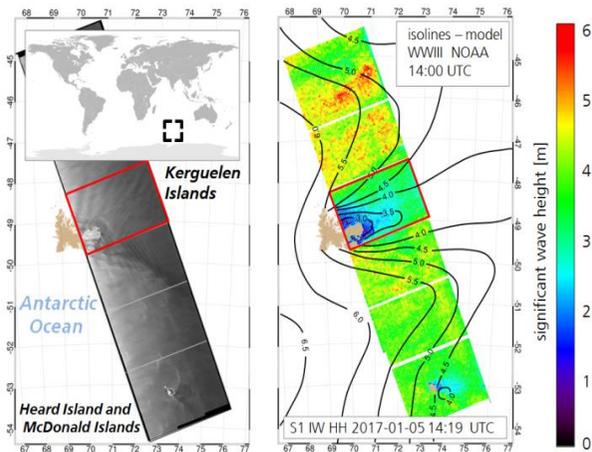


Sea State for safe ship navigation

The majority of global transportation of goods is held over the oceans, justifying the need for safe and secure ship navigation. The sea state information in combination with wind data is an important part of maritime situation awareness, meteorology, and physical oceanography model validations. Combined with model forecasts NRT satellite data will help reducing the dangers to maritime traffic.

Support of scientific cruises with information from space

DLR supports scientific campaigns with SAR acquisitions downlinked and processed in near real-time at DLR ground station Neustrelitz using algorithms developed at Maritime Safety and Security Lab in Bremen. The example in the bottom shows wave height estimation from Sentinel-1 data taken over the Antarctic Ocean under storm conditions. *In-situ* measurements from buoys are not available for this area. The data was processed and delivered in NRT directly on board of the research vessel "Akademik Tryoshnikov" during Antarctic Circumnavigation Expedition (December 2016 to March 2017) journey around Antarctica.



An example of sea state processing under storm conditions with wave height about 3-5 m acquired over the Antarctic Ocean on 05.01.2017. *In-situ* buoy measurements are not available for this area; the isolines show the wave height from WWII model of NOAA. The red marked image was processed in NRT and delivered directly on board the research vessel "Akademik Tryoshnikov".

DLR at a glance

DLR is the Federal Republic of Germany's research centre for aeronautics and space. The organisation also completes research in the areas of energy, transport, security and digitalisation. Acting on behalf of the federal government, the DLR Space Administration designs and implements Germany's space programme, together with national and international partners. DLR is also the umbrella organisation for two project management agencies that promote research.

DLR has approximately 9000 employees at 27 locations in Germany. It also has international offices in Brussels, Paris, Tokyo and Washington D.C.

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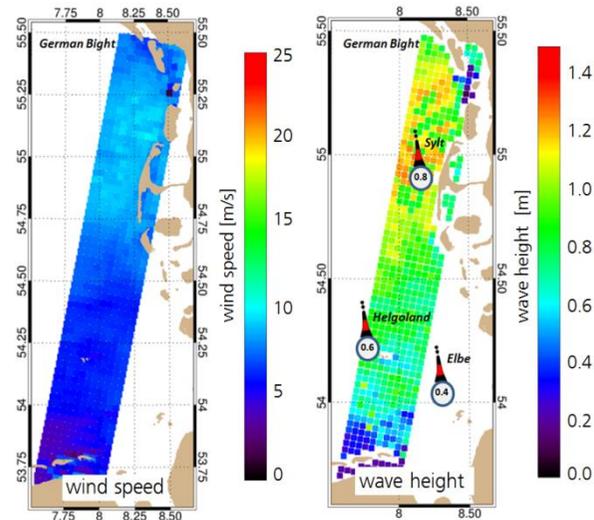
Sea State Retrieval

Maritime Safety and Security Lab Bremen



Meteo-marine parameters observed by satellite radar images: wind fields and sea state

Synthetic Aperture Radar (SAR) can provide wind information over the ocean by measuring sea surface roughness. Corresponding sea state parameters can be estimated from the same image. Recent development of meteo-marine parameter assessment with SAR allows obtaining wind and sea state information over large areas at high resolution and thus represents a valuable complement to *in-situ* measurements and forecast model results.



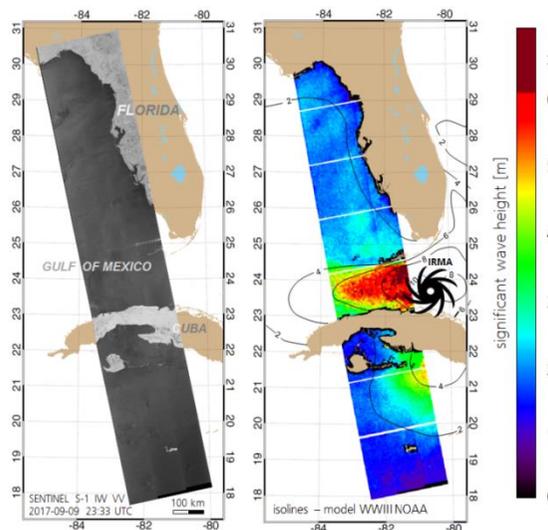
Meteo-marine parameters processed from TerraSAR-X data acquired over the German Bight on 07.04.2015 at 05:50 UTC. The acquisition consists of four individual images and covers an area of 30 km × 250 km with resolution of 1.2 m pixel size. Significant wave height H_s and surface wind speed U_{10} are processed with 3 km × 3 km posting.

Storm observation using satellite SAR imagery

The rapid development of satellite techniques, SAR sensors, SAR processors, algorithms and ground infrastructures made possible a series of oceanographic applications in NRT in recent years. New methods allow tracking storms and hurricanes.

Importantly, this information about the state of the sea can help to assess how destructive a hurricane is and predict its path – and, therefore, where and when it is likely to make landfall. The same information can also be used to warn ships and to issue warnings of coastal flooding. This new technique was used for the first time when hurricane “Irma” struck Cuba and the Florida Keys in early September. Here, waves up to 10m high were measured.... This is especially important because in-situ measurements of wind and sea state cannot be gained from buoys or dropped probes in such extreme weather or over such a wide area

ESA news 2017: Sentinel-1 sees through hurricanes



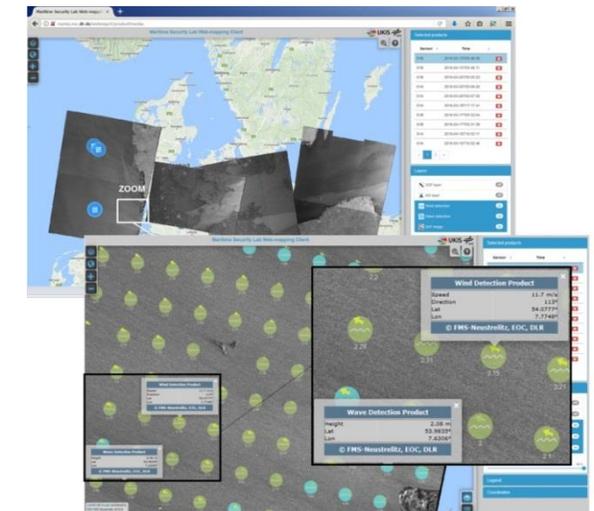
Significant wave height H_s estimated from a Sentinel-1 scene that covers approximately an area of 250 km × 1500 km, consisting of eight individual images. The acquisition was taken over Cuba and Florida on 09.09.2017 while hurricane “Irma” was moving towards Gulf of Mexico. The isolines present the WWIII model results for H_s (NOAA).

Near real-time Sea State Processor

The Sea State Processor retrieves integrated sea state parameters from spaceborne Synthetic Aperture Radar data of TerraSAR-X and Sentinel-1 in near real-time (NRT).

DLR Ground Station Neustrelitz applies the processor as part of a NRT demonstrator service which involves daily provision of surface wind and sea state parameters estimated fully automatically from Sentinel-1 Interferometric Wide Swath (S1 IW) images of North Sea and Baltic Sea.

The nature of SAR imagery for moving targets imposes a limit for imaging of ocean waves: only long wave structures with wavelengths longer than ~100m can be clearly seen in the SAR images. The empirical sea state algorithms have been developed with focus on automatic, fast and robust raster processing independent of wave patterns, applicable even when only clutter is visible in the SAR images.



Screenshot of the SAR wind and wave product on Web Mapping Server at Ground Station Neustrelitz. The sea state and wind estimation algorithms are implemented into the NRT server chain. The maritime environment: wind (arrows) and sea state (circles) are combined in layers. The demonstrator runs daily for Sentinel-1 IW in southern North Sea and western Baltic Sea.