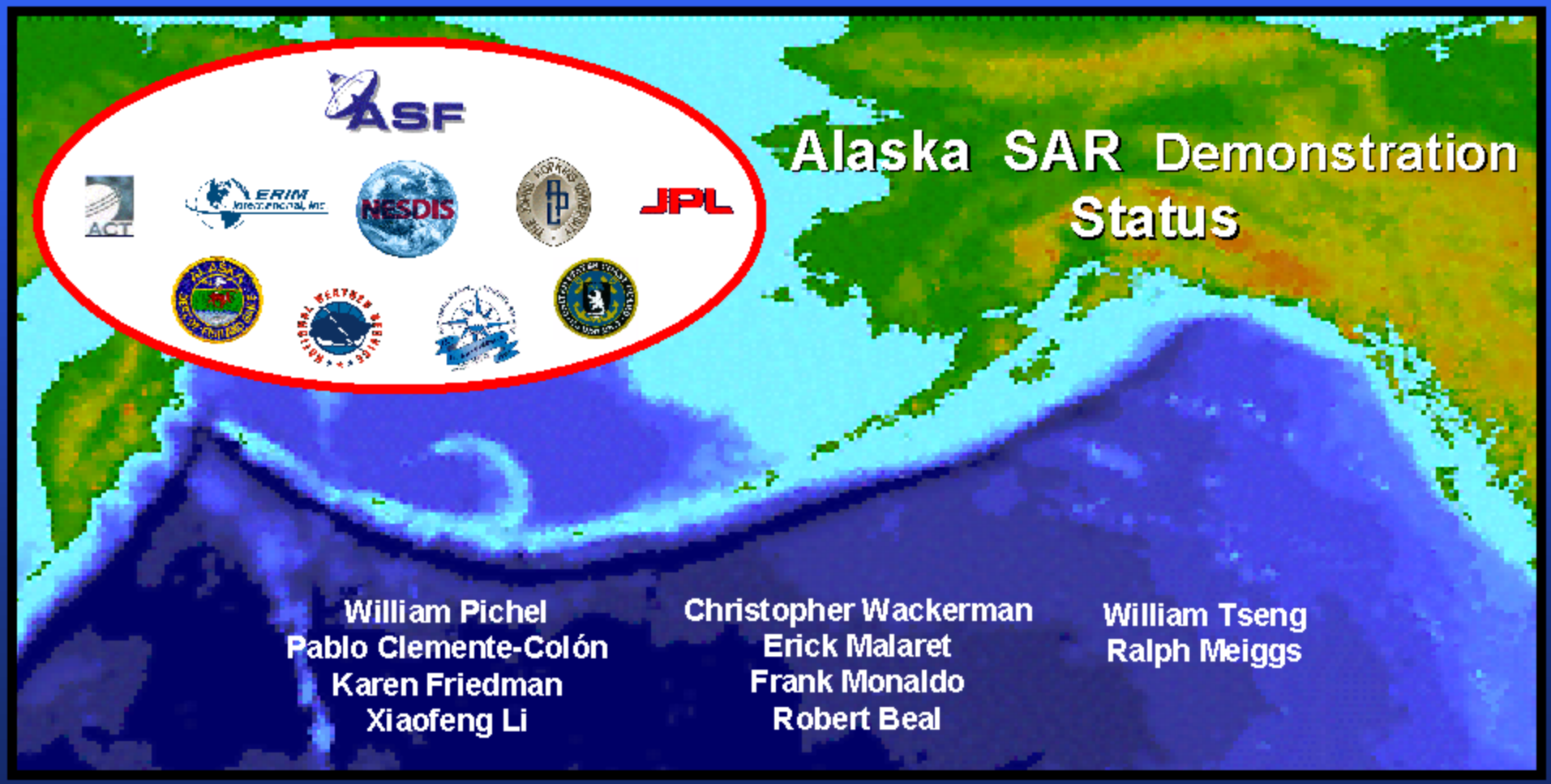
NOAA

Alaska SAR Demo

NESDIS



Alaska SAR Demonstration Status

William Pichel
Pablo Clemente-Colón
Karen Friedman
Xiaofeng Li

Christopher Wackerman
Erick Malaret
Frank Monaldo
Robert Beal

William Tseng
Ralph Meiggs

Alaska SAR Demonstration

Outline

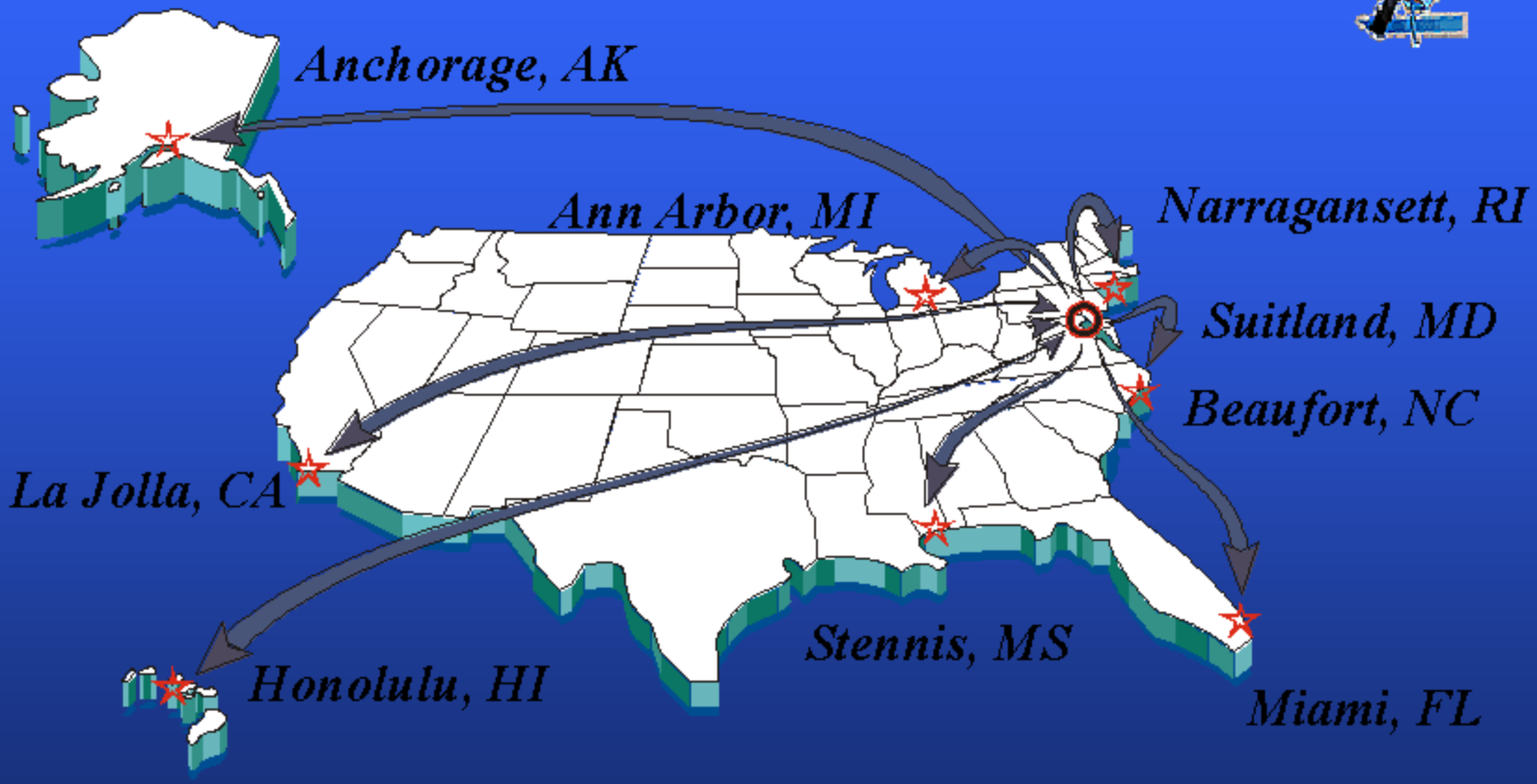
1. CoastWatch
2. Alaska SAR Demonstration Description
3. Demonstration Products

NOAA Alaska SAR Demo

CoastWatch

- NOAA Program
- Managed by NESDIS
- Established 1990
- All Eight Nodes Operating by 1993
- 2000 + Users

Alaska SAR Demo



CoastWatch NODES

Alaska SAR Demo

CoastWatch Mission

Provide environmental data and products (especially satellite imagery) for near real-time monitoring of U.S. coastal waters in support of environmental science, management, and hazard response.

Alaska SAR Demo

CoastWatch Products

- AVHRR and GOES Imager -- IR/ Visible/SST Imagery and Products
- SeaWiFS -- Ocean Color Imagery and Products
- ERS-2 -- Scatterometer Winds
- DMSP SSMI -- SSMI Winds
- RADARSAT -- SAR Imagery

NOAA Alaska SAR Demo

CoastWatch SAR Applications

PRE-OPERATIONAL

- o Sea and Lake Ice Analysis
- o Alaska River Monitoring

UNDER DEVELOPMENT

- o Winds
- o Vessel Detection
- o Oil Spill Mapping

ACTIVE RESEARCH

- o Internal Wave Studies
- o Feature Detection and Analysis with Wavelets
- o Storm Signatures

Alaska SAR Demo

NOAA/NESDIS
Alaska Synthetic Aperture Radar (SAR)
Applications Demonstration

Definition:

A pre-operational demonstration of near real-time coastal and marine products for Alaskan waters, derived from satellite SAR data.

Alaska SAR Demo

Goals:

1. Validate and test prototype SAR products that respond to critical data needs not satisfied with present observational data in the Alaska region.

2. Provide the products in near real-time via internet for trial use by operational agencies.

3. Familiarize the operational community with SAR image data and derived products.

Alaska SAR Demo

DEMO PRODUCTS:

SAR IMAGERY

- RADARSAT-1 Images (ScanSAR Wide and Standard)
- ERS/2 Images

ANCILLARY DATA

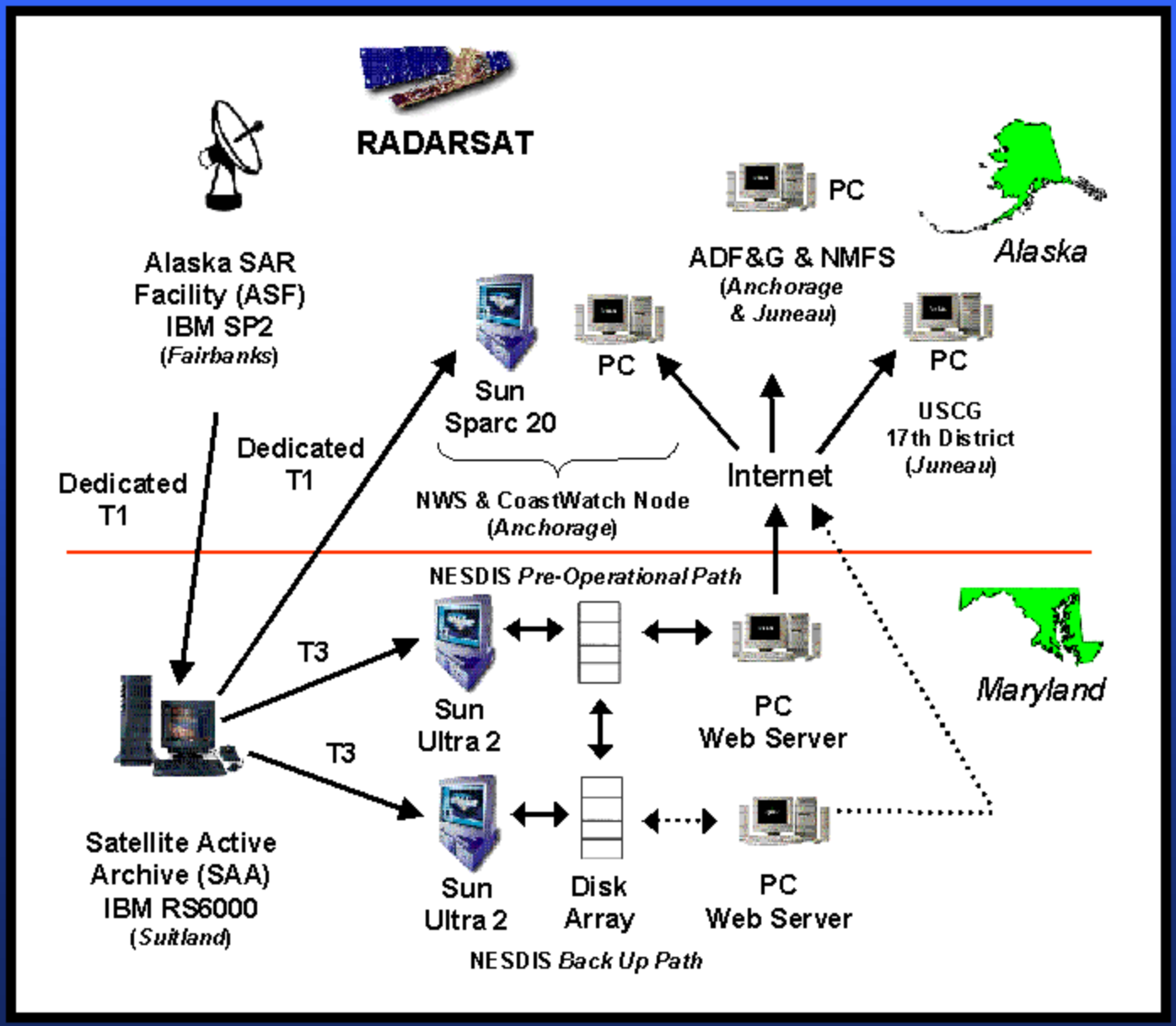
- GOES Imagery
- ERS-2 Scatterometer Winds
- SSM/I Passive Microwave Winds
- Model Wind and Wave Analyses
- SST Fields
- Buoy Wind and Wave Reports

Alaska SAR Demo

System Concept:

- DATA FROM: Alaska SAR Facility via SAA, NESDIS, and NCEP
- PRODUCTION: NESDIS
- USER ACCESS: FTP and Web Browser

Alaska SAR Demo



DATA FLOW

Alaska SAR Demo

Demo Participants - Product Development:

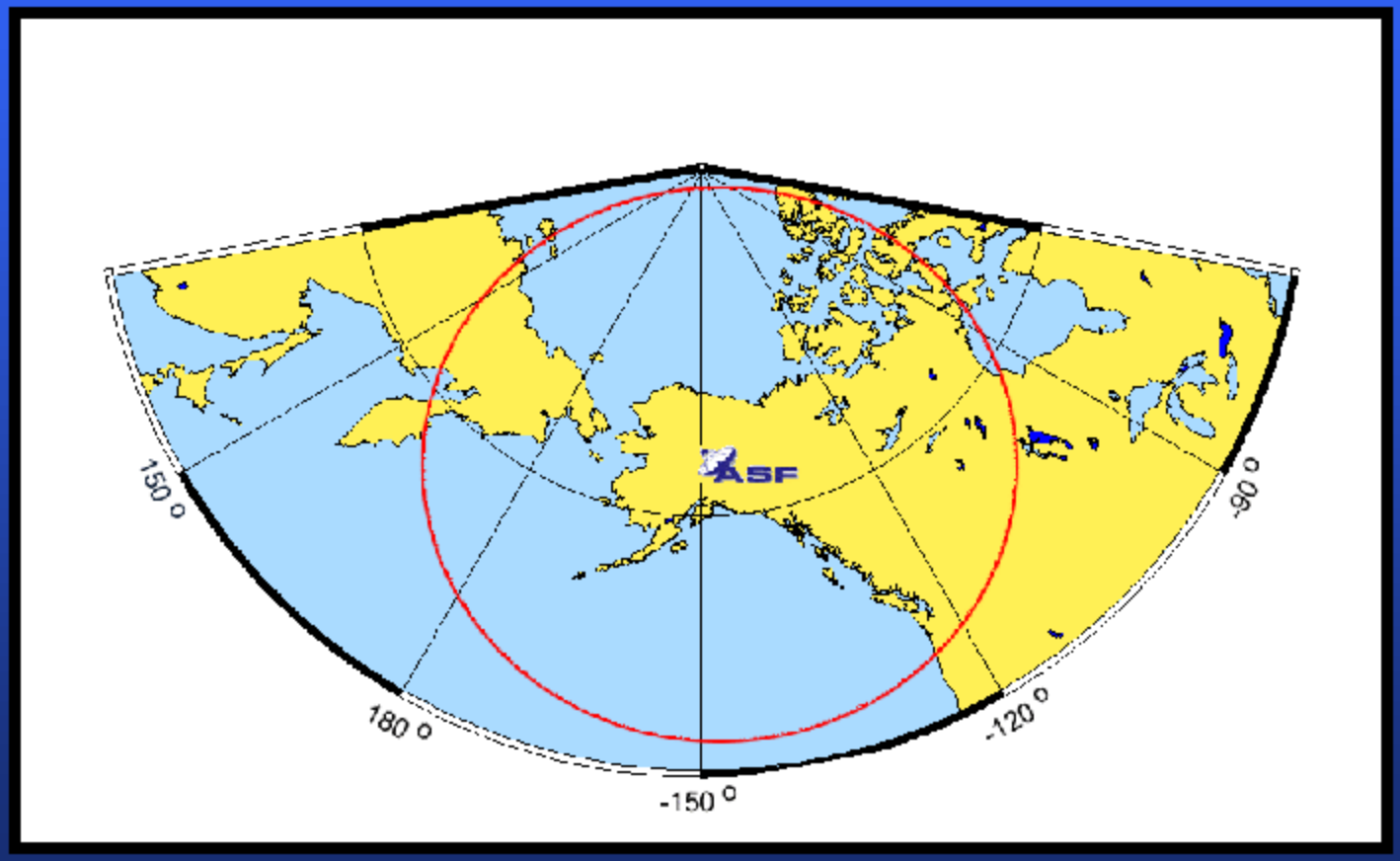
AGENCY	ROLE
JHU/APL	Wind Speed Image Products
ERIM Intl., Inc.	Hard Target and Wind Vector Products
ACT	SAR Data Browse and Product Web Server
JPL	Ship Detection - Consulting and Validation
NESDIS	Algorithm Testing, System Integration & Product Validation

Alaska SAR Demo

Demo Participants - Production:

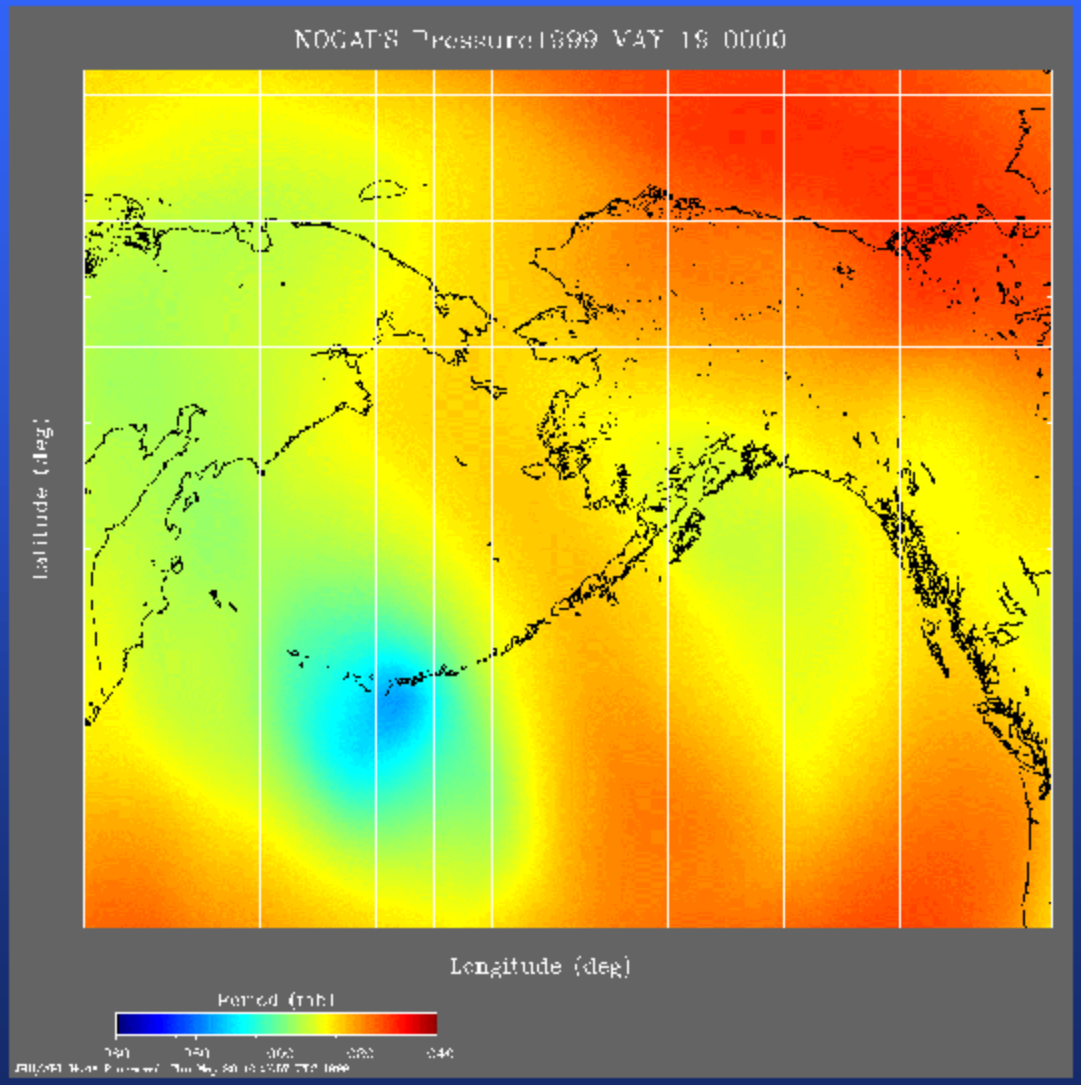
AGENCY	ROLE
Alaska SAR Facility	SAR Data Acquisition and Image Production
NESDIS SAA NESDIS OSDPD NESIDS ORA	SAR Image Data Serving Routine Product Production System Backup

Alaska SAR Demo



ASF RADARSAT AND ERS-2 STATION MASK

Alaska SAR Demo



ALASKA SAR DEMONSTRATION REGION

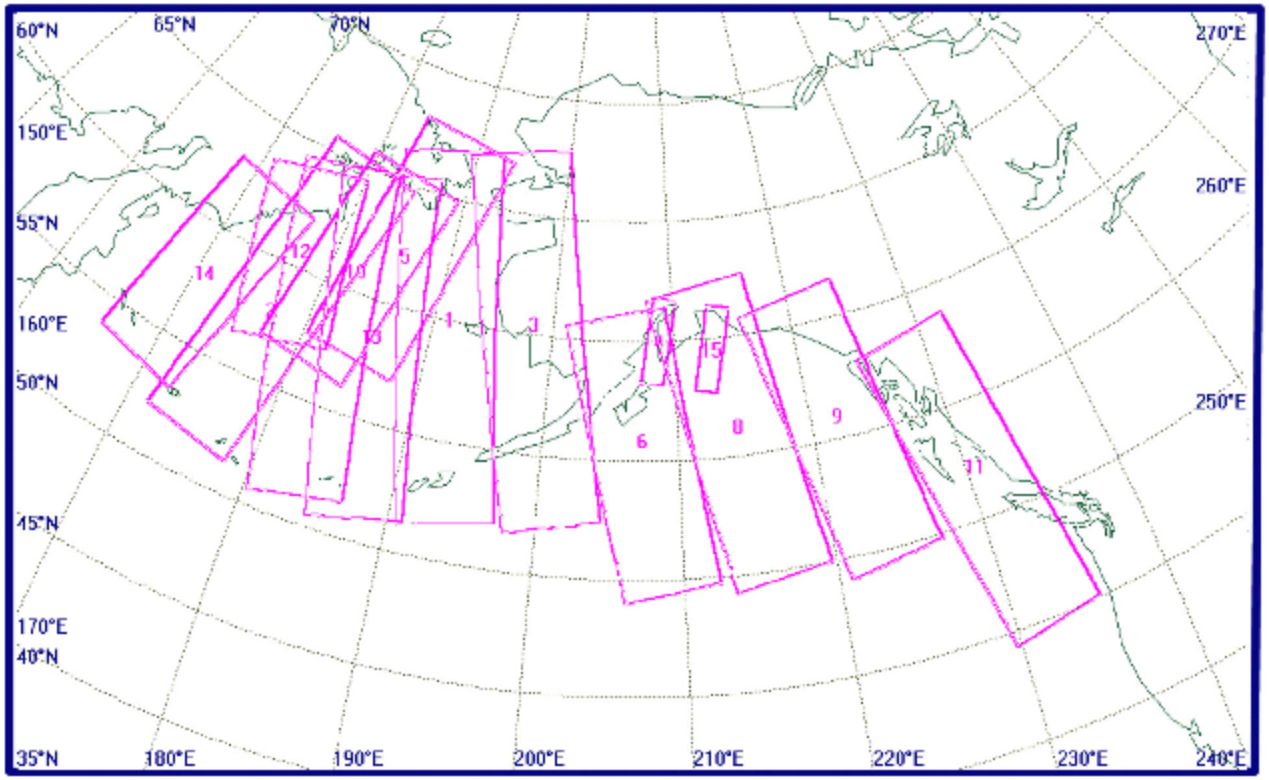
Alaska SAR Demo

NOAA

NESDIS

RADARSAT Data Scheduled for Demo

DEMO COVERAGE WEEK 1



NOAA Alaska SAR Demo

NESDIS

Alaska SAR Demo Users:	Applications
NOAA NWS Alaska Region Alaska CoastWatch Node	Storm & Ice Warnings
USCG 17th District	Fishing Enforcement
Alaska Department of Fish & Game	Fisheries Management
NOAA NMFS	Enforcement & Research

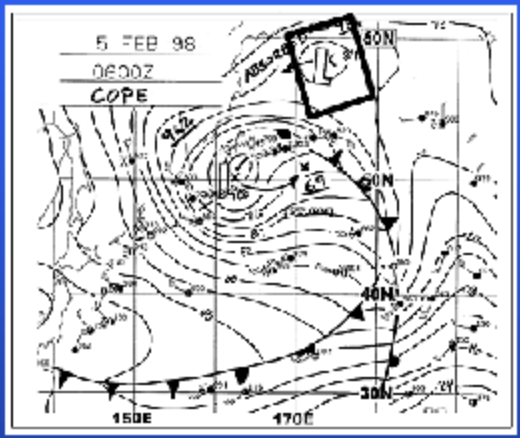
New Users: U.S. Air Force, Elmendorf AFB and NOAA HAZMAT, Anchorage

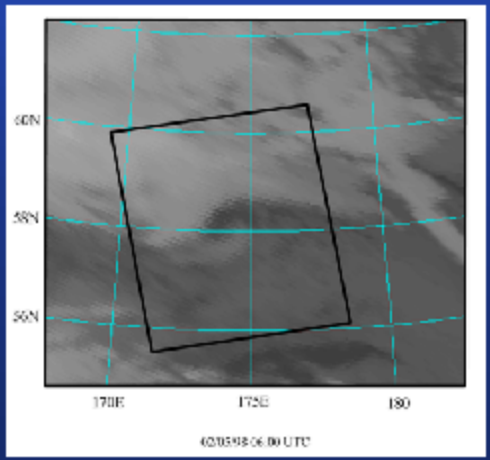
Alaska SAR Demo

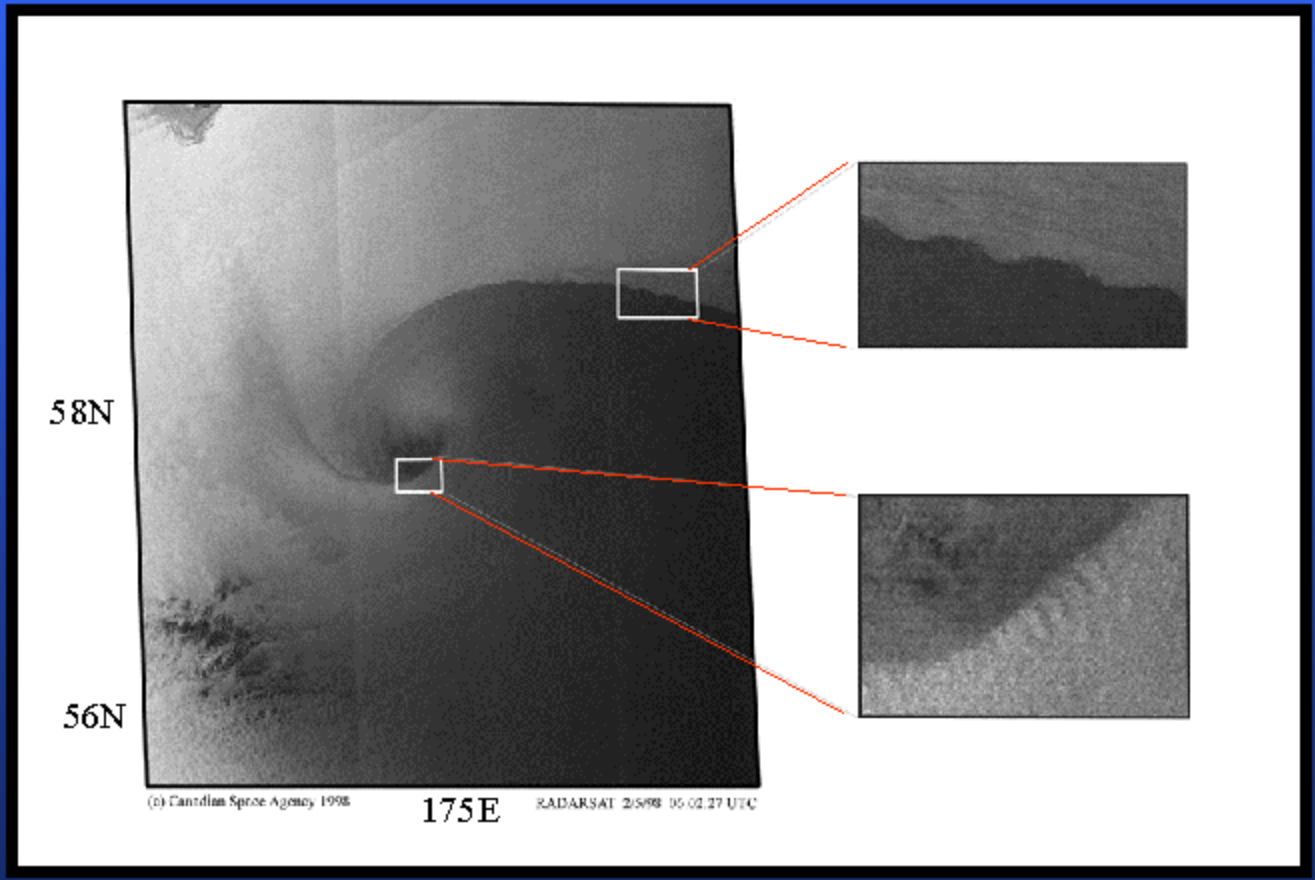
NOAA

NESDIS

APPLICATION 1: STORM WARNINGS

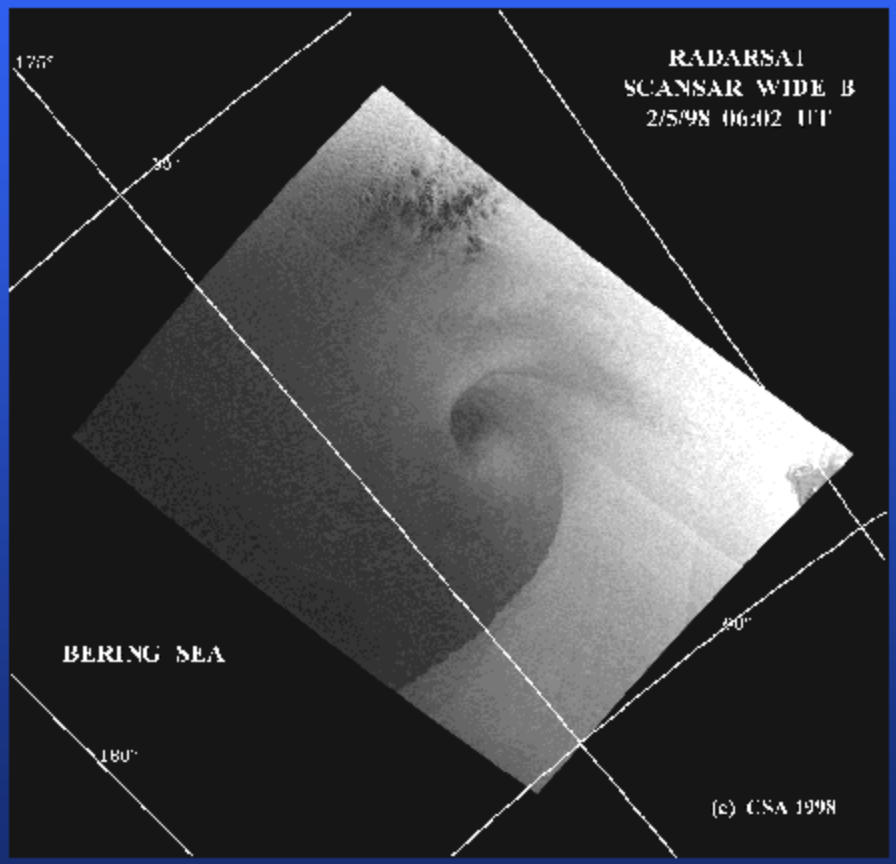


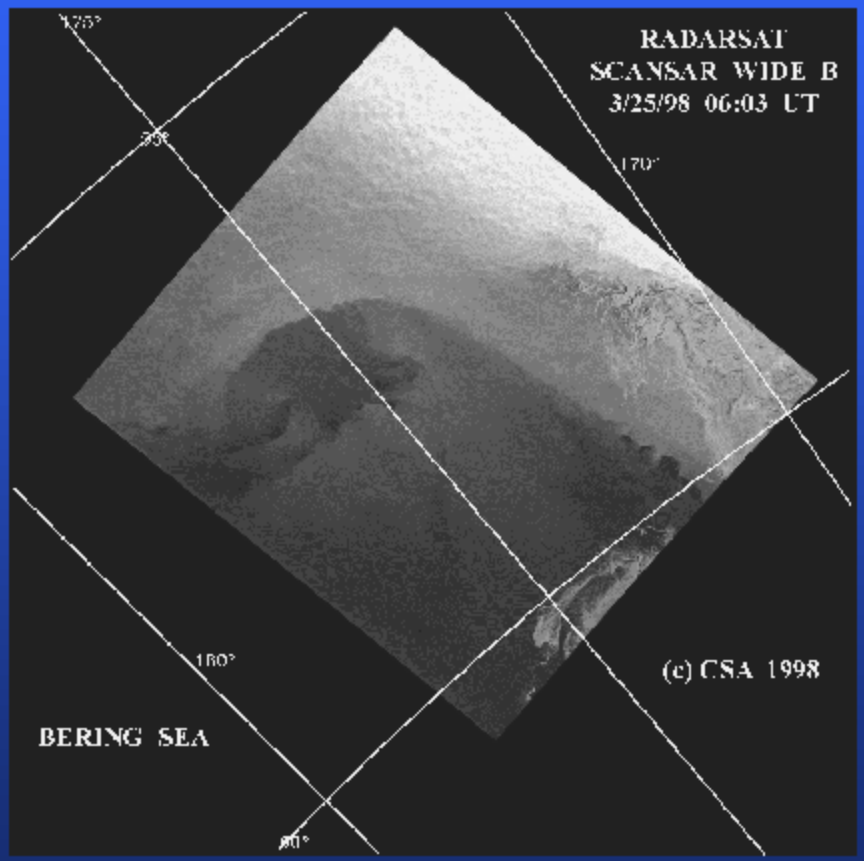




POLAR MESOSCALE CYCLONE - BERING SEA

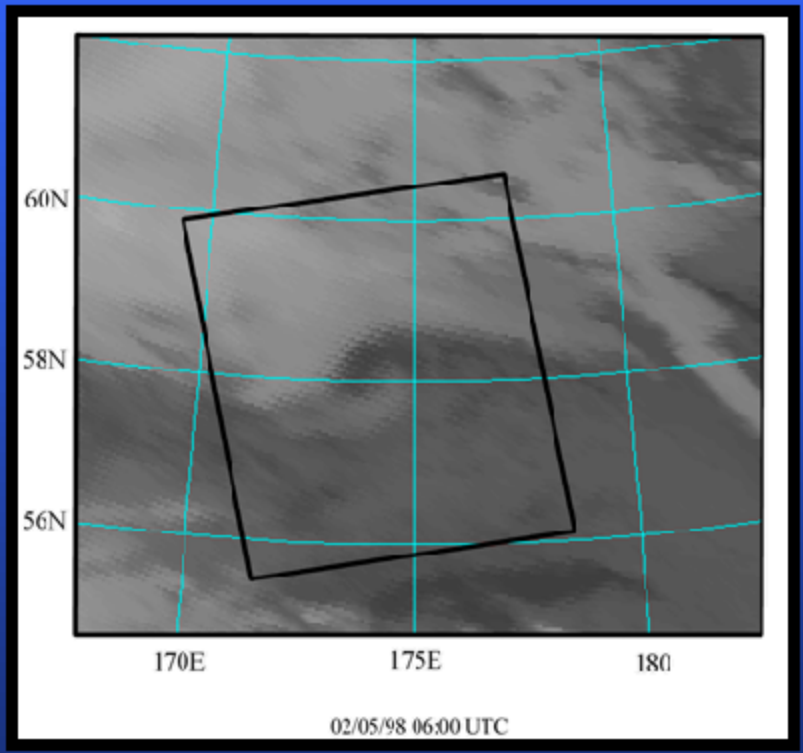
Alaska SAR Demo

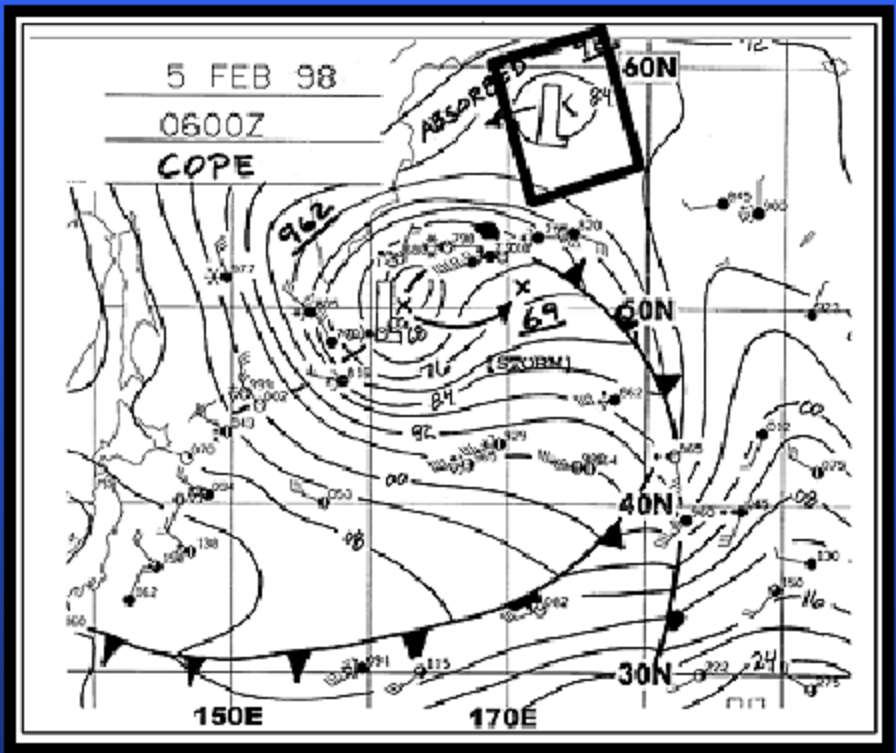




SAR OBSERVATIONS OF POLAR LOWS

Alaska SAR Demo





GOES IR

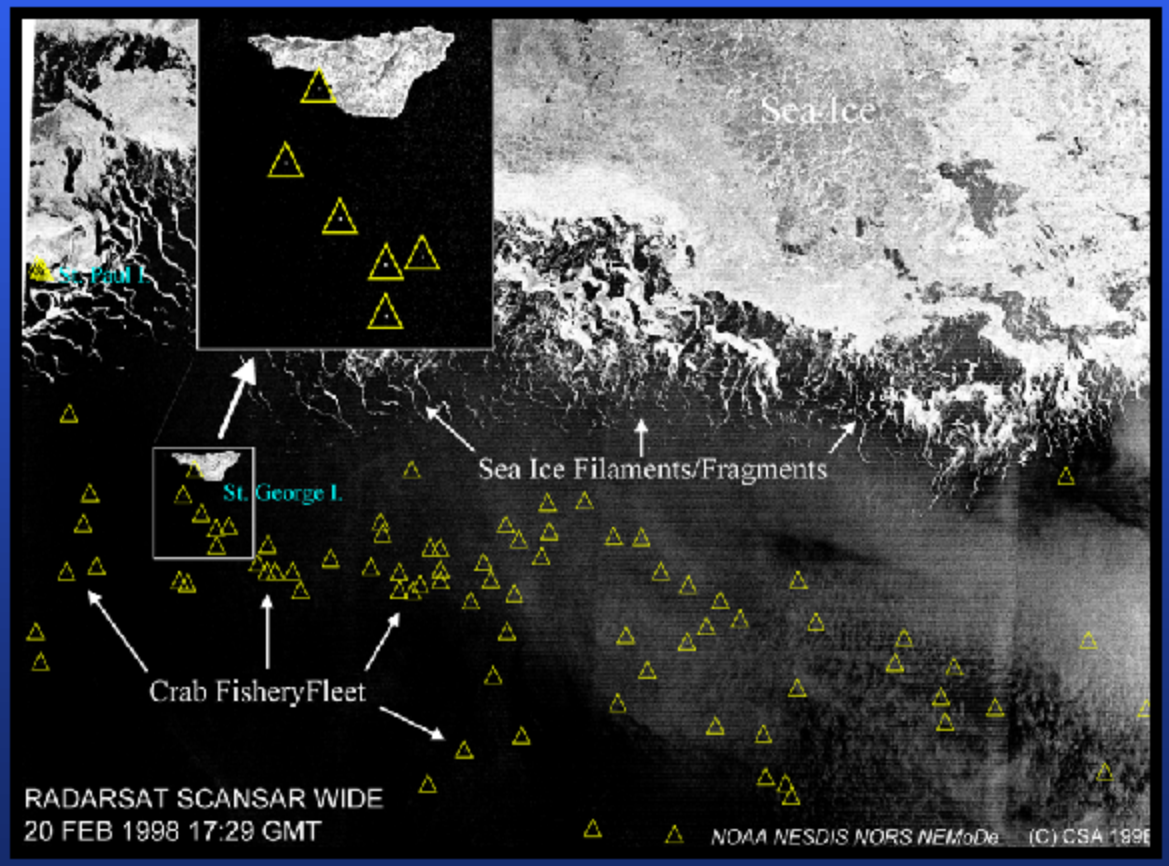
NWS SURFACE ANALYSIS

POLAR MESOSCALE CYCLONE

NOAA Alaska SAR Demo

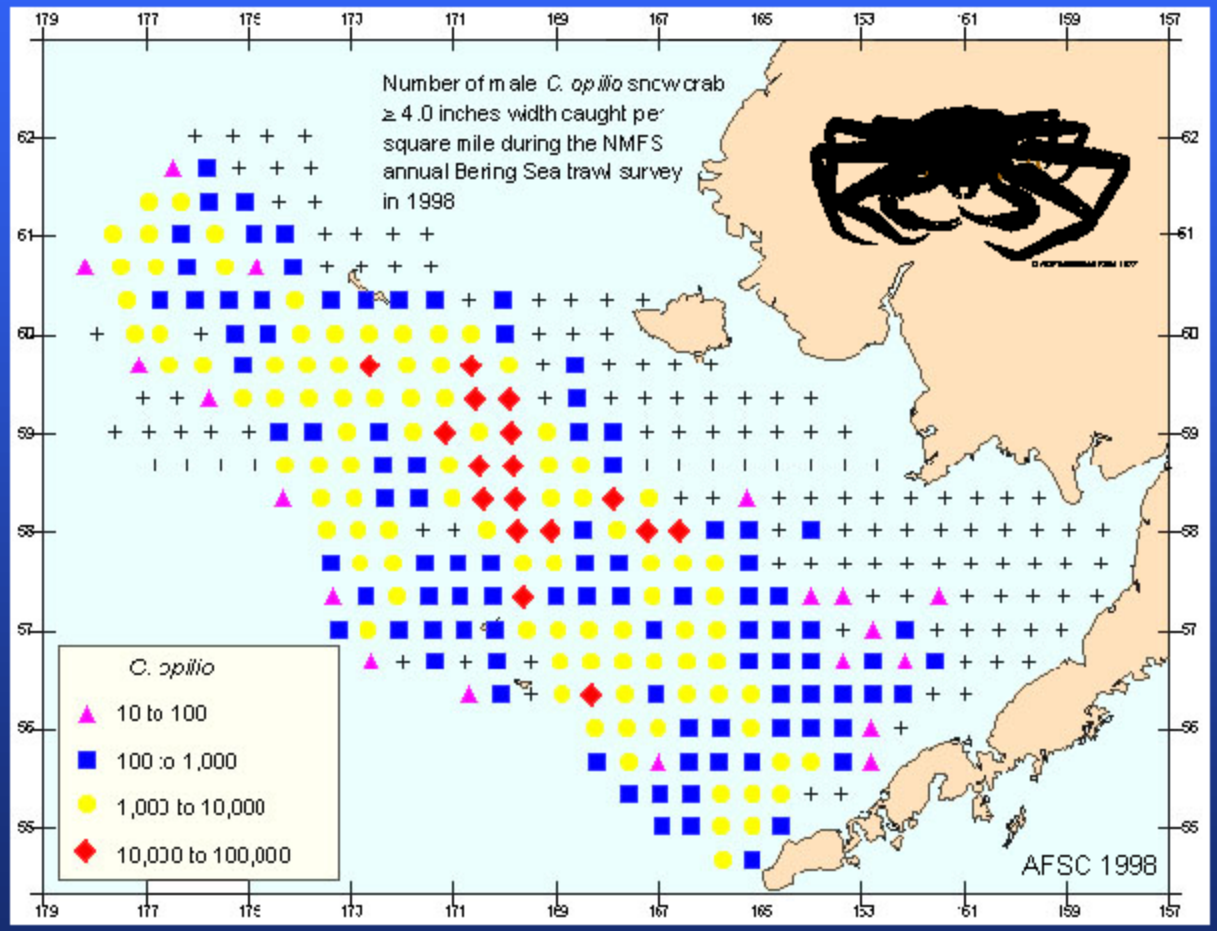
NESDIS

APPLICATION 2: ICE WARNINGS FOR FISHERIES



BERING SEA ICE EDGE AND SNOW CRAB FISHERY FLEET

Alaska SAR Demo



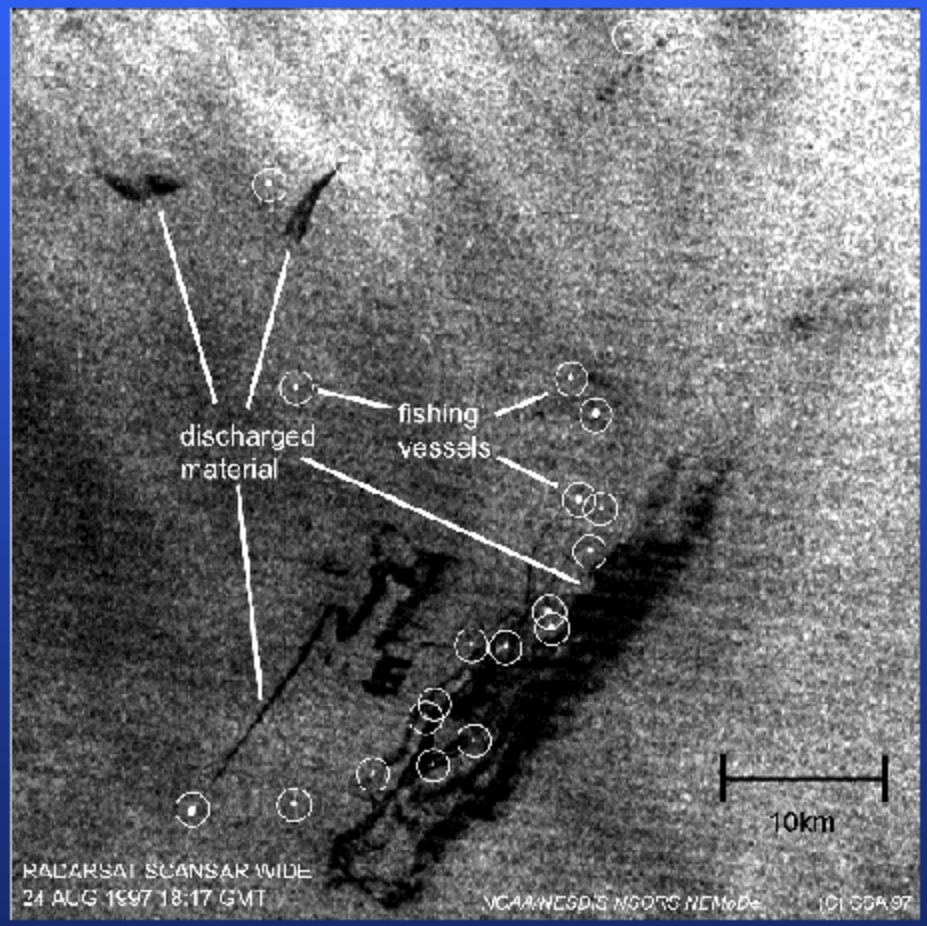
E. BERING SEA SNOW CRAB DISTRIBUTION

Alaska SAR Demo

NOAA

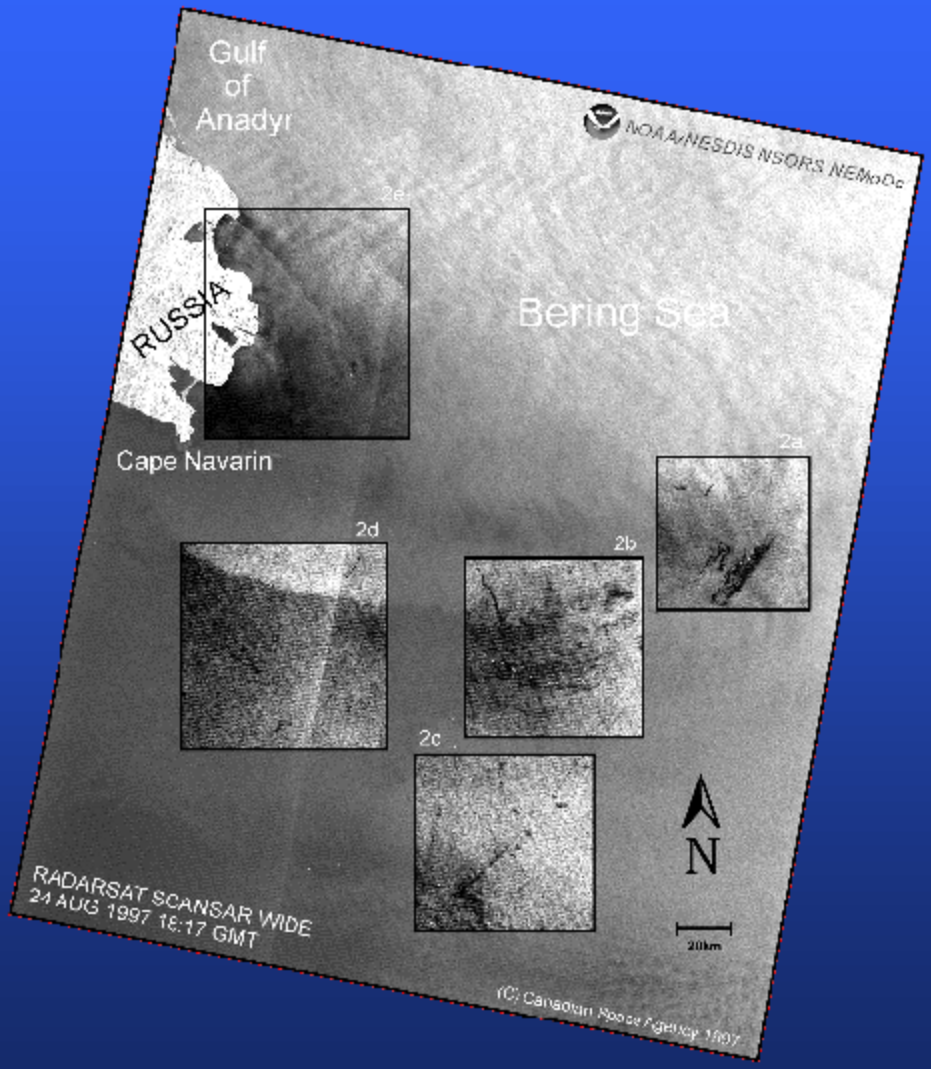
NESDIS

APPLICATION 3: FISHING SURVEILLANCE



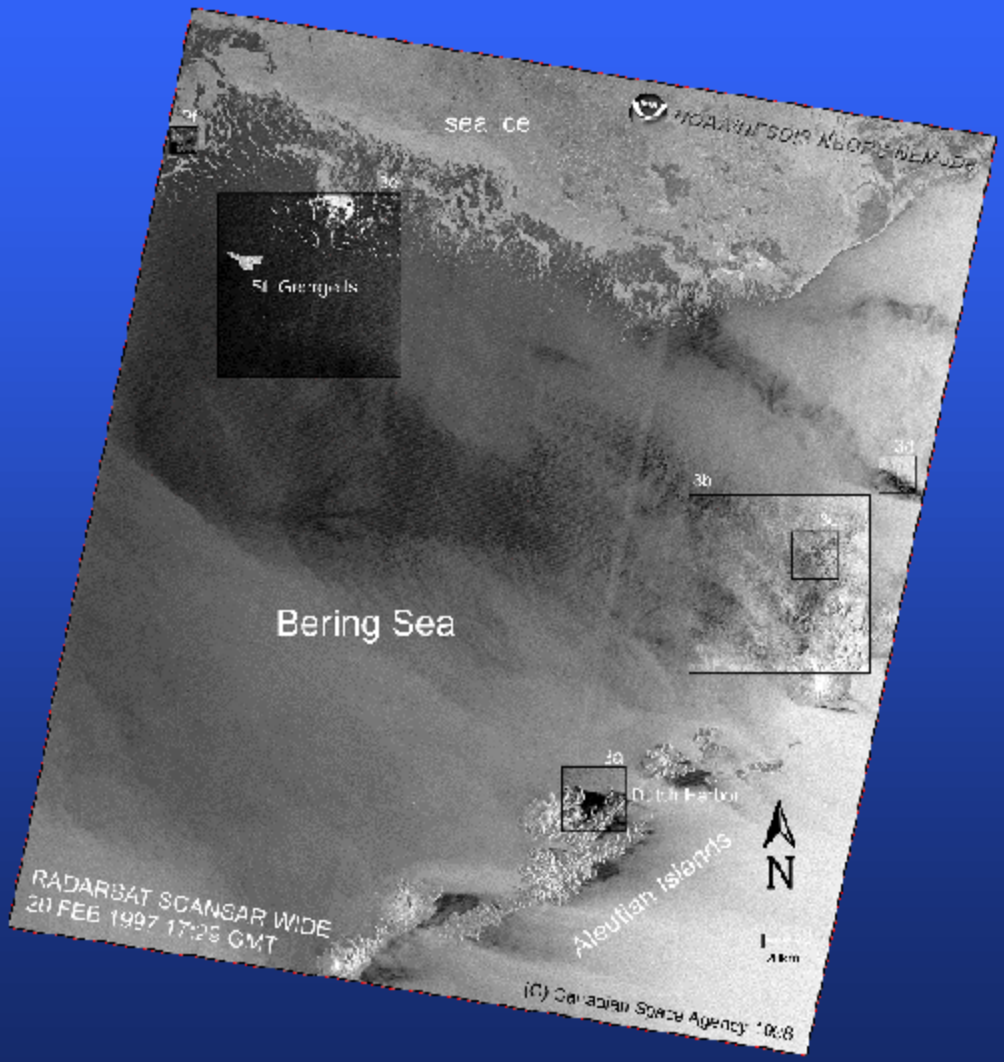
BERING SEA WALLEYE POLLOCK FISHERY

Alaska SAR Demo



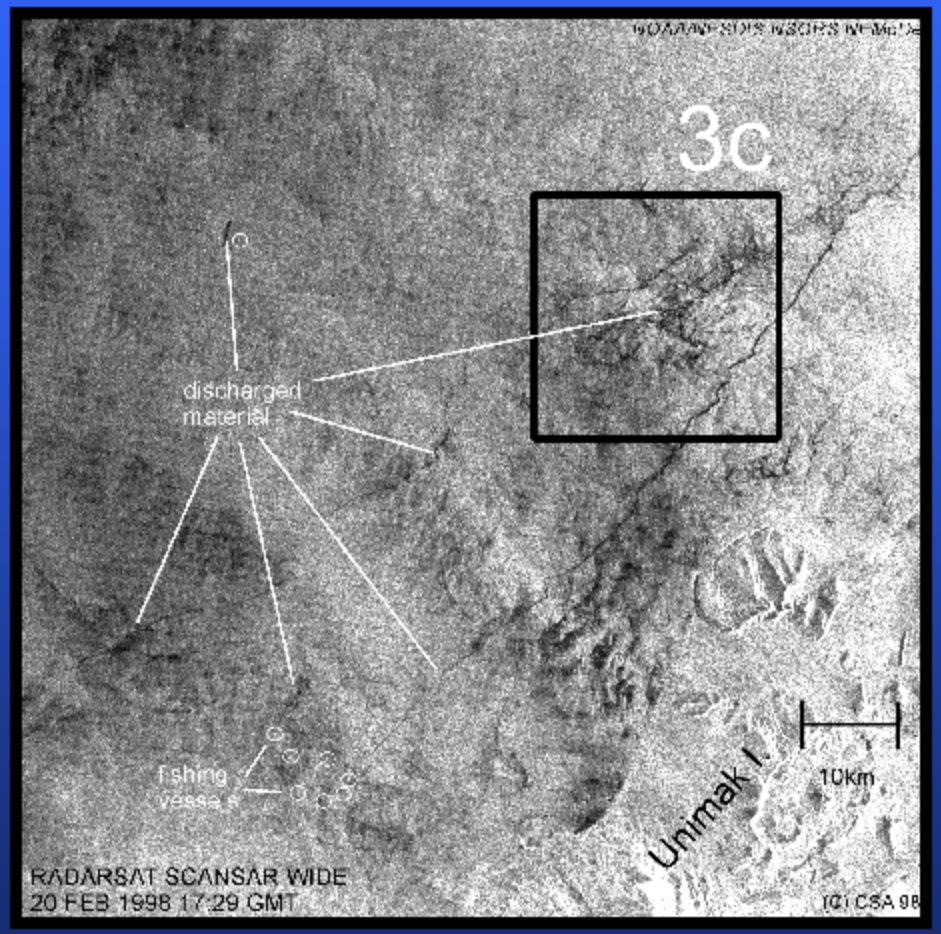
W. BERING SEA FISHERIES SAR IMAGE

Alaska SAR Demo



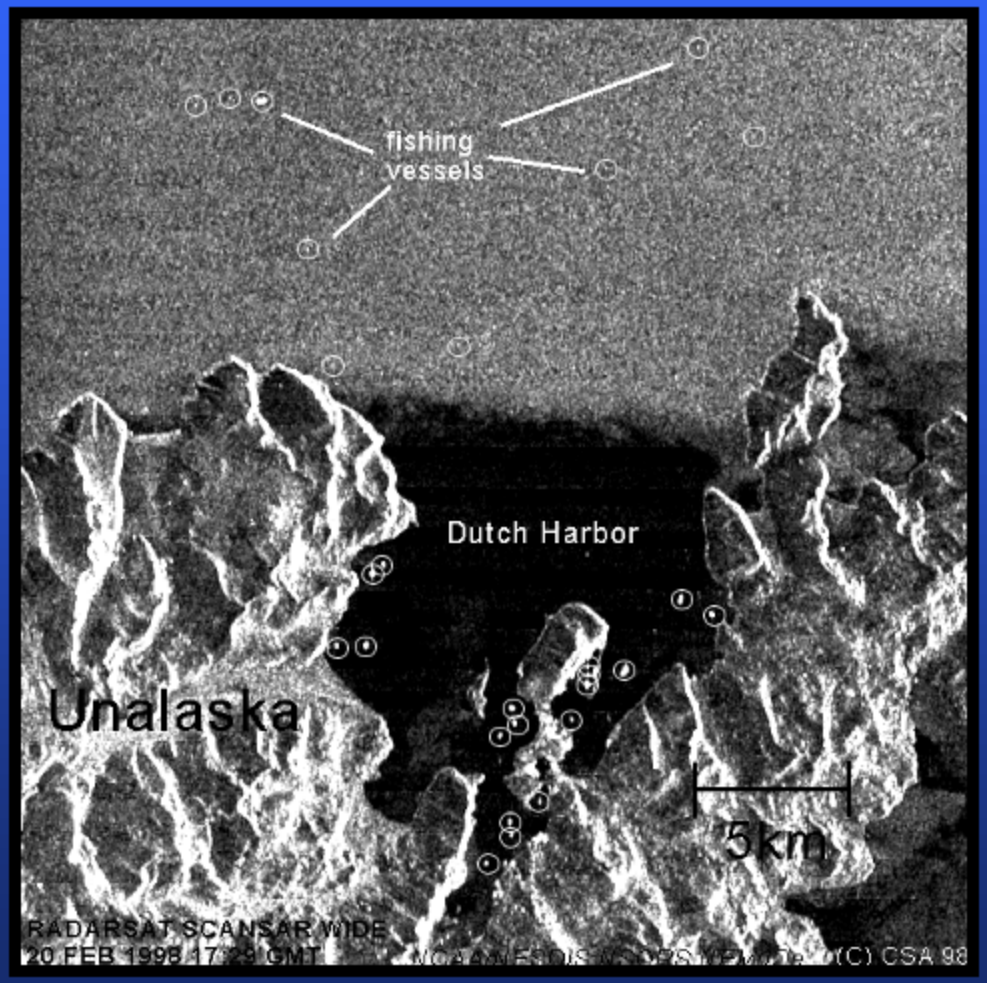
E. BERING FISHERIES SAR IMAGE

Alaska SAR Demo



U.S. WALLEYE POLLOCK FISHERY NEAR ALEUTIANS

Alaska SAR Demo



SAR SUB-IMAGE OF DUTCH HARBOR

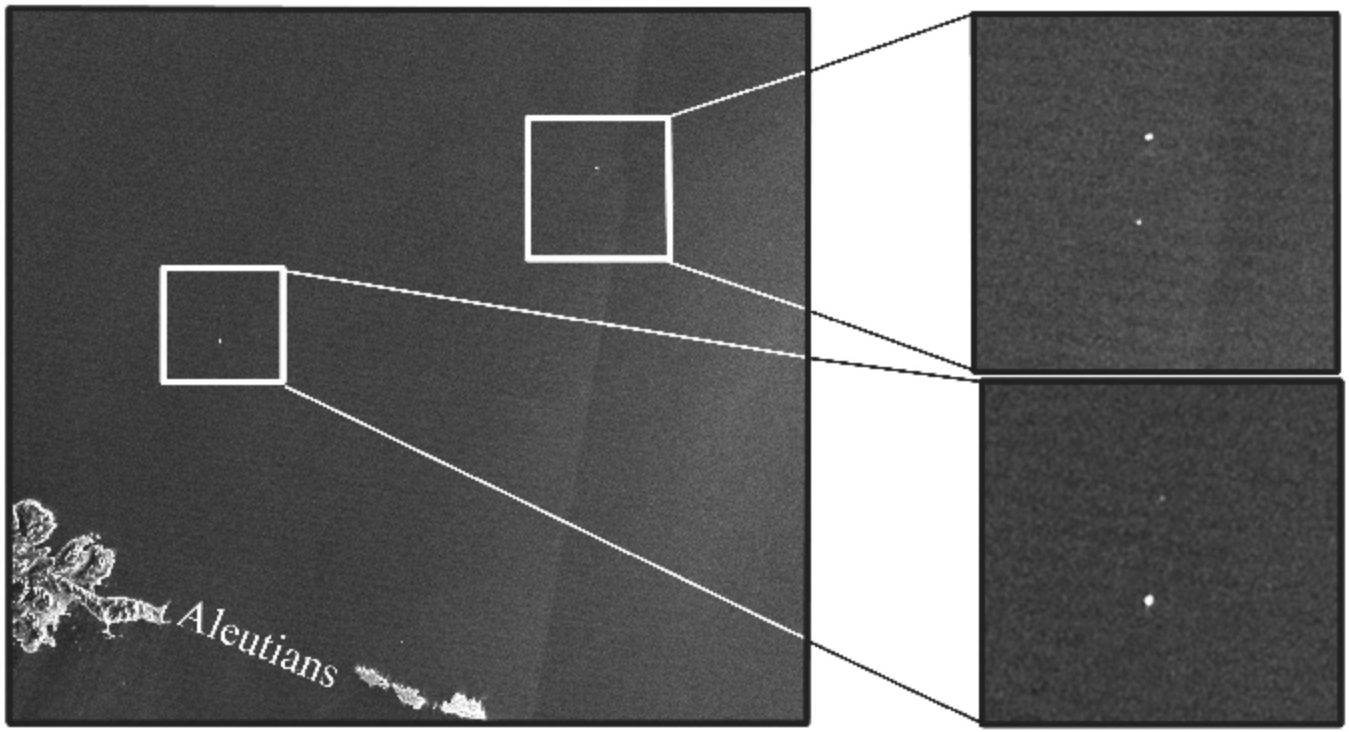
Alaska SAR Demo

NOAA

NESDIS

Pre-demo Imagery - Fishing Surveillance

HIGH SEAS DRIFT NETS



5/13/99 18:32 GMT Just north of Aleutians, 53N, 178E

(C) CSA 1999

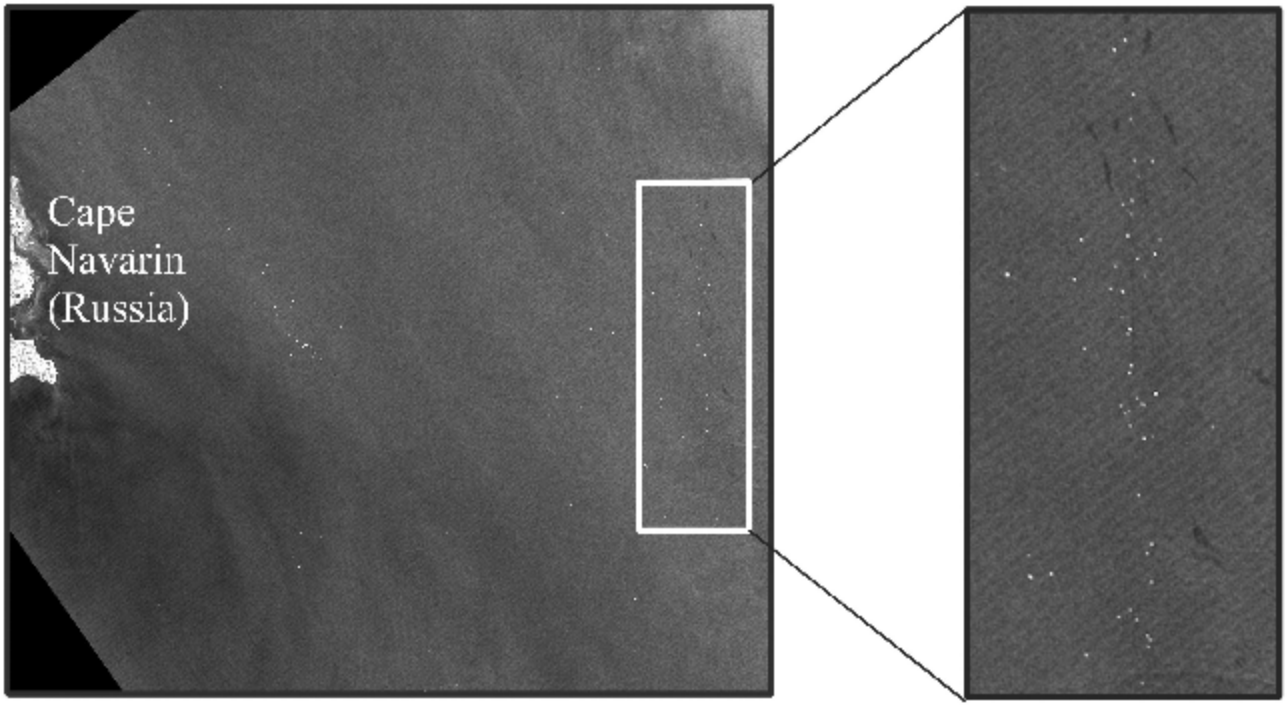
Alaska SAR Demo

NOAA

NESDIS

Pre-demo Imagery - Fishing Surveillance

MARITIME BOUNDARY



6/27/99 18:17 GMT, Bering Sea, 62N, 178W

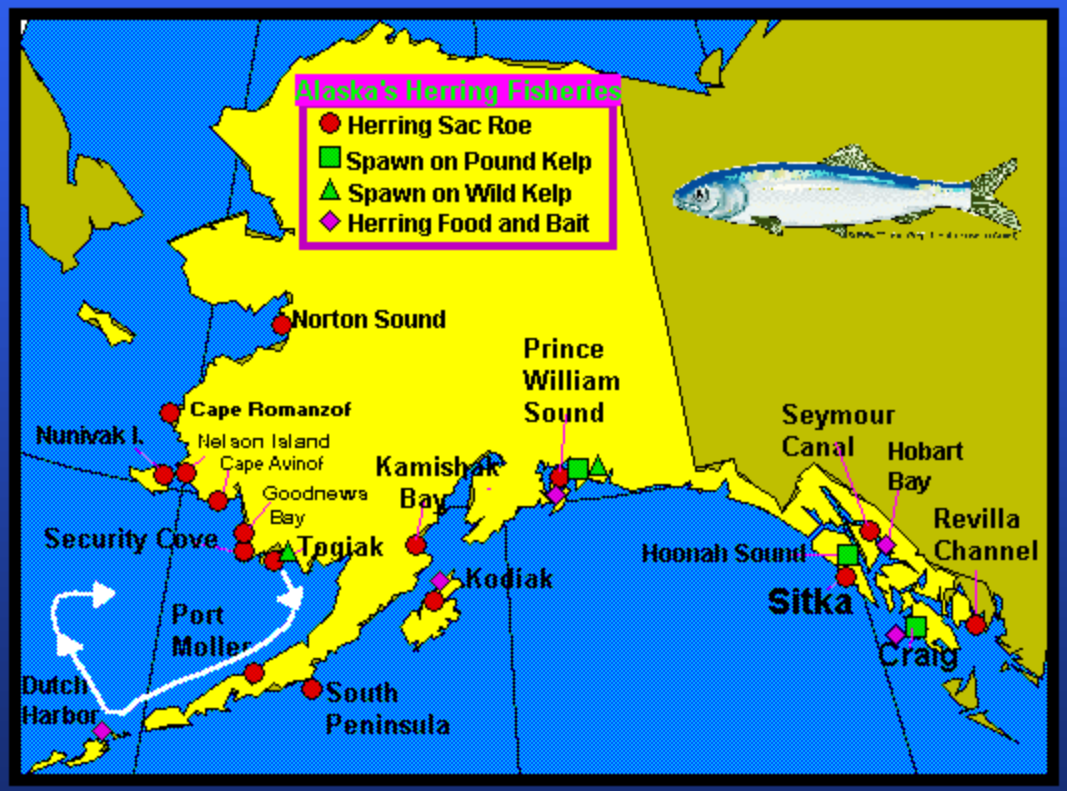
(C) CSA 1999

Alaska SAR Demo

APPLICATION 4: FISHERIES MANAGEMENT

HERRING ROE FISHERY - BRISTOL BAY

Alaska SAR Demo



ALASKA HERRING FISHERIES

Alaska SAR Demo

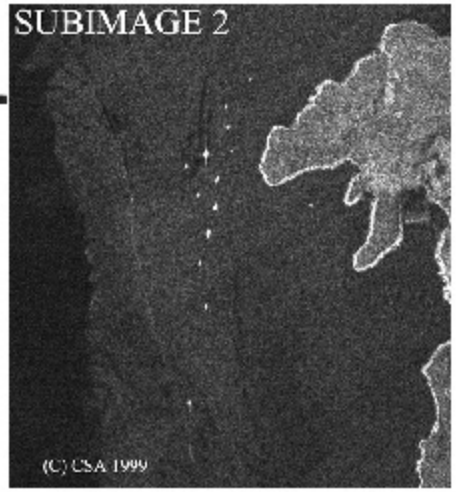
NOAA

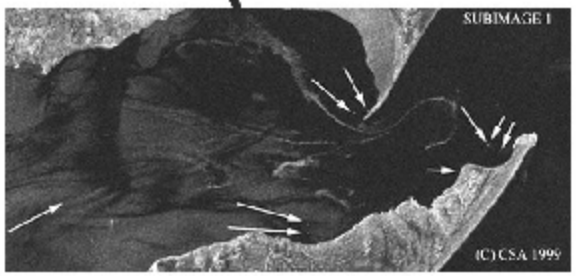
NESDIS

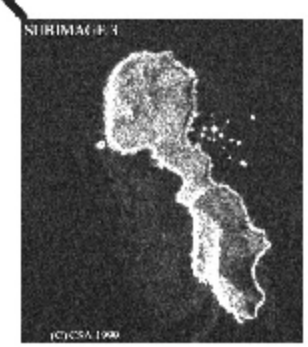
Pre-demo Imagery - Fisheries Management

TOGIAK BAY HERRING FISHERY

5/14/99 4:17 GMT, 58.5N, 160.5W







*** SAR TARGETS AGREE WITH AERIAL SURVEY

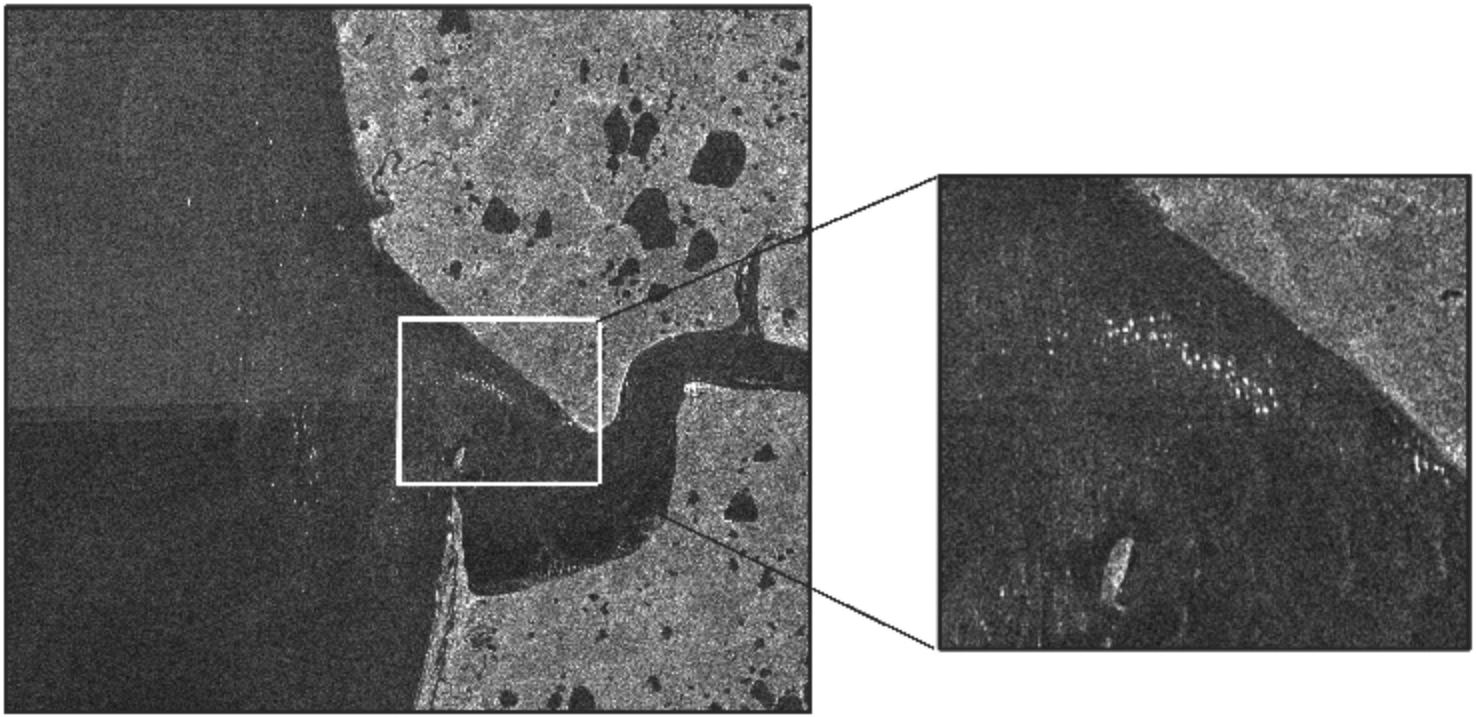
Alaska SAR Demo

NOAA

NESDIS

Pre-demo Imagery - Fishing Surveillance

EGEGIK BAY SALMON FISHERY



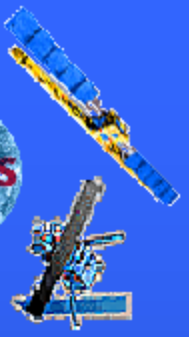
6/30/99 16:50 GMT, in Bristol Bay, 58N, 157.5W

(C) CSA 1999

Alaska SAR Demo

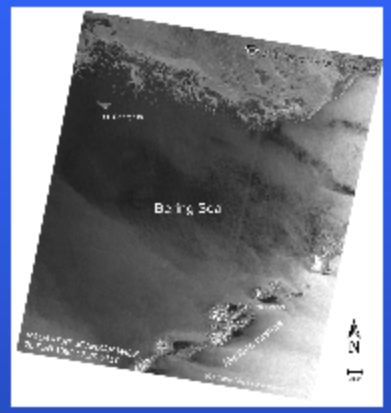
NOAA

NESDIS

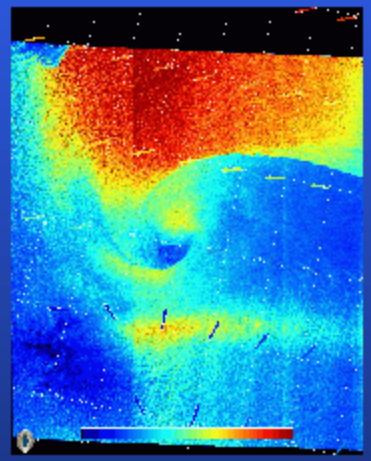


Initial Products:

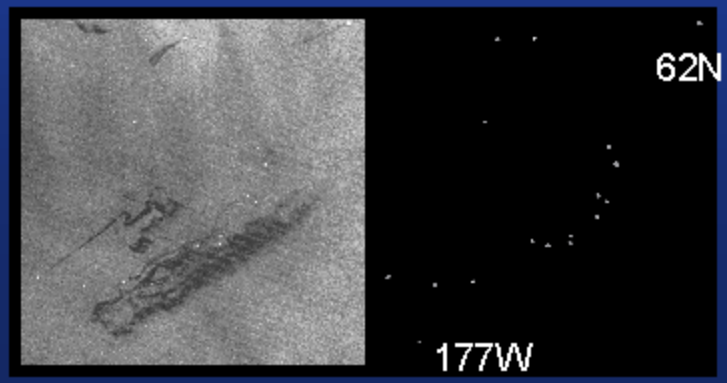
1. High Resolution Ocean and Coastal SAR Imagery.



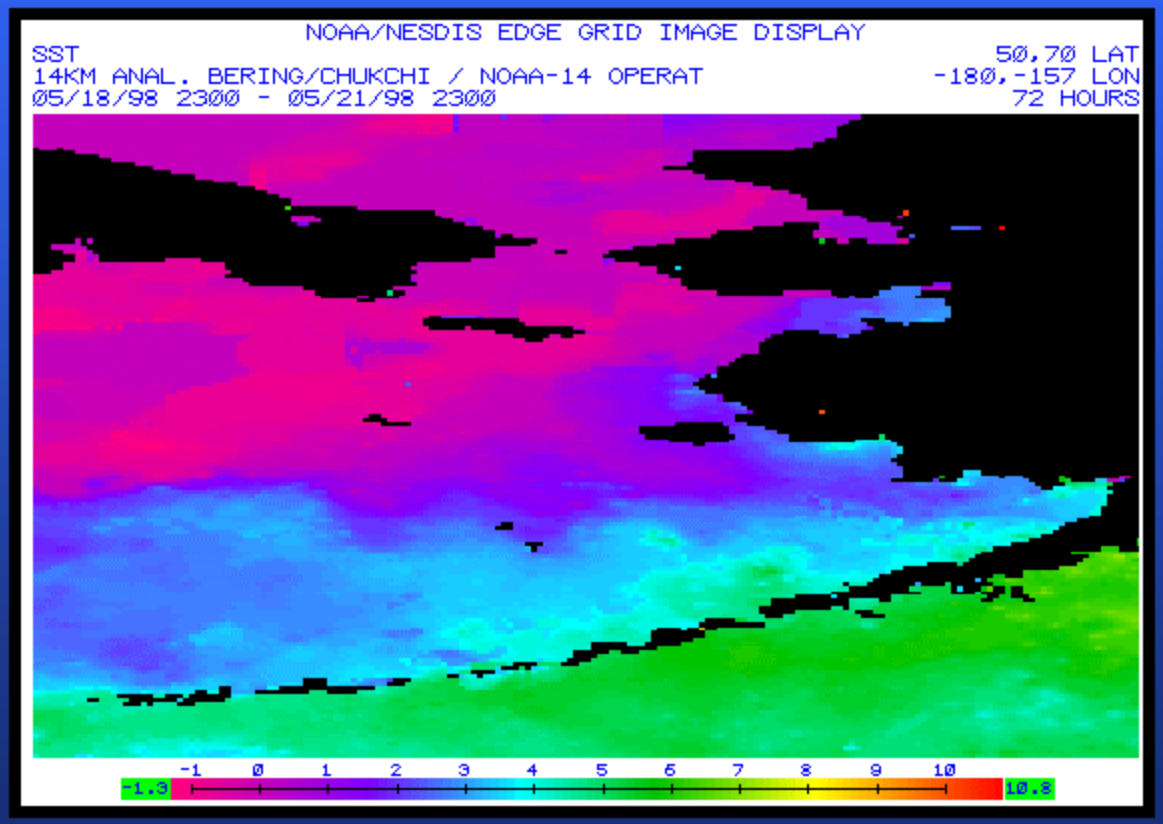
2. Ocean Surface Wind Maps and Vectors



3. Hard Target (ship) Locations



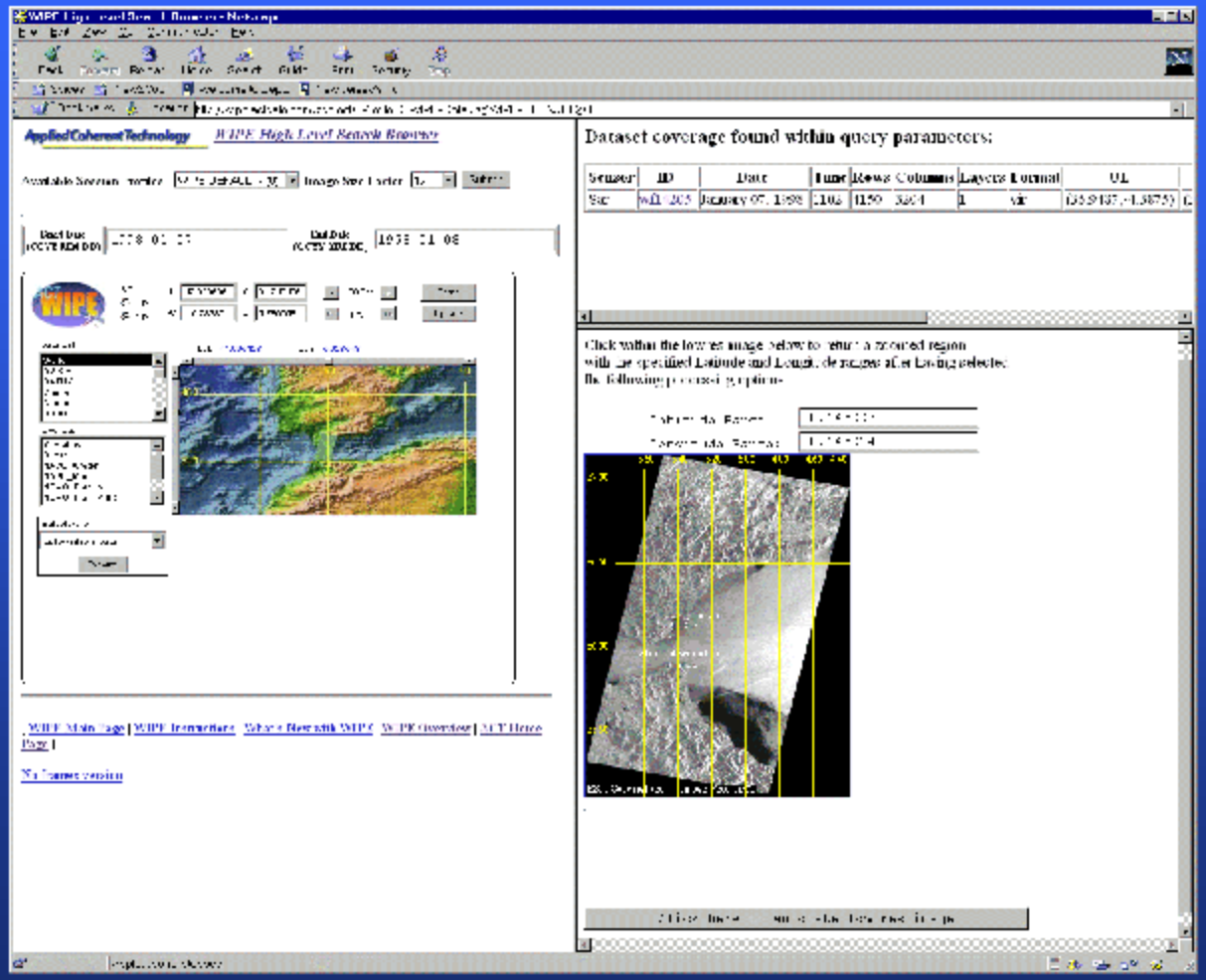
Alaska SAR Demo



SEA SURFACE TEMPERATURE ANALYSIS

NOAA Alaska SAR Demo

NESDIS



WWW Interactive Processing Environment (WIPE)
DATA/PRODUCT BROWSER INTERFACE

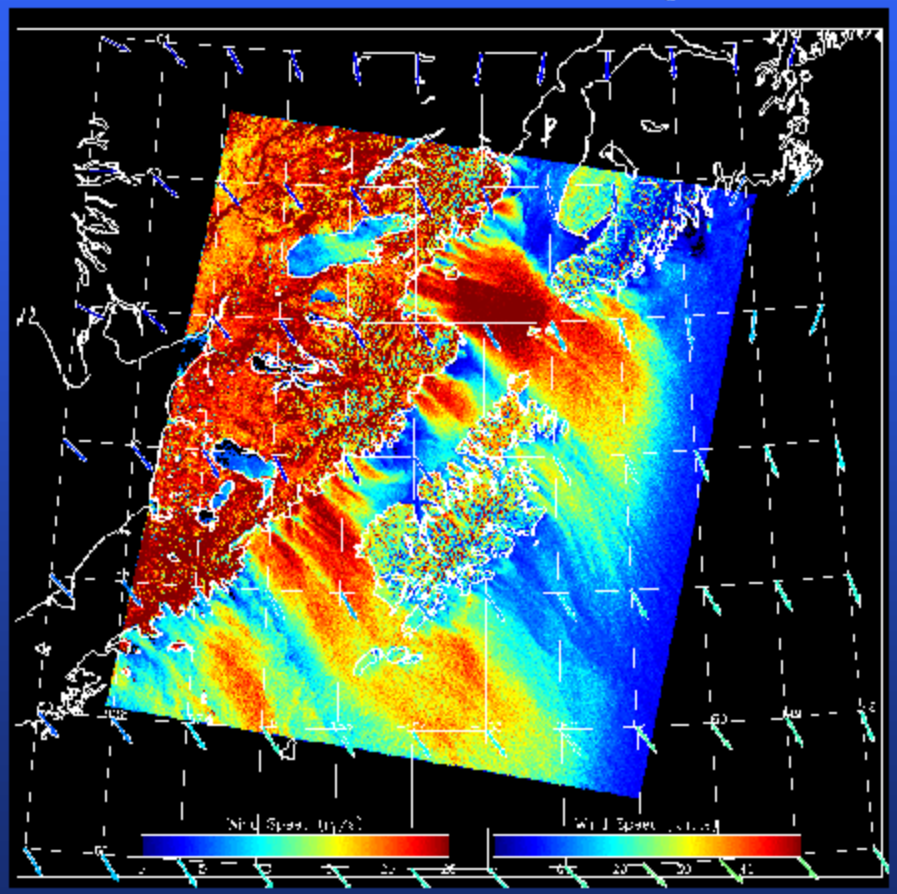
Alaska SAR Demo

SAR Wind Speed Product

INPUT: SAR Radar Cross Section
SAR Incidence Angle
Model Wind Direction Field

ALGORITHM: CMOD4
Vertical/Horizontal
Polarization Ratio

OUTPUT: Mapped 1 km
Resolution SAR
Wind Estimates



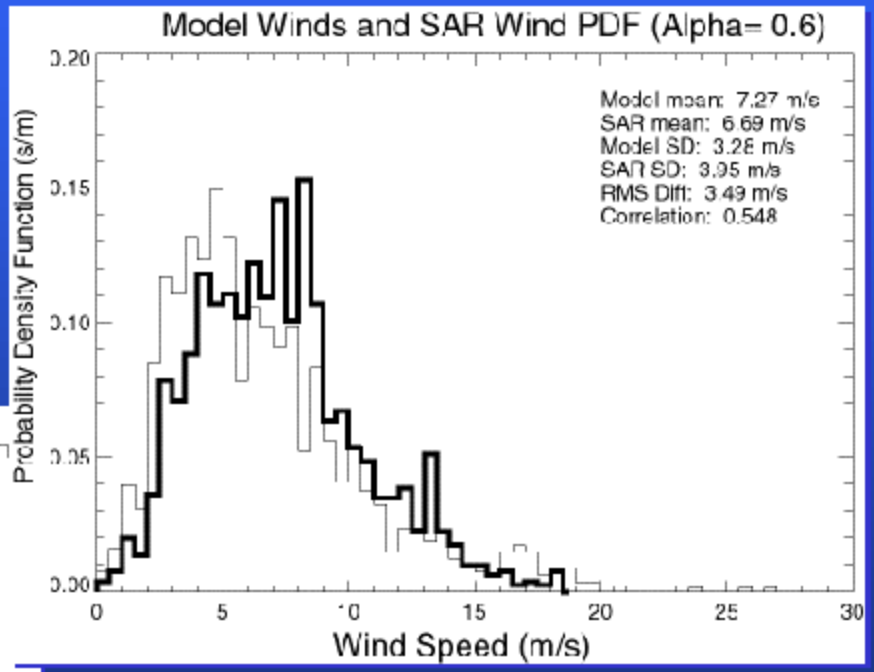
SAR WIND SPEED MAP

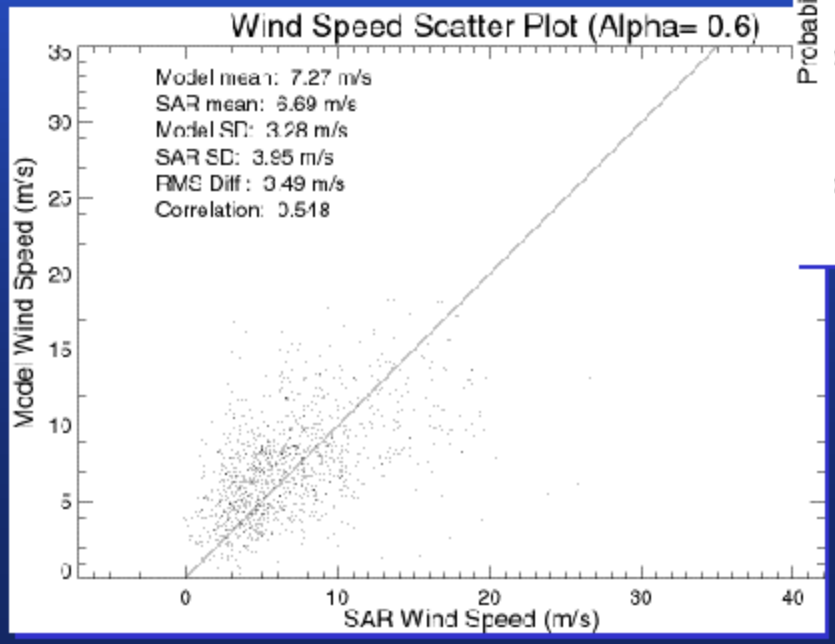
October 25, 1999 16:37 GMT

Alaska SAR Demo

Preliminary Comparisons

Probability Density





Scatter Plot

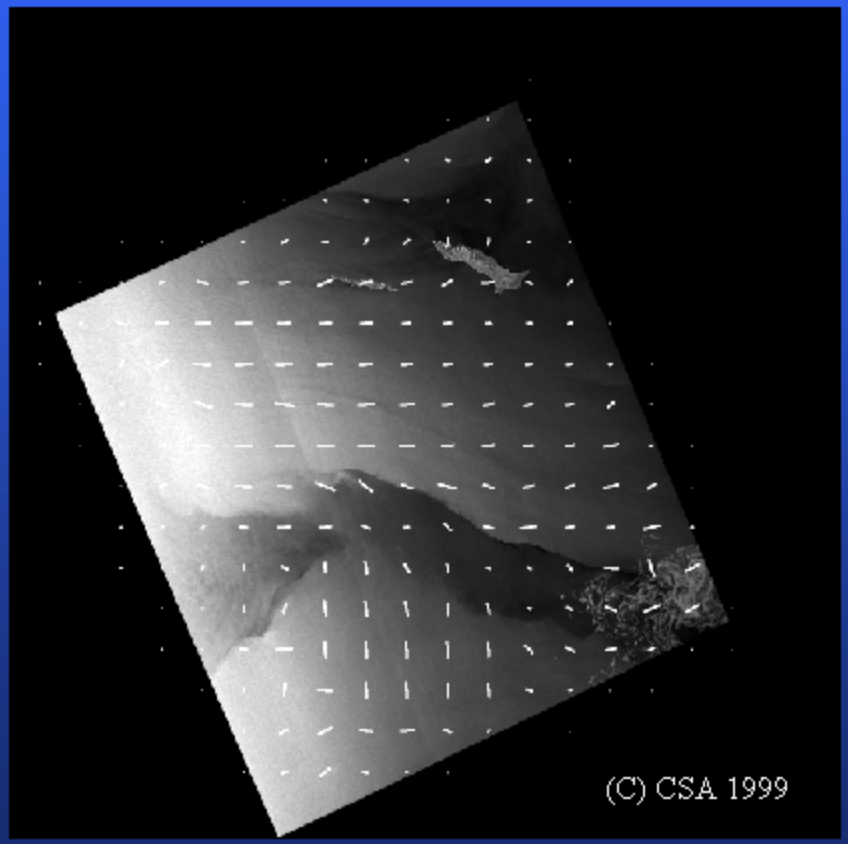
Alaska SAR Demo

SAR Wind Vector Product

INPUT: SAR Radar Cross Section
SAR Incidence Angle

ALGORITHM: Wind Direction from
Wind-aligned Features
in SAR Image
Speed from CMOD4

OUTPUT: Grid of Wind Vectors
with 180° Ambiguity

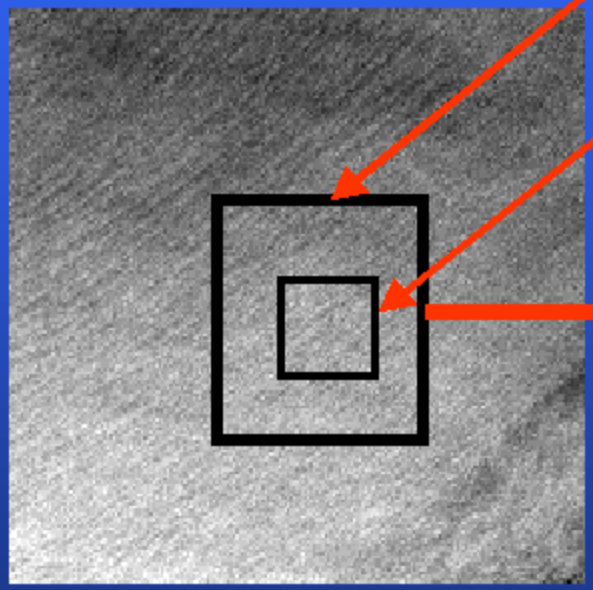


SAR WIND VECTOR MAP

January 1, 1999

Alaska SAR Demo

Estimating Wind Direction From SAR



Region to use to estimate a wind vector

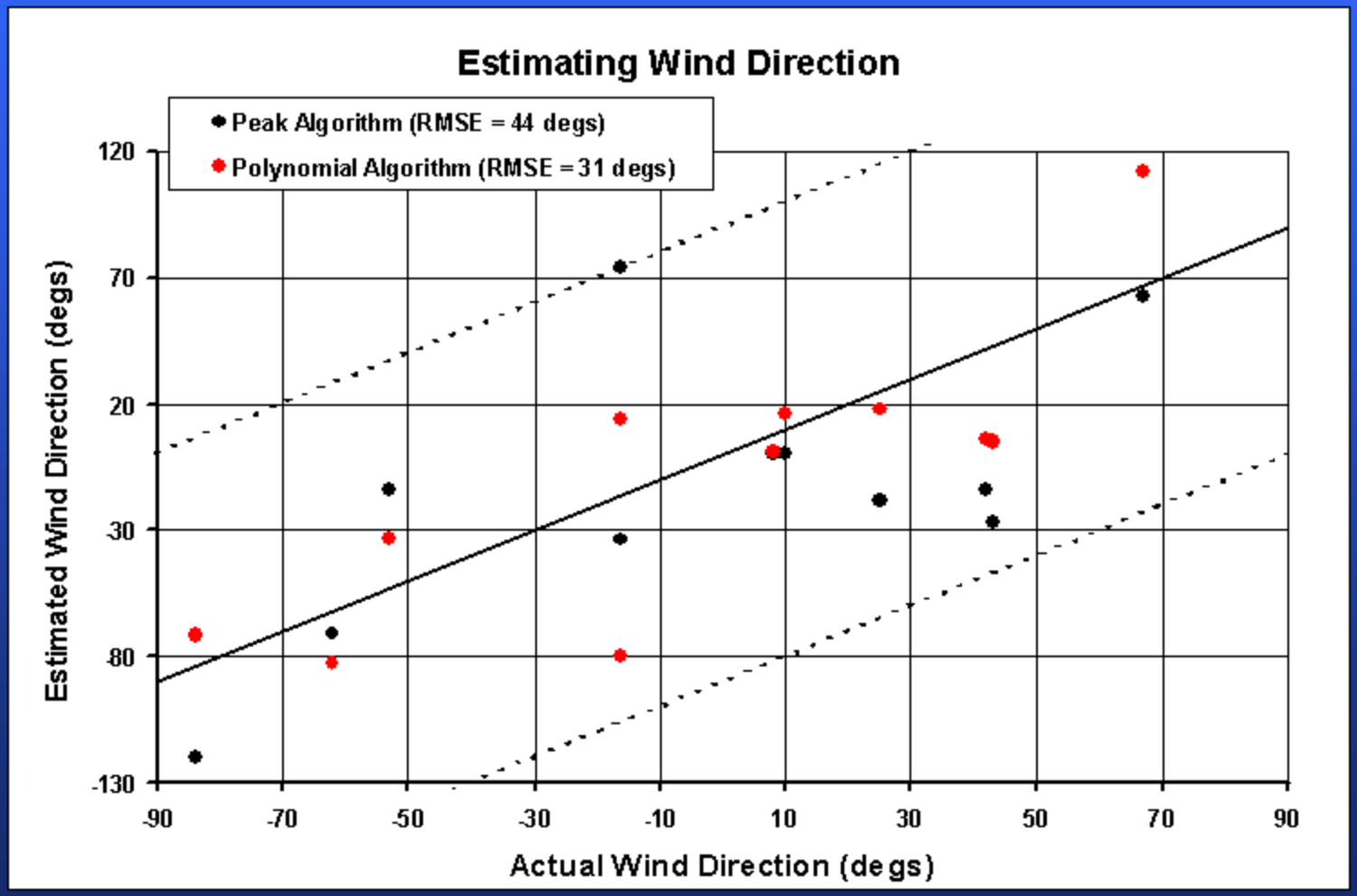
Region to use to generate a spectrum from the image

Form a smoothed spectrum by calculating a spectrum over multiple placements of the smaller region, then averaging the spectra

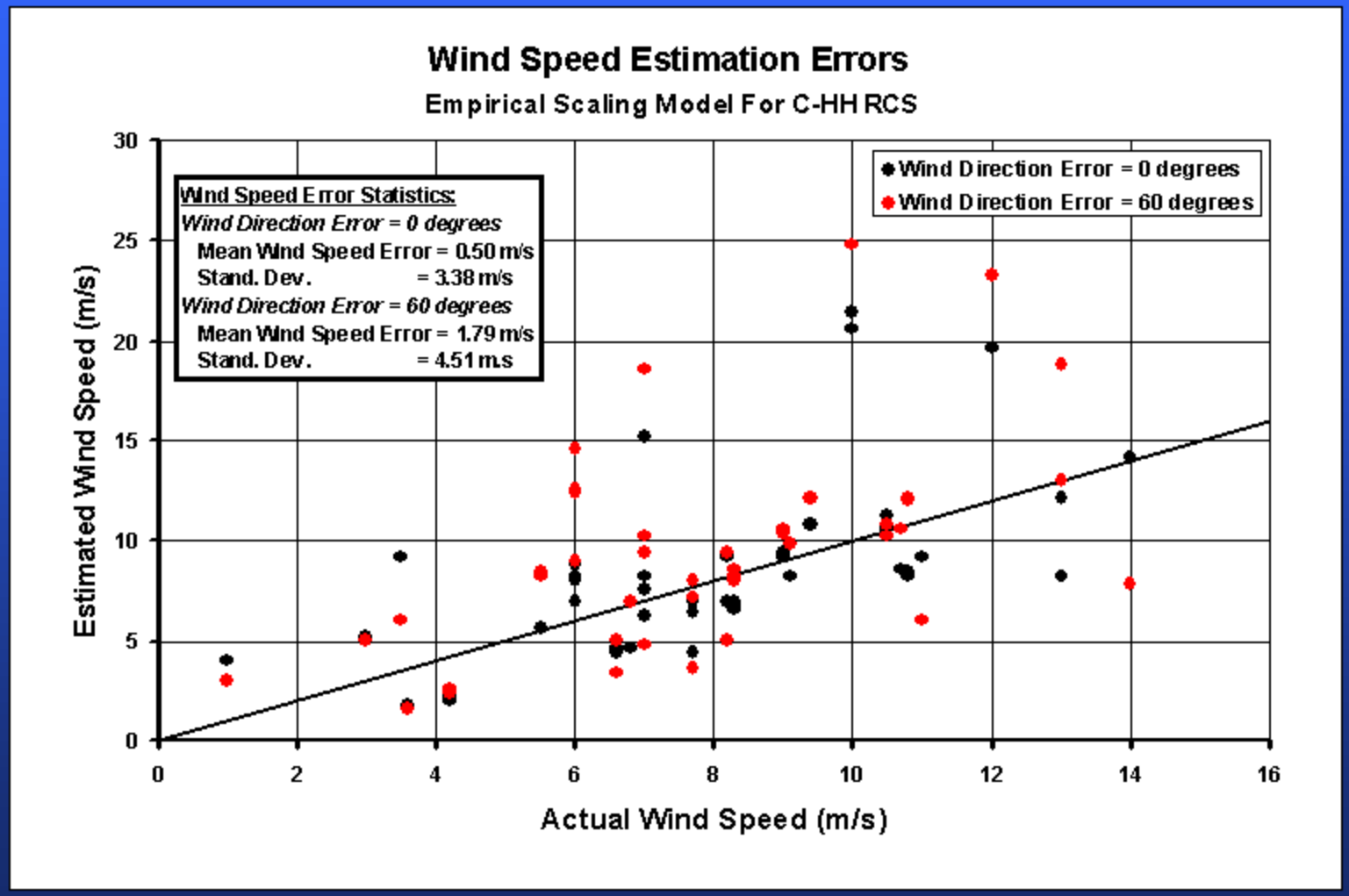
Calculate the elongation direction of the spectral energy over large scales (3 - 20 km), wind direction is rotated 90 degrees from this direction
(red=estimate, white=actual)

Alaska SAR Demo

Initial RADARSAT Results



Alaska SAR Demo



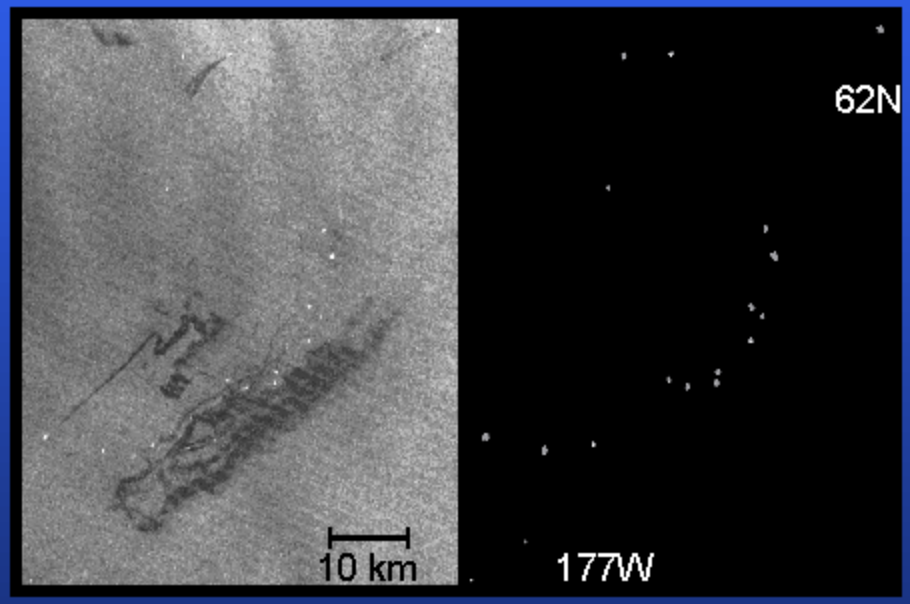
Alaska SAR Demo

SAR Hard Target Detection Product

INPUT: Calibrated SAR Image

ALGORITHM: Constant False Alarm Rate

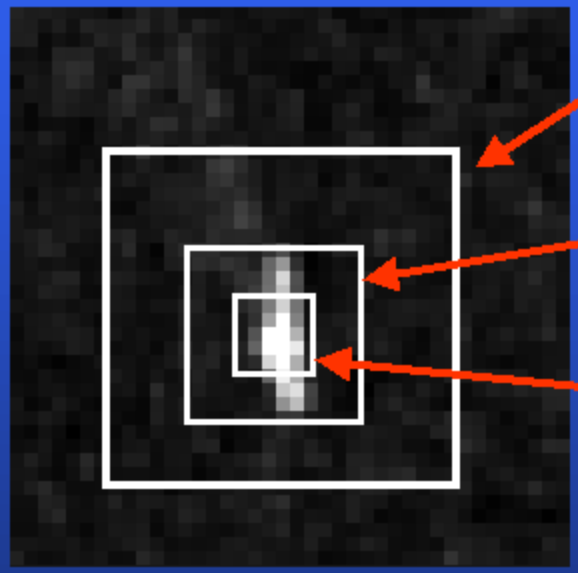
OUTPUT: Text List of Ship Lat/Long Positions



SAR HARD TARGET DETECTION MAP

Alaska SAR Demo

Locating Ships With SAR



Background box
(as big as possible without including another ship)

Background removal box
(size of the biggest ship)

Signal box
(size of the smallest ship)

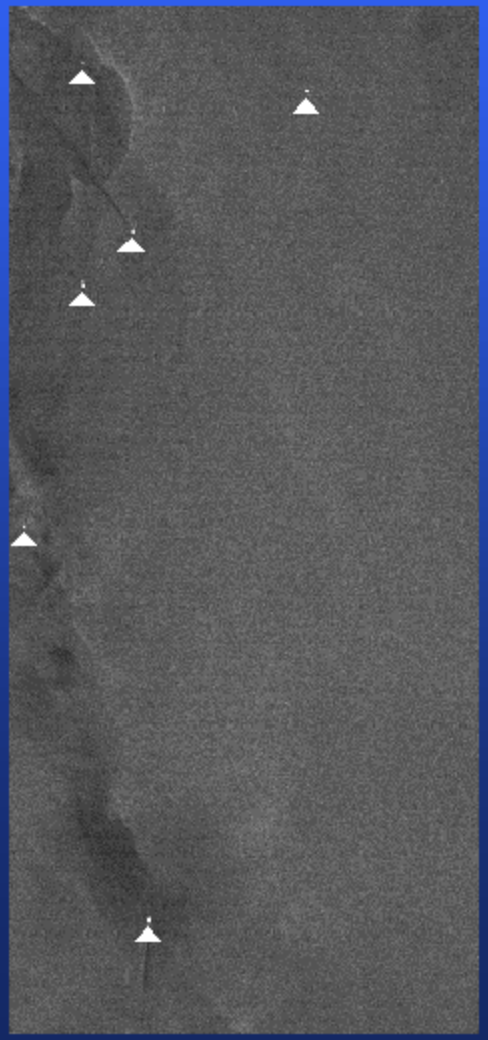
Calculate the mean of the signal box, m_s

Calculate the mean, standard deviation of the background box ignoring samples within the background removal box, m_b, σ_b

Form the metric $d = \frac{\sqrt{N_s}\left(m_s - m_b\right)}{\sigma_b}$ where Ns = number of samples in signal box

Alaska SAR Demo

Locating Ships With SAR (cont.)



Move the background box through the image, flagging each location for which the d metric is larger than a threshold.

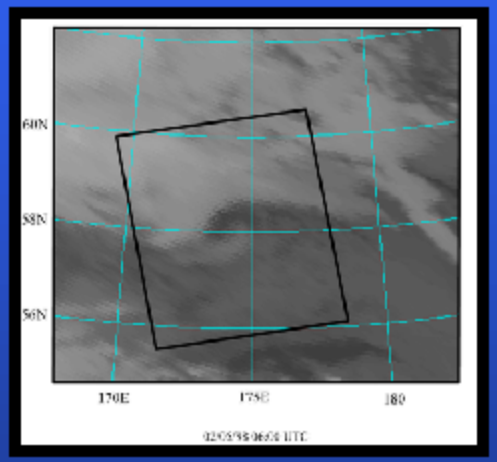
Throw away locations where the total energy from the signal box is below a threshold (eliminates noise spikes)

Use a land mask to throw away all detection on land (keep a 500m border in case there are registration errors

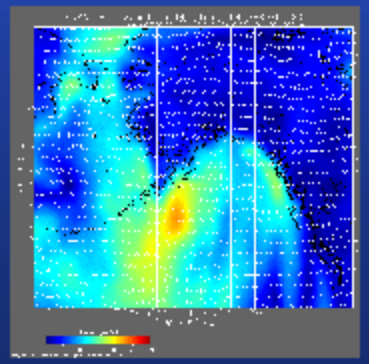
Alaska SAR Demo

ANCILLARY DATA

- SATELLITE IMAGERY and PRODUCTS
  - GOES Vis and IR Imagery
  - ERS-2 Scatterometer Winds
  - SSM/I Passive Microwave Winds
  - AVHRR SST Fields

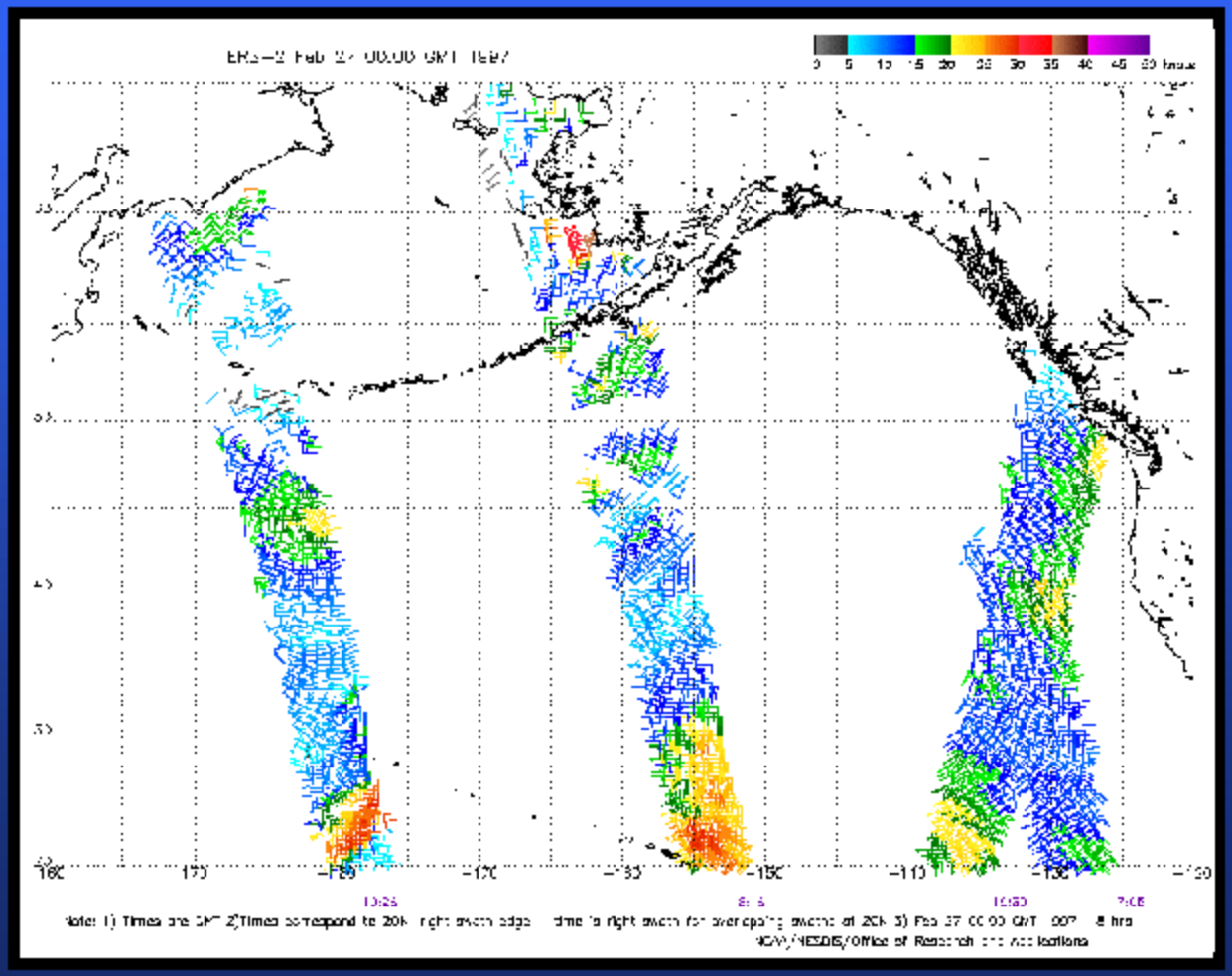


- Model Wind and Wave Analyses



- Buoy Wind and Wave Reports

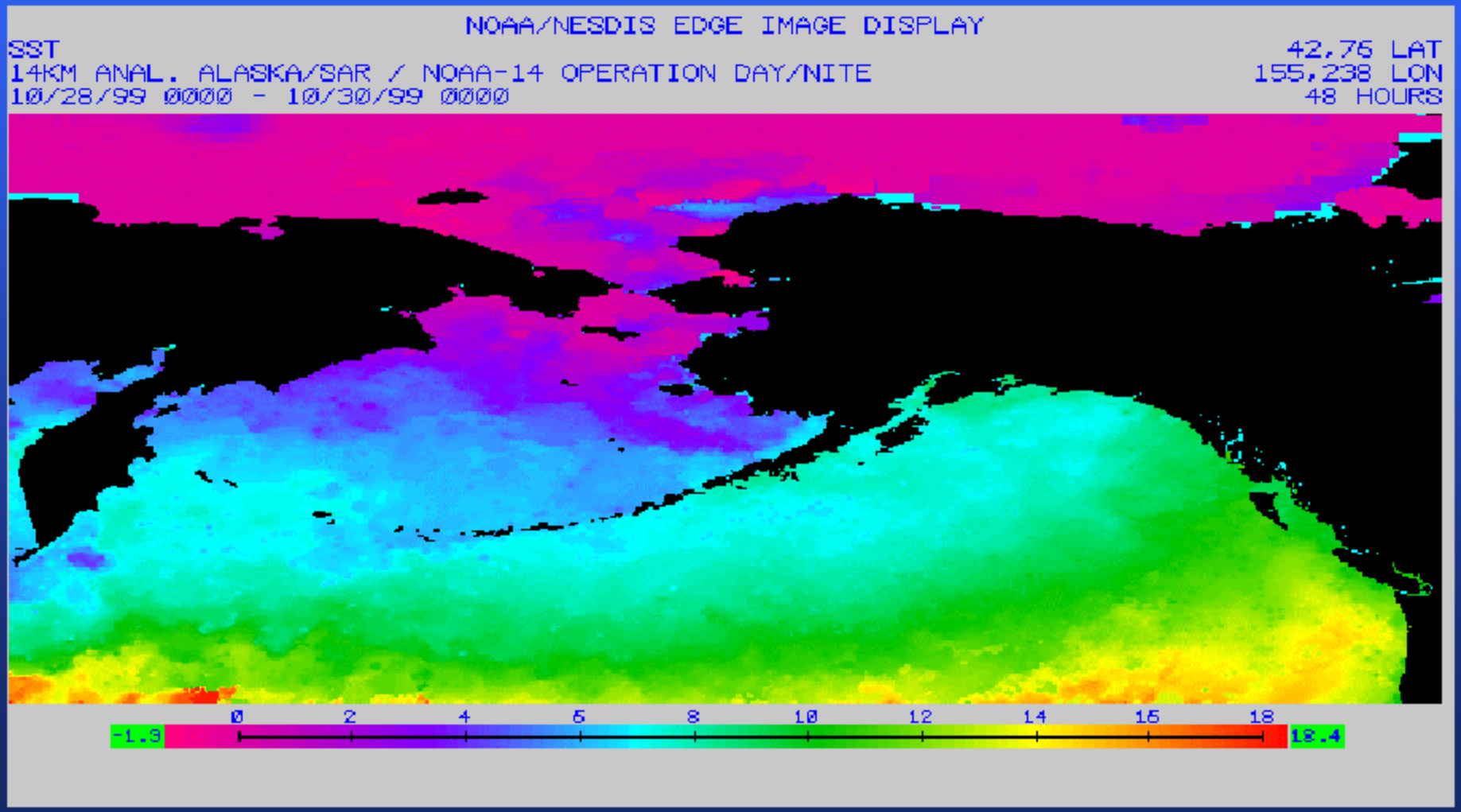
NOAA Alaska SAR Demo



ERS-2 SCATTEROMETER WINDS

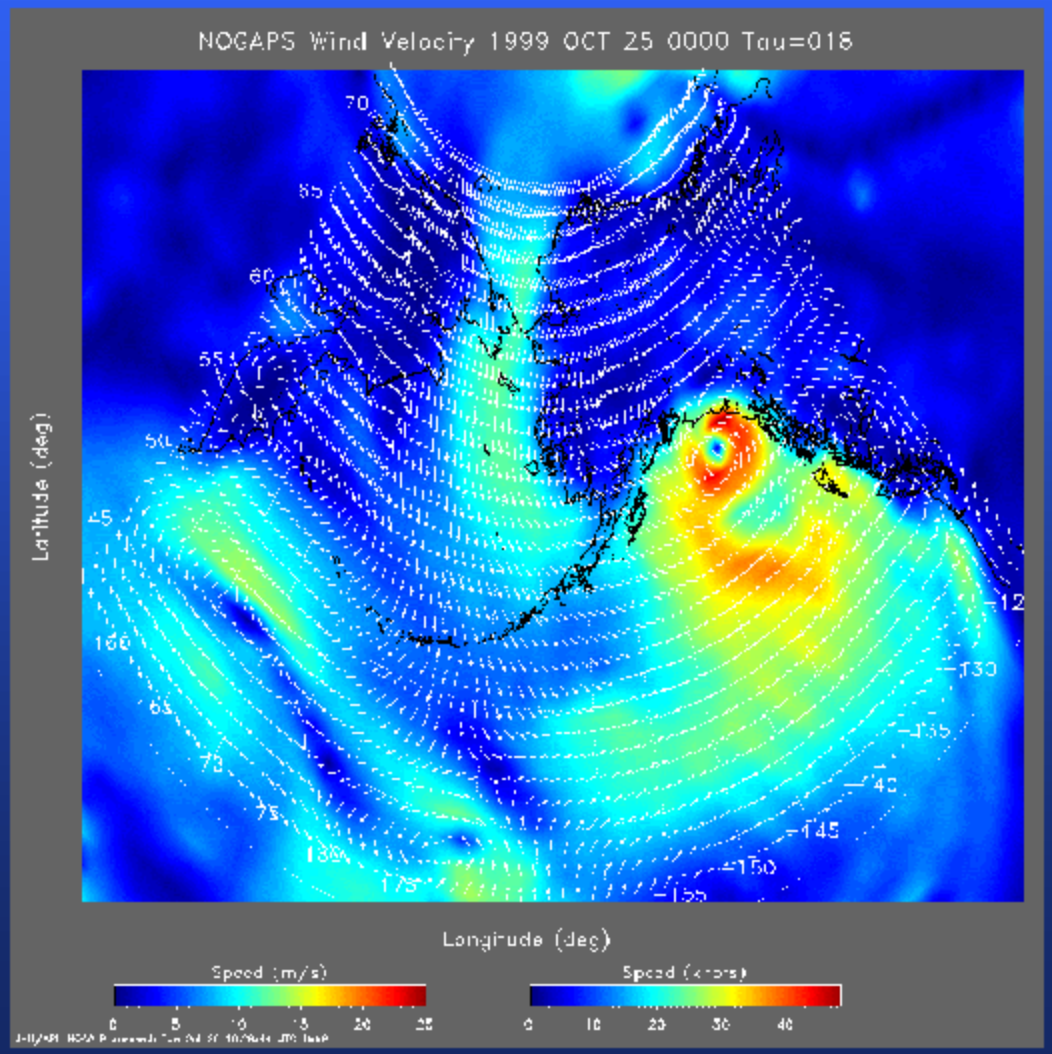
Alaska SAR Demo

NESDIS 14 km SST Analysis



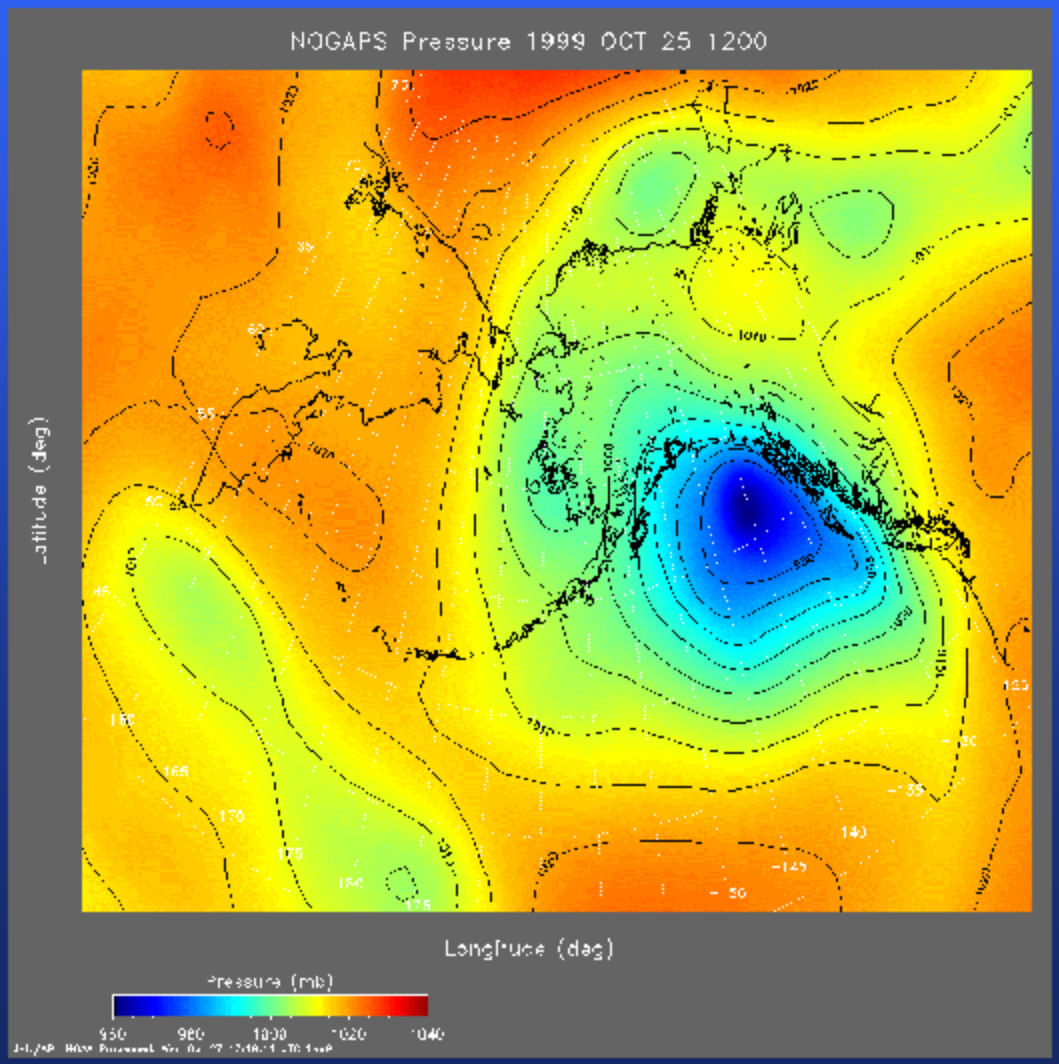
Alaska SAR Demo

FNMOC NOGAPS Model Wind Field



Alaska SAR Demo

FNMOC NOGAPS Surface Pressure



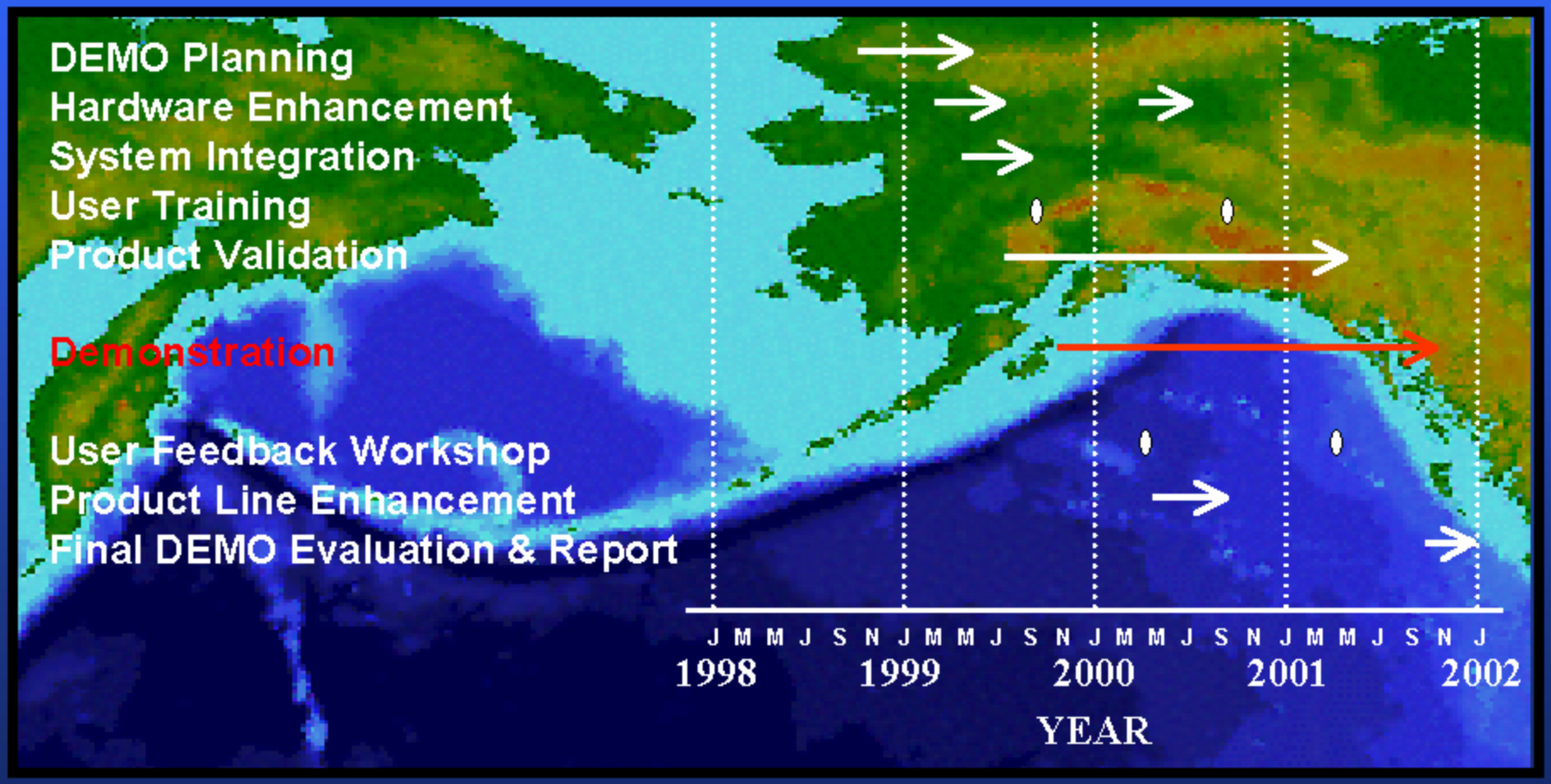
Alaska SAR Demo

Future Products:

1. NCEP Model Fields
2. Quickscat Winds
3. Ice Mask
4. Feature Tagged Files

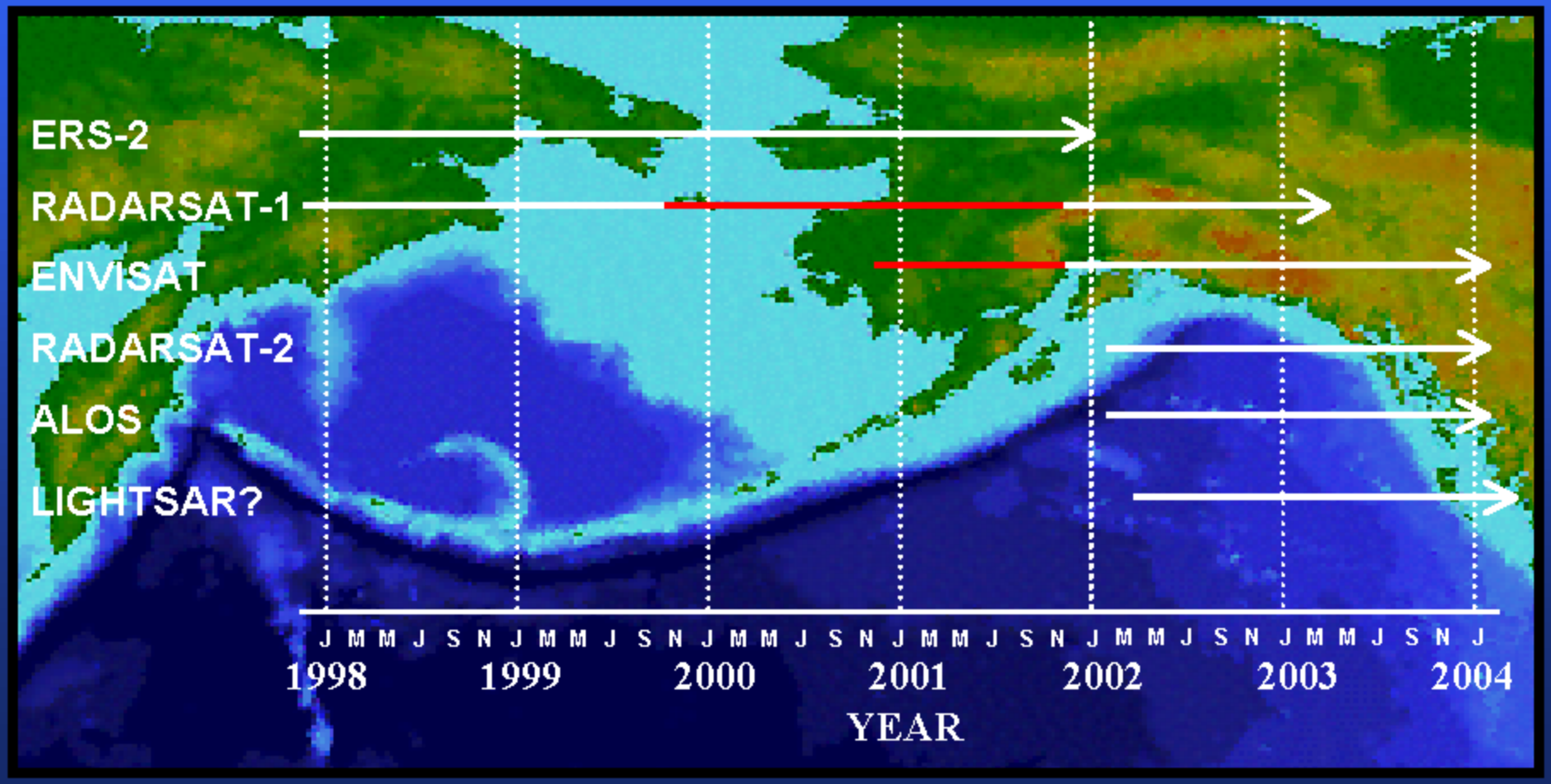
Alaska SAR Demo

Demonstration Timeline:



Alaska SAR Demo

Spaceborne SAR Missions:



Alaska SAR Demo

Points of Contact:

NESDIS/ORA	Bill Pichel, Pablo Clemente-Colón
NESDIS/OSDPD	William Tseng, Ralph Meiggs
NESDIS/SAA	Help Desk
ASF	Rick Guritz
ERIM Intl. Inc.	Chris Wackerman
JHU/APL	Frank Monaldo, Bob Beal
ACT	Erick Malaret
JPL	Don Montgomery
NWS	Gary Hufford
USCG	LCD Greg Busch
NMFS	David Flannigan
ADF&G	Fritz Funk, Kathy Rowell

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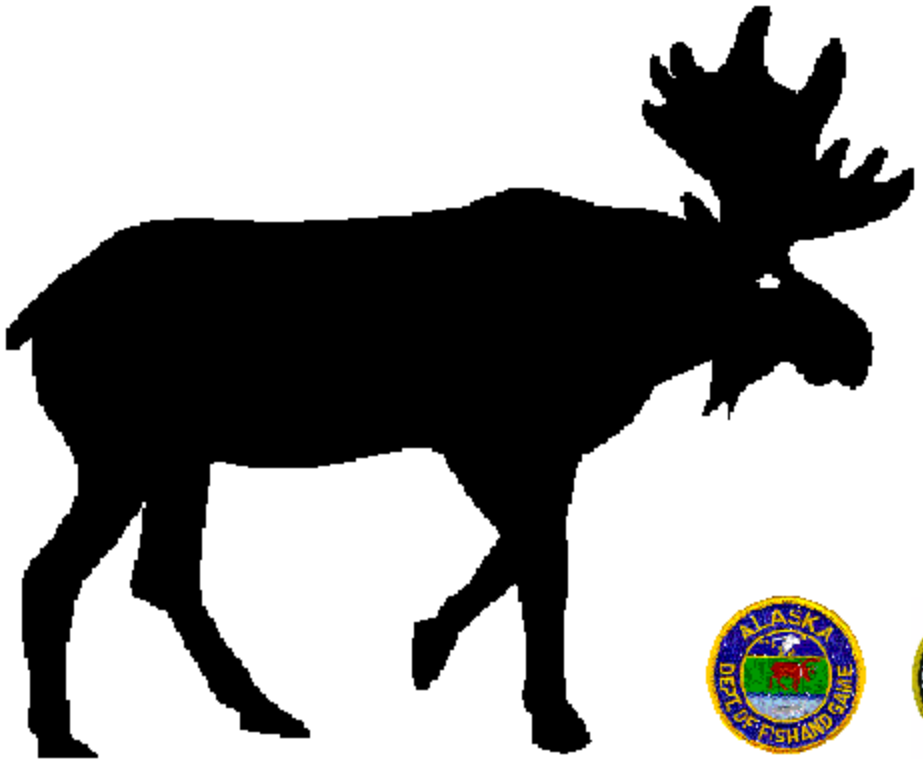

Alaska SAR Demo