Validation of river data

A hindcast run of the hydrological model E-HYPE 2.1 for the years 1979 – 2008 is validated against available observations for selected rivers in northern Europe, south-eastern Bay of Biscay and the western Black Sea. This is a task that addresses the OPERR objective of assessing the usefulness of the E-HYPE predictions in numerical ocean modelling.

E-HYPE is developed and run by SMHI and produces numerical estimates of daily freshwater discharge, N and P species concentrations for all of Europe. E-HYPE 2.1 has a horizontal basin configuration that resolves catchments of about 3000 km2 or more. The hindcast dataset consisting of the discharges to the sea has been compared to observational estimates of freshwater discharge from rivers in four regions: Norway, the United Kingdom, the south-eastern Bay of Biscay and the western Black Sea. In addition, modelled and observed concentrations of N and P have been compared for rivers entering the Kattegat (water body between Denmark and Sweden) and in the Bay of Biscay.

In Norway and the UK, the E-HYPE freshwater estimates are compared with observational data for 21 and 22 rivers, respectively. In addition, comparisons are made for regional aggregate data around the Norwegian coast. E-HYPE validates fairly well with observed estimates for major rivers and aggregated data, with more mixed results for smaller rivers. This is to be expected, considering the native resolution of E-HYPE. The main deficiency of the E-HYPE dataset is underestimation of the total runoff. The Norwegian data basis makes it possible to estimate the deficit in mean flow to 27% of the observed value. For the UK, no corresponding data basis was found in this study, but the comparative statistics for individual rivers suggest that there is also an underestimation of the total runoff in that region, too. The underestimation of total runoff is believed to be due to inadequacies in the precipitation data used to force the model. On the positive side, E-HYPE is able to replicate fairly well the short-term, seasonal and inter-annual variability in the major rivers. This is an important finding for ocean modelling, since the climatological data that are commonly used for freshwater forcing lack this variability.

E-HYPE predictions of Total N and P are compared with observations from some 20 stations around the Kattegat. For TN, the mean concentrations compare fairly well so that E-HYPE should be able to give a good estimate of fluxes to the Kattegat. P is notoriously more difficult to simulate than N, and in this study there is a bias toward overestimation of TP around the Kattegat.

In the south-eastern Bay of Biscay, two major and four small rivers are studied, both for freshwater discharges and nutrients. The results for freshwater discharge are rather similar to those found for northern Europe. E-HYPE tends to underestimate the mean flow, especially for the small rivers. The short-term, seasonal and inter-annual variability are fairly well reproduced, although the maximal events are generally underestimated. These results suggest that, here too, the E-HYPE freshwater runoff data may be beneficial when applied in ocean models. On the other hand, the E-HYPE N and P data do not validate well at all in the SE Biscay rivers. This is a difficult modelling task, for which comparable observations are scarce, and is clearly an area for further model development.

In the western Black Sea, the freshwater discharge from three major rivers, including the Danube, is investigated. For the Danube, E-HYPE underestimates the overall mean flow by about 10%; there is a seasonal signal, where the underestimation occurs in May-September. For the other two rivers, South Bug and Dnieper, E-HYPE 2.1 overestimates considerably the observed flow, by 135% and 75%, respectively. This is attributed to the complexity of water consumption in these watersheds. For all three rivers, E-HYPE reproduces rather well the observed variability patterns (seasonal and inter-annual scales).

This study has elucidated strengths and weaknesses of the E-HYPE 2.1 hindcast data and concludes generally that, with some bias correction, they should be useful in physical ocean modelling. For ocean ecosystem modelling, the benefits of the N and P predictions are dubious based on this study alone. The companion OPERR Deliverable D4.2 should shed more light on that issue.