Fusion of GLOBCURRENT and Ocean Colour CCI products

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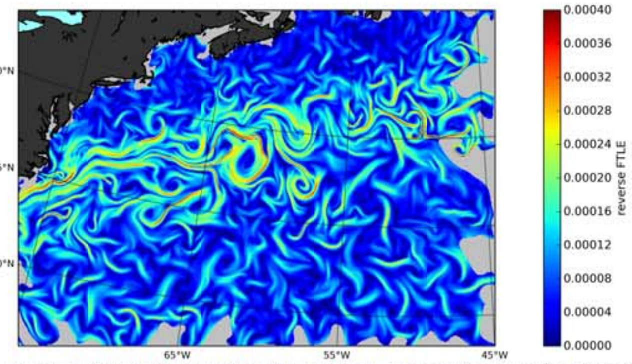
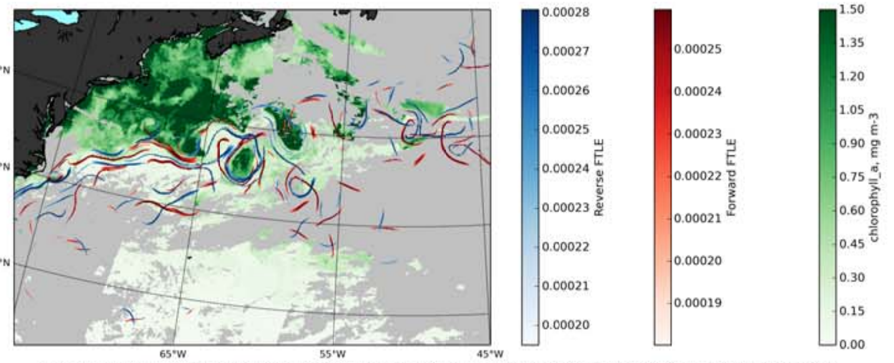
Optical satellite measurements provide knowledge about the interaction between physical and biological processes in the upper ocean. The dynamics of chlorophyll-a concentration is estimated from satellite multispectral data. This is controlled by phytoplankton growth and decay rates as well as the horizontal advection of water masses. Data from ocean color spectral imagers such as SeaWIFS, MODIS, MERIS and Sentinel-3 OLCI is merged into a single product by the OC CCI team and provided as daily global snapshots of chlorophyll-a and other water quality parameters in 4x4 km pixels [http://www.esa-oceancolour-cci.org/]. However, frequent occurrence of cloud screening is a major obstacle in using this data to study surface ocean processes on a day-to-day basis. For example, only about 15% of the optical satellite data is not obscured by clouds in the North Atlantic. This leads to a reduction in the number of surface observations to only one measurement every 3 days.

In highly dynamic areas (e.g. Gulfstream in the North Atlantic), the limited ocean color data does not allow characterization of the underlying causes in changing chlorophyll-a distributions, e.g., growth / decay or also advection. A method for fusion of the OC CCI data and surface current data from the GLOBCURRENT project is proposed. This helps to provide significantly improved ocean color data coverage, which in turn may help to better describe the upper ocean dynamic and biological processes.

The GLOBCURRENT project provides satellite data based ocean surface Eulerian displacement of water due to geostrophic, Ekman and tidal currents [http://www.globcurrent.org/]. The geostrophic component of the current is calculated from satellite altimetry measurements, the Ekman current is calculated from scatterometry wind observations and the tidal component is calculated using a global tidal model. The product is publicly available at 10 km spatial resolution every 3 hours for the three years period from 2009 to 2011.

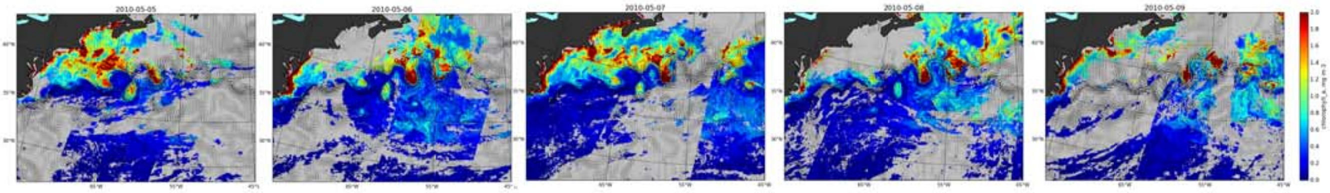


Reverse Finite Time Lyapunov Exponent. FTLE indicates Intensity of convergence of the flow field and maps sceleton of the current. FTLE is calculated from GLOBCURRENT surface current following [d'Ovidio et al., 2004,

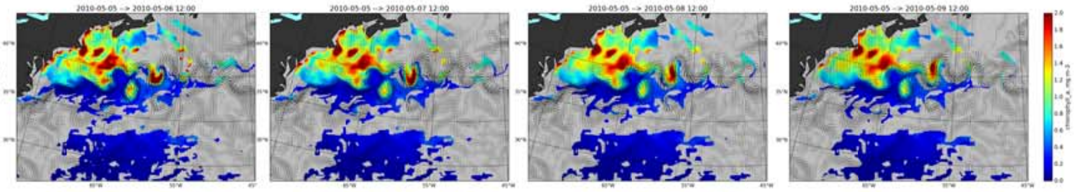


Reverse FTLE (blue) and forward FTLE (red) is calculated from GLOBCURRENT surface geostrophic + Ekman product and ovelayed on top of chlorophyll-a surface concentration. Generally chlorophyll gradients align well with strong stable/unstable manifolds indicating high quality of GLOBCURRENT products.

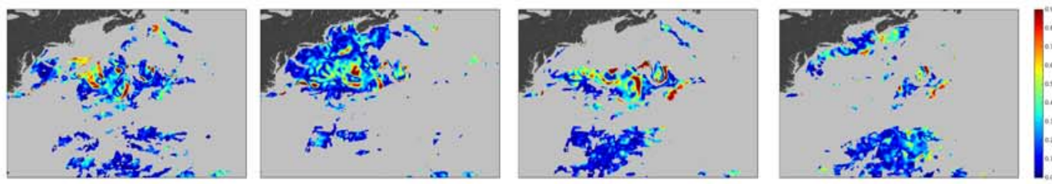
Surface geostrophic + Ekman current from GLOBCOLOR portal overlayed with actual observationf of surface chlorophyll-a from the Ocean Colour CCI data portal.

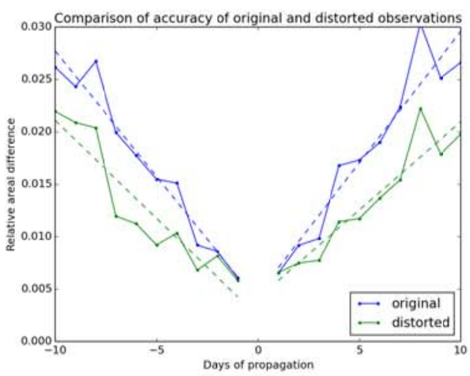


Results of propagation of the chlorophyll image taken on 5 June 2010 forward in time to the dates from 6 to 9 June.



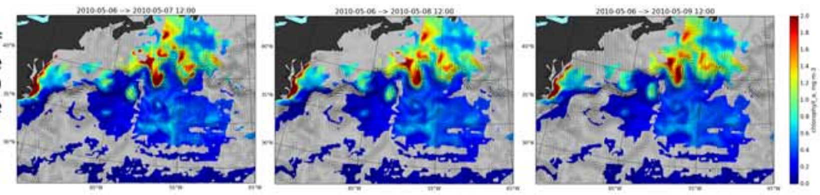
Relative difference (RD) between actually observed products (first row) and propagated products (second row). RD is calculated as absolute value of difference divided by average of actual and propagated products. Difference is due to both inaccurate advection and growth/decay of chlorophyll.



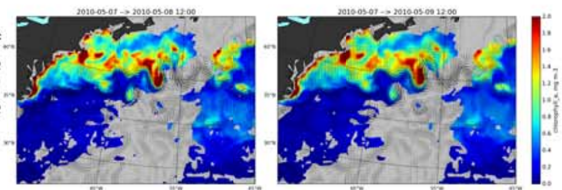


Blue line shows relative difference beween actual image taken on day 0 and actual images taken from previous (or consecutive) dates. Green line shows relative difference beween actual image taken on day 0 and actual images taken from previous (or consecutive) dates and propagted forward (or backward) in time using our method. Lower values of RD for propagated products indicate that propagation helps to reduce errors due to advection.

Results of propagation of the chlorophyll image taken on 6 June 2010 forward in time to the dates from 7 to 9 June.

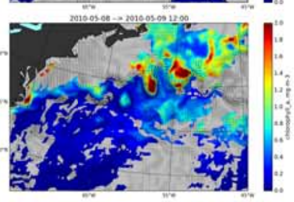


Results of propagation of the chlorophyll image taken on 7 June 2010 forward in time to the dates from 8 to 9 June.

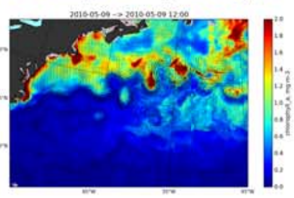


It is assumed that each pixel in the OC CCI dataset represents a parcel of water that can be considered as a passive Lagrangian drifter with an associated accuracy. Under this assumption we take a field of an OC product as input data and use the GLOBCURRENT product as a forward operator. For each pixel in the region of interest we predict coordinates of this pixel at the next time step (i.e. 3 hours after actual observation). For calculating the coordinates we integrate the time and space dependent field of eastward and westward surface water velocities (U and V) using the Runge-Kutta 4th order scheme. In other words, we spatially distort the field of OC CCI chlorophyll-a using GLOBCURRENT U, V.

Results of propagation of the chlorophyll image taken on 8 June 2010 forward in time to the 9 June.



Merging of actual observations on 9 june and products propagated from various dates towards 9 June provides high coverage with reduce errors due to advection.



SUPPORTED BY:

GLOBCURRENT ocean colour cci