HyMeX

MISTRALS

REMEMBER

ANR

State of the LMD physics in WRF

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meeting REMEMBER, Tolouse. France – January 23rd 2015

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Introduction

- Objectives

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- Design

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- Technical aspects

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- Experiments
- Reflexions
- Planned work up to April

Objectives

- Open a complementary way for the development of LMDZ physic schemes
- Construct a platform to perform limited area runs with the LMDZ physics
- Test LMDZ physics resolution limitations with an appropriated dynamical core
- Test a non-hydrostatic use of the LMDZ physics

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   - Use of WRF compilation structure/framework

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4. Technical aspects:
   - Minimal changes in LMDZ code
   - Use of WRF compilation structure/framework
5. Usability aspects:
   - Use LMDZ physics as a new WRF set of parameterizations
   - Preserve WRF flexibility and capabilities

Technical

- **Dynamics-Physics:** Atmospheric models split atmosphere in two ’independent’ pieces
  - **Dynamics:** Resolution of the dynamic of the atmosphere throughout the Navier-Stokes equations
  - **Physics:** Resolution of the sub-scale processes via parameterizations/schemes: solar radiation, convection, cumulus, boundary layer, surface, micro-physics

Technical

- Coupling of the WRF dynamics and LMDZ physics:
  - $WRF_{dynamics}$: Evolution of the state variables via Navier-Stokes equations
  - $LMDZ_{physics}$: Tendencies of the state variables due to the sub-scale processes

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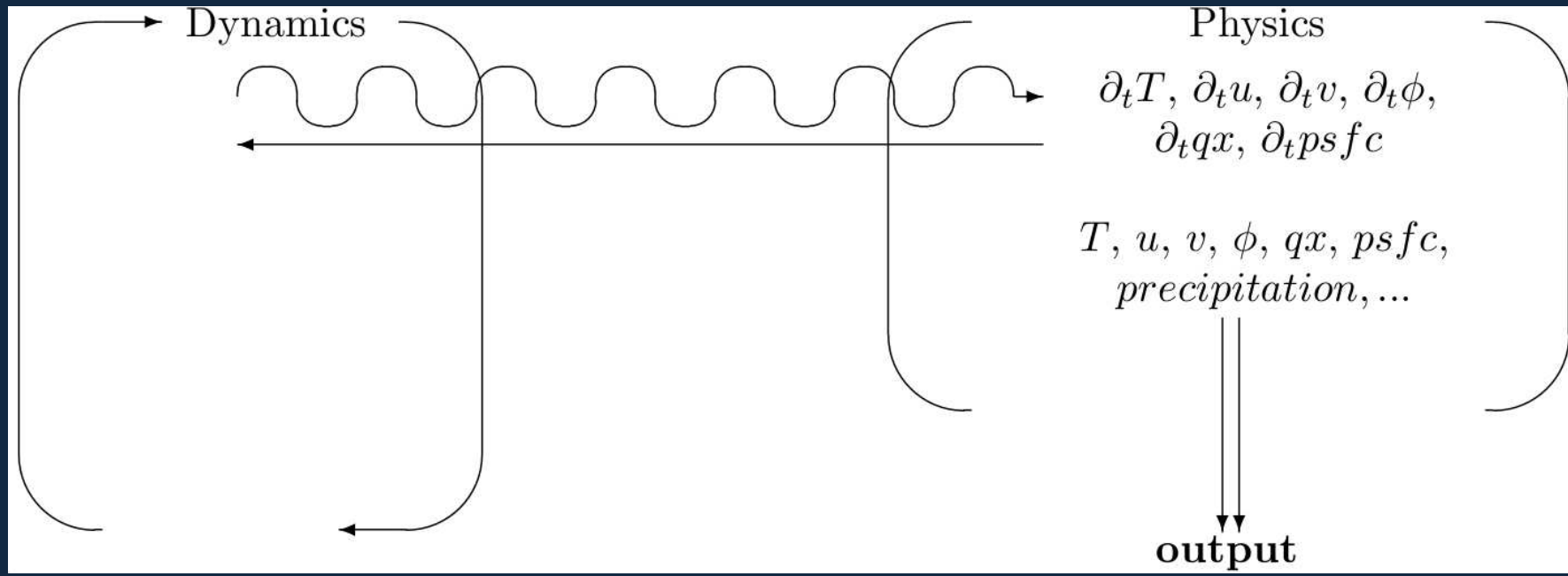

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- A WRF$\leftrightarrow$LMDZ interface is introduced in WRF code:

WRF $\Longleftrightarrow$ Interface $\Longleftrightarrow$ LMDZ

`dyn_em/solve_em.F` — `physiq.F`

$T, U, V, Q, pres, ...$ — $\partial_t T, \partial_t U, \partial_t V, \partial_t Q$

Adjustments

- Vertical Coordinate
  $\mathcal{WRF}$: $\eta = \frac{p - p_{top}}{p_{sfc} - p_{top}}$, $\mathcal{LMDZ}$: hybrid $\sigma = \frac{p}{p_{sfc}}$ (low lev.), $pressure$ (high lev.); $p_l = A_l + B_l p_s$. LMDZ simulates full atmosphere, WRF up to 5 hPa

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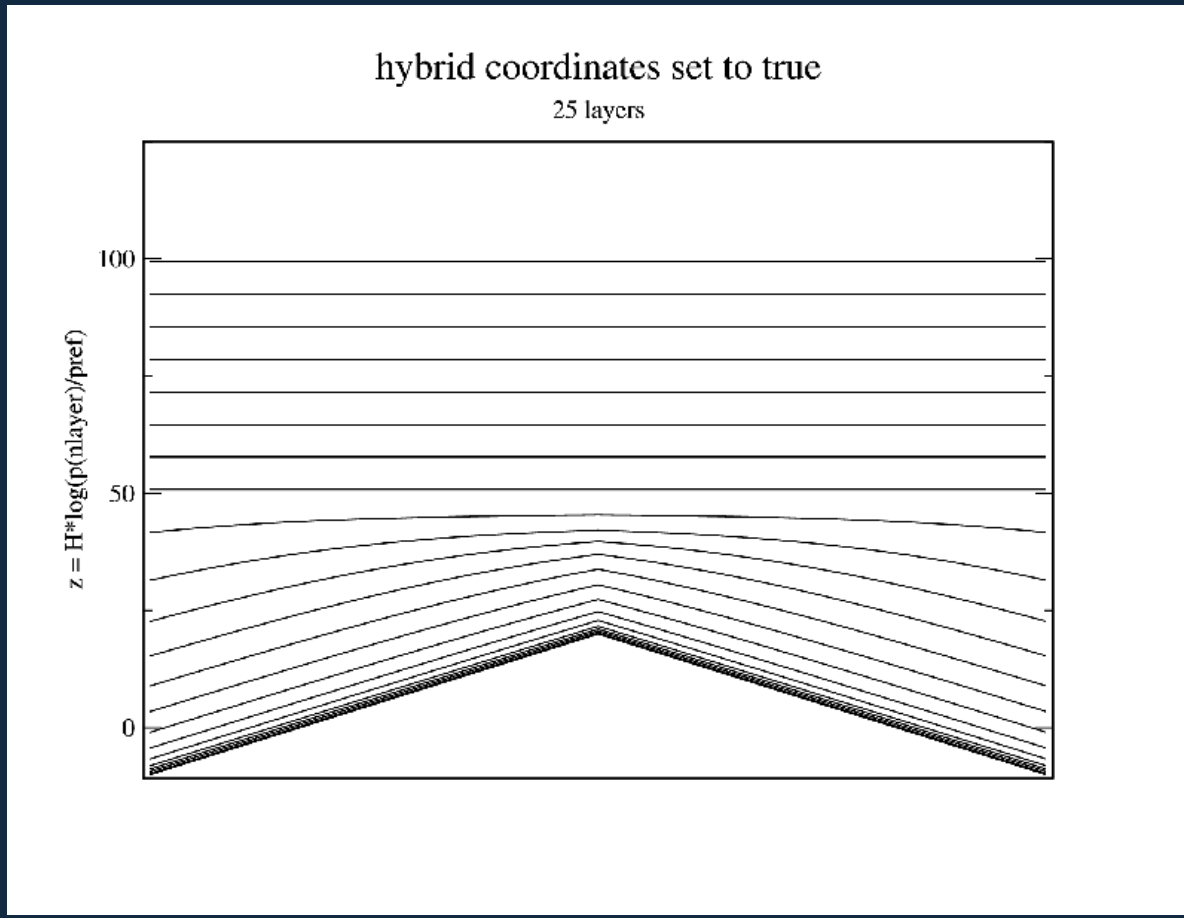

source: *LMDZ5: A documentation*

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- Surface soil types
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$$ter = \sum_{Urban}^{Savannah} WRF_{soil}$$

$$lic = \sum_{ice}^{glacier} WRF_{soil} \times \frac{ter}{ter + oce}$$

$$sic = \sum_{ice}^{glacier} WRF_{soil} \times \frac{oce}{ter + oce}$$

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$$qsol = \sum_{k=1}^{4} \sum_{s=i}^{Nsoil} \delta x \delta y \delta z(k) \rho_s smois(k)$$

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- WRFmeas: Development of a code to retrieve lidar-like observations from WRF runs

`http://www.lmd.jussieu.fr/~lflmd/WRFmeas/index.html`

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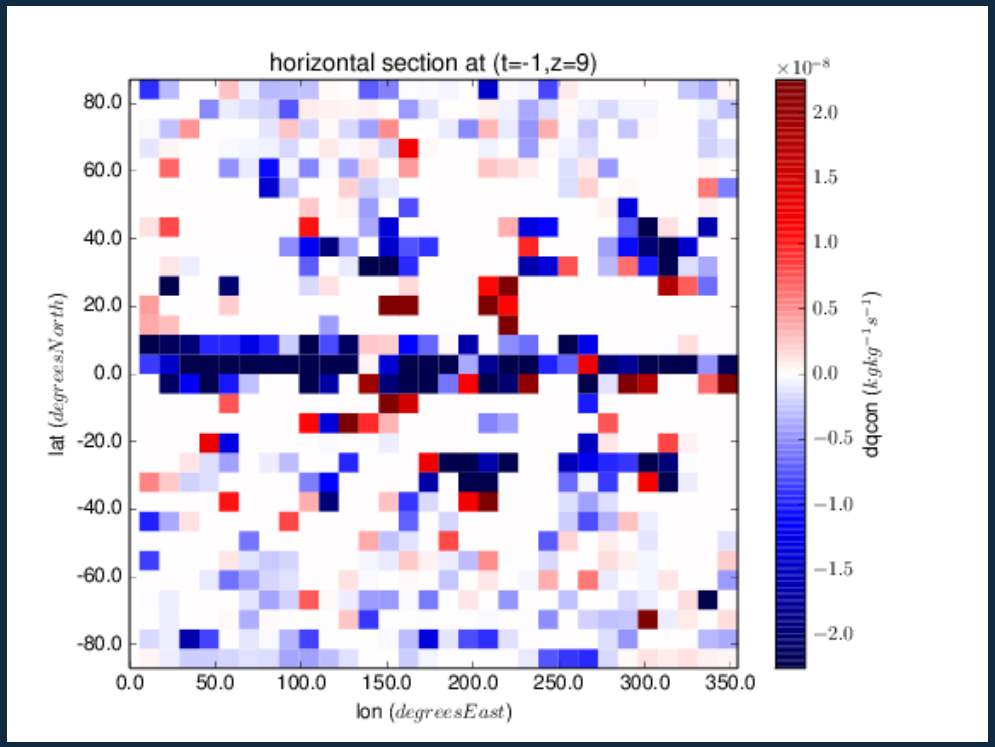
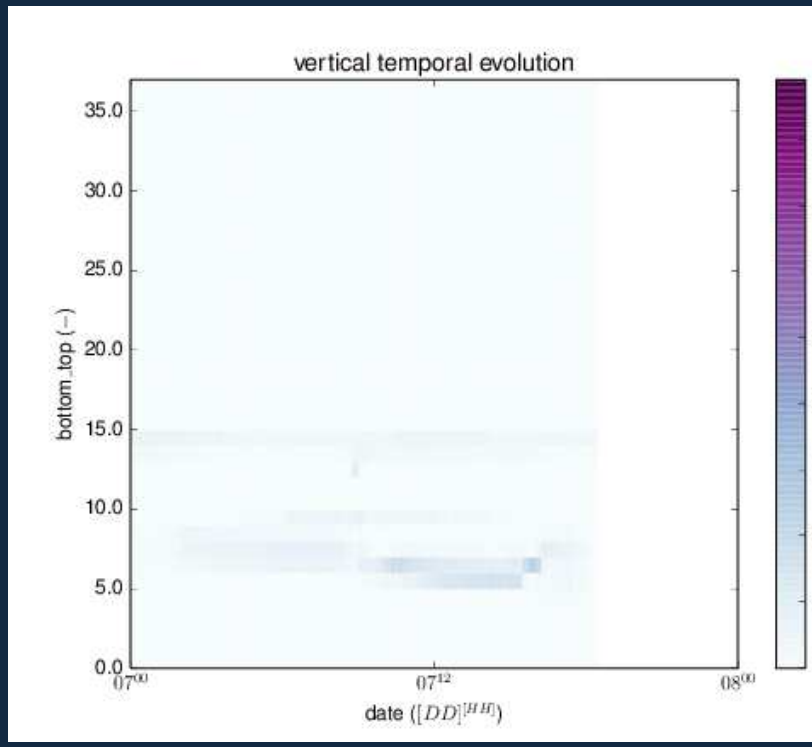
$\partial_t q^{con}$



$liquid\ water$



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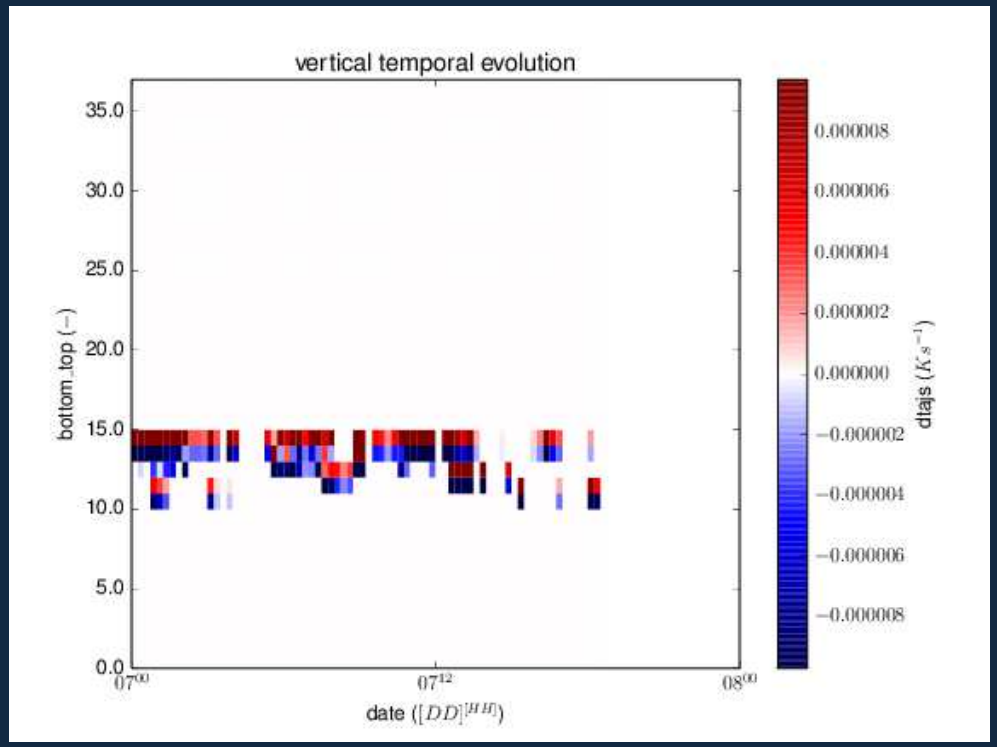
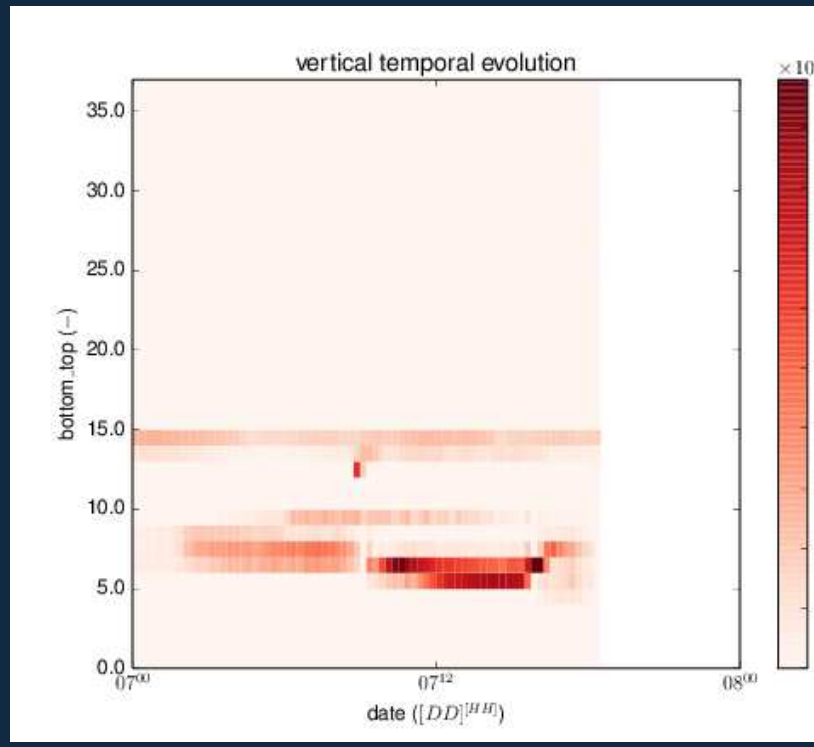
$\partial_t t^{ajs}$



$\partial_t q^{eva}$



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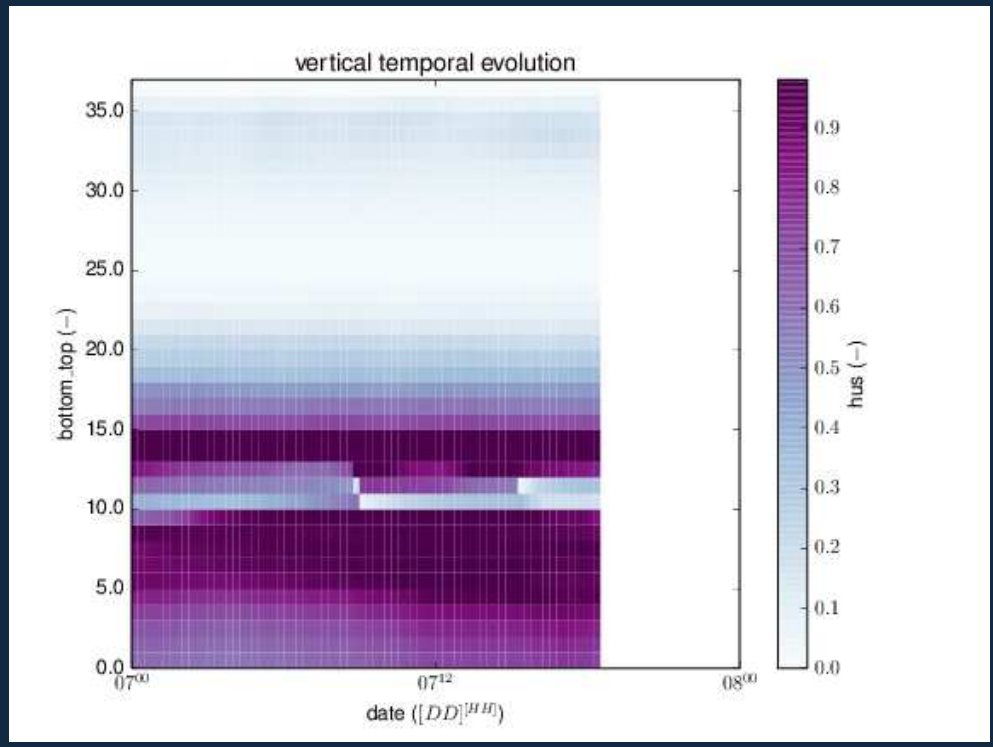

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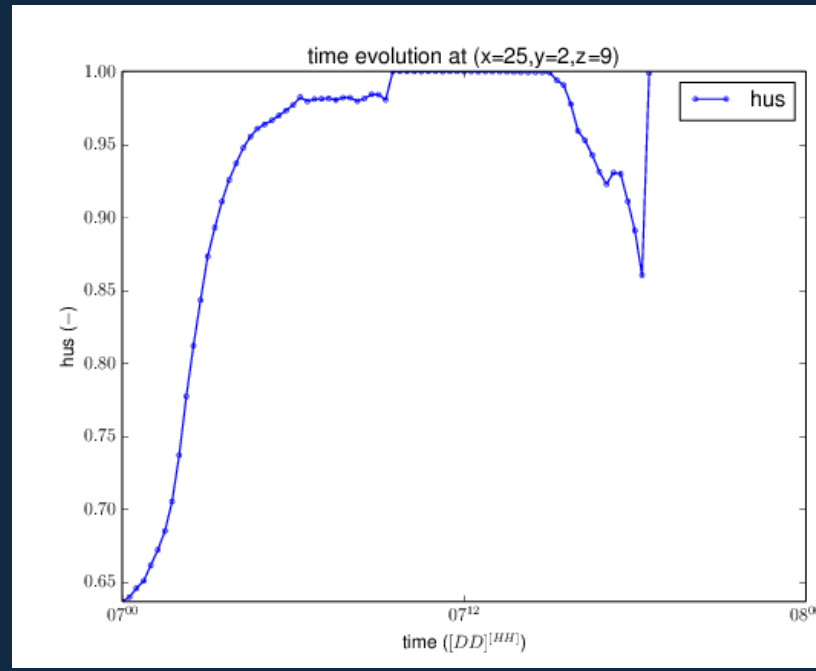

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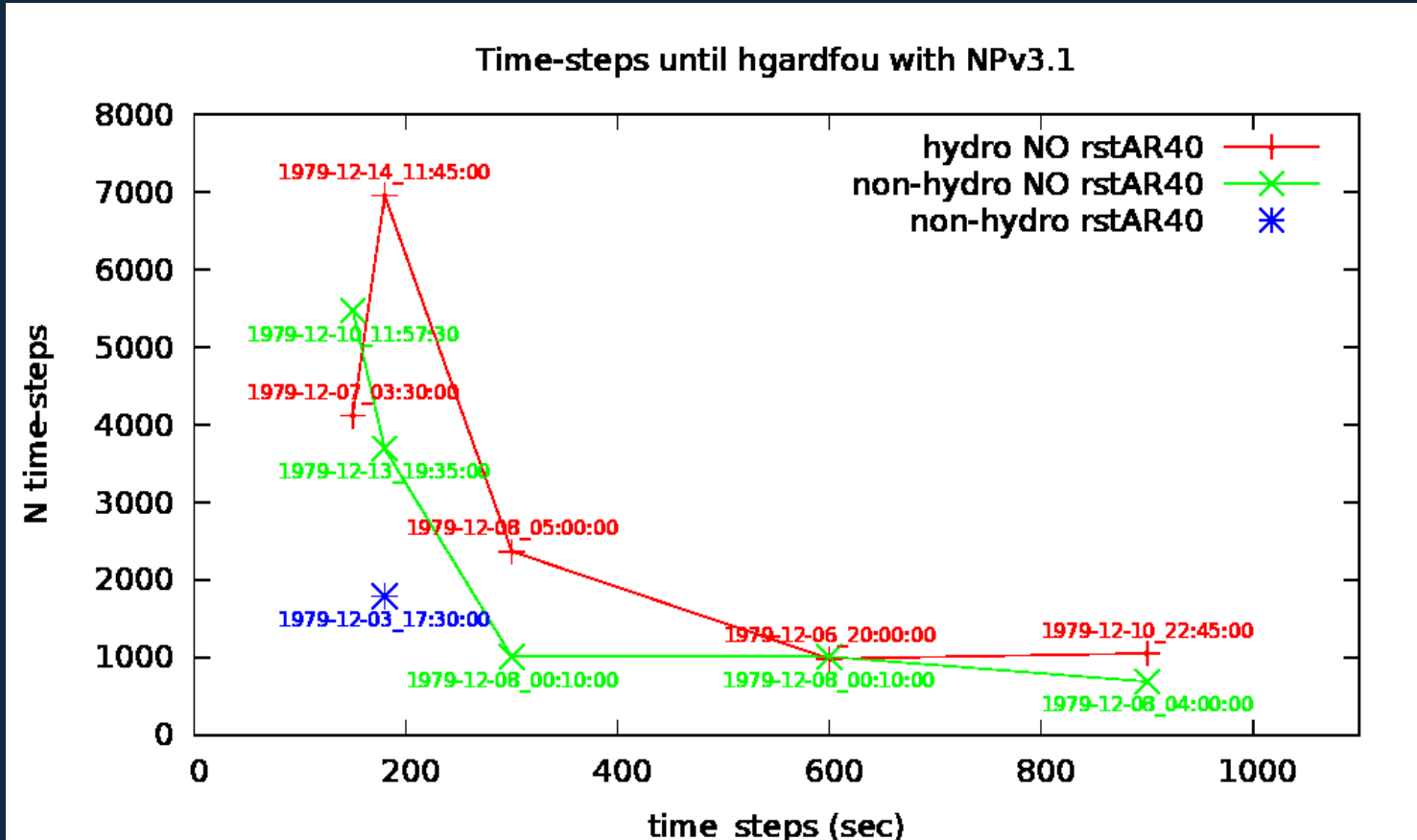

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- Initial simplest tests of the correct working of the framework
- Coarse resolution (32x32x39)
- Old results from a wrong 'working' version

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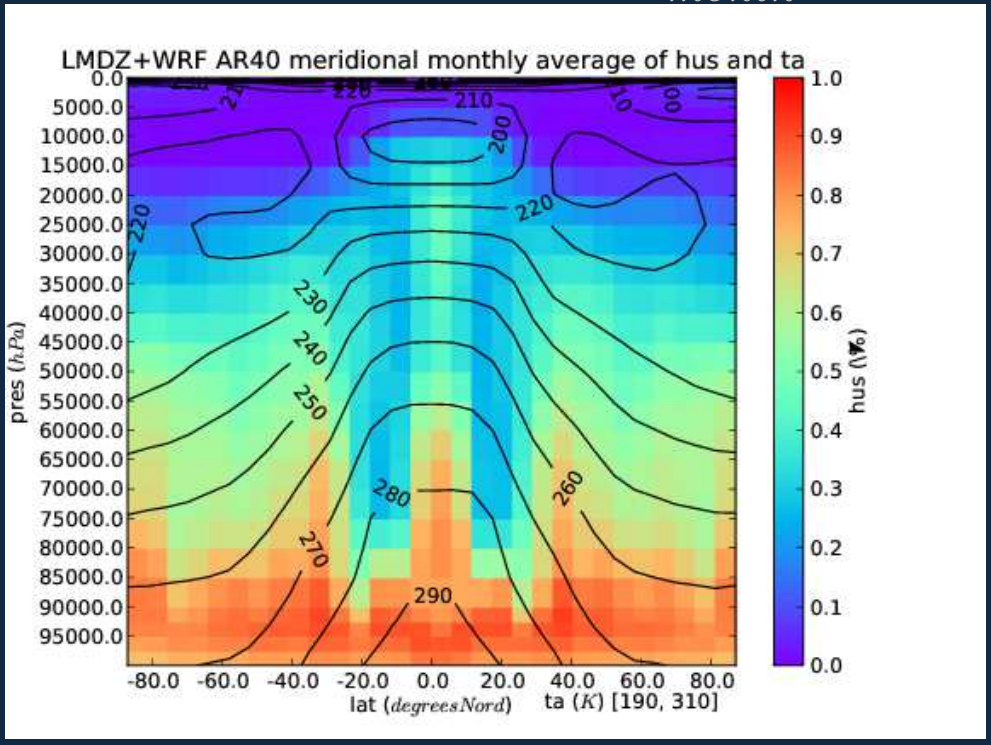

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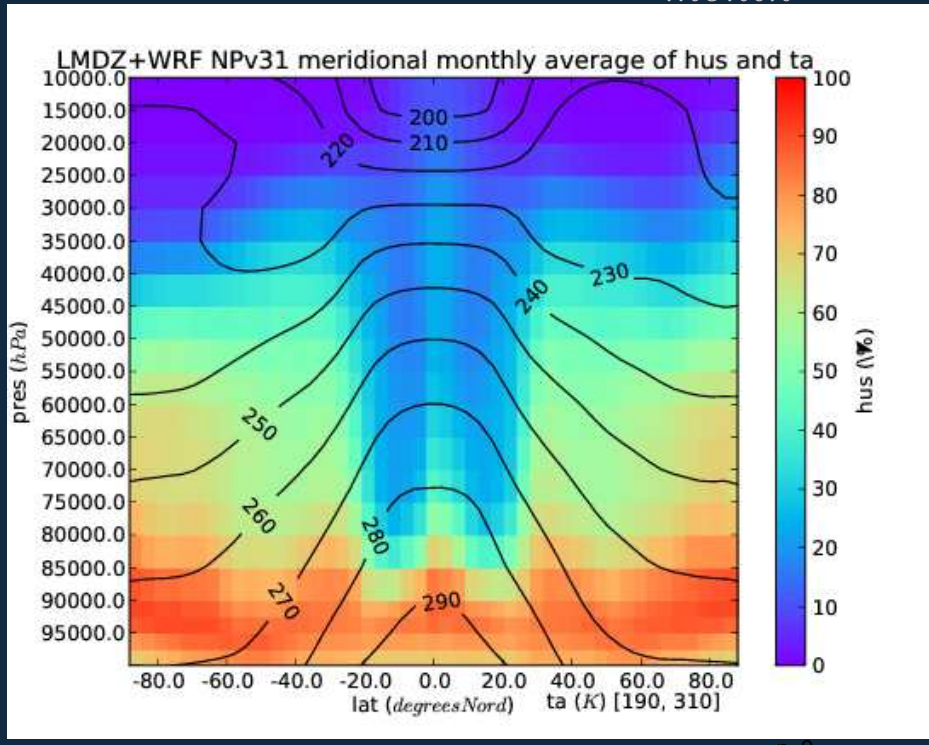

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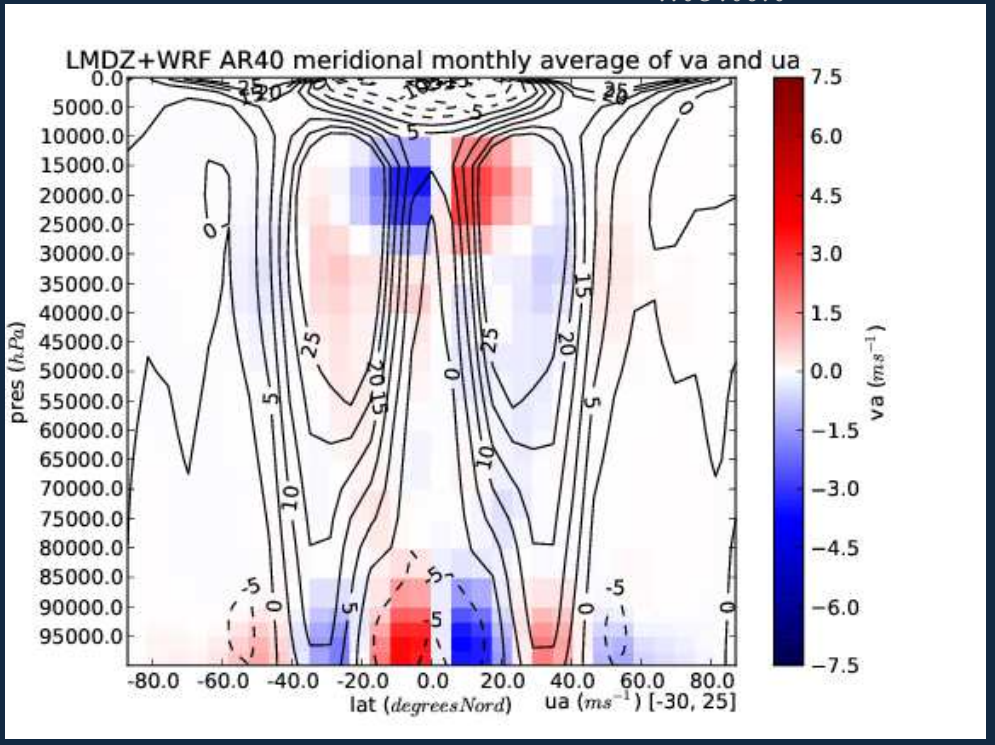

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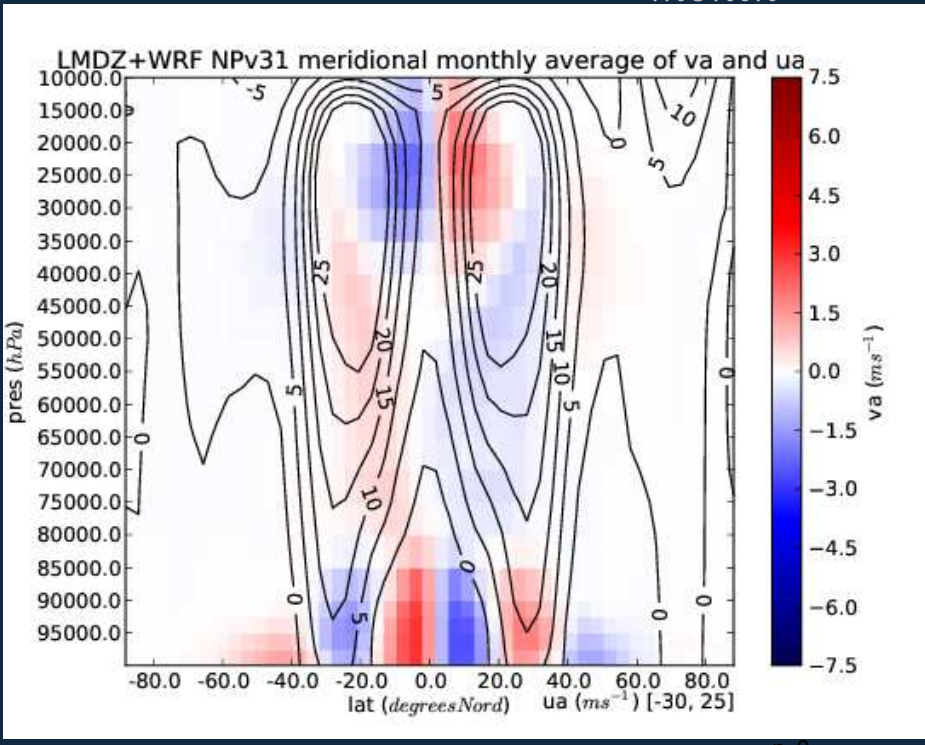

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WL_HyMeX: HyMeX regional case study

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case	sim. period	description
Superstorm	10-12/xi/2001	strongest W-Med. storm
medic950116	13-18/i/1995	medicane 1995 January
Cévennes96	17-21/ix/1996	Strong precip. Cévennes
IOP15	18-22/x/2012	Strong pr. Valencia and Cévennes

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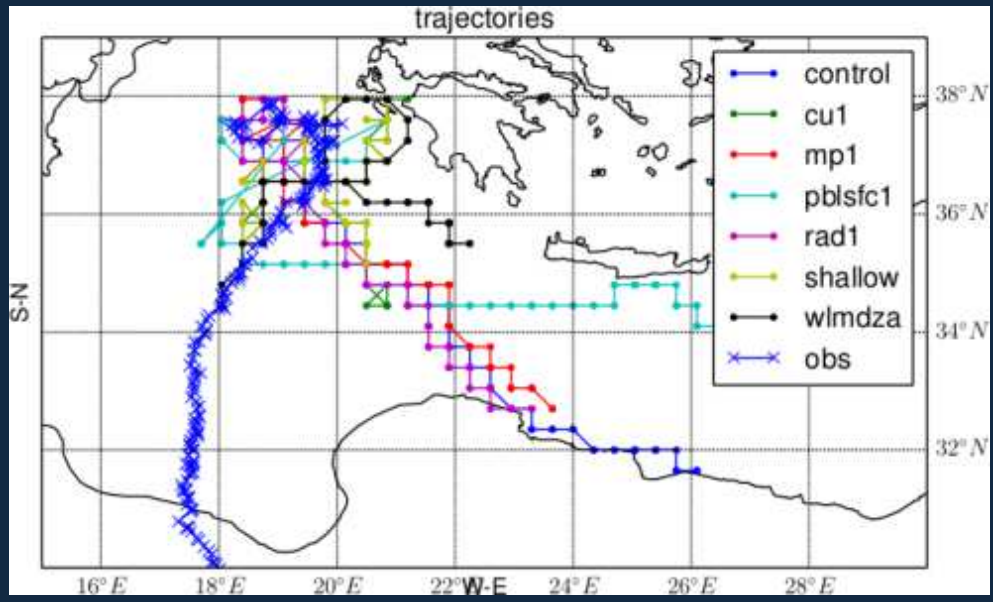
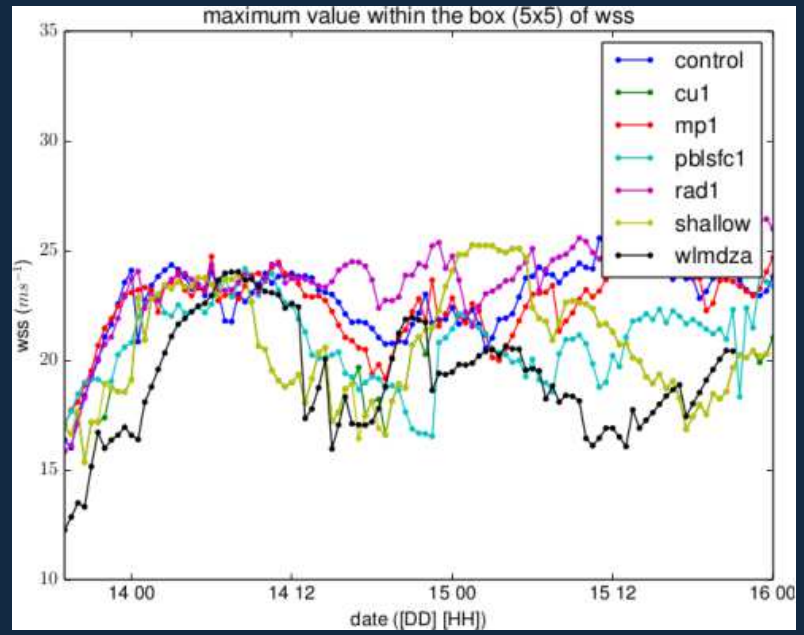


Trajectories



max 2m wind around center

Experiments

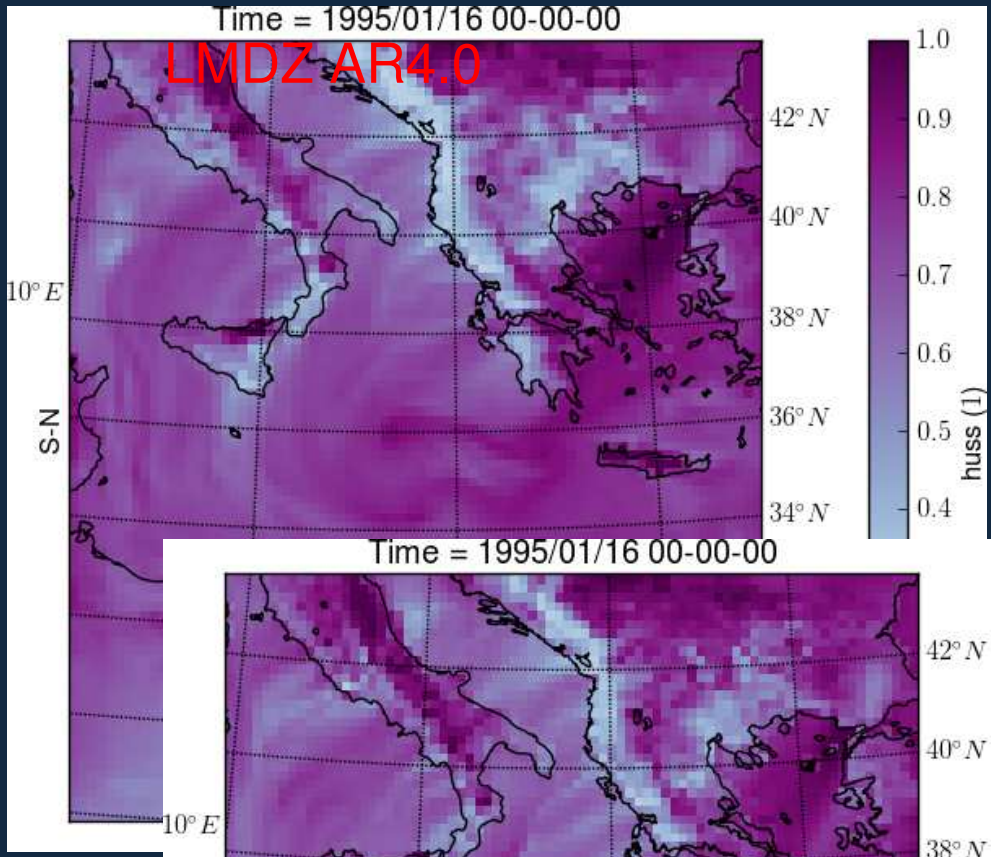
Cloud Resolving runs

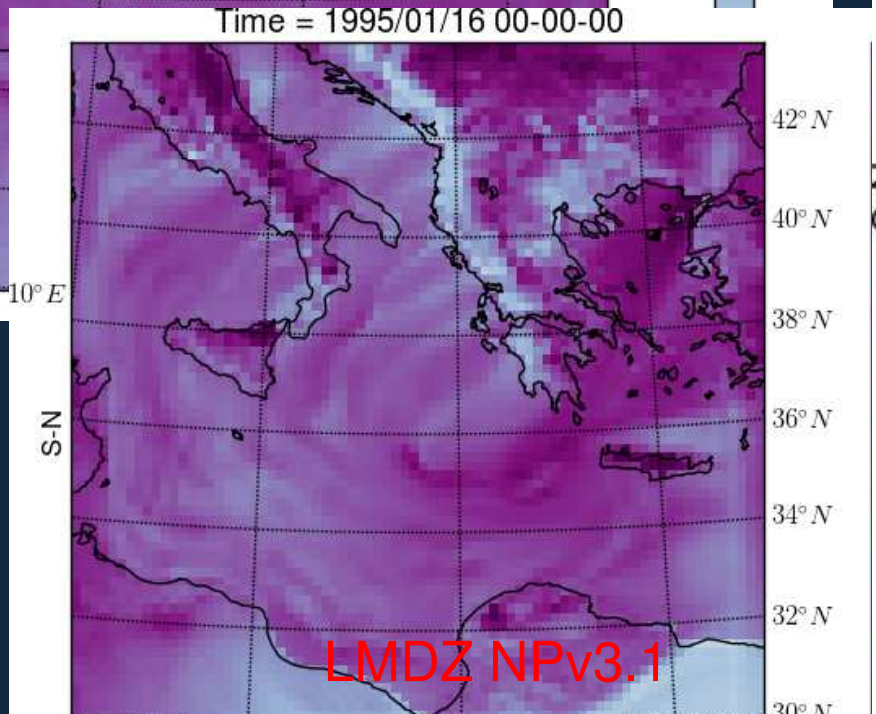
- Perform $\mathcal{WRF}$ runs at very high resolution ($2\ km$) over different cases to be used as 'reality' to validate outputs from $\mathcal{LMDZ}$ physics

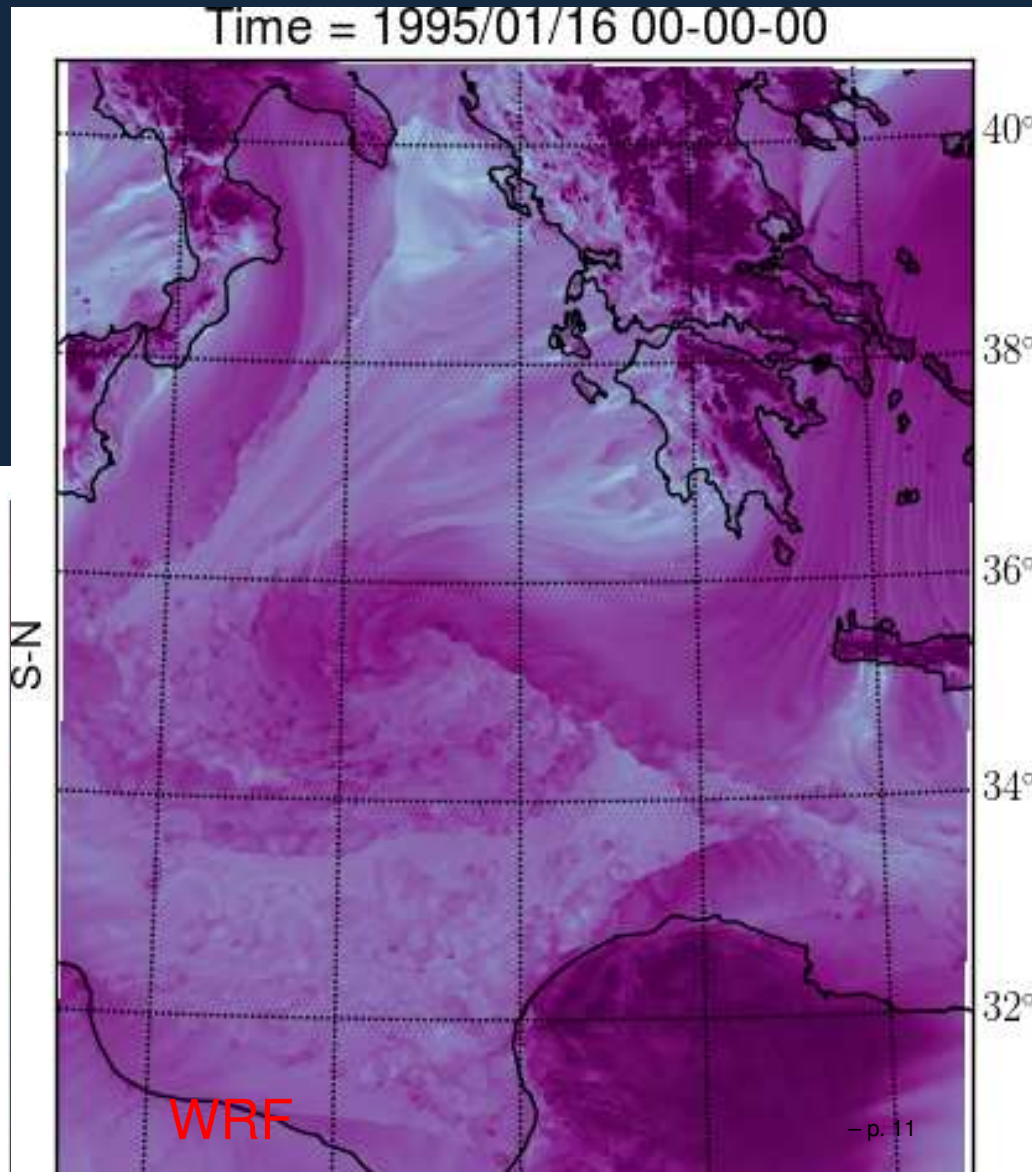
Experiments

Cloud Resolving runs

huss 1995/01/16 00 UTC







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- Not too scientific work. Need of a IT person

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- NOT doable (?):
  - Compilation in parallel
  - Update of the codes

Further further work beyond April...

- Use of WRF v3.6.1

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  - Expand (30 grid points S-N) MEDCORDEX domain to include the Black Sea ($> 50\%$ fresh water income in Mediterranean Sea), but to small to be simulated by NEMO

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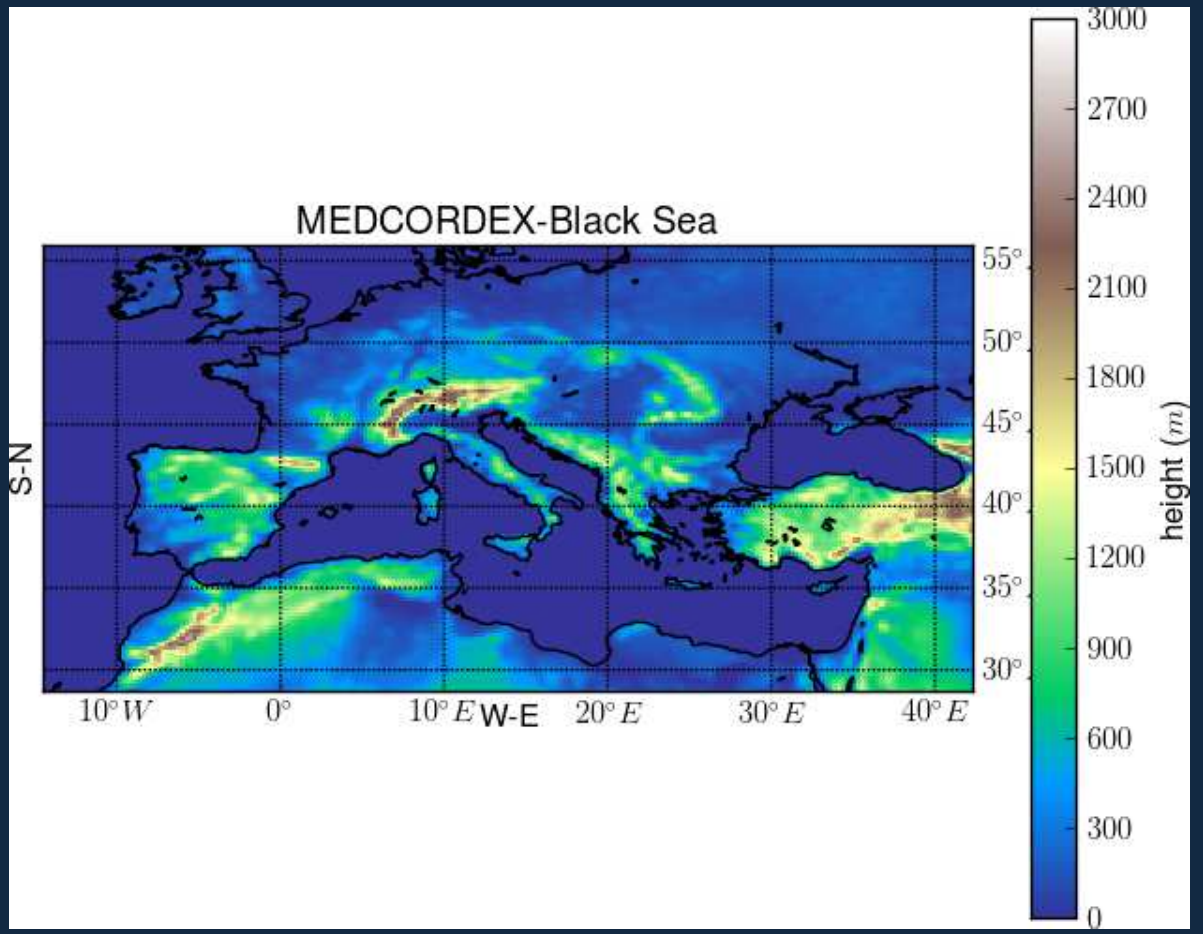
- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX



Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
  - 'Realistic' representation of all the river of the basin which discharge to the Black Sea with ORCHIDEE

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
  - Implementation of an ‘evaporating’ scheme for the Black Sea

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
  - More realistic representation of the fresh water income in present and future

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
- High resoluiton (5 km?) re-analysis for the Mediterranean basin

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
- High resoluiton (5 km?) re-analysis for the Mediterranean basin
  - Easiest: Via re-hindcasts of ERA-Interim of 36 hours joining 24 h (12h for spin-up), *[Menendez et al., 2014, Clim. Dyn.]*
  - Complet: using WRF-DVAR with all available data

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
- High resoluiton (5 km?) re-analysis for the Mediterranean basin
- Being ‘accessible’ for ‘punctual’ needs

Further further work beyond April...

- Use of WRF v3.6.1
- 5-year $< 3\ km$ MEDCORDEX from MEDCORDEX $20\ km$ runs (ndown)
- Black-Sea MEDCORDEX
- High resoluiton (5 km?) re-analysis for the Mediterranean basin
- Being ‘accessible’ for ‘punctual’ needs

Merci pour tout !!