Dynamics of the Antarctic and Arctic mesosphere and lower thermosphere – Part 1: Mean winds

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Zonal and meridional winds have been measured in the upper mesosphere and lower thermosphere at polar latitudes using two ground-based meteor radars. One radar is located at Rothera (68° S, 68° W) in the Antarctic and has been operational since February 2005. The second radar is located at Esrange (68° N, 21° E) in the Arctic and has been operational since October 1999. Both radars have produced relatively continuous measurements. Here we consider measurements made up to the end of 2009. Both radars are of similar design and at conjugate geographical latitudes, making the results directly comparable and thus allowing investigation of the differences in the mean winds of the Antarctic and Arctic regions. The data from each radar have been used to construct climatologies of monthly-mean zonal and meridional winds at heights between 80 and 100 km. Both Antarctic and Arctic data sets reveal seasonally varying zonal and meridional winds in which the broad pattern repeats from year to year. In particular, the zonal winds display a strong shear in summer associated with the upper part of the westward summertime zonal jet. The winds generally reverse to eastward flow at heights of ~90 km. The zonal winds are eastward throughout the rest of the year. The meridional winds are generally equatorward over both sites, although brief episodes of poleward flow are often evident near the equinoxes and during winter. The strongest equatorward flows occur at heights of ~90 km during summer.

There are significant differences between the mean winds observed in the Antarctic and Arctic. In particular, the westward winds in summer are stronger and occur earlier in the season in the Antarctic compared with the Arctic. The eastward winds evident above the summertime zonal wind reversal are significantly stronger in the Arctic. The summertime equatorward flow in the Antarctic is slightly weaker, but occurs over a greater depth than is the case in the Arctic.

Comparisons of these observations with those of the URAP and HWM-07 empirical models reveal a number of significant differences. In particular, the zonal winds observed in the Antarctic during wintertime are significantly weaker than those of URAP. However, the URAP zonal winds are a good match to the observations of the Arctic. Significant differences are evident between the observations and HWM-07. In particular, the strong wintertime zonal winds of the Arctic in HWM-07 are not evident in the observations and the summertime zonal winds in HWM-07 are systematically stronger than observed. The agreement with meridional winds is generally poor.

There is a significant amount of inter-annual variability in the observed zonal and meridional winds. Particularly high variability is observed in the Arctic zonal winds in spring and is probably associated with stratospheric warmings.

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