

# ESA Earth Observation and Polar Areas

[ESA and International Polar Year 2007-2008]



*Henri Laur*

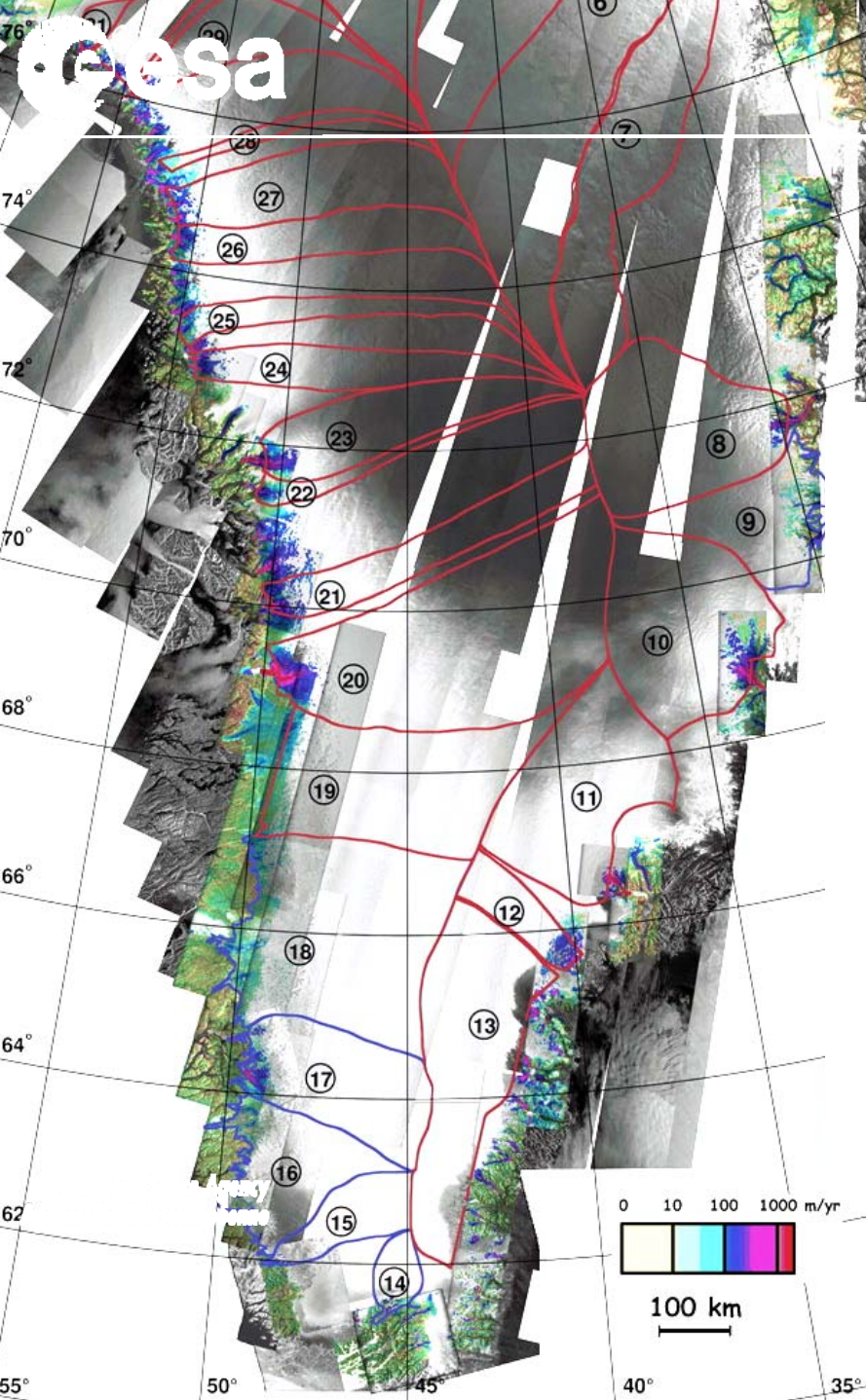
ESA Earth Observation Mission Management Office

Since 20+ years, ESA is increasingly supporting the Cryosphere communities with the provision of Earth Observation data:

- in the 80's, with Landsat (European Arctic),
- since 1991, through **ERS-1** and **ERS-2** (SAR, Altimetry, Ozone monitoring),
- from 2002, with an increased capacity provided by **Envisat** (SAR, Altimetry, Atmospheric Chemistry, Imaging Spectrometer).

→ ESA was the initiator of the space agencies contribution to International Polar Year 2007-2008 (GIIPSY initiative).

→ importance of legacy data acquisition.



## Importance of the legacy data acquisition

One very relevant example:

### Acceleration of Greenland glaciers flow during last 10 years

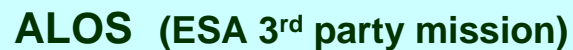
*E. Rignot et al., Science, Feb. 2006*

based on ERS SAR tandem data  
acquired in 1995

&

Radarsat-1 + Envisat SAR data  
acquired in 2005.

→ suggesting that  
existing estimates of  
future sea-level rise are too low



ESA supported the International Polar Year activities:

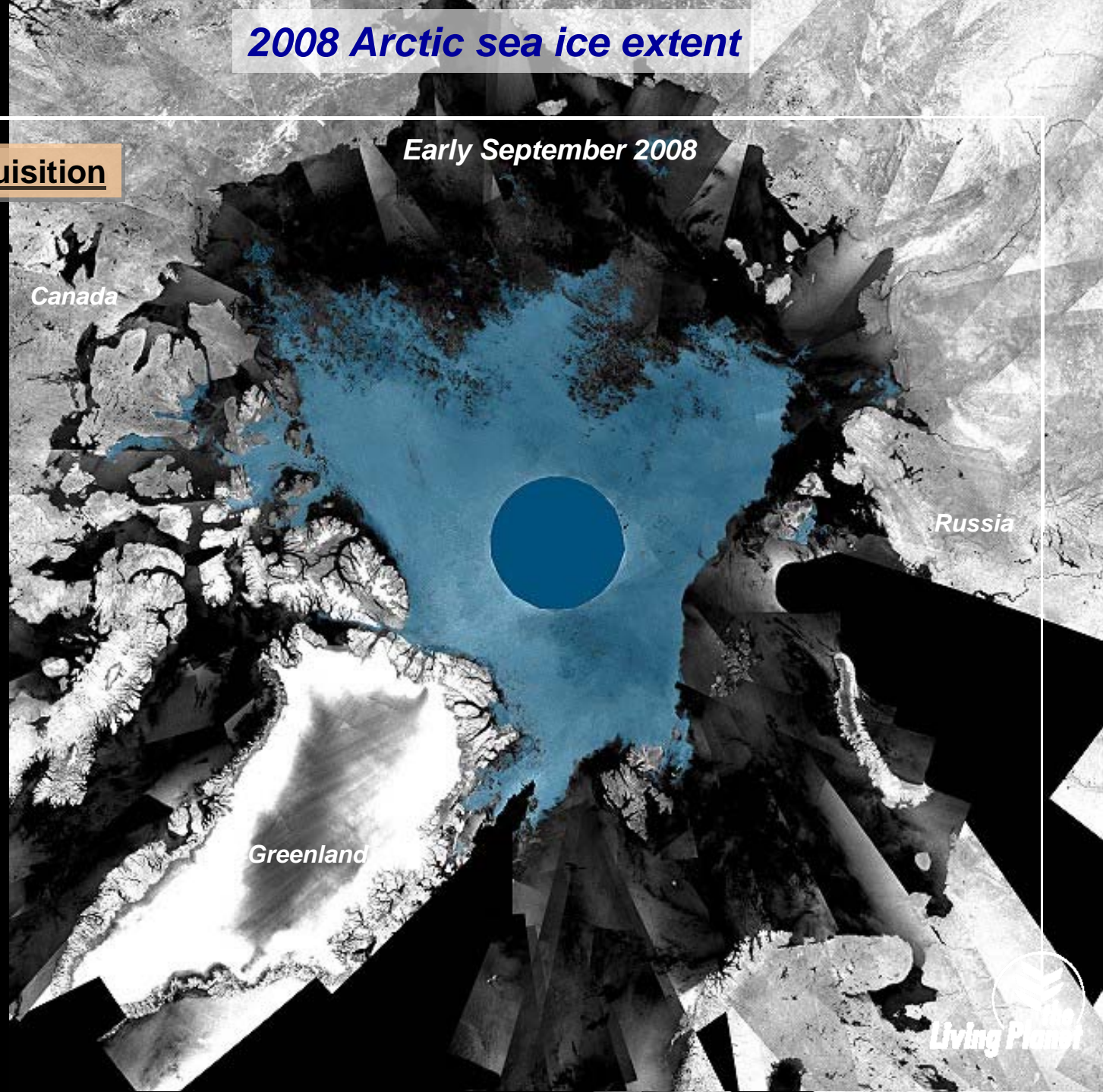
- ❑ dedicated Announcement of Opportunity (AO) for EO data provision in support of IPY with data provision to 48 scientific projects.
- ❑ in the framework of the IPY Space Task Group (GIIPSY), several activities to ensure the acquisition of an increased amount of EO data over polar areas:

**→ *ESA legacy EO data portfolio for IPY***

## Legacy SAR data acquisition

**Envisat ASAR for polar applications (e.g. sea ice, support to polar expedition):**

- 1- Systematic coverage of Antarctica, Antarctica seas and Arctic seas, using ASAR Wide Swath Mode (150 m resolution) or Image Mode (25 m res.)
- 2- Supplementary coverage of all polar areas using ASAR Global Monitoring Mode, (1000 m resolution) when ASAR not operated in Wide Swath Mode or Image Mode.

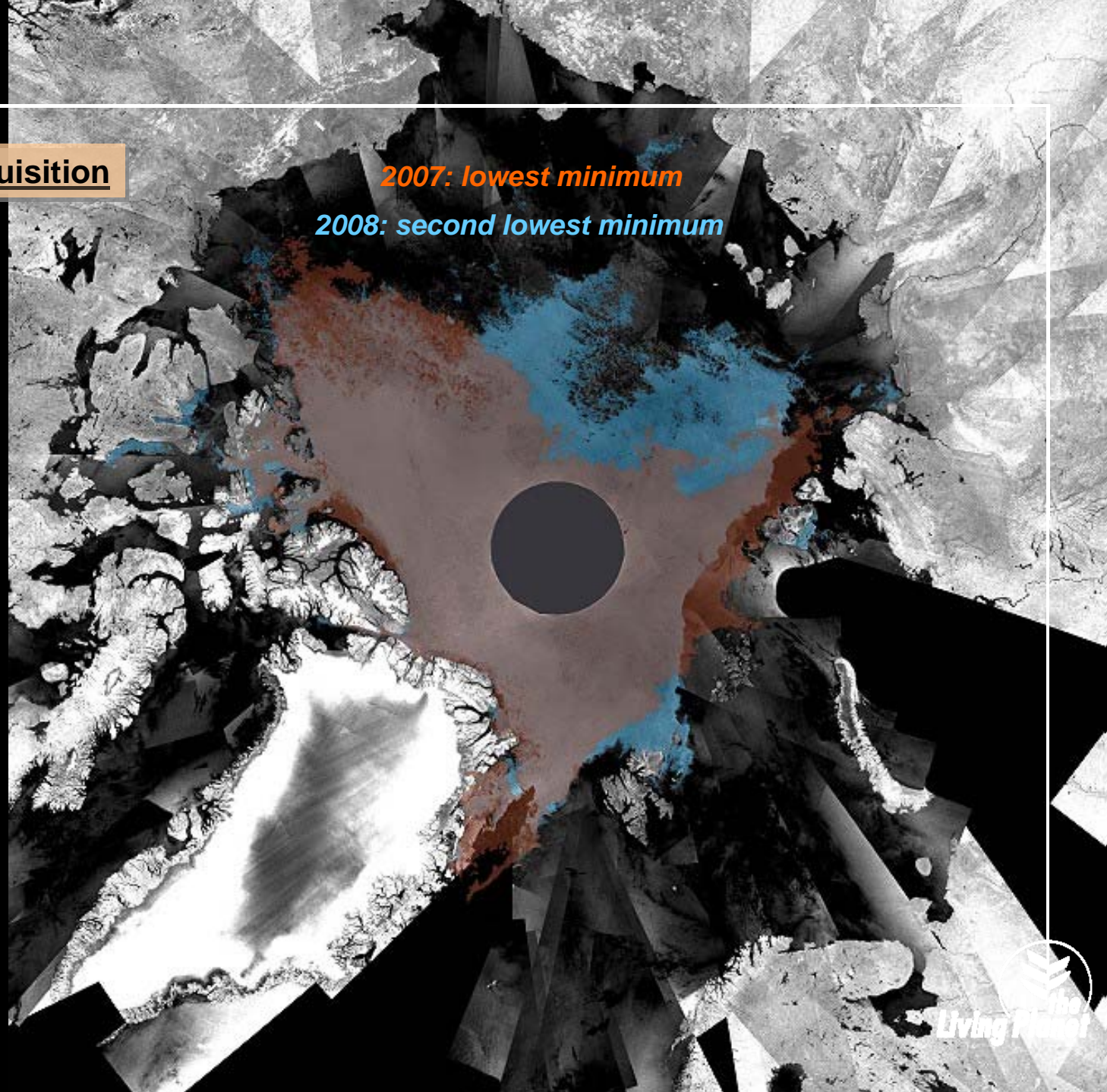


Legacy SAR data acquisition

*Arctic  
sea ice  
extent  
2008*

*Envisat ASAR  
mosaic*

*European Space Agency  
Agence spatiale européenne*

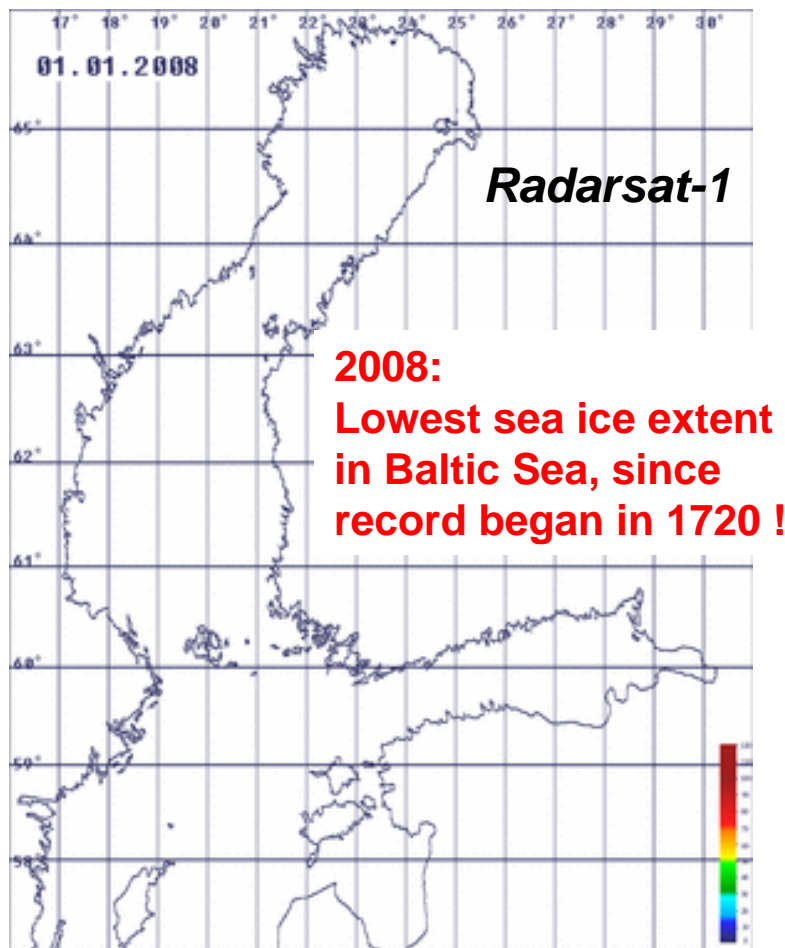




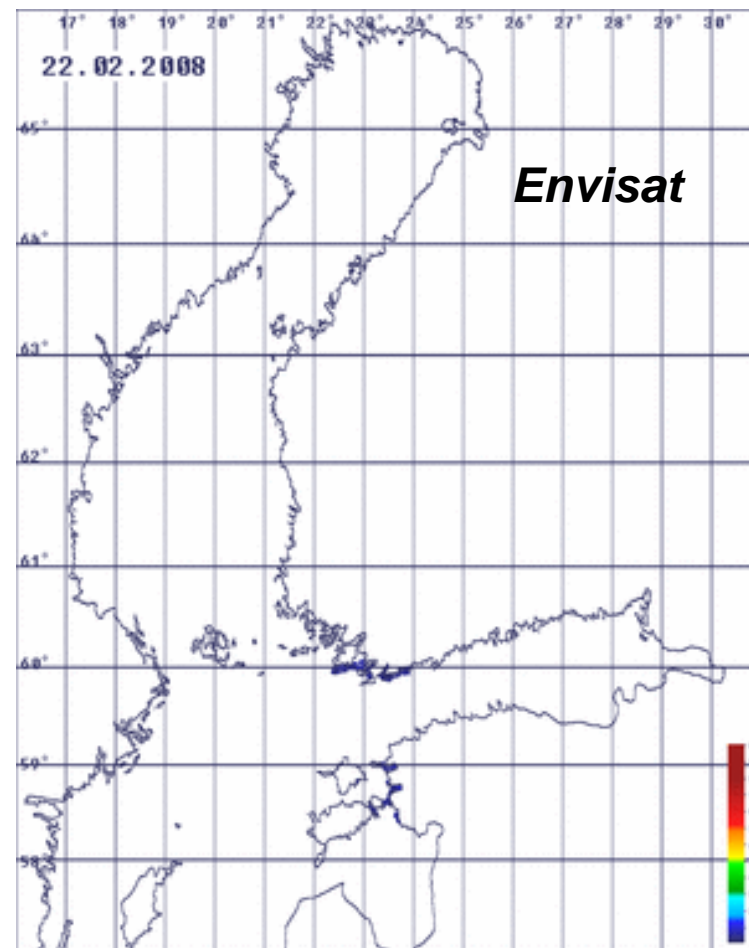
*Envisat ASAR - 31 August 2007*  
*Direct North West Passage open*

*This type of Envisat ASAR  
products were freely available  
for IPY use*

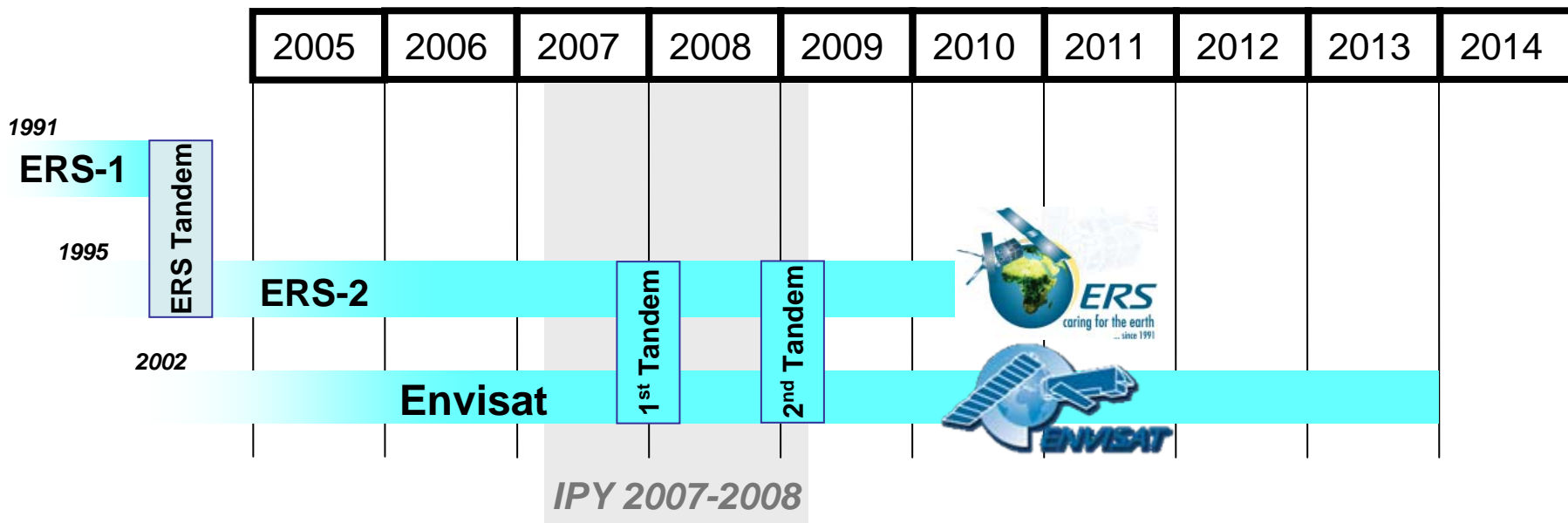
## Winter 2007-2008



## Winter 2008-2009



*Credit: Finnish Institute of Marine Research*



- ❑ The **ERS-2 / Envisat SAR Tandem campaigns** aimed to:
  - ✓ Measure velocity of fast moving northern polar glaciers (> 200 m/year). ERS/Envisat SAR data should be suited to map velocities of 1 cm between the two 30-minutes passes.
  - ✓ Generate accurate low relief Digital Elevation Models. This is of particular interest for many low elevation delta regions, in particular for polar areas (North Canada, North Russia) where there is no available SRTM DEM's.
- ❑ Temporary modification of ERS-2 orbit (2 km off-set versus nominal ground track) to have optimal SAR interferometric baselines between ERS-2 and Envisat (30 min. separation) over Northern latitudes.

## Fast moving glacier

Greenland

Kangerdlugssuaq Glacier

*ERS-2 / Envisat  
2 October 2007*

*High coherence on ice*

*Fringes were not visible in  
ERS-1/2 tandem 1-day data  
on this glacier (too fast)*

*Courtesy: E. Rignot (JPL, USA)*



Image MERIS © ESA

03 August / août 2009

Ice Br

Greenland  
Groenland

*Image interpretation by  
Canadian Ice Service*

Ellesmere Island  
Île d'Ellesmere

Petermann Glacier  
Île de glace Petermann

Kane Basin  
Bassin Kane

Agassiz Ice Cap  
Calotte glaciaire Agassiz

Meris Image  
Image©ESA

European Space Agency  
Agence spatiale





Antarctica Mosaic Image  
15. January - 15. February 2006

Lambert Conformal Conic Projection

Latitude of origin:  $\approx 90.0^\circ \text{ S}$

Latitude of Intersection 1:  $\approx 75.0^\circ \text{ S}$

Latitude of Intersection 2:  $\approx 75.0^\circ \text{ S}$

Scale: one pixel = 2 km along the Latitude of Intersection ( $75^\circ \text{ S}$ )

Antarctica peninsula

2002

2000

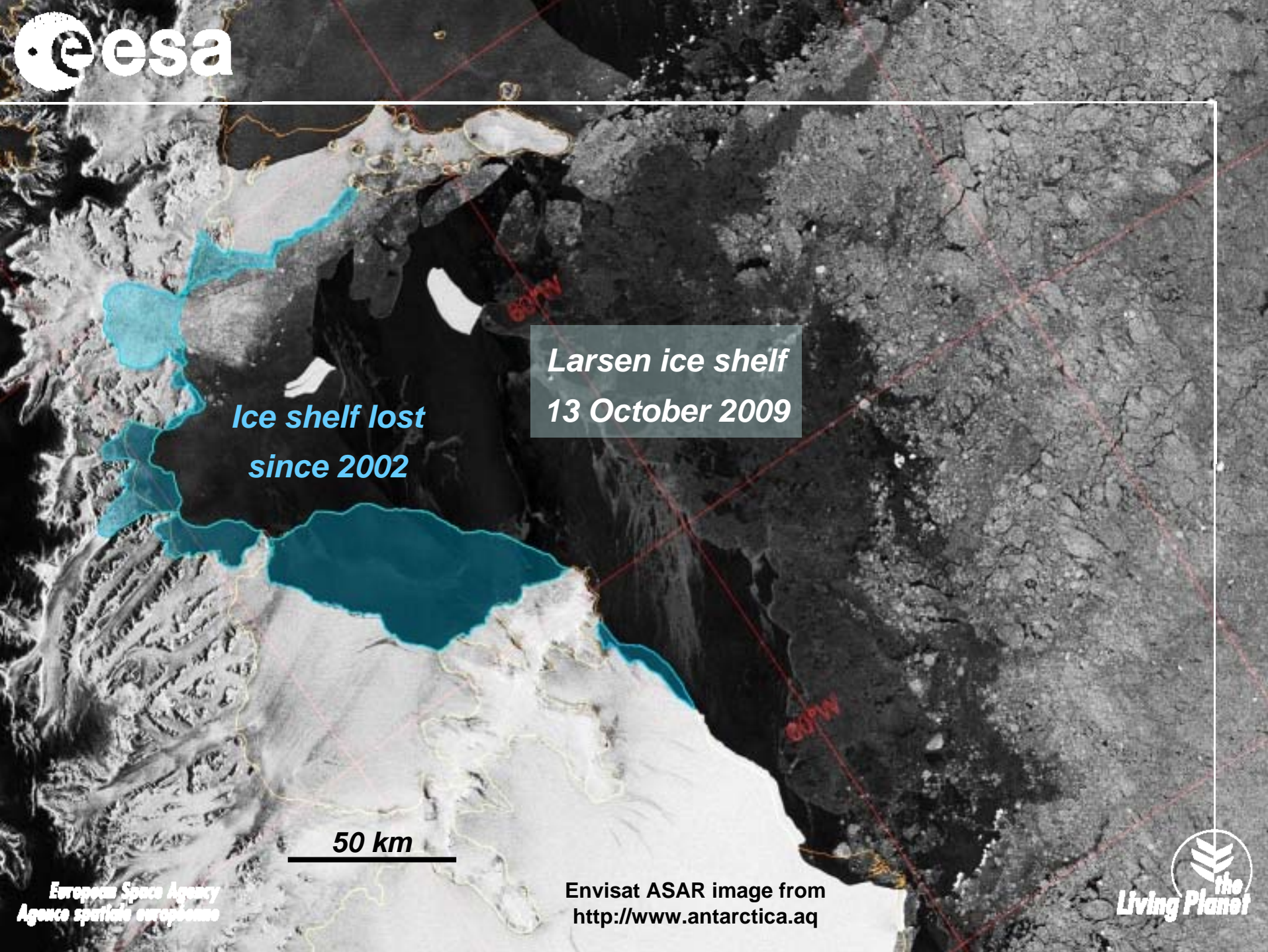
1995

1992

**Larsen-B  
ice shelf  
break-up in  
March 2002**

**As seen  
by ERS-1  
in 1992**

**First Envisat ASAR image  
(March 2002)**



*Ice shelf lost  
since 2002*

*Larsen ice shelf  
13 October 2009*

**50 km**

**Birth of a giant  
iceberg that  
has broken off  
from the Pine  
Island Glacier  
in West  
Antarctica**

**Length: 34 km  
Width: 20 km**

**ASAR  
Wide Swath,  
150 m res.**

Charcot Island

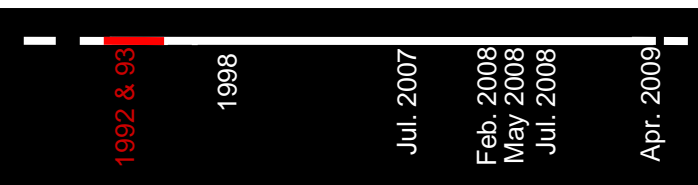
**Wilkins Ice Shelf  
(Antarctica)**

**ERS-1, January 1992**

ERS-1 SAR - 13 Jan 1992

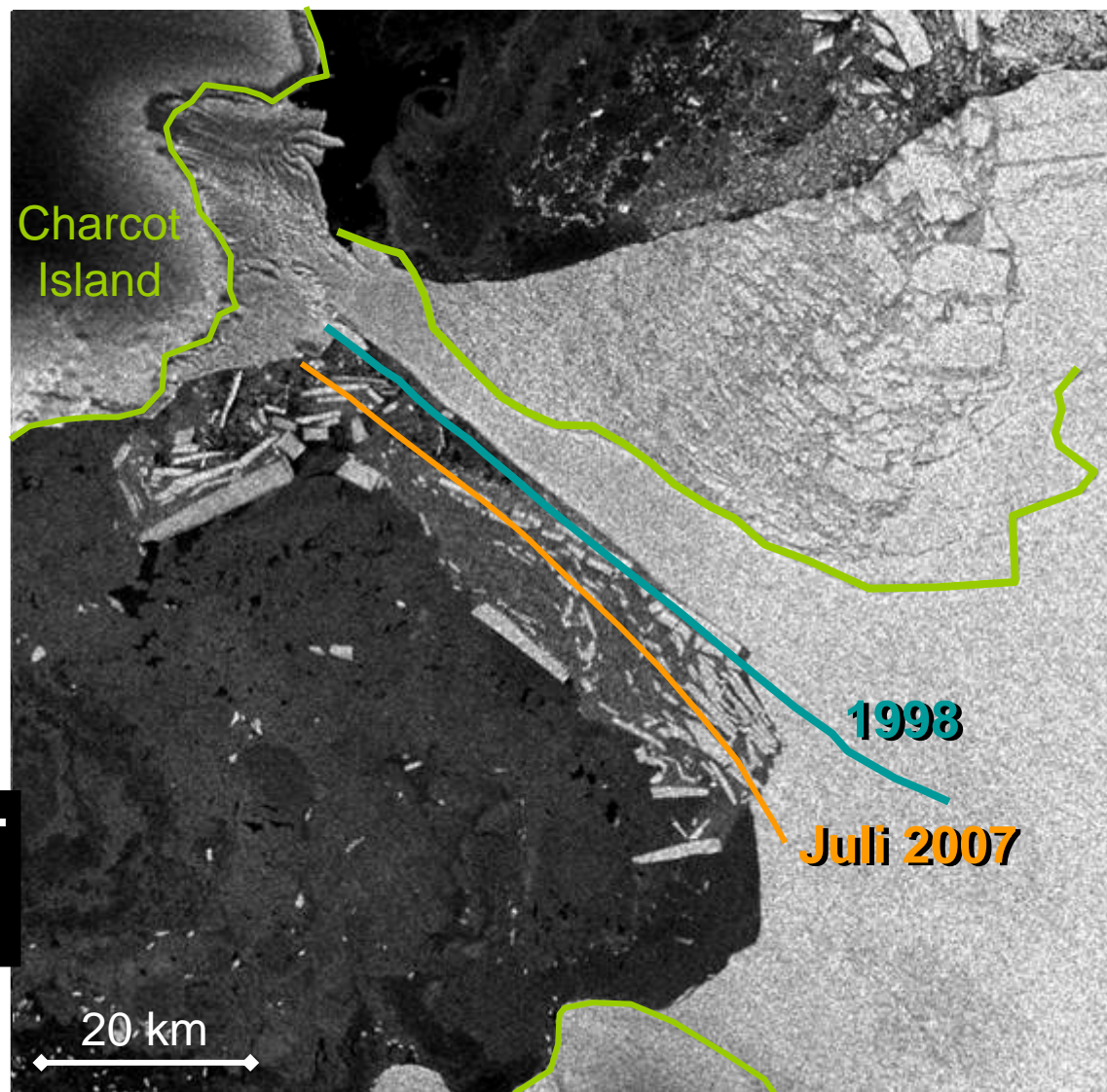
**1998**

**Juli 2007**



## Wilkins Ice Shelf (Antarctica)

February & May 2008



1992 & 93  
1998  
Jul. 2007  
Feb. 2008  
May 2008  
Jul. 2008  
Apr. 2009

Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)

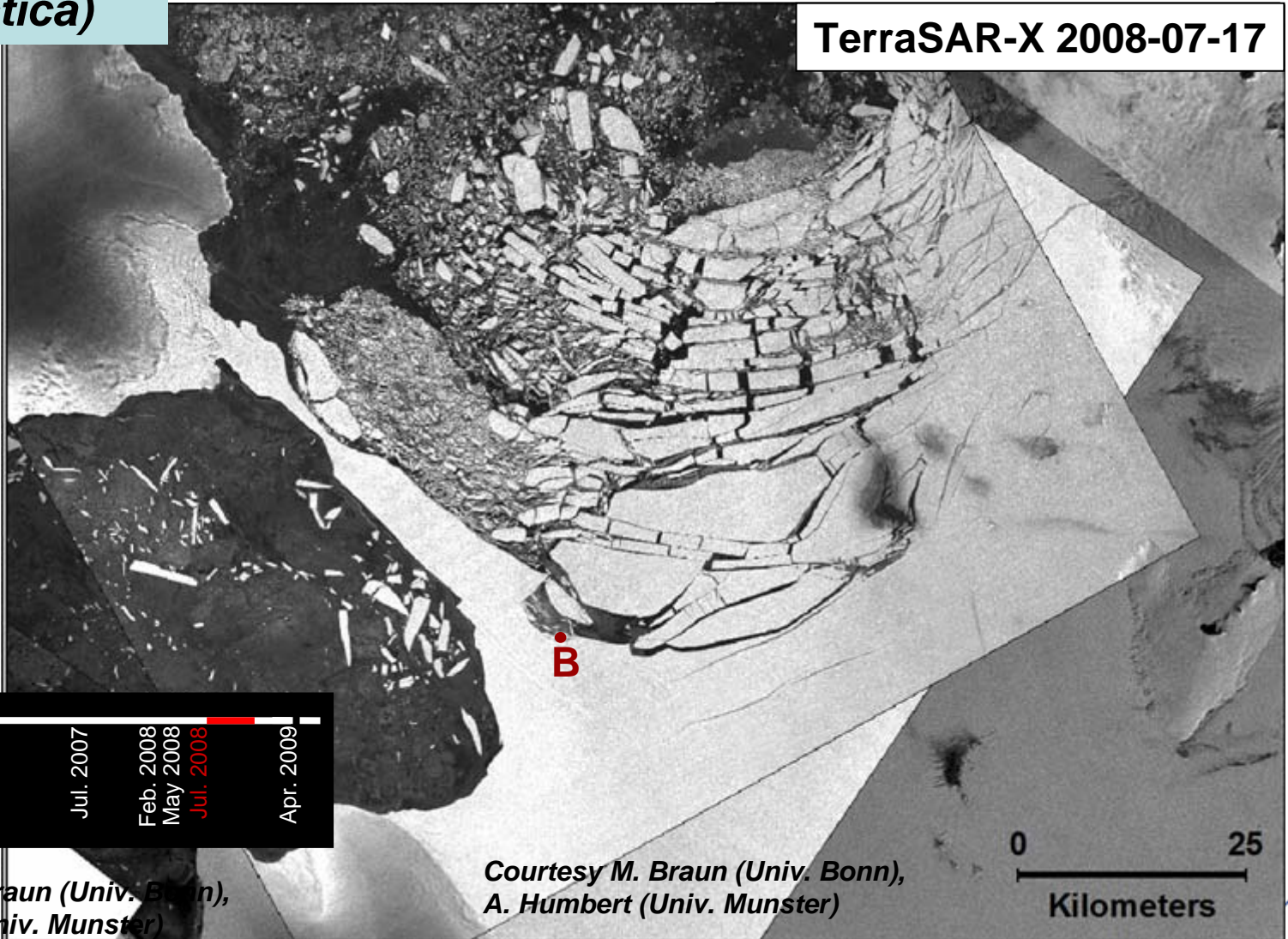
20 km

## Wilkins Ice Shelf (Antarctica)

TerraSAR-X 2008-07-17

*Break-up*

*July 2008*

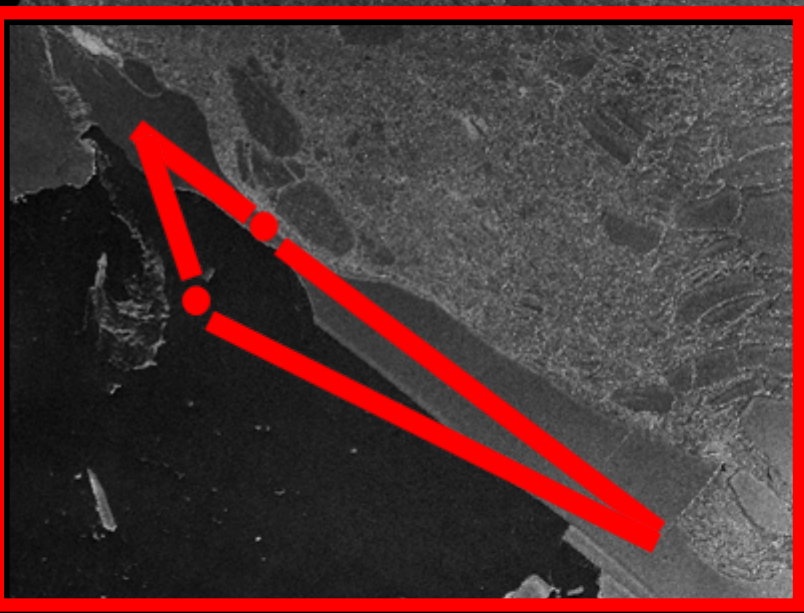


Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)

# Legacy SAR data acquisition for IPY (Antarctica)

## *Collapse of the ice bridge*

***Wilkins Ice Shelf  
(Antarctica)***



1992 & 93

1998

Jul. 2007

Feb. 2008

May 2008

Jul. 2008

Apr. 2009

Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)

**TSX scansar – 10 March 2009**

# Legacy SAR data acquisition for IPY

TerraSAR-X  
04 MARCH 2009  
© DLR, 2009

**Ice front position:**

— 04 MAR 2009

— 29 JUN 2008

↑ ECMWF  
wind direction

↙ Direction of  
movement

● Ice rise

GPS (04 March 2009)

1992 & 93

1998

Jul. 2007

Feb. 2008

May 2008

Jul. 2008

Apr. 2009

Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)

TerraSAR-X / ENVISAT ASAR

01 April / 30 March 2009

© DLR/ESA, 2009

0 6  
Kilometres



• GPS (01 April 2009)

1992 & 93

1998

Jul. 2007

Feb. 2008

May 2008

Jul. 2008

Apr. 2009

Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)

ENVISAT ASAR  
02 April 2009  
© ESA, 2009

0 6  
Kilometres



GPS (02 April 2009)

1992 & 93

1998

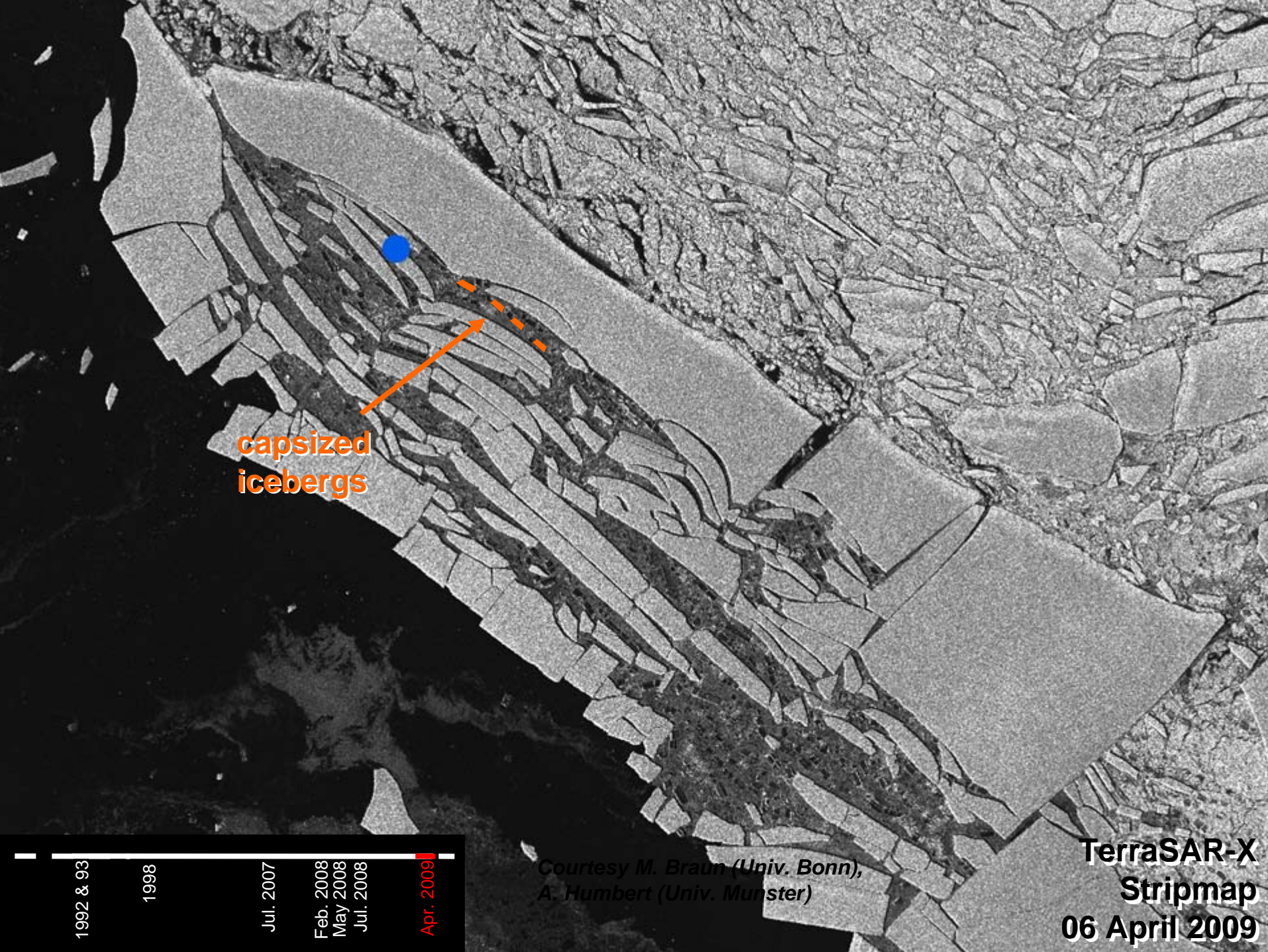
Jul. 2007

Feb. 2008

May 2008

Jul. 2008

Apr. 2009



**capsized  
icebergs**

1992 & 93

1998

Jul. 2007

Feb. 2008

May 2008

Jul. 2008

**Apr. 2009**

*Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)*

**TerraSAR-X  
Stripmap  
06 April 2009**

Legacy SAR data acquisition for IPY

Proposed best  
case scenario  
(May 2008)

Proposed worst  
case scenario  
(May 2008)

*Strong general public  
and media interest:  
→ Webcam from Space  
on ESA web portal*

1992 & 93

1998

Jul. 2007

Feb. 2008

May 2008

Jul. 2008

Apr. 2009

Courtesy M. Braun (Univ. Bonn),  
A. Humbert (Univ. Munster)



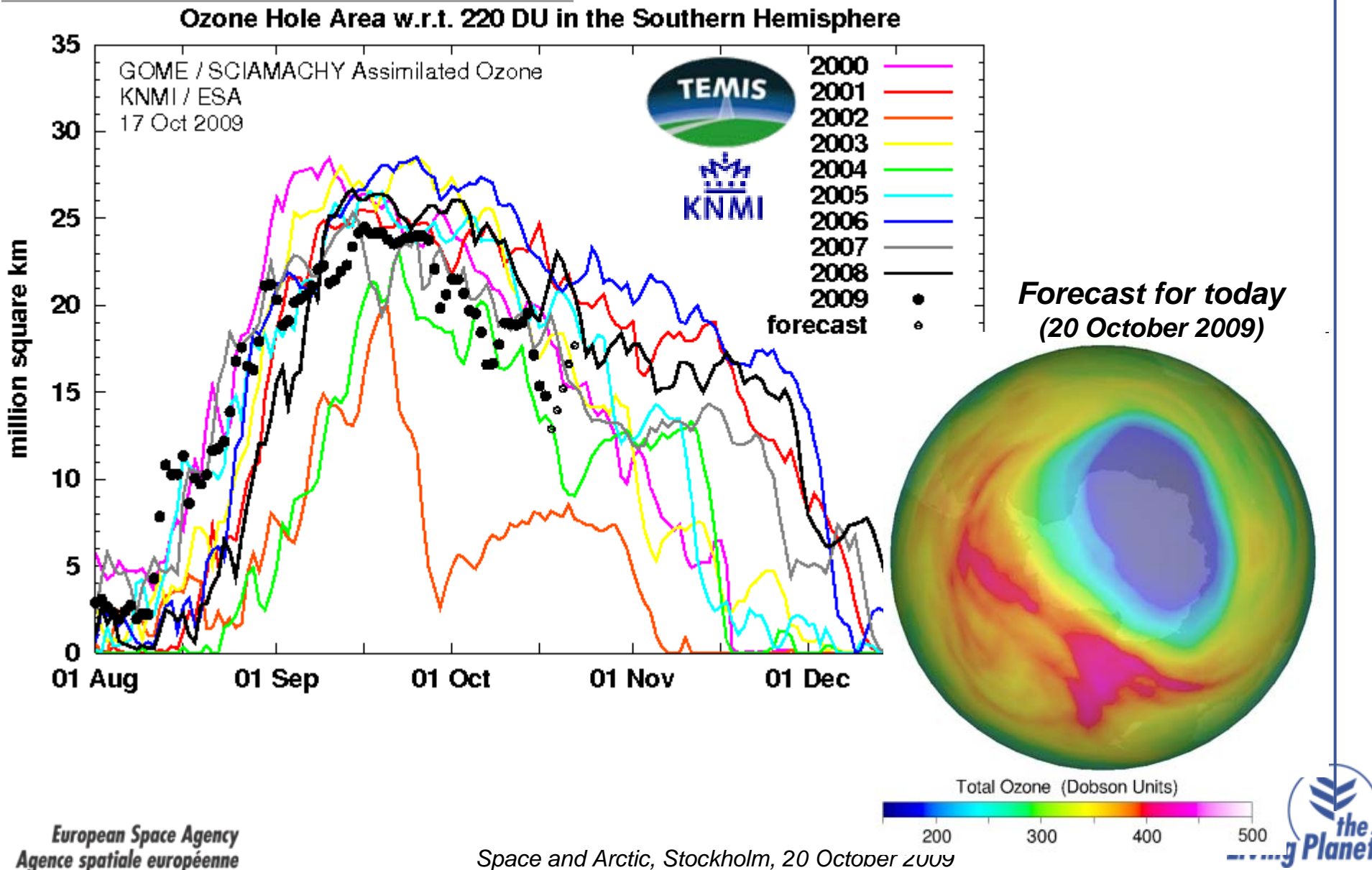
## Polar View:

- Project supported by ESA, EC and CSA
- Promotes the utilization of satellites in the areas of sustainable economic development, marine safety, and the environment.
- Polar View's objective is to provide products for environmental monitoring and safety in the **polar regions**



<http://www.ipy-ice-portal.org>

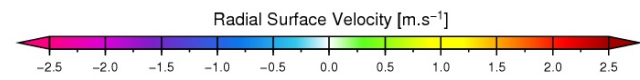
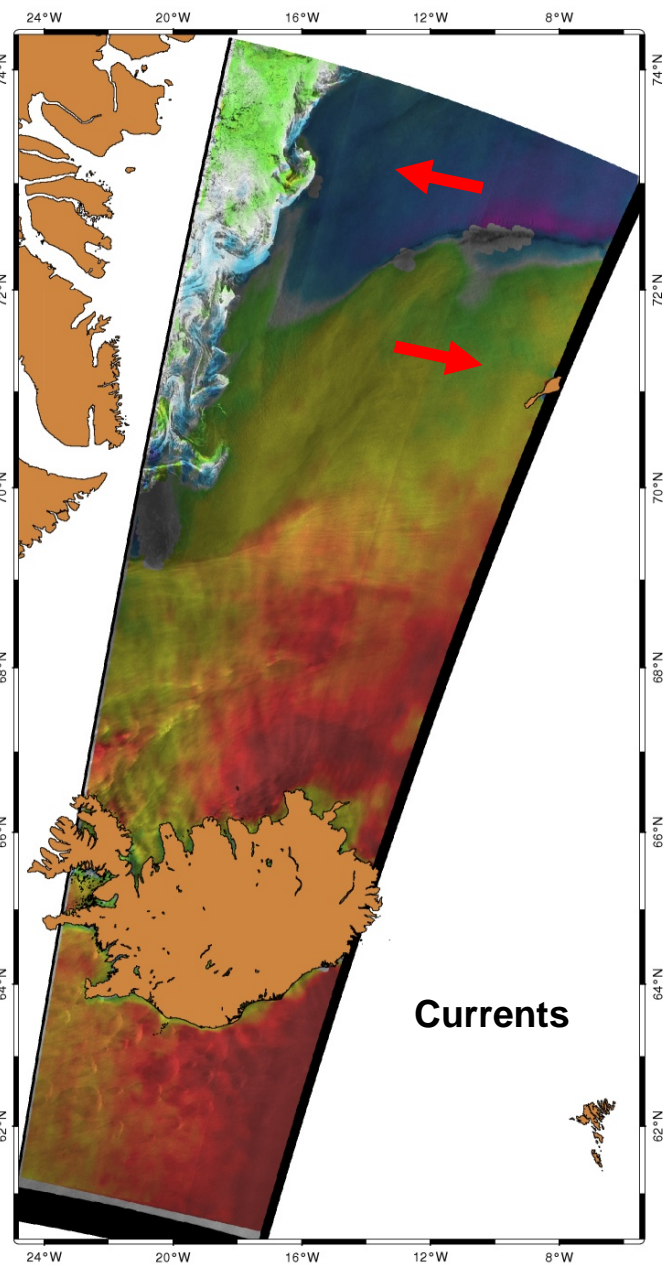
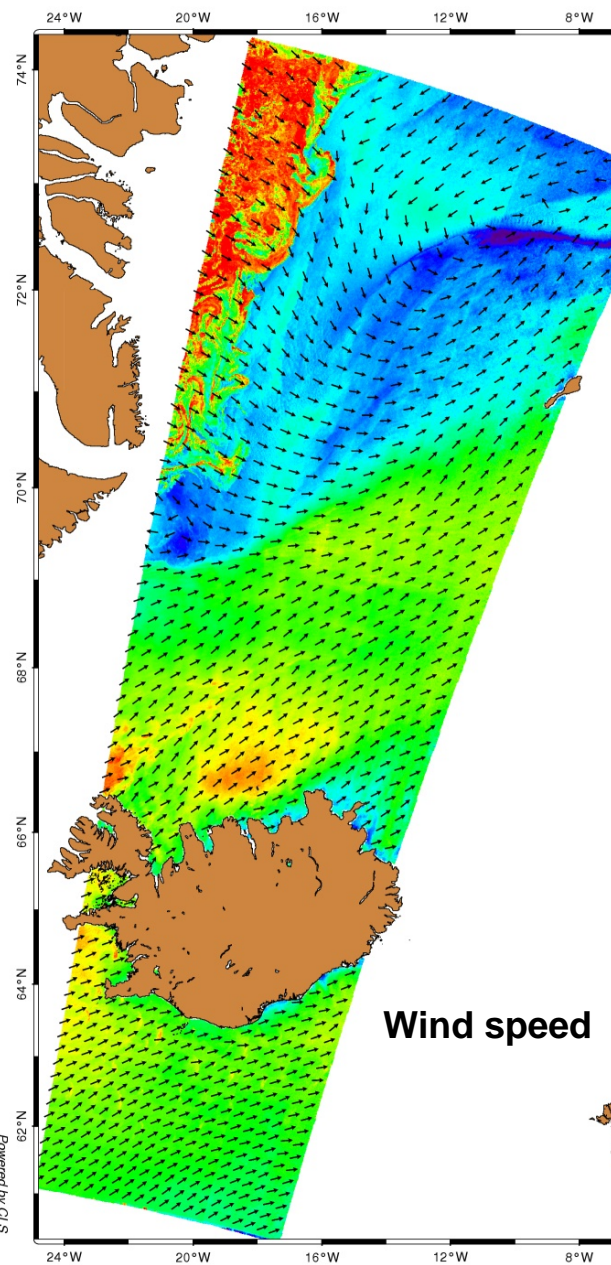
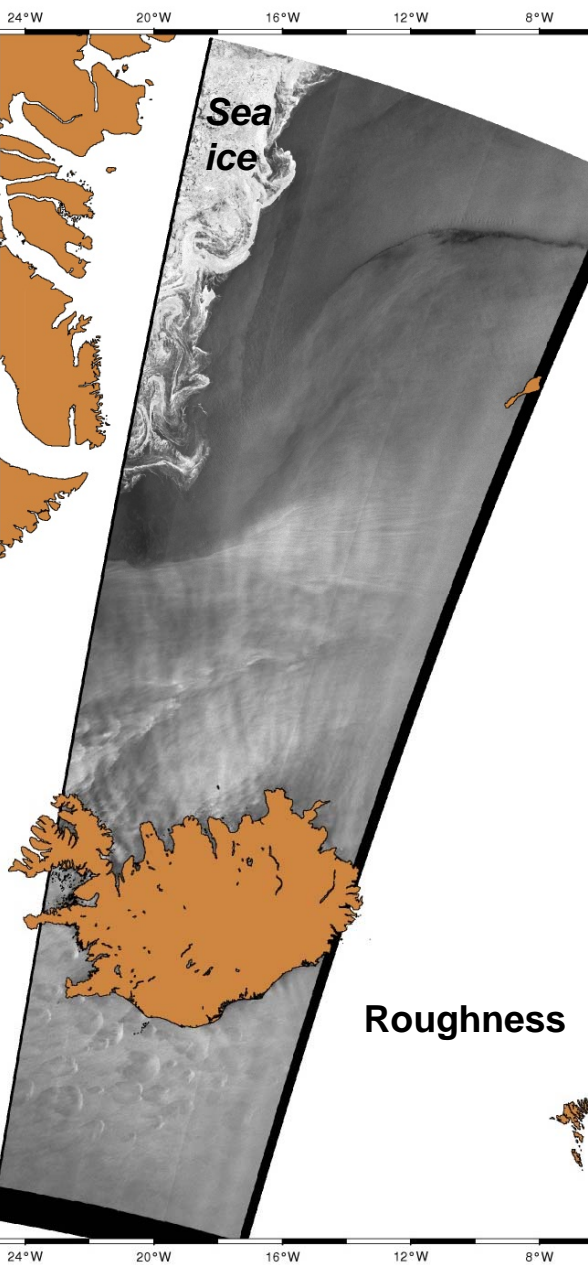
## Legacy Atmospheric data acquisition



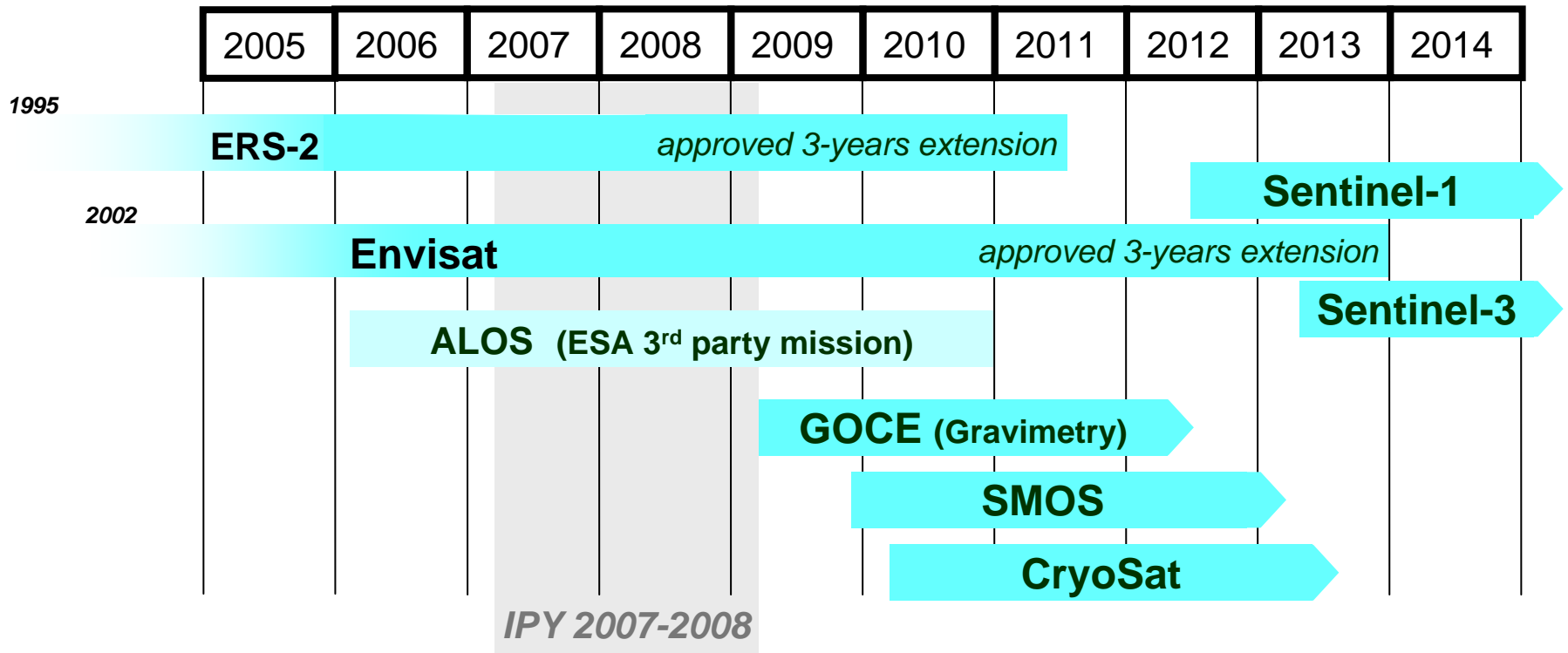
**A constant objective:**

**→ *ease access to Earth Observation data***

- ❑ **Common objective for all missions data handled by ESA:**  
Envisat, ERS, Earth Explorers, and Third Party Missions
- ❑ **New ESA EO data policy in preparation:**
  - **open and free of charge** for most data (user registration)
  - some restrictions for some SAR data and some 3rd Party Missions
- ❑ **Internet access to Near Real Time (NRT) data and to archived data**
- ❑ **Development of alternative ways to provide data (e.g. processing on demand, toolboxes)**
- ❑ **Maintain effort in improving quality of products (algorithms, validation)**
- ❑ **Maintain effort in exploiting data (e.g. ESA Climate Change Programme)**



## ESA EO missions contributing to polar observations



# CryoSat mission objectives

- To determine fluctuations (rates of change) in the Earth's ice fields
  - sea-ice thickness
  - mass balance of ice-sheets and ice-caps
  - variations in major glaciers
- Technique: advanced radar altimeter – SIRAL
  - high pulse repetition with interferometric capability
  - operates in several modes adapted to surface type
  - supported by additional instrumentation (DORIS, Star Trackers, Laser Retro-Reflector)



- *Higher spatial resolution*
- *Factor 10 improvement in sampling over sea ice*
- *Sampling of dynamic ice sheet margins*
- *Measurements to 88° latitude*

## Sentinel-1: C-band SAR mission



### Applications:

- monitoring sea ice zones and the arctic environment
- surveillance of marine environment
- monitoring land surface motion risks
- mapping in support of humanitarian aid in crisis situations

### 4 nominal operation modes:

- strip map (80 km swath, 5X5 m res.)
- interferometric wide swath (250 km swath, 20X5 m res.)
- extra wide swath (400 km swath, 25X100 m res.)
- wave (5X20 m res.)

2300 Kg spacecraft mass

Sun synchronous orbit at 693 Km mean altitude

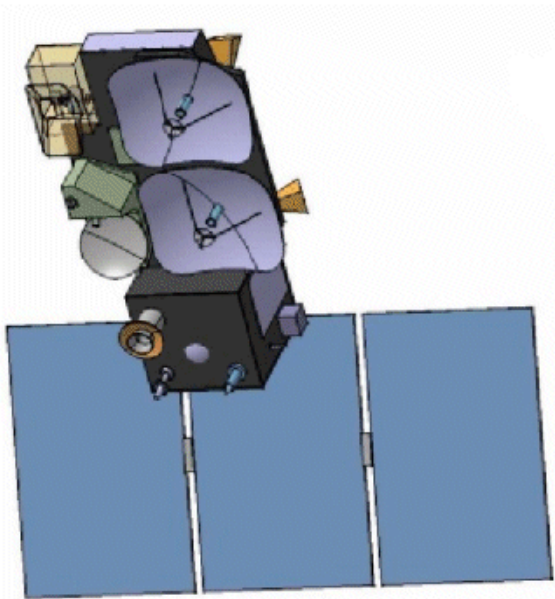
12 days repeat cycle

7 years design life time, consumables for 12 years

Sentinel-1A: launch 2012

Sentinel-1B: foreseen 2015

## Sentinel-3: ocean & global land mission



### Applications:

- sea/land colour data and surface temperature
- sea surface and land ice topography
- coastal zones, inland water and sea ice topography
- vegetation products

1198 kg spacecraft mass

Sun synchronous orbit at 814.5 km  
mean altitude over geoid

27 days repeat cycle

7 years design life time, consumables  
for 12 years



<http://www.esa.int>

<http://earth.esa.int>

*[eohelp @ esa.int](mailto:eohelp@esa.int)*