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Prepared by JAXA
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Discussed in Plenary

Status of EarthCARE/CPR

The current status of JAXA's Global Change Observation Mission (GCOM) is updated. GCOM-W project has made a progress to start its Preliminary Study in JFY2007. A possibility of GCOM and NPOESS cooperation in the GEOSS context is also reported.

1 Introduction

As a result of IPCC-AR4, we have still large uncertainties to predict the global average temperature for next 100 years. The results of various Global Circulation Models (GCMs) with several social development scenarios on IPCC-AR4 indicates the variation of results is approximately three to four Celsius.

Investigating the cause of such variation, the factors and its forces to modify climate are identified as shown in figure 1. In the figure, Carbon Dioxide is the most powerful factor among all. However, we recognize that the influence by Carbon Dioxide is well understood quantitatively, in contrast, aerosol and its interaction with cloud are not known quantitatively, in spite of their certain amount of influence.

The causes of uncertainties by aerosol and clouds are well known as lack of understandings regarding interaction process between aerosol and clouds. Additionally, lack of global distribution data of the vertical structure of aerosol and clouds, are making large errors not in the antholopogenic point of view, but natural point of view. The reason is that the influence of warming climate mainly depends on the vertical structure of aerosoland cloud. High cloud accelerate warming, in contrast, low cloud decelerate.

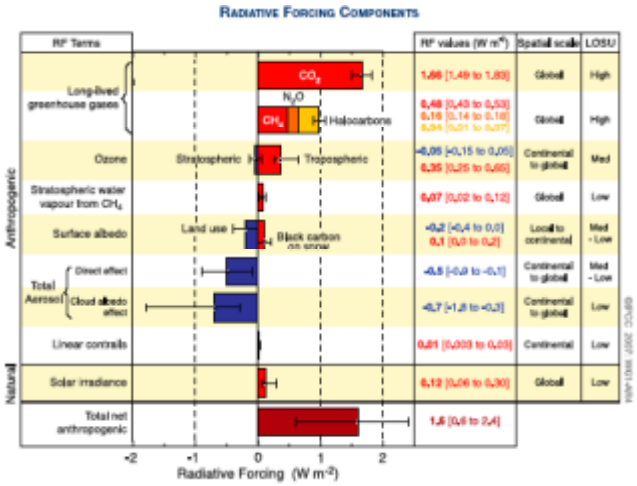

Figure 1. Human activity factors to influence climate change (IPCC-AR4,2007)

To know the global distribution of vertical structure of aerosol and cloud, and to reveal interaction of process of them, ESA and JAPAN (JAXA and NICT) started the development of EarthCARE mission as the first ESA-JAXA joint development mission on Earth Observation area.

2 EarthCARE and CPR

2.1 Mission Objectives of EarthCARE and CPR

The observation requirements of EarthCARE are set as follows. Firstly to observe vertical structures of aerosol and its micro physical properties. Secondly to observe vertical structures of water/ice clouds and their micro physical properties. Thirdly to observe updraft in cloud layer and fall velocities of ice cloud nuclei. Fourthly to observe holizontal distribution of cloud and aerosol. Fifthly to observe short and long wave out-going radiative flux at top of atmosphere.

To materialize these requirements, we decided to carry four instruments as shown in Figure 2. The unique point of this mission is the synergetic observation with these four instruments. For example, the synergetic observation of cloud using LIDAR and RADAR materialize simultaneous determination of cloud optical thickness and effective radius of cloud particle without any hypothesis, as in the case using single instrument.

Figure 2. Observation requirements to instrumentation (ESA)

2.2 System Overview

The outlook of EarthCARE satellite is shown Figure 3. The orbit of EarthCARE is sun-synchronous polar orbit, of which local time descending node is 13:30~14:00. Orbit height is around 400 km. Mission life time is three years from launch. The satellite carries four instruments, i.e.; CPR, ATLID, MSI and BBR. Their brief characteristics are shown in Table 1. All other systems than CPR are prepared by ESA.

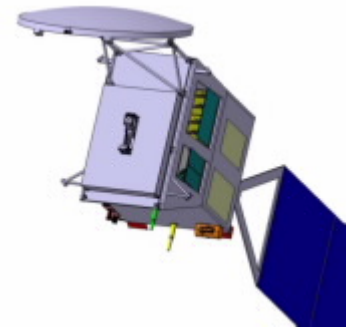

Figure 3. Overview of EarthCARE satellite (ESA)

Table 1. Brief characteristics of instruments on EarthCARE

CPR	94 GHz Doppler Radar (see Table 2.)
ATLID	355 nm Hyper Spectral Resolution Lidar with three channels (Mie co-polar, Rayleigh, Mie cross-polar)
MSI	Push broom imager Resolution 500m, swath 150 km seven channels (0.67, 0.865, 1.65, 2.21, 8.8, 10.8, 12.0 micron)
BBR	Three views radiometer Angle: Nadir, +- 55 deg Two channels; 0.2-4, 4-50 micron

CPR is a 94 GHz Doppler RADAR which has several characteristics. First point is the high sensitivity. This requirement is divided into large antenna size requirement, low noise figure of receiver requirement and high power of transmitter requirement. Second point is the Doppler capability. To materialize this function with satisfactory accuracy, large diameter of antenna with precise surface figure and high pulse repetition frequency (PRF) are required. To keep accuracy especially at boundary layer region, several other fine characteristics, such as side lobe characteristics of antenna, cross polarization characteristics and so on, are also required for CPR design.Outlook of CPR is shown in Figure 4 and major specification of CPR is shown in Table 2.

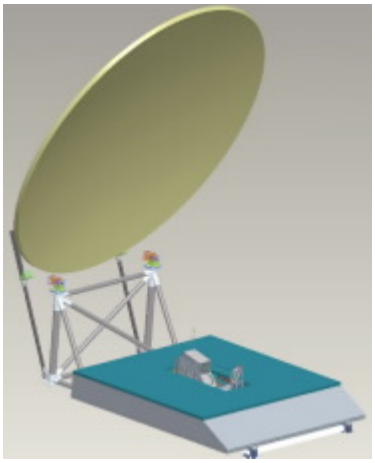

Figure 4. Outlook of Cloud Profiling Radar

Table 2. CPR Major Specifications (Draft)

Radar type	94 GHz Doppler Radar
Center frequency	94.05 GHz
Pulse width	3.3 micro second (equivalent to 500m vertical resolution)
Beam width	0.095 deg
Polarization	Circular
Transmit power	> 1.5 kW (Klystron spec.)
Height range	-0.5 ~ 20 km
Resolution	500 m (100 m sample); Vertical, 500m integration; Horizontal
Sensitivity*	-35 ~ +21 dBZ
Radiometric accuracy*	< 2.7 dB
Doppler range*	-10 ~ +10 m/s
Doppler accuracy*	< 1 m/s
Pulse repetition frequency	Variable; 6100~7500 Hz
Pointing accuracy	< 0.015 degree

*; at 10 km integration and 387 km orbit height

2.3 Data Products

Draft Data products list of CPR is shown in Table 3. Products list and its accuracy are currently under discussion in Joint Mission Advisory Group consists of European and Japanese scientists

Table 3. CPR Standard Products (DRAFT)

Level	Product		Parameter	accuracy			Scene unit	Swath	Spatial resolution	
				Release	Standard	Target			Horizontal	Vertical
1	Cloud product		Received power	<11.2 dB	<9.2 dB		1orb.	0.8km	0.8x0.5km	500m
			Radar reflection factor	<4.7 dB	<2.7 dB	<2.7 dB	1orb.	0.8km	0.8x0.5km	500m
			Normalized scattering cross section of ground	<4.7 dB	<2.7 dB	<2.7 dB	1orb.	0.8km	0.8x0.5km	500m
	Doppler product		Doppler velocity	–	<4.5 m/s		1orb.	0.8km	0.8x0.5km	500m
			Spectral bandwidth	–	–	–	1orb.	0.8km	0.8x0.5km	500m
2	Standalone product	Cloud product	Cloud mask				1orb.	0.8km	0.8x0.5km	500m
			Radar reflection factor with atmospheric correction	<7.7 dB	<5.7 dB	<4.5 dB	1orb.	0.8km	0.8x0.5km	500m
			Profile of Ice water and liquid water contents				1orb.	0.8km	0.8x0.5km	500m
			Profile of optical thickness	<7.7 dB	<5.7 dB	<4.5 dB	1orb.	0.8km	0.8x0.5km	500m
		Doppler product	Doppler velocity		<1m/s	0.2m/s	1orb.	0.8km	0.8x0.5km	500m
			Spectral bandwidth	–	–	–	1orb.	0.8km	0.8x0.5km	500m
	Synergy product		Profile of effective radius with radar and lidar				1orb.	0.8km	0.8x0.5km	500m
			Profile of Ice water and liquid water contents with radar and lidar				1orb.	0.8km	0.8x0.5km	500m
			Profile of optical thickness with radar and lidar				1orb.	0.8km	0.8x0.5km	500m
			Profile of radiative flux			10W/m2	1orb.	0.8km	0.8x0.5km	500m

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EarthCARE whole products and data distribution

Whole EarthCARE products are also under discussion in Joint Mission Advisory Group. Whole EarthCARE products are distributed by ESA and also by JAXA.