APPENDIX B

MAGICC Model Description

(Supplemental to Chapter 2)

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MAGICC (Model for the Assessment of Greenhouse-gas Induced Climate Change) is a coupled gas-cycle/climate model. Various versions of MAGICC have been used in all IPCC assessments. The version used here is the one that was used in the IPCC Third Assessment Report (TAR; IPCC, 2001; Cubasch and Meehl, 2001; Wigley and Raper, 2001). A critical assessment focused on its skill in predicting global average sea-level rise is found in Chapter 10 Appendix 1 of the Working Group I contribution to the Fourth Assessment Report (AR4) of the IPCC (Meehl *et al.,* 2007).

The climate component is an energy-balance model with a one-dimensional, upwelling-diffusion ocean (UDEBM). For further details of models of this type, see Hoffert *et al.* (1980) and Harvey *et al.* (1997). In MAGICC, the globe is divided into land and ocean "boxes" in both hemispheres in order to account for different thermal inertias and climate sensitivities over land and ocean, and hemispheric and land/ocean differences in forcing for short-lived gases and particles.

In order to allow inputs as emissions, the climate model is coupled interactively to a series of gas-cycle models for CO_2, CH_4, N_2O, a suite of halocarbons and SF_6. Details of the carbon cycle model are given in Wigley (1991a, 1993, 2000). The carbon cycle model includes both CO_2 fertilization and temperature feedbacks, with model parameters tuned to give results consistent with the other two carbon cycle models used in the TAR; *viz.* ISAM (Kheshgi and Jain, 2003) and the Bern model (Joos *et al.*, 2001) over a wide range of emissions scenarios. Details are given in Wigley *et al.* (2007). The other gas cycle models are those used in the TAR (Prather and Ehhalt, 2001; Wigley *et al.*, 2002). Radiative forcings for the various gases are as used in the TAR. For sulfate particles, both direct and indirect forcings are included using forcing/emissions relationships developed in Wigley (1989, 1991b), with central estimates for 1990 forcing values. Sea-level rise estimates use thermal expansion values calculated directly from the climate model. Ice melt and other contributions are derived using formulae given in the TAR (Church and Gregory, 2001), except for the glacier and small ice cap contribution which employs an improved formulation that can be applied beyond 2100 (Wigley and Raper, 2005).

The standard inputs to MAGICC are emissions of the various radiatively important gases and various climate model parameters. For the TAR, these parameters were tuned so that MAGICC was able to emulate results from a range of Atmosphere-Ocean General Circulation Model (AOGCMs) (Cubasch and Meehl, 2001; Raper *et al.*, 2001). For the present calculations, a central set of parameters has been used. The most important of these is the climate sensitivity, where we have used a value of 2.6°C equilibrium global-mean warming for a CO_2 doubling, the median of values for AOGCMs used in the TAR.