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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Vertical mixing in the lower troposphere by mountain waves over Arctic Scandinavia" *by* M. Mihalikova and S. Kirkwood

Anonymous Referee #3

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This is a nice little paper, and the authors have some intriguing observations. It is very well written; the presentation is clear and concise. While I would have no objection to its being published "as is" in ACP, I think it could be made much more valuable with some significant additional effort.

The analysis is very simple, and the difference between the in-wave and outside-wave profiles almost convincing. Unfortunately, however, it relies on the averages of two groups of 17 and only 6 ozonesonde profiles. But this data is from a short campaign 15 years ago — are there no other data available since then? On page 31478 the authors note the existence of data from Sodankyla, Ny Alesund, Lerwick and Scoresbysund, and rather cryptically say that they "initially" considered these data. There are also regular soundings from a number of European and Canadian sites. With more than 25

years of ozonesonde and ESRAD data would it not be possible to find a much larger set of "matched" soundings, in the same way that the Match program (Von der Gathen et al., 1995) does? Comparing "before" and "after" profiles would give a much clearer idea of the extent of wave-induced mixing, not to mention its seasonality, variability, etc..

The simple analysis of equations 1 and 2 is very neat, except that the two equations give very different answers that must be reconciled by invoking thin layers of turbulence. While the authors argue that this is evidence for such turbulence, the reader may take the opposite view. Here again, more data, particularly radar observations of turbulence, would support the authors' interpretation. There is also the issue that the "in-wave" ozone mixing ratio profile in Figure 4, although linear below 3500m, is not vertical, so mixing is not complete.

Incidentally, the wiggles above 3500m shown in Figure 1c and 4c look rather like a wave pattern. Could they be the signature of the dominant wave pattern above Esrange?

Minor points:

Page 31478, line 6: "around". "Approximately" would be better. Line 8: "erroneous data was excluded" should read "suspicious data were excluded" or "data outliers were excluded".

Page 31478, lines 7-11: Kreher et al. is not an appropriate reference for ozonesonde precision/accuracy. The ECC ozonesonde has a precision of about 3-5% and an absolute accuracy of about 10% in the troposphere [Smit et al., 2007; Liu et al., 2009]. The 30-60m figure is also too low, since the ozone sensor response time (1/e) of about 25 seconds implies a vertical resolution of about 100m for a typical balloon ascent rate of 4 m/s.

Page 31479, lines 12-14: Are waves detected simply on the basis of vertical velocity? I find it puzzling that some measure of an oscillation (like the standard deviation of

vertical velocity) isn't used.

Page 31483, lines 15-16: "To ensure a more representative result, we have decided to concentrate on ozone profiles under the height of the lowest identified tropopause fold". It is not clear what this implies, although on page 31481 there is a reference (line 20) to "the maximum height considered here 6000 m.".

Liu, G., D. W. Tarasick, V. E. Fioletov, C. E. Sioris, and Y. J. Rochon (2009), Ozone correlation lengths and measurement uncertainties from analysis of historical ozonesonde data in North America and Europe, J. Geophys. Res., 114, D04112, doi:10.1029/2008JD010576.

Smit, H.G.J., W. Straeter, B. Johnson, S. Oltmans, J. Davies, D.W. Tarasick, B. Hoegger, R. Stubi, F. Schmidlin, T. Northam, A. Thompson, J. Witte, I. Boyd and F. Posny (2007) Assessment of the performance of ECC-ozonesondes under quasi-flight conditions in the environmental simulation chamber: Insights from the Juelich Ozone Sonde Intercomparison Experiment (JOSIE), J. Geophys Res., 112, D19306, doi:10.1029/2006JD007308.

Von der Gathen et al. (1995) Observational evidence for chemical ozone depletion over the Arctic winter 1991-92. Nature, 375, 131-134.

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