Heavy Metals in Arctic Snow

-Distribution between particulate and soluble phase-

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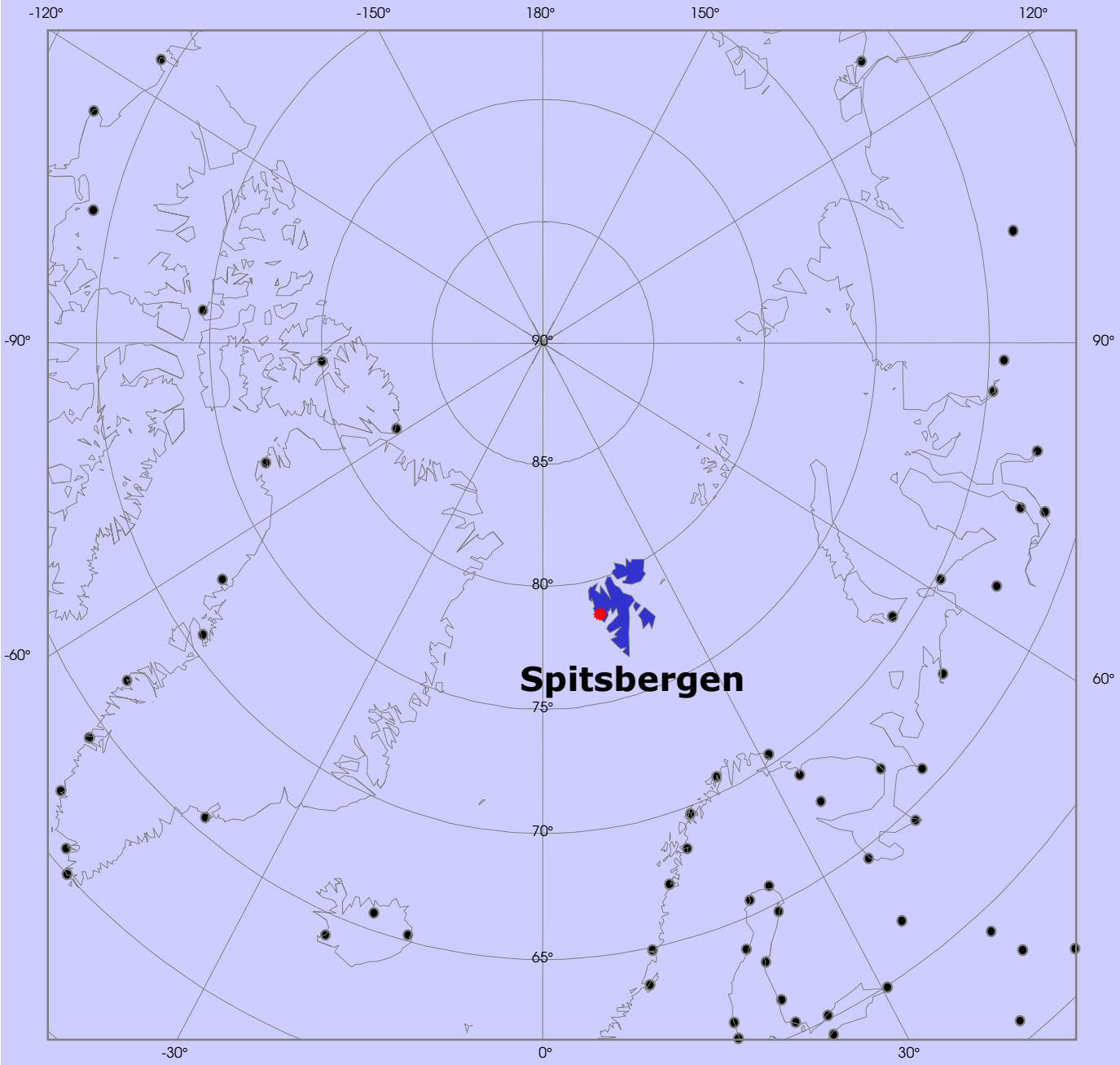


Sampling location for aerosols and precipitation at Spitsbergen (79°N, 12°E)

Ny Alesund


Sampling location for aerosols and precipitation
4 km northwest of the settlement.
Instrument installation on top of the roof
of the Japanese station in 8 m above ground
to avoid snow drift influence.


Precipitation sensor
Automatic precipitation sampler NSA181
Open sampling funnel after sensor signal
Automatic bottle changer

Trace element analyses in polar snow samples

Cleaning procedure of sampling material

1 week in 3% Mucasol, rinsing with ultra pure water

1 week in p.a. HCL (1:4), rinsing with ultra pure water

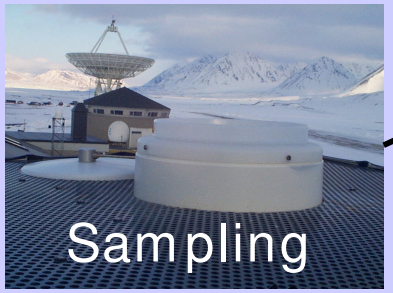
1 week in p.a. HNO_3 (1:4), rinsing with ultra pure water

1 week in ultrapure HNO_3 (1:10), rinsing with ultra pure water

Packing into two polyethylene bags

All handling steps were carried out in a clean room laboratory U.S. class 100

Trace element analyses in polar snow samples

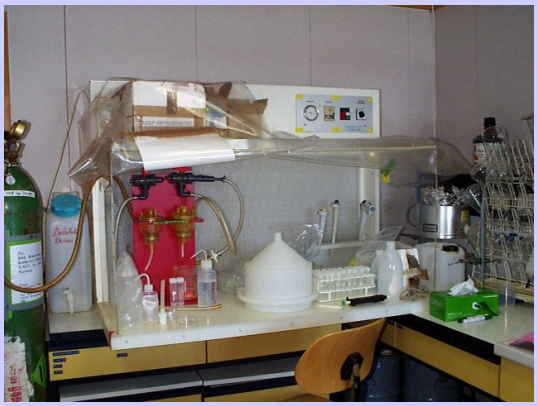


Storing at –20 °C

Melting at 4 °C

Dividing of samples

Subdividing for measurements of pH, conductivity and anions



Filtration of a sample aliquot through 0.45 µm Polycarboante filter

Bulk samples

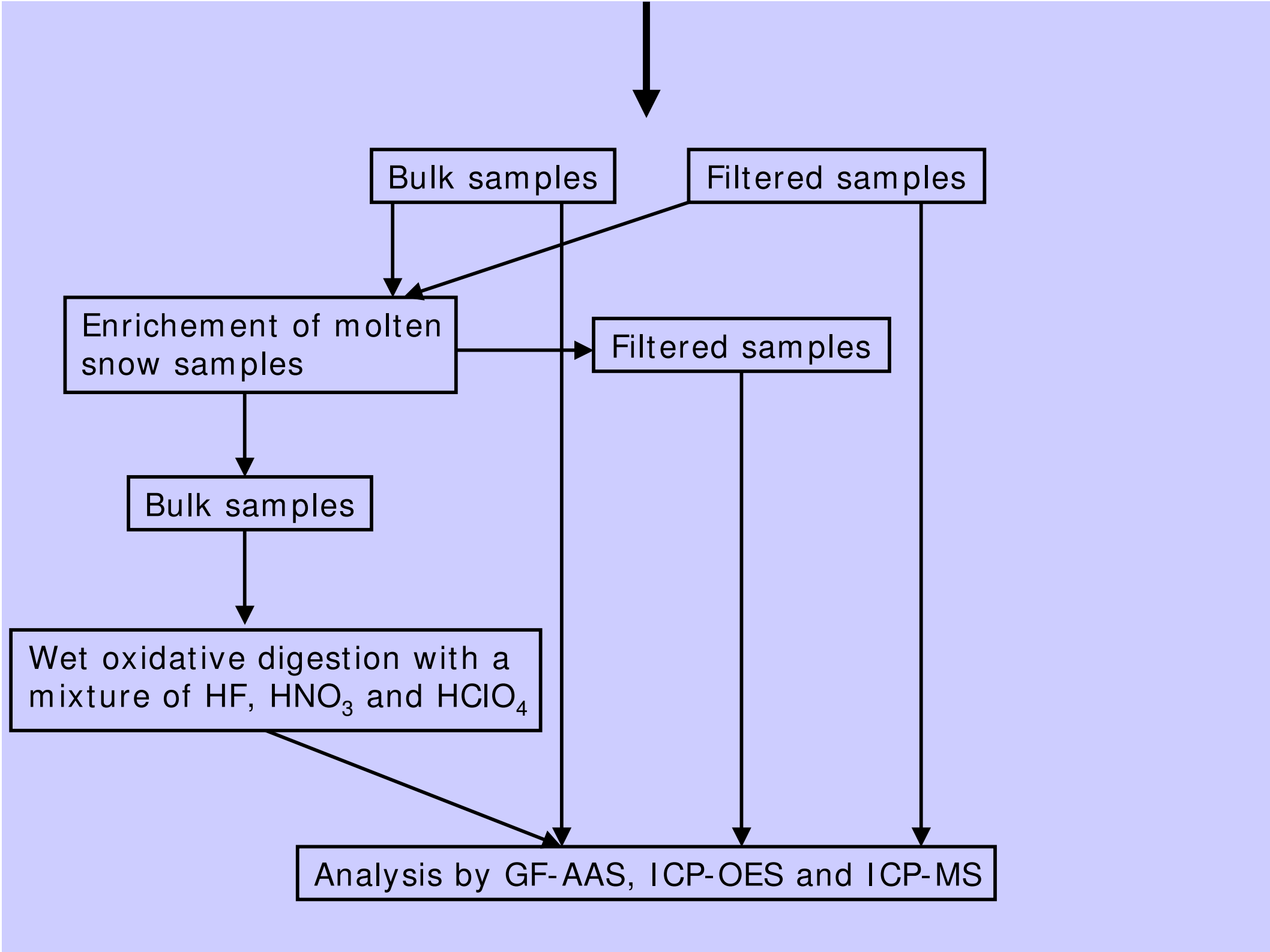
Filtered samples

Acidifying with HNO_3 ultrapure

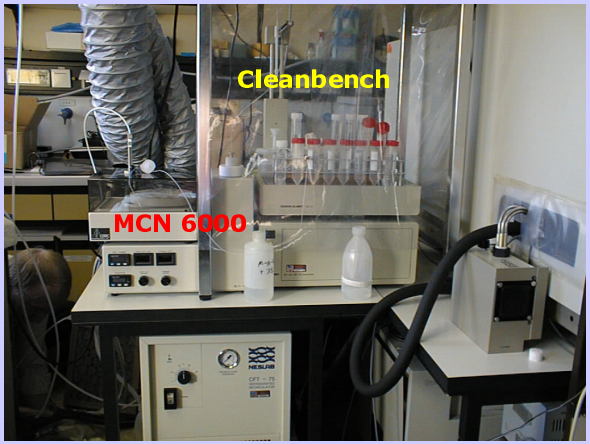
Transport to the home laboratory

Drying of filters

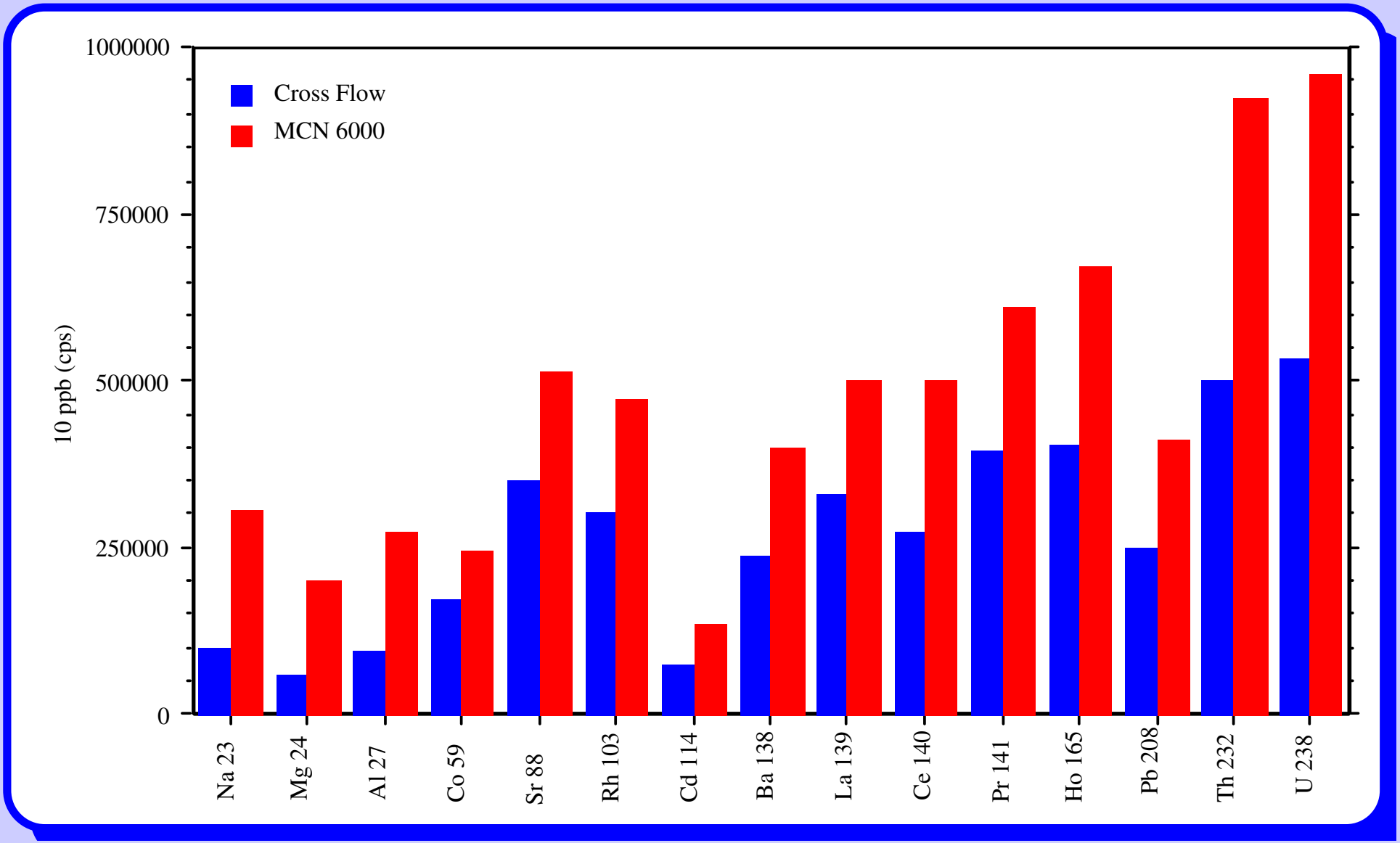
SEM/EDX Analyses


Bulk samples
Filtered samples
Enrichement of molten snow samples
Filtered samples
Bulk samples
Wet oxidative digestion with a mixture of HF, HNO_3 and $HClO_4$
Analysis by GF-AAS, ICP-OES and ICP-MS

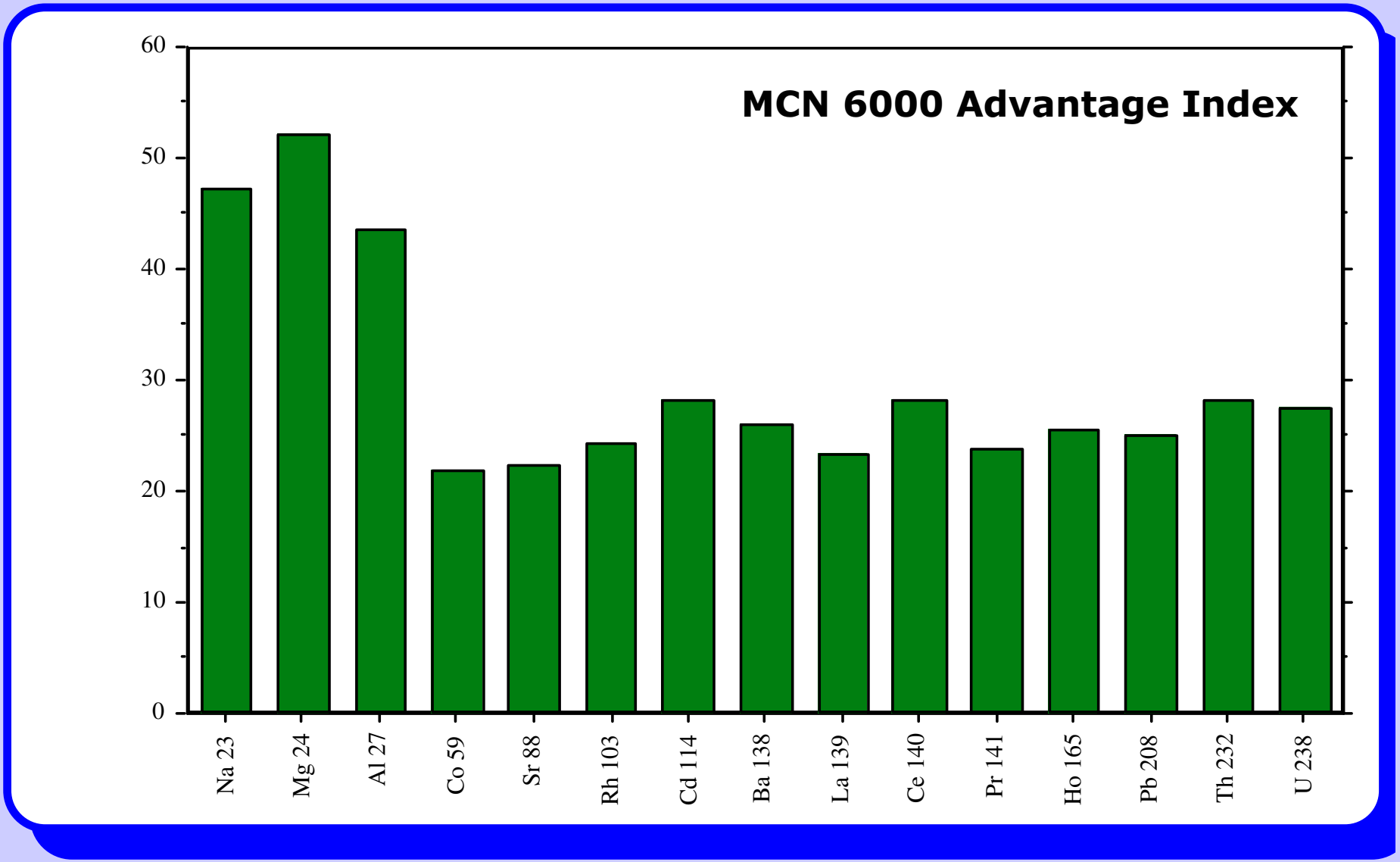
ICP-MS operating conditions for two different sample introduction systems



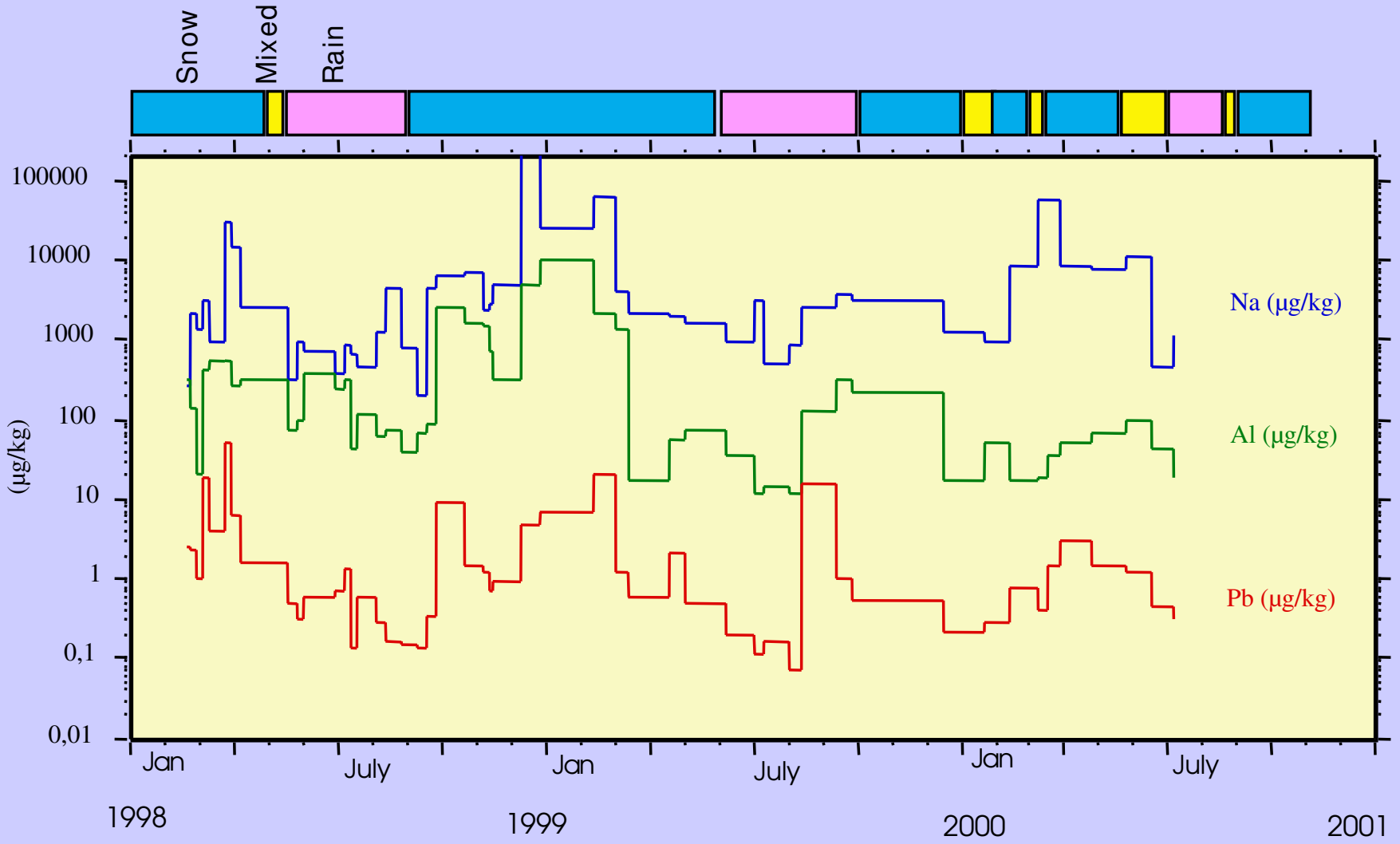
ELAN 6000	Cross-Flow	MCN 6000
RF-Power (W)	1000	1350
Nebulizer Flow (ml/min)	0.95	0.68
Lens voltage-^{103}Rh (V)	6.9	5.0
Autolens	on	on
Sample uptake rate (µl/min)	1000	65
Sweep Gas (l/min)		2.21
Nitrogen (ml/min)		15
Temperature Spray chamber-Teflon (°C)		80
Temperature Membrane (°C)		160
Ba^{++}/Ba (%)	1.6	3.5
CeO/Ce (%)	3.0	0.02
RSD (%) for 10 ppb	0.2-1.5	1.3-5.3
Background at mass 8 (cps)	3	65
Background at mass 220 (cps)	3	60



Intensities (cps) for a 10 ppb multielement solution by using a Cross Flow Nebulizer and a microconcentric Nebulizer with membrane desolvatisation kit (MCN 6000)



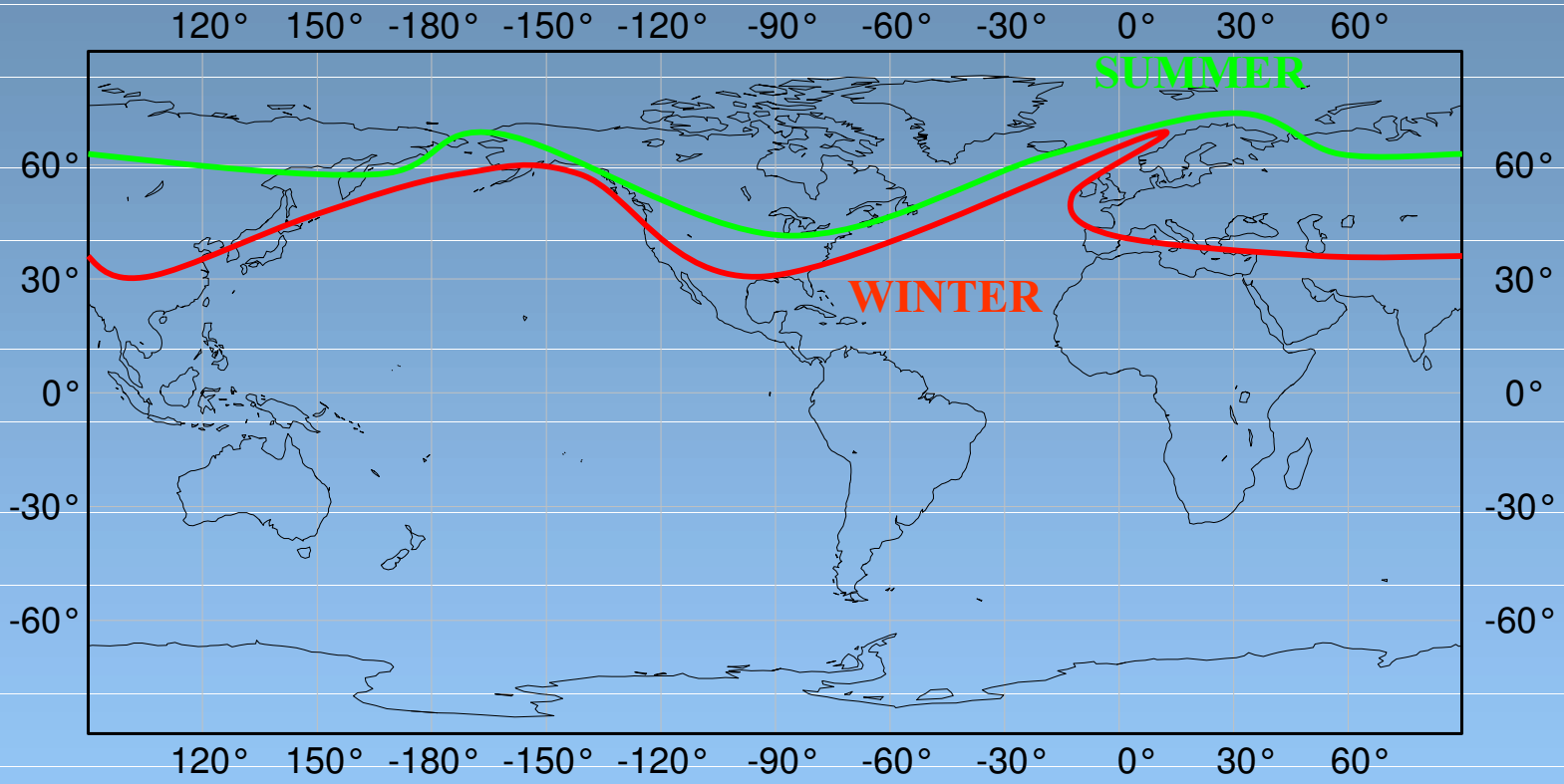
Advantage index for a MCN 6000 in comparison to a Cross Flow Nebulizer for a 10 ppb multielement solution, defined as relative Sensitivity/Sample uptake rate (Cross Flow Nebulizer = 1)



Variability of Na, Al, Pb, concentrations in precipitation samples from Ny Alesund

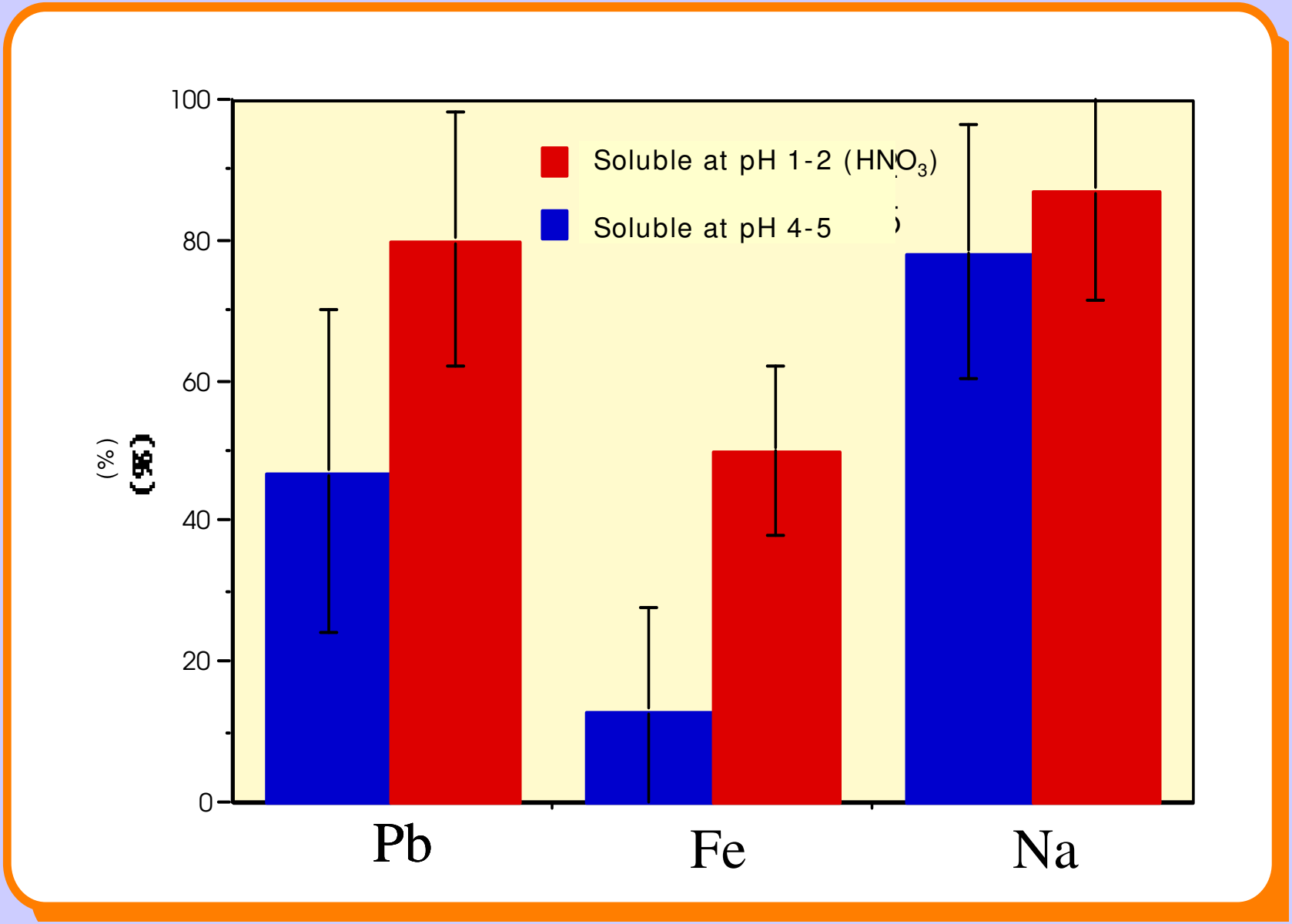
Concentration maxima were measured in winter and spring time as an effect of meteorological conditions and Arctic Haze events

Geographical position of polar front in summer and winter time at sealevel

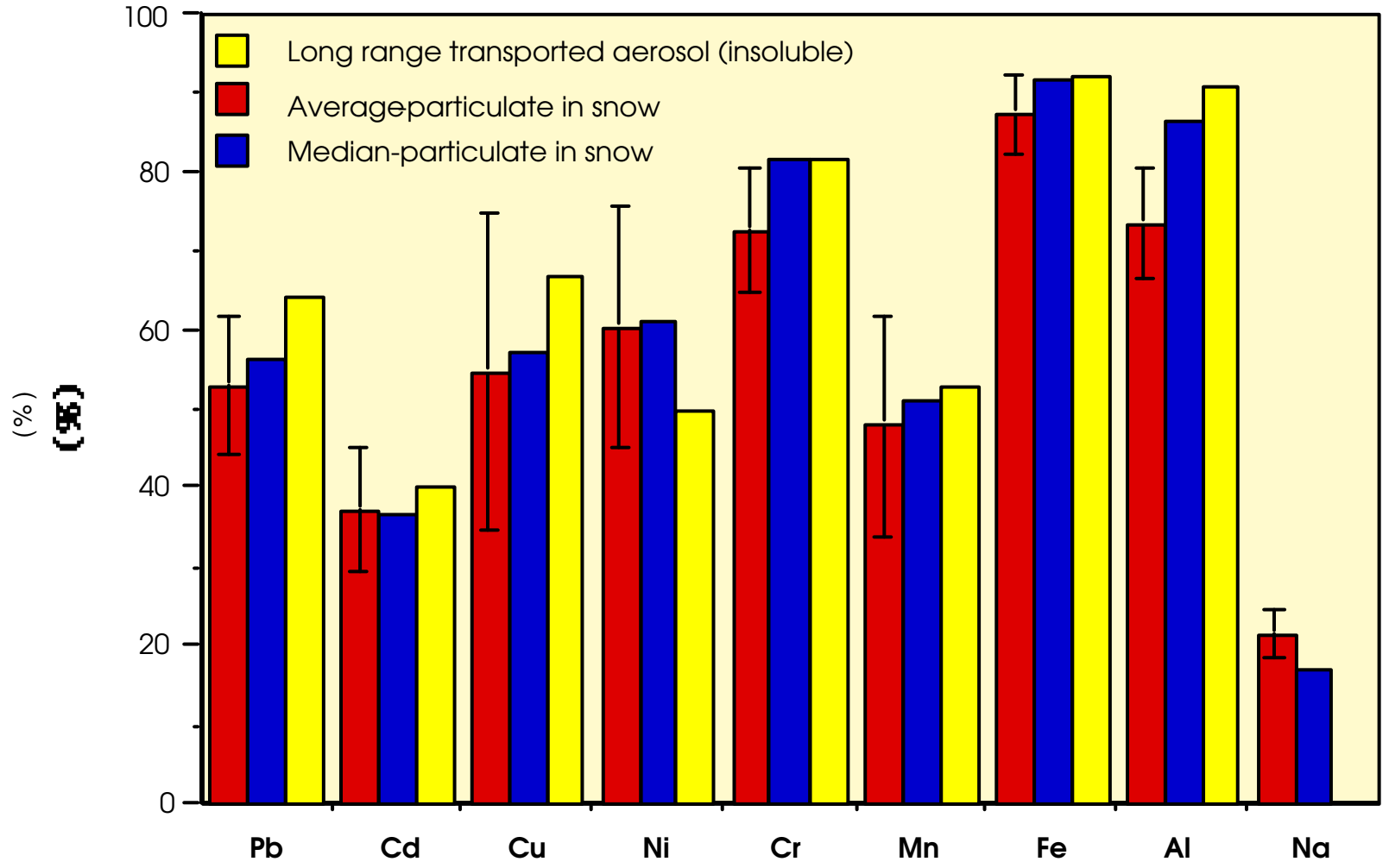


Scale: 1:249187266 at Latitude 0°

Source: Heidam NZ (1984) Atmos Environ, 18:243-329



Dissolved and acid soluble amount in es sno sam les



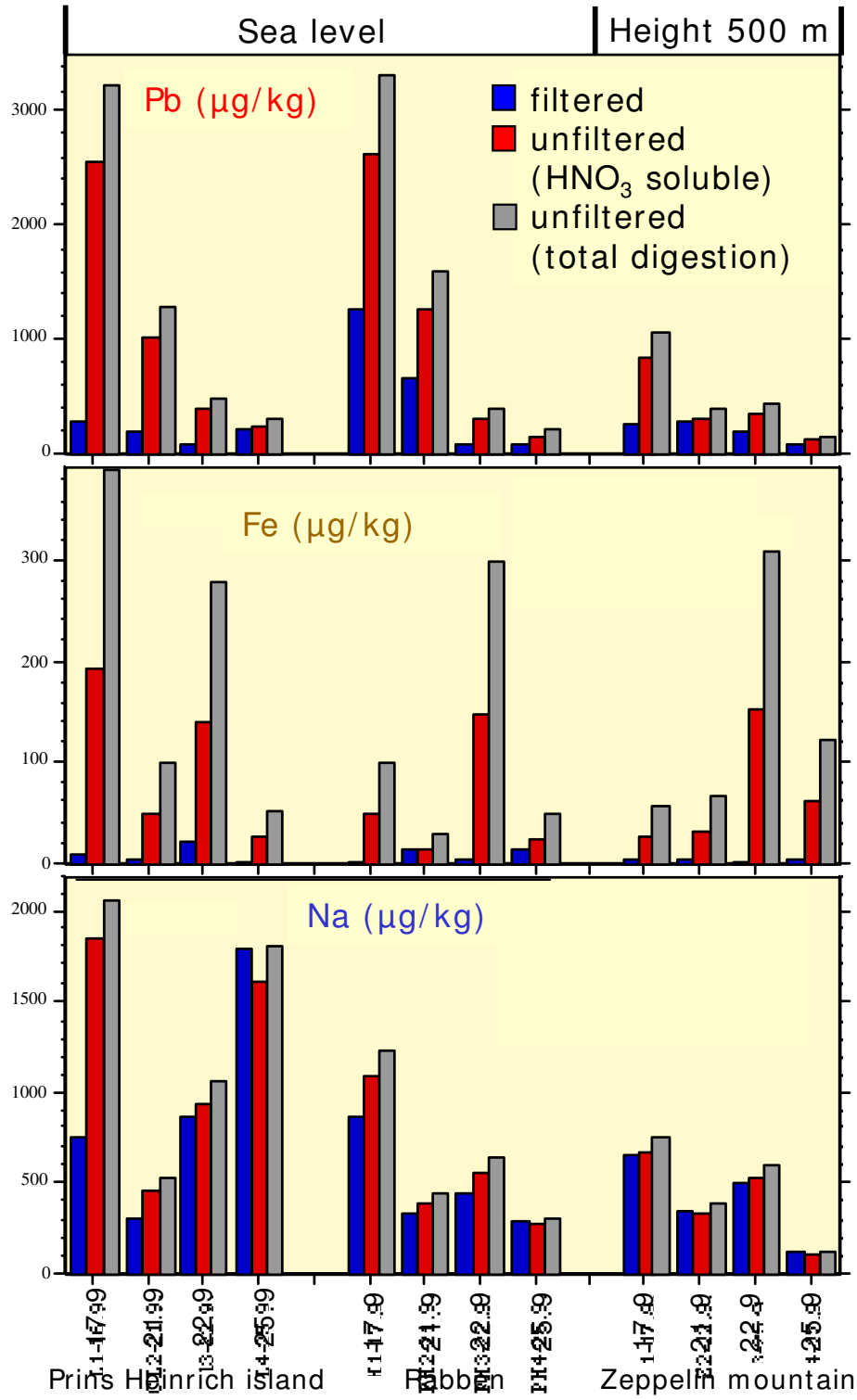
Particulate amount of some selected elements (anthropogenic, seasalt and mineral dust) after total digestion (n=45) in snow samples in comparison to the insoluble amount of long range transported aerosols (n=25) in water (pH 4-5).

Element concentrations in fresh snow samples after a long dry period in late summer at three places in Ny Ålesund. (■ natural pH-value of 4-5, ■ after acidifying with nitric acid, pH 1-2 and ■ after total digestion with hydro fluoric acid, nitric acid and perchloric acid for the anthropogenic element Pb, the seasalt component Na and the mineral dust tracer Fe.

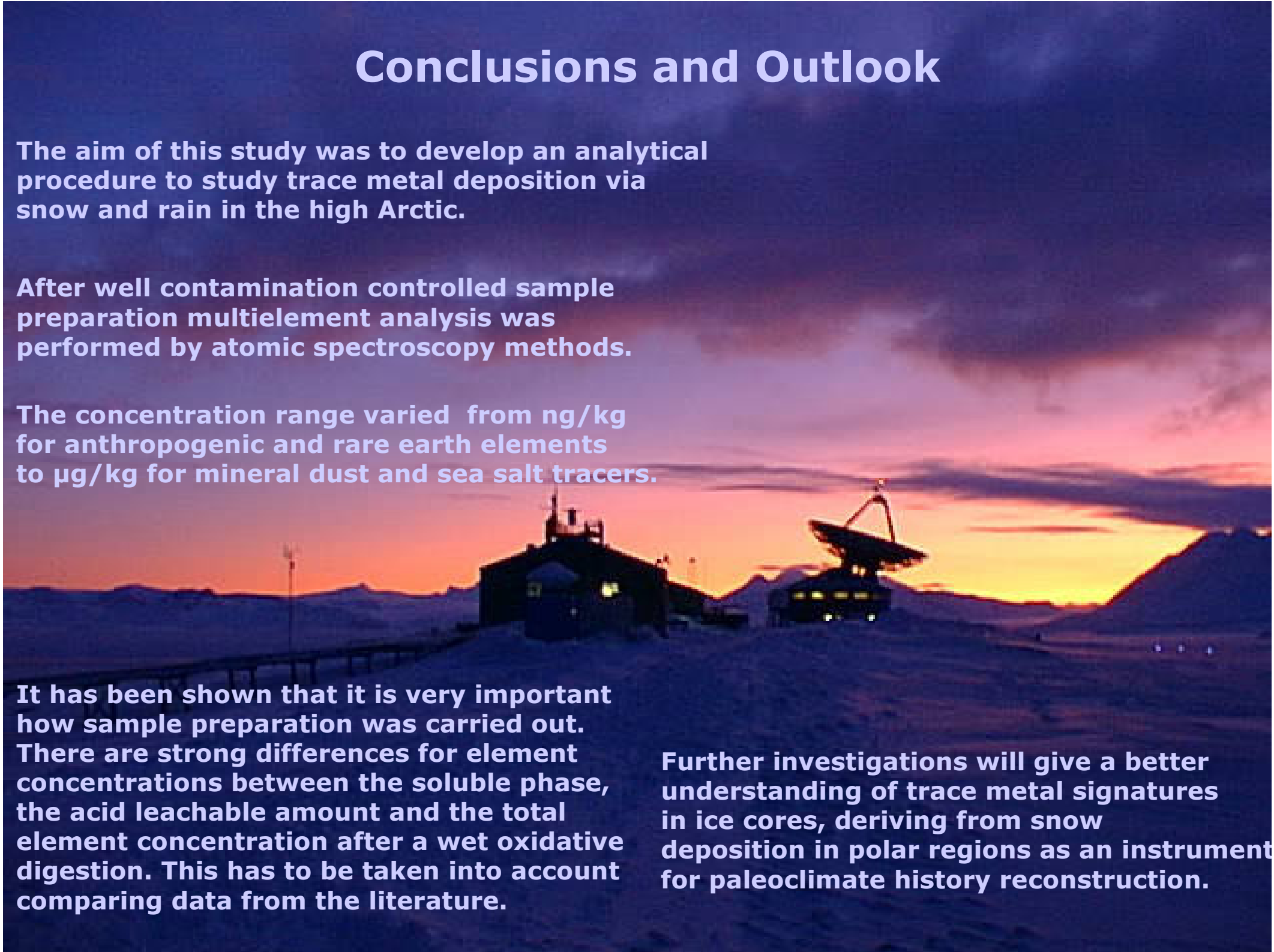
Anthropogenic tracer

Mineral dust tracer

Sea salt tracer



Conclusions and Outlook



The aim of this study was to develop an analytical procedure to study trace metal deposition via snow and rain in the high Arctic.

After well contamination controlled sample preparation multielement analysis was performed by atomic spectroscopy methods.

The concentration range varied from ng/kg for anthropogenic and rare earth elements to µg/kg for mineral dust and sea salt tracers.

It has been shown that it is very important how sample preparation was carried out. There are strong differences for element concentrations between the soluble phase, the acid leachable amount and the total element concentration after a wet oxidative digestion. This has to be taken into account comparing data from the literature.

Further investigations will give a better understanding of trace metal signatures in ice cores, deriving from snow deposition in polar regions as an instrument for paleoclimate history reconstruction.