Near-surface parametrizations in HIRLAM

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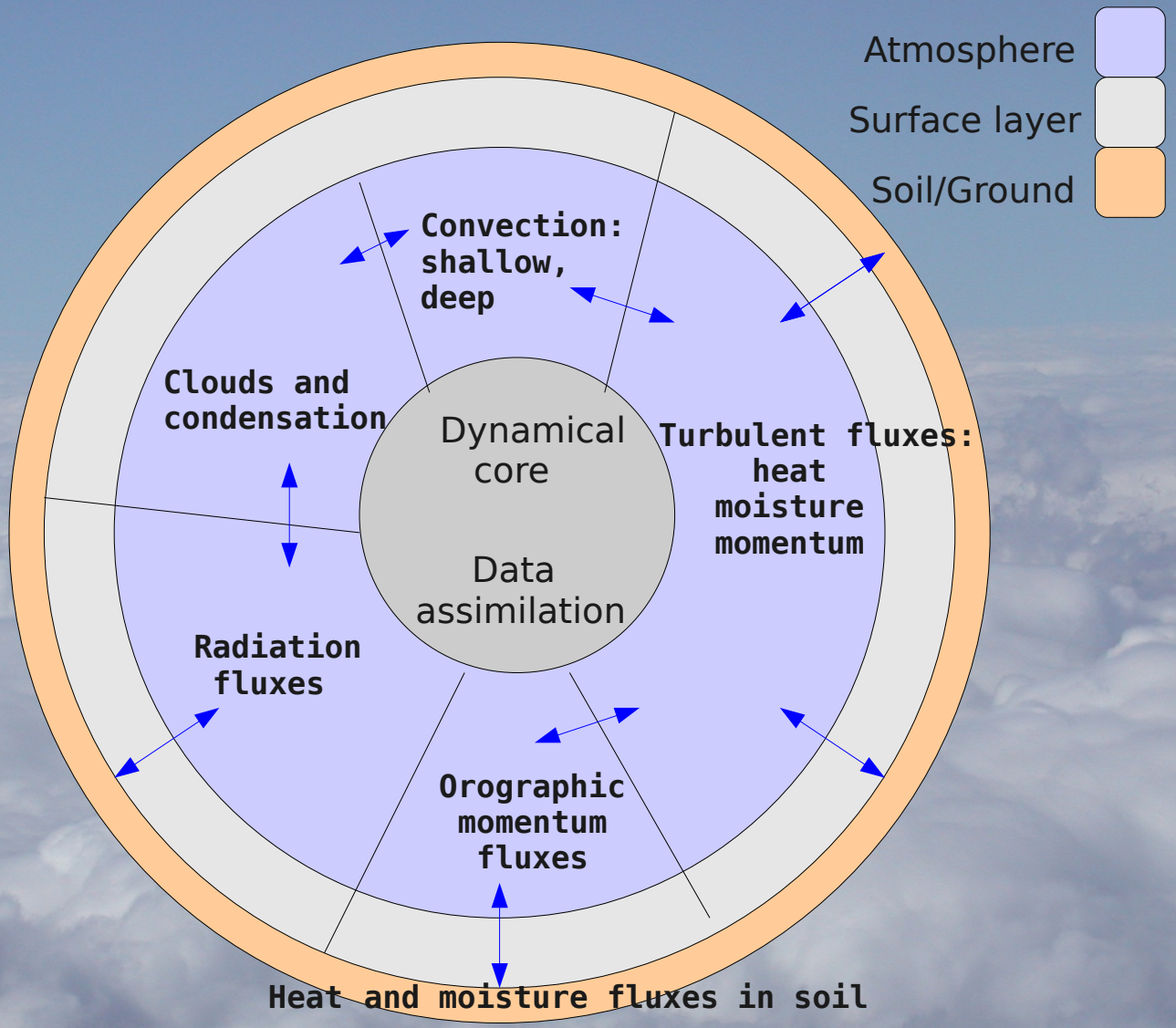
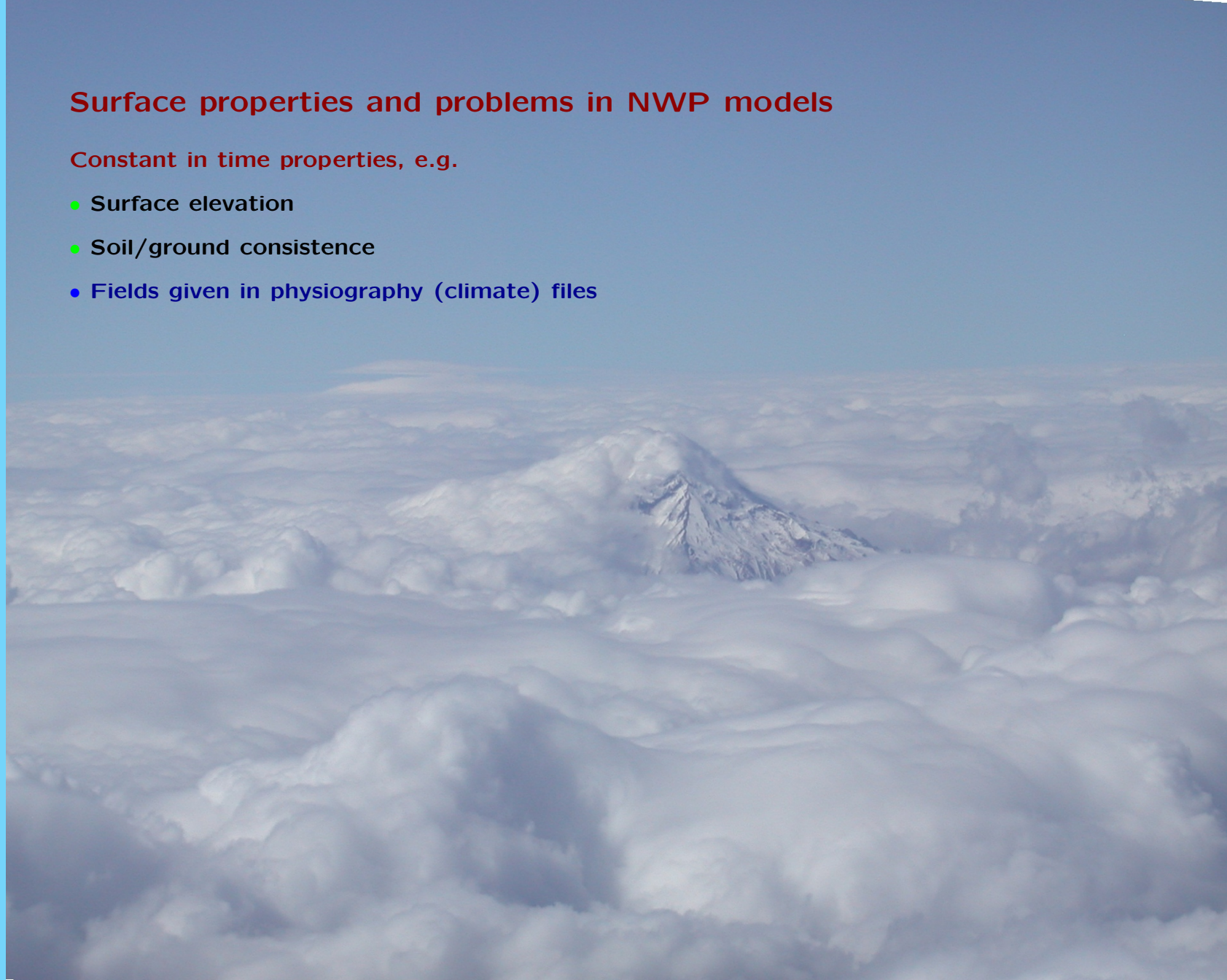

Atmosphere
Surface layer
Soil/Ground
Convection: shallow, deep
Clouds and condensation
Dynamical core
Data assimilation
Turbulent fluxes: heat moisture momentum
Radiation fluxes
Orographic momentum fluxes
Heat and moisture fluxes in soil

Surface properties and problems in NWP models



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Constant in time properties, e.g.

- Surface elevation
- Soil/ground consistence
- Fields given in physiography (climate) files

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- Snow depth
- SST $\Rightarrow$ sea ice cover
- Fields in model analysis and forecast files

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Analysed properties, e.g.

- Snow depth
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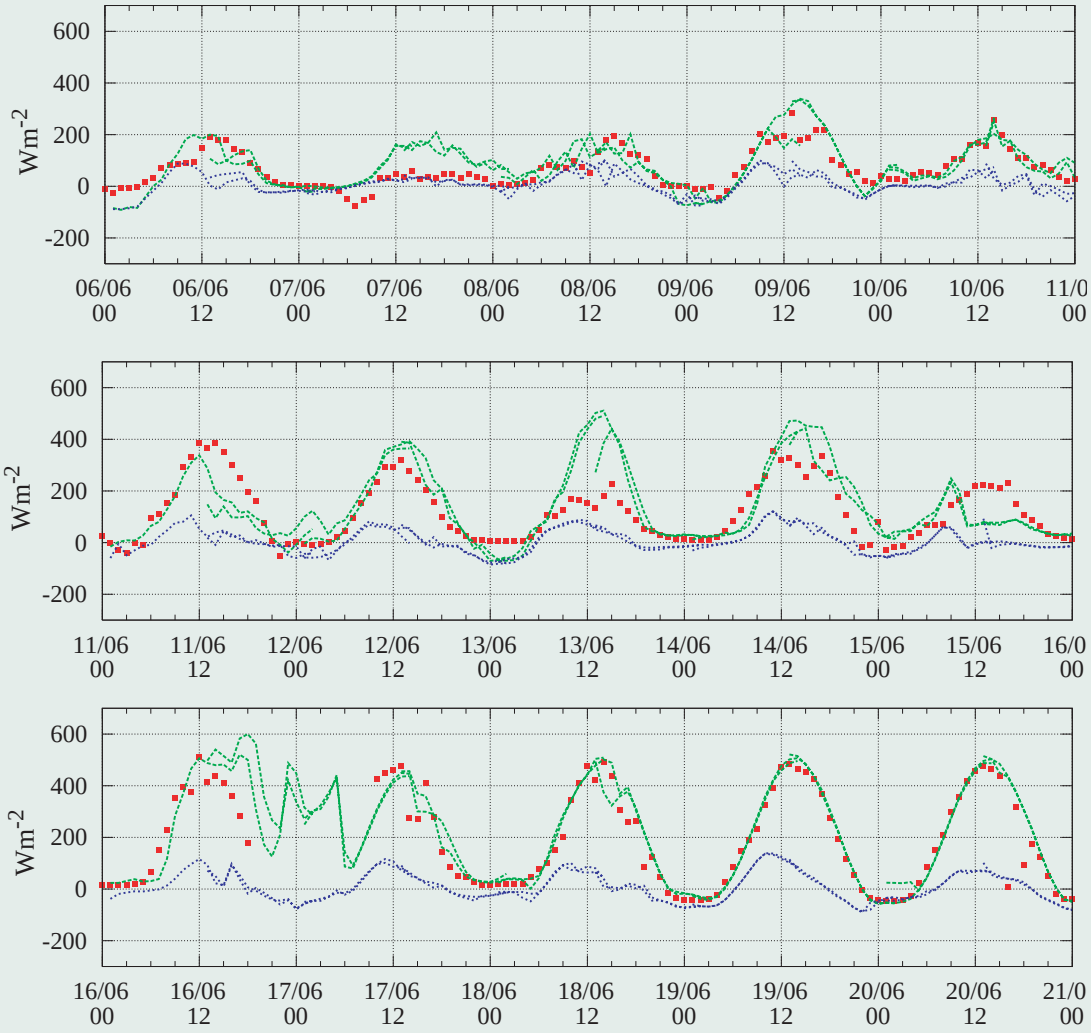
Analysed and predicted properties, e.g.

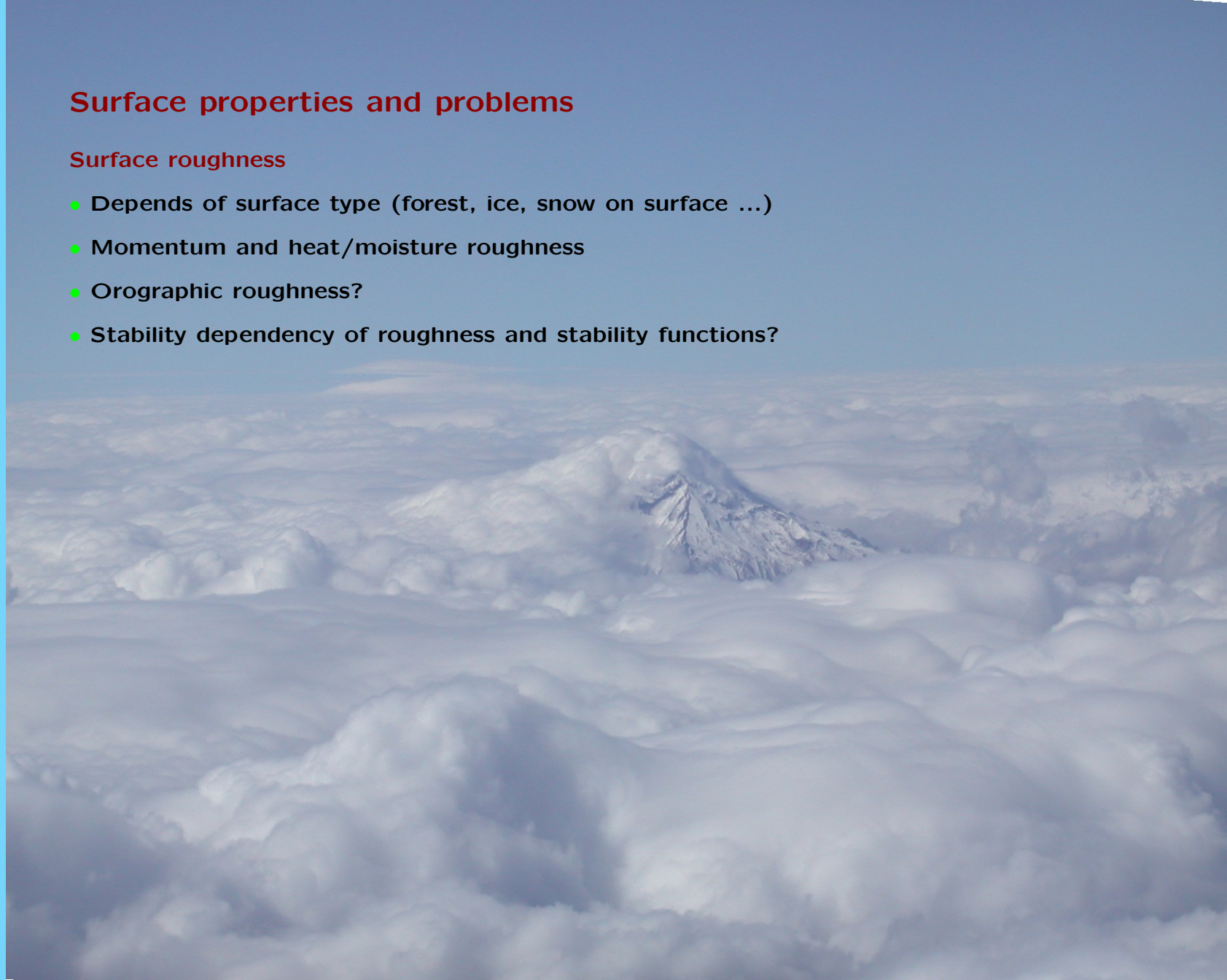
- Snow depth, snow density
- Lake temperature $\Rightarrow$ lake ice cover
- Fields in model analysis and forecast files

Example from Vatjajökull, Iceland



Date / hh (UTC) year 1996

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?

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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

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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
- Sukoriansky et al, 2006. A quasi-normal scale elimination
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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

Orography-related new parametrizations

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MSO/SSO - Meso-scale and small-scale orography effects

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- (Enhanced) orographic roughness removed everywhere
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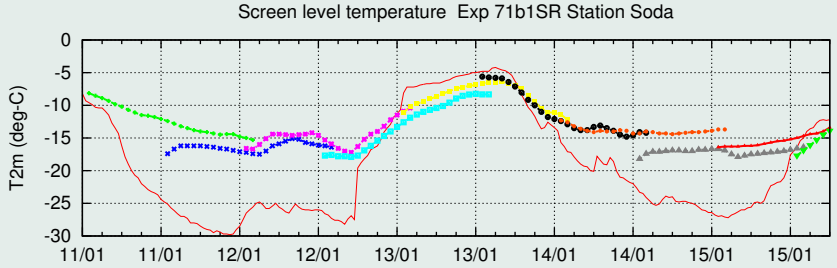
Orographic effects on radiation

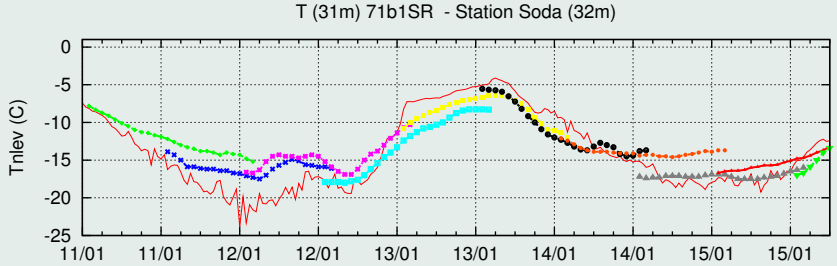
- Radiation on sloping surfaces
- Senkova et al, 2007. Parametrization of orographic effects on surface radiation balance. Tellus, 59A

January 2007 Sodankylä: HIRLAM reference a year ago

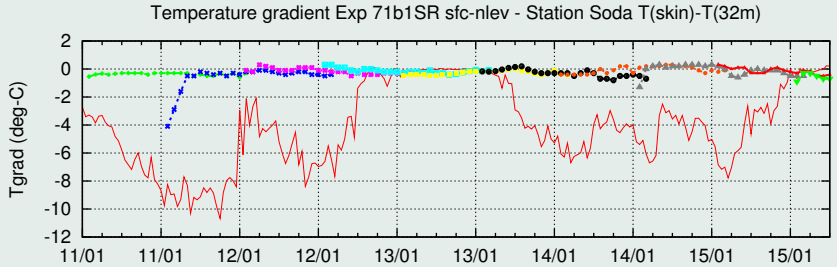
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m

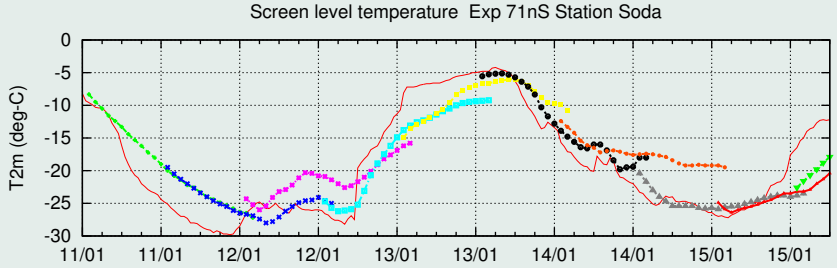


Temperature gradient Ts-Tnlev mast/Hirlam



January 2007 Sodankylä: HIRLAM "newsnow" a year ago

Temperature AWS 2m/Hirlam 2m



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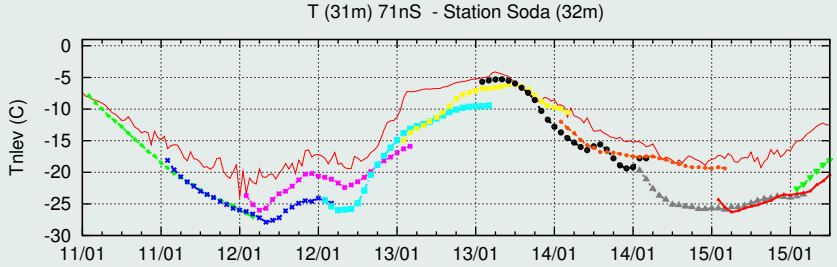

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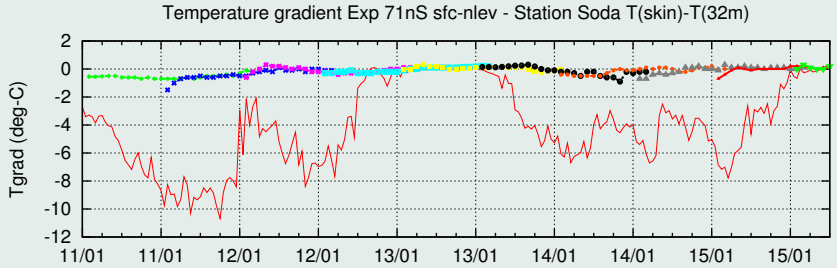

January 2007 Sodankylä: HIRLAM "newsnow"+oro+qnse

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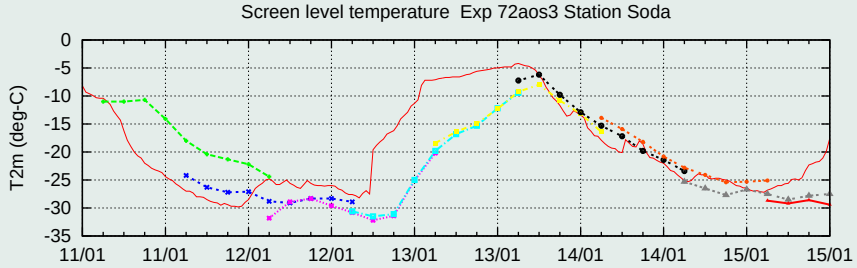

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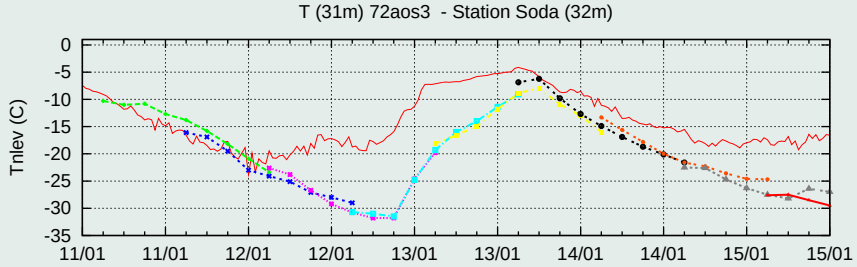

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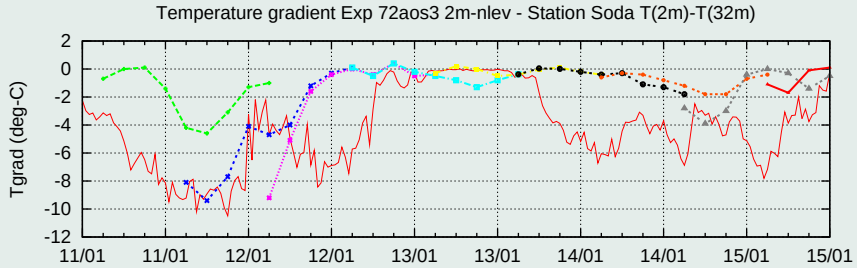

January 2007 Sodankylä: HIRLAM "newsnow" no oro no qnse

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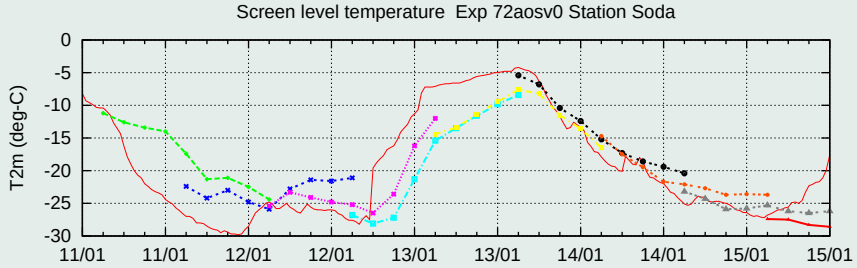

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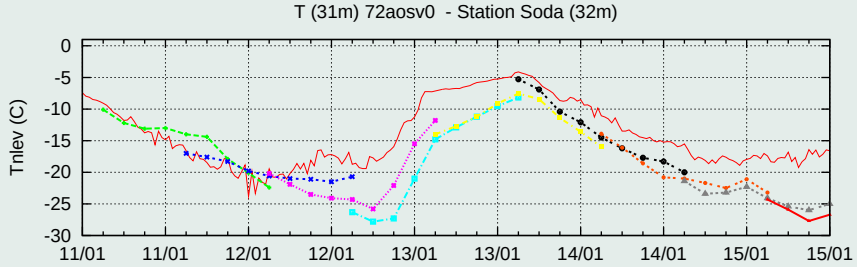

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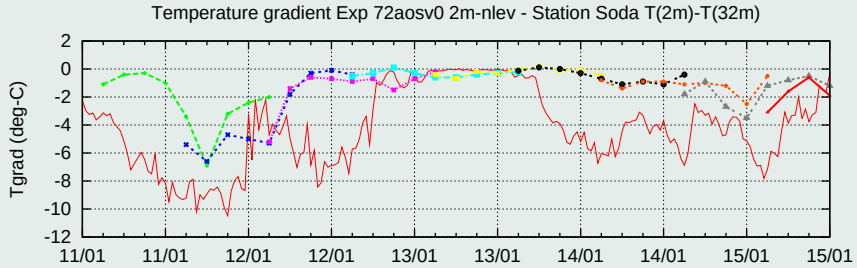

HIRLAM "newsnow" experiments

Table 1: HIRLAM experiment properties

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

Table 2: Experiment names

	MSO/SSO/Radoro	QNSE
OROSUR	**ON**	**ON**
NO QNSE	**ON**	**OFF**
NO ORO	**OFF**	**OFF**
AFRICA	**ON**	**ON**

Summary of the forecast-observation bias

Table 3:

Experiment	10m Wind ALL	10m Wind Mountain	2m Temperature ALL	2m Temperature Mountain	sfc. pressure ALL	sfc. pressure Mountain
OROSUR	0.72	0.12	-0.40	0.11	-0.36	-0.65
NO QNSE	0.60	0.02	-1.00	-0.67	-0.25	-0.40
NO ORO	0.33	-0.83	-1.05	-0.83	-0.22	-0.33

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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 of all these schemes and their implementation

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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 in the HIRLAM-HARMONIE framework

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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.
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Step back: remove to allow better configuration and systematic comparison