ECLIPSE project – WP6: Climate Responses

Objectives

This WP will use climate integrations from models coupled to a full ocean representation in order to capture changes in climate from short-lived climate forcers beyond the simple global surface temperature. Unlike configurations with no ocean or a mixed-layer ocean, these coupled simulations will not be run to equilibrium.
Instead comparisons between transient runs will be analysed. This will deliver a time dependent result which will be more policy relevant than running to equilibrium.
The experimental design will set up a number of parallel transient runs with a control and several experiments (with perturbed species). The difference between the experiments and the control will be quantified as a decadal average after 50 years of integration. Previous experience suggests that this length of integration is necessary to identify a signal.

The climate models (HadGEM, NorESM and ECHAM) will incorporate interactive chemistry and/or aerosols.
Additional components such as dynamic vegetation and full carbon cycles may be switched on where appropriate.
O6.1 – Quantify the models' responses to changes in short-lived climate forcers (SLCFs) for a range of climate variables.
O6.2 – Quantify the climate effects of the chosen measures
O6.3 – Evaluate the climate models' responses to past SLCF changes
O6.4 – Assessment of metrics and timescales

Description of work

T6.1 – Perturbation experiments (Lead METOFFICE; Month 1 - 21)
The experimental design to provide the data for objective O6.1 will be based on perturbations to the emissions of SLCFs and their precursors. It will be too computationally expensive to examine all combinations of SLCFs, regions and sectors. Specifically, we aim at global perturbations of the seven individual SLCFs: BC, OC, SO2, NH3, NOx, CO, and VOC. A special sensitivity study will be carried out for BC, where in two simulations (i) the indirect and (ii) the semi-direct effects will be switched off.

The runs will start in 2005 taking the model states from the CMIP5 historical integrations. The "control" will be created by continuing this integration, but with concentrations of long-lived gases fixed at 2005 levels, and emissions of short-lived species also fixed. The control therefore will include some committed warming. The experiments will be performed by removing the anthropogenic emissions of an individual short-lived species.

The experiments will be integrated for 50 years in order to separate a robust signal from the interannual variability. Previous experience has suggested that this timeframe is adequate for forcings of the order of a few tenths of a Wm-2. Each modelling group would run the same scenarios. The results will be stored in a database (D6.1)

T 6.2 – Experimental analysis (Lead METOFFICE; Month 12 - 30)
The data from the experiments will be analysed, quantifying global and regional changes in meteorological variables of importance for human and ecological impacts to achieve objective O6.1 and deliverable D6.2.
These will include surface temperature, precipitation, run off, cloud cover and ecosystem productivity. The decadal averages of the signals will be compared with the interannual variability to determine the robustness of the changes. Comparisons between the three models will give further understanding of the significance of the results.

T6.3 – Historical analysis (Lead ULEI; Month 1 - 18)
As an evaluation of the climate model responses, the historical simulations from the three models (as submitted to the CMIP5 project) will be analysed in detail over the period 1975-2005 to compare climate signals from the models and observations due to rapid changes in aerosols over that time period. This will achieve objective O6.3 and meet deliverable D6.3. The focus would be on changes over Europe resulting from the sudden decline in heavy industry in eastern and central Europe in the early 1990s and the recent controls on particulate matter for air quality purposes within the European Union. The variables analysed would include surface temperature, surface short-wave fluxes (dimming/brightening), cloudiness and precipitation, specifically their extreme values (including the diurnal temperature range).

T 6.4 – Analysis of measures (Lead CICERO; Month 21 - 36)
In this task we will repeat the experiments and analysis of tasks 6.2 and 6.3 for a set of measures identified as the most effective in WP 1. Instead of perturbing single SLCF emissions, the measures follow those control scenario emissions consistent with those that have been identified as key sets of measures as defined by task 7.1 and 7.2. The analysis will achieve objective O6.2 and be delivered in D6.4.
The climate signals may be of smaller magnitude for the control measures compared to the experiments in task 6.2, hence an ensemble of runs will be carried out to increase the statistical significance of the signal.

T 6.5 – Exploitation of GCM output for metric calculations (Lead UREAD; Month 18 - 36)
This task will provide the link between WP 6 and WP 5. The GCM output will provide information on the efficacy of different SLCFs mechanisms and the timescale of response to them, and their regional dependence. These will be exploited to improve the calculation of standard metrics and also to explore more novel metrics, which go beyond global mean temperature. . The assessment will meet objective O6.4 and deliverable D6.5.