

MODEL EVALUATION

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The models weather@home, EC-Earth 2.3, HadGEM-3A and EURO-CORDEX (box 1) were validated for their ability to represent 3-day heat waves in (i) the SE-box and (ii) at the closest model grid point to stations Madrid-Cuatro Vientos, Montélimar, Monte Cimone, and Gospić.

The EC-Earth and HadGEM3-A models are considered to perform well enough if their GEV fit parameters (scale parameter σ and shape parameter ξ), evaluated for the whole ensemble to improve precision, are within the 95% confidence interval (CI) of the GEV fit parameters for observations. Note that we use the variability in observations to represent the inherent uncertainty, rather than requiring the fit parameters from observations to fall within the spread of the ensemble. For the current analysis, the uncertainty in the fit parameters of the observations is larger, but adequately sampled because the observed time series is dominated by high-frequency natural variability. We employ an additive bias correction of the mean (which does not affect σ or ξ), if necessary. For weather@home the same test is applied.

The EURO-CORDEX temperatures were pre-bias-adjusted using the cumulative distribution function–transform (CDFt) method (Vrac et al. 2016). The outcome was verified against observations. Below we describe the cases where the validation criteria were not met.

BRIEF MODEL DESCRIPTIONS

Weather@home. A distributed computing framework (Massey et al. 2015) providing very large, SST-driven, regional ensembles of HadRM3P (50 km) with “all forcings,” “natural,” and “future +2°C” scenarios.

EC-Earth 2.3. A global, 16-member, coupled atmosphere–ocean transient ensemble (1860–2100; T159 × 150 km) (Hazeleger et al. 2010), using historical CMIP5 protocols until 2005 and the RCP8.5 scenario thereafter (Taylor et al. 2012).

HadGEM-3A. A global, 15-member, SST-driven, transient ensemble (1960–2015; N216 × 60 km), with “Historical” and “HistoricalNat” scenarios (Ciavarella et al. 2018).

EURO-CORDEX. An ensemble of 11 regional (12 km), bias-adjusted (CDFt method; Vrac et al. 2016) models, producing transient simulations, for four periods (past: 1971–2000, current: 2001–30, near-future: 2021–50, mid-century: 2041–70).

Weather@home. In the SE-box, and at all four stations, the model variability (σ) was too large; ξ was inconsistent with observations at Gospić.

EC-Earth. In the SE-box, σ was too large.

In Madrid, σ was too large. For Monte Cimone, σ was too large (by 20%) and only just outside the 95% CI for observations; results were used with caution.

HadGEM-3A. In the SE-box, and all four stations, σ was too large.

EURO-CORDEX. For the SE-box, the 2017 observed value lies too far above the past distribution to calculate a risk ratio accurately.

At Monte Cimone, ensemble temperatures were above observations for the same return period; probably an elevation issue. At Gospić, ensemble temperatures were too low.

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