RELEVANCE OF GLOBAL REMOTE-SENSING FAPAR PRODUCTS TO CARBON FLUX ESTIMATES

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ABSTRACT

This contribution gives an overview of the Medium Resolution Imaging Spectrometer (MERIS) global land product corresponding to the biophysical variable of the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR). This product can be used in large-scale biosphere modeling for better estimating the carbon fluxes since they directly represent the amount of solar energy which serves as a ‘battery’ during the photosynthetic process.

The daily FAPAR value is operationally estimated from MERIS data1 and the (demonstration) global products, recently produced at European Space Research Institute (ESRIN) by the grid on demand system2, are first compared against the Joint Research Centre (JRC) SeaWiFS global datasets which is available since September 1997 [1][2].

The second part presents a first evaluation against the simulations by the Biosphere Energy Transfer Hydrology Scheme (BETHY) model [3][4][5] for a 10 year period and over 3 regional windows. The results show a good agreement between both space remote sensing data and model simulations which promotes the assimilation of the MERIS FAPAR products into a Carbon Cycle Data Assimilation System (CCDAS) [6].

1. Introduction

The MERIS FAPAR algorithm was developed to produce useful, quantitative, reliable and accurate information on the state of terrestrial vegetation using MERIS Level 1 data, i.e. Top Of Atmosphere (TOA) Bidirectional Reflectance Factors (BRFs) at both full and reduced resolutions using the physically-based approach developed by [7][8][9].

The same time-composite procedure of the JRC-FAPAR proposed by [10] has been applied to the MERIS data to generate monthly products at the reduced resolution [11]. An aggregation algorithm is then applied to produce large-scale products at lower resolutions suitable for global applications [12].

The first section presents the results of a comparison between these preliminary global MERIS products and the global JRC-SeaWiFS products using data in June 2003. The last section shows a comparison of time profiles between the simulated BETHY FAPAR and remote sensing FAPAR datasets averaged over three regions around the globe to see the consistency between the space remote sensing products and the BETHY simulations.

2. MERIS Global FAPAR products

In order to derive a long times series of a given biophysical parameter, i.e. FAPAR, which are derived from various space instruments, comparison exercises must be conducted.

Figures 1: Global maps of FAPAR value derived from SeaWiFS and MERIS in June 2003.

1 http://earth.esa.int/
2 http://eogrid.esrin.esa.int/
The daily products derived from these two sensors have been shown to be in good agreement during the validation phase that included ground-based estimates [2][13]. Additional results of comparisons at regional scale have been also presented in the evaluation report in [14]. Here, we present the first comparison between the global products derived from MERIS and SeaWiFS. The data correspond to a 10 km x 10 km resolution datasets in a sinusoidal projection during June 2003 (See maps in Figure 1).

The results are presented on a scatter-plot (Figure 2) which analysis demonstrates that both products correlate at 98% and that the absolute difference rarely exceeds 0.03. To ensure the use of the both source of global products, additional comparison exercises will be performed for a longer time period when both sensor data are available over the same period, i.e. from June 2002 until end of 2004.

3. FAPAR from Remote Sensing and BETHY

The seasonal variations of FAPAR which are derived form the BETHY simulations and those derived from the space remote sensing data are compared over 3 large geographical regions covered by different land surfaces types.

The biosphere model has been run within a 2° x 2° grid cell and provides the FAPAR assuming an illumination zenith angle of 20° whereas the remote sensing products have been generated in a 0.5° x 0.5° grid resolution grid (Note that the daily FAPAR retrieval from MERIS or SeaWiFS corresponds to a value for a sun zenith angle of the actual time of acquisition).

The plots presented here correspond to the time series of monthly FAPAR spatially averaged over each regional window from the 1st of January 1997. The vertical bars are the spatial standard deviation over this window.
The second example of comparisons is performed over the European continent and we can notice that the same seasonal profile, typical agricultural fields, is well retrieved from both the model and the remote sensing products. However, the levels simulated by the biosphere model are much lower that the one observed by space remote sensing. This difference can be partly explained by a miss representation of the plant functional type in the model over Europe.

The third and last example is given in Figure 5 and corresponds to the Australia continent.

![Figure 5: Seasonal comparison between spatially averaged FAPAR value derived from BETHY, SeaWiFS and MERIS since 01/01/1997 over the Australia continent [10°S, 40°S, 110°E, 160°W].](image)

The inter-annual variations detected from the model and the remote sensing data follow approximately the same trend. The seasonal cycle suggests a decrease of photosynthetic activity from 2000 to 2003 which has been already studied in [15][16]. The response of the vegetation to drought period seems to be indeed detected with a time lag by the remote sensing estimates with respect to the biosphere model.

4. Perspectives and Conclusion

Global demonstration products from MERIS will permit us to consolidate results from the comparison exercise illustrated here. They will also promote their ingestion by complex data assimilation systems which incorporate land surface process models.

5. Acknowledgements

We are grateful to the G-POD Team members Fabrice Britto (Terradue), Emmanuel Mathot (ESRIN) and Olivier Colin (ESRIN) whom ensure the processing of the demonstration MERIS global products and Frédéric Melin (EC-JRC) for the processing of the SeaWiFS data and Monica Robustelli (EC-JRC) for the JRC database. We would like to thank the SeaWiFS Project (Code 970.2) and the Distributed Active Archive Center (Code 902) at the Goddard Space Flight Center, Greenbelt, MD 20771, for the production and distribution of the SeaWiFS data, respectively.

6. References


