FLAG #25

Expedition: Spatial Distribution and Impact of Black Carbon Along The West Antarctic Ice Sheet

SUMMARY

Scientist and researcher Dr. Ulyana Horodyskyj Peña carried WINGS Flag #25 to Antarctica aboard PONANT's icebreaker, *Le Commandant Charcot*, in January 2024.

The expedition sailed from the far south of the American continent, starting in Ushuaia, Argentina, and completed a half-circumnavigation of Antarctica, before pulling into port in New Zealand a month later. Stops on Ulyana's expedition included the Bellingshausen Sea, Amundsen Sea, and Ross Sea along West Antarctica, with the goal of studying the spatial distribution of pollutants (black carbon, BC) and quantifying the extent of human impact to this pristine region.

DR. ULYANA HORODYSKYJ PEÑA

THE EXPEDITION

Scientist, researcher, and first-time WINGS Flag Carrier Dr. Ulyana Horodyskyj Peña, led a ship-based expedition, sailing along the western coast of Antarctica. Surface snow samples were collected for analysis to contribute baseline data on pollutants present in a remote and relatively untouched region of Antarctica.

In total, 19 samples were collected and analyzed for the presence of light-absorbing particulates (LAPs). The significance of these LAPs lies in the fact that, being dark in color, they absorb more solar radiation than the reflective snow, leading to expedited melting. While climate change is leading to increasing air and ocean temperatures, the impact of LAPs is not as well-constrained.

All samples measured from this expedition had concentrations of LAPs higher than observed background levels on the continent. The impact to albedo (reflectivity) is less than 1%. However, this value is not insignificant when considering the persistent solar radiation during the austral summer, which can still lead to extra kilograms of snowmelt during the melting season.

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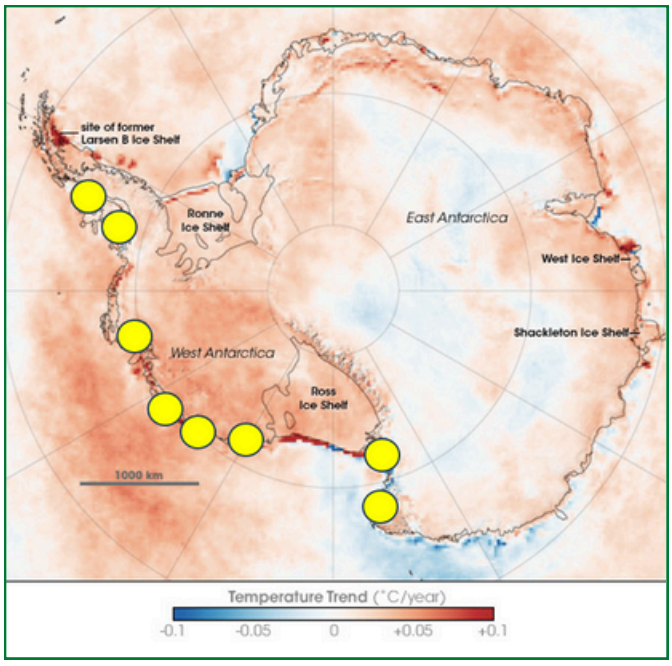
THE EXPEDITION (cont.)

The expedition set sail from Ushuaia, Argentina, on January 8, 2024. After 1.5 days of crossing the infamous Drake Passage (which was mercifully pretty calm), we arrived at the Antarctic Peninsula, one of the fastest-warming regions on the continent. No stops were made here, but this location has been the subject of previous studies (e.g., Cordero et al., 2022) from which data collected on this expedition could be compared.

Over the course of three weeks, we made stops along the coasts of the Bellingshausen Sea, Amundsen Sea, and the Ross Sea, reaching our furthest point south by ship at a latitude of 78 degrees, 40 minutes South. Our landings consisted of shore-based exploration near historic huts, including those of Scott and Shackleton when they were attempting to reach the South Pole, as well as thick sea ice along the coastlines of the seas.

Sea ice is a natural reflector of solar radiation and acts to keep the polar regions cool. If sea ice melts, it exposes darker ocean water below, which absorbs and heats the water, melting any remaining ice. In Antarctica, the sea ice plays a role in buttressing the coastline and protecting it from heavy wave action that leads to erosion of coastal ice. This coastal ice "holds back" the land-based ice. This latter ice, if it ends up in the ocean, contributes directly to sea level rise once it melts.



WHO: **Dr. Ulyana Horodyskyj Peña**

WHAT: **A sample-collecting expedition aboard PONANT's icebreaker, *Le Commandant Charcot.***

WHEN: **January 8-February 5, 2024**

WHERE: **Ushuaia, Argentina, to the Antarctica Peninsula, to the Ross Sea, Antarctica, to Lyttelton, New Zealand**

WHY: **To study the spatial distribution of pollutants (black carbon, BC), to quantify the extent of human impact to this pristine region**

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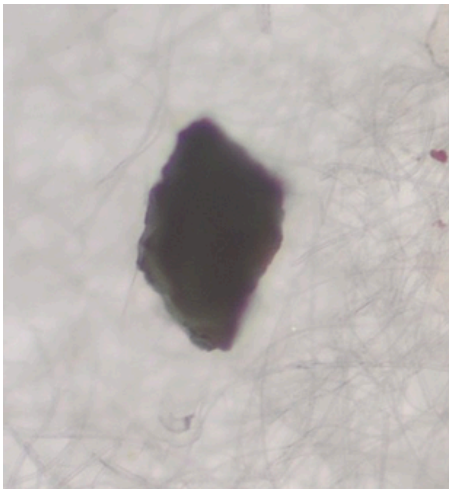
EXPEDITION GOALS

The expedition's goals were as follows:

- To collect snow samples from sea ice to measure black carbon and other light-absorbing particulates along the western coast of Antarctica.
- To collect field data (snow crystal size, shape, and density) for more accurate numerical (computer) modeling of snowmelt.



The photo to the right shows black carbon found in a sample from frozen sea ice in the Ross Sea, Antarctica.

EXPEDITION RESULTS

At each sampling spot, a GPS point was taken, along with field data in the form of snow grain size and shape. Snow density was measured using a kit from BackCountry Access, a US-based company. Photos were taken of the sampling sites, and then physical samples of snow were collected.

Once back on board the ship, samples were melted and filtered into coin-sized filters in the ship's wet lab. Once dry, the filters were analyzed visually under a microscope in the ship's dry lab. Analysis of concentrations of particulates was conducted once home in Colorado, using the "Light Absorption Heating Method."

These values, along with field data, were then put into numerical (computer simulation) models to determine the impact of these particulates on melting of the snowpack due to a reduction of albedo (reflectivity) of the snow. All samples had measured values higher than the background level in Antarctica (at one nanogram of black carbon per gram of water), though far below values found in the Arctic and alpine peaks.

Thus, while west Antarctica is still relatively pristine compared to other regions on the planet, particulates do find a way down South and should continue to be monitored. Further data collection will be useful in the future to compare against these initial baseline values.

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CHALLENGES AND LESSONS LEARNED

Challenging weather conditions (e.g., katabatic winds) and rough seas did not allow for some landings for more sampling, especially once we crossed the Ross Sea. However, given this was an exploratory expedition to gather the first snow on sea ice samples from this region of Antarctica, any samples collected contributed to new scientific data and discovery. Sea sickness was a challenge due to the 4-day crossing from Antarctica to New Zealand, but managed with scopolamine patches. Microscope analysis was avoided during the rough seas!

ABOUT THE FLAG CARRIER

Dr. Ulyana Horodyskyj Peña, scientist/researcher, received a B.S. in earth sciences (geochemistry) from Rice University (Texas, USA) in 2007, which included research experience on the Nathaniel B. Palmer icebreaker to the Antarctic Peninsula. She completed her Masters in geological sciences from Brown University (Rhode Island, USA) in 2010, with a research expedition to Iceland; and her PhD in geological sciences (glaciology) from the University of Colorado Boulder (USA) in 2015, which included research expeditions to Nepal. She lived abroad in Nepal for one year, on a Fulbright fellowship. Ulyana completed a post-doc with the National Snow and Ice Data Center (Colorado, USA), with a research expedition to Baffin Island in the Canadian Arctic and has worked multiple seasons in the Arctic (Svalbard) and Antarctica from 2019 – 2024. She leads expeditions with her adventure participatory science initiative, Science in the Wild, which focuses on outdoor activity and collecting data.

CONTACT INFORMATION

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