Sea level variations in the North Atlantic and adjacent seas from multiple satellite sources

P. Knudsen [1], O. Andersen [1],
J.L. Hoyer [1], A.A. Nielsen [2],
K.B. Hilger [2], C.C. Tscherning [3],
N. Hoejerslev [3], E. Buch [4], V. Hues [4]
[1] (Kort og Matrikelstyrelsen, Denmark)
[2] (Technical University of Denmark, Denmark)
[3] (University of Copenhagen, Denmark)
[4] (Danish Meteorological Institute, Denmark)

Satellite observations from high-precision satellites as Jason-1 and TOPEX/POSEIDON have a great impact on the understanding of sea level variations at high latitudes due to their high spatial coverage at these latitudes. Our analysis will focus on various temporal scales ranging from tidal to decadal variations. Multi-satellite and multi-channel investigations will be carried out to improve the understanding of the processes acting on the sea level and on its variations.

Ocean tide modeling

Despite the progress in global ocean tide modeling over the last five to ten years, most global ocean tide models are still much more accurate in the deep ocean than in shallow water. The proposed tandem mission of Jason-1 and TOPEX/POSEIDON (interleaved ground tracks) will provide a unique opportunity to improve on this. Shallow water constituents need further investigation to be included in future ocean tide models, as they can exceed 0.5 meters in some near-coastal locations. Finally, the major ocean tide constituents in the shallow water region exhibit considerable annual variation, ranging up to eight percent of the tidal amplitude in shallow water regions like the eastern North Sea.

Multi-sensor/multi-channel sea level recovery from satellite measurements

Numerous processes and effects combine to influence sea level and its variations. These may be internal density variations, or meteorological forcing and wind effects. Fusion of multi-mission, multi-channel satellite sources using empirical correlations and advanced image processing techniques will be used to investigate these processes. Amongst the different satellite sources are satellite altimetry from Jason, TOPEX and ERS/ENVISAT, sea surface temperature from AVHRR/ATSR, sea level models from regional meteorological models, and finally multi-channel optical images from the SeaWIFS satellite.

Regional long-term changes in sea level and sea surface temperature

Satellite altimetry has proven its ability to measure global and regional sea level changes. With the launch of Jason-1, more than a decade of observations will be available and satellite altimetry for climate studies will be very valuable. However, ground truth calibration is essential. So is comparison with other satellites such as ERS/ENVISAT and other satellite sensors. Sea level trends estimated from the TOPEX/POSEIDON and ERS satellite missions show extremely high correlation on regional scales. Similarly, AVHRR and ATSR sea surface temperature data will be included to characterize the nature of sea level changes.

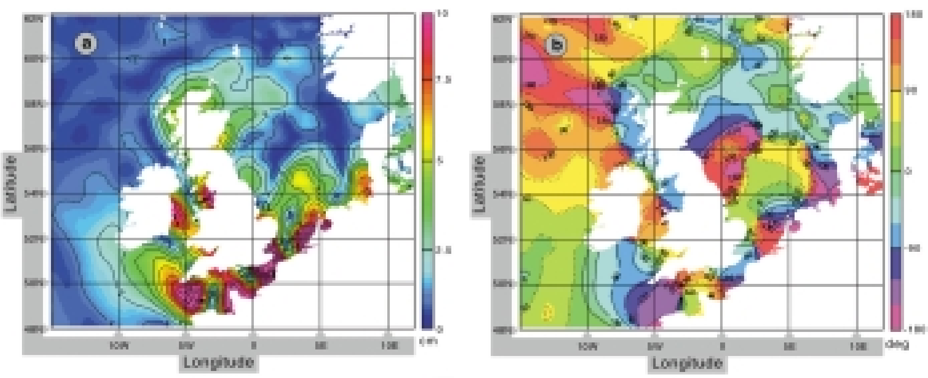

Figure 1: Ocean tide models have been improved in shallow water regions using TOPEX/POSEIDON altimetry. In the North Sea the M4 tidal constituent, which has a period of about six hours, is considerable. The proposed tandem mission of Jason-1 and TOPEX/POSEIDON (interleaved ground tracks) will provide a unique opportunity to improve on those models. a) Amplitude in centimetres, b) Phase in degrees.

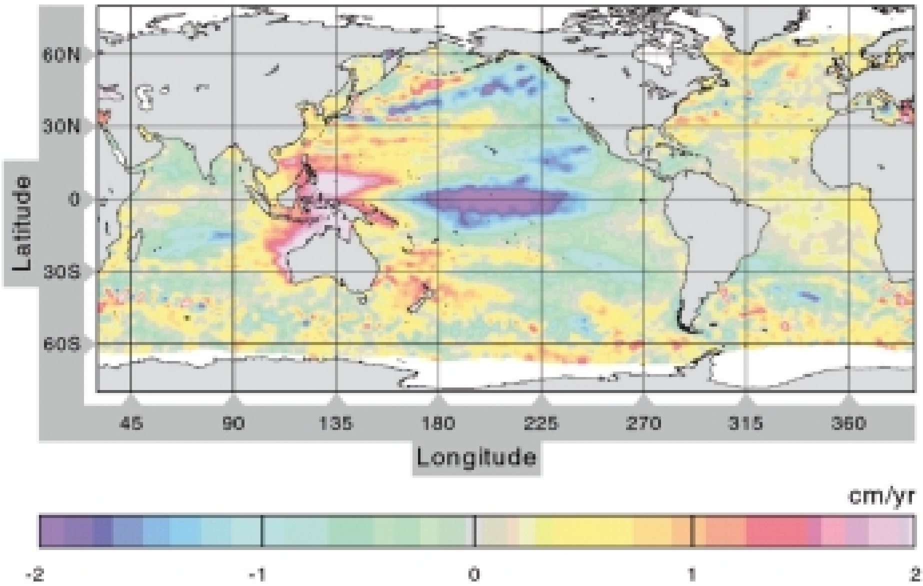

Figure 2: Sea level trends from the TOPEX/POSEIDON mission from linear regression analysis using eight years of satellite data. Jason-1 and future satellites are needed to study the effects on climate changes on sea level.

Global marine gravity field and mean sea surface modeling

Jason data are expected to provide information for further development of the high-resolution global marine gravity field and particularly the mean sea surface. Investigations will be continued and revised with the launch of dedicated gravity field satellite missions such as the CHAMP, GRACE and GOCE missions.

Exchange of waters between the North Atlantic and adjacent regions

The overflows of cold, dense deep water from the Nordic Seas into the North Atlantic make significant contributions to the global thermohaline circulation. Changes in this circulation may have a huge impact on the transport of heat by the Gulf Stream and change the climate in Northern Europe. Using TOPEX/POSEIDON data, fluctuations associated with the overflows between Greenland and Iceland and between the Faeroe Islands and the Shetland Islands can be detected. With the Jason-1 satellite, extended analysis will be possible to detect and monitor decadal changes in the variability of the subsurface overflows.

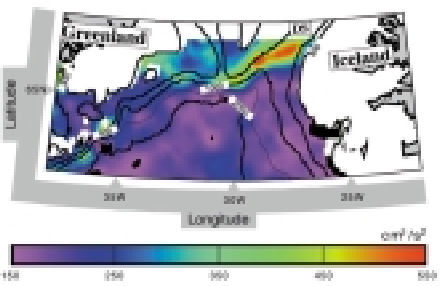

Figure 3: Current variability downstream of the Denmark Strait (DS). The increase in variability which is seen immediately downstream of the sill is due to very large fluctuations in the dense bottom water that flows southwestwards through the Denmark Strait and follows the Greenland slope. Contours represent the bottom depth.

References

Huess V. and O.B. Andersen, 2000: Seasonal variations in the tidal constituents from altimetry data, *Geophys, Res. Lett,* (in press).

Andersen O. and P. Knudsen, 2000: The role of satellite altimetry in gravity field modeling in coastal areas, *Phys. Chem. Earth,* Vol. 25, p. 17-24.

Hoyer J.L. and D. Quadfasel, 2001: Detection of deep overflows with satellite altimetry, *Geophys. Res. Lett.* (in press).

Andersen O. and P. Knudsen, 2000: Regional sea surface height and temperature trends from ERS satellites, *Proceedings 3. ERS/ENVISAT symp.* (in press).

Corresponding author:
Ole B. Andersen
Kort og Matrikelstyrelsen
LG/GEK, Rentemestervej 8
DK-2400 København NV - Denmark
E-mail: oa@kms.dk