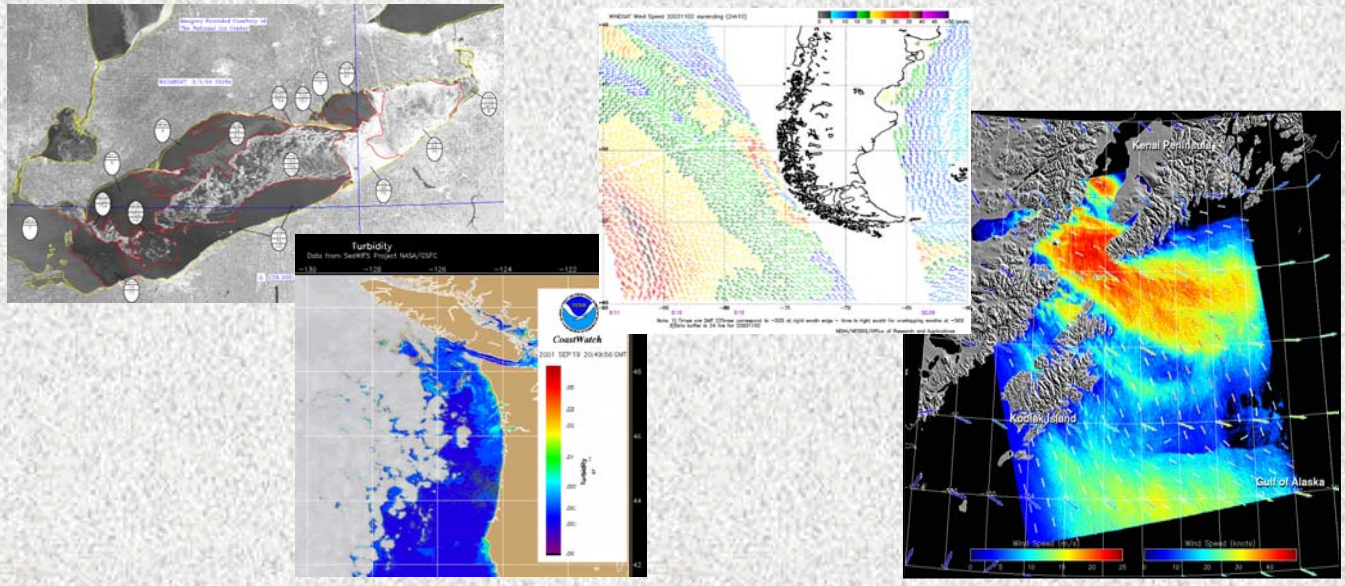


Present and Future Activities in Ocean Remote Sensing at NOAA

Pablo Clemente-Colón

NOAA/NESDIS/ORA Satellite Oceanography Division

NOAA/NESDIS

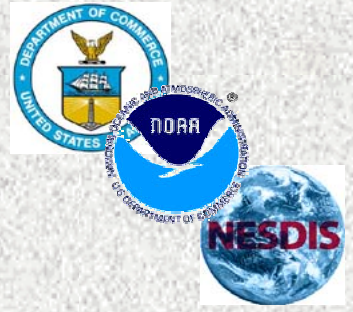
NOAA' s MISSION

To understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet the Nation's economic, social, and environmental needs

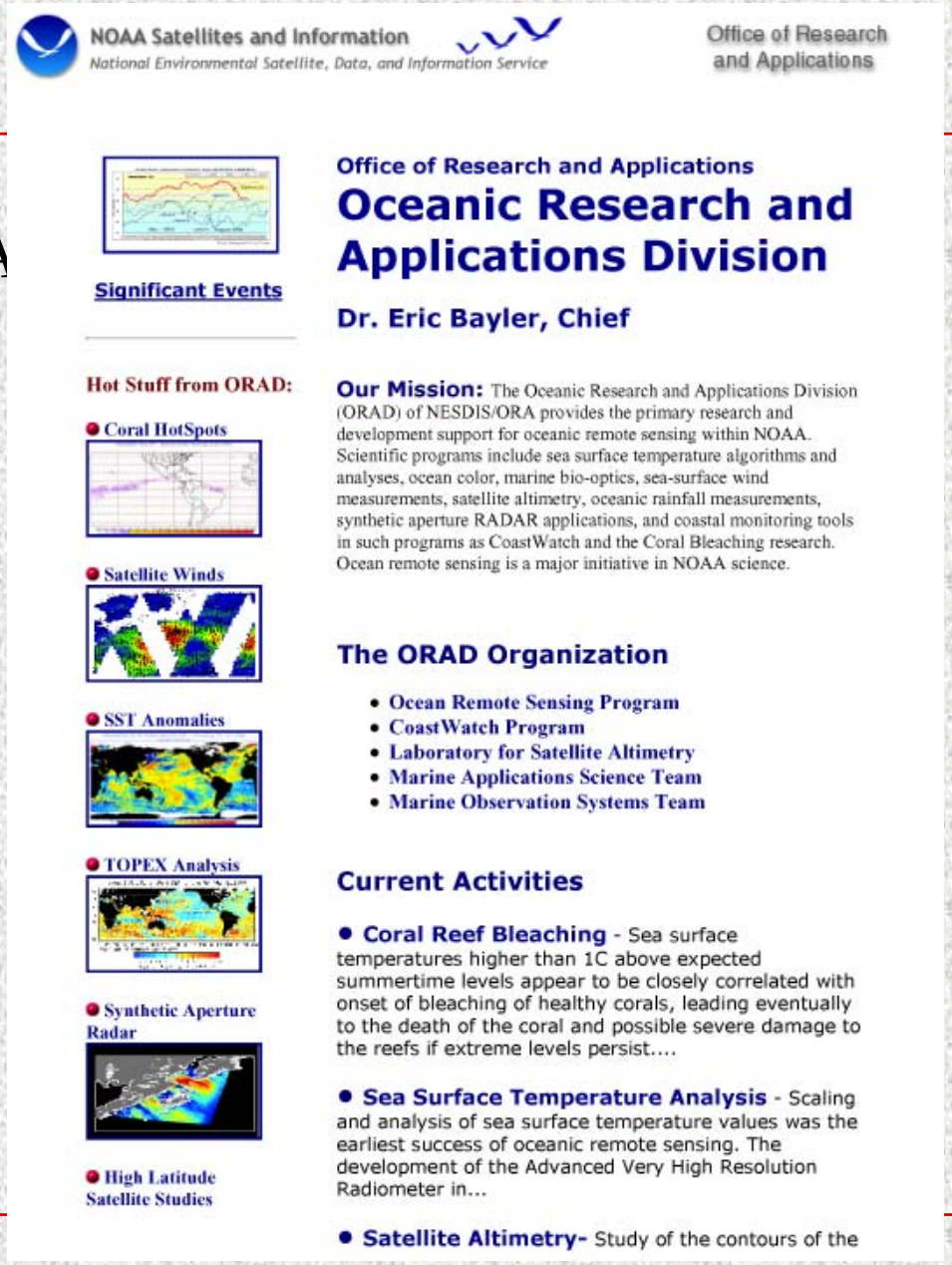
NESDIS' MISSION

To deliver accurate, timely, and reliable satellite observations and integrated products and to provide long term stewardship for global environmental data in support of the NOAA mission

NOAA SATELLITE OCEA
REMOTE SENSING PRODUCTS



ORAD ➔Satellite Oceanography Division (SOD)



NOAA SATELLITE OCEAN REMOTE SENSING PRODUCT

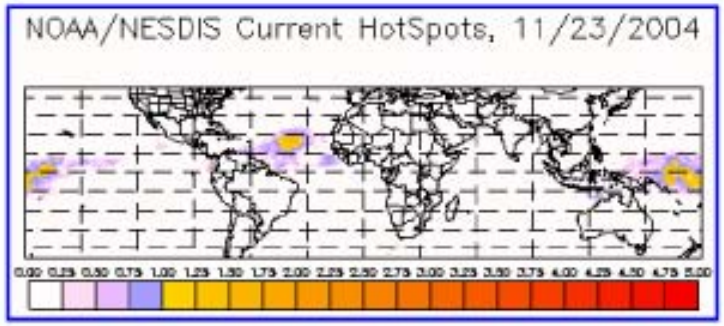
NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

Office of Satellite Data Processing & Distribution

Information Processing Division | Product Systems Branch | Computer Operations Branch | CLASS

Current Operational Coral Bleaching Hot Spots for the year 2004

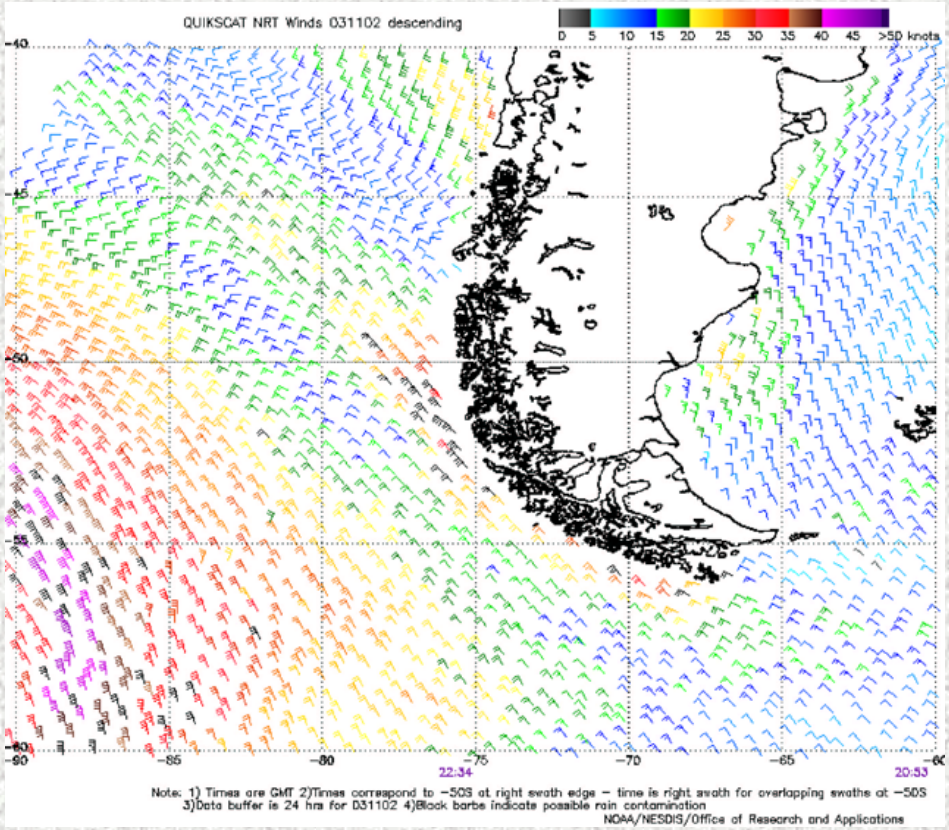
Click on the map to go to your region of interest.



For information about these images, go to the methodology webpage.

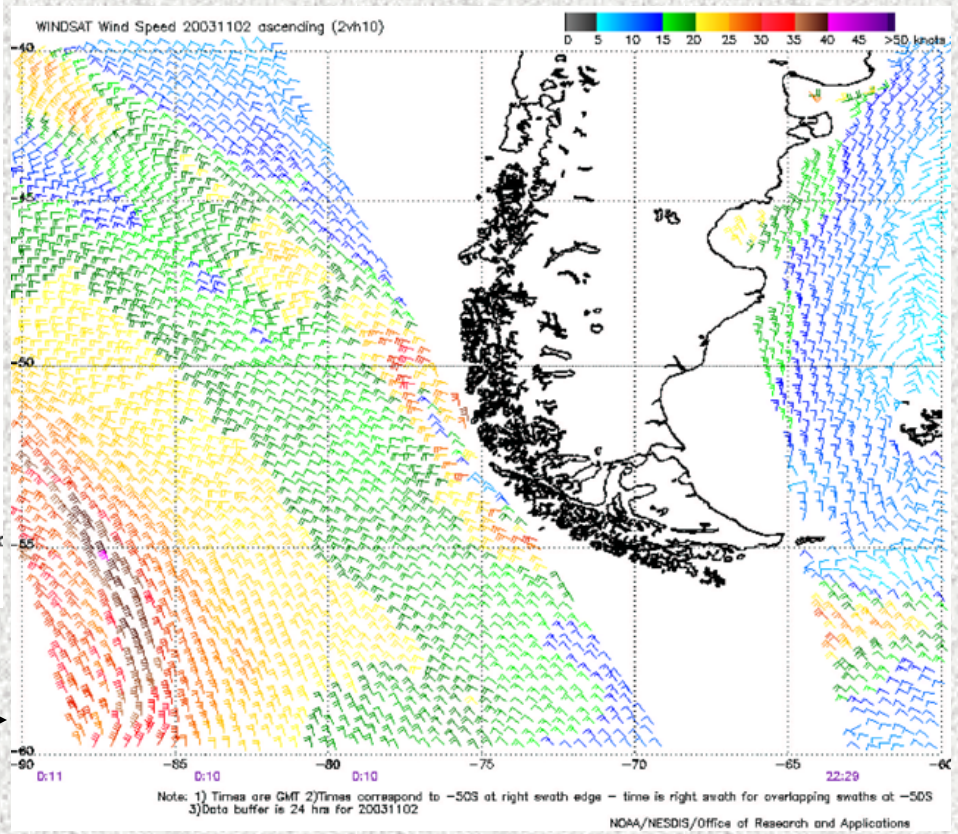
January	3 E.Hemi W.Hemi	5 E.Hemi W.Hemi	10 E.Hemi W.Hemi	13 E.Hemi W.Hemi	17 E.Hemi W.Hemi	20 E.Hemi W.Hemi	23 E.Hemi W.Hemi	27 E.Hemi W.Hemi	31 E.Hemi W.Hemi

NOAA SATELLITE OCEAN REMOTE SENSING PRODUCTS



← QUIKSCAT (Active MW)

WINDSAT (Passive MW) →



Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

OBJECTIVE:

To Provide a Robust National Capability to Remotely Observe the World's Oceans to Assess Their Current State and to Monitor Change.

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

GOALS:

- To Access, Process , and Distribute Data and Products From NOAA's System of Environmental Satellites
- Obtain Additional Non-NOAA Satellite Data
- Provide Data and Products in Common Formats
- Provide the Ability to Fuse Satellite Data With In-Situ, Historical and Other Remotely Sensed Data
- Develop a Robust Science Base to Support the Development of Assessment Techniques and Products

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

STRATEGY:

- Leverage Existing World-Wide Investment in Ocean Sensing Satellites
- Partner With Federal Agencies, Foreign, State and Local Governments as well as Academia and the Private Sector.
- Develop an End-to-End System for Data and Product Acquisition and Access

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

APPROACH:

- Develop Necessary Infrastructure
  - Communications, Processing and Distribution
- Conduct Demonstration Projects
- Build Sustainable, Operational Critical Mass
  - Integrate New Capability into Operations

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

PARTNERSHIPS:

- Within NOAA (All Line Offices)
- NASA
- DoD
- Intelligence Community
- Foreign Governments
- Universities
- Private Sector

NOAA SATELLITE OCEAN REMOTE SENSING PROGRAM

New environmental remote sensing capabilities are offering:

higher spatial resolution
more spectral bands
higher spectral resolution
higher temporal resolution
better calibration
better science

VIS
IR
MW
active
passive

Synergy is increasing between:

POES and GOES sensors
research and operational sensors
US and international sensors

land
ocean
atmosphere
weather
climate

NESDIS/ORA opportunities can be realized only with:

new approaches
new partnerships
early involvement in science teams
and associated field programs

NOAA SATELLITE OCEAN REMOTE SENSING COASTWATCH PROGRAM

*C*oast*W*atch → *O*cean*W*atch

What is *O*cean*W*atch?

Scientifically expanded *C*oast*W*atch from coastal and regional coverage to global coverage

Ocean***W***atch Initial first principles

- Collaboration between major ocean remote sensing nations
- Emphasis on ground system, applications and utilization
- Provide opportunities for exchanges of personnel, data and ideas in satellite ocean remote sensing
- Strong scientific basis

*Coast**W**atch* → *Ocean**W**atch*

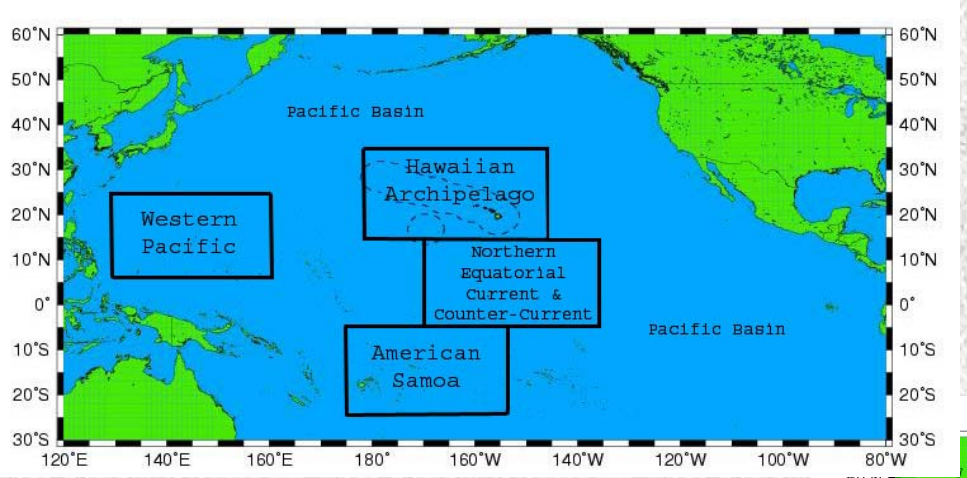
- Retain *Coast**W**atch* (name recognition). Link to IOOS
- *Ocean**W**atch* would be new, yet somewhat different. Link to GOOS
- DoC direction was received with FY 2003 budget guidance
- Execution would retain many CW principles and practices
- Similar architecture as *Coast**W**atch*
- Seek new national and international partnerships
- Encourage value added roles for partners (analysis centers, etc.?)
- Facilitate access to data and products (NPP, NPOESS, GOES-R) for ocean applications
- Strong science roles: climate, calibration, etc.
- Develop data fusion product lines

Coast*W*atch → *O*cean*W*atch

What are the initial plans?

- Establish OW Demonstration at West Coast Node
- Transition Central Pacific Node Products to OW
- Expand coverage area to 120°E – 60°W/ 70°N – 70°S: Entire Pacific
- Develop NRT Ocean Color product (L3, 3-day composite)
  (Currently, produce weekly and monthly maps with MODIS/Aqua data)
- Develop NRT Ocean Surface Winds (speed and direction)
  (Currently, produce weekly and monthly maps for wind stress and wind stress curl)
- Provide SSH Empirical Orthogonal Functions (EOF) for selected sub-regions: Central North Pacific, Eastern Pacific, and the Alaskan Gyre
- Redesign Central Pacific *O*cean*W*atch website to accommodate the current and new remote sensing datasets, in addition to an expanded outreach component

West Coast Node Ocean*W*atch Expansion



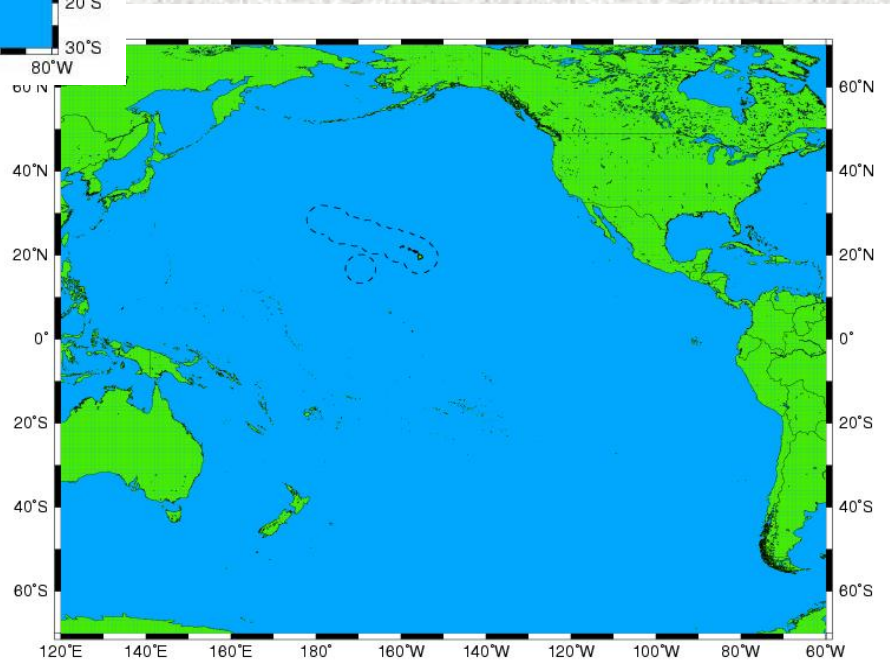
Current Coverage Area:

120°E – 80°W/ 60°N – 30°S

OW Coverage Area:

120°E – 60°W/ 70°N – 70°S

'zoom-in' areas have not yet been defined



Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Ocean***W***atch
Ideas for International Collaboration

- Science collaboration:
  -- calibration validation of satellite based ocean observations

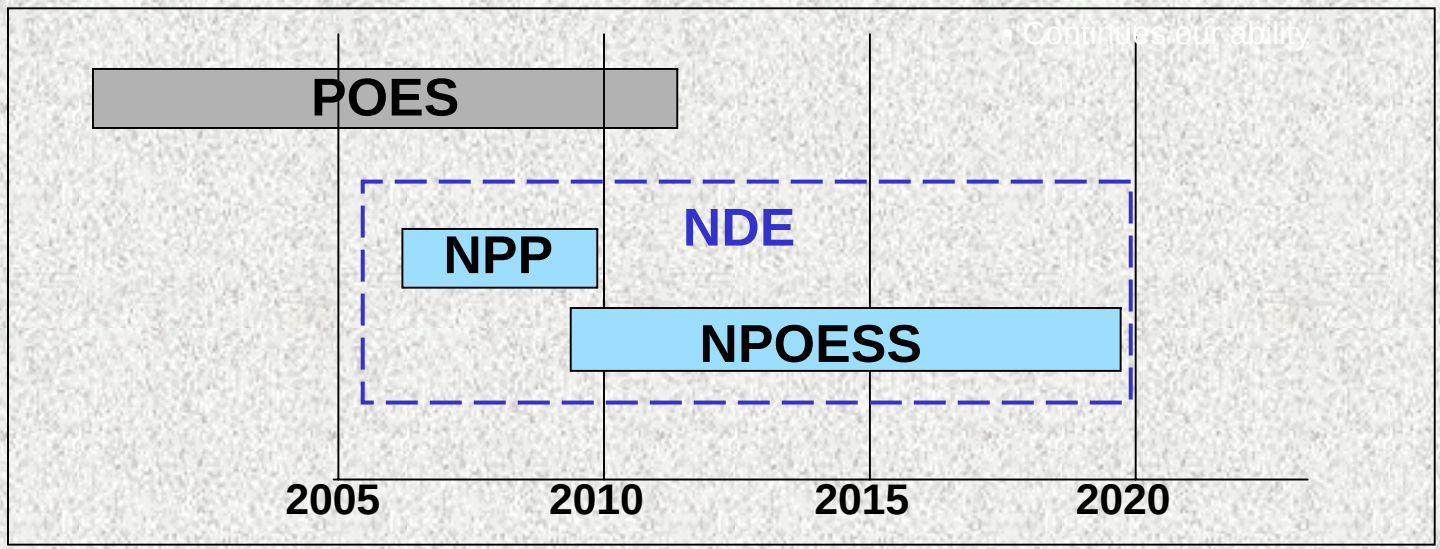
- Exchanges:
  -- students, scientists, operations personnel

- Data and information exchange:
  -- enhance availability of national ocean satellite data and products

- Operational collaboration and coordination:
  -- collaboration: system design and development
  -- distant water cruise support for research and operations

Transition of NOAA's Polar Satellite Mission

- Polar-orbiting Operational Satellite
  - Forty year successful mission history
  - End of POES mission in 2012
- NPOESS Preparatory Project (NPP) risk reduction
- NPOESS continues polar mission
- Data and Products Provided Operationally Trough the NPOESS Data Exploitation Program (NDE)



NPOESS Preparatory Project (NPP)

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

National Polar-orbiting Operational Environmental Satellite System

Search NPOESS
go
Home Site Map
Text Version

NPOESS
National Polar-orbiting Operational Environmental Satellite System
ABOUT NPOESS NEWS PROJECTS SCIENCE TECHNOLOGY INFO CENTER SEARCH

Projects
NPOESS Preparatory Project

Program Definition & Risk Reduction
NPOESS Aircraft Sounder Testbed

Ocean Surface Wind Speed & Direction
Risk Reduction & Heritage

npoess preparatory project

PROJECT DESCRIPTION

The NPOESS Preparatory Project (NPP) is a joint NASA/IPO instrument risk reduction project. It is designed to function as a bridge between the NASA EOS program and NPOESS for the development of the following sensors:

- Advanced Technology Microwave Sounder (ATMS)
- Cross-track Infrared Sounder (CrIS)
- Ozone Mapping and Profiler Suite (OMPS)
- Visible/Infrared Imager Radiometer Suite (VIIRS)

Its mission is to demonstrate advanced technology for atmospheric sounding, giving continuing observations about global change after EOS-PM (Terra) and EOS-AM (Aqua). It supplies data on atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, and cloud and aerosol properties.

PROJECT CONTRIBUTIONS

- instrument risk reduction, offering early instrument and system level testing
- lessons learned for design modifications in time to ensure NPOESS launch readiness
- ground system risk reduction
- early user evaluation of NPOESS data products, such as algorithms and instrument verification, opportunities for instrument calibration.

NPOESS Project

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

National Polar-orbiting Operational Environmental Satellite System

Search NPOESS
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Text Version

NPOESS
National Polar-orbiting Operational Environmental Satellite System
ABOUT NPOESS | NEWS | PROJECTS | SCIENCE | TECHNOLOGY | INFO CENTER | SEARCH

WHAT IS NPOESS?

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) is a satellite system used to monitor global environmental conditions, and collect and disseminate data related to: weather, atmosphere, oceans, land and near-space environment. In 1994, it was recognized that converging the existing polar systems from the Department of Commerce (DoC) and Department of Defense (DoD) would result in a more cost effective and higher performance integrated system. As a result, in May 1994, a convergence plan was submitted to the U.S. Congress stating NPOESS can *reduce the cost of acquiring and operating polar-orbiting environmental satellite systems, while continuing to satisfy U.S. operational requirements for data from these systems.* The President endorsed this initiative, signing Presidential Decision Directive NSTC-2. The NPOESS program is managed by the tri-agency Integrated Program Office (IPO), employing personnel from the DoC, DoD and the National Aeronautics and Space Administration (NASA).

Artists concept of NPOESS satellite

Converging U.S. polar-orbiting satellite programs, the National Polar-orbiting Operational Environmental Satellite System will reduce the number of polar-orbiting systems from four U.S. satellite groups to three. NPOESS has initiated a systematic program of convergence projects (sensors, concept demonstrations, and with NASA, the NPOESS Preparatory Project). The Integrated Program Office has initiated planning and development programs of satellite transition, sensor development and user training.

PROJECTS & DEMONSTRATIONS

QUICK LINKS

Background
Contact NPOESS
Contract Opportunities
FAQs
Image Collection
Project Summary
IPO Information Center
Sensor Summary
Upcoming Events
Visitors Guide / Directions

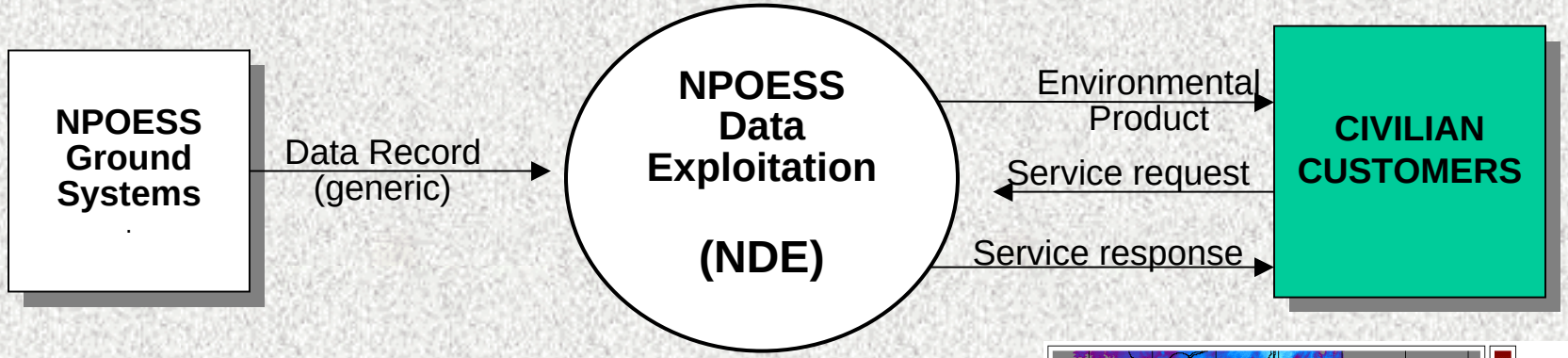
PROGRAM NEWS »

Earth Observation Magazine features NPOESS

Earth Observation Magazine is running a series of articles on the next-generation of Polar-orbiting Operational Environmental Satellites and the benefits they provide now, and will provide in the future, to a broad and diverse community of users.

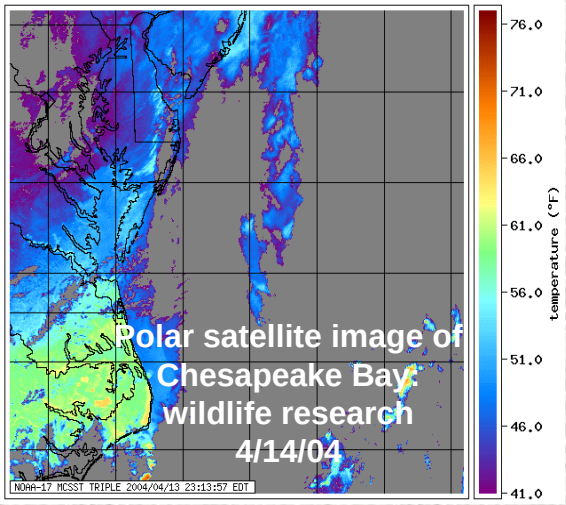
NOAA's
NPOESS Data Exploitation (NDE) Project

NDE Provides the Connection to Customers



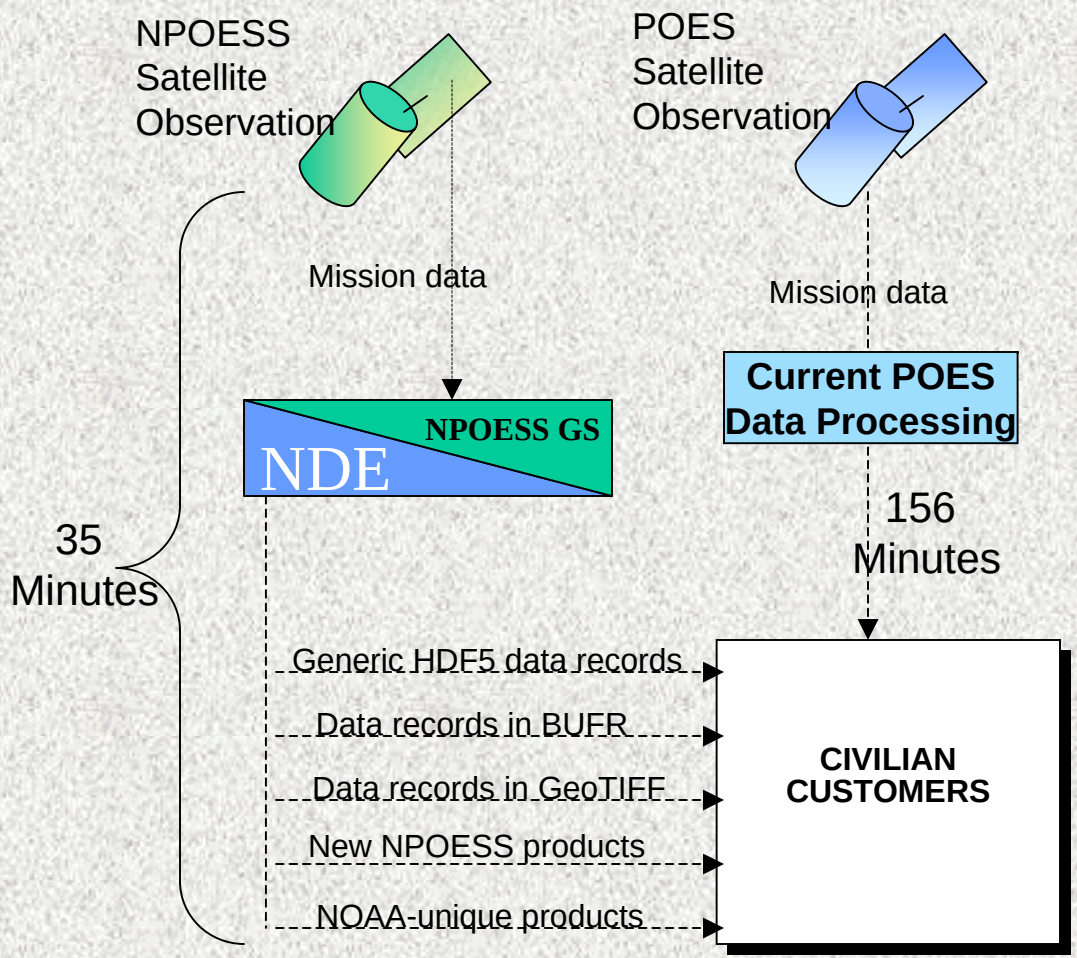
NDE Goals:

- **Connect civilian customers to NPOESS**
  - **Near-real time product dissemination**
  - **Near-real time product processing**
- **Provide new products and services**
  - **Products related to new instruments**
  - **New customer services**



NDE Ensures Timely Delivery of NPOESS Products

- **New Products**
- **Higher Quality**
- **Improved Communications**
  - **NOAA Line Offices will rely on NDE to provide the NPOESS observations in near-real time**



http://directreadout.noaa.gov/miami04

.: HOME :. .: Overview :. .: Program :. .: Travel & Lodging :. .: Registration :. .: Contact :. .: Exhibitors :.

2004 Satellite Direct Readout Conference: A Decade in Transition

Miami, Florida – December 6-10, 2004

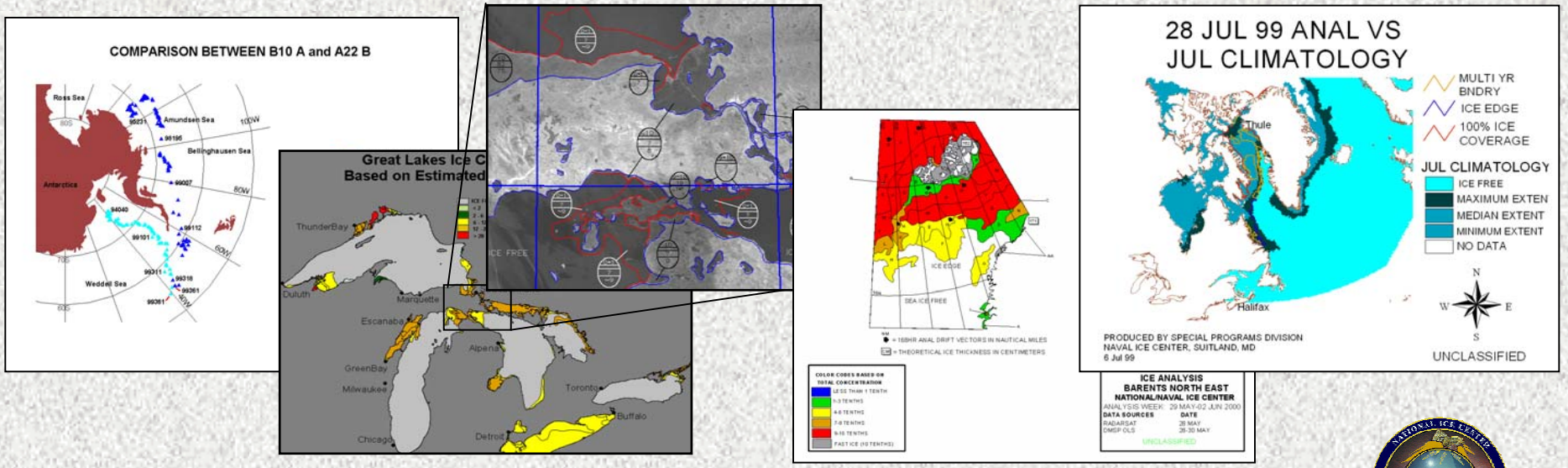
Welcome to the U.S. National Oceanic and Atmospheric Administration (NOAA) 2004 Satellite Direct Readout Conference web site. NOAA will host this year's conference on December 6-10, 2004 at the Hilton Miami Airport Hotel* in Miami, Florida. The purpose of this Conference is to continue discussions initiated during the 2002 Satellite Direct Readout Conference for the Americas and to expand the scope to include all users world wide. This year's Conference theme is: A Decade in Transition. The goal is to meet with users who receive data directly from NOAA's environmental satellites and provide a forum to help them prepare for upcoming changes as NOAA transitions into new technologies for direct broadcasts.

We are grateful for the sponsors of this conference who include: the NOAA Satellite and Information Service's Office of Systems Development, Integrated Program Office and the Office of Satellite Data Processing and Distribution as well as the NOAA National Weather Service, and to the National Aeronautics and Space Administration (NASA) Direct Readout Lab at the Goddard Space Flight Center.

This Conference will provide users the opportunity to provide feedback on upcoming satellite changes, engage in two-way communication among NOAA/NASA and the user community, as well as inform users of the innovative new changes in direct readout technologies coming within the next decade. For more information on the conference program and how to submit abstracts for presentations, click on the above navigation link.

National Ice Center Support to Coastal and Marine Operations

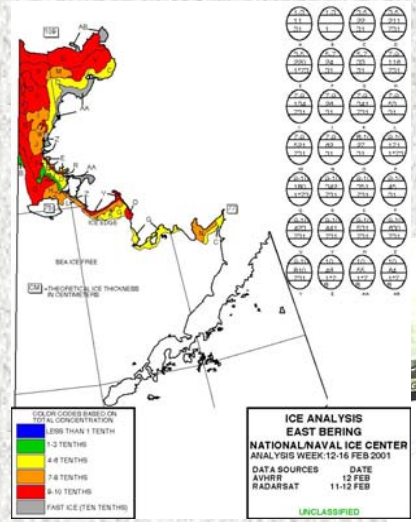
- The National Ice Center (NIC) is a Unique National and Navy Asset Leveraging DOC (NOAA), DHS (USCG) and DOD (NAVY) Resources



- Commerce & Asset Management in Great Lakes, Alaska, and Chesapeake/Delaware Bays
- Ice monitoring over all frozen ocean areas in the world
- Internationally Recognized Role in Antarctic Iceberg Detection &Tracking
- Ice Data Analysis & Visualization Supporting Climate Initiatives
- RADARSAT Order Desk for NOAA

NIC Product Suite

- Global scale: 1:1M scale, bi-weekly
  - supports mission ops
  - long term climate monitoring
  - scientific studies
- Regional Charts - two times a week
  - US interests - Alaska, Great Lakes
- Tailored support to US submarine force
- Tailored forecasts for safety of navigation
- Daily Ice Edge messages
- Annotated images
- Ice Recon/Ice Camp Support
- Daily value added SSMI

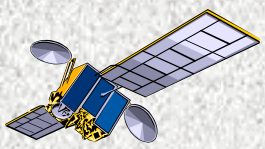


NIC and Canadian Ice Service Mandates Coincide

To provide ice information and hazard warnings in support of:

- marine safety
- icebreaking operations
- climate monitoring and science
- numerical weather forecasting

CIS and NIC Data Reception and Communications



DMSP OLS, SSMI;
NOAA AVHRR;
QuikScat

Internet

DERA

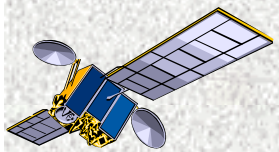
Internet

Tromso

T-1 to SAA

Alaska SAR Facility

RADARSAT



NOAA AVHRR

Prince Albert

Gatineau

ITN
T-1

Edmonton,
Halifax

Order Desk
SIMS: ERDAS/Arc Info

NIC

NAIL
(data and products)

CIS

Order Desk
ISIS:ERDAS/Arc Info,
CIDAS, BAPS

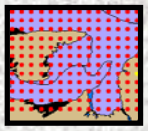
WWW

HF Broadcast
GTS

Naval
Message

Archive

Icebreakers

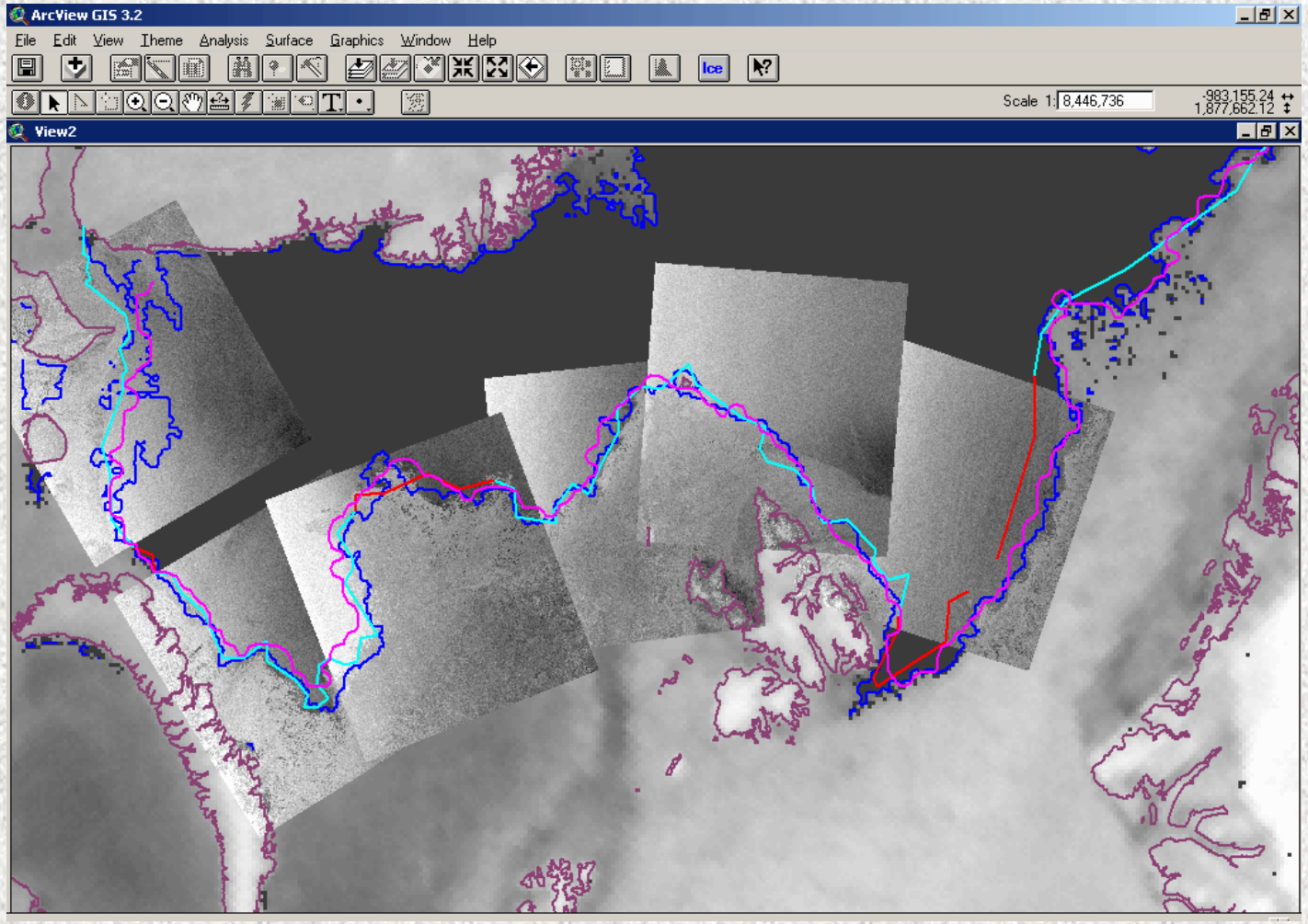


Numerical Weather
Forecasts

Ice Operations
Offices

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

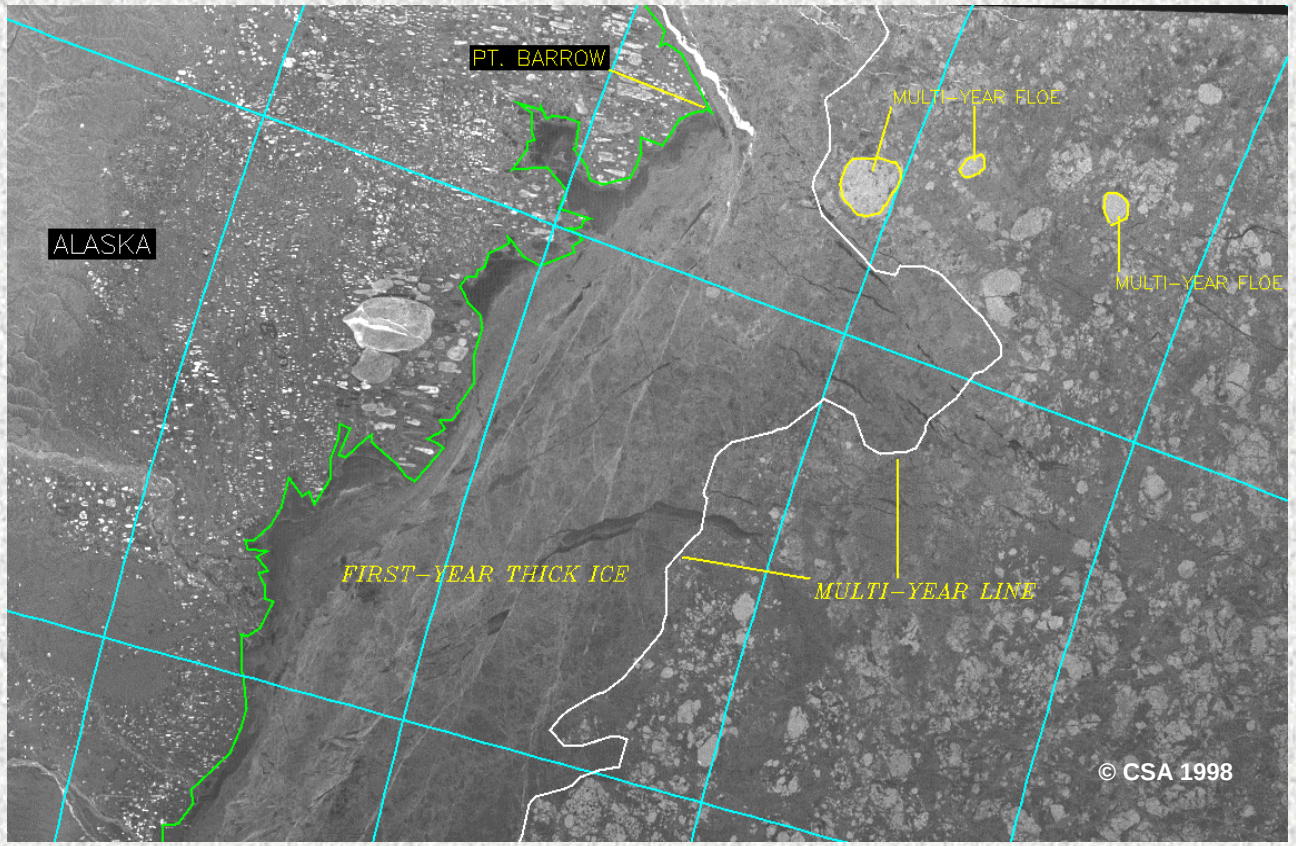
NIC Automated Ice Edge Product Development



QuikSCAT edge (Blue), SSM/I (Magenta), Analyzed (Cyan), Estimated (Red)

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

SAR Imagery is Critical to Operational Ice Analysis

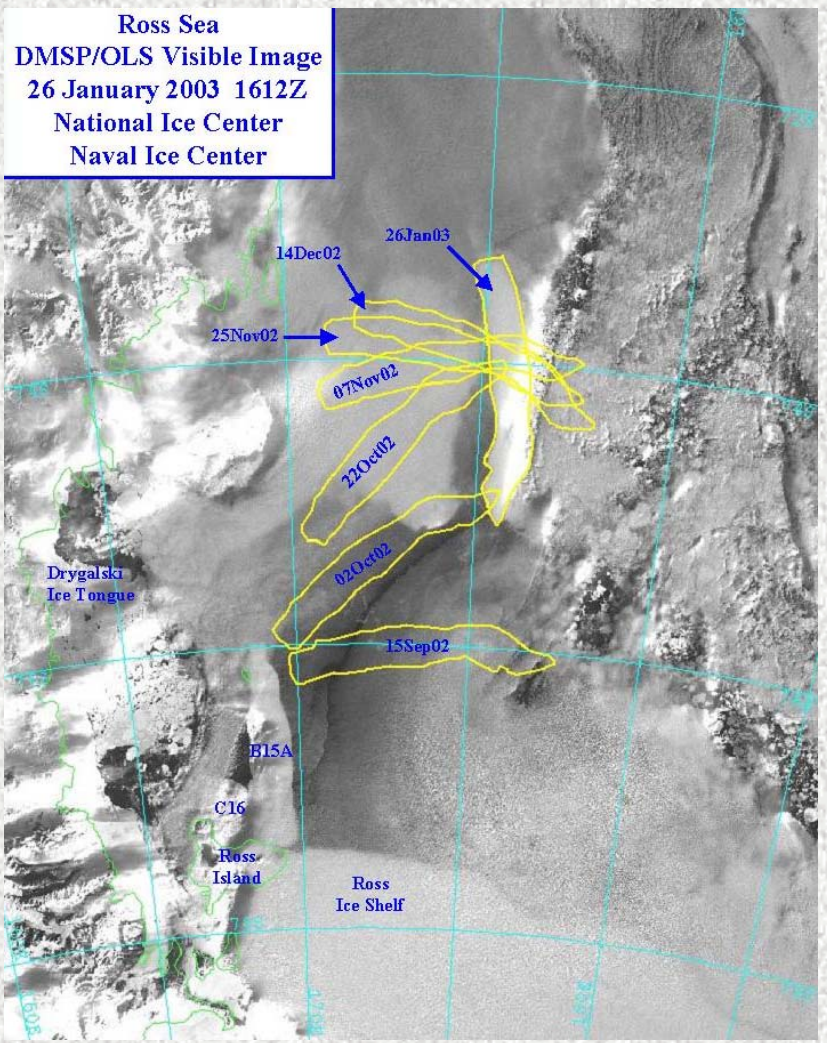


SAR imagery is the *data source of choice* for ice analysts

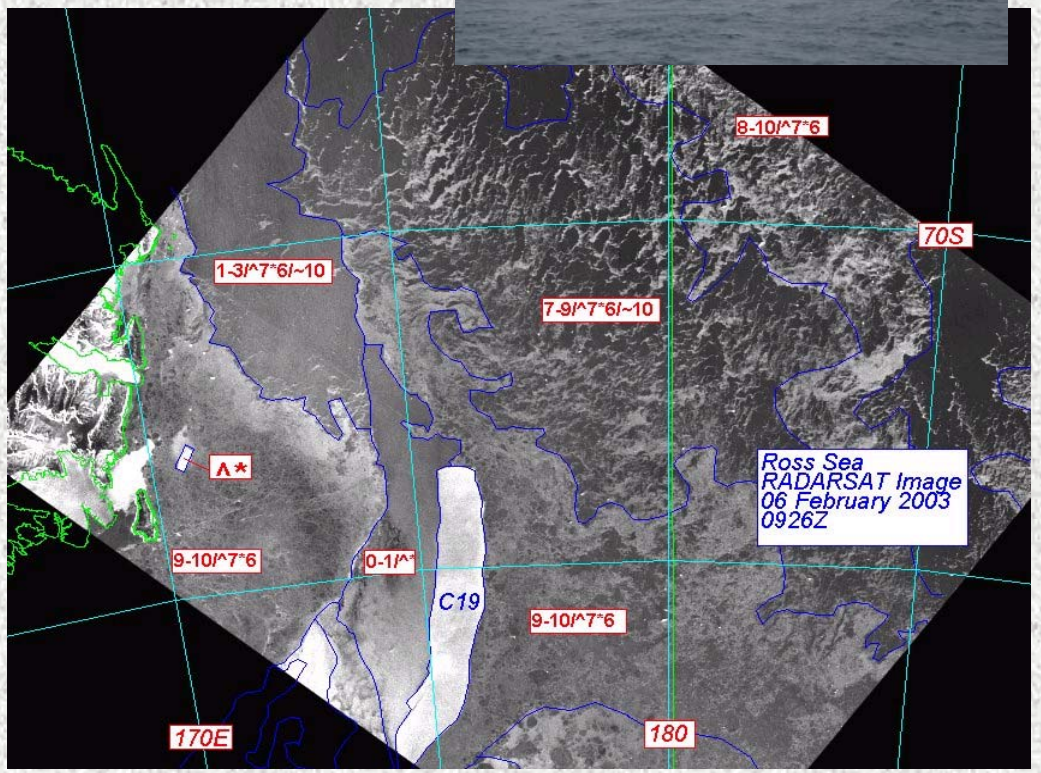
- 23% of NIC operational Arctic ice products analyzed using SAR (focus on high priority areas)
- Primary data source when available

Operational customers demand detail and reliability of SAR for critical operations (e.g., vessels operating in or near ice)

DMSP OLS Tracking and RADARSAT-1 Comparison in Ross Sea



Increased iceberg presence suspected for anomalous sea ice conditions

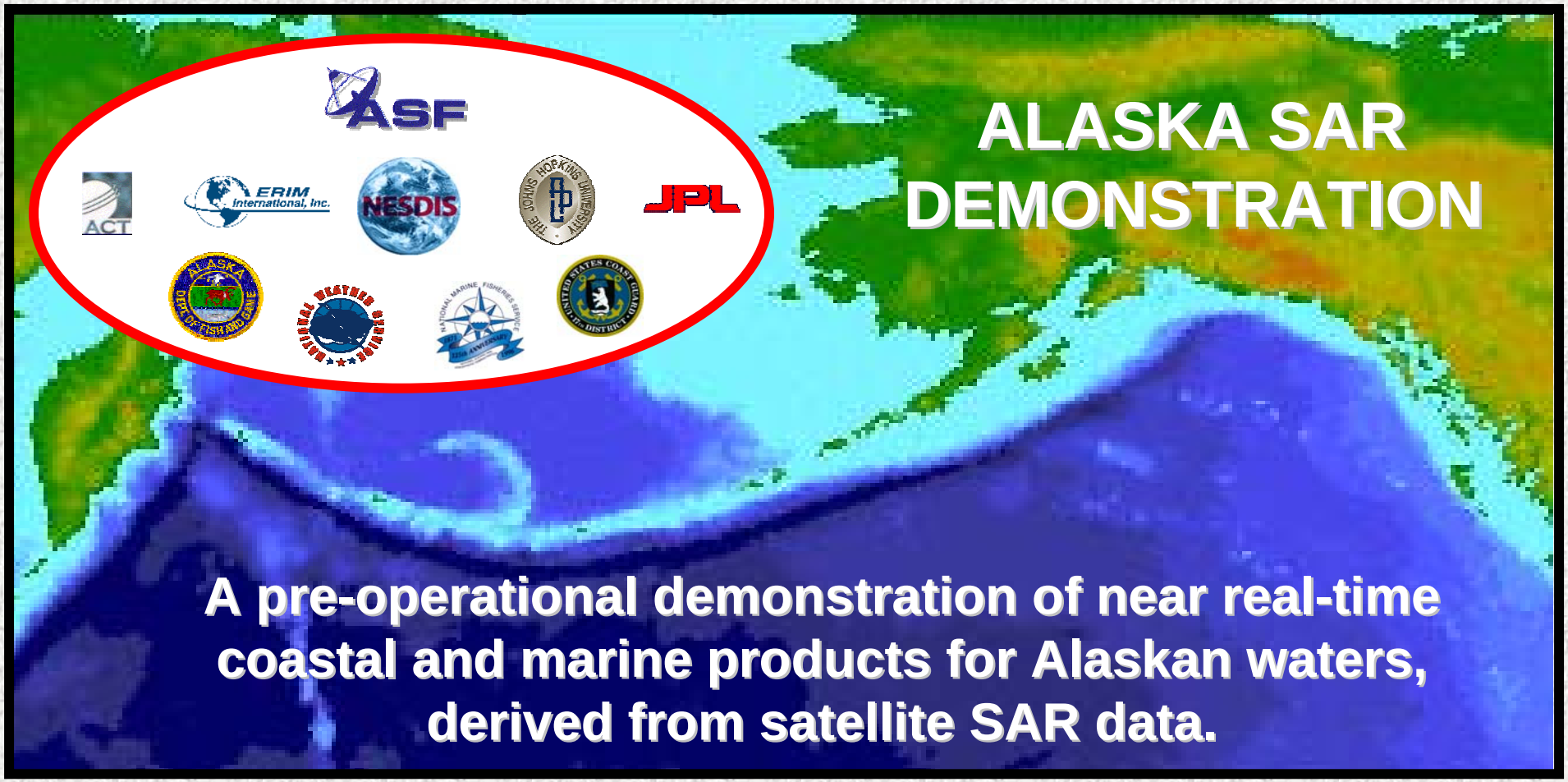


Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

NOAA and NIC IPY PROPOSALS

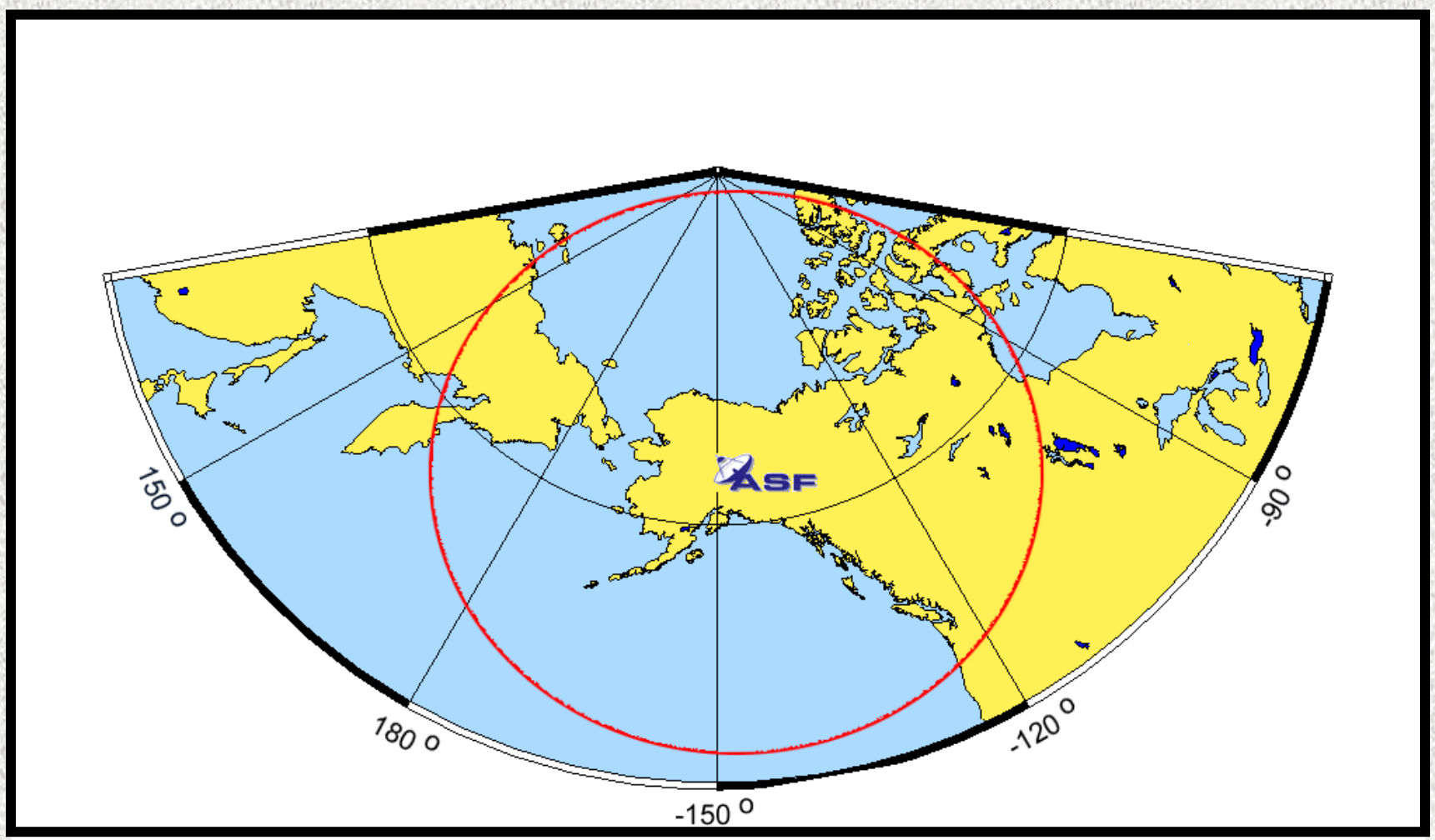
- The International Polar Year (IPY) will be observed in 2007-2008
- Polar Oceanography and Meteorology Science proposals for international collaborative work are been sought
- Areas of interest may include sea ice charting, sea ice climate, polar winds, ice-sea-air interaction, etc.

AKDEMO Synthetic Aperture Radar Applications



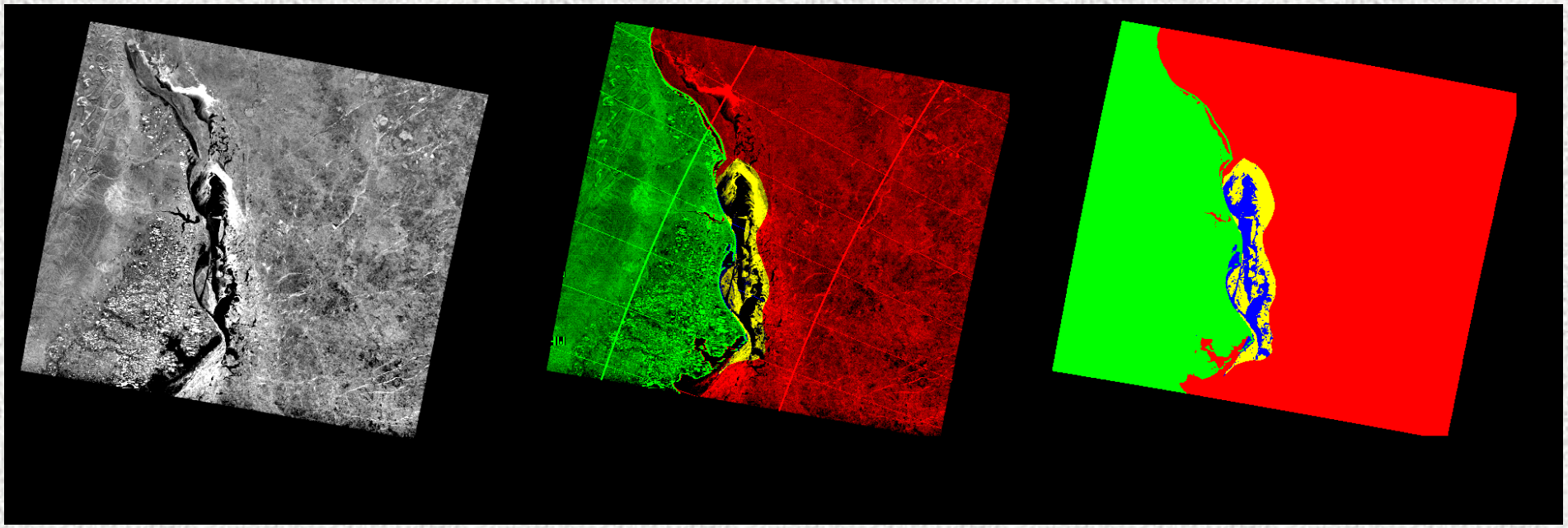
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Alaska Satellite Facility (ASF) RADARSAT-1 Station Mask



Automatic Sea Ice Detection With SAR

SAR Image **Ice Map Image** **Ice Map Mask**



System is being incorporated operationally into the NOAA/NESDIS Alaska SAR Demonstration Project
Resulting ice-type mask will be used to filter out ship detection and wind vectors over ice regions

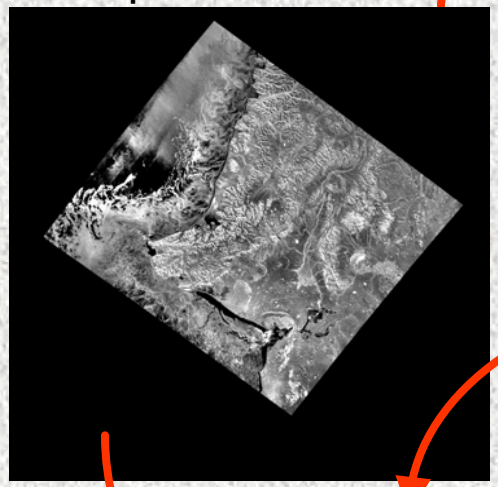
Red = solid ice
Yellow = ice filaments
Blue = water
Green = land

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

NESDIS/STAR Automated Ice Detection with SAR

General Dynamics

Input Data Sets



Extract subsets of known types → Form optimal separation of feature vectors for known types

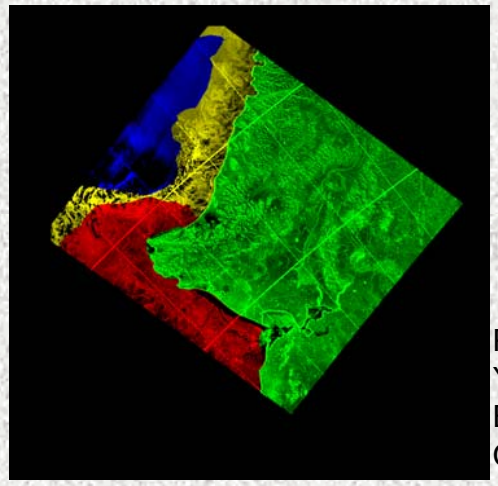
Training

Classification Vectors

Apply classification vectors to entire image, voting to decrease noise

Classifying

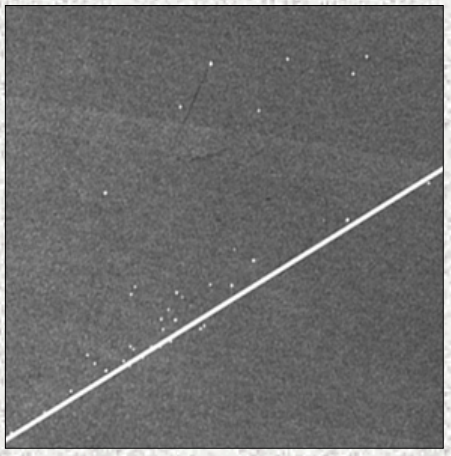
- Based on already developed code to estimate land cover type from SAR
- Supervised classification, where the user indicates subsets of known types, and optimal classification vectors are derived

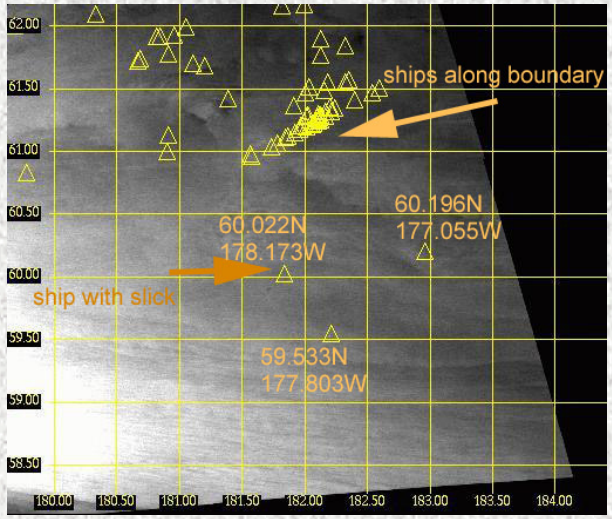


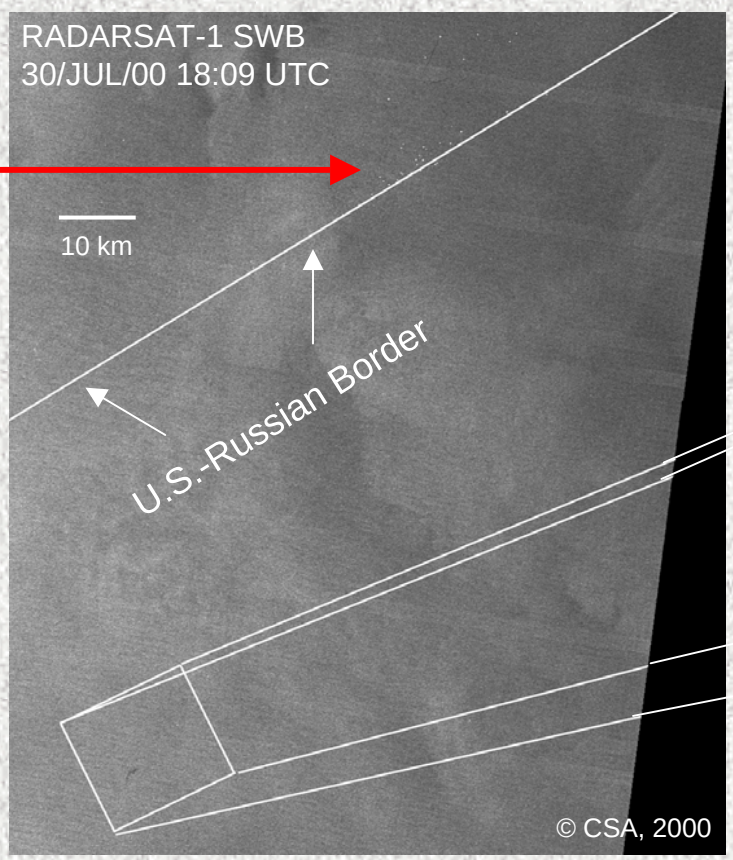
Ice Map

Red = solid ice
Yellow = ice "fingers"
Blue = water
Green = land

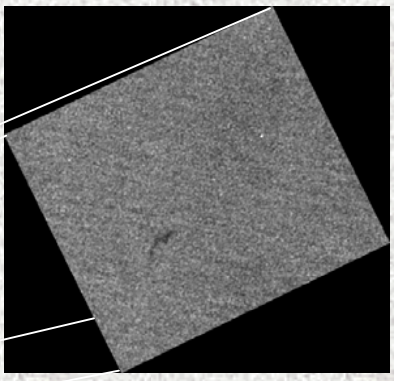
SAR Image of Russian Fleet at U.S.-Russian Border





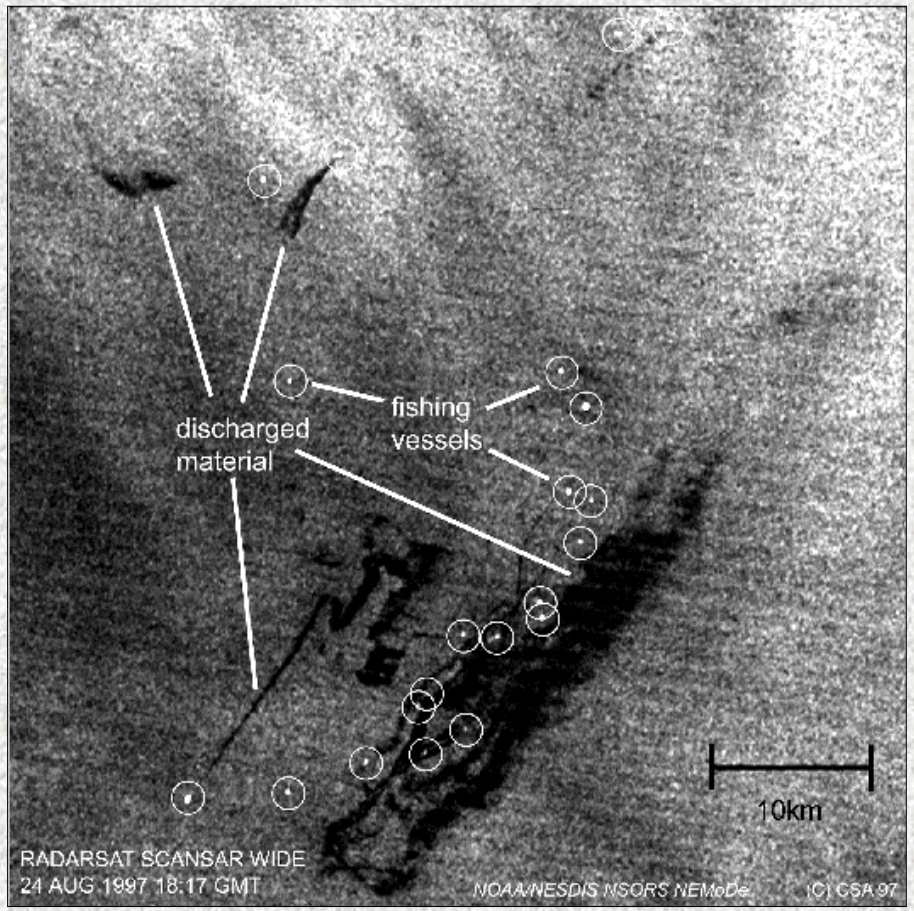


"Coast Guard seized a Russian trawler 800 yards inside the U.S. EEZ on August 1, 2000."



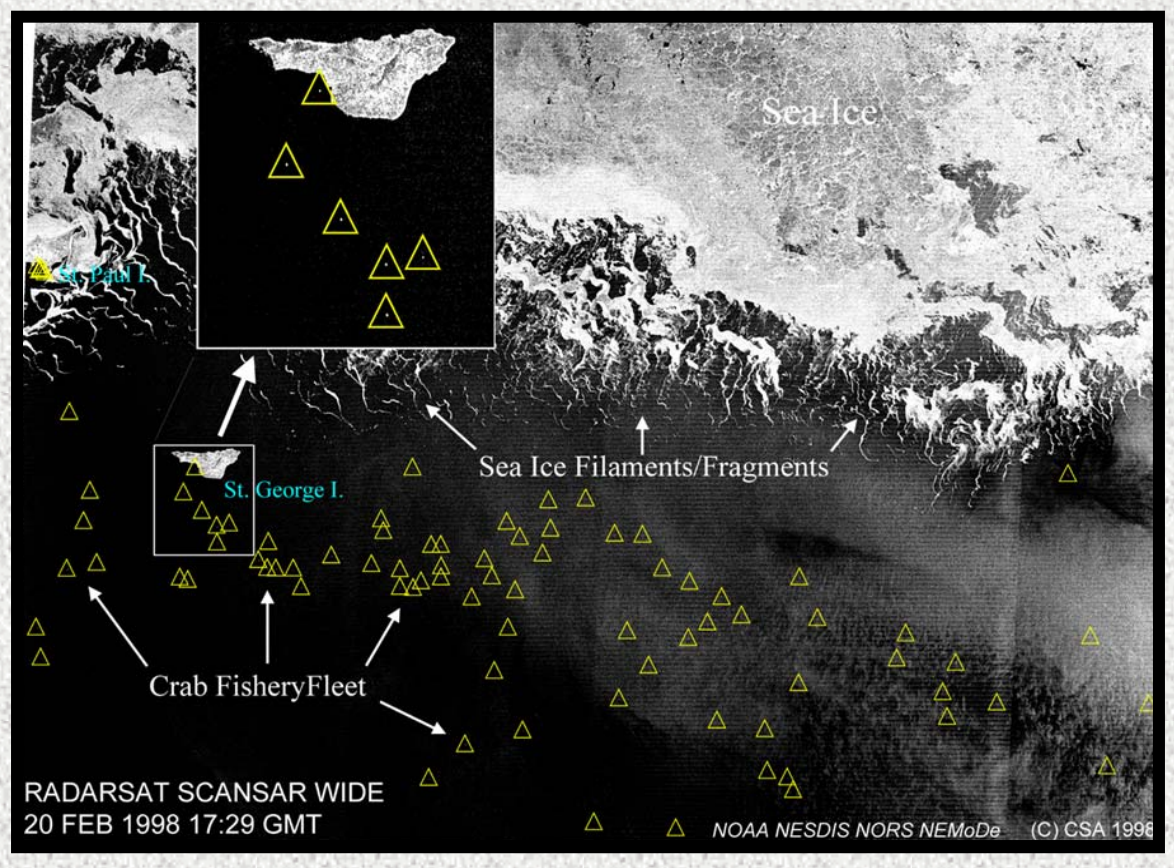
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Bering Sea Walleye Pollock Fishery



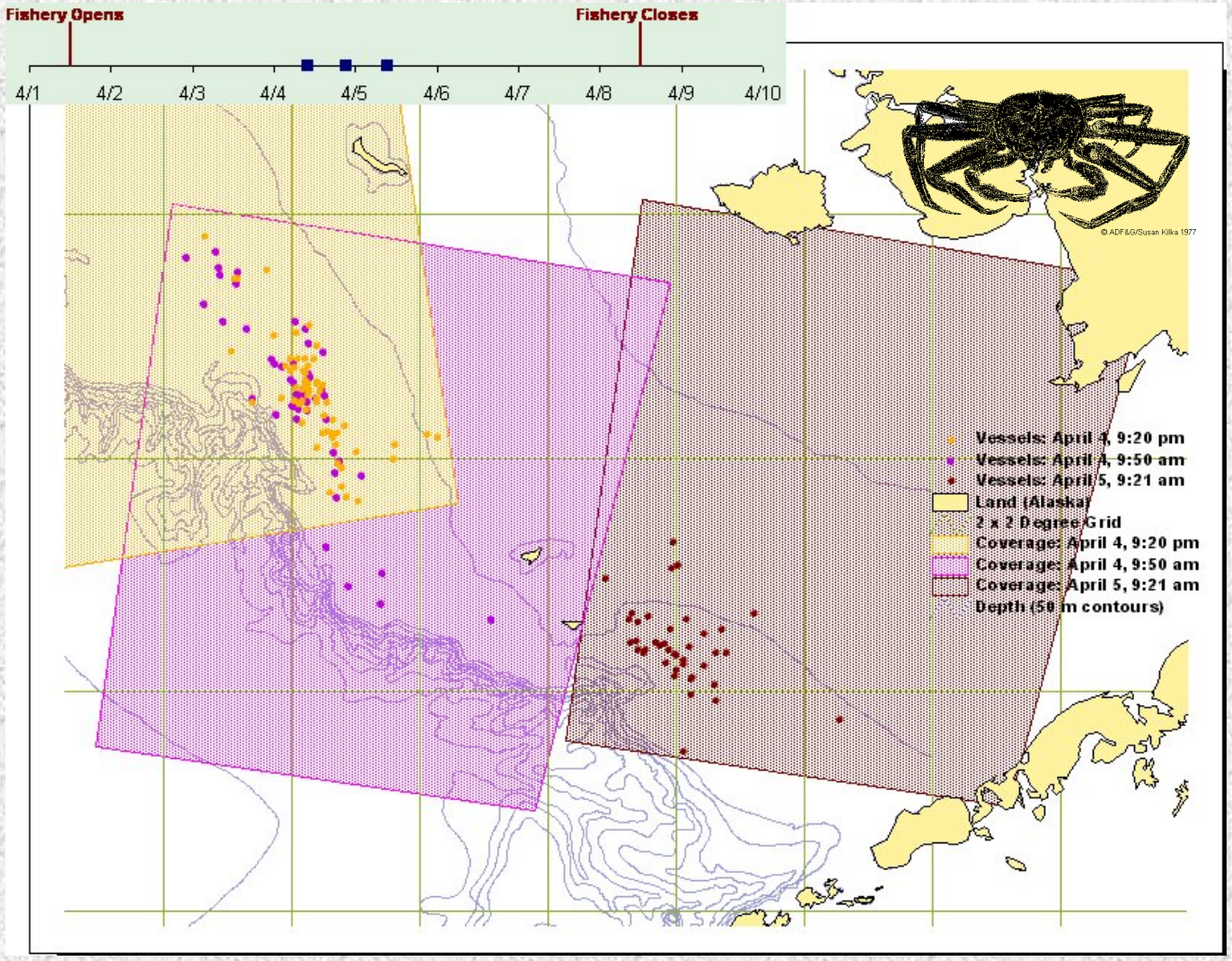
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Snow Crab Fishery Fleet at Ice Edge



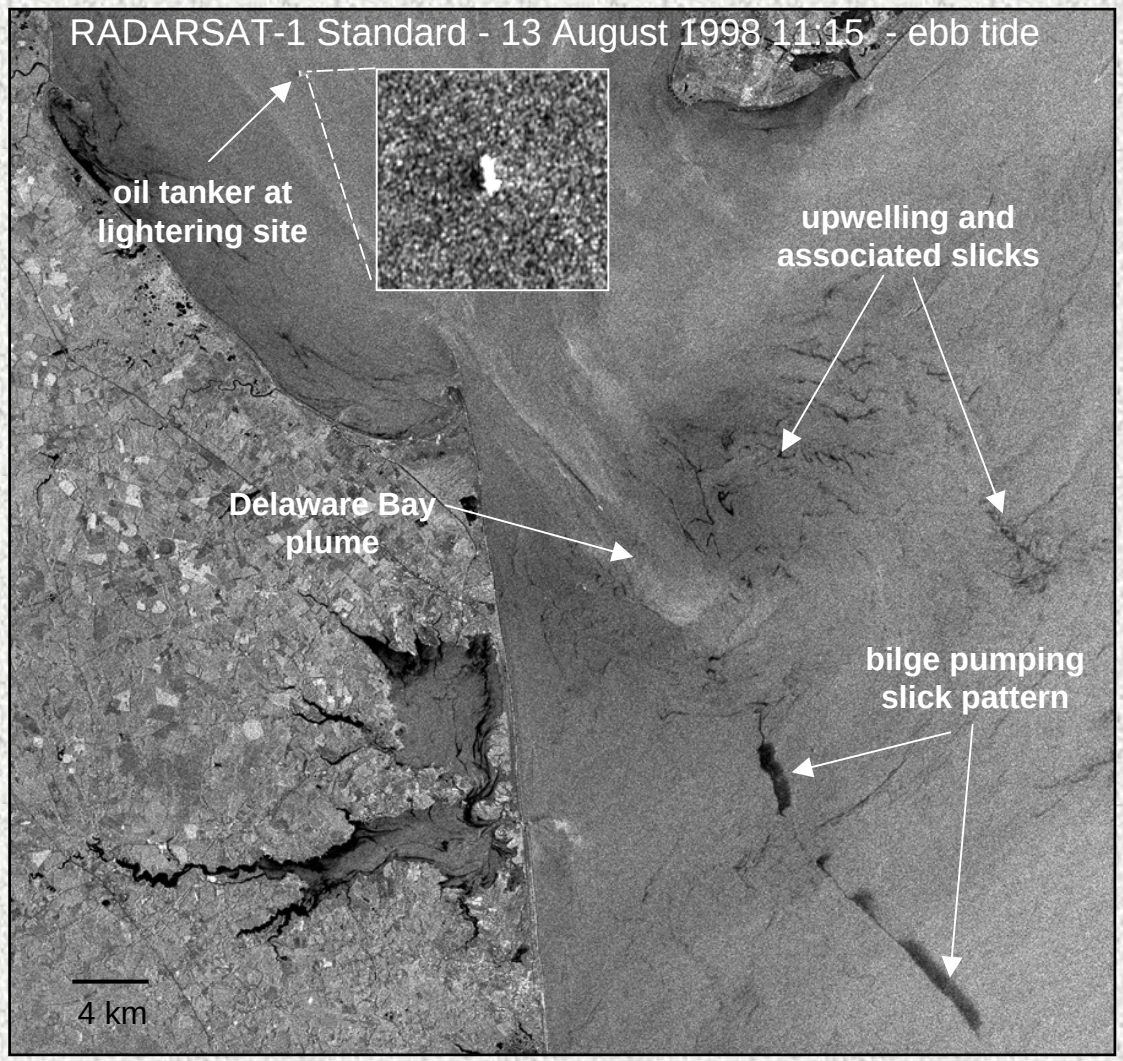
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

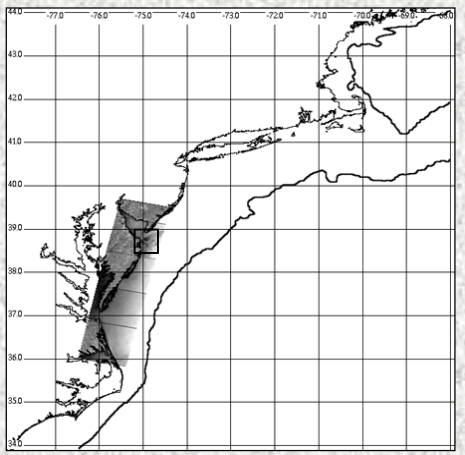
Snow Crab Fleet Mapping - APRIL 4-5, 2000

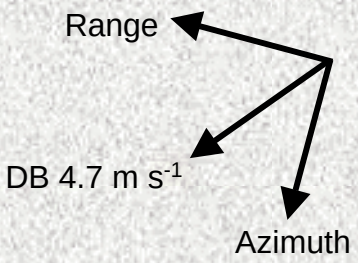


Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Oil Dumping at the Delaware Bay Mouth

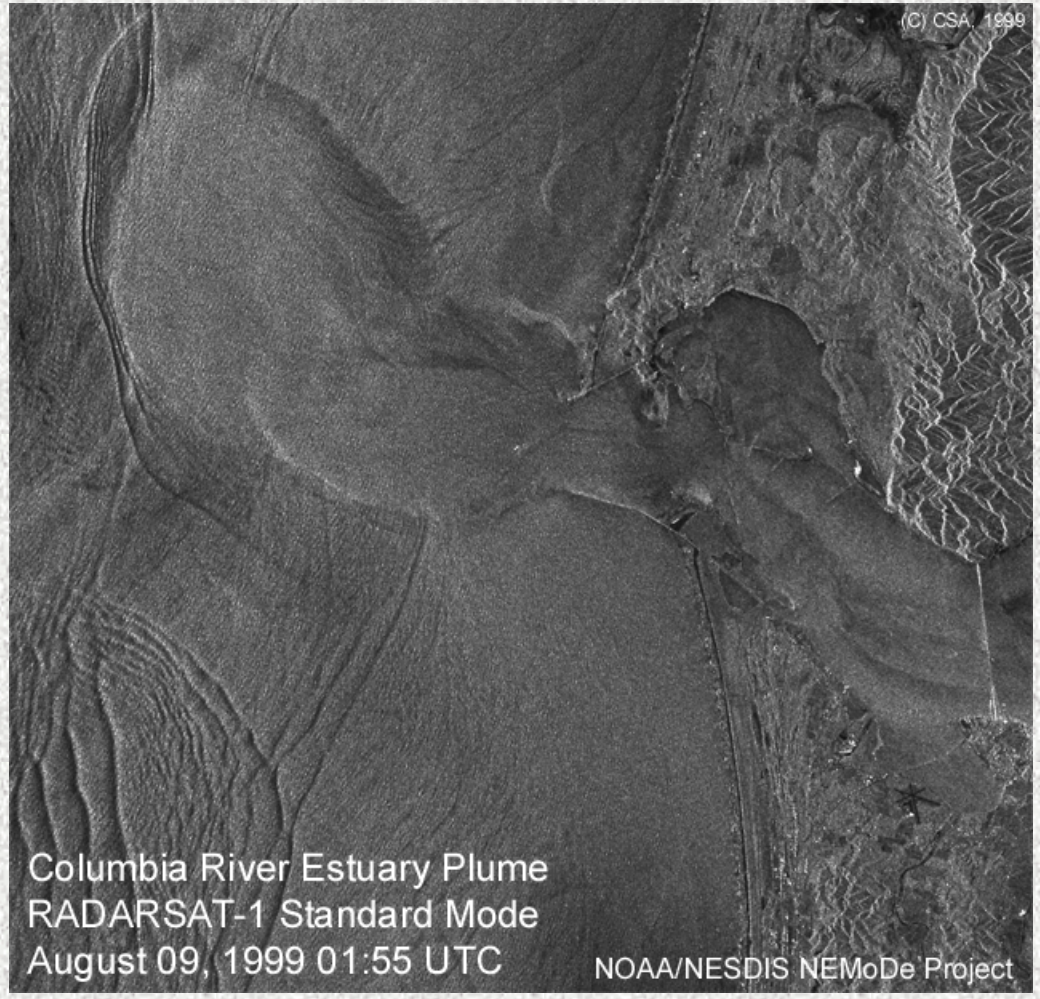




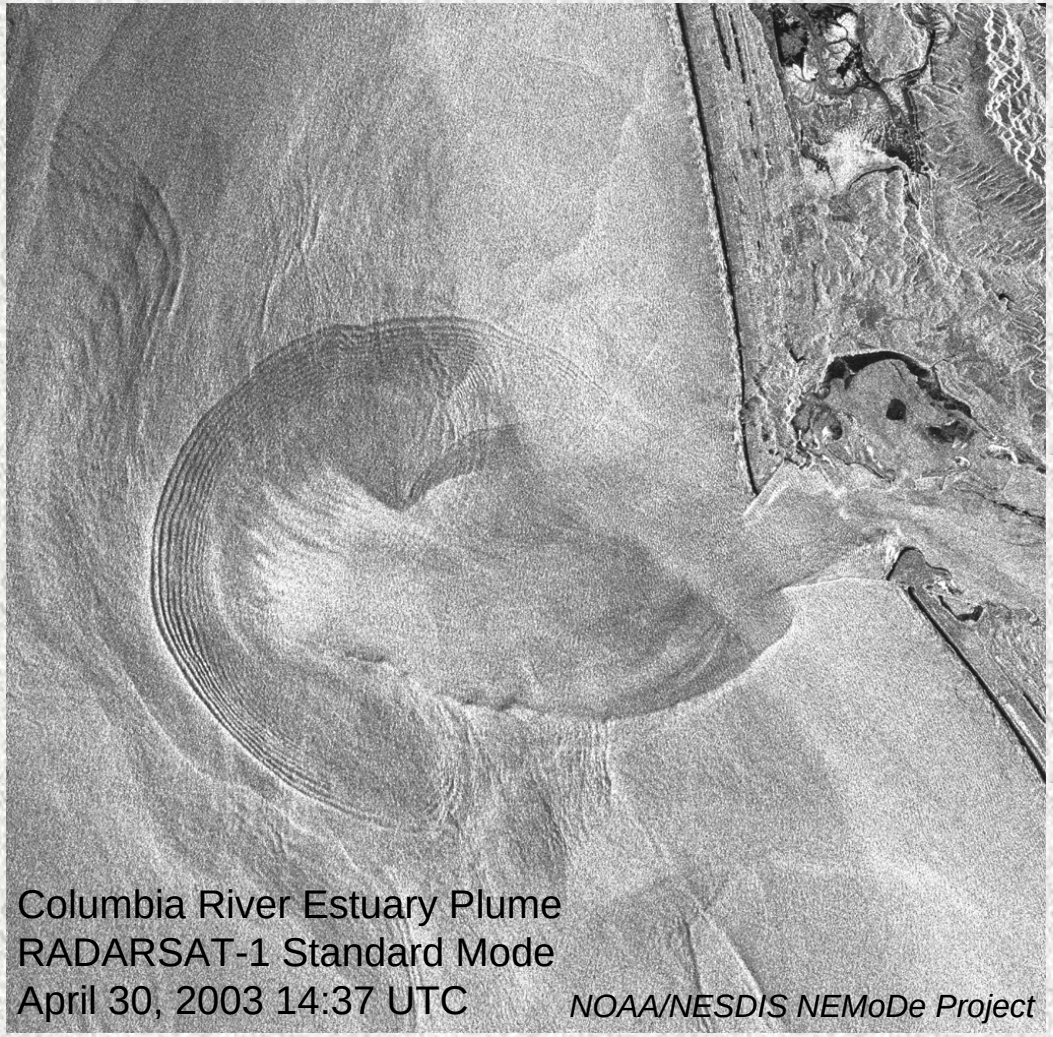


Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

RADARSAT-1 SAR Observation of the Columbia River Plume



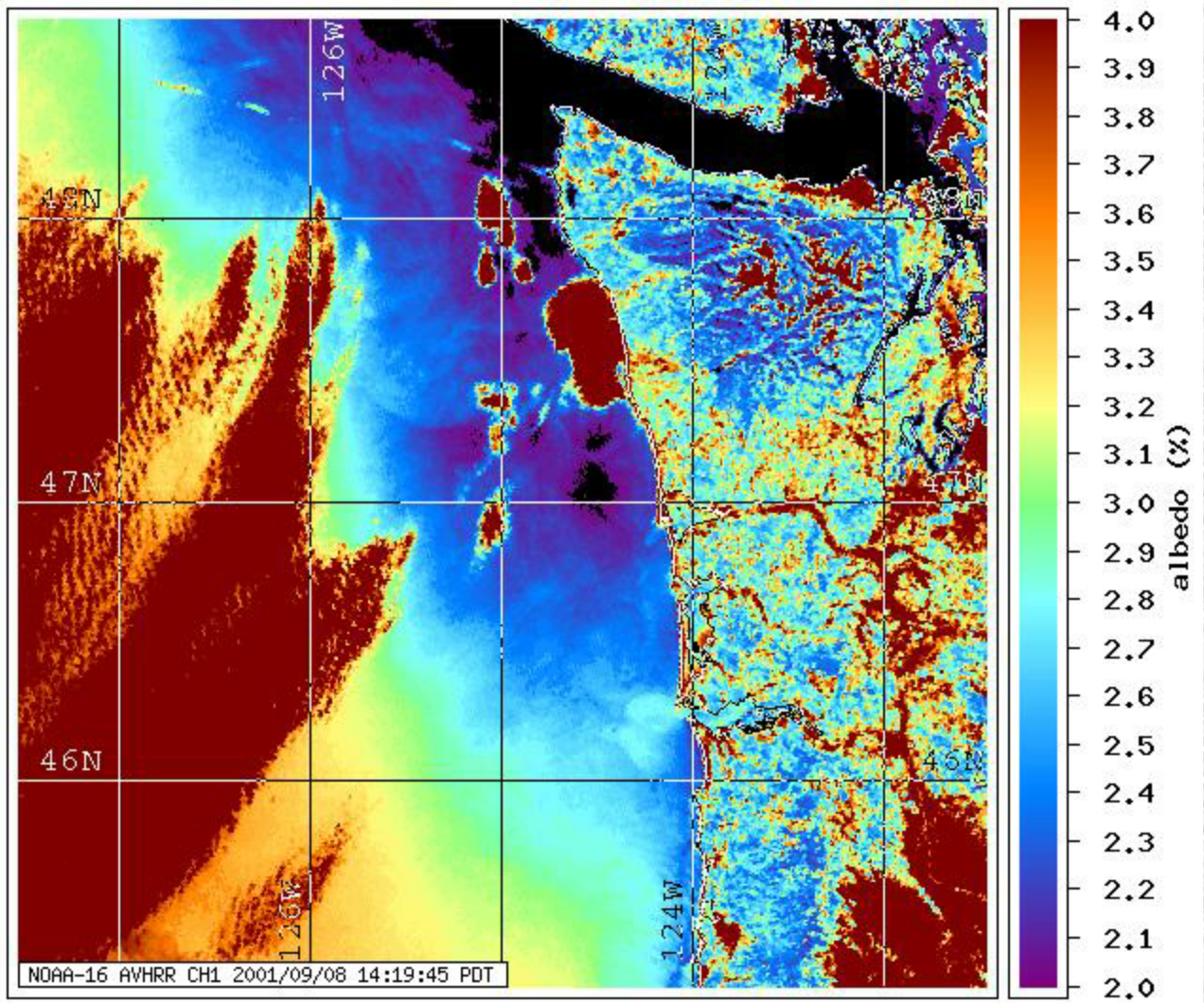
RADARSAT-1 SAR Observation of the Columbia River Plume



Columbia River Estuary Plume
RADARSAT-1 Standard Mode
April 30, 2003 14:37 UTC

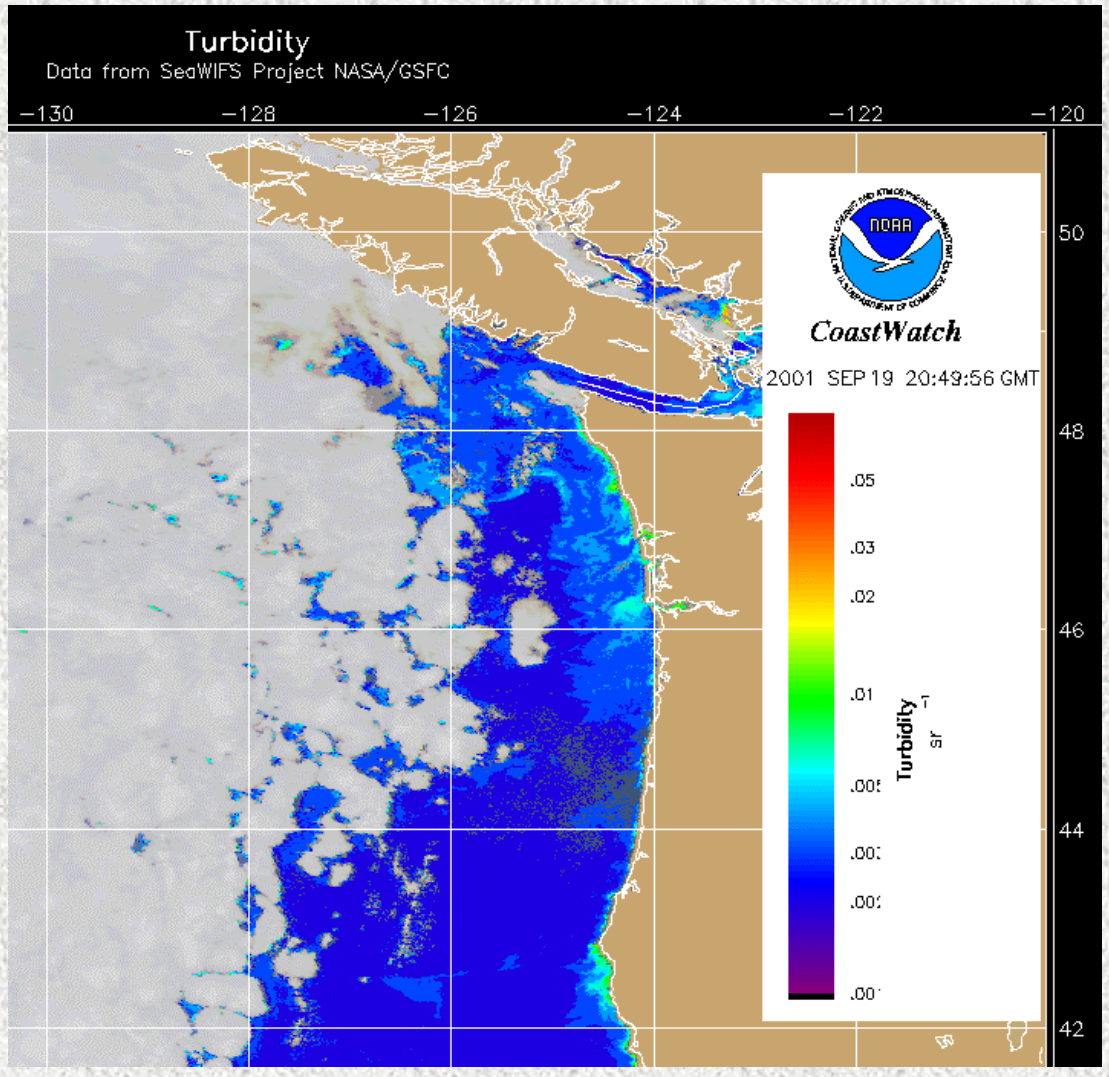
NOAA/NESDIS NEMoDe Project

AVHRR Turbidity Off the Columbia River Mount



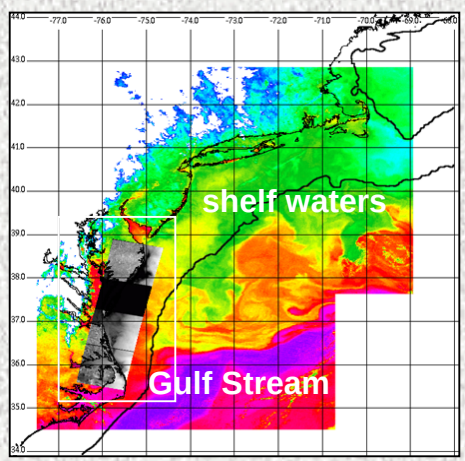
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

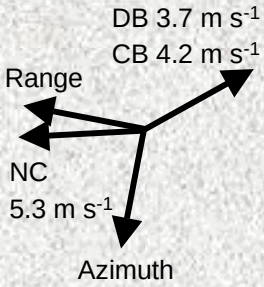
SeaWiFS Turbidity Off the Columbia River

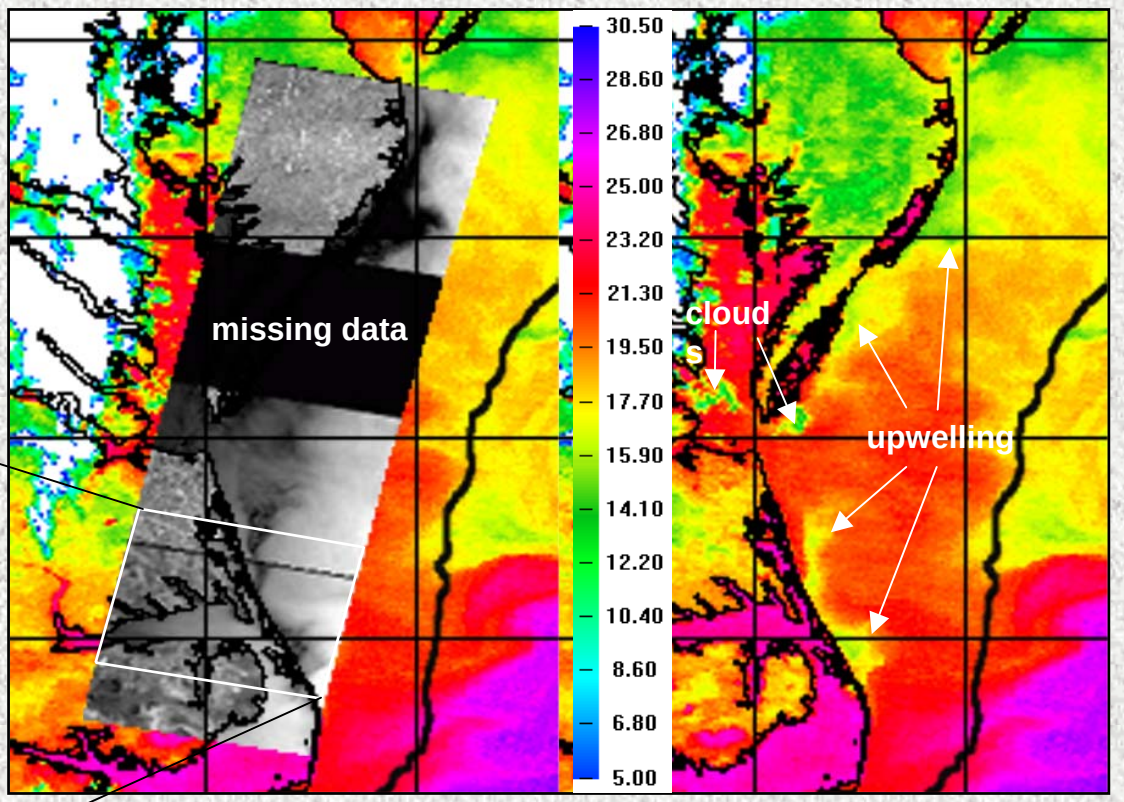


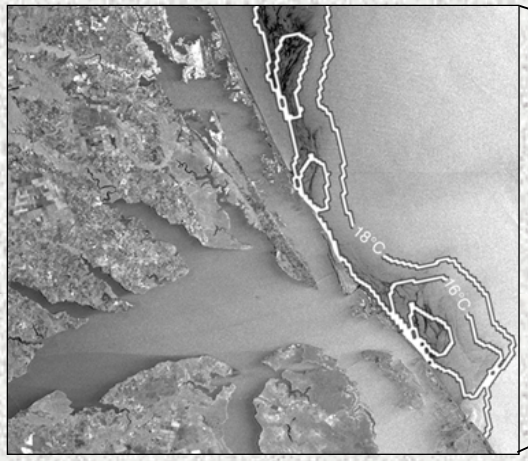
Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Upwelling Activity from Delmarva to North Carolina - 02 JUN 98





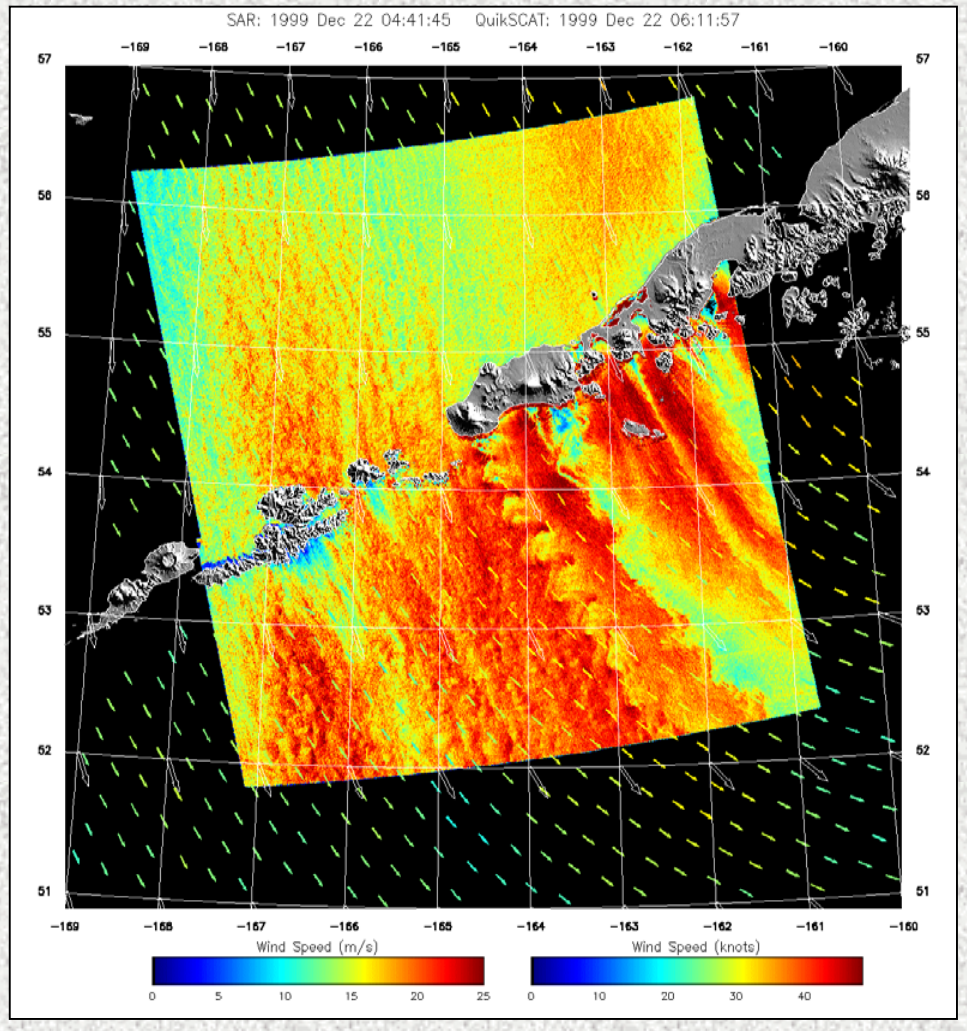




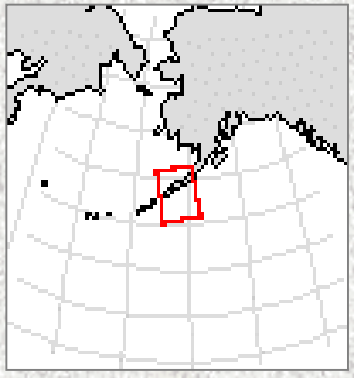
RADARSAT-1 S1 at 11:15 UTC and AVHRR SST (°C) at 11:08 UTC

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Wind Rows, Wind Intensification, and Vortex Shedding Observed with RADARSAT-1



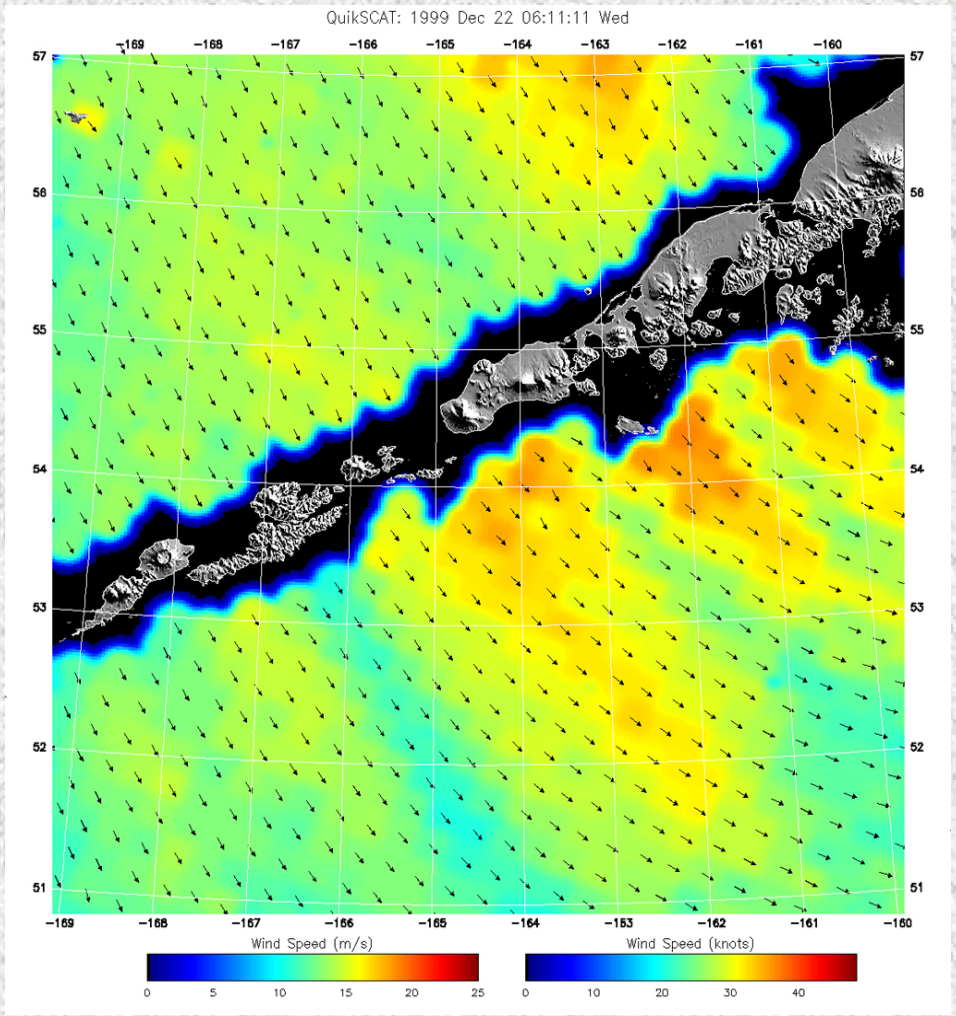
Small arrows represent QuikSCAT wind speed and direction.

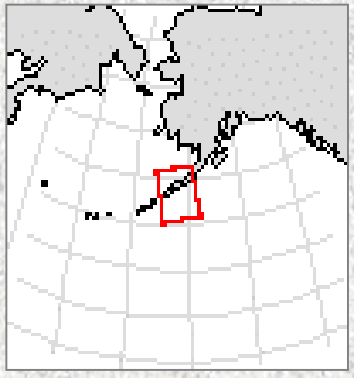


1999 Dec 22 0441 UTC

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

Coastal/Topographic Wind Effects Observed with QuikSCAT





1999 Dec 22 0611 UTC

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

SAR-QuikSCAT Comparison

Incidence > 25°

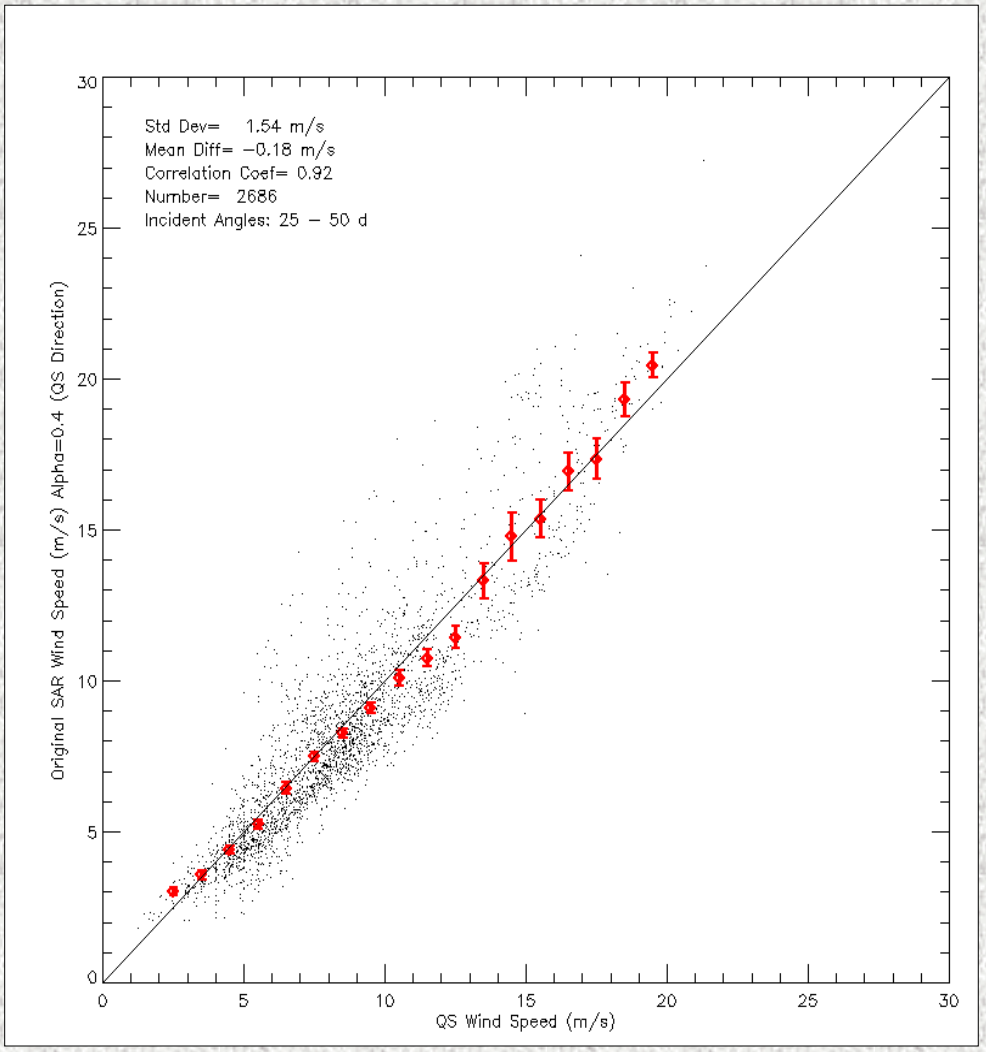
α=0.4

Time diff < 15 min.

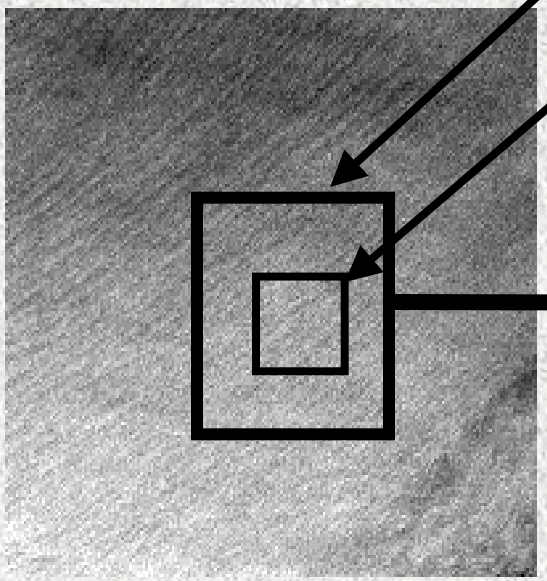
QuikSCAT directions

Std Dev= ***1.54*** m/s

Bias= ***-0.18*** m/s



Veridian Automated Estimation of Wind Direction from SAR



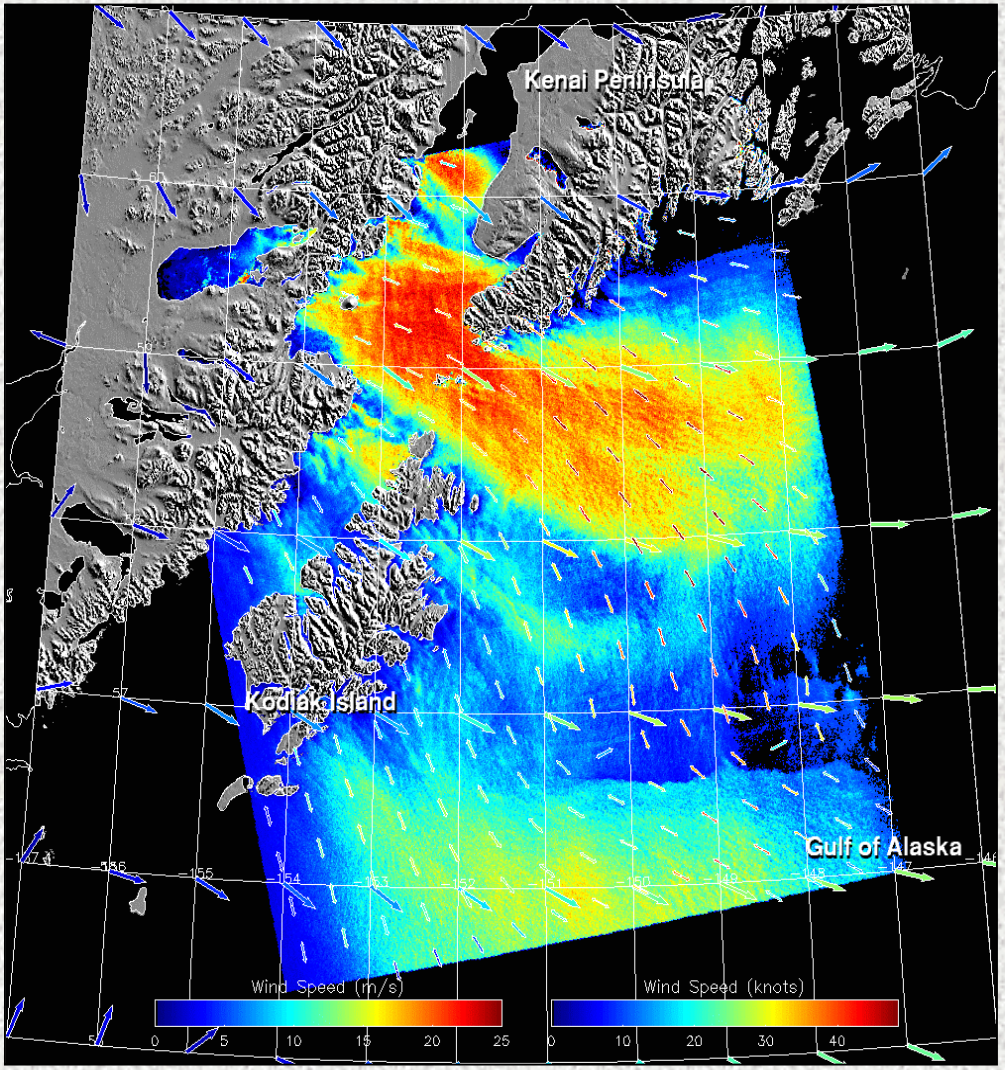
Region to use to estimate a wind vector

Region to use to generate a spectrum from the image

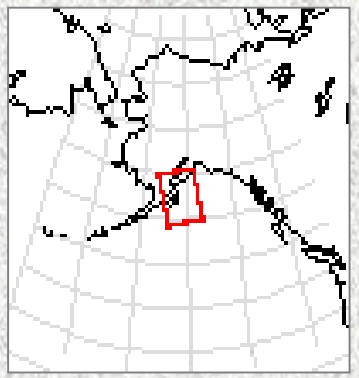
Form a smoothed spectrum by calculating a spectrum over multiple placements of the smaller region, then averaging the spectra

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)

Wind Direction From SAR



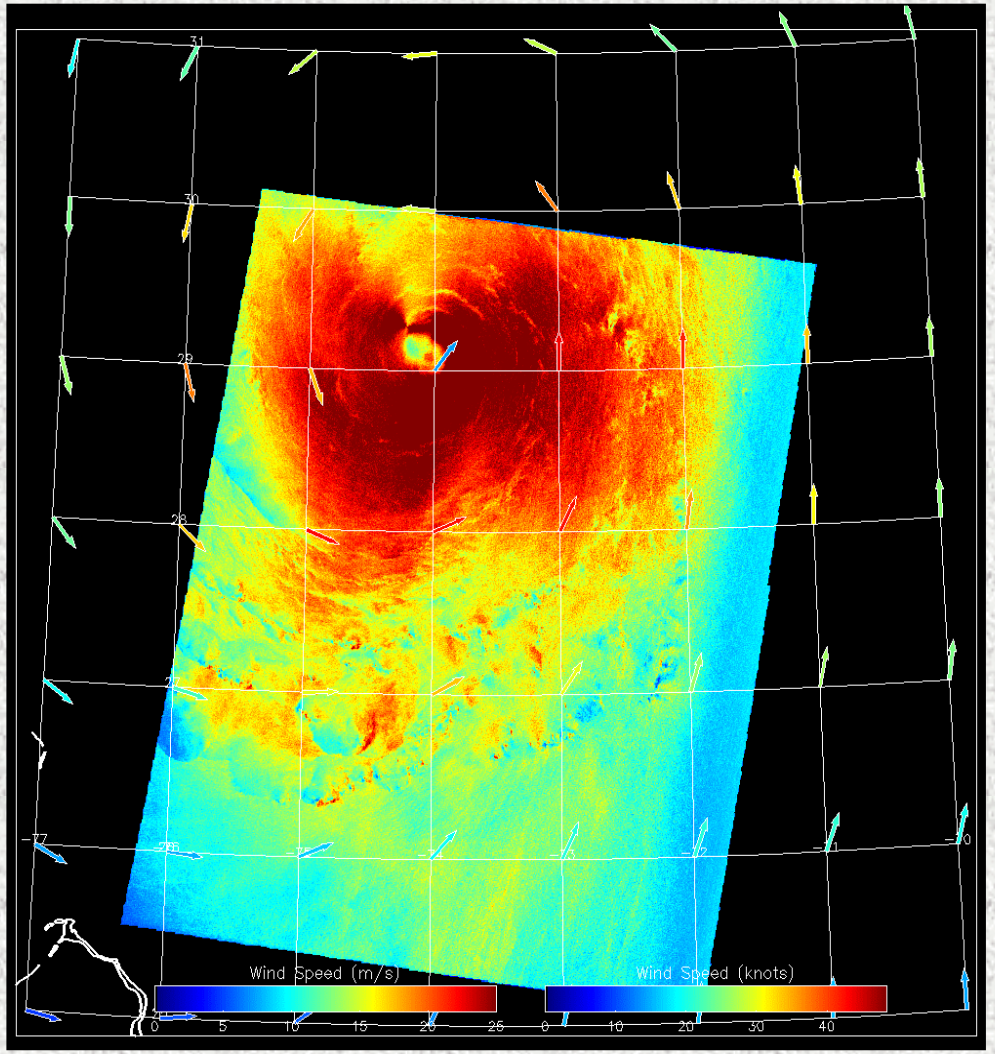
Small arrows represent Veridian SAR-derived wind directions with 180º ambiguity.



2001 Dec 13 0343 UTC

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

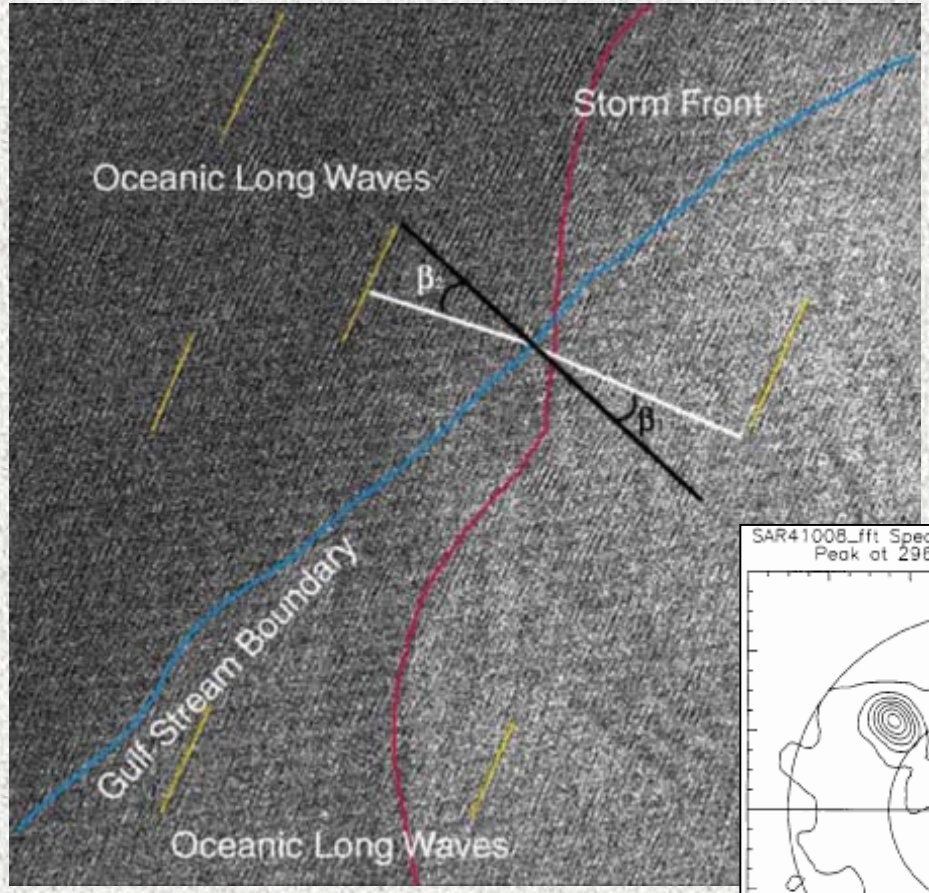
Hurricane Location and Forecasting

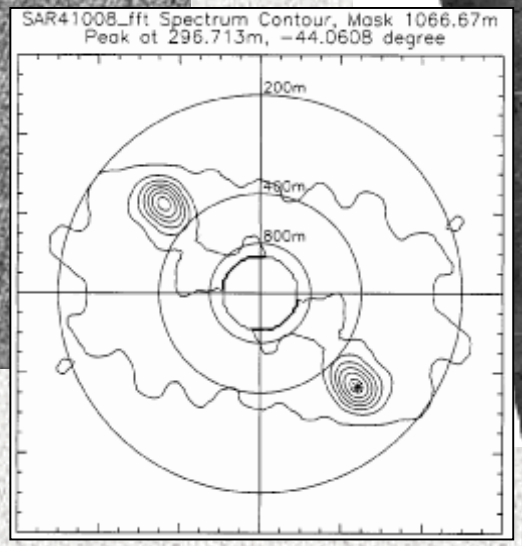


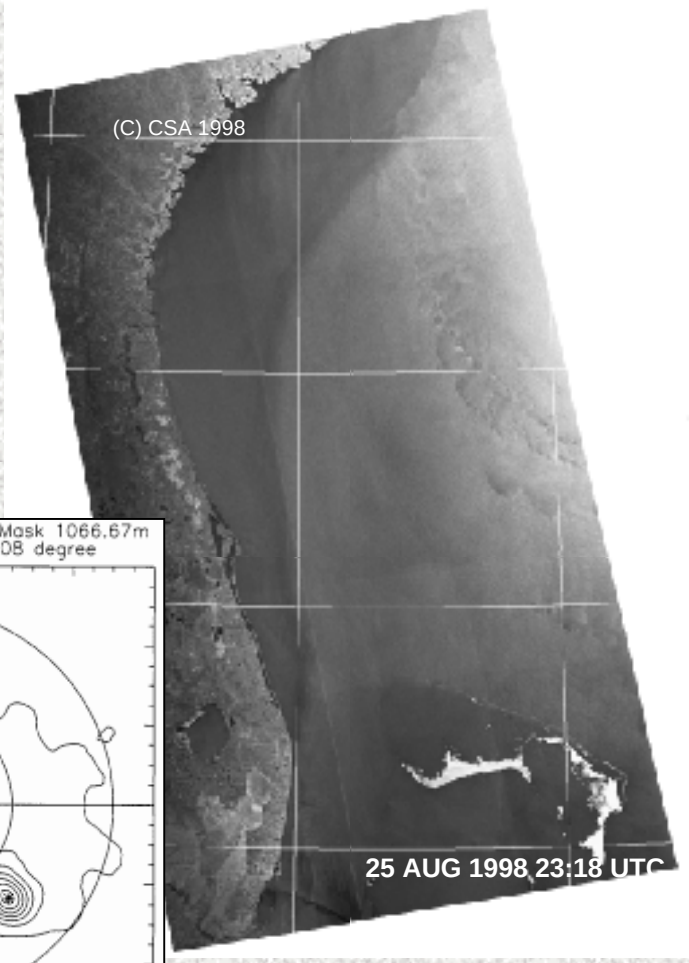
H. Danielle
1998 Aug 31 1053 UTC

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

H. Bonnie Swell





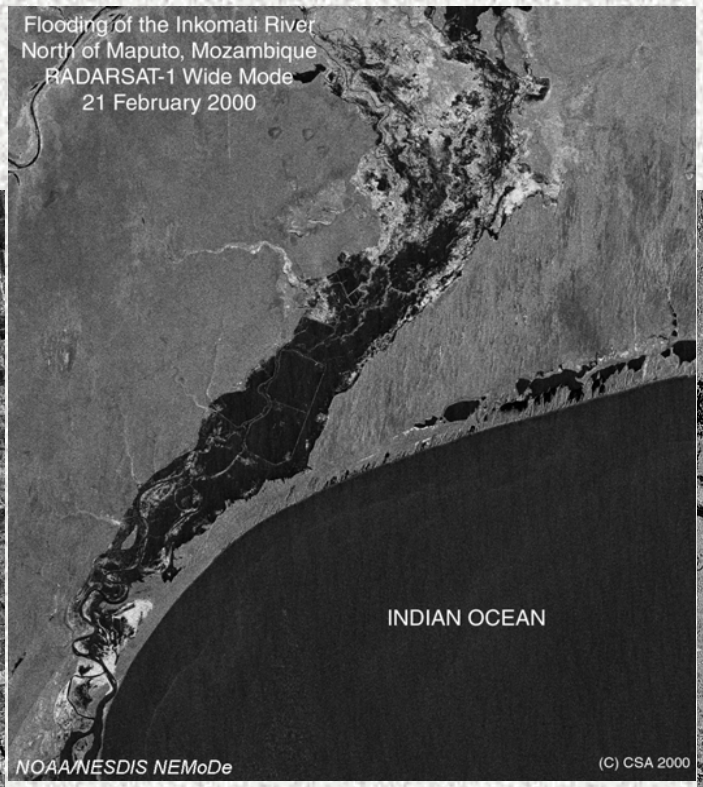


Dual SAR monitoring role for storm-generated swell and associated coastal flooding

Pablo Clemente-Colón, NOAA/NESDIS/ORA/SOD, PORSEC2004, Concepción, Chile , December 3, 2004

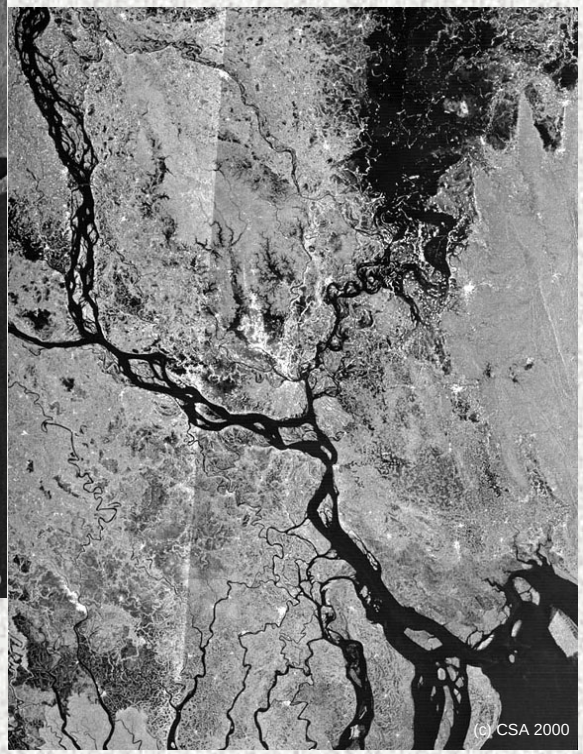
River Flooding Detection

Inkomati River – 21 FEB 00



Red River – 4 MAY 97

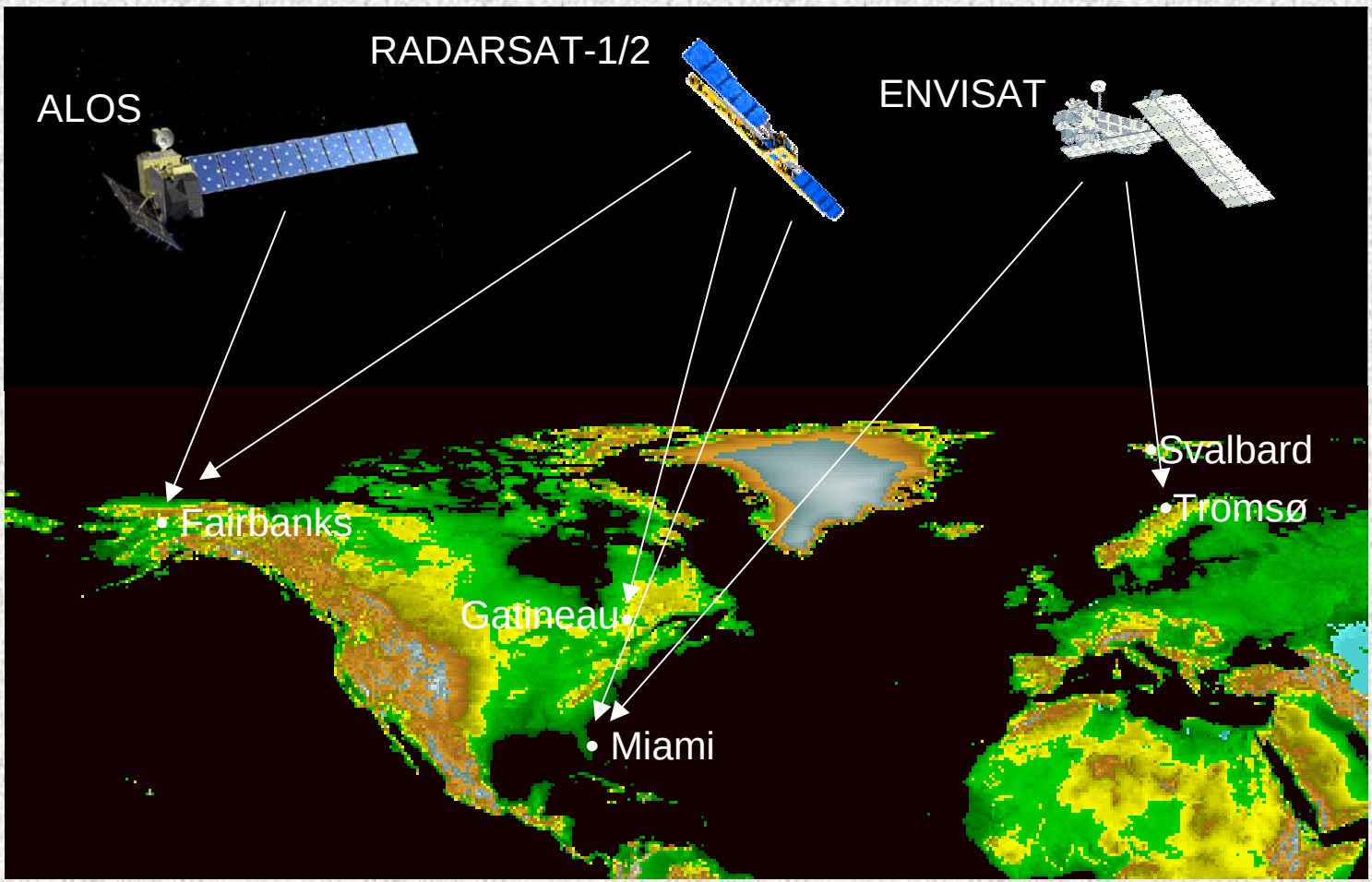
Ganges River – 21 AUG 00



Future Outlook for SAR Operational Applications

- Need to secure access to SAR data in post-RADARSAT-1 data
- Study the impact of polarimetric sensor data on present applications
- Need to increase bilateral and multinational collaborations, such as:
  - JIWG/NAIS
  - IICWG
  - WMO/JCOMM SEIT and GDSIDB
- Need to continue working towards
  - Assuring civilian SAR operational data stream continuity
  - Development/update of algorithms/models as data from new missions become available
  - Incorporating new earth observing (EO) data sources into multi-sensor products

International SAR Operational Products System



Goal: Development of an international SAR coastal ocean products system by expanding operational aspects of the Alaska Synthetic Aperture Radar (SAR) Demonstration to other international sites through cooperation with Norway, Canada, Japan, ASF at the Univ. of Alaska, Fairbanks, and CSTARS at the Univ. of Miami, and others.

A SAR Technical Workshop was held in Svalbard, Norway on September 8-12 2003.

NESDIS Latin American Initiative

- NESDIS International and Interagency Office (IA) is drafting a plan to develop a capacity building program for Latin America in ocean remote sensing
- The program may follow the structure of the National Weather Service (NWS) Latin American Desk in Camp Springs, MD
- The program may include the rotation of Latin American trainees in the U.S and/or providing U.S trainers to Latin American countries
- Ocean product and sensor development collaborations may also be viable under the program
- A spring 2005 mission to South America is planned to further explore some of these ideas.

Summary of Potential Areas for International Collaboration

- *Ocean**W**atch* Partnerships
- NPP/NPOESS Product Transition and Validation
- IPY Projects
- SAR Operational Data Access and Products
- NESDIS Latin American Initiative