

Discussion notes on the seminar "New developments in modelling of boundary layer for numerical weather prediction"

17 June 2008 10.00-14.30

Finnish Meteorological Institute, Sykloni (4A08c)

Notes: LR, 18 June 2008

Tasks of QNSE implementation to HIRLAM

There are three elements of the QNSE parametrizations being implemented in HIRLAM: surface layer stability functions (within the ISBA surface parametrizations), boundary layer stability functions and formulation of the mixing length (both in the TKE-based turbulence parametrizations inside the CBR scheme). Until now, the parametrizations have been systematically tested in the single-column framework using a basic ("dry") CBR formulations. The following tasks are considered important in the short range:

1. Surface layer QNSE formulations are presently applied over open land surface types, not in forest, not over sea. They should be implemented and tested also over these types to understand the sensitivity of the results and possible problems.
2. In the surface layer, only the stable stratification functions are applied. Functions for (weakly) unstable cases could be tried over all surface types.
3. Within the CBR parametrizations, QNSE functions for the moisture conserving variables (liquid water potential temperature and total humidity) should be tried and needed developments made.
4. Sensitivity of the results to the choice of the two separate elements of QNSE - stability functions and length scale - should be studied within the CBR parametrizations in order to understand their relative importance.
5. The behaviour of the QNSE stability functions could be included in a comparison such as reported by Timo Vihma in the present seminar.
6. The updated QNSE code should be carefully tested within the "newsnow" HIRLAM, in single column and full three-dimensional experiments. The model output and diagnostics used for comparison and validation should be well defined before starting the three-

dimensional model experiments. The results should be reported in HIRLAM newsletter/Technical report before implementation in the HIRLAM development version, writing a journal paper is encouraged.

Roughness in HIRLAM

In the present HIRLAM, different and not sufficiently well defined formulations of roughness are applied for the surface flux calculations. The orographic roughness will be soon replaced by meso-scale and small-scale orography parametrizations. Vegetation roughness for momentum and scalars will remain over land and water surfaces. Technically, consistency and correctness of the different roughness formulations within different parts of HIRLAM should be checked. New understanding of the stability-dependency of the momentum roughness, gained in the studies by Zilitinkevich et al., allows modification of the formulations related of the vegetation momentum roughness but also requires tuning of the surface layer stability functions. Stability dependencies of the scalar (heat and moisture) roughness require further study. The concept of displacement height is not considered important for the NWP application.

Introduction and update of the HIRLAM roughness formulations can be considered a short-term task for the FMI/UH team. The modification of the stability functions should be connected with introduction of QNSE formulations to the surface layer parametrizations.

From HIRLAM to HARMONIE

In the discussion, two longer term tasks related to the HARMONIE turbulence and surface-layer parametrizations were raised for inclusion in the common HIRLAM-ALADIN plans:

- Development and application of three-dimensional formulations in the turbulence parametrizations. QNSE approach offers a possibility to handle the transition between horizontal and vertical spectra of the turbulence. In practice, the AROME/MesoNH includes a version of three-dimensional turbulence parametrizations. The semi-lagrangian spectral smoothing, developed and applied in ALADIN, has been reported to bring elements of horizontal diffusion to the model, that should be considered together with the vertical diffusion parametrizations.

- Application of (QNSE-based) turbulence parametrizations together with EDMF-based shallow convection parametrizations.

Due to the lack of time in the seminar, the following two topics were left for further discussion and development:

Implementation of Zilitinkevich et al parametrizations into HIRLAM

- surface layer and the rest of boundary layer - no need for separation?
- definition of free atmosphere variables, PBL height and other input parameters
- formulation of the basic equations
- relation to the QNSE formulations: surface fluxes / turbulence in the free PBL?

Consistency between the orography-related and turbulence parametrizations