

Editor's comments on revised Gravity wave induced cross-isentropic mixing: A DEEPWAVE case study

p.1 l.18 downwind of the Alps

p.1 l.19 and N₂O, are

p.1 l.23 downstream of the mountain

p.1 l. 24 prior to the measurements

p.2 l.5 I think this sentence would read better as 'Orographic gravity waves affect the large-scale stratospheric circulation and play an important role in determining the thermal and dynamical structure of the atmosphere'

p.2 l.10 I don't think the sentence 'Gravity waves ... 2010)' is needed – the paragraph reads better without it.

p.2 l. 13 Both types of instability

p.2 l.14 occurs, potentially leading to mixing...

p.2 l.17 radiation-driven

p.2 l.18-25. This part of the text needs redrafting. Do you mean that wave breaking causes diabatic heating (or cooling) separate to its role in promoting turbulence? If so, please explain what process you are referring to. Otherwise the sentence beginning 'Wave breaking' could be omitted and the following sentence changed to 'In addition, turbulence produced by wave breaking and wind shear above the tropopause' While I like the term 'cross-isentropic mixing', all mixing driven by turbulence (whether cross-isentropic or not) is irreversible. I'm not sure what point you're trying to make here so won't offer an alternative wording.

p.2 l.23 and 26. Just because a process is diabatic doesn't mean it's irreversible. Radiative heating and cooling for example is in principle reversible, as is condensation and subsequent evaporation of a cloud. You need to be much clearer about the difference between diabatic and irreversible processes.

p.3 l.11 omit 'occurrence'

p.3 l.18 omit 'diabatic'

p.4. l.5 During 12 July, which.....paper, no HIAPER.....

p.4 l.9 Herriott cell

p.5 l.17 on 12 July

Fig 1 caption. 'The solid red line in b) denotes the -2 pvu isoline', also say that the solid black line is the flight track.

p.6.l.7 upwind of the region

p.7 l.1 Particularly in the regions of strong variability of the vertical wind, Θ , N₂O.....

p.8 l.1 downwind of

p.13 l.15 downwind of the mountain is indicative of

p.13 l.20 downstream of

p.13 l.22 either 'led' or 'leads' but not 'lead'

p.13 l.28 the following analysis (omit 'below')

p.13 l.30 'referring to specific measurements' (omit 'further below')

Fig 7 Gray arrows mentioned in caption but not visible on diagram

p.16 l.9 omit 'on display'

p.17 l.1 -0.6 K/ppbv (you have it as +!) (also l.8)

p.19 l.16 Reference is made here to 'the last region' and in the next section to 'the second region'. Which parts of the plot are you referring to in each case?

p.20 l.11. 'frequencies smaller than 721 m' – clearly this is nonsense even if you do put 0.3 Hz in brackets. More importantly, the $E \sim k^{-3}$ spectrum of geostrophic (2-D) turbulence is usually found at much larger scales than here (several hundred km e.g. Nastrom and Gage 1985) so although your results are consistent with k^{-3} for wavelengths 1-10 km it doesn't follow that this is due to 2-D turbulence. I don't agree either that the slopes of both w and θ 'turn to $-5/3$ ' at high frequency – the θ spectrum in particular could be argued to have the same slope throughout.

p.21 l. 6 you're saying here that the N_2O spectrum has the same slope ($-5/3$) throughout, which isn't what the diagram shows. You need to be very careful with your argument here. Both N_2O and θ are passive tracers on the time and length scales of turbulence, so their spectra should look the same. The fact that their slopes are so different suggests either an instrumental issue, probably with N_2O , or some sampling issue. I certainly don't see a 'transition from geostrophic to isotropic turbulence' (p21 l.8).

p.21 l/13 cube root, also 'the we used' at the end of the line

p.22 l.1. First of all, it is difficult to distinguish the lines in the EDR panel of fig 14 – could they be coloured? But either way, two of the components are enhanced at the end of the line whereas the third is not. The text says the opposite – that only one component was enhanced. Text and figure must be consistent.