Near-surface parametrizations in HIRLAM

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Constant in time properties, e.g.

- Surface elevation
- Soil/ground consistence
- Fields given in physiography (climate) files
Surface properties and problems in NWP models

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Slowly varying properties/soil climatology, e.g.
- Leaf area index
- Deep soil temperature
- Fields given in monthly physiography (climate) files
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Analysed properties, e.g.
- Snow depth
- SST ⇒ sea ice cover
- Fields in model analysis and forecast files
Surface properties and problems in NWP models

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- Leaf area index
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- Fields given in monthly physiography (climate) files

Analysed properties, e.g.
- Snow depth
- SST $\Rightarrow$ sea ice cover
- Fields in model analysis and forecast files

Analysed and predicted properties, e.g.
- Snow depth, snow density
- Lake temperature $\Rightarrow$ lake ice cover
- Fields in model analysis and forecast files
Example from Vatjajökull, Iceland
Surface properties and problems
Surface properties and problems

Surface roughness

- Depends of surface type (forest, ice, snow on surface ...)
- Momentum and heat/moisture roughness
- Orographic roughness?
- Stability dependency of roughness and stability functions?
Surface properties and problems

Surface roughness
- Depends of surface type (forest, ice, snow on surface ...)
- Momentum and heat/moisture roughness
- Orographic roughness?
- Stability dependency of roughness and stability functions?

Snow and its influence
- Influences surface/ground heat flux to atmosphere
- Modifies albedo, emissivity, roughness ...
- Snow on ice, snow on trees, permanent snow/ice?
Schemes under development
Schemes under development

Newsnow

- Advanced treatment of soil and surface layer processes especially over snow/ice and in forest
- Based on ISBA, tiled and with heat diffusion in soil
- Samuelsson et al, 2006. The land-surface scheme of the Rossby Centre regional atmospheric climate model (RCA3).

SMHI, Meteorologi 122
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QNSE - Quasi-normal scale elimination

- Advanced theory leading to new stability functions for ISBA and CBR
- Fragmentary implementation in HIRLAM has been removed
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Alternative for turbulence

- Tuning of coefficients related to surface exchange
- Removal of surface turbulent stress turning
- De Bruijn and Tijm, 2008. Overall tuning of the turbulence scheme of HIRLAM with the focus on the stable boundary layer. HIRLAM Newsletter 53
Orographic-related new parametrizations
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MSO/SSO - Meso-scale and small-scale orography effects

- Wave and form drag due to hills and mountains
- (Enhanced) orographic roughness removed everywhere
- MSO based on Meteo France GWD parametrizations

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Orographic effects on radiation

- Radiation on sloping surfaces

January 2007 Sodankylä: HIRLAM reference a year ago

Temperature AWS 2m/Hirlam 2m

Temperature mast 31m/Hirlam 32m

Temperature gradient Ts-Tnlev mast/Hirlam
January 2007 Sodankylä: HIRLAM “newsnow” a year ago

Temperature AWS 2m/Hirlam 2m

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January 2007 Sodankylä: HIRLAM “newsnow” +oro+qnse

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Temperature AWS 2m/Hirlam 2m

Temperature mast 31m/Hirlam 32m

Temperature gradient T2m-Tnlev mast/Hirlam
# HIRLAM “newsnow” experiments

## Table 1: HIRLAM experiment properties

<table>
<thead>
<tr>
<th>HIRLAM versions</th>
<th>Northern domain</th>
<th>East Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>resolution</td>
<td>“newsnow” before Easter 17km/60L</td>
<td>“newsnow” before Easter 11km/60L</td>
</tr>
<tr>
<td>period</td>
<td>January 1-15, 2007</td>
<td>April 1-10, 2006</td>
</tr>
<tr>
<td>domain</td>
<td>North Atlantic-European</td>
<td>Tanzanian</td>
</tr>
<tr>
<td>initial analysis</td>
<td>3DVAR STRACO for condensation</td>
<td>interpolated ECMWF (climate mode)</td>
</tr>
<tr>
<td>parametrizations</td>
<td>ECMWF analysis</td>
<td>STRACO for condensation</td>
</tr>
<tr>
<td>boundaries</td>
<td>HARMONIE tools + Sodankylä</td>
<td>ECMWF analysis</td>
</tr>
<tr>
<td>validation</td>
<td>HARMONIE tools</td>
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</table>

## Table 2: Experiment names

<table>
<thead>
<tr>
<th>MSO/SSO/Radoro</th>
<th>QNSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OROSUR</td>
<td>ON</td>
</tr>
<tr>
<td>NO QNSE</td>
<td>ON</td>
</tr>
<tr>
<td>NO ORO</td>
<td>OFF</td>
</tr>
<tr>
<td>AFRICA</td>
<td>ON</td>
</tr>
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</table>


### Summary of the forecast-observation bias

Table 3:

<table>
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<tr>
<th>Experiment</th>
<th>10m Wind</th>
<th>2m Temperature</th>
<th>sfc. pressure</th>
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<tbody>
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<td></td>
<td>ALL</td>
<td>Mountain</td>
<td>ALL</td>
</tr>
<tr>
<td>OROSUR</td>
<td>0.72</td>
<td>0.12</td>
<td>-0.40</td>
</tr>
<tr>
<td>NO QNSE</td>
<td>0.60</td>
<td>0.02</td>
<td>-1.00</td>
</tr>
<tr>
<td>NO ORO</td>
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### Quick conclusions

- oroparametrizations + QNSE are good for temperatures everywhere
- oroparametrizations + tuned turbulence are good for mountain winds
- tuned turbulence without oroparametrizations are good for winds over the whole domain and for pressure everywhere
- (not shown) no significant differences from 925 hPa upwards
Concluding remarks (from ASM08 presentation)
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Did we learn something from this study?

- Schemes are better for some parameters and domains, worse for others
  - no clear winners
- There is a need to improve, tune, combine different aspects
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It is not easy to improve model by physical parametrizations

- Significant positive-only signals are not so common nowadays
- The amount of possible combinations is increasing - supermarket?
  Optimized code combinations for different usage?
- The best schemes and combinations are those with the least amount of coding errors?
- Methods of code development and implementation require attention
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Things to study and develop further

- Consistent implementation of QNSE functions
  (switchable on/off) and a sensitivity study
- Connections between the surface layer and the whole boundary layer
- Removal of the effective roughness - main influence outside of mountains?
- Behaviour of and parametrization of the (orographic) buoyancy waves in the boundary layer
Thanks to

Stefan Gollvik (SMHI), Jevgeni Atlaskin (RSHU)
Story of QNSE implementation & removal in HIRLAM
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QNSE functions in VCBR turbulence scheme

- Early 1D-3D implementation into (dry) CBR scheme in Sweden, testing by V.Perov et al.
- Implementation into HIRLAM moist CBR within development versions (“trunk” and “newsnow”)
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QNSE functions in the surface layer

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- No QNSE in "trunk" surface layer!
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Step back: remove to allow better configuration and systematic comparison