

## Reply to Anonymous Referee #2

We would like to thank Anonymous Referee #2 for their helpful comments. Below are the original comments in normal with our responses in *italic* text.

### Comments to the author:

This paper describes the EarthCARE MSI cloud mask (M-CM) algorithms, showing algorithm descriptions and validations. Validations has been performed by using, synthetic dataset, versus MODIS, versus SEVIRI. This paper is well organized and reliable. However, some minor improvements will be needed before accepting this paper. Reviewer recommends that this paper to be accepted with some minor modifications.

(1) Line 27.

Could you please mention about how large of uncertainties can be lead. Please add some reference papers?

The answer to that can be rather complex and difficult. *The cloud masking method used here is based on multispectral sorting of data rather than numerical calculation. There is no direct measure on how uncertain the cloud mask retrieval is. But, to get uncertainties, comparison studies and intercomparison studies have been done like eXercise (Skakun et al., 2022, Zekoll et al. 2021). We also take part in the ICWG intercomparison study (Wu et al., Fig 9), which shows a difference in the cloud fraction up to 30% for the SEVIRI disk. Other studies used comparisons with active instruments. For instance, the ASTER cloud mask for optical thin clouds over ocean gives an uncertainty of 2,7% (Mieslinger et al.). What we meant more is that cloud masking is the fundamental step for the following retrievals like cloud or aerosol properties. As the aerosol properties, which rely on the cloud-free pixel. If thin clouds are not detected by the cloud mask. The aerosol optical thickness will increase.*

*We changed: "Small errors in the cloud mask can lead to large uncertainties, misrepresentations and misinterpretations in subsequently derived products. Many different cloud detection techniques have been developed in the past." to*

*"If for instance cloudy areas are misclassified as clear or vice versa this could negatively impact subsequent retrievals of aerosol or cloud optical properties which underlies the importance of an accurate cloud masking algorithm. "*

(2) Line 77.

What is "a histogram-based scene analysis"? Please clarify this point.

*With the histogram-based scene analysis, the Maximum-Likelihood method (M-Ctype) is meant, since this method uses the three-dimensional histogram (Fig 4) of the observations (VIS, SWIR-2 and TIR-2) to determine the cloud type. We update this sentence: "It exploits the*

*full spectral information content of the MSI instrument, and also includes a histogram-based scene analysis” to “It exploits the full spectral information content of the MSI instrument (e.g., the cloud type is determined using three-dimensional histograms of the VIS, SWIR-2 and TIR-2 channels).”*

(3) From Line 111 to 115.

Please unify the symbol that means "phi".

*Done.*

(4) Line 138.

Please define "the sun glint angle" by schematic figure or formulation.

*The formulation has been given on page 5. We now give a reference to the equation. “Ocean pixels affected by sun glint also apply thresholds based on the 0.865  $\mu\text{m}$ -channel, but the thresholds are calculated depending on the sun glint angle (see Eq. 2)”*

(5) Equation (3) and (4)

Why multiply 100?

*Indeed, the 100 was not very meaningful. Thanks for pointing it out to us, this was an old relict in the Algorithm Theoretical Baseline Document (ATBD) of M-CLD from the first code.*

(6) Line 253, and 254.

Please write formulations of the NDVI and the NDSI.

*Equation has been added.*

(7) Line 299.

That does a sentence "The M-CF algorithm yields a cloud fraction of 50%" mean? Please clarify this point (*see Fig.7*).

*We averaged the cloudy pixel from the M-CF product for the Halifax scene and get an average of 50% cloud fraction.*

*We changed the sentence to: “: Using M-CF, a cloud fraction of 50 % is determined for this scene (see Fig.7).”*

(8) Line 329.

I'm confusing. My understanding is that, Fig.8 MODIS cloud flag was generated by using MODIS-Level1b data with use of the M-CLD processor as noted Line around 315. So, spectral channels used in both MODIS cloud flag and MSI cloud flag is the same (is it true?). However, this sentence mentioned that "the MODIS cloud tests are based on much more spectral channels". I imagine that two examinations are mixed in this topic. Please explain more.

*In order to make it clearer, the MSI M-CLD processor used only a subset of the 36 MODIS channels. The seven MSI channels are taken from the comparable MODIS channels. The cloud flag from MODIS is the standard L2 MODIS product, which uses also additional MODIS channels.*

*We changed the phrase to: “We have used the MODIS Terra L1b calibrated radiances (MOD021KM) of seven similar channels to MSI and global forecast data from the Copernicus Atmosphere Monitoring Service (CAMS) as input for the M-CLD processor. For verification of our results, however we use the standard MODIS L2 cloud product which makes use of more spectral channels compared to MSI. “*