A new high-resolution European region reanalysis dataset for RCM evaluation and calibration – first tests and comparison to other datasets

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Introduction

As the resolution of regional climate models (RCMs) increases it becomes increasingly more difficult – and important – to find new evaluation and calibrations data-sets. For a consistent evaluation of the whole CORDEX or Ensembles domains the E-OBS datasets (Haylock et al, 2008) having a spatial resolution of ~25 km is, in practice, the only one. Within the just recently concluded European project EURO4M new high-resolution datasets have been produced through regional reanalysis.

EURO4M reanalysis setup and output data

A version of the operational forecasting system HIRLAM was used as the key component of the system. At the lateral boundaries the HIRLAM was forced by ERA-Interim data. Moreover, the large-scale flow was introduced into the variational assimilation by an additional term representing the ERA-Interim vorticity in the cost function (Dahlgren and Gustafsson, 2012). Within the domain data from the ERA-Interim observational database was ingested into the model using 3-dimensional variational assimilation. Through this system, HIRLAM/3DVAR, the 3-dimensional state of the atmosphere, as well as relevant surface variables are saved for every 3 hours for the period 1979-2014 (1989-2012 currently finished) at a spatial resolution of 0.2° (rotated latitude/longitude), or about 22 km (Fig. 1)

From this dataset surface fields were extracted for downscaling using the MESAN system (Häggmark et al., 2000). The downscaling was done in two steps, first the HIRLAM 0.22° field was interpolated to the MESAN 0.05° (rotated latitude/longitude) grid. This was then used by MESAN as first guess in an optimum interpolation in which available surface observations (Fig. 2) were analysed. The data (Table 1) consists of 1286 x 1361 gridcells at a spatial resolution of ~5.5 km. Wind components were treated differently in that the downscaling of the HIRLAM/3DVAR output to was produced by a simplified version of HIRLAM called DYNAD for *dyn*amical *ad*aptation.

Table 1. List of MESAN output variables, 24h data are valid for 00UTC to 24UTC.

2 m	**Temperature**	**3 h**
2 m	**Minimum temperature**	**24 h**
2 m	**Maximum temperature**	**24 h**
2 m	**Relative humidity**	**3 h**
2 m	**Minimum relative humidity**	**24 h**
2 m	**Maximum relative humidity**	**24 h**
surface	**Accumulated precipitation**	**24 h**
sea level	**Pressure**	**6 h**
10 m	**U-component of wind**	**6 h**
10 m	**V-component of wind**	**6 h**

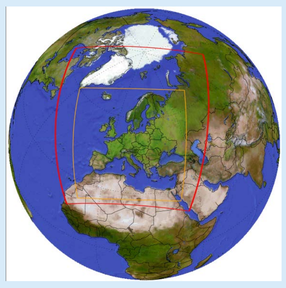


Fig. 1. EURO4M regional reanalysis domain (red) used for both the HIRLAM/3DVAR and the subsequent MESAN downscaling. The CORDEX EUR-11 domain (yellow) is shown for comparison

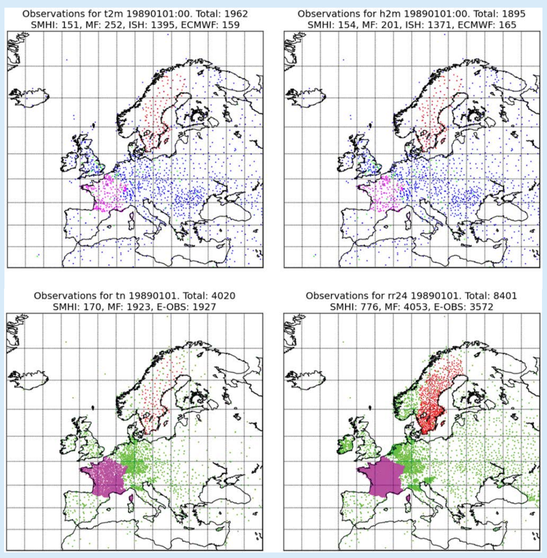


Fig 2. Example of the surface observations coverage for one particular day.

Evaluation

An evaluation of MESAN and other EURO4M reanalysis products has beencarried out by Jermey & Renshaw (2014). They concluded that MESAN compared favourably almost all aspects. Fig. 3 shows of the annual mean daily precipitation over the Iberian Peninsula according to the HIRLAM/3DVAR reanalysis and the MESAN downscaled data in relation to E-OBS, which is the standard reference dataset used in many applications

Applications

A high-quality gridded dataset comprising several of the essential climatic variables and covering all of Europe at a spatial resolution of ~5.5km will have many uses. A key application is for evaluating and bias-adjusting RCM output. For example, until now it has not been possible to find a consistent European dataset to use with the CORDEX EUR-11 simulations.

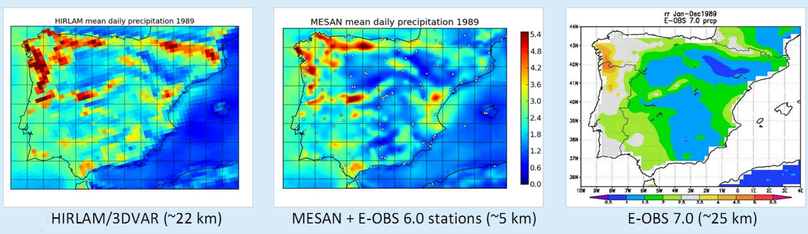
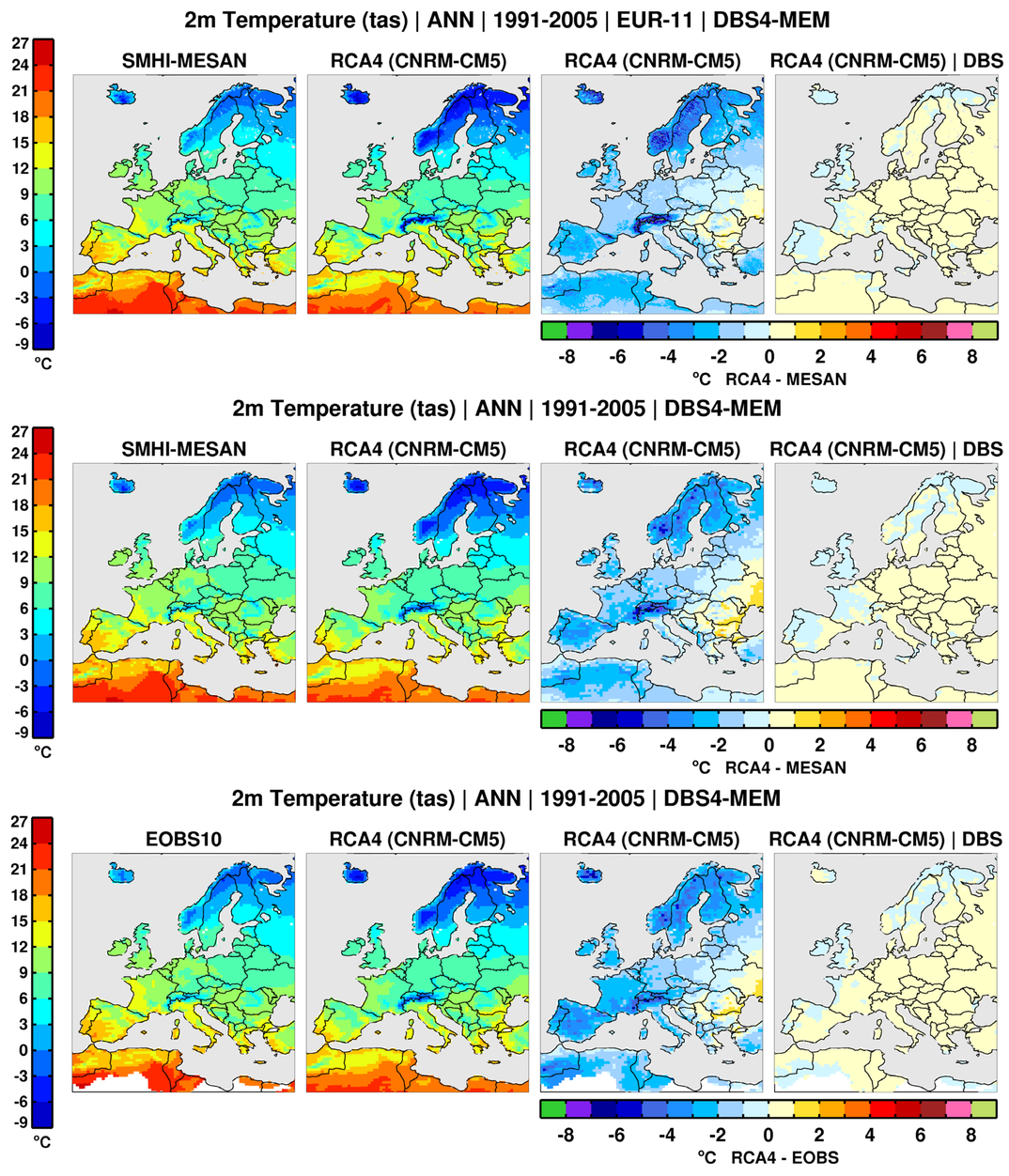
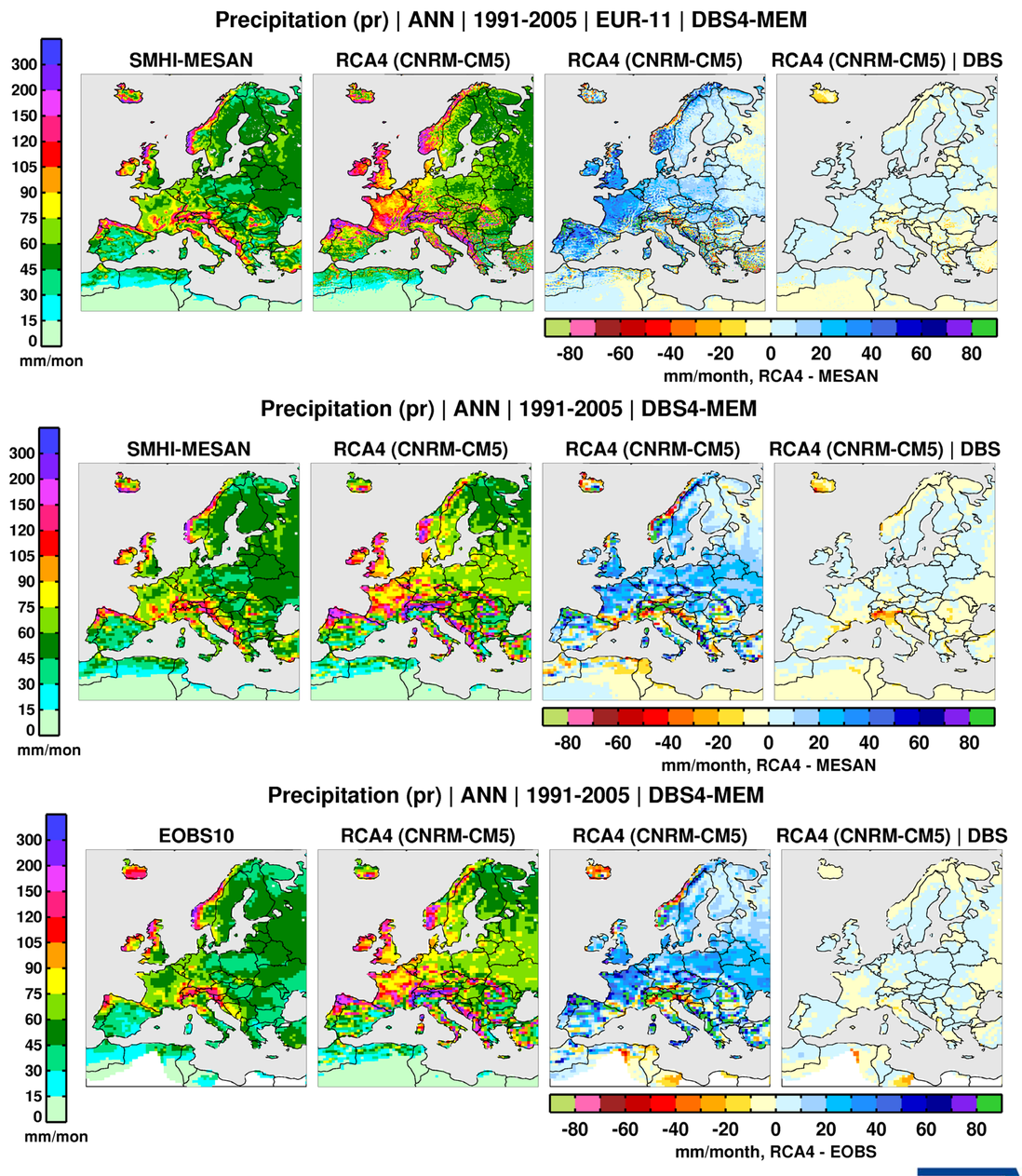


Fig. 3. Daily mean precipitation for 1989 for the Iberian Peninsula.

Below are maps of annual mean temperature and annual total precipitation (expressed as monthly mean) from one particular RCA4 EUR-11 (~12.5km) scenario simulation compare to E-OBS v.10, and MESAN. To compare with E-OBS the RCA4 output was aggregated to the E-OBS grid (~50 km). The MESAN data was aggregated to both the E-OBS grid and to the EUR-11 grid). Each panel of four maps show (from left to right): 1) the reference data set (MESAN or E-OBS), 2) the RCA4 regional scenario simulation, 3) the bias before calibration; and 4) same as 3 but after bias correction

Dahlgren,P. & N. Gustafsson, 2012. Tellus A, 64, 15836,
Häggmark, L. et al. 2000. Tellus, 52A, 2-20.
Haylock, M.R. et al. 2008. J. Geophys. Res. (Atmos.), 113.
Jermey P. & R. Renshaw, 2014..
http://www.euro4m.eu/Deliverables.html
Wilcke, R. A. I., et al. 2013. Climatic Change, 120(4), 871-887





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