Atmospheric and Marine Controls on Aerosol Iron Solubility and Bioavailability in Seawater

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The biogeochemical impact of atmospheric iron input to the ocean does not scale linearly to the magnitude of total Fe input.
A (cartoon) cast of characters:

- Mineral Dust
- Anthropogenic Fe
- Acidic particles
- Seasalt

Aerosols

Gases
- NO$_x$
- SO$_2$
- NH$_3$
- R-CO$_2$H
- H$_2$O
What size are these particles?

(chemical gas to particle conversion)

SO$_2$ \rightarrow H$_2$SO$_4$  \rightarrow HNO$_3$

(chemical sources)

Coarse aerosol

Fine aerosol

Volcanic Ash

Sea Spray

Soil Dust

Idealised schematic of the distribution of particle surface area.
Aerosol mixing state

EXTERNAL MIXTURE

INTERNAL MIXTURE
Aerosol sampling limitations

Simple filtration

Size separation
What do we know about iron solubility in aerosol?

1. Fe solubility in dust aerosol is higher than in soil.

2. Fe solubility increases during transport through the atmosphere.
Solubility increase during transport

Sholkovitz et al., GCA, 2012
What causes this change in Fe solubility?

- Acid processing
- Mixing of dust with anthropogenic Fe
- Decreasing particle size / changing mineralogy
- Redox chemistry
Can we identify the controlling process(es)?
Is there a “simple” way to conceptualise iron solubility?

Electrical resistance as a metaphor for aerosol iron dissolution:
Dust Fe

Atmosphere

Mineralogy / Source
Chemical Processing
Physical Processing
Transport / Mixing

Ocean

Inorganic Solubility
Fe-binding Ligands
Biotic Control
Dissolution Kinetics

Dissolved Fe
Conclusions / Questions

Fe solubility in aerosol is influenced by several complex processes in the atmosphere. Should we care?

Is organic complexation of Fe in seawater the globally dominant control on aerosol Fe solubility and bioavailability?

Fe is the most “important” marine micronutrient, but it isn’t the only one. Also studying other trace metals makes a lot of sense.