Atmos. Chem. Phys. Discuss., 6, S3082–S3089, 2006
www.atmos-chem-phys-discuss.net/6/S3082/2006/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mesoscale modelling of water vapour in the tropical UTLS: two case studies from the HIBISCUS campaign" *by* V. Marécal et al.

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Received and published: 13 September 2006

The authors evaluate the ability of a mesoscale model (BRAMS) to simulate the vertical structure of two observed water vapour profiles (SF2 and SF4 from the HIBISCUS field campaign) in the tropical upper troposphere and lower stratosphere. The BRAMS simulated relative humidities with respect to ice (RHI) agree slightly better with the observations than those calculated from the ECMWF analysis for SF2 and somewhat better for SF4 (see first two "specific comments" below). Not very surprisingly, some significant differences still exist between BRAMS and the observations. A number of sensitivity runs with BRAMS were conducted in order to distinguish between influences of the vertical and horizontal resolution and the microphysics scheme. Altogether, I find that the results are likely to be of relevance to the community. Apart from the one issue raised in the first "specific comment", a fairly well balanced discussion of the results is presented. I recommend the manuscript for publication in ACP after one major (see first "specific comment") and a few minor corrections.

Specific Comments

- In my opinion, the root mean square error of the relative humidity over ice (RHI RMSE) of the "reference run" in Table 1 is not calculated from data of the reference run, but instead from BRAMS simulated water vapour mixing ratios r_v and the temperatures observed during SF2 (i.e. the "green solid line" in Figure 6c). I can't find this stated anywhere in the text. (Please correct me in case I overlooked it.) However, in my opinion the "BRAMS" RHI RMSE should be calculated from the BRAMS data using BRAMS simulated temperatures. Based on the data from Figs. 5c and 6c, I calculate the following approximate RHI RMSEs for SF2 (details below):

	ECMWF	BRAMS reference run	"green solid line in Fig. 6c"
RHI RMSE (%)	26.7	25.4	15.9

The RMSE for the ECMWF analysis based RHI is close to the RMSE in Table 1 (26.5%), and the RMSE for the "green solid line" is close to the RMSE for the BRAMS reference run in Table 1 (15.7%), indicating that in Table 1, the "BRAMS" RHI RMSE is actually calculated based on temperatures from the SF2 observations. The "real" RHI RMSE for the BRAMS reference run in the table above, on the other hand, is only slightly lower than the RHI RMSE for the ECMWF analysis.

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The RMSEs in the table above were calculated as follows: From Figure 5c, I estimated the following RHIs (extracted using the “Plot Digitzer” program and rounded):

altitude (m)	RHI_{obs} (%)	RHI_{ECMWF} (%)
4550	29.0	23.9
5000	14.9	24.7
5530	11.9	24.7
6100	19.2	22.6
6730	10.7	25.6
7340	26.4	29.4
7950	50.7	37.1
8630	40.9	47.8
9330	64.0	62.7
10070	100.2	91.7
10770	112.6	97.7
11620	112.2	98.9
12360	108.7	98.9
13170	166.7	91.3
14020	110.9	72.1
14910	121.1	75.9
15790	110.4	58.0
16750	35.0	28.6
17820	27.3	13.6

where RHI_{obs} and RHI_{ECMWF} are the relative humidities with respect to ice calculated from observations during SF2 and calculated from the ECMWF analysis, respectively.

And from Figure 6c:

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altitude (m)	RHI_{obs} (%)	RHI_{BRAMS} (%)	$RHI_{green\,solid\,line}$ (%)
4800	24.6	31.6	37.2
5280	7.8	28.1	33.0
5790	21.5	26.2	32.2
6280	12.1	28.9	35.3
6810	12.9	34.0	40.8
7290	27.3	40.6	46.7
7800	53.9	49.6	58.5
8290	45.7	56.2	59.3
8770	41.8	65.2	69.9
9330	64.5	77.7	85.5
9790	85.5	91.0	103.6
10300	110.5	101.6	112.6
10760	109.0	110.2	108.7
11310	119.1	116.4	127.9
11800	111.7	117.2	125.2
12270	107.0	114.5	115.4
12660	112.5	108.2	117.4
13480	162.5	101.2	140.1
13750	119.5	100.4	136.6
13990	117.2	100.0	138.1
14210	91.0	99.2	122.5
14500	91.8	94.1	117.8
14700	100.4	91.8	119.4
14960	127.3	89.5	133.1
15200	152.0	87.1	146.4
15470	177.3	82.8	164.8
15730	112.5	75.8	113.6
16000	62.5	67.6	83.8
16200	46.5	57.8	60.7
16510	40.6	46.5	51.0
16730	34.8	39.1	41.2
16990	29.7	30.5	32.2
17240	31.6	23.4	27.1
17480	23.4	19.5	21.2
17770	28.5	16.0	20.5
18010	28.1	13.7	18.1
18250	28.9	12.1	17.0

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I calculated the Root Mean Square Error (RMSE) from:

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(RHI_{i,obs} - RHI_{i,m})^2} \quad (1)$$

(dividing by N instead of $N+1$). Where $RHI_{i,m}$ is either $RHI_{i,ECMWF}$, $RHI_{i,BRAMS}$ or $RHI_{i,green\,solid\,line}$.

- I did not repeat the calculations above for Table 3, but I strongly recommend, that the authors add the RHI RMSEs calculated from the reference runs using BRAMS temperatures to Table 1 and Table 3, and include those values in their discussion. For SF4, the RHI from BRAMS looks better than the RHI from the ECMWF analysis (dashed black lines in Figs. 9c and 10c), and the influence of taking the BRAMS calculated temperatures instead of observed temperatures appears to be not as important as for SF2 (Figs. 6c and 10c).

- I assume that observed temperatures instead of BRAMS calculated temperatures were also used to calculate the RHI RMSEs for the other BRAMS sensitivity runs in Tables 1 and 3. I recommend to use BRAMS calculated temperatures instead.

- The BRAMS calculated profiles (black dashed lines) in Figs. 6 and 10 are still much smoother than the observations.

- The spatial pattern of the simulated rain-rates (Figs. 2 and 7) agrees pretty well with TRMM observations. Nice to see! (How about the domain averaged amount of precipitation?)

- p. 8254, line 23: 100% supersaturation with respect to water: Sounds like an ad-hoc assumption based on the lack of a better parameterization and the lack theoretical understanding. (Perhaps this should also be mentioned in Section 4.1).

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- I find the trajectory analysis is an important part of the paper. It would, however, be easier to follow if the authors could show some plots and very briefly describe how the layers were identified.
- p. 8253, line 28: "The reason is that there is for any model variable a correlation between vertical levels, particularly between two adjacent levels": Could there be other reasons, such as too smooth detrainment profiles in the deep convection parameterization? Perhaps the authors could also briefly explain the reason for the "stronger than observed" correlation between vertical levels found in the model. Which advection scheme and which subgrid turbulence parameterization were used?
- p. 8255, line 28: it would be nice if some profiles from the run with 5 km horizontal resolution could be shown.
- p. 8264, line 18–24: based on the results from the sensitivity runs, would it make sense to order these points according to their importance? From Tables 1 and 3 it seems like the difference in horizontal resolution does not have a very significant effect.
- p. 8244, line 25: in principle, global models can be run with high vertical resolution and detailed microphysics
- In my opinion, it would be nice to move the description of the micro-SDLA (Section 3.1) and the modelling tools (Section 4) before the results section and to regroup the results section, so that first SF2 is described and then SF4. My suggestion (optional) is:

1. Introduction
2. Description of the micro-SDLA instrument

3. Modelling tools (incl. brief description of trajectory analysis)
4. Results for flight SF2

4.1 SF2 flight and its meteorological environment
4.2 SF2 water vapour and temperature profiles
4.3 Comparison of the reference run and ECMWF analysis with SF2
4.4 Trajectory analysis for SF2
5. Results for SF4

5.1 ....
.. ...
6. Conclusions

I find, this would make reading the paper easier.

Suggestions for Technical Corrections

- p. 8243, line 5: for measuring → of measuring
- p. 8243, line 14: have a dry bias → has a dry bias
- p. 8244, line 29–p. 8245, line 1: tropospheric weather phenomena that take place in the troposphere
- p. 8246, line 13: is was cut → it was cut
- p. 8247, line 12: Micro-sdla → Micro-SDLA (just in case LaTeX and BibTeX were used, I think one can write "`Micro−{SDLA}`" in the BibTeX file).
- p. 8248, line 25: omit the word "and"
- p. 8249, line 5: tendency is ... → slowly increases with altitude
- p. 8249, line 27: values → mixing ratios

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- p. 8251, line 24: ECMWF model → the ECMWF model
- p. 8259, line 7: 3.5–8 m → 3.5–8 km
- p. 8265, line 17: mid-latitude ... → the mid-latitude
- Tables 1 and 3: see first specific comment above.
- Figs. 5,6,8,9,10 in the print version should be much bigger in order to be readable.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 8241, 2006.