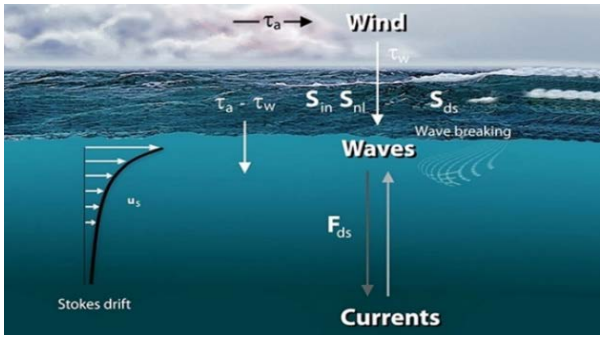
CFOSAT DATA AND THEIR SYNERGY WITH IN-SITU MEASUREMENTS AND MODEL SIMULATIONS AT REGIONAL AND COASTAL SCALES.



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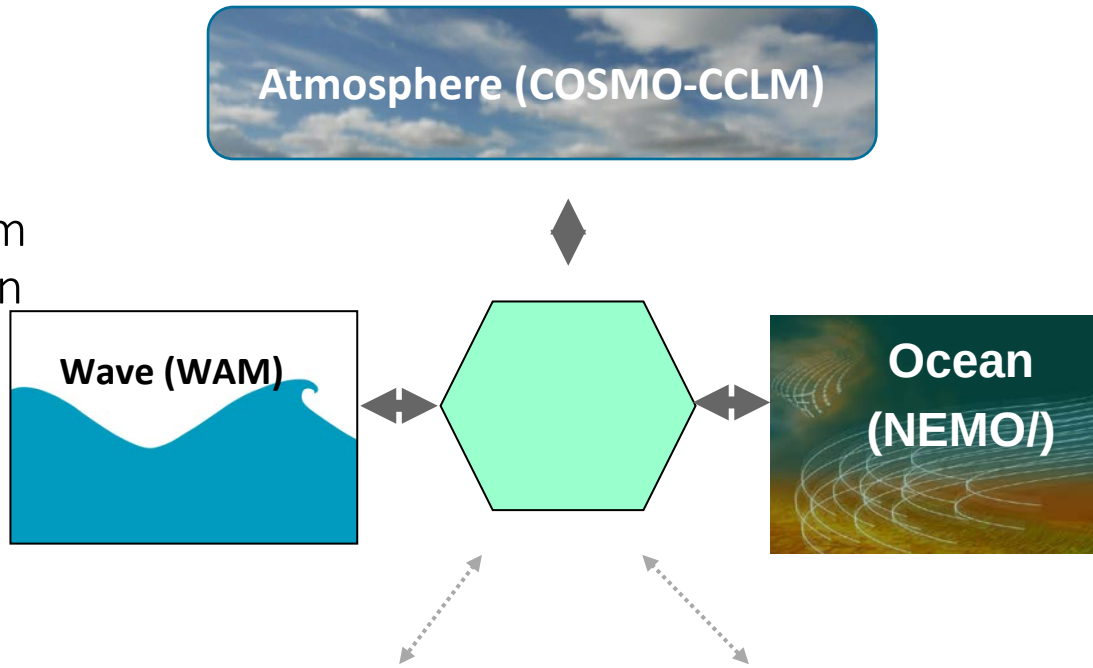
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

CFOSAT 2nd International Science Team Meeting
March 15-19, 2021

INTRODUCTION

- SWIM (Surface Waves Investigation and Monitoring) instrument carried by CFOSAT (China France Oceanography Satellite) data are used in a comparison with in-situ measurements and simulations from a spectral wave model coupled to an ocean circulation model.
- The focus is on the regional and coastal areas, where the satellite observations are of lower quality than in the open ocean.
- The model is a part of the Geestacht COAstal model SysTem(GCOAST) and the study area is the north-east Atlantic, North Sea and Baltic Sea.
- CFOSAT Data were assimilated and the impact of DA is demonstrated



Satellite data

In-situ observations

WAVE MODEL

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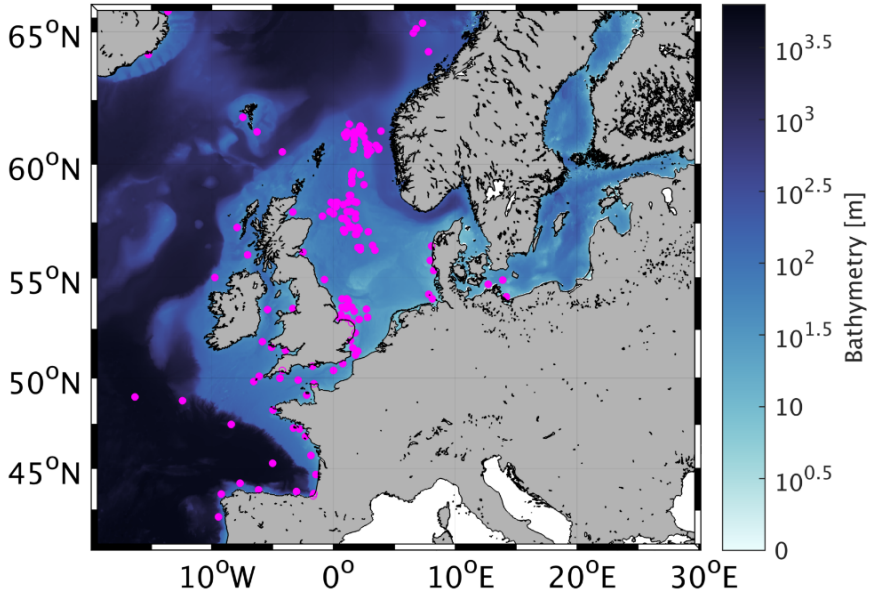
- Wind-wave model WAM v4.7
- Spectral model
- Includes: shallow water, depth refraction and wave breaking parameterizations
- Directional resolution:
  - Number of directions: 24
  - Number of frequencies: 30
- ERA5 wind forcing
- WAM is coupled with the ocean MODEL NEMO and regional atmospheric model CCLM via OASIS

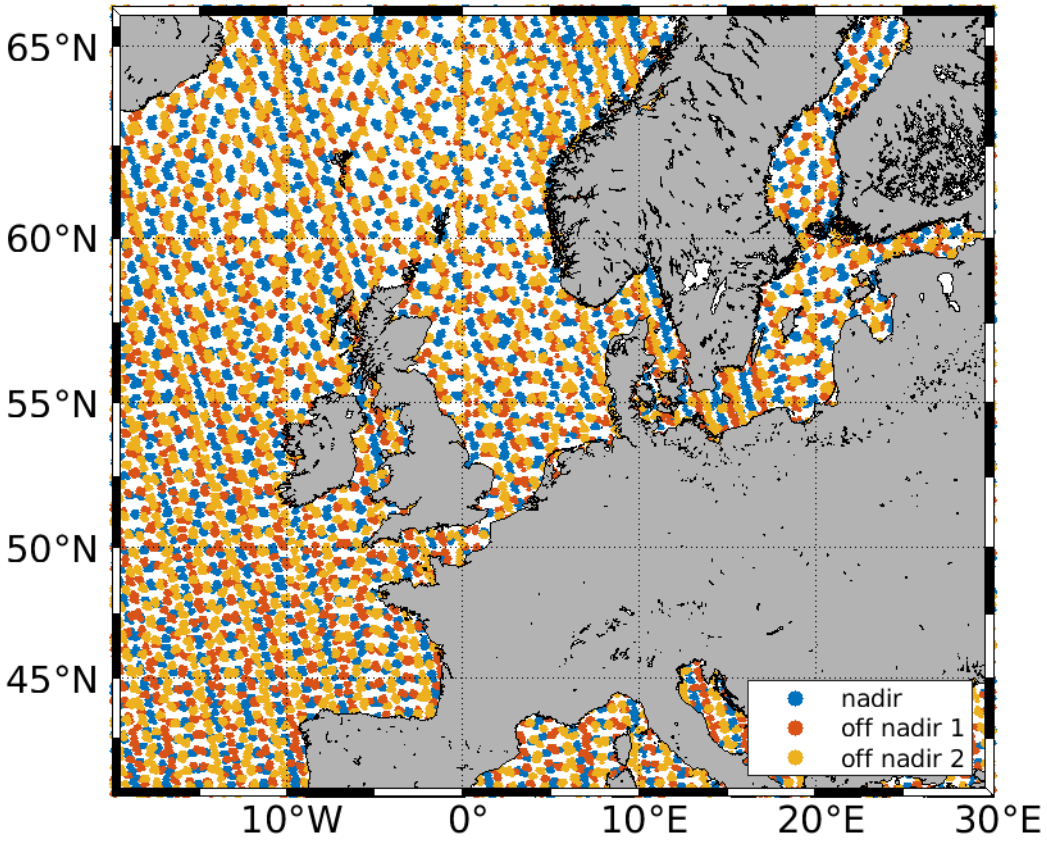


- Spatial resolution GCOAST:
  - dx: ~0.06°, dy: ~0.03°
- Spatial resolution GB:
  - dx: ~0.016°, dy: ~0.009°

MOTIVATION

- While in the open ocean, satellite data are of good quality and used routinely, their quality tends to deteriorate in coastal areas, which results in systematic flagging of up to a few ten kilometers from the coast.
- The memory of improving the sea state by assimilating CFOSAT altimeter data into the wave model is low at regional and coastal scales.
- Directional wave spectra describe the complexity of sea state and give access to directional parameters (mean direction and directional distribution of energy) and frequency parameters (peak frequency, frequency spread).
- Different processing tools are applied for the 2D ocean-waves spectra evaluation supporting a combined analysis of high-resolution remote sensed data, buoy observations and model simulations for multipole validations of coastal processes.

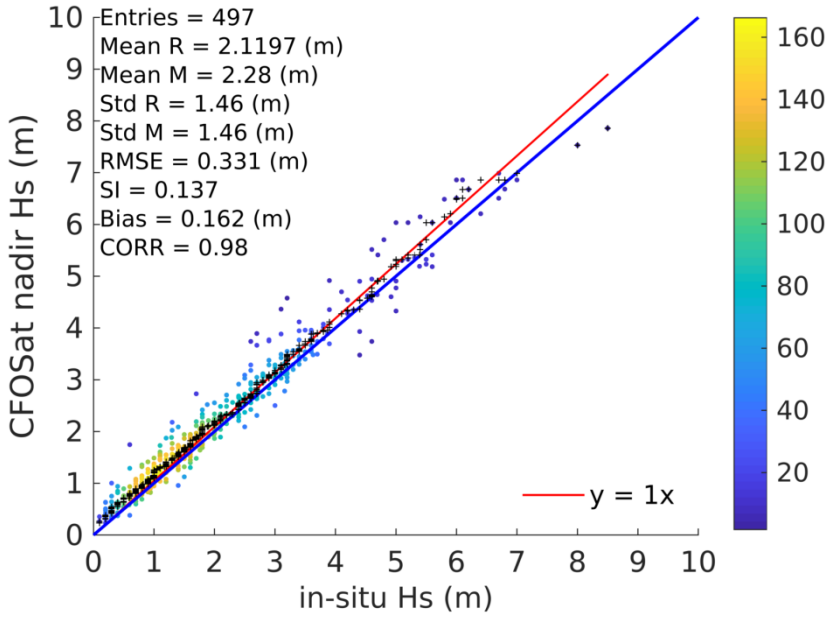
CFOSAT DATA OVER THE STUDIED AREA



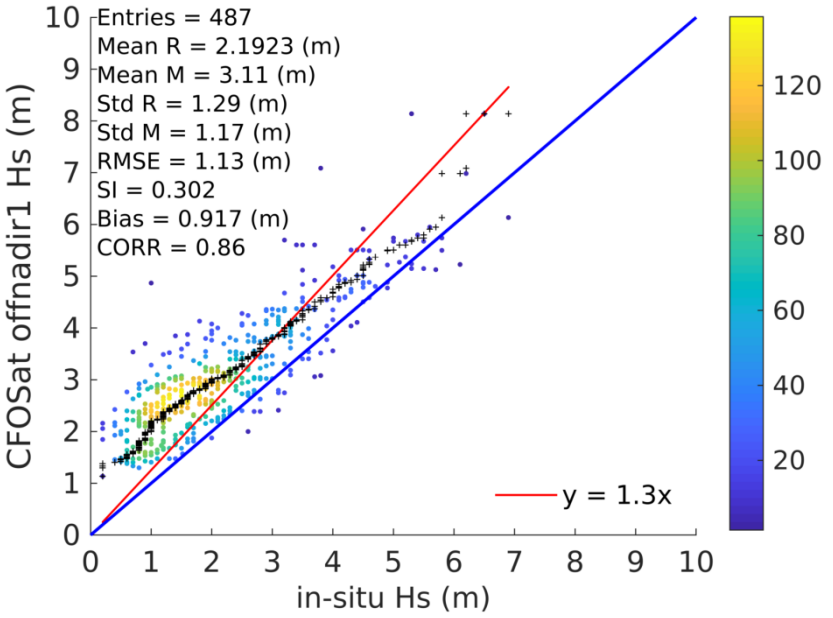
Version 5.1.2: ftp-access.aviso.altimetry.fr/cfosat

SWH
GENERAL COMPARISON CFOSAT VERSUS IN-SITU

CFOSAT (nadir)



CFOSAT (offnadir)



SIGNIFICANT WAVE HEIGHT - SCATTER INDEX

Averaged over the studied period July 2019-August 2020)

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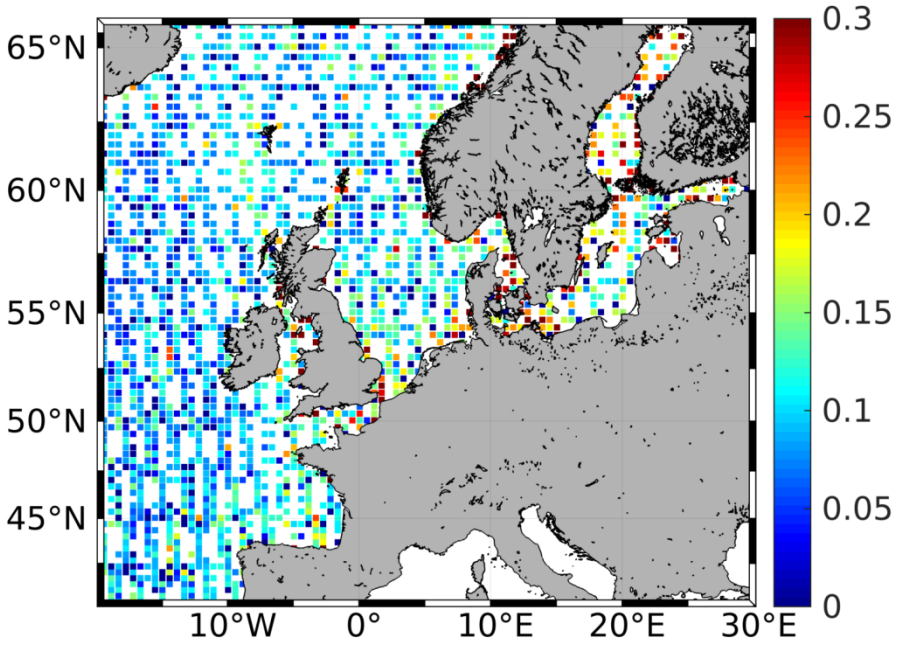
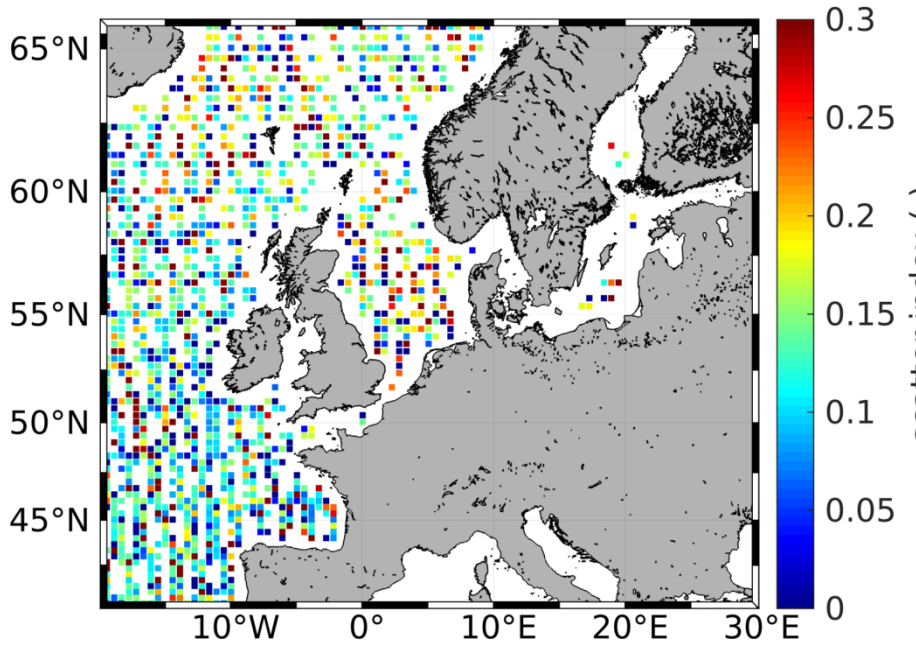
CFOSAT (nadir)



CFOSAT (offnadir)



SIGNIFICANT WAVE HEIGHT (CFOSATVS WAM)

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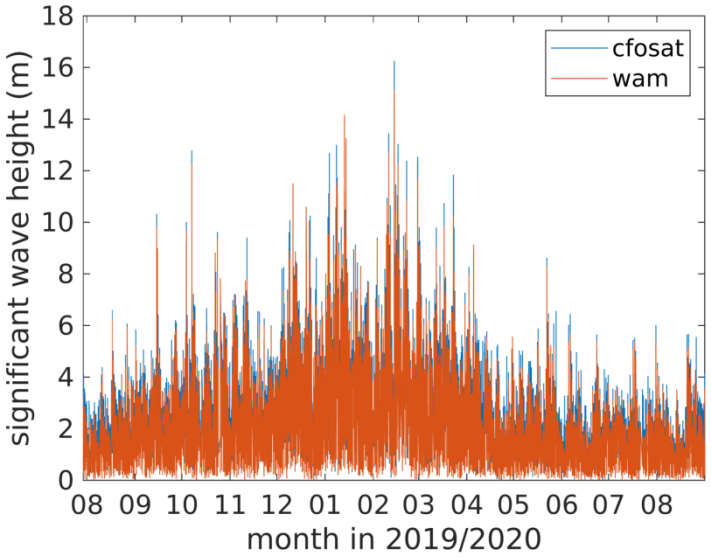
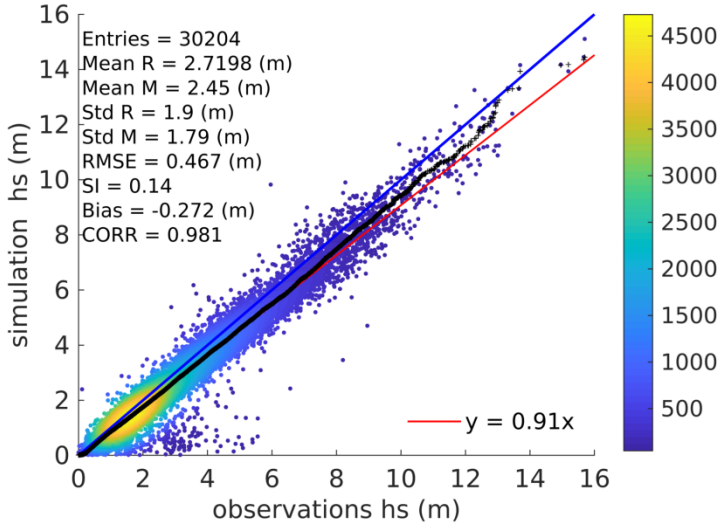
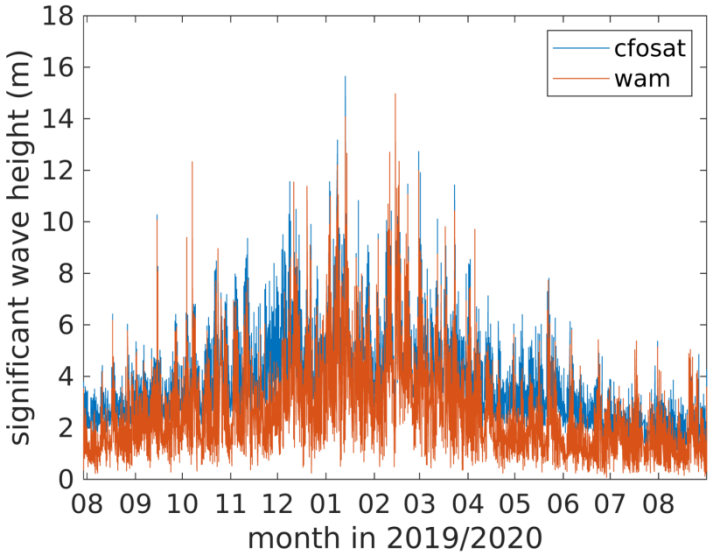
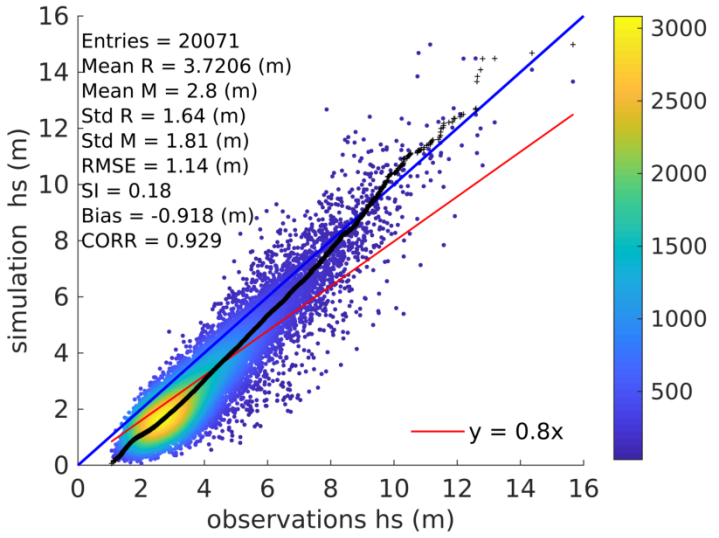
CFOSAT (nadir)





CFOSAT (offnadir)





IMPACT OF CFOSAT DA (MEAN)

Averaged over the studied period July 2019-August 2020)

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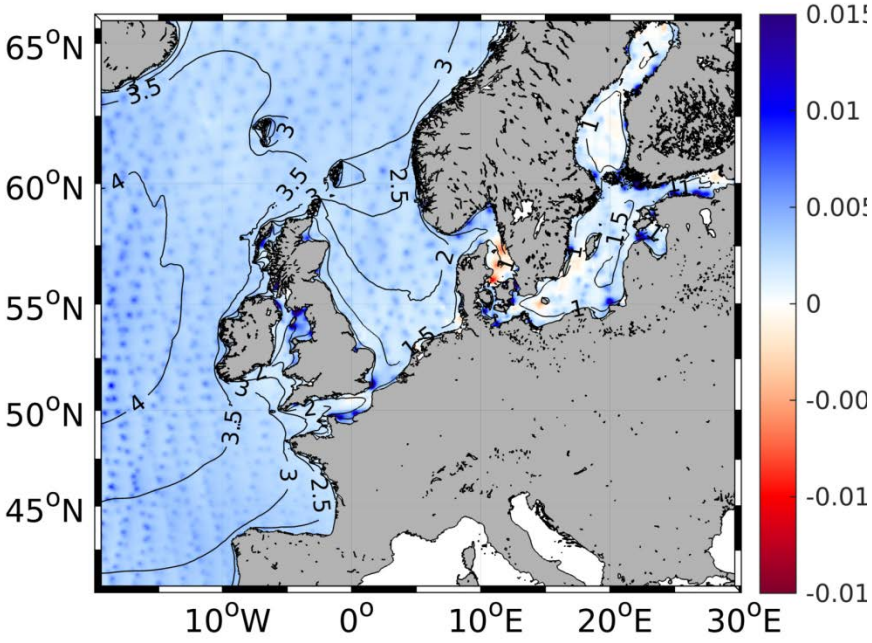
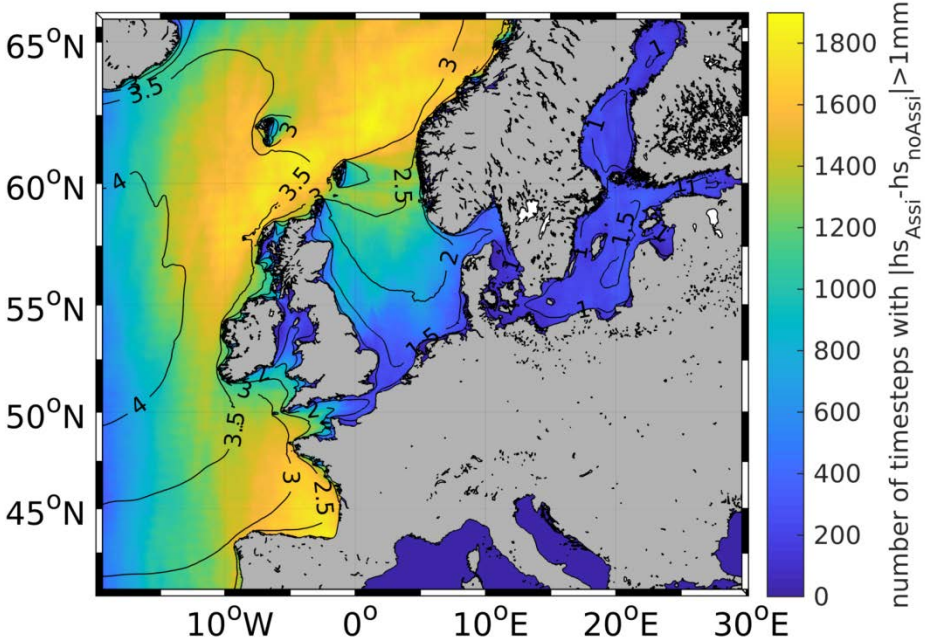
Change of SWH due to DA



Memory of the DA



CHANGE IN SWH DUE TO CFOSAT DA

Examples of extreme sea state situations

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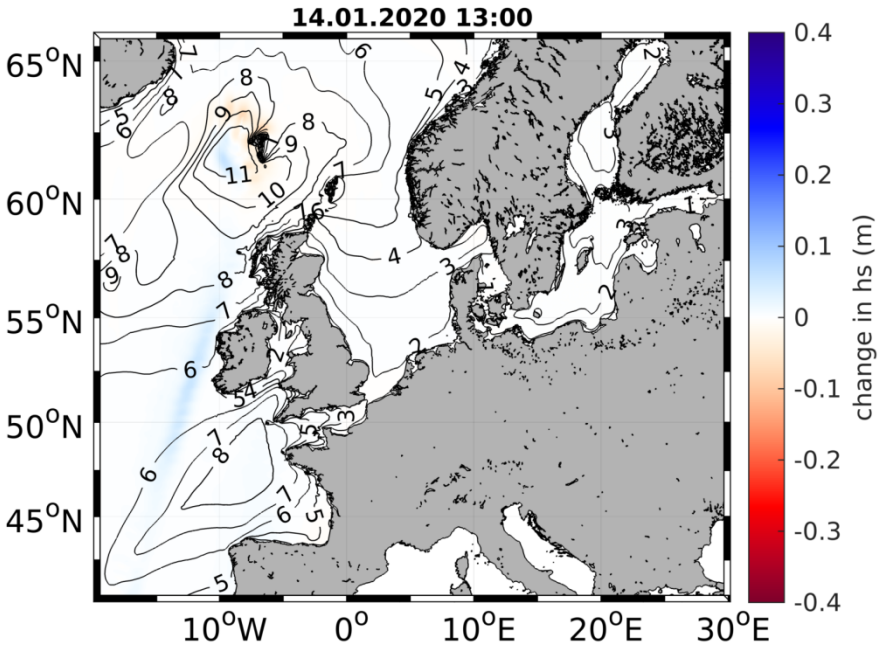
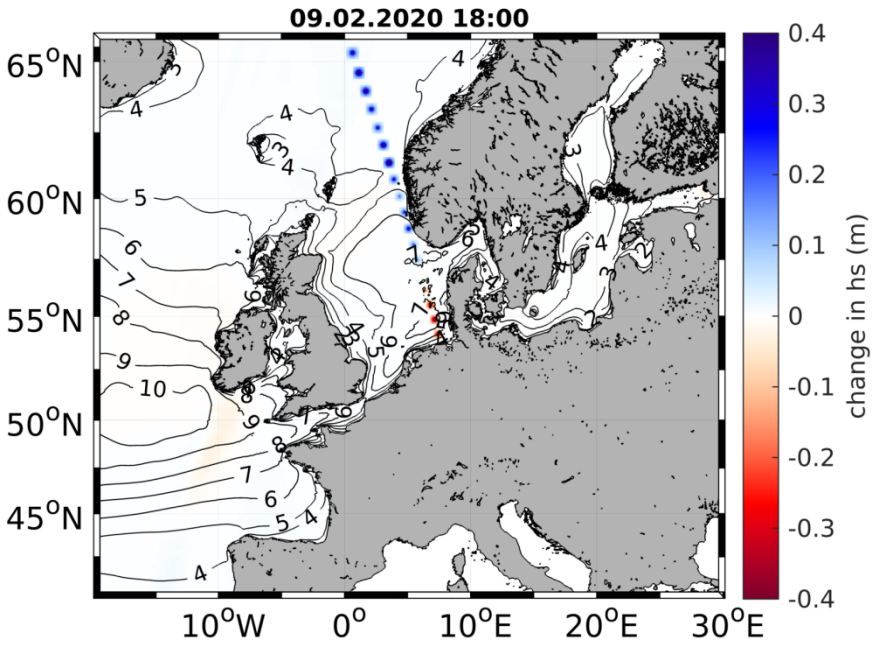




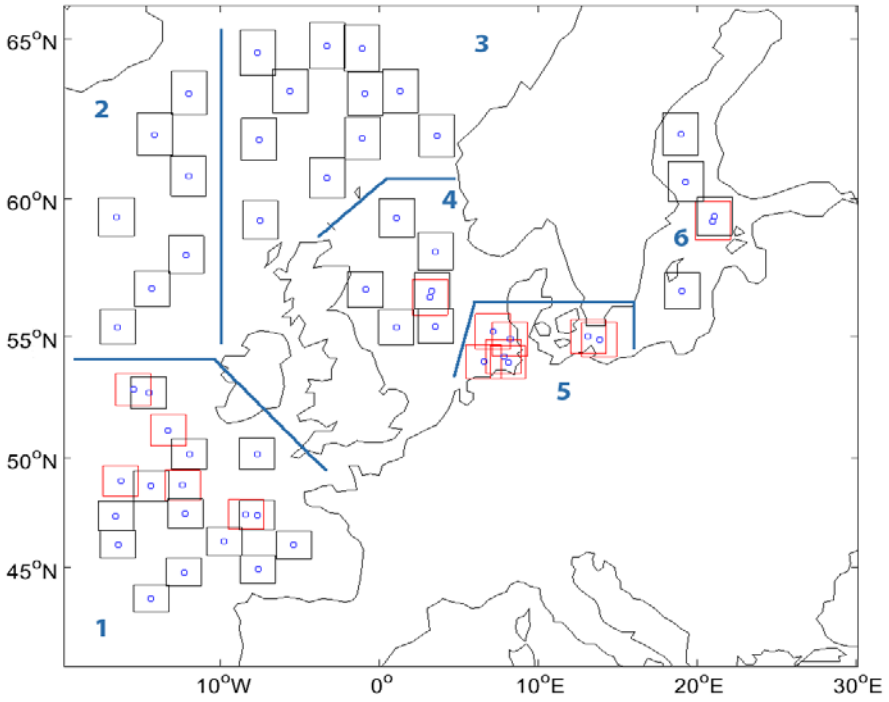
MOTIVATION

- Directional wave spectral data over the European Seas is very rare.
- SWIM CFOSAT is the only satellite mission providing spectral information and
- Besides, most of the available in-situ observations are near the coast.
- Inter-comparisons between remote sensing and in-situ observations over the study area are done to demonstrate the overall performance of SWIM directional wave spectra for several beams (6°, 8°, 10°} during the CFOSAT.

AREAS FOR SWIM ANAYSES

The CFOSAT spectra data analyses are done for the following areas:

- Atlantic (south of 55°N)
- Atlantic (north of 55°N and west c 10°W)
- Atlantic (east of 10°W)
- North Sea
- German Bight and south-westerly part f Baltic Sea
- Baltic Sea



CFOAST Version 5 of CAL(VAL

ENERGY SPECTRUM

Station 20

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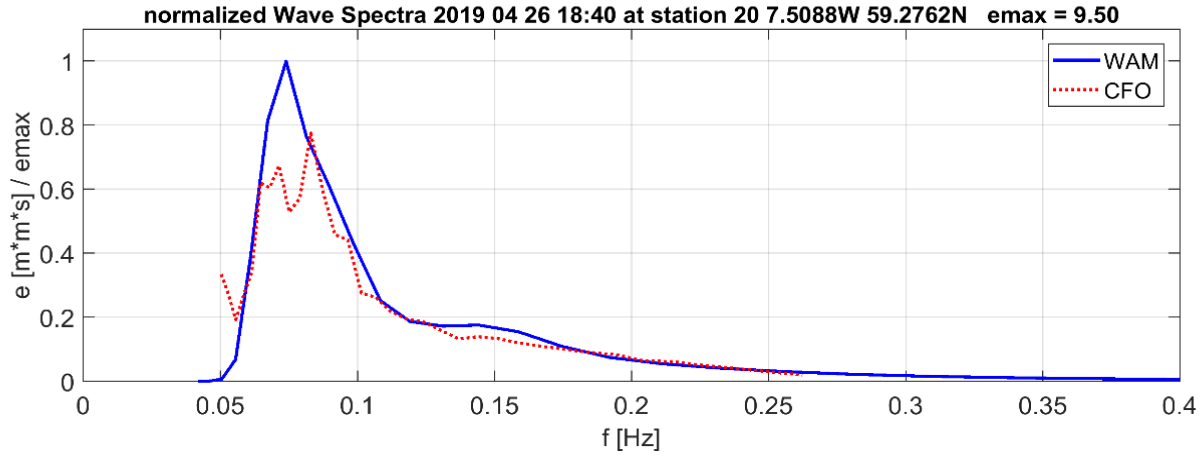
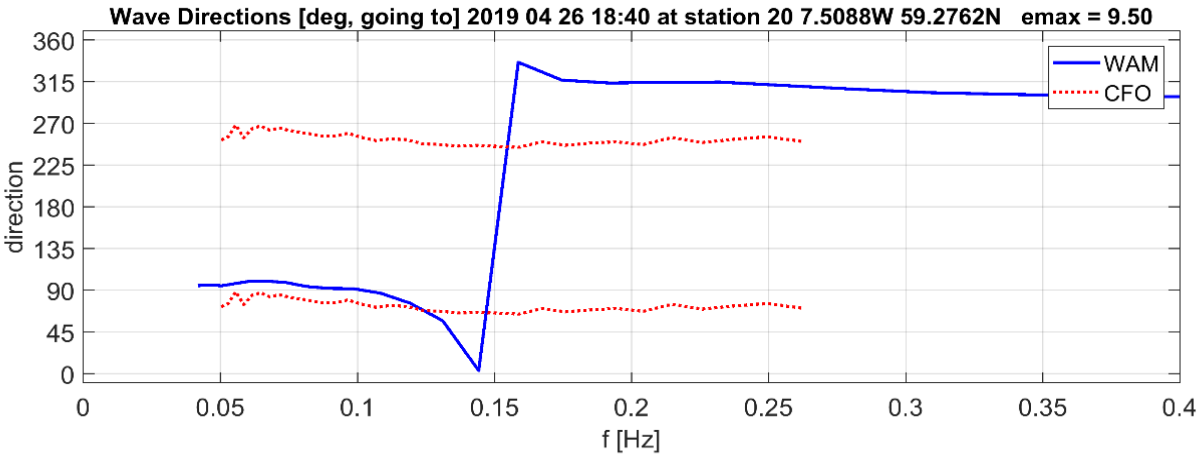
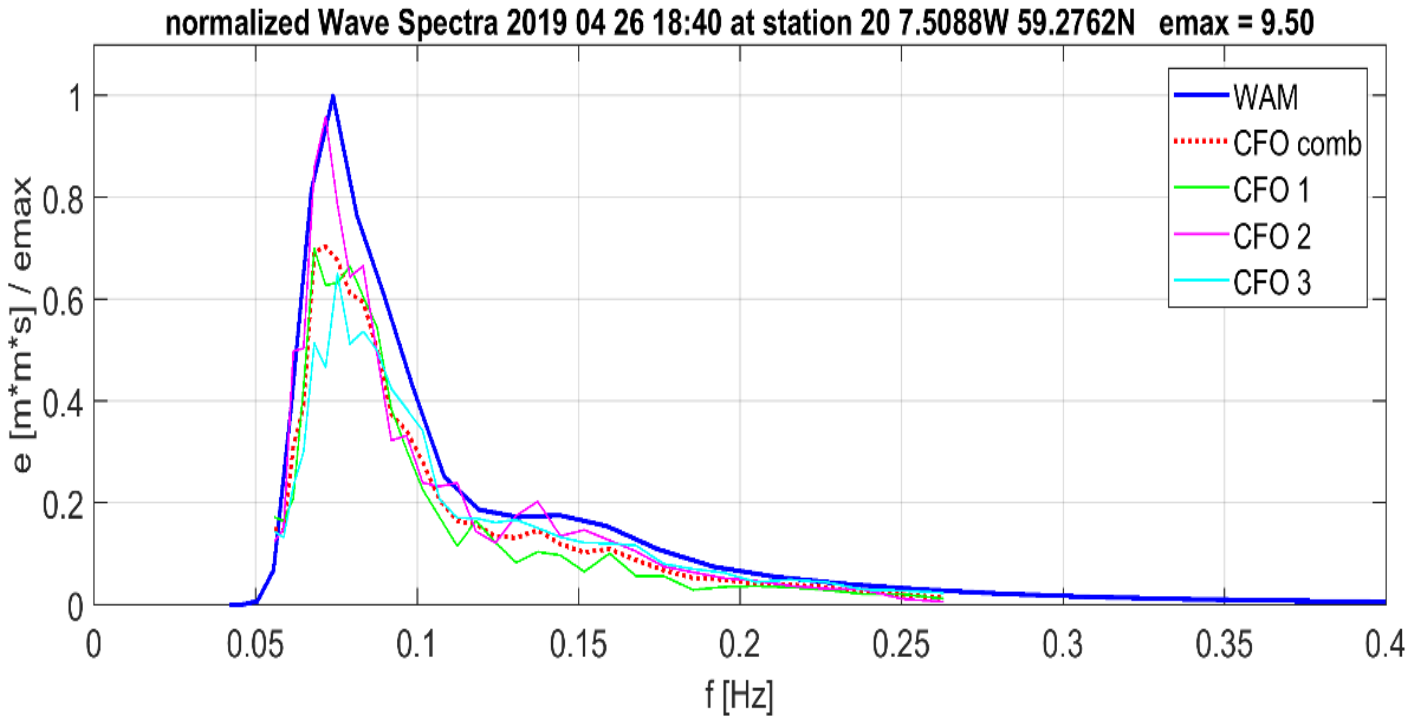




Comparison of normalized unfiltered 1D-Spectra.

ENERGY SPECTRUM

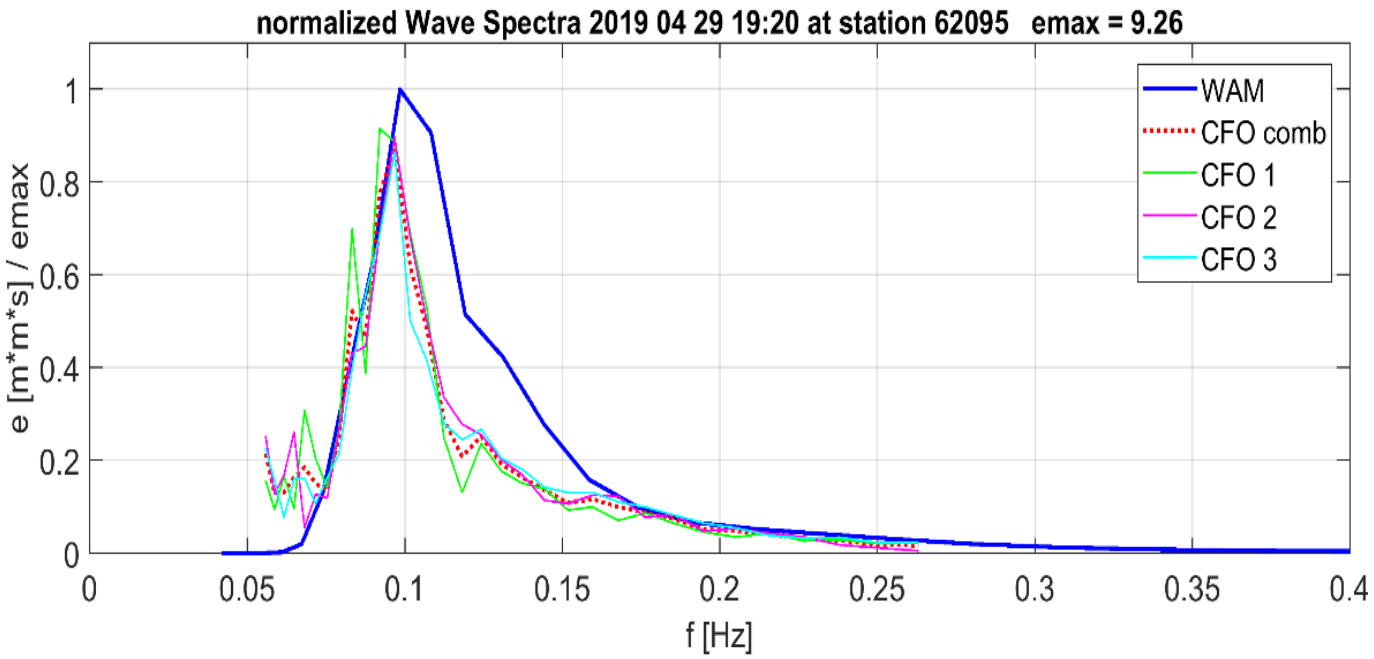
Station 20



Filtered 1D-Spectra. Moderate damping of the combined CFOSAT spectrum, stronger at lowest frequency. Reduced peakedness.

ENERGY SPECTRUM

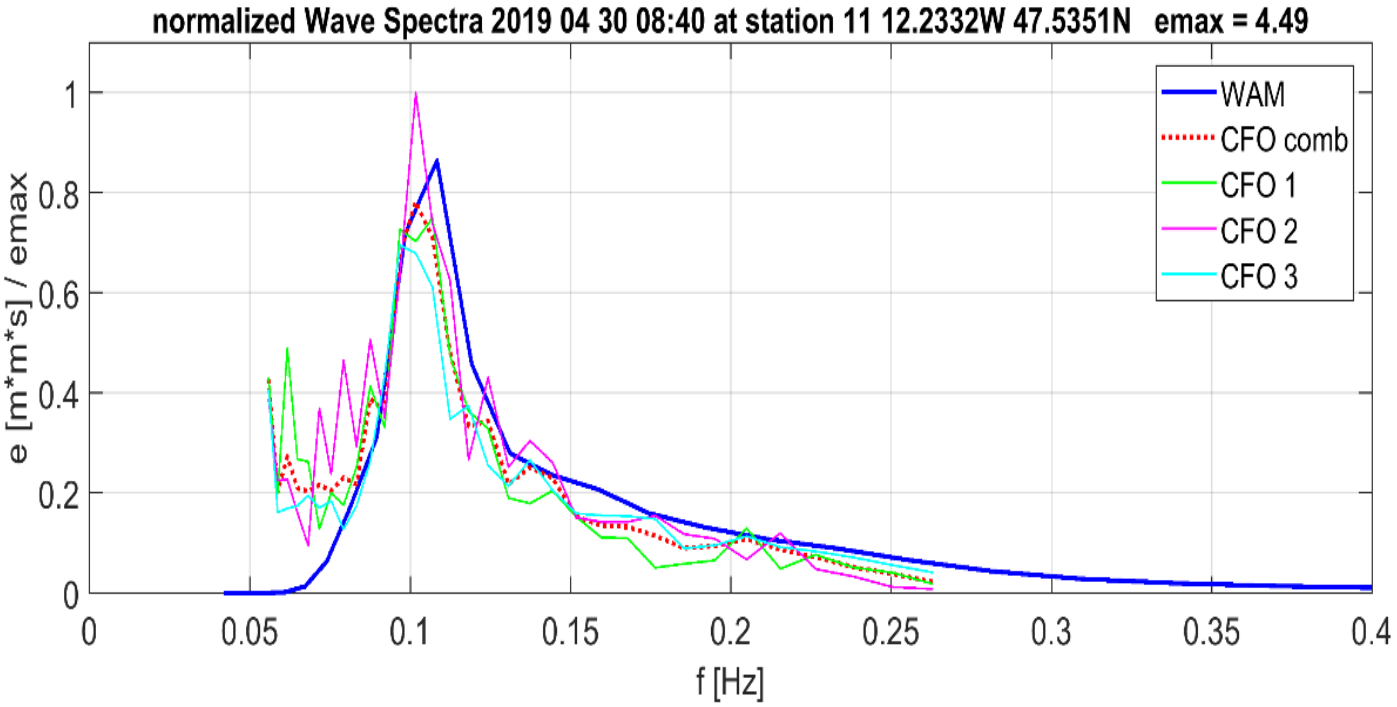
Station 62095



Filtered 1D-Spectra. Spikes in the low frequency range of the combined spectrum (red dotted line) are also visible in the 6° beam spectrum (CFO 1, green line).

ENERGY SPECTRUM

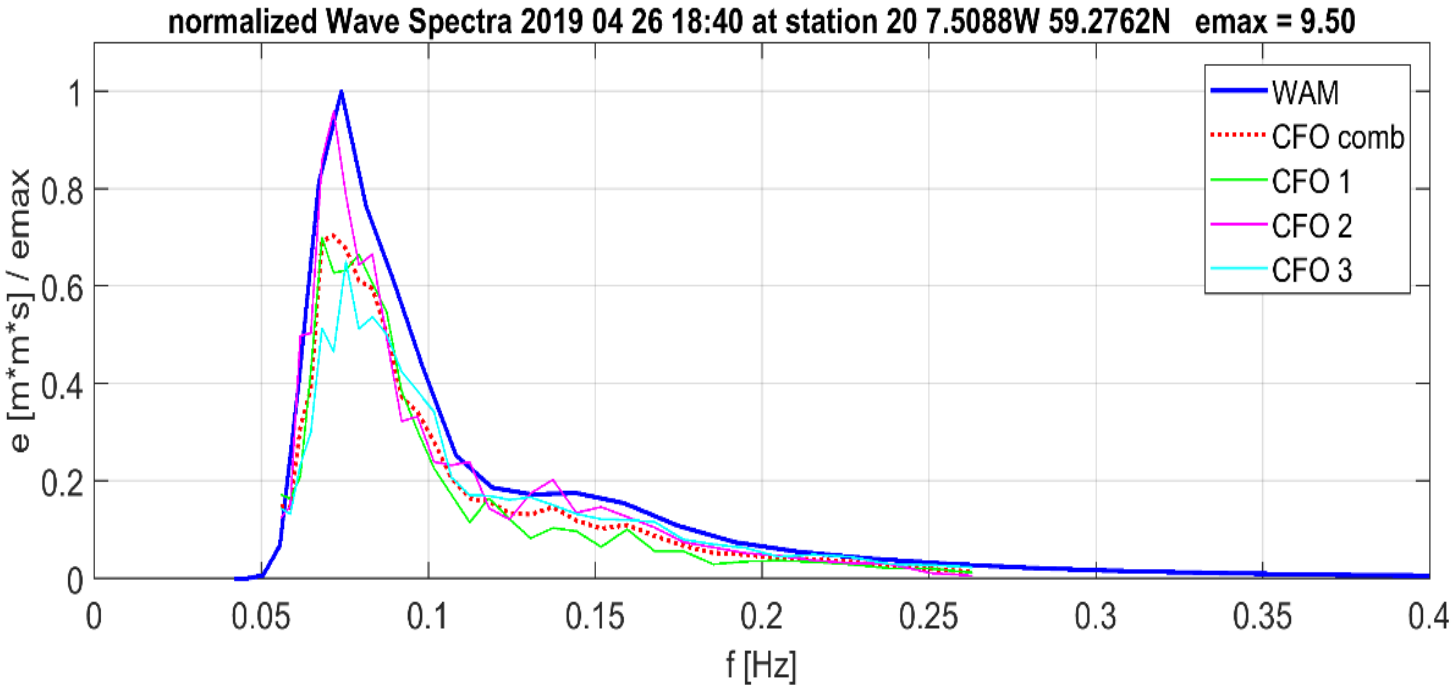
Station 11



Filtered 1D-Spectra. Spikes in the low frequency range of the combined spectrum (red dotted line) are also visible in the 6° beam spectrum (CFO 1, green line).

ENERGY SPECTRUM

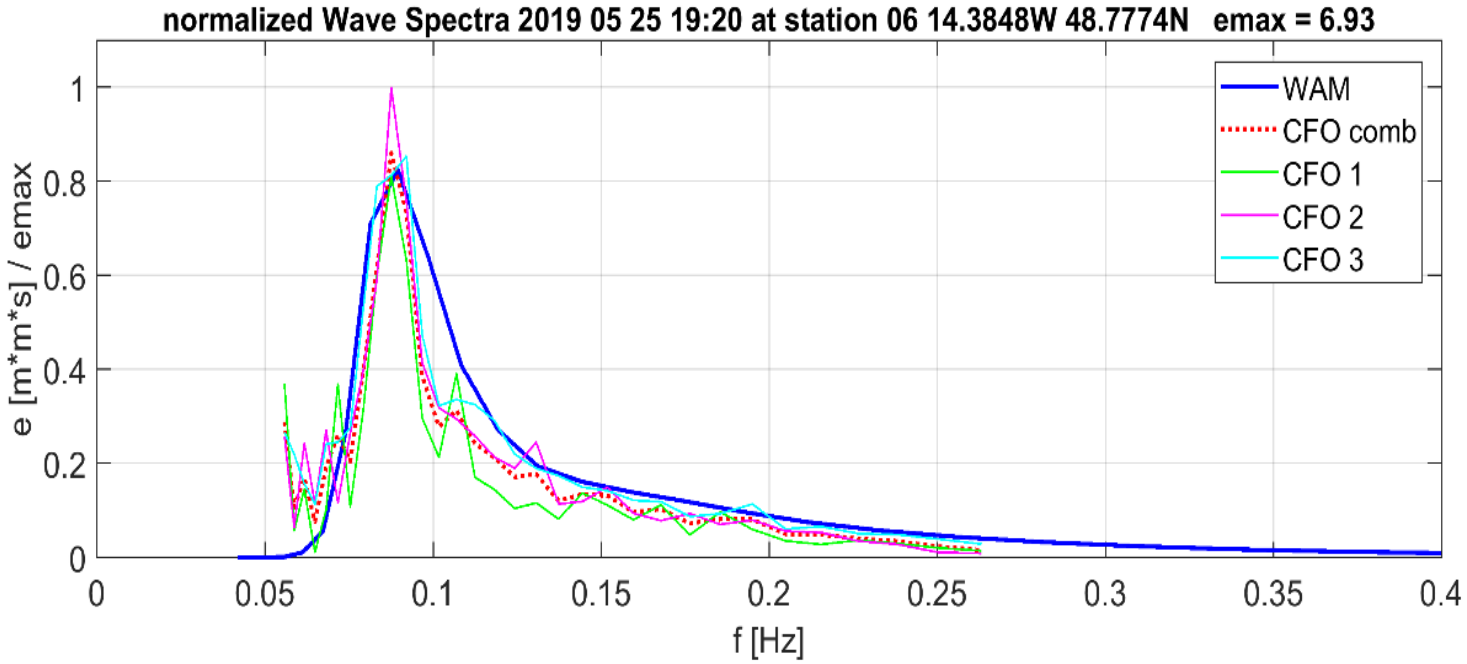
Station 20



Filtered 1D-Spectra. Spikes in the low frequency range of the combined spectrum (red dotted line) are also visible in the 6° beam spectrum (CFO 1, green line).

ENERGY SPECTRUM

Station 06

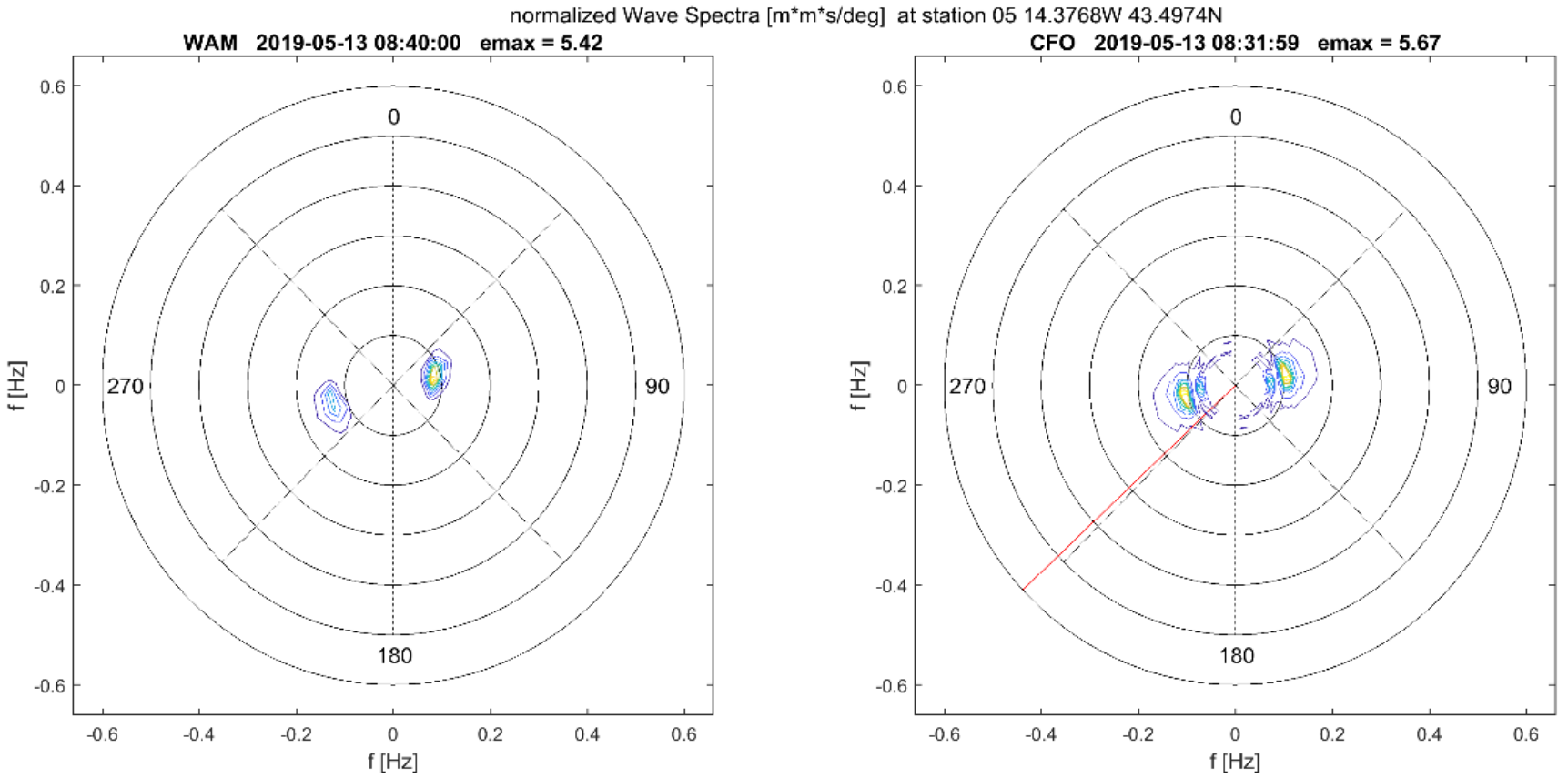


Filtered 1D-Spectra. Spikes in the low frequency range of the combined spectrum (red dotted line) are also visible in the 6° beam spectrum (CFO 1, green line).

ENERGY SPECTRUM

WAM

CFOSAT



DISCUSSION

- Comparing CFOSAT 1D spectra with WAM model results and buoy data show that in many cases, the spectra compare well in the frequency range from model's peak position to high frequencies.
- In some coastal areas, left from model's peak position, the CFOSAT spectra show a low-frequency tail, often sloping upwards to high energy densities. This behavior is pronounced in the Baltic (area 6), in coastal waters (area 5), in the North Sea (area 4), and at some locations in area 3.
- The filtering process used in the v5 was sometimes insufficient (especially at lower sea states).
- At higher sea states (significant wave height in the order of 2 m and above) the filter works as expected in the low frequency range with stronger damping of energies, whereas the energies at higher frequencies are damped moderately.

CONCUSIONS AND OUTLOOK

- This study we compared the SWIM directional wave data set with the GCOAST outputs and buoy observations.
- This comparison aimed first at assessing the performances on main wave parameters (significant wave height, mean direction at the peak, peak frequency) retrieved from SWIM over our study area
- The analyses were performed in different conditions (wind sea, swell, mixed seas),
- Parameters characterizing the shape of the wave spectra, (the frequency and the directional spread) were studied.
- The assimilation of satellite data in the wave models will provide a new level of understanding and increase the predictability of the regional and regional ocean scales phenomena that differ from the better-studied conditions for open seas.