Application of Cumulative Probability Distribution Function to Compositing Precipitable Water with LEO

Junhyung Heo, Geunhyeok Ryu, Jaedong Jang
Korea Meteorological Administration/National Meteorological Satellite Center(KMA/NMSC)

hurbbang@korea.kr

Introduction

- Precipitable water (PW) data are retrieved from various Low Earth Orbit (LEO) satellite measurements such as NOAA-18,19, MetOp-A,B, Suomi-NPP, and so on. And forecaster want to know more dense distribution of PW from many paths of multi LEO on map (Kidder and Jones, 2007).
- When compositing PW retrieved from multi satellites, there are difference among them. Generally, the difference between Satellite retrievals is corrected by another reference data.
- In this study, we use Unified Model (UM) Regional Data Assimilation Prediction System (RDAPS) analysis data as the reference data. And we use direct reception LEO data of the National Meteorological Satellite Center (NMSC) as the observation data.
- The cumulative probability distribution function (CDF) matching method matches the CDF of the precipitable water (PW) retrieved from the LEO with the CDF of the reference PW to lessen their differences (Kidder and Jones, 2007).

Data & Method

TPW : surface-top of atmosphere
BL, ML and HL : surface to 850 hPa, 850-500 hPa, and 500 hPa-top of atmosphere

TPW = Precipitable Water

<table>
<thead>
<tr>
<th>Local</th>
<th>Metop-A</th>
<th>Metop-B</th>
<th>Suomi-NPP</th>
<th>NOAA-19</th>
<th>NPP-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>00:00</td>
<td>00:00</td>
<td>00:00</td>
<td>00:00</td>
<td>00:00</td>
</tr>
<tr>
<td>06:00</td>
<td>06:00</td>
<td>06:00</td>
<td>06:00</td>
<td>06:00</td>
<td>06:00</td>
</tr>
<tr>
<td>12:00</td>
<td>12:00</td>
<td>12:00</td>
<td>12:00</td>
<td>12:00</td>
<td>12:00</td>
</tr>
<tr>
<td>18:00</td>
<td>18:00</td>
<td>18:00</td>
<td>18:00</td>
<td>18:00</td>
<td>18:00</td>
</tr>
<tr>
<td>24:00</td>
<td>24:00</td>
<td>24:00</td>
<td>24:00</td>
<td>24:00</td>
<td>24:00</td>
</tr>
</tbody>
</table>

Fig. 1. Visiting Time of LEO to Korean Remaneter

Fig. 2. Satellite retrieved TPW data and Reference data

(a) : NOAA-18,19, MetOp-A,B,ATVDSS, : Suomi-NPP-NOVIS and ATMS, : Reference data, UM and TPW

Regression Coefficients & CDF Comparison

Data selection Condition : CDF(0bs) – CDF(Ref) < 1 (%) ------- (2)
Regression equation : Adjusted PW = a0 + a1PW + a2PW2 + a3PW3 ------- (3)

Fig. 3. CDF matching algorithm

Fig. 4. For Metop case, (a) Construct to select pairs of observed and reference TPW data and CDF of observed, reference, and regression TPW (b) Calculation of regression coefficients[2014. 4, 2009/2016, 4, 2, 2500UTC]

Results

- Suomi-NPP(2016. 8. 6. 03:00~ 8. 6, 09:00 UTC)
- NOAA-18,19(2016. 8. 6. 03:00~ 8. 6. 09:00 UTC)
- Mapping(2016. 8. 6. 03:00~ 8. 6, 09:00 UTC)

Validation

- Truth : Radio Sonde data
- Region : East Asia
- Target : LEO retrieval and Regressed PW data
- Time window : 03:00-09:00, 09:00-15:00, 15:00-21:00, and 21:00-03:00
- Period(UTC) : 2015, 6,7,8 and 2016, 6,7,8 months

Summary and Conclusion

- Using 5-day UM analysis PW data as reference data and PW data retrieved from direct reception LEO data of NMSC as observation data, the CDF matching method is operated.
- The reference data that match with observation data are time and spatial-dependent. The time windows are 03:00-09:00, 09:00-15:00, 15:00-21:00, 21:00-03:00 UTC.
- After the method, the accuracy of PW and BL retrieved from Suomi-NPP using NUCAPS is approved in RMSE. Especially, the ratios of improvement of Suomi-NPP BL is much better than the other PW retrieved from the LEO of NMSC.

This study was funded by the KMA/NMSC (Korea Meteorological Administration/National Meteorological Satellite Center’s R&D Project[NMSC-2016-3137]).