UNIVERSITY OF HOHENHEIM

EVALUATION OF NOAH-MP'S SIMULATED GROUND HEAT FLUX AND TEMPERATURES AT A PINE FOREST AND A GRASSLAND SITE IN GERMANY

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CONTENT

MOTIVATION

CORDEX Flagship Pilot Study on
Land **U**se and **C**limate **A**cross **S**cales:

- 1986-2015, ERA-Interim forced RCMs
- Afforestation vs. Deforestation

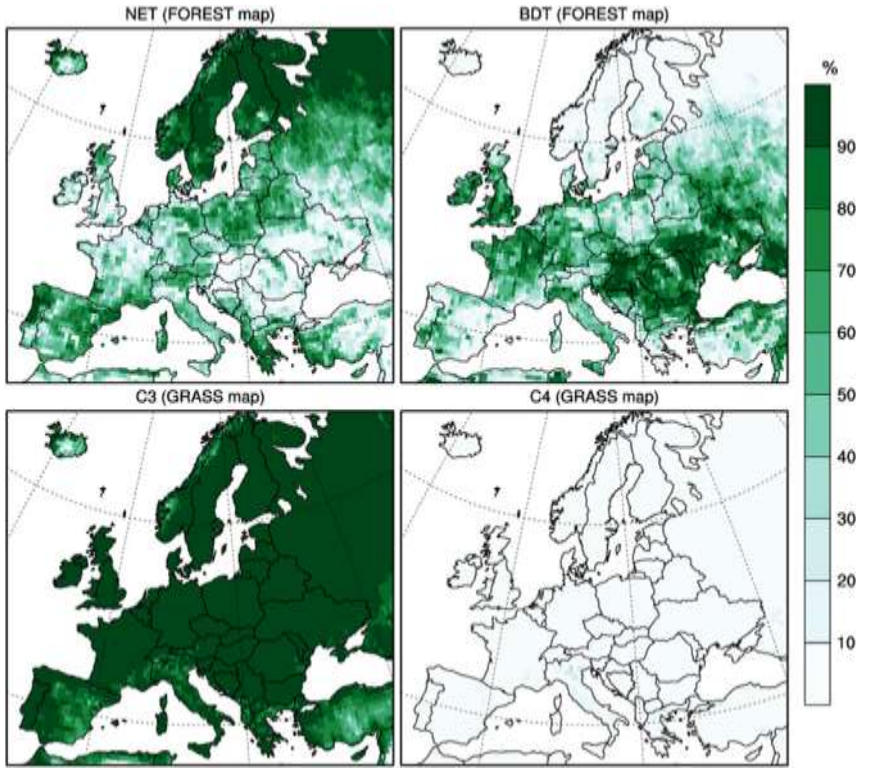
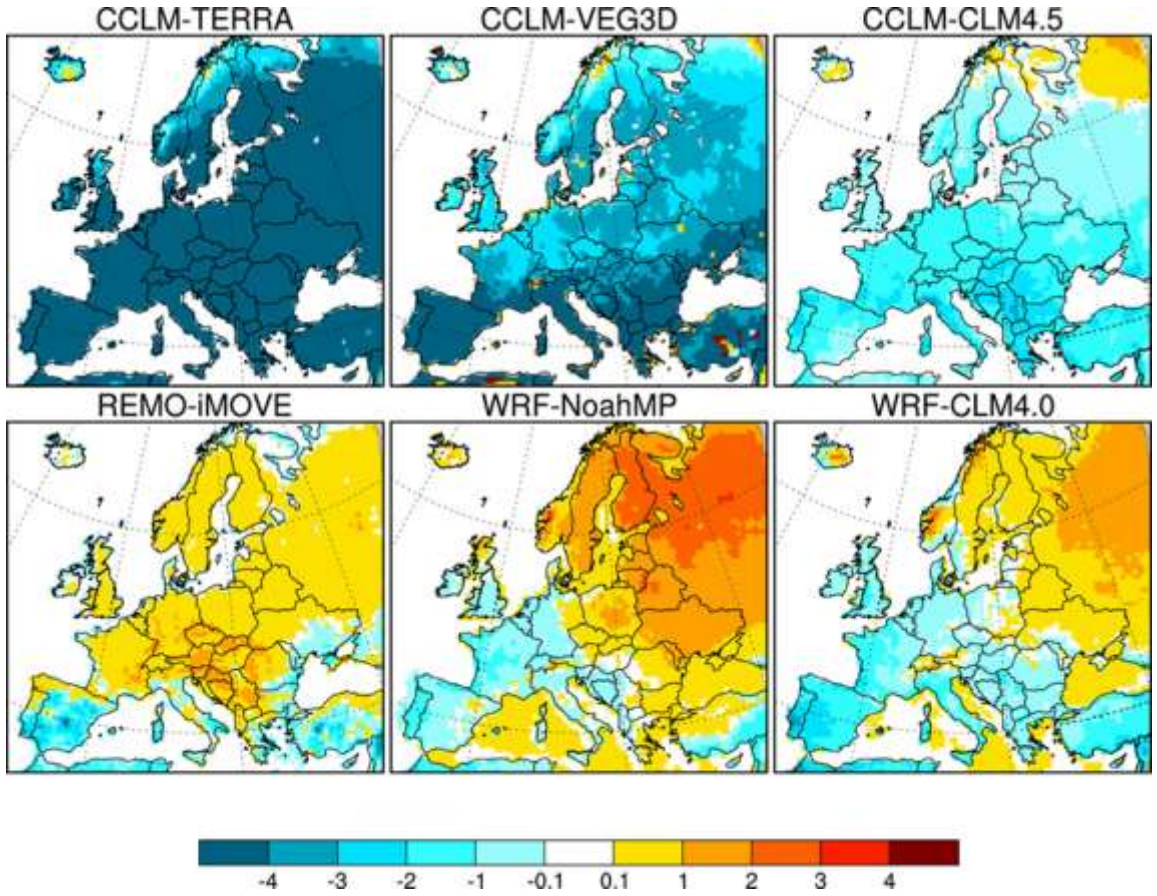


Figure from Breil et al., 2020 https://doi.org/10.1175/JCLI-D-19-0624.1

MOTIVATION

Summer (JJA) Surface Temperature FOREST-GRASS [K]



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MOTIVATION

- Can we compare the surface temperatures and ground heat fluxes between the RCMs and between forest and grassland?
- Which ground heat fluxes and temperatures are calculated in NoahMP and can we evaluate this?

Difference in Annual Amplitude of Soil Temperature im 1 m depth (FOREST-GRASS) [°C]

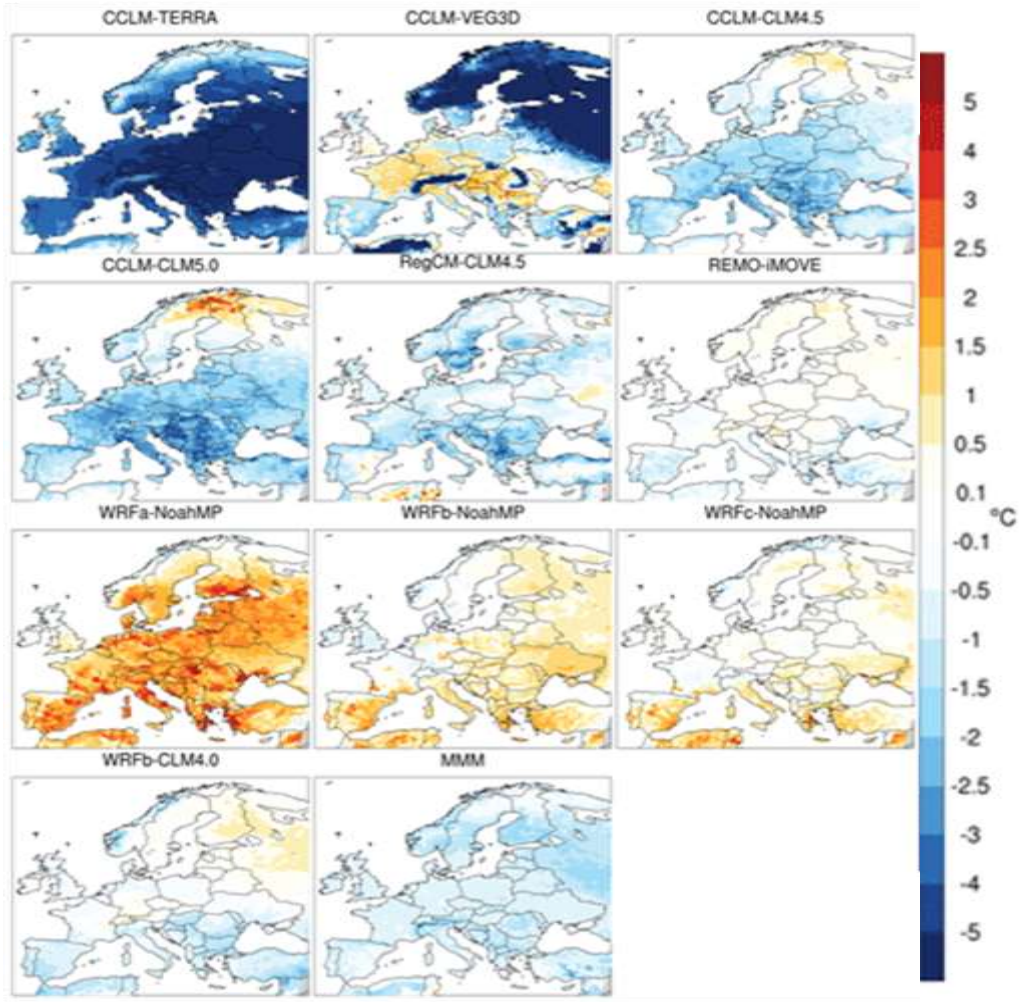


Figure from Sofiades et al., 2022 https://gmd.copernicus.org/articles/15/595/2022/

STUDY SITE

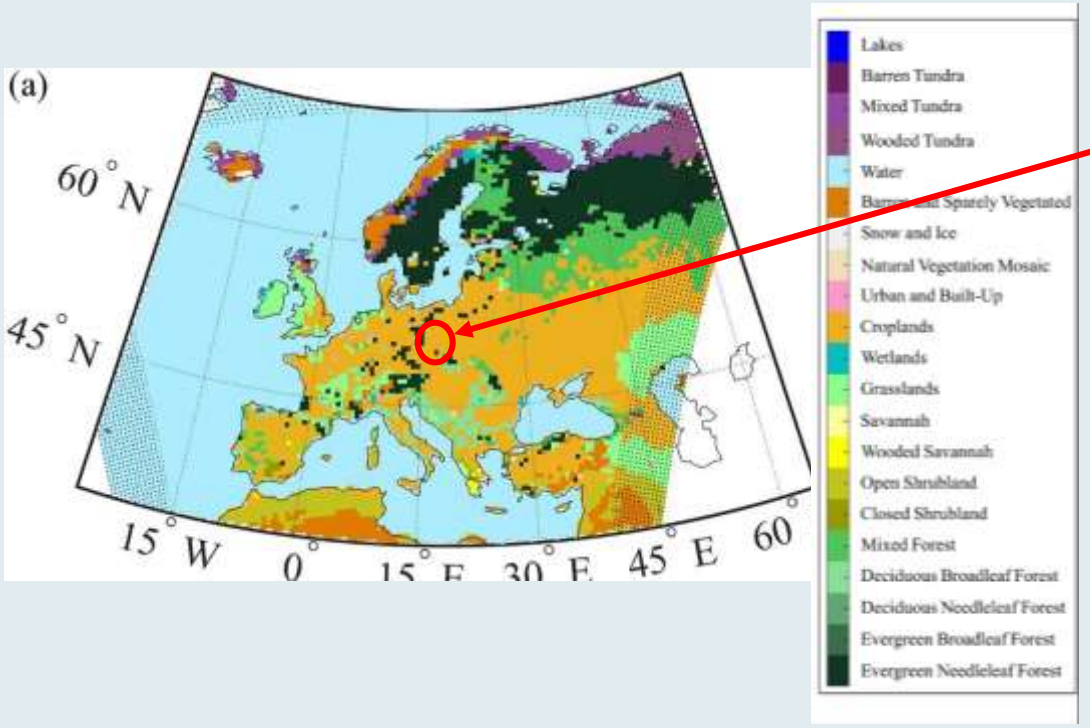


Figure from Jach et al., 2020 https://doi.org/10.1029/2019JD031989

Measurements at Meteorological Observatorium Lindenberg by the German Weather Service (lowlands 40-100 m amsl)

Falkenberg
(52.17°N, 12.10° E)

Forest
(52.18° N, 13.95° E)

Photos from Beyrich and Adam, 2007, DWD Report 230
https://www.cen.uni-hamburg.de/en/icdc/data/atmosphere/docs-atmo/dwd230-ceop-report.pdf

STUDY SITE

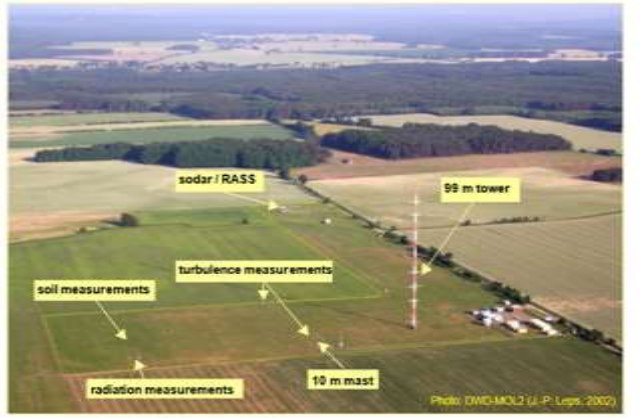
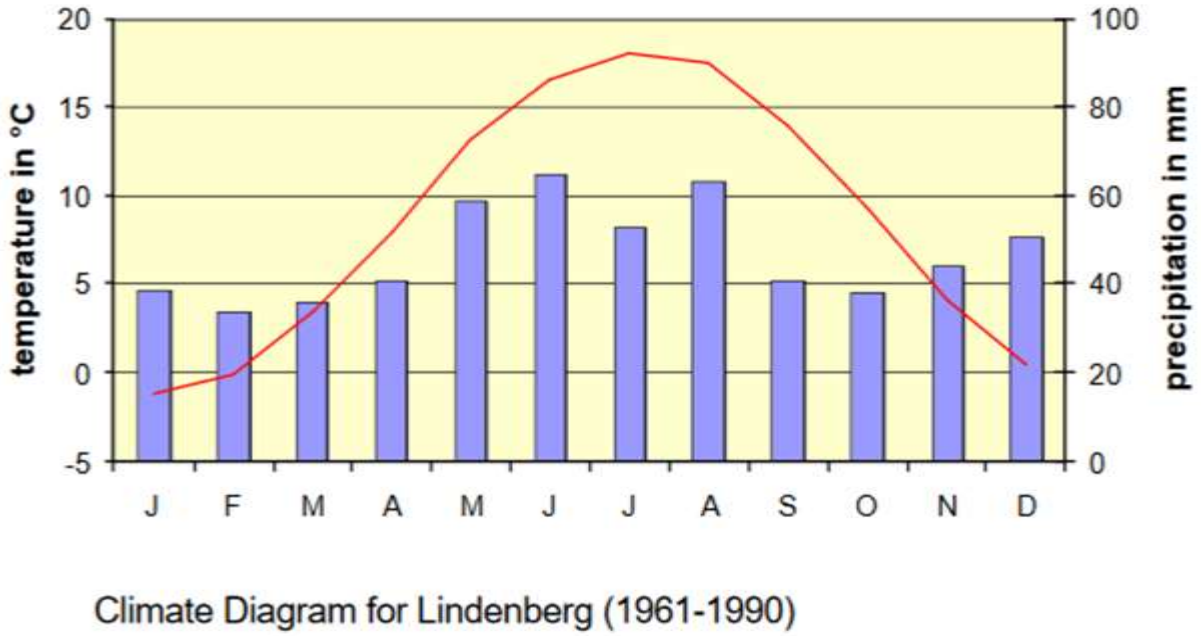


Figure 8 The DWD-MOL boundary layer field site (GM) Falkenberg towards WNW

View towards NW across the pine forest with the Forest Station tower in the upper left quadrant



Climate Diagram for Lindenberg (1961-1990)

Figures from Beyrich and Adam, 2007, DWD Report 230

https://www.cen.uni-hamburg.de/en/icdc/data/atmosphere/docs-atmo/dwd230-ceop-report.pdf

CONFIGURATION

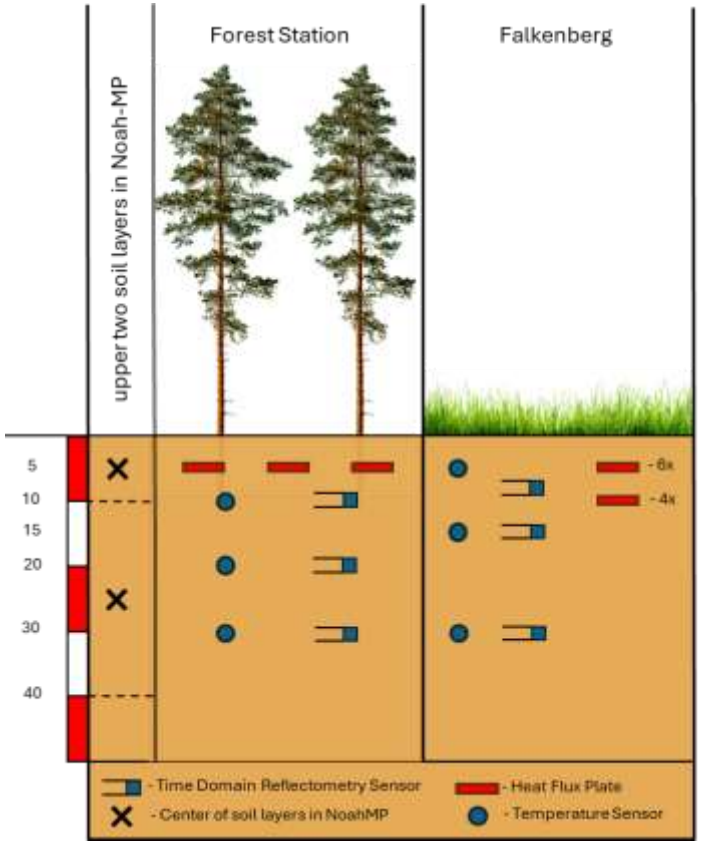
NOAH-MP 5.0 WITH HRLDAS ENVIRONMENT FOR 2 LOCATIONS

- Falkenberg: Grassland
- Forest Site: Evergreen Needleleaf Trees
- Loamy Sand
- MODIS IGBP parameters for vegetation
- Default namelist options except Dynamic_Veg_Option = 8 (LAI from table, FVEG calculated)
- Grassland cut every month to 20 cm height
- Halfhourly forcing 2005-2009
- 2005 run twice for spinup

CHALLENGE

Heat flux measurements at forest site:
LH, SH, Radiation at top of canopy (30 m)
Ground heat flux in 5 cm soil depth

Missing: change of heat storage within the top 5 cm soil and the ~30 m canopy layer, including heating of vegetation, air, or water



Sensor set up depth of placement in the soil for measurement of soil temperature and humidity as well as for ground heat flux measurements at the Lindenberg Reference Site for the Forest Station and the boundary layer measurement field Falkenberg. The left column shows the depth of the upper three soil layers used in Noah-MP with their mean depth used as reference for output data marked as cross.

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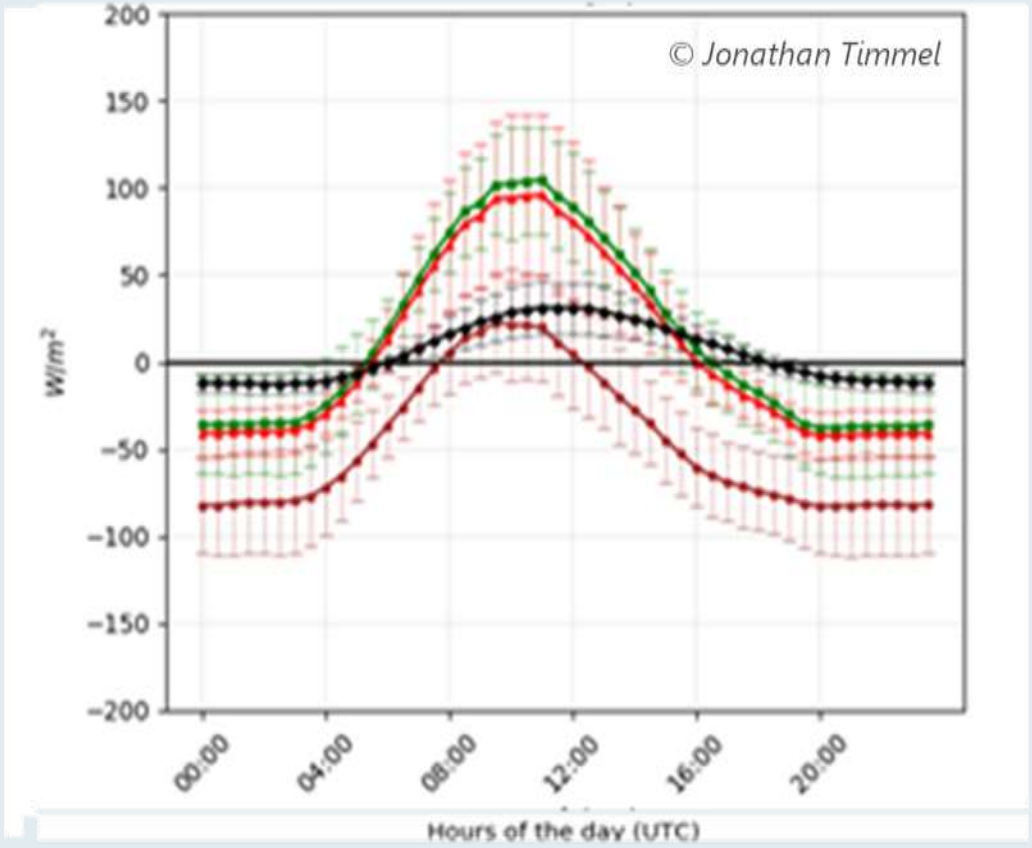
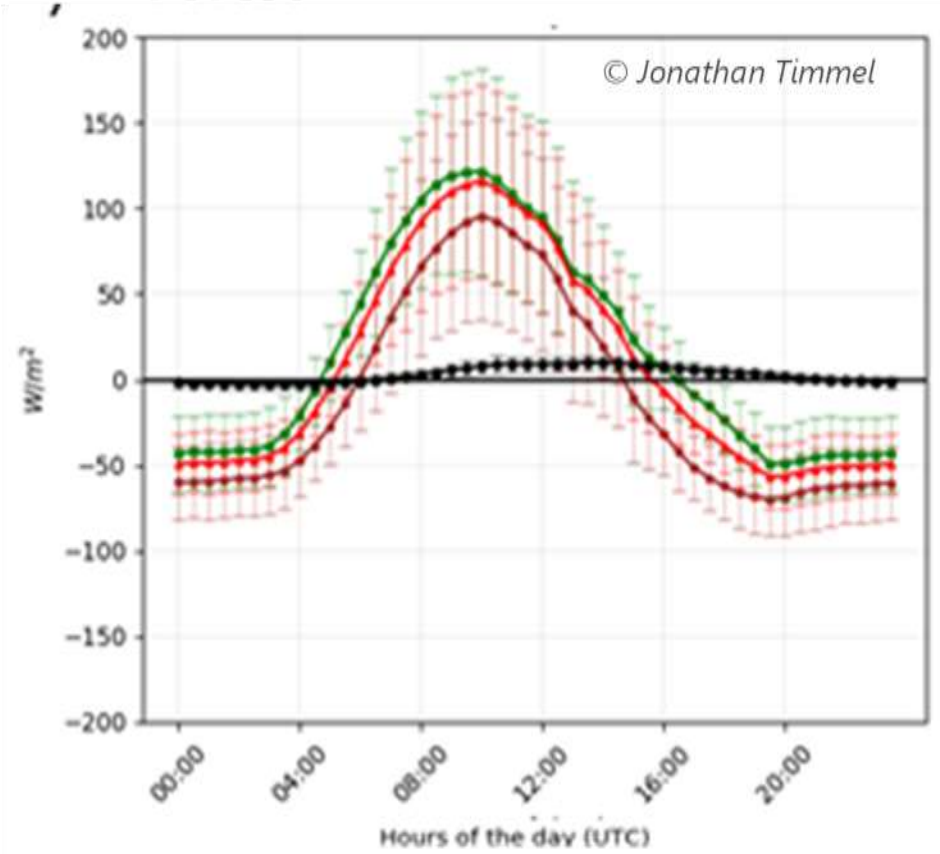
GROUND HEAT FLUXES

Grassland



Diurnal mean cycle and standard deviation
June 2005-2009

Forest



Q_G (bare ground) Q_G (vegetated)

Q_G (grid wide) Q_G (observed)

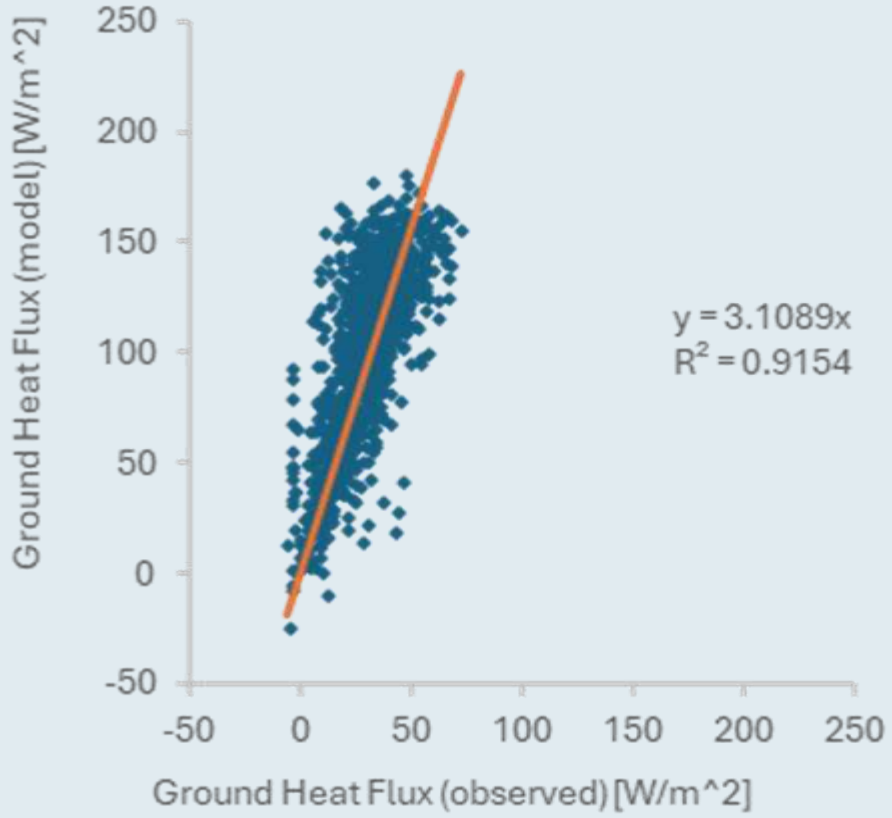
Q_G(observed) => corrected for storage in top 5 cm of soil

10 UTC = 12 local time

GROUND HEAT FLUXES

Daily Maxima, March-October, 2005-2009

Grassland



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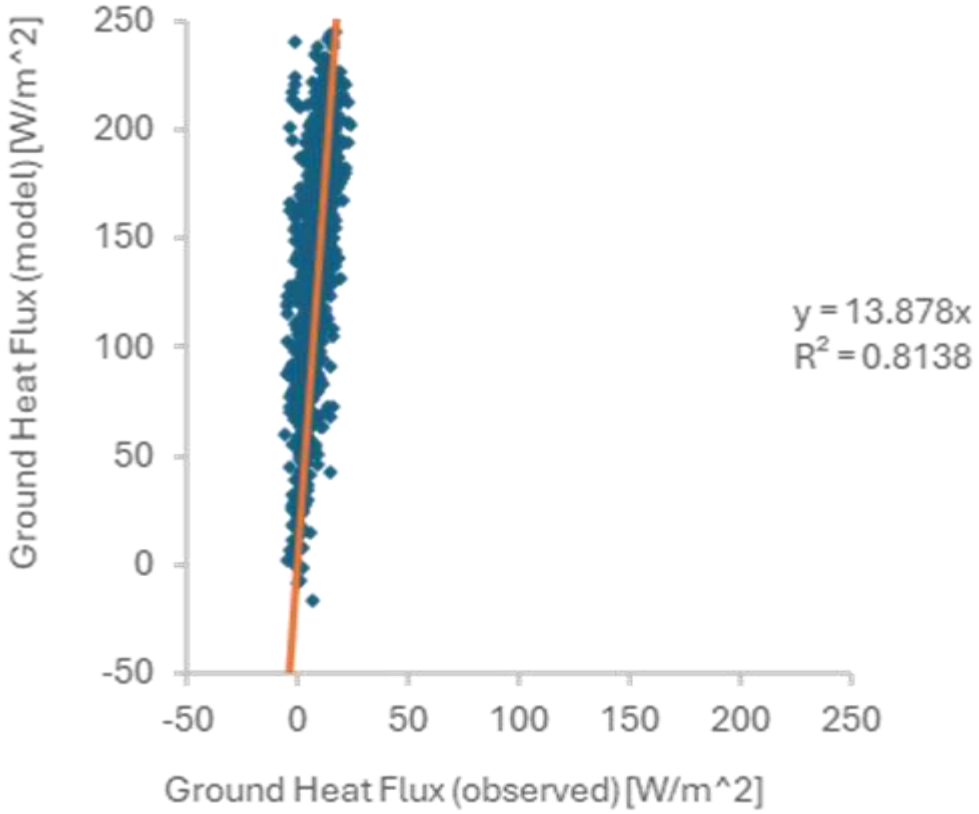
Forest



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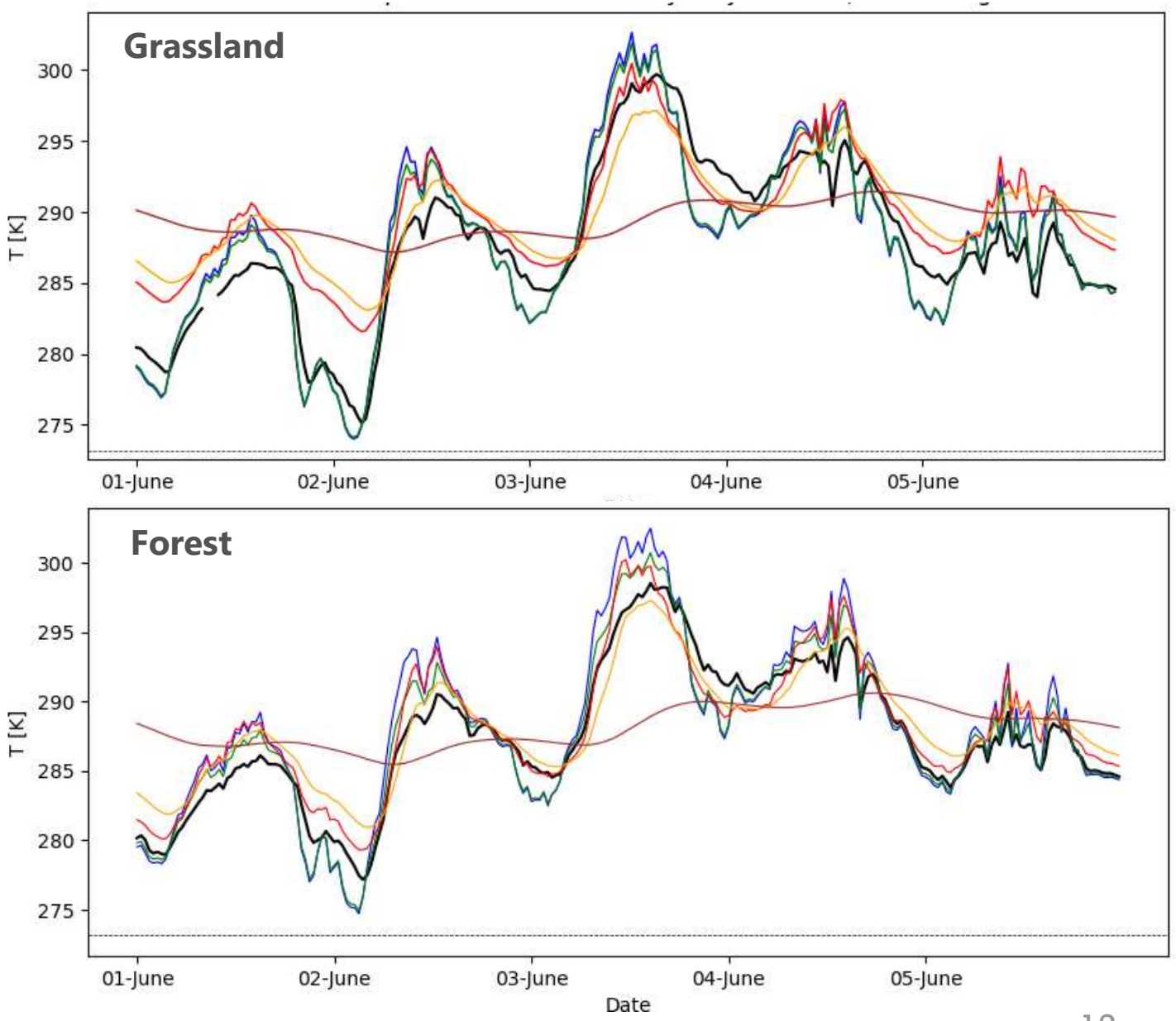
Q_G(observed) => corrected for storage in top 5 cm of soil

TEMPERATURES

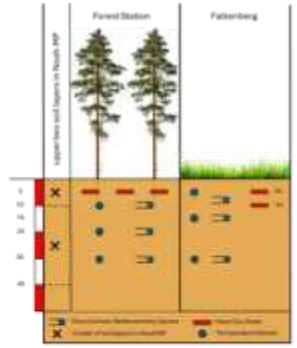
1-5 June 2005
Observed forcing
and simulated below

- T_{ref} left(forcing)
- T_{veg}
- $T_{can_{air}}$
- T_g
- $T_{soil\ layer\ 1}$ (−5 cm)
- $T_{soil\ layer\ 2}$ (−25 cm)

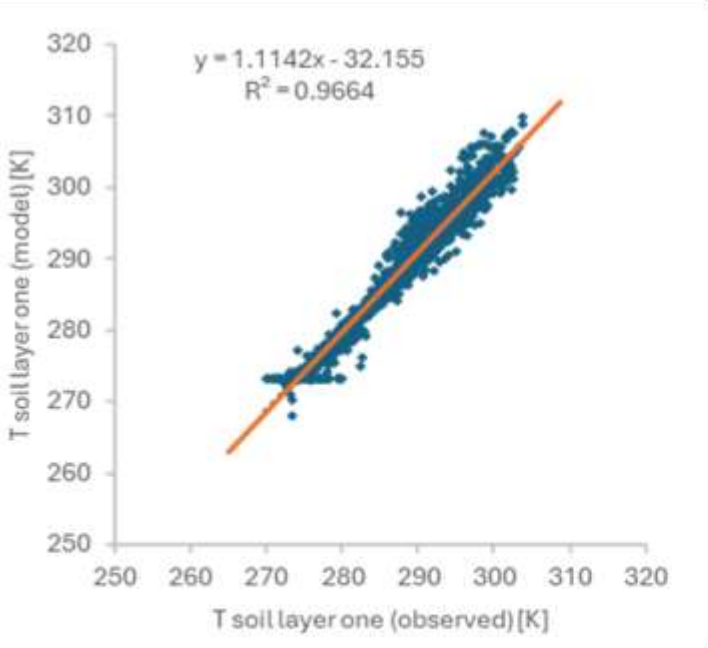


TEMPERATURES

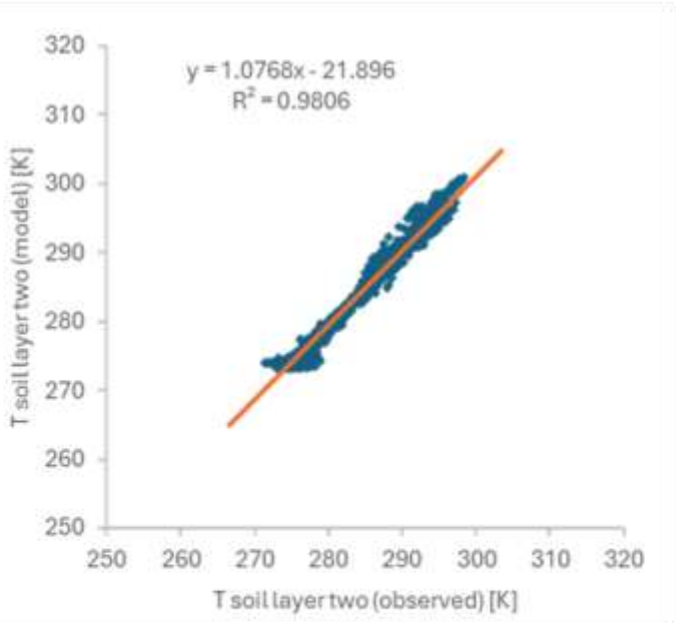
Daily Soil Maxima, March-October, 2005-2009



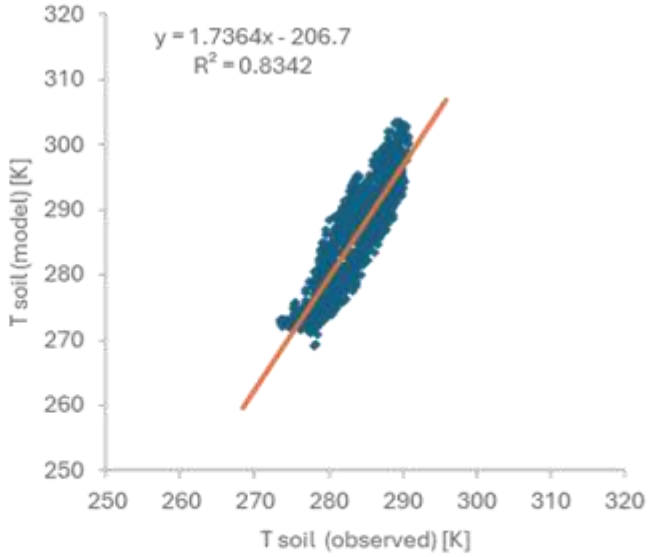
Grassland
5 cm depth



Grassland
25 cm depth

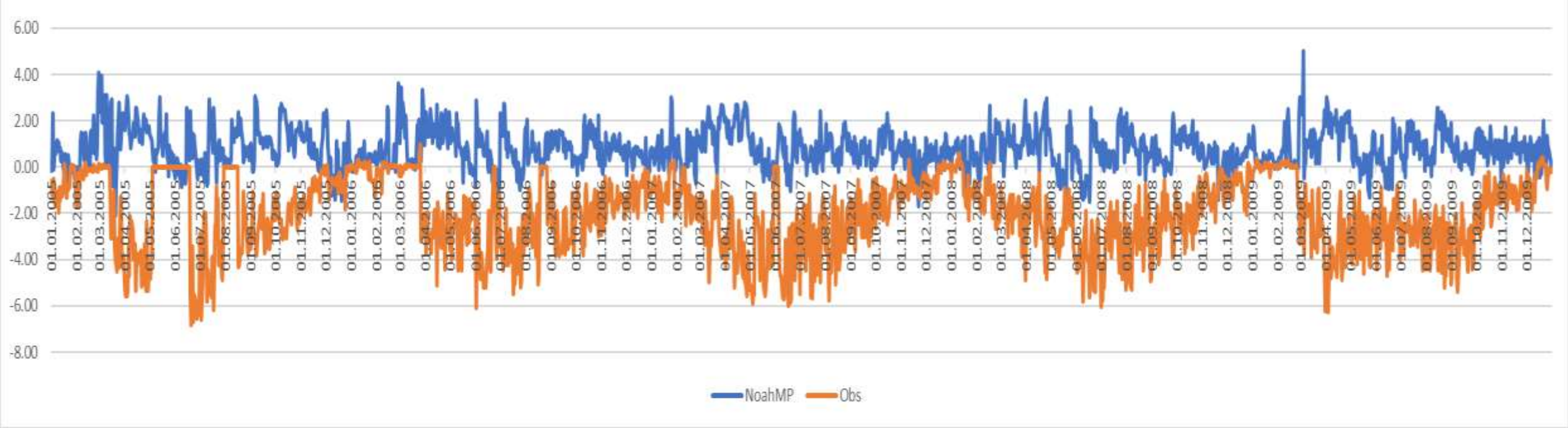


Forest
15 cm depth



TEMPERATURES

Difference in daily Amplitude of Soil Temperature in 15 cm depth (FOREST-GRASS) [K]



Annual mean about 0.9 K (NoahMP) and – 2 K (Observation)

CONCLUSIONS

Diurnal temperature range in 15 cm depth forest larger than in grassland in NoahMP

Diurnal temperature range in 15 cm depth forest smaler than in grassland in observations

Why?

e.g. In Forest correlation is only 0.86, in Grassland 0.97

Ground heat flux of NoahMP deviates significantly from observations , especially in forest

Tcan, Tveg and heat fluxes need further evaluation

=> Data available at Lindenberg, subject to research

CONCLUSIONS

- Can we compare the surface temperatures and ground heat fluxes between the RCMs and between forest and grassland?

- Which ground heat fluxes and temperatures are calculated in NoahMP and can we evaluate this?

NoahMP needs to be evaluated with respect to forest and grassland measurements at close sites

Forest soils: litter layer consisting of needles ?

Temperatures can be evaluated. Canopy temperature should be also compared.

Ground heat fluxes need further research. NoahMP should calculate ground heat flux in measurement depths to allow direct evaluation.

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ACKNOWLEDGEMENT:
WE THANK FRANK BEYRICH FROM THE GERMAN WEATHER SERVICE IN LINDENBERG FOR THE DATASET AND CENLIN HE FOR ANSWERING ALL MY QUESTIONS FOR RUNNING Noah-MP®