CALIPSO Payload

Introduction

This document provides an overview of the **C**loud-**A**erosol **L**idar and **I**nfrared **P**athfinder **S**atellite **O**bservations (CALIPSO) Payload.

The CALIPSO payload consists of three instruments.

- **C**loud-**A**erosol **LI**dar with **O**rthogonal **P**olarization (CALIOP)
- **I**maging **I**nfrared **R**adiometer (IIR)
- **W**ide **F**ield **C**amera (WFC)

These instruments are designed to operate autonomously and continuously, although the WFC acquires data only under daylight conditions. Science data are downlinked using an X-Band transmitter. The key physical layout is shown in Figure 1, with key instrument characteristics listed below.

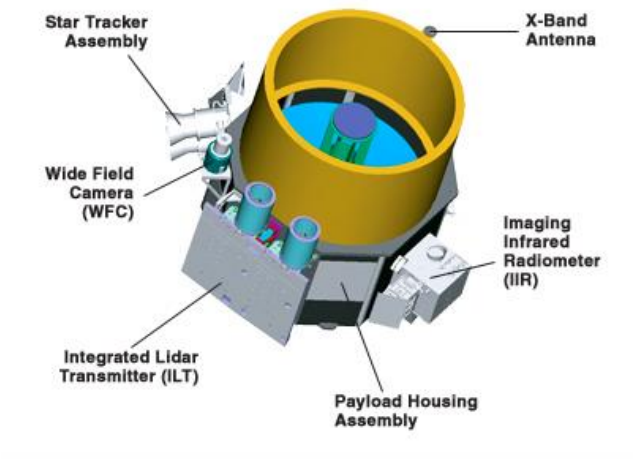

Figure 1: CALIPSO Payload.

CALIOP

CALIOP is a two-wavelength polarization-sensitive lidar that provides high-resolution vertical profiles of aerosol and clouds. Two CALIOP lasers (Primary and Backup) are housed in separate pressured (18 psia, nitrogen) containers. CALIOP utilizes three receiver channels: one measuring the 1064 nm backscatter intensity and two channels measuring orthogonally polarized components of the 532 nm backscattered signals. Dual 14-bit digitizers on each channel provide an effective 22-bit dynamic range. The receiver telescope is 1 meter in diameter. An active boresight system is employed to maintain co-alignment between the transmitter and the receiver, with complete alignments typically conducted every 6 weeks during operation and achieved within a single nighttime orbital segment. Ball Aerospace Corporation developed the instrument. Table 1 contains more detailed specification of the instrument, both transmitter and receiver components.

Table 1: CALIOP Transmitter and Receiver Characteristics

CALIOP Characteristics	
Laser	Nd: YAG, diode-pumped, Q-switched, frequency doubled
Wavelengths	532 nm, 1064 nm
Pulse Energy	110 mJoule/channel
Polarization	532 nm
Repetition Rate	20.25 Hz
Pulse Length	20 nsec
Boresight Range	+/- 1 degree, 1.6 µrad steps
Receiver Telescope	1.0 m diameter
Field of View	130 µrad

CALIOP Characteristics	
Optical Filter Bandwidth	532 nm: 30 pm, 1064 nm: 400 pm
Detector Effective Quantum Efficiency	532 nm: 0.11, 1064 nm: 0.40
Detector Dark Count Rate	532 nm: 2.3×10^3, 1064 nm: 2.0×10^7
Digitizer Sample Rate	10 MHz
Vertical Sample Spacing	15 m
Electronic Bandwidth	30 m
Single Digitizer Resolution	14 bits
Merged Digitizer Dynamic Range	2.5×10^6 (>21 bits)
Data Rate	316 kbps

IIR

A three-channel IIR is provided by CNES with algorithm development performed by the Institute Pierre Simon Laplace (IPSL) in Paris. The IIR is a nadir-viewing, non-scanning imager having a 64 km by 64 km swath with a pixel size of 1 km. The CALIOP beam is nominally aligned with the center of the IIR image. The instrument uses a single microbolometer detector array, with a rotating filter wheel providing measurements at three channels in the thermal infrared window region at 8.65 µm, 10.6 µm, and 12.05 µm. These wavelengths were selected to optimize joint CALIOP/IIR retrievals of cirrus cloud emissivity and particle size. Table 2 contains more detailed specification of the instrument.

Table 2: IIR Characteristics

IIR Characteristics	
Wavelengths	8.65 µm, 10.6 µm, 12.05 µm
Spectral Resolution	0.6 µm – 1.0 µm
Field of View / Swath	1 km / 64 km
NETD at 210 K	0.3 K
Calibration	+/- 1.0 K
Data Rate	44 kbps

WFC

The WFC is a modified version of the commercial off-the-shelf Ball Aerospace CT-633 star tracker camera. It is a fixed, nadir-viewing imager with a single spectral channel covering the 620-670 nm region, selected to match band 1 of the MODIS (MODerate resolution Imaging Spectroradiometer) instrument on Aqua. Table 3 contains more detailed specification of the instrument.

Table 3: WFC Characteristics

WFC Characteristics	
Wavelength	645 nm
Spectral Bandwidth	50 nm
Field of View / Swath	125 m / 61 km
Data Rate	26 kbps

References

Hovis, F., 2006: "Qualification of the laser transmitter for the CALIPSO aerosol lidar mission", *Proc. SPIE, 6100*, https://doi.org/10.1117/12.659748.

Hunt, W. H, D. M. Winker, M. A. Vaughan, K. A. Powell, P. L. Lucker and C. Weimer, 2009: "CALIPSO Lidar Description and Performance Assessment", *J. Atmos. Oceanic Technol.*, **26**, 1214–1228, https://doi.org/10.1175/2009JTECHA1223.1.

Winker, D. M., W. H. Hunt, and M. J. McGill, 2007: Initial performance assessment of CALIOP, *Geophys. Res. Lett.*, 34, L19803, https://doi.org/10.1029/2007GL030135.