Physical Sciences

Satellite Multiangle Spectropolarimetric Imaging of Aerosols

One instrument would implement a synergistic combination of multispectral, multiangle, and polarimetric techniques.

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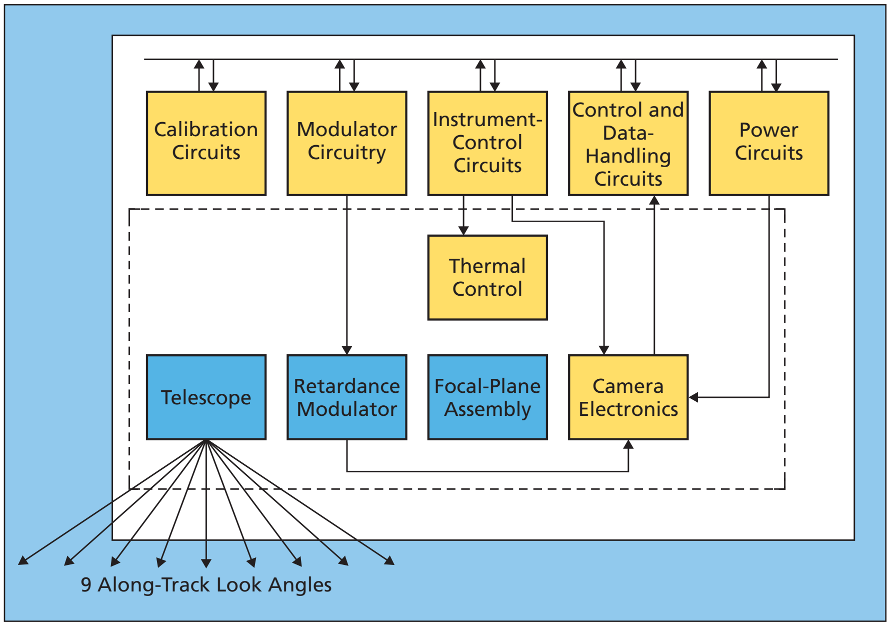
A proposed remote-sensing instrument, to be carried aboard a spacecraft in orbit around the Earth, would gather data on the spatial distribution and radiative characteristics of tropospheric aerosols. These data are needed for better understanding of the natural and anthropogenic origins of aerosols, and of the effects of aerosols on climate and atmospheric chemistry.

The instrument would implement a synergistic combination of multispectral, multiangle, and polarimetric measurement techniques to increase the accuracies of aerosol-optical-depth and aerosol-particle-property characterizations beyond what is achievable by use of each technique by itself. Additional benefits expected to be realized by the specific novel combination of different measurement techniques in one instrument include the following:

- The instrument could make simultaneous measurements (described below) that are essential for determining the mesoscale variability of aerosols;
- The instrument would have a wide-swath, high-resolution imaging capability for discerning clouds and for frequent global sampling; and
- The cost of building this instrument would be less than the cost of building separate instruments for the various measurements.

Features of the design and performance of the instrument would include spectral coverage from near ultraviolet to short-wave infrared, global spatial coverage within a few days, simultaneous intensity and polarimetric imaging at multiple view angles, kilometer to sub-kilometer spatial resolution, and measurement of the degree of linear polarization in one visible and one short-wave infrared spectral band.

The instrument (see block diagram) would acquire data in push-broom fashion in nine cross-ground-track swaths, each aimed at a different along-ground-track look angle. A separate camera would be used for each look angle, but all nine cameras could be of the same design. Reflective telescope and camera optics would be used because they offer significant advantages over refractive optics, including high transmittance over the broad wavelength range of interest, absence of chromatic aberration, the possibility of achieving the desired effects by use of fewer optical elements, less susceptibility to formation of ghost images, and better and more stable polarization performance. The instrument would measure intensity at wavelengths of 380, 412, 446, 558, 866, 1,375, and 2,130 nm. Polarization plus intensity would be measured at 670 and 1,630 nm.



This **Simplified Block Diagram** shows the functional relationships among basic components of the proposed instrument.

The design of the instrument would be dominated by the requirement for polarimetric accuracy. Of several polarimetric approaches that were considered, the one selected to satisfy this requirement involves adaptation of advanced techniques of high-precision imaging polarimetry used in ground-based solar astronomy. The approach involves the use of (1) a photoelastic modulator to rapidly rotate the plane of polarization, (2) one or two analyzers and corresponding linear arrays of photodetectors, and (3) demodulation of the photodetector outputs to obtain data from which one can compute the Stokes parameters Q and U (pertaining to the predominance of horizontal over vertical linear polarization and the predominance of 45° over 135° polarization, respectively). In order to implement the specific detection scheme, it would be necessary to design and build flight-qualified modulators, as well as a custom complementary metal oxide/semiconductor integrated circuit for the low-noise, rapid-readout photodetector array.

This work was done by David Diner, Steven Macenka, Lawrence Scherr, and Suresh Seshadri of Caltech; Russell Chipman of the University of Arizona; and Christoph Keller of the National Solar Observatory for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1). NPO-40936*