# Investigations of Plasma Instabilities using GNSS observations and a combination of Propagation model and a first principles Plasma model

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Fluctuations in plasma density in the ionosphere can be observed as amplitude and phase scintillations in the Global Navigation Satellite Systems (GNSS) signals. Phase scintillations are frequently observed in the high latitude ionosphere. Plasma processes responsible in the production of density structures in auroral and polar regions, some of which generate these phase scintillations, include gradient-drift instability (GDI) and Kelvin-Helmholtz instability (KHI). In order to investigate these phenomena, we combine the capabilities of a forward propagation model and a plasma model. Satellite-beacon Ionospheric-scintillation Global Model of the upper Atmosphere (SIGMA) is a model that simulates GNSS signal propagation through random media. A plasma instability model called Geospace Environment Model of Ion-Neutral Interactions (GEMINI) is used to simulate the GDI and KHI instabilities in a confined region of ionosphere. This model can provide the ionospheric number density simulation as an input to SIGMA. SIGMA-GEMINI together can be used to model GNSS scintillations on the ground through different types of plasma instabilities and can prove to be an excellent tool to investigate evolution of instabilities at small to medium scale sizes. This kind of modeling approach could prove to be a unique way of studying the cascading phenomena.

Magnetospheric sources such as dayside or nightside reconnections can produce ionospheric instabilities through direct coupling in the cusp and polar regions. We investigate these using GNSS scintillation data from high latitude locations (such as Resolute Bay and Poker Flat). With the help of auxiliary observations, we relate the instabilities producing GNSS scintillations to the type of instability (of KHI and GDI) using our modeling approach.