OCEAN VIRTUAL LABORATORY: A NEW WAY TO EXPLORE MULTI-SENSOR SYNERGY DEMONSTRATED OVER THE AGULHAS REGION

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ABSTRACT

Ocean Virtual Laboratory is an ESA-funded project to prototype the concept of a single point of access for all satellite remote-sensing data with ancillary model output and in situ measurements for a given region. The idea is to provide easy access for the non-specialist to both data and state-of-the-art processing techniques and enable their easy analysis and display. The project, led by OceanDataLab, is being trialled in the region of the Agulhas Current, as it contains signals of strong contrast (due to very energetic upper ocean dynamics) and special SAR data acquisitions have been recorded there. The project also encourages the take up of Earth Observation data by developing training material to help those not in large scientific or governmental organizations make the best use of what data are available. The website for access is: http://ovl-project.oceandatalab.com/

1. INTRODUCTION

Nowadays, satellite sensors provide measurements of surface currents, sea surface height, sea surface temperature and salinity, roughness, chlorophyll concentration, wind speed and direction, and sea-ice conditions with the data available from multiple instruments, different agencies, and with different versions of products. Many datasets still require careful dedicated processing to achieve useful products at the optimal resolution, often with great demands on computing and scientific expertise. This can be a barrier to the take up of Earth Observation data by individuals working within the marine sphere, whether as a tourist, ecological resources manager or involved in pleasure boating. The Ocean Virtual Laboratory is an ESA-funded project to overcome many of the barriers to the wider use of satellite remotely-sensed data. The chosen area for the prototype being the Agulhas Current system, a complex region including a Western Boundary Current, with large velocities and temperature signals. the Benguela Upwelling, with its high productivity, and the East Madagascar Current, with its strong thermal and optical contrasts [1].

2. DATA ACCESS

For those inexperienced in accessing and processing satellite data, it can be challenging to know which products to use for sea surface temperature (SST), chlorophyll concentration, sea surface roughness etc. — which instrument for the period of interest. which space agency, what spatial resolution, processing version, editing criteria? And then there is the issue of how to get hold of the data. *Ocean Virtual Laboratory* saves the user from agonising over many of these issues by i) referring to fields by the parameter of interest rather than initially by the satellite/sensor name, ii) using sources that permit free open transfer of their data, and iii) making use of a number of merged products (e.g. ODYSSEA for SST, OSCAR and GlobCurrent (http://www.globcurrent.org/) for ocean surface currents.

A recent addition has been the Level 2 fields for sea surface height (SSH) and significant wave height (SWH) from individual altimeter missions as a complement to the gridded Level 3 and merged Level 4 products, since the individual tracks allow the finer detail within along-track altimetry sections to be seen.

3. DATA PROCESSING

Not all the original datasets come in the form that the user wants for display. Thus the *Ocean Virtual Laboratory* contains a number of plug-ins that allow simple but user-controlled operations on the data. For example, high-resolution SAR images contain a lot of speckle (very short scale 'salt and pepper' noise on the image); one of the project partners is developing denoising algorithms to apply to such data.

Another issue is the patchy nature of ocean colour imagery and the limited coverage throughout the day by extant ocean colour sensors. This is being addressed by

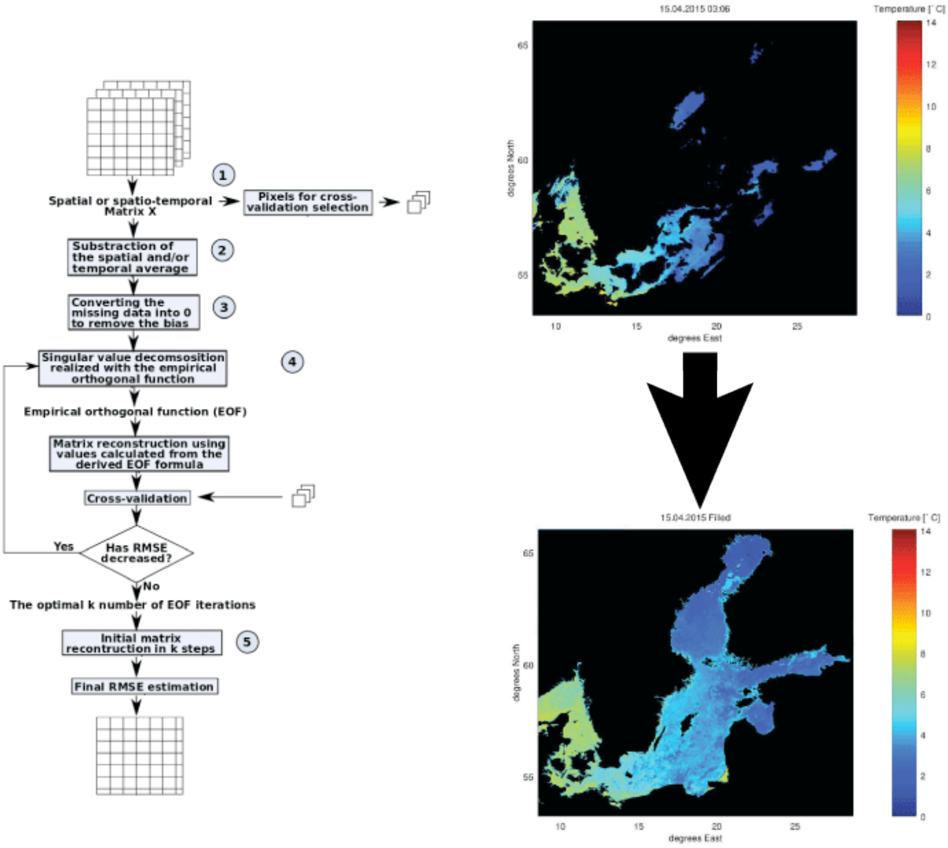

Figure 1. Processing scheme to utilise the better spatial coverage from multiple AVHRR passes to inform the gap-filling of a MODIS chlorophyll image for the same day. (Illustration is of the Baltic Sea).

developing a plug-in to use DINEOF (Dynamic Interpolation using EOFs) to determine local relationships between ocean colour and the more frequent coverage by thermal infra-red instruments such as AVHRR to allow a more detailed ocean colour picture to be inferred (see Fig. 1).

The project is also investigating means to use occasional high spatial resolution imagery to provide a trustworthy interpolation that can be applied to other ocean data having a coarser spatial resolution but improved spectral capabilities [1]. This process works via a trained neural net and has shown promising results for combining ASTER and MODIS data from the Aqua platform, and will be implemented to get the best synergetic use of the MSI on Sentinel-2 with the OLCI instrument on Sentinel-3.

Finally, it must be stressed that the Ocean Virtual Laboratory is designed with a very modular approach, allowing the user to specify their own plug-ins that will fit seamlessly into the system.

4. IMAGE DISPLAY

OVL is designed as a quick visualization tool, enabling environmental understanding through easy and convenient display of images, although a later version will enable users to extract the numerical data behind the images. It achieves a responsive display by having pre-rendered "tiles" of images that are directed to the users display, rather than generating images on the fly. The images are handled using a robust interface based on *OpenLayer* software.

A key component of the display is the user's control over the order and transparency of images, allowing different sensors to be displayed without the base images being totally obscured.

5. SYSTEM IMPLEMENTATION

The OVL implementation will follow the client-server model, the server part being completely decentralized in order to alleviate storage and network limitations.

Decentralization will give the whole OVL system horizontal scalability: instead of adding specialized/ high-end hardware to the existing servers, growth is achieved by adding small new servers. This way of achieving scalability lowers the cost of servers, making the OVL platform a viable option to serve data even with small infrastructures. The servers will contain the components necessary to search effectively through high volumes of data: a catalogue giving all details about products, a spatiotemporal index that lists all.

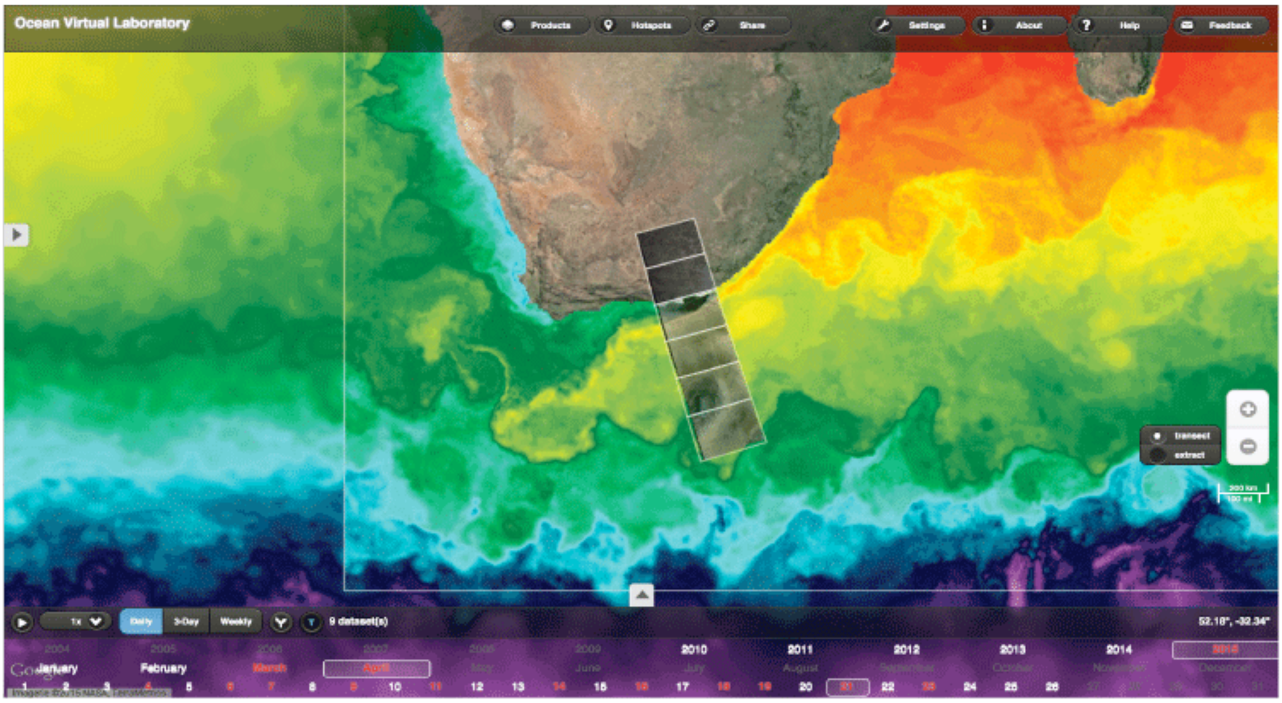

Figure 2. Screenshot illustration of the prototype interface for the Ocean Virtual Laboratory, with a background image of sea surface temperature (from the ODYSSEA L4 product) with an overlay of SAR scenes showing surface roughness. By use of transparency the underlying image can be seen at the same time showing how the surface roughness patterns are affected by SST through its effect on air-sea interactions. The display shows (at the top) menu options for adding other parameters, whilst the bottom of the screen highlights the time information, including whether single days or short-interval composites are shown.

available data and a tagging system to help users find data of interest.

A plug-in mechanism will be used to grant the system extensibility: adding support for new formats, protocols and data transformations should be as simple as adding a new plug-in (i.e. implementing the plug-in interface). In order to provide interoperability with existing and future applications, servers will host data and services, making them accessible through URLs via an HTTP API (application programming interface).

On the client-side, two implementations will be developped: a fully-featured standalone/installable client and a web client including functionalities that are not hindered by the reduced performance and security restrictions of web browsers. The standalone version will also embed a local data server so that users may visualize their own data and process them in the tools provided by the OVL server.

6. TRAINING AND FEEDBACK

One of the central aims to this project is to enable access to Earth Observation data to users outside academia. In particular it has been designed not to require large data-processing capabilities or detailed user knowledge of algorithms. However, to enable its take up, and for the OVL consortium to benefit from user feedback, the *Ocean Virtual Laboratory* is being showcased at a number of events in 2015 and 2016. One of the first of these was POGO's 2nd Blue Planet Symposium in Cairns, which provided OVL with good visibility to those in governmental or transnational organizations working to understand and protect the environment.

As the project evolves through its 2-year lifetime, further feedback is sought from all interested parties to help develop the potential of this project. Already, through an early consultation exercise the remit has been extended to include calculation of anomalies (relative to a stored climatology) and for the display of time-series via Hovmöller diagrams. We will aim to implement these in a later version of the OVL.

7. References

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