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First experiments with COSMO-1 at MeteoSwiss

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with contributions from Oliver Fuhrer

COSMO-GM, CORSO-project, 11.9.2012

Contents

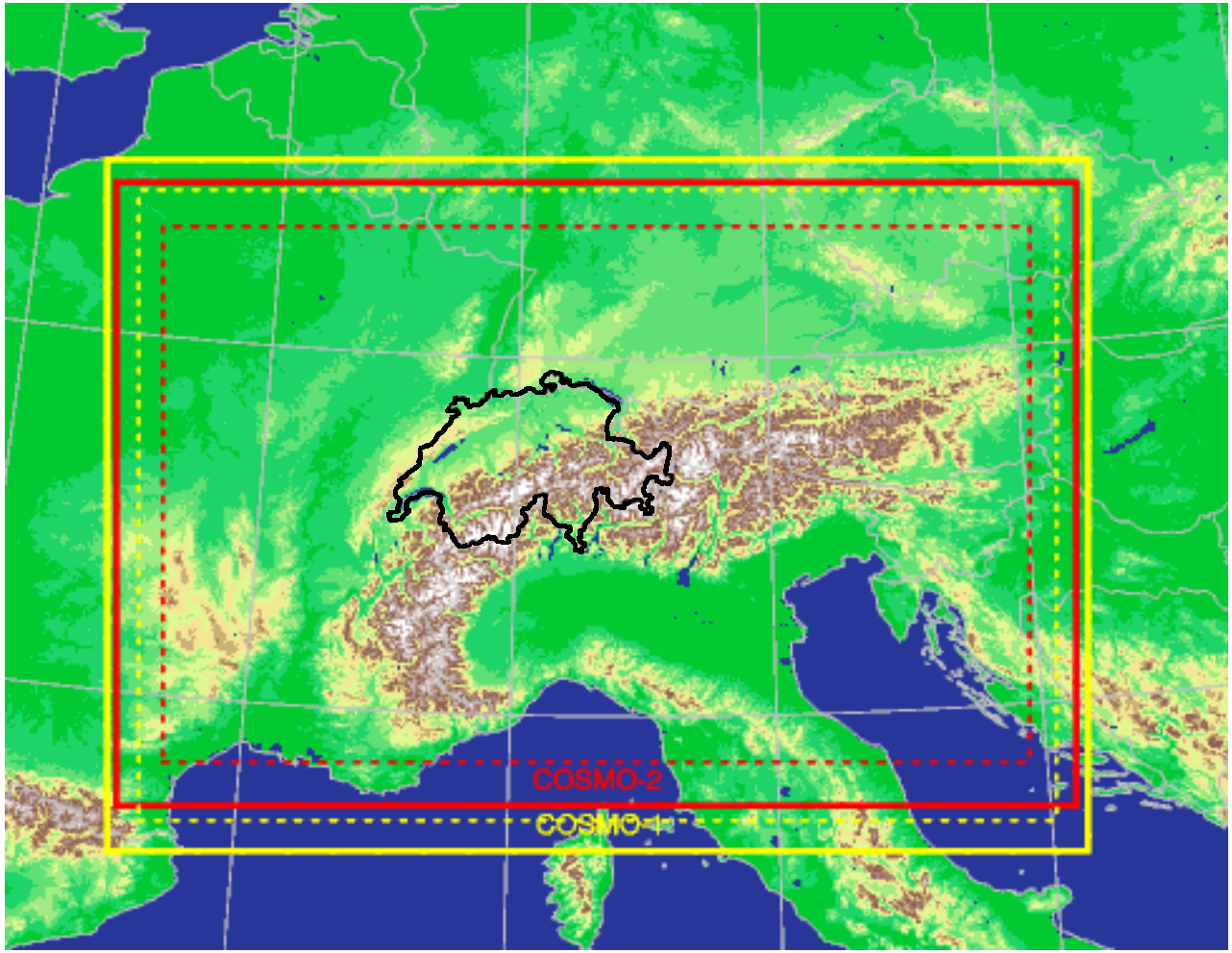
- Setup (domain and vertical grid)
- Orography Filtering and Gradients
- Choices for the Dynamics and the Physics
- External Parameters
- Initial- and Boundary Conditions (COSMO NExT)
- Test Cases
- Summary and Outlook

COSMO-1 Setup (1) Domain

- dlon = dlat = 0.01, ie × je =1062 × 774

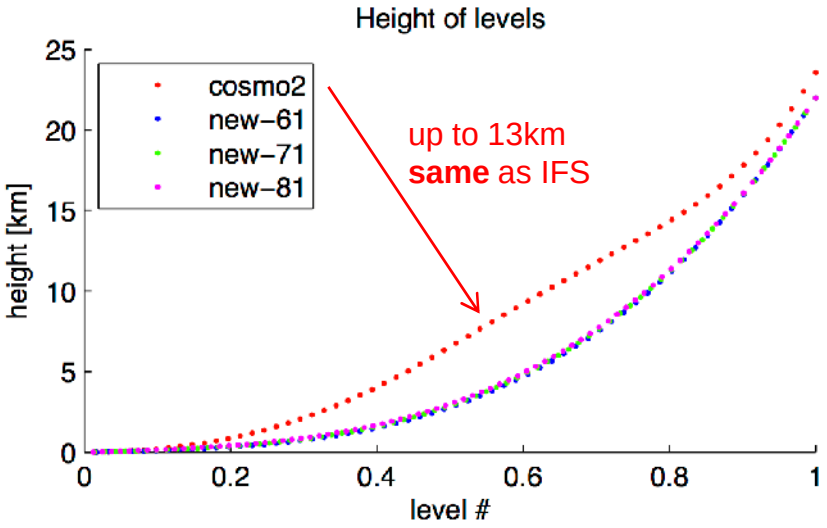
$1062 = 2^5 \times 3 \times 11 + 6$

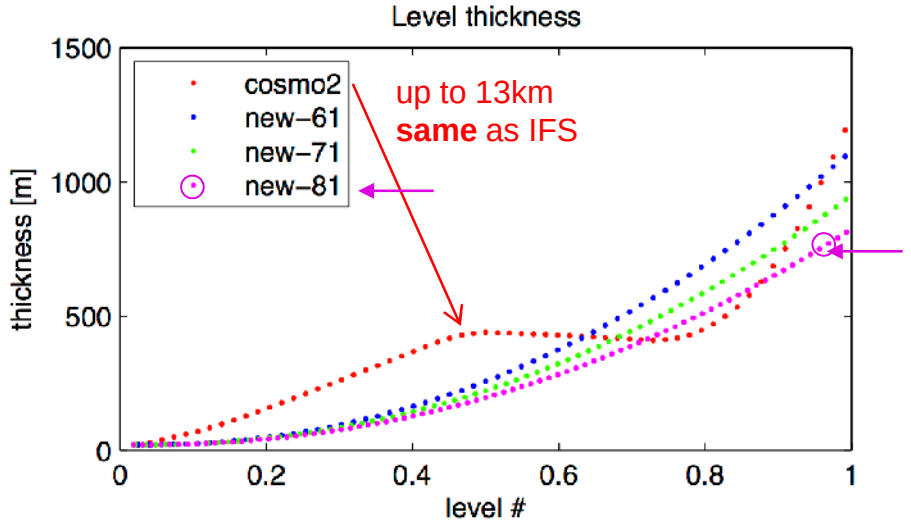
$774 = 2^8 \times 3 + 6$



COSMO-1 Setup (2) Vertical Grid

- **ke = 80**, quadratic distribution

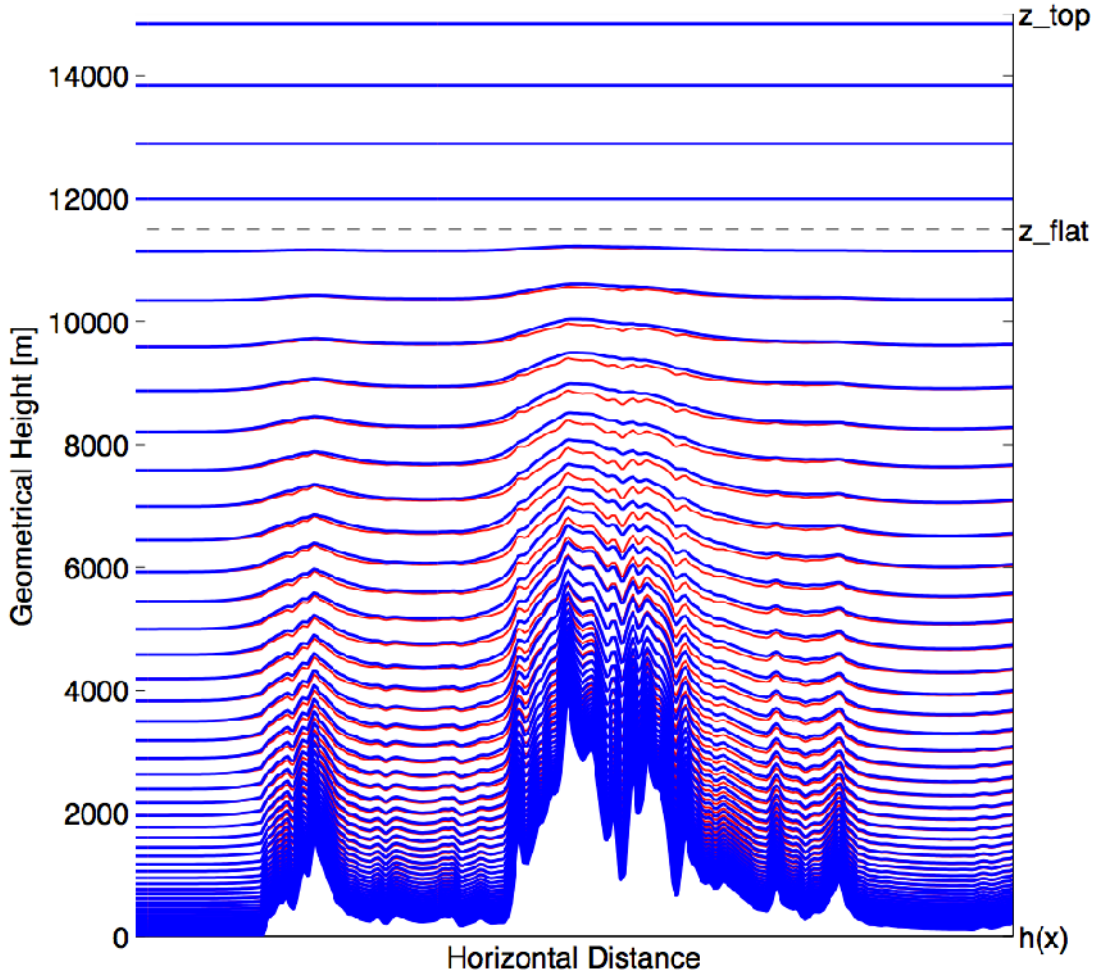




- ie * je * ke = 66 Mgridpoints (COSMO-2 * 6)

Coordinate Transformation

- Generalized **SLEVE** (after Leuenberger et al. 2010)
  (**ivctype=4, svc1=10km, svc2=3.5km, nfltvc=100,n=1.35**)



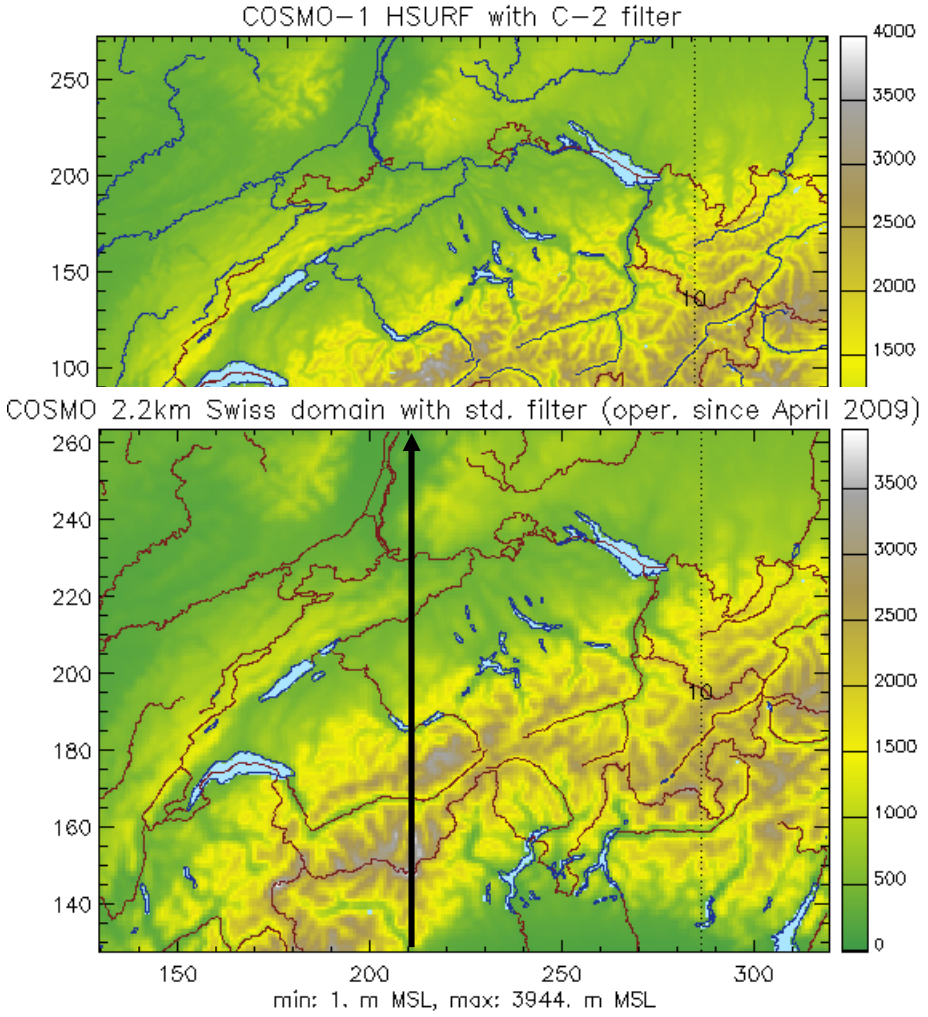
Gal-Chen
Δz_{min} = 13.1 m

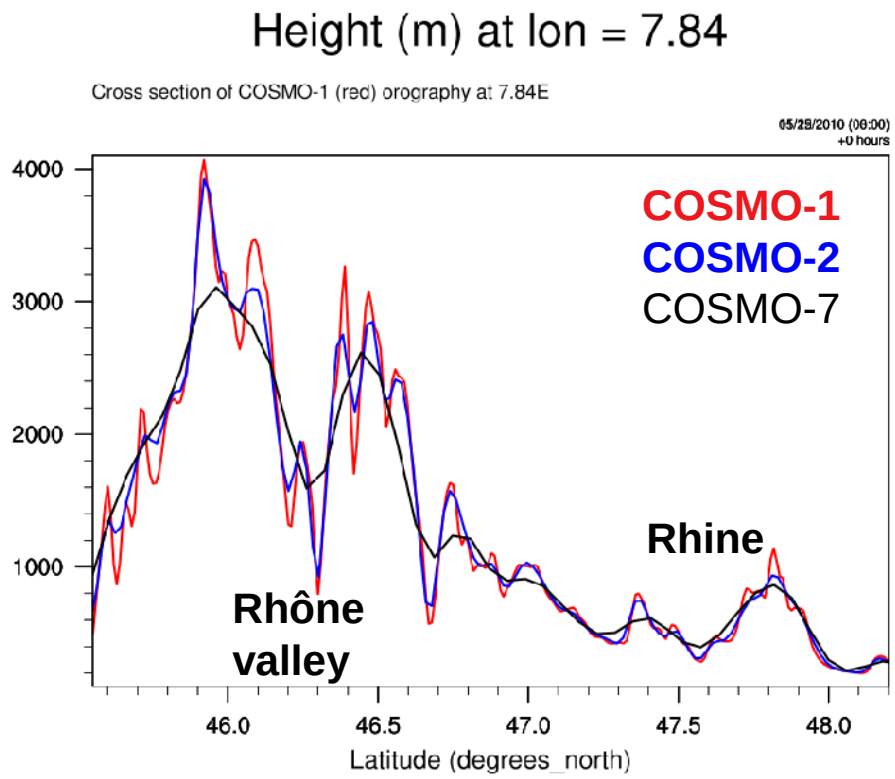
SLEVE
Δz_{min} = 4.2 m !!!

SLEVE2
Δz_{min} = 15.6 m

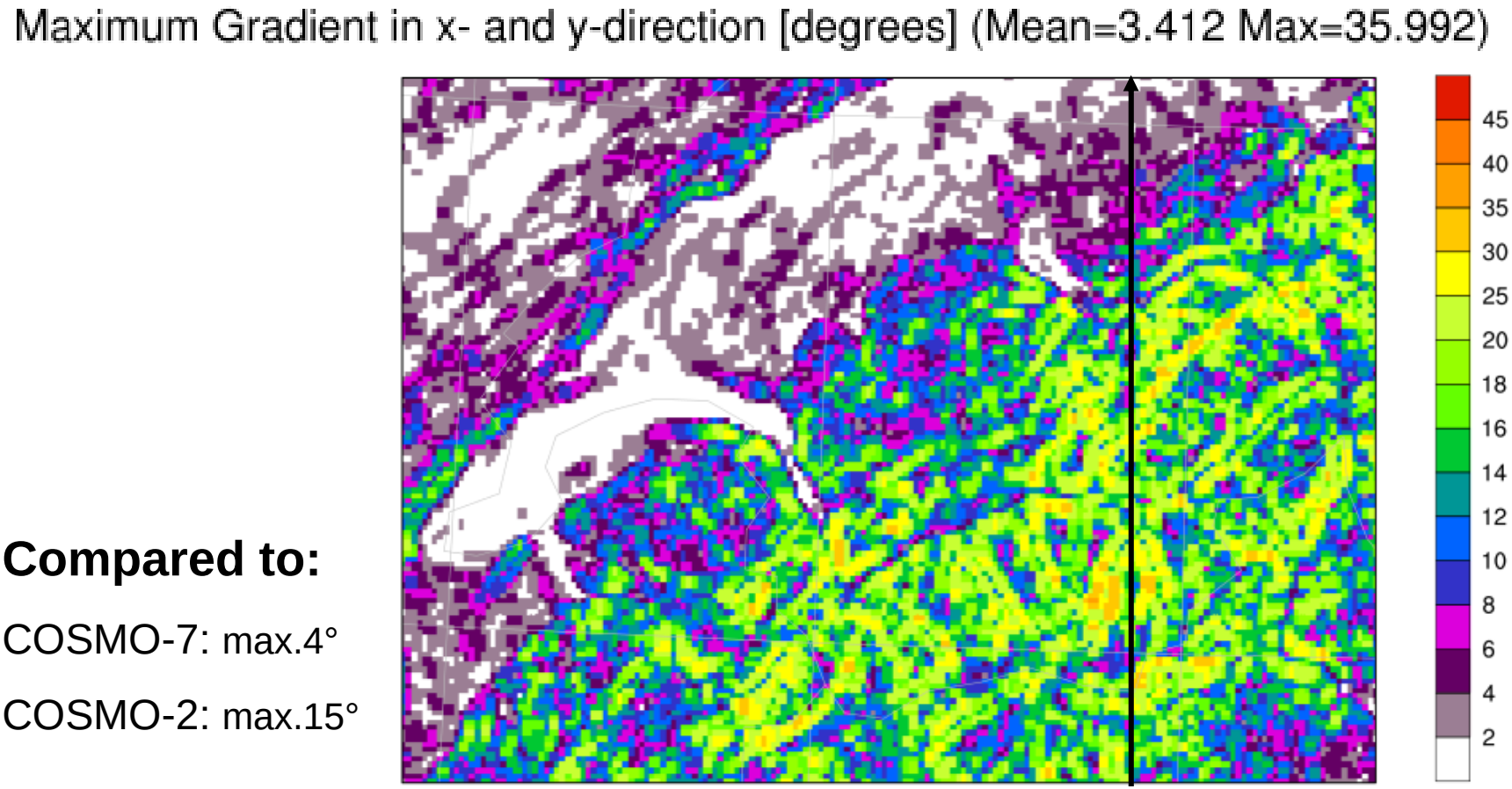
Orography filtering

4 Δx (9-point filter) + extra smoothing where steps > than 750m (xso_mask,13-point filter)





Gradients of orography

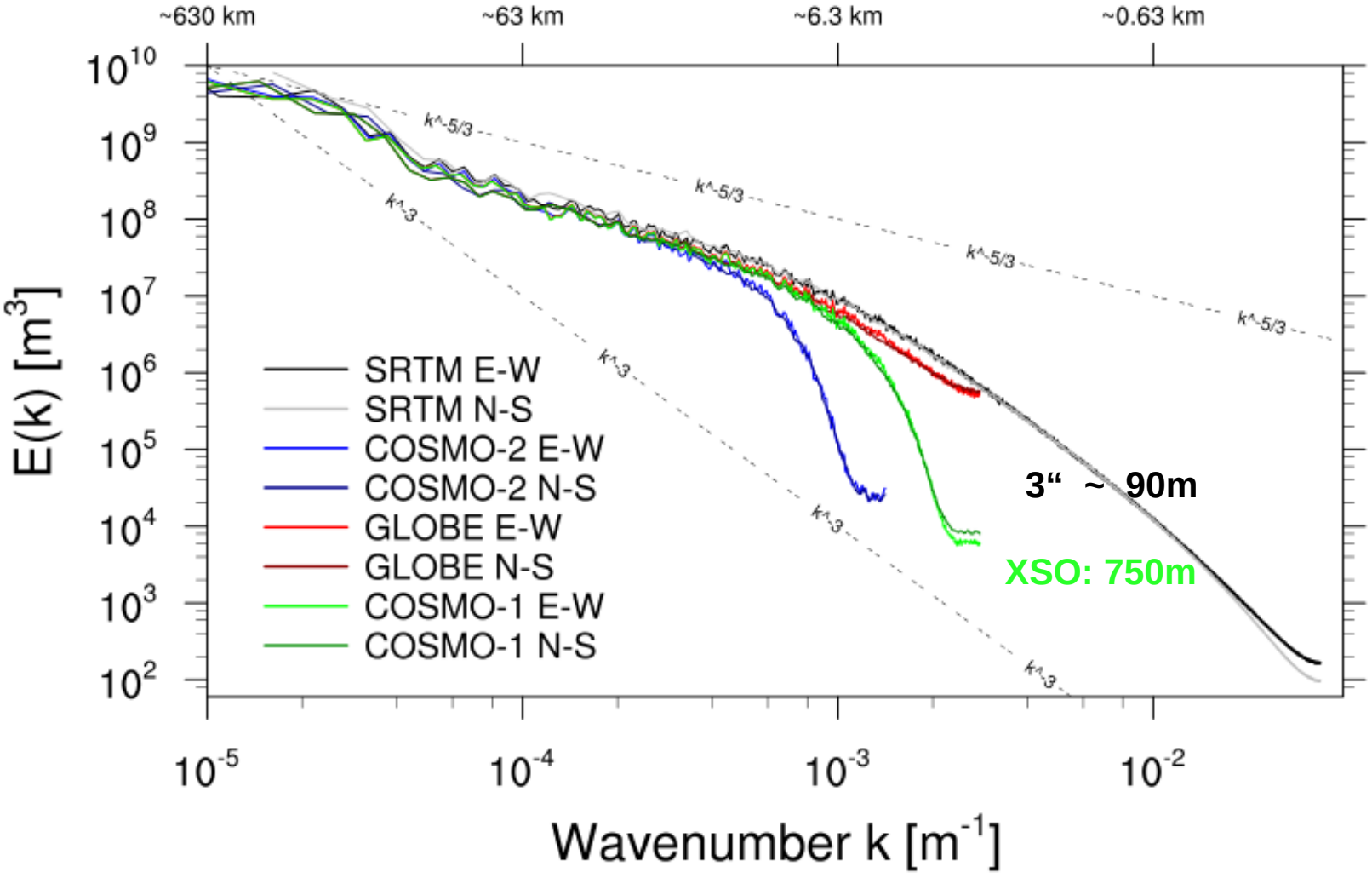


Compared to:

COSMO-7: max.4°

COSMO-2: max.15°

Orographic spectra



Namelist choices: Dynamics

Bold for C-2 operational **RED = C-1**

- ✓ time step (C-2: Δt = **20sec,** **C1:** Δt = **10sec**)
- qx advection (**BOTT2_STRANG**) => Experiment with **SL3_MF**
- **NO** horizontal diffusion, but **C-1: 2D-Smagorinsky** (l_diff_Smag=T)
- ✓ upper boundary condition (nrdtau=**5**/**3**)
- ldyn_bbc= **T**, itype_bbc_w = **1**/**2**/14 (**Bottom Bound. Cond. for w**)
- ltadv_limiter = **T** / **F** (T not tested with C-1)

New code with **new** fast wave (FW) solver in COSMO V4.23:
i_type_fast_w=2 + irefatm=2

- **SLEVE2** (ivctype=4) => Experiment with Gal-Chen

Namelist choices: Physics (1)

Radiation: **RED = C-1**

- ✓ Same as COSMO-2 but:
  - Aerosol climatology? (itype_aerosol, Tegen)
  - Albedo? (itype_albedo)
- Calling frequency (**0.1h** instead of **0.25h** for COSMO-2)

Convection: **only shallow** conv. parameterization (Exp. without)

SSO: **off** (**on** for COSMO-2)

Turbulence: Which parameterization?

- 1D TKE
- 1D TKE + horizontal TKE advection
- ✓ **1D TKE + horizontal Smagorinsky**
- 3D LES

Namelist choices: Physics (2)

Land Surface:

- **Same** as COSMO-2 and 7
- **NO** Flake, Tiles, Urban or Multilayer snow model

Microphysics: Which scheme?

✓ **4-category scheme (ice, rain, snow, graupel)**

- 2-moment microphysics?
- Uncertainties:
  - below cloud evaporation, fall speeds
  - tune to higher vertical wind speeds

External parameters

- **Current status**
  - GLOBE topo (~1 km)
  - FAO soil (~10 km)
  - GLC2000 land cover (~1 km)

- Improvements:
  - **SRTM topo** (~100 m)
  - **HWSD** soil type (~1 km)
  - **CORINE land cover** (~100 m)

- Integration into EXTPAR?
- Tuning of TERRA?

Initial- & Boundary Conditions (IC & BC)

- COSMO-1 is only **one** part of the **N**ovel **Ex**pert **T**ool (COSMO **NExT**) project (2012-2015) at MeteoSwiss

- Short term (**NOW, since end of August, see plot outside**)
  - IC: COSMO-1 assimilation cycle driven by COSMO-7
  - BC: directly from COSMO-7

- Long term
  - IC: downscaled KENDA analysis
  - BC: directly from IFS (~10 km)

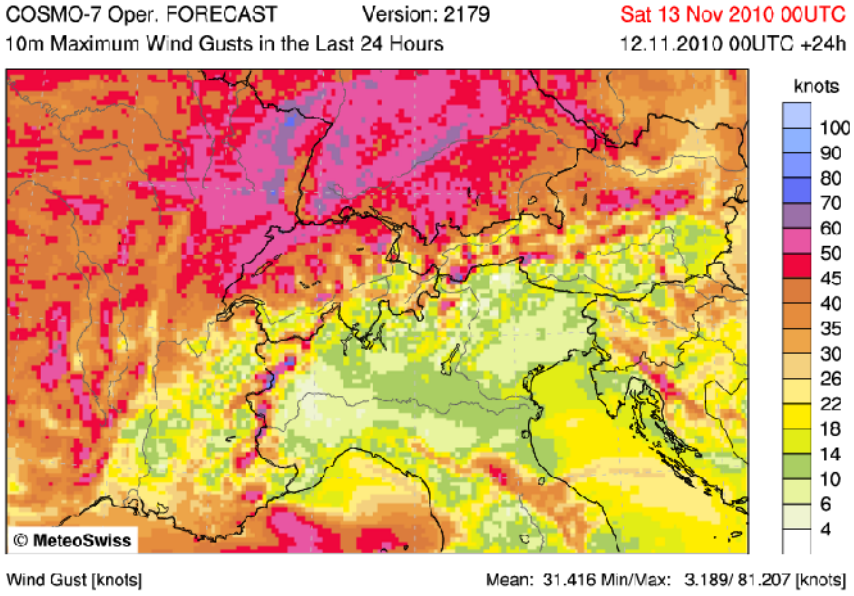
COSMO-1 cases with new FW code

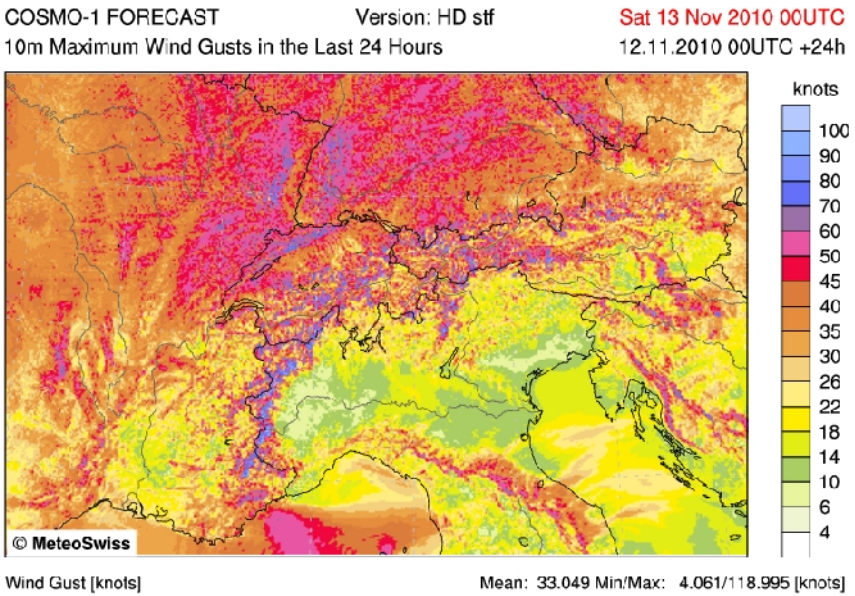
A. Storm Carmen 12 November 2010
Although max. wind ~ 0.8 CFL **needs 8s time step**
Experiments:
1) horizontal diffusion (**HD**) instead of Smag. Diff.
2) Gal-Chen vs. SLEVE2, etc.

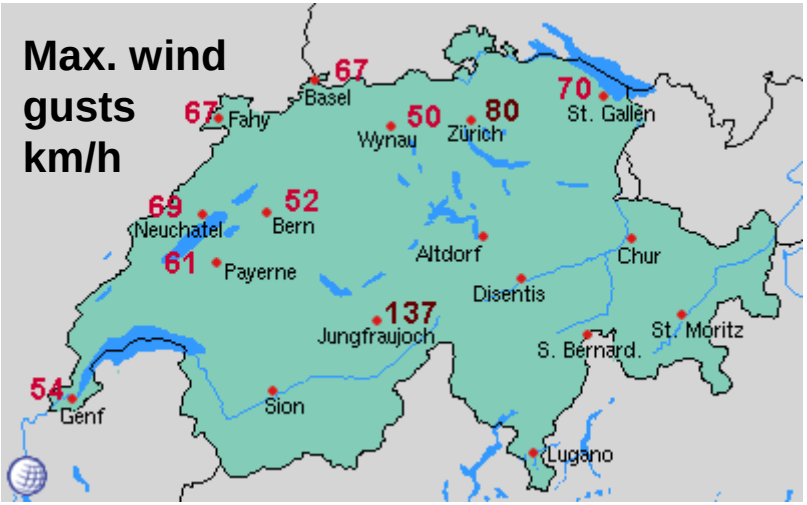
B. Convective case 29 May 2010 with:
1) **SL3_MF** **2) HD**
3) different bottom boundary conditions (**BBC**)
4) shallow conv. parameterization (**lconv** ON/OFF)

C. Stratus case of 27 October 2009
with the same exp. as B. (no slides)

A. **Storm CARMEN (12.11.2010)**



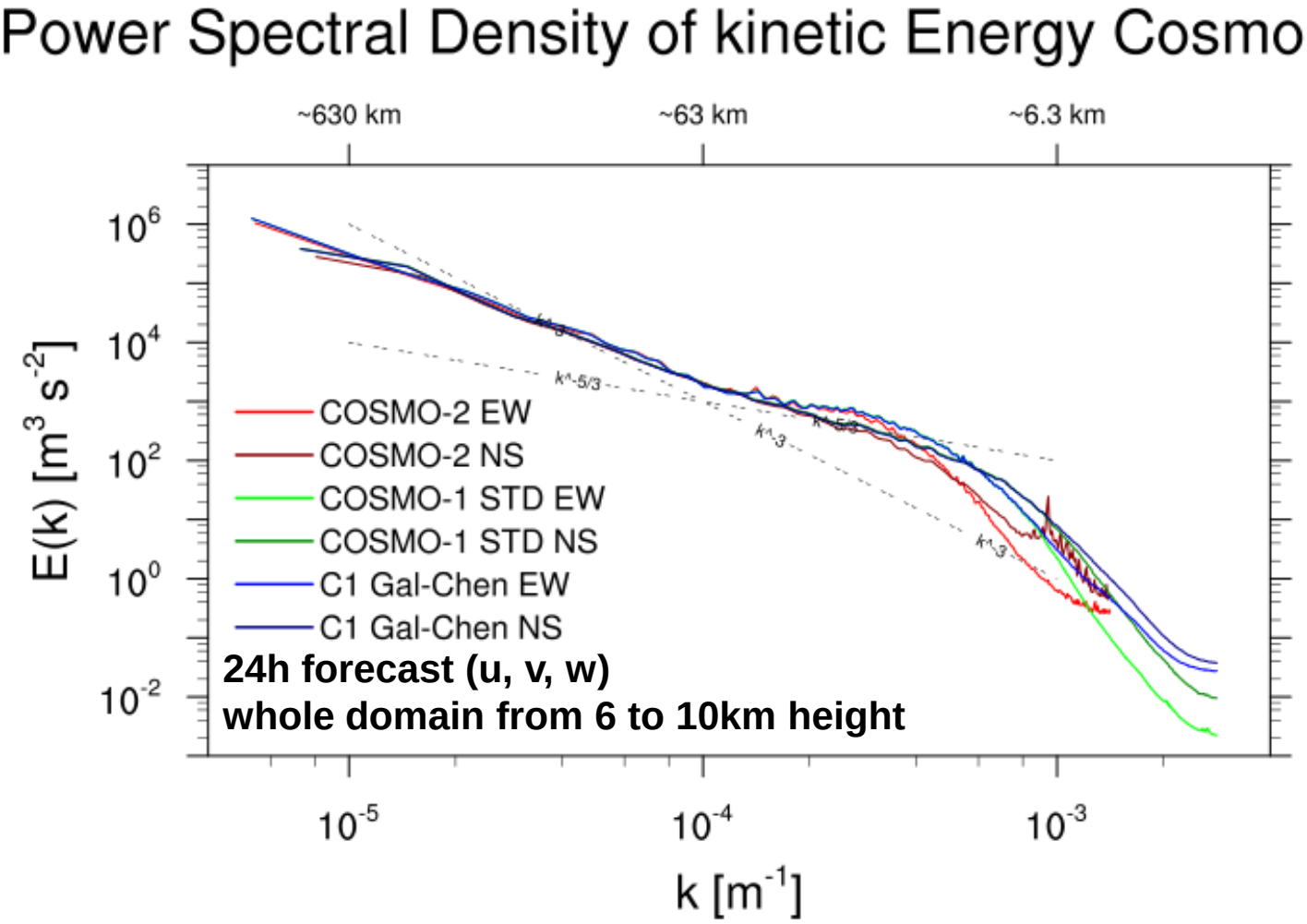




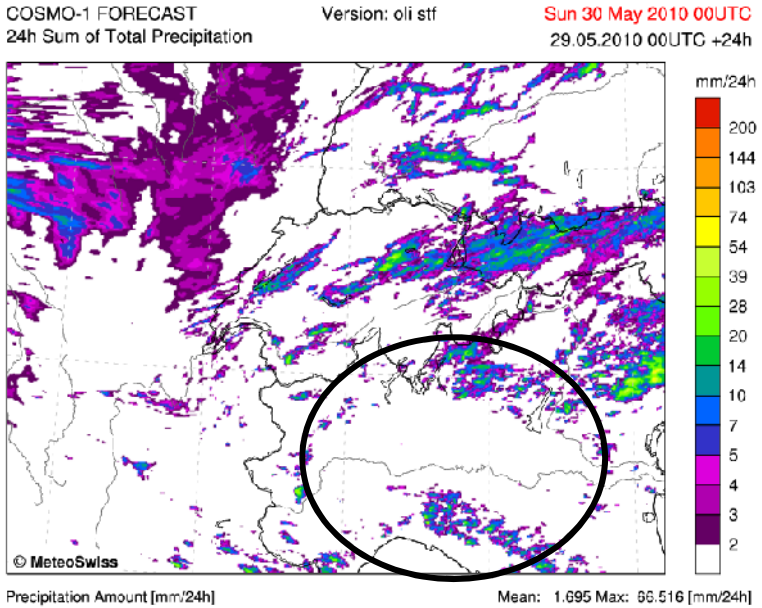
Impact of:

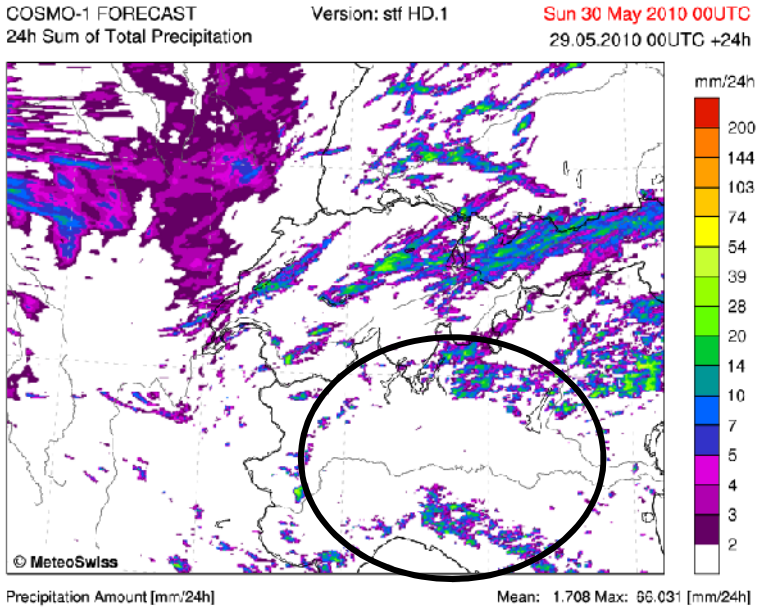
- Orography (Cosmo-2 interpolated, c2) can be important
- Generalized Horizontal Diffusion (HD) instead of selective nonlinear Smagorinski is rather **small**

A. **Energy spectra CARMEN (12.11.2010)**



B. **Convective case with COSMO-1**





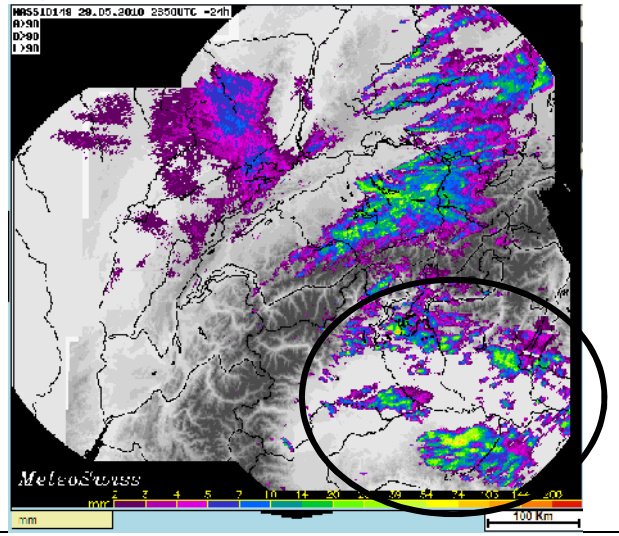
- COSMO-1 less precipitation
- Bottom Bound. Cond. for w (bbc)

and

- Hor. Diff. (HD) have

little IMPACT but

- qx advection with SL3_ML has



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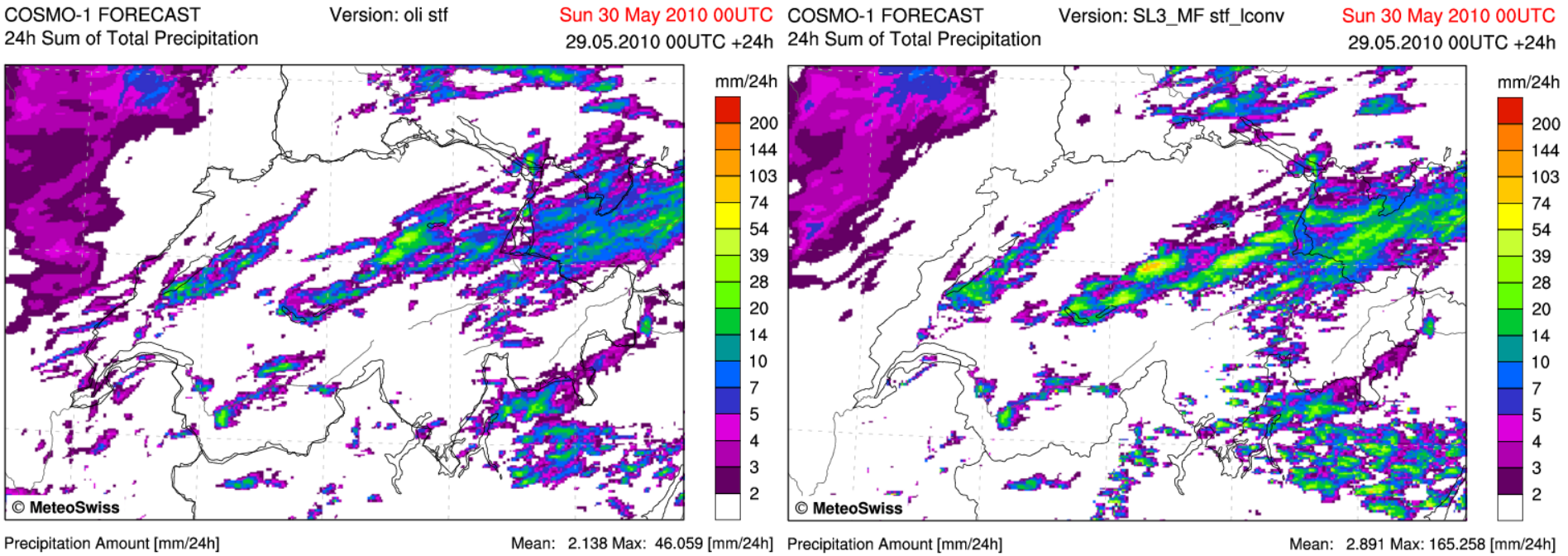

- shallow convection **increases** precipitation
- qx advection with SL3_ML **increases** peak precipitation
- combination of the 2 options look (subjectively) better (**reduced** peaks)

Summary

- From the 3 cases:
  - The impact of the SLEVE2 coordinate is small but produces smoother wind fields
  - The shallow convection (y/n) **and** the choice of qx advection can change precipitation patterns
  - The bottom boundary condition for w has a **very small** impact on results
- **Horizontal nonlinear Smagorinsky** diffusion scheme works well (on selective scales) but the results are not very different than those with simple horizontal diffusion
  => more relevant tests combined with other turbulence settings

Outlook

- **Fix** unstable storm case
- Evaluate **other dynamical and physical settings** (eg. temp. limiter, turbulence etc…)
- **Check regular** runs including assimilation cycle
- Evaluate more cases in more details…
- If you are interested to look at particular situations or the routine runs, **please,** contact **Marco Arpagaus** and he will organize your access to all the data you need!

THANK YOU FOR YOUR ATTENTION