SUPPLEMENT

CHASER

An Innovative Satellite Mission Concept to Measure the Effects of Aerosols on Clouds and Climate

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CHASER meets its science goals employing only high-heritage, passive optical remote sensing instruments.

INSTRUMENTATION. The Clouds, Hazards, and Aerosols Survey for Earth Researchers (CHASER) team selected high-heritage, low-risk instruments capable of satisfying the mission science requirements while minimizing risks to cost and schedule. These instruments are the Multiangle Imager (MAI), the Multispectral Imager (MSI), and the Lightning Imaging Sensor (LIS). The MAI and the MSI together compose the Cloud Profiler Suite (CPS), which will be a contribution from Deutsches Zentrum für Luft- und Raumfahrt (DLR). The CPS is at technology readiness level 6 (TRL 6), and the LIS is at TRL 8. Figure S1 illustrates the position and orientation of the instrument payloads (P/Ls) on the spacecraft (S/C), as well as their respective field of views (FOVs).

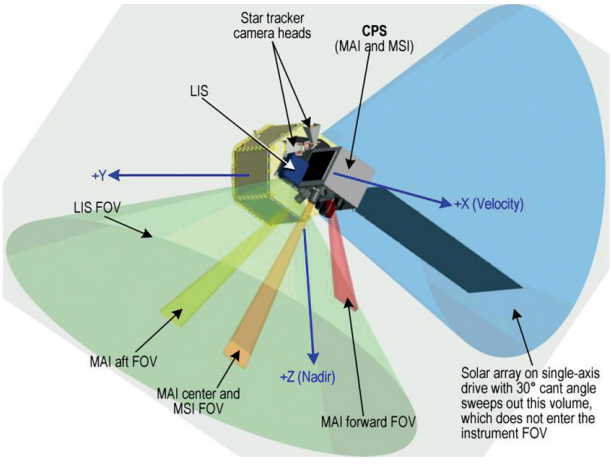

FIG. S1. The CHASER spacecraft uses high-heritage components, resulting in a low-risk mission.

The MAI, MSI, and LIS meet the CHASER scientific requirements described in the traceability matrix (Table 1). As indicated by the projected performances listed in the traceability matrix, these three instruments exceed the CHASER mission functional requirements.

CLOUD PROFILER SUITE. The CPS contains the MAI (Fig. S2), the MSI (Fig. S3), and a payload control unit (PCU). The PCU is the interface between the S/C and the instruments; it provides power and clocking to the two instruments, as well as bidirectional communication and data transmission.

MULTIANGLE IMAGER. The MAI consists of three cameras, labeled stereo_F (forward), stereo_C (center), and stereo_A (aft). These cameras are used to capture stereo images, determine cloud geometry and evolution, and measure aerosol optical depth (AOD). They are identical in form, but differ in function. The center camera points 30° off nadir eastward. The other two cameras point 30° off nadir across track (eastward) and ±30° off nadir along track to achieve a stereo geometry with the sun at the back as illustrated in Fig.1 in the main text. Each camera has a spectral channel at 670 nm (red) for stereo imaging. In addition, the center camera has spectral channels at 450 nm (blue) and 560 nm (green) for aerosol retrieval. The FOV of each camera is 50 m by 102.4 km, with a spatial resolution of 50 m.

The MAI was chosen to satisfy the CHASER requirement of measuring cloud reflectance and sampling cloud elements with sufficient resolution (50 m) to study their evolution and determine updraft speeds, as described in the main text.

MULTISPECTRAL IMAGER. The MSI consists of three cameras, labeled shortwave infrared (IR) (SWIR), SWIR/midwave IR (MWIR), and longwave IR (LWIR). These cameras are used to study cloud microphysics and thermodynamic forcing. Each camera points 30° off nadir eastward and contains three spectral channels. The SWIR camera has two spectral channels at 1.135 μm, one wideband and one narrowband, and one spectral channel at 1.380 μm. The SWIR/MWIR camera has spectral channels at 2.115, 2.225, and 3.685 μm. The LWIR camera has spectral channels at 8.50, 10.7, and 11.8 μm. The FOV of each camera is 100 m by 102.4 km, with a spatial resolution of 100 m.

The MSI was chosen to satisfy the CHASER requirements of determining the vertical profiles of cloud microphysical quantities with sufficient resolution to retrieve activated CCN and to measure the cloud thermodynamic environment, as described in the main text.

LIGHTNING IMAGING SENSOR. The LIS is a high-heritage, compact, solid-state optical imager that detects lightning from low-Earth orbit (LEO) with high detection efficiency and location accuracy. The LIS marks the lightning time of the occurrence, and it measures the radiant energy. Its major elements are an imaging system, a focal plane assembly, a real-time signal processor and background remover, an event processor and formatter, a power supply, and

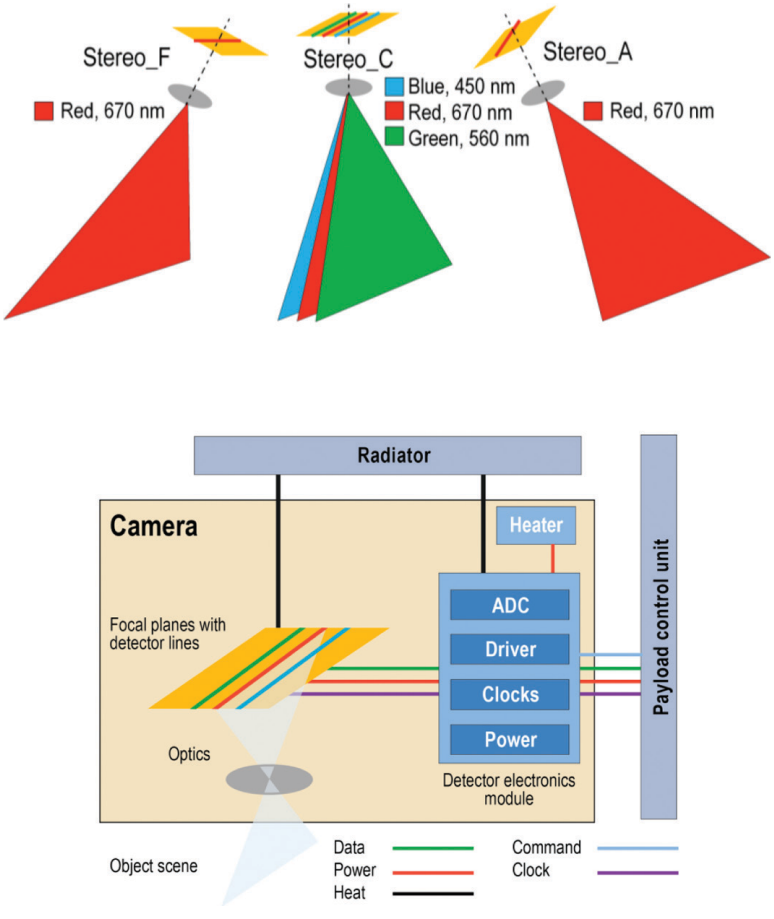

Fig. S2. MAI. (top) Instrument concept. (bottom) Top-level architecture for its cameras. ADC is analog-to-digital converter.

interface electronics. The LIS has an FOV of 1,024 × 1,024 km^2.

The LIS was chosen to satisfy the CHASER requirements of measuring lightning to quantify thunderstorm intensity, as described in the main text.

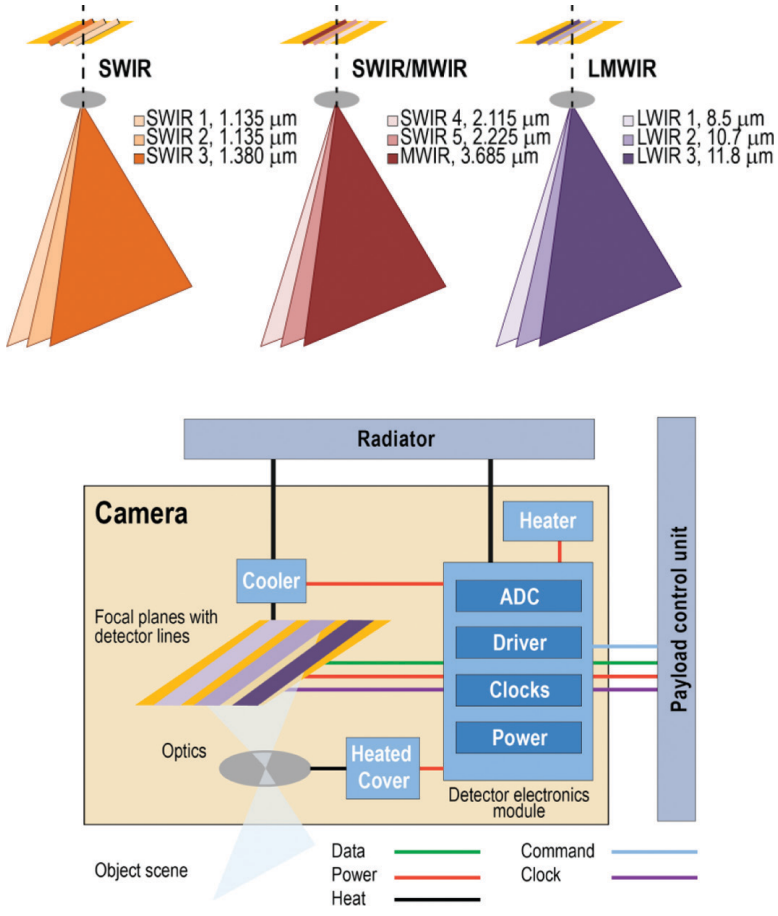

Fig. S3. MSI. (top) Instrument concept. (bottom) Top-level architecture for its cameras.

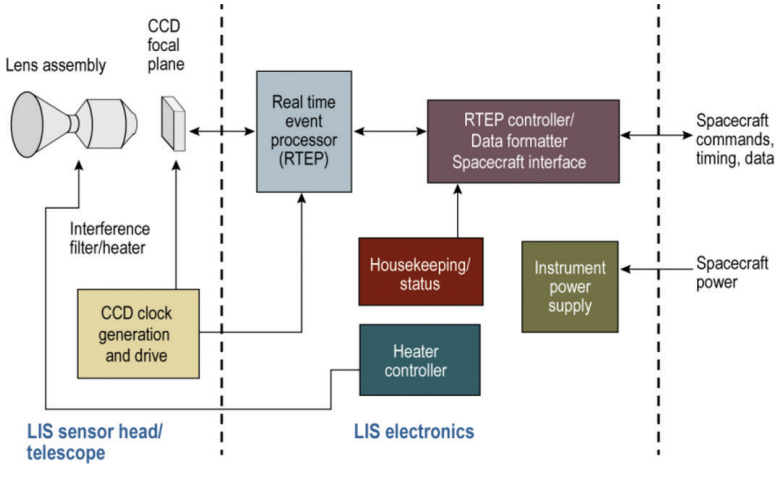

Fig. S4. LIS Functional block diagram. CCD is charge-coupled device.