Deltares
Enabling Delta Life

Estimating ebb-tidal delta bathymetries using X-band radar

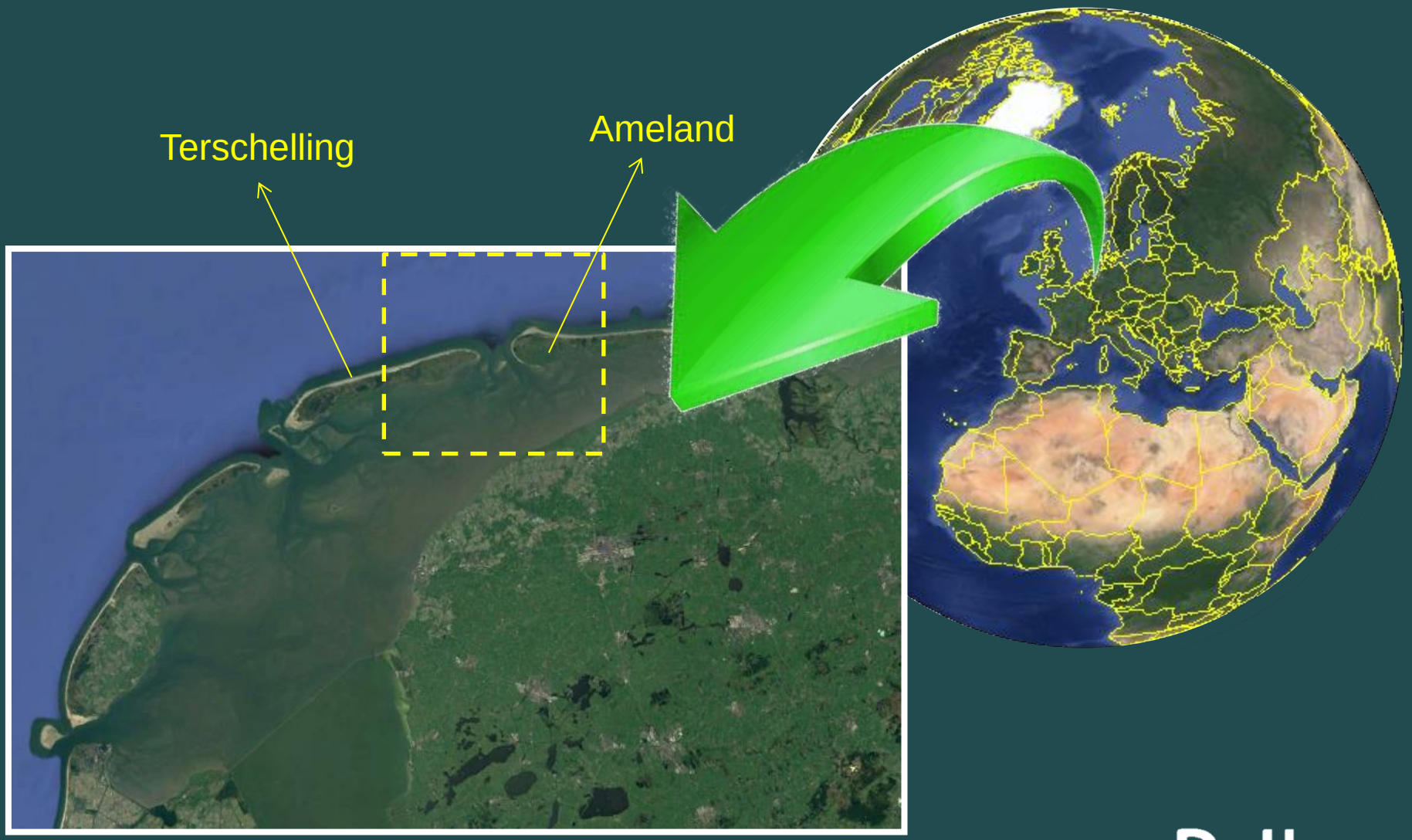
Matthijs Gawehn

31st October 2017

1 Project location Ameland

Project location: Ameland ebb tidal delta

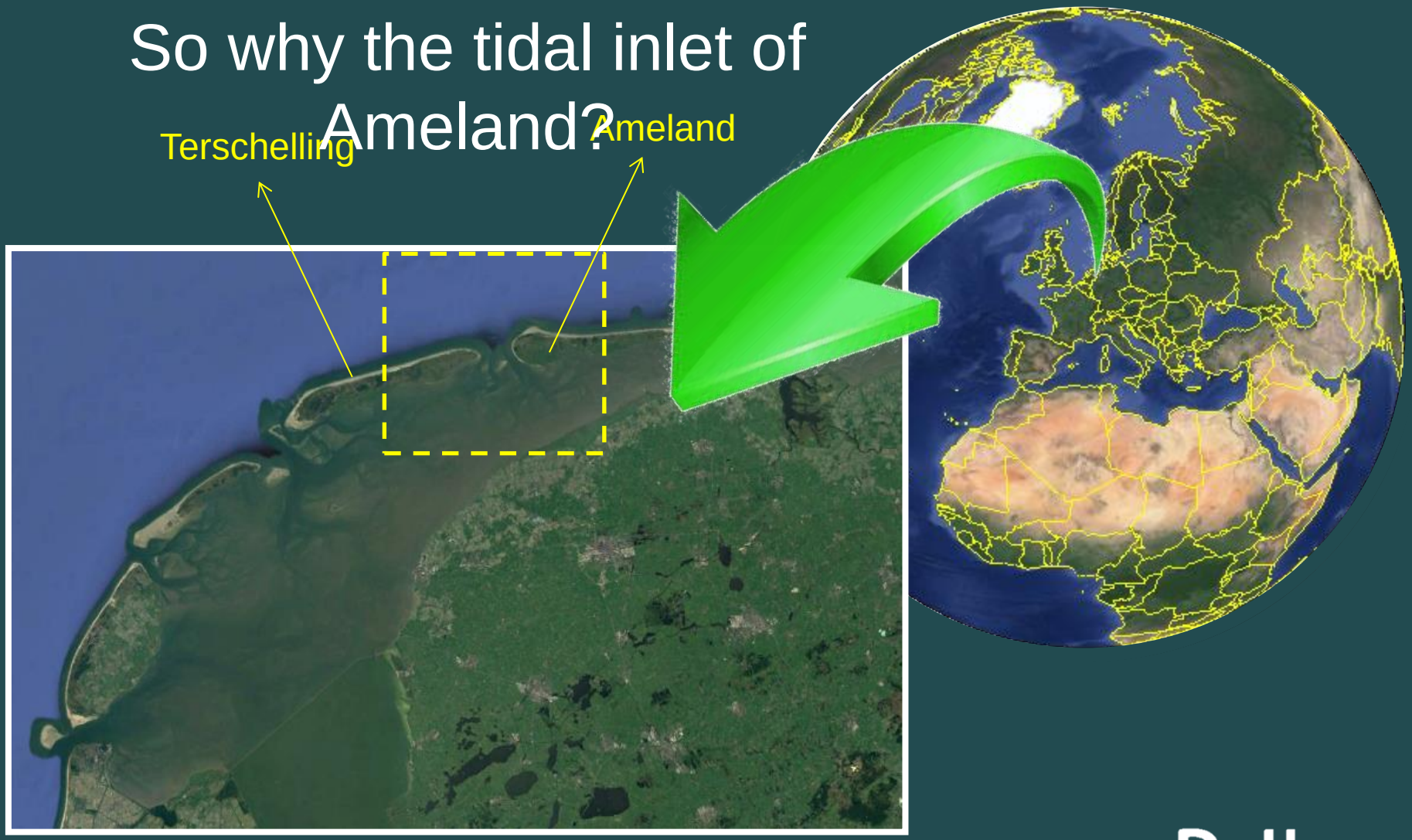
1 Project location Ameland



Deltares

1 Project location Ameland

So why the tidal inlet of Ameland?



1 Project location Ameland

So why the tidal inlet of Ameland?

- Existing navigational X-Band radar
- Coastal Genesis 2
  - Involves: Rijkswaterstaat, Deltares, SEAWAD

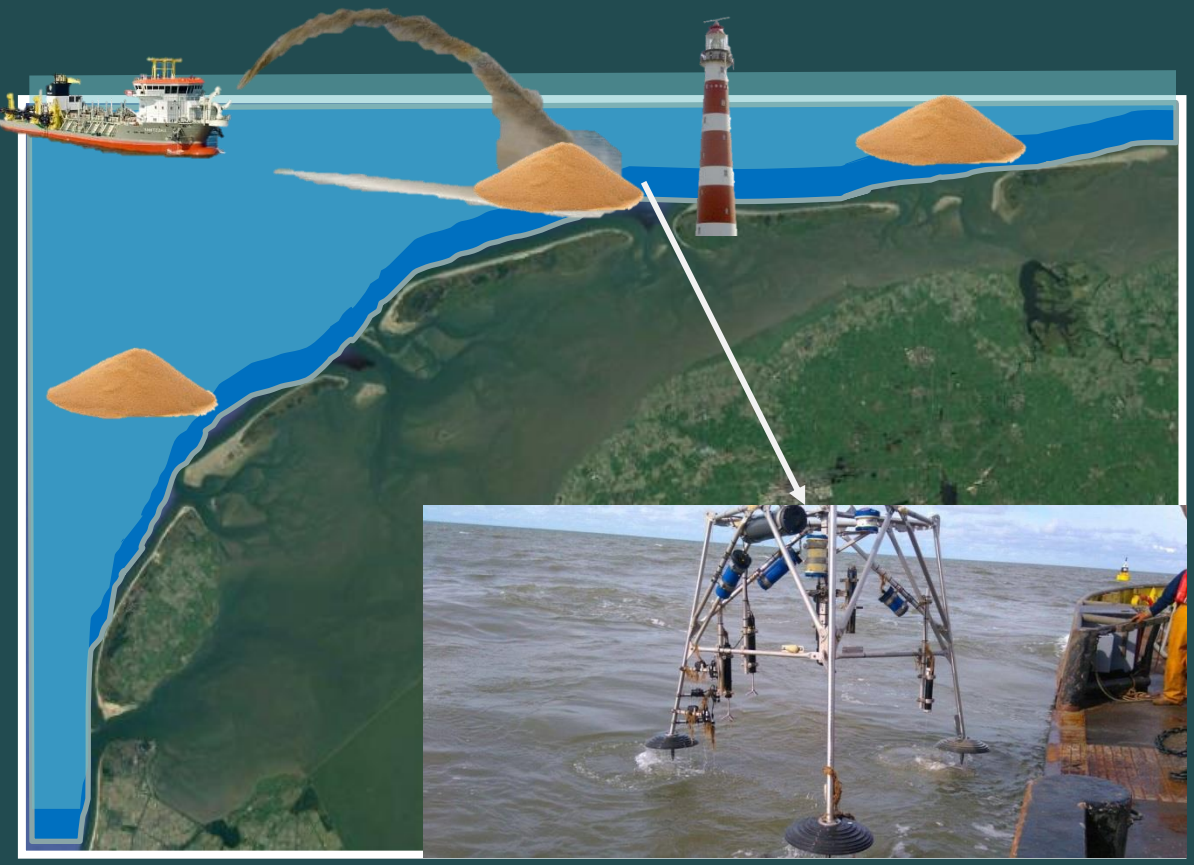
1 Project location Ameland

So why the tidal inlet of Ameland?

- Existing navigational X-Band radar
- Coastal Genesis 2
  - Involves: Rijkswaterstaat, Deltares, SEAWAD

1 Project location Ameland: Coastal Genesis 2

Coastal Genesis 2



→ Goals:

- Better understanding of the coastal system,
- To give advice on
  - How much sand is needed to grow with sea level rise
  - Where to nourish most efficiently

1 Project location Ameland: Coastal Genesis 2

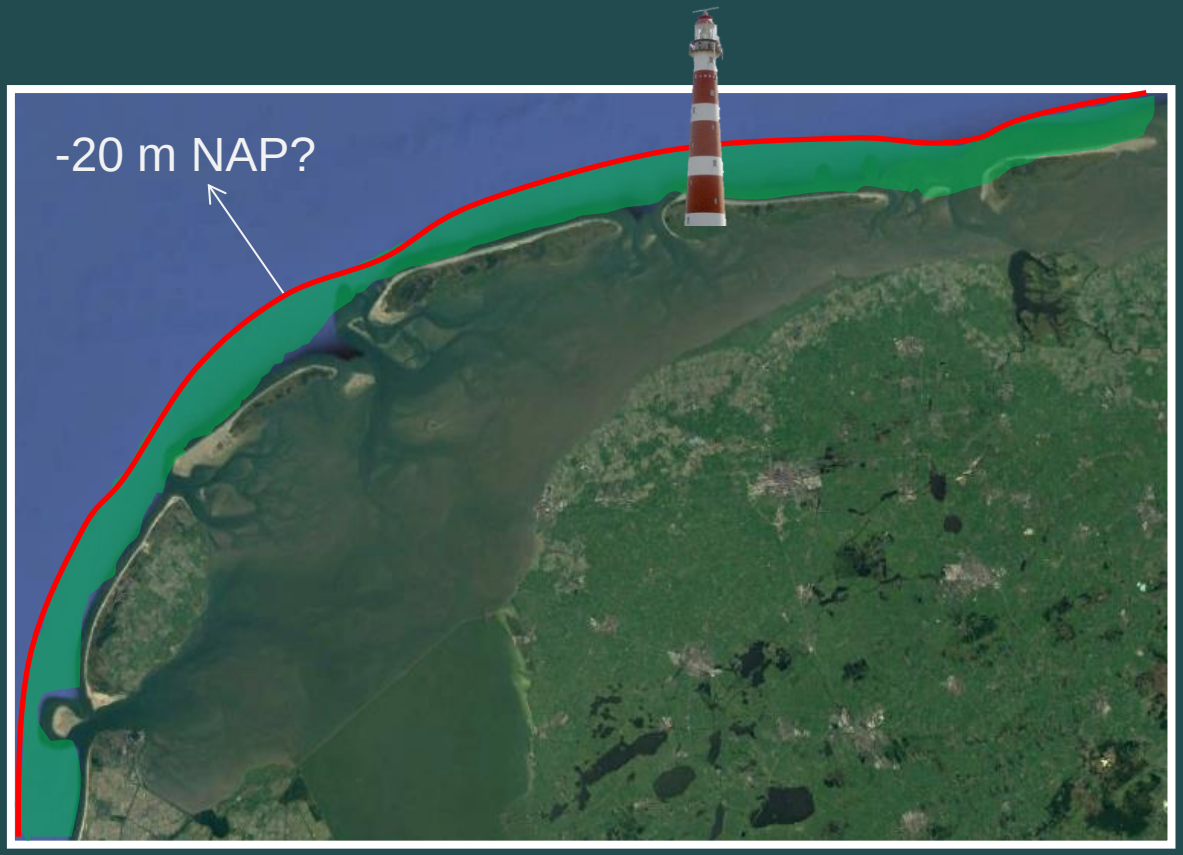
Coastal Genesis 2

→ Goals:

- Better understanding of the coastal system,
- To give advice on
  - How much sand is needed to grow with sea level rise
  - Where to nourish most efficiently

1 Project location Ameland: Coastal Genesis 2

Coastal Genesis 2

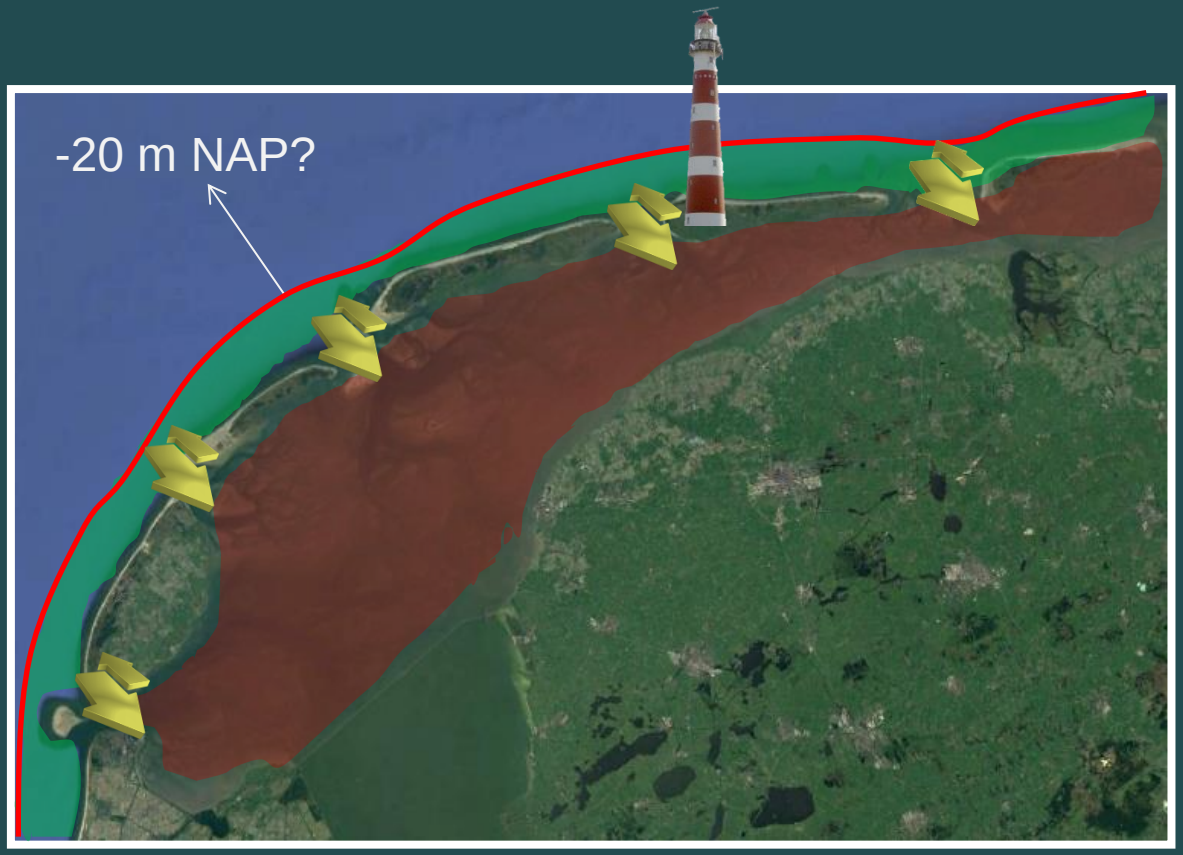


→ Main focus:

- Definition of coastal foundation

1 Project location Ameland: Coastal Genesis 2

Coastal Genesis 2

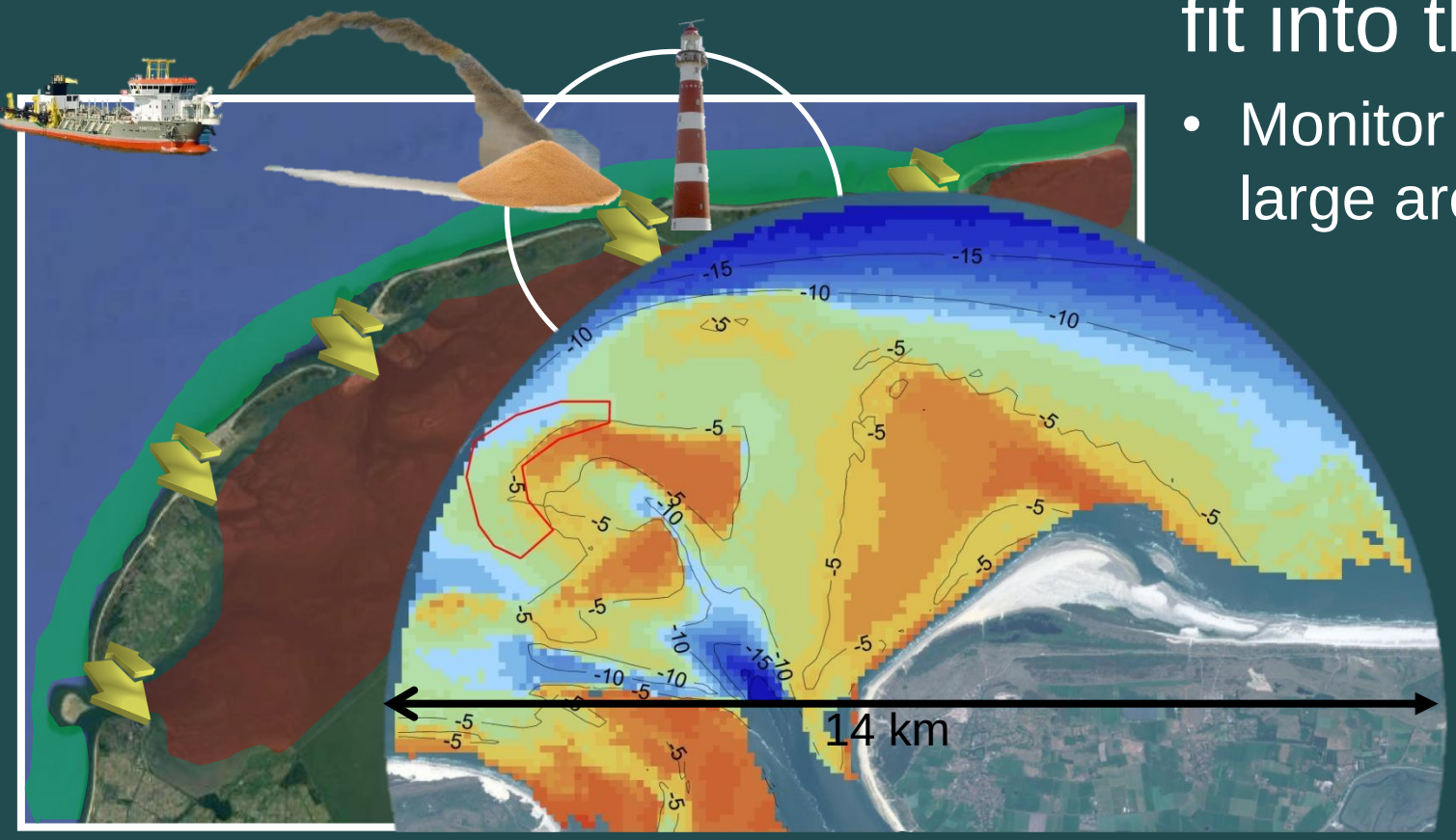


→ Main focus:

- Definition of coastal foundation
- Sediment exchange between North Sea and Wadden sea

1 Project location Ameland: Coastal Genesis 2

Coastal Genesis 2

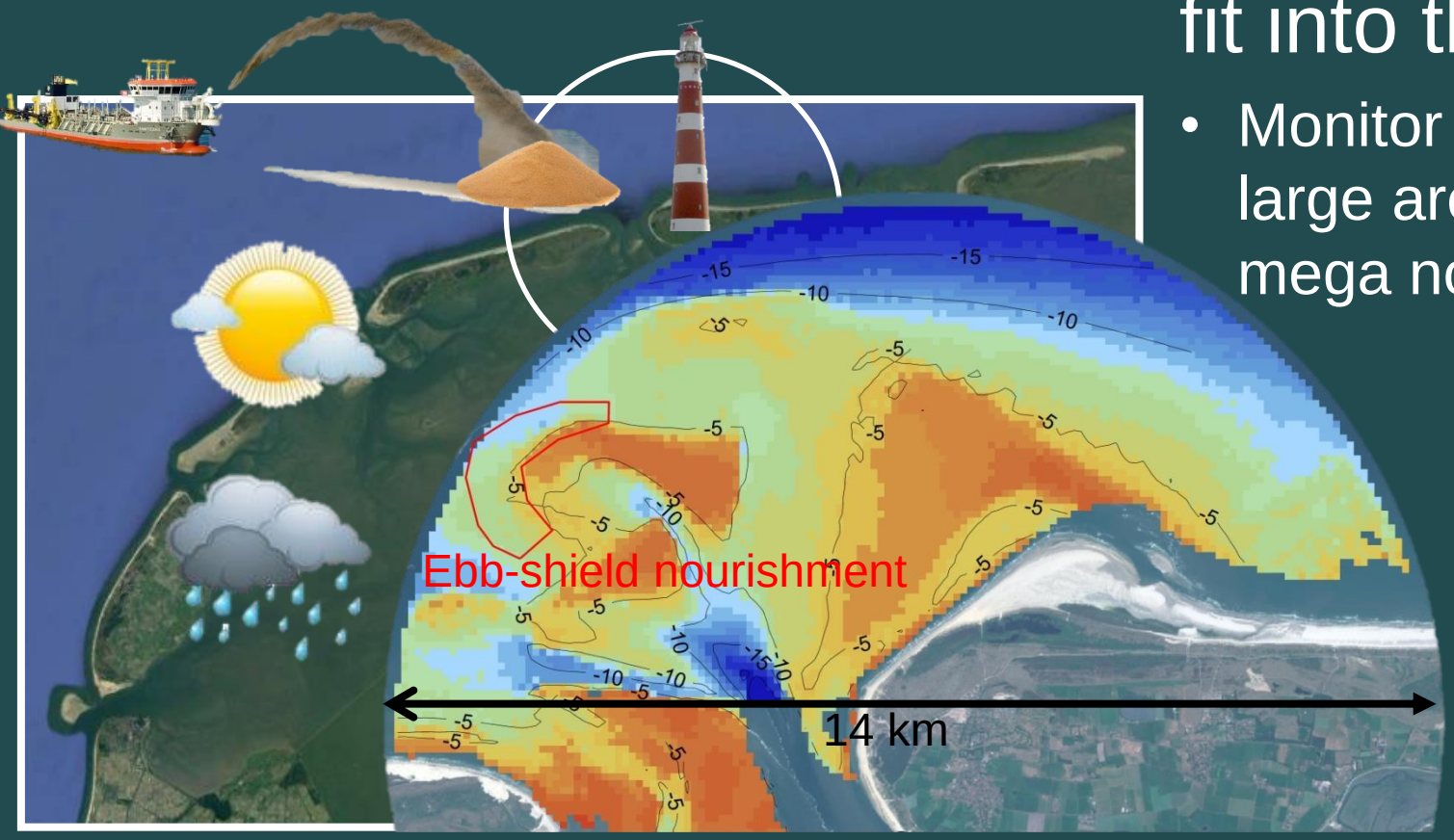


How does radar fit into this ?

- Monitor bathy over a large area

1 Project location Ameland: Coastal Genesis 2

Coastal Genesis 2



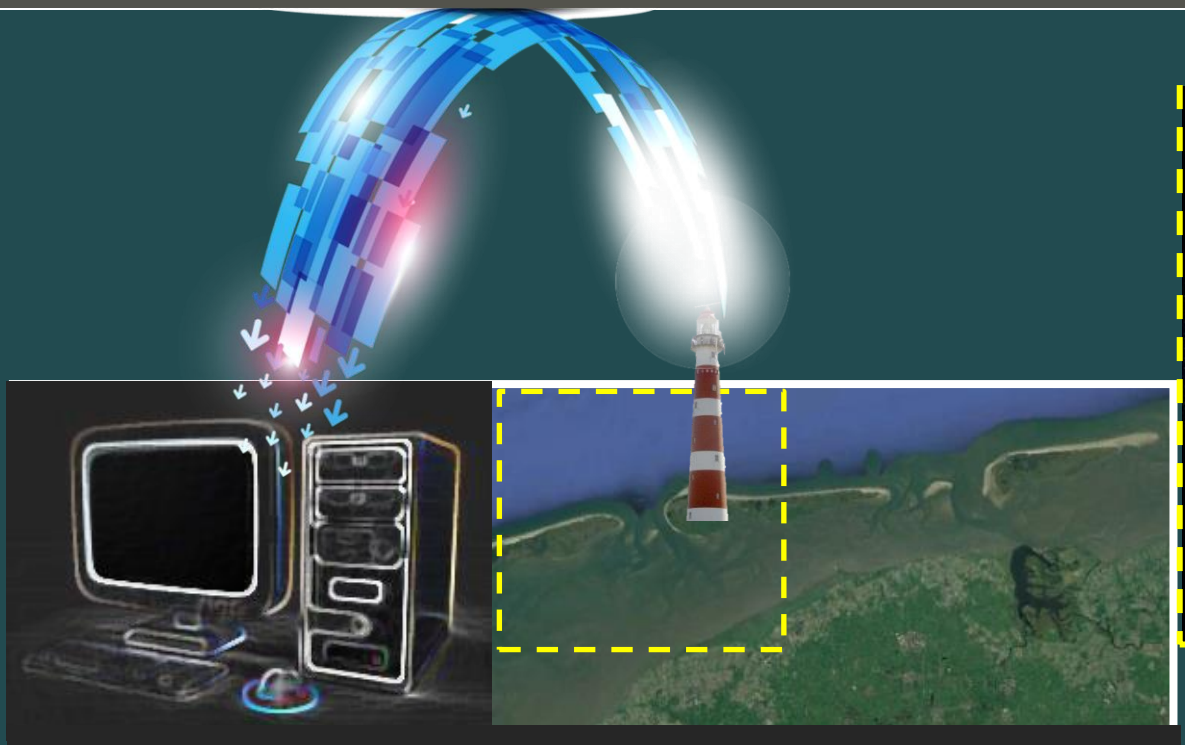
How does radar fit into this ?

- Monitor bathy over a large area → trace a mega nourishment

Data acquisition ?

Deltares

2 Data acquisition



2010

How ?

Radar data on drives

…local computer analyzing data every 40-60 min 24/7

…measured bathy every 3-5 years

…but, since 2017: **operational system**

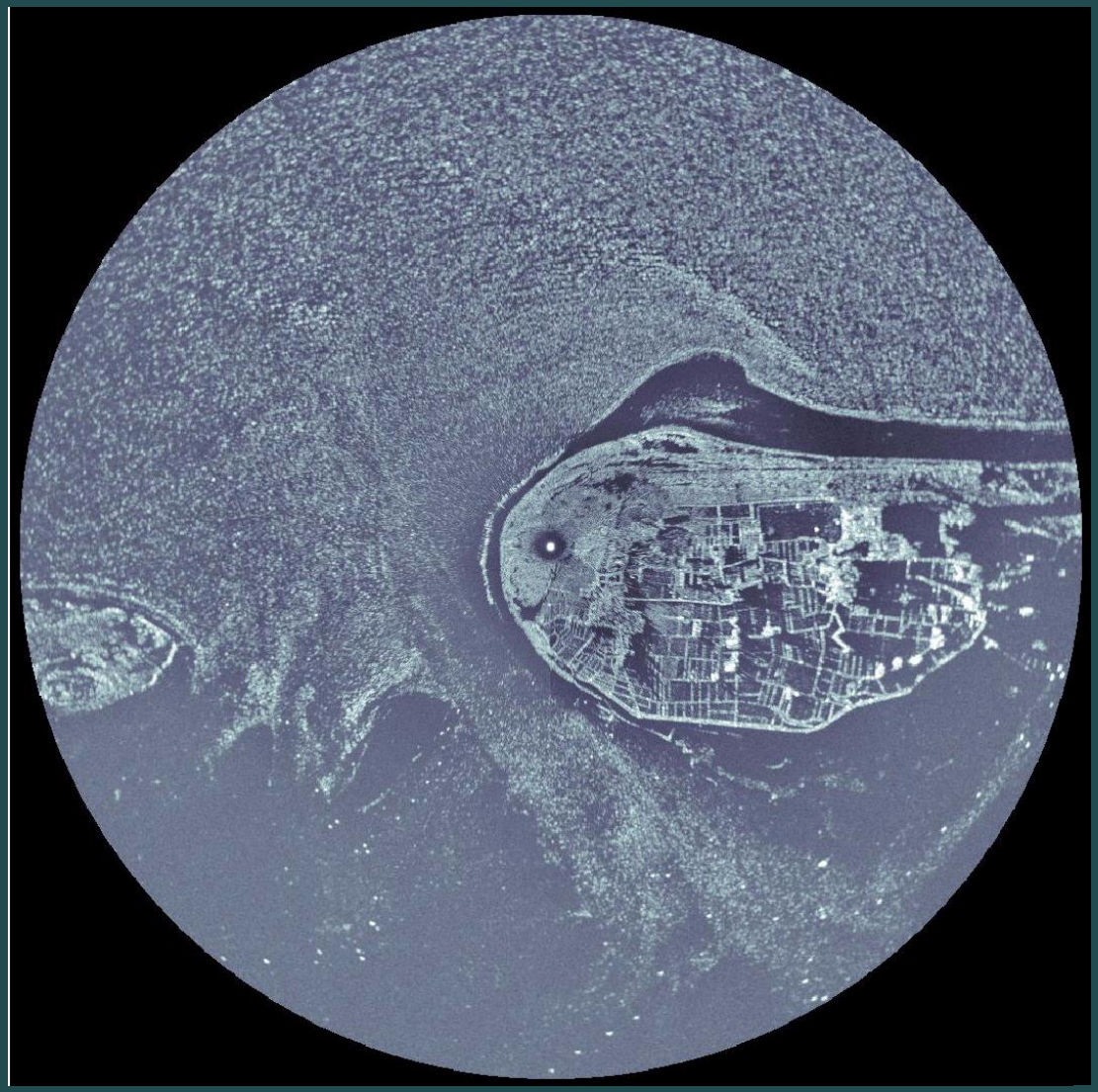
Analysis technique: XMFit

X-Band

MATLAB

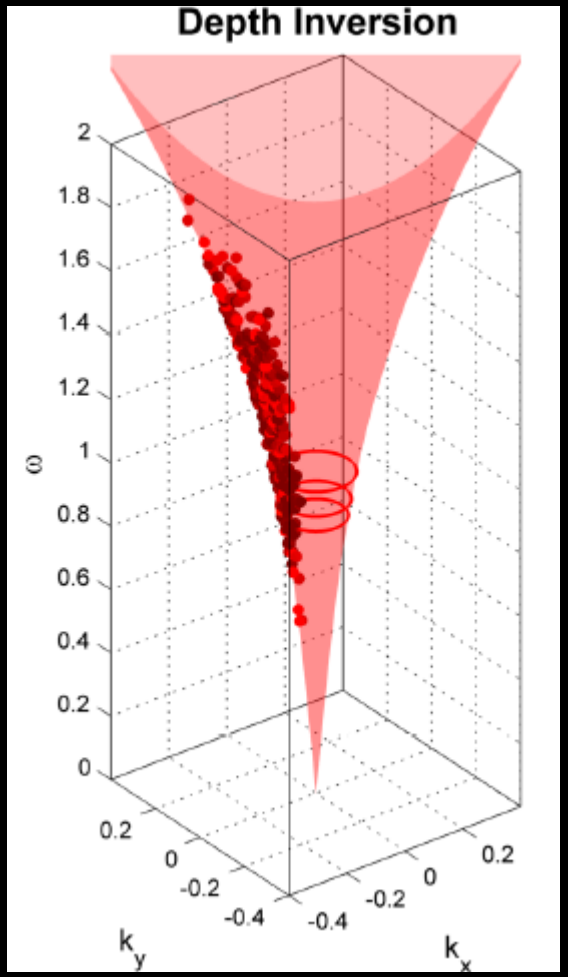
Fitting? Yes.
But what to fit and how?

3 XMFit



3 XMFit

- Bathymetry (d) and hydrodynamics ($\vec{U}$) can be **simultaneously** estimated from raw radar images using the doppler-shifted linear dispersion relation



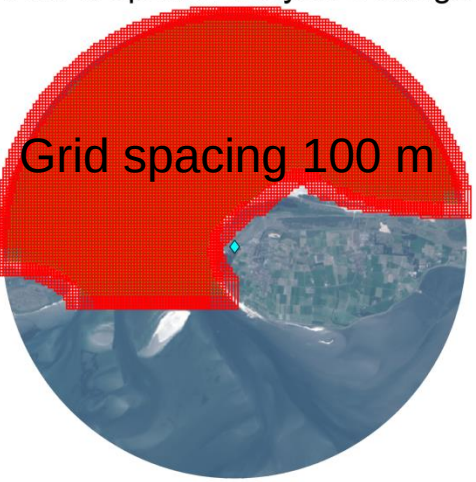
$$\omega = \sqrt{gk \tanh kd} + k \cdot \vec{U}$$

4 Results

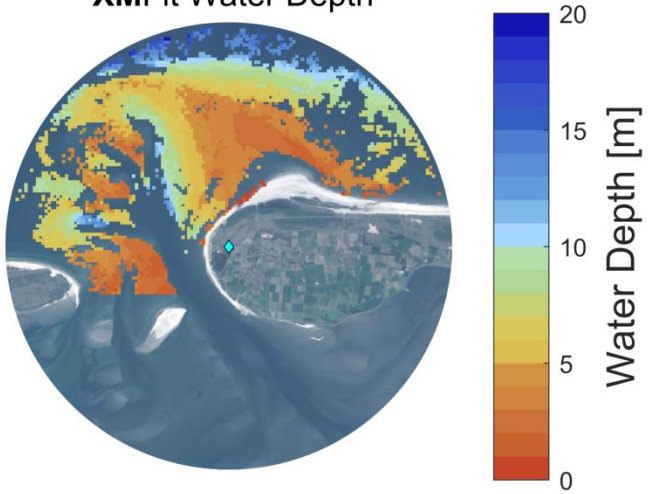
Results

2015/03/14 11:09:21

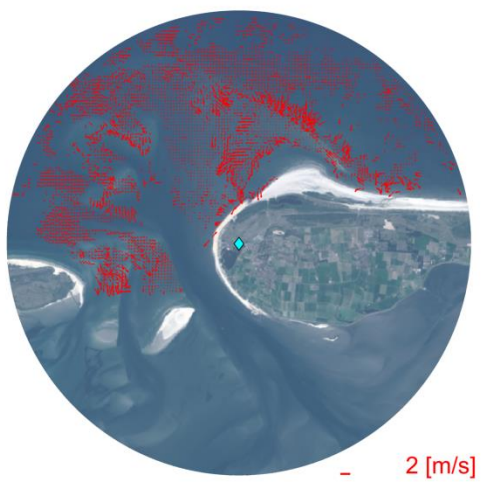
XMFit Spatial Analysis Settings



XMFit Water Depth

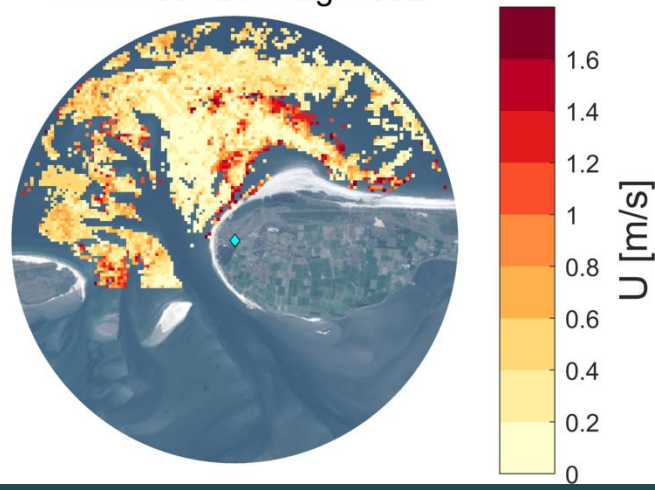


XMFit Current Vectors



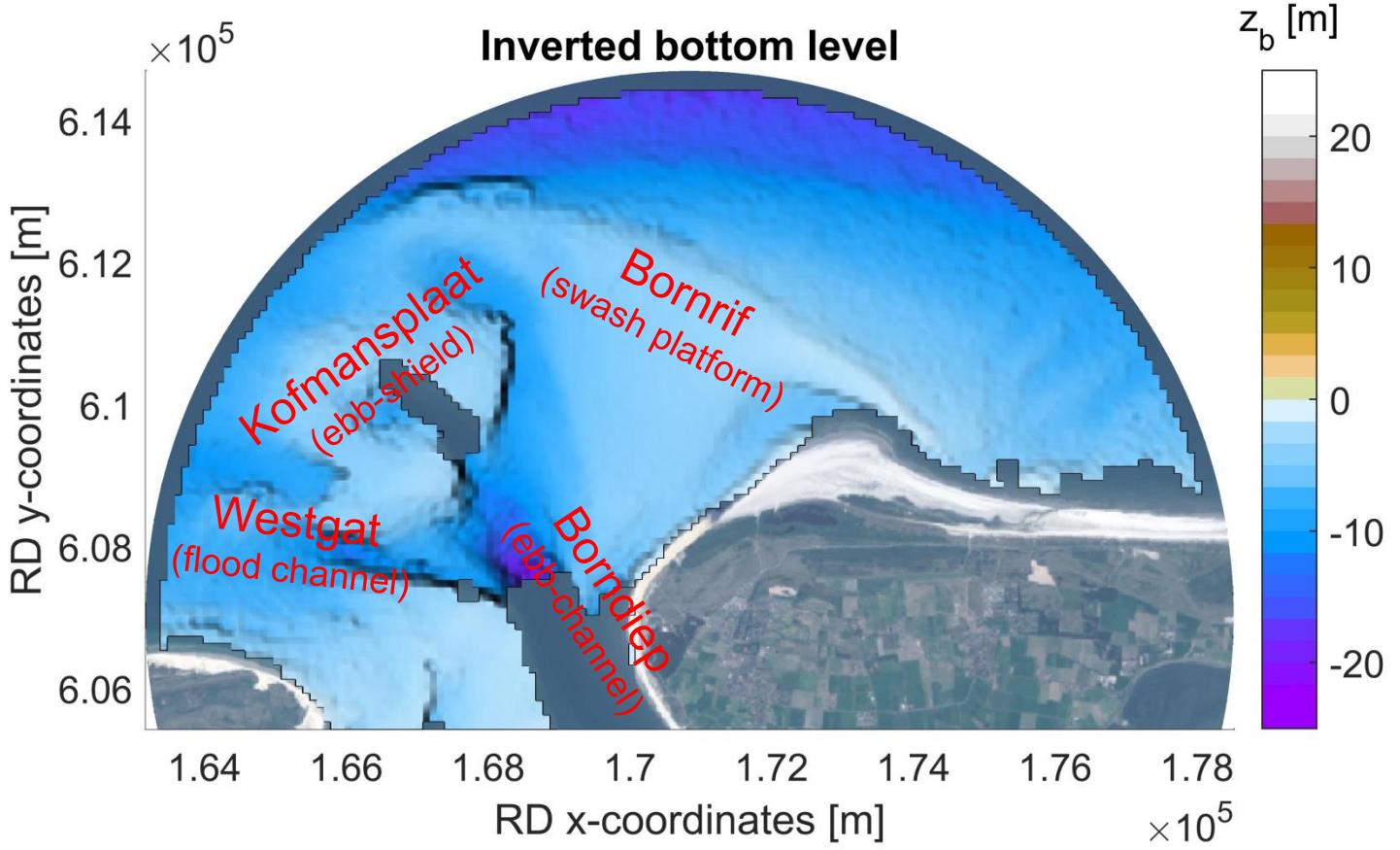
- Input → radar images
  - Pixel resolution = 7.5m
  - Image size 2048 x 2048
  - Radar rotation time 2.8 sec
- Output → depth and current data
  - Grid resolution 100 m
  - Every 40-60 min

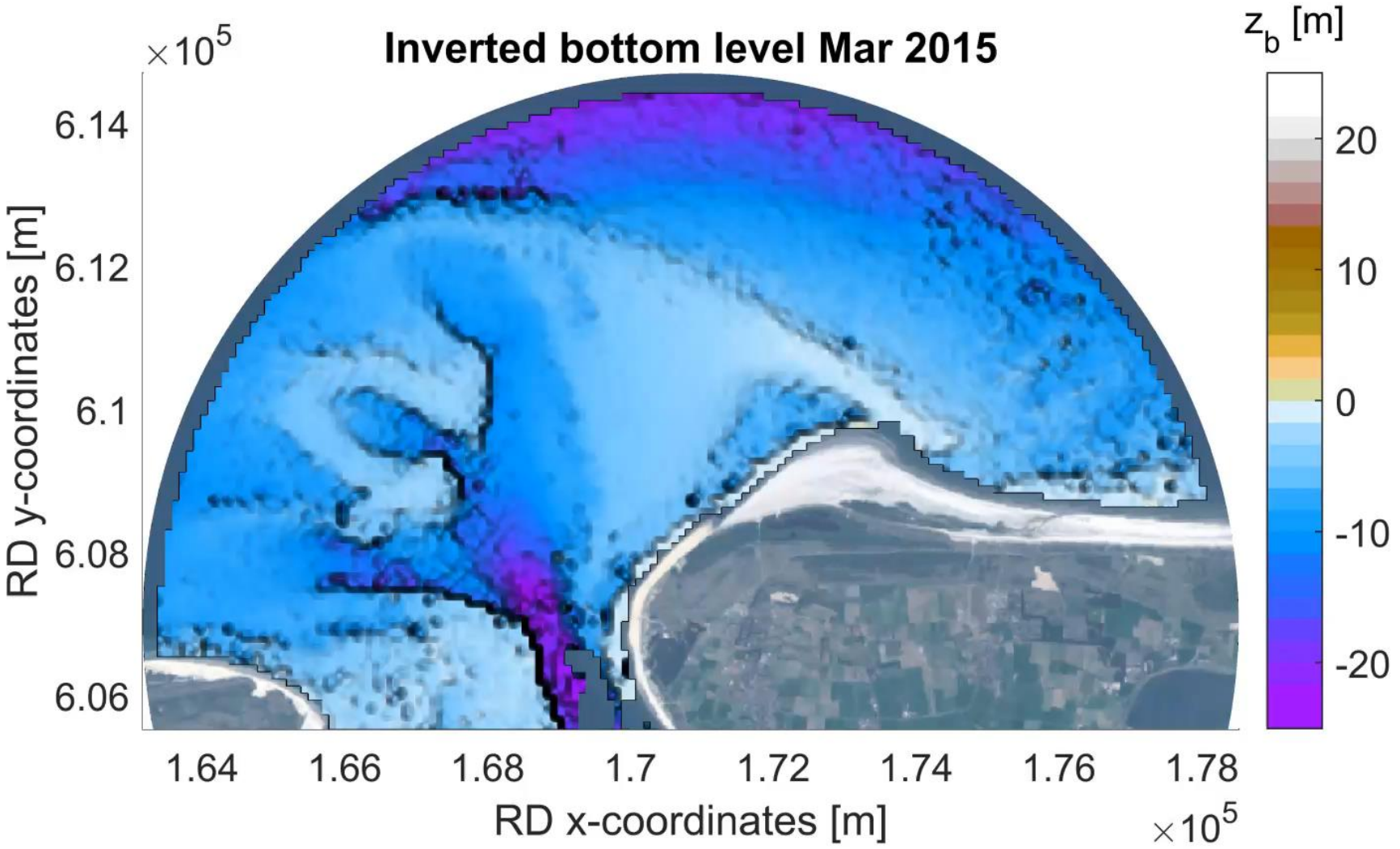
XMFit Current Magnitude



4 Results

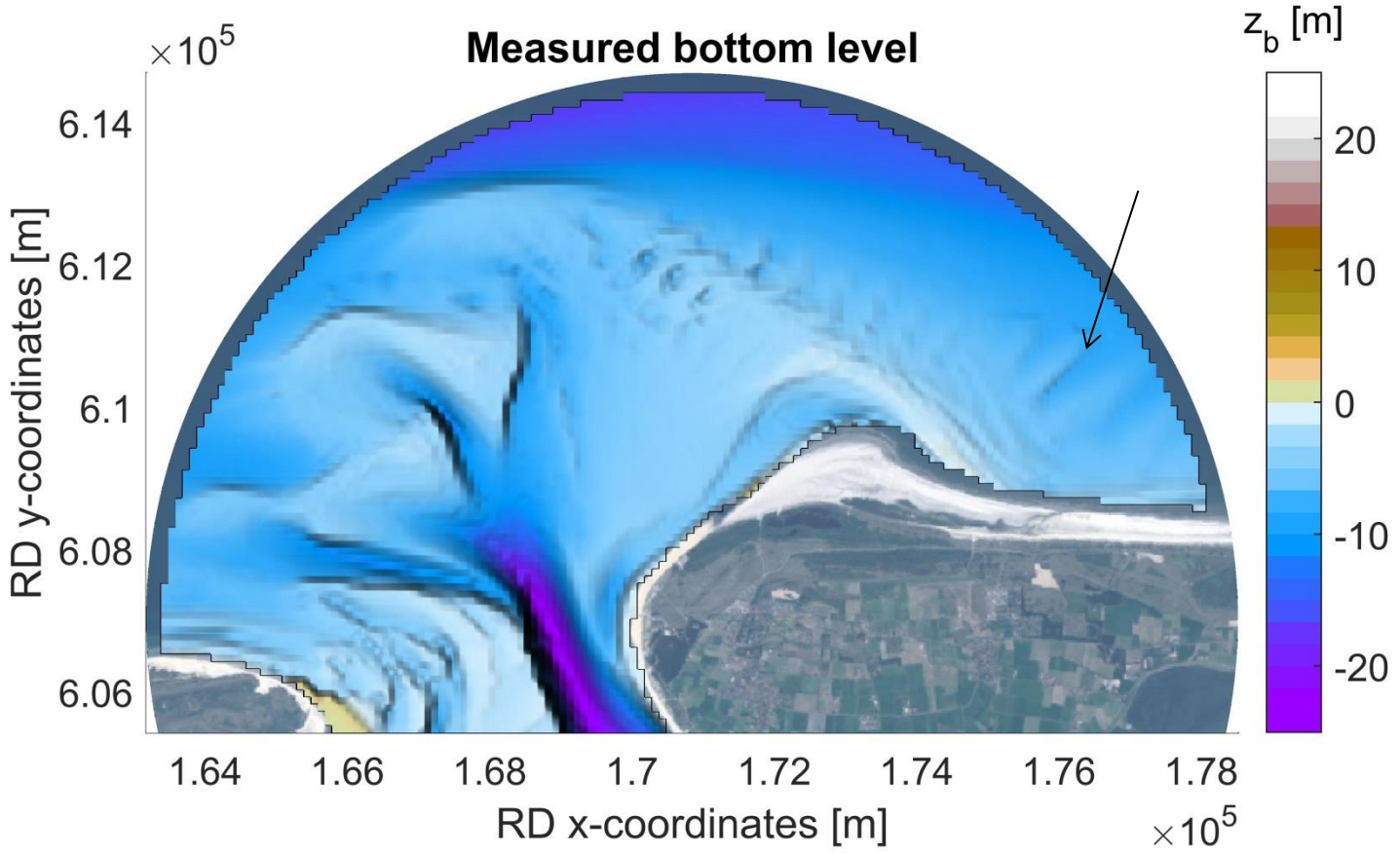
2 month averaged results (march-may **2015**)




Inverted bottom level Mar 2015
z_b [m]
20
10
0
-10
-20
$\times 10^5$
6.14
6.12
6.1
6.08
6.06
RD y-coordinates [m]
1.64
1.66
1.68
1.7
1.72
1.74
1.76
1.78
RD x-coordinates [m]
$\times 10^5$

4 Results

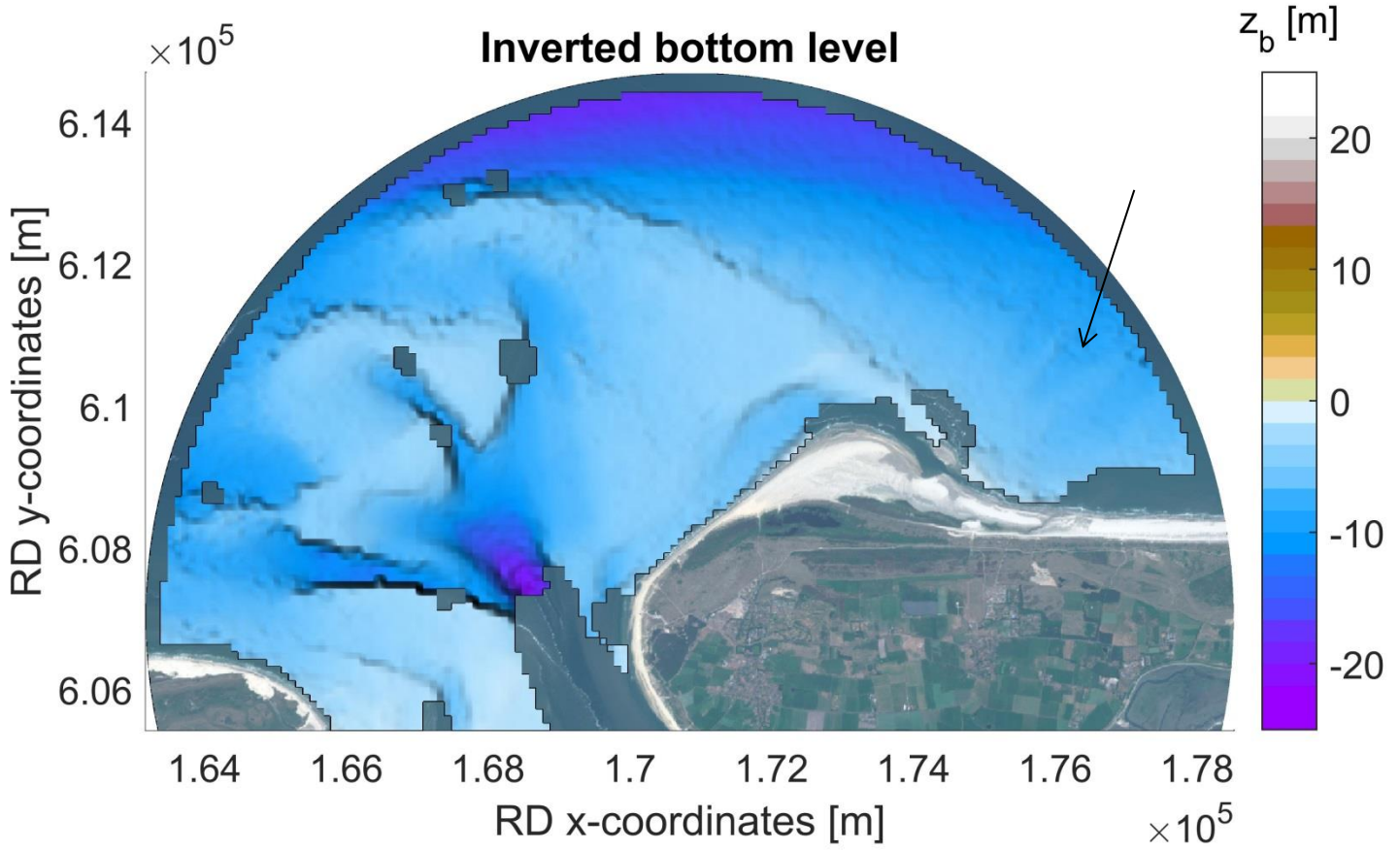
Measured bottom level (February **2017**)



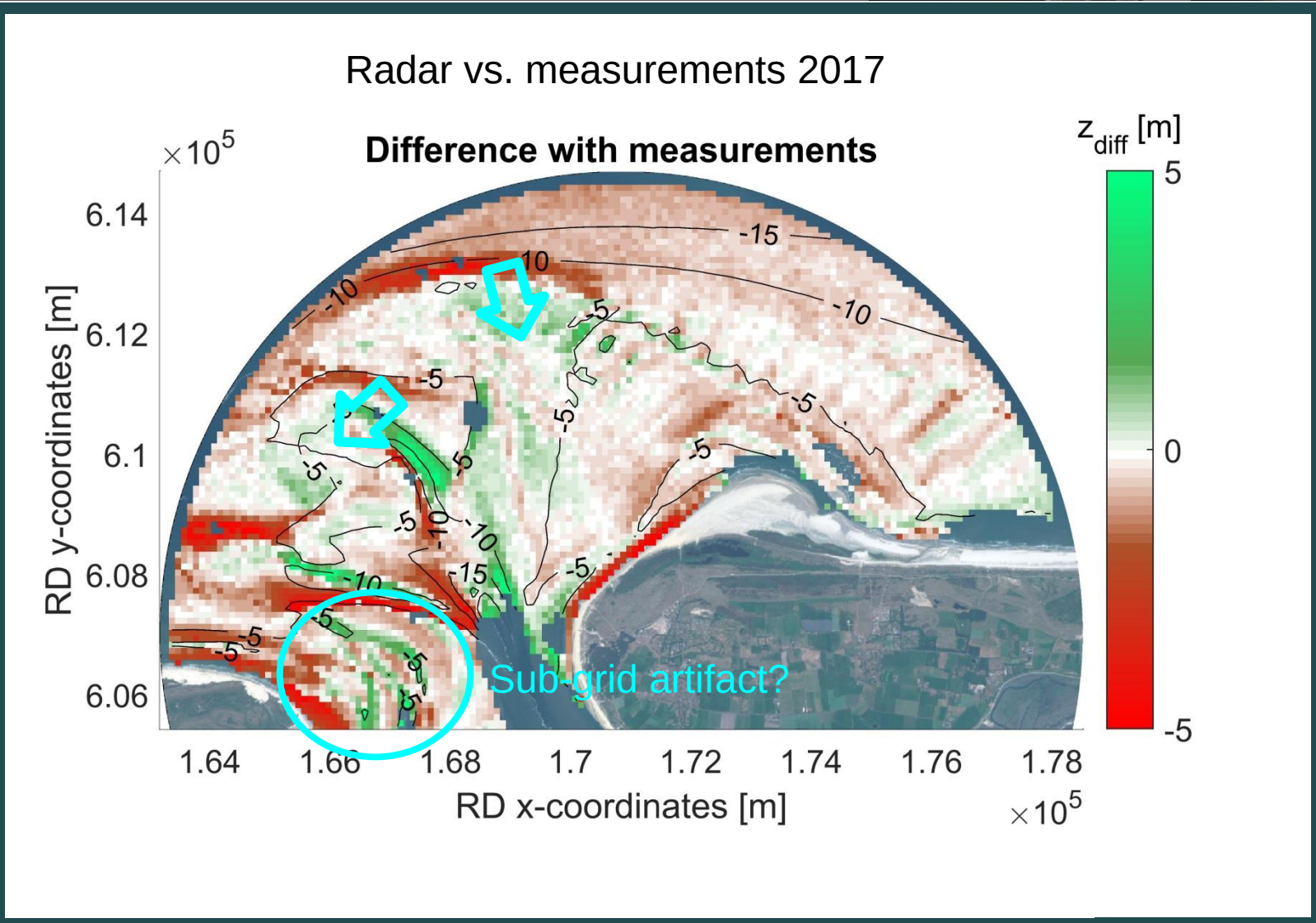
Data are expensive! And therefore very scarce

4 Results

Inverted bottom level (Oktober **2017**)



5 Results



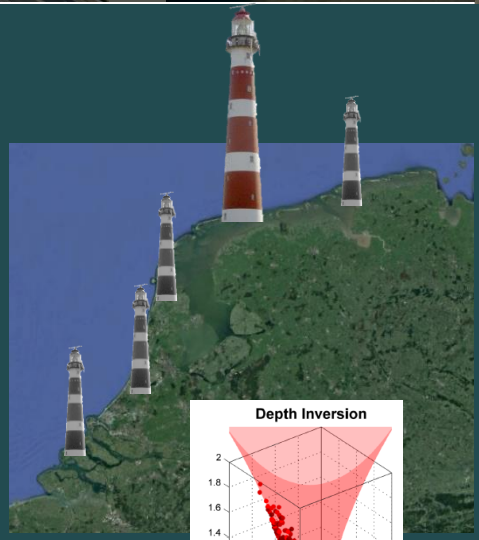
Deltares

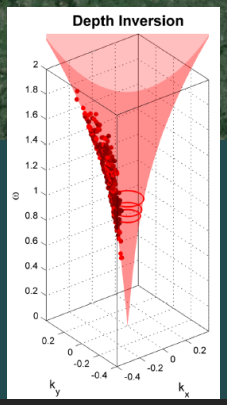
5 Summary

Summary

5 Summary

- Existing navigational X-Band radar can be used to track morphological features (Coastal Genesis 2)
- Analysis technique called XMFit (based on 3D-FFT)
- Operational processing system on Ameland for cheap, real time monitoring of bathymetry (and currents)



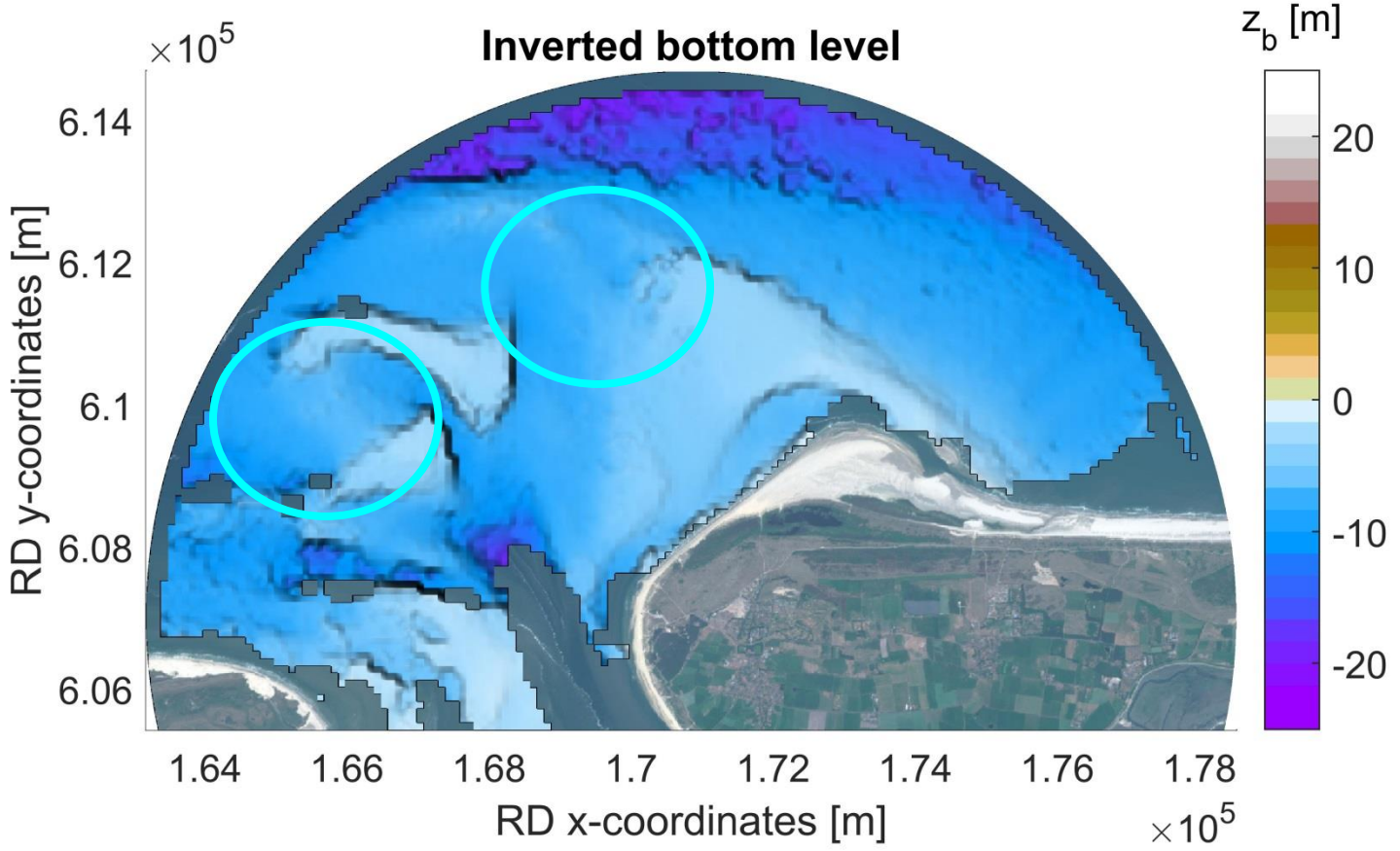


Deltares

Questions?

5 Results

Before storm 13-14. september 2017



5 Results

After storm 13-14. september 2017