North Sea and Skagerrak Strait

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Overview

The North Sea is a semi-enclosed sea located on the continental shelf of Northwestern Europe bounded by the United Kingdom, Continental Europe and Scandinavia (Figure 1). The sea covers an area of 745,950 km² the vast majority of which is shallower than 200 m but also contains the Norwegian Trench in the Skagerrak Strait at the southern end of Norway [LME 2004].

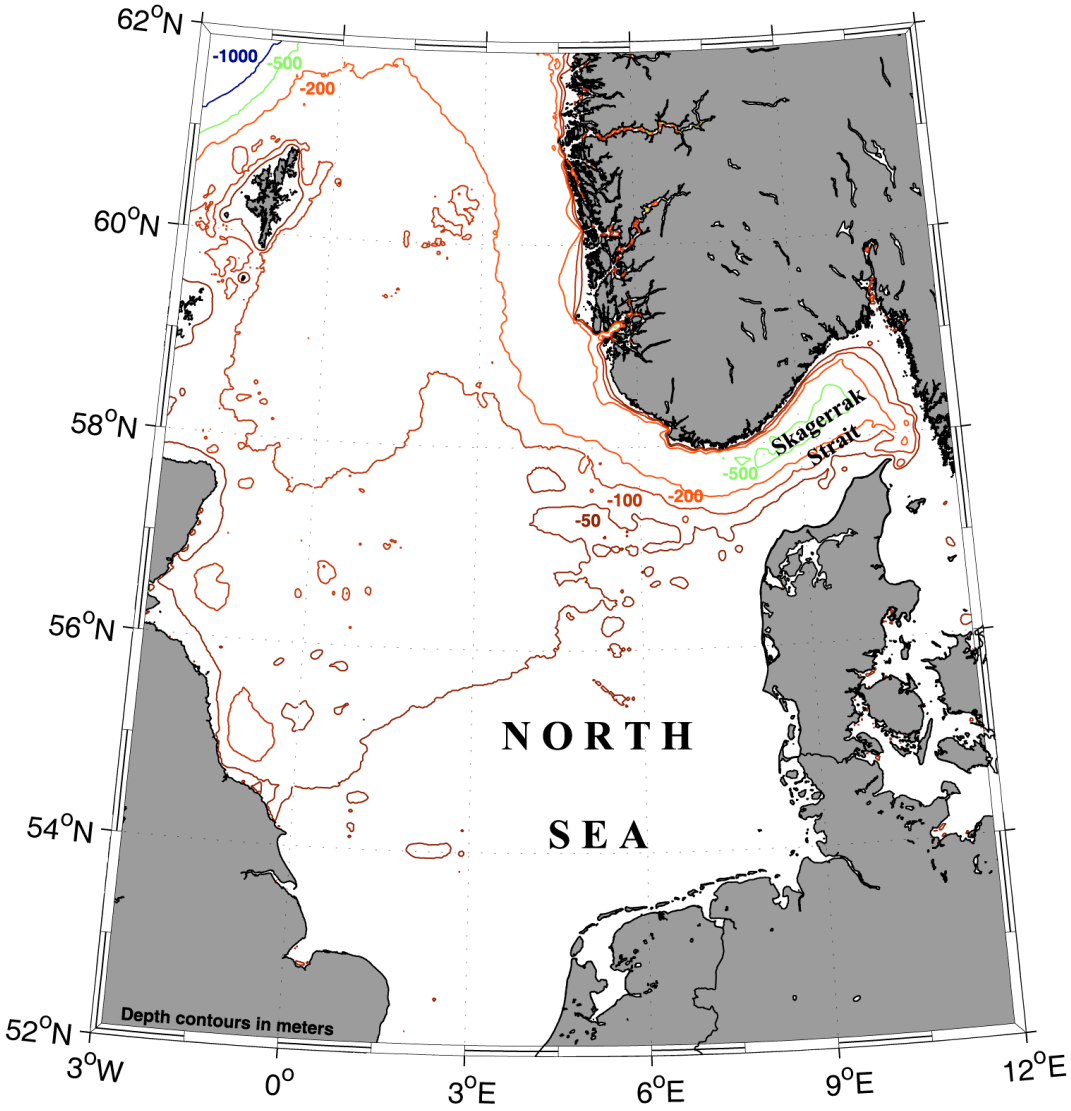


Figure 1. Bathymetry of the North Sea. [Smith and Sandwell, 1997].

Observations

Internal waves in the North Sea can be generated either by the interaction of tidal flow with bathymetry, or by strong atmospheric disturbances (fronts) which frequently pass over the North Sea.

Throughout most of the North Sea, strong tidal currents produce turbulence of sufficient intensity to keep the entire water column well mixed throughout most of the year. However, in some areas stratification can occur between May and September when the depth of the seasonal thermocline typically between 10 and 40 meters depth.

The waves have been more frequently observed by in-situ measurements in the North Sea after the passage of strong atmospheric disturbances (storm fronts) that cause the vertical density profile changes significantly. Thus the distribution of internal waves in the North Sea is expected to be very irregular and sporadic (intermittent). The exception being the Skagerrak Strait over the Norwegian Trench where the generation of internal waves are more regularly caused by the interaction of the tidal current with the bathymetry and by seasonal upwelling.

Table 1 - Months when internal waves have been observed in the North Sea and Skagerrak Strait.
(Numbers indicate unique dates in that month when waves have been noted)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	1			1	1	1			1		

References

Large Marine Ecosystems of the World: LME #22: The North Sea Large Marine Ecosystem; January 2004, http://na.nefsc.noaa.gov/lme/text/lme22.htm

Schott, F., On horizontal coherence and internal wave propagation in the North Sea, Deep Sea Research, 18, 291-307, 1971

Smith, W. H. F., and D. T. Sandwell, 1997; Global seafloor topography from satellite altimetry and ship depth soundings, *Science*, v. **277**, 1957-1962
http://topex.ucsd.edu/marine_topo/mar_topo.html

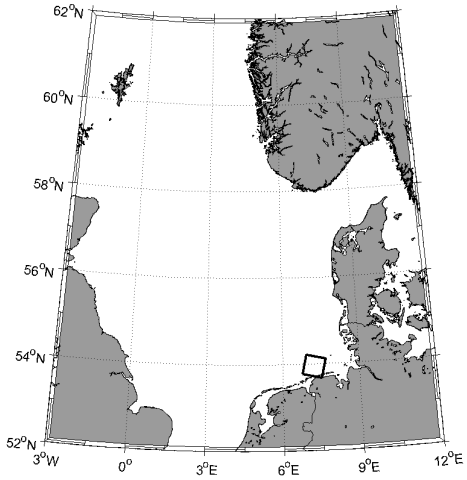
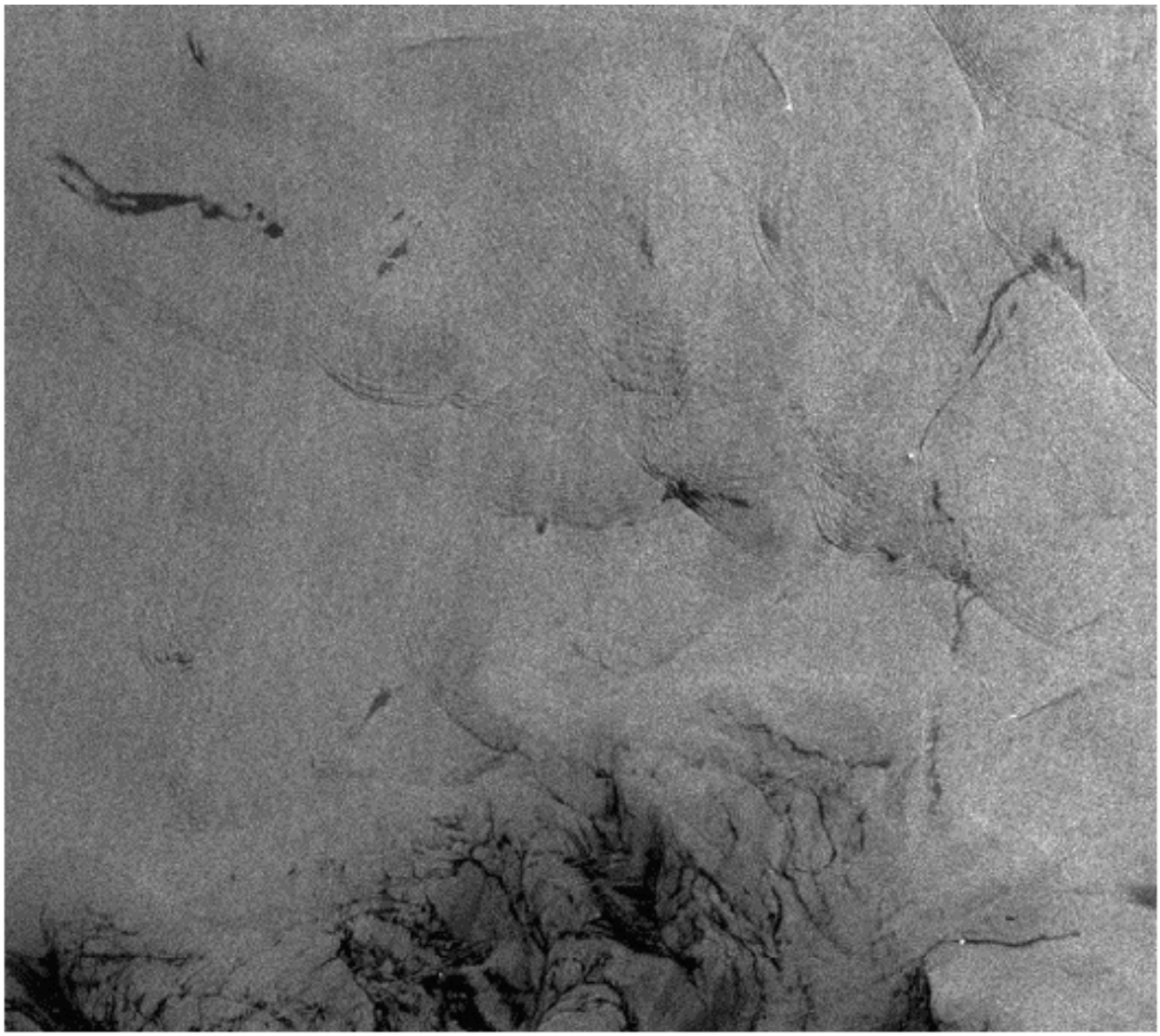


Figure 2. ERS-1 (C-band, VV) SAR survey image off the coast of the Netherlands acquired on 6 May 1995 at 1031 UTC (orbit 19907, frame 2571). The image shows several fine scale, tidally generated internal wave packets propagating west across the North Sea (top left to lower right across the image). Imaged area is approximately 50 km x 50 km. ©ESA 1995



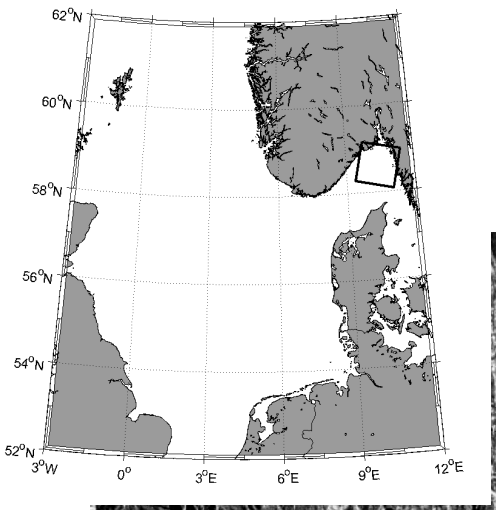


Figure 3. ERS-1 (C-band, VV) SAR image over the Skagerrak Strait off Norway acquired on 10 February 1992 at 1024 UTC (orbit 2986, frame 2421). The image shows an unusual continuum of fine scale waves propagating along the coast (middle left to center across the image) in addition to several packets in open water. Imaged area is 100 km x 100 km. ©ESA 1992. [Image courtesy of Richard Olsen Norwegian Defense Research Establishment (FFI), Department of Electronics, Norway.]

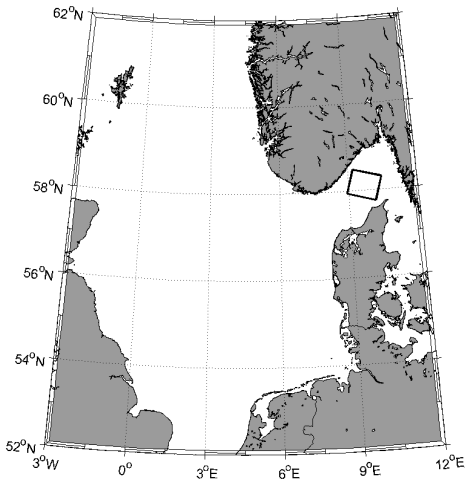


Figure 4. ASTER false-color VNIR image acquired on 9 July 2003 at 1049 UTC in the Skagerrak Strait area south of Norway. The image shows a large internal wave packet propagating westward. The packet contains 5 solitons. Imaged area is 60 km x 60 km.

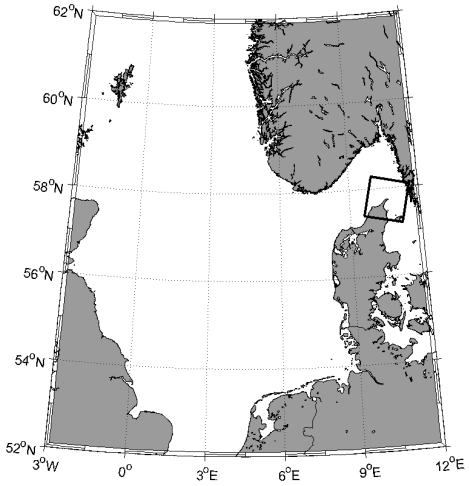


Figure 5. ERS-1 (C-band, VV) SAR image over the northern part of the Kattegatt between the Skagen peninsula in Denmark and the western coast of Sweden. The image was acquired on 13 October 1993 at 1022 UTC (orbit 11733, frame 2439). The image shows packets of fine scale internal waves propagating west in the dark region which is in the lee of the wind front, represented by the north-south boundary between rough (light) and calm (dark) water. The bright linear feature to the east of the image, oriented in a north-south direction is thought to show current shear. The local wind speed was recorded as 7 m/s from the southwest. Imaged area is approximately 100 km x 100 km. ©ESA 1993. [Interpretation http://earth.esa.int/applications/data_util/SARDOCS/spaceborne/Radar_Features/Ocean_Features/internal_waves_denmark.htm]