Assimilation of ATMS data at DWD

1. Introduction

There are several differences between ATMS and the predecessor AMSU-A (see table 1):
- The horizontal coverage of ATMS is better, due to the bigger maximum scan angle. For this reason it is important to use scan angle dependent observers for the assimilation of ATMS data (see boxes 2 + 3).
- The horizontal resolution of ATMS is better at the cost of a smaller measurement accuracy. In order to assimilate ATMS with a weight similar to AMSU-A superobbed ATMS data is assimilated. At DWD we use a simple 3x3 superobbing (see Fig.1). The use of superobbed data allows to introduce new QC criteria (see box 4).

2. Scan angle dependent observers

Motivation:
ATMS swaths are much wider than AMSU-A swaths. The larger scan angles and zenith angles at the edges of the swath cause several problems:
- Strongly nonlinear dependency of geolocation on scan angle
- Geolocation error
- Strongly nonlinear dependency of path through atmosphere on scan angle
- Forward model error
- Probably larger instrument error
- Larger FOVs/superobbing areas

QC problems (see Fig. 4. Superobbing QC criteria)

Scan angle dependent observers might be important for ATMS

Method:

Results:

3. ATMS impact experiments

In a first experiment the ATMS obserrors were inflated. A second experiment with scan angle dependent ATMS obserrors was assimilated. At DWD we use a simple 3x3 superobbing (see Fig.1). The use of superobbed data allows to introduce new QC criteria (see box 4).

4. Superobbing QC criteria

Motivation/idea:
- As a byproduct of superobbing it is possible to derive information about the horizontal homogeneity of the observed scenes. Inhomogeneities within the superobbed observations might be caused by observations that are disturbed by clouds or surface influences. Thus, it might be recommended not to use the superobbed observations that were calculated from inhomogeneous observations.
- For technical reasons in the DWD system the superobbing is performed on observations before undergoing a cloud check. The subsequent cloud check using the superobbed data might fail at the edges of clouds, where clear and cloudy observations are mixed. Particularly, for such systems it might be important to flag strongly inhomogeneous scenes as they may be caused by cloud affected observations.

Implementation:
Let \( y = \sum_{i=1}^{n} \gamma_i \), where the \( \gamma_i \) are the individual observations. Implementing a threshold criterion requires a measure for the inhomogeneity. Possible candidates are:

\[
\text{stddev}(\gamma) = \sqrt{\sum_{i=1}^{n} (\gamma_i - \bar{\gamma})^2} > C_1 \text{ or } \text{mean}(\gamma) - \text{median}(\gamma) > C_2
\]

However, since the inhomogeneity varies strongly with the size of the area covered by the superobbed FOVs, and since the size of this area strongly depends on the scan angle (see Fig. 6), the threshold values \( C_1 \) and \( C_2 \) should also be functions of the scan angle. We propose the following expression:

\[
C_{i,j} = \{\text{stddev}(\gamma_i) + 0.5\beta \times (\text{mean}(\gamma_i) - \text{median}(\gamma_i)) \}
\]

For stratophanic channels and surface sensitive channels a more sophisticated approach for \( C_1,j \) might be required. However, as explained above (see Motivation/idea) the idea is to screen out cloud-affected areas and/areas with inhomogeneous surface. Thus, it is sufficient to apply the criterion to a selected strongly cloud sensitive channel, e.g. a window channel.

Results:
Figure 7a shows stddev(\( \gamma_i \)) (with (1)). The agreement is good for the stratophanic channels (e.g. Figs. 7 and 8). For the surface sensitive channels the inhomogeneously close to nadir is larger than the value given by \( C_{i,j} \), since the surface influence is increasing close to nadir. In the stratophanic most spatial variability is on scales larger than the superobbed areas. Therefore, the curve is much flatter for stratophanic channels.

5. Conclusions/Outlook

- For the assimilation of ATMS it is important to take into account the scan angle dependency of the observers.
- A QC criterion is proposed, that is based on superobbing. Inhomogeneous areas (affected by clouds or inhomogeneous surfaces) are screened out by this criterion.
- Instead of using the inhomogeneity within the superobbed FOVs as a QC criterion, it might be used alternatively as part of the observer model.

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