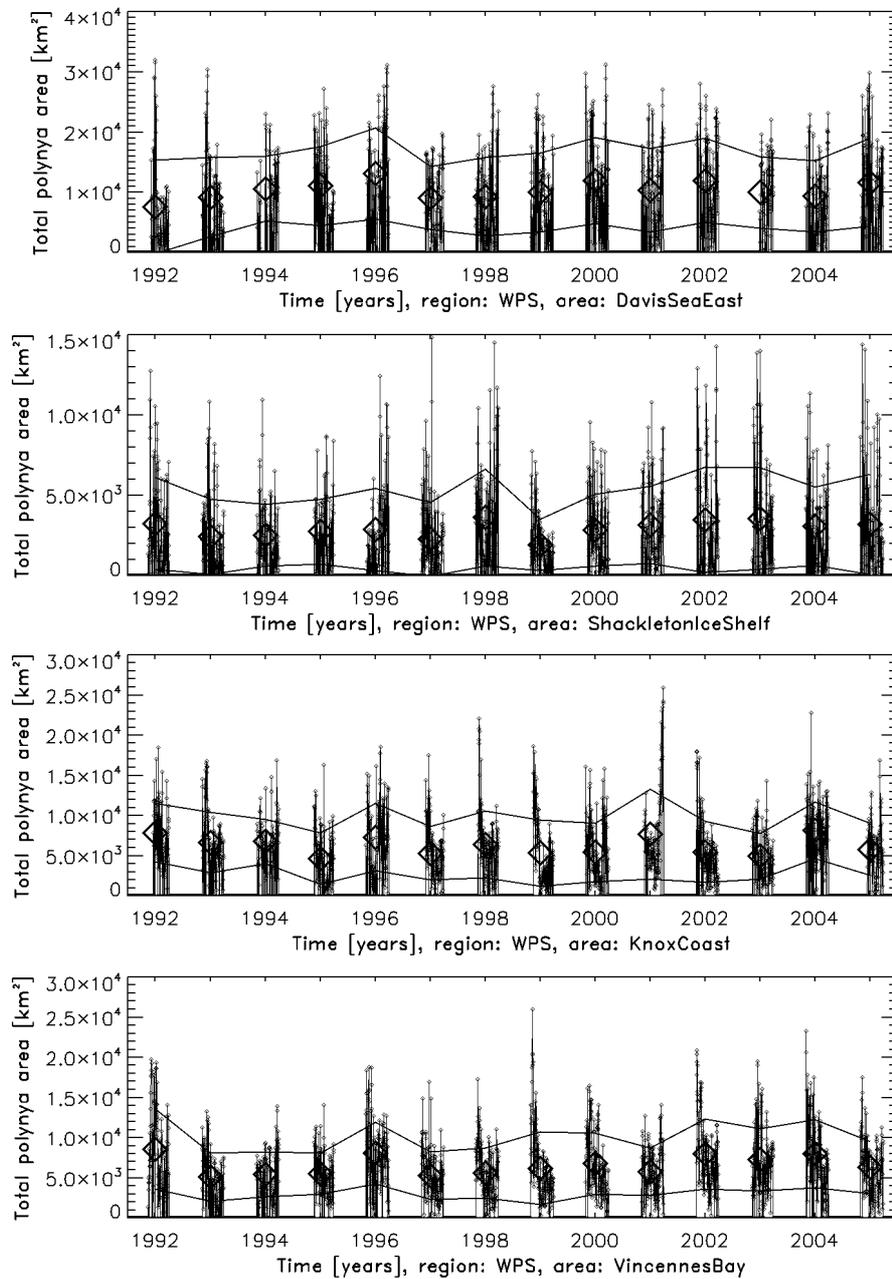


**Figure 38:** Relative polynya distribution of region WPS for the period 1992-2005 (see caption of Figure 23 for details). The red / orange circles mark the approximate location of the Dalton / Dibble Ice tongues mentioned in the text, respectively.

The relative polynya distribution in these areas should be close to zero – not necessarily equal to zero, because the fast-ice maps of Giles et al. (2008) are valid for November and it can of

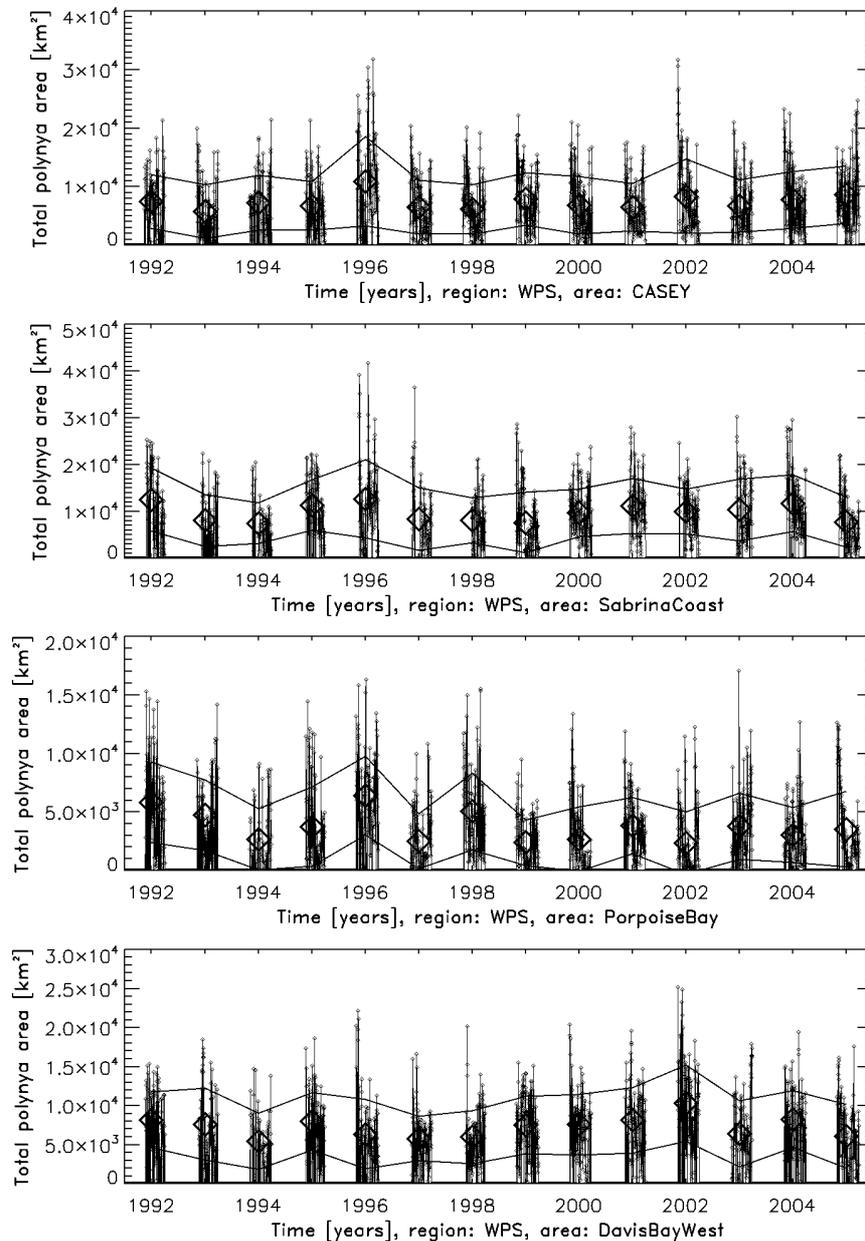
course not be excluded, that these areas started with a polynya early in the freezing season. In fact, the polynya distribution maps of 1997 and 1999 (Figure 38) show values below 20 % or even below 0.5 % in these areas, which puts some confidence on the fast-ice masking method used in this study.



**Figure 39:** Total polynya area of sub-regions of region WPS (see Figure 37) for May-Sep. 1992-2005 (see caption of Figure 24 for further details).

Figure 39 summarizes the time series of the (sub-)daily total polynya area of each of the eight sub-regions together with the average total polynya area for May.-Sep. for the period 1992-2005. Table 2 lists the displayed average values together with the averages for June/July/August and the respective standard deviations. The largest mean total polynya area within region WPS are found for sub-region 1 (Davis Sea East) and sub-region 6 (Sabrina Coast) with values around 10 000 km<sup>2</sup>. In sub-regions 3, 4, 5, and 8 the mean total polynya area is between around 5000 and 10 000 km<sup>2</sup>; the one in sub-regions 2 and 7 stays on average

below 5000 km<sup>2</sup>. The highest inter-annual variability is found for sub-region 7 (Porpoise Bay) with a low of 2500 km<sup>2</sup> (1999) and a high of 6500 km<sup>2</sup> (1996) as already indicated in Figure 38. The mean total polynya area of sub-region 1 (Davis Sea East) tends to increase over the shown period – similar to what was found for sub-region 6 (Davis Sea West) of region EIS; the fact that the total values are smaller than those found for Davis Sea West can be attributed to the smaller size of the sub-region.



**Figure 39: continued.**

## 8.7 Polynya area: Eastern Pacific Ocean Sector (EPS)

Figure 40 shows a sample map of the polynya distribution of region EPS together with the four sub-regions selected. Sub-region 4 overlaps with sub-region 8 of region WPS. Sub-regions 2-4 are characterized by a coastline with a (very) steep topography and (if present) rather narrow ice shelves, and are therefore subject to (extremely) strong catabatic airflow. Sub-region 3 contains the well-known Mertz-Glacier polynya, which has been topic of many

studies dealing with ice production in a coastal polynya, the associated water mass modification and its impact on a larger oceanographic scale (Lytle et al., 2001; Bindoff et al., 2001; Marsland et al., 2004; Flocco, 2007; Marsland et al., 2007). Sub-region 1 (Balleny Islands) is totally different in that it lies well within the ice cover several hundreds of kilometers off the coastline. It could be expected that polynyas developing here are partly also caused by oceanic upwelling and have to be regarded as mixed latent-sensible-heat polynyas. Figure 41 gives an overview about the relative polynya distribution (polynya probability) for the entire region EPS for May-Sep. for the period 1992-2005. Similarly to what has been discussed in the context of Figure 38 for region WPS, two regimes can be identified. The one

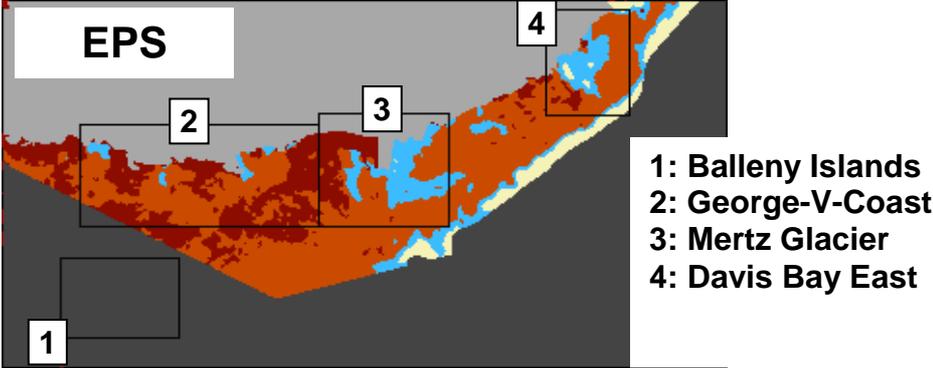


Figure 40: Zoom of region EPS – similar to Figure 22.

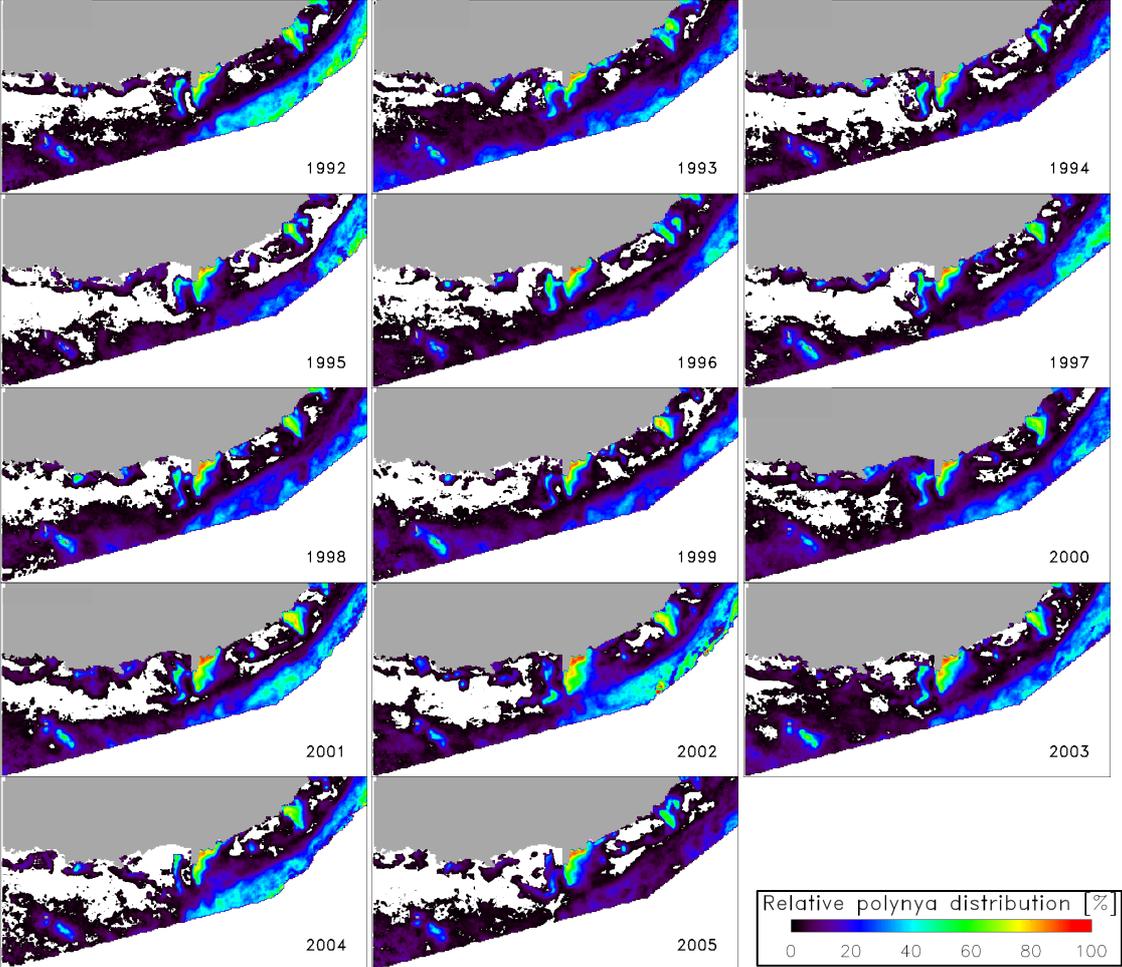
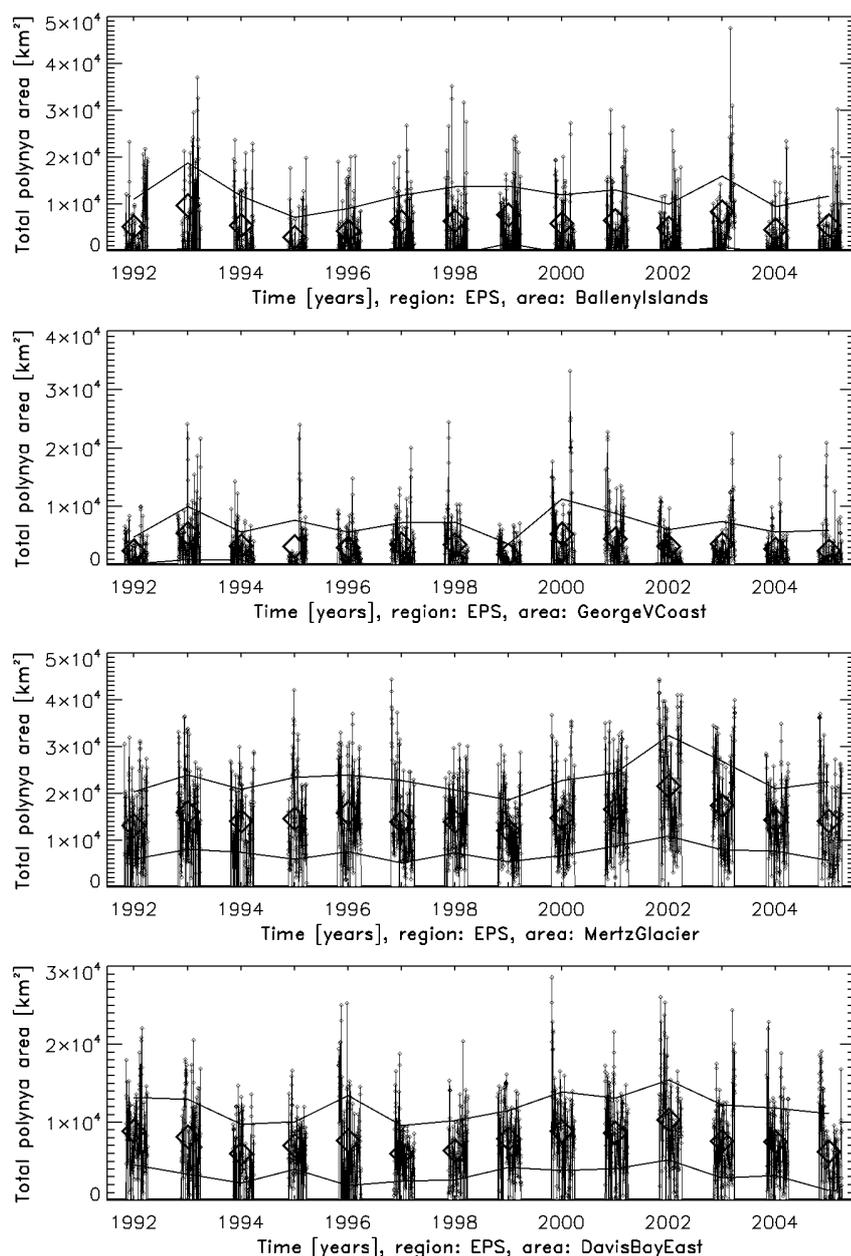


Figure 41: Relative polynya distribution of region EPS for the period 1992-2005 (see caption of Figure 23 for details).

influenced by the ice edge / MIZ is limited to the western and northern parts of the region EPS, however. The other regime differ in so far from the one described already for regions EIS and WPS, that large relative polynya distribution occur only in its western half, i.e. in sub-regions 3 and 4. The sub-region 3 (Mertz Glacier polynya) clearly exhibits one of the most persistent polynyas around Antarctica. The polynya probability peaks at values close to 100 % (2002), and did not fall below the minimum peak value of about 80 % (1992). The given images depict nicely that the total polynya area of the Mertz-Glacier region comprises



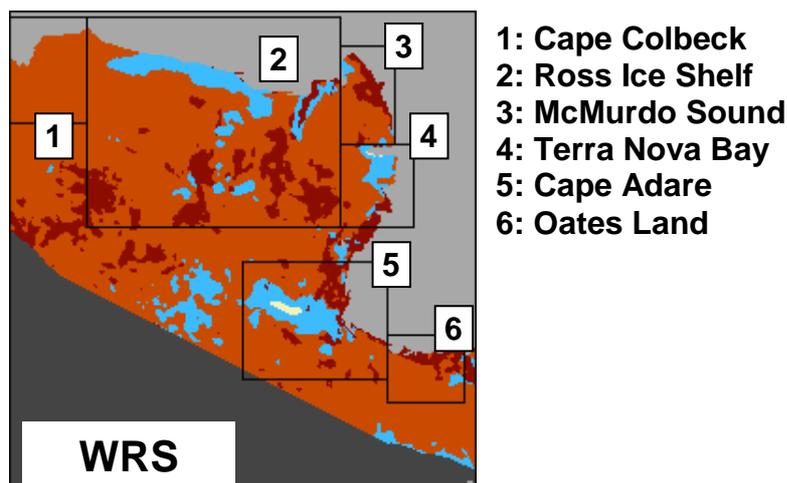
**Figure 42:** Total polynya area of sub-regions of region EPS (see Figure 40) for May-Sep. 1992-2005 (see caption of Figure 24 for further details).

two major polynyas: one to the west of the Mertz Glacier tongue and one to the east of this tongue but further off the coast. Massom et al. (2001) give a description of the reasons for this peculiar distribution, which is basically determined by the occurrence of fast ice and grounded icebergs. The second major polynya of the region EPS is the one in the Davis Bay in the

vicinity of the Dalton Ice tongue (see description of the polynya maps of region WPS). The polynya probability reaches regularly 70 to 80 % in this polynya; only the years 1994 and 2005 reveal lower peak values. Sub-region 2 reveals only small areas of polynya activity with a probability remaining below 40-50%. The polynya activity around the Balleny Islands (sub-region 1) is not negligible, and can be identified by a peak in the relative polynya distribution between about 25 (1995) and 45 % (2003).

Figure 43 summarizes the time series of the (sub-)daily total polynya area of each of the four sub-regions together with the average total polynya area for May.-Sep. for the period 1992-2005. Table 2 lists the displayed average values together with the averages for June/July/August and the respective standard deviations. As evident from Figure 42, the Mertz Glacier polynya region has the largest mean total polynya area: 15 000 km<sup>2</sup>, peaking in 2002 in 22 000 km<sup>2</sup>. This average values is smaller than the one given by Massom et al. (1998), who reported a mean winter polynya area of 23 300 km<sup>2</sup> based on a 75 % ice concentration threshold applied to Comiso-Bootstrap ice concentration data and subsequently summing up the open water area. In comparison to Marsland et al. (2004), who reported a mean winter polynya area of between 10 000 km<sup>2</sup> and 13 000 km<sup>2</sup> from a modeling study focusing on the Mertz-Glacier polynya area. Taking into account the fact, that the work of Massom et al. (1998) includes data from October, which is the month of maximum polynya area according to their study, the results of both studies lie within the envelope given by the standard deviation given in Figure 42. The second largest mean total polynya area is observed for sub-region 4 (Davis Bay East) with values between 5000 and 10 000 km<sup>2</sup> - similar to what has been found for sub-region 8 of region WPS. The mean total polynya area of the Balleny Island region takes values between 2000 and 10 000 km<sup>2</sup>. It has to be stressed here, however, that the peak value of 10 000 km<sup>2</sup> occurs in years (1992 and 2003) which coincide with a comparably far southward extension of the MIZ and thus a contribution of the thin ice present in the MIZ to the mean total polynya area derived for this region can not be excluded.

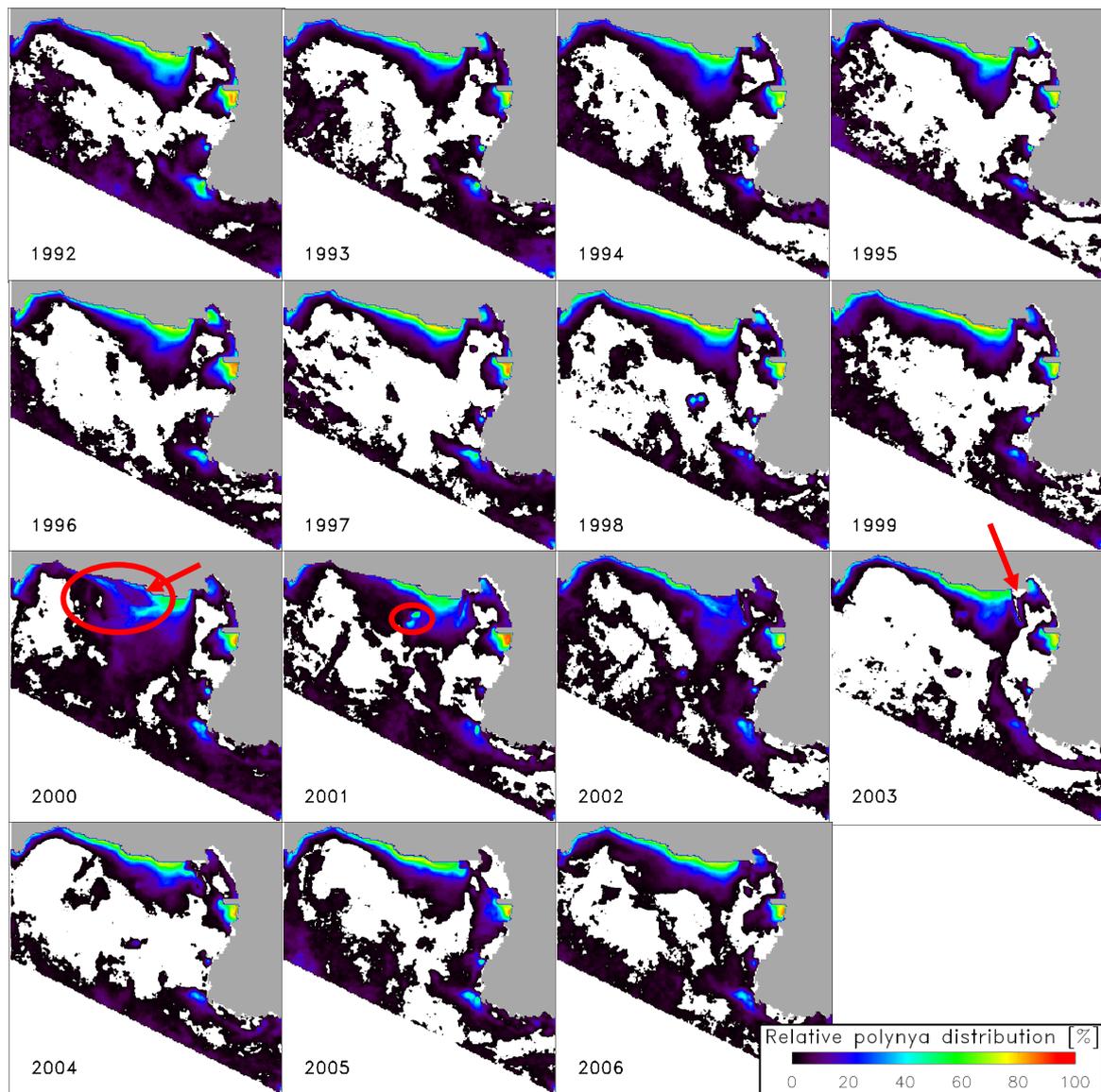
## 8.8 Polynya area: Western Ross Sea (WRS)



**Figure 43:** Zoom of region WRS – similar to Figure 22.

Figure 43 shows a sample map of the polynya distribution of region WRS together with the six sub-regions selected. This region is probably the most interesting and also important region to consider in this study. It contains six sub-regions quite different characteristics. Sub-regions 1 and 2 basically border the vast Ross Ice Shelf. The Ross Ice Shelf polynya has been subject of quite some studies in the past – especially because the calving, drift and grounding

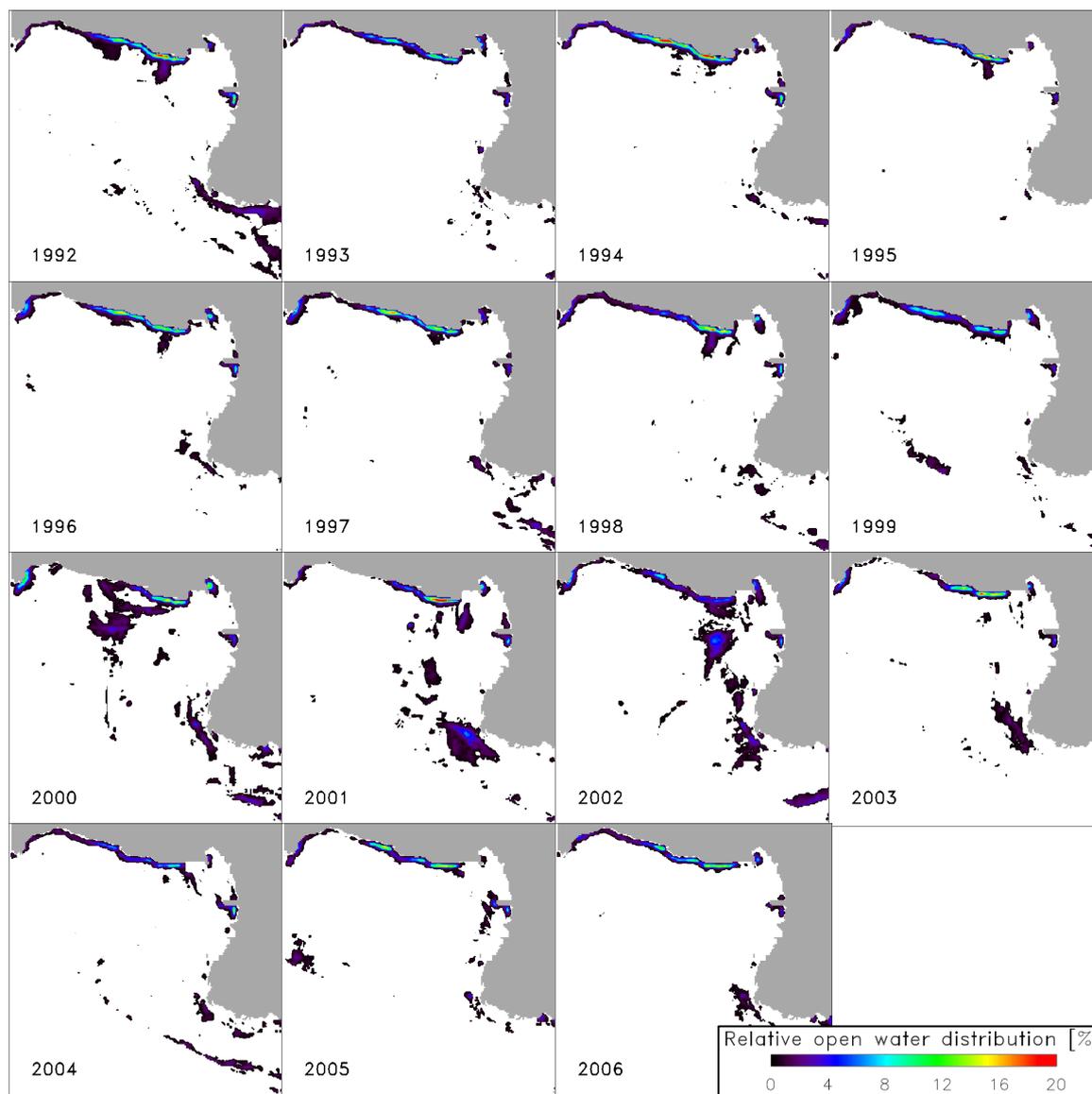
of a few giant icebergs did change the oceanic circulation in the southern Ross Sea and triggered the development of polynyas off the main coastline (shelf ice border) (e.g. Martin et al., 2007). Sub-region 3 is sort of a transition region between these two and sub-region 4, which covers the Terra Nova Bay polynya, which has also been subject of numerous studies (e.g. Kurtz and Bromwich, 1985; Van Woert, 1999, Flocco, 2007). This sub-region is extreme in that an extremely strong and persistent catabatic airflow dominates its meteorological conditions. Less influenced by such catabatic flows but in terms of the atmospheric conditions probably similar to sub-region Enderby Land (region WIS) is the sub-region 5 (Cape Adare); this is rather an open ocean than a real coastal polynya. Finally, sub-region 6 (Oates Land) has similar characteristics as sub-region 2 of region EPS. Sub-regions 1 to 4 have in common, that they are all sheltered quite well against atmospheric influence, because the main storm tracks do typically not penetrate that far into the Ross Sea.



**Figure 45:** *Relative polynya distribution of region WRS for the period 1992-2006 (see caption of Figure 23 for details). Red arrows denote the approximate position of the giant iceberg B15A; red ellipses mark polynyas generated in the lee of such giant icebergs.*

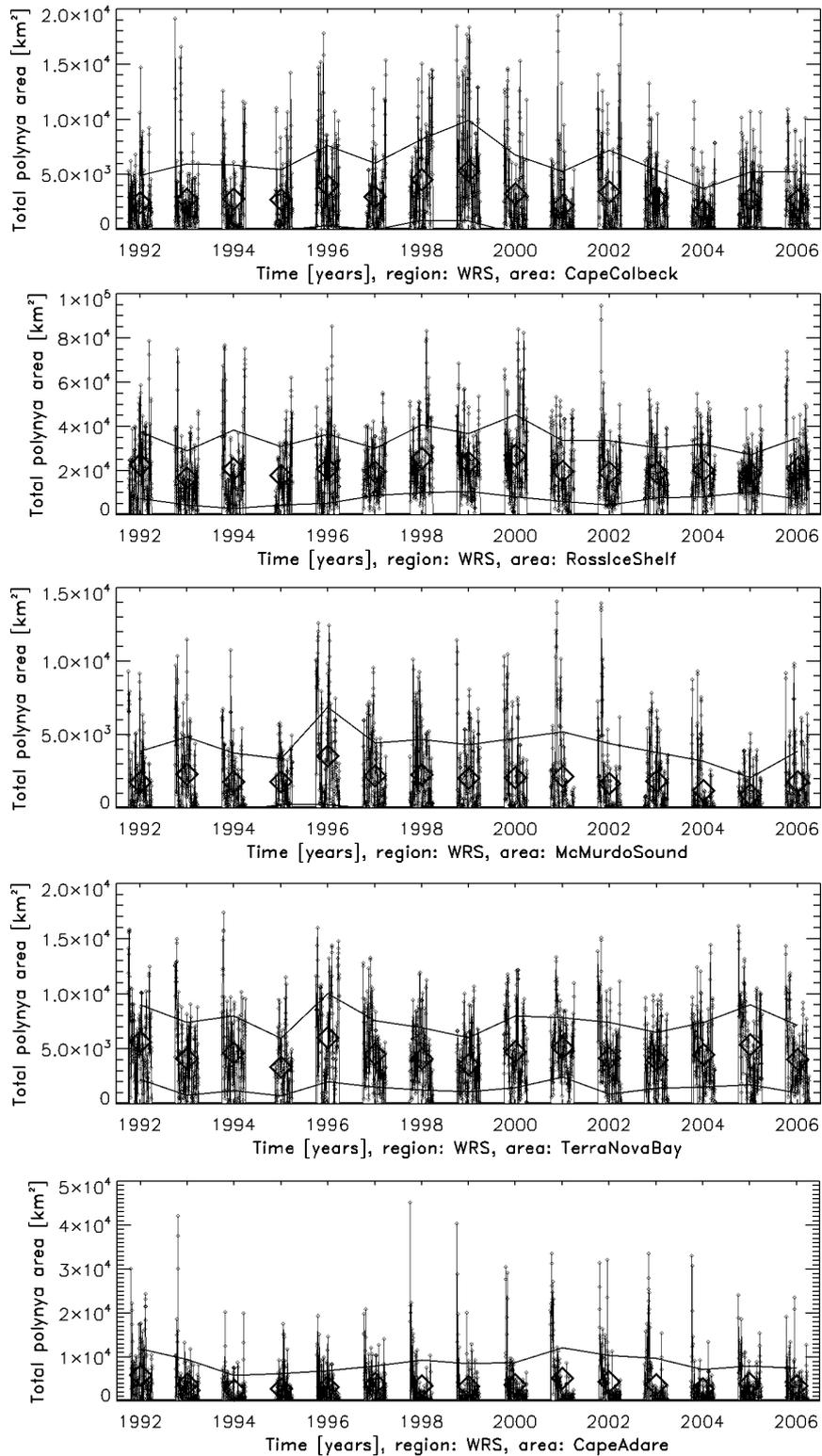
Figure 44 gives an overview about the relative polynya distribution (polynya probability) for the entire region WRS for Apr.-Sep. for the period 1992-2006. Note that the period starts in

April and that data of one more year (2006) are given. A large area where the relative polynya distribution exceeds 50 % can be identified along practically the entire Ross Ice Shelf. Peak values within this area are between 60 and 80 % during “normal” winters, i.e. prior to 2000. Starting with 2000 the already mentioned drift and grounding of a few giant icebergs (see Martin et al., 2007) influenced the probability for polynya formation substantially (Figure 45, years 2000-2002). This influence is twofold: on the one hand the probability of polynya formation along the ice shelf itself is reduced (see eastern part of sub-region 2 in years 2000 and 2001). On the other hand, such giant icebergs are able to generate polynyas on their leeward side as well (see years 2000, inside the red ellipse north of the



**Figure 46:** Same as Figure 45 but showing the relative distribution of open water.

“drifting iceberg indicated by the red arrow, and 2001, inside the small red ellipse). In 2003, after iceberg C19 has left the Ross Sea and B15A has become grounded in front of Ross Island (red arrow in image of year 2003), the polynya distribution returned to “normal” conditions (Figure 45, 2003-2006). The polynya probability at Cape Colbeck (sub-region 1) seemed not to be influenced by this event. Also the one of sub-region 3 (McMurdo Sound)



**Figure 47:** Total polynya area of sub-regions (except sub-region 6) of region WRS (see Figure 44) for Apr.-Sep. 1992-2006 (see caption of Figure 24 for further details).

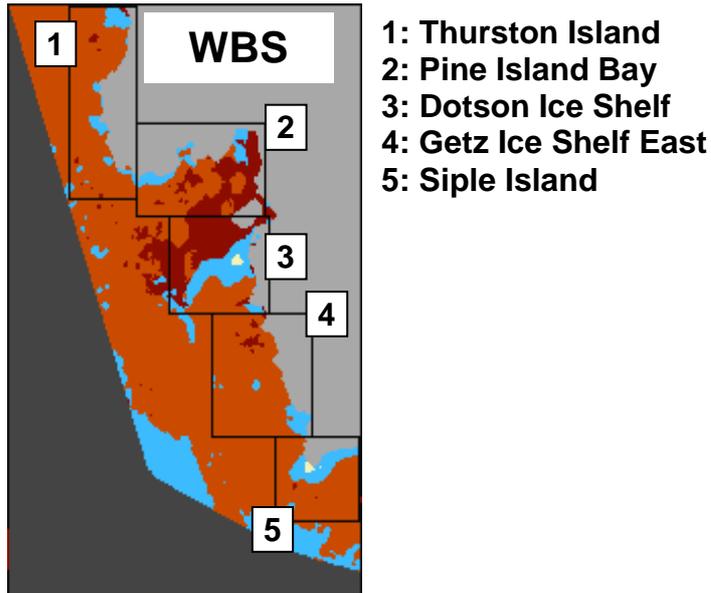
seemed not to vary stronger during this event. Both regions show peak values in the relative polynya distribution of about 40-50%. The Terra Nova Bay polynya region reveals the highest polynya probabilities in the region WRS; values peak typically between 80 and 90 % every winter. The maximum relative polynya distribution of sub-region 5 (Cape Adare) is between 20 and 40 %. Sub-region 6, finally, shows consistently low polynya probabilities (below 15

%); this sub-region will not be considered further. Figure 46 illustrates how the relative distribution of open water (as associated with the polynyas shown in Figure 45) varies from year to year, and under the influence of icebergs drifting through the Ross Sea. During typical conditions (1992-1999) open water areas only occur directly along the Ross Ice Shelf (with peak values up to 20 %) and in the Terra Nova Bay region. During the years 2000-2002 this pattern changed. In particular, an extension of areas with a substantial probability of open water towards the north can be observed. The most remarkable feature in this context is the maximum of the open water distribution well off the Ross Ice Shelf in 2002 (see red arrow in Figure 46).

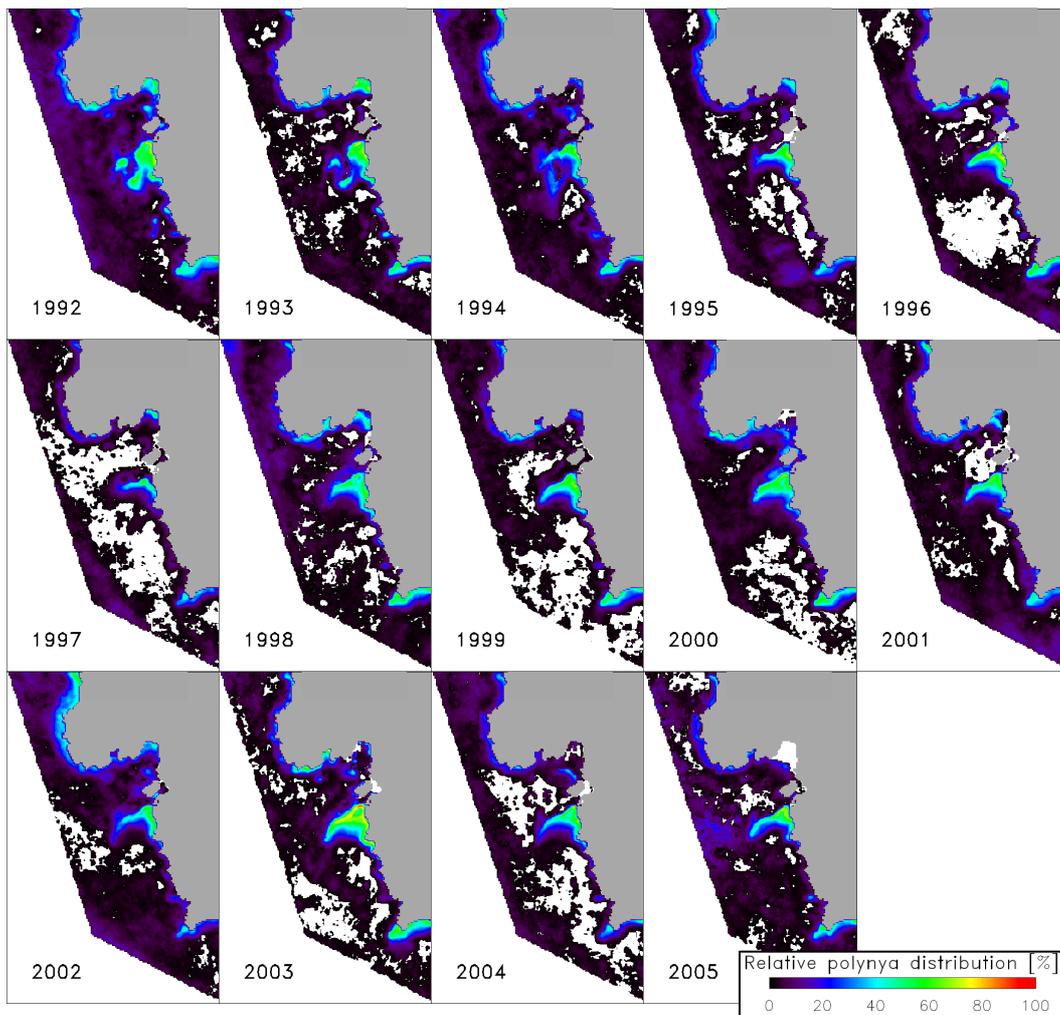
Figure 47 summarizes the time series of the (sub-)daily total polynya area of each of the four sub-regions together with the average total polynya area for Apr.-Sep. for the period 1992-2006. Table 2 lists the displayed average values together with the averages for June/July/August and the respective standard deviations. The mean total polynya area of the Ross Ice Shelf polynya (sub-region 2) takes values around 20 000 km<sup>2</sup> and ranges between 16 000 km<sup>2</sup> (1993) and 27 000 km<sup>2</sup> (2000). Note that the year of maximum total polynya area coincides with the year when the giant iceberg B15 calved and drifted along the Ross Ice Shelf through the Ross Sea, underlining the importance of polynyas generated downwind of such icebergs. Compared to this sub-region the mean total polynya area of sub-regions 1, 3, and 4 are rather small, taking values of about 3000 km<sup>2</sup>, 2000 km<sup>2</sup> and 4000 km<sup>2</sup>, respectively. Martin et al. (2007) reported annual mean polynya areas for a sub-region, which is similar to our sub-region 2, of between 18 000 km<sup>2</sup> (1993) and 35 000 km<sup>2</sup> (2000). These figures are 2000 km<sup>2</sup> and 8000 km<sup>2</sup> larger than the results given in this study but are within the envelope given by the standard deviation. Note, that their estimates of the mean total polynya area are based on the entire year, while the estimates of this study are based on data from April to September. Their estimates for the mean total polynya area of the McMurdo Sound area (around 2000 km<sup>2</sup>) and the Terra Nova Bay polynya (around 3500 km<sup>2</sup>) agree with the observations of this study. Note that the two lowest mean total polynya area values (2004, 2005 of about 1000 km<sup>2</sup>) coincide with the period, when the iceberg B15A remained grounded in front of Ross Island, causing the formation of more fast ice in McMurdo Sound than during previous years. Iceberg B15A drifted out of the area in late 2005/2006, so that the polynya area returned to normal values in 2006 (see Figure 45). Sub-region 5 is the only sub-region of region WRS, that is influenced by thin ice / open water in the MIZ early during the freezing season as is suggested by the decrease of the (sub) daily polynya area estimates given in Figure 47 from the beginning towards the middle of the freezing season (years 1993, 1998 to 2004). Consequently the mean total polynya areas derived for Apr.-Sep. differ substantially from those of the period June-Aug. (see Table 2).

## **8.9 Polynya area: Western Bellingshausen Sea (WBS)**

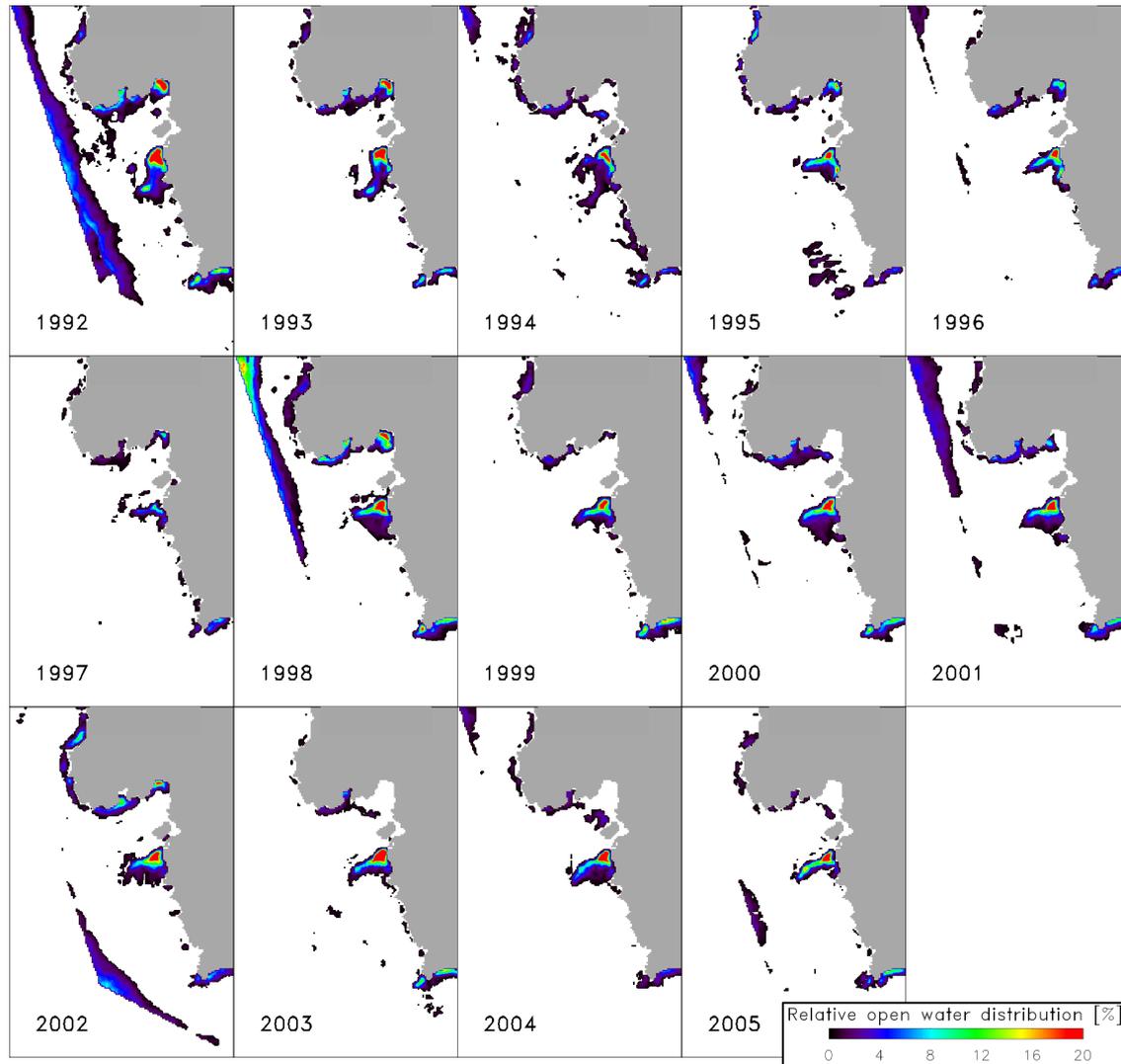
Figure 48 shows a sample map of the polynya distribution of region WBS together with the five sub-regions selected. All sub-regions share a mixed coastline with the Antarctic landmass and/or islands and ice shelves. The influence of catabatic air-flow is probably only weak to moderate. Figure 49 gives an overview about the relative polynya distribution (polynya probability) for the entire region WBS for May-Sep. for the period 1992-2005. These images reveal, that the relative polynya distribution in region WBS is dominated by three major polynyas: one in Pine Island Bay (sub-region 4), one at Siple Island (sub-region 5), and the most pronounced one off the Dotson Ice Shelf (sub-region 3). The most persistent of these polynyas is the Dotson Ice Shelf polynya. It occurs in every year but exhibits large inter-annual variability in its extent as well as in the peak value of the polynya probability, which



**Figure 48:** Zoom of region WBS – similar to Figure 22.



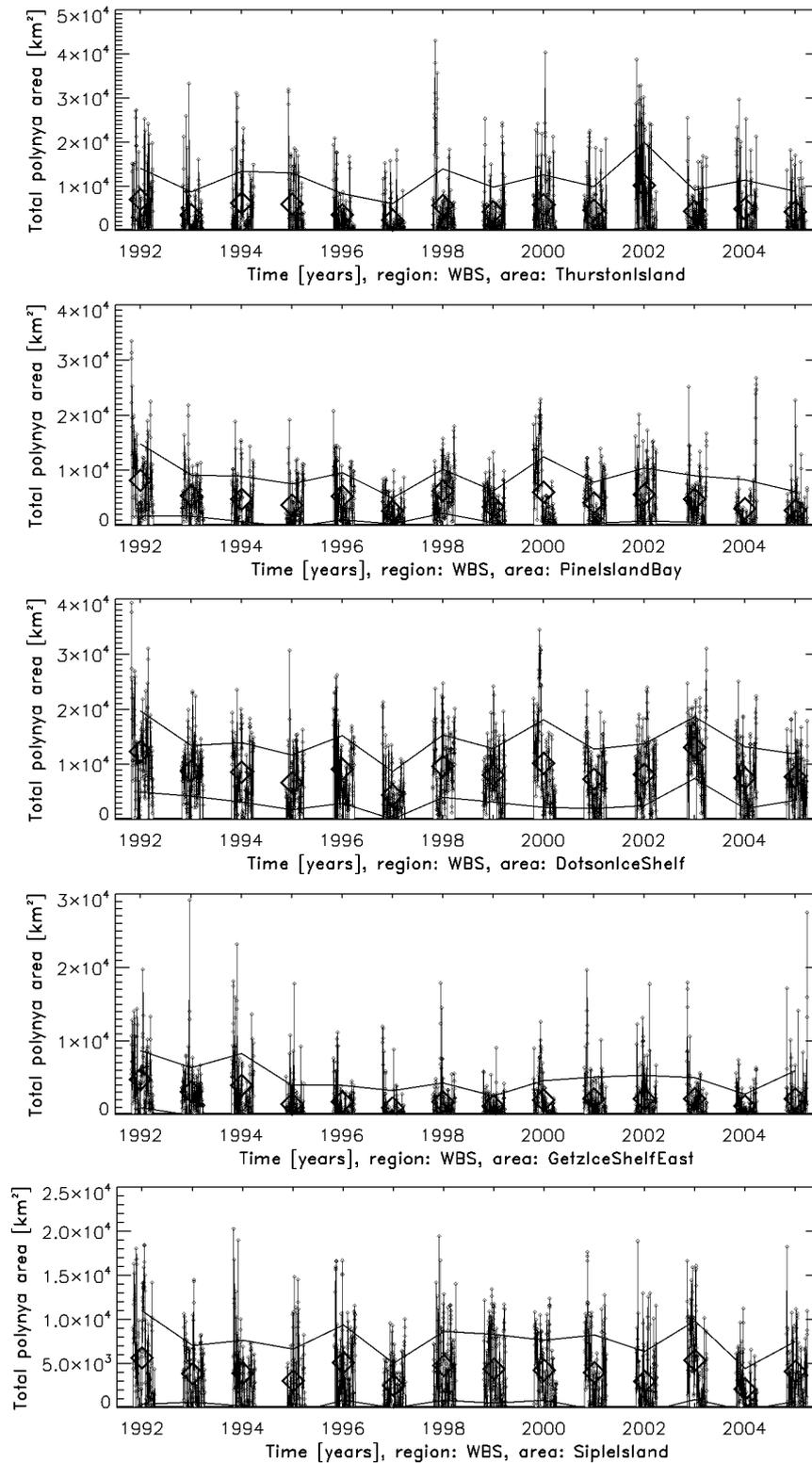
**Figure 49:** Relative polynya distribution of region WBS for the period 1992-2005 (see caption of Figure 23 for details).



**Figure 50:** Same as Figure 49 but showing the relative distribution of open water.

can be as low as 40 % (1997) but can also be as high as 90 % (2003). The Pine Island Bay polynya exhibits a high inter-annual variability as well; it can be practically absent (years 2000, 2003 to 2005) but may also cover a considerable area with a peak polynya probability of 55 % (1993). The Siple Island polynya is also quite variable (compare years 2002 and 2003) with peak polynya probabilities between 40 and 50 %. Values of the relative polynya distribution peaking between 10 and 20 % off the coastline can be attributed to the penetration of the MIZ into the shown area and/or weather effects, which tend to be particularly strong in this region and also in region EBS.

Figure 50 shows the relative open water distribution of region WBS for the period 1992-2005 (compare with Figure 46). This figure illustrates how persistent the Dotson Ice Shelf polynya is - not only concerning the presence of a polynya but also concerning the occurrence of open water. Only two other coastal polynyas exhibit a similarly high and persistent probability for the occurrence of open water within a coastal polynya: the one in the Davis Sea “downwind” of the Shackleton Ice Shelf (sub-region 6 of region EIS) and the Prydz Bay polynya “downwind” of the West Ice Shelf (sub-region 4 of region EIS). In every year except 1997 the probability for the occurrence of open water within the Dotson Ice Shelf polynya exceeds 20 %. This value is also exceeded in the Pine Island Bay polynya in the years 1992, 1993, and 1998. Other coastal polynyas, which exhibit occasionally an open water probability above 20



**Figure 51:** Total polynya area of sub-regions of region WBS (see Figure 48) for May-Sep. 1992-2005 (see caption of Figure 24 for further details).

% are the Mertz Glacier polynya (sub-region 3 in region EPS), the Davis Bay polynya (sub-region 4 in region EPS), all major polynyas in region WPS (in particular the ones at the Dalton Ice Tongue and in Vincennes Bay), the Cape Darnley polynya (sub-region 2 in region EIS), and in sub-region 4 of region EBS. It has to be noted, though, that the fact that the

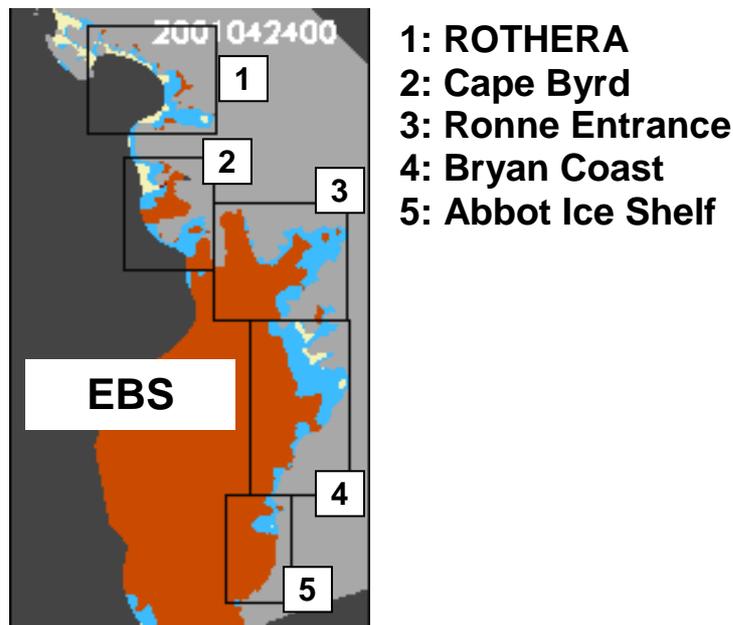
relative open water distribution remains low for a particular polynya does not mean, that no open water is present. It is more likely, that the limited spatial resolution, which is achieved with the PSSM, is not sufficient to resolve the open water area.

Moreover, it has to be noted, that a high percentage of open water does not necessarily mean, that this polynya is subject to an especially high wintertime ice production (see Section 9). At first, particularly in the East Antarctic it can be observed, that the occurrence of a high probability of open water is a function of the distance of the ice edge from the coast. In years with a low distance, i.e. a rather narrow band of compact sea ice between the coastal polynyas and the MIZ, it is more likely to observe a high percentage of open water inside a coastal polynya than in years, when this band of compact sea ice is broad. Why? Because a narrow band of compact sea ice can more easily be pushed northward, allowing in principle a larger polynya area and thus a higher probability for the occurrence of open water. And because an ice edge, which is closer to the coast likely coincides with higher air temperatures, which in turn could slow down the freezing processes in the polynya and thus could keep the polynyas open for a longer time. Secondly, a value of the open water probability of 20 % is already achieved if for the duration of one month, e.g. May, the respective region is ice free – a fact that can easily occur particularly during the beginning of the freezing season. And third, the analysis of the polynya distribution of the regions CWS and WRS is based on a period, which is one month longer than the period used for the other seven regions. Therefore, the relative distribution of a polynya or open water obtained for these regions is naturally a bit smaller compared to the other regions.

Figure 51 summarizes the time series of the (sub-)daily total polynya area of each of the five sub-regions together with the average total polynya area for May-Sep. for the period 1992-2005. Table 2 lists the displayed average values together with the averages for June/July/August and the respective standard deviations. The largest mean total polynya area is found for sub-region 3 (Dotson Ice Shelf polynya); it ranges between 4000 km<sup>2</sup> (1997) and 13 000 km<sup>2</sup> (2003). The mean total polynya areas found for sub-regions 2 and 5 range between 2000 and 8000 km<sup>2</sup>, and 2000 km<sup>2</sup> and 5500 km<sup>2</sup>, respectively. Sub-region 1 (Thurston Island) reveals also a quite large mean polynya area (although the peak polynya probabilities are comparably low, see Figure 49) of around 4000 km<sup>2</sup> with a peak value in 2002 of 10 000 km<sup>2</sup>. Sub-region 4 exhibits the lowest mean total polynya area of region WBS with values between almost zero and 5000 km<sup>2</sup> (1992).

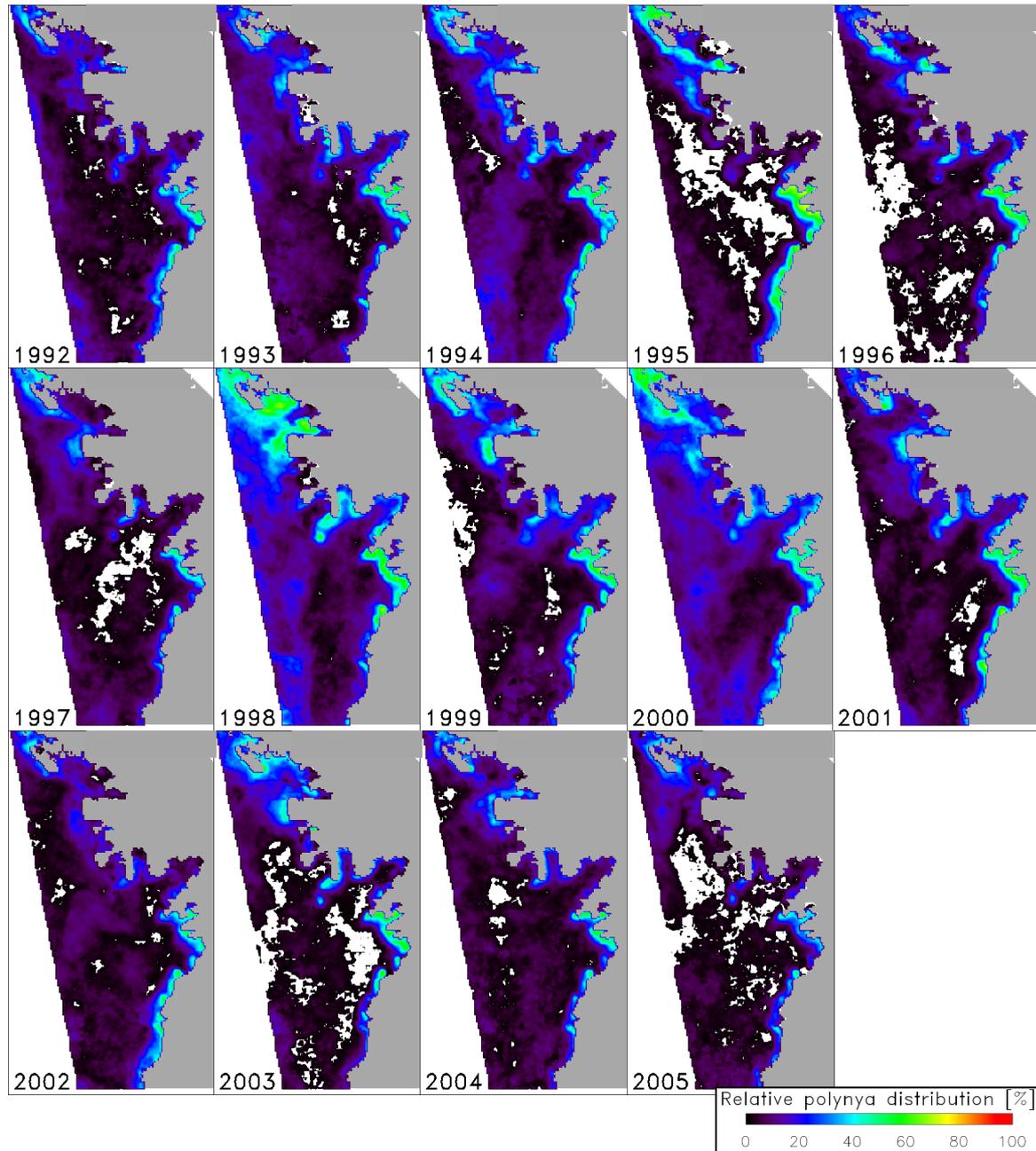
## 8.10 Polynya area: Eastern Bellingshausen Sea (EBS)

Figure 52 shows a sample map of the polynya distribution of region EBS together with the five sub-regions selected. Sub-region 5 overlaps with sub-region 1 (Thurston Island) of region WBS. Sub-regions 1 to 3 are situated in the vicinity of the Antarctic Peninsula and the adjacent islands between which a number of ice shelves exist. The influence of catabatic winds in these regions is probably small – except perhaps in sub-region 3. Sub-regions 4 and 5 border the coastline of the Antarctic landmass and also a number of ice shelves. Particularly sub-region 4 is likely influenced by weak to moderate catabatic winds. The location of the ice edge / MIZ in this region is known to be very variable (e.g. Stammerjohn and Smith, 1996). In some years it is located that far south, that sub-regions 1 and 2 cannot be analyzed properly with the PSSM in term of the identification of polynyas, because rather the ice edge than polynyas are present within region EBS and also in sub-regions 1 and 2. This becomes evident in Figure 53, which gives an overview about the relative polynya distribution (polynya probability) for the entire region EBS for May-Sep. for the period 1992-2005. High polynya probabilities can be identified in the area covered by sub-regions 1 and 2 particularly in 1998 and 2000. Also during the other years elevated polynya probabilities occur well off the coast and might influence the polynya area computed for the given sub-regions, so that the interpretation of the results obtained for the region EBS has to be done with care. The largest confidence could be put on the results of sub-regions 3 to 5. Given the substantial influence of the ice edge in sub-region 1, the sub-region 4 (Bryan Coast) exhibits the most persistent polynya, with peak values in the relative polynya distribution between 40 % (2005) and 75 % (1995).



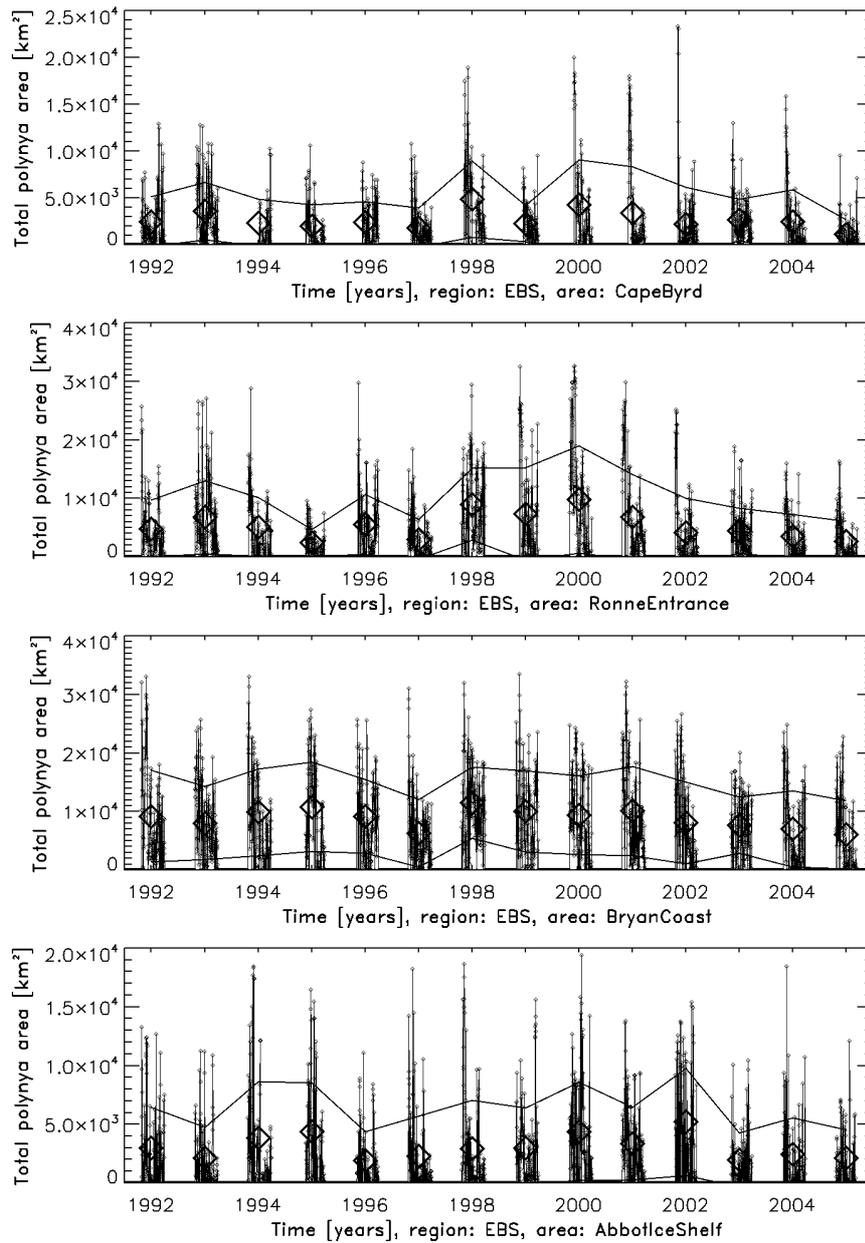
**Figure 52:** Zoom of region EBS – similar to Figure 22.

Figure 54 summarizes the time series of the (sub-)daily total polynya area of each of the four sub-regions 2 to 5 together with the average total polynya area for May-Sep. for the period 1992-2005. The values for sub-region 1 (Rothera) are omitted. Table YYY lists the displayed average values together with the averages for June/July/August and the respective standard deviations. Keep in mind that also the polynya areas of sub-region 2 have to be considered with care. Sub-region 4 (Bryan Coast) reveals the largest mean total polynya area with values between 6000 km<sup>2</sup> (1997, 2005) and 11 000 km<sup>2</sup> (1998). The mean total polynya areas found



**Figure 53:** *Relative polynya distribution of region EBS for the period 1992-2005 (see caption of Figure 23 for details).*

in sub-regions 3 and 5 take values between 1000 km<sup>2</sup> (1995) and 10 000 km<sup>2</sup> (2000) and 1500 km<sup>2</sup> (1996) and 5000 km<sup>2</sup> (2002), respectively. It remains difficult to interpret these values because of the variability of the ice edge in region EBS. So, the mean total polynya area given for sub-region Bryan Coast for 2003 is slightly smaller than the one for 2002 (Figure 54). However, Figure 53 reveals a much more clearly defined coastal polynya in 2003 as compared to 2002, so that more confidence can be put to the results of 2003 than those of 2002. In fact, if restricting the analysis to the months June to August, the mean total polynya area obtained for 2003 is larger than the one obtained for 2002.



**Figure 54:** Total polynya area of sub-regions 2-5 of region EBS (see Figure 52) for May-Sep. 1992-2005 (see caption of Figure 24 for further details).

## 8.11 Summary of PSSM areas

Table 2 summarizes the overall mean (i.e. averaged over the entire period 1992-2005) total polynya area of all sub-regions of all nine regions given in Figure 2.

Sub-region	1	2	3	4	5	6	7	8
Apr.-Sep.	1357	1377	941	1516	9538	1517	1409	3740
Min.	200	100	0	0	6400	200	300	2000
Max.	2200	2900	1600	4200	12 000	3000	2600	5700
June-Aug.	997	1099	878	1426	8901	1198	977	3060
Min.	100	200	100	200	6000	200	500	1800
Max.	2200	2500	2500	4000	12 000	1500	3000	5000

**Table 2:** Mean overall total polynya area of sub-regions 1-8 of region CWS (see Figure 22). For each period (Apr.-Sep. and June-Aug.) the mean value, its standard deviation and the minimum and maximum total polynya area are given from top to bottom, respectively. The sub-region with the largest (second-largest) mean overall total polynya area is highlighted red (orange). All values have the unit km<sup>2</sup>.

Sub-region	1	2	3	4
May-Sep.	2630	11 112	10 074	6606
Min.	1600	5400	5500	4600
Max.	3600	16 800	15 500	8700
June-Aug.	2274	10 108	8323	5701
Min.	1500	4500	5500	3500
Max.	3600	19 500	12 300	9200

**Table 2, continued:** Region EWS, see Figure 27.

Sub-region	1	2	3	4
May-Sep.	8710	5330	3284	6042
Min.	4500	3100	2000	5000
Max.	13 000	7800	5400	9600
June-Aug.	8264	5412	3222	6164
Min.	4300	2800	1300	4200
Max.	14 000	9500	6000	9800

**Table 2, continued:** Region WIS, see Figure 31.

Sub-region	1	2	3	4	5	6
May-Sep.	4836	12 022	4951	15 078	4206	13 755
Min.	2000	8600	3500	10 100	2200	10 200
Max.	8000	18 000	6400	18 600	7000	17 000
June-Aug.	4289	11 739	4412	14 907	3693	12 766
Min.	2000	7000	3100	10 000	2000	9600
Max.	8400	18 000	6500	20 000	8000	16 700

Table 2, continued: *Region EIS, see Figure 34.*

Sub-region	1	2	3	4	5	6	7	8
May-Sep.	10 365	2925	6269	6559	7385	9802	3751	7263
Min.	7600	1900	4600	5100	5800	7200	2200	5400
Max.	13 000	3600	8200	8500	10 800	12 400	6300	10 200
June-Aug.	10 015	2740	5740	6157	6566	9611	3316	7000
Min.	8000	1900	4200	4700	4000	6900	1200	4800
Max.	12 300	3800	8200	9400	10 000	14 100	6000	9700

Table 2, continued: *Region WPS, see Figure 38. Because sub-regions 1 and 8 are already considered in regions EIS and EPS, they are marked in grey, and are not considered for the ranking of the largest polynya area.*

Sub-region	1	2	3	4
May-Sep.	5991	3436	15 230	7655
Min.	2900	1500	12 000	6000
Max.	9500	5400	21 500	10 200
June-Aug.	5347	3129	13 786	7147
Min.	2500	1200	11 000	4500
Max.	8400	5400	18 000	9900

Table 2, continued: *Region EPS, see Figure 41.*

Sub-region	1	2	3	4	5	6
Apr.-Sep.	3095	20 825	1961	4533	3752	710
Min.	1600	16 300	900	3300	2400	0
Max.	5300	27 000	3400	6000	5900	1500
June-Aug.	2585	19 229	1911	4040	2835	507
Min.	1200	12 400	700	3200	1200	0
Max.	5600	29 400	3300	5000	6200	1600

Table 2, continued: *Region WRS, see Figure 44.*

Sub-	1	2	3	4	5
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region					
May-Sep.	5247	4739	8726	2219	4024
Min.	1915	1576	2196	1097	1064
Max.	2400	2800	4500	1000	2000
June-Aug.	10 200	8100	13 100	4800	5600
Min.	4679	3906	7886	1870	3584
Max.	2254	1591	2635	1111	1248
Min.	2000	1200	3400	400	1600
Max.	11 000	6900	13 200	4500	5500

**Table 2, continued:** *Region WBS, see Figure 48.*

Sub-region	1	2	3	4	5
May-Sep.	5761	2714	5387	8811	3067
Min.	2882	1003	2306	1661	1035
Max.	1800	1100	2400	6000	1900
June-Aug.	13 800	4900	9700	11 500	5200
Min.	5988	2541	4443	7819	2694
Max.	3334	1283	2639	2503	1358
Min.	1800	800	1200	4000	1400
Max.	15 000	5000	9700	12 900	5300

**Table 2, continued:** *Region EBS, see Figure 52. Values for sub-region 1 (Rothera) are marked in grey and are not considered in the ranking of the largest mean total polynya area because of the enhanced influence by the MIZ and weather.*

Taking into account, that several sub-regions of the different region overlap, the total wintertime (June to Aug.) polynya area for all regions can be calculated and is given in Table 3 together with the mean error. The mean error takes a value between 10 and 20 percent of the total polynya area for most of nine regions; only region EBS exhibits a substantially larger mean error. From that it can be concluded that during 1992-2005 the mean total wintertime (June to Aug.) polynya area around Antarctica amounts about:  $(235\ 000 \pm 12\ 400)$  km<sup>2</sup>. Most important in terms of the polynya area is region EIS (see Figure 2); regions WPS and WRS have the second-largest contribution to the circum-Antarctic polynya area, followed by regions EPS, EWS, and WBS (see Figure 2).

CWS	EWS	WIS	EIS	WPS	EPS	WRS	WBS	EBS
16 485	23 555	18 921	51 806	34 130	24 062	31 107	21 925	12 801
2784	4943	3895	5219	3671	2774	5038	4165	3882
16.9	21.0	20.1	10.1	10.8	11.5	16.2	19.0	30.3

**Table 3:** *Total mean wintertime (June to August) polynya area of every region together with the mean absolute (middle row) and relative (bottom row) error of the mean total polynya area. Note that sub-region Balleny Islands (region EPS) has been excluded because it is not a coastal polynya. Note also that sub-regions Rothera and Cape Byrd (region EBS) have been excluded because of the too large influence of the MIZ.*