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SYNCHRONOUS LIGHTNING OBSERVATIONS BY A CONSTELLATION OF 3 NANOSATELLITES DURING THE C3IEL MISSION

Abstract

At any given moment there are approximately 1000 active thunderstorms on earth, generating an average planetary rate of 50 lightning flashes per second. Lightning discharges are formed in deep convective clouds, mostly over tropical continents but also in mid-latitudes and over the oceans. Their importance of thunderstorms in climate processes is clearly visible, through the production of NOx, injection of H2O into the stratosphere and by the ignition of forest fires, to name but a few effects. Thunderstorms are also a sensitive progenitor of severe weather, including hail, flash floods and downbursts, and are one of the most lethal natural hazards.

The French-Israeli C3IEL (Cluster for Cloud evolution, ClImatE and Lightning) is an innovative space mission that aims to provide high-resolution data on cloud vertical evolution and flash rate. The C3IEL coordinated train of 3 nano-satellites in polar LEO orbit will carry visible imagers measuring at a spatial resolution of 20 meters (CLOUD), water vapor near-infrared imagers measuring in and near the water vapor absorption bands (WV), and the Lightning Optical Imagers and Photometers (LOIP).

The LOIP measurements will be conducted during both day and night, with a sufficient sensibility during daytime to extract the lightning optical signal within a rather bright cloud scene. During daytime, LOIP observational strategy, driven by the CLOUD observational requirements, will conduct continuous measurements during the 200-s of each scene sampled by the CLOUD. During nighttime, LOIP observations will be conducted continuously along the nadir. The lightning imager will provide a 2D mapping of the optical signal radiated at 777.4 nm within a few-nm band by the lightning discharges, signal scattered by the cloud hydrometeors and emanating from the cloud edges. The optical signal will be sampled at a time resolution of a few milliseconds and with a spatial resolution of a few hundred meters. This mission will be able to provide for the first time stereoscopic (or 3 dimensional) observations of vertical flash evolution from space.

The measurements of lightning activity in concordance with deep convective clouds is of major importance, and especially at high latitudes that are poorly covered by current and upcoming geostationary lightning sensors like GLM (Geostationary Lightning Mapper). These regions are expected to experience increased lightning activity as climate changes progress in the coming decades. The C3IEL mission aims to improve our understanding of deep convection, thunderstorms and lightning and their feedbacks in the climate system.