Remote Sensing of Sea Ice

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Users of Sea-Ice Information

- Historically: people living near ice infested waters since the sea ice affected people’s lives in various ways.
  
  *(In worst cases no fishing, no travel, no harvest…)*

- Seafarers and fishermen for navigational safety

- Meteorologists and climatologists as the sea ice affects weather and plays a big role in climatology

- Tourist companies and others carrying out operations in icy waters

- Fish farms and other activities at sea

- The media, the public, officials and researchers.

*The requirements for ice information vary greatly – concerning the parameters observed, area coverage, geometric resolution, time resolution and timeliness.*

*Best to get information as close to real time as possible,*

*Make accessible to users but build up an archive at the same time*
Sea-Ice observations

- Marine Sediment Cores - indication of sea ice and iceberg extent *(diatoms, foraminiferas, IP25, IRD)*
- Historical Sea-Ice Information – maximum ice extent, type, consequence *(charts, logbooks, diaries)*
- Direct observations from ships, aircraft, coastal stations and submarines (thickness data)
- Satellite imagery – optical, thermal, passive and active microwave, lidar.

*Again, different timescale, precision and properties are needed.*
Properties of sea ice

- Sea-ice extent
- Sea-ice concentration
- Ice types and ice age
- Sice and shape of floes
- Thickness, roughness, ridges
- Salinity
- Ice drift
- Surface melt
- Snow cover
- Soot, sediments, algea...
- Icebergs

Remote Sensing in regions that are frequently covered by clouds, are inaccessible and dark for considerable part of the year.

Studying features that change fast, are affected by wind, currents and internal forces.

So... Remote sensing of sea ice is challenging but never boring.
Data types

- Optical and multi spectral images
  - Ice extent and concentration, ice type

- Thermal images
  - SST, new ice formation

- Passive microwave images
  - Daily coverage of the hemisphere, back to 1979

- RADAR (SAR) images
  - Various ice parameters independent on clouds

- LIDAR
  - Ice thickness
AMSR-2 data from NASA & seaice.dk

Daily mosaic of the Arctic (and Antarctic) low spatial resolution various parameters

18.06.2018
Satellite era – 1979 onwards
Thinning of sea ice
Low summers extent
Record low conditions in winter

Based on passive microwave data from the Defense Meteorological Satellite Program
https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph
SENTINEL-1 from ESA & seaice.dk

High resolution SAR data available in near real time independent of cloud cover and sunlight

1a and 1b
Borgaris 11.06.2018 (beir sem greinast)

Hafis 11.06.2018 kl. 8:29 (V) og 18:59 (A)

Iskönnun Landhelgisgæslu 11.06.2018 kl. 15:43 GMT

Hafis við Ísland 11. júní 2018

Isköunnarflug Landhelgisgæslu Íslands

Bakgrúnur: SENTINEL-1 frá ESA Copernicus
Kortagrúnur: Landmælingar Íslands

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Hafísjakar og borgarís geta verið utan hafisjáðars og aðstæður breyttast hratt

Hafís við Ísland 14. júní 2018 kl. 08:05 GMT
Bakgrunnur: SENTINEL-1 frá ESA Copernicus
Kortgrunnur: Landmælinar Íslands
Ingibjörg Jónsdóttir i@hi.is Háskóli Íslands
Tracking iceberg 2018

It was possible to chart the ice up to 3 times per day (June '18)

Icebergs vs ships still a problem but can be solved (AIS)
Ice charts

A question of accuracy and presentation? Misleading to have the charts too accurate, since the ice changes so fast? Direct contact with users of ice information is important.
Optical images

- NOAA AVHRR 1978-
- MODIS 2000-
- SUOMI NPP VIIRS
- SENTINEL-3
- LANDSAT-8 2013
- SENTINEL-2

Denmark Strait 28.02.2017 12:30 GMT
MODIS

Tracking floe drift and break

Possible to monitor ice drift ~10 times per day (+VIIRS)
VIIRS Night time image
INDIVIDUAL ICE FLOES VISIBLE TWICE A WEEK – FEW HOURS MORE SATELLITES LAUNCHED SNOW COVER, ICE TYPE ICE EXTENT, ICE CONCENTRATION
Various images have become available through archives.

Data that was not available in real time at the time but will now allow study of previous ice conditions and processes.

LANDSAT series.
DMI Annual reports from the Arctic
Summary

- Many options for using satellite images to study sea ice on a long time scale as well as in real time
- For operations, using many data sources is essential to get the „full picture“
- Archives, that have become available recently, offer many possibilities to examine past conditions and processes
- The combination of high spatial, spectral and temporal resolution will enhance knowledge on sea ice properties, drift and decay