Atmos. Chem. Phys. Discuss., 10, C814–C818, 2010
www.atmos-chem-phys-discuss.net/10/C814/2010/

Atmospheric Chemistry and Physics Discussions

ACPD
10, C814–C818, 2010

Interactive Comment

Interactive comment on "A climatological perspective of deep convection penetrating the TTL during the Indian summer monsoon from the AVHRR and MODIS instruments" *by* A. Devasthale and S. Fueglistaler

A. Devasthale and S. Fueglistaler

abhay.devasthale@smhi.se

Received and published: 22 March 2010

Reply to Referee #1

We are very thankful to the referee for her/his careful review and thoughtful suggestions which lead to improvements in the clarity of our manuscript.

The point by point reply to the referee's suggestions is given below.

"horizontal versus vertical resolution of the used data" Here, the authors avoid some clear statements like "there is no vertical resolution in the nadir data of the AVHRR instrument" (The 4 km spatial resolution mentioned in the paper is the horizontal resolution of the instrument, I guess). Thus the brightness temperature used in this paper has no vertical information and, consequently, different instruments, like AIRS, with vertical profiles of temperature have to be used. Here, some more detailed information on the vertical resolution of AIRS (and on the quality of the AIRS retrieval) is necessary. Same for MODIS.

- The referee's remarks are duly noted. The AVHRR, being an imager, essentially provides 2D information, and there is no vertical information available. This is one of the reasons AIRS profiles are used for the analysis. For the conversion from brightness temperatures to vertical position (in pressure/pot. temperature space), we use standard methods; the revised manuscript will describe these in more detail (see also next answer).

"proxy how to estimate the altitude of convection from the observed brightness temperature". Here, the used procedure is not sufficiently well explained. I guess (and because I am not an expert, I am not sure) that the used procedure works in the following way: The brightness temperature measured by AVHRR has no vertical information, so the assumption is used that "if the observed brightness temperature is smaller than the mean clear sky temperature at a given pressure-level, then convection may reached this level". The mean temperature profiles are obtained from the AIRS observations. In this way, a proxy for the altitude of convection can be derived and, of course, there are some shortcoming of this procedure (which are partially described in section 2). I missed some clear sentences describing the method which should be included into the revised version.

- The referee's interpretation of our method is correct. Since we do not have direct and accurate measurements of cloud top pressure from AVHRR, we used monthly mean clear-sky temperatures from AIRS at 200hPa, 150hPa and 100hPa levels. Please note that the AIRS instrument provides very accurate retrievals of temperatures during the study period at above mentioned pressure levels. If the AVHRR channel 4 brightness

ACPD

10, C814–C818, 2010

temperature (which is also rigorously validated in previous studies) is less than the corresponding temperature from AIRS, we assume that convection may have reached that particular pressure level. We have revised Section 2 accordingly to describe the methodology in a more detailed manner.

Minor comments: Fig.1 Maybe you should mark also the "North western India/southeastern Pakistan" region in the figure. In Fig. 5 (the most important figure of the paper) you describe this region as an important source region of convection.

- Fig. 1 is changed and the North western India/southeastern Pakistan region is marked over it.

section 2.2, par 2 Please explain "NOAA-N" and "afternoon polar orbiting platform"

- NOAA-N is a generic name used here for all NOAA satellites launched to date (e.g. NOAA-6 to NOAA-14 and then new NOAA-15, -16, -17, -18, and -19 satellite series). For the present study, we have used data from some of these sun-synchronous polar orbiting satellites that have equator crossing times in the afternoon (about 1:30 – 2:30). For example, to study the role of active and break periods, we have used data from NOAA-7, -9, -11, -14 and -16 (or NOAA-L) satellites. This is now written clearly in the revised manuscript.

section 2.3, last par Even if the figure 2 (bottom panel) is very instructive, I have some doubts with the interpretation you give. If the (deep) convection reaches the LZRH level over India, i.e. 360 K, the high level anticyclone would transport these air masses, approximately isentropic, northwards, and "press" these air masses below the LZRH, i.e. back into the troposphere. Thus to transport these air masses into the stratosphere, either convection has to reach higher pot. temperature levels or other physical processes like radiation (within the clouds) or vertical mixing are necessary. Please discuss these points.

- The manuscript is arguably a bit short on these aspects, but it essentially provides

ACPD

10, C814–C818, 2010

Interactive Comment

exactly the discussion referee has mentioned (please see page 2815, lines 1-14). Because this paper really focuses on presentation, analysis and interpretation of measurements, we prefer to defer full analysis of the problem from a model point of view (which would allow answering the type of question referee has mentioned - though with the caveat that results are subject to biases in the model, which in turn would require a longer discussion) to a publication of its own.

section 3.3, 2nd par Please replace "mean temperature of" by "mean temperature at"

- Corrected.

Fig. 3 What is the cloud fraction that corresponds to the red colors (0.3 or 10). Please add this mark at the color bar.

- Corrected.

Fig 6-9 Maybe you cane remove one of these figures?

- Each of these figures contributes to a different aspect. For example, Fig. 6 provides an overview of clouds in a joint histogram of pressure and optical thickness, but without the spatial context. The figures 8 and 9 take into account the latitudinal distribution of clouds, but only for two cases a) when all clouds are included in the analysis, and b) when only those clouds with optical thickness larger than 23 are analysed. Fig. 7 is crucial as it provides convective cloud amount penetrated deep into the TTL (and required for comparison with AVHRR for consistency check). Distilling all this information in fewer plots is not really possible, and the information is required to provide from a measurement point of view as complete description of the problem as possible. Hence, we would prefer not to remove these figures.

Fig 10 Legend: Instead of temperature, the corresponding pressure level would be a more desired information.

- Indeed, expressing plots in Fig. 10 in terms of pressure level rather than temperature would be quite interesting as one can then directly relate cloud amount to height. How-

ACPD
10, C814–C818, 2010

ever, in such case, we would also need optical depth information to capture only thick opaque ice clouds. Unfortunately, we do not have these retrievals from METEOSAT-5. Optical depth information is only available for the daytime part, thus providing the description of only daytime part of the diurnal cycle. Hence, in order to describe the full diurnal cycle (which is the objective here), we must use brightness temperature only. It is very likely that cloud with top temperature less than 210K are deep convective cores compared to those with top temperatures less than 230K, which may additionally contain thick anvil cirrus. The contribution from thin cirrus can easily be ruled out as they will have much higher brightness temperatures.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 2809, 2010.