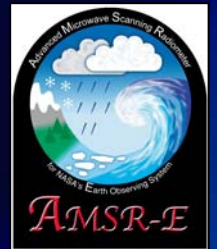# Using RADARSAT imagery to evaluate the NASA Team Ice Concentration Algorithm 2 applied to gridded AMSR-E data

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Background and methodology

AMSRIce03 validation program

- Funded by NASA
- Participants:
    - University of Colorado Aerospace Engineering Department, Boulder, CO: Jim Maslanik
    - U.S. Army Cold Regions Research & Engineering Laboratory-Alaska, Fairbanks, AK: Matthew Sturm
    - NASA-Goddard Space Flight Center, Greenbelt, M: Don Cavalieri, Thorsten Markus
    - U.S. Army Cold Regions Research & Engineering Laboratory, Hanover, NH: Don Perovich, Jackie Richter-Menge
    - National Snow and Ice Data Center: Julienne Stroeve
    - Fort Hays State University Department of Geosciences, Hays, KS: John Heinrichs
    - Geophysical Institute, University of Alaska-Fairbanks, Fairbanks, AK: Ken Tape
    - NOAA Environmental Technology Laboratory, Boulder, CO: Al Gasiewski
- Operations:
    - Field campaign: snow and ice property measurements
    - Aerosonde flights
    - Airborne microwave radiometer (PSR)
    - Radar imagery (RADARSAT)
    - Visible, infrared imagery (MODIS, Landsat)

Ice concentration and AMSR-E

- Ice concentration: the percentage of the ocean surface that is covered by sea ice – varies from 0 to 100%

- New algorithm (NASA Team Algorithm 2) to generate ice concentration from AMSR-E data was developed by a NASA team (Markus and Cavalieri, 2000)

- Previous NASA Team Algorithm had errors of 8-20% when applied to SSM/I data (Steffen et al., 1992)
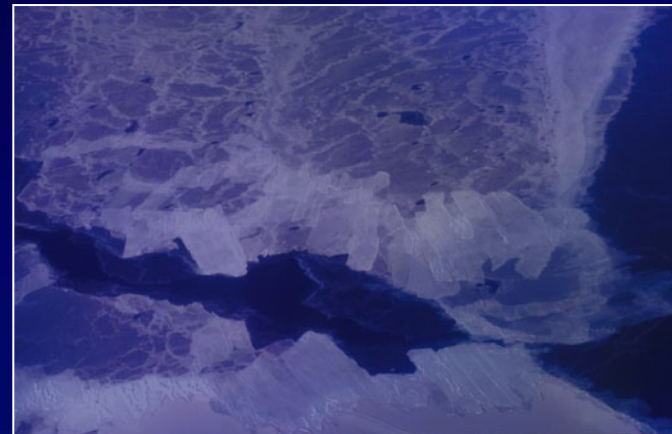
General approach

- Use higher-resolution radar data (from RADARSAT) to qualitatively assess the AMSR-E ice concentration product under wide range of ice conditions:
    - Pack ice in the Arctic Ocean (Beaufort and Chukchi Seas)
    - Polynyas and flaw leads
   - Along the ice edge

The study area

AMSR-E ice concentration data

- Obtained from the National Snow and Ice Data Center (Cavalieri and Comiso, 2004)

- Period covered: March 1, 2003 through April 10, 2003 (concurrent with the field campaign)

- Data supplied in a 25 km resolution gridded polar stereographic projection

AMSR-E Ice Concentration
March 5, 2003

Ice Concentration (%)
High : 100
Low : 0

0   600 1,200   2,400   3,600
Kilometers
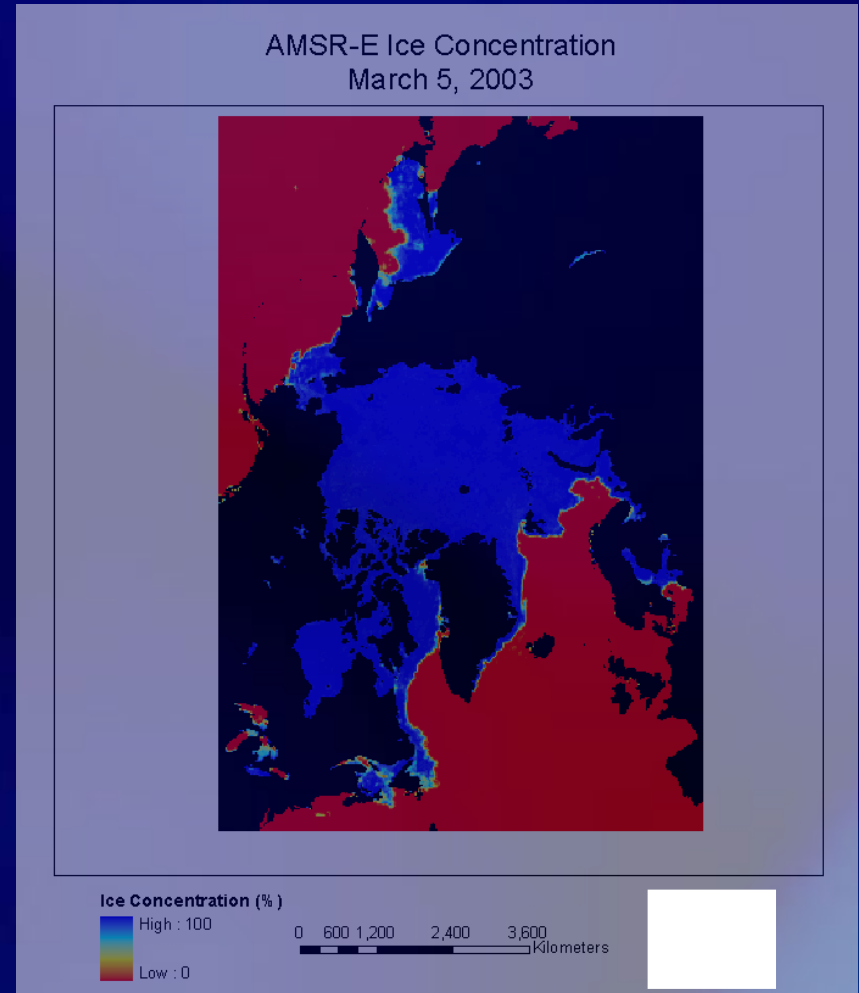
RADARSAT data used for the project

- SCANSAR Wide Beam Quicklooks
- Resolution 100 m
- Total of 163 images collected between March 1, 2003 and April 10, 2003
- Data obtained from the Alaska SAR Facility
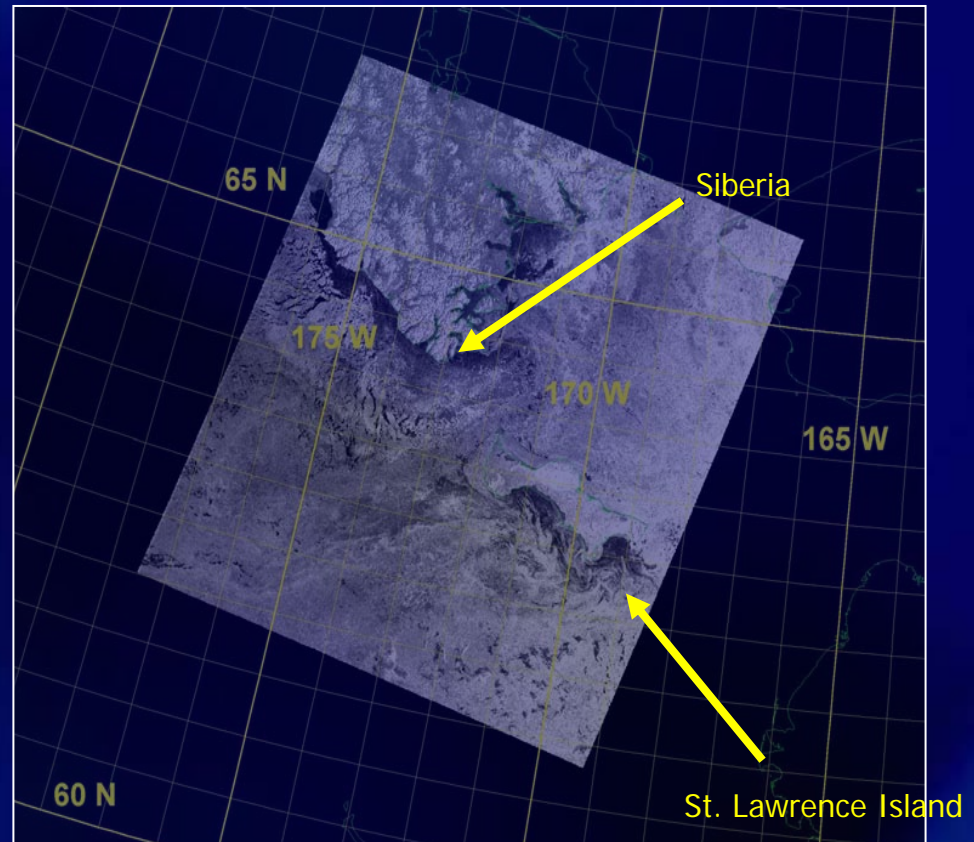
Processing and visualization

- RADARSAT data displayed and enhanced with ENVI and georeferenced using the ImageWarp extension to ArcView 3.3

- RADARSAT and AMSR-E data reprojected to Universal Transverse Mercator (UTM) zone 4N

- ArcMap (ArcGIS 9.0) used to overlay the AMSR-E ice concentration data on the RADARSAT images with 80% transparency

- Visual inspection and interpretation used to assess AMSR-E performance

AMSR-E Ice Concentration/RADARSAT Overlay
March 14, 2003

Ice Concentration (%)
Value
High : 100
Low : 80

0 105 210   420   630
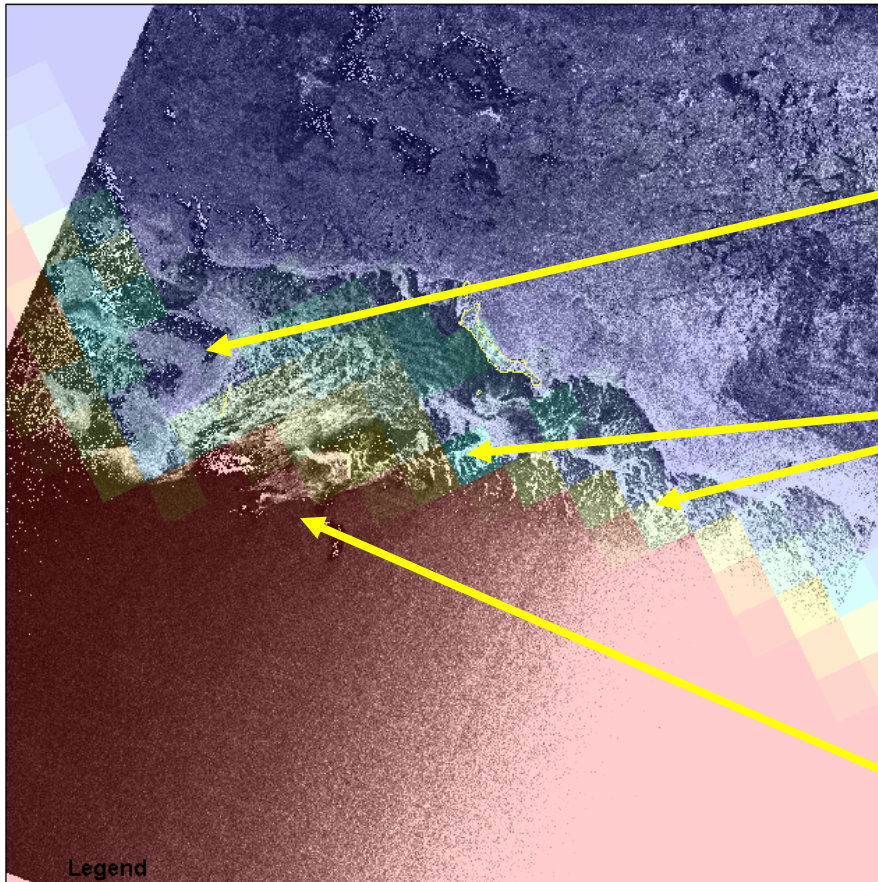Kilometers
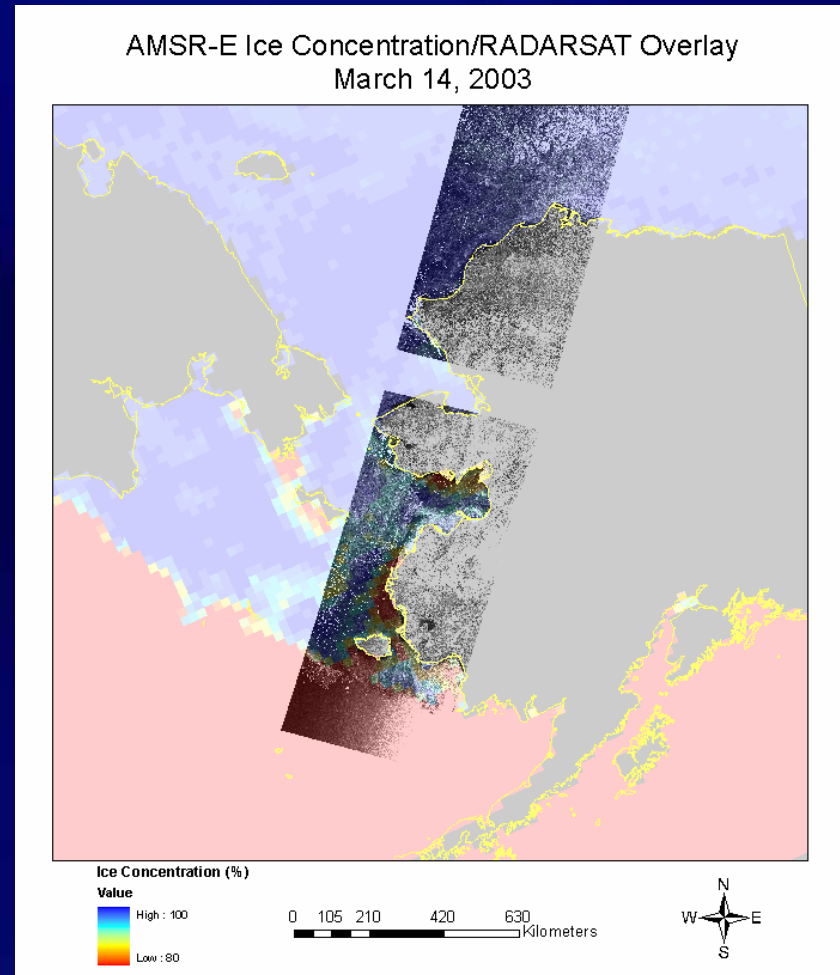
Results

The ice edge

AMSR-E Ice Concentration/RADARSAT Overlay
March 17, 2003
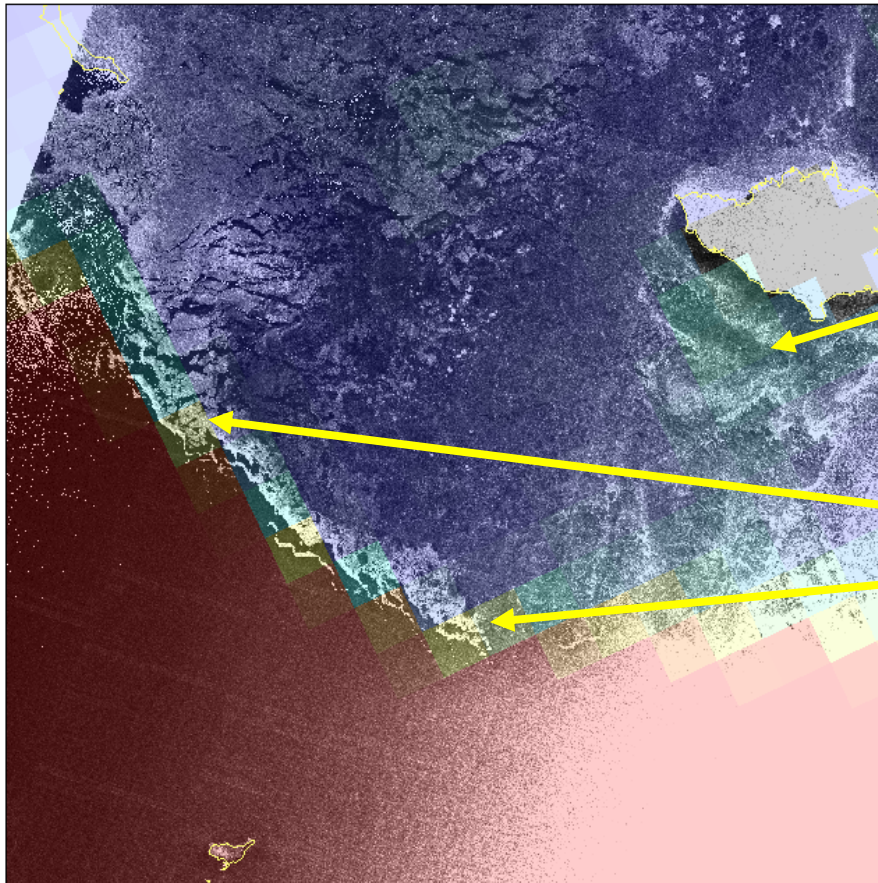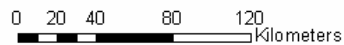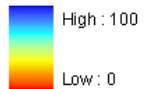
Area of reduced ice cover detected In AMSR-E product

AMSR-E ice edge within one pixel (25 km) of edge visible in RADARSAT image

Ice Concentration (%)

High : 100

Low : 0

0 20 40   80   120
Kilometers

N
W   E
S

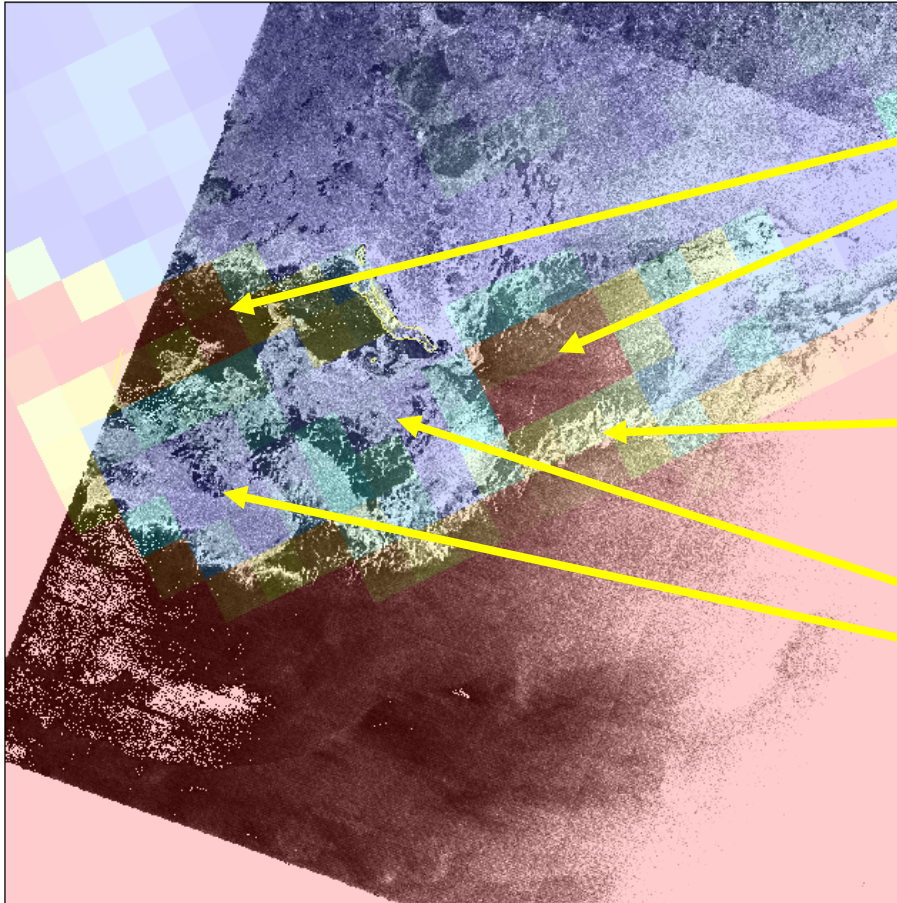AMSR-E Ice Concentration/RADARSAT Overlay
March 13, 2003

"Tongue" of ice captured by the AMSR-E product

AMSR-E ice edge within one pixel of the edge seen in RADARSAT

Possible two-pixel error (ice drift between image times?)

Legend

Ice Concentration (%)

High : 100

Low : 0

0 20 40   80   120
                              Kilometers

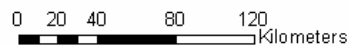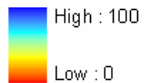AMSR-E Ice Concentration/RADARSAT Overlay
March 3, 2003

AMSR-E captures areas of reduced ice cover near edge

Ice "bridge" captured perfectly by AMSR-E

Large drifting ice masses captured by AMSR-E

Ice Concentration (%)
High : 100
Low : 0

0 20 40   80   120
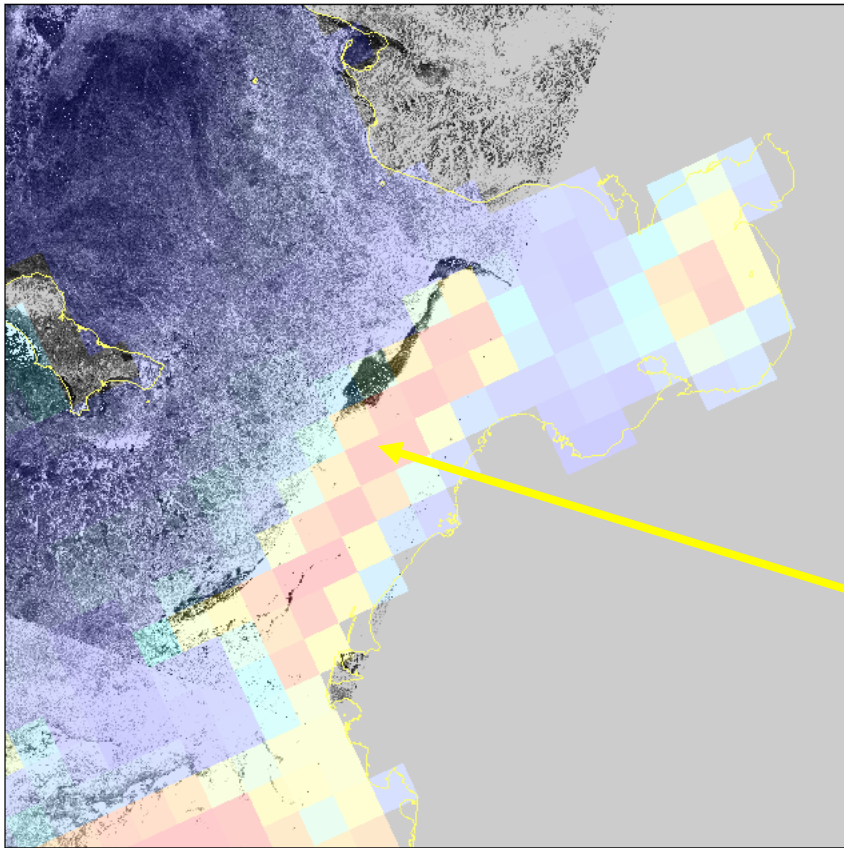Kilometers

N
W E
S

Ice edge – performance assessment

- AMSR-E ice concentration product ice edge within 25 km of that visible in RADARSAT imagery
- AMSR-E ice concentration product captures dynamic ice features near the edge

Polynyas and flaw leads
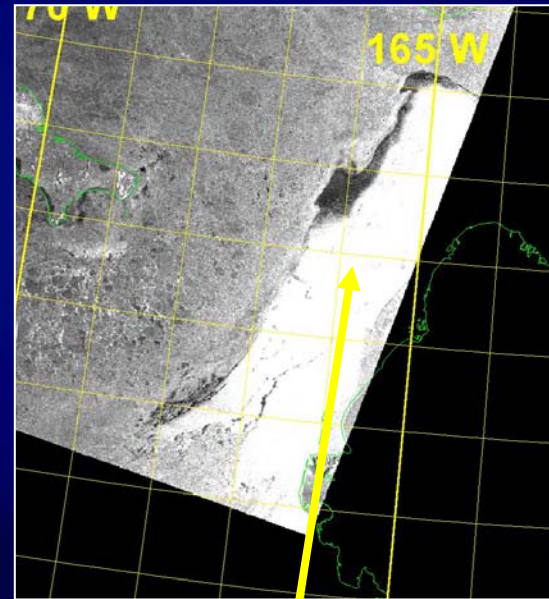
AMSR-E Ice Concentration/RADARSAT Overlay
March 3, 2003
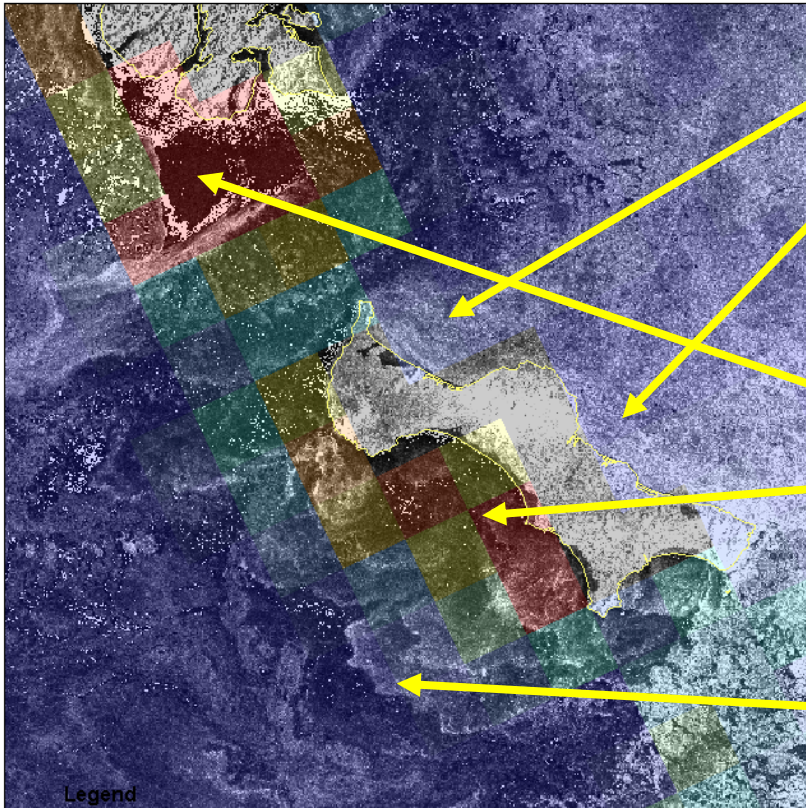
Large flaw lead captured by the AMSR-E product (note that wind roughening causes high backscatter in the RADARSAT image

AMSR-E Ice Concentration/RADARSAT Overlay
March 13, 2003

Legend

Ice Concentration (%)

High : 100

Low : 80

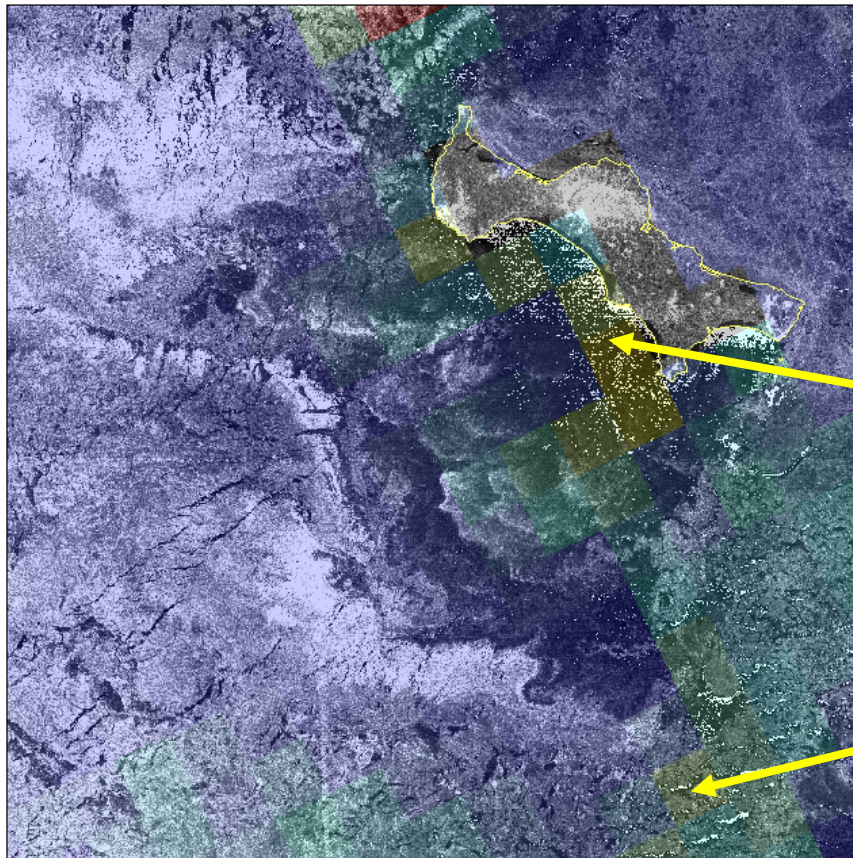0 12.5 25   50   75
Kilometers

N
W   E
S

AMSR-E shows high ice concentration where NE winds have pushed ice up to the coast of St. Lawrence Island
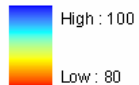
Polynyas on leeward side of island/peninsula captured by AMSR-E

AMSR-E product also captures area where new ice has piled up to form first-year ice

AMSR-E Ice Concentration/RADARSAT Overlay
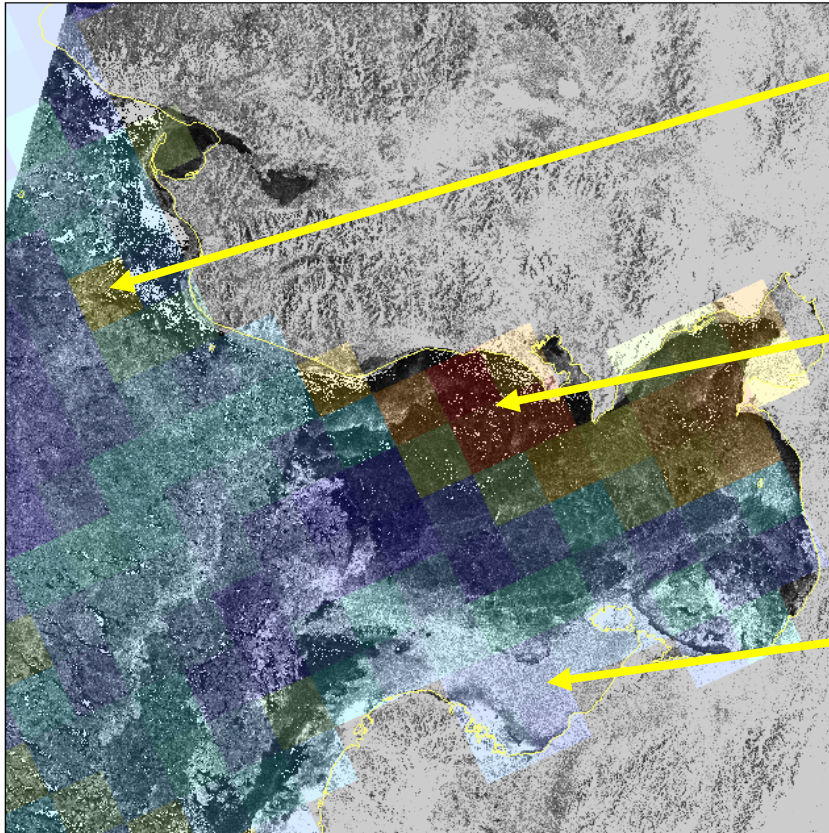March 15, 2003

Ice Concentration (%)
High : 100
Low : 80

0   15   30   60   90
Kilometers

N
W   E
S

Closing polynya
captured by AMSR-E
product

Reduced AMSR-E
ice concentration
associated with high-
backscatter areas
(leads with rough
water?)

AMSR-E Ice Concentration/RADARSAT Overlay
March 14, 2003

Area of reduced ice concentration with no obvious divergence feature in RADARSAT image

Area of reduced ice concentration in Norton Sound captured by AMSR IC product

Ice buildup captured by AMSR IC product

Ice Concentration (%)
Value

High : 100

Low : 80

0   15   30   60   90
Kilometers

Polynyas and flaw leads – performance assessment

- Open water areas apparently captured effectively by AMSR-E ice concentration product

- Some of the areas may actually be nilas (very young, soft ice) – cannot distinguish from calm water using SAR

- Areas of ice pileup captured well

- A few areas of reduced ice concentration observed in AMSR-E product with no counterpart in RADARSAT imagery

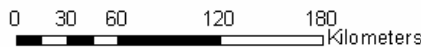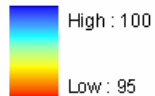# Pack ice in the Beaufort/Chukchi Seas

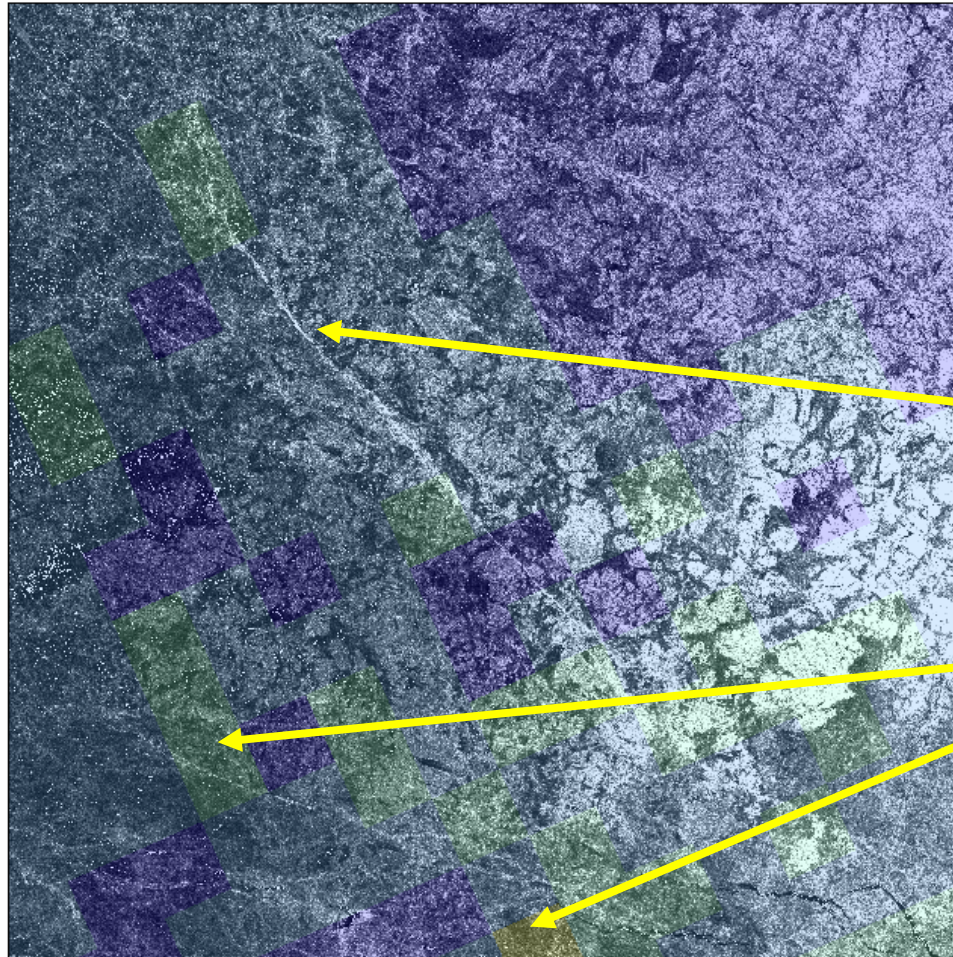AMSR-E Ice Concentration/RADARSAT Overlay
April 6, 2003
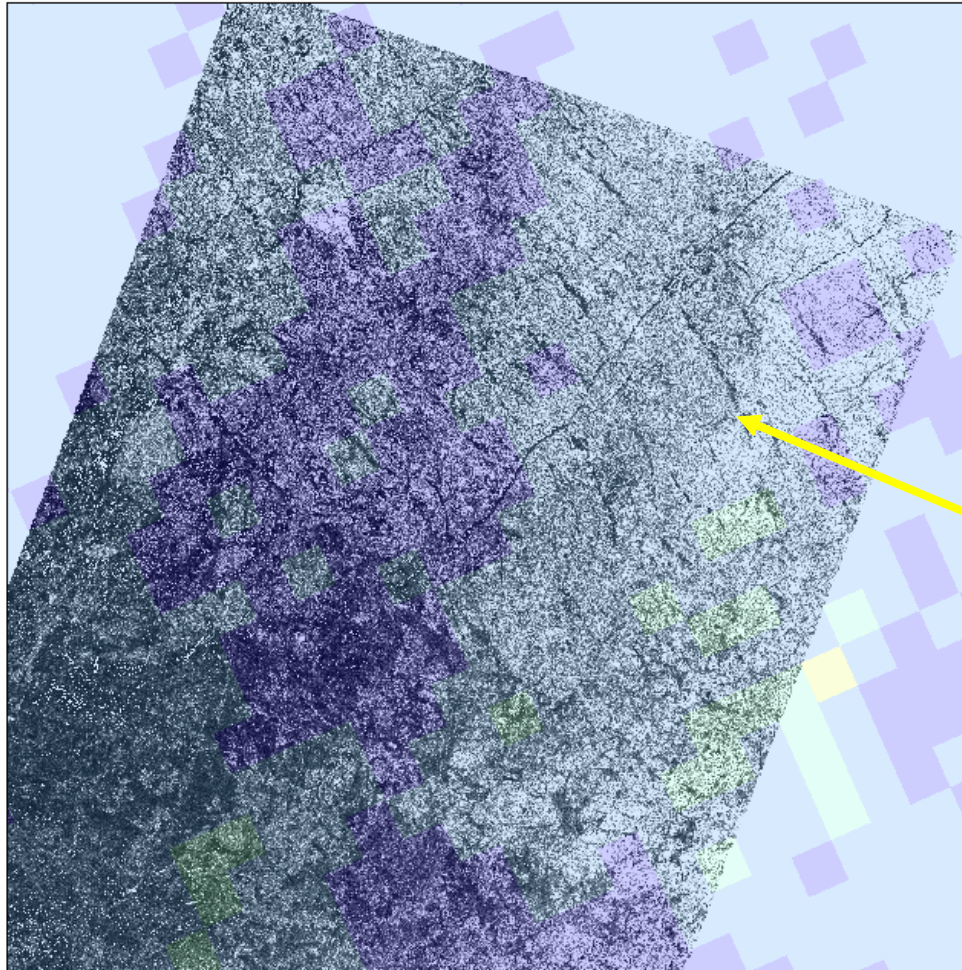
AMSR-E ice concentrations all 95% or greater

Area of slightly lower AMSR-E ice concentration associated with clear divergence in RADARSAT imagery

Ice Concentration (%)

High : 100

Low : 95

0   30   60   120   180
Kilometers

N
W   E
S

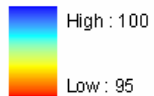AMSR-E Ice Concentration/RADARSAT Overlay
March 17, 2003

AMSR-E ice concentrations all 95% or greater

Reduced ice concentration along fracture

Reduced ice concentration areas with no clear divergence visible in SAR image

Ice Concentration (%)

High : 100

Low : 95

0   15   30   60   90
Kilometers

N
W   E
S

Pack ice – performance assessment

- AMSR-E ice concentration product generates high values in pack ice areas, corresponding to RADARSAT imagery

- Some divergence features in RADARSAT imagery associated with reduced AMSR-E ice concentration

- A few areas of lower AMSR-E ice concentration are not associated with any divergence features in the RADARSAT images

Conclusion and discussion

- AMSR-E/RADARSAT GIS overlay technique highly effective for comparing data sets of vastly different resolutions

- Hypothesis was confirmed - AMSR-E ice concentration product performs well to very well in all ice conditions assessed

- Best performance is for areas where greatest variety of ice concentrations found (ice edge, polynyas/flaw leads)

- Future directions - incorporate field data near shore in Beaufort Sea, aircraft microwave measurements; extend to 12.5 km AMSR-E gridded data

Acknowledgements

References

- Cavalieri, D., and J. Comiso. 2004, updated daily. *AMSR-E/Aqua Daily L3 25 km Tb, Sea Ice Temperature, and Sea Ice Conc. Polar Grids V001, March to June 2004*. Boulder, CO, USA: National Snow and Ice Data Center. Digital media.

- Markus, T., and D. Cavalieri. 2000. An enhancement of the NASA Team sea ice algorithm. *IEEE Transactions on Geoscience and Remote Sensing* 38: 1387-1398.

- Steffen, K., J. Comiso, K. St. Germain, P. Gloersen, J. Key, and I. Rubinstein, 1992, *Microwave Remote Sensing of Sea Ice: Chapter 10: The Estimation of Geophysical Parameters Using Passive Microwave Algorithms*, ed. F. Carsey, AGU Monograph, 201-228.