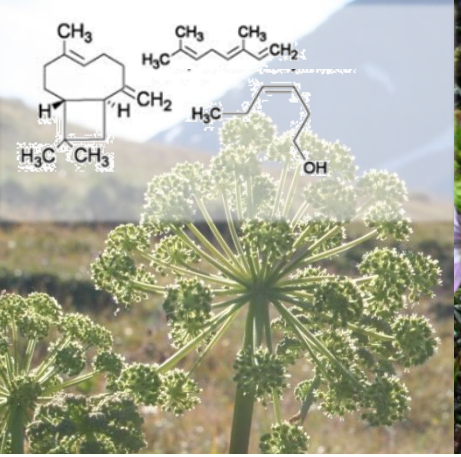

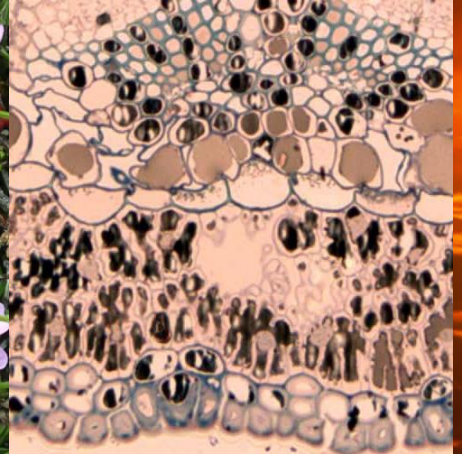
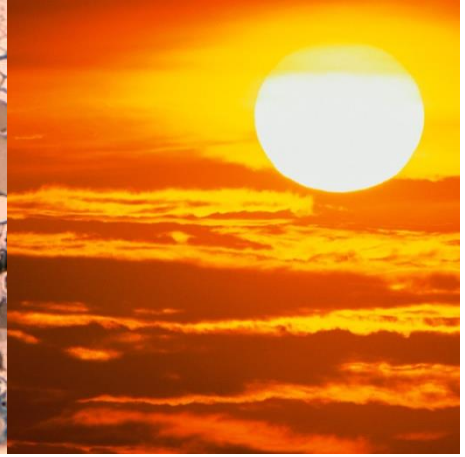

Effects of warming on herbivore-induced plant volatiles in the tundra

Tao Li, Jolanta Rieksta, Anders Michelsen, **Riikka Rinnan**

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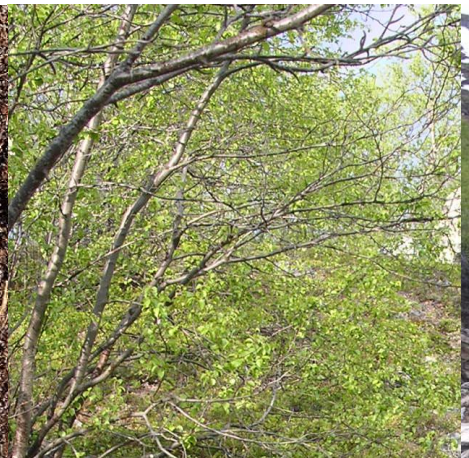



Functional plant traits

Permafrost thaw & soil carbon

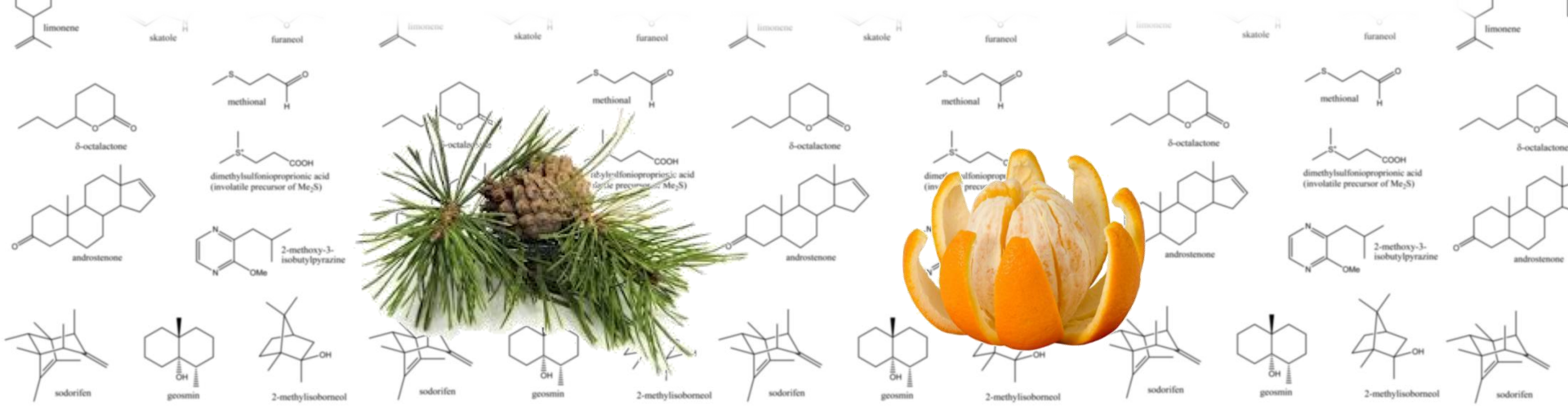
Eddy covariance & remote sensing

But today we focus on insect herbivory…

What are

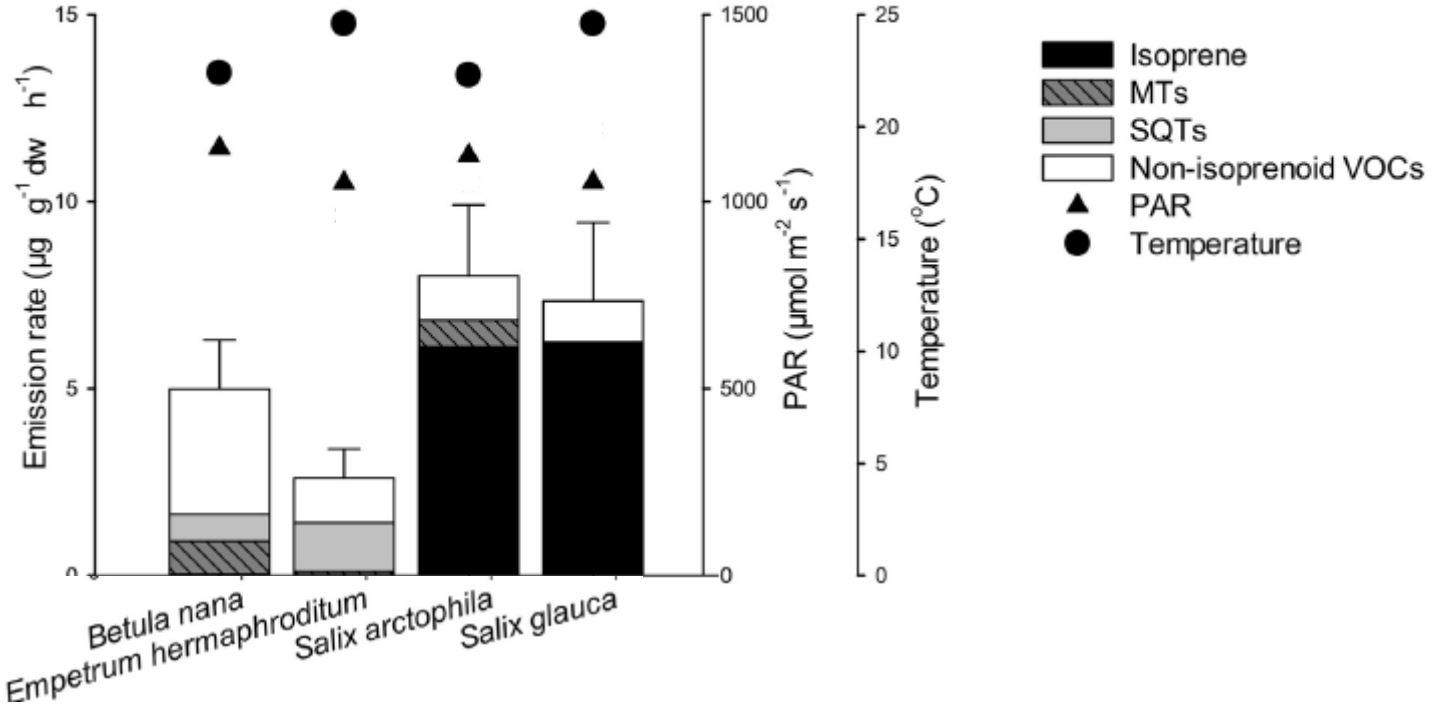
plant volatiles?

Volatile Organic Compounds, VOCs



Each plant species has different VOC ”bouquet” -

Vegetation changes alter ecosystem VOC emissions

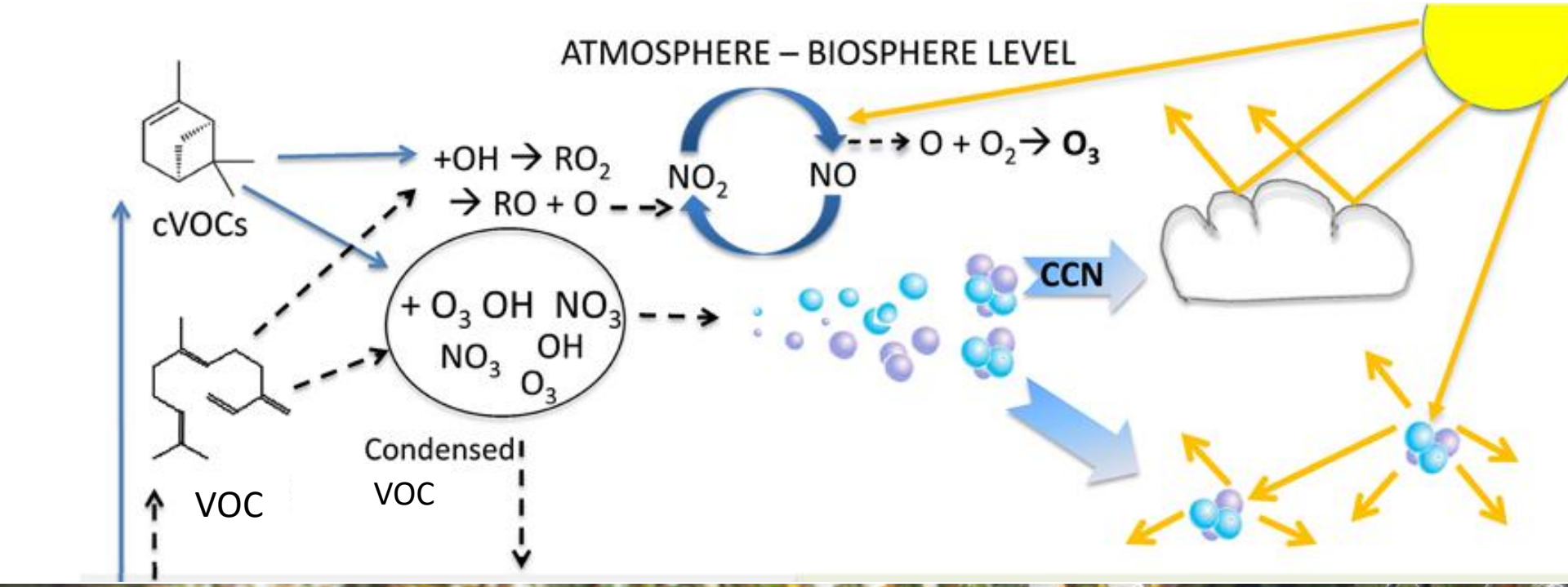


Vedel-Petersen et al. 2015. *Atmospheric Environment*

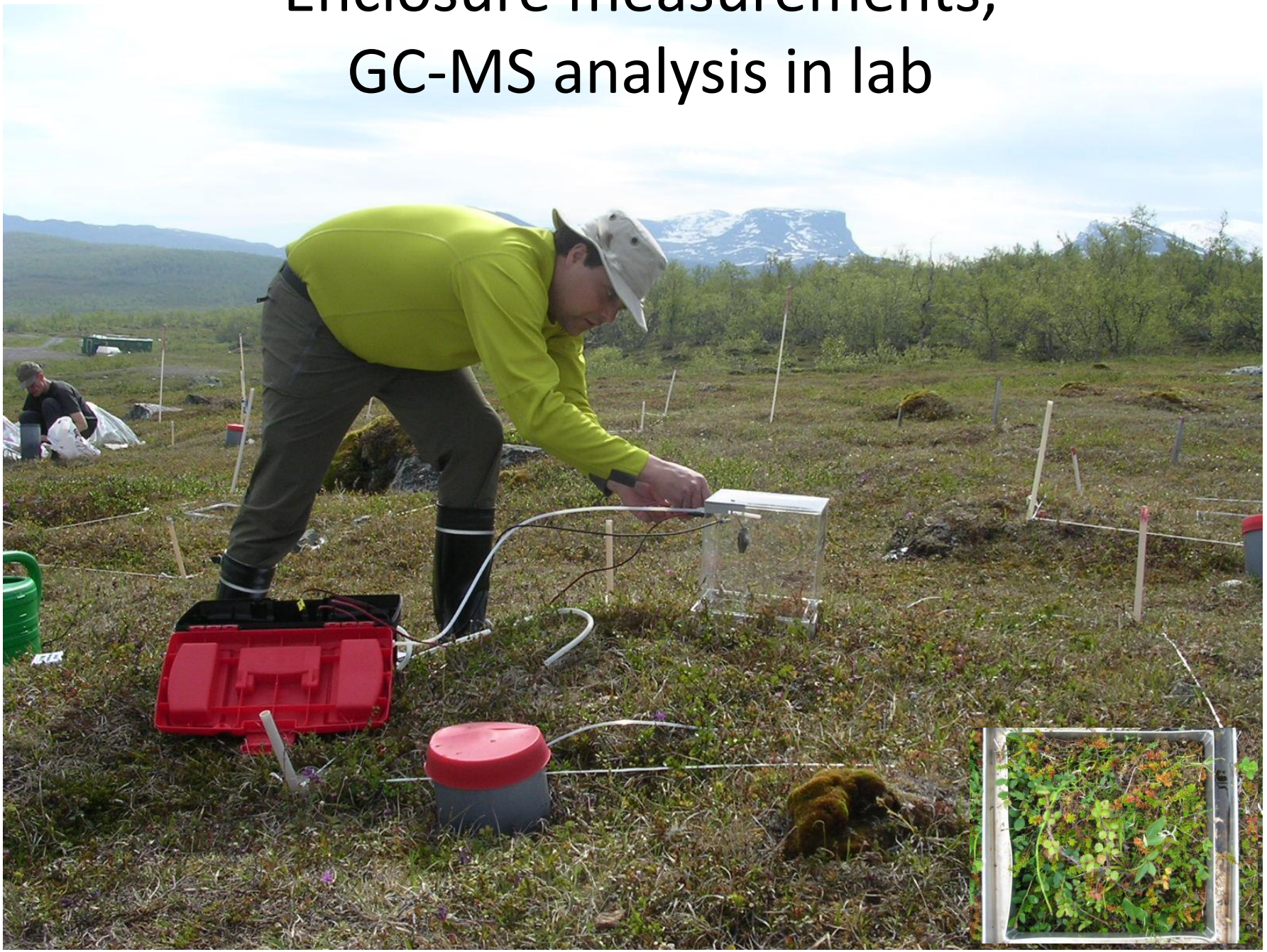
The atmosphere

Compound	**Concentration (**parts per billion, ppb)	**Lifetime (years)**
Nitrogen	781 000 000	1.6×10^7
Oxygen	209 000 000	>3000
CO_2	400 000	not defined (5-200)
CH_4	1800	12
N_2O	300	110
Methanol	1-10	0.02
Toluene	0.5-2	0.02
Isoprene	0.5-10	0.0002
Monoterpenes	0.5-2	0.0000001-0.001

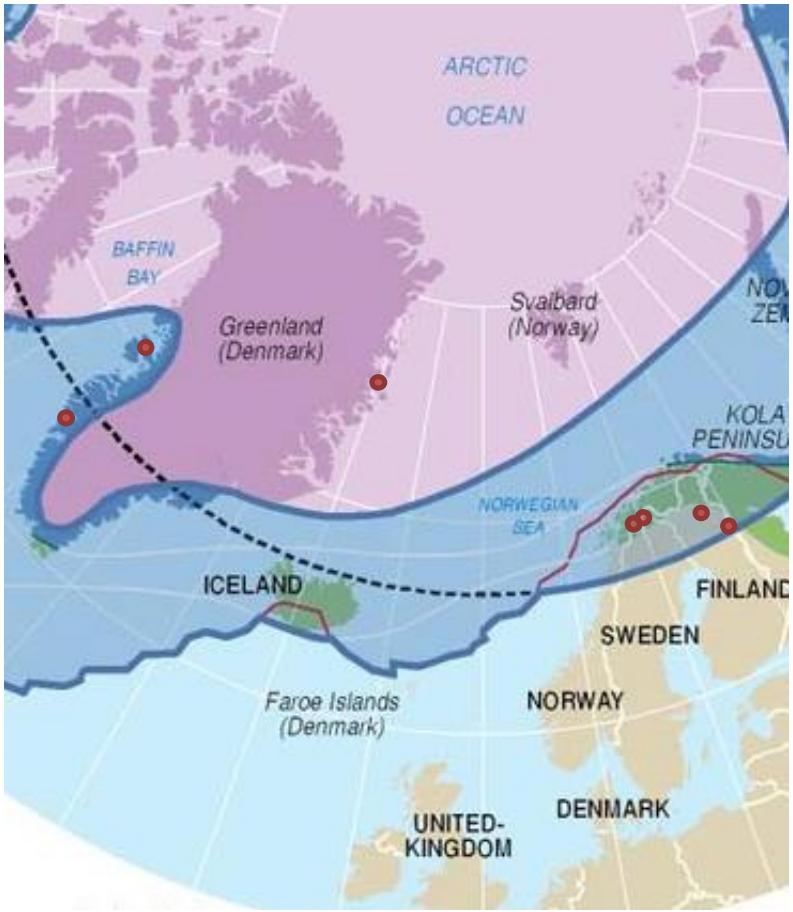
Encyclopedia Britannica


ATMOSPHERE – BIOSPHERE LEVEL
cVOCs
+OH → RO2
→ RO + O
NO2
NO
O + O2 → O3
+ O3 OH NO3
NO3 OH
O3
CCN
Condensed
VOC
VOC

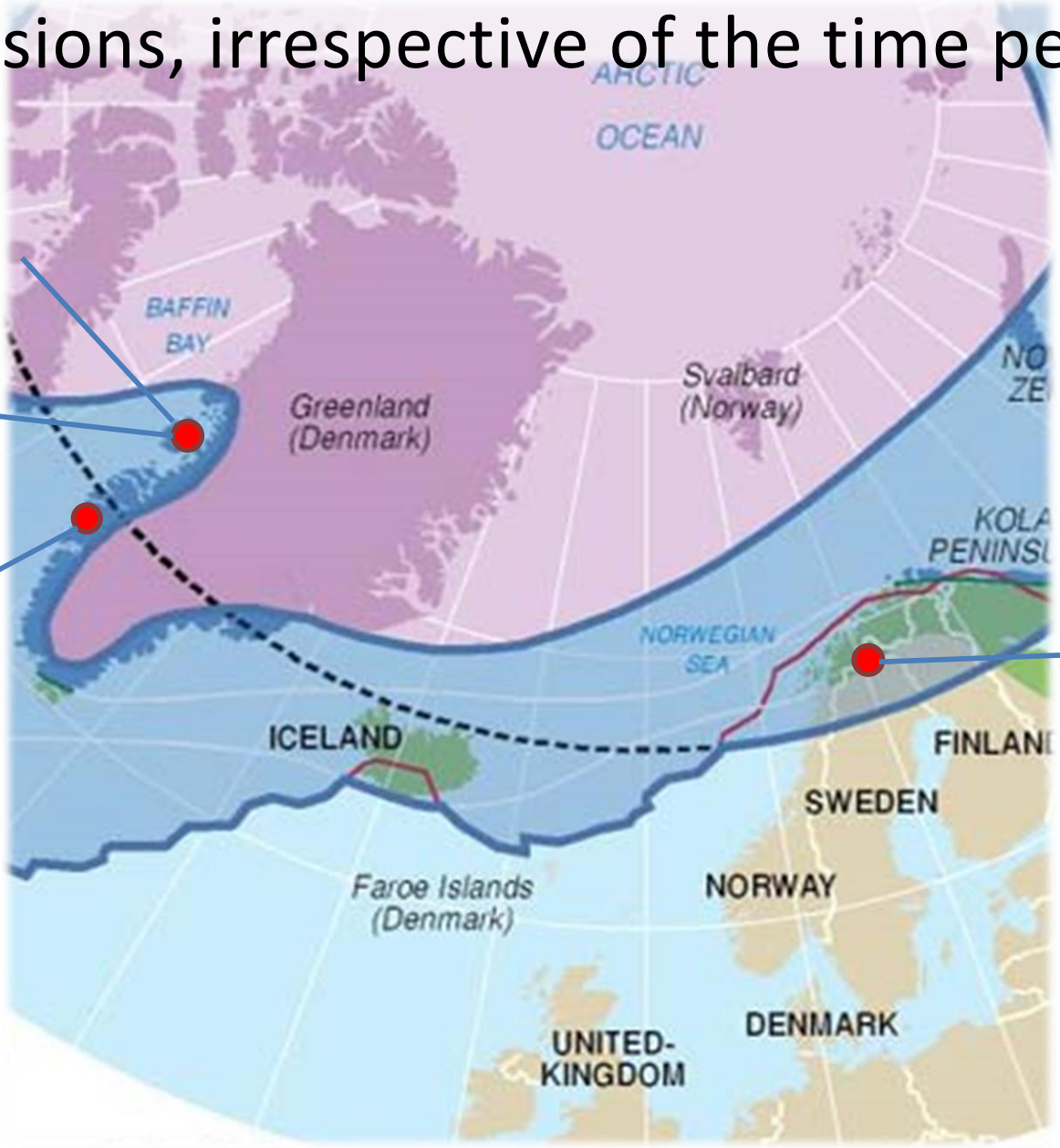
Enclosure measurements, GC-MS analysis in lab



Long-term multifactor experiments



OTC warming causes large increases in arctic tundra VOC emissions, irrespective of the time perspective



240-340%

Lindwall et al. 2016, STOTEN

280%

Lindwall et al. 2016, JGR Biogeosciences

260%

Kramshøj et al. 2016, Nature Geoscience

~100%

Valolahti et al. 2015, Global Change Biology

Faubert et al. 2010, New Phytologist

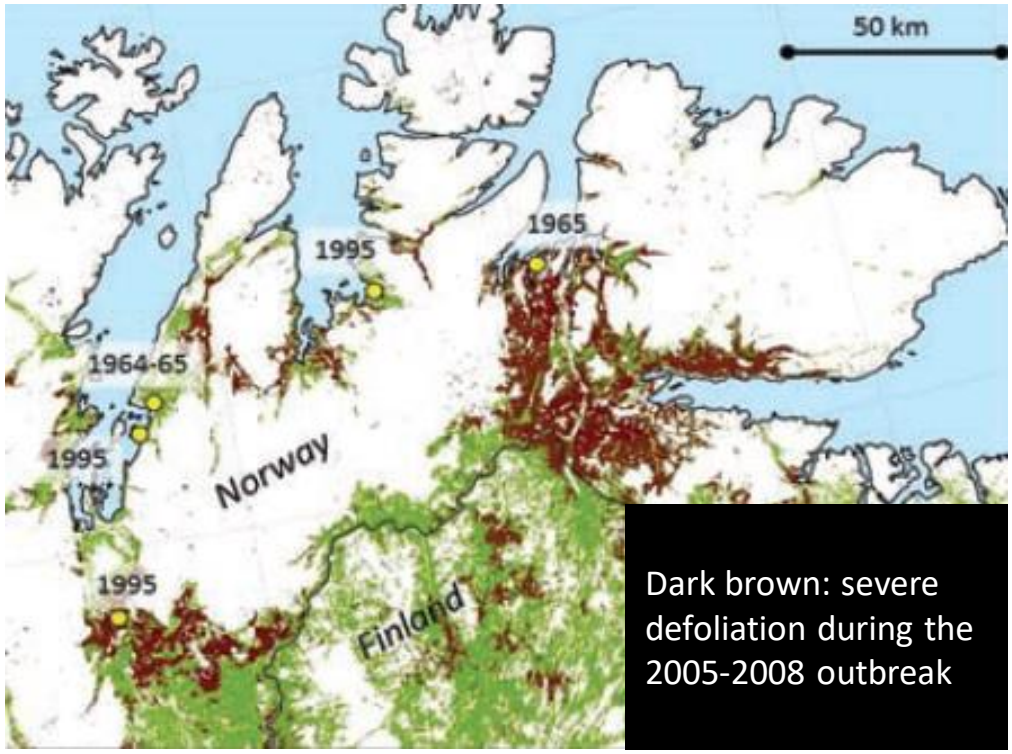
Tiiva et al. 2008, New Phytologist

Are VOC emissions from **alpine tundra** outside the Arctic as temperature sensitive?

Contact me
if interested in
collaboration!

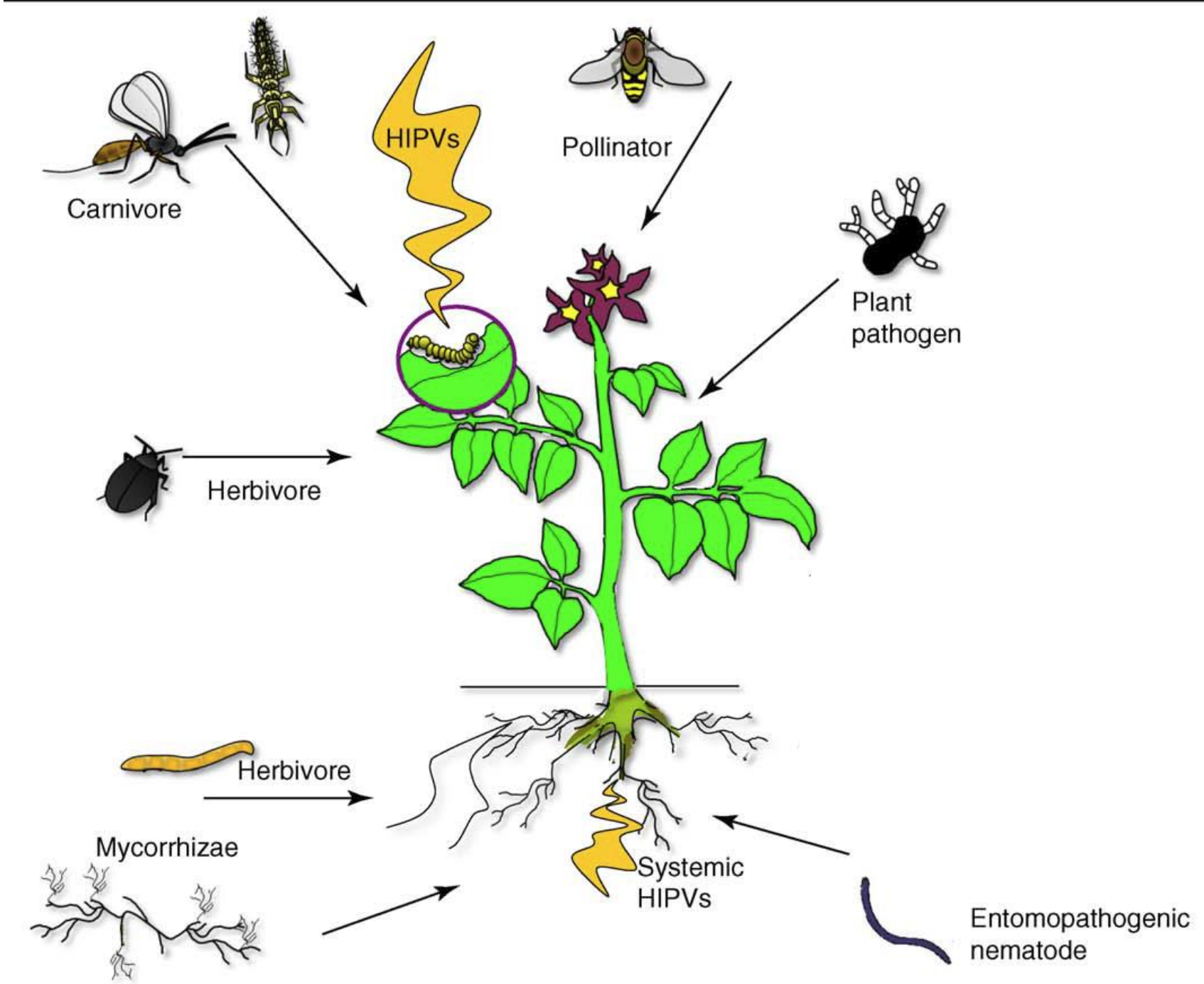
What about biotic stresses like insect herbivory?

Outbreaks of the geometrids *Operophtera brumata* and *Epirrita autumnata* in subarctic birch forests



Dark brown: severe defoliation during the 2005-2008 outbreak

Post et al. 2009. *Science*

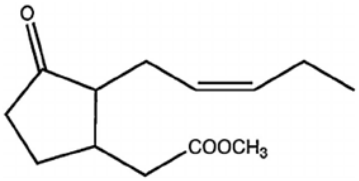


Dicke & Baldwin 2010. *Trends in Plant Science*

Abisko, Sweden

Comparison of larval feeding and mimicked herbivory effects on *Betula nana* volatiles

Epirrita autumnata

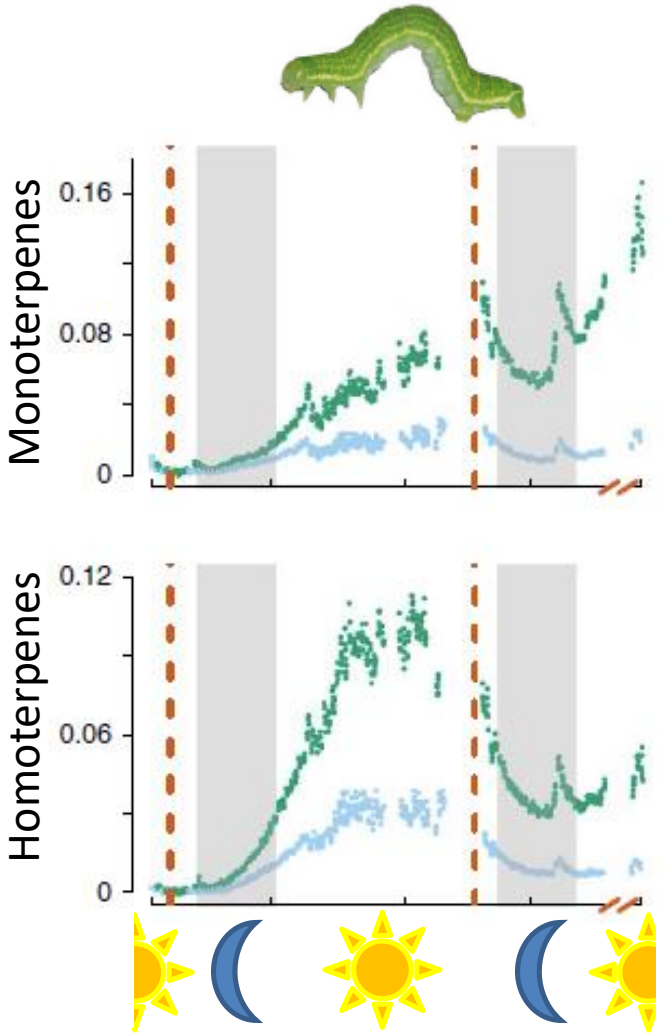


Methyl jasmonate (MeJA)

Proton transfer reaction-time of flight-mass spectrometer

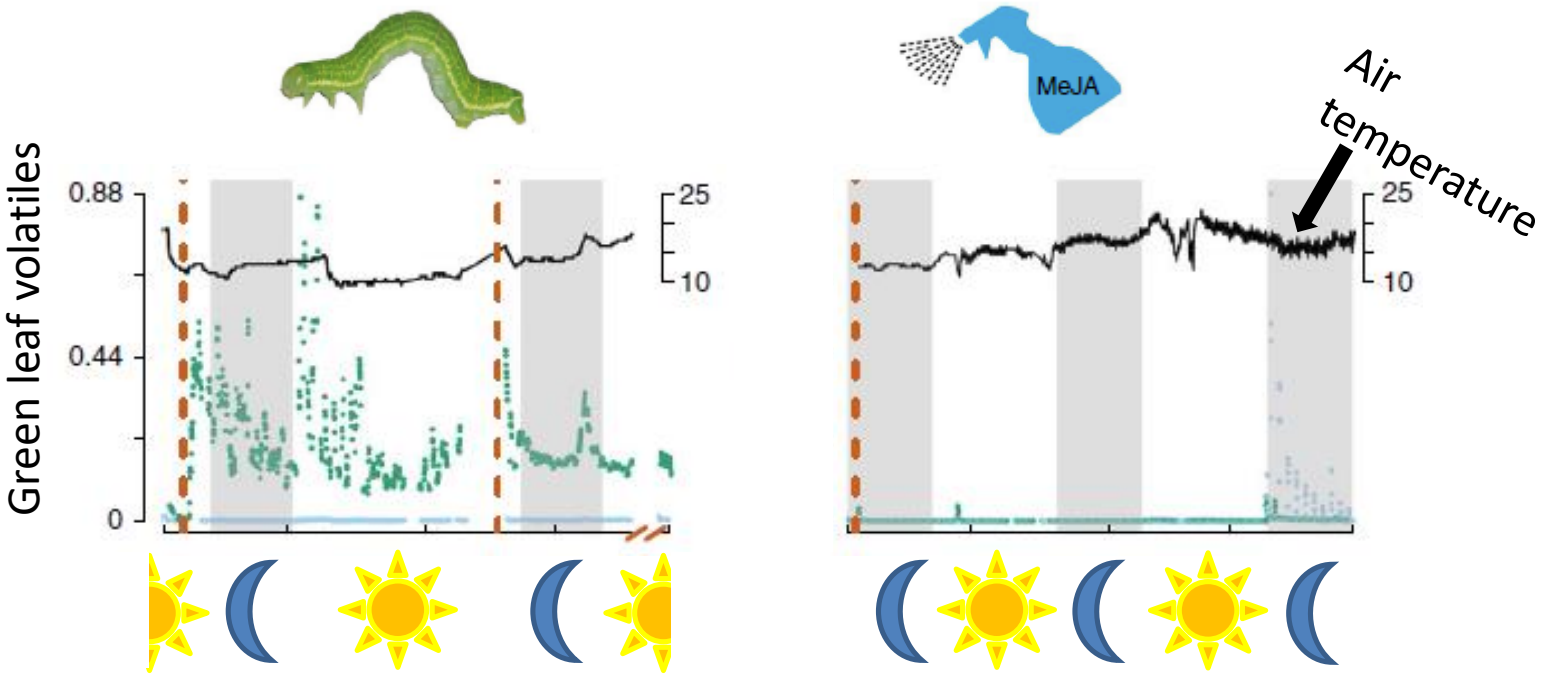
Li et al. 2019. *Nature Plants*

Larval feeding and mimicked herbivory (MeJA-treatment) had similar effects on *induced* VOCs



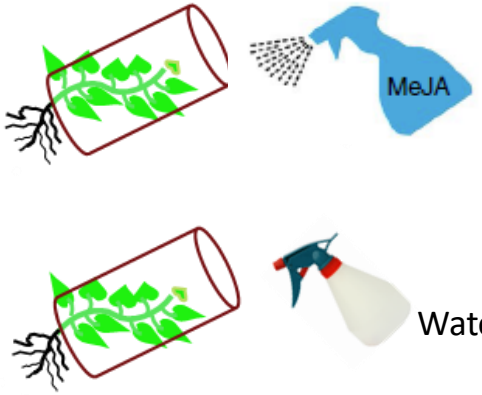
Li et al. 2019. *Nature Plants*

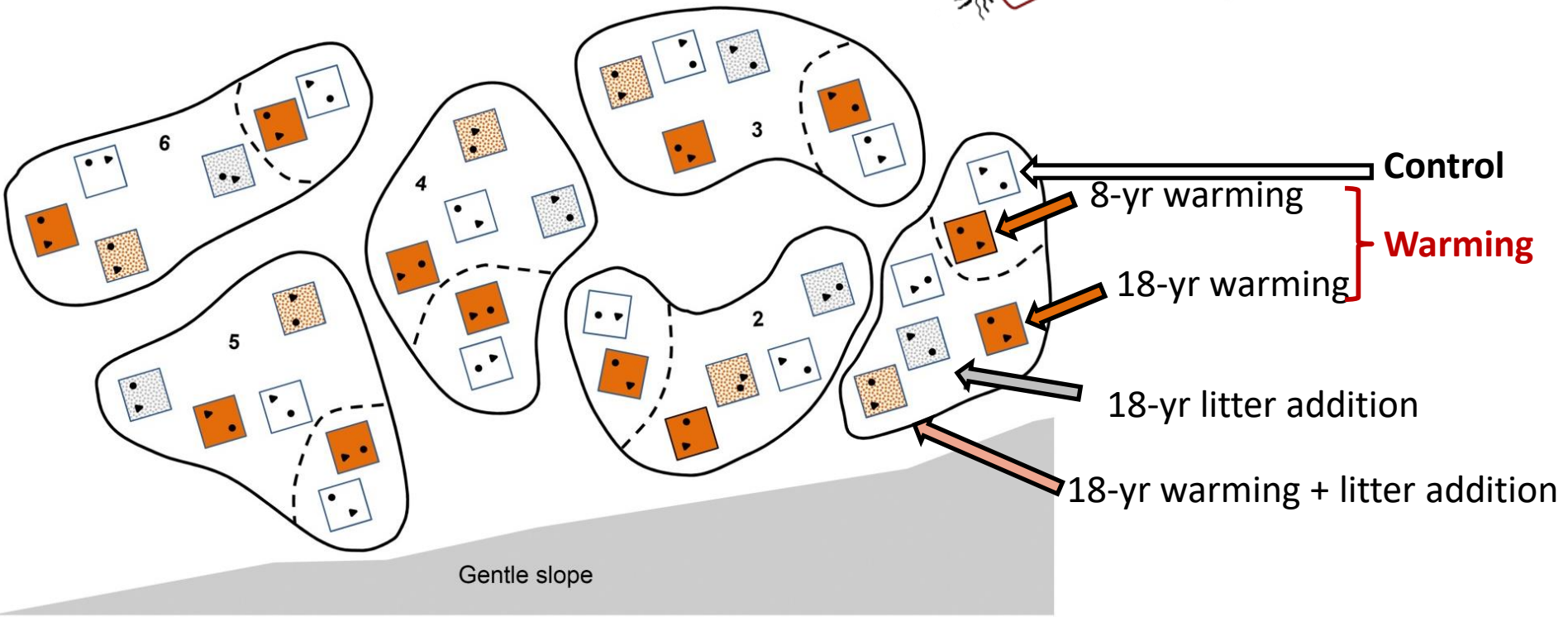
But MeJa-treatment did not mimick larval feeding effects on compounds released from broken tissue



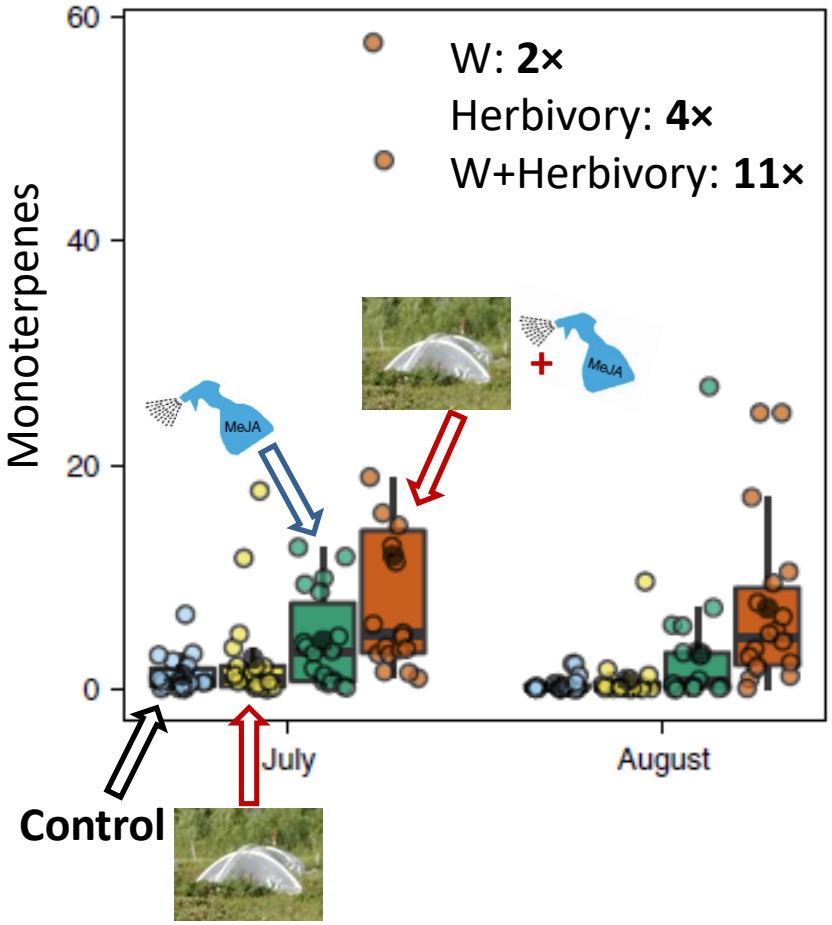
Li et al. 2019. *Nature Plants*

Effects of warming and herbivory on *Betula nana* volatiles



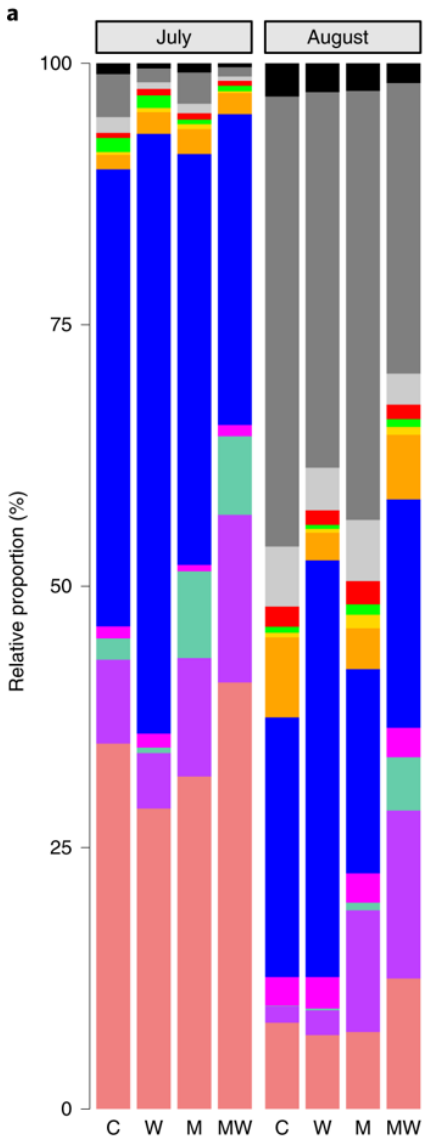


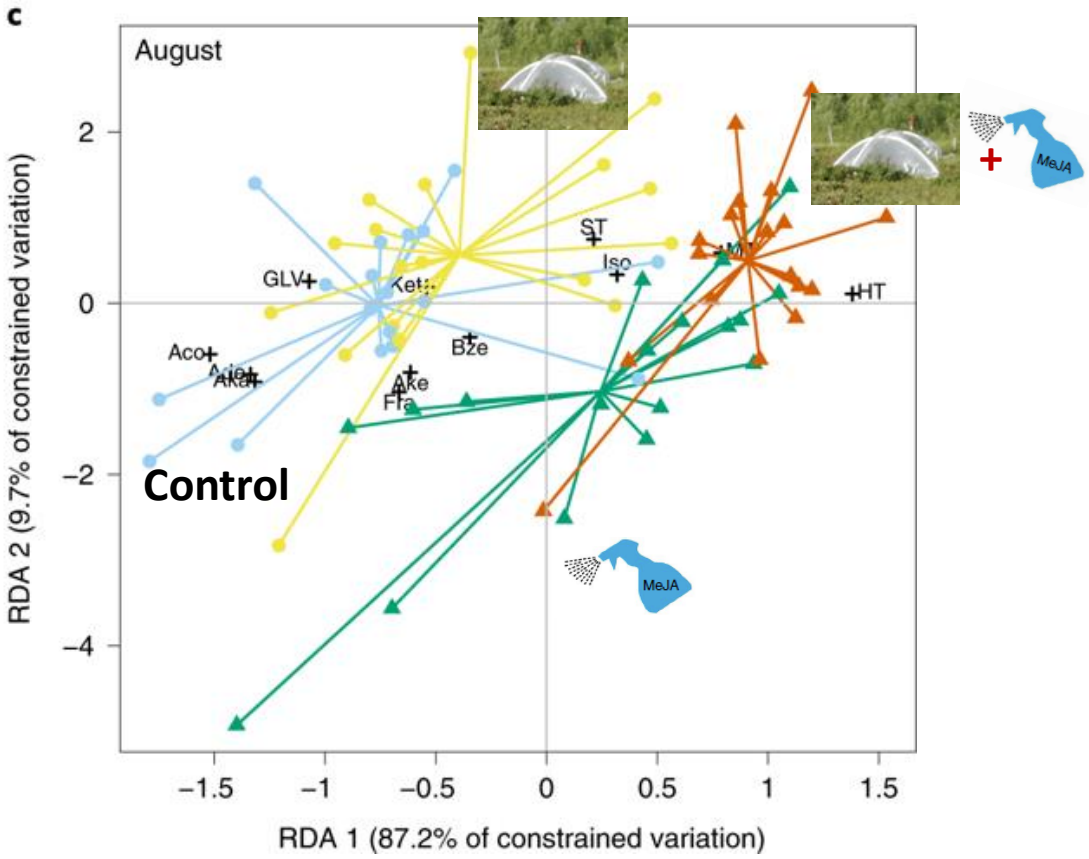
Warming amplifies effects of herbivory on *Betula nana* volatiles



Li et al. 2019. *Nature Plants*

Compound composition of *Betula nana* volatiles strongly altered by herbivory





Li et al. 2019. *Nature Plants*

Herbivory drastically increases VOC release

especially under warmer climate

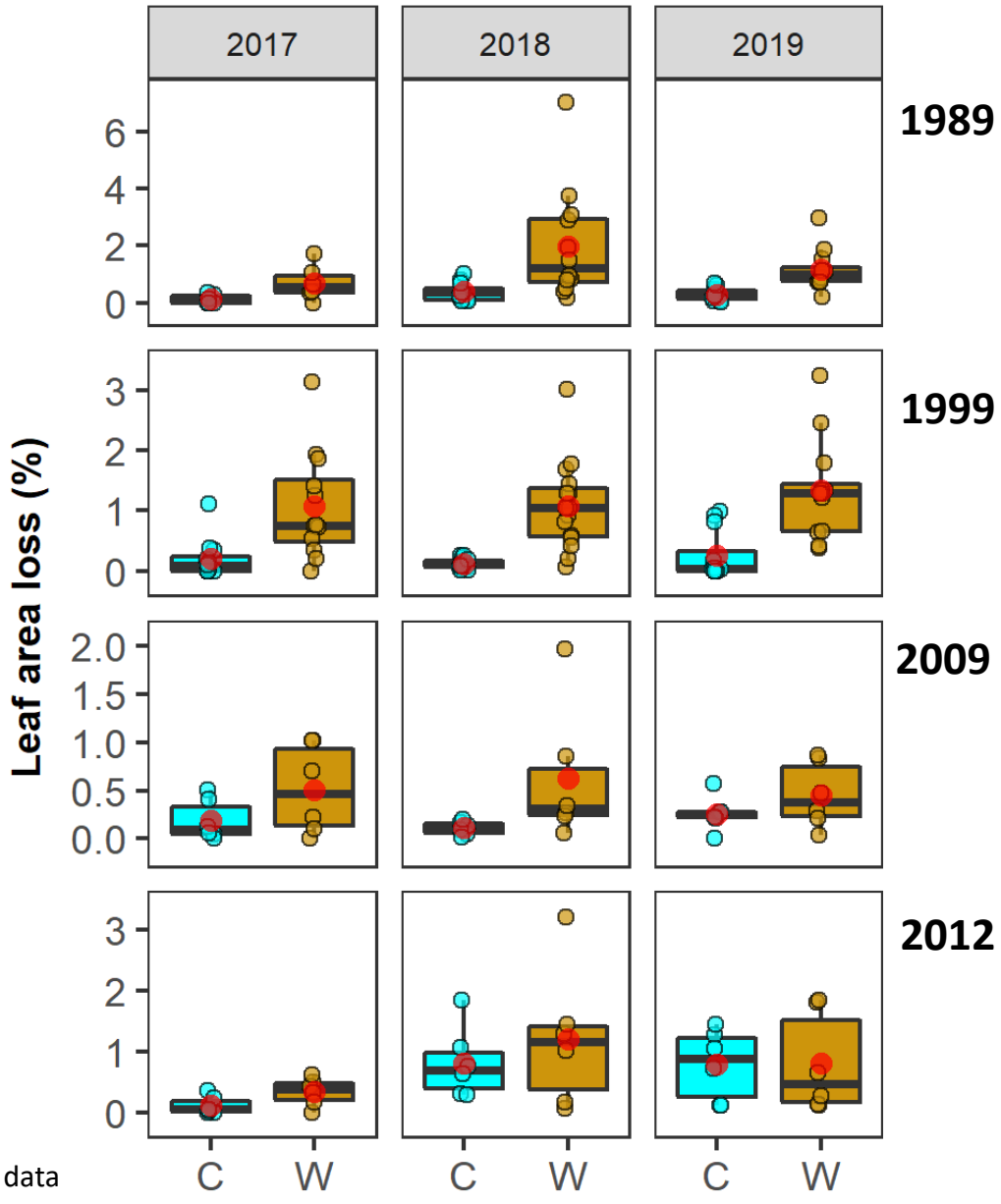
but how does warming impact herbivory?

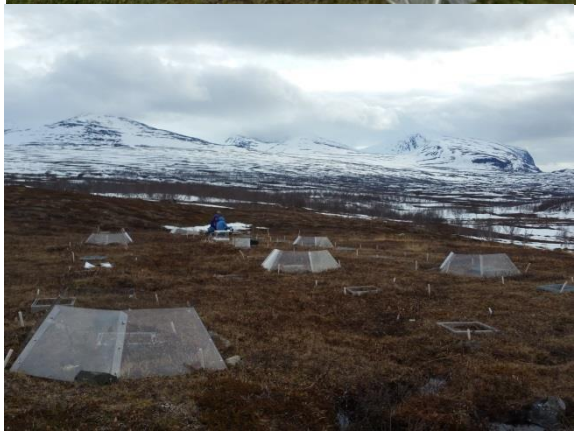
Effects of warming on herbivory

Leaf area loss
estimated in 3 *B. nana* twigs per plot

Li, Rinnan et al. unpubl. data

OTC warming strongly increases leaf area loss due to chewing insects





Li, Rinnan et al. unpubl. data

Take-home messages

- **Biotic stress (insect herbivory) drastically increases VOC release from *B. nana***
  - Induced production
  - changed compound composition
- **Warming amplifies the herbivory effects**
- **OTCs increase herbivory damage**

Importance on atmospheric chemistry and climate?

Implications on ecological interactions?

Thank you!

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@Riikka_Rinnan

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