Dynamics & Coupling

2007-2008 progress report

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CHMI

New interpolators for SL

Work of: J. Mašek (Sk) and F. Váňa (Cz)

- The Lagrangian cubic interpolation is replaced by a general two-parametric interpolator:

$$F(x,\mathbf{y}) = w_0(x)y_0 + w_1(x)y_1 + w_1(1-x)y_2 + w_0(1-x)y_3$$

where $\mathbf{y} = (y_0, y_1, y_2, y_3)$

$$w_0(x) = a_1 x + a_2 x^2 - (a_1 + a_2)x^3$$

$$w_1(x) = 1 + (a_2 - 1)x - (3a_1 + 4a_2)x^2 + 3(a_1 + a_2)x^3$$

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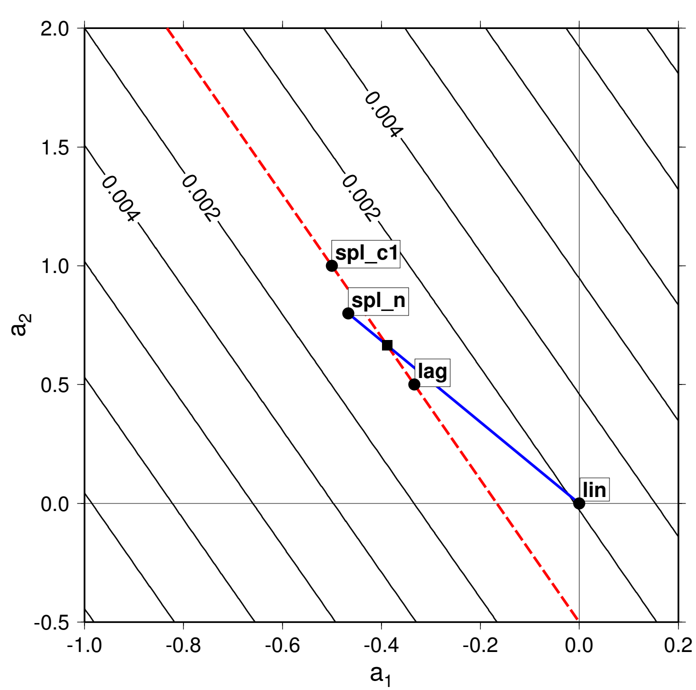
- Any interpolator F in (a_1,a_2) plane can be composed as a linear combination of (three) other interpolators:

  $$F = \kappa_1 F_1 + \kappa_2 F_2 + (1 - \kappa_1 - \kappa_2)F_3$$

New interpolators for SL

Mean absolute error of interpolation

Mean absolute error of interpolators, w = exp(-25.m/M)



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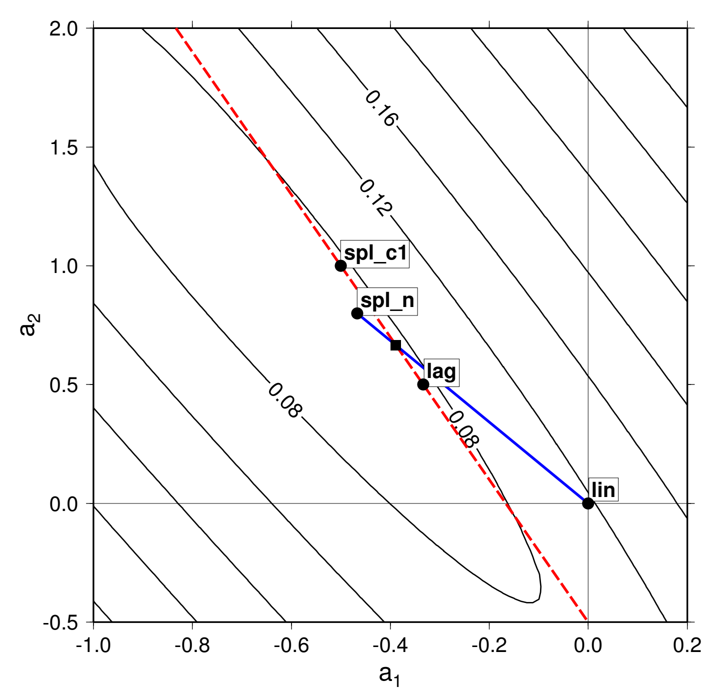
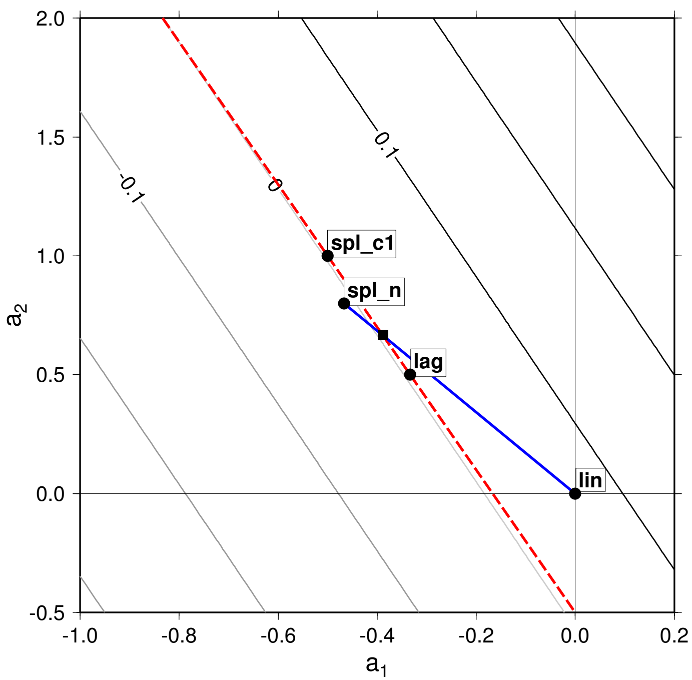


New interpolators for SL

Dimensionless damping rate

Damping factor for N = 100, m = 10



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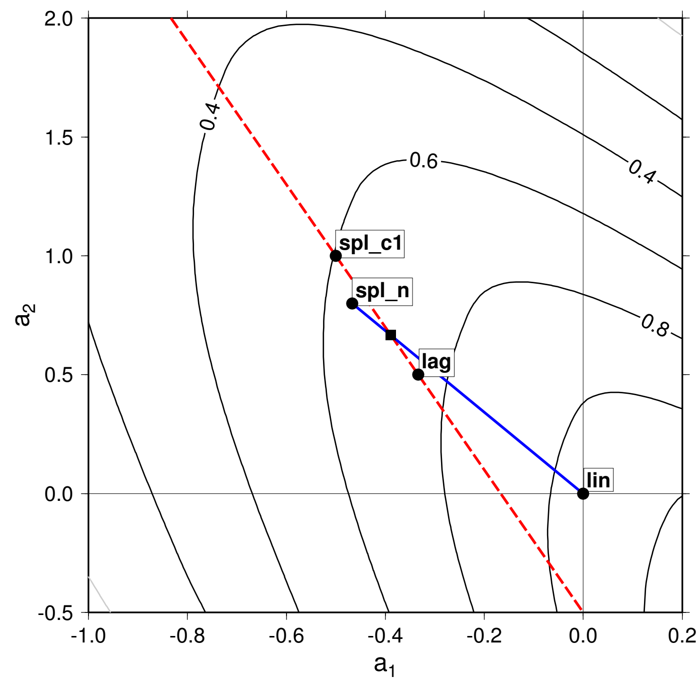
Damping factor for N = 100, m = 40



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Implementation guidelines

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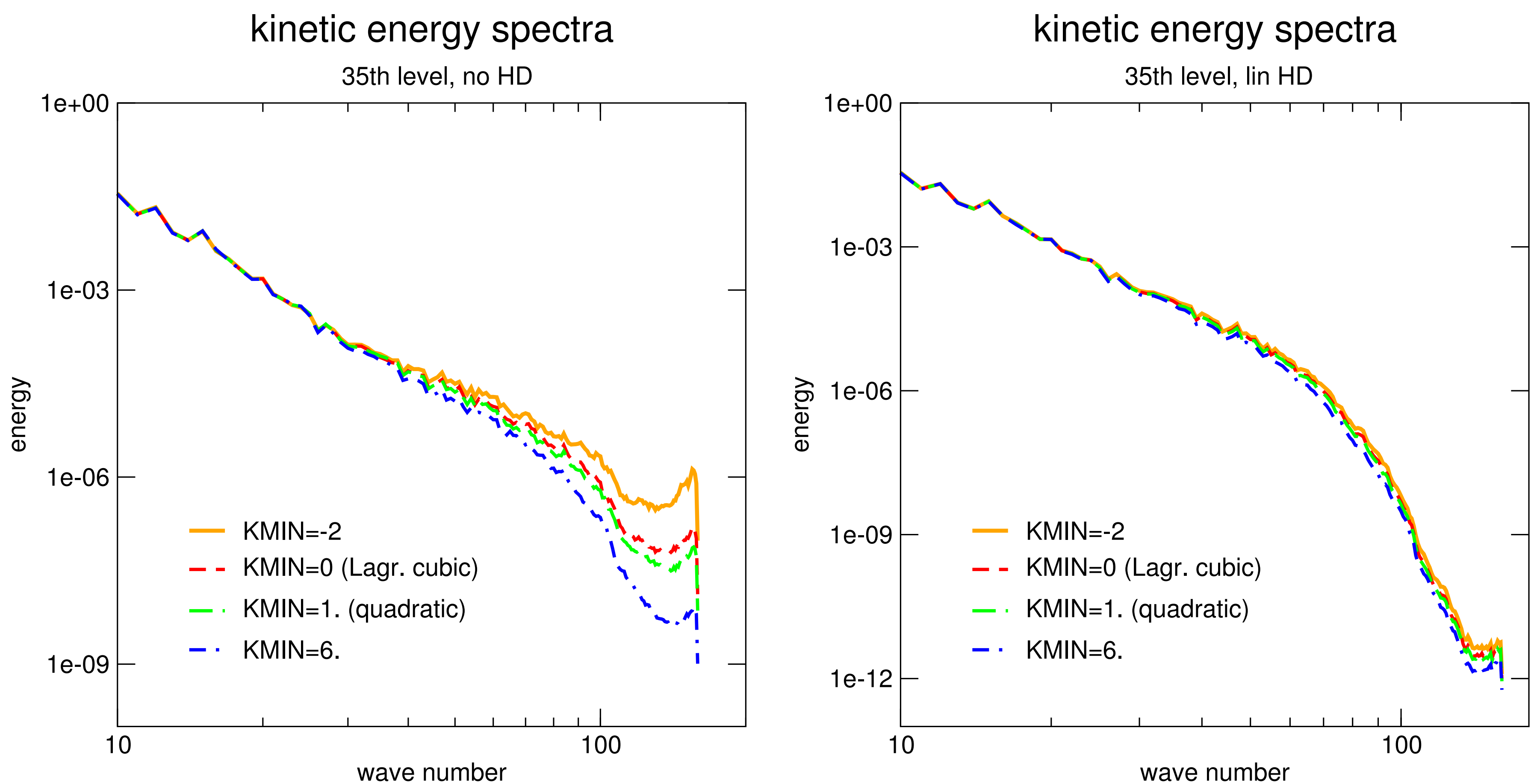
- The new data-flow (including the TL/AD code) is available from CY35T1.

New interpolators for SL

3h adiabatic forecast



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New features in SLHD

Work of: J. Mašek (Sk), F. Váňa (Cz) and P. Bénard (Fr)

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- Optionally the 3D grid-point laplacian is available as the damping operator.

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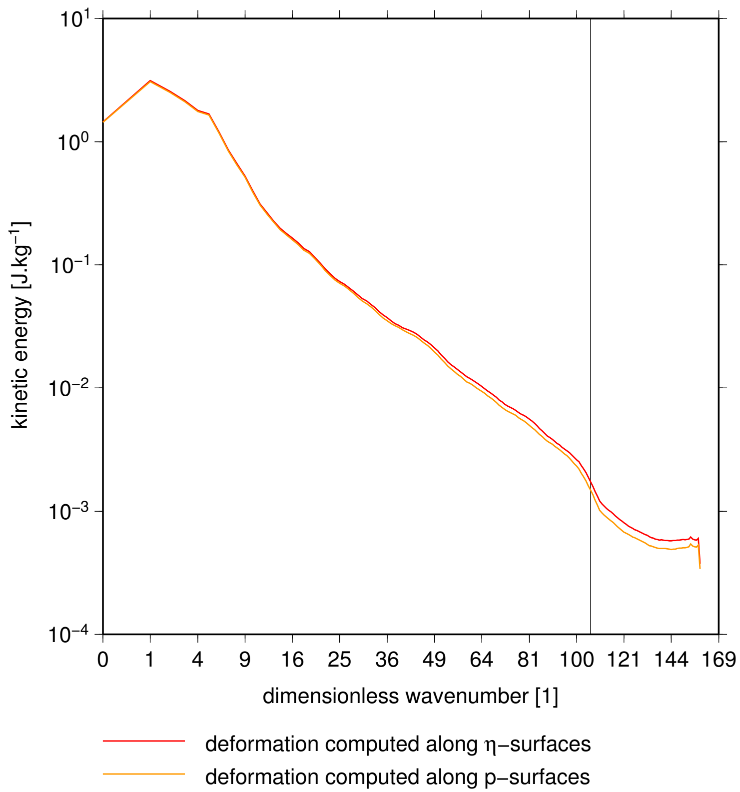
New features in SLHD

Impact of horizontal triggering, Alps Δx=2.5 km

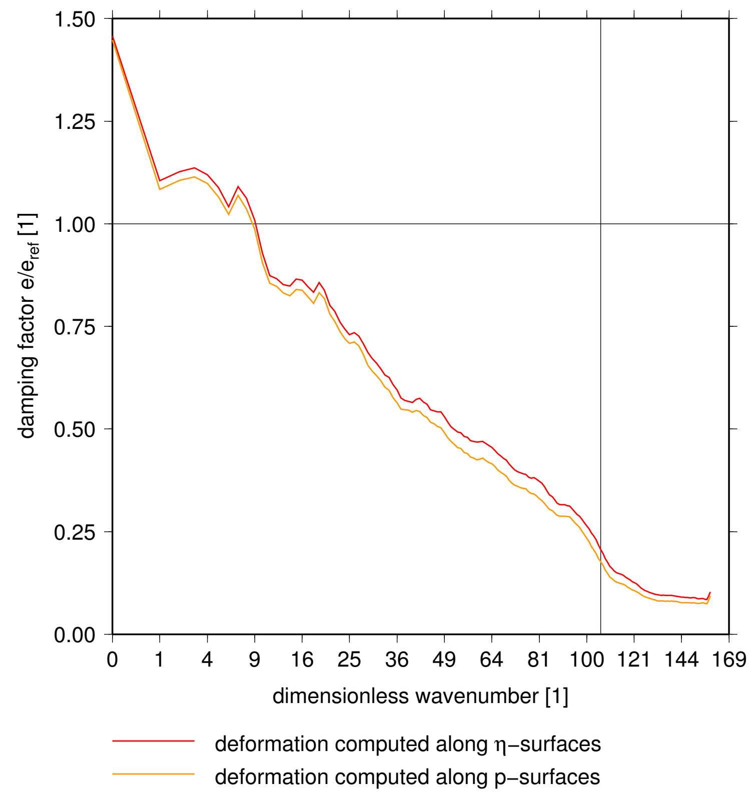
Kinetic energy spectrum

(+0006 hour forecast, model level 041)



Spectral damping by SLHD scheme

(+0006 hour forecast, model level 041)



New features in SLHD

Laplacian transformed to weights

Applying 2nd order diffusion to interpolated quantity y:

$$\begin{aligned}\tilde{y} &= (1+\varepsilon\Delta x^2\partial_x^2)y \\ &= (1+\varepsilon\Delta x^2\partial_x^2)w_1(y_1-y_0)+w_2(y_2-y_0)+w_3(y_3-y_0)\end{aligned}$$

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The implementation distinguish between ε_H and ε_V

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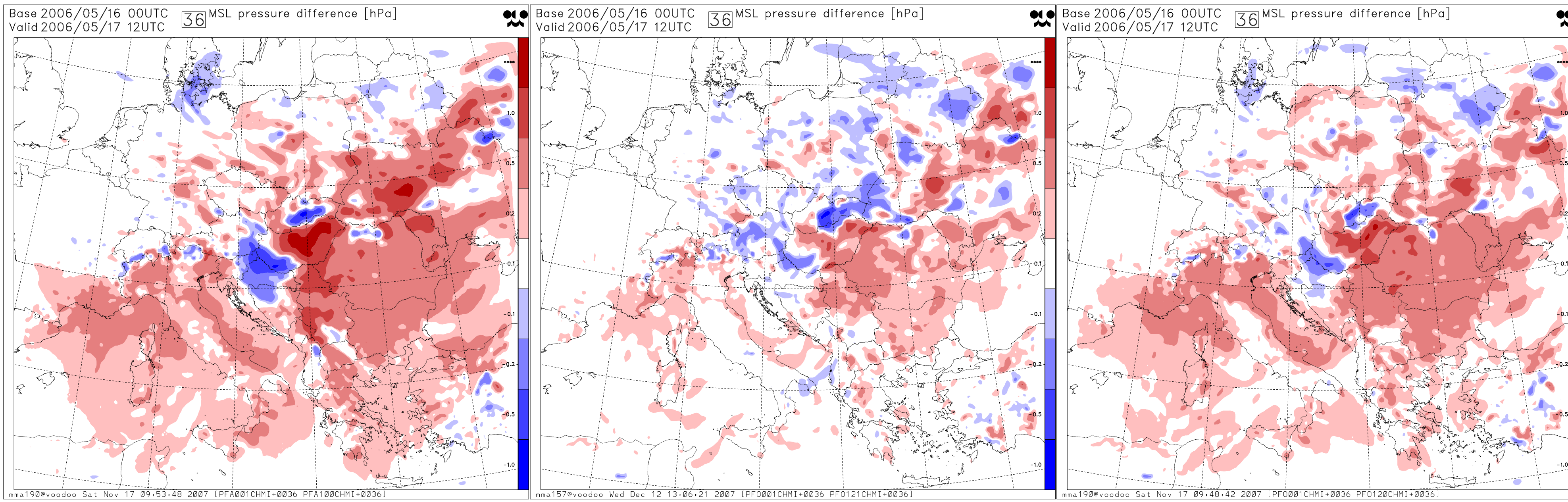
New features in SLHD

Impact of SLHD to MSL pressure bias



old SLHD   new SLHD   new SLHD; $\varepsilon_V = 0.02$

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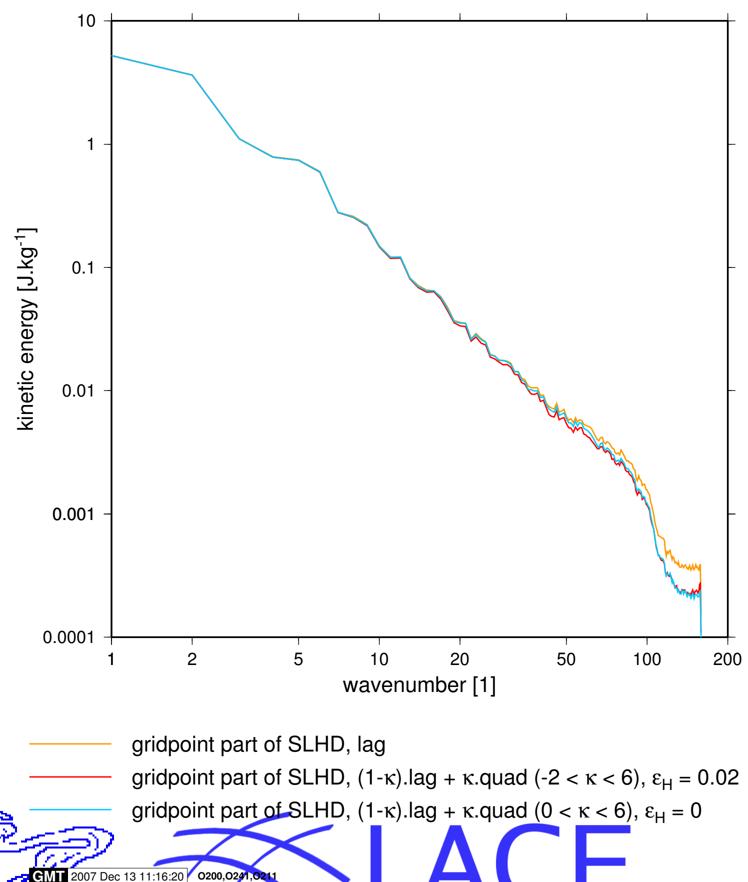
New features in SLHD

Impact to KE spectra

Impact of gridpoint part of SLHD
(kinetic energy spectra, level 041, t = +0006 h)



Impact of gridpoint part of SLHD
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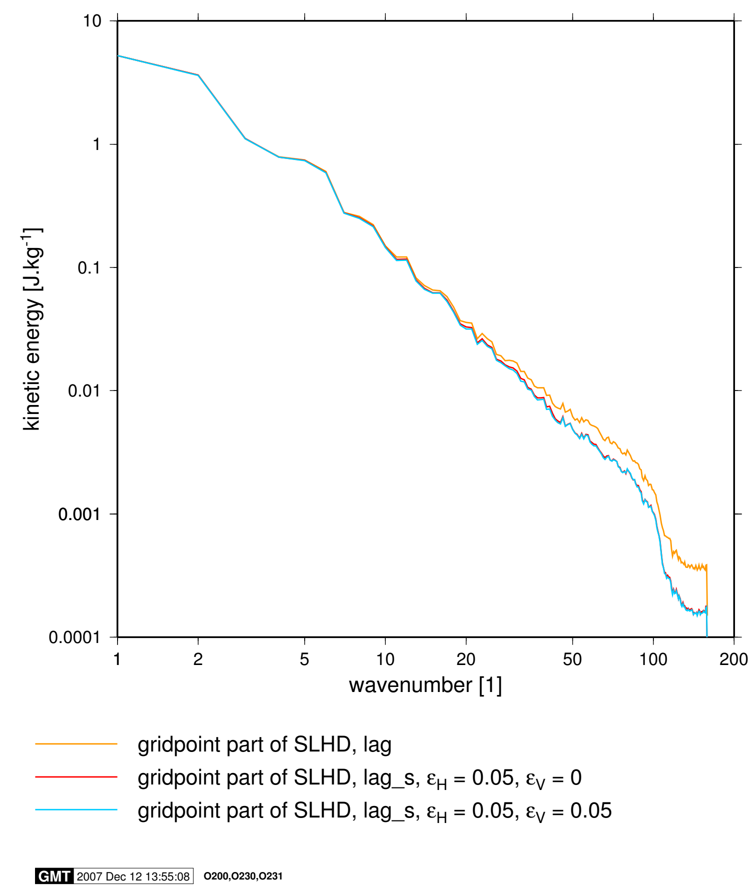

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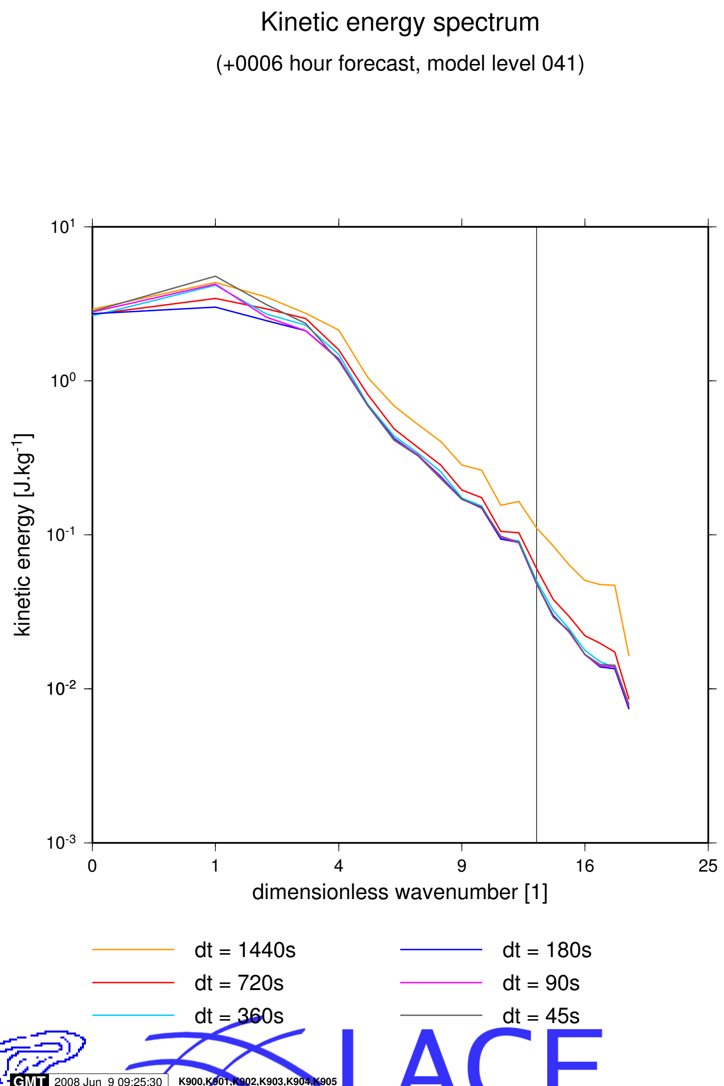
New features in SLHD

Impact of Δt



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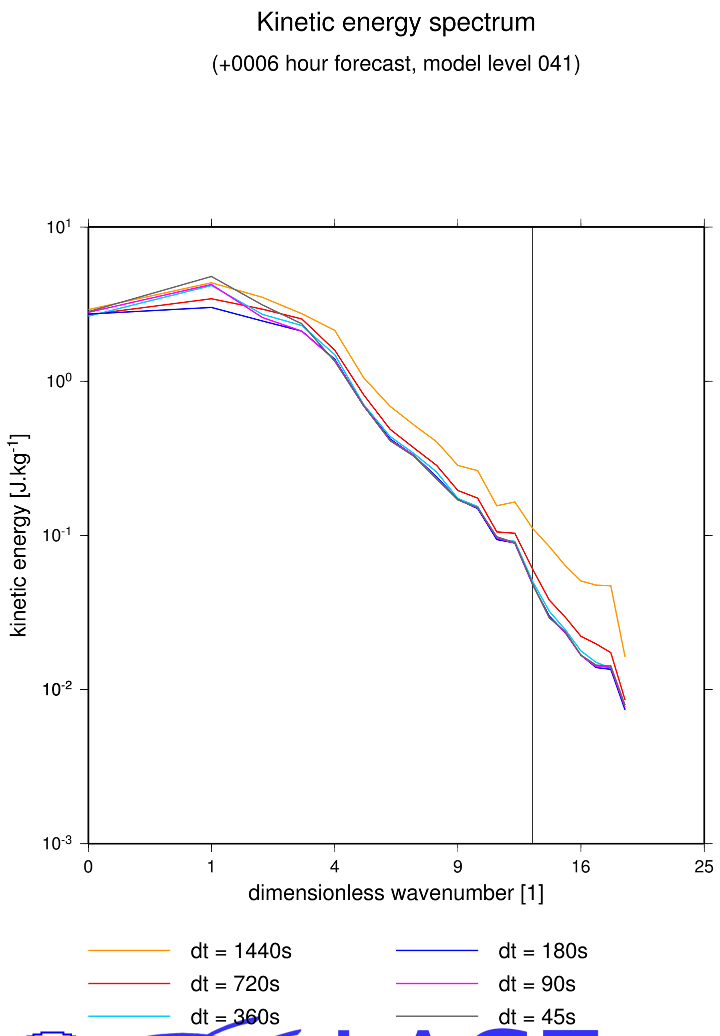

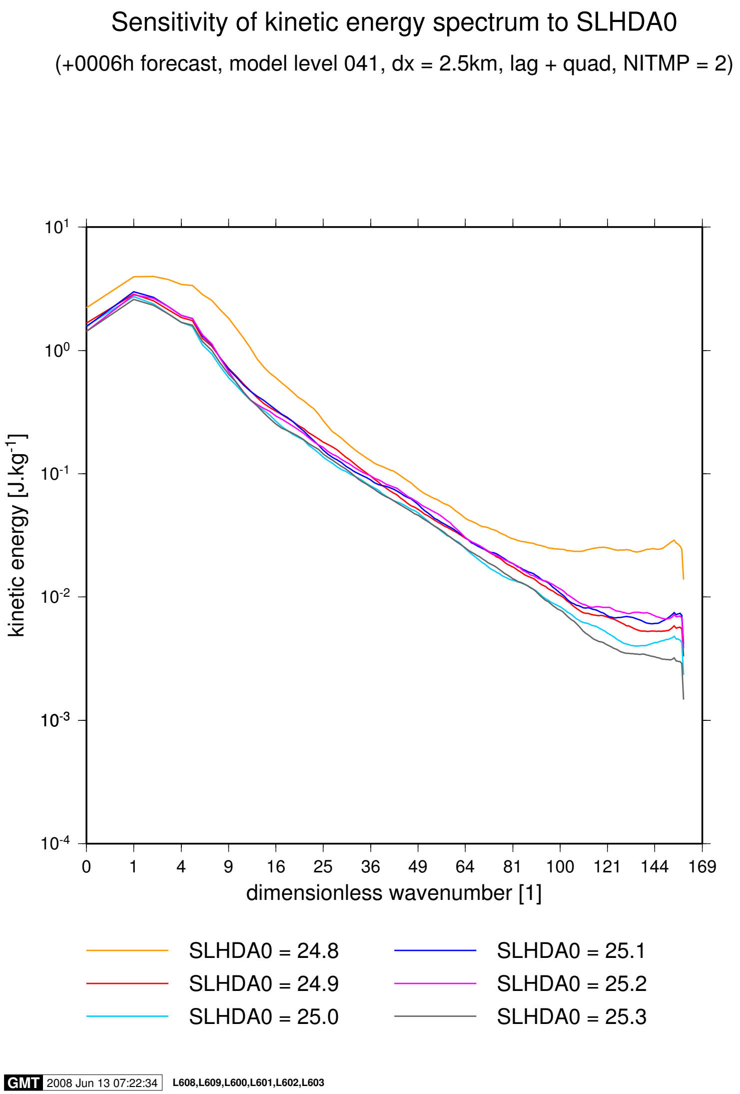

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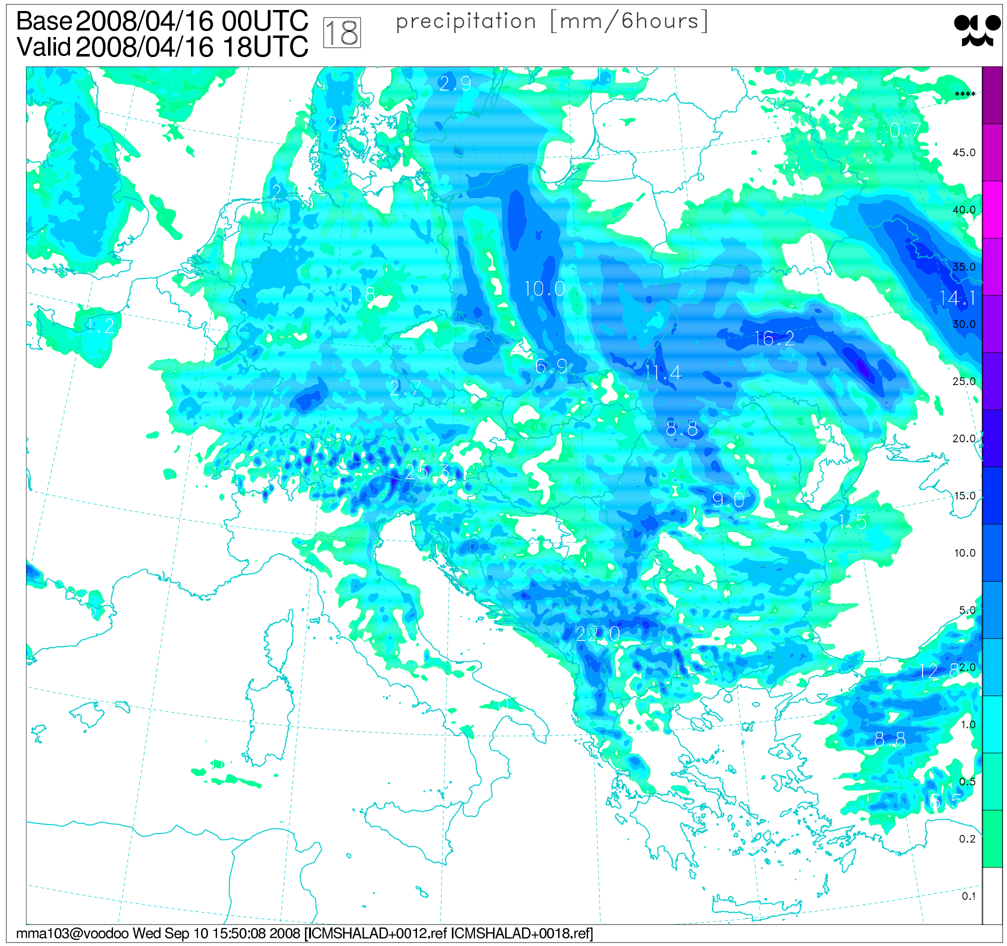
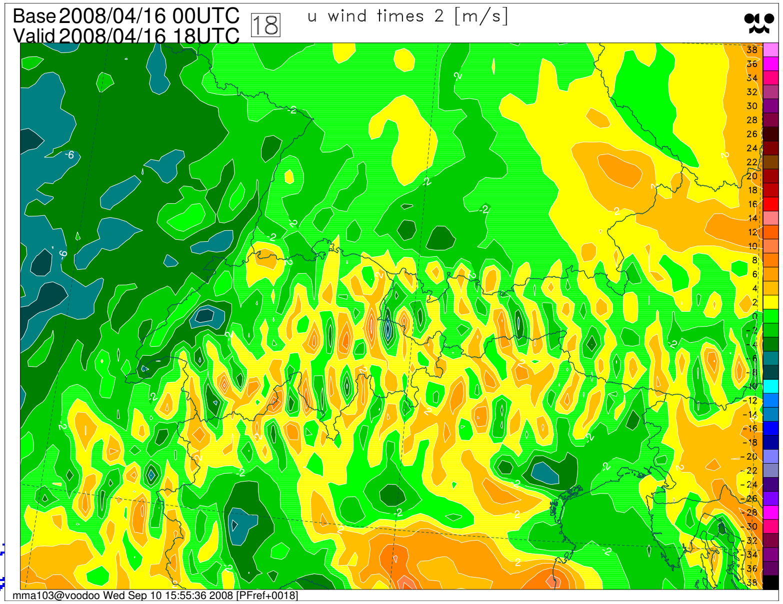
Spectral orography representation

Work of: F. Váňa and R. Brožková (Cz)



Spectral orography representation

- Quadratic orography modified according Bouteloup (MWR, 1995)



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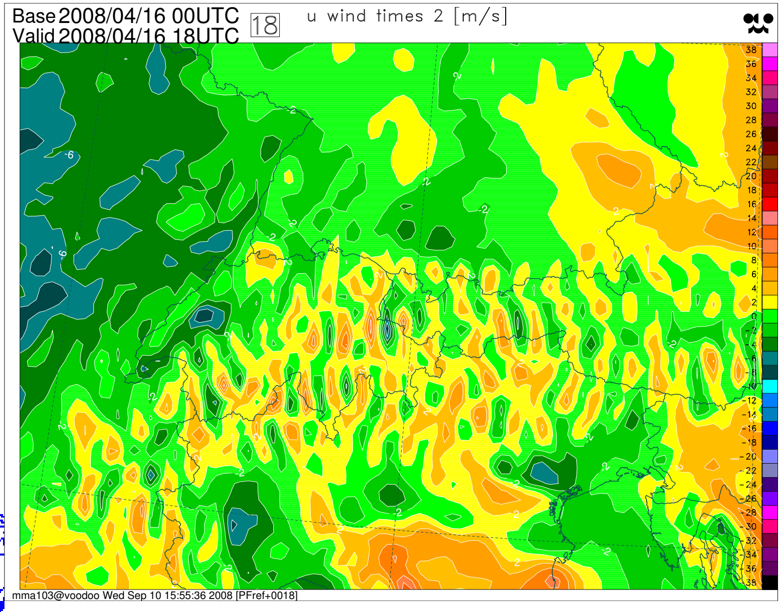
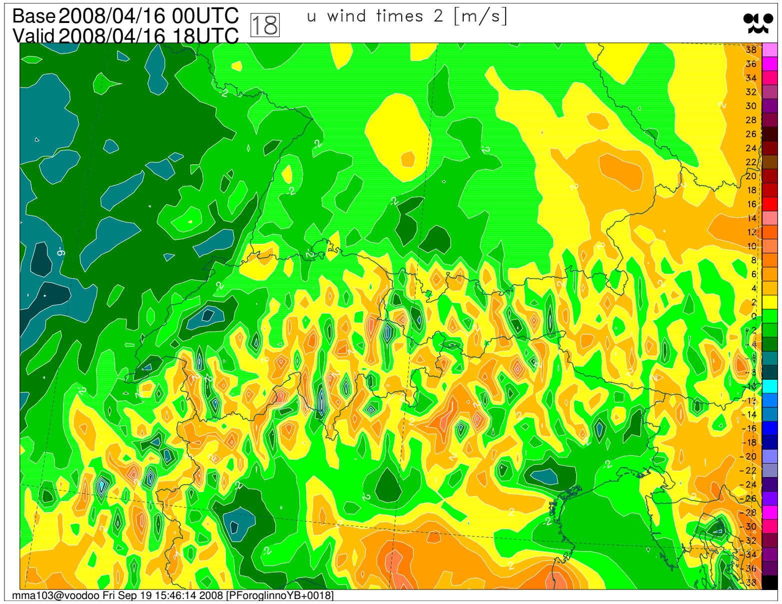
- Linear orography filtered by diffusion operator





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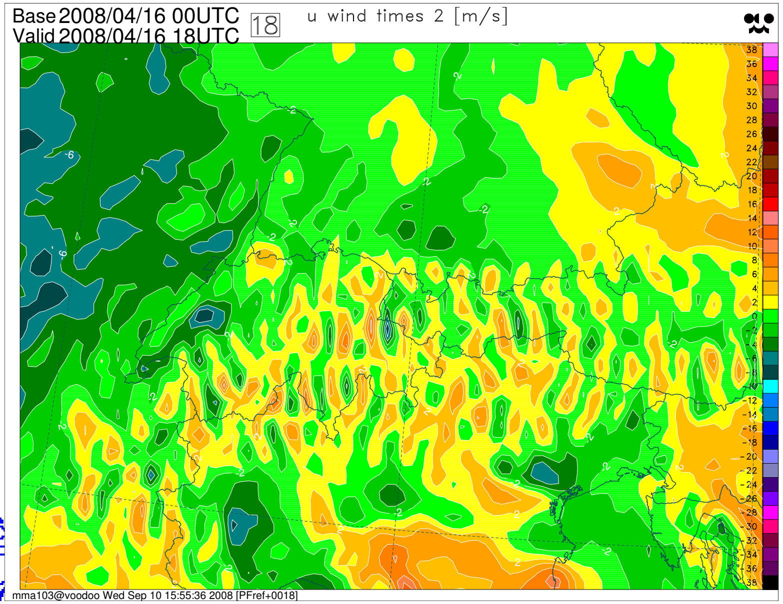
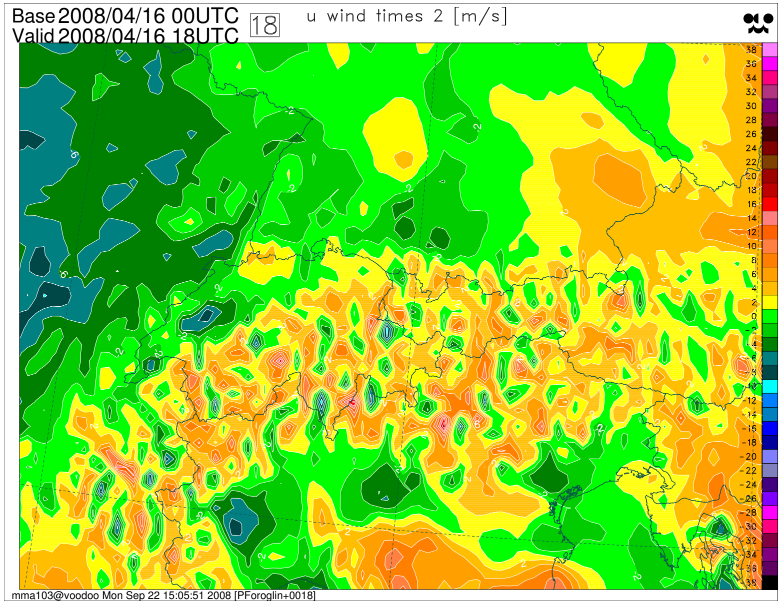
- Linear orography, no filtering





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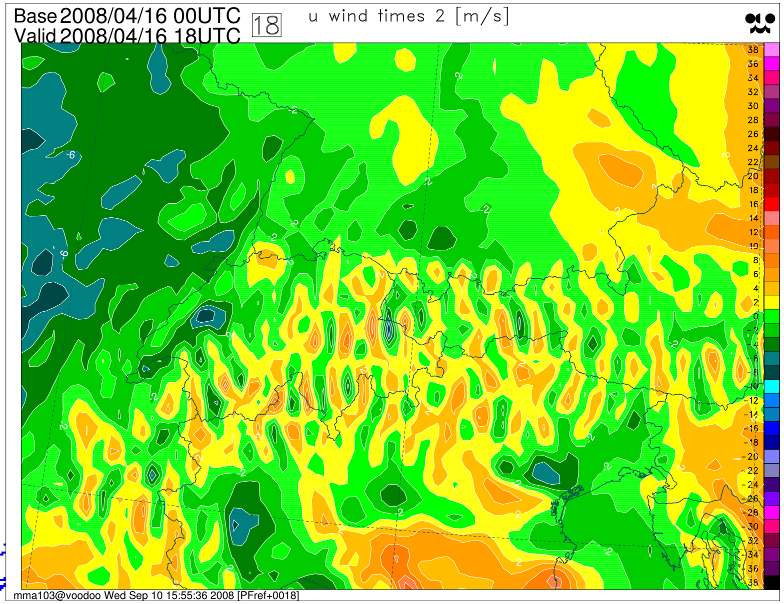

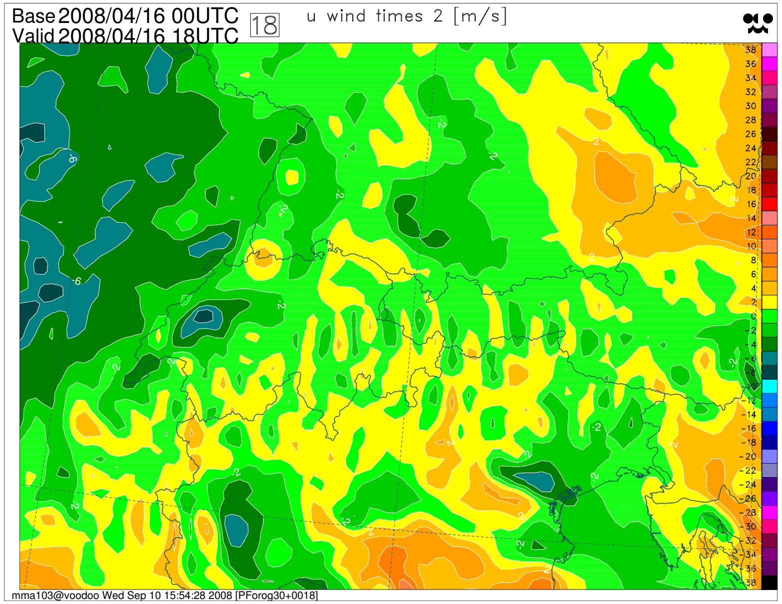

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⇒ A new cost function formulation ought to be defined. The E-zone seems to be an attractive place to displace the "noise" from model flat areas.

Other topics

- Implementation of the fully compressible flux conservative thermodynamic equations
  Work of: P. Smolíková and R. Brožková (Cz)

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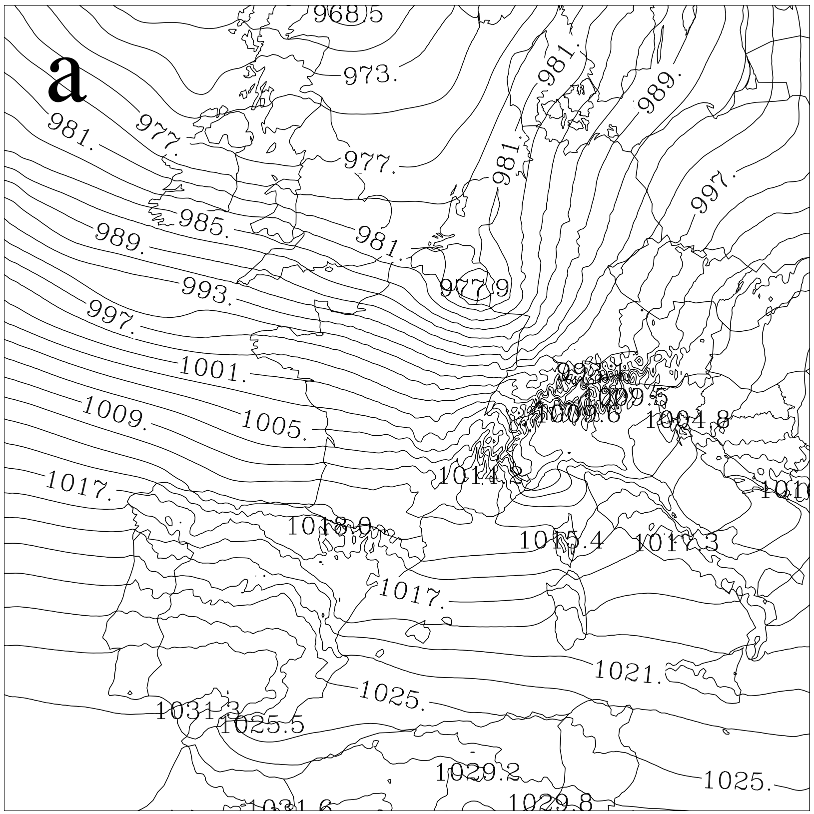
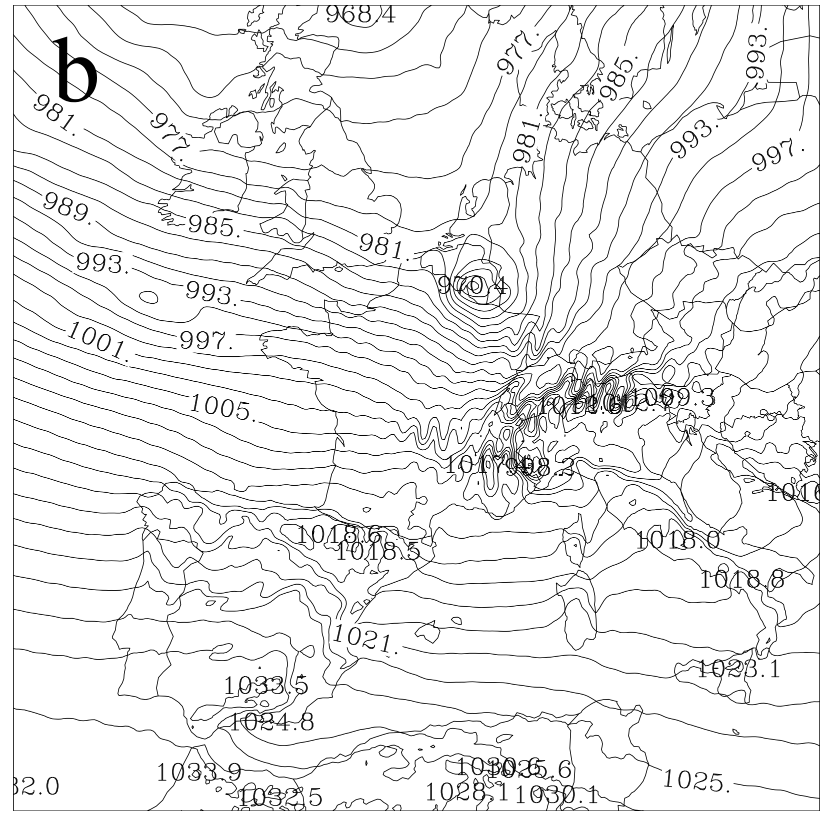
- Interaction of DFI with the way how the derivatives of RT are computed
  Work of: P. Smolíková and R. Brožková (Cz)
- 2nd order accurate physics-dynamics interface
  Work of: I. Bašták-Durán (Sk), P. Termonia and R. Hamdi (Be)

Scale selective DFI

Work of: P. Termonia (Be)



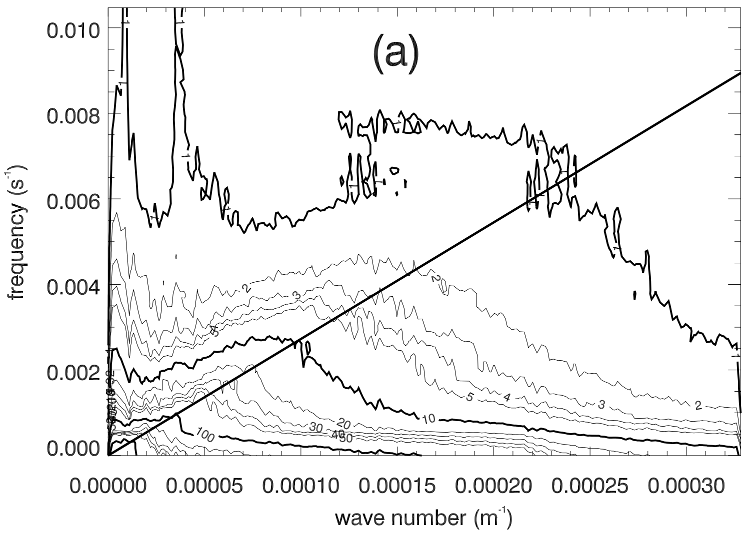
The result of a standard (operationally) used DFI (**977.9 hPa**).

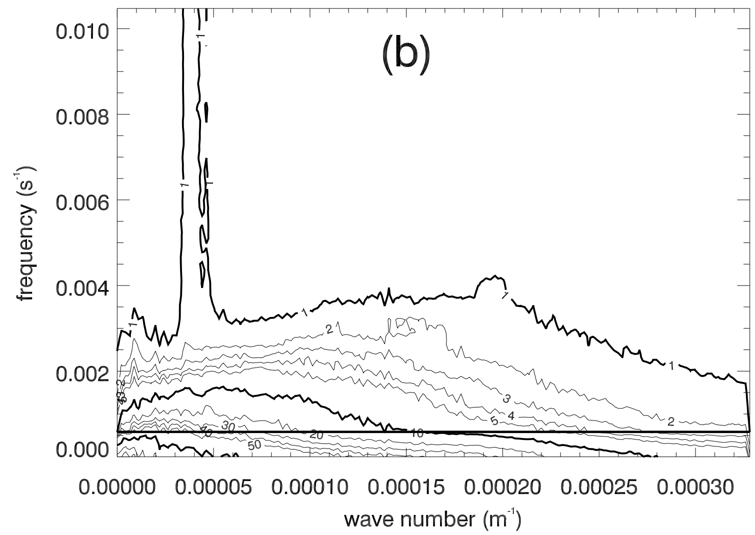


ALADIN forecast after developing for 9 h (**970.4 hPa**).

Scale selective DFI

Spectrum in time and space



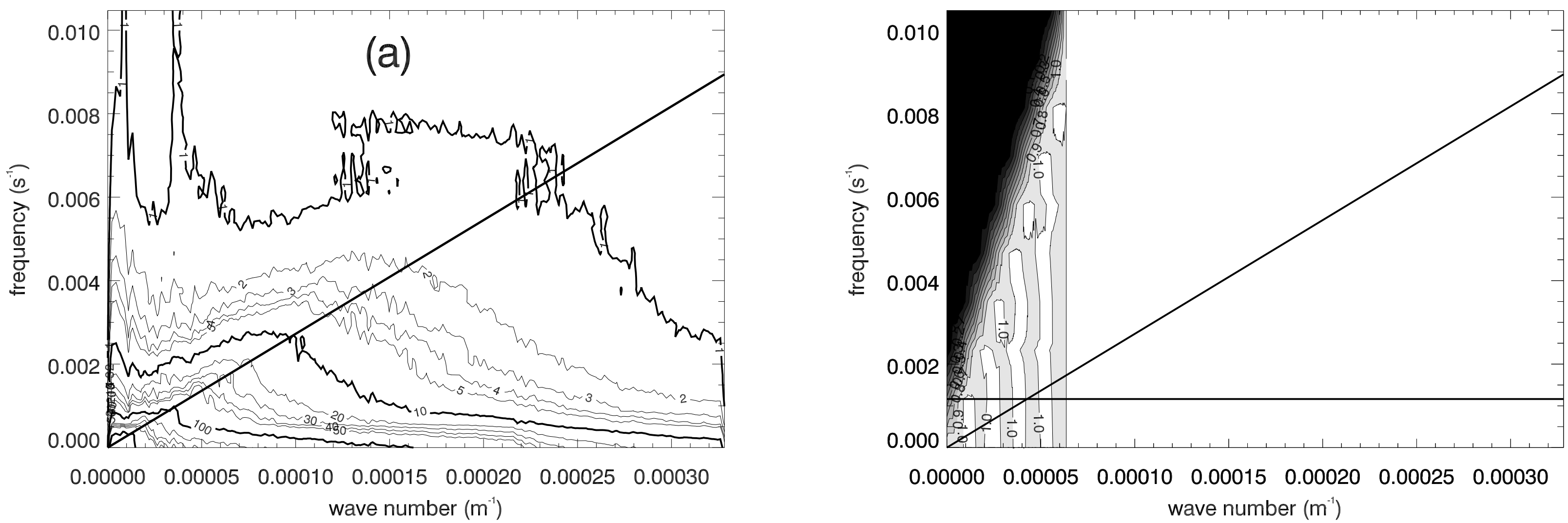


The Lothar storm $\ln p_s$ decomposed between 0600 UTC and 1200 UTC on 28 December 1999. The thick line is the propagation speed of the storm in this time interval: 98 km/h.

$\ln p_s$ decomposed between 0600 UTC and 1200 UTC of an anticyclonic case on 28 December 1999. The thick horizontal line corresponds to a filter cut-off period of 3 h.

Scale selective DFI

Scale-selective low-pass windows



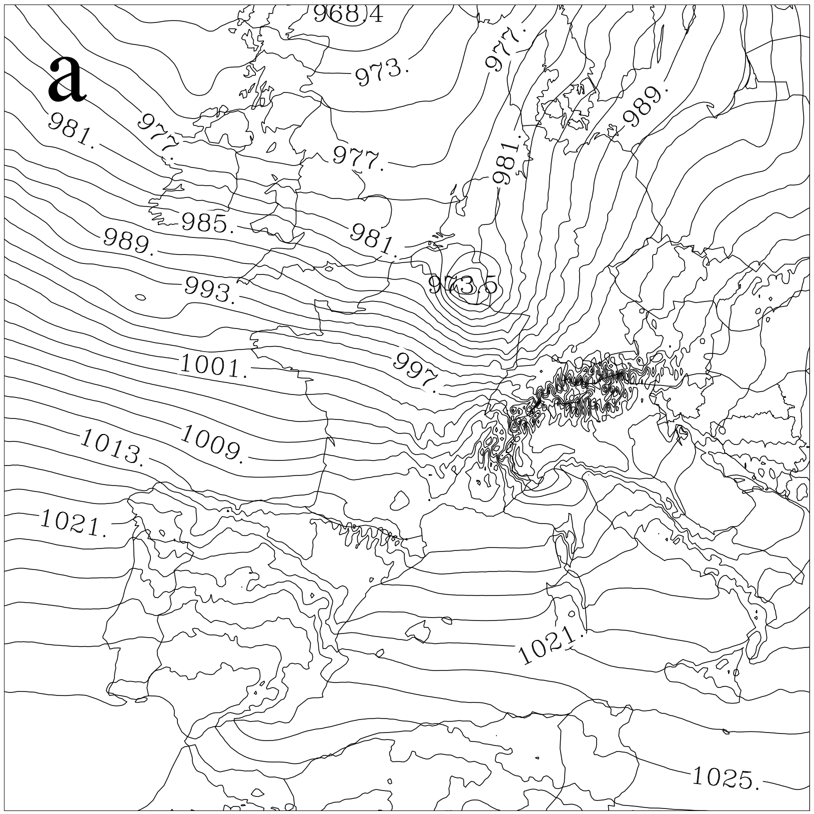
The *scale-selective* cut-off frequency of a low-pass Lancsoz filter:

$$\omega_c(\kappa) = \begin{cases} \omega_c^0 + \frac{\kappa}{\kappa_c}\left(\frac{\pi}{\Delta t} - \omega_c^0\right) & \text{if} \quad \kappa \leq \kappa_c \\ \frac{\pi}{\Delta t} & \text{if} \quad \kappa > \kappa_c \end{cases}$$

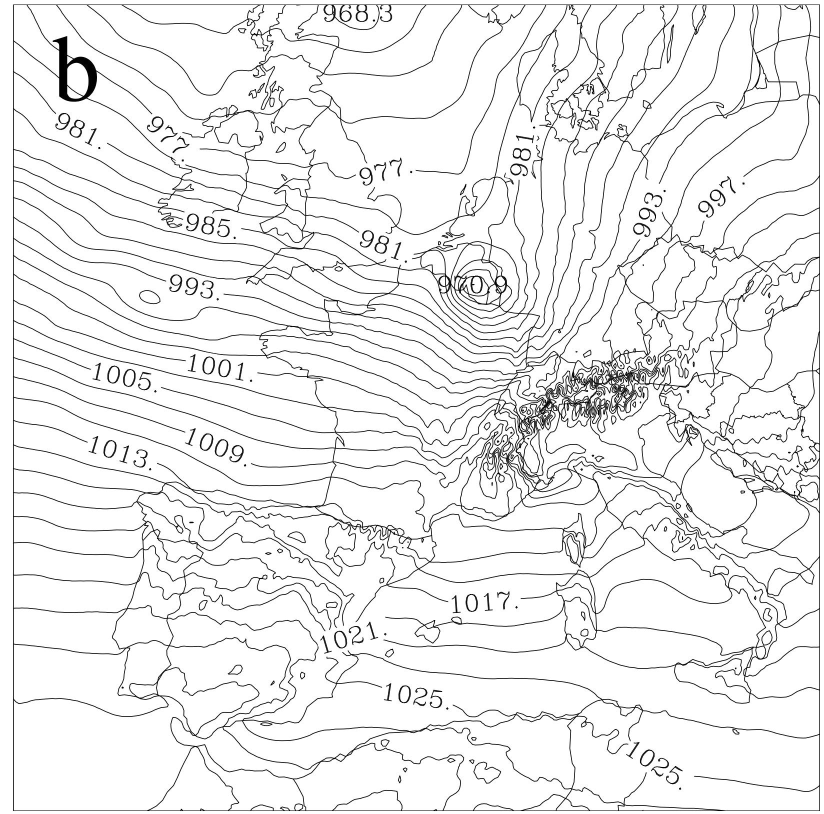
The cut-off period is $T_c^0 = 2\pi/\omega_c^0$ while the *slope* of the cut-off frequencies is $c = \pi/(\kappa_c \Delta t)$.

Scale selective DFI

Results:



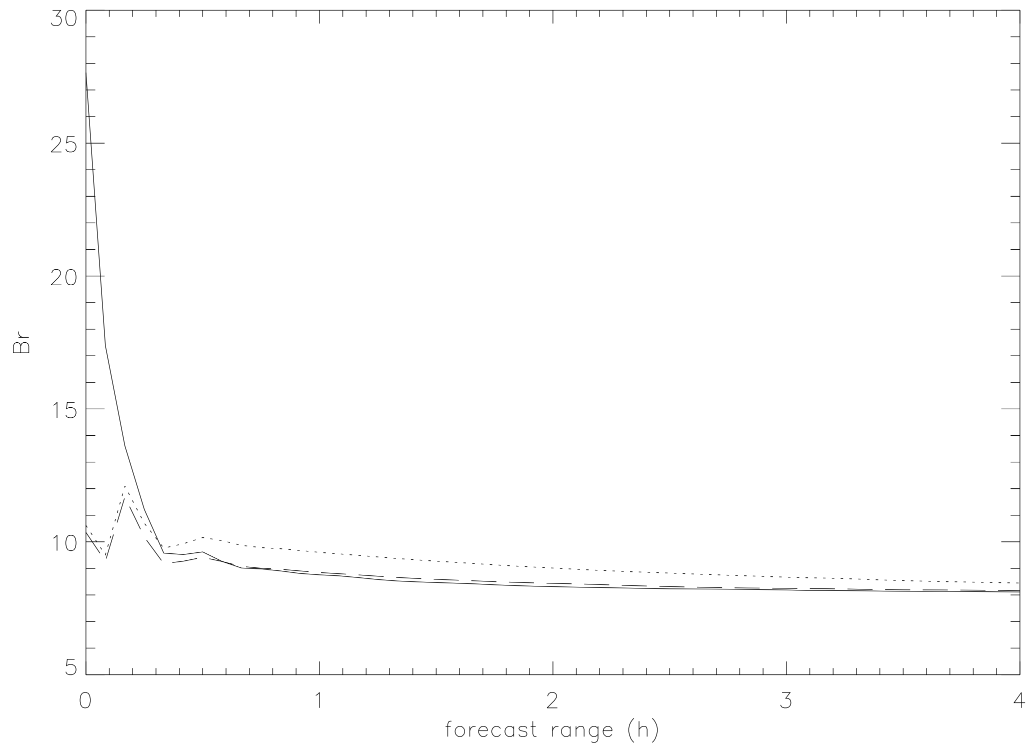
a run with $T_c^0 = 3h$ (**973.5 hPa**).



a run with $T_c^0 = 1.5h$ (**970.9 hPa**).

Scale selective DFI

$$Br = 100 \frac{\sum_{IJ} |\sum_L \nabla \cdot \Delta p_L \mathbf{V}_{IJL}|}{\sum_{IJ} \sum_L |\nabla \cdot \Delta p_L \mathbf{V}_{IJL}|}$$ (Lynch and Huang, MWR, 1992)



solid: uninitialized

dots: full DFI

dashed: $\mathrm{SSDFI}_{1.5\mathrm{h}}$

There are 2 surprises:

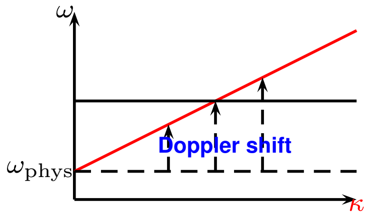
- filtering *less* ($\mathrm{SSDFI}_{1.5\mathrm{h}}$) $\Rightarrow$ *more* balanced!
- but, full DFI is *worse* than uninitialized after *half and hour*!?

DFI actually creates an unbalance in the *slow* part of the part of dynamics! So it needs a longer time to adjust.

Scale selective DFI

Going to higher resolution

Δx = 10 km $\rightarrow$ Δx = 2 km: problems smaller with $(5\times)$ propagation speeds:



Scale selective DFI

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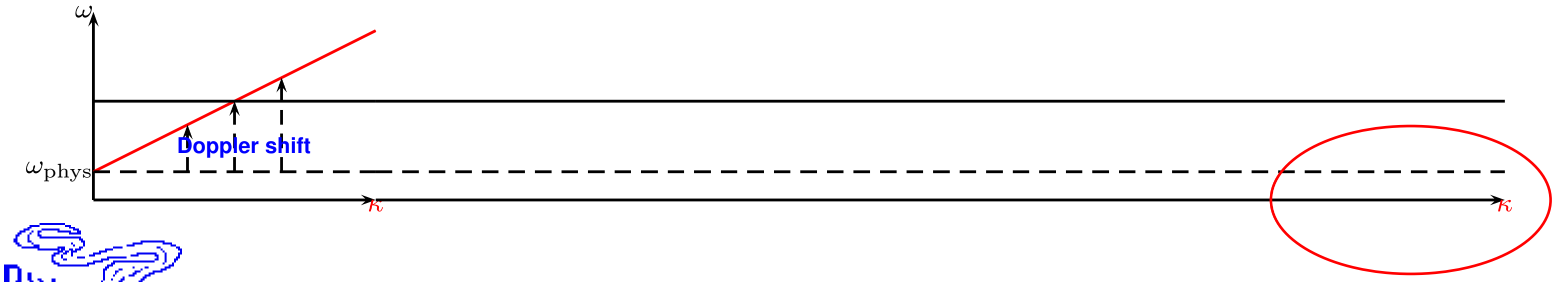
Δx = 10 km $\rightarrow$ Δx = 2 km: problems smaller with $(5\times)$ propagation speeds:

$$\omega = \omega_{\text{phys}} + c\,\kappa$$



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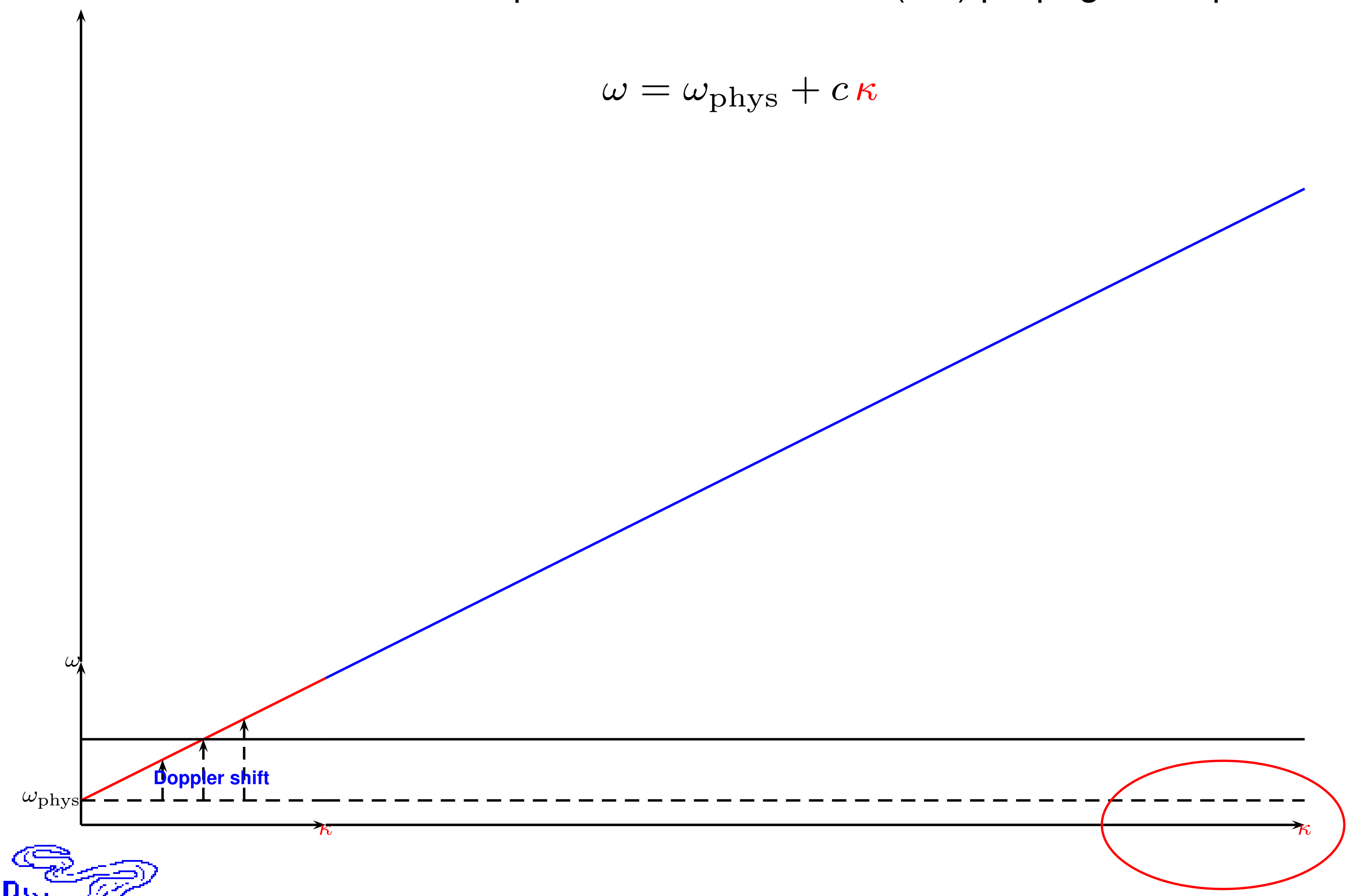

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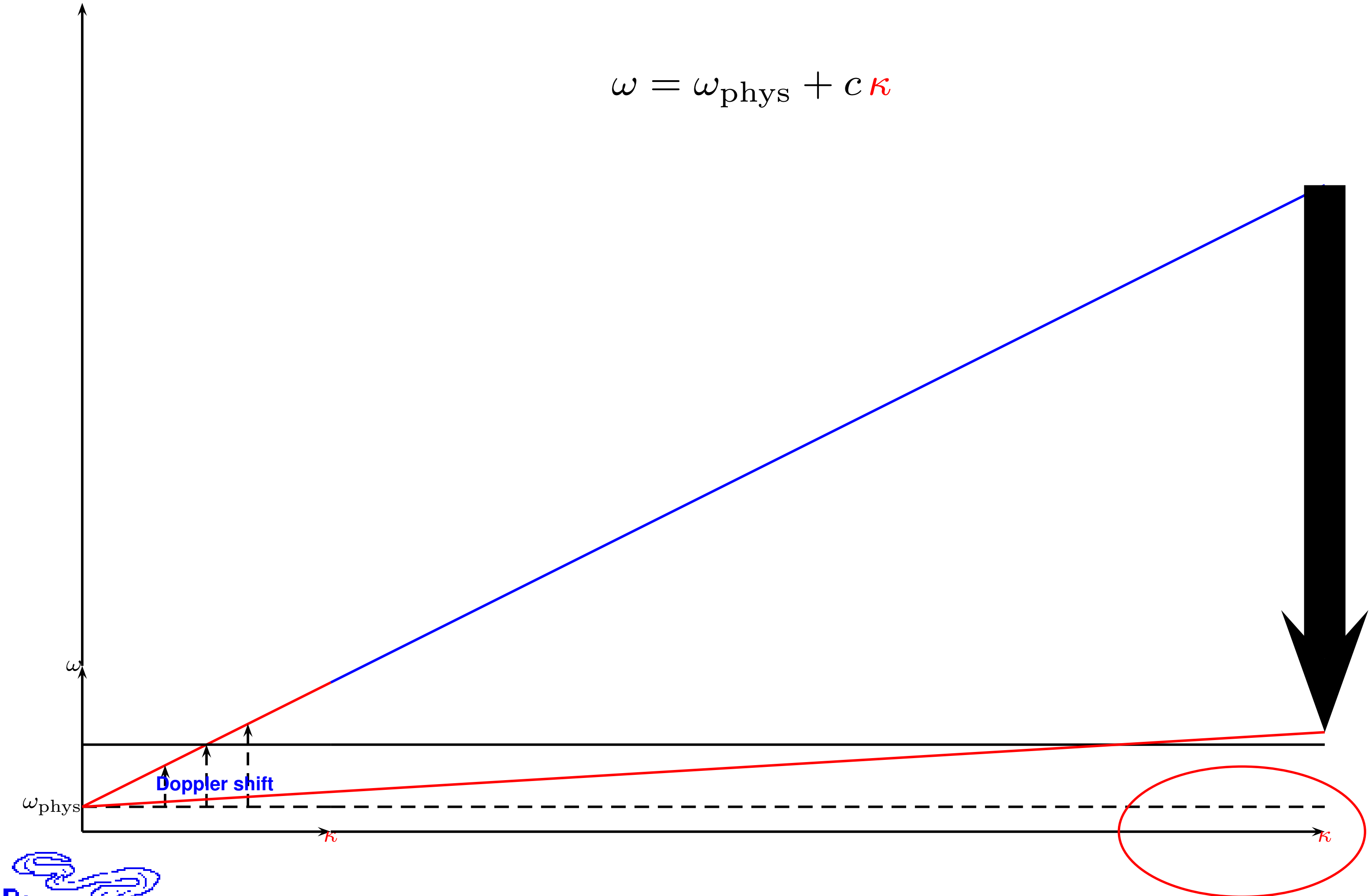
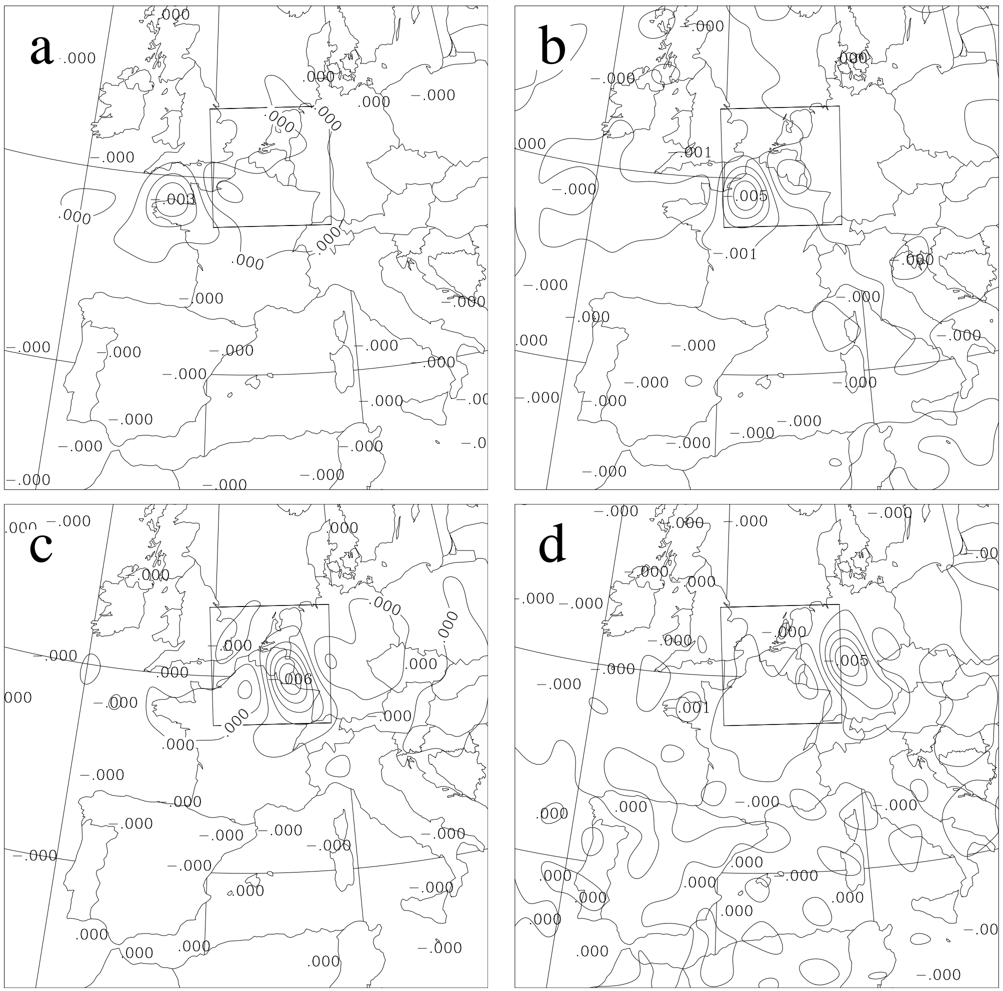


MCUF + BER

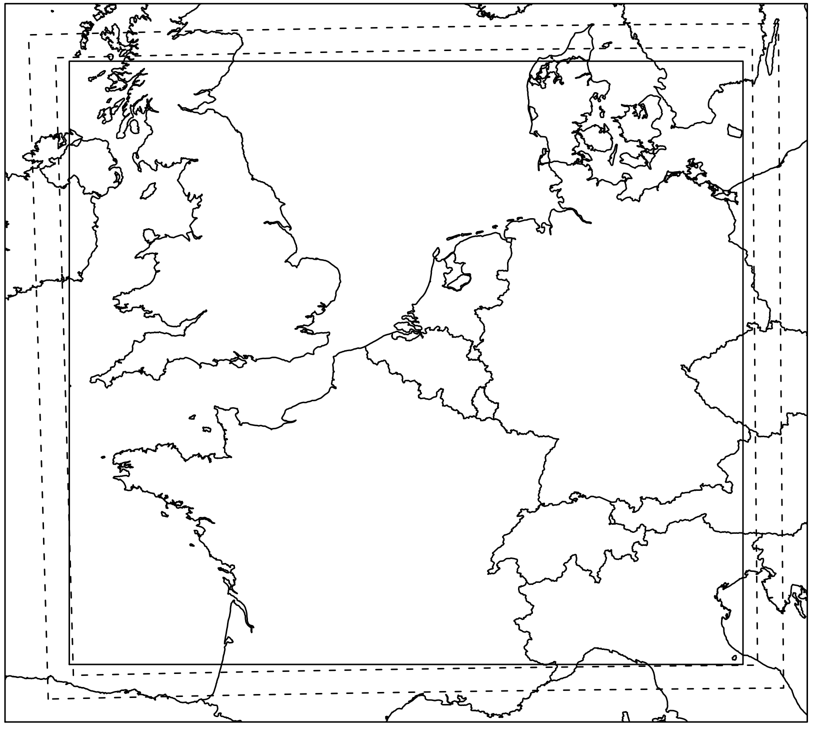
Work of: P. Termonia, A Deckmyn and R. Hamdi (Be)



The monitoring by the MCUF field is done in ALADIN-France, i.e. the coupling model.

MCUF + BER

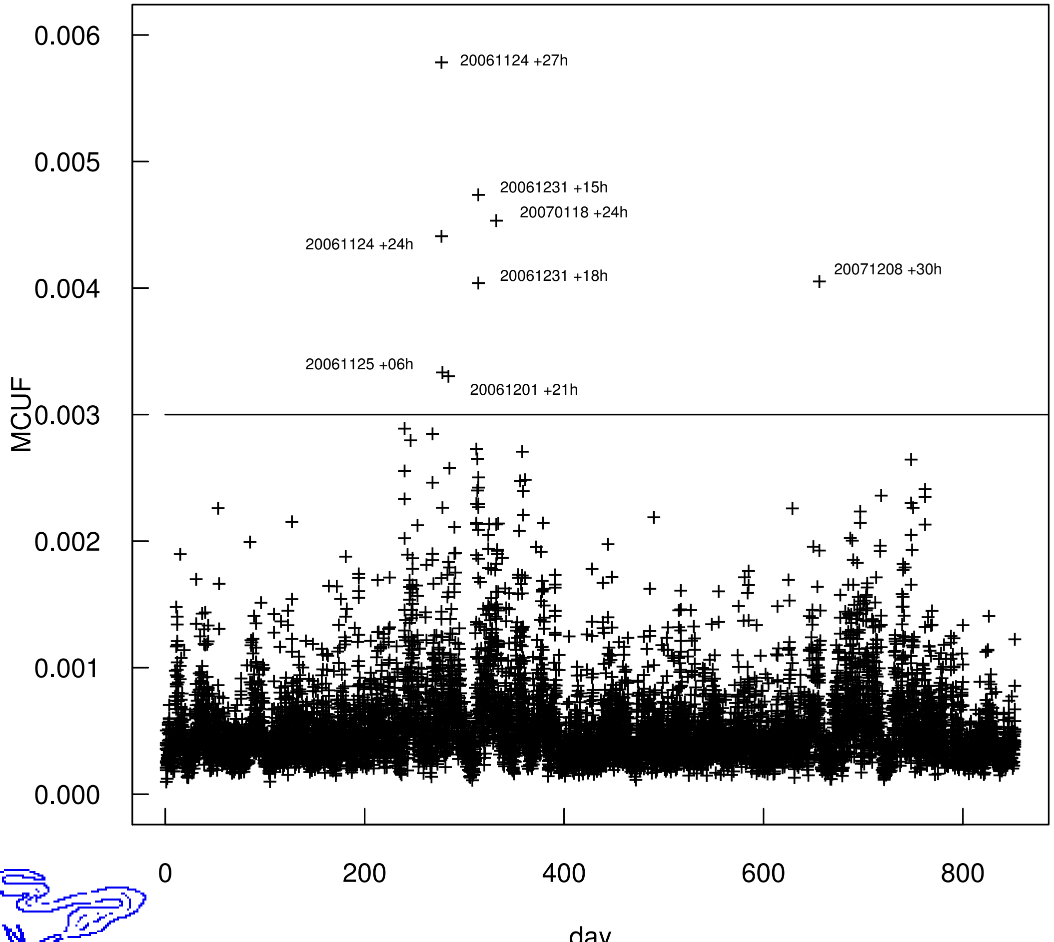
This MCUF field is operationally computed in ARPEGE and written to the coupling files of the ALADIN models. We considered it in the frame (solid line) covering the Davies zone (dashed),



MCUF + BER

The maximum MCUF in the frame

in the period 21 February 2006 – 30 June 2008



Let us consider a threshold value of 0.003. Then we had 8 alerts.

MCUF + BER

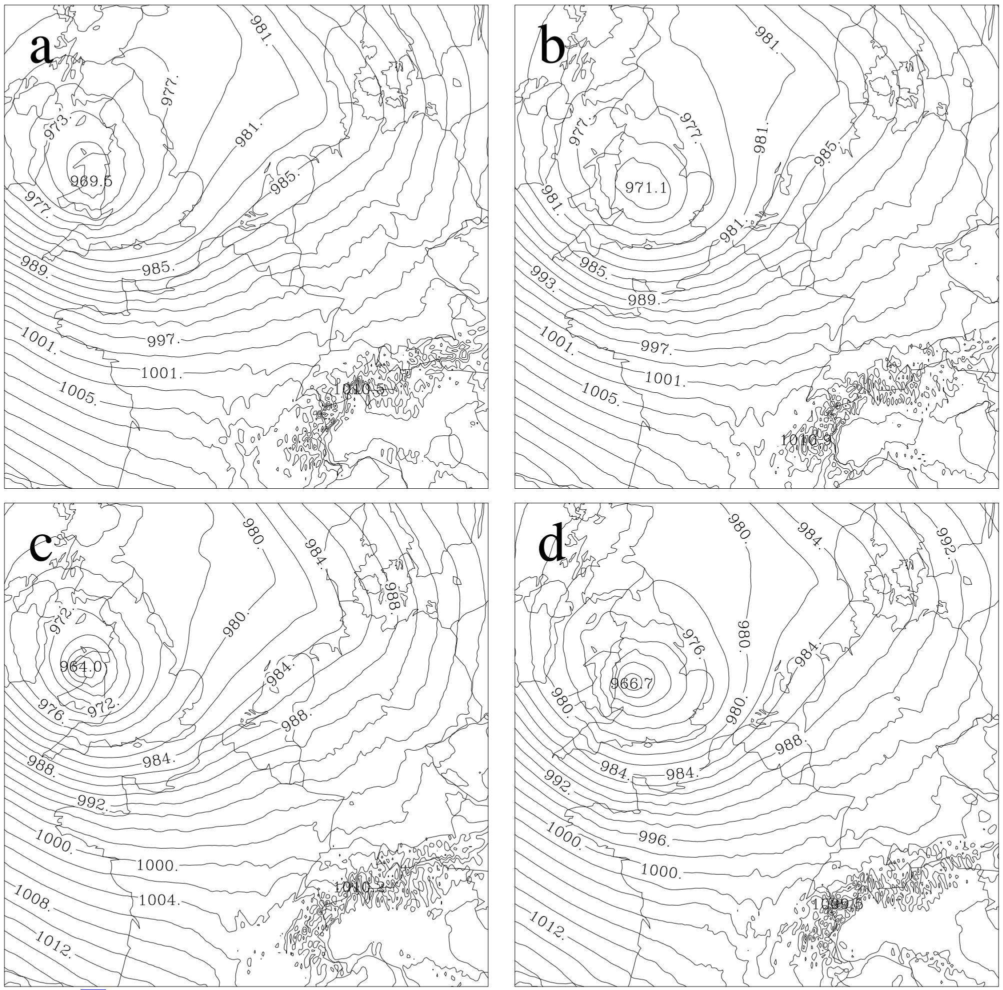
The maximum MCUF in the frame

date	MCUF time	MCUF value	type	BER time
2006/11/24	+24h	0.0044	*incoming*	+27 h
	+27h	0.0058	*incoming*	+27 h
2006/11/25	+06h	0.0033	*incoming*	+09 h
2006/12/01	+21h	0.0033	corner (NE)	+24 h
2006/12/31	+15h	0.0047	tangent	+18 h
	+18h	0.0040	tangent	+18 h
2007/01/18	+24h	0.0045	outgoing	+ 30 h
2007/12/08	+30h	0.0041	*incoming*	+ 33 h

We carry out a restart 3 hours later than the MCUF alert: *Boundary-Error Restarts* (**BER**). However these restarts should be initialized by a SSDFI!!! Otherwise, we will filter out the low again in the restart in a way that is comparable to the loss at the boundary.

MCUF + BER

Improvements by a restart



(a) 33-h forecast range (969.5 hPa)

(b) 36-h forecast range (971.1 hPa)

(c) BER at 0900 UTC (964.0 hPa)

(d) BER at 1200 UTC (966.7 hPa).

⇒ 4.4 hPa improvement.