CCAMLR

Commission for the Conservation of Antarctic Marine Living Resources
Commission pour la conservation de la faune et la flore marines de l'Antarctique
Комиссия по сохранению морских живых ресурсов Антарктики
Comisión para la Conservación de los Recursos Vivos Marinos Antárticos

WG-SAM-2021/21

11 June 2021

Original: English

WG-SAM

2021 updated analysis of the sea ice concentration (SIC) in research blocks 4 (RB4), and 5 (RB5) of Subarea 48.6 with sea surface temperature (SST) and winds

T. Namba, R. Sarralde, T. Ichii, T. Okuda, S. Somhlaba and J. Pompert

EN

2021 updated analysis of the sea ice concentration(SIC) in research blocks 4(RB4), and 5(RB5) of Subarea 48.6 with sea surface temperature(SST) and winds

T. Namba, R. Sarralde, T. Ichii, T. Okuda, S. Somhlaba and J. Pompert

Abstract

In RB5, the SICs in Feb. 2021 were the highest and the SSTs were the lowest for the years 2016-2021. In March 2021, the highest SICs decreased to nearly the long-term average while the SST increased accordingly. In the same year, the SICs and SSTs had two peaks in Feb. and March respectively. In RB4, the SICs during Jan.-Feb (Austral summer) in 2021 were also the highest since 2016. The sharp spikes of SST (rapid increasing SST) had become smaller year by year from 2017 to 2021, which indicates that the SSTs had a cooling phase in 5-6 year periodical cycles corresponding to an increasing trend in SICs.

Spatial dynamics of SICs with SSTs contour of -1.8°C and -0.8°C were analyzed. It was found that the ice edges are at approximately -1.8°C and partially broken ices exist between -1.8°C and -0.8°C when comparing imagery by GIBS and SICs distribution by AMSRs with SSTs by NOAA.

Daily wind stick plots indicate that the eastward winds could encourage the off-shore Ekman transport at the end of Feb. and the beginning of Mar. which resulted in late (slow) ice retrieval in 2021.

Results

1. Research blocks of Subarea of 48.6 exploratory fisheries (**Figure 1**)

   There are four research blocks 2,3,4 and 5 in Subarea of 48.6. Research block 2 is located north of 60°S and the other blocks are located south of 60°S. In general, research blocks 4 and 5 are covered by ice spatially at almost 100% concentration, except for 4 months from December to March. The SICs of RB4 and RB5 starts to decrease at the beginning of November and then reach their minimum in the middle of February. Then, the SICs starts to increase again and reaches almost 100% spatial coverage in Apr. and remains at 100% coverage from Apr. through to Oct.

   (Figure 2).

2. Data sources of sea ice concentration (SIC) and sea surface temperature (SST) anomaly

   The SIC provided by the University of Bremen (https://seaice.uni-bremen.de/sea-ice-concentration/) based on the Advanced Microwave Scanning Radiometer 2 (AMSR2), the photo of Global Imagery Browse Services (GIBS) by NOAA (https://developer.earthdata.nasa.gov/gibs/gibs-api-for-developers, https://worldview.earthdata.nasa.gov) and SIC provided by HYCOM are analyzed. The resolutions of the ice concentration of the AMSR2 are 3125m and 6250m/grid and that of GIBS is 250m/grid (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/). (http://map1.vis.earthdata.nasa.gov/wmts-geo/MODIS_Terra_CorrectedReflectance_TrueColor/default/2019-02-15/EPSG4326_250m). In addition, sea surface temperature (SST) is obtained from the ERDDAP of NOAA (https://coastwatch.pfeg.noaa.gov/erddap/index.html).

   Evaluation of the data for the analysis of the SIC in the subarea 48.6 by three data sources above had been conducted carefully.

3. Daily plots of SICs in RB4 and RB5 for 6 years in 2016-2021 (**Figure 2**).

   In RB5, the SICs in 2021 were the highest almost over the summer season. Unlike in 2016- 2020, the SICs both in RB4 and RB5 in 2021 had rather peculiar seasonal dynamics as the highest SICs in the beginning and middle of Feb. and then decreased dynamically at the end of Feb. and in the beginning of Mar., and remained at the average in the middle of Mar.

4. 4. Four-year comparison of SICs spatial distribution of 15th Jan. and 15th Mar. respectively (**Figure3 & 4**) for 2018 - 2021 in RB4 and RB5

The spatial coverage of SICs in RB5 in Jan. 2021 was the highest for the period , but then in Mar. reached the lowest for 2018-2021. However, as the color of SICs indicate, the density of SICs in Jan. 2021 was the second highest with 2019 the highest. The rather dense ice in 2021 had less spatial coverage.

5. Four-year comparison of the SST contours of -1.8 °C (red) and -0.8 °C (black) with SICs chart of 15th Jan. and Mar. (respectively **Figure 5 & 6**) from 2018 - 2021 in RB4 and RB5, based on ERDDAP of NOAA.

   -1.8 °C of SST is considered the border between sea ice and water. There are partially broken ices located between -1.8 and -0.8°C. In Jan. 2021, both the contours of -1.8°C (red) and -0.8°C (black) were located further north than in 2018-2020, which indicates that the SST in 2021 was the lowest and the SICs was highest for four years (2018-2021). The color of SICs, indicating the intensity of SICs, corresponds well to the SST contours. In Mar. 2021, the contours were located almost the same as in 2019 and 2020 (not further north) unlike the contours in Jan. 2021.

6. Daily SST plot in 2021(top) in RB4 and RB5, 6 years daily plot (middle) and for 20 years from 2002-2021 (lower) (**Figure 7**)

   SSTs in RB5 in Jan.-Mar. in 2021 (top) indicate that there were two peaks in SSTs, which coincidence with the two peaks of SICs in Jan. and Mar.. The six year plot(upper) indicates that the SST spikes (sharp increase) became smaller year by year since 2018 in RB5 and since 2019 in RB4 respectively. The 20 years plot(lower) indicate that there are 5-6 year periodical cycle of SSTs spikes (sharp increase) for 20 years in 2002-2021. Higher SST spikes in RB5 occurred in 2003, 2005-2006, 2011,

2017 and 2018 and the lower spikes occurred in 2007-2009, 2012-2016 and 2021.

7. Seasonal changes in SST anomaly for 6 years in RB5 (lower) with 20 years daily plot of SST (upper) (**Figure 8**)

   Dashed red line indicates the daily SST anomaly in 2021, which is the lowest since 2016. The SST anomaly in Feb. 2021 was the lowest overall which correspond to the smallest spikes in 20 years daily SST. The SST anomalies also show the two peaks in Jan. and Mar. but not as clear as in Figure 7. The SST plots for 20 years in 2002-2021 (upper) indicates that higher SST spikes in RB5 occurred in 2003, 2005-2006, 2011 and 2017-2018 and the lower spikes occurred in 2007-2009, 2012-2016 and 2021.

8. Five-year comparison of SICs spatial distribution for Subarea 48.6 by month (Dec. - Mar.), 2016/2017 to 2020/2021 (upper) with year-to-year plots of SST anomalies (lower) (**Figure 9**)

   These ice chart cover the whole Subarea 48.6 (called middle scale chart), as the charts in Figure 3 and 4 cover only the southern part of Subarea 48.6(called small scale chart).

   As the SST spike has decreased since 2018, the SICs especially in 15 Feb has increased. The SICs in 15 Dec 2020 was the highest for 2016-2021 then in January, the SICs had decreased dynamically more. However, in Jan. and Feb. 2021, the SICs were still the highest.

   Even though the SIC in Dec. was the lowest, the SICs in Mar. was the highest. The SICs in Dec. 2019 was the lowest for 2017-2021 and then dropped down rapidly

through Jan.-Feb. 2020 and in Mar. the SICs became the highest for 2017-2021.

9. Daily stick plots of the south-north(left) and west-east component (right) of wind in RB5, 6years for 2016- 2021 (**Figure 10**).
   (https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdQMekm1day)
   The daily stick plot of the south-north component of wind indicates that there seems to have been more dominant northwardly wind in Feb. -Mar. 2021, in which the north- ward(red) wind could bring the sea ice northward toward off the coast. The eastward wind at the end of Feb. and the beginning of Mar. 2021 also were rather more dominant than in 2018, 2019 and 2020 The dominant eastward wind along the Antarctic continent could strengthen the Ekman off-shore transport. Theoretically, the eastward winds in Subarea 48.6 can be propelled by higher air pressure on the Antarctic continent which results in decreasing cloud coverage and increases sunlight. According to the images by GIBS, there was a lot of cloud coverage from Jan. to Feb. 2021 so that less sunlight could prevent the surface from heating. The relationship between SICs and winds (or air pressure) is complicated in physics. However in respect of physical oceanography, so further study and atmospheric analysis of winds and air pressure should be developed with a parameter of cloud albedo.

Conclusions

1. In RB5 and RB4, the SICs in 2021 had exceptional dynamics and unlike 2016-2020. The SICs dynamics in 2021 had two peaks in Feb. and Mar. which increased and remained higher in Feb and then started to decrease in the end of Feb. and remained rather low approximately for two weeks. It is rare that the SICs started to increase in early or middle of Feb. which was much earlier than in 2017-2020.

2. In RB5 the sharp SSTs spike in 2021 is the smallest for the 6 years 2016-2021 which is the lowest SST and corresponds to the highest SICs.

3. SST of -1.8 °C is the ice edge based on the ice images (GIBS) and SSTs(NOAA). Between -1.8 and -0.8°C, there are partially broken ices which could provide the useful information on fishable area in RB5 and RB4.

4. Dominant eastward winds in the end of Feb. and the beginning of Mar. in 2021 could encourage the ices to leave off shores which resulted in late ice retrieval. South-north word winds must also have the influence on the ice extension.

Related documents

- T. Namba, K. Taki and T. Ichii, 2016, Analysis of sea-ice concentration of 48.6_4 and _5 with remote sensing data during the latest four seasons, WG-SAM-16/42 Rev. 1
- T. Namba, T. Ichii and T. Okuda, 2017, Update of analysis on sea-ice concentration of southern part of 48.6 and 58.4.2 for the new research block on expected spawning ground of TOA,WG-FSA-17/10.
- 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. Okuda, T. Namba and T Ichii1, 2018, hypothesis in region for 48.6, 58.4.2, and 58.4.1,WS-DmPH-18/06
- H. Pehlke, K. Teschke and T. Brey, 2018, Predicting fishing ground accessibility in the Antarctic Weddell Sea, WG-SAM-18/01
- T. Namba, R. Sarralde, S. Somhlaba and J. Pompert, Possibility of predicting sea-ice concentration (SIC) in research block (RB) 48.6-5 (Southern part of Subarea 48.6) using sea surface temperature (SST) in RB 48.6-2 (Northern part of 48.6)WG-FSA-2019/49

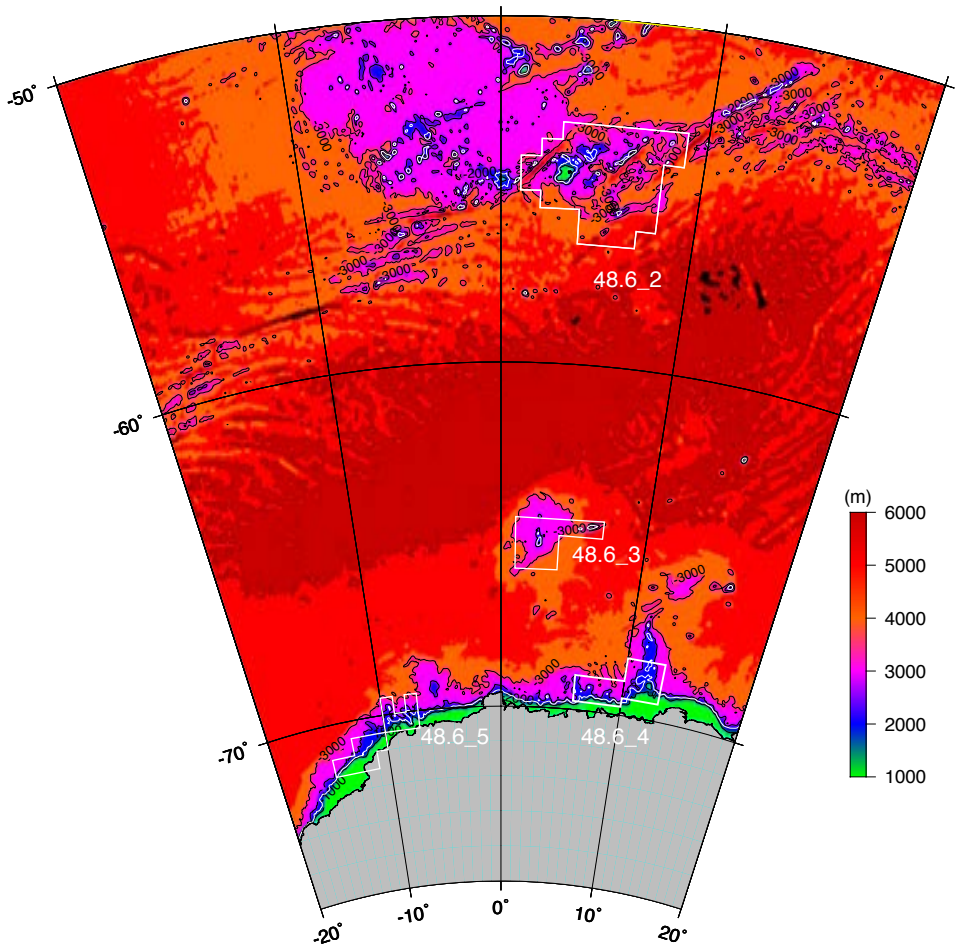

Figure 1 Location and topography of Subarea 48.6. There are four research blocks 2,3,4 and 5 in 48.6 where the research block 2 is located north of 60°S with other blocks south of 60°S.

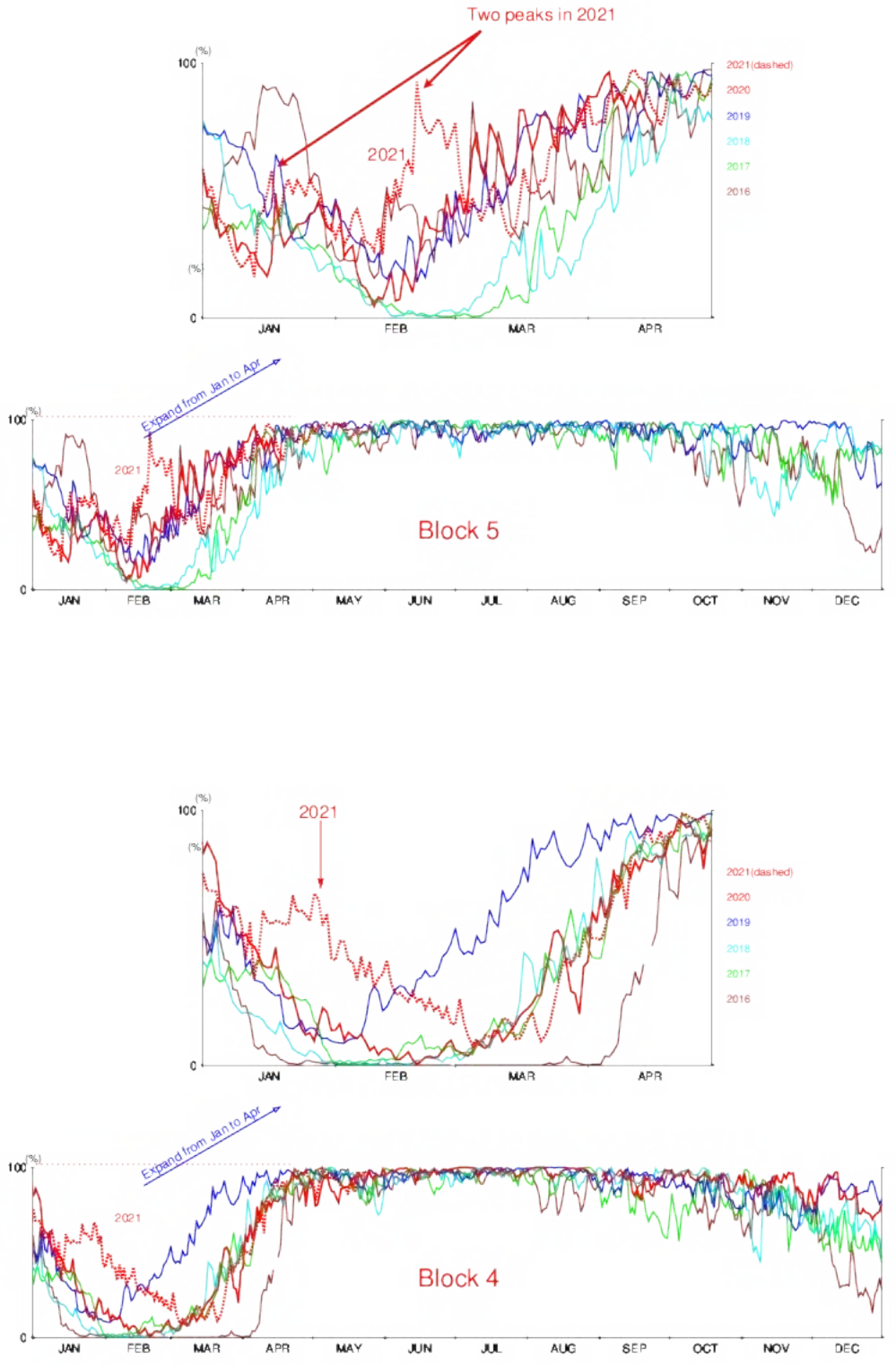

Figure 2. Daily plots of SICs for 6 years in 2016-2021in RB4(lower) and RB5 (upper). (`https://seaice.uni-bremen.de/sea-ice-concentration/`)

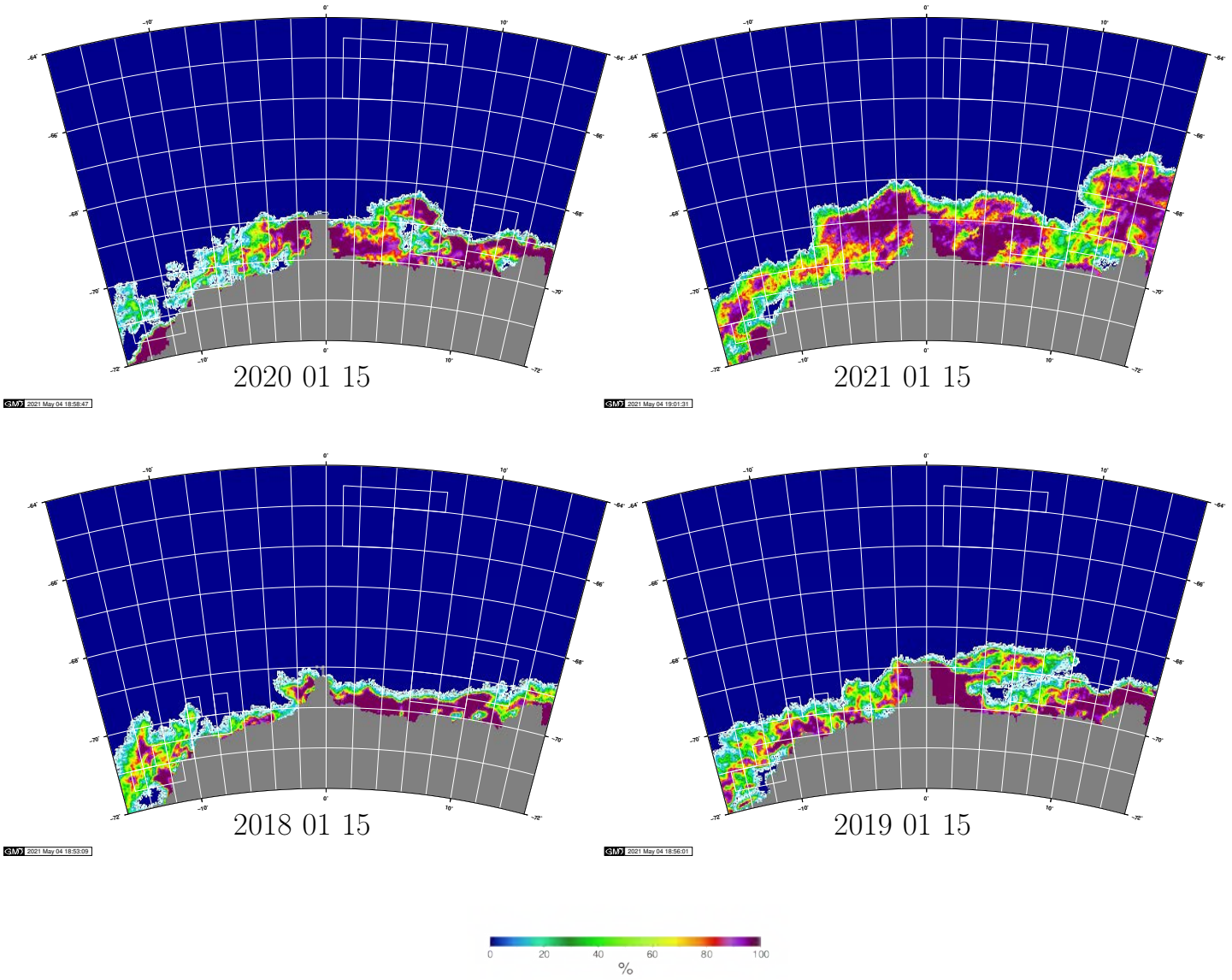

Figure 3. Four-year comparison of SICs distribution of 15th Jan., in 2018 - 2021 in RB4 and RB5 of souther part of Subarea 48.6 based on AMSR2.

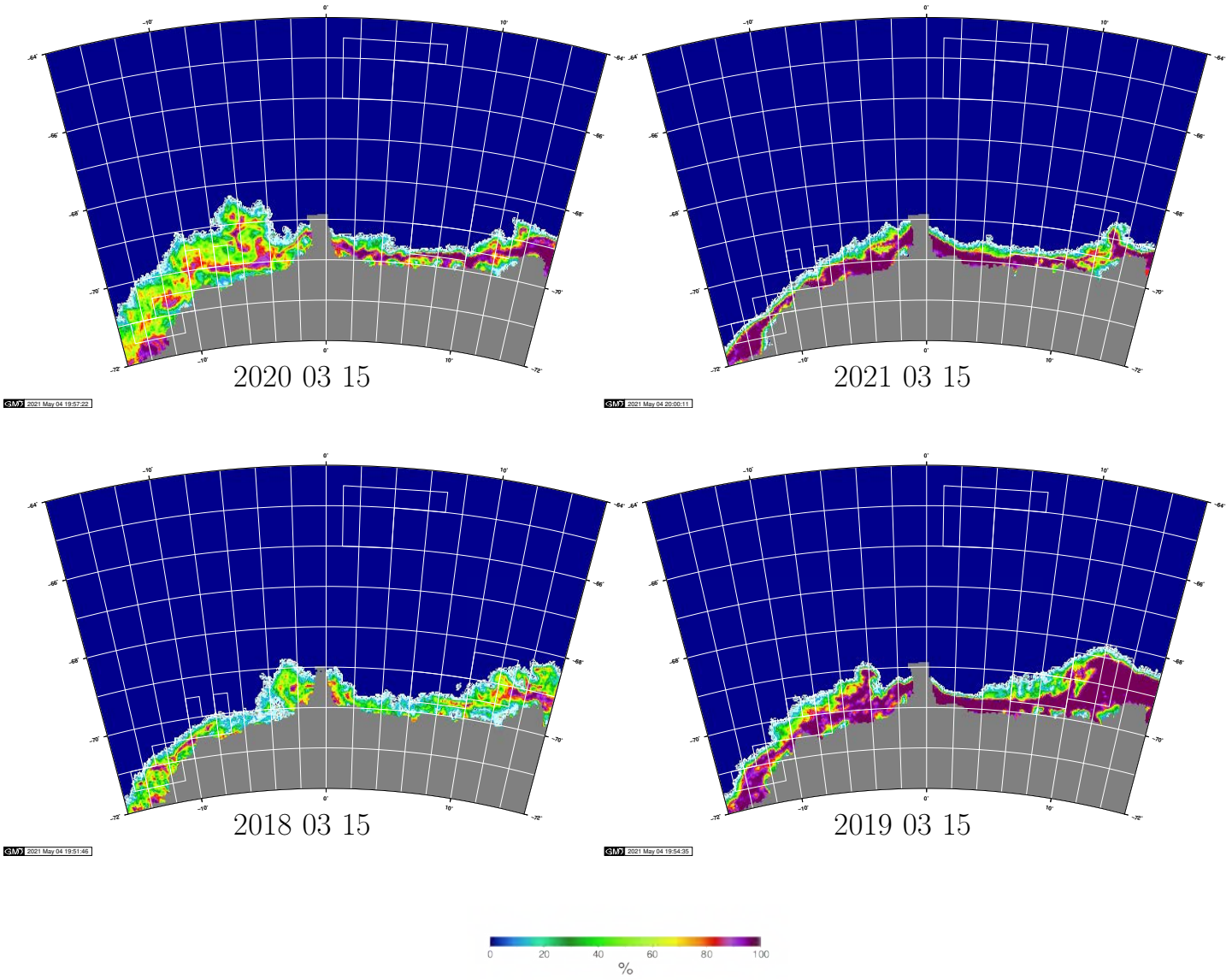

Figure 4. Four-year comparison of SICs distribution of 15th Mar., in 2018 - 2021 in RB4 and RB5 of souther part of Subarea 48.6 based on AMSR2.

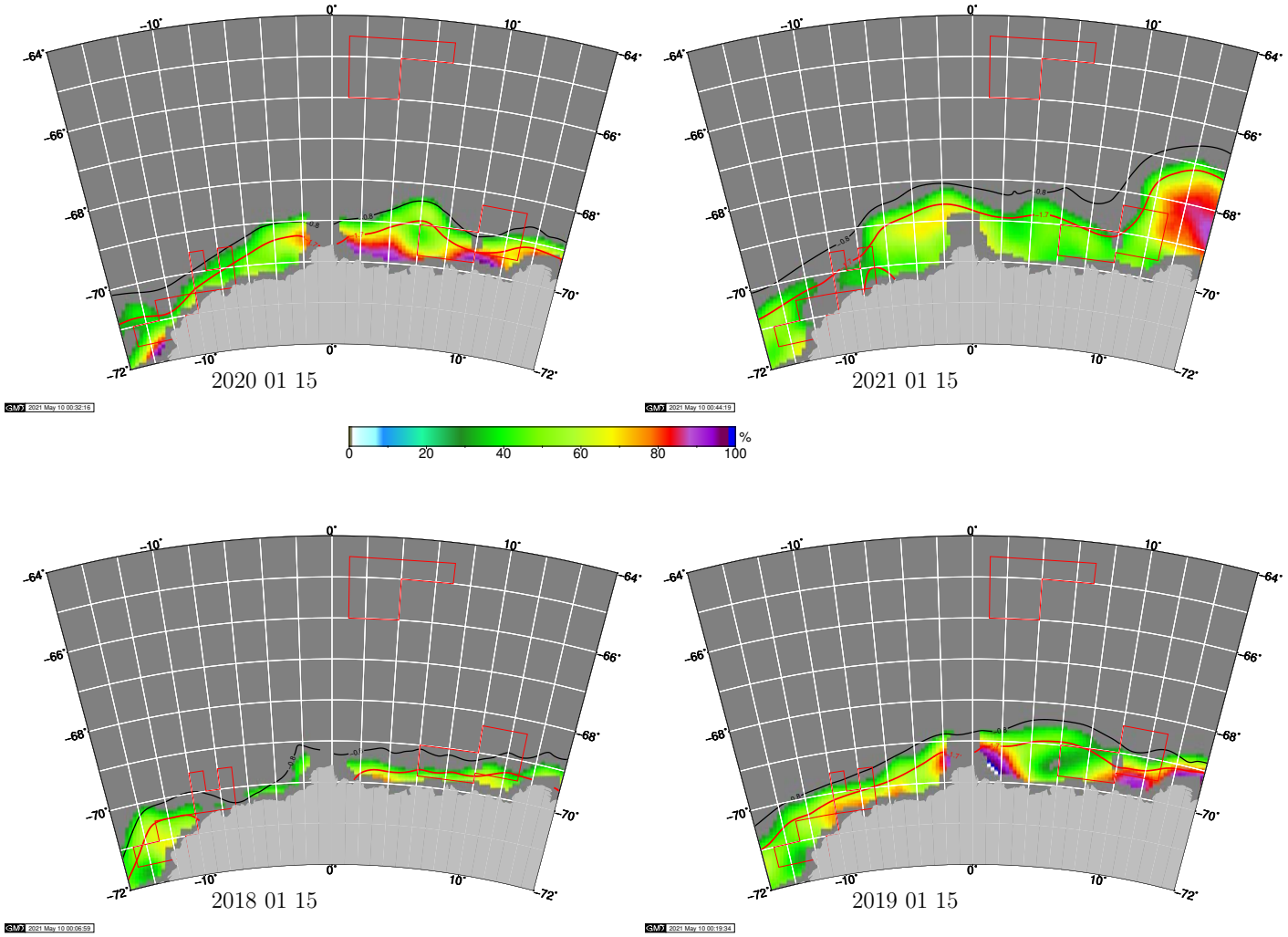

Figure 5 Four-year comparison of SICs (based on SSTs(NOAA)) distribution of 15th Jan., in 2018 - 2021 in RB4 and RB5 of the Southern part of Subarea 48.6 based on ERDDAP of NOAA.

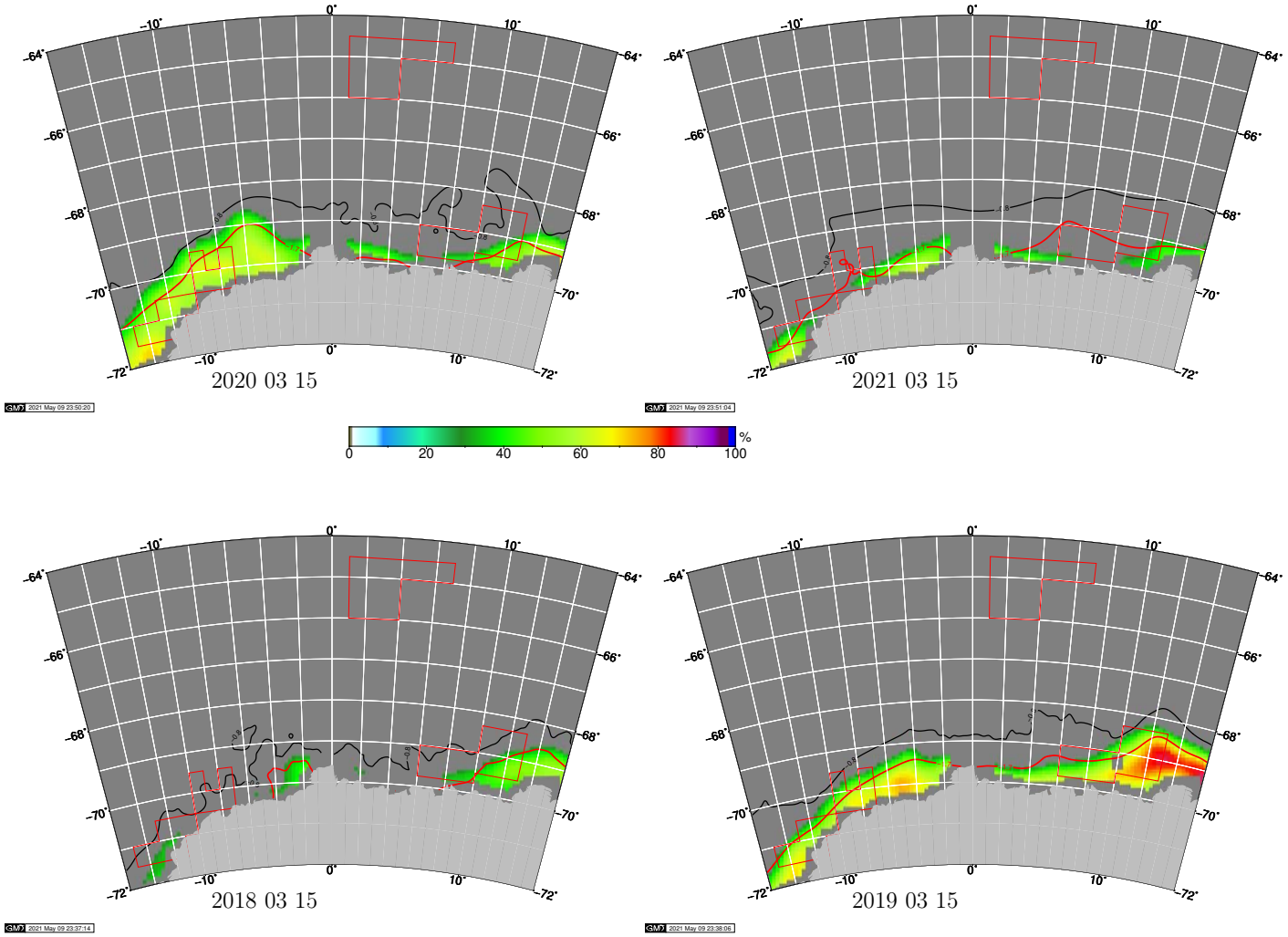

Figure 6. Four-year comparison of SICs (based on SSTs(NOAA)) distribution of 15th Mar., in 2018 - 2021 in RB4 and RB5 of the souther part of Subarea 48.6 based on ERDDAP of NOAA.

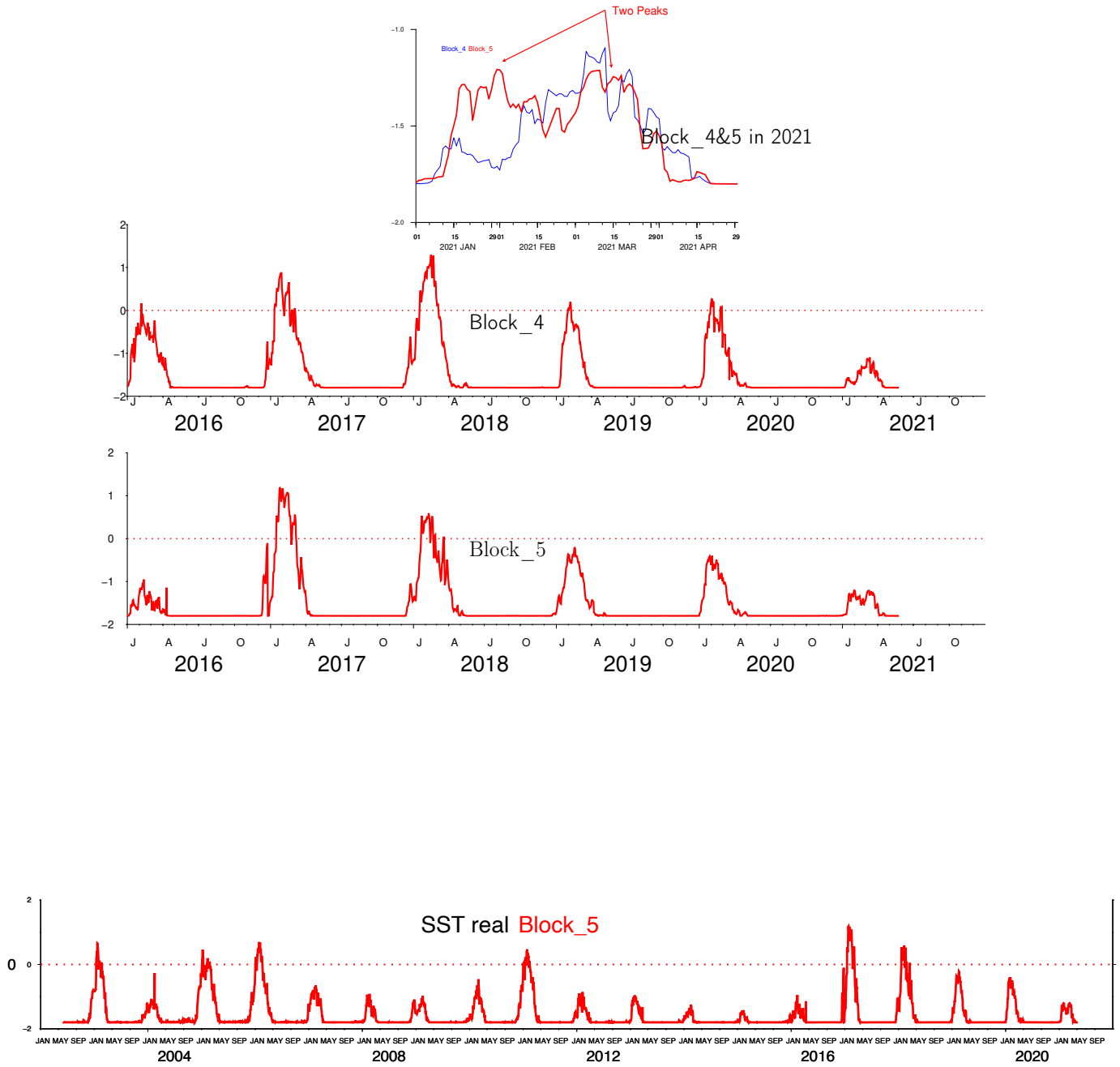

Figure 7. Daily plots of SICs for 6 years in 2016-2021.
(`https://seaice.uni-bremen.de/sea-ice-concentration/`)

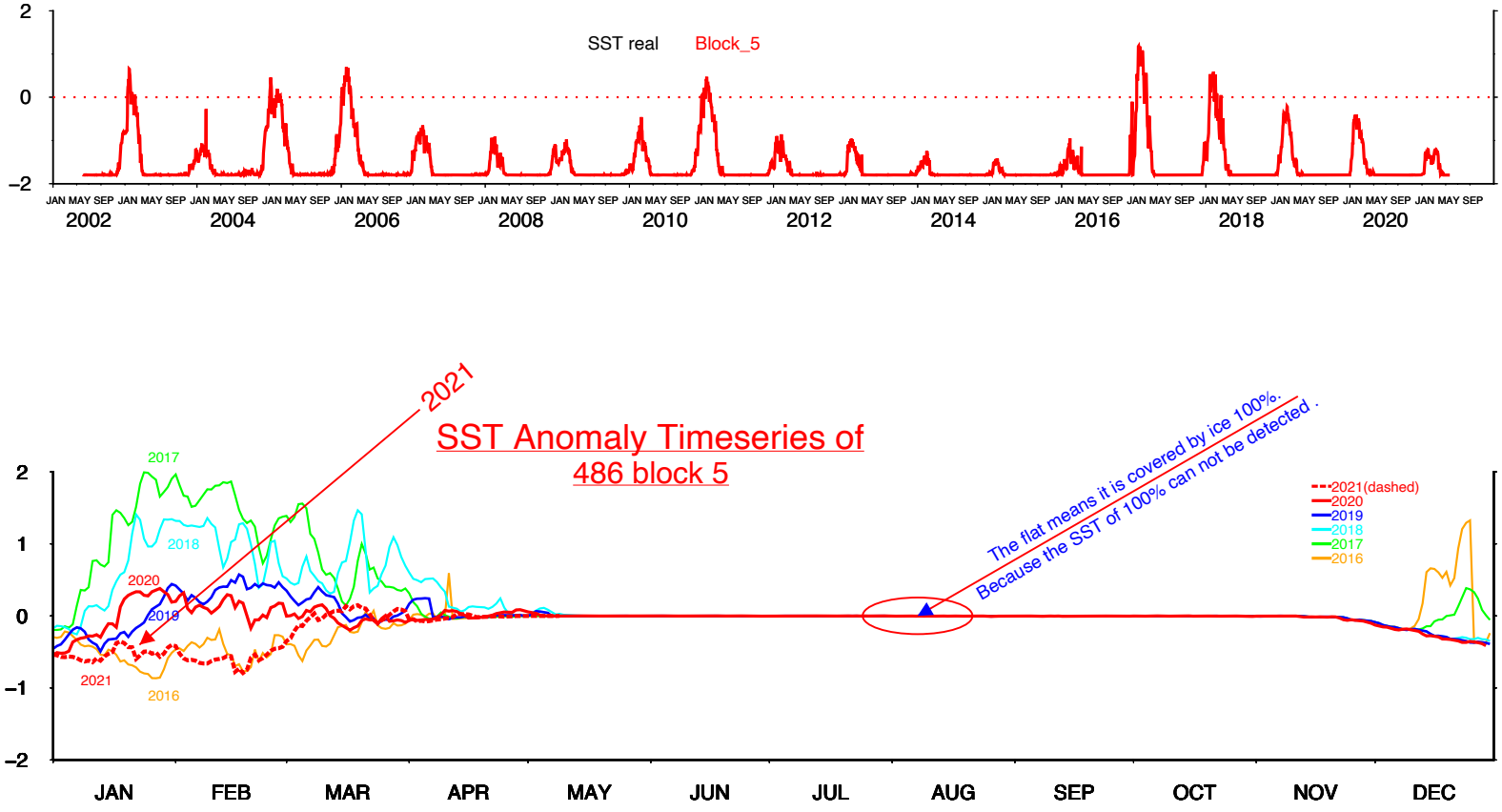

Figure 8. Seasonal change in SST for 6 years in RB5 (lower) with 20 years daily plot of SST (upper) (Figure 8).

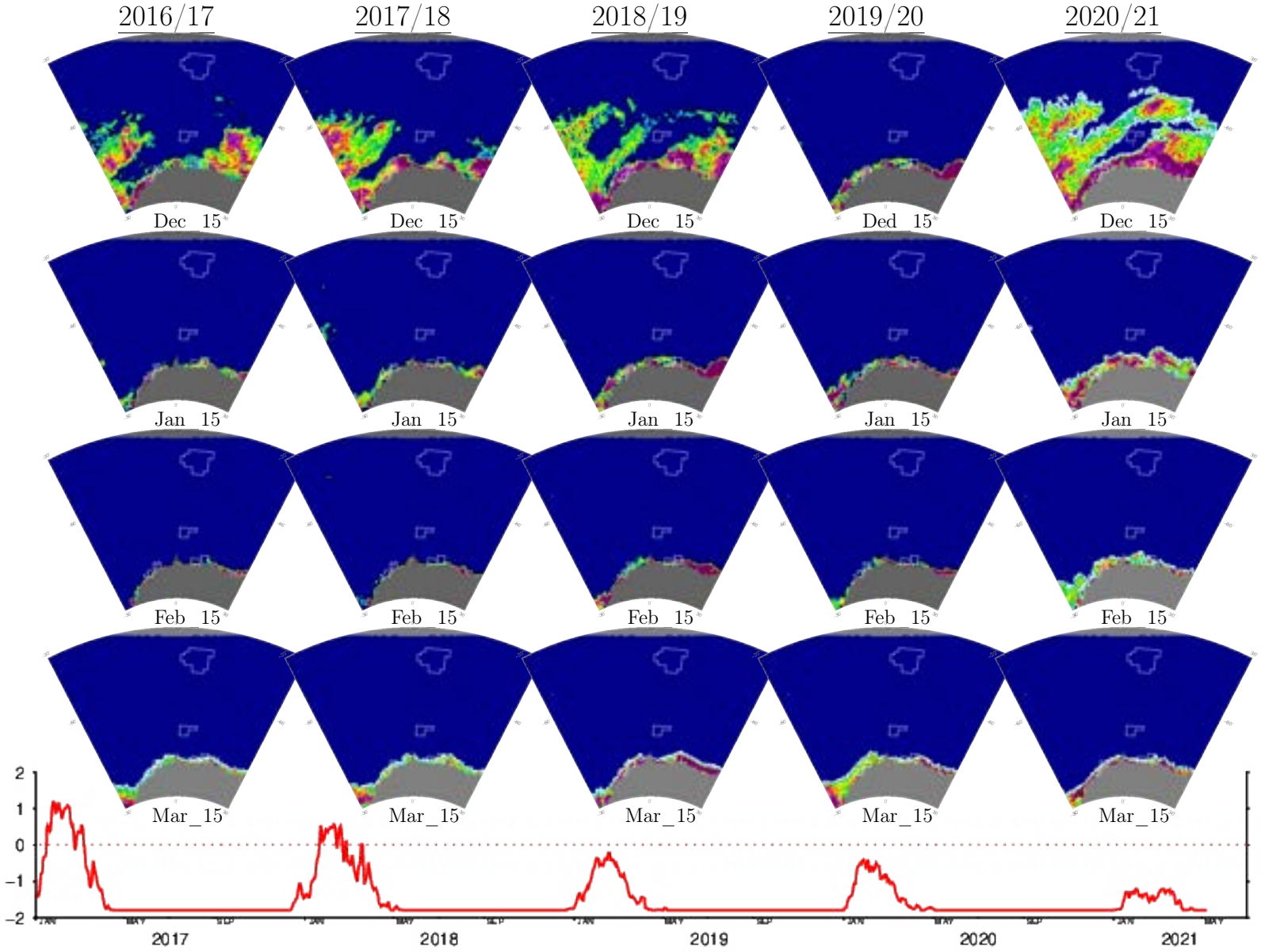

Figure 9. Five-year comparison of SICs distribution for Subarea 48.6 by month (December - March), 2016/2017 to 2020/2021 (upper) with daily plots (red) of SSTs for 6 years in 2016-2021 (lower).

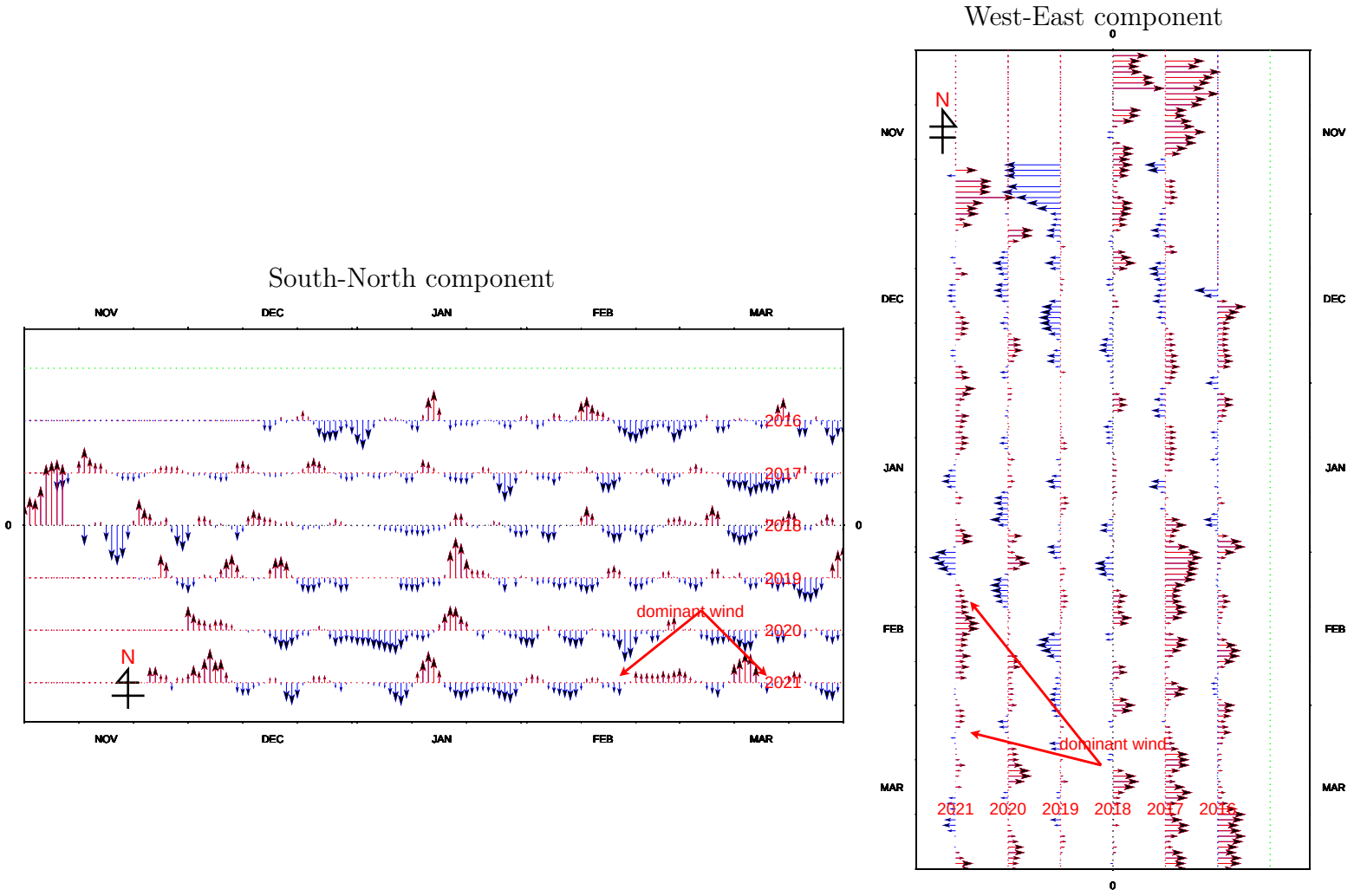

Figure 10. Wind stick plots of the south-north(left) and west_east component (right) of wind in RB5, 6years for 2016-2021.