ČESKÝ
HYDROMETEOROLOGICKÝ
ÚSTAV

NH dynamics at high resolution - setup and results

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The current application of CHMI: X The future application of CHMI:

4.7km in horizontal — 2.325km in horizontal

432x540 grid points — 864x1080 grid points

linear truncation

87 vertical levels

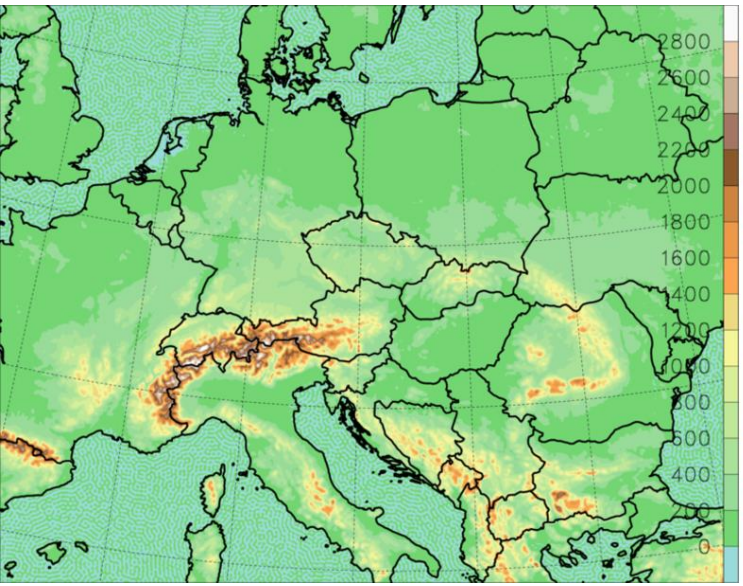
coupling to ARPEGE/3h

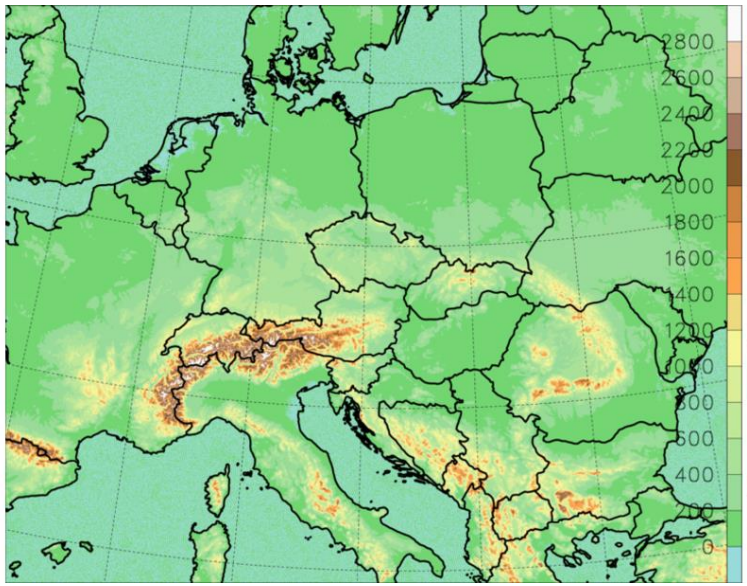
8 points coupling zone — 16 points coupling zone

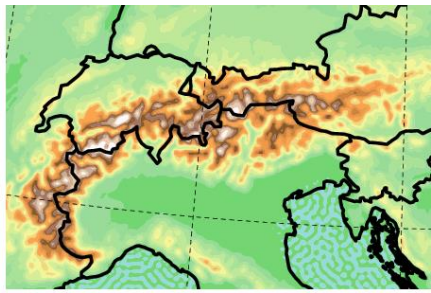
cy43t2_bf10

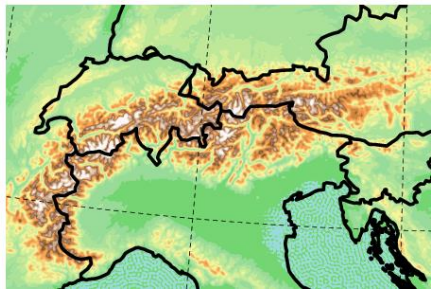
ALARO v1B

HY dynamics — **NH dynamics**









Basic setting: NH dynamics		LNHDYN = T, NDLNPR = 1
Prognostic variables	ln(p/π)	NPDVAR = 2
	d4	NVDVAR = 4, ND4SYS = 1
	w in NL model	LGWADV = T, LRDBBC = F
Iterative centered implicit time scheme		LTWOTL = T, LPC_FULL = T NSITER = 1
		LSETTLS = F, LPC_NESC = T
		YX_NL%LADV = T => YX_NL%LPC = T
Trajectory search	4 iterations	NITMP = 4
	no recomputation	LPC_CHEAP = T
		LSETTLST = T, LSETTLSV = T
		LPC_NESCT = F, LPC_NESCV = F
		NXLAG = 3 for X = T,V,W,SPD,SVD
		LQMX = F for all X

Basic setting: NH dynamics LNHDYN = T, NDLNPR = 1

SI reference state SIPR = 90000.

SITR = 350., SITRA = 100.

No decentering VESL = 0, XIDT = 0

Time step 90 s

SLHD on prognostic variables T, W, SPD, SVD, GFL = I, L, Q, TKE

Tests done

1) temporal evolution of spectral norms

2) visualisation of some fields (vertical velocity, precipitation)

3) kinetic energy spectra and vertical velocity spectra

4) objective scores (RMSE, BIAS, STDE)

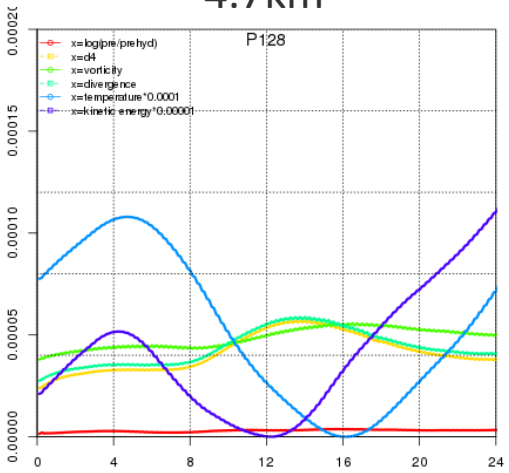
- compared to previous operational results

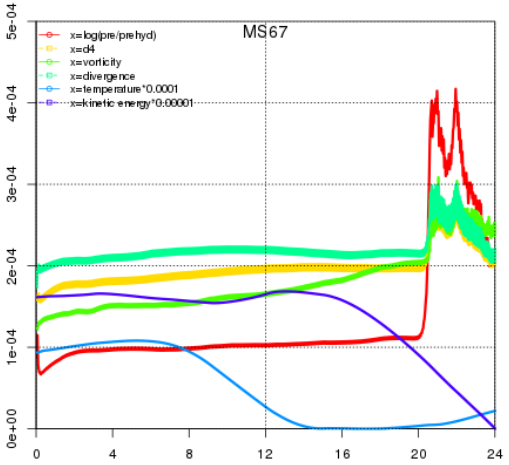
Tests done (examples)

1) temporal evolution of spectral norms

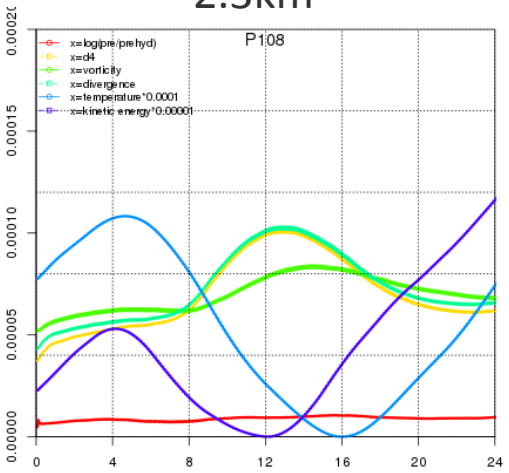
Press.departure
Vert.div.
Vorticity
Divergence
Temperature
Kinetic energy

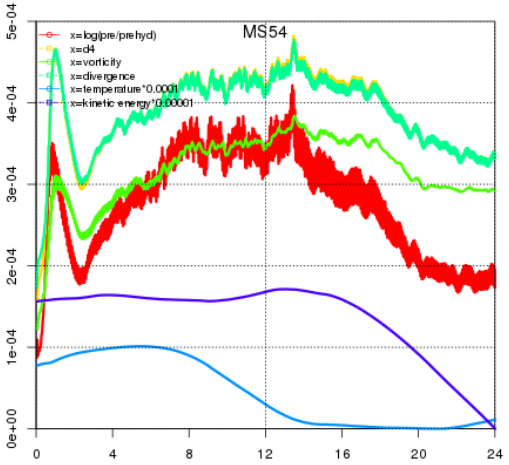
4.7km

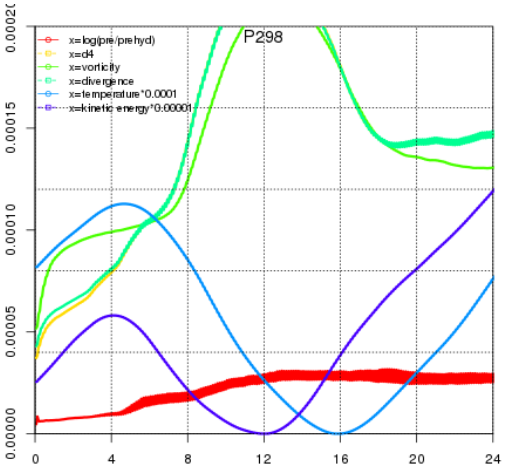


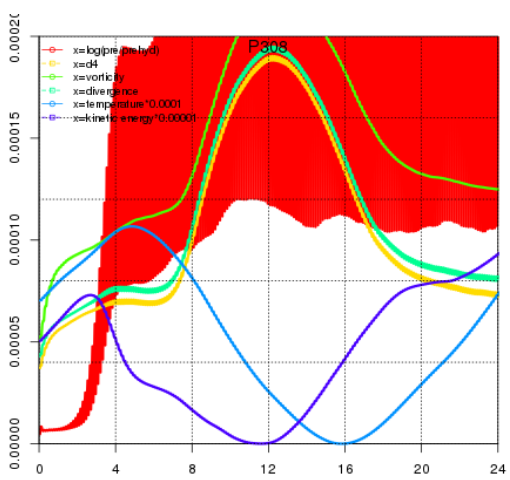


2.3km



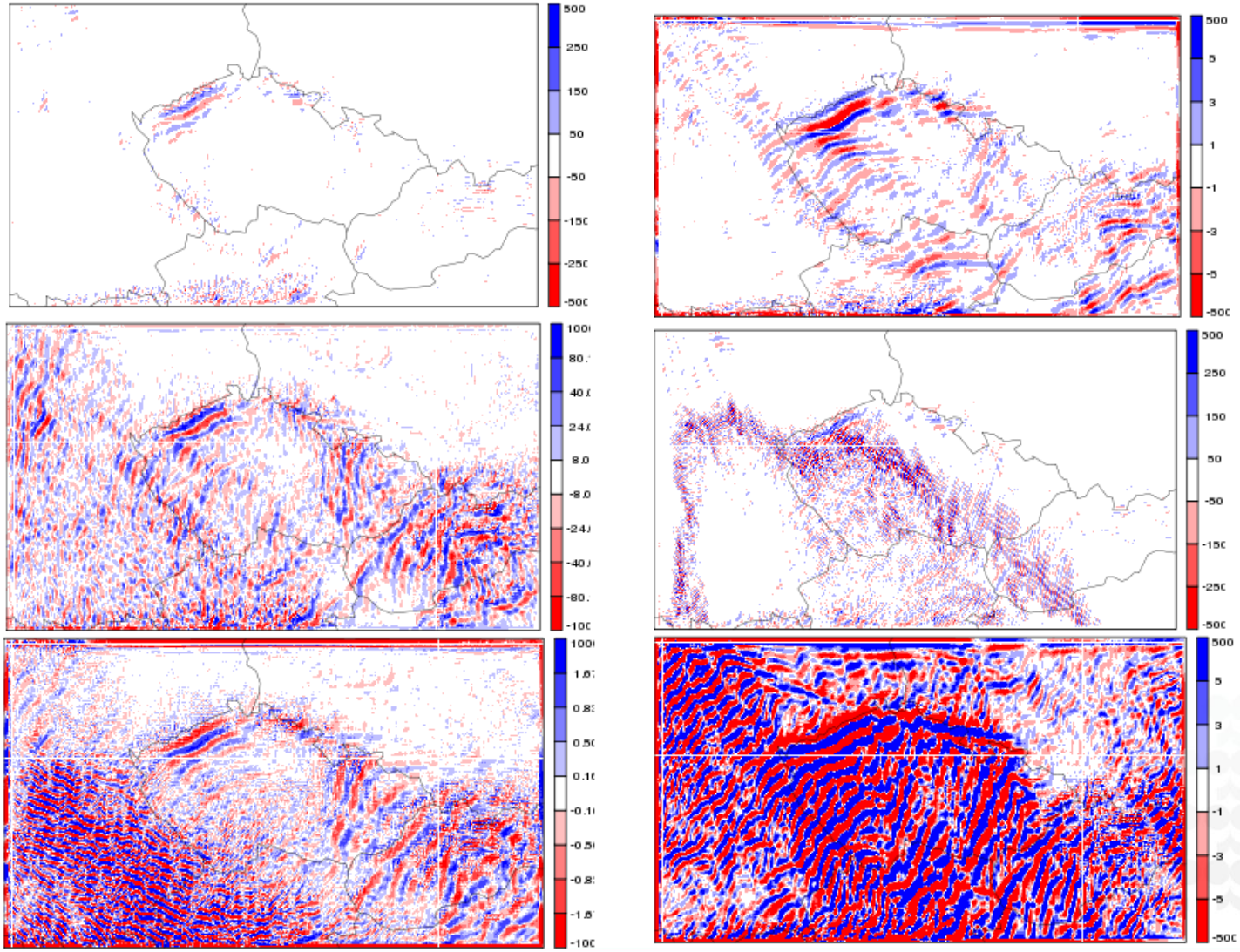






Tests done(examples)

2) visualisation of some fields (pressure departure)

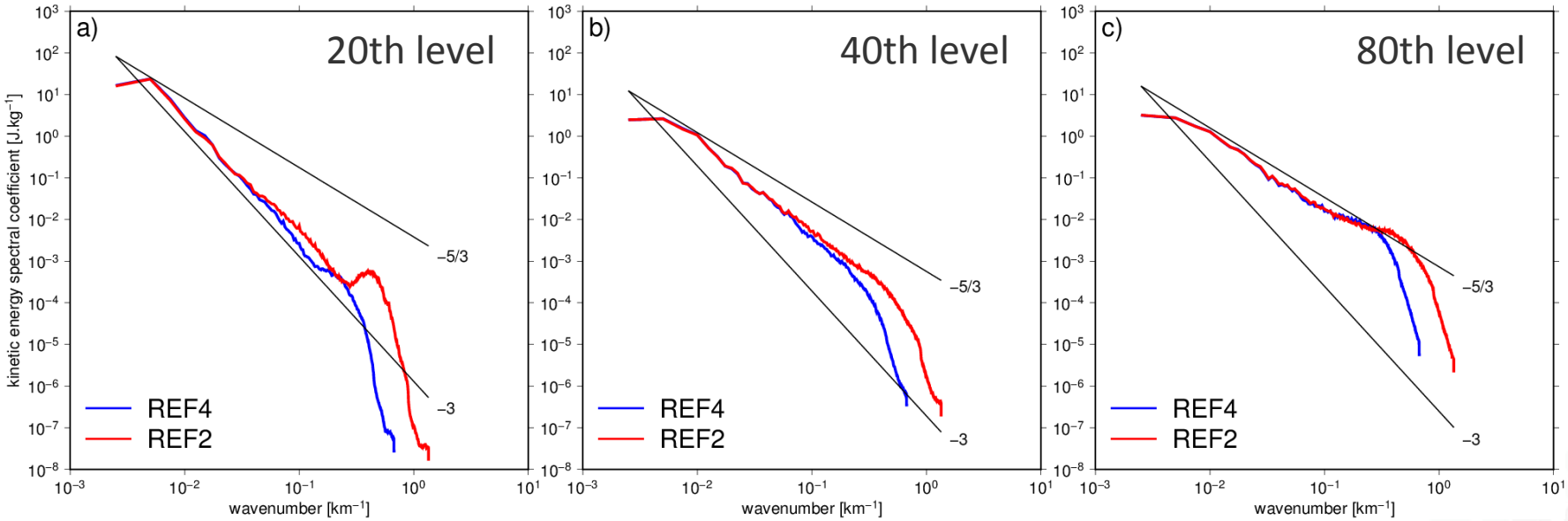


Tests done

3) kinetic energy spectra and vertical velocity spectra

REF4 – basic NH at 4.7km

REF2 – basic NH at 2.325km

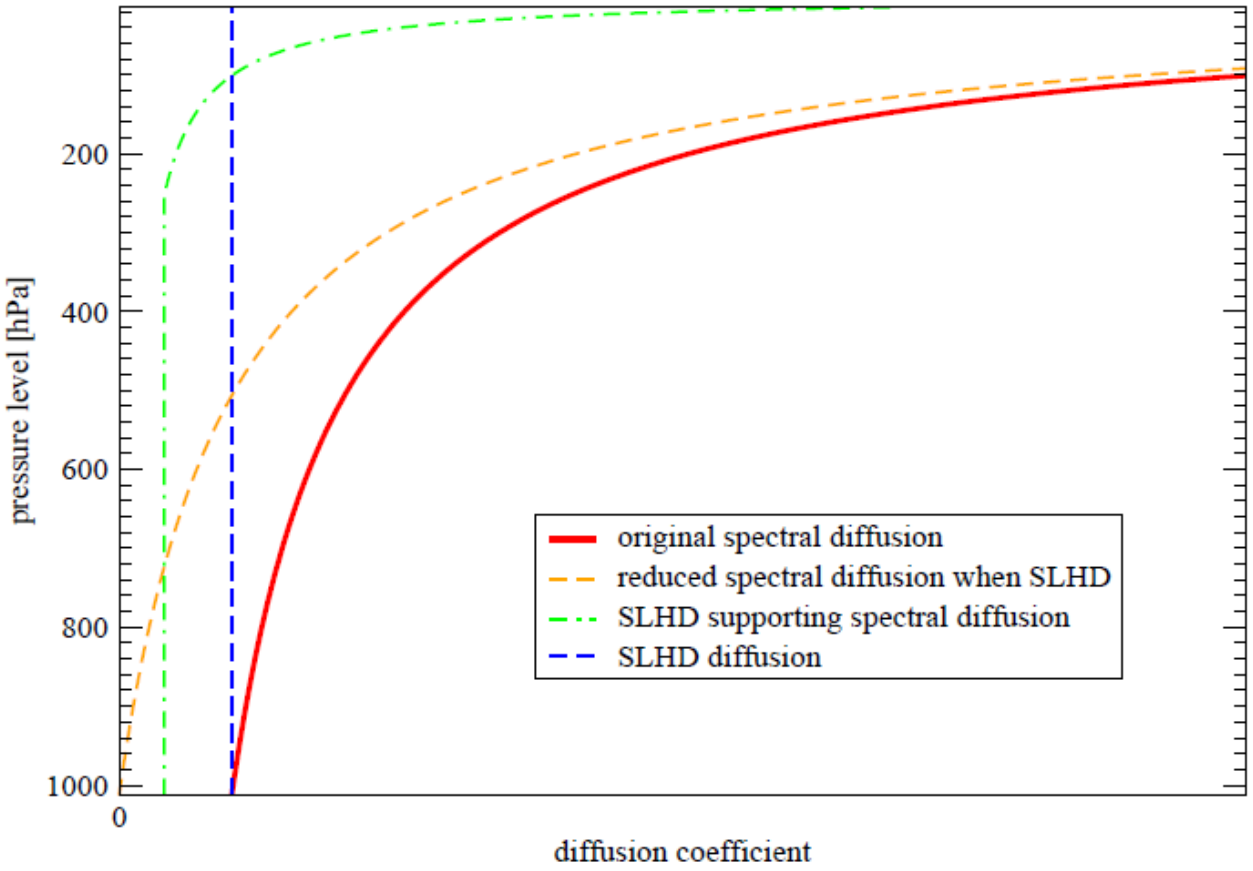


Several parameters tested:

- shorter time step, more steps of PC through NSITER>1 helps but expensive

Horizontal diffusion SLHD (developped and tunned by F.Váňa)

with 3 components:	grid-point diffusion	T, W, PD, VD, advected GFL
	reduced spectral diffusion	T, Q, VOR, DIV, PD, VD
	supporting spectral diffusion	VOR, DIV, VD



Horizontal diffusion SLHD

with 3 components:

grid-point diffusion
- realistic non-linear diffusion (local, 3D)
- wind field deformation -> kappa
- SL interpolations

(combination of accurate and diffusive operator, smoothing)

reduced spectral diffusion
- filtering near the upper bound of the domain
- strength and order
- vertical profile of the diffusion coefficient

supporting spectral diffusion – controls the small scale impact of orography (at the end of spectra)
- strength and order
- vertical profile of the diffusion coefficient

Horizontal diffusion

SLHD with 3 components:

grid-point diffusion

SLHDA0 = 0.25

SLHDB = 4

SLHDD00 = 6.5e-5

ZSLHDP1 = 1.7

ZSLHDP3 = 0.6

SLHDKMAX = 6

$$\kappa = \kappa_{max}\frac{\Delta t F(d)}{1+\Delta t F(d)}$$

$$F(d) = 2ad(max(1., \frac{d}{d0}))^{B}$$

$$a = A0(\frac{\Delta x_{ref}}{\Delta x})^{P1}$$

$$d0 = D00(\frac{\Delta x_{ref}}{\Delta x})^{P3}$$

(SL interpolations)

SLHDKMIN = -0.6

basic operator $(1-\kappa_{min})A + \kappa_{min} D$

diffusive operator $(1-\kappa)A + \kappa D$

SLHDEPSH = 0.016, SLHDEPSV = 0.

$$D_S = D \circ S = D \circ [1 + \varepsilon(\Delta x)^2 \partial^2]$$

Horizontal diffusion

reduced spectral diffusion

REXPDH = 2

RRDXTAU = 123, RDAMPX

SDRED = 1

SLEVDH = 0.5 (SLEVDH1, SLEVDH2, SLEVDH3)

supporting spectral diffusion

REXPDHS = 6

RRDXTAU, RDAMPXS

SLEVDHS = 1 (SLEVDHS1, SLEVDHS2)

SLEVDH

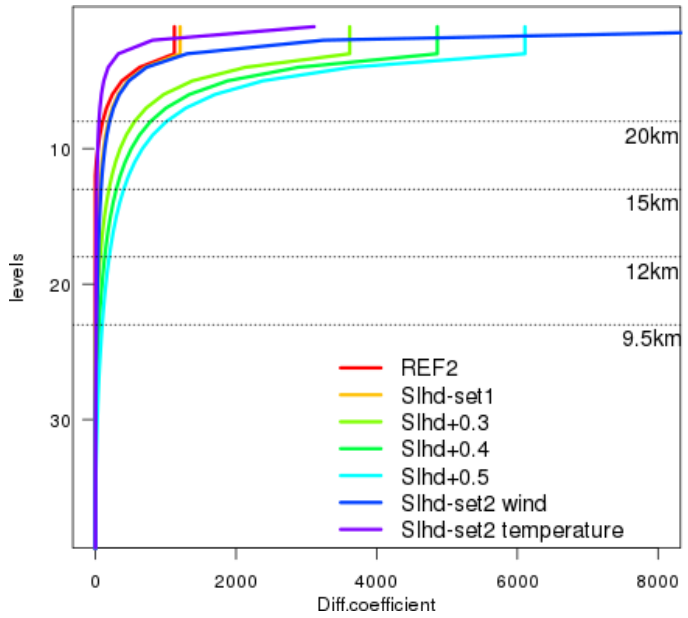
0.1

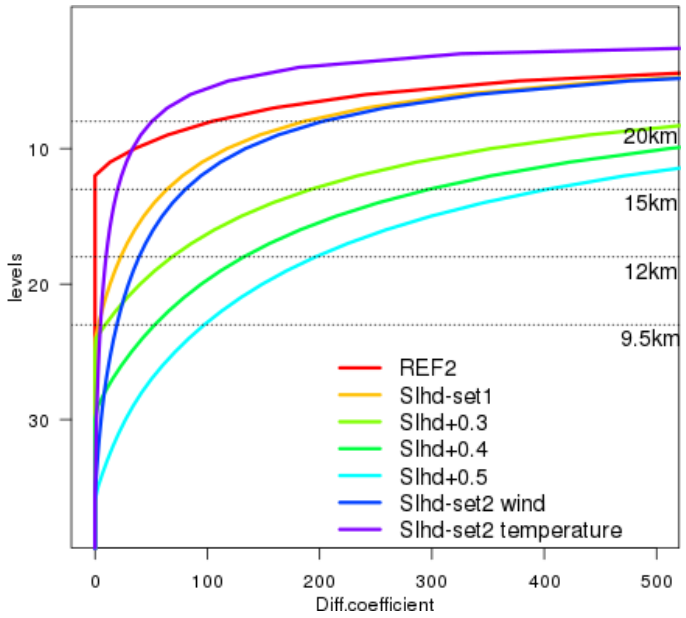
0.2

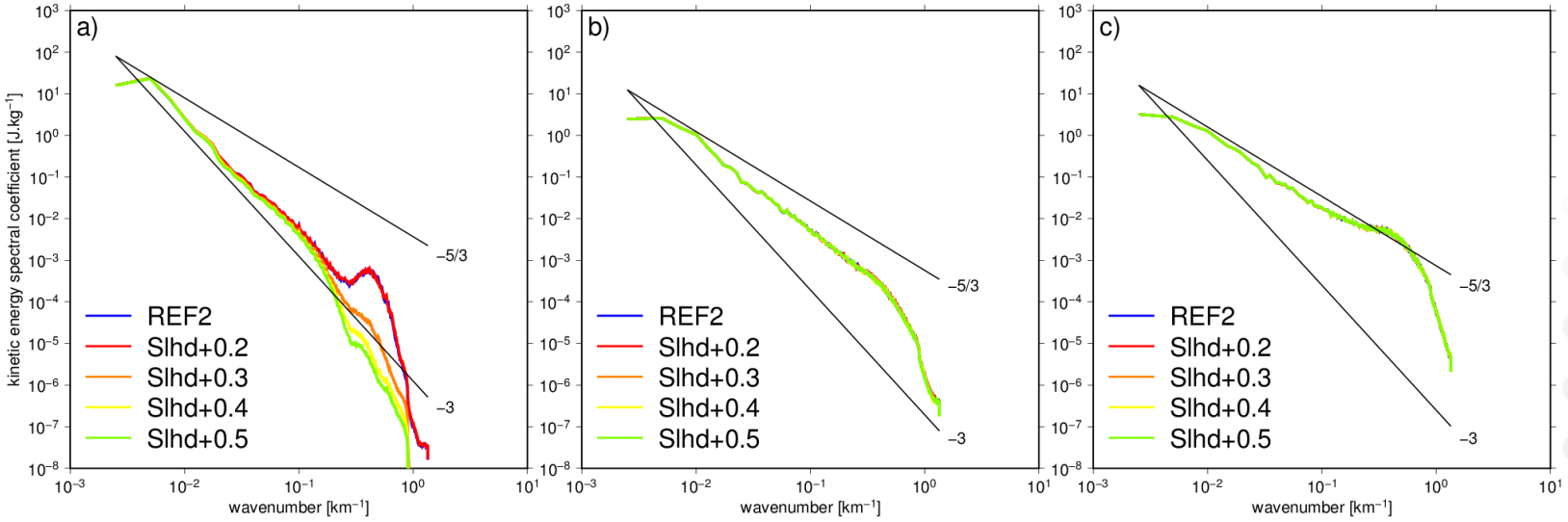
0.3

0.4

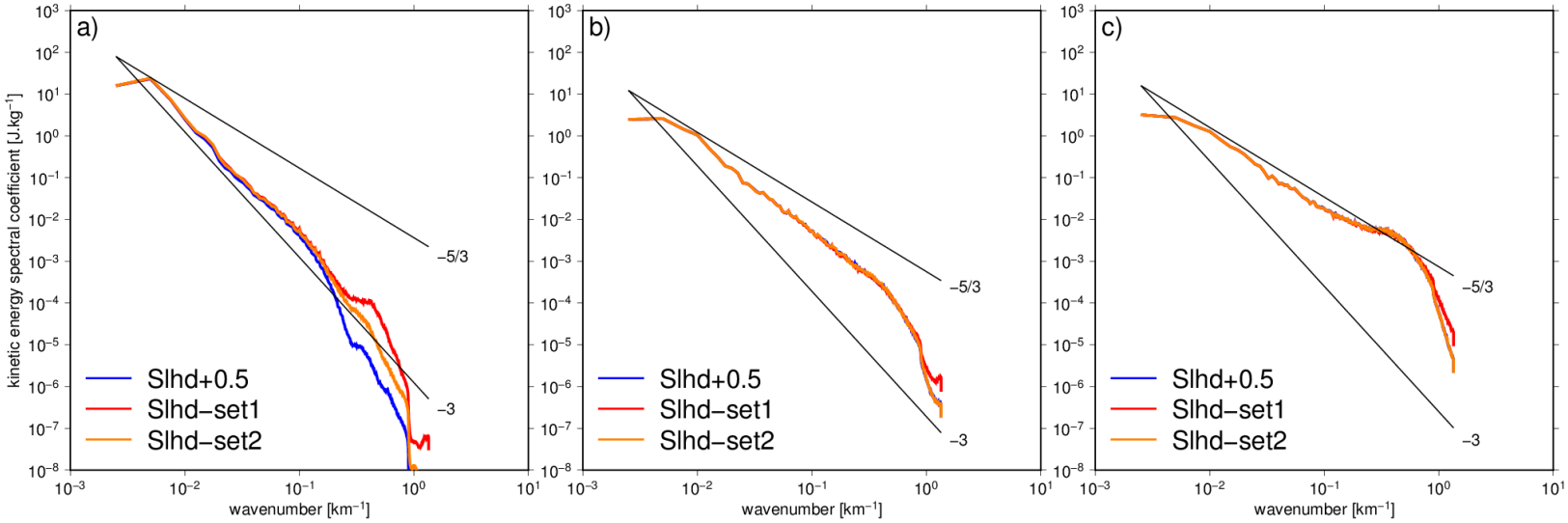
0.5





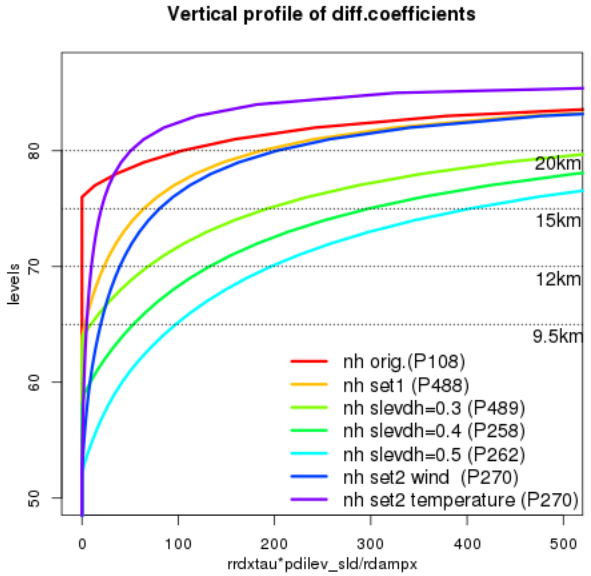


Spectral damping tuned separately for temperature and wind



RDAMPDIV =5
RDAMPVOR=5
RDAMPPD=5

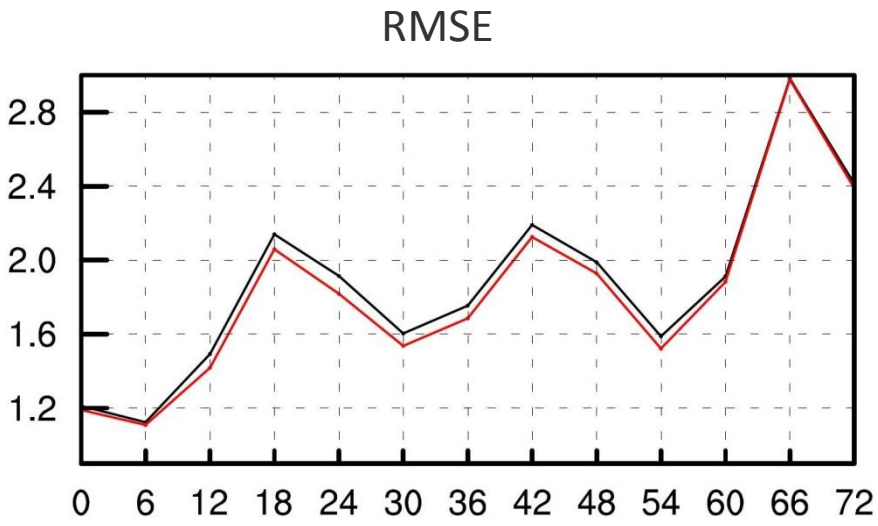
RDAMPT=20
RDAMPQ=20
RDAMPVD=20

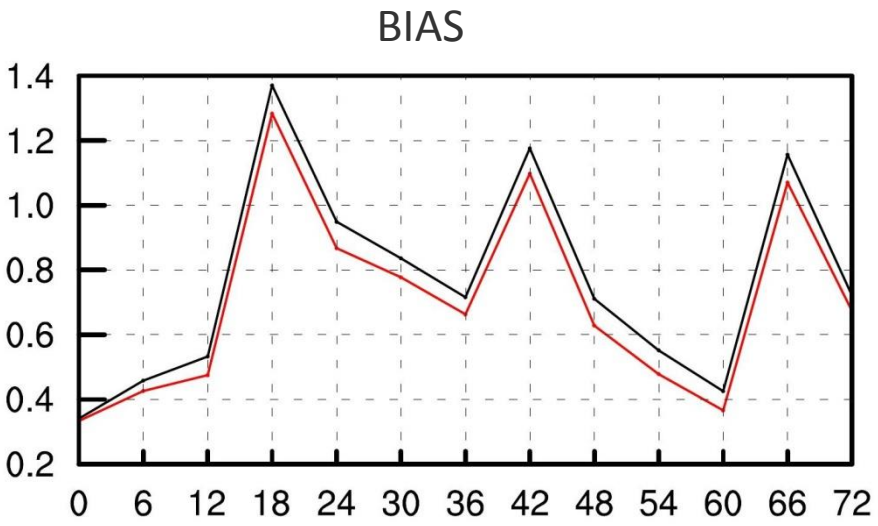


Tests done

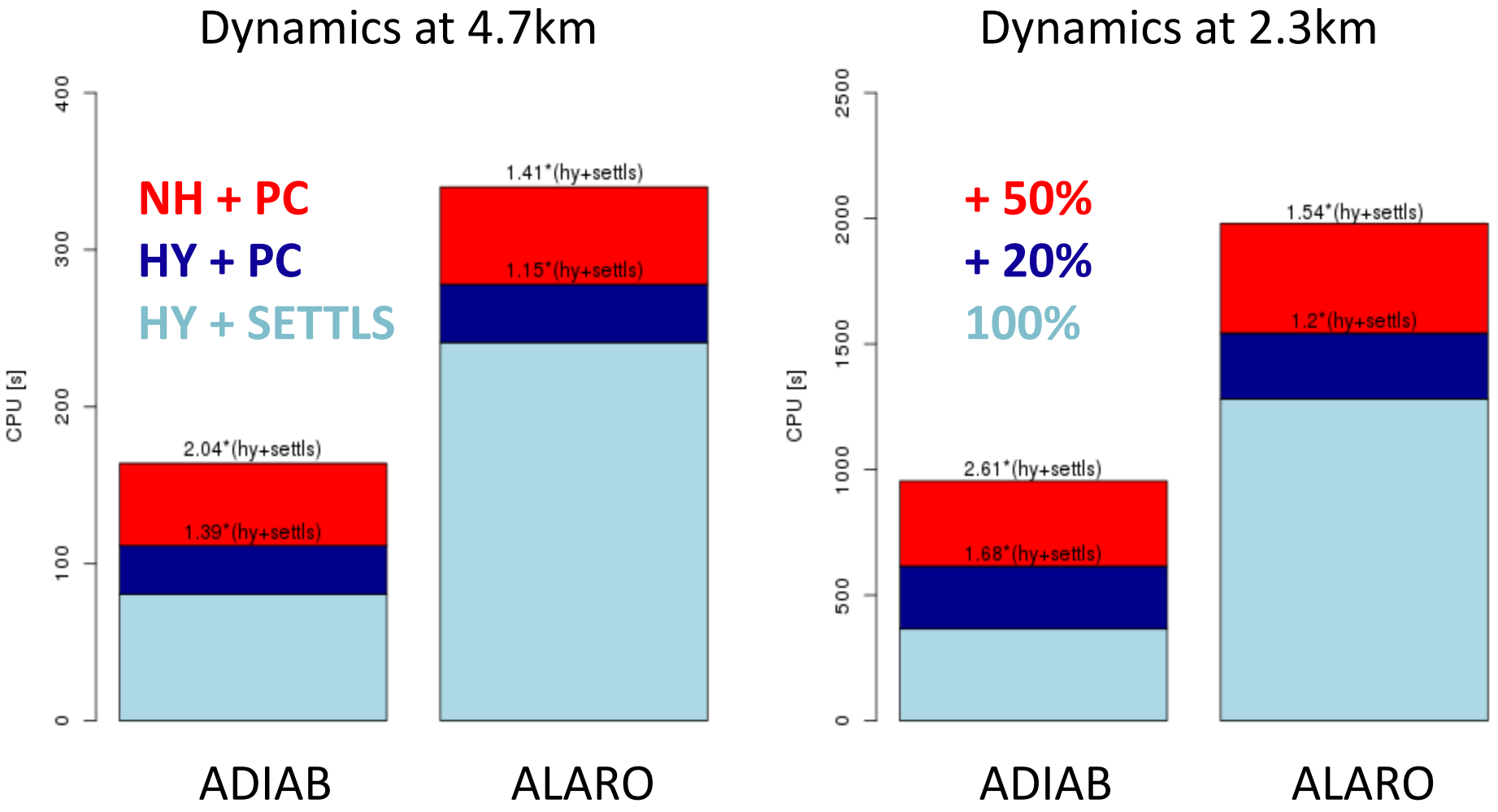
4) objective scores (RMSE, BIAS, STDE)

- spectral damping tuned separately for temperature and wind
- objective scores neutral except for temperature at 250hPa

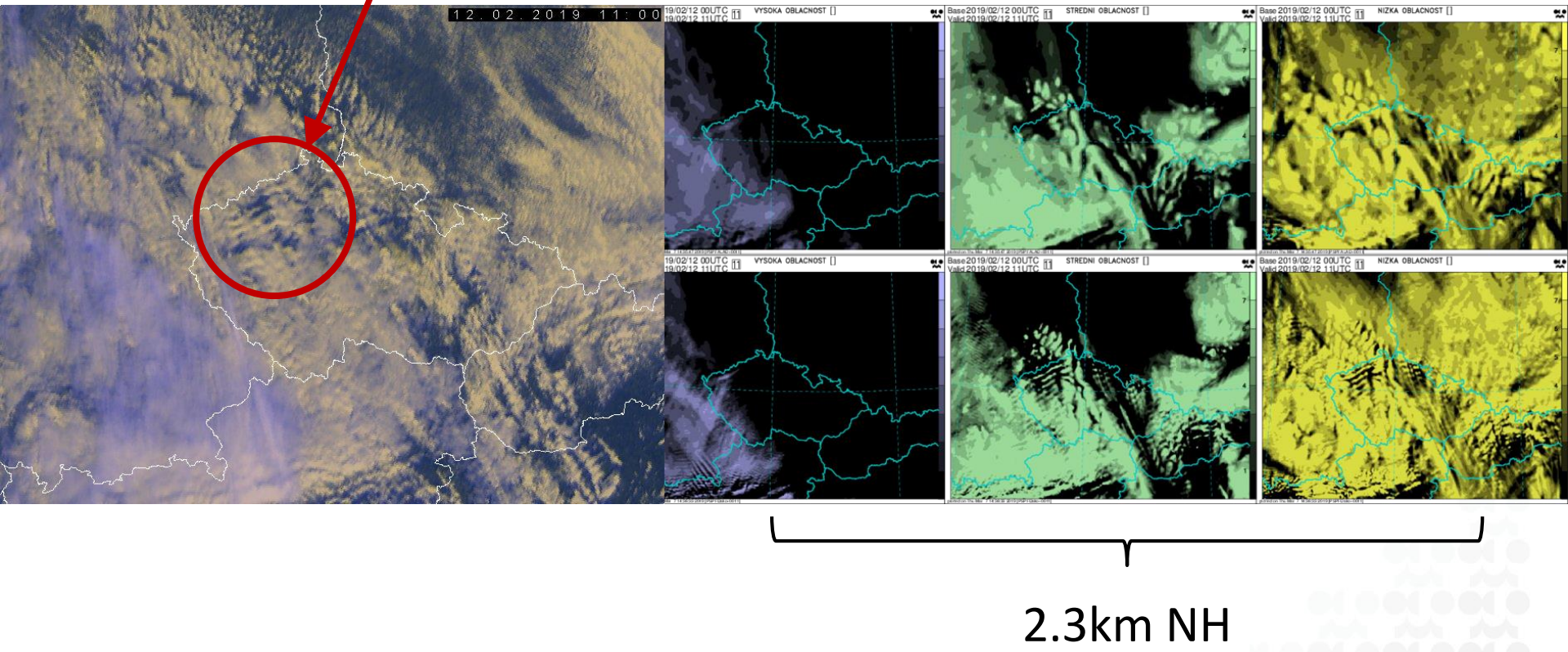




CPU time usage



Gravity waves seen in clouds




Thank you !
ElenaSalvai