A Comprehensive Data Set of the State of the Atmosphere Around the Geodetic Observatory Wettzell During the CONT17 Campaign

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Abstract During the last continuous VLBI campaign CONT17, a comprehensive data set reflecting the atmospheric conditions around the Geodetic Observatory Wettzell was created. The recorded atmospheric parameters comprised the meteorological quantities taken from the local meteo station close to the surface, temperatures up to 1,000 m above the surface from a temperature profiler, total vapor and liquid water content from a water vapor radiometer, and cloud coverage and temperatures from a nubiscope. Vertical profiles of pressure, temperature, and humidity from radiosonde ascents and numerical weather models complement the data set. The graphical representation and comparison show a good correlation in general, but also some disagreements at special weather situations. The accuracy as well as the temporal and spatial resolutions of the individual data sets are very different and represent a sound basis for further investigations. The data set is available online at https://doi.pangaea.de/10.1594/PANGAEA.895518.

Keywords VLBI, CONT17, Geodetic Observatory Wettzell, atmosphere

1 Introduction

Continuous VLBI observations are designed to obtain highly accurate VLBI data for detailed studies of high frequency Earth rotation variations, reference frame stability, and daily to sub-daily site motions. The last campaign, CONT17 [IVS 2017], covered a time span of 15 days between November 28 and December 12, 2017. During this time span, a comprehensive data set of atmospheric observations and weather model data were acquired at the Geodetic Observatory Wettzell, where three radio telescopes contributed to three different networks, which were established for this campaign. The data set is available to all the interested users in order to provide an optimal data base for the analysis and interpretation of the CONT17 VLBI data. In addition, it is a good data set for the validation and comparison of tropospheric parameters resulting from different space techniques with regard to the establishment of a common atmosphere at co-location sites.

2 Data Base

During the CONT17 campaign, all atmospheric sensors deployed at Wettzell yielded continuous time series, in particular:

- local meteo station (surface pressure, temperature, humidity, wind, and rain),
- temperature profiler (radiometric temperatures up to 1,000 m above surface),
- water vapor radiometer (integral water vapor and liquid water content),
- nubiscope (cloud distribution, temperature, and height of cloud base).

In addition, radiosonde balloons were launched twice per day at 8:00 and 14:00 UTC during the entire campaign providing pressure, temperature, humidity, and wind data up to 26 km in height. The average height reached was 19 km. The data set is augmented by

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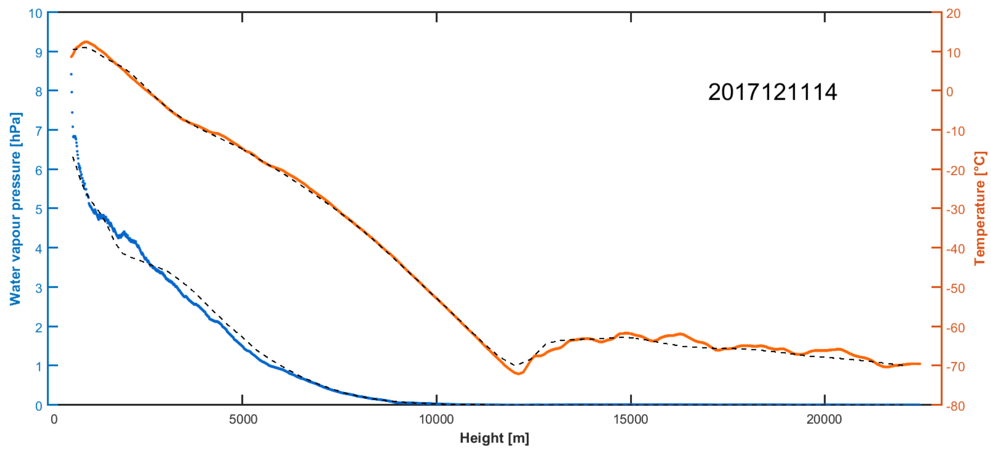

Fig. 1 Temperature (red) and water vapor pressure (blue) vs. height profiles of one particular radiosonde ascent as compared to the weather model profile at the launch location (dotted line).

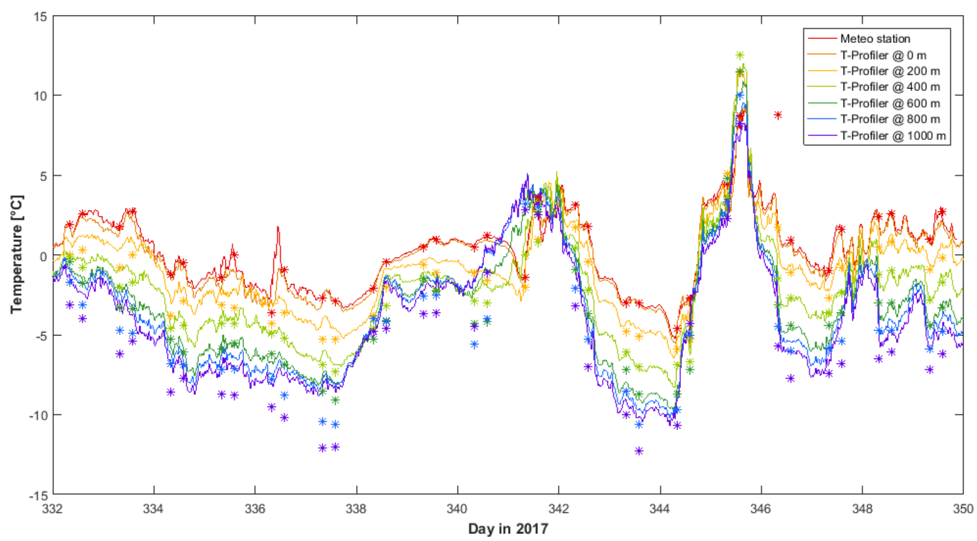

Fig. 2 Temperature profiler time series at particular heights compared to temperature record of meteo station and radiosonde data at equivalent heights (asterisks).

an excerpt of data from two different weather models. This comprises surface fluxes from the NCEP (National Center for Environmental Prediction), a global numerical weather model being interpolated to the location of Wettzell, and a set of 3-dimensional atmospheric state parameters from the ICON-EU model (ICOsahedral Nonhydrostatic model of EUrope) covering a 4-degree radius around Wettzell and a height of 22.5 km. This paper presents examples of some time series. A detailed description of the entire data set and the analysis procedure is given in [Klügel et al. 2018].

3 Results

All measurements plus the weather model data were compiled to obtain optimal information of the state of the atmosphere and to cross-check results from different sensors and models. The graphical representation and comparison show a good correlation in general, but it also shows some disagreements in special weather situations.

The vertical profiles recorded by the radiosondes are almost in good agreement to the ICON-EU model data at the Wettzell location. Some small scale perturbations in the radiosonde data are not present in the model; however, the trend is always in accord. In the example shown in Figure 1, even the inversion close to the ground is indicated by the model, although in a less pronounced form.

Figure 2 depicts the traces of the temperature profiler at six different height levels and the ground temperature of the meteo station compared to temperatures measured by the radiosondes in the equivalent height. The profiler measures the blackbody thermal radiation of the atmosphere at a frequency of 56.6 GHz at varying elevations and computes the temperatures at different levels up to 1,000 m height in 50 m steps. While a good agreement is given at heights up to 400 m, the profiler systematically yields higher temperatures at higher levels; however, it provides a continuous record and helps identifying short-term features. As an example, the beginning and the end of the temperature inversions on days 341 and 354 can precisely be determined using the T-profiler. Figure 3 shows the time vs. height plot of the profiler records.

Data of the atmospheric water vapor content stem from radiosonde measurements and the water vapor radiometer (WVR). While the latter yields only the integral water vapor content given in the height of the eqivalent water column, the radiosondes provide the vertical distribution of water vapor; however, it is in a poor temporal resolution. Thus, the radiosonde humidity measurements were converted to a specific humidity and then integrated level-by-level up to the maximum height of the radiosonde ascent. Specific humidities from the ICON-EU model were treated in a similar way up to the upper model boundary. The comparison of the resulting integrated water vapor is shown in Figure 4. The overall agreement is good; however, the WVR produces outliers during periods of rain, which is a known issue due to droplets resting on the radiometer window. In general, the weather model slightly underestimates and the WVR slightly overestimates the water vapor content as measured by the radiosonde.

4 Conclusions

While the accuracy as well as the temporal and spatial resolutions of the individual data sets are very different, the data as a whole comprehensively characterizes the atmospheric conditions around Wettzell during the CONT17 campaign and represents a sound basis for further investigations. The complete data set is available online at https://doi.pangaea.de/10.1594/PANGAEA.895518

References

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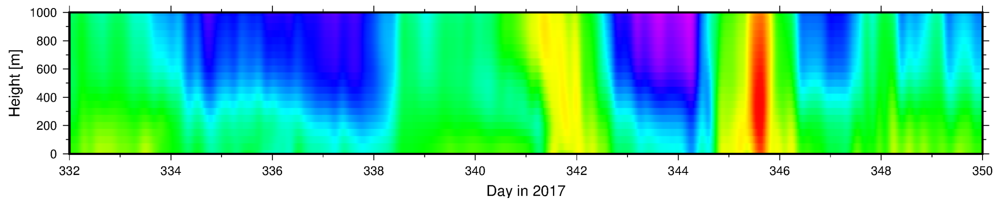

Fig. 3 Time vs. height plot of the temperature profiler records. The temperatures range from +12°C (red) to −10°C (violet).

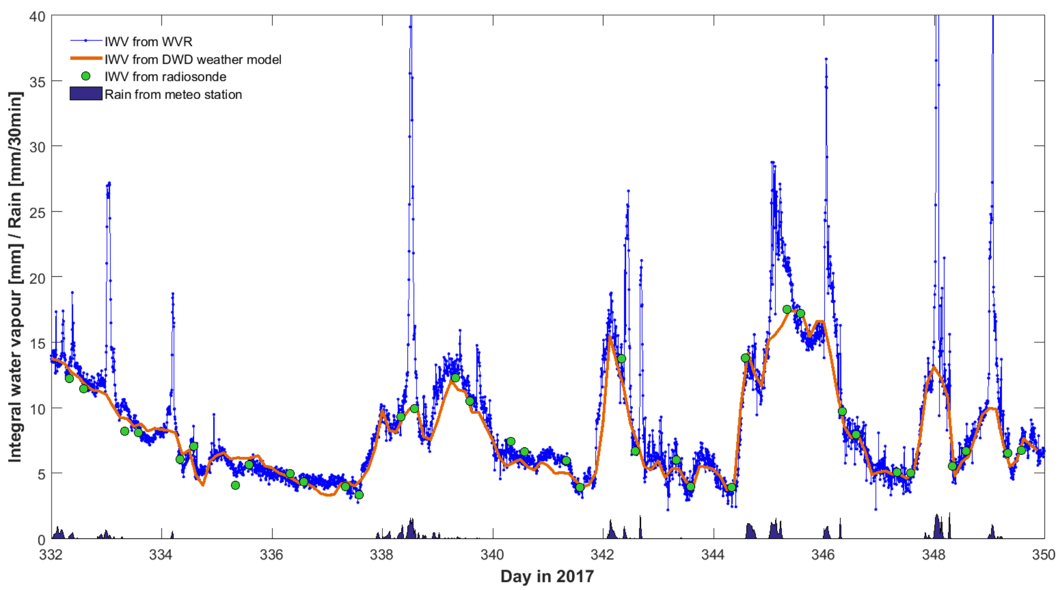

Fig. 4 Integrated water vapor (IWV) content as measured by the water vapor radiometer (WVR) compared to IWV values derived from weather model and radiosonde data. WVR spikes coincide with periods of rain.