Convection permitting climate simulations (CPCS)
Lessons learned at the Wegener Center

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1. Improvements in convective precipitation in the Alpine region

2. Increased global radiation at surface

3. Resolution of 1 km enables nighttime inversions

4. Resolution of 1 km adds some (minor) value in extreme precipitation
Models and data

- Models: MM5 3.7.4, WRF 2.2.1 (WEGC)  
  CCLM 4.8 (BTU Cottbus)

- Driving data: IFS (ECMWF) (Bechtold et al., 2008)

- Grid spacing: 10 km → 3 km → (1 km)

- Evaluation periods: JJA 2007 (DJF 2007/08)

- Reference data (gridded) nowcasting system INCA (ZAMG) (Haiden et al., 2011)  
  hourly precipitation & global radiation, 1 km grid spacing

(from Prein et al., Clim. Dyn., 2013)
**Effects due to 3 km resolution**

- **Selected results** *(from Prein et al., Added value of convection permitting seasonal simulations, Clim. Dyn., 2013)*

  - **Diurnal cycle is delayed** → better timing of the onset and peak
  - **Precipitation areas become smaller and more intense**

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**JJA 2007**

**10 km**

- **CCLM**
  - **4.8**

**3 km**

- **MM5**
  - **3.7.4**

**Structure-Amplitude-Location (SAL) JJA 2007** *(Wernli et al., 2008)*
Effects due to 3 km resolution

- **Selected results** *(from Prein et al., Added value of convection permitting seasonal simulations, Clim. Dyn., 2013)*

  - Increase of global radiation (+20% in JJA; CCLM 4.8) as a **geometric effect**, but also as a consequence of the **shift in the diurnal cycle**

Funding: Austrian Science Fund (FWF) projects **NHCM-1** and **NHCM-2** *(www.nhcm-2.eu)*
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Nighttime inversions

WegenerNet (www.wegenernet.org) in operation since 2007 (Kirchengast et al., BAMS, 2013)

- 151 stations ➔ 1 station per 2 km²
- temperature, rel. humidity, precipitation
- 12 wind & soil parameters
- 1 net radiation & pressure
- 5 min interval
July 2007

Spatial anomalies of temperature from sunrise +/- 2 h

Compare with MM5, WRF, CCLM
Nighttime inversions

Mean anomalies

10 km

Mean: -0.0  Stand.Dev.: 1.2  Max: 4.2  Min: -2.4

3 km

Mean: 0.0  Stand.Dev.: 0.5  Max: 1.2  Min: -0.7

1 km

Mean: -0.0  Stand.Dev.: 0.6  Max: 1.4  Min: -1.0

MM5 3.7.4

WRF 2.2.1

CCLM 4.8
Overview

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Assessing Climate impacts on the Quantity and Quality of Water (ACQWA) **www.acqwa.ch**

funded by EU FP7

*(from Prein et al., Project report, 2013)*

- **Applicability of convection permitting RCMs for capturing extreme precipitation events in the Alpine region**
  
  - **Model:** CCLM 4.8 (WEGC)
  - **Driving data:** ERA-Interim (ECMWF)
    - *(Dee et al., 2011)*
    - *(ERA-40) (Uppala et al, 2006)*
  - **Grid spacing:**
    - 5 x 50 km → 7 x 12.5 km
    - 4 x 3 km → 4 x 1 km
  - **Evaluation period:** September 19 to 21, 1999
    - *(~MAP IOP 2b)*
    - *(Rotunno & Houze, 2007)*
  - **Reference data (gridded)**
    - RhiresD (MeteoSwiss) *(Wüst et al., 2010)*
    - daily precipitation, 2 km grid spacing
Effects due to even higher resolutions

- Two day sum of precipitation (September 19, 06:00 UTC to 21, 06:00 UTC)

- 12.5 km necessary to capture the location of the maxima
- 3 km: major improvements
- 1 km: structural improvements
Effects due to even higher resolutions

- Spatial Taylor diagram of two day sum of precipitation (September 19, 06:00 UTC to 21, 06:00 UTC)
Effects of 3 km grid spacing:

- Convective precipitation (in JJA) in the Alpine region get improved
- Biases are not necessarily reduced
- Global radiation is increased in JJA due to
  - changes in liquid cloud water
  - geometric effect (smaller clouds, larger cloud free areas)
  - shift in the diurnal cycle

⇒ effect in long-term simulations is unclear

Further increase of the resolution to 1 km grid spacing:

- nighttime inversions emerge
- added value to some extent in extreme precipitation events
Thank you very much!