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Distribution Statement

**National/Naval Ice Center
Seasonal Outlook
Western Ross Sea and McMurdo Sound
2007-2008**

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ABSTRACT

This Seasonal Outlook for the ROSS SEA covers the upcoming melt period for the southern hemisphere 2007 spring. Conditions of first year ice and multiyear ice, in both open water and in vicinity of McMurdo Sound and Station, are provided. Data is compiled using various approved forecasting methods and numerous remote sensing tools. Forecast conditions are for the open water regions to melt with the typical hourglass pattern, and with a slightly later opening date than is normal. The Ross sea ice band is projected to be 80 – 100 nm in width, requiring vessels to use ice breaker escorts until mid January. Conditions in McMurdo Sound are forecast for the thicker first year fast ice to flush from the channel after icebreaker transit, with much multiyear ice remaining to the western regions, south of Drygalski Ice Tongue to Cape Royds.

I. INTRODUCTION

This outlook presents the expected positions of the sea ice “edges” in the Western Ross Sea and the depiction of the mid-October fast ice boundary in McMurdo Sound. (See figure 1 for a map of the areas of interest within McMurdo Sound). Ice edge positions at 15-day intervals, beginning 15 December, are forecast through the end of the shipping season in mid-February. The term “edges” is used to indicate and describe the typical “hourglass” melt pattern of the Ross Sea ice cover. This pattern of pinching off the pack ice occurs due to the concurrent ice melt along the northern ice edge and an enlarging polynya adjacent to the Ross Ice Shelf. The concentration and stage of development of ice remaining between these two edges are important factors in this outlook as a measure of predicted severity along the shipping route located between 175E and 177W.

Additional factors evaluated for the forecast are sea ice model estimates, atmospheric forecast model estimates, climate teleconnective patterns, and the ice thickness and linear distance from Hut Point to the fast ice edge in McMurdo Sound. The linear distance is measured along a bearing of 330 degrees from Hut Point to the closest access point at the fast ice edge for incoming vessels. Additional estimates of the fast ice edge use optimal distance from Hut Point.

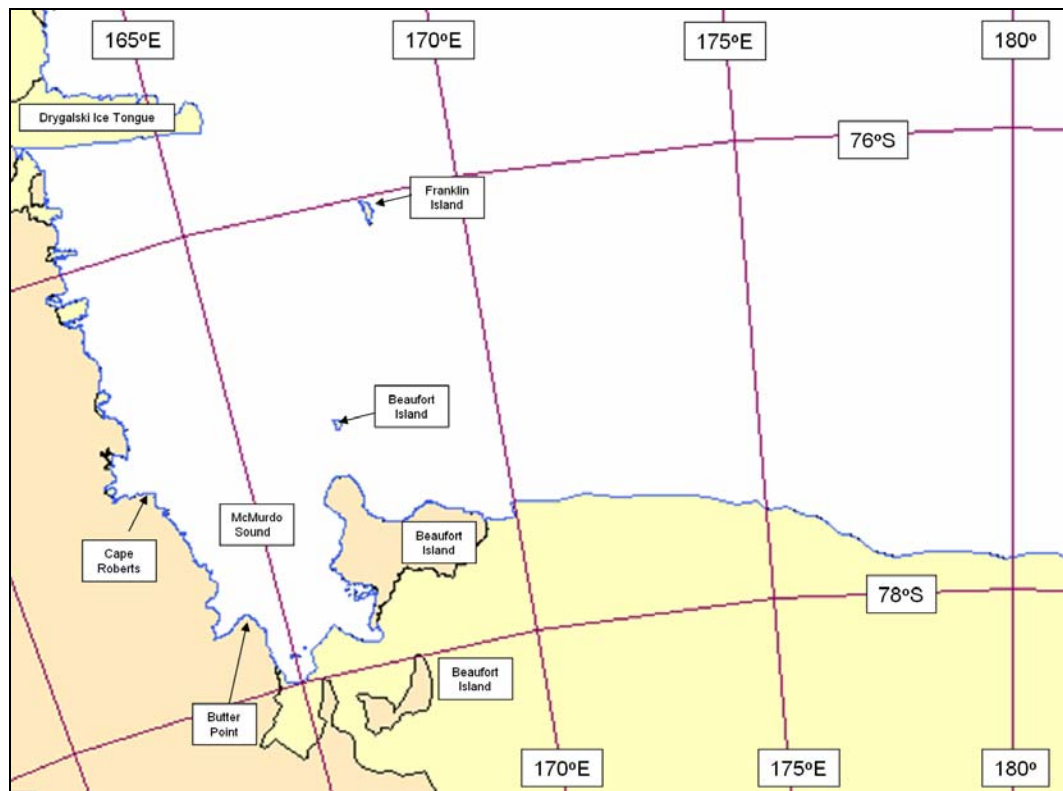


Figure 1 Map of McMurdo Sound

The categories of environmental data used to compile this outlook include:

- 1) Remotely sensed imagery: visible satellite imagery from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS), the Defense Meteorological Satellite Program (DMSP) Operational Line-Scan System (OLS), NOAA's Advanced Very High Resolution Radiometer (AVHRR), DMSP Special Sensor Microwave Imager (SSM/I), QUIKSCAT, EnviSat Global Monitoring Mode (GMM), and Advanced Microwave Scanning Radiometer for EOS (AMSR-E),
- 2) Drilled ice thickness measurements in McMurdo Sound,
- 3) Archived meteorological data received from McMurdo Station for 2007,
- 4) National Centers for Environmental Prediction (NCEP) / National Center for Environmental Research (NCAR) Reanalysis Data through September 2007, and
- 5) Sea ice climatology for the Ross Sea.

The rates of recession for the Ross Sea ice edge and the McMurdo Sound fast ice edge are derived using an analogue forecasting technique that relates historical observations of pre-season ice extent and thickness to the predicted severity of austral summer ice conditions. This relationship is based upon the premise that ice conditions of similar areal extent and thickness will follow the same historical progression of decay. This "persistence" of antecedent ice conditions and recession rates has been well documented during the many years of Operation DEEP FREEZE.

(Operation DEEP FREEZE is the unclassified code name given the operations previously conducted by the U.S. Navy to provide operational and logistic support to the United States Antarctic Program (USAP).)

The estimated position of the ice edge and the "opening date" are based on the collection of evidence from analogue years, adjusted to reflect alterations of current conditions from past conditions, forecast atmospheric models, oceanic models, and cryospheric models.

II. INITIAL ICE CONDITIONS AND ICE CLIMATOLOGY

The National Ice Center (NIC) ice analysis from 01-05 October 2007 (**Figures 2a-2c**) reveals that the position of the northern ice edge is between a climatological mean and a maximum across the majority of the Ross Sea. Concentrations of multi-year pack ice are found to the west of 176E in the southern Ross Sea, continuing northwestward around Cape Adare and into the western Ross Sea to the south and west of the Bellany Islands.

During the austral summer, the majority of the multiyear fast ice south of the Drygalski Ice Tongue was able to breakup and melt without the presence of iceberg C-16 which had hampered the breakup of the fast ice in past years. The majority of the fast ice now is first year ice with the exception of McMurdo Sound, which is still a majority of old ice, with reported ice thickness of 78" to 88". Total concentration and stage of development of sea ice and icebergs is labeled using World Meteorological Organization (WMO) international system of sea ice symbols, also known as "Egg Code" (see **Figure 3** for an explanation).

Historically, a flaw lead occurs along the Ross Ice Shelf during the first week of November. This flaw lead is already beginning to develop to the east of Ross Island (see **Figure 4**), but still has a few more weeks before it becomes a persistent feature.

As of 12 October 2007, there are two icebergs of significance remaining in the Ross Sea. B-15J is closest to McMurdo Sound, and is centered near 75°57'S/167°19'E. **Figure 4** shows the relative position of this iceberg. And the second iceberg of interest is C-19A, which is currently centered at 65°10'S/176°55'W. At 88x17 NM, iceberg C-19A is the largest of the two large icebergs in the Ross Sea. C-19A is far enough north that it has become caught in the West Wind Drift, and is slowly drifting eastward. Numerous smaller bergs are calving off of C-19A. These smaller bergs, along with C-19A itself, could pose a hazard to the shipping route into the Ross Sea between 178E and 170W at some point during Operation DEEP FREEZE 2007-2008.

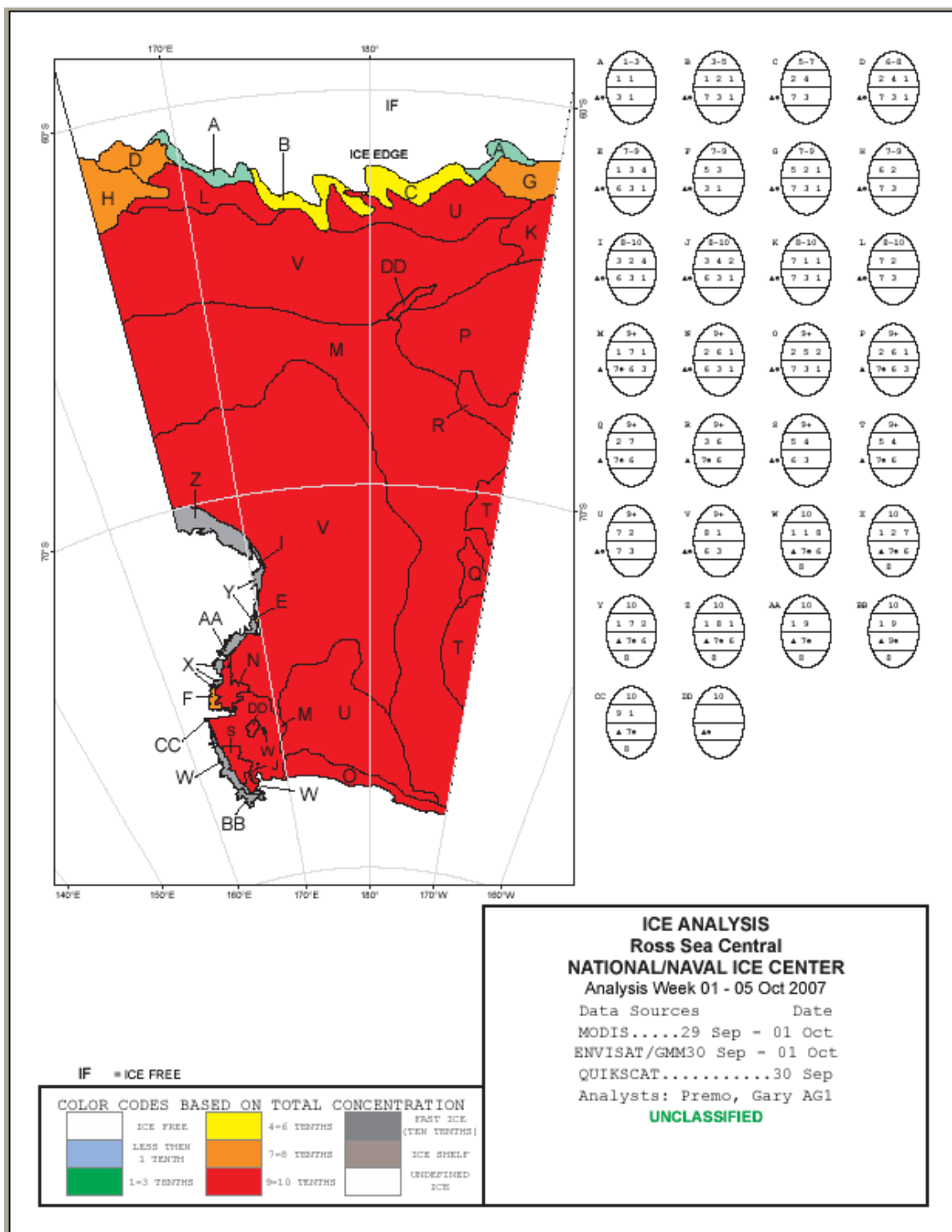


Figure 2a. 01-05 October 2007 Ross Sea Central Ice Conditions

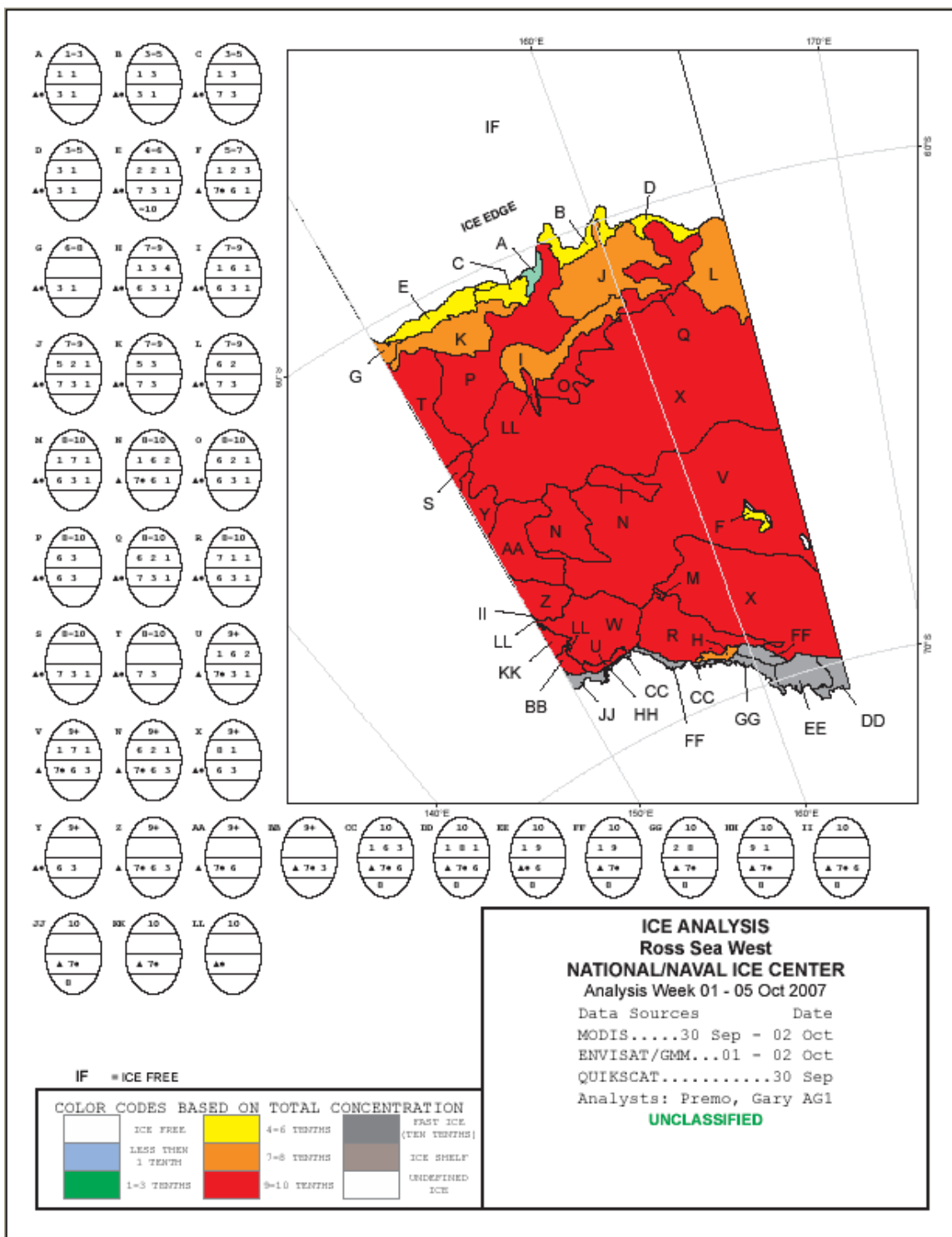


Figure 2b. 01-05 October 2007 Ross Sea Central Ice Conditions

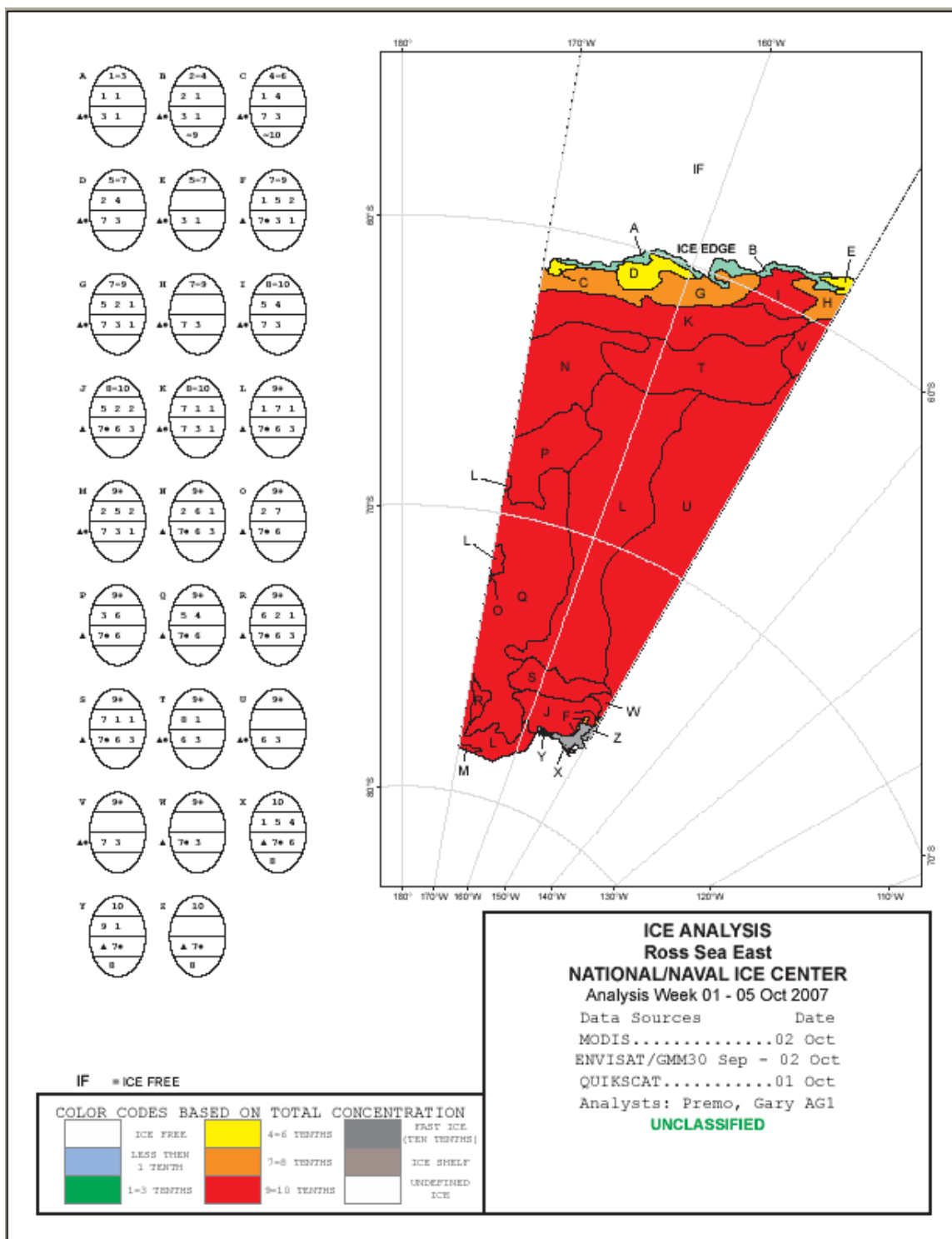
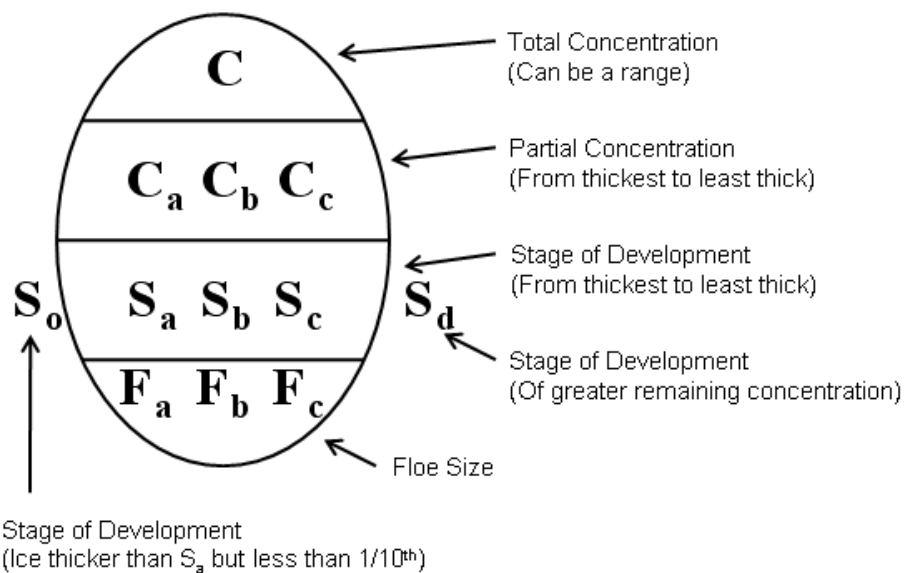


Figure 2c. 01-05 October 2007 Ross Sea East Ice Conditions



STAGES OF DEVELOPMENT

- 1 = New ice (0 - 10 cm)**
- 3 = Young ice (10 -30 cm)**
- 6 = First year (30 – 100 cm)**
- 7 = First year thin (30 -70 cm)**
- 1 · = First year medium (70 -120 cm)**
- 4 · = First year think (120 – 200 cm)**
- 7 · = Old ice (survived at least 1 summers melt)**
- 8 · = Second year ice (survived 1 summers melt)**
- 9 · = Multi yea ice (survived at least two summer melt)**

Figure 3. WMO Egg Code

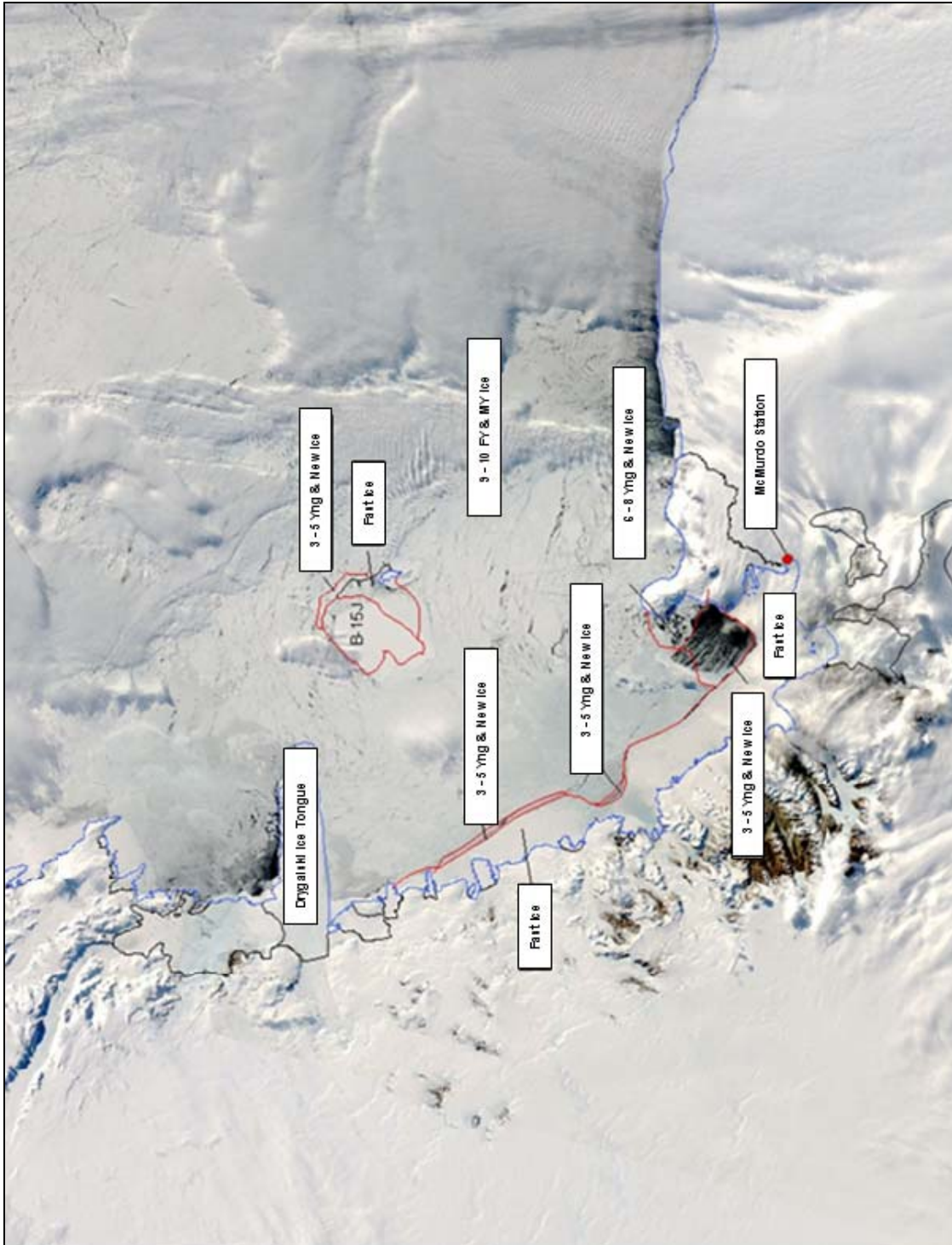


Figure 4. 15 Oct 2007 – MODIS – aqua

III. OUTLOOK

Ross Sea

The average opening date for the icebreaker-led convoys to transit the western Ross Sea shipping lane is historically 7-10 January. Typical conditions on the opening include a 20-50 NM wide “band” of lesser ($<4/10$ tenths) concentration ice. **A slightly later than normal opening date is forecast this year.** This forecast is based on:

- a) *Surface Air Temperatures.* The NCEP reanalysis model suggests that surface air temperatures over the Ross Sea were mild during the austral winter. Air temperatures at McMurdo Station suggest a mild winter as well, although temperatures were significantly below normal during the second half of June into the first week of July of 2007. The mild winter should act to lessen both the ice thickness and the subsequent time required to melt the first/multi-year sea ice. Additionally, global climate models (GCMs), like the Scripps’ Global Spectral Model, indicate slightly warmer than normal conditions are expected for the summer in the Ross Sea. This will aid the melt of sea ice along the Ross Ice Shelf.
- b) *Near Normal Sea Surface Temperatures along Ice Edge.* Near normal sea surface temperatures have been seen along the western Ross Sea ice edge from March-September 2007. The current outlook from NOAA’s Climate Prediction Center suggests near normal conditions will persist until early 2008.
- c) *Fast Ice Extent in McMurdo Sound.* The fast ice extent in McMurdo Sound in October 2007 is closer to a normal extent for this time of year. The majority of this fast ice has survived through 2 years, but is likely to fracture and flush from the sound. Isolated areas of fast ice with large multi-year content located along the shoreline from Drygalski Ice Tongue south to Cape Royds (see **Figure 7**) are likely to remain late into the Antarctic summer melt.
- d) *Icebergs.* Icebergs scattered in the western Ross Sea continue to drift along with oceanographic currents typical throughout the region. The impact of icebergs on the flushing of sea ice out of the McMurdo region should be significantly less this season than in the recent past. However, because icebergs typically move at a slower velocity than sea ice, the sea ice could be restricted from advecting around the remaining large icebergs, resulting in greater ice concentrations along their windward side.
- e) *Analog Years.* Comparing Ross Sea ice conditions in early October of 2007 reveals similarities to ice conditions found in early October of 1998, 2001 and 2005. During these analog years, the mean unescorted date ($< 4/10$ ice coverage) was 13 January.

- f) **Statistical Model Results:** the newly developed multiple linear *Statistical Model Results*. The newly developed multiple linear regression method for determining ice recession predicted Jan 12th as a navigable date. Since this tool is still under evaluation and has not undergone peer review, it is treated as only one tool within the overall assessment. This linear empirical model was used in forecasting previous opening dates, and since 1972 has resulted in only two years exceeding 15 days from the actual opening date. With this low variability, it appears able to give an objective estimate of previous opening dates with reasonable accuracy. The date provided by the model has been adjusted based on the additional variables used in the forecast.

Taking into consideration the inputs mentioned above, **it is projected that the Ross Sea ice “band” will be 80-100 NM in width and vessels will require icebreaker escort until about 16 January 2007 (Figure 5).** Navigable ice conditions for unescorted vessels (< 4/10 tenths) are expected after 13 January 2007.

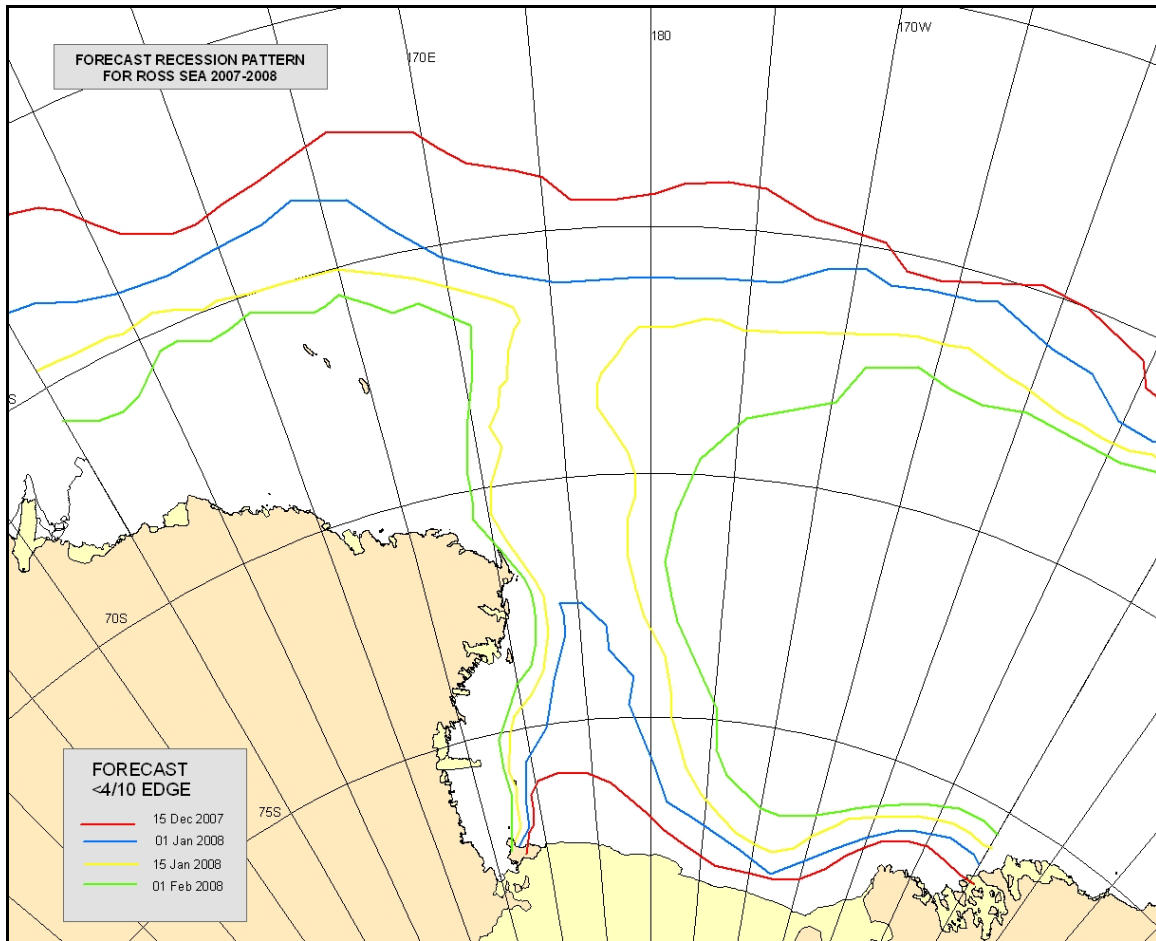


Figure 5. Forecast Recession Pattern for Ross Sea (2007-2008) Season (<4/10 edge)

McMurdo Sound

After a cooler than normal period from March through June, July through September of 2006 was milder than normal for McMurdo Sound. Current observed fast ice thickness around McMurdo is at least 5 ft in first-year thick and multi-year ice within the previous years' ice channels. The historical average breakout date of the land fast ice at Hut Point is 15 February. Fast ice with large multiyear content, located along the shoreline from Drygalski Ice Tongue south to Cape Royds (see **Figure 6**) may remain throughout much of the summer melt. Ice cut during the icebreaker transit should be expected to flush from the channel. This will provide a lane of safer navigation along the channel with reduced ice concentrations and thickness. Existing conditions are demonstrated in **Figure 6** (MODIS).

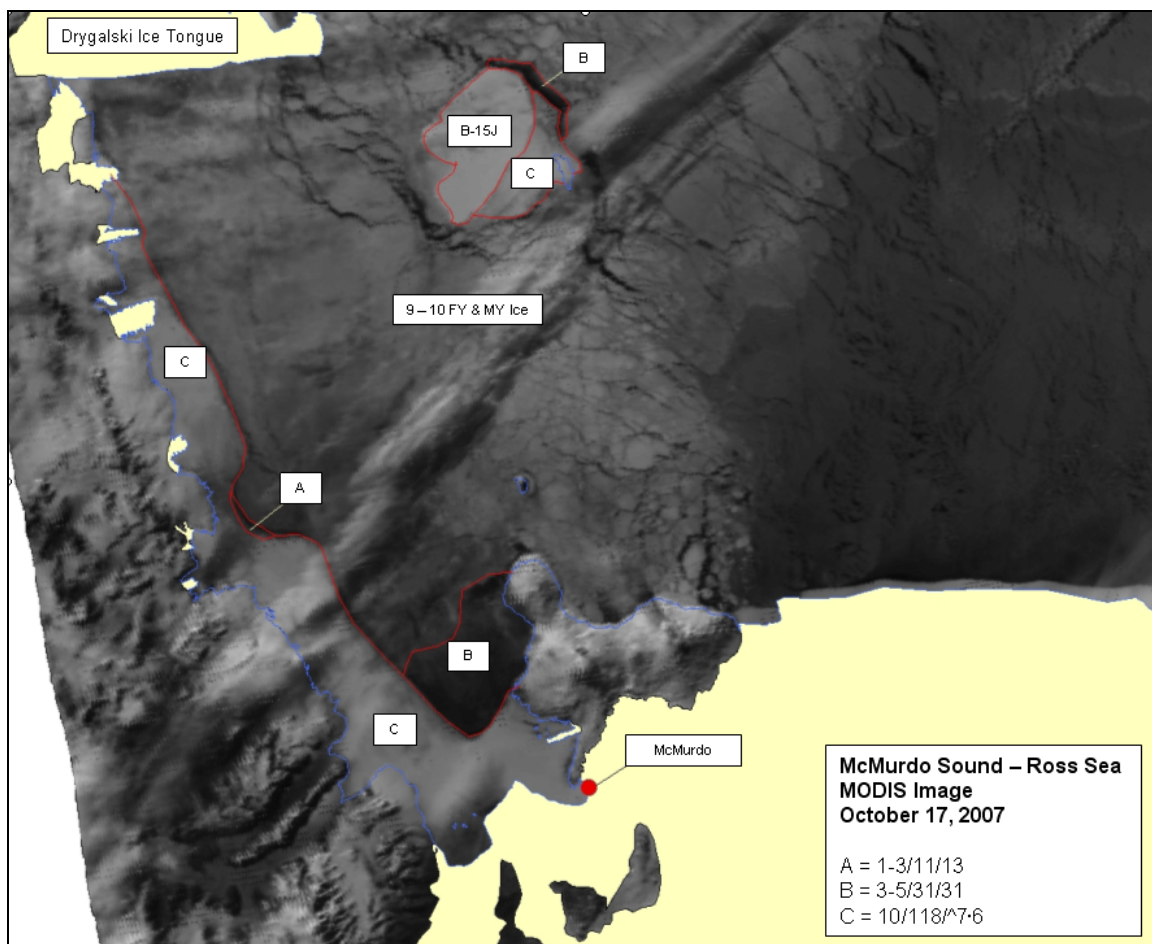


Figure 6. 17 Oct 2007 Annotated MODIS Image - McMurdo Sound

Icebergs and Shelf Ice

Due to the significant calving of the Ross ice shelf over the past few years, icebergs have posed a greater than normal hazard to navigation in the Ross Sea, and have had a significant influence on the ocean currents, weather, and sea ice conditions in the vicinity of McMurdo Sound. However, the past couple of years have seen the number and magnitude of icebergs in the McMurdo Sound region decrease. The continuing presence of iceberg B-15J is likely to have some impact on ice cover. B-15J is meandering slowly to the north as it passes on the west side of Franklin Island. As long as B-15J remains in the vicinity, it will serve as a hindrance to the prevailing winds and the Antarctic Coastal Current, and pack ice may accumulate on the windward side of the iceberg.

During its trek northward and out of the Ross Sea, C-16 knocked a portion of the Drygalski Ice Tongue loose, creating iceberg C-25 (**Figure 4**). (Note that the end of the Drygalski Ice Tongue is missing in **Figure 6**). C-25 is a relatively small iceberg (7x6 NM), and is currently floating just southwest of Coulman Island in the western Ross Sea.

Another iceberg feature of interest is C-19A, which is near the ice edge at 65°13'S/177°29'W on 07 October 2007. C-19A has been caught in the West Wind Drift, and has slowly drifted eastward and now places C-19A, along with the numerous smaller bergs calving from it, in the path of the shipping route into the Ross Sea between 175E and 177W.

For regular updates on the location of these and other Antarctic icebergs, visit the National/Naval Ice Center's Iceberg Database at:

<http://www.natice.noaa.gov/products/iceberg/index.htm>