GRUAN Data Product (ver.2) for Meisei iMS-100 & RS-11G radiosondes

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Background / motivation

- Meisei iMS-100 radiosonde has been used since 2017 at JMA’s radiosonde sites including Tateno and Minamitorishima
- The TU sensor used in iMS-100 is common with RS-11G
- The validation of RS-11G-GDP.1 (Kobayashi et al., 2019) shows some issues especially in RH observation
- The improvement of processing algorithm is needed
Major changes / differences from RS-11G-GDP.1 (RH)

• Considering of the different time constant / sensor-temperature relation for absorption / desorption in time-lag correction

• Formulation of hysteresis (slow regime time-lag) effect correction

• Improvement of TUD (temperature-humidity dependency) correction with laboratory experiments and CFH observations
Major changes / differences from RS-11G-GDP.1 (iMS-100 specific)

• The wind from motion vector from GPS-based position (latitude and longitude) is adopted as the wind data instead of the wind from GPS doppler shift.

• The GPS module for iMS-100 interpolates the geoid height from the sparse (10 deg x 10 deg) grid model. In GDP processing, the geometric altitude is recalculated with the geoid height interpolated from the finer model (EGM2008, 5 min x 5 min grid model).
Major changes / differences from RS-11G-GDP.1 (other)

• The long gap over 3 minutes in temperature observation is treated as the end of reliable sounding even if the payload achieved higher level (but it rarely occurs).
Intercomparison between IMS-100-GDP and RS92-GDP.

- Weekly dual-sounding with iMS-100 and RS92 at 00 UTC (09 LT, daytime) or 12 UTC (21 LT, nighttime) at Tateno (except summer, when the payload will fall on the populated area around Tokyo)

- Since September 2017 to January 2020, 99 dual soundings (52 and 47 cases for daytime and nighttime)

- After screening quality assessment for both radiosondes, 55 (29 and 26 for daytime and nighttime) soundings are used for intercomparison
Intercomparison between IMS-100-GDP and RS92-GDP.2

• Following the method of former researches (e.g. Kobayashi et al. (2019) for RS-11G-GDP.1 and RS92-GDP.2), the ensemble mean of differences in 13 pressure layers are derived for temperature, humidity, pressure, geopotential height and wind

• Variables except wind are compared for daytime and nighttime separately and for all data.
Intercomparison between IMS-100-GDP and RS92-GDP.2 (T, U)

- IMS-100-GDP is about 0.5 K lower than RS92-GDP.2 in stratosphere in daytime
- IMS-100-GDP is about 1.8 %RH higher than RS92-GDP.2 below 200 hPa level and about 1.0 %RH lower above 30 hPa level
Intercomparison between IMS-100-GDP and RS92-GDP.2 (P, H)

- Pressure of IMS-100-GDP is 0.4 hPa lower than RS92-GDP.2 in lower troposphere
- Geopotential height of IMS-100-GDP get larger above 100 hPa level
Pressure difference of RS92-GDP.2 at surface

The surface pressure of RS92-GDP.2 tends to be slightly larger (median = 0.35 hPa) than surface pressure measured by barometer. This difference may cause the pressure bias between IMS-100-GDP and RS92-GDP.2 in lower troposphere.
The geoid height around Tateno vary greatly depending on model.
If the radiosonde launched from Tateno take the typical track, it will pass through the region where the correction of geoid height is very large.
Intercomparison between IMS-100-GDP and RS92-GDP.2 (wind)

Wind comparison parameters for each layer

- Bias of wind speed became larger at higher level
- RMSVD (Root mean square of vector difference) is about 3 m/s under 15 hPa level
- Difference of wind direction became larger in stratosphere, because of weak wind speed
Comparison with reference sensor

Quad-sounding (RS41, iMS-100, CFH and Meisei SKYDEW) is conducted on 21 October 2020.
Comparison with Meisei SKYDEW

- In this case, the data of CFH is unstable above ~15 km height and below ~2 km.
- iMS-100 is slightly wetter than SKYDEW and RS41 in UTLS (but almost in agreement with RS41; 
\[ \Delta U < \sqrt{u_{41}^2(U) + u_{ims}^2(U)} \]
Comparison with Meisei SKYDEW

- In this case, new algorithm improve the dry bias in the lower troposphere
- In the layer around tropopause, the new algorithm shows wet bias.

<table>
<thead>
<tr>
<th>[%RH]</th>
<th>BIAS</th>
<th>RMSE</th>
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<tbody>
<tr>
<td>Sonde</td>
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<td>New</td>
</tr>
<tr>
<td>IMS-100</td>
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<td>1.4</td>
</tr>
<tr>
<td>RS-11G</td>
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<td>-0.7</td>
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<tr>
<td>RS41</td>
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Summary

• Temperature: IMS-100-GDP is about 0.5 K lower than RS92-GDP.2 in stratosphere in daytime
• RH: IMS-100-GDP is about 1.8 %RH higher than RS92-GDP.2 below 200 hPa level and about 1.0 %RH lower above 30 hPa level
• RH: The bias and RMSE of IMS-100-GDP to SKYDEW is about +1.4 %RH and 2.3 %RH
• Pressure: IMS-100-GDP is about 0.3 hPa lower than RS92-GDP.2 in lower troposphere and 0.1 hPa lower for almost whole profile
Summary

• Geopotential height: the difference below 100 hPa level is small, but became larger (exceeds ~10 m) above 50 hPa level. This difference seems to be caused by estimated geoid height.

• Wind: the bias of wind speed became larger at higher level and RMSVD is about 3 m/s below 15 hPa level.
Future issues

• Revised version of TD is preparing and call for comments for the draft
• Intercomparison between GDP for iMS-100 and RS92-GDP.2 is will be submitted in near future
• Validation of the new version of GDP for RS-11G will be submitted
• Intercomparison between iMS-100 and RS41-SG at Tateno has started in July 2020. The result will be summarized in 2021 or later.
Thank you for your attention!