Atmospheric Gravity Waves in Aeolus Wind Lidar Observations

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Overview

- Aeolus is the **first** Doppler wind lidar in space, providing unique **high-resolution** measurements of **horizontal wind** in the **upper-troposphere/lower-stratosphere (UTLS)**, with **global coverage.**
- We demonstrate Aeolus' ability to observe **gravity waves (GWs)**, and show results from a special change to the onboard **range-bin settings (RBS)** over the **Southern Andes** during **austral winter 2021**.
- Although GWs are an important driver of the global atmospheric circulation, they are difficult to observe due to their scale size and location. Wind measurements of GWs in the free troposphere and UTLS are limited, so Aeolus has the potential to fill this gap.
- We compare synthetic Aeolus wind measurements from ERA5 with the Aeolus data, and explore one case-study from 2019, and another of two intersecting Aeolus orbits using the special RBS in May 2021.

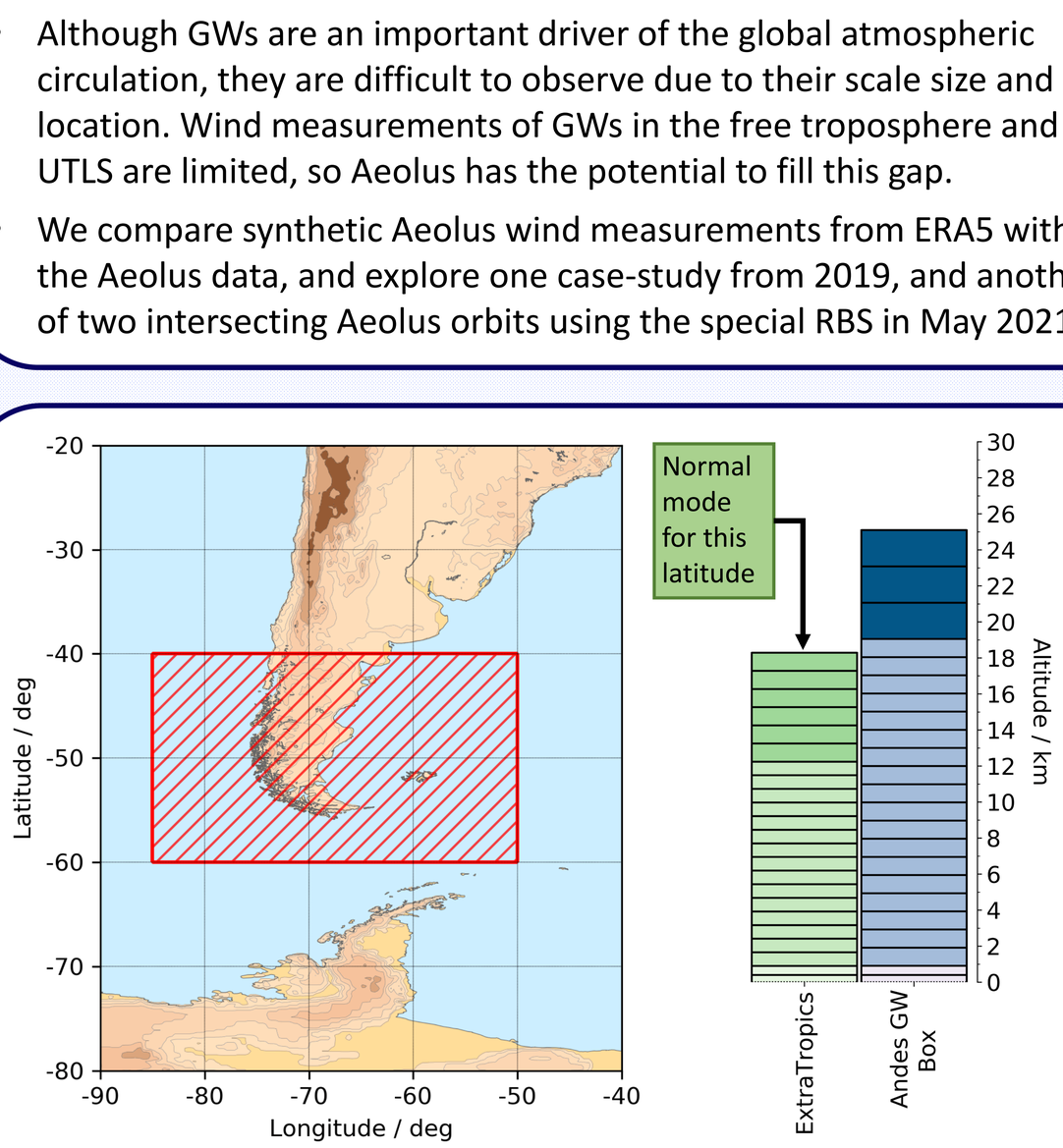

Fig. 1: Geographical and vertical extent of the special GW RBS

Southern Andes GW Range-bin Settings

- The Southern Andes are a GW hotspot and frequently produce the strongest GW fluxes anywhere on Earth.
- Many studies, e.g. [1,2], show strong GW activity in the region between 40°S-60°S and 50°W-75°W , with large amplitudes around 40 km altitude. Since these are orographic waves, there must be similar GW structures down to the surface.
- The Southern Andes GW RBS Box is placed over this same region, extended west to 85°W to provide good background conditions.

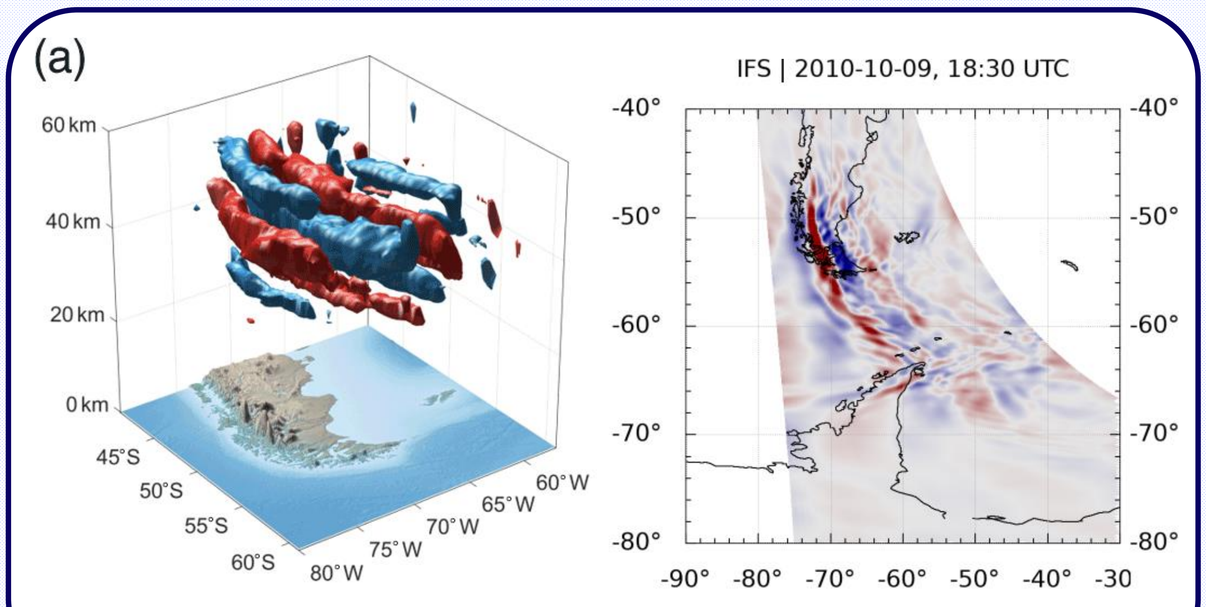

Fig. 2: Figures from Wright et al. 2021, *AMT* and Kruse et al. 2022, *JAS*

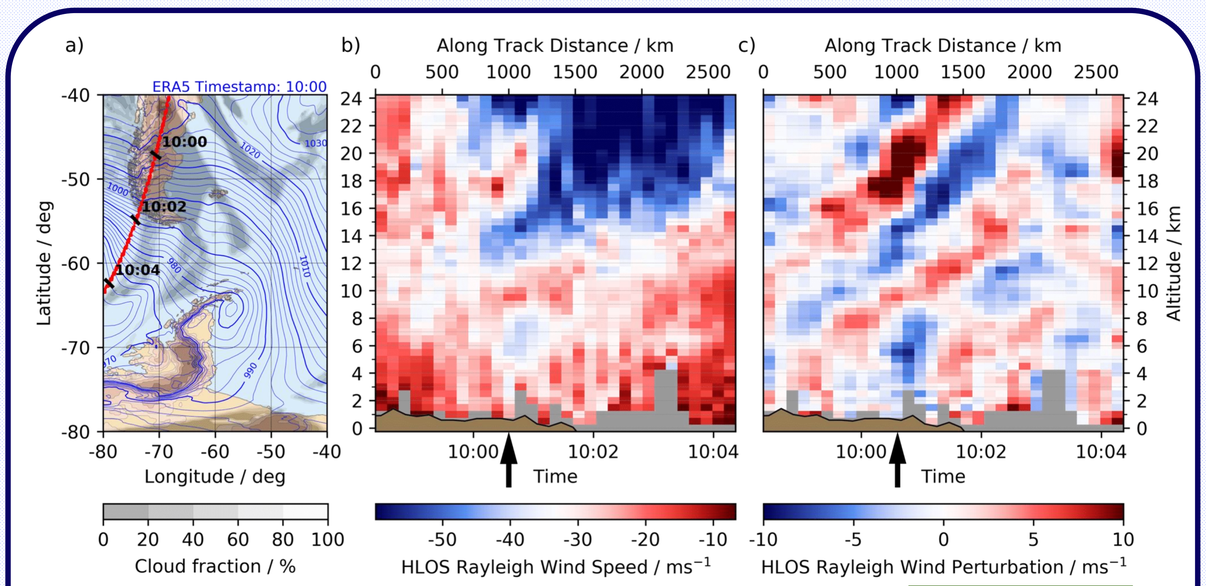

Fig. 3: Figure from Banyard et al. 2021, *GRL*

July 26, 2019

Results

- Figure 3 demonstrates for the first time that GWs can be observed using a space-borne wind lidar.
- Figure 4 shows two intersecting Aeolus orbits from the Southern Andes GW RBS, where the effect of increasing the highest altitude can be seen.
- In both, reasonable agreement is seen between Aeolus and ERA5.

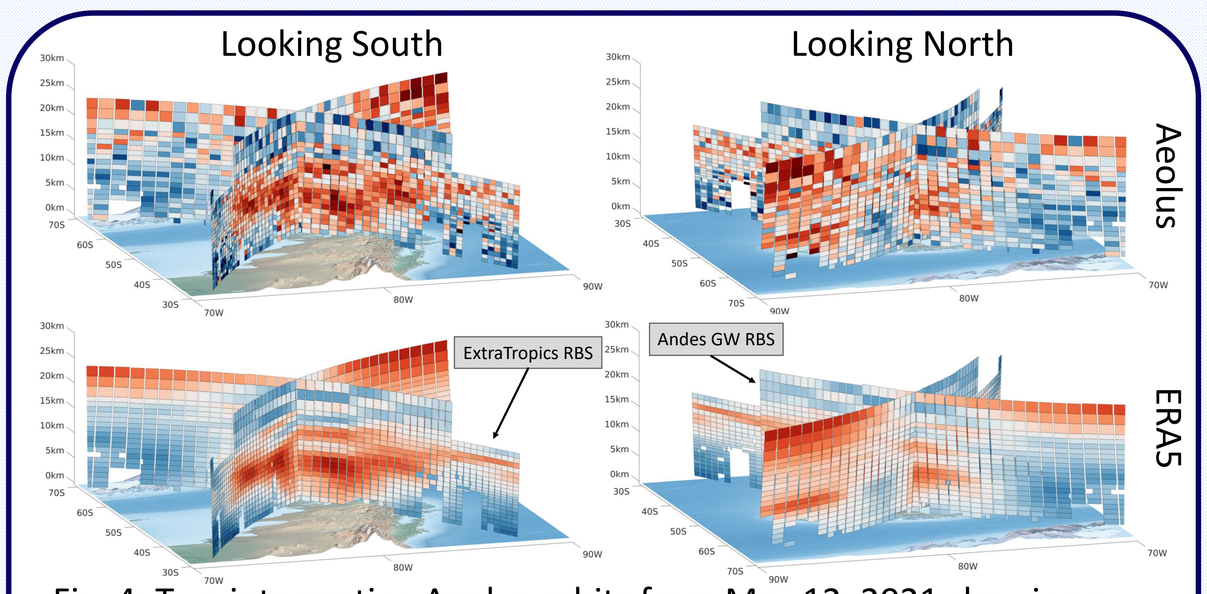

Fig. 4: Two intersecting Aeolus orbits from May 12, 2021 showing a strong GW propagating upwards above the Southern Andes

Conclusions and Future Work

- Aeolus provides the first measurements of GWs using a space-borne wind lidar. These compare well with ERA5 and other observations.
- The special change to the onboard RBS allows us to see much higher into the stratosphere above the Andes, which are a GW hotspot.
- Further work to extract GW momentum fluxes and construct a GW climatology using Aeolus, as well as study on the QBO, is ongoing.

References

1. Wright, C. J., Hindley, N. P., Alexander, M. J., Holt, L. A. and Hoffmann, L. (2021). Using vertical phase differences to better resolve 3D gravity wave structure. *Atmospheric Measurement Techniques*, 14(9), doi.org/10.5194/amt-14-5873-2021
2. Kruse, C. G., Alexander, M. J., Hoffmann, L., van Niekerk A., Polichtchouk, I., Bacmeister, J. T., Holt, L., Plougonven, R., Šácha, P., Wright, C. and Sato, K. (2022). Observed and Modeled Mountain Waves from the Surface to the Mesosphere Near the Drake Passage. *Journal of the Atmospheric Sciences*, 79(4), doi.org/10.1175/JAS-D-21-0252.1
3. Banyard, T. P., Wright, C. J., Hindley, N. P., Halloran, G., Krisch, I., Kaifler, B. and Hoffmann, L. (2021). Atmospheric gravity waves in Aeolus wind lidar observations. *Geophysical Research Letters*, 48, doi.org/10.1029/2021GL092756

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Paper Reference 3: Banyard et al. 2021, *GRL*