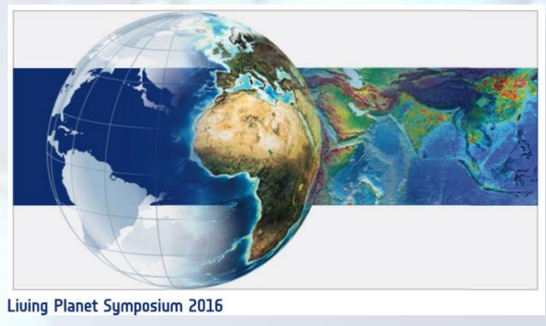
Level 4 Global and European Chl-a daily analyses for end users and data assimilation in the frame of the Copernicus - Marine environment monitoring service.



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Abstract

- The level-4 daily Optimal-Interpolation product is a combination of a water typed merge of chl-a products and an optimal interpolation based on the kriging method with regional anisotropic models [1,2]. The Level 4 product basically provides a global continuous (cloud free) estimation of the surface chl-a concentration at 4 km resolution over the world and 1 km resolution over the Europe. The level-4 products gather Modis, Meris, SeaWiFS, VIIRS and OLCI **daily observations from 1998 to now**.

- The Level 4 product avoids end users to consider typical lack of data as observed during cloudy conditions and the historical multiplicity of available algorithms such as involved by case 1 (oligotrophic) and case 2 (turbid) water issues in ocean colour.

- To provide to end users the best quality products, most popular algorithms have been assessed using available in-situ databases on three defined water types, each associated with a predefined radiometric shape (oligotrophic waters, chl-a dominated waters and coastal turbid waters). One specific algorithm has been retained for each water type depending on its validation results [1]. The merging between the algorithms is obtained as a weighted sum depending on the membership probability to the considered water type. The anisotropic covariance models allow both seeking for observations along the principal covariance axes, typically coastal gradients or fronts, and giving more important weights to the observations close to the main covariance axes [1].

- A total product uncertainty, a combination of the interpolation and the estimation error, is provided for each pixel.

- These products are freely distributed in the frame of the Copernicus - Marine environment monitoring service:

  Register first: http://marine.copernicus.eu/web/56-user-registration-form.php
  ftp://myocean.artov.isac.cnr.it/Core/OCEANCOLOUR_ATL_CHL_L4_NRT_OBSERVATIONS**_009_037**/dataset-oc-atl-chl-multi-l4-oi_1km_daily-rt-v01/
  ftp://myocean.artov.isac.cnr.it/Core/OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS**_009_033**/dataset-oc-glo-chl-multi-l4-oi_4km_daily-rt-v01/

A total uncertainty provided with each daily product

- The CMEMS L4 products are provided with a total chl-a uncertainty σ. σ² is expressed as the quadratic sum of the interpolation and the product errors:

$$\sigma = \sqrt{\sigma_{products}{}^2 + \sigma_{interpolation}{}^2}$$

With $\sigma_{interpolation}$ the classical kriging variance [1,2]:

$$\sigma_{interpolation}{}^2 = -\sum_{i=1}^{n}\sum_{j=1}^{n} \lambda_i \lambda_j \gamma(xi, ti; xj, tj) + 2\sum_{i=1}^{n} \lambda_i (xi, ti; x0, t0)$$

And $\sigma_{products}$ expressed as the probability membership weighted sum of the uncertainty per water type σ_k (estimated in a previous step using in-situ comparisons [1]): $\sigma_{products} = \sqrt{\sum_{k=1}^{ncluster} P(i=k)\, \sigma_k{}^2}$

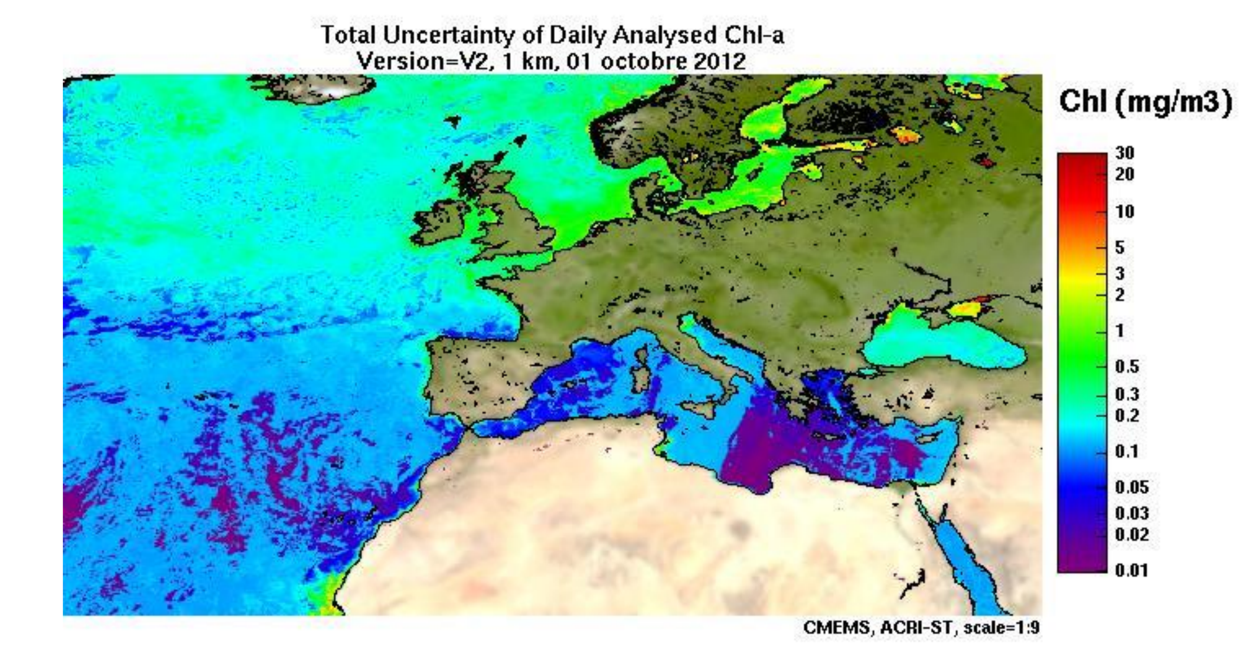

Figure 2: An example of the total chl-a uncertainty, in mg.m-3, provided with the chl-a L4 daily analysed fields. The stripes, or spatial discontinuities, in the total uncertainty refer to the observation distribution: if some observations are available for the current day, the interpolation error term is lower leading to a lower total uncertainty.

The CMEMS L4 chl-a analysis functional scheme

Figure 1 shows a synthetic flow diagram to explain the two-step processing algorithm involved for the L4 products:

- The first step aims at merging chl-a fields estimated using different algorithms, depending on the ability of each algorithm to estimate correctly the chl-a on different water types. The qualification of each algorithm has been performed in a previous validation step using all available in-situ datasets. The aim of this merging is to provide to end-users the 'best' estimation of the chl-a concentration for the observed pixel and hence to **avoid considering the historical multiplicity of available algorithms** such as involved by case 1 (oligotrophic) and case 2 (turbid) water issues in ocean colour.

- The second step consists in the spatio-temporal interpolation of the chl-a merged fields. Our interpolation technique is an advanced version of the standard Optimal Interpolations technique (OI, see [1,2] for details).

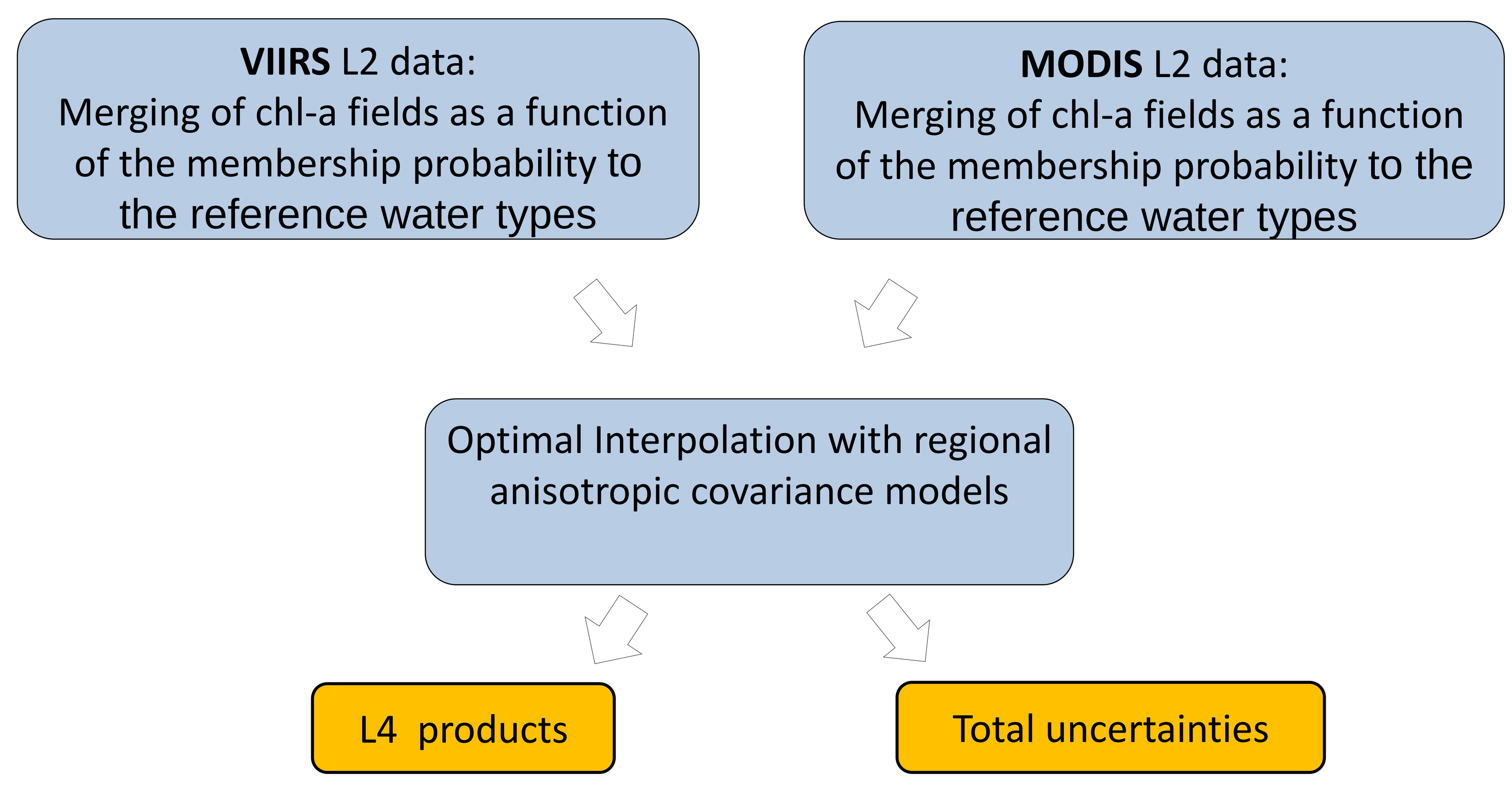

Figure 1: Synthetic flow diagram for the L4 CMEMS chl-a products

Daily continuous Chl-a fields estimated from space-based observations

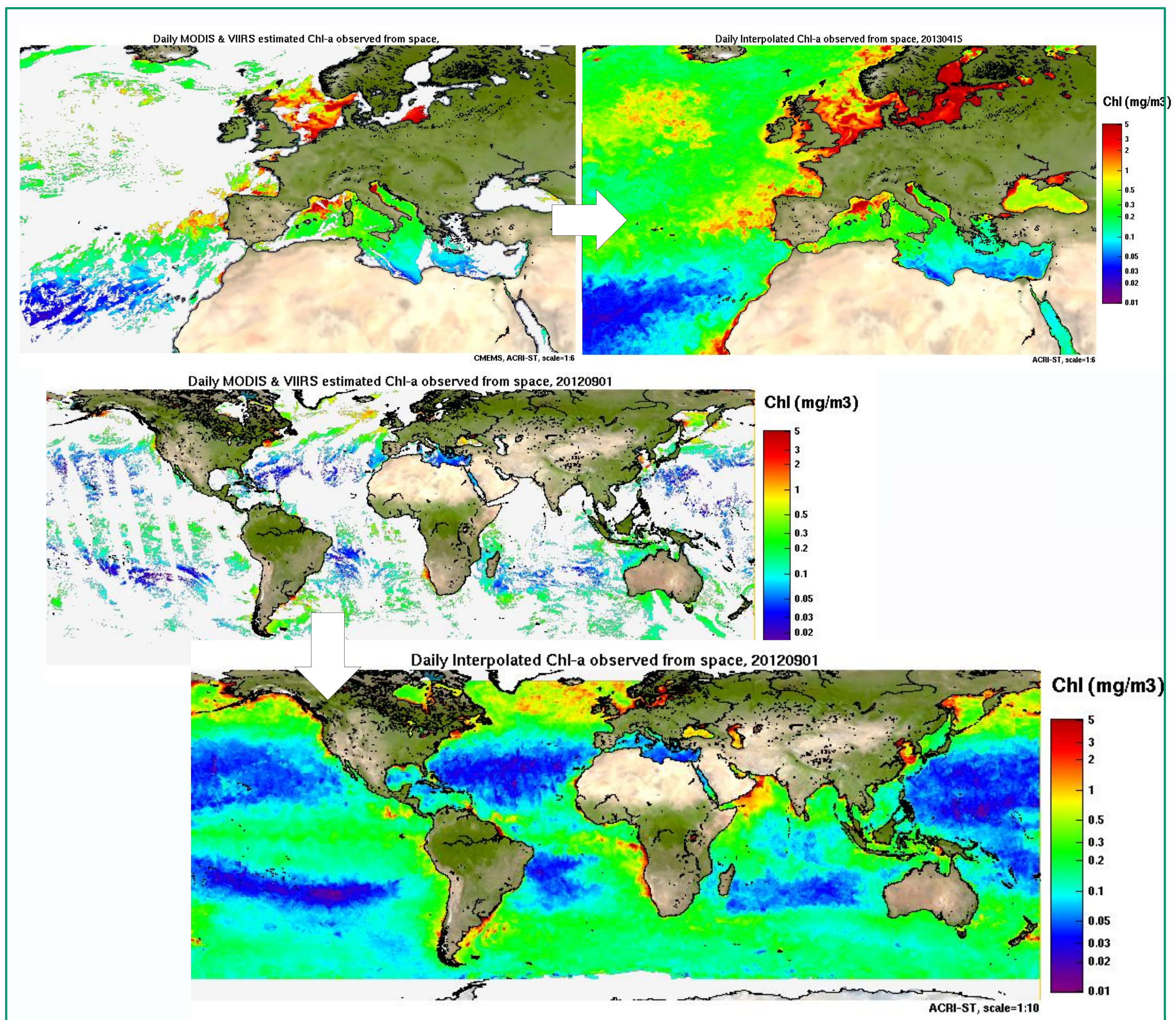

Figure 3: Comparisons between daily space-based observations and corresponding interpolated fields.

References:

[1] CMEMS QUality Information Document http://marine.copernicus.eu/documents/QUID/CMEMS-OC-QUID-009-033-037-082.pdf

[2] Saulquin, B., Gohin, F., and Garrello, R. (2010) Regional Objective Analysis for Merging High-Resolution MERIS, MODIS/Aqua, and SeaWiFS Chlorophyll-a Data from 1998 to 2008 on the European Atlantic Shelf. IEEE Trans. Geosc. and Remote Sensing.

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