



The EarthCARE mission: An active view on aerosols, clouds and radiation

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Heritage: A-Train Observations



Mission Summary



Mission Objective:

Understanding of cloud-aerosol-radiation interactions so as to include them correctly and reliably in climate and NWP models

Required Global Observations:

- Vertical profiles of natural and anthropogenic aerosols, their radiative properties and interaction with clouds.
- Vertical distributions of atmospheric liquid water and ice, their transport by clouds and their radiative impact.
- Cloud distribution ('cloud overlap'), cloud-precipitation interactions and characteristics of vertical motions within clouds.
- Retrieval of profiles of atmospheric radiative heating and cooling through the combination of the retrieved aerosol and cloud properties.

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Mission Concept





Temperature and humidity from operational analysis



ATmospheric LIDar ATLID





Cloud Profiling Radar CPR









- High power W-band (94GHz) nadirpointing
- Doppler capability (Doppler velocity ±10m/s, accuracy 1m/s)
- Antenna aperture 2.5m
- Variable pulse rep. freq.: 6100-7500 Hz
- Sensitivity at least -35dBZ at 20km height
- Sampling: 500m horizontal, 100m vertical
- Vertical range up to 12, 16 or 20km as function of latitude. Lower vertical range → higher PRF → better Doppler
- -3dB beamwidth = 0.09° → effective footprint on ground = 750m x 1000m
- Instrument: 321 W, 270 kg, 265 kbps
- Level 1 product: reflectivity & Doppler profiles

Multi-Spectral Imager MSI





To provide contextual imagery information to support the retrievals of geophysical parameters by the active instruments onboard EarthCARE

Characteristics:

150 km swath (-35km to +115 km) 500 m ground sampling distance 57 W, 58 kg, 652 kbps

Level 1 product: radiances (VNS) & brightness temperatures (TIR)

VNS = visible, near-infrared, short-wave infrared *TIR* = thermal infrared

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	SWIR-2 ra	adiator	
VNS TIR Sun Baffle OB			
inel	Centre Wavelength [µm]	Bandwidth (50%) [μm]	
S	0.67	0.02	
R	0 865	0.02	

Centre Wavelength [µm]	Bandwidth (50%) [µm]
0.67	0.02
0.865	0.02
1.65	0.05
2.21	0.1
8.8	0.9
10.8	0.9
12.0	0.9
	Centre Wavelength [µm] 0.67 0.865 1.65 2.21 8.8 10.8 12.0

Broad-Band Radiometer BBR



Three fixed telescopes: forward (55°), nadir, backward (-55°)

Two channels:

Short-wave (SW) channel 0.25 μ m to 4 μ m Total-wave (TW) channel 0.25 μ m to >50 μ m \rightarrow "synthetic" LW derived

Abs. accuracy 2.5 (SW) / 1.5 (LW) Wm⁻²sr⁻¹

- Spatial resolution 10 km x 10 km
- Spatial sampling distance 1 km
- Interface data: 48 W, 45 kg, 145 kbps
- **Products: TOA SW/LW radiances & flux**



3 fixed, single mirror telescopes, each with a linear microbolometer detector array Chopper drum rotates continuously, chopping the signal between SW, drum & TW views Calibration drum periodically rotates into view:

- Hot or cold blackbody, every 88s, to calibrate LW
- View to sun diffuser, every 2 months for 30 orbits, to monitor aging in the SW chain

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Payload Summary





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Science Data Products



Advanced Retrieval Techniques

Synergistic retrieval using lidar, radar and imager together.

Example: North-Atlantic cloud system observed by CloudSat and CALIPSO.

Left column: forwardmodelled radar reflectivity and lidar backscatter versus observed, showing successful algorithm convergence.

Right column: Retrieved atmospheric constituents.

Figures courtesy of Robin Hogan, VARSY Project.



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Science Data Products





Preparatory Science Activities





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Validation



ESA Tentative Schedule

- 1. Draft EarthCARE Validation Requirements Document
- 2. Validation Requirements Status Review
- **3**. Issue ESA International Validation AO $\approx L 2$ yrs
- 4. Evaluate Val AO \rightarrow draft Validation Implementation Plan
- 5. First ESA Validation Workshop
- 6. Consolidate Val. Implementation Plan (incl. securing funding)
- 7. Start implementation
- 8. Pre-launch Joint ESA-JAXA Validation Workshop < L 1/2 yrs
- 9. Validation Rehearsal, Val. Readiness Review
- 10. Flight Acceptance Review
- 11. Launch

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European Space Agency

 \approx L – 1½ yrs

2nd half 2018

CLOUDSAT





CloudSat / CALIPSO / MODIS / CERES: cloud-aerosol profile + radiation data record since 2007

CALIPSO



improved cloud-aerosol profile + radiation data record 2018 – 2021/22

beyond EarthCARE:

- no follow-up mission planned
- end of cloud-aerosol profile data record?

Cloud profiles are the key to atmospheric heating

Community concern: What after CloudSat, CALIPSO and EarthCARE?

- Clouds-precip-water vapour → hydrological cycle
- C/nd profiles → key to at the heating, not possible to quantify with passive
- NWP → impact of Assimilation/NWP to be studied with EarthCARE → if successful, what's next?

No CloudSat-CALIPSO-EarthCARE type of mission on the horizon for the 2020's

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