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Wind regime at 80–110 km at mid-latitudes of the northern hemisphere

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Abstract—The dynamics of the mesosphere and lower thermosphere (80–110 km) are investigated using data for 1987 from two radar systems which are widely spaced in longitude but close in latitude; the meteor radar at Kazan, Russia (56°N, 49°E) and the medium frequency radar at Saskatoon, Canada (52°N, 107°W). The mean prevailing zonal winds at both locations are dominated by eastward/westward circulations in winter/summer months below ~95 km, but the shape and strength of the wind contours and the timing of equinoctial transitions differ significantly. Also, while the meridional winds at both locations demonstrated their strongest southward flows at 85–90 km during summer, consistent with the closure of the westward circulation, other months and heights differed. These differences are discussed and/or explained in terms of the amplitudes and phases of the semi-annual and annual oscillations, longitudinal differences in circulation and planetary waves. Considering the tides, the semi-diurnal oscillations at Kazan and Saskatoon have rather similar characteristics, namely, strong transitions in the equinoxes between solstitial states having longer wavelengths in summer (100–∞ km) and shorter in winter (30–100 km). During several months, however (November, December, February), the wavelengths are significantly different (e.g. 90 and 35 km, respectively, in February), and in summer and autumn months the Kazan oscillations demonstrate consistent 0.5–2 h phase shifts toward later times for maximum amplitudes. For the diurnal tide, amplitudes are generally smaller and the phase gradients less regular; given this the oscillations are rather similar at each location with a tendency toward evanescence in summer and shorter wavelengths or irregularity in winter months. The differences in tidal behaviour are discussed in terms of non-migrating tidal modes.

The results of the comparisons between Kazan and Saskatoon are discussed in terms of other mid-latitude observations and empirical models [e.g. MIYAHARA *et al.* (1991) *J. geophys. Res.* **96,** 1225]. The paper also contains a comparison (favourable) between the winds obtained from a non-height ranging meteor radar at Obninsk (400 km distant) and the mean winds (~95 km) from the Kazan radar. An important conclusion is that the seasonal/monthly dynamics of the mesopause region may differ significantly with longitude.

1. INTRODUCTION

The currently operative world radar network intended to investigate dynamical processes at the mesosphere/lower thermosphere altitudes has provided a large amount of data on wind regimes as part of various national and international programmes, among them GLOBMET, MAP, and MLTCS of the Solar Terrestrial Energy Program (1990–1997). Based on consistent data analyses, statistically validated conclusions have been drawn about regularities in climatic wind regimes at heights 70–110 km at mid-, high- and low-latitudes of the northern and southern hemispheres (MANSON *et al.*, 1990 in CIRA, 1986; PORTNYAGIN, 1986). It has been found that the major contribution to seasonal variations of the prevailing wind and tidal parameters is made by the annual mean wind and annual and semi-annual harmonics of the daily-mean winds. The seasonal wind variations were found to be primarily dependent on latitude, while longitudinal and year-to-year variability of the wind velocities appeared to be smaller (PORTNYAGIN, 1986). That is why regularities of the seasonal/latitudinal variations of wind regime parameters have received most study.

Meanwhile, to develop three-dimensional global circulation models and to determine the contribution of stationary planetary waves of small wave numbers ($n = 1, 2$) into the climatic wind regime at the heights under study, it is crucial to investigate the longitudinal dependence of major components of the seasonal variations.

There are indications in a number of papers (MANSON *et al.*, 1990; KAZIMIROVSKY and VERGASOVA, 1989; PORTNYAGIN and LYSENKO, 1983) that radar measurements of the lower thermosphere winds exhibit significant longitudinal variations. It should be noted, however, that conclusions about these differ-