



Iceberg monitoring service by joint use of drift model, SAR and altimeter data

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Collecte Localisation Satellites (CLS)

SeaSAR, Tromso, June 21, 2012

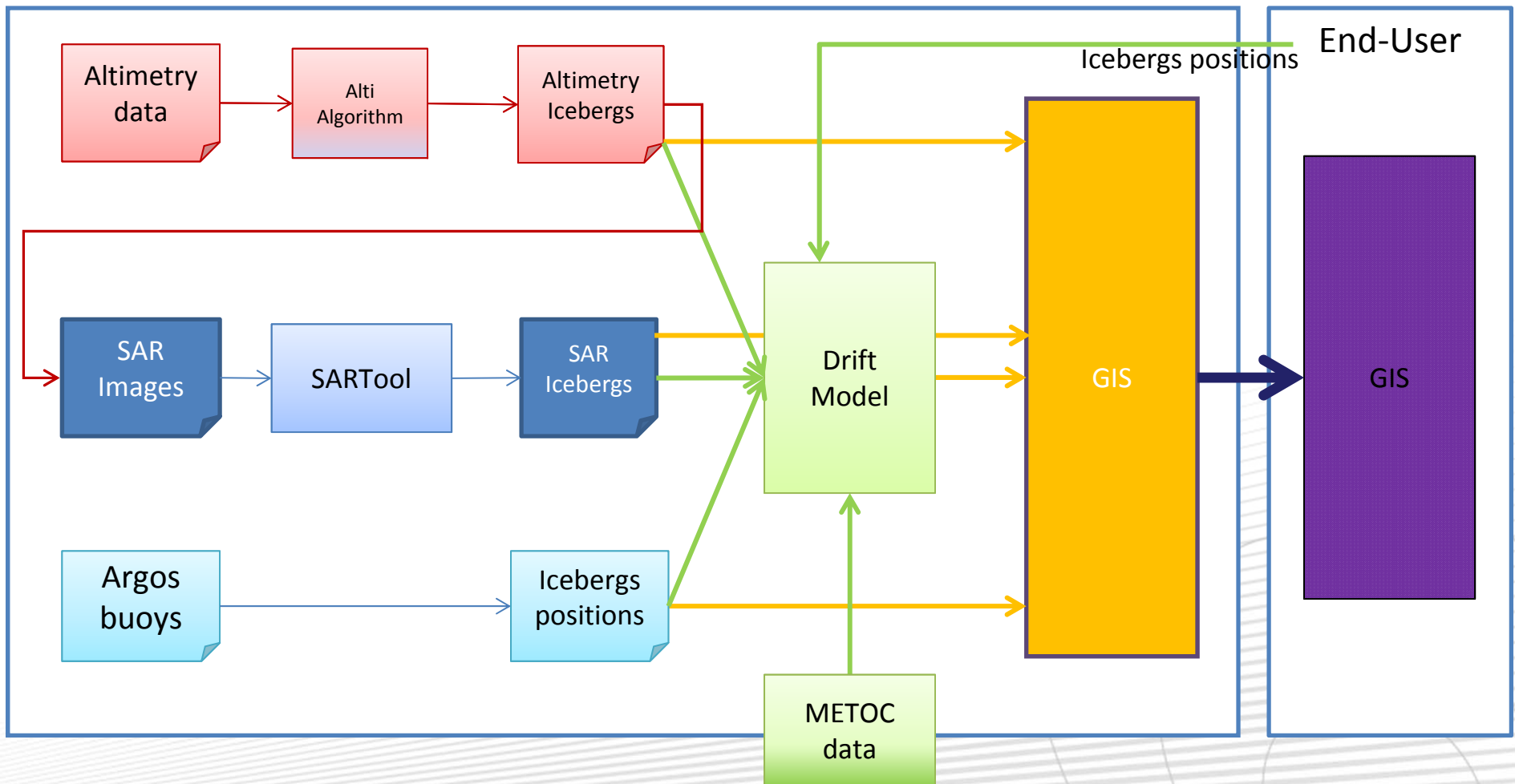
Iceberg monitoring service



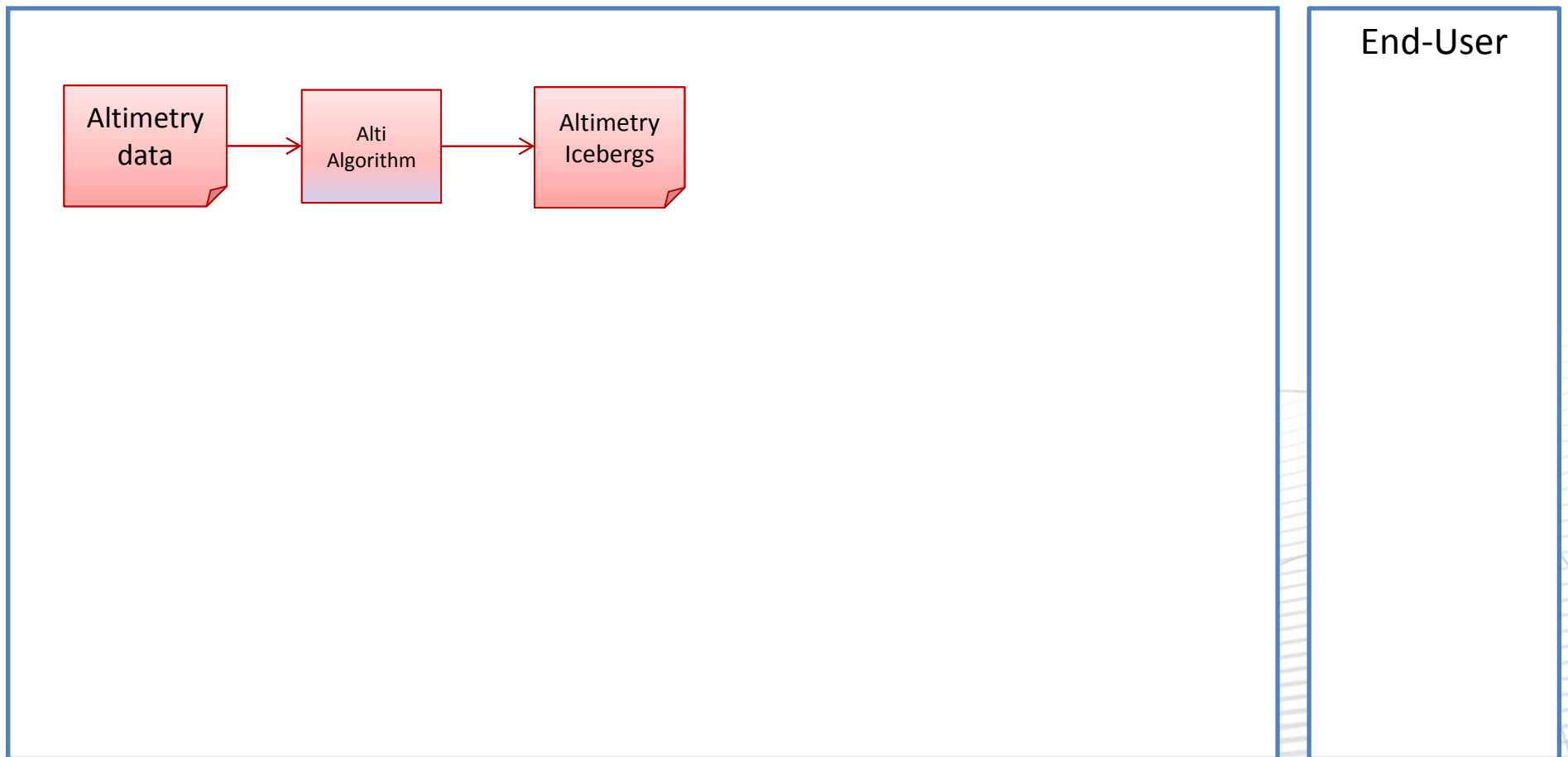
- An 24/7 Iceberg detection service delivered during
 - **the Vendee Globe Challenge (2008-2009)**
a sailing race around the world, for single-handed, without any stopover
 - **the Jules Verne Trophy (2010)** record attempt with Groupama 3 skippered by Franck Cammas
 - **the solo round the world (2011)** of Sodebo skippered by Thomas Coville
- Service included
 - Preliminary iceberg detection by altimeter
 - Iceberg detection using SAR imagery
 - Iceberg drift forecast
- Further scientific/technical development
 - SIDARUS FP7 project
 - CITEPH program
(sponsored by GEP – Total oil company, Doris, CGG Veritas ...)

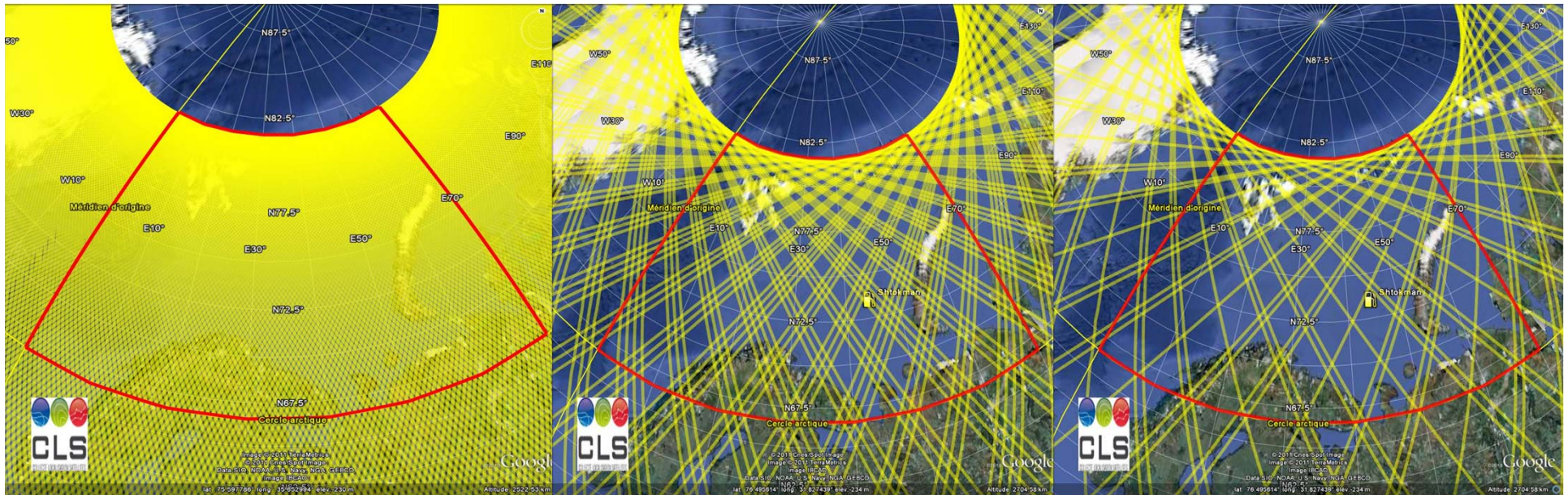


System and processing chains



System and processing chains





35-day coverage of EnviSat

10-day coverage of EnviSat

3-day coverage of EnviSat

- Area illuminated by the radar
 - 10-20 km on each side of the track
- Area that actively contribute to the leading edge of the waveform (beginning of the peak)
 - Not more than 5 km on each side of the track (depending on the sea state condition) useful for iceberg detection



- Cumulative approach over one month

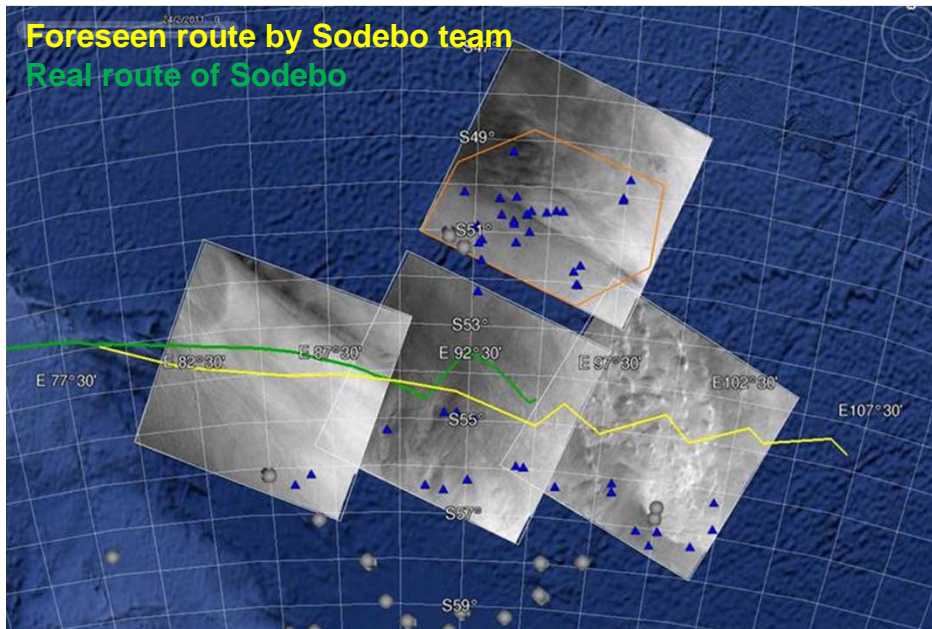
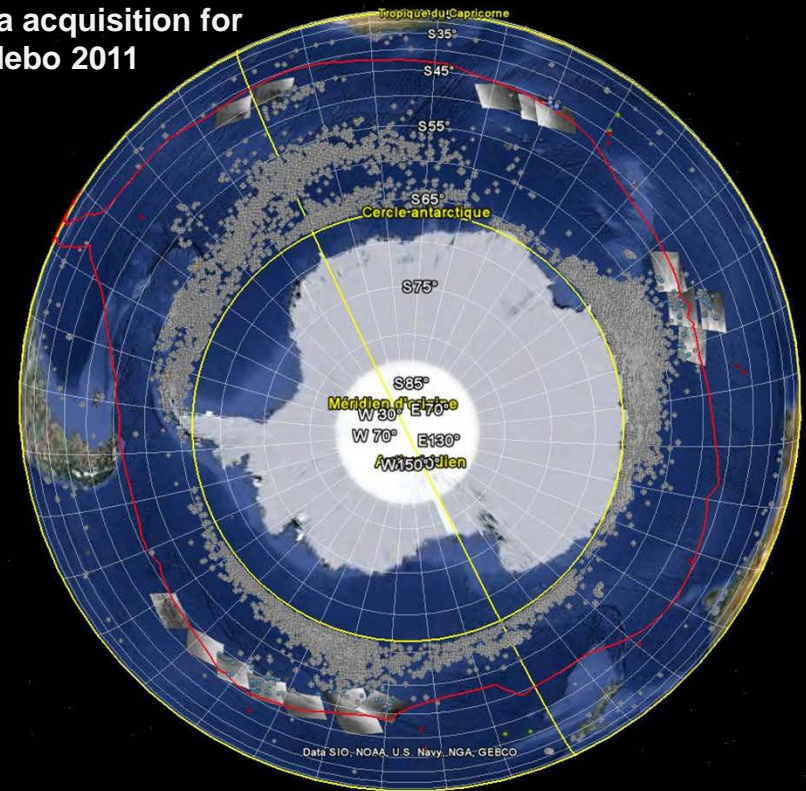




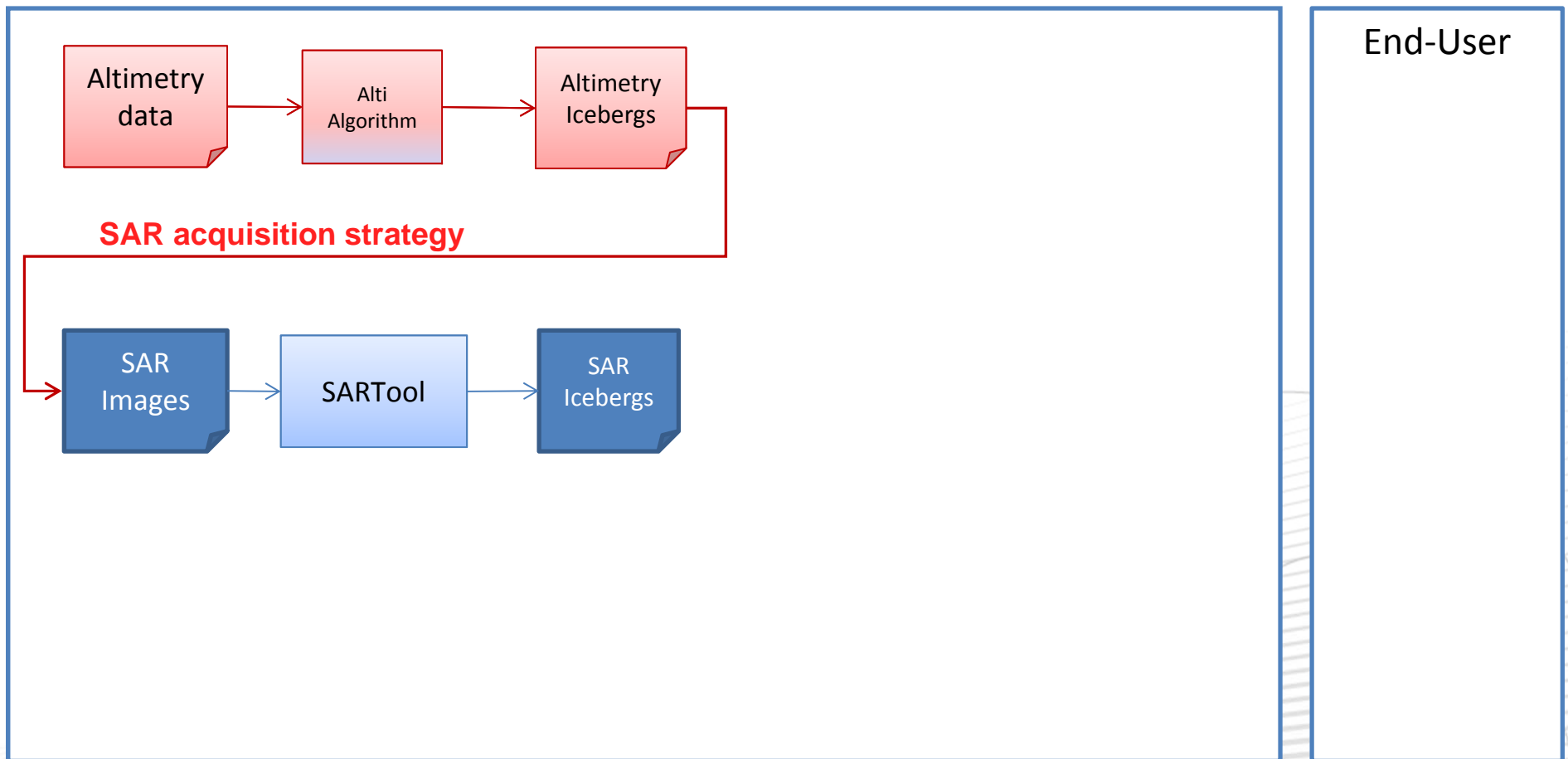
2008-2009: During Vendée Globe Challenge, **250 ENVISAT SAR** images were used to monitor icebergs: Very efficient but the market is not ready today for such a high volume of SAR acquisitions

2010 Jules Verne Trophy : 30 RS2 SAR scenes were programmed in short notice over pre-identified risky areas.

Data acquisition for Sodebo 2011

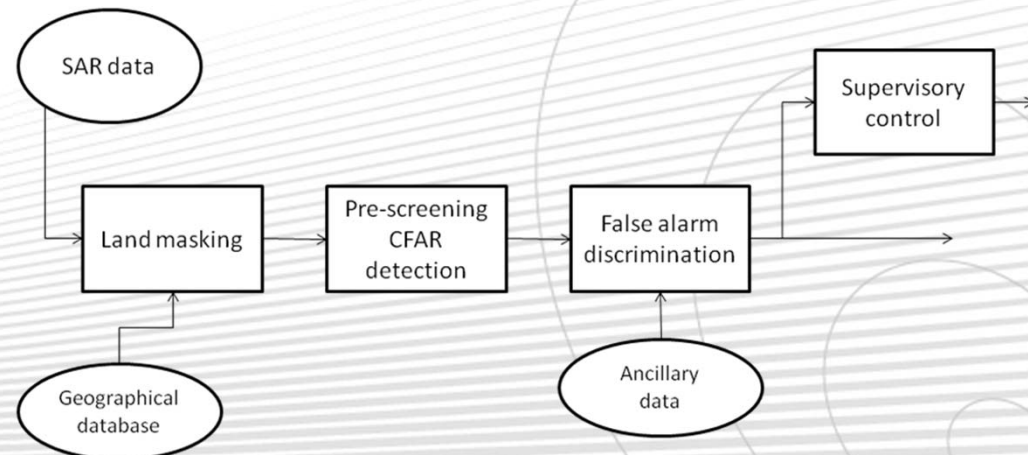


- Use of altimetry allows more efficient planning of SAR acquisition over risky areas
 - Risky areas can be identified and tracked well before the passage of the sailboat



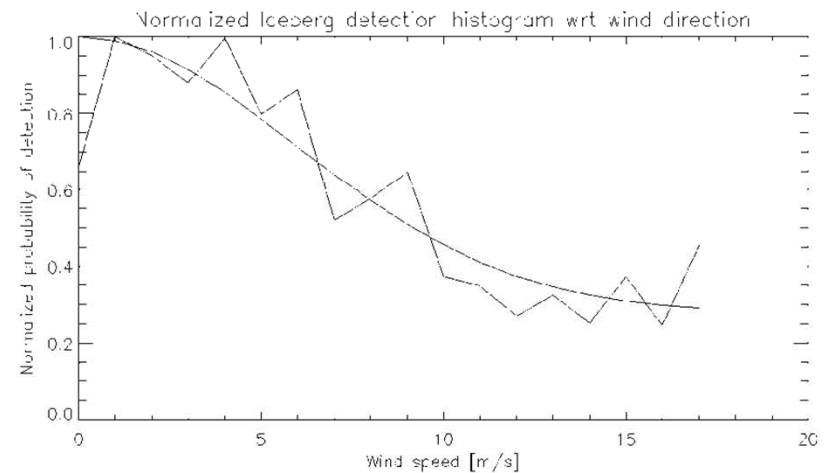
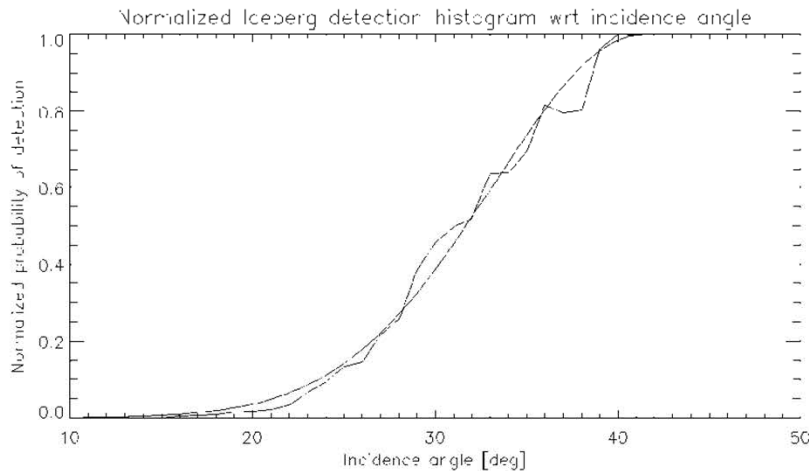


Imaging mechanism	Possible detection methods	Comments
Double-bounce scattering	CFAR-like approach	Commonly used method, robust, good capacities except at steep angle or strong wind condition
Shadowing, Specular reflection	Dark point-target detection	Observable with decametric resolution only
Effect of surrounding sea surface, Wakes	Segmentation, Hough transform	Strongly depend on sea condition
Shape	Image segmentation	Large icebergs only
Volume scattering	Multifrequency or polarimetric approach	Observable only with multi channel data, for sea surface only





- Over 218 ASAR WSM in HH channel from Vendée Globe 2008-2009 dataset
 - No ground truth but a systematic detection approach
 - Occurrences of detection wrt incidence angle, wind speed
 - Valid for WSM products only (150m resolution – 75 m pix. spacing).
 - medium (61-122m length), large (123-213m) and extra-large (> 213m) icebergs



- Incidence angle appears as a critical parameter.
 - Below 30°, the detection rate is particularly low
- CFAR algorithm: based on the supposedly high contrast between the iceberg and the ocean clutter
 - Increase of ocean backscattering (linked to incidence angle or wind speed) -> diminution of the overall detection accuracy.

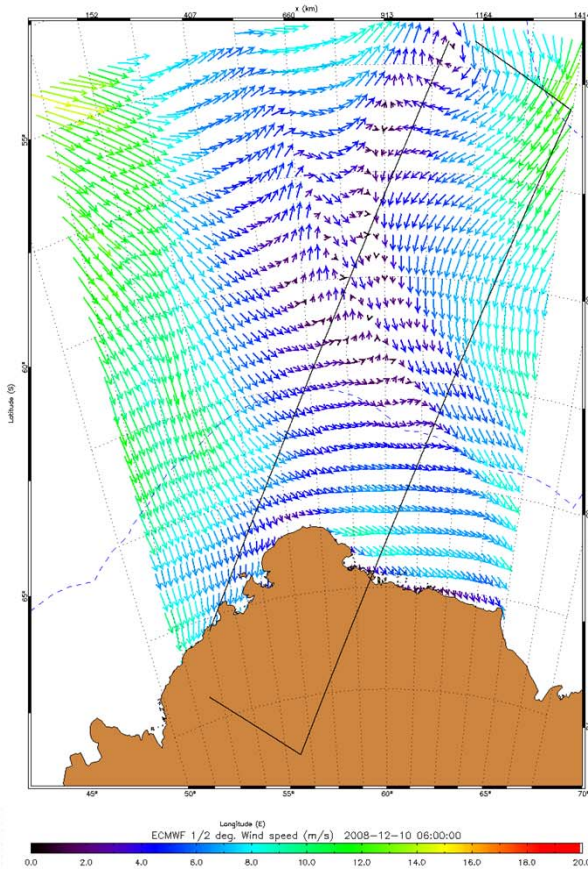


- Modeling of detection performance
 - Given incidence angle and wind speed (by ancillary data) -> a priori probability of detection

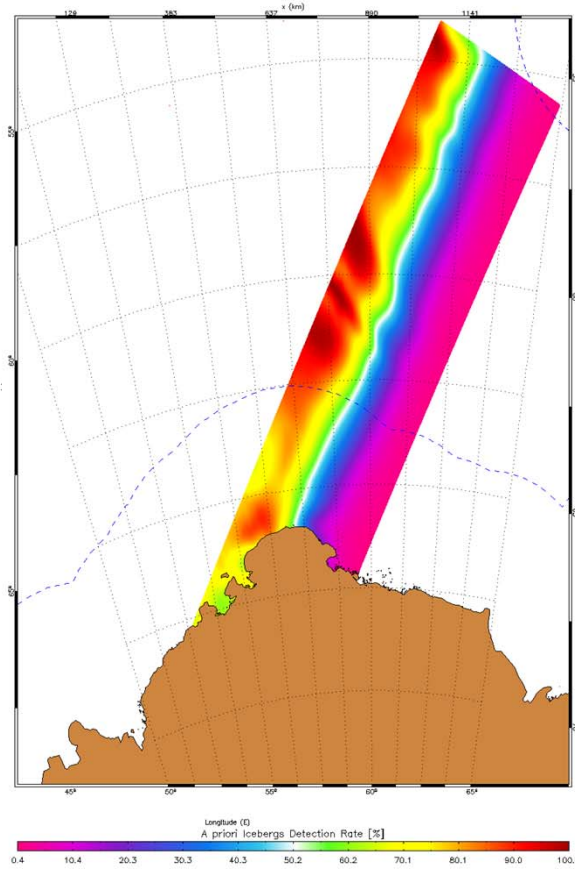
CLS

CLS

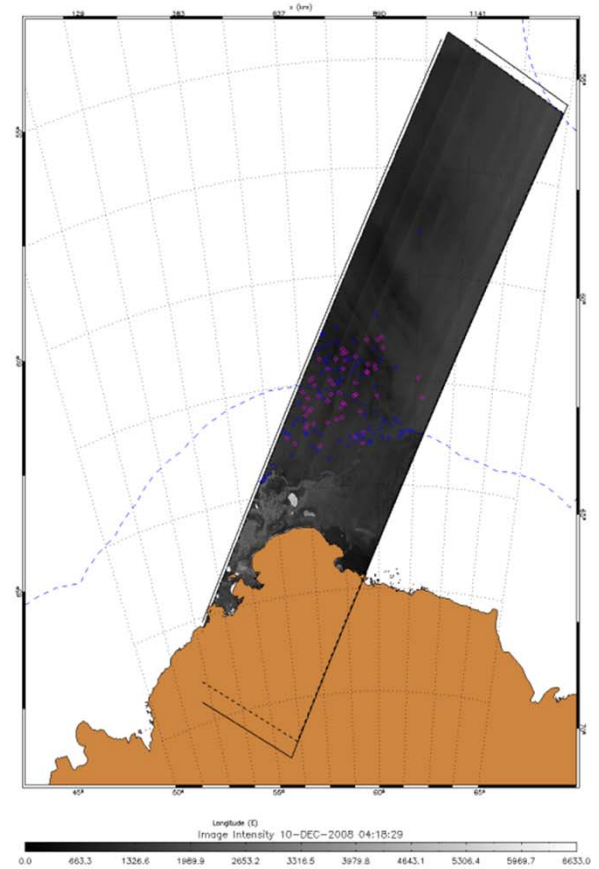
CLS



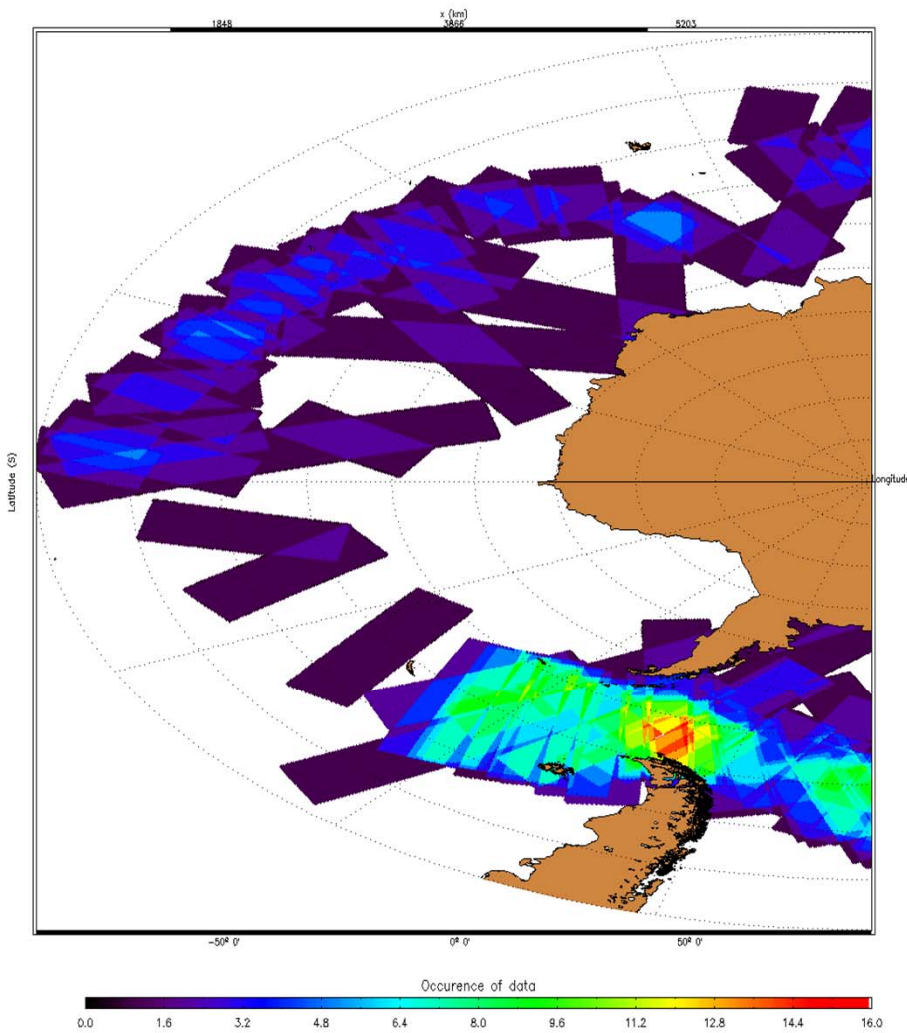
ECMWF wind field



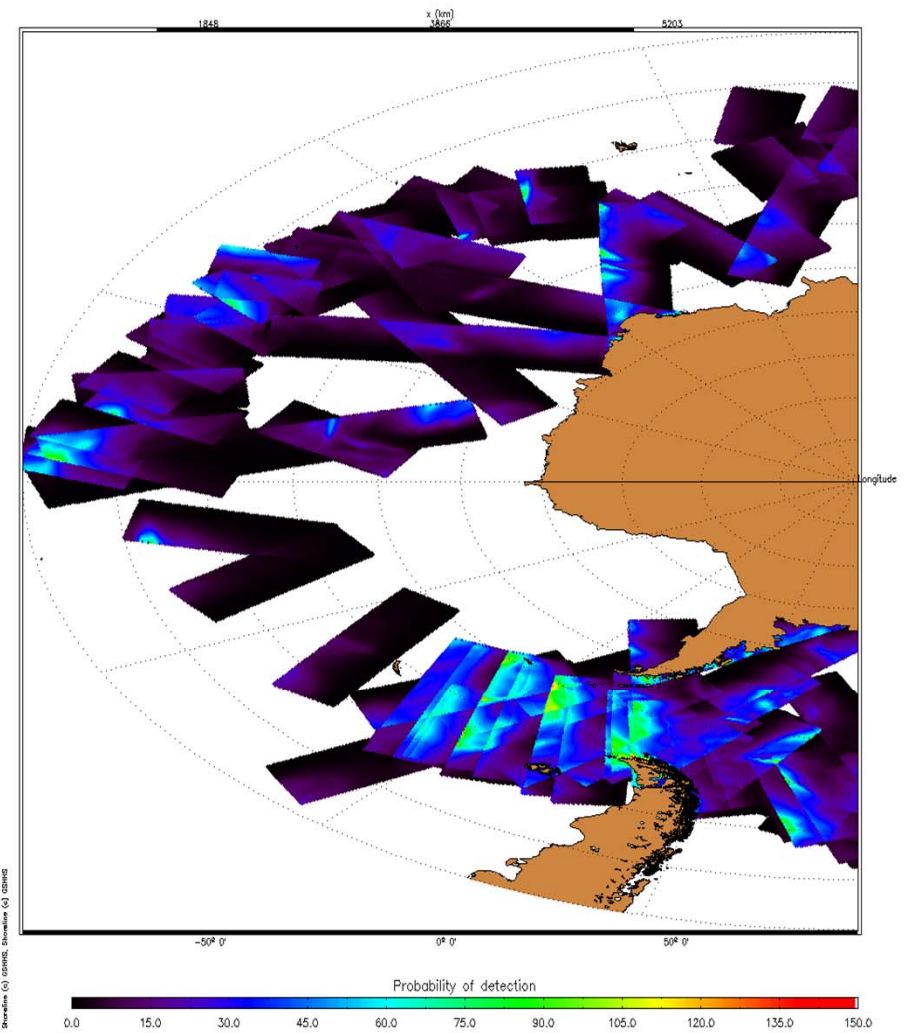
A priori iceberg detection rate



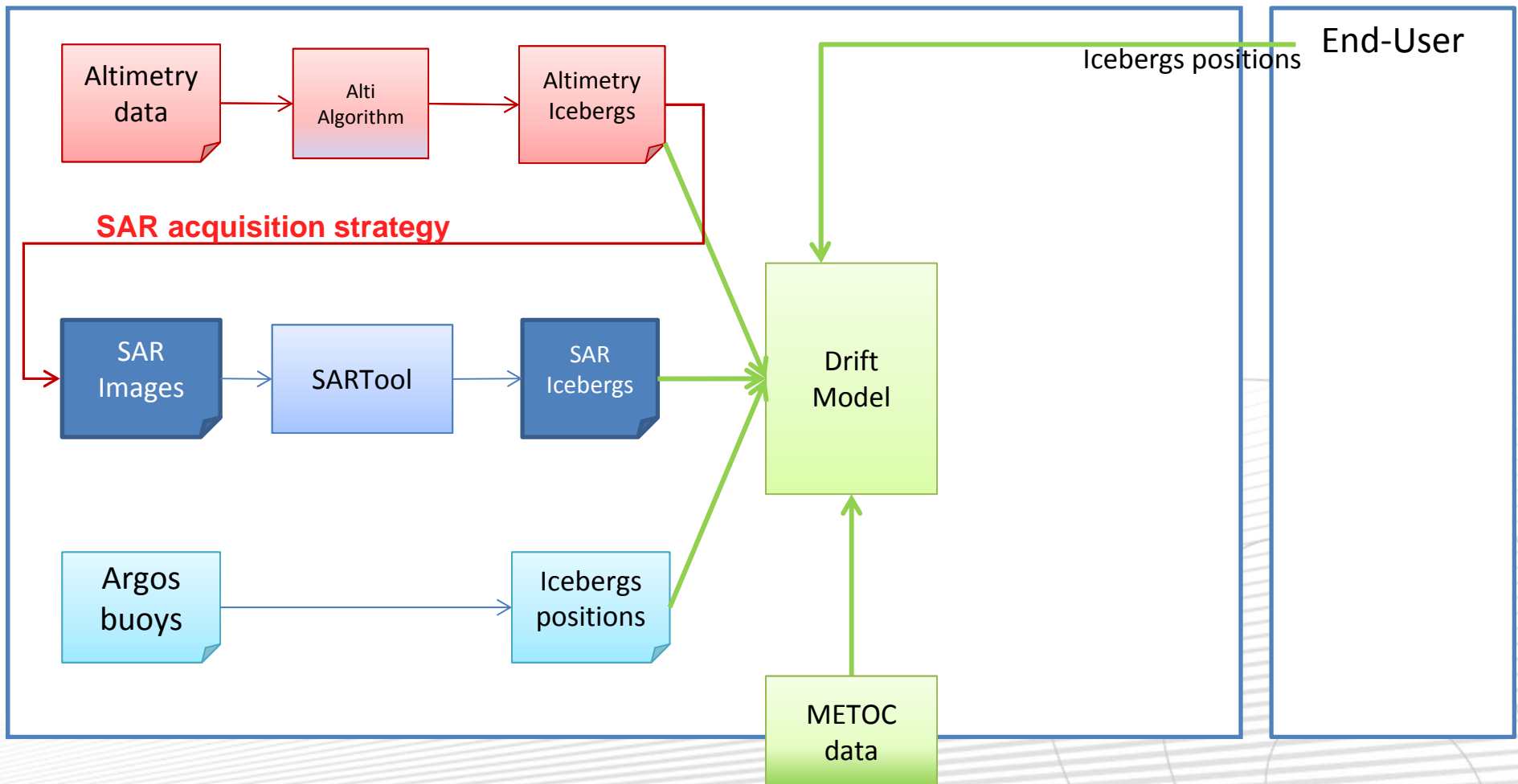
Detected icebergs



WSM acquisitions in South Atlantic and Indian Oceans from Dec 2008 – mid-Feb 2009



Probability of icebergs detection





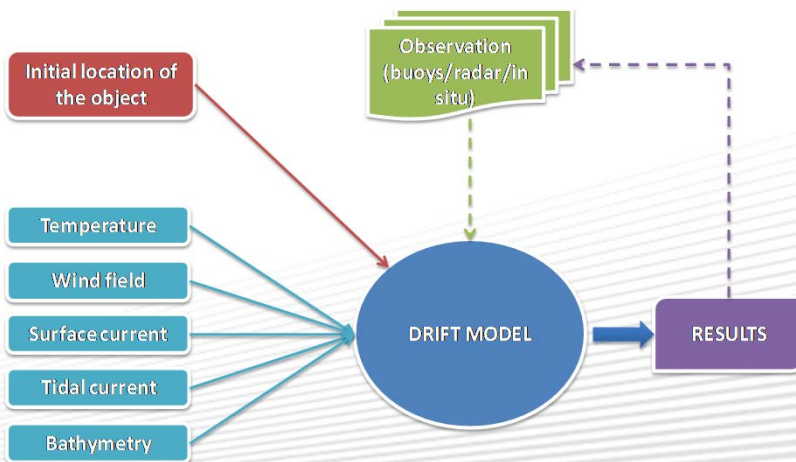
MOBIDRIFT

Icebergs

Oil spill

Leeway

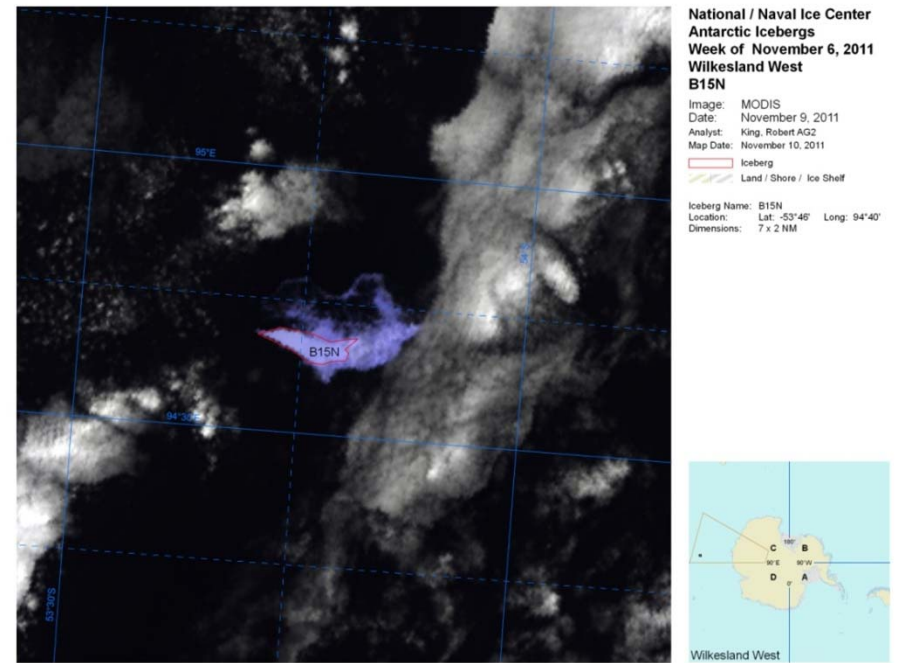
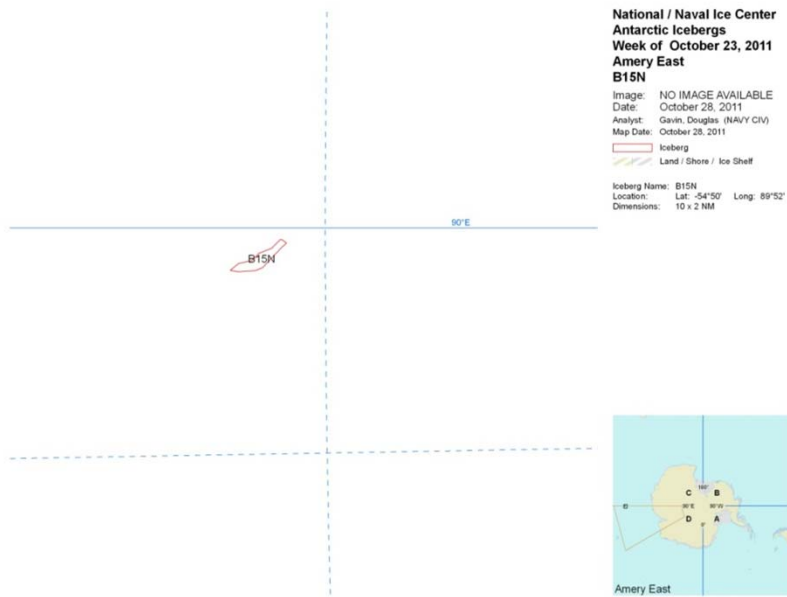
Container



Iceberg modeling with

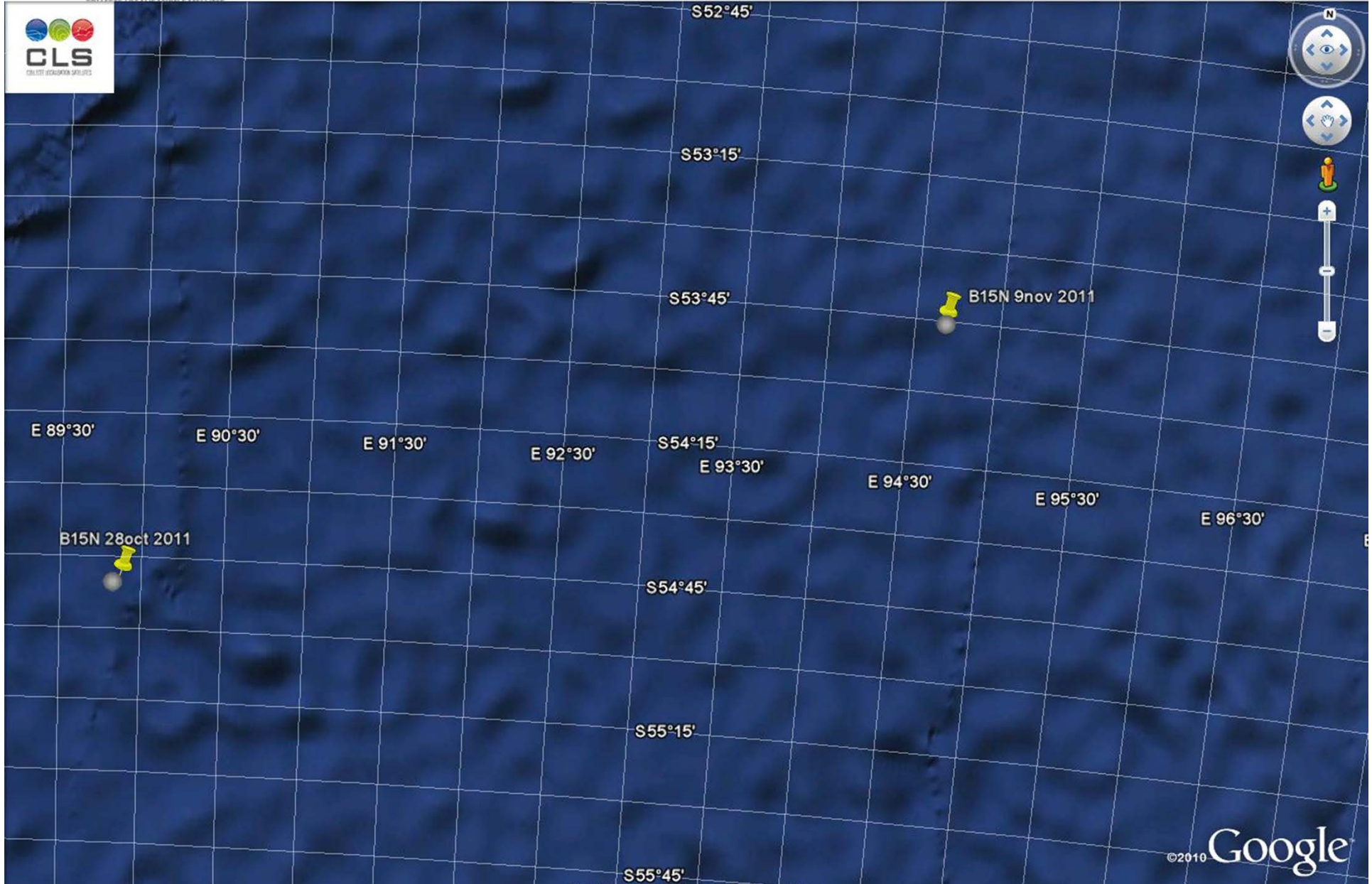
- advection
- thawing
- rolling over
- dislocation
- icebergs generation

Example of Drift modelling and validation with B15N



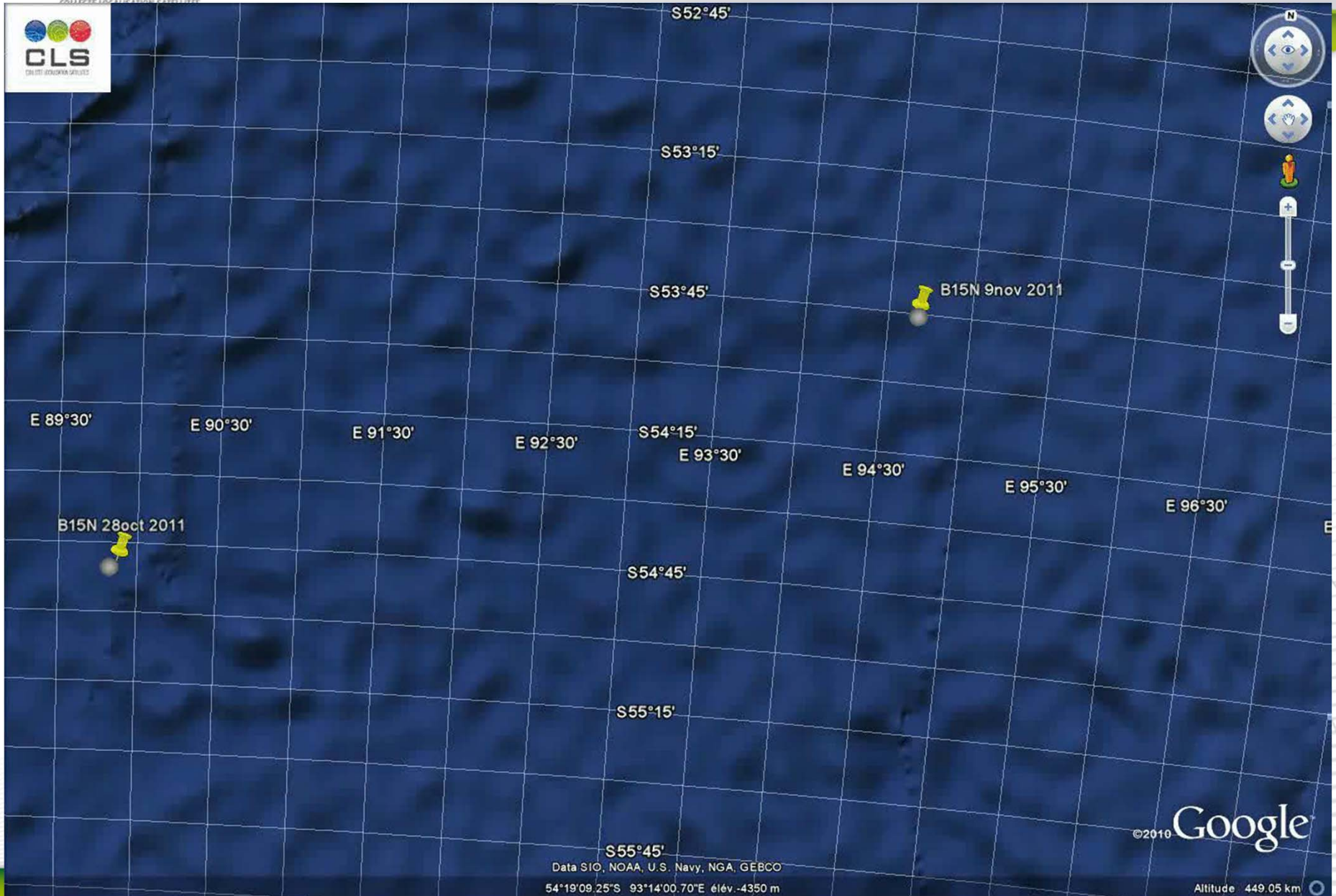


B15N: Status Oct., 28 and Nov. 9, 2011





B15N: Drift simulation from Oct., 28 and until Nov. 9, 2011





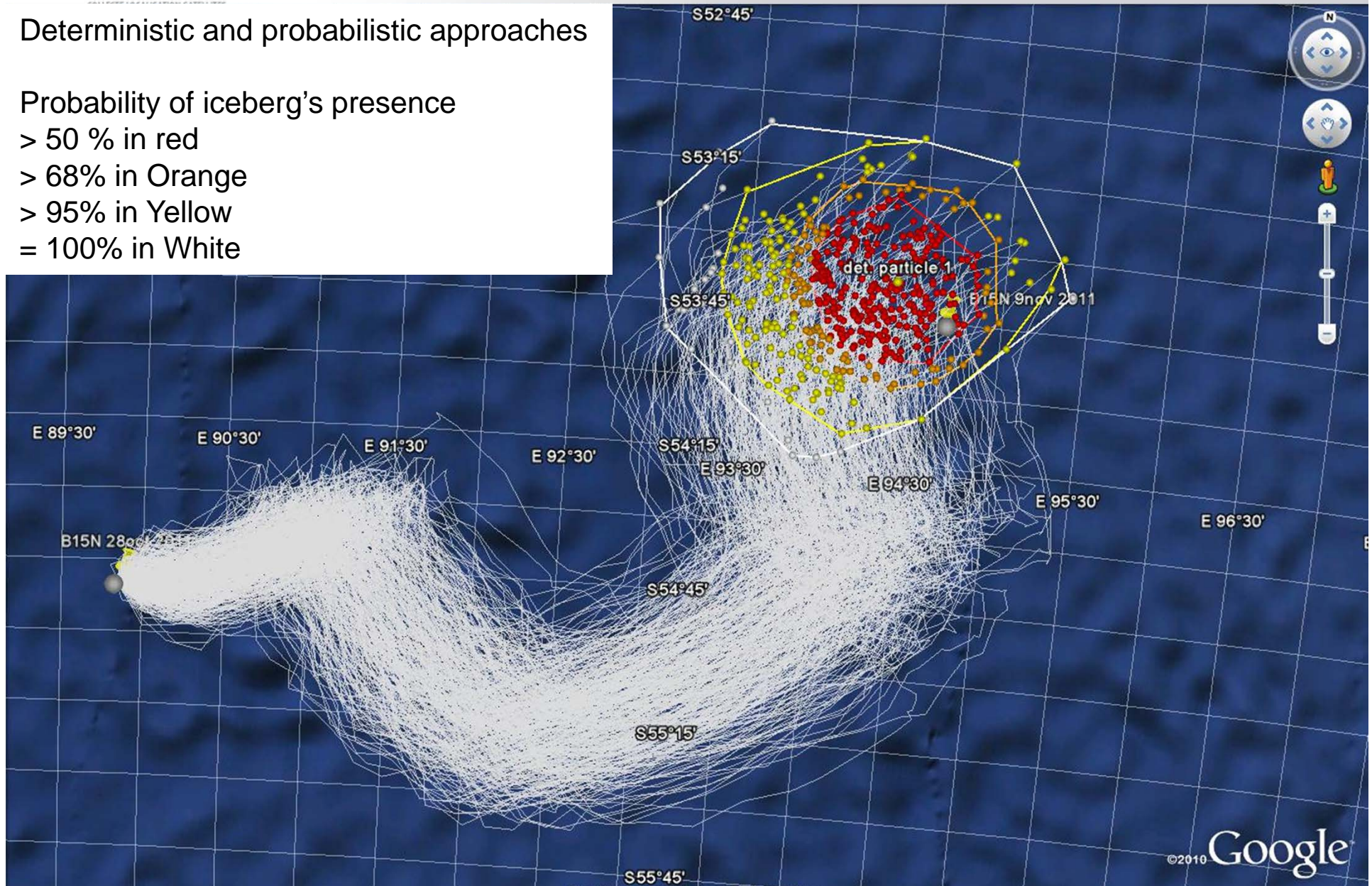
B15N: Drift simulation from Oct., 28 and until Nov. 9, 2011



Deterministic and probabilistic approaches

Probability of iceberg's presence

- > 50 % in red
- > 68% in Orange
- > 95% in Yellow
- = 100% in White





- Development of a complete prototype for iceberg detection and forecast
 - Use of altimetry: more efficient planning of SAR acquisition over risky areas
 - SAR data enable a reliable and well-controlled iceberg detection
 - Drift model for an Early Warning System
- Technical/scientific challenges
 - Complete integration of various data types (SAR, altimeter and metoc data)
 - Ensure a low false alarm rate with altimetry (waveform analysis)
 - Ensure a good SAR-based detection rate even in the icepack
 - Integration of SAR-based sea ice map -> toward an automated methodology ?
 - Tune the CFAR-based method ?
- Future demonstrations
 - **the Vendee Globe Challenge (2012-2013)**
 - **An Early Warning System for oil platform**, ongoing prototype demonstration for the Shtokman gas field in the Barents Sea

