European Commission's 7th Framework Programme
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Project acronym: **COMBINE**

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

D2.1: Implementation of a stochastic treatment of clouds and radiative transfer to the COSMOS ESM to account for the subgrid-scale cloud effects

A stochastic treatment of clouds and radiative transfer has been implemented to the COSMOS ESM. Details of the implementation are given in the publication:

Räisänen, P and H Järvinen (2010) Impact of cloud and radiation scheme modifications on climate simulated by the ECHAM5 atmospheric GCM. *Q. J. R. Meteorol. Soc.*, **136**, 1733-1752. doi:10.1002/qj.674.

A brief summary of its behaviour is given below. Extensive experimentation (more than 700 years at T63 resolution) was carried out to assess the impact of modifying two physical parametrizations in the context of a coupled atmosphere-ocean GCM. First, a diagnostic (relative humidity based) cloud fraction scheme was replaced by one based on a prognostic description of the subgrid-scale distribution of total water content (the Tompkins scheme). Second, the subgrid-scale information provided by the Tompkins scheme was introduced into radiation calculations using the Monte Carlo Independent Column Approximation (McICA). The experiments were carried out in three model configurations: (1) ECHAM5 with prescribed distributions of sea-surface temperature and sea ice, (2) ECHAM5 coupled to a mixed-layer ocean model, and (3) ECHAM5 coupled to the MPIOM ocean GCM.

The primary direct impact of replacing the RH-based cloud fraction scheme by the Tompkins scheme was an increase in very low cloudiness, mainly at mid and high latitudes, along with a reduction in mid-level cloudiness. The most notable effect of using McICA was a strengthening of the negative short-wave cloud radiative effect, without substantial effects on cloudiness. However, when compared to observational data, all model versions performed essentially equally well. For all of them, cloud field statistical properties showed substantial differences from the International Satellite Cloud Climatology Project data; in particular, there was a general lack of low- and midlevel clouds associated with low optical depth. The differences in temperature, precipitation and sea-level pressure between the model versions were rather small. However, in spite of similar performance for present climate, the different model versions show marked differences in their response to increased atmospheric CO_2.