Climate-related variations in atmospheric selenium as recorded in Greenland ice core during the past 20,000 years

이강현[1], 한창희[1,2], 전성준[1,2], 문장일[1],

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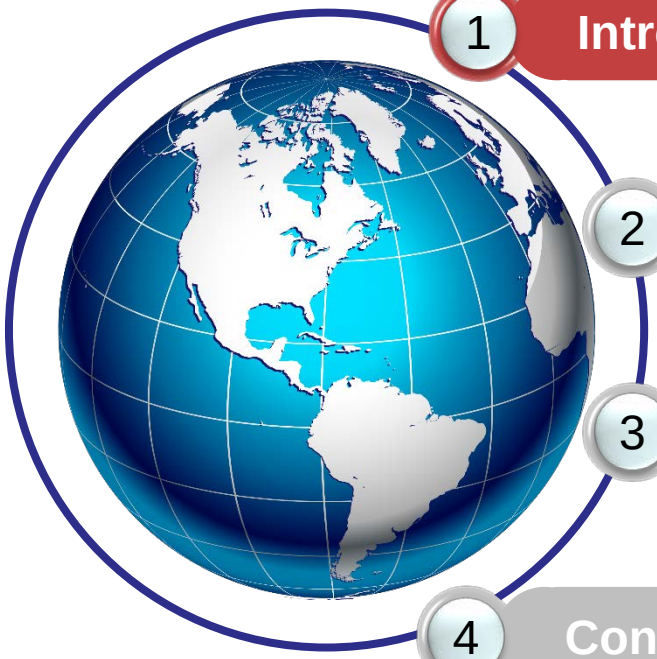

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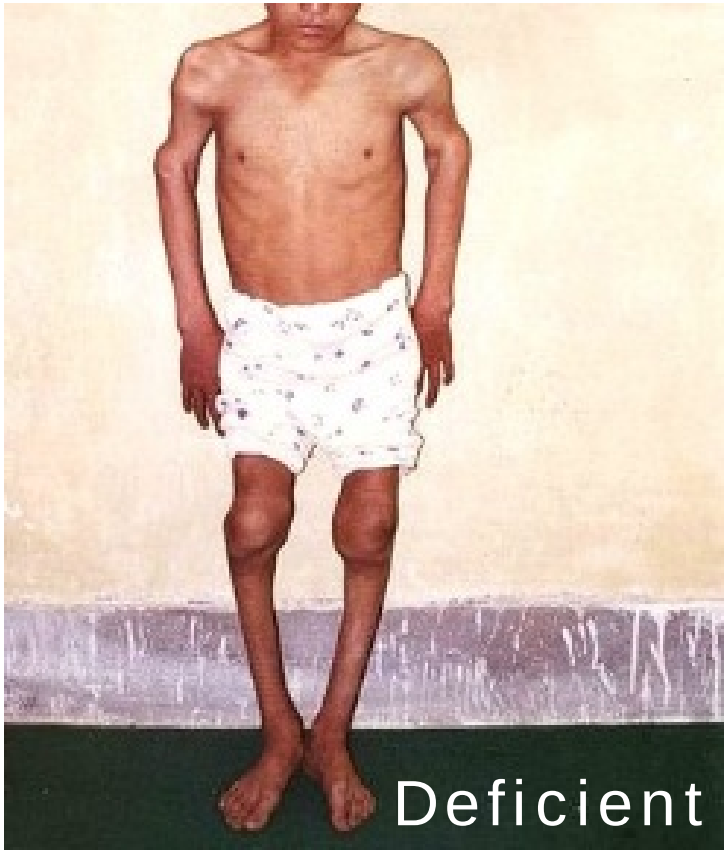
Essential for health

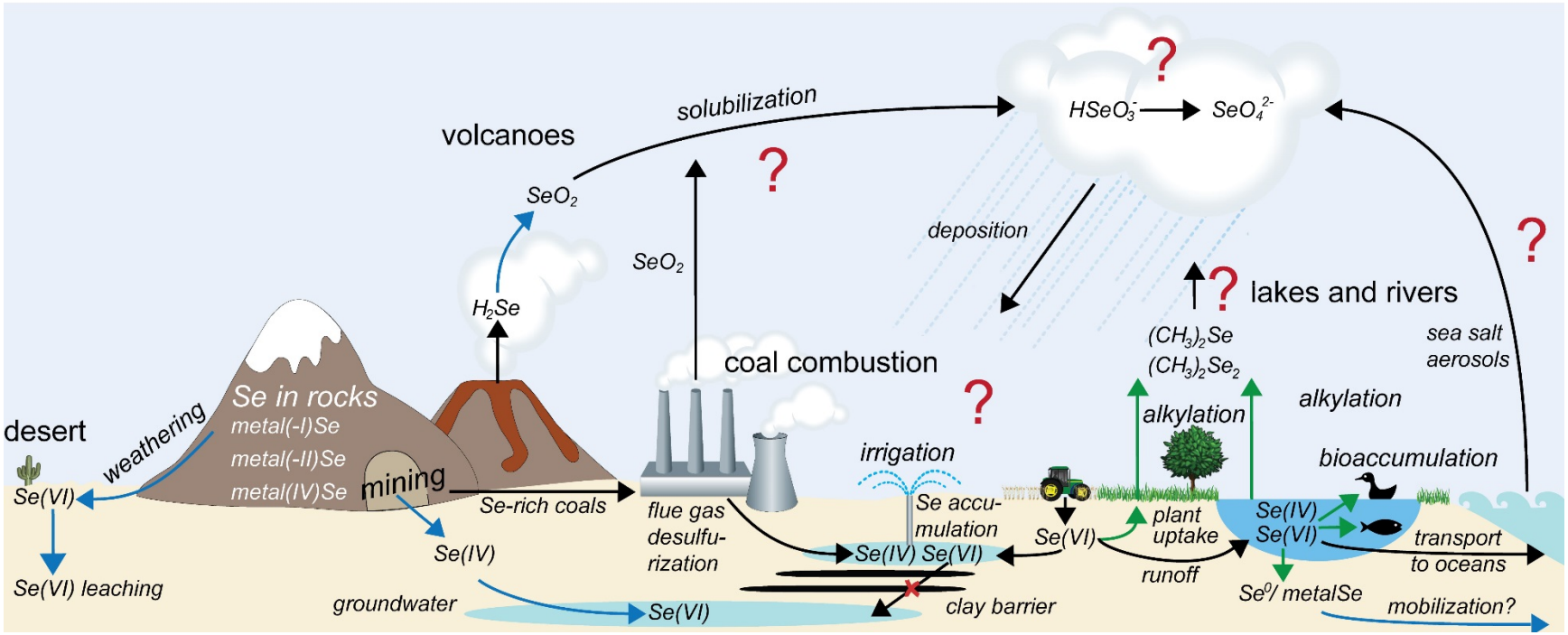


<http://www.mineravita.com/en/selenium-disease.html>

vs.

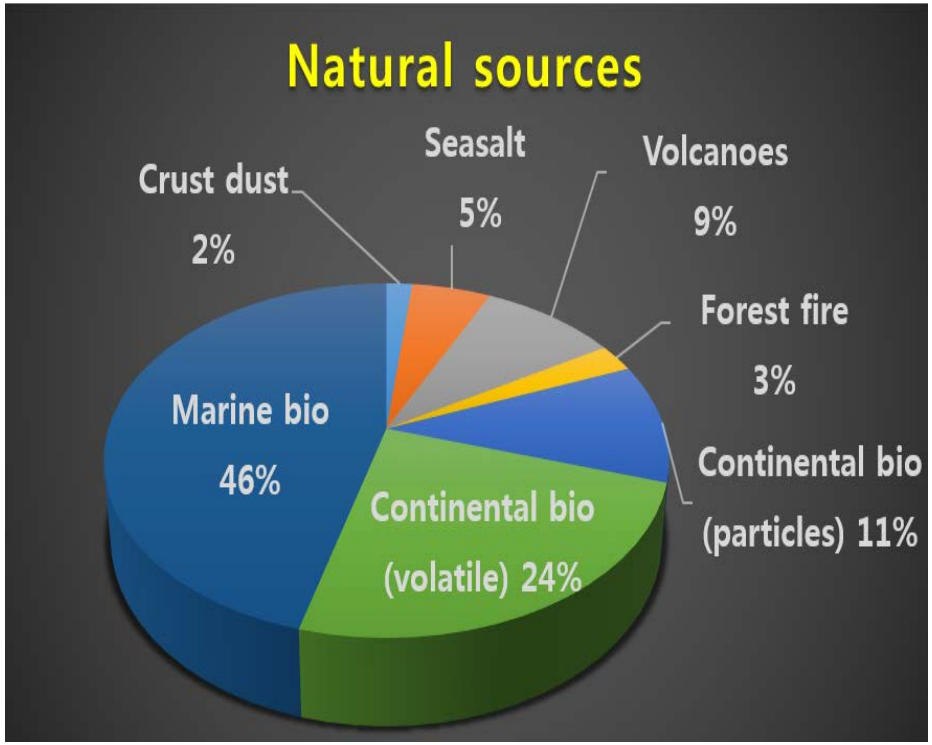
<http://www.southeastcoalash.org/?page_id=2013>

Biogeochemical cycle

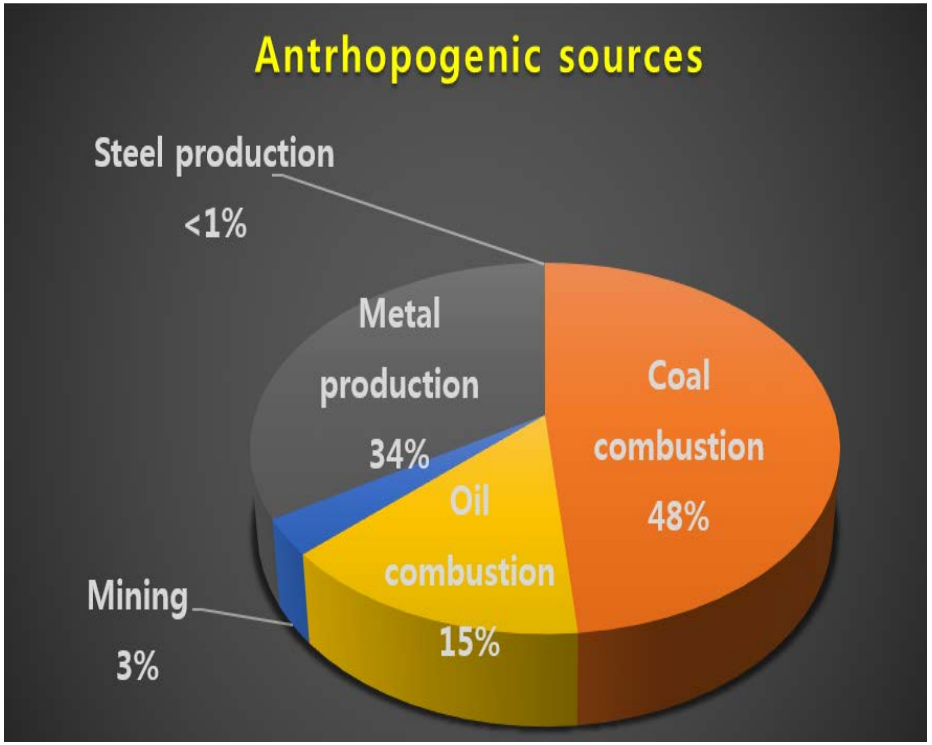


<http://www.ieg.ethz.ch/research/research-interests.html>

Sources for atmospheric Se



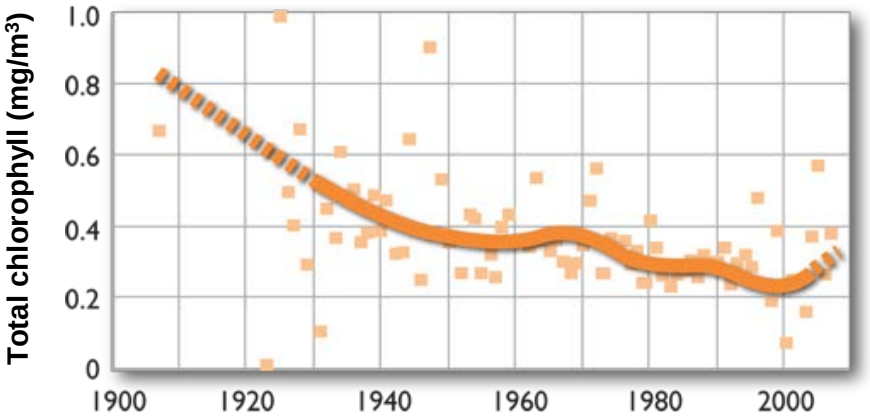
<Nriagu and Pacyna, 1989>



<Nriagu, 1988>

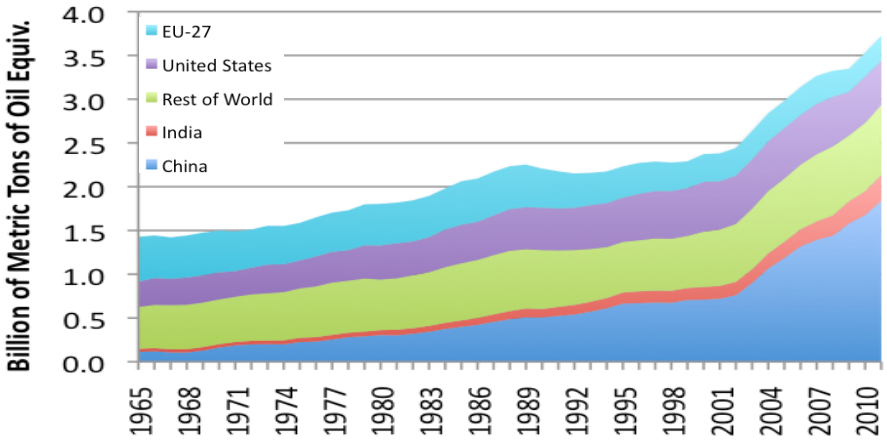
Purpose of the study

<Primary production in North Pacific>



<Boyce et al., 2010>

<World coal consumption>



<BP's 2012 Statistical Review of World Energy>

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1 Introduction of Se

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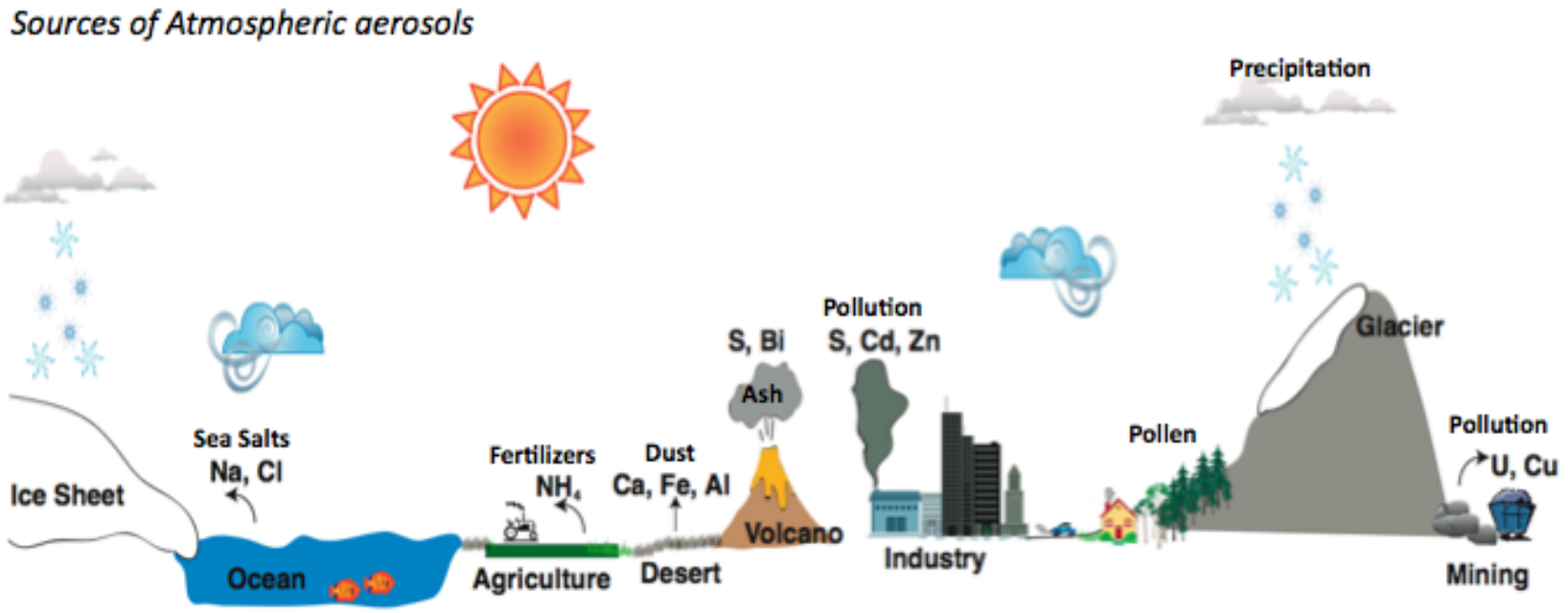
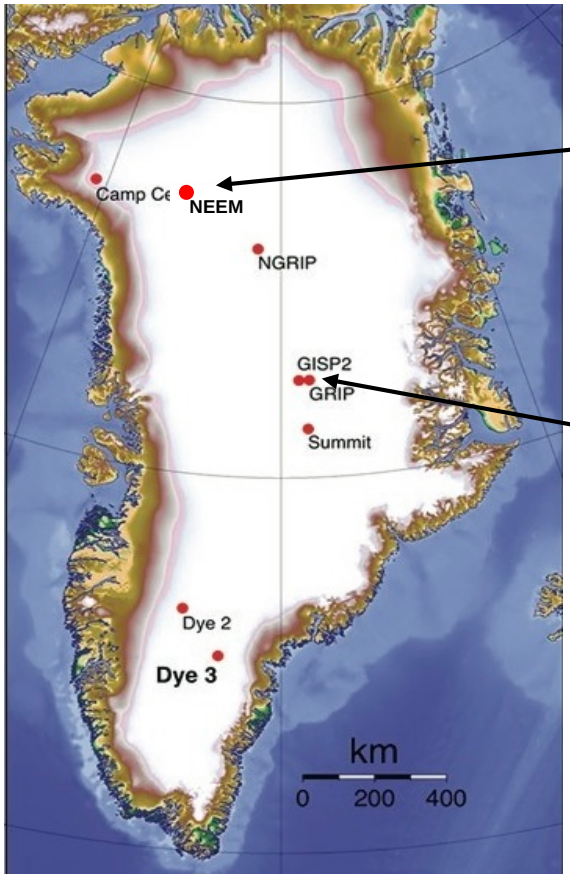
Ice cores

- Well dated
- High resolution
- Direct response
- Air bubble
- Various proxies

Ice core proxies



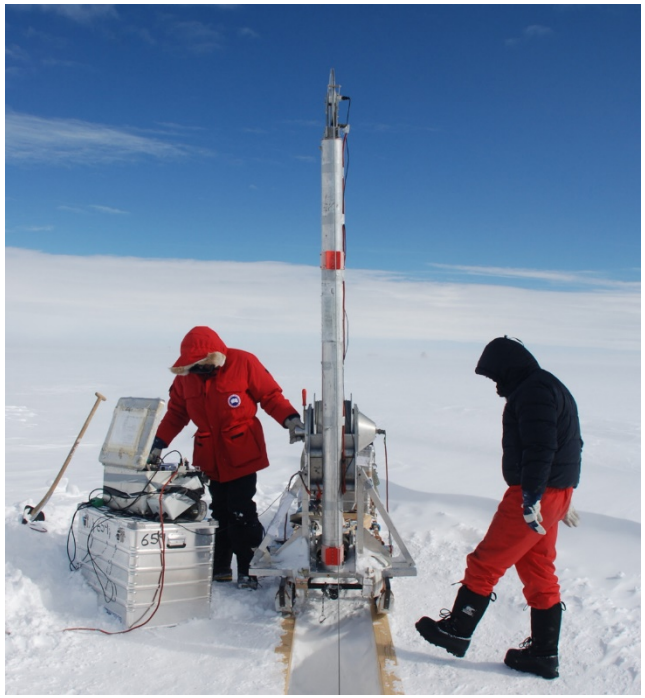
Greenland ice cores



NEEM ice core	
Site	77.45°N, 51.06°W
Camp	2007~2011
Length	136 m, 2200 m

Euro & GRIP ice core	
Site	72.68°N, 37.63°W
Camp	1989~1992
Length	70 m, 3050 m

Drilling ice cores



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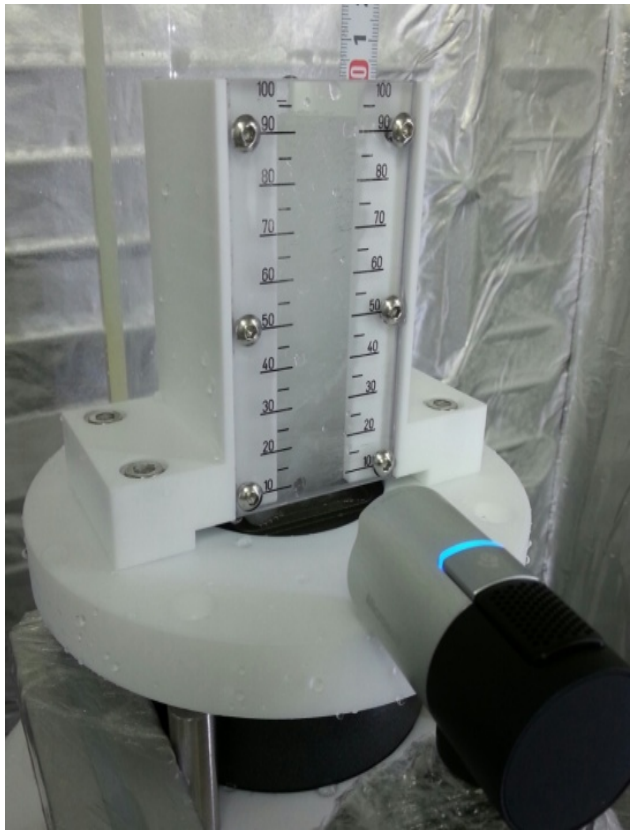
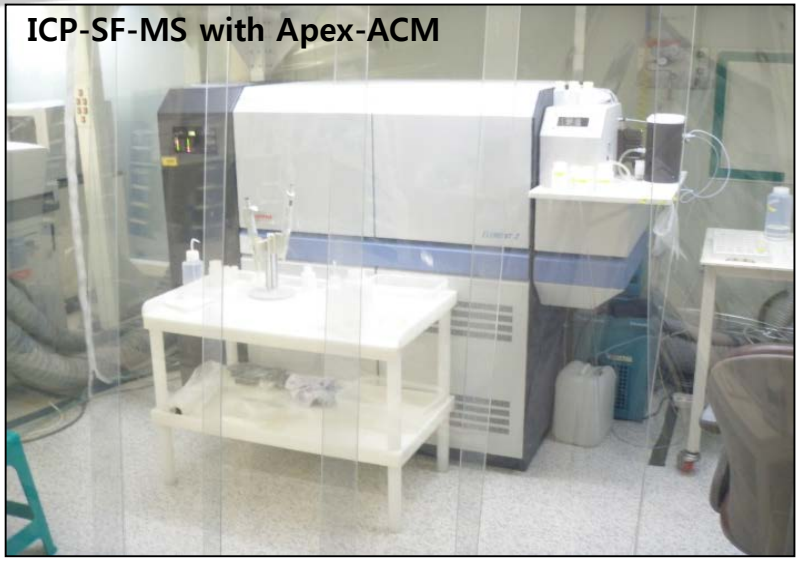
Decontamination

Melting

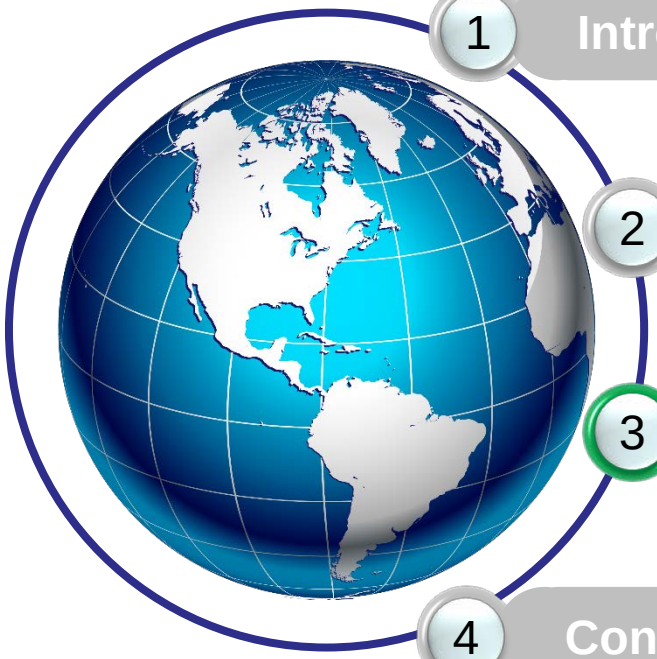


Data acquisition



- 322 samples from NEEM ice core (TE)
  - 1823 ~ 1975 AD (1902~1975 for Se)
  - 8000~20000 yr BP
- 38 samples from Euro ice core (Se & ions)
  - 1773~1965 AD
- 22 samples from GRIP ice core (Se & ions)
  - 500~9000 yr BP

	Measured	Certified	Accuracy (%)
Al	132.3 ± 6.0	138.3	95.6
As	58.2 ± 1.7	59.0	98.7
Ba	547.4 ± 4.4	531.0	103.1
Bi	13.5 ± 0.2	13.8	97.9
Cd	6.7 ± 0.1	6.4	104.9
Co	29.4 ± 1.2	26.4	111.5
Cr	19.7 ± 1.2	19.9	98.8
Cu	21.4 ± 1.8	22.2	96.2
Mn	37.1 ± 1.9	38.0	97.7
Mo	119.4 ± 0.9	118.5	100.7
Ni	56.6 ± 4.7	60.9	92.9
Pb	20.7 ± 6.6	19.2	107.9
Rb	14.8 ± 0.2	13.8	107.3
Sb	57.7 ± 0.6	56.9	101.4
Se	**11.7 ± 1.0**	**11.7**	**100.4**
Sr	340.6 ± 3.2	315.2	108.1
Tl	7.4 ± 0.1	7.3	102.0
V	34.0 ± 3.2	36.9	92.1
Zn	73.7 ± 5.1	76.5	96.3



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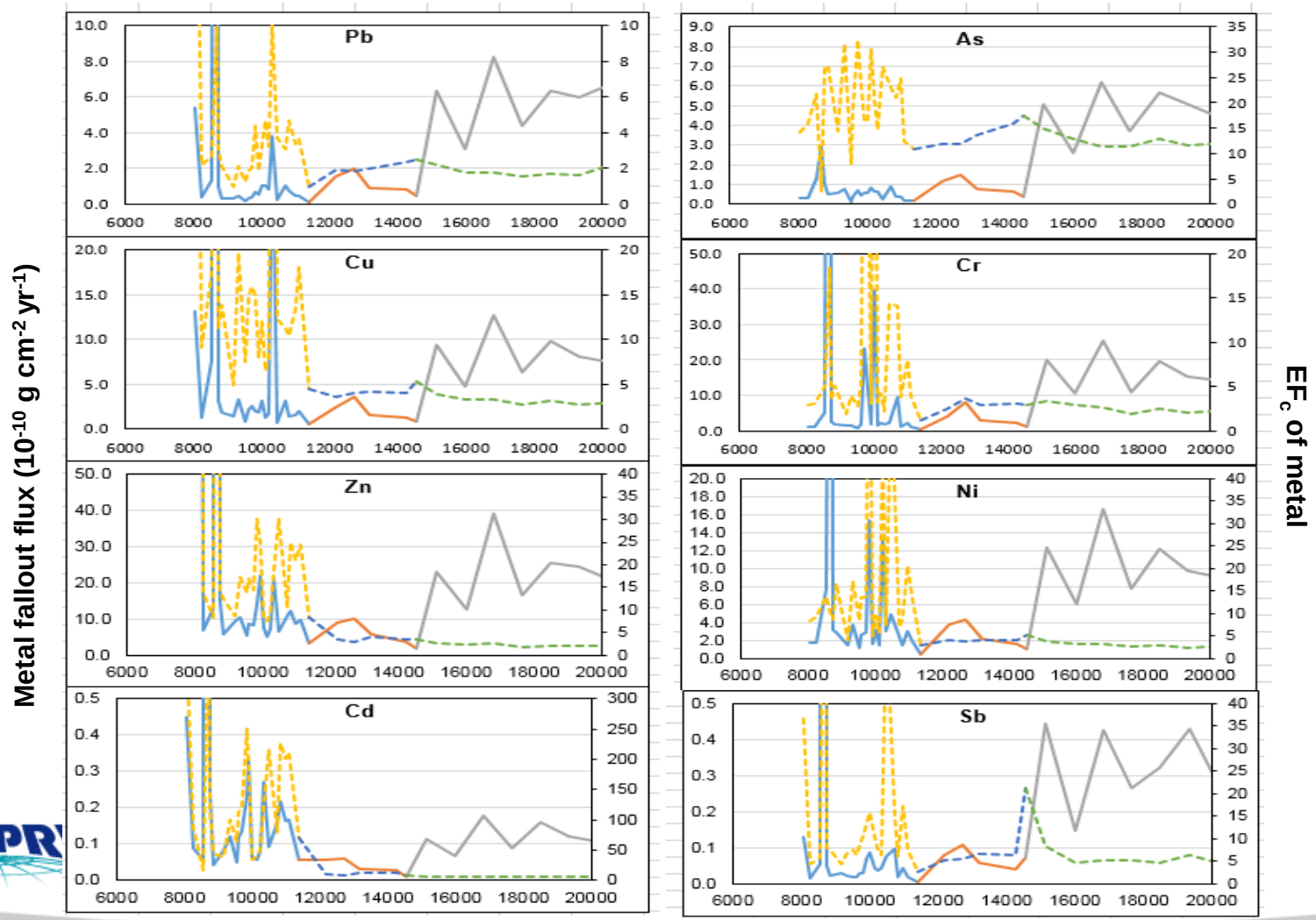
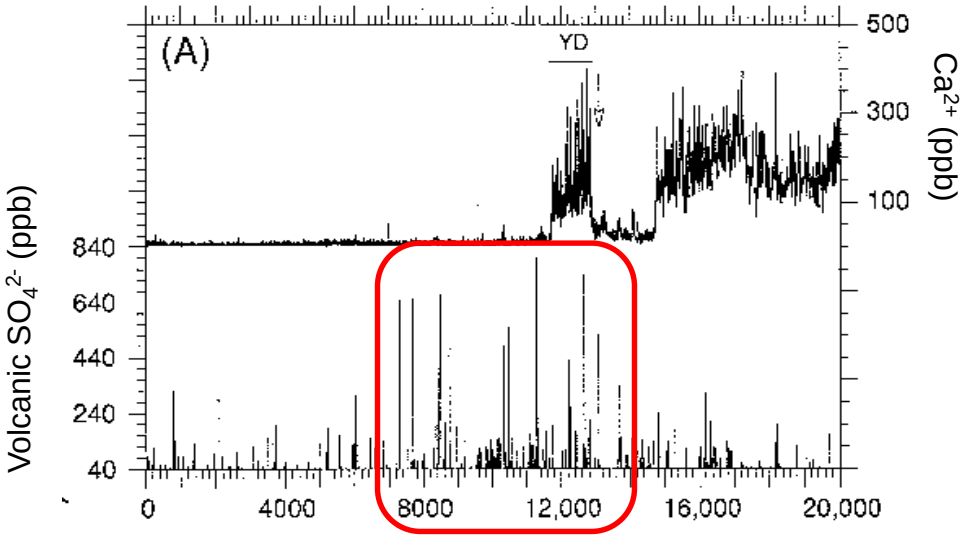
Trace elements records



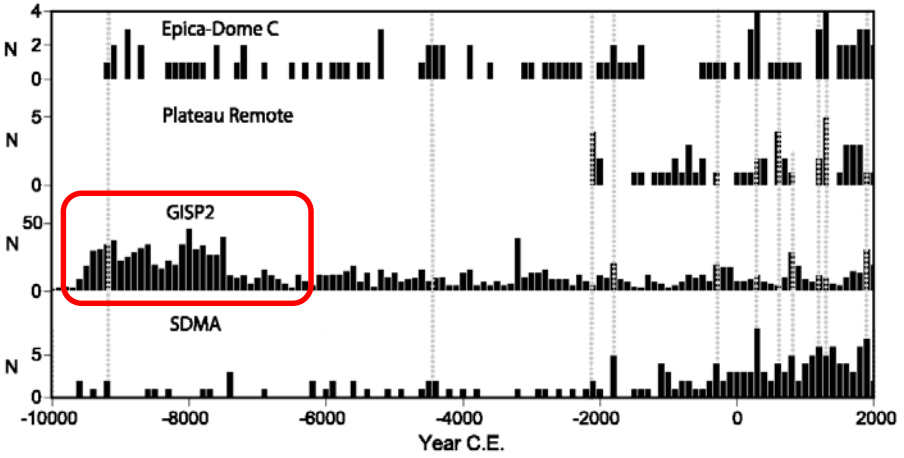
Volcanic signals

<Volcanic signal in GISP2 ice core>



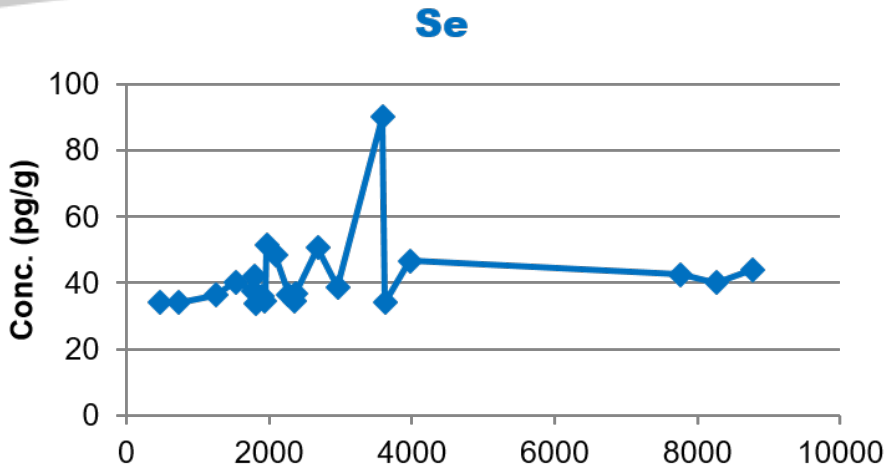
<Zielinski et al., 1996>

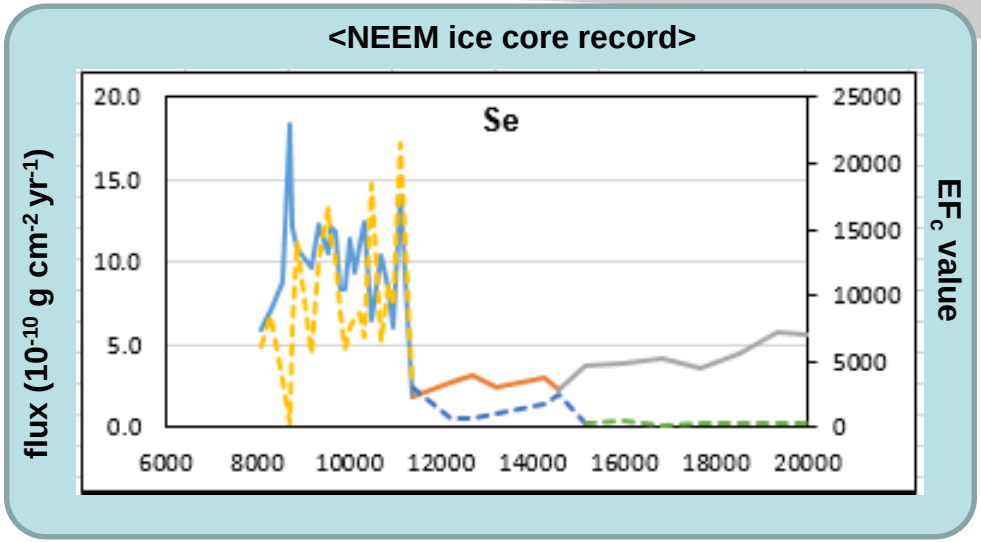
<Number of volcanic eruption>

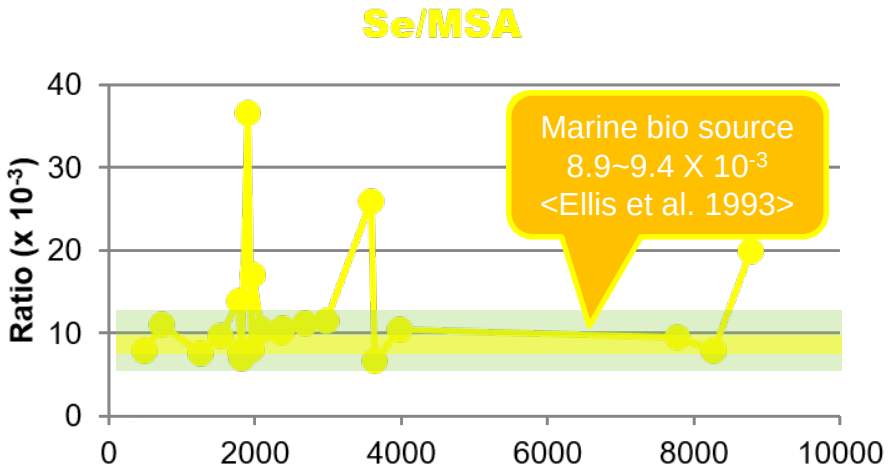


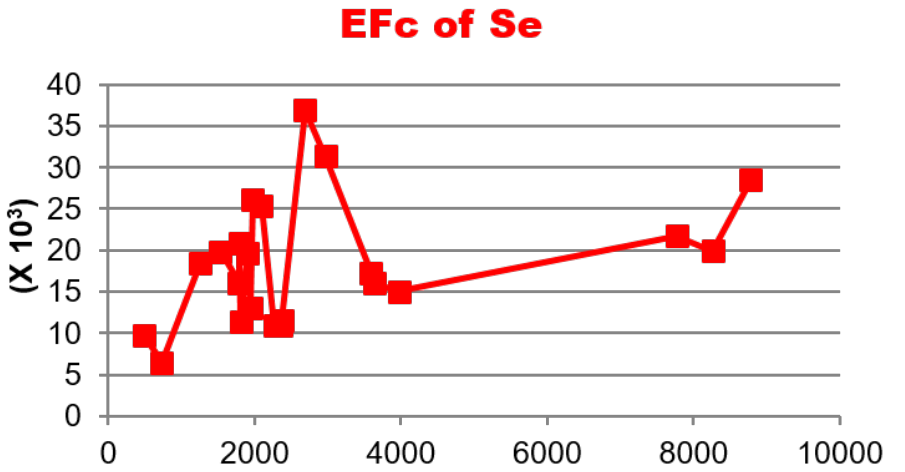
<Kurbatov et al., 2006>

Se records



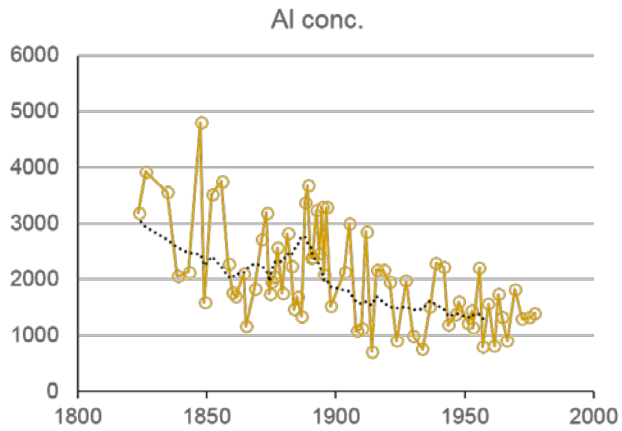


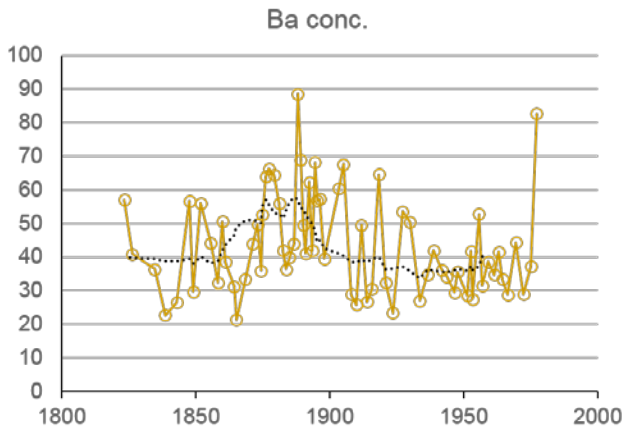


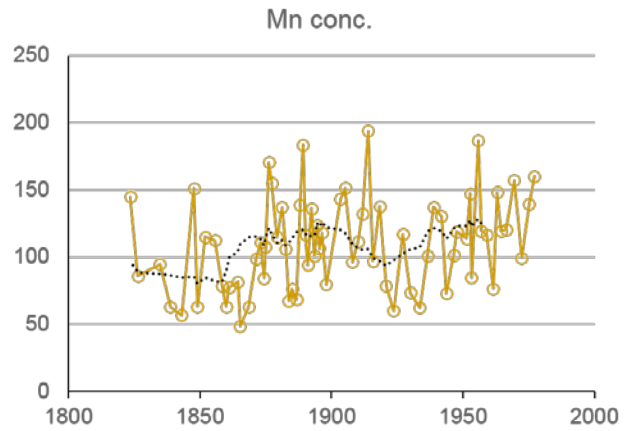


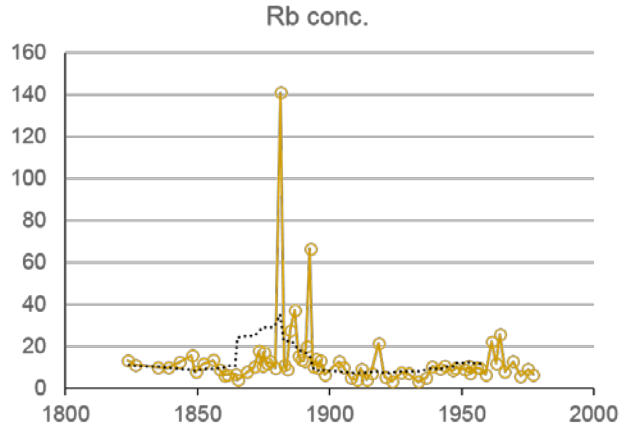
Year (B2K)

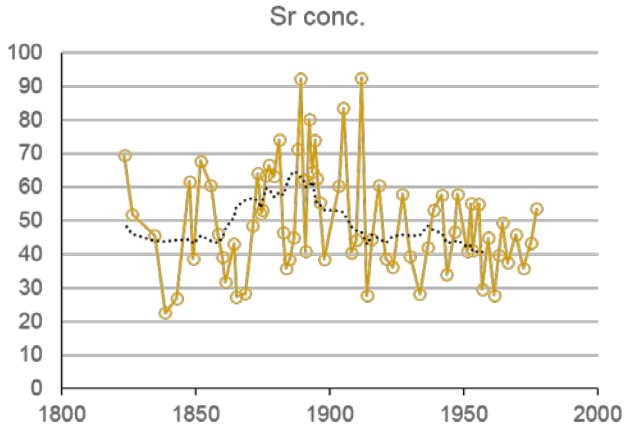
Dust origin trace elements

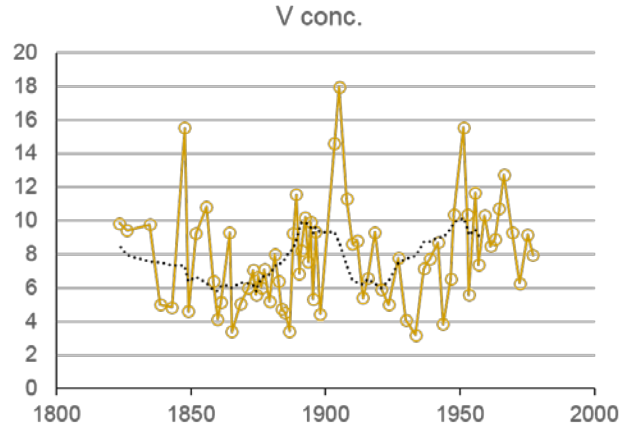






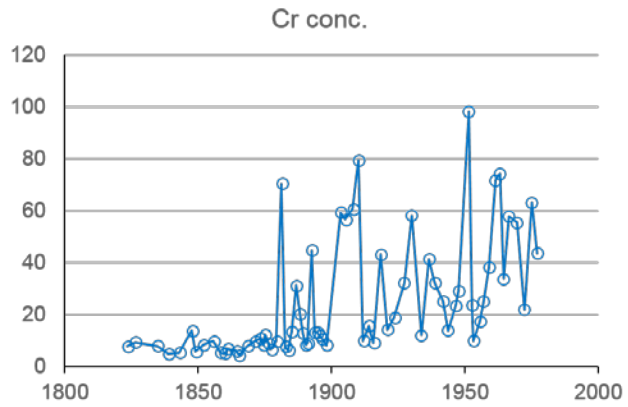


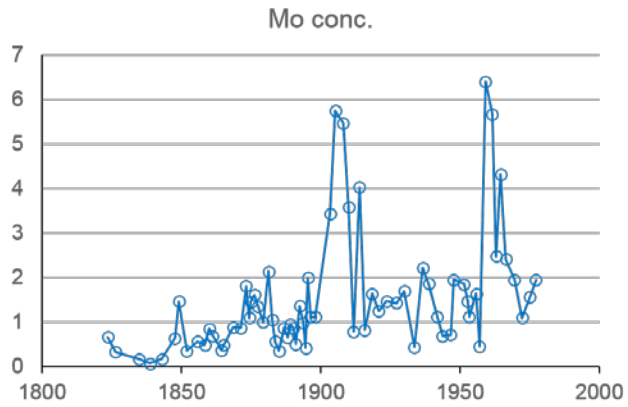


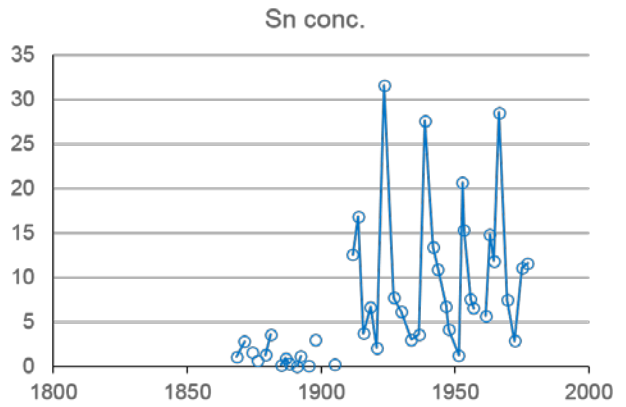


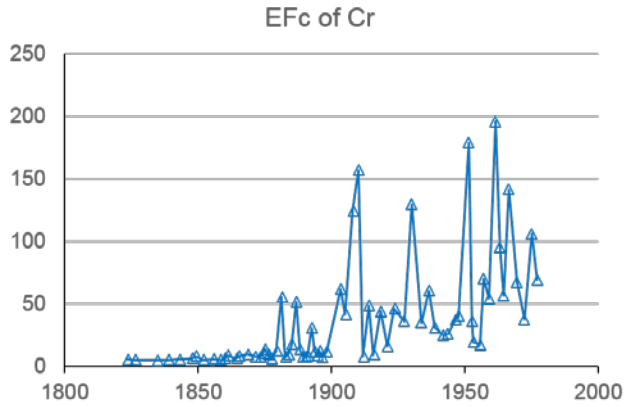
Year (AD)

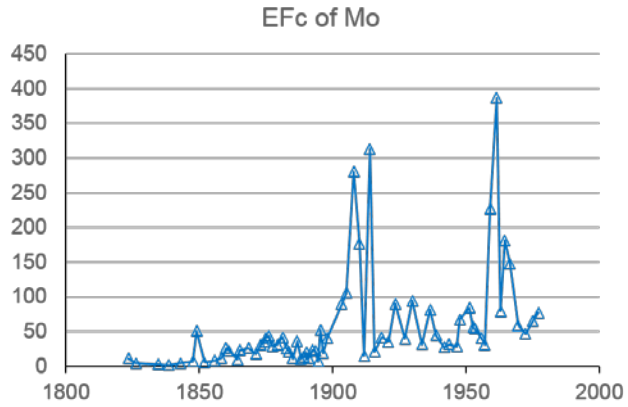
Anthropogenic (Coal) trace elements

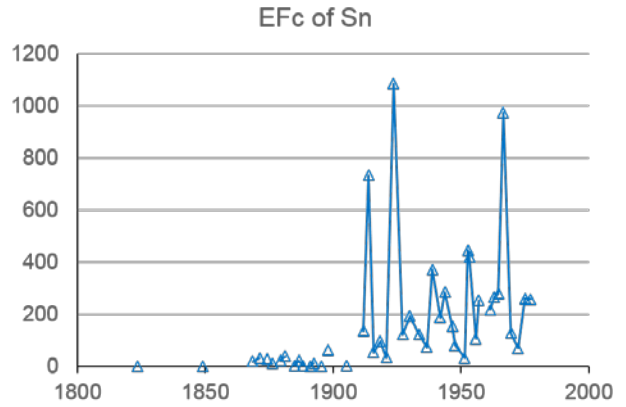












Year (AD)

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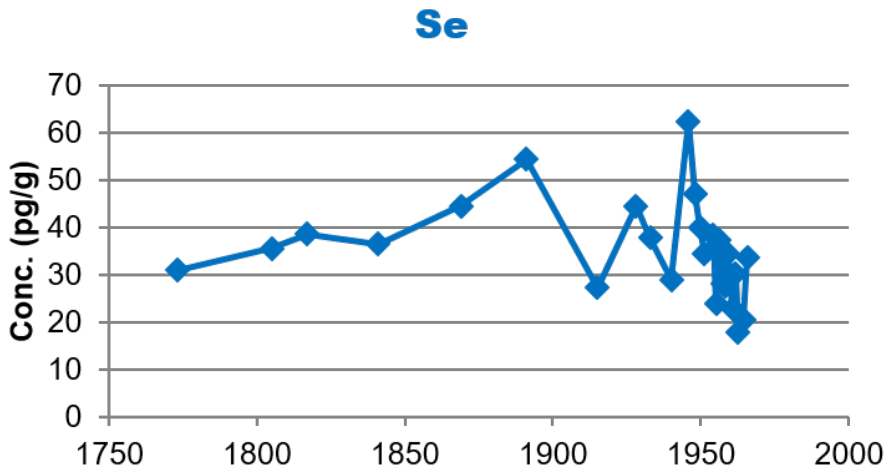
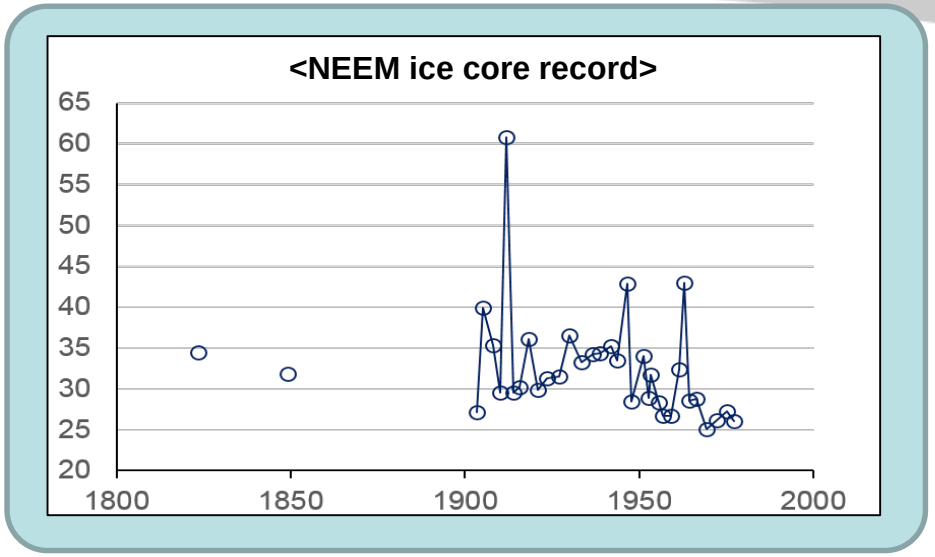
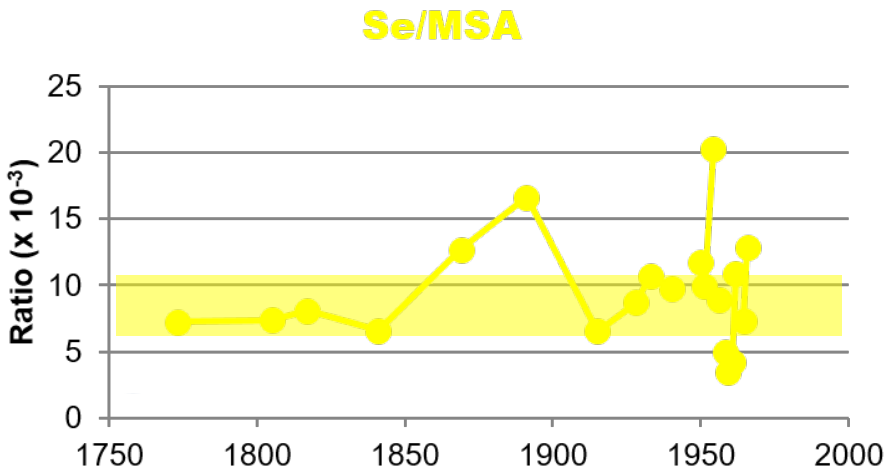
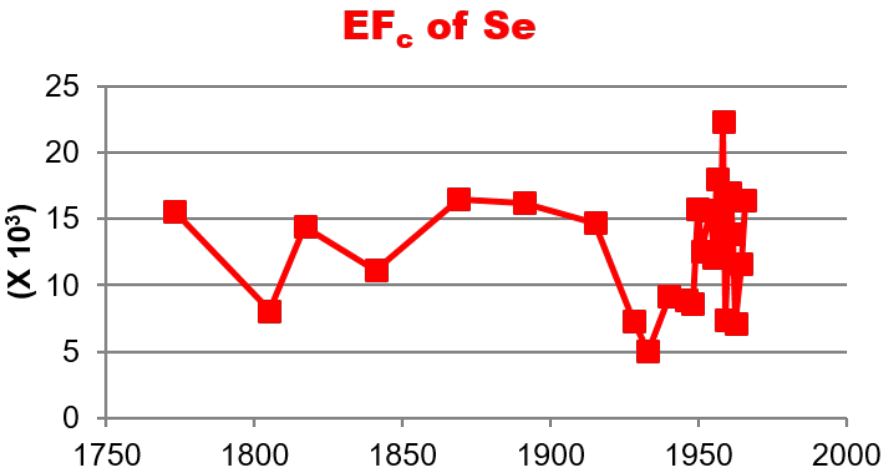
Se in Euro ice core



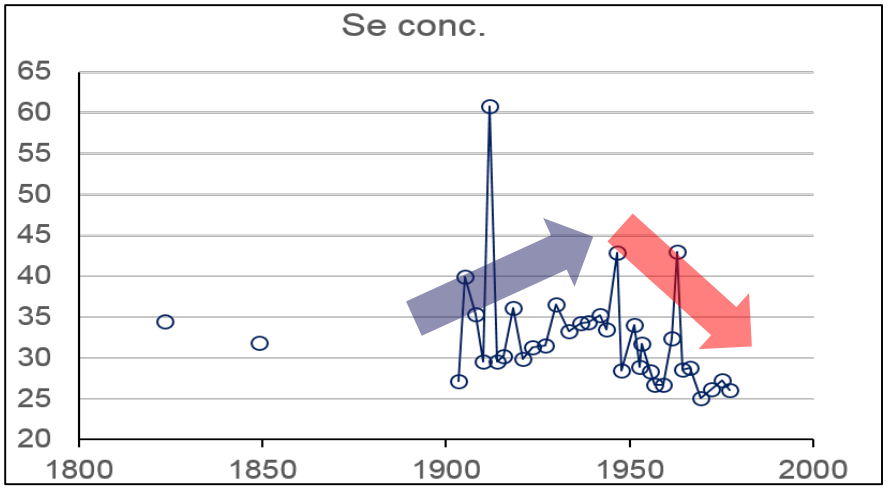


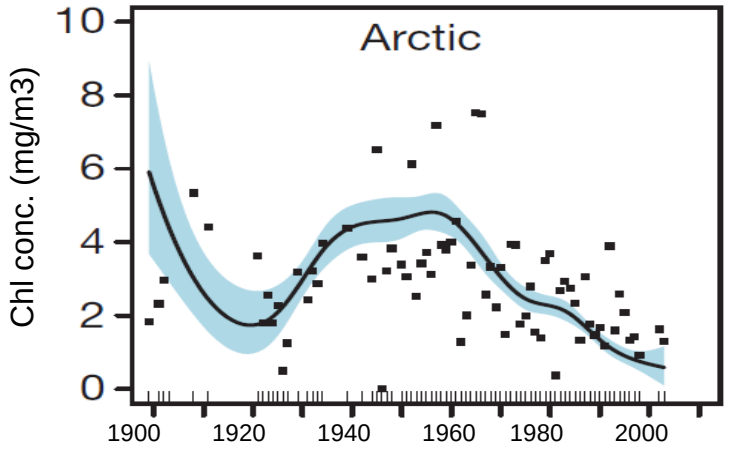


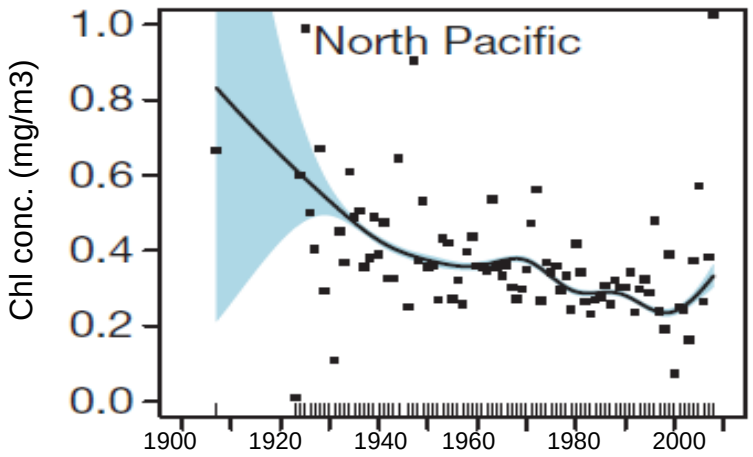


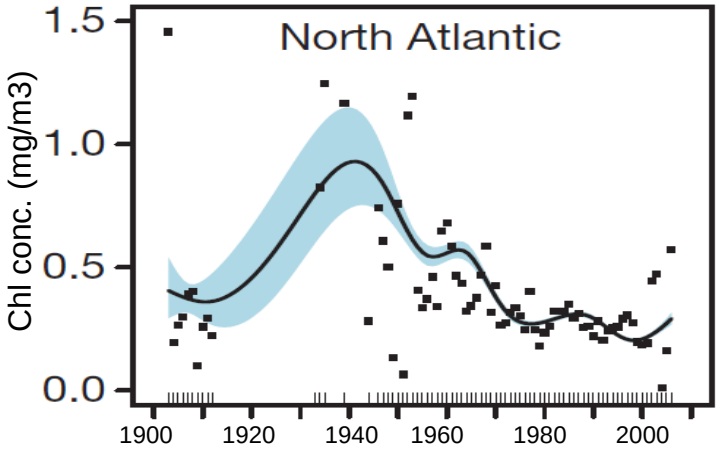
Year (AD)

Se in NEEM ice core









Year (AD)

<Boyce et al., 2010, Nature>

Air mass trajectories

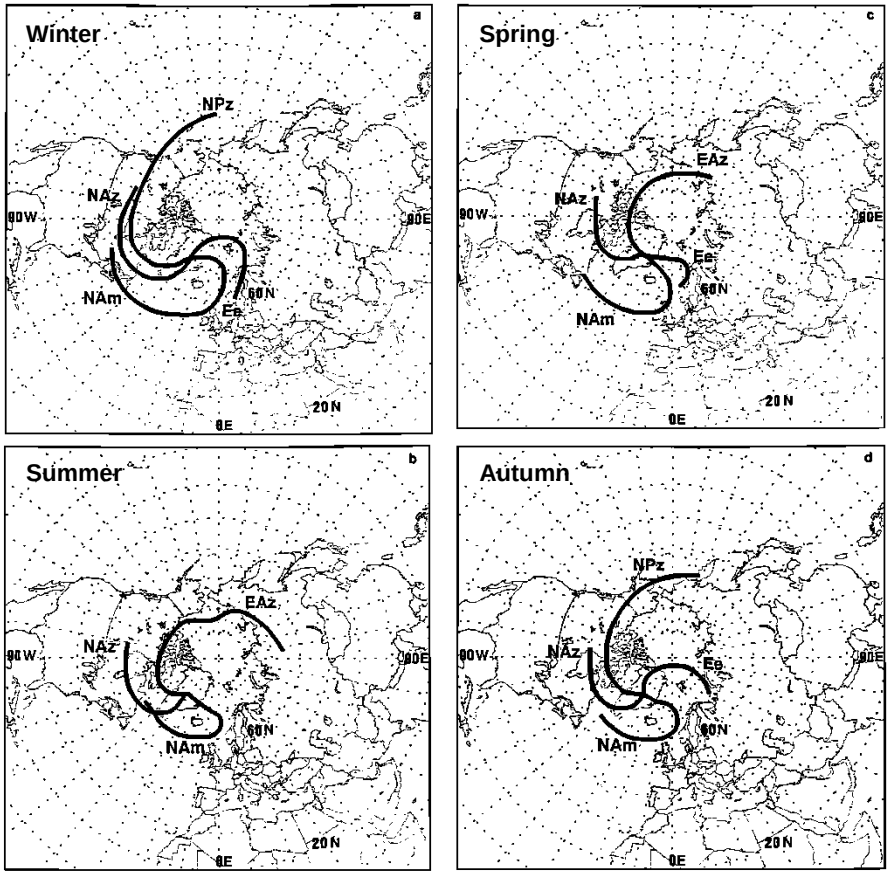


Table 3. Summary of Source Regions and Transport Routes for 10-day, 700-hPa Back Trajectories to Summit, Greenland

Season	North America[a] Zonal (NAz)	North America[b] Meridional (NAm)	North Pacific Zonal (NPz)	Europe Easterly (Ee)	East Asia Zonal (EAz)
Winter	70%	2%	19%	7%	–
Spring	85%	3%	–	--	8%
Summer	85%	3%	–	6%	6%
Autumn	74%	4%	17%	5%	–

a Principally westerly transport.
b Arriving at Summit from the east.

<Kahl et al., 1997>

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Conclusion

- Se/MSA ratios during 1900~1970s were mostly fit in the range of those for 500~9000 years BP when no significant anthropogenic influence
- High EF_c values of Se (>5,000) represent little influence of crust dust
- Se records of Greenland ice core were similar to north Atlantic chlorophyll change
- The atmospheric Se input during 1900~1970s seemed to be mainly controlled by natural emission from marine biogenic source

Further studies

- Changes from natural Se to anthropogenic Se
  - Upper part of NEEM ice core
- Responses of biosphere to the climate event such as AO and NAO
- Se isotope ratios research
  - Fractionation by oxidation/reduction
  - Estimation of fluxes between various reservoirs

Thanks for your attention