CL5.11/AS1.32 EGU2017-1336 Introducing the Met Office 2.2-km Europe-wide convection-permitting regional climate simulations

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Keywords: **Climate change, high-resolution models, convection-permitting models**

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INTENSE project website: https://research.ncl.ac.uk/intense/

Abstract

Met Office is currently conducting multi-year continuous 2.2-km Europe-wide convection-permitting model (CPM) climate simulations. The simulations are driven by ERA-Interim (presented here) [2] and HADGEM N512 present- and future-climate GCM simulations [6]. Initial results show improvement in the diurnal cycle and probability distribution of precipitation over UK. Precipitation diurnal cycle is well simulated for Germany. Simulation over Alps is more challenging; however, the CPM simulation still shows improvement over 12-km parameterised-convection simulations by reducing mean precipitation biases.

Data and analysis methodologies

- Europe-2.2: 2.2-km Europe convection-permitting ERA-Interim hindcast (1998-2003)
- Europe-12 GA3: 12-km Europe UM GA3 parameterised-convection ERA-Interim hindcast
- Europe-12 GA7: 12-km Europe UM GA7 parameterised-convection ERA-Interim hindcast
- SUK-1.5: 1.5-km southern UK convection-permitting simulation; driven by Europe-12 GA3 (domain: Fig. 6)
- UK-Radar: UK gauge-calibrated Radarnet NIMROD analysis (Jan 2003 –) [3]
- DE-Gauge: Germany radar-disaggregated gauge analysis (Jan 2001 – Dec 2008) [7]
- CH-RdisaggH: Switzerland radar-disaggregated gauge analysis (May 2003 – Dec 2010) [11]
- EURO4M-APGD: Alps-region daily precipitation (Jan 1971 – Dec 2008) [5]
- SAFRAN: French gauge precipitation analysis (Jan 1958 – Dec 2010) [10]
- EOBS: Europe-wide daily precipitation and temperature observations [4]

Not all data cover the same time period. 2.2 simulation has not advanced to the stage that it fully overlaps with hourly precipitation observations. Model inter-comparisons common period: **Dec 1998 – Nov 2003**. Inter-comparison carried out at a common 12-km grid. We **do not nudge** our simulations.

Mean biases relative to E-OBS for the 2.2-km CPM & 12-km GA7 hindcasts

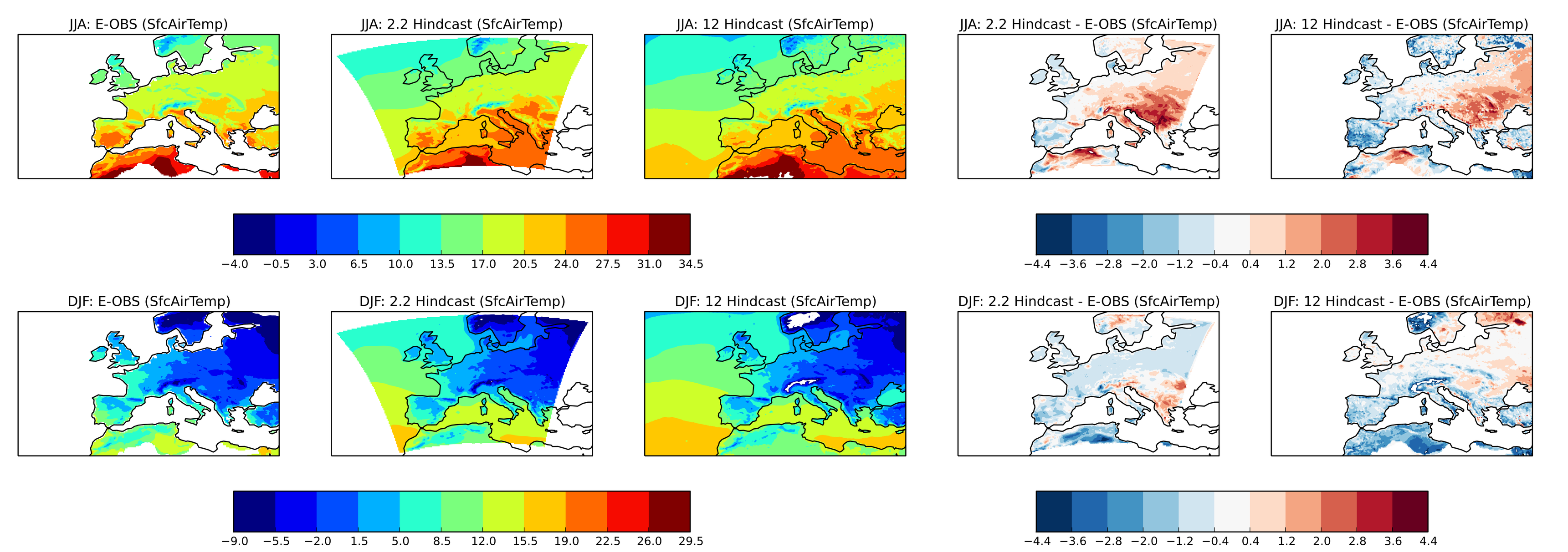

Figure 1: Seasonal temperature means – JJA (upper panels): Too cold in the north and west but too warm in south and east (especially in the Balkans and Slavic states) for both models; the summer warm biases over former Yugoslavian states is associated with dry biases over the same region (see figure below). DJF (lower panels): The two models have opposite signed temperature biases over Greece despite having similar mean precipitation biases (see below), cold biases for both models in most of Western Europe, including UK, France and Iberia.

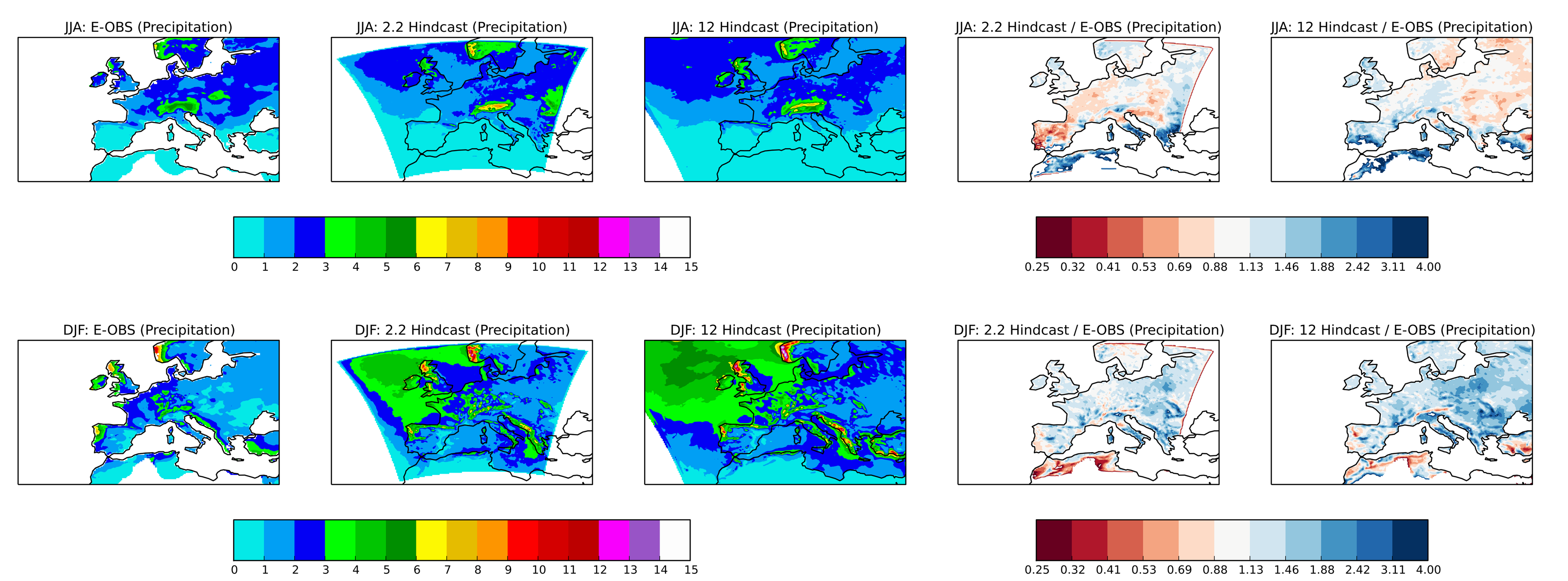

Figure 2: Seasonal precipitation means – JJA (upper panels): 2.2-km simulation is too dry for Western Europe; the Mediterranean is too wet for both models except inland Balkans and northern Adriatic. DJF (lower panels): winter is too wet for almost everywhere for both models except Portugal and the Maghreb.

Diurnal cycle & mean inter-comparison

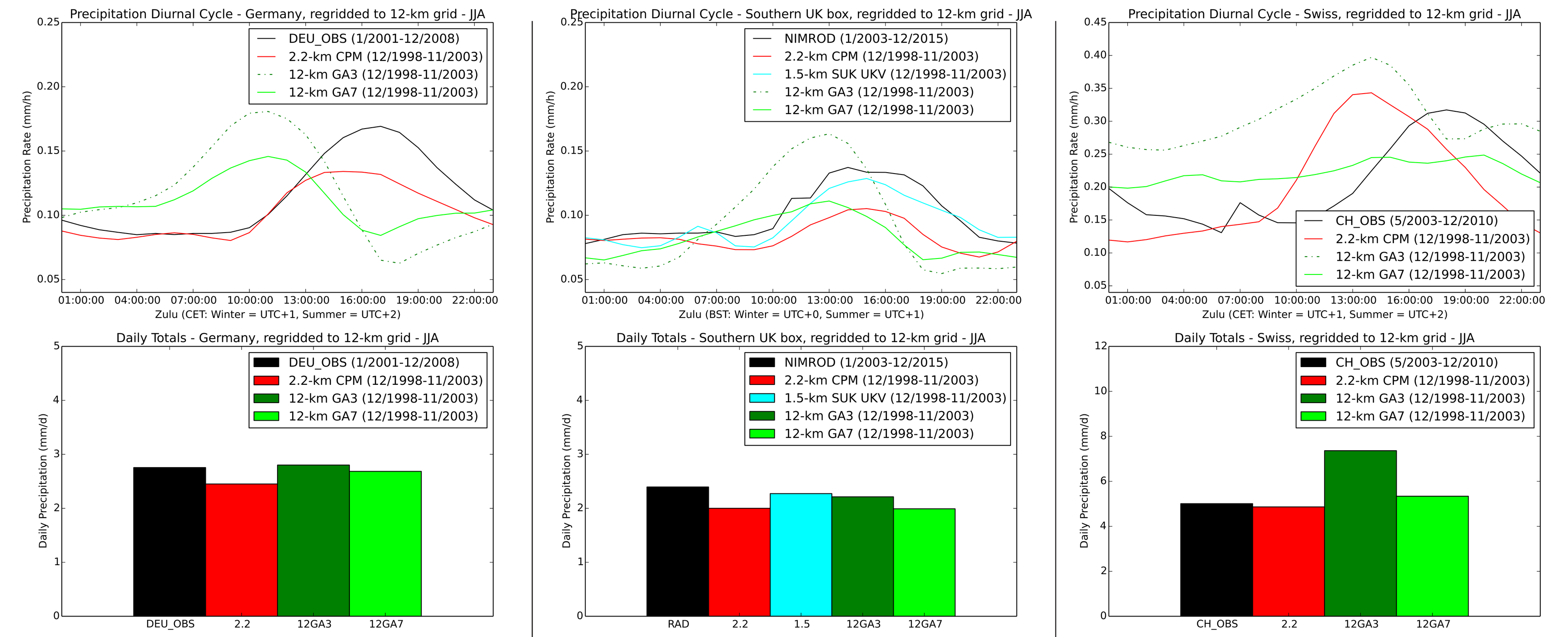

Figure 3: Upper panels: JJA diurnal cycle of mean precipitation for Germany (left), a southern UK (centre), and Switzerland (right). Lower panels: mean daily JJA precipitation for the same region (NOTE: DIFFERENT YEARS for OBS due to incomplete 2.2 hindcast). For southern UK panel, results from SUK-1.5 are included. 2.2 (and 1.5) simulations capture peak of diurnal cycle well in Germany and southern UK. 12-km GA3/7 diurnal peaks occur too early, and GA3 has a larger diurnal variability than GA7. No models get the diurnal peak over Switzerland correct; GA7 simulation has hardly any diurnal cycle at all. The 2.2-km hindcast has a tendency to be drier. The 12-km simulations have a lot more precipitation over Alps over the 2.2-km simulation.

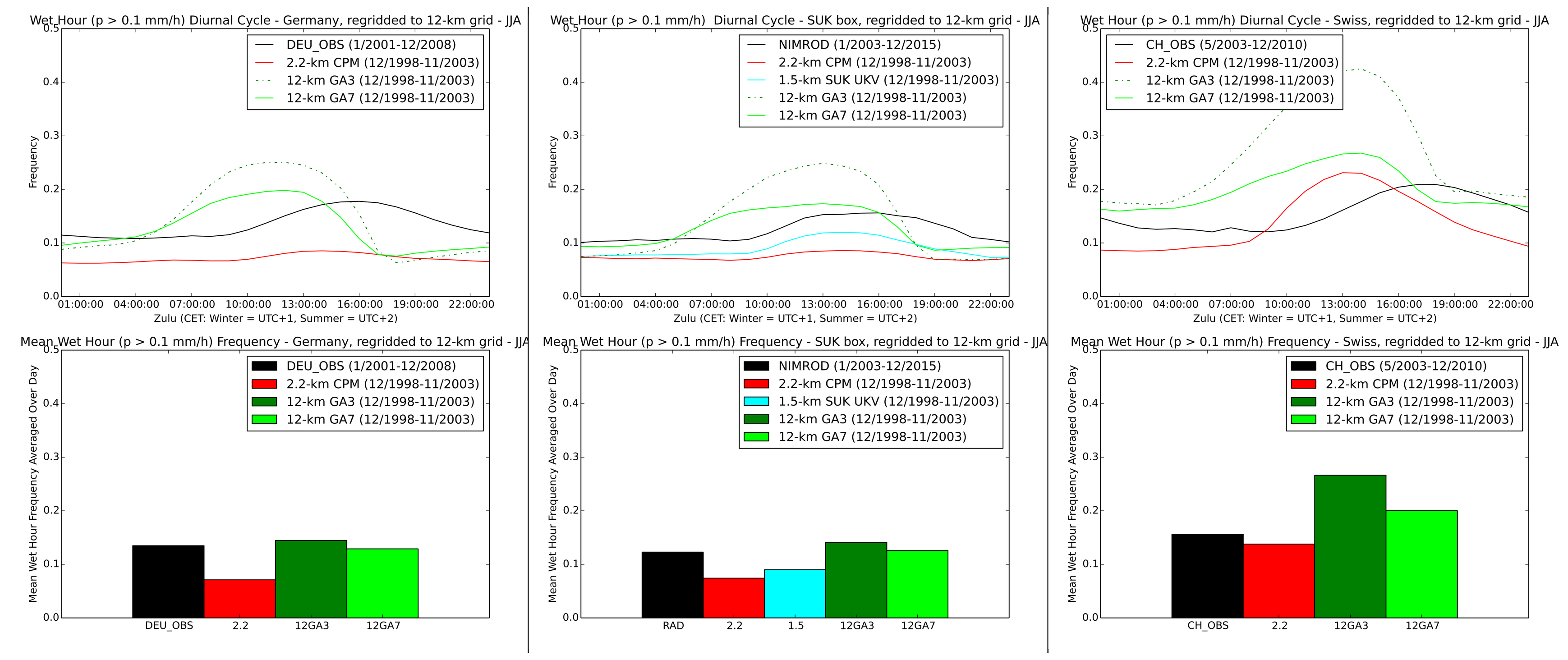

Figure 4: Same as in Fig. 3, but for frequency of hourly precipitation above 0.1 mm/h. Similar to the mean precipitation, CPMs capture the late afternoon well over low land regions (southern UK and Germany), but performs poorly in Switzerland. The 2.2 (and 1.5 for southern UK) hindcast simulation has much less (nearly 1/2) wet hours than the 12-km simulations.

Histogram of hourly precipitation intensity

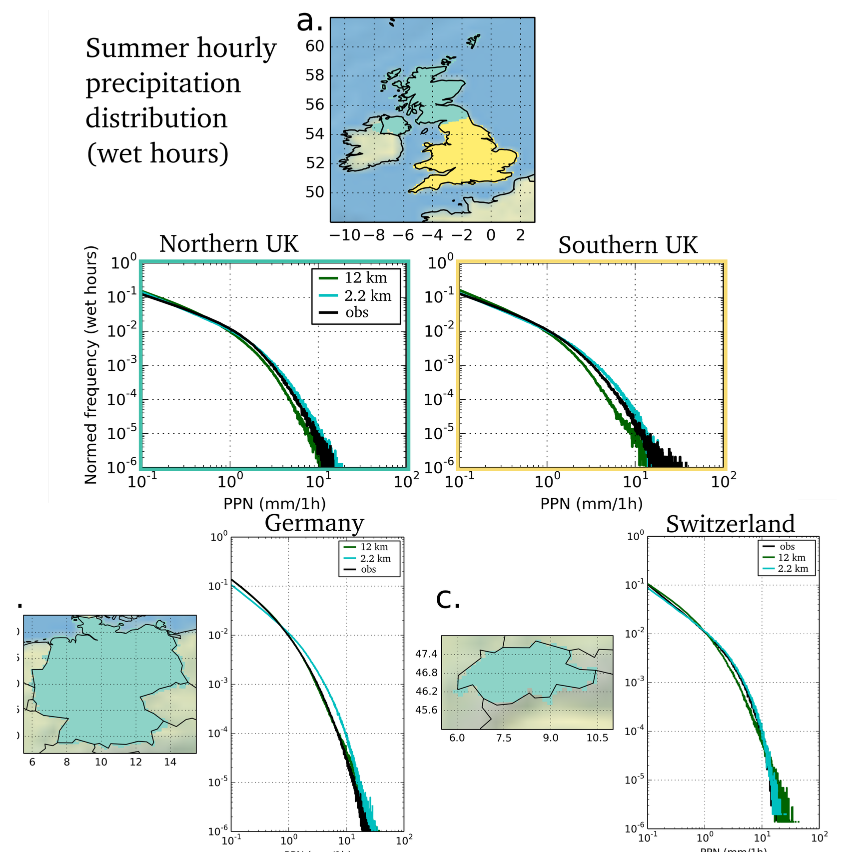

Figure 5: JJA hourly precipitation intensity probability distribution for observations (black), 12-km GA7 (cyan) and 2.2-km (green) simulations. Only intensities above 0.1 mm/h (post 12-km regridding) are included.

- For differences in wet hours, see the last section; mean precipitation bias (left column) is a combination of both intensity (this section) and frequency (last section) biases
- Northern UK: 2.2-km simulation's intensities are higher than both 12-km and radar-observed intensities (note: UK radar data are more sparse in the north)
- Southern UK: Radar observations have a fat tail for intensities above 10 mm/h; 2.2-km simulation intensities are generally higher than the 12-km simulation, and are closer to radar for intensities below the radar fat tail
- Germany: Unlike UK, the 12-km simulation has a more realistic PDF than the 2.2-km simulation
- Switzerland: 12-km simulation's intensities are heavier tailed than 2.2-km simulation and observations; the 2.2-km simulation has more realistic PDF than the 12-km simulation

Case study - challenges in orographic precipitation

As hindcast simulations are driven by reanalysis, hindcasts generally follow observed synoptic variability. Hence, observed extreme precipitation events can often be diagnosed from the hindcasts, and case study comparisons can be conducted.

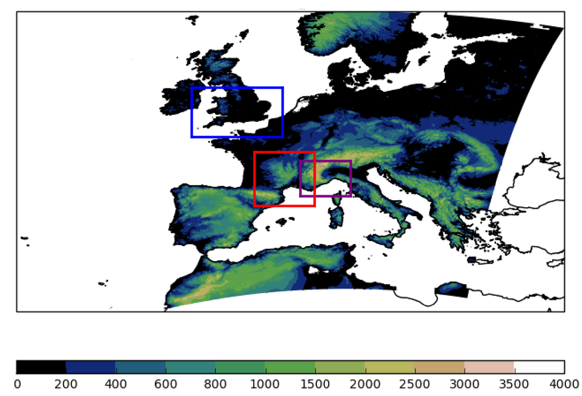

Figure 6: Case study regions:
Blue = 1.5-km SUK domain
Red = N Italy/S France
Purple = S France near Massif Central

Table 1: Events presented

Massif Central [1]	8th Sept 2002
N Italy/S France [9]	10th Aug 2002

2.2-km improvements:

- Lower 2.2-km orographic precipitation totals than the 12-km simulation near high orography (e.g. Alps); the latter shows positive precipitation bias over Switzerland
- Improved storm location and total due to improved storm dynamics as consistent with previous NWP studies [8]

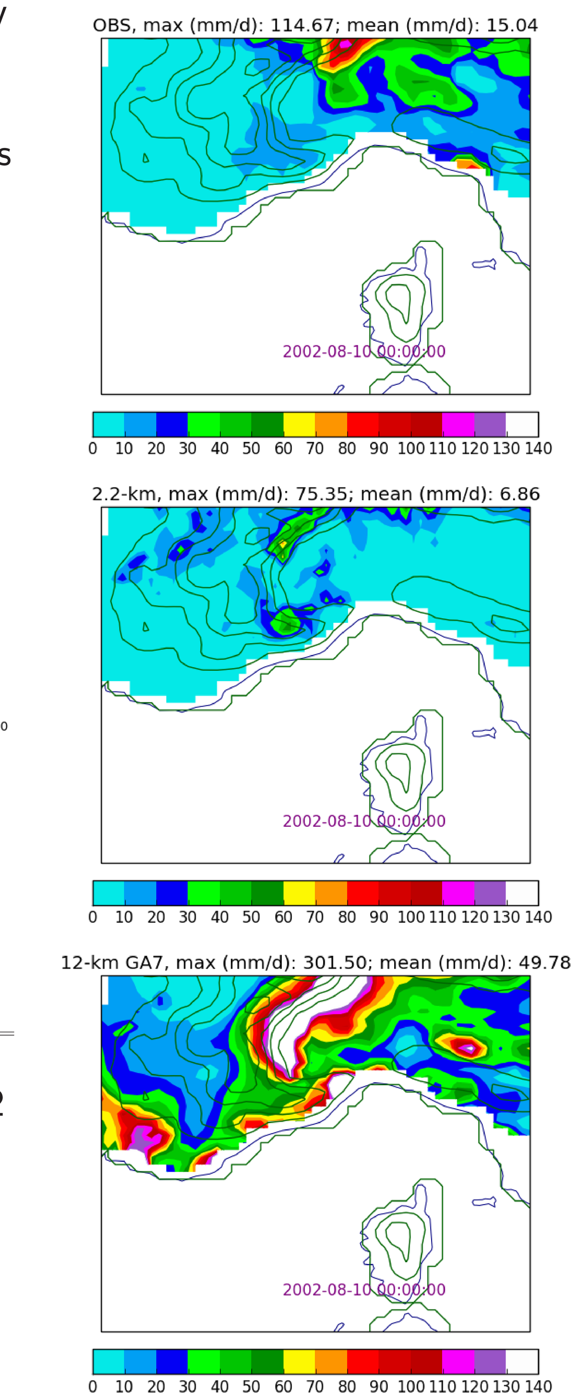

Figure 7: Observed (EURO4M-APGD) and 2.2-/12-km (GA7) model-simulated daily precipitation for a case of high orographic precipitation event in northern Italy. Note the 12-km GA7 simulation has much more precipitation than observations and 2.2-km simulation. The same system causes subsequent flooding in Germany later.

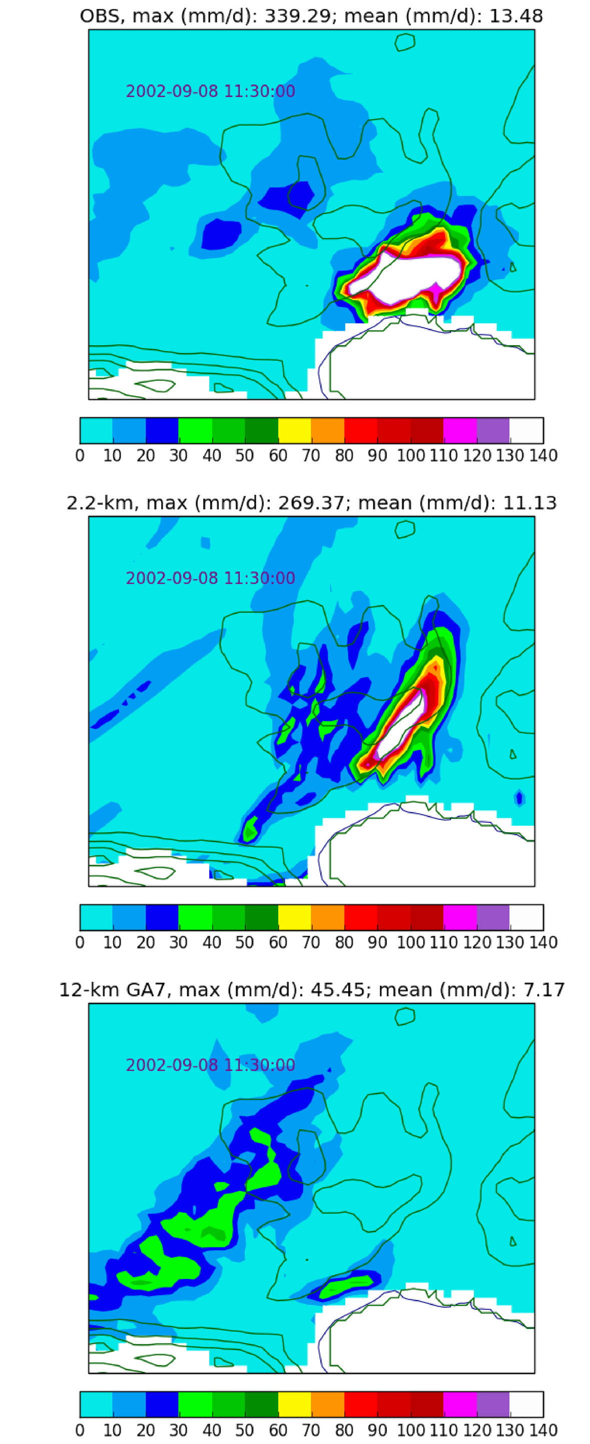

Figure 8: Observed (SAFRAN) and 2.2-/12-km (GA7) model-simulated daily precipitation for an extreme event near Massif Central. The 2.2-km simulation captures the location of maximum precipitation well (south east of Massif Central), and the precipitation totals are more accurate than the 12-km GA7 simulation.

Summary

- The new 2.2-km and old Southern-UK-only 1.5-km simulations have too many summer dry hours. Overall, there is a negative bias (relative to EOBS) in mean summer precipitation for the 2.2-km hindcast over Western Europe; the 12-km simulation does not have that bias.
- The 2.2-km simulation captures the diurnal cycle in Germany and UK well. GA7 physics update to the 12-km model seems to have an impact to the diurnal precipitation range in UK and Germany, but diurnal phase remains as poor as the older GA3 simulation. No models (including the 2.2-km CPM) simulate the diurnal cycle over Switzerland properly.
- Simulations near orography remain a challenge. The 2.2-km model reduces the biases in both the mean and specific events. The 2.2-km simulation may have also improved storm locations.

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