Relationship between the nighttime VLF amplitude and total column Ozone density: Possibility of monitoring atmospheric Ozone from VLF remote sensing

Sujay Pal* [1,3], Yasuhide Hobara [1,2]
(1) The University of Electro-Communication, Chofu, Tokyo, Japan.
(2) Earth Environment Research Station, The University of Electro-Communications, Tokyo Japan.
(3) Indian Centre for Space Physics, Kolkata 700084, India.

Remote sensing of the lower ionospheric region (60-100 km) using Very Low Frequency (VLF) radio waves (3-30 kHz) is a very powerful technique. This paper studies the relationship between the nighttime VLF amplitudes and total column Ozone (TCO) density for the first time. We also look how the relationship between the VLF amplitudes and TCO density depends on the latitudinal dynamics. We further consider the comparison of stratospheric temperatures at different altitudes with the VLF amplitudes and TCO density.

We have found very strong correlations among the TCO density, stratospheric temperatures and VLF nighttime data for mid-latitude propagation paths throughout the year. Coefficient of determination between the variability of nighttime VLF amplitudes and TCO density is 58% to 83% for mid-latitude VLF propagation paths. Relatively strong correlation between the TCO density and VLF data has been found only during winter to spring time for high latitude paths due to contribution from the Sun at other times. For propagation paths involving the low latitude tropical region, no significant correlations among the TCO density, VLF and temperature have been found. We explain our findings using a theoretical wave propagation model coupled with a reference ionosphere model.

This study indicates the latitudinal dependence of the influence of atmospheric dynamics on the upper mesosphere and thus the correlations of TCO density and stratospheric temperature with VLF amplitudes are not unique rather depend on the propagation paths involved. Our study also indicates a possibility of monitoring atmospheric Ozone density by monitoring mid-latitude sub-ionospheric VLF signals.