CONSORTIUM FOR SMALL SCALE MODELING
COSMO

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

Implementation of a Mire parameterization in TERRA - Experiments with COSMO-D2

J. Helmert, A. Yurova, I. Rozinkina, J.M. Bettems, M. Baldauf, K. Stephan,
U. Schättler, D. Mironov, G. Zängl

Topics

Mass ascension at balloon fiesta - Wikipedia

Dragon fly (Sumpf-Heidelibelle) - Wikipedia

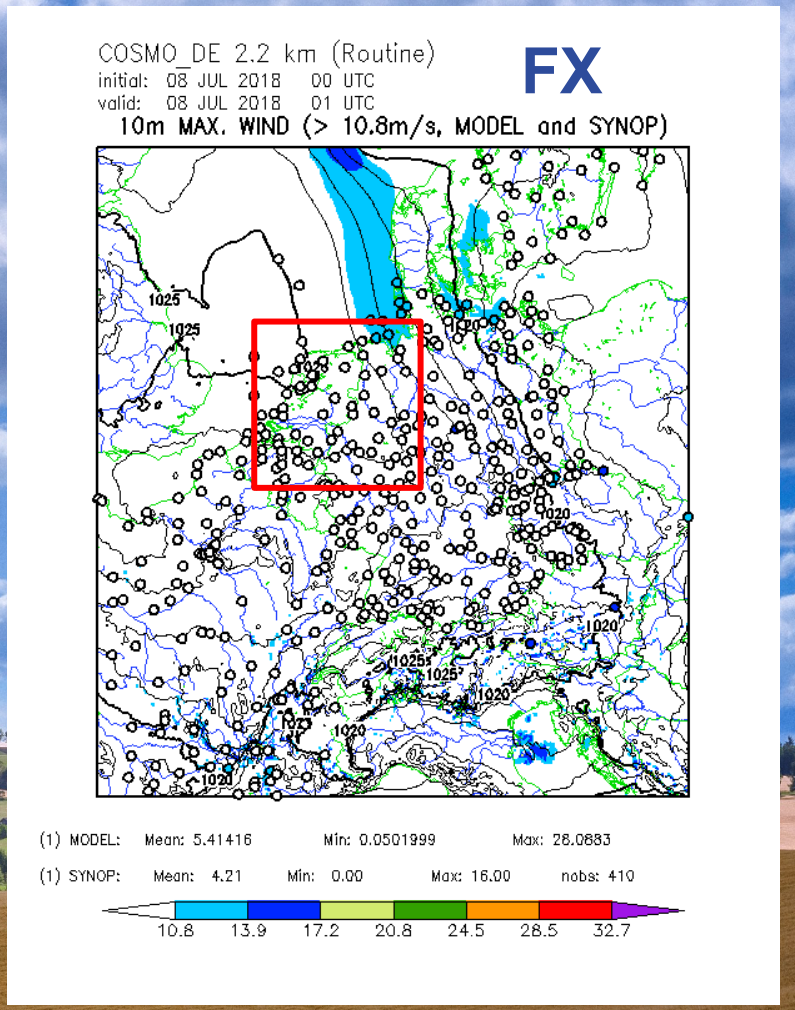
Topics

Mass ascension at balloon fiesta - Wikipedia

Summer 2018

- Very warm
- Very dry
- In principle good conditions for ballon rides…

Guidance from COSMO-D2 too gusty …
Problem for ballon rides and forecasters of national service



View from Skreiabanen towards Lensbygda at Toten - Wikipedia

Model validation July, 8 2018, 16 UTC

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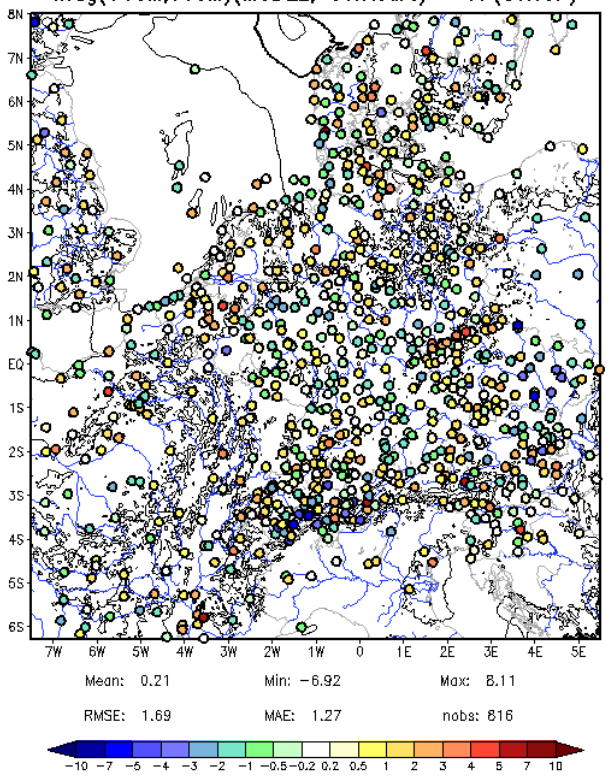
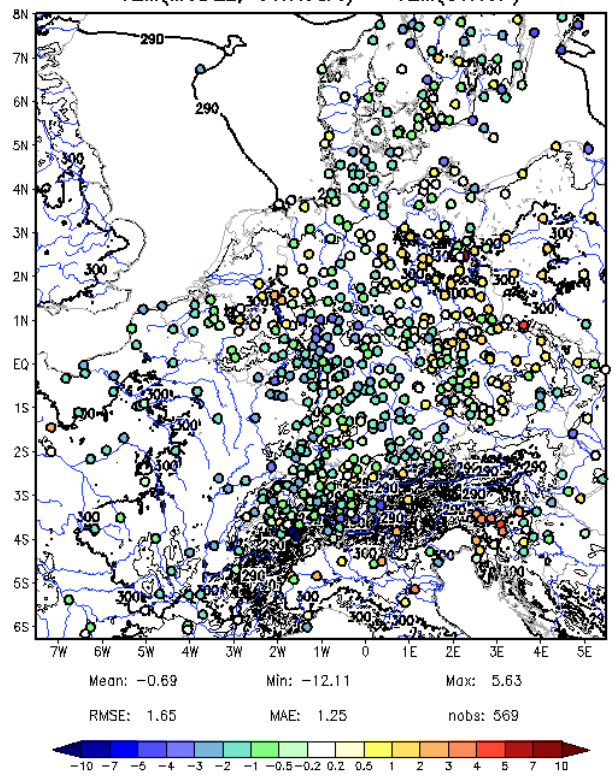
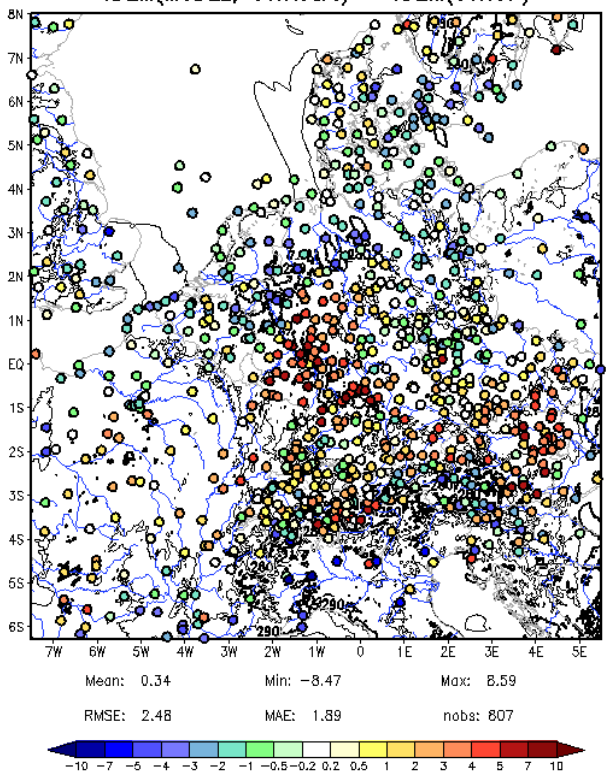
FF



T2M



TD2M



View from Skreiabanen towards Lensbygda at Toten - Wikipedia

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COSMO-D2 physical processes

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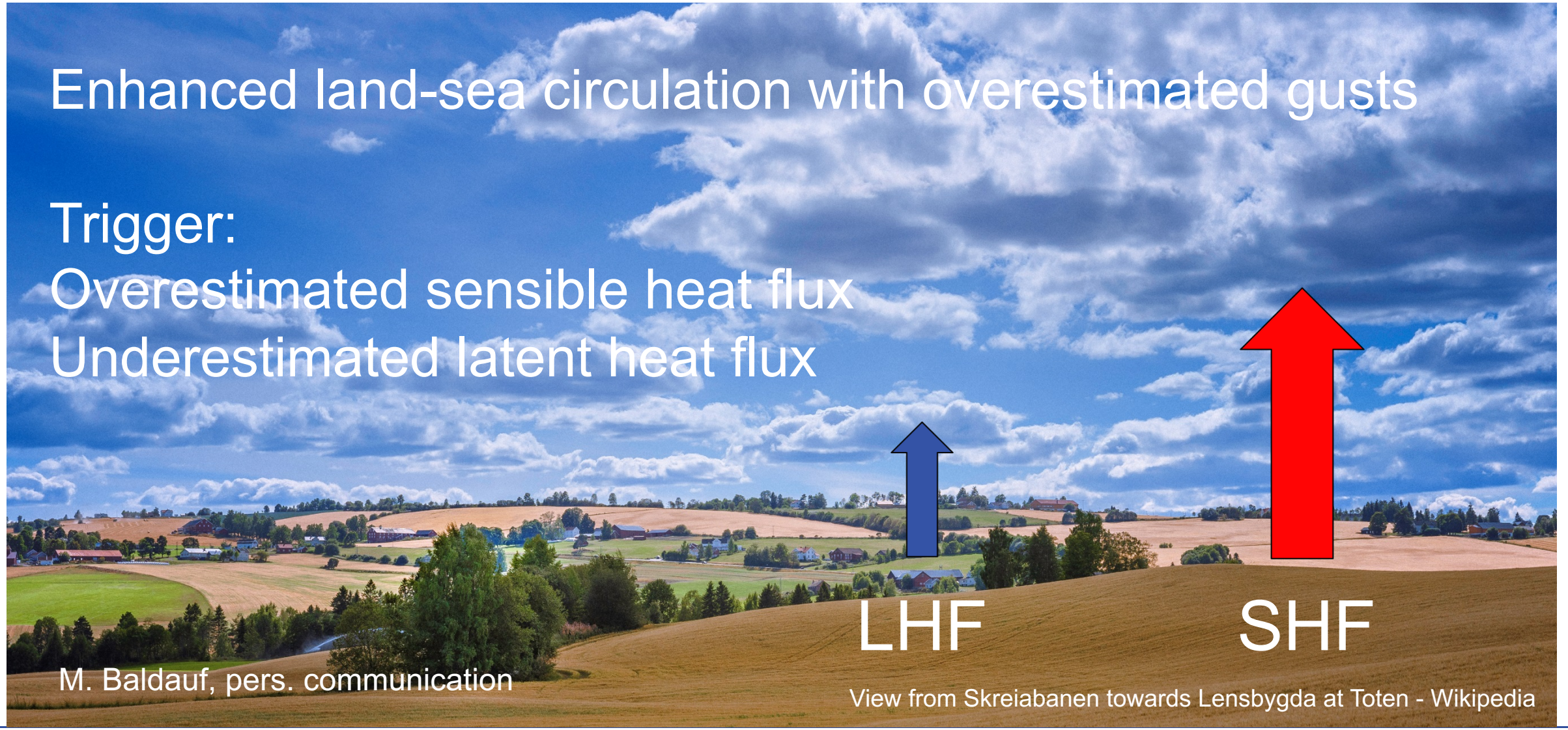

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Possible solution

Sympetrum depressiusculum Dragon fly- Wikipedia

Peatlands (Mires, Bogs)

Peatlands are important ecosystems covering about 3% of the global land area

Majority located above 45°N (Madgwick and Parish, 2008; Yu et al., 2011)

Peatlands represent about one third of the World's terrestrial carbon(C) pool (European Environment Agency, 2010; Roulet,2000

Peatlands represent a variety of wetlands and are defined as‘any ecosystem where in excess 0.3–0.4 m of peat has formed’(Charman, 2002;Harris and Bryant, 2009).

Weissert and Disney (2013)

NSG „Ewiges Meer“, Hochmoorweite - Wikipedia

Peatlands (Mires, Bogs)

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Peatlands in COSMO-D2

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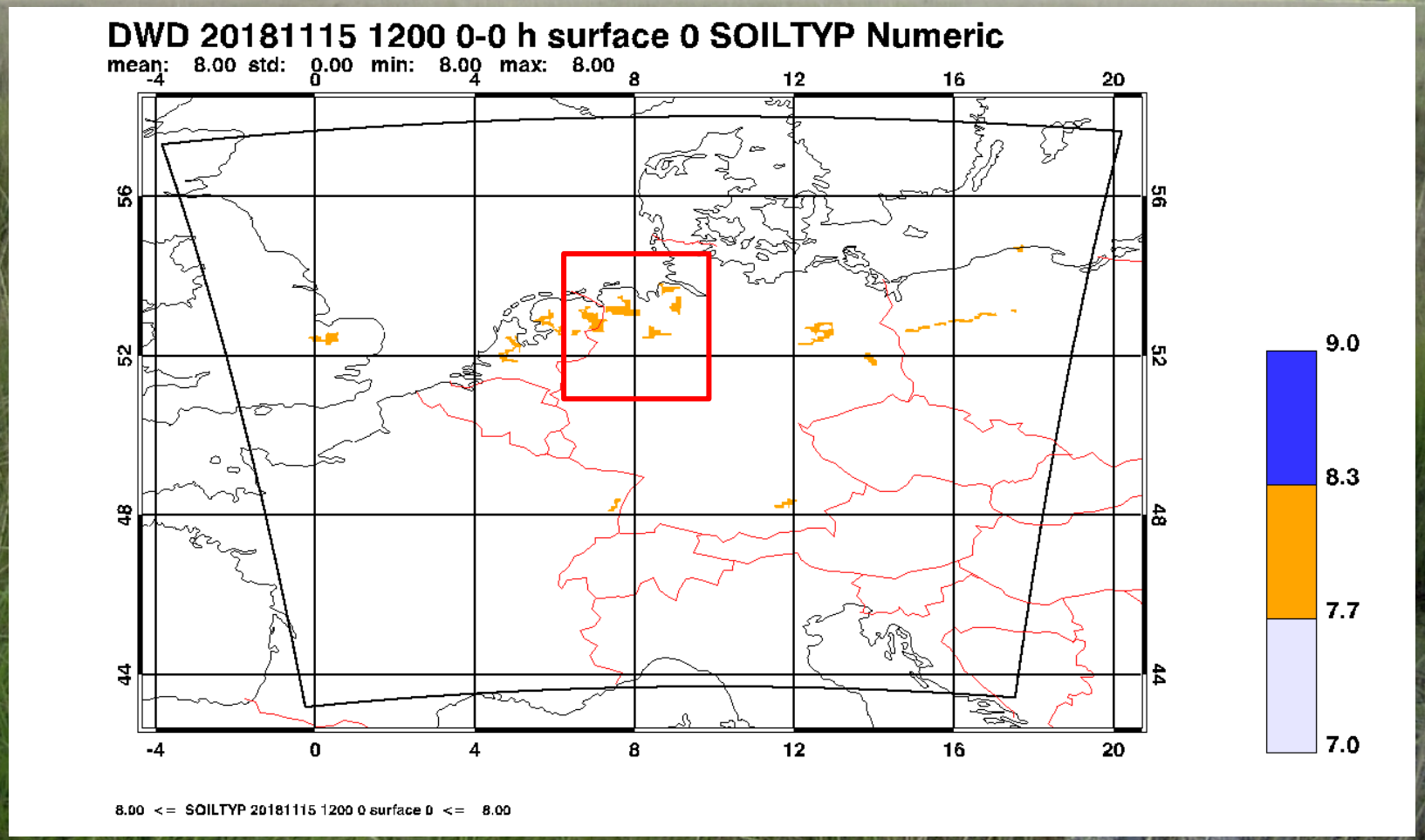

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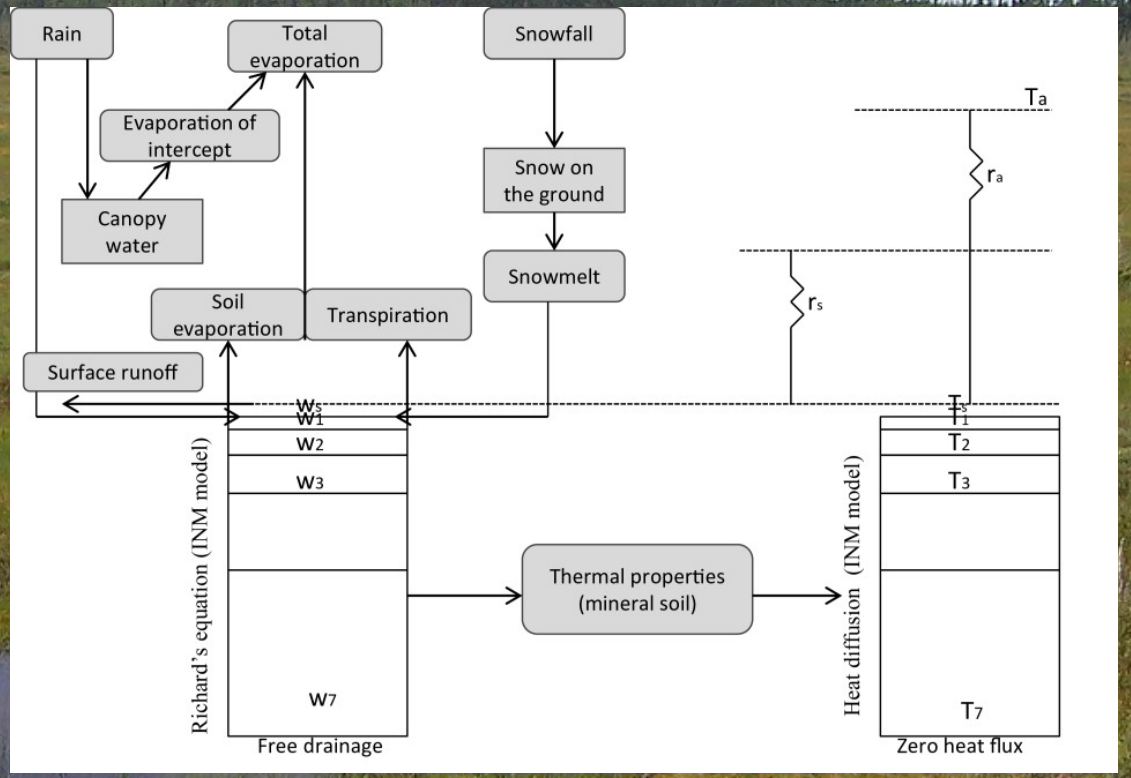
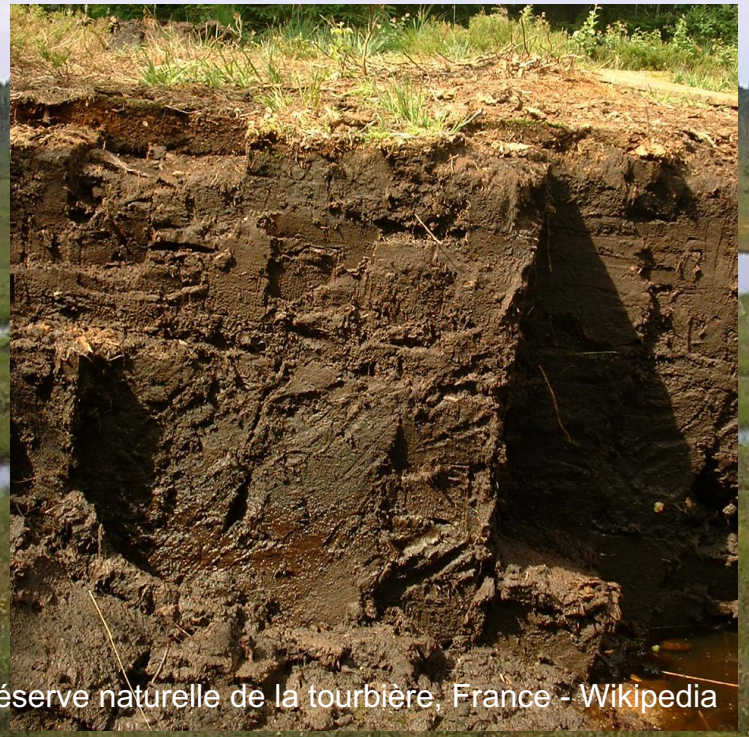
Peatlands in TERRA



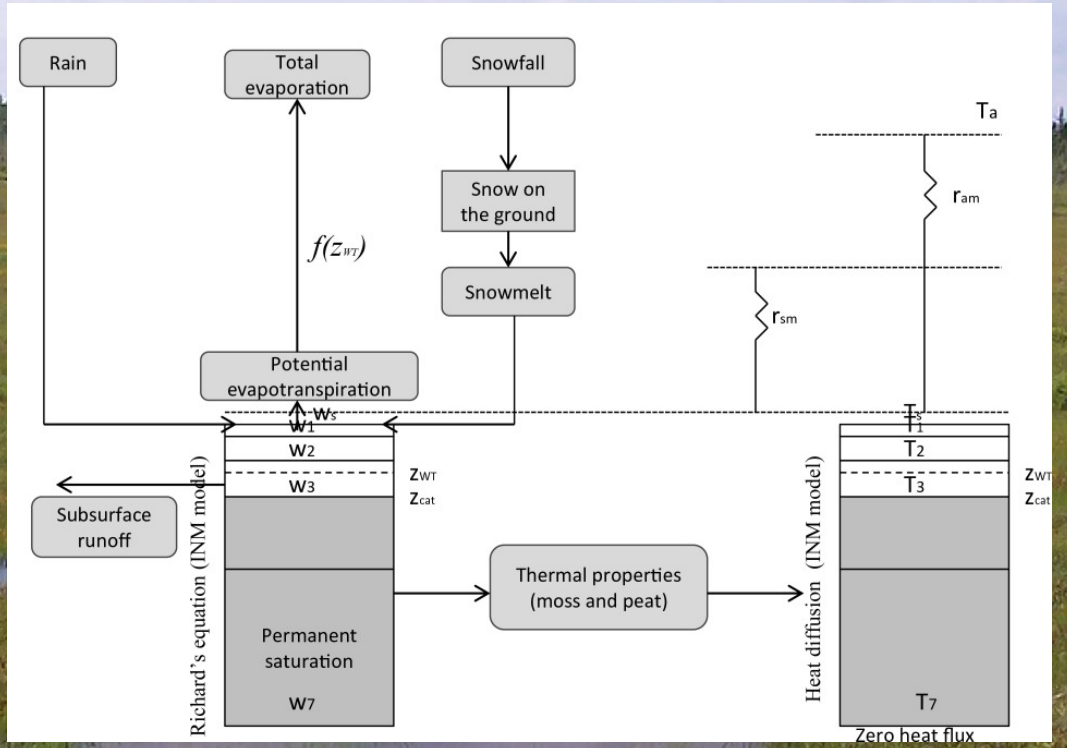
Yurova et al., 2014

Bog - St-Daniel sector - Frontenac National Park (Québec, Canada) -Wikipedia

Peatlands in TERRA



Réserve naturelle de la tourbière, France - Wikipedia

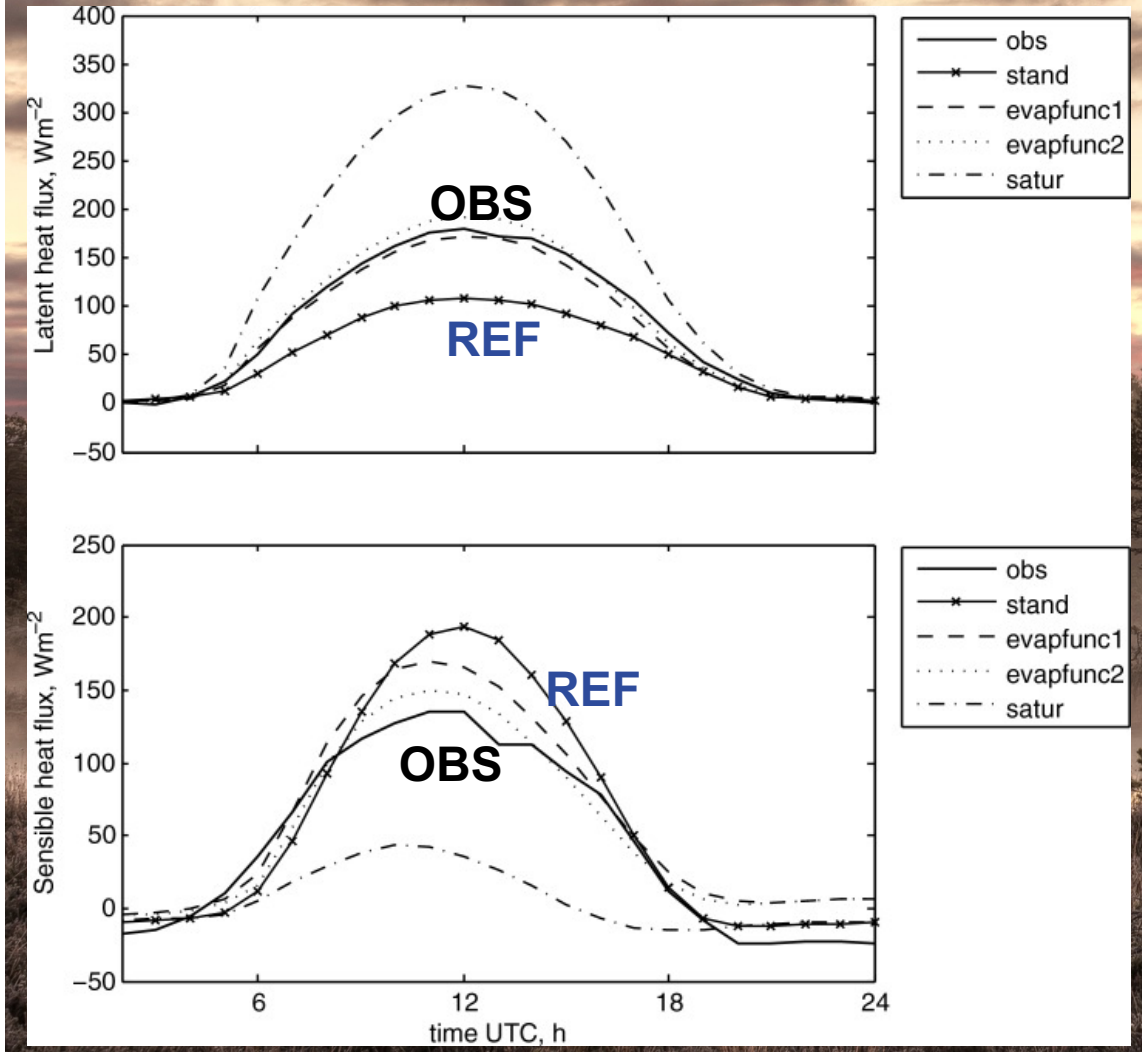


- Modification in TERRA: Evaporation
  - Soil heat conductivity
  - Soil water budget

Yurova et al., 2014

Bog - St-Daniel sector - Frontenac National Park (Québec, Canada) -Wikipedia

Expected impact



Results from uncoupled runs using precipitation data from the fully coupled 3-D NWP model SL-AV, averaged daily cycles over July with 30 min time resolution.

Model incorporating saturated mire representation (satur); and field measurements from the eddy covariance system (obs) at Degerö Stormyr, northern Sweden.

Sensitivity different functions presented by *Weiss et al.* [2006] and *Lafleur et al.* [2005] for evapotranspiration (evapfunc1 and evapfunc2

Yurova et al., 2014

Mukri bog - Wikipedia

Numerical experiments

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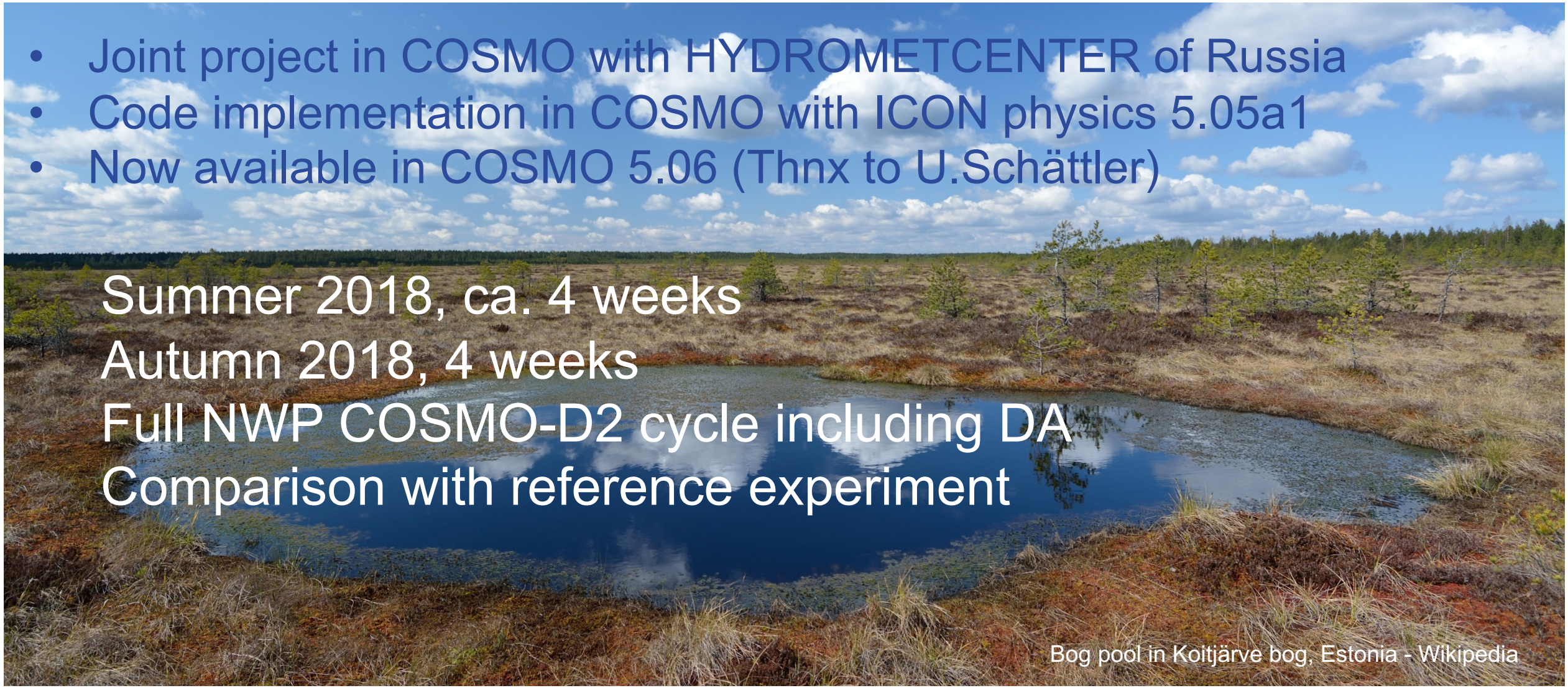
- Joint project in COSMO with HYDROMETCENTER of Russia
- Code implementation in COSMO with ICON physics 5.05a1
- Now available in COSMO 5.06 (Thnx to U.Schättler)

Summer 2018, ca. 4 weeks
Autumn 2018, 4 weeks
Full NWP COSMO-D2 cycle including DA
Comparison with reference experiment



Bog pool in Koitjärve bog, Estonia - Wikipedia

Surface moisture REF-EXP

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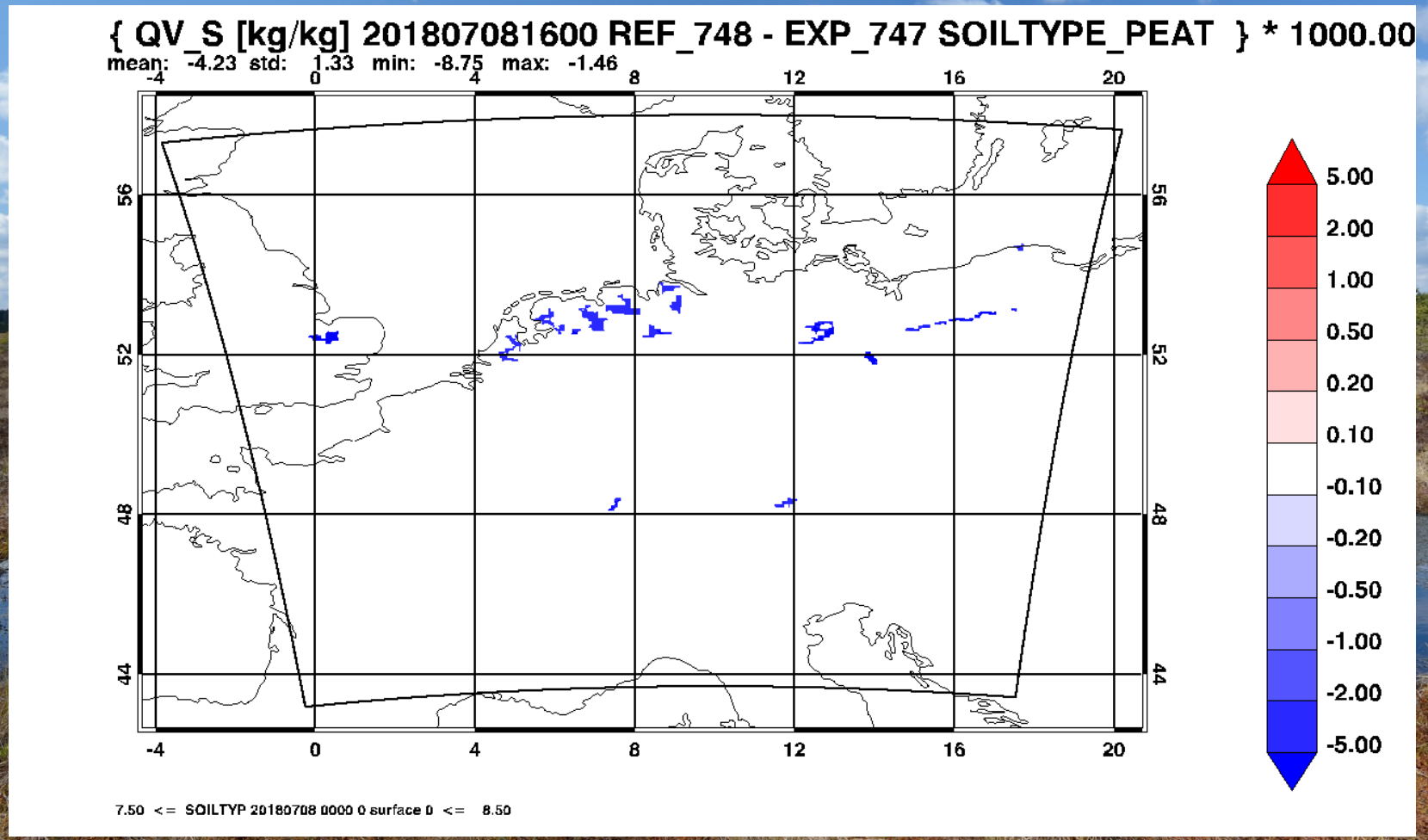


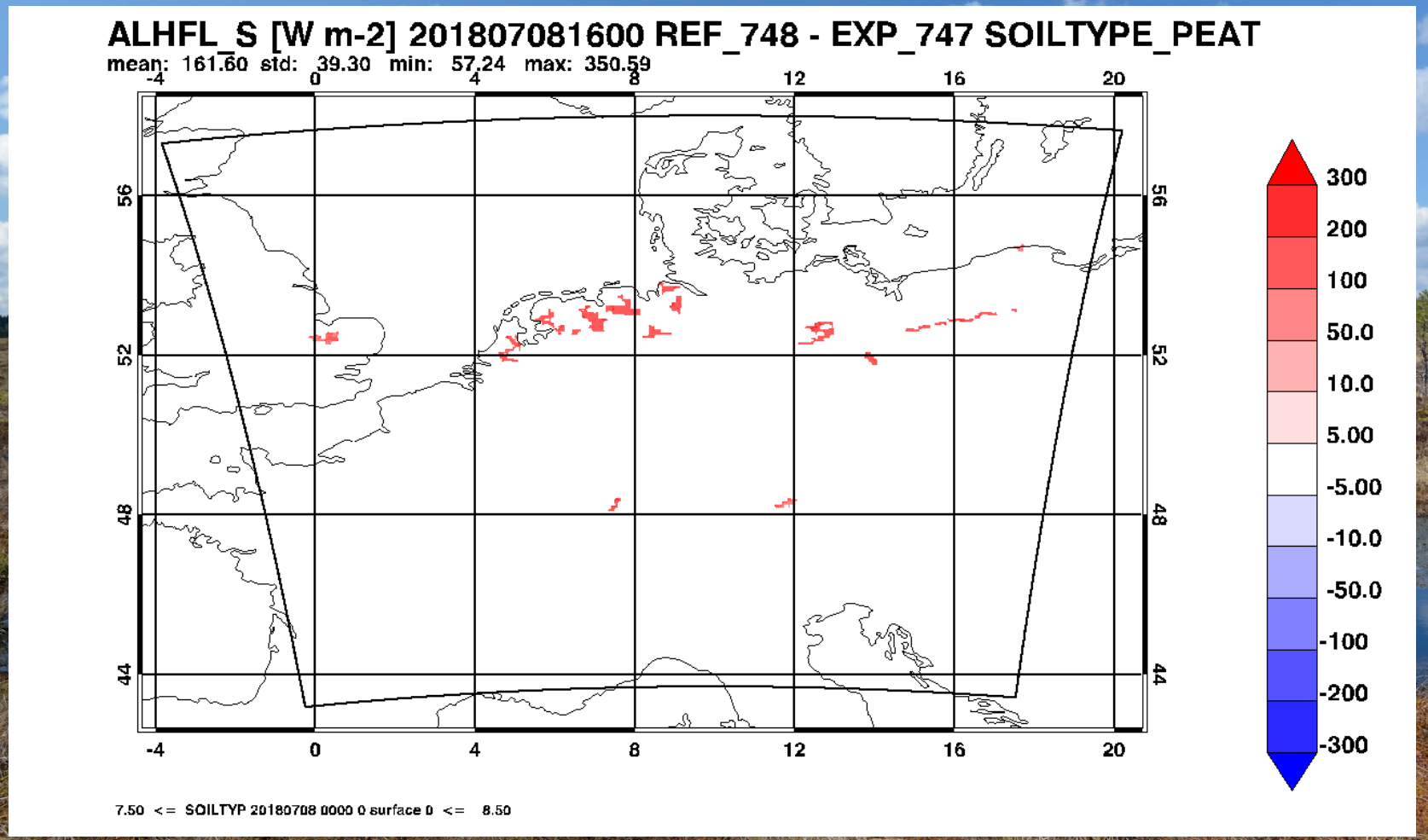
with Mire scheme

Bog pool in Koitjärve bog, Estonia - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

Averaged latent heat flux REF-EXP

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



with Mire scheme

Bog pool in Koitjärve bog, Estonia - Wikipedia

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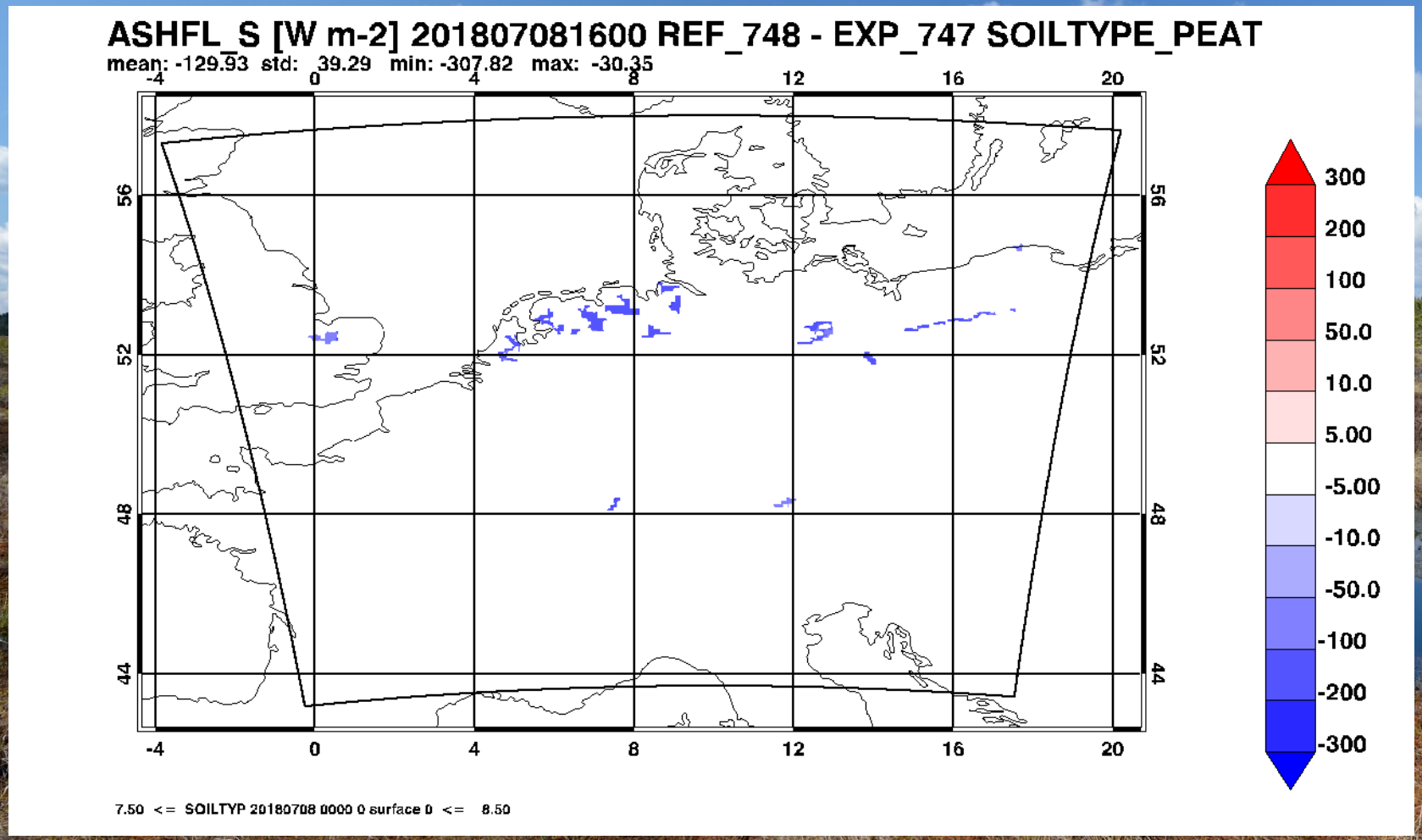
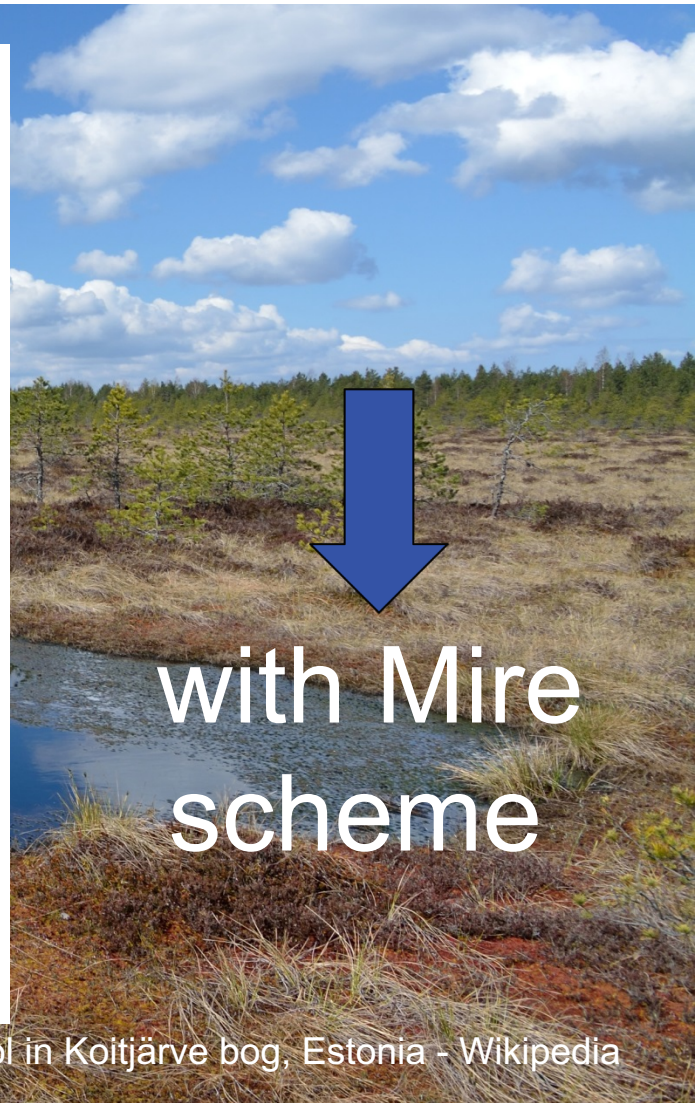
Averaged sensible heat flux REF-EXP

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



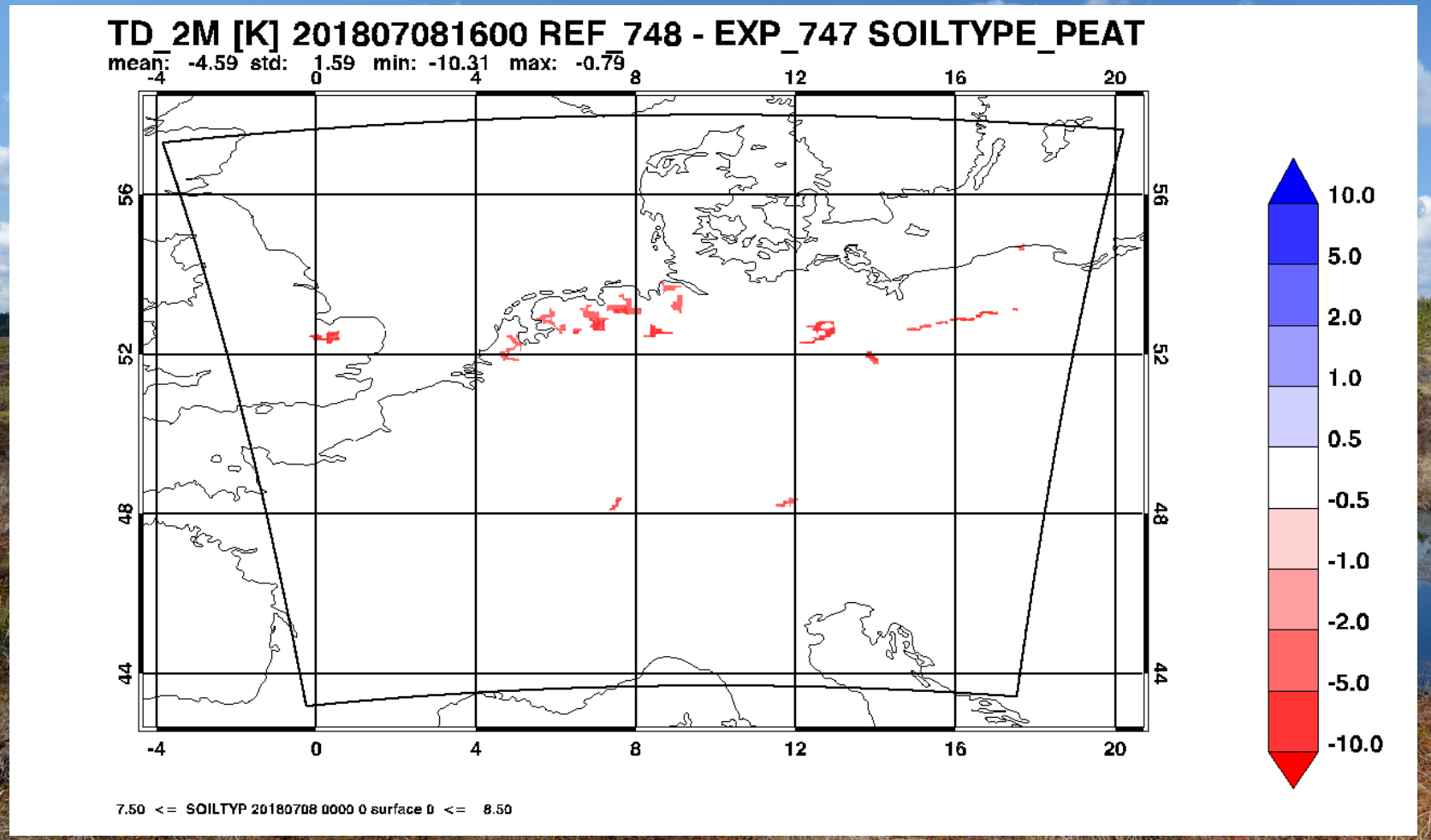


Bog pool in Koitjärve bog, Estonia - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

2m dew point temperature REF-EXP

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



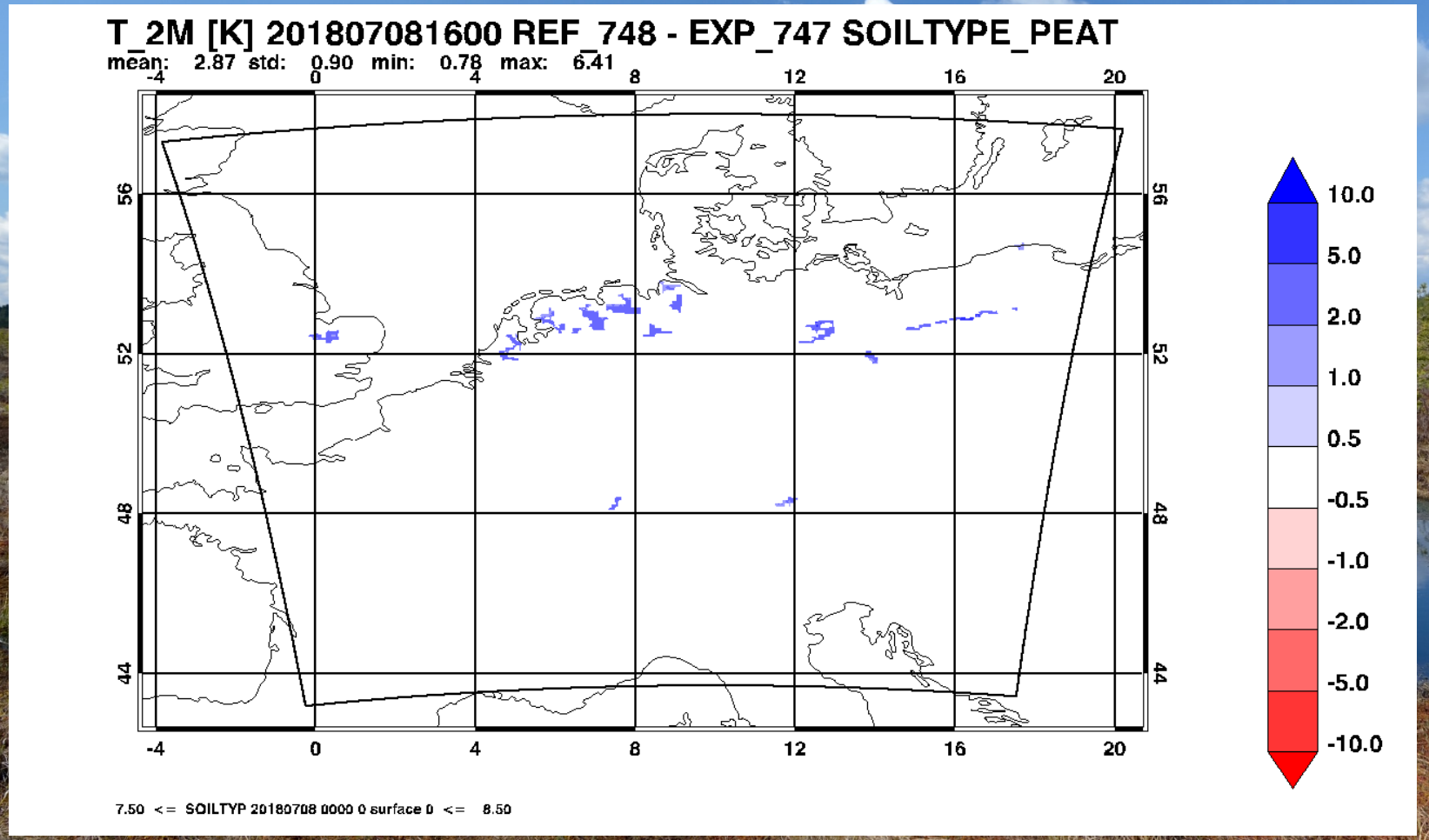
with Mire scheme

Bog pool in Koitjärve bog, Estonia - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

2m temperature REF-EXP

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



with Mire scheme

Bog pool in Koitjärve bog, Estonia - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

10 m gusts REF-EXP

Deutscher Wetterdienst
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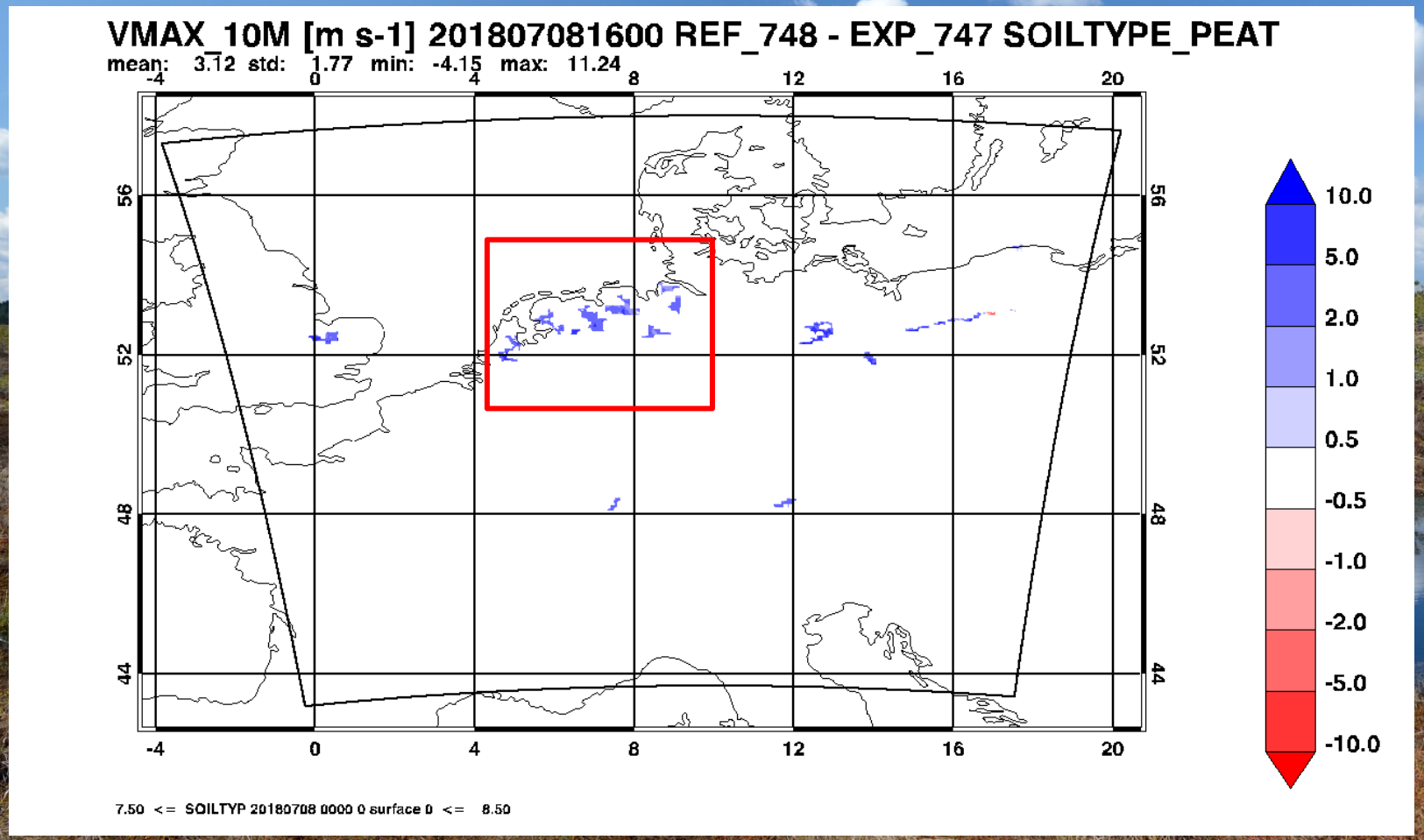


with Mire scheme

Bog pool in Koitjärve bog, Estonia - Wikipedia

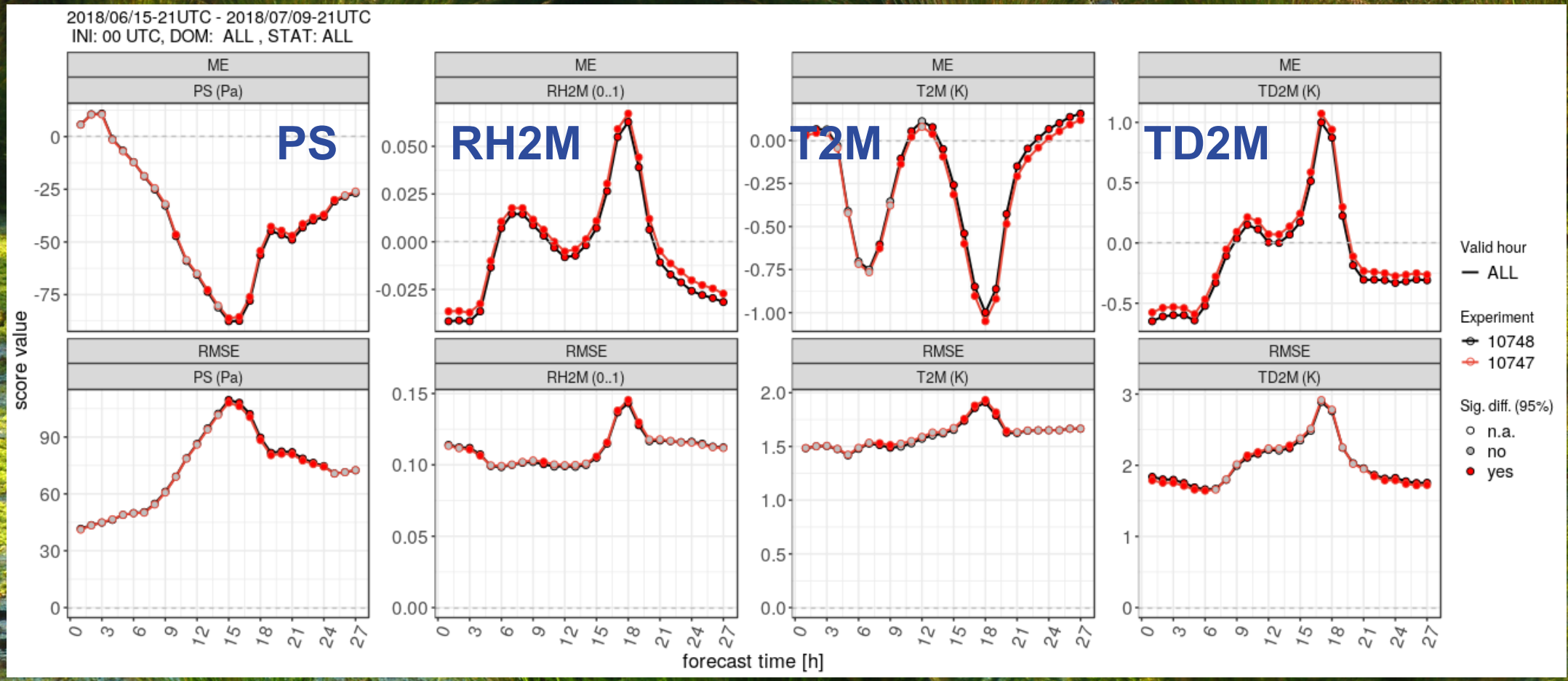
J. Helmert et al., ICCARUS 2019 WG3b

Verification – COSMO-D2

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

BIAS

RMSE



VV

Lütt-Witt Moor, Henstedt-Ulzburg, Germany - Wikipedia

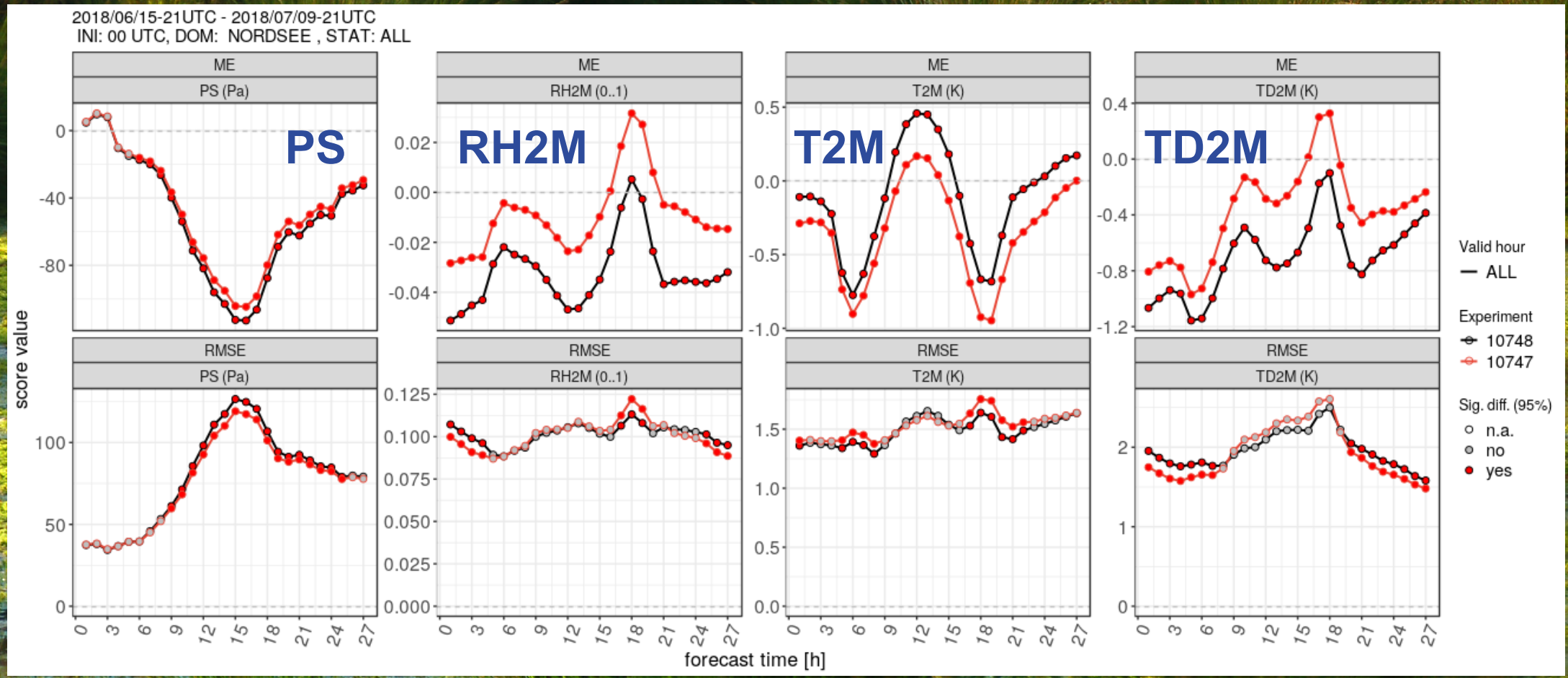
J. Helmert et al., ICCARUS 2019 WG3b

Verification – Region North-Sea

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

BIAS

RMSE



VV

Lütt-Witt Moor, Henstedt-Ulzburg, Germany - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

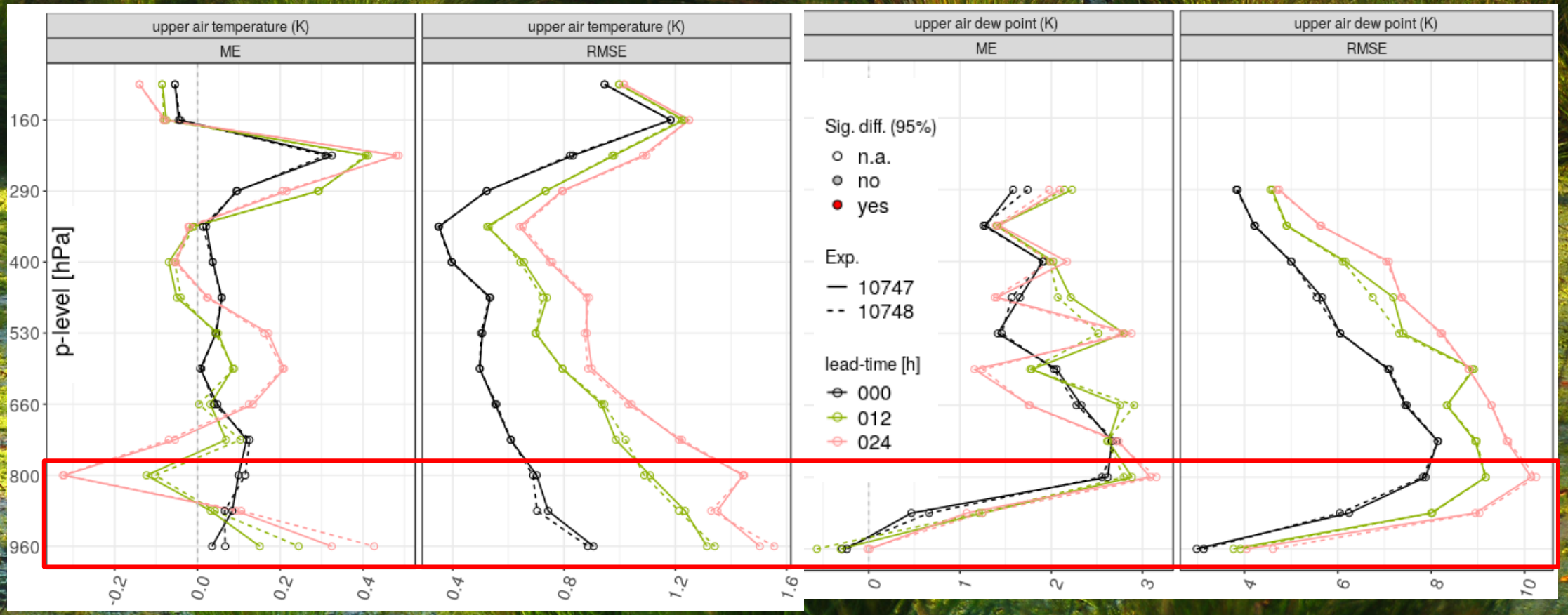
Verification – Region North-Sea

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

T

TD

p
[hPa]



Bias

RMSE

Bias

RMSE

J. Helmert et al., ICCARUS 2019 WG3b

Verification – Region North-Sea

Deutscher Wetterdienst
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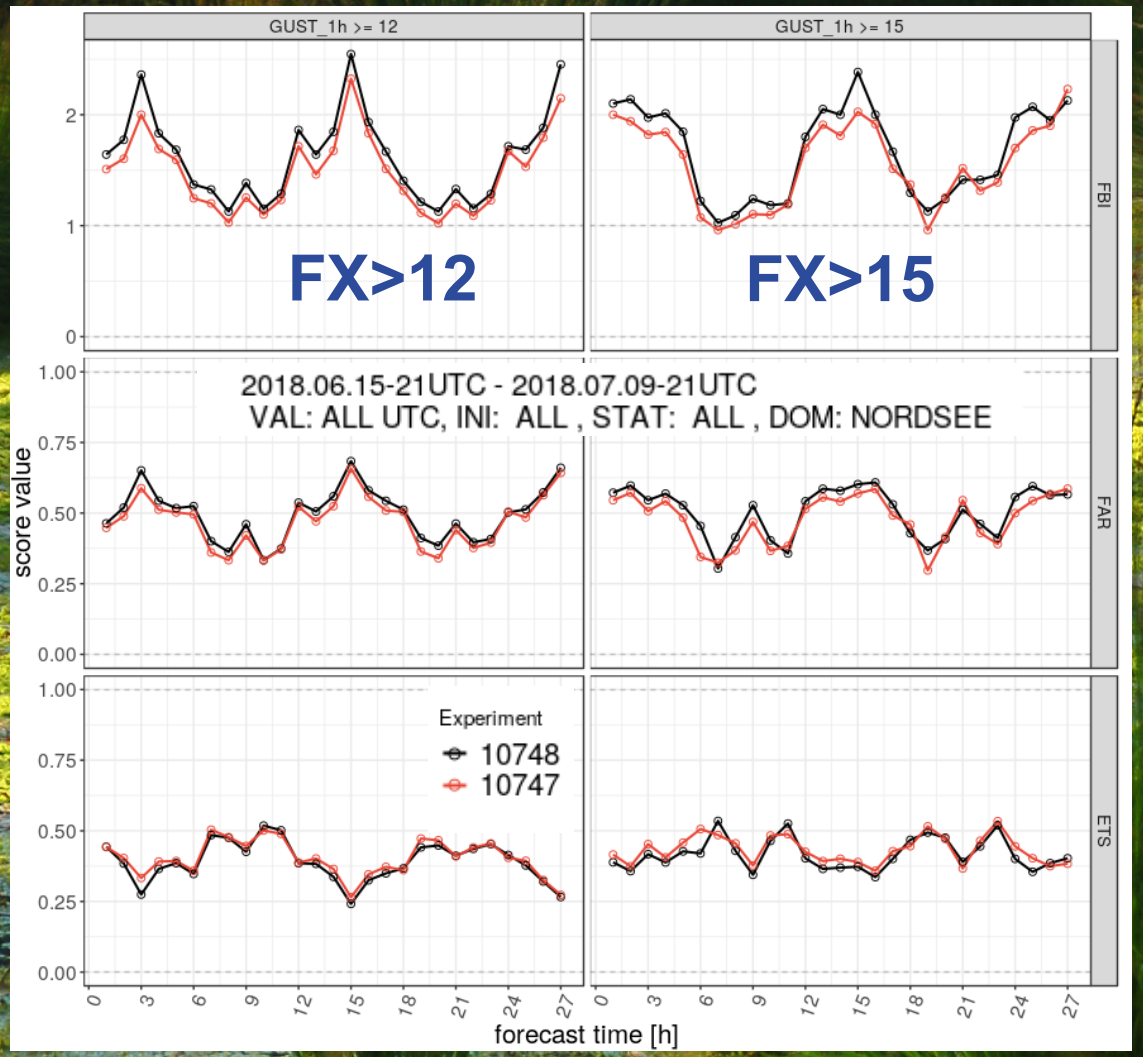
FBI

FAR

ETS



Gust classes FX12,FX15

Overestimated FBI, with Mire scheme

False alarm rate, with Mire scheme

ETS with Mire scheme

Lütt-Witt Moor, Henstedt-Ulzburg, Germany - Wikipedia

J. Helmert et al., ICCARUS 2019 WG3b

Summary

- Mire parameterization as part of TERRA in COSMO 5.06
- First step towards improved simulation of peatlands in op. NWP
- Current limitations: Evapotranspiration, fixed water table, dry bogs not captured

- Demand for synoptical guidance and realistic warnings in regions with peatlands
- Experiment verification showed some positive impact from Mire parameterization in COSMO-D2 (PS,FX)
- Further tests in COSMO partner domains are needed


Thank you.
itype_mire = 1
Formerly peat bog,recultivated as a wetland near Sitniki, Russia - Wikipedia

Verification

Deutscher Wetterdienst
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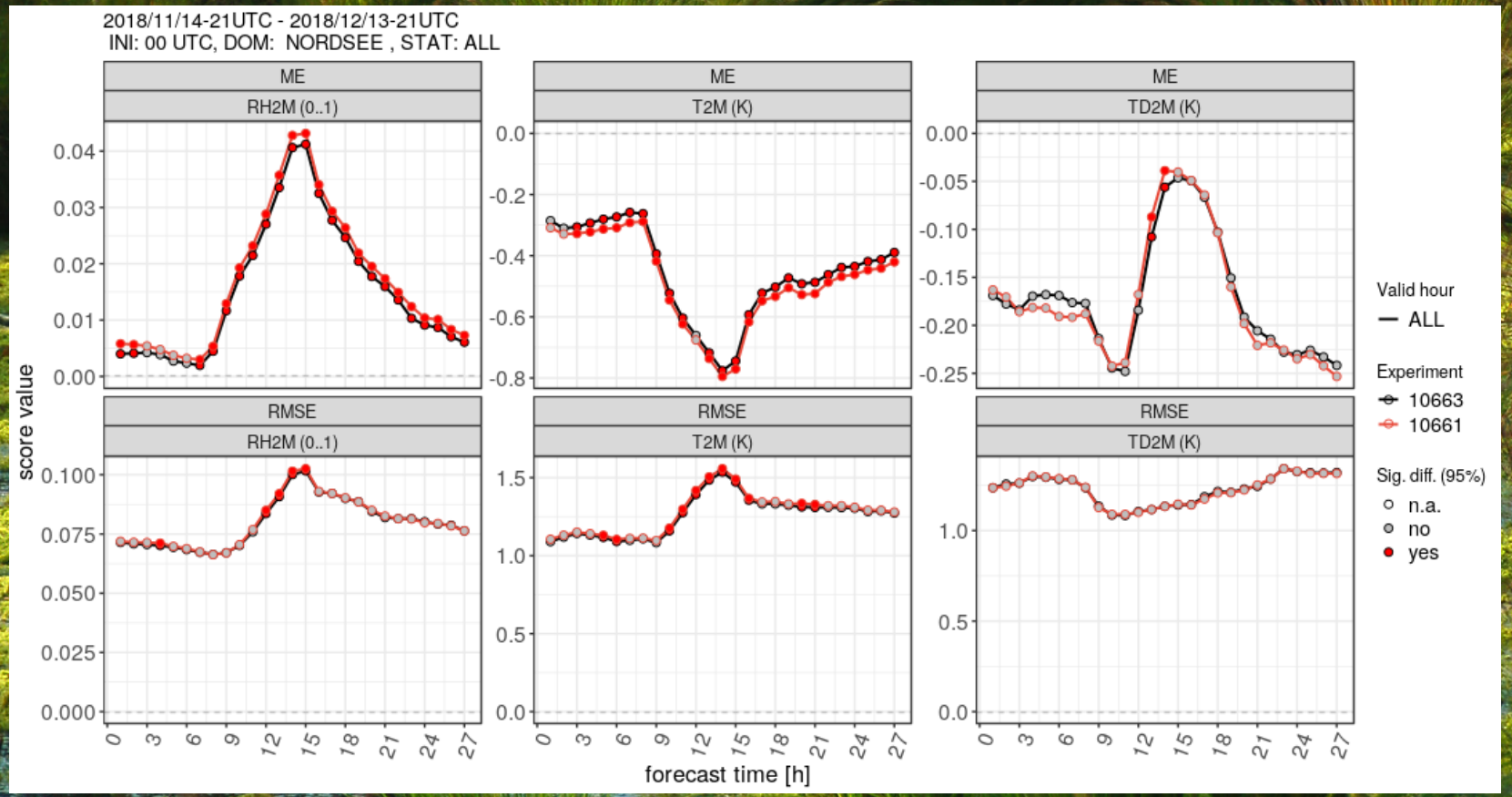
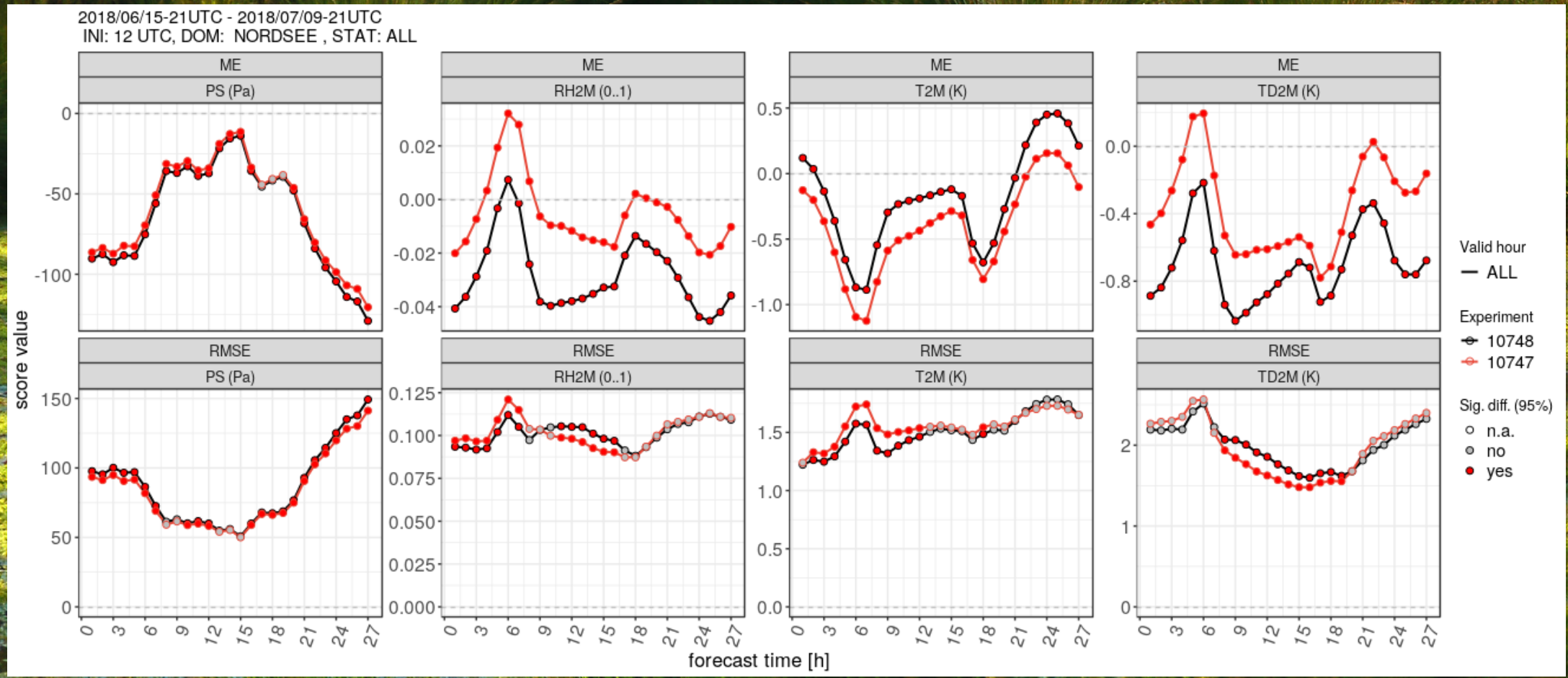


- In Autumn, small decrease of scores for RH2M, T2M, TD2M
- Visible only for the small verification area

Lütt-Witt Moor, Henstedt-Ulzburg, Germany - Wikipedia

Verification

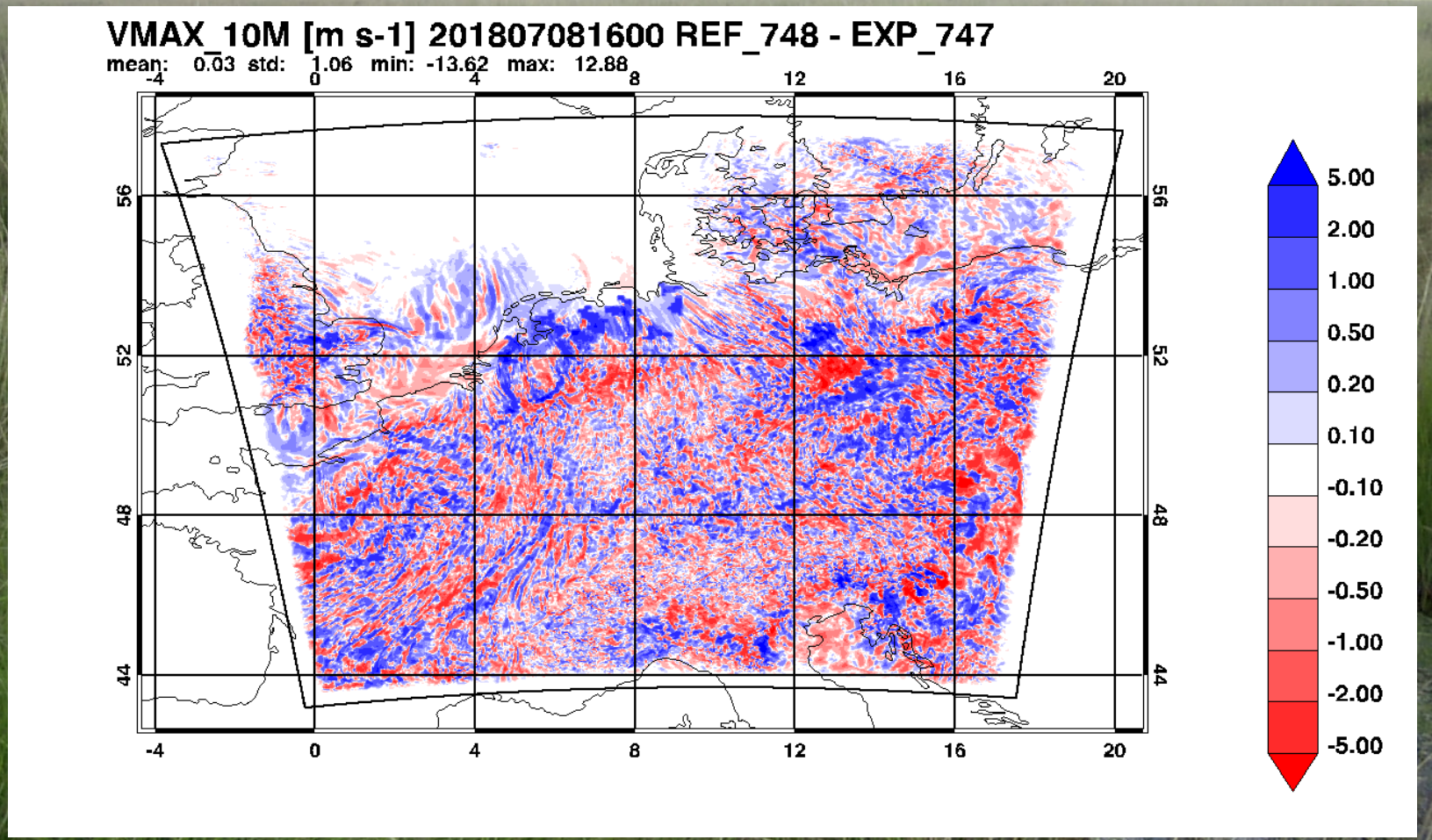
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Lütt-Witt Moor, Henstedt-Ulzburg, Germany - Wikipedia

Supplemental slides

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



NSG „Ewiges Meer“, Hochmoorweite - Wikipedia

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Meteogram – Soiltype Peat Spreewald

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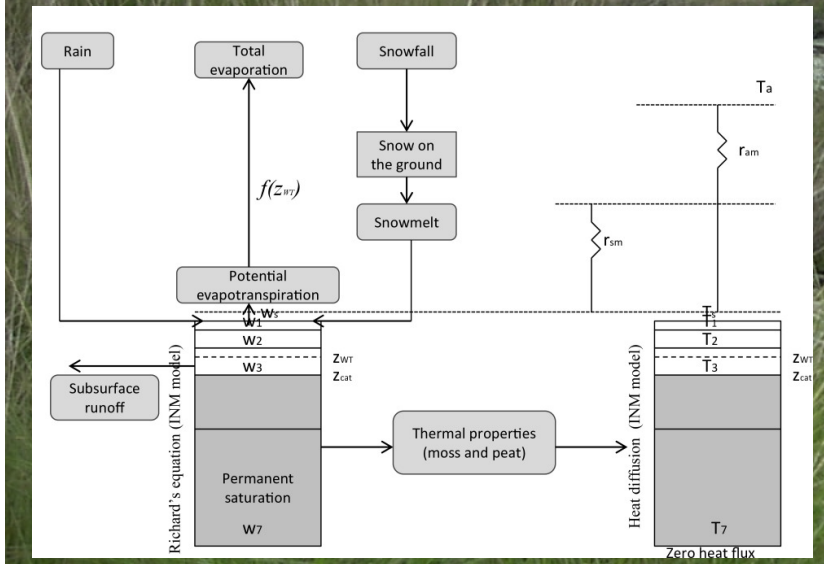
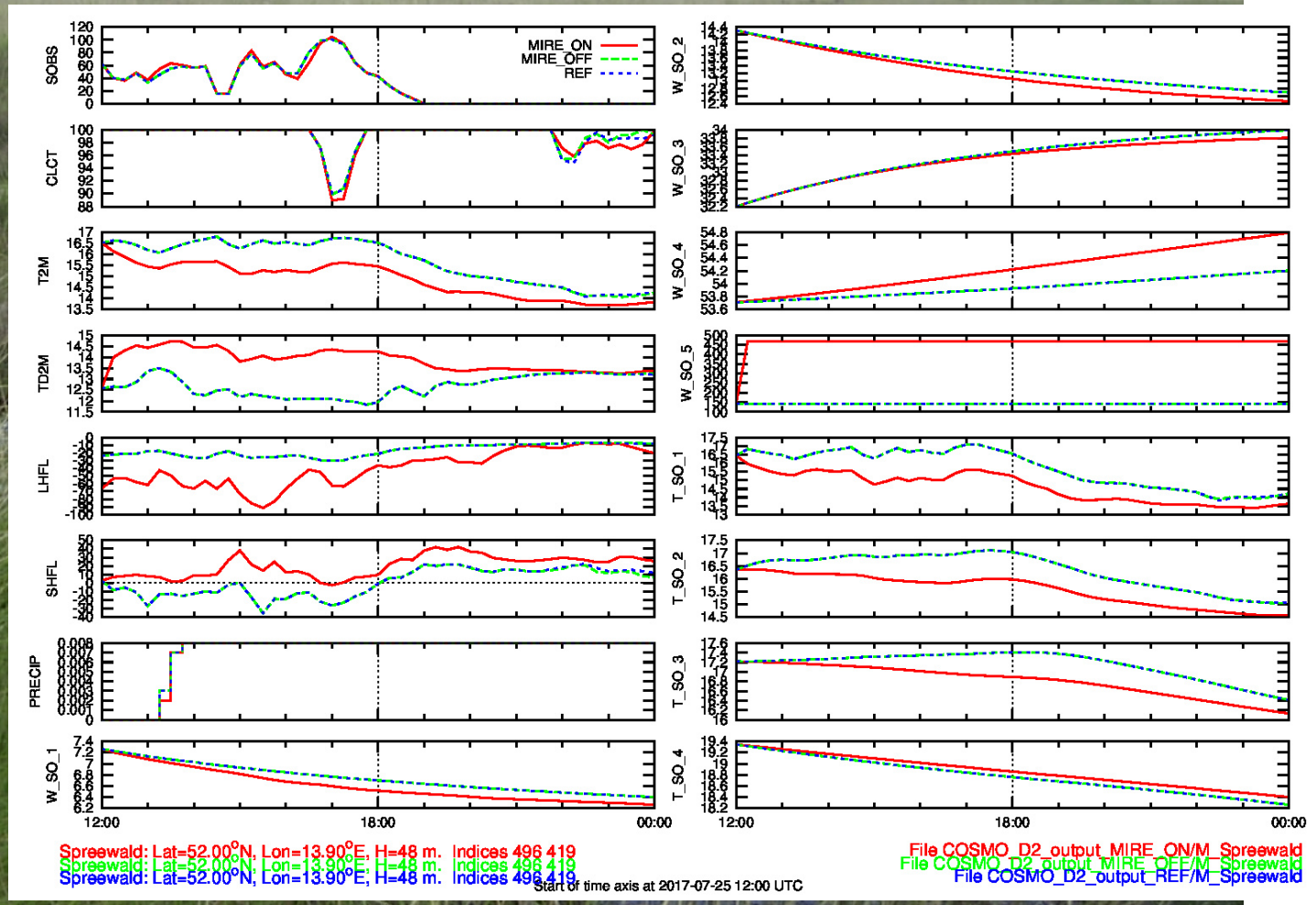
Wetter und Klima aus einer Hand





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Meteogram – Soiltype Peat Leba

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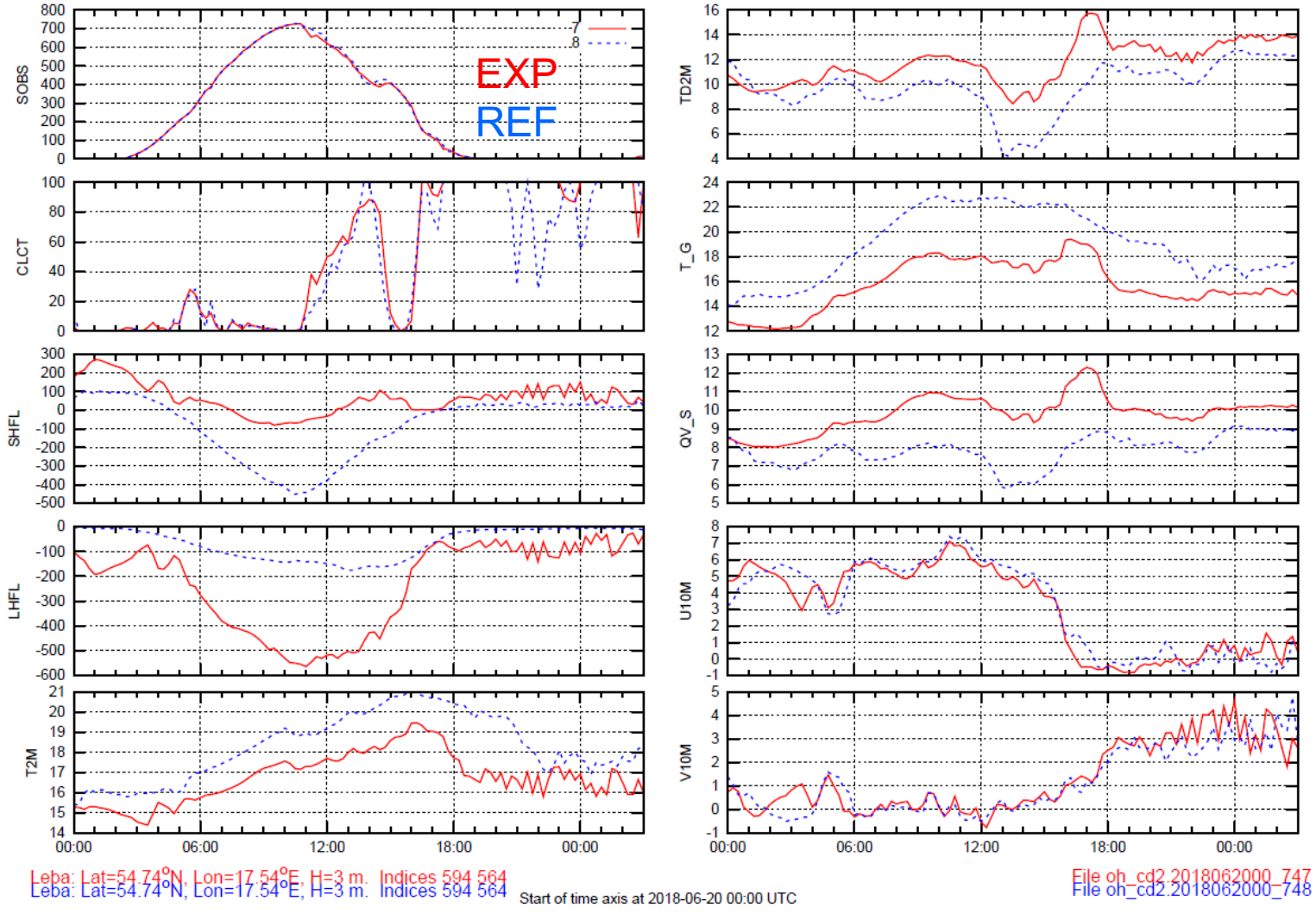
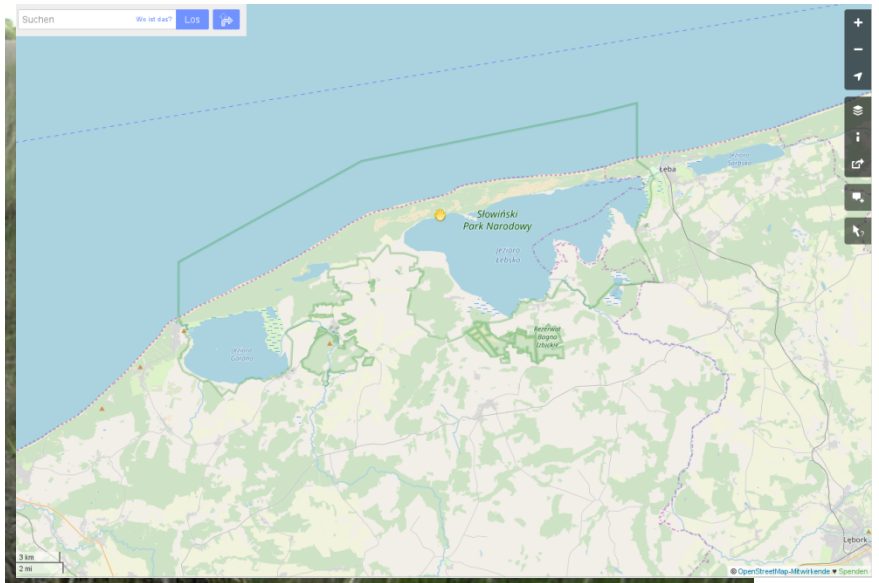
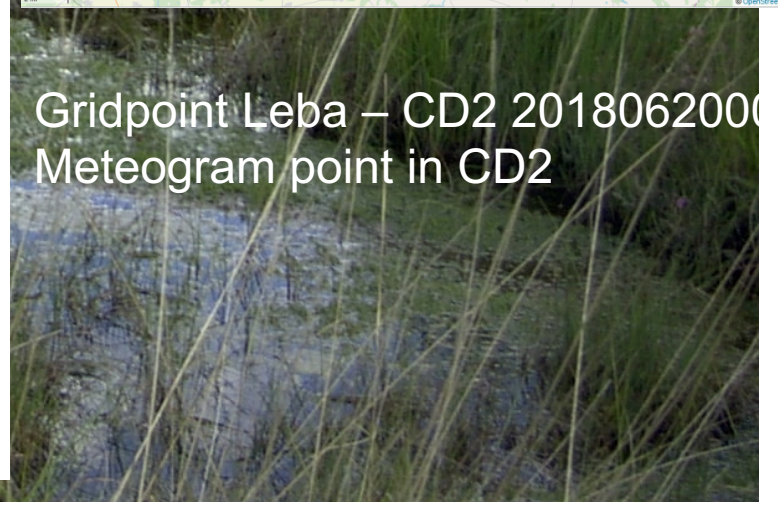
Wetter und Klima aus einer Hand







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Peatlands - Map

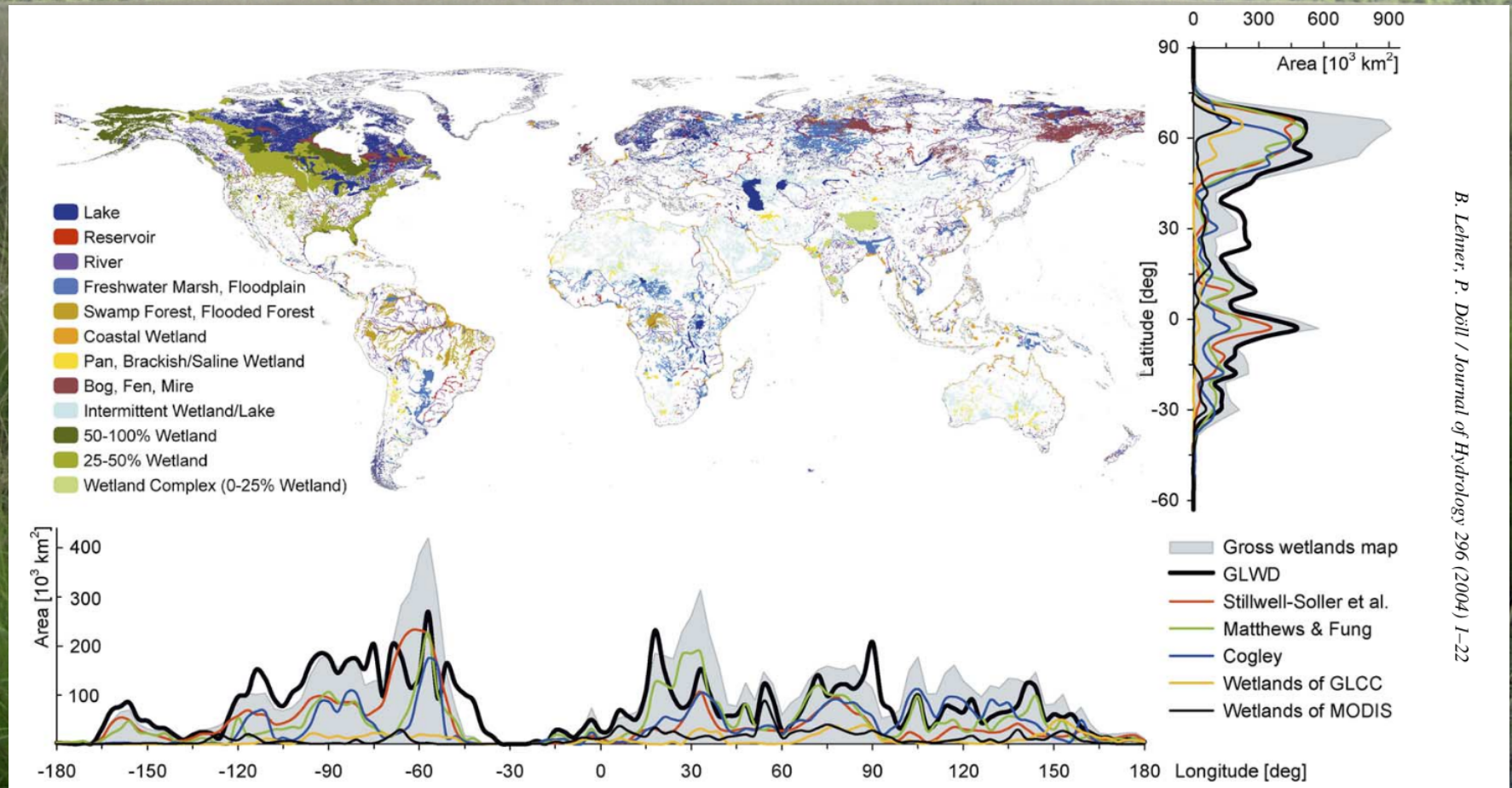

Fig. 5. Global wetlands map GLWD-3, with latitudinal and longitudinal distributions of global wetland areas. Area values are aggregated in steps of 3°. The three fractional wetland classes of GLWD-3 were calculated at their class centers (75, 37.5, and 12.5%). For data description and references see text and Table 1.

Peatlands – ICON R03B07

Deutscher Wetterdienst
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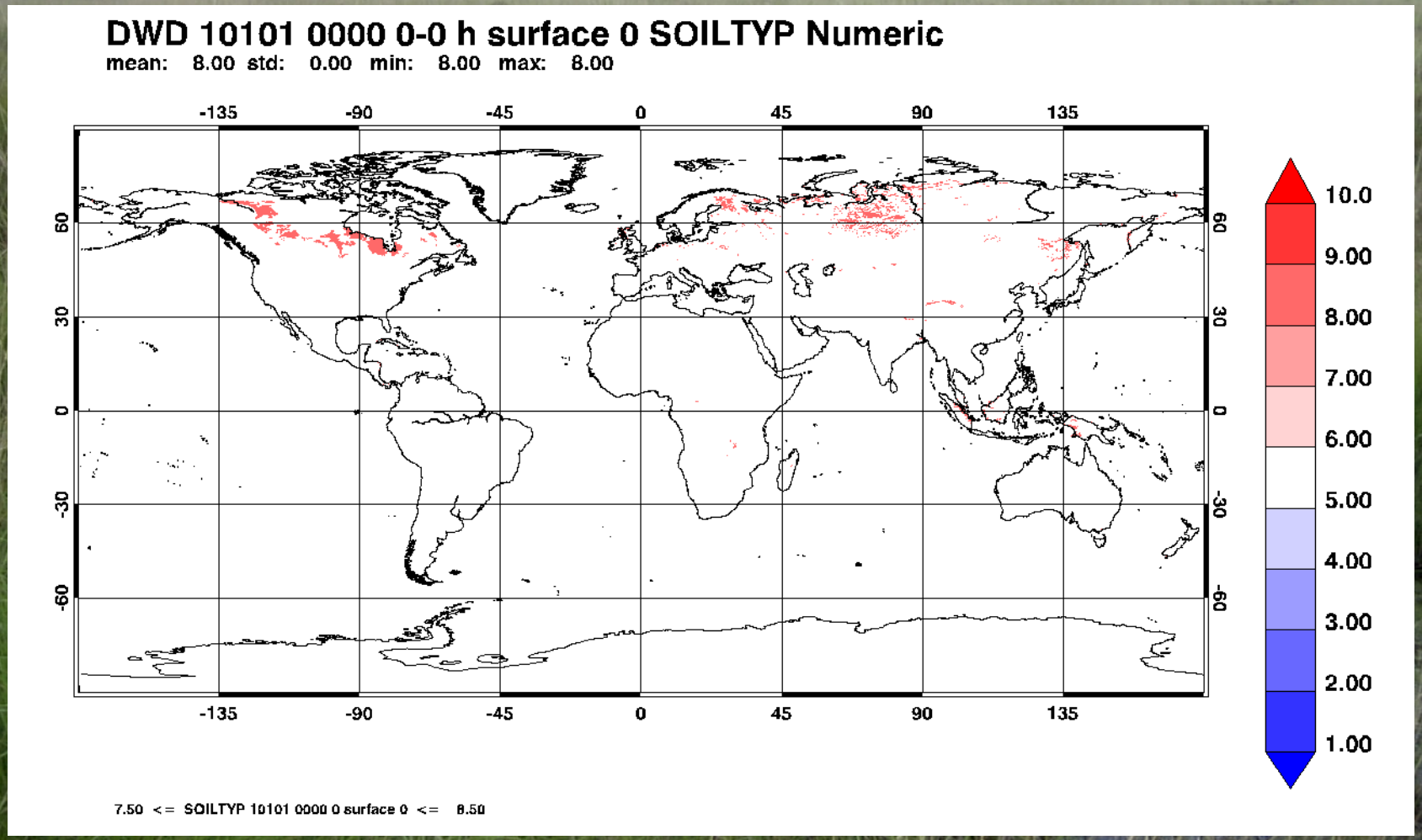

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Concept

In addition, evapotranspiration (ET) was calculated, using a novel approach, as a function of water table depth (z_{wt}, *cm*) and potential evapotranspiration (PET). Two equations describing the relationship between ET and PET were tested in this application. The first is based on measurements taken at several sites in Finland [*Laine*, 1984]:

$$ET = PET \cdot m, \qquad m = s_0 + s_1(z_{wt} - z_L) + s_2(z_{wt} - z_L)^2 + s_3(z_{wt} - z_L)^3, \; if z_{wt} > z_L$$
$$1, \quad if \quad z_{wt} \leq z_L, \tag{7}$$

In the simulations described here, the regression coefficients s_0, s_1, s_2, *and* s_3 and the values of the critical water table level z_L (cm) were those given by *Weiss et al.* [2006] for a bog.

The second function is based on measurements taken at a bog in southern Canada [*Lafleur et al.*, 2005]:

$$ET = \alpha_1 \cdot PET, \quad if \quad z_{wt} \geq z_{L1}$$
$$ET = \alpha_2 \cdot PET, \quad if \quad z_{L2} \leq z_{wt} < z_{L1} \tag{8}$$
$$ET = \alpha_3 \cdot PET, \quad if \quad z_{wt} < z_{L2},$$

where $\alpha_1 = 0.427$, $\alpha_2 = 0.53$ (min = 0.51, max = 0.55), $\alpha_3 = 0.617$ (min = 0.59, max = 0.64) are model parameters and $z_{L1} = 65$cm and $z_{L2} = 25$ cm are the critical water table level values.