Broadband Measurement of Waveforms for VHF Lightning Impulses by SOHLA-1 (BMW on SOHLA Satellite)

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INTRODUCTION

Lightning Imaging Sensor (LIS) on Tropical Rainfall Measuring Mission (TRMM) satellite unveils an interesting relationship between lightning activity of convective thunderclouds and total amount of cloud volumes, where solid phase particles of precipitation may exist. Lightning Research Group of Osaka University (LRG-OU) claims this feature as the universal power five law for lightning activity and thunderstorm snow depth. LRG-OU also demonstrates less lightning activity over west Indonesia and East China Sea during El-Nino period than the ordinary period. Though TRMM/LIS provides many scientific products, we still have many issues to be solved due to the opaqueness thundercloud. To overcome this disadvantage Los Alamos Science Team is concerned with VHF observations by FORTE (Fast On-orbit Recording of Transient Events) satellite. LRG-OU concludes that the combination of optical observations and VHF ones is complementary each other, and join the SOHLA (Space Oriented Higashi-Osaka Leading Associate) Satellite Project granted by NEDO (New Energy Development Organization). This is a preliminary report how our team plans the VHF observations from space.

VHF BROADBAND DIGITAL INTERFEROMETRY

LRG-OU has been developing the VHF Broadband Digital Interferometer (DITF) to image precise lightning channels and monitor lightning activity widely. The feature of the broadband DITF is its bandwidth (from 25MHz to 100MHz) and implicit redundancy for estimating a VHF source location. The basic principle of a DITF is calculating phase difference between two EM signals captured by two properly separating antennas, and this procedure is applied to all Fourier components of VHF broadband EM pulses caused by lightning discharges. By equipping two pairs of antennas azimuth and elevation of a VHF EM impulse location can be estimated. In other words to obtain one VHF source location a few tens Fourier components contribute, and this 'implicit redundancy' is the noticeable superiority to any other source location techniques. It is well known that one lightning flash emits a few thousands of VHF impulses, and imaging VHF source train could give us the development of lightning discharges. It is noticed that a few meters base line may present the sufficient accuracy for source locations. According to the previous observations and numerical calculations the accuracy of 0.01 radians may be feasible.

SOHLA-1 AND Broadband Measurement of Waveform for VHF Lightning Impulses

SOHLA is manufacturing a small satellite, SOHLA-1, as a corporation among Osaka Prefecture University and JAXA. It will be launched in early 2006, and LRG-OU is required to take responsibility for a mission of SOHLA-1. As described in the former session, the VHF broadband DITF is one of candidates for PETSAT, LRG-OU proposes the Broadband Measurement of Waveform for VHF Lightning Impulses (BMW) to examine the feasibility of the DITF on PETSAT by receiving VHF lightning impulses in space. To finalize the specifications of the amplifier and A/D converter, LRG-OU conducts comparisons of VHF impulses radiated by lightning discharges both measured on the ground and from space. The data from space is the courtesy of Los Alamos FORTE Science Team. SOHLA-1 is planed to be a low altitude satellite about several hundred kilometers from the ground, and LRG-OU will conduct ground base measurements to evaluate the functions of BMW.