# Carbon fluxes and allocation above- and below-ground in high Arctic tundra

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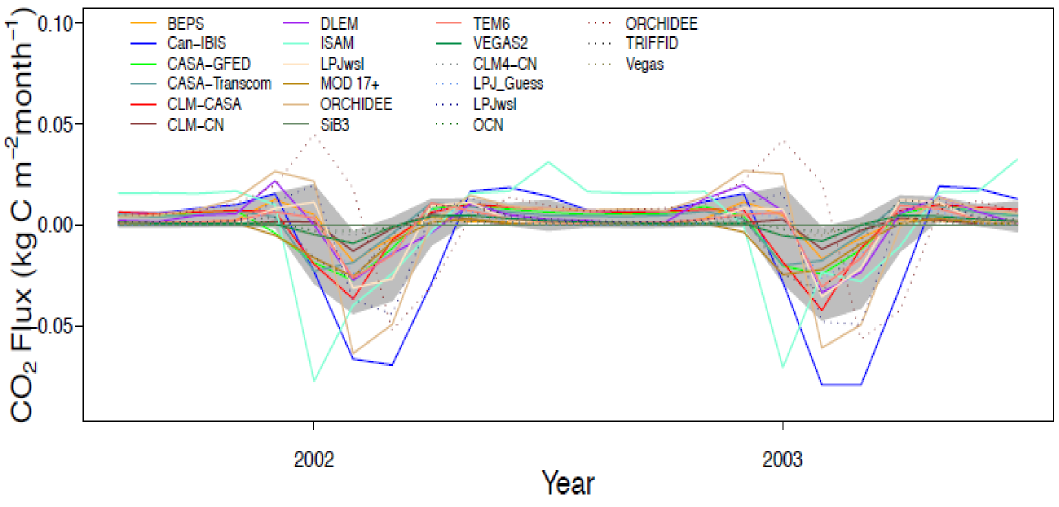
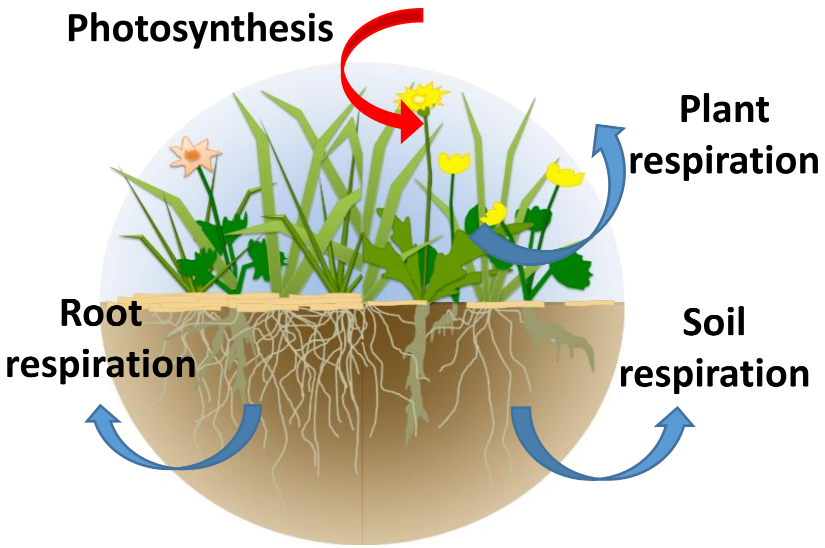
# Why study Carbon fluxes in Arctic?

- Climate changes affect plant physiology and metabolism that contribute to carbon balance
- Arctic soils contain almost 50% of the carbon stored globally in soils and effects of global warming on microbial respiration, can be very impactful on global Carbon balance
- Carbon fluxes have been modelled, but uncertainaties are still present, mainly due to the future contribution of Arctic ecosystems as sink or source

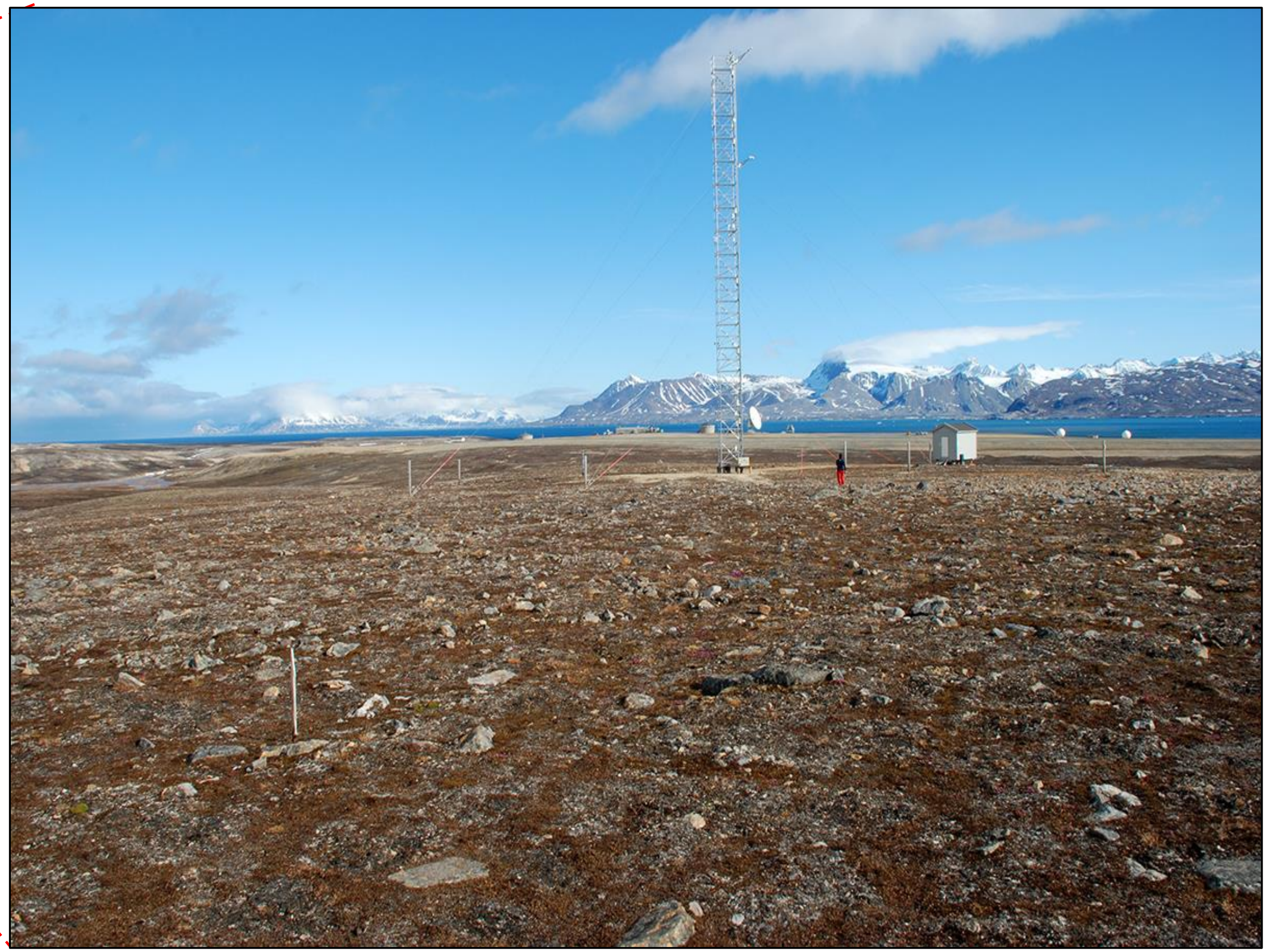



- ❑ In this study, we look at the fate of the newly assimilated carbon in the different plant and soil metabolic pools and fluxes
- ❑ This, with the aim to foresee the contribution of different tundra species to carbon fluxes

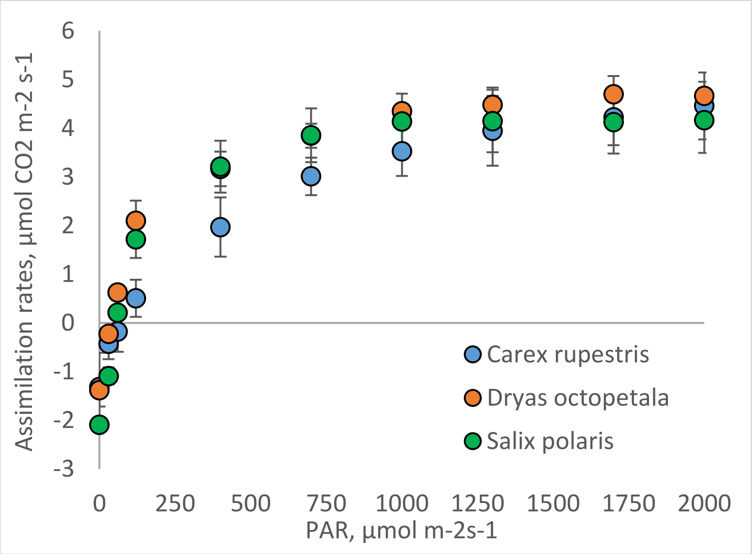
# Study site

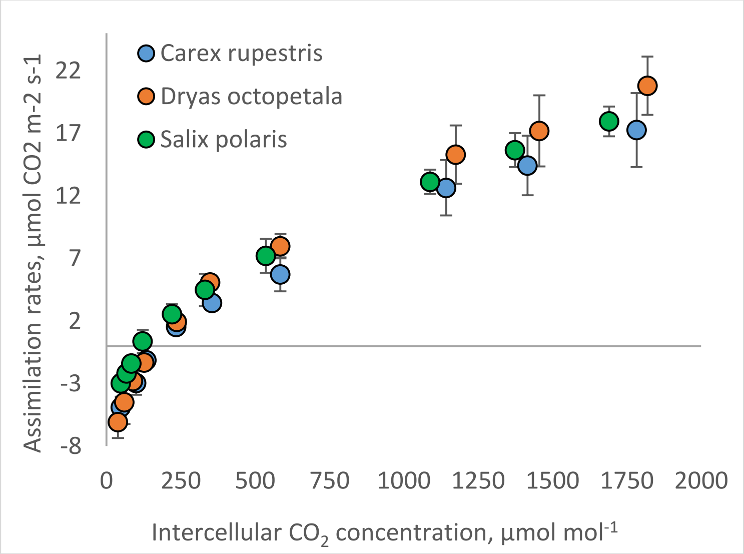
The study was carried out near Ny Ålesund (78°55’ N, 11°56’ E) in the Svalbard archipelago, Norway

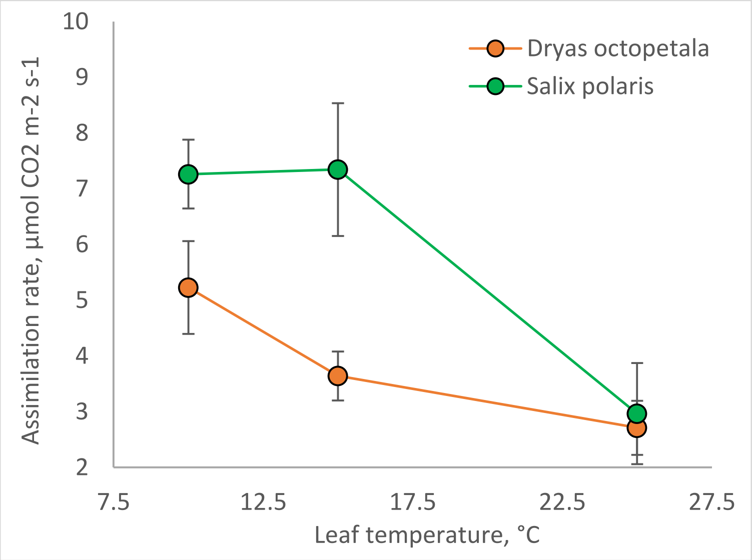



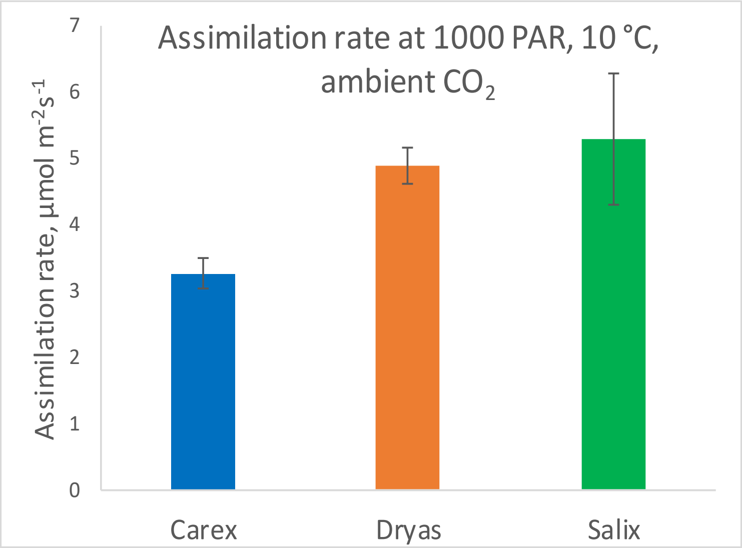
- The study site is defined as a **polar semi-desert**
- Mean annual air temperature is **-4.2 °C** (-13 °C in January and 5 °C in July)
- Annual precipitation about **433 mm**

# Arctic species and their photosynthetic characteristics

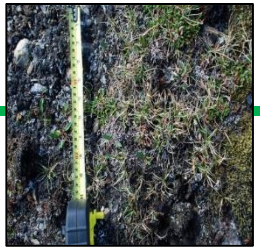



- Assimilation rates show similar response to Light and $CO_2$ concentration, although with some differences
- Decrease of Assimilation to increased temperature is species-specific



*Carex rupestris*

*Dryas octopetala*

*Salix polaris*


**The interaction of biotic and abiotic factors at multiple spatial scales affects the variability of $CO_2$ fluxes in polar environments**

N.Cannone, A. Augusti, F. Malfasi, E. Pallozzi, C Calfapietra, E Brugnoli

**Polar Biology**, 2015 39:1581-1596

# Ecosystem respiration at plot level

During the period from half of July until beginning of August measurements of $CO_2$ efflux at plot level were performed to evaluate separately plant and soil respiration contribution to ecosystem $CO_2$ emission.

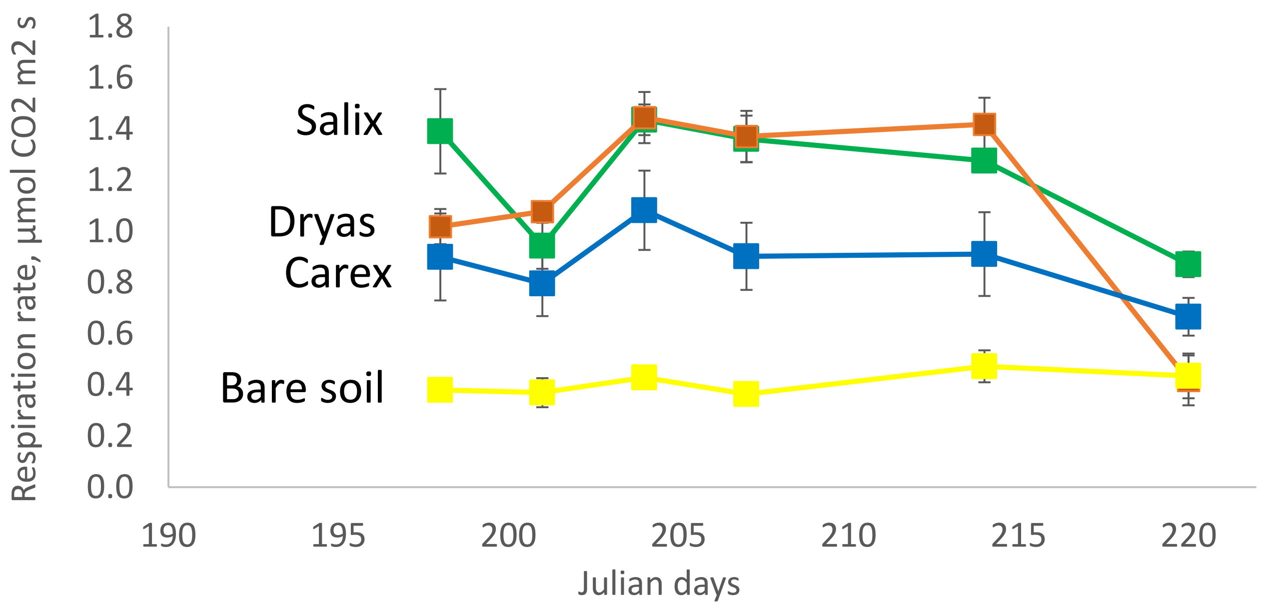
*Carex rupestris*

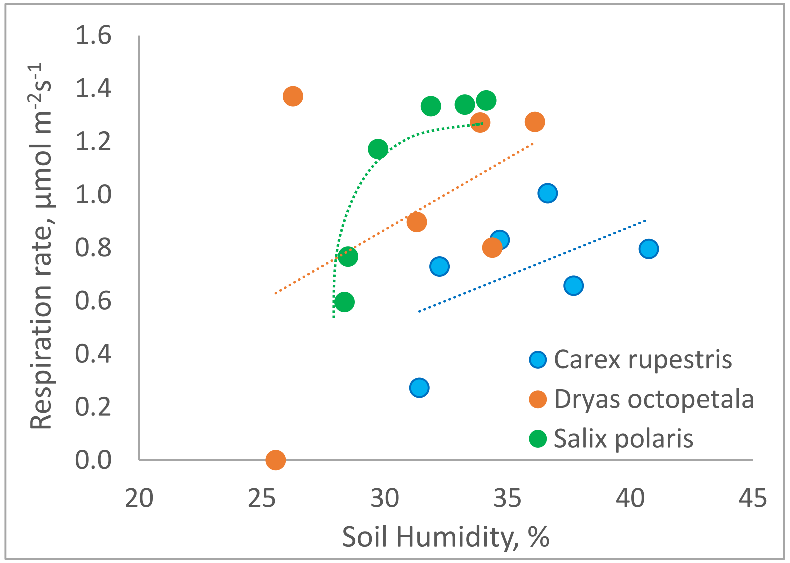
*Dryas octopetala*

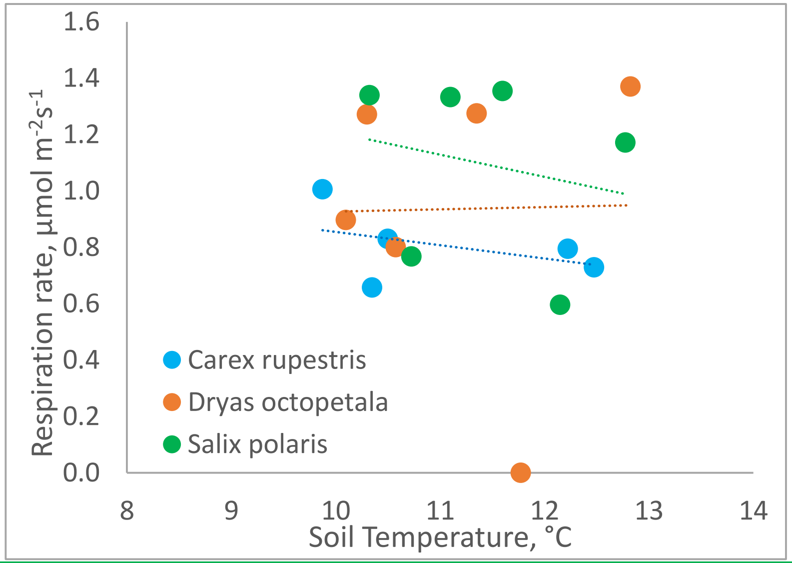
*Salix polaris*

Bare soil with crusts

# Ecosystem respiration seasonal pattern and dependence on climate

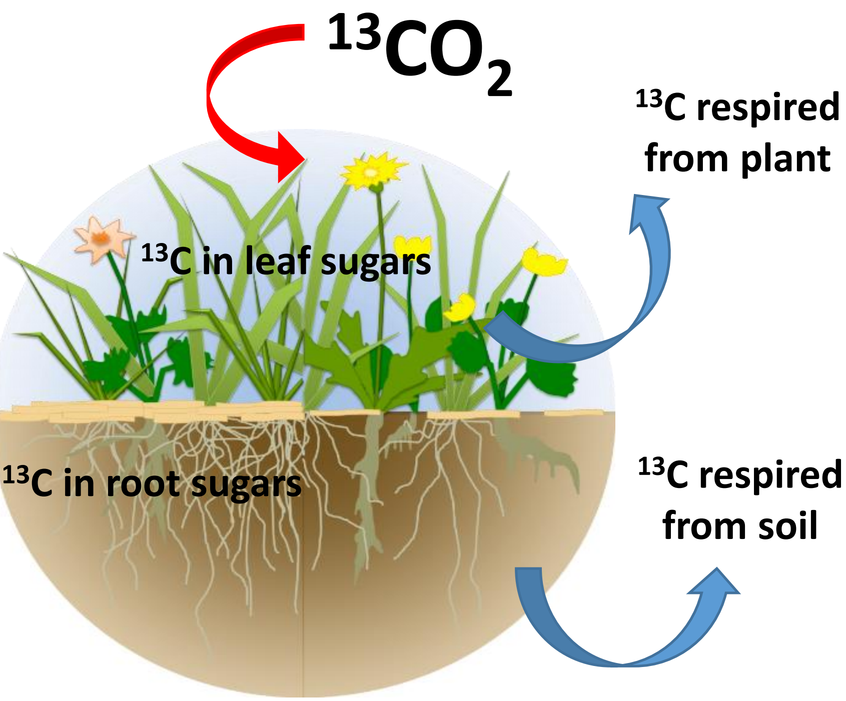


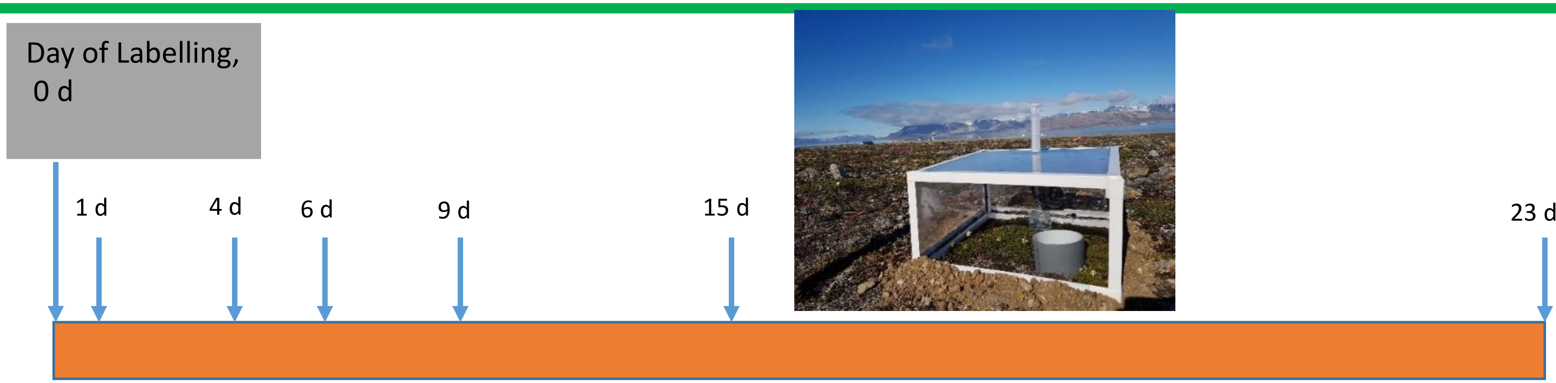



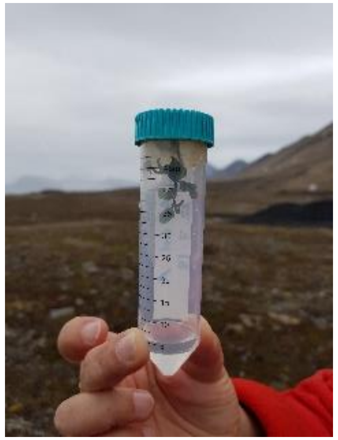

- ❑ $CO_2$ efflux are different for the different species
- ❑ Both seasonal pattern and intensity are different
- ❑ Respiration flux was more sensitive to humidity than to temperature

# Tracing the carbon in the continuum plant-soil in different tundra species

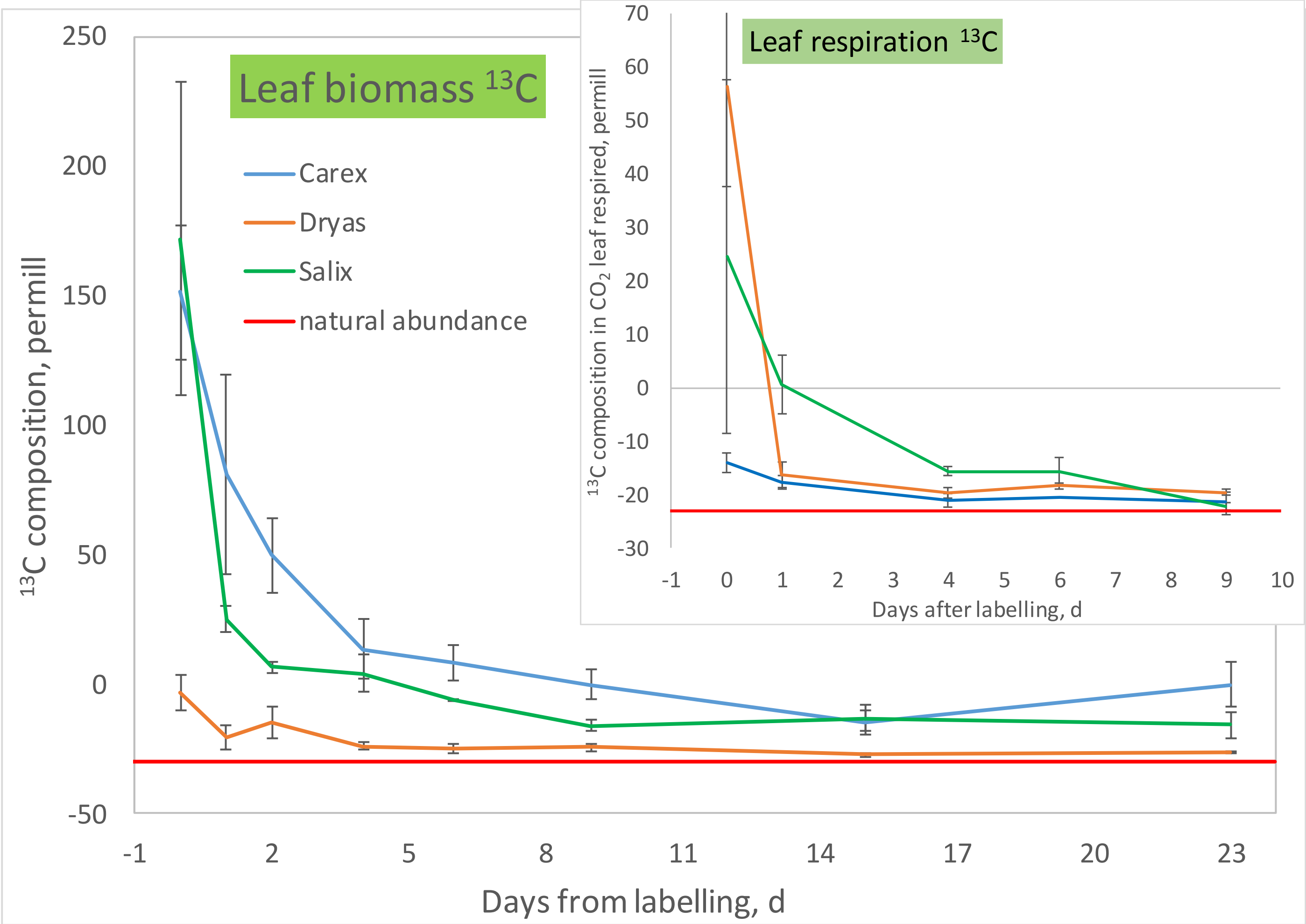


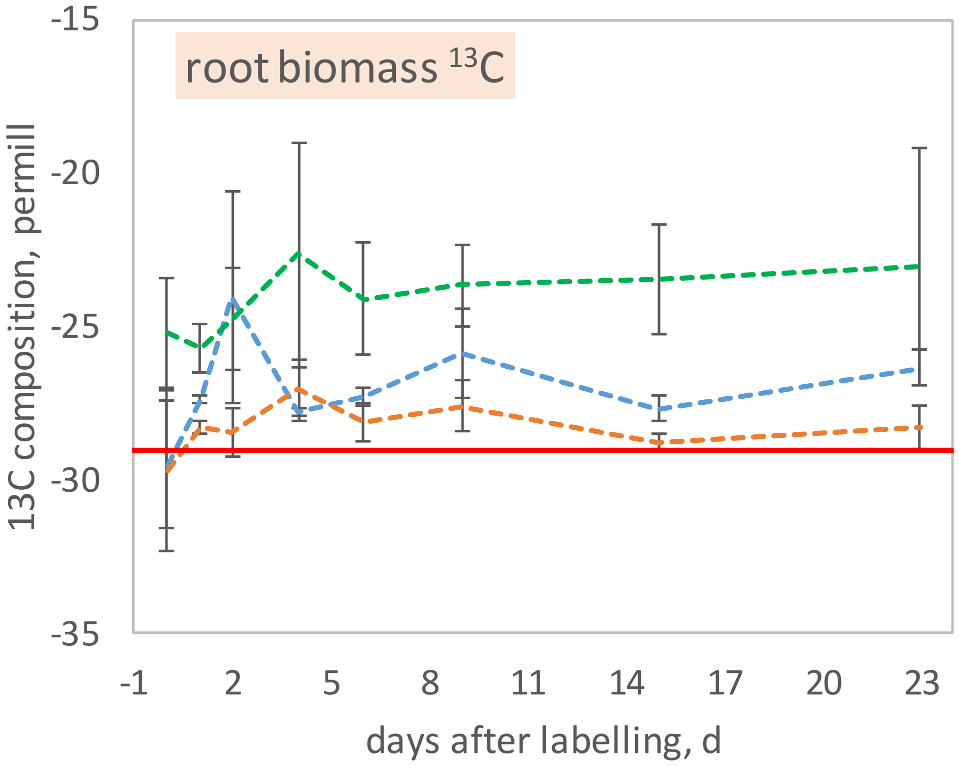




- *Salix*, *Carex* and *Dryas* were incubated with $^{13}C$-$CO_2$ for 40 minutes allowing assimilation of $^{13}C$
- Above-ground material and soil core were collected on day 0, 1, 4, 6, 9, 15 and 23 after labelling
- To trace C enrichment, $^{13}C$ composition was measured, via IRMS, on:
  - leaf and root bulk material
  - plant specific-compounds
  - soil
- To trace $^{13}C$ in respiratory fluxes, incubation onsite of plant material and soil in presence of NaOH was performed on days 0, 1, 4, 6 and 9 after labelling
- NaOH samples titrated with HCl and precipitated with $SrCl_2$ were analysed for $^{13}C$



# Newly assimilated Carbon in leaves and roots of tundra species



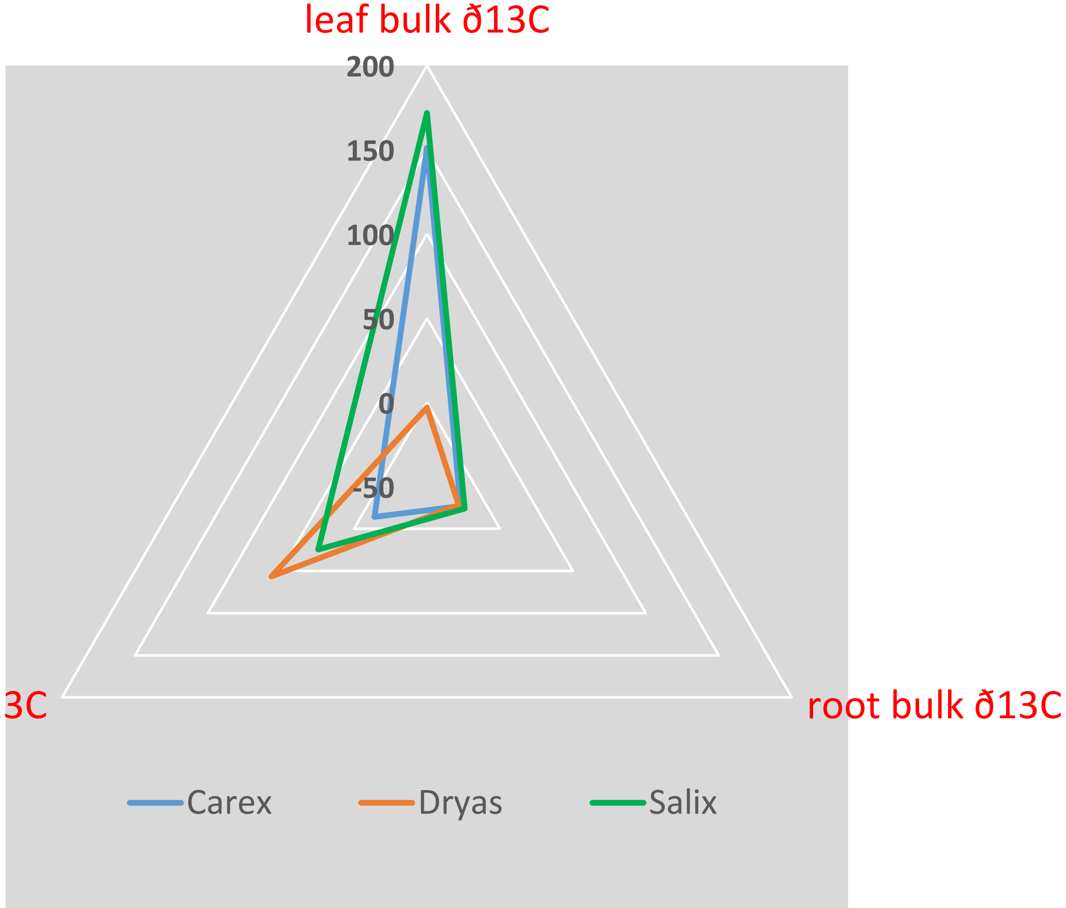




Salix levels of $^{13}C$ in roots are higher compared to the other species

Carex and Salix incorporated highest amount of $^{13}C$ in leaves

Dryas seems to emit highest amount of $^{13}C$ from leaves

# $^{13}C$ allocation in Arctic plants




- Althought the $^{13}C$ enrichment confirmed the expected pattern, C allocation in Arctic ecosystems shows differences among the species
- Carex and Salix invest most of the newly formed C in above ground biomass
- For Dryas, most of the newly formed C is lost in respiration

# Preliminar conclusions and open question

- The most representatives higher plant species, present at the Ny Alesund site, contribute differently to carbon sequestration and emissions
- *Carex* and *Salix* invest most of the C assimilated in above-ground biomass, but in which molecular compound they invest most?
- *Dryas* emits good part of assimilated C at shoot level
- These behaviours are partially confirmed by assimilation and respiration data
- What about soil, how much of the C assimilated at plant level is respired by microbial community?

# Ongoing studies and future perspectives

- ❑ Ongoing analysis of $^{13}C$ on leaf and root soluble sugars and storage sugars will complete the overview on the allocation of C between above and below-ground in Arctic species
- ❑ Ongoing analysis of $CO_2$ evolved from soil will give insights on the residence time of C in the soil and on the microbial biomass content in Arctic soil

- ❑ In future, the results obtained for these species, together with their abundance can be used to estimate their contribution to C fluxes that should be considered in climate models

# Acknowledgement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