Algorithm Theoretical Basis Document

ATBD 2.18

PHOTOSYNTHETICALLY AVAILABLE RADIATION

(PAR)

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1. Introduction

The following describes the algorithm for the derivation of Instantaneous integrated Photosynthetically Available Radiation (PAR), integrated in the band 400-700nm.

2. Overview

The fluorescence from chlorophyll at the 682.5 band will require further processing for interpretation in terms of phytoplankton biomass. Although the exact further processing chain has not been specified, it is know that the fluorescence observed is related to incident light, with a variable quantum yield. Normalisation of fluorescence to incident light will be a first step in analysing such data.

3. Algorithm Description

3.1. Theoretical Description

3.1.1 Mathematical Description of the Algorithm

Gregg and Carder (1990) provide a good model for downwelling incident PAR. The model has been subject to sensitivity tests, and look up tables can be generated from this model. Generation of the tables for all sun angles would produce large tables. The normalisation of the product to solar zenith angle, where the tables will contain normalised PAR defined as $PAR/\cos(\theta_s)$ for a fixed earth sun distance, considerably reduce the table size, and will only lose accuracy at low sun angles, where the corresponding geochemical products are of reduced accuracy.

Tables of PAR have been generated be generated for $\tau_a(865)$, n (Angstrom Exponent), O3 and W_{tco}. The calculations are based on a sun zenith angle of 45^o, and the results stored as normalised output.

3.1.2 Input Parameters

The following table 3.1.2-1 summarises the input and output parameters of the algorithm.

Symbol	Descriptive Name	I/O	Range/Reference /Remarks
$\tau_a(775)$, $\tau_a(865)$	Aerosol Optical Thickness	I	From ATBD 2.7
O_3	Ozone Concentration	I	From External Data
W_{tco}	Column water vapour	I	From ATBD 2.4
θ_s	Solar Zenith Angle	I	From Navigation
ESD	Earth Sun Distance	I	From Navigation (Or calculated locally from date)
PAR	Integrated PAR	O	Product

Table 3.1.2-1: PAR Algorithm Parameters

3.1.3 Error Budget Estimates.

Specified in Gregg and Carder (1990), will also depend on error budgets for ATBD 2.7 (τ_a).

3.1.4 Validation Procedures.

The algorithm will be validated using shipboard measurements, and sun-photometer measurements. There is an existing data set from the Atlantic Meridional Transect and this will be used for global validation. In addition the AERONET sun photometer located at Plymouth will be used for time series validation along with SeaWiFS imagery.

3.1.5. Look-up Tables

The following table 3.1.5-1 provides a provisional estimates of the look-up table indexing requirements for the PAR algorithm.

Variable	Name	N Values	Range
τa (865)	Aerosol Optical Thickness	20	0.. 3
n	Angstrom Exponent	20	-0.8 .. 2
W_{tco}	Column Water Vapour	20	0 .. 6.0
O_3	Ozone Concentration	20	200-400

Table 3.1.5-1: PAR Algorithm Look-up table indexing

160,000 Entries, PAR stored as 16-bit integer - storage requirement 320Kbytes.

4. References

Gregg, W. W. & Carder, K. L. (1990): A simple spectral solar irradiance model for cloudless marine atmospheres.

Summary Sheet

Product Name Instantaneous PAR
Product Code
Product Level 2

Product Parameters

Coverage	regional / global
Packaging	MERIS Scene
Unit	[micro Einsteins = micromol photon s^{-1}]
Range	50-1000
Sampling	pixel by pixel
Accuracy	+/-3%
Geo.-location requirements	None
Format	16bits
Frequency	as atmospheric correction
Size	Integer

Additional information

MERIS data requirements	τ_a at two bands, column water vapour from atmosphere products
Ancillary Data	Solar Zenith Angle from Navigation Ozone Concentration