Assessment of WRF physical parameterisations for regional climate simulations over the CORDEX European domain

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Introduction

In this study, we examine the Weather Research and Forecasting (WRF-ARW) model as a regional climate model for the European region (in accordance with Region 4 of the WCRP CORDEX Experiment - Figure 1). The work shown here forms part of a larger body of research (Mooney et al) which is undertaken with a view to identifying the optimal choice of parameterisations for this region.

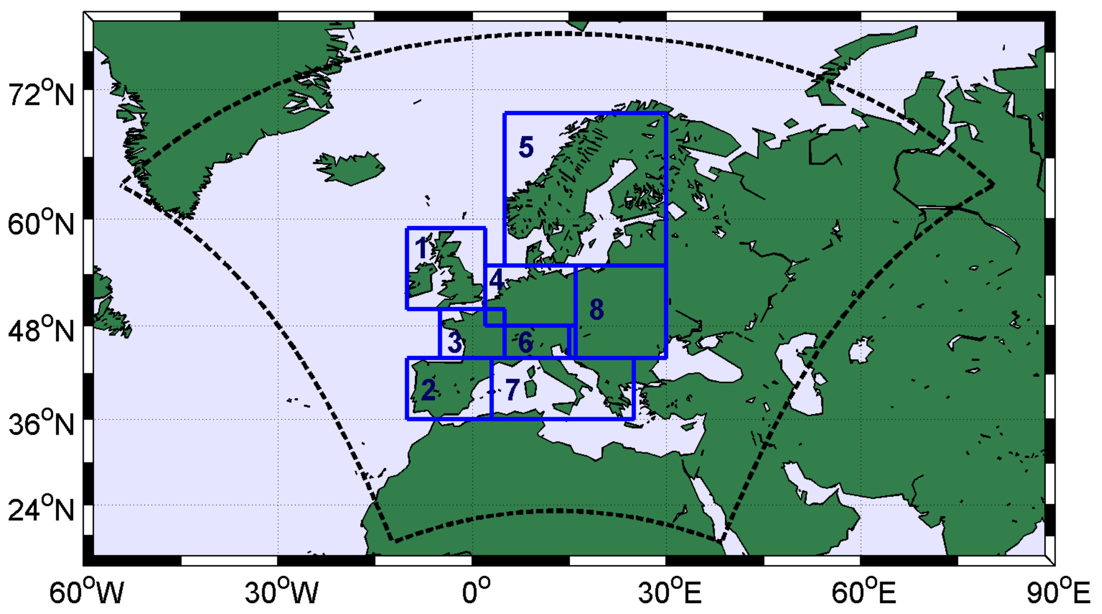

Figure 1. Map of Europe showing the WCRP CORDEX Region 4 (dashed black line) and the eight Rockel regions (solid blue lines).

Surface temperature, precipitation and mean sea-level pressure (MSLP) are compared to EOBS; a gridded dataset of daily observed temperature, precipitation and MSLP (Haylock et al., 2008). These variables are examined over eight Rockel regions (Christensen & Christensen, 2007) indicated by solid blue lines in Figure 1. We examine monthly mean values, standard deviation (amplitude of variability about the mean), temporal correlation and bias corrected root-mean-squared (RMS) difference.

Model Configurations

WRF-ARW model (version 3.1) is used to simulate the climate over the European CORDEX domain (see figure 1) for the period 1989-1995 with a spatial resolution of 0.44° for 8 different combinations of physical parameterizations (see Table 1). Initial conditions, lateral boundaries and sea surface temperatures are provided by ERA-Interim reanalysis. The period 1989-1995 was chosen to economize on computational resources and the availability of ERA-Interim data.

	Microphysics	LW radiation	Land Surface Model	SW radiation	PBL Scheme	Cumulus Physics
Experiment 1	WSM5	RRTM	Noah	CAM	YSU	Kain-Fritsch
Experiment 2	Morrison	RRTM	Noah	CAM	YSU	Kain-Fritsch
Experiment 3	WSM5	CAM	Noah	CAM	YSU	Kain-Fritsch
Experiment 4	Morrison	CAM	Noah	CAM	YSU	Kain-Fritsch
Experiment 5	WSM5	RRTM	RUC	CAM	YSU	Kain-Fritsch
Experiment 6	Morrison	RRTM	RUC	CAM	YSU	Kain-Fritsch
Experiment 7	WSM5	CAM	RUC	CAM	YSU	Kain-Fritsch
Experiment 8	Morrison	CAM	RUC	CAM	YSU	Kain-Fritsch

Table 1. The combination of parameterization schemes used in each experiment.

Surface Temperature

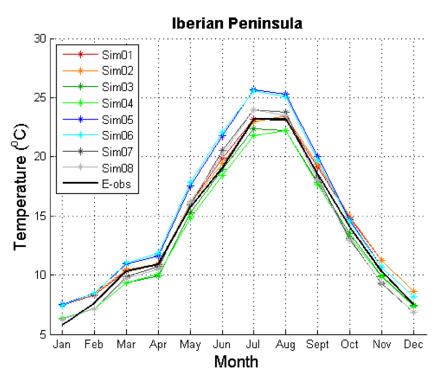

Figure 2 Mean monthly surface temperature for each experiment and EOBS over the seven year period for the mid-Europe.

Figure 2 is a typical example of the mean monthly surface temperatures for the eight Rockel regions and it shows that:

- All WRF simulations capture the general trend in surface temperatures over the seven-year period.
- Simulations using the <u>*NOAH LSM exhibit lower bias*</u> in summer compared with those in which RUC is used.

Figure 3 is a typical example of the Taylor diagram for the 8 Rockel regions and it shows that:

- All simulations <u>*compare favourably*</u> to EOBS in terms of correlation coefficient, RMS difference and variability about the mean.
- Simulations using the <u>*NOAH LSM capture variability*</u> about the mean <u>*more accurately*</u> than those using RUC.

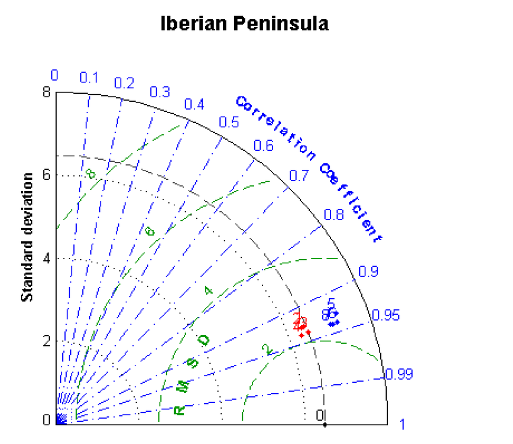

Figure 3 Taylor diagram of the eight WRF simulations over the seven-year period for the mid-Europe region.

Daily Precipitation Rates

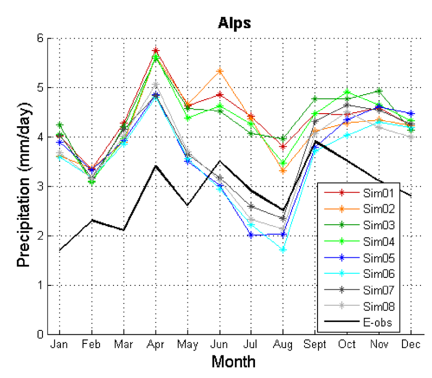

Figure 4 Daily mean precipitation by month for the eight WRF simulations and EOBS (black line) over the seven year period for the Alps.

Figure 4 is a typical example of the mean daily precipitation for each month over the seven-year period for the 8 Rockel regions and it shows that

- *All simulations overestimate* the *mean daily precipitation rates* in winter months compared with EOBS.
- Simulations using the NOAH LSM *exhibit the general precipitation trends o*bserved in the EOBS data albeit with an offset.
- Simulations using the *RUC scheme* are closer to EOBS in *summer months* only.

Figure 5 is a typical example of the Taylor diagram for the 8 Rockel regions and it shows that:

- All simulations have *poor temporal correlation* with EOBS data and *high bias-corrected RMS differences*.
- The eight WRF simulations have amplitudes of variability about the mean *comparable* to the EOBS data.
- Simulations using RUC LSM capture variability about the mean *marginally better* than those using NOAH.

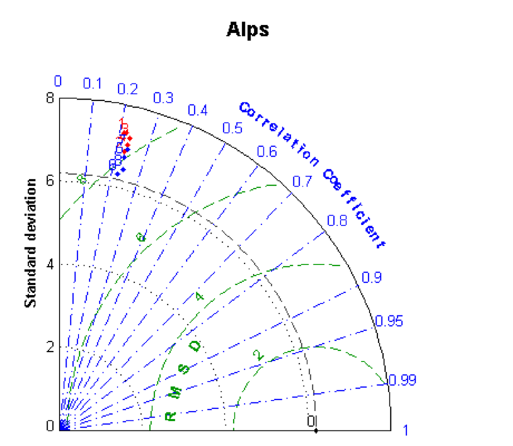

Figure 5 Taylor diagram of the eight WRF experiments over the seven year period for the Alps

Summary/Future Work

Summary for the domain and resolution examined:

- WRF reproduces surface air temperatures reasonably well but models precipitation poorly.
- Choice of Land Surface Model (LSM) used has significant impact on models ability to simulate surface air temperature and precipitation.
- Model simulations of surface air temperature and precipitation are largely independent of choice of Microphysics Scheme and LW Radiation Scheme.
- There is no clear optimum set of parameterisations for all variables for all regions.

Future Work:

- Compare WRF simulations to other datasets e.g. CRU, TRMM.
- Extend the study to examine sensitivity to other atmospheric variables, e.g. U10, V10, MSLP.

References

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3.Christensen JH, Christensen OB, (2007) Climatic change, 81:7-30. doi:10.1007/s10584-006-9210-7

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