



European Commission's 7<sup>th</sup> Framework Programme  
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Project acronym: **COMBINE**

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

Instrument: Collaborative Project & Large-scale Intergrating 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: 48 Months

**Milestone Reference Number and Title:  
M3.1 Stratosphere implemented in ESMs**

**Lead work package for this milestone: WP3**

**Organization name of lead contractor for this milestone: CMCC**

**Due date of milestone: April 2010  
Actual submission date: June 2010**

### M3.1 Stratosphere implemented in ESMs

The M3.1 milestone consists of producing the software (computer codes) for the incorporation of a dynamical stratosphere sub-model into a coupled atmosphere-ocean-sea-ice model, thus providing a prototype model on which to base the work of WP3.

Means of verification: The milestone is reached once the prototype model has passed the technical validation level.

As reported at the COMBINE General Assembly 2010, the milestone has been reached by all WP3 partners: For each of the WP3 models, the prototype model comprising a coupled atmosphere-ocean-sea-ice model that includes a well resolved stratosphere, has been implemented and passed the technical validation level.

For completeness, we report here on the validation of both the technical and scientific levels, in order to facilitate and guide the work for the following report on the incorporation of the stratosphere in ESM, deliverable D3.1.

The technical validation level includes:

- The atmosphere + ocean&seaice coupled code exists.
- Technical tests and short runs have been performed.
- Longer runs are in progress and the scientific evaluation will follow.
- Possibly a link/reference to a technical documentation; including upgrades to what already published.

Table 1 reports basic information of the WP3 models that have passed the technical validation level.

Table 1. Technical validation level

	<b>CMCC</b>	<b>COSMOS</b>	<b>EC-EARTH</b>	<b>METO</b>	<b>IPSL</b>
<b>Model components</b>	echam5 opa8.2+lim	echam6 mpiom	ECMWF s3, NEMO2+LIM2	HadGEM2 MOSES/TRIFFID + HadOC	LMDz, NEMO, OASIS
<b>Atmos. resolution</b>	T31L39 or T63L95	T63L47	T159L62 or T159L91	N96L60	96x72x39
<b>Ocean resolution</b>	2 deg x 31 levels	1° or 0.4° 40 levels	1 x 1 deg, 42 levels	1 deg (1/3 deg in tropics) x 40 levels	2°x2°
<b>Model top</b>	80 km	0.01 hPa (~80km)	1 or 0.01 hPa	84km	70km
<b>100-1 hPa Resolution</b>	44 levels	15 levels	11 or 30 levels	32 levels	1 km
<b>Documentation Reference</b>	Fogli et al 2009	Not yet available	Hazeleger et al. BAMS 2010	Collins et al., 2008	Not yet available
<b>Control run (started or ongoing)</b>	340 years Preindustrial	200 years spin-up	500-yr Preindustrial	240-yr Preindustrial	500-yrs spinup + Preindustrial

The scientific validation level includes the evaluation of the basic performance of a few hundred years of a simulation with constant external forcing:

- Limited surface climate drift (diagnosed by trends in annual and global mean, time series of 2m temperature, and Arctic and Antarctic sea-ice concentrations)
- Top of the atmosphere radiation close to be balanced (diagnosed by annual and global mean, time series of top of the atmosphere net radiative flux)
- Annual mean sea surface temperature distribution, averaged over many years
- Stratospheric climate and variability (monthly and/or seasonal zonal mean of temperature and zonal wind, climatology and standard deviation, QBO diagnostics)

Table 2 reports the requested diagnostics for the scientific validation level.

Table 2. Scientific validation level

	<b>CMCC</b>	<b>COSMOS</b>	<b>EC-EARTH</b>	<b>METO</b>	<b>IPSL</b>
<b>Control run</b>	340 years Preindustrial	200 years Preindustrial	500-yr Preindustrial	240-yr Preindustrial xxx-yr 20 <sup>th</sup> century	500-yrs spinup + Preindustrial
<b>2m Temp</b>	X	X	X	X (1.5m)	X
<b>Sea ice cover</b>	X	X	X	X	X
<b>TOA radiative fluxes</b>	X	X	X	X	X
<b>SST</b>	X	X	X	X	X
<b>U,T clim</b>	X	X	X	X	X
<b>U Eq</b>	X	X	X	X	X
<b>U,T int var</b>	X	X	X	X	X

X: The relevant diagnostic will be reported in deliverable 3.1