

Uncovering the Unexplored:
Microbial Ecology of sub-Antarctic island
soils



The sub-Antarctic Islands (SAIs)

- Positioned around the Antarctic Polar front.
- Distinct glacial histories, and highly variable biomes.
- Very remote and inaccessible.
- Unique local ecology.
- Studies mainly focused on SAIs with stations:
 - Prince Edward (Marion) (RSA)
 - South Georgia (UK)
- Very few studies (culture-based) on the microecology of SAIs.



The ACE program

- The Antarctic Circumnavigation Expedition (ACE) was conceived as an inter-disciplinary effort to study the Southern Ocean and sub-Antarctic islands around Antarctica.
- The ACE was launched from Cape town in December 2016 in the research/logistics vessel Akademik Tryoshnikov.
- Projects developed in this initiative included:
 - *Mapping changes in phytoplankton abundance in the Southern Ocean.*
 - *Study of the aerobiology over Antarctica.*
 - *Testing the diversity of marine refugia at sub-Antarctic Islands*
 - ***Documenting the functional biogeography of the sub-Antarctic***



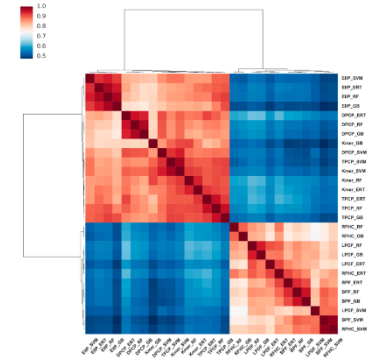
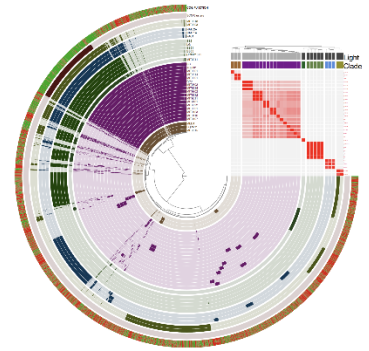
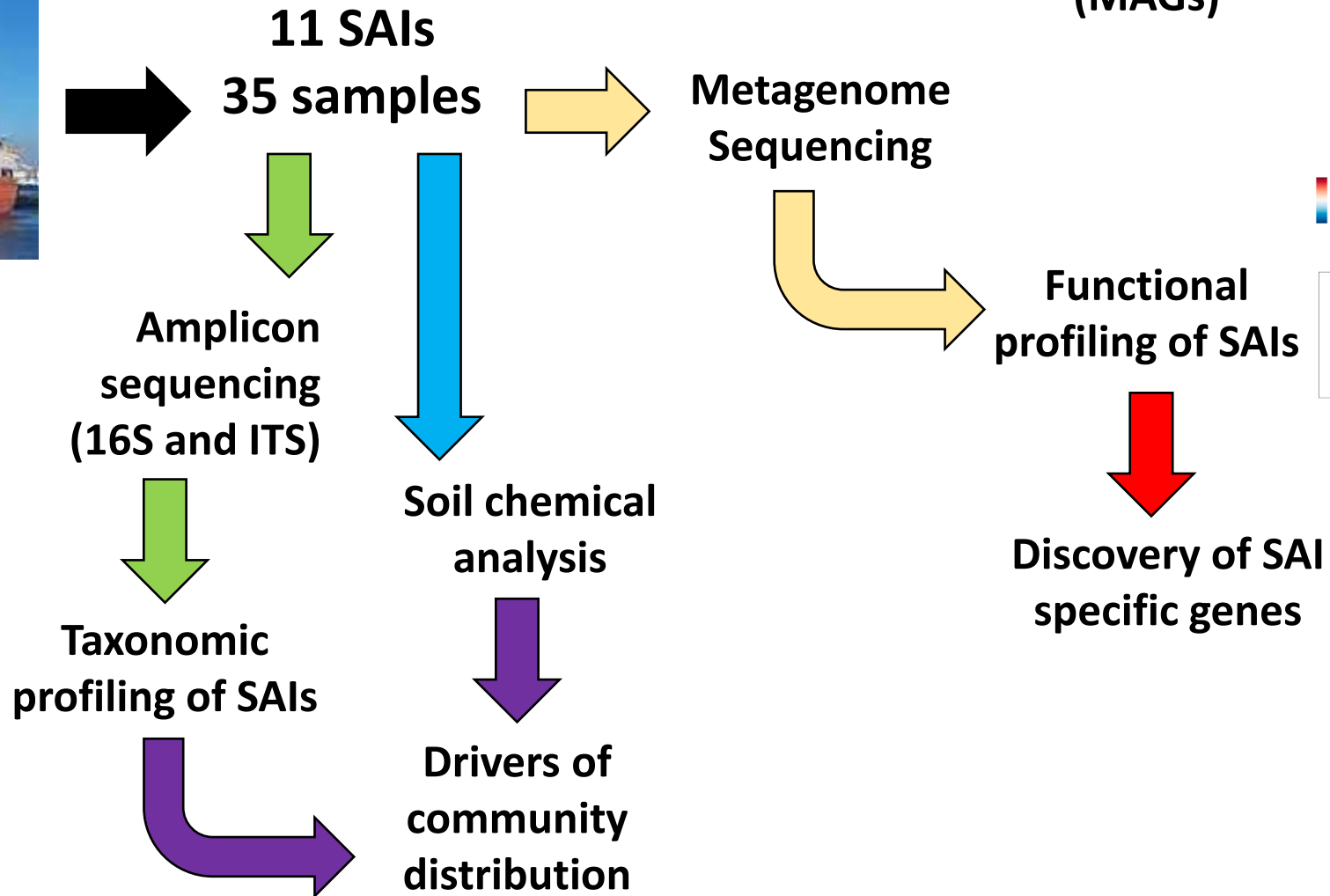
Aim of the study

The micro-ecological survey of the sub-Antarctic Islands surrounding the Antarctic continent.

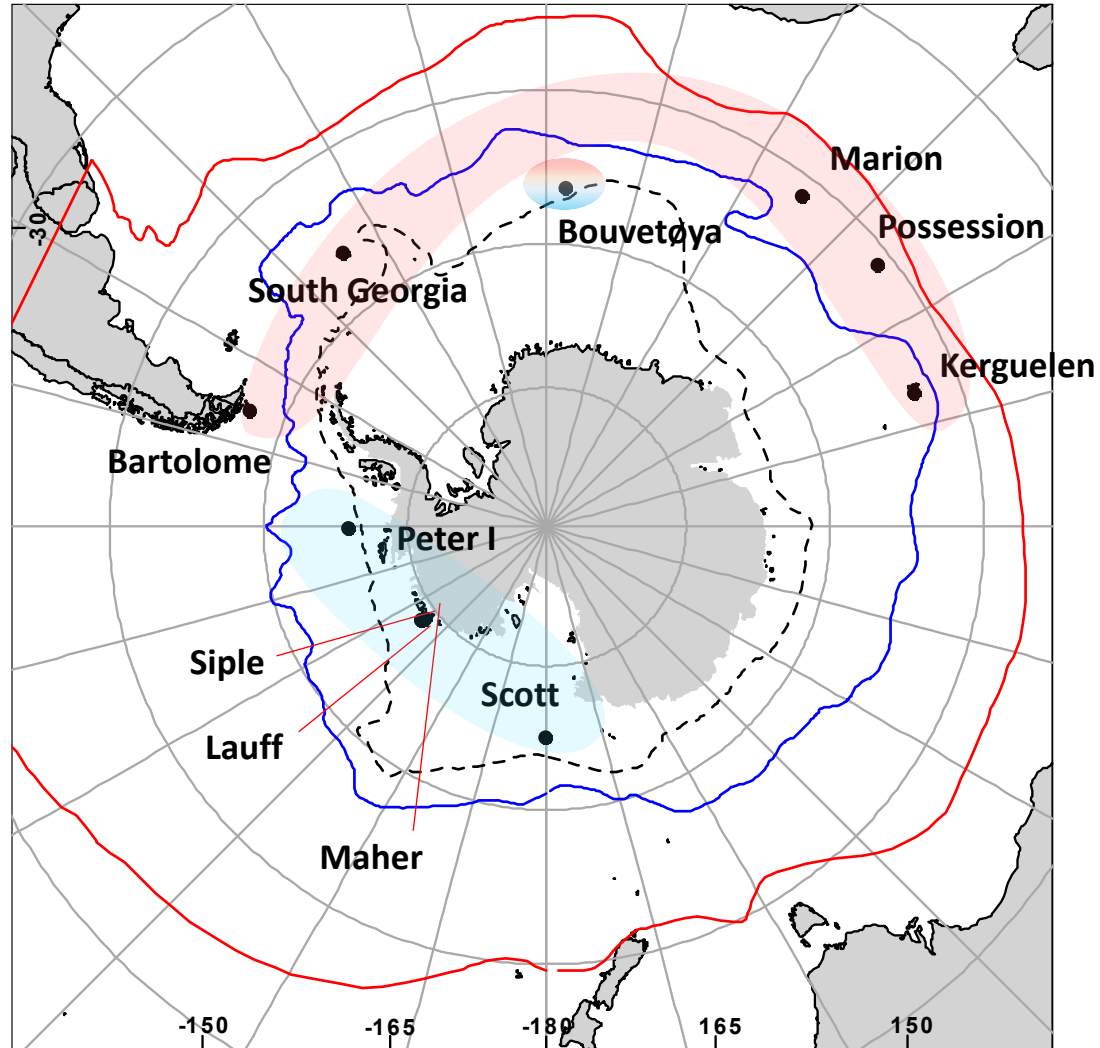
Objectives

- *To document the biodiversity and functional potential of soil microbiomes from sub-Antarctic islands.*
- *Identify possible drivers of community specialization in sub-Antarctic islands.*

Methodology

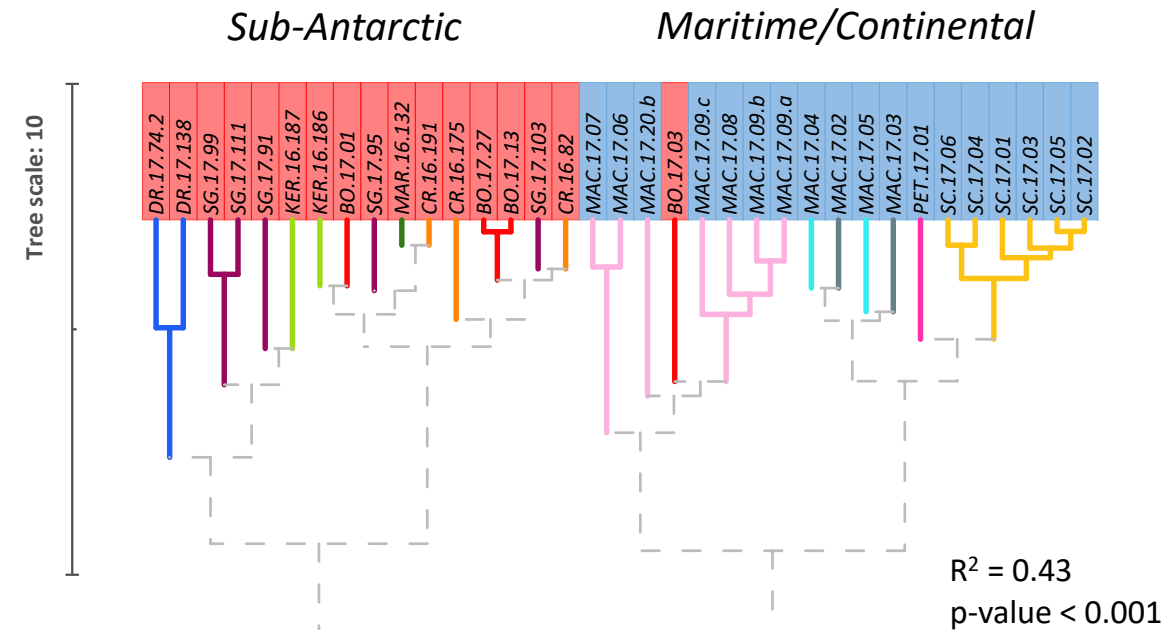
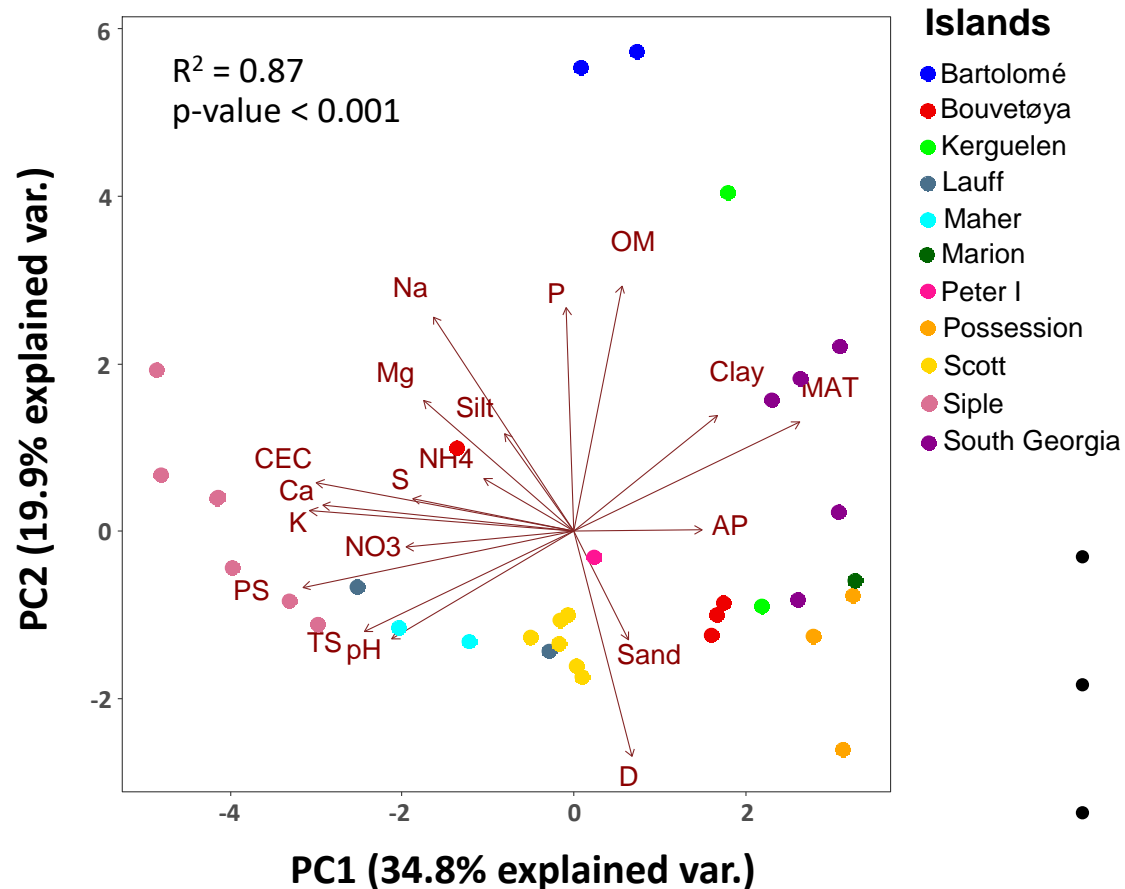


Sample sites



- Maritime/Continental Islands:
 - Peter I (1 sample)
 - Siple (7 samples)
 - Lauff (2 samples)
 - Maher (2 samples)
 - Scott (6 samples)
- SAIs in sub-Antarctic Zone:
 - Bartolomé (2 samples)
 - Possession (3 samples)
 - Marion (1 sample)
 - Kerguelen (2 samples)
 - South Georgia (5 samples)
- Transition island:
 - Bouvetøya (4 samples)
- Uneven sampling set.

The soil chemistry and climate of Antarctic islands

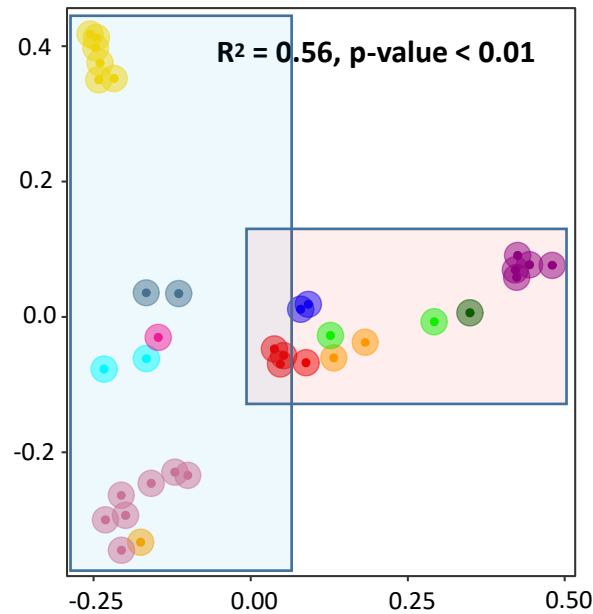


- Islands are distinct in terms of soil chemistry and climate.
- Islands also clusters according to biogeographical regions.
- Higher concentrations of calcium and nitrates might be associated with mineral aerosol deposition or calcium carbonate accumulation in coastal Antarctica.

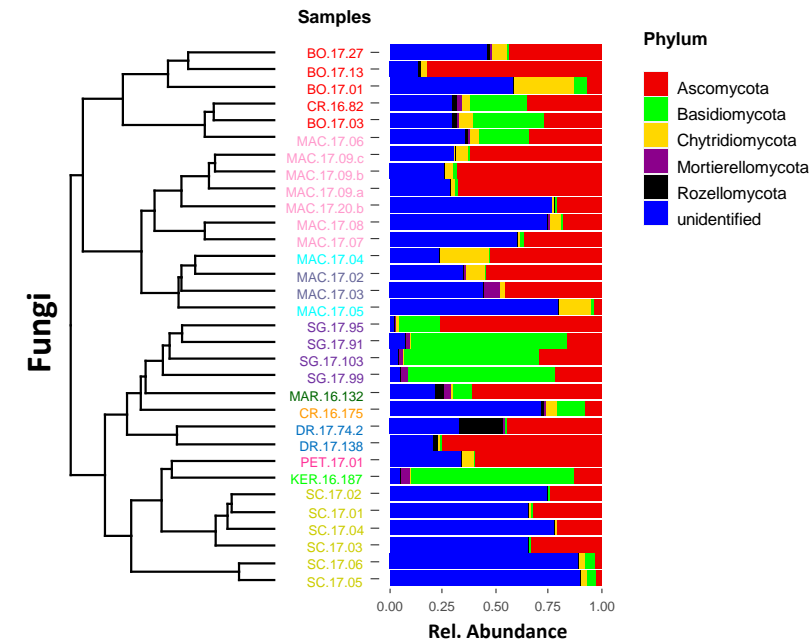
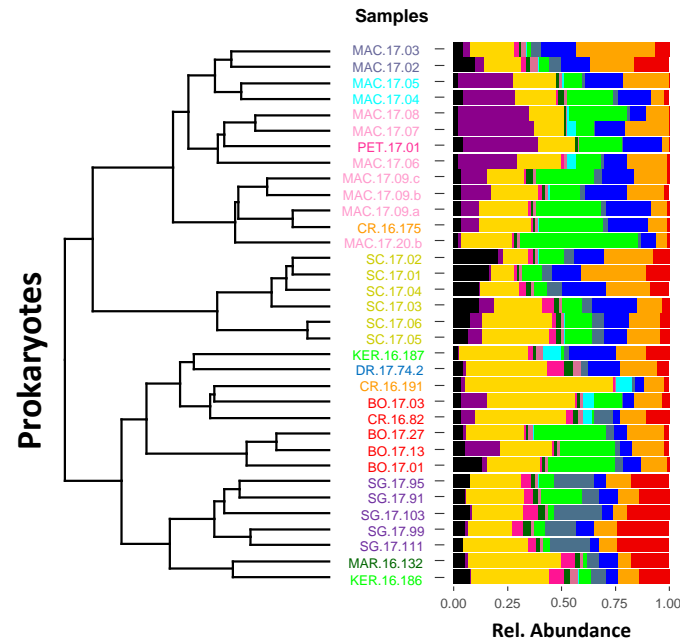
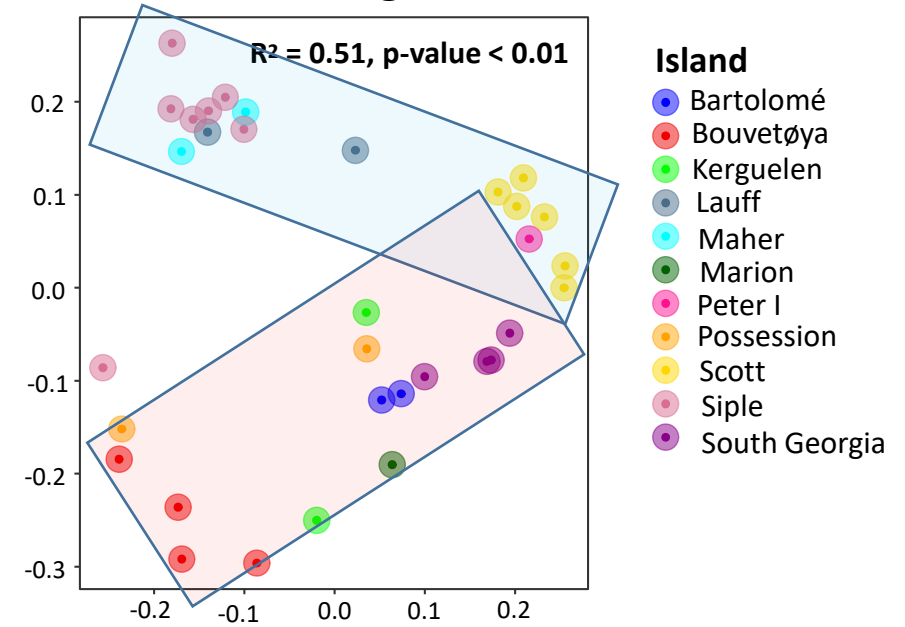
Localized microbial communities

- Samples cluster significantly according to islands.
- Island soil fungal communities not as clearly separated according to sub-Antarctic and Maritime/Continental regions.
- High percentage of unknown prokaryotic taxa in Siple/Maher/Lauff.

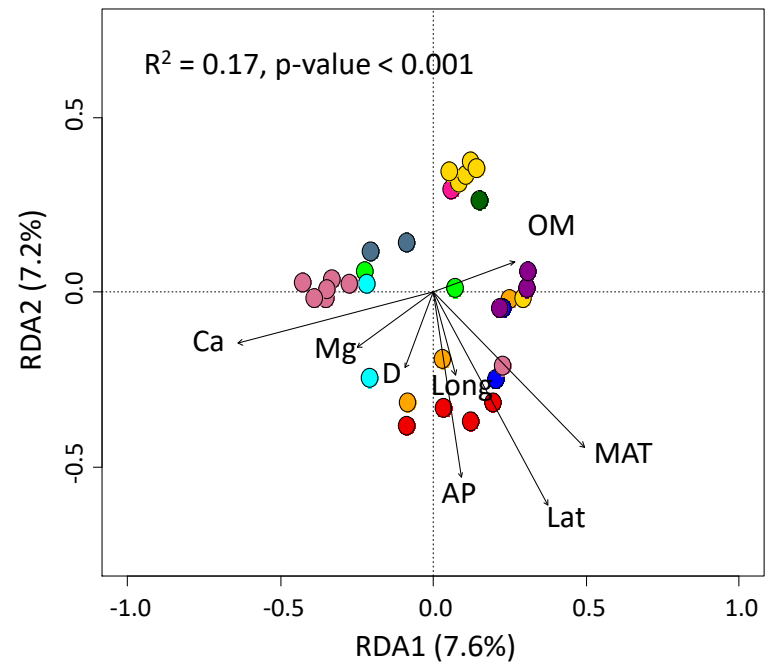
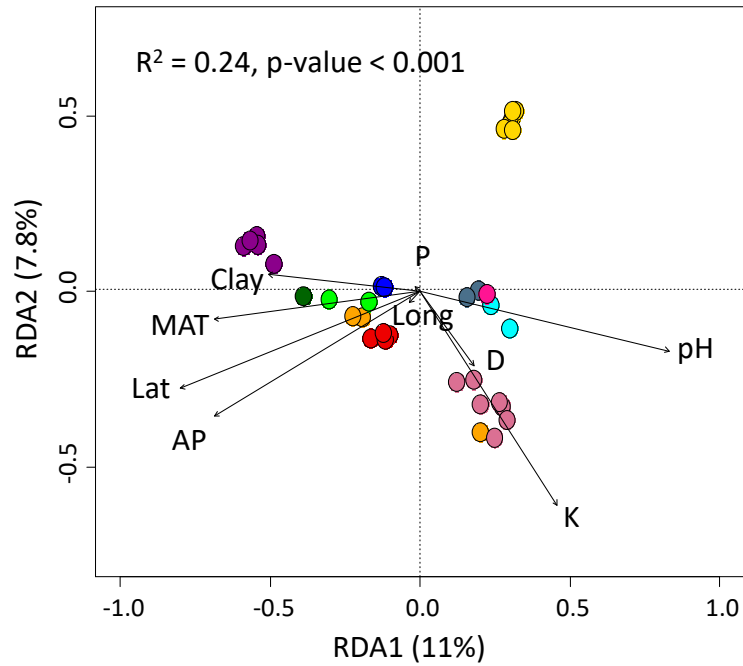
Prokaryotes



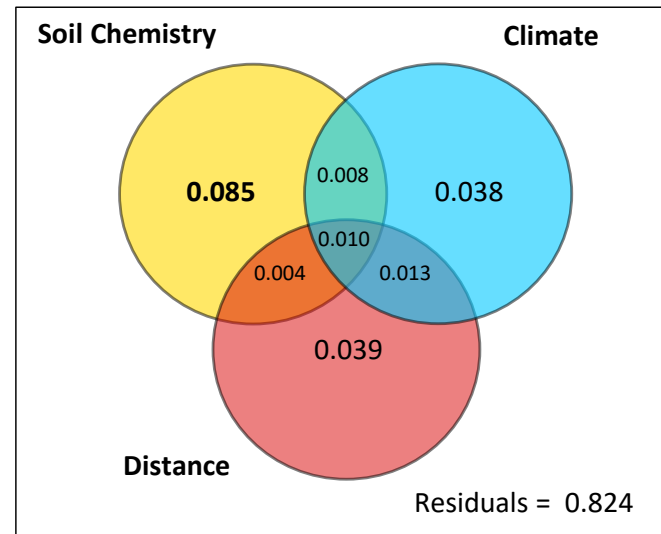
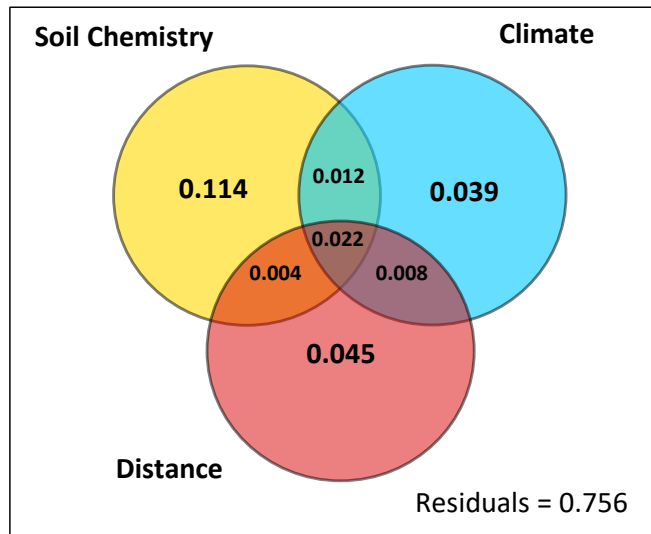
Fungi



Abiotic drivers of island microbial communities

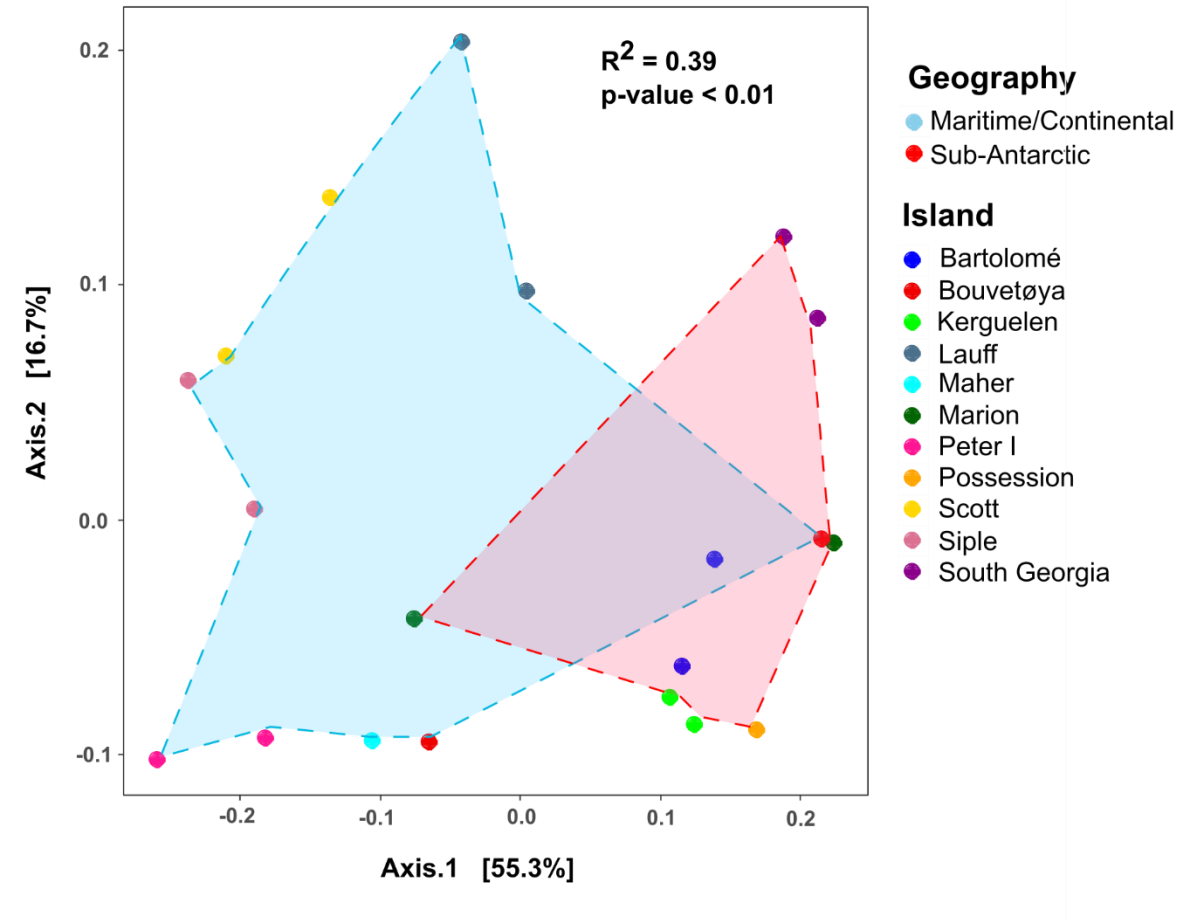


- Latitude and temperature are the common factors explaining microbial distribution.
- Soil chemistry is the biggest driver of microbial community structure
- Stochastic processes (e.g. ecological drift) might play important roles in shaping microbial distribution.

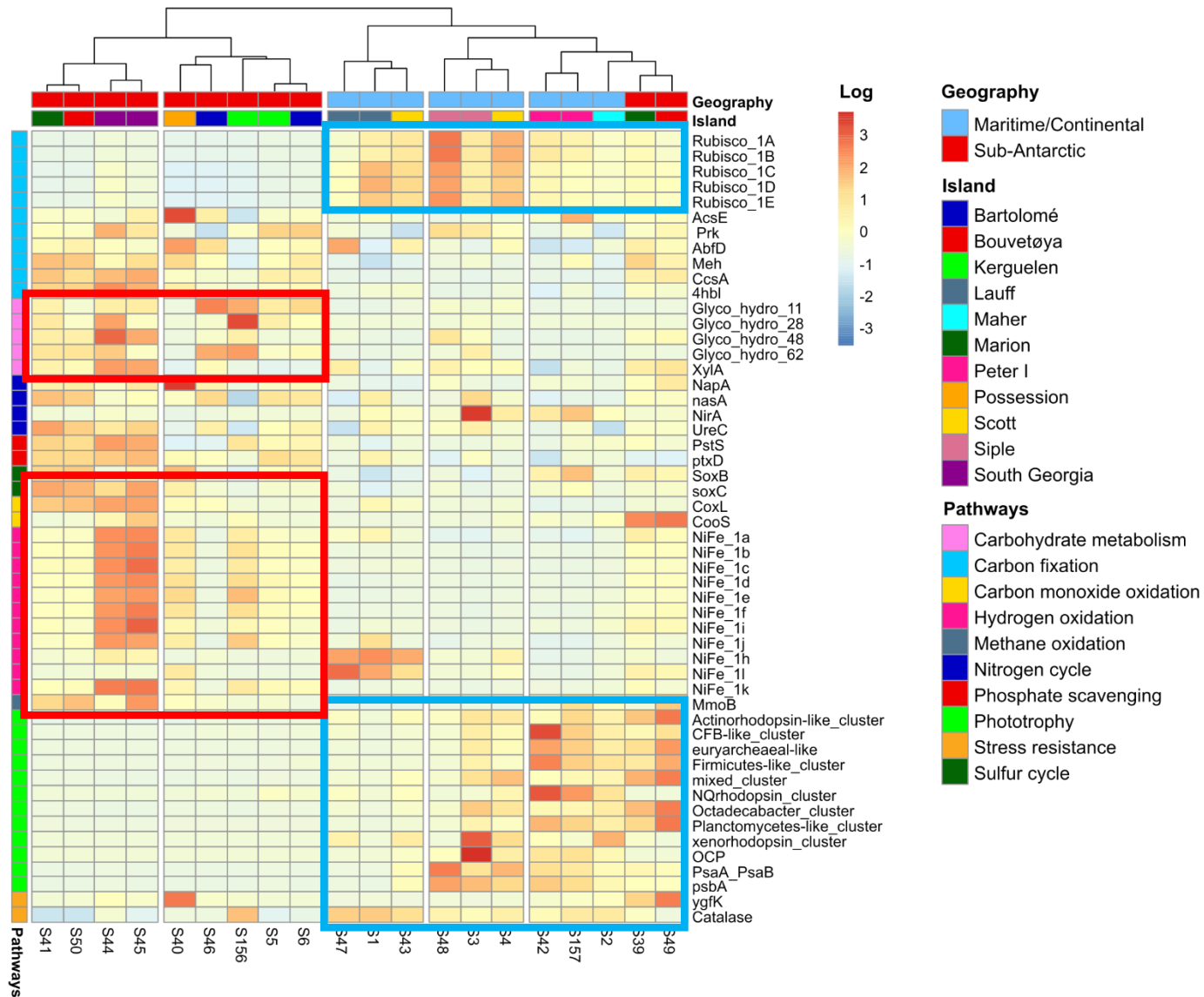


The functional potential of SAI soils

- 20 metagenome assemblies were obtained from SAI soils.
- High degree of functional redundancy.
- All metagenomes have the potential to perform ecosystem service functions such as carbon fixation and nitrification.
- Based on gene abundances, metagenomes clustered significantly into the two biogeographic regions.



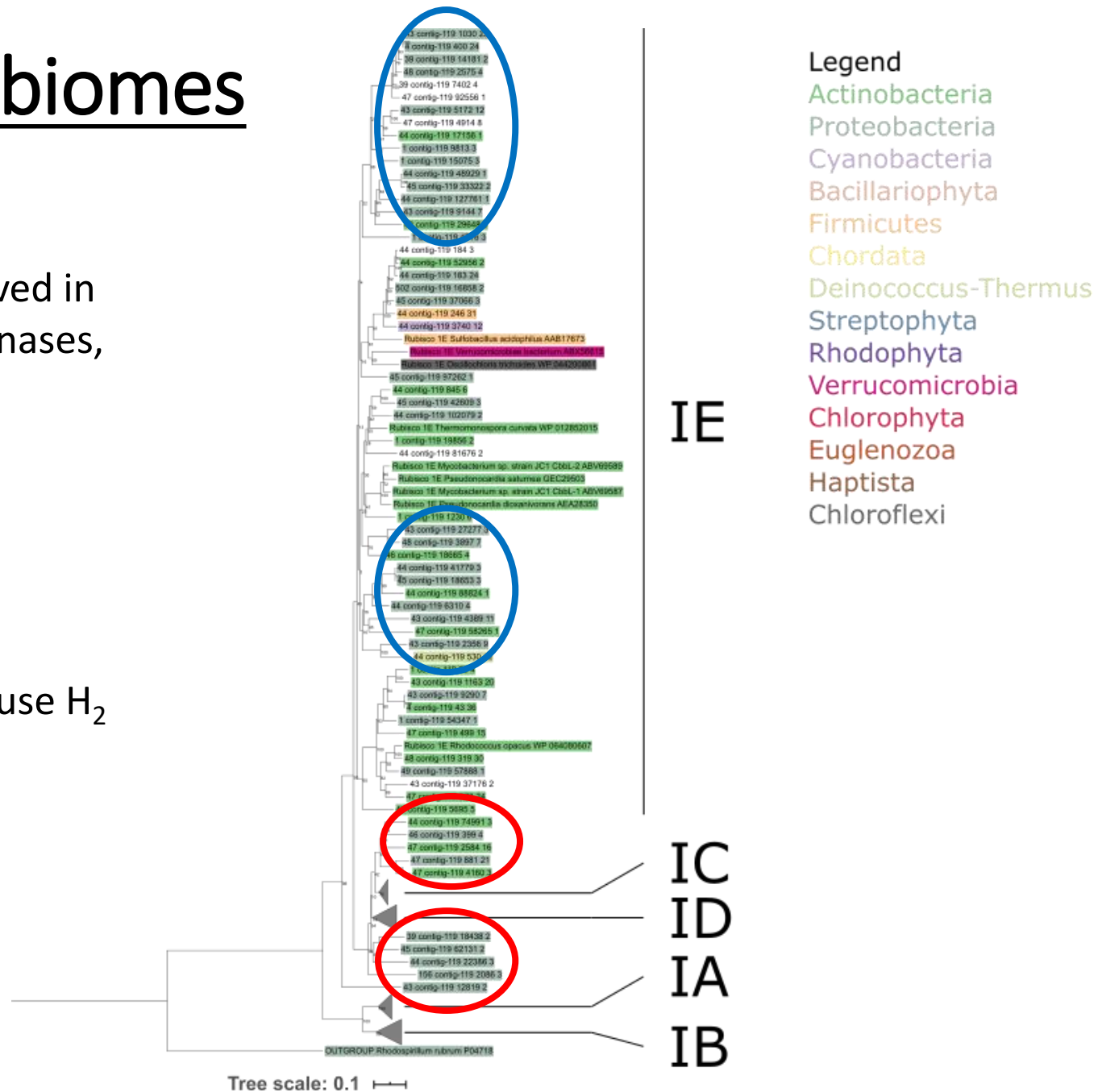
Differentially abundant genes across SAIs



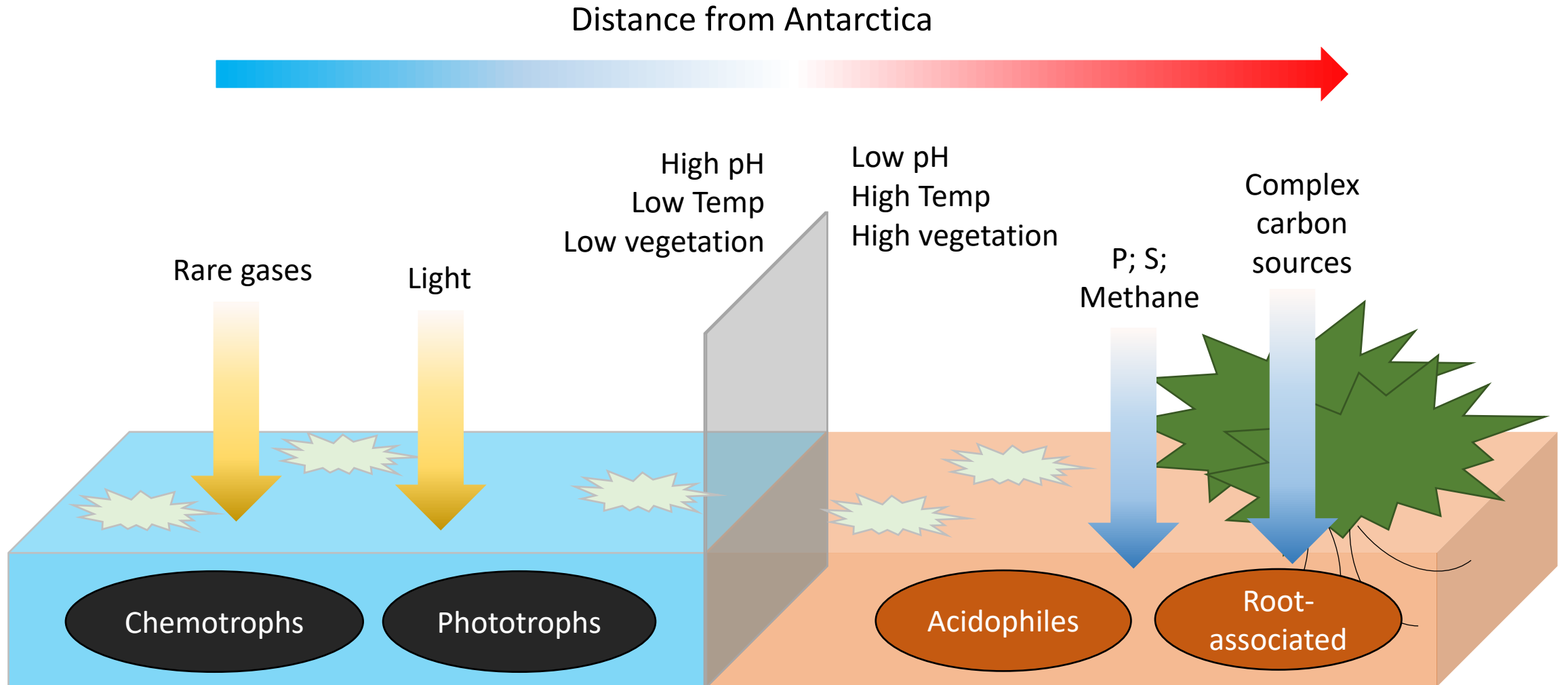
- Genes involved in phototrophy and chemotrophy are over-represented in Maritime/Continental islands.
- Genes associated with degradation of complex plant materials are over-represented in sub-Antarctic islands.
- Evidence of functional selection by the environment.

Novelty in the island microbiomes

- Screening metagenomes for novel genes involved in ecosystem services (eg. RuBisCo; Nife hydrogenases, CO dehydrogenases).
- Several potential novel RuBisCo families.
- New sub-clades within the RuBisCo IE family.
- RuBisCo IE are high affinity CO/CO₂ fixers that use H₂ as energy source.



The picture so far ...



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