Dealing With The Influence Of Differences In Measurement Time, Space and Addressed Air Volume Of Satellite and Reference Measurements On Validation Results: Development And Presentation Of An Internet-Based Tool

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Mismatch error & its quantification

Mistime and misdistance (= mismatch) → natural variability to leads to differences between two measurements which must not be interpreted in terms of instrument’s failure

Goal: Quantification of expected differences between measurements (mainly due to atmospheric dynamics)

- Use of ERA-40, TIMED-SABER & radiosonde based temperature data

- Mean difference (estimated value for bias)

- Standard deviation (estimated value for precision)

\[
\Delta T_{\text{mean}} = \frac{1}{n} \sum_{i=1}^{n} \Delta T_i
\]

\[
\Delta T_{\text{std}} = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (\Delta T_i - \Delta T_{\text{mean}})^2}
\]
\( \Delta T_{\text{mean}} \) and \( \Delta T_{\text{stdd}} \) for the Environmental Station Schneefernerhaus (UFS), 47.5°N, 10°E, Germany

ECMWF temperature data
720 pairs

Below 35 km: \( \Delta T_{\text{mean}} \) mainly attributed to the horizontal temperature gradient

Above 35 km also the temporal mismatch has an effect on \( \Delta T_{\text{mean}} \) and particularly on \( \Delta T_{\text{stdd}} \)

Wendt et al., 2013, JASTP
Root-mean square difference combines mean value & standard deviation

\[ \Delta T_{rms} = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \Delta T_i^2} \]

\[ \Delta T_{rms}^2 = \Delta T_{mean}^2 + \Delta T_{stdd}^2 \]

338 km misdistance at UFS (10.98°E, 47.42°N)

Quiet layers

Influence of planetary waves and tides (on these scales)

Wendt et al., 2013, JASTP
Mismatch in meridional direction leads to higher values

Monthly mean values of $\Delta T_{\text{rms}}$ at the station Schneefernerhaus, UFS, for January based on ERA-40:

Values are averaged over altitudes from 8 to 65 km and the years 1979–2002
Comparison of $\Delta T_{\text{rms}}$ for different data

SABER and ERA

Monthly mean value of $\Delta T_{\text{rms}}$ for February 2002 on basis of SABER (left) and ERA-40 (right). The regarded misdistance is about 400 km in average.

Wendt et al., 2013, JASTP
Comparison of $\Delta T_{\text{rms}}$ for different data

*Radio sondes and ERA*

$\Delta T_{\text{rms}}$ for an increasing temporal mismatch on basis of ERA-40 and SIGMA-1 data at the observatory Hohenpeißenberg (47.80°N, 11.07°E).

SIGMA-1 radiosonde measurements from November 2009 are compared to ECMWF data averaged from November 1978–2001.

Wendt et al., 2013, JASTP
Internet tool

http://wdc.dlr.de/ufsdaz/ufsdaz_neu/mismatch-tool.php
Observational filter: SABER’s viewing geometry

- TIMED is a polar-orbiting satellite, ascending – descending branch
- SABER averages over his FoV → observational filter (of special importance for small-scale processes such as gravity waves)
Observational filter: SABER’s viewing geometry

- Orientation of SABER’s FoV meridionally symmetric for asc. & desc. mode

- Max. difference (in orientation) between FoV\textsubscript{asc.} & FoV\textsubscript{desc.}: 90°
  - ~80°N and ~40°S (Northern Yaw Cycle)
  - ~40°N and ~80°S (Southern Yaw Cycle)

IF the angle between FoV\textsubscript{asc.} & FoV\textsubscript{desc} is ~90° AND the waves show a preferred orientation, GW activity in asc. & desc. branch should also differ (→ averaging along / across wave fronts)
Ratio of gravity wave activity (asc. vs. desc. mode)

- Significant differences between GW activity asc. & GW activity desc.
- ~80°N:
- Result supports our hodograph analysis
Summary and future plans

• Quantification of statistical differences between the measurement which is validated and the validation measurement
  o Below 35 km: $\Delta T_{\text{mean}}$ mainly attributed to the horizontal temperature gradient
  o Above 35 km also the temporal mismatch has an effect on $\Delta T_{\text{mean}}$ and particularly on $\Delta T_{\text{std}}$
  o Mismatch in meridional direction leads to higher values
  o Seasonal variation & quiet layers

→ Optimized planning of validation activities with regard to natural variability
  o Quiet layers $\rightarrow$ natural variability reduced (referring to temperature)
  o Choice of validating stations
  o According to expected natural variability, choice of maximal acceptable misdistance

• Additional information about atmospheric wave orientation available through observation of observational filter effect

• Future plans: Update of validation tool based on ERA-5, ADM-Aeolus (sufficient number of data assumed)