Geophysical Research Abstracts
Vol. 14, EGU2012-14166, 2012
EGU General Assembly 2012

SPEX2Earth, a novel spectropolarimeter for remote sensing of aerosols and clouds

J.M. Smit (1), J.H.H. Rietjens (1), O. Hasekamp (1), D.M. Stam (1), F. Snik (2), G. van Harten (2), C.U. Keller (2), O. van der Togt (3), A.L. Verlaan (3), K. Moddemeijer (3), M. Beijersbergen (4), R. Voors (5), K. Wielinga (6), and B.-J. Vollmuller (7)

(1) SRON Netherlands Institute for Space Research, Sorbonnelaan 2, Utrecht, the Netherlands, (2) Sterrewacht Leiden, Universiteit Leiden, Niels Bohrweg 2, Leiden, The Netherlands, (3) TNO Science & Industry, Stieltjesweg 1, Delft, the Netherlands, (4) Cosine, Niels Bohrweg 11, Leiden, the Netherlands, (5) Dutch Space, Newtonweg 1, Leiden, the Netherlands, (6) Mecon Engineering BV, Koopmanslaan 25, Doetinchem, the Netherlands, (7) NLR, Voorsterweg 31, 8316PR Marknesse, the Netherlands

Multi-angle spectro-polarimetry is the tool for the remote detection and characterization of aerosol and clouds in the Earth's atmosphere. Using a novel technique to measure polarization, we have developed a 30 kg instrument design to simultaneously measure the intensity and state of linear polarization of scattered sunlight, from 400 to 800 nm and 1200 to 1600 nm, for 30 viewing directions, each with a 30º swath.

Aerosols affect the climate directly by scattering and absorption of solar radiation, and by scattering, absorption, and emission of thermal radiation. Aerosols also affect the climate by changing the macro- and microphysical properties of clouds (the so-called indirect and semi-direct effects). Estimates of aerosol effects on the climate are hampered by insufficient knowledge of aerosol properties (size distribution, shape, and single scattering albedo) at a global scale. From several studies we know that these properties can only be determined with sufficient accuracy and unambiguously with satellite instruments that measure both intensity and polarization at multiple wavelengths and multiple viewing angles1,2.Polarization measurements must have a high accuracy, typically better than 0.1%. Achieving global coverage requires a large instantaneous field of view. Developing an instrument that combines all of these specifications can be considered as the most important challenge in polarimetric aerosol remote sensing. SPEX2Earth is such an instrument. It has been derived from the prototype spectropolarimeter SPEX (Spectro-polarimeter for Planetary Exploration), that was originally developed for a Mars orbiter. Possible target platforms for SPEX2Earth are the International Space Station, or a low-Earth orbit platform.

SPEX2Earth uses a novel technique for its radiance and polarization measurements: through a series of carefully selected birefringent crystals, the radiance of scattered sunlight is spectrally modulated3. The modulation amplitude and phase are proportional to the degree and angle of linear polarization respectively. Two modulated spectra are produced per ground pixel, with a 180º degree phase shift between their modulations. The sum of the two spectra yields a modulation-free high resolution radiance spectrum of the scattered sunlight. The birefringent crystals determine the modulation frequency and thereby the resolution of the polarization spectrum. The technique is entirely passive, i.e. the polarization modulation is established without moving parts or active components..

SPEX2Earth's novel polarimetric technique allows for achieving the extremely high polarimetric accuracy ($\sim$0.001 in linear polarization) needed to derive properties of aerosol (size, shape, refractive index, optical thickness, single scattering albedo) and clouds (droplet size, number concentration, optical thickness, phase, top/base height, cloud cover) with sufficient accuracy for climate research. With its relatively high spectral resolution, SPEX2Earth resolves the O_2-A absorption band, which is important for deriving aerosol and cloud height. The viewing angles sample the scattering phase functions of aerosol and cloud particles, resolving characteristic angular features, and allowing to distinguish different types of particles.

We will present the SPEX2Earth instrument, outline its spectral modulation principle and discuss its advantages compared with traditional polarimetric techniques. Expected performances are discussed, and recent performance results of the SPEX prototype are presented.

References

1. Hasekamp, O., and J. Landgraf, 2007: Retrieval of aerosol properties over land surfaces: capabilities of multiple-viewing-angle intensity and polarization measurements. Appl. Opt. 46, 3332–3344.
2. Mishchenko, M. I., and L. D. Travis, 1997: Satellite retrieval of aerosol properties over the ocean using polarization as well as intensity of reflected sunlight. J. Geophys. Res. 102, 16989–17013
3. Frans Snik, Theodora Karalidi, and Christoph U. Keller: Spectral modulation for full linear polarimetry, Appl. Opt. 48, 1337-1346 (2009)