GLOBAL ENVIRONMENT MONITORING SYSTEM IN JAXA

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ABSTRACT

Current and future plan for Earth Observation of JAXA is introduced. For global environment monitoring, not only satellite systems but also ground observation systems are going to be integrated to cover many physical parameters and temporal / spacial requirements. In Japan, an independent system called Global Environment Monitoring System is proposed by "JAXA VISION". And internationally, GEOSS was proposed and promoted as the result of 2nd Earth Observation Summit held in Tokyo in 2004. According to these visions, JAXA is promoting current Earth Observation missions; ALOS, GOSAT, TRMM/GPM, AMSR-E and GCOM. On the other hand, EarthCARE with 94 GHz RADAR and UV High-Spectral Resolution LIDAR, CO_2 DIAL and Geostationary sensor are emerging with the maturity of related technologies. Future satellite missions require both these technological progress and close development cooperation with domestic users / international partnership, to be a social infrastructure.

1 INTRODUCTION

After the second Earth Observation summit held in Tokyo, 2004, all Earth Observation plan including not only satellite observation but also ground observation, are moving toward to be integrated under international cooperation. The philosophy of the integrated system is called "Global Earth Observation System of Systems"; GEOSS [1]. In the summit, Japan expressed its interests in three areas out of nine social benefit areas, i.e.

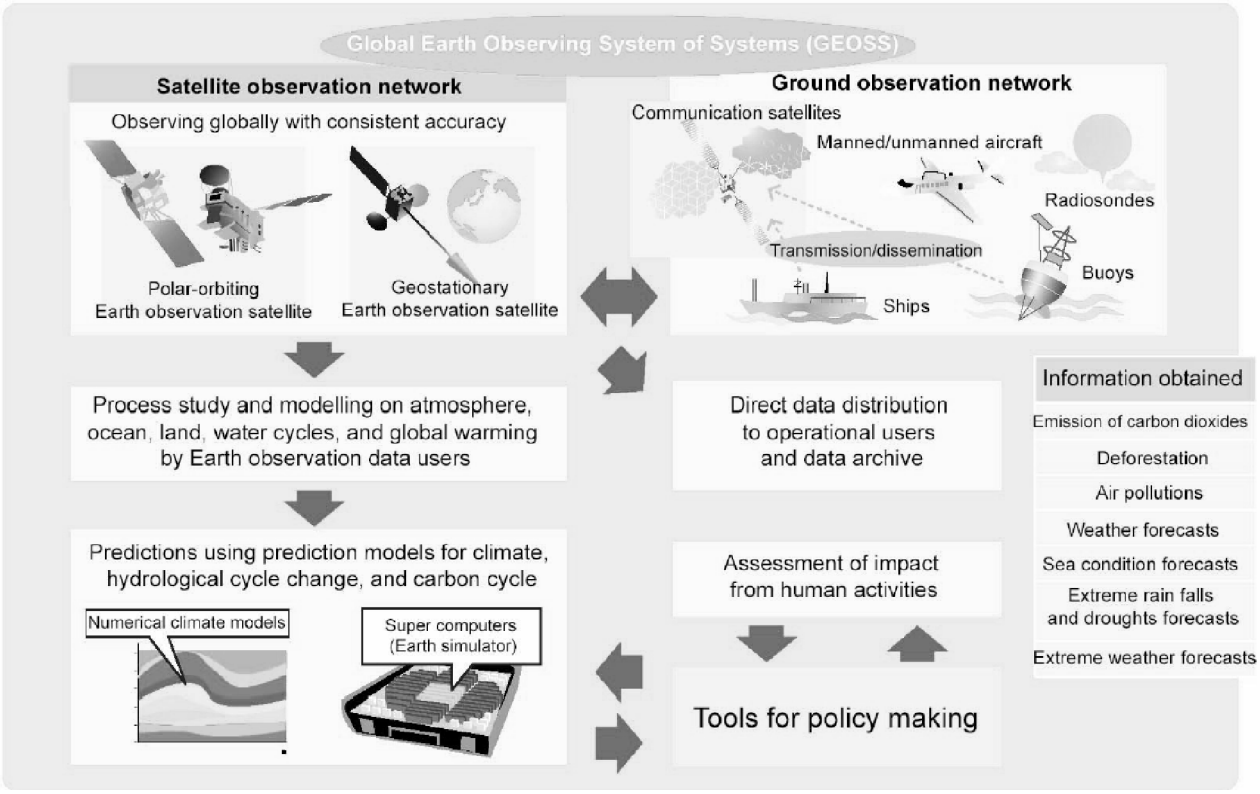

Fig. 1. Image of "Global Environment Monitoring System". The system consists of satellite observation network (JAXA), ground observation network, integrated data center and numerical model center for global environment prediction.

"Disaster monitoring", "Global warming and carbon cycle" and "Climate change and water cycle". At same time, JAXA defined their future plans towards 2025 as "JAXA VISION" [2]. To cover "Global warming and carbon cycle" and "Climate change and water cycle", JAXA planed to integrate its satellite systems to be a part of "Global Environment Monitoring System" shown in Fig. 1 as the image in 2025. This system is the independent Japanese system to observe fundamental Essential Climate Valuables; ECVs. However, almost all ECVs, will be able to observe under cooperation in the frame of GEOSS.

2 CURRENT and PLANED MISSIONS

Fig. 2 shows the current JAXA Earth Observation Missions, on orbit or planed to be launched in near future.

ALOS was launched in early 2006, and now to start its operational phase for three years. It carries three sensors; PRISM, AVNIR2 and PALSAR [3]. PRISM is a high-resolution panchromatic stereo imager. Its spatial resolution is 2.5 m. AVNIR2 is a multi channel high-resolution imager with pointing. Four channels including Near Infrared Channel have 10 m spatial resolution. PALSAR is the L-band (1.27 GHz) Synthetic Aperture RADAR, which has various modes including polarimetry to observe various targets. In global environment monitoring area, AVNIR2 will observe land use change including vegetation, and PALSAR will observe ice / water related physical parameters.

TRMM is launched in 1997 and continuing its operation over eight years under cooperation with NASA [4]. PR on TRMM is the first precipitation Ku-band (13.6 GHz) phased array radar on orbit. It revealed many three-dimensional precipitation structures including typhoon. The observation data has also important information regarding energy transfer / budget by water.

GPM carries improved PR system called DPR. DPR has Ka-band (35.5 GHz) RADAR in addition to Ku-band RADAR developed for PR [5]. By using DPR, wide range of precipitation, i.e. from weak precipitation to snow fall, will be observed. In addition, by calibration relationship between DPR and passive microwave radiometer, frequent precise precipitation measurement will be materialized with other satellite systems equipped with such microwave sensors. GPM is also the mission under cooperation with NASA.

Passive microwave radiometer; AMSR-E is equipped with EOS-Aqua satellite of NASA [6]. Sea surface temperature observation and soil moisture observation under all weather condition were achieved. Its observation frequency is from 6.9 GHz to 89 GHz. Remarkably 5 km resolution channel is achieved at 89 GHz. Also its observation capabilities of precipitation,

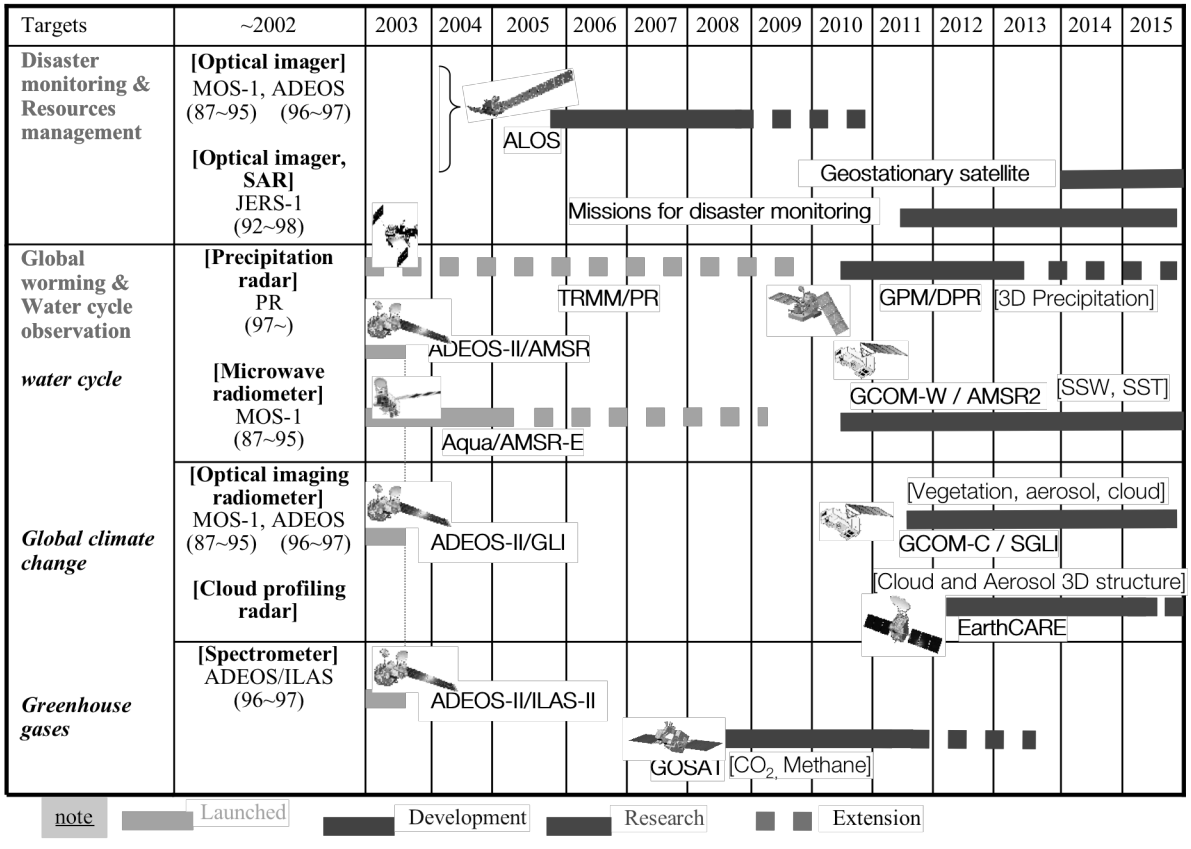

Fig. 2 Long term plan for Earth Observation in JAXA

sea surface wind speed and column water vapor, are currently used by meteorological agencies' operational systems over three years since launch.

GOSAT is the challenging mission to observe the distribution of Carbon Dioxide emission and sink globally [7]. The unique combination use of SWIR (1.6 / 2.0 micron) and IR Fourier Transform Spectrometer is to get higher accuracy for detecting 1% of CO_2 concentration difference. GOSAT will be launched in 2009. GOSAT is joint mission with Ministry of Environment.

GCOM is the successor of ADEOS-II and the core mission for climate change observation [8]. Two satellite named GCOM-W and GCOM-C, carry the improved AMSR; AMSR2 and the super spectral radiometer / multi-angle polarimeter; SGLI, respectively. SGLI has wide spectral range from 0.38 to 12 micron and capability to detect aerosols over land using multi-angle polarimeter. It observes mainly aerosol, clouds, ocean color, vegetation, snow physical characteristics and sea surface temperature with 250 m resolution, mostly. GCOM is planned to achieve over 13 years observation to detect slight climate change signals by observing many fundamental ECVs. Its mission objective is to reveal the relationship between human activity and climate change, especially. GCOM-W1 and GCOM-C1 will be launched in early 2011 and 2012, respectively.

Finally, from around 2010, all these missions will be in operation. We are studying also regarding the data fusion of these and construct integrated data system as described in first section.

3 FUTURE MISSIONS

EarthCARE is the joint mission between ESA and Japan. Japan is going to provide Cloud Profiling RADAR; CPR, of which center frequency is 94 GHz [9]. Its unique function is to measure updraft velocity in cloud using Doppler. CPR is jointly developed by JAXA and NICT. ESA provides other three sensors on EarthCARE. Firstly, ESA provides the other core sensor, Atmospheric LIDAR; ATLID. It has 355 nm UV mono band transmitter, and high spectral resolution receiver to materialize detection of Mie and Rayleigh scattering signal independently. Multi spectral imager with seven channels; MSI and three angle broadband radiometer; BBR are also provided. EarthCARE is designed to observe three-dimensional structure of aerosol and clouds. In addition, with BBR observation, vertical distribution of radiative flux under all weather conditions will be evaluated with certain accuracy. It is expected to reveal the quantitative interaction process between aerosol and cloud, which is the most unknown process in climate system.

Differential Absorption LIDAR; DIAL is expected to be a next generation sensor for precise measurement of gas concentration, such as Carbon Dioxide. Many Japanese institutions including JAXA started to study feasibility of DIAL system [10]. DIAL is known as its ascendancy for night observation and over the surface with low reflection. On the other hand, system feasibility as a spaceborne sensor should be studied further regarding such as, lifetime of laser transmitter, stability of observation wavelength, scanning function.

Geostationary sensors not for meteorological observation, but for general Earth Observation, has not been studied deeply in past by JAXA. However, some new technologies, such as a light-weighted large mirror with new material [11], make us to improve expected observation performance from geostationary orbit. The mission is suitable to observe the physical parameters which needs frequent observation, such as distribution of atmospheric contamination, water vapor and so on. It is also expected to be a key optical sensor in the disaster monitoring area.

4 CONCLUSION

Current and future Earth Observation plan of JAXA is introduced. Regarding Global Environment Monitoring area, Japan is focusing "Global warming and carbon cycle" and "Climate change and water cycle". Satellite plan is also focusing these two areas. Many of current missions are joint developments with domestic institutes, ministry or foreign space agencies. We recognized such cooperation is crucial to develop the satellite system as a social infrastructure and international cooperative system towards materializing GEOSS. For future missions, current candidates introduced in previous section, are enabled with new technologies. We believe that the progression of such new technology regarding observation methodology, material, sensor system and other key technologies, produces future missions and

expands capability of satellite Earth Observation.

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