LAND-ATMOSPHERE FLUX FEEDBACKS TO THE DROUGHT 2018 AS OBSERVED AT EC SITES

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TERENO WORKSHOP 11-13 SEPTEMBER 2019

Member of the Helmholtz Association

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

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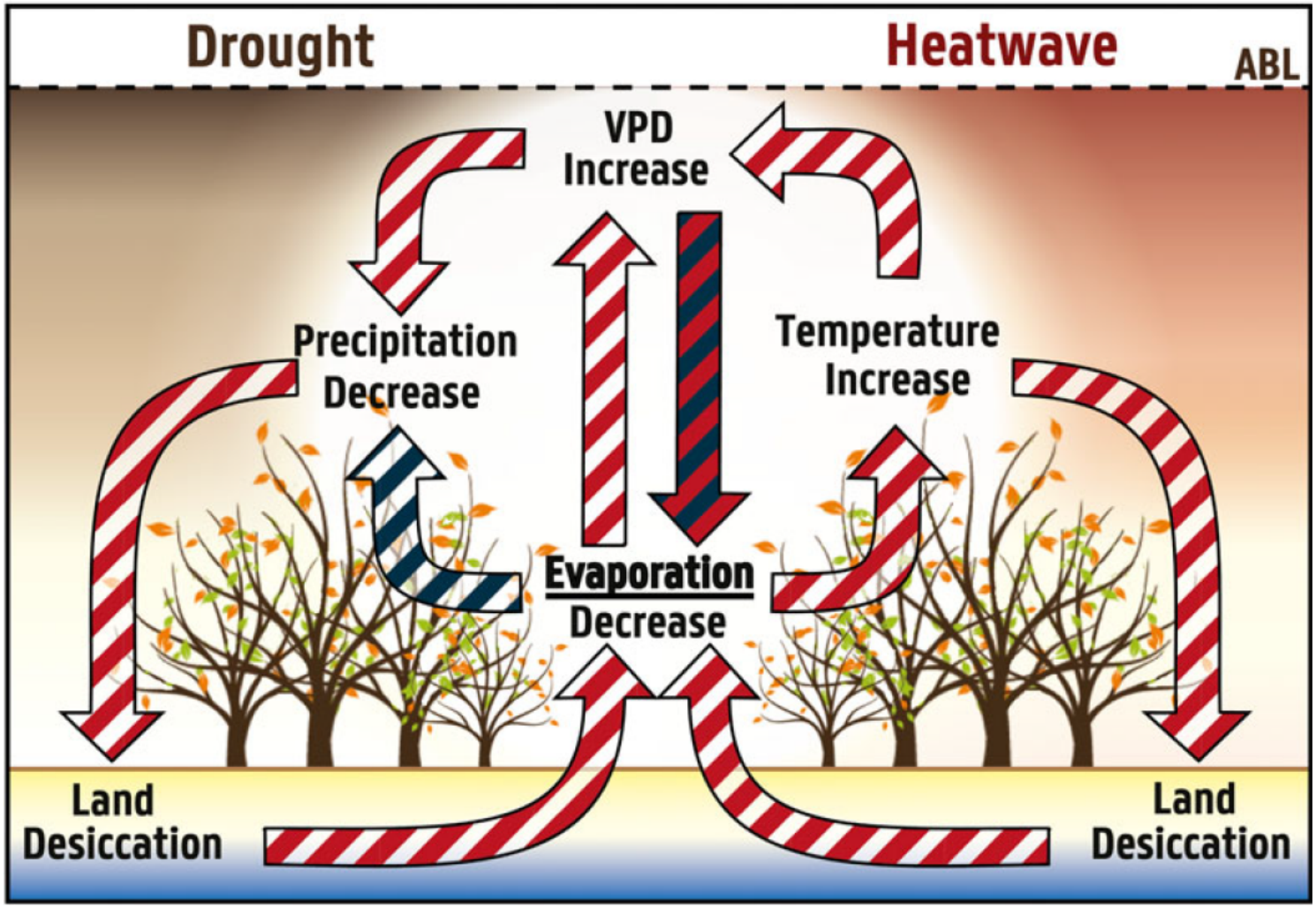
LAND SURFACE FEEDBACKS DURING DROUGHTS AND HEATWAVES

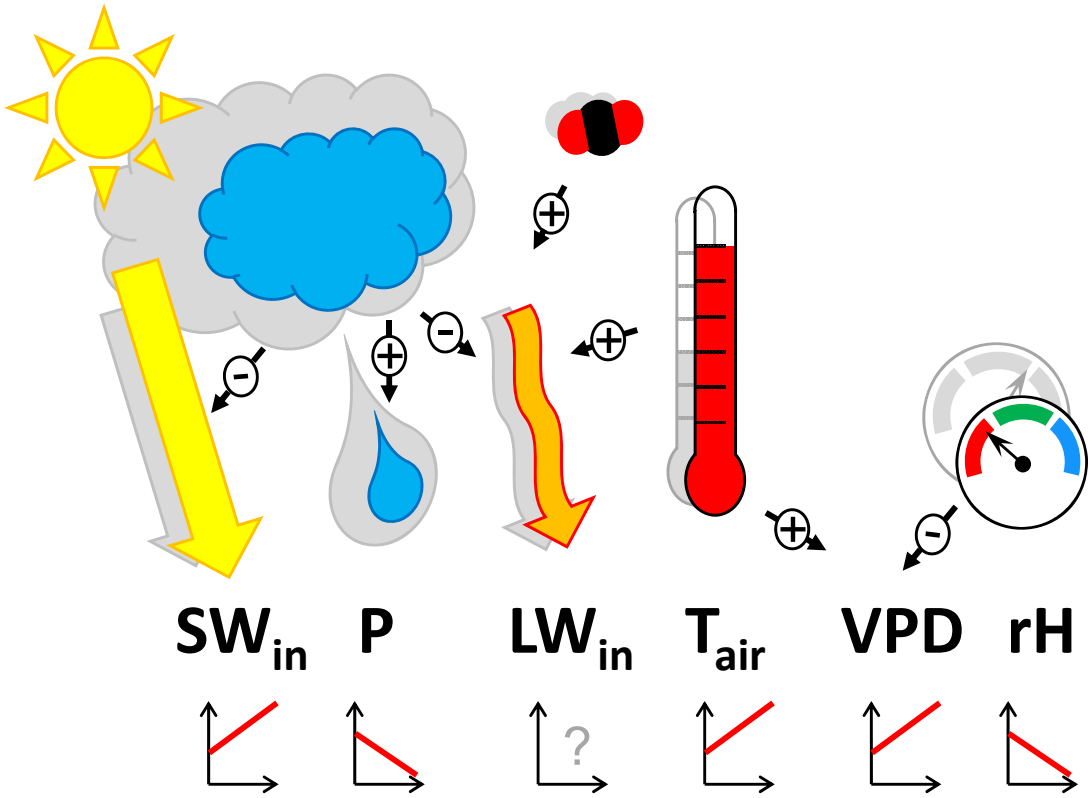


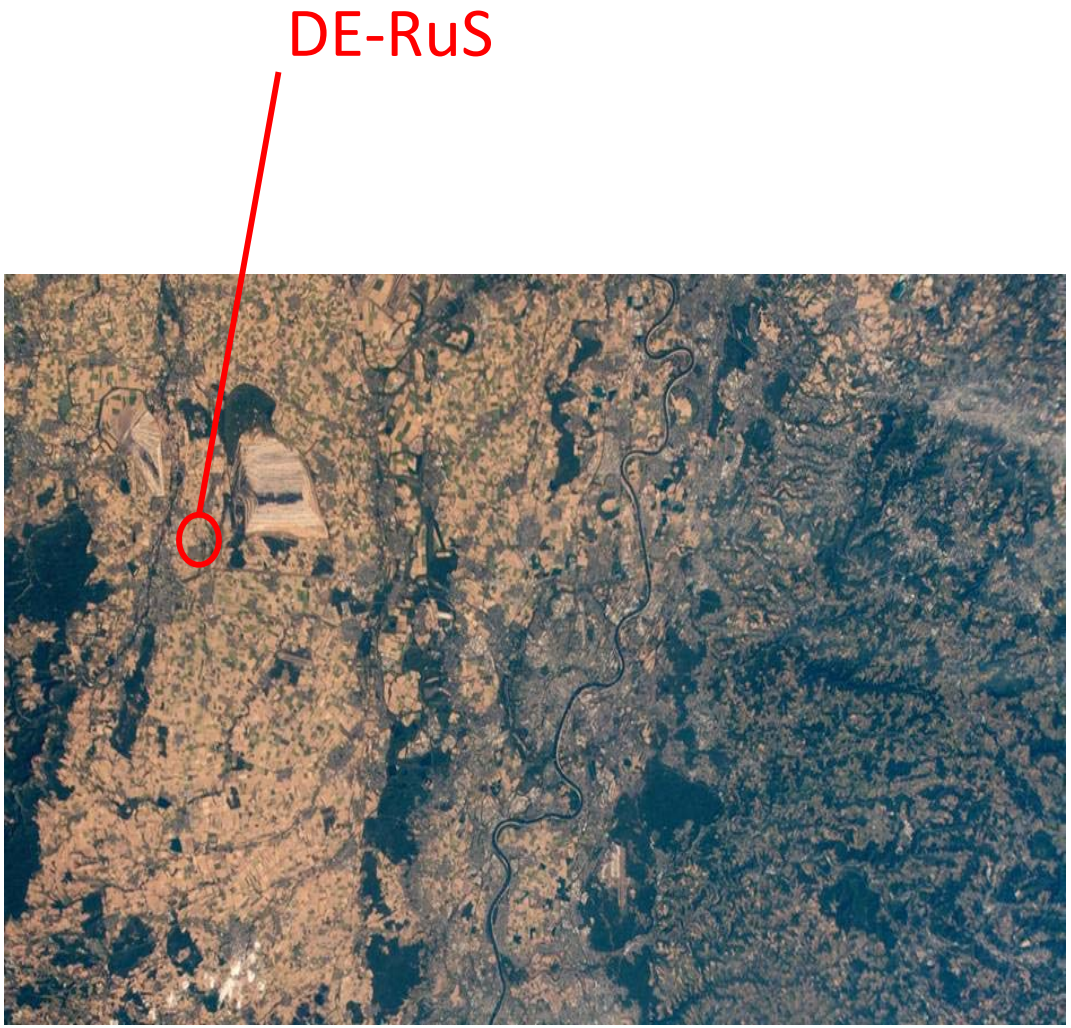
Positive feedback

Negative feedback

Miralles et al. (2019)

ATMOSPHERIC CONTROLS





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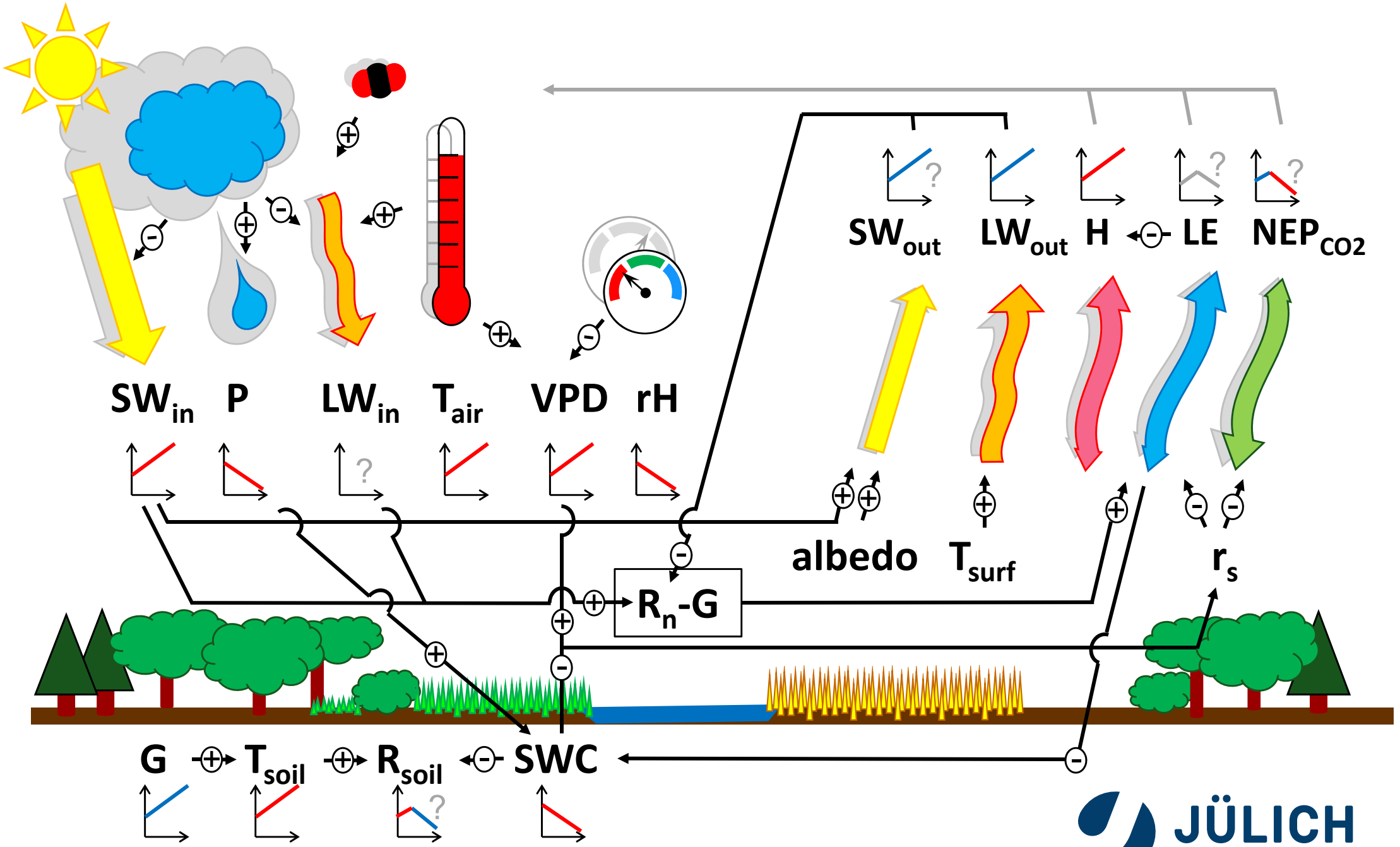
LAND SURFACE – ATMOSPHERE INTERACTIONS



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EDDY COVARIANCE MEASUREMENTS

$$F_C = \overline{w'c'}$$

$$w' = w - \bar{w}$$

$$c' = c - \bar{c}$$

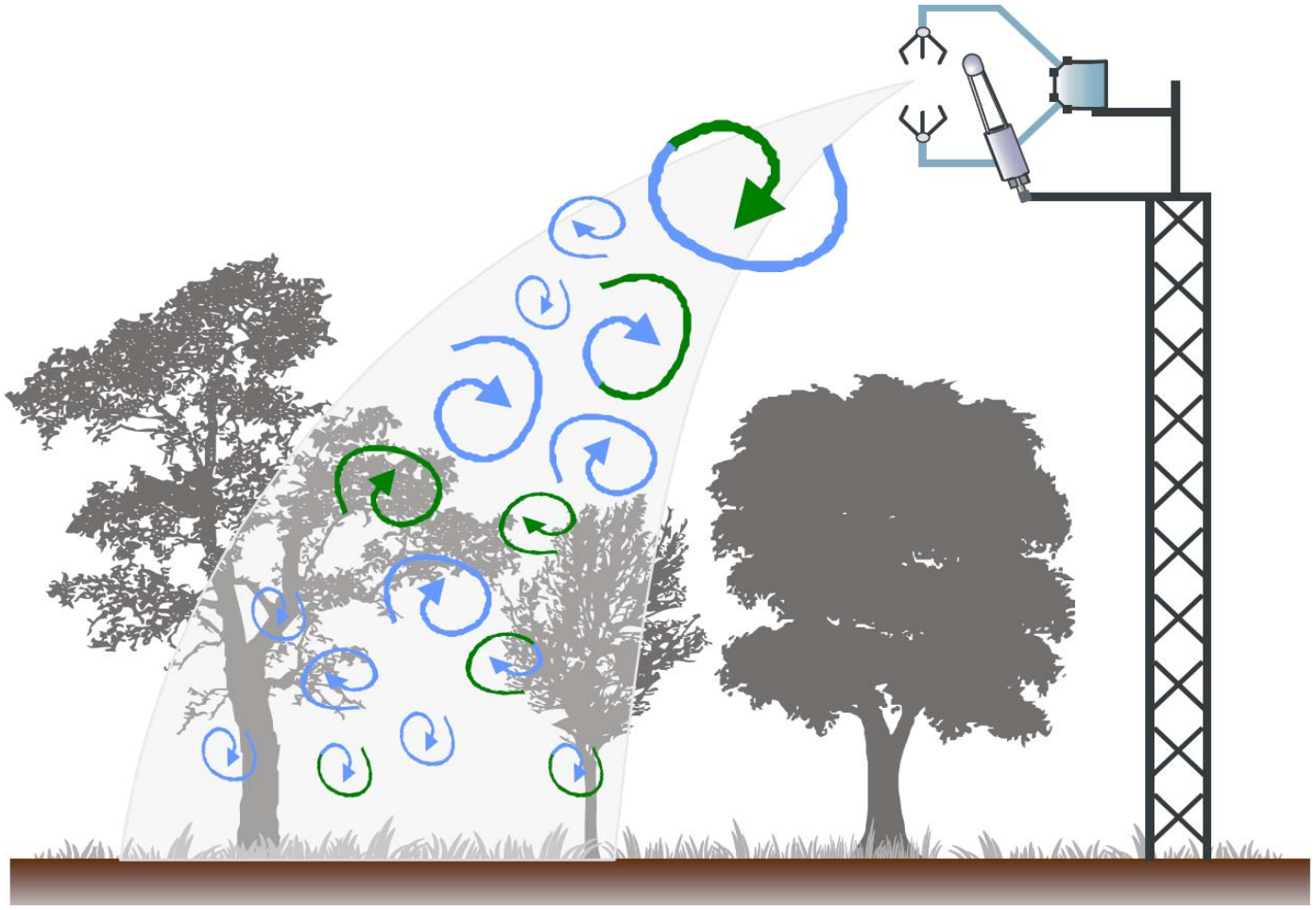
F_C =Turbulent flux ~ ETa

c = H_2O concentration

w = Vertical wind speed

Overbar denotes average & prime's the deviations from this average

Sonic anemometer + gas analyser



PROCESSING

10 / 20 Hz eddy covariance raw data

PI

half-hourly flux data

meteorological data

fill gaps with nearby stations (RMA/EOF regression)

REddyProc (Wutzler et al. 2018)

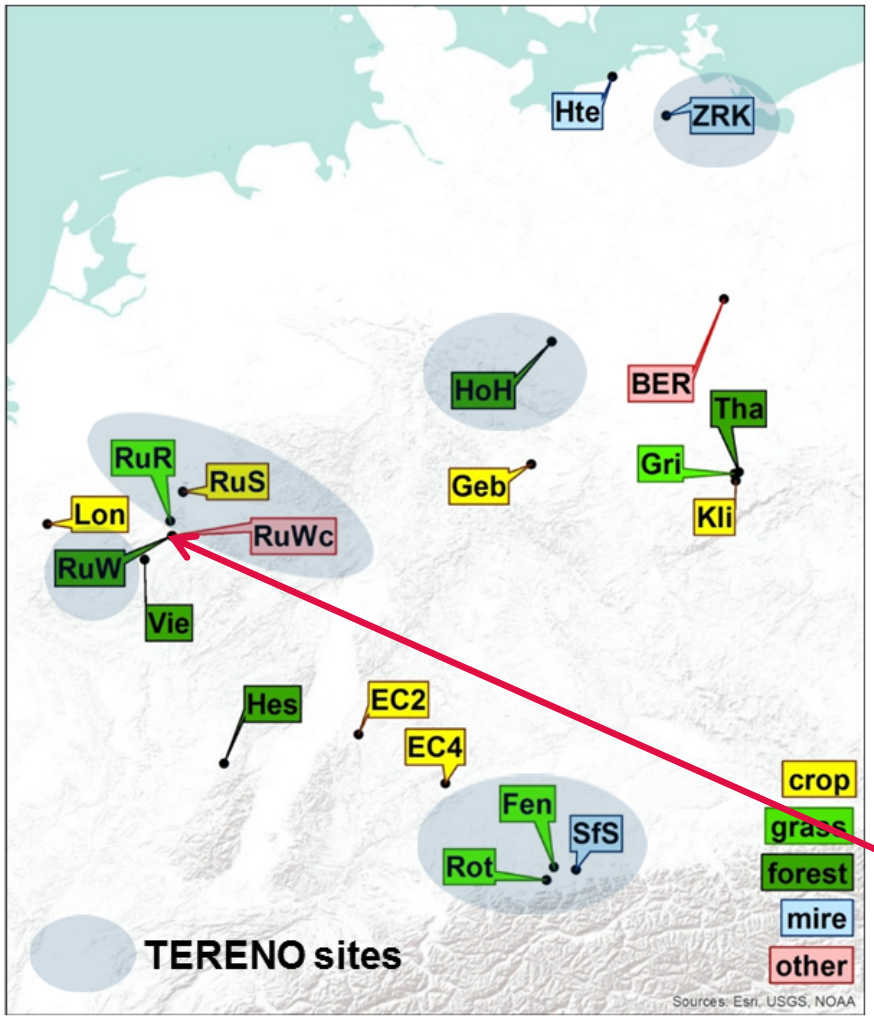
soil heat flux correction, ET0 estimation (FAO56)

NEE, LE, H, ET, ET0

daily aggregation

comparison to (averaged) reference year(s)

INVESTIGATED SITES



- 20 EC sites with various landuse covers
- Net effect of the 2018 event at a site depends on the balance between the positive and negative effects on the fluxes

⇨ Feedback on global warming

TERENO test site Wüstebach
- RuW (forest)
- RuWc (clear cut)

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WÜSTEBACH TEST SITE

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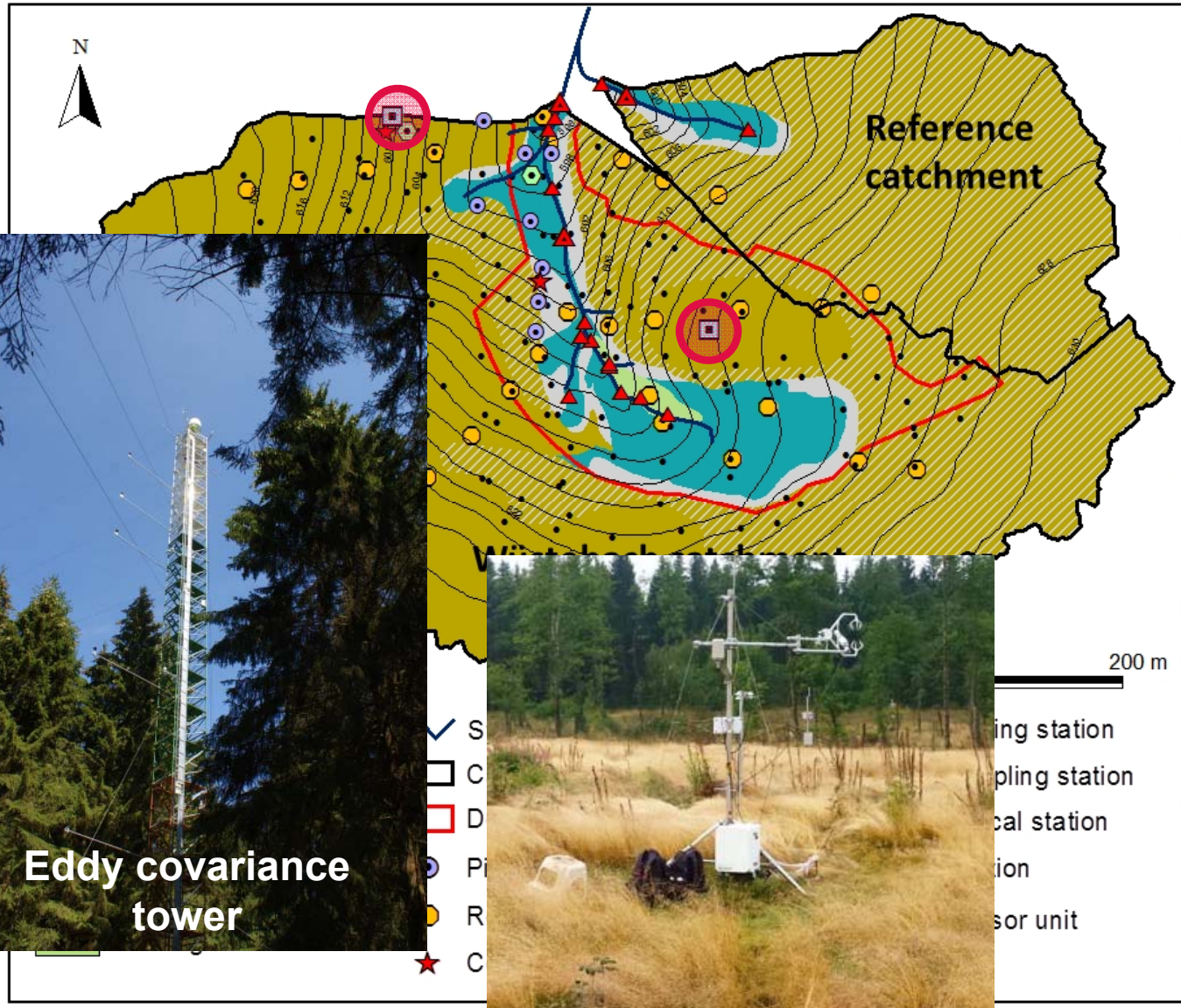
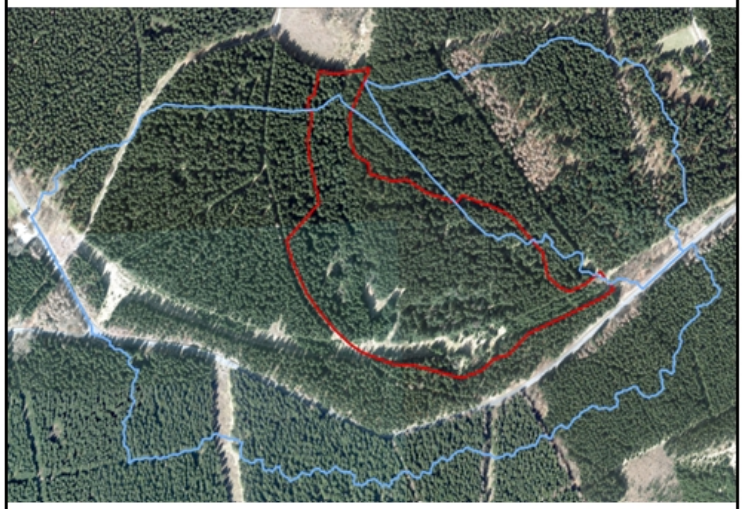
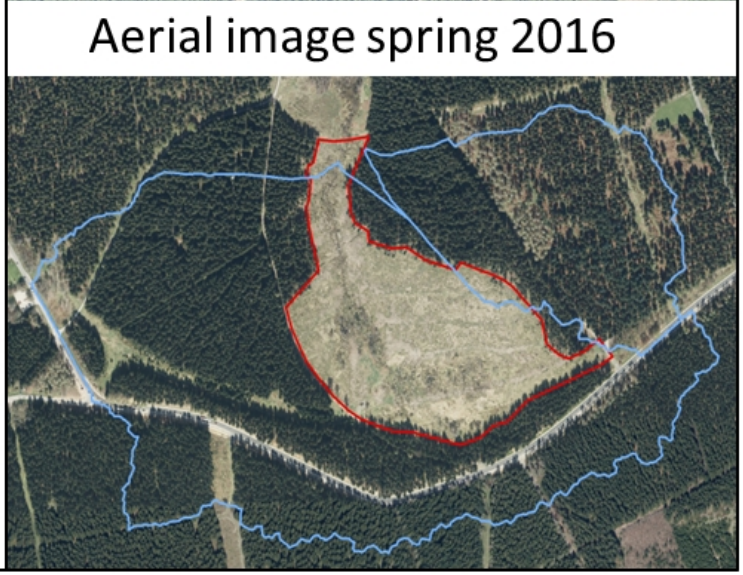
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES







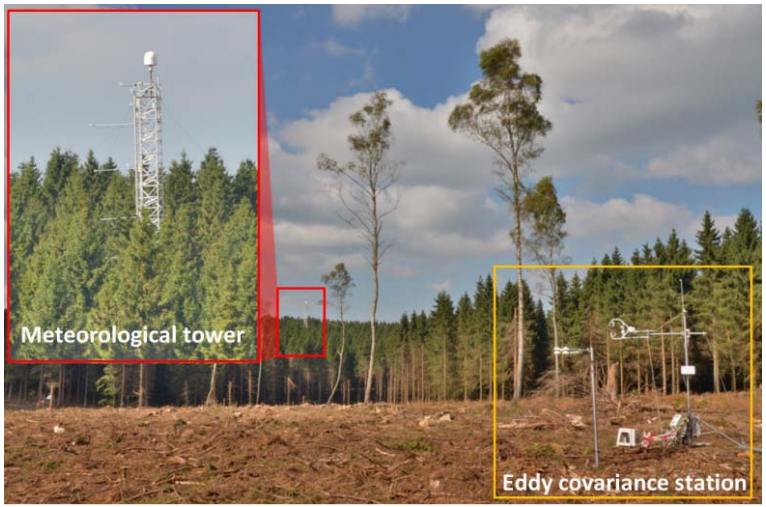
Bogena et al. (2018), VZJ

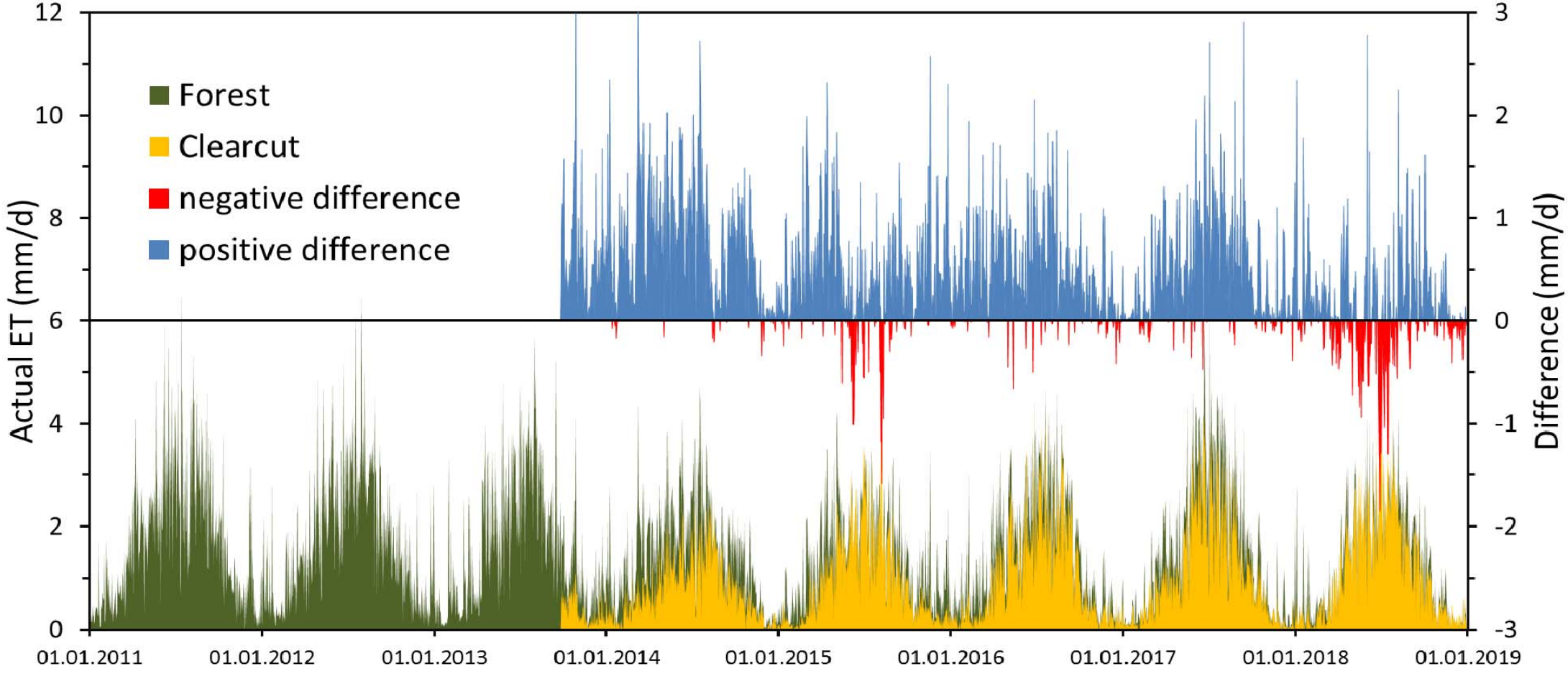
CLEAR-CUT AREA IN 2014

CLEAR-CUT AREA IN 2016

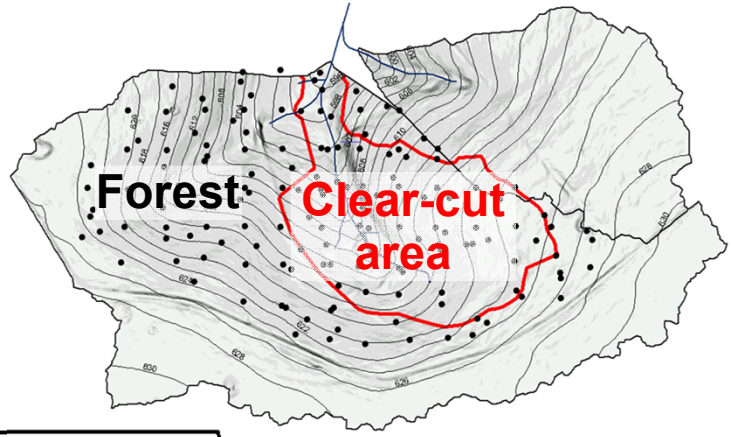
EVAPOTRANSPIRATION

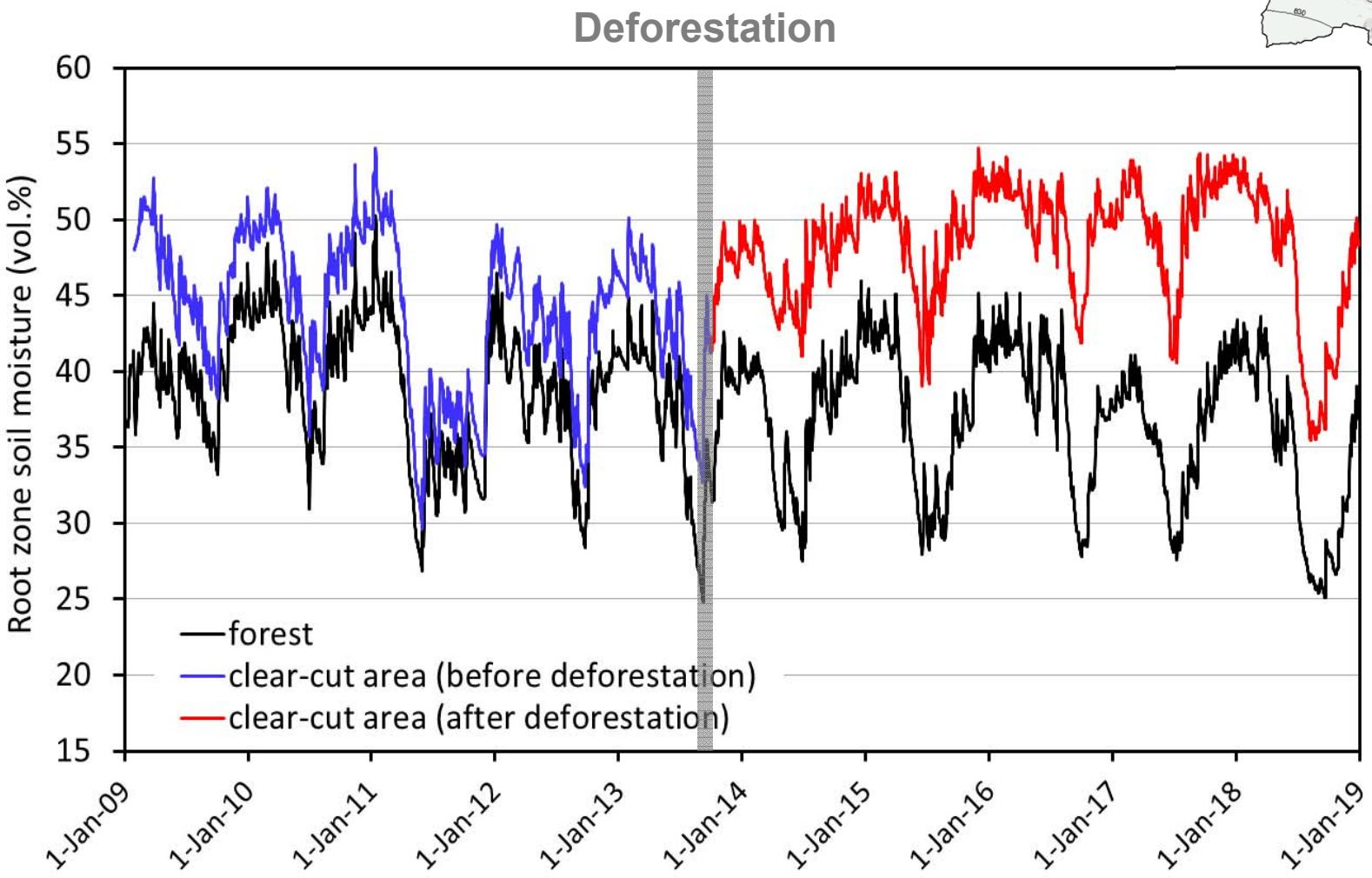
	Annual ETa (2014-2017)	Annual ETa 2018
Forest	602 mm	638 mm
Clear-cut	389 mm	455 mm





SOIL MOISTURE



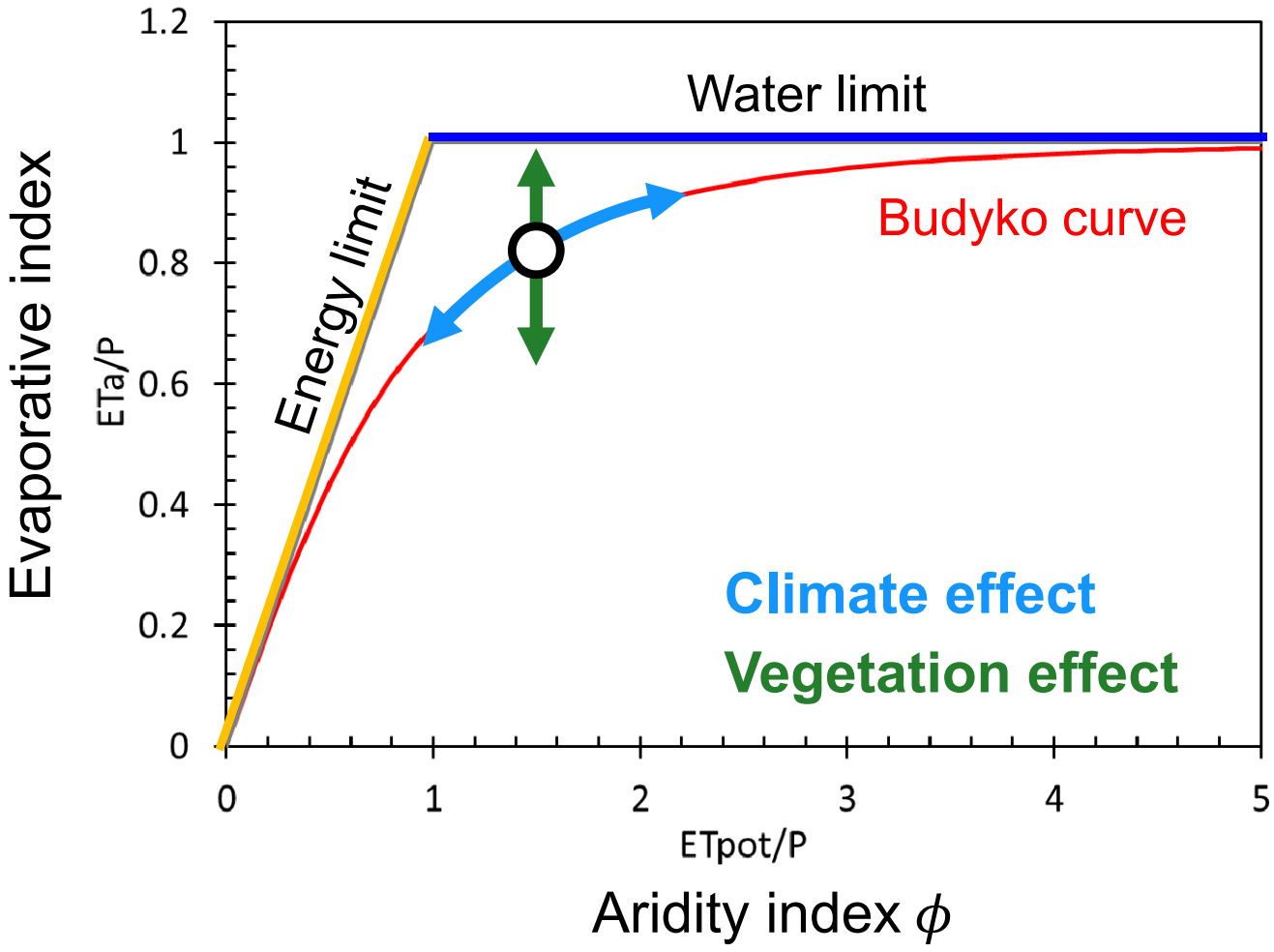


Which event did have a larger impact on the local water balance?

?

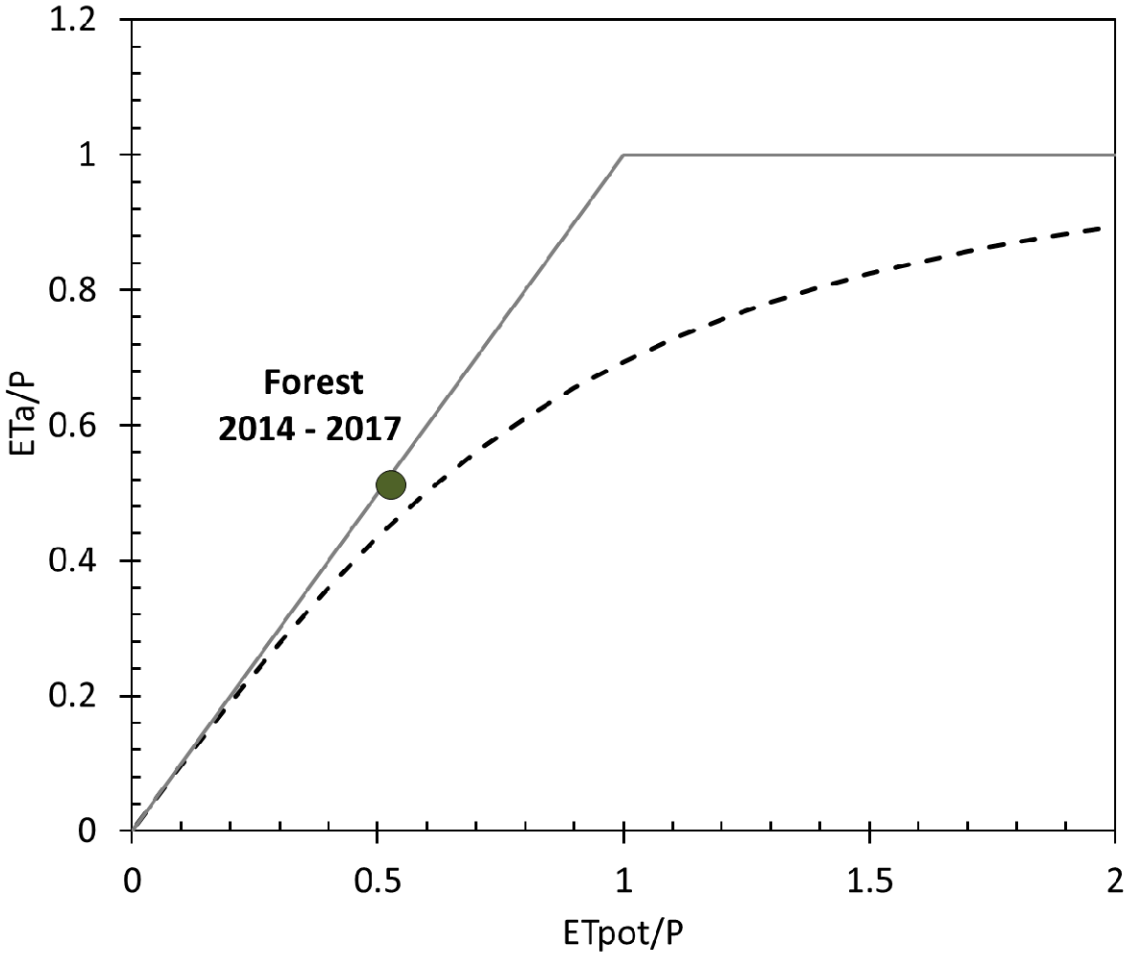
THE BUDYKO FUNCTION

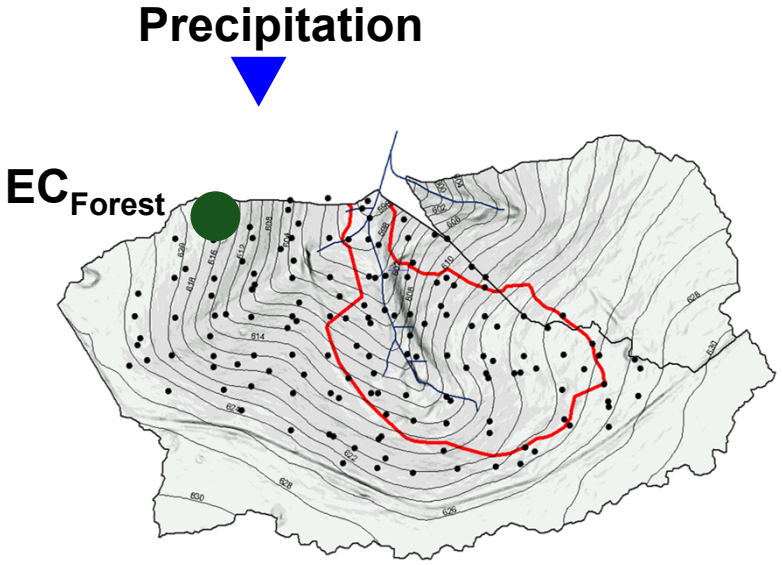
$$ETa = f(P, ETpot) \rightarrow ETa/P = f(\phi)$$



Mikhail Budyko
Russian climatologist
1920 – 2001

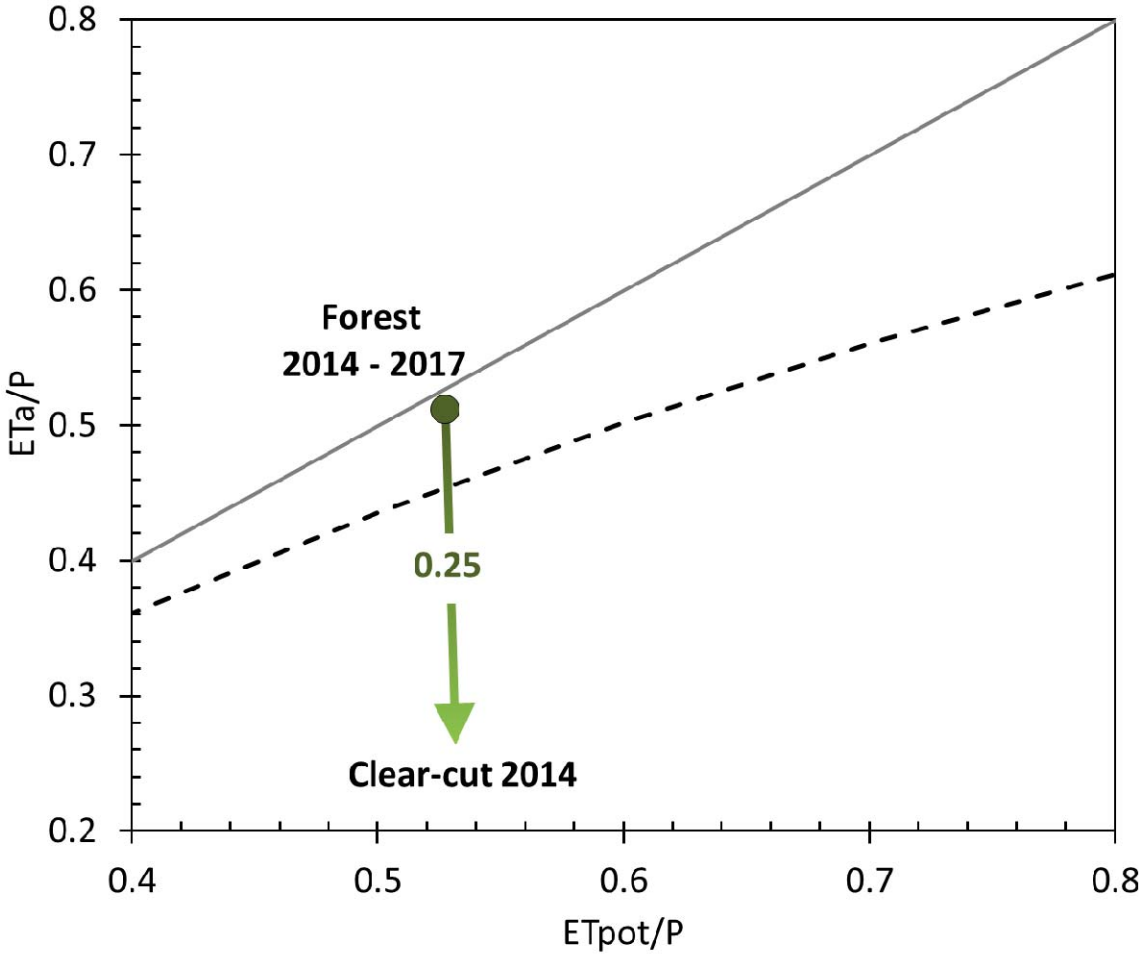
BUDYKO PLOT WÜSTEBACH

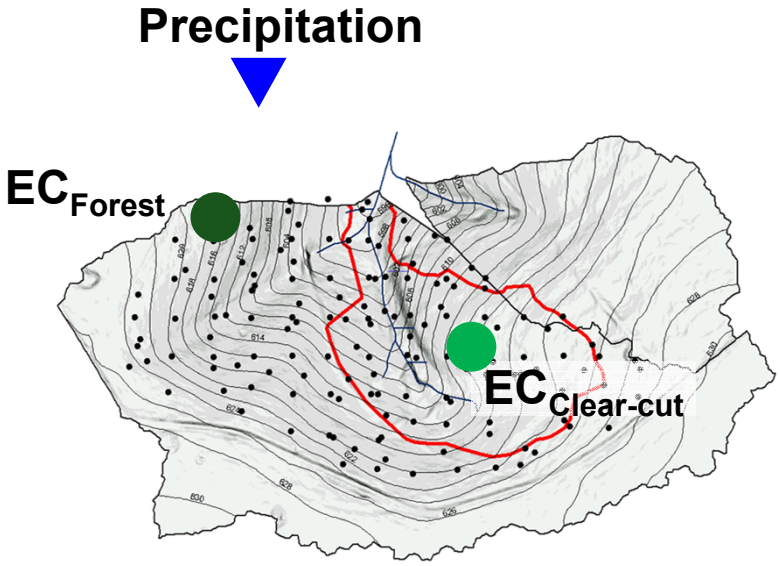




Wüstebach

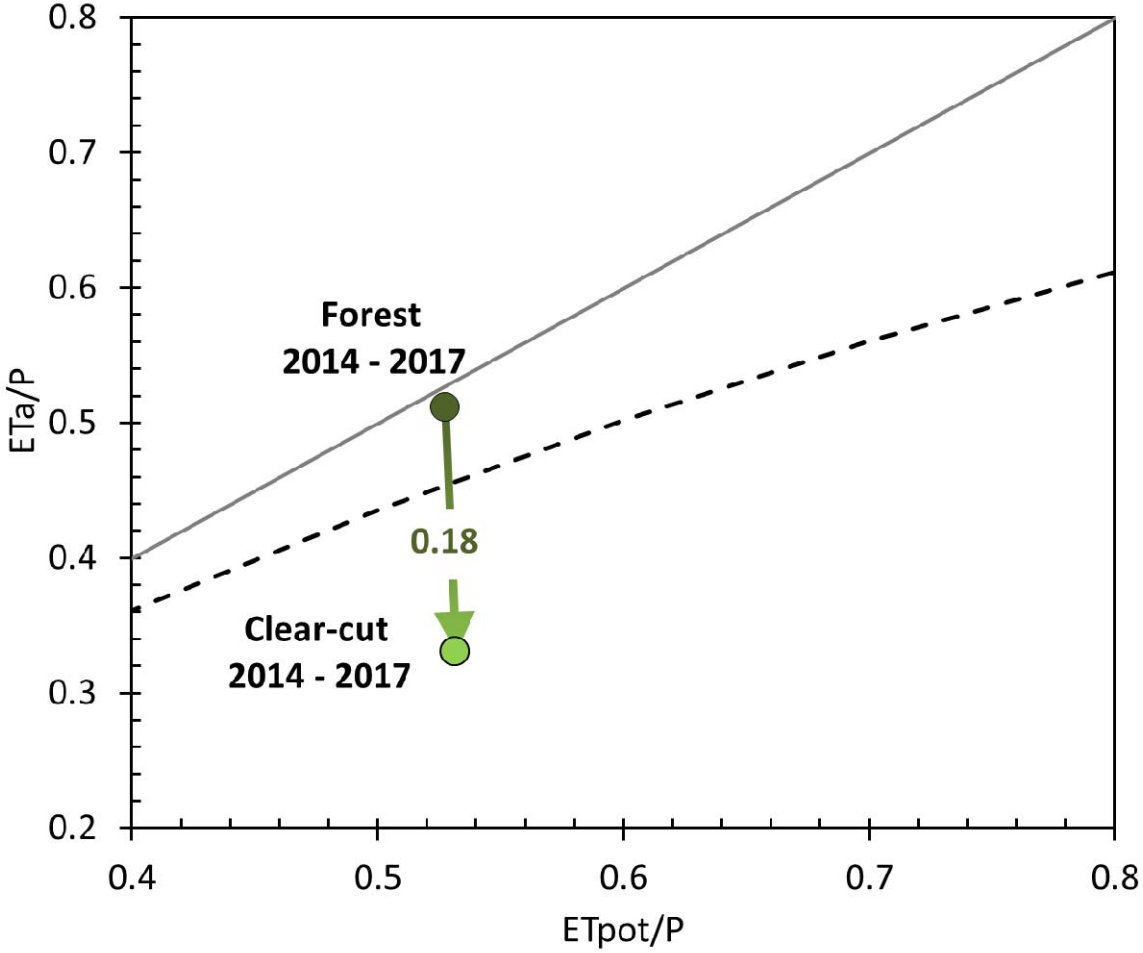
CLEAR-CUT EFFECT

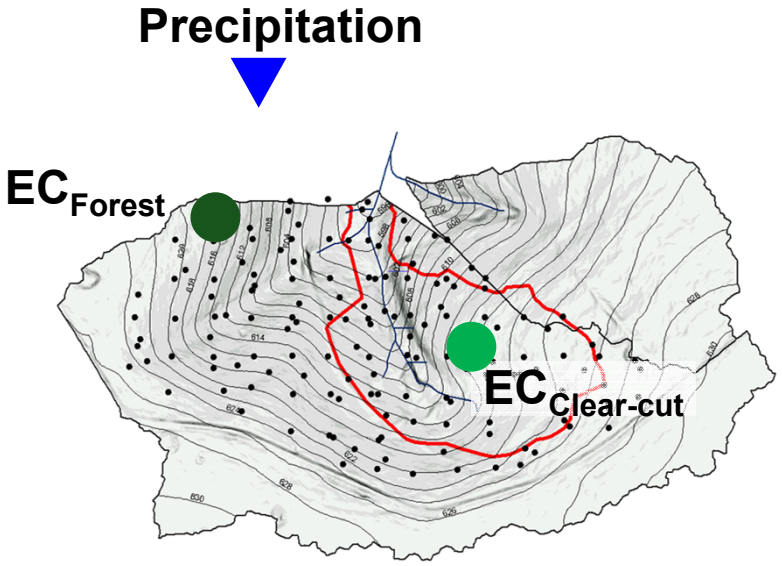




Wüstebach

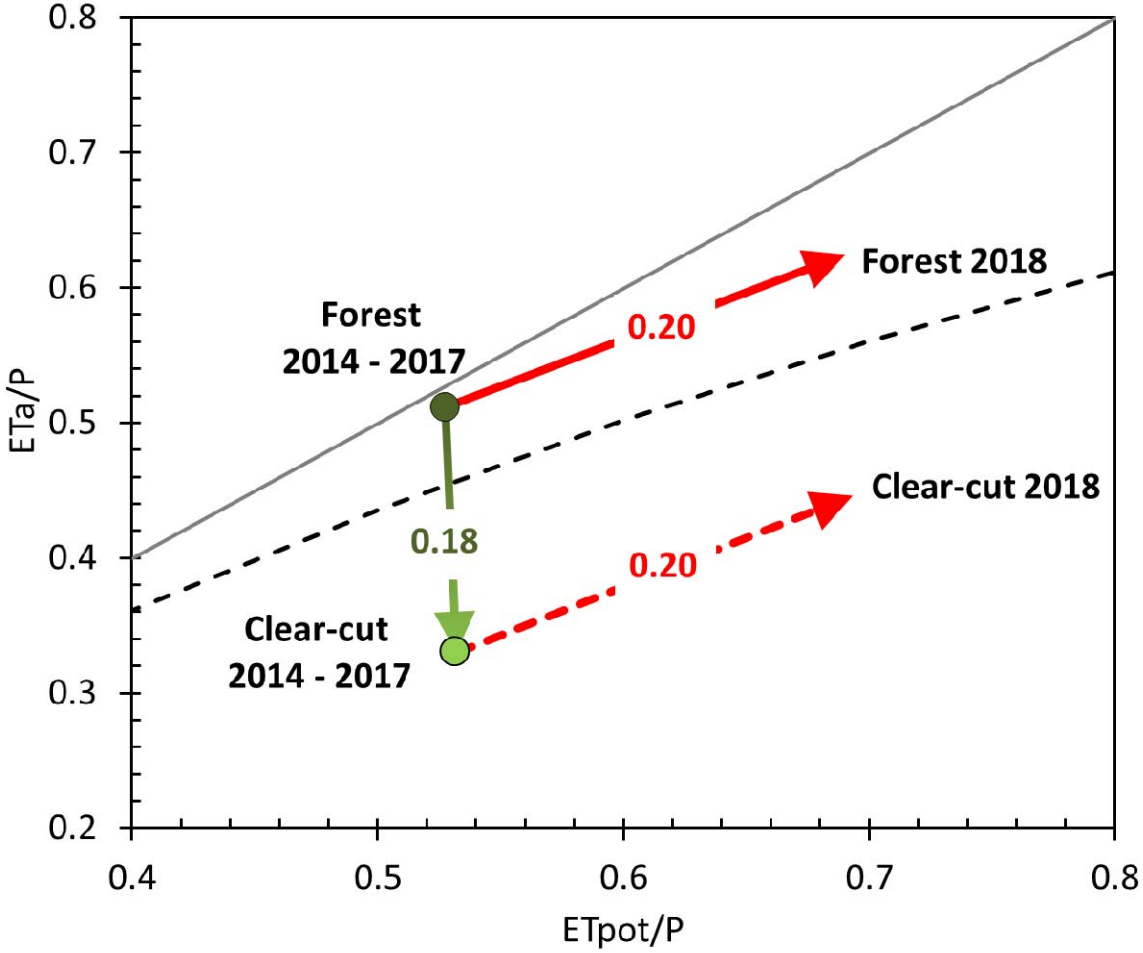
CLEAR-CUT EFFECT

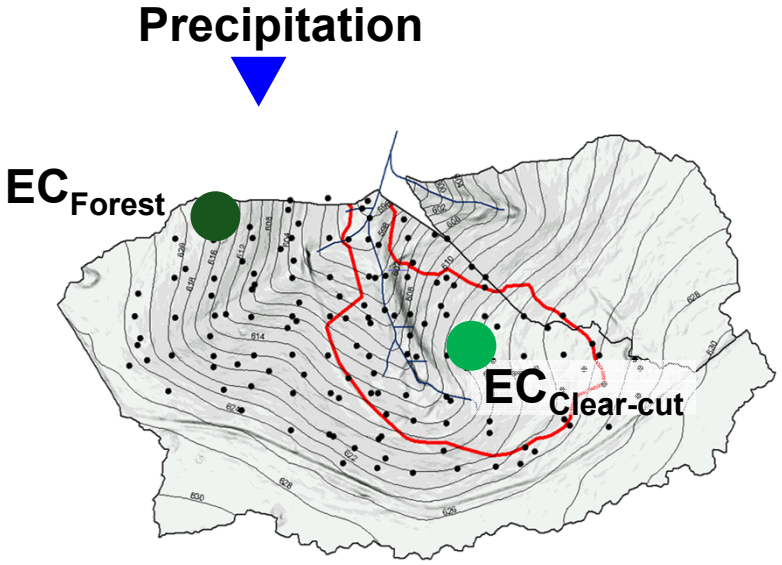




Wüstebach

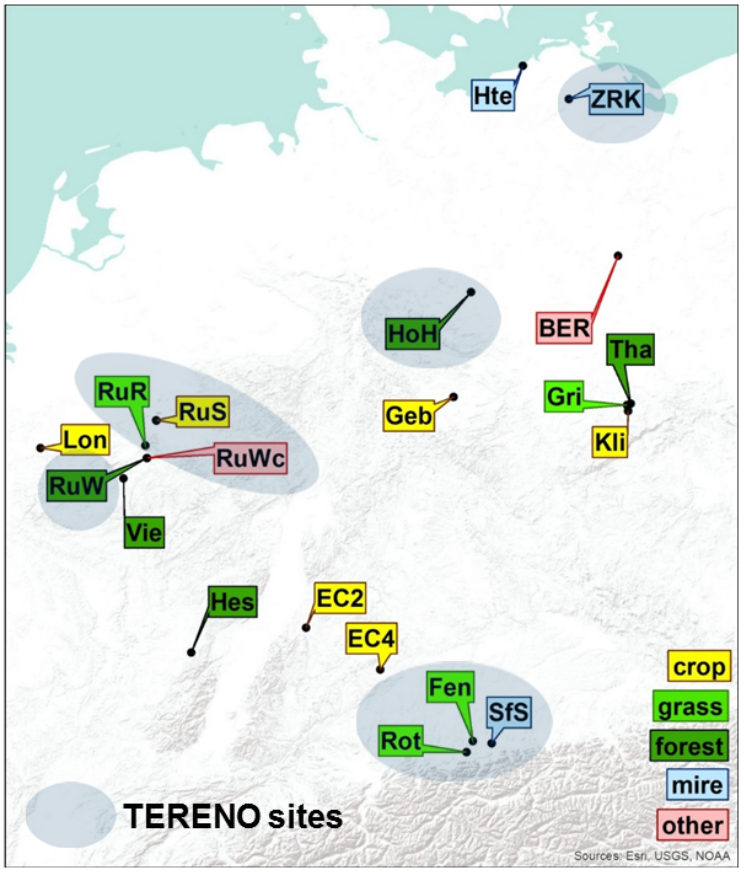
DROUGHT EFFECT

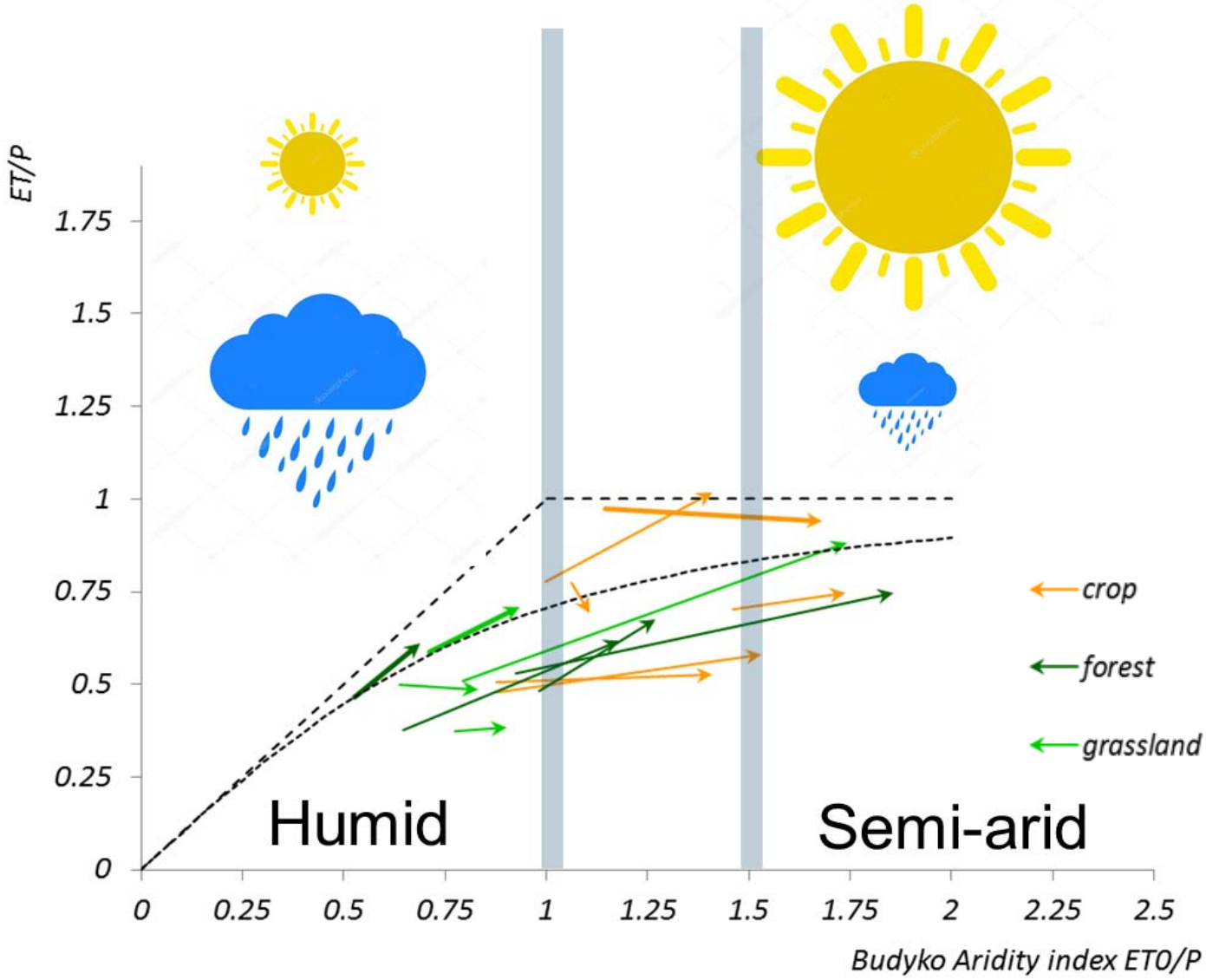




⇨ Deforestation and drought-related impacts on the local water balance were of similar magnitude

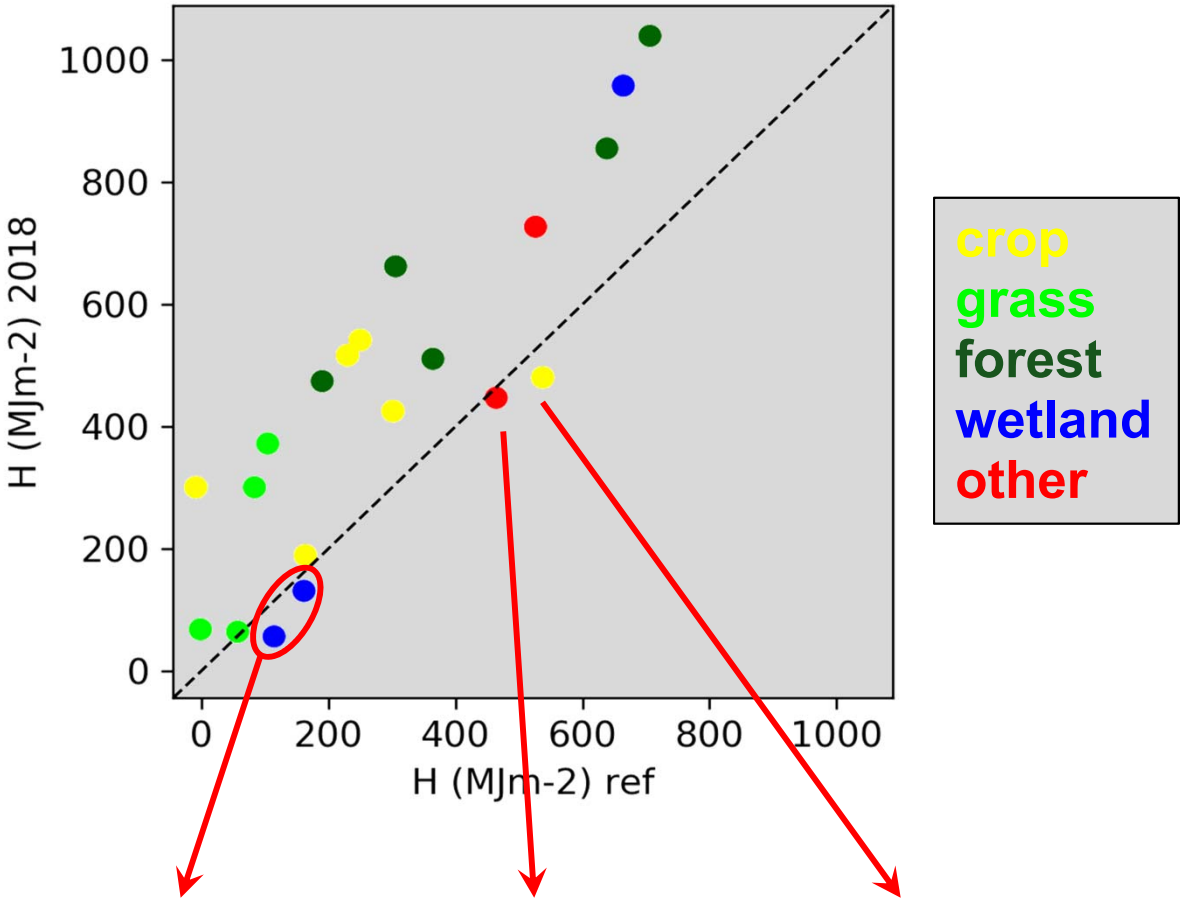
DROUGHT EFFECT IN CENTRAL EUROPE





CHANGES IN ENERGY FLUX AND WATER USE

Sensible heat flux (median: +44%)



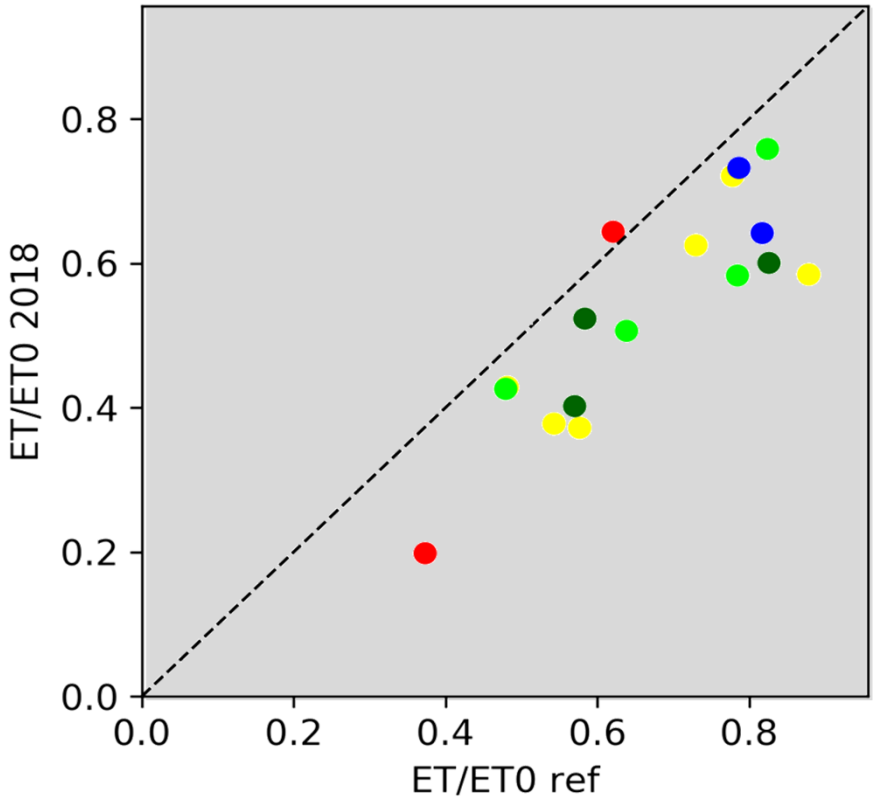
crop
grass
forest
wetland
other

(usually) flooded

Wüstebach clearcut

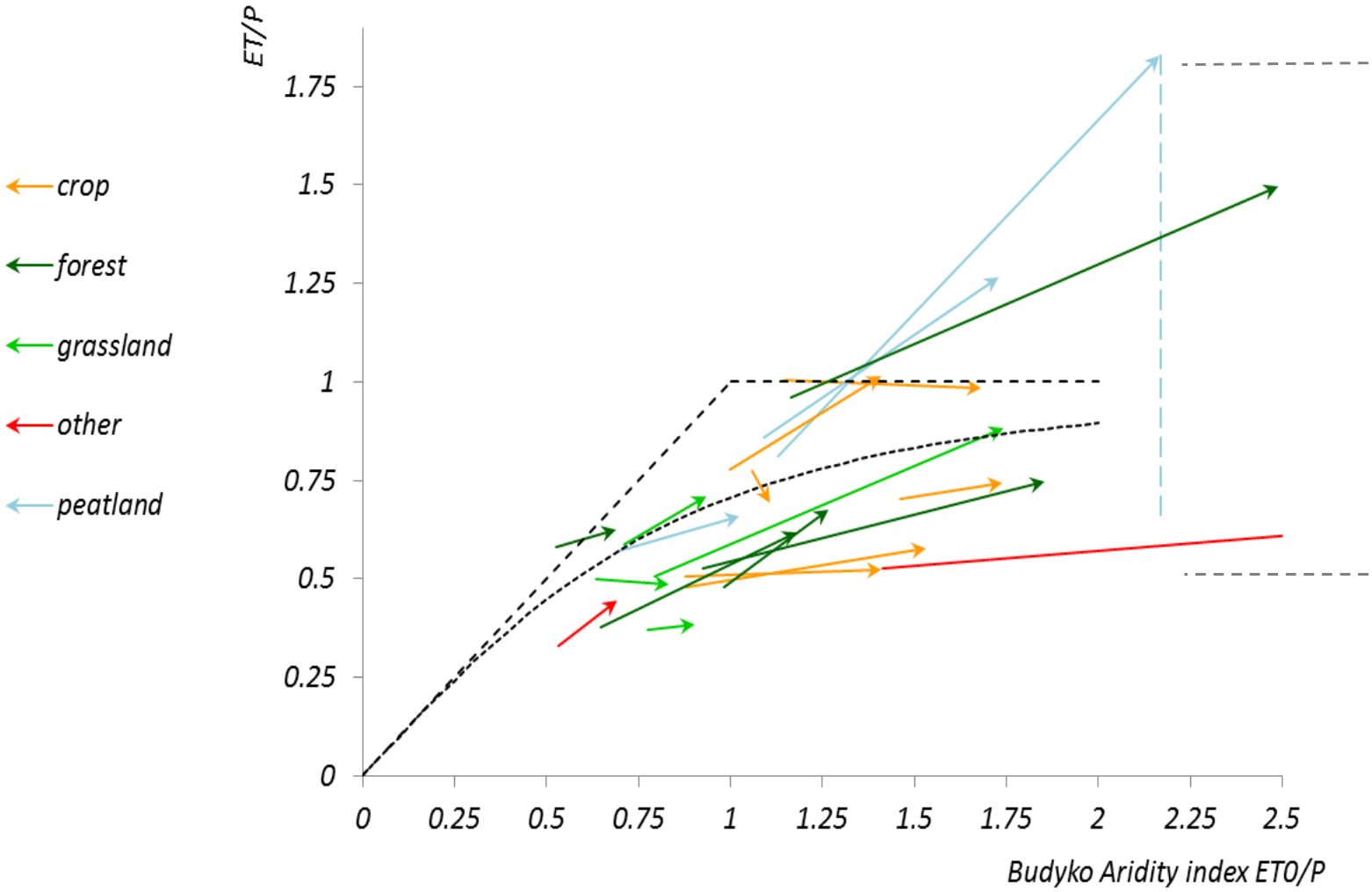
only site with more precipiation

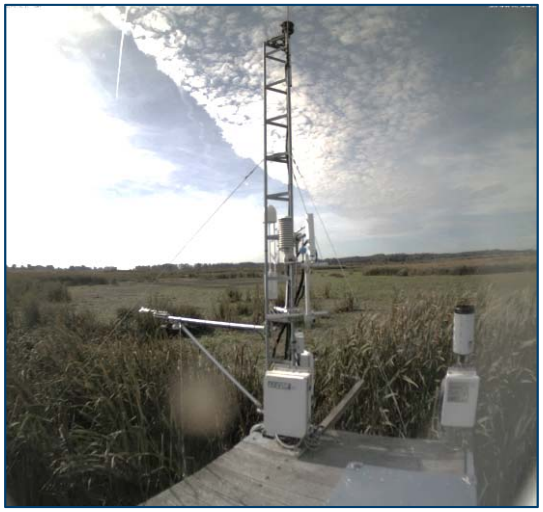
ET/ET0 (median: -18%)



SWC reduced by ~20%

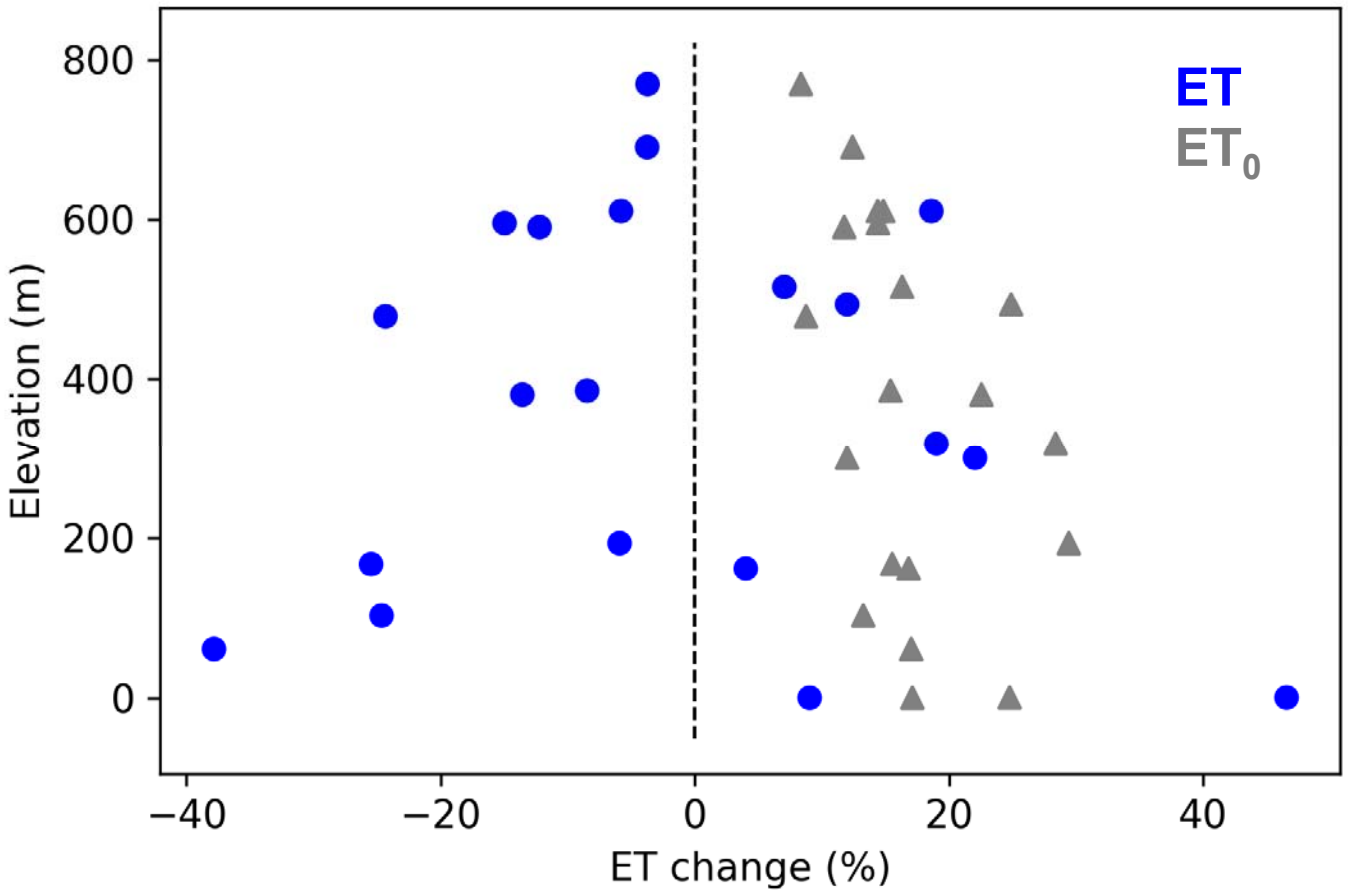
EFFECT OF WATER STORAGE



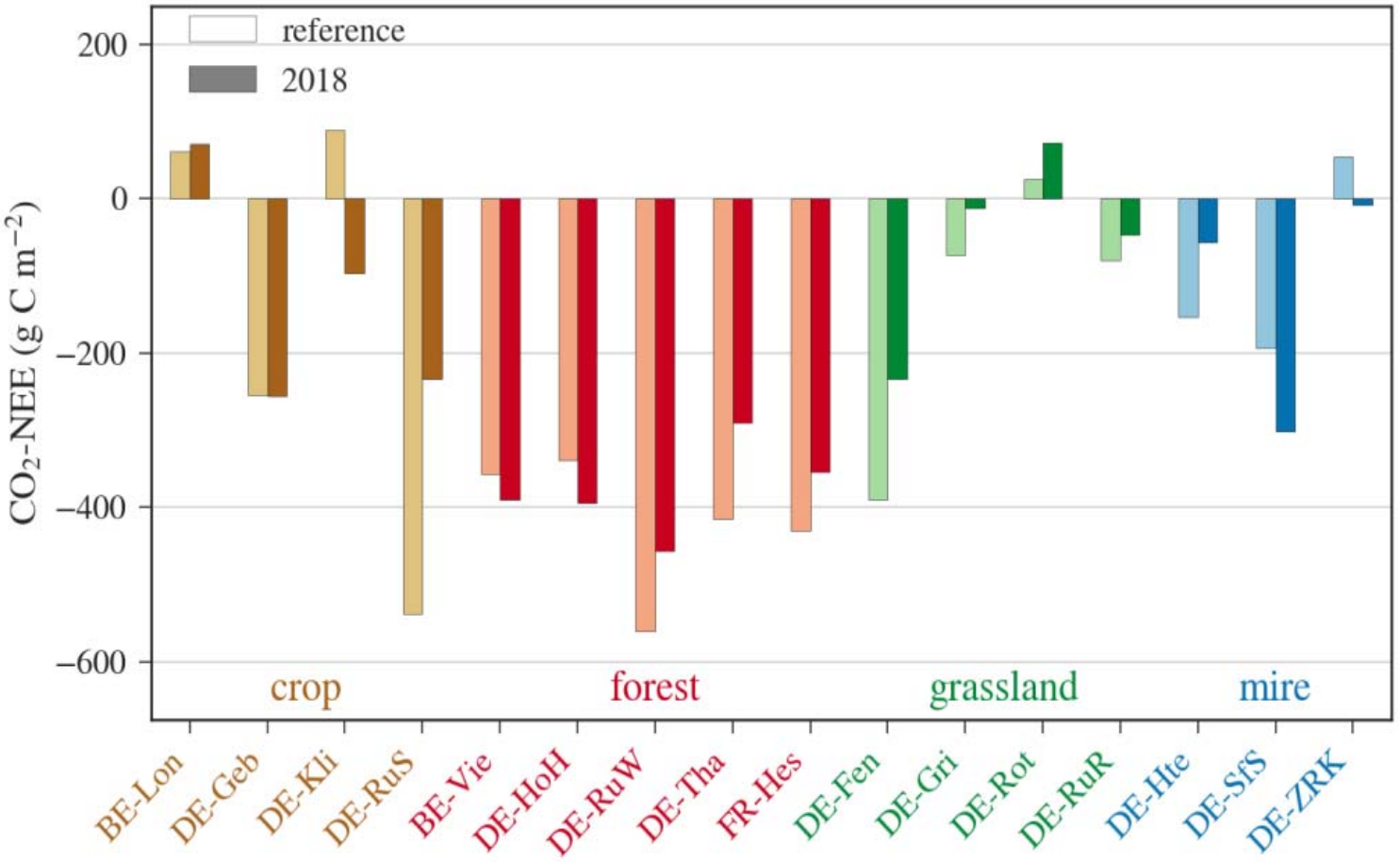


DE-Zrk (Zarnekow):
0.65 m WTD change

ELEVATION EFFECT



NET ECOSYSTEM EXCHANGE (NEE)



⇨Most sites showed **less** **CO_2 uptake** (less growth, closed stomata, early harvests)

⇨Net water use efficiency decreased by 19%

CONCLUSIONS

- Wüstebach: Deforestation and drought-related impacts on the local water balance were of similar magnitude
- All sites: In- and output of energy generally increased
- Weak ET signal, but: ET/ET0 strongly decreased, ET/P increased
- Net CO_2 uptake and water use efficiency decreased, but not everywhere
- No or positive effect on ET and/or CO_2 uptake:
  - Sites with large water storage
  - Sites at higher elevations
  - Sites with higher precipitation

OPEN QUESTIONS

- Uncertainty / significance from variance across reference years
- Other affected regions (Scandinavia, UK)
- Total warming feedback (radiative forcing from smaller CO2 uptake)
- Memory / carry over effects

Acknowledgement

Anne Klosterhalfen, Christian Bernhofer, Christian Brümmer, Clemens Drüe, Pia Gottschalk, Thomas Grünwald, Günther Heinemann, Bernard Heinesch, Janina Klatt, Jan Konopka, Anne De Ligne, Bernard Longdoz , Matthias Mauder, Patrizia Ney, Inken Rabbel, Corinna Rebmann, Torsten Sachs, Marius Schmidt, Frederik Schrader, Caroline Vincke, Ingo Völksch, Stephan Weber, Christian Wille, Daniel Dolfus

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