

Project Details

ROSES ID: NNH09ZDA001N

Selection Year: 2010

Program Element: Data, Tools, & Methods

Project Title:

TOOLS & METHODS: Mesosphere/lower thermosphere tidal strength product

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- Drob, Douglas Patrick; Collaborator; Naval Research Laboratory

Summary:

Proposal title: Mesosphere/lower thermosphere tidal strength product

Key deliverables

1. Daily quantitative value of the amplitude and phase of the low latitude propagating diurnal tide in the mesosphere/lower thermosphere altitude range. This will be a zonally averaged product, essentially describing the Hough (1,1) diurnal tide.
2. Daily assessment of the strength of periodic waves in the mesosphere/lower thermosphere. This will be a zonally averaged product describing, but not limited to, the semi-diurnal tide, the two-day wave, and the two-day planetary wave.

Methods/techniques

The TIDI experiment aboard the TIMED satellite acquires a synoptic description of the global neutral wind pattern from pole to pole and throughout the mesosphere and lower thermosphere with nearly a 100% duty cycle on a daily basis. A dominant periodic signal is the propagating diurnal tide traditionally described by the Hough (1,1) function. At equinox and at low latitudes, the neutral wind and temperature respond almost exclusively in the MLT with a 24-hour periodicity. The strength of the diurnal tide is known to vary on a semi-annual basis and to exhibit inter-annual variations. It also exhibits day-to-day changes in amplitude. Consequently, it has a variability that is difficult to capture with either first principle or empirical models. These models would be better served to adjust their behaviour given an observed tidal strength, much in the same fashion as thermosphere general circulation models employ published solar flux and geomagnetic activity indices.

Simple analysis techniques exist to extract the amplitude and phase of the diurnal tide from MLT observables, and which have been described in the literature. The University of Michigan is the point of contact for the TIDI MLT wind-measuring instrument and has the in-house capability to provide a daily diurnal tide index. Such an index may be retrieved on a daily basis in near real-time from TIDI and made deliverable to the LWS community via our mission site.

The analysis will also extract the power of other periodic features in the TIDI data. This approach requires an assessment of potential aliasing that may act to contaminate specific features such as the 2-day wave. The deliverable product will be a map of the power spectrum in terms of wavenumber and frequency (/day). The modeling community may use such a product to tune models on a daily basis rather than relying on empirical formulations or adjustable parameters.

We propose to develop the software tools that can identify tidal strength in the MLT region. The deliverable product will be a stand-alone index for the propagating diurnal tide and a web application for mapping other periodic features.

Perceived importance of the research problems and significance to NASA Heliophysics research focus areas

This proposed research is important to the Heliophysics Division of NASA via roadmap focus area 1: open the frontier to space environment prediction, which has the goal of understanding the fundamental physical processes of the space environment. The proposed work will lead to progress in LWS strategic goal #4, by providing a tool for predictive models to better deliver upper atmospheric response to changes in solar radiation and to coupling from above and below and to goal #2, understanding the degree variations in the solar radiative output have on climate.

DELIVERABLE: 1) tool to quantify MLT Hough (1,1) amplitude/phase on a daily frequency in the form of a daily index; 2) tool to portray spectral map in wavenumber/frequency of MLT periodic modes on a daily basis

DELIVERY SITE: mission site for TIDI: <http://tidi.engin.umich.edu>

SCHEDULE: first quarter of year 2) of proposal, estimated as spring 2011

Publication References:

Summary: no summary

Reference: Niciejewski, R.; Skinner, W.; Cooper, M.; Marshall, A.; Meier, R. R.; Stevens, M. H.; Ortland, D.; Wu, Q.; (2011), Verification of large-scale rapid transport in the lower thermosphere: Tracking the exhaust plume of STS-107 from launch to the Antarctic, Journal of Geophysical Research, Volume 116, Issue A, doi: 10.1029/2010JA016277

Summary: no summary

Reference: Wu, Q.; Ortland, D. A.; Solomon, S. C.; Skinner, W. R.; Niciejewski, R. J.; (2011), Global distribution, seasonal, and inter-annual variations of mesospheric semidiurnal tide observed by TIMED TIDI, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 73, Issue 17, p. 2482-2502, doi: 10.1016/j.jastp.2011.08.007