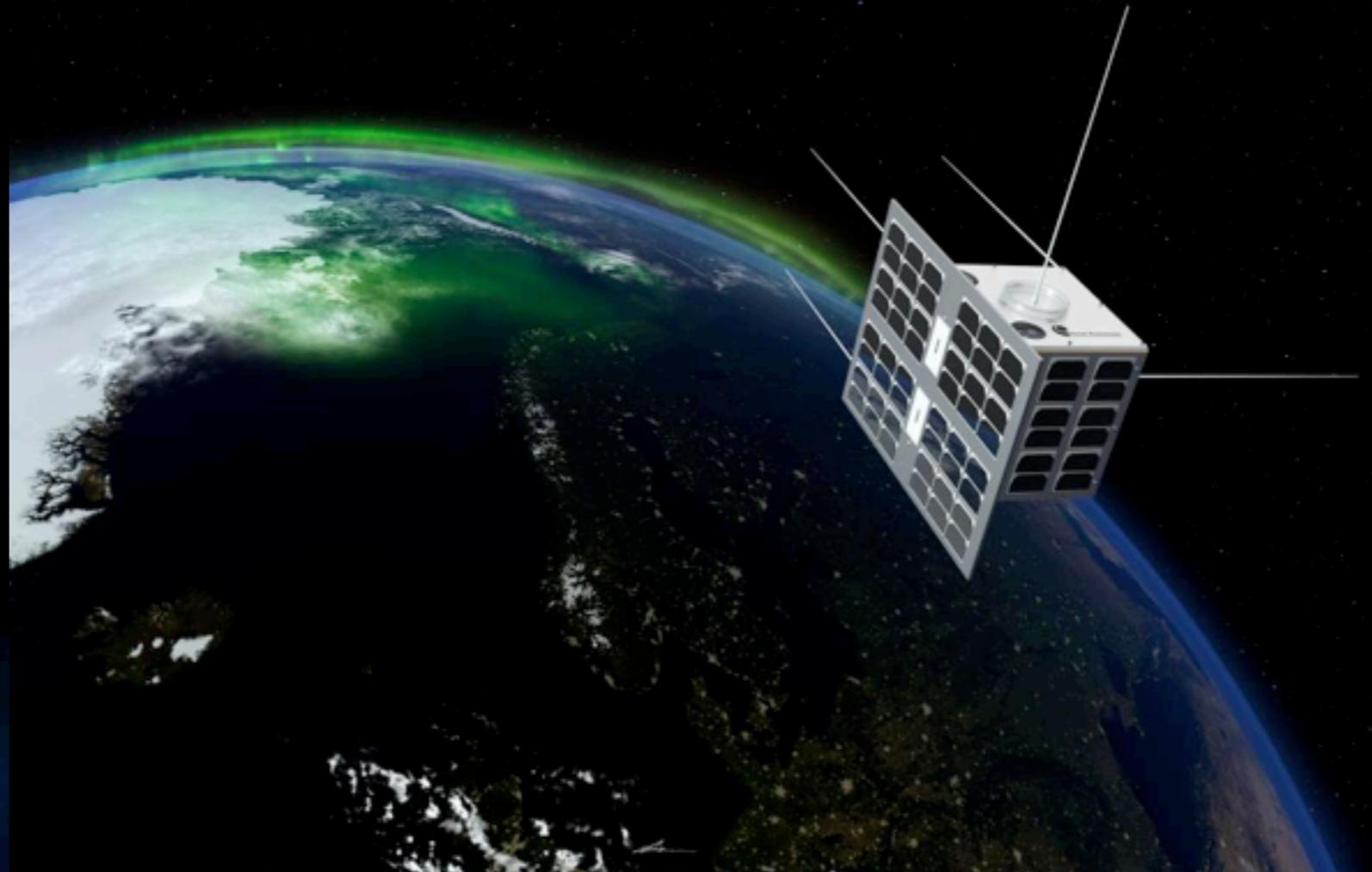


NORSAT-1

Total Solar Irradiance, Space Weather, and Ship Detection



Why NorSat?

- Utilise well developed satellite bus technology for niche technology testing and science.
- Number one will fly:
 - new and more advanced AIS receiver developed by Kongsberg Seatex (under ESA ARTES Programme)
 - Provide a platform for instrument testing within climate/solar physics and space weather (ESA PRODEX).
- Future platforms will concentrate on issues essential for Norwegian or international partners.



NORSAT-1

NORSAT-1 will be a small Norwegian satellite designed to carry three scientific payloads

- AIS-receiver - Ship detection - to test new algorithms
- CLARA - Solar Total Irradiance monitor (Sun-Climate)
- Mini-Langmuir probes (Space Weather - Plasma densities)

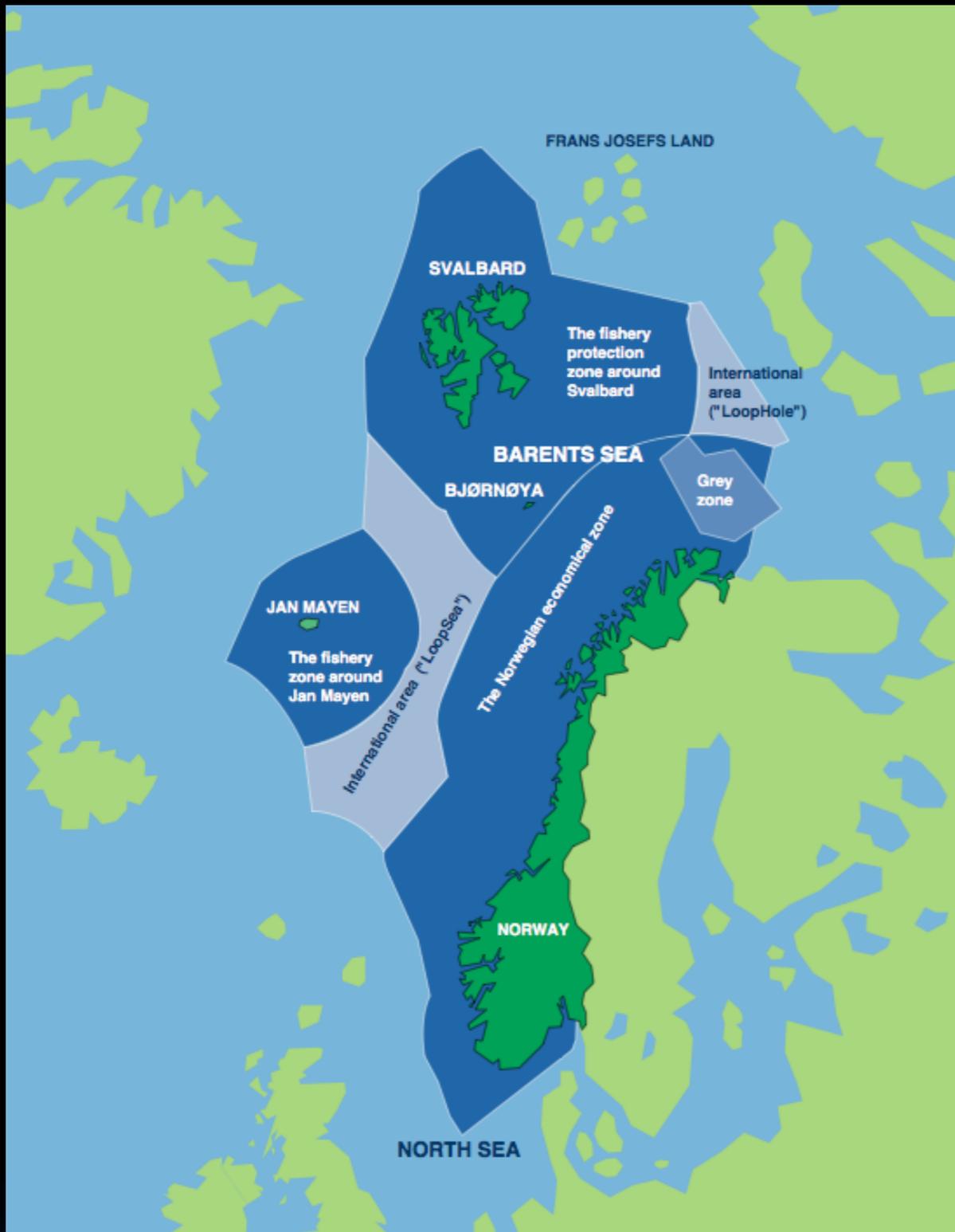


NORSAT-1 - facts

- CDR: 10-13 February 2014 - then the construction starts
- Launch Q4-2015/IQ-2016 (piggyback)
- Satellite bus: University of Toronto (CA).
- Size: 20x20x40 cm
- Weight: 16kg / 4.6kg payload
- Cost (without payload): 4 mill USD.
- Orbit: 550-650 km - depending on the launcher. Preferable a dusk-dawn orbit but not a requirement.
- Attitude control system: Reaction weels and magnet-coils. No thrusters or de-orbit mechanism.
- NORSAT-1 is designed for continuous payload operation.



How did it all start?

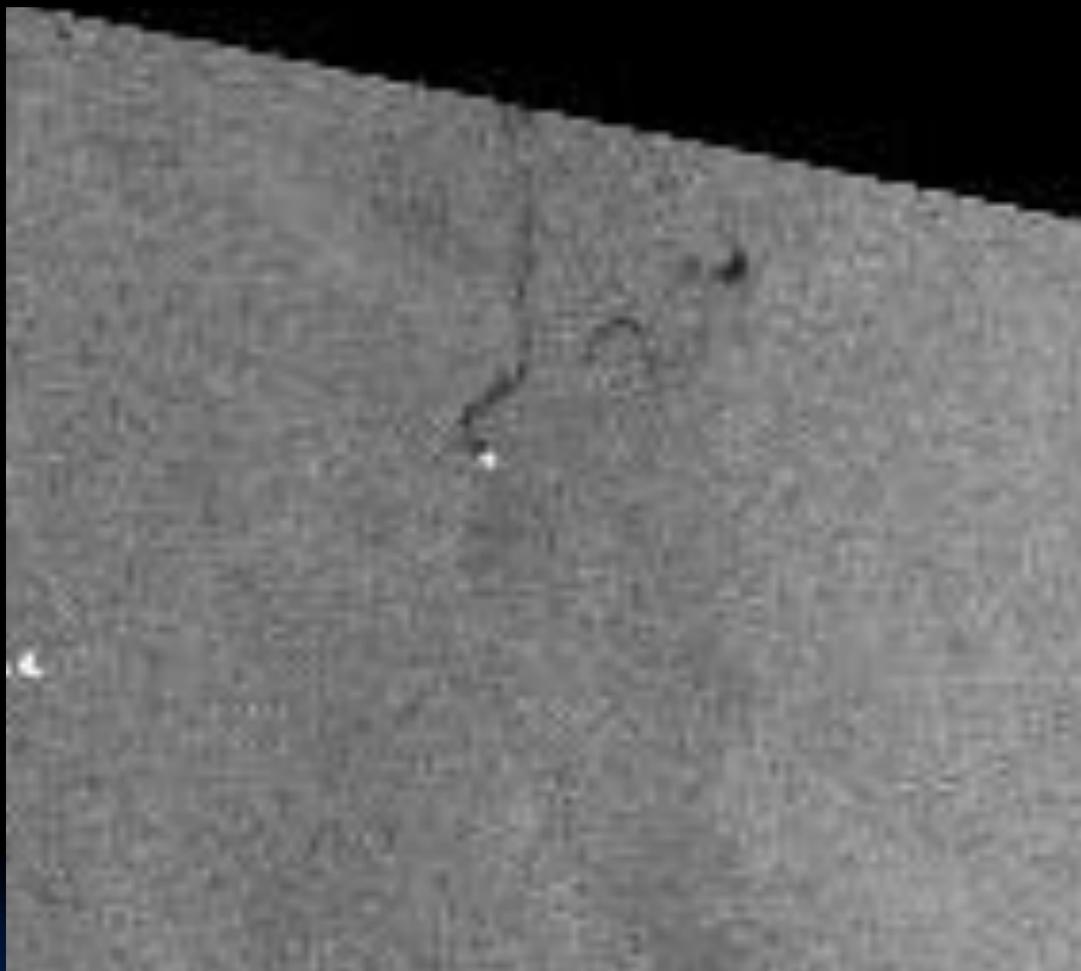
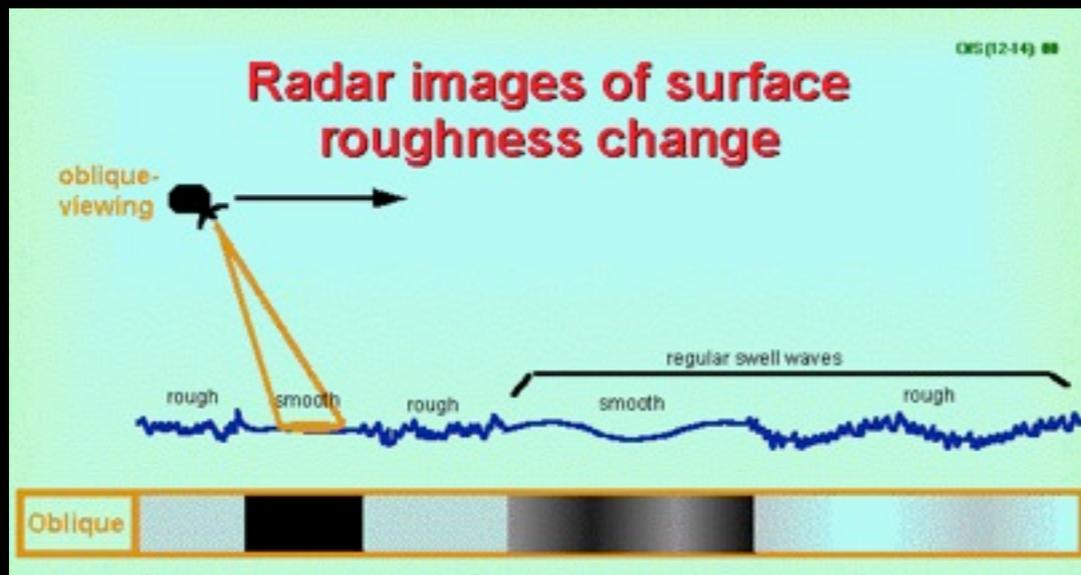


- Extensive land/ocean areas
- Large distances
- Few people
- Far north including arctic islands
- Fish, oil and gas
- Fragile environment
- Large shipping fleet
- Strategic geopolitical location

→ Tailormade for space applications

First operational oil spill detection from satellites

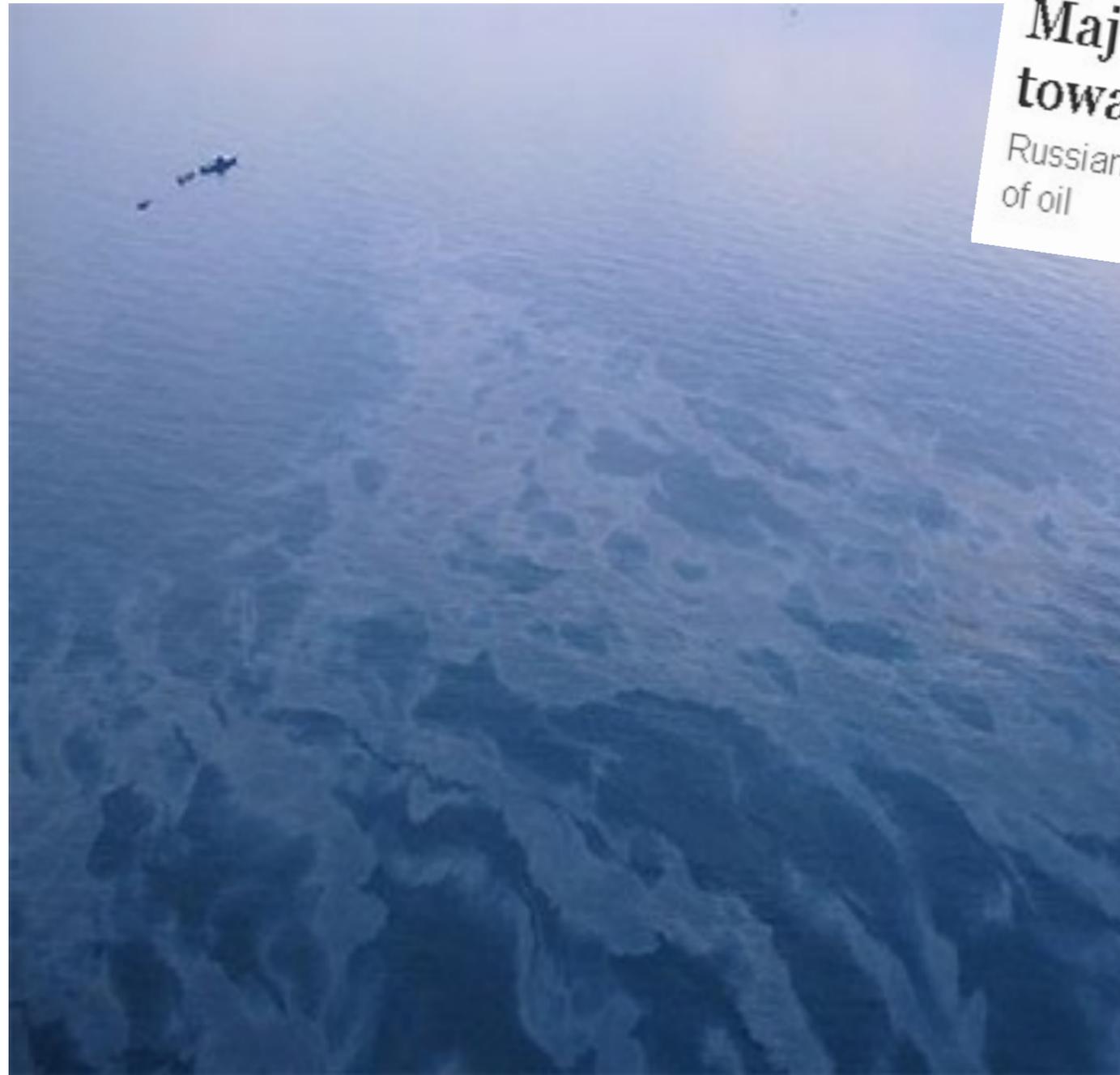
Radar satellites can “see” oil spills day and night and through clouds



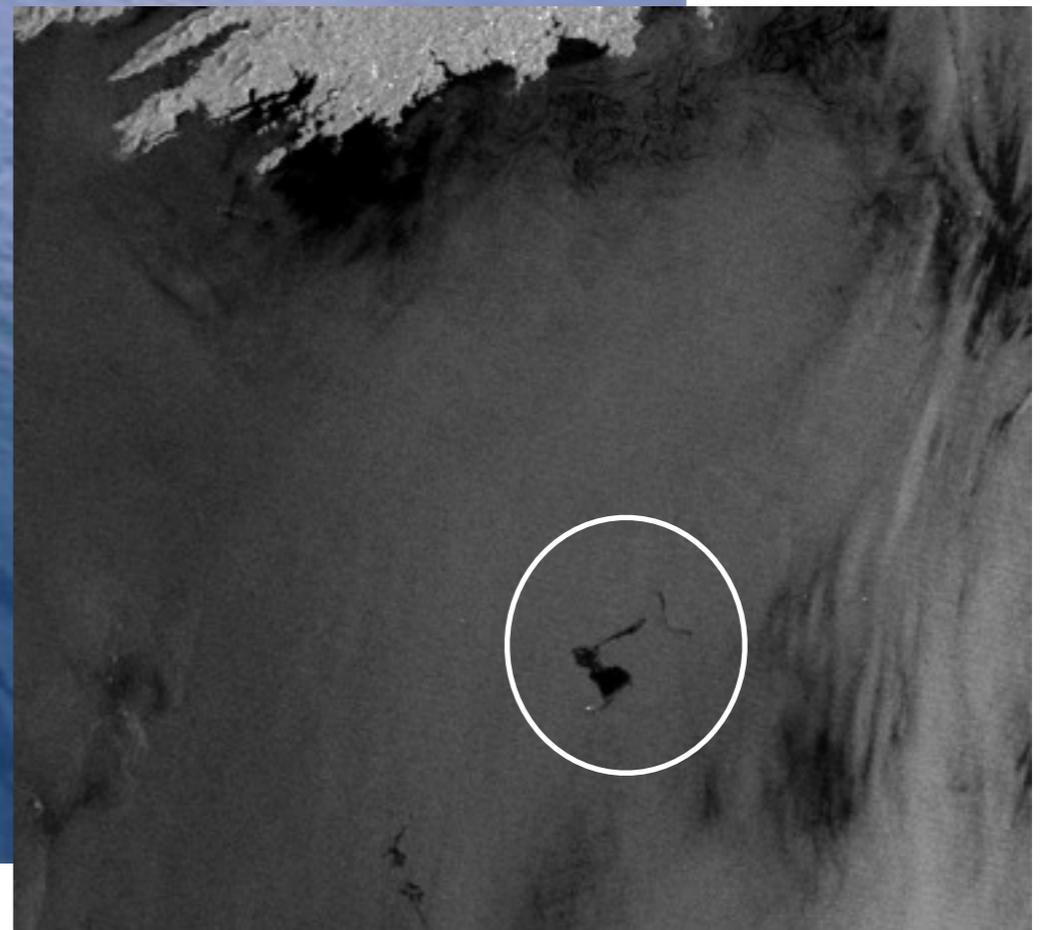
Oil spill from a Norwegian platform in 2004

EMSA CSN Detection Example

Oil spill detected by KSAT, alert through EMSA



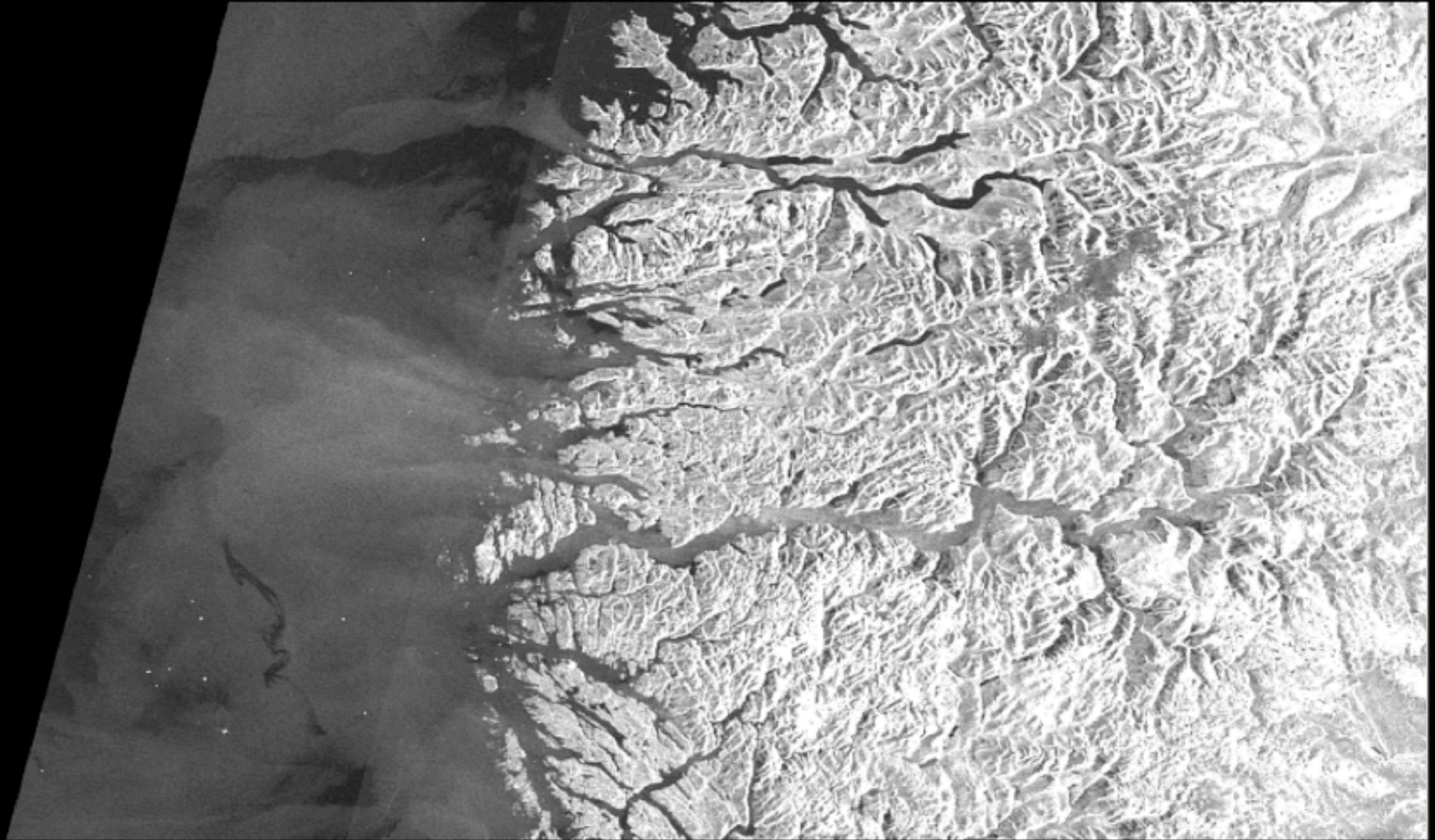
Major oil spill from tanker heads towards British Isles
Russian oil tanker off Irish coast thought to be source of 500 tonnes of oil



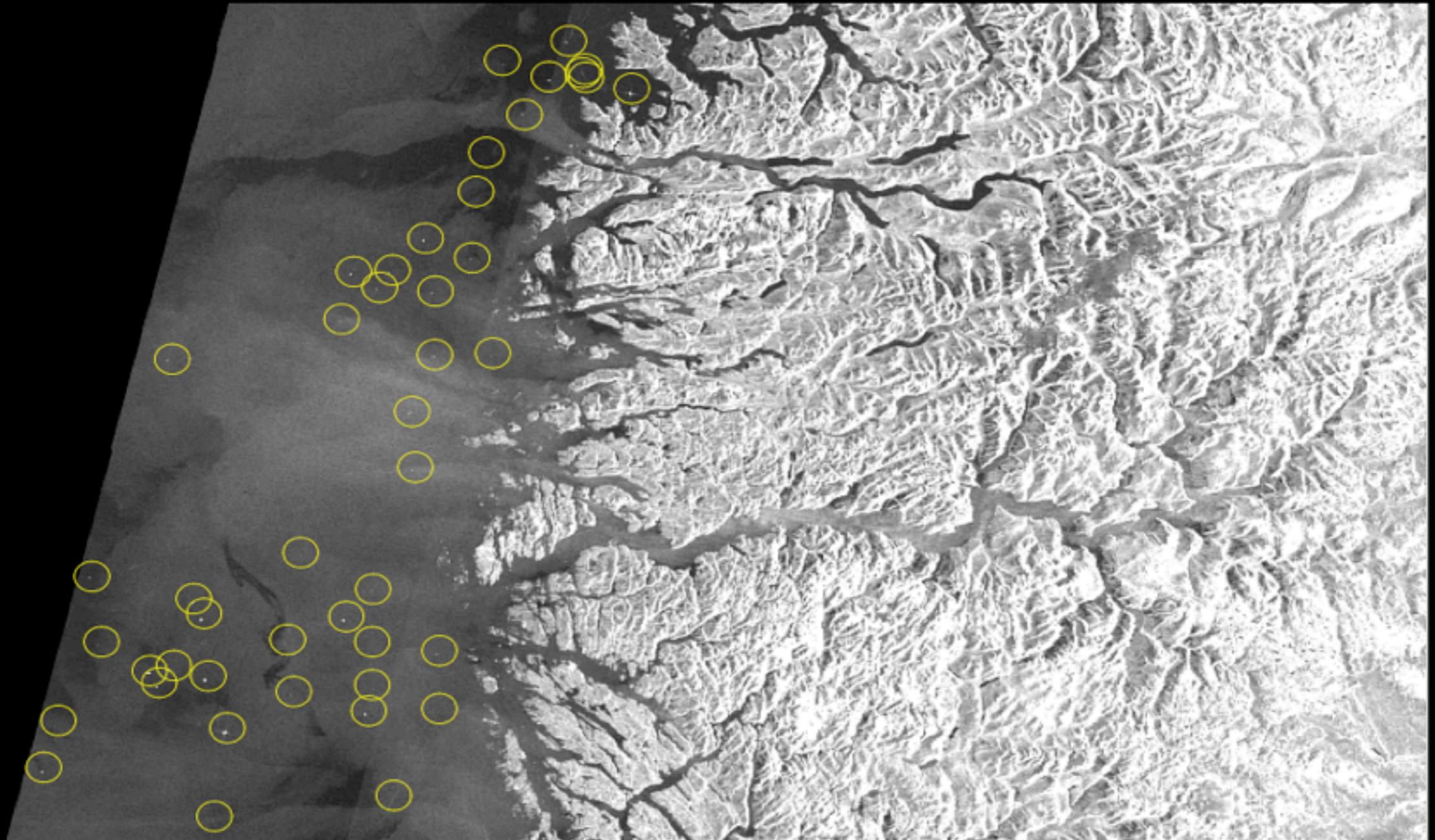
Oil spill detected by KSAT, alert through EMSA, Verified by Coastguard airplane. 14.02.2009

ESA2009/processed by KSAT

Surveillance of ship traffic

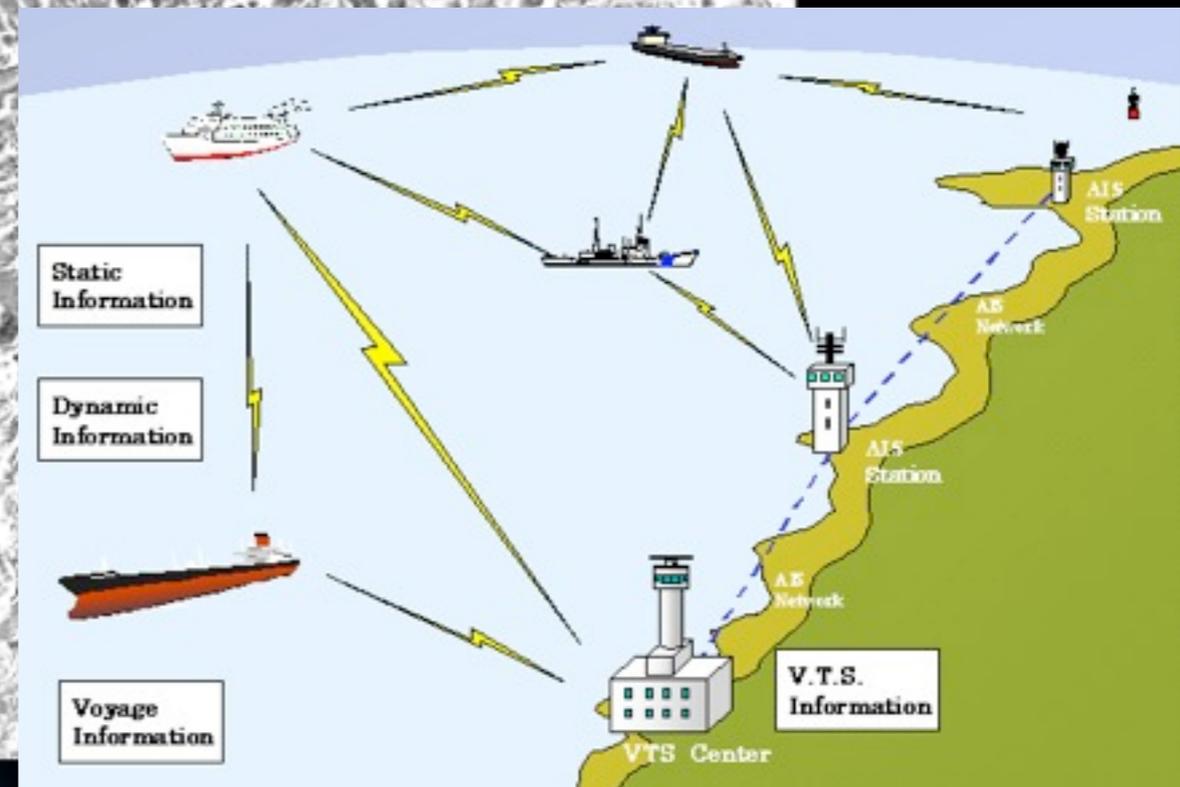
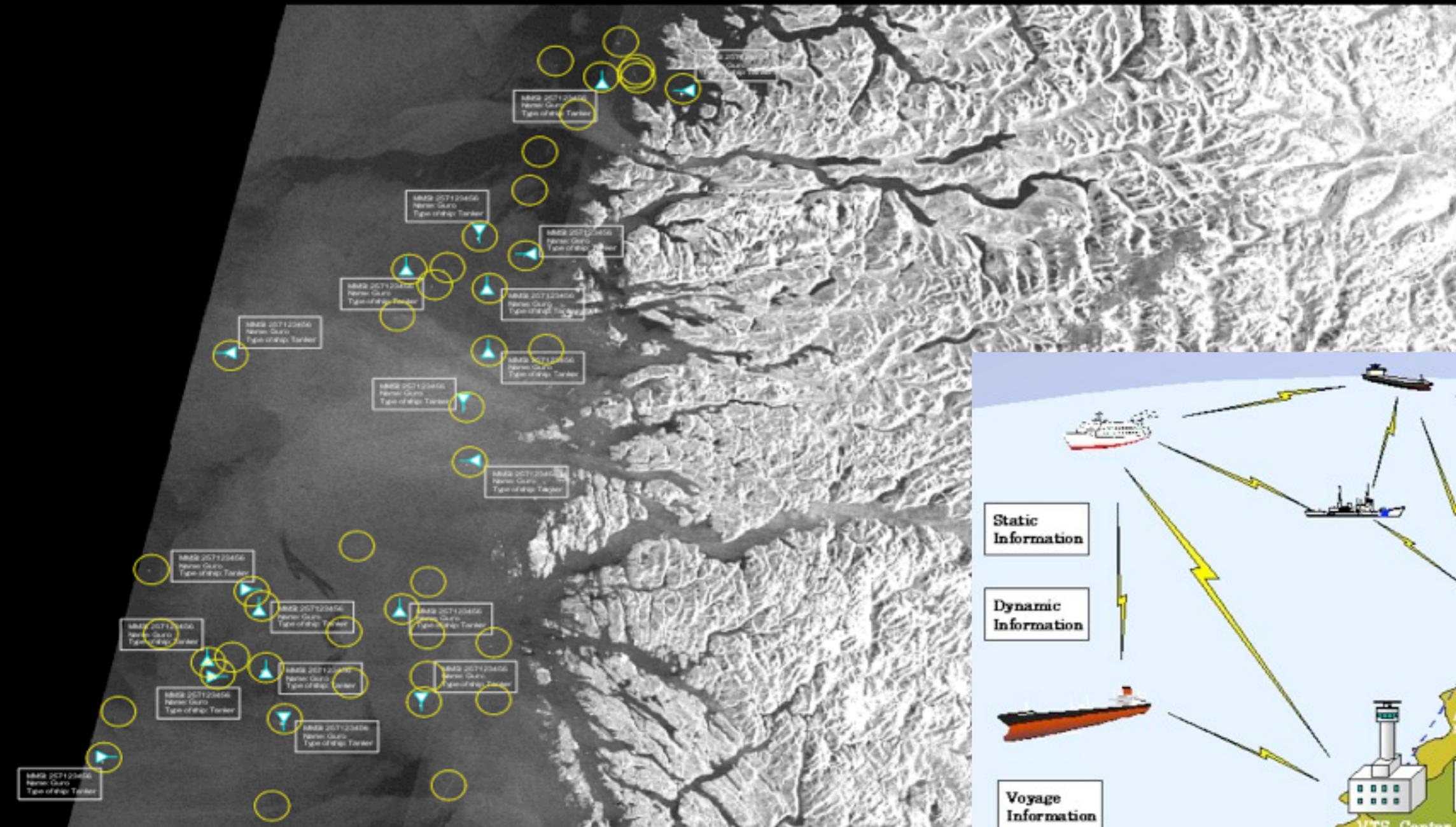


Detecting ships with RADARSAT

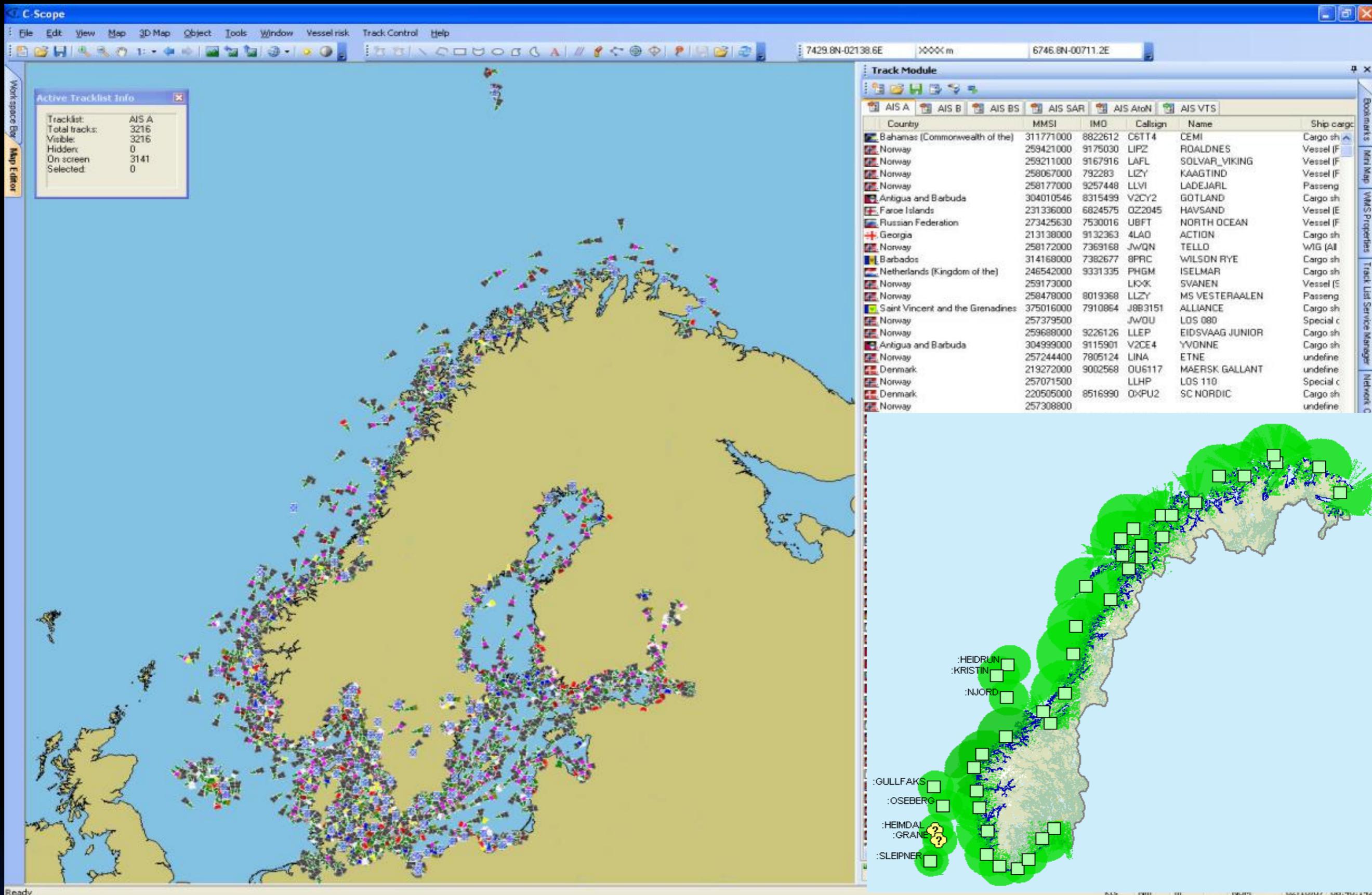


Identification of ships using AIS signals

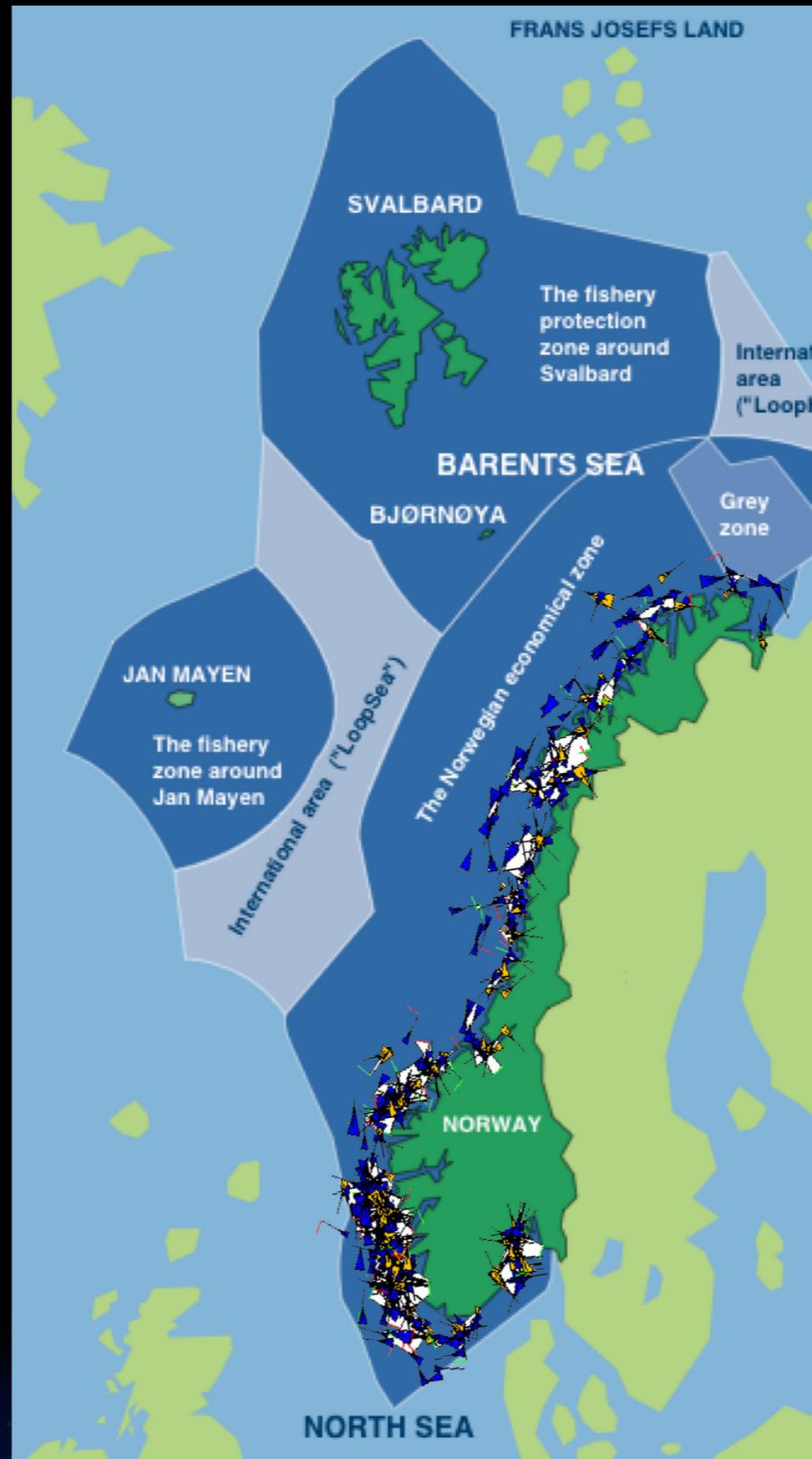
Automatic Identification System (AIS) system being mandatory for all maritime vessels greater than 300 gross tons or carrying 12 or more passengers.



Coast guards AIS monitoring system

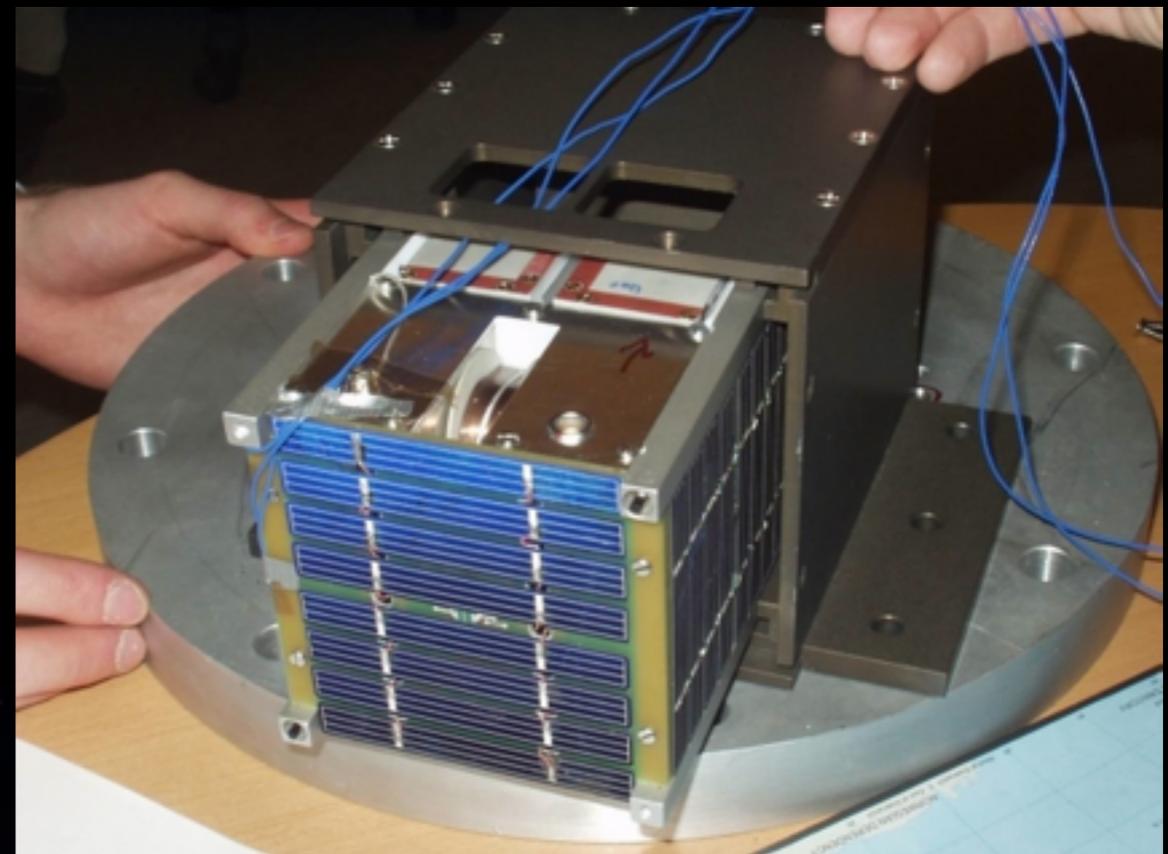
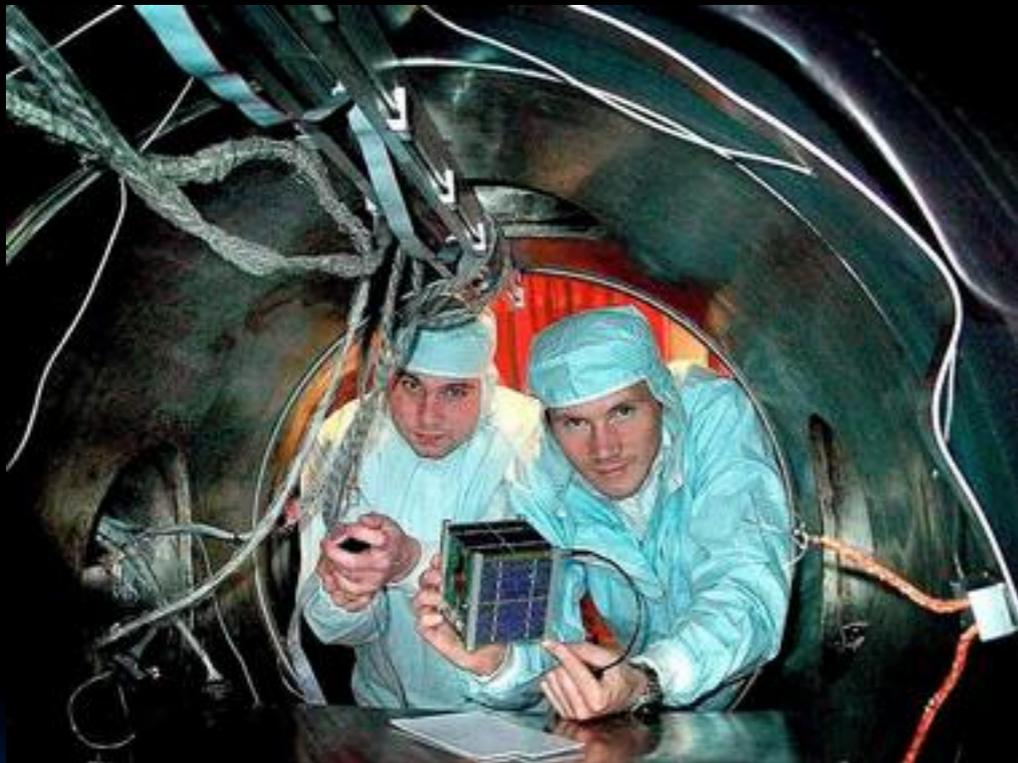


Coast guards monitoring system not enough!



The Rudolf-satellite (NCUBE)

Can AIS signals be received from space?
Can we track a reindeer?



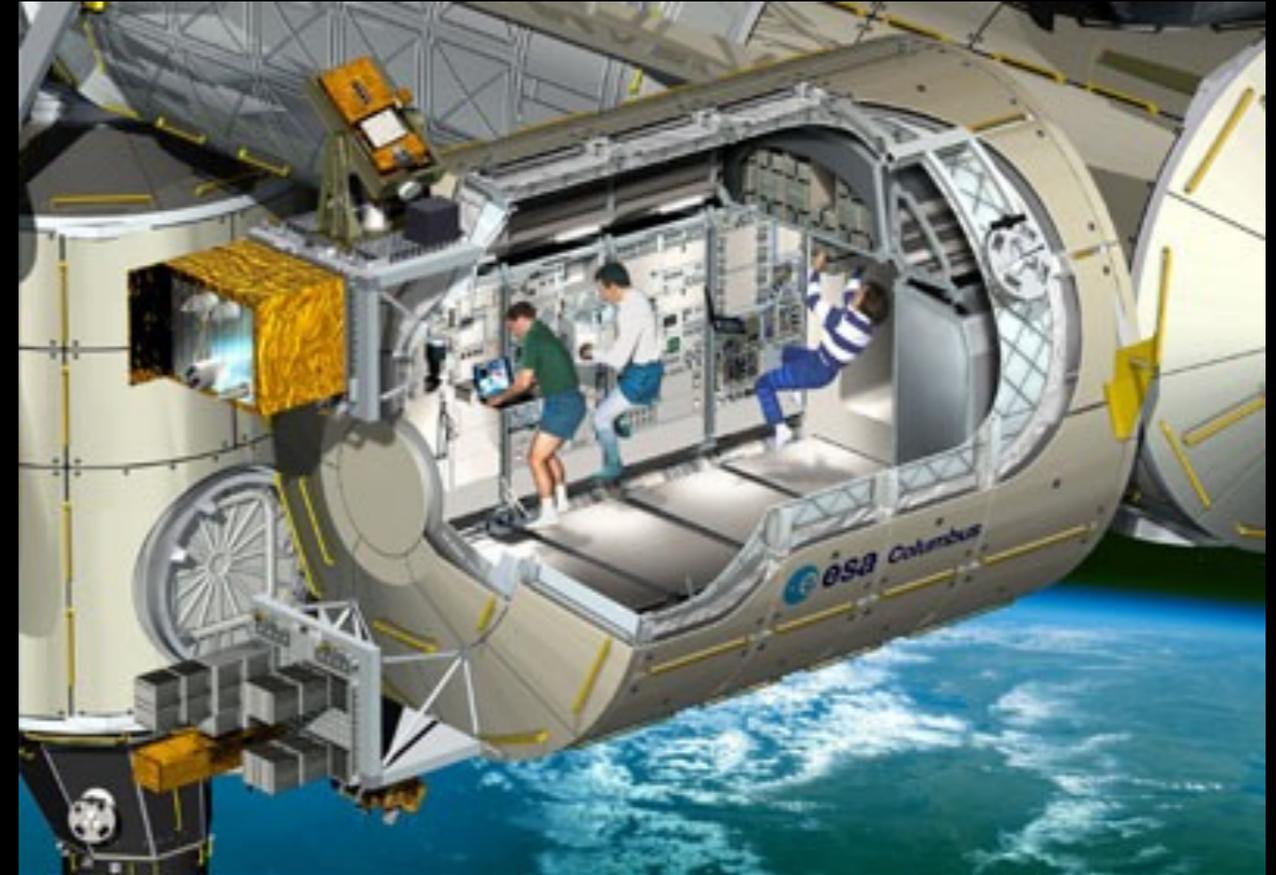
Norwegian AIS satellite - AISSat-1

- Total cost ca. 30 million NO (5 mill USD).
- Launched summer 2010 from India
- Norwegian Space Centre and includes funding from NHD.
- Developed by the Norwegian Defence Research Establishment (FFI/NDRE), with contribution from Kongsberg Defence & Aerospace og Kongsberg Seatex
- Satellite bus from University fo Toronto (CA)

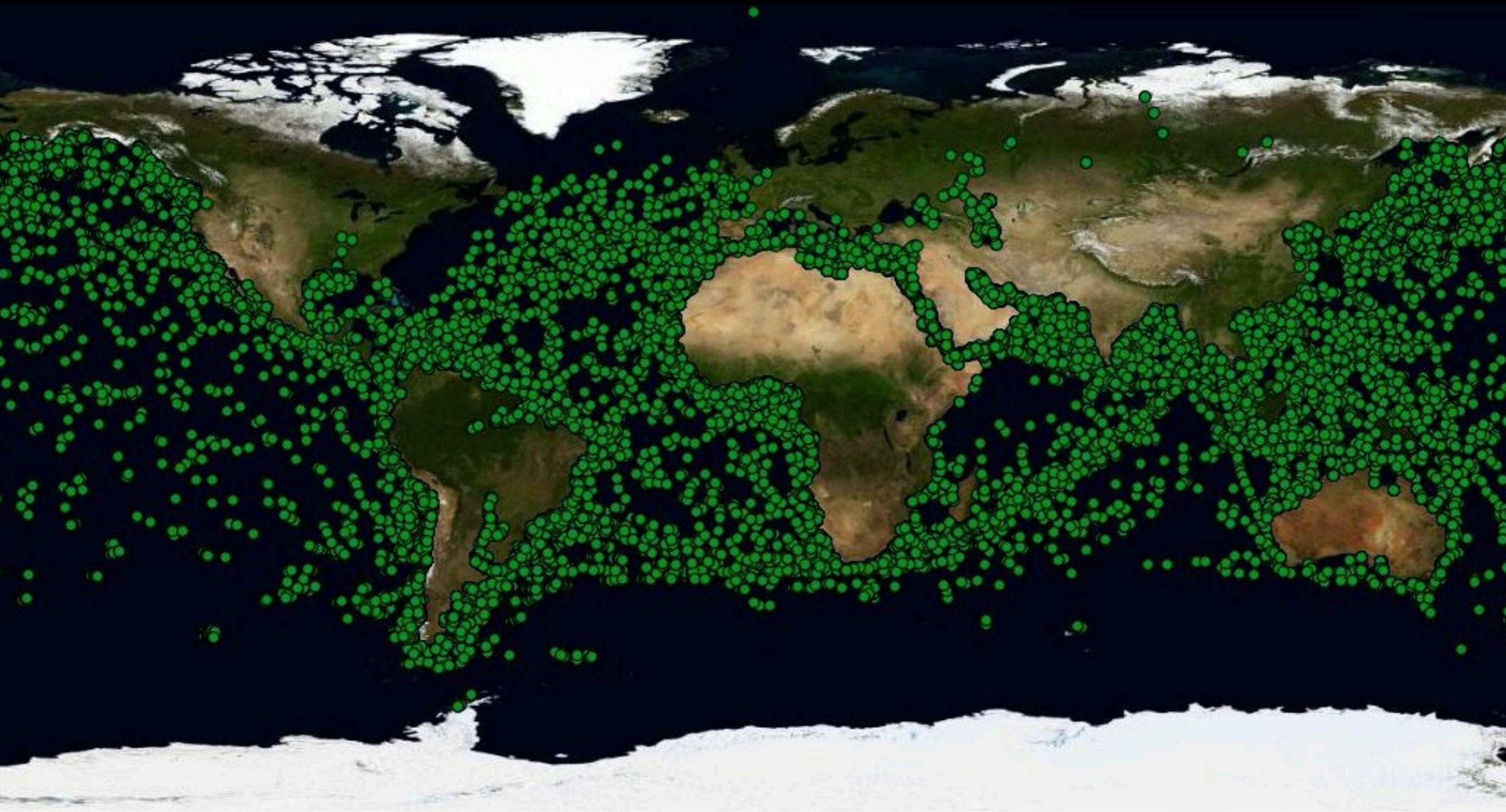


Test version of AISsat (NORAIS) was installed at ISS

- Launch: NORAIS was launched in September 2008, antenna late 2009
- Start of experiment: Early 2010
- Main goal: AIS signal tests in crowded areas

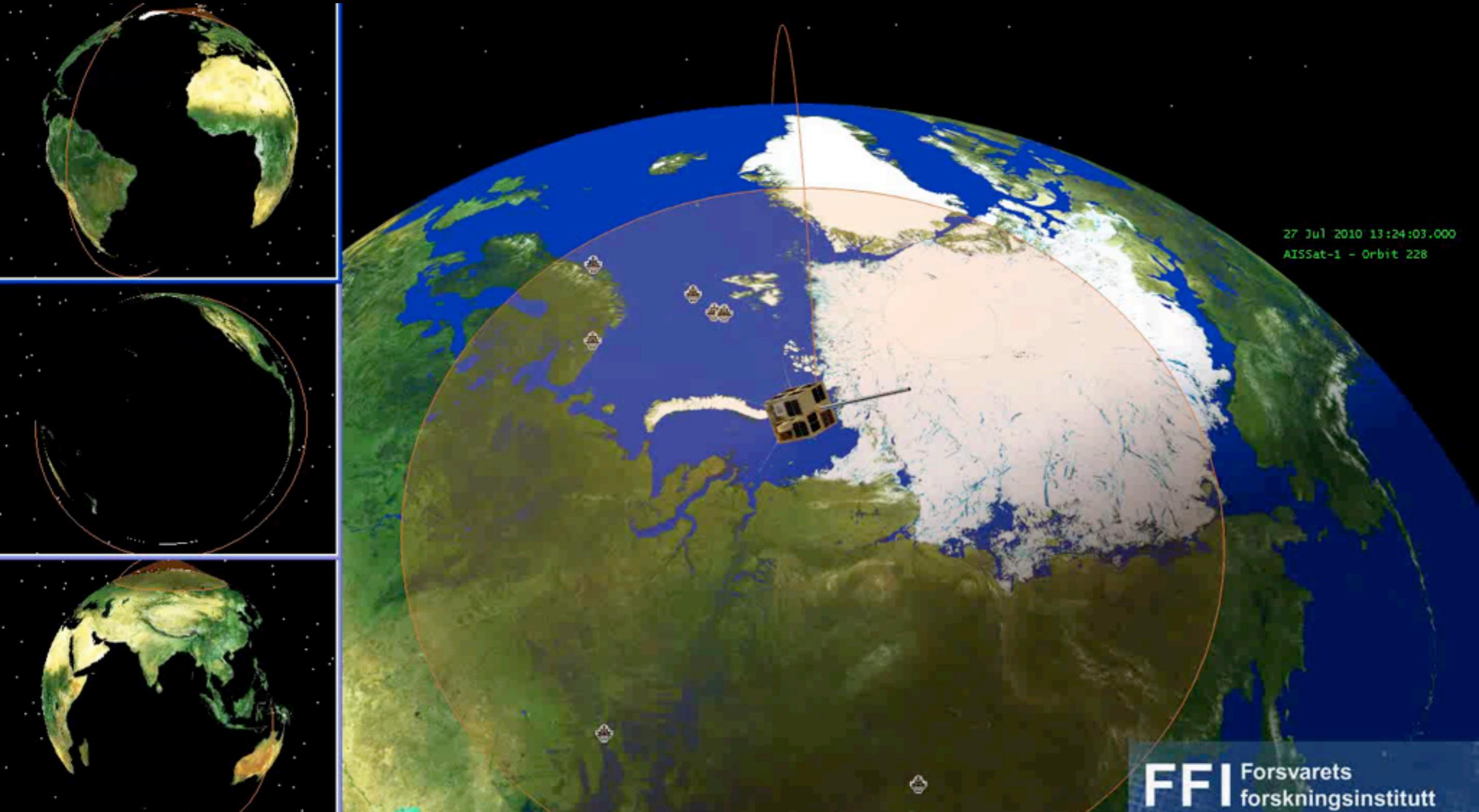


Ship traffic detected from ISS

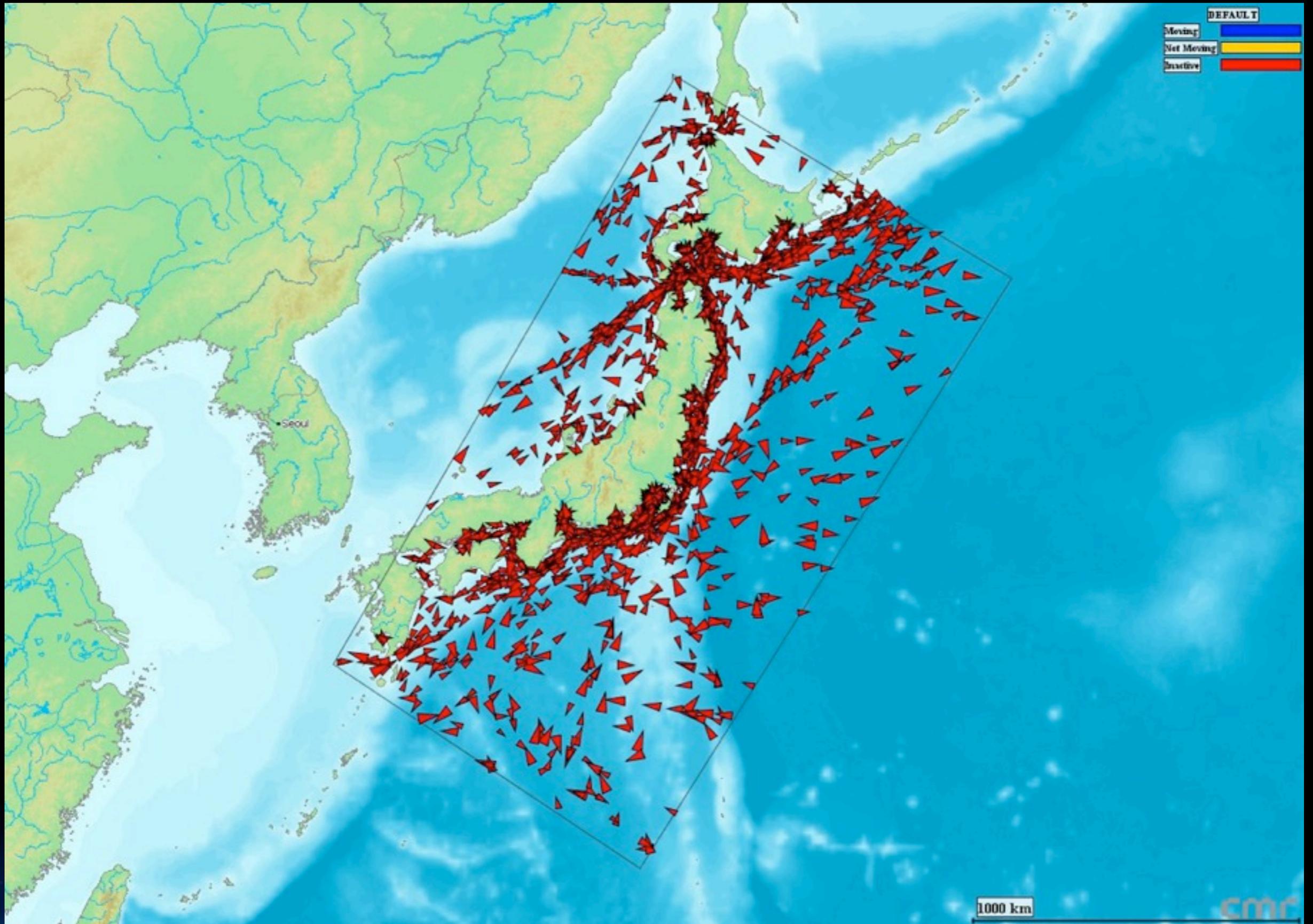


Norwegian AIS satellite - AISat-1

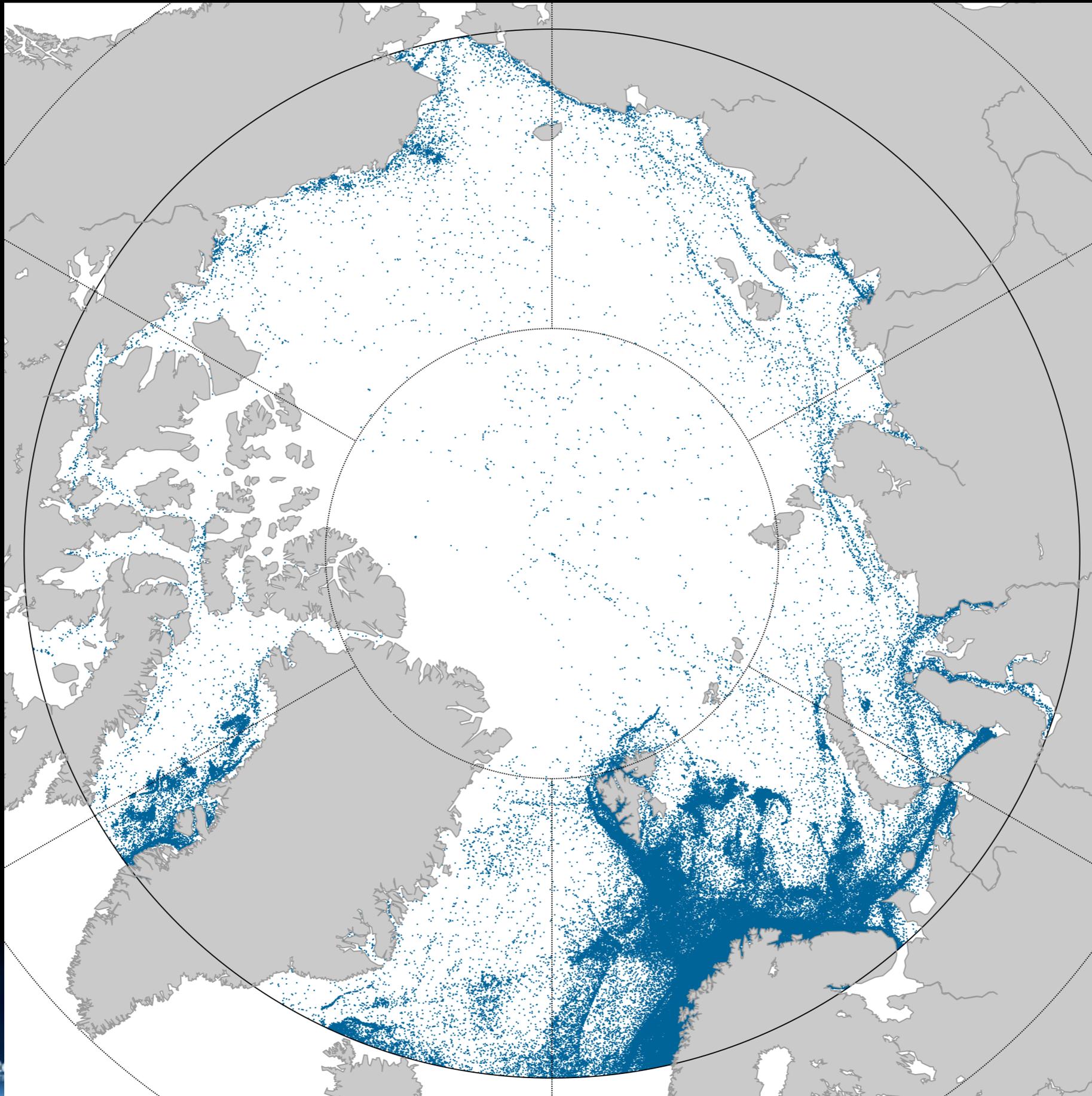
Today, the Norwegian Coastal Administration and other governmental institutions are using the data from AISat-1 for a variety of purposes, including monitoring fisheries, oil spills, and maritime traffic, to support anti-piracy operations along the coast of Africa, and other areas of interest to Norway.



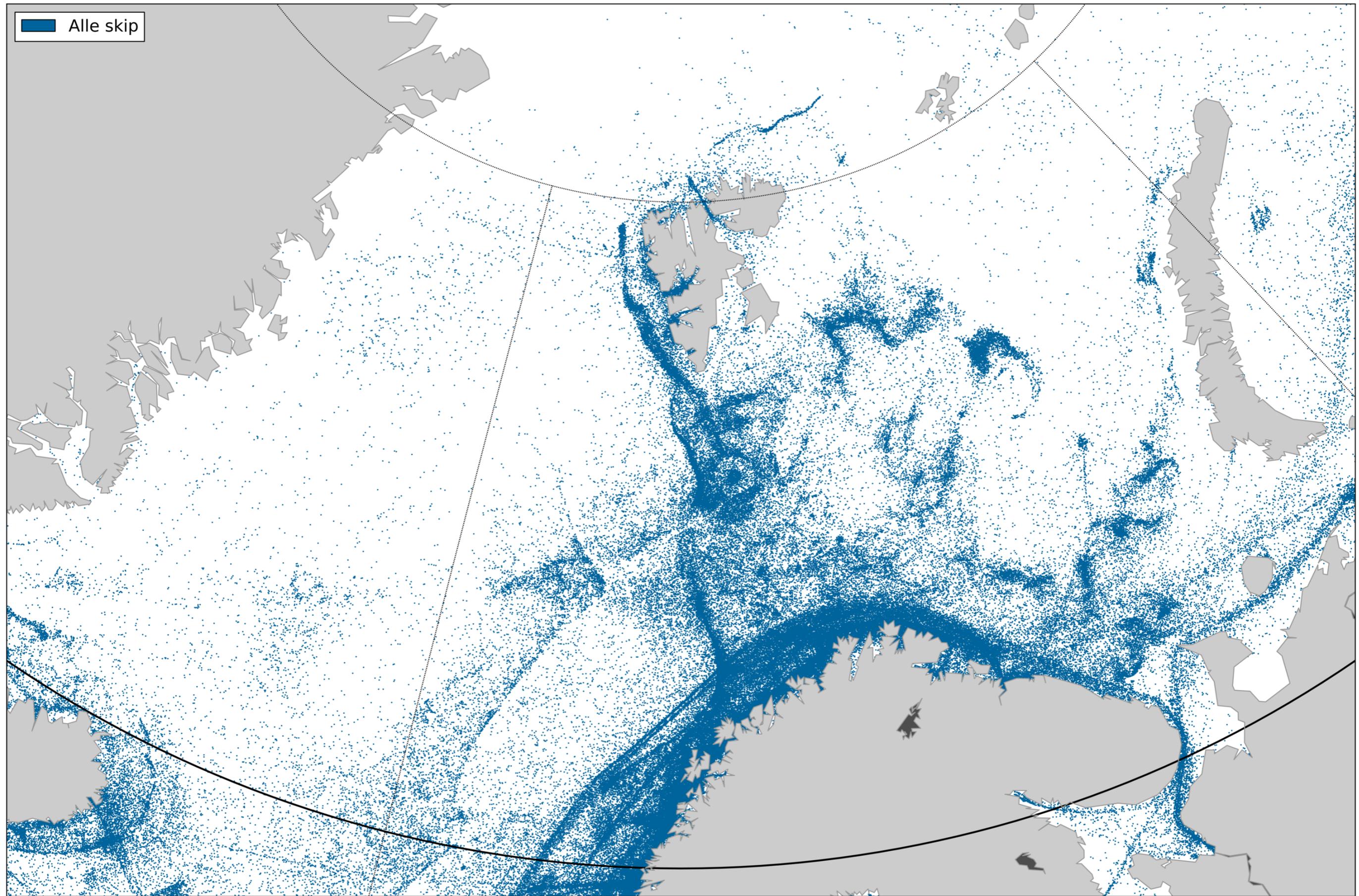
AisSat-I supported Japan



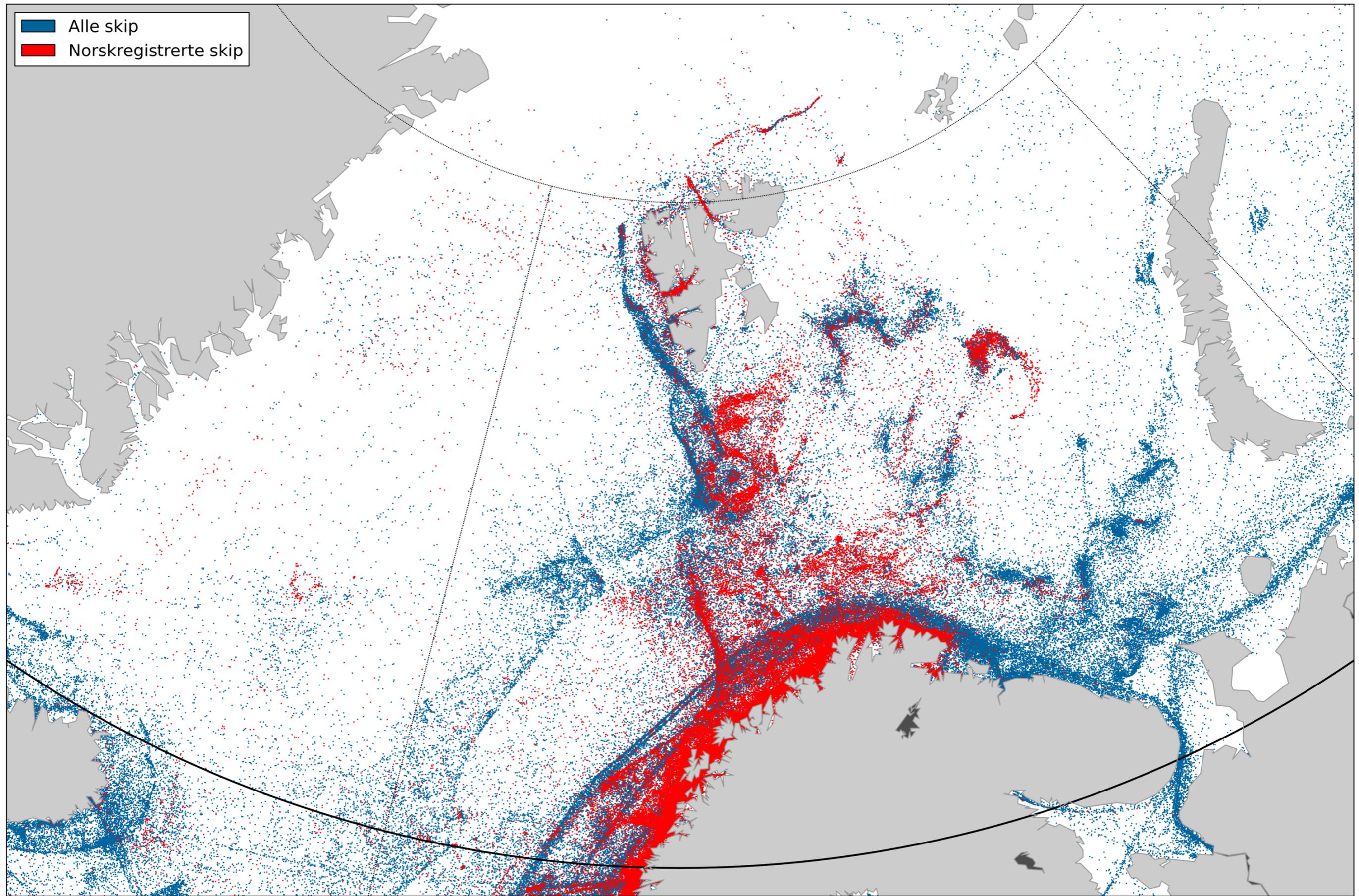
Ship traffic in the Arctic from September 2010 to September 2012



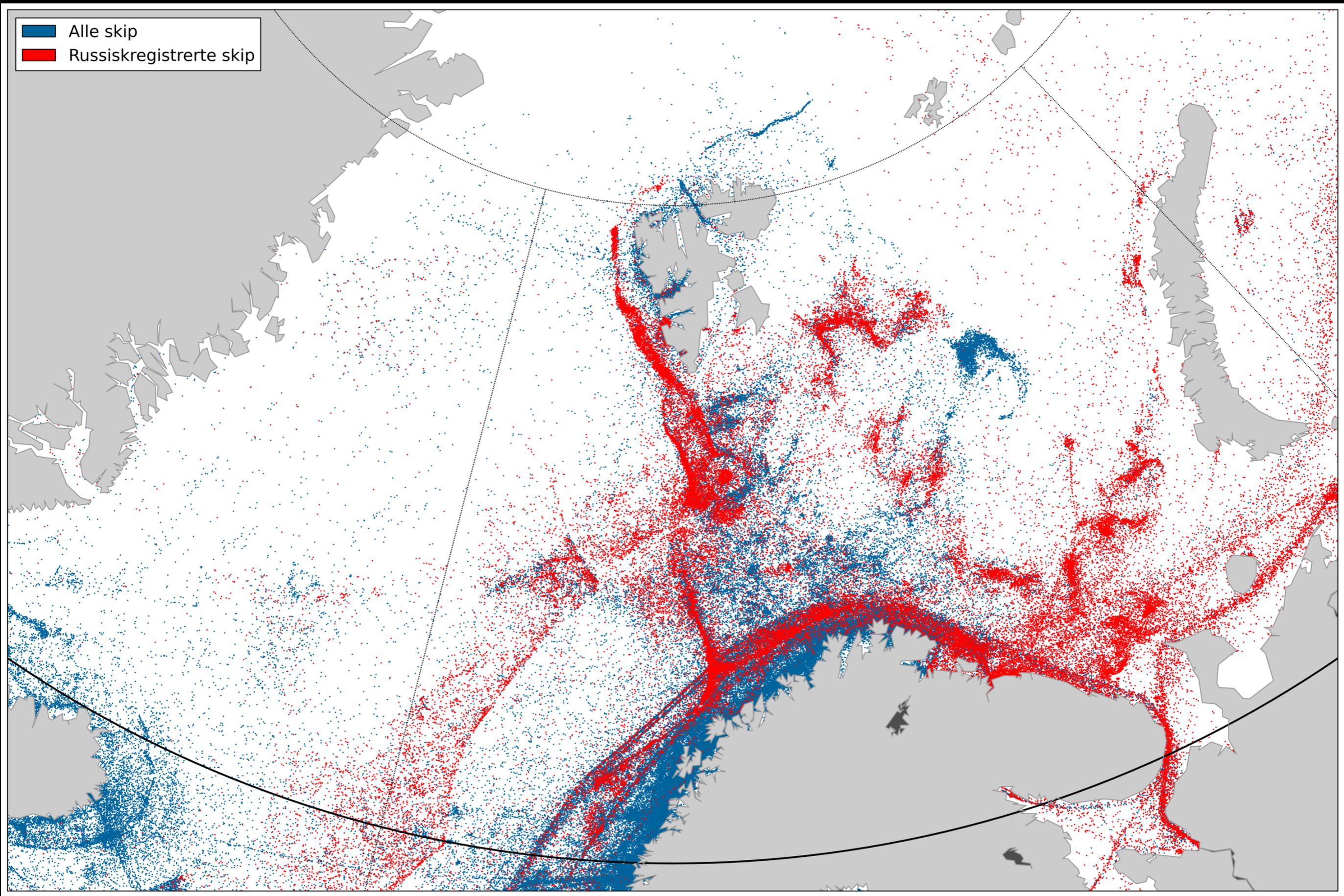
Alle skip



Alle skip
Norskregistrerte skip

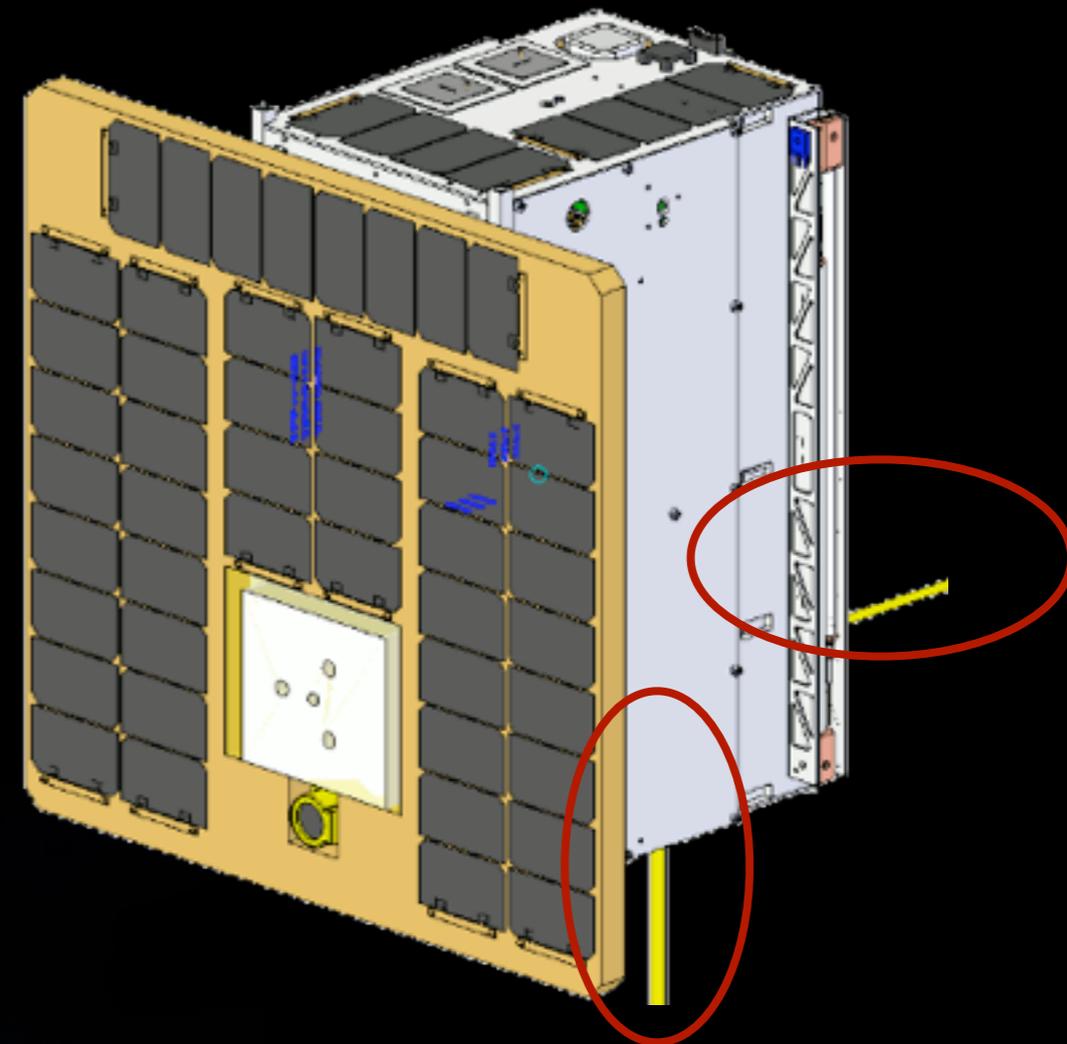


Alle skip
Russiskregistrerte skip



NORSAT-I AIS-system

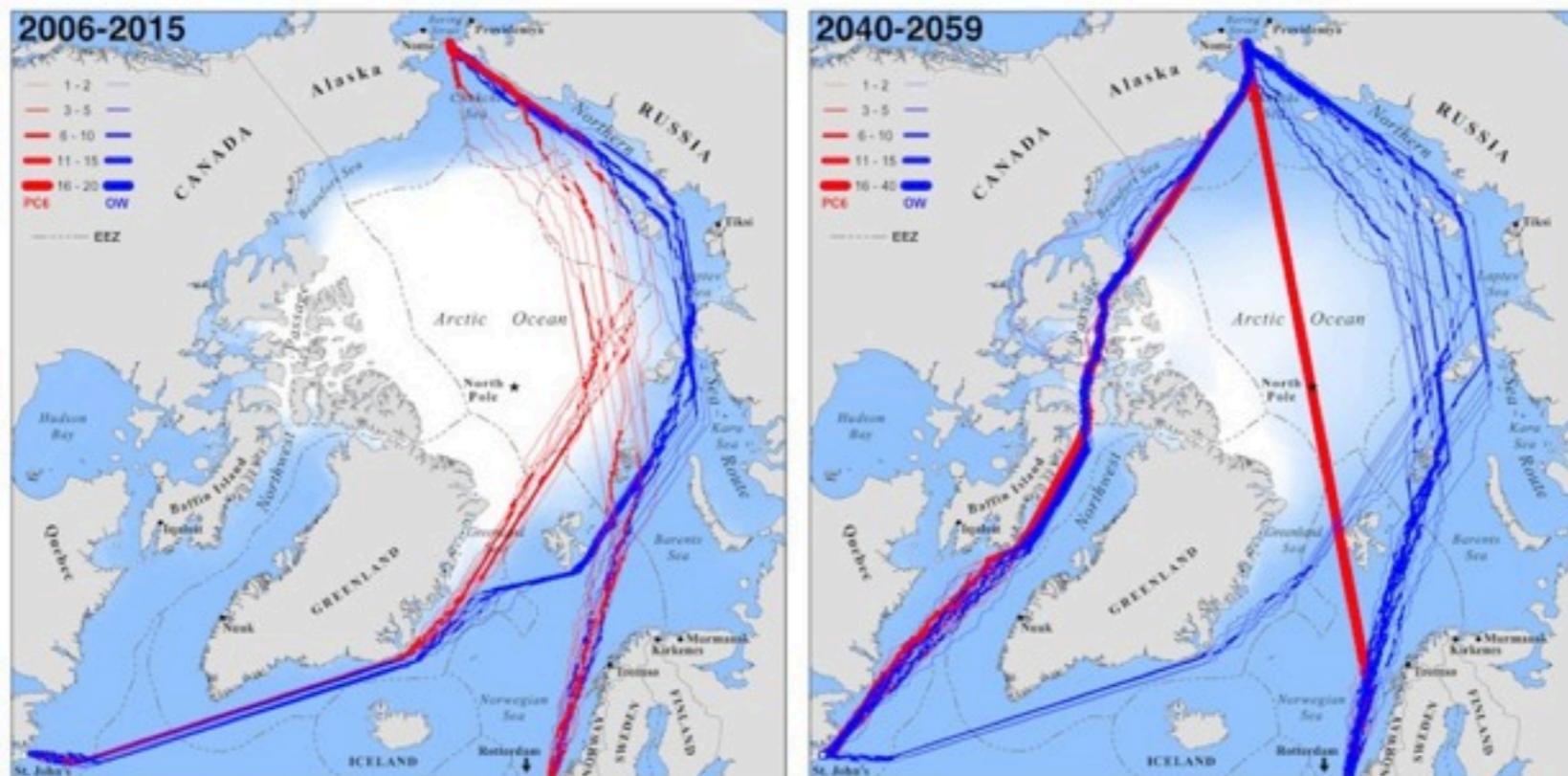
- Built by Kongsberg Seatex and The Norwegian Defence Establishment.
- New generation AIS-receiver with new algorithms
- The AIS payload is a dual antenna VHF receiver supporting four VHF channels each.
- Two antennas (to be deployed after launch).
- Operated by StatSat and data piped to the Norwegian Coastal Administration ++



NORSAT-I Sun-Climate

- Climate change in the Arctic important for future activities in the High North
- Where will the ice edge be in 50 years?

Melting the Arctic leads to increased shipping



Red lines indicate fastest available routes for moderately ice-hardened vessels (PC6)

Blue lines indicate fastest available routes for common open-water ships.

Credit: L.C. Smith and S.R. Stephenson, PNAS.

7

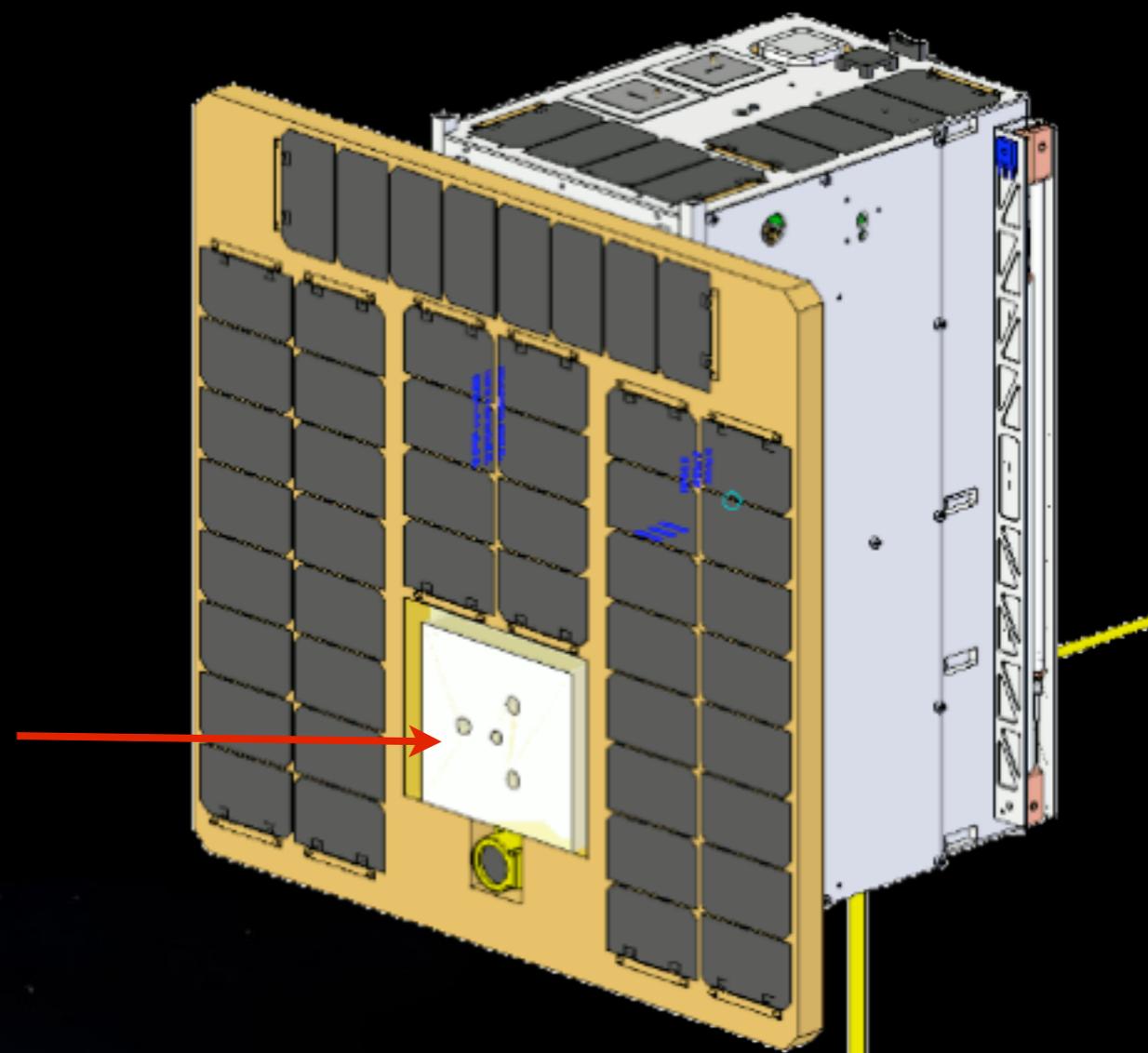
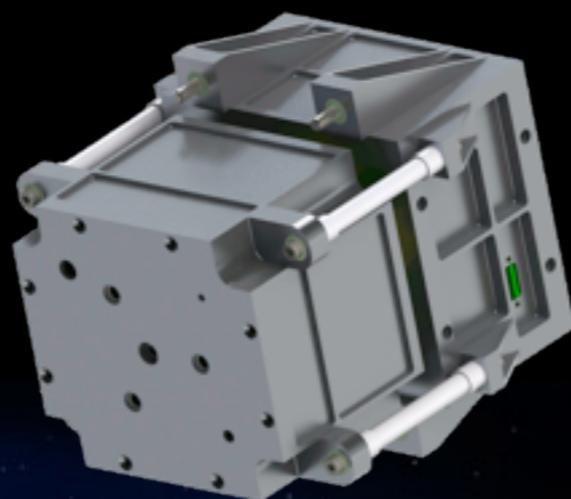
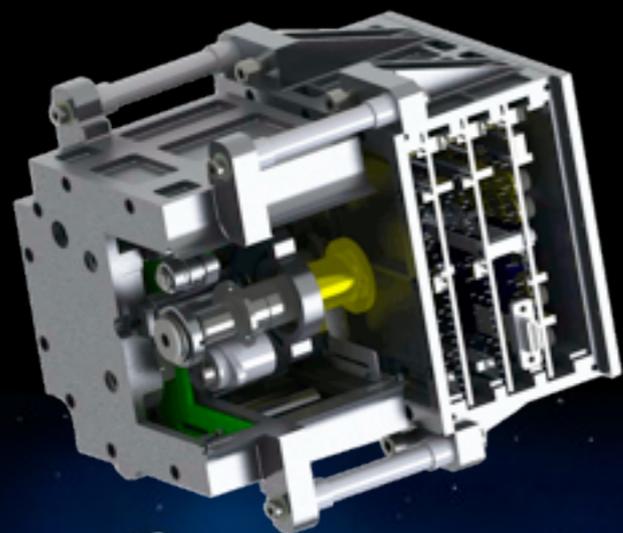
CLARA

Compact and Light-weight Absolut RAdiometer

The CLARA is based on a new design by PMOD/WRC which minimizes size and weight while improving the radiometric performance.

CLARA will be characterized in house in Davos and calibrated against the World Radiometric Reference in Davos as well as compared to the TRF (LASP).

CLARA specs	
Dimensions	114 x 141 x 155 mm ³
Mass	2.63 kg
Power consumption	5.6 W
Measuring cadence	30 s



CLARA Science Goals

1. Radiometry

- Confirm WRR-to-SI scale offset found with PMO6/PREMOS
- Confirm design improvements (optical/thermal and weight reduction)
- Meet or exceed highest currently achievable uncertainty level (by PMO6/PREMOS)

2. Climate Research

- Extend the TSI data record for solar atmosphere and climate modellers (solar variability, global warming)

3. Helioseismology

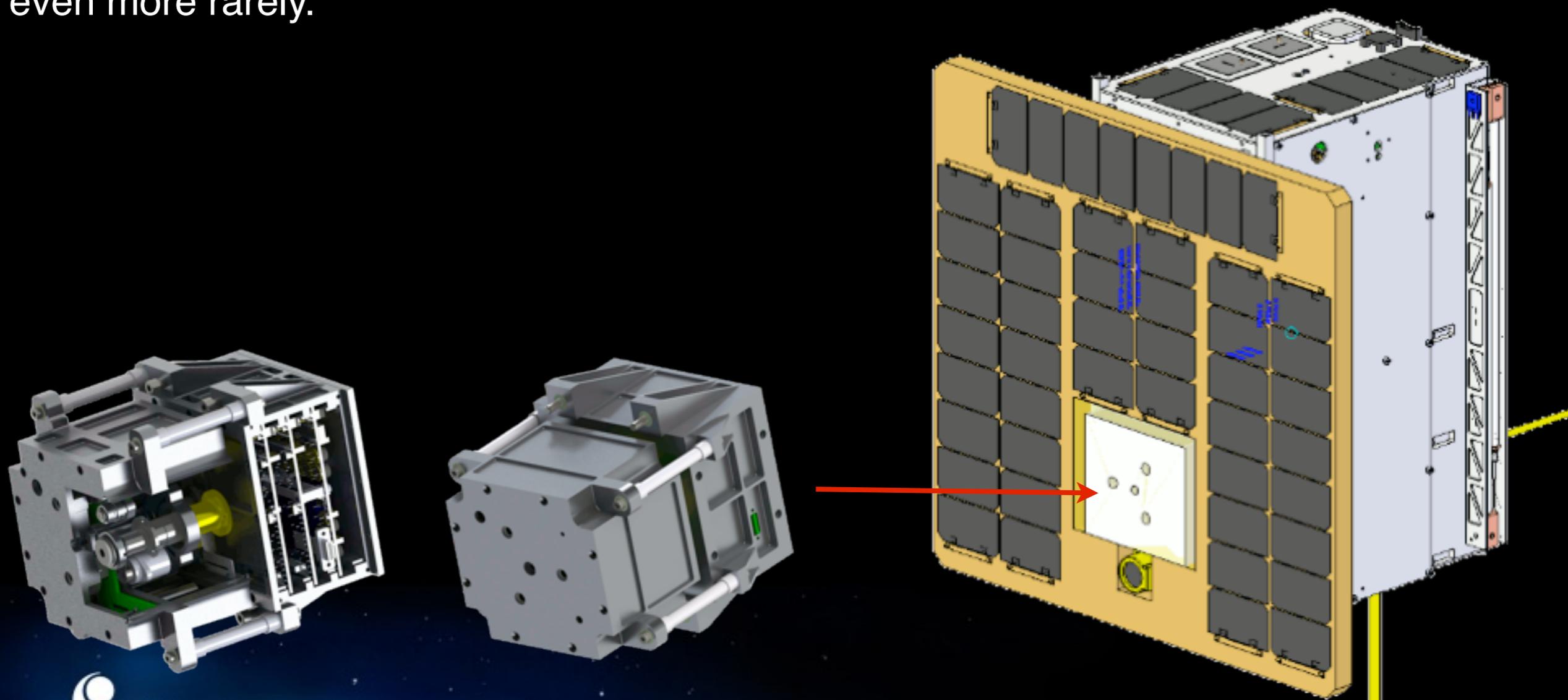
- Assess the acoustic energy carried into the solar atmosphere by high frequency sound waves (above the acoustic cut-off frequency)

CLARA

Compact and Light-weight Absolut RAdiometer

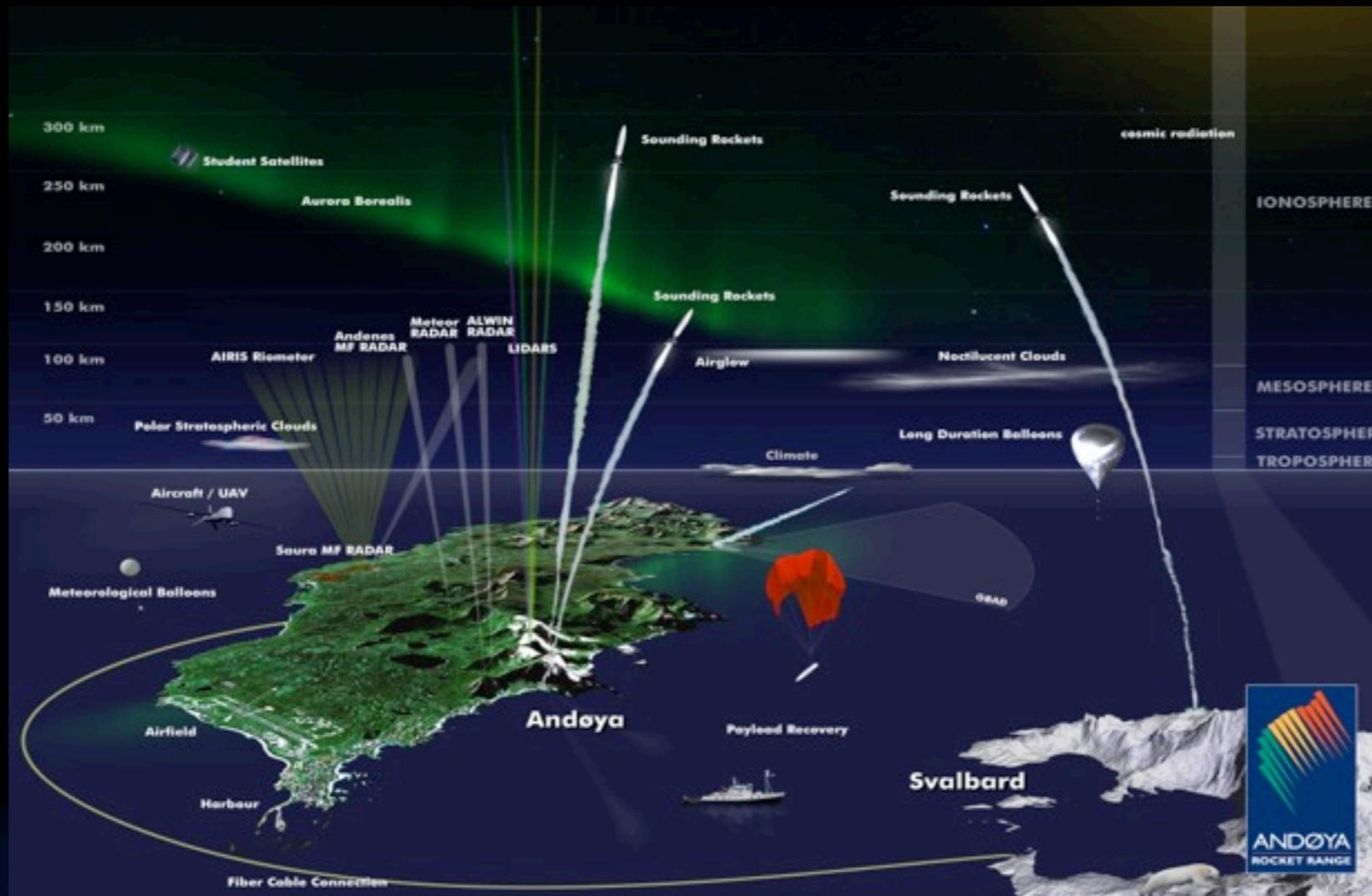
During daylight the CLARA will measure the TSI continuously every 30 seconds with the primary cavity.

Once per month or so, two cavities will simultaneously measure the TSI during one orbit to assess the degradation of the primary cavity. The third cavity will be exposed even more rarely.



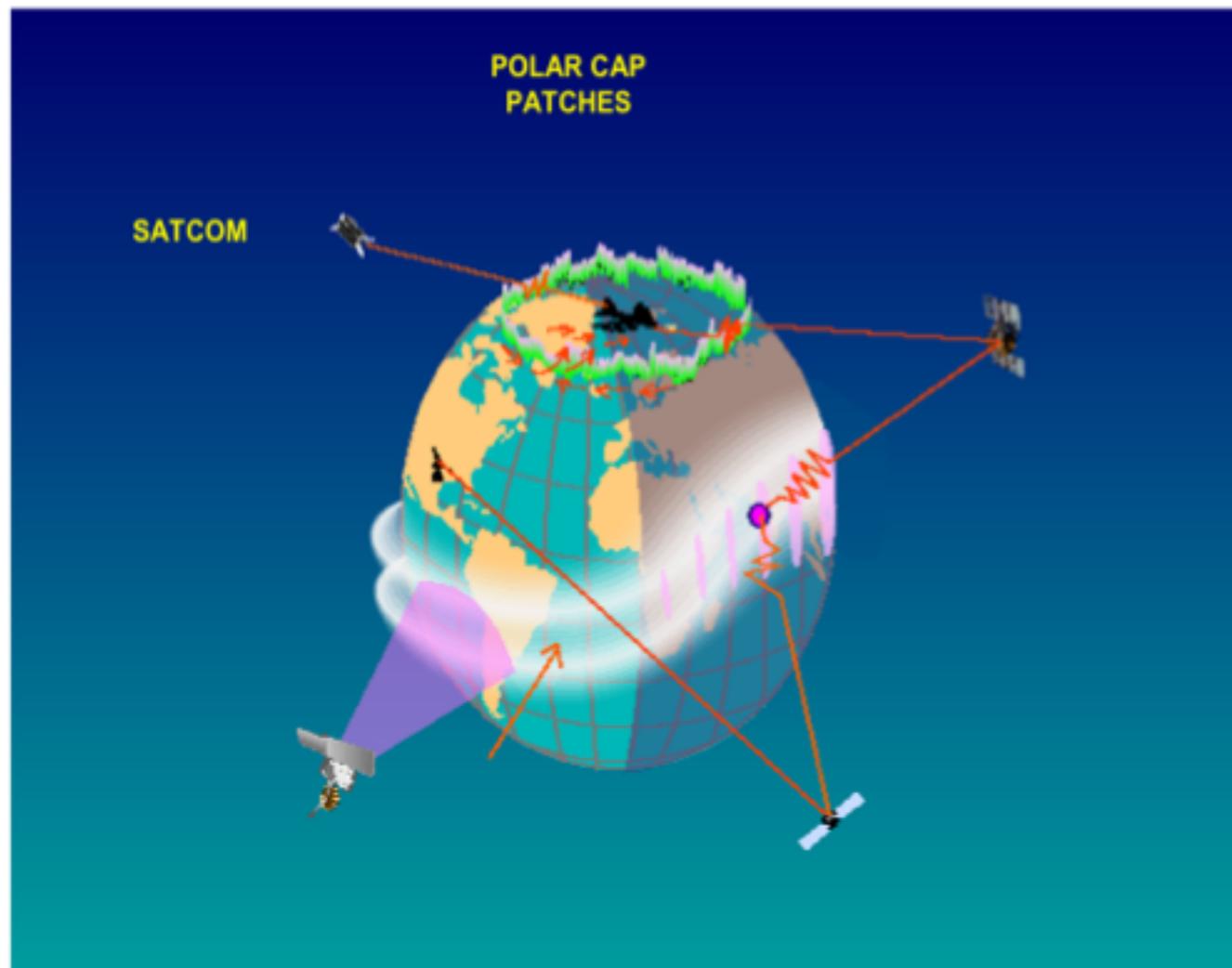
NORSAT-I Space Weather

- Norway has long traditions in Sun-Earth connection/SW science
- Large number of ground based instrumentation
- Increased activities in the Arctic make Space Weather knowledge important



Objectives NORSAT-1 NLP

Global Satcom Outage Regions



- Global survey of global outage regions
- Provide scientific data on plasma turbulence
- Key to develop scintillation forecasts

4-Needle Langmuir Probe (4-NLP)

- A new concept Langmuir probe system for ionosphere space weather monitoring
- Miniaturized system consisting of 4 x cylindrical probes of Length: 25 mm and Diameter: 0.51 mm
- Key parameters: Absolute electron density & platform potential (up to 10 kHz sampling rate).

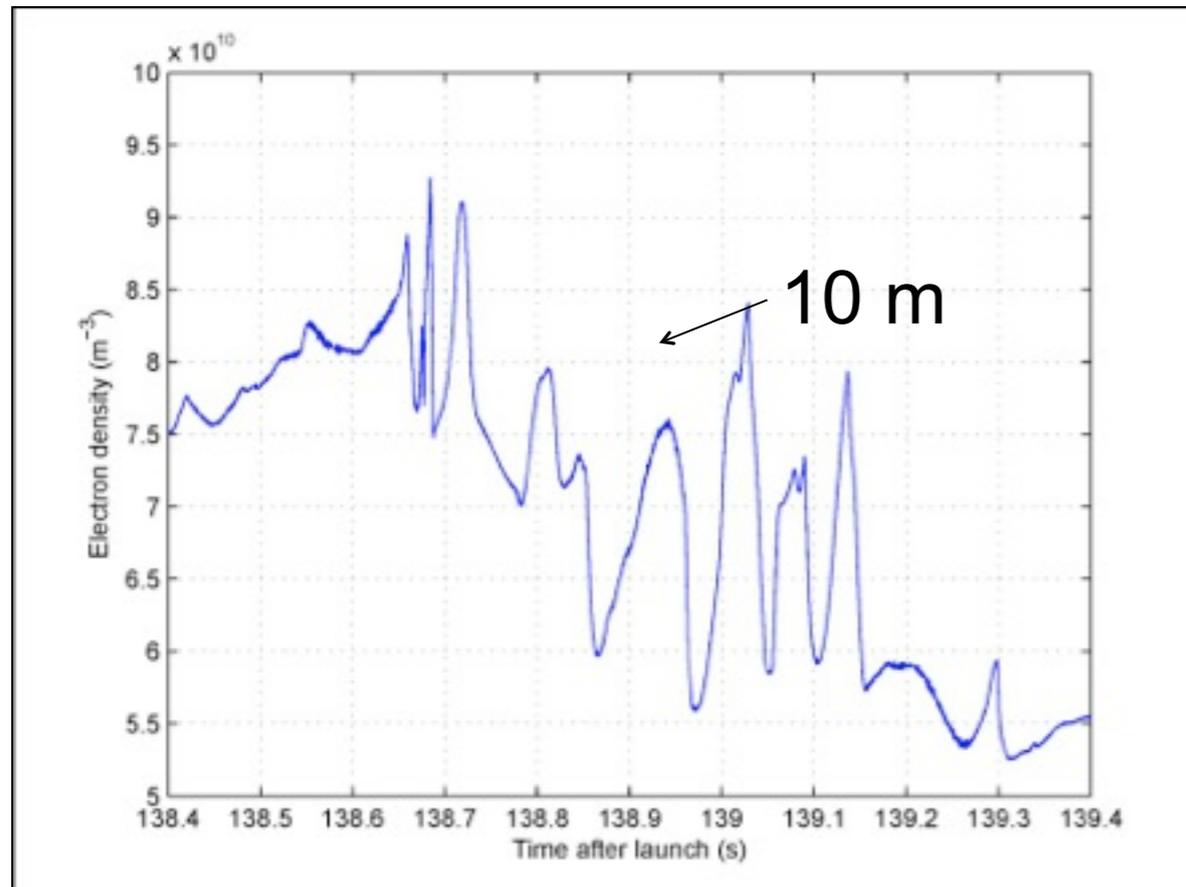
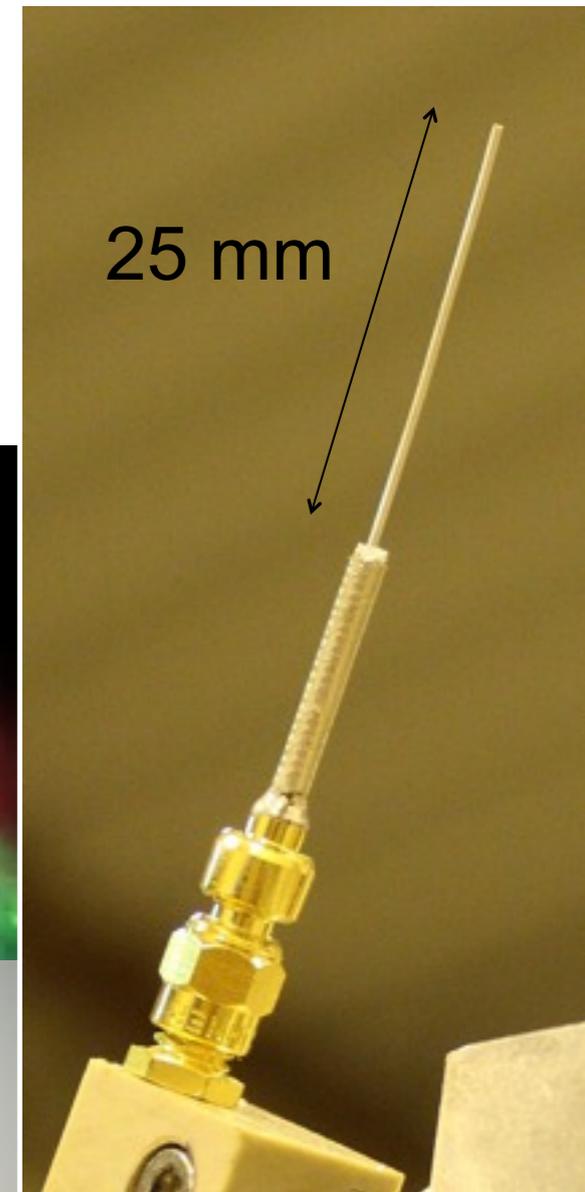


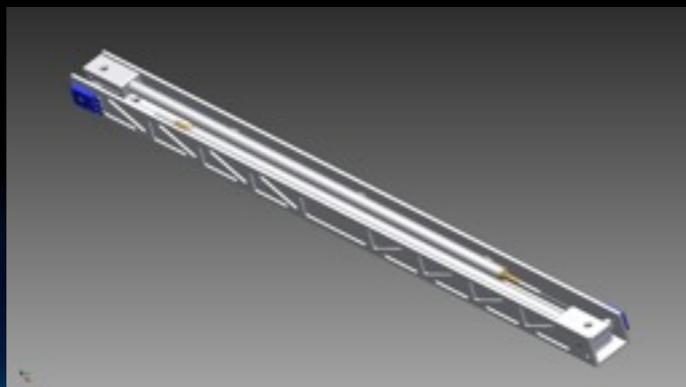
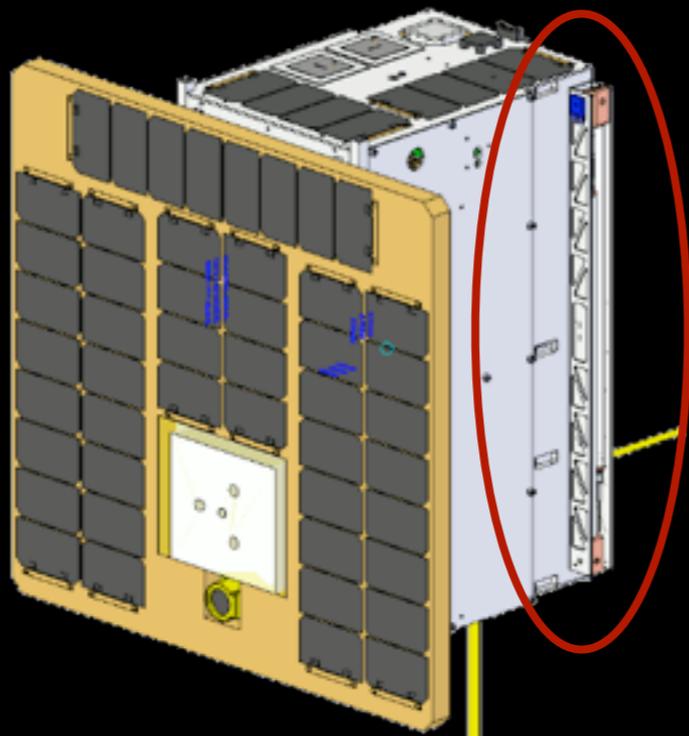
Fig: 1s worth of ICI-2 rocket data revealed decameter electron density structures (2008)



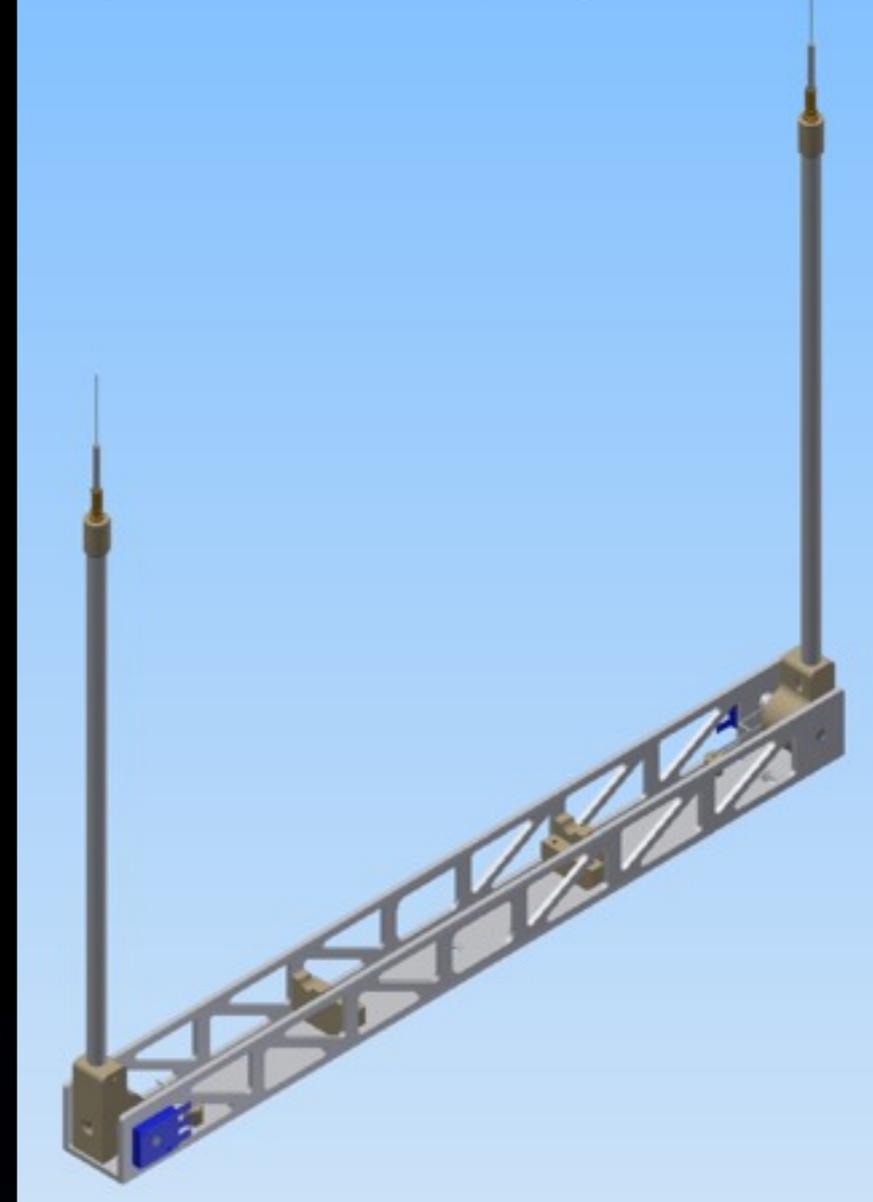
NORSAT-1 NLP

- Built by University of Oslo (PI: Jøran Moen) and EIDEL

The Langmuir Probe instrument consists of 4 individual probes each mounted at the end of a boom (4 booms total). The instrument will measure electron density and the platform floating potential along the orbit.



2 x penals = 4 NLP (650g; <1W ; kHz)

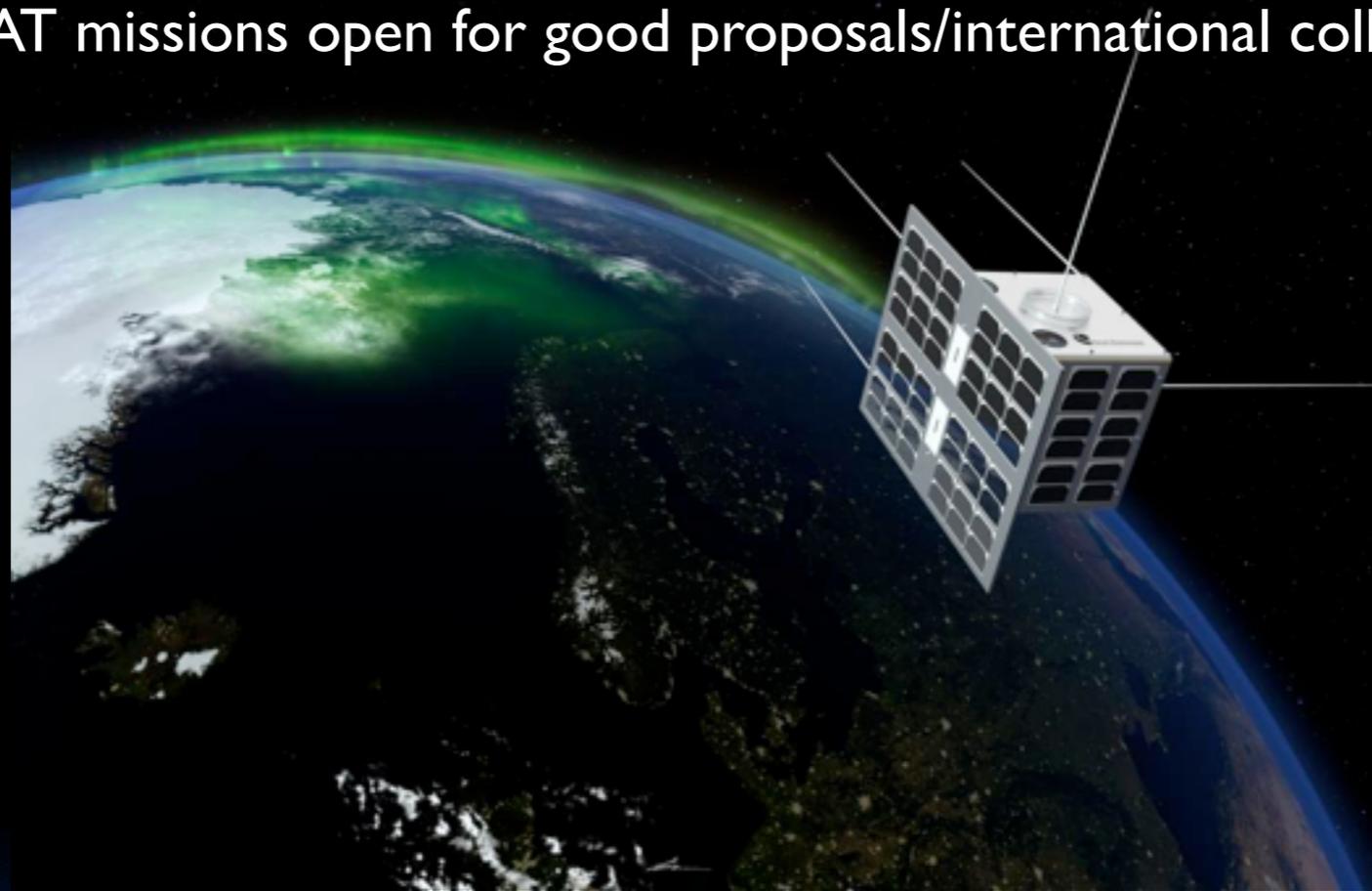


NORSAT-I Operation

- The platform shall have an attitude determination and control (ADC) capability that will facilitate full 3D pointing control (Pointing withing 0.5 degree)
- The CLARA instrument determines the orientation/pointing of the satellite when the satellite is illuminated by the sun.
- During eclipse the CLARA will normally point to the Earth to stay in thermal balance
- In eclipse the satellite may be oriented to achieve optimal performance of the AIS receiver, the Langmuir Probe or to perform calibration of the CLARA instrument.

Summary

- NORSAT provides a fast-track possibility to test new technologies and to extend important time series such as TSI.
- Provides an important ship traffic monitoring system.
- Will extend the TSI time series
- Low cost mission
- Future NORSAT missions open for good proposals/international collaboration



NORSAT-1 Ship Traffic

- Norway has long tradition as an international shipping nation
- Increased activities in the Arctic make ship detection very important.
- The AIS payload is a VHF receiver designed to acquire messages from the maritime AIS system. An improved version from the AisSat-1.

