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Interactive comment on "Lee waves detection over the Mediterranean Sea using the Advanced Infra-Red WAter Vapour Estimator (AIRWAVE) Total Column Water Vapor (TCWV) dataset" *by* Enzo Papandrea et al.

Anonymous Referee #2

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Review of "Lee waves detection over the Mediterranean Sea using the Advanced Infra-Red WAter Vapour Estimator (AIRWAVE) Total Column Water Vapor (TCWV) dataset" by E. Papandrea et al., 2019

The authors describe the use of total column water vapour (TCWV) data from ATSR-2 and AATSR satellite radiometer measurements to study lee waves, which create a phase imprint on the former quantity resulting from the lee wave perturbations of atmospheric motion. The TCWV retrieval algorithm was created by a number of the same authors. They also here develop a gridded lee wave diagnostic tool based on

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the variability of TCWV within a grid square, which is shown to be largely instrument-independent due to its focus on relative variability compared to areas measured by the same instrument where lee waves are weak. After applying to 20 years of satellite data, a number of case studies are extracted to show the diagnostic's representativity of lee wave activity. Aside from the usefulness of the authors' method for general lee wave research, as model resolution increases, resolution of lee waves by regional scale numerical weather models is becoming more commonplace, and it is important that the models represent these phenomena accurately due to their impacts on surface winds and variability, as well as orographic drag on the atmosphere. To validate this properly, distributed measurement methods are required, to which common observation networks are not well suited. A number of methods including visible satellite imagery, focussed field campaigns and spaceborne synthetic aperture radar wind measurements can be used but each has its weakness, and the more corroborating sources of information are available the better. This paper provides a good demonstration of another rich source of information which can be used in the above capacity, or simply as a real-time detection method for meteorological guidance providers, and which builds upon examples of similar data exploitation in the literature. It is well written and straightforward to understand. Subject to addressing a number of minor queries and questions below ("p" referring to page and "l." referring to line numbers), I recommend it for publication in Atmospheric Measurement Techniques.

p1:

l.11. Redundant full-stop before citations.

l.13. M. Teixiera et al. have recently published a number of papers studying drag due to trapped lee waves, which could be referenced here (DOI:10.1002/qj.2008, 10.1175/JAS-D-12-0350.1, 10.1175/JAS-D-16-0199.1, 10.1002/qj.3177).

p2:

l.25-34. Can the authors outline the basic mechanism by which lee waves cause TCWV variation?

p4:

l.5-6. Does significant variation of the baseline TCWV occur in different cases depending on the moistness of the atmosphere or other factors, and does this in turn influence the value of NTSD for a given wave amplitude (as defined in terms of vertical velocity or some other more direct parameter)? Alternatively, do other factors (such as the propensity for sea surface evaporation due to whatever cause) influence the value of TCWV for a given wave amplitude?

l.10. Can the authors give some idea of the areas and criteria used?

l.17. By what criteria was "best performance" determined?

l.23-24. Over what interval is TR1 calculated (or how many scenes)? Or do the authors mean "cloud-free grid cells" and not "cloud-free scenes" on line 23? Can the authors comment on the possible effects of variable coverage of TCWV due to missing data on the values of TR1 and TR2? For instance, if data is missing in one case close in the lee of a mountainous island, and in another case the opposite.

p5:

l.6-7. The correlation is reasonable in an absolute sense, but the fall to zero in winter despite a still-substantial minority of cloud-free scenes is notable - can the authors speculate on reasons for this? For instance, are significant lee waves in winter ubiquitously accompanied by cloud (due to the synoptic conditions in which they arise)? Or some other reason?

l.22. Why does wavelength influence the NTSD? Assuming, for simplicity, sinusoidal behaviour, I would think the NTSD should be the same for a given amplitude regardless of wavelength. As the wavelength approaches the data resolution, this could emphasise extreme TCWV values, increasing NTSD, but will also smooth them, with a compensating (or greater) diminution of the NTSD value.

Figures 2-5. It would be useful to have a key for the ERA-Interim wind vectors shown on these plots, indicating the wind speed for a given vector size (e.g. 20 m/s).

p6:

l.9. There is some redundancy/repetition within this sentence.

p7:

l.33. This is helpful but the link is deprecated - at the moment it provides information and links through to https://esar-ds.eo.esa.int/oads/access/, the new catalogue. It would be useful to add the latter link in case the former legacy page becomes defunct.

Figure 5. There appear to be some large NTSD values in grid squares to the left of the lowermost red box in the top panel, an area with a high degree of missing data, although the TCWV variability in the same area seems rather tame - is this some artefact of missing data? The SAR and TCWV data patterns (i.e. wave phase) are not quantitatively alike in the respective panels, presumably due to a time offset. Rather than quoting orbits for these data, which mean little to the reader, could the authors state the overpass times corresponding to the SAR and TCWV images.

Figure 6. "Wavelength" is spelled wrong in the axis title.

p9:

l.2-7. It would be useful also to compute at least a rough trapped wave wavelength based on the Scorer parameter (or very crudely, 2*Pi*U/N over some layer close to the mountain top) for comparison with these values.

l.17. I assume the method may struggle to distinguish lee waves from e.g. the Bora outflows common in the Adriatic, convective storms or other features that could create large NTSD values? I don't wish to invalidate the authors' method, which has virtues of simplicity and transparency, is relatively instrument-independent, and is effective where we know lee waves are the dominant cause of TCWV variance. I do, however,

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wonder if there are certain caveats, or if a further layer of analysis or diagnosis would be required before the algorithm could be reliably operated in a fully automated way.

l.28-29. Given the potential usefulness of this technique (and the low frequency of overpasses), are the authors able to highlight a more comprehensive list of instruments for which this type of analysis would possible?

Final comment (an inversion of comments above concerning p4. l5-6.): Have the authors done any study concerning the vertical velocities corresponding to a given NSTD value, for instance a correlation plot at the level for which lee waves most strongly influence TCWV? Although the correlation may contain some scatter, the equivalence would presumably be less crude than, for instance, the commonly-used inference from satellite images in the visible range. If not, this would be a useful future study, which could be carried out using either model data or, where vertical velocity data may be obtained, observations.

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