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Sensitivity study of the reduced electric field and geometry of observation on the thermal infrared signature of a sprite

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Since their first recording in 1989, effects of sprites on the atmospheric composition have become an open and important question. The lack of suitable infrared experimental data is a shortcoming that hampers our understanding of the physical and chemical effects involved during a sprite. HALESIS (High-Altitude Luminous Events Studied by Infrared Spectro-imagery) is a future experiment dedicated to the measurement of the atmospheric perturbation induced by a transient luminous event in the minutes following its occurrence, from a stratospheric balloon flying at an altitude of 25 km to 40 km.

The aim of this work is to describe the population of electrons and vibrational levels of N2 and CO_2 following a sprite for different reduced electric fields. Then, the thermal infrared emission intensity and duration are evaluated considering the radiative emissions of vibrational N2 and CO_2 in the 500-2500 cm-1 spectral range for different lines-of-sight. The radiance signature is computed for observers located on the ground, plane, stratospheric balloon and satellite.

To do that, we first built an input atmospheric composition model from the Whole Atmosphere Community Climate Model (WACCM, Marsh et al., 2013). The kinetic model of sprite comes from Gordillo-Vazquez, 2008. We updated it with vibrational processes of Parra-Rojas, 2015. Then, we computed the time-dependent concentrations of the species solving the kinetics with ZDPlaskin (Pancheshnyi et al., 2008). Finally, we obtained the disturbed atmospheric radiance spectra using the Line-By-Line Radiative Transfer Model (LBLRTM, Clough et al., 2005) code.

We will conclude that the maximum increase of radiance stands between 900-1100 and 2200-2400 cm-1 and could be significant for an airborne observer and a satellite during several tens of seconds after the visible flash is over.