Global-scale quantification of ionospheric state from UV remote sensing onboard the Ionospheric Connection Explorer (ICON)

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Ultraviolet (UV) remote sensing of the terrestrial ionosphere from space-borne platforms provides the most comprehensive means of quantifying the ionospheric state on a global scale. Accurate quantification of ionospheric parameters based on UV remote sensing requires the development of comprehensive radiative transfer models for the emission processes used as proxies for ionospheric state and subsequent numerical methods for the inversion of integrated line-of-sight measurements to infer ionospheric profiles. In this work, we present techniques for daytime and nighttime ionospheric remote sensing using EUV and FUV measurements anticipated from the upcoming NASA Ionospheric Connection Explorer (ICON) mission.

ICON Extreme Ultraviolet spectrograph, ICON EUV, will measure altitude profiles of the extreme-ultraviolet (EUV) OII emission near 83.4 and 61.7 nm that are used to determine density profiles and state parameters of the daytime ionosphere. Both of these emissions are created by solar photoionization of atomic oxygen in the lower thermosphere, below 200 km. The 83.4 nm emission undergoes multiple resonant scattering by O+, while the 61.7 nm emission is optically thin. Thus, these emissions provide a well-configured pairing to measure the ionospheric effect on the altitude profile shape and intensity of the 83.4 nm emission as measured by the limb-viewing ICON EUV, and thereby infer the ionospheric density profile through forward modeling and inversion.

ICON Far Ultraviolet (FUV) imager, ICON FUV, will measure altitude profiles of OI 135.6 nm emissions to infer nighttime ionospheric parameters. Accurate estimation of the ionospheric state requires the development of a comprehensive radiative transfer model from first principles to quantify the effects of physical processes on the production and transport of the 135.6 nm photons in the ionosphere including the mutual neutralization contribution as well as the effect of resonant scattering by atomic oxygen and pure absorption by oxygen molecules. This forward modeling is then used in conjunction with a constrained optimization algorithm to invert the anticipated ICON FUV measurements. Furthermore, it is shown that a statistical learning algorithm capable of inferring prior ionosphere distributions in a Bayesian estimation framework can produce accurate quantification of ionospheric state even in very low SNR scenarios.

The work presented here describes the ICON EUV and FUV measurements, algorithm concepts, and approaches to inverting the measured emission profiles to derive the associated O+ profiles from 150-450 km in the ionosphere that directly reflect the electron content in the F-region of the ionosphere.