



INPE-BESM components for CMIP6

Atmosphere: CPTec global spectral model, with new physical parameterizations (deep and shallow cumulus convection, short and longwave radiation, modified CLIRAD, climatological aerosol direct effect on radiation).

Ocean: GFDL's MOM5 with marine ice, biogeochemistry, River discharges, and modified KPP vertical mixing.

Surface: INPE's version of NCAR's IBIS with improved representation of tropical biomes.

Coupler: Hourly coupling via GFDL's FMS.

INPE will commit to CMIP6 DECK, DCPP, ScenarioMIP, and HighResMIP (CPU-permitting) simulations.

INMCM: model progress from CMIP5 to CMIP6

1. Aerosol block has been switched on in climate model.
2. Increase in number of vertical levels in the atmosphere allowed to improve stratospheric dynamics, including QBO and sudden stratospheric warmings.
3. Climate model with high resolution (Atmosphere 0.67x0.5 L73, ocean 0.167x0.125 L40) was prepared for HiResMIP.
4. Greenland ice sheet model was switched on in climate model for participation in ISMIP6.

NorESM based on (NCAR) Community ESMs, where:

- The ocean model, NorESM-O, elaborated MICOM (Miami Isopycnic Coordinate Ocean Model);
- Ocean bio-geochemistry is based on HAMOCC (HAMburg Ocean Carbon Cycle Model);
- Aerosol life-cycle, physics, cloud microph. are CAM-Oslo (MET Norway / Univ Oslo);
- Adjusted processing of sea-ice and snow on sea-ice.

NorESM2 – the CMIP6-versions

to be based on CESM2, and possibly CESM1.5.

NorESM2	_MM	_LM	_LME
Based on	CESM2	CESM1.5	CESM1.5
Atmos. – Land	M : 0.9x1.25 deg. Atm:32 levels	L : 1.9x2.5 deg. 32 or 48 levels	L : 1.9x2.5 deg. 32 or 48 levels
Ocean - Sea-Ice	M : 1 deg.	M : 1 deg.	M :1 deg.
GHG	Conc. driven	Conc. driven	E : Emis. driven
Ocean BGC.	OFF	ON	ON
CMIP-DECK + CMIP6 Hist	ALL	AMIP, PreInd, Historic	ALL except AMIP

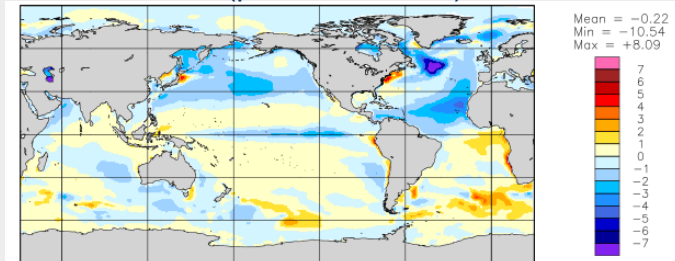
- **NorESM2_LM & NorESM2_LME.** (**L**ow/**M**edium Resol. **E**: Emis.-driven GHG)
 - Built on CESM1.5 [preCLUBB]
 - Aerosol components are now more interactive earth system processes;
 - Corrected global conservation of energy and angular momentum;
 - **preCLUBB**: CLUBB (conv. & turb.) is cpu-demanding, and key tropical features are bad;
- **NorESM2_MM / To be built on CESM2 released in Dec 2016** [preCLUBB?]
 - Calibration is initiated with pre-release (beta) versions

CMCC in CMIP6

The CMCC Climate Model (running)

- **Atm: CAM-5.3** ✓ Finite Volume dynamical core; $1^\circ \times 1^\circ$ and $1/4^\circ \times 1/4^\circ$ horiz. resolution, 30 ver. Lev. (top at ~ 2 hPa)
- **Land: CLM-4.5** ✓ C&N cycles (BGC mode); same atmosphere grid
- **River: RTM** ✓ 0.5×0.5 deg horizontal resolution
- **Ocean: NEMO-3.6** ✓ ORCA1 ($1^\circ \times 1^\circ$) & ORCA025 ($1/4^\circ \times 1/4^\circ$) horizontal resolution, 50 vertical levels
- **Sea-Ice: CICE-4.0** ✓ same ocean grid, 5 sea-ice categories
- **Marine Biogeochemistry: BFM-5.1** ✓ same ocean grid
- **Cpl: CPL-7** ✓ coupling time-step: atm, land, sea ice = 0.5 hours
✓ ORCA1 (ORCA025) coupling time-step: ocn, rof = 1 hours (1.5 hrs)

Some preliminary results of the ocean state
SST bias (present climate)



CMCC Contribution to MIPs

C4MIP, DCPP, GMMIP, HighResMIP*, LS3MIP, LUMIP, OMIP, ScenarioMIP, SIM