

Review report

Total column water vapour measurements from GOME-2 MetOp-A and MetOp-B, Grossi et al.

2 June 2014

### **General :**

The manuscript describes the improved GDP v4.7 operational retrieval algorithm for total water vapour columns derived from GOME2. It also compares -for the 8 month overlap period- the H<sub>2</sub>O total columns measured by GOME2 on Metop-A and Metop-B. In addition, GOME-2A H<sub>2</sub>O total columns are validated/compared with ECMWF ERA interim data, SSMIS, and a new combined SSM/I-MERIS H<sub>2</sub>O total column product.

In general the topic is well suited for AMT. However, the manuscript needs some serious improvements to improve the readability. This relates both to the English used as to better/more accurate descriptions/explanations and argumentations of statements made. I have listed below what was not clear to me and/or needs improvement.

Also it is not clear to me why the GOME2 satellite products are not also validated with ground based measurements as a starting point. Are the satellite data used (SSMIS, SSM/I, MERIS) more accurate ? But to what extent have these been validated ? It is clear that on a global scale comparisons/validation is only possible with other satellite measurements. But one would expect to first start with validation with more accurate ground based data (e.g. radiosondes, FTIR,...) and then extent to comparisons on the global scale. Please explain.

### **Detailed comments :**

Abstract l5,l16,l23 not clear to me why one comparison is called a comparison and the other is called validation. Is there a clear difference ?

Section 1 (introduction) It is not clear to me if earlier versions of the GOME2 H2O total column product have been validated before and what the outcome of those validations was ?

p.3027,14 ENVISAT was not launched in 1995

p.3031, 13-20. It is not 100% clear to me on which parameters the LUT for correction factor depends. I assume also cloud fraction (I13) but it is not mentioned where that information is taken from.

p. 3035,14 please provide precise information on which ground pixel(s) is(are) used as a reference, and explain why this observation is used as reference to normalize. How can we be sure the H2O column is more accurate for that viewing angle ?

Is it not possible to use the comparison with ECMWF, SSMIS, SSM/I or MERIS to determine which of the ground pixels is best use to base the SAD correction/normalisation on ?

p.3035, 11-2 I don't think I understand '(we require ...). In this way we avoid .... H2O columns.'

p.3035 It would be interesting to see the spread on the datapoints in figure 1 to give an impression of how well this SAD 'correction' can be determined. Please also provide some information on what you think is the accuracy of the correction and why.

p.3035 do I understand correctly that the SAD correction is also depending on the month in the year ? Please state clearly on which parameters (latitude, month, pixel across swath, land or sea, ...) the SAD correction depends on.

p.3034 do I understand correctly that 6 years of GOME2A data is used to derive the correction that is then also applied to GOME2B ? Please add in caption figure 1 that this is GOME2A data.

p. 3036, 18 what is the 'operational offline water vapour product' ?

p. 3037, 119 does it make sense to add a stdv to the mean bias ?

p. 3038, 17 what is asymmetric cloud screening ?

p.3038 it should also be clearly stated somewhere after the SAD correction is explained that in principle always SAD corrected data is used unless otherwise stated (or is this not the case ?)

p. 3038, l9 is this for individual collocated observations ? or how is this done ?

Fig. 4 it would be useful to also include the spread (1 sigma) on the monthly averages

p. 3038, l21 is there a way to get access to Hovila et al. ? I tried to look up what was stated here, but did not manage to find the document.

What is the stdv on the mean difference and to what extent does that influence the statement on 'can be used for scientific purposes', or is that not relevant ?

p. 3038, l25 again, how is this done ? is first the monthly mean determined per grid cell for GOME2A and GOME2B separately and then the differences taken per grid cell ? Or are first only individual collocated datapoints per grid cell taken and then the monthly mean determined, and then the differences per grid cell plotted ?

Fig. 6 From the plots it looks like the red points indicate lower H<sub>2</sub>O VCD than the green points. According to the figure caption the red points are the GOME2B values, so then the difference plot would be mostly negative. So I get the impression the red and green is interchanged.

Fig. 6 also here stdv/spread on points would be appreciated. You can make light grey or something so we don't miss the main message.

p. 3039, l14-15,  
largest deviations → largest absolute deviations  
low latitudes ( $\pm 10^\circ$ ) → near the equator (10S-10N) (?)

p.3040, l3 ECMWF is not only modeled data, please rephrase. Also, I think ECMWF uses radiosonde data which is possibly also used by the SSM/I dataset for calibration ?

p. 3040, l4 what does that mean 'at all available time steps' ? please provide numbers and what that means for the comparisons.

p.3040, l23-27 I think this was already defined earlier in the manuscript, then it can be removed here.

p.3040, l28-29 please make clear if collocated data is being compared or monthly averaged data or ..

p.3041, l6 how is the RMSE determined because I don't see such a large RMSE in the fig.7 data ?

Fig. 7 why is the SSMI+MERIS vs GOME2A comparison limited to 2007-2008 ?

p.3041, l24 what does 'cloud corrected' mean ? Or is cloud-free meant here ?

p.3042, l25-28 I do not understand on what evidence the explanation of (changing) cloud conditions is based to explain the observed seasonal differences between GOME2(A) and SSMIS. Please explain more clearly. I mean is the much better agreement between GOME2(A) and ECMWF not suggesting the problem is with SSMIS ?

p.3042, l10-12 you mention the diurnal cycle in H<sub>2</sub>O. To what extent does that affect the comparison between MERIS, SSMIS, SSM/I with GOME2 ? I mean for ECMWF you take -I presume- the output closest in time with GOME2A. For the others you only have fixed observation times. Please elaborate to what extent this can explain the observed differences (or not).

p.3042, l18-20 do you mean that the microwave measurements are affected by clouds and these can not be flagged ? therefore their TCWV is biased low compared to e.g. GOME2 ?

p.3043, l10 can something be said and referenced as to the quality of ECMWF data ? I mean we need to have some idea to judge its value for the comparison provided here.

p. 3043, l4 would another advantage not possibly be that there is output at several moments during the day ? which moments in time have been used here in comparison with GOME2, and what does that mean of average and stdv in differences in temporal sampling between the two ? (and what can that mean for observed differences ?) in l12 it is stated that 12 h forecast values have been used to derive a daily mean, why is not the ECMWF data closest in time with GOME2A used ?

p. 3043, l21 inner → inter

p.3043, l25 tropical ? total column H<sub>2</sub>O

p.3043,l26-27 should it not say monthly mean differences between GOME2A and ECMWF ?

p.3044, l2 good accuracy is a bit too strong I would say. I would say it confirms that GOME2 captures the overall spatial variability in the H2O total column values quite well.

p.3044, l15-19 if undetected clouds are the problem should this not lead to a systematic underestimation of the H2O by GOME2 ? is that what we observe and where you are referring to here ? that is not clear to me.

p.3044, l23 right panel → lower panel

p.3044, l26-... in fact the region with largest deviation (e.g. over central Africa) does not seem to correspond with the actual desert regions or highest surface albedos (I did a quick check with the surface albedos I found on the TEMIS website). So I don't understand this hypothesis.

p.3045, l8-11 can we then explain why this results in always higher GOME2 values compared to ECMWF ? or is this not the case ?

p.3045, l22 what is a physically based algorithm ?

p.3046, l5 How is collocated defined here ? Later only the temporal collocation is specified.

p.3046, l9 what is the max. difference in time ? is that as much as 7 hours ? What is the effect of this large temporal difference (even 4.5 hrs is quite large) ? or is this issue of minor importance ?

p. 3046, l19-25 I would first remark that these differences were also observed in the comparison of GOME2 with ECMWF and are thus likely related to GOME2, is that correct ? Or is the calibration of SSMIS with radiosondes and the use of radiosondes by ECMWF causing a dependence between the two datasets making it impossible to draw this conclusion ?

p.3046, l24-25 I do not understand that a cloud residual would cause GOME2 to give higher values than SSMIS (or ECMWF), should we not expect that this gives lower values. Please clarify why this would give a positive bias for GOME2.

p. 3047, l8 how should I interpret the bias of 0.25 g kg<sup>-1</sup> in terms of g/cm<sup>2</sup> as used here ?

p.3047, l10 where is the estimate of 1% for 1 hr time difference coming from ? please provide reference or explanation.

p.3047, l20 does this now mean different SSM/I data is being used compared to section 5.2 ? Please explain in text to avoid confusion.

p. 3047, l22 I understand from this that anyhow a different retrieval algorithm was used for SSM/I compared to the SSM/I data used in section 5.2 ?

p.3047, l26 why was the L3 GOME2 dataproduct used here ? and not first daily colocated data and then averaged as in all previous comparisons ?

p.3048, l5-7 I don't understand is the SSM/I data cloud contaminated ?

p.3048, l10-11 I would add that the differences show large resemblance to what is seen in the comparison with ECMWF.

p.3049, l14-16 please add that similar patterns were observed in the differences with ECMWF hinting at a problem in the GOME2 data. Wrt remark on surface albedo see my previous comment on that in section 5.1. If you think there is a correlation with high albedo please provide corresponding plot (in reply) to illustrate that.

p.3049, l8 I don't understand 'and consequently the different cloud selections ...'. Caption fig. 11 mentions only cloud free data used. Do you mean here remaining cloud contamination ? But I don't really see why that is more of a problem when using daily colocated or not as SSM/I does not suffer from cloud contamination (if I understood correctly)

p.3049, l29 is this then due to the effect of temporal mismatches ?

Fig. 12 Figure captions mentions GOME2A – GOME2B, incorrect

p.3050, l. 13 unclear to me what other satellite retrieval methods are meant here, or was this mentioned already elsewhere ?

p.3051, l10 four or three ?

p.3051, l19-21 see earlier remarks on the correlation with surface albedo

In section 4 it is concluded that GOME2B is biased high compared to GOME2A. In section 5 GOME2A is compared with other water vapour datasets. Would it not be useful to say something about the fact that

GOME2B is also biased high compared to the other datasets and to first order could be corrected based on the comparison with the GOME2A data ?

p.3061, Table1 The mentioned time period does not apply to all comparisons, please correct.

**Major point :** The English in the manuscript should be improved. I advice to ask a native speaker to read the manuscript. The following is just my first suggestions w.r.t. improving the English :

p.3022,l24 are → is

p.3023,l2 are also present → are observed

l23 However, ... Sentence needs rephrasing

l25 explicitly state what 'it' is

p. 3024, l3-4 something is missing in the sentence

l6 over → under

l8 what are spurious changes ?

l22 on → over

l26 timescale

l29 this sentence is now very unclear. I think you want to say two things. One is that in NIR you can not see through clouds, and the other thing is related to observations over oceans. Please rephrase.

P3025, l16 was → is

L18 current → current operational

L20 take out 'which ...predecessor GOME' sentence is much too long

P3026, l9 out, but the results pointed out → out pointing to large....

L13 against → with

L17 type instruments → instruments

P3027, l3 launched in

L8 at → using

L13-14 strange formulation '.. improved version.., but we can identify ...'. Please rephrase.

L20 Finally, ... I think that is a consequence of the statement in the sentence before on the swath, please rephrase.

L23 the different GOME-type sensors.

L23 why is there a hard return here ?

P3027, l3 At → On

L4 operating a reduced swath width of 960 therevly increasing its spatial resolution....

L4 if you use GOME-2B in that sentence I would also use GOME-2A. Please introduce somewhere this terminology, so GOME-2/MetOp-A (GOME-2A) ....

P3028,l8 improves → improve

L11 and it is foreseen to guarantee → guaranteeing  
L18 variety of methods .... has been ... → Various retrieval methods ..  
have been  
P3029, l6 what does it mean to take into account the cross sections of  
O2 and O4, I presume you mean taking into account absorption by ...  
L7 what is meant by a single H2O cross section is used ?  
L12 similar spectra, please rephrase  
L22 we therefore apply  
L23 correction  
L25 and they are larger, sentence does not make sense. Rephrase.  
L3031,l20 what does this sentence mean ? why is this product –  
contrary to others apparently- especially valuable .... ?  
L24 another example of connecting singular with plural, this and  
errors, I will no longer explicitly list these errors, just too many.  
L26 may be also → may also be  
I also suggest to try to avoid the use of 'we' in the manuscript.

I stopped on page 3031 identifying faulty English. Please have a  
native speaker read your manuscript.

p.3032, l21 variable scenes → inhomogeneous scenes  
l22 largely separated detector channel, unclear what this means  
l26 begin (?) of channel 4 → beginning

Table 1. The main ... are clearly visible. Maybe say Summary ...  
characteristics illustrating the main improvements of GOME-2  
compared to its ....

Table 1 what does LT mean ?

## **Figures**

- Most figures (fig 1, 2, 3, 5, 8, maybe also 6 and 12) should be  
increased in size as they are too small to see any details. Also delete  
all titles of figures if information is already in the figure caption as in  
a lot of cases the title text is too small to read.