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Parameterization of Lakes in ALADIN-HIRLAM NWP System in HARMONIE-AROME Configuration

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Outlines

- HIRLAM and HARMONIE
- FLake in HARMONIE
- FLake performance, impact and verification

HIRLAM and HARMONIE

- HIRLAM is an NWP model and a consortium
- HIRLAM consortium and ALADIN-LACE consortia are merging
- HIRLAM consortium decided to use AROME NWP model, but to transfer the experience from HIRLAM model into it
- The result is HARMONIE-AROME NWP system configuration
- Parameterization of lakes runs operationally in HIRLAM model for many years, but not yet in HARMONIE …
- As in HIRLAM model, parameterization of lakes in HARMONIE is based on FLake (via land surface modeling platform SURFEX)

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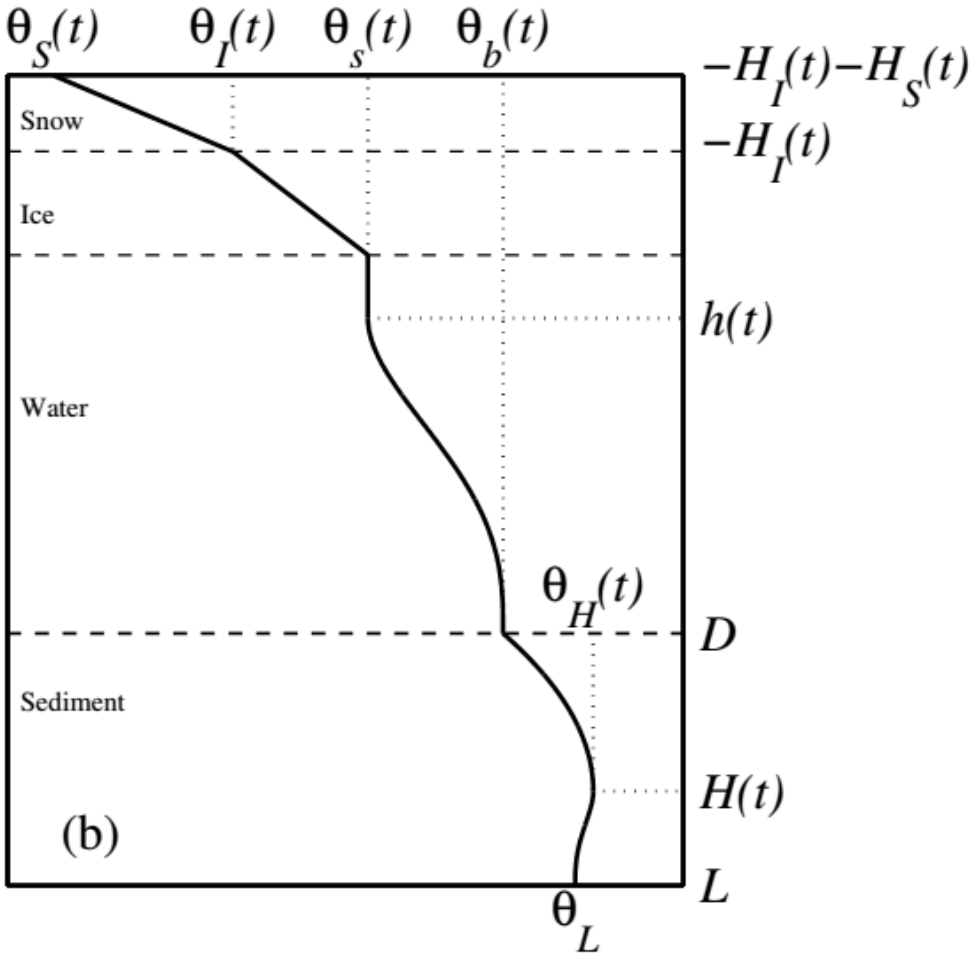
FLake in HARMONIE



Lake model FLake:

- Self-similarity concept
- Parametric representation of temperature profile in water, ice, snow on ice and in bottom sediments
- Temperature profile in water: the mixed layer and thermocline
- Solar radiation flux: exponential approximation of the decay law

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FLake in HARMONIE

- **Lake fraction**: land-use map ECOCLIMAP
  Tiling!
- **Lake depth**: GLBD3
- **Initialization of FLake**: Lake climatology, v.1

Problems to solve:

- Consistency problem: in ECOCLIMAP, different types of wetlands and coastal lagoons contained "lake water" => new version of ECOCLIMAP was created
- Aggregation/interpolation problem in SURFEX:
  only aggregation!
  no interpolation for the lake depth for fine grids!
  at least, use the nearest neighbor method

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FLake performance

HARMONIE experiments:

- Nordic domain, 2.5 km res
- 2 runs: Nov.2015- Jan.2016
  Apr.-May 2016
  } Winter 2015-2016
- 3h forecasts for DA cycling
- 48-h forecasts start at 00 and 12 UTC

FLake performance

Winter 2015-2016 was unusually warm in the region!

Ice cover periods:

	from MODIS, winter 2015-2016	climatology
Vännern	no ice cover	from Nov.-Dec. to Apr., not every year
Vättern	no ice cover	from Nov.-Dec. to Apr., not every year
Ladoga	from Jan., 21 to Jan., 29	from Dec.-Feb. to beg. of May
Peipsi	from Jan., 3 to Apr., 5	from Nov.-Dec. to Apr.-May

Challenge for FLake to reproduce!

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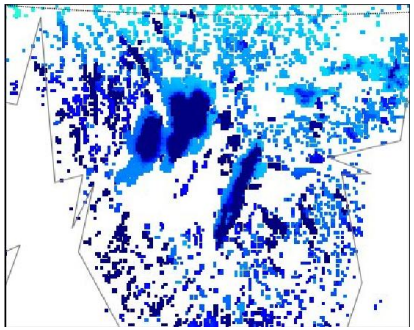
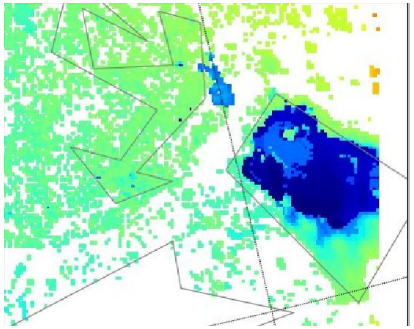
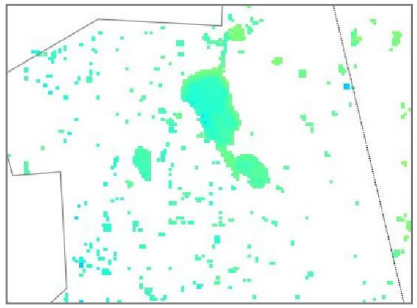
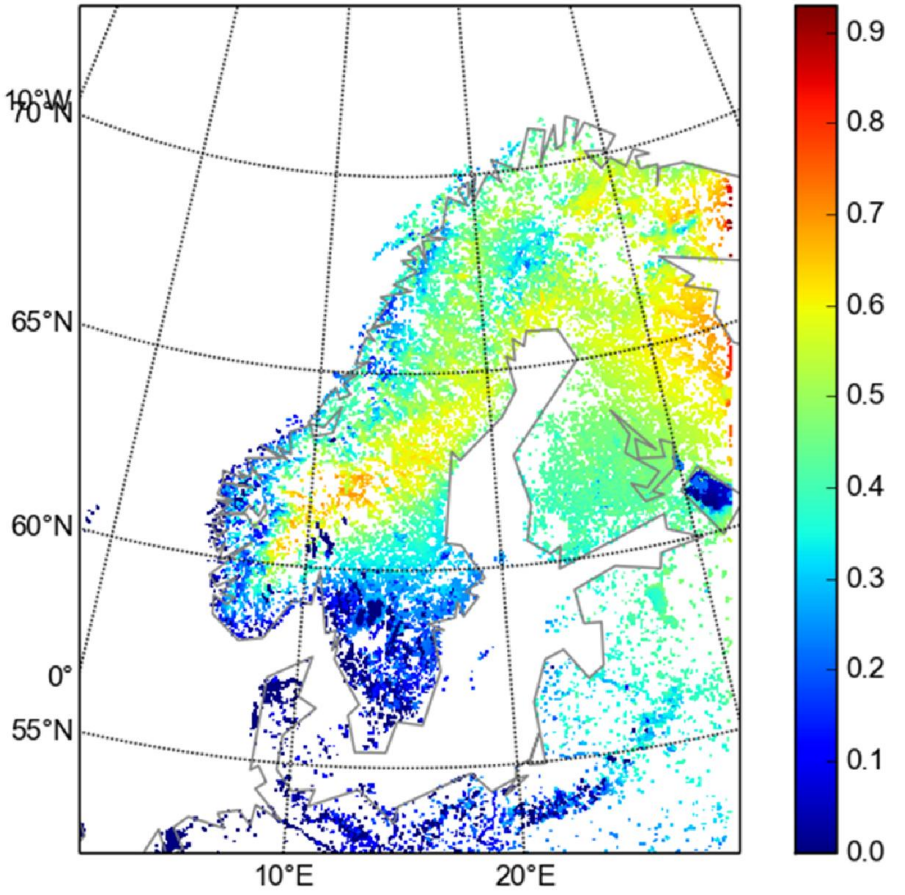
FLake performance: autumn

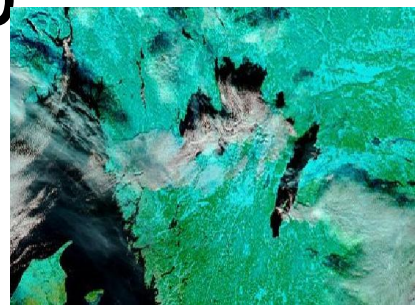


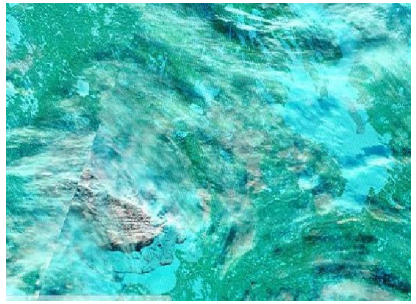


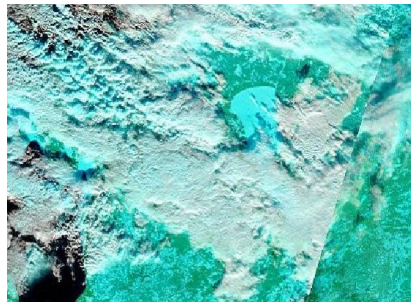


H ice, m, 15.01.2016.00+00









FLake performs good!

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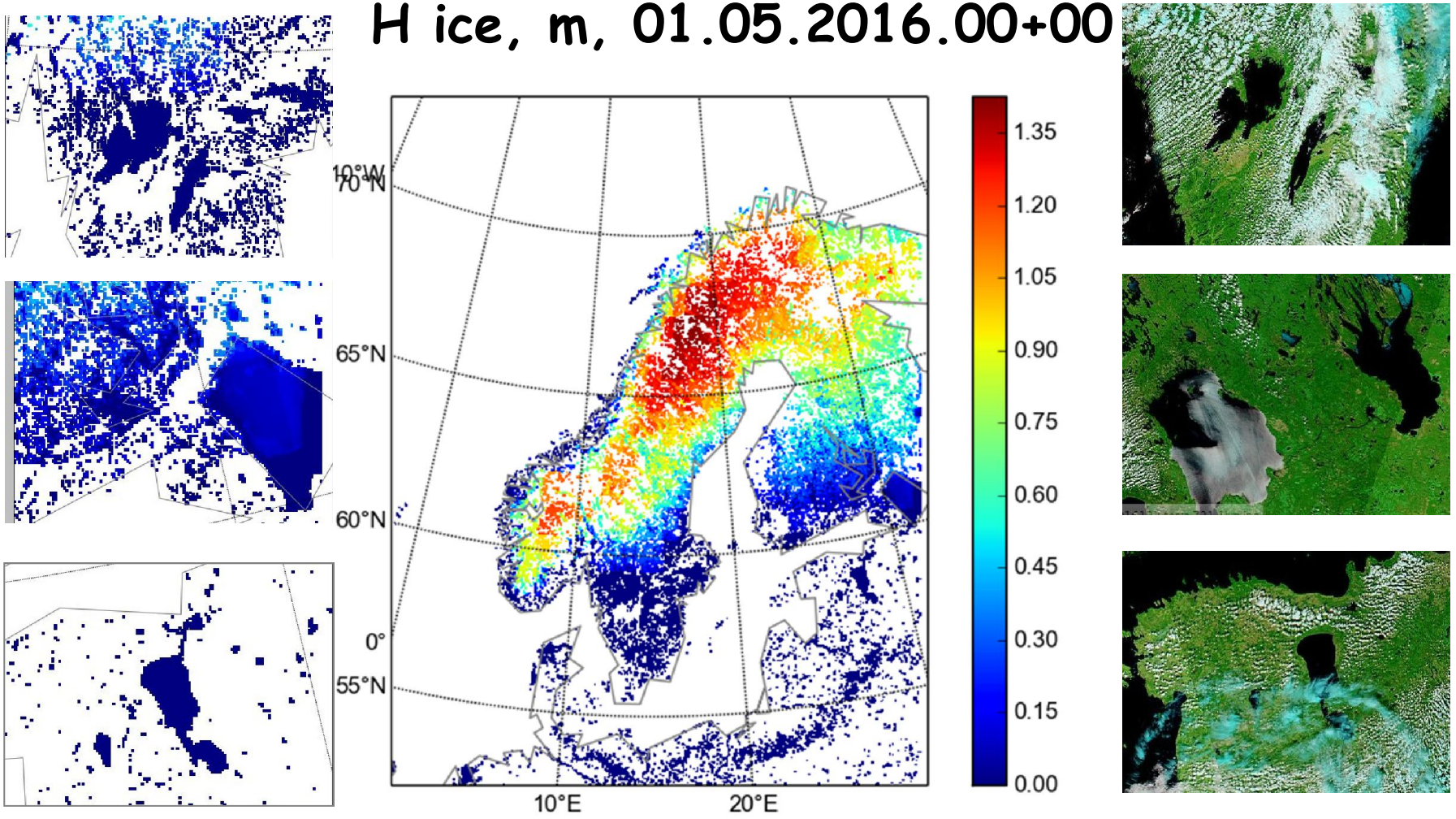
FLake performance: spring



Too much ice in FLake due to starting from climatology

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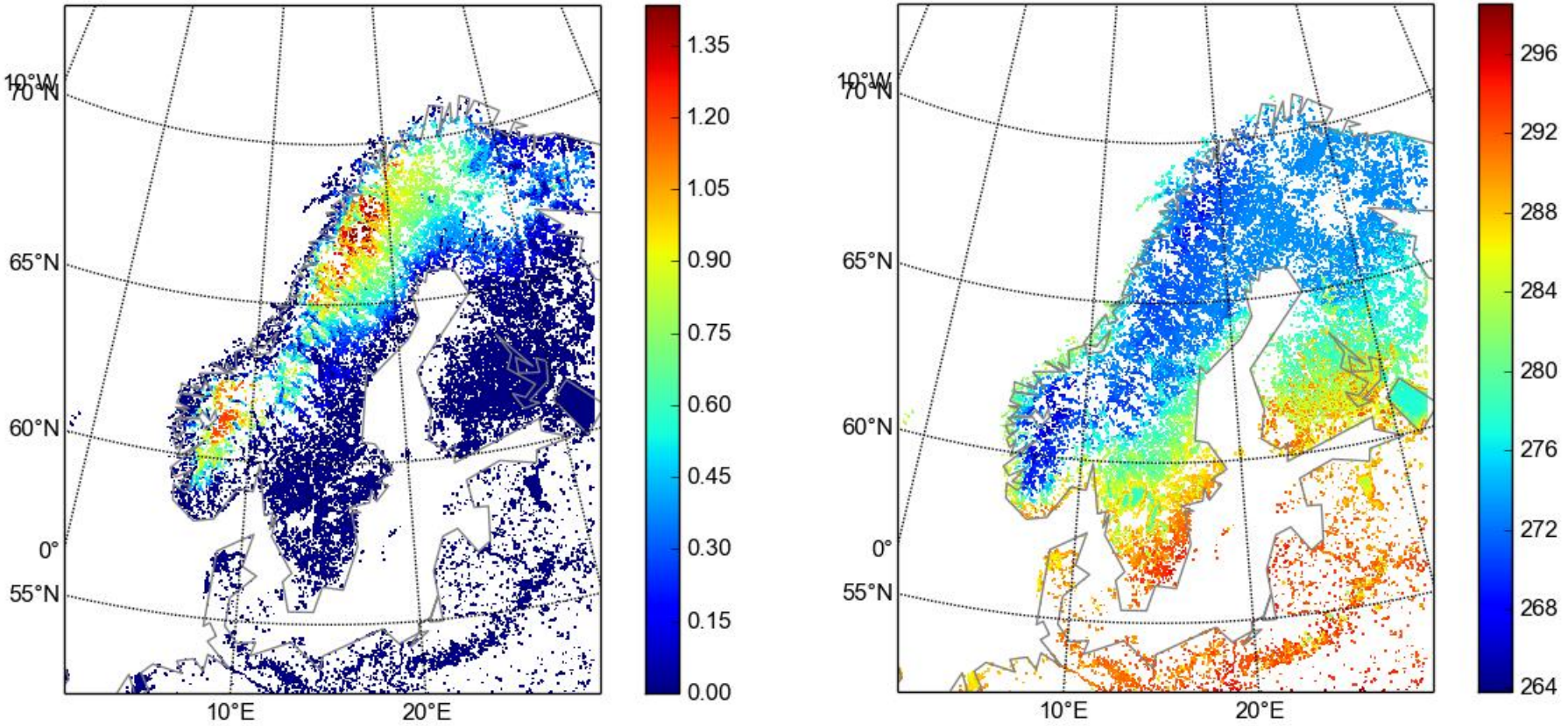
FLake performance: spring

H ice, m 01.15.2016.00+00 Ts, lake, K



Situation improves gradually, ~ in one month

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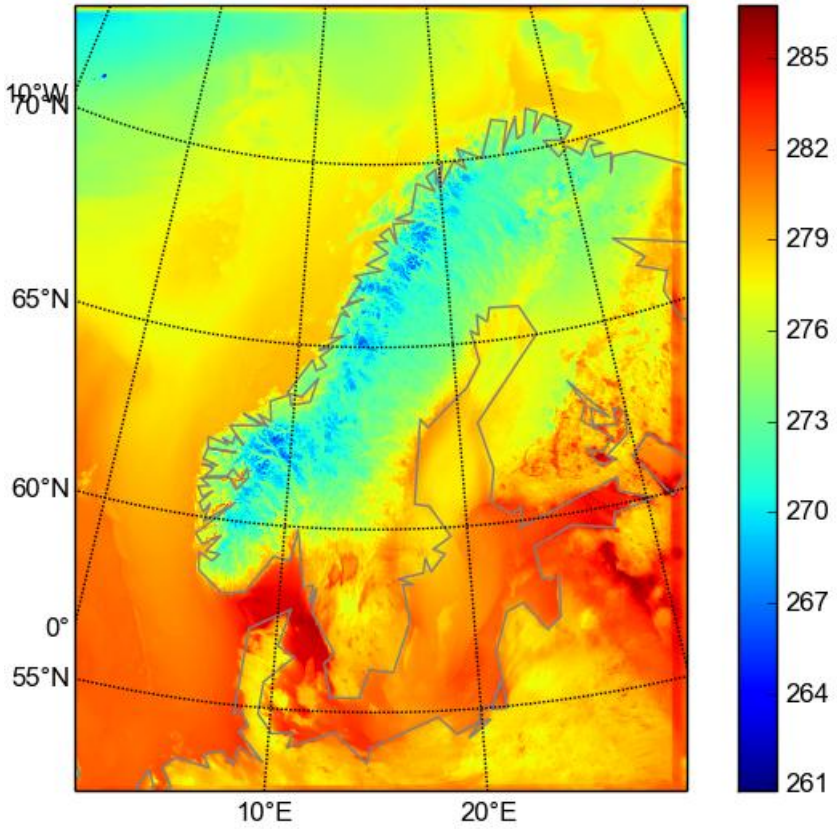
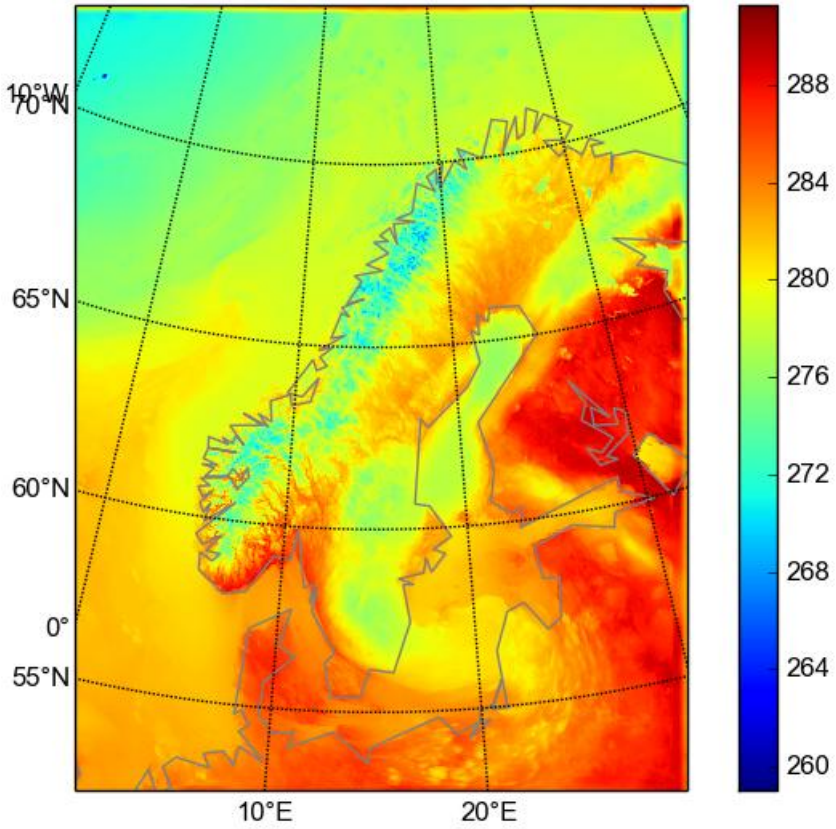
On impact of lakes …

T lowest model, K

15.05.2016.00+24



15.05.2016.00+36



Atmospheric model often "sees" large and medium lakes;
Lakes might affect large scale atmospheric motions

Verification: FLake vs WATFLUX

WATFLUX:

- Ts lake is constant during the forecast
- Ts lake is initialized each forecast cycle from the interpolated SST and the deep soil temperature

WATFLUX is affected by T2m observations via the analysis procedure (due to using of the deep soil temperature).

FLake runs freely!

Not easy to beat WATFLUX!

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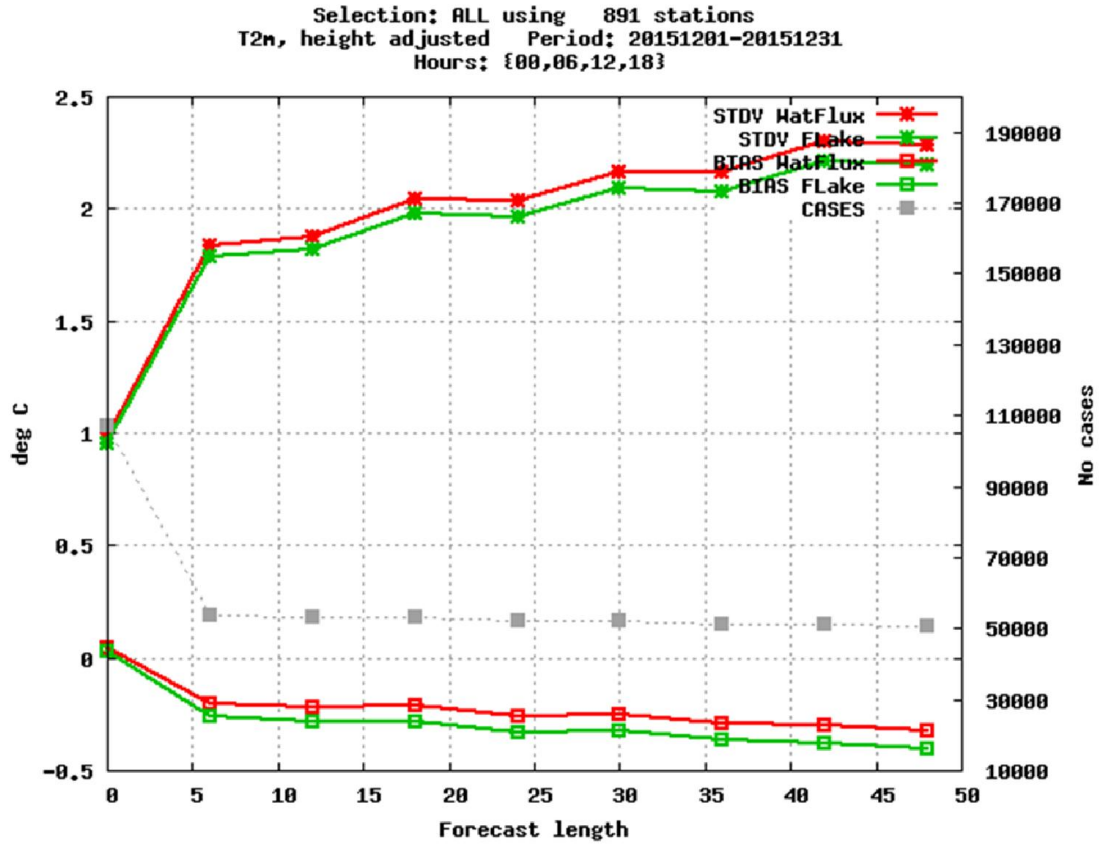
Verification: FLake vs WATFLUX

T 2m bias and STDV, K, December, 2015

WATFLX **FLAKE**



From standard verification,

it is difficult to make conclusions

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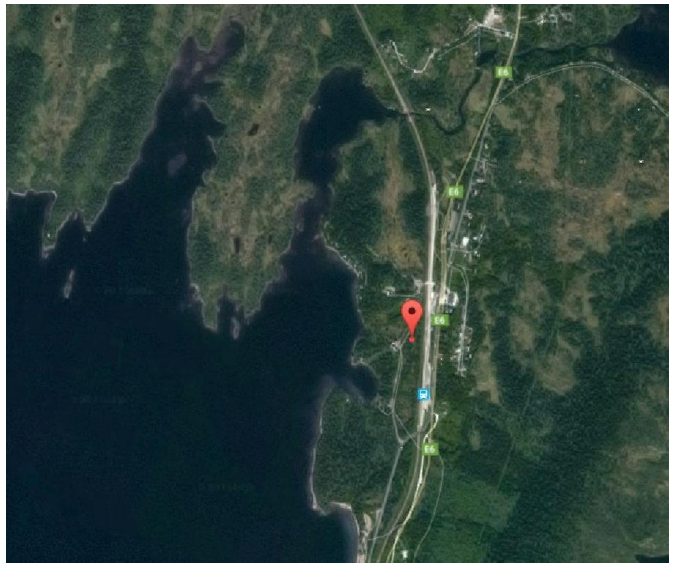
Verification: FLake vs WATFLUX

Lists of lake stations for different regions



- Norway lowland NL – 12 stations
- Norway mountains NM – 9 stations
- Sweden lowland SL – 12 stations
- Sweden mountains SM – 14 stations
- Finland North FN – 12 stations
- Finland South FS – 39 stations
- Baltic region BR – 7 stations
- Russia North RN – 4 stations
- Russia Arctic RA – 4 stations
- Russia Center RC – 1 station
- Lake Vänern VN – 2 stations
- Lake Vättern VT – 2 stations
- Lake Ladoga LA – 3 stations
- Lake Peipsi PE – 1 station

We may see improvements and degradations for different lake regions

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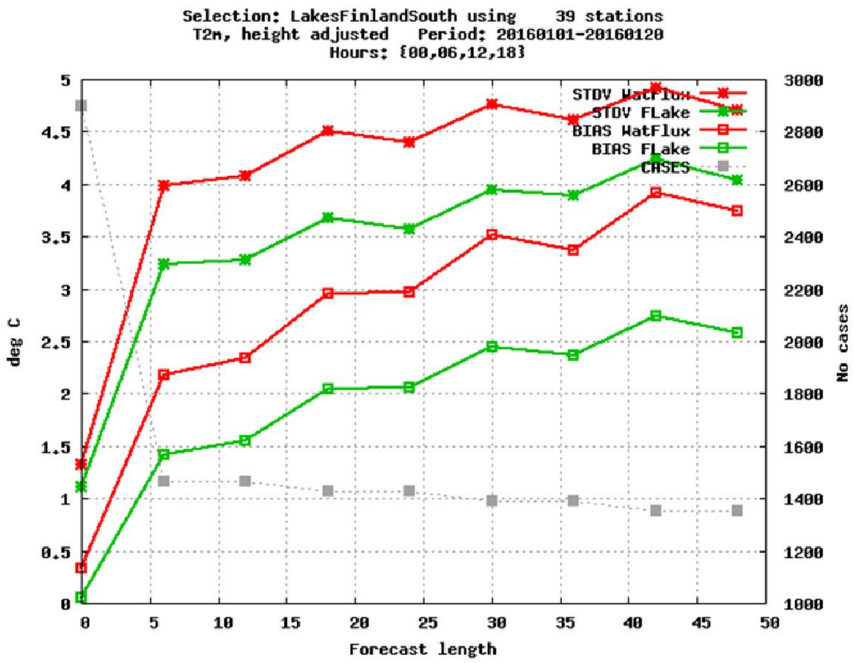
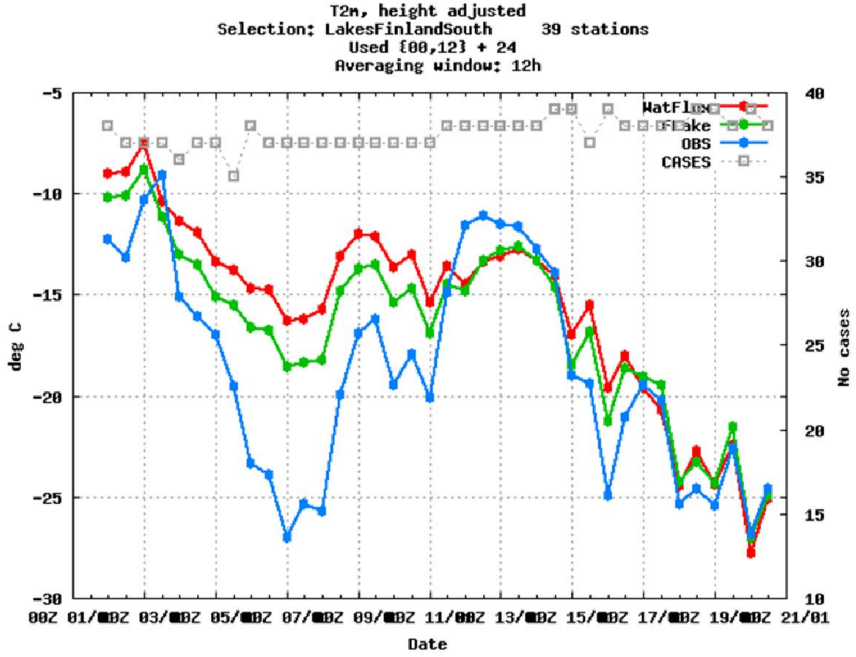
Verification: FLake vs WATFLUX

January, 2016, Finland South, WATFLX vs FLAKE

T 2m bias and STDV, K



T 2m, K, timeserie



Improvement of T2m scores.

FLake contributes to the solution of the "stable boundary layer" problem?

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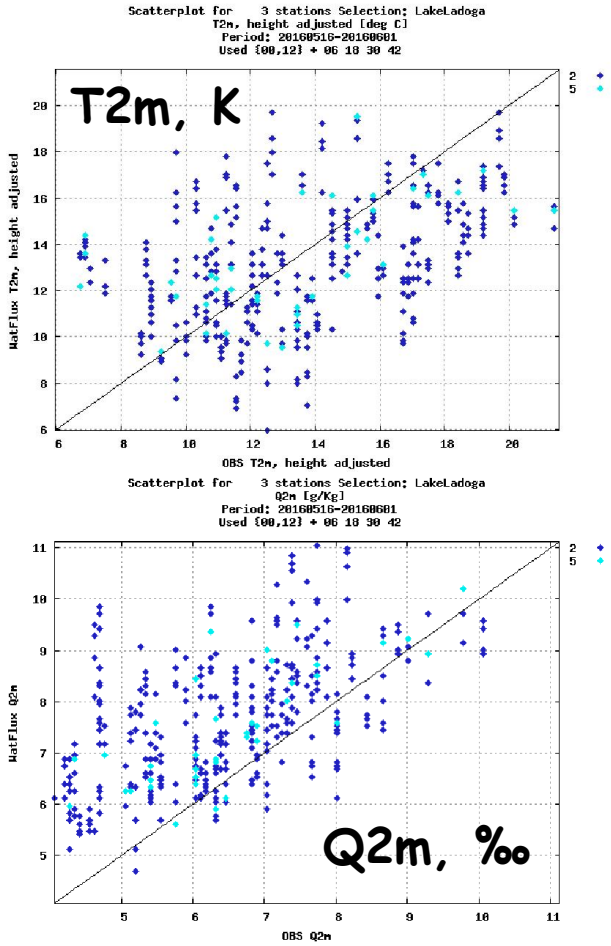
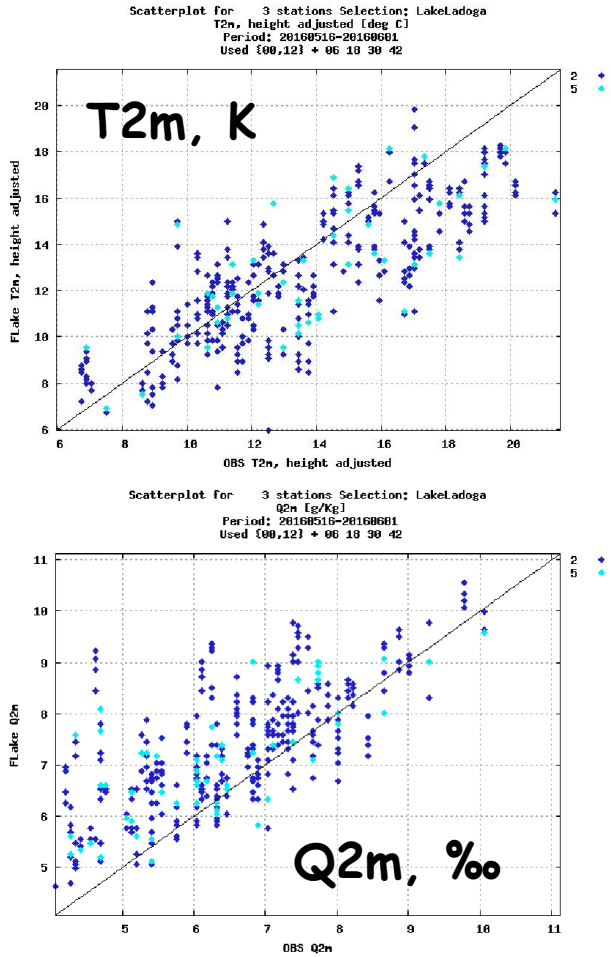
Verification: FLake vs WATFLUX

May 15- June, 1,2016, Ladoga

WATFLUX



FLake



Improvement of T2m and Q2m scores.

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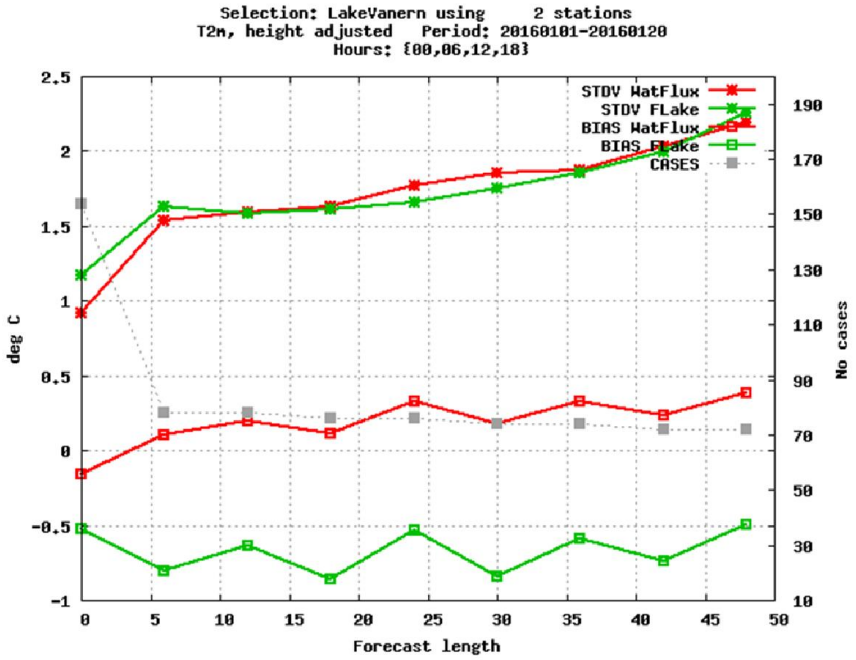
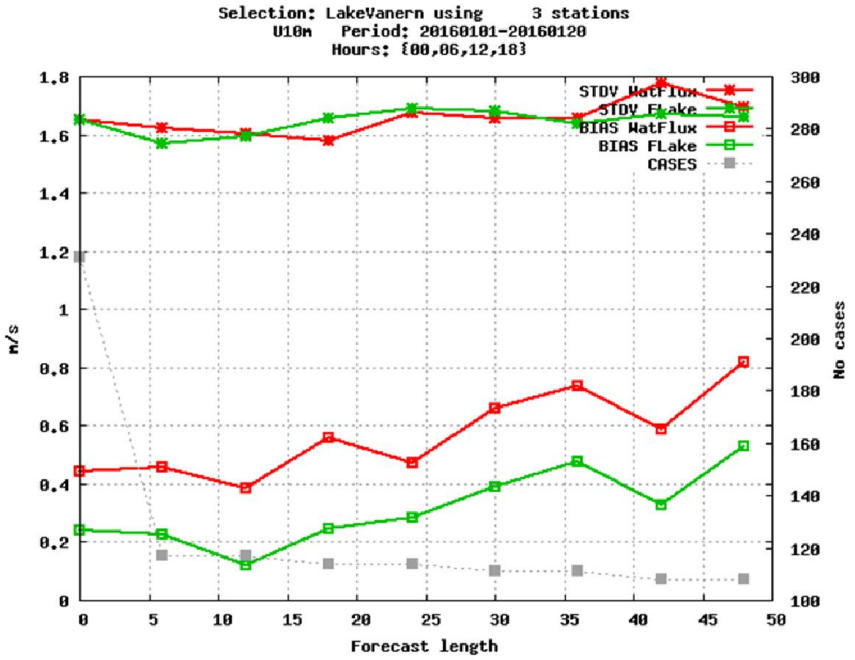
Verification: FLake vs WATFLUX

January, 2016, Vänern, WATFLX vs FLAKE

T 2m bias and STDV, K



U 10m bias and STDV, m/s



Deterioration of T2m scores

Improvement of U10m scores

Main conclusions and findings

- Starting from the climatology in unusually warm situation, FLake performs better in autumn than in spring.
  Too cold spring state in FLake improves in ~ 1.5 months.
- Atmospheric model often "sees" large and medium lakes; Lakes might affect large scale atmospheric motions.
- For verification, lists of "lake stations" are useful.
- Verification scores are very different for different variables (T2m, Q2m and U10), there are examples of improvement and deterioration.
- It is possible to make a general conclusion that parameterization of lakes (based on FLake) allows to improve HARMONIE forecasts.

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Thank you for your attention!

And many thanks for
Laura Rontu and Carl Fortelius
for useful scripts and visualization
tools