



European Commission's 7<sup>th</sup> Framework Programme  
Grant Agreement No. **226520**

Project acronym: **COMBINE**

Project full title: **Comprehensive Modelling of the Earth System for Better  
Climate Prediction and Projection**

Instrument: Collaborative Project & Large-scale Integrating Project

Theme 6: *Environment*

Area 6.1.1.4: *Future Climate*

ENV.2008.1.1.4.1: *New components in Earth System modelling  
for better climate projections*

Start date of project: 1 May 2009

Duration: 54 Months

**Milestone Reference Number and Title:**

**IMAGE run with updated climate sensitivities and assessment of implications on  
existing climate policy scenarios**

**Lead work package for this milestone: WP8**

**Organization name of lead contractor for this milestone:  
PBL Netherlands Environmental Assessment Agency**

**Due date of milestone: 31 October 2013**

**Actual submission date: 31 October 2013**

The IMAGE model has been run under different implementations of climate sensitivities, carbon cycle model emulations and with several climate feedback implementations, to assess their impact on climate policy scenarios.

Feedback	Process implementation	Reference
<b>Climate Sensitivity</b>	Sensitivities of 2, 3 and 4 °C	Meinshausen <i>et al.</i> (2009)
<b>Carbon Cycle</b>	Emulations of carbon cycle models	Meinshausen <i>et al.</i> (2011)
<b>Permafrost</b>	CO <sub>2</sub> and CH <sub>4</sub> emissions, T dependent	Burke <i>et al.</i> (2012)
<b>Wetlands</b>	CH <sub>4</sub> emissions, T and [CO <sub>2</sub> ] dependent	Melton <i>et al.</i> (2013)
<b>Fires</b>	Added radiative forcing, T dependent	Arneth <i>et al.</i> (2010)
<b>Ozone</b>	(negative) CO <sub>2</sub> emissions, [O <sub>3</sub> ] dependent	Sitch <i>et al.</i> (2007)

Arneth, A., Harrison, S.P., Zaehle, S., Tsigaridis, K., Menon, S., Bartlein, P.J., Feichter, J., Korhola, A., Kulmala, M., O'Donnell, D., Schurgers, G., Sorvari, S., Vesala, T. (2010) Terrestrial biogeochemical feedbacks in the climate system. *Nature Geoscience* 3, 525-532.

Burke, E.J., Hartley, I.P., Jones, C.D. (2012) Uncertainties in the global temperature change caused by carbon release from permafrost thawing. *Cryosphere* 6, 1063-1076.

Meinshausen, M., Meinshausen, N., Hare, W., Raper, S.C.B., Frieler, K., Knutti, R., Frame, D.J., Allen, M.R. (2009) Greenhouse-gas emission targets for limiting global warming to 2°C. *Nature* 458, 1158.

Meinshausen, M., Raper, S.C.B., Wigley, T.M.L. (2011) Emulating coupled atmosphere-ocean and carbon cycle models with a simpler model, MAGICC6 - Part 1: Model description and calibration. *Atmospheric Chemistry and Physics* 11, 1417-1456.

Melton, J.R., Wania, R., Hodson, E.L., Poulter, B., Ringeval, B., Spahni, R., Bohn, T., Avis, C.A., Beerling, D.J., Chen, G., Eliseev, A.V., Denisov, S.N., Hopcroft, P.O., Lettenmaier, D.P., Riley, W.J., Singarayer, J.S., Subin, Z.M., Tian, H., Zürcher, S., Brovkin, V., van Bodegom, P.M., Kleinen, T., Yu, Z.C., Kaplan, J.O. (2013) Present state of global wetland extent and wetland methane modelling: conclusions from a model inter-comparison project (WETCHIMP). *Biogeosciences* 10, 753-788.

Sitch, S., Cox, P.M., Collins, W.J., Huntingford, C. (2007) Indirect radiative forcing of climate change through ozone effects on the land-carbon sink. *Nature* 448, 791-794.