Aeolian transport in the McMurdo Dry Valleys (MCM), Antarctica

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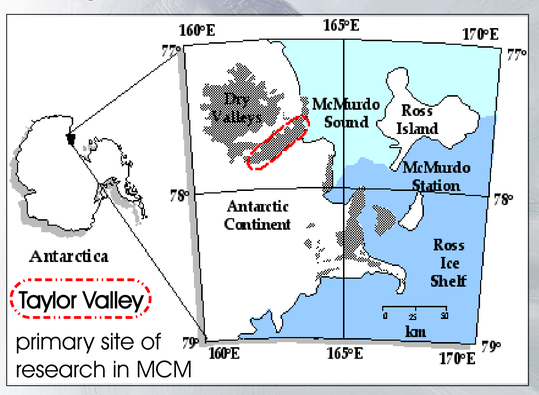
Background

- MCM: driest (< 10 cm y^{-1}) and coldest (mean -20°C) desert on Earth; **end member** ecosystem in the **LTER** network
- Largest relatively **ice-free** area in Antarctica
- Landscape of the MCM: mosaic of permanently ice-covered **lakes**, ephemeral **streams**, **exposed soils** and **glaciers**
- Biology of each of these landscape units is **dominated by microorganisms**
- **Constant** and often strong winds distribute material among the landscape units



primary site of research in MCM

Hypotheses

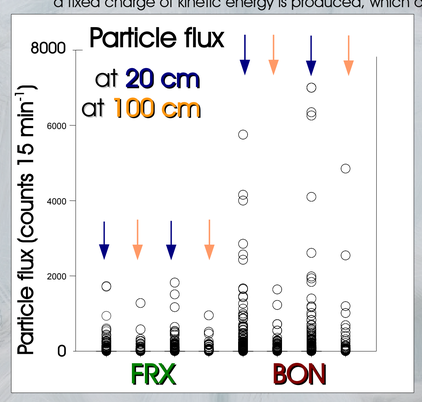
Given the relatively low and seasonal growth rates observed for the **microorganisms** within MCM, their overall **distribution** should be **controlled** to a large degree **by** the **physical environment**

Aeolian transport during strong katabatic winds is the **primary dispersive agent** of microorganisms and associated organic matter among the MCM landscape units

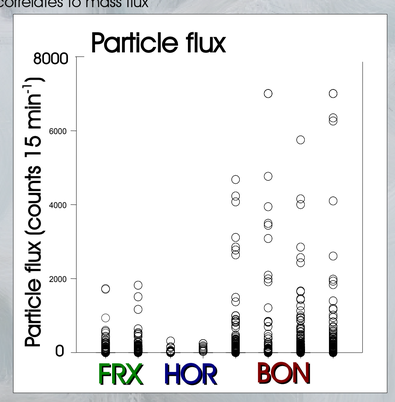
1. Aeolian Transport in Taylor Valley (TV)

Measured using Sensit™ **acoustic wind** eroding mass **sensor** installed in the upper (BON), middle (HOR) and lower parts (FRX) of TV

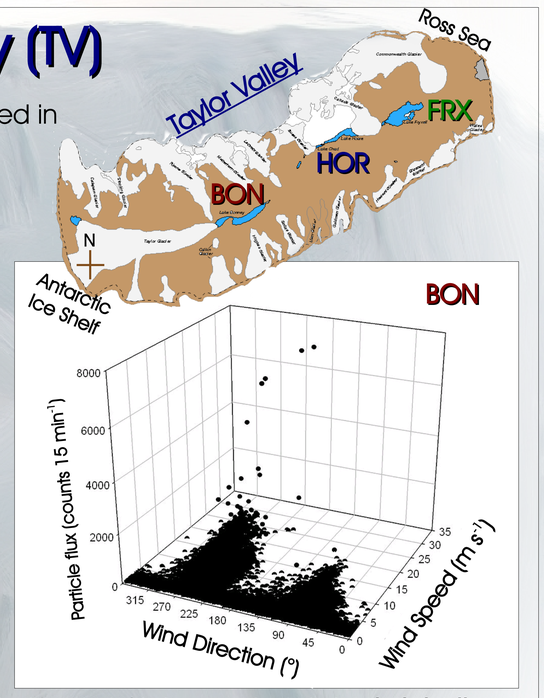
As particles hit the crystal, a fixed charge of kinetic energy is produced, which correlates to mass flux



Sediment **transport** at a given location is **greater** ($p<0.001$, H=1374.8) **near the soil surface** (20 cm) than higher above the ground (100 cm)

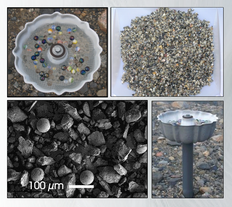


Upper Valley (BON) has the **greatest** ($p<0.001$, H=1475.1) amounts of aeolian material transported through the air



Most material is transported during **katabatic winds from SSW** (from the continent toward the Ross sea) and partially from NE (from the ocean inland) during sporadic low pressure events

2. Aeolian Sediment Characteristics

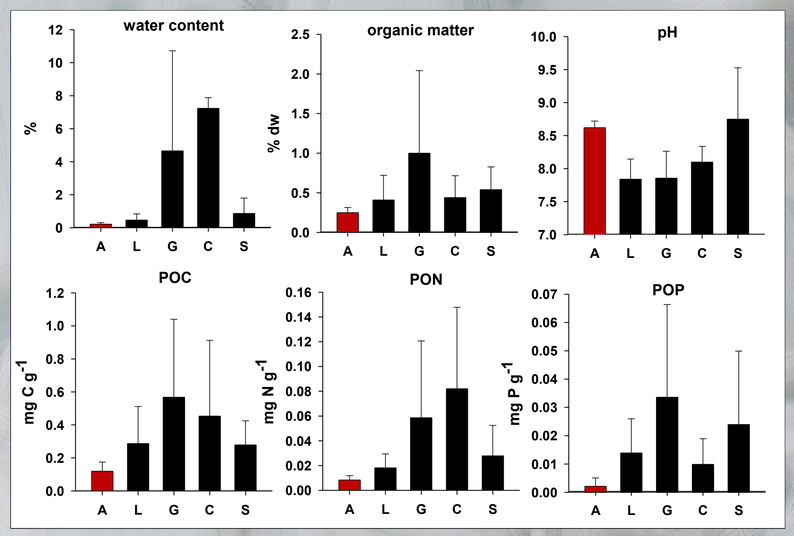


97.8% (±2.15%) of the aeolian material is **coarse sand** (particles > 250 µm)

Lower water, organic matter, POC, PON and POP **content** than other sediments

Higher pH than lake ice, glacier ice and cryoconite sediment; similar to soils

Collected from **sediment traps** installed at BON, HOR and FRX of TV



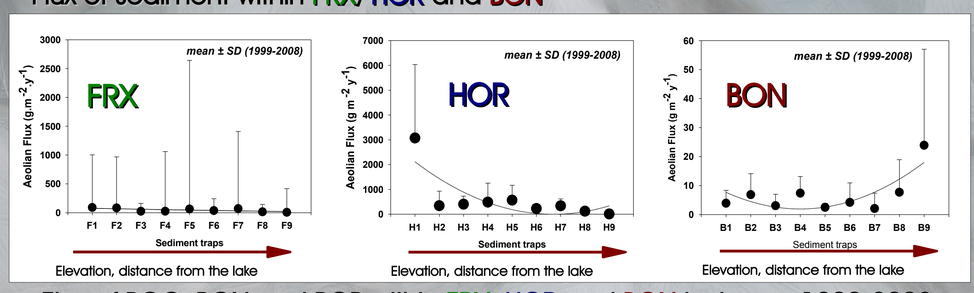
A =aeolian material L=lake ice sediment G=glacier ice sediment
C=cryoconite S=soil Mean ±SD

Aeolian processes = wind generated processes

3. Aeolian Fluxes

Based on the amount of material collected from **sediment traps** installed at BON, HOR and FRX of TV and sampled yearly from 1999-2008

Flux of sediment within FRX, HOR and BON

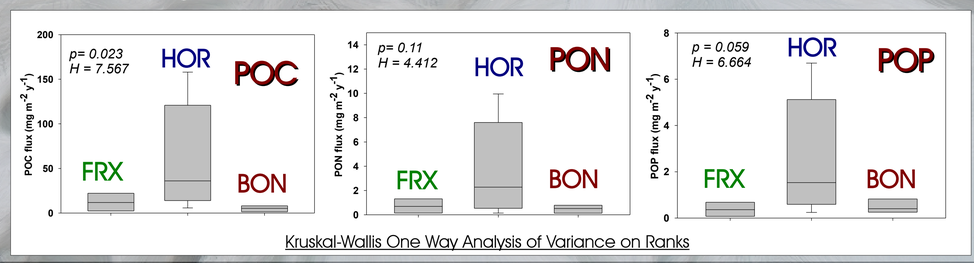


At FRX sediment flux does not change with elevation

At HOR sediment flux is greatest at the lowest elevation site

At BON sediment flux is the greatest at the highest elevation

Flux of POC, PON and POP within FRX, HOR and BON between 1999-2008



Kruskal-Wallis One Way Analysis of Variance on Ranks

On average the sediment flux is greatest in the medium part of the valley (HOR)

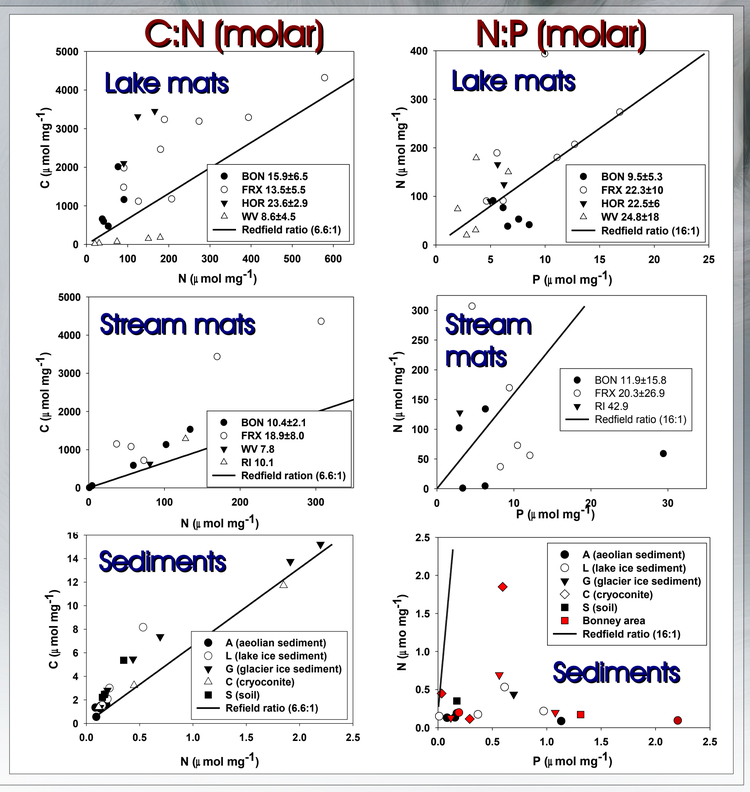
Katabatic winds originate from the cooling of air atop the Polar Plateau. The cold dense air then flows downhill, warming adiabatically as it descends.

4. TV Stoichiometry

Lake ice and stream mats in Taylor Valley have C:N and N:P ratios similar to or higher than the **Redfield ratio** suggesting a balance growth

Aeolian **sediment**, lake ice and glacier ice sediment, cryoconites and soil have C:N ratios close to the Redfield. N:P ratios vary greatly among different habitats and localities and are generally bellow the Redfield ratios suggesting N or P defficiency

Redfield ratio proportion of elements equals to 106 atoms C per 16 atoms of N per 6 atoms of P



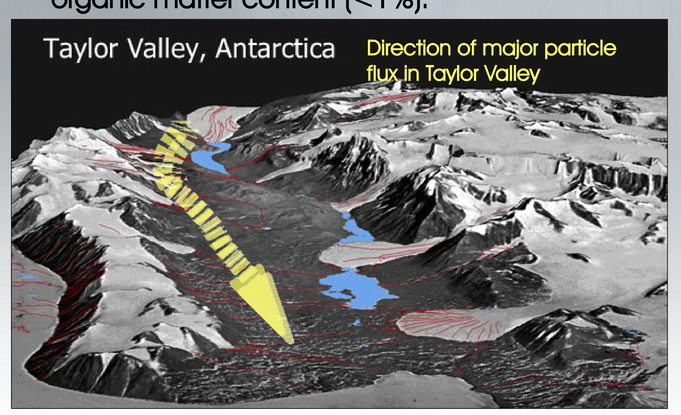
Conclusions

1. Aeolian transport in Taylor Valley

Most material is transported down-valley from Taylor glacier towards the Ross Sea during katabatic events when the wind speed reaches above 10 m s^{-1} . Sediment is predominantly transported near the soil surface.

2. Aeolian sediment

The material transported via wind is physically and chemically similar to nearby soils. It is slightly alkaline (~ 8.6), has a very coarse texture (98% of particles > 250 µm), very low water content (< 2%) and organic matter content (<1%).



3. Aeolian fluxes

Over the past decade, on average, most aeolian material have been collected from sediment traps located in the middle part (HOR)of the TV

4. Basic stoichiometry

C:N:P ratios suggest balance growth within lake ice and stream mats while the sediments are N or P deficient

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