

Progresses of Chinese Modeling Groups

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National Key Scientific and Technological Infrastructure project "Earth System Numerical Simulation Facility" (EarthLab)

EarthLab will be fully established in 2022, with a budget about 200 Million USD





CAS-FGOALS-g3 super-large ensemble simulations





110 realizations for historical + SSP5-8.5

Peak Performance : 15PetaFLOPS Storage: 30P Hard disk + 50P Tape

- CAS FGOALS3: High resolution climate system model
- CAS ESM-2: ESM with 8 component models including carbon cycle

(Courtesy to Pengfei LIN)

High resolution modeling of FGOALS-f3-H



120°F 135°F 150°F 165°F 180° 165°W 150°W 135°W 120°W 105°W



Surface Current from OBS and FGOALS-f3-H with 10km resolution for ocean and sea ice, 25km resolution for atmos. and land

Daily EKE movie from 5km resolution ocean model LICOM3.0

(Courtesy to H. Liu & P. Lin)

China Meteorology Administration (CMA): A Global-to-Regional Integrated forecast SysTem (GRIST) for Unified Weather-Climate Forecast



Weather forecast





♦ A global model developed for capturing regional details, via uniform/variable-mesh high-resolution modeling

Weather and climate models within a unified system

- Seamless prediction from days to months to decades
- Enable exploratory research of global high-resolution simulations at storm-resolving scales
- China-oriented modeling framework and infrastructure

Global Storm-Resolving modeling

Vertically-integrated qv Time: 2020-01-28 00:30:00



Vertically-integrated qv (kg/m^2)

(Courtesy to Jian LI)

Tsinghua University: CIESM

	Grid points	nest	remark	
TS045 (0.45°)	800 x 560 x 60	1	Climate modeling	
TS015 (0.15°)	2400 x 1680 x 60	3	>60% ocean mesoscale eddy resolving	
TS010 (0.1°)	3600 x 2520 x 60	~ 5	Similar to CESM TX0.1V2	
TS005 (0.05°)	7200 x 5040 x 60	9	ocean submesoscale eddy resolving	
TS003 (0.03°)	12000 × 8400 × 60	15		

New ocean model grid

C-Coupler3: a coupler based model infrastructure





A double-plume scheme unifying shallow and deep convection



A new plume model considering in-cloud inhomogeneity

Ministry of Natural Resources: FIO-ESM v3.0

An ESM coupled with ocean surface wave model

- Increase resolution: Atm with 50 km, Ocn with 25/50 km
- Replace the OGCM with FIO-COM
- Ocean: Tidal mixing, internal wave mixing

- Air-sea fluxes: Wave effect on shortwave radiation (albedo) and momentum flux (direction, magnitude)
- Ocn-Ice flux: Three-equation turbulent heat flux

Carbon Cycle (CQ ² Transport)				FIO-ESM v1	FIO-ESM v2	FIO-ESM v3	
	Atmosphere (CAM)		Deschutien	Atm	300 km	100 km	50 km
		Resolution	Ocn	100 km	100 km	25/50 km	
River Runoff (RTM)		Component	Ocn	POP 2	POP + Wave	FIO-COM	
			Ocn	 Non-breaking surface wave-induced mixing (Bv) 	 Bv SST diurnal cycle	 Bv SST diurnal cycle Tidal mixing Internal wave mixing 	
Land Surface (CLM) Carbon Cycle (CN)	Surface Waves (MASNUM)	Ocean (MASNUM) Carbon Cycle (NPZD)	Distinctive physical processes	Air- sea fluxes		 Stokes drifts (momentum and heat fluxes) Sea spray (heat flux) 	 Stokes drift Sea spray Shortwave radiation (albedo) Momentum flux (direction, magnitude)
Framewo	ork of FIO-ES	M v3.0		Ocn- ice			• Three-equation turbulent heat flux

(Courtesy to Fangli Qiao & Zhenya Song)

Suggestion for CMIP7

- High resolution and even cloud resolving modelling is needed to get a reasonable simulation of global monsoon rainfall, including extreme events
- Large ensemble is needed to detect the forced response of monsoon rainfall and the modulation of internal variability on
 - monsoon changes
- New experiments and metrics are need to combine weather and climate together.

