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# On the predictability of Equatorial Plasma Bubbles for Global Navigation Satellite System users

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Industries such as mining, agriculture, construction and aviation heavily rely on Global Navigation Satellite Systems (GNSS) signals in their daily operations. Thus, GNSS contributes significantly to the global economy. This fact has motivated research efforts towards ensuring the resilience and robustness of GNSS applications against a variety of disruptions; e.g., radio interference and "spoofing". A natural source of GNSS signal disruption is the presence of ionospheric irregularities, which induce random fluctuations in the signal amplitude and phase (called "scintillations"), potentially causing receivers to loose lock. Therefore, there exists a present need to reliably predict the presence of ionospheric irregularities specifically for GNSS users. Equatorial Plasma Bubbles (EPBs) – also referred to as Equatorial Spread F due to their appearance in ionogram traces – are common sources of plasma irregularities that occur during the nighttime hours in the low-latitude region. The generation of EPBs is understood to be caused by the Generalized Rayleigh-Taylor (R-T) plasma instability, in which a strong vertical plasma density gradient and an upward plasma drift combine to destabilize the plasma. The R-T instability growth rate magnitude exhibits both a seasonal and daily dependence, which is important to consider in the prediction of EPBs. The seasonal trends are rather well understood, but the daily variability remains a significant challenge. Recently, R-T growth rates were calculated from global coupled ionosphere-thermosphere models and were shown to exhibit a similar daily variability to the observed EPB occurrence in multiple locations and periods. Such progress motivates our current efforts to translate these findings into an operational forecast for GNSS users in low-latitude regions. As this research proceeds towards translation into operations, effective measures of forecast skill and success must be determined and used to track progress, compare against other models and techniques, and to identify room for improvement to ensure that the need for reliable GNSS scintillation forecasts is being met. In this contribution, GNSS and VHF scintillation data collected by the Scintillation Network Decision Aid (SCINDA) network around the world in 2013-2014 is analyzed and compared against the R-T growth rates calculated using the most recent Thermosphere Ionosphere Electrodynamics General Circulation Model. As part of this comparison, the usefulness of various forecast skill metrics for the prediction of EPBs for GNSS users is explored.