Black carbon in Arctic snow: Results for 2006 and Planned Observations

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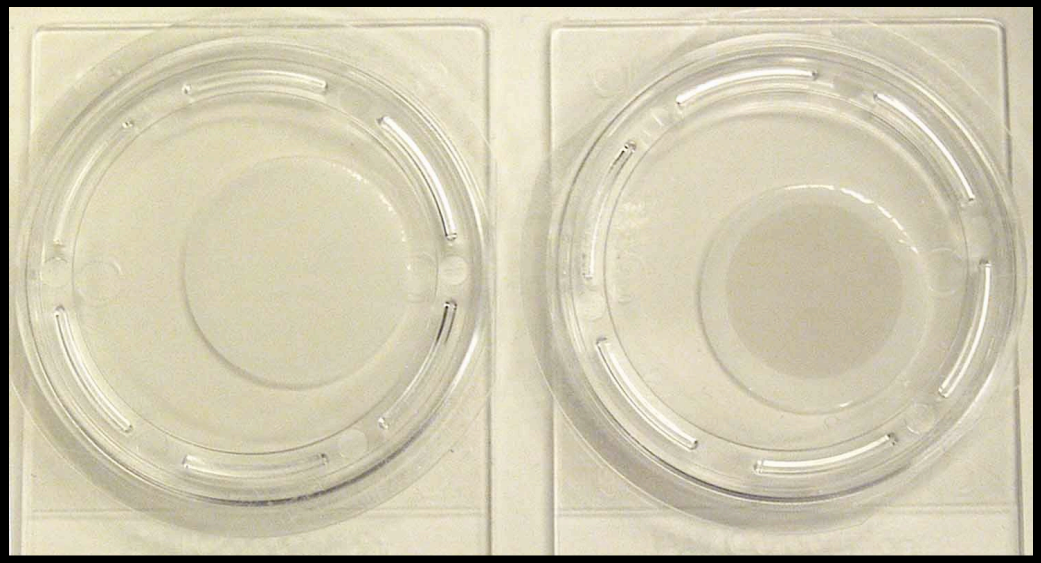
Project Web Site: www.atmos.washington.edu/sootinsnow

Collection of snow samples at remote sites

Filled Sample Jars – must be extremely clean

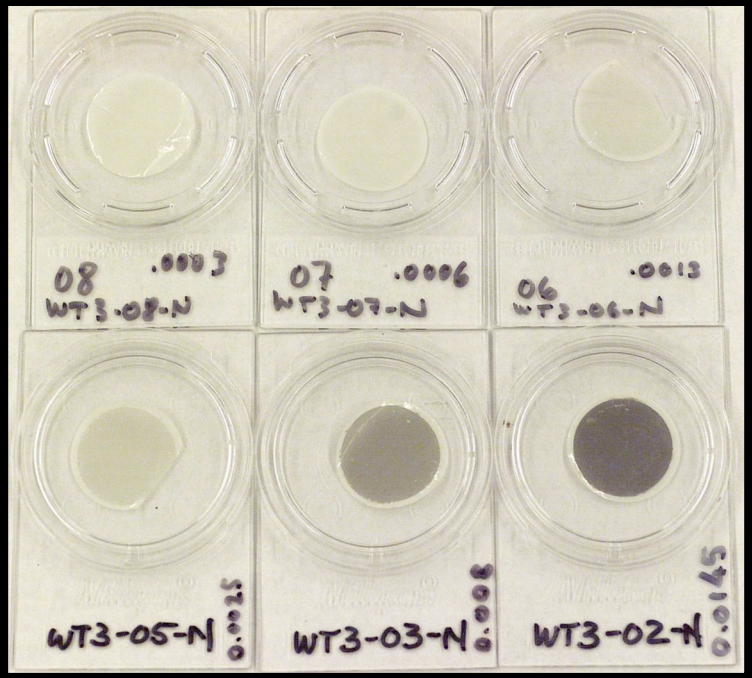
Field processing (versatile) – e.g. NE Greenland & Cambridge Bay



NE Greenland: Snow at 96 km Snow at 38 km (some dust). Soot versus dust.

(1) Visual comparison with BC standards made by Tony Clarke with "Monarch-71 soot"

(2) Spectral transmissivity to separate soot & dust contributions (in progress).



Even remote field stations have sooty areas – pay careful attention to site selection.

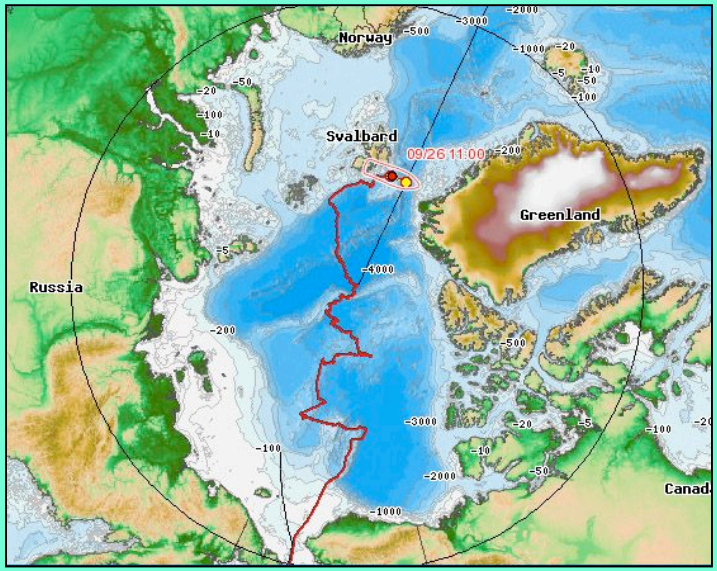
Samples from Summit Station, Greenland, July 2006 (sampled by Mike Town)

SHEBA Ice Station May 1998

Grenfell, Light, Sturm: Median 4 ppb, range 2-11

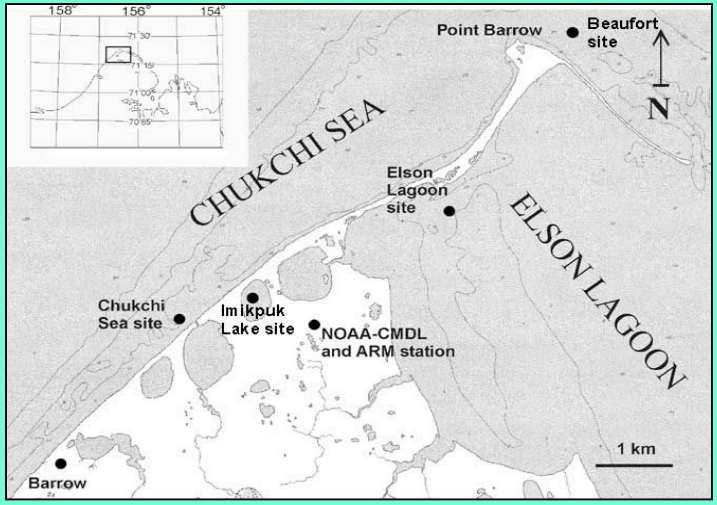
Arctic Basin Traverse, Aug-Sept 2005

TCG: Median 4 ppb, range 0.8-10



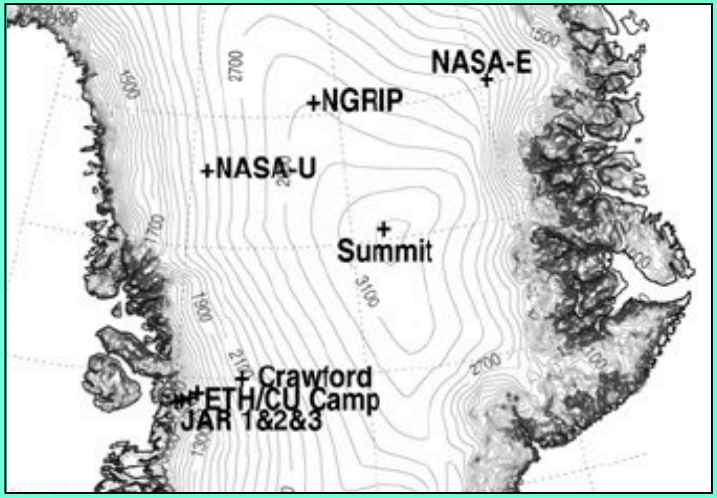
Barrow Alaska May 2000-2002

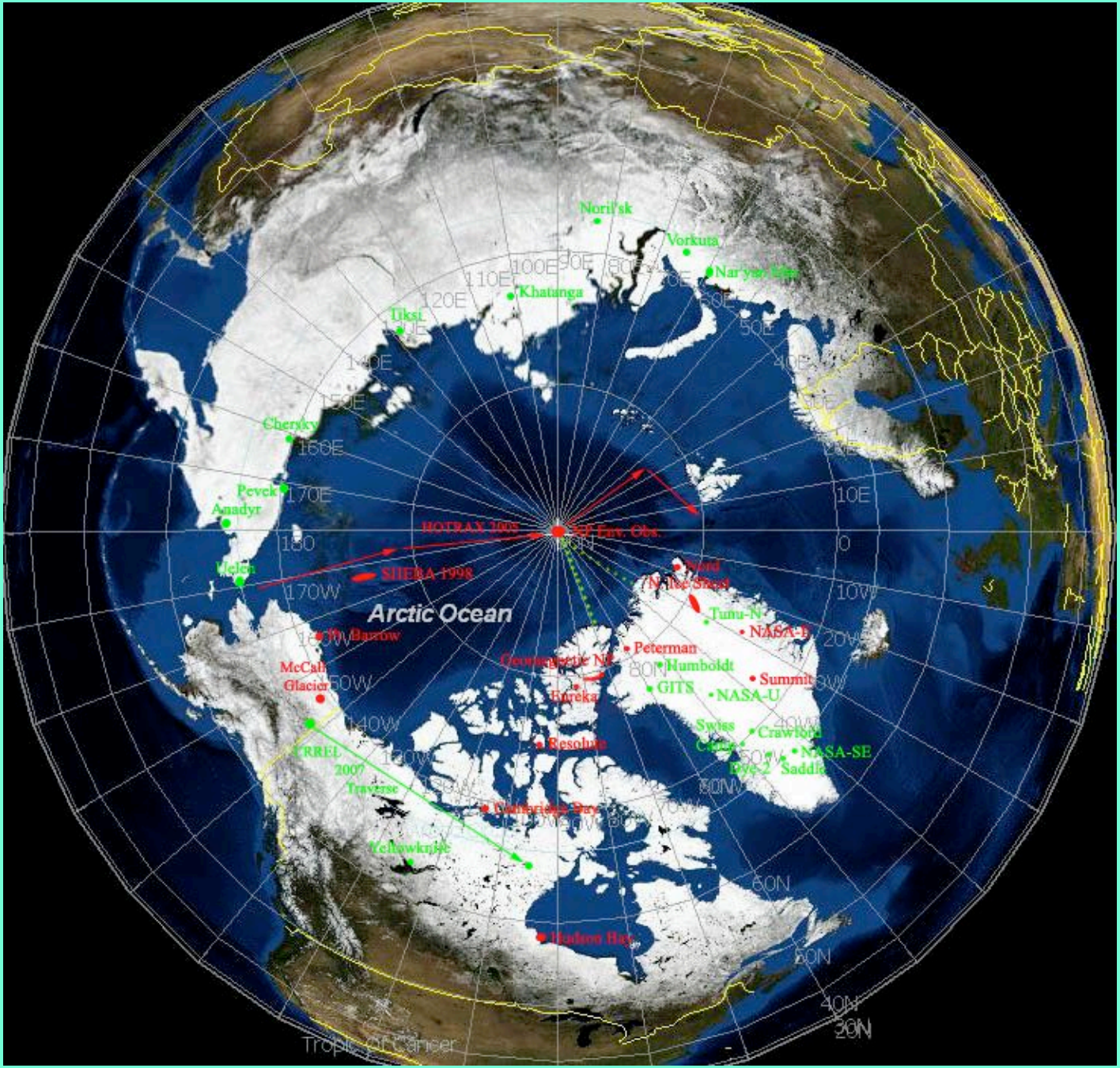
TCG: Ave 8 ppb, range 5-10



Greenland Summit Station

Chylek et al. 1987, Slater et al. 2002: <4 ppb but some 19-30

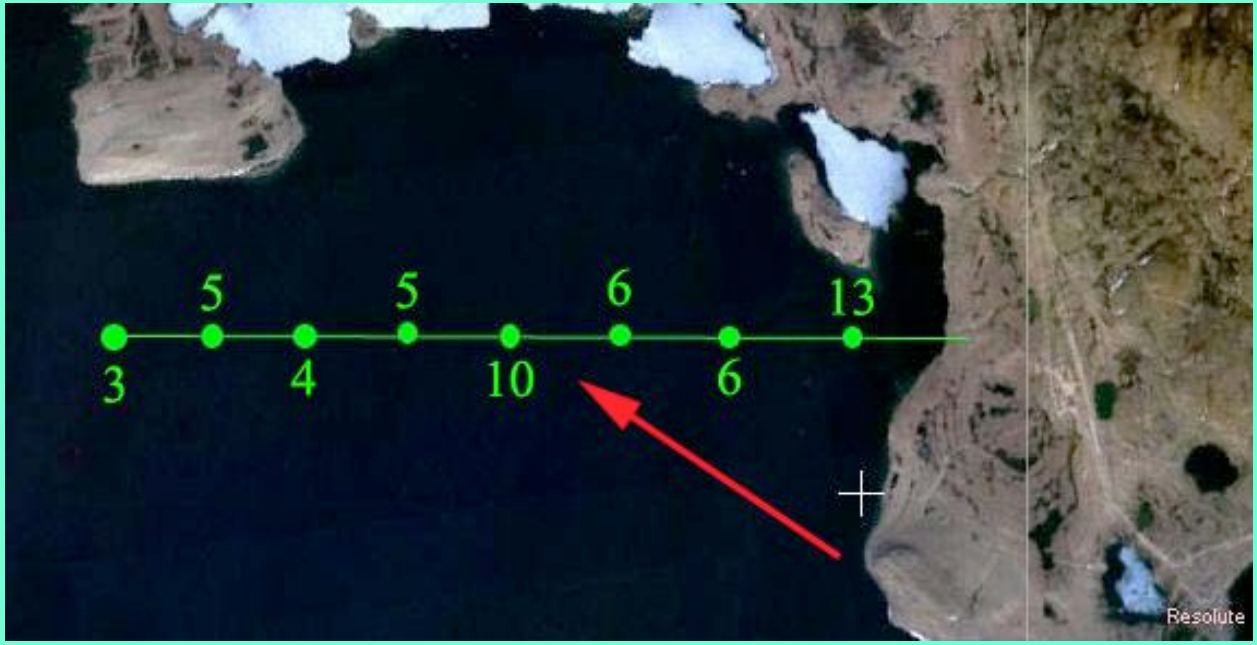


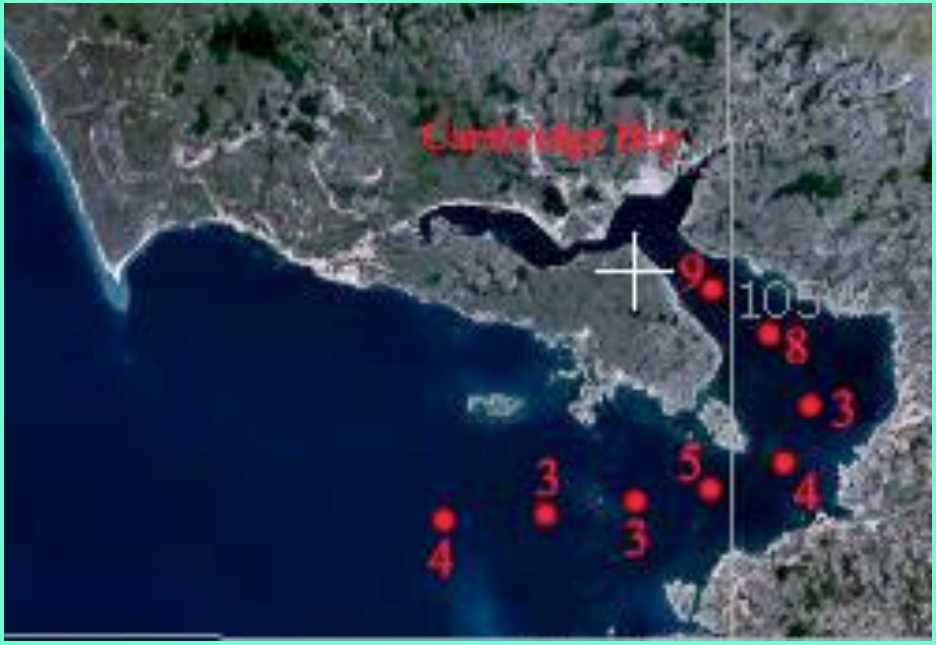


Overview of sites:
CATF sponsored project began 2006.
Continuing with
NSF support

Warren, Grenfell, Clarke + Volunteers

Resolute and Cambridge Bay Surveys, April May 2006





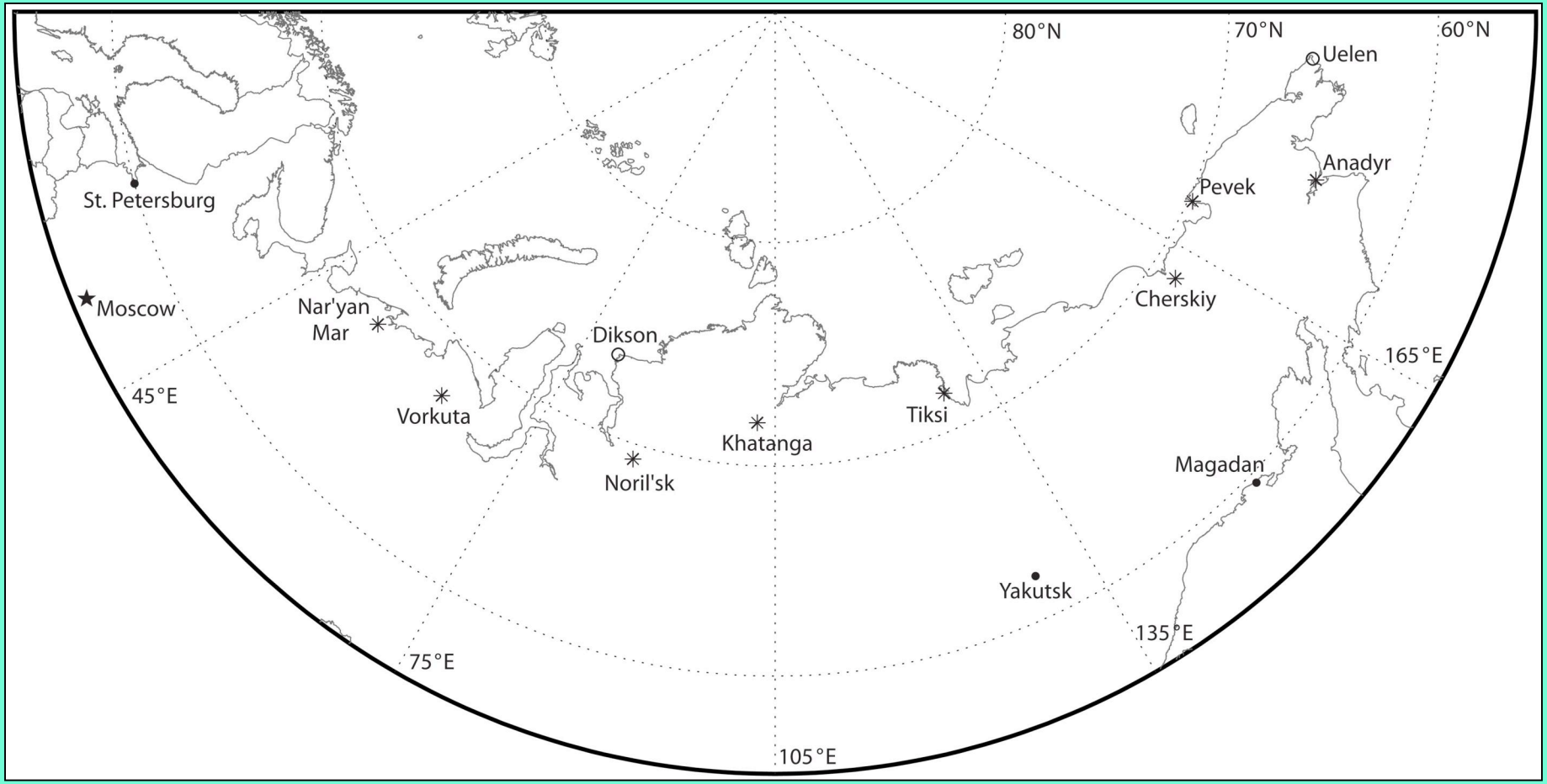
Background Soot concentration in snow from visual estimates in ngC/g.	1998-2006		1983-84 (Clarke & Noone)	
	Median	Range	***Median***	Range
Greenland				
10-20 km around Summit Station	***0.7***	0.6-1.0	***2***	1-11
K. Steffen Automatic Weather Stations	***0.6***	0.4-1.2		
Northeast: new snow	***1.4***	1.3-1.5		
Northeast: old melting snow	***3***	2-8		
Canada				
SW Hudson Bay	***7***	3-16	***21***	17-127
Eureka Area	***3***	2-4		
Resolute traverse	***5***	3-7		
Cambridge Bay traverse	***4***	3-5		
N. Alaska, Barrow area	***8***	5-10	***15***	7-60
Arctic Ocean				
North Pole Environmental Obs.	***5***	3-7	***32***	0.6-75
Basin Traverse: new snow	***4***	0.8-9		
Basin Traverse: granular surface ice	***6***	2-18		
SHEBA Central Beaufort Sea: snow	***5***	2-11		
SHEBA Central Beaufort Sea: ice	***6***	2-10		
Scandinavia, Abisko			***30***	3-77
Svalbard, Glaciers & near Ny Ålesund			***22***	5-50

Preliminary results:

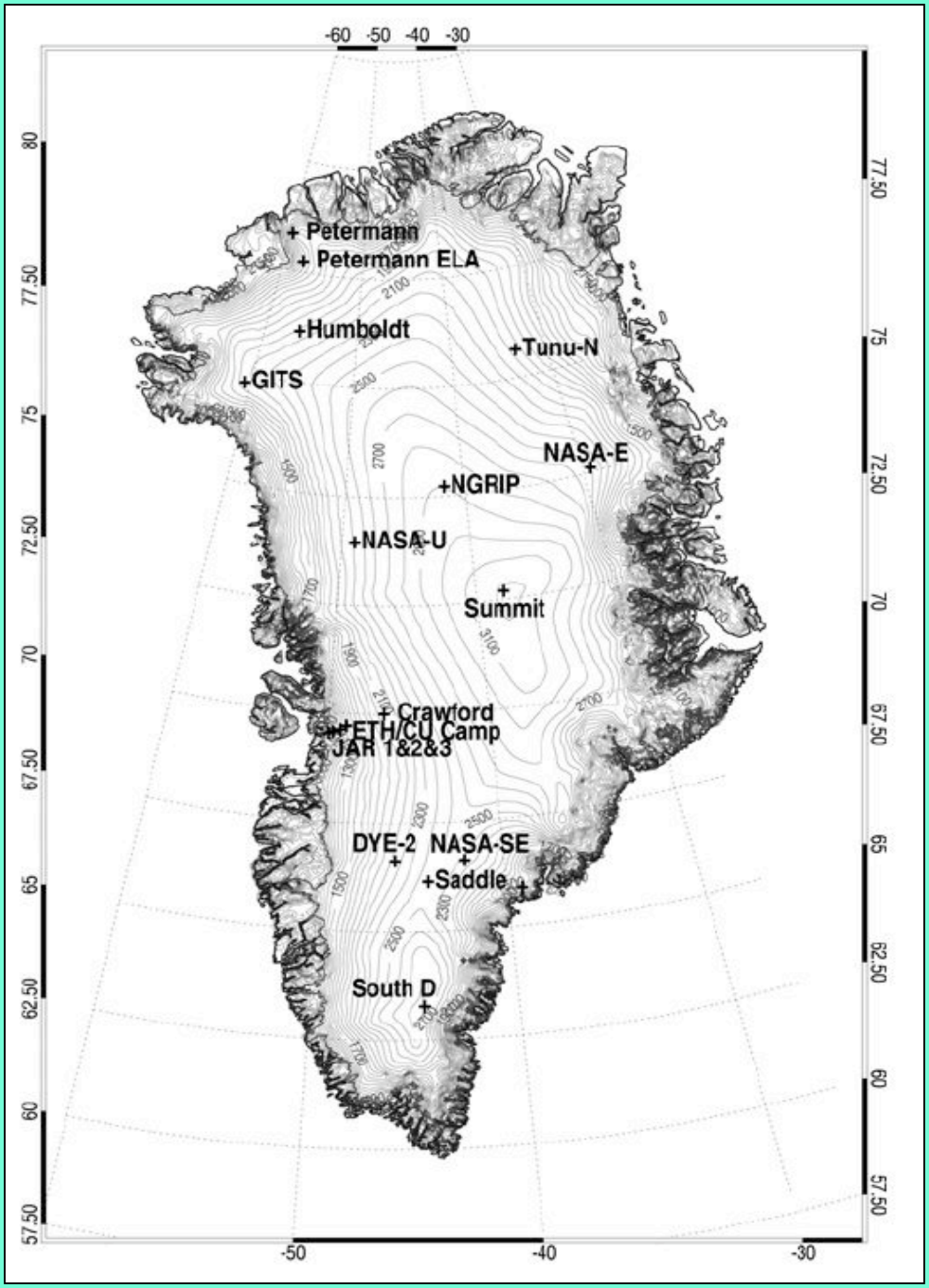
- Median BC values in Greenland are in the same range as reported by Clarke & Noone (1985).

- Median values from Canada, Alaska and the Arctic Basin are 2-4 times lower than in 1983-84.

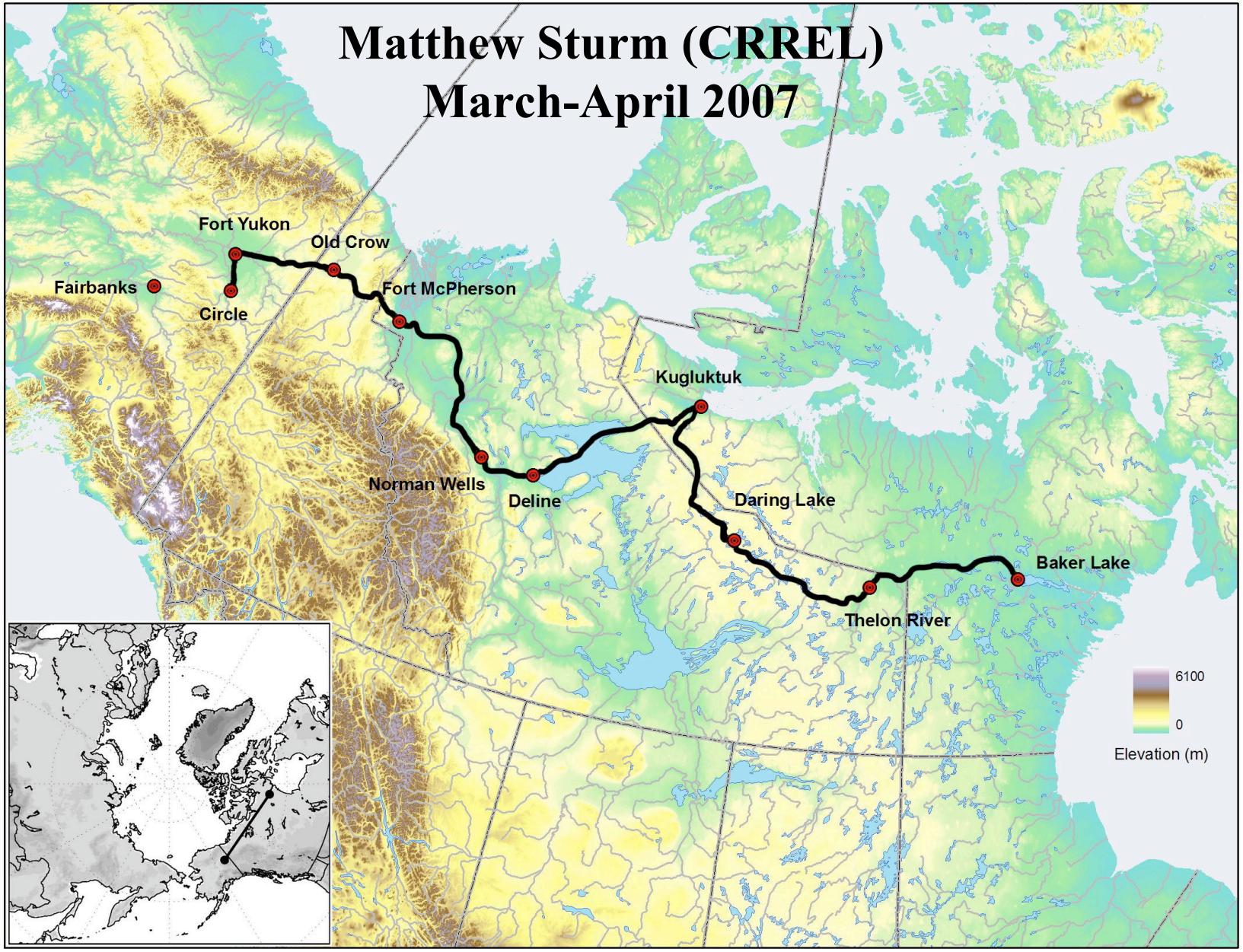
Quantification awaits
- new spectrophotometer
- new reference standards



Highlights starting this year: Arctic Russia Collaboration with Vladimir Radionov (AARI) and Victor Boyarsky (VICAAR) 2007, 2008



Konrad Steffen, Univ. Colorado Automatic weather stations at 2000-m level. 3 stations sampled to date.


Matthew Sturm (CRREL)
March-April 2007
Fort Yukon
Old Crow
Fairbanks
Circle
Fort McPherson
Kugluktuk
Norman Wells
Deline
Daring Lake
Baker Lake
Thelon River
6100
0
Elevation (m)

Official Collaborators:
Carl-Egede Bøggild (*Greenland*)
Vladimir Radionov (*Russia*)
James Morison (*North Pole Environmental Observatory*)
David Barber (*Canada*)
Tomas Johannesson (*Iceland*)
Matthew Sturm (*Alaska*)
Konrad Steffen (*West Greenland*))

Other Volunteers who collected samples in 2006:
Von Walden, U of Idaho (*near Eureka, Ellesmere Island*)
Mike Town, U of Washington (*Summit Station Greenland*)
Eric Larsen, One World Expedition (*Lincoln Sea to N Pole*)
Alex Morales, IW Expedition (*Eastern Ellesmere Island*)
Matt Nolan, U of Alaska Fairbanks (*McCall Glacier*)

Special Thanks to:

Jim Hansen
for inspiring us to take on this project

Ellen Baum and the *Clean Air Task Force*
for motivational support and for getting us going with funding (Torrance, Redman, Hatch, Kendall, Oak Foundations)

NSF Arctic Program

Polar Continental Shelf Project of Canada
for logistics support at Resolute, Nunavut

Absorptive impurities in snow:

Soil dust

Volcanic ash

Black carbon (soot)

To reduce total albedo of old melting snow by 1% requires mass fractions:

$\sim 1 \times 10^{-8}$ black carbon

$\sim 50 \times 10^{-8}$ soil dust

$\sim 200 \times 10^{-8}$ volcanic ash