Subgrid-scale orography parametrization

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

laura.rontu@fmi.fi
robert.sigg@smhi.se
ksa@DMI.dk

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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
<table>
<thead>
<tr>
<th>Property</th>
<th>HIRLAM 7.3</th>
<th>HIRLAM 7.4</th>
<th>Switchable</th>
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<tbody>
<tr>
<td>Default resolution</td>
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<td>0.075/65L</td>
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<td>Freshwater lake (FLake) parametrisations</td>
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</table>
IN SEARCH OF SOLUTIONS FOR THE HIRLAM SURFACE TEMPERATURE PROBLEMS

Laura Rontu, Finnish Meteorological Institute

Problems

A known Nordic winter temperature problem is related to cold surface

cases. Most of the NWP models have problems in treating these situa-
tions. Symptoms of the problem in HIRLAM include

- screen-level temperature in stable surface inversion conditions
- almost no, screen-level temperature

and in some cases, not clearly in standard verification scores.

![Graph of temperature over time](image1)

![Graph of temperature over time](image2)

Studies

![Graph of temperature over time](image3)

![Graph of temperature over time](image4)

Discussions

Now the screen-level temperature is realistic, presumably

most probably because the insulating effect of tree snow cover

is properly handled by the "snow" surface parameterizations.

However, there is still almost no, not clearly in the lowest model level and the near-surface temperature.

This means that the lowest model level temperature is too

cold. This feature seems to be typical for the simulations of the shallow arctic boundary layer. Possible reasons to be

studied further:

- surface layer turbulent flux formulations and related dis-
gnostics of screen-level temperature over different surface

- types

- surface layer turbulent flux formulations and related dis-
gnostics of screen-level temperature over different surface

- types

- formulations related to the long-wave radiation

- humidity and cloud formation in these conditions

Conclusion

The "snow" parameterizations seem to solve the "Nordic

temperature problem" from the practical point of view, i.e.,

the predicted screen level temperature is realistic. How-

ever, deeper questions of modeling the shallow arctic

boundary layer remain.

SPRING HUMIDITY PROBLEM

Nordic spring humidity problem

Nordic spring humidity problem

Nordic spring humidity problem

Nordic spring humidity problem

Nordic spring humidity problem

Nordic spring humidity problem

Most of the NWP models have some problems in treating

these situations, but the reference HIRLAM seems to

behave worst of all, as is regularly seen at the mast ver-

ification page http://fmi.weathermatic.

The HIRLAM 7.3b4a shows the same unrealistic fea-

tures as the operational RCR. In "snow", the screen-

level temperature and dew point deficit are not mostly

realistic. The sensible heat flux is larger, and latent heat flux

smaller, both clearly closer to the observations than in the

reference simulation (not shown). The afternoon 17th of

April is an exception: too moist and with unrealistically

large latent heat flux also in "snow".

Conclusion

Based on comparisons during three weeks of April 2009,

it can be concluded that "snow" parameterizations ba-

Pically solve the spring humidity problem. Also the ver-

ification scores show clearly improved humidity forecast.

However, in individual cases the old problem shows up,

indicating that the subtle surface layer energy and mois-

ture balance is difficult to simulate and sensitive to small

changes in any of the near-surface meteorological param-

eters: snow cover and (low level) cloudiness. Again, the

role of surface data assimilation may be important in these

cases.
Newsnow has solved, from the point of view of a synoptic forecaster.
IN SEARCH OF SOLUTIONS FOR THE HIRLAM SURFACE TEMPERATURE PROBLEMS

Laura Rontu, Finnish Meteorological Institute

Problems

- Nordic temperature problem
  (snow insulates ground heat flux)
- Spring humidity problem
  (realistic treatment of melting snow)
- Ice (glacier) heat flux problem
  (better estimate of heat transfer in ice)

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- **Nordic temperature problem** (snow insulates ground heat flux)
- **Spring humidity problem** (realistic treatment of melting snow)
- **Ice (glacier) heat flux problem** (better estimate of heat transfer in ice)

**The role of surface data assimilation:**

where is snow and ice?
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

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fc20101102_06+006mdcr_168_105_0

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MSO-SSO PARAMETRIZATIONS REPLACE USAGE OF OROGRAPHIC ROUGHNESS

MOMENTUM VEGETATION – HEAT – OROGRAPHIC
Parametrization of orographic effects on surface radiation in HIRLAM

By A. V. SENKOVA¹, L. RONTU²,* and H. SAVIJÄRVI³, ¹Russian State Hydrometeorological University, St.Petersburg, Russia; ²Finnish Meteorological Institute, Helsinki, Finland; ³University 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°C–3°C in the screen-level temperature. Interactions between clouds and radiation were detected both in the single-column and three-dimensional sensitivity experiments.
FRACTION OF LAKE ICE 15.12.2009

USING FLAKE – 7.4 NO FLAKE – DIFFERENCE

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

SURFACE DATA INTERPOLATION AND ASSIMILATION
LAKE SURFACE TEMPERATURE AND ICE

SURFACE LAYER PARAMETRIZATIONS
SCREEN LEVEL VARIABLES
TURBULENT AND RADIATION FLUXES

FLAKE PARAMETRIZATIONS
with own prognostic lake variables

SURFACE FORECAST FIELDS
DIAGNOSTIC LAKE SURFACE TEMPERATURE AND ICE
<table>
<thead>
<tr>
<th>STATUS OF FLAKE IN OPERATIONAL HIRLAM AND IN SURFEX</th>
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<tr>
<td><strong>Deepth and fraction of lakes</strong></td>
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<tr>
<td><strong>Cold start climate data</strong></td>
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<table>
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<tr>
<td>Implemented in climate generation</td>
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<tr>
<td>Implemented in climate generation</td>
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<td>Peaceful coexistence LST, ice</td>
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<table>
<thead>
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HIRLAM, NWP MODEL
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 suggested 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!