

Review for Hierro et al., “*Orographic and convective gravity waves above the Alps and Andes mountains during GPS radio occultation events – a case study*”

Summary:

This paper analyzed the collocated GPS radio occultation profiles near the convective systems identified from ISCCP over two orographic regions of Alps and Andes. Out of a total of 10 collocated RO profiles, one RO sounding (bending angle and temperature profiles) from each region was analyzed. The convective cloud top height was identified. Gravity wave (GW) analysis over both selected regions were also carried out. The gravity wave signature from the two case studies were derived base on the WRF simulation and the RO vertical profiles.

The GWs with horizontal wavelengths of 20 km and 40 km (two mode) and vertical wavelengths (15 km or 20-25 km) were identified from the WRF simulation over the two regions. The vertical propagating GWs with “apparent” vertical wavelength of ~4 km over Alps, or ~4.5 km over Andes were also identified from GPS RO soundings. The so-called distortion factor was also investigated, which measures the discrepancy between the “apparent” (or measured) and the “real” vertical wavelength affected by the RO observation geometry reference to the GWs propagation direction.

Overall, the paper use the case study to demonstrate the GPS RO capable of detecting the vertically transporting GW over the orographic regions, where mountain waves persistent as seen in the WRF simulations. The high vertical resolution GPS RO sounding has the advantage of detecting the fine vertical scale GWs but less capable of identify the GW with fine horizontal wavelength (e.g., Wu et al., 2006). The paper seems trying to synergize the GPS RO observation with the WRF simulation to present a more complete picture of the GW morphology, which has the merit for publication. However, it is not clearly stated in both the introduction and conclusion of the paper.

I would recommend publication of the paper after “major revision” with my comments below:

Major comments:

- (1) The paper writing need some significant improvement to better describe the research work, including the grammar and sentence structures.
 - a. Many super long sentences should be split into shorter sentences.
 - b. The author(s) intend to use the “first” person throughout the paper. Generally the scientific paper should be written with third person.
- (2) The motivation and key contribution of this paper need to clearly stated in the introduction. The authors add a short paragraph (L102-108) in the introduction, which was the details of work of the paper, but not “Why” to carry out such work. The motivation should be the science or technical questions that haven’t been addressed, or what is new in this paper that advances the field of study.
- (3) Only 5 collocated cases from each regions (Alps and Andes) were identified between GPS RO and ISCCP. And only one RO case for each region were used for the case studies. It is hard to believe that one single RO case is representative of such a large region,

especially hard to believe the single cloud-top-height identified from the bending/temperature anomaly method will be representative over such a large study domain.

- a. The author's response shows 294 collocations over Alps but only 50 collocation over Andes within 3-hr and 100 km of the ISCCP convective systems, which should be included in the manuscript. The selection of the 10 case need to be justified.
 - b. Should consider demonstrate these RO soundings in **statistical sense** that they can detect consistently the gravity waves with vertical wavelength of 4-4.5 km, instead of randomly pick one out of 5 cases.
 - c. Also ISCCP website shows the DX (B3) data are available 07/01/1983 - 12/31/2009.
 - d. More robust analysis of the GW from more collocated GPS RO soundings near convective systems will strengthen the selection of the "representative" case for further WRF simulation study and improve the paper quality.
- (4) Some technical details are missing and need to be added,
- a. What exact parameters from ISCCP were used?
 - b. How ISCCP identify the convective system? Any uncertainty related to the usage of infrared CTT to identify the convective system, especially over cold surface?
 - c. How to detect the CTH from the anomaly method (Biondi et al, 2012)? What threshold etc. used to identify the CTH in Fig. 1a,b? Can't just cite the paper. The basic details are still needed to be included in the paper.
 - d. Discussion on the result out of CWT is missing for both Fig. 5 and Fig. 9. What exactly plotted (e.g., parameters) need to be detailed described in the manuscript, and should be after the discussion of Fig. 4. The author(s) sometimes jump the discussion without following the orders of the figures.
 - e. Section 2: missing information of the duration of RO data used in this paper, e.g., what years data were used, are they same for different RO missions?
 - f. L156: need description of the reference climatology profile, e.g., how many year average, horizontal, vertical sampling interval, how to do average etc.
 - g. L159: WRF model description needed, e.g., version, horizontal, vertical resolution, citation.
- (5) Figures need to be improved:
- a. Fig. 1: The four cases in smaller inlet are hardly legible.
 - i. Might consider combine all five (or more cases) into one statistical plot plus the one individual plot in the middle panel.
 - ii. RO profiles from which RO mission should be indicated in plot or the manuscript.
 - b. Fig. 8&9 should be consistent with Fig. 4&5, respectively
 - i. Why Fig. 8 only has three UTC time but Fig. 4 shows four UTC time?
 - ii. Why adding temperature wavelet analysis result in Fig. 9d but not in Fig. 5?
 - c. Fig. 10:

- i. The distortion factor could explain the discrepancy of the GW vertical wavelength seen in GPS RO (4 – 4.5 km, L322,) as compared to the WRF simulation (~15 km, L288, ~20-25km, L421). But why the two “green circle” at those certain locations were not discussed. Will the plot different for other region, e.g., over Alps?
- (6) Most of the figure captions did not describe what is plotted and need to be updated.
 - a. The reader should be able to understand the figure without the need to consult the text. It might be worth consulting the paper by de la Torre A. et al. (2006) or others on caption writing.
 - b. All the color bars do not have “UNITS” either on plot or in the caption.
 - c. Fig. 3: There are no description on what is plotted in Figure 3, variance??. You can’t simply say it is “GW” structure.
 - d. Same for Fig. 5, 6c, 7,8, 9c. The details in each panel need to be clearly described in caption succinctly.

Technical comments:

- L40: “Vertical profiles ... (Kursinski and Gebhardt, 2014). Need to be rewritten to be parallel statement.
- L42: “0.1-0.3 g kg⁻¹”
- L48: “troposphere and lower stratosphere
- L72: “storms”
- L74: “strongly affects”
- L83: “Fovel et al., ..., generating high-frequency???” Sentence is not complete.
- L102 -108: Not a motivation, need to be rewritten.
- L109: “Section 2...”
- L125: RO data duration should be added
- L130: Figure 1 caption should include what is plotted. E.g., the elevation map, Alps over Europe and Andes in South America...
- L143: According
- L146: “interval” → “difference”
- L156: Missing description of the reference climatology profile, e.g., how many year average, horizontal, vertical sampling interval, how to do average etc.
- L172: The total number of collocations (e.g, 294 over Alps, 50 over Andes) should be mentioned, and better to show the statistical results of the analysis instead of the hand-pick of the 5 cases. Or justification of the representativeness of the selected cases are required.
- L180: Fig.1 need to be updated. Hardly legible.
- L183: Caption should describe/mention each panel. Very hard to understand and need to be rewritten.
- L195: 3.1. Case study over the Alps region
- L205: What is plotted in Fig. 3 need to be clearly stated.
- L240: They reach again... after a partial... → They reach large amplitudes again in stratosphere after ... tropopause at around 11km.
- L247: in red ~~for altitude reference~~.
- L250: (CWT) corresponding to Figs. 4a, b, and d, ..., Why missing Fig. 4c??

- L311: “perfect” band-pass, What does that mean?
- L297: Fig. 6c caption should describe what is plotted, basically what is the results after CWT, plus the unit of the color bar.
- L313: “This method has two steps: ..., ..., and to force a zero mean.” Super long sentence and need to be broken up into smaller pieces.
- L316: We keep in mind that → Note that.
- L328: prevent us ~~to~~ (from) observing
- L371: 3.2. Case study over the Andes region
- L377: What does “[7;-3]” mean? It was shown in many places.
- L390: caption need to describe what is plotted, plus the unit.
- L414: Missing detailed description and discussion of Fig. 9.
- L415: Fig. 8, Zonal variation of w in WRF simulation at ??altitude in three UTC times (13, 17, and 21 UTC) over the Andes region. The GPS RO took place at 16:56 UTC with mean LTP at
- L440: Similar to Fig. 6, but for the RO case study from Fig. 1b over the Andes region.
- L455: Equation (1): should $\cot(\alpha)$ be $\cos(\alpha)$ instead?
- L465: please describe why the two green circles at the specific “propagation angle”.
- L474: were → where