Aim of the algorithm : Providing cloud parameters defining an advanced vertical structure of cloudy atmosphere.

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PRODUCT AND ALGORITHM DESCRIPTION AND CONDITION OF USE

The aim of these algorithms is to determine macrophysical vertical properties of cloudy atmospheres from POLDER/PARASOL measurements. It consists in three vertical parameters for single layer cloudy atmosphere and in a cloud multilayer flag. The four parameters define the CLOVES product which stands for CLOud VErtical Structure. These parameters and flag were obtained and validated statistically using measurements of POLDER3/PARASOL coincident with CloudSat/CALIOP.
We estimate the pressures in hPa at the top and at the geometrical middle of the cloud layer with **CTOP** (Cloud Top Oxygen Pressure) and **CMOP** (Cloud Middle Oxygen Pressure), respectively, the cloud geometrical extent (**CGT**) in meters, and a multilayer flag (**MLF**) which gives the confidence in the mono/multi-layer character of the cloud scene.
Cloud pressures and vertical extent are obtained from the POLDER cloud oxygen pressure Poxy (Vanbauce et al 2003) and its angular standard deviation ADPoxy and with parameterizations which depend on the cloud optical thickness COT and on MUS, the cosine of the solar zenithal angle (Desmons et al 2013), and on the surface type. Cloud geometrical thickness is obtained either directly from ADPoxy (Ferlay et al 2010; Desmons et al 2013) or from CMOP and CTOP. The multilayerflag (MLF) is obtained from a synergy of POLDER measurement thanks to a decision tree approach (Desmons et al 2015). The flag consist in integer and discrete values between 0 and 100, indicating a confidence in % in the multilayer character, 0% (resp. 100%) pointing out a doubtless monolayer (resp. multilayer) cloudy case.
For multilayer cases, the parameters CTOP, CMOP, CGT are provided but users are warned that their significances are less guaranteed when the value taken by MLF goes away from low values. The threshold value Thres = 54 for the parameter MLF for a binary distinction between monolayer (MLF < Thres) and multilayer (MLF > Thres) cloudy cases is the one that minimizes the risk of misclassifying a cloudy situation (31% of risk). The value Thres = 42 might be the one to be retained in order to avoid the misclassification of cloud single layer cases (Desmons et al 2015).
Beside a multilayer scenario, single layer parameters should be use with caution in the following cases : at the edge of clouds; MUS < 0,3 ; COT < 5 .
Range values of CTOP and CMOP : 0 to 1200 hPa; Range values of CGT : 0 to 18000 m for ice clouds, 0 to 12000m for liquid and mixed clouds.
Performances of the CLOVES products are illustrated on Figure 1 for estimated pressures of deep convective clouds, and on Figure 2 for the multilayer flags.

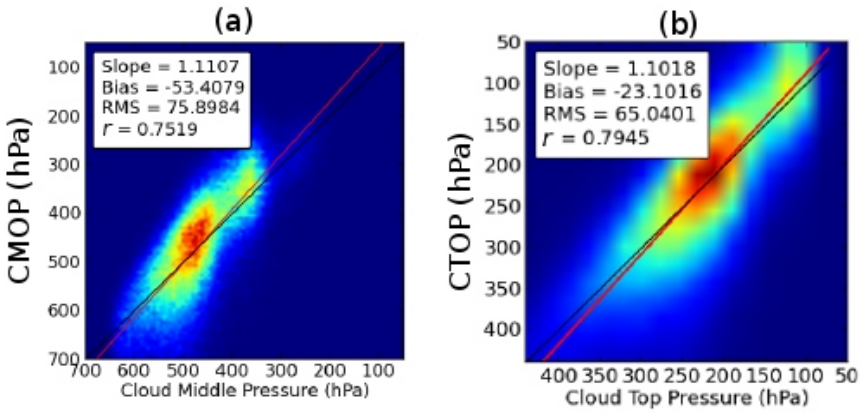

Figure 1: Evaluation of POLDER cloud middle and top oxygen pressure (CMOP on panel (a) and CTOP on panel (b)) against CPR/CALIOP cloud middle pressure (in abscissa). Cloud cases over ocean in 2008. Black lines indicate the one-to-one relationship, while red lines indicate the linear regression between CMOP and CMP.

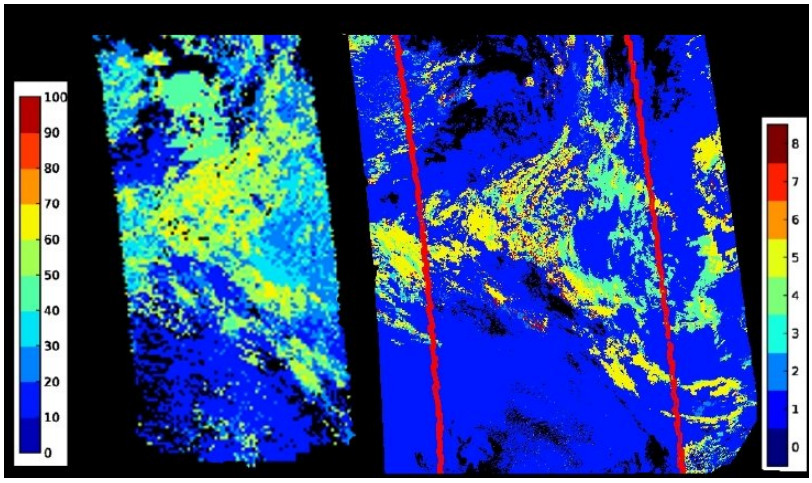

Figure 2 : Qualitative comparison between POLDER (left) and MODIS Collection 5 (right) cloud multilayer flag. Orbit : September, 24, 2008, South of Madagascar.

REFERENCES

Desmons, M. , N. Ferlay, F. Parol, L. MCharek, C. Vanbauce, 2013 : Improved information about the vertical location and extent of monolayer clouds from POLDER3 measurements in the oxygen A-band, *Atm. Meas. Tech.*, Volume 6, Issue 8, pp. 2221-2238

Desmons, M. , N. Ferlay, F. Parol, J. Riédi, F. Thieuleux, 2015 : Multilayer cloud detection using the synergy of POLDER/PARASOL measurements, in preparation for *J. of Geophys. Res.*

Ferlay, N., F. Thieuleux, C. Cornet, A. B. Davis, P. Dubuisson, F. Ducos, F. Parol, J. Riédi et C. Vanbauce, 2010 : Toward new inferences about cloud structures from multidirectional measurements in the Oxygen A band : Middle-of-cloud pressure and cloud geometrical thickness from POLDER-3/PARASOL, *J. Appl. Met. Clim.*, vol. 49, p. 2492–2507.

Vanbauce, C., Cadet, B. and Marchand, R.T., 2003 : Comparison of POLDER apparent and corrected oxygen pressure to ARM/MMCR cloud boundary pressures, Geophys. Res. Lett., 30(5), 1212, doi: 10.1029/2002GL016449.

PARAMETER DESCRIPTION

CTOP	Cloud Top Oxygen Pressure	hPa	0-1200
CMOP	Cloud Middle Oxygen Pressure	hPa	0-1200
CGT	Cloud Geometrical Thickness	m	0-18000 (ice cloud) 0-8000 (ice cloud)
MLF	MultiLayer flag	-	0-100

ALGORITHM DESCRIPTION