



Atmospheric deposition of trace elements over the Southern Indian Ocean

a time series at Kerguelen and Crozet islands



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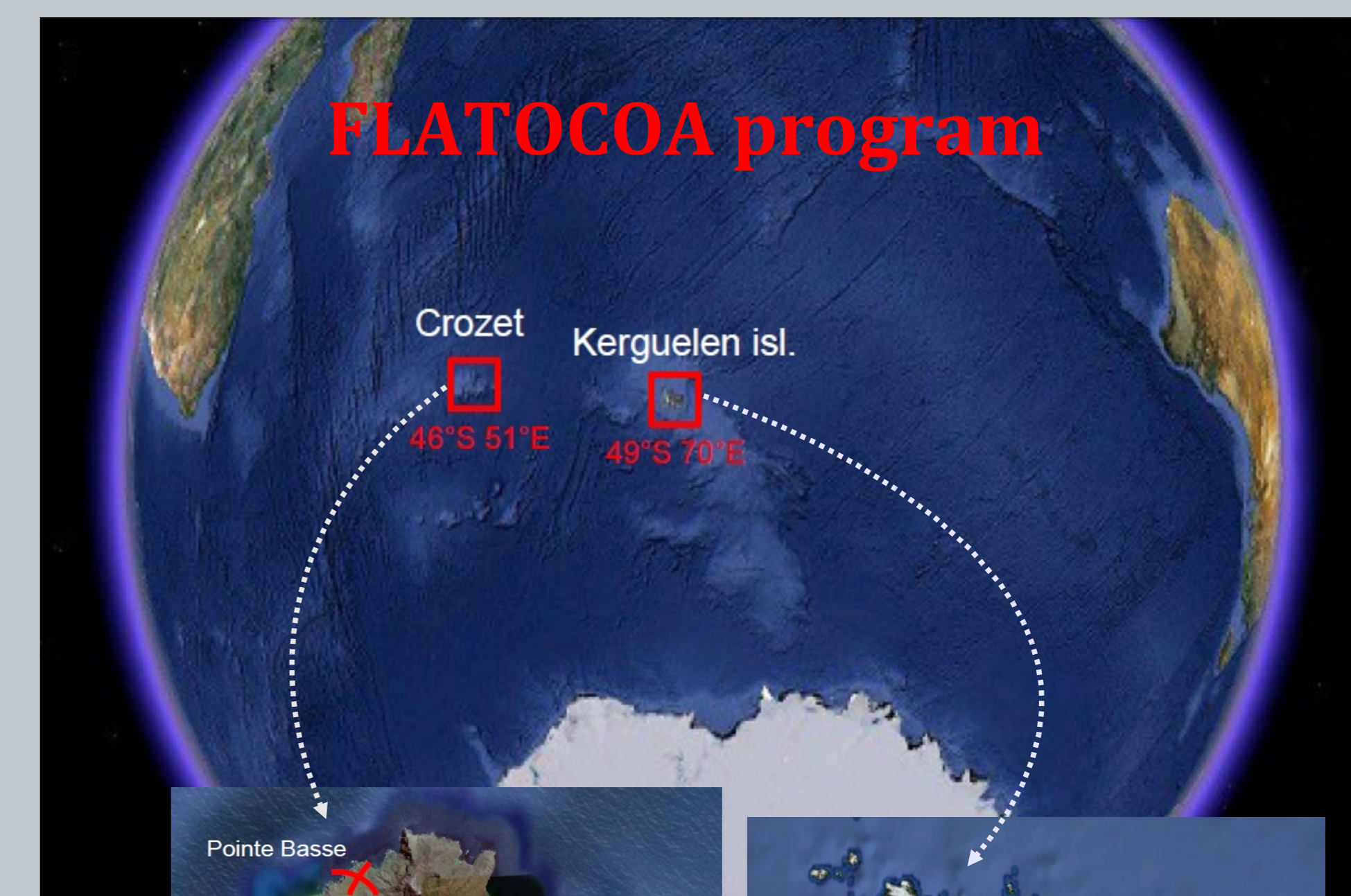
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Abstract

Atmospheric deposition is one of the major sources of nutrients to the remote marine biota. Total atmospheric deposition and crustal aerosols sampling were continuously monitored during 2009-2010 at Kerguelen (49°18'S; 70°07'E) and Crozet (46°20'S; 51°40'E) Islands in the Southern Indian Ocean.

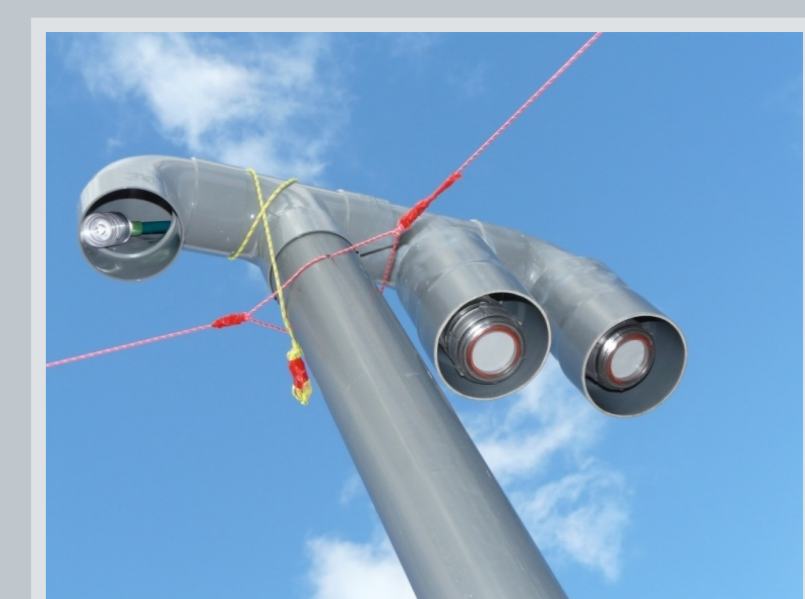
Results are similar for the both sites and show very low levels of atmospheric dust concentrations but **higher deposition fluxes (650 $\mu\text{g m}^{-2} \text{d}^{-1}$ on average)** than simulated by current atmospheric models. Simultaneously **measured Fe and Co deposition fluxes** are respectively **30 $\mu\text{g m}^{-2} \text{d}^{-1}$ (520 $\text{nmol m}^{-2} \text{d}^{-1}$)** and **0.020 $\mu\text{g m}^{-2} \text{d}^{-1}$ (0.30 $\text{nmol m}^{-2} \text{d}^{-1}$)**, giving elemental ratios to Al compatible with a purely crustal origin.

Observations and models show that **dust is transported above the marine atmospheric boundary layer** to Kerguelen location, suggesting that **surface concentrations are not representative of the total dust column**. This lead to very large wet scavenging ratio, and to the conclusion that deposition flux is difficult to derive from concentrations at remote ocean sites.



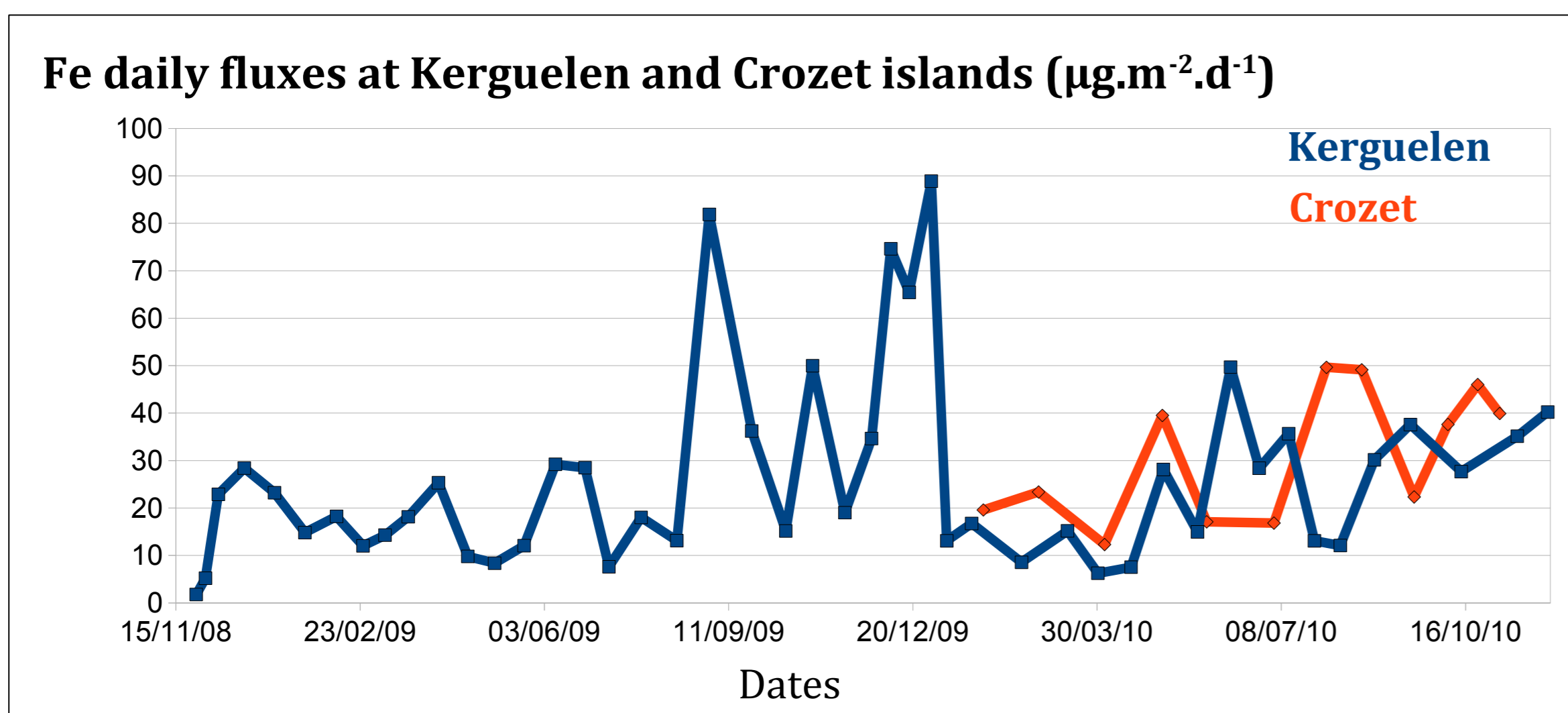
Duplicate sampling

Because of high wind, rainwater has a strong horizontal velocity component. The funnel section must be as horizontal as possible to intercept the real vertical flux.



At "Jacky" only:
Aerosol filtration on Teflon filters at ground level

Fe fluxes: direct measures

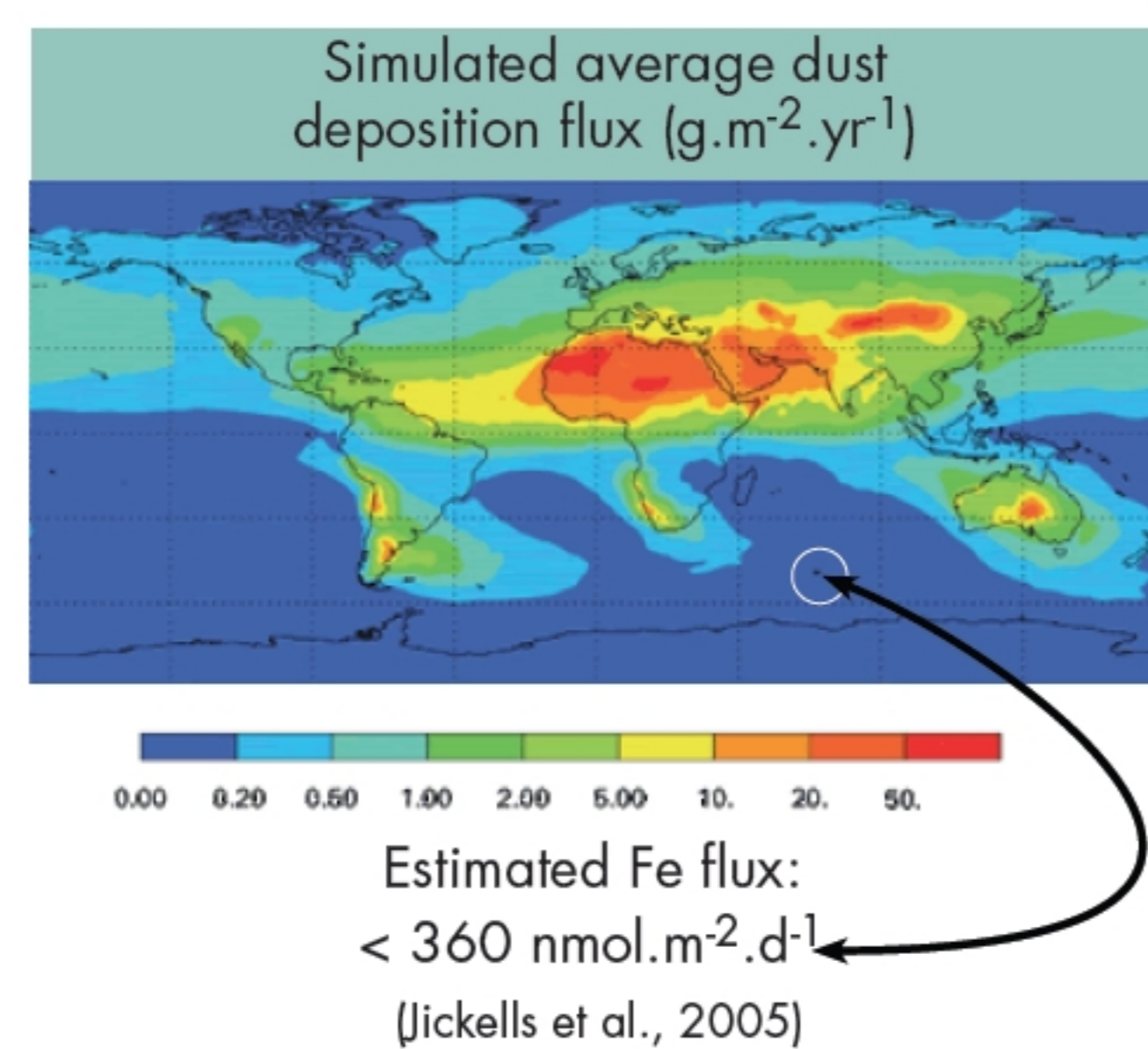


Averaged iron fluxes

At Kerguelen over 2009-2010: **540 $\text{nmol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$**

At Crozet over 2010: **490 $\text{nmol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$**

Comparison with atmospheric dust transport model



Slight underestimation of the model

Methodology:

Total atmospheric deposition sampling:

- Where: over the three stations.
- When: bi-monthly
- How: by a duplicate system (1L polypropylène bottle connected to a Teflon PTFE machined funnel, 12 cm diameter, stands 2 m high at the top of a 10 cm diameter PVC tube secured with Kevlar ropes).
- Analysed at lab by AES-ICP and HR-ICP-MS to obtain metals concentrations.

Aerosol sampling:

- Over one site and bi-monthly
- By filtration on 47 mm diameter Teflon Zefluor filter.
- Analysed by X ray fluorescence (Al, Na).

Determination of dust flux

Al: continental dust tracer

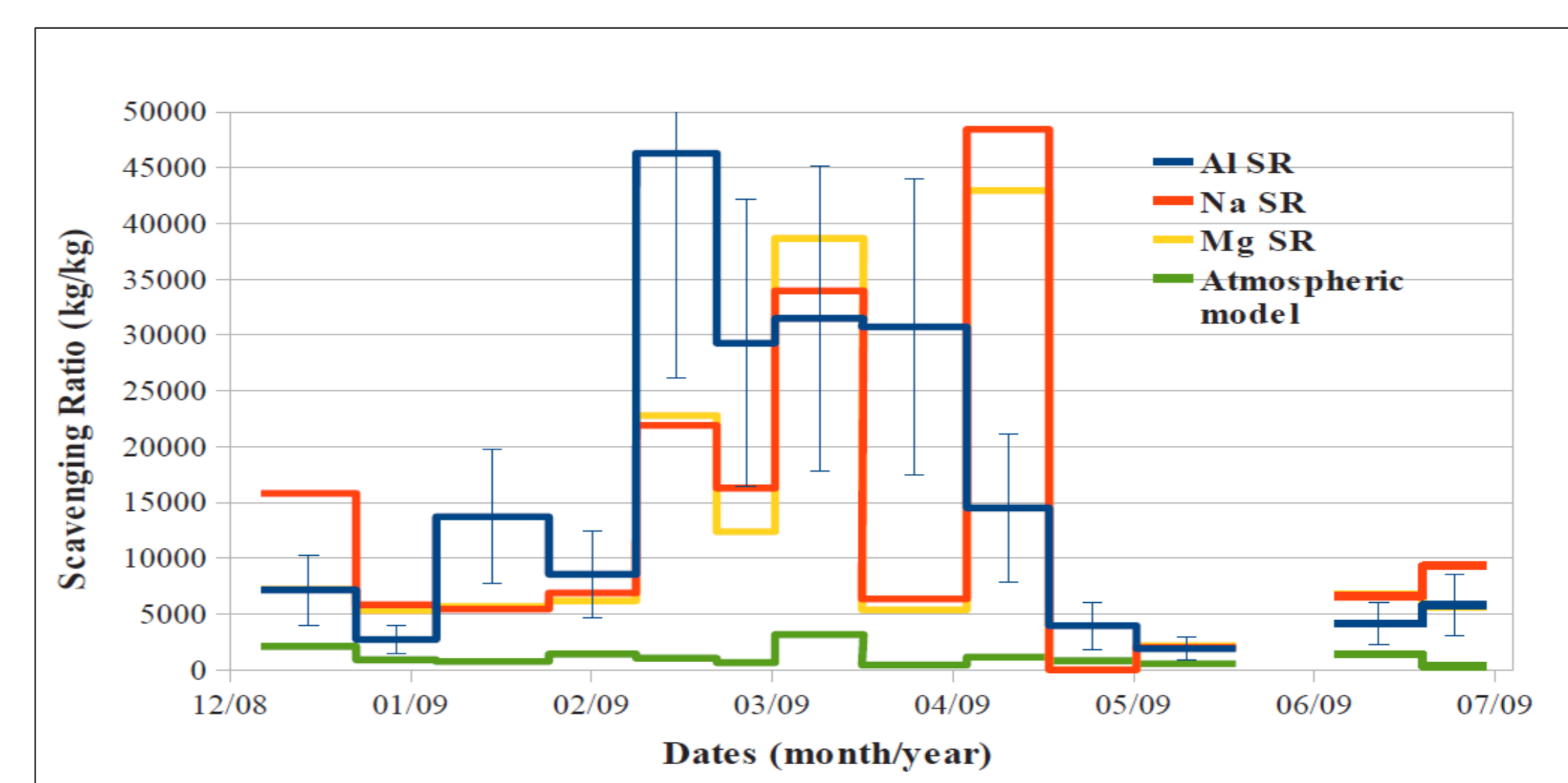
$$F_{dust} = \frac{\text{averaged daily } F_{Al}}{\text{Al abundance}}$$

8,1%: earth's crust
(« Essentials of Geology » de Lutgens et Tarbuck)

$$F_{dust} = 650 \mu\text{g}\cdot\text{m}^{-2}\cdot\text{j}^{-1}$$

$\sim 490 - 540 \text{ nmolFe}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$

Scavenging ratios $SR = \frac{C_{i,rain} \cdot \rho_{air}}{C_{i,aerosol}}$



Experimental scavenging ratio is higher by one order of magnitude than SR used in atmospheric models and presents improbable values. This result suggest that aerosol concentrations sampled at ground or sealevel are not representative of dust in the tropospheric column scavenged by rain.

Flux controlled by dust amounts at altitudes:
Deposition area

