Progresses of Chinese Modeling Groups

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Working Group on Coupled Modeling 24th session
Remote Session 7-9 Dec. 2021
EarthLab will be fully established in 2022, with a budget about 200 Million USD.

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

**110 realizations for historical + SSP5-8.5**

(Courtesy to Pengfei LIN)
High resolution modeling of FGOALS-f3-H

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)
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

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**China Meteorology Administration (CMA):**

A Global-to-Regional Integrated forecast SysTem (GRIST) for Unified Weather-Climate Forecast

(Courtesy to Jian LI)
Tsinghua University: CIESM

New ocean model grid

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

C-Coupler3: a coupler based model infrastructure

A double-plume scheme unifying shallow and deep convection

A new plume model considering in-cloud inhomogeneity

(Courtesy to Yanluan LIN)
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

### Framework of FIO-ESM v3.0

#### Distinctive physical processes

<table>
<thead>
<tr>
<th>Component</th>
<th>FIO-ESM v1</th>
<th>FIO-ESM v2</th>
<th>FIO-ESM v3</th>
</tr>
</thead>
</table>
| **Air-sea fluxes** | Ocn | • Non-breaking surface wave-induced mixing (Bv) | • Bv | • Bv
| | | • SST diurnal cycle | • SST diurnal cycle |
| | | • Tidal mixing | • Tidal mixing |
| | | • Internal wave mixing | • Internal wave mixing |

#### Air-sea fluxes

- Stokes drifts (momentum and heat fluxes)
- Sea spray (heat flux)
- Stokes drift
- Sea spray
- Shortwave radiation (albedo)
- Momentum flux (direction, magnitude)
- Three-equation turbulent heat flux

### Resolution

<table>
<thead>
<tr>
<th></th>
<th>FIO-ESM v1</th>
<th>FIO-ESM v2</th>
<th>FIO-ESM v3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmosphere (Atm)</td>
<td>300 km</td>
<td>100 km</td>
<td>50 km</td>
</tr>
<tr>
<td>Ocean (Ocn)</td>
<td>100 km</td>
<td>100 km</td>
<td>25/50 km</td>
</tr>
</tbody>
</table>

(Courtesy to Fangli Qiao & Zhenya Song)
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.