COLOUR TABLES AND SEA-ICE INFORMATION PRODUCTS AND FORECASTS: FLEXIBILITY VERSUS CONSISTENCY. Allowing polar mariners to understand multiple ice products within a common visualisation system

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ABSTRACT

In order to interpret ice information products correctly and efficiently, it is important to have the information presented in a consistent way. In a system where the user can access many kinds of Near-Real-Time sea-ice related products from different providers, this issue is critical. The challenge is how to present these products in a way that effectively communicates the information and which is consistent across the whole range of available products, thus fulfilling the requirement that the colour scheme should be harmonised per physical parameter. The principle adopted and implemented is to use a layered approach where the values in the raster products are mapped to either explicit categories or to ranges of physical values. The physical values are then mapped to colour ranges thus ensuring that the same physical value is shown in the same colour independent of the origin. The system implemented in the FP7 POLAR ICE project enables harmonisation of the products coming from different providers and also supports interactive changing of the colour scale.

1. VISUALISING SEA ICE INFORMATION

Operators working in icy waters can benefit from a range of different ice information products: thickness, concentration, pressure, drift and forecasts. In a visualisation system that accommodates several providers of products, it is important to present the information consistently to minimise the risk of misinterpretation and to enable a comparison of products from different providers. Also, in an environment where different parameters can be displayed on the same map and this map is displayed to many persons that only take a quick look at the displayed image, different parameters should use distinct colour spaces to minimise the risk of misunderstandings. These criteria are somewhat conflicting as the distinct colour spaces do limit the spectrum of colours to be used for the different parameters. A third factor to be accounted for, are existing presentation standards. In the domain of ice information the most important standard is the ice chart colouring standard by the World Meteorological Organisation.[1]

In the project POLAR ICE, supported by the European Union's Seventh Framework Programme (FP7), these requirements have been identified and a solution has been implemented and demonstrated with a series of end users operating in the Arctic and Antarctic.

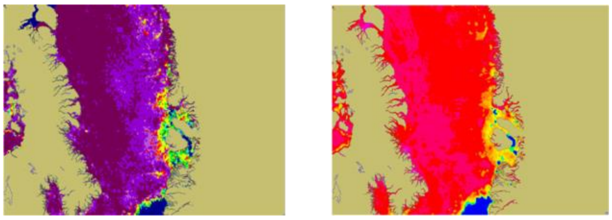

Figure 1. The problem of different colour codes: The leftmost picture above shows sea ice concentration derived by the University of Bremen, whereas the rightmost picture shows an ice concentration map produced by the Danish Technical University. Both products are based on passive microwave information from the AMSR 2 satellite. Visual comparison of these products is very difficult even though they show the same region at approximately the same time.

2. STATE-OF-THE-ART

The Open Geospatial Consortium (OGC) has defined two standards relevant in this context: the OpenGIS® Symbology Encoding Implementation Specification (SE) [2] and the OpenGIS Styled Layer Descriptor Profile of the Web Map Service Implementation Specification [3]. These standards are relevant in a WMS (Web Map Server) environment, and do provide a standardised way of defining how to display data in raster, vector as well as portrayal of symbols and labels. As the architecture in the pilot ice information system was not based on a Web Map Server, we considered these standards not to be applicable to our system. Thus we decided to develop a more appropriate solution described in the following section.

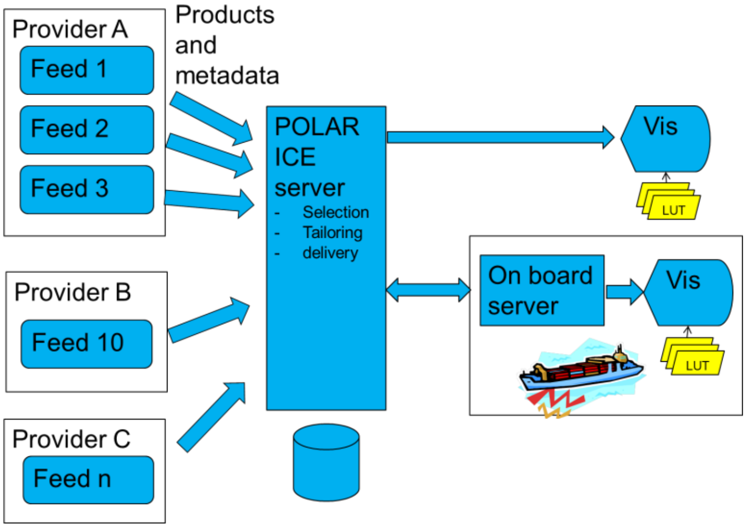

Figure 2. The POLAR ICE System – sea-ice products from several providers are made available to a central server where a Catalogue of available products, is produced. The Visualisation system enables the users to order the products in a tailored format. It is possible to change the colouring scheme at the end user's side and this is applied to products representing the same physical ice parameter.

3. THE VIEWICE SOLUTION

The ViewIce solution developed in the POLAR ICE project is based on interpreting rules followed by colouring tables. The colouring tables define the colours of the specific categories and of the physical parameters. This facilitates a harmonised presentation of products in the form of raster images (like ice concentration maps) and ice forecasts as numerical gridded information. A flexibility to modify the colours on the Client side is also possible while still maintaining a harmonised presentation of the physical parameters independent of whether the parameter is originating from a numerical forecast or ice concentration estimation based on satellite data.

The algorithm works as follows: for each input data stream (a Feed defined per product provider and type of product) a set of rules is defined. These rules are of two kind: category rules and scaling rules. The category rules are used to identify discrete feature categories defined by the value of the pixel in the data product, such as “land mask”, “clouds”, “open water”, “data not available”. These values can also be used for distinct categories in the data product such as “New ice”. The scaling rules are used to convert the pixel values into physical values such as fractional ice concentration (0.0 to 1.0) or ice thickness (in metres).

Using a separate look-up table, each category is then mapped to a RGBA value, i.e. the colour and the transparency (alpha) is specified. Each type of physical value, like ice concentration or ice thickness is also assigned a colour table of its own. The syntax in the colour table allows for specifying the colour for specific values and what colour values outside of the value range should be given. This approach is feasible as the size of the look-up table is usually limited by the number of colours that the user can distinguish between as well as the limited number of input values in an eight bit representation. Thus the look-up table can be (pre)generated with an external script doing the interpolation between distinct colours.

In the user interface of the visualising software, the user can select between the predefined colour look-up tables thus changing the colouring depending on the operating ranges of interest for the user. Users in the Baltic Sea seldom experience (level) ice thicknesses above 1 meter, whereas the thicknesses in the Arctic extend to several meters.

An additional advantage is that the mapping to a physical value enables the visualising software to present the numerical value in physical value units (like ice thickness in meters) of any pixel containing a valid physical value on the map.

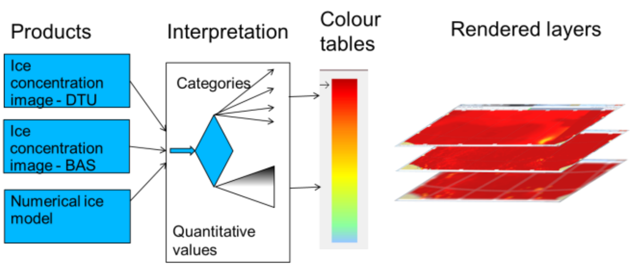

Figure 1. Schematic drawing of rendering process. The source products are interpreted using predefined rules, then the categories and the physical values are coloured according to parameter specific colour tables.

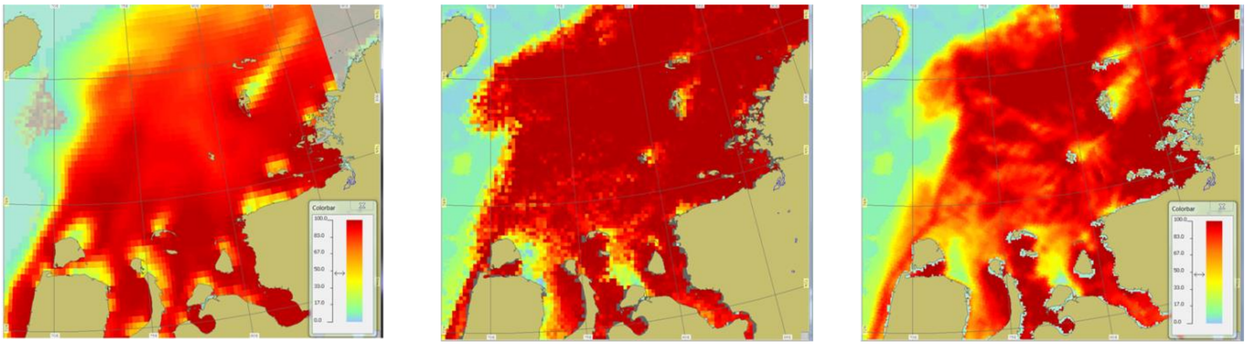

Figure 2. After harmonisation: The three ice concentration products shown above are easy to compare. The leftmost is an ice concentration forecast by DMI, the middle one is ice concentration derived from AMSR2 data by Bremen University and the rightmost one is ice concentration from AMSR 2 by the Danish Technical University.

4. DISCUSSION

The solution presented here gives a mechanism for visual harmonisation of ice products that represent the same physical parameter. The advantage of the set-up is that existing production chains on the provider side can easily be adapted to the input requirements of the system in situ with the end user in Polar waters. What is still missing is a protocol for providing the necessary metadata from the provider side that would inform the POLAR ICE system about the interpretation rules and thus automatically accommodate any changes in the coding of the product that the provider might wish to implement. An alternative solution could be based on numerical values offered via an interface like NetCDF without any default visualisation of the products. This type of interface would, however, require some extra effort on the producer's side compared to making the raster maps available as GeoTIFF images. Also – as the products are intended for users at sea with just a limited bandwidth connection – using simple 8- bit raster data for the ice thickness and ice concentration products with the special categories included in the pixel data – saves bandwidth and reduces the latency for product delivery.

For vector based products (in the format of Shapefiles or GML), the above simple rendering scheme is not applicable. The ice chart rendering is defined by standards and thus there are only a few alternatives for the visualisation of the ice polygons on the ice chart. Thus a fixed implementation in the visualisation software is justifiable for the standardised products like the ice charts. As POLAR ICE does not include complex vector charts, there has not been any need for the mechanisms defined in the OGC Symbology Encoding Standard. If, however, the product portfolio expands to include more complex products, and the architecture would include a Web Map Server, use of OpenGIS Styled Layer Descriptor Profile would be highly recommended.

5. ACKNOWLEDGMENTS

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6. REFERENCES

1. WMO, *Ice Chart Colour Code Standard*, WMO/TD-NO.1215, May 2014

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