HIRLAM LAKE EXPERIENCES

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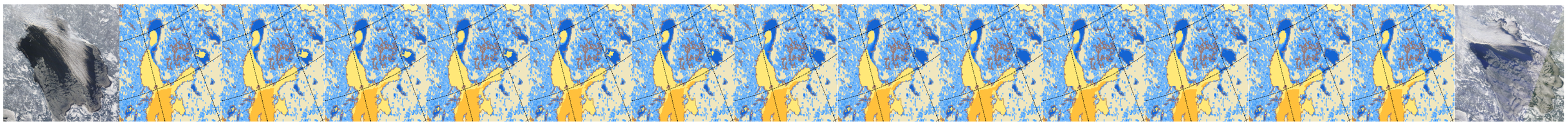
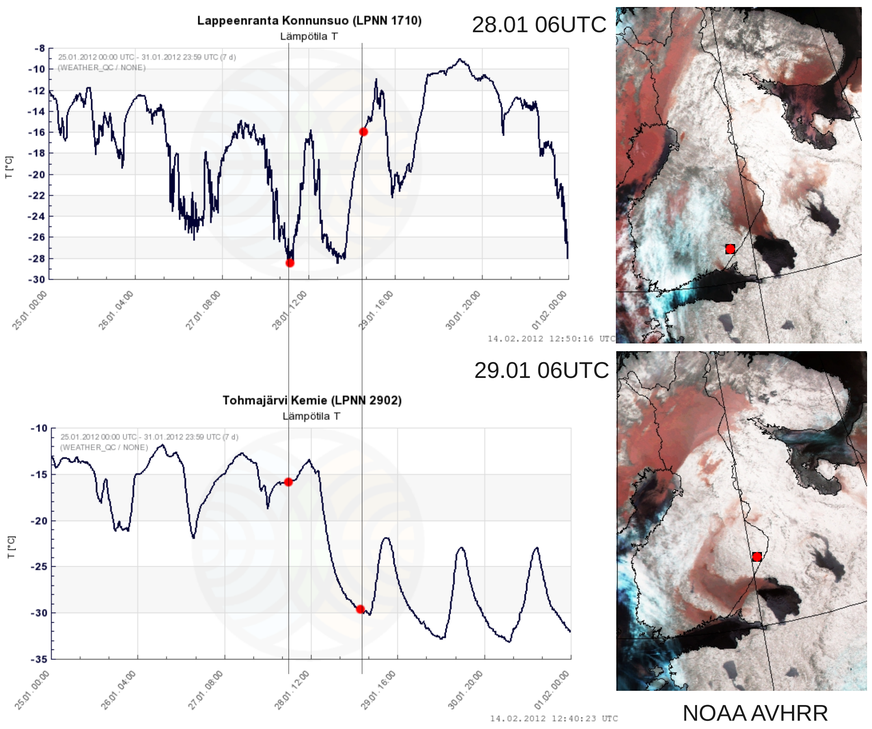
Lake Ladoga freezing

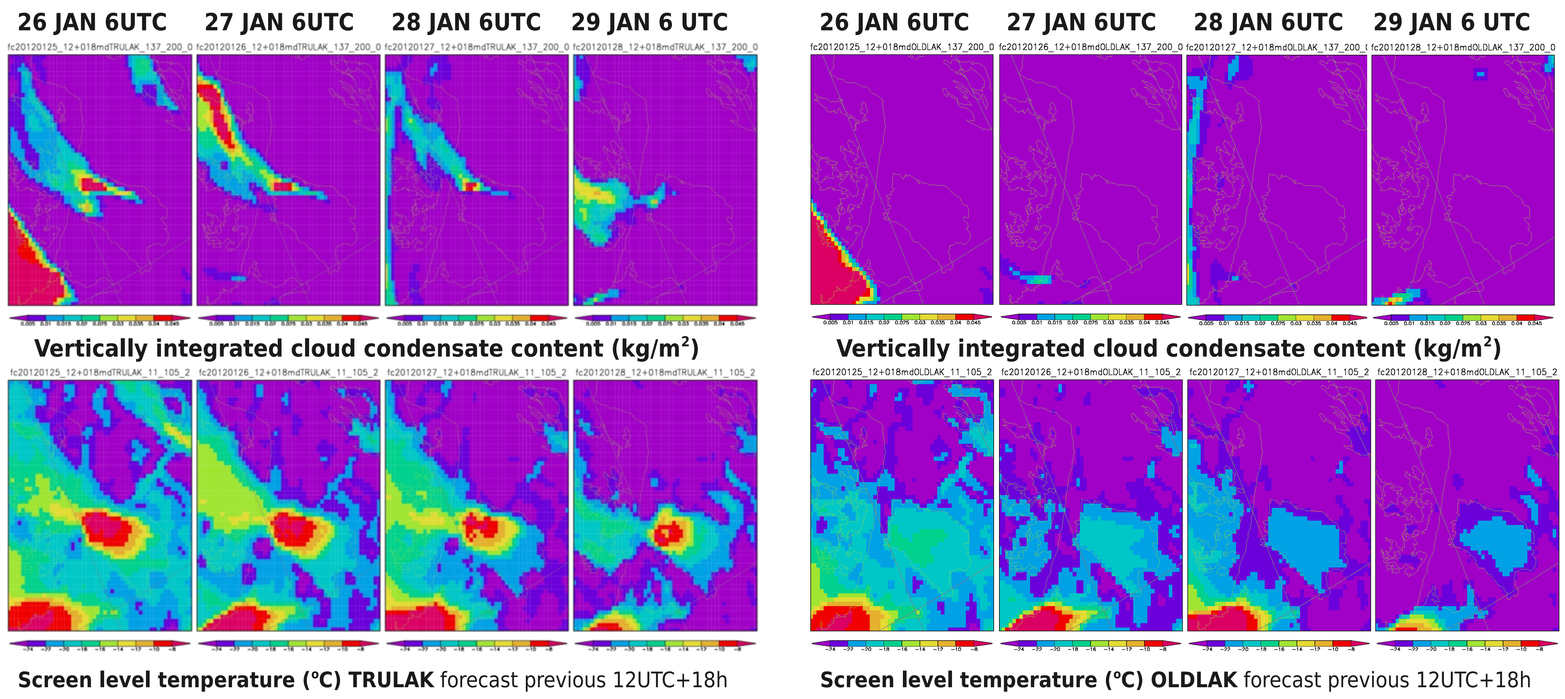


Ice cover growth over freezing Lake Ladoga between 00UTC 26th and 18UTC 29th of January 2012, as diagnosed from FLake in HIRLAM v.7.4 RCR +6hour forecasts four times a day. Corresponding MODIS Terra images are shown in the beginning and in the end.



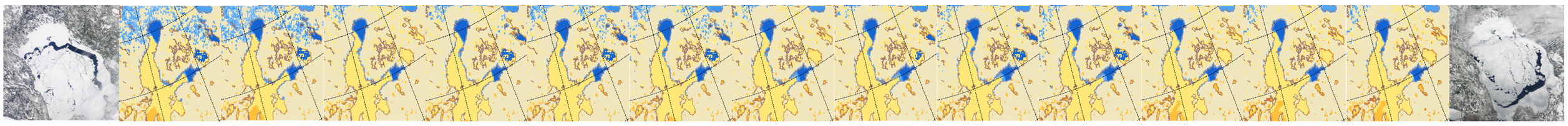
Screen-level temperatures observed at two stations: Konnunsuo (upper left, southern red dot in the satellite image) and Tohmajärvi (lower left, northern red dot) and clouds forming over the northern unfrozen part of Lake Ladoga from NOAA AVHRR (right). The dates of two consequtive mornings of satellite images are marked with vertical lines and red dots into the temperature graphics. The temperatures under clear sky are significantly colder than under the cloud.

The operational HIRLAM 7.4 RCR includes the Freshwater Lake (FLake) thermodynamical model as parametrisations in and over lakes. An example of the end of January, 2012 over the Lake Ladoga shows that the new parametrisations can lead to quite realistic description of the lake surface state in the conditions of freezing. HIRLAM was able to forecast the clouds developing over the unfrozen lake and related temperatures over nearby areas in the Eastern Finland.



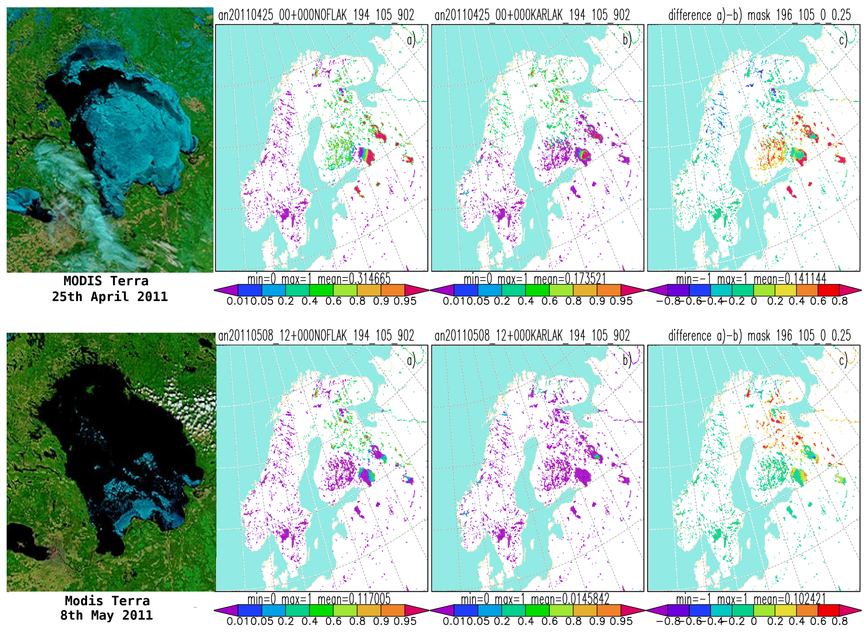
Comparison of two HIRLAM experiments. The setup TRULAK (left) corresponds to the operational HIRLAM v.7.4, containing FLake parametrisations, while OLDLAK (right) utilises only climatological information about the surface state of Lake Ladoga. In TRULAK the northern part of the lake was open, in OLDLAK frozen. Cloud and temperature forecast by TRULAK is close to the observations. Lake Ladoga is in the middle of each figure, end of Gulf of Finland in the lower left corner.

Lake Ladoga melting



Ice cover variations over melting Lake Ladoga between 00 UTC the 10th and 18 UTC the 12th of April 2012, as diagnosed from FLake +6hour forecast four times a day, HIRLAM RCR. Corresponding MODIS Terra images are shown in the beginning and in the end.

HIRLAM RCR started to melt Lake Ladoga quite early in March 2012. Ice cover oscillates unrealistically from day to night and according to changes in the synoptic situation and air temperature. This may be due to the sensitivity of FLake parametrisations to the atmospheric forcing, especially short wave radiation when the ice is thin. Experiments were run during spring 2011 in order to study the possibilities to improve the analysis of lake surface state.

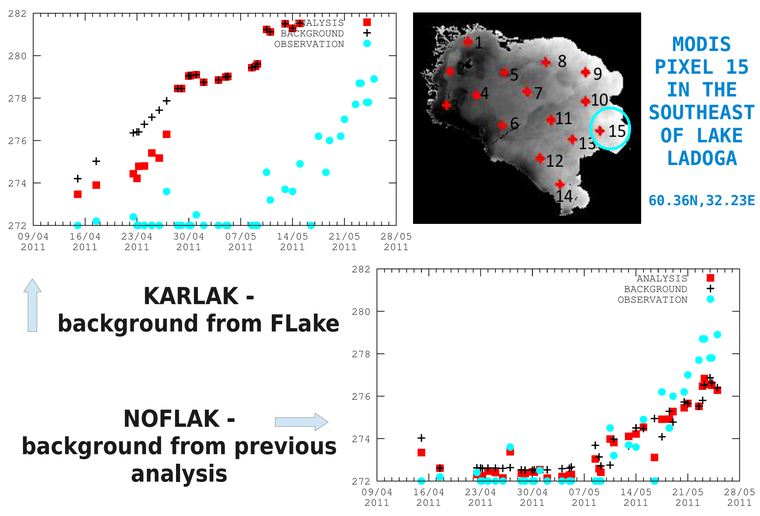


MODIS Terra image over Ladoga (left) and analysis of ice fraction (0...1) from two HIRLAM analyses: a) NOFLAK with first guess from previous analysis, b) KARLAK with background diagnosed from FLake +6h forecast, c) difference. Upper panel: 25th April, lower: 8th May, 2011.

Experiments over Ladoga in April - May 2011

MODIS lake surface temperature observations over Ladoga were introduced to the surface analysis of two HIRLAM experiments between 15th April and 31th May, 2011. Experiment KARLAK applied FLake parametrisations, which produced background for the optimal interpolation analysis. Experiment NOFLAK worked without prognostic lake parametrisations, thus the background for analysis was provided by the previous analysis relaxed to climatological values. FLake considered Ladoga to be unfrozen from the beginning of the experiment. Figures on the right show that the analysis of KARLAK managed to utilize the MODIS observations till the 29th April. After that the difference between background and observation grew too large for the quality control and observations were rejected. In KARLAK, the MODIS observations determined the lake state during the whole period.

Figure on the left shows differences between the experiments also over the other lakes of Scandinavia, where no remote sensing or in-situ observations were available for the analysis. There the difference is due to the difference between FLake and climatological information about lake surface state.



Time series of analysed (red squares), background (black crosses) and observed by MODIS (light blue balls) lake surface temperatures 15th April - 25 May, 2011 from two HIRLAM experiments. Values are shown for the MODIS pixel 15 (map on the upper right). Temperatures below 273.15 indicate frozen conditions.

The description of the lake surface state might be improved by combining in-situ or remote sensing observations with the model background. Over Lake Ladoga, MODIS thermal remote sensing data 2008 - 2011 have been processed for assimilation in NWP models and tried in HIRLAM. The quality of the resulting analysis depends on the availability of observations, quality of the model background and formulations of the optimal interpolation.

Lake prognostic parametrisations provide background for an independent analysis of lake water surface temperature and ice cover in HIRLAM. However, during the forecast the FLake parametrisations - not the analysis - determine the lake surface state. The real assimilation of the observations into the prognostic lake model requires advanced methods, which are currently under development.

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References

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Kheyrollah Pour H., C. Duguay, A. Martynov, L. C. Brown, 2012. Simulation of surface temperature and ice cover of large northern lakes with 1-D models: a comparison with MODIS satellite data and in situ measurements. Tellus A 2012, 64, 17614, DOI: 10.3402/tellusa.v64i0.17614

HIRLAM All-staff Meeting and ALADIN Workshop, Marrakech, 7 - 11 May 2012