Dynamical Downscaling with ECMWF Seasonal Forecasts

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The principal aim of seasonal forecasting is to predict the range of values that is most likely to occur during the next season. Seasonal forecast information can be used for decision making in, for example, agriculture, water resources management, production of electricity, etc. It can also help alleviating the effects of extreme climate fluctuations such as droughts and floods.

General circulation models make seasonal forecasts at spatial scales of the order of hundreds of kilometres without actually revealing details in surface fields that depend on orography, such as precipitation or surface temperature. One method of increasing the spatial and temporal resolution of the fields of interest is to dynamically downscale the output of global models by using regional climate models.

In this study we used the Regional Climate Model (RegCM; Giorgi et al. 1993) to downscale ECMWF operational seasonal forecasts for the summer (June-August) of 2003. The ECMWF model resolution was T_L95, approximately corresponding to 1.875º on the quasi-regular grid. The input fields for RegCM have been taken from the ECMWF seasonal forecast archive – only fields at six standard pressure levels (1000, 925, 850, 700, 500 and 200 hPa) with the 12-hour frequency were available. In order to reduce computational requirements for downscaling the whole ECMWF seasonal forecasts ensemble (40 integrations), a subset of seasonal forecasts has been made by applying Ward's hierarchical clustering technique (Anderberg, 1973). For a given area, those members that explain 50% of the ensemble variance have been selected. For the clustering purpose, monthly means of 500 hPa geopotential heights for the first and second summer month (June and July) in 2003 have been retrieved from ECMWF seasonal forecast archive. The common members from the most populated clusters in each month were selected, thus resulting in 12 seasonal forecasts to be downscaled. The RegCM domain covered the central and southern Europe and the northern Mediterranean and the model horizontal resolution was set to 50 km. The model top was at 200 hPa with 14 vertical levels.

In order to determine the differences between the fields after downscaling, the RegCM seasonal ensemble means have been compared with the sub-ensemble seasonal means of the ECMWF model. ECMWF sub-ensemble seasonal means have been retrieved at 2ºx2º lat/lon grid for the same 12 members used for downscaling.

The benefits of the denser grid can be clearly seen from Figure 1. showing the total precipitation seasonal mean for (a) RegCM seasonal forecasts ensemble and (b) ECMWF model sub-ensemble mean. While the ECMWF model seasonal mean indicates increased precipitation in the Alpine region, the RegCM seasonal mean clearly gives more detailed structure over the Alps, the Carpathian Mountains, the Balkan Peninsula, the Pyrenees and the Atlas Mountains on the border of the integration domain. The

difference between RegCM and ECMWF precipitation averages is not negligible – in both coastal and continental parts of Croatia it amounts between 1 and 3 mmday^{-1}. RegCM proved to be very robust despite such a poor input from the ECMWF operational archive. It is therefore hoped that with more levels and more frequent time intervals even better downscaling result would have been achieved.

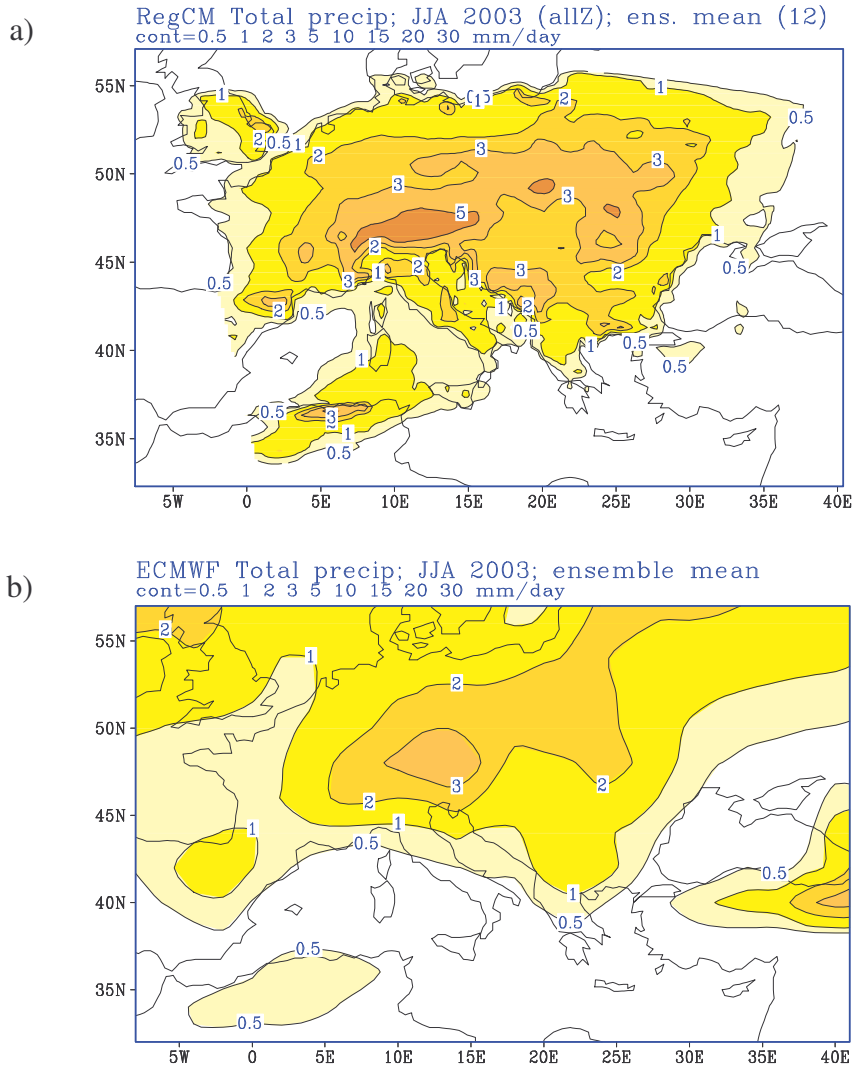

Figure 1. The JJA 2003 total precipitation ensemble mean (mmday^{-1}) for a) RegCM and b) ECMWF model. Contouring: 0.5, 1, 2, 3, 5, 10, 15, 20, 30 mmday^{-1}.

References:

Anderberg, M.R., 1973: Cluster analysis for applications. Academic Press, New York.

Giorgi, F., Marinucci, M.R. and Bates, G.T. , 1993: Development of a second-generation regional climate model (RegCM2), Part I: Boundary-layer and radiative transfer processes, *Monthly Weather Review,* 121, 2794-2813.