Subgrid-scale orography parametrization

Laura Rontu (FMI), Robert Sigg (SMHI)
and Kai Sattler (DMI)

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May 1, 2001

THE LAST HIRLAM

Laura Rontu

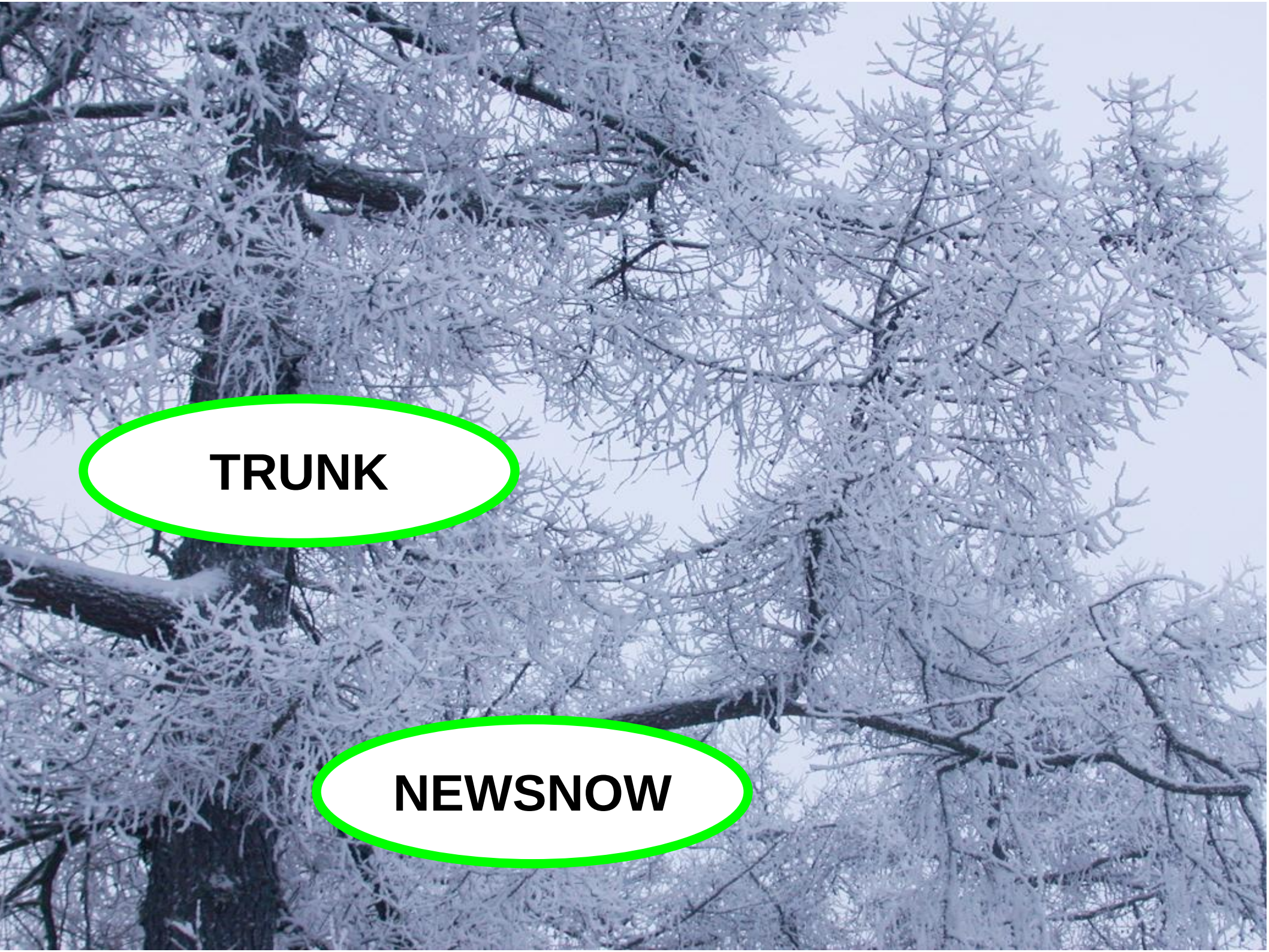
Thanks to
Ekaterina Kurzeneva, Kalle Eerola

Finnish Meteorological Institute

HIRLAM-ALADIN ASM-WORKSHOP
Norrköping 5-8.4.2011


Towards HIRLAM 7.4
Newsnow
Orographic parametrizations
Handling of lakes
Forecasting future of HIRLAM


TRUNK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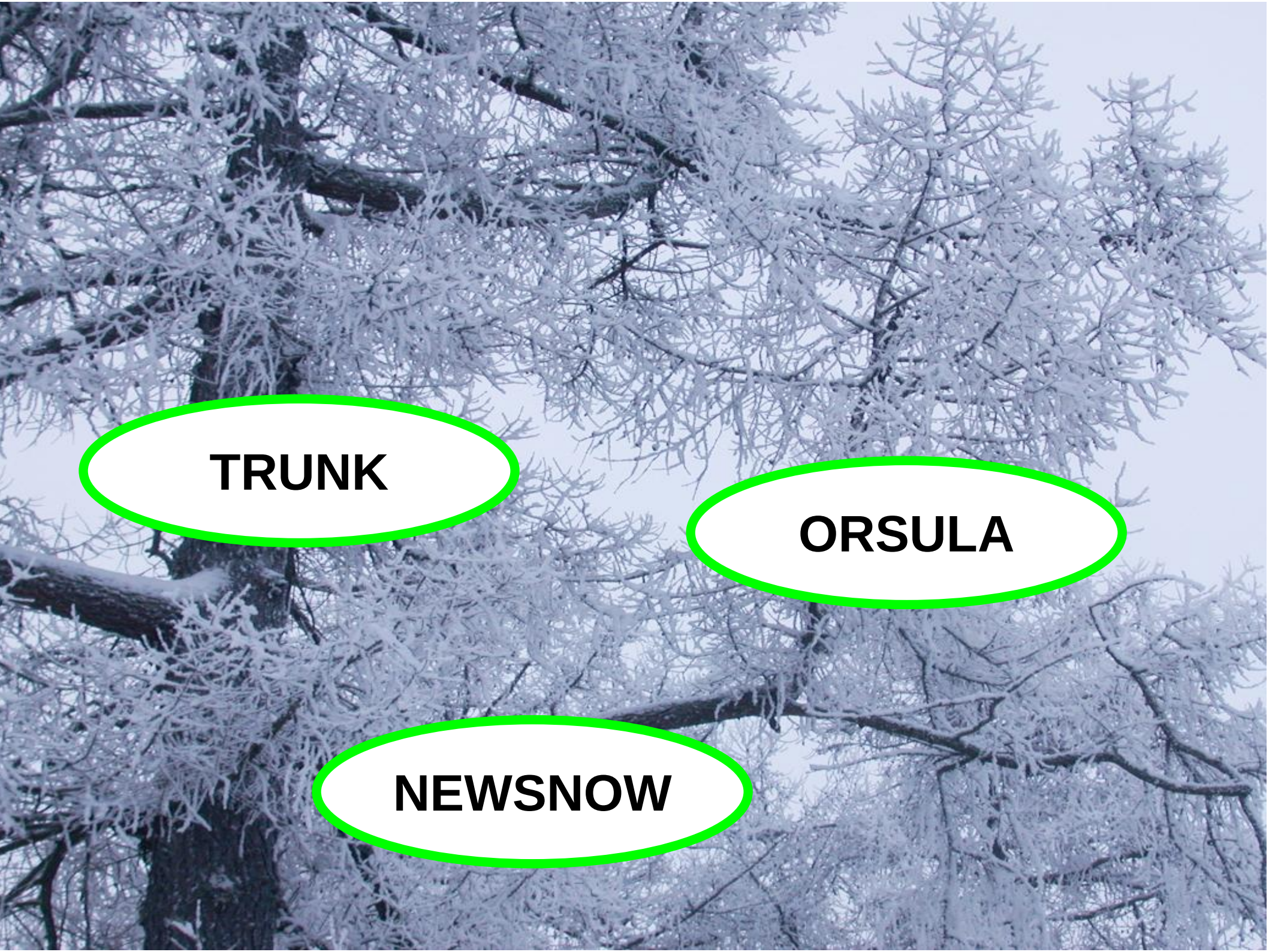
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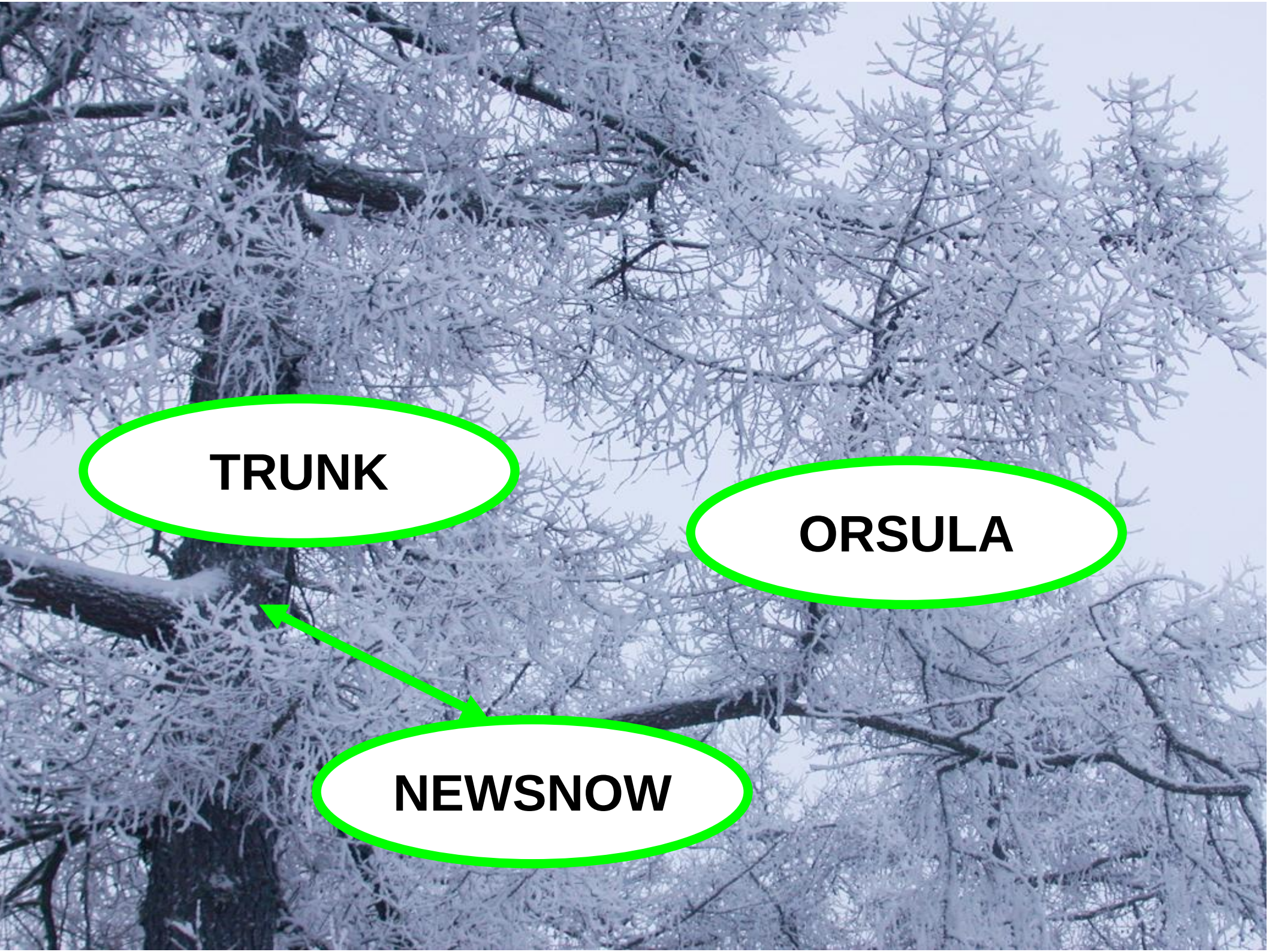
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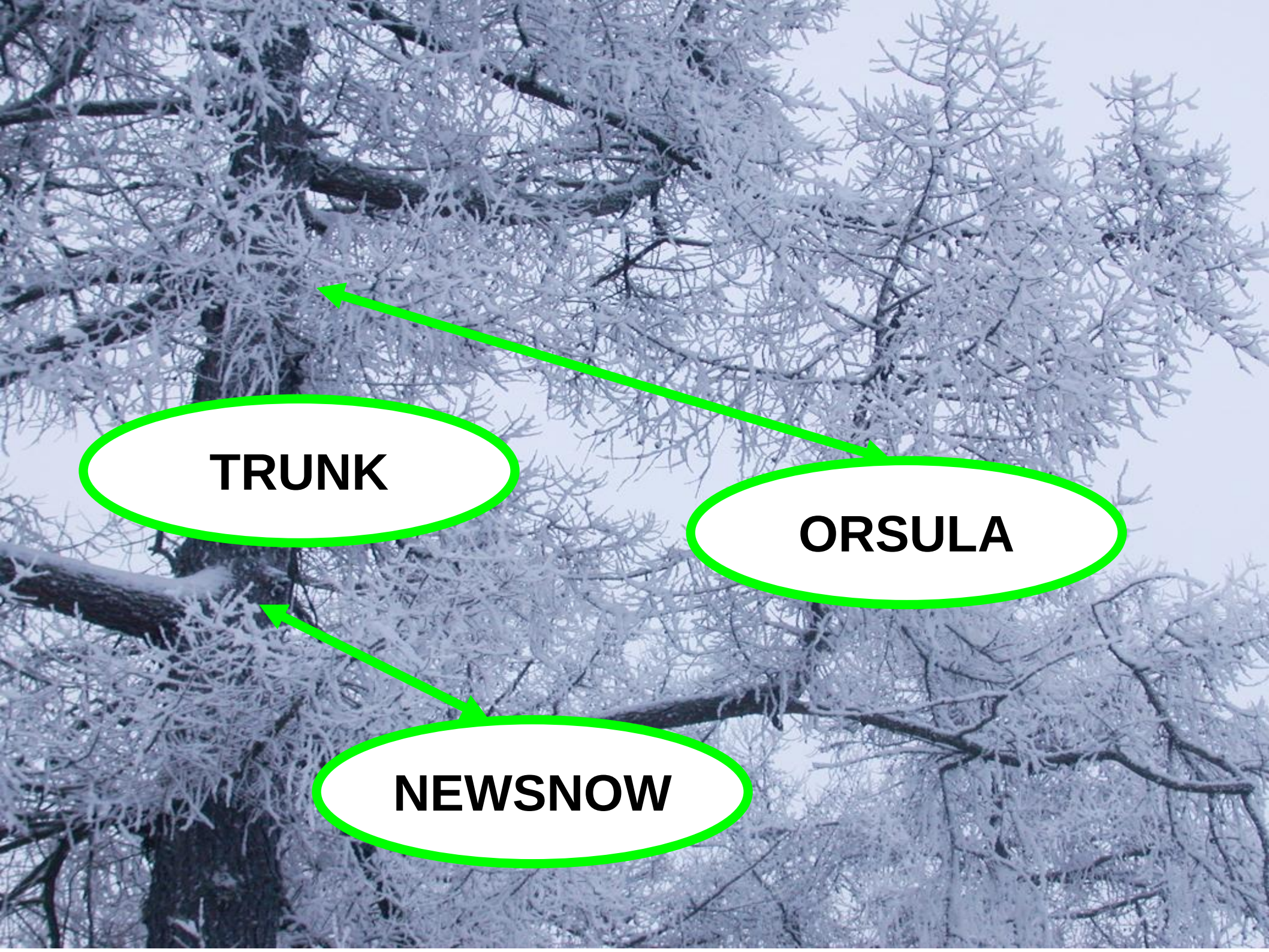
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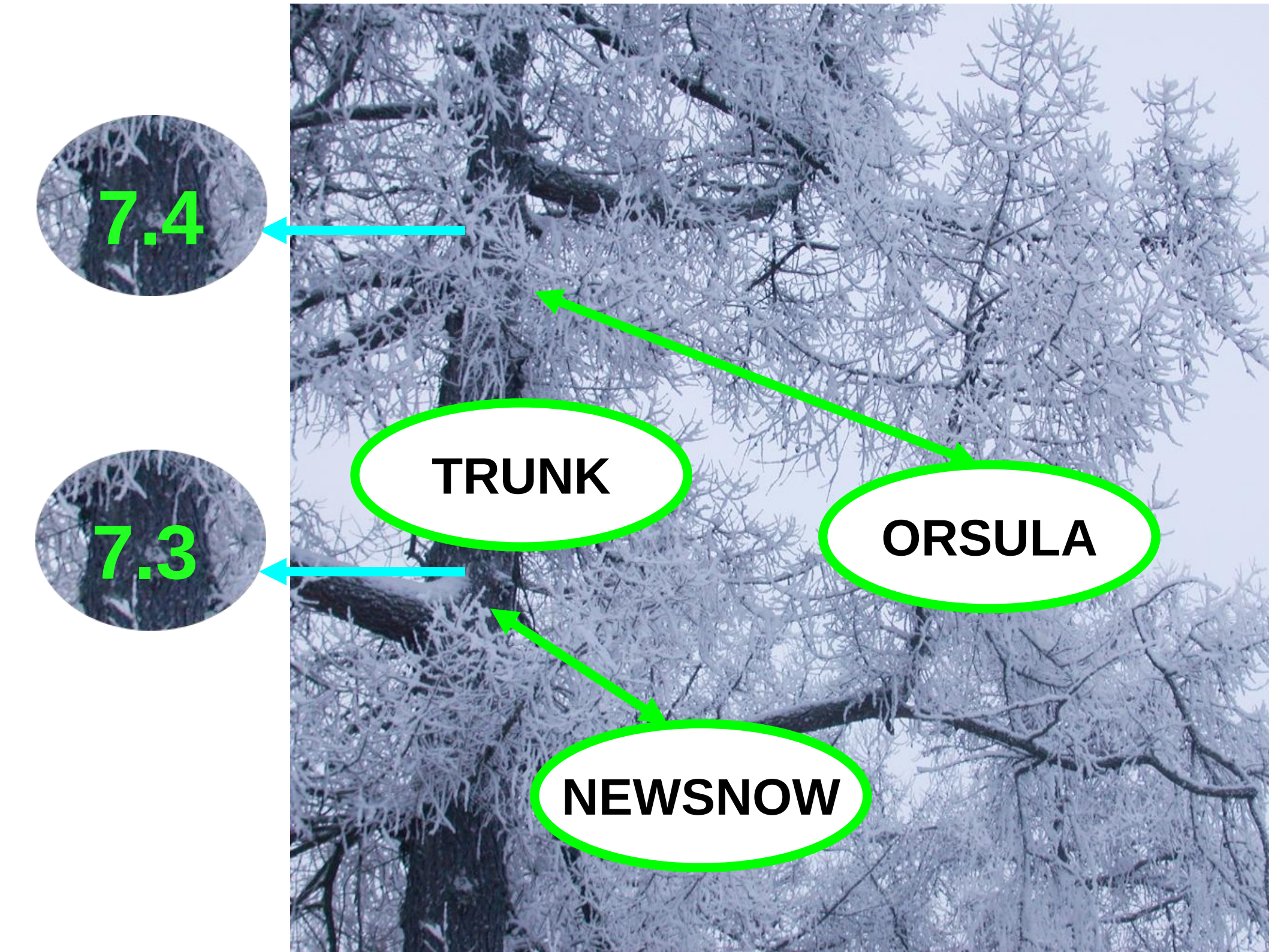
7.4
7.3
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ORSULA
NEWSNOW

Property	HIRLAM 7.3	HIRLAM 7.4	Switchable
Default resolution	0.15/60L operational RCR	0.075/65L	
Newsnow surface scheme	default	default	NO
Mesoscale / small-scale orography parametrisations	default	default	YES
Parametrisation of orographic effects on radiation	available	default	YES
Freshwater lake (FLake) parametrisations	none	available	YES

ASM09 poster/LR:

IN SEARCH OF SOLUTIONS FOR THE HIRLAM SURFACE TEMPERATURE PROBLEMS

Laura Rontu, Finnish Meteorological Institute laura.rontu@fmi.fi

Problems

WINTER TEMPERATURE PROBLEM NORDIC WINTER TEMPERATURE PROBLEM NORDIC WINTER TEMPERATURE PROBLEM NORDIC WINTER TEMPERATURE PROBLEM NORDIC WINT

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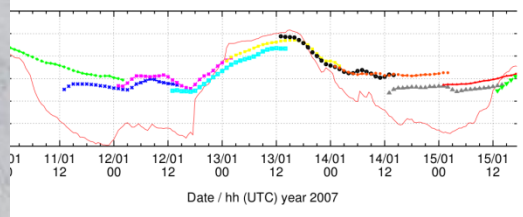

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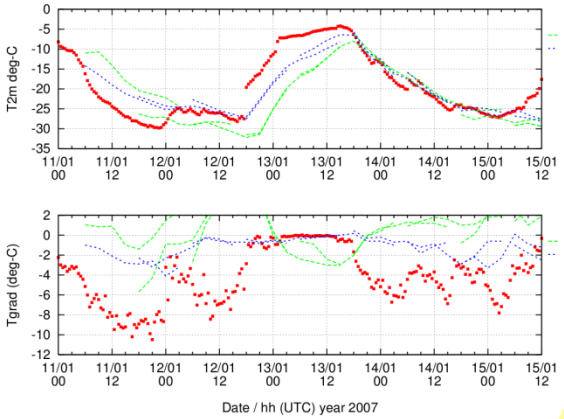
Studies



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Discussions

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- surface layer turbulent flux formulations and related diagnostics of screen-level temperature over different surface types
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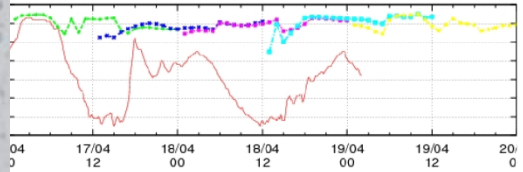

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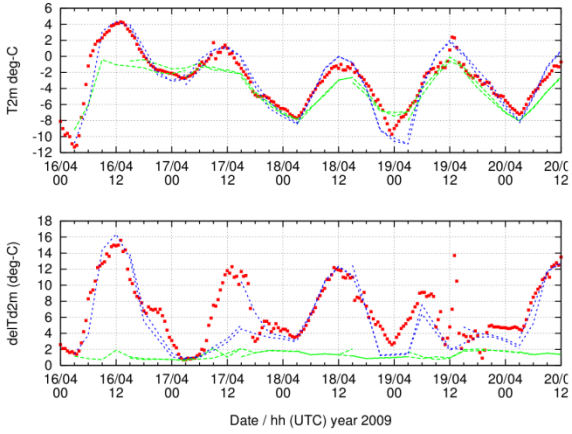

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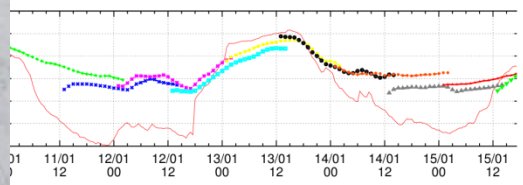

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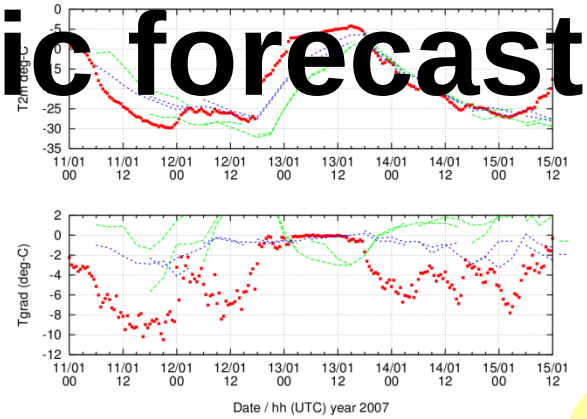

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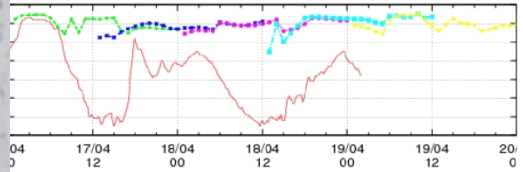

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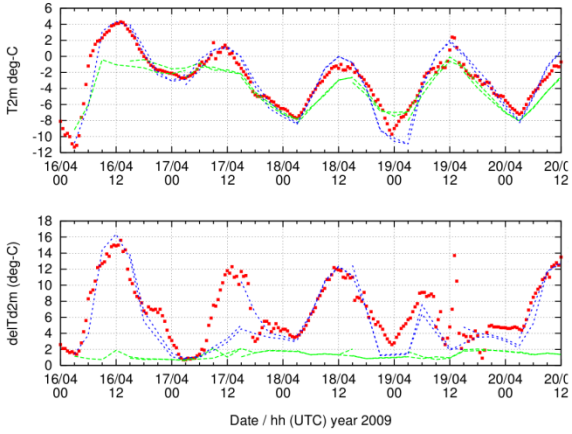

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Newsnow has solved, from the point of view of a synoptic forecaster

- **Nordic temperature problem**
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- **Spring humidity problem**
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- **Ice (glacier) heat flux problem**
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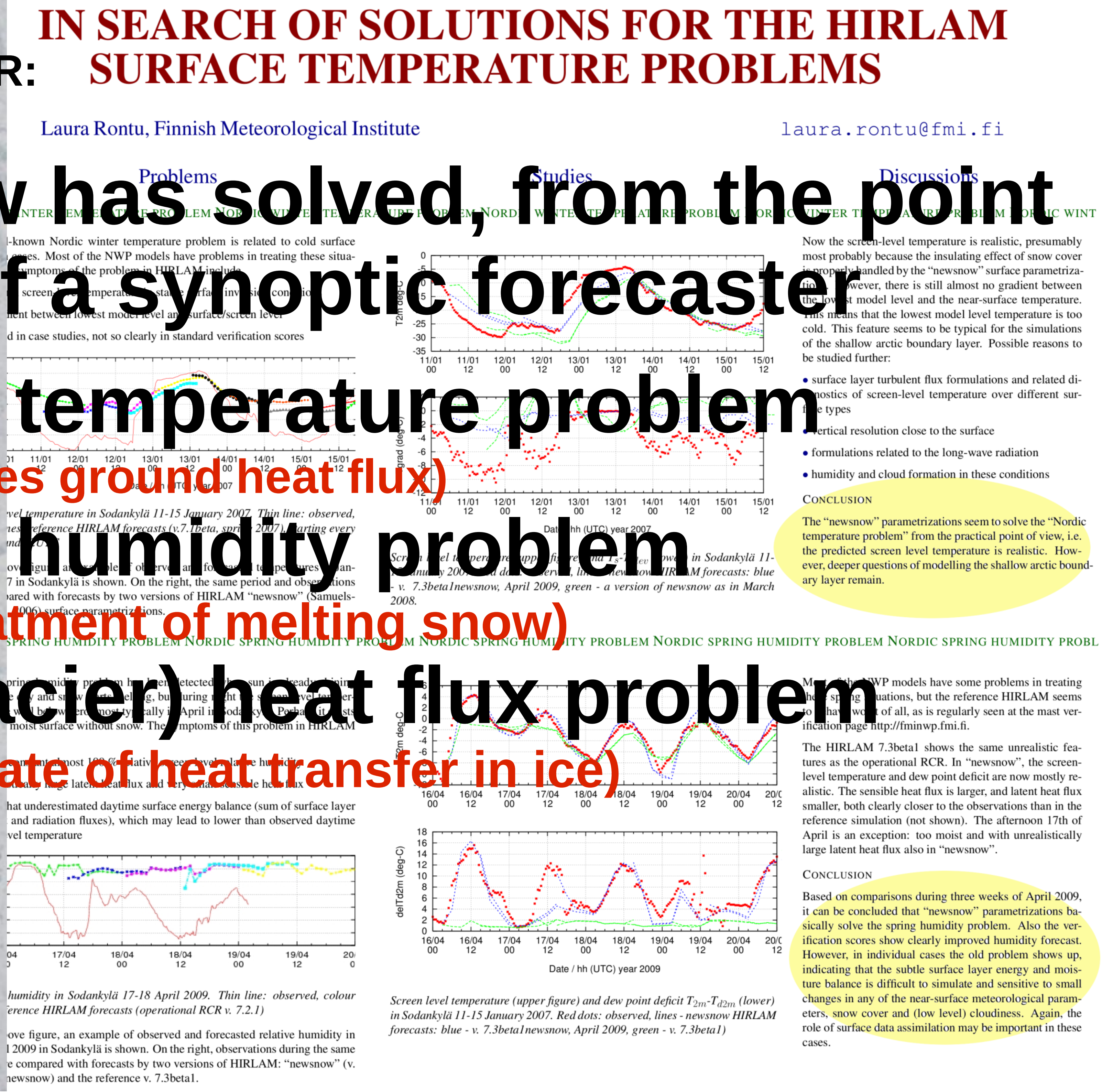

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The role of surface data assimilation: where is snow and ice?

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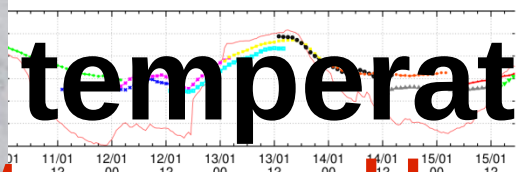

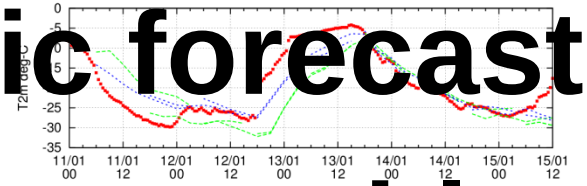

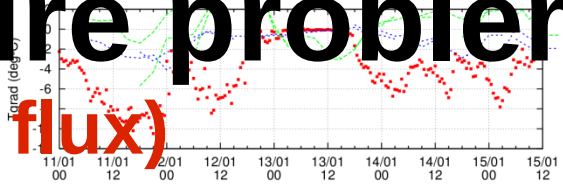

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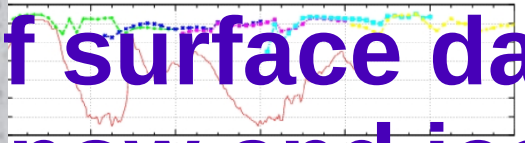

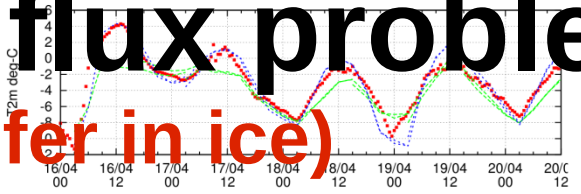

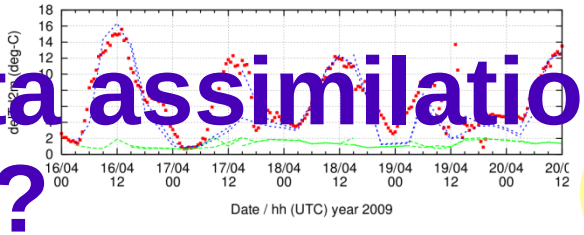

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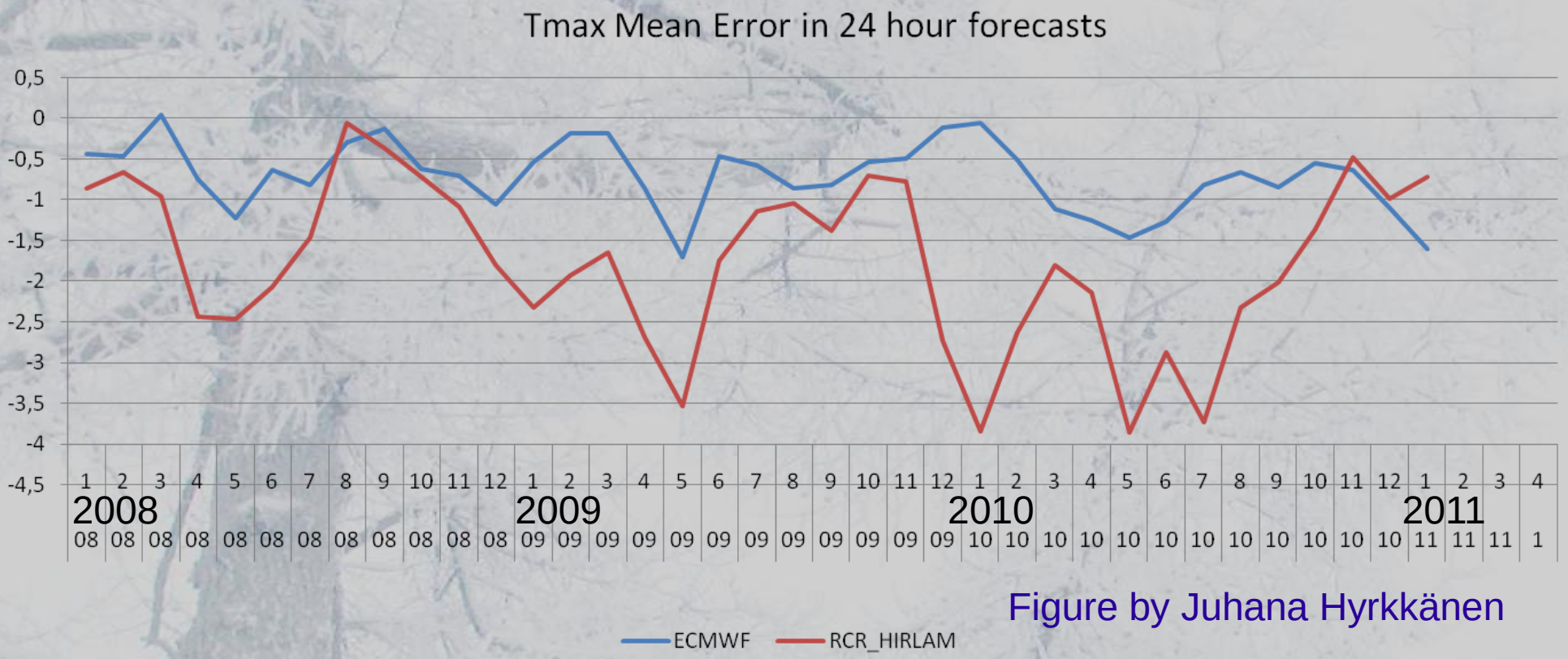


Figure by Juhana Hyrkkänen

A FMI forecaster's comment on the “reborn” HIRLAM:
“Improvement in November 2010 has been significant. Earlier, HIRLAM temperature forecasts have been a kind of joke. Now they are of similar quality, even better than ECMWF, which has experienced certain problems during this winter.”

THANKS AND CONGRATULATIONS TO SMHI RESEARCHERS BEHIND THE NEWSNOW PARAMETRIZATIONS: STEFAN AND PATRICK et al.!

HIRLAM output snow variables

water equivalent of snowpack, grid average

water equivalent of snowpack: ice, open land, forest

water equivalent of snow on canopy

snow depth, grid average

open land snow depth

accumulated total, large-scale, convective snowfall

temperature of snow surface: open land, forest

water in open land, forest snow

snow albedo

snow density

fraction of snow on ice, open land, forest

Experiments

Questions

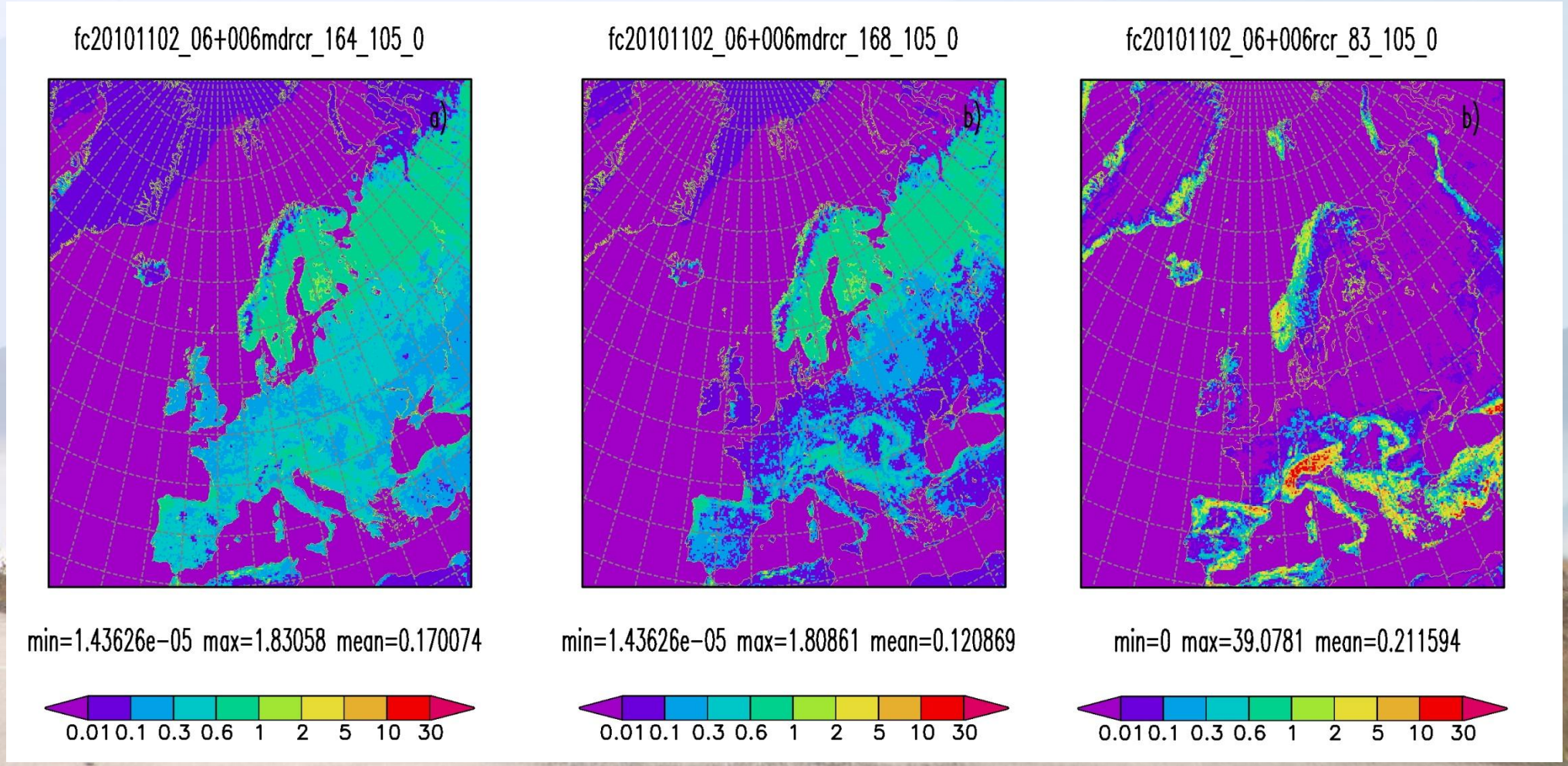
- Is the new MSO scheme technically correctly implemented?
- Does the scheme behave physically correctly?
- In which scales the new parametrization has an effect?
- Are the relations between turbulent and wave drag reasonable?
- How do the modifications influence on the verification results of HIRLAM?
- How sensitive are the results to the representation and filtering of the orography-related variables?

First conclusions

The momentum fluxes from the MSO scheme are one order of magnitude smaller than turbulent fluxes. Within the MSO parametrization flow blocking has the greatest effect. Verification against observations shows yet no improvement compared with the present situation.

ABOUT ROUGHNESS

MOMENTUM VEGETATION – HEAT – OROGRAPHIC



MSO-SSO PARAMETRIZATIONS REPLACE USAGE OF OROGRAPHIC ROUGHNESS

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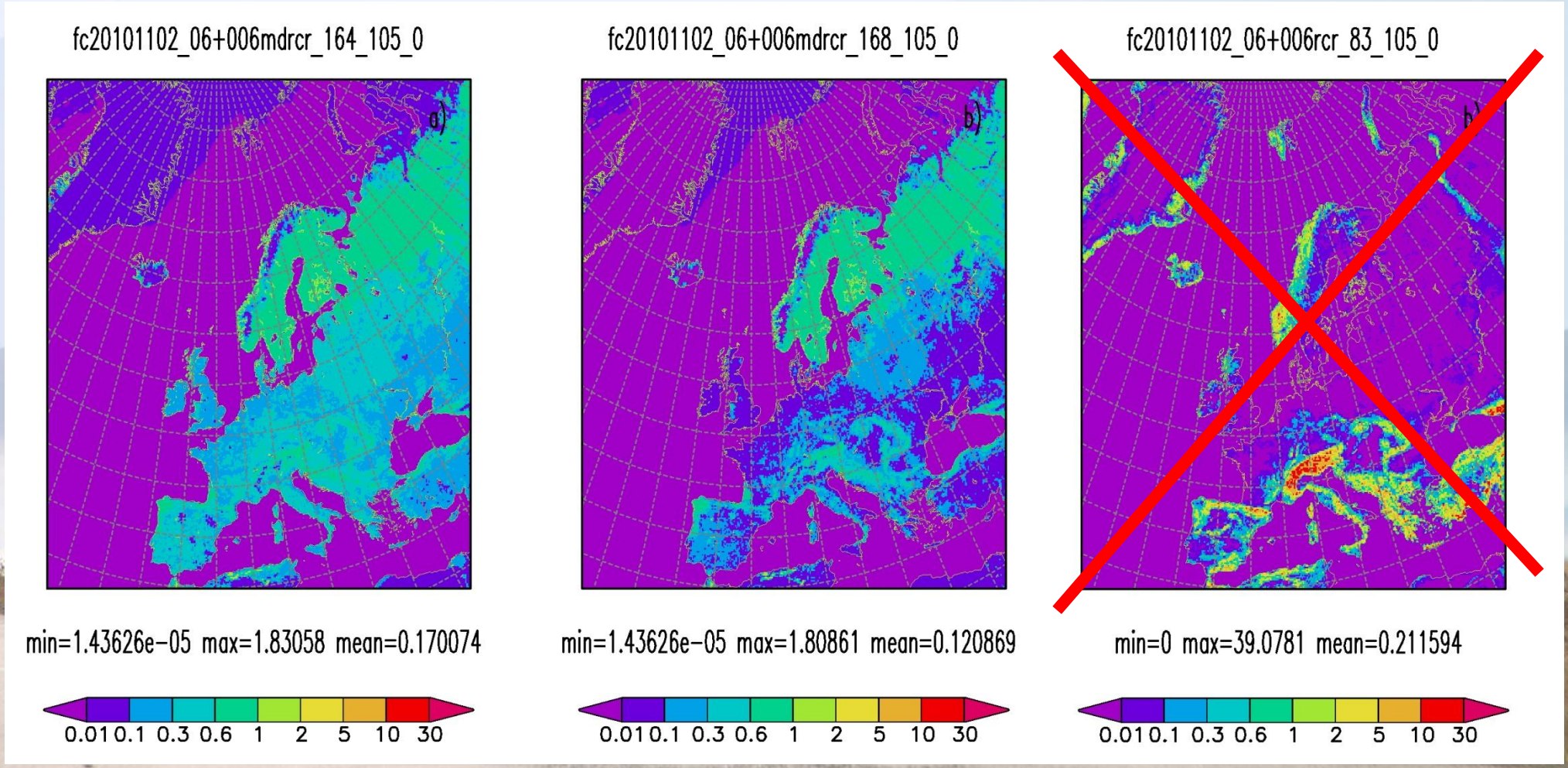

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TELLUS

Parametrization of orographic effects on surface radiation in HIRLAM

By A. V. SENKOVA[1], L. RONTU[2,*] and H. SAVIJÄRVI[3], [1]*Russian State Hydrometeorological University, St.Petersburg, Russia;* [2]*Finnish Meteorological Institute, Helsinki, Finland;* [3]*University of Helsinki, Helsinki, Finland*

(Manuscript received 15 September 2006; in final form 19 February 2007)

ABSTRACT

A parametrization scheme for orographic effects on surface radiation was introduced in the High Resolution Limited Area Model. One-kilometre resolution digital elevation data were used to derive the needed orographic parameters. The scheme is applicable within a model setup of any resolution, but is shown to significantly affect the local near-surface temperatures only when the horizontal resolution is less than a few kilometres. Then, typical maximum local differences due to the new parametrizations are 50–100 W m^{-2} in the net radiation fluxes and 1°–3° in the screen-level temperature. Interactions between clouds and radiation were detected both in the single-column and three-dimensional sensitivity experiments.

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ORORAD TO ENTER PREOPERATIONAL PHASE WITHIN HIRLAM 7.4

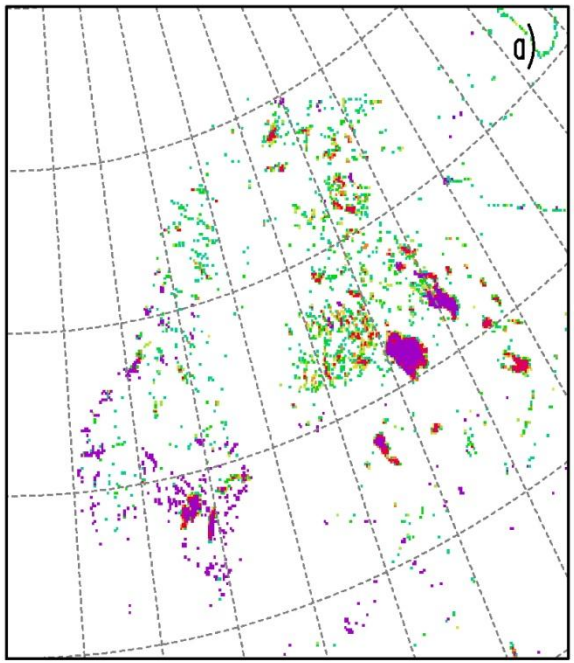
(available in HIRLAM since 2007, to be suggested also to SURFEX)


TERRA MODIS
HIRLAM RCR ANALYSIS

FRACTION OF LAKE ICE 15.12.2009

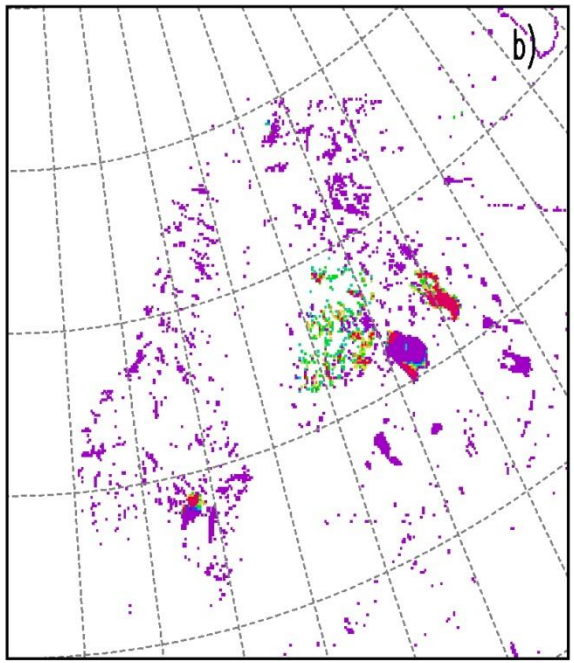
USING FLAKE – 7.4 NO FLAKE – DIFFERENCE

fc20091215_06+006orsyk12_194_105_902



min=0 max=1 mean=0.415457

fc20091215_06+006test74_194_105_902



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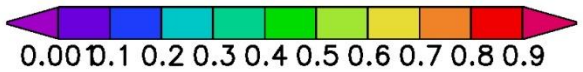
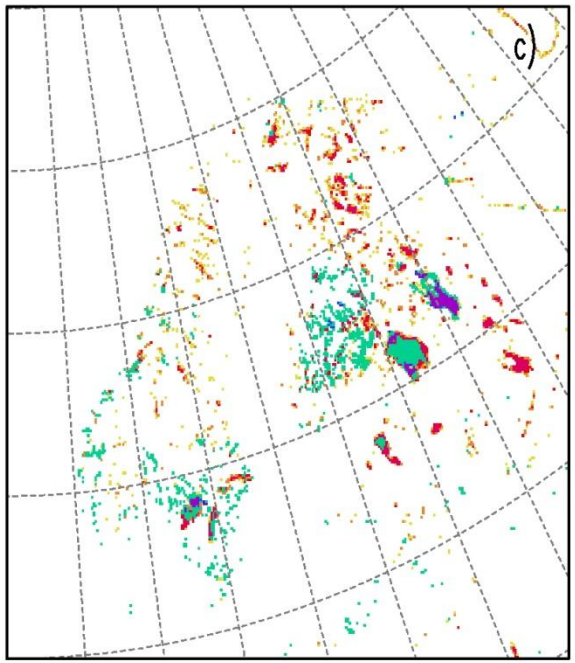


difference a)–b) mask 196_105_0_0.3



min=–1 max=1 mean=0.256761

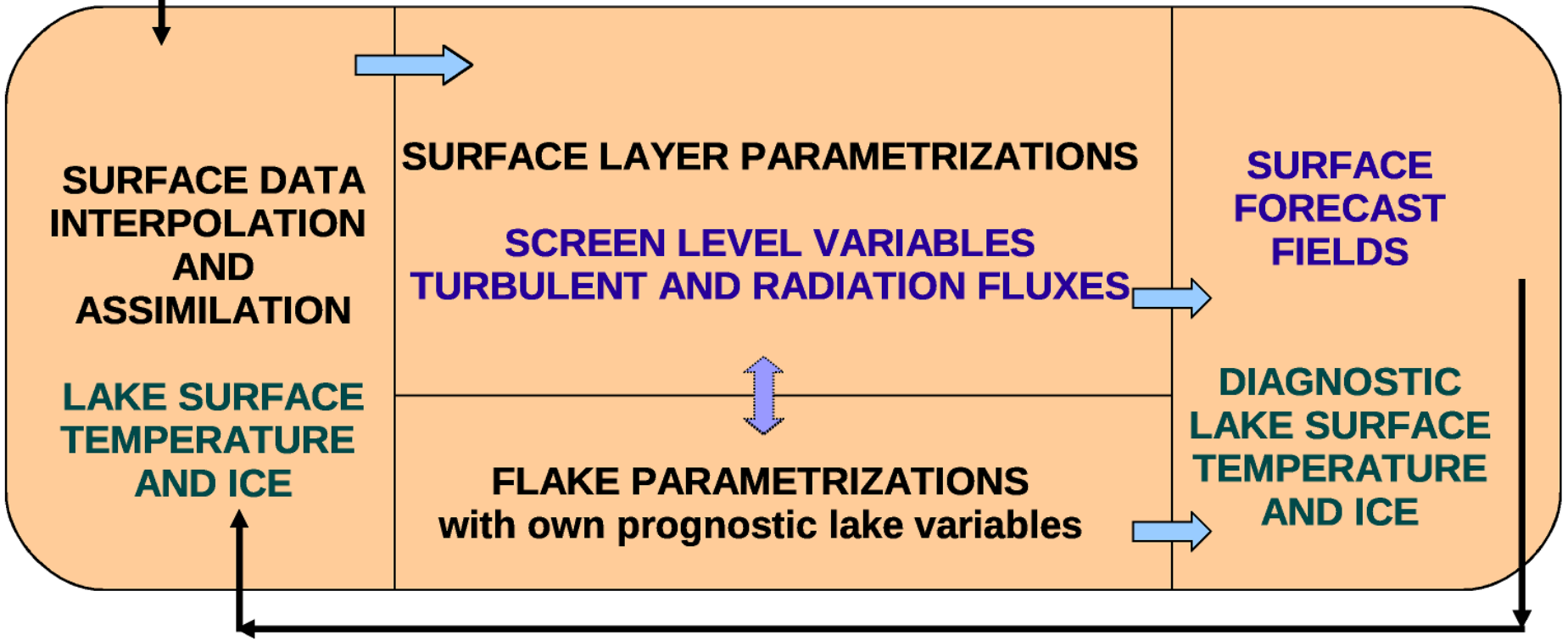
SYKE OBSERVATIONS FROM 27 FINNISH LAKES USED

PEACEFUL COEXISTENCE OF SURFACE DATA ASSIMILATION AND FLAKE

INPUT (OBSERVATIONS)

- ECMWF analysis = climate!
- Finlake climate data
- Baltic sea observations
- Local lake observations

- **FLake provides background for the LST analysis**
- **FLake prognostic lake variables are not influenced by the data assimilation**
- **During the forecast, the HIRLAM surface layer parametrizations see the assimilated SST and ice/water fraction and evolving lowest model level variables**
- **FLake parametrizations know the evolving atmospheric fluxes at each time step**



STATUS OF FLAKE IN OPERATIONAL HIRLAM AND IN SURFEX	Depth and fraction of lakes	Cold start climate data	Data assimilation	Prognostic model
HIRLAM	Implemented in climate generation	Implemented in climate generation	Peaceful coexistence LST, ice	Integrated to ISBA + all over HIRLAM switchable
SURFEX	Stand-alone only	Stand-alone only	Not implemented	Module for water tile


HIRLAM, NWP
MODEL
1.1.1985 -31.12.2015

HIRLAM NWP MODEL 2011-2015

Operational weather forecasting

- HIRLAM 7.4 RCR to be operational in the end of 2011?
- Using HIRLAM 7.4 within operational GLAMEPS

Transfer of experience from HIRLAM to HARMONIE

- Snow + forest and lake/sea ice data assimilation and modelling
- Orography-related parametrizations
- HIRLAM experience on radiation, clouds and convection
- Experience on single-column model and diagnostic tools

HIRLAM NWP MODEL 2011-2015

Research projects and applications

- Development and application of (surface) data assimilation using space-born observations
- Renalysis projects
- Atmospheric forcing for stand-alone SURFEX, HIGHTSI, FLake ...
- Ongoing model intercomparison experiments
- Studies on chemistry and urban effects with Enviro-HIRLAM
- HIRLAM on Mars
- Climate research – RCA model and NWP HIRLAM

REBORN HIRLAM

- towards operational RCR-7.4

in the end of 2011

1. Import the latest small technical corrections

2. Declare 7.4 beta and start systematic testing with the sugggested operational setup (Europe with 0.075/65L)

3. Continue improvement of FLake parametrizations to ensure proper work of peaceful coexistence in all seasons


THANK YOU!