**Introduction**

Most intense tropical cyclones (TCs) such as Categories 4 and 5 (Saffir-Simpson Hurricane Scale) undergo rapid intensification (RI). However, the physical mechanisms associated with RI and the inner-core processes have not been fully understood. The purpose of this study is to examine the impacts of ice-phase microphysics and boundary layer processes on the inner-core processes of an extremely intense TC by using two types of 2-km mesh non-hydrostatic models (NHM2).

1. **Model descriptions of 2 NHMS**

**JMANHM:** The Japan Meteorological Agency operational mesoscale model (Saito et al. 2007)

**CReSS:** Cloud Resolving Storm Simulator developed in HyARC, Nagoya University (Tsuboki and Sakakibara 2002)

2. **List of sensitivity experiments**

<table>
<thead>
<tr>
<th>Model</th>
<th>Name</th>
<th>Turbulence cloud microphysics vertical level</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGCM</td>
<td>AGCM20</td>
<td>863 79 -38</td>
</tr>
<tr>
<td>2dLK</td>
<td>MPD</td>
<td>852 77 -60</td>
</tr>
<tr>
<td>2dLK64</td>
<td>MPD</td>
<td>854 79 -75</td>
</tr>
<tr>
<td>2dCRS</td>
<td>MPD</td>
<td>852 82 -84</td>
</tr>
<tr>
<td>2dCRSDB</td>
<td>MPD</td>
<td>860 77 -85</td>
</tr>
</tbody>
</table>

All NHMS experiments underwent RI.

**3. Initial and boundary conditions**

The results of the climate experiments by a 20-km mesh atmospheric general circulation model (AGCM20).

A case of an extremely intense TC

Maximum central pressure (MCP): 863 hPa

**4. Results**

**i) Tracks and intensities**

<table>
<thead>
<tr>
<th>Model</th>
<th>MCP</th>
<th>MWS</th>
<th>MPD</th>
</tr>
</thead>
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<tr>
<td>AGCM20</td>
<td>863</td>
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</tr>
</tbody>
</table>

**ii) General characteristics**

- Time variations of MCP

**iii) RI1 stage**

- Hourly precipitation

**iv) Vertical cross-sections**

- Compact TC
- Large eye
- Small eye
- Broad TC

**v) Mature stage**

- Hourly precipitation

**vi) Hormoller diagrams for topographical experiments**

- Azimuthally averaged vertical velocity and qg (z=10km) and relative humidity at q (z=28km)

**vii) RI2 stage**

- Hours precipitation

**viii) Vertical cross-sections**

**Appendix**

**K-Vmax diagram**

**5. Summary**

- i) In all experiments by NHM2s, TCs underwent RI.
- ii) Cloud microphysics and ERC;
  - CReSS with a 1-moment microphysics: w/o ERC
  - All experiments with a 2-moment microphysics: with ERC
- iii) Favorite situations for intense RI;
  - Tall and intense updraft, an asymmetric small eyewall and shallower inflow boundary layer with intense near-surface inflow.
- iv) Cloud microphysics and the horizontal scale;
  - Gruzelier-dominated experiments (CReSSs): A compact TC with large eye.
  - Snow-dominant experiments (JMANHMs): A broad TC with small eye.

*The cloud microphysics and PBL processes are closely related to the inner-core structures and evolutions of simulated extremely intense TCs.*

Even TCs with similar MCP or MWS, the characteristics of the TCs (including the inner-core and horizontal expansions) differ among NHMS.

**Issues to be solved in the future**

- RI or not: Why can only NHM2ksms realize RI? i.e. the processes or structures for RI that only NHM2ksms can represent [AGCM20 vs NHM2ksms]
- Favorite conditions for intense RI: Relationship between RI and the inner-core structures (e.g. tall and intense updraft around the eye, an asymmetric small eyewall and shallower inflow boundary layer with intense near-surface inflow) [CReSSs vs JMANHM]

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