**Atmospheric
Chemistry
and Physics
Discussions**

# Interactive comment on "Technical note: a new day- and night-time Meteosat Second Generation Cirrus Detection Algorithm MeCiDA" by W. Krebs et al.

W. Krebs et al.

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Both reviewers made very valuable comments for which we like to thank them! In fact, the main points of both were very similar for which reason we could even use identical replies for some points. In the following, the comments of reviewer 3 are printed in italics:

*About terminology: Cirrus by its very definition relates to optically thin ice clouds. In this paper, the authors often use the term cirrus in conjunction with optically thick ice clouds, and this bothers me a bit ...*

Yes. This point was already raised by the reviewer in his initial quick review and we removed all references to "optically thick cirrus", except in the mentioned figures where

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our text search obviously did not find them. We now changed the axis legend to "optical thickness" (instead of "cirrus cloud optical thickness") and hope that this was the last remainder of "optically thick cirrus" in the manuscript.

*The authors refer to surface emissivity but set it to unity for each channel for their RT simulations. The cirrus signal in the IR bands is typically small (but not so for optically thick ice clouds), so it is very impor tant that surface emissivity be included in their analyses. The surface emissivity varies quite a bit over non-vegetated surfaces, especially at 8.7 microns in comparison with 11 and 12 microns. For example, the emittance at 8.7 microns can drop as low as 0.7 over the Sahara Desert, while the 11-micron emittance remains above 0.9. This will lead to substantial changes in the anticipated brightness temperatures for these channels, as well as their brightness temperature differences (BTDs). Having said this, the dependence on surface emissivity in the MeCiDA tests will be mitigated somewhat by the subtraction of the "clear-sky" BTDs from the measured (cloudy pixel) BTDs as discussed by the authors. As the authors state, however, the clear-sky BTD of the nearby pixel may not be representative of the surface under the cloudy pixel. This issue could be mitigated through the use of ancillary emissivity maps. Fortunately, a full set of global, monthly, high spatial resolution (1 km) IR spectral emissivity maps is available at http://cimss.ssec.wisc.edu/iremis as well as a publication by Seemann et al. that is now in press in the Journal of Applied Meteorology and Climatology. There are also other sources for surface emissivity as this is also a concern for IR hypspectral data analyses, and is the object of concer ted study by the AIRS and IASI teams, for example. I'm not suggesting that this be implemented for this paper, as I'm not sure that it would change anything, but I mention this for future study.*

We changed some sentences in the text following the suggestions of reviewer 1 who also made this point. Many thanks to reviewer 3 for pointing out the availability of the emissivity maps. We added a sentence to the conclusions, to use those as a further improvement.

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*The comparison of the MeCiDA ice cloud detection product with MODIS is a bit unclear to me, and it does not rise to the level of a validation of either product. It is simply a product intercomparison. MODIS does indeed have a 1.38-micron band that is used in the cloud clearing process, but there are some issues to consider with this particular band. First, this band is specifically located in a spectral region that has strong absorption by water vapor. In a moist atmosphere, the signal will attenuate above the surface, so that any scattering object above the attenuation level will contribute to the upwelling radiance. What this means is that this channel, in addition to being particularly sensitive to ice particles, will also be sensitive to the presence of any cloud or aerosol layer above the attenuation level. The 1.38-micron band also picks up mid-tropospheric water clouds as well as dust layers. It generally can be used to detect any scattering object above the attenuation level. While this channel is often referred to as ideal for cirrus detection, it is by no means exclusively sensitive to ice particles. Thus, the use of the MODIS flag for this channel needs to be carefully considered. Secondly, the 1.38-micron channel can see down to the surface in a dry atmosphere as there is little absorption by water vapor. Therefore, there is a potential for snow-covered mountains or low clouds to be observed, depending on the particular meteorological conditions in any given region.*

The reviewer is of course right: A comparison with another satellite sensor is only a product intercomparison but not an independent validation. We chose the MODIS products because they are well-established products from a higher-resolution sensor which has channels specifically for the detection of cirrus clouds and should therefore provide reliable data. Also, MODIS has been compared to independent data (e.g. Mahesh et al., "Passive and active detection of clouds: Comparisons between MODIS and GLAS observations", GRL 31, 2004) for which reason it may serve as an established data source of known quality. In the original manuscript we showed only examples of the comparison to the 'cirrus reflectance flag' from the MOD06 Level 2 collection level 004 datasets. The comparison to monthly means was done against the Cirrus_Fraction_SWIR product of MYD08 M3 Level 3. We added a table showing the

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results of the latter.

*Another aspect of the MODIS-MSG intercomparison is exactly what MODIS product is used - is it solely the 1.38-micron bit in the cloud mask product (MOD35 for the Terra platform or MYD35 for Aqua) or is it the actual MODIS cloud top proper ty product (MOD06/MYD06)? The actual MODIS products used for the intercomparison, as well as the Collection level should be stated. The Collection level refers to the fact that the MODIS project updates the algorithms and calibration about once a year, and then reprocesses the entire data stream accordingly. The current products are at Collection 5.*

At the time of the comparison we got collection 004 data. This is added to the text.

*Perhaps a better way to really understand the strengths of the MeCiDA algorithm is to intercompare the MSG/SEVIRI product with an active sensor such as CALIOP, the depolarization lidar on the CALIPSO platform currently in operation. The CALIOP measurements provide extinction and depolarization information, and would permit an in-depth analysis of the MeCiDA performance.*

Certainly true and a valuable suggestion for further work. As outlined above, we choose MODIS because MODIS is a well-characterized sensor which has been compared to GLAS and other sensors. Of course one could learn a lot by repeating all these comparisons for MeCiDA but for a first step we thought that the comparison with MODIS might be enough.

*page 10938, line 23: how do the authors arrive at a limit in optical thickness of 0.1 for the detection of cirrus with MeCiDA?*

Only by an educated guess and experience. Depending on the viewing geometry, 0.1 might be a reasonable number for the smallest optical thickness to be visible from space (in the sense that 1 is too large and 0.01 is too small). This number is by no means meant as a quantitative detection limit and we phrased the sentence even more

carefully: "with an optical thickness in the order of magnitude 0.1 or more depending on the atmospheric and surface conditions as well as on the viewing geometry".

*page 10939: the authors use a fairly simplistic set of ice cloud scattering and absorption properties, assuming only hexagonal ice columns. Scattering and absorption properties are available for a much expanded set of ice particles, including aggregates, hollow and solid columns, droxtals, 3D bullet rosettes, and plates and have been discussed in the literature. However, the use of more complex ice particle shapes probably will not change the formulation of the MeCiDA approach in a significant way as the focus is on IR channels (where particle shape is less important than with solar channels), but should be tested in future study. A few pertinent references are provided below ...*

We want to thank the reviewer for this suggestion! Actually, there was a small inaccuracy in the manuscript: For the "systematic calculation" (number 1 on page 10939) we used the parameterization by Fu et al. (1998) because that was the only one available for the thermal IR back then. For the "test data set" (number 2 on page 10939) we actually used a parameterization based on the optical properties which we obtained from Ping Yang. The ice crystal habit was also varied randomly and the effect of shape is included in Figure 3, 6, and 9. We changed the text accordingly.

If we were to redo the calculations today, we would certainly prefer to use the parameterization by (Baum et al., "Bulk scattering models for the remote sensing of ice clouds. Part 1: Microphysical data and models", JAM 44, 1885-1895, 2005) which we already included in our model. As the parameterization by Baum et al. is based on the optical properties of Yang et al. we would expect a reduced variability of the data points in our plots, as not all different habits are explicitly considered but only a specific combination of habits.

*page 10947, line 2: what is meant by "background BTD from the neighborhood"? Do the authors mean from nearby clear-sky pixels?*

Yes, rephrased.

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*page 10947, lines 9 through 14: With the IR8.7 and IR10.8 BTD, the ice cloud test threshold is set to 0K, but this test could fail if the pixel falls over a snow-covered surface (e.g., over mountains). The BTD for snow (rather large ice particles) can be above 0K with this BTD.*

We did not see major problems with this test, perhaps because SEVIRI is a geostationary satellite, which limits the amount of snow covered surfaces.

*page 10952, line 3: the authors mention the MODIS Level 3 products, but the thing to keep in mind for these cloud products is that they are based on many different algorithms - not the 1.38-micron test previously discussed. This paragraph caused some confusion on my part.*

We added the 'official?' name of the product: Cirrus_Fraction_SWIR of the MYD08 M3 Level 3 collection 004 dataset.

*page 10952, line 6: do the authors mean larger solar zenith angles, or smaller solar zenith angles? Seems to me that the use of solar channels is most useful when the sun is closer to overhead than when it is on the horizon (which would indicate smaller solar zenith angles).*

Sorry, this was a mistake. Of course we meant smaller solar zenith angles or larger sun elevations.

Thanks also for the numerous suggestions for smaller changes which we all considered but did not list here!

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 10933, 2007.

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