Atmos. Chem. Phys. Discuss., 7, S4959–S4964, 2007
www.atmos-chem-phys-discuss.net/7/S4959/2007/

Atmospheric Chemistry and Physics Discussions

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7, S4959–S4964, 2007

Interactive Comment

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

Anonymous Referee #3

Received and published: 14 September 2007

This paper discusses a methodology to discriminate ice clouds in Meteosat Second Generation (MSG) SEVIRI imager data, with a focus on optically thin ice clouds, based on the use of six infrared (IR) narrowband channels. The strength of this article lies in the approach of first assessing the anticipated utility of the various channels for cloud screening through rigorous radiative transfer (RT) analyses, and then subsequent testing on SEVIRI data. The discussion of the thermal band simulations and ice cloud discrimination tests is well written and clear. Towards the end of the paper, an effort is made to intercompare MODIS cloud products with those from MSG/SEVIRI, but what is learned from this effort is less clear. Further comments are given below that the authors might consider in revising this article. All in all, this is an interesting article and

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Interactive Discussion

Discussion Paper

is well written in general.

Specific comments:

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. Perhaps the authors could refer to optically thick ice clouds as just that, rather than using the term "optically thick cirrus" To some groups, like the active lidar community, optically thick cirrus has an optical thickness of about 1 or 2, whereas in this paper it can refer to opaque clouds having much higher values. This may seem a small point but it is a distinction that has been made many times in other papers, and by other communities. It is very unusual for a community to use the term "cirrus" to describe an ice cloud with an optical thickness of 5 or greater, as is done in Figures 1,3,4,5,6,7,8, and 9.

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 important 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 Meteorol-

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ogy 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 concerted 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.

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.

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 property 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.

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.

Technical Corrections:

Abstract, line 15: suggest the word "frequency" instead of "efficiency"

Abstract, line 19: suggest changing ’allows to derive’ to ’permits the derivation of’

page 10935, line 1: suggest deleting the words ’up to’

page 10935, line 16: suggest changing ’On the other side’ with ’However,’

page 10936, line 2: suggest changing the word patchy to limited

page 10938, line 9: change ’are currently’ to ’is currently’

page 10938, line 20: change ’equivalent’ to ’equivalently’

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?

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:

Baum, B. A., P. Yang, A. J. Heidinger, A. J. Heymsfield, J. Li, and S. L. Nasiri, 2007: Bulk scattering properties for ice clouds. Part 3. High resolution spectral models from 100 to 3250 cm-1. J. Appl. Meteor. Clim., 46, 423–434.

Yang, P., H. Wei, H. L Huang, B. A. Baum, Y. X. Hu, M. I. Mishchenko, and Q. Fu, 2005: Scattering and absorption property database of various nonspherical ice particles in the infrared and far-infrared spectral region. Appl. Opt., 44, 5512-5523.

page 10940, lines 7-11: as discussed previously, the effect of surface emissivity should be further studied, especially over non-vegetated surfaces, and surface emissivity maps are available for this purpose.

page 10944, line 7: change und to and

page 10944 on lines 8 and 23: the grammar is unclear - the authors put 'e.g.' into the sentence rather than spelling out 'for example', and the sentence structure becomes awkward

page 10945, line 9: suggest changing 'of background' to 'of the background'

page 10945, line 26: again the authors put 'e.g.' into the sentence - awkward structure.

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

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.

page 10949, line 13: change 'to reach' to 'from reaching'

page 10952, line 3: the authors mention the MODIS Level 3 products, but the thing

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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.

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).

page 10952, line 18: change ’for a near’ to ’for near’

page 10953, line 1: perhaps change ’allows to investigate’ to ’facilitates the investigation’

Mispellings in figure captions should be corrected as follows:

Figs. 3, 6, and 9: "treshold" should be "threshold"

Figs. 6 and 9: "fore" should be "for"

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