Evaluation of available data sets of stratospheric water vapor from ground based microwave radiometers

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1. Introduction

The Network for the Detection of Atmospheric Composition Change, NDACC, contains a variety of in situ and remote sensing instruments distributed over the whole world that measure the concentration of numerous constituents of the atmosphere. In this study we evaluate the available datasets of middle atmospheric water vapor observed by ground based microwave radiometers.

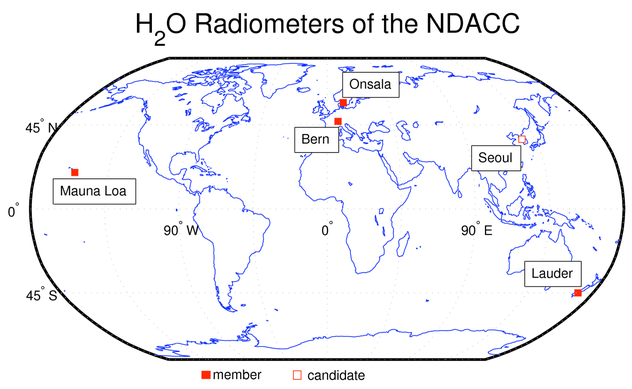
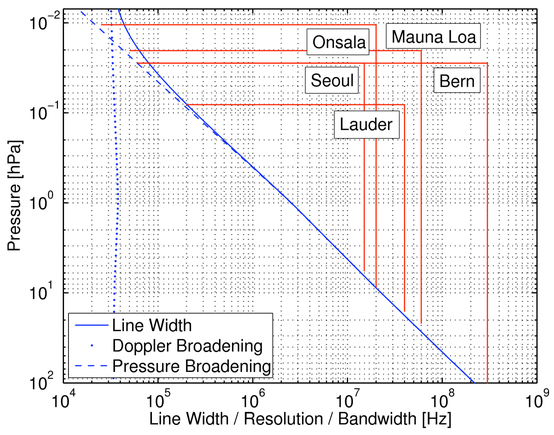


Figure 1: Location of the five water vapor radiometers of NDACC.

2. Instruments



- The spectrometer types:

  - Mauna Loa and Lauder: Filterbank
  - Bern: Acousto optical and digital FFT
  - Seoul: Digital FFT
  - Onsala: Autocorrelator

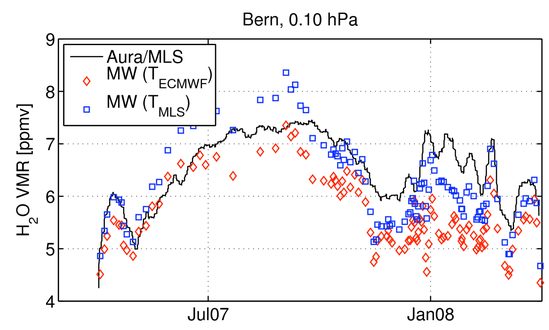
- Profile sampling:

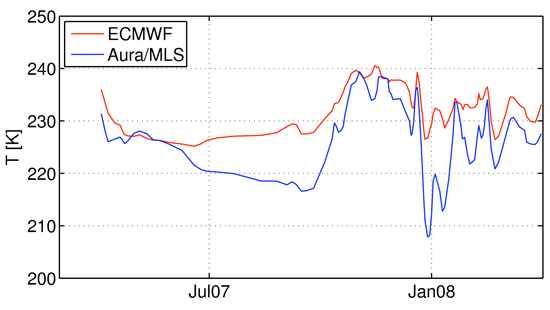
  - Mauna Loa and Lauder: Weekly
  - Bern and Seoul: Variable (hours to weeks)
  - Onsala: Daily

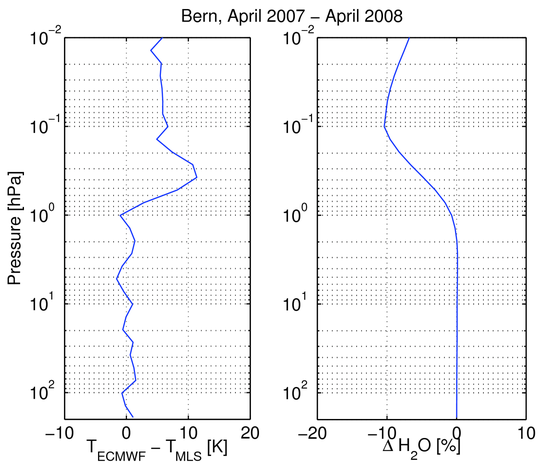
Figure 2: The spectral resolution and bandwidth of the five radiometer systems in the context of the line width. Beside the spectral properties the signal-to-noise ratio and the baseline characteristics further limit the accessible altitude range.

3. Temperature profile

- The temperature profile is important for the retrieval of upper stratospheric and lower mesospheric water vapor. The bottom Figure shows the difference between ECMWF and Aura/MLS temperatures and the corresponding difference in retrieved water vapor for Bern.



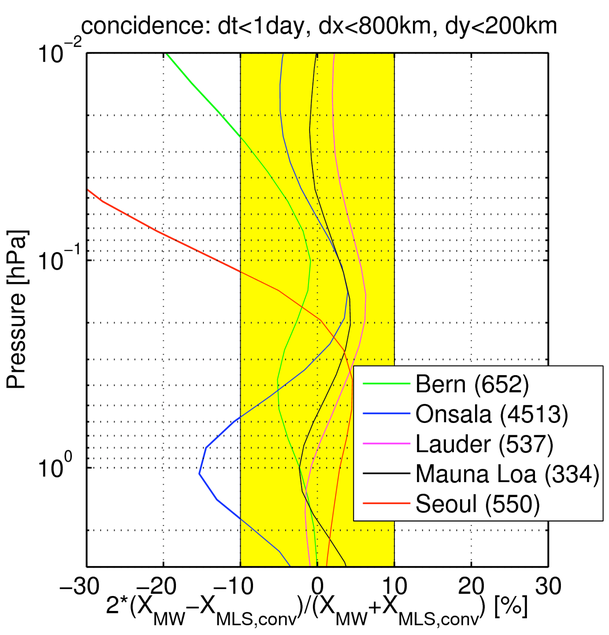




- The use of the MLS temperature data set leads to a better representation of the secondary wintertime maximum.

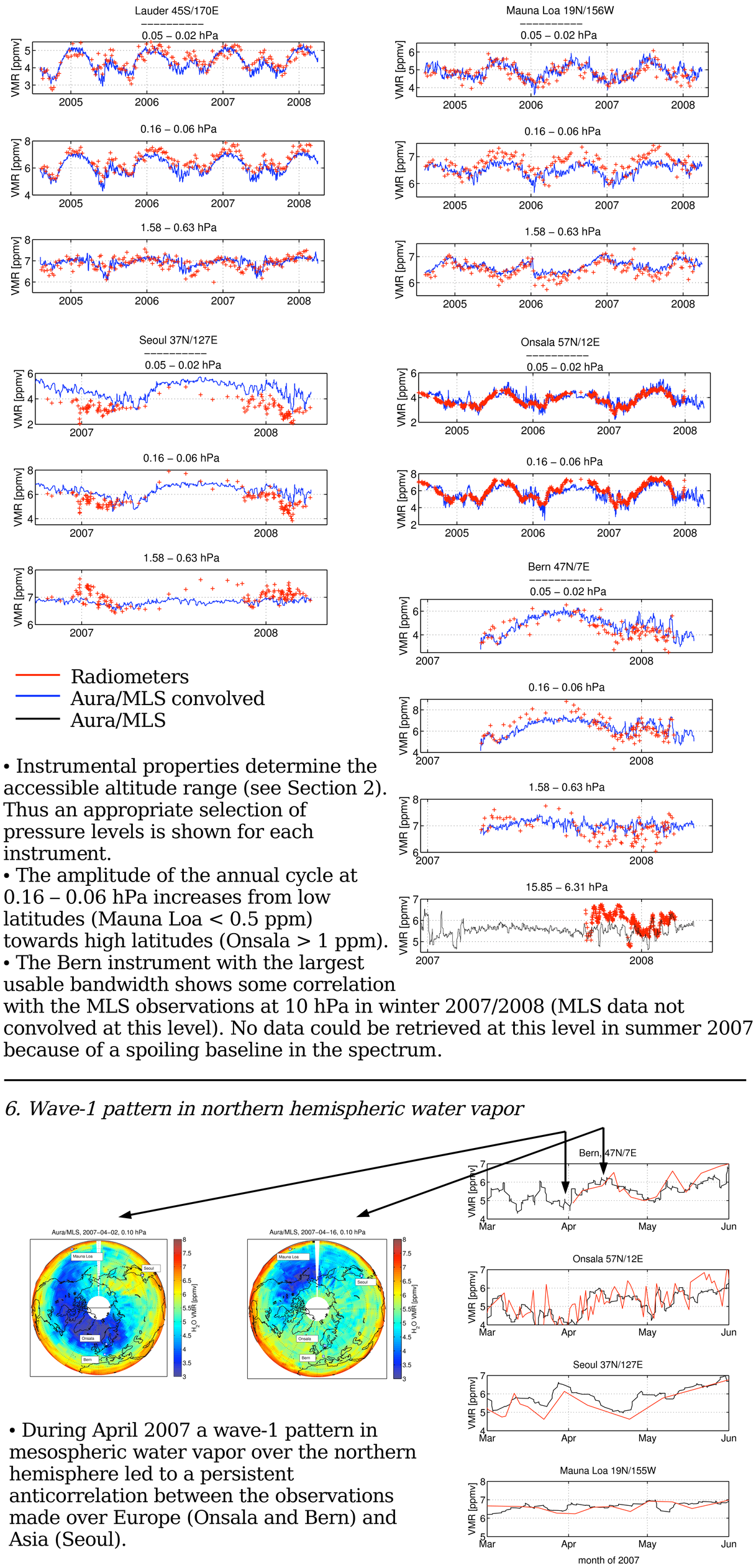
- In this study a common a priori profile and the Aura/MLS temperature data set have been used in the retrievals of all radiometer systems.

4. Difference Profiles



- For the comparison the Aura/MLS water vapor measurements have been convolved with the averaging kernels of the radiometer systems in order to account for the different vertical resolution and for sensitivity issues.
- The low bias of the Seoul instrument at the upper levels is not well understood.
- The bump in the Onsala profile at 1 hPa must be related to the choice of the a priori profile and the background temperature set. It does not appear in the standard retrieval of the Onsala system.

5. Time series



- Instrumental properties determine the accessible altitude range (see Section 2). Thus an appropriate selection of pressure levels is shown for each instrument.
- The amplitude of the annual cycle at 0.16 – 0.06 hPa increases from low latitudes (Mauna Loa < 0.5 ppm) towards high latitudes (Onsala > 1 ppm).
- The Bern instrument with the largest usable bandwidth shows some correlation with the MLS observations at 10 hPa in winter 2007/2008 (MLS data not convolved at this level). No data could be retrieved at this level in summer 2007 because of a spoiling baseline in the spectrum.

6. Wave-1 pattern in northern hemispheric water vapor

- During April 2007 a wave-1 pattern in mesospheric water vapor over the northern hemisphere led to a persistent anticorrelation between the observations made over Europe (Onsala and Bern) and Asia (Seoul).

7. Conclusions

- Generally the ground based radiometer systems perform best in the lower mesosphere and upper stratosphere.
- The background temperature profile is crucial at these levels and for the comparison MLS temperatures have been used in all retrievals.
- Access to the mid- and lower stratosphere is difficult and requires an excellent suppression and characterization of the baseline.

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