Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

Recent improvements to the KNMI Cloud Physical Properties algorithm

Gerd-Jan Van Zadelhoff & Jan Fokke Meirink

Royal Netherlands Meteorological Institute (KNMI)

CM SAF
Climate Monitoring

Within the Satellite Application Facility on Climate Monitoring (CM-SAF), KNMI has developed the Cloud Physical Properties (CPP) algorithm. CPP has been used to generate two long-term CM-SAF datasets: CLARA-A1 (CLoud, Albedo and RAdiation using AVHRR) and CLAAS (CLoud property dAtAset using SEVIRI). In the coming years these datasets will be reprocessed using improved algorithms and for extended time periods. In this work recent improvements to the CPP algorithm are discussed.

1. Introduction

The CPP algorithm retrieves cloud optical thickness at visible wavelengths (COT), cloud particle effective radius (R_e), cloud thermodynamic phase (CPH), and cloud water path (LWP/IWP). The CPP updates include new look-up tables, the use of observational sea ice and numerical weather prediction (NWP) snow cover data to better characterize the surface albedo, and a new cloud phase determination.

2. Look up tables (LUTs)

A crucial set of inputs required are the radiative transfer look up tables, which link the reflectances to COT and R_e. Before the LUTs were created, the adopted ice crystal habit (imperfect hexagonal crystals [Hex]) properties have been re-evaluated against the mixture of roughened crystals [Mix]used for MODIS collection 6[1], which showed relatively small differences (Fig 1).

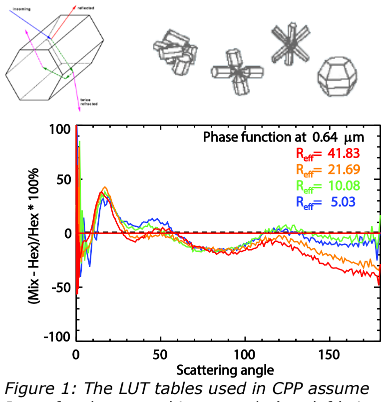

Figure 1: The LUT tables used in CPP assume Imperfect hexagonal ice crystals (top left), in comparison to the Mixture of roughened crystal habits(top right)[1]. The bottom plot shows the phase function differences between the two habits in the 0.64 micron channel.

The most important changes in the LUTs are:

- Extension of the range of solar zenith angles (SZAs) and viewing zenith angles (VZAs) using pseudospheric correction
- Increasing the number and range of effective radii (Table 1).

Table 1: Size and ranges[µm] of the CPP LUTs with in brackets the old values

Phase	Min Re	Max Re	# points
Liquid	3 (1)	24√2 (24)	8 (7)
Ice	5 (6)	80 (51)	9 (4)

The new LUTs span a larger area in parameter space and reduce inter-polation errors as is shown in Figure 2 for a single set of angles.

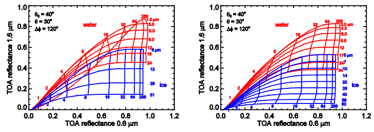

Figure 2: Old CPP LUT (left) versus new CPP LUT for liquid (red) and ice (blue) clouds

3.Cloud Phase

The major change within the new CPP algorithm is the adoption of a new phase determination, following the approach used in PATMOS[2]. This results in the retrieval of new cloud phase types:

Table 2: Changes in cloud phase determination

Old CPP	New CPP
Clear	Clear
Liquid cloud	Fog
	Water
	Supercooled
Ice cloud	Opaque ice
	Cirrus
	Overlap

The evaluation of the cloud phase is generally adopted in plots where the liquid fraction is plotted against CTT[3]. However, if one wants to focus on cloud type phase analysis, the phase products have to be plotted against the same CTT.

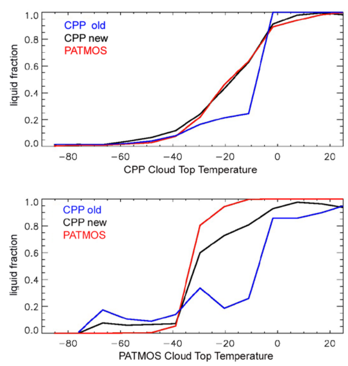

Figure 3: Retrieved liquid fraction with respect to Cloud Top Temperature taken from CPP (top) and PATMOS (bottom).

In Fig3, the liquid fraction distributions are plotted against different CTT distributions, showing that the new CPP results are close to the PATMOS results when using the same CTT.

The evaluation scores of the new CPP have improved significantly with respect to the old CPP code

Table 3: Cloud phase evaluation scores for CALIPSO vs. AVHRR (7374 samples)[3] for CALIPSO cloud phase at τ=0.25. POD: probability of correct detection, HSS: Heidke Skill score.

Evaluation scores	Old CPP	New CPP
POD liquid	0.71	0.88
POD ice	0.69	0.82
HSS	0.34	0.66

4. Microphysical retrievals

The combination of all updates are summarized in the change in effective radius distributions (Fig 4), for a single AVHRR orbit. The changes are much smaller for liquid clouds compared to the ice cloud distributions. This is mostly due to the use of roughened ice spheres for the 3.7 µm channel, in contrast to Hex crystals in the other channels, in the old CPP LUTs.

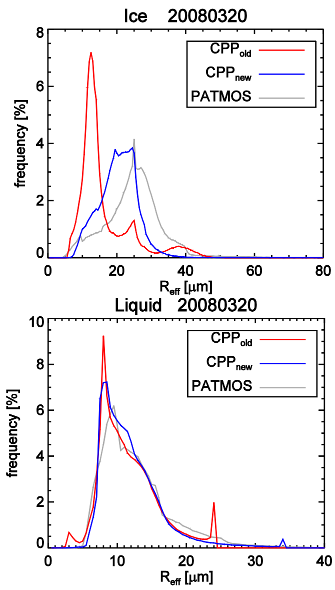

Figure 4: Effective radius distributions for the old and new version of CPP using the 3.7 µm AVHRR channel. The grey line shows the latest PATMOS results for the same orbit.

References

[1] Baum et al. Submitted to *J. Quant. Spectrosc. Radiant. Transfer, Special Issue ELS-XIV, 2014*
[2] Pavolonis et al. , J. Appl. Meteorol., 44, 804-826, 2005
[3] Stengel et al. Remote Sensing of Enviroment, in press, 2013

E-mail: zadelhof@knmi.nl