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Testing HIRLAM surface and orography parametrizations

Laura Rontu, FMI
laura rontu@fmi.fi

April 3, 2008

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Contribution to evaluation of surface-related parametrizations

- Build a newsnow + orography framework for comparisons
- Try HARMONIE verification tools
- Detect problems and suggest improvements

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Schemes touched in the study

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- Subgrid orography parametrizations
- QNSE stability functions

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Behaviour of the schemes in

- Mountains
- Sodankylä
- (Eastern Africa)

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Related material in Newsletter 53 (Kabelwa et al, Rontu)

“Newsnow” maybe influenced by developments of HIRLAM code

also outside the surface parametrizations

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Schemes and definitions

Schemes and definitions

Newsnow

- Advanced treatment of soil and surface 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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Schemes and definitions

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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
- Rontu, 2006. A study on parametrization of orography-related momentum fluxes in a synoptic-scale NWP model. Tellus, 58A

Orographic effects on radiation

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

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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

QNSE - Quasi-normal scale elimination

- Advanced theory leading to new stability functions for ISBA and CBR
- (HIRLAM implementation is fragmentary)
- Sukoriansky et al, 2006. A quasi-normal scale elimination model of turbulence and its application to stably stratified flows. Nonlinear Processes in Geophysics, 13

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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. Newsletter 53

HIRLAM experiments

Table 1: HIRLAM experiment properties

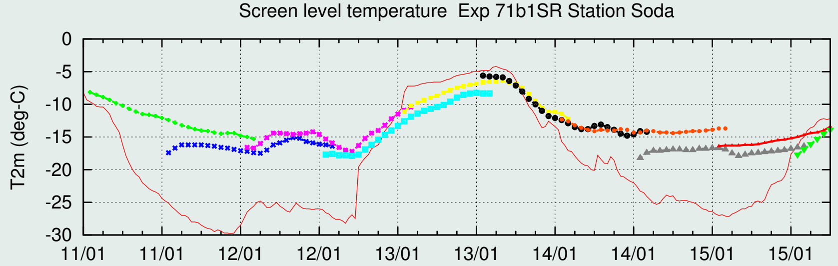
	Northern domain	**East Africa**
HIRLAM versions	"newsnow" before Easter	"newsnow" before Easter
resolution	17km/60L	11km/60L
period	January 1-15, 2007	April 1-10, 2006
domain	North Atlantic-European	Tanzanian
initial analysis	3DVAR	interpolated ECMWF (climate mode)
parametrizations	STRACO for condensation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

Table 2: Experiment names

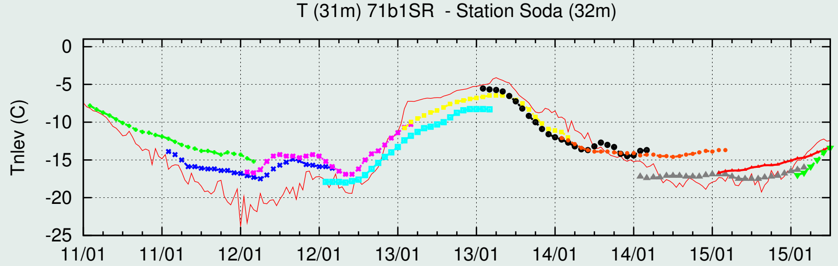
	MSO/SSO/Radoro	QNSE
72aos3	**ON**	**ON**
72aosv	**ON**	**OFF**
72aosv0	**OFF**	**OFF**
72T11r	**ON**	**ON**

January 2007 Sodankylä: HIRLAM reference a year ago

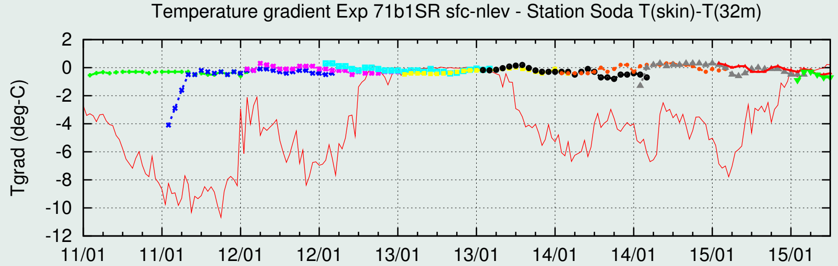
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m



Temperature gradient Ts-Tnlev mast/Hirlam



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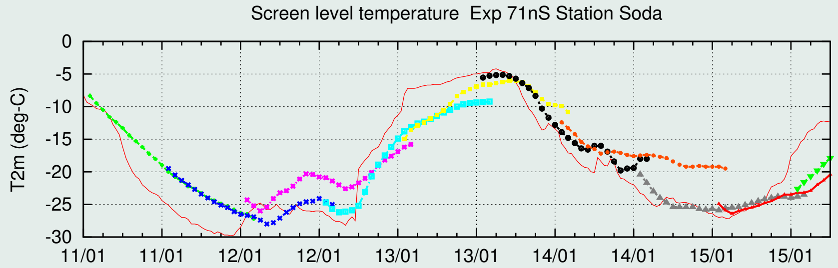
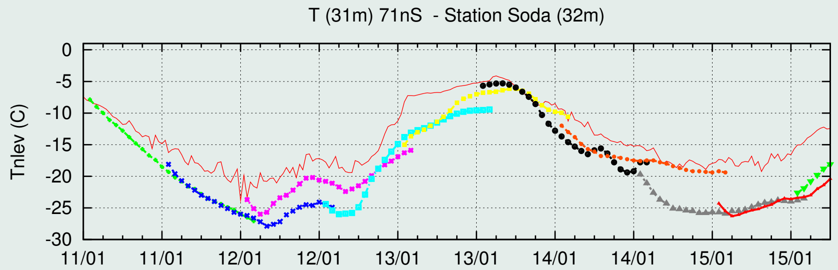
January 2007 Sodankylä: HIRLAM “newsnow” a year ago

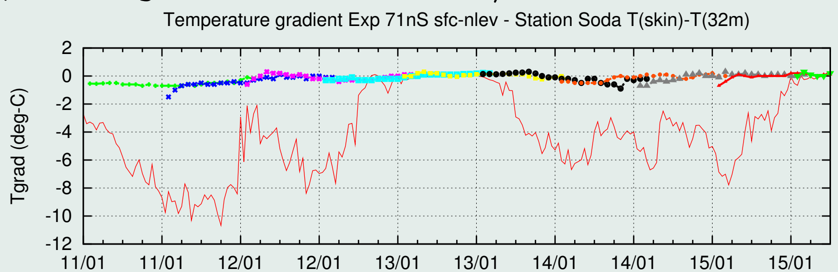
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m

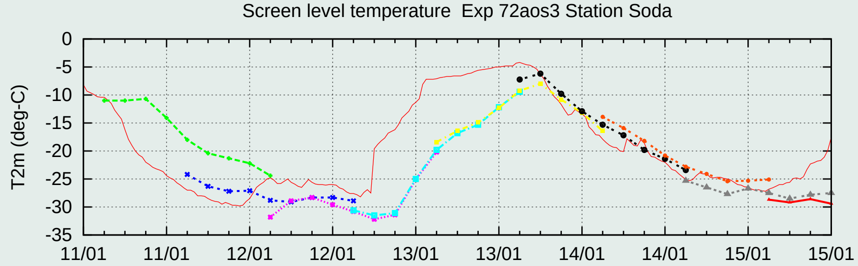


Temperature gradient Ts-Tnlev mast/Hirlam

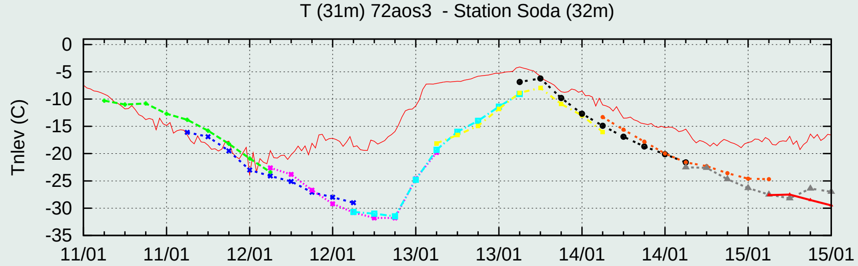


January 2007 Sodankylä: HIRLAM “newsnow” +oro+qnse

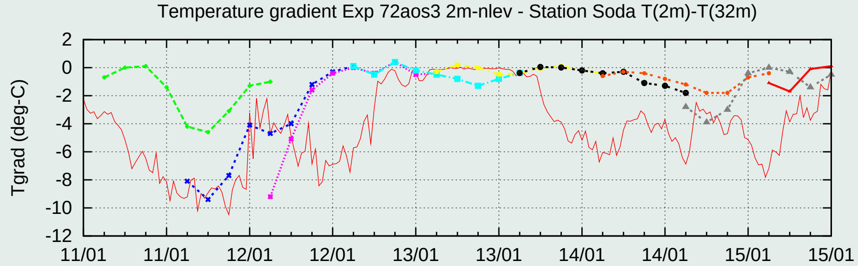
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m



Temperature gradient T2m-Tnlev mast/Hirlam



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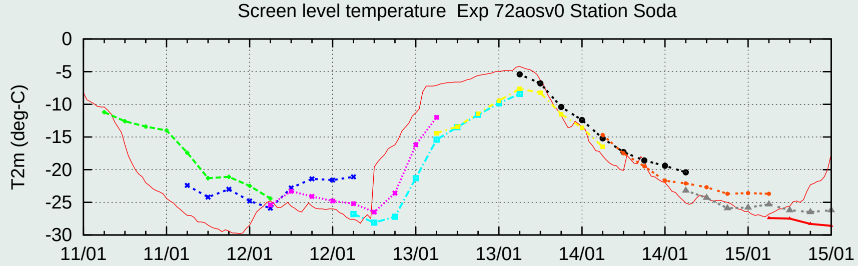
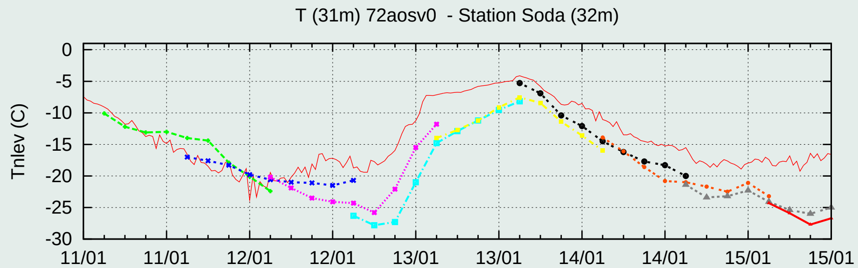
January 2007 Sodankylä: HIRLAM "newsnow" no oro no qnse

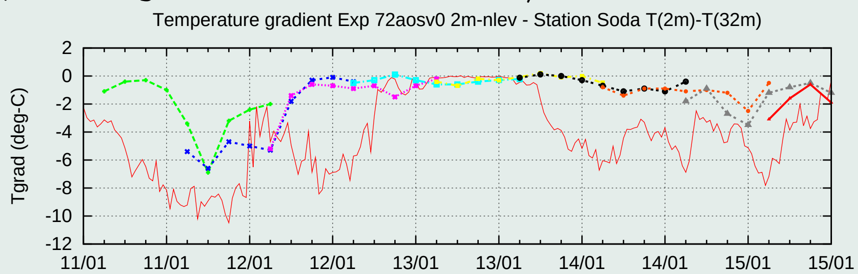
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m

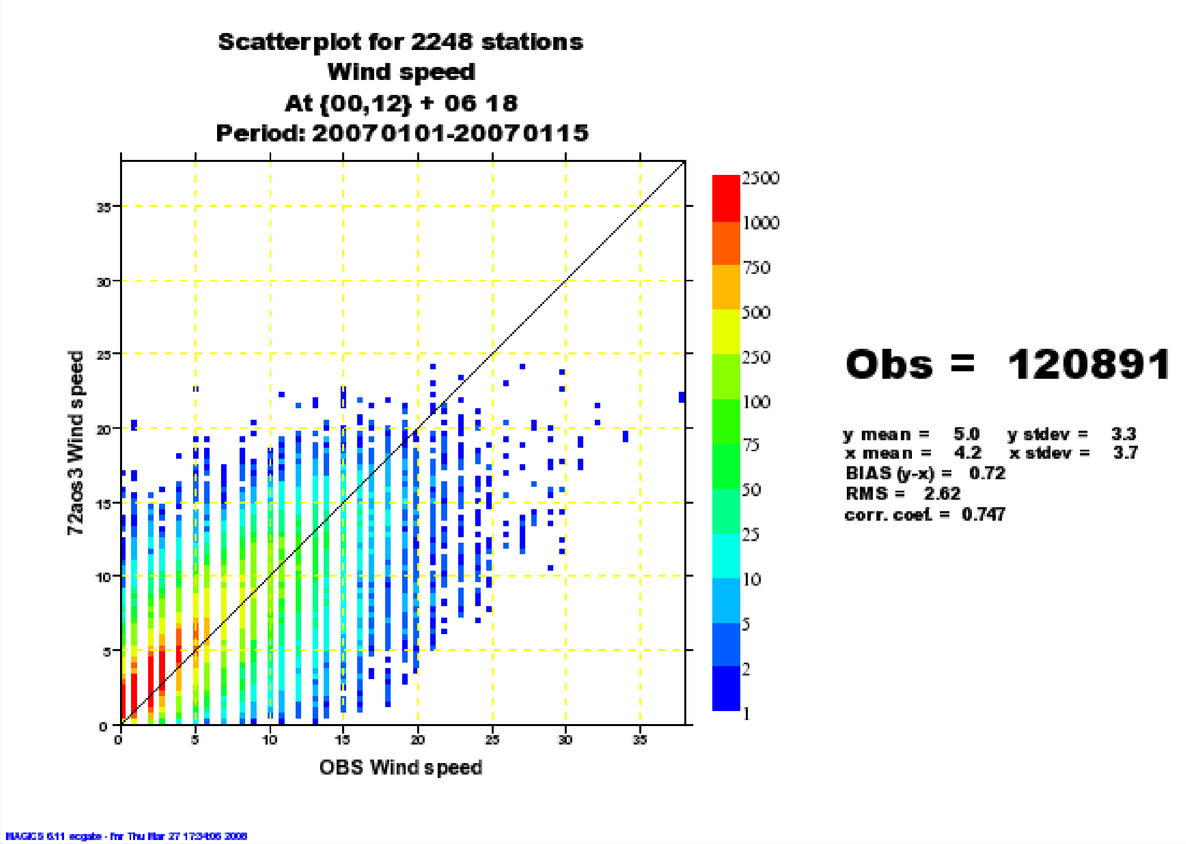


Temperature gradient T2m-Tnlev mast/Hirlam



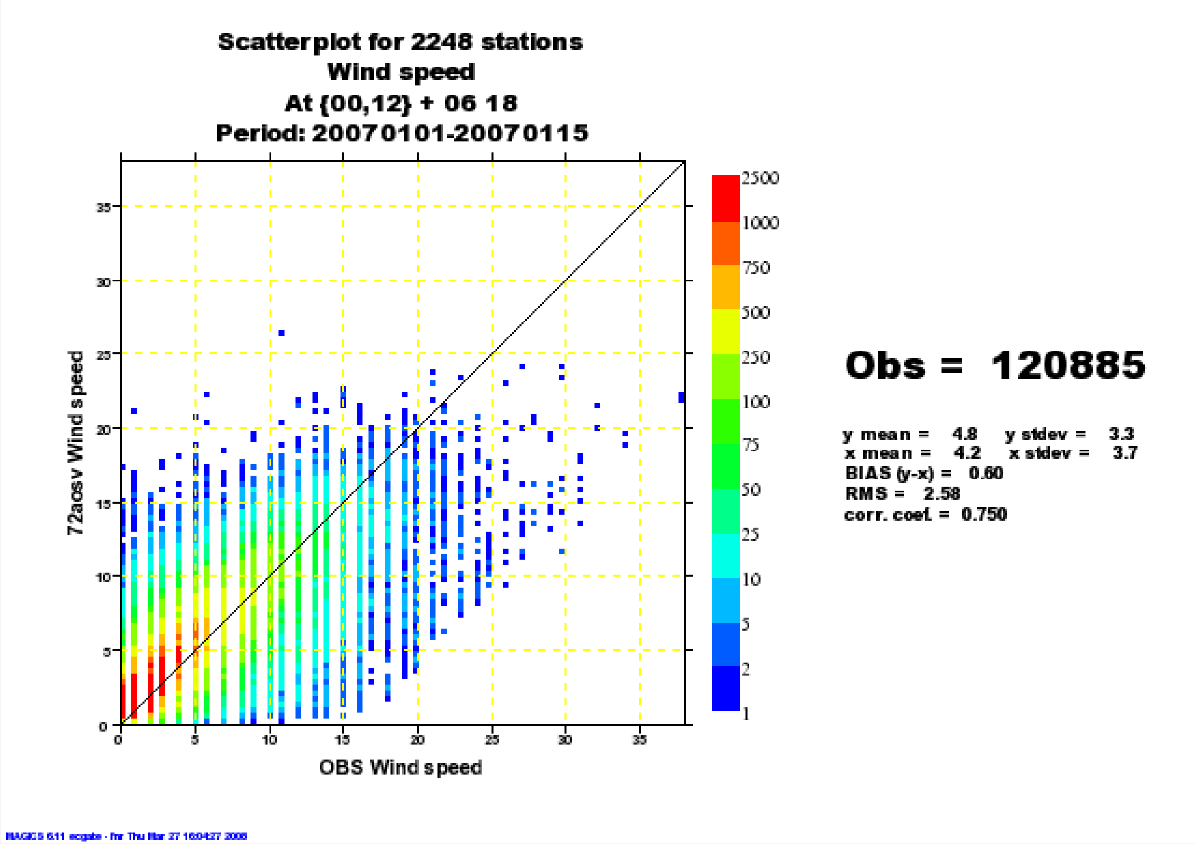
January 1-15,2007 72aos3, ALL stations

10-metre wind speed, bias = 0.72



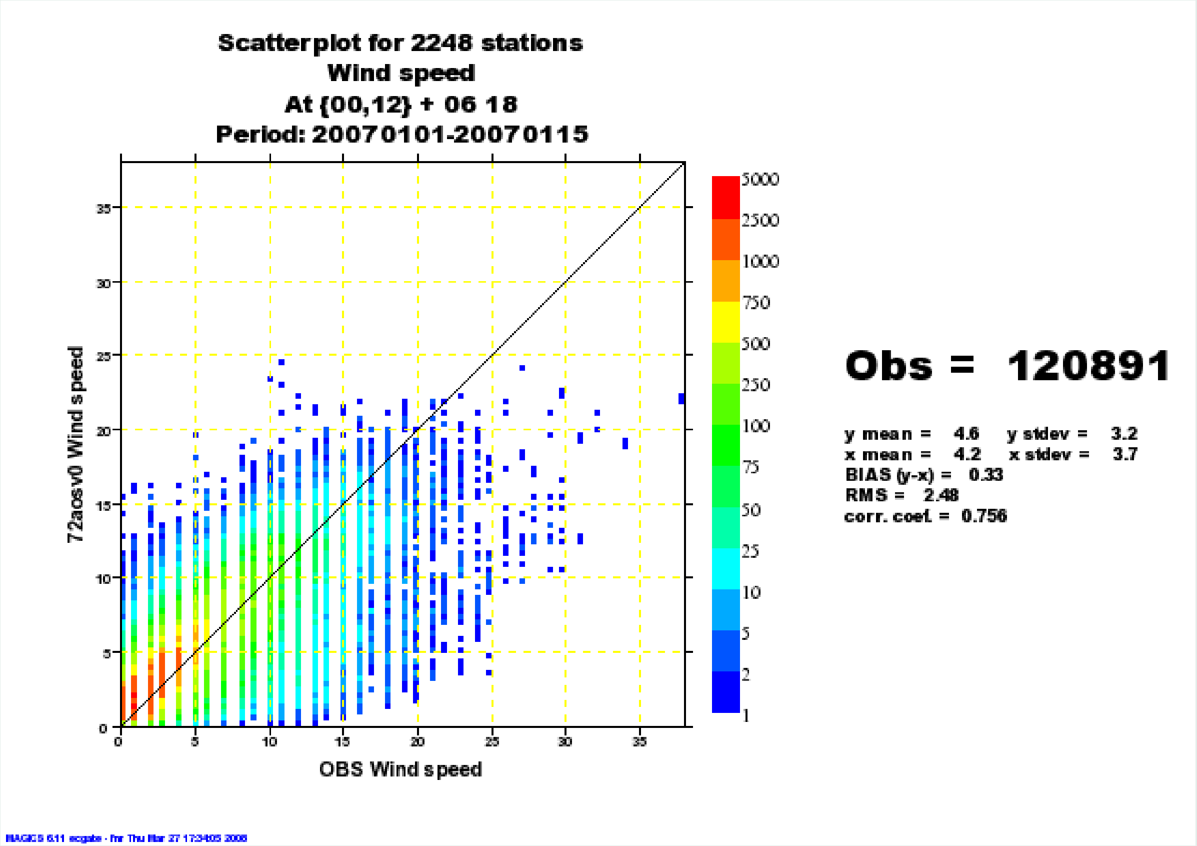
January 1-15,2007 72aosv, ALL stations

10-metre wind speed, bias = 0.60



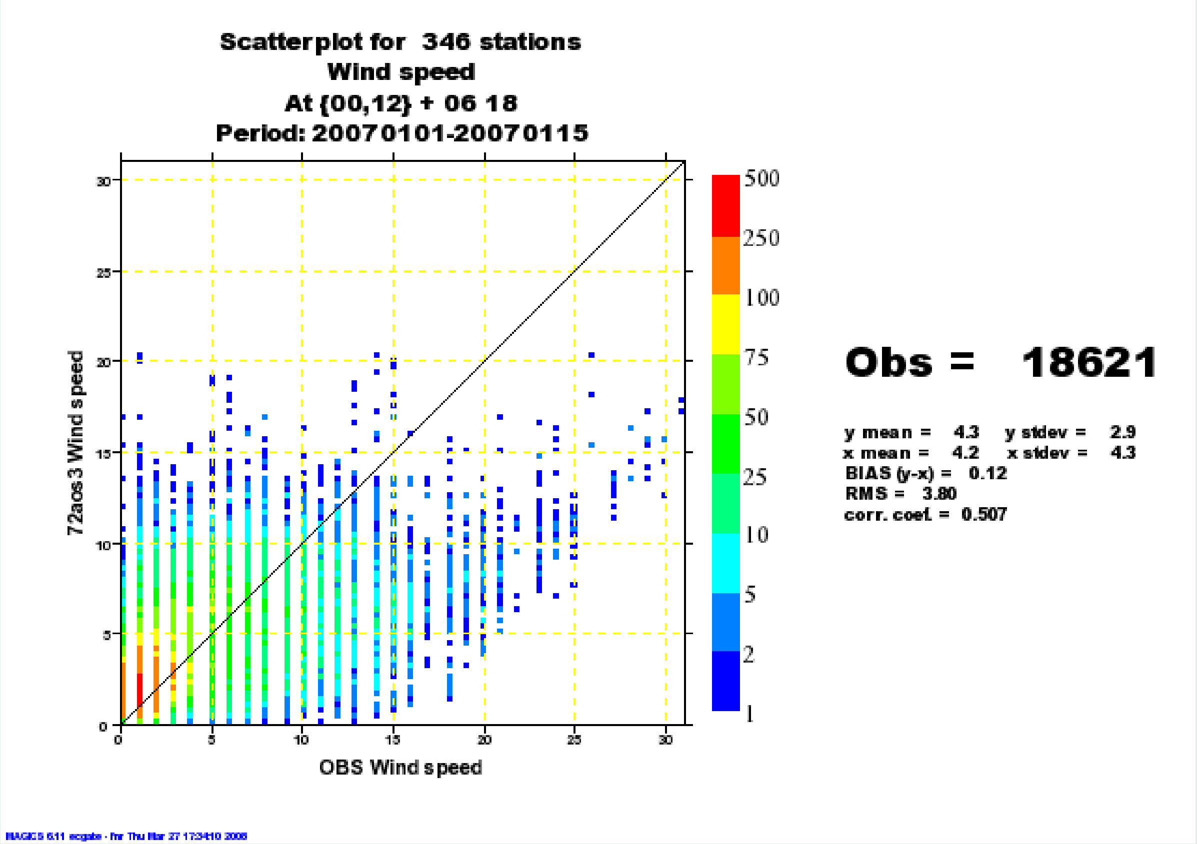
January 1-15,2007 72aosv0, ALL stations

10-metre wind speed, bias = 0.33



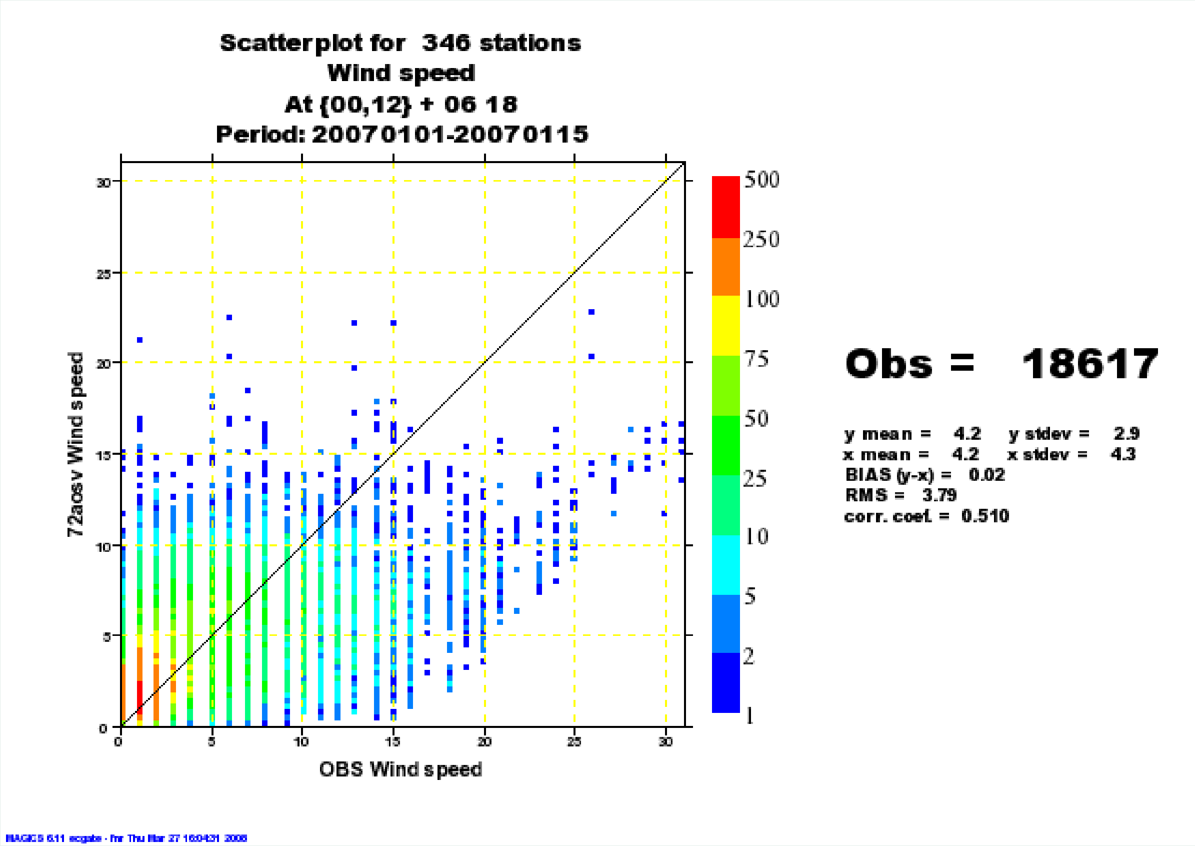
January 1-15,2007 72aos3, European mountains

10-metre wind speed, bias = 0.12



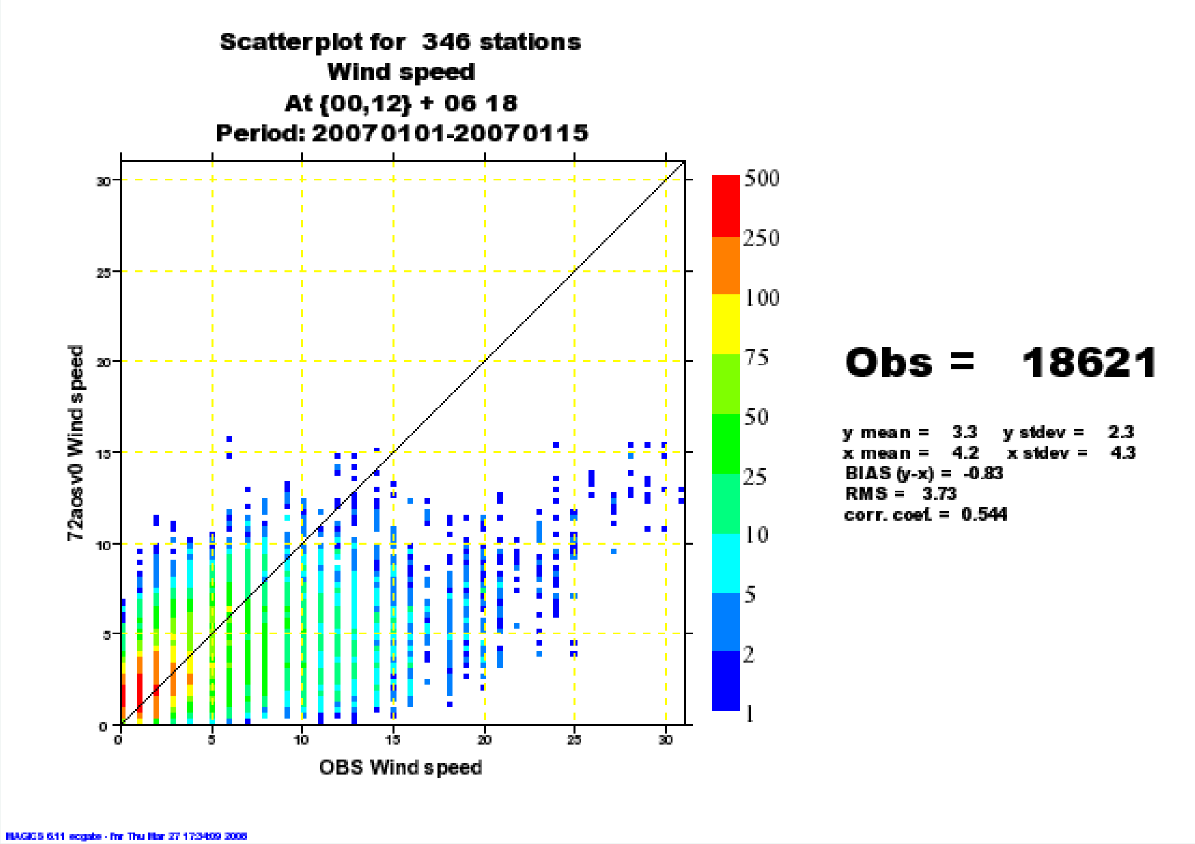
January 1-15,2007 72aosv, European mountains

10-metre wind speed, bias = 0.02



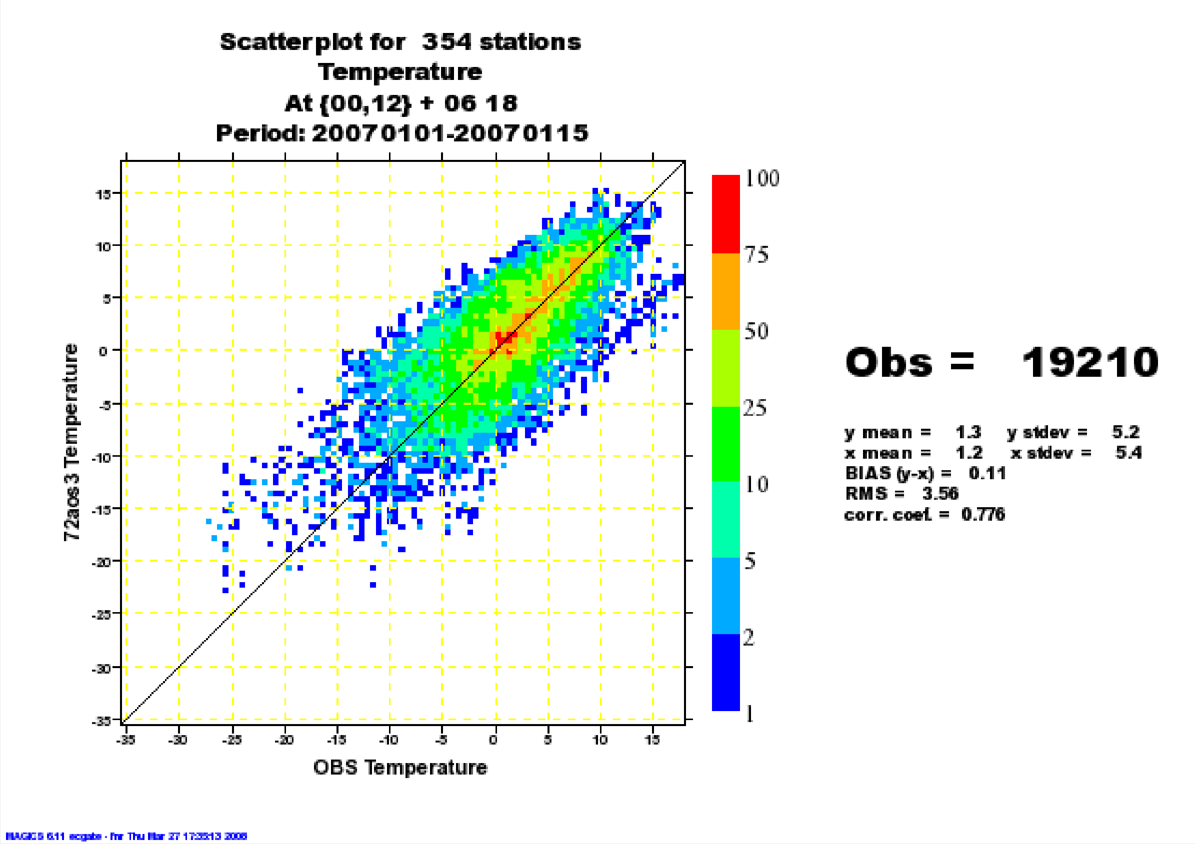
January 1-15,2007 72aosv0, European mountains

10-metre wind speed, bias = -0.83



January 1-15,2007 72aos3, European mountains

2-metre temperature, bias = 0.11



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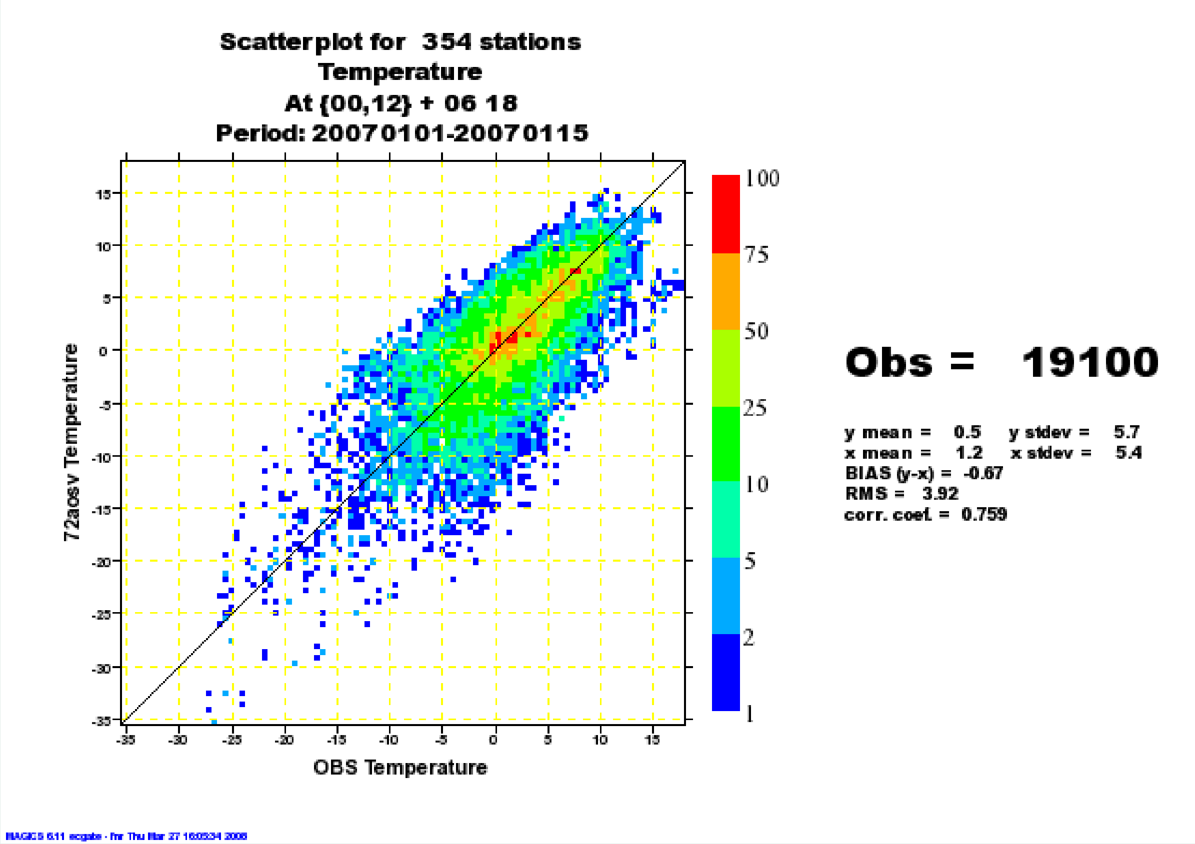
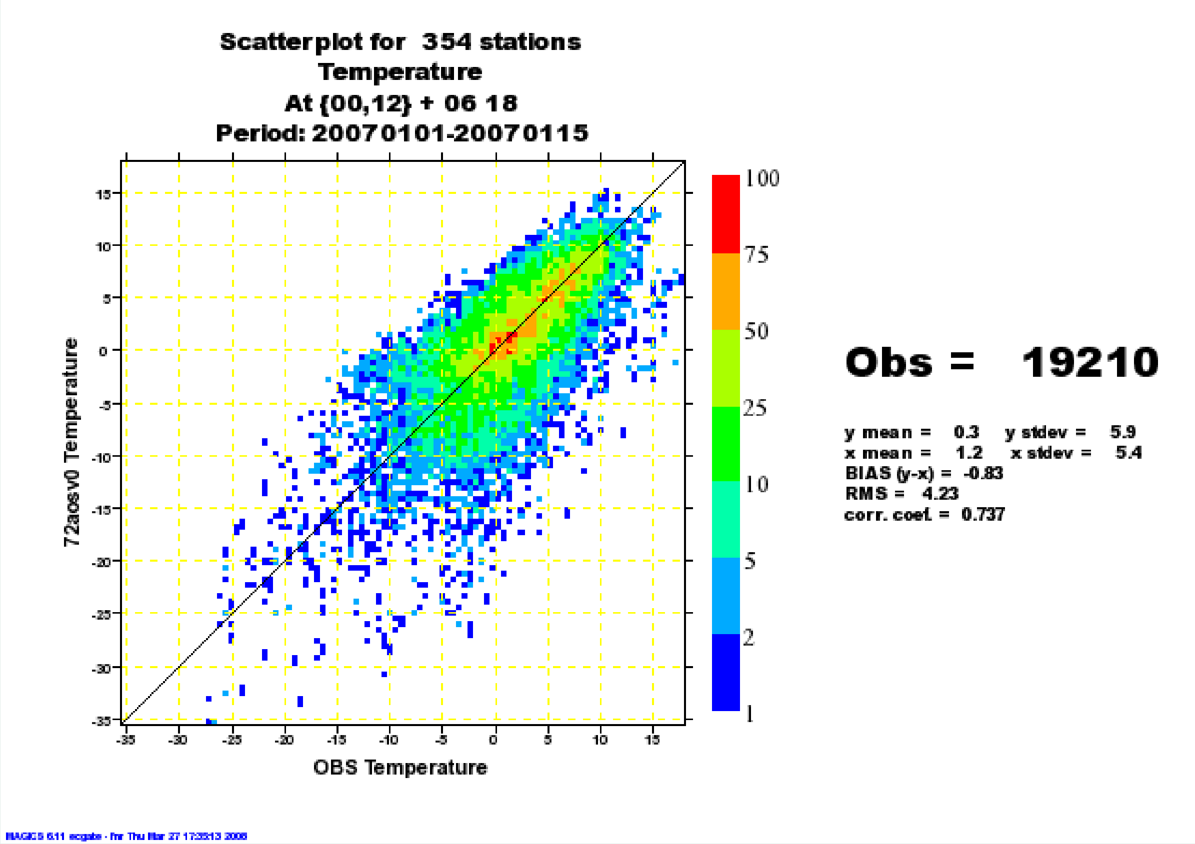
January 1-15,2007 72aosv, European mountains

2-metre temperature, bias = -0.67



January 1-15,2007 72aosv0, European mountains

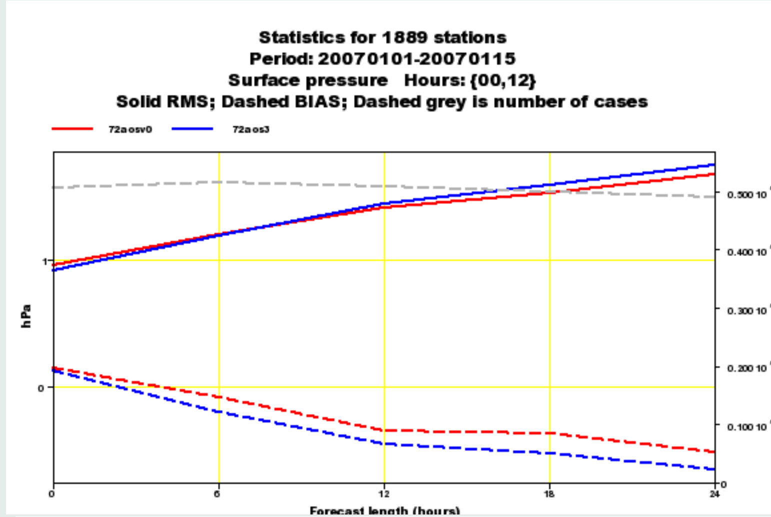
2-metre temperature, bias = -0.83



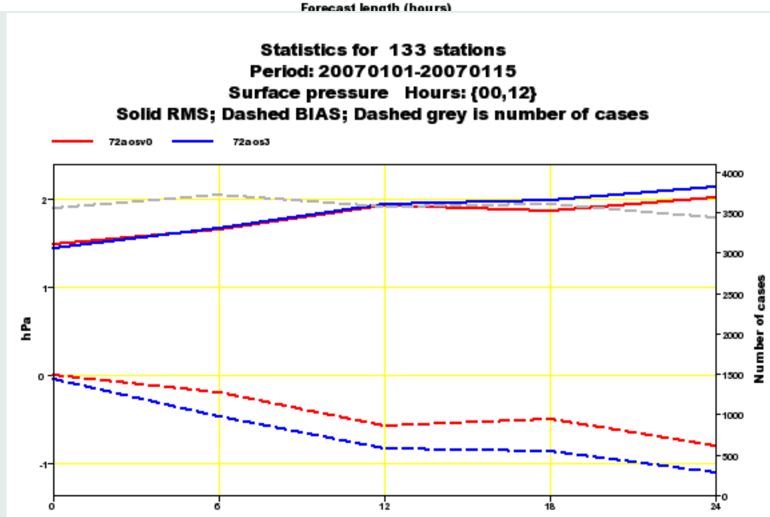
January 1-15,2007 surface pressure (1)

72aosv0 v.s. 72aos3 ≈ ref newsnow -v.s. all modifications

ALL:



MOU:



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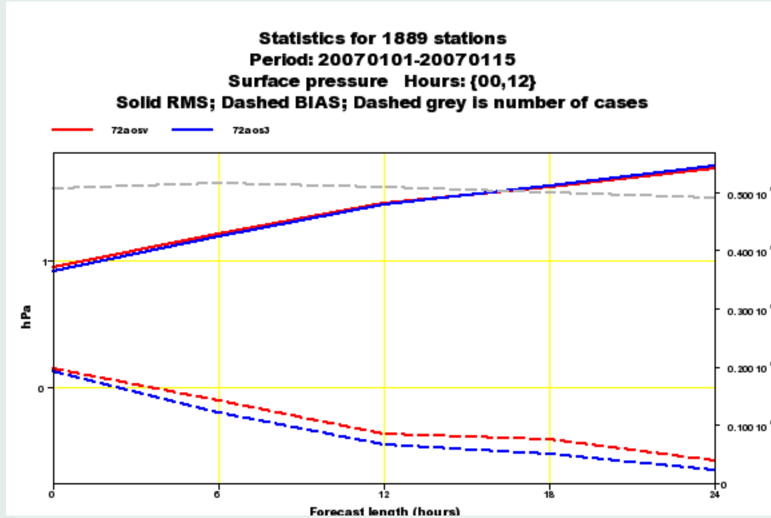
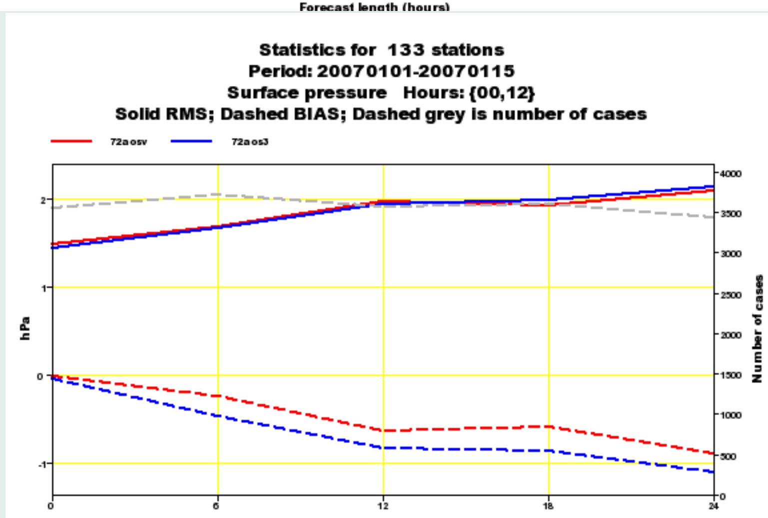
January 1-15,2007 surface pressure (2)

72aosv v.s. 72aos3 ≈ oro + no qnse -v.s. oro + qnse

ALL:



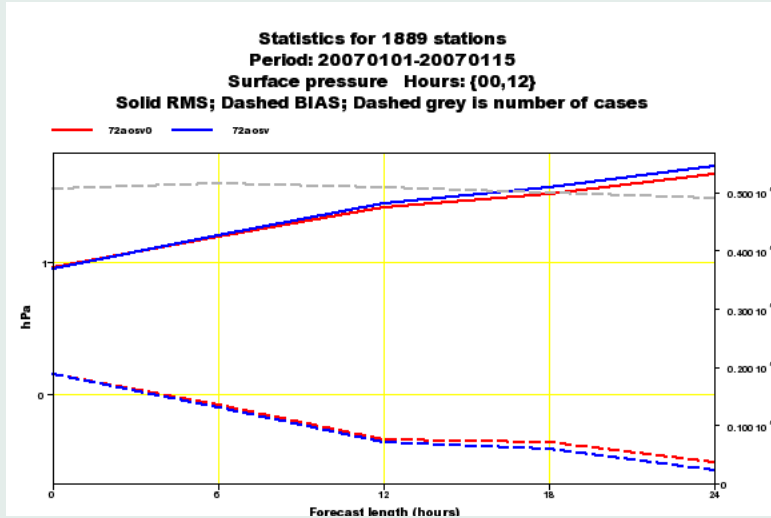
MOU:



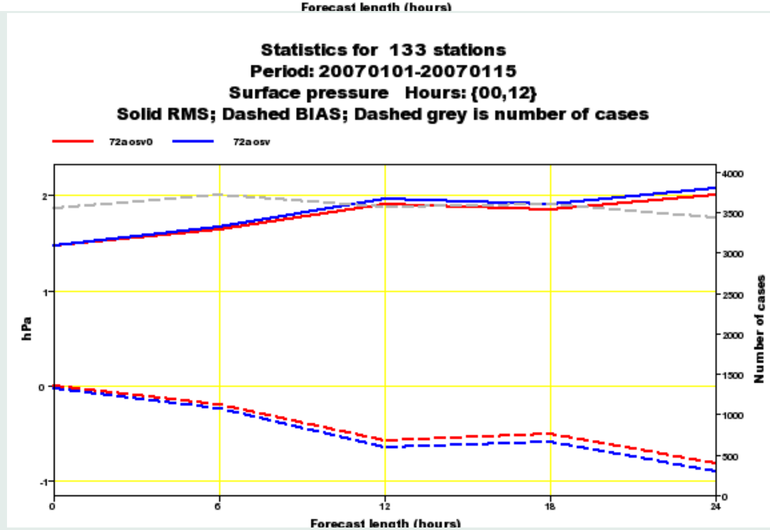
January 1-15,2007 surface pressure (3)

72aosv0 v.s. 72aosv ≈ ref newsnow -v.s. oro no qnse

ALL:



MOU:



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Summary of the forecast-observation bias

Summary of the forecast-observation bias

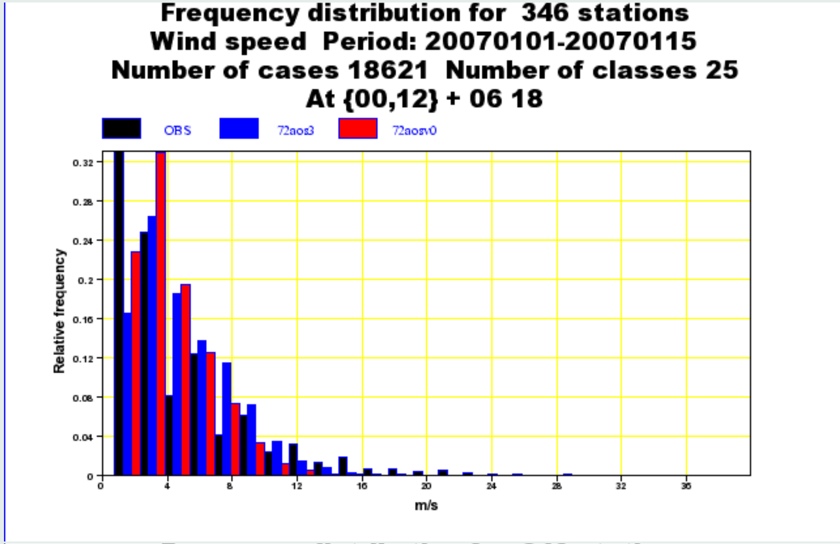
Quick conclusions

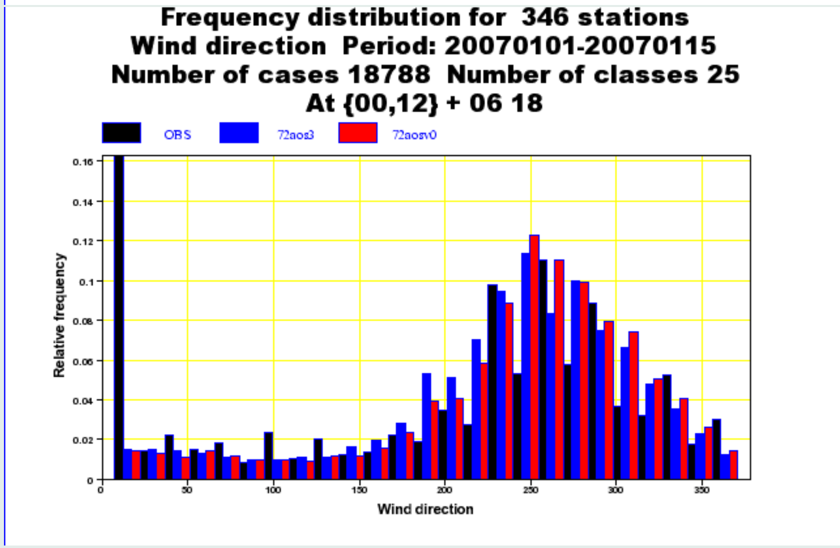
- oroparametrizations + QNSE are good for temperatures everywhere
- oroparametrizations + tuned turbulence are good for mountain winds
- tuned turbulence without oroparametrizations are good
  for winds over the whole domain and for pressure everywhere
- (not shown) no significant differences from 925 hPa upwards

Table 3:

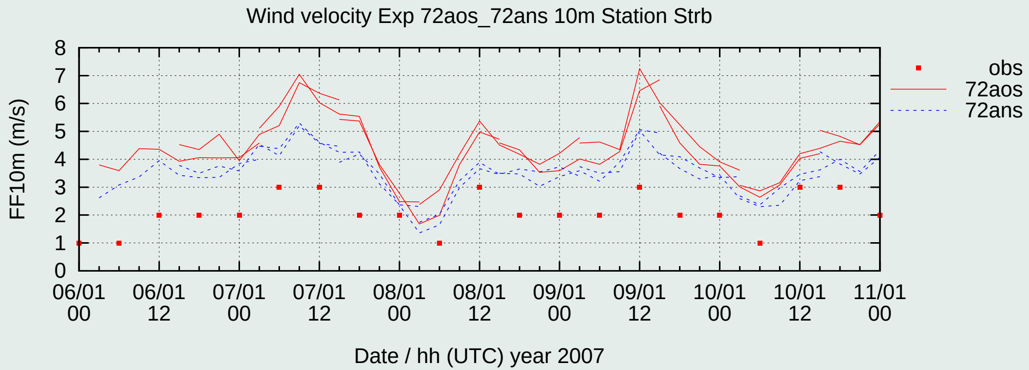
Experiment	Wind		Temperature		Pressure	
	ALL	Mountain	ALL	Mountain	ALL	Mountain
72aos3	0.72	0.12	-0.40	0.11	-0.36	-0.65
72aosv	0.60	0.02	-1.00	-0.67	-0.25	-0.40
72aosv0	0.33	-0.83	-1.05	-0.83	-0.22	-0.33

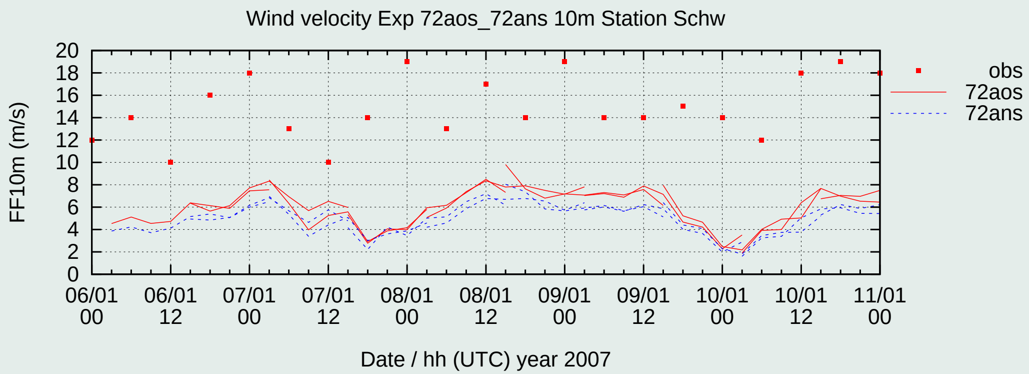
The problem of calm cases



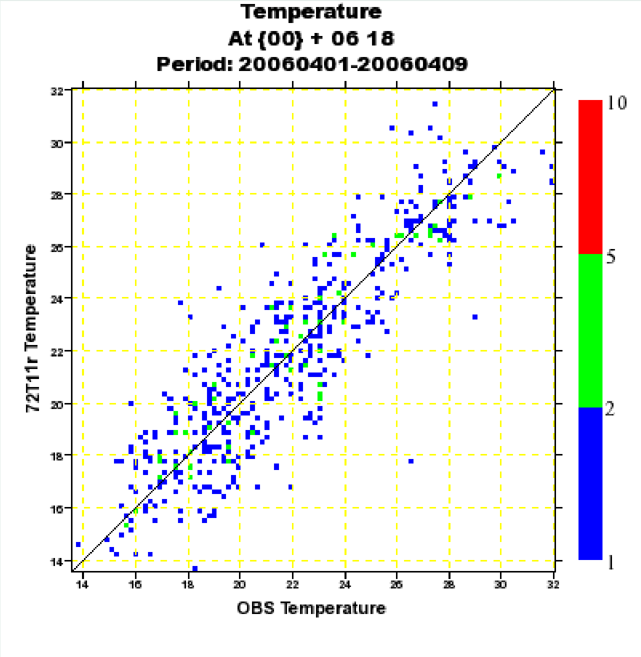


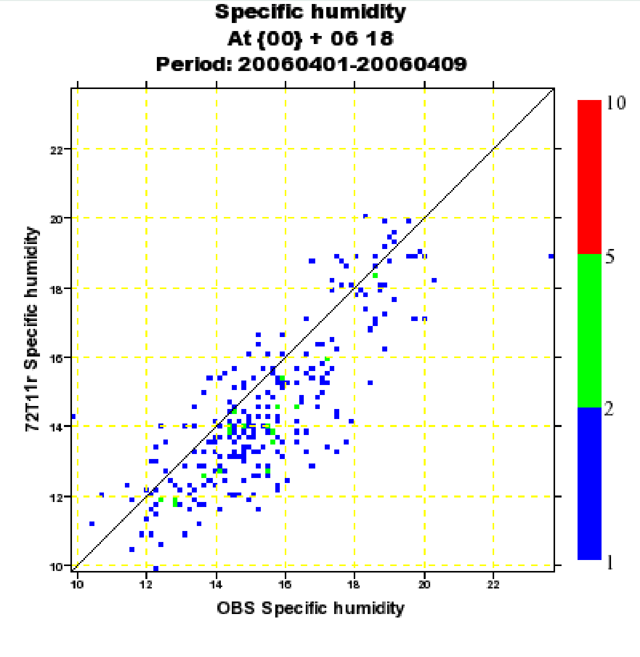
The problem of representativeness



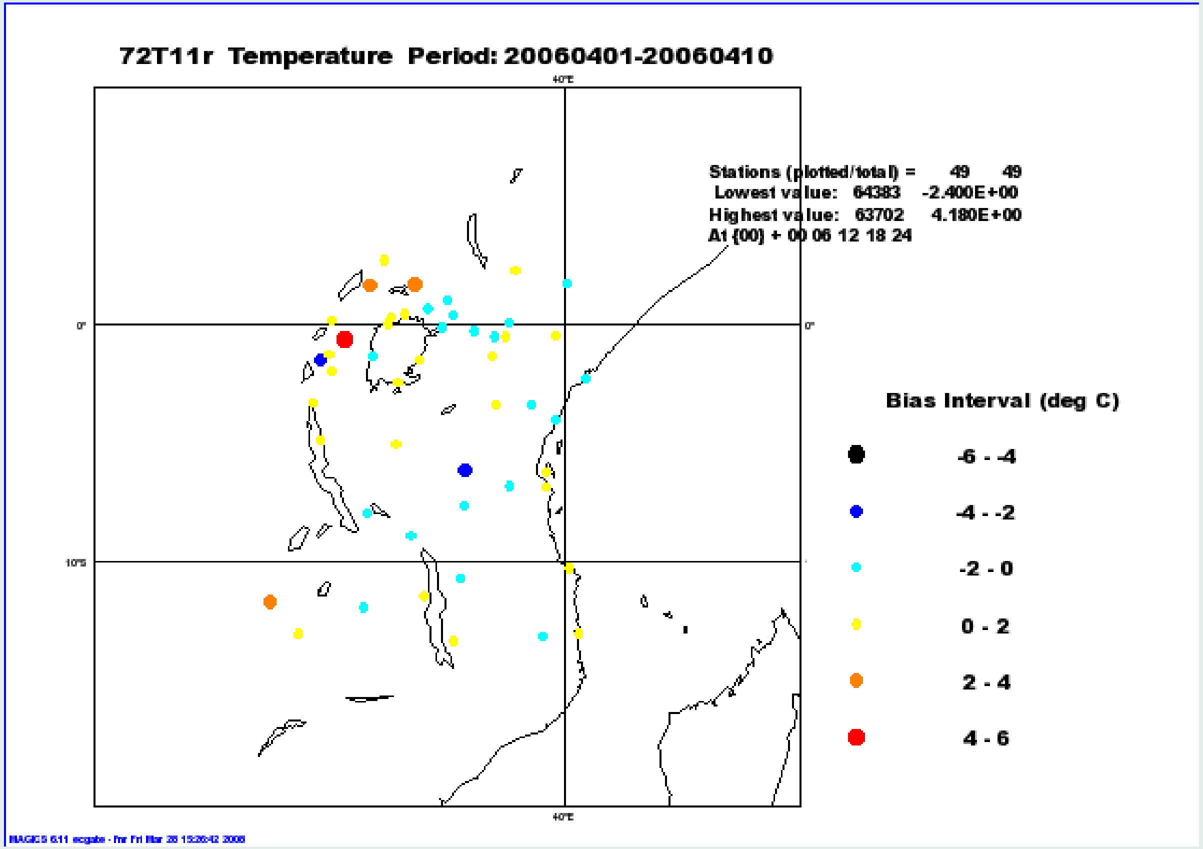


Newsnow in Tanzania





Newsnow in Tanzania



Concluding remarks

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Concluding remarks

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

Concluding remarks

Did we learn something from this study?

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Things to study and develop further

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

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It is not easy to improve model by physical parametrizations

- Significant positive-only signals are not so common nowadays
- Validation and comparison methods need developments, too
- The amount of possible code combinations is increasing - supermarket?
- 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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Thanks to

Stefan Gollvik, SMHI (newsnow)

Jevgeni Atlaskin, RSHU (QNSE)

Hamza Kabelwa, RSHU and TMA (Tanzania)

Ulf Andrae, SMHI (verification tools)

Thank YOU for attention!