JGR Atmospheres

INTRODUCTION TO A SPECIAL SECTION
10.1029/2019JD030247

Special Section:
Atmospheric Gravity Wave Science in the Polar Regions and First Results from ANGWIN

An Introduction to Atmospheric Gravity Wave Science in the Polar Regions and First Results From ANGWIN

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Citation:
Moffat-Griffin, T. (2019). An introduction to atmospheric gravity wave science in the polar regions and first results from ANGWIN. *Journal of Geophysical Research: Atmospheres*, *124*, 1198–1199. https://doi.org/10.1029/2019JD030247

Received 1 JAN 2019
Accepted 7 JAN 2019
Accepted article online 15 JAN 2019
Published online 15 FEB 2019

Author Contributions:
Writing - original draft: T. Moffat-Griffin

Gravity waves are small-scale waves (horizontal wavelengths of the order tens to hundreds of kilometers) in the atmosphere that are one of the main contributors to driving atmospheric circulation (Fritts & Alexander, 2003). As these waves propagate upward they become unstable and break, depositing their energy and momentum into the mean flow. They are generated by a range of mechanisms, for example, instabilities at the edge of the polar vortex, wind flow over topography, and the aurora.

Gravity waves are ubiquitous throughout the atmosphere, however in the Polar Regions there are hotspots of intense gravity wave activity. The small-scale size of gravity waves means that they have to be represented by parameterizations in global numerical atmospheric models. These parameterizations do not accurately represent the momentum deposited in the atmosphere from gravity waves. This can cause problems in some models with middle atmospheric temperatures being too cold in the polar regions and the polar vortex dispersing too late (Garcia et al., 2017; McLandress & Scinocca, 2005). These parameterizations can be constrained and improved using observations of the gravity wave field, however there is a lack of comprehensive observations in the Polar Regions.

The Antarctic Gravity Wave Instrument Network (ANGWIN) was formed by Antarctic scientists wanting to develop a network of Antarctic gravity wave observatories, sharing data and standardizing analysis techniques in order to understand gravity wave processes on a continent wide scale (Moffat-Griffin, 2015). This network has expanded over the years and now includes work in the Arctic and modeling gravity waves work.

This special issue came about as a result of the third ANGWIN international workshop (Moffat-Griffin et al., 2017). The papers in this issue cover a range of ANGWIN activities and also observations from across the atmosphere.

One paper utilizes mesospheric airglow all-sky imager data from several Antarctic stations (Matsuda et al., 2017) as a direct result of early ANGWIN work. It provides a good example (and template) for future work in the standardization of analysis techniques and comparisons across the continent.

The rest of the papers can be divided up into mesospheric/lower thermosphere gravity wave studies and lower atmosphere gravity wave studies. The seasonal variation of Traveling Ionospheric Disturbances over Alaska (Negale et al., 2018) is examined using the Poker Flat radar. A rare case of mesospheric frontal gravity waves over the South Pole is also discussed (Pautet et al., 2018), with around 70% of the waves shown to be ducted waves. The first detailed study of radiometer data from Davis Station, Antarctica (68°S, 78°E), is included in another paper (Rourke et al., 2017), where the mesospheric gravity waves were ray traced back to reveal a range of sources including the Polar Vortex and local storm activity. A case study looking at mountain waves close to the Polar Regions (New Zealand) shows how strong tropospheric forcing can cause large amplitude mountain waves (Bramberger et al., 2017). The first application of tomography on Polar Mesospheric Clouds using AIM data examines gravity waves is explained in detail (Hart et al., 2018) in the last mesospheric paper of the special issue.

The lower atmosphere papers include another study of observations from Davis, this time focusing on lower atmosphere observations using a VHF wind profiling radar and comparing its observations with a high resolution version of the unified model (Alexander et al., 2017); the findings in this paper conclude that these lower atmosphere waves have an influence on the locally observed cirrus clouds. A climatological paper studying waves in the lower stratosphere above Halley (75°S, 26°W), Antarctica is also included in the collection, examining the variation in gravity wave properties throughout the year (Moffat-Griffin & Colwell, 2017). The final paper in the collection uses LIDAR observation from Syowa (69°S, 40°E), to study the gravity wave field from the stratosphere to the lower mesosphere and demonstrates the role of wind filtering in determining the gravity wave field at a given height (Kogure et al., 2017).

This special issue has been a catalyst for future ANGWIN activities and we hope to further our goals and contribute to the understanding of the gravity wave field in the Polar Regions and contribute to improving gravity wave parameterizations in models.

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