FROM TRMM EXPERIENCE

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1. INTRODUCTION

The Tropical Rainfall Measuring Mission is a on-going satellite mission to measure rainfall in the tropics and sub-tropics. Since the launch of the satellite in November 1997, the data from the on-board sensors have been processed and delivered to users without any serious trouble. TRMM data have already brought new findings and given impact on the precipitation studies. (For example, Takayabu et al. (1999). Visit NASA and NASDA's TRMM Web sites for more examples.) The TRMM is considered to be a successful joint mission between the United States and Japan. There were, of course, many difficulties and obstacles to come to this success. In this short article, I would like to point out some key factors in TRMM's success. I believe that some of the experience from the TRMM may be of some use to the planned satellite cloud profiling mission.

2. BRIEF HISTORY OF TRMM

It is not easy to state exactly when the TRMM concept emerged. Listed below are some of the important events in the TRMM history. (The selection may be somewhat biased in view of CRL.)

April 1978: Radio Research Laboratory (RRL, Now CRL) started developing an airborne rain/ radiometer (Fully developed in March 1980).

1981: Workshop on the precipitation measurements from space held at NASA/GSFC.

Dec. 1981: D. Atlas (NASA/GSFC) proposed a collaboration study to RRL.

March 1985: Started airborne radar experiment by RRL-GSFC collaboration.

Sept. 1985: J. Theon proposed a joint satellite development to RRL.

June 1986: Senior Standing Liaison Group (SSLG) #4 adopted TRMM.

Jan. 1987– March 1988: TRMM feasibility study. RRL: PR, NASDA: Rocket.

1987: NASA publication: *On requirements for a satellite mission to measure tropical rainfall.*

Oct. 1987: International Symposium on Tropical Precipitation Measurements, Tokyo.

April 1988: Space Activities Commission (SAC) in Japan approved TRMM "Study".

Aug. 1988: *Tropical Rainfall Measuring Mission* ed. by J. Simpson.

1990: NASA: TRMM conceptual design, CRL: PR conceptual design.

1991: NASA started TRMM development, NASDA/CRL: PR study.

April 1991: Japanese side: "Development Study" phase.

April 1993: Japanese side: "Development" phase.

1996: PR flight model completed.

Aug. 1997: TRMM full system is ready. Satellite Transported to Tanegashima.

Nov. 1997: Launch.

3. KEYS TO SUCCESS

The keys to succsess can be summarized as matured groundwork, good science, good leaders, good organization, good collaboration, and good luck.

Groundwork for TRMM

Before the TRMM was officially approved, scientific significance had been studied well in the U.S.A. (Simpson, 1988). The well-founded plan helped selling the mission. At the same time, there was no spaceborne rain radar before, and CRL was interest in developing such a system. In fact, CRL had developed an airborne rain radar as a first step to realize a spaceborne radar. A US-Japan joint experiment on rain measurement with the CRL's airborne radar was going on when the TRMM was proposed. Good mutual understanding that had grown in the collaboration also helped jointly proposing the mission.

Scientific Factors

When proposed, the TRMM had clear science objectives. The science requirements were defined well. We were also fortunate to have excellent

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and influential science leaders and advocates, which included J. Simpson, G. R. North, M. A. Geller, T. T. Wilheit, etc. on the US side, and T. Matsuno, A. Sumi, T. Nitta, etc. on Japansese side. When the TRMM concept was growing, measurement of rain with spaceborne microwave radiometers was not reliable method yet. Measurement with radar was considered to be the only solution to difficulty of accurate global observation of rain. Since there was no spaceborne precipitation radar before TRMM, the mission itself became new and unique.

Mission Leaders

Both US and Japanese mission leaders (Drs. Fugono, Theon, Geller, etc.) were tough and good fighters. At the same time, however, the leaders knew that they could not win the battle by captains alone. They appointed competent adjutants. When there was no bridge, they made a great effort to make one, believing that someday they would be able to go over it. With such an optimistic view, even when the situation was adverse, they could proceed with the mission.

Organization

The TRMM is a US-Japan Joint project. Neither side is subordinate to the other. Equal partnership was agreed on. NASA and NASDA clearly defined their responsibilities and separated the tasks: NASA was responsible for developing the satellite, TMI, VIRS, LIS and CERES, and NASDA for PR and launch. They kept good communication between them. On the science side, the science teams in both countries agreed to hold a Joint Science Team Meeting once a year. The establishment of the TRMM Science Data and Information System (TSDIS) provided a test environment and helped algorithm development as well as efficient data production and delivery.

Collaboration

The feasibility study of the mission was carried out for one year with the collaboration of US and Japanese scientists. Through such collaborative activities, mutual understanding and friendship grew naturally among scientists. US and Japanese engineers also developed mutual understanding and solved difficult problems. Both scientists and engineers held many meetings and kept good communication among scientists and project people.

Political Factors

Support from international organizations such as WCRP and GEWEX helped to proceed with the plan. The mission leaders made an effort to persuade administrative people and to increase the supporters, cooperators, and advocates. The framework of international cooperation worked positively to deal with the administration.

Other Factors

The TRMM was originally planned as a small satellite mission, although it turned out to be a medium size satellite mission. The manageable mission size seems to have given enough flexibility and mobility.

To keep the plan unceased, the mission leaders took advantage of differences in schedule between US and Japan, which included the differences in fiscal year, definitions of development phases, review processes, and budgetary system.

Finally I would like to mention, as an algorithm developer, that a few sets of realistically simulated data, realistic in terms of science, engineering and format, helped us debug and adjust the computer code for data processing before launch. The synthetic data sets for different sensors were created from a common high-resolution numerical storm model. The synthetic Precipitation Radar data, for example, included not only rain echoes but also surface echoes and random noise in addition to miscellaneous satellite and radar parameters and orbital information.

4. SUGGESTIONS

It is suggested that scientists and engineers in both Japan and Europe carry out a feasibility study for a year to see if the proposed joint cloud profiling mission is practically possible. The TRMM international workshop held during the feasibility study was very effective in this respect. Scientific collaboration is very important. Exchanges of data and people, in particular scientists, are recommended.

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