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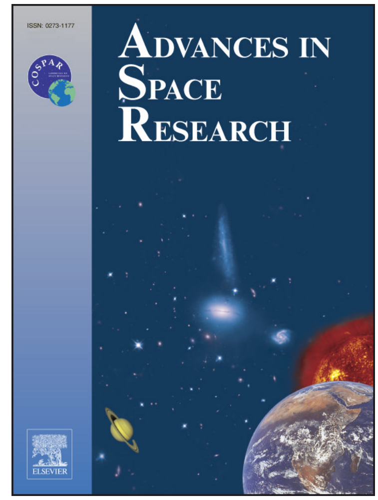

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Simulation and analysis of chemical release in ionosphere

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Abstract: Ionospheric inhomogeneous plasma produced by single point chemical release has simple space-time structure, and cannot impact radio wave frequencies higher than Very High Frequency (VHF) band. In order to produce more complicated ionospheric plasma perturbation structure and trigger instabilities phenomena, multiple-point chemical release scheme is presented in this paper. The effects of chemical release on low latitude ionospheric plasma are estimated by linear instability growth rate theory that high growth rate represents high irregularities, ionospheric scintillation occurrence probability and high scintillation intension in scintillation duration. The amplitude scintillations and the phase scintillations of 150 MHz, 400 MHz, and 1000 MHz are calculated based on the theory of multiple phase screen (MPS), when they propagate through the disturbed area.

Key words: ionosphere; chemical release; multiple-point release; growth rate; MPS

1. Introduction

Active space experiments have been used for investigating the ionospheric scintillations and instabilities (Bernhardt, 1975, Bernhardt, 1993, Hunton, 1998, Robert A. Morris, 1995). Theory and experiment results demonstrate that chemical release in the upper atmosphere is an efficient perturbation triggering ionospheric instabilities (Bernhardt, 1987, 1993) . Ionospheric modification chemicals can be classified as ionization enhancement materials and ionization depletion substances. Ionization enhancement chemicals, such as barium (Ba) and samarium, can cause highly concentrated ion cloud in the ionosphere, while the ionization depletion chemicals, such as carbon dioxide, hydrogen and sulfur hexafluoride (SF_6), can largely reduce the electron density in the pre-existing plasma. Spatial and temporal structure of the inhomogeneous plasma body which was generated by the single-point chemical release is quite simple, so its perturbation area is relatively small if the ionospheric instabilities were not triggered. Whether ionospheric instabilities and irregularities can be triggered by chemical release depend on the background ionospheric conditions. Hence, instability theory is applied here for predicting the release effect on irregularity triggering.

Investigations show that there are good correlations between linear growth rate and the occurrence probability of irregularities and ionospheric scintillation; and there is a positive correlation between the occurrence probability of irregularities and ionospheric scintillation and generalized Rayleigh-Taylor (R-T) growth rate (Luo, 2015). Corresponding relation between ionospheric scintillation and the value of linear growth rate is found out that higher growth rate signify more intense scintillation (Retterer, 2005). Linear growth rate can present the main characteristics of ionospheric scintillation (Singh, 2010). Growth rate derived from linear stability analysis can be used in prediction of the occurrence of irregularities and ionospheric scintillation (Basu, 2002). Application of linear growth rate has been successful in predicting the generation of a convective equatorial ionospheric storm using background parameters (Kelley, 2008). It is demonstrated that the statistical characteristics of irregularities and ionospheric scintillations correspond to the growth rate of the generalized R-T instability (Luo, 2015). Hence, the maximum value of the nighttime R-T growth rate of the high occurrence probability season in (Luo, 2015) is set as an indicator. When the R-T growth rate of the