# Aconcagua 2017


# Field Report

# Introduction

**Dates:** January 8 – 31, 2017
**Location:** Aconcagua, Argentina (6,962 m/22,841 ft.)
**Trip level:** Wildest
**Team members:** Dr. Ulyana Horodyskyj, Leandro Ignacio, Thomas Edunk, Chris Lundeen, Michael John

**Summary**: At 6,962 meters (22,841 ft.), Aconcagua is the highest summit outside the Himalaya and is located on the border of Argentina and Chile. Given its height, it is surprising how few glaciers there are atop the mountain. High winds and strong sun play a role in this. During our expedition, we investigated the role of black carbon, dust, and other natural contaminants on snowmelt. When dark particles fall on clean snow, they lower the snow's reflectivity, absorb more solar radiation given their dark color, and accelerate melting of the snow. In the long-term, this accelerated melting can affect water supplies down-valley, where people depend on runoff from glaciers.

Penitentes, as seen to the left, are features that form primarily due to the aridity of the Andes, where sublimation (the process of turning from solid to gas) occurs regularly. A key factor in formation is that the dew point is always below freezing. Solar radiation can get trapped in the "hollows," leading to enhanced melting, while penitente "blades" sublimate away much more slowly. Another interesting fact: A dirt cover of less than 2 cm on snow can accelerate melting, while more than 2 cm can insulate the snow from further melt.

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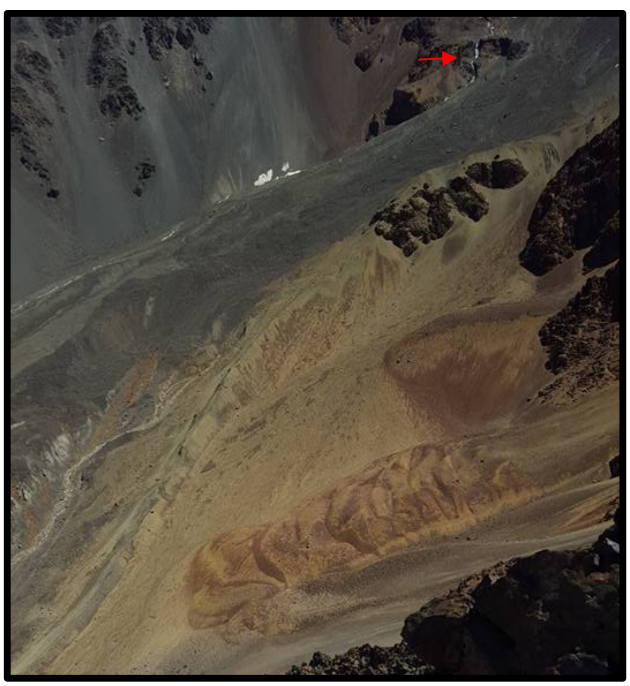
# Acclimatization in Cordon del Plata

In order to prepare for the 4300 meter/14,100 foot base camp of Aconcagua, we first traveled to a region called "Cordon del Plata," home to peaks ranging from 3650 meters (12,000 ft.) to just under 5500 meters (18,045 ft.). We were able to climb a couple of peaks from 3840 meters (12,600 ft.) to 4300 m (14,107 ft.) to aid in acclimatization and get our bodies used to the thinner air, as well as practice how to navigate steep talus slopes (piles of unstable rocks along mountain slopes, due to erosion of the mountain).

U.N. Horodyskyj



In the above photo, Thomas Edunk navigates his way up a 3840 n/12,600 ft. peak called Lomos Blancas during one of our acclimatization hikes in the Cordon del Plata region.

The photo to the left shows the view from 4300 m/14,107 ft. during an acclimatization hike to the top of Adolfo Calle. The red arrow points to runoff from a heavilly- debris-covered glacier flowing off of Vallecitos (5435 meters/17,831 ft.).

In the foreground, a rock glacier can be seen flowing downhill. Rock glaciers are best defined by their morphology (shape). Here you can see the tongue-shape, as well as all the talus (boulders) on the surface. Most likely, an ice core still exists below all those rocks. The glacier flows, but very slowly.

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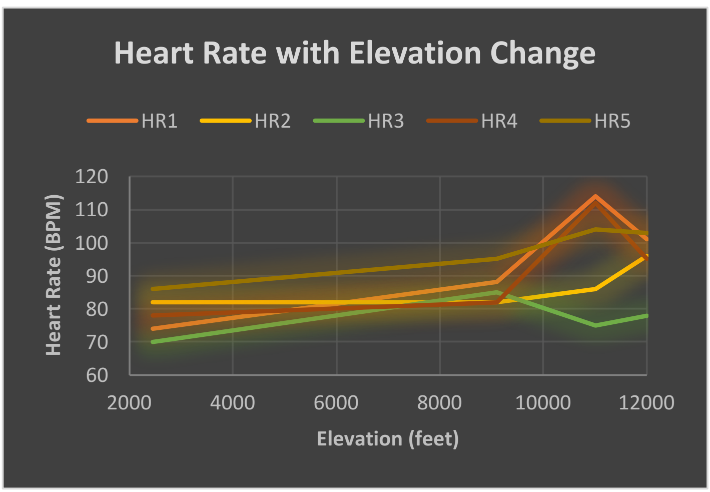
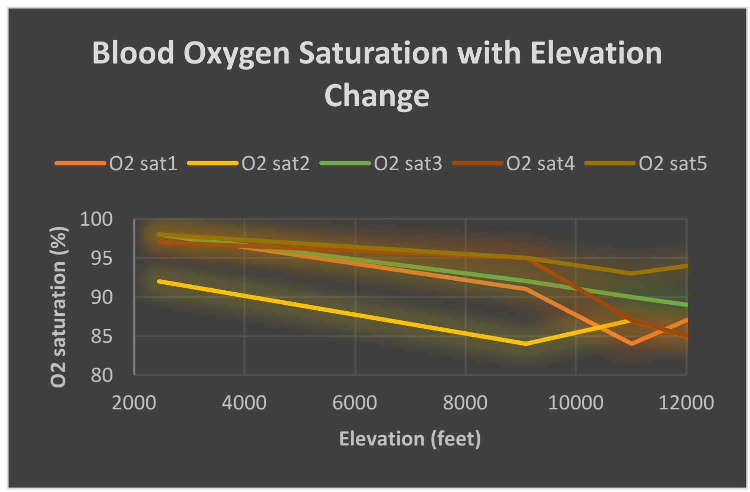
# Acclimatization in Cordon del Plata

In the first few days of our expedition, we tracked our resting heart rates and blood oxygen saturation levels, to see how well we were acclimatizing. Once arriving at Plaza de Mulas (Aconcagua base camp), we had our measurements taken by base camp doctors. Our focus then shifted to moving gear to the higher camps and collecting snow samples and snow data along the way to the summit.

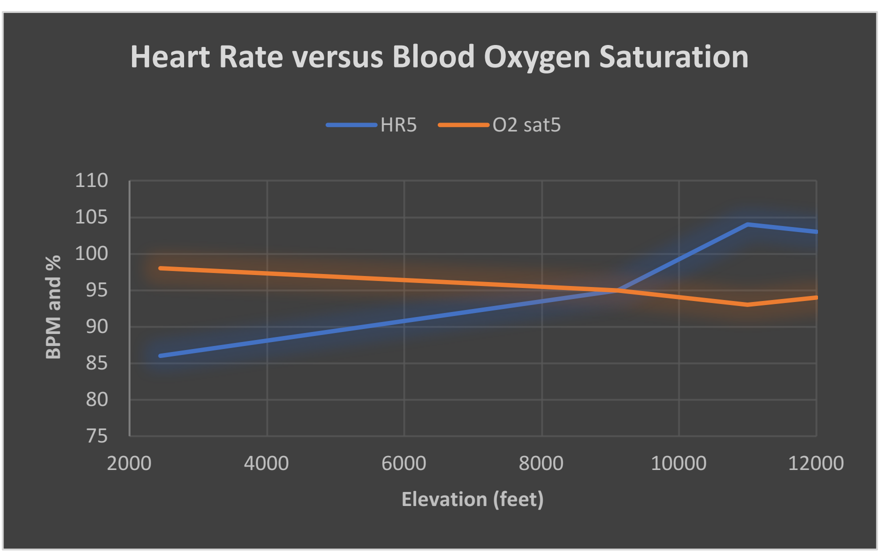
In the graphics below, you can see how our numbers compare (for privacy, we are not identified by name, just subject number). In general, our heart rates increased with altitude and the associated exertion of climbing, with a range of the low 70s to just below 120 beats per minute (BPM). With increases in altitude, our blood oxygen saturation levels decreased, as expected, from near 100% at low altitude (760 m/2500 ft.) to the mid-80s at 3650 meters/12,000 ft. Heart rate decrease at higher altitude for one team member is likely due to that member's pre-acclimatization at high altitude.




Heart rate changes with increasing elevation for all team members.




Blood oxygen saturation changes with increasing elevation for all team members.




Sample data from one team member, comparing heart rate and blood oxygen saturation percentage with increasing elevation.

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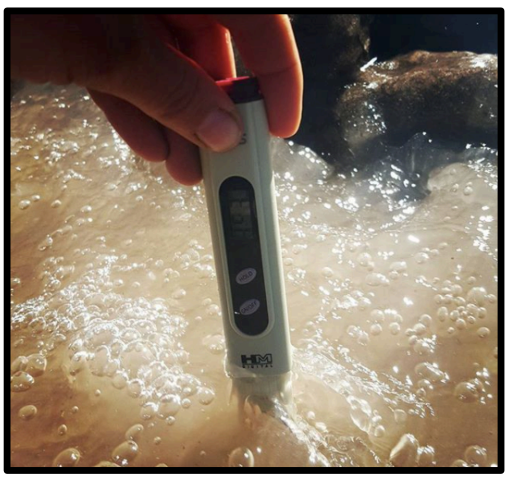
# Approach to Aconcagua Base Camp

After acclimatizing at Cordon del Plata, we hired mules to carry a majority of our gear and then hiked over two days with daypacks to Aconcagua base camp. The first night, we stopped at Confluencia (3390 meters/11,122 ft.). The water here is concentrated with a high number of dissolved solids, so we relied on services from a logistics provider for our drinking water (to avoid upset stomachs). Dissolved solids can include minerals, salts (calcium, magnesium, potassium, sodium, sulfates), metals, cations and anions dissolved in water.

Confluencia camp at 3390 meters/11,122 ft.



Measuring the number of total dissolved solids (TDS) in the waters along trail. The further we were from the glaciers of Aconcagua, the higher the numbers (reported in parts per million (ppm), where 1 ppm = 1 milligram of solids per kilogram of water). Less than 500 ppm is considered safe for drinking. Our samples ranged from the low 100s to near 1000 ppm.

While at Confluencia, we had time to explore some of the local geology. Mt. Almacenes (4800 m/15,750 ft.), pictured above, is a beautiful formation that can be viewed by hiking a short distance from Confluencia. The strata (layers of rock) seen come from what's called the "Mendoza Group." This dates back to the Mesozoic time period: from the Jurassic to mid-Cretaceous (200 to 70 million years ago). The rocks are a mixture of sea sediments containing marine (shell) fossils and sandstones.

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# Base Camp Life

On the final approach to base camp, we noticed an outcropping of white rock: gypsum! This is an evaporite mineral that is soft to the touch and with the chemical formula: $CaSO_4 - 2H_2O$. Some was used some as "field chalk" in order to be able to teach in the field. Thomas is pictured here with the outcropping, in order to provide a sense of scale. Geologists typically use people, pens, and rulers in their photos for scale.


Upon arrival to base camp, our team checked in with the park rangers and doctors, to make sure we were healthy enough for the climb. While acclimatizing for a few days, we explored the numerous penitentes surrounding the camp.

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# Base Camp Science


While at base camp, we went over all the scientific equipment we would use higher up on the mountain. This included a portable weather station, snow thermometer, snow density cutter, snow grain card, snow sampling syringes and filters, and a typical geology rock kit, in order to identify the types of rocks found on the mountain (a mix of volcanic, metamorphic, and sedimentary rocks).

In the photo to the left, Thomas learns how to identify a rock by studying its color, texture, minerals present, and reaction to acid (in this case, we used vinegar). In the photo on the right, Chris learns how to identify snow grain sizes using a grain card and magnifier.

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# Camps 1 – 3

In order to stay healthy on the mountain (no altitude sickness), we made our way up and down between camps 1, 2, and 3 over the course of a week before attempting the summit. The "climb high, sleep low" strategy helps the body acclimate. Staying well-hydrated is also key to warding off altitude sickness.

Camp Altitudes:
Camp 1 (Plaza Canada): 4900 m/16,076 ft.
Camp 2 (Nido de Condores): 5400 m/17,716 ft.
Camp 3 (Camp Cholera): 6000 m/19,685 ft.

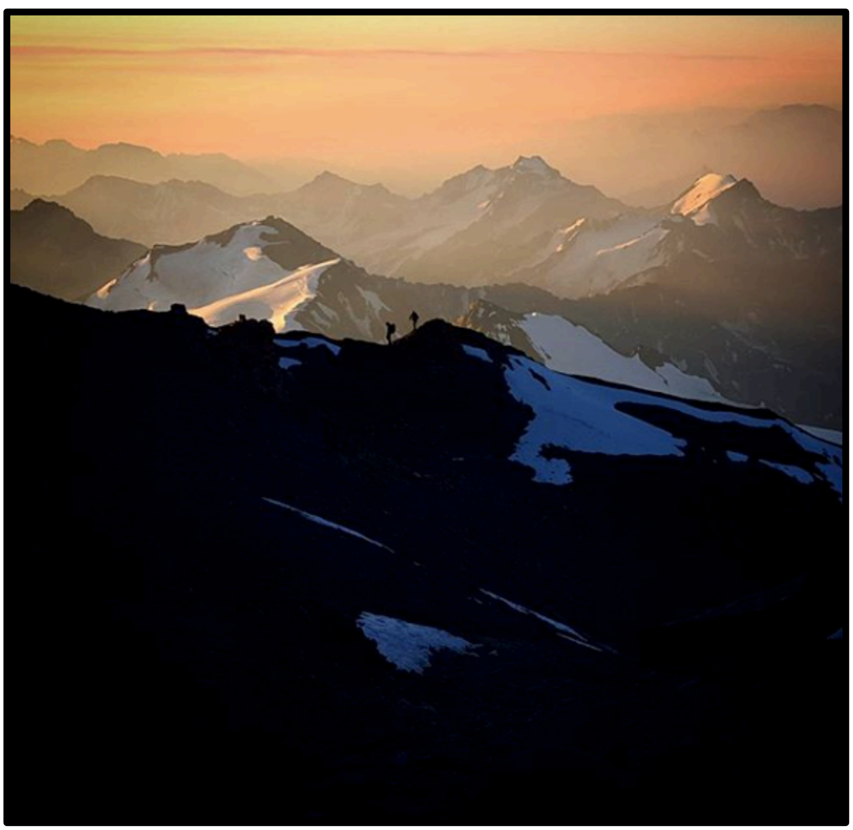
During our rest days, we collected snow and made measurements of air temperature, wind direction, snow temperature, snow grain sizes, and snow density. All this data would be used in a computer model upon return that reveals how much the snow reflectivity drops depending on how dirty the snow is and these other parameters.

Chris waits for a snow temperature measurement.

Thomas hides amongst the penitentes. Note the presence of contaminants (in this region, naturally occurring dust from the mountain) coating and darkening the snow.

# Summit Push

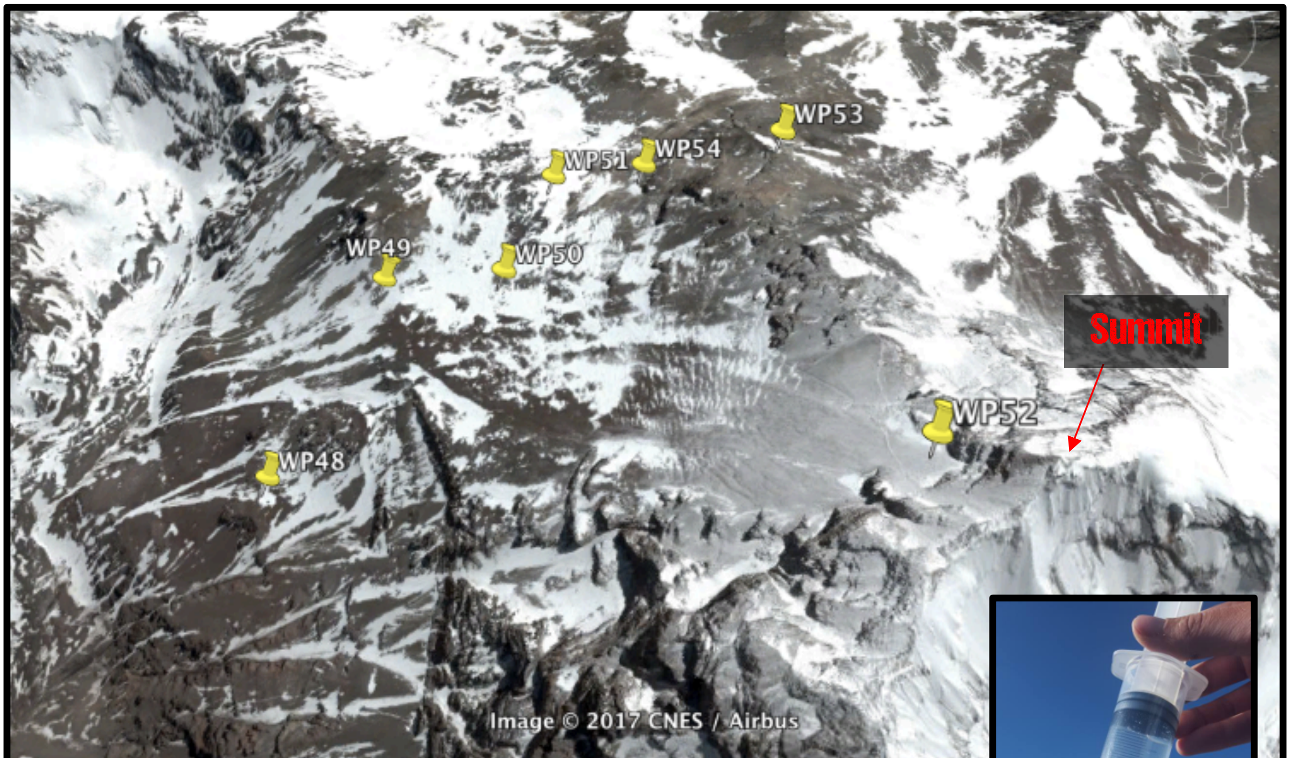
On January 24, 2017, after 8 hours of effort, Ulyana, Thomas and Chris made the summit of Aconcagua (6,962 m/22,841 ft.). On the descent, high altitude snow samples were collected for later filtering in camp. Samples and other data (air and snow temperatures, density, grain sizes) were collected on the way down in order to save energy on the ascent. After a full day of physical effort, however, this task proved to be quite challenging!

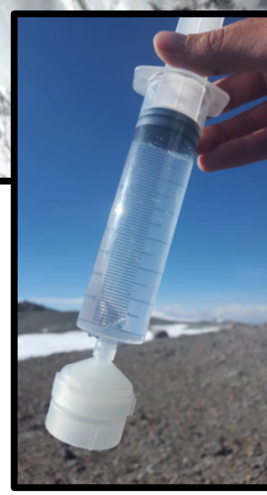


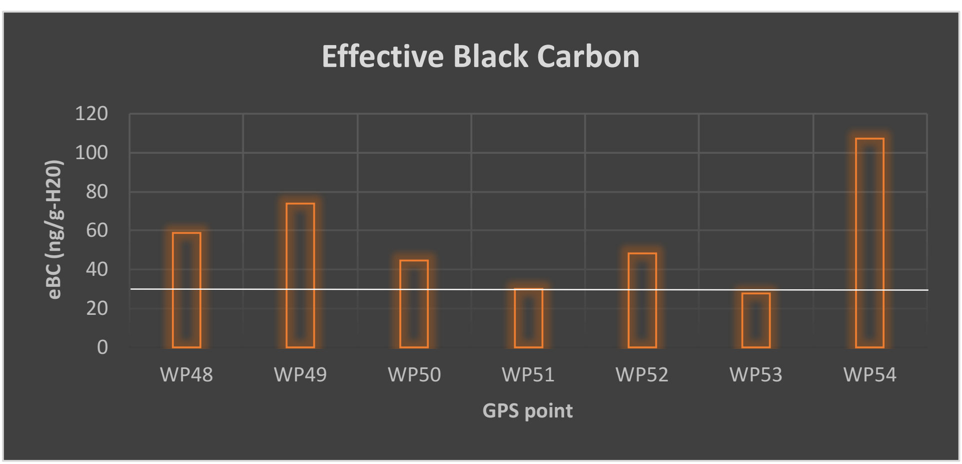
The entire time we were on the mountain, we noticed a haze in the air and a slight smell of campfire smoke. Once back in town (Mendoza), we learned that multiple wildfires were burning in neighboring Chile. The soot from these wildfires is dark in color and can also be a contributor to increased melting of snow and ice, given dark colors absorb more of the sun's radiation.

# Effective Black Carbon in Snow

Snow was sampled from multiple locations on Aconcagua, with waypoints shown on the map. An ice axe, as well as bare hands (if temperatures allowed for it) were cleansed in the nearby snowpack before sampling. Gallons of snow would be collected in bags, melted, and then filtered through a syringe (pictured) as a technique for determining black carbon and dust concentrations. Back home, filters were measured with a "light absorption heating method" to determine concentrations of "effective" black carbon, which includes ALL contaminants present in the snow.






Waypoints and their effective black carbon values, which include all contaminants, natural and manmade, present in the snowpack. The white horizontal line shows the North American average of 30 ng/g-H20 of black carbon.

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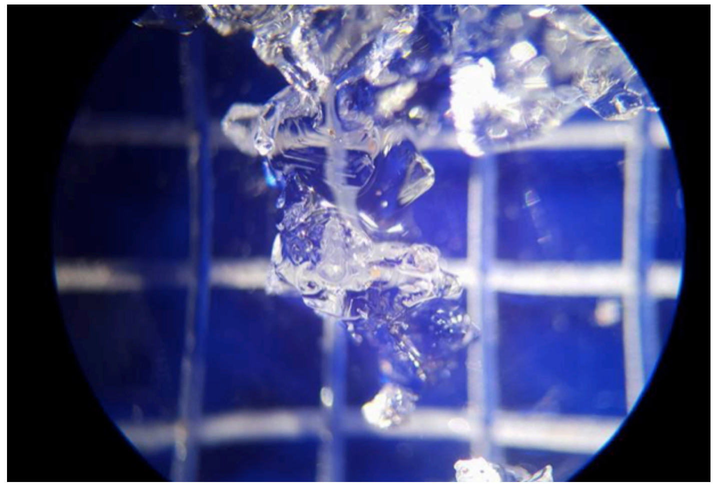
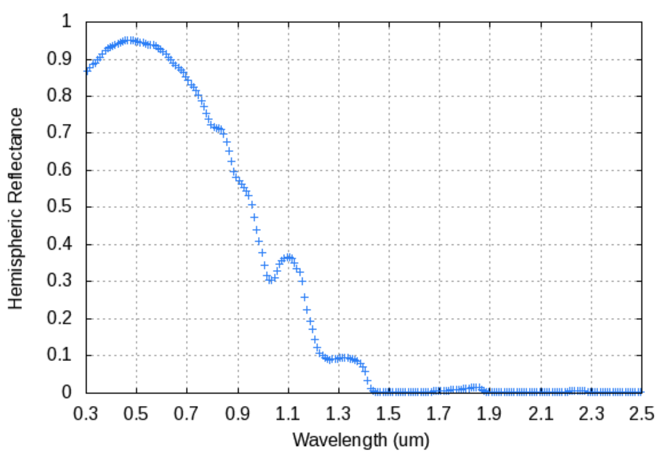
# Snow Albedo (Reflectivity) Study

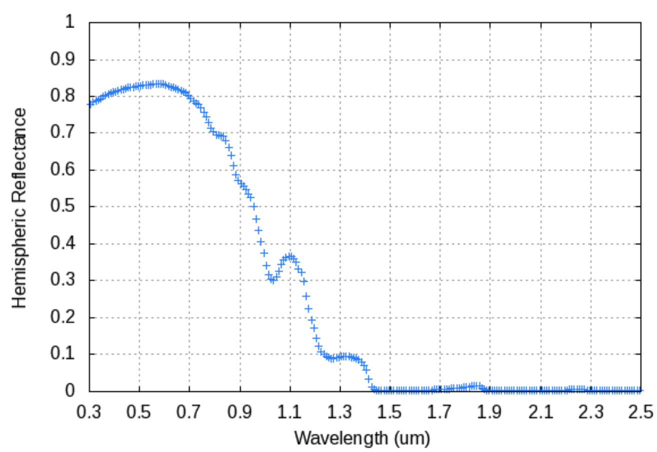
In addition to sampling the snow, we took in-situ measurements of the snow temperatures, snow grain sizes, and snow density. Using SNICAR, a computer model that measures how snow reflectivity changes, we input our data and it produced a graphic of snow albedo. Waypoint 54 is shown as a sample below.

The graphic on the left shows snow albedo (reflectivity) if the snow was completely free of contaminants. Note its peak reflectance is at 95%. The graphic on the right shows the result when using the measured value of eBC from our sample (107 ng). Peak reflectance drops to just over 80%. The broadband albedos (albedo over the whole range of visible and near-infrared light) are 67% and 61%, respectively. Albedo dropped 6% due to the contaminants (both natural and manmade) which can cause more melting than if the snow was completely clean. A future expedition to the region will seek to measure just for black carbon through collection of frozen samples (a tall order bringing that back from the summit to home!).

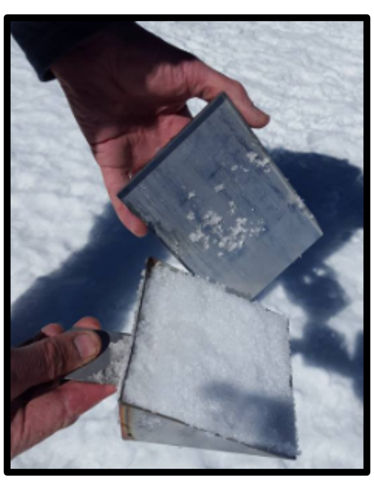




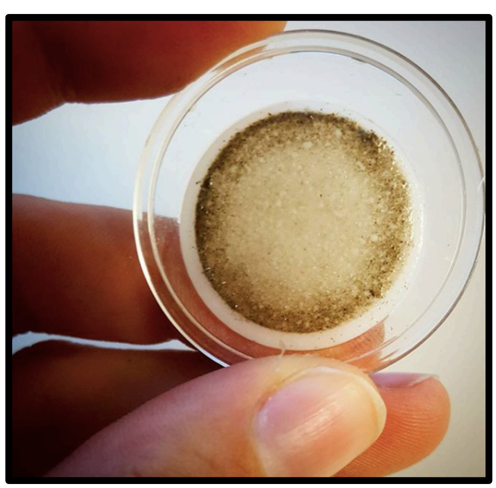

**Broadband Snow Albedo: 0.66636753**




**Broadband Snow Albedo: 0.60929799**



A snow density cutter.



Example of a filtered snow sample.

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