Detection of Ionospheric Alfven Resonator Signatures Onboard C/NOFS Implications for IRI Modeling

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Abstract

The 2008-2009 long-lasting solar minimum activity has been the one of its kind since the dawn of space age, offering exceptional conditions for investigating space weather in the near-Earth environment. First ever detection of Ionospheric Alfven Resonator (IAR) signatures in orbit offers new means for investigating ionospheric electrodynamics, namely MHD (MagnetoHydroDynamics) wave propagation, aeronomy processes, ionospheric dynamics, and Sun-Earth connection mechanisms at a local scale. Local and global plasma density heterogeneities in the ionosphere and magnetosphere allow for formation of waveguides and resonators where magnetosonic and shear Alfven waves propagate. The ionospheric magnetosonic waveguide results from complete magnetosonic wave reflection about the ionospheric F-region peak, where the Alfven index of refraction presents a maximum. MHD waves can also be partially trapped in the vertical direction between the lower boundary of the ionosphere and the magnetosphere, a resonance mechanism known as IAR.

In this work we present C/NOFS (Communications/Navigation Outage Forecasting System) Extremely Low Frequency (ELF) electric field measurements related to IAR signatures, discuss the resonance and wave propagation mechanisms in the ionosphere, and address the electromagnetic inverse problem from which electron/ion distributions can be derived. These peculiar IAR electric field measurements provide new, complementary methodologies for inferring ionospheric electron and ion density profiles, and also contribute for the investigation of ionosphere dynamics and space weather monitoring. Specifically, IAR spectral signatures measured by C/NOFS contribute for improving the International Reference Ionosphere (IRI) model, namely electron density and ion composition.