

## ***Interactive comment on “Climatology of free tropospheric humidity: extension into the SEVIRI era, evaluation and exemplary analysis” by M. Schröder et al.***

**Anonymous Referee #2**

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### General comments

In this study a long time series of satellite retrieved relative humidity, obtained based on METEOSAT observations in the free troposphere, is presented. Water vapour is the most effective greenhouse gas and is very important for the Earth's water cycle. In addition, water vapour has probably an increasing role due to the global warming and a positive feedback loop. Thus, it is important to establish a long data record to be able to investigate these issues and therefore the present study is important. So this study is relevant for ACP, however, the current version needs to be improved and a major revision is recommended.

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### Major comments

In the beginning of the introduction a motivation for the present study is presented, thus, stating the important role of water vapour in the Earth's energy balance and for the water cycle. In the present study, merely the relative humidity has been analyzed. It is not obvious how the present results of changes in relative humidity can be linked to this important greenhouse gas. A change in RH due to the global warming could be due to either a change in water vapour or temperature, depending on the region of interest. In the manuscript, at many places, it is not clear that it is actually purely RH that has been investigated here (e.g. the title of the manuscript).

The language is sometimes somewhat confusing and needs to be improved, language is more clear in some chapters and less clear in others. Some suggestions are presented in "Specific comments" below, however, the full text needs an English proof-check.

### Minor comments

1. Page 9614, paragraph 2 of Section 4. I wonder how accurate it is to use ERA re-analysis data here for the cloud screening, due to the poor horizontal resolution and uncertainties in estimated cloud fraction. Since at least the SEVIRI performs observations at visible wave lengths these data could be used for cloud screening.
2. I do not understand equation (1). It seems that the data before and after the break should be corrected with the same factor, but then the factor "a\_before/a\_after" is applied only on "b\_after". Is it that the latter factor should be removed?
3. The treatment of the abbreviations is confusing. Since so many have been introduced please include a list, so it is easier for the readers to find what they stand for. Even so, if a non-"important" abbreviation is used only a few times after it has been introduced, e.g. ML and PL, it is not necessary to introduce it at all. If an abbreviation has been introduced use it consequently, e.g. "RH" instead of "relative humidity", in the remaining text. Define an abbreviation at the first place where it has been introduced,

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e.g. FTH and BT in the introduction, as well in the abstract. Note that the abstract is separated from the main text. Suggestion: the "FTH" should be "FTRH", but probably better with "RHFT". The latter abbreviation: "RH" should be in normal size and "FT" in subscript (also below).

4. A description of statistics used need to be included. For example, results of absolute and relative bias are obtained of the data analyzed. It is not clear how it is calculated, particularly the relative values.

5. End of page 9613, What is meant by "samples of the seasonal cycle with the 1st day of the months....." How representative is the obtained seasonal cycle based on a single day of the month?

6. page 9618, lines 17 and 18, How does differences in absolute BTs minimize cloud contamination?

7. Page 9612, lines 4 – 7, The two last temperature values, 4.5 and 0.8 K, seem not agree with the results in the figure.

8. Page 9616, lines 3 and 4, Not completely convincing concerning the outliers. "Such outliers" could be marked in the figures.

9. Section 6.3. Figure 6a present relative bias with negative values. Please give the expression used to calculate the relative bias. Line 9, What is meant by "The temporal correlation" ? If it is "R" then write "No correlation ( $R = -0.01$ ) is found between N and relative bias." Line 19, Should it be "relative RMSD" ? Check the full manuscript. Suggestion: introduce "NRMSD (Normalized root mean square deviation)" beside "RMSD". Line 24. The unit "%RH" is confusing and since the word "absolute" is used it is actually clear what is meant. Suggestion: "The time series averages of absolute bias ("better with" differences ?) and RMSD (Fig.6, third panel) for the RHFT are -1.2% and 5.0%, respectively."

Lines 16 and 27, What is meant by "normalisation" ?, not explained in the text. Lines

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26 and 27, The explanation sounds realistic, but the increase in FTH is it real or bias? Maybe an explanation for what "normalisation" stands for will help me here.

10. Page 9625 and line 15, Could it be worth to investigate 1 month instead of 3 months period? For this, one particularly month could be chosen in a test.

#### Specific comments

Page 9604 Line 1, Suggestion: "A new free tropospheric relative humidity (RHFT) data. . ." Line 2, "with" instead of "of" Line 6, "data record covers the period 1983-2009, with a. . ." Lines 12 and 13, "Under the given assumptions constant. . . . . theory it means. . . . .". Line 19, "The RHFT product is compared to computed relative humidity, obtained based on Analysed. . . ." Lines 21-22, Suggestion "and normalized root mean square deviation (NRMSD). . . .are obtained. The NRMSD confirms.....". Introducing NRMSD will help when it is presented in the figures. e.g. Figure 1. Otherwise you have to write "relative NRMSD" in the figure. Line 26, Suggestion: "RH10FT". The latter abbreviation: "RH10" is in normal size and "FT" in subscript .

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Line 8, Is it ok to write "Sects." instead of "Sections"? Lines 15-18, Only radiance data are presented in this section. This part may be integrated into the last paragraph of Section 1, or has to be rephrased in some way. Lines 20-21, "Meteosat-7, which belong to the first generation of Meteosat satellites." Line 21, Remove the second "orbit" Line 26, "channels that cover the" Lines 27-, "on board the geostationary satellites Meteosat-8 and Meteosat-7, which are positioned . . ."

Page 9610 Line 1, I do not understand why "while in operational mode" is written here. Line 2, "present day." Lines 4 and 5, "at length" ? Line 6, "Meteosat-2 - Meteosat-5". Suggestion: "Meteosat2 - Meteosat5", and then at all other places in the text. Note that "Meteosat" is in normal size and "2" and "5" could be in subscript Line 7, "Cloud" Line 8, "DX level"? Rephrase the content in the paragraph. Line 13, "ISCCP-DX" ?

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Line 14, "in sensor resolution"? Lines 18 – 20, A R2 value should be presented, and a suggestion: move "(not shown)" after "excellent linear behavior". Scatter plots of what? Line 24, "...homogeneous and exhibits..." Line 26, "The work by Picon"

Page 9611 Line 1, Write out "ECMWF" Line 3, "Meteosat-5-like" ?

Page 9612 Lines 4-5, "The difference in BT for January....." Line 8: "possible" instead of "potential" Line 12, "The magnitude of the observing period" ? Change to "are different, but"

Page 9613 Line 9, ".....BT at the 6.3 Åm to the mean RH (defined with respect to water only)...." Lines 10 and 11, "Equation (2) also correct for the satellite viewing angle ...." Line 12, "and" instead of "to" ? Line 16, Remove "(ML)" Line 17, Remove "(PL)" Line 20, Change "ML" to "model levels" Line 22, "sampling the field of view" ? Line 25, "of clear sky profiles" ? Lines 24-, ".....covering the seasonal cycle with the 1st day (4 time steps per day) of the months January, April, July and October corresponding to the years 2001, 2006 and 2007."

Page 9614 Line 1, "The clear sky profiles Line 11, "due to problem with cloud detection." Line 13, "700 hPa, since" Line 17, "RH, for which the weights" Line 27, Remove "the"

Page 9615 Line 1, "highlights" Line 14, What is meant with "straightforward" ? Line 18, either "period March 1997 – May 1998" or "period from March 1997 to May 1998" Line 19, Confusing. By introducing instead NRMSD (see above) beside RMSD for RHFT, and writing absolute and relative difference for RHFT this will be clear what is meant (see also the comment to Figure 6 below). Line 21, "...series of seasonal...." Lines 20-24, "Figure 3 shows examples of instantaneous and monthly average products. Strong minima in FTH over northern and southern Africa as well strong maxima in FTH at the Inter Tropical Convergence Zone (ITCZ) are evident during the boreal summer. Furthermore, Figure 4 illustrates the seasonal averages in FTH. The figure shows that the location, extent and strength of the humidified and dry areas highly depend on season."

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Page 9616 Line 1, "large" instead of "strong" Line 11, "difference, while" Lines 11 and 12, what is meant by "varies along the design of the algorithm." Line 12, "representativeness" ?, should it be "sampling uncertainty"? Lines 21 and 22, "tropical training a RMSD of 2% .....and an average absolute difference of 0.3% were estimated. Line 23, "20% yield a 10% relative"" ? Line 24, "uncertainty in the estimation of mean FTH is" Line 25, Remove "so" ?

Page 9617 Line 14, "with as much as" ? Line 17, "...2009), showing." Lines 21-23, "...Meteosat-5 observations the Radiative Transfer for the TIROS Operational Vertical Sounder (RTTOV) 9.3 model has been applied to ARSA (Matricardi et al., 2004). The RTTOV uses....."

Page 9618 Lines 4 and 5, "...as the calibration uncertainty of ~2K (e.g. Stephens....." Line 6, "(2003), which is.....user guide, the uncertainty" Line 12, "are considered in the comparison" Line 13, "applied for the validation:" Line 14, It is not clear what is meant with "remaining". Suggestion: "night time only to avoid possible problem with radiosonde quality...." Line 21, Suggestion: "contains radiosonde measurements from ships..." otherwise "...contains measurements from radiosondes launched on ships and at small islands..." Lines 23-27, Not clear written, rephrase.

Page 9619, "are -3.2%, 16.8% and 170, respectively."

Page 9621 Line 3, "PDF" ? Line 10, "more than 70%", Is this the cases really for the months September-May? Line 24, "for each season" Line 21 and 22, This sentence is confusing.

Page 9622 Line 28, R of +/-0.15 is not much of correlations. Suggestion: "of only around"

Page 9624 Lines 1 and 2, "We tested two different methods for the analysis of linear trends: median of pair wise slopes regression (named "Theil-Sen slope estimator", Theil, 1950) and linear regression." Line 11, remove "only" ? otherwise rewrite the

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sentence.

Figure 2, What is "RMS" and "RS" ? The first sentence is hard to understand, particularly when "and the "observed" FTH." at the end is included.

Figures 3-5, Suggestion: "RHFT (%)" as y-label. Change to "considered periods" (Fig.4).

Figure 5. "Time series of regional RHFT averages"

Figure 6. Increase the size of the figures and fonts. The name of the three y-ables used in Figures 6a - 6c are not coherent. Suggestion: Fig. 6a "Relative diff. (%)", Fig. 6b "NRMSD (%)", Fig. 6c "Absolute diff. & RMSD (%)" and then explain in figure caption what the labels stand for.

Figure 8, "Relative standard deviation in FTH and FTHp10 for each season (top four panels and bottom four panels, respectively) of the period 1984–2009."

Figure 9, "Difference in decadal averages of FTHp10 between the periods 1990–1999 and 2000–2009."

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