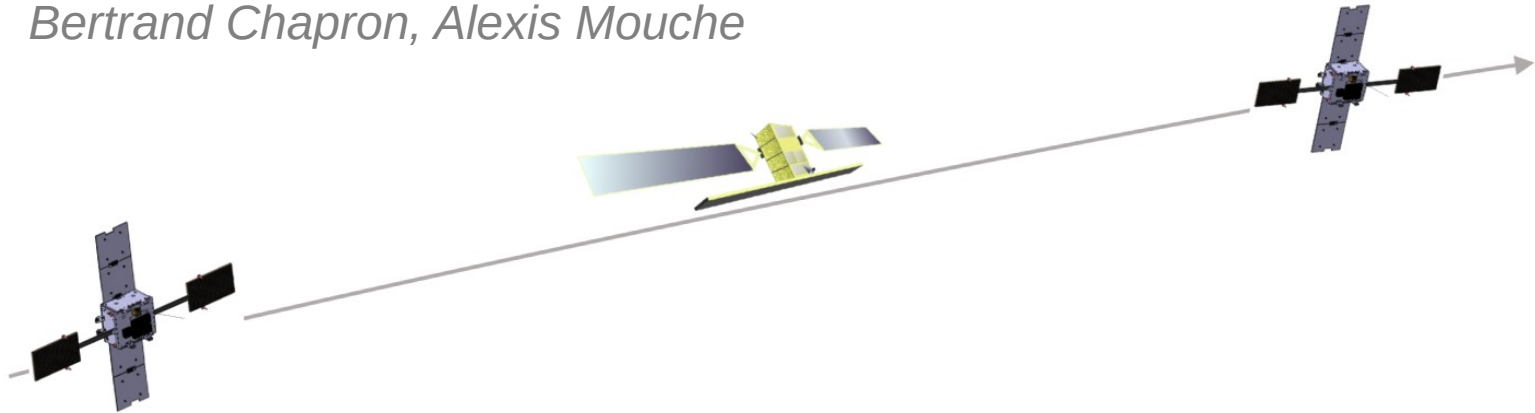


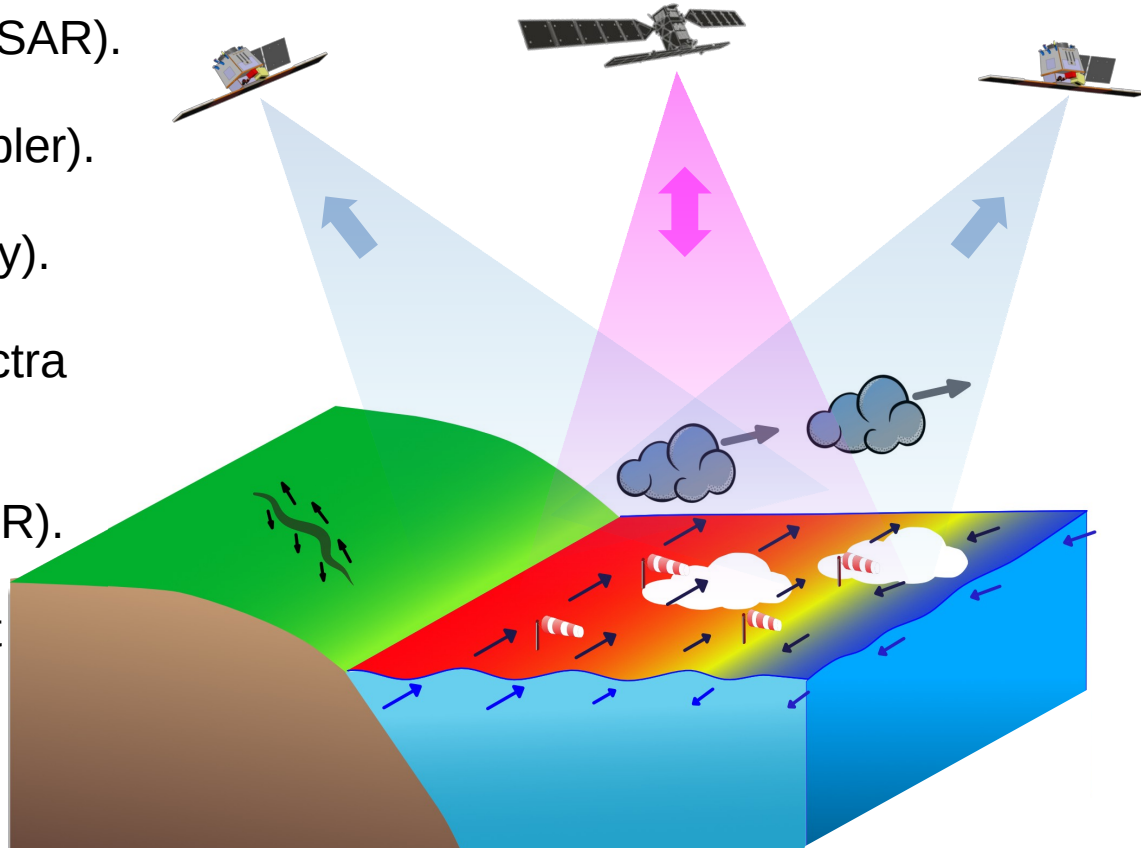
Ocean wave spectra in tropical cyclones with the Earth Explorer 10 candidate Harmony

*Marcel Kleinherenbrink, Paco Lopez-Dekker,
Bertrand Chapron, Alexis Mouche*



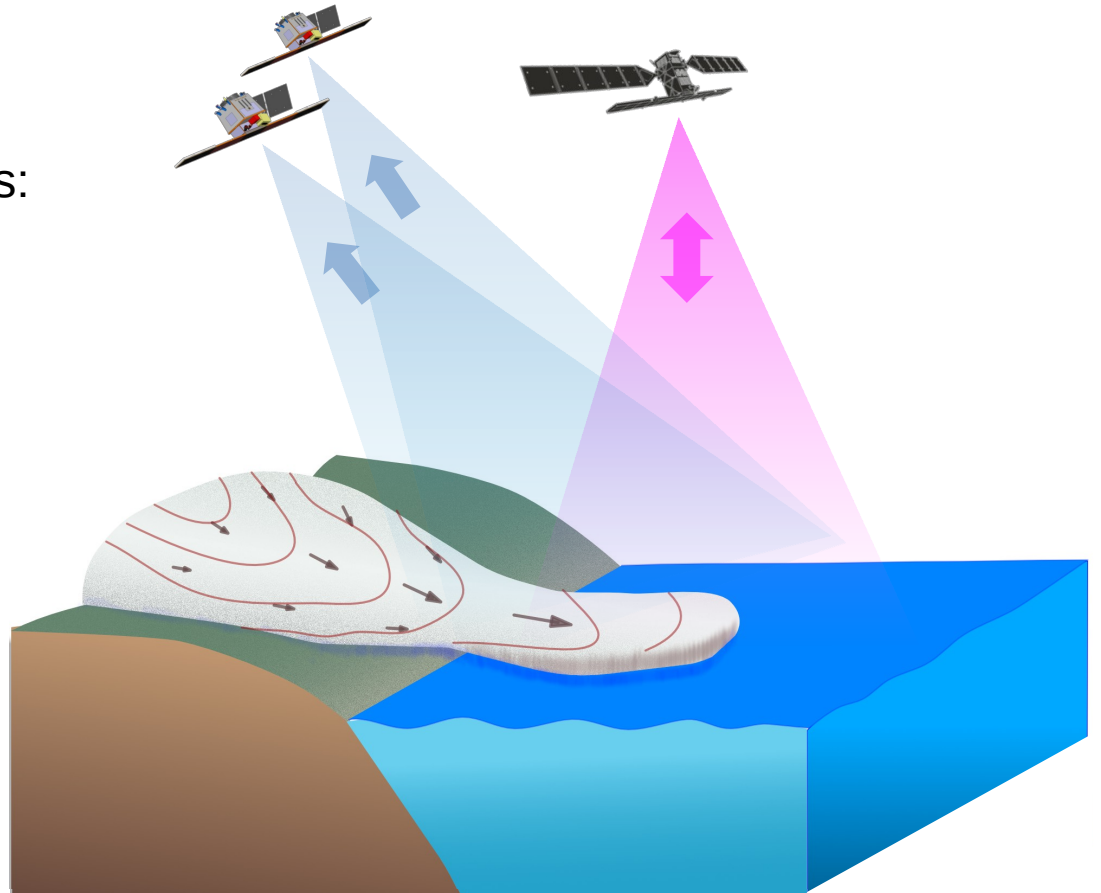
Harmony observation concept: Stereo phase

- 3D surface deformation (dInSAR).
- Ocean surface motion (Doppler).
- Surface winds (scatterometry).
- Improved surface wave spectra (NRCS modulation).
- Sea surface temperature (TIR).
- Cloud-top motion and height (TIR time-lapse/parallax).

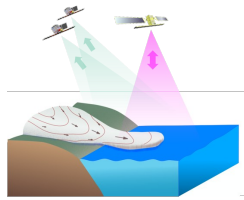


Harmony observation concept: XTI phase

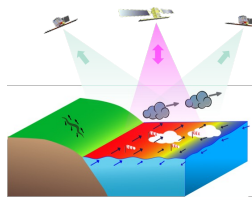
- 3D surface deformation.
- Surface elevation time-series:
 - Glaciers
 - Permafrost
 - Icebergs
 - Volcanoes
- Ocean topography.



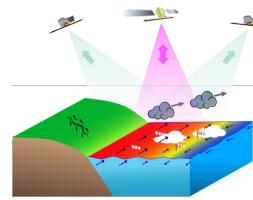
Mission Timeline



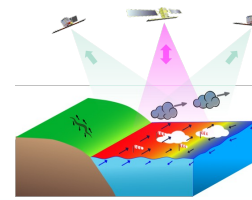
Y1



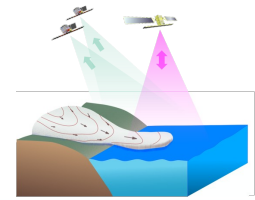
Y2



Y3



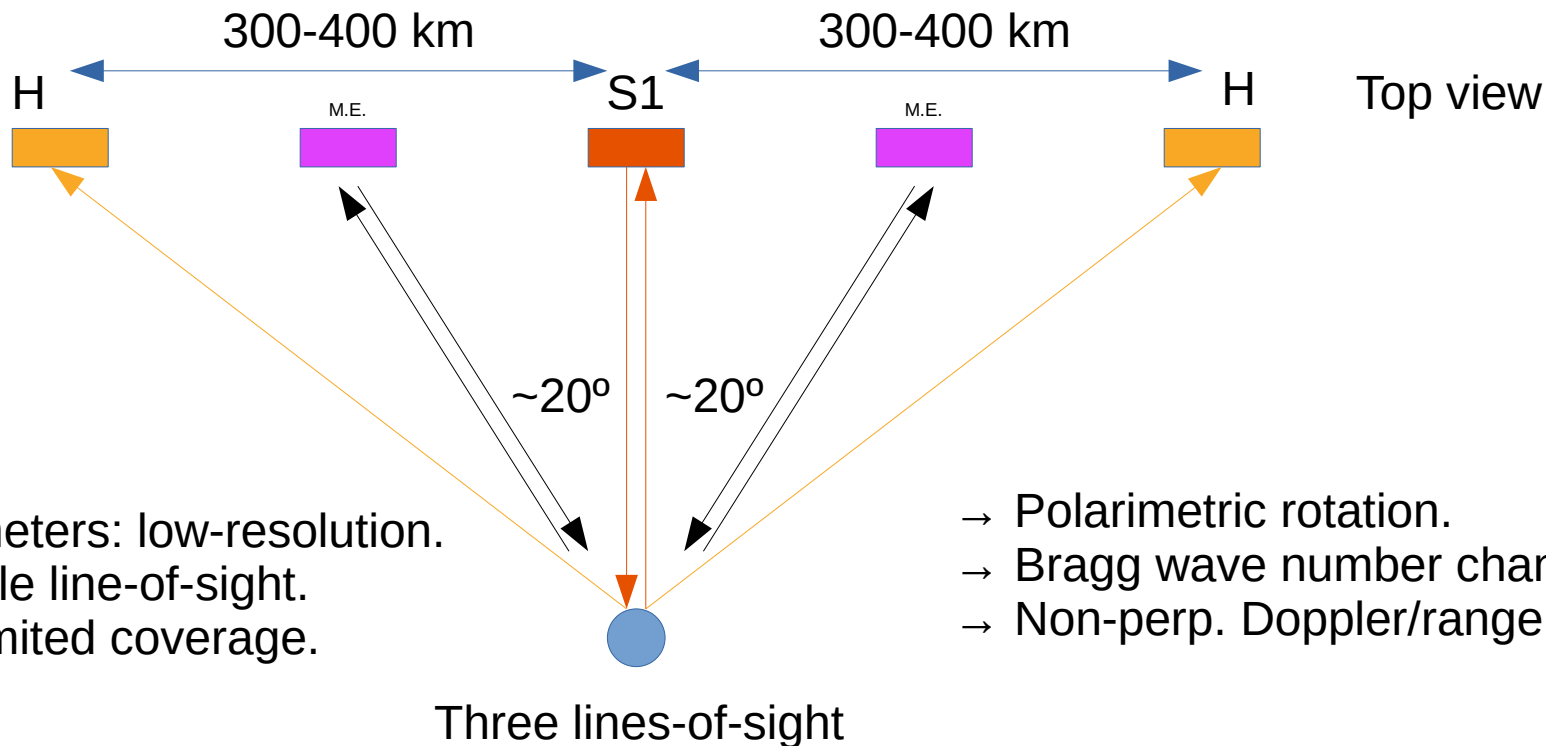
Y4



Y5

Ice Volume change				Ice Volume change
Glacier dynamics				Glacier dynamics
	3-D Ice surface motion			
	Air-sea interactions			
Exp. Ocean topography	Atmosphere-ocean-extemes (Tropical Cyclones, Polar lows, etc)			Exp. Ocean topography
	Upper ocean dynamics			
	Tectonic Strain			
Vol. change (volcanoes)				Vol. change (volcanoes)
Iceberg volume	Sea-ice instantaneous motion/deformation			Iceberg motion

Monostatic 'equivalent'

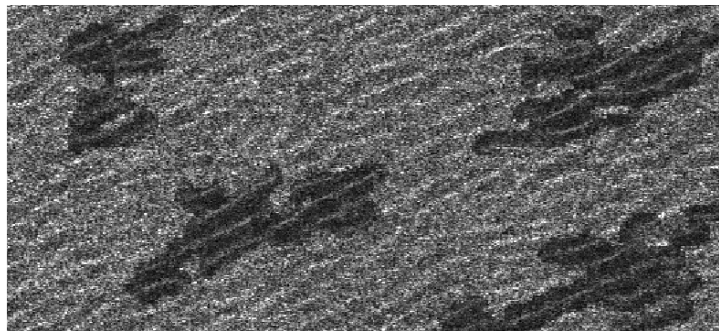


- Scatterometers: low-resolution.
- SAR: single line-of-sight.
- Planes: limited coverage.

- Polarimetric rotation.
- Bragg wave number change.
- Non-perp. Doppler/range.

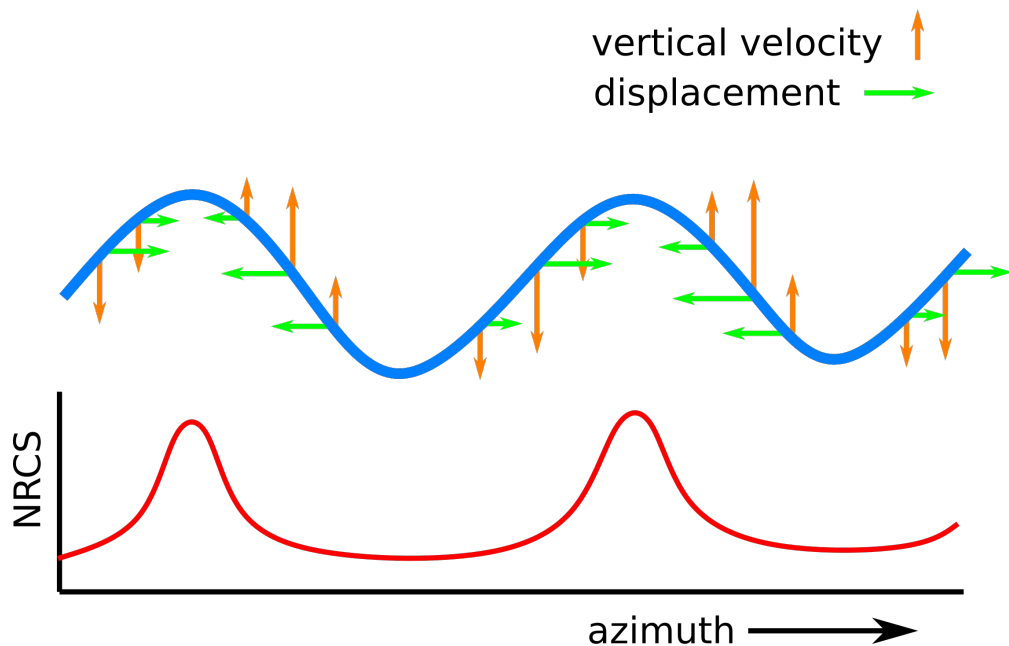
SAR distortions

- RAR modulation:
 - Surface tilt.
 - Hydrodynamics.
 - Range bunching.

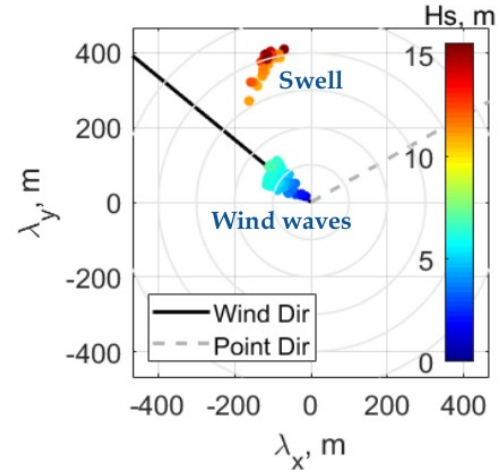
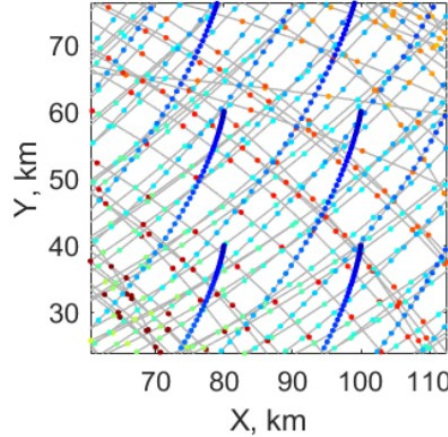
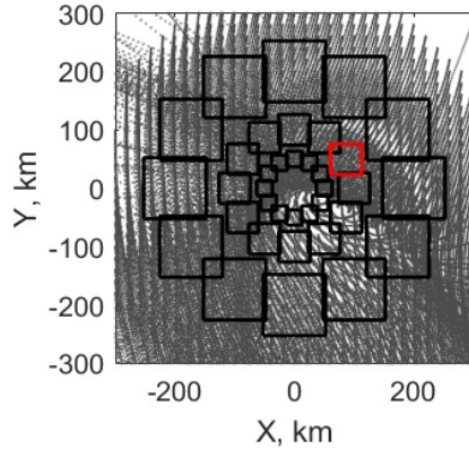


Gunson and Lehner, 2001

- SAR distortion:
 - Velocity bunching.
 - Azimuthal cut-off.



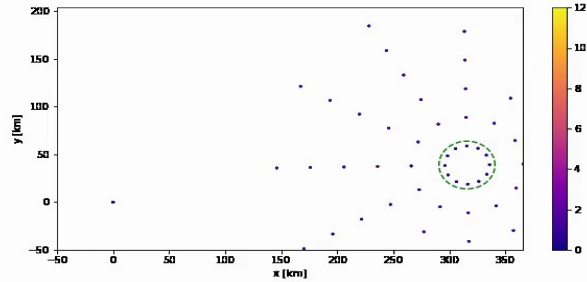
Tropical cyclone wave modeling



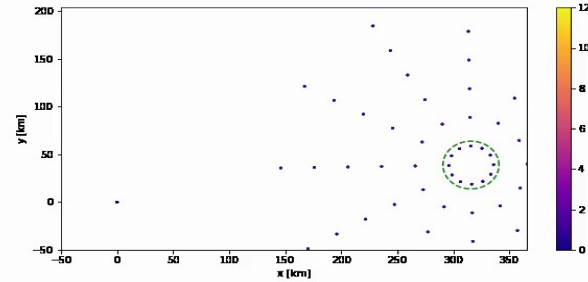
- Kudryavtsev et al. (2021a/b).
- Numerically grow wave trains in a wind field.
- ‘Wave spectra’ estimated in the red box.

Tropical cyclone waves

→ Inflow angle: 20 deg



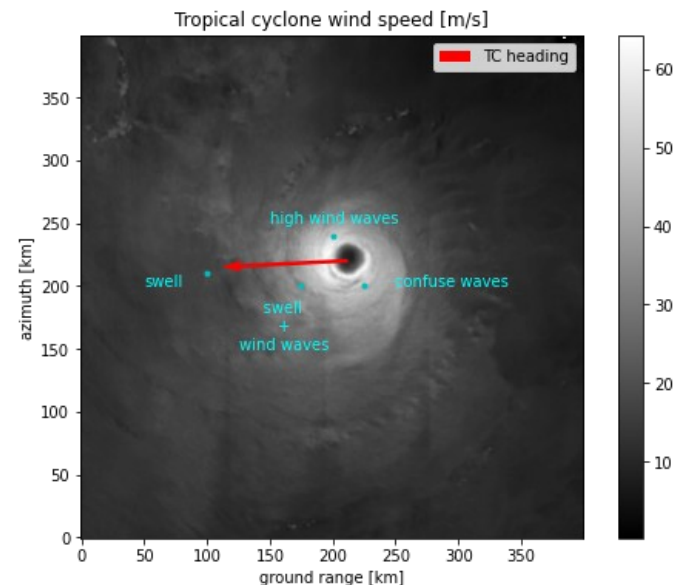
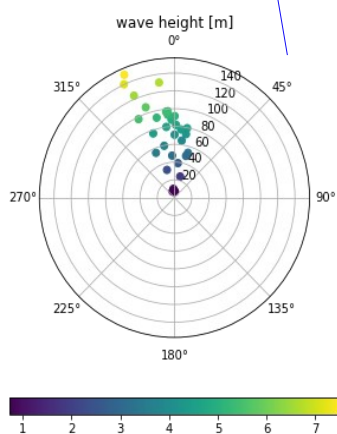
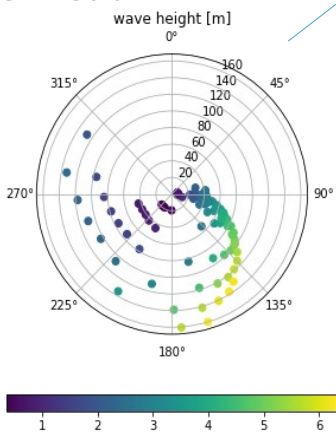
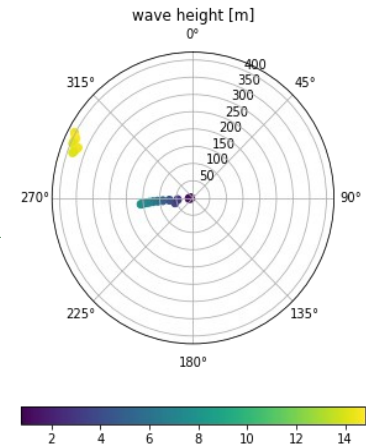
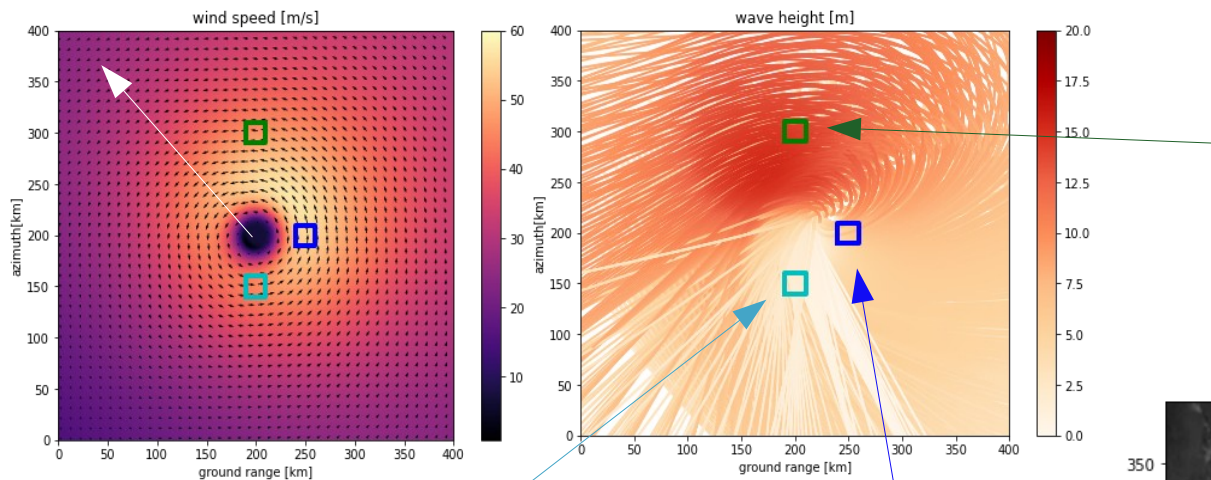
→ Inflow angle: 5 deg



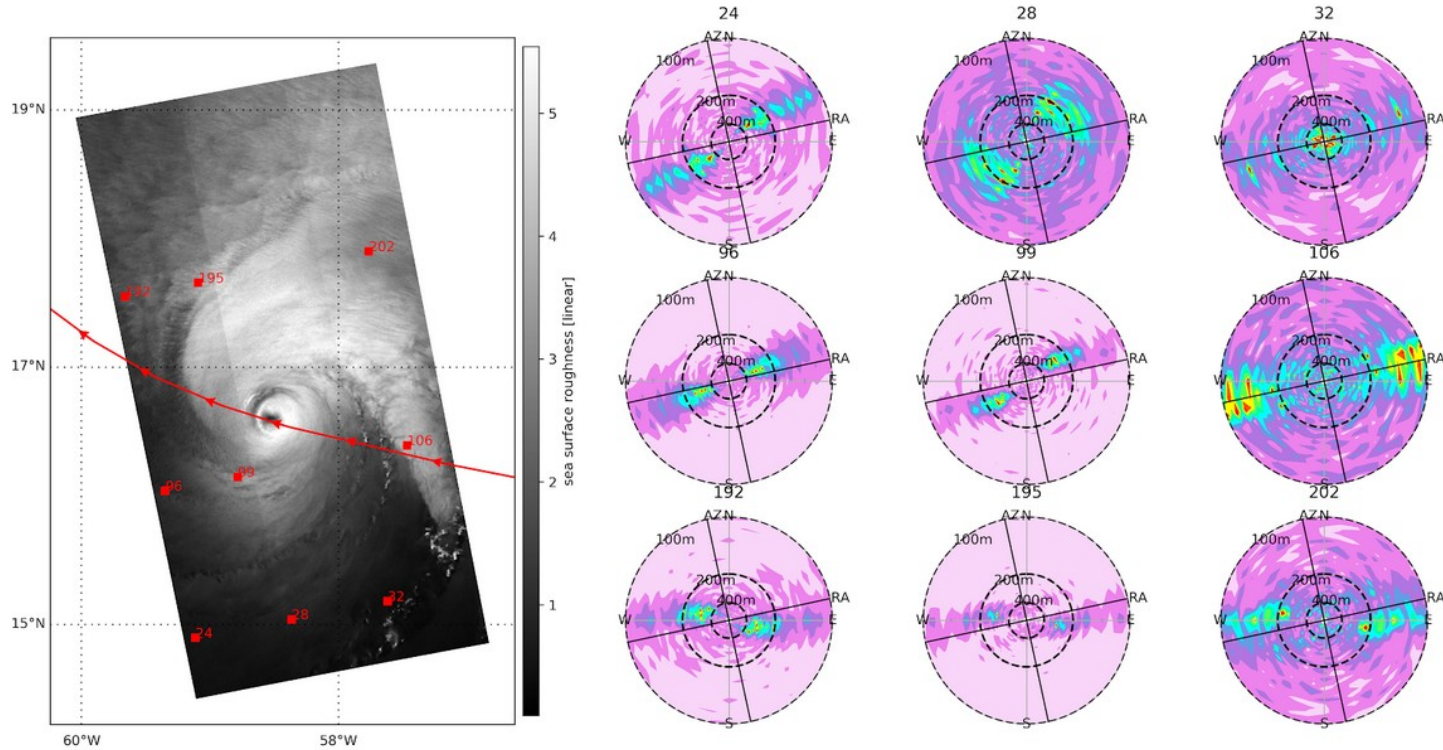
Significant wave height [m]

Wave spectra contain information about the wind field.

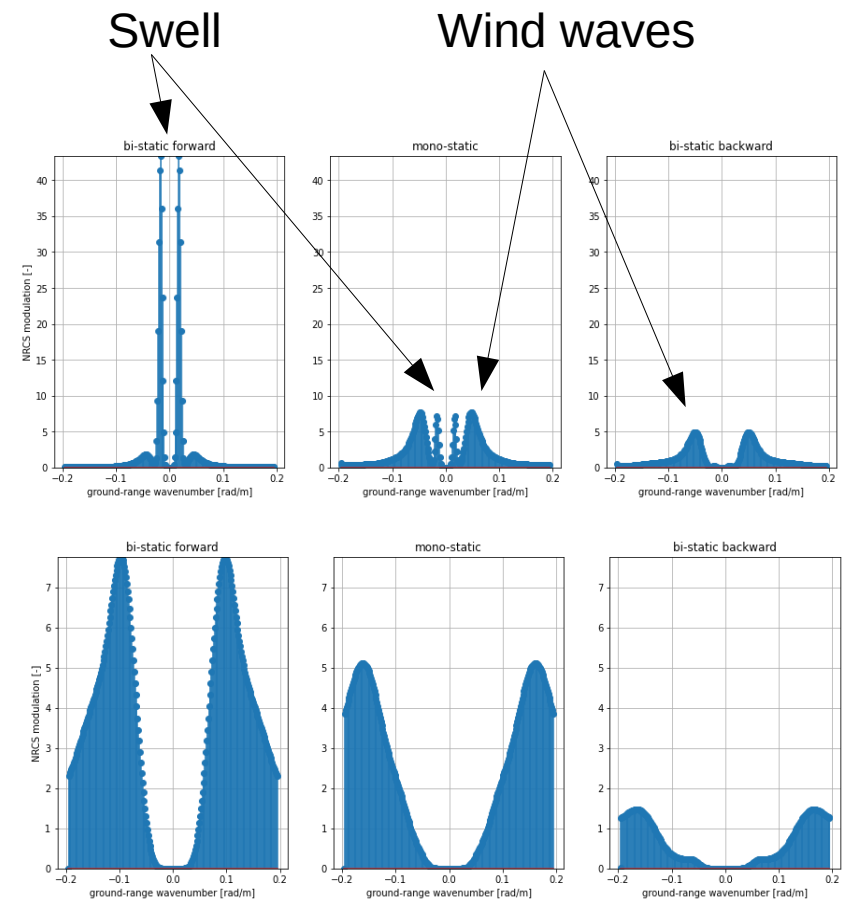
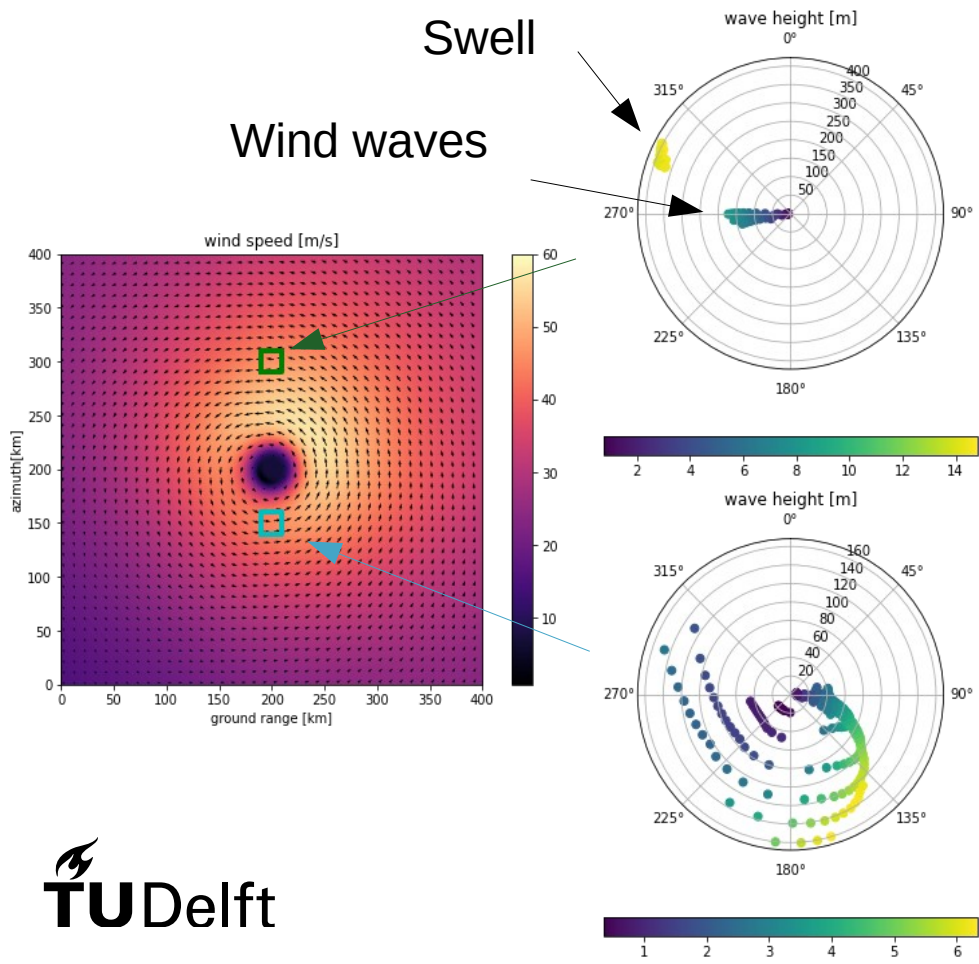
Tropical cyclone wave modeling



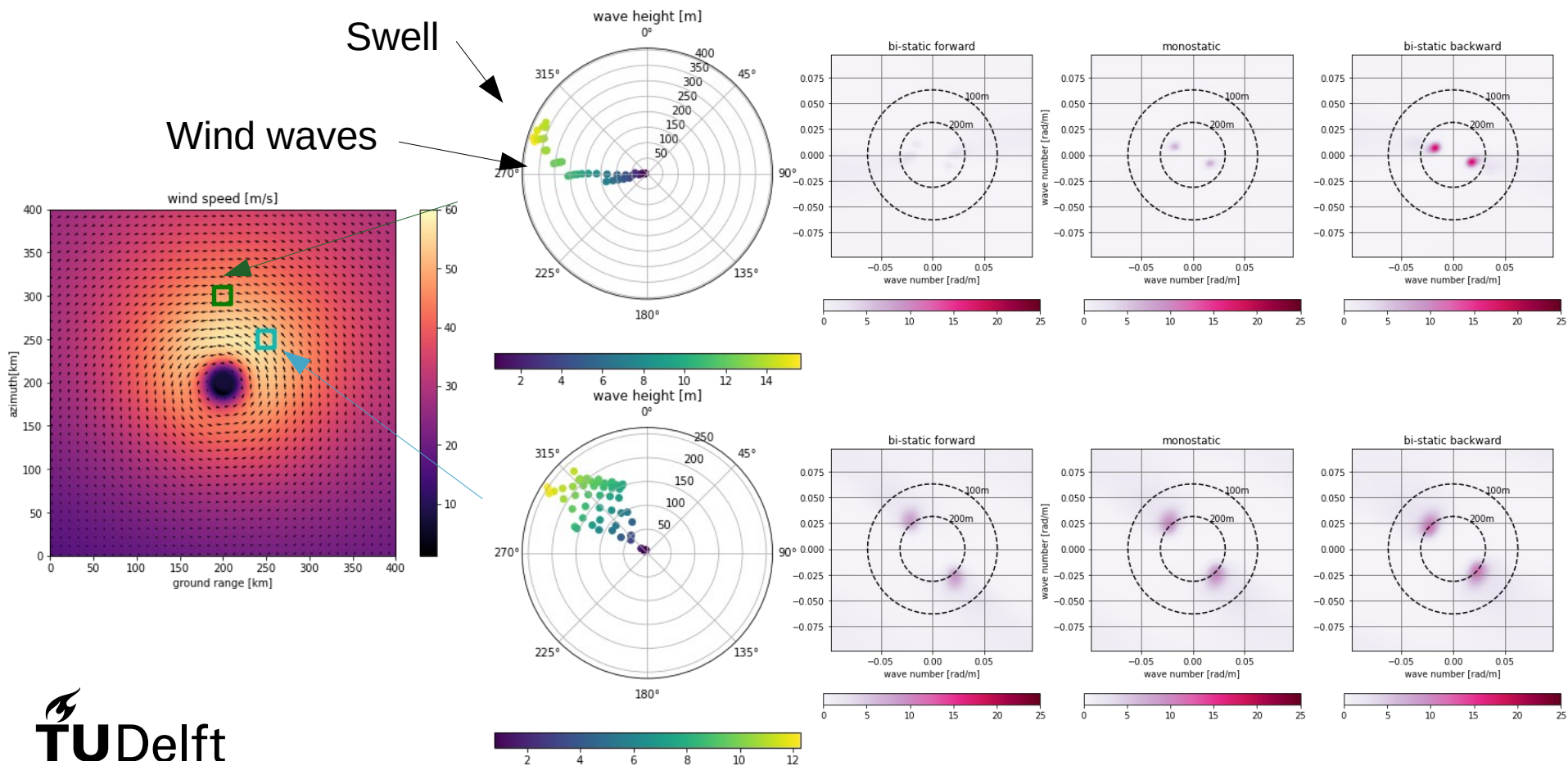
SAR observations



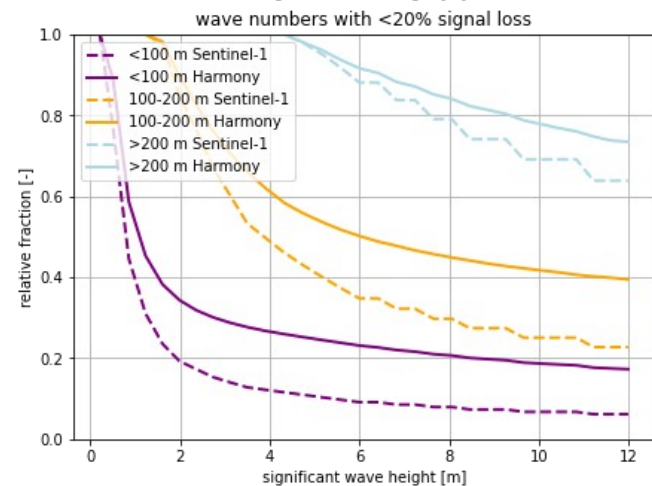
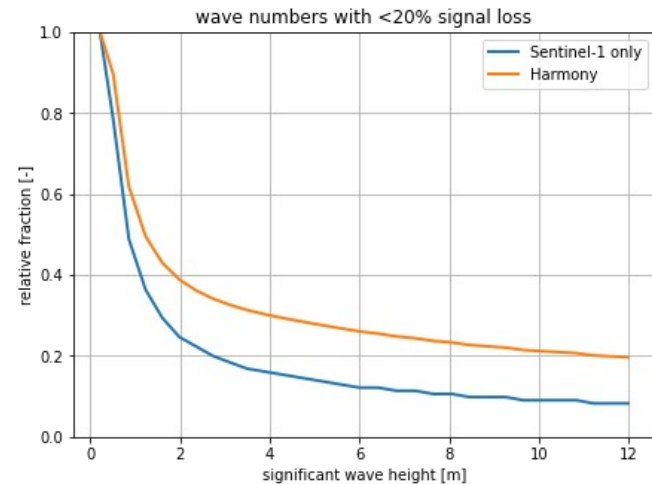
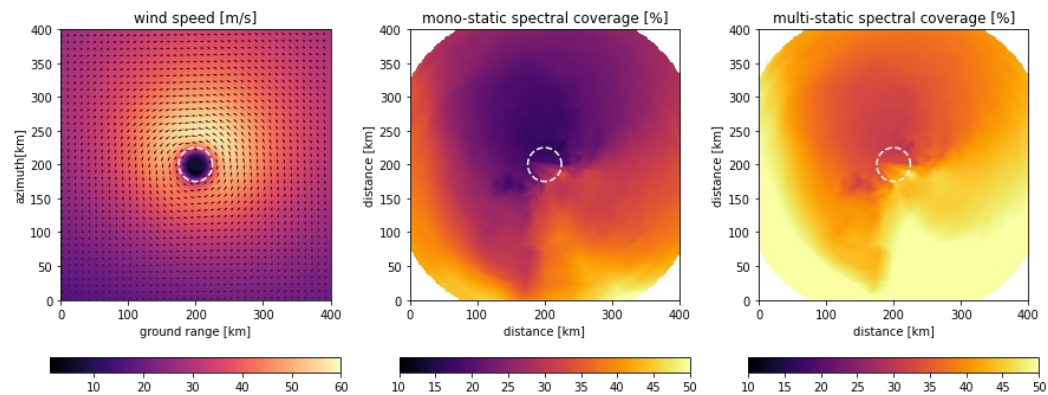
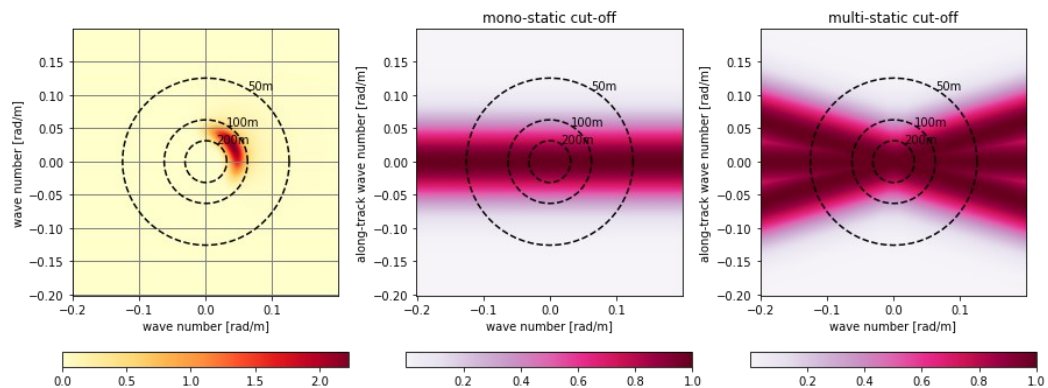
RAR wave spectra



SAR wave spectra



SAR spectral coverage



Summary

- Harmony's multi-target mission:
 - Ocean and air-sea interactions (currents, waves, wind, clouds).
 - Cryosphere (sea ice, land ice, icebergs).
 - Solid Earth (strain, volcanoes).
- Tropical cyclones:
 - Harmony has three lines-of-sight:
 - High-resolution Doppler.
 - High-resolution backscatter.
 - Harmony's SAR spectra:
 - Improved spectral coverage.
 - Improved constraints on wave spectra.

