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Using remote sensing observations with in-situ observations at a northern Scots pine forest to improve carbon cycle modelling

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Contents

- Introducing the site: Sodankylä
- Introducing the model: QUINCY
- Eddy covariance fluxes and the snow model
- SIF observations and SIF modelling
- Remotely sensed and modelled leaf chlorophyll

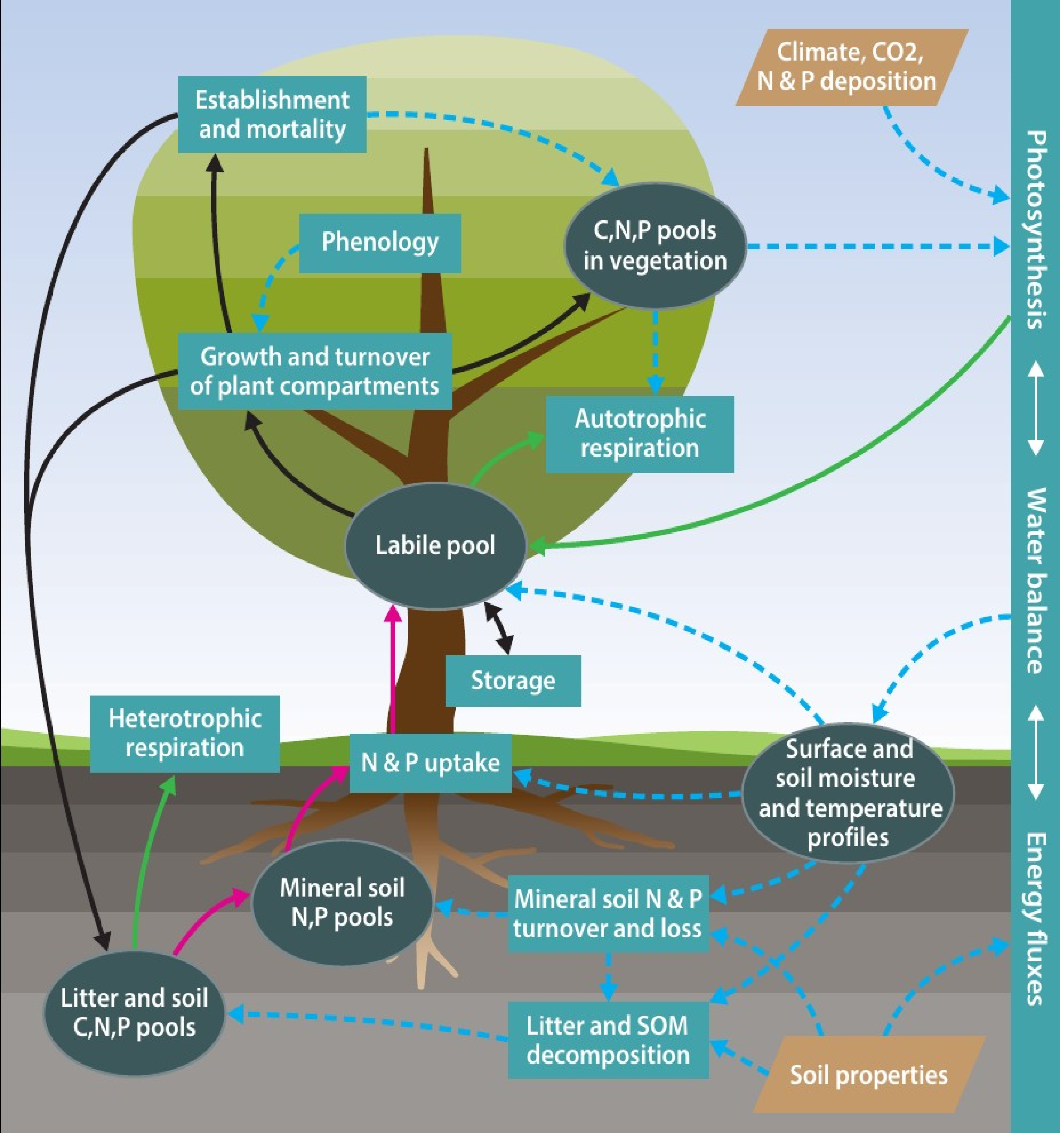
Sodankylä

Scots Pine forest

100 km north from the Arctic Circle

~120 years old

Eddy covariance observations 2001->



QUINCY

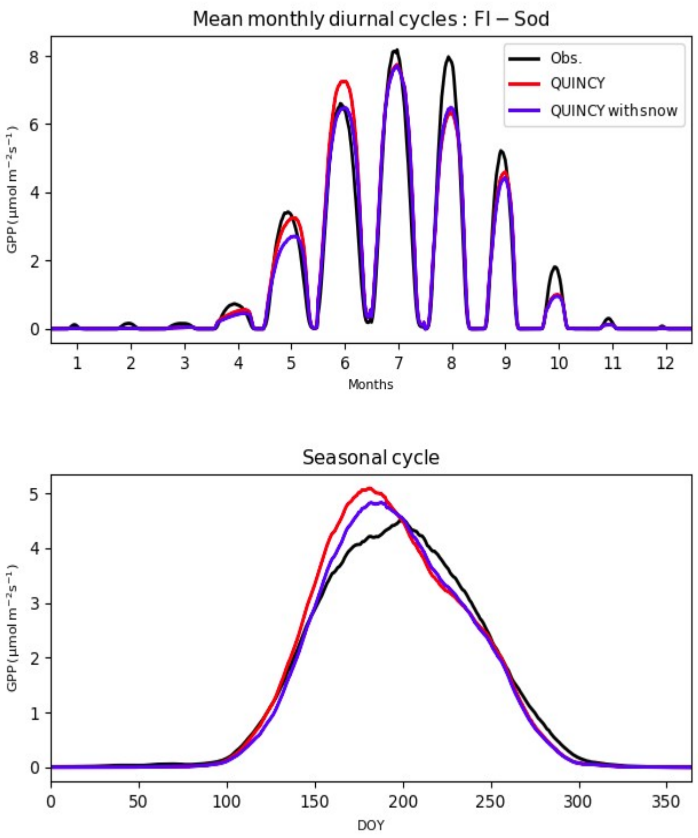
(QUantifying the effects of Interacting Nutrient CYcles on terrestrial biosphere dynamics and their climate feedbacks)

(Thum et al., GMD, 2019)

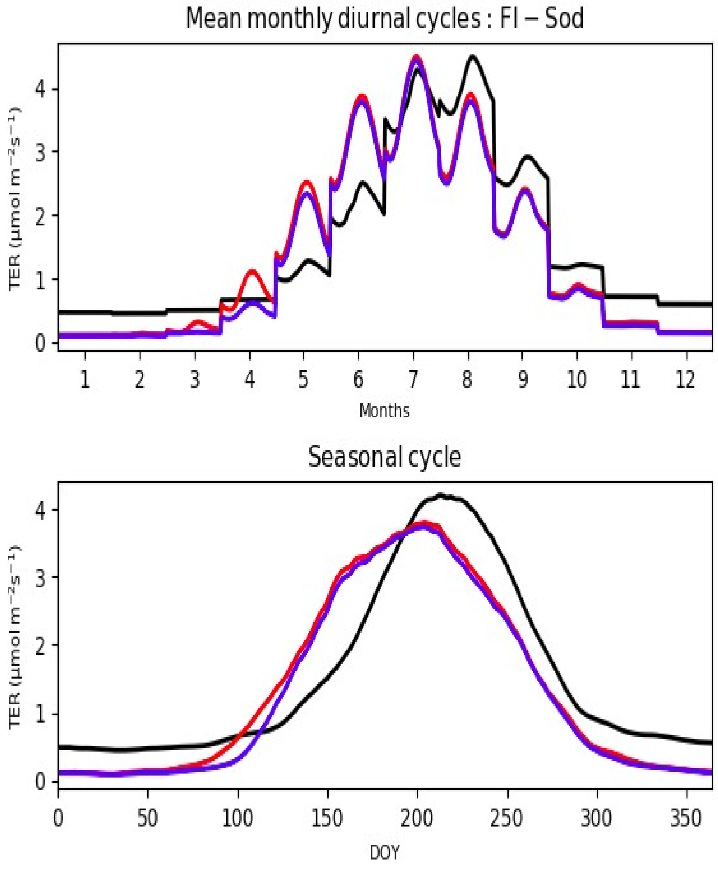
Carbon fluxes with snow

OBSERVATION
QUINCY
QUINCY WITH SNOW

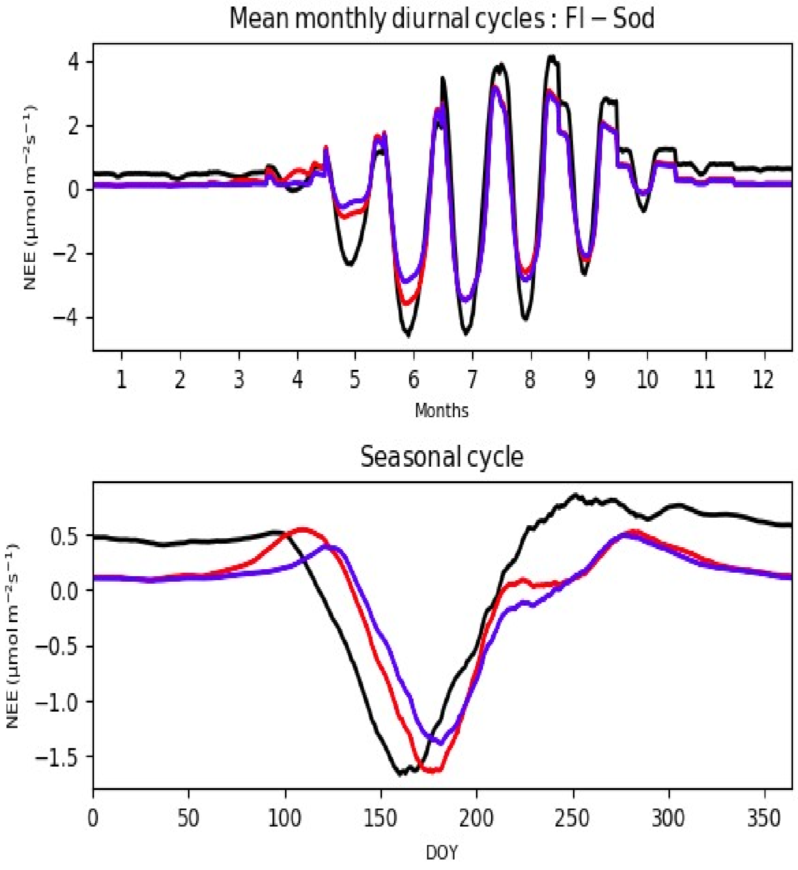
GPP



TER



NEE



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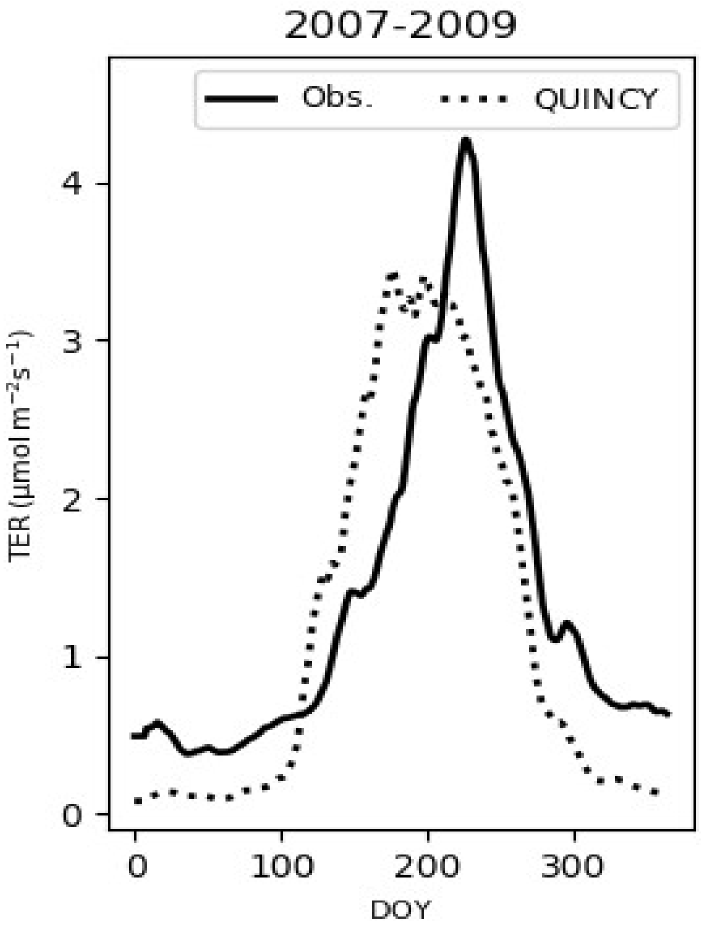
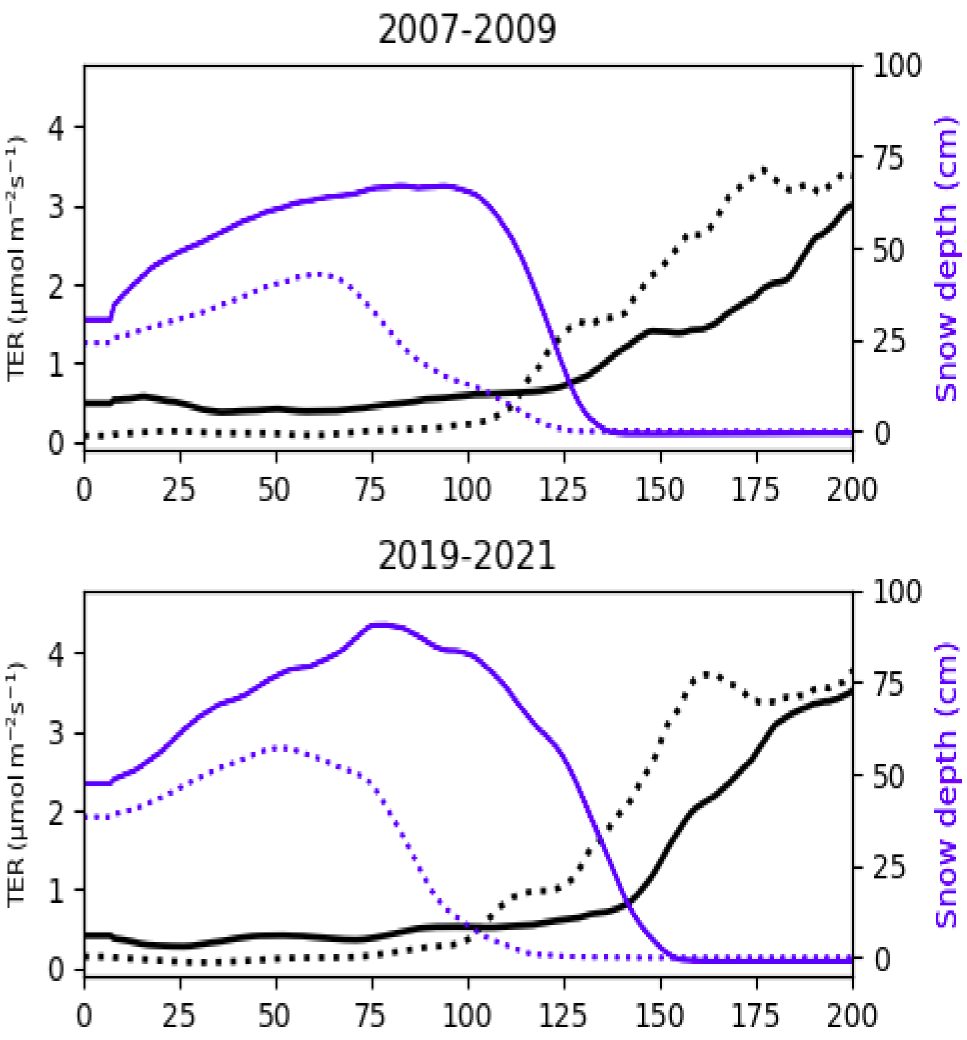
Having snow in QUINCY improves the component fluxes.
Still issue with TER...

Changes in TER biases between model and observations



Is **spring** the bias towards **earlier increase** gets larger,
in **autumn** the model matches the observations better.

Change in spring connected to snow



Observations
Thicker snowpack delays the melting compared to earlier time period.

Simulations
Simulated snowpack does get thicker, but the increased spring air temperatures accelates the snow melt → snow clearance day becomes earlier and TER increases.

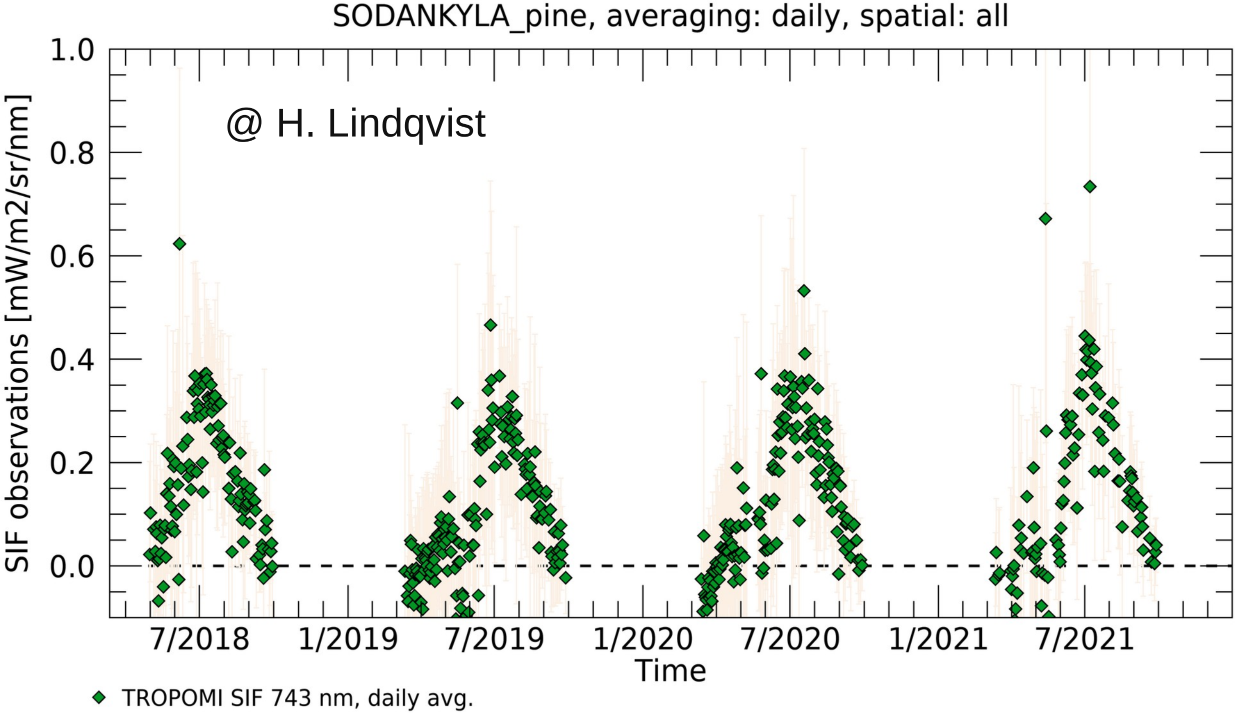
(K. Böttcher – CryoBioLinks ESA project)

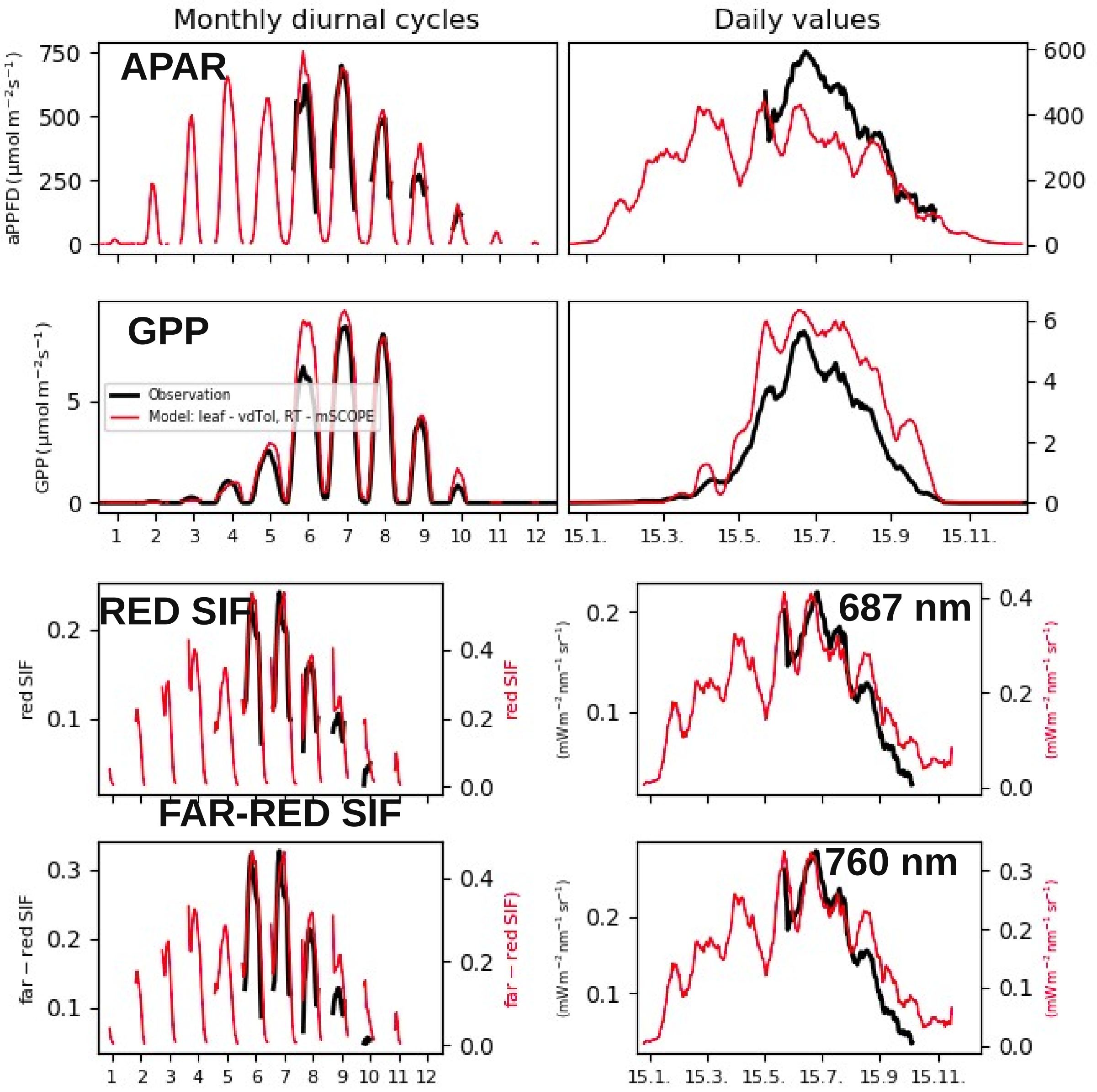
Sun-induced chlorophyll fluorescence (SIF)

- Emission from plant leaves, related to photosynthetic activity
- Observable from space
- FloX observations at Sodankylä 2021 ESA-LCC campaing (M. Honkanen, H. Lindqvist)

Modelled SIF

- Results from mSCOPE implementation
- High Apr values & winter → need to describe sustained non-photochemical quenching

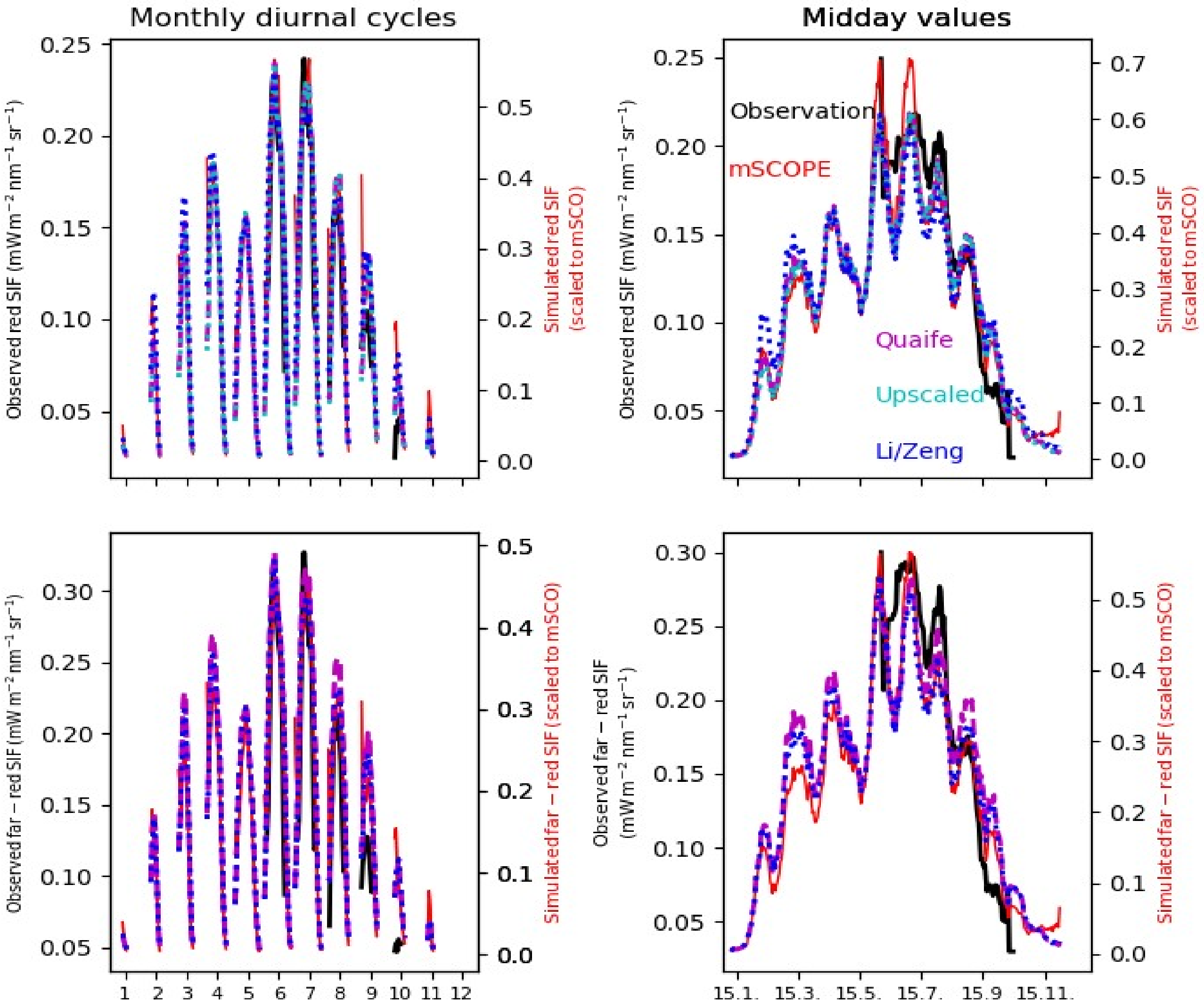




GPP data: M. Aurela
FloX data: M. Honkanen, ESA-LCC measurement campaign

Radiative transfer of SIF

- Radiative transfer scheme of mSCOPE is too calculationally heavy for large scale applications
- Other, simplified approaches, seem to be doing good job capturing changes (calculation of magnitude still in progress)



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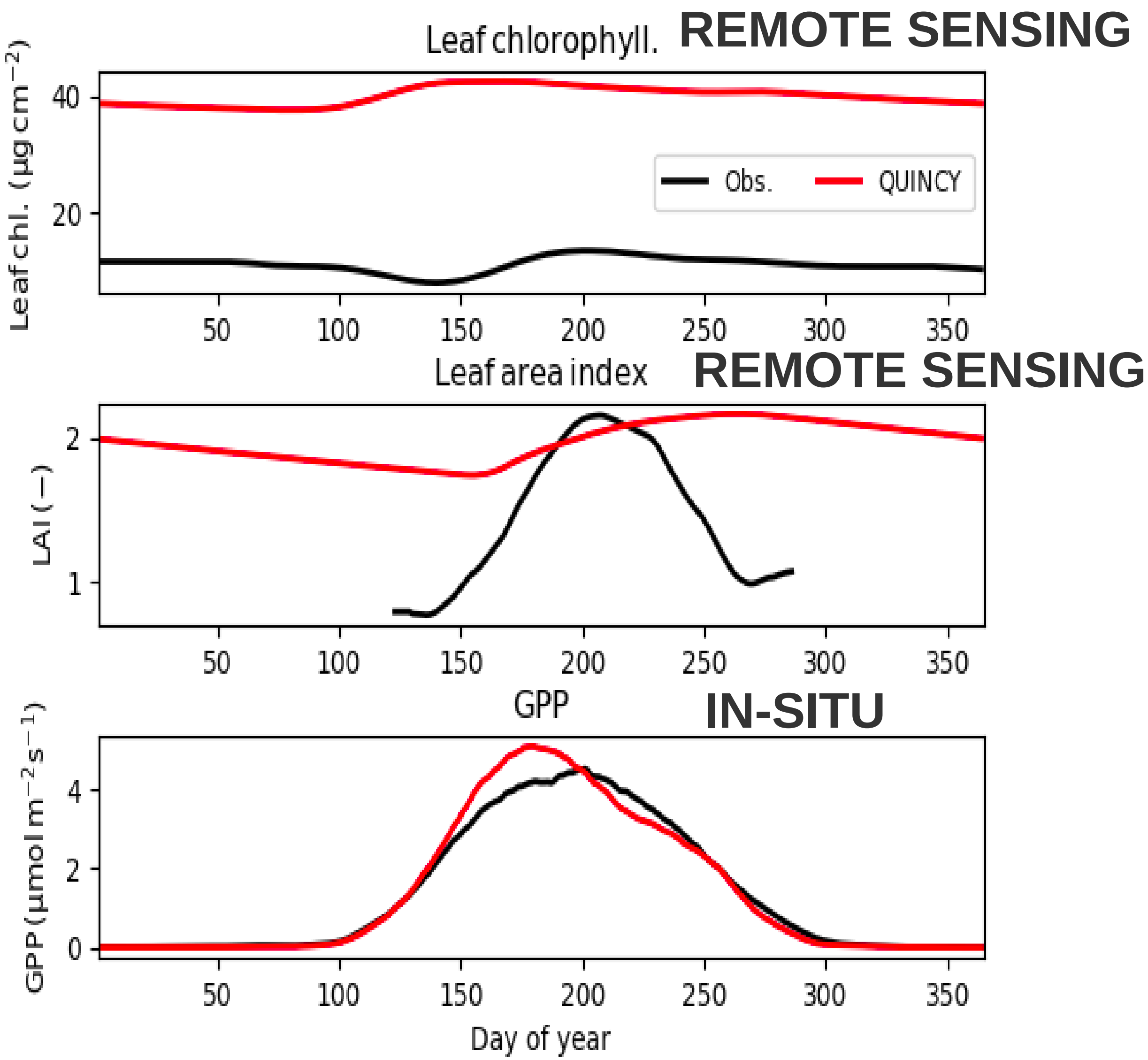
Leaf chlorophyll

- Remote sensing product (Croft et al., RSE, 2020) (LAI from Copernicus)
- In-situ chlorophyll ~59 µg cm^{-2} (SIFLEX report)



RS data processing: A. Ojasalo

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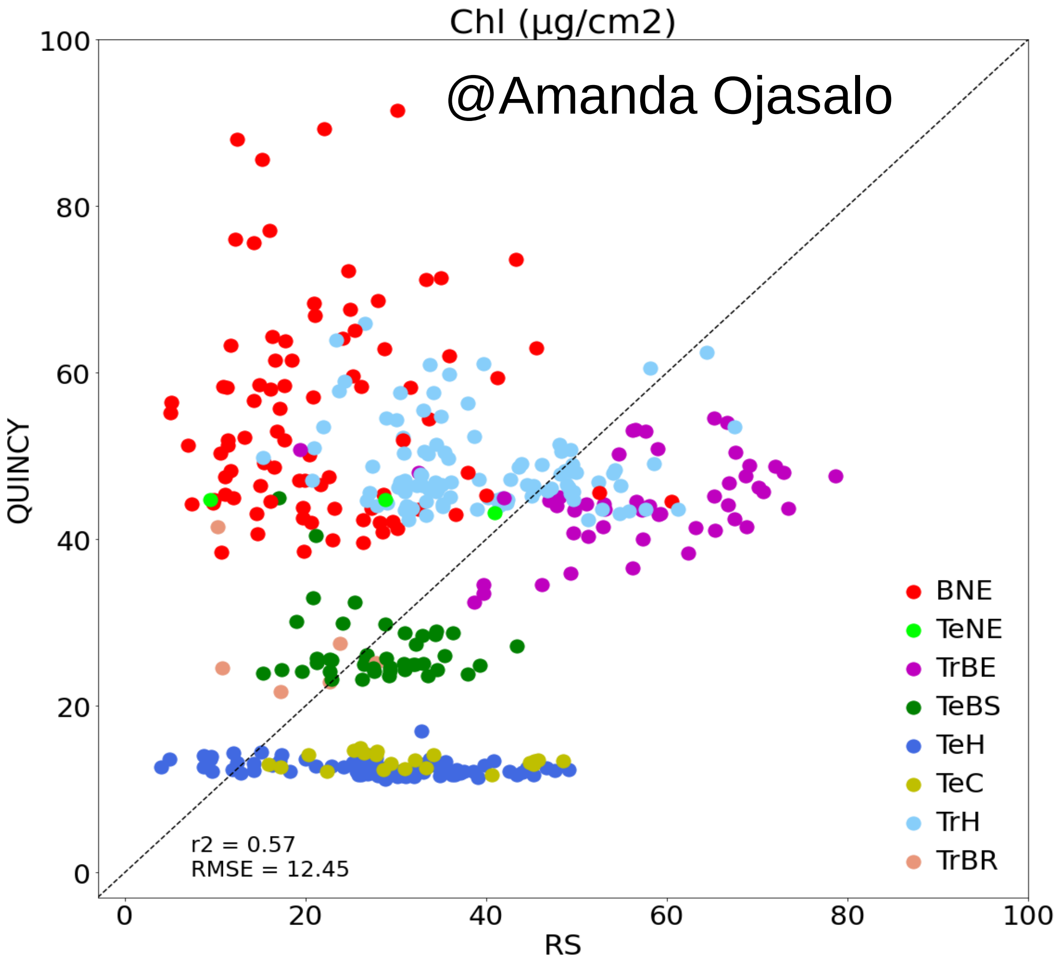
Leaf chlorophyll estimates by QUINCY



- For boreal needleaf forest (BNE) QUINCY overestimates RS chl
- Also doesn't capture precipitation and air temp gradients seen in the data

BNE: Boreal needle-leaved evergreen TeBS: Temperate broad-leaved summer green TeNE: Temperate needle-leaved evergeen

TeH: C3 Grass TrH: C4 Grass TeC: C3 Crop

TrBE: Tropical broad-leaved evergreen TrBR: Tropical broad-leaved rain deciduous

Conclusions

- Combining in-situ and remote sensing data with simulations helps to identify the needs for model improvement
- Current remote sensing data helps in assessing cryospheric processes, as well as carbon cycle. Using leaf chlorophyll we also get a metric for the nitrogen cycle.

Knowledge gaps and priorities

- Importance of **respiration** in the carbon cycle: we can use also remote sensing observations indirectly to gain more understanding
- A metric for the nitrogen cycle from remote sensing observations

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Thank you!

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