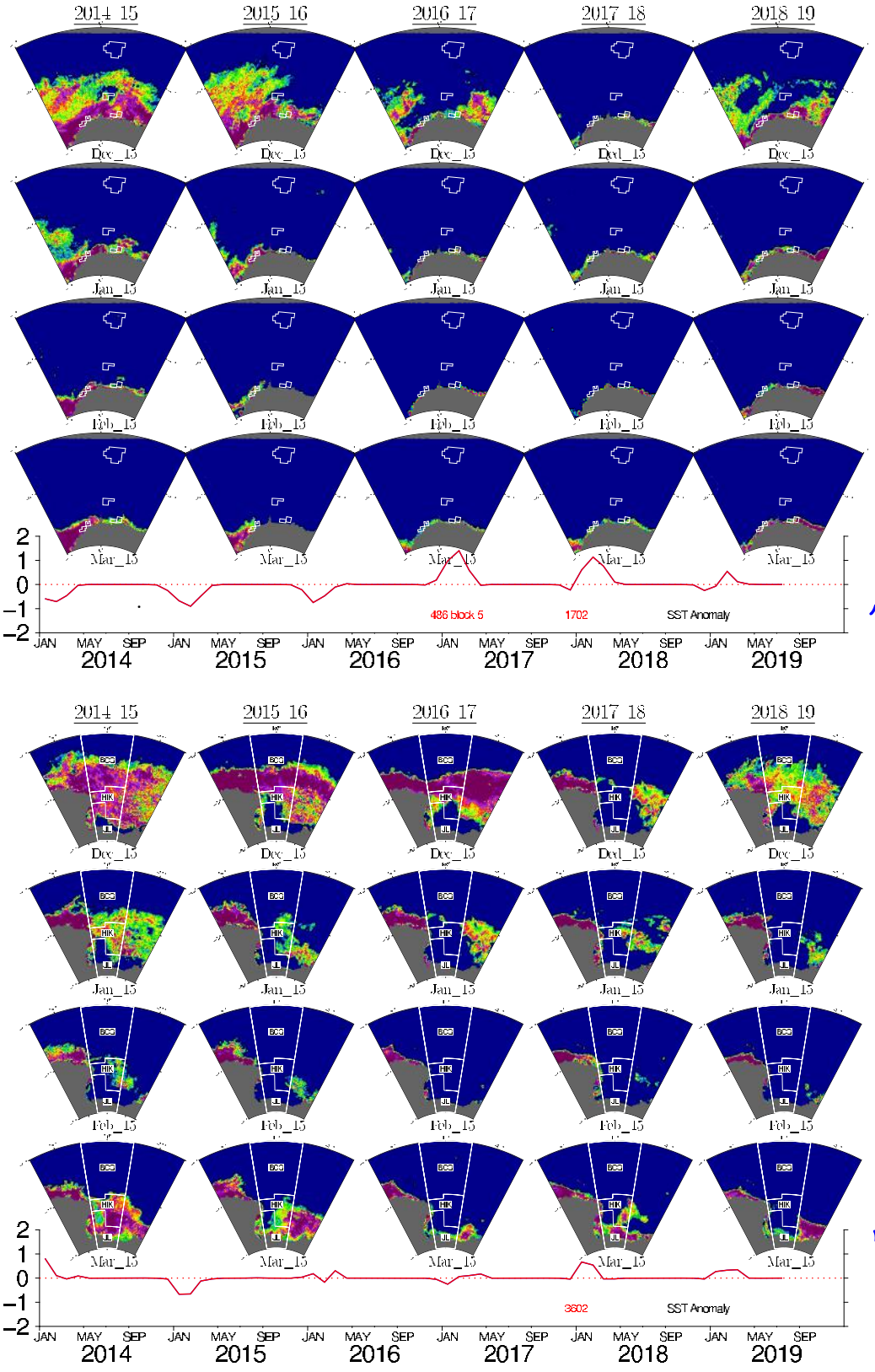


Figure 2 shows the charts of SIC from 2013-2019 both in Subarea 48.6 and 88.1 with SST anomalies.

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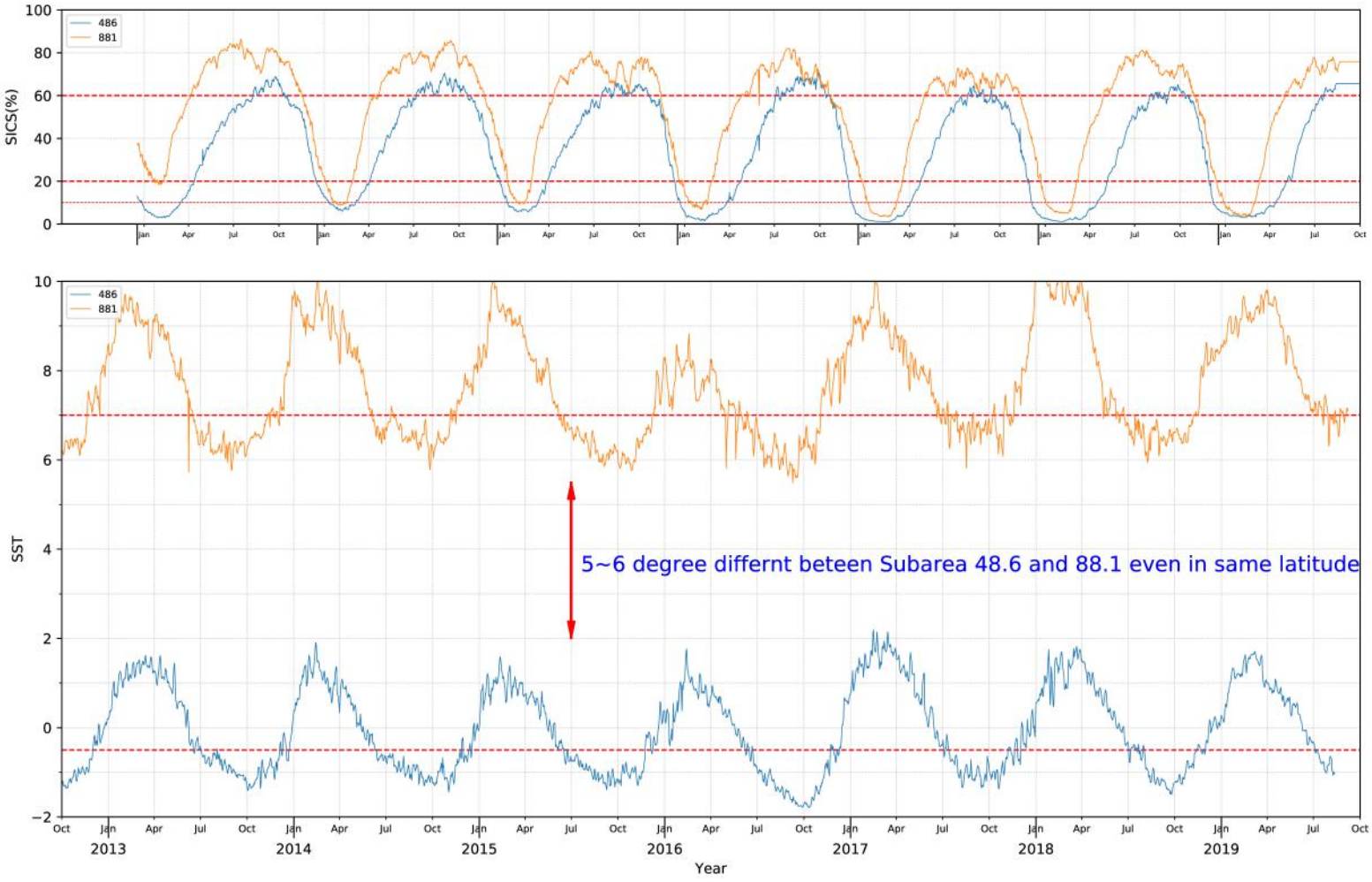

Figure 3 Figure 3 shows the time series of daily SIC(top) and SST(bottom) both in Subarea 48.6(blue) and 88.1(light brown) from 2013-2019. The areas of both 48.6 and 88.1 are shown in Figure 1.

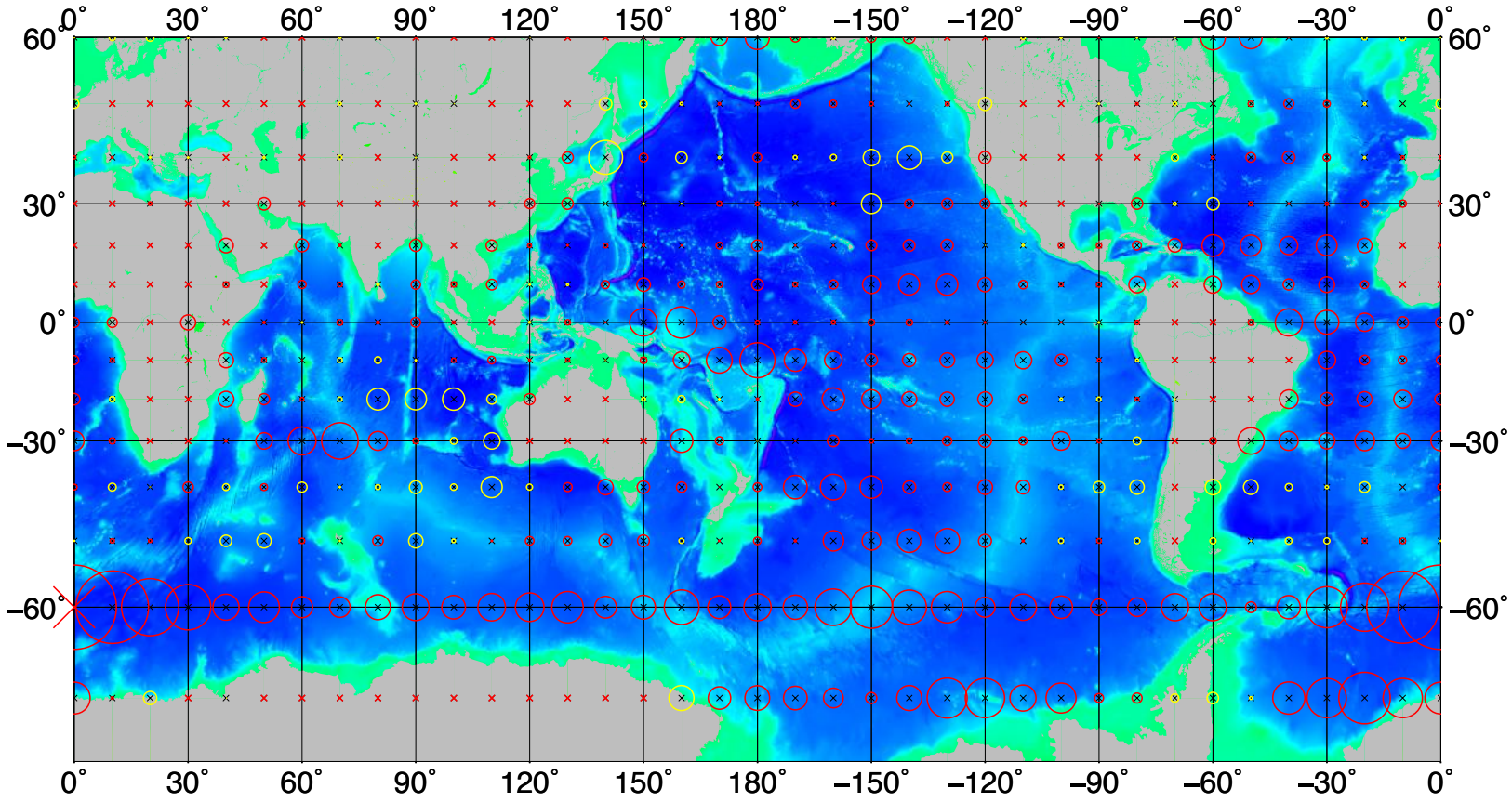

Figure 4 Correlation between the SST anomaly of Subarea 48.6 and other stations in the world from 2002-2019. The data were sampled by 1° of grid at intervals longitude and latitude). Each station has the SST anomaly averaged over 1° both in longitude and latitude. The locations of Subarea 48.6 is shown by ✕. The circle ◯(positive correlation) and◯(negative correlation) show the positive and negative correlation size of circle indicates the intentisy of correlation.

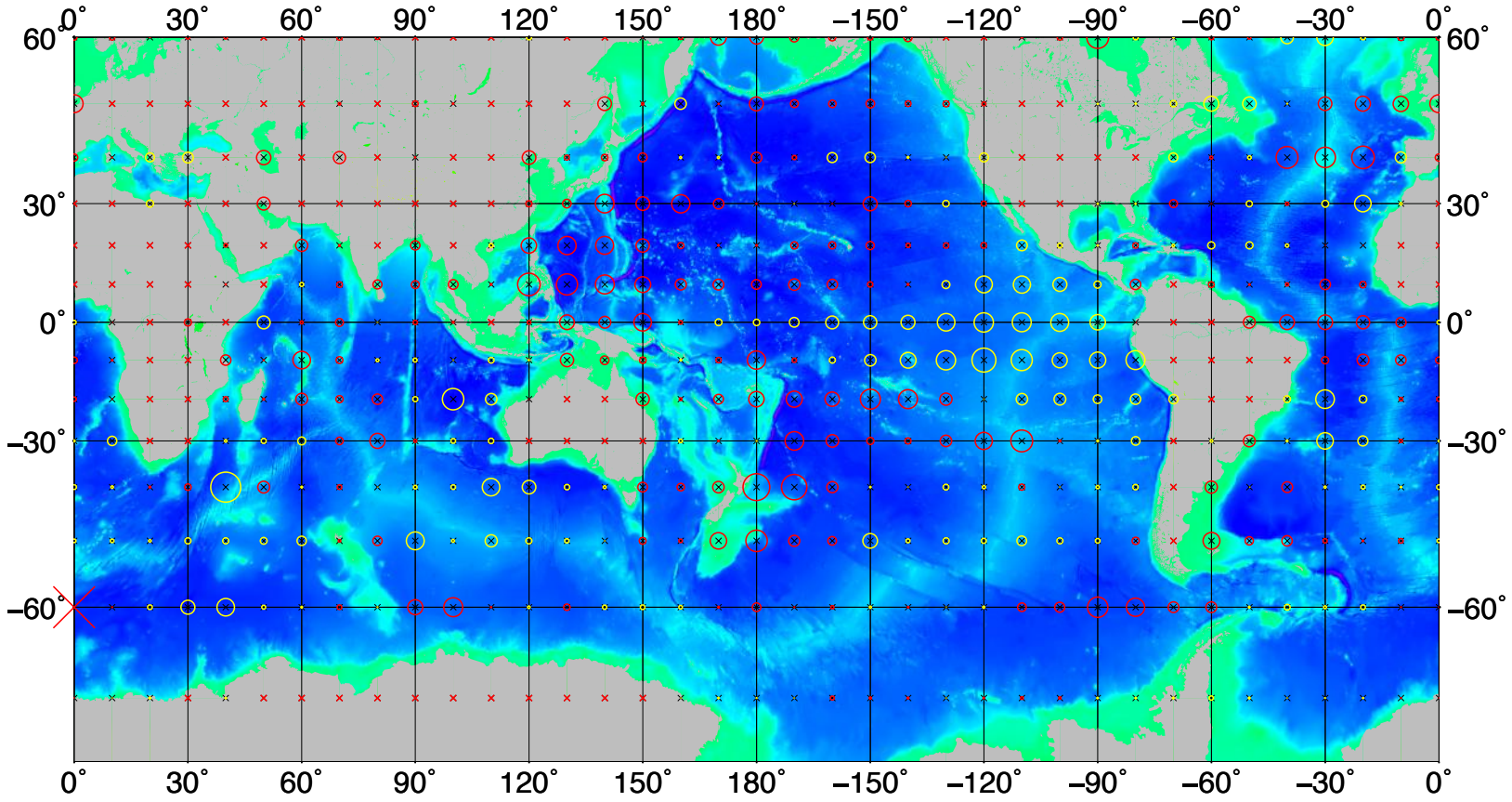

Figure 5 Correlation between the SST anomaly of Subarea 48.6 and other stations 6 months shifted forward in the world from 2002-2019 (10° intervals longitude and latitude) for the SST anomaly. Each station has the SST anomaly averaged over 1° both in longitude and latitude. The locations of Subarea 48.6 is shown by ×. The circle ○(positive correlation) and○(negative correlation) show the positive and negative correlation size of circle indicates the intensity of correlation.