

Requirements for infrastructure in Polar Research

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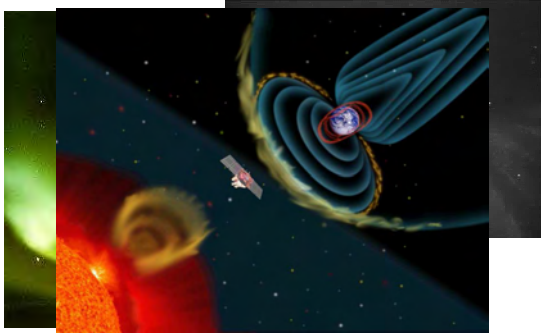
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The importance of polar research is immense because

- Unique conditions for study of planetary scale mechanisms
 - Magnetosphere, solar phenomenae
- Crucial in understanding of global change
 - Kitchens for processes of profound consequences for climatic change
- Challenges in management of natural resources
 - Minerals, biological
- Areas of great international strategic significance

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Unique observation conditions



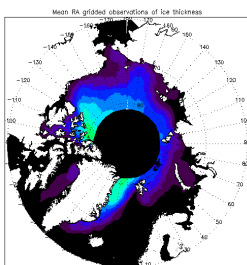
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Arctic ocean circulation



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Cryosat (2005) Arctic ice thickness



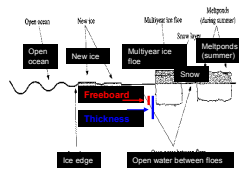
Arctic ice thickness map, satellite-borne radar altimeter

Challenges:

- Measure absolute ice thickness
- Change of ice thickness
- Meteorological predictions

Applications:

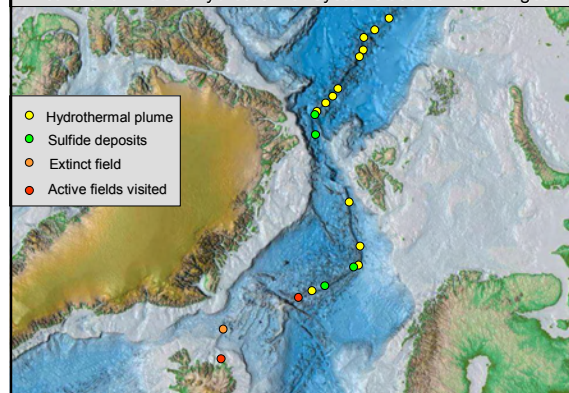
- Climate change/prognosis
- Operational ice mapping
- Ice volumes and fluxes

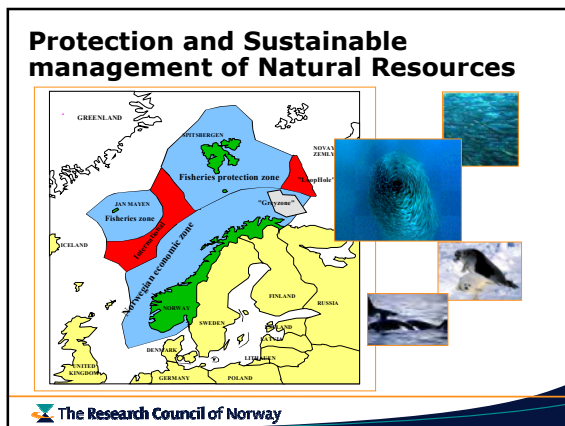
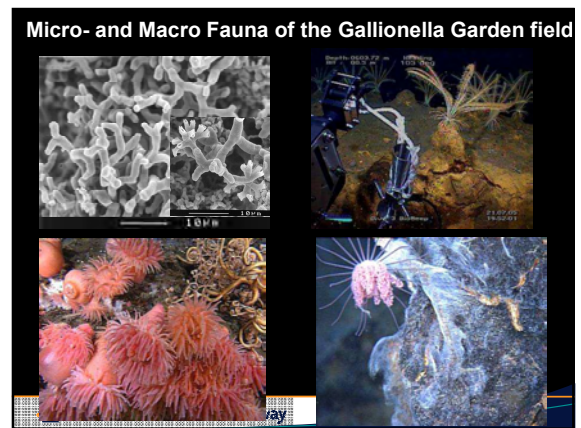


Measurement of freeboard ice thickness

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Active and Ancient Hydrothermal Systems at the Arctic Ridges





Polar regions: Key areas for understanding Global Change

- Vulnerable to change;
 - Detect climatic response at an early stage
- Physical processes that are "easily" detectable
 - Ice thickness
- Limited human activity;
 - High signal to noise ratios
- Good natural observation conditions;
 - Rich biological populations
 - Relatively simple biotopes and food-chains
- Accessible to remote sensing equipment and automatised observation systems

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Requirements for the research system

- Observation and data acquisition
- Data handling
- Understanding generic processes
- Modelling and prediction
- Decisions to support sustainable development

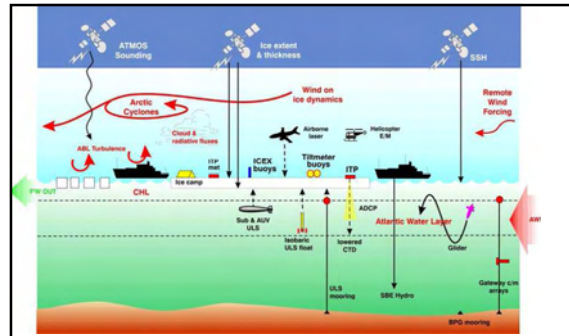
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Logistics are improving



Fridtjof Nansen: The first crossing of Greenland 1888

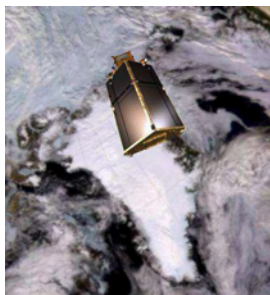
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Schematic of the vertical stack of observations from satellites to seabed that would be necessary to inform an IAOS study focused on the present state and future fate of the Arctic perennial sea-ice.

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CryoSat



- Lost during its 8 October launch, CryoSat would have been Europe's first spacecraft dedicated to the study of ice. Its 1000-day mission was to precisely measure variations in the thickness of polar ice sheets and floating sea ice.

- The observations made during CryoSat's lifetime would have determined whether or not Earth's ice masses are actually thinning in response to climate change.

- CryoSat was the first in a new class of ESA Earth Observation spacecraft known as Earth Explorers, which are small research missions designed to address critical issues of Earth science.

- The concept behind the CryoSat mission - which was approved in 1999 - is to respond to the current debate on global warming and the effect this may be having on Earth's polar masses.

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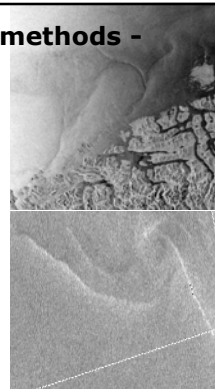
Active remote sensing methods - SAR

Challenges

- Back scatter mechanisms
- Validation
- Increased data availability

Application

- Wave monitoring
- Mesoscale wind monitoring
- Current-front mapping
- Oil-spill detection and mapping

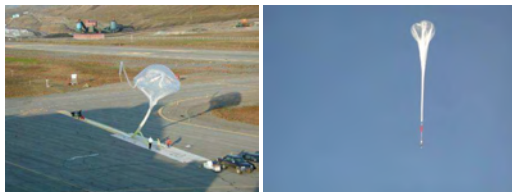


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Balloon Launching Service

- The mild coastal winter climate makes northern Norway suitable for balloon launch operations. Experienced launch team has up till now launched more than 450 balloons in Norway. An agreement with the Royal Norwegian Air Force gives Andøya Rocket Range customers access to ideal launch sites including supporting infrastructure.

- Large balloons (>100.000 m³) are launched in cooperation with other space organizations. Launches of scientific balloons from Spitzbergen at 78deg N can result in circular flights driven by the systemic circulation of high altitude winds around the North Pole.



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But not to forget the conventional planes



Troll-station, Arctarctica



Winter accommodation
6-8, summer ca
30 scientists



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European Incoherent Scatter (EISCAT) Scientific Association

- Studies the interaction between the Sun and the Earth
- These interactions also give rise to the Northern Lights
- Located in Northern Norway (including Svalbard), Sweden and Finland.
- Funded by the research councils of Norway, Sweden, Finland, Japan, France, the United Kingdom and Germany.



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SvalSat – connected by high-speed fiber cable to the mainland

Kongsberg Satellite Services operates two multi-mission polar ground stations, in Tromsø (Tromsø Station at 69°N) and at Svalbard (SvalSat at 78°N). Due to the high latitude location, KSAT offers support for all passes (14 of 14) for polar orbiting satellites.

November 5, 2003: the first telephone call using the new fiber cable system was placed between Norway and Svalbard. The fiber cable links KSAT's installations in Tromsø and at Svalbard in a high speed network. It is also a super-highway allowing almost unlimited data transport between KSAT's sites and the rest of the world.



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Drifting ice stations are combined monitoring laboratory facilities



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Ship-based monitoring; K/V Svalbard



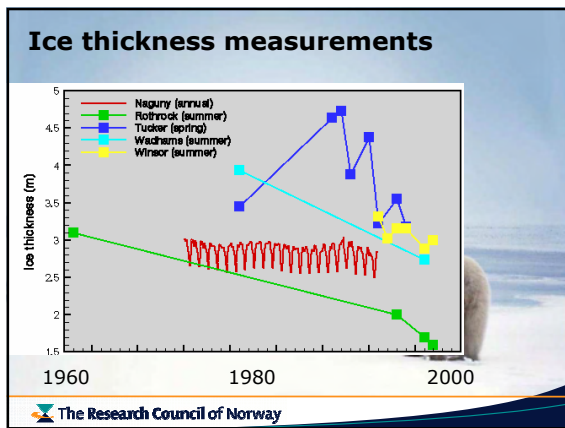
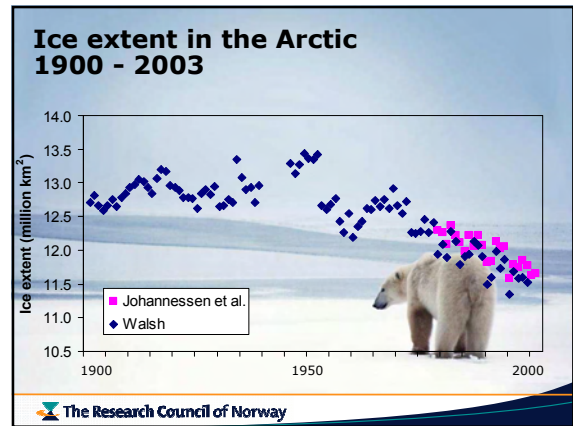
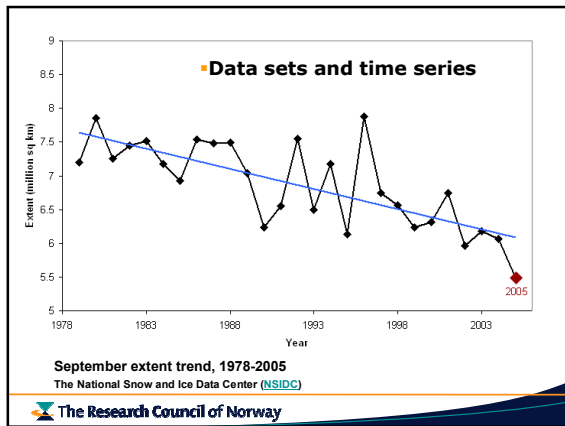
Photo: S. Gesten

Photo: S. Gerland

Data acquisition and handling

- Multi-disciplinary;
 - ability to utilize several datasets and observations for modelling purposes
- Long and uninterrupted time series
 - Particular problem; changing access due to seasonal changes
- Great variance in observation conditions, and hence need for instrumentation and equipment
 - The Arctic very different from Antarctica

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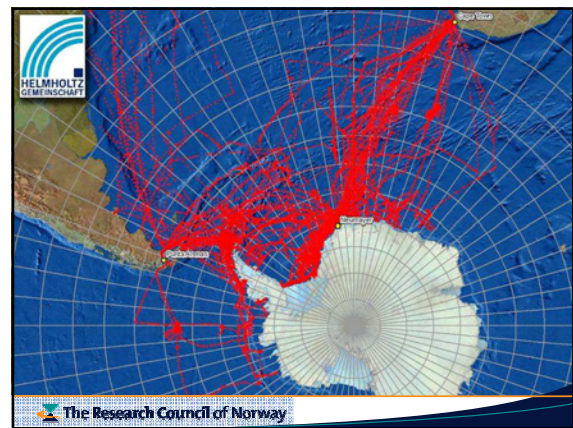
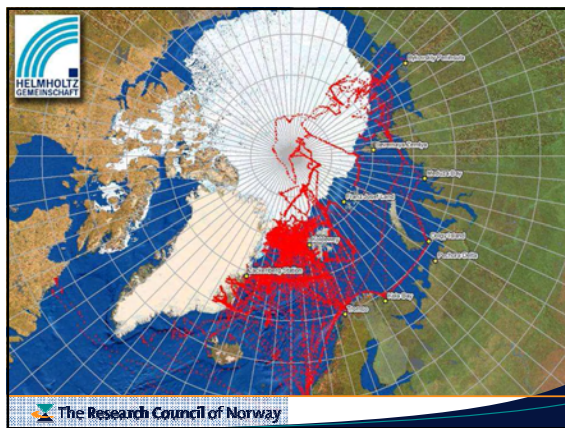
Ice distribution monitoring and modelling - Challenges

- Improved algorithms, combined radar data in multi-year data series
- Applications
 - Climate
 - Ice distribution forecasts
 - Fishery
 - Transport
 - Exploration and exploitation of natural resources

100%
90%
80%
70%
60%
50%
40%
30%
15%

water
land

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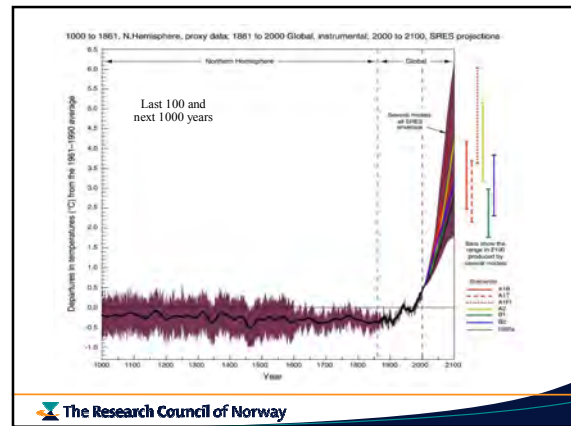


Capacity for modelling and data handling

- Multi-disciplinary
 - ability to utilize several datasets and observations for modelling purposes
- Extremely extensive data sets
 - Data-processing and network facilities; eScience
- Complex numerical problems
 - Non-linear and multivariable processes
 - Mathematical methods

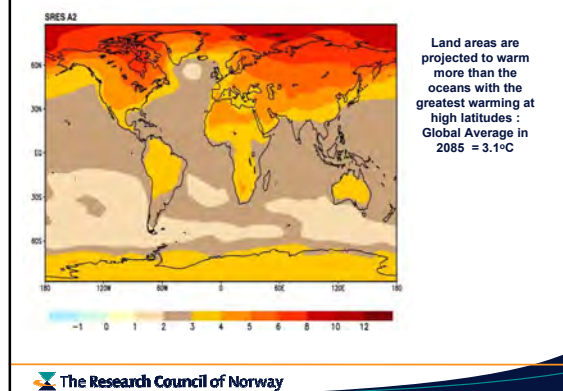


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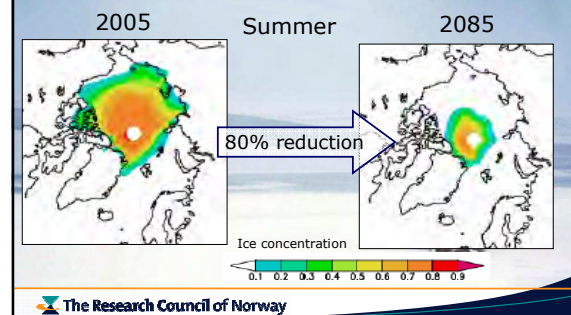
Climate scenario 2085 rel. to 1990 (IPCC):



Land areas are projected to warm more than the oceans with the greatest warming at high latitudes :
Global Average in 2085 = 3.1°C

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Simulation of ice-concentration as function of doubling of CO₂



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The future; we cannot afford to neglect research in the polar regions

- More advanced and agile infrastructure
- Improved overall capacity
- Improved international cooperation -
 - planning and coordination of research activity
 - funding and optimization of resources

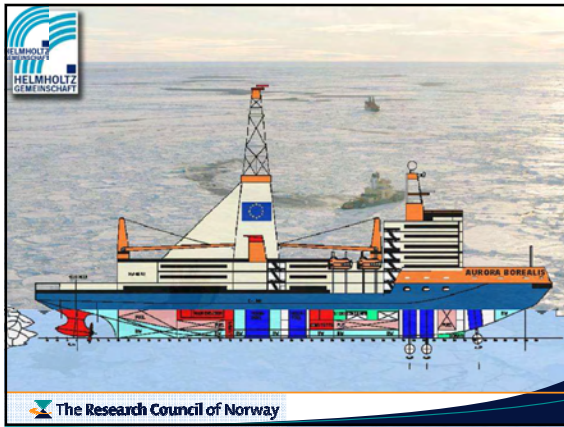


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Vidar Viking could keep its position for max. 9 days

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Svalbard represents a unique natural laboratory for study of

- The Polar environment
- The atmosphere
- The interaction between the magnetosphere and solar activity
- The marine environment
- The biosphere of polar regions
- The geology of the Northern Atlantic and the Barents Sea
- Continental margins and plate tectonics
- The cultural heritage of the polar regions

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Great investments have been done in scientific infrastructure, for example

- University Centre in Svalbard (UNIS)
- European Incoherent Scatter (EISCAT)
- The Arctic Marine Laboratory
- Svalbard Scientific Centre
- Norwegian Polar Institute
- Associated with facilities like Andøya Rocket Range

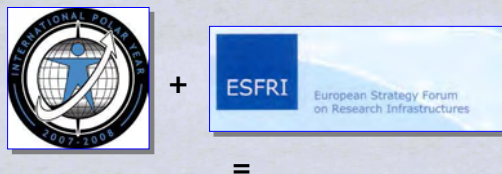
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IPY 2007-2008



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Conclusion



Unique possibility to create robust and flexible strategies for future polar research -
Let us use it

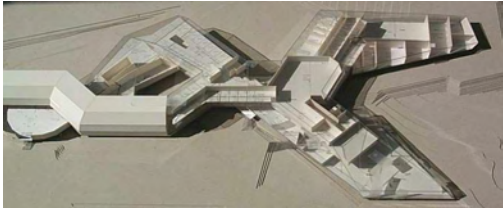
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The Arctic Marine Laboratory in Ny-Ålesund, a unique laboratory



SVALBARD SCIENCE CENTRE


- 8502 m2 built as an extension to the present UNIS complex.
- UNIS 45%, NP 13%, Svalbard Museum 22%, The Governor of Svalbard 10%, common areas 10%.
- Start: 2003, finished 2005. Official opening March 2006



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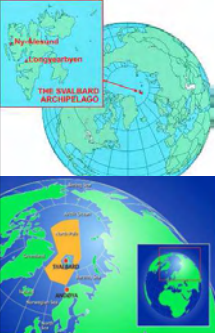
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ARR Toolbox



- ARR is a "toolbox" for science and education related to the exploration of the upper atmosphere and space (<1600 km altitude).
- Provides launch services for customers with own rockets or balloons.
- Or provides a rocket with a "hotel" where scientist can book a room with a plug for their experiment.
- Payload can be recovered for reuse.
- Provides integration with the best ground instrumentation.
- More than 40 highly qualified staff.
- A limited company owned 90% by the state.

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Andøya Rocket Range



Largest polar launch facility for sounding rockets and balloons:

- Andøya (69° N)
- Svalbard (79° N)

Extensive support infrastructure:

- Lidars, Radars, Cameras

Up to 20 tonnes rockets.
>800 launches since 1962.


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