DINEOF univariate reconstruction of missing satellite data from the North Sea Belcolour-1 database

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The Belcolour-1 database holds more than 4 years of uniformly resampled MERIS chlorophyll (CHL), total suspended matter (TSM), MODIS-AQUA CHL, TSM and sea surface temperature (SST) over the North Sea. A first step of the RECOLOUR[1] project consists in the univariate reconstruction of missing data with the DINEOF method (Data Interpolating Empirical Orthogonal Functions). In particular, the DINEOF treatment of MERIS CHL and TSM images available for the year 2003 allowed an efficient synthesis of the coherent modes of variability existing at the scale of the whole North Sea. For both parameters, 4 modes were retained by general cross validation as an optimum for the reconstruction of missing data.

For CHL, the first spatial mode shows the high influence of coastal nutrients outputs (mainly continental estuaries and diffused coastal sources) and the lower concentration in the well stratified central and northern part of the North Sea compared to the southern bight and the eastern English Channel. The spatial trends described by the first mode are permanent features during the year, although slightly enhanced during the summer and reduced during winter. The second spatial mode corresponds to the main algal blooming events (spring and autumn) with increased concentrations in the southern bight of the North Sea, around the Isle of Wight and in frontal-like structure north-west of Denmark. The third Eof describes well the dynamics of an early phytoplankton bloom occurring in March along the Norwegian coast, where a strong stratification induced by an output of cold water from Baltic Sea provides good light conditions to phytoplankton.

Concerning TSM, the first spatial mode shows the dominant influence of large estuaries and of resuspension from shallow coastal sedimentary plains. The patterns suggest a general transport of sediments from south-east England up to the northern Dutch coastal waters, and a clear distinction between the stratified northern part and the well mixed and charged southern and German bights. Although these trends are permanent during the year, the range of spatial variations is slightly reduced during the summer, following the reduction of resuspension, of total sediment outputted by rivers and of advection along continental coasts. The second mode shows a clear seasonal signal. The winter influence of the second spatial mode can be understood as general sediment enrichment due to higher resuspension, but a clear influence of intense terrestrial water outflows contributing to reduce the sediment concentration in the plumes comparatively to the surrounding waters. This is clear for the Elbe river discharge, the whole natural part of the Wadden Sea and the Seine river plume. The Scheelde and Thames rather seems to be just neutralizing the seasonal TSM resuspension signal. The Rhine river discharge seems to make exception as no influence is detected in the second spatial mode. During summer, the contribution of the second EOF is reversed with a general reduction of suspended matter concentration in most part of the area but some local sediment enrichment at specific river discharges.

Original MERIS CHL and TSM images were filled and reconstructions were produced at a daily interval based on a linear interpolation of the temporal modes. From this, weekly averages could be calculated at stations such as the turbidity maximum of the Scheelde river plume, showing the onset of the spring bloom co-occurring with a period characterised both by the TSM seasonal reduction and by important TSM temporal variability.

1 BELGIAN SCIENTIFIC POLICY - RESEARCH PROGRAMME FOR EARTH OBSERVATION - CONTRACT SR/00/111 – PROJECT RECOLOUR