Description of wind speed product derived by the POLAC algorithm from POLDER/PARASOL data

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This document aims at describing the method used to derive the wind speed from POLDER/PARASOL sensor at the full spatial resolution of 6 km.

1. Overview of the POLAC algorithm

The POLarized Atmospheric Correction (POLAC) algorithm has been described in detail in Harmel and Chami (2011). The primary objective of the POLAC algorithm is to correct the POLDER/PARASOL data for the atmospheric effects over the oceans using the polarimetry and multidirectionality features of the POLDER sensor. Therefore, the POLAC algorithm allows getting the Stokes vector (I, Q and U), which describes the radiance and polarization state of light, at the sea surface level. The general overview the POLAC atmospheric correction algorithm is summarized in figure 1. The phase (1) of the algorithm is devoted to the determination of the aerosol model (size distribution and spectral variation) using the multidirectional polarized radiation (i.e., Stokes components Q and U) at various wavelengths, including at 490 nm for which the oceanic radiation has been shown to be fairly insensitive to variations in phytoplankton biomass in open ocean waters (Harmel and Chami, 2008). Then, the aerosol optical depth is estimated using the radiance measured in the near infra-red at 865 nm. The phase (2) of the algorithm is dedicated to the determination of the water leaving radiation by subtracting the atmospheric Stokes vector derived in phase (1) from the top-of-atmosphere signal.

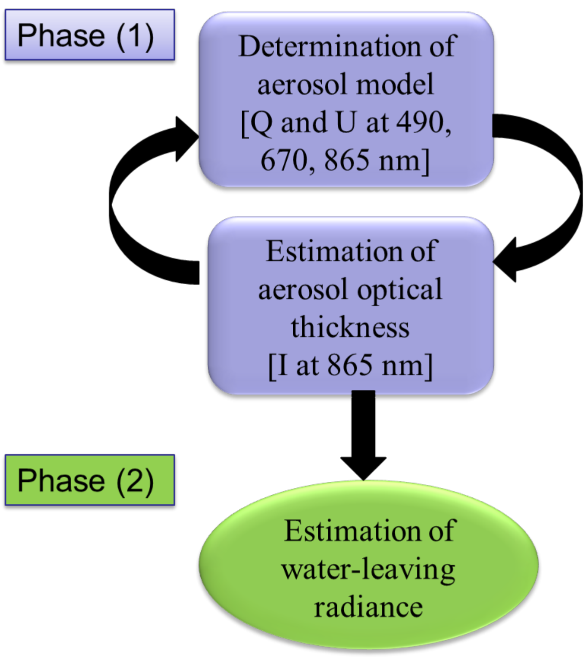

Figure 1: Overview of the POLAC algorithm for the atmospheric correction of POLDER/PARASOL data.

2. Wind speed product

The POLAC algorithm has been adjusted to derive the wind speed from POLDER/PARASOL data (Harmel and Chami, 2012 and 2013). The method is based on the fact that the sunglint radiation, which is defined as the reflection of the solar direct light onto the rough sea surface, depends on the wind speed at the air-sea interface. Thus, the coupling between POLDER/PARASOL multidirectional observations and modeling of the sun glint radiation (Breon and Henriot, 2006; Cox and Munk, 1954) was used to adjust the POLAC algorithm to provide the wind speed value (in m s^{-1}) and its associated uncertainty. Figure 2 shows the overview of the methodology that is used to estimate the wind speed from POLDER/PARASOL data.

Briefly, pixel's viewing directions that are potentially contaminated by the sun glint radiation are corrected for the atmosphere using POLAC aerosol model and aerosol optical depth. Thus the sunglint component of the measured Stokes vector is obtained for each viewing direction. Then, the sunglint signal is inverted to provide the wind speed value and its uncertainty through an optimization procedure (Levenberg-Marquardt method) (figure 2). Note that the wind direction is not derived by the algorithm. It is interesting to note that the wind speed product is delivered here for the full spatial resolution of POLDER/PARASOL data, namely 6 km per 6 km at nadir.

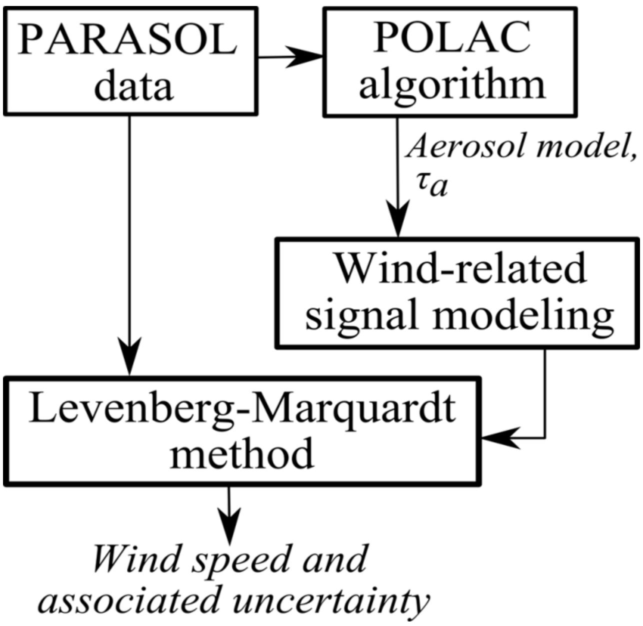

Figure 2: Algorithm that is used to derive the wind speed and its associated uncertainty from POLDER/PARASOL data using the POLAC methodology (taken from Harmel and Chami, 2012). τ_a is the aerosol optical depth.

3. Validation of the wind speed product

The quantitative validation of the wind speed product retrieved for POLDER/PARASOL data was carried out using first, comparison with in-situ measurements and second, comparisons with satellite data acquired by a microwave wind sensor, namely, AMSRE sensor (see Harmel and Chami, 2012 for details).

The comparison of POLDER/PARASOL wind speed product with in-situ wind data was performed using measurements acquired from buoys (Météo-France) moored in the Mediterranean Sea (Gulf of Lion) for 1-year time series (2006) (figure 3). The results showed a strong correlation between POLDER/PARASOL and in-situ data with a discrepancy less than 5%. The root-mean-square error is about 1 m s^{-1}, which is satisfactory. Figure 3 also showed that the POLDER/PARASOL retrieval of wind speed does not exhibit any systematic error.

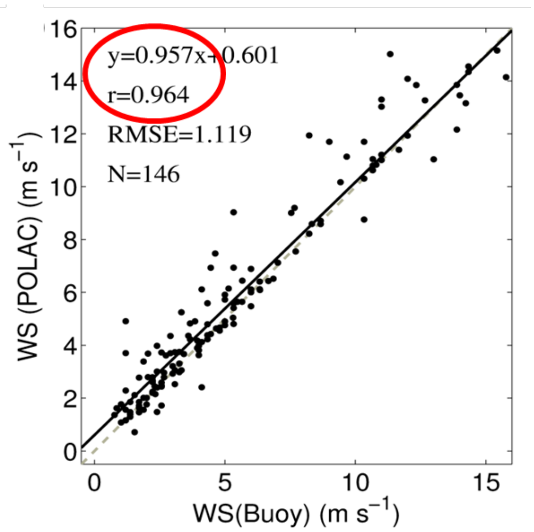

Figure 3: Quantitative validation of the wind speed product (noted "WS" in m s^{-1} in the figure) delivered by POLDER/PARASOL (POLAC algorithm) through comparisons with in-situ measurements acquired by buoys (Météo France) in the Mediterranean Sea for the entire year 2006 (taken from Harmel and Chami, 2012).

As mentioned above, the wind speed product derived by POLDER/PARASOL was also compared to the wind speed retrieved by AMSRE (NASA) microwave satellite sensor at global scale over the ocean (figure 4). For this purpose, the spatial resolution of POLDER/PARASOL sensor was degraded from 6 km to 25 km to match with the spatial resolution of AMSRE sensor. A strong correlation was observed between POLDER and AMSRE wind speed products; a discrepancy less than 1% is obtained. Note that the density plot of figure 4 also shows that a wind speed value around 5 m s^{-1} is observed for the majority of the ocean pixels at global scale.

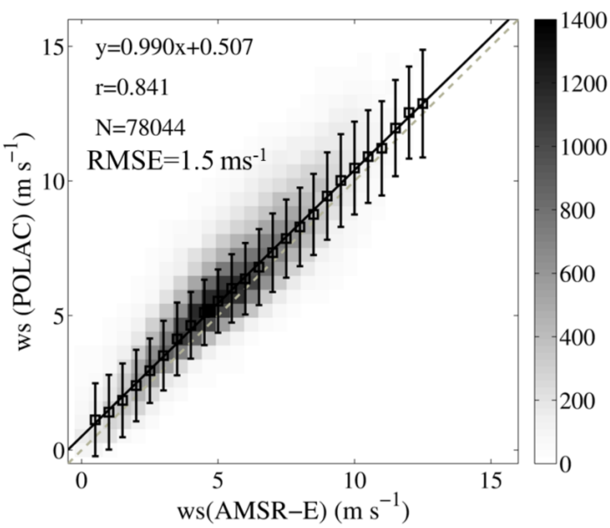

Figure 4: Comparison of POLDER/PARASOL wind product with AMSRE (NASA) satellite sensor (taken from Harmel and Chami, 2012). Data acquired over the entire global ocean (from May 5 to 7, 2006) were compared.

As a result of the validation, one benefit of using POLDER/PARASOL wind speed product relies on the significant improvement of the spatial resolution (by a factor of 4) relatively to current other wind satellite sensors.

4. References

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