Spatial and Temporal Variability in Southern Ocean Sea Ice Coverage

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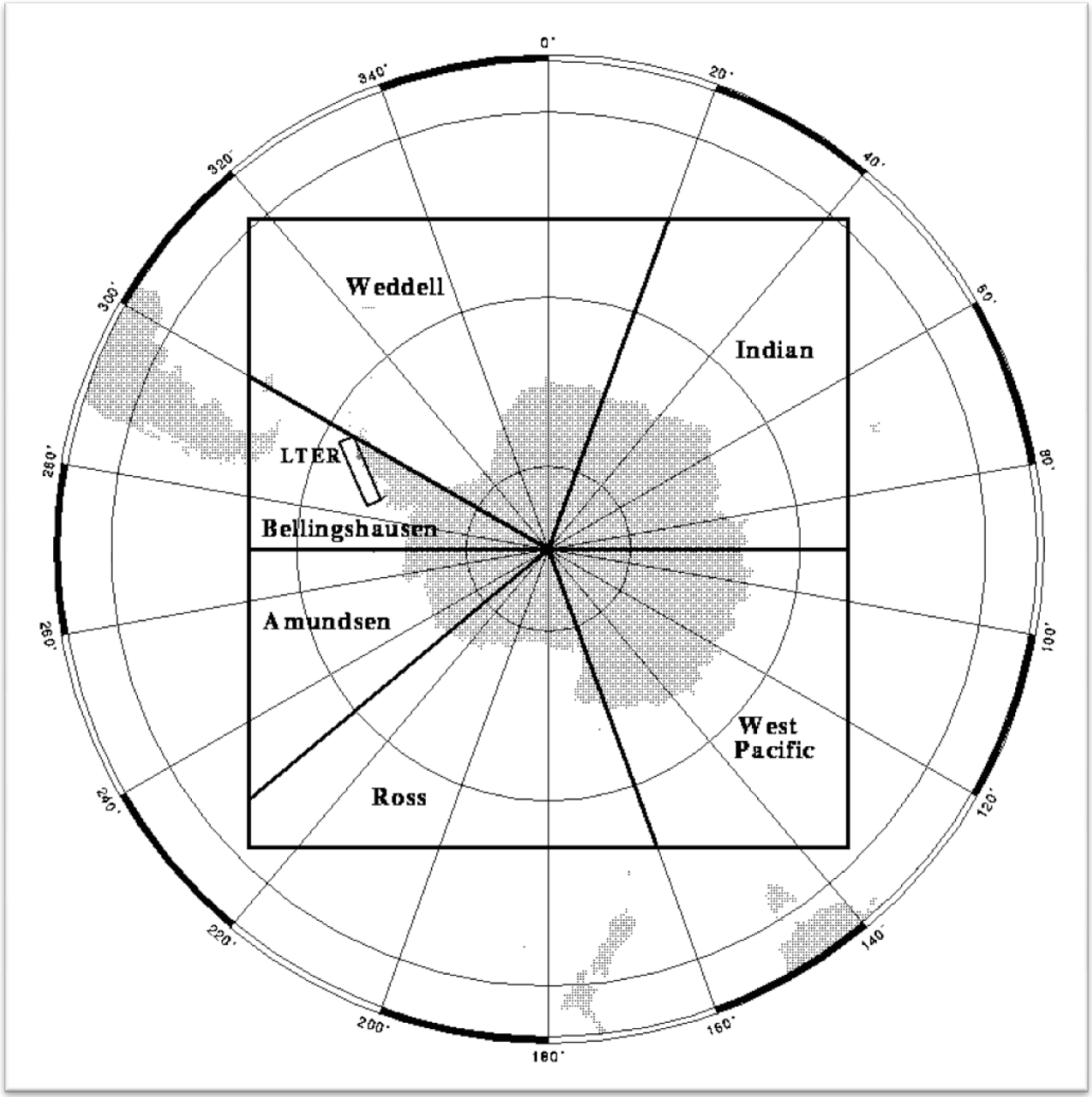
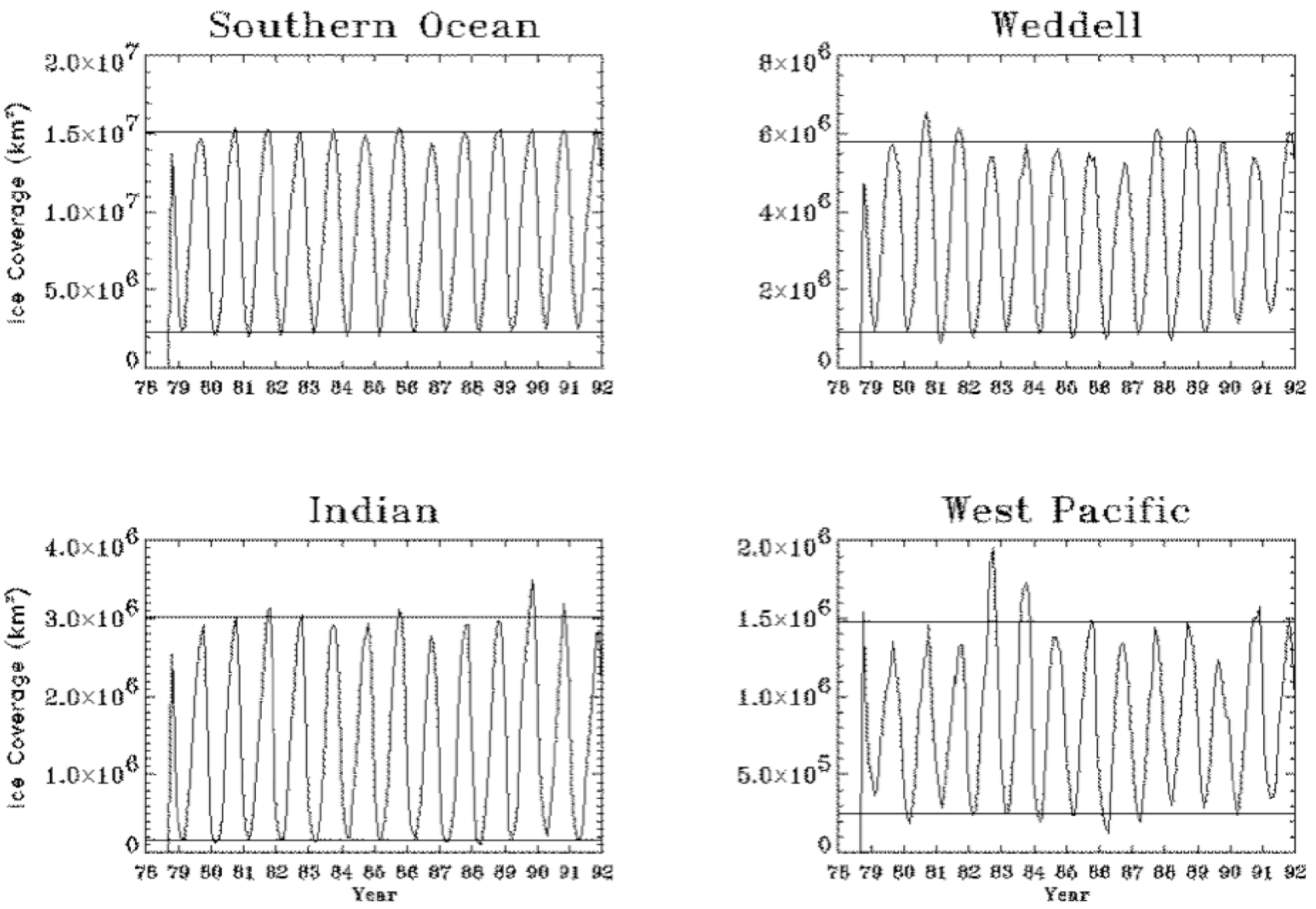
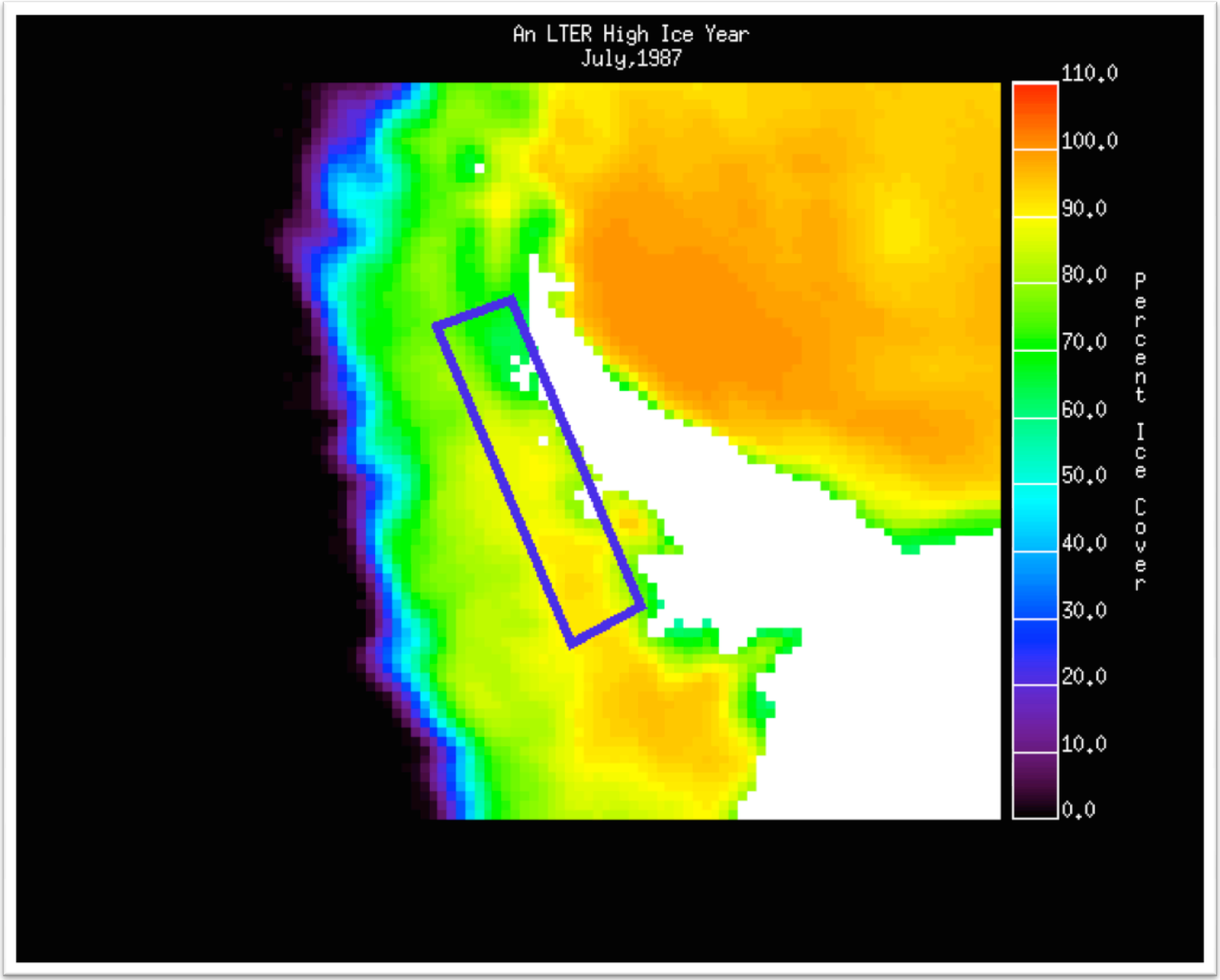
- Spatial and temporal variability in Southern Ocean sea ice coverage is analysed from October, 1978 to December, 1991. Sea ice coverage is calculated from passive microwave satellite data, using Scanning Multi-Channel Microwave Radiometer (SMMR) and Special Sensor Microwave/Imager (SSM/I) data. Spatial variability in sea ice coverage was based on the following eight regions: Southern Ocean, Weddell, Indian, West Pacific, Ross, Amundsen and Bellingshausen regions, as well as a subregion of the Bellingshausen, the Long Term Ecological Research (LTER) study area located west of the Antarctic Peninsula. The six adjacent Southern Ocean regions all show unique interannual variability which is confirmed by cross spectral analysis of monthly anomalies, and no two regions have the same anomalous years of extreme maximum or minimum ice coverage. Regional interannual variability appears to be a yearly re-distribution of near constant ice coverage for the whole Southern Ocean, and in extreme high or low ice years there are asymmetries in Southern Ocean ice coverage. Spectral analysis of monthly anomalies confirmed that most of the variance in regional ice coverages is due to interannual variability. Several patterns in interannual and annual variability are observed in the 13.25-year time series of Southern Ocean ice coverage, and possible climatic forcings contributing to these patterns are discussed. A thorough characterization of LTER ice coverage in comparison to the other regional ice coverages is provided, and possible ice-ocean-air and ice-ecosystem dynamics in the LTER region are explored.

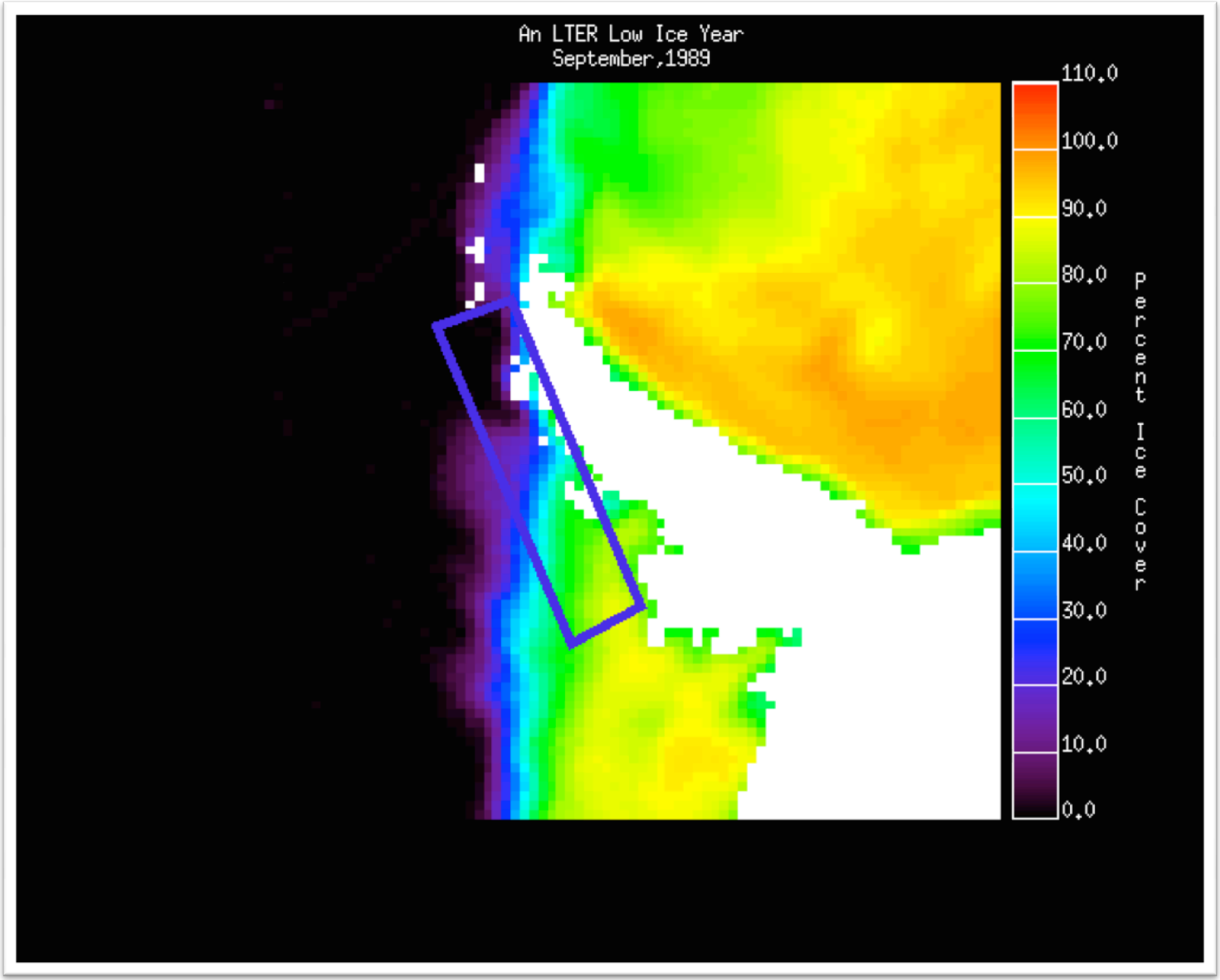

0°
20°
40°
60°
80°
100°
120°
140°
160°
180°
200°
220°
240°
260°
280°
300°
320°
340°
Weddell
Indian
LTER
Bellingshausen
Amundsen
West
Pacific
Ross

- The above map shows the eight regions used in the analysis of spatial variability in Southern Ocean sea ice coverage. The first region is the Southern Ocean as defined by the area inside the large square which corresponds to the National Snow and Ice Data Center's southern grid. The Southern Ocean was then divided up into six additional regions as follows: Weddell, Indian, West Pacific, Ross, Amundsen and Bellingshausen. The eighth region is the LTER study area which is defined by the rectangle just west of the Antarctic Peninsula.


Southern Ocean
Weddell
Indian
West Pacific
Ice Coverage (km²)
2.0×10⁷
1.5×10⁷
1.0×10⁷
5.0×10⁶
0
8×10⁶
6×10⁶
4×10⁶
2×10⁶
4.0×10⁶
3.0×10⁶
2.0×10⁶
1.0×10⁶
2.0×10⁶
1.5×10⁶
1.0×10⁶
5.0×10⁵
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92
Year

- The above two figures show monthly ice coverage for the Southern Ocean, Weddell, Indian, West Pacific, Ross, Amundsen, Bellingshausen and LTER regions. The time series begins October 1978 and ends December 1991. The horizontal lines are 13.25-year mean maximum and minimun ice coverage. Note that the y axes have different scales.


An LTER High Ice Year
July,1987
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
percent Ice Cover


An LTER Low Ice Year
September,1989
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
percent Ice Cover

- SSM/I images of high and low ice years for the LTER study area. The blue box defines the LTER study area. These images represent the months of maximum ice coverage for the highest and lowest ice years in the 12.5 year record. Note that the high ice year reached a maximum in July, one month earlier than the average maximum month (ie., August), and the low ice year reached a maximum in September, one month later that the average.