



KIVI, Afdeling voor Telecommunicatie

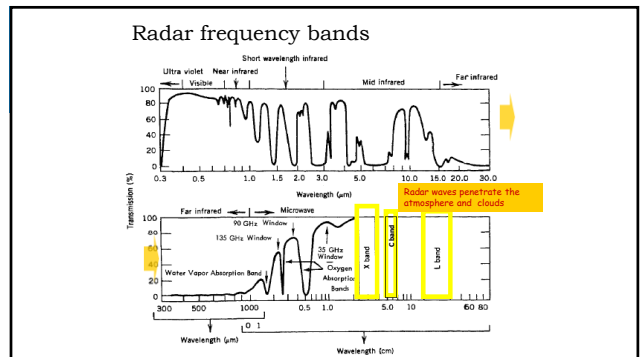
**Een sterrenhemel op aarde;
hoe microgolfwaarnemingen vanuit de ruimte ons
ongeveenaarde inzichten geven**

11-5-2022

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Delft University of Technology

lezingenvond: "Satellite Communication with optical waves for Earth observation" Den Haag 11 mei 2022

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Challenge the Future





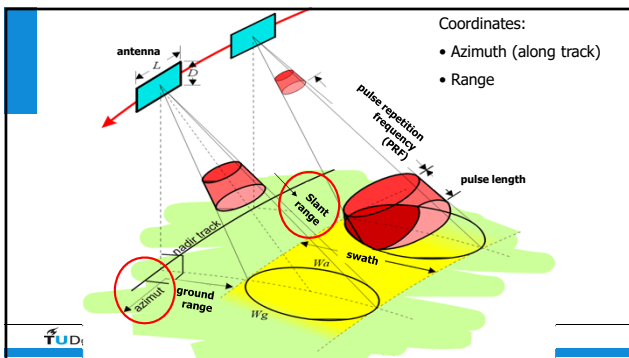
Imaging radar: Synthetic Aperture Radar (SAR)

Angular Resolution (Beamwidth) is dependent on

1. Antenna size
2. Wavelength of the radar: C-band, X-band, L-band, S-band

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Resolution I: RAR

- Real Aperture Radar
- Resolution dependent on antenna dimension/pulse length
- Beam width (half power width) is ratio wavelength over antenna size:

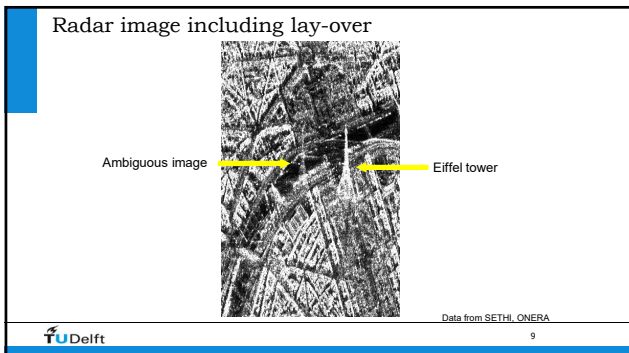
$$\theta = \alpha \frac{\lambda}{D}$$

with $0.9 < \alpha < 1.4$

Figure 1.8 Illustration of real-aperture radar capability to resolve two targets separated in azimuth.

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Calculate Ground Resolution

$$\theta = \frac{\lambda}{D}$$

Antenna dimensions

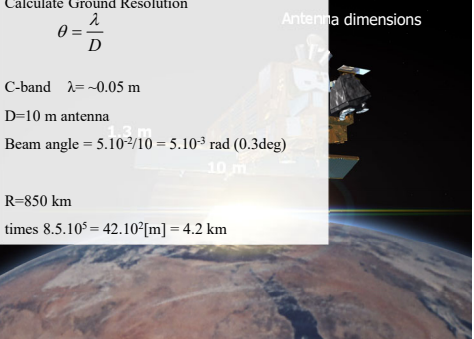
C-band $\lambda = 0.05 \text{ m}$

D=10 m antenna

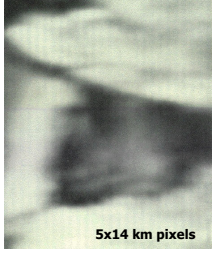
Beam angle = $5.10^{-2}/10 = 5.10^{-3} \text{ rad (0.3deg)}$

R=850 km

times $8.5.10^5 = 42.10^2[\text{m}] = 4.2 \text{ km}$

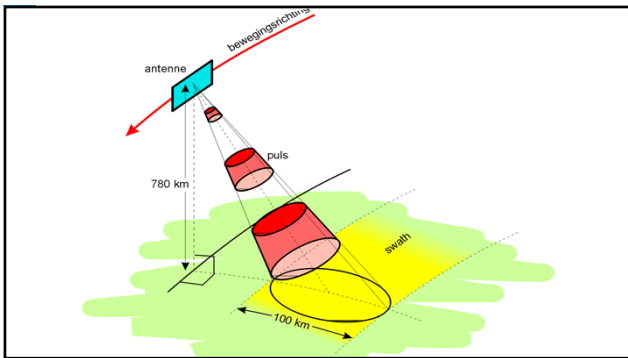


Improvement in Resolution
(Crimea, Ukraine)
Real Aperture Radar

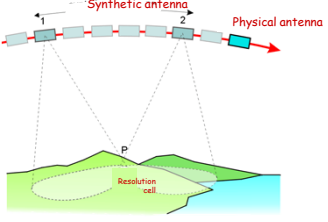


5x14 km pixels

Massonnet and Feigl, 1998



Improvement of along-track resolution: SAR



Synthetic antenna

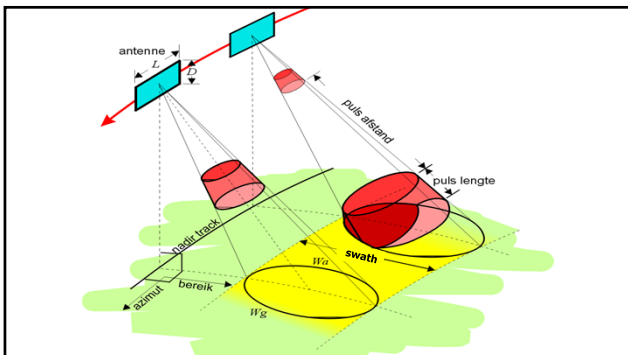
Physical antenna

P

Resolution cell

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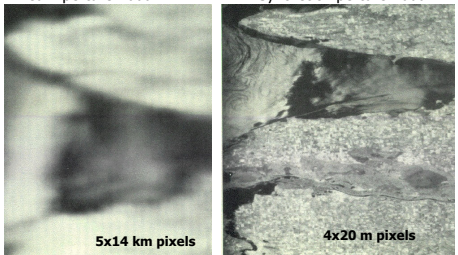
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Improvement in Resolution
(Crimea, Ukraine)

Real Aperture Radar

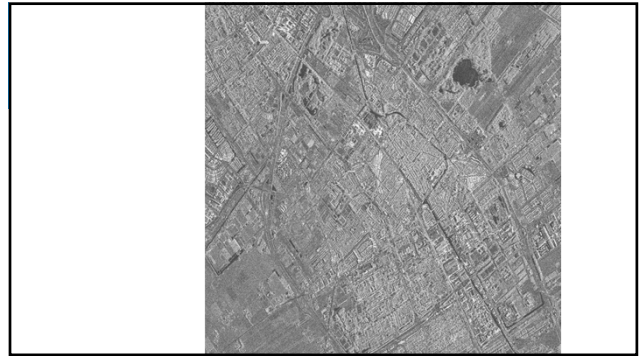
Synthetic Aperture Radar



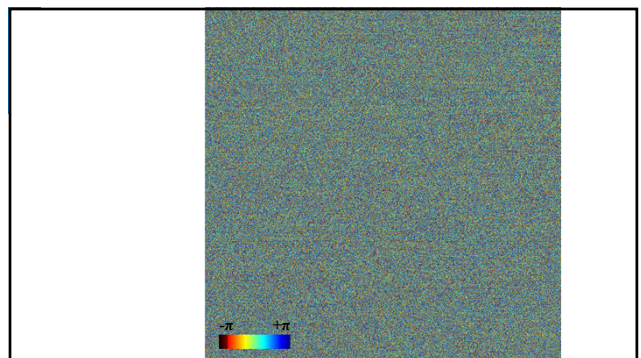
5x14 km pixels

4x20 m pixels

Massonnet and Feigl, 1998



TU Delft logo and three images: a SAR image, a photograph of a modern building, and an aerial photograph of a city area.



SAR observations

- SLC: Single-Look Complex data
- Single-look: no averaging, finest spatial resolution
- Complex: both real and imaginary (In-phase and quadrature phase) stored

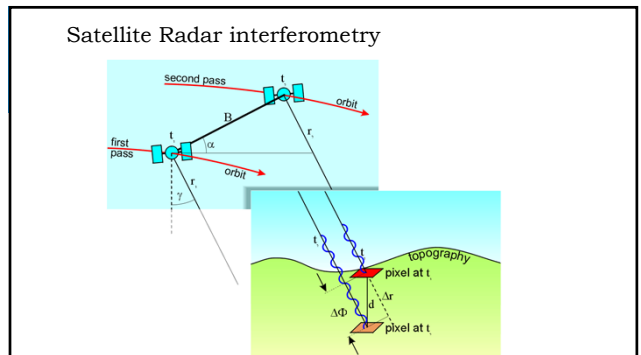
Coherent imaging

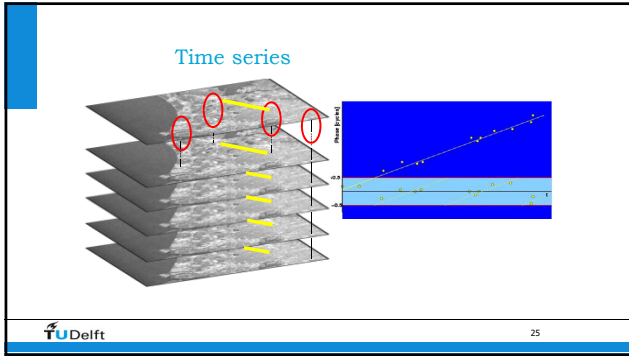
$$y_1 = |y_1| \exp(j\psi_1)$$

Amplitude Phase

Uninterpretable, due to scattering mechanism

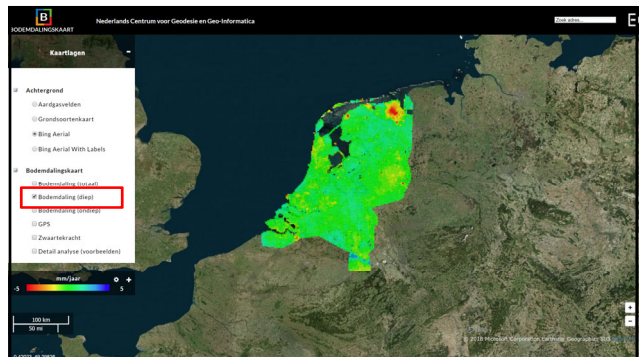
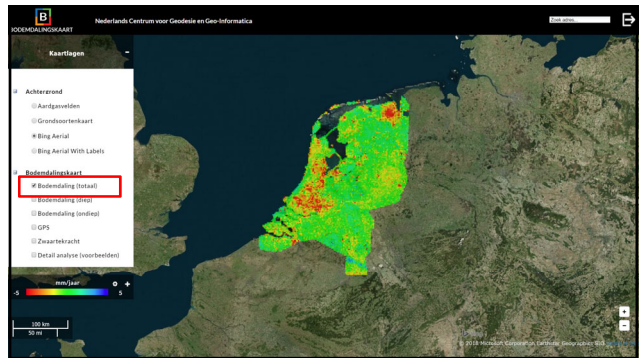
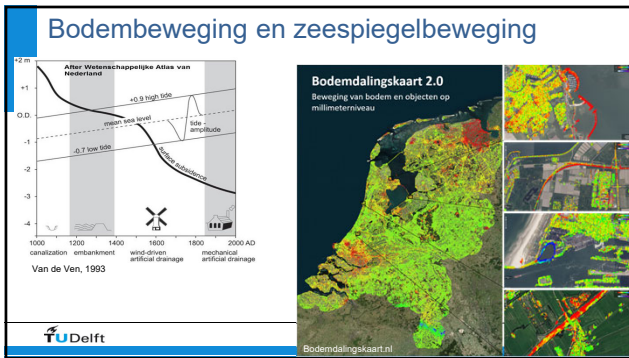
TU Delft logo

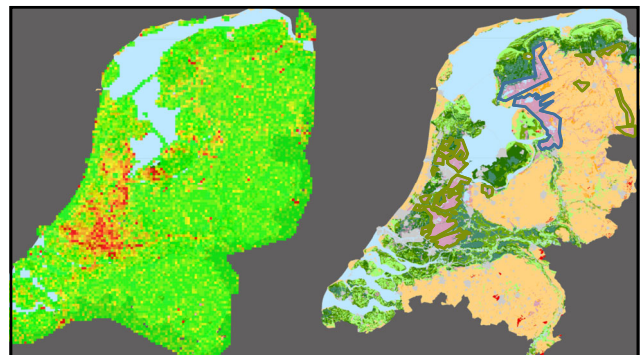
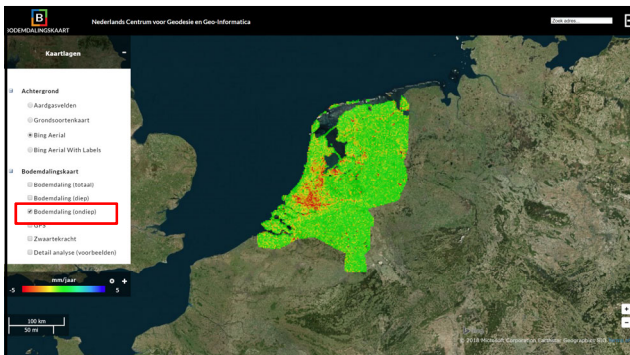
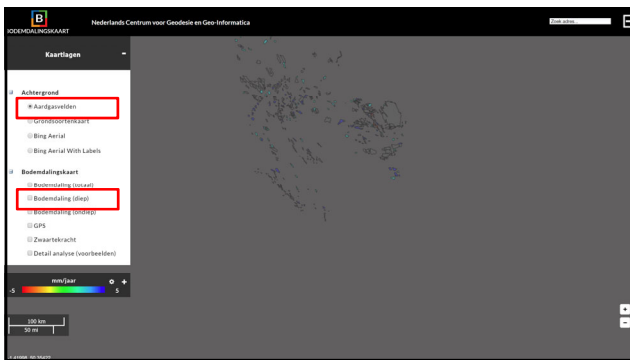
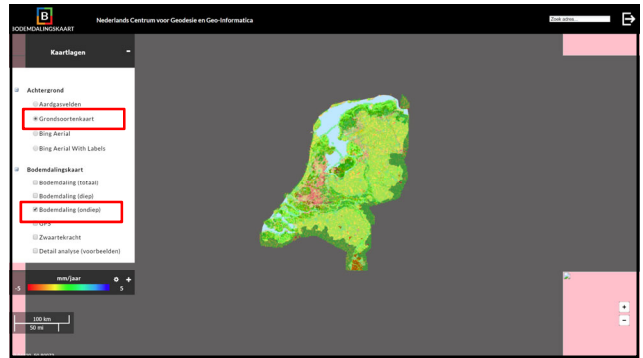
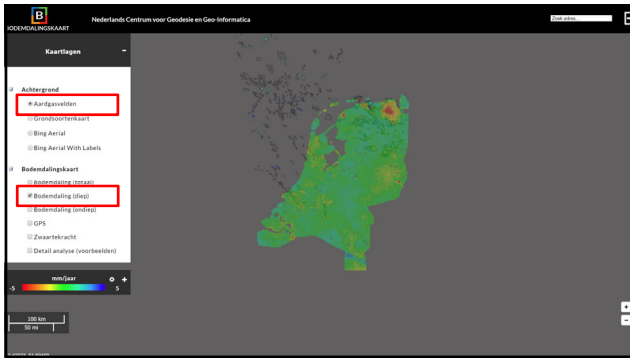




Diepe en ondiepe oorzaken

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Metingen hebben verschillende oorzaken

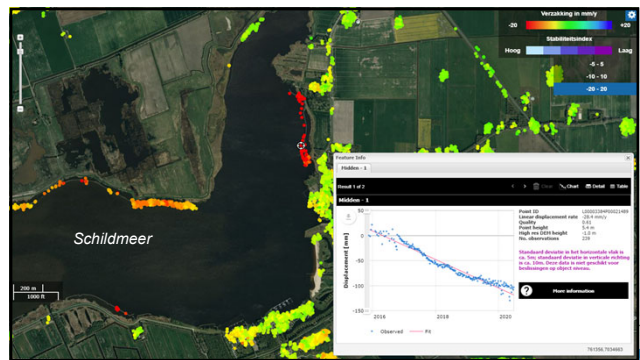
Hoge meetpunten (links), lage meetpunten (rechts), +/-5mm schaal (Voorbeeld Diemen)

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Begrijpen we wat we waarnemen?
Nemen we waar wat we begrijpen?

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Niet alle beweging is verticaal

Horizontaal
30 mm/year
2σ

Verticaal
30 mm/year
±1/2σ

Brouwer, 2021

