

Longitude variability of the solar semidiurnal tide in the lower thermosphere through assimilation of ground- and space-based wind measurements

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Abstract

Wind measurements from the Upper Atmosphere Research Satellite (UARS) and model output from the Middle Atmosphere General Circulation Model (GCM) at Kyushu University are used to investigate the nature of nonmigrating semidiurnal tides between 50-55°N using combined space-based (SBM) and ground-based (GBM) wind measurements at 95 km. The GCM is used to create a mock database to test the effects of various sampling scenarios, data gaps, and relative weighting between SBM and GBM, on retrieval of the longitude structure of the semidiurnal tide. SB sampling is based upon orbital characteristics of UARS. GB sampling corresponds to hourly radar measurements from Saskatoon (52°N, 107°W), Sheffield (53°N, 4°W), Collm (52°N, 15°E), Obninsk (55°N, 37°E), and Kazan (56°N, 49°E). Results are presented for the month of August when semidiurnal amplitudes are large and sampling by UARS instruments is good. By compositing over a 5-10 day "fit span," it is found that the combination of temporal coverage by GB radars and spatial sampling by the satellite is sufficient to allow reasonable recovery of the zonal wave number $s = 1, 2, 3$ components of the semidiurnal tide. Over significantly longer fit spans, the contributions of GBM become less critical. Using actual UARS and GBM during 1-20 August 1993, the semidiurnal amplitude of eastward wind is found to vary from a minimum value (12 ms⁻¹) at 20°E, to a maximum of 45 ms⁻¹ near 160°E, and a secondary maximum (29 ms⁻¹) at 300°E. The zonal wave number components corresponding to this longitude variation in the semidiurnal tide are 7.7 ± 1.9 ms⁻¹, 19.8 ± 1.5 ms⁻¹ and 13.0 ± 1.3 ms⁻¹ for $s = 1, 2, 3$ (westward), respectively where ± 1 - σ uncertainties are indicated. These results are in reasonable agreement with those simulated within the Kyushu GCM. However, there is roughly a four- to five-hour phase offset between the phases recovered from the observational data and from the Kyushu GCM, possibly connected with strong model phase gradients in this atmospheric regime. Copyright 2003 by the American Geophysical Union.

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Keywords

Aliasing, Nonmigrating, Sampling, Satellite, Semidiurnal, Tides