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Phase II

Abstract

In this note we present results obtained by the LBNL group during the second phase of the UNFCCC assessment exercise. For this part of the exercise we have developed a spreadsheet interface that allows us or any user to choose from a given set of scenarios, two databases for historic data and various parameter values. The regional contributions are calculated using the *ceteris paribus* method and results for different sets of parameters can be compared graphically.

1 Methodology

The methodology for calculating concentration levels for the greenhouse gases (GHGs) CO_2, CH_4 and N_2O, as well as the implied radiative forcing, temperature increase and sea level rise were discussed in the documentation of Phase I of the assessment exercise. There the A2 marker scenario was used to gauge the parameter values in order to get consistent results.

The centre of Phase II is the attribution calculation. With the help of the simple climate model each region's contribution to the global change in GHG concentration levels, radiative forcing, temperature and sea level is estimated. This can be done in various ways, but care has to be taken, because the climate model is non-linear. This means, for our purposes, that in order to assess the impact of GHG emissions we not only have to count the emissions, but also to take into account the amount of GHGs already present in the atmosphere at the time the gases are released. Consequently, the *absolute* regional contributions are not additive: The total mean climate change is not necessarily the same as the sum of the absolute changes attributed to the regions. In plain English: the total is not equal to the sum of its parts.

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In order to get around this difficulty we favour the method of *ceteris paribus* scenarios, which we describe briefly. For a given scenario we first calculate the radiative forcing, the temperature increase and the sea level rise for a fixed point in the future, say for the year 2100. The result is what might be called the global values, because the emissions of all regions are taken into account. We then calculate the same functions, but this time we set the emissions of one of the regions, say OECD90, to zero during the emission period.[2] As a result, the forcing, temperature and sea level in this "background calculation" will be lower than the corresponding global values[3], and the difference to the global values is attributed to the single region considered, in this case to OECD90. The calculation is repeated for all regions, and so for each region we obtain an absolute contribution to radiative forcing, temperature increase and sea level rise. The relative contributions, expressed in percent, are calculated in relation to the sum of the absolute contributions.[4]

In this way we obtain relative regional contributions for temperature increase and sea level rise. It is important to understand that this method is based on the question how much of the warming and sea level rise could be *avoided* by reducing emissions. It is therefore appropriate in the context of carbon mitigation scenarios.

In contrast to the results provided in Phase I, in Phase II of the UNFCCC assessment exercise a whole variety of scenarios and underlying assumptions can be combined, so that the number of attribution calculations is fairly large. The UNFCCC Secretariat has singled out a reference scenario which all participating groups have to provide in order to make a comparison possible (see project web site). In general, parameters that can be

[2]The emission period is the time between the emission start date and the emission end date, see below.

[3]Due to lack of regional data we have to accept that the radiative forcing from aerosols currently cannot be attributed to individual regions.

[4]As a consequence of the non-linear nature of the temperature and sea level function the sum of absolute contributions is not necessarily the same as the value in the original global calculation.

adjusted include the emission start and end date[5], the attribution date and carbon cycle parameter values. Moreover, there are two emission databases to choose from. We have summarized some of the results in the attached charts and tables (see also Sec. 3), and others can be reproduced individually with the help of the interface (see Sec. 2).

It should be mentioned that CH_4 and N_2O emission data are only available from the EDGAR-HYDE database. Therefore these data have also be used when CO_2 emission data from the CDIAC database are chosen. For CH_4 this simplification does not have any implications on the current concentration levels because the lifetime of CH_4 in the atmosphere is relatively short, so even with a different set of emission data the difference would not be noticible. For N_2O, which has a lifetime longer than a century, a distinct data set would be necessary to make a useful comparison.

The fact that, at this stage, we have to combine two different databases is rather unsatisfactory, because even though we seem to take into account three different gases only the CO_2 emissions and implied CO_2 concentrations make the difference in the calculation of the radiative forcing. Even the temperature increase and sea level rise are functions only of the concentrations (and other parameters), so that when we compare temperature increase and sea level rise calculated from the two historic data sets, the differences are driven by the differences in CO_2 emissions.

2 The Spreadsheet Interface

The spreadsheet interface is easy to use and self-explanatory.[6] On the left hand side of the sheet "Interface" the user can choose between sets of parameter values and scenarios. In the first box the set of parameter values for the simple carbon model is fixed. The options are "SAR standard", "SAR low", "SAR high" and "TAR Standard" and are taken from Joos (2002).

[5]Emission data before the emission start date are treated as a background, *i.e.* they are treated as global emissions and not attributed to any particular region. The same applies to bunkers.

[6]The EXCEL spreadsheet implementation of the attribution calculation can be obtained by writing to FWagner@lbl.gov.

In the second box the user can choose between three future emission scenarios, the A2 (ASF) and B1 (IMAGE) marker scenarios, and a fossil fuel intensive scenario A1FI (this version offers the AIM A1C scenario). The choice between historic data from the CDIAC or EDGAR-HYDE database only applies to CO_2 emissions, for CH_4 and N_2O emissions are taken from EDGAR-HYDE for both choices, as discussed above. The emission start date refers to the point in time from which cummulative emissions, implied temperature change and sea level rise are attributed to the emitting region. All emissions after the emission end date are set equal to zero. Finally, the user has the choice between two sets of lifetimes for CH_4 and N_2O (see below).

3 Key to the Diagrams

Figure 1 shows the relative contribution of each of the four world regions in the reference case, *i.e.* in this case we use TAR parameter values for the carbon model and consider the emission period 1890-2000 in the EDGAR-HYDE database. Note that at this stage no future scenario data are taken into account. Figure 2 shows the corresponding data for the relative contribution to the sea level rise. In both cases we observe a growing contribution for OECD90 after the end of the emission period, while for all other regions the constribution is decreasing over time.

In Figure 3 and 4 again the relative contributions are shown, but this time the attribution calculation takes also into account emissions during the 21st century, for which we have used A2 ASF scenario data. We observe growing contributions for ASIA and ALM and decreasing shares for OECD90 and REF. As expected, changes in sea level rise contributions occur slower than in the corresponding temperature increase contributions, and the trend away from Annex I to non-Annex I is clearly discernable in both Figures.

In order to estimate the effect that changes in the parameters can have on the relative contributions we first assess the effect of different choices of parameters on the global results. Figures 5 and 6 compare the *absolute* *global* temperature increase and sea level rise at different points in time for various sets of parameters. In each case, only emissions between 1760 and 2000 are taken into account. The left half of the diagrams uses emission data from the CDIAC database, while the right half uses EDGAR-HYDE data. The second line in the legend refers to the lifetimes of CH_4 and N_2O used in the calculation: "with feedback" refers to lifetimes of 12 and 114 years, respectively, "without feedback" to 8.4 and 120 years.[7] Finally the third line in the legend indicates which set of parameters was used in the Bern model (for the parameter values consult the note by Joos on the project web site).

Finally, in Figure 7 and 8 we compare the regional contributions to temperature increase for the three SRES scenarios, first under the assumption that the emission period ends in 2050 (Figure 7) and then in 2100 (Figure 8). In both cases TAR parameter values and EDGAR-HYDE emission data were used, as well as $CH_4$and N_2Olifetimes that reflect feedback mechanisms.

4 Conclusions

The *ceteris paribus* method is useful for assessing relative regional contributions to climate change. In the present context it can be applied whenever regional emission data are available. Relative contributions can be compared for different sets of parameter and GHG emission databases. We note that for $CH_4$and N_2Oonly one set of historic emission data is available, so that a comparison between EDGAR-HYDE and CDIAC data is of limited use.

References

Joos, F., April 2002. CO_2 Impulse Response Function of Bern SAR and TAR models.

[7]Calculations that use the same pair of lifetimes are grouped in sets of four in the diagrams.

http://cru.uea.ac.uk/unfccc_assessment/tuning_carbon/,
UNFCCC Assessment.

URLs are as of June 2002