Atmos. Chem. Phys. Discuss., 2, S520–S523, 2002
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global ozone forecasting based on ERS-2 GOME observations" *by* H. J. Eskes et al.

H. J. Eskes et al.

Received and published: 21 October 2002

We thank the referee for his kind words concerning the paper. The more specific comments are answered below:

p922: The referee suggests to include remarks on the nature of the errors:
In the paper we refer to our recent paper in Q.J.R.Meteorol.Soc. which contains such a discussion. We agree that it is relevant for the present paper to add a more detailed discussion of the assimilation, and in particular about the bias and Gaussian statistics. To our opinion the best place for this is the subsection "Assimilation results". The last paragraph is replaced by:
The observation minus forecast statistics is discussed in more detail in Eskes (2002). On average the root-mean-square (RMS) observation-minus-forecast difference between GOME observations (before assimilation) and the short range model forecast (between 1 and 3 days) is small: about 9 Dobson Units (DU), or roughly 3%. The

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distribution of RMS differences is well approximated by a Gaussian curve, which is consistent with the Kalman filter assumption that both the observation and forecast have Gaussian random errors. The bias between the model forecast and the GOME ozone columns is in general smaller than 1%, a factor of 3-10 smaller than the RMS. Because of this, no additional bias corrections are applied to the forecast model. The small bias implies that the assimilation efficiently adopts the ozone levels as retrieved from the GOME spectra. Note that this small bias does not imply that the GOME data themselves have a similar small bias. In general the comparison between the GOME fast-delivery retrieval and ground-based observations is within 5% for low- and midlatitudes, and within 10% at high latitudes and high solar zenith angles (Valks,2002).

p923: The address of the SODA project web site, and the start date of ECMWF ozone forecasts are added to the text.

p925: As suggested by the referee, we have added a comment that the Cariolle ozone parametrisation is also used by ECMWF and DARC.

p926: line 7: retrieval → retrieved

P. 926: lines22-23 middle panel → top panel. Figure 1 serves two purposes. First it shows the comparison with TOMS. Secondly it compares the ozone map with the corresponding monthly mean. Therefore we have displayed the ozone map as the second panel, despite the fact that this panel is the first one being referred to in the text.

p927: line 11: *what do you mean by "new" GOME observations?*
The text is replaced by "the root-mean-square (RMS) observation-minus-forecast difference between GOME observations (before assimilation) and the short range model forecast "
lines 11-14: *How do the figures quoted compare with the GOME errors?*
We have extended the text by discussing the main results of the forecast error statistics (see above). The implications for the GOME random error is discussed in detail in the

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Quarterly Journal paper. We feel that we should not repeat this discussion here and focus on the forecast performance and directly relevant aspects.

P. 927: line 22: below is → below are.

P. 928: line 20: As suggested by the referee: "will have a positive contribution to Ct" → "will tend to inflate Ct"

p.929: We are not sure how the figure will be displayed in ACP (in one or two column format). Therefore we have replaced references to "top", "middle", "bottom" by "first", "second", "third".
The referee suggests two references. Déqué provides a good overview of problem related to the evaluation of the anomaly correlation, and we have added this paper to the list of references. Miyakoda, in his 1972 paper in Monthly Weather Review, provides a discussion of rms errors and anomaly correlations. However, this paper does not provide a discussion on the cut-off at 0.6, as indicated by the referee. The paper does not really provide additional information on this issue and we have not included it as a reference.
The referee mentions it is interesting to perform the calculation with a "climatology" of different length in time. In fact we have done this. For longer climatologies, or monthly means the result is a larger anomaly correlation, as mentioned in the text. Much shorter averages than for a period of one month does not make much sense, as the average time should be considerably larger than the forecast time to be able to judge the forecast skill. This issue made us decide to add the rms plot because it does not depend crucially on the definition of the "climatology" and therefore brings additional information.

P. 931: line 2: This in → This is in.
P. 931: line 10: *Is the characteristic length scale/ time scale relevant to the parameters in the Cariolle parametrisation?*
No. The parameterised chemistry is meant to describe the stratosphere, and the strato-

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sphere is rather constant in the tropics. The remark goes back to the four points mentioned on pages 930-931, especially points 2-4. Both retrieval artifacts and tropospheric chemistry may be involved. The remark is meant to focus attention on the difference in TR versus NH, SH persistence, demonstrating more rapid, small scale variations.

P. 932: lines 1-10: *Perhaps the authors should comment why Et does not tend to the square root of 2?*
Unfortunately in the past two years we have restricted our forecasts to 5 days. A 10 day forecast would show more clearly if the curves will continue to rise above 1 like the TR curve. The ozone forecast model is not "lazy", i.e. the amount of structure / detail does not decrease significantly as a function of the forecast time, and we expect that the curve will approach square root of 2.
Is there a reference for the statement about the ozone hole in 2000?
We have added a reference to the latest UNEP/WMO report on ozone depletion.
lines 21-22: Africa → Southern Africa

P.933: line 5: which depends quite sensitively on details → which is quite sensitive to

P.933: line 13: *Is there a reference to the events of Autumn/Winter 2001/2002 (NH)?*
We are not aware of a paper discussing these events. We have, however, added a recent paper by Allen on the 1999 low ozone event which provides an additional discussion on the dynamical aspects and includes relevant recent references.

P. 933: line 17: verifying analysis → verifying analysis (bottom panel); three day forecast predicts → three day forecast (top right panel) predicts

P. 934: line 15: forecasted → forecast

P. 936: line 32: submitted → in press

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 921, 2002.