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The summer North Atlantic Oscillation (SNAO) in CMIP3 models and related uncertainties in precipitation projections in the Euro-Mediterranean region

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Climate simulations for the XXIst century project pronounced precipitation decreases in the entire Mediterranean region, particularly in summer. This projected summer drying is quite consistent across models, which makes this projection particularly reliable, but only in terms of model signal-to-noise. Overall, however, there is little observational evidence that this signal has already started to emerge from the background of natural variability. The mechanisms associated with this projected summer drying have also not been sufficiently studied. We attempt to increase our confidence in model projections by investigating whether the large-scale mechanisms that currently influence summer precipitation in the Mediterranean region are well represented in the models. Specifically, we compare the role of the summer NAO in driving interannual and long-term changes in precipitation in the observations and in the CMIP3 models (20C3M runs).

The spatial structure of the observed summer NAO is significantly different than that of the winter NAO, being more spatially confined and shifted to northern latitudes. Summers with a positive NAO tend to be characterized by warm and dry conditions in northwest Europe (particularly the British Isles) but cold and wet conditions in the northern Mediterranean (particularly Spain, Italy and the Balkans). This enhanced precipitation is related to the presence of a strong upper-level trough over the Balkans - part of a hemispheric pattern of anomalies that develops in association with the SNAO - that leads to mid-level cooling and increased potential instability.

We find that many CMIP3 models correctly capture the spatial features of the SNAO as well as the strength of the associated dry anomalies in northwest Europe. Models also generally reproduce the widespread increase in precipitation in the Mediterranean that occurs during the positive SNAO phase, but the effect is consistently too weak and in some models completely non-existent. The failure of the models to reproduce the observed signal in the Mediterranean is a matter of concern for simulations of future climate because many of these models predict an upward trend in the summer NAO, which leads to large precipitation reductions over Europe (SRESA1B runs). There are two problems with this result. First, the plausibility of this trend cannot be confirmed based on past observations or theoretical arguments: thus, the intensity of the projected drying becomes uncertain. Second, based on observations, we would expect the SNAO trend to lead to increased precipitation in the northern Mediterranean, which would offset some of the non-SNAO related drying. This offset, however, does not occur because the influence of the SNAO in this region is not well-captured by the models. Therefore, if the upward SNAO trend is verified, drying could be less drastic over the Mediterranean region than some of the models anticipate.

Results from available CMIP5 simulations will also be presented to assess whether the new generation of models performs better with regard to the summer NAO.