Regional Climate Modelling at the RMI

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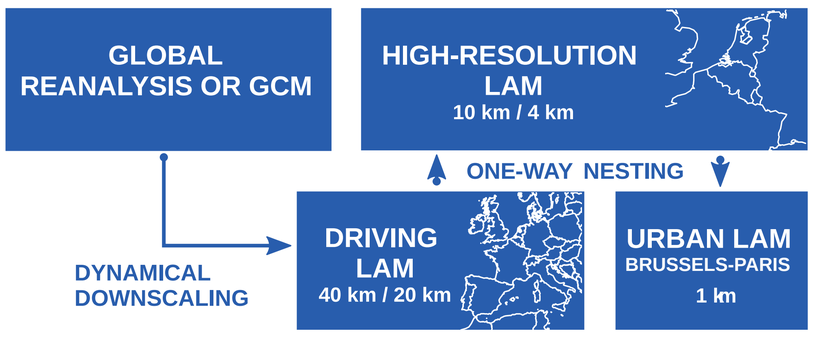
Regional Climate Modelling is a widely used tool to inform policy makers on local climate and its potential changes. This poster gives an overview of the progress made by the Regional Climate Modelling Group at the Royal Meteorological Institute (RCMG-RMI) of Belgium during the last year. It is structured following the essential steps within climate research: going from experimental setup to validation, projections and applications.

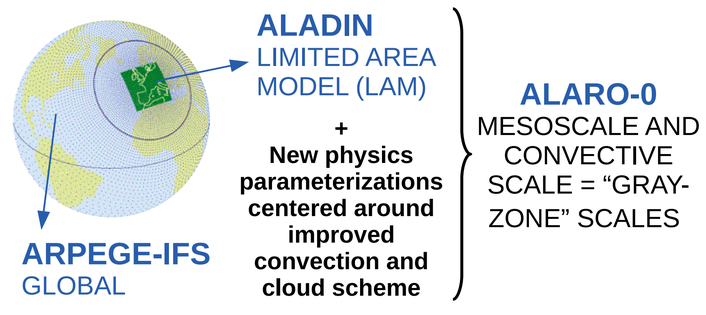
1 Experimental Setup

To gain local climate information Global Climate Models (GCMs) or reanalyses are dynamically downscaled using a Regional Climate Model (RCM). A daily re-initialization approach is used: each day the RCM is initialized from the GCM and runs for 48 hours, of which the first 24 hours are dismissed as spin-up.



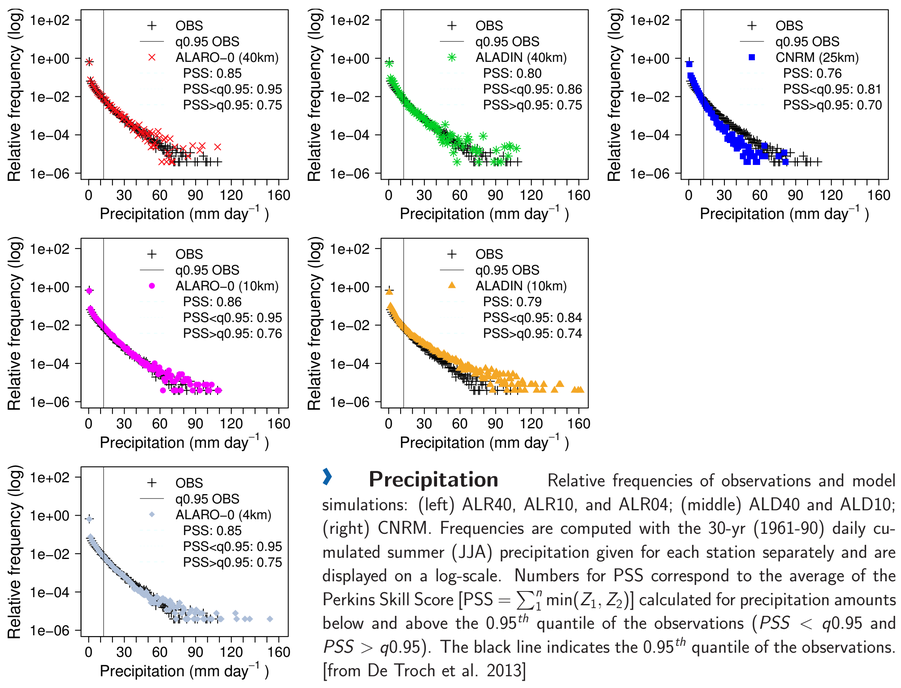
› The dynamical downscaling resolution cascade from GCM to urban LAM after several nestings.

The RCM used at the RMI is **ALARO-0**, an extended version of ALADIN, which in turn is a Limited Area Model (LAM) version of the GCM Arpège-IFS. ‹



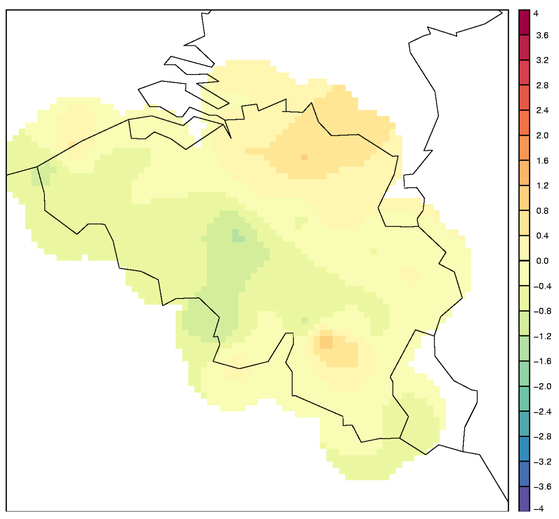
2 Validation

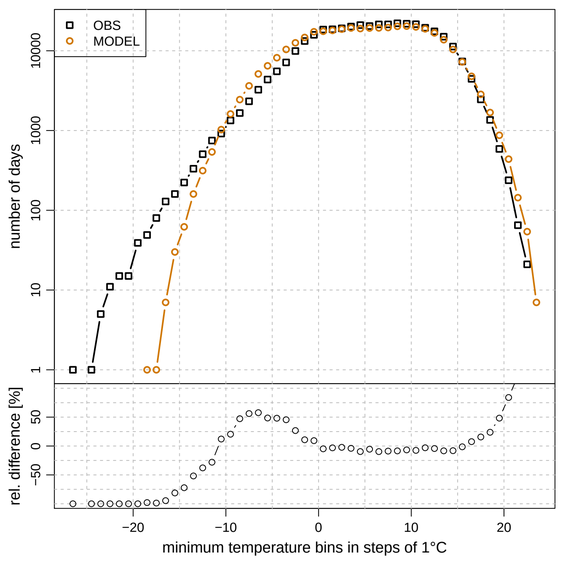
In order to make reliable statements about the climate and its potential changes from model output, model skill in reproducing historically observed values should be assessed. Some non-exhaustive examples of model validation against the observational network of Belgium for precipitation and 2-meter minimum and maximum temperature are presented.



› **Precipitation** Relative frequencies of observations and model simulations: (left) ALR40, ALR10, and ALR04; (middle) ALD40 and ALD10; (right) CNRM. Frequencies are computed with the 30-yr (1961-90) daily cumulated summer (JJA) precipitation given for each station separately and are displayed on a log-scale. Numbers for PSS correspond to the average of the Perkins Skill Score [PSS $= \sum_1^n \min(Z_1, Z_2)$] calculated for precipitation amounts below and above the 0.95^{th} quantile of the observations ($PSS < q0.95$ and $PSS > q0.95$). The black line indicates the 0.95^{th} quantile of the observations. [from De Troch et al. 2013]

Maximum Temperature Spatial distribution over Belgium of 30-yr average summer (JJA) biases (model minus observed in °C) of the daily maximum temperature obtained with ALR04 driven by the ERA-40 reanalysis. The mean bias over the 50 climatological stations used for validation is -0.22°C. [from Hamdi et al. 2012] ‹

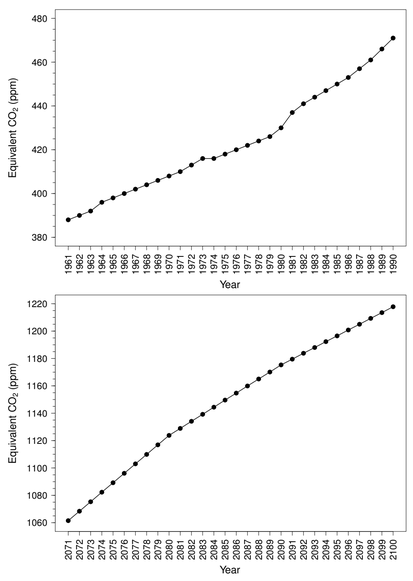




› **Minimum Temperature** Histogram of the observed and modelled daily minimum temperature at 33 stations using ALARO-0 driven by ERA-INTERIM over the period 1980-2010 (top panel) and the relative difference ((MODEL-OBS)/OBS) between the two (bottom panel).

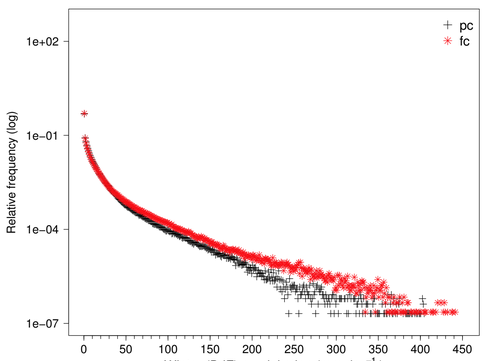
3 Projections

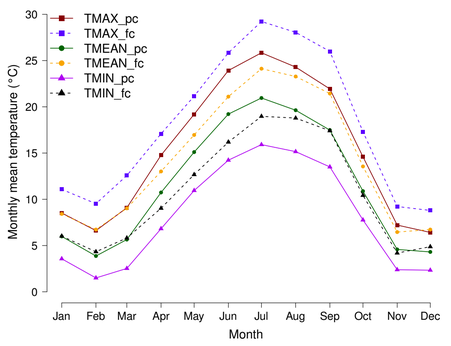
Currently the RMI is investigating climate change under the A1B scenario, which describes a future world of very rapid economic growth and the rapid introduction of new and more efficient technologies. This scenario assumes a 'balance' across all energy sources, i.e. not relying too heavily on one particular energy source. For the computation of this projection ALARO-0 is driven by the GCM Arpège-IFS for a historical and future period.



› **CO_2** Values for equivalent CO_2 corresponding to the A1B scenario for 1961-1990 (top) and 2071-2100 (bottom).

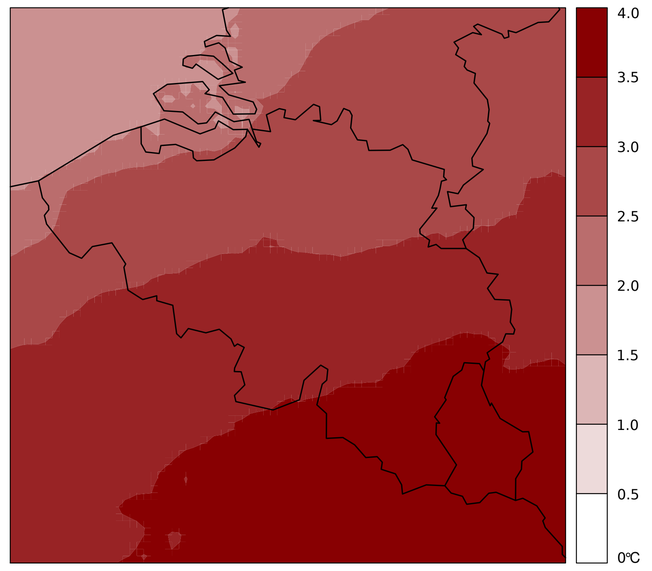
Precipitation Relative frequencies of 30-yr (pc; 1961-1990) and 27-yr (fc; 2071-2099) daily cumlated winter precipitation. The frequencies are calculated for the model gridpoints coinciding with a subdomain located in the centre of Belgium and are displayed on a logarithmic scale. ‹





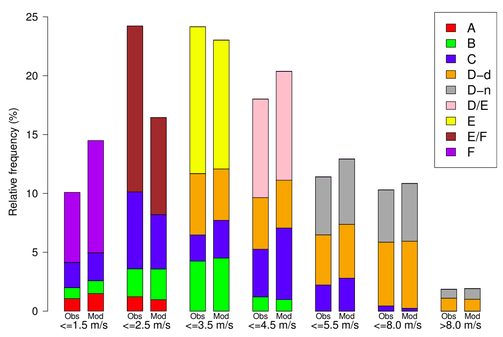
› **Temperature** The 30-yr and 27-yr average monthly minimum, maximum and mean temperature for the present (pc, 1961-1990) and future climate (fc, 2071-2100).

Maximum Temperature The 27-yr (2071-2099) mean anomaly relative to the 30-yr mean for the period 1961-1990 for summer (JJA) maximum temperature. ‹



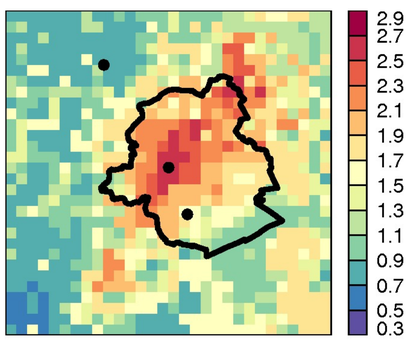
4 Applications

The results and their uncertainties from the regional climate research of the RCMG-RMI can be used to give a balanced advice to local policy makers. Some projects in which these decision makers cooperate are shown.



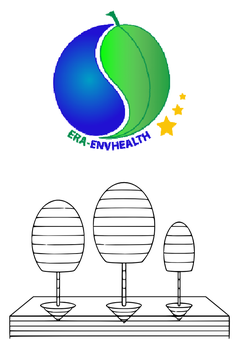
› **Air Quality** The ERA-INTERIM reanalysis is dynamically downscaled to generate a dataset of meteorological parameters for Quantitative Risk Analysis (QRA), in particular dispersion calculations of pollutants. The figure shows a histogram of Pasquill stability classes as a function of 10m-windspeed for observations and model for Uccle and for the 3-yr period 2008-2010.

Urban Heat Island The Urban Heat Island (UHI) is the effect that urban air temperatures are substantially higher than corresponding temperatures in the surrounding rural areas. The figure shows the 30-yr (1961-1990) average UHI of Brussels during nighttime. ‹



ACCEPTED The European ERA-HEALTHENV funded project Assessment of Changing Conditions, Environmental Policies, Time activities, Exposure and Disease (ACCEPTED) will investigate air pollution in urban areas and health impacts on vulnerable groups under changing conditions. ‹

ECORISK The aim of the ECORISK project is to design a decision support tool capable of modelling scenarios of forest growth, nutrient uptake and pollutant behaviour under different forest, soil, groundwater and climate conditions in Belgian forests. ‹



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References:
De Troch et al., 2013: Multiscale performance of the ALARO-0 model for simulating extreme summer precipitation climatology in Belgium, *Journal of Climate*, doi: 10.1175/JCLI-D-12-00844.1, in press.
Hamdi et al., 2012: New cloud and microphysics parameterisation for use in high-resolution dynamical downscaling: application for summer extreme temperature over Belgium, *International Journal of Climatology*, **32**, 2051-2065, doi: 10.1002/joc.2409.