

# Global Climate Change and the Arctic

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## Remote Sensing and Models



Episode 2: Satellite remote Sensing in the polar regions

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# Overview of the learning unit

**Episode 1:**  
Polar regions and climate change

**Episode 2:**  
**Satellite remote Sensing in the polar regions**

**Episode 3:**  
Interview with the lecturer

# Learning target of the episode

## Learning target 1:

Earth Observation with satellites provide a cost effective and technically feasible means of obtaining information in the extensive and isolated Polar Regions.

## Learning target 2:

You understand that there are different types of satellite sensors with

- different resolutions and
- able to observe many different quantities.

# Overview: Satellite remote sensing of the polar regions

**Part 1:**

Sea ice

**Part 2:**

Land-fast ice and ice edge

**Part 3:**

River floods

**Part 4:**

Glaciers

# Overview: Satellite remote sensing of the polar regions

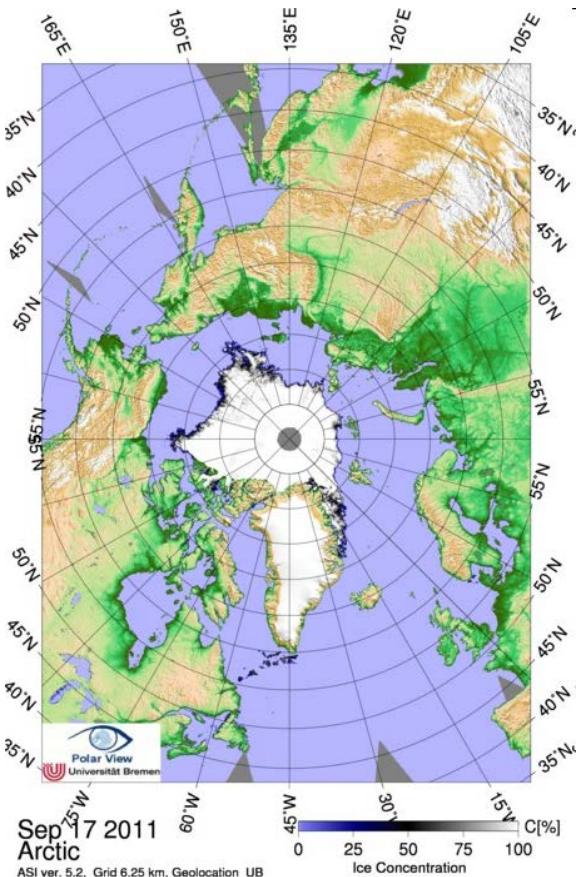
**Part 1:**  
**Sea ice**

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# The Arctic

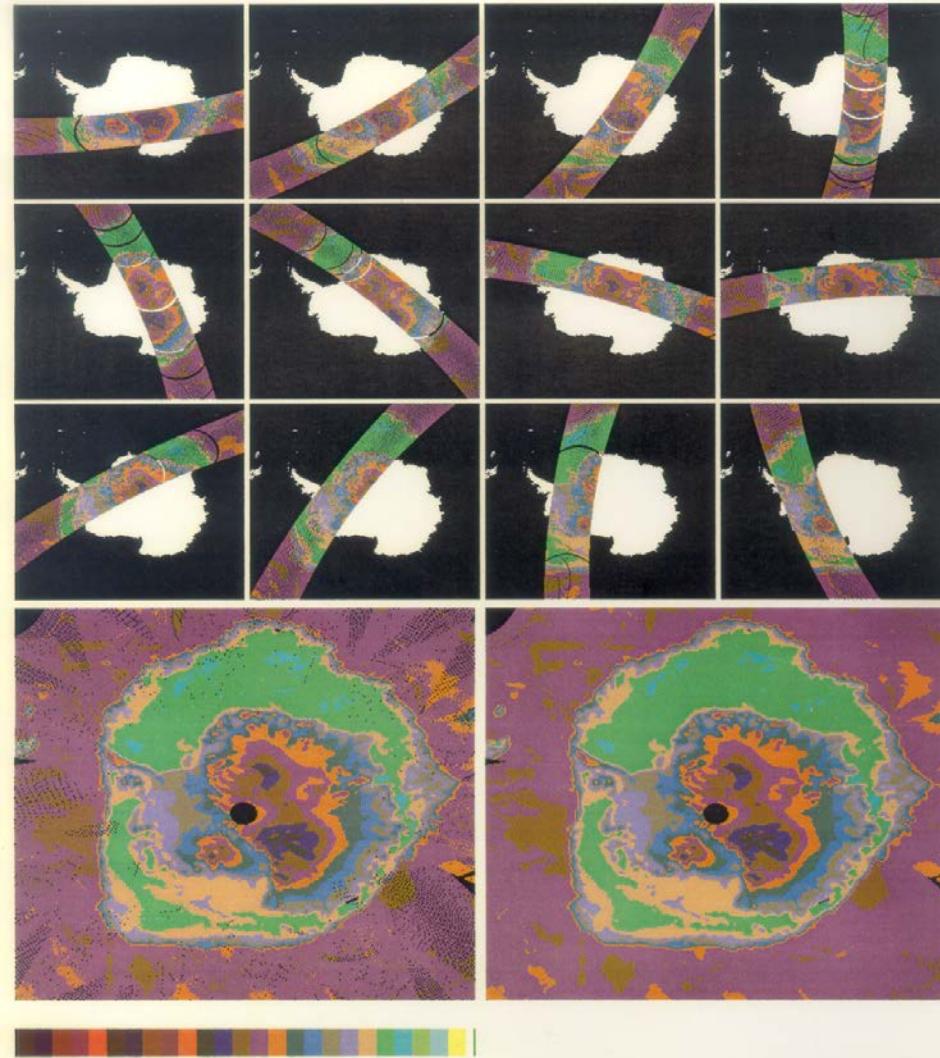


- Large, remote areas of limited accessibility
- Key role in global climate system
- Increasing industrial activity
- Sensitive ecosystems of global importance
- Rich resources
- Low population density

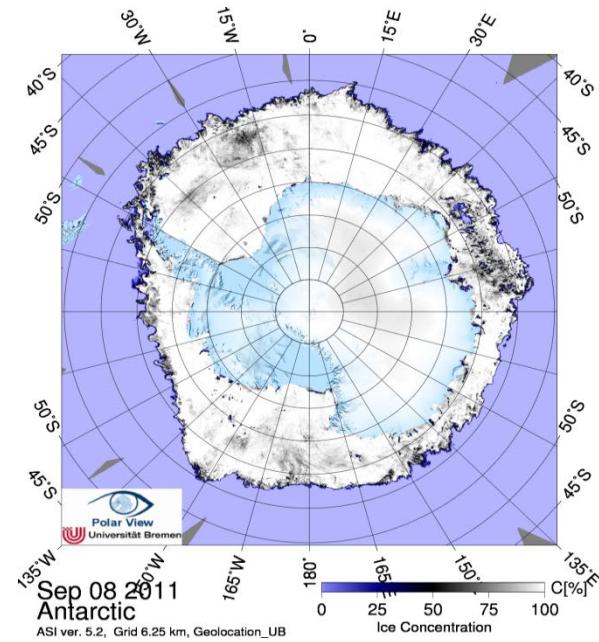
## The vast Arctic

	mill.km <sup>2</sup>	inhabitants/ km <sup>2</sup>
Canada	10	3.4
Siberia	13	4
Sea ice	4...15	-
Germany	0.35	230

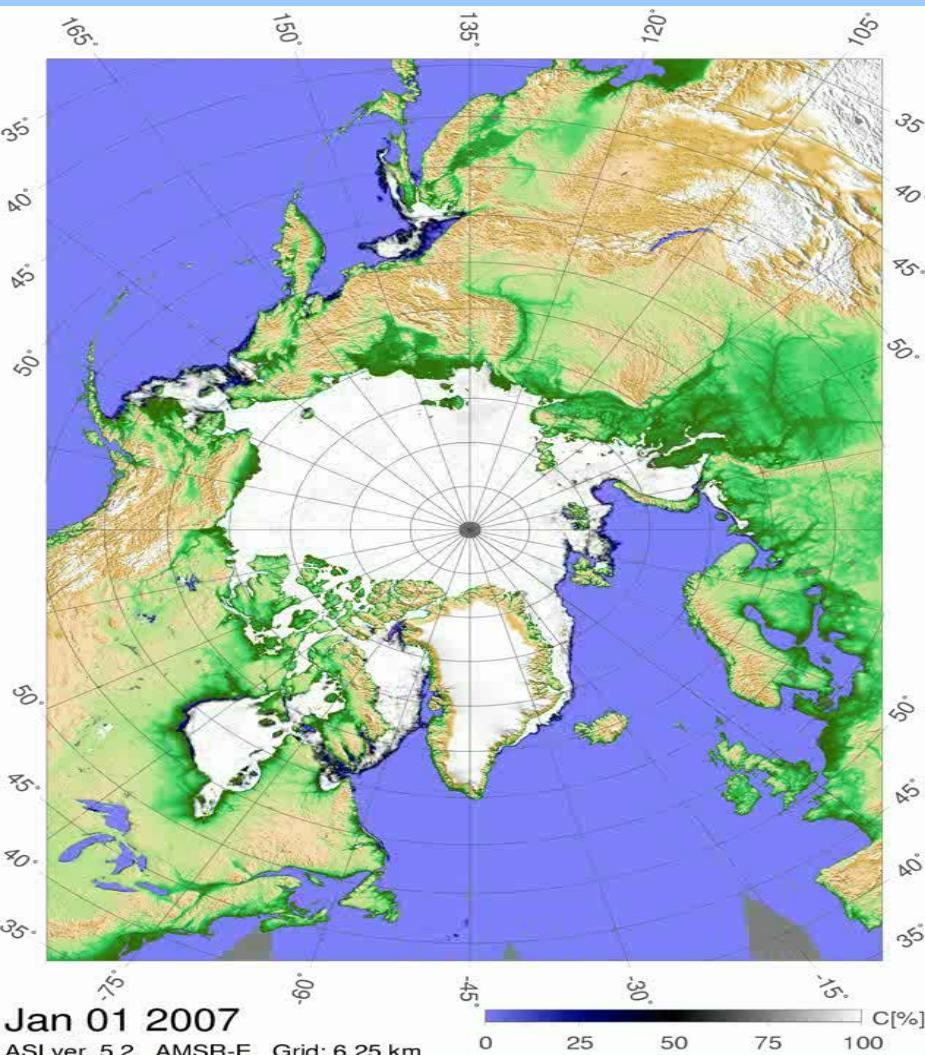
# Earth observation with microwave sensors



- observe at 6 to 90 GHz (20 to 1 mm wavelength)
- penetrate clouds
- work at (polar) night
- resolution on surface 5...50 km



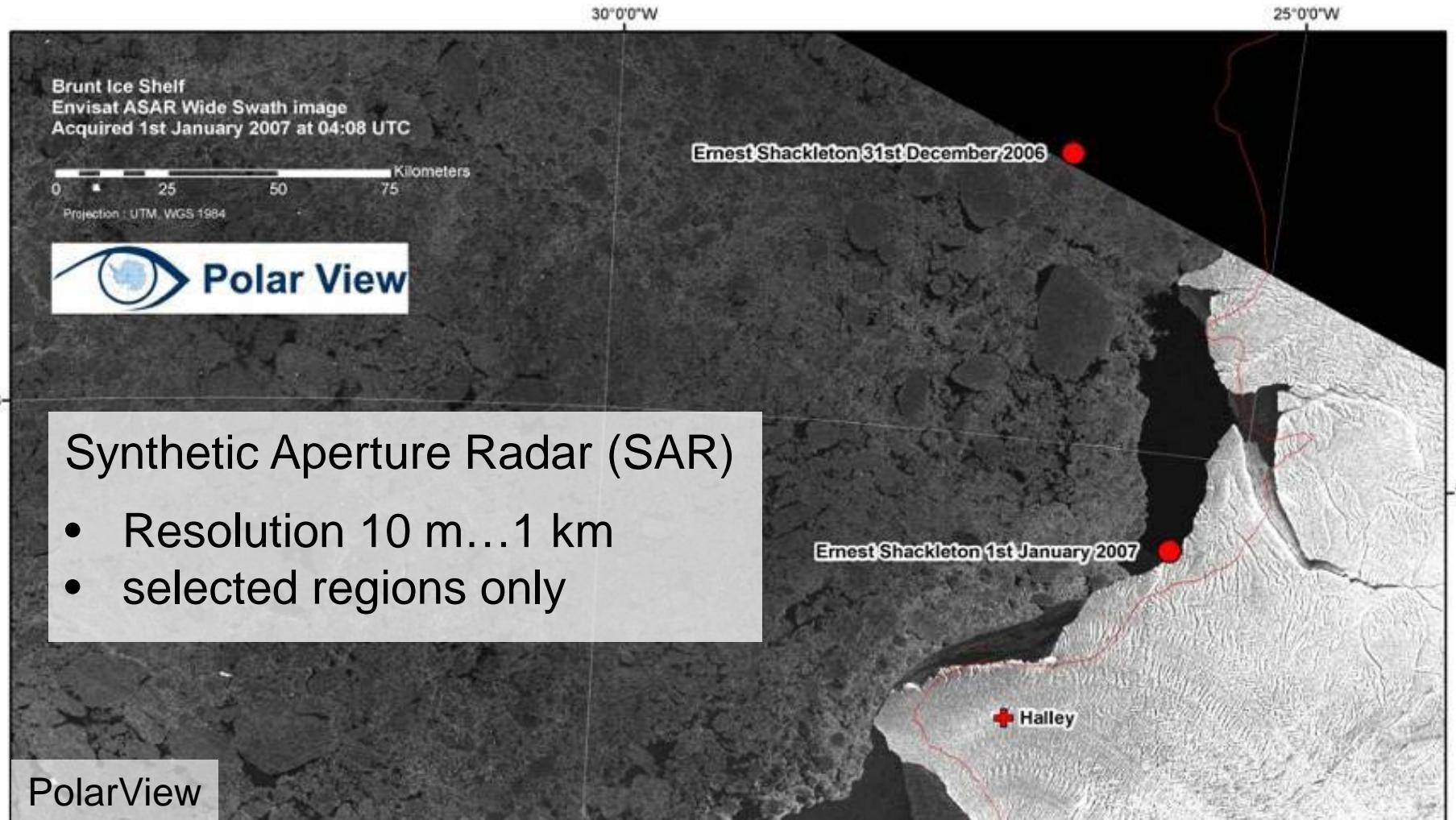
# Earth observation with microwave sensors



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# Earth observation with microwave sensors: SAR

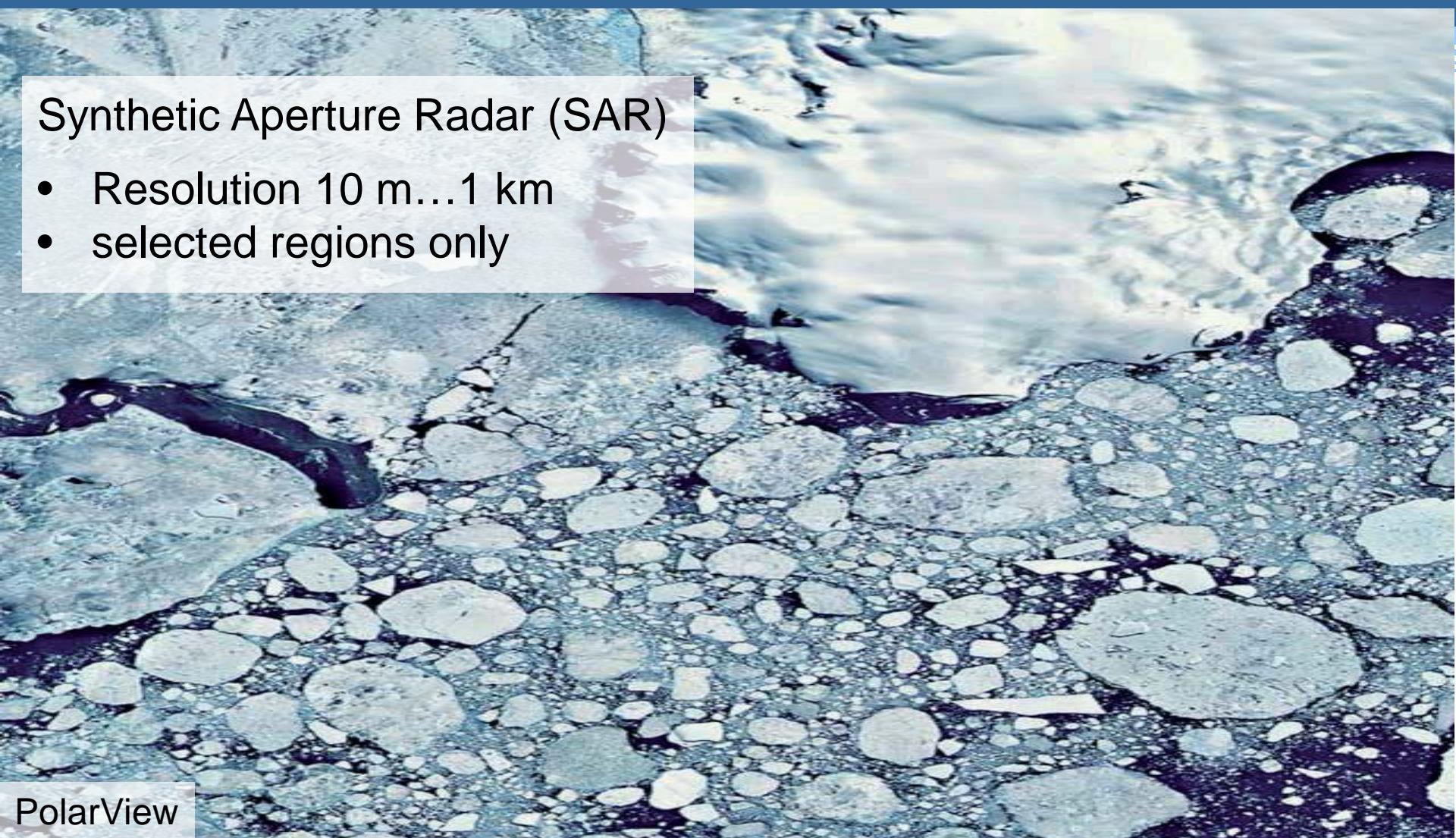


PolarView

# Earth observation with microwave sensors: SAR

## Synthetic Aperture Radar (SAR)

- Resolution 10 m...1 km
- selected regions only



# Satellite remote sensing of the polar regions

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# Polar View

is an ESA / GMES project (Global Monitoring for Environment and Security)

- Providing safe transportation routes
- Guiding fishing and hunting expeditions
- Protecting off-shore drilling operations and
- Improving flood protection
- Addressing environmental concerns and adaptation to climate change
  - Supporting research into the role of the Polar Regions in the Earth system
  - Helping to understand and manage animal populations and habitats
  - Increasing global awareness of climate change impacts and adaptation.
- ‘one stop shop’ [PolarView.org](http://PolarView.org)



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## Land-fast ice and ice edge

Floe edge: boundary between fast (i.e., not moving) ice and moving ice or open water, important for

- hunting and fishing,
- developing tourism industry.



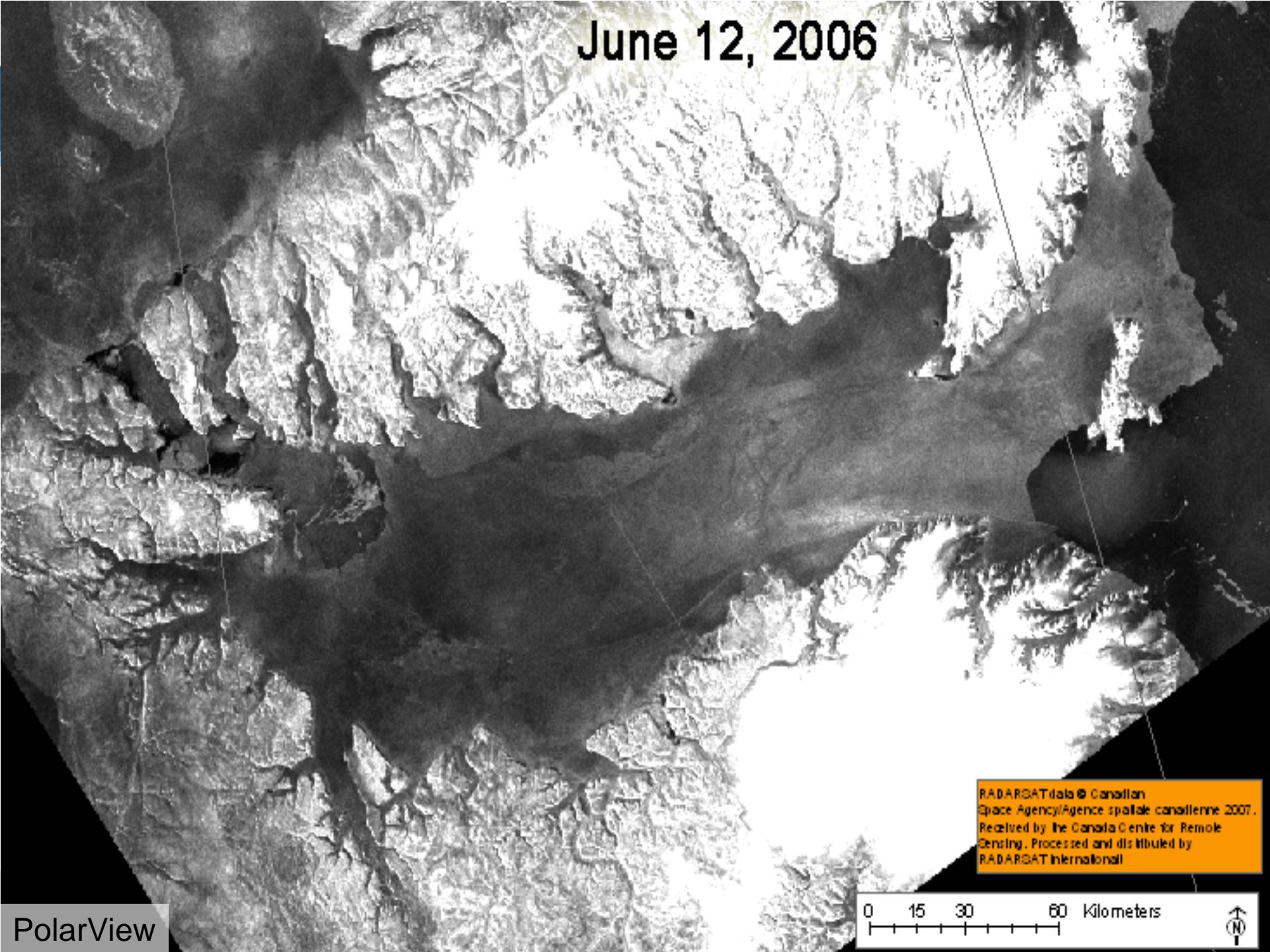
Identifying locations of interest on the ice edge, and selecting the shortest route around ice ridges and open water important to

- minimize travel time, fuel, equipment wear,
- maximize the safety of travel on the ice.

**Traditional knowledge on navigation becoming less reliable in the context of a changing global climate.**



June 12, 2006

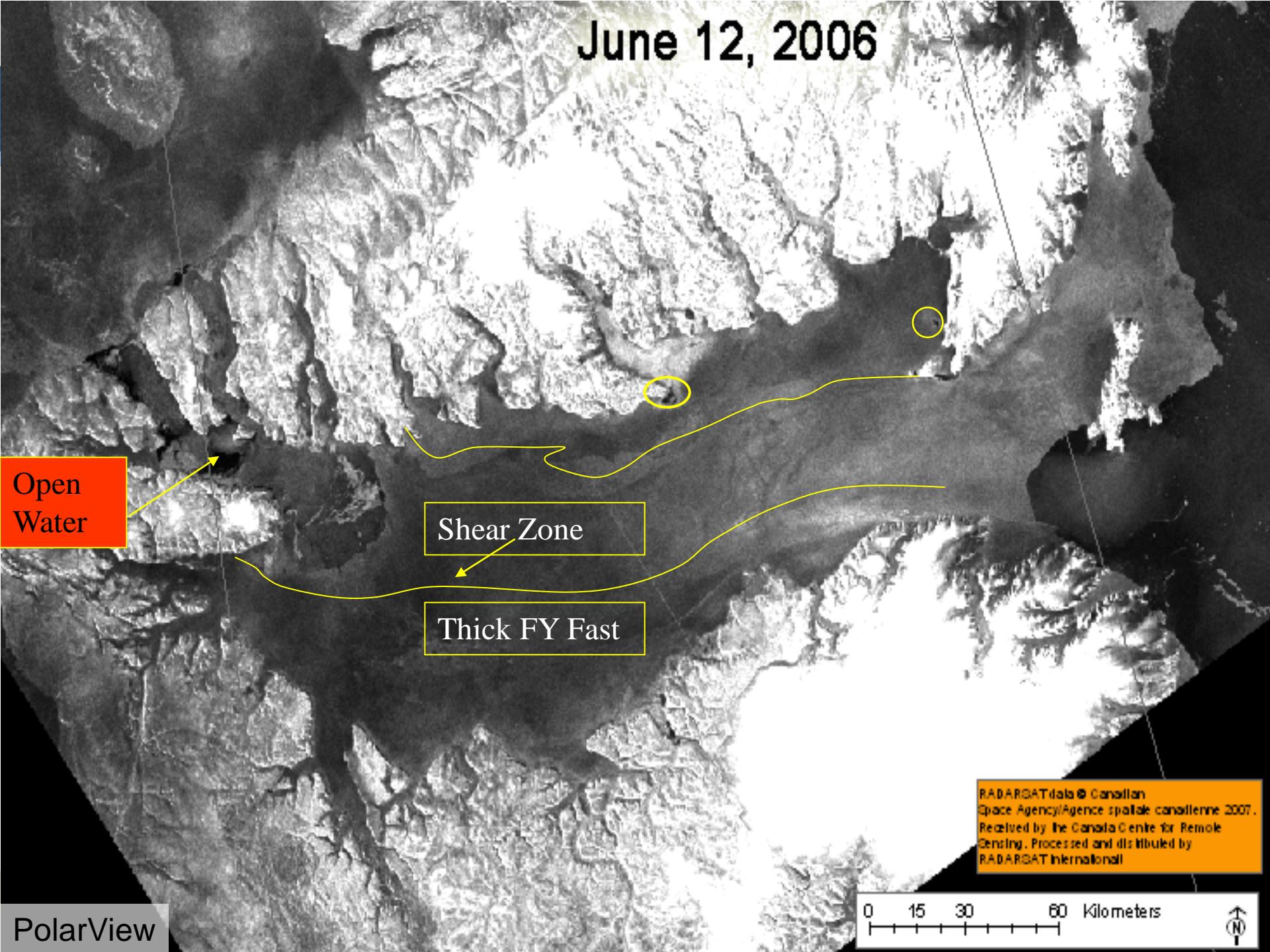


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RADARSAT International

0 15 30 60 Kilometers



# June 12, 2006

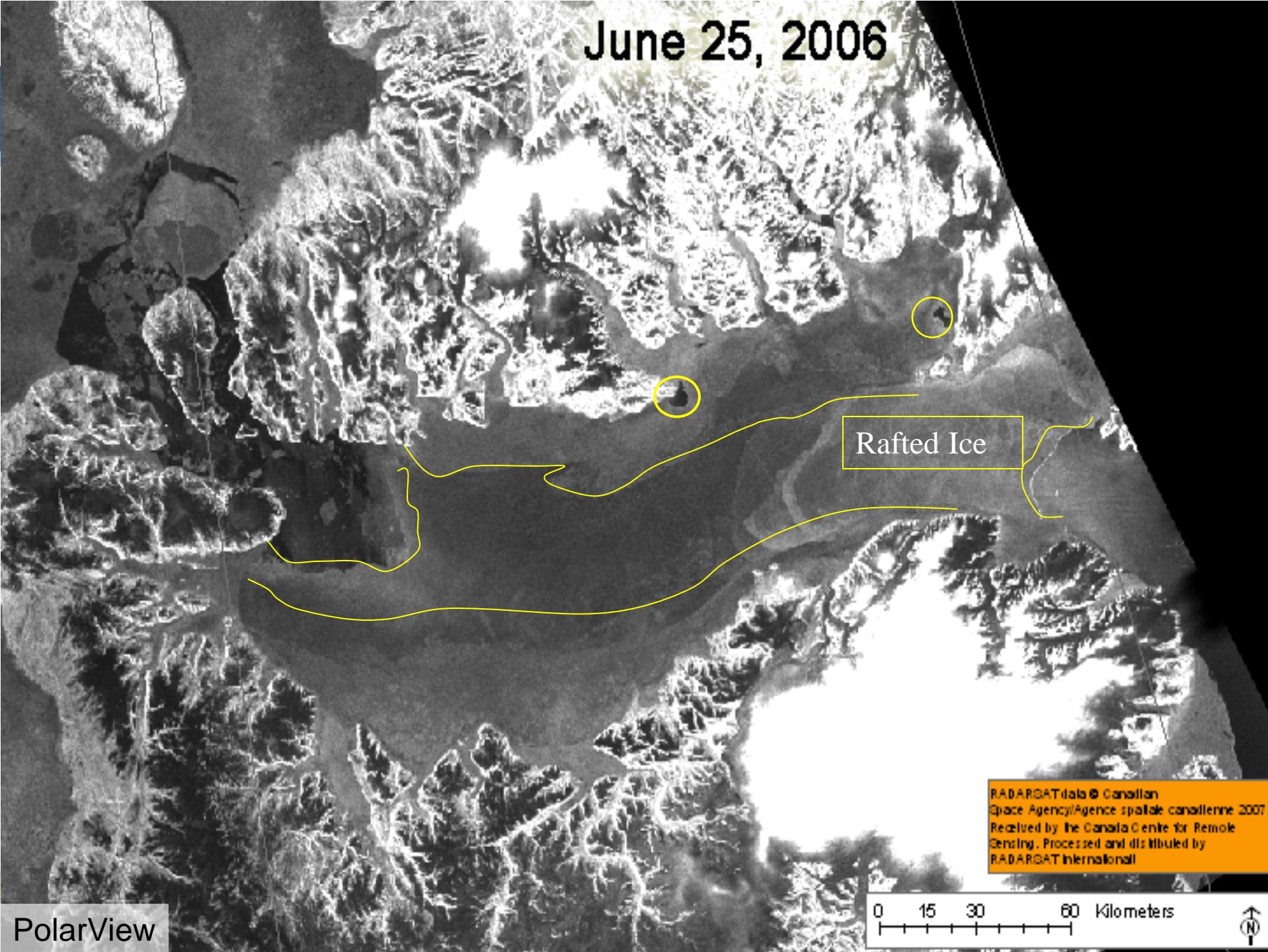


PolarView

0 15 30 60 Kilometers



June 25, 2006



Rafted Ice

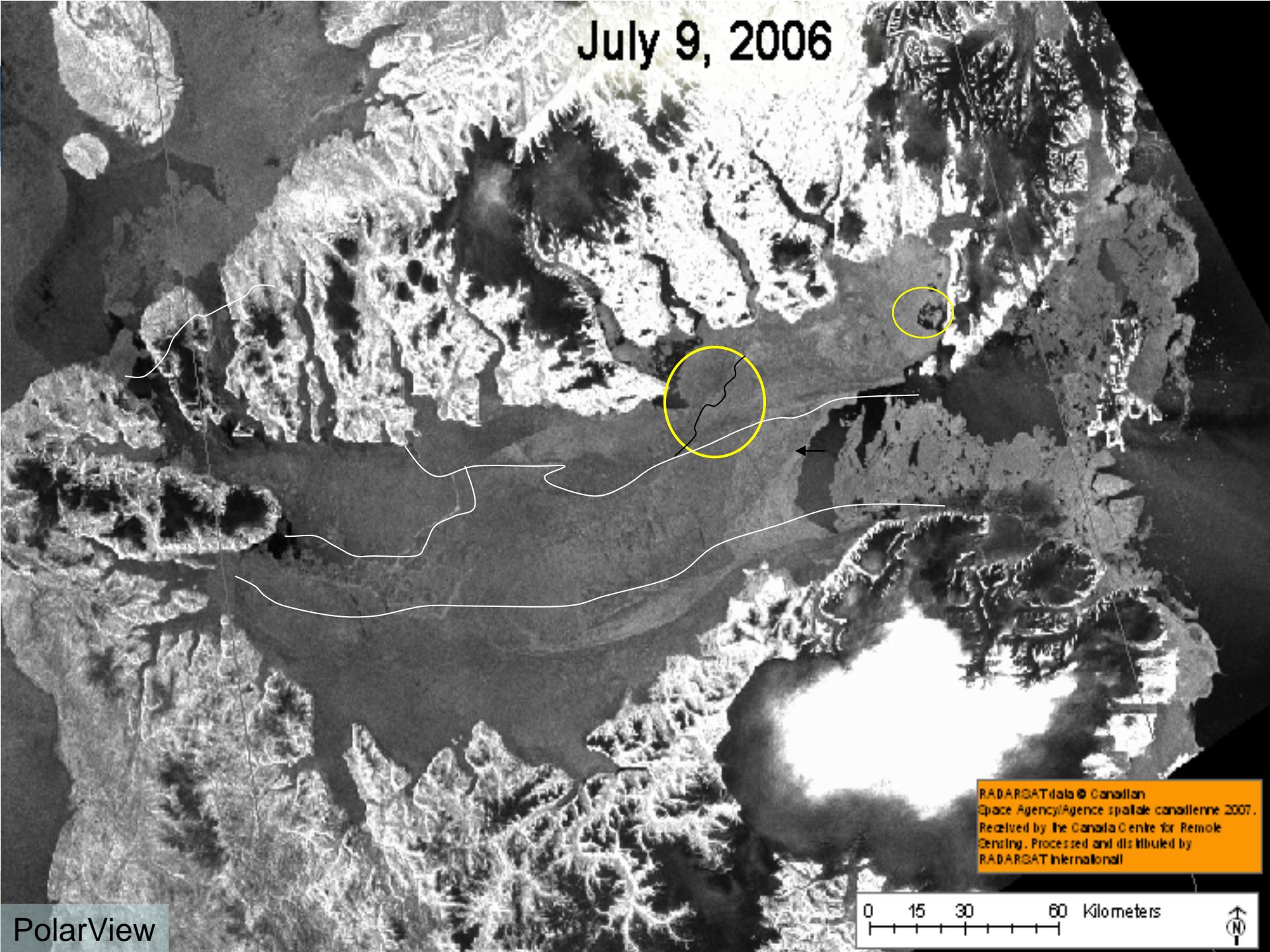
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PolarView

July 9, 2006



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0 15 30 60 Kilometers



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# River Floods

- ice covers on large rivers can result in ice jamming and flooding over extensive areas.
- Post-flooding freeze up may exacerbate the damages
- Up-to-date information in riverine ice development required to identify and mitigate potential hazards
- Key parameters: location, extent and structure of the ice field
- Difficult to determine with field-based methods
- EO is an ideal to collect such data repeatedly and consistently throughout ice season

# River Floods



PolarView

Das Bild kann zurzeit nicht angezeigt werden.

# River Floods

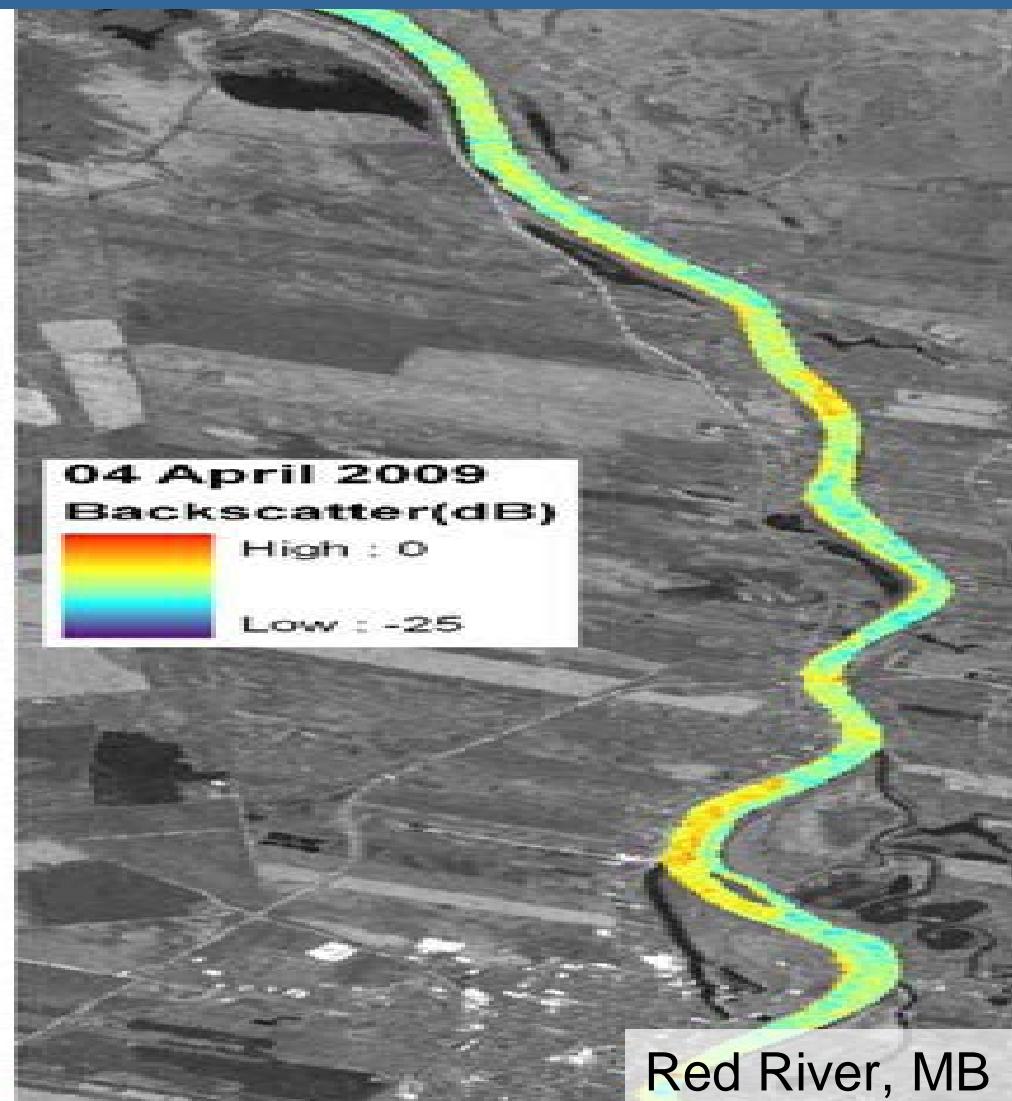


<http://www.flickr.com/photos/chriswaits/6126989839/>



<http://www.flickr.com/photos/taaaalia/2287041451/>

# River Floods



# River Ice Change Detection

Lena river,  
Russia

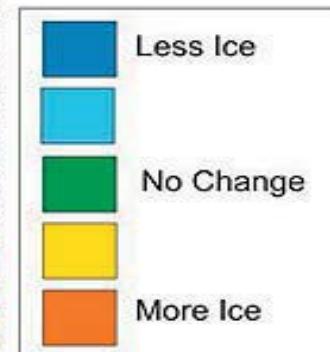
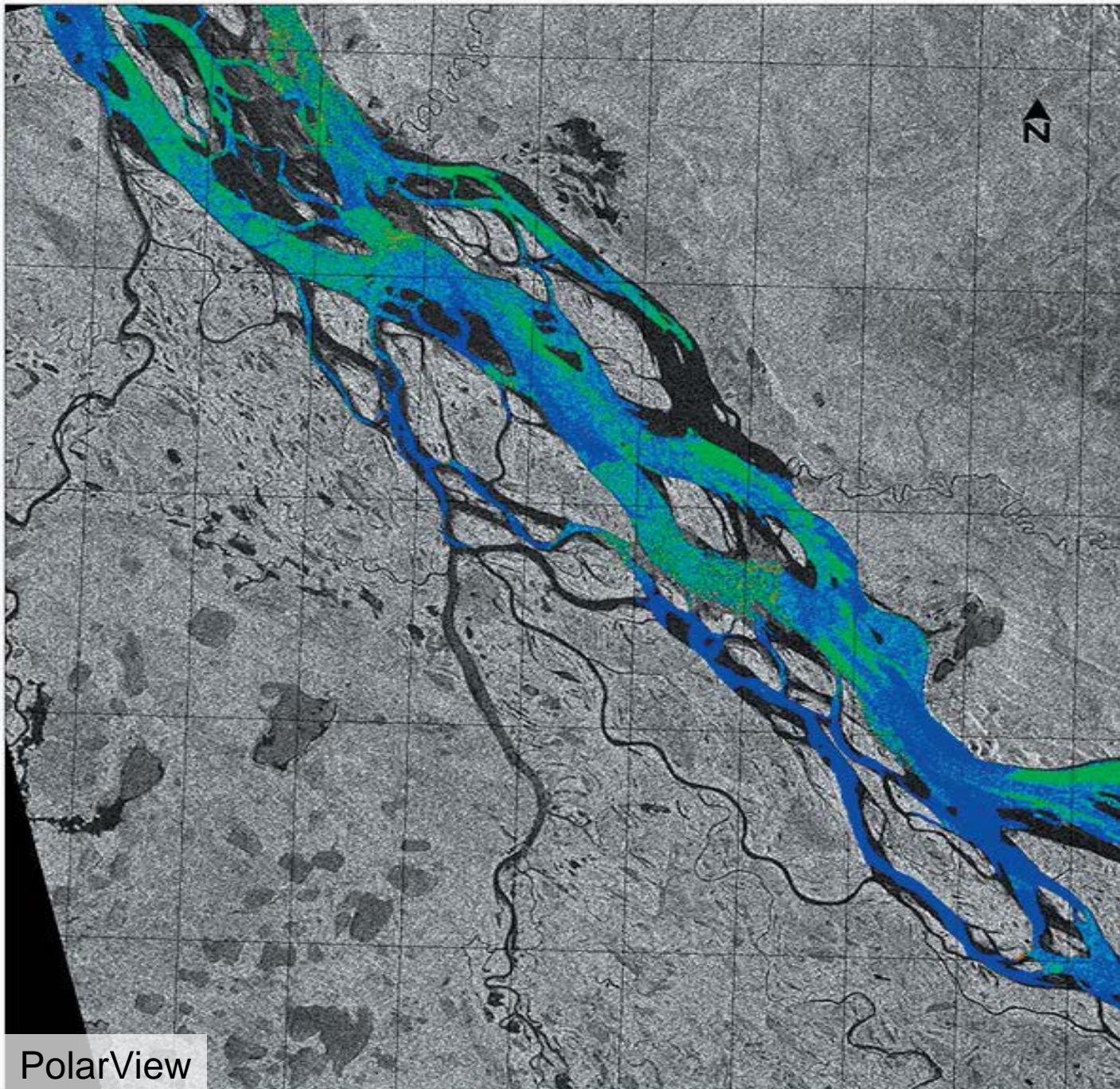


Image acquired on  
May 24, 2006 12:51:05 UTC

 c-core

 Polar View

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# Glaciers

Earth Observation and numerical modeling  
of **glaciers** needed by

- Water resource management
- Hydropower generation and energy intensive industries
- Environmental and health policy

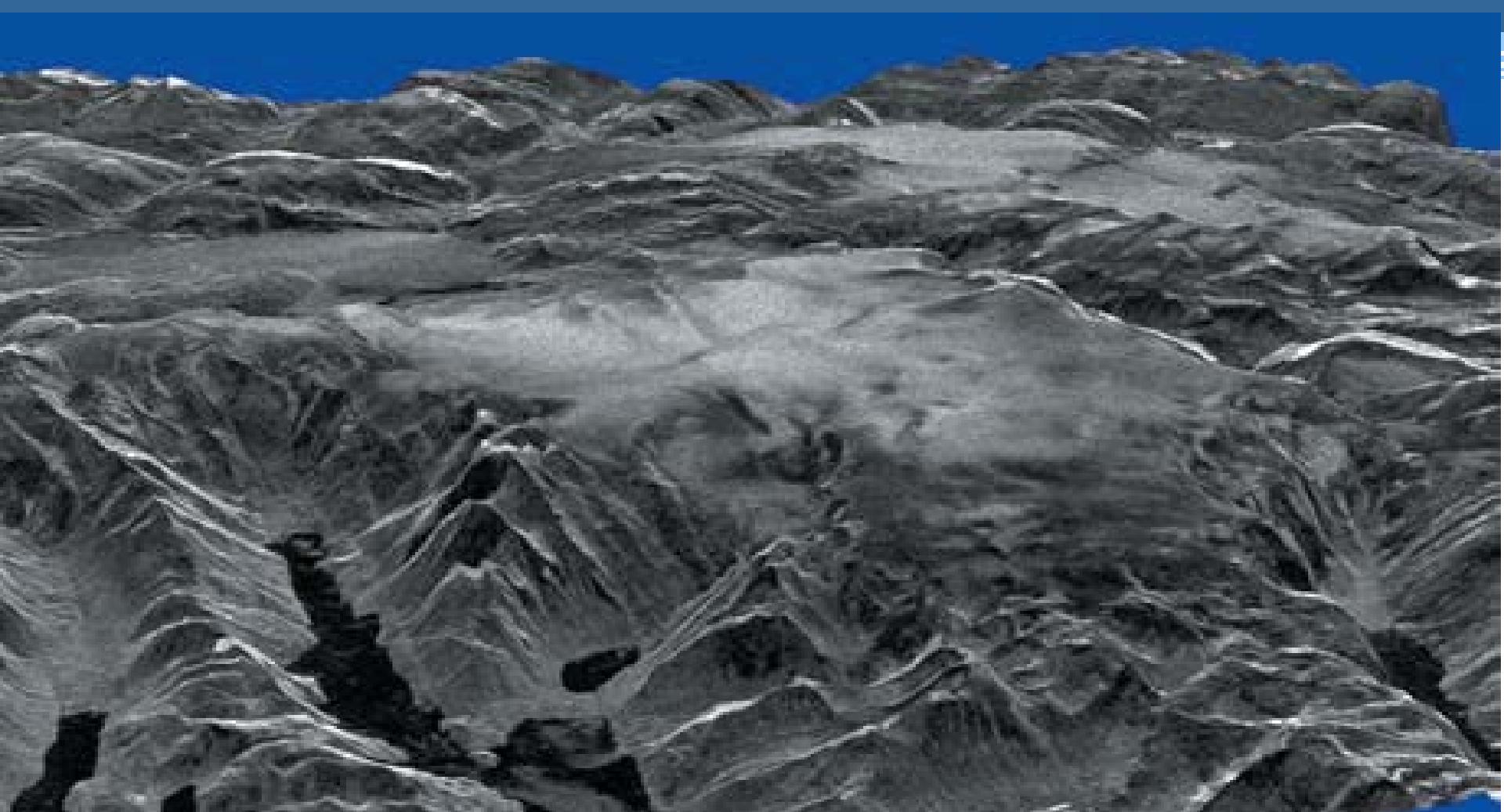
PolarView

# Glaciers

Some typical products and applications:

- Snow line and glacier facies maps derived from SAR or optical imagery
- Snow cover and snow melt maps from SAR imagery
- Historical glacier extent or snow line maps from optical or SAR imagery
- Mass-balance modeling
- Glacier runoff modeling
- Glacier size and distribution inventories
- Glacier velocity from InSAR, speckle tracking or feature tracking

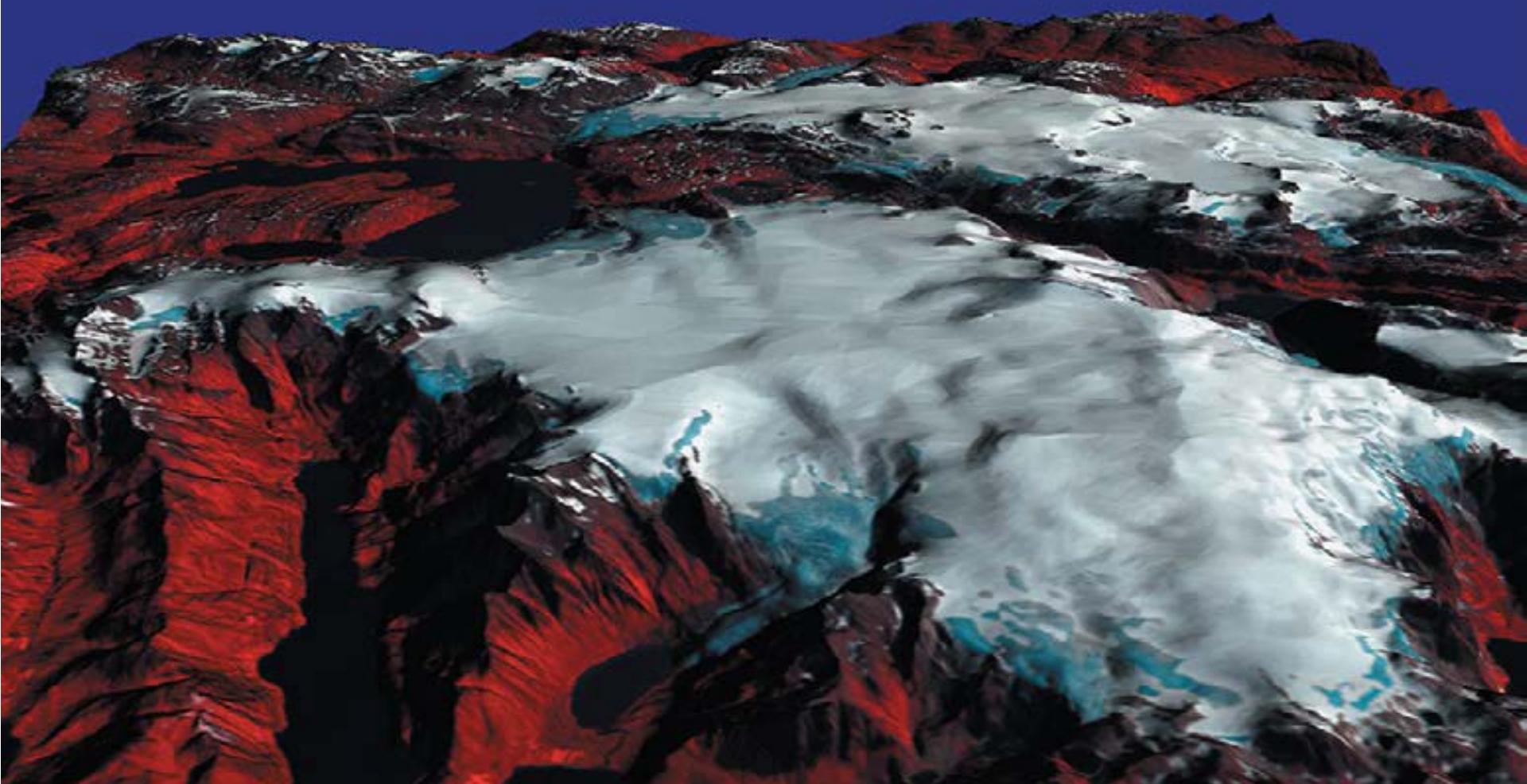
# Svartisen icecaps, Norway



Envisat ASAR image, draped over a Digital Terrain model.

PolarView

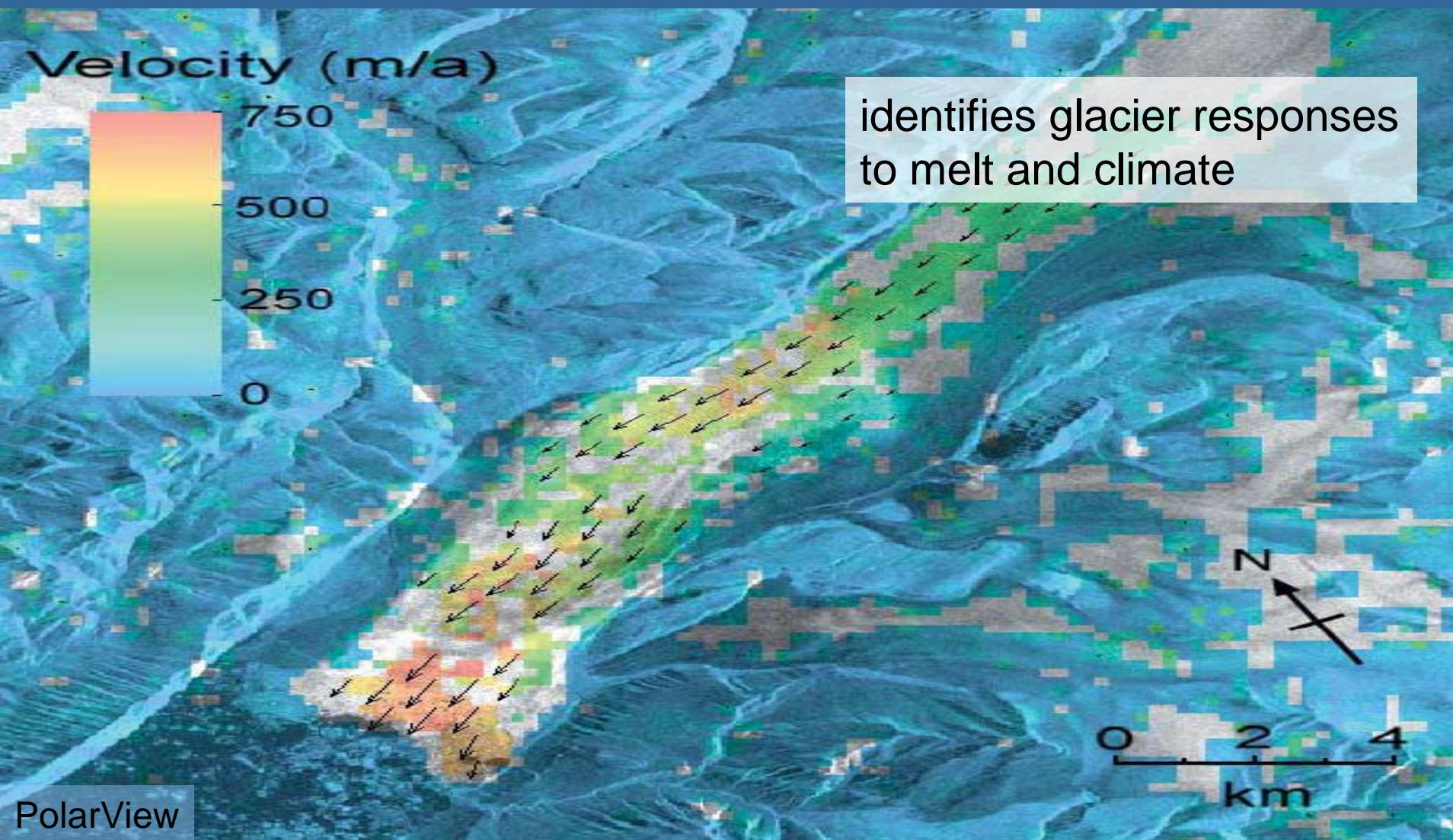
# Svartisen icecaps, Norway



Landsat false color image, draped over Digital Terrain model.

PolarView

## Glacier velocity map



# Conclusions

Earth Observation is a powerful observation tool in the vast Polar Region.

Used for surveillance helping northern inhabitants for everyday's life (fishing, hunting, transportation), earth numerical modeling for weather prediction and climate research.

Three satellite sensor types:

- passive microwave sensors for large-scale sea ice mapping ('ice concentration') 5...50 km resolution
- SAR (Synthetic Aperture Radar) small-scale sea ice and river ice 50...1000 m resolution
- optical sensors 10....1000 m resolution

Remote sensing can provide a cost effective and technically feasible means of obtaining information in the extensive and isolated Polar Regions that do not lend themselves easily to conventional, field-based data collection.

## Exercises for Self Study

1. Research the background information of the different types of satellite sensors and what they are for?
2. Which chances and risks do you see in the observation with satellites?
3. Research critical voices of the observation with satellites in the polar region.
4. Which technical limits have the observation with satellites? Are there other limits without the technical, which are limiting the observation?

# References

## Literature:

<http://www.epa.gov/climatechange/science>

<http://polarview.org/files/PVFinalReport.pdf>

## Further reading:

[www.polarview.org](http://www.polarview.org)

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