Comment on revised version of "Retrieving characteristics of Inertia Gravity Wave parameters with least uncertainties using hodograph method" by Gopa Dutta et al.

Referee #2, Vladimir Gubenko

This paper presents an attempt to overcome the inconsistency of hodograph method when retrieving the internal wave parameters from radisonde measurements. It seems to me, the description of scientific methods and theoretical expressions used for calculations of wave characteristics and their uncertainties **is not satisfactory and needs to be strongly improved**. **Authors of this paper should better learn the basic equations and hodograph method for internal gravity waves.** I think that this **paper is not acceptable for publication in the journal with a high standard "Atmospheric Chemistry and Physics"** in its present form. For this reason, I would advice **MAJOR REVISION.**

Major Comments:

1. Page 3, line 27. Authors would like to leave in the text of revised version their polarization Eq. (1) and following designations: *u'* are zonal wind perturbations and *v'* are meridional wind perturbations (see author's answers to my comments). Of course, authors may choose any designations for variables, but **in this case your Eq. (1) is not polarization Equation for the values *u'* and *v'*! In reality, your Eq. (1) is polarization Equation for the parallel and perpendicular perturbation components** of wave-induced horizontal wind speed to the wave propagation direction [see for details, for example, Gubenko et al. (2008, JGR, p. 2); Gubenko et al. (2011, AMT, p. 2155); Gubenko et al. (2012, Cosmic Res., p. 22)].

For the general case of an inertia gravity wave with intrinsic frequency ω, propagating in an atmosphere with Coriolis parameter *f*, the meridional (*v'*) and zonal (*u'*) wind oscillations differ in amplitude and phase, and are related through the following expression (see formula (2) on page 513 of Eckermann and Vincent (1989), or Gossard and Hooke (1975)):

$$v' = \frac{(l/k)\left[1 - i(f/\omega)(k/l)\right]u'}{\left[1 + i(f/\omega)(l/k)\right]} = \frac{(l/k) - i(f/\omega)}{1 + i(f/\omega)(l/k)}u' = \frac{(\omega l - ifk)u'}{\omega k + ifl}, \qquad (1)$$

where k and l are the zonal and meridional components of the horizontal wavenumber vector, respectively. This formula implies elliptical wave polarization, with frequency dependent ellipse eccentricity of (f/ω). The phase motion of such an inertial gravity wave will have a horizontal component, lying along the major axis of this motion ellipse. **Only in the special case, for a zonally propagating wave ($l = 0$), our polarization Eq. (1) will coincide with polarization Eq. (1) of your manuscript.**

Unfortunately, the citation of Tsuda et al. (1994) is not the real argument, because this work contains the same mistakes as you do.

2. Page 3, line 32. **You have not considered my early comments.** In the work of Gubenko et al. (2012, Cosmic Res., p. 23), the dispersion equation in the interval of intermediate intrinsic frequencies ($f^2 << \omega^2 << N^2$) is given: $|k| = \omega\,|m|\,/\,N$. This equation assumes **only** linear wave polarization but nor elliptical wave polarization, because $f^2 << \omega^2$. **If you use your Eq. (3)** to calculate the value $|k|$, then calculated values of horizontal wave number $|k|$ **will be systematically**

overestimated by factor $(1 - f^2/\omega^2)^{-1/2}$. This is connected with fact that **the appropriate dispersion equation for your case study** should be valid for internal waves both with low and with intermediate intrinsic frequencies ($f^2 < \omega^2 << N^2$). **The appropriate dispersion equation** has form (Gubenko et al. 2012, Cosmic Res., p. 23): $|k| = (1 - f^2/\omega^2)^{1/2} \cdot \omega\ |m| / N$.

For example, for ratio $f/\omega = 0.6$ (see your Table 2), one can find that $(1 - f^2/\omega^2)^{-1/2} = 1 / 0.8 =$ 125%. Here, we see the significant overestimation by 25% for the calculated value of $|k|$. This is not "small mistake" (see author's answers to my comments), **and the obtained results about horizontal wavelengths and wave numbers must be recalculated.**

3. Page 4, line 5. Your phrase **"Intrinsic periods of IGW obtained using equation (4) …"** is completely incomprehensible.

4. The description **of Section 3.3 "Direction of wave propagation" is not satisfactory,** and it should be remade.

References

Eckermann, S.D. and Vincent, R.A., 1989. Falling Sphere Observation of Anisotropic Gravity Wave Motions in the Upper Stratosphere over Australia. Pure Appl. Geophys. 130 (2/3), 509–532.

Gossard, E.E. and Hooke, W.H., 1975. Waves in the Atmosphere, Elsevier, Amsterdam.

Gubenko, V.N., Pavelyev, A.G., Andreev, V.E., 2008. Determination of the intrinsic frequency and other wave parameters from a single vertical temperature or density profile measurement. J. Geophys. Res. 113, D08109, doi:10.1029/2007JD008920.

Gubenko, V.N., Pavelyev, A.G., Salimzyanov, R.R., Pavelyev, A.A., 2011. Reconstruction of internal gravity wave parameters from radio occultation retrievals of vertical temperature profiles in the Earth's atmosphere. Atmos. Meas. Tech. 4, 2153–2162, doi: 10.5194/amt-4-2153-2011.

Gubenko, V.N., Pavelyev, A.G., Salimzyanov, R.R., Andreev, V.E., 2012. A method for determination of internal gravity wave parameters from a vertical temperature or density profile measurement in the Earth's atmosphere. Cosmic Res. 50, 21–31, doi: 10.1134/S0010952512010029.

Tsuda, T., Murayama, Y., Wiryosumarto, H., Harijono, S.W.B., Kato, S., 1994. Radiosonde observations of equatorial atmospheric dynamics over Indonesia, 2. Characteristics of gravity waves. J. Geophys. Res., 99, 10507-10516.