

Spectral albedo measurements taken using ASD during MOSAiC expedition

Data abstract:

This dataset contains spectral albedo data recorded on the sea ice surface June-September, 2020, during the MOSAiC expedition in the Central Arctic Ocean. Measurements were made in three modes: (i) along ‘albedo lines’, between 60-200 m in length, with measurements every 5 meters, (ii) at specific ‘library sites,’ or (iii) ‘experiments’. Albedo lines were chosen with the aim of crossing representative surface conditions during the summer sea ice evolution, including snow-covered ridges, bare ice, and ponded ice. Included in the dataset are classification of the surface cover and depth for most measurements. Spectral albedo data was collected using an Analytical Spectral Devices (ASD) FieldSpec Pro spectroradiometer with a custom spectralon cosine collector. Incident and reflected values were recorded subsequently, with 10 scans averaged for each. Processing of the data includes calculating an albedo from the relative values of incident and reflected scans, and completing quality control to (i) correct for parabolic offset between sensors, (ii) add flag quantifying variability of incident light that may be used to filter scans, (iii) remove scans with physically unrealistic values or slopes, and (iv) remove and filter noisy parts of the spectrum.

Data contents:

- The bulk of the dataset is comprised of .csv files for each set of observations
 - The naming structure is asd_mosaic_\${DATE}_\${TIME}_\${LINE}_processedvX.csv
 - \${DATE}: date is formatted at YYYYMMDD
 - \${TIME}: If applicable, a time string is included. This is either formatted as the UTC time (i.e. 0700) or the block during which data collection occurred (i.e. AM for morning)
 - \${LINE}: name corresponding to the location of data collection. See maps below for locations of measurements on Legs 4 and 5. *Note that this gives approximate location relative to ship, and latitude longitude of ship at the time is provided in file headers
 - Files begin with header information
 - Start time: time of first ASD measurement, in UTC
 - Sky conditions: typically recorded as BC (brilliantly clear), PC (partly cloudy), CO-SDV (completely overcast, solar disk visible), CO-SDNV (completely overcast, solar disk not visible)
 - Other notes: may include names of those completing observations, notes on conditions
 - Ship latitude: latitude in decimal degrees of R/V Polarstern at the start time as recorded in header file. See map for approximate location of

albedo line relative to ship. All albedo measurement locations were with approximately 1 km from the ship.

- Ship longitude: longitude in decimal degrees of R/V Polarstern at the start time as recorded in header file. See map for approximate location of albedo line relative to ship. All albedo measurement locations were with approximately 1 km from the ship.
- Position: locations of albedo observations. For lines, these are in meters from start
- Surface type: S (snow or SSL), P (pond)
- Surface thickness (cm): approximate depth of surface type indicated, measured manually with a ruler. See photos in separate folder for a more complete picture of instrument footprint.
- Notes: information on surface type or footprint, as applicable
- Change in incident (%): the change in incoming radiation from scans before and after, as a percent of the measured incoming, at 600 nm. We recommend the user *discard scans where the incident differs by more than 15%* for analysis and application, as rapidly changing conditions may result in inaccurate albedos.
- Table of albedo data
 - Wavelengths (nm): 350 - 2500
 - Albedo (): processed and QC'd albedo values for each position at each wavelength. Cells are empty when data has been removed in QC (see below)

Description of hardware and software:

- Analytical Spectral Devices (ASD) FieldSpec Pro spectroradiometer
 - Outfit with a custom built spectralon cosine collector at the end of a 1-m wand.
 - Albedo is calculated using the ratio of upwelling and downwelling irradiance, eliminating the need for absolute radiometric calibrations.
 - The instrument measures over the range of 350-2500 using 3 detectors: VNIR silicon photo-diode array (350-1000 nm), SWIR1 graded index, TE-cooled, extended range photo-diode (1000-1830), and SWIR2 graded index, TE-cooled, extended range photo-diode (1830-2500 nm)
- Data collection was completed using ASD's High Contrast RS3 software
- Data files were output to ASCII using ASD's ViewSpecPro software

Description of data collection:

Data was collected on the ground using the ASD FieldSpec 3 Pro. At each point, incident and then reflected irradiance were collected to calculate albedo. Measurements were made with a cosine collector on a 1-m wand held at hip height (approximately 1 m). The instrument was leveled using a bubble level, and then 10 spectra were collected and averaged by the software.

Note: photos are available at most locations. Photo files are named based on location/line name, position, and date; additional photos are appended with a number.

Quality control procedures:

- The .csv files include quality-controlled datasets. They have been produced by the following procedure.
 1. Reflected is divided by incident for each measurement.
 - The QC metric “Change in incident (%)” is calculated as the change in incident value at 600 nm, using an average of the absolute value of change from scan before and/or after (when both are applicable). We recommend the user *discard scans where the incident differs by more than 15%* for analysis and application, as rapidly changing conditions may result in inaccurate albedos.
 2. Parabolic correction for temperature-related offset between VNIR sensor and SWIR sensor is applied to between 750 and 1000 nm (see: Hueni & Bialek 2017 for description of issue):
 - Scans where offset at 999 to 1000 nm is greater than 100% of albedo at 1000 nm are removed.
 3. Remove scans when slope of albedos over 400-450 is negative.
 4. Remove noisy parts of scans. Wavelength bands are removed if rolling standard deviation (with a window of 20 nm) is greater than 0.02.
 5. Smooth long wavelengths.
 - From 800 nm onwards, a rolling mean with a window of 15 nm is applied
 - From 1800 nm onwards, a rolling mean with a window of 30 nm is applied
 6. Remove any spectra with albedos greater than 1 or less than 0 in wavelengths less than 750 nm.
 7. Remove any albedos at individual wavelength bands that are less than 0. This is common in the infrared range where spectra are close to 0 somewhat noisy, even after QC.
- All spectra for a few dates were manually QC'd due to technical or light conditions that resulted in unusable measurements.
- Albedos are output with a precision of 3 (three) significant figures. However, we expect that the accuracy is unlikely to exceed two significant figures in the best conditions.
- Although careful quality control has been completed, users should be cautious in interpretation of scans and take into account in interpretation the weather and light conditions as challenging observation conditions were often encountered.

Individuals associated with the data:

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Figure 1. Typical use of the ASD during the MOSAiC expedition. Instrument is leveled and recording incoming radiation. Credit: Lianna Nixon.

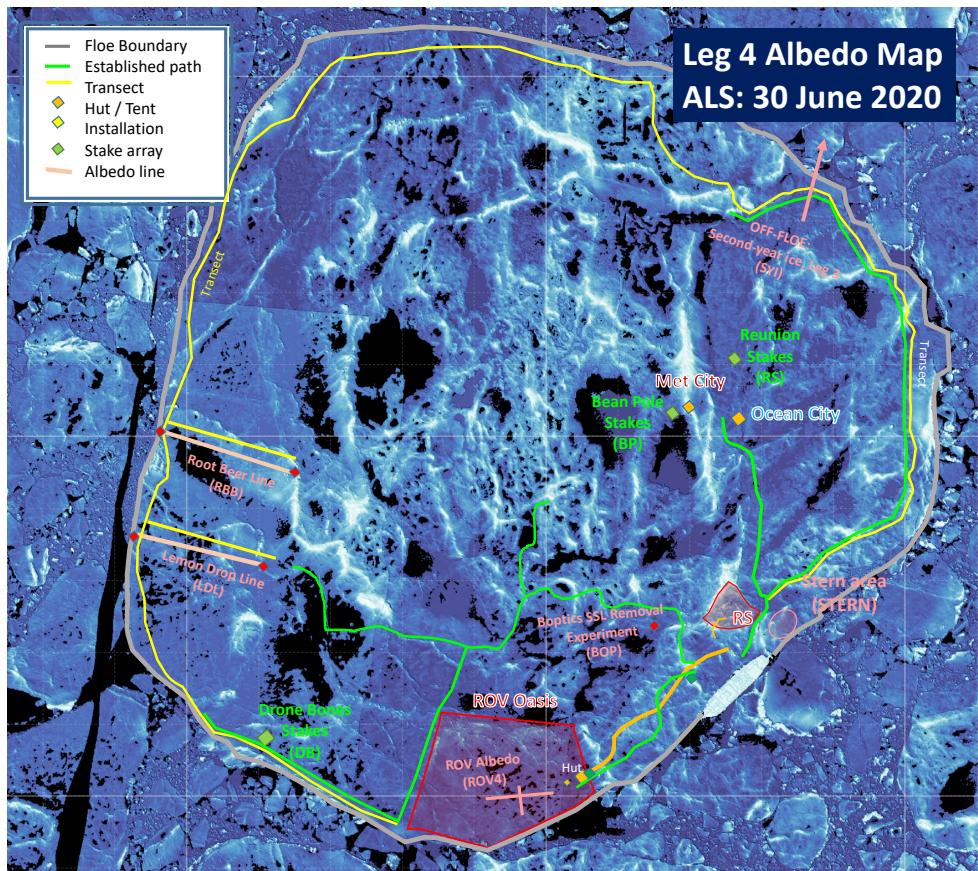


Figure 2. Locations of albedo measurements during Leg 4. Albedo-specific measurement locations are marked with pink, and mass balance stake locations where albedo was measured are marked in lime green. ALS image provided by Stefan Hendricks

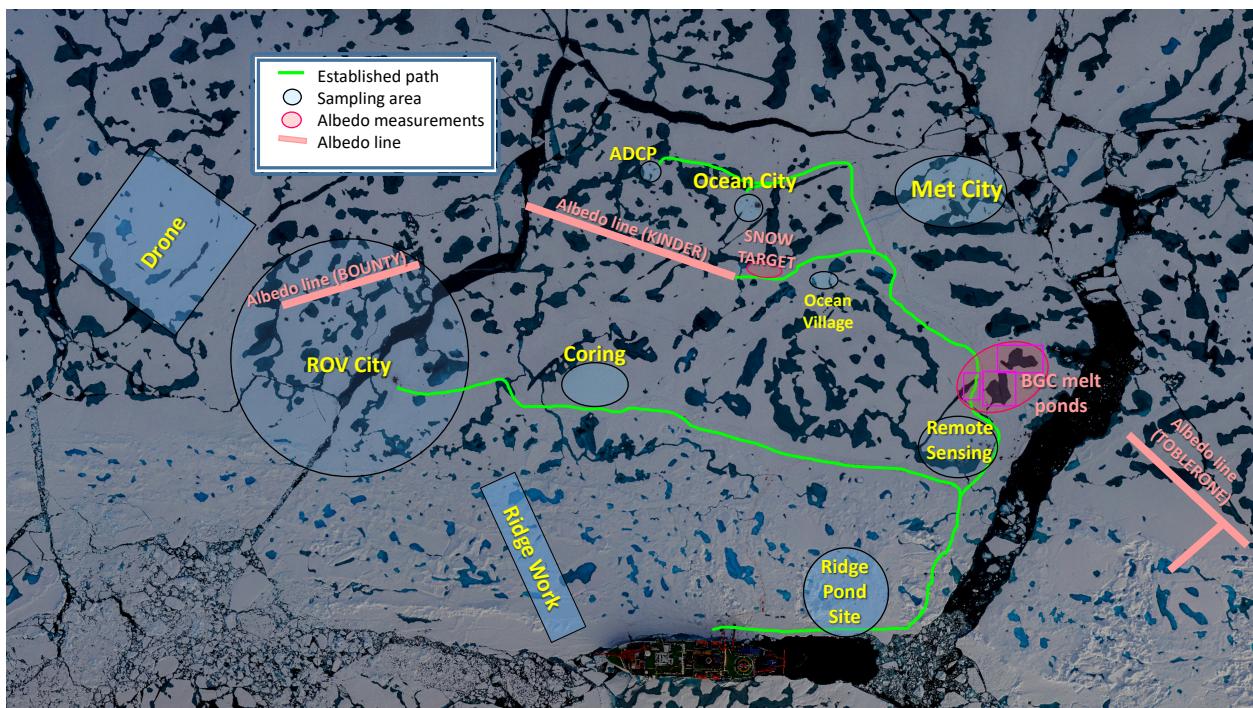


Figure 3. Albedo measurement locations on Leg 5. Drone image provided by Charles Finkbeiner and Steffen Graupner.