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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Simultaneous retrieval of water vapour and temperature profiles and cirrus clouds properties from measurements of far infrared spectral radiance over the Antarctic Plateau" *by* Gianluca Di Natale et al.

Anonymous Referee #2

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This manuscript describes temperature, water vapor, ice cloud effective radius and optical thickness retrievals from surface-based, uplooking spectral infrared observations in Antarctica. These observations have been made for several years and are collocated with a depolarization lidar which is very useful for determining cloud base, cloud top in the case of thin ice clouds, and cloud phase (liquid, ice, mixed, etc.). The most unique aspect of these observations is the detailed spectral coverage of the far-infrared region (250-650 cmˆ-1) in addition to a portion of the mid-infrared (650-1000 cmˆ-1). An optimal estimation framework is described in great detail and is then used to obtain the retrievals of thermodynamic profiles and ice cloud properties with error estimates.

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Discussion paper

Some examples of retrievals are shown and a longer record of retrievals is used to develop a parameterization of optical thickness as a function of cloud top temperature and effective diameter as a function of ice water content, which are compared to published parameterizations.

The authors present a unique data sub-set of a continuous observing record for some years in a very challenging part of Earth's atmosphere. For this reason alone the paper is worth publishing and very valuable. However, the paper is very poorly written in terms of grammar and spelling throughout the manuscript (which needs a major copyediting overhaul), and is poorly organized and too brief in the results and conclusions sections. While a fairly thorough job of explaining the retrieval methodology was included, the authors did a poor job explaining the results and placing them into broader context. A few of the figures need to be improved to be useful. Some of the details regarding the vertical levels chosen for temperature and water vapor are unclear. The spectral regions used in the retrieval are not made clear. The reference list is incomplete and should include some papers related to infrared cloud remote sensing in Antarctica in addition to those already referenced. All of these problems are fixable with some significant revisions, however. Detailed comments follow.

Title: This should be the most carefully worded part of the paper and it isn't grammatically correct. How about the following: Simultaneous retrieval of water vapor, temperature, and cirrus cloud properties from measurements of far-infrared spectral radiance over the Antarctic plateau

Comments on the subject of the title: technically, this paper isn't about retrievals only from the far-infrared. The mid-infrared channels were used too since they are shown in Figure 7 with modeled and observed spectral fits shown for the entire 250-1000 cmˆ-1 region. Which matters more? The mid-infrared or the far-infrared? The authors may want to consider showing what might happen if one spectral region was used without the other, and vice-versa, if that is not a significant level of effort. This way the authors can really show without a doubt that the far-infrared is really valuable for the ice cloud

properties, especially the effective diameter, as argued in the Introduction section.

Abstract: poorly written although the content appears appropriate. However, lines 16-17 are not clear. What does 'disturbed' mean? That the atmospheric state as retrieved has a bias in the presence of clouds, or that temperature and water vapor geophysical variability aren't correlated to cloud presence? Certainly the latter can't be right.

Introduction:

Some additional papers of relevance should be included:

Bromwich, D. H., et al. (2012), Tropospheric clouds in Antarctica, Rev. Geophys., 50, RG1004, doi:10.1029/2011RG000363.

This paper contains many relevant papers to infrared remote sensing of clouds in Antarctica that are not cited.

For global ice cloud climatology:

Wylie, D. P. and Menzel, W. P.: Eight years of high cloud statistics using HIRS, J. Climate, 12, 170–184, 1999.

Line 2: cirrus clouds do not permanently cover 30% of the same part of Earth. They cover 30-ish percent of the Earth at any given time. But there are big differences depending on the platform (ISCCP, HIRS, AIRS, IASI, MODIS, AVHRR, etc.). The Baran references aren't the right ones for cloud climatology percentages.

Line 9: I believe this is 'Lynch'

Lines 14-15: what are the different components of which system?

Line 16: these are high spectral resolution measurements, not broadband

Lines 31-32: they aren't so much 'unpredictable' as 'highly variable' for a given temperature range

Lines 33-35: need to connect better that you are using the delta-Eddington approach

because it is appropriate for single layer clouds

Lines 4-5: more description of the radiosondes is needed. How many times per day? At the same times or different times? What types of sondes?

line 9: choose, not choice

Section 2:

line 24: parameterise

Section 3:

Lines 2-3: how can these two parameters completely describe clouds? What about cloud temperature (single layer), habit distribution, temperature and water vapor profiles, etc.?

Line 19: why use 'U" for water vapor? Its pretty standard to use 'q' or 'Q'

Section 3.1:

Line 8: why 3-sigma? Should also make clear that the climatology was constructed from actual radiosondes – this is not entirely clear. Also, is it a climatology for only those cases simulated, e.g., for the radiosondes launched closest to the times of the attempted retrievals?

Section 4:

Lines 19-20: with regard to why T and U are retrieved, it isn't necessarily for getting an accurate set of T and U profiles, but rather so that the retrieval can obtain better estimates of cloud properties. Is this a correct supposition to make? Next, given that there are only two or three levels (U and T respectively) based on the singular value approach in the previous section, how can one conclude that the profiles are in 'very good' agreement with the sondes? They are off by large amounts at some levels. Also, if one looks at Figure 8, you can see that the T and U retrievals (red curves)

are more than simply two or three levels. Each level has some ‘curvature’ or ‘shape’ to them. That is not consistent with a two or three level retrieval, which should have (presumably) linear segments within each level unless there is some other assumption made or something is not explained well in the paper.

Line 24: ambient air

Line 26: varies

Lines 27 and 28: the fact that larger Des are obtained in summer is consistent with downlooking Atmospheric Infrared Sounder retrievals. See the following papers:

Lubin, D., et al. (2015), Variability in AIRS-retrieved cloud amount and thermodynamic phase over west versus east Antarctica influenced by the SAM, Geophys. Res. Lett., 42, doi:10.1002/2014GL062285. âĂĺ

Kahn, B. H., et al. (2014), The Atmospheric Infrared Sounder Version 6 cloud products, Atmos. Chem. Phys., 14, 399–426. Specifically, Figure 13 shows the big seasonal variations.

p. 10, lines 11-12: a strong correlation is suggested but no correlations coefficient is shown (unless I missed it somewhere)

Figure 2: the seasons should be labeled on the individual panels

Figure 7: label seasons on the individual panels so that they match better with Figure 2. There is little obvious difference between the four panels. What about taking the four observed spectra and making an additional plot (or panel) in which they are overlaid with the radiance on a log scale so that the spectral shapes and differences become more apparent? All Figure 7 does is to show that the simulations fit the observations quite well, which is nice to know. However, it would be also nice to see what the spectral variations due to cloud properties look like and perhaps if they are shown against each other in some stretched scale that could be seen.

Figure 9: the y-axes are too constrained. Stretch it out so that the variability can be better seen. Also, is each dot an error bar for an individual single cloud layer case? Or is it from a set of spectra over some extended single layered ice cloud that lasted for some time? Or do these include more complicated ice clouds? Is the error estimate from a single retrieval or is it from several single layer ice clouds combined together? Additional detail on what data was used to make this figure is warranted.

Figure 10: Same problem as figure 9 except that the range could be narrowed for both optical thickness and De.

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