

1 Journal of Atmospheric Chemistry and Physics

2
3 Please find the list of corrections of the manuscript entitled “Short vertical-wavelength
4 inertia-gravity waves generated by a jet–front system at Arctic latitudes – VHF radar,
5 radiosondes and numerical modelling
6 ” by Anne Réchou, Sheila Kirkwood, Joel Arnault and Peter Dalin “

7
8
9 Replies to reviewer 1 comments/suggestions

10
11 At the outset, we would like to thank the reviewer for his constructive suggestions and
12 comments, which we feel improved the manuscript significantly.

13
14 *1) REFERENCE: I suggest to include Zülicke & Peters (2008) into the references: they*
15 *showed combined observations and modellings studies of jet-generated waves. They also*
16 *include the Lagragian Rossby number as an indicator for potential wave- generation regions.*
17 *Perhaps, it helps the interpretation of results with the model data.*

18
19 Reply : Thanks to the reviewer to give us the references, which will be added in the text.

20
21
22 *2) PROPAGATION: The authors describe the wavepackets in the 10-to-14-km height region.*
23 *In the discussion they should mention, that the wave packets are remaining there and do not*
24 *propagate further up. If they are captured there (Bühler & McIntyre, 2005) or absorbed in a*
25 *critical layer, remains to be discussed.*

26
27 Reply: we can't see the wave well higher up with the radar, but the model sees them going
28 higher up – Fig 6b for example.

29
30 *3) APPENDIX: For my taste this justification to study the Brunt-Vaisala frequency N is not*
31 *neccessary. The authors describe what they have done, and that is sufficient. It is pretty*
32 *technical information.*

33
34 Reply : The editor asked us to put such information

35
36
37 *4) FIGURES: The figures should all re-processed. The axes are difficult to read, may be the*
38

39 Reply : We will process the figures carefully to make them as clear as possible.

40
41 *Further below, some specific comments are added.*

42
43 TECHNICAL CORRECTIONS

44
45 *At many places in the text the authors refer to waves - perhaps they might abbreviate inertia-*
46 *gravity waves with IGWs.*

47
48 Reply : It is done, thanks !.

49
50 *31252-19: "+" -> "+/-" : done, thanks !.*

51
52 31253-2: "*inertia gravity*" → "*inertia-gravity*" :done, thanks !.
53
54 31253-20: "*Eckermann*" :done, thanks !.
55
56 31253-10: *Include here reference to Zülicke & Peters (2008) for study of jet-generated IGWs*
57 *with 10 field campaigns and modelling at 54 N* : done, as follows :.
58
59 « In the stratosphere, the waves were dominated by upward energy propagation (clockwise
60 rotation of the wind vector) and in the troposphere by downward propagation, consistent with
61 the dominant source for IGWs being at tropopause level. Zülicke & Peters (2008) showed
62 combined observations and modellings studies(MM5 mesoscale model) of jet-generated
63 waves over northern Germany(54°N). They also include the Lagrangian Rossby number as an
64 indicator for potential wave-generation regions. At high southern latitudes, Guest et al.
65 (2000)...”
66
67 31254-18: "and al." → "et al." :done, thanks !.
68
69 31255-12: *Include Zülicke & Peters (2008)* : done, as follows :.
70
71 « Another possibility might be to use modelling, as in case studies (e.g. O'Sullivan and
72 Dunkerton, 1995; Wu and Zhang, 2004; Zhang, 2004; Plougonven and Snyder, 2007; Zülicke
73 and Peters, 2008). However, it is not...”
74
75 31255-21: *Here, I guess you refer to horizontal wind speed - but I do not understand why these*
76 *should be small. I would expect the opposite due to the shallow inclination of the waves.*
77 *However, this remark could also be taken out.*
78
79 Reply: The fluctuations in horizontal wind speed are seen in the radiosonde data and they are
80 small. A comment to this effect will be added in the text.
81
82 31255-23: "*buoyancy-frequency*" → "*buoyancy frequency*" :done, thanks !.
83
84 31256-5: "*spectral analysis (FOR observations)*":done, thanks !.
85
86 31256-6: "*analysis (FOR radiosonde)*" :done, thanks !.
87
88 31256-8: *Perhaps, a linout-of-the-paper section can be given here.* :done, thanks !.
89
90 31256-25: "*N*" *has been defined before - should be used here.* :done, thanks !.
91
92 31257-4: *Please, specify value and unit of A. ??*
93
94 Reply: Value and units depend on the value and units of Pr. Here we use comparison with
95 radiosondes to find A, with arbitrary units for Pr, so arbitrary units for A (for absolute values
96 see Kirkwood et al 2010a). A comment to this effect will be added in the text.
97
98 31257-12: "*this ISSUE can*", *but it need not (see above).* ???
99
100 Reply : Sorry, We don't understand this comment.

101
102 31257-14: "for THIS study":done, thanks !.
103
104 31258-25: Please add an information on the used moisture scheme and orography : done,
105 thanks !.
106
107 We add : « Convection is explicit and microphysics is parameterized with the 3-class liquid
108 and ice hydrometeors scheme of Hong et al. (2004) »
109
110 31259-8: "westerly-north-westerly" -> "west-north-westerly":done, thanks !.
111
112 31260-8: "cross sections" -> "cross-sections" :done, thanks !.
113
114 31260-9: "north westerly" -> "north-westerly" :done, thanks !.
115
116 31260-15: "waveS" : done, thanks !.
117
118 31260-20: "Leningrad" -> "St. Petersburg" :done, thanks !.
119
120 31260-22 delete "/wind" :done, thanks !.
121
122 31261-14: This forward-inclined wave packet is also not in Zülicke & Peters (2008). :done,
123 as follows :
124 « The waves directly over the main jet, tilting equatorward with height, are very similar in
125 morphology and location (relative to the jet) to those found in the simulations by Lane et al.,
126 2004, Plougonven and Snyder, 2007 and Zülicke and Peters, 2008. However... »
127
128 *May be this is an effect of extraordinary strong upper-front activity?*
129
130 Reply: We see these waves very often at ESRAD – so they can't need 'extraordinary'
131 conditions.
132
133 31261-24: "waveS" 31263-1: "7.5 h, of" -> "7.5 h is of":done, thanks !.
134
135 31264-9: Please, give here an information how the mean profile has been eliminated.
136
137 Reply : The mean of the vertical profile of the function is first determined by fitting and
138 subtracting a 3rd-order polynomial over the height interval shown: A comment to this effect
139 will be added in the text
140
141 31264-29: "inertia gravity" -> "inertia-gravity":done, thanks !.
142
143 31266-13: "Gaussian weighted" -> "Gaussian-weighted":done, thanks !.
144
145 31267-14 (eq. 10): If you defined u' and v' in eq.s (8, 9) for the width components, you should
146 use the two compents of the momentum flux.
147
148 Reply : We have written that u' and v' are parallel and perpendicular to the wave propagation
149 direction and that this is the momentum flux in the direction of wave propagation, i.e. in the
150 direction of u' , so there should not be any contribution from v' .

151
152 31267-17: The formula should read " $(u'^2)_{\text{mean}} = |u'|^2/2$ ", shouldn't it?
153
154 Reply : Sorry for this error, it should indeed say " $(u'^2)_{\text{mean}} = |u'|^2/2$ "
155 In the text it is $(u'w')_{\text{mean}} = |u'|^2k / (2m)$
156
157
158 31267-18 (eq. 11): See two items above!: so it is ok like it is
159
160 31268-6: "Ern et al." → "They" : done, thanks !.
161
162 31268-21: "wave driven force" → "wave-driven forces (also referred to as gravity wave
163 drag)" done, thanks !.
164
165 31268-25: "per day" → "d⁻¹" 31268-27: "and the wavefronts distorted, by" → "and
166 distorted by" : done, thanks !.
167
168 31269-21: "short vertical wavelength" → "short-vertical-wavelength" : done, thanks !.
169
170 31269-23: "2 day" → "2-day" done, thanks !.
171
172 31270-13: Here, a remark should be added that the waves in the present case do not
173 propagate further up into the middle atmosphere. In other situations, with more wind, they
174 well could.
175
176 Reply : in the models, the waves propagates further up.
177
178 31270-22: Include Zülicke & Peters (2008) : done, thanks !.
179
180 31271-11: Delete ", in the parameter which is to be used" : done, thanks !.
181
182 31271-17: "signal power to noise power" → "signal-to-noise ratio" : done, thanks !.
183
184 31272-12: Define "UTLS" : done, thanks !.
185
186 31273-2: I would insert a coma after "winds" : done, thanks !.
187
188 31273-6: I have my problem with "SNR > 0.5". Going into fig. A1, I see for $\sigma_w = 0.1$
189 m/s an SNR of 0.5, for 0.2 m/s 0.25 and for 0.3 m/s just 0.20 - or am I wrong.
190
191 Reply : this is a correct interpretation of Fig A1. We have reasoned that, to look at
192 fluctuations due to the waves, you would need sigma to be less than the amplitude of the
193 fluctuations by at least a factor 2. To make this clearer, the phrase « (assuming that sigma
194 should be less than half the amplitude of the fluctuations to be detected) » can be added to this
195 sentence
196
197 31273-8: "that" → "than". Further, a SNR information on N^2 should be given: for 0.1 I take
198 from fig. A1 a SNR of 0.2 - right?
199 Reply : The solid black line in fig. A1 should be taken for the relation between SNR and
200 standard deviation for N^2 , so that $\sigma_{N^2} = 0.1$ corresponds to SNR = 0.1. 94% of

201 observations have SNR>0.1. However, here we have been inconsistent with the comment
202 about limits for detecting fluctuations in vertical wind. The sentence « Wave signatures as
203 small as 10% in N^2 could be detected more that 90% of the time » should be changed to
204 « Wave signatures as small as 20% in N^2 could be detected more than 90% of the time (SNR
205 > 0.1) »

206

207 *31279 (fig. 1): Please, superimpose the radar mean wind in order to distinguish weak- wind*
208 *and strong-wind periods as done for fig.s 5 and 6.*

209

210 Reply : The strong winds are not seen at the radar location – the mean winds at this location
211 are everywhere less than 15 m/s and do not change much over the interval plotted. The jet
212 seen in Figs. 5 and 6 does not reach this location. Adding wind contours to Figs1 and 2 does
213 not add anything useful.

214

215 *31280 (fig. 2): Please, add mean model wind. :*

216

217 Reply : same comment as for Fig. 1.

218

219 *31281 (fig. 3): Please, add wind (for intercomparison with fig.s 5 and 6).*

220

221 Reply : the wind speed is shown by the length of the arrows – adding contours would make
222 the plot very hard to read

223

224 *31283 (fig. 5): Please, control the wind arrows for the cross-sections. Looking into the map, I*
225 *would expect there arrows pointing to the left (into southerly directions).*

226

227 Reply : Sorry there was a programming error - the figure has been corrected.

228

229 *31284 (fig. 6): See item above.*

230

231 Reply : as for Fig 5 - the figure has been corrected.

232

233 *31288 (fig. A1): delete "all measured" : done, thanks !*

234

235

236

237 OTHER CORRECTIONS

238

239 Typing errors in equations 6, 8 and 9 have been pointed out to us by Dr. Gubenko. These
240 should read

241

$$242 \quad a_e = [2 (1-f^2/\omega_e^2)^{0.5}] / [1+(1-f^2/\omega_e^2)^{0.5}] \quad (6)$$

243

$$244 \quad |u'| = (2 - a_e) \lambda_z N / 2 \pi \quad (8)$$

$$245 \quad |v'| = (1 - a_e)^{0.5} \lambda_z N / \pi \quad (9)$$

246

247