Atmos. Chem. Phys. Discuss., 4, S2294–S2298, 2004
www.atmos-chem-phys.org/acpd/4/S2294/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of the vertical diffusion coefficients from ERA-40 with ^{222}Rn simulations" *by* D. J. L. Olivié et al.

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Received and published: 2 November 2004

We thank reviewer 1 for his/her constructive and useful comments.
Please find below our detailed answer to the comments.

Answers to general comments :

We have made important improvements to the paper :
1. The objectives are more clearly stated through the inclusion of 3 research questions that are studied and answered in the Conclusions.
2. The structure of the paper has been reorganized : the introduction has been completely rewritten. Sections 2 and 3 have been reorganised. We more clearly draw conclusions from the presented material in the Conclusions. We have separated the results and methods as suggested. The methods are now described only in Section 2

'Methods'.
3. By centring the paper around research questions the conclusion are much more explicitly drawn.

Ad 1 : It is correct that not only the archived K_z from ERA-40 are evaluated, but also two other K_z sets which are however also based on ERA-40 meteorological fields. Therefore we now explicitly refer in the title to the archived or off-line diagnosed origin of the K_z-coefficients.

Ad 2: We have tried to improve the organization of the paper.

Answer to the detailed comments

- p.4131-l.7 : 'radioactive tracer' is replaced by 'radionuclide'.

- p.4131-l.21 : We mean that the off-line diagnosed K_z values quite well reproduce the archived K_z.

- p.4135 : As mentioned above, we state research questions in the introduction, and come back to them in the Conclusions.

- p.4136-l.22 : It is true that the availability of 3-hourly data implies availability of 6-hourly data. We have changed this accordingly in the text.

- p.4137-l.5 : The temperature excess coefficient is a dimensionless proportionality constant. In a well-mixed unstable ABL, the potential temperature of the air near the surface will always be higher than in the first atmospheric model layer. One assumes that this potential temperature difference is proportional to the surface heat flux, and inversely proportional to some vertical velocity scale. The proportionality

ACPD

4, S2294–S2298, 2004

Interactive Comment

factor is called the temperature excess coefficient.

- p.4140-l.10 : We removed also here the ambiguity about the 3- or 6-hourly archived ABL height. We say in the text that the ABL height is available every 3 hours.

- p.4143-l.2 : The off-line coefficients are diagnosed on a $1^\circ \times 1^\circ$ degree, and 60 layers (a spectral grid of T159 or reduced Gaussian grid of N80 correspond with a resolution of $1.125^\circ \times 1.125^\circ$). In a second step, these K_z values are interpolated to the desired TM3 model grid of $2.5^\circ \times 2.5^\circ$ and 31 levels.

- p.4144 : We moved the comparison of K_z to the result section.

- p.4144-l.12 : To avoid confusion, we replaced 'below 600 hPa' by 'between the surface and 600 hPa'. The first layer is around 60 m thick, the second layer is around 150 m thick.

- p.4144-l.20 : We have added this finding in the conclusions.

- p.4145 : In the comparison of the K_z profiles, we added information about the profile over sea. One of the figures now shows the time evolution of a K_z profile over sea. We now show the median and the 10 and 90 percentile.

- p.4145 : We agree that we have only made a limited comparison between the modelled and observed ABL heights, and that it would be interesting to compare the ABL height also in different regions. In the tropics, there are actually still many uncertainties. This is one of the reasons why our institute has started an observational station in Surinam. Amongst others we plan to study the diurnal variations of the ABL there. For the moment, we do not have the opportunity to enlarge the comparison to other regions because of lack of observations available to us.

ACPD

4, S2294–S2298, 2004

Interactive Comment

- p.4146-Figure 6 : We have included the corresponding numerical values of the scatter plots.

- p.4147-l.20 : Cincinnati and Socorro are not mentioned here anymore.

- p.4148-Table 4 : The columns (a) and (c) in former Table 4 are analogue to the middle and lower panels in former Figure 7. The quantities in the table give correlations calculated on the data of the whole year, while in the figure it is done per month. The results in the table and the figure are analogue : correlation of the daily mean is much higher than the correlation of the residue; the correlation of the residue in Schauinsland is lower than in Freiburg. The extra column (b) (which has no equivalent in the figure) in the table gives the correlation of the hourly values : it shows that the correlation of the hourly values is in general smaller than the correlation of the daily mean value, but higher than the correlation of the residue.

- p.4149 : We fully agree with the comment on the interpretation of the Schauinsland observations.

- p.4150 : We have shifted the discussion about the time shift to the end of the section about Freiburg and Schauinsland.

- p.4151 : Combination of Section 3.2.5 and 3.2.3. : these are now successive section, but we kept them separated.

- p.4153 : As suggested, we added in the text that the morning measurements represent more local emission conditions, which may not fulfil the 1 atom/(cm^{2}s) emission rate.

ACPD

4, S2294–S2298, 2004

Interactive Comment

- p.4154 Section 3.4 : We have added horizontal plots of relative differences in mixing ratio's, however only for ^{222}Rn.

- p.4156 : We have tried to put all the important findings in the Conclusions.

- p.4172-Figure 2 : We now show the 10 percentile, median, and 90 percentile values of the profile. We have added an explanation of the relation between K_z and the time scale of mixing. The dimensions of K_z are L^2T^{-1}. Taking the ABL height as a representative length scale for the effect of diffusion gives a relationship between K_z and the time scale of turbulent diffusion. If for example the ABL height is 1000 m and K_z is 300 m^2/s, one finds a time scale of around 1 hour. This means that a tracer initially only present at the surface, will be well mixed throughout the complete ABL on a time scale of 1 hour.

- Figure4-6 : We have omitted the scatter plot of the ABL height in Cabauw. For the other scatter plots, we have quantified the differences.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 4131, 2004.

ACPD

4, S2294–S2298, 2004

Interactive Comment