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Editorial

Special Issue Editorial: Atmospheric Airglow—Recent Advances in Observations, Experimentations, and Modeling

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Airglow observations, experimentations, and theoretical studies have significantly advanced our understanding of airglow in recent decades. This Special Issue is a collection of recent studies to showcase the latest results from studies in airglow observations, experimentations, and numerical modeling in the Mesosphere and Lower Thermosphere (MLT) and F regions of the terrestrial atmosphere. There are three main themes in this Special Issue. The first theme is focused on the use of satellite measurements to study the variabilities observed in the airglow emissions. The second theme is focused on ground-based observations of airglow to characterize gravity waves. The third theme is focused on airglow modeling.

The recent (NASA) Global-scale Observations of the Limb and Disk (GOLD) mission provides a unique new view of the daytime thermosphere. Immel et al. [1] studied the daily variability in the UV airglow (OI and N_2 in the 133–168-nm range) observed by the GOLD mission to characterize the behavior of these constituents of the thermosphere. Their results indicate that oxygen densities in the altitude range of 150–200 km vary independently from the variations in nitrogen. Yue et al. [2] performed a preliminary comparison between airglow-based Atmospheric Gravity Wave (AGW) observations from two space-borne sensors, the Visible/Infrared Imaging Radiometer Suite/Day-Night Band (VIIRS/DNB) and the Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere/Visible and near-Infrared Spectral Imager (IMAP/VISI). They found that wide field of view, fine horizontal resolution, sensitivity to narrow-band airglow emission lines, and minimized stray light contamination are highly desired properties for detecting AGWs in airglow emissions.

Hydroxyl (OH) airglow emissions are often used to infer neutral temperatures near the mesopause, which requires accurate Einstein coefficients. Franzen et al. [3] calculated the Q-branch of OH (6,2) Einstein coefficients from the spectroscopic observations of OH airglow by the Nordic Optical Telescope. Their study shows that values currently tabulated in the HIgh-resolution TRANsmission molecular absorption (HITRAN) database overestimate many of the Q-branch transition probabilities, which will lead to artificial inconsistencies between rotational and translational temperatures. Hart [4] used simultaneous ground-based Apache Point Observatory Galactic Evolution Experiment (APOGEE) observations and space-based Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) observations of OH emission to examine five sets of Einstein coefficients for their impact on rotational temperature calculations. Hart found that non-Local Thermal Equilibrium (LTE) effects were a larger source of error for OH rotational temperature measurements than the Einstein coefficients. In contrast, the Einstein coefficients were found to have a larger effect on column density measurements.

Giongo et al. [5] deduced the observed gravity wave characteristics and wave propagation for the year of 2017 over Comandante Ferraz Antarctic Station. It is suggested that averages of wind be used in short-day intervals for difficult airglow observational conditions and that hourly winds be used for analyses of specific wave filtering. Vargas et al. [6] presented their analysis of AGW observations made by a Na lidar and an all-sky imager in the Brazilian sector. Amplitude growth rates of gravity waves were estimated and compared from multiple instrument measurements. They found that growth rate

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distributions for waves observed in lidar are remarkably distinct from those observed in imager data. Martinis et al. [7] used all-sky imagers at magnetically conjugate locations in the American sector and in both hemispheres to investigate different characteristics of airglow depletions associated with equatorial spread F. Their work provides insights into the characteristics of equatorial spread F and can help understand how the Earth's magnetic field affects the dynamics of ionospheric plasma. Vargas et al. [8] presented a new method to analyze equatorial plasma bubble events and calculated mean zonal drift velocities using keogram images of the OI 6300.0-nm nightglow emission collected in the Brazilian sector.

Yankovsky and Vorobeva [9] presented a review of their model development for ozone and molecular oxygen photodissociation, which includes a detailed description of the formation mechanism for excited oxygen components in the daytime MLT region. They also presented new results from the latest model. Their model suggests possible applications of daytime oxygen emissions that can be used as a proxy to retrieve the altitude profiles of $O(^3P)$, O_3, and CO_2.

Huang and Vanyo [10] used two airglow models to simulate the $O(^1S)$ green line, $O_2(0,1)$ atmospheric band, and OH(8,3) airglow temperature variations induced by the CO_2 increase, solar variations (F10.7 as a proxy), and geomagnetic activity (Ap index as a proxy) in the MLT region. Their results show that all three airglow temperatures display a cooling trend due to the increase in CO_2 gas concentration. They also showed that in addition to solar variations, geomagnetic activity can have a rather significant effect on the temperatures that had not been previously looked at. A follow-up study by the same authors derived F10.7 and Ap index trends in the SABER temperature measurements [11]. They found that the annual mean zonal mean SABER temperature was highly correlated with F10.7 and moderately correlated with Ap index. The F10.7 (Ap index) trends in the simulated O_2 and $O(^1S)$ temperatures are smaller (larger) than those in the SABER temperatures.

Monitoring airglow has become a very useful diagnostic tool to help us better understand our atmosphere and the wave dynamics and airglow chemistry in the MLT and F regions. It is hoped that the results presented in this Special Issue on airglow will further spur investigations in this area for more invigorating research to come.

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