Dynamics & Coupling

2006 fulfilment and plan for 2007

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Plan for 2006

Project	Topic	Planned/Fulfilled effort	LACE support
I.	Iterative schemes	0/0	
	Further improvement of NH	1.5/0	
	Diabatic forcing	0/0	
	VFE	3/5	1/1
	BBC	-/0.5	
II.	Studies linked to high resolution	0/0	
	Horizontal pressure gradient term	0.5/0.5	
	HD above slopes	0/0	
	RUBC	0/0	
	Phys. coupling to dynamics	1.5/1.5	1/1
	Spline interpolation for SL	1.5/1.75	1/1
	TL/AD of the plane SL	5/6	
	SLHD	-/1	
III.	3D diagnostic tool for coupling	1.5/1.5	1/1
	Spectral coupling	0/0	
	Total:	**14.5/17.75**	**4/4**

Vertical Finite Element scheme

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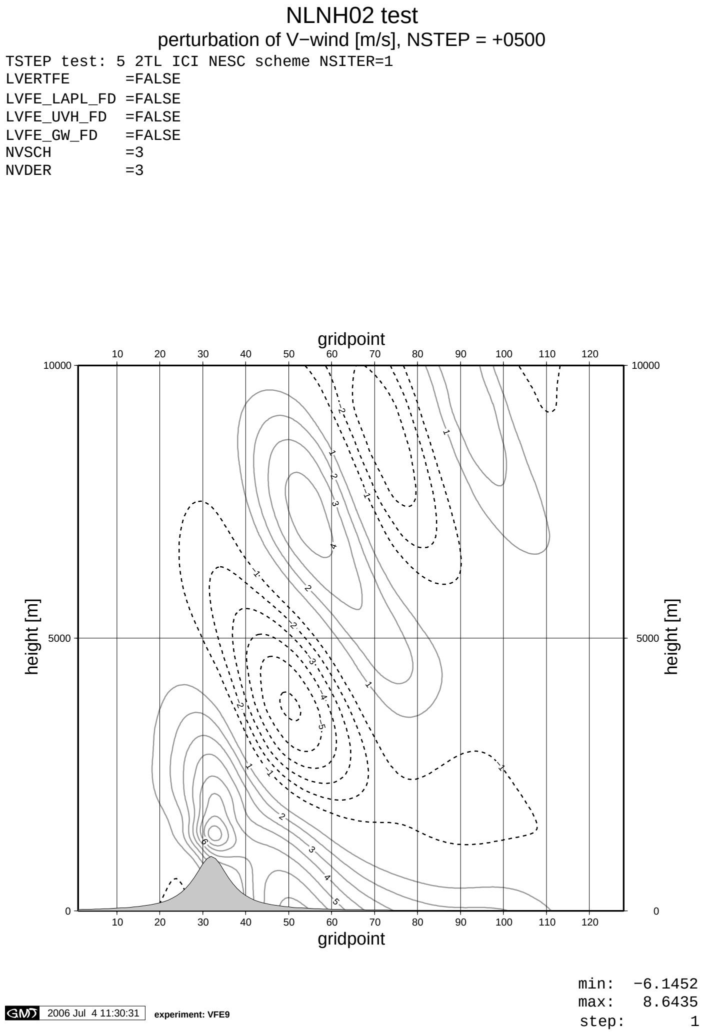
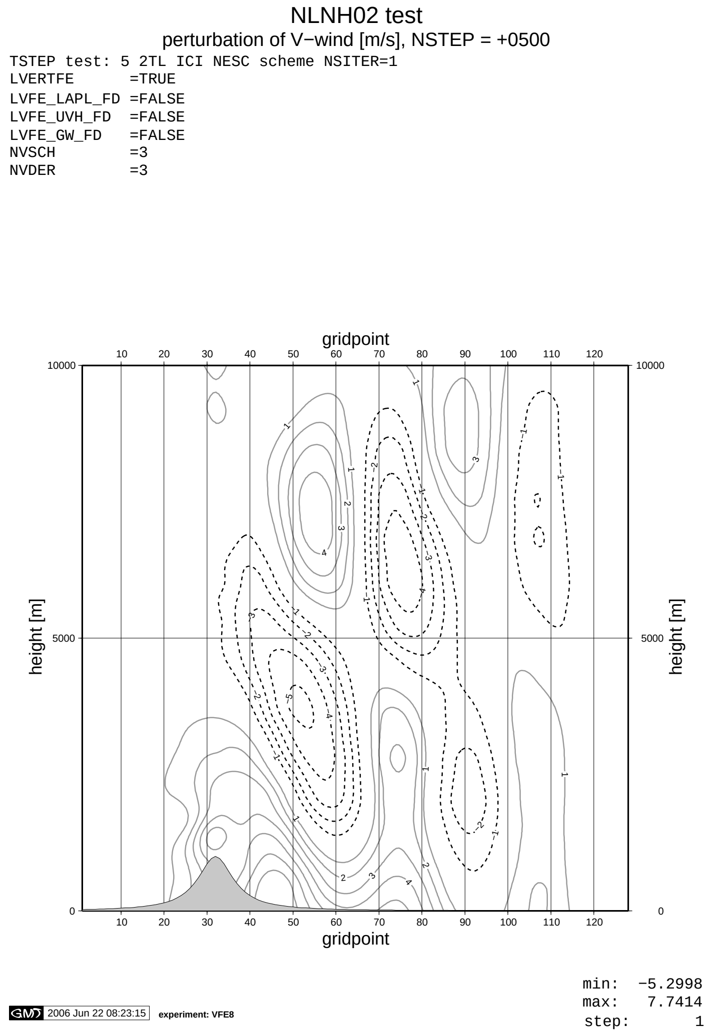
- First version of VFE implemented to the code. It is stable, efficient (2-3 % extra CPU) but (for the moment) noisy.
- Plan to implement VFE without major revision of the NH core.

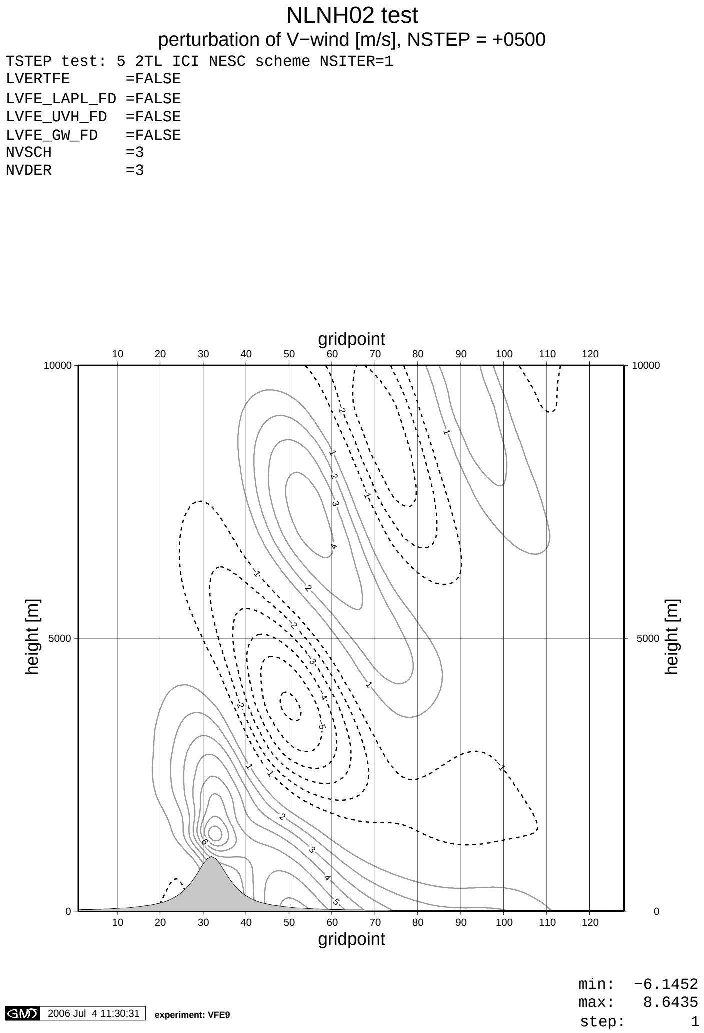
Vertical Finite Element scheme

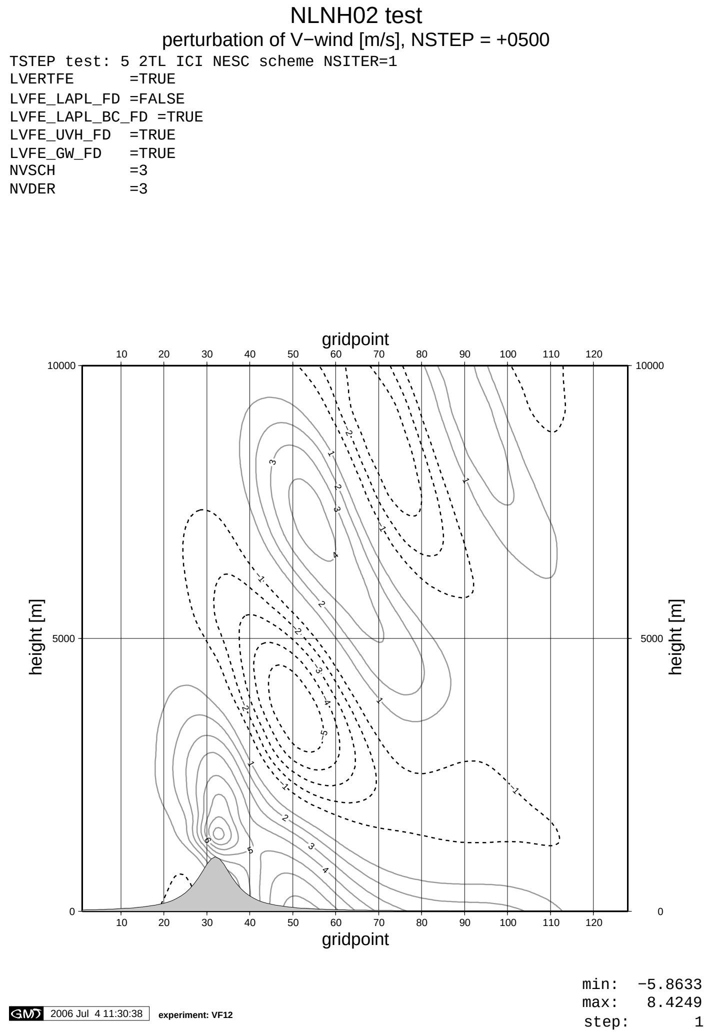




FD scheme versus full VFE

Vertical Finite Element scheme

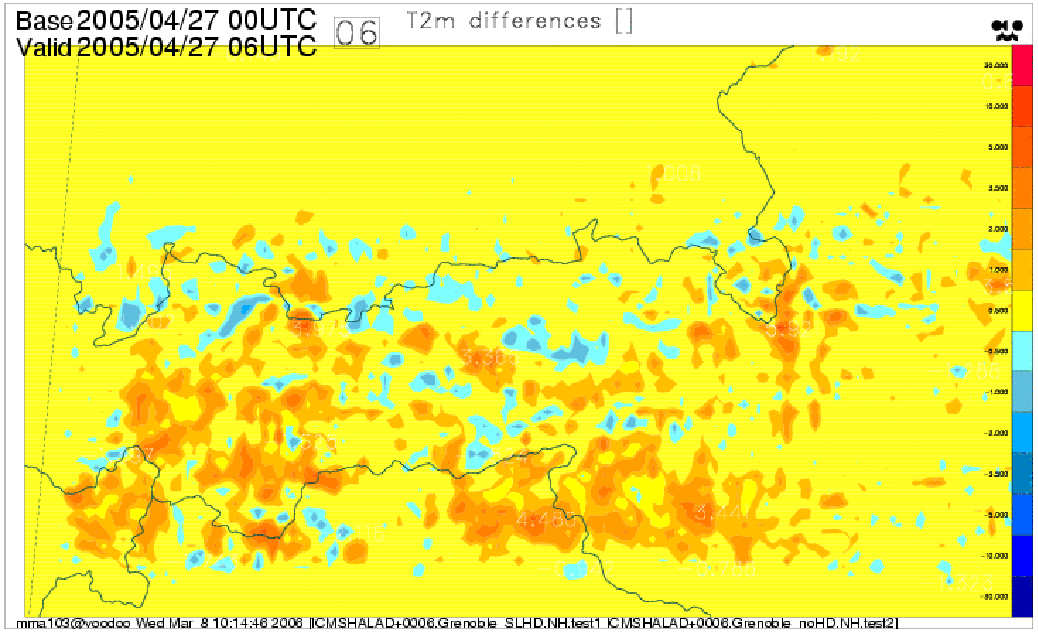




FD scheme vs. FD with VFE integ. and laplacian operators

BBC

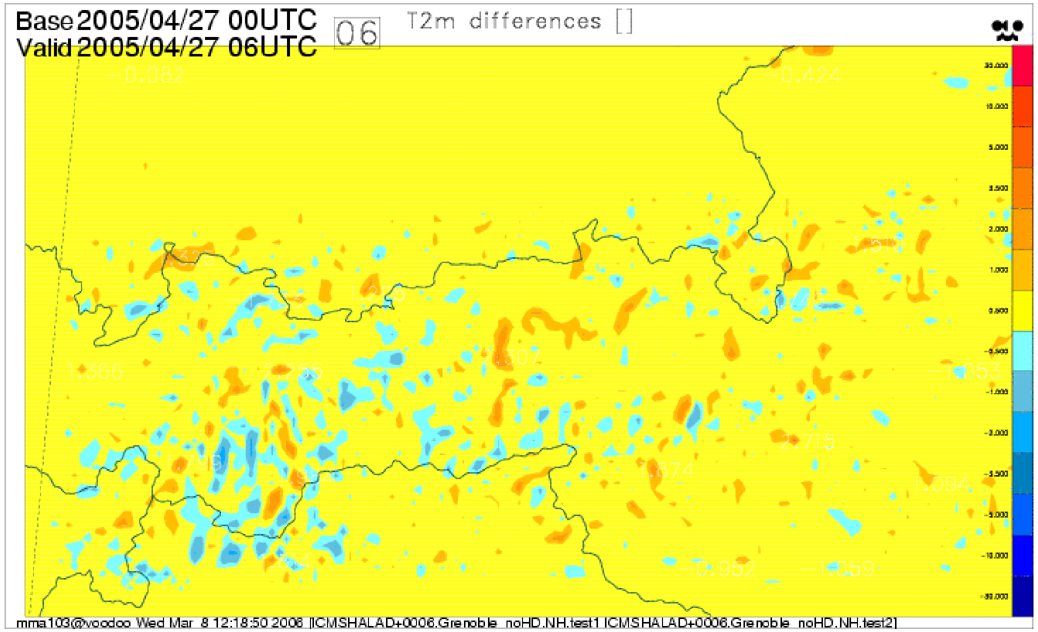
T2m differences (model - noHD)



- Original SLHD tuning

BBC

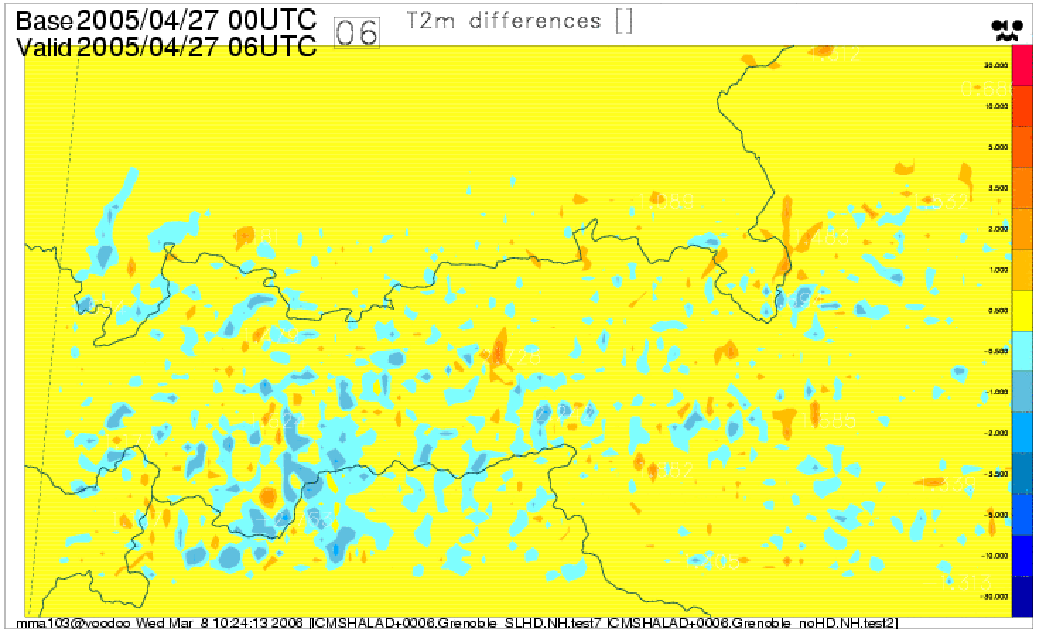
T2m differences (model - noHD)



- Original SLHD tuning
- Spectral diffusion

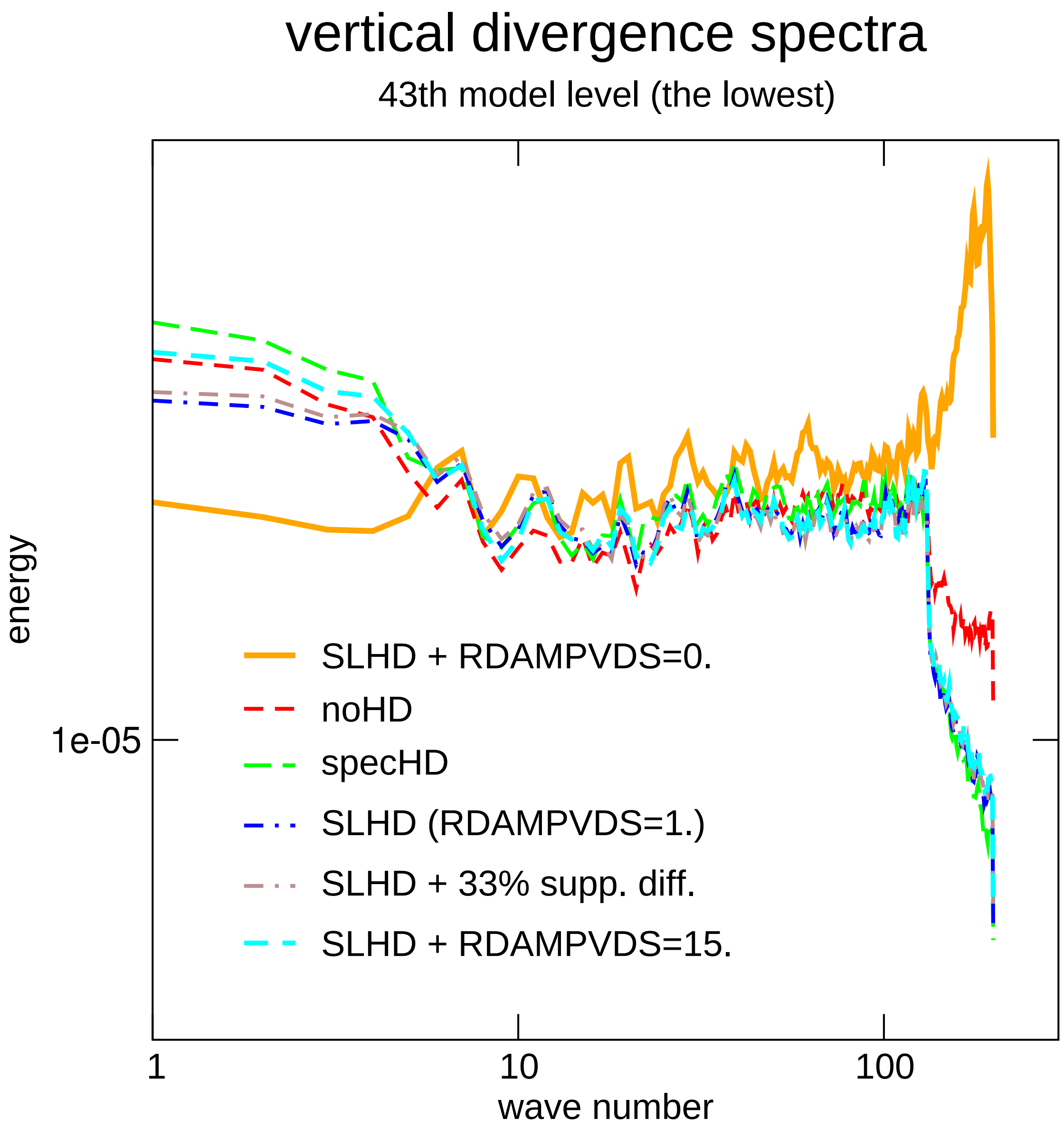
BBC

T2m differences (model - noHD)

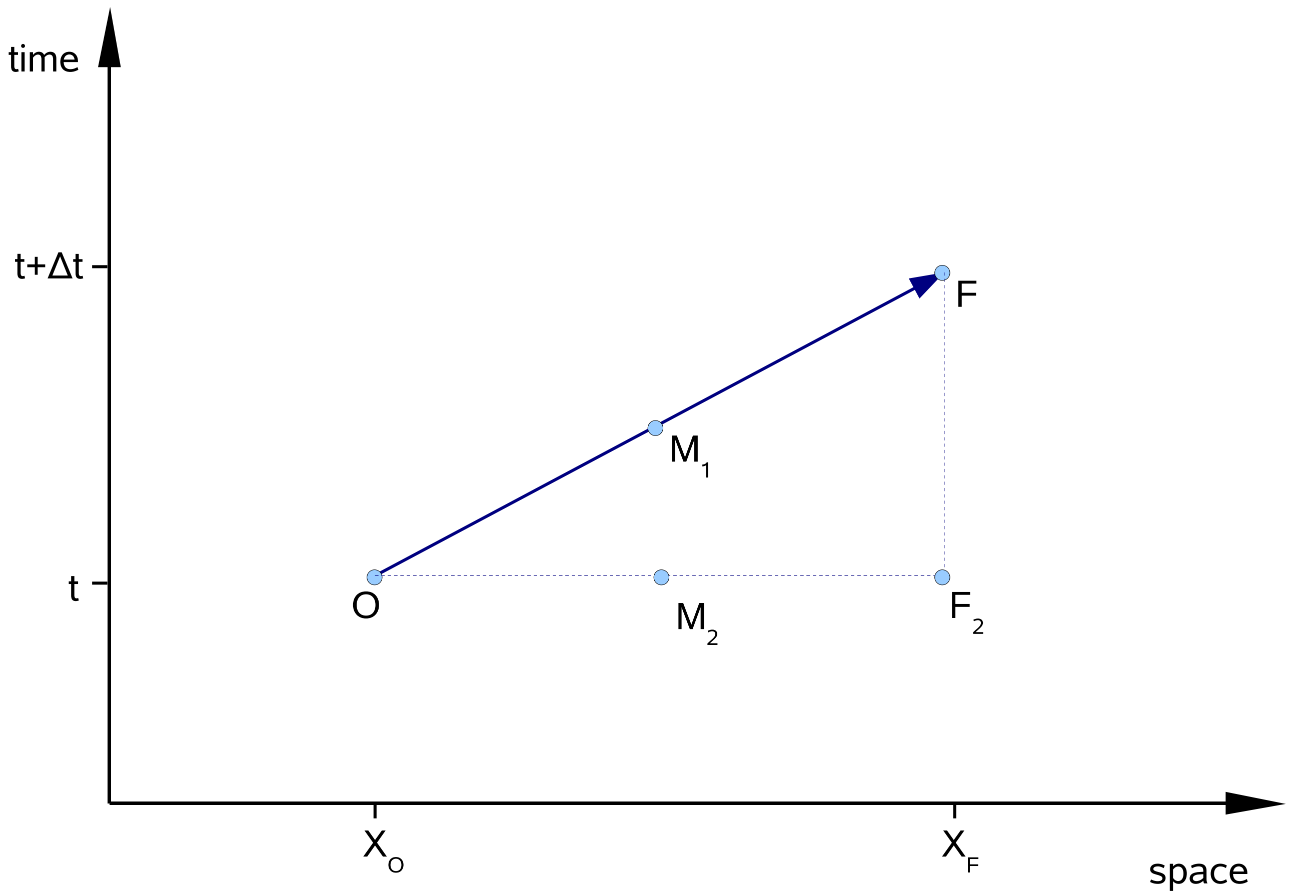


- Original SLHD tuning
- Spectral diffusion
- New SLHD tuning

BBC - II.

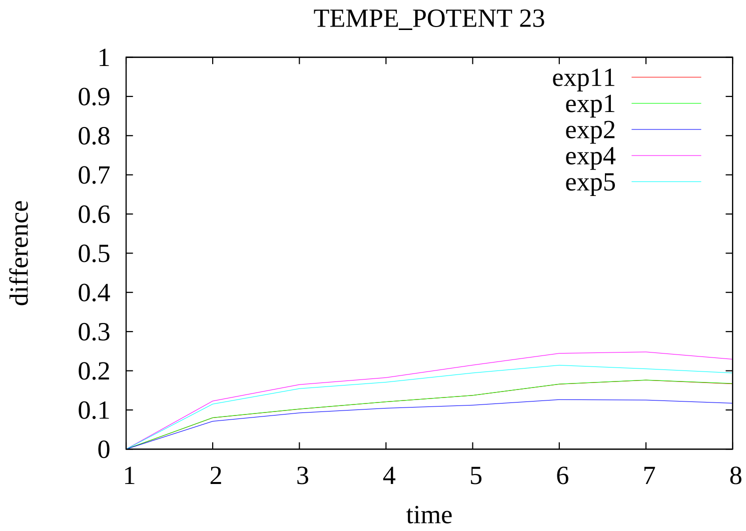

vertical divergence spectra
43th model level (the lowest)
energy
1e-05
1
10
100
wave number
SLHD + RDAMPVDS=0.
noHD
specHD
SLHD (RDAMPVDS=1.)
SLHD + 33% supp. diff.
SLHD + RDAMPVDS=15.

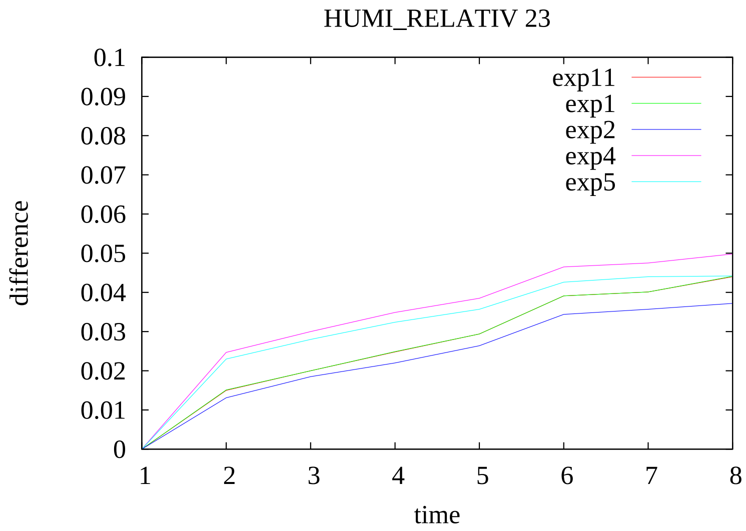
Phys-dyn coupling



Phys-dyn coupling II

$$dev = \sqrt{\overline{(F_{\Delta t=360} - F_{\Delta t=30})}}$$





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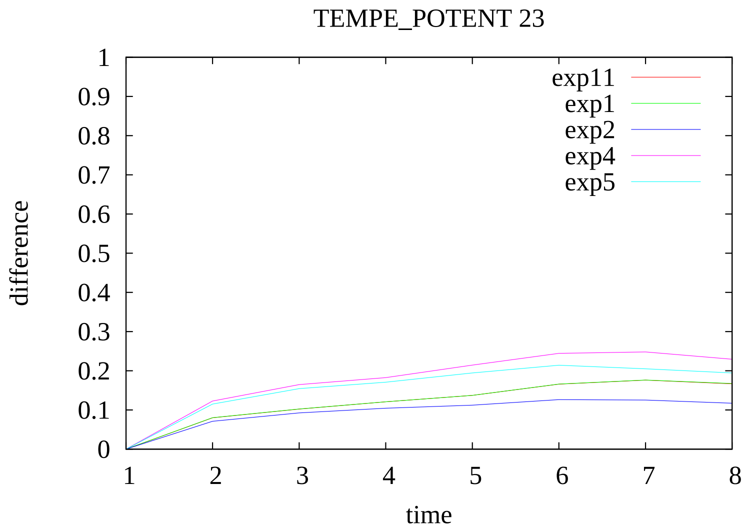
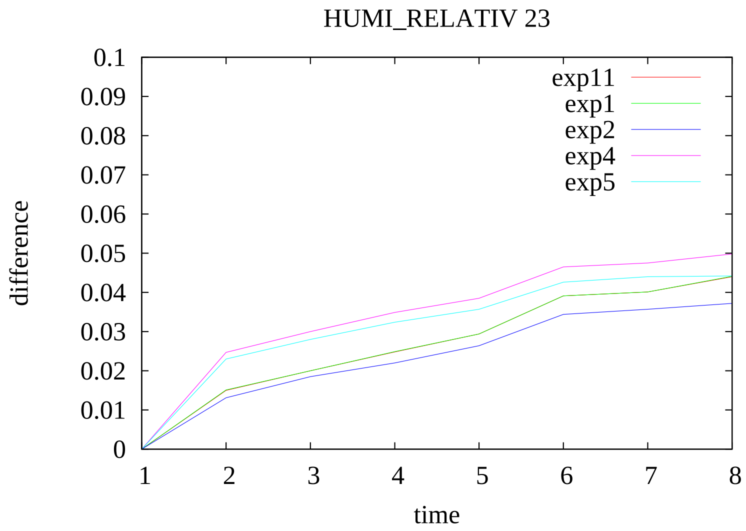
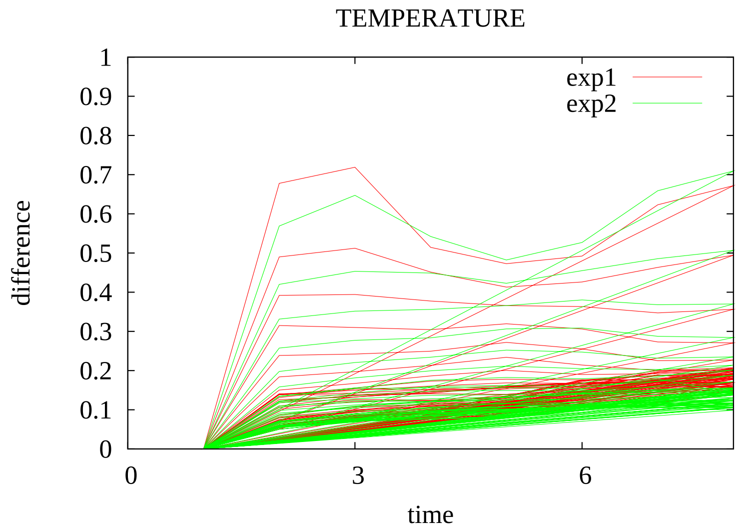
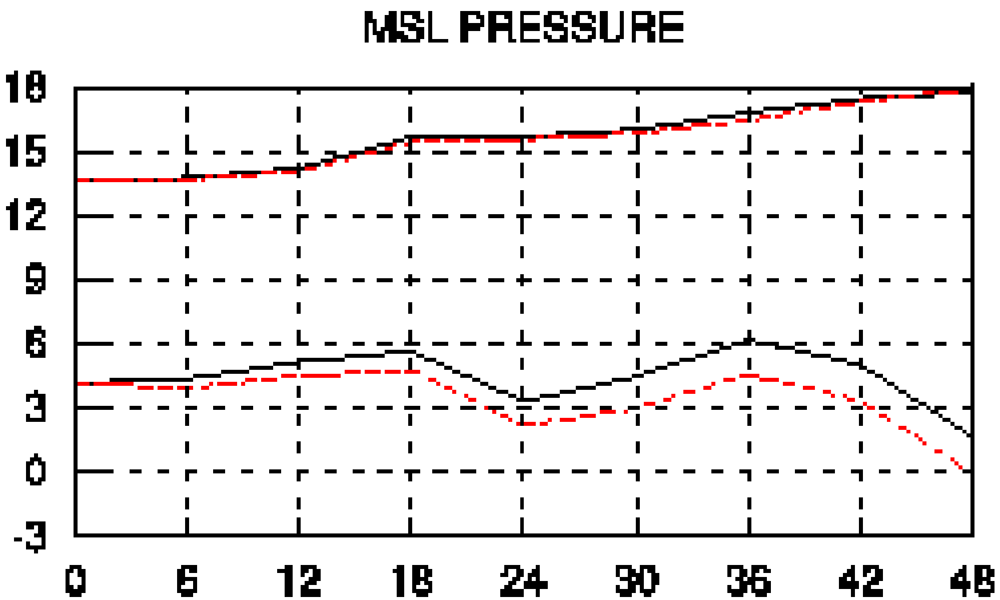






New interpolators for SL

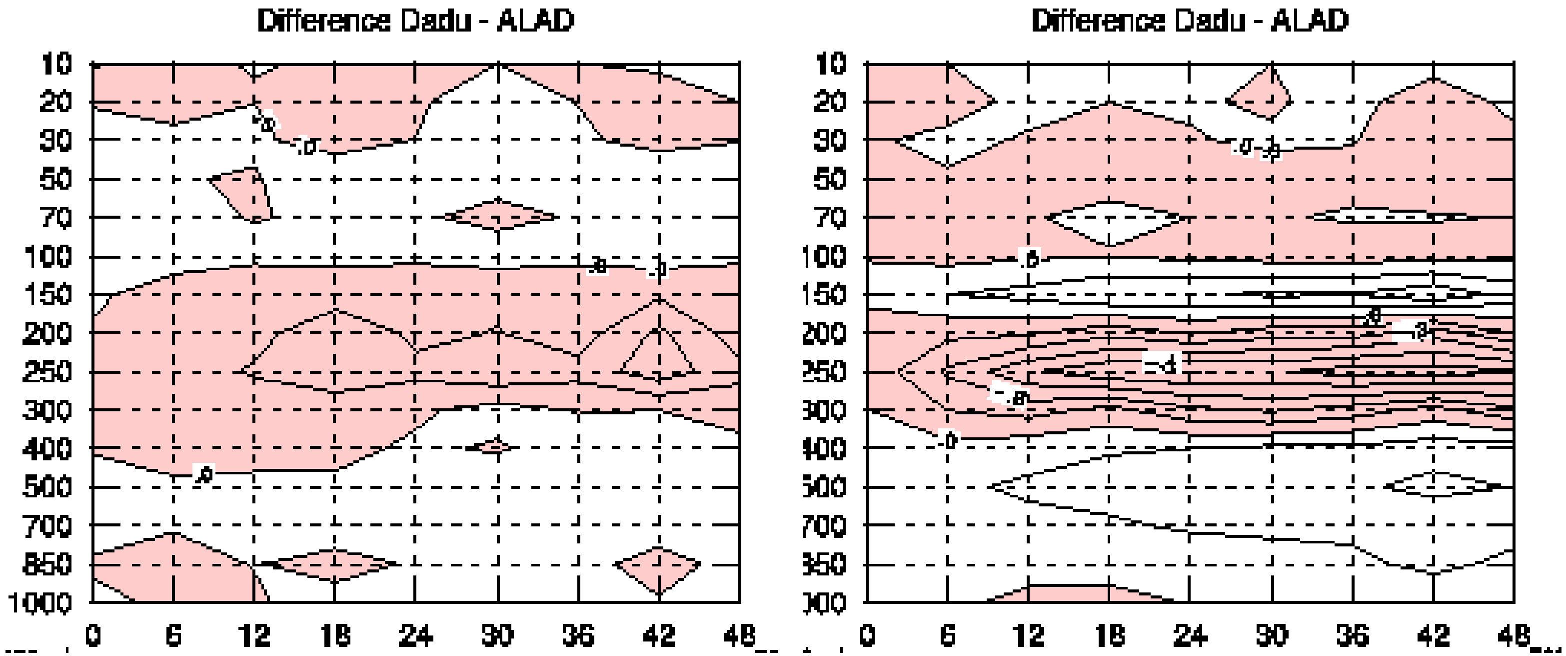
Motivation: SLHD affects conservative properties of the model $\Rightarrow$ need to an improvement of the SL interpolators accuracy.



MSL pressure RMSE and BIAS for 15 days of parallel run

New interpolators for SL

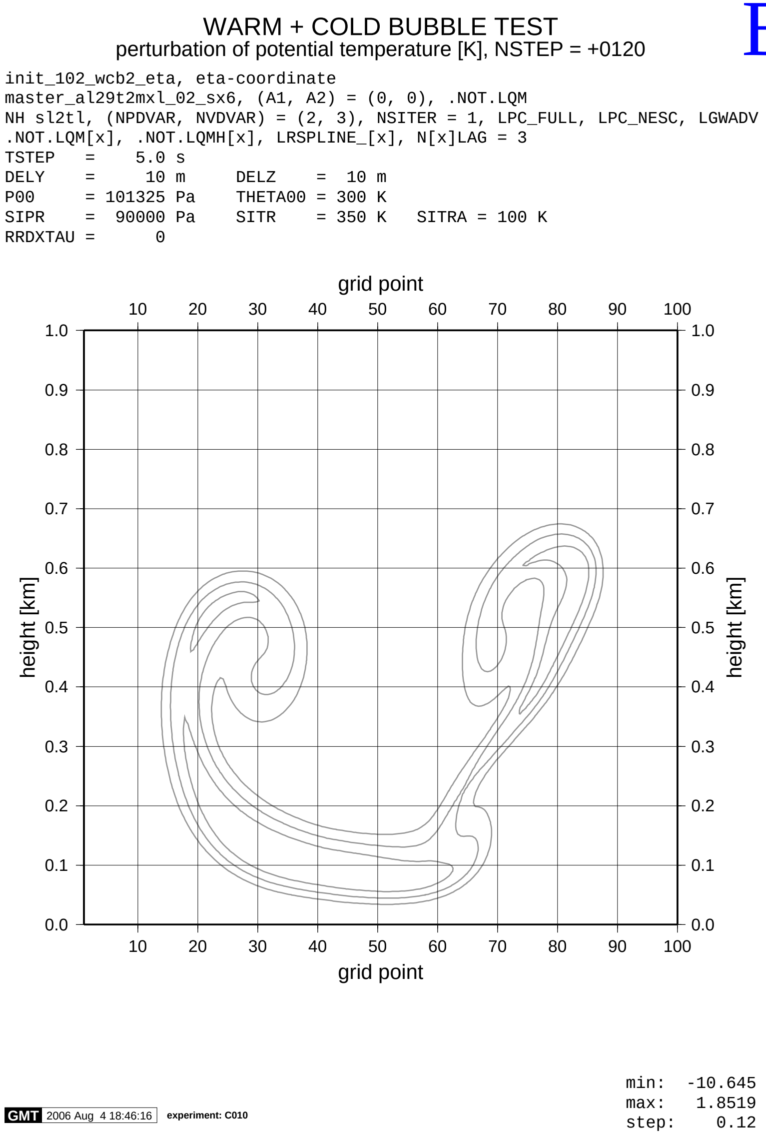
Motivation: Performance of the local splines is not superior to the Lagrangian cubic interpolation in SL.



temperature RMSE and BIAS for 15 days of parallel run

New interpolators for SL

Bubble test, after 10 minutes



- Linear

New interpolators for SL

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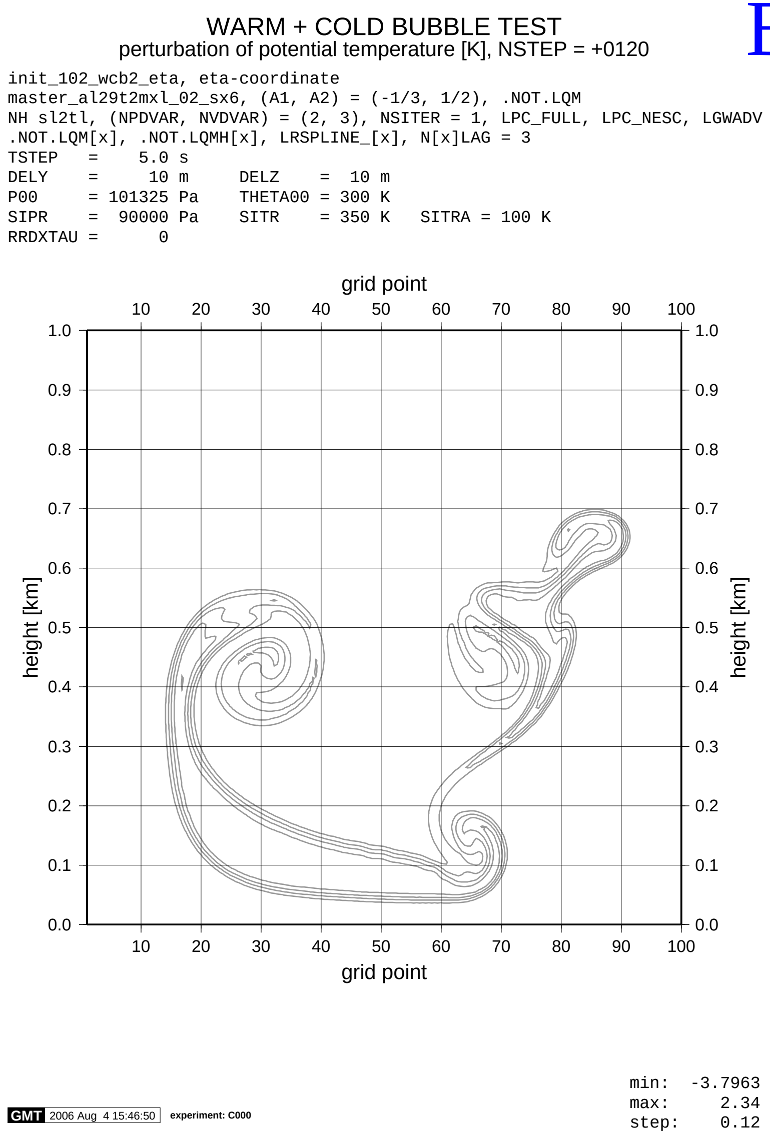
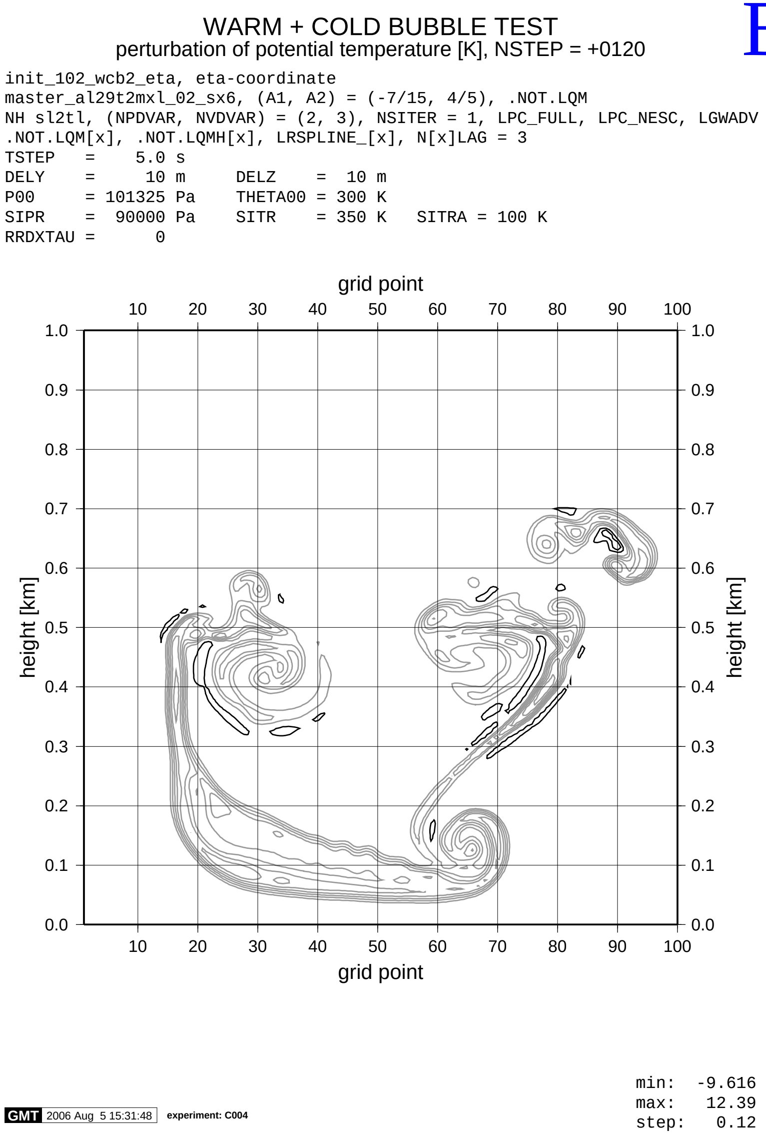


- Linear
- Lagrangian cubic

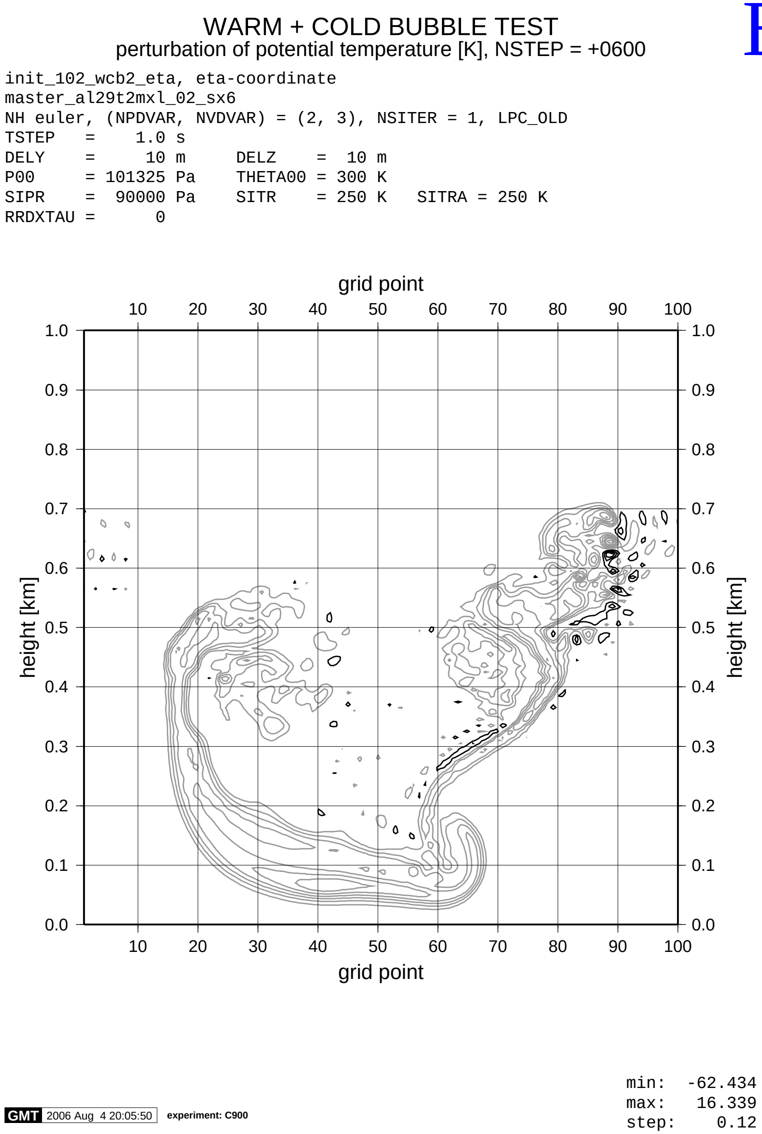
New interpolators for SL



Bubble test, after 10 minutes

- Linear
- Lagrangian cubic
- Splines

New interpolators for SL



Bubble test, after 10 minutes

- Linear
- Lagrangian cubic
- Splines
- Eulerian adv.

New interpolators for SL

Family of two parametric cubic interpolators

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

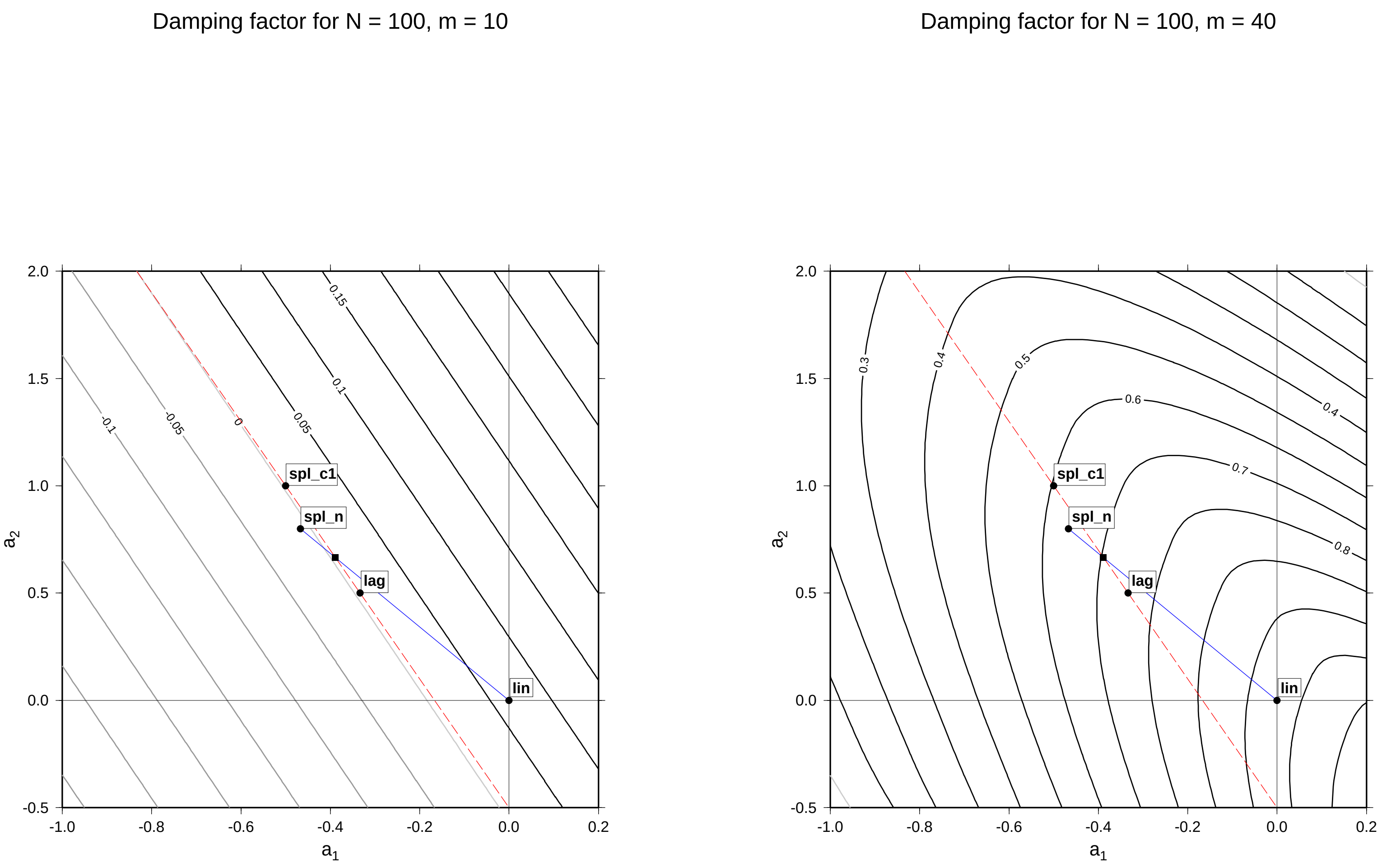
where

$$\mathbf{w_0(x) = a_1x + a_2x^2 - (a_1+a_2)x^3}$$

$$\mathbf{w_1(x) = 1 + (a_2-1)x - (3a_1+4a_2)x^2 + 3(a_1+a_2)x^3}$$

New interpolators for SL

Dimensionless damping rate



TL/AD of the ALADIN SL

Convergence for the TL code (e501):

$$\lim_{\epsilon \longrightarrow 0} \frac{M(x+\epsilon\delta x) - M(x)}{\mathcal{M}'(\epsilon\delta x)}, \qquad \epsilon = \epsilon_0 10^{\lambda}$$

	Eulerian advection Δt=120s	SL advection Δt=450s
λ = 0	RAT = 0.9685219082957116E+00	RAT = 0.1094034387101322E+01
λ = -1	RAT = 0.9970618603595810E+00	RAT = 0.1008012195504008E+01
λ = -2	RAT = 0.9997073040468342E+00	RAT = 0.1002141025110223E+01
λ = -3	RAT = 0.9999707398884352E+00	RAT = 0.1000160788422592E+01
λ = -4	RAT = 0.9999970679271253E+00	RAT = 0.1000099605664519E+01
λ = -5	RAT = 0.9999995490240665E+00	RAT = 0.1000001139215519E+01
λ = -6	RAT = 0.9999987045356886E+00	RAT = 0.1000001847670018E+01
λ = -7	RAT = 0.9999936488857756E+00	RAT = 0.1000041939684409E+01
λ = -8	RAT = 0.9999533728917936E+00	RAT = 0.1000246087384355E+01
λ = -9	RAT = 0.9991377690586460E+00	RAT = 0.9994838411148169E+00
λ = -10	RAT = 0.9970808134568164E+00	RAT = 0.1032182685987080E+01

TL/AD of the ALADIN SL

Test of the adjoint code (e401):

Eulerian advection (1 hour, Δt = 120 s)

```
TEST OF THE ADJOINT
                  12345678901234567890
< F(X) , Y >  = -.90189924198410820200E-02
< X , F*(Y) > = -.90189924198410612030E-02
THE DIFFERENCE IS    10.395 TIMES THE ZERO OF THE MACHINE
```

SL advection (1 hour, Δt= 120 s)

```
TEST OF THE ADJOINT
                  12345678901234567890
< F(X) , Y >  = -.66041517403842070130E-02
< X , F*(Y) > = -.66041517403841827300E-02
THE DIFFERENCE IS    16.562 TIMES THE ZERO OF THE MACHINE
```

SL advection (1 hour, Δt= 360 s)

```
TEST OF THE ADJOINT
                  12345678901234567890
< F(X) , Y >  = -.71646146174093533820E-02
< X , F*(Y) > = -.71646146174093447100E-02
THE DIFFERENCE IS     5.452 TIMES THE ZERO OF THE MACHINE
```

TL/AD of the ALADIN SL

Adjoint code optimization

```
ZPP=0.
DO JROF = KSTART, KPROF
...
ZPP= ZPP+  ZNORDY5(JROF)*PO(JROF,JLEV)
...
ZPP=0.
ENDDO
```

- **Support for vector platforms**
  - Vectorization of loops

TL/AD of the ALADIN SL

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```
DO JROF = KSTART, KPROF
...
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...
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- **Support for vector platforms**
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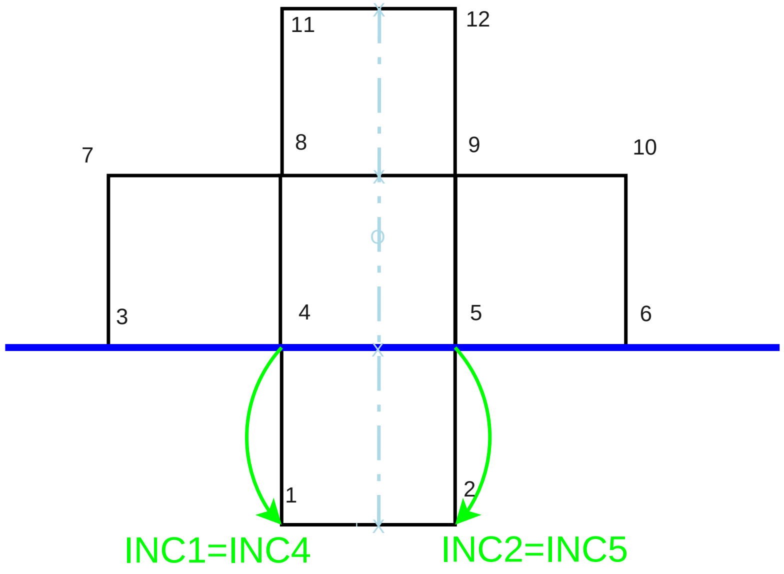
TL/AD of the ALADIN SL

Adjoint code optimization

```
DO JINC=ISTART,ISTOP
PSLBUF1(INC(JINC,JROF)) = &
& PSLBUF1(INC(JINC,JROF)) + &
& ZINC(JINC,JROF)
ENDDO
```



- **Support for vector platforms**
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TL/AD of the ALADIN SL

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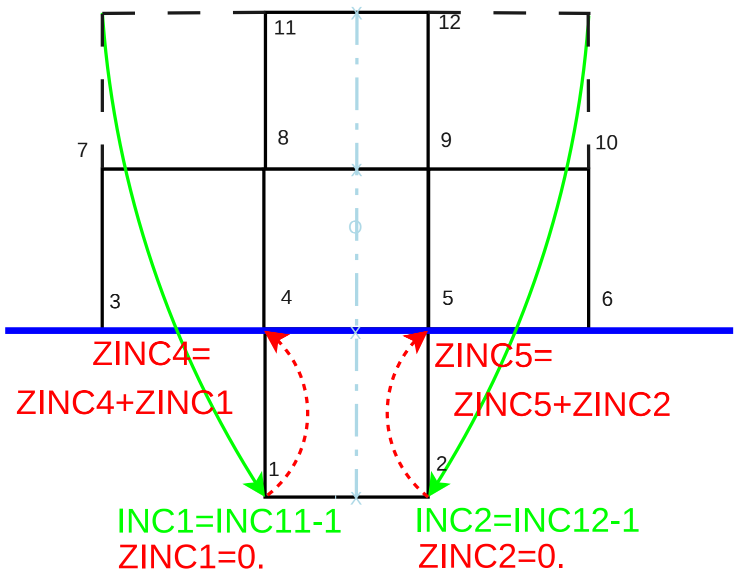

- **Support for vector platforms**
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  - Specific LAM development for LVECADIN option

TL/AD of the ALADIN SL

Adjoint code optimization

V.Op.Ratio = 98.814048 %
VLEN = 225.948825

- **Support for vector platforms**
  - Vectorization of loops
  - Specific LAM development for LVECADIN option

TL/AD of the ALADIN SL

Adjoint code optimization

MPI:

LIMP_NOOLAP=.TRUE.,
LSLONDEM=.TRUE.

- **Support for vector platforms**
  - Vectorization of loops
  - Specific LAM development for LVECADIN option
- **Parallel processing**
  - MPI

TL/AD of the ALADIN SL

Adjoint code optimization

OpenMP:
extra care for YOMOML module
during compilation

- **Support for vector platforms**
  - Vectorization of loops
  - Specific LAM development for LVECADIN option
- **Parallel processing**
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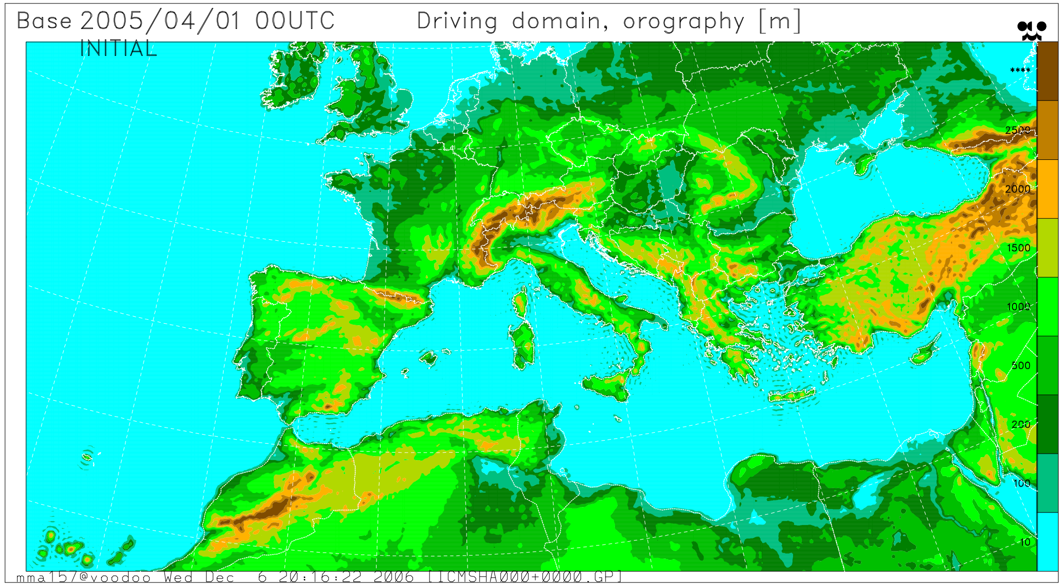
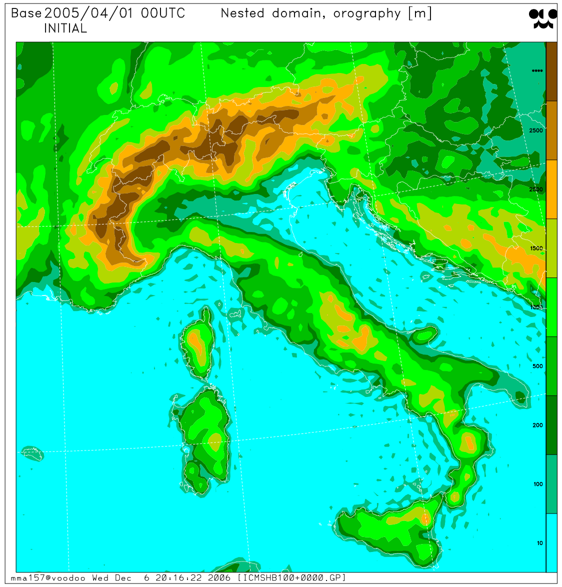
  - OpenMP

Diagnostic tool for lat. coupling

- Based on perfect model approach (Elía et al., 2002) using the same LAM on two domains with the same resolution and matching grid-points.





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- Jump in resolution between driving and nested LAM is simulated by spectral filtering.

Diagnostic tool for lat. coupling

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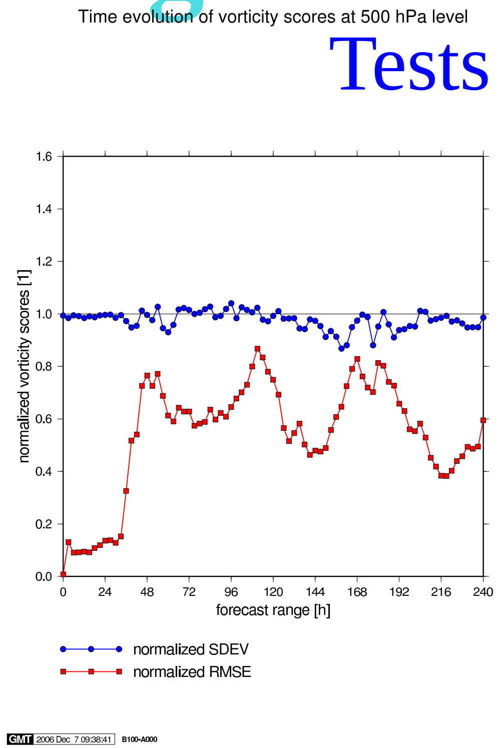
- Jump in resolution between driving and nested LAM is simulated by spectral filtering.
- Performance of coupling is judged according 10 days normalized RMSE difference (from reference solution) of vorticity field at 500 hPa.

Diagnostic tool for lat. coupling

Tests of Davies relaxation scheme



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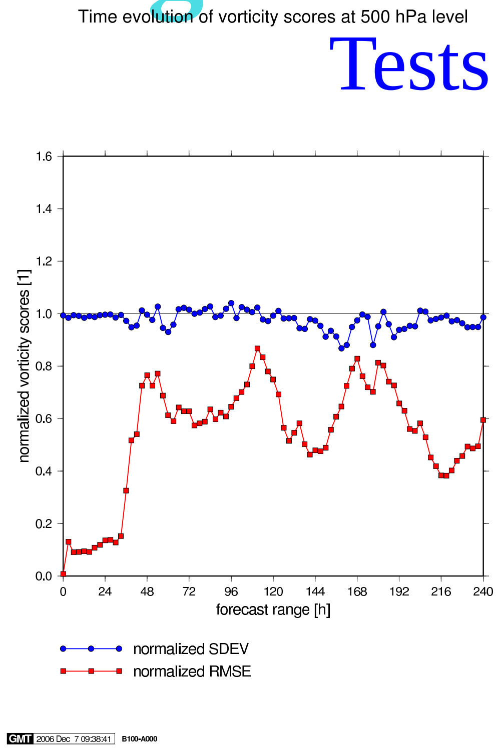

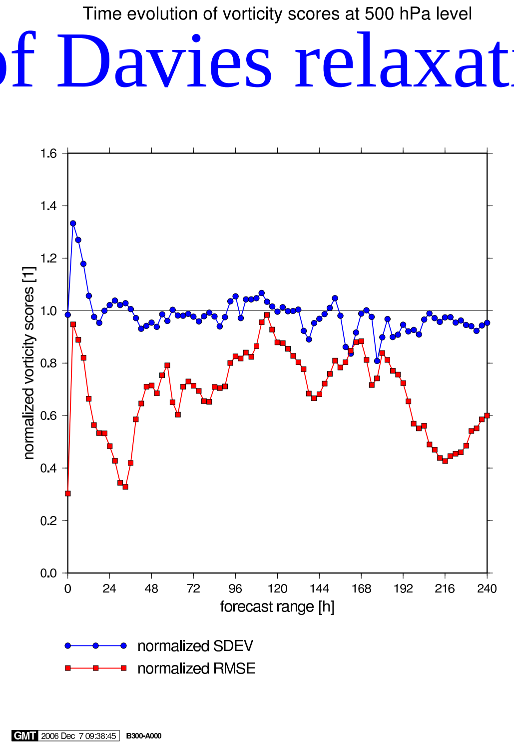

Diagnostic tool for lat. coupling

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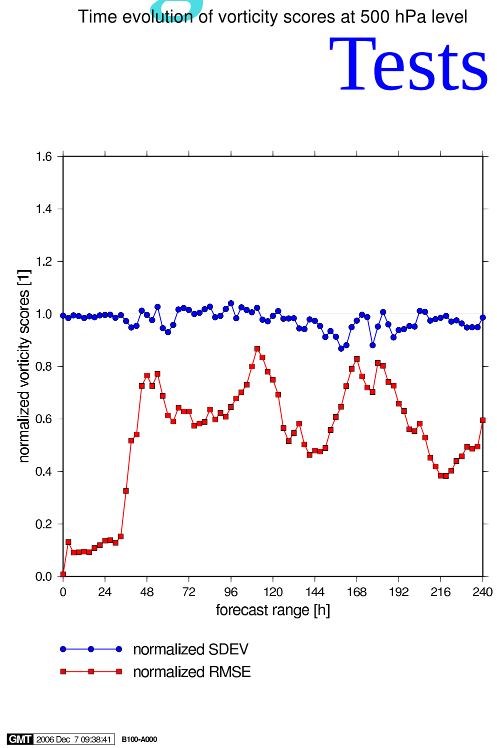

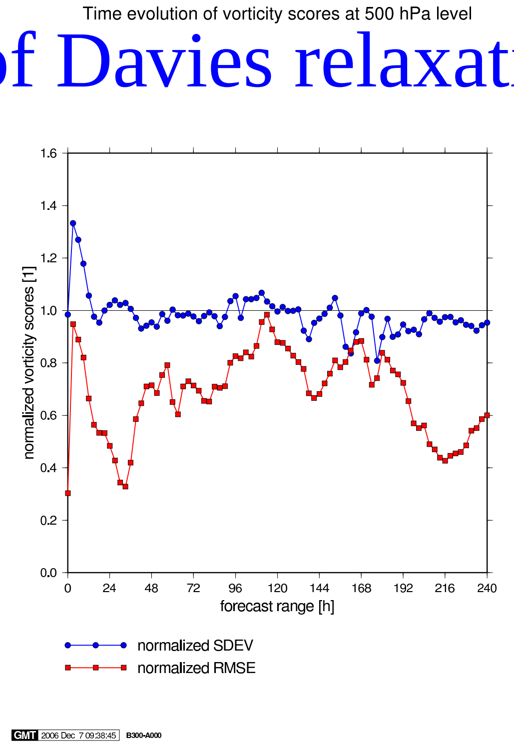

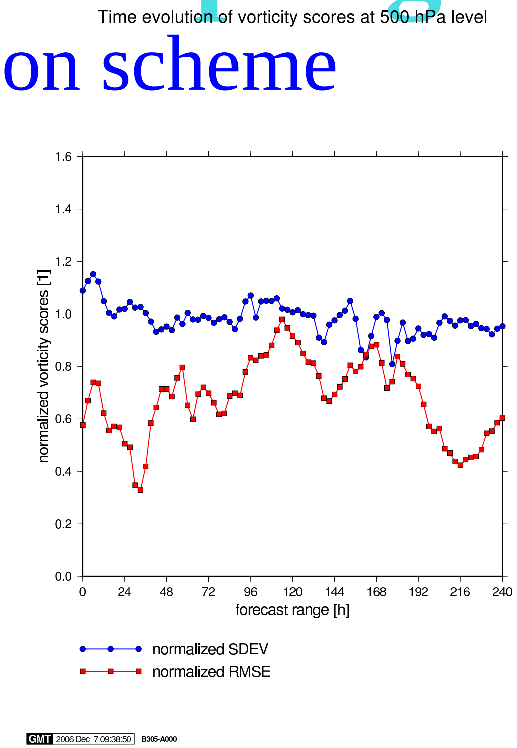

Diagnostic tool for lat. coupling

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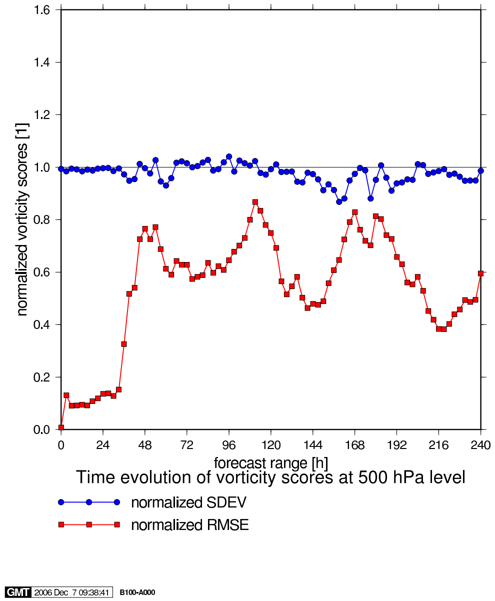

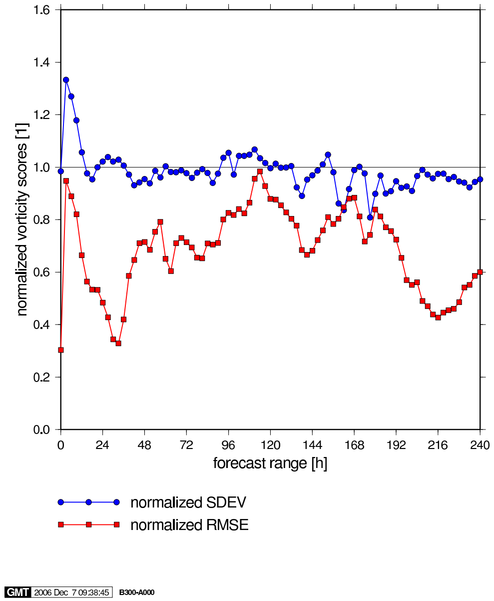

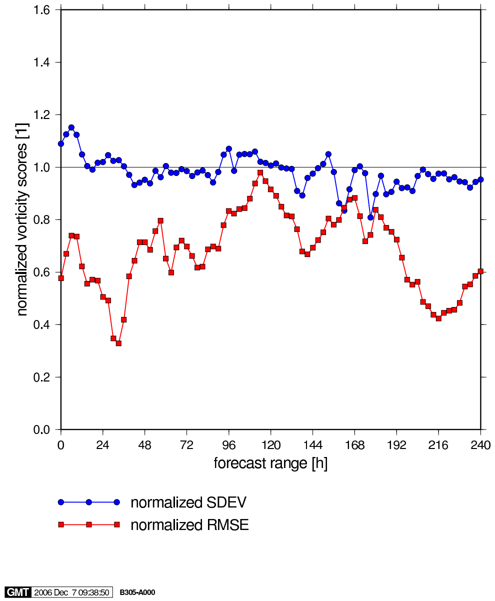

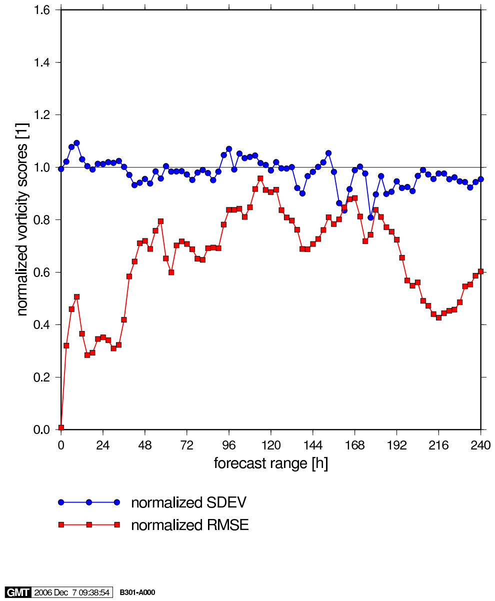

Diagnostic tool for lat. coupling

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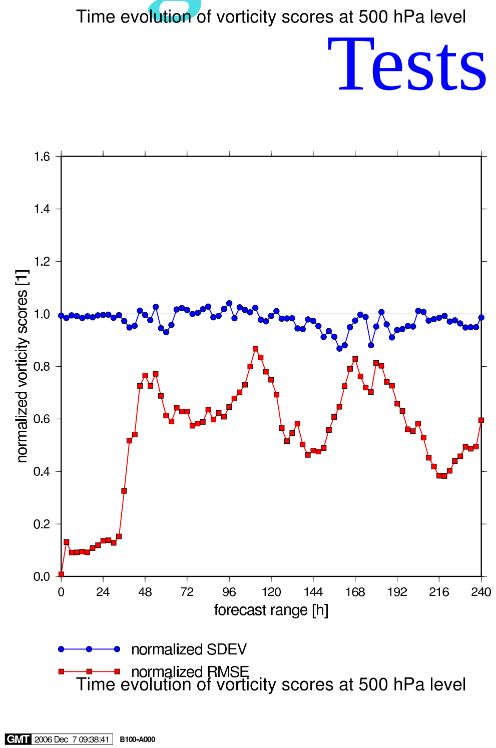
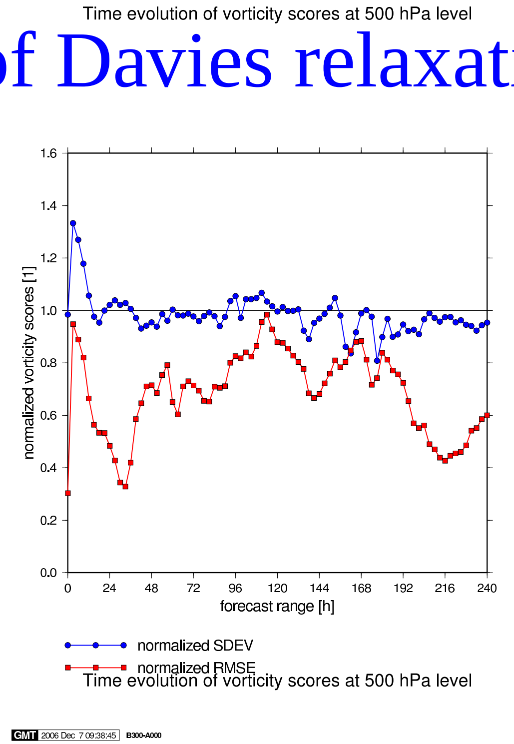
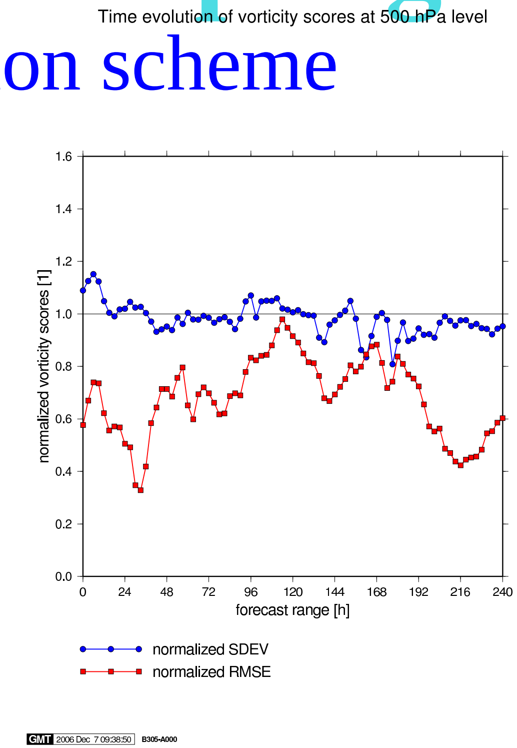
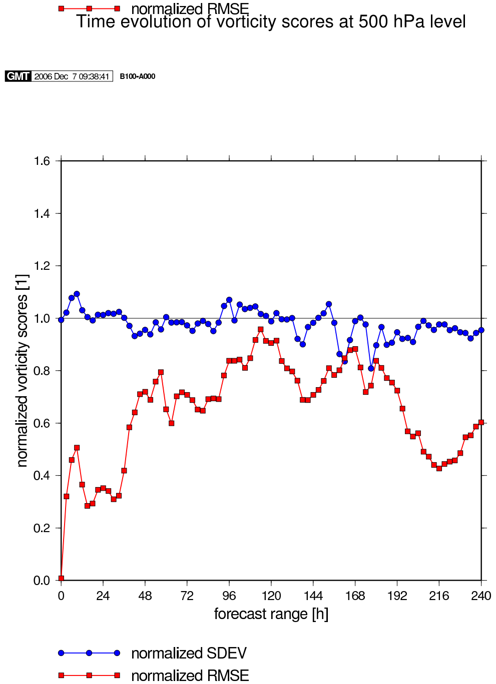
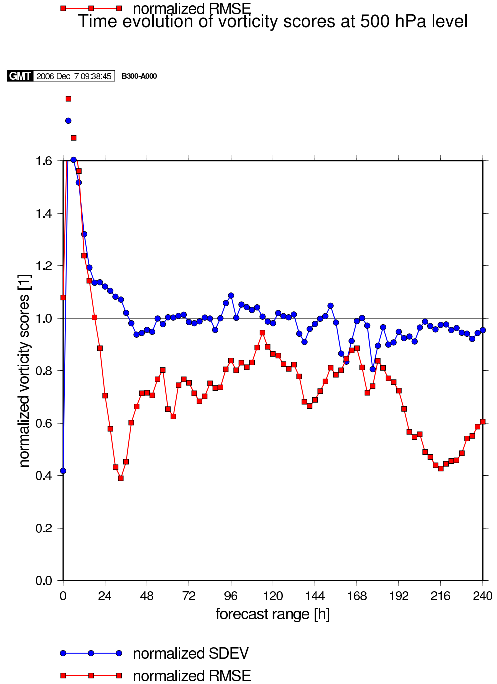




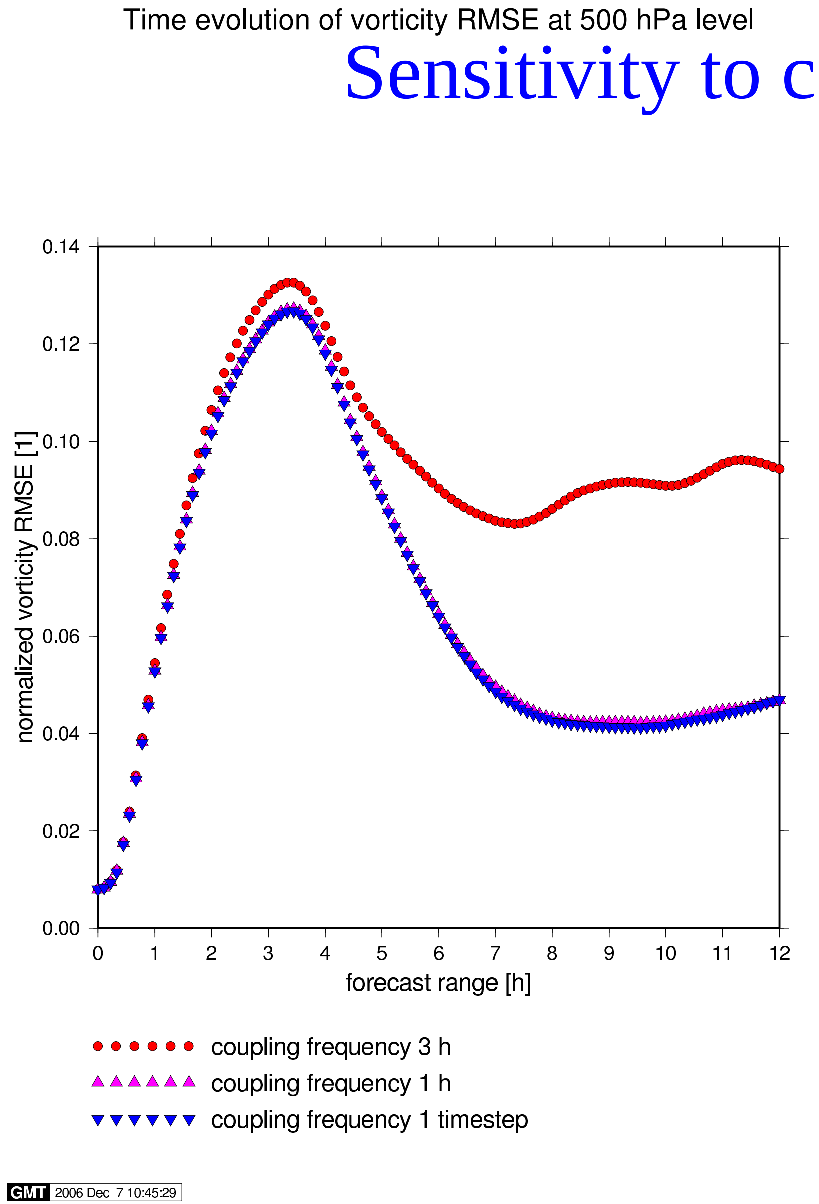






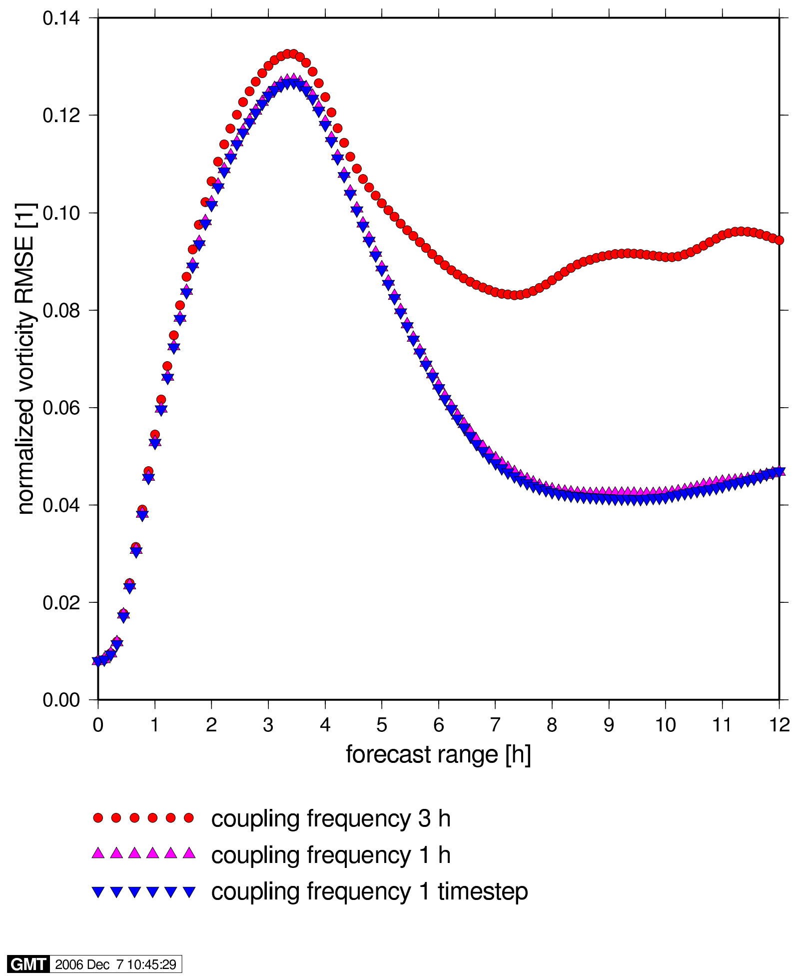
Diagnostic tool for lat. coupling

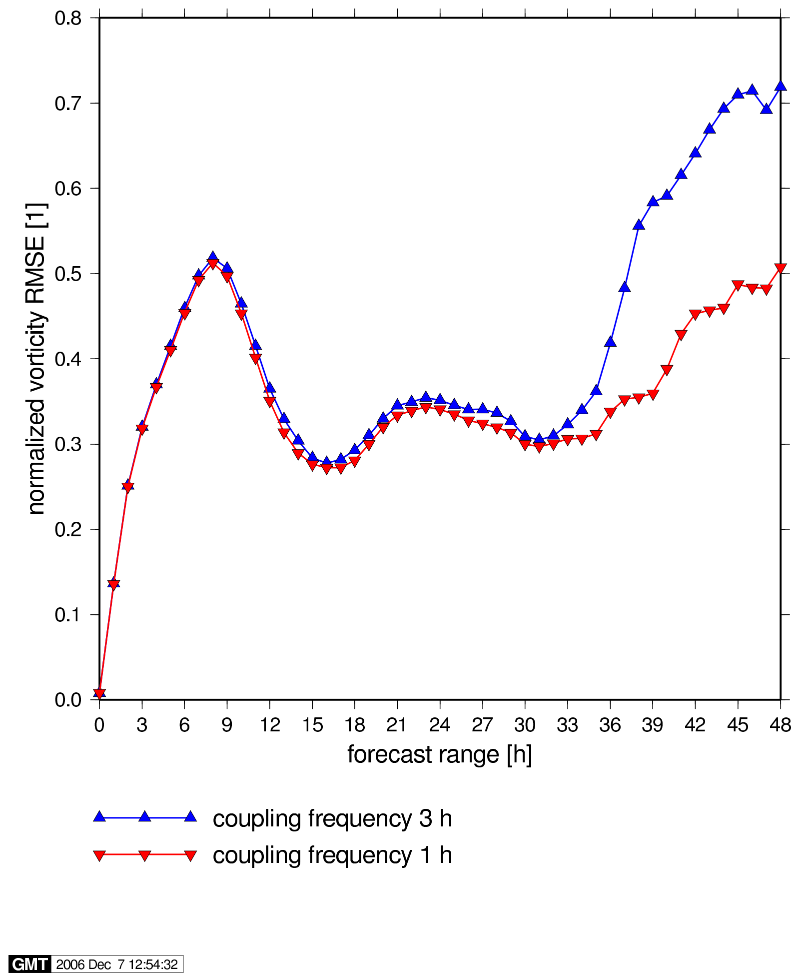
Sensitivity to coupling frequency



Diagnostic tool for lat. coupling

Sensitivity to coupling frequency



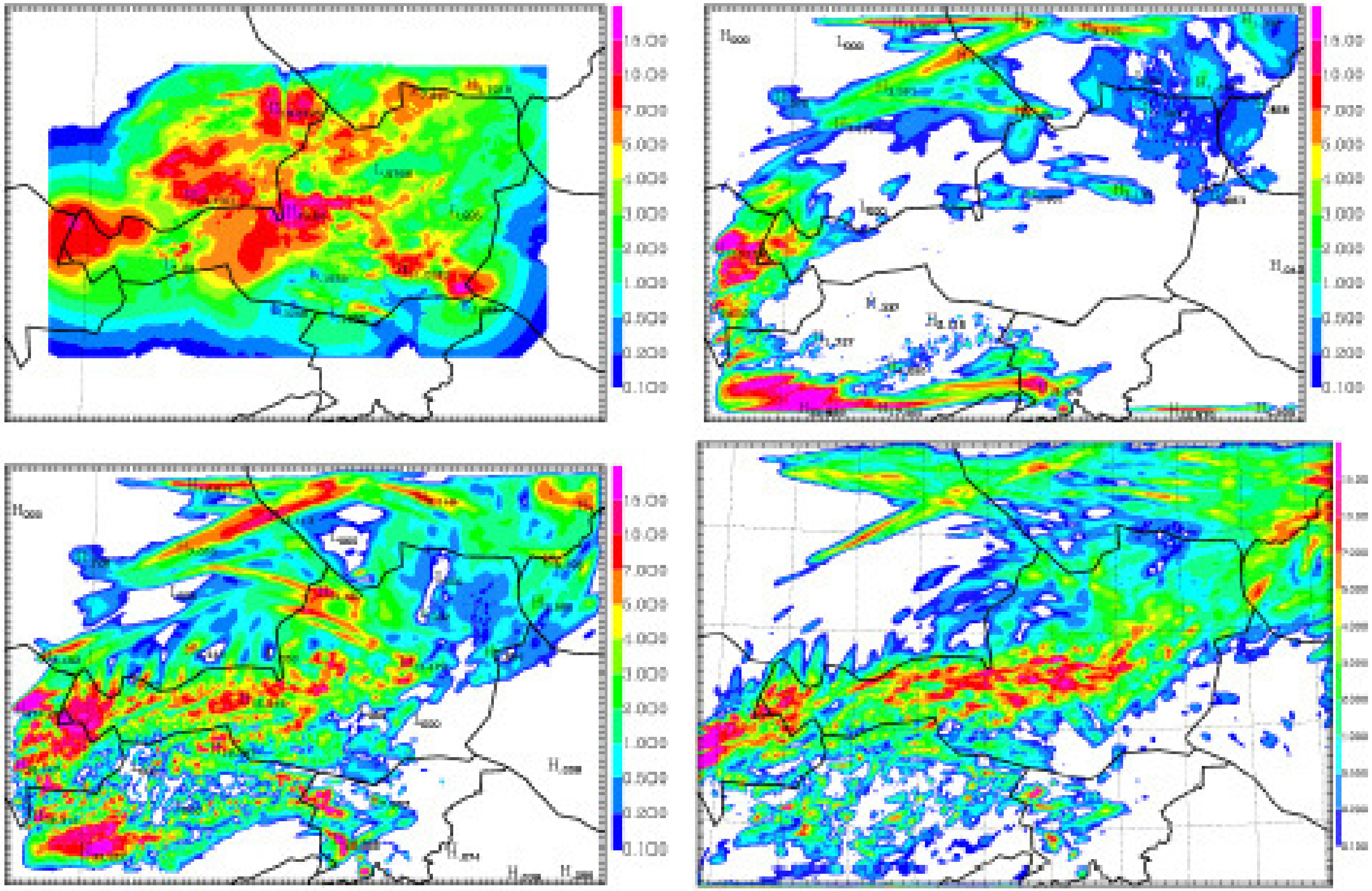


Plan for 2007

Project	Topic	Planned effort	LACE support
I.	VFE	7.5	2
II.	SLHD above orography	1.5	
	RUBC	1.5	
	New interpolators for SL	4	2
	Phys. coupling to dynamics	2	1
	TL/AD of plane SL	1	
	TL/AD of SLHD	3.5	
	Thermodynamic consistency	2	
III.	Alternative LBC formulation	2	
	Spectral coupling	2	
	Total:	**27**	**5**

SLHD above orography

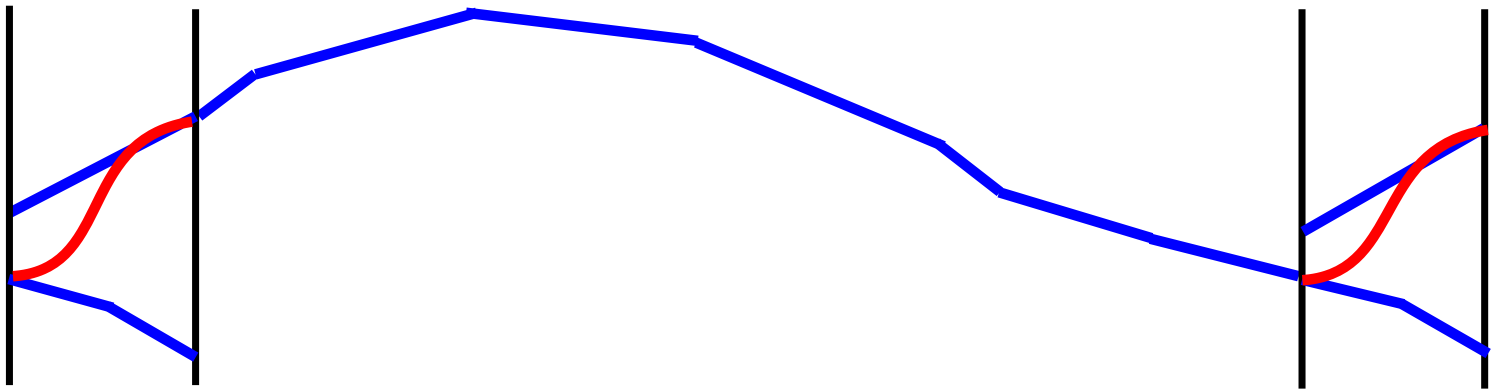
24h accumulated precipitation over Austria for the 23/06/2006



Alternative formulation of LBC

Ingredients:

- Boyd (2005)



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Alternative formulation of LBC

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- Boyd (2005)
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Alternative formulation of LBC