Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Chukchi and Beaufort Seas, Coastal Marine Institute Project (NOFA MMS09HQPA0004T)

Monthly progress report, January 2009

(1) Summary of work performed and progress made during preceding month

A. Analysis of ice distribution and lead patterns

For the past month, we have been reviewing patterns of pack ice motion in the Chukchi Sea as determined from the study of sequential AVHRR images. The objective is to identify repeatable movement patterns that can be interpreted in terms of the interaction of the pack ice with the coasts surrounding the Chukchi Sea. That effort should be completed in next few weeks.

Code for analysis of imagery is awaiting review and checks, planned for late February.

B. Analysis of landfast ice extent

Updates to the IDL scripts that generate the gradient difference imagery are underway.

1998-1999 ice season mosaics were compiled for the Chukchi portion of the study area. Preliminary delineations of the Seaward Landfast Ice Extent are underway for this season. These will be finalized upon creation and review of the gradient difference imagery.

The 1:1,000,000 scale data for the Russian portion of the study area was deemed too coarse for the landfast ice mapping. The AlaskaMapped.org Best Data Layer (BDL) imagery was utilized to digitize a better coastline for the Russian portion. The Alaska portion of the Chukchi derived from the 1:63360 shoreline had several inconsistencies in terms of the way river deltas were digitized when compared with similar areas in the Beaufort Sea. These areas were cleaned up to be more consistent. Alaska Mapped DBL imagery and the USGS DRGs were also useful in noting extensive mudflats which can be challenging to interpret (and confused with ice) during the shoulder seasons when ice is setting up or melting (particularly in the area of Icy Cape.)

C. Assessing potential alternative approaches at deriving landfast ice edge locations and landfast ice stability

For analyzing the robustness of fast-ice detection from InSAR we processed more data sets covering wider ranges of the sea ice season as well as different climatic conditions. Both of these influences were addressed by adding the Seward Peninsula, Alaska, as a second data rich test site to the study. ALOS PALSAR data were available for the entirety of the fast ice season. Also, due to its lower geographical latitude and its more moderate climatic conditions, the sensitivity of the interferometric coherence to surface melting and larger amounts of snow fall can be assessed.

Quantitative Analysis of Extraction Performance

The first example shows an interferogram over the Seward Peninsula spanning December 23, 2007 to February 7, 2008. This time span is covered by a total of 6 reference outlines stemming from analyses of RADARSAT ScanSAR imagery. The location of the fast ice edge according to the reference outlines is shown in Figure 1 together with the acquisition date associated with each outline.

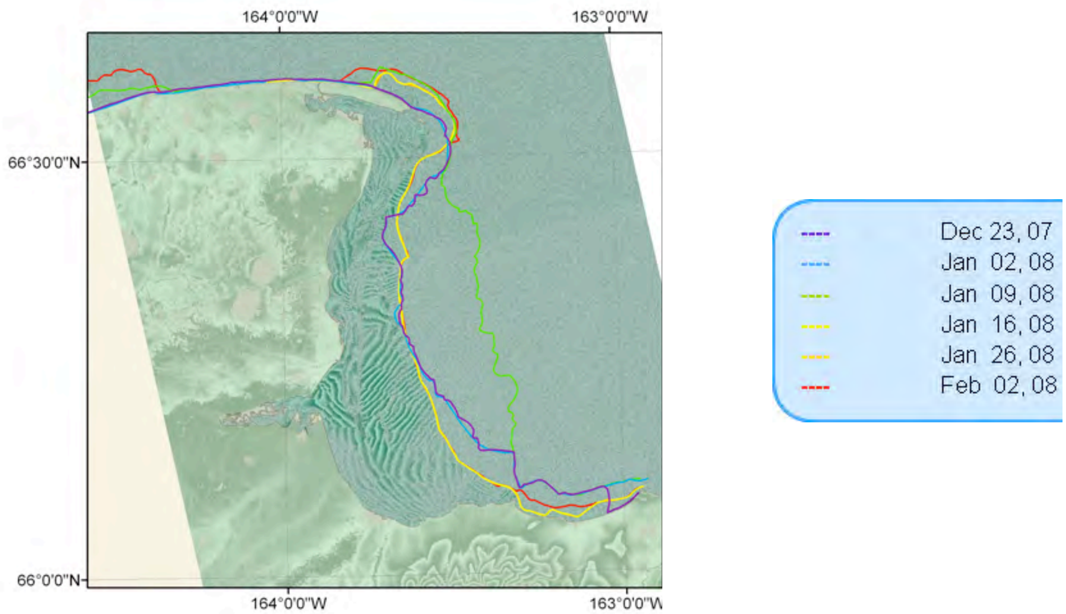


Figure 1: Fast ice outline extracted from RADARSAT ScanSAR data corresponding to the individual dates indicated on the right side of the figure.

The minimum of the outline in Figure 1 defines the reference outline that is then compared to the fast ice outline that is determined from InSAR. Figure 2 shows this comparison where the reference outline is presented in blue and the InSAR-derived outline in red. Area differences are classified into two classes: i) reference extent smaller than InSAR-based extent (blue areas in Figure 2), reference extent larger than InSAR-based extent (red regions in Figure 2). As we know that all areas that remained coherent in the interferogram remained stable over the entire 46 day interval, we can conclude that red regions indicate extraction errors of the reference technique and can be used to estimate its performance. Blue areas indicate extraction errors of the InSAR-based method.

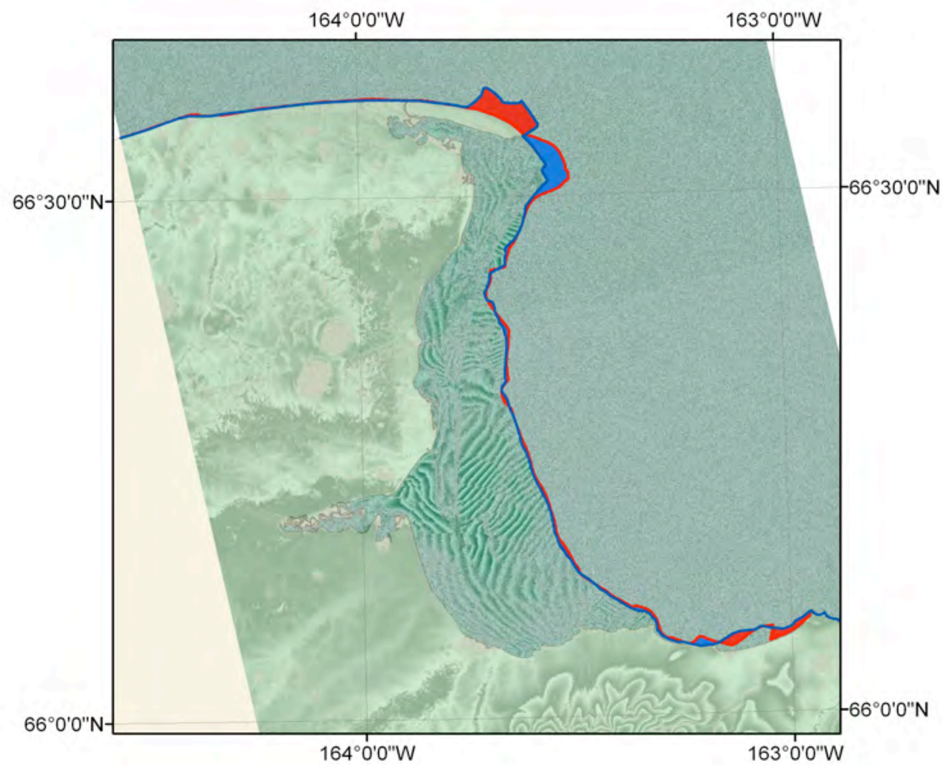
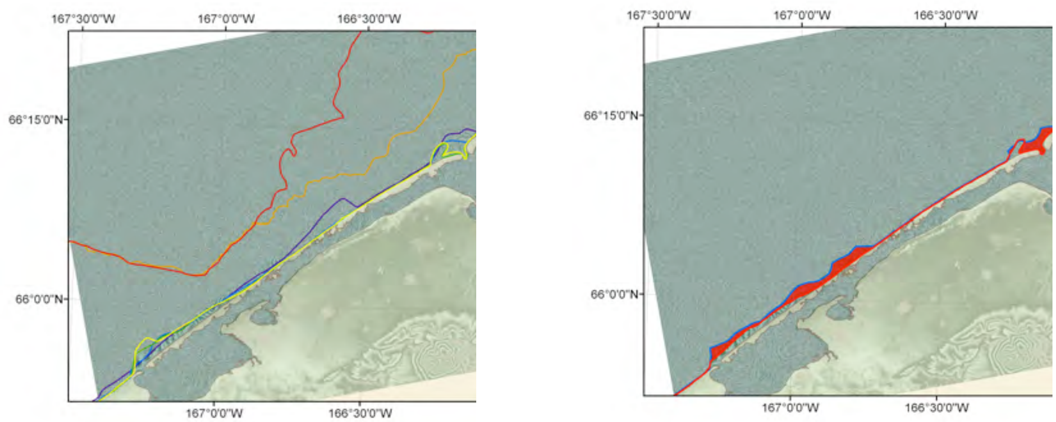


Figure 2: Reference fast ice edge in blue compared to InSAR based fast ice edge in red. Differences in fast ice area between the two techniques are show as well. Red areas correspond to underestimation by reference technique; blue area shows underestimation by InSAR-based technique.

It can be seen from Figure 2 that over large areas the outlines are practically identical, confirming the high performance of the InSAR based extraction method. Moreover, from the prevalence of red-tainted regions we also see that most of the area differences are due to extraction errors of the reference technique.

These results are confirmed by a second example covering the northwestern tip of the Seward Peninsula between the villages of Wales and Shishmaref. The interferogram used in this example spans January 2, 2008 to February 14, 2008. As it can be seen from Figure 3a from the variability of the short-term outlines as determined from RADARSAT data, the fast ice coverage seems to vary dramatically over time from virtually fast-ice free situations in the beginning of the covered time span to large fast ice areas at the end of the period. This large variability raises the question whether or not the extent of fast ice can be determined over a time span as short as a few days. The comparison between the determined reference outline and the InSAR derived outline is shown in Figure 3b and again shows very high comparability between the determined fast ice areas with virtually all extraction errors stemming from fast ice underestimation by the reference technique (red areas in Figure 3b).



a) b)

Figure 3: a) Fast ice outline extracted from RADARSAT ScanSAR data for a second test site on the Seward Peninsula; b) analysis of areal differences between the outlines. Red areas correspond to underestimation by reference technique; blue area shows underestimation by InSAR-based technique.

D. Miscellaneous activities
n/a

(2) Summary of significant technical, schedule or cost problems encountered during preceding month
n/a

(3) Summary of resolutions agreed to between Contractor and MMS re item (2)
n/a

(4) Significant meetings held or other contacts made in connection with project during preceding month

Hajo Eicken gave a presentation at the Alaska Marine Science Symposium in Anchorage, January 20, 2010. A copy of the presentation is attached with this report.

(5) Action items, open questions etc.
n/a