VHF Broadband Digital Interferometer on Panel Extension Satellite

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INTRODUCTION

The usefulness of thunderstorm observations from space has been shown by Tropical Rainfall Measuring Mission (TRMM) satellite. As one of the principal organizations of Lightning Imaging Sensor (LIS) on TRMM, Lightning Research Group of Osaka University (LRGOU) demonstrates the universal power-five law between lightning activity and thunderstorm snow depth. 'Snow depth' means the height of cloud top from the freezing level, and 'Snow depth' is unveiled to be a key index of the thunderstorm activity. LRGOU also demonstrates less lightning activity over west Indonesia during El-Nino period than the ordinary period, and concludes that it is partly because the contrast of temperatures between land surface and sea surface. Though TRMM/LIS provides many scientific products, we still have several issues to be solved due to the opaqueness thundercloud. Los Alamos Science Team is concerned with VHF observations by FORTE (Fast On-orbit Recording of Transient Events) satellite. LRGOU concludes that the combination of optical observations and VHF ones is complementary each other, and join the SOHLA 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

LRGOU has been developing the VHF Broadband Digital Interferometer (DITF) to image precise lightning channels and monitor lightning activity widely. The feature of broadband DITF is its bandwidth (from 20MHz to 100MHz) and implicit redundancy for estimating VHF source location. The schematic of 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. 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. Figure 1 shows one of examples of VHF source mapping in azimuth and elevation format (two dimensional format). As shown in Figure 1, the time resolution is enough to discriminate the branching of the lightning channel, and the branching in Figure 1 is noticeable. Because of the advantage of DITF it may be cleaver to equip on a satellite.

PANEL EXTENSION SATELLITE (PETSAT) AND VHF BROADBAD DITF

Figure 2 gives a conceptual drawing of PETSAT. As shown in Figure 2, PETSAT may consist of ten and a few of independent panels. Each panel will be designed to own individual function and the configuration of PETSAT is adjustable depending on the objectives. Since it is shown that the short baseline of DITF could accomplish the high time and space resolution for VHF source locations, we can reach an idea of VHF broadband DITF operation on PETSAT. In Figure 2 a possible setup of VHF broadband DITF is given. For the design of the details, a comparison of VHF pulses radiated by lightning discharges both measured on the ground and from space is done. The data from space is the courtesy of Los Alamos FORTE Science Team. PETSAT is planed to be a low altitude satellite about several hundred kilometers from the ground, and the locations accuracy of 0.01 radians may provide us the sufficient and unique opportunity to discriminate between the active thundercloud from non active ones by satellite observations. We are expecting to launch PETSAT by 2007.

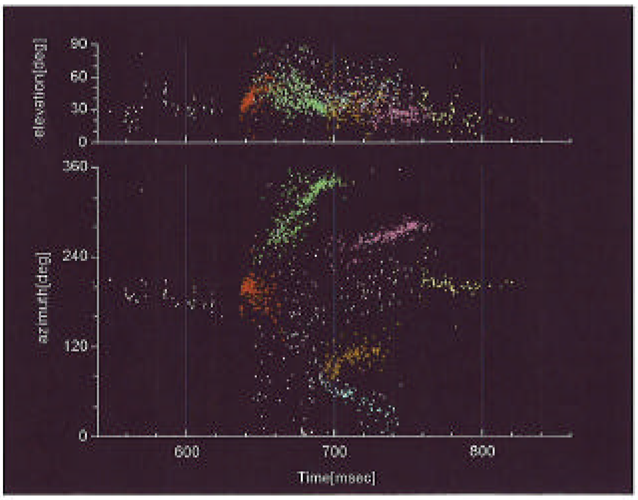

Fig.1. VHF source mapping by DIFT on the ground

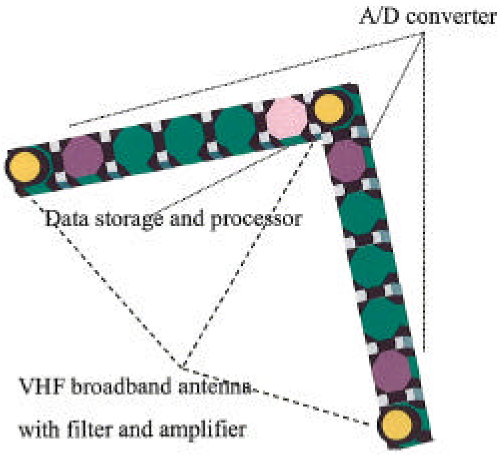

Fig.2. A conceptual drawing of PETSSAT