

Field work at Iškoras and input to transpiration modelling

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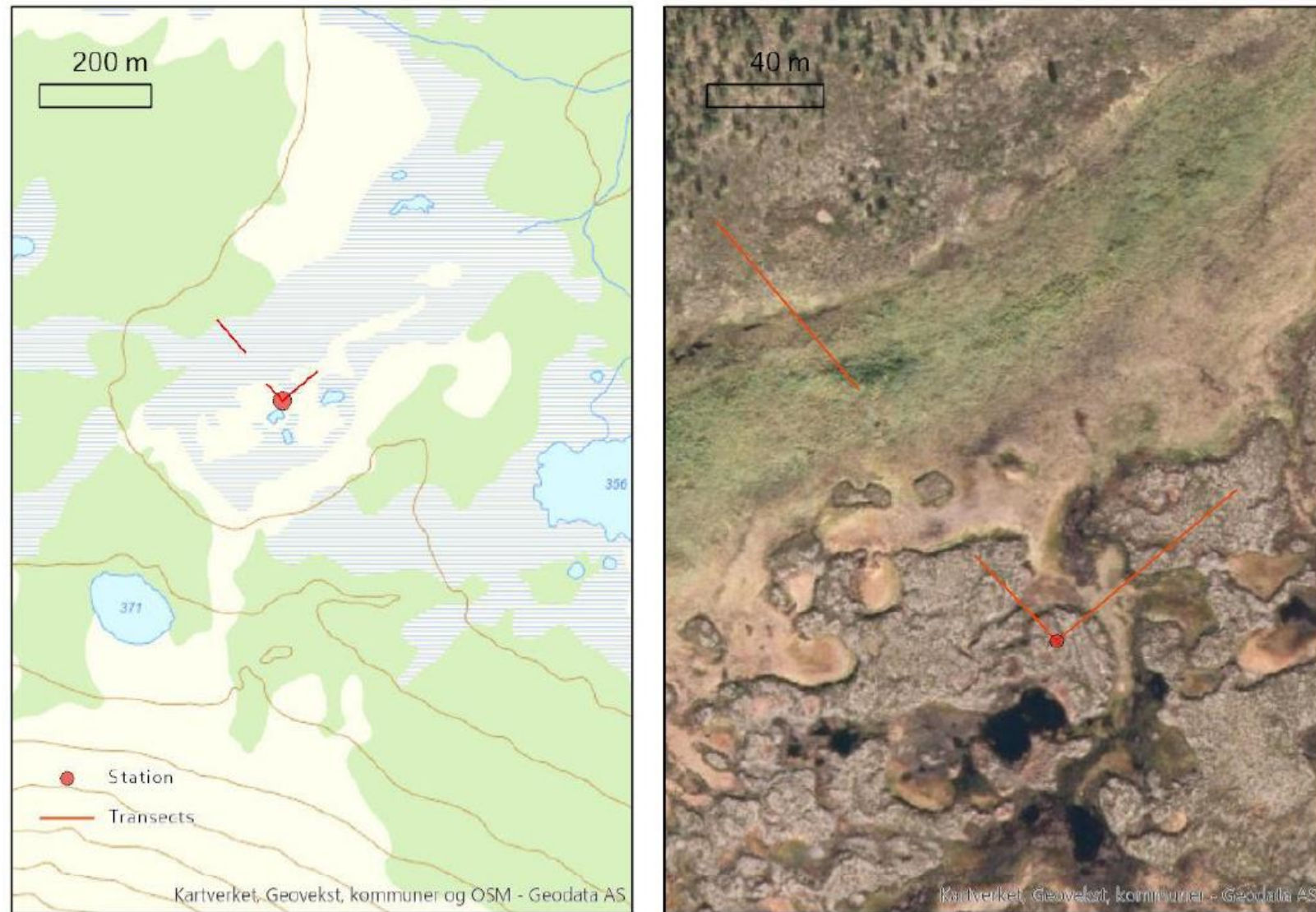


Figure 6 Overview of transects along which vegetation and soil moisture were sampled. Aerial photo (right) from August 2011. Map and orthophoto from Kartverket.

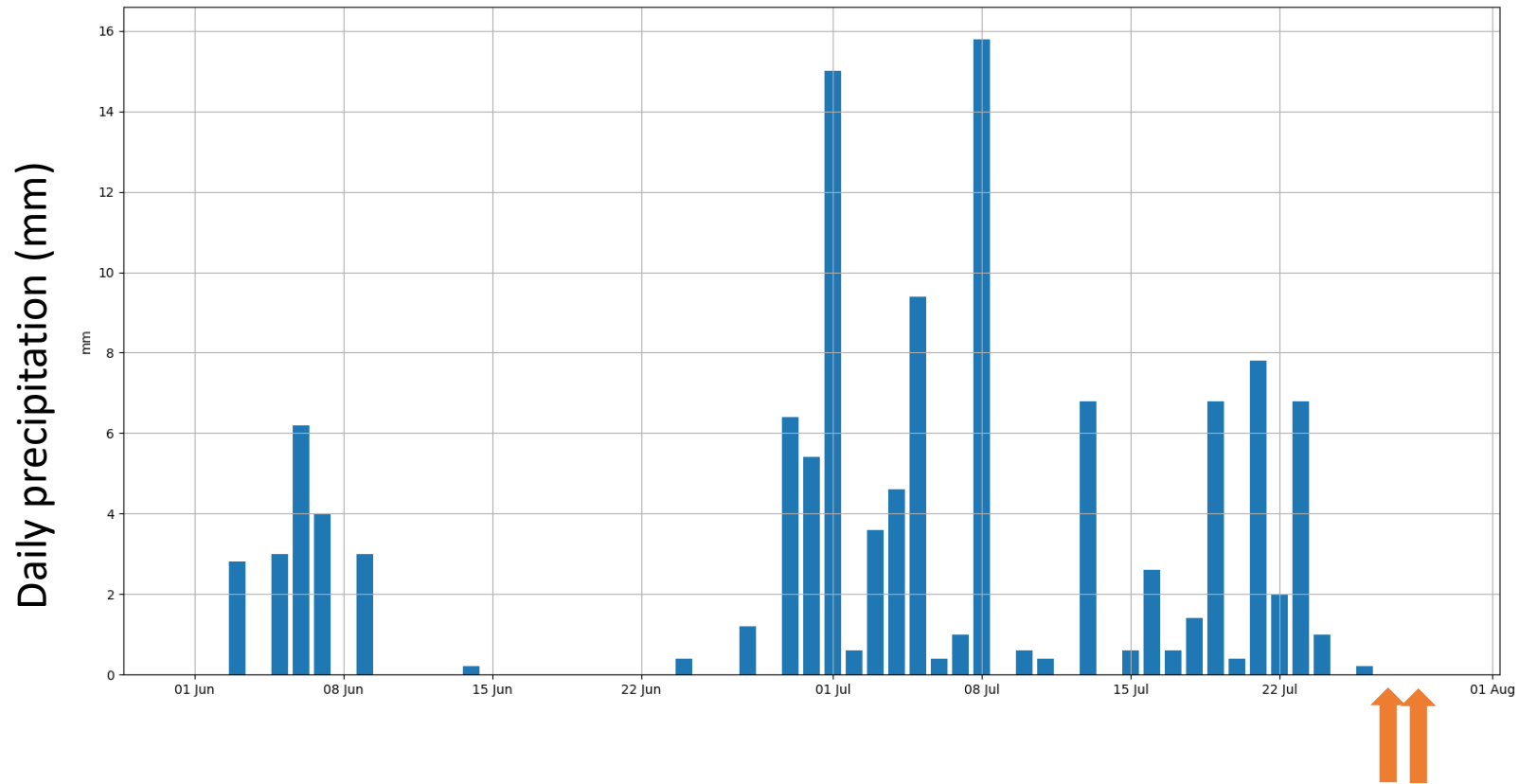
Work along transects from the tower



- Distance to frozen ground
- Volumetric soil water content
- Presence of plant groups
- Height of tallest plants
- Coverage of bare soil, open water, lichens, mosses



Precipitation before measurements

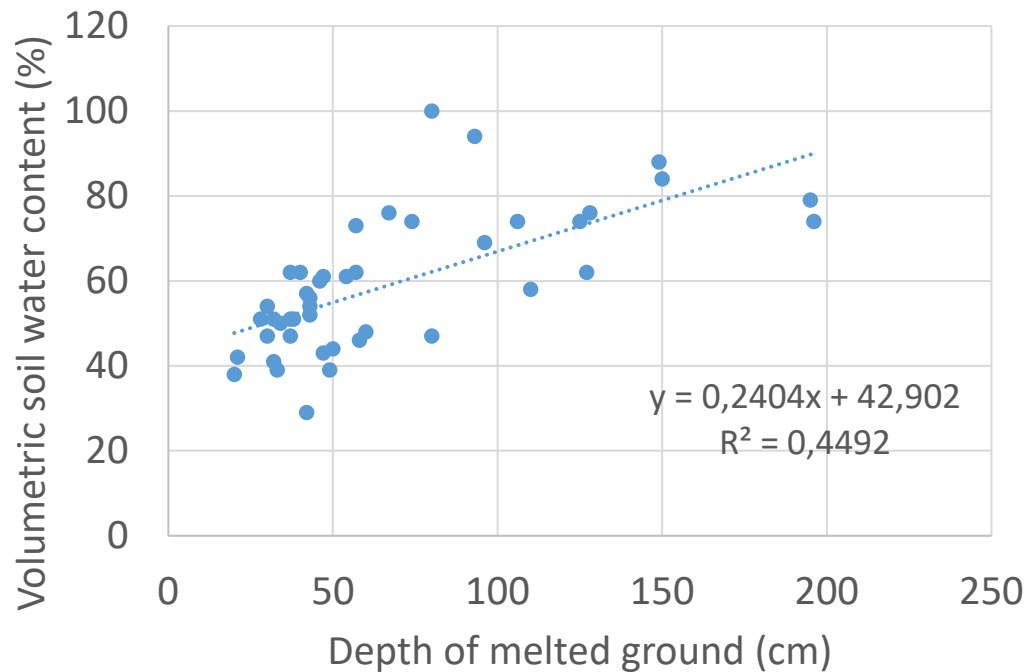


Two or three days
without rain

But 150 % of normal
precipitation in July

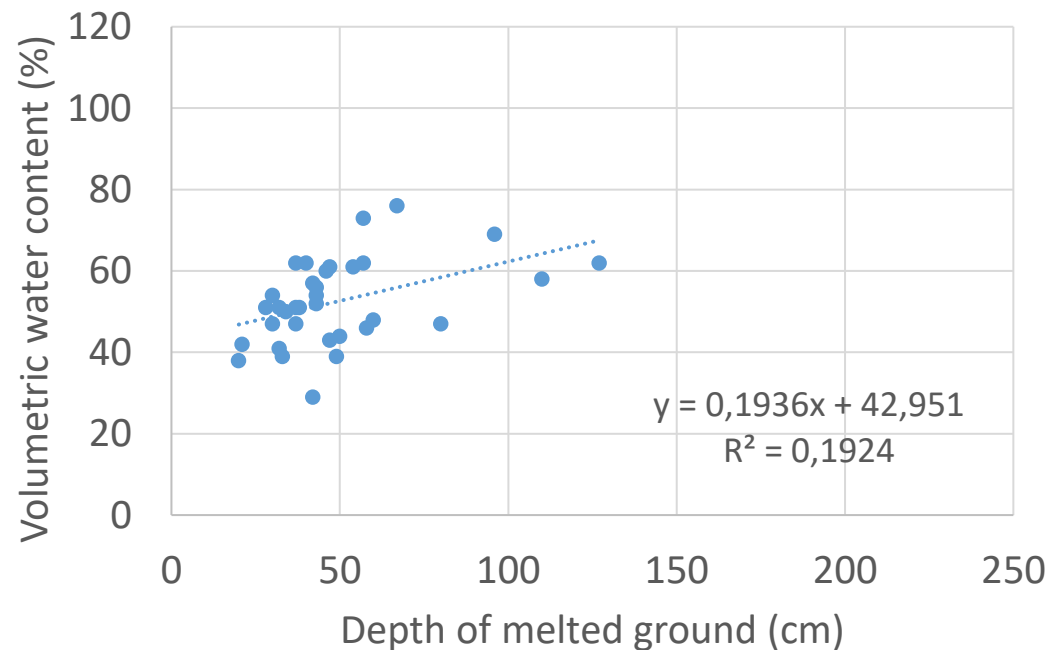
Snapshot of volumetric soil water content

All plots

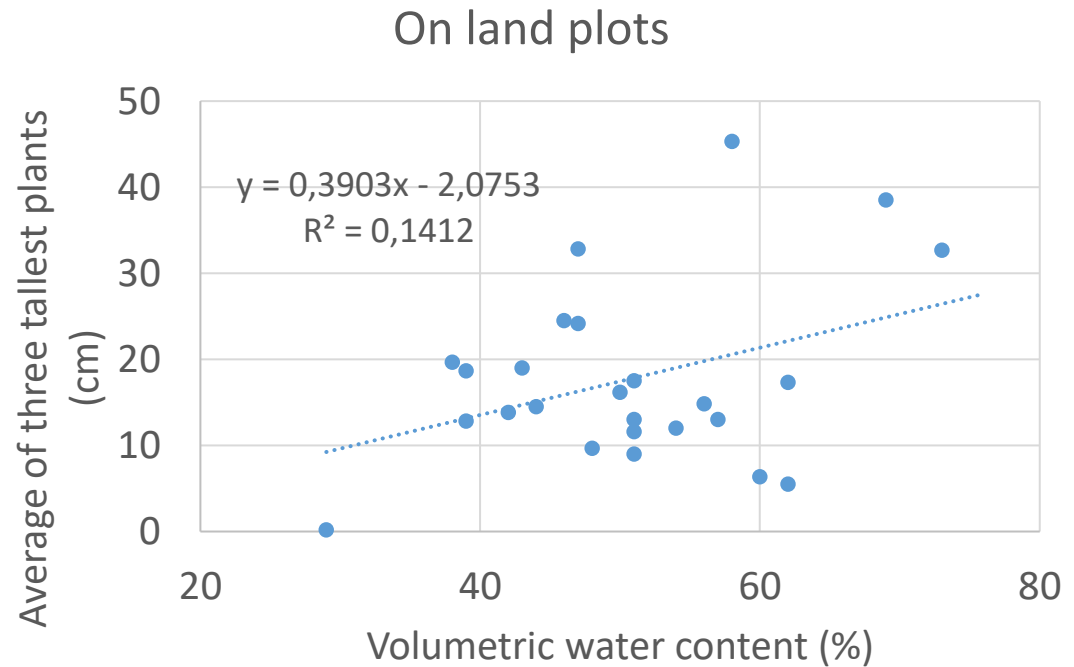
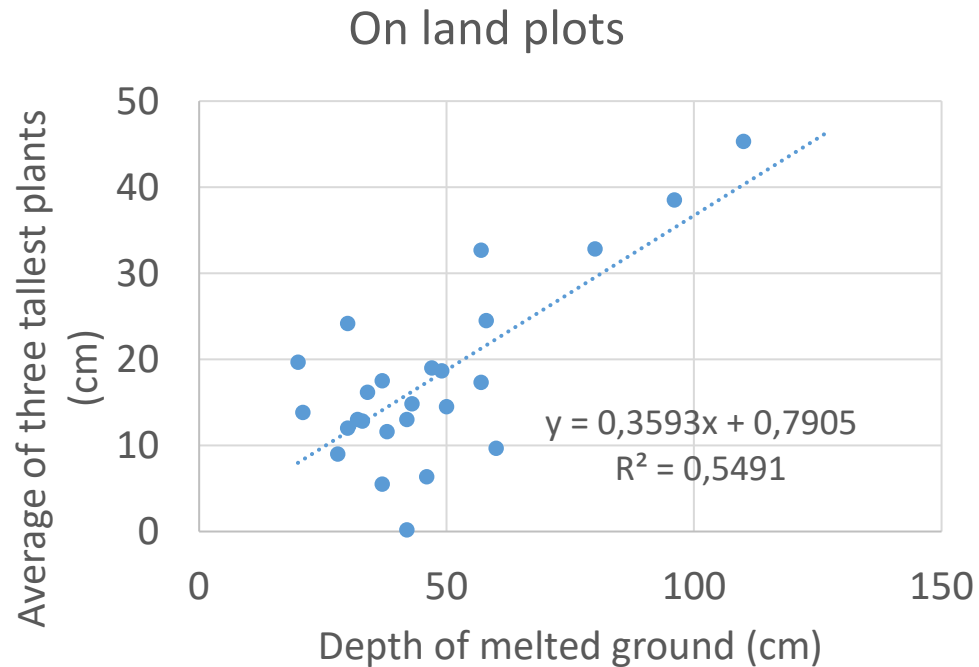


- Distance to frozen ground: 20-196 cm
- Under water: 74-196 cm

On land plots



Tallest plants and depth of melted ground

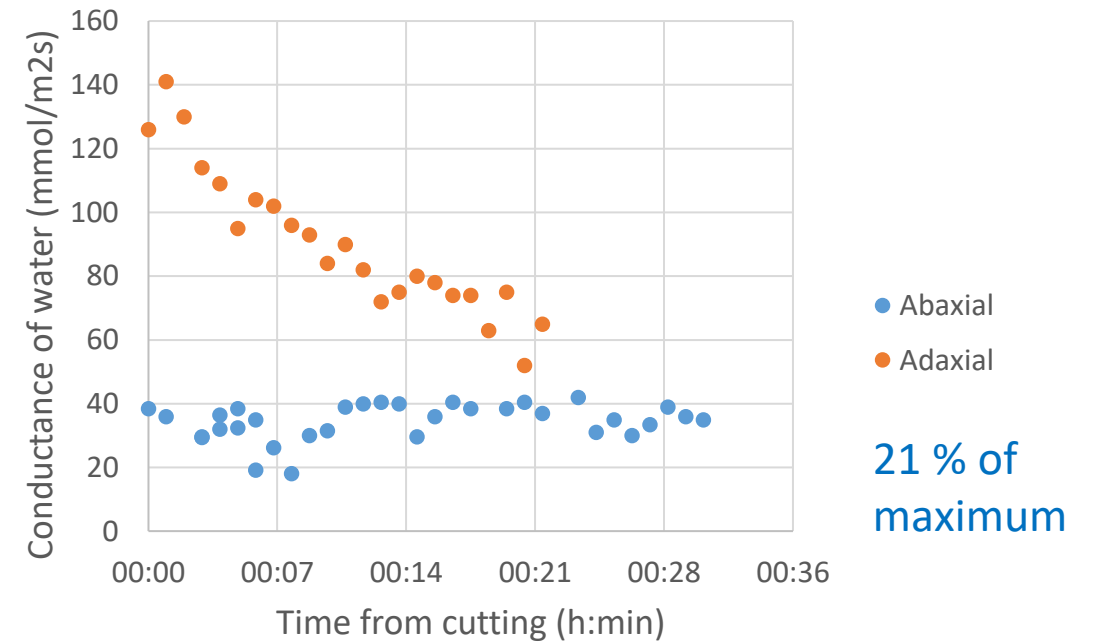


- Depth of melted ground puts restrictions on plant height
- Snapshot of water content is not a so good predictor this day

Stomatal closure and minimal conductance



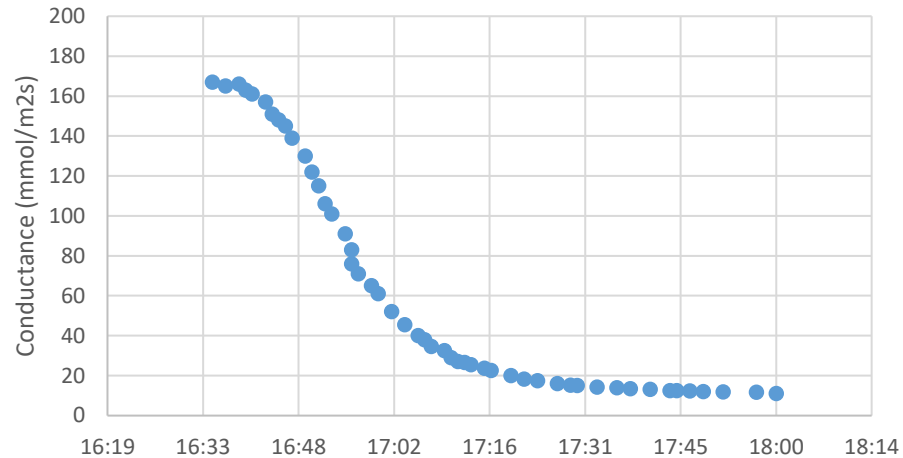
- Lakselv
- Wetland
- Grass (*Calamagrostis* sp.)



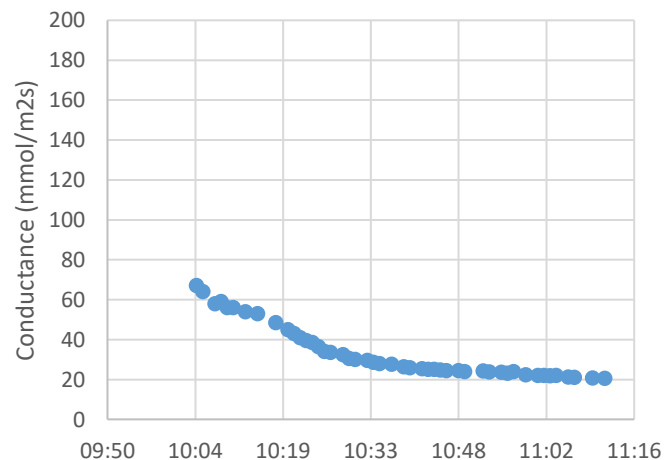
- Stomata close on **adaxial** side
- On **abaxial** side: minimal conductance

Stomatal closure and minimal conductance

Duskull 4 abaxial, 0.15 mg/min

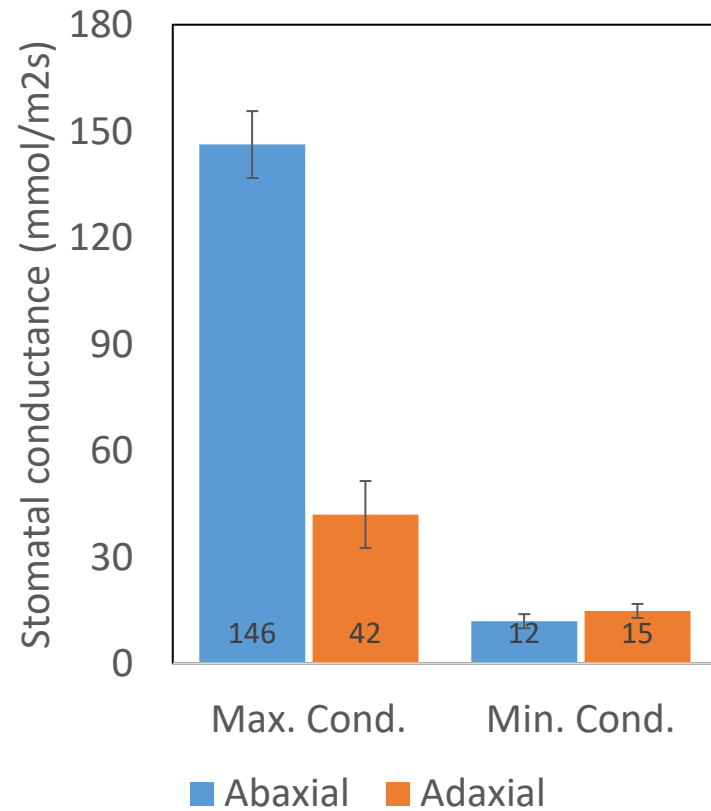


Duskull 6 adaxial, 0.15 mg/min



- *Eriophorum angustifolium*
- Wetland
- Graminoid
- Opposite distribution of stomata (or normal distr.)
- Some on the adaxial side
- Many on the abaxial side
- Eight individuals, four replicates

Stomatal closure and minimal conductance

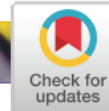


- On abaxial side, the maximum conductance was high.
- Closing of stomata caused a 90 % reduction of abaxial conductance
- On adaxial side, the maximum was much lower
- Closing of the low number of stomata caused a 60 % reduction of adaxial conductance
- In sum for the two sides: minimum conductance was 14 % of maximum conductance

Minimum conductance



Review



Tansley review

On the minimum leaf conductance: its role in models of plant water use, and ecological and environmental controls

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Minimum conductance

- Through stomata that cannot close properly (broken?)
- Through cuticle
- What we observe during night and darkness (includes both factors)
- What we observe during low light periods or during severe drought
- What we observe during extreme temperatures

Why?

$$g_s = g_0 + g_1 \frac{A_n}{C_a} f(D)$$

- g_0 is often found through regression
- It could differ depending on the reasons for A_n to approach 0: light, temperature, drought, stress.

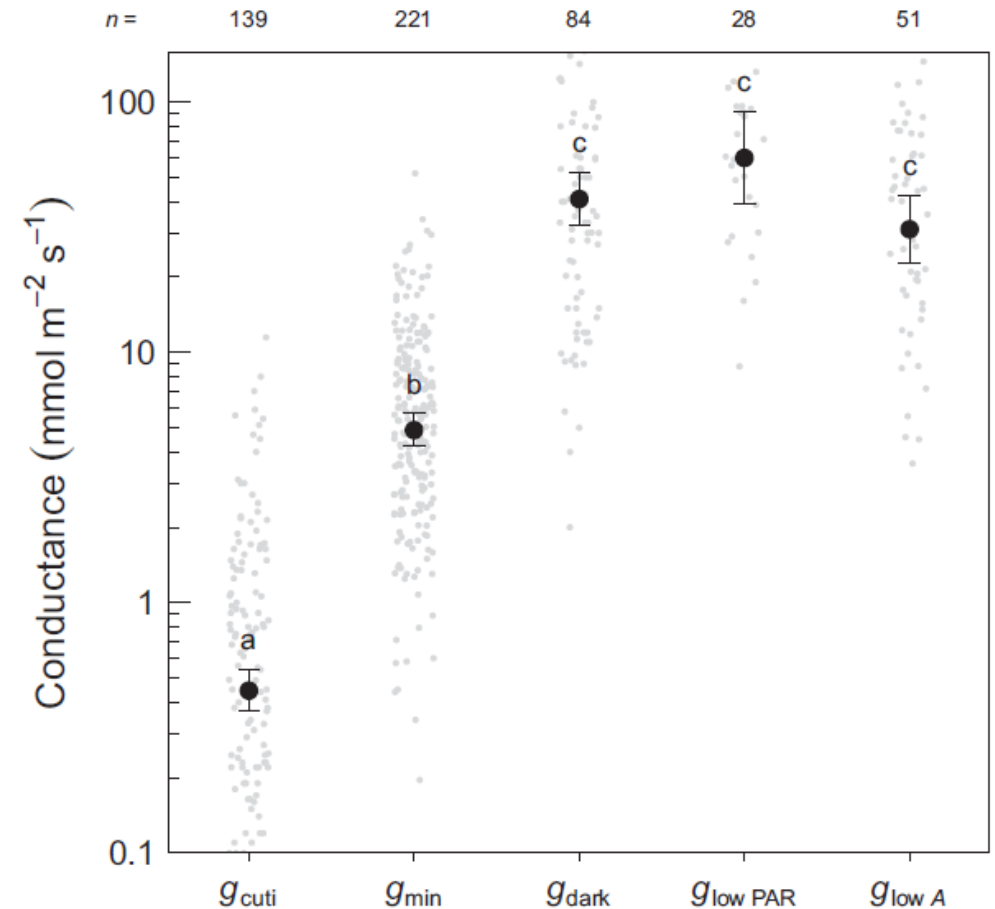


Fig. 1 Comparison of various estimates of the (presumed) minimum conductance. Error bars are 95 % confidence intervals. Gray dots are the original data (but a few data points occur outside the figure range). Different letters denote significant differences (at $\alpha = 0.05$). g_{cuti} , conductance of isolated cuticles; g_{min} , minimum conductance measured with mass loss of detached leaves; g_{dark} , leaf conductance during the night or after dark adaptation; $g_{\text{low PAR}}$, leaf conductance during low light (PAR, photosynthetically active radiation); $g_{\text{low A}}$, leaf conductance during periods of very low photosynthesis. See Section II for data sources and methods.

g_0 and water use efficiency

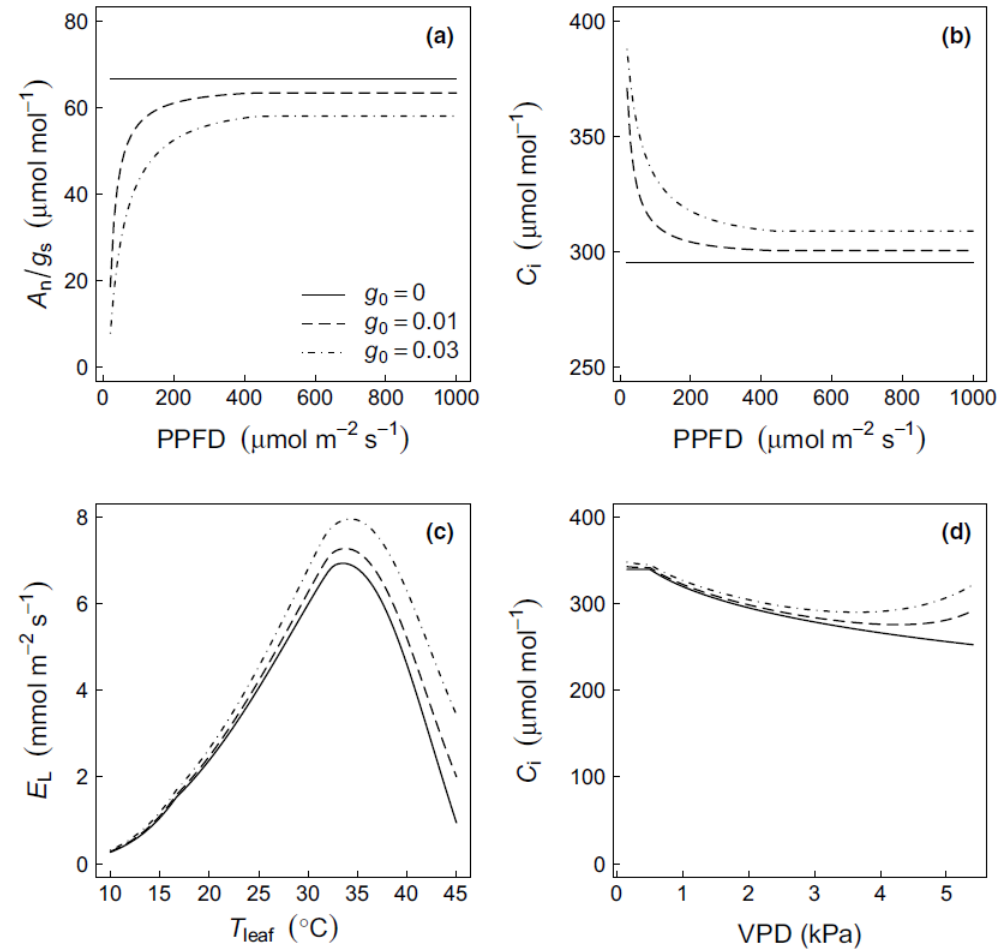


Fig. 5 Simulations with a coupled leaf gas exchange model (Duursma, 2015), demonstrating the effect of inclusion of the g_0 parameter (Eqn 1) on leaf fluxes. (a) Intrinsic water use efficiency (A_n/g_s) as a function of the photosynthetic photon flux density (PPFD), holding other environmental drivers constant, for three values of g_0 . (b) The same simulations as in (a), but showing the intercellular CO_2 concentration (C_i). (c) Leaf transpiration (E_L) simulations, where the vapor pressure deficit (VPD) and air temperature (T_{air}) were covaried based on an empirical relationship (Duursma *et al.*, 2014), reflecting typical covariation in field conditions. (d) The same simulations as in (c), but showing C_i . Note how C_i increases at high VPD and T_{air} , only when $g_0 > 0$. For all simulations, it is assumed that T_{leaf} is equal to T_{air} , and we ignore the differential permeability of the cuticle to CO_2 and H_2O (Hanson *et al.*, 2016).

g_0 and plant dessication

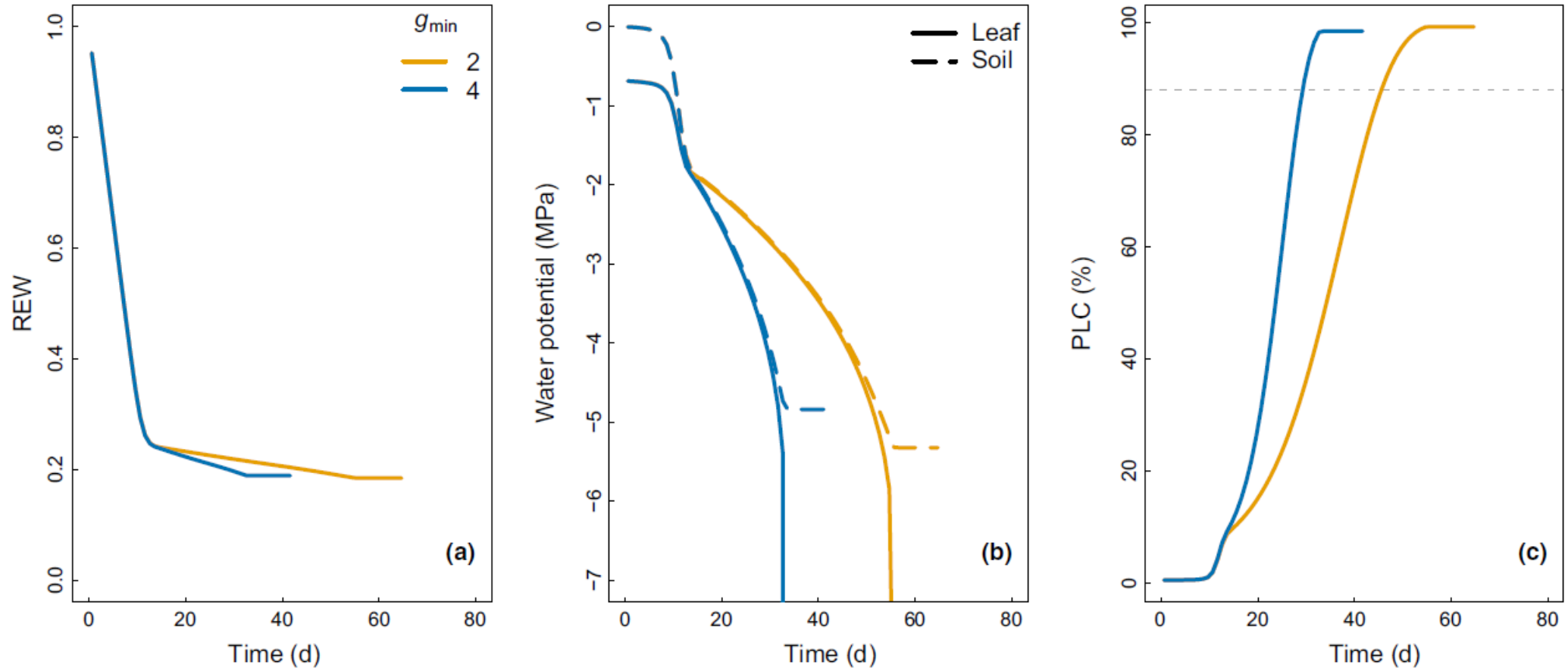


Fig. 6 Simulations with the *Sureau* model demonstrating the effect of g_{\min} on the desiccation tolerance of plants. The *Sureau* model simulates water transport in the soil–plant–atmosphere continuum, and includes a detailed representation of capacitance in stem and leaf tissues. (a) Soil relative extractable water (REW; 1 = field capacity, 0 = permanent wilting point) for the two simulations, using a minimum conductance (g_{\min}) of 2 or 4 $\text{mmol m}^{-2} \text{s}^{-1}$ – all other parameters were equal. (b) Water potential in the soil and leaf as the dry-down progresses. (c) Progression of percent loss conductivity (PLC) of the xylem. Dashed line is at a PLC of 88%, indicating possible mortality.

g_0 estimated through regression

- Low model fit gives inflated values for g_0

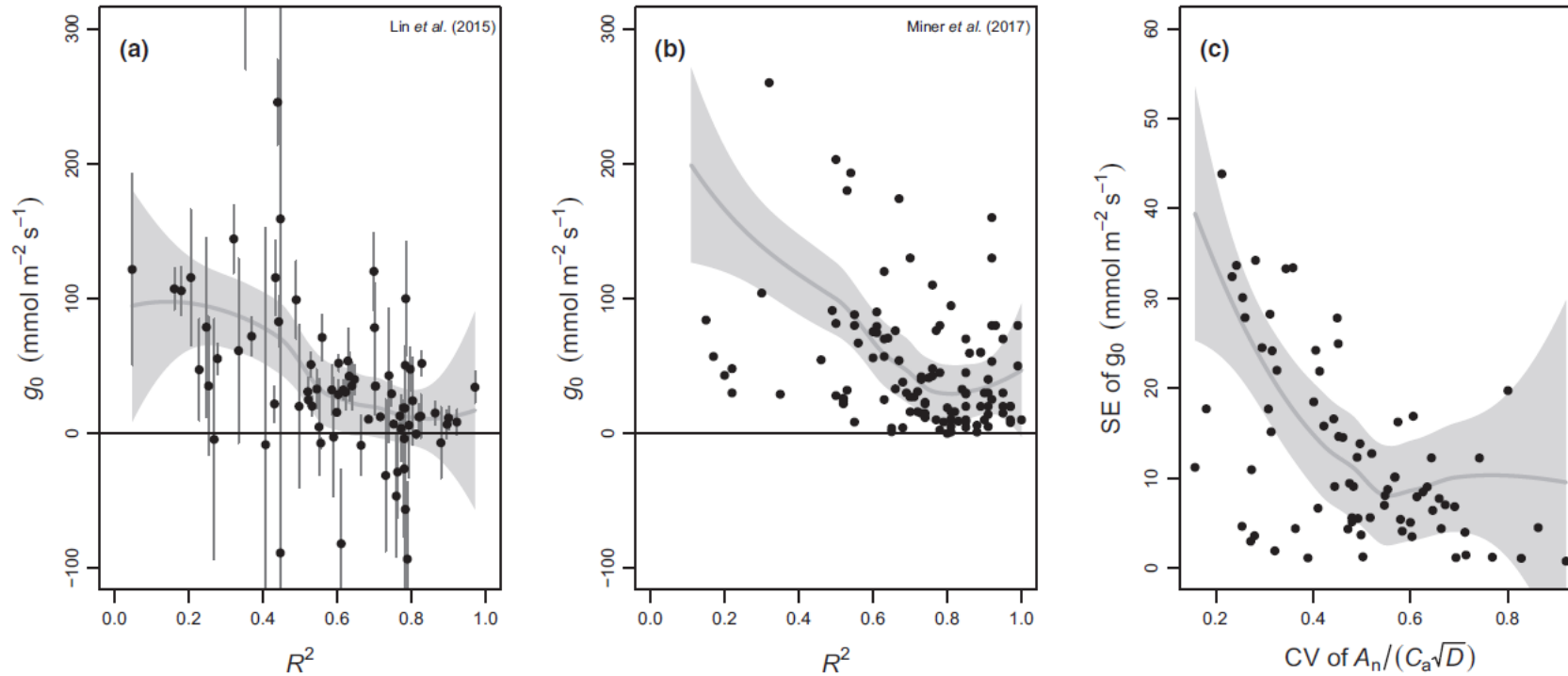


Fig. 8 Statistical uncertainty in the estimation of g_0 from regression, demonstrated with two parameter databases. (a) We fitted the linearized form of the Medlyn *et al.* (2011) model to each of the datasets in the Lin *et al.* (2015) leaf gas exchange database, showing that, for poorly fitted relationships (low R^2), inflated estimates of g_0 are obtained. Vertical lines are 95% confidence intervals. The gray line is a fitted loess smoother with 95% confidence interval. Note the wide confidence intervals and frequent negative values. (b) Similar to (a), but using the published compilation by Miner *et al.* (2017). The gray line is a fitted loess smoother with 95% confidence interval. (c) Using the fits from (a), a demonstration that the standard error (SE) of g_0 is much higher when the coefficient of variation (CV) of the predictor (i.e. right-hand side of the equation being fitted) is lower.

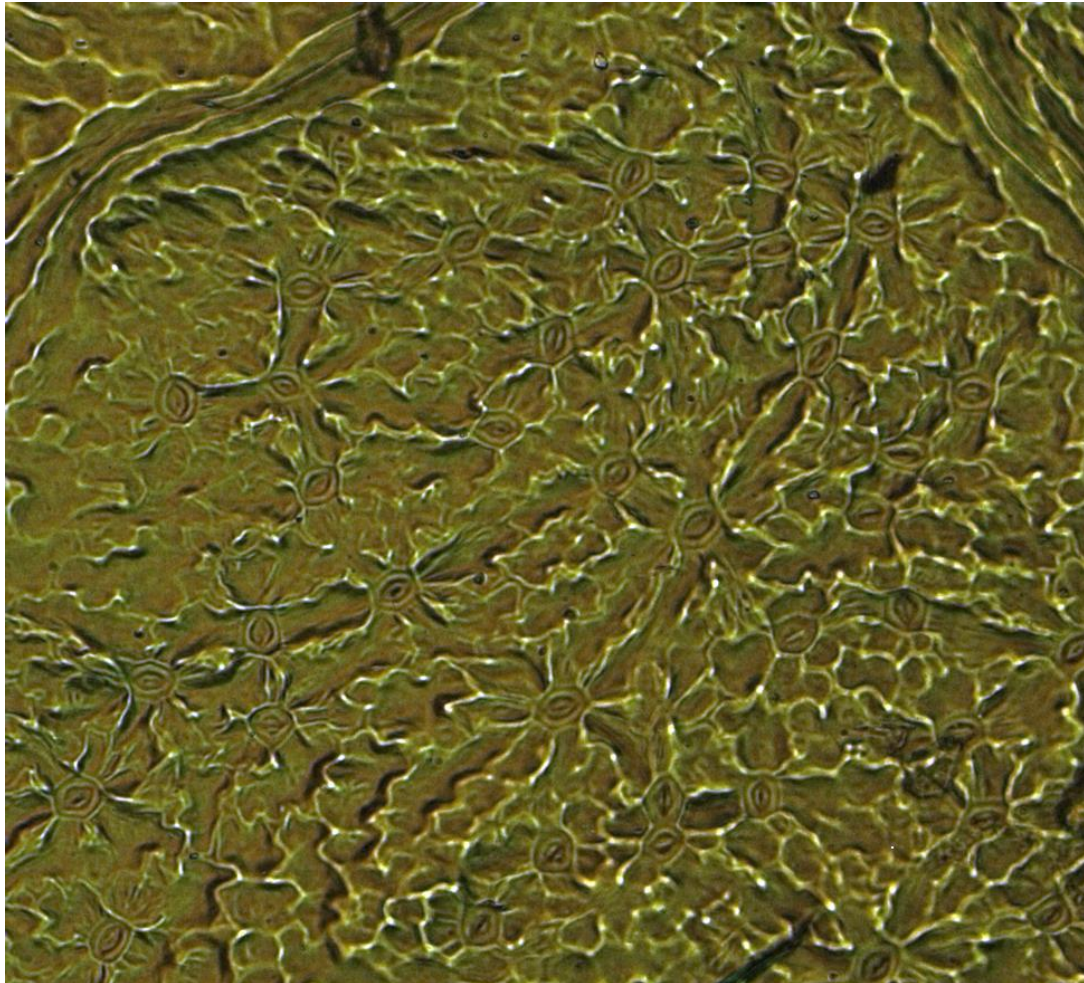
Suggestion

- Include both g_0 and g_{\min}

$$g_s = \max \left[\max(g_{\min}, g_0), g_1 \frac{A_n}{C_a} f(D) \right]$$

- Converges to g_0 during periods of low photosynthesis
- Converges to g_{\min} during periods of drought, if g_0 depends on water availability
- Work in progress

Thanks for your attention



Nail polish imprint of stomata on *Rubus arcticus*.

Astrid Vatne
The Iškoras people and data
Finse research station
LATICE
EMERALD
Research Council of Norway