



Spectral Profiler Probe for *In Situ* Snow Grain Size and Composition Stratigraphy

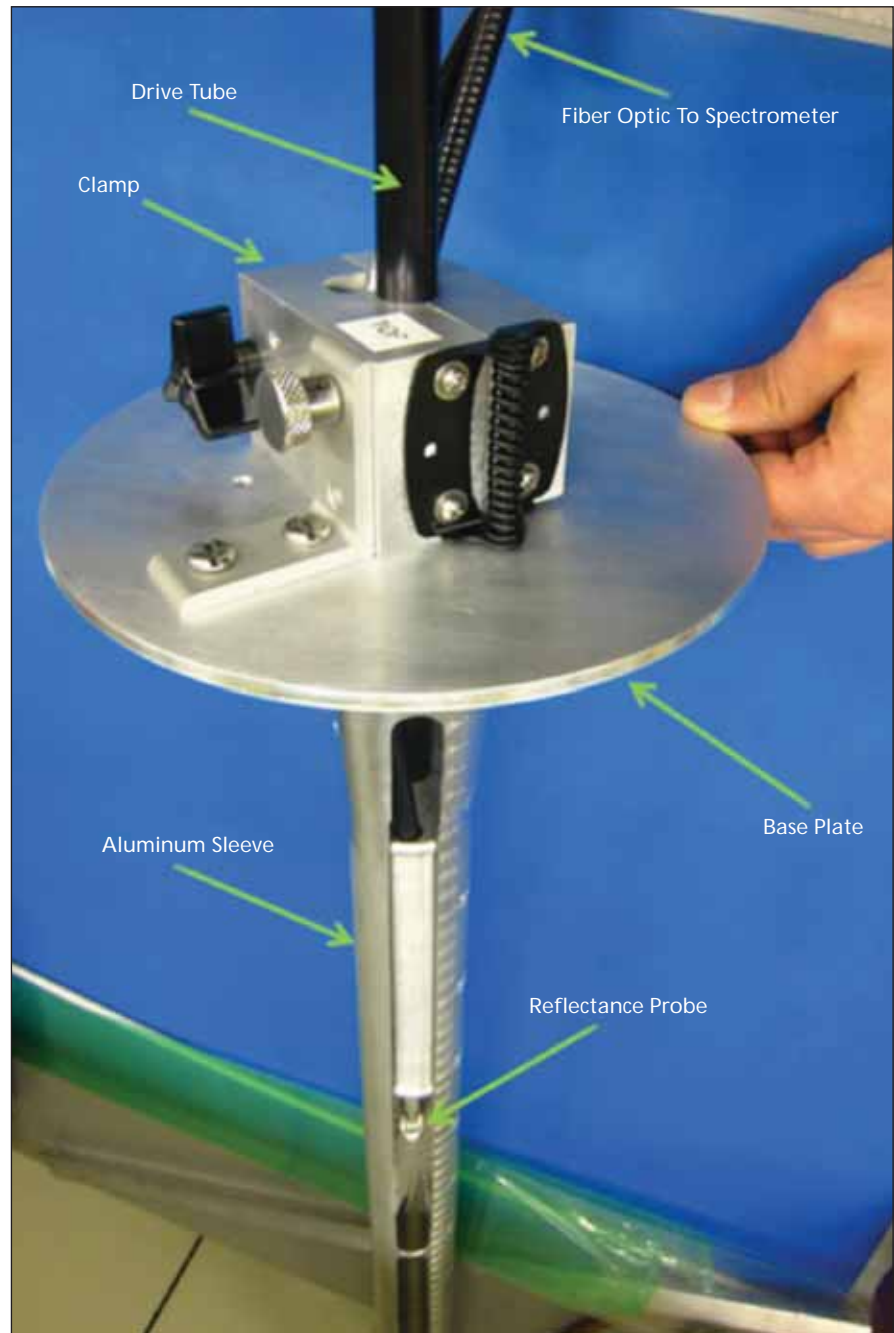
This device can be used by water resource personnel to obtain snowpack data.

NASA's Jet Propulsion Laboratory, Pasadena, California

An ultimate goal of the climate change, snow science, and hydrology communities is to measure snow water equivalent (SWE) from satellite measurements. Seasonal SWE is highly sensitive to climate change and provides fresh water for much of the world population. Snowmelt from mountainous regions represents the dominant water source for 60 million people in the United States and over one billion people globally. Determination of snow grain sizes comprising mountain snowpack is critical for predicting snow meltwater runoff, understanding physical properties and radiation balance, and providing necessary input for interpreting satellite measurements. Both microwave emission and radar backscatter from the snow are dominated by the snow grain size stratigraphy. As a result, retrieval algorithms for measuring snow water equivalents from orbiting satellites is largely hindered by inadequate knowledge of grain size.

Current techniques for measuring grain size include near-infrared photography and contact spectroscopy, both of which significantly disturb the snowpack and require many hours of labor to obtain a single measurement that is extrapolated with great error. To accurately determine the SWE and predict meltwater runoff, the grain size profile (from surface to ground) must be known at many points over a large geographical area, which is not practical with current techniques.

A prototype compact probe was developed that can be inserted into the snowpack to rapidly measure grain size without the need for digging a snowpit. The probe is portable and can be easily transported to take many measurements over a large area. The probe sends into the snowpack an optical package consisting of an optical infrared reflectance probe with near right-angle mirror, an optical camera, and a light source. In typical field operation, a standard federal snow sampler is used to drill a 2-in. (≈ 5 -cm)-diameter hole vertically into the snow and re-



The main components of the **Spectral Profiler Probe** include an optical fiber bundle that carries the light to a spectrometer on the surface, which records the reflectance spectrum. A manual clamping mechanism mounted to the top of the sleeve allows the user to move the shaft up and down and clamp in place during each measurement.

move the core. A thin aluminum sleeve (comprised of tubing assembled in sections) is then inserted into the empty hole. The probe optical package is then lowered inside the sleeve by an aluminum shaft, assembled in sections. The sleeve has a machined slot running the length of the sleeve, except at the joints, allowing the probe optics to view the snow surface horizontally through the slot.

The reflectance probe couples light reflected from the snow surface into an optical fiber bundle that carries the light to a spectrometer on the surface, which records the reflectance spectrum. A manual clamping mechanism mounted to the top of the sleeve allows the user to move the shaft up and down and clamp in place during each measurement. Vertical location measurement is accomplished manually by observing the align-

ment of centimeter graduation markings on the shaft with the top of the clamping mechanism.

The fiber optic bundle coming from the reflectance probe is bifurcated as it comes out of the probe, so that two separate cables go to the surface. One cable connects to the spectrometer, and the other cable connects to another light source on the surface. With this configuration, two different modes of operation are possible. In the first, the external light source is not energized, and the internal light source on the probe tip is energized, shining directly onto the snow surface. This provides strong lighting and is preferable to use under low reflectance conditions, such as large crystals in the snow or large amounts of contamination. The second mode uses the external light source through the fiber optic cable and does

not use the in-bore light. This mode couples less heat into the snow and eliminates any melting concern due to the light source.

The probe provides approximately 1 cm vertical spatial resolution for measuring the stratigraphy. Grain size is determined by integrating the normalized 1,020-nm absorption feature in the ice reflectance spectrum and comparing it to a lookup table generated from an optical scattering model of uniform ice spheres.

The entire probe assembly can be dismantled and stowed into a large backpack for cross-country transport over large distances.

This work was done by Daniel F. Berisford, Noah P. Molotch, and Thomas Painter of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47992

Portable Fourier Transform Spectroscopy for Analysis of Surface Contamination and Quality Control

Goddard Space Flight Center, Greenbelt, Maryland

Progress has been made into adapting and enhancing a commercially available infrared spectrometer for the development of a handheld device for in-field measurements of the chemical composition of various samples of materials. The intent is to duplicate the functionality of a benchtop Fourier transform infrared spectrometer (FTIR) within the compactness of a handheld instrument with significantly improved spectral responsivity.

Existing commercial technology, like the deuterated L-alanine triglycine sulfide detectors (DLATGS), is capable of

sensitive in-field chemical analysis. This proposed approach compares several subsystem elements of the FTIR inside of the commercial, non-benchtop system to the commercial benchtop systems. These subsystem elements are the detector, the preamplifier and associated electronics of the detector, the interferometer, associated readout parameters, and cooling.

This effort will examine these different detector subsystem elements to look for limitations in each. These limitations will be explored collaboratively with the commercial provider, and will

be prioritized to meet the deliverable objectives. The tool design will be that of a handheld gun containing the IR filament source and associated optics. It will operate in a "point-and-shoot" manner, pointing the source and optics at the sample under test and capturing the reflected response of the material in the same handheld gun. Data will be captured via the gun and ported to a laptop.

This work was done by Diane Pugel of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16002-1

In Situ Geochemical Analysis and Age Dating of Rocks Using Laser Ablation-Miniature Mass Spectrometer

Instrument offers a more quantitative assessment of elemental composition than techniques that detect laser-ionized species produced directly in the ablation process.

NASA's Jet Propulsion Laboratory, Pasadena, California

A miniaturized instrument for performing chemical and isotopic analysis of rocks has been developed. The rock sample is ablated by a laser and the neutral species produced are analyzed using the JPL-invented miniature mass spectrom-

eter. The direct sampling of neutral ablated material and the simultaneous measurement of all the elemental and isotopic species are the novelties of this method.

In this laser ablation-miniature mass spectrometer (LA-MMS) method, the

ablated neutral atoms are led into the electron impact ionization source of the MMS, where they are ionized by a 70-eV electron beam. This results in a secondary ion pulse typically 10–100- μ s wide, compared to the original 5–10-ns