



Session 88: Human-environmental Interactions Along the Ancient Silk Roads 18th July 2023

Sébastien **Joannin**, Odile **Peyron**, Dilfuza **Egamberdieva**,
Shafag **Bayramova**, Jahongir **Alimov**, Xiaozhong **Huang**, Rafiq
Safarov, Imran **Muradi**, Shabnam **Isayeva**, Mary **Robles**,
Amy **Cromartie**, Suzanne **Leroy**, Salomé **Ansanay-Alex**,
Elshan **Abdullayev**, Sayyara **Ibadullayeva**, Parvana
Garakhani, Fahu **Chen** and Guillemette **Ménot**.



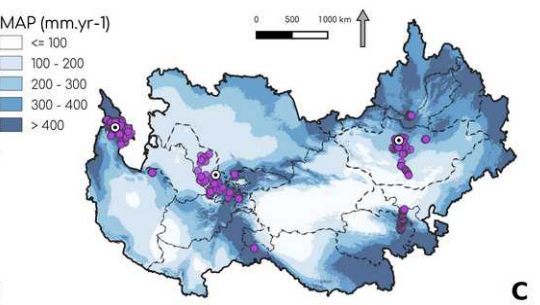
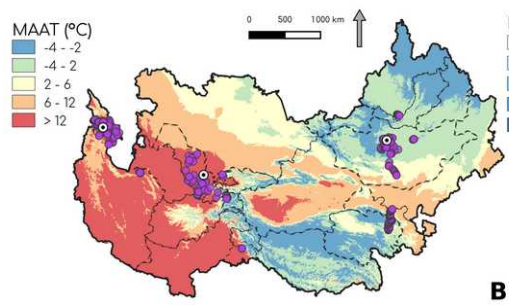
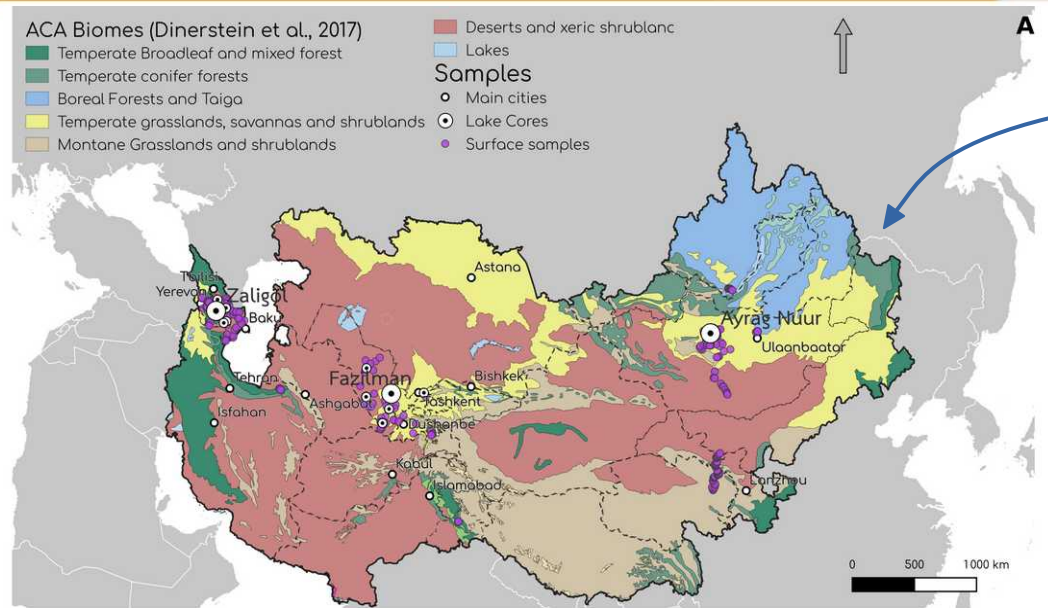
**First surface sample dataset for pollen transfer functions and biomarkers (brGDGTs)
covering the Caspian sea to Arid Central Asian area.**



Lucas Dugerdil

phD student,
UMR 5554 ISEM, Montpellier,
UMR 5276 CNRS - LGLTPE, ENS de Lyon

Study area: the Arid Central Asian bioclimate (ACAB)

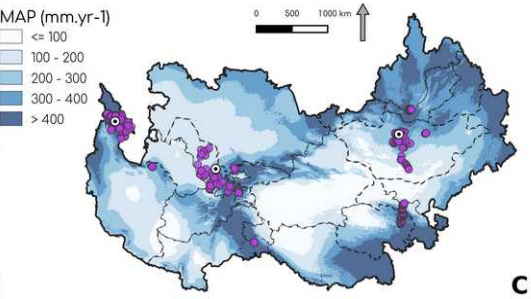
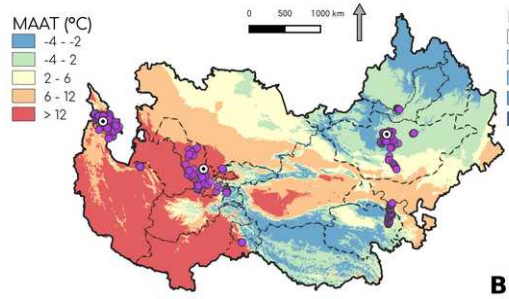
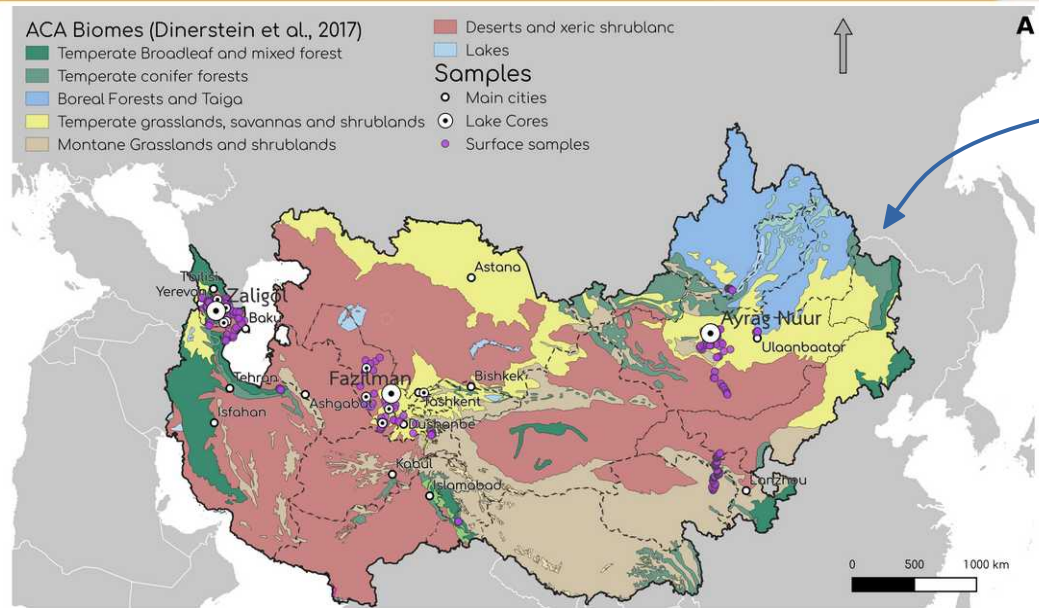


A: Biome map for ACA (Olson et al., 2001) with the surface samples and potential coring sites; **B:** Mean Annual Air Temperature; **C:** Mean Annual Precipitation (WorldClim 2, Fick and Hijmans 2017)



Context: Arid Central Asian biomes and climates

Looking the past for the future



Arid biome issues :

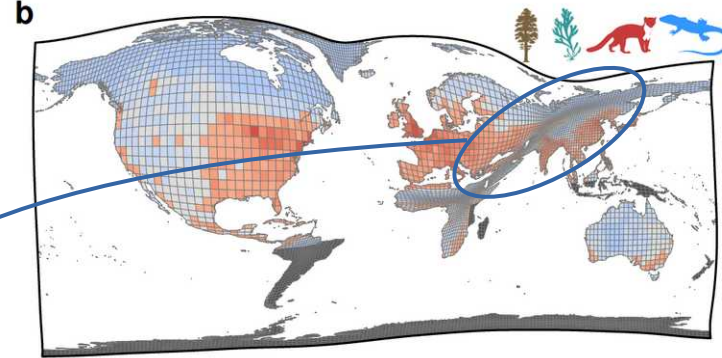
- Global aridification in the future is expected (Park et al., 2018)
- **Spreading** of arid environments (Huang et al., 2016) especially in **ACA** (Boonman et al., 2022)
- Following the ecosystem services and **resilience** studies (Carter et al., 2018) help land use management.
- Ecosystem **conservation** is a necessity (Dinerstein et al., 2017)

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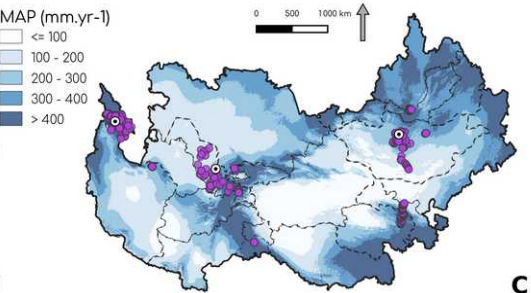
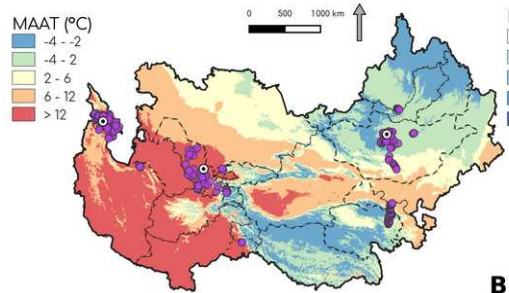
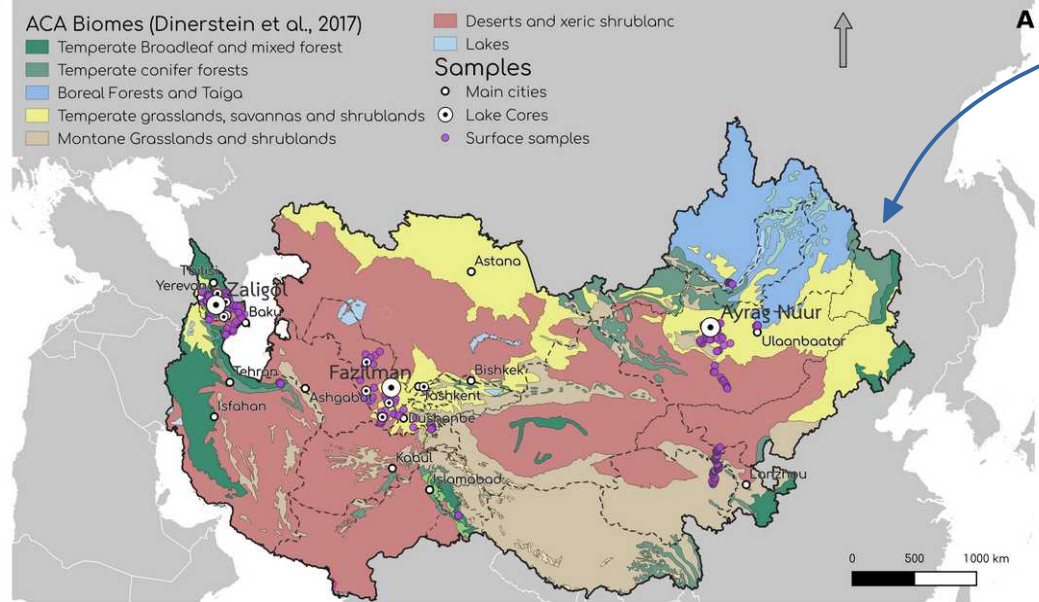


Context: Arid Central Asian biomes and climates

Looking the past for the future



Lenoir et al., 2020, Nature Ecology & Evolution



Arid biome issues :

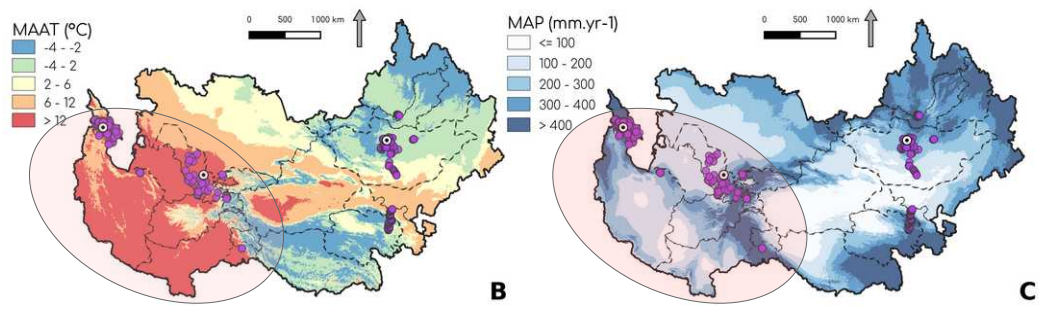
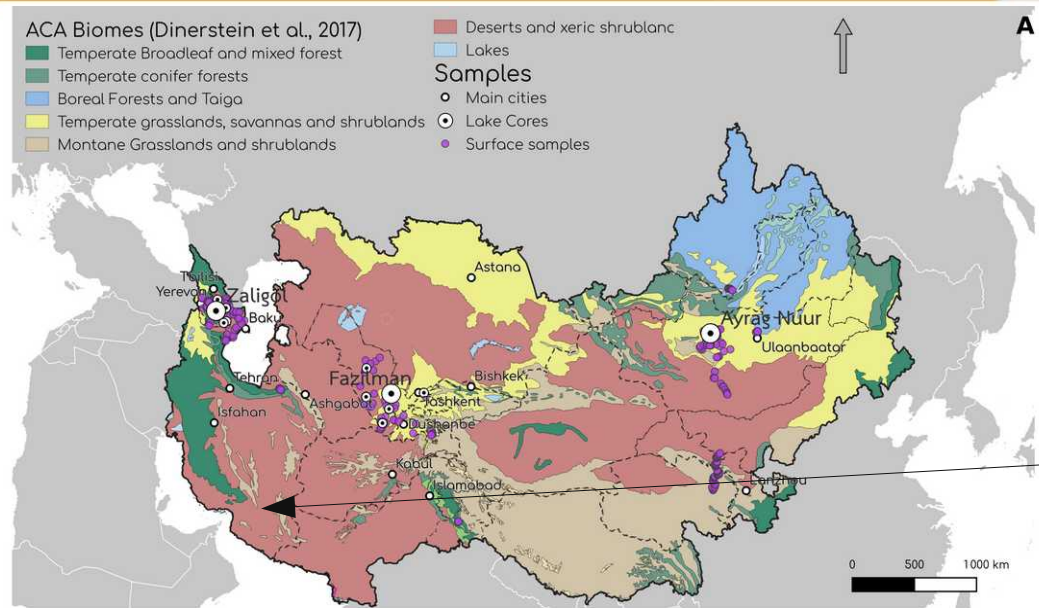
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- Ecosystem **conservation** is a necessity (Dinerstein et al., 2017)
- **Dramatically understudied**

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Context: Arid Central Asian biomes and climates

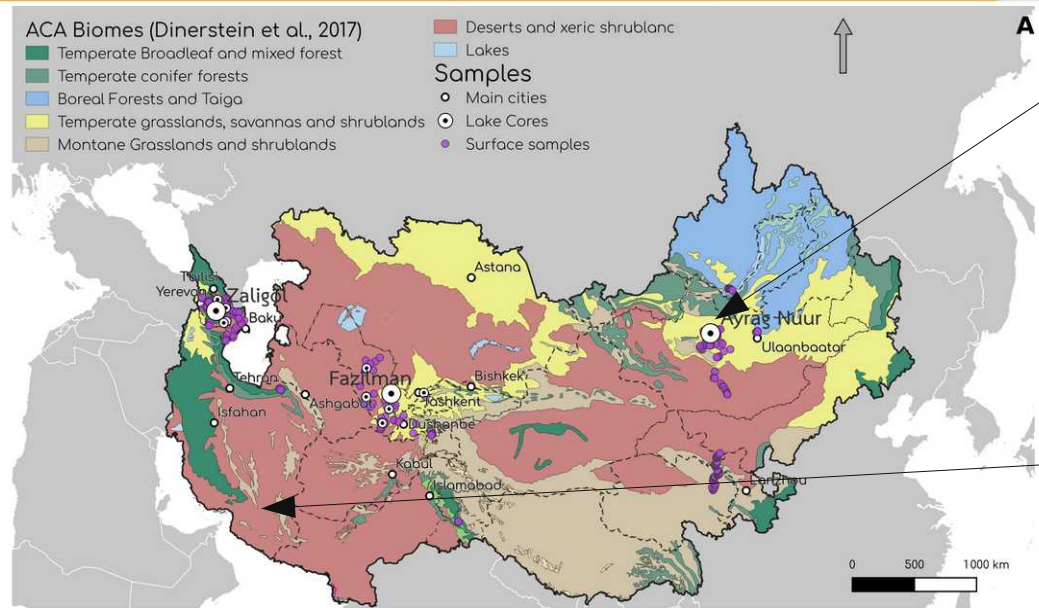
Cold steppes vs. warm steppes



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Context: Arid Central Asian biomes and climates

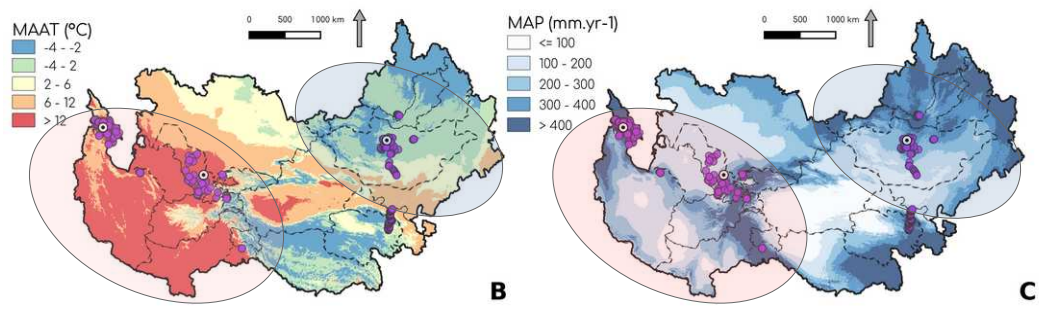
Cold steppes vs. warm steppes



Cold desert / steppe
(Mongolia, Continental China...)



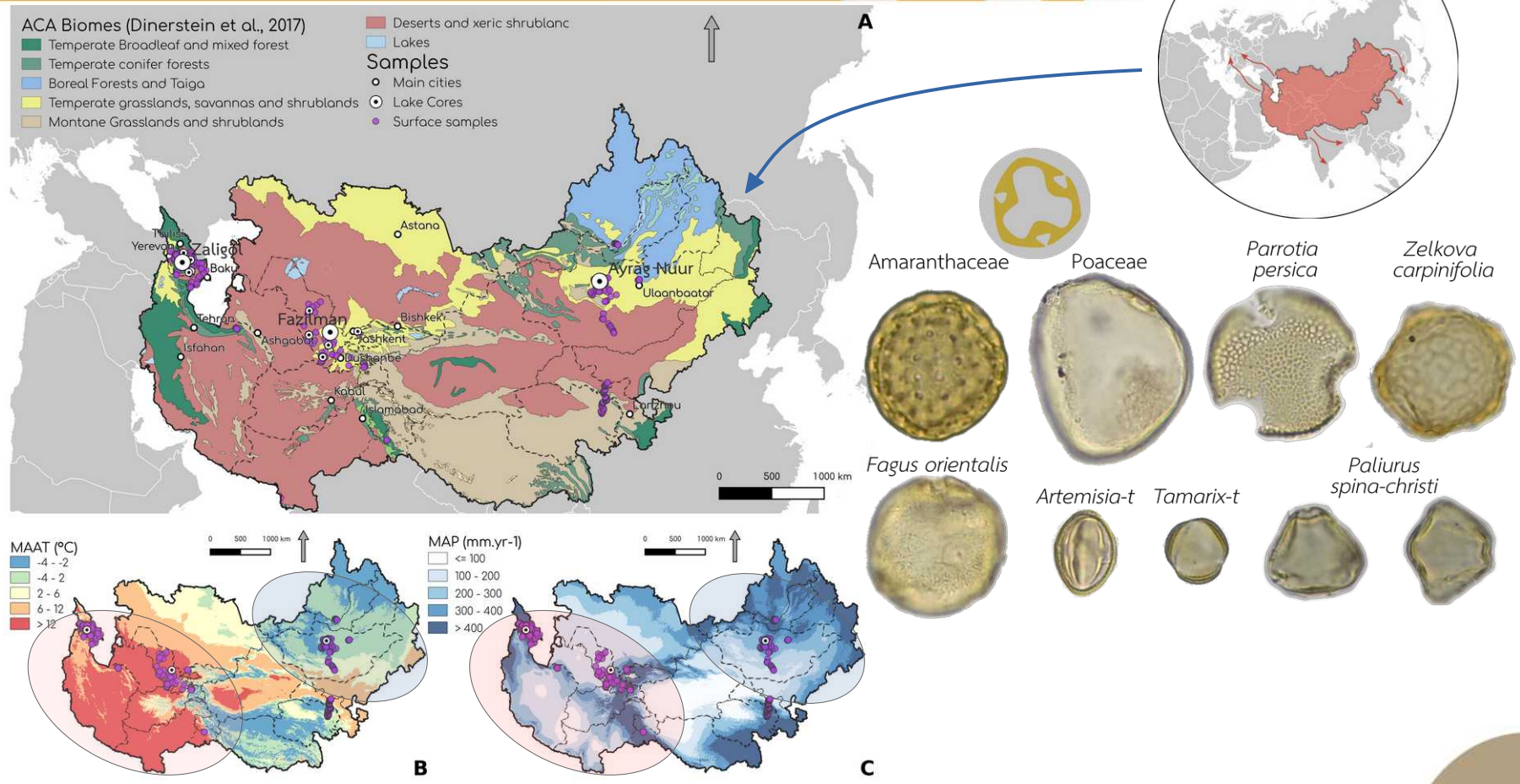
Warm desert / steppe
(Iran, Uzbekistan...)



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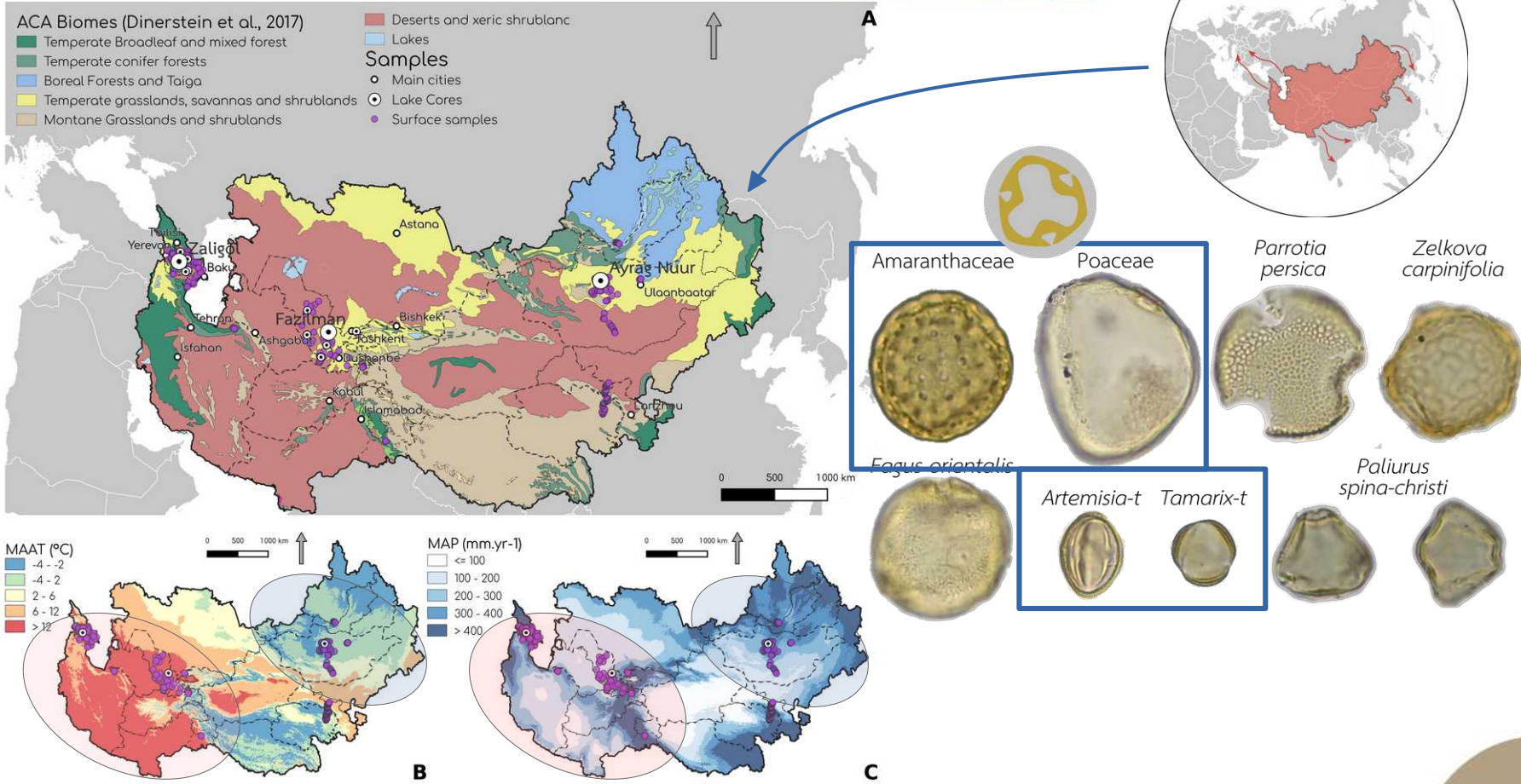


Context: Arid Central Asian biomes and climates



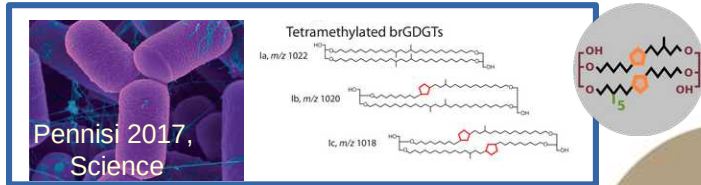
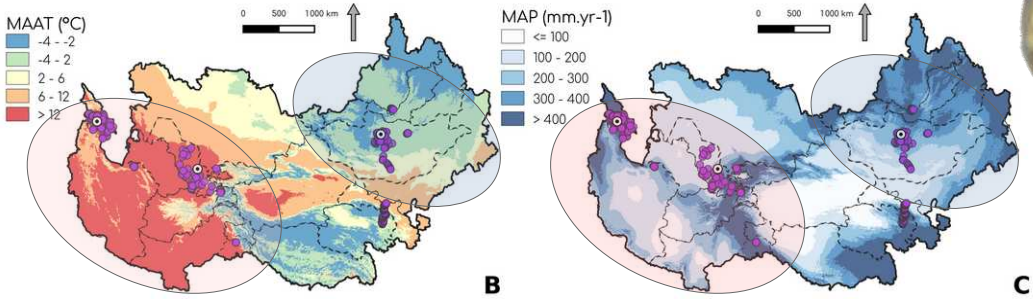
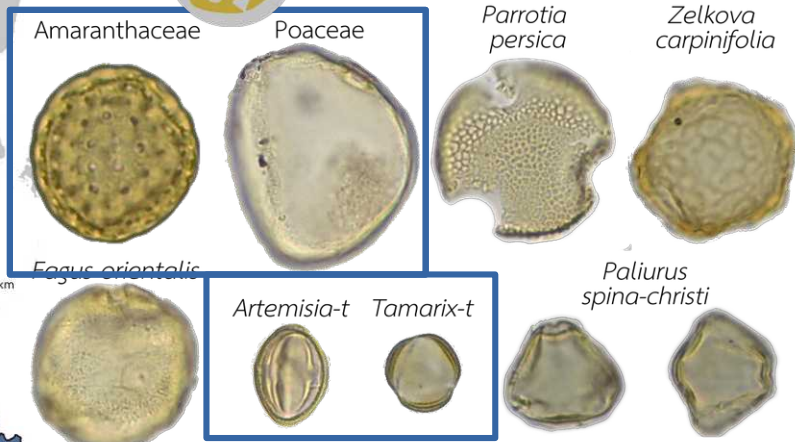
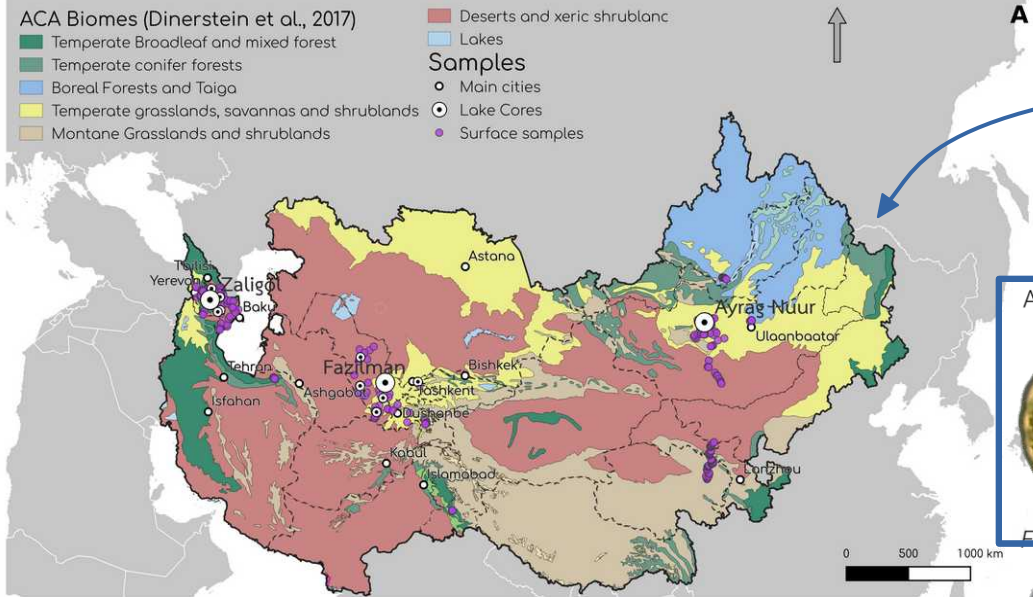
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Context: Arid Central Asian biomes and climates



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Context: Arid Central Asian biomes and climates



Pennisi 2017, Science

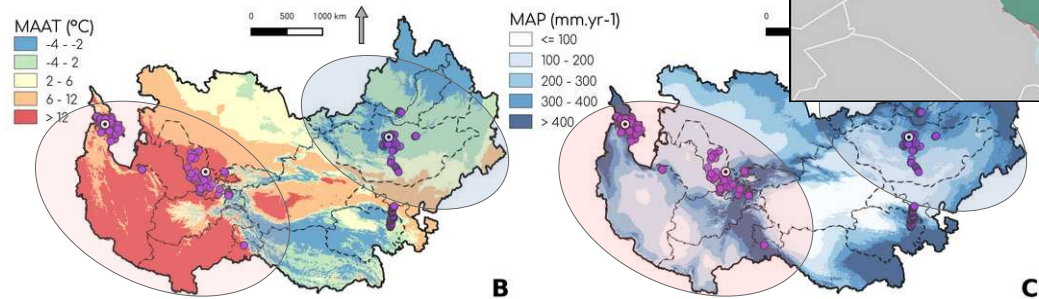
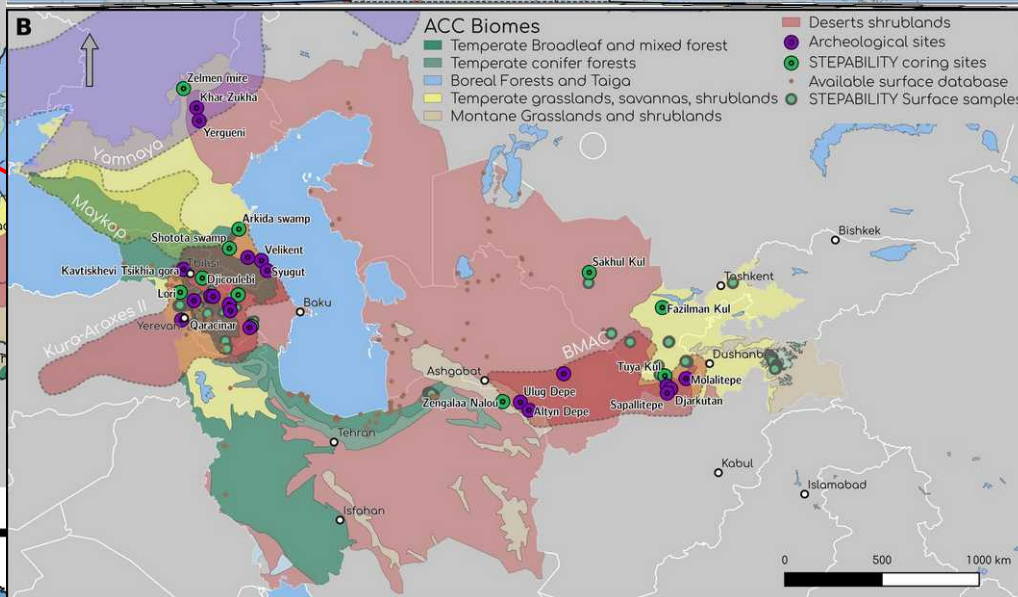
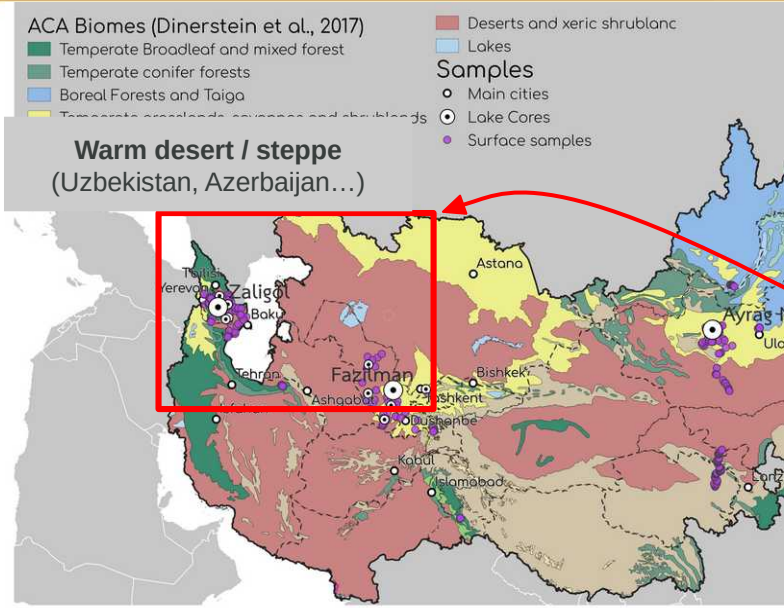
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ANR STEPABILITY: Steppe sustainability in a changing world

PhD thesis (2022-2024)

Human societies link



A: Map of the Bronze age main human societies in Eurasia. **B:** Circum-caspian area presenting the main Bronze age societies, the biomes and the available archeological sites and lake coring for STEPABILITY project;



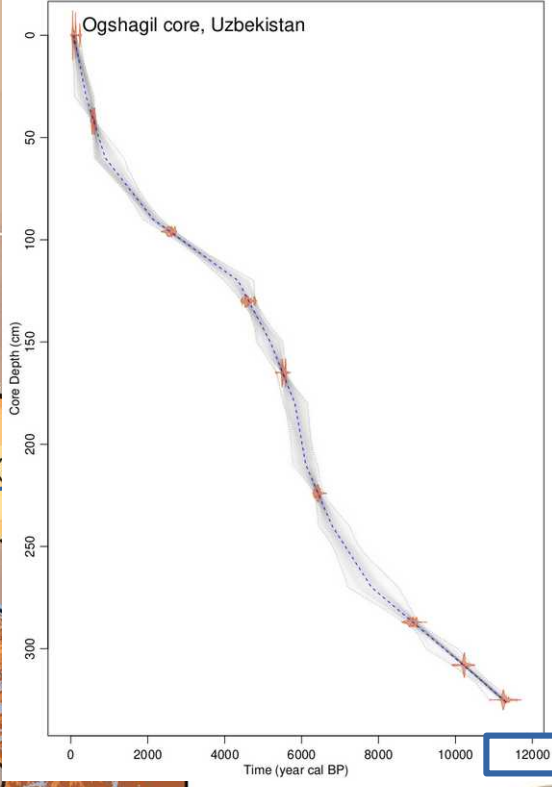
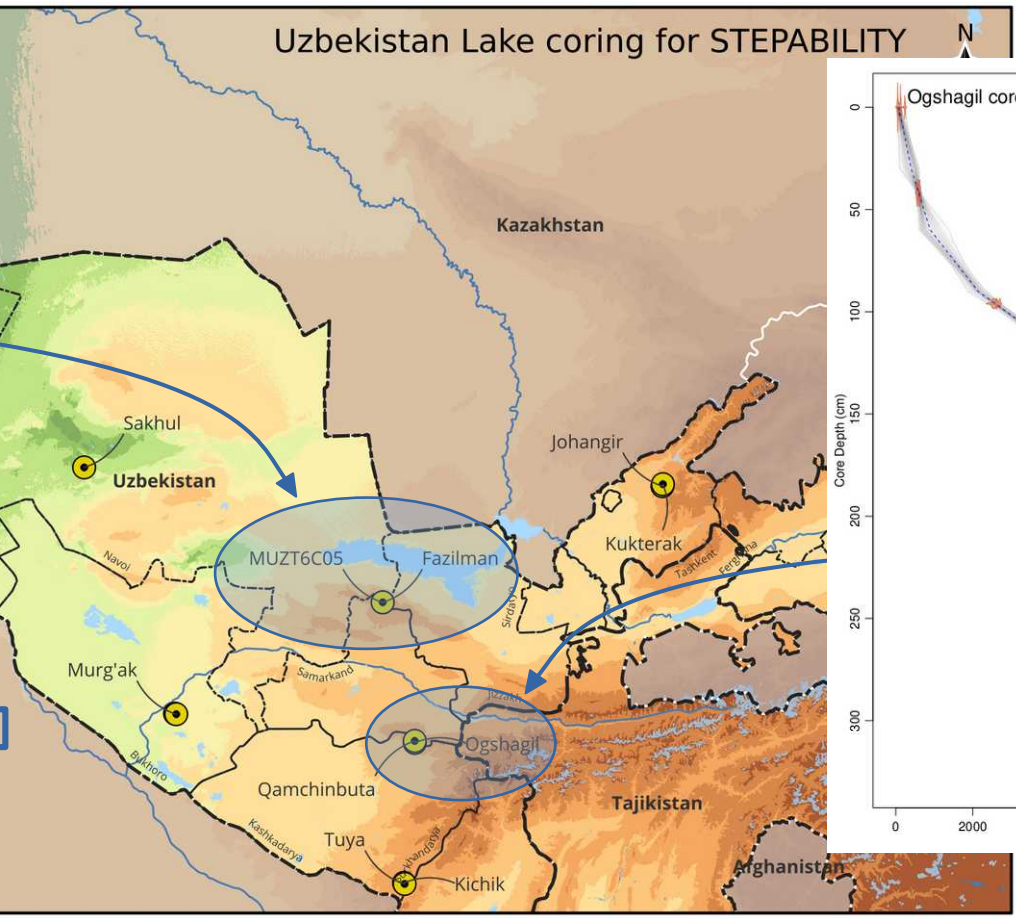
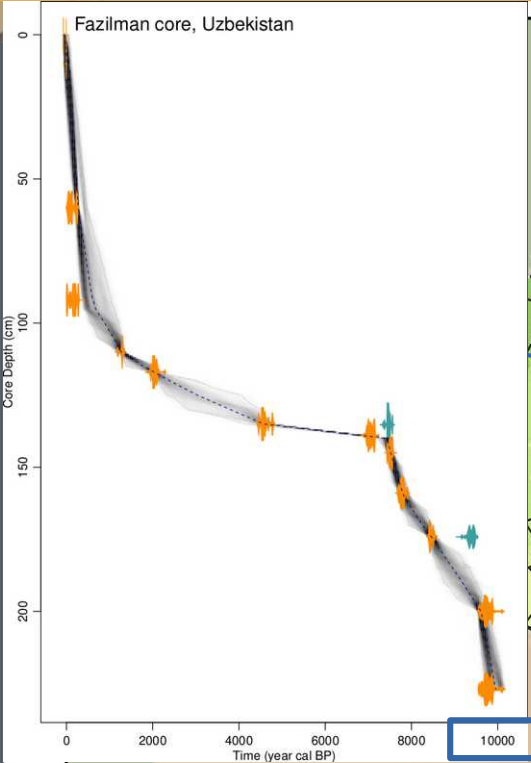
Uzbekistan and Tajikistan samples



A: Uzbekistan and Tajikistan map of elevation with the location of the (14 coring points).



Uzbekistan and Tajikistan samples



A: Uzbekistan and Tajikistan map of elevation with the location of the (14 coring points).

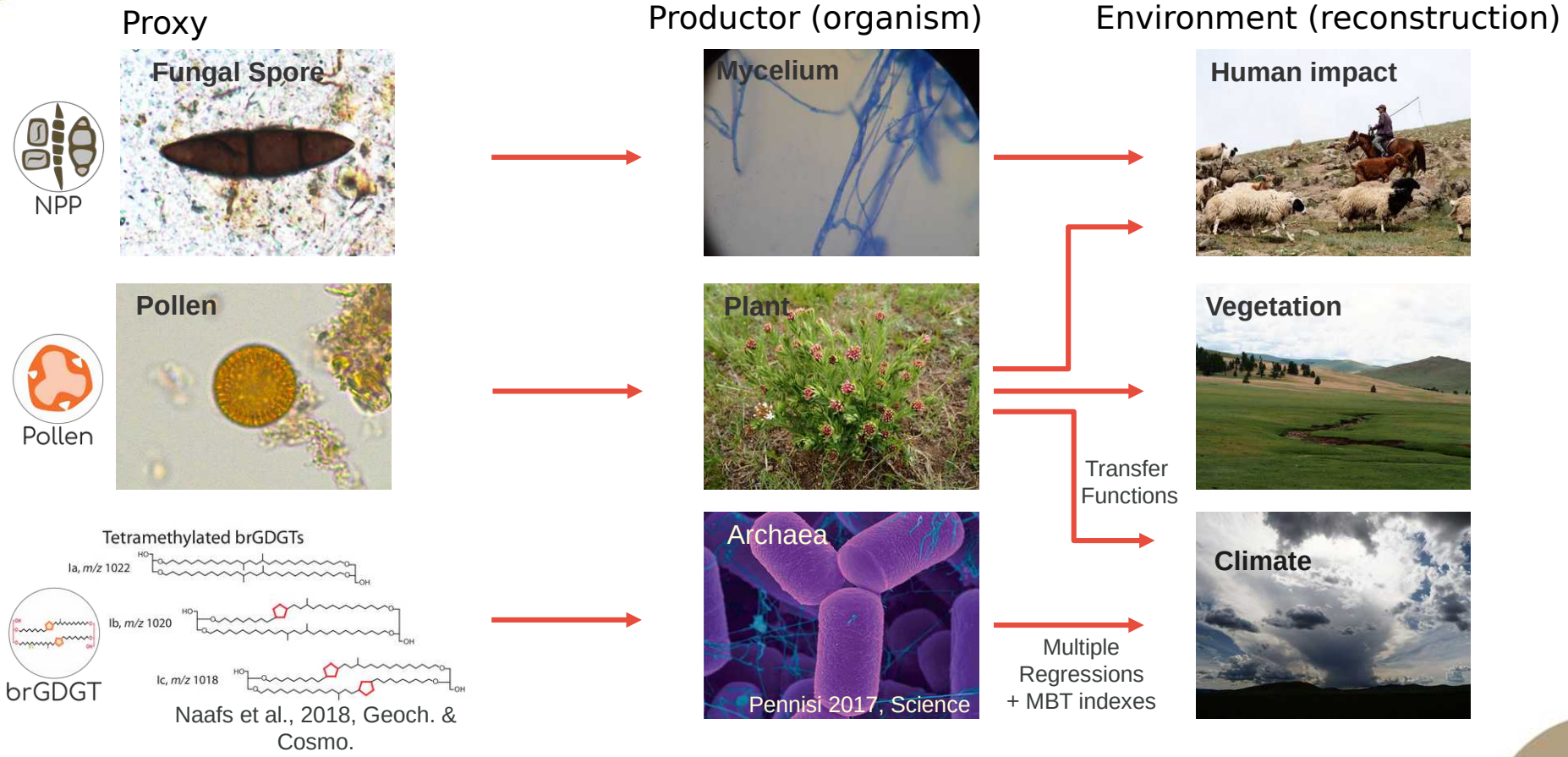




Methods

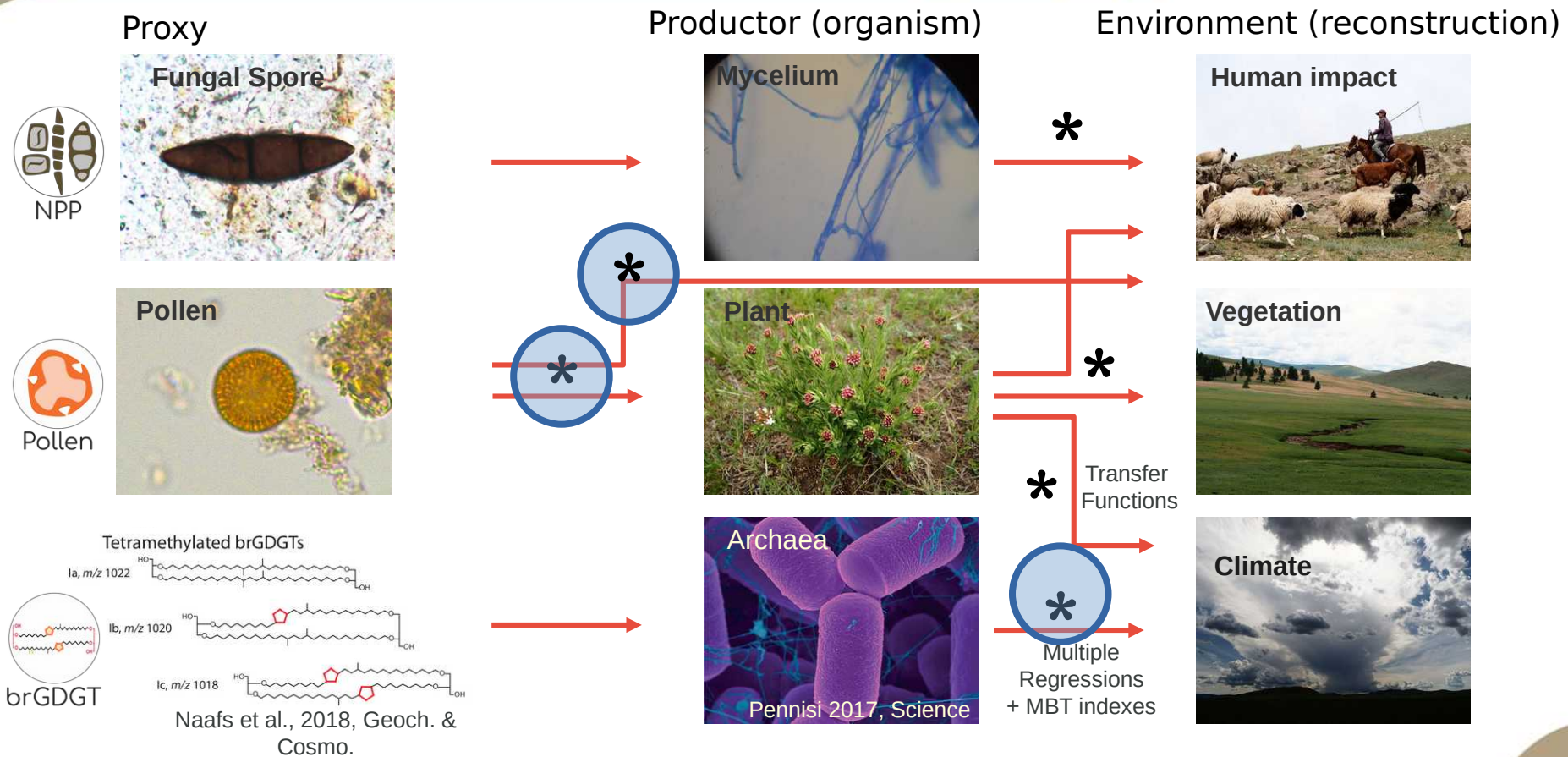
How to properly reconstruct climate, human impact and vegetation changes along the Holocene in drylands ?

Environmental proxies



Schematic diagram of the proxy-environment reconstruction relationship.

Environmental proxies



Schematic diagram of the proxy-environment reconstruction relationship.

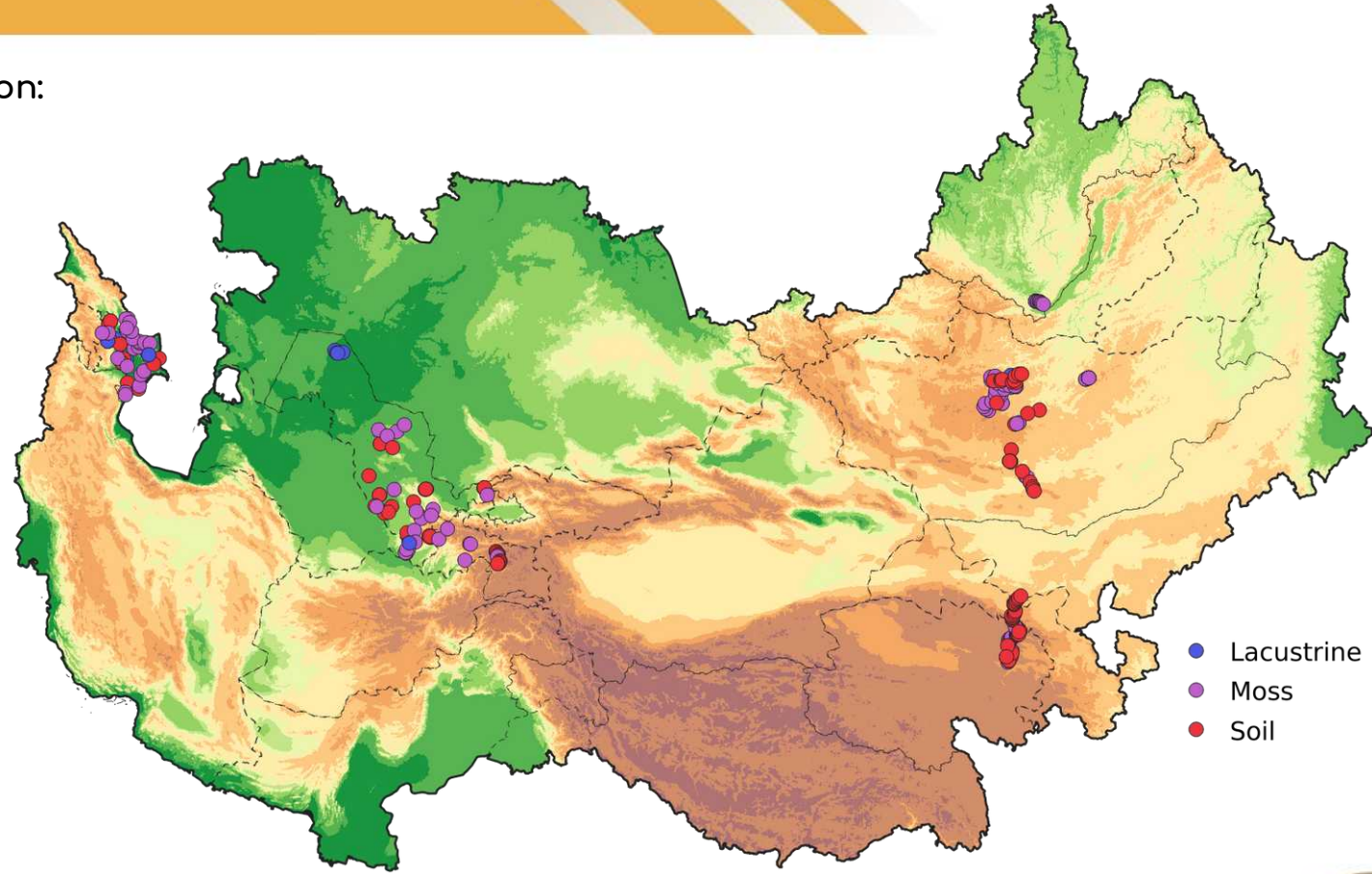


Materials in ACA (Uzbekistan, Tajikistan & Azerbaijan)

Pamir mountains, Tajikistan, August 2021

Surface samples database

The surface sample location:

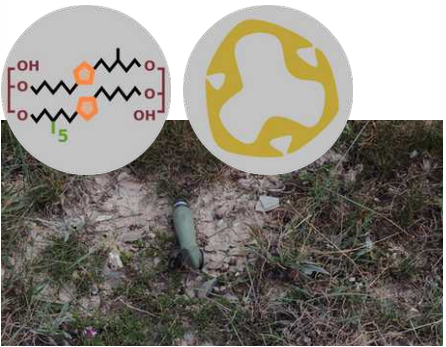


ACADB surface samples $n = 173$.



Surface samples database

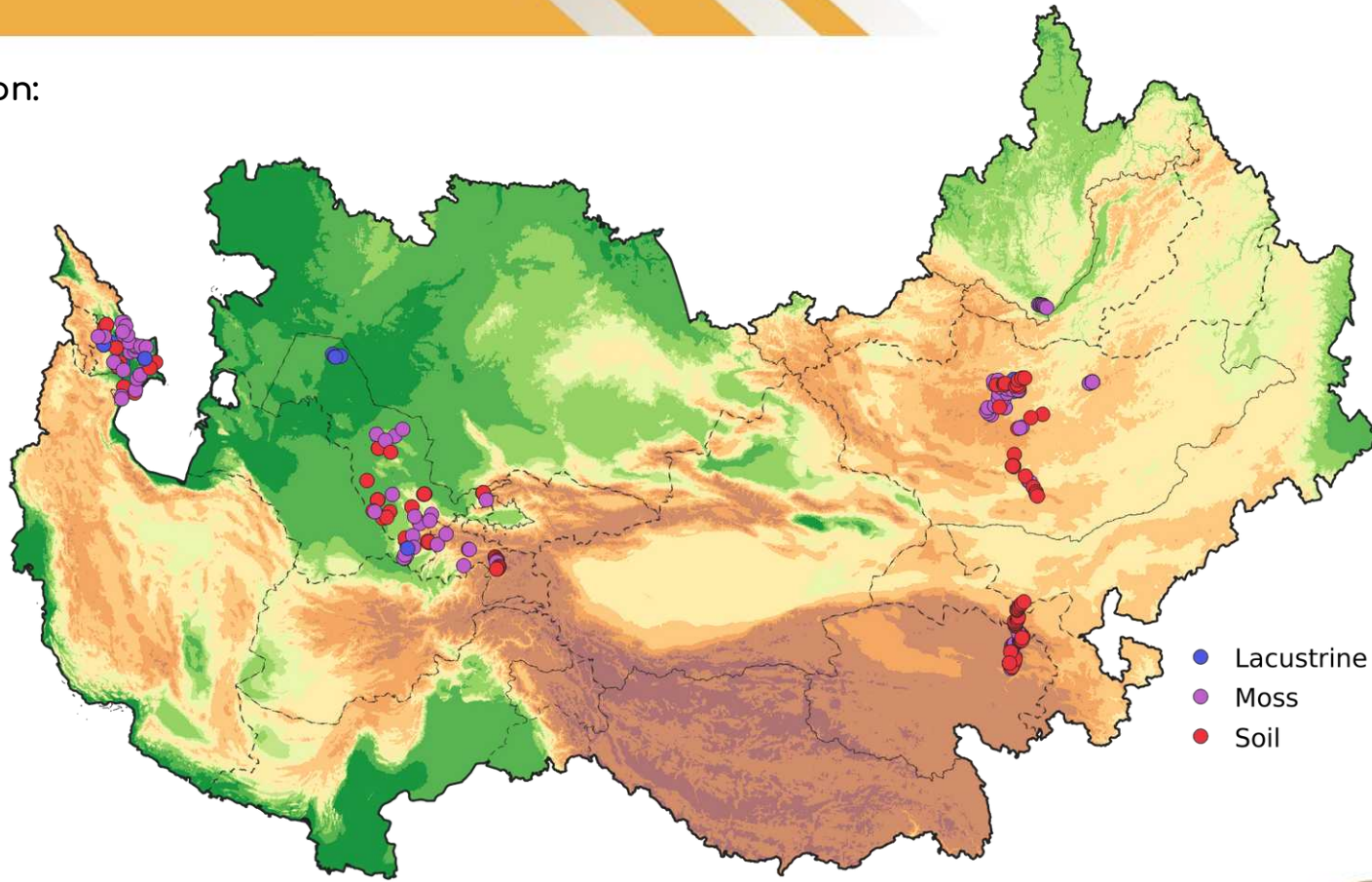
The surface sample location:



BrGDGTs et pollen surface samples



Vegetation plots

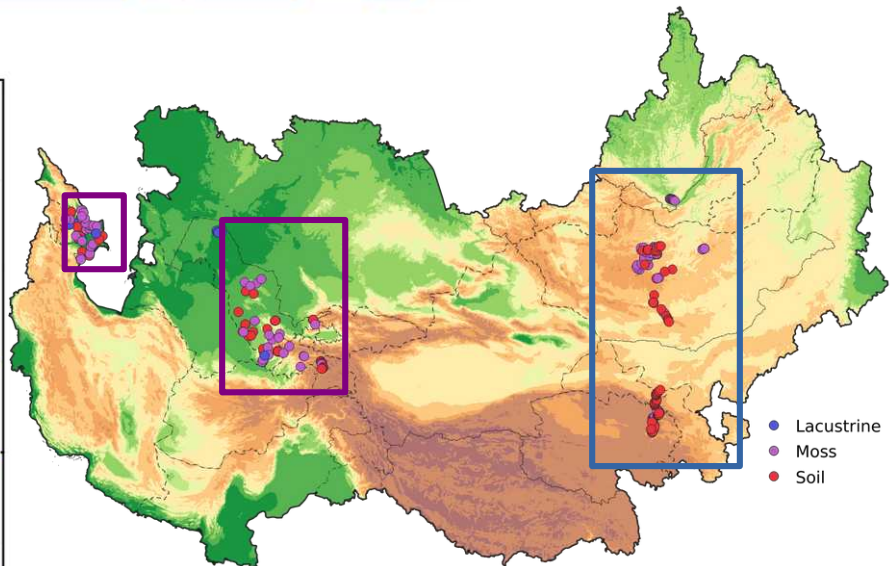
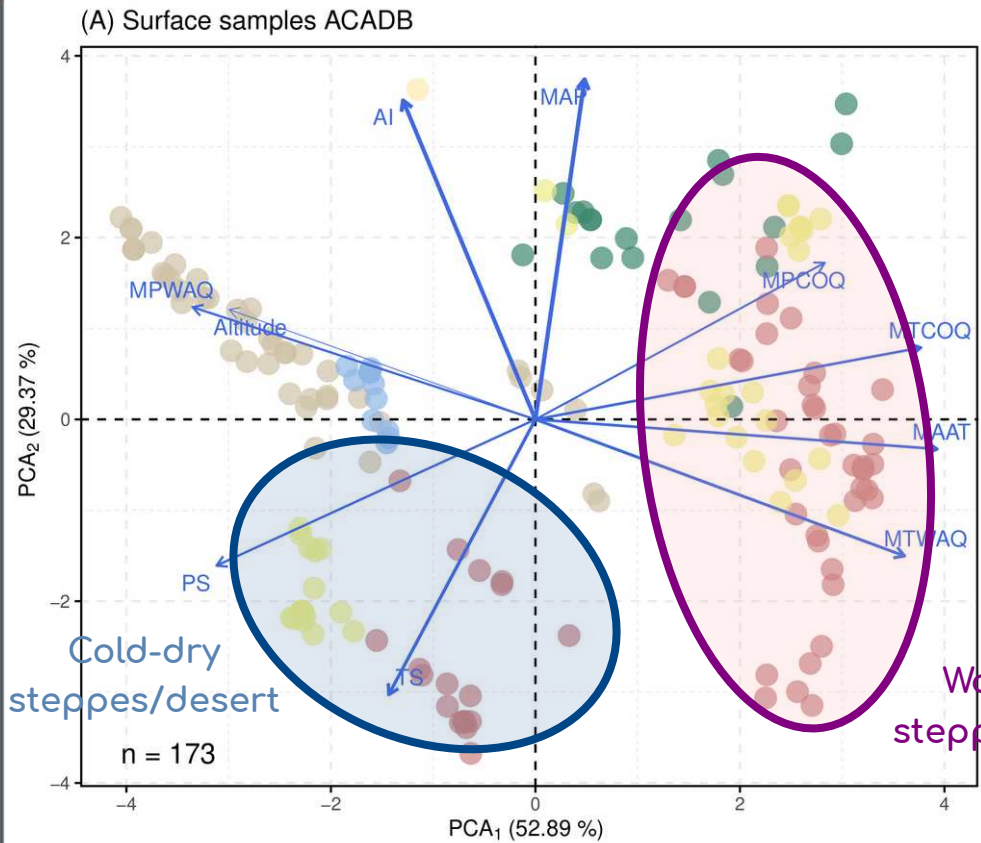


- Lacustrine
- Moss
- Soil

ACADB surface samples n = 173.



Surface samples database



Surface samples climate parameters variance space (PCA).





First prospect for brGDGT calibrations in ACA

Pamir mountains, Tajikistan, August 2021

Surface samples database

GDGTs theoretical background

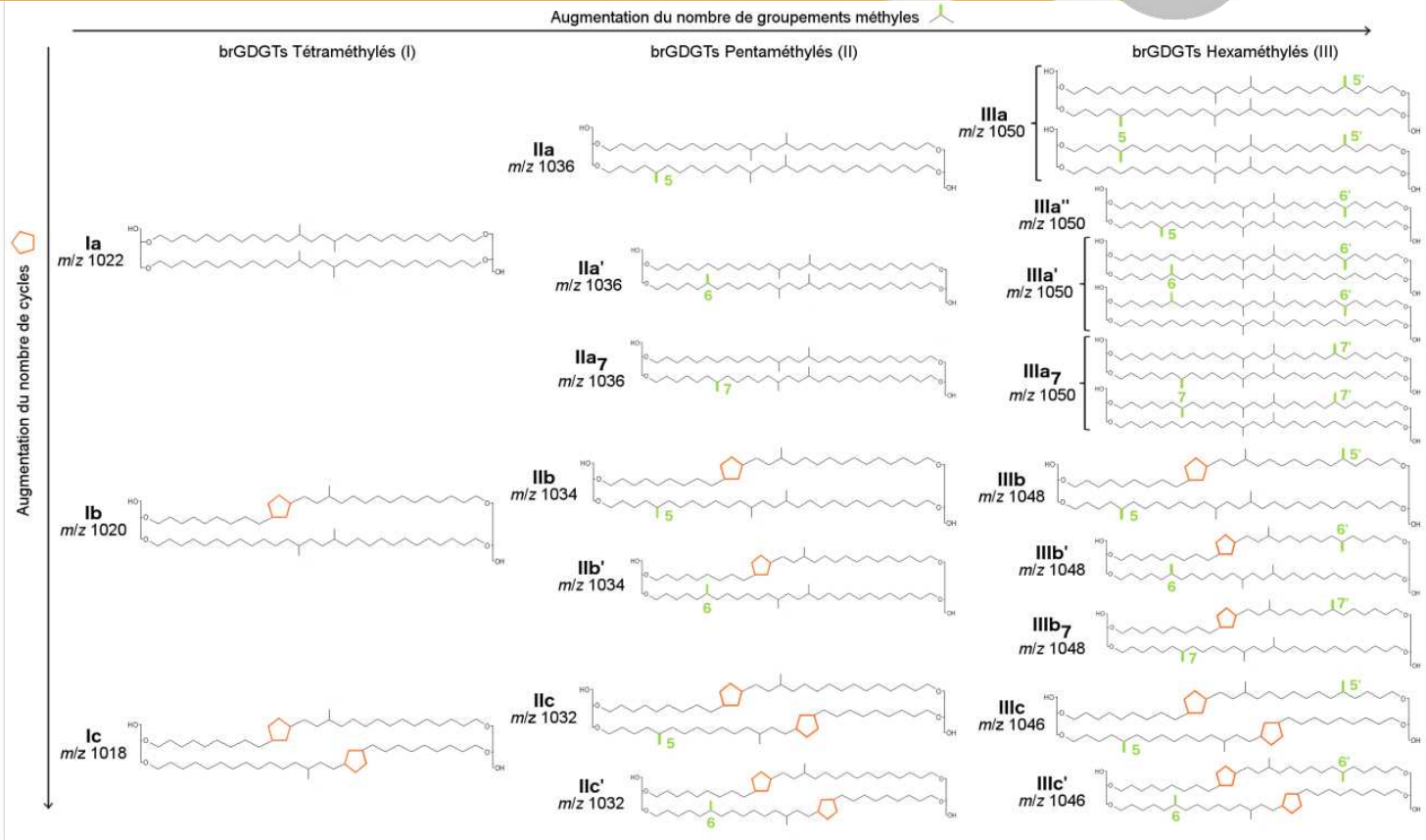
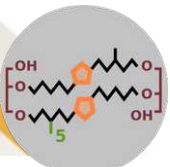
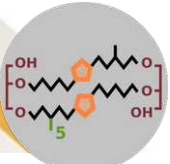


FIGURE 1.7 – Structure des différents tétraéthers de glycérol ramifiés.



Surface samples database

GDGTs theoretical background



MAAT
methyls

pH

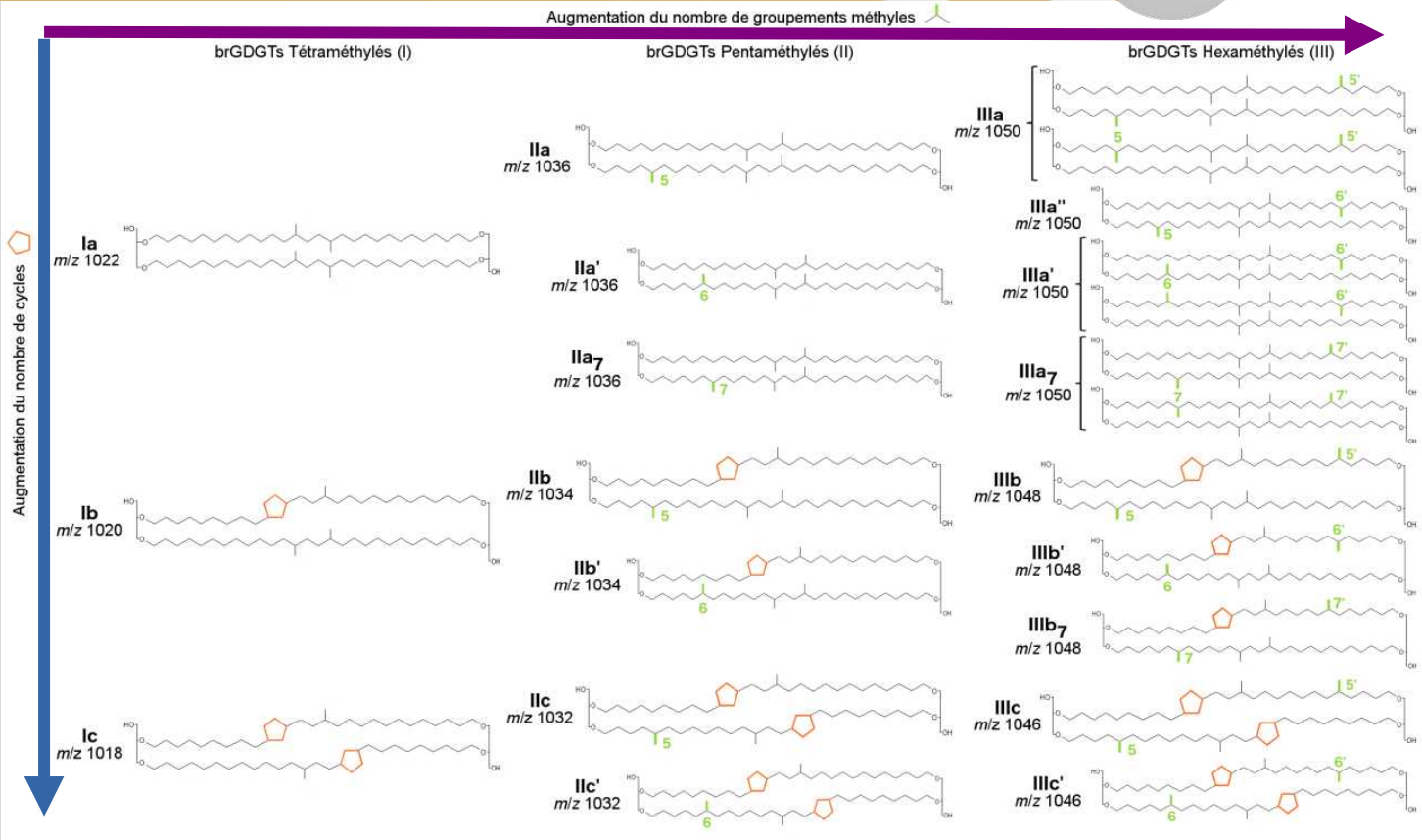


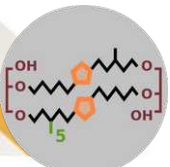
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Martin et al., (2018)

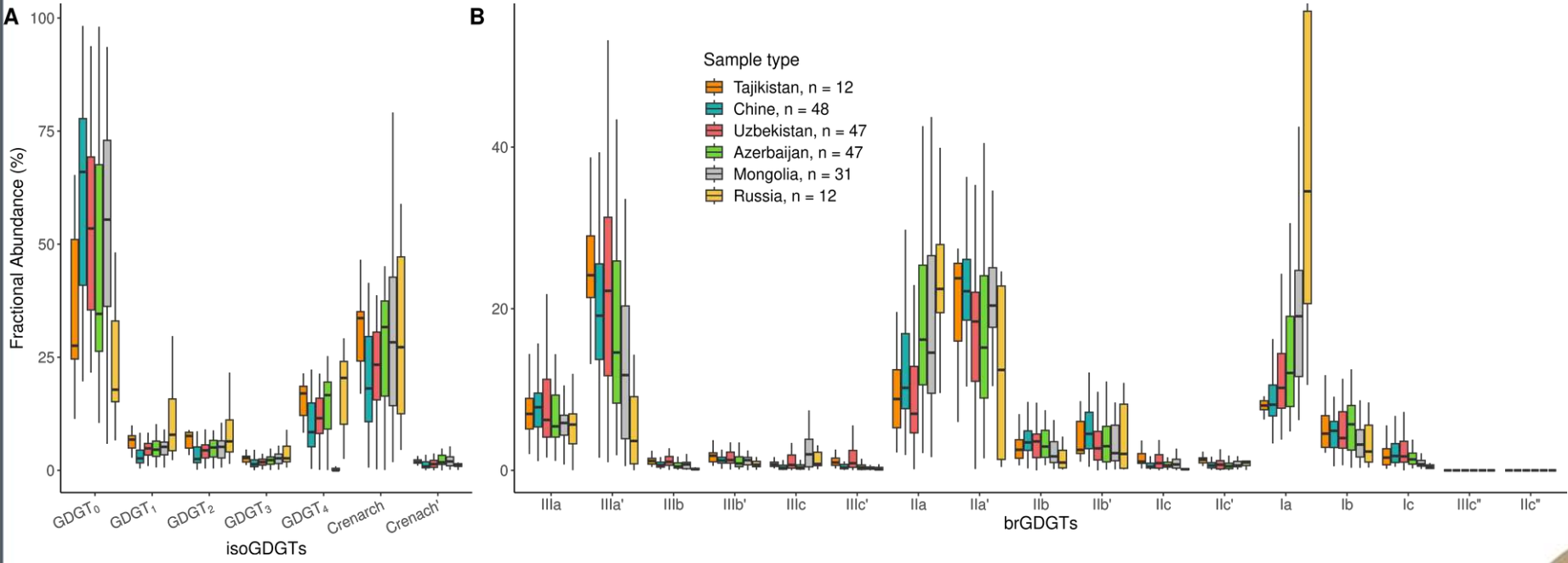


Surface samples database

GDGTs integrations and calibrations



Huge variability:
- Biogeography (bacterial community)

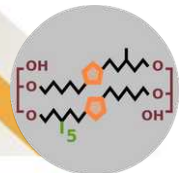


Fractional abundances of (A) isoGDGTs and (B) brGDGTs clustered by **country** of origin.



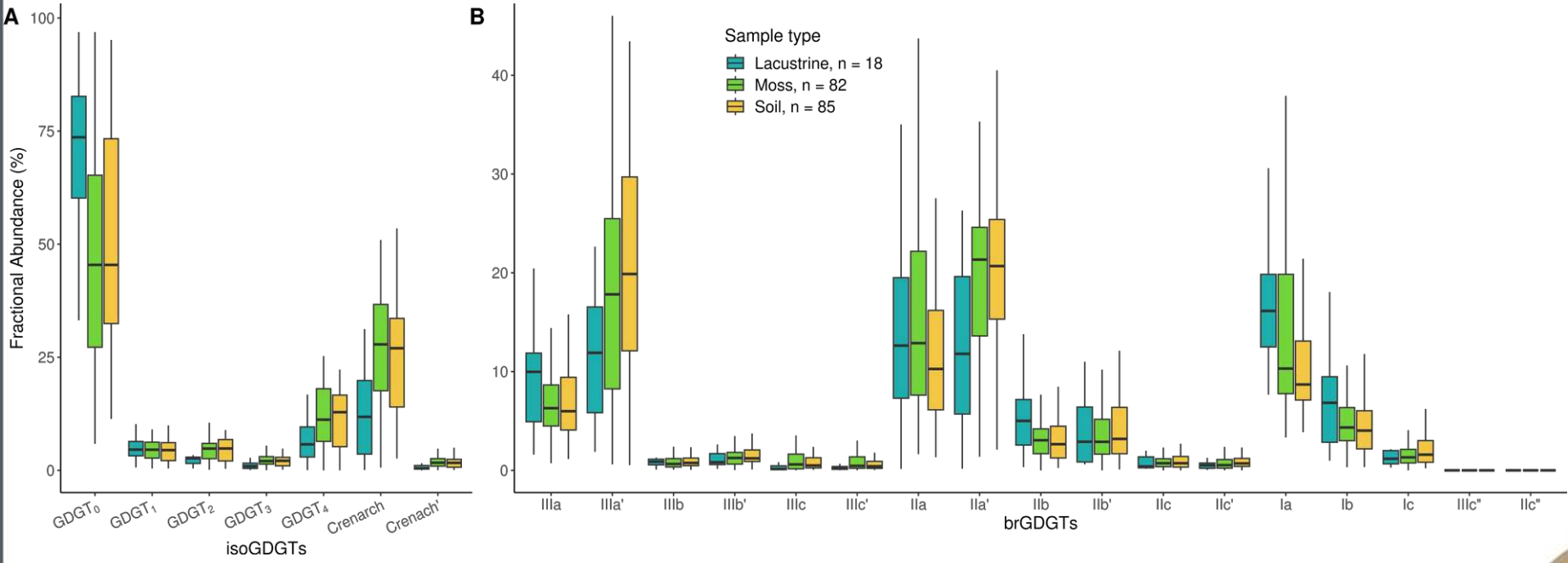
Surface samples database

GDGTs integrations and calibrations



Huge variability:

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- Sample type (soil chemistry, pH & bacterial community)

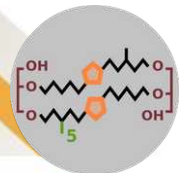


Fractional abundances of (A) isoGDGTs and (B) brGDGTs clustered by **sample types**.



Surface samples database

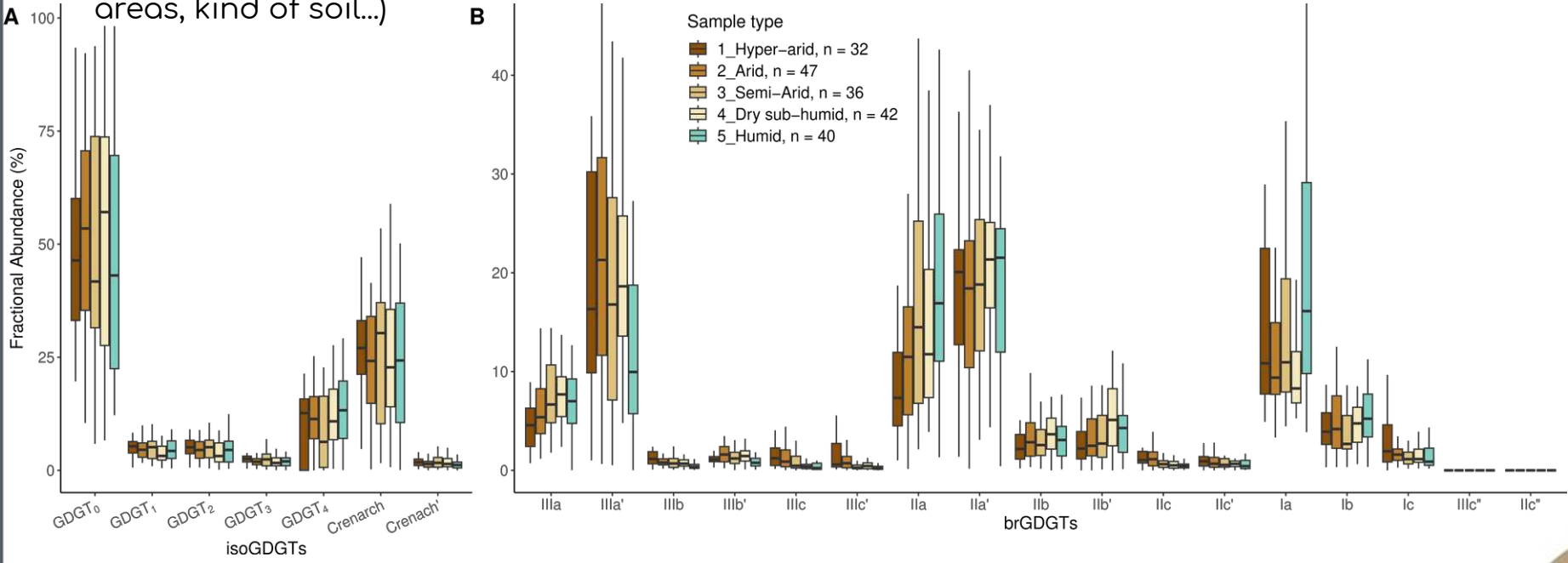
GDGTs integrations and calibrations



Huge variability:

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- Sample type (soil chemistry, pH & bacterial community)
- Climatic impact

That is why we need different calibration (made on selected samples types, areas, kind of soil...)

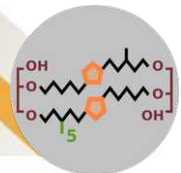


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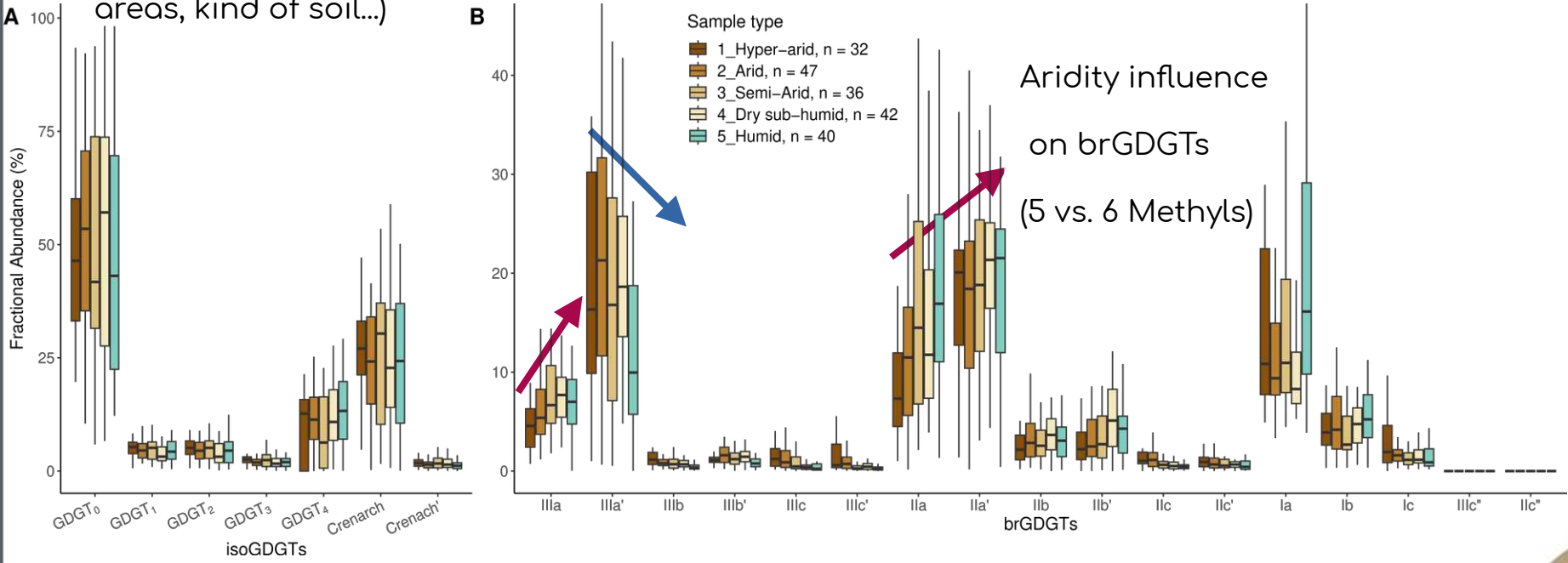
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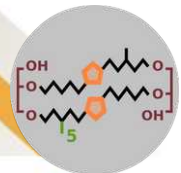


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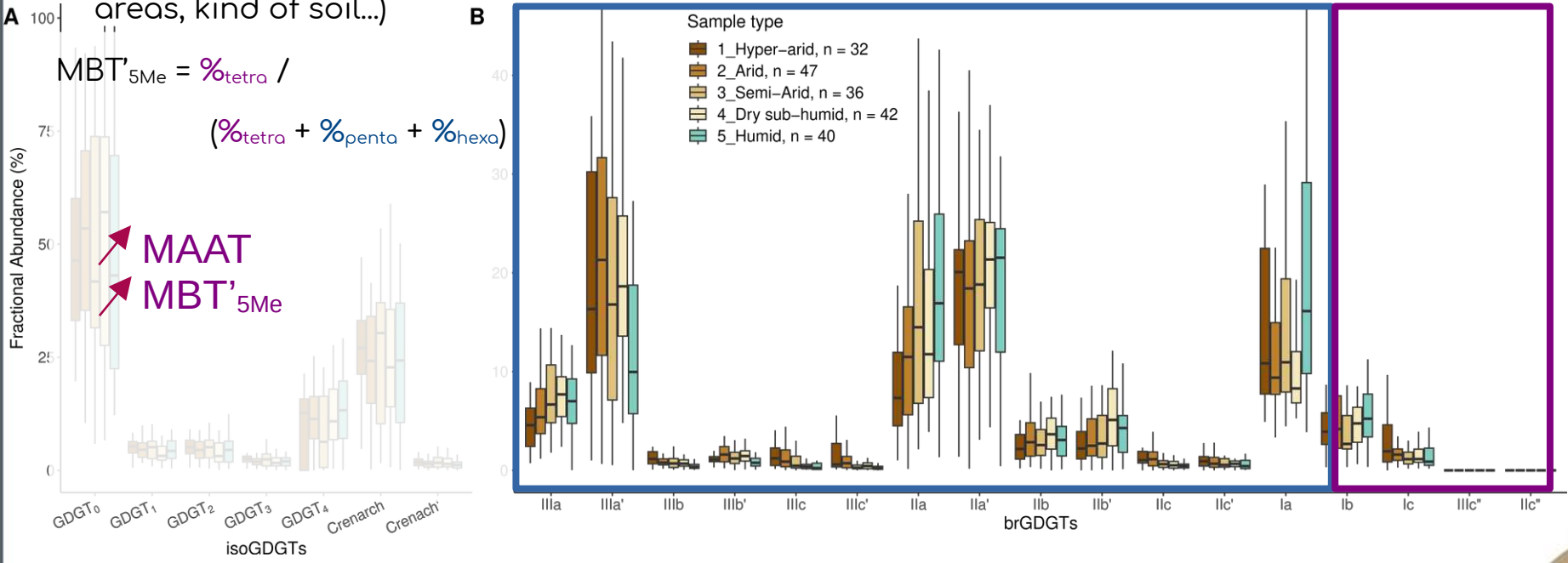
GDGTs integrations and calibrations



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Surface samples database

GDGTs integrations and calibrations

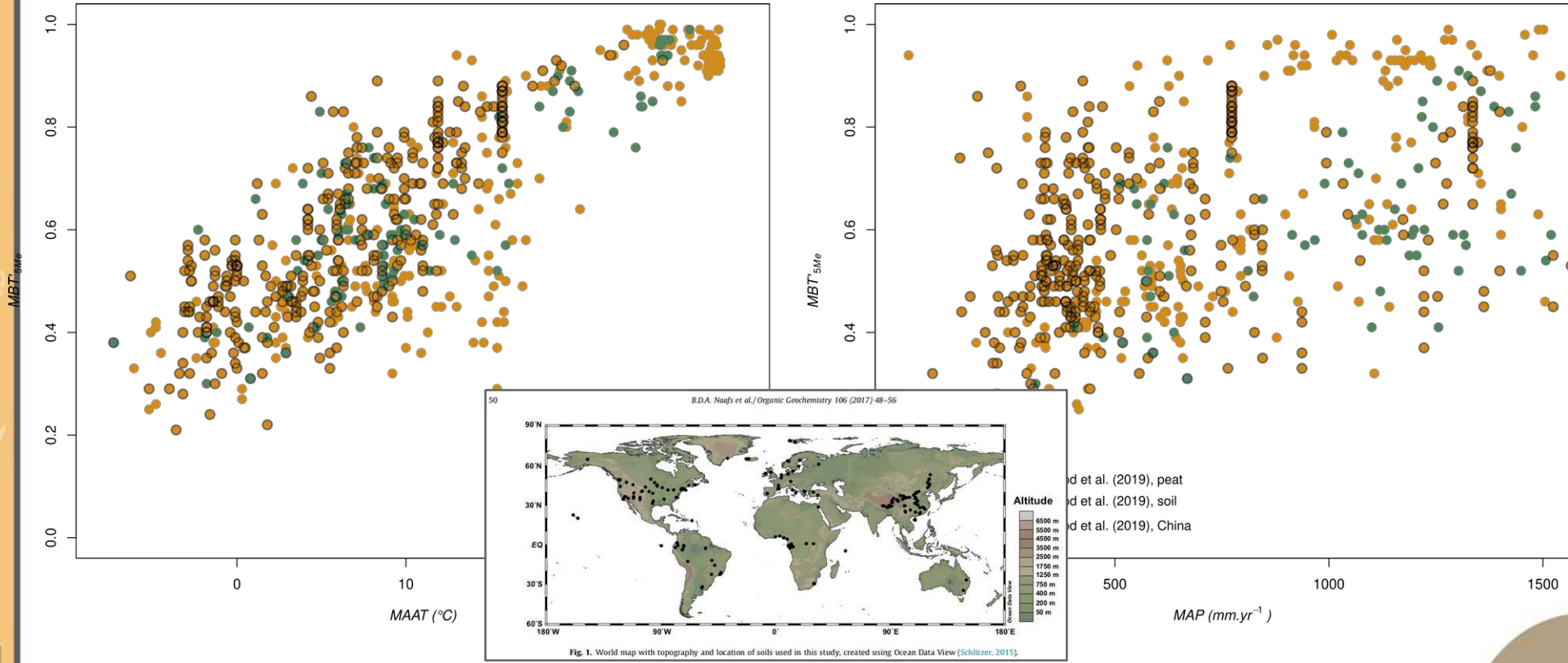
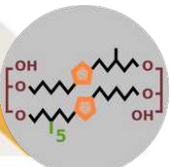


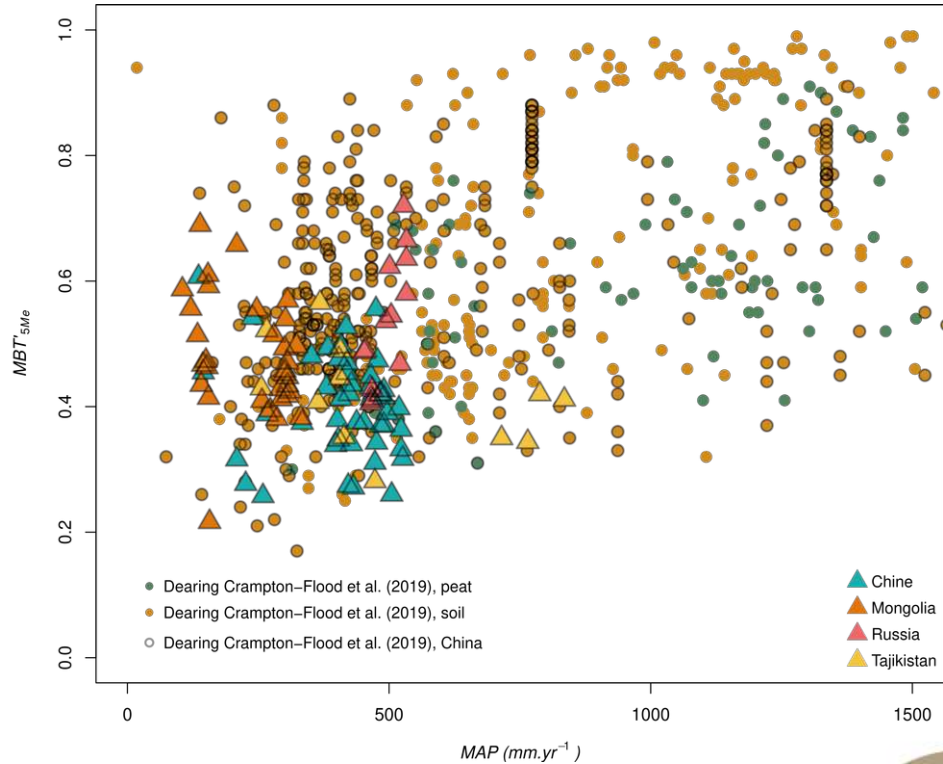
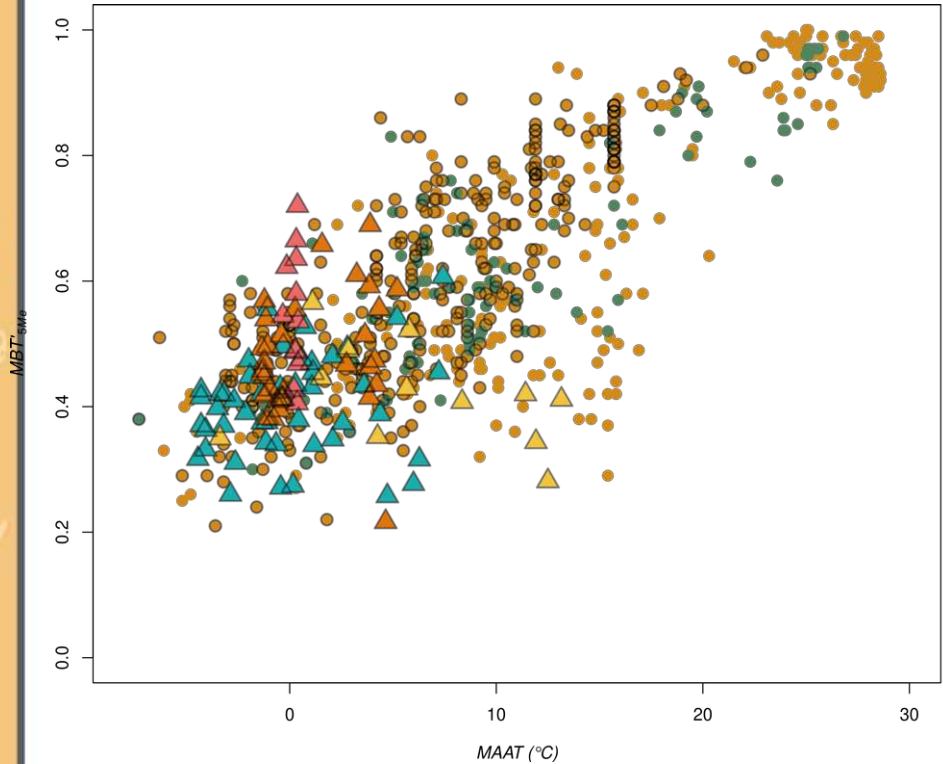
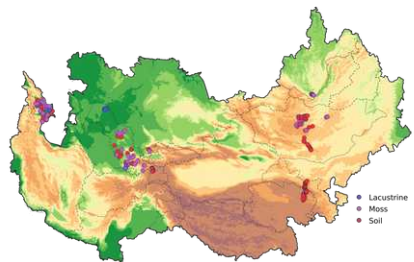
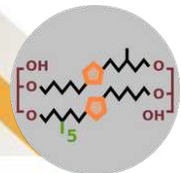
Fig. 1. World map with topography and location of soils used in this study, created using Ocean Data View (Schlitzer, 2015).

Linear relation between (A) MAAT, (B) MAP and MBT'5Me. Surface samples from Dearing-Crampton-Flood et al., (2019).



Surface samples database

GDGTs integrations and calibrations

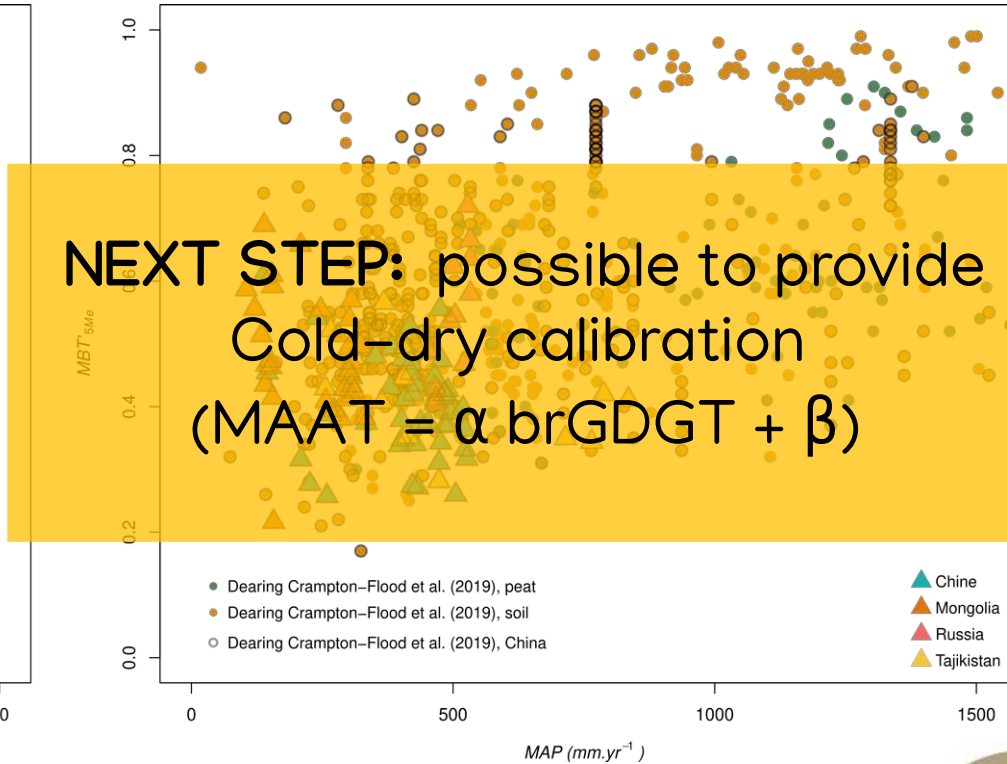
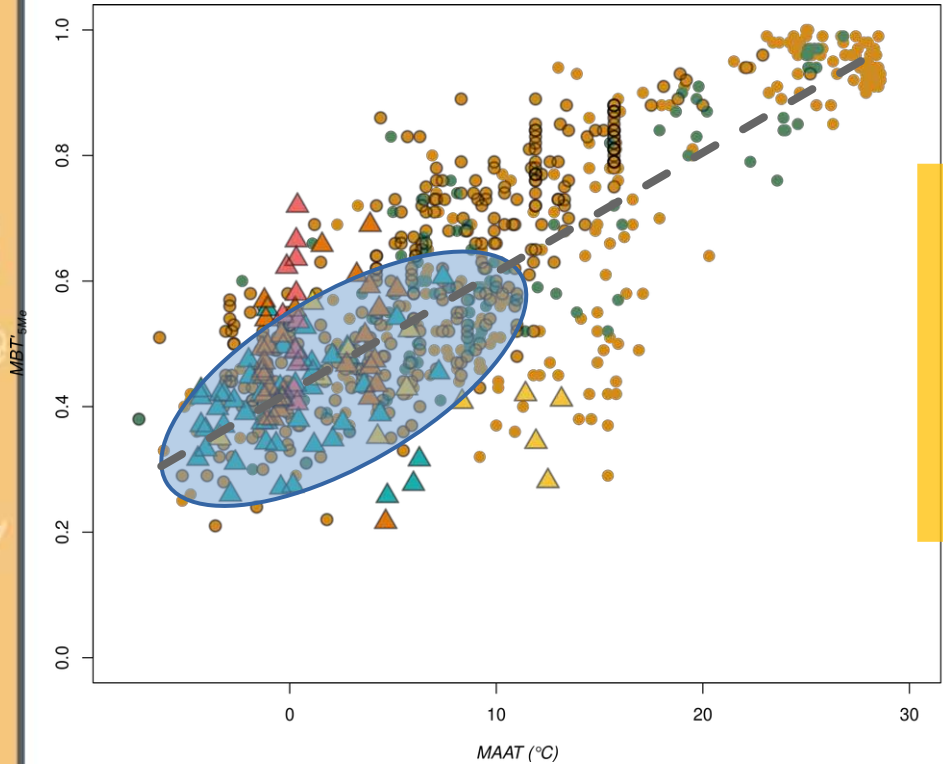
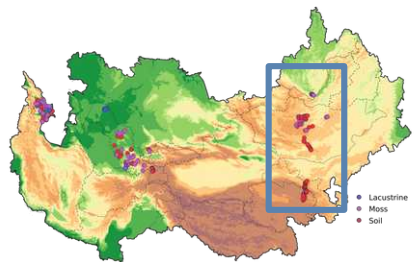
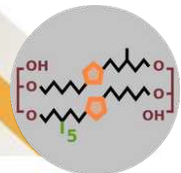


Linear relation between **(A)** MAAT, **(B)** MAP and MBT'_{5Me} . Surface samples from Dearing-Crampton-Flood et al., (2019) and ACA surface samples clustered by **country**.



Surface samples database

GDGTs integrations and calibrations

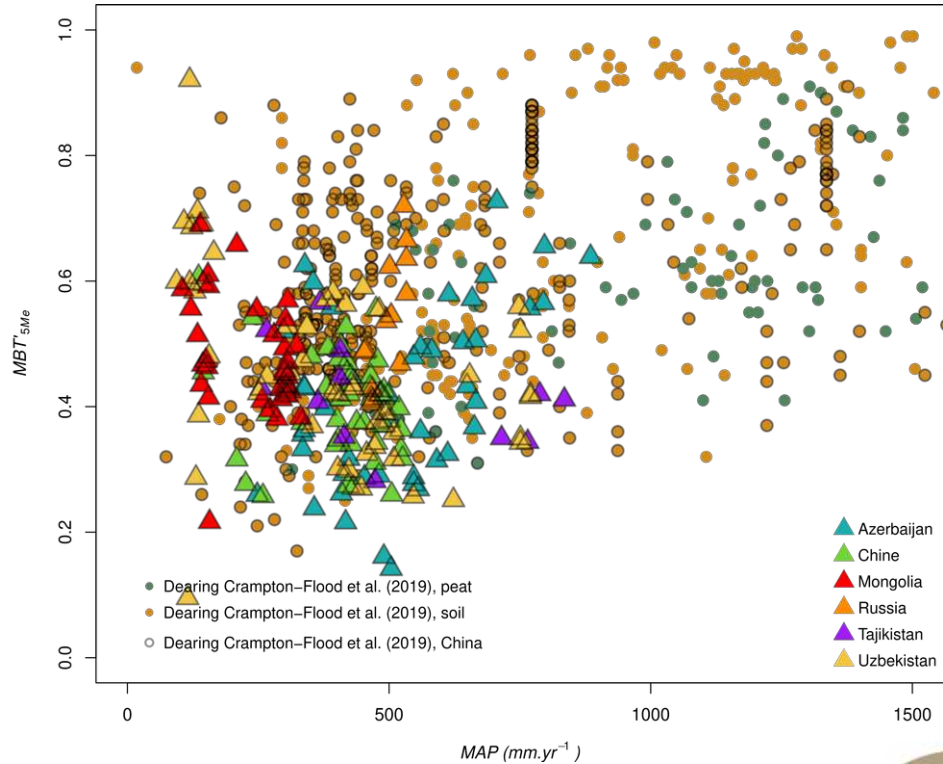
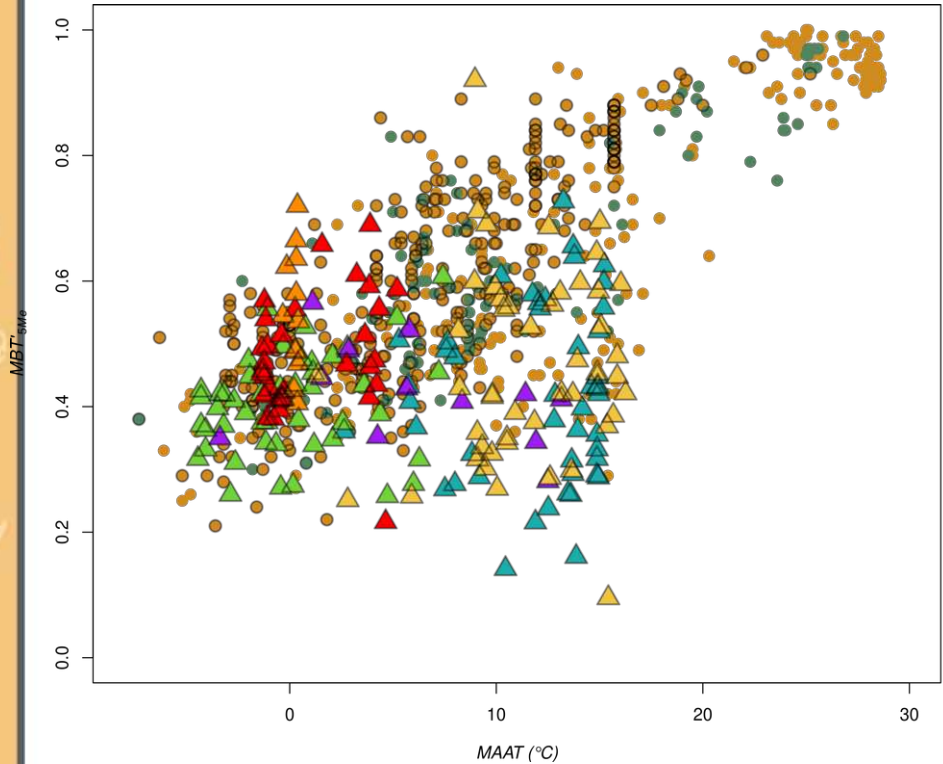
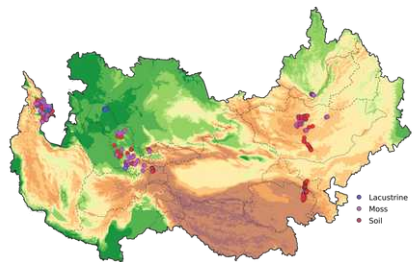
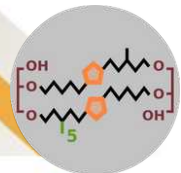


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GDGTs integrations and calibrations

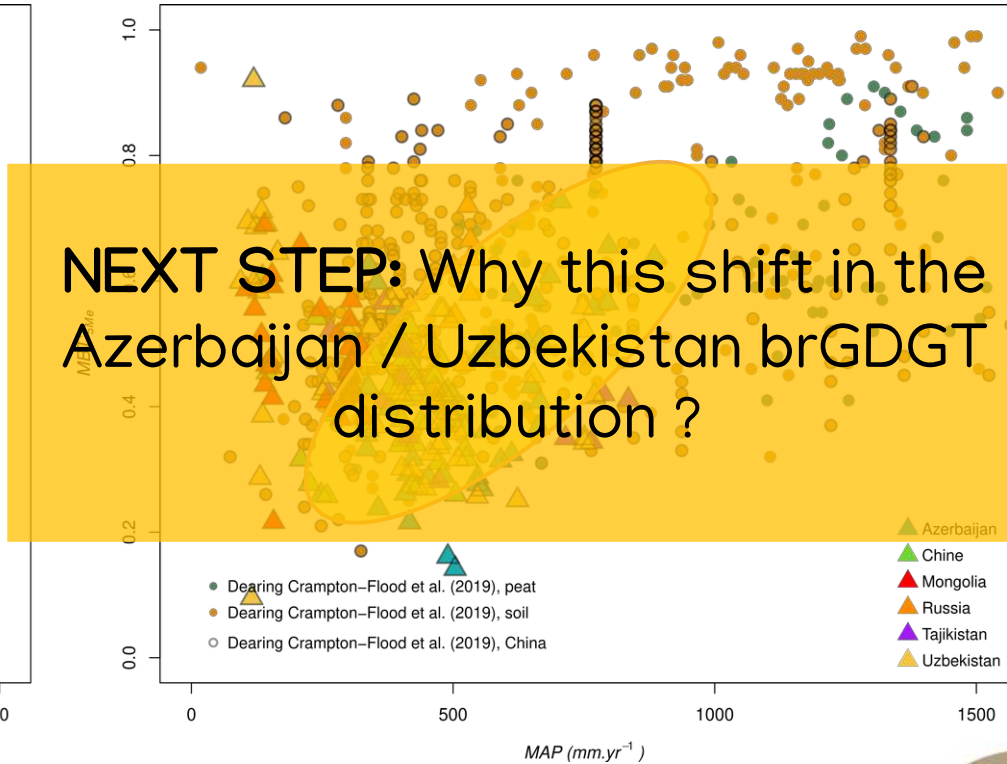
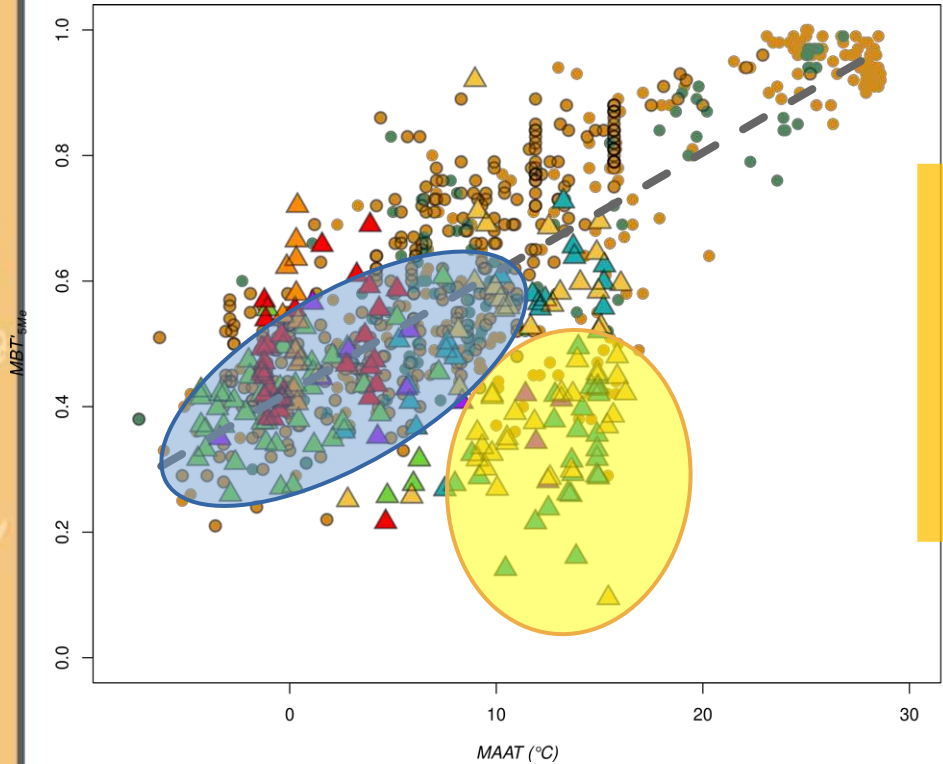
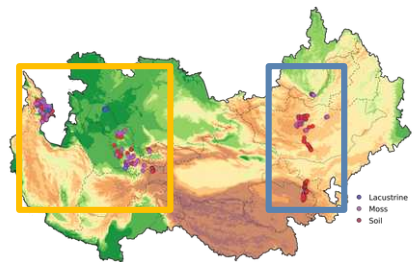
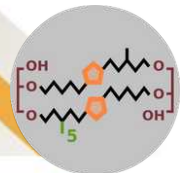


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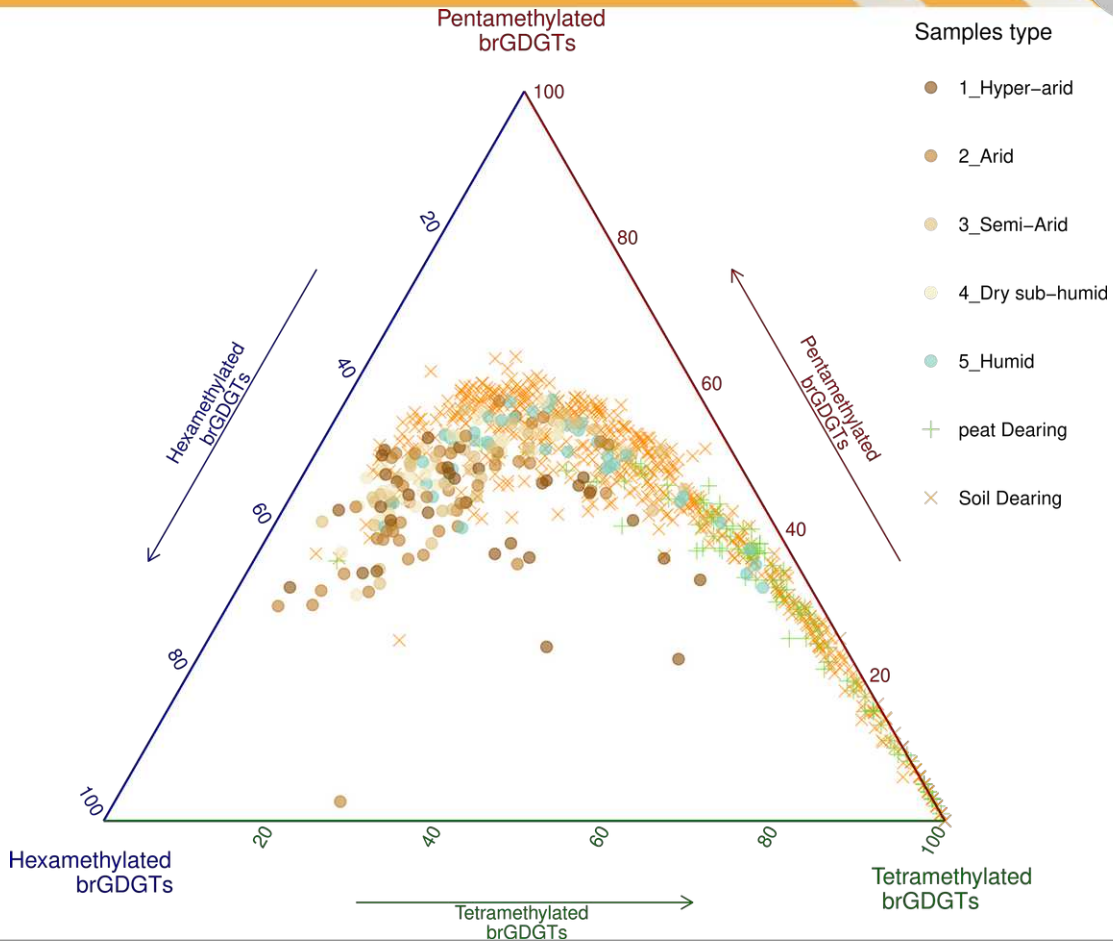
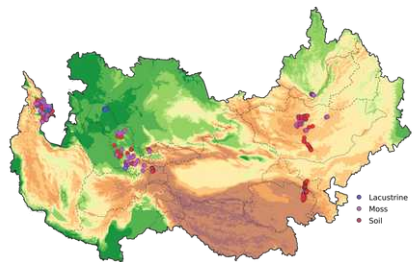
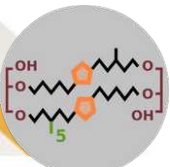


Linear relation between (A) MAAT, (B) MAP and MBT'_{5Met}. Surface samples from Dearing-Crampton-Flood et al., (2019) and ACA surface samples clustered by **seasonality**.



Surface samples database

GDGTs integrations and calibrations

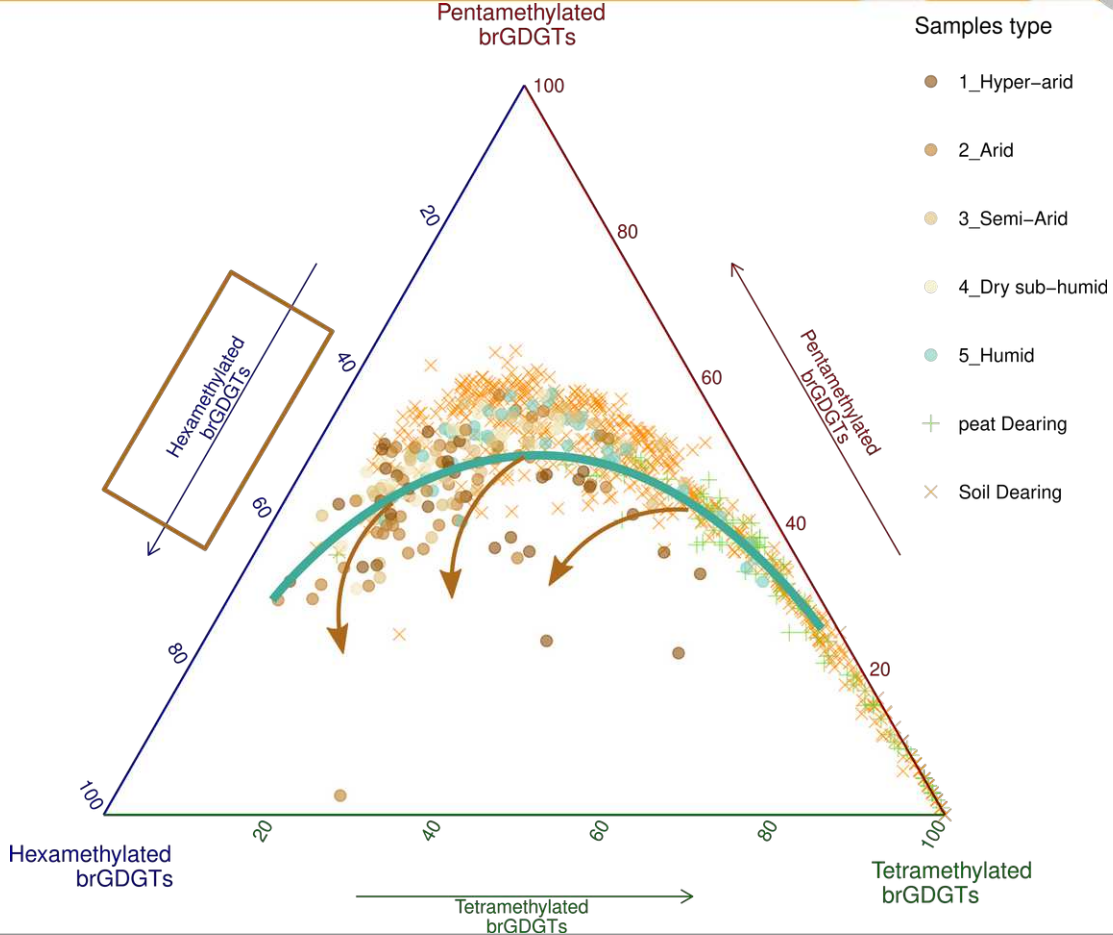
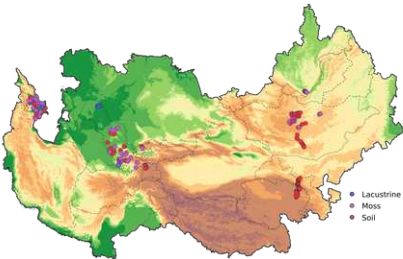
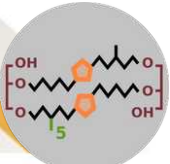


Tertiary plot of the brGDGTs distribution among number of methyl groups (%_{tetra}, %_{penta} and %_{hexa}).



Surface samples database

GDGTs integrations and calibrations



Tertiary plot of the brGDGTs distribution among number of methyl groups (%_{tetra}, %_{penta} and %_{hexa}).



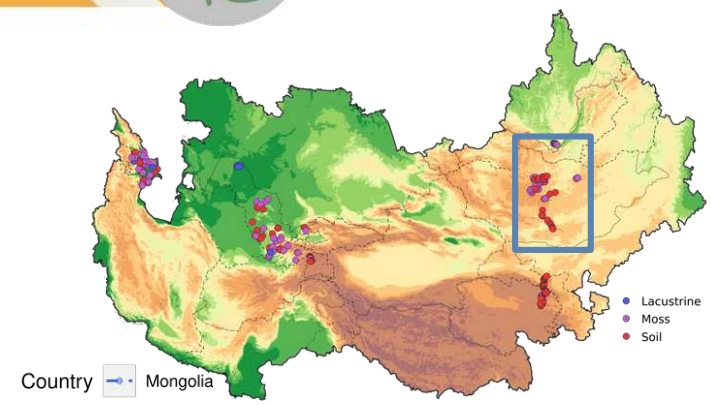
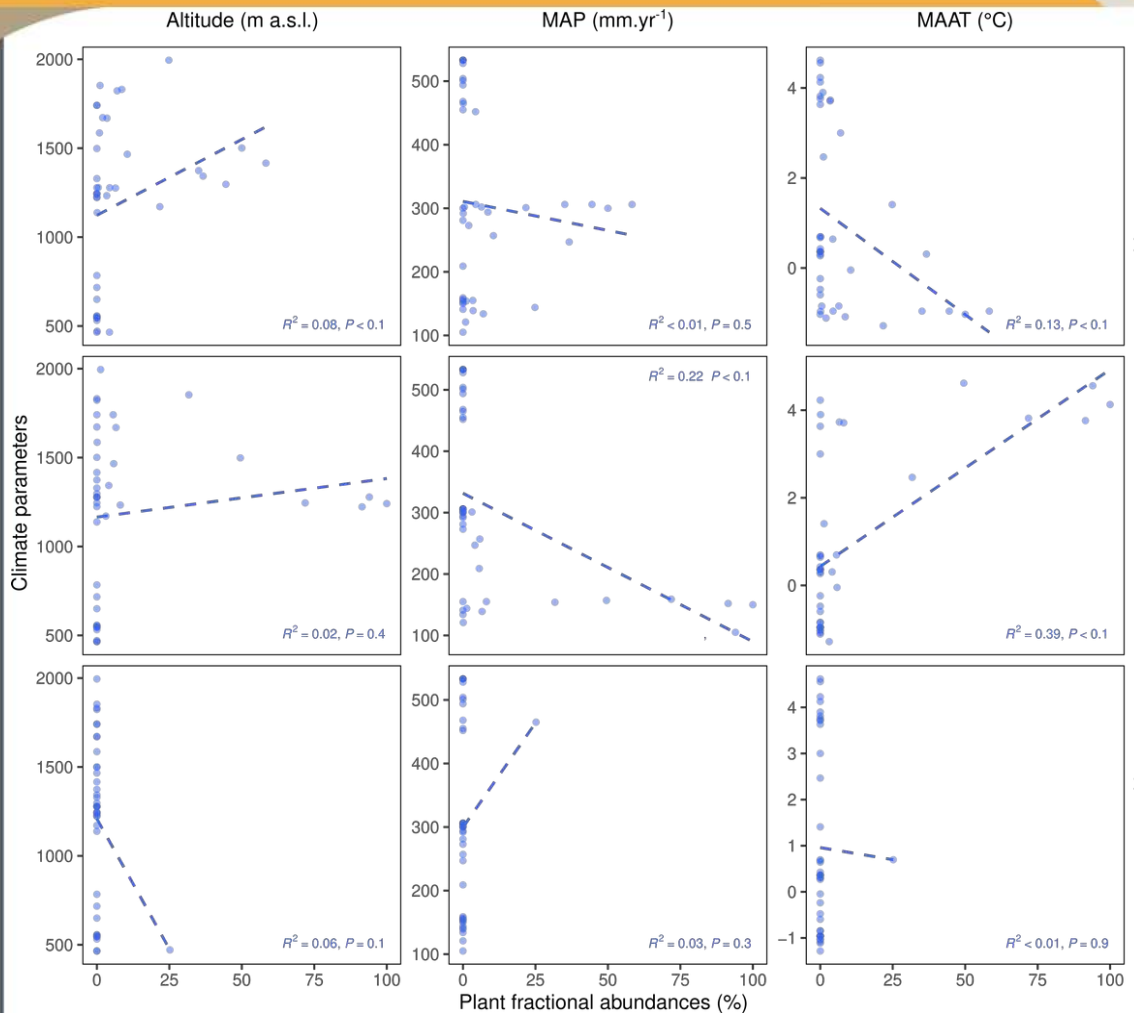


Uzbekistan Pollen surface samples: implication for climate and vegetation reconstructions in the past.

Gobi desert, November 2016

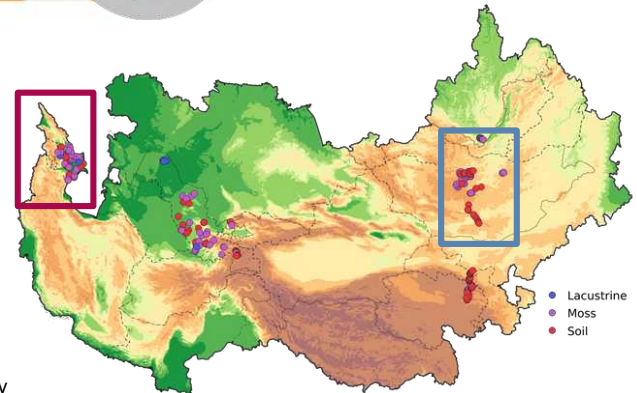
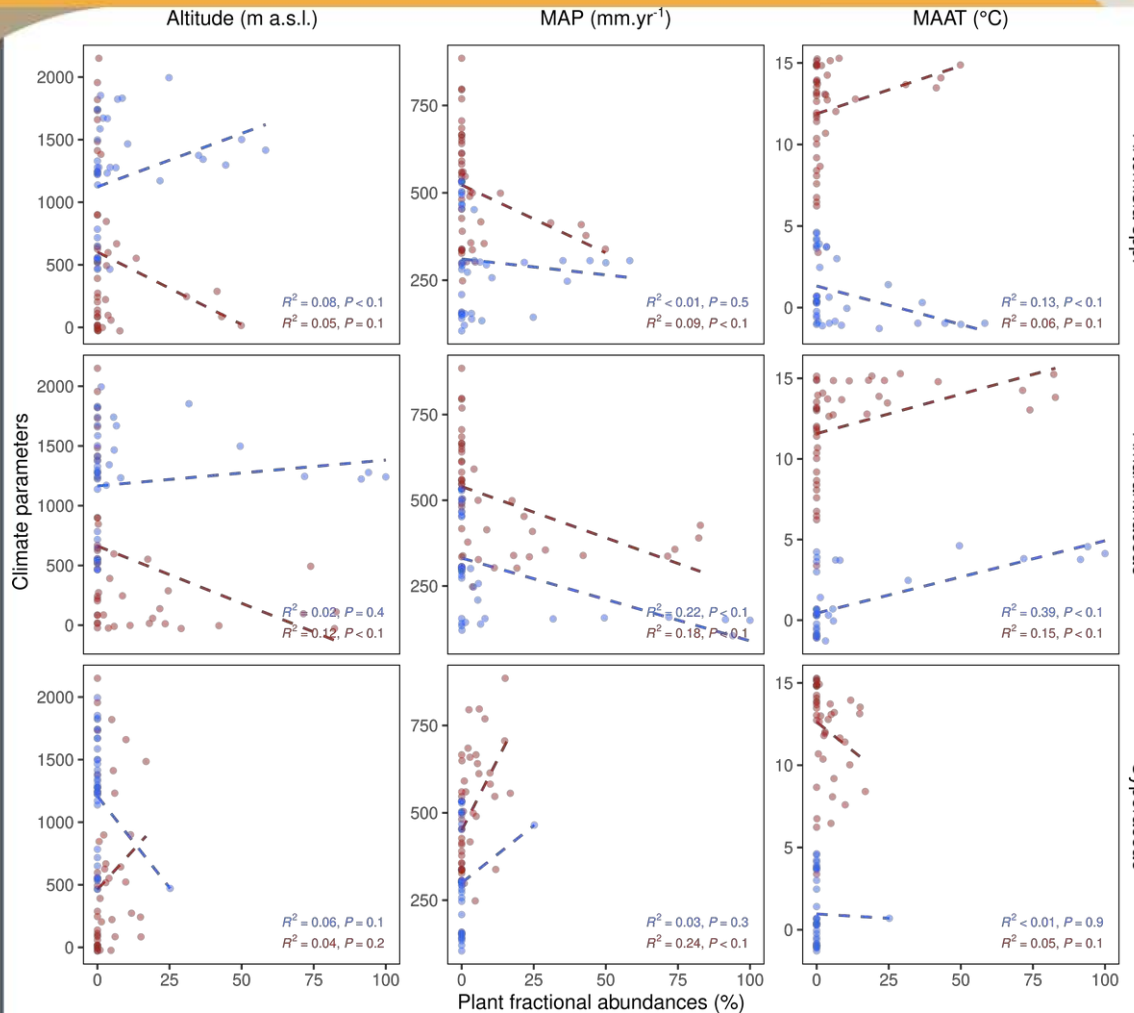
Surface samples database

Looking at the ecophysiological response of the ACA plants.



Surface samples database

Looking at the ecophysiological response of the ACA plants.

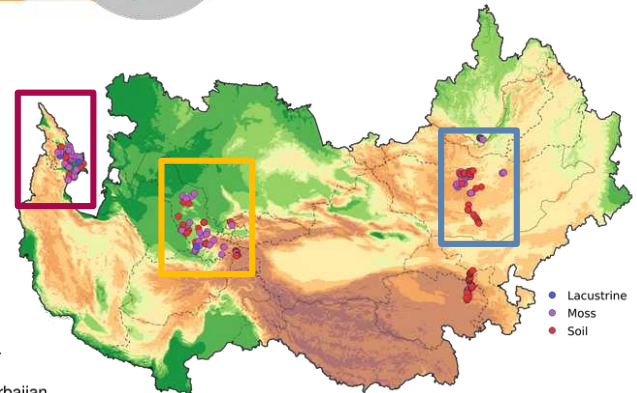
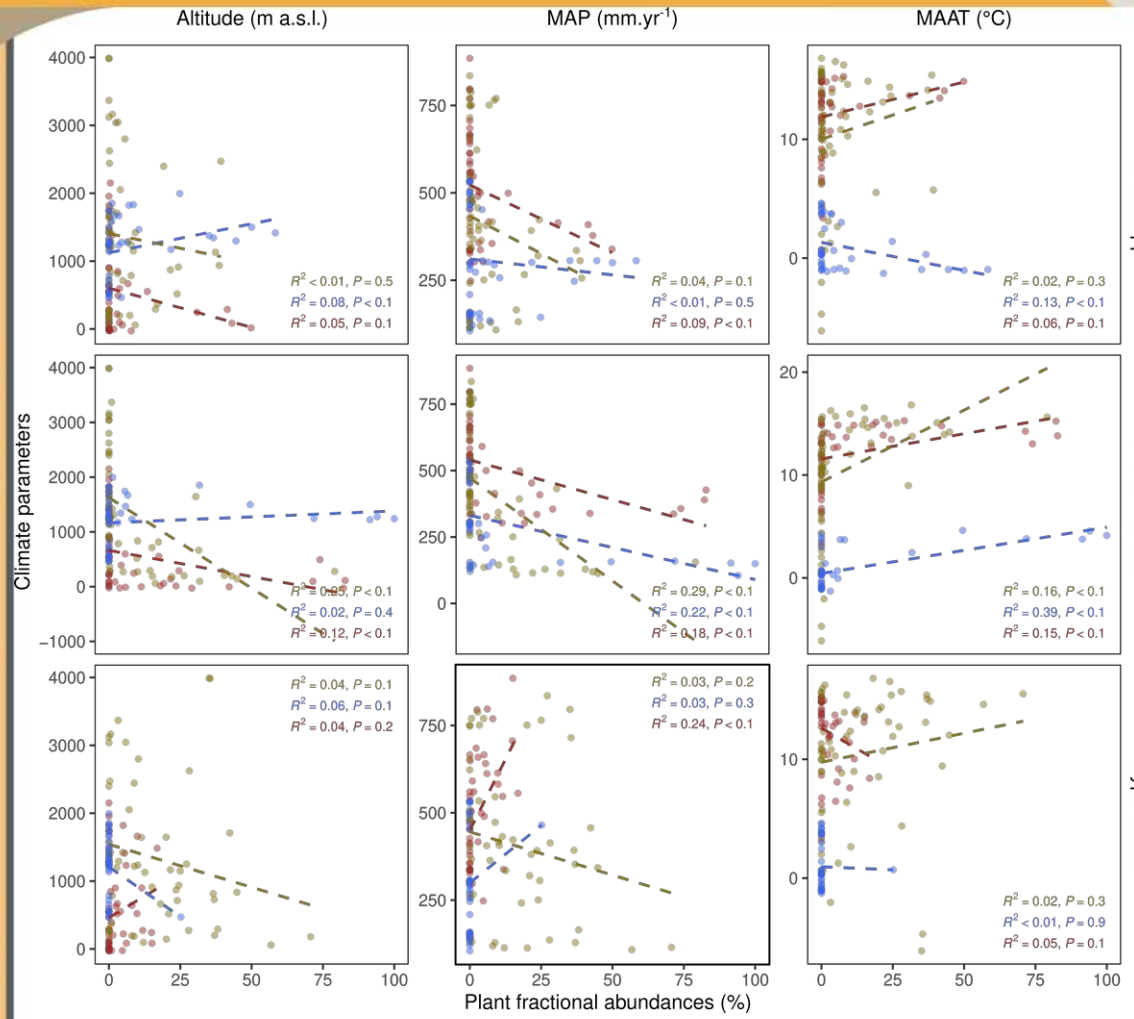


Country
 - Azerbaijan
 - Mongolia



Surface samples database

Looking at the ecophysiological response of the ACA plants.

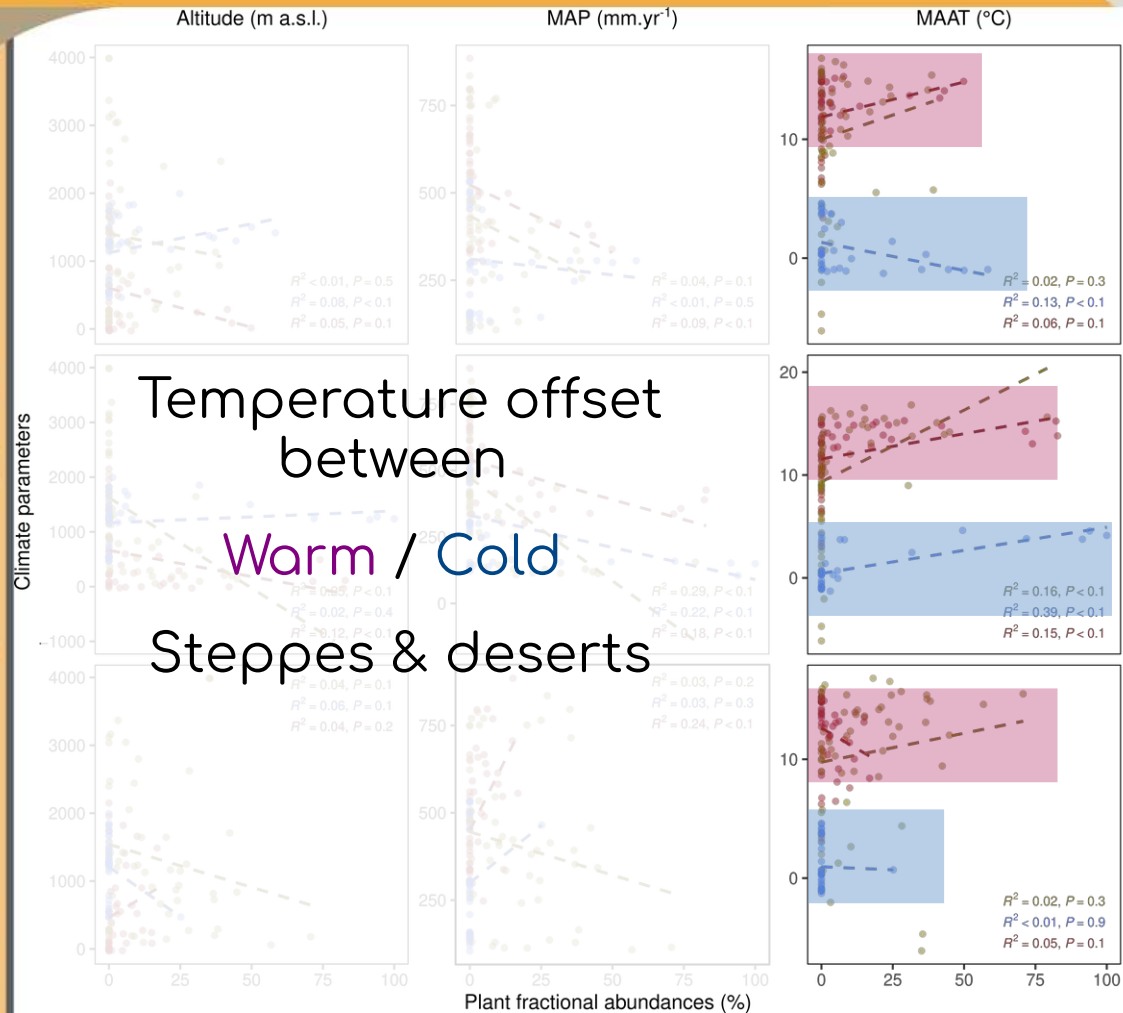


- Country
- Azerbaijan
 - Mongolia
 - Uzbekistan

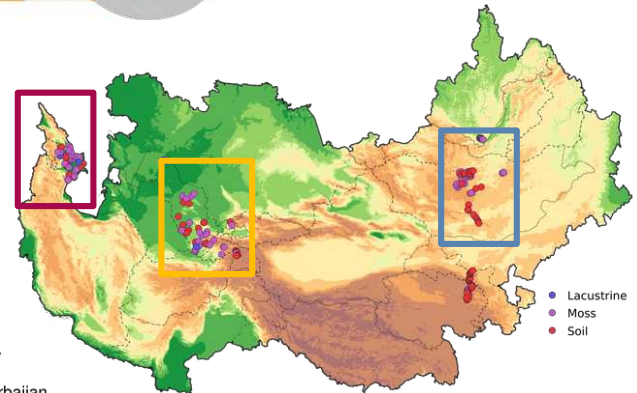


Surface samples database

Looking at the ecophysiological response of the ACA plants.



Temperature offset between
 Warm / Cold
 Steppes & deserts



- Country
- Azerbaijan
 - Mongolia
 - Uzbekistan

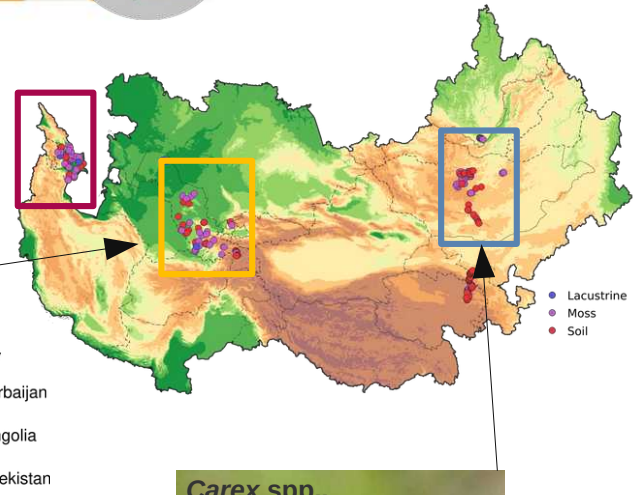


Surface samples database

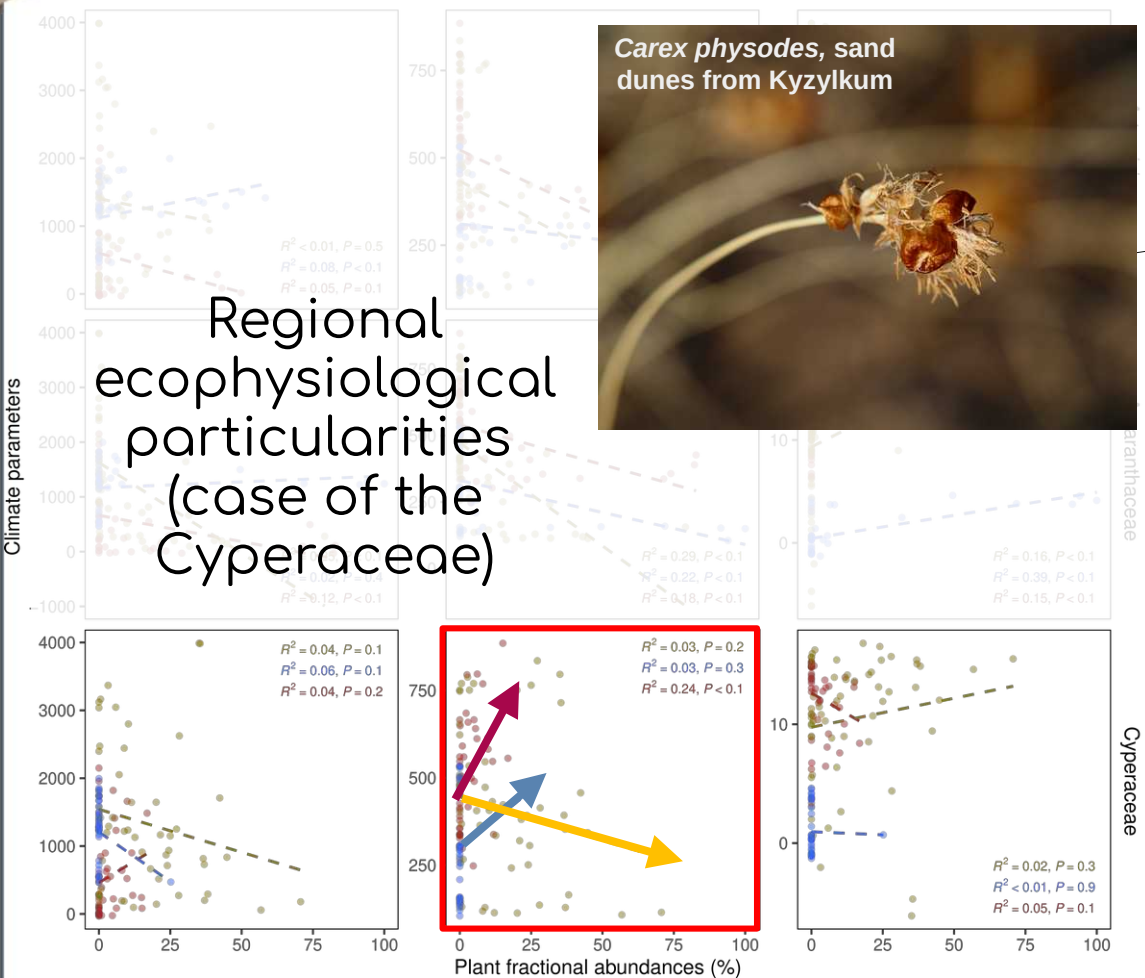
Looking at the ecophysiological response of the ACA plants.



Altitude (m a.s.l.) MAP (mm.yr⁻¹) MAAT (°C)

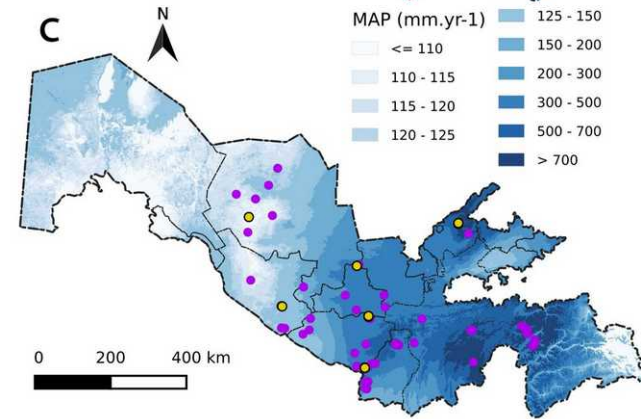
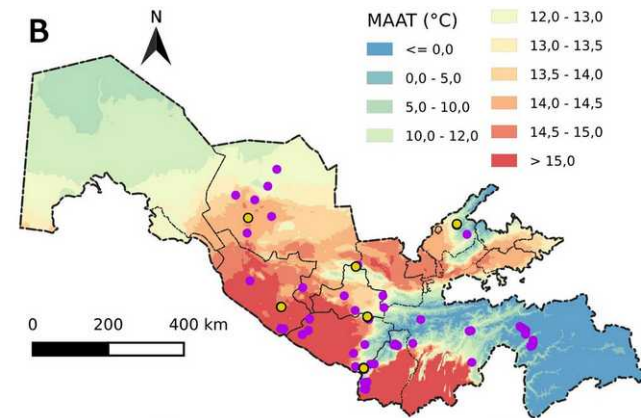
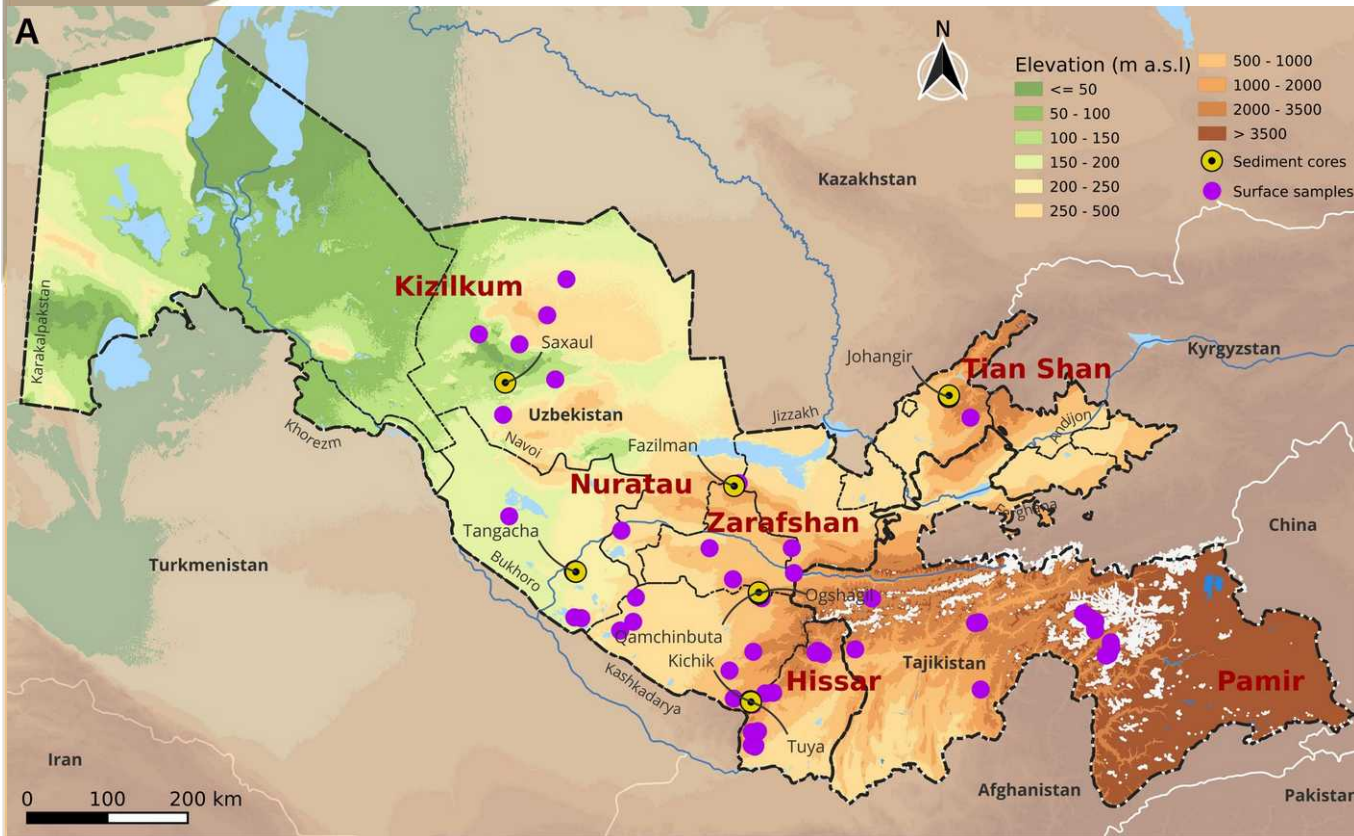


Regional ecophysiological particularities (case of the Cyperaceae)



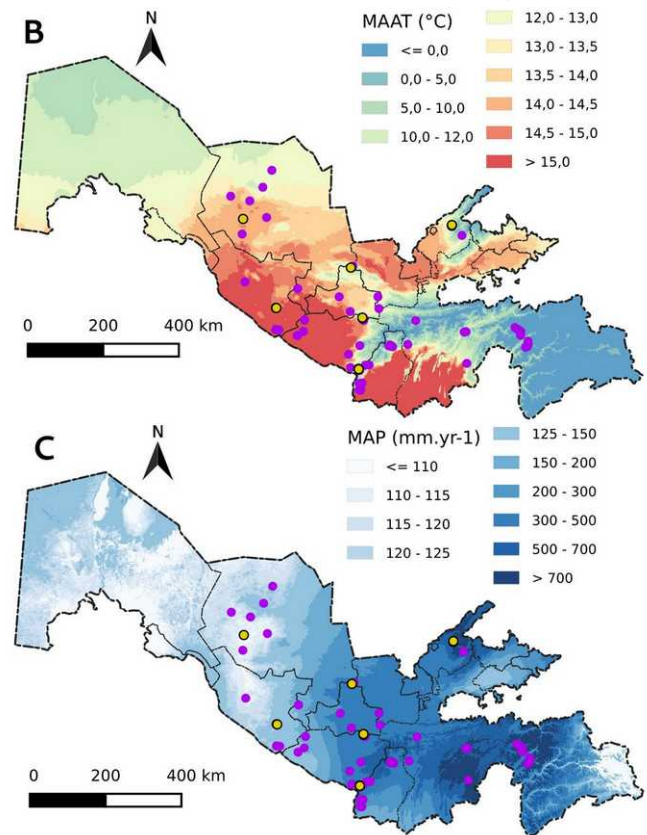
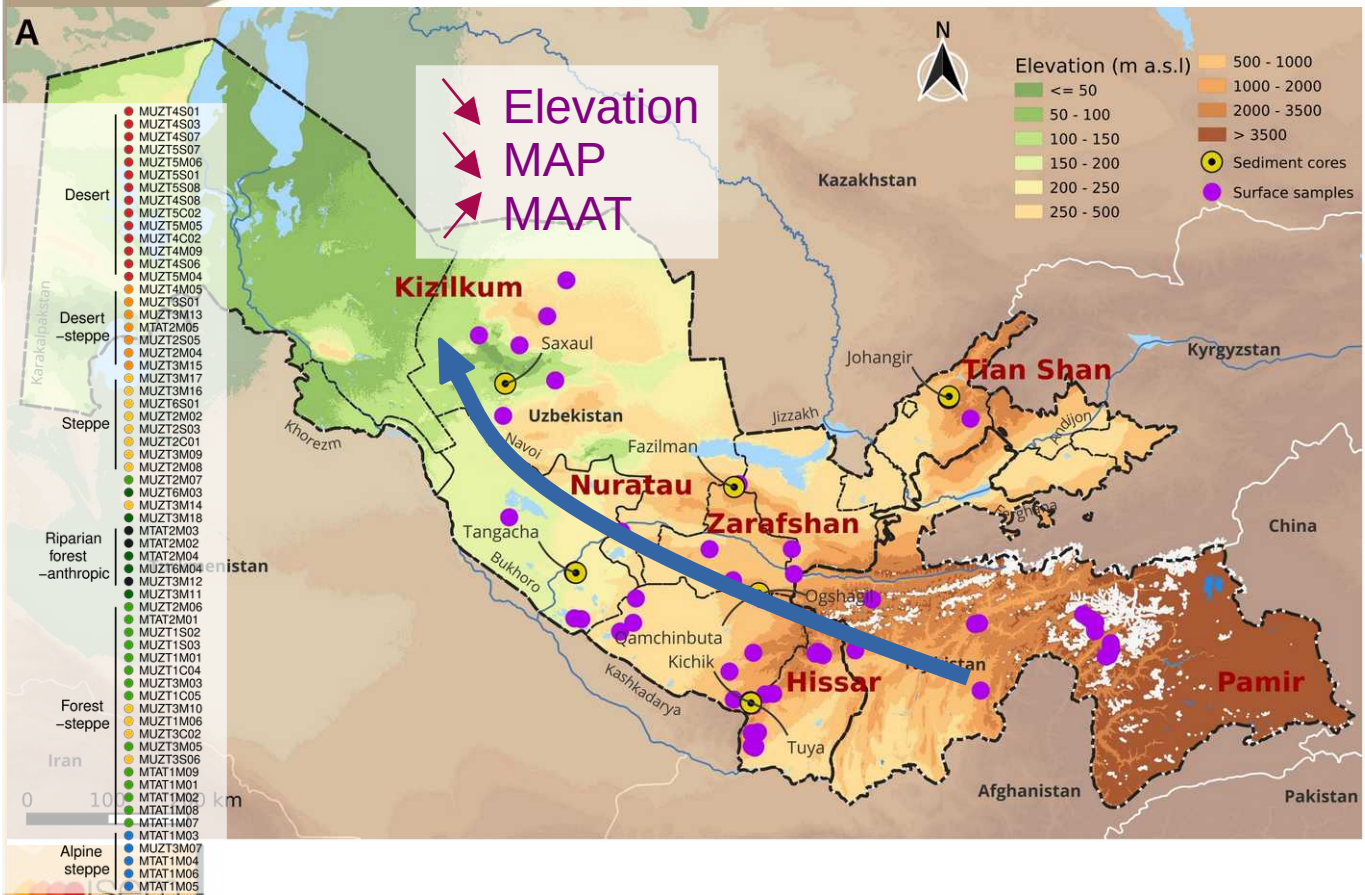
Surface samples database

Study case: Uzbekistan pollen distribution.



Surface samples database

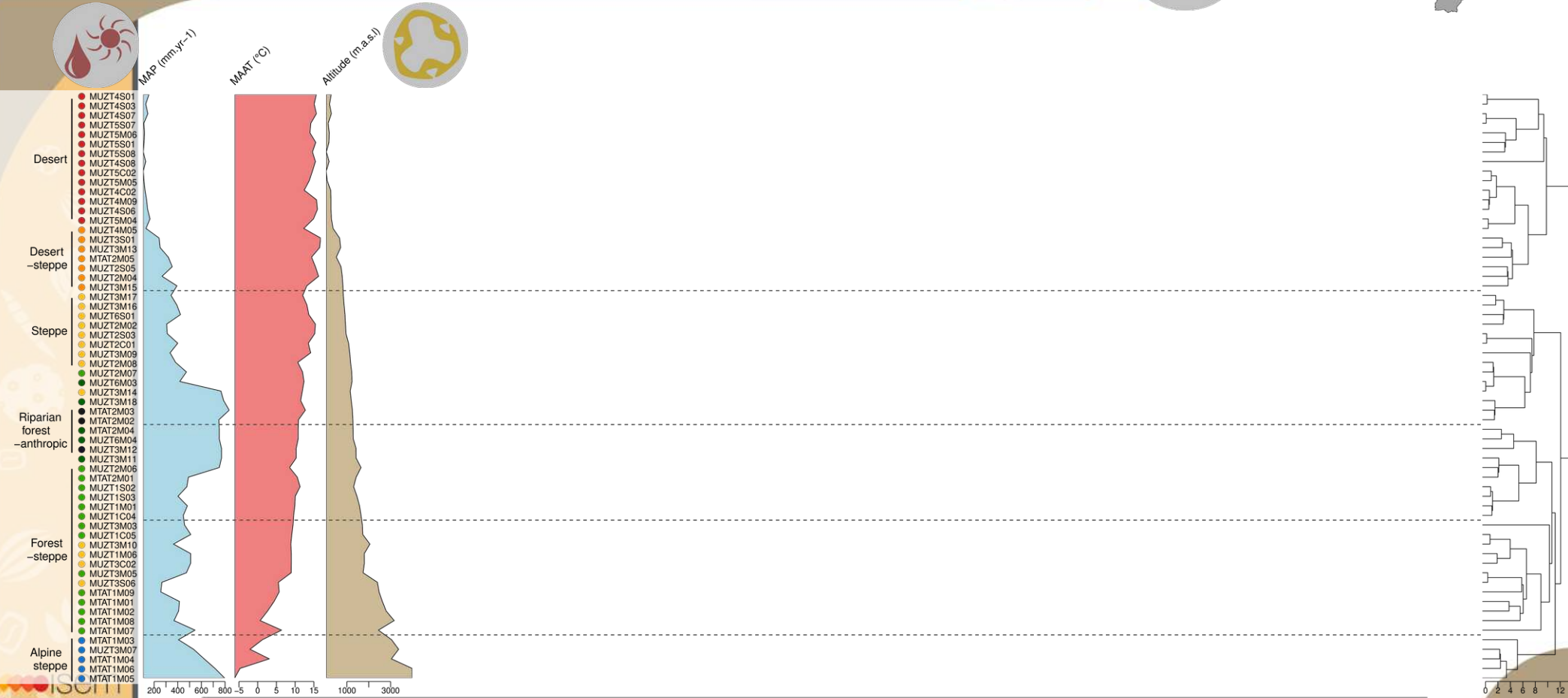
Study case: Uzbekistan pollen distribution.



Pollen surface samples from Uzbekistan and Tajikistan, n = 62.
 Climate parameters from WorldClim2 (Fick & Hijmans 2017).

Surface samples database

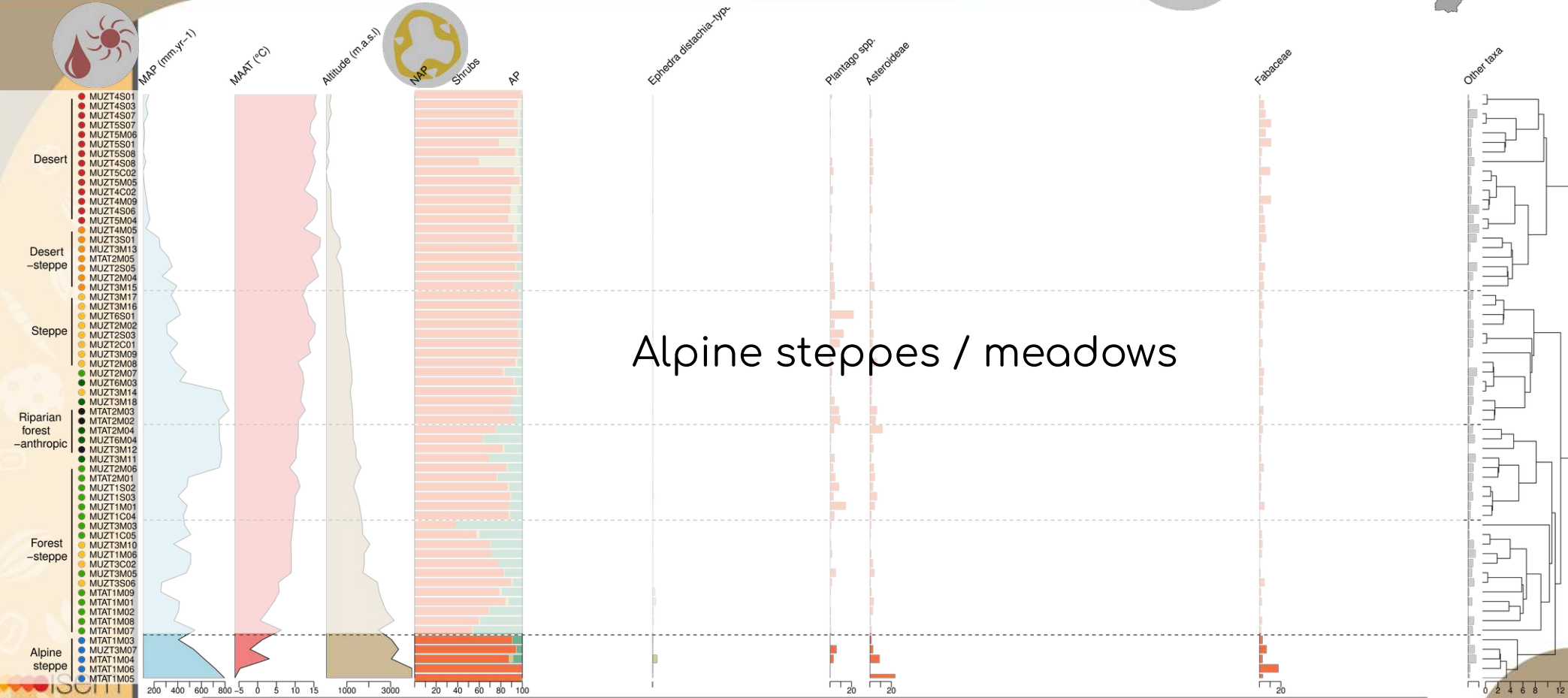
Study case: Uzbekistan pollen distribution.



Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

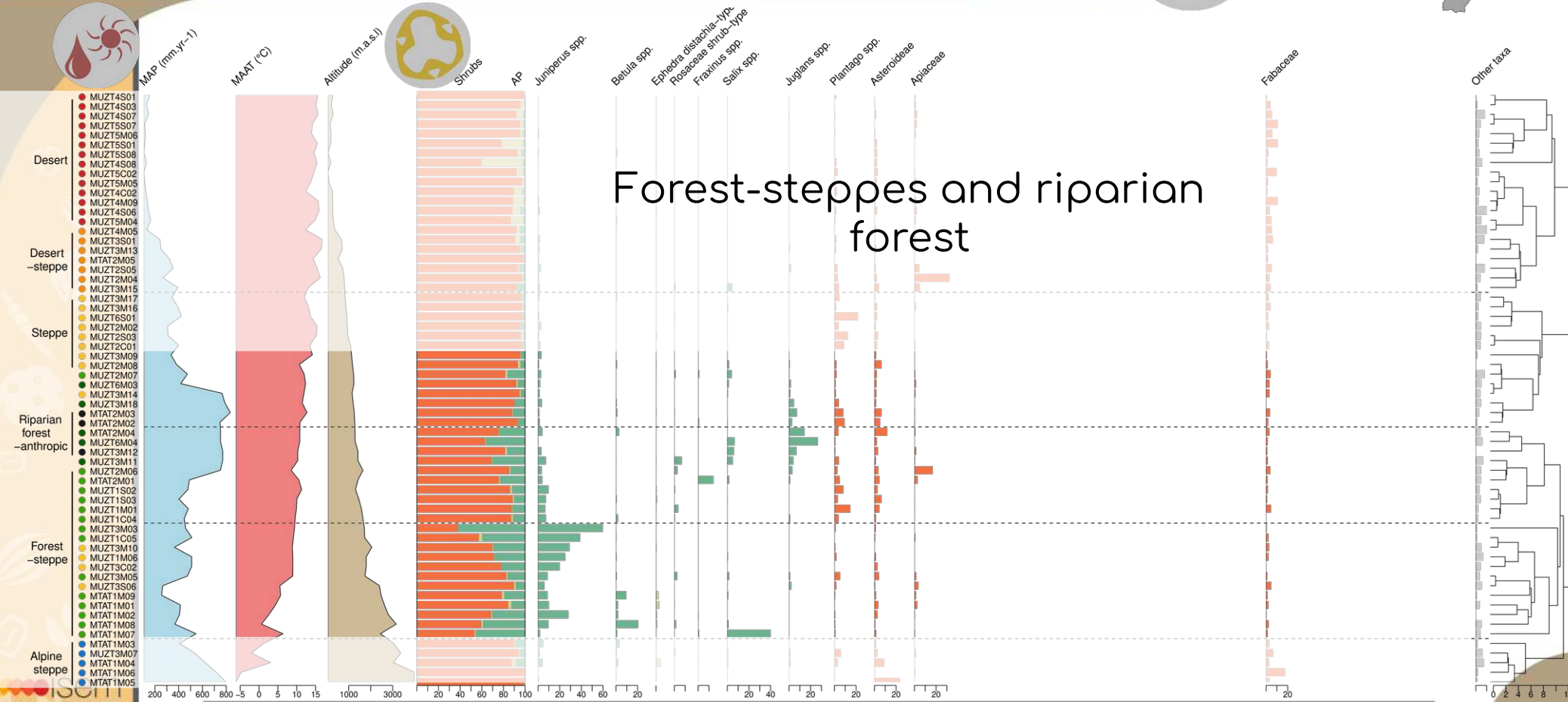
Study case: Uzbekistan pollen distribution.



Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

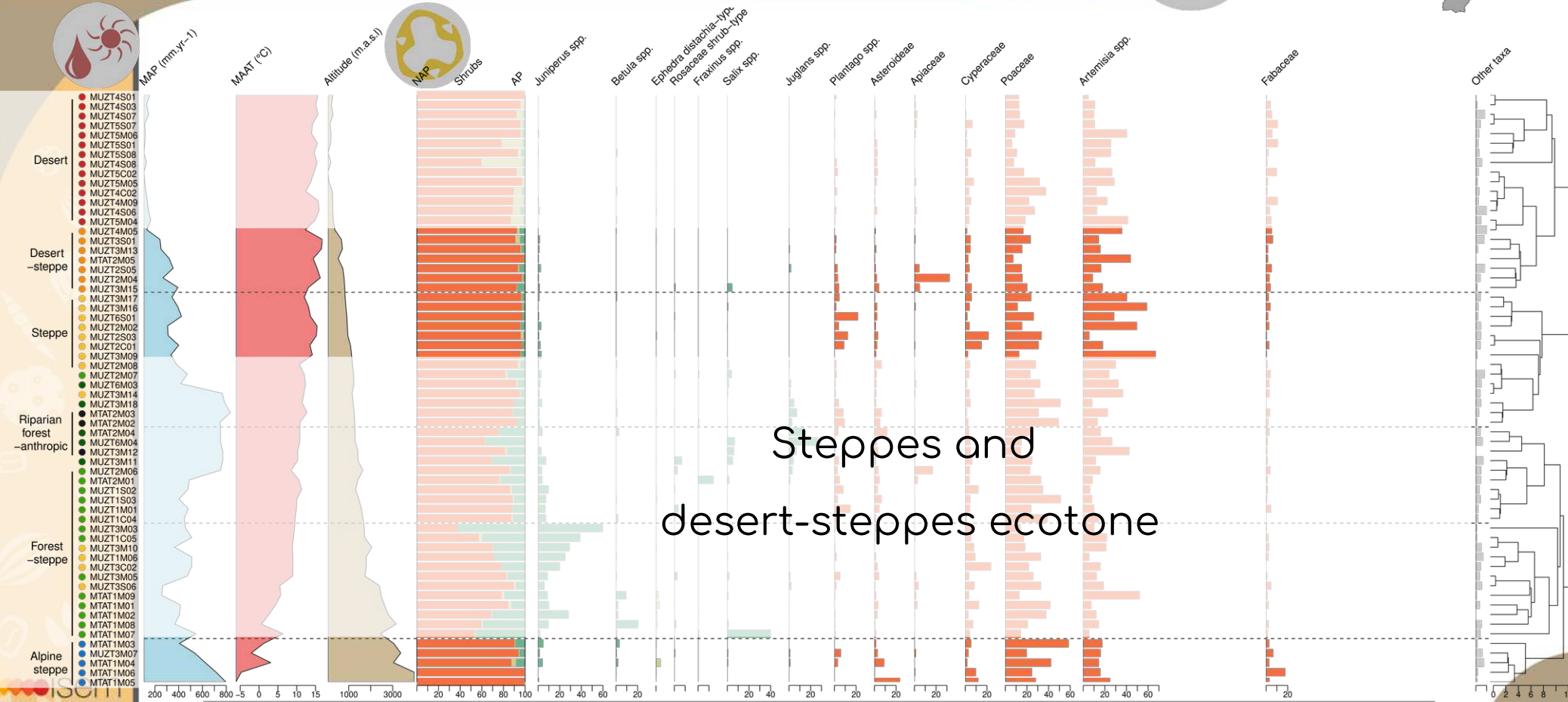
Study case: Uzbekistan pollen distribution.



Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

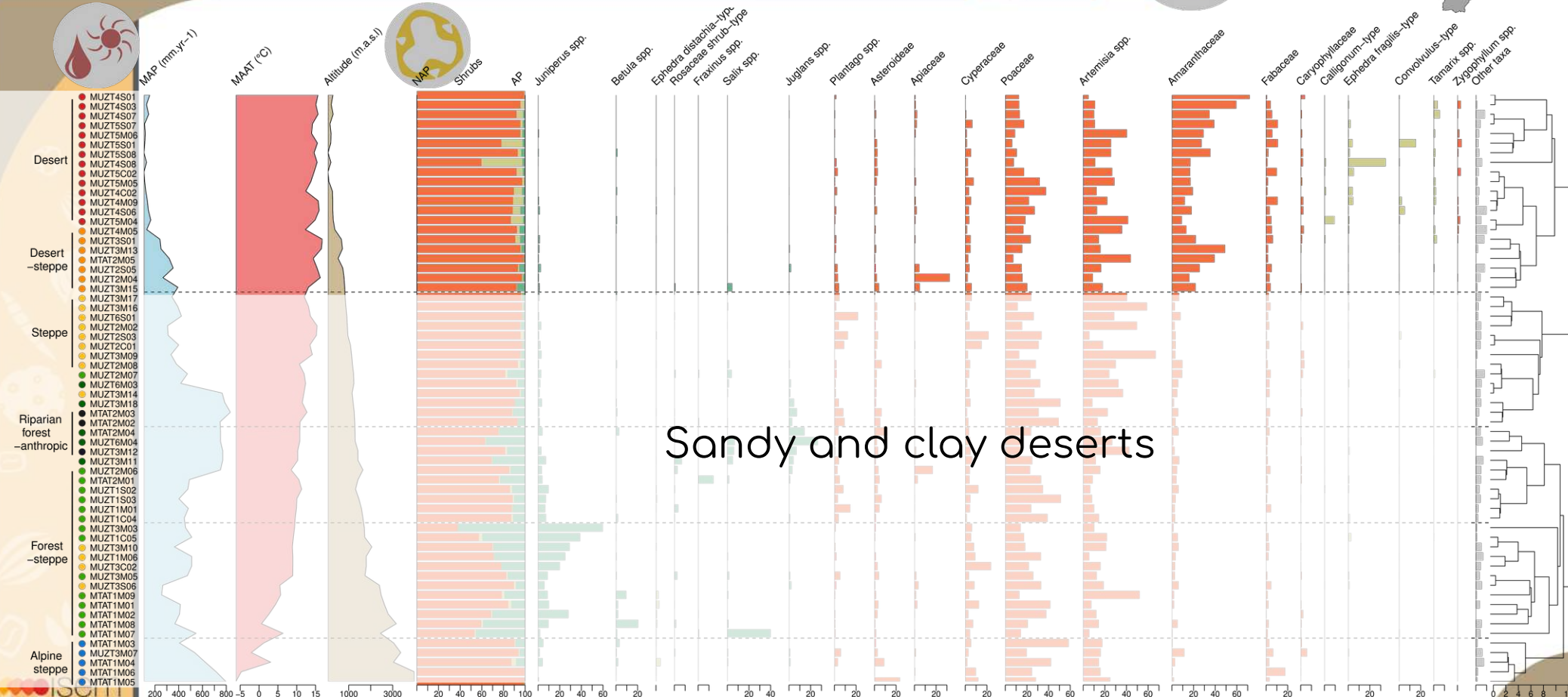
Study case: Uzbekistan pollen distribution.



Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

Study case: Uzbekistan pollen distribution.

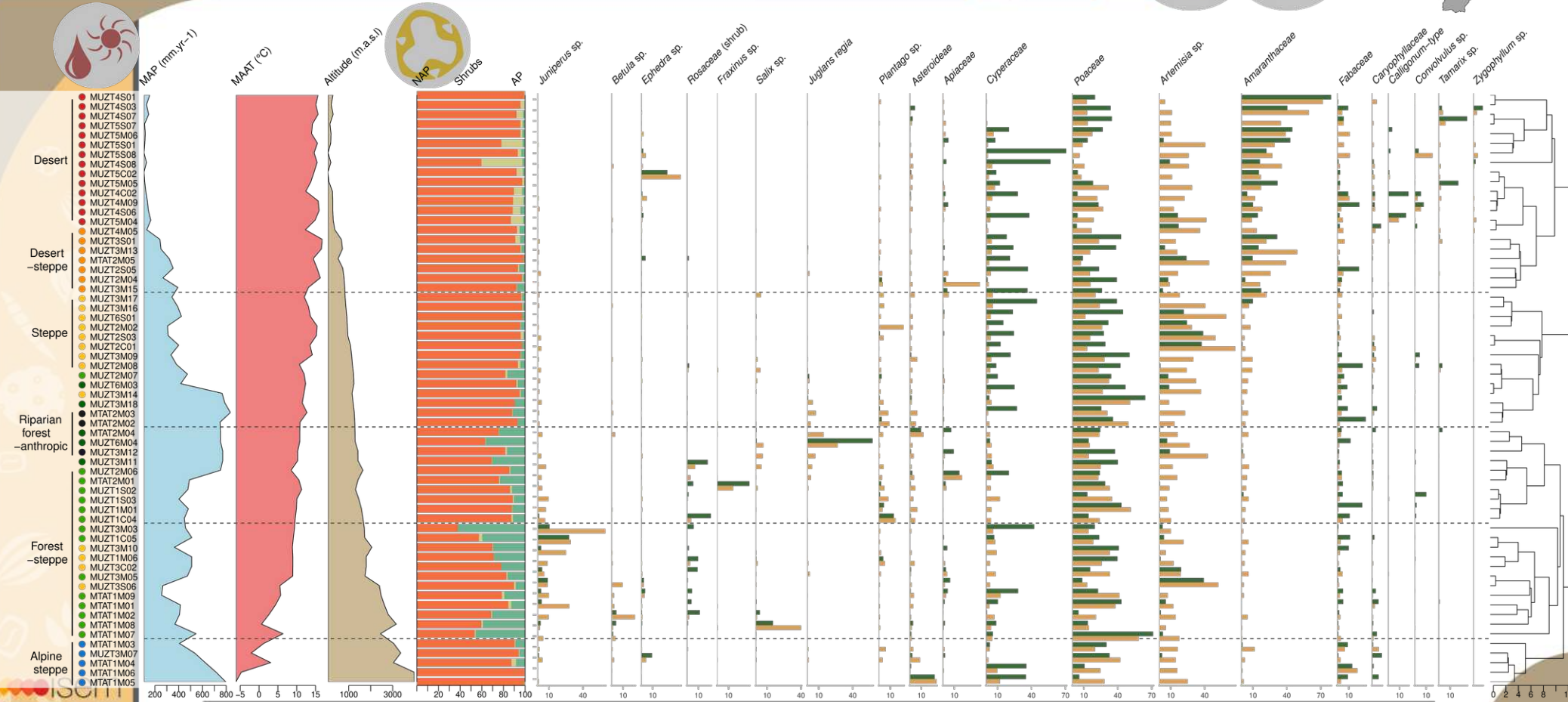
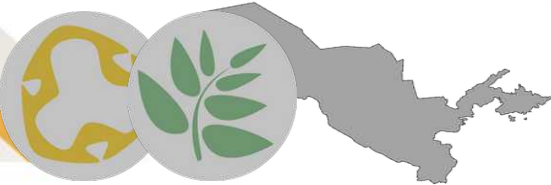


Sandy and clay deserts

Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

Study case: Uzbekistan pollen distribution.



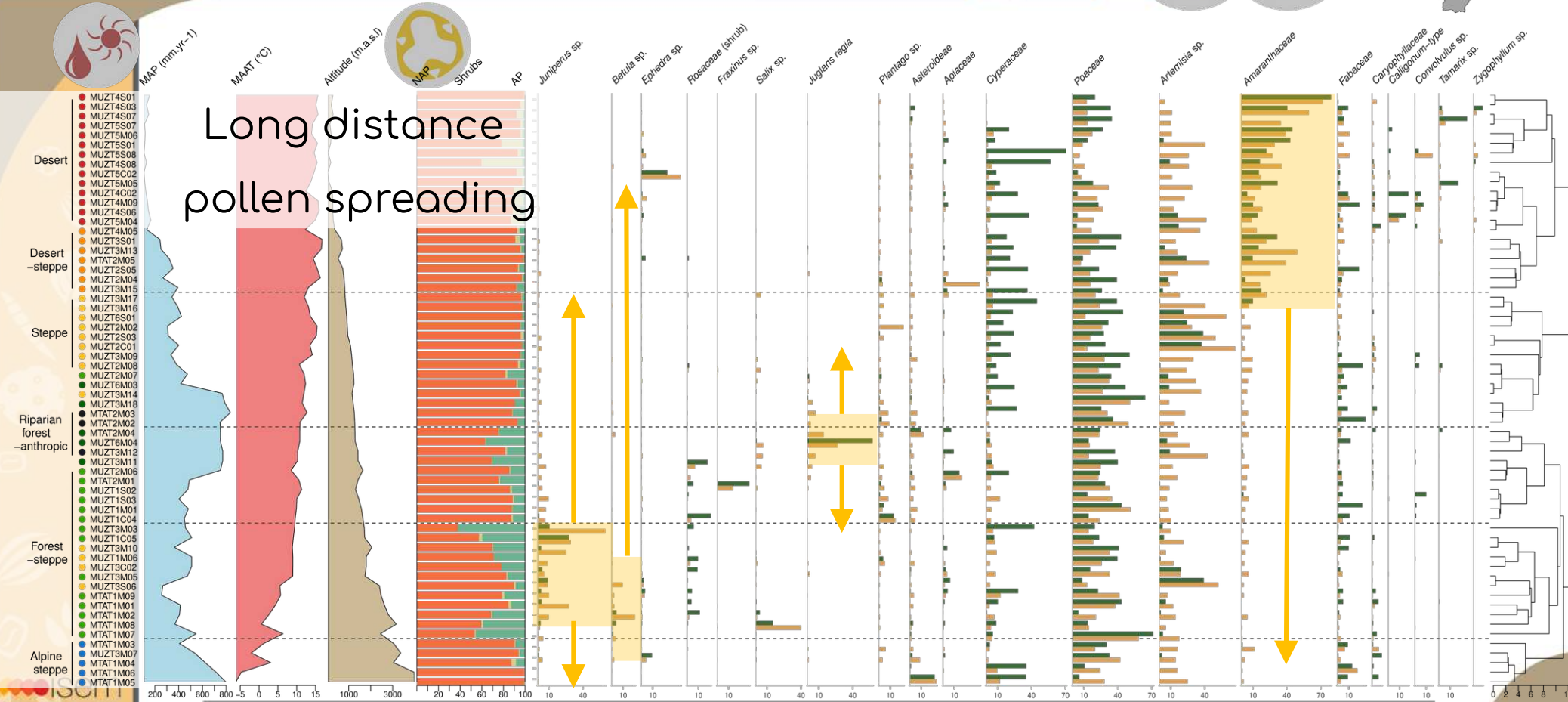
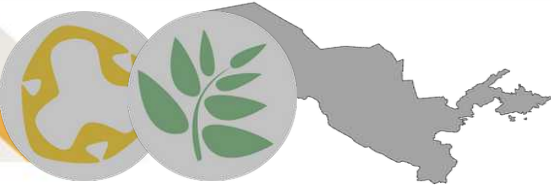
Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Relative abundance (%)
 Sample Type: Pollen (orange), Vegetation (green)



Surface samples database

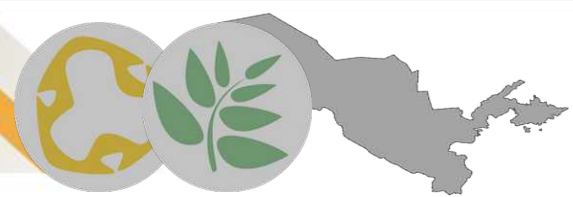
Study case: Uzbekistan pollen distribution.



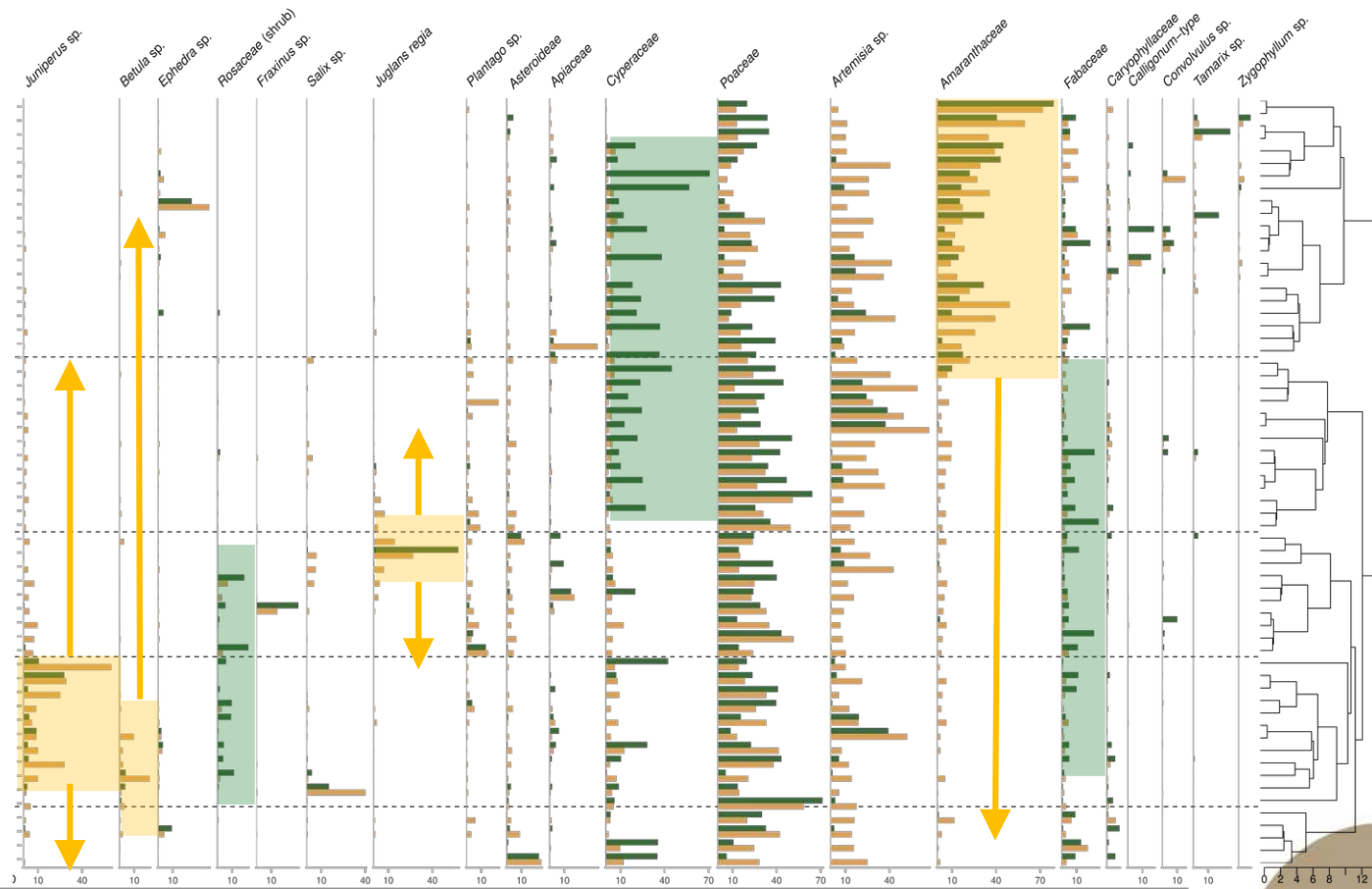
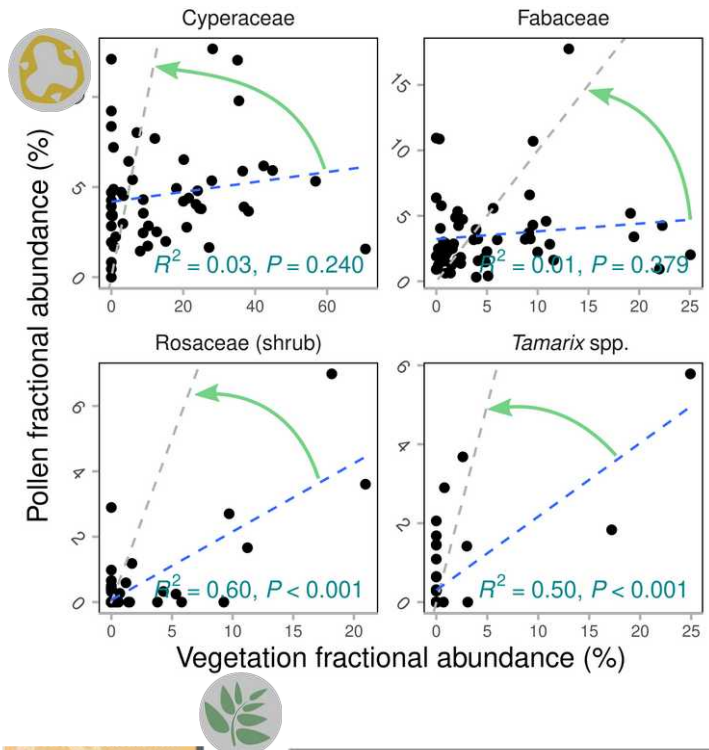
Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

Surface samples database

Study case: Uzbekistan pollen distribution.



Under estimated pollen-types

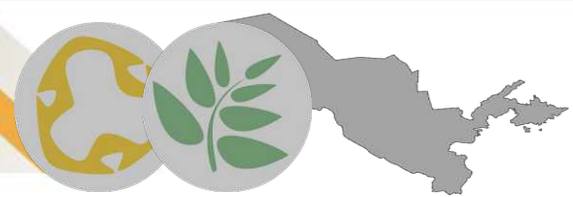


Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

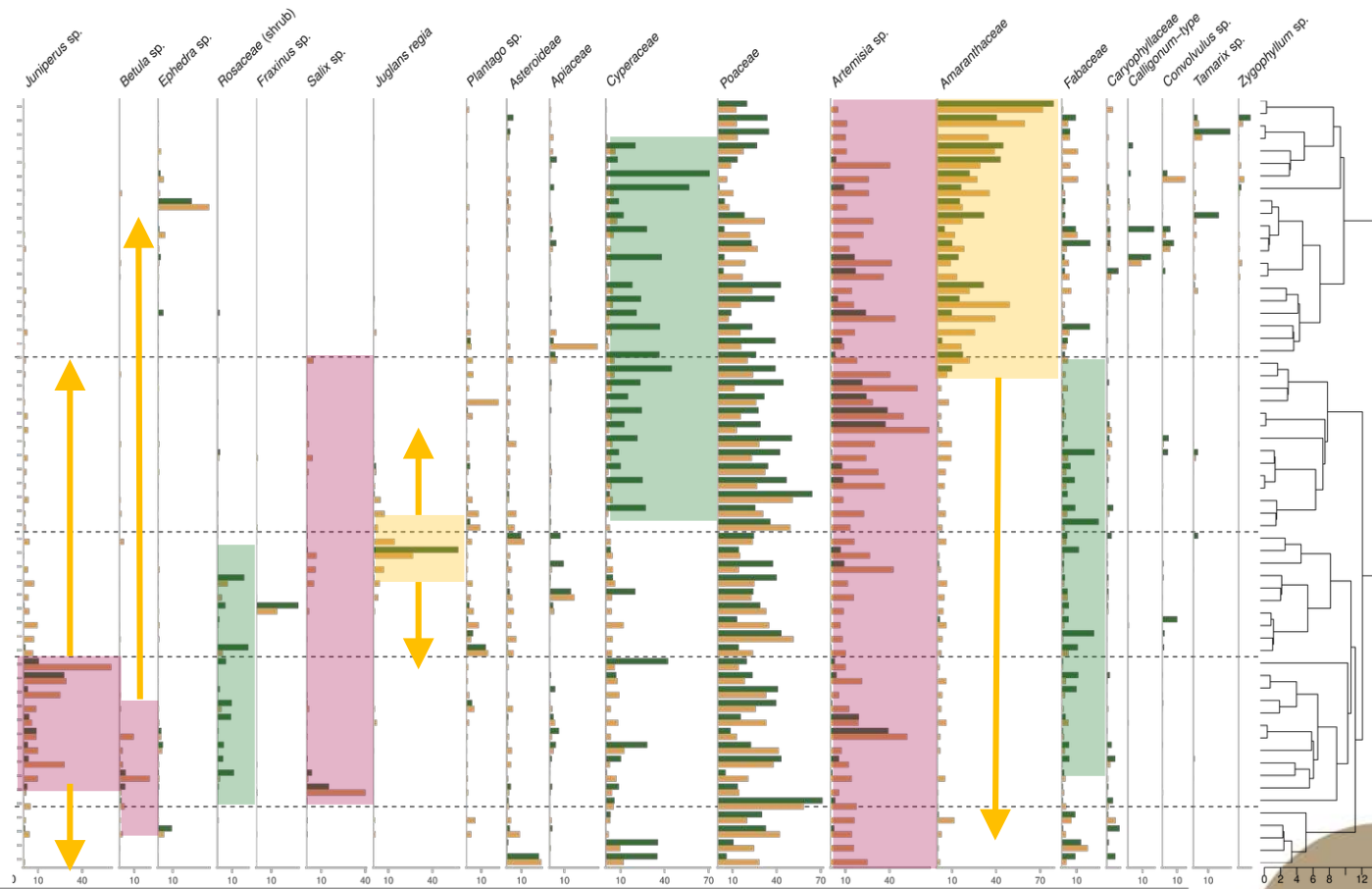
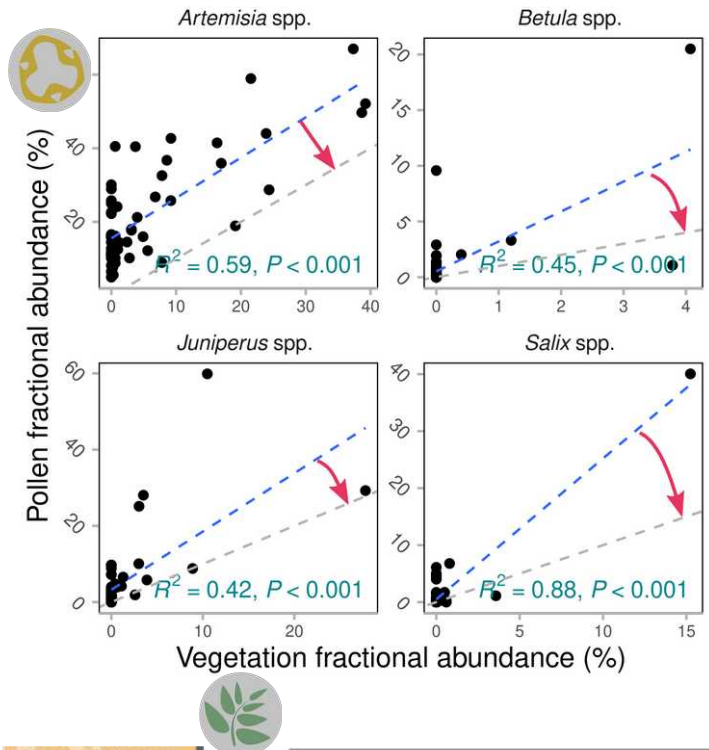
Relative abundance (%)
 Sample Type ■ Pollen ■ Vegetation

Surface samples database

Study case: Uzbekistan pollen distribution.



Over estimated pollen-types

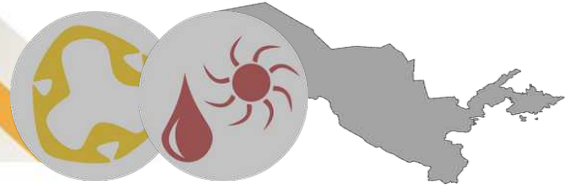


Pollen diagram of the surface samples from Uzbekistan and Tajikistan.

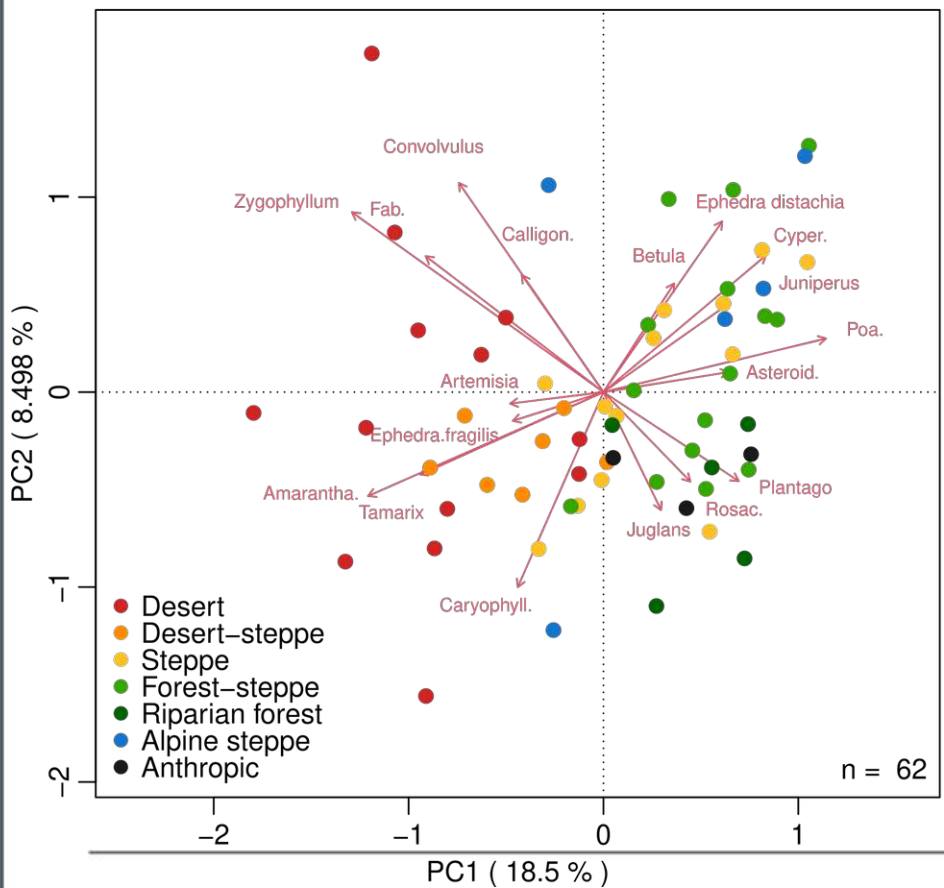
Relative abundance (%)
 Sample Type ■ Pollen ■ Vegetation

Surface samples database

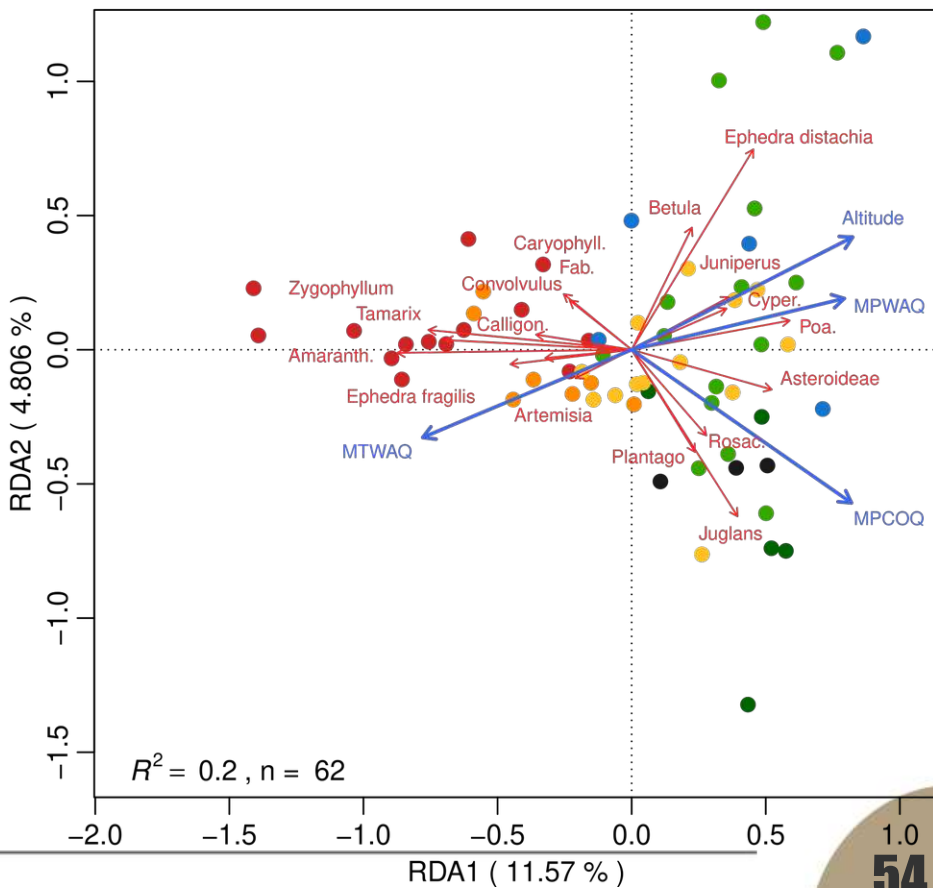
Climate signal controlling the uzbek pollen distribution ?



PCA Pollen

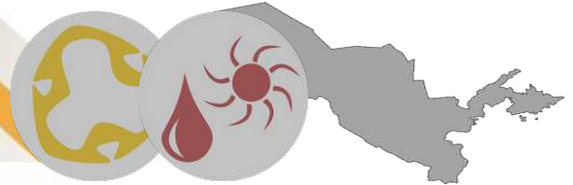


RDA Pollen /Climate

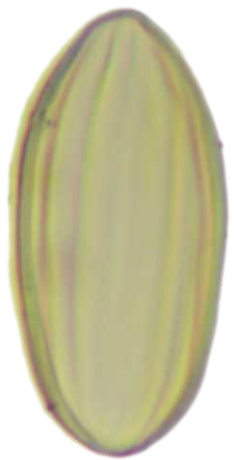


Surface samples database

Climate signal controlling the uzbek pollen distribution ?



Ephedra fragilis-type



Warm-dry

Ephedra distachia-type



Cold-dry

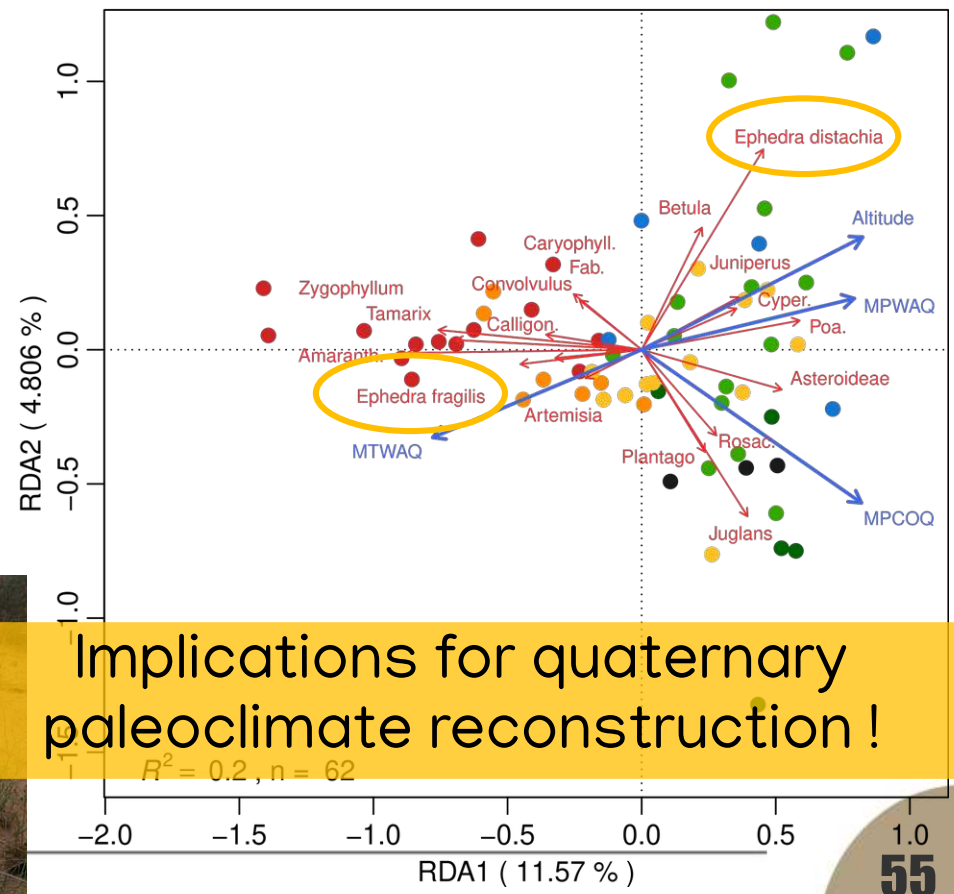
Ephedra glauca



Ephedra strobilacea



RDA Pollen /Climate



Implications for quaternary paleoclimate reconstruction !



Thank you for your attention.

Lucas Dugerdil

ENS Lyon, ISEM

Töv province, Mongolia, July 2019