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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Determination and significance of upper-tropospheric humidity" *by* Klaus Gierens and Kostas Eleftheratos

Anonymous Referee #1

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General Comments:

This paper updates an upper tropospheric humidity (UTH) retrieval method introduced by Soden and Bretherton (1993) using the GOES infrared imager channel and was later extended to the HIRS 6.7 micron water vapor channel on NOAA polar orbiting satellites. The purpose for the update was to better mitigate a known bias known to exist in the HIRS UTH retrieval due to a shift in central frequencies between the HIRS/2 and HIRS/3 instruments. The introduction of a second order term in the retrieval formulation is shown to significantly reduce the bias between these instruments especially for retrievals conducted using relatively cold brightness temperatures. The updated retrieval is applied to the NOAA HIRS observations over a 35 time period and it is found that UTHi has a positive trend over that period.

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Discussion paper

The mathematical description describing the updated retrieval is described well and the addition of the 2nd order term to the linearized equation is shown to provide an improvement to the retrieval formulation. However, there are sections where the text should be made more concise and my suggestions are given in the minor corrections section. I feel the topic of this paper meets the requirements of the ACP journal in that the retrieval is has global extent, it describes a physical process of the troposphere, and it uses a remote sensing technique to identify a gas (water vapor) in the troposphere.

One issue I have is that the title of the paper needs to be more specific. I think the title should indicate that this is an update to an existing HIRS UTH retrieval which only involves retrievals of infrared observations.

I also have concerns that there is no description on the cloud clearing technique used to derive the UTH data in this paper. Cloud contaminated observations will generally reduce brightness temperature and which will likely cause a positive UTH bias in the retrieval should they be introduced. The positive trend in UTH shown in this paper should be clearly identified as a trend derived from clear-sky observations. Furthermore, cloud contaminated satellite observations could contribute to that trend depending on how stable the cloud-cleared technique is for these observations are over the data record.

I also think the positive trend in UTH shown in figure 9 and discussed in item 4 in the conclusions needs to include another caveat to the discussion. That issue is the possible effects of diurnal bias from HIRS observations on the trend in the time series. Diurnal bias is an issue with most NOAA polar orbiting satellites since observation times drift through the diurnal cycle.

Minor Corrections and Comments:

I suggest changing all references to HIRS2, HIRS3, and HIRS4 to the more commonly used acronyms of HIRS/2, HIRS/3, and HIRS/4.

Satellite names interchange between the NOAA-14 and N14 format throughout the paper. I suggest only using one name type.

Page 2, Line 1: I suggest changing ". . . and study with a view to determining . . ." to ". . . and study for determining ..."

Page 2,Line 11: Polar-orbiting satellite sensors only have this advantage.

Page 2, Lines 11-13: I suggest a more concise sentence – "For climate variability studies it is important to understand the continuity of long term measurements in both the stratosphere and upper troposphere".

Page 2, Line 17: The first HIRS/2 instrument was on TIROS-N which was the satellite before NOAA-6.

Page 2 Line 22: Replace "an unwanted" with "a".

Page 2, Line 24: Replace "solved" with "corrected"

Page 3, Line 22: I suggest changing "we look in this study further into the retrieval formula" to "we further studied the retrieval formula"

Page 5, line 8: I suggest changing "is fraught with relative errors" with "has relative errors"

Page 8, line 13: I suggest changing "The table" to "Table 1"

Page 9, Line 2: I suggest changing "this problem does no longer occur when" to "this problem no longer occurs when"

Page 9, line 8: I suggest changing "there is not anymore a considerable derivation" to "there is little deviation"

Page 10, line 1: I suggest changing "mild" to "small"

Page 10, line 4: I suggest changing "instead of the here used non-intercalibrated" to "instead of using non-intercalibrated"

Page 10, line 11: The statement in parenthesis should be omitted unless more specific detail is provided on what interesting but useless results means.

Page 10, line 24: suggest changing “more high UTHi and less low values” with “higher UTHi and fewer low values”

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