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Preface: Variability and coupling of the equatorial, low- and mid-latitude mesosphere, thermosphere and ionosphere: Latest developments of monitoring and modeling techniques

Multi-scale forcing through various types of atmospheric waves including gravity waves, tides, and planetary waves, transport energy and momentum across different spatio-temporal scales coupling the lower and middle atmosphere to the thermosphere and the ionosphere. The development of observational techniques and modelling methodologies to quantify the mechanisms of such forcing is still a critical challenge. With a view to present recent developments in monitoring and modelling the Mesosphere-Thermosphere and Ionosphere (MTI) system, in the framework of the scientific session C1.1 of the COSPAR assembly held in Pasadena between 14 and 22 July 2018, a special issue on this subject was organized with an invitation to the entire relevant scientific community to submit appropriate manuscripts for review. Out of 58 articles submitted by scientists from different parts of the globe, 27 papers were accepted for publication after a meticulous review process, with each manuscript evaluated by a minimum of two reviewers.

The papers forming this special issue give an interesting picture on the recent advances and new experiments for a better understanding of the coupling processes through winds and waves in the MTI system and their variability during quiet and disturbed conditions. Papers in this issue are based on the latest and long term observations from ground- and satellite-based experiments such as Ionosondes, IGS and several regional GPS networks, medium-frequency and Meteor Radars, Airglow, multi-spectral photometer, magnetometers, and satellite missions as F-3/COSMIC, TIMED-SABER and CHAMP. Simulation results from several empirical and numerical models such as IRI, IRI-Plas, NeQuick2, TIE-GCM, CTIpe, SPIM, GSM-TIP, EAGLE, and YM2011 are also presented.

The papers are grouped into four sections. Section 1 discusses the multi-scale coupling processes in the mesosphere and low-thermosphere region including the following: Ultra Fast Kelvin waves and related wind and temperature relations; tidal effects on longitudinal variability of Pedersen and Hall conductivities; Sudden Stratospheric Warming effects through waves; mesospheric bores and "Ripple-type" structures as seen through airglow measurements; chemical reactions with the participation of Rydberg states of O_2, N_2 and NO; and the response of the MTI system to tides. This section also introduces new experiments such as the Atmospheric Coupling and Dynamics Across the Mesopause (AcaDAMe) mission to study the multi-scale wave dynamics, the Elevation-scanned Oblique Incidence Sounder Experiment (ELOISE) to study the ionospheric effects on the oblique HF propagation, and advanced meteor radars. Methods to retrieve the altitude profiles of $O(^3P)$, O_3, and CO_2 using dayglow oxygen volume emission rates, and turbo pause level estimation using artificial periodic irregularities are also presented.

Space weather effects are presented in Section 2. Main aspects addressed in this section are the role of sub-storms behind the increase of Birkeland currents, nitrogen oxide volume emission ratio during geomagnetic storms, atmospheric effects on ground magnetic field measurements, and possible contamination in the estimation of magnetic indices ap, Ap and Kp.

Section 3 is dedicated to modelling studies and numerical simulations. Performance of IRI and other models in estimating the ionospheric dynamics for both quiet and disturbed conditions are presented. Section 4, the last section of this special issue, presents studies on ionospheric irregularities at the base of sporadic E layers, spread-F phenomena, and scintillations.

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