A European tool for the explotation of remote ocean color data in biological oceanography: the OPPP

C. Rodríguez-Benito
Correo electrónico: info@mariscope.de
Mariscope Meerestechnik. Wischofstr. 1-3 Halle F11. 24148 Kiel. Germany
Phone:+49-431 722111; Fax:+49-431 722171.

RESUMEN

The new generation of ocean color data has promote the development of new tools for the exploitation of this type of remote sensed data of the seas. The OPPP (Ocean Primary Production Processor) prototype is the output of a ESRIN project whose main propose is to create a basic infrastructure for primary production estimation and validation with new satellite's data, as the ones from MERIS, in the near future. In this article we present a short compilation of the scientific results obtained in the calibration/validation of the new tool OPPP. Also some examples of the application of the software to the Canary Islands waters

KEY WORDS: ocean color, primary production, calibration, bio-optical algorithm, CZCS, SeaWiFS

ABSTRACT

La nueva generación de sensores de color del océano tras el CZCS ha promovido el desarrollo de nuevas herramientas para la explotación de este tipo de datos oceánicos obtenidos por sensores espaciales. El OPPP (Ocean Primary Production Processor) es el prototipo obtenido en un proyecto de ESRIN/ESA, cuyo objetivo era crear la infraestructura básica para la estimación y validación de datos satelitares, como los que medirán sensores como MERIS. En este artículo se presenta una recopilación reducida de los resultados científicos obtenidos en la calibración y validación de la herramienta OPPP. También se muestran algunos resultados de la aplicación del programa informático en las aguas de las Islas Canarias (España).

PALABRAS CLAVE: color del océano, producción primaria, calibración, algoritmos bio-ópticos, CZCS, SeaWiFS

INTRODUCCIÓN.

The improvement of the knowledge of the role of phytoplankton in the global bio-chemical cycles has led the necessity of determine the ocean primary production from basin to global scales. The best technik to carry out these studies, at these scales is the use of the ocean color sensors from remote satellites. A new generation, of these equipments, after the pioneer CZCS, started to work with the short life of OCTS and POLDER sensors. Then the german equipment MOS was launch in March'96. Afterwards the american SeaWiFS, MODIS and MISR, the japanese OCI, the indian OCM and the corean OSMI started to get ocean color information over the earth. A considerable list of these new sensors will be launch in the near future, as MERIS from ESA, MODIS-FM1 from NASA, GLI from NASDA, POLDER-2 from CNES and others at least until the year 2006 that will allow to the oceanographic community continuous observations of the color of the seas.

In our work we have carried out the calibration and validation of a new tool to use ocean color data. The tool OPPP (Ocean Primary Production Processor) was developed by the spanish company of engineers GMV - S.A. and the department of oceanography from the I.C.C.M.

For the development of the OPPP was implemented the analytic model of Platt and Sathyendranath (1988), with some modifications regarding the atmospheric model and the parametrization of the phytoplankton biomass profile. The algorithm is described for case I waters although some application has been made on case II water (Hoepffner *et al*., 1994). In our work we made the calibration only for a case I environment.

The main modules of the algorithm are: the amount of light which reach the photic zone, in the PAR (Photosynthetic Available Radiation) range, the vertical distribution of phytoplankton and the photosynthetic efficiency of these organisms.

We introduced a modification regarding the gaussian distribution of the biomass profile to get an assimetric profile, regarding the (DCM) Deep Chlorophyll Maximum which represent better the real distribution of the chlorophyll in the ocean (Rodríguez-Benito, *et al.*, in preparation).

Regarding the atmospheric model, we applied Gregg and Carder (1990) model, whereas the original work model used Bird's (1984). The reason to make this modification is to include in the

computation several parameters as: atmospheric pressure, air mass type, relative humidity, water vapor, visibility, wind speed, ozone and air temperature which influence the final solar irradiance and modify the final computation of primary production.

One of the first products obtained with this new tool was the primary production image in Figure 1.

CAL/VAL RESULT OF THE OPPP

Although our first intention was to arrived the end of the project using SeaWiFS data, the big delay of the launch of this sensor drive us to carry out the main calibration/validation tasks of the tool before the launch of SeaWiFS. The end of the development of the software prototype arrived during the summer of 1997. At this time the comparisons of the OPPP computations and the real data were made using the historical data of primary production from the Canary Islands waters and some CZCS image from the same period of the measurements in the sea. The production was computed with these remote sensed information. Afterwards the tool was tested with SeaWiFS data.

For the validation of the instrument the OPPP was ingested with some data from the authors of the original primary production model (Platt & Sathyendranath, 1988). These data were kindly provided by Dr. Platt from the BIO, in Canada. The satellite data correspond to CZCS observations, the primary production measurements were carried out by García-Braun *et al*., (1985) and Fernández de Puelles (1986); and the chlorophyll profile parameters belong to the general data base of the local research of the ICCM and the biomass profiles measured in the ESTOC station during the period 1994-1997.

The result of the process by the OPPP differs with the ones from the authors of the model in 16.82%. This difference found during the validation of the software is assumed mainly to the use of a different model to compute the incident irradiance field, regarding the original algorithm.

The results of the calibration procedures of the OPPP (Rodríguez-Benito *et al.*, 1997) was carried out in two groups of available data: the first include 5 cases of in situ primary production measurements made during the R/V Poseidon P202, P212 and the R/V Victor, Hensen/1995 cruises, both carried out in the Canary Islands waters. The second group included two years of sampling in a time-series station (28°30'N, 16°6'W), NE Tenerife Island, in the middle of the Archipelago, betwenn 1983 and 1985 (Braun et al., 1985; Fernández de Puelles, 1986). The second group of observations belong to the period of the CZCS activity and some images were selected for the comparison. A reasonable agreement of the results have been found (Fig. 2). In the second group of comparisons, the correlation of the measured primary production and the one obtained using the OPPP with CZCS data, were better than 90%, when using the average monthly, seasonal and annual biomass profiles, and only 53% when using the biomass data of the same station where pp was measured. The differences in the results are between 47% and 59%, for the data used. This values, around 50% are very similar to the values given by Platt et al. (1995), for the computation of primary production from remote sensed ocean color information

APPLICATION OF THE TOOL WITH NEW OCEAN COLOR DATA

The availability of new ocean color data have led us to obtain the primary production maps as the ones shown in the following Figures. The maps of the Figures 3 and 4 represent the total biological

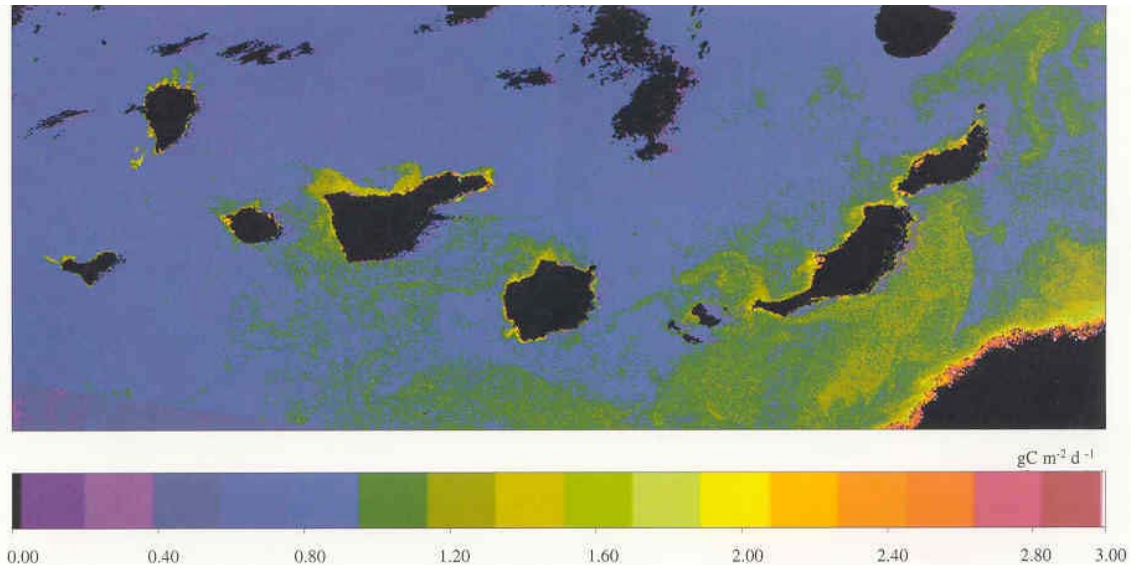

Figure 1. Primary production ($gC \cdot m^{-2} \cdot d^{-1}$) in the Canary Islands waters obtained with the OPPP from the CZCS image of the julian day 37 of 1979.

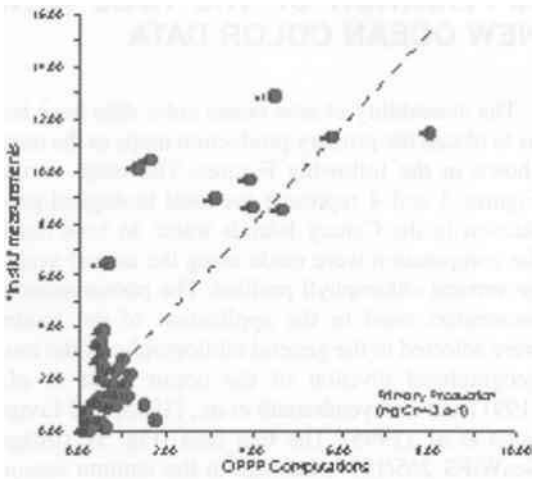

Figure 2. Comparison of the results of primary production obtained using the OPPP, and the *in situ* primary production observations, for the bigger group of data available which is included in the second group of data in the area (see text). Number of pairs of data = 44. Correlation = 81%.

production in the Canary Islands wa t e r. In both cases the computation were made using the annual average vertical chlorophyll profiles. The photosynthetic parameters used in the application of the model were selected in the general bibliography of the biogeographical division of the ocean: Platt *et al.*, (1991) and Sathyendranath *et at*., (1995) and Longhurst *et al.* (1995). The first case (Fig. 3): (image SeaWiFS 265/1997) belongs to the autumn season and the maximum primary production data is around 0.6 $gCm^{-2}d^{-1}$. The second example (Fig. 4) (image SeaWiFS 094/1998) show higher values (mean $1gCm^{-2}d^{-1}$) typical from the spring season. We do not take into account for these consideration the upwelling coastal area of the African continent.

CONCLUSIONS

It has been tested that the implementation of Platt and Sathyendranath (1988) model for the application around the Canary Islands has been consistent with the original work, and the results are adequate when they are analysed with the *in situ* observations.

The regression analysis has been carried out and the relation: *PPobserved=1.814·PPcomputed+0.806 (n=44; r=0.81)* was obtained, which drive us to conclude that the tool will be very useful to compute the primary production in this part of the Atlantic ocean and can be extended to other areas if the local biomass profile and P-I parameters are known.

It is shown the functionality of the OPPP when new ocean color data (SeaWiFS) are used.

More than new 400 chlorophyll profiles data from the Canary basin from the last years and new ocean color data were recolected to analysed and improve the relationships of the *in situ*-remote chlorophyll data.

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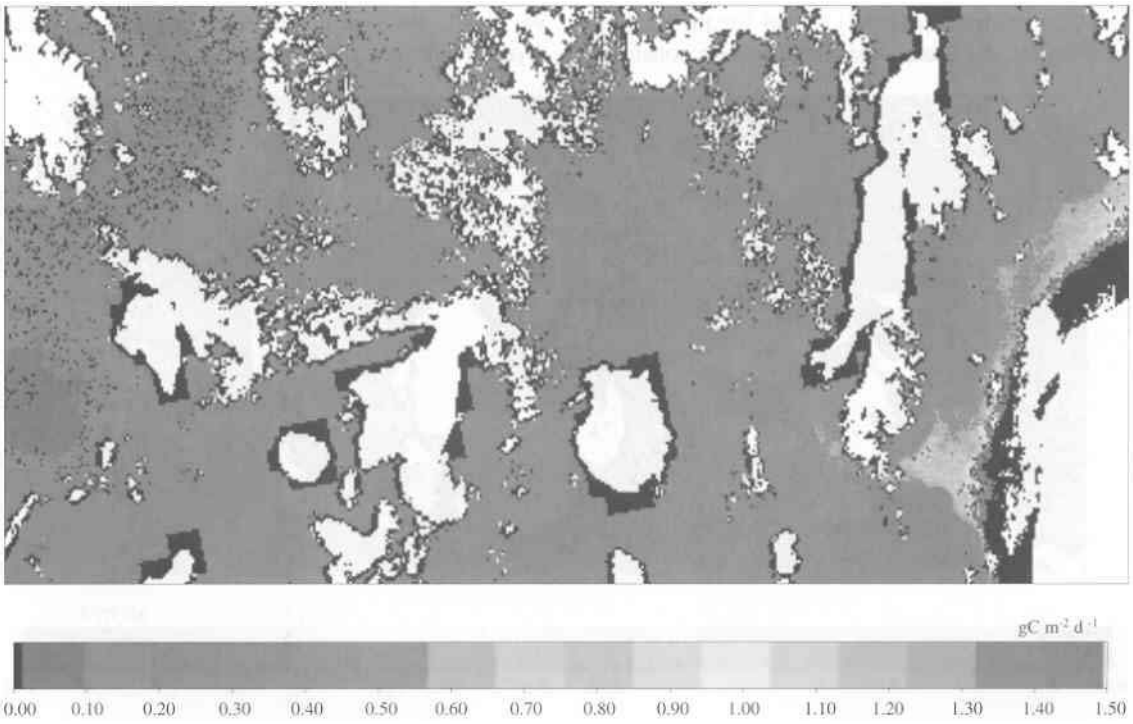

Figure 3. Map of primary production in the Canary Islands waters (Spain) after the application of the tool OPPP in the SeaWiFS image from the julian day 265 of 1997.

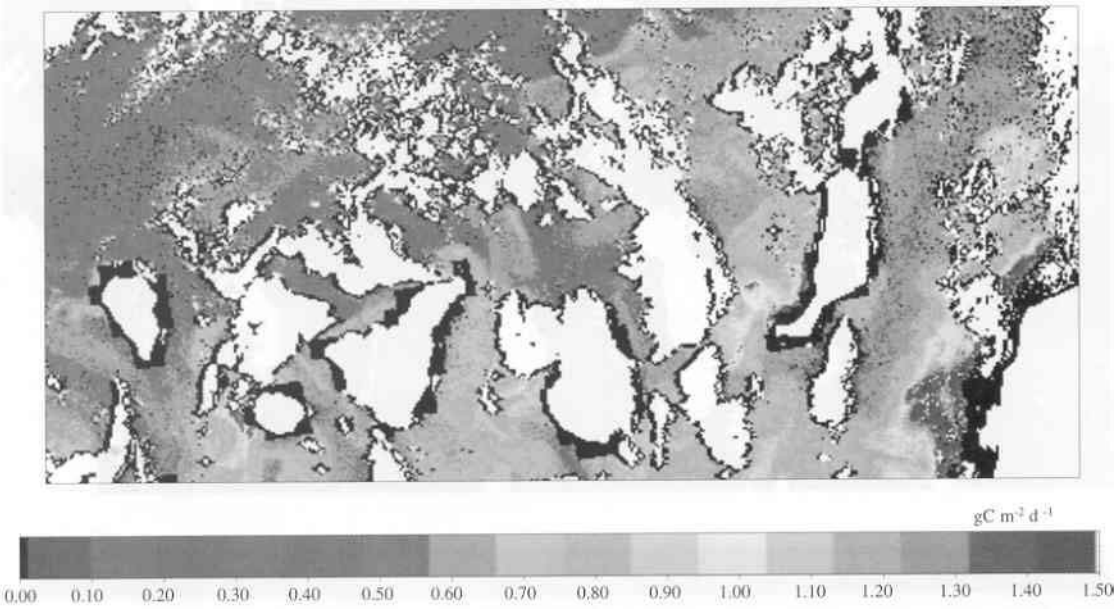

Figure 4. Map of primary production in the Canary Islands waters (Spain) after the application of the tool OPPP in the SeaWiFS image from the julian day 94 of 1998.