Impacts of Sloped Terrain and Precipitation on Evapotranspiration from a Boreal Forested Catchment

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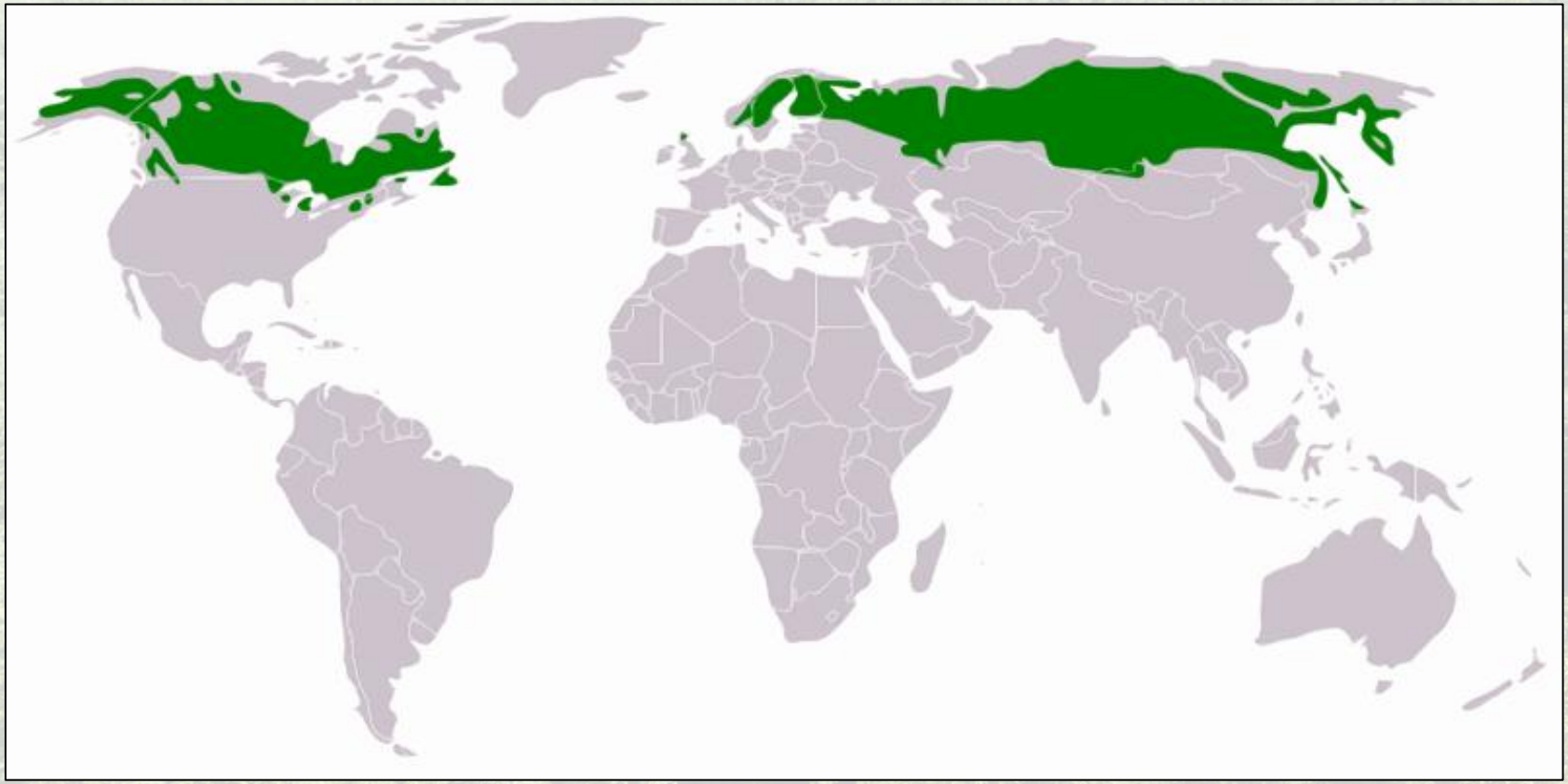
Motivation

Motivation

- Boreal zone: **10% of the Earth's emerged surface**



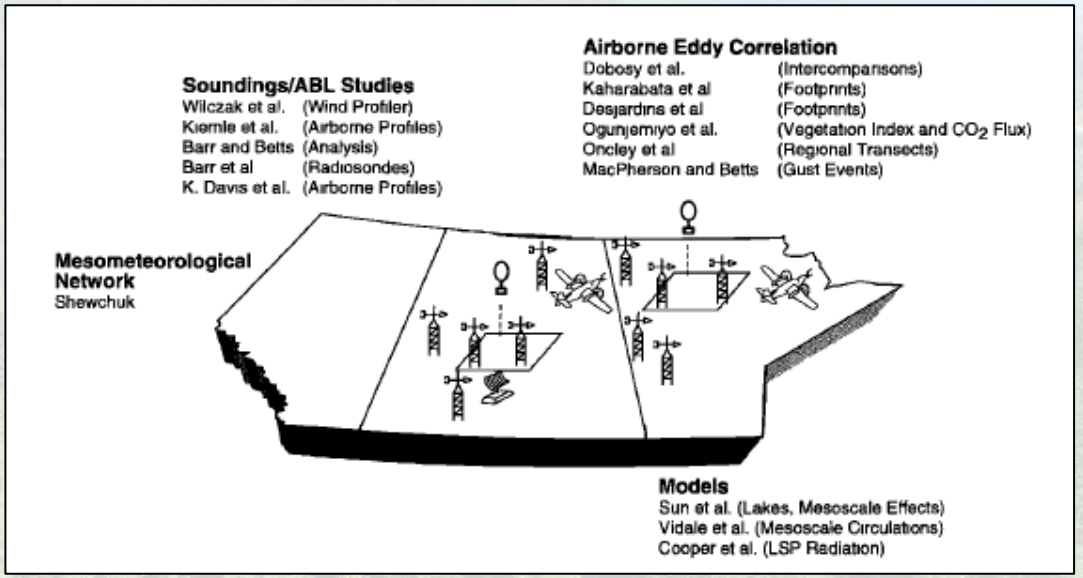
Global boreal zone (https://upload.wikimedia.org/wikipedia/commons/a/a8/Distribution_Taiga.png)

Motivation

- Evapotranspiration (ET):
  - Modeled with energy budget and hydrometeorological variables
  - Simple models can lead to erroneous hydrological predictions in the future
    (Lofgren *et al.*, 2011; Hoerling *et al.*, 2012; Seiller & Anctil, 2014)
  - **Calibration with *in situ* measurements is paramount**

Motivation

- Energy budget: **Boreal forest**



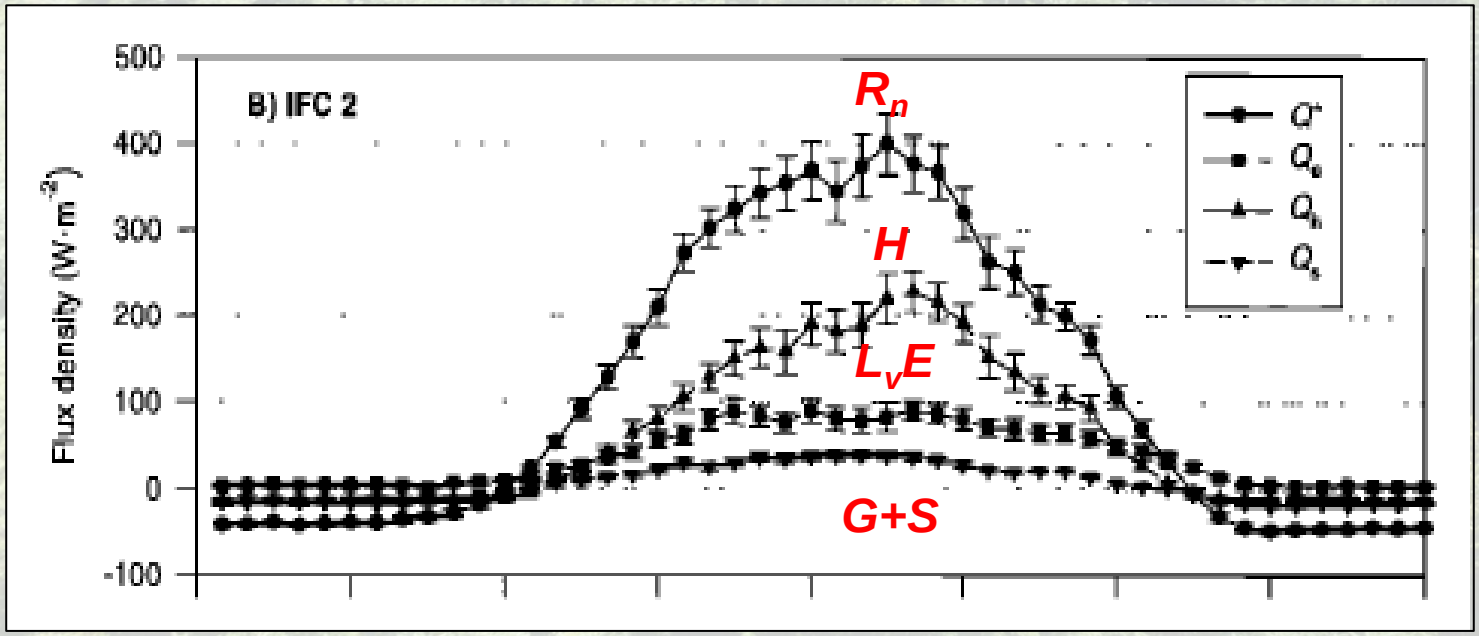
Experimental setup on BOREAS (from Sellers *et al.*, 1997)

- Most of what we know comes from the :

  Boreal Ecosystem Atmosphere Study (BOREAS) (Sellers *et al*. 1995; 1997)

Motivation

- BOREAS: **Energy budget**
  - Very low albedo (8%) (McCaughey, 1978a; Sellers *et al*., 1997)
  - *H* dominates energy partitioning (Saugier *et* al., 1997; Sellers *et al.*, 1997)



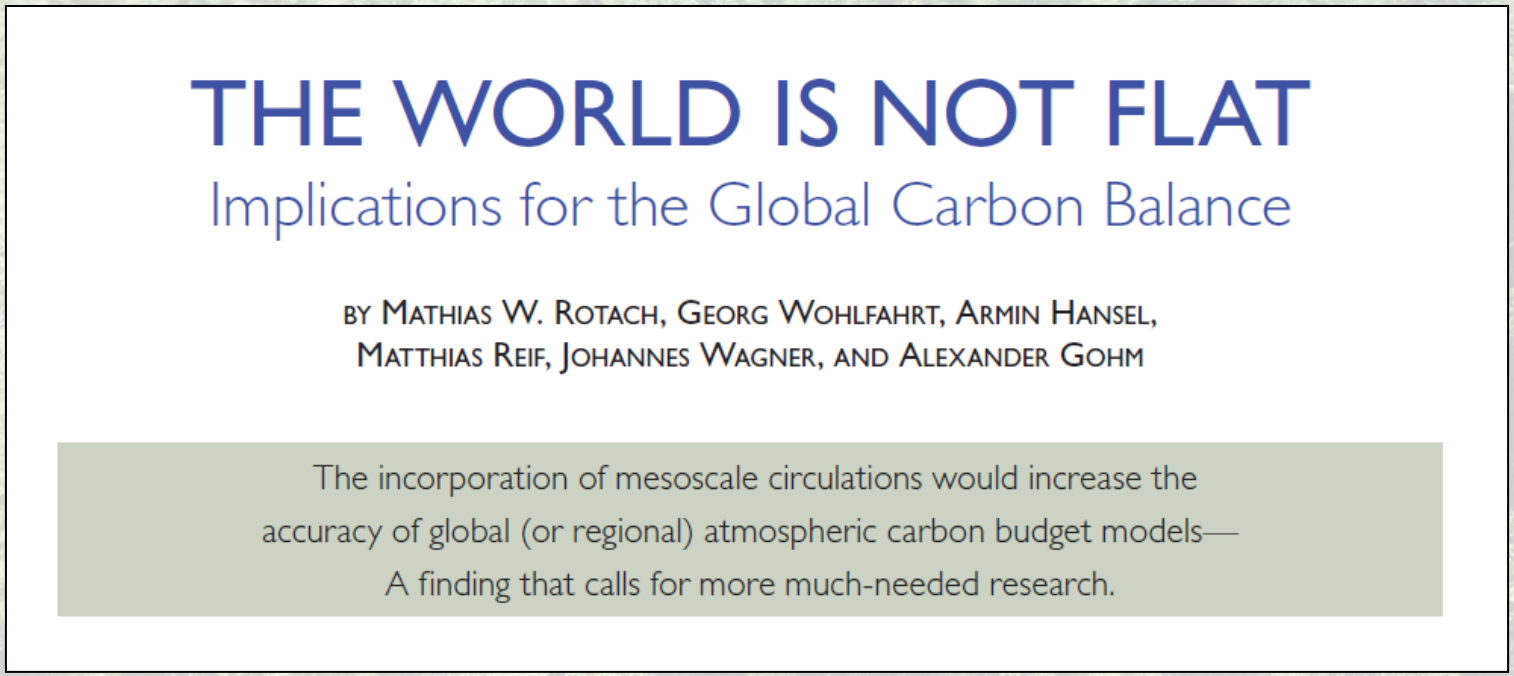
Typical daily energy budget of a boreal forest (from McCaughey *et al*., 1997)

Motivation

- BOREAS: **Evapotranspiration**
  - Controled by air temperature and humidity
  - Soil moisture, when under a ~35% threshold (McCaughey, 1978b)
  - ET depends on forest stand maturity (Amiro *et al.*, 2006)
  - **ET increases after rain events** (Kelliher *et al.*, 1998; Joiner *et al.*, 1999)

Motivation

- BOREAS: **Research gaps**
  - Western Great Plains:
    - Flat terrain



THE WORLD IS NOT FLAT

Implications for the Global Carbon Balance

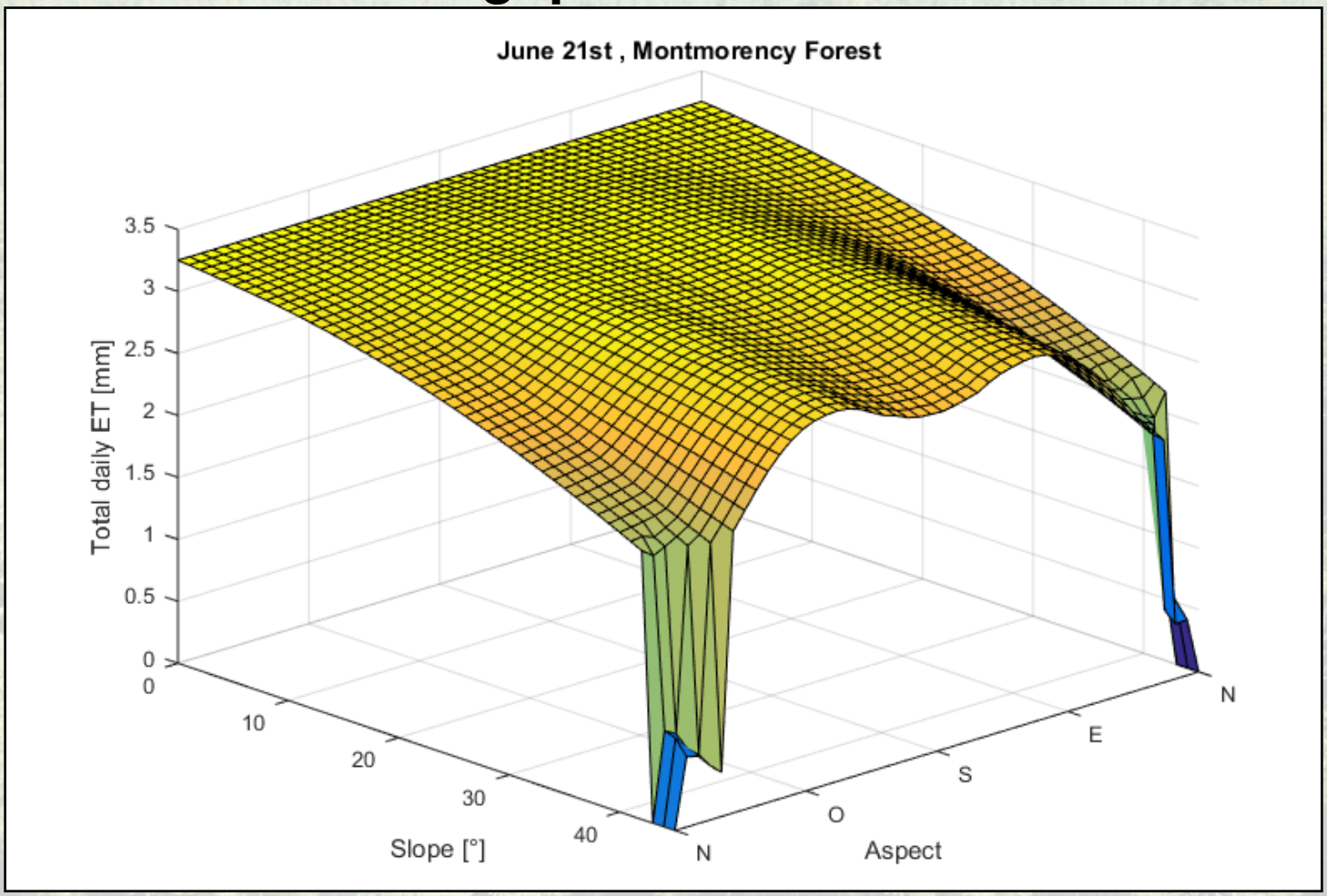
BY MATHIAS W. ROTACH, GEORG WOHLFAHRT, ARMIN HANSEL, MATTHIAS REIF, JOHANNES WAGNER, AND ALEXANDER GOHM

The incorporation of mesoscale circulations would increase the accuracy of global (or regional) atmospheric carbon budget models— A finding that calls for more much-needed research.

Headline, Rotach *et al*. (2014)

Motivation

- BOREAS: **Research gaps**

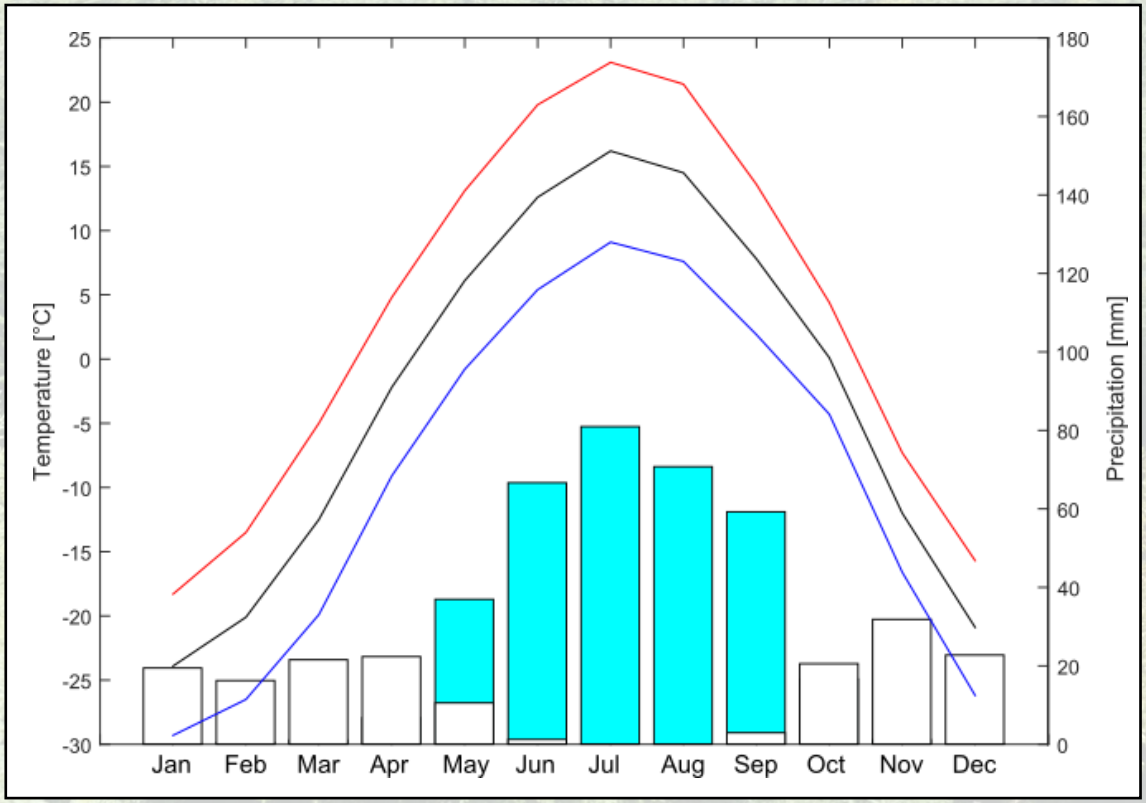


Total daily ET vs. slope and aspect. Calculated with Whiteman & Allwine (1986) and Priestley & Taylor (1972)

Motivation

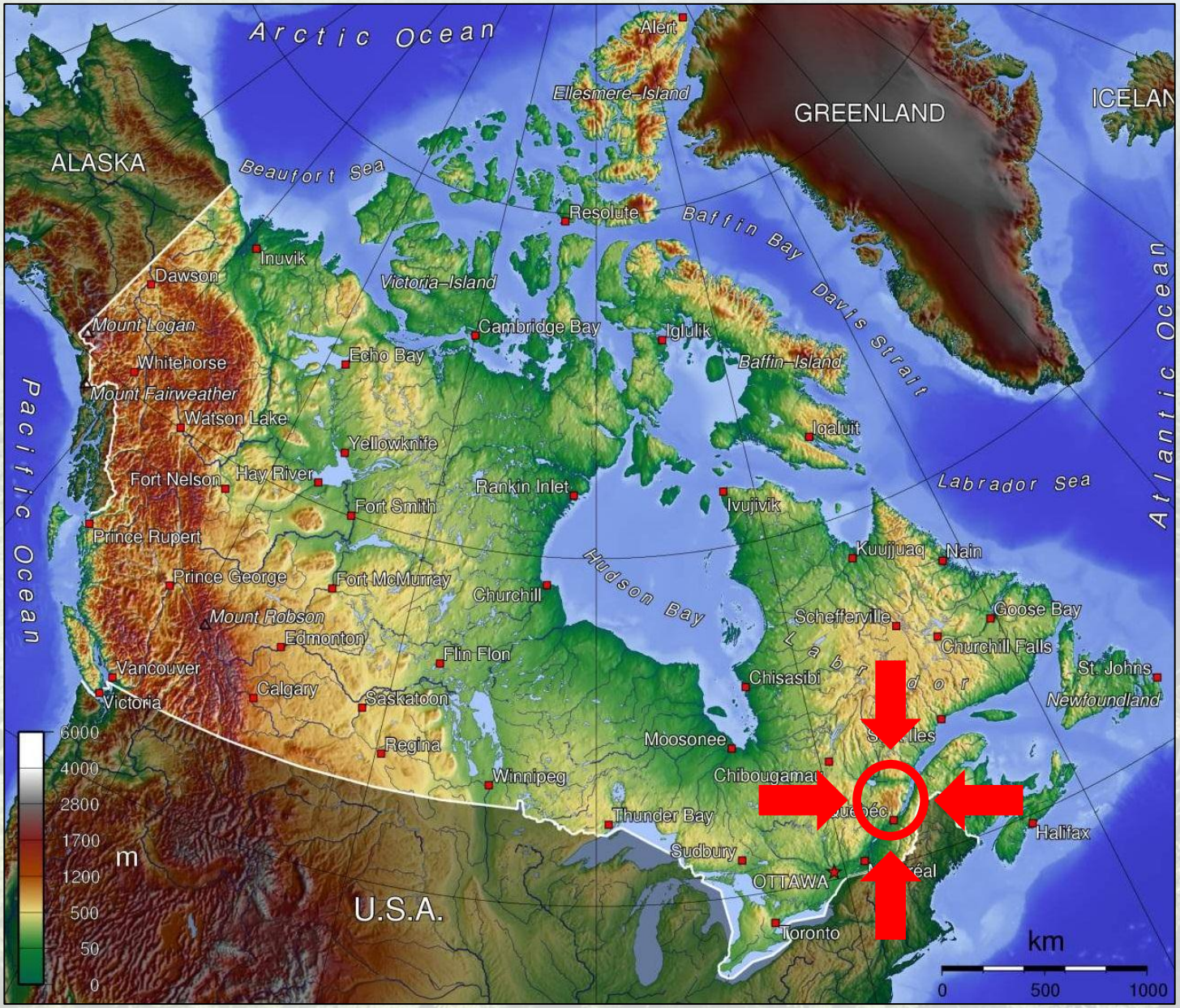
- BOREAS: **Research gaps**
  - Western Great Plains:
    - Flat terrain
    - Low precipitation

      (~500 mm / year)



Climatology of BOREAS sites (1981-2010) (Thompson station, Environment Canada)

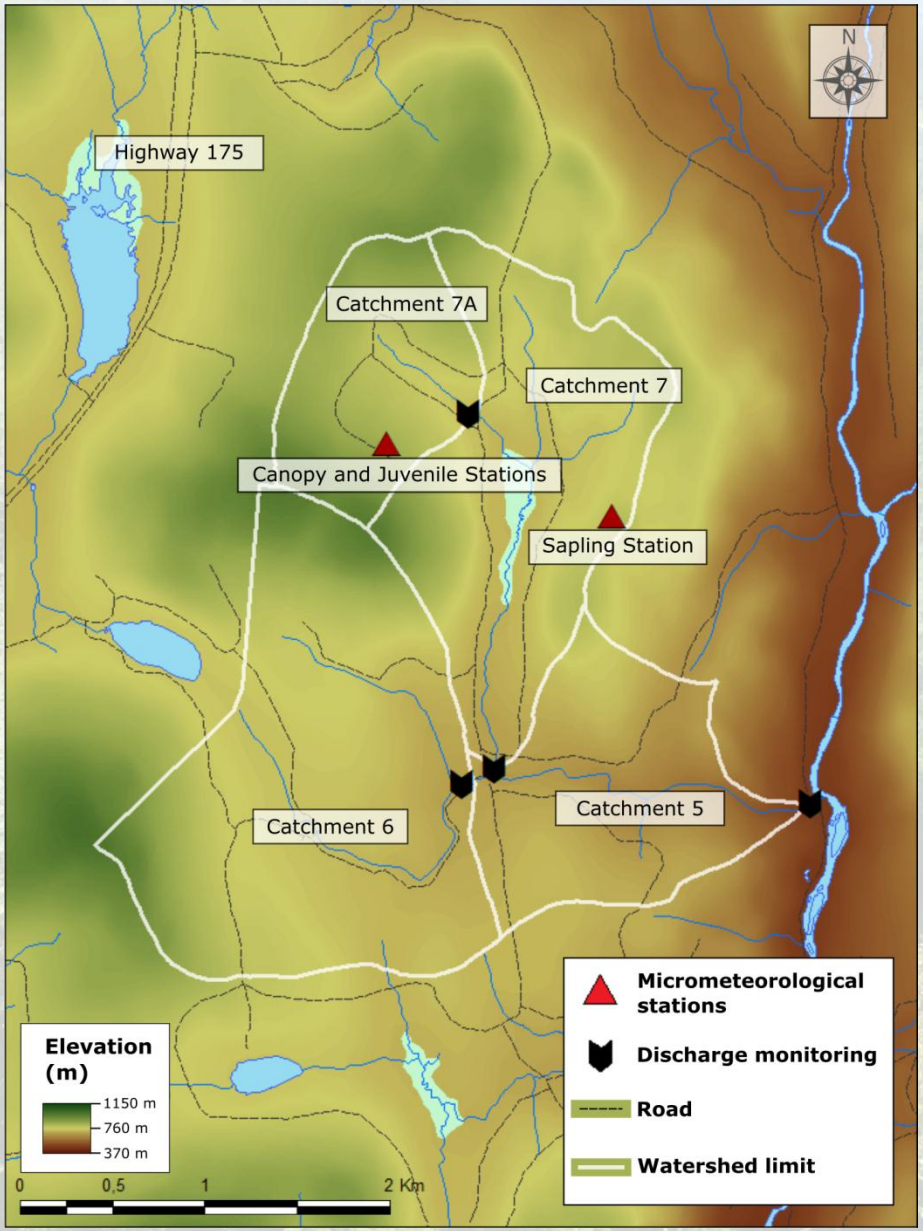
Method



Topography of Canada (http://www.carte-du-monde.net/)

Method

- Study site: **Montmorency Forest** (BEREV watershed)
  - Area: 9,2 km^2



BEREV watershed and experimental setup

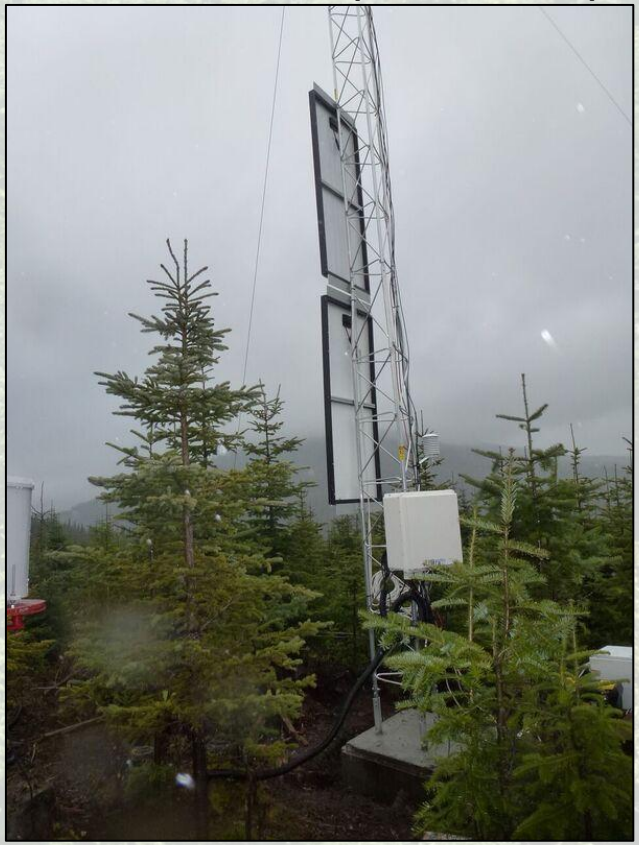
Method

- Study site: **Montmorency Forest** (BEREV watershed)

Catchment 7A (8-10m trees)

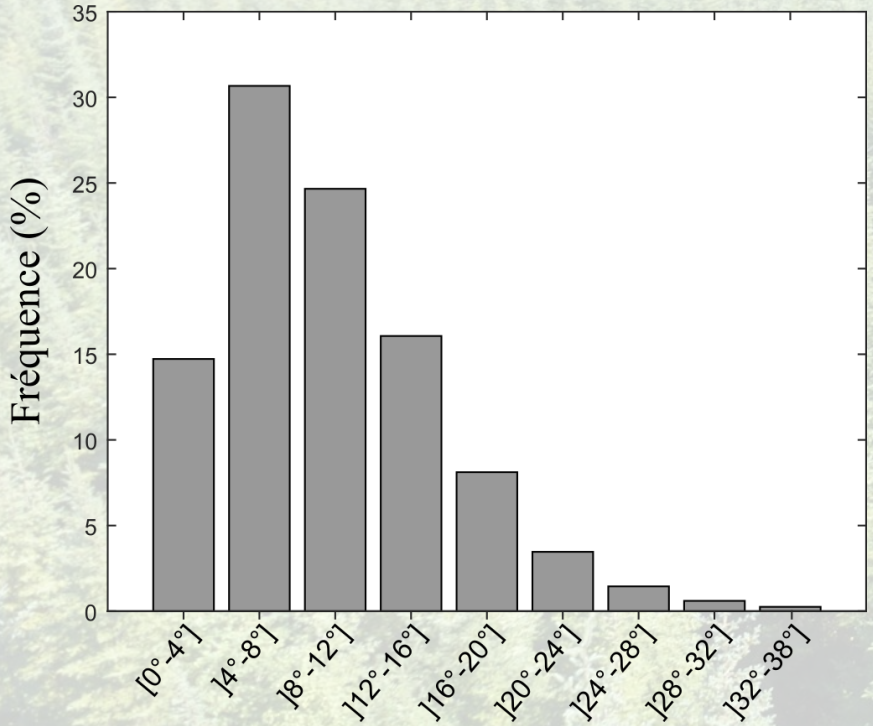
Mostly balsam firs, with some spruce and birch

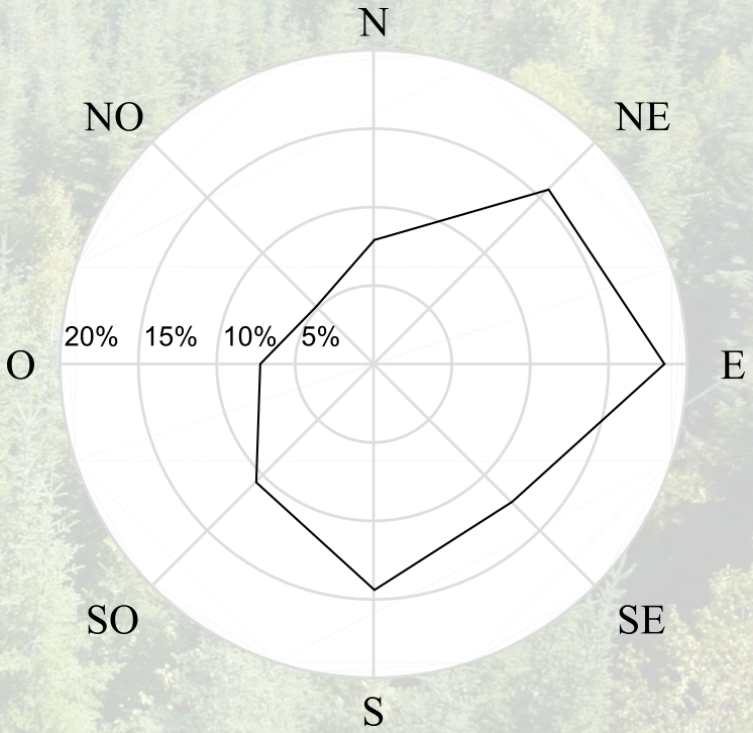
Catchment 7 (4-5m trees)



Method

- Study site: **BEREV - Slopes**

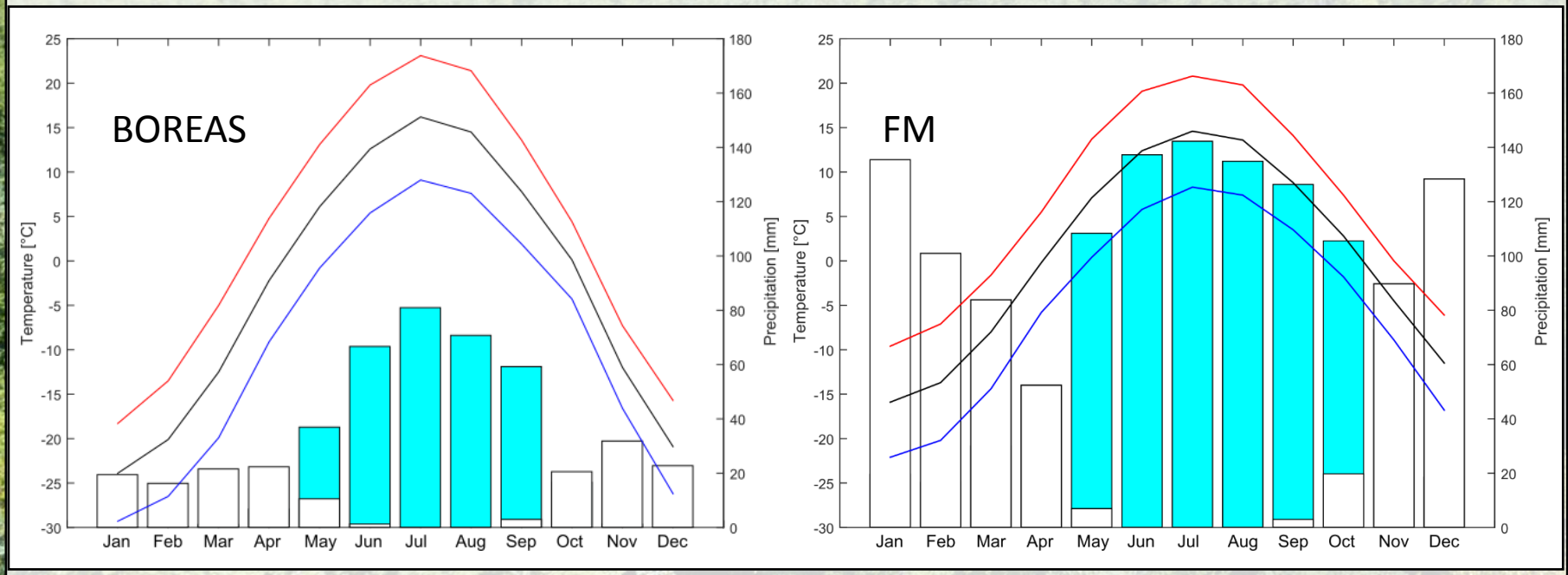




BEREV slope characteristics

Method

- Study site: **BEREV – Climatology**

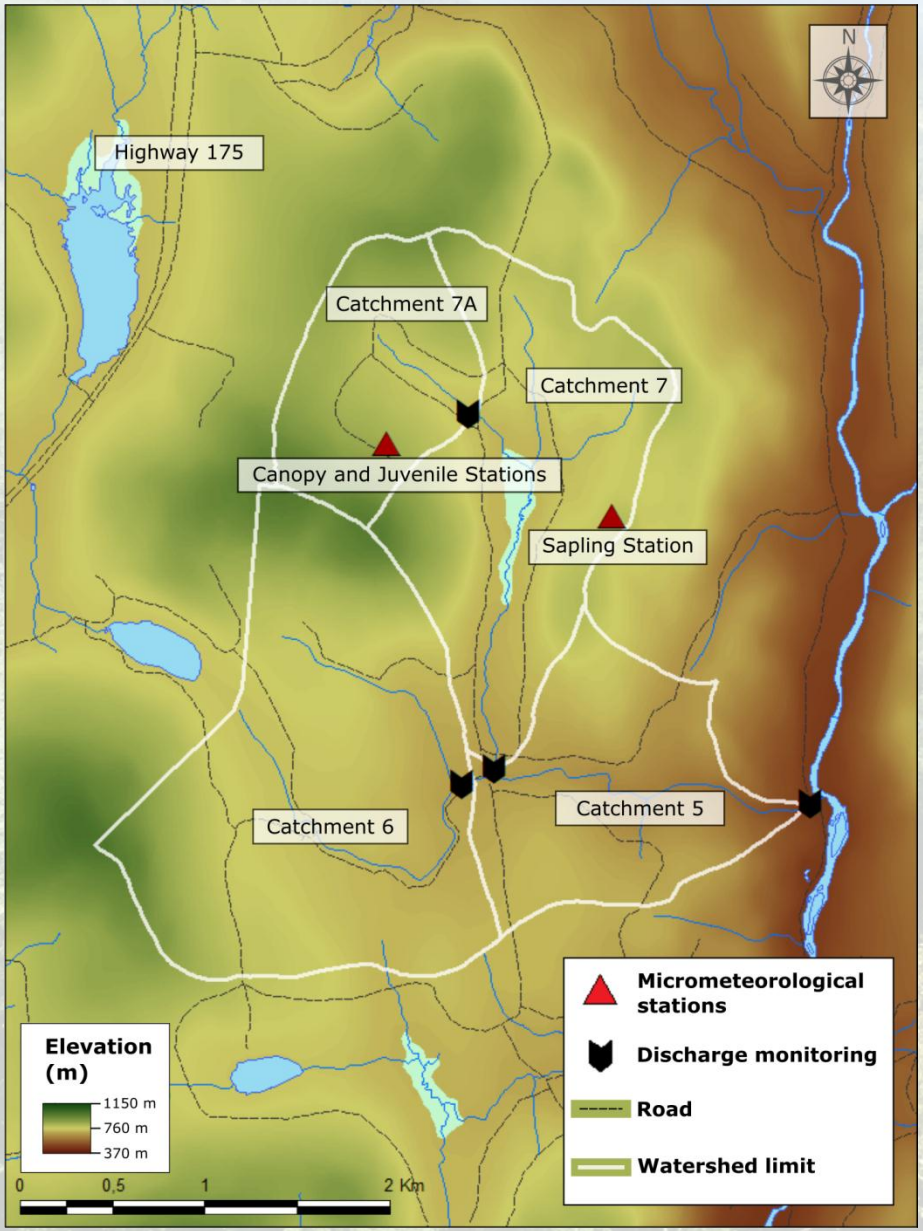


BEREV and BOREAS climatology (1981-2010) (from Thompson and Forêt Montmorency stations, Environment Canada)

P ~1500 mm !

Method

- Experimental setup : **Micrometeorological stations**
- Juvenile station
- Sapling station



BEREV watershed and experimental setup

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- Experimental setup : **Micrometeorological stations**
- **Juvenile station**
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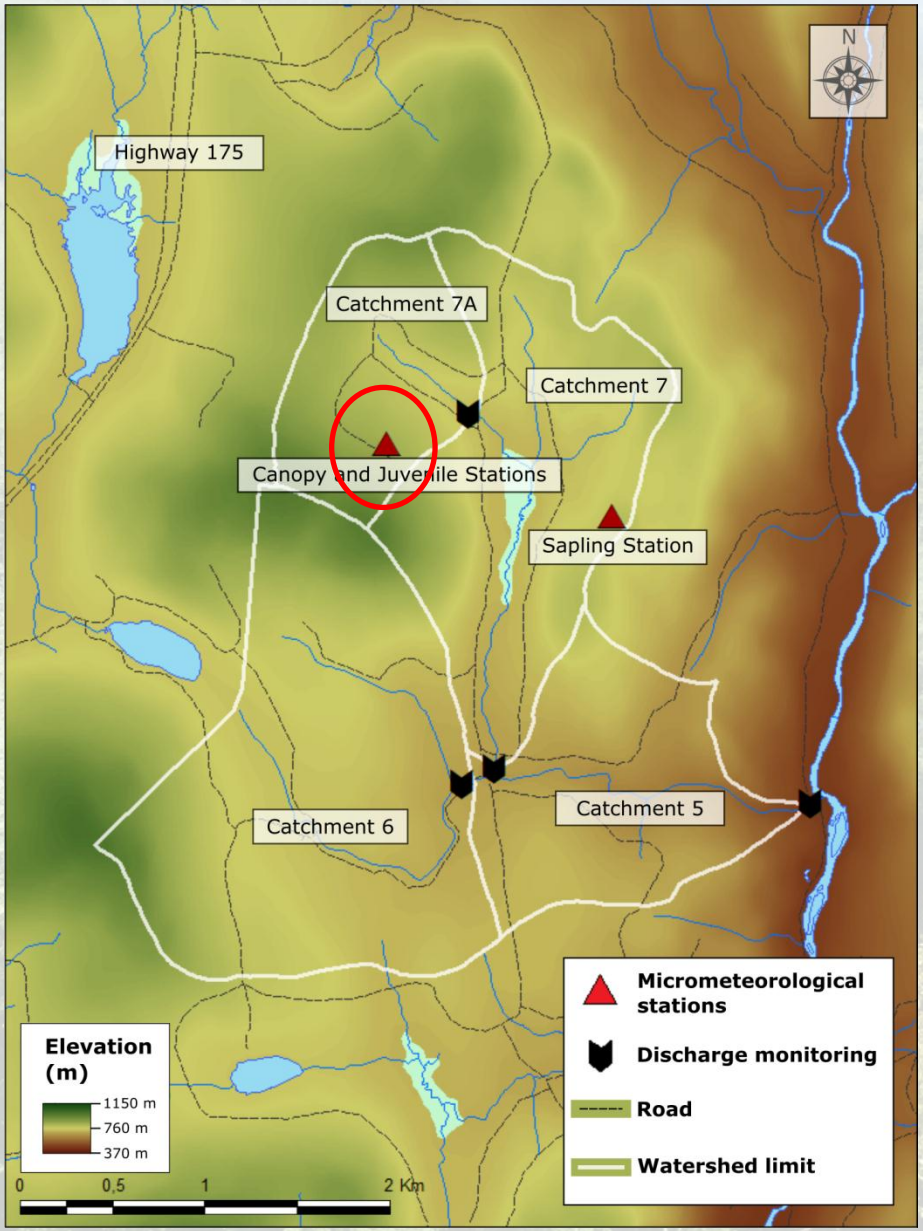
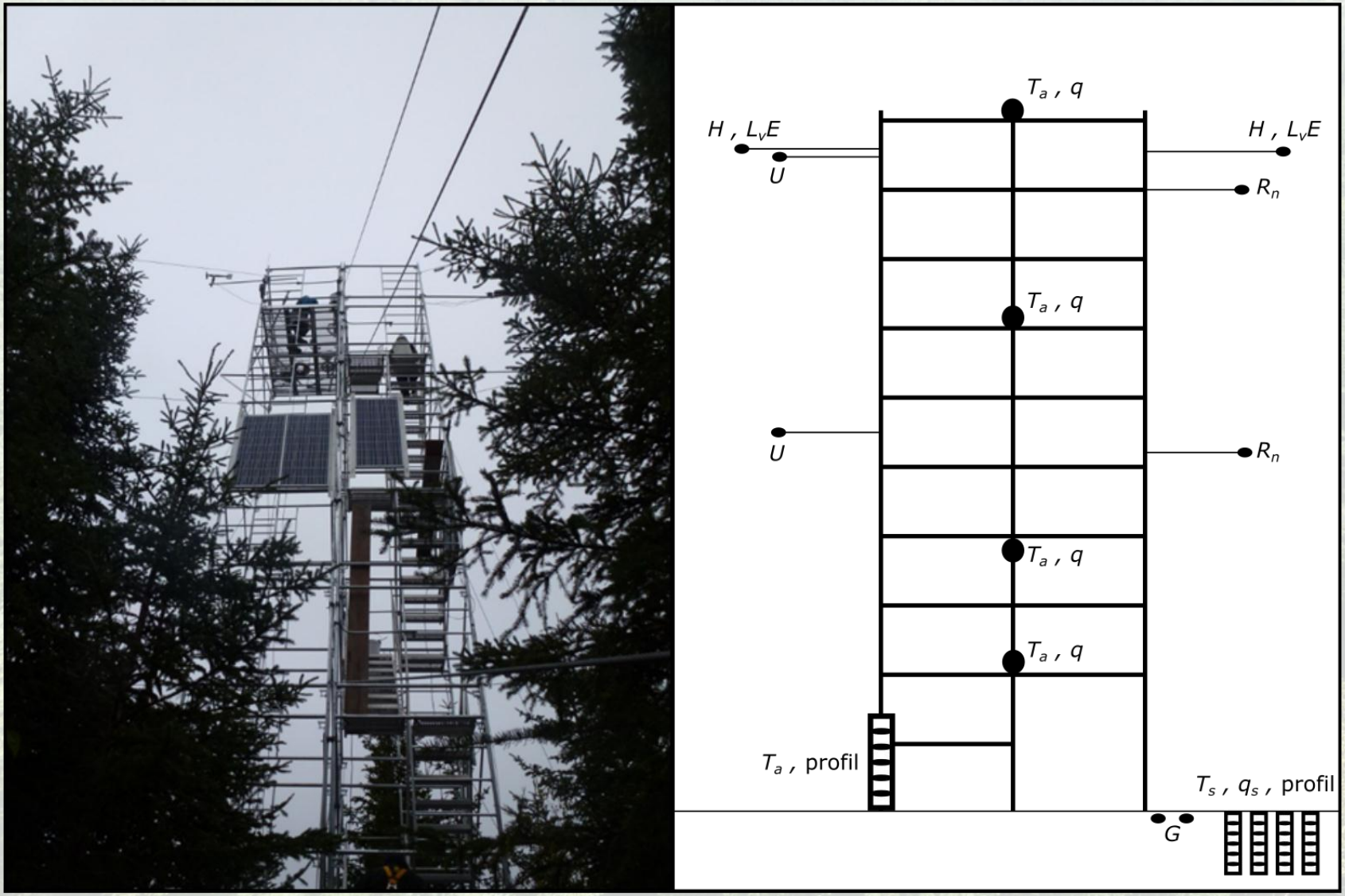


BEREV watershed and experimental setup

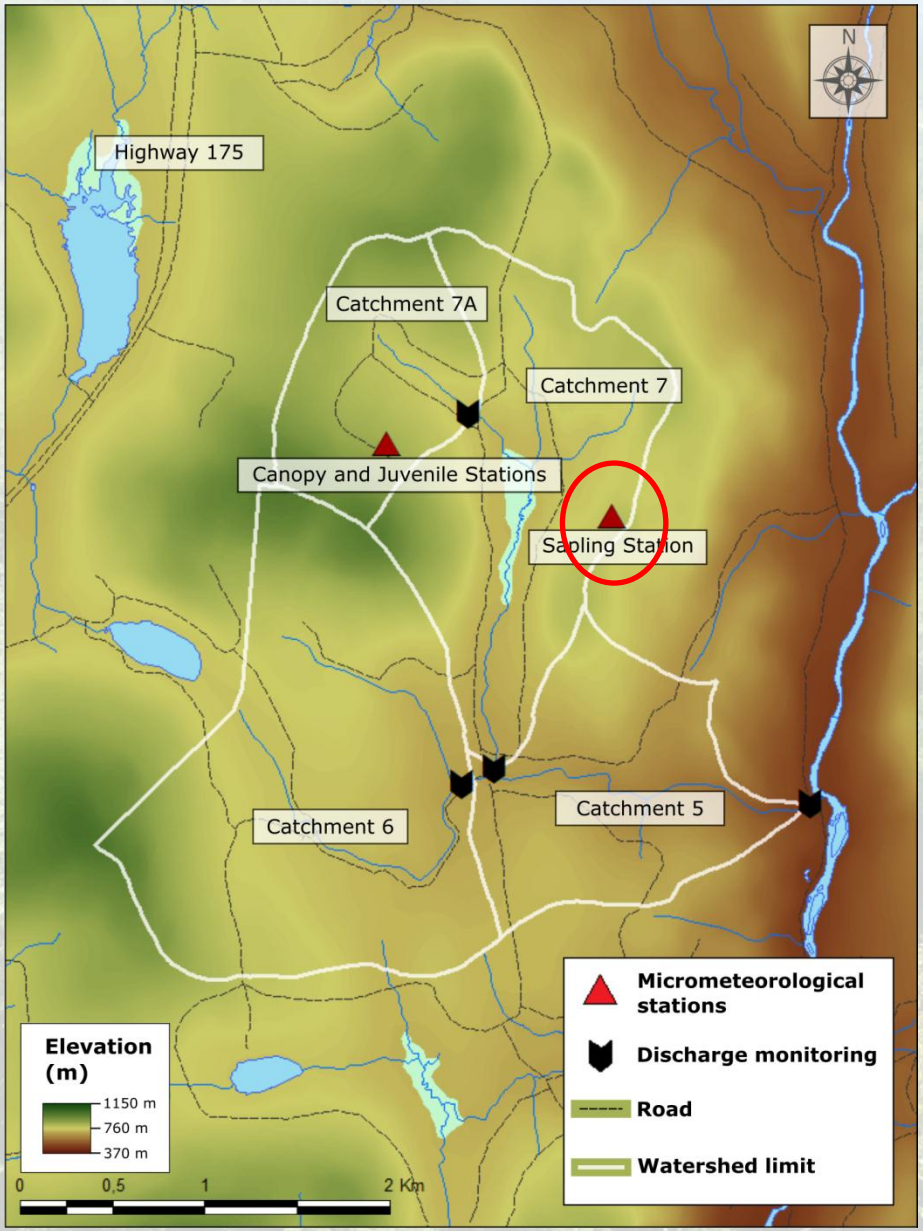
Method



Picture and schematics (not to scale) of the Juvenile station

Method

- Experimental setup : **Micrometeorological stations**
- Juvenile station
- **Sapling station**



BEREV watershed and experimental setup

Method

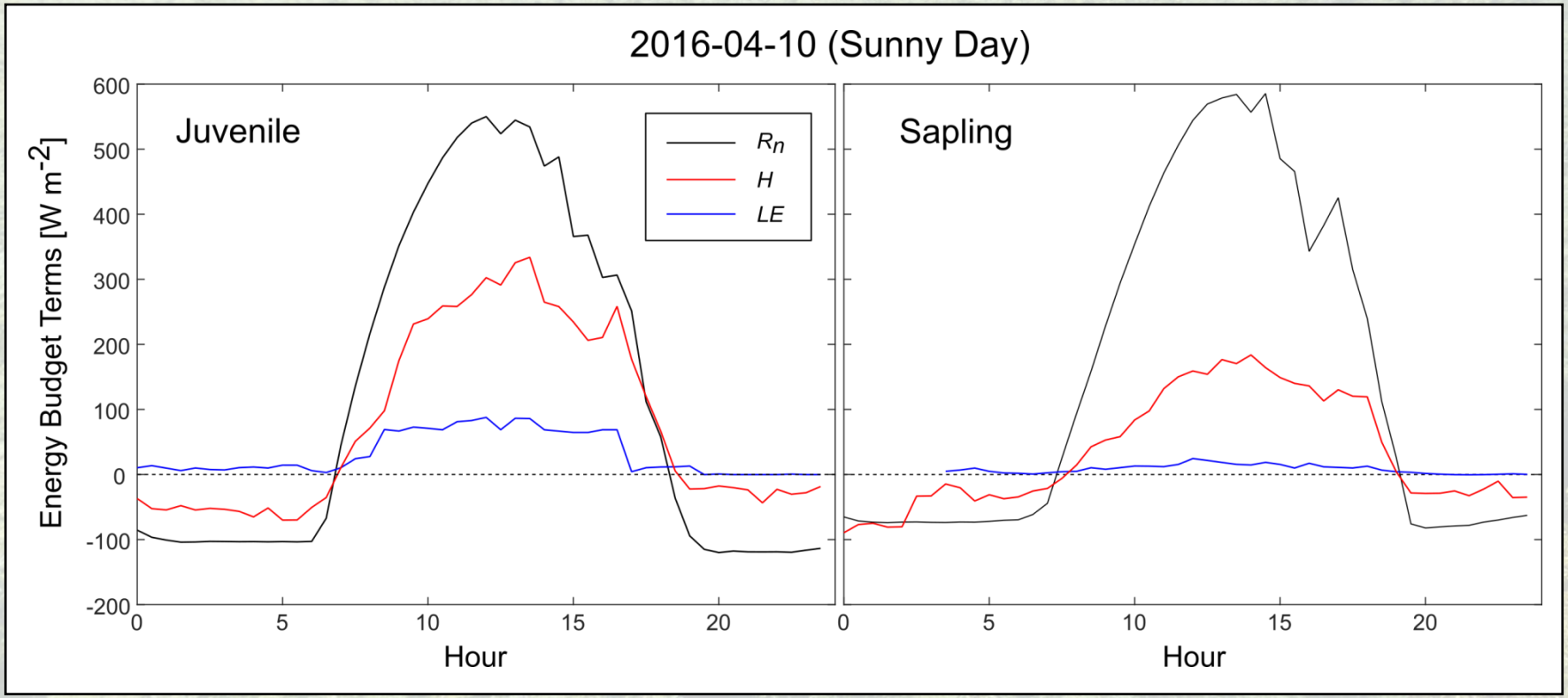
- Experimental setup : **Micrometeorological stations**
- Juvenile station
- **Sapling station**

Picture of Sapling station

Preliminary results

Preliminary results

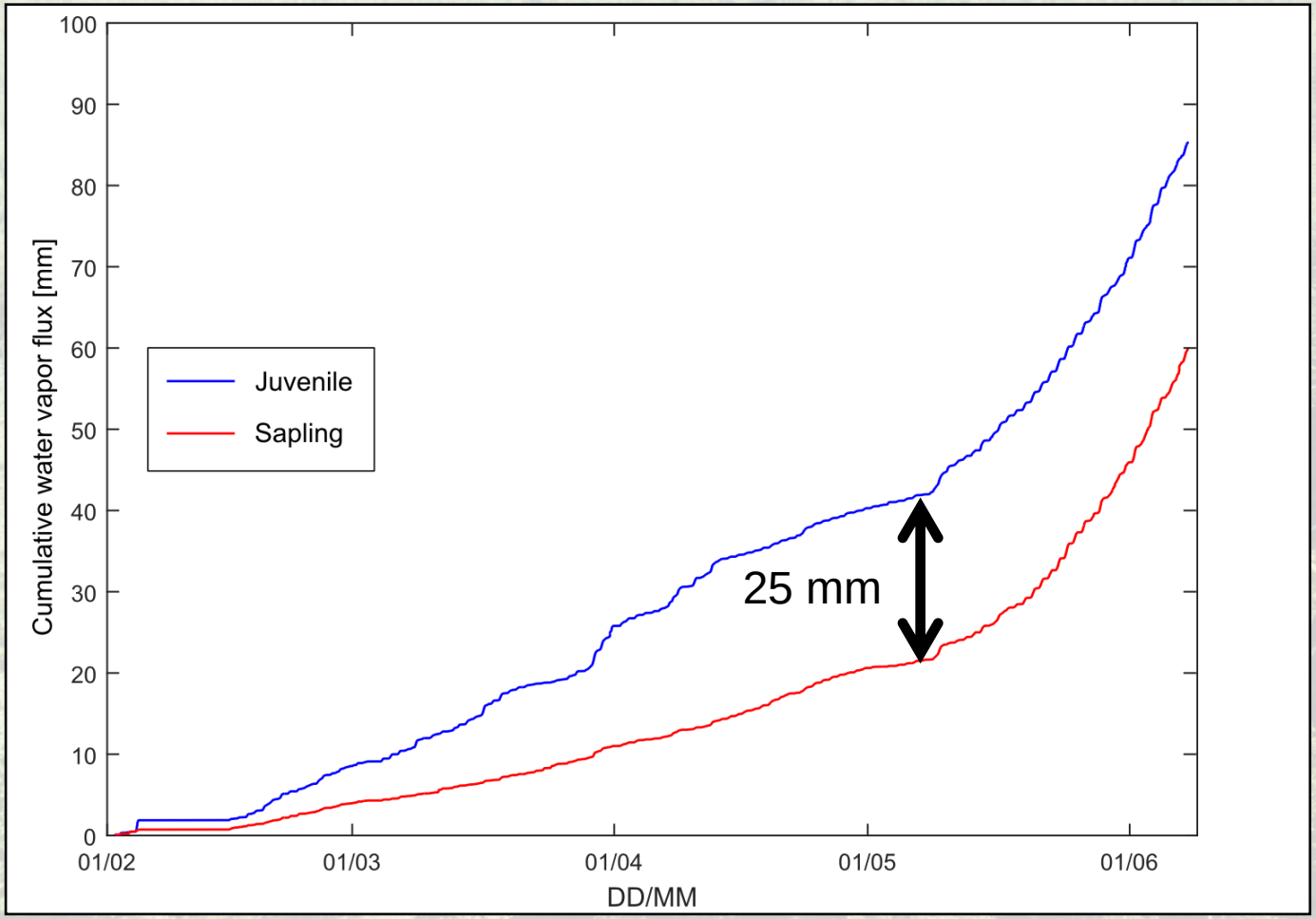
- Description of water vapor fluxes: **Energy Budget**



Energy budget at the Juvenile and Sapling stations, April 10th 2016

Preliminary results

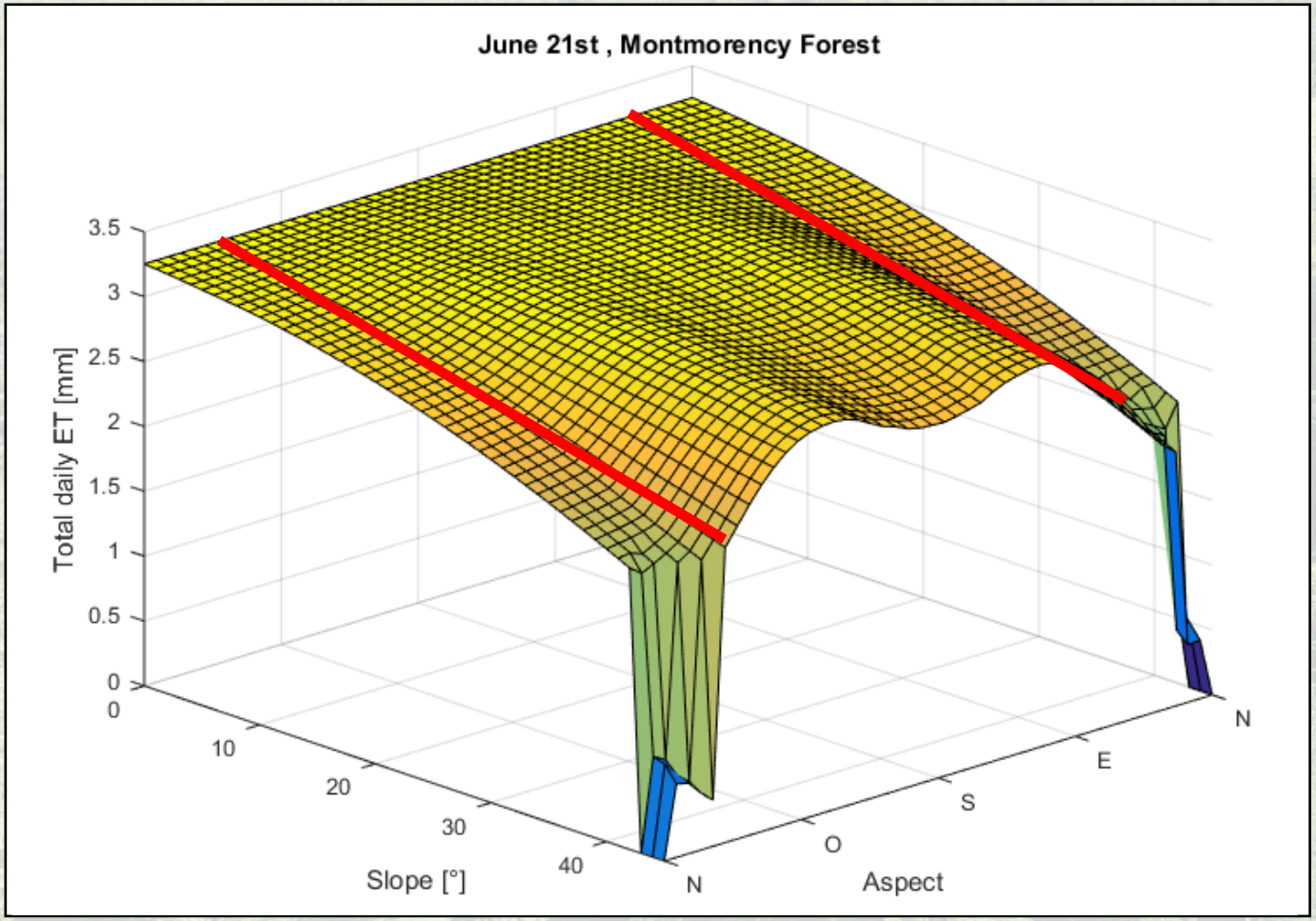
- Description of water vapor fluxes: **Cumulative**



Cumulative water vapor flux at Juvenile and Sapling stations, winter 2016.

Preliminary results

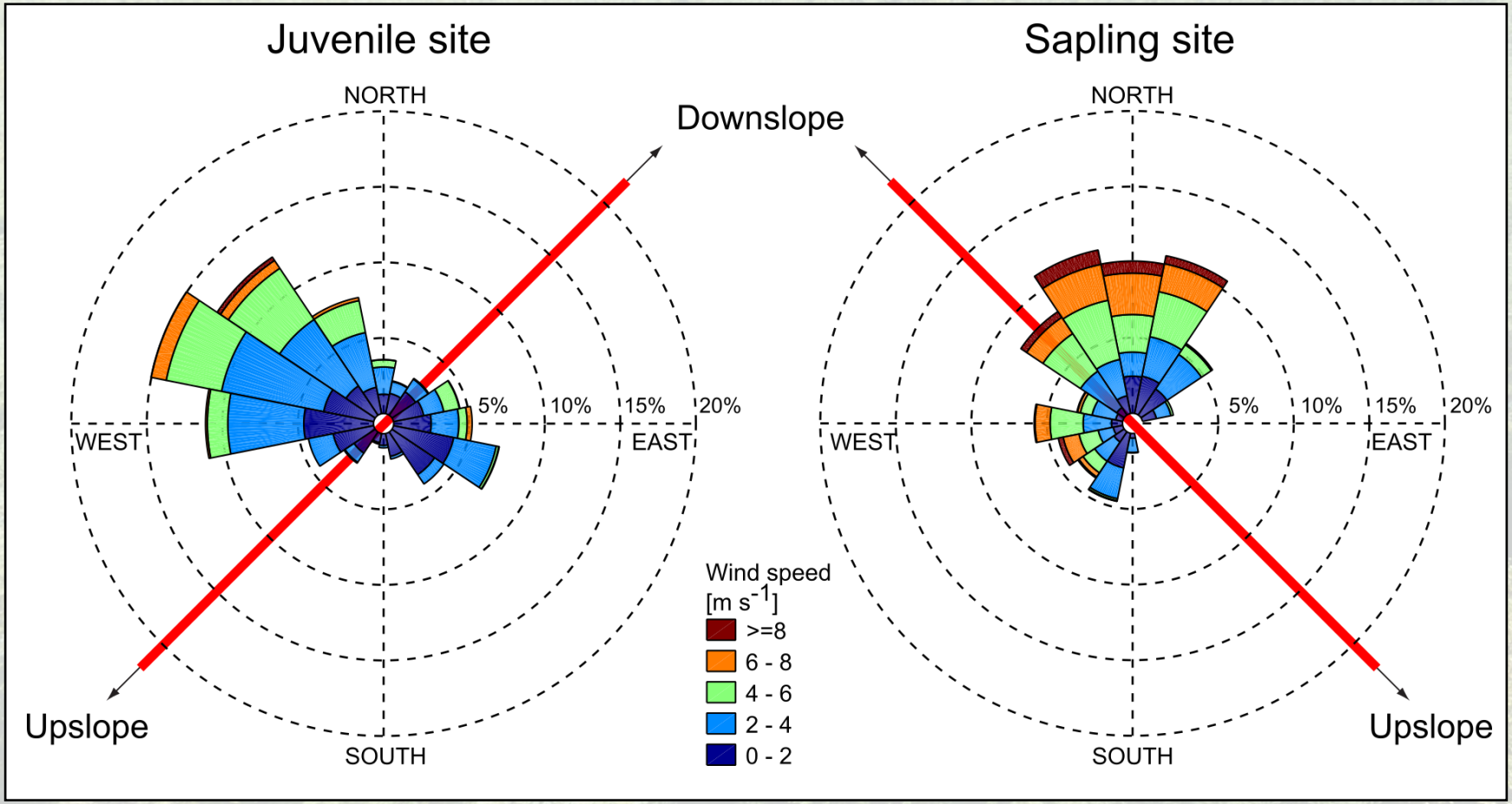
- Impacts on ET: **Slopes ?**



Total daily ET vs. slope and aspect. Calculated with Whiteman & Allwine (1986) and Priestley & Taylor (1972)

Preliminary results

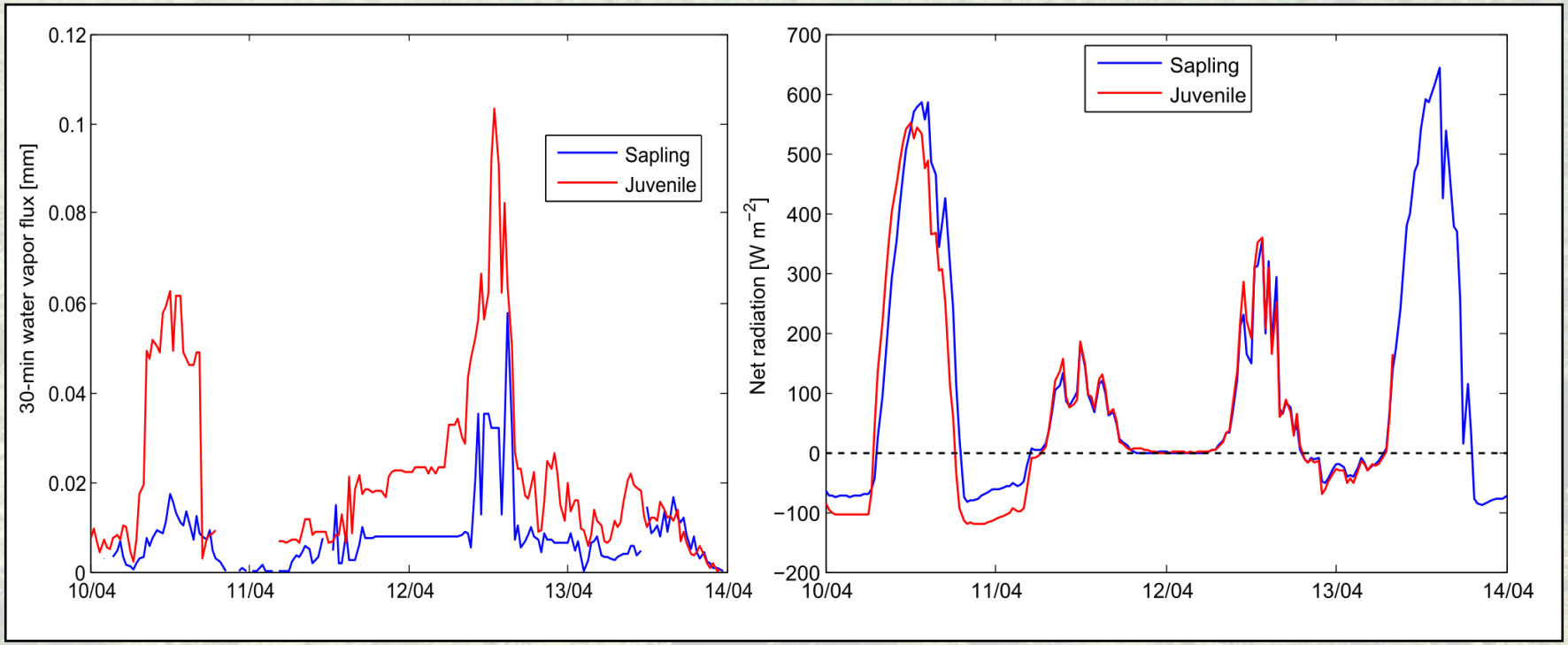
- Impacts on ET: **Slopes ?**



Wind rose histogram of the Juvenile and Sapling stations, winter 2016

Preliminary results

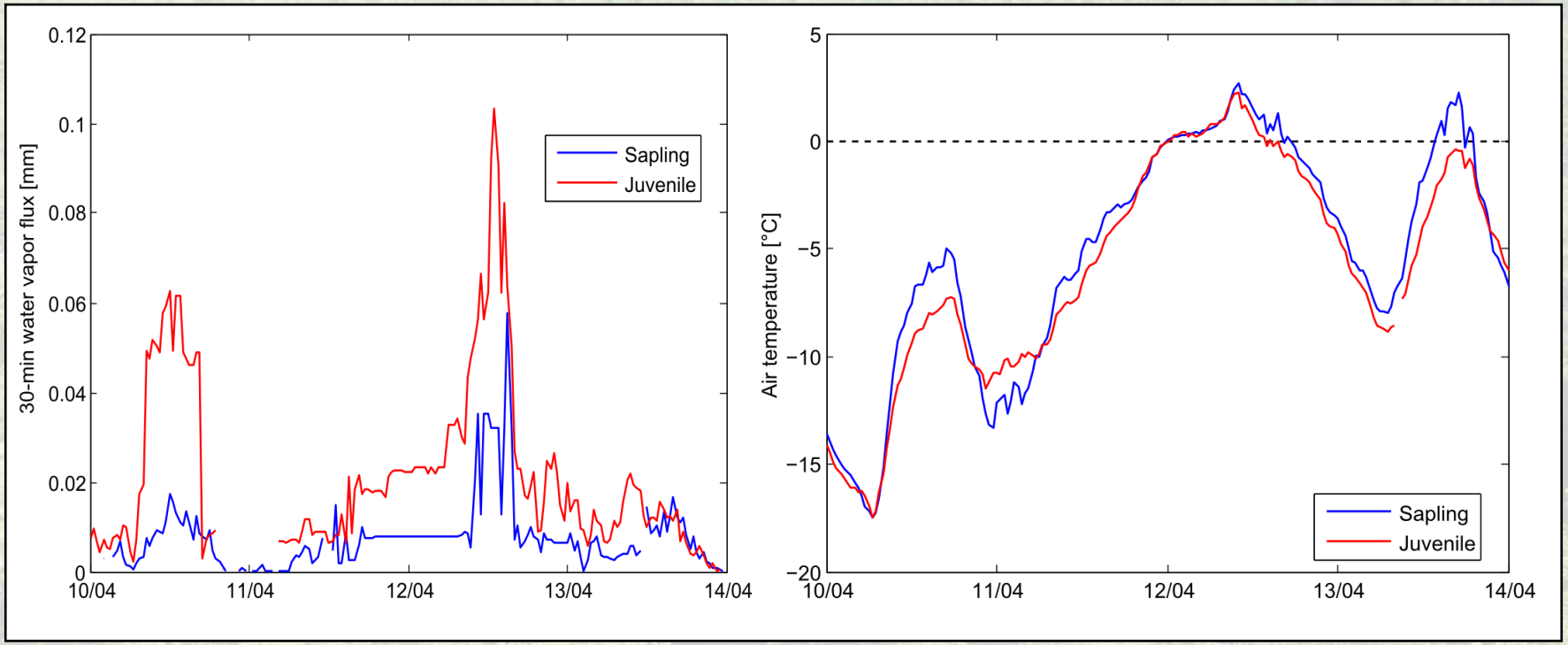
- Impacts on ET:



Water vapor flux and net radiation at the Juvenile and Sapling stations, April 10th to April 14th 2016

Preliminary results

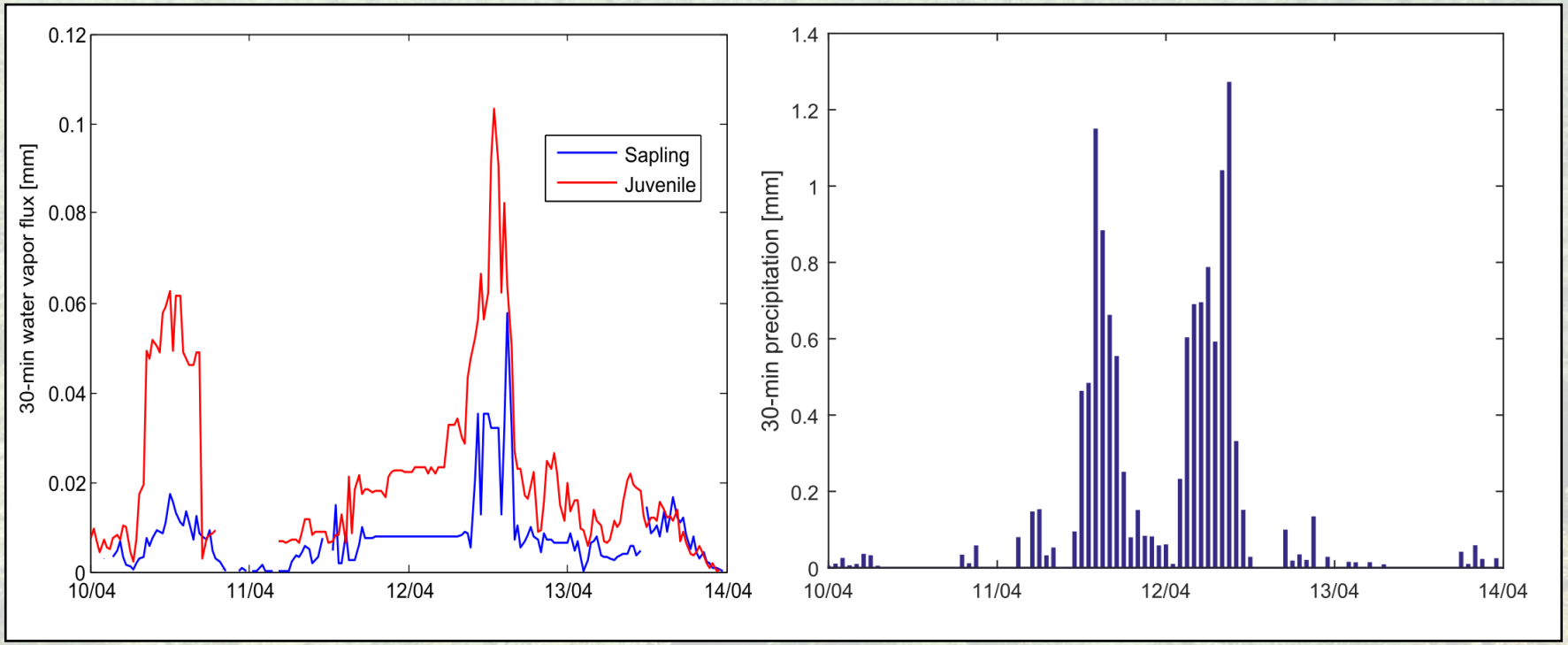
- Impacts on ET:



Water vapor flux and temperature at the Juvenile and Sapling stations, April 10th to April 14th 2016

Preliminary results

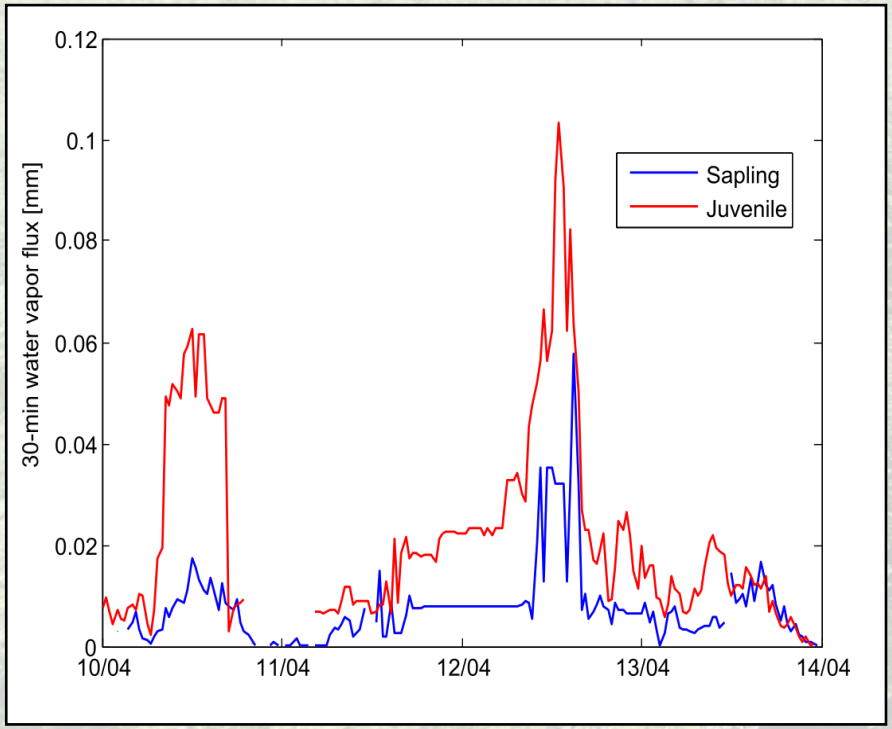
- Impacts on ET: **Precipitation ?**



Water vapor flux and precipitation at the Juvenile and Sapling stations, April 10th to April 14th 2016

Preliminary results

- Impacts on ET: **Precipitation**



Water vapor flux at the Juvenile and Sapling stations, April 10th to April 14th 2016

Intercepted droplets on coniferous needles

Concluding remarks

Concluding remarks

- Results include mostly periods with snow cover (**ET low**)
- **Slope effects** on ET **undetected** so far
- **Strong precipitation effect** on ET suspected: probably caused by evaporation/sublimation of interception
- **Snow-free/growing season data** should help us further our understanding (**higher ET**)


Thank you.
Questions?


Reference

Reference

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