TanDEM-X measurement of sea ice drift and sea surface current in the Fram Strait and in the Baltic Sea

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Photo: Anders Berg, Chalmers

4th TanDEM-X Science Meeting, 12 – 14 June 2013

Outline

- Project objectives
- Test sites
- Data availability
- Sea ice drift
- Sea surface current
- Summary and discussion

Objectives

- Implement and improve algorithms and methods for retrieval of *sea surface current* and *sea ice drift* from TanDEM-X along track interferometry data.

- Validate the algorithms and methods through dedicated field campaigns and comparisons with independent data sources.

- Evaluate possibilities to use retrieved information for validation of climate and ocean circulation models.

- Evaluate the usefulness for future scientific and operational use.

Test Sites

- Sea Surface Current:
  - Baltic Sea: SMHI operate buoy at Huvudskär.
  - Kattegatt: SMHI operated buoy at Läsö.
  - Skagerak: Proposed location for a future Nordic Network of coastal radars.
  - Svalbard: Warm water from the Atlantic
- Sea Ice Drift:
  - Gulf of Bothnia: Easy access and previous experience of field campaigns in the area.
  - Fram Strait: Important for sea-ice transport from the Arctic Ocean

Data Request

- Surface Currents
  - Optimal along track baselines of 30-50 m (KoRIOLIS project report 2002, papers by Romeiser).
  - Polarization same as for DEM data sets to improve possibility to get data with useful baselines.
  - Imaging mode: StripMap; Interferometric mode: Bistatic
- Sea Ice drift
  - Polarization VV-VH for improved separation between sea-ice and open water
  - Data requested for months with maximum ice cover, but data from all months with ice cover useful.
  - Imaging mode: StripMap; Interferometric mode: Bistatic

TanDEM-X acquisitions useful for ATI 2011-2013

Test site	Number of acquisitions	Acquisitions useful for ATI
Fram Strait	4	2
Gulf of Bothnia	1	(1)
Svalbard	2	1
Skagerak	2	0
Kattegatt	2	0
Baltic Sea	2	0
Total	13	3

SEA ICE DRIFT

CLIMATICE
Spaceborne radar measurements of sea-ice parameters for climate models

Area: Seas around Greenland and Gulf of Bothnia

Years: 2010 to 2013

Cooperation: Swedish Meteorological and Hydrological Inst. (SMHI)

Funding: Swedish National Space Board

Data: SAR data from ALOS, Envisat and COSMO-SkyMed

                      Altimeter data from Cryosat-2

Expected outcome

- New or improved algorithms for retrieval of ice concentration and ice drift.

- New or improved algorithms for retrieval of ice thickness. These algorithms can be based on a combination of altimeter and SAR data.

- Development of satellite based sea-ice products that can be used for validation of climate models.

- Validation that can lead to improved parameterization and/or initialization of the climate model.

Multi-resolution processing system

M. Thomas *et al.* 2008

Down-scaled images → 1: Phase correlation → Motion field

1: Phase correlation → 2: Back-translation → 3: Increase Resolution → 1: Phase correlation
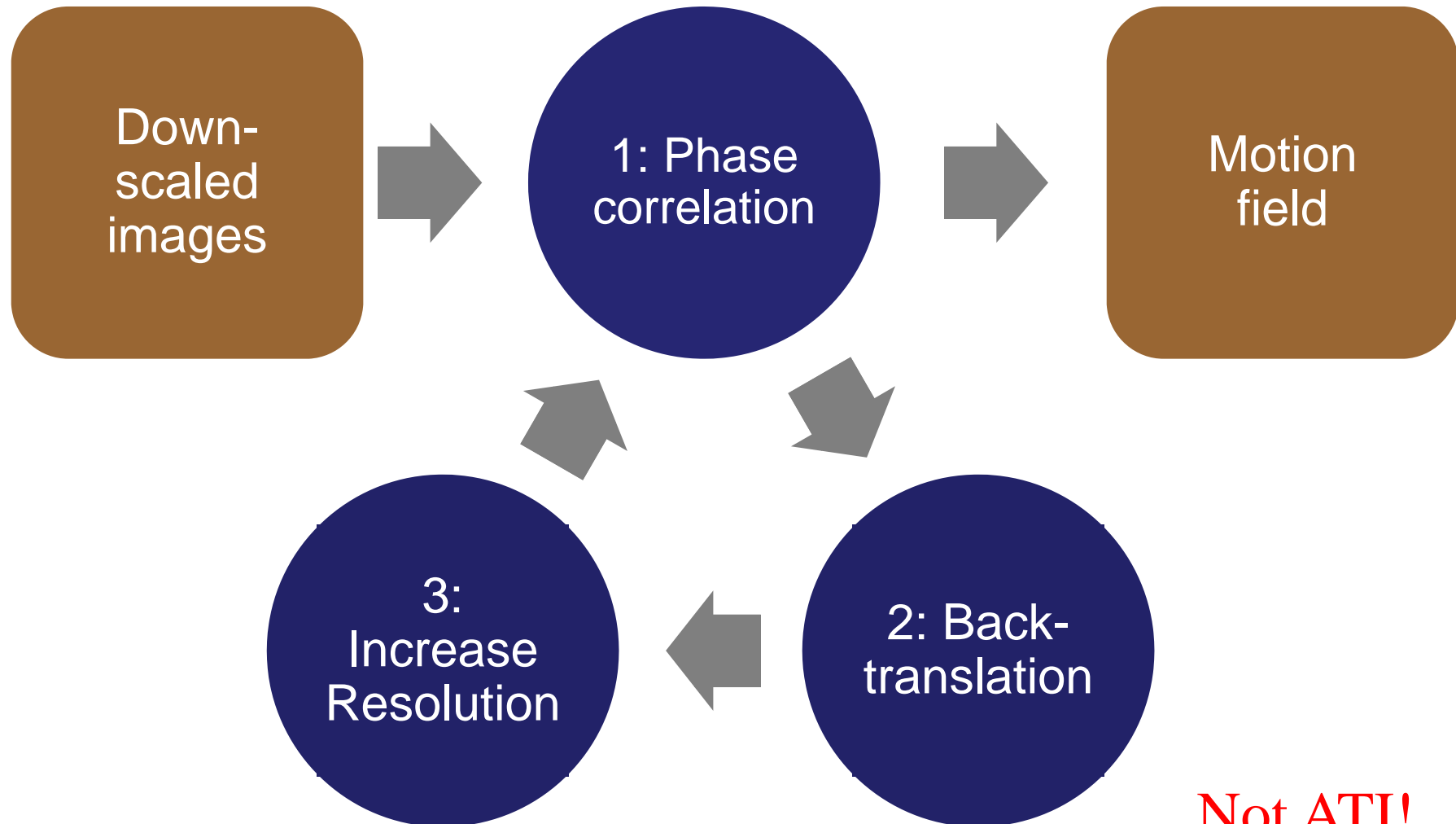
Not ATI!

Feature tracking necessary for marginal ice

Requires
1) Image segmentation
2) Feature tracking – Peddada & McDevitt 1996
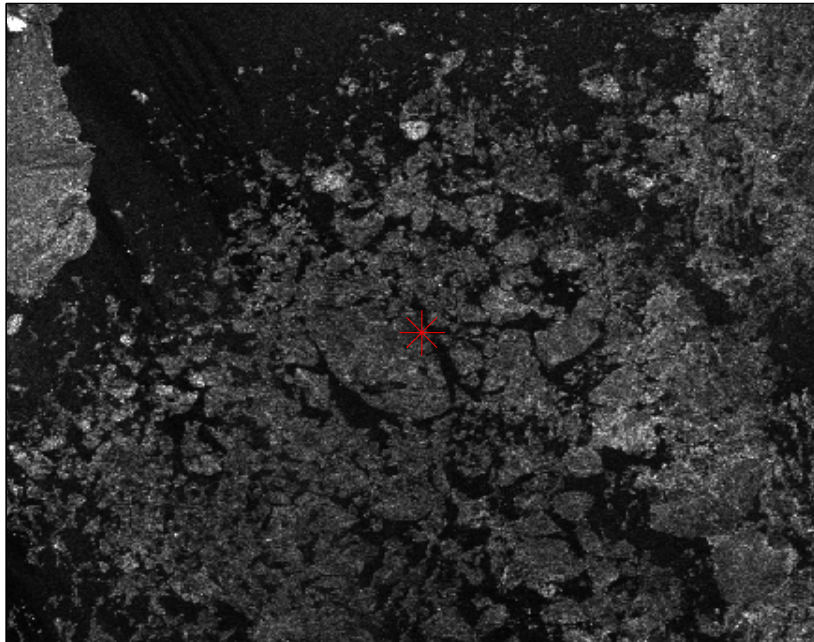
Mean ice drift in Fram Strait
April 2011
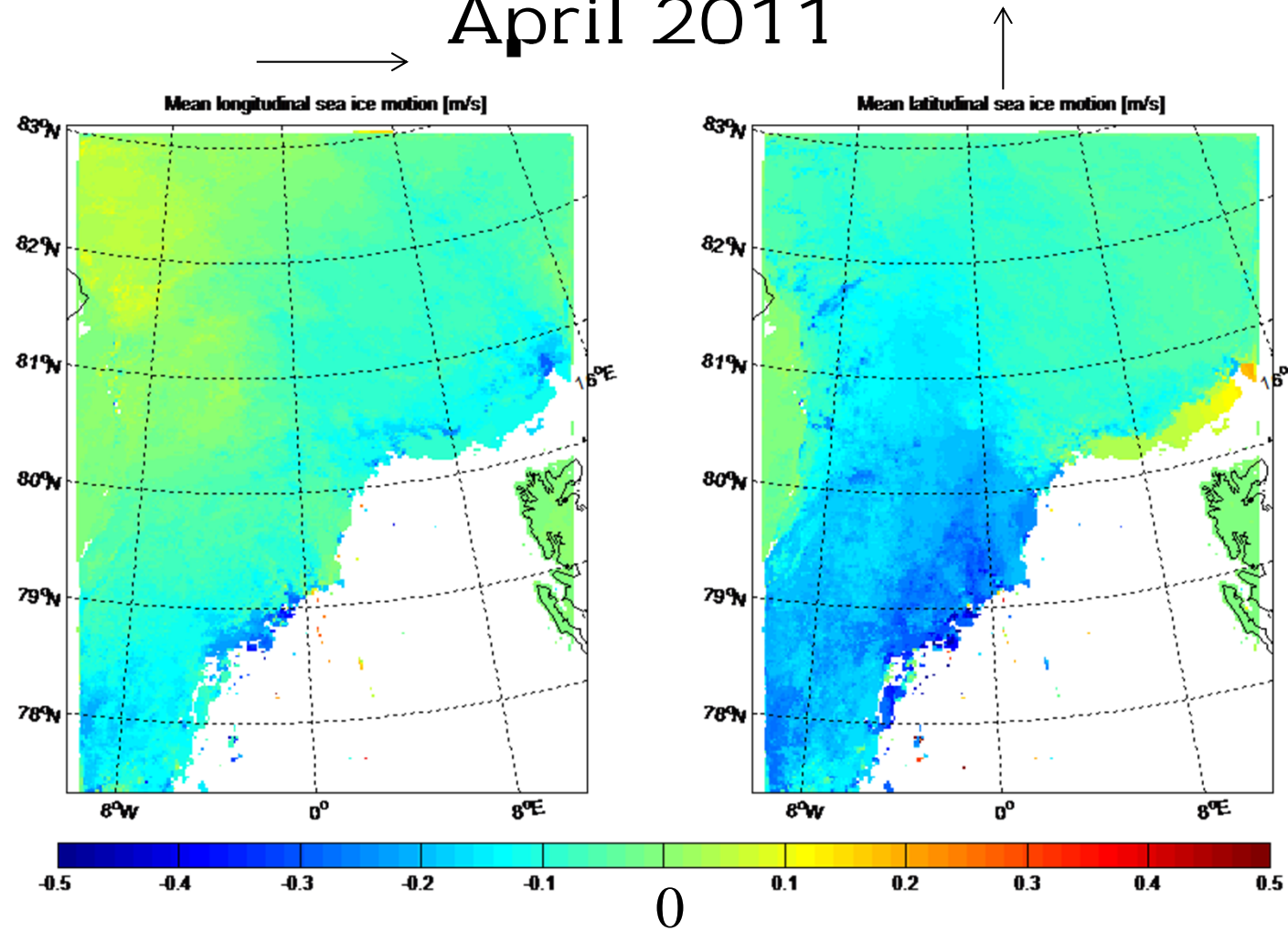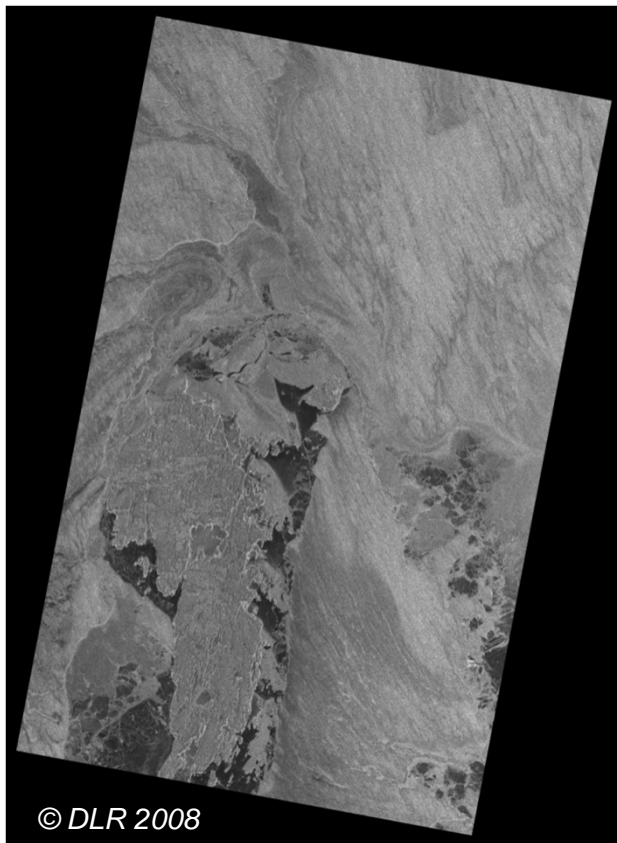
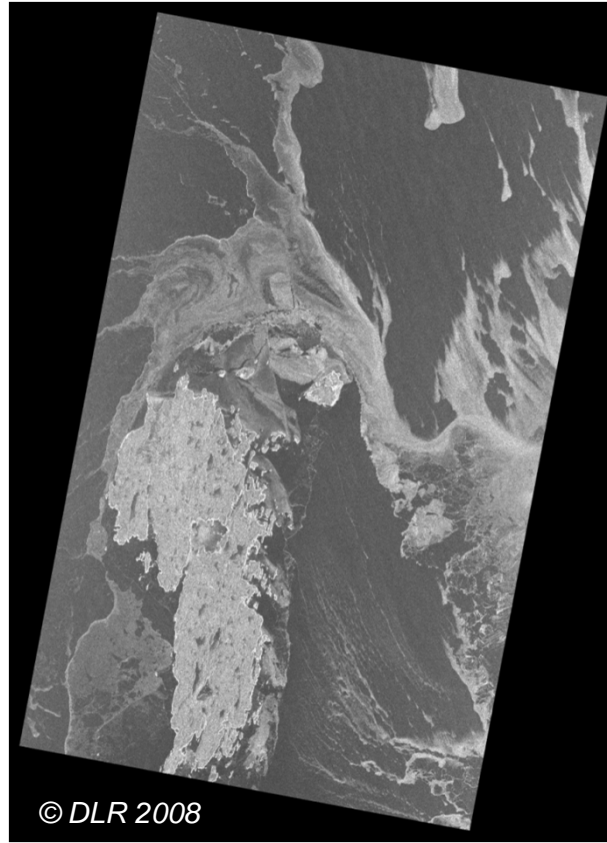# Expeditions to the Fram Strait Aug. 2012 and Aug 2013

RADARSAT–2   2012–08–29   0806 UTC
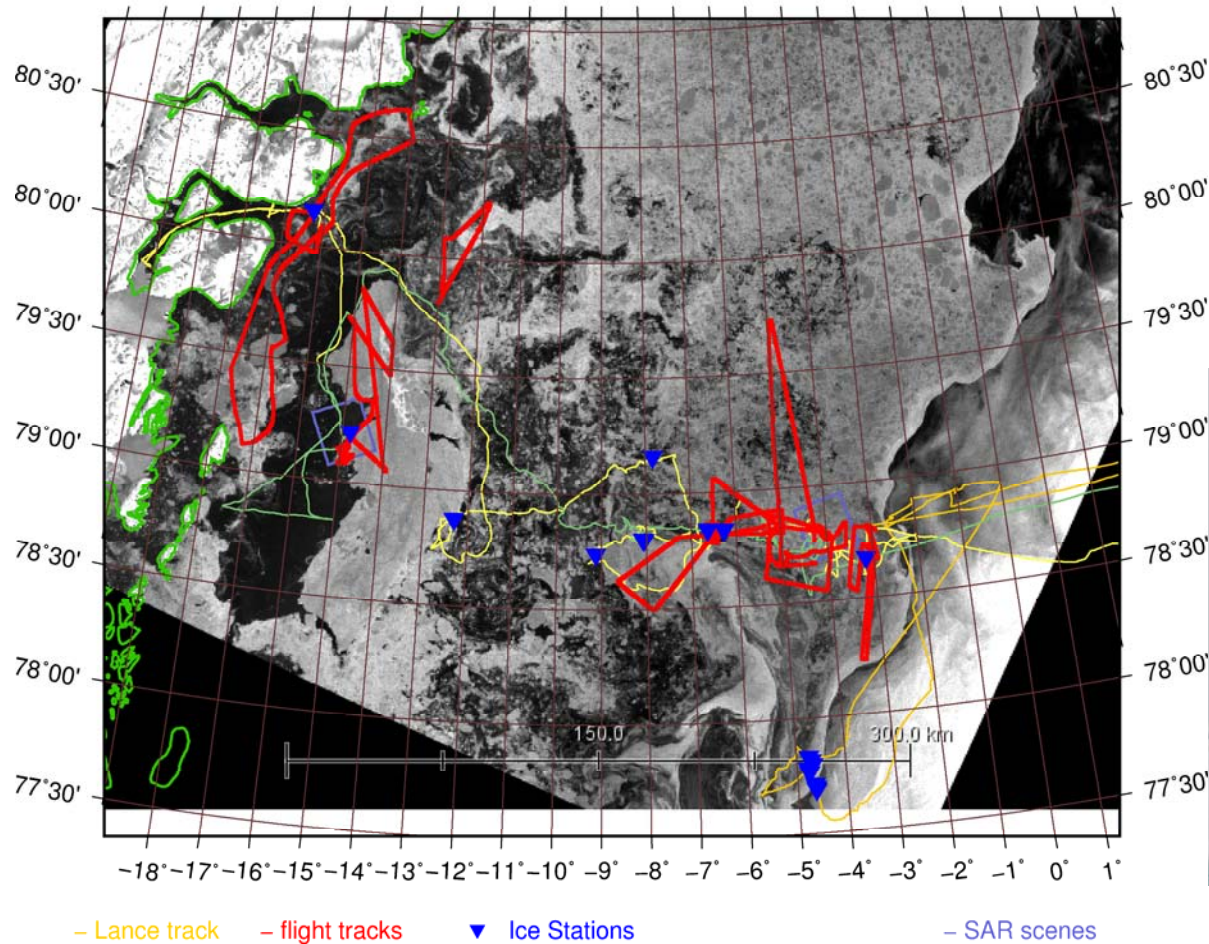
Expeditions organized by the Norwegian Polar Institute in Tromsö

R/V Lance

Photo: Anders Berg, Chalmers

– Lance track   – flight tracks   ▼ Ice Stations   – SAR scenes

Why dual polarisation TSX/TDX for sea ice?

2008-03-27 HH

2008-03-27 HV
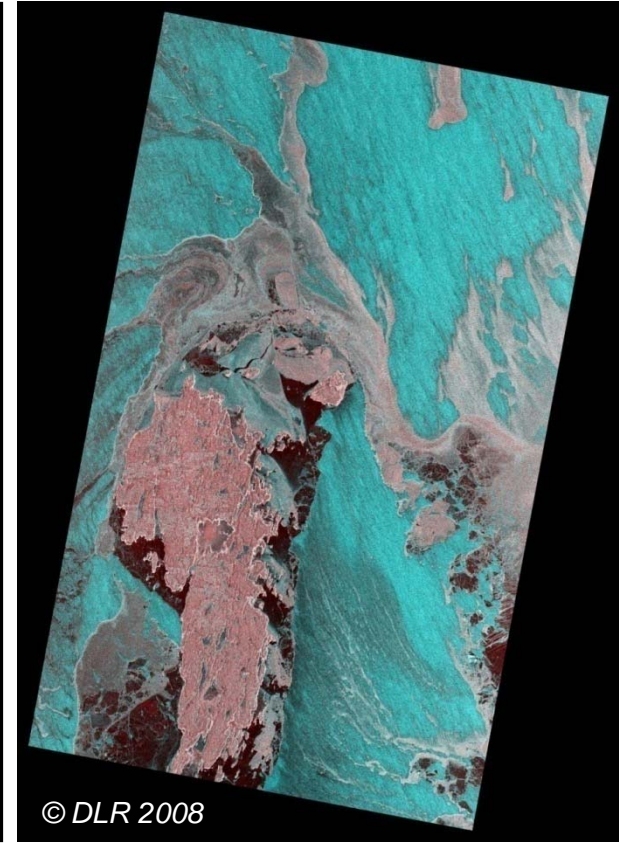
R:HV G:HH B:HH

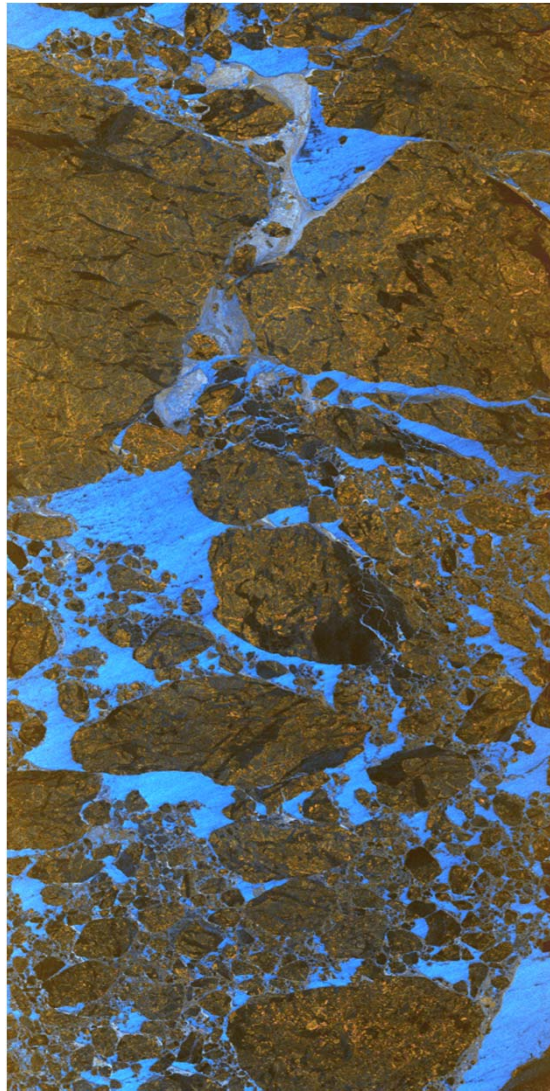# Fram Strait
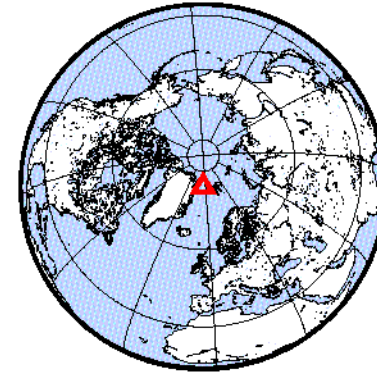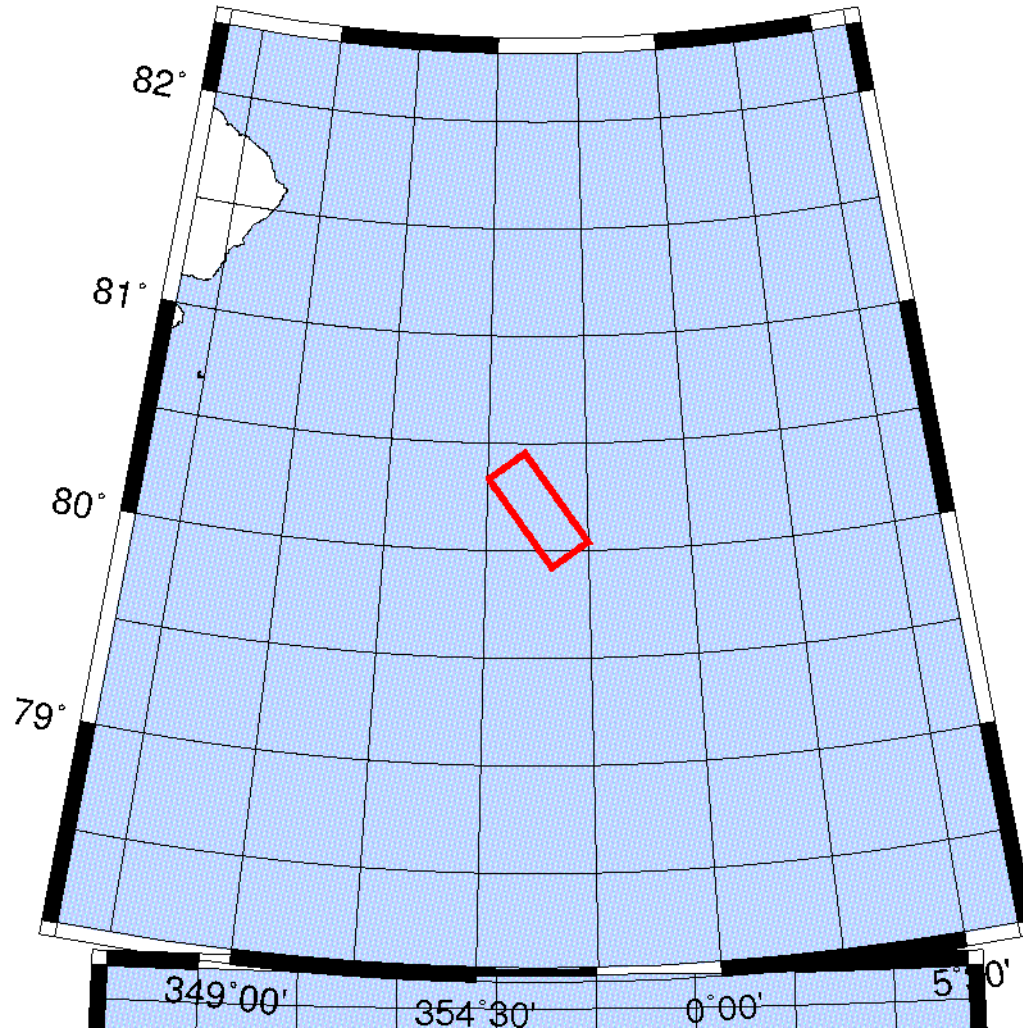
TDX

Date: 2012-05-13

Start time: 16:00:05

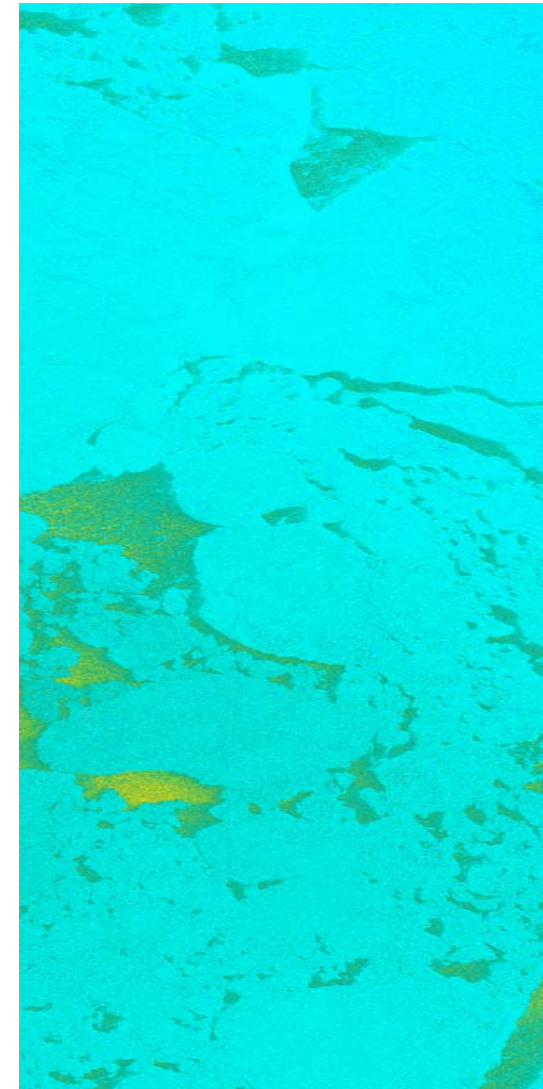Mode: SM

Pol.: VV/VH

AT baseline: 26 m

Eff. Baseline: 110 m

HOA: -31 m

2012-05-13

Amplitude   Coherence (>0.8)   Phase

SEA SURFACE CURRENT

Measurement of sea surface currents with satellites

Area: Baltic Sea, Kattegat and Skagerak
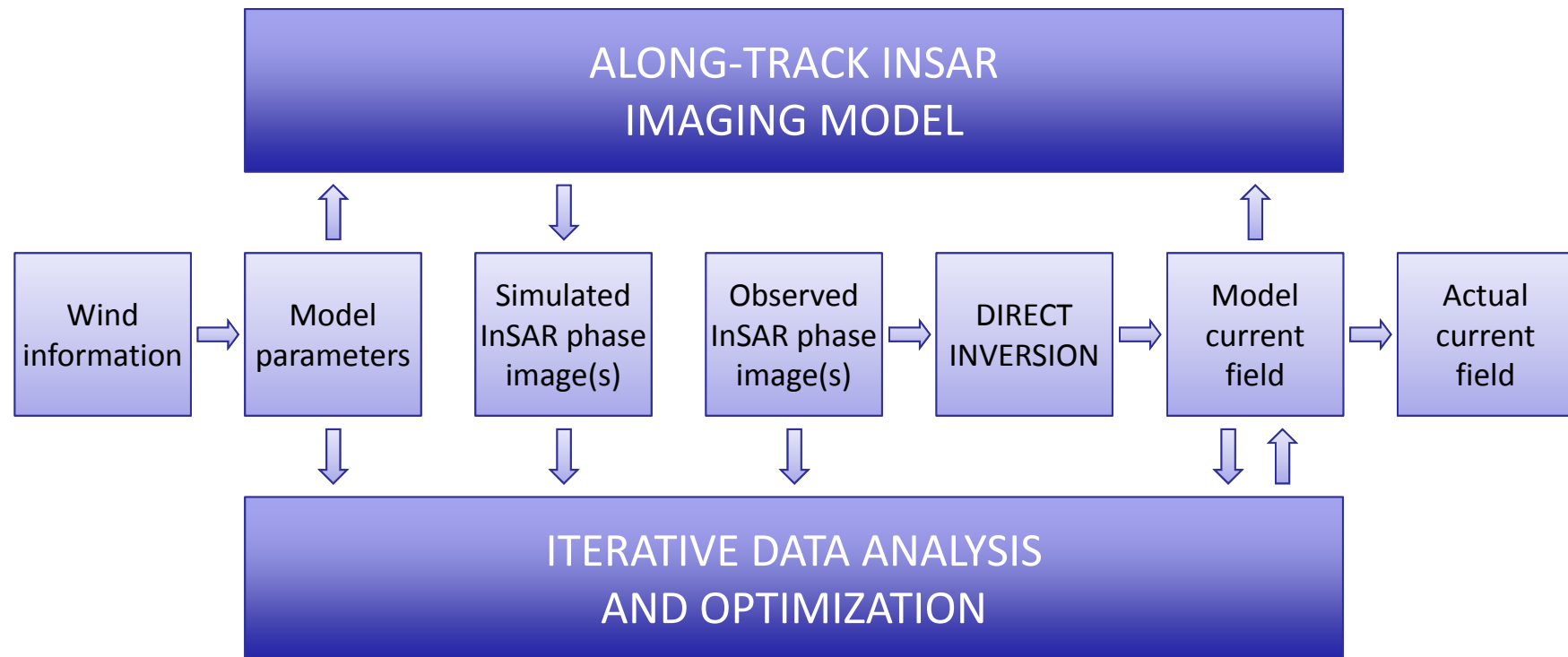
Years: 2011 to 2013

Cooperation: Swedish Meteorological and Hydrological Inst. (SMHI)

Funding: Swedish National Space Board

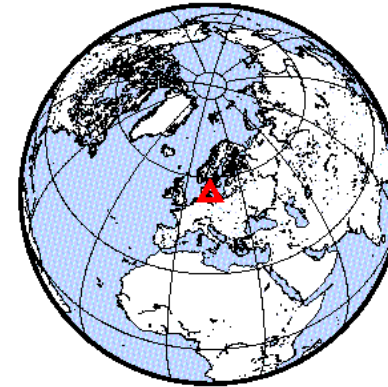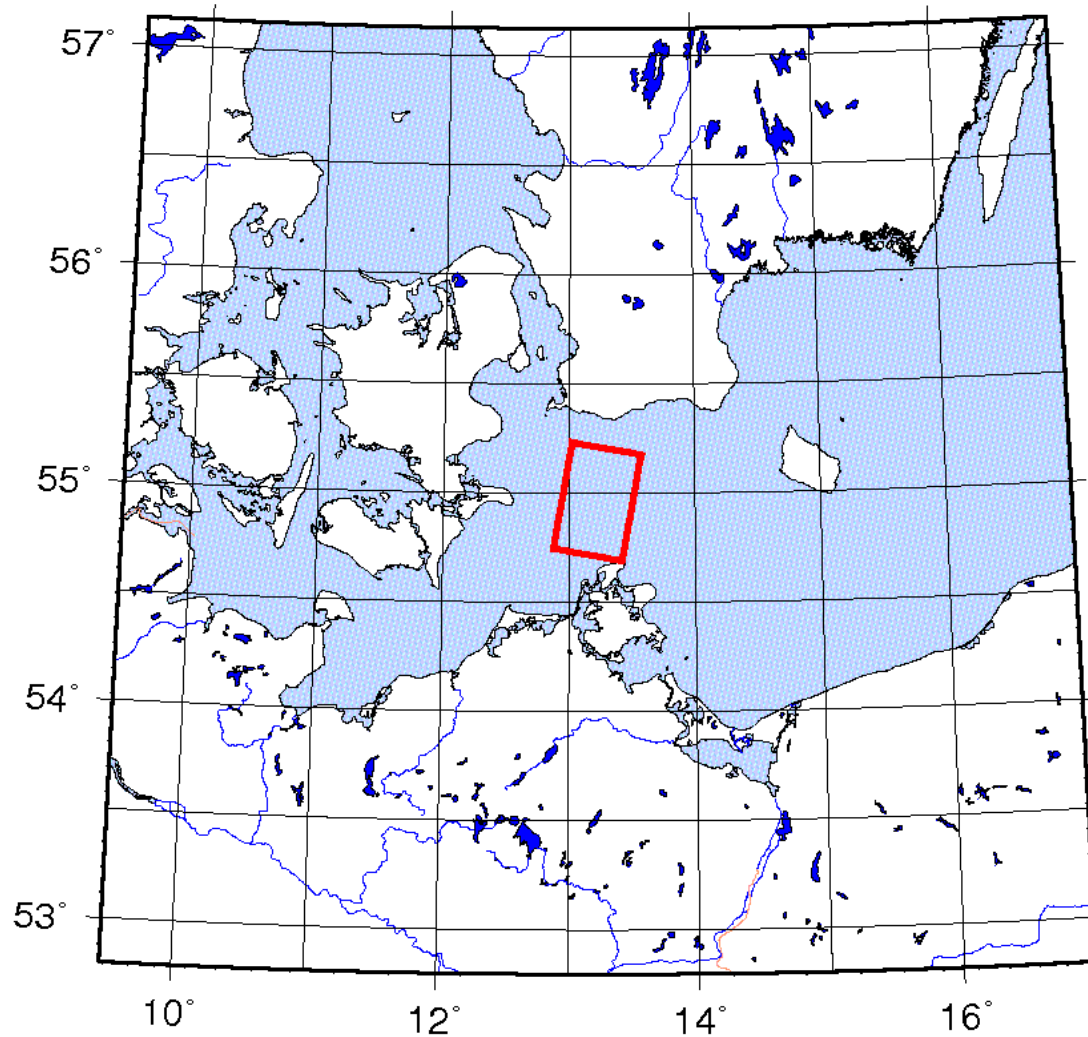**Data:**   SAR data from TerraSAR-X

Radiometer data from AVHRR

Retrieval of Current Fields
From Along-Track InSAR Signatures

Romeiser et al, KoRIOLIS project report, 2002

Southern Baltic Sea

TDX
Dates: 2012-02-03
            2012-02-14
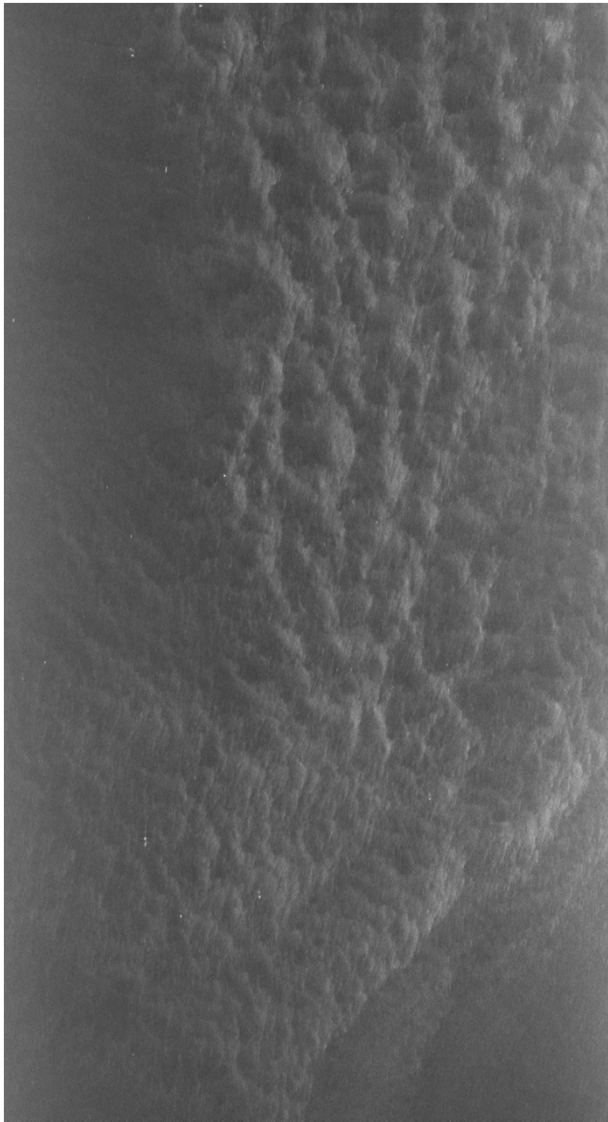   2012-02-25
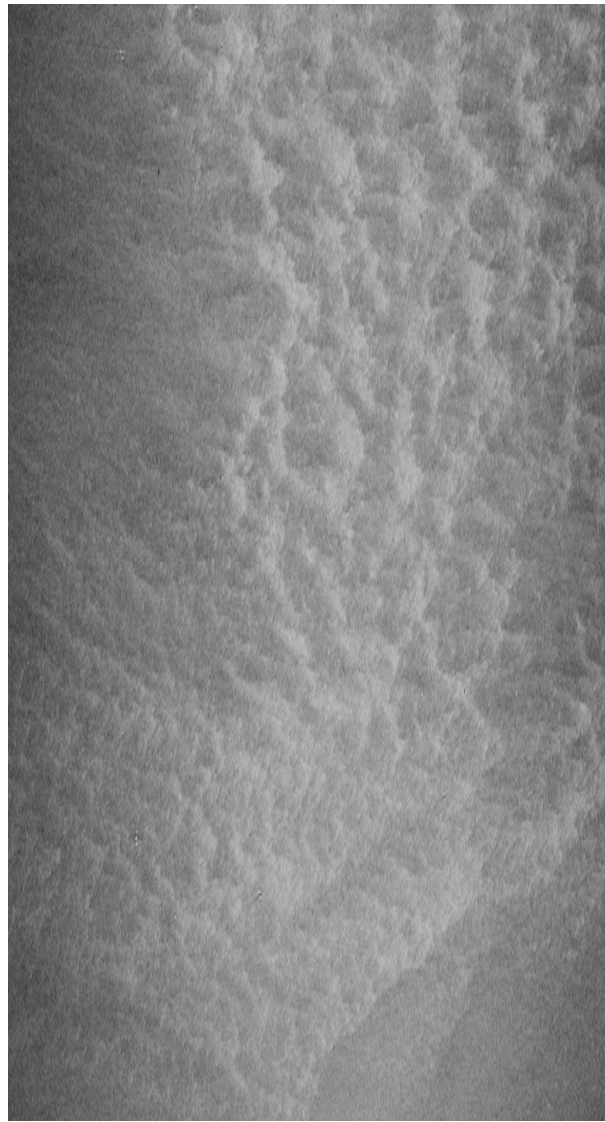Start time: 05:24:46
Mode: SM
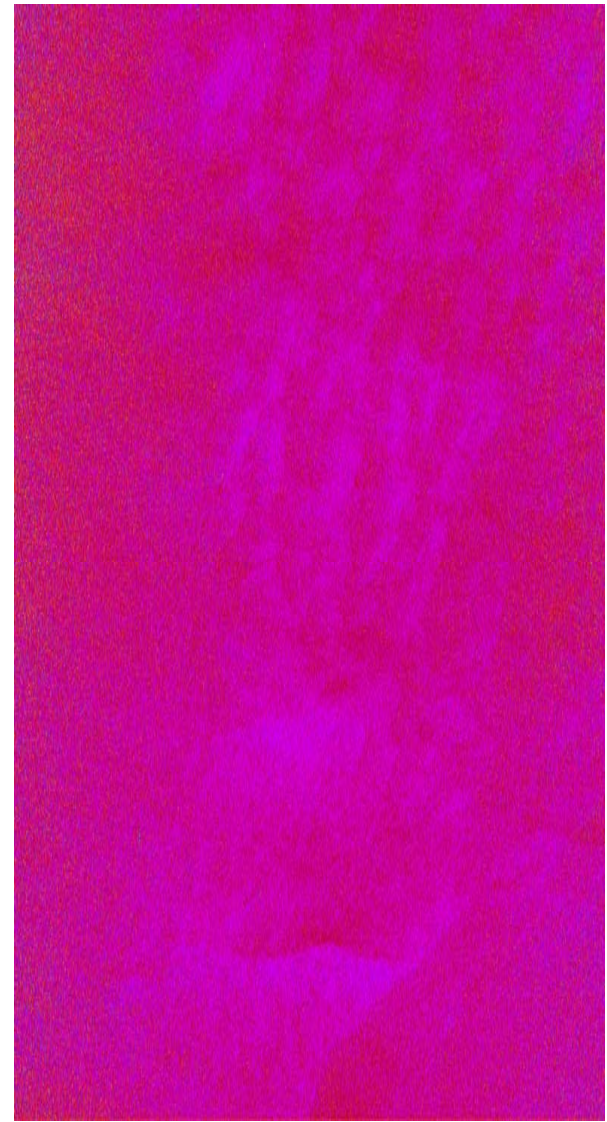Pol.: VV
AT baseline: 7 - 31 m
Eff. Baseline: 40 m
HOA: -170 m

# 2012-02-14

Amplitude   Coherence (0.54)   Phase

Field campains

- Two field campaigns were planned for sea surface currents in the Baltic Sea or along the West Coast of Sweden.

- So far no field campaigns have been conducted because:
  - No TDX acquisitions with suitable baselines have been planned for our test sites
  - HF coastal radar system not available for demo
  - Less funding than planned granted for field work
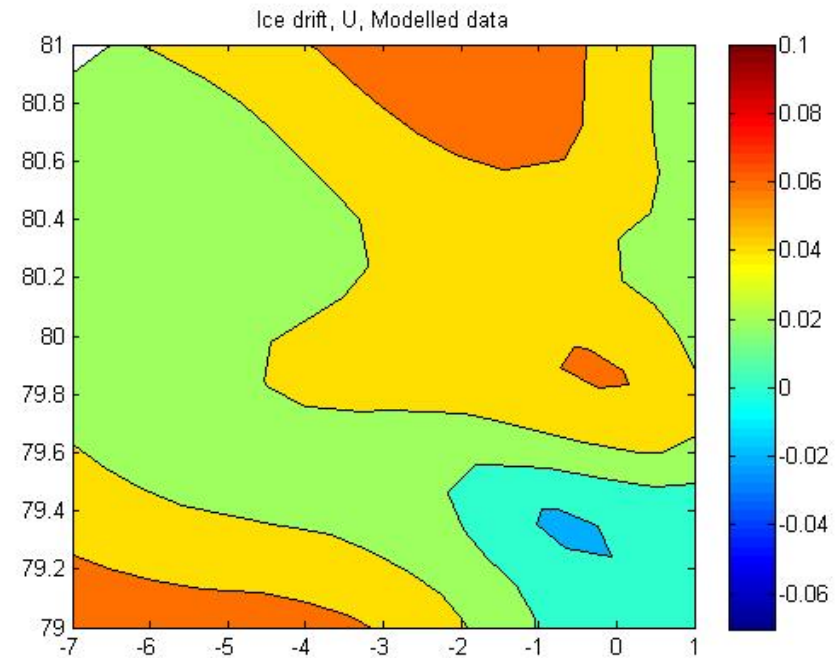
Model data

HIROMB 2012-02-14
Test site: Southern Baltic
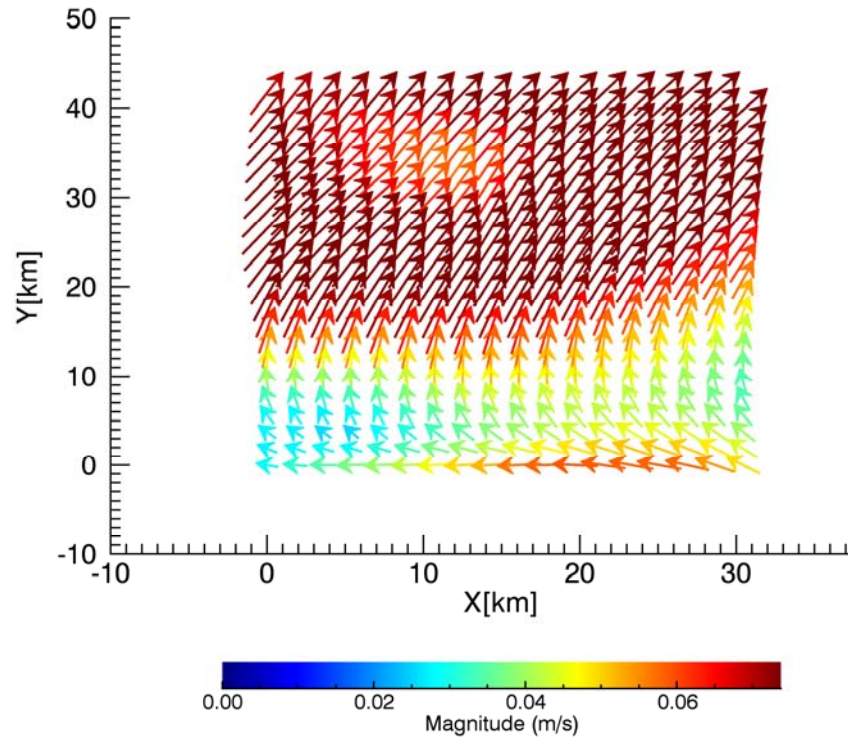
TOPAZ4 2012-05-13
Test site: Fram Strait

Summary

- Chalmers use TanDEM-X data in two projects, one for sea ice drift and one for sea surface current.

- TanDEM-X data with baselines suitable for ATI have been acquired for the test sites between Svalbard and Greenland, but not for our four Swedish test sites.

- TanDEM-X data from Sweden will be substituted by TanDEM-X data from the southern Baltic Sea.

- For sea ice drift methods are under development.

- For sea surface currents, methods described by Romeiser will be used.

For discussion

- Validation of new methods and algorithms for retrieval of oceanographic parameters requires access to independent measurements, preferably from *in situ* observations.

- Field campaigns for collection of in situ observations normally need to be planned several months in advance.

- To set dates for a field campaign you need to know if useful satellite data will be available.

- For ATI the along track baseline is a critical factor that determines if the data will be useful.

- If the along track baselines can be predicted several months in advance, this information should be made available.

Thank you!

Photo: Anders Berg, Chalmers