Observing system experiments of MTSAT-2 Rapid Scan Atmospheric Motion Vector for T-PARC 2008 using the JMA operational NWP system

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Outline

• T-PARC 2008

• Global and Meso-scale Experiments Specification

• Experimental design
  – Trial of 2-step thinning scheme

• Results of OSE

• Summary and Future plan
• Objectives
  – Research the mechanism of genesis, recurvature and extratropical transition for tropical cyclones in the northwestern Pacific.
  – Assess the effectiveness of Global Interactive Forecasting System (GIFS) for tropical cyclones.
  – Improve the performance of numerical weather prediction for tropical cyclones.
Tenth International Winds Workshop

**THORPEX Pacific Asian Regional Campaign (T-PARC 2008)**

- **International Cooperation**
  - Project by the Asian, North American and European THORPEX Regional Committees.
  - JMA contributed to the provision of forecast sensitivity analysis and special observations.

<table>
<thead>
<tr>
<th>Aircraft Dropsonde</th>
<th>Upper-Sounding By Observatories</th>
<th>Upper-Sounding By JMA Vessels</th>
<th>MTSAT-2 Rapid-scan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sep. 10 12UTC – 14 06UTC Sep. 27 12UTC – 28 00UTC</td>
<td>Sep. 27 12UTC – 28 12UTC</td>
<td>Sep. 17 12UTC – 18 12UTC</td>
</tr>
</tbody>
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| | Sep. 27 12UTC – 28 12UTC | Sep. 17 12UTC – 18 12UTC | Sep. 27 12UTC – 28 12UTC | Sep. 17 12UTC – 18 12UTC |

| MTSAT-2 Rapid-scan | Sep. 10 12UTC – 13 06UTC Sep. 27 12UTC – 28 12UTC | Sep. 27 12UTC – 28 12UTC | Sep. 27 12UTC – 28 12UTC | Sep. 27 12UTC – 28 12UTC |
## Global and Meso-scale Experiments Specification

<table>
<thead>
<tr>
<th>GSM: Hydrostatic Global Spectral Model</th>
<th>MSM: Non-hydrostatic Meso-scale Model</th>
</tr>
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<tbody>
<tr>
<td><strong>Horizontal rez./ Vertical rez.</strong></td>
<td><strong>20 km / 60 level</strong></td>
</tr>
<tr>
<td><strong>Top</strong></td>
<td><strong>0.1 hPa</strong></td>
</tr>
<tr>
<td><strong>21,800 m</strong></td>
<td><strong>21,800 m</strong></td>
</tr>
<tr>
<td><strong>Inner-loop model rez. for DA</strong></td>
<td><strong>80 km</strong></td>
</tr>
<tr>
<td><strong>15 km</strong></td>
<td><strong>15 km</strong></td>
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<tr>
<td><strong>Assimilation method</strong></td>
<td><strong>4D-Var</strong></td>
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<tr>
<td><strong>Time windows</strong></td>
<td><strong>6 hour</strong></td>
</tr>
<tr>
<td><strong>3 hour</strong></td>
<td><strong>3 hour</strong></td>
</tr>
<tr>
<td><strong>Forecasts</strong></td>
<td><strong>84 hours (00, 06, 12, 18 UTC)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>15 hours (00, 06, 12, 18 UTC)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>33 hours (03, 09, 15, 21 UTC)</strong></td>
</tr>
</tbody>
</table>

- **Target**: Tropical Cyclone (TC)
  - SINLAKU and Tropical depression (TD)
    - From 18 UTC 10/09/2008 to 06 UTC 13/09/2008
    - From 18 UTC 17/09/2008 to 12 UTC 18/09/2008
Experimental Design

- **TEST** – MTSAT-2 rapid scan AMVs are assimilated.
- **CNTL** – No MTSAT-2 rapid scan AMVs are assimilated.

### Utilization of special observations

<table>
<thead>
<tr>
<th></th>
<th>TEST</th>
<th>CNTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTSAT-2-RS-AMVs</td>
<td>○ (use)</td>
<td>×</td>
</tr>
<tr>
<td>Dropsonde and Special upper sounding (3-hourly)</td>
<td>× (no use)</td>
<td>×</td>
</tr>
<tr>
<td>TC BOGUS</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>The other observations</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Trial of 2-step thinning scheme for MTSAT-2 rapid scan AMVs

• Step 1
  – Equal-distance thinning with 200km (one AMV in 2deg. x 2deg. x 100hPa box)
  – One AMV selected per box in the 6 hour time window.

• Step 2
  – Equal-distance thinning with 100km (one AMV in 1deg. x 1deg. x 100hPa box)
    • For MTSAT-2 rapid scan AMVs (IR and WV, 4 or 7 min. intervals)
  – One AMV selected per box in the hourly time window.
  – Small observation error correlation

MTSAT-2 Rapid Scan AMVs have as almost same accuracy as MTSAT-1R.
Presented by K. Shimoji and S. HOSHINO
Example of MTSAT-1R AMVs (CNTL) after QC at 300hPa in 17-19UTC 17th September
Example of MTSAT AMVs (TEST) after QC at 300hPa in 17-19UTC

17th September

Red barb: MTSAT-2-RS-47MIN
Yellow barb: MTSAT-2-RS-15MIN
Blue barb: MTSAT-1R
Experimental results for GSM-DA
Analysis and First-guess against radiosonde observations

- **BIAS and RMAE** of wind analysis for GSM-DA using MTSAT-2 rapid scan AMVs reduced.

**Ex.**

U-comp. wind speed BIAS and RMSE, and Z500 difference from 11 to 13 Sep.
Normalized score against initial forecast (FT=0)

- Significantly positive impacts (average ~3%) on three-day GSM forecast in Japan area.

**Ex.**

Forecast Improvement Rate wrt RMSE for 1-3 day forecasts (CNTL-TEST)/CNTL from 11 to 13 Sep. in Japan area.

![Diagram showing forecast improvement over time for different variables like Psea, T850, Z500, Wsp850, and Wsp250.](image)
Mean TC Track Forecast Error

- SINLAKU track predictions were worse in the late-forecast time. But TD predictions were better.
Experimental results for MSM-DA
Initial forecasts against radiosonde observations

- RMSE above 500hPa level were reduced, where many MTSAT-2-RS-AMVs were assimilated.

Ex. RMSE and ME against Japan Radiosonde Wind speeds both 10-13 and 17-18 September 2008 (FT: Forecast time)
Equitable Threat Score against Precipitation

- There was a **improvement** of rain in one-day forecasting for precipitation **over 1-15 mm per three hours around Japan**.

**Ex.** Equitable Threat Score against Radar-Rainfall composite precipitation data in Japan both 10-13 and 17-18 September 2008 (Init. 03,09,15,21UTC : Error bar : 95% confidence interval)

- **Ex. threshold 10mm/3hour**
Mean TC Track Forecast Error

- SINLAKU track predictions were slightly better in the after-recuvature stage. Another TD predictions were better.
Summary

• OSEs for MTSAT-2 rapid scan AMVs using the global and meso-scale NWP system were conducted.
• The trial of 2-step thinning scheme for MTSAT-2 rapid scan AMVs was performed.
• This scheme contributed to the increase of AMVs in the vicinity of Japan where AMVs data was sparse heretofore.
• BIAS and RMSE of wind analysis in GSM and MSM reduced against radiosonde observations using AMVs.
• This better wind analysis brought the improvement of forecasts in GSM and MSM.
• SINLAKU track predictions were improved or neutral in GSM and MSM except the late-forecast time of GSM.
Future Plan

• We will investigate the reason why SINLAKU track predictions were worse in GSM.
• We will perform more OSEs for MTSAT Rapid Scan AMVs to validate accuracy 2-step thinning scheme.
• Considering usage of the other satellite rapid scan AMVs (METEOSAT-8 etc.)
Thank you for your attention
Back up slide
Mean TC Intensity Forecast Error (GSM)

- SINLAKU intensity predictions were worse in the beginning-forecast time in the after-recurvature stage. TD predictions were neutral.

From 11 to 13 Sep.
10 samples

From 17 to 18 Sep.
4 samples
Mean TC Intensity Forecast Error (MSM)

- Mean TC intensity predictions were almost neutral impact.
MTSAT-2 Rapid Scan AMV comparison

IR_HL for T0813 during T-PARC 2008
Case study with initial time of 18UTC 17/09/2008

Slightly improvement of slow bias speed for TC track forecasts
Case study with initial time of 18UTC 17/09/2008

- Impact of MTSAT-2-RS-AMVs in the north or north-west side on 300 – 400 hPa.
Case study with initial time of 15UTC 11/09/2008 for MSM