SLHD

(Recent status and perspectives)

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  - efficient and stable implicit formulation
  - straightforward control and tuning
  - coefficient of diffusion K should be reduced with the increased model spatial resolution
  - only little theoretical or observational foundation

Horizontal diffusion in ALADIN - I.

Spectral diffusion

- $r = 4$
- $K = -\frac{\exp(-0.5\pi i r)}{(2\pi)^r}\left[\frac{L_x^2}{\mathcal{M}^2} + \frac{L_y^2}{\mathcal{N}^2}\right]^{\frac{r}{2}} \frac{g(l)\quad \mathsf{RRDXTAU}}{\mathsf{RDAMP}_\Psi (1+0.5 r_{nlginc})^{2.5} [\Delta X]_{gp}}$
- preserves mean
- affected by extension zone (LAM only)
- suitable to just spectral fields
- difficulty with sloped coordinate
  - causes false advection
  - in presence of orographic features targets might be masked

Horizontal diffusion in ALADIN - II.

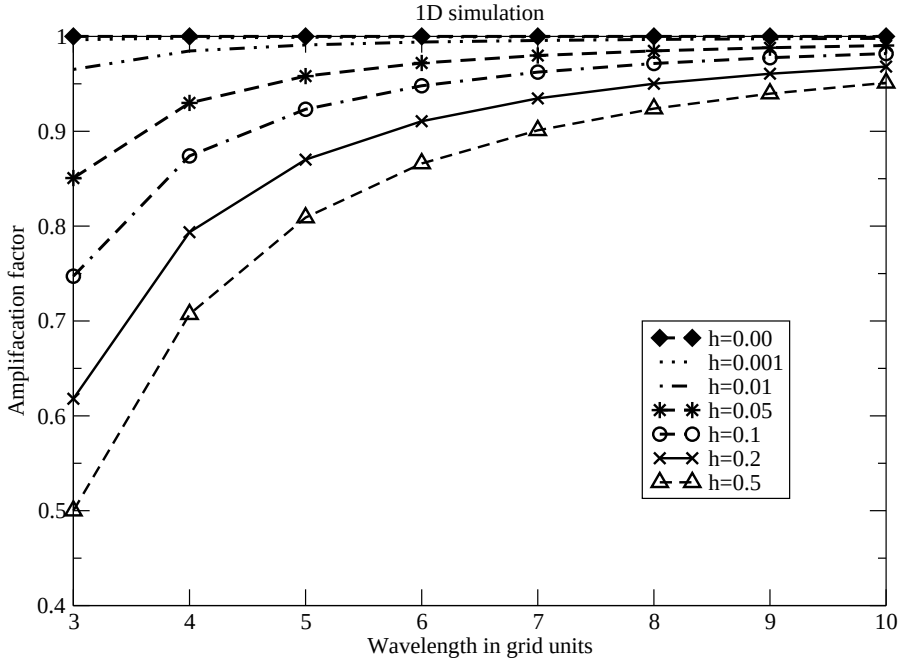
SLHD (since 2003)

- grid point space scheme
- non-linear scheme $\approx K(d)\nabla^r X$
- triggered by flow field deformation
- ∇^r represented by sL interpolators ($r \approx$ 2-4)
  $I = (1 - \kappa)I_A + \kappa I_D = I_A + \kappa(I_D - I_A)$
- special care to control orography triggered noise
- local and 3D character
- efficient (for NL diffusion) and stable

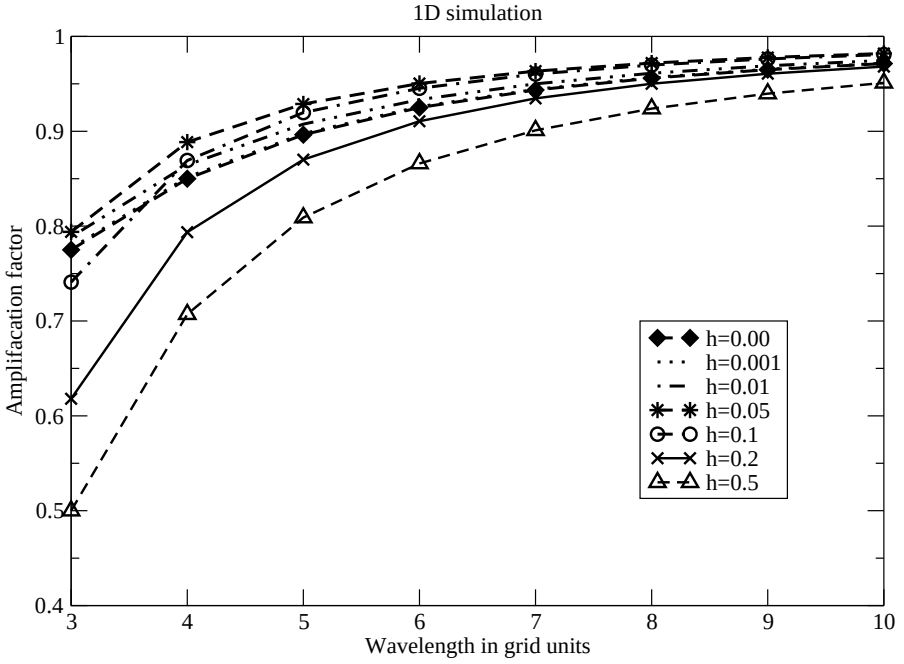
SLHD design - I_D

Linear vs. homogeneous interpolation

Amplification by linear interpolator



Amplification by I_D operator



SLHD design - κ

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SLHDB

$$d = \frac{1}{2}\sqrt{\left(\frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}\right)^2 + \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)^2}$$

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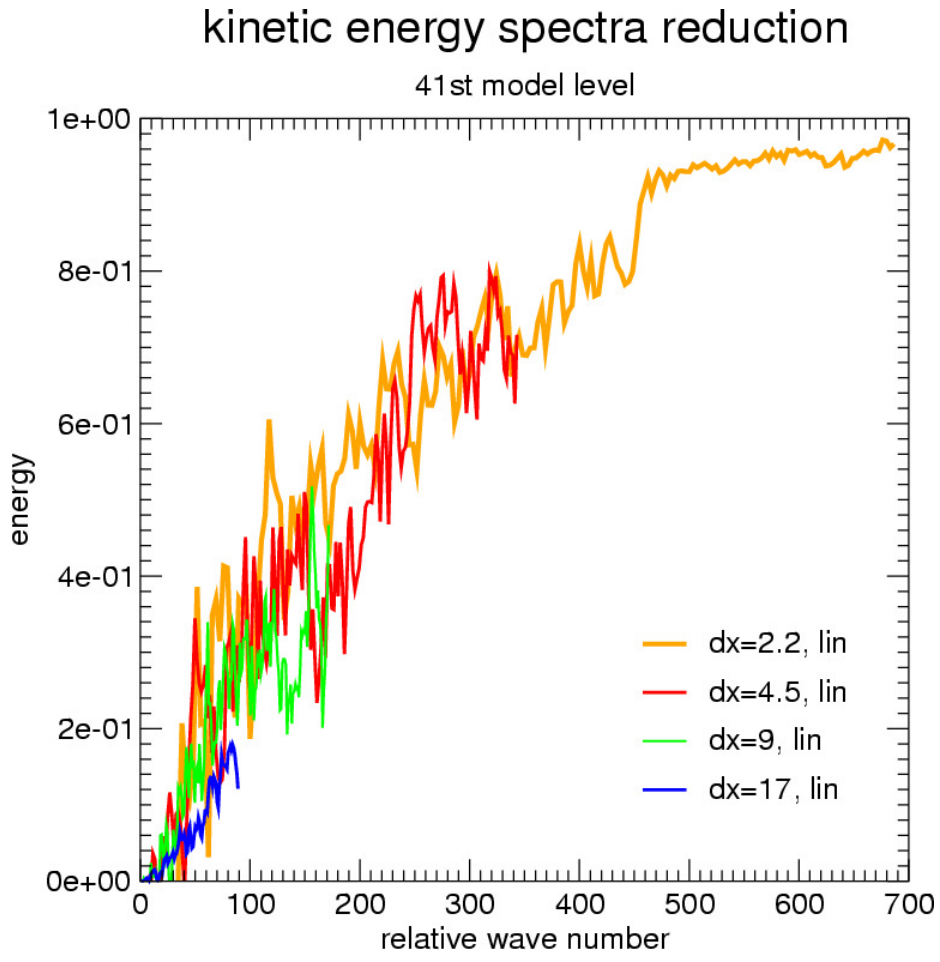
SLHD tuning - experimental setup

- various domains and resolutions between 2.2 km – 17 km
- linear and quadratic truncations considered
- 6 hours forecast in adiabatic mode
- recomputed to relative wave-numbers (all experiments directly comparable)
- diffusion impact diagnosed for each wave as: $\frac{\zeta_{0i'} - \zeta_{i'}}{\zeta_{0i'}}$

SLHD tuning



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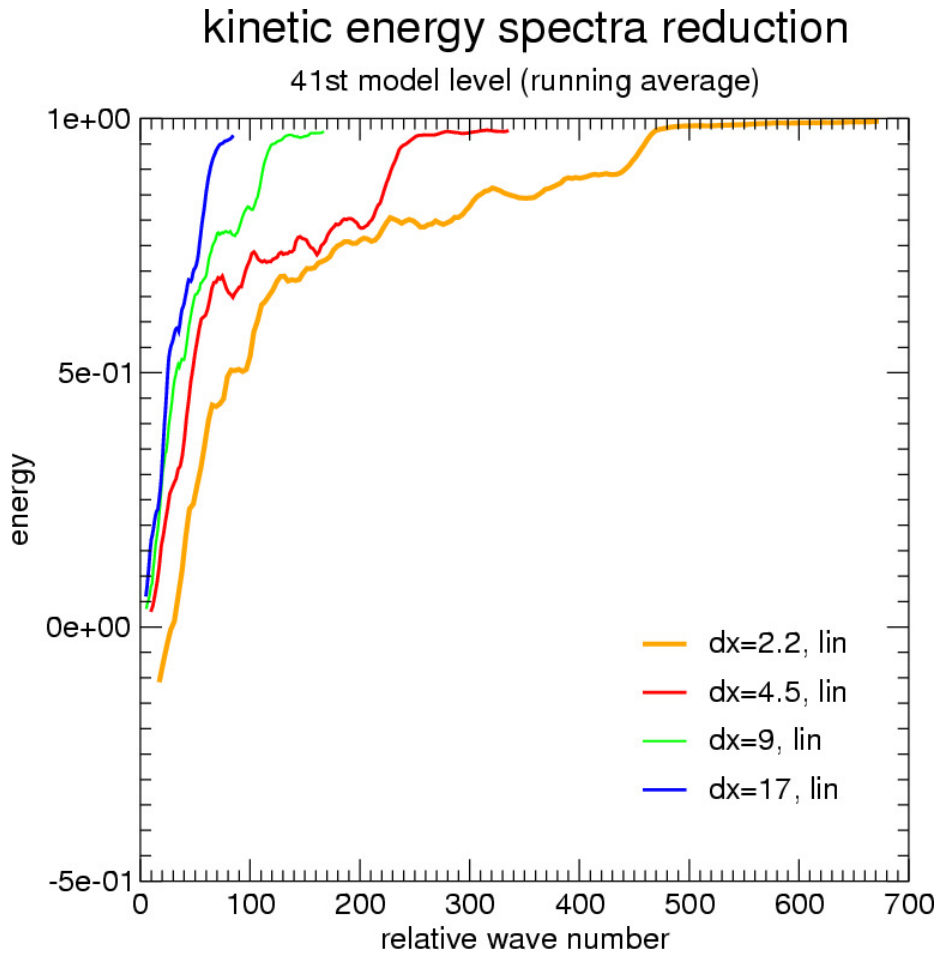
SLHD tuning



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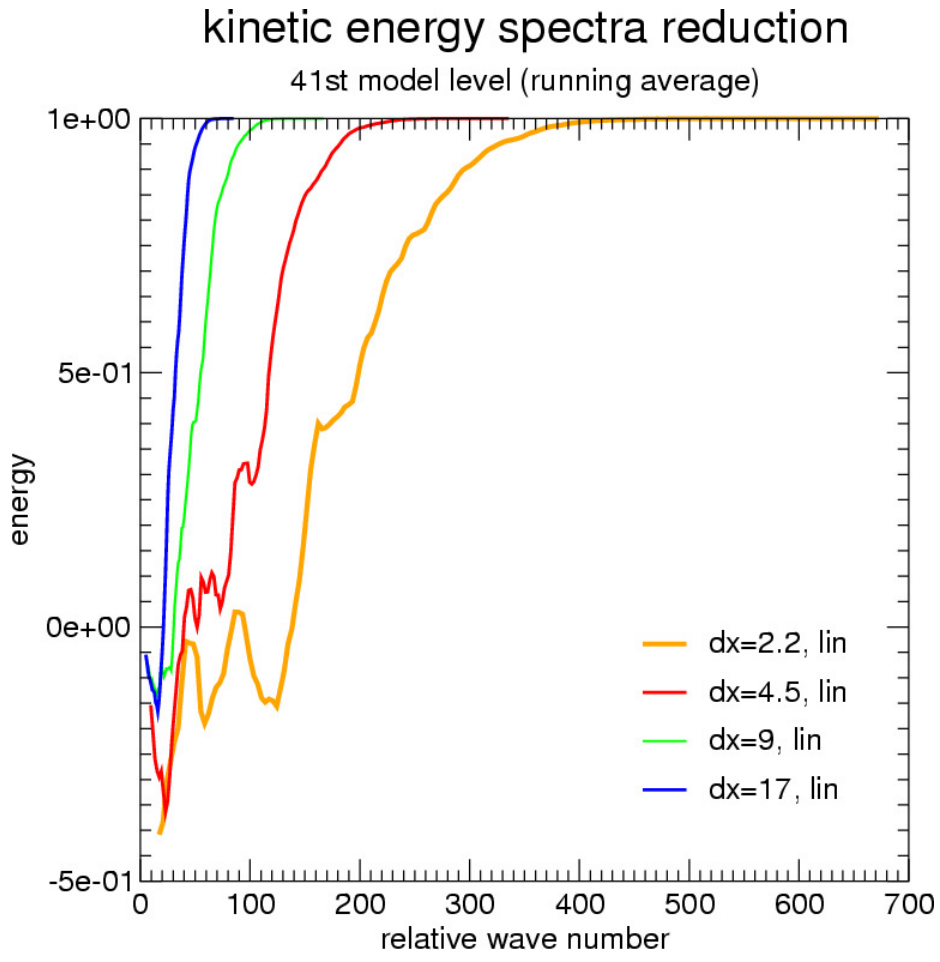

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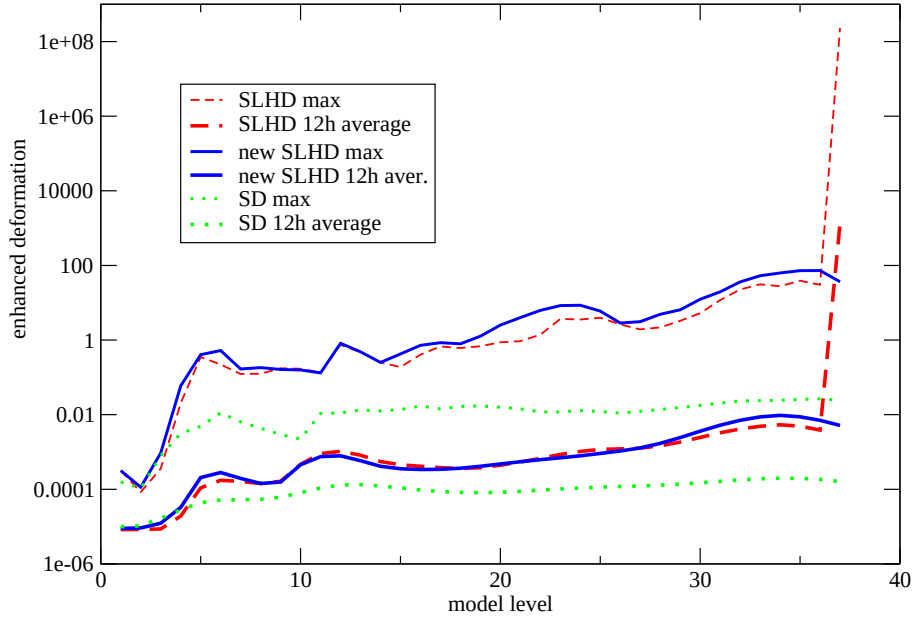

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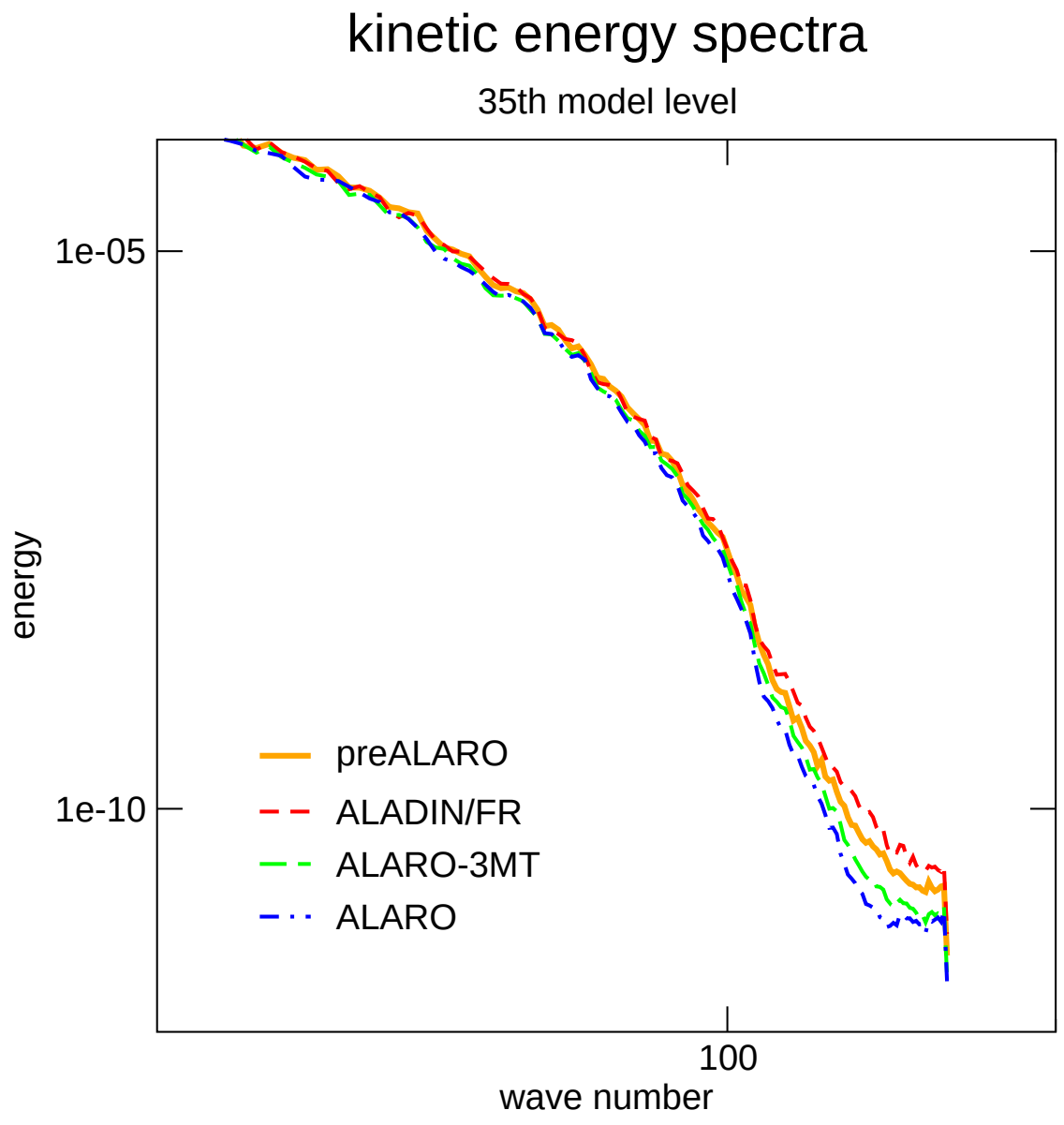
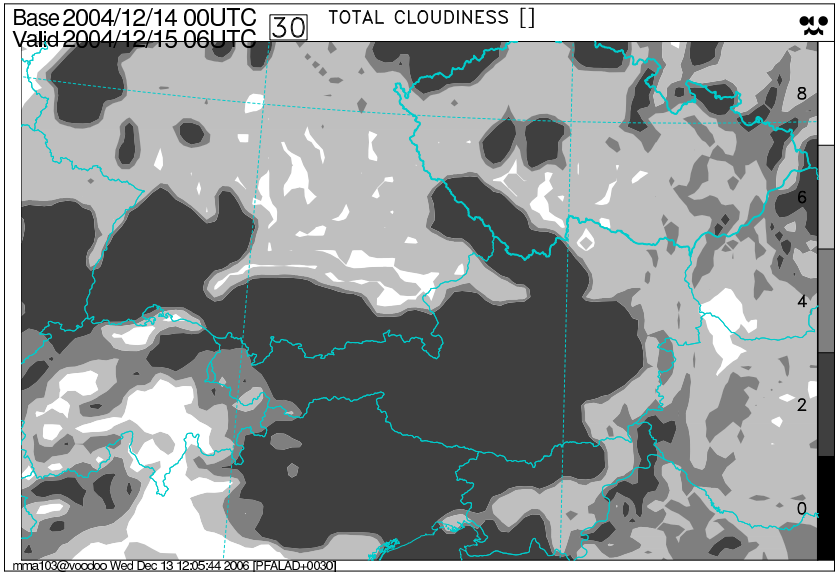
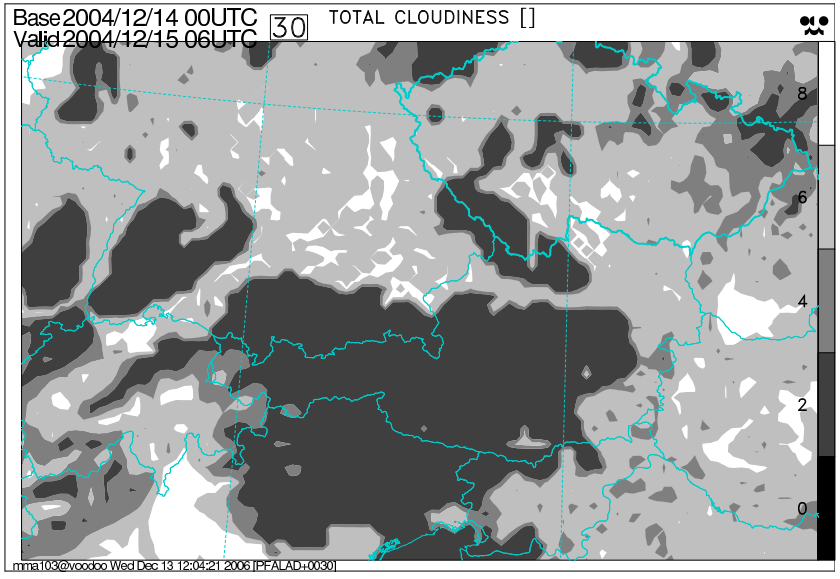


SLHD on moisture

Total cloudiness forecast for December 15th, 2004

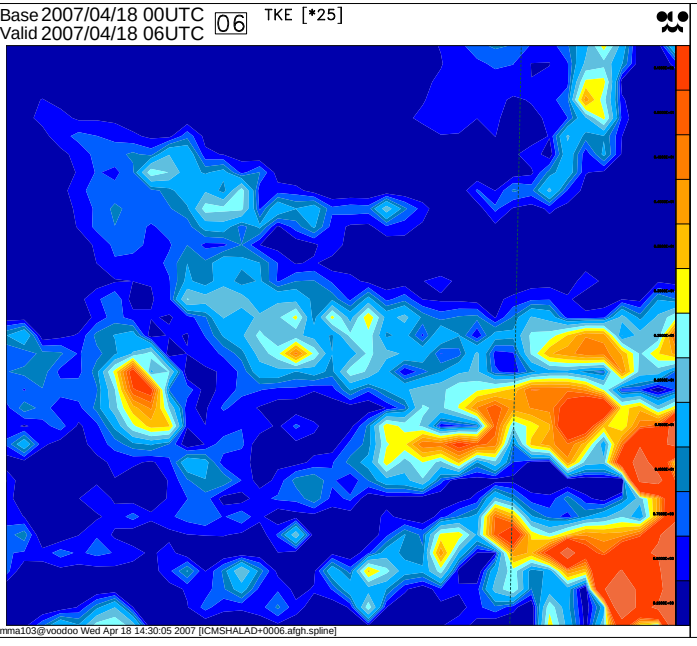


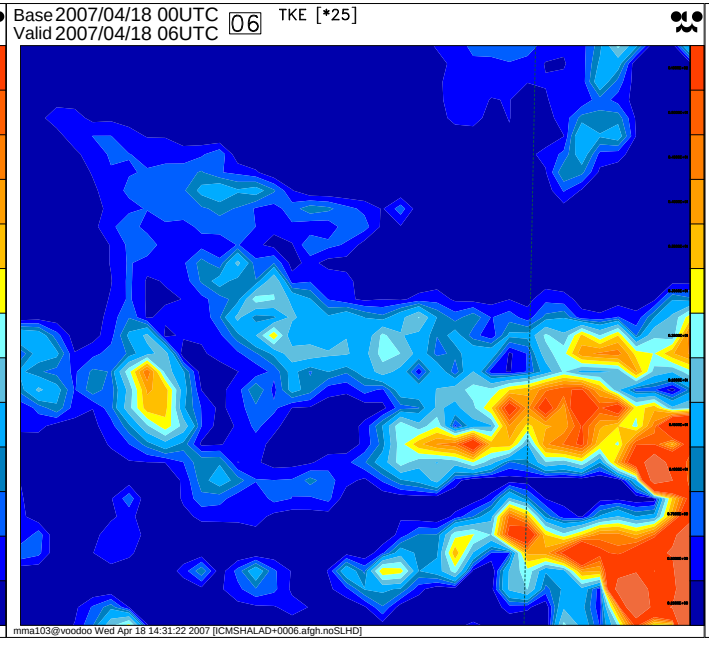


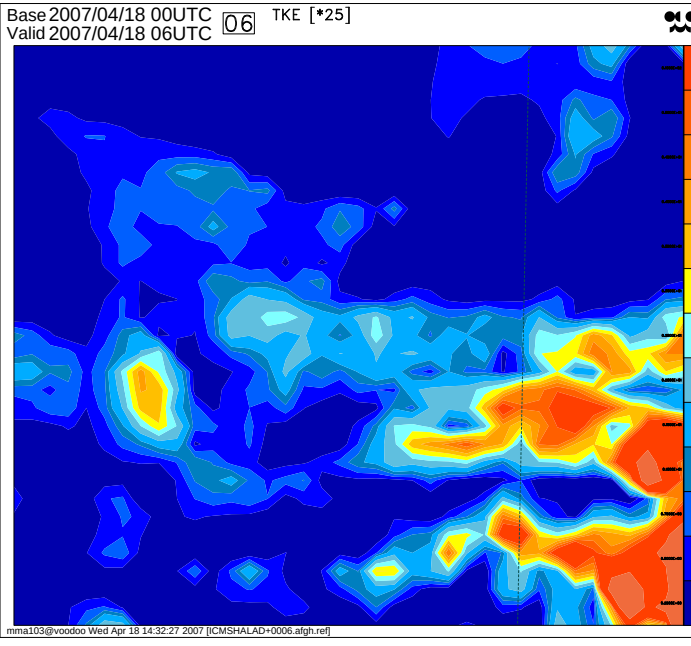
linear diffusion vs. SLHD

SLHD and prognostic fields from physics

TKE (at 1500 m above flat terrain)



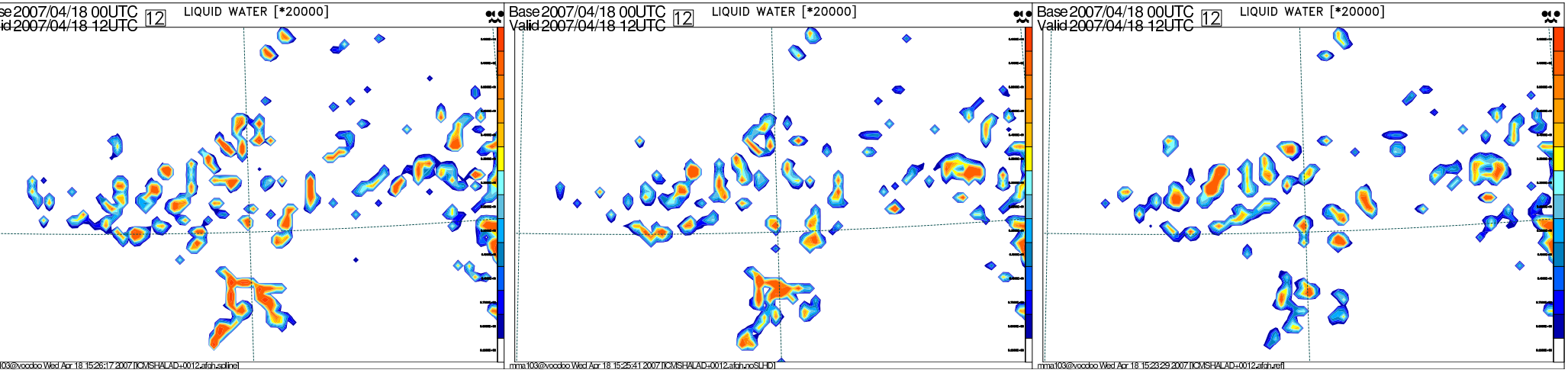




spline | Lagr. cubic | Lagr. cub. + SLHD

SLHD and progn. fields from physics - II.

q_l (at 110 m above mountain region)



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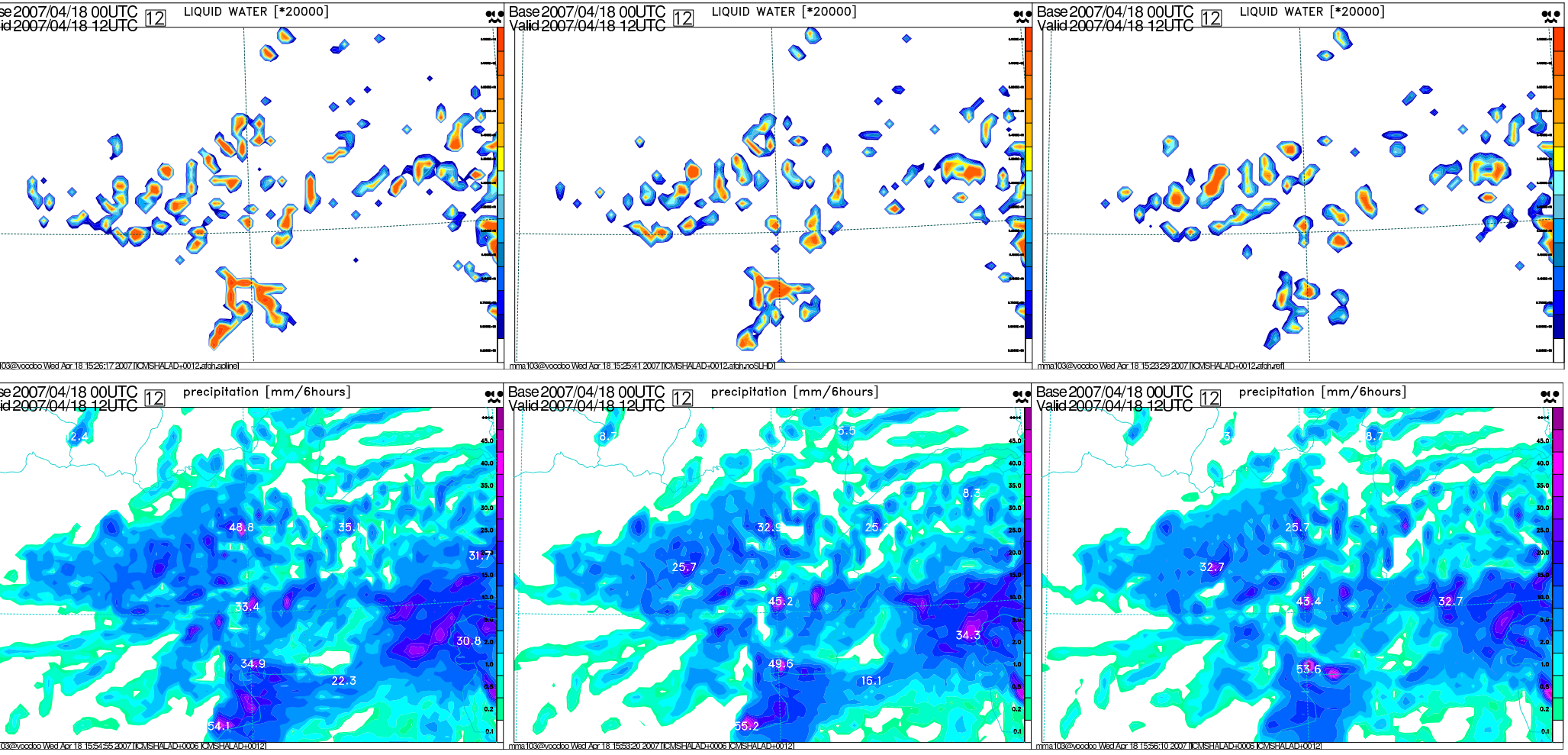

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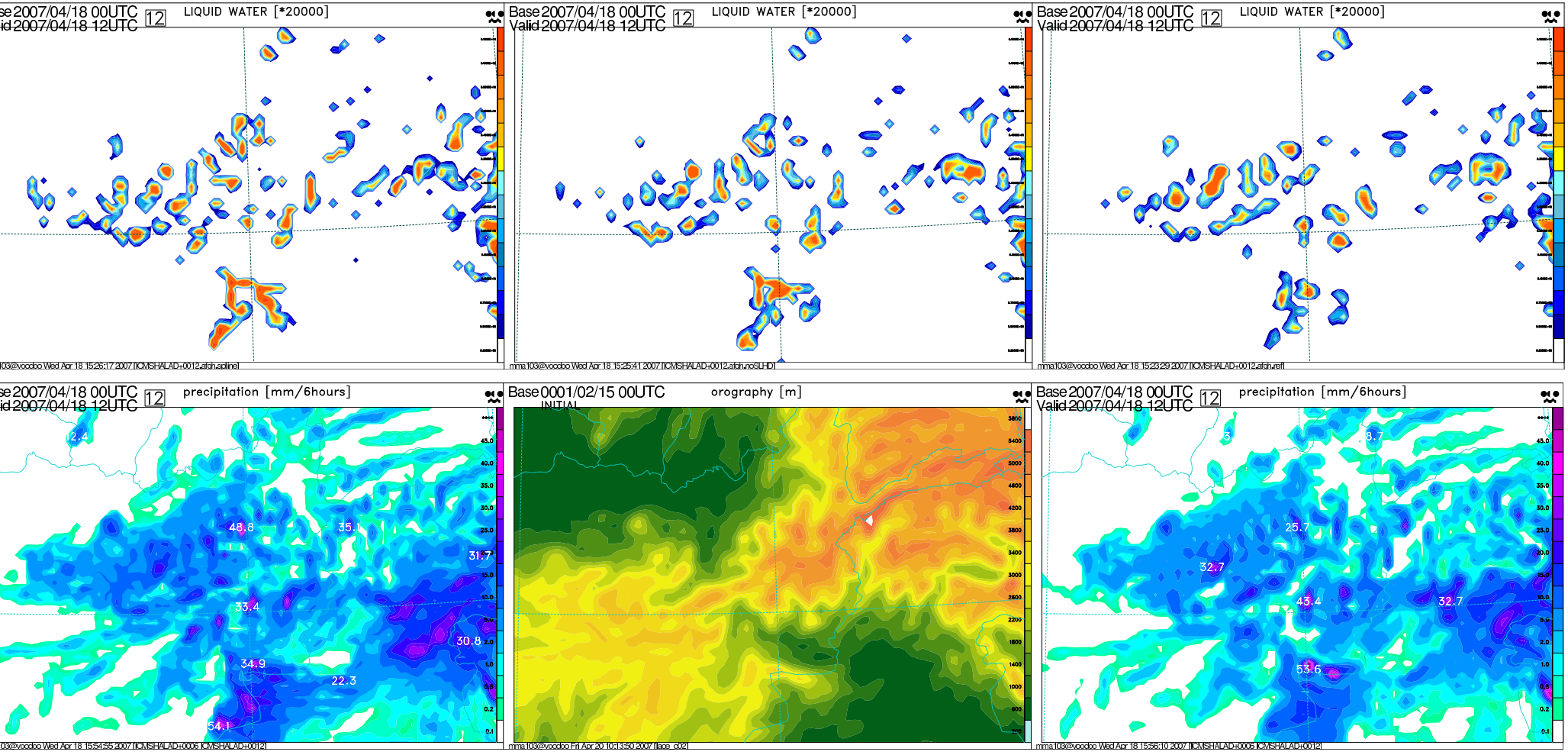
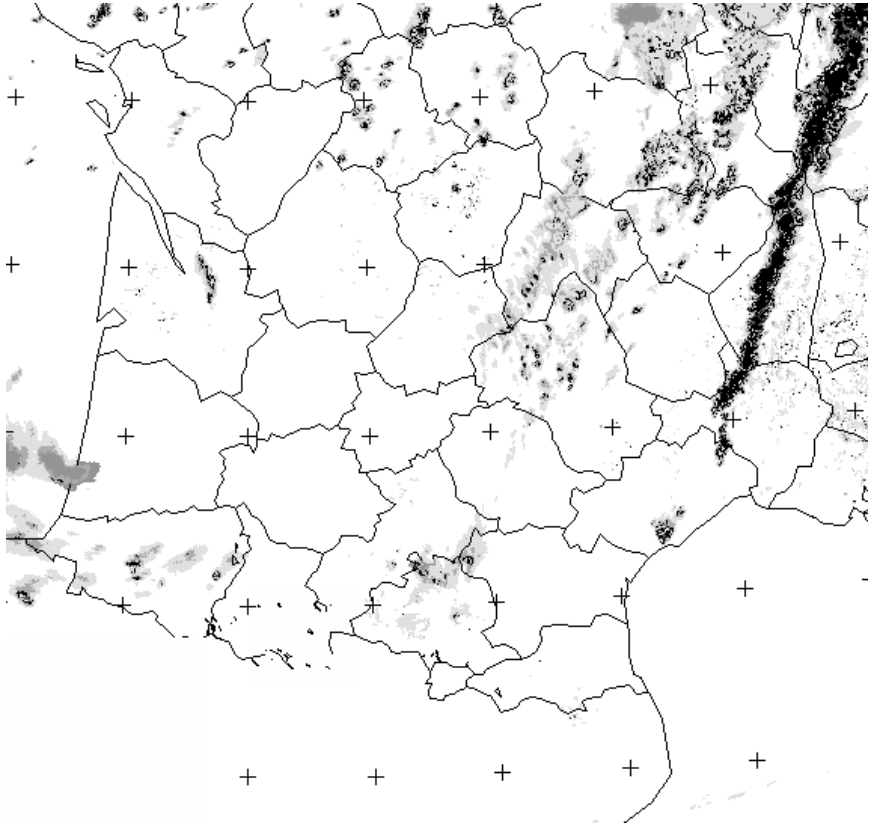
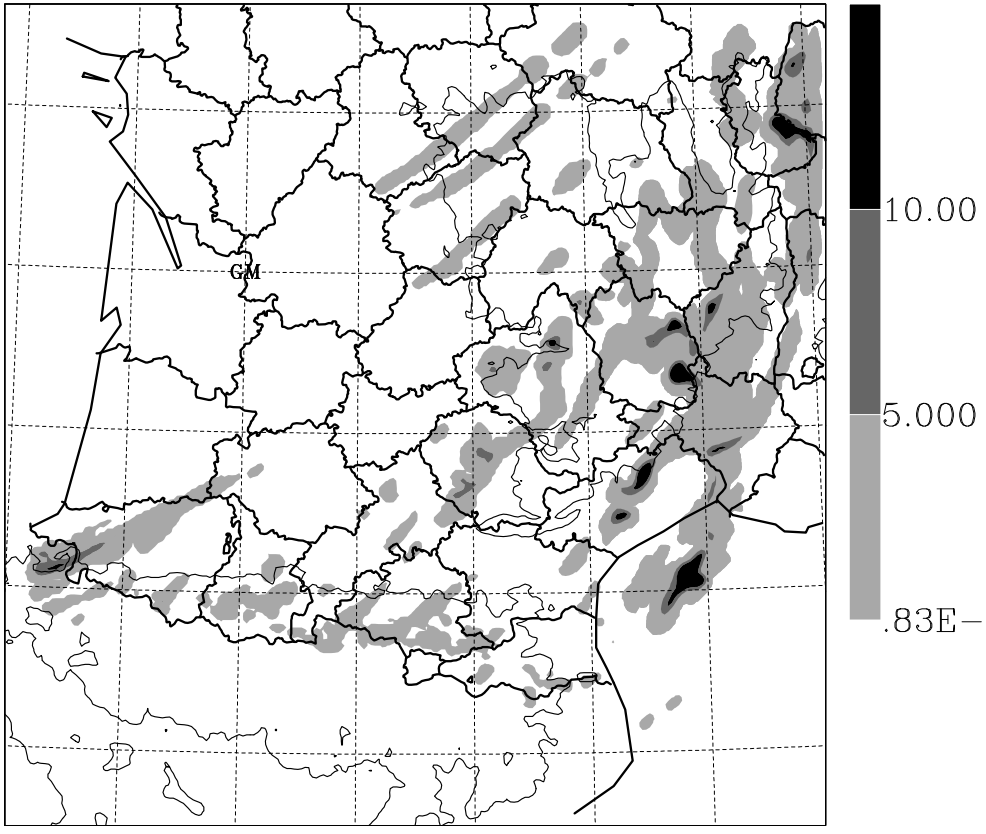


SLHD at kilometric scale

00 +15 UTC May 22nd, 2006





Radar **AROME with spectral diffusion**

SLHD at kilometric scale

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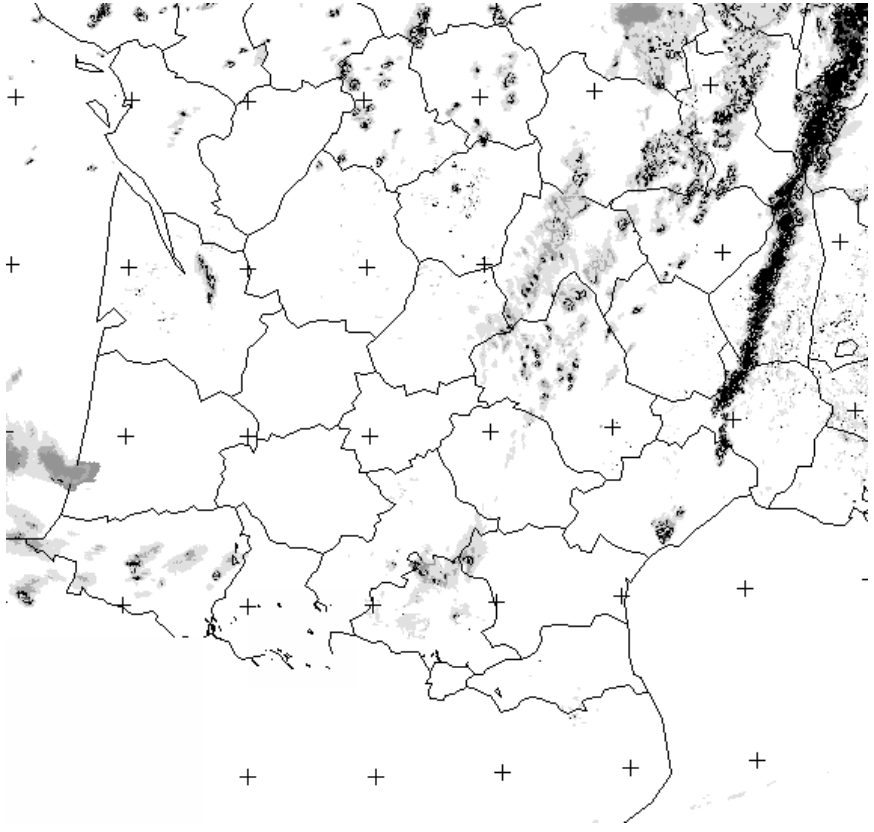
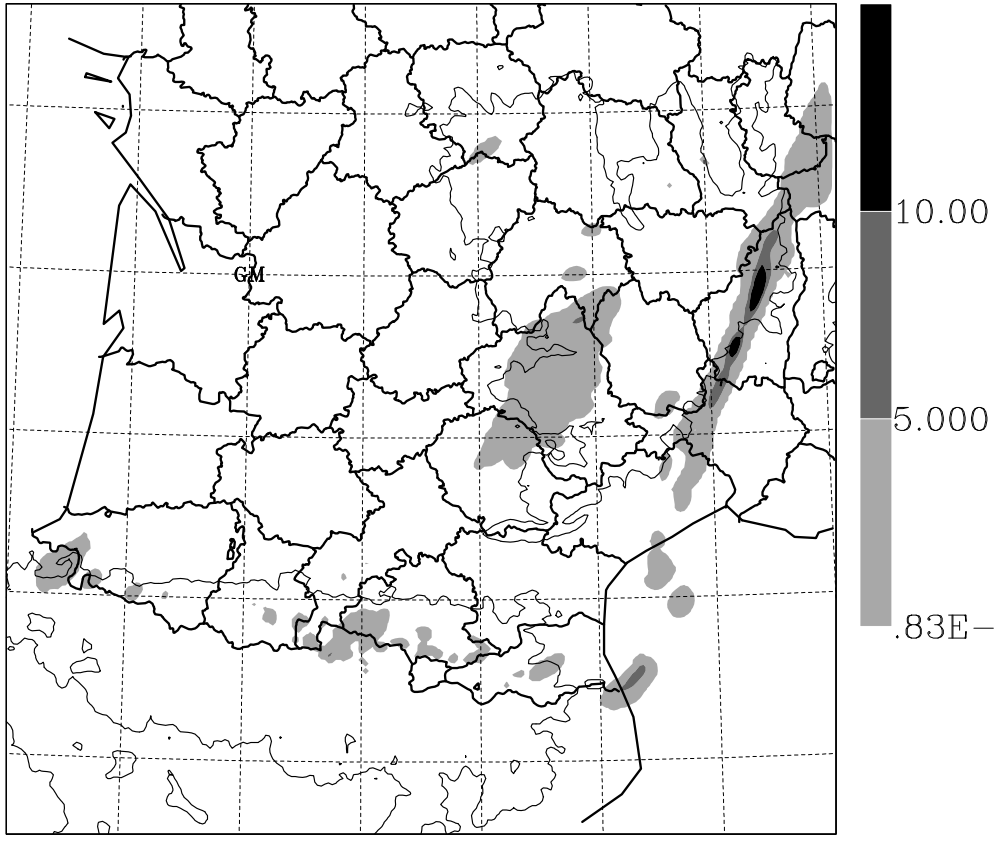


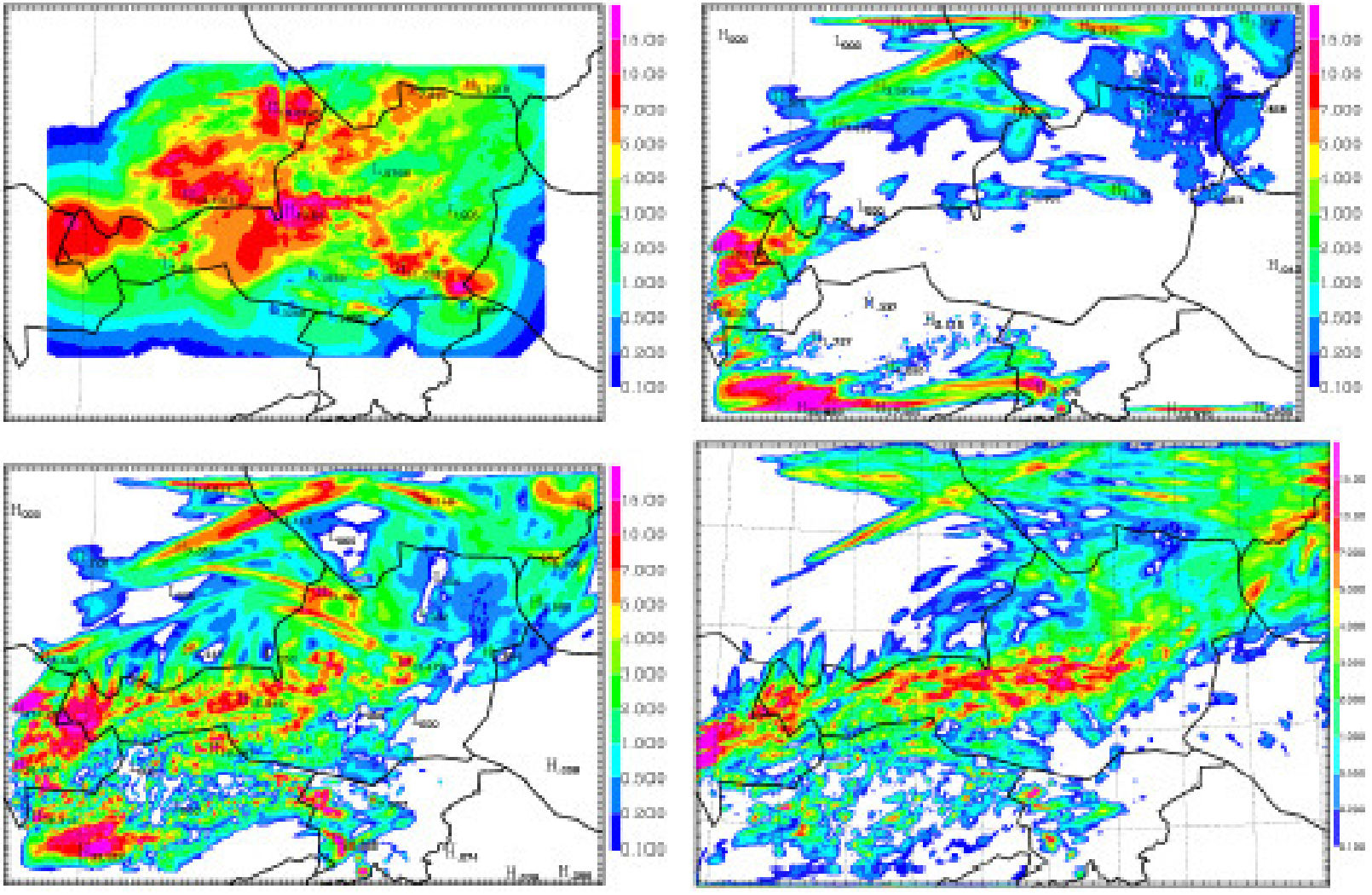
Radar



AROME with SLHD

SLHD at kilometric scale - II.

24 hours accumulated precipitation over Austria for the 23/06/2006



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- there's no universal tuning for SLHD
- it is numerical scheme $\rightarrow$ can't substitute the physics (3D turbulence)