



ARCTIC2003 EOS Aqua AMSR-E Sea Ice Validation Aircraft Campaign

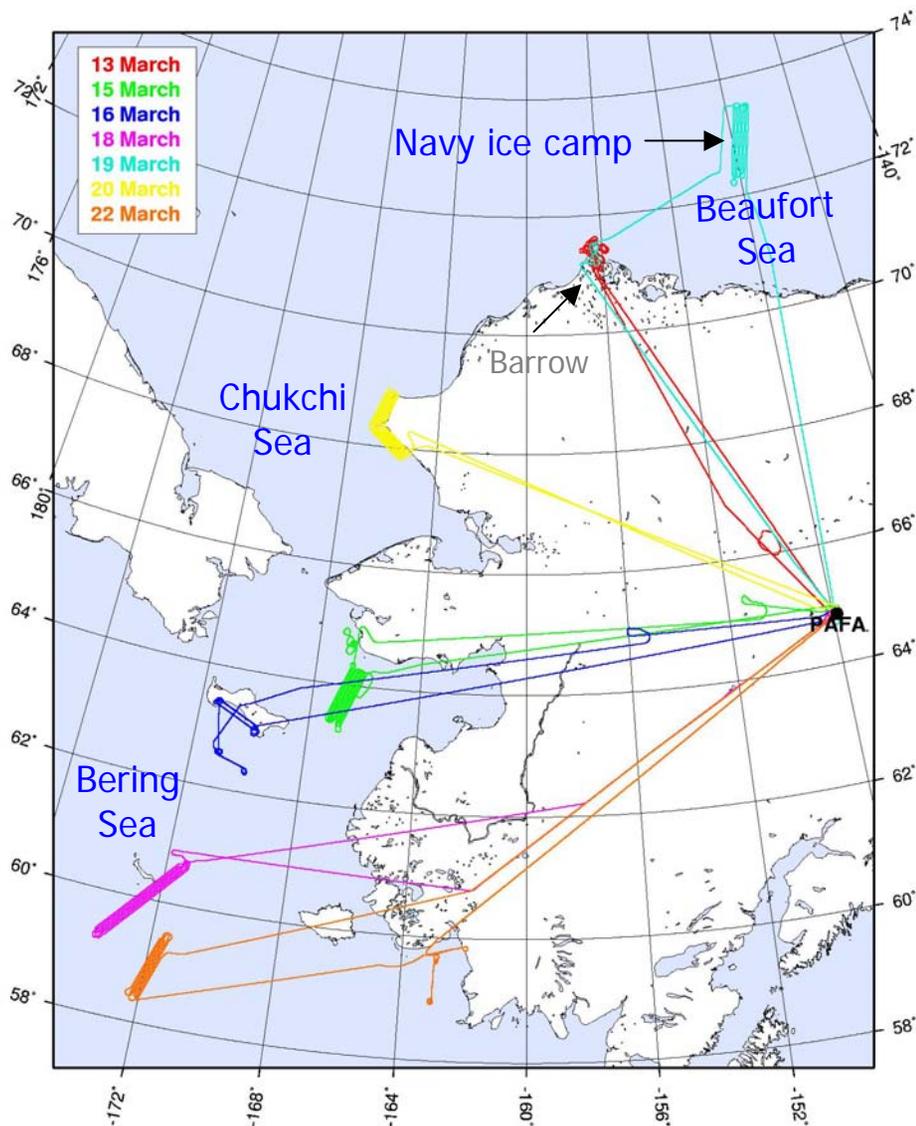
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NASA Goddard Space Flight Center
Greenbelt, Maryland



Joint AMSR Science Team Meeting
3-4 August 2004
Fort Collins, CO



2003 Alaska Sea Ice Validation Missions



March 13, 2003; Barrow (Elson Lagoon):
Low altitude flights (500ft) coincident with in-situ surface measurements of snow and ice physical properties (collaboration w/ M. Sturm & J. Maslanik)

March 15, 2003; Norton Sound/Bering Sea:
Maps of a divergent ice cover at 4300 ft coincident with Landsat 7 coverage; a/c stacks over coastal polynya at different altitudes to measure heat and moisture fluxes (collaboration w/ B. Walter)

March 16, 2003; St. Lawrence Island polynya:
stacks over polynya at different altitudes to measure heat and moisture fluxes (collaboration w/ B. Walter); coincident Landsat 7 and ICESat coverage

March 18, 2003; Ice edge near St. Matthew Island:
Mapping of ice edge at 4300 ft; coincident Radarsat Coverage

March 19, 2003; Beaufort Sea ice camp, Barrow:
Mapping of area at 4300 ft, mostly multiyear ice; coincident ICESat coverage; 2nd Barrow survey

March 20, 2003; Point Hope/Kotzebue Sd.:
Mapping of area at 4300 ft; various sea ice types; co-incident Landsat 7 and Radarsat coverage

March 22, 2003; Ice edge and Kuskokwim Bay:
Mapping of ice edge (coincident Landsat 7 coverage) and a/c stacks over polynya in Kuskokwim Bay to measure heat and moisture fluxes

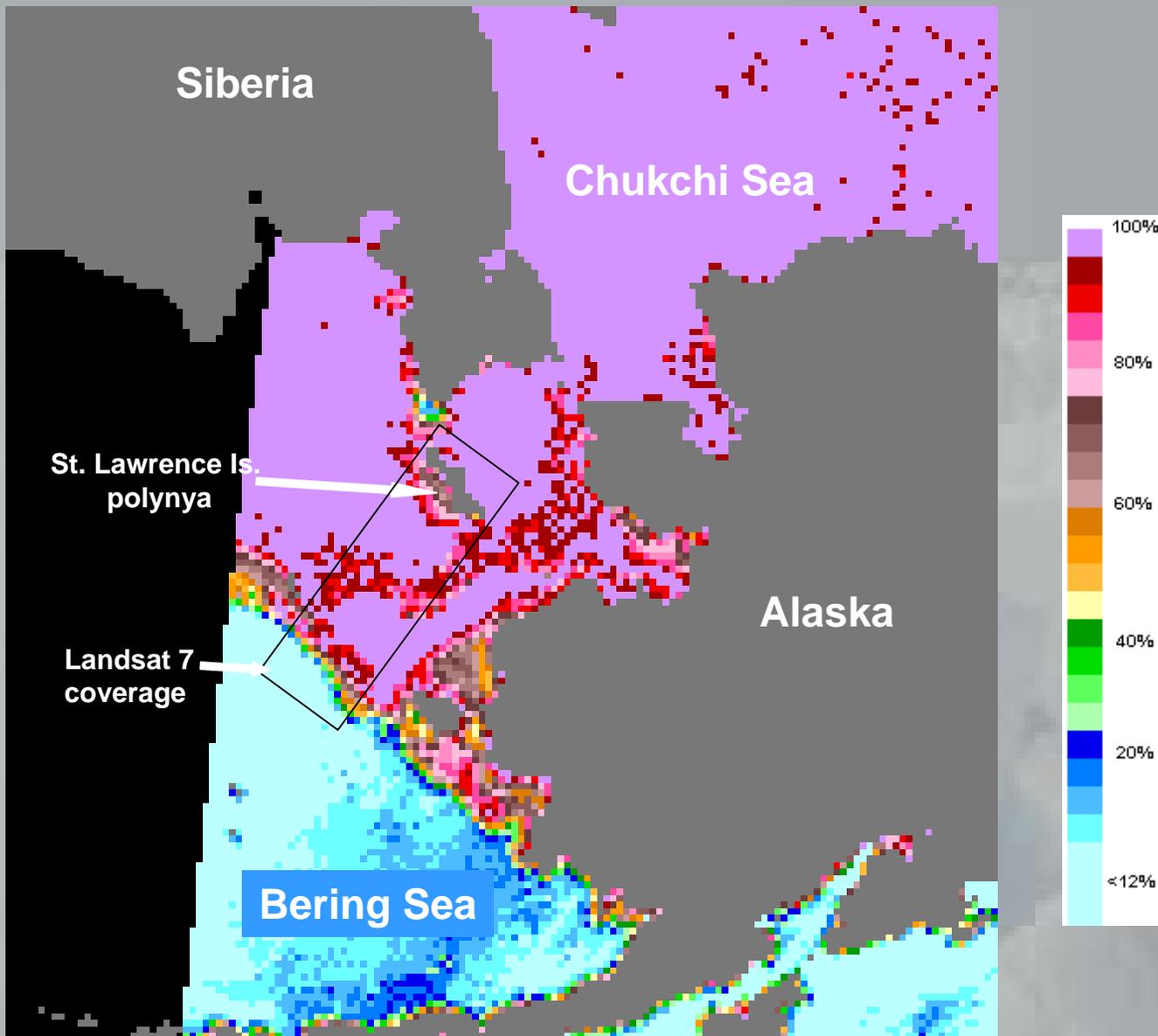


ARCTIC 2003 AMSR-E Sea Ice Validation Data Sets Collected During March 2003

- **NASA P-3 data sets:**
 - **NOAA ETL Polarimetric Scanning Radiometers (PSR-A and PSR-CX) (A. Gasiewski and M. Klein)**
 - **NASA Wallops Airborne Topographic Mapper (ATM); digital cameras (J. Sonntag and Rob Russel)**
 - **NASA Langley Turbulent Air Motion Measurement System (TAMMS) (L. Thornhill and J. Barrick)**
- **Surface snow and ice measurements at Barrow, AK and at a Beaufort Sea Navy ice camp both coordinated with aircraft flights (J. Maslanik, M. Sturm, J. Stroeve, J. Heinrichs)**
- **Satellite-aircraft and satellite-satellite comparisons: Aqua AMSR-E and MODIS, RADARSAT, and Landsat 7 ETM+ (March 13, 15, 20, 22)**

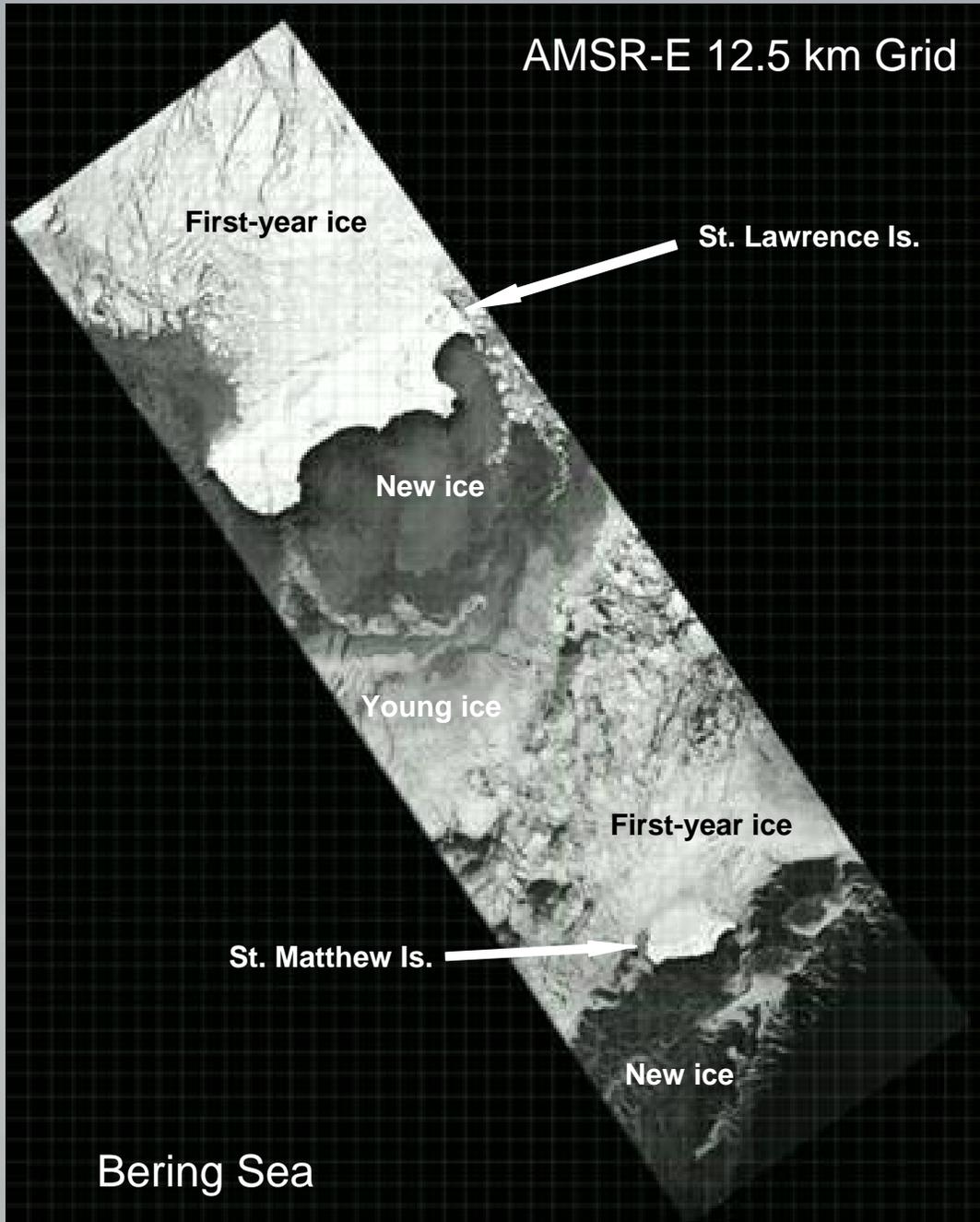


AMSR-E Bering Sea Ice Concentration March 13, 2003





AMSR-E 12.5 km Grid



Landsat 7 ETM+ Image
of the Bering Sea
March 13, 2003





Aqua AMSR-E / Landsat 7 ETM+ Sea Ice Concentration Comparison

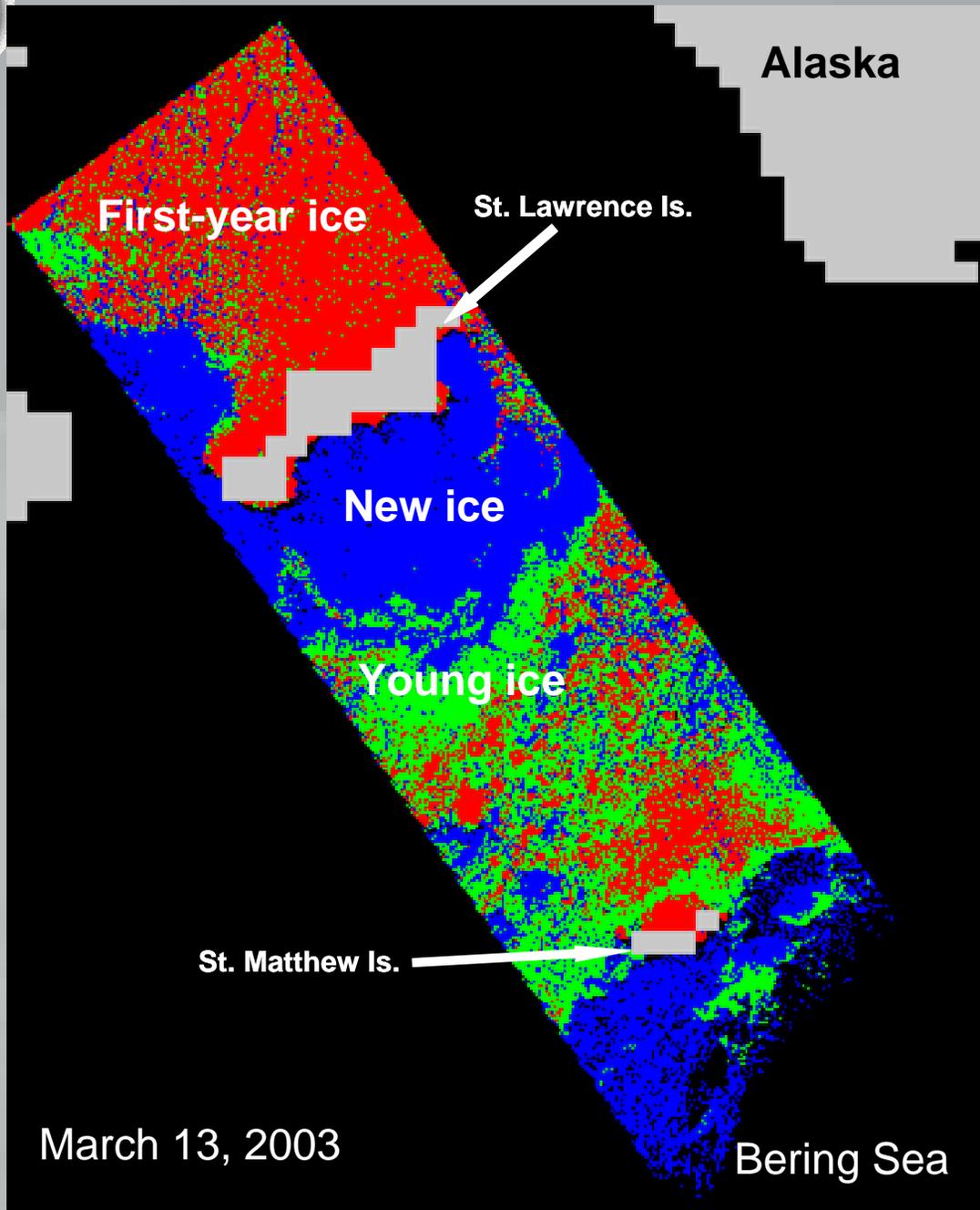
Method for calculating sea ice concentration from Landsat 7 ETM+:

- Calculate albedo from ETM+ Band 8 (panchromatic) radiances at a 15-m resolution
- Calculate sea ice types from albedo
- Calculate sea ice concentrations by summing the ice type fractions for each 12.5 km AMSR-E grid
- Apply an “AMSR-E” antenna-pattern correction to the Landsat ice concentrations
- Filter those AMSR-E pixels contaminated by clouds

Landsat 7 ETM+ Sea Ice Type Classification

L7 Albedo ≤ 0.10	Ice-Free Water	
$0.10 < \text{albedo} \leq 0.30$	New Ice	$0 \text{ cm} < \text{Thickness}^* \leq 8 \text{ cm}$
$0.30 < \text{albedo} \leq 0.40$	Young Ice	$8 \text{ cm} < \text{Thickness}^* \leq 32 \text{ cm}$
$0.40 < \text{albedo} \leq 0.50$	Thin First-Year Ice	$32 \text{ cm} < \text{Thickness}^* \leq 85 \text{ cm}$
$0.50 < \text{albedo}$	First-Year Ice	$85 \text{ cm} < \text{Thickness}^*$

*** Albedo = $0.44 \text{Thickness}^{0.28} + 0.08$ (Perovich et al., 1986)**

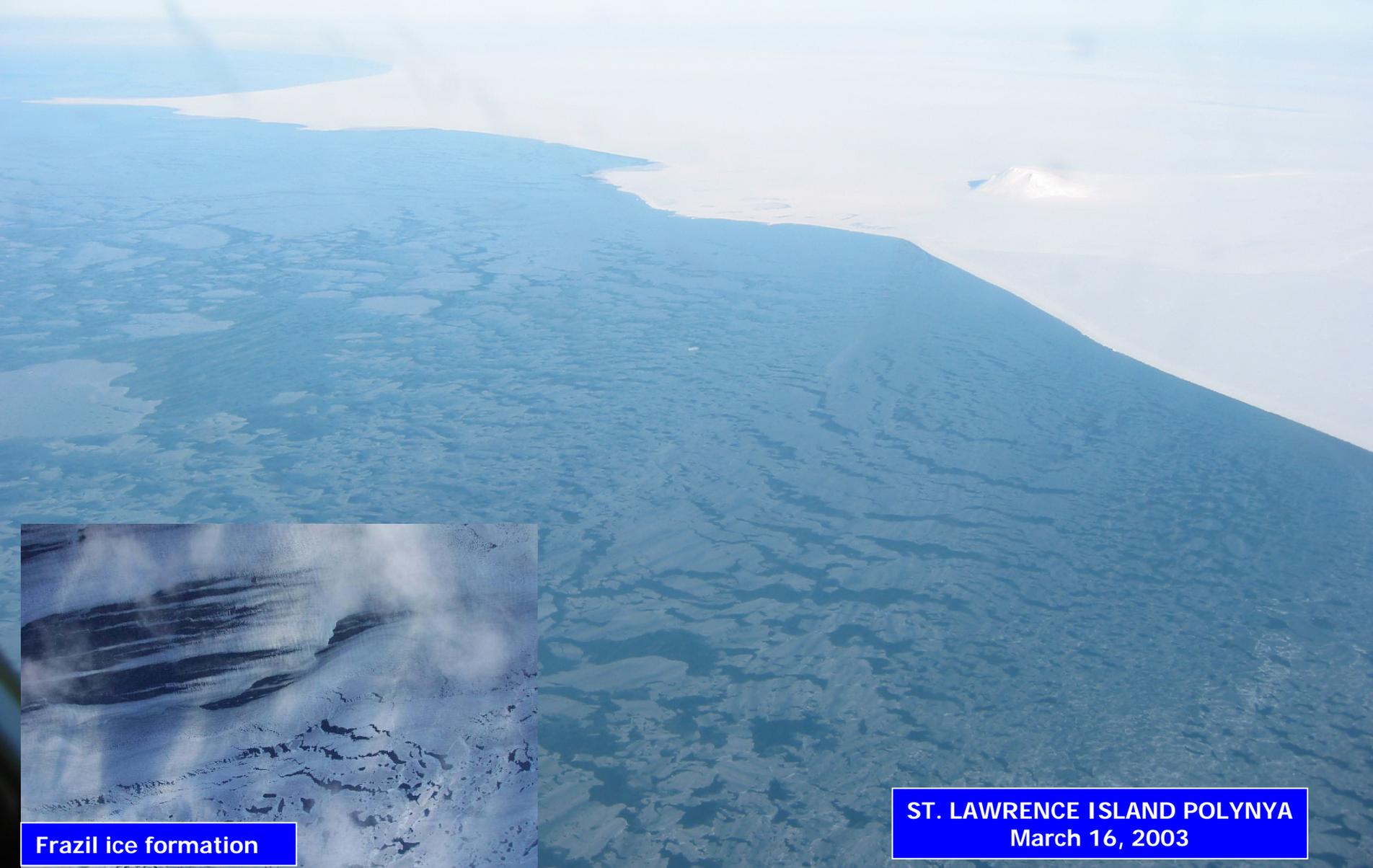


Bering Sea ice types derived from Landsat 7 ETM+ for March 13, 2003
Red – First-year ice
Green – Young ice
Blue – New ice





New Ice Production in a Coastal Polynya

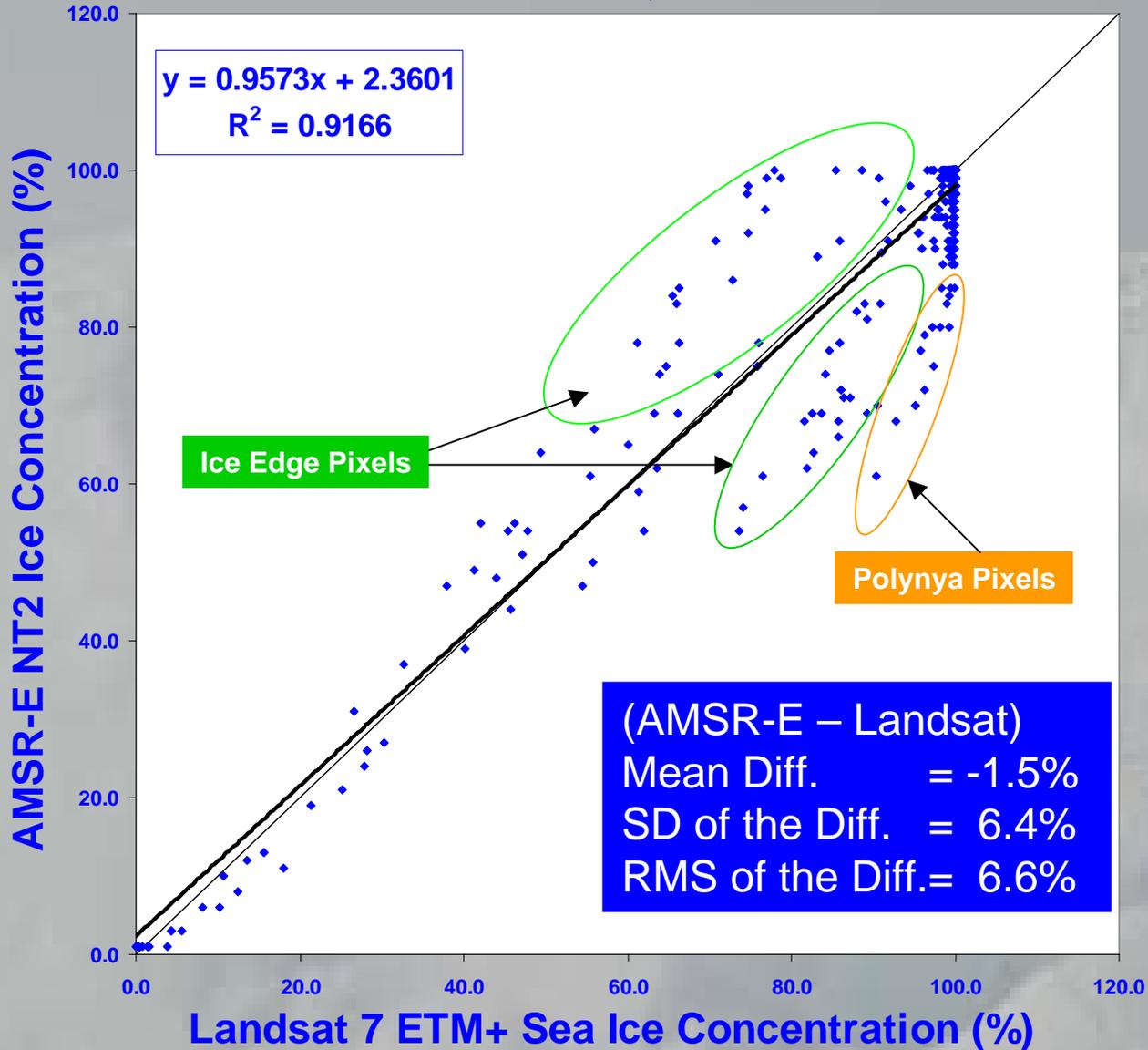


Frazil ice formation

ST. LAWRENCE ISLAND POLYNYA
March 16, 2003

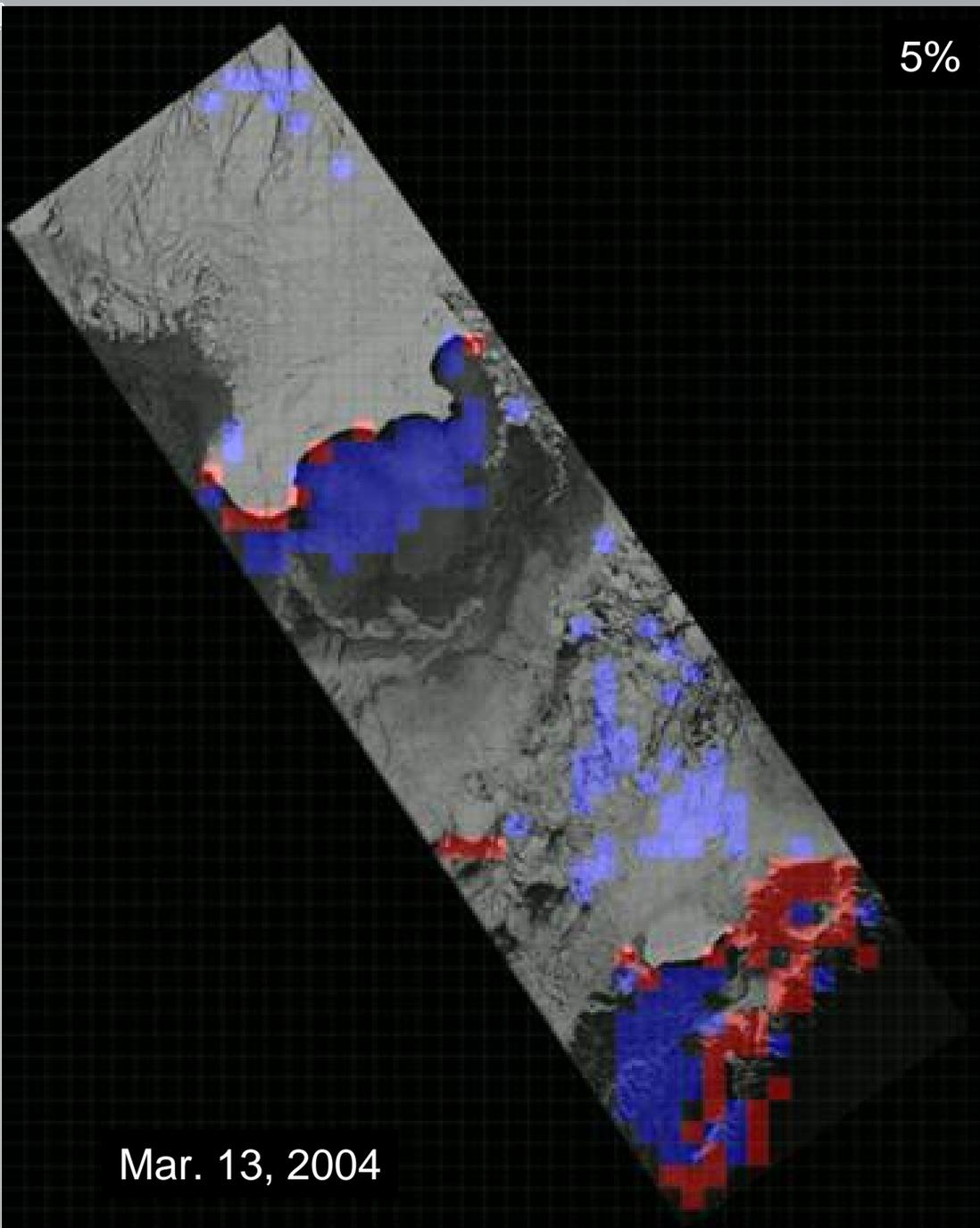


Bering Sea Ice Concentration Comparison March 13, 2003





5%

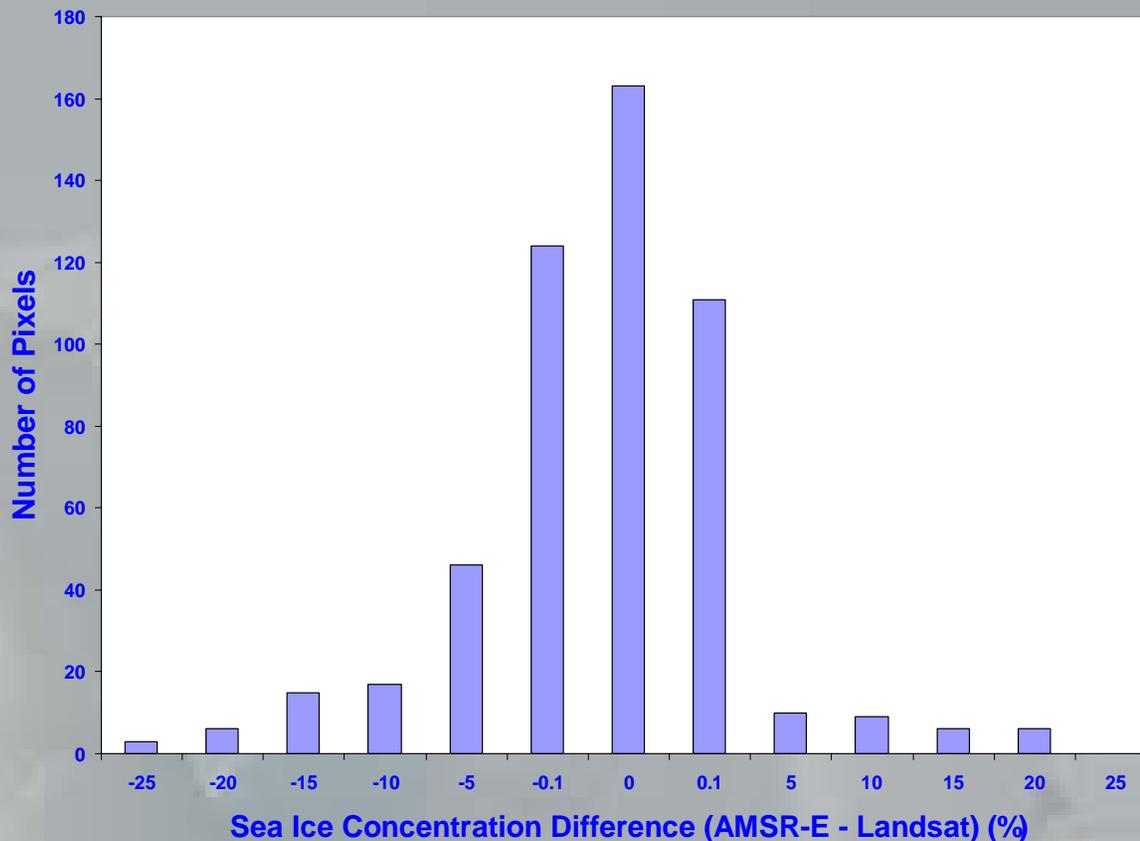


**AMSR-E – Landsat 7 ETM+
Sea Ice Conc. Diff. > 5%
Red (AMSR-E>Landsat)
Blue (Landsat>AMSR-E)**

Mar. 13, 2004



AMSR-E - Landsat 7 Sea Ice Concentration Differences March 13, 2003

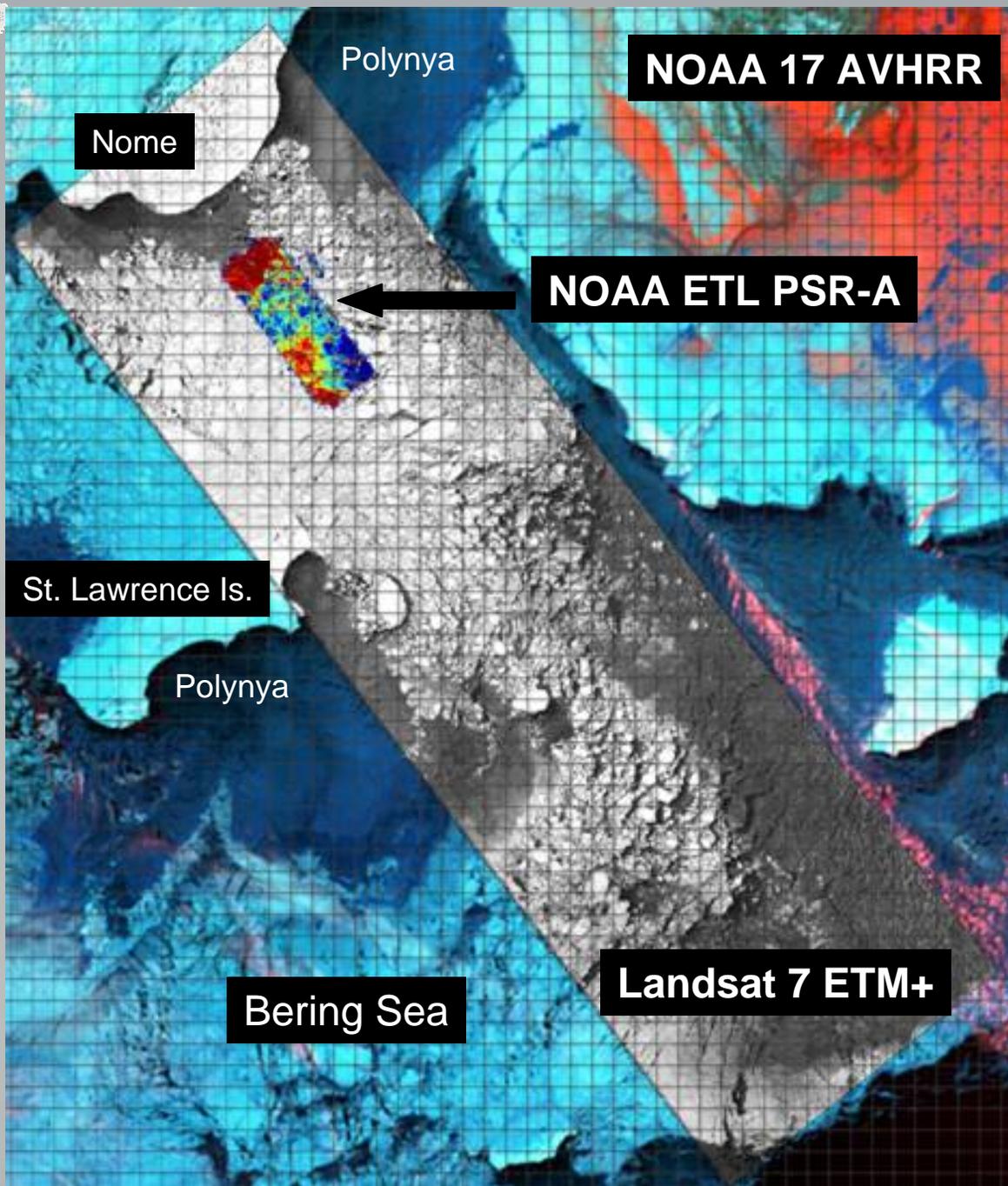


Sea Ice Con. Diff. Category	$\geq -25\%$	-24.9% to -20.0%	-19.9% to -15.0%	-14.9% to -10.0%	-9.9% to -5.0%	-4.9% to 4.9%	5.0% to 9.9%	10.0% to 14.9%	15.0% to 19.9%	20.0% to 24.9%	$\geq 25\%$
Population	3	6	15	17	46	398	10	9	6	6	0
Percent	0.6%	1.2%	2.9%	3.3%	8.9%	77.1%	1.9%	1.7%	1.2%	1.2%	0.0%



Comparison by Surface Type for March 13, 2003

Surface Type	Number of pixels (% pure)	Landsat Ice Concent Mean \pm 1SD	AMSR-E Ice Concent Mean \pm 1SD	AMSR-E - Landsat RMS Diff.
OW	6 (100%)	0.3% \pm 0.2%	1.0% \pm 0.0%	0.7%
New	52 (>99%)	99.2% \pm 1.3%	94.3% \pm 7.5%	8.4%
Young	9 (>89%)	100% \pm 0.0%	100% \pm 0.0%	0.0%
First-year	44 (>90%)	100% \pm 0.0%	99.6% \pm 1.1%	1.2%
All Ice Types	388 (>99%)	99.6% \pm 1.5%	98.1% \pm 3.9%	4.2%



NASA P-3 Flight 2 Bering Sea

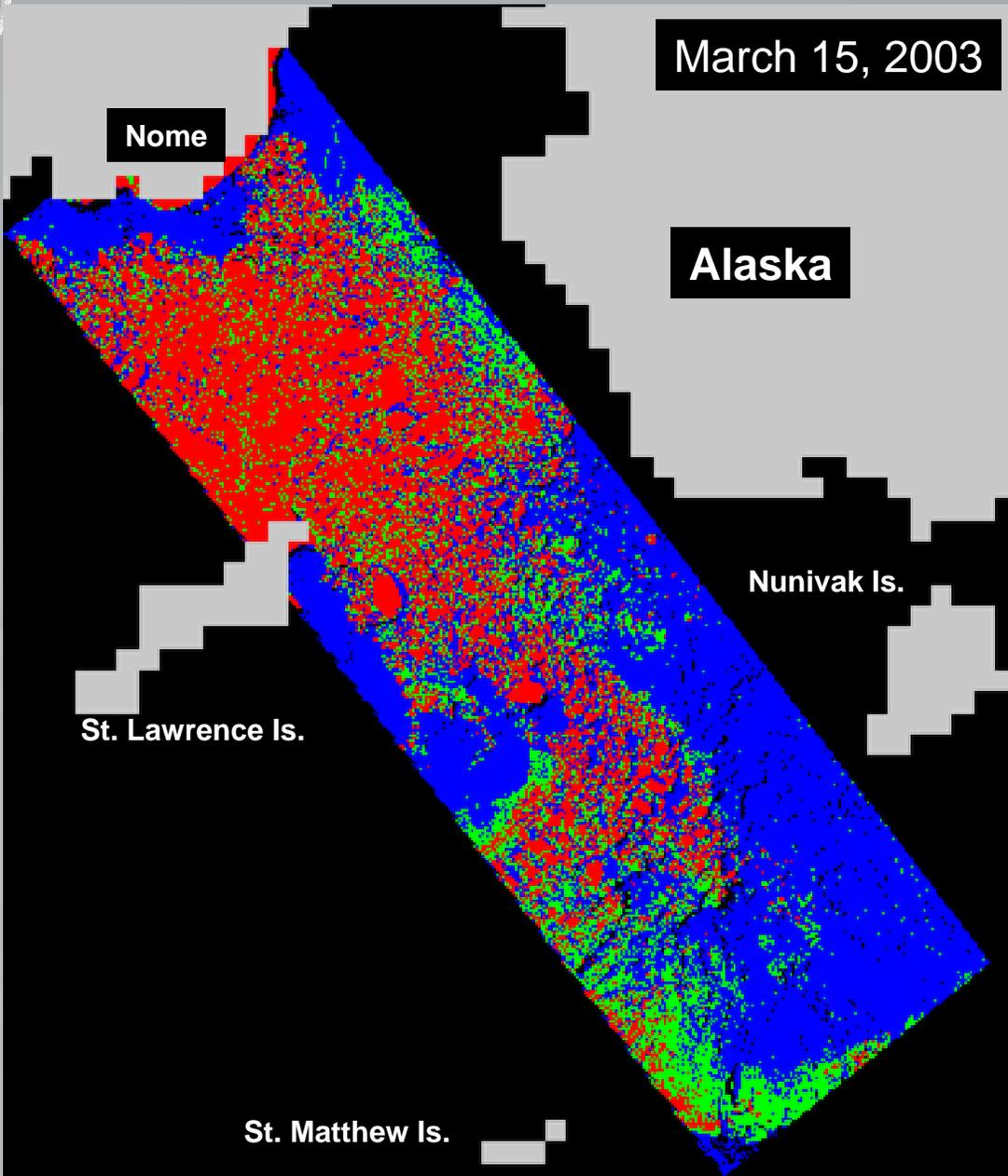
15 March 2003

NOAA 17 AVHRR image of the Bering Sea (Lt. Blue) with a NOAA ETL PSR-A (18H) mosaic overlain a Landsat 7 ETM+ B&W image for the same day. A 12.5-km AMSR-E grid is also shown for comparison.



March 15, 2003

Bering Sea ice types derived from Landsat 7 ETM+ for March 15, 2003
Red – First-year ice
Green – Young ice
Blue – New ice



Nome

Alaska

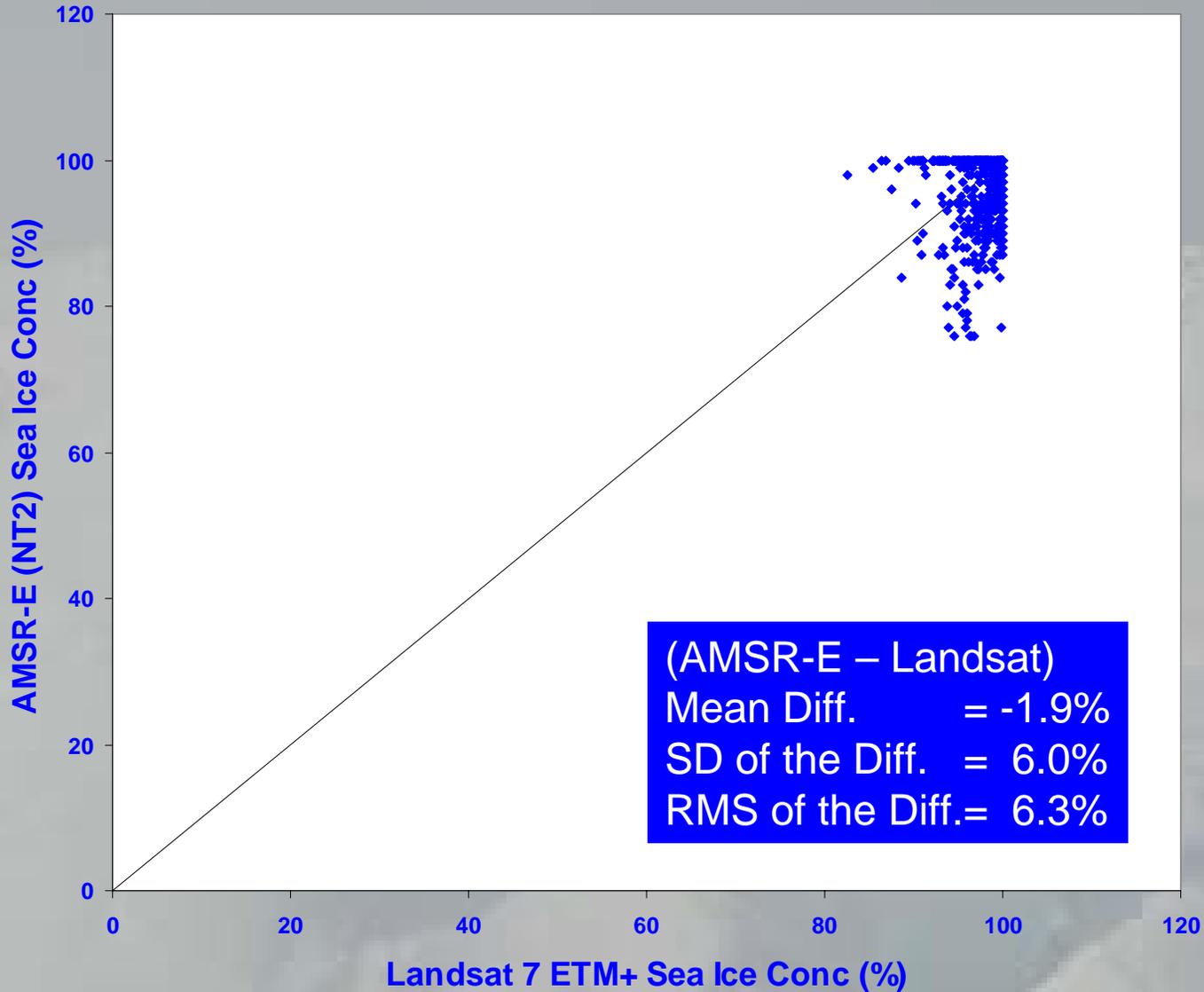
Nunivak Is.

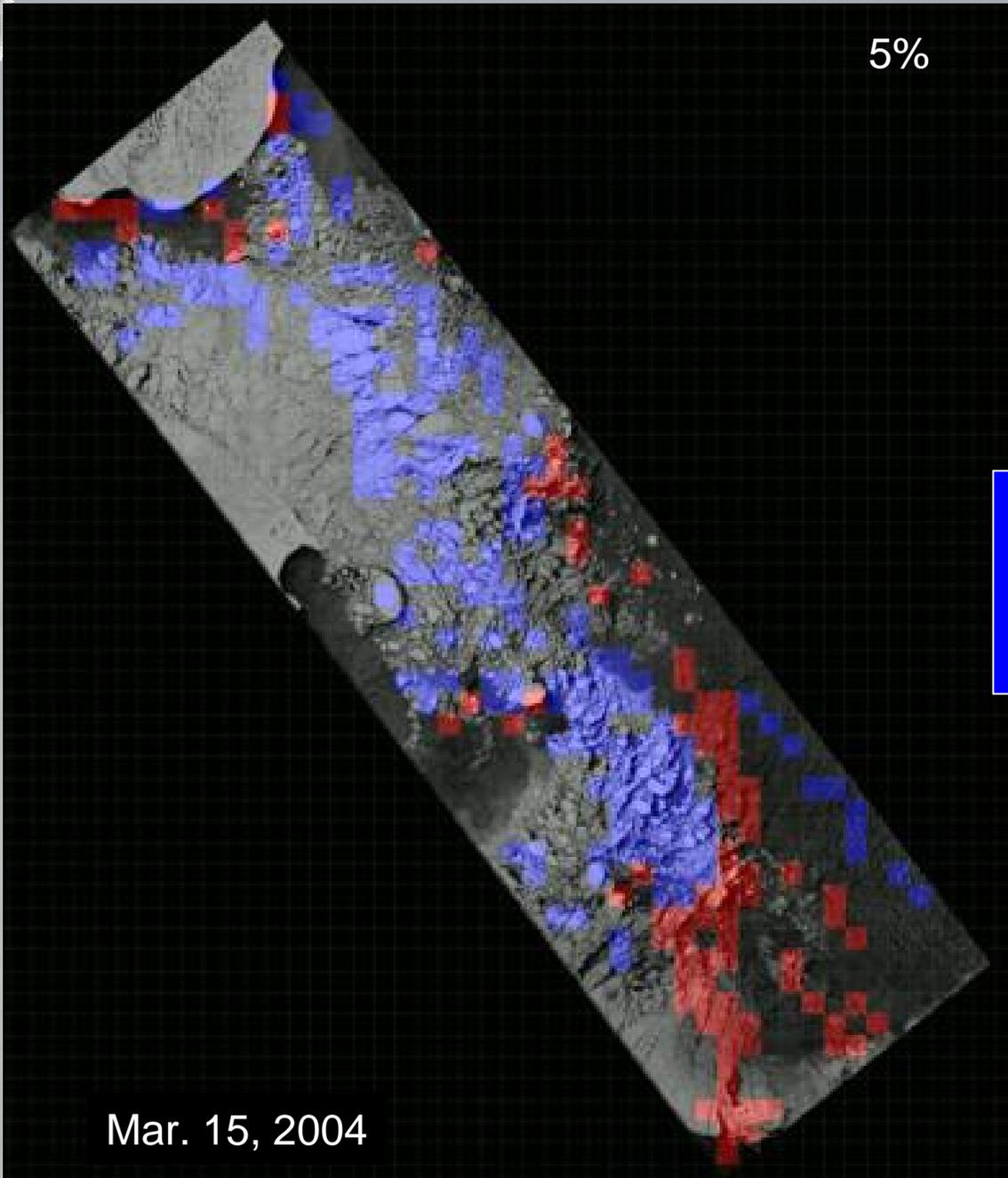
St. Lawrence Is.

St. Matthew Is.



Bering Sea Ice Comparison March 15, 2003





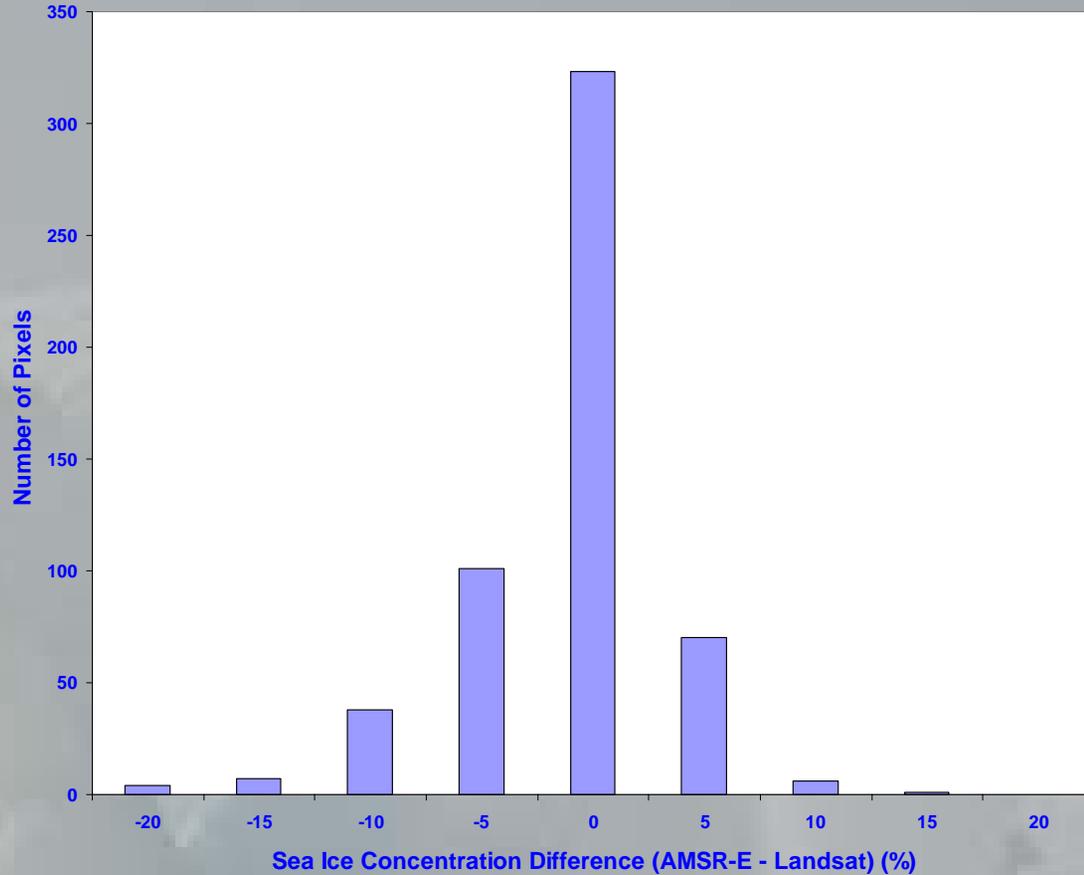
5%

**AMSR-E – Landsat 7 ETM+
Sea Ice Conc. Diff. > 5%
Red (AMSR-E>Landsat)
Blue (Landat>AMSR-E)**

Mar. 15, 2004



AMSR-E - Landsat 7 Sea Ice Concentration Differences March 15, 2003

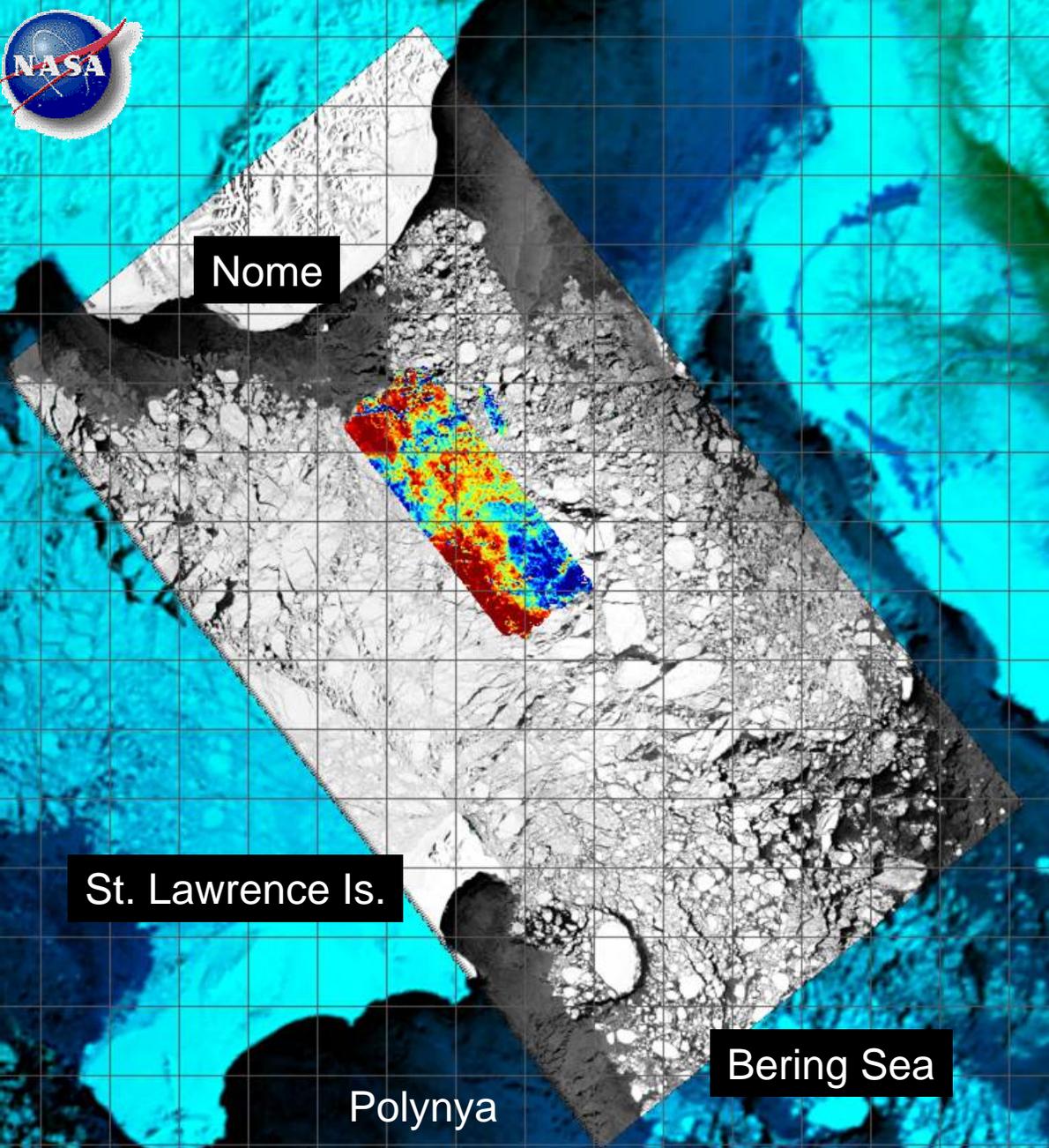


Sea Ice Con. Diff. Category	-24.9% to -20.0%	-19.9% to -15.0%	-14.9% to -10.0%	-9.9% to -5.0%	-4.9% to 4.9%	5.0% to 9.9%	10.0% to 14.9%	15.0% to 19.9%	20.0% to 24.9%
Population	4	7	38	101	323	70	6	1	0
Percent	0.8%	1.3%	7.2%	19.1%	60.9%	13.2%	1.1%	0.2%	0.0%



Comparison by Surface Type for March 15, 2003

Surface Type	Number of pixels (% pure)	Landsat Ice Concent Mean \pm 1SD	AMSR-E Ice Concent Mean \pm 1SD	AMSR-E - Landsat RMS Diff.
OW	0	-	-	-
New	54 ($\geq 90\%$)	96.7% \pm 2.3%	99.2% \pm 3.4%	5.1%
Young	0	-	-	-
First-year	9 ($\geq 90\%$)	99.7% \pm 0.5%	96.3% \pm 3.7%	4.7%
All Ice Types	160 (100%)	99.6% \pm 1.0%	96.0% \pm 4.2%	5.5%



NASA P-3 Flight 2 Bering Sea

15 March 2003

NOAA 17 AVHRR image of the Bering Sea. NOAA ETL PSR-A (18H) mosaic overlain a Landsat 7 ETM+ image for the same day. An 25-km AMSR-E grid is also shown for comparison.