SNACS mercury (Hg) project metadata file

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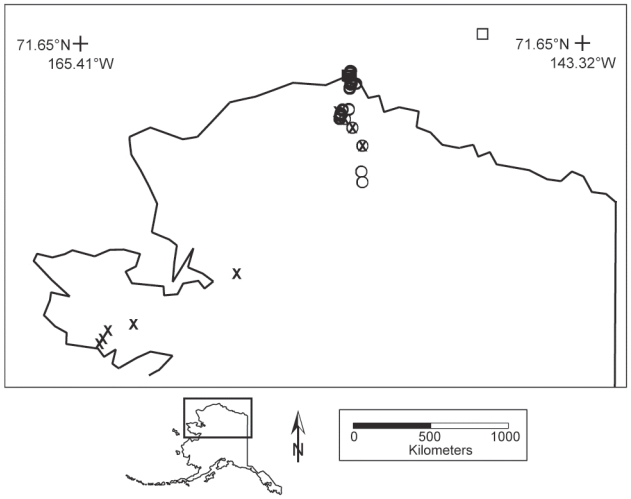
Description

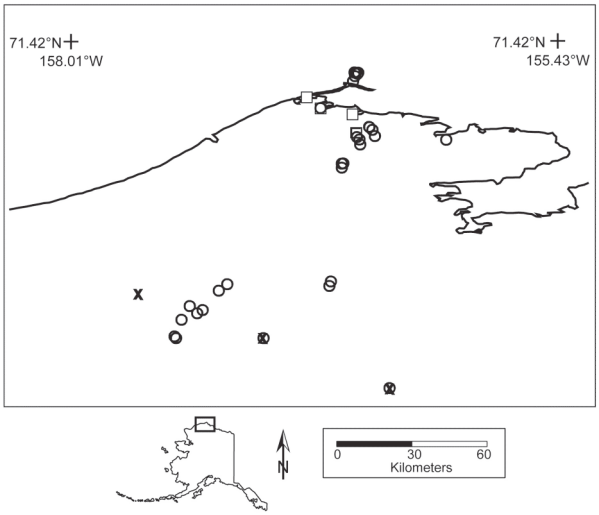
This document describes metadata for chemical samples from the NSF-funded SNACS-Hg project "Collaborative Research on Snow and Ice Processes in the Deposition and Fate of Mercury in the Arctic." The data are chemical measurements along with classification codes. The file contains all data from 2004, 2005, and 2007 field campaigns. The data set consists of more than 1400 snow samples, many of which were sampled in duplicate or triplicate and analyzed for major ion and mercury concentrations.

Sampling sites in northern Alaska

A regional view:



A local view of the Point Barrow area:

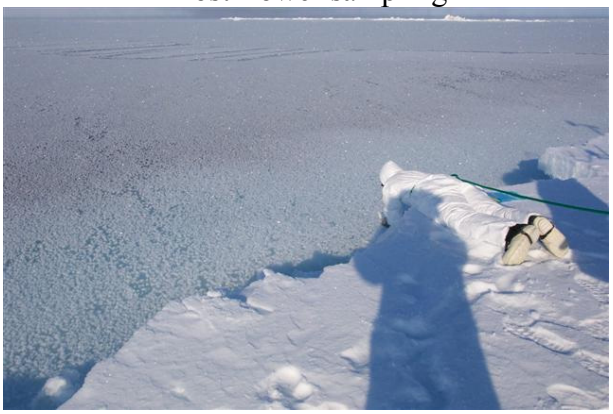


x – 2004 sampling sites
o – 2005 sampling sites
□ - 2007 sampling sites

Images of field collection procedures

Snow sampling

Frost flower sampling



Needle like frost flowers

Tray sampling

Survey snow sampling on first-year sea ice at Point Barrow

Kite sampling

Snow core sampling

Sample list columns and definitions

The sample list has been sorted by the columns "Year" and "Ion_name". The following is a list of column definitions.

- Column Ion_name: Contains labels for field vials and by the name they were analyzed for ionic concentration.
- Columns with ion chemical symbol_N (e.g. F_1): contain the measured ion concentration in micromolar (1 micromolar = 10^{-6} moles per liter of solution). The N stands for the field replicate. These values were measured using Ion Chromatography.
- Columns dil_fac_XN (e.g. dil_fac_a1): Samples were diluted by these numbers to be analyzed in the IC, it represents dilution factor. The letter X in the column label could be either a or c and stands for anions (a) or cations (c), and the N corresponds to the number of field replicates. The values reported have been multiplied by the dilution factor and represent the actual sample concentration. When the dilution factor is 1 the samples was run without any dilutions.
- Columns Inj_vol_XN (Inj_vol_a1): Injection volume, represents the volume of sample injected in the IC for analysis. The letter X in the column label could be either a or c and stands for anions (a) or cations (c), and the N corresponds to the number of field replicates.
- Columns IC_run_XN (IC_run_a1): Given name to each particular IC run. The name is the date the run was started, first the year then month and last day. The letter X in the column label could be either a or c and stands for anions (a) or cations (c), and the N corresponds to the number of field replicates.
- Columns ion chemical symbol_avg (e.g. F_avg): Averaged ion concentration in micromolar.
- Columns Hg_N_name (e.g. Hg_1_name): The N is number of field replicates for mercury samples. This column contains the both the field label and the label used in the analytical laboratory.
- Columns Hg_N (e.g. Hg_1): mercury concentration in ng/L, or ppt. The N corresponds to the number of field replicates.
- Column Hg_Avg: Averaged mercury concentration from field replicates in ng/L or ppt.
- Columns Cond_N (e.g. Cond_1): Specific conductance measurements in microSiemens/cm (μS/cm). The N denotes the number of replicates. Conductivity was measured using a conductivity meter. For most samples this was a direct measurement except for some samples in 2005 which were diluted before analysis. Most of these samples when you plot sum of anions vs. conductivity show an asymptotic behavior at low numbers. We believe that this curving behavior is due to the exposure of the water that is going to be use for dilutions to atmospheric CO_2. The conductivity of water exposed to atmospheric CO_2 is approximately 1 to 2 μS/cm and we dilute samples 11 times then the lowest conductivity for a dilute sample should be approximately 10 to 20 μS/cm even in the absence of ions in the actual snow sample.
- Column pH: Acidity values ($pH = -\log_{10}([H^+]/Molar)$) were direct measurements using a pH meter, and can be found following the conductivity values. This was only done for the 2004 samples.
- Column Biogeochem: This is the name of extra vials that were filled with snow to test and be analyzed for biogeochemistry, but no values were reported back. Can be found in samples from 2005.
- Column DOC: This is the name of 500 mL bottles collected for dissolved organic carbon analysis, but no values were reported back. Can be found in year 2005.
- Column Description: Contains field observations of snow types, air temperature and surroundings of sampling site. This column was used later on to classify samples in the different codes described below.

- Column Site: Assign sampling site name. Refer to the classification section (below) for a more detailed description of sites.
- Column Date: Sampling date.
- Column Time: Sampling time.
- Column FractionalDOY: Calculated fractional day of the year.
- Column Year: Campaign year.
- Column Temperature: Temperature of the sample in Celsius. It does not correspond to air temperature.
- Column Distance: In 2007 we were interested in studying sea salt distribution in different sites and surroundings in the Arctic. We designed a series of experiments sampling surface snow every 5 m in a 100 m long line, so this column corresponds to this description.
- Column Snow_depth: In the same experiment described above (column Distance) snow depth was measured in cm.
- All columns after Snow_depth correspond to snow classifications and codes given later on by their descriptions, see next section.

Classification codes

Each year had different objectives and therefore different types of samples, so we gave codes that would facilitate sorting the data for analysis (see Tables 1-5). All three years have their own codes that classify samples according to the objectives for each year, and as we are now done with the data set we have found common ground for the three-year data set. We assigned codes that unify the three-year data set (see Table 1).

Table 1. Unifying codes

Location	land	1
	thick ice	2
	thin ice	3
	multi-year ice	4
New_old	New snow	1
	Old snow	2
layer	surface	1
	vertical	2
	entire stratigraphy	3
snow_type	new / fresh	1
	blowing snow	2
	new hoar frost	0.5
	wind crust	8
	sintering drift	5
	depth hoar	10
	fluted	6
	surface hoar	0.1
	nodules, popcorn, rime growing into the wind	0.2
	diamond dust	0.3
	Saltating grains	0.02
	Suspended grains	0.01
	depth hoar mixed layers	11
	frost flowers	12
	frost flowers mixed with snow	13

In 2004, the objective was to explore and contrast concentrations of sea salts and Hg with increasing distance from the shore (see Table 2). In 2005, the objective was to study sea salt sources more closely and focus on the sea ice and sea ice lead environments. We collected different types of ice forms that included surface snow, layers under the surface snow, frost flowers, and other classes mentioned in Table 3. In 2007, the effort focused on two main aspects: a time-series of ion and Hg concentration in aerosol/snow and the spatial distribution of sea salt at different locations and snow/ice (see Table 5).

Table 2. 2004 classifications

a.

Class	Main Transect with values increasing from Barrow inland to the Brooks range	1
	Coastal locations near Barrow and on sea ice	2
	Unique locations- drifts and manipulation experiments	3
	Along a transect from Nome inland in to the Brooks range	4
Code	Distance from the coast where 1 is closer to shore	1 - 11

b.

Site	Class	Code	Distance (km)	Latitude	Longitude
AB-BEO	1	101	1.5	71.18366	-156.39478
AB-Pipe	1	102	8.5	71.11942	-156.44685
AB-4	1	103	17.8	71.03761	-156.52039
AB-3	1	104	76.8	70.50703	-156.58046
AB-2	1	105	92.5	70.40197	-157.12968
AB-Walt	1	106	106.5	70.28126	-157.24467
OA-11Land	1	107	104.9	70.28083	-156.86608
OA-7Land	1	108	127.3	70.06389	-156.31972
CO-013	1	109	181.0	69.60389	-155.57278
IC-10	1	110	255.0	68.93458	-155.65944
IC-004	1	111	285.7	68.65361	-155.57944
Phase1Lead	2	201	-5	Sea ice Barrow, AK	
S.Runway	2	202	0	Airport Barrow, AK	
Scott	2	203	0	71.14000	-156.07500
Pt.BRW	2	204	0	71.39283	-156.478
Chukchi	2	205	0	Sea ice	Barrow, AK
Phase3Block	2	206	-5	Sea ice Barrow, AK	
MeadeE	3	301	107	70.38872	-157.15342
MeadeW	3	302	107	70.36072	-157.22103
Drift_AB-4	3	303	17.8	71.03761	-156.52039
Unknown	3	304			
Topkok	4	401		64.58	-164.01
N-C02	4	402		64.73	-163.75
CB-000T	4	403		64.84	-163.70
CB-01T	4	404		65.03425	-163.29194
CB-3F	4	405		65.19	-162.28
HunterCreek	4	406			
BS-4T	4	407			
SA-3T	4	408		66.70333	-158.71669
SA-6T	4	409		67.01484	-157.91813
AI-4T	4	410		67.46586	-157.60075
AI-9T	4	411		68.12631	-156.34719

c.

StdName	LayerCode
blowing	10
febcrust	40
febslab	41
hoar	50
janmelt	42
marslab	30
other	60
recent10apr	20
recent28mar	21
surfacehoar	22

Table 3. Codes from 2005.

Major class	Description	Sub class	Description	Sub sub class	Description	Sub sub sub class	Description
1	Lead X	1.x	Transects	.1	Lead 01		
				.2	Lead 02		
				.3	Lead 03		
				.4	Lead 04		
				.5	Lead 05		
				.6	Lead 06		
				.7	Lead 07		
		2.x	Salty samples	.1	Whole frost flower (ff)		
				.2	FF tip		
				.3	Young ff		
				.4	Old ff		
				.5	Slush-brine		
				.6	Hoar		
		3.x	Experiments	.1	Kite		
				.2	Aerosonde		
				.3	Snow fence		
				.4	Atqasuk-ABBEO		
		4	Lead trays				
2	Tundra time series	1	Trays				
		2	Surface snow				
3	Melt	1.x	Transect	0.1	Snow		
				0.2	Core		
				0.3	Water		
		2.x	Sea ice site	0.1	Snow	.xx	Layer from surface
				0.2	Core		
				0.3	Water		
		3.x	Mayoeak	0.1	Snow	.xx	Layer from surface
				0.2	Core		
				0.3	Water		
4	Other						
5	Stratigraphy transect	1.x	Atqasuk	0.1	Snow		
				0.2	Core		
				0.3	Water		
		2	Barrow				
		3	Sea ice				
		4	ABBEO				
6	No description						
7	Not found						

Table 4. GPS coordinates in 2005

Site	Latitude	Longitude
Lead 01	71.43165	-156.472
Lead 02	71.43069	-156.471
Lead 03	71.43027	-156.466
Lead 04	71.4311	-156.455
Lead 05	71.42679	-156.459
Lead 06	71.41582	-156.47
Lead 07	71.39283	-156.478
Tundra trays	71.3134	-156.613
Mayoeak	71.25600	-156.46800
Atqasuk	70.28782	-157.25125
Lead trays	71.4313	-156.459

There are only a few sampling sites in 2005 compared with 2004. There are 7 sites located on the sea ice starting with lead 01 from the lead edge to lead 07 still on the sea ice but close to shore. There are a few other sites like "Gate pan," 100 m from lead, and "lead cloud" that were collected on the sea ice, but do not belong to a particular transect or series of samples. Then we collected samples inland just 3.6 kilometers from shore and we called this locality "Tower" site. As time passed the tower site also was differentiated into "table trays," or just "trays" or "tundra," depending upon the snow type at the same location. If the site was called "tundra surface" we know the sample is snow from the ground, and if it was called "trays" the sample was collected from the elevated Pyrex trays. There was another site farther inland close to the Mayoeak River called "Mayoeak." Most of the melt samples originate from this site, although we also collected on the sea ice to track both inland and sea ice melt. The other site names correspond to 2004 sites or Atqasuk, which is a village 102 kilometers south of Barrow.

Table5. Codes from 2007

			Latitude	Longitude
Exp_code	Point Barrow	1	71.39283	-156.478
	Mayoeak	2	71.25600	-156.46800
	Elson Lagoon	3	Barrow, AK	
	6 miles South of Mayoeak	4	71.16900	-156.46500
	Thick first year sea ice	6	72.28000	-147.79000
	Multi-year sea ice	7	72.28000	-147.79000
	Thin first year sea ice	8	72.28000	-147.79000
Repeat	Duplicates of the same line	1 or 2		
s_v_ff_b	Surface	s		
	Vertical	v		
	Frost flower	ff		
	Bag	b		

The effort in 2007 concentrated on a time series and a spatial distribution of sea salts in different Arctic terrains. There are two time series one located close to Barrow, AK in the site that we used in 2005 as the tower site, which we called here table tray site. We sampled for 30 days and used the trays to collect some snow whenever new, freshly fallen snow was deposited. However, the objective was to construct a time-series of snow on the ground, and therefore the majority of samples are ground samples. The other time series was on the ice camp APLIS 2007 for about 10 days. The spatial distribution experiments were done in 7 different sites summarized in Table 4.

Sampling procedures:

- Snow sampling: Collected into 50 mL polypropylene vials (for ion sampling) or into variable-sized FEP Teflon bottles (for Hg sampling). Used the edge of the vial to scoop the snow inside the vial for ion sampling and used either polystyrene scoops or the Teflon bottle lip to fill the bottles for Hg sampling.
- Vertical snow sampling: Dug a snow pit and with the edge of the vial scraped the edge of the pit from the bottom to the top.
- Frost flower sampling: Usually used the vial edge to scoop the crystals into the vial. When sampling brine we used a dropper. For frost flower tips we used tweezers and transferred the tips to a vial.
- Tray sampling: Four Pyrex trays were elevated approximately 1 m above ground on a wooden table. Freshly falling snow would settle into the trays and would be collected soon afterward
- Survey samples: Sampled surface and vertical snow in every 5 m along four 100 m lines.
- Bag: part of the survey experiment, consisted of approximately 1 cup scoop of snow into a 2 gallon bag for each 100 m line every 5 m.
- Kite sampling: Filled a 500 mL bottle half-way with liquid nitrogen. The bottle was hoisted up a pulley on a kite and lifted to an altitude of roughly 100 meters above the snow/ice surface. We collected condensate on the outside of the bottle into a precleaned Teflon bag or bottle. In the lab we melted the sample and transferred it to a vial for analysis.
- Snow core: Dug a snow pit, penetrated the entire snow pack with a PVC corer, slid a shovel under the corer opening and inverted the sample into a bottle. Two to four PVC cores were combined for each core sample.
- Water: Filled 50 mL polypropylene syringes with melted snow, melted sea ice or river water and transferred it to a 50 mL polypropylene vial (ions) or Teflon bottle (mercury). We used the same bottle types as were used for snow sampling.