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DOE/SC-ARM/TR-122

G-Band Vapor Radiometer Precipitable Water Vapor (GVRPWV) Value-Added Product

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1.0 Introduction

The G-Band Vapor Radiometer Precipitable Water Vapor (GVRPWV) value-added product (VAP) computes precipitable water vapor using neural network techniques from data measured by the GVR. The GVR reports time-series measurements of brightness temperatures for four channels located at 183.3 ± 1, 3, 7, and 14 GHz.

2.0 Algorithm and Methodology

2.1 Retrieval Algorithm

The retrieval uses a neural network algorithm to derive precipitable water vapor and liquid water path from radiometric brightness temperatures. The neural network is trained with a climatology of modeled brightness temperatures. The brightness temperatures are modeled with the radiative transfer code MonoRTM. The code uses the latest spectral lines and water vapor continuum parameters and the dielectric model of Liebe93. For more details on the retrieval algorithm please refer to Cadeddu et al. 2009.

2.2 Estimation of Retrieval Uncertainties

Three sources of uncertainty are addressed in the algorithm: The target noise, the covariance matrix of the network, and the uncertainty due to measurement noise. A detailed explanation of the retrieval noise is given in Cadeddu et al. 2009.

3.0 Input Data

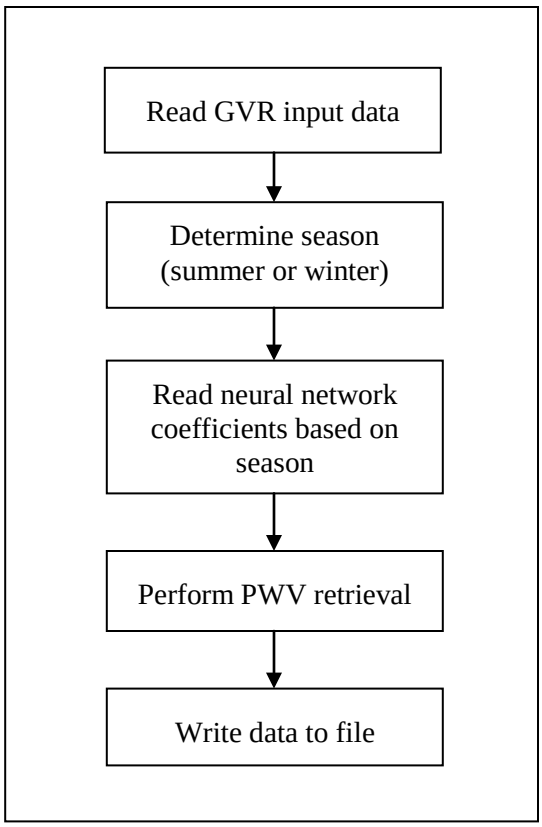
The primary inputs to the GVRPWV VAP are tbsky1, tbysky3, tbsky7 and tbsky14, which are read from the GVR datastream.

Here are the descriptions of the input fields used by GVRPWV:

```
float tbsky1(time) ;
    tbsky1:long_name = "183.3 +/- 1 GHz sky brightness temperature" ;
    tbsky1:units = "K" ;
    tbsky1:valid_min = 3.f ;
    tbsky1:valid_max = 310.f ;
    tbsky1:missing_value = -9999.f ;
float tbsky3(time) ;
    tbsky3:long_name = "183.3 +/- 3 GHz sky brightness temperature" ;
    tbsky3:units = "K" ;
    tbsky3:valid_min = 3.f ;
    tbsky3:valid_max = 310.f ;
    tbsky3:missing_value = -9999.f ;
```

float tbsky7(time) ;
    tbsky7:long_name = "183.3 +/- 7 GHz sky brightness temperature" ;
    tbsky7:units = “K”;
    tbsky7:valid_min = 3.f ;
    tbsky7:valid_max = 310.f ;
    tbsky7:missing_value = -9999.f ;
float tbsky14(time) ;
    tbsky14:long_name = "183.3 +/- 14 GHz sky brightness temperature" ;
    tbsky14:units = "K" ;
    tbsky14:valid_min = 3.f ;
    tbsky14:valid_max = 310.f ;
    tbsky14:missing_value = -9999.f ;

3.1 Flowchart



4.0 Output Data

The GVRPWV VAP generates the gvr.c1 datastream. This datastream contains all of the input fields from gvr.b1 data, plus these new fields:

float pwv(time) ;
pwv:long_name = "Precipitable water vapor retrieved using a Neural Network algorithm" ;
pwv:units = "mm" ;
pwv:valid_min = 0.f ;
pwv:missing_value = -9999.f ;
int qc_pwv(time) ;
qc_pwv:long_name = "Quality check results on field: Precipitable water vapor retrieved using a Neural Network algorithm" ;
qc_pwv:units = "unitless" ;
qc_pwv:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_pwv:bit_1_description = "Value not computed because 183.3 +/- 1 GHz sky brightness temperature is not valid, data value set to -9999 in output file." ;
qc_pwv:bit_1_assessment = "Bad" ;
qc_pwv:bit_2_description = "Value is less than the valid_min." ;
qc_pwv:bit_2_assessment = "Bad" ;
float pwv_error(time) ;
pwv_error:long_name = "Estimated 1-sigma uncertainty in precipitable water vapor retrieval" ;
pwv_error:units = "mm" ;
pwv_error:valid_min = 0.f ;
pwv_error:missing_value = -9999.f ;
int qc_pwv_error(time) ;
qc_pwv_error:long_name = "Quality check results on field: Estimated 1-sigma uncertainty in precipitable water vapor retrieval" ;
qc_pwv_error:units = "unitless" ;
qc_pwv_error:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data.";
qc_pwv_error:bit_1_description = "Value not computed because 183.3 +/- 1 GHz sky brightness temperature is not valid, data value set to -9999 in output file." ;
qc_pwv_error:bit_1_assessment = "Bad" ;
qc_pwv_error:bit_2_description = "Value is less than the valid_min." ;
qc_pwv_error:bit_2_assessment = "Bad" ;

5.0 Summary

The GVRPWV VAP provides precipitable water vapor data derived from the GVR measurements. These data are generated approximately one day after the initial GVR measurements are taken.

5.1 Example Plots

Figure 1 shows an example of PWV retrieval with associated uncertainties.

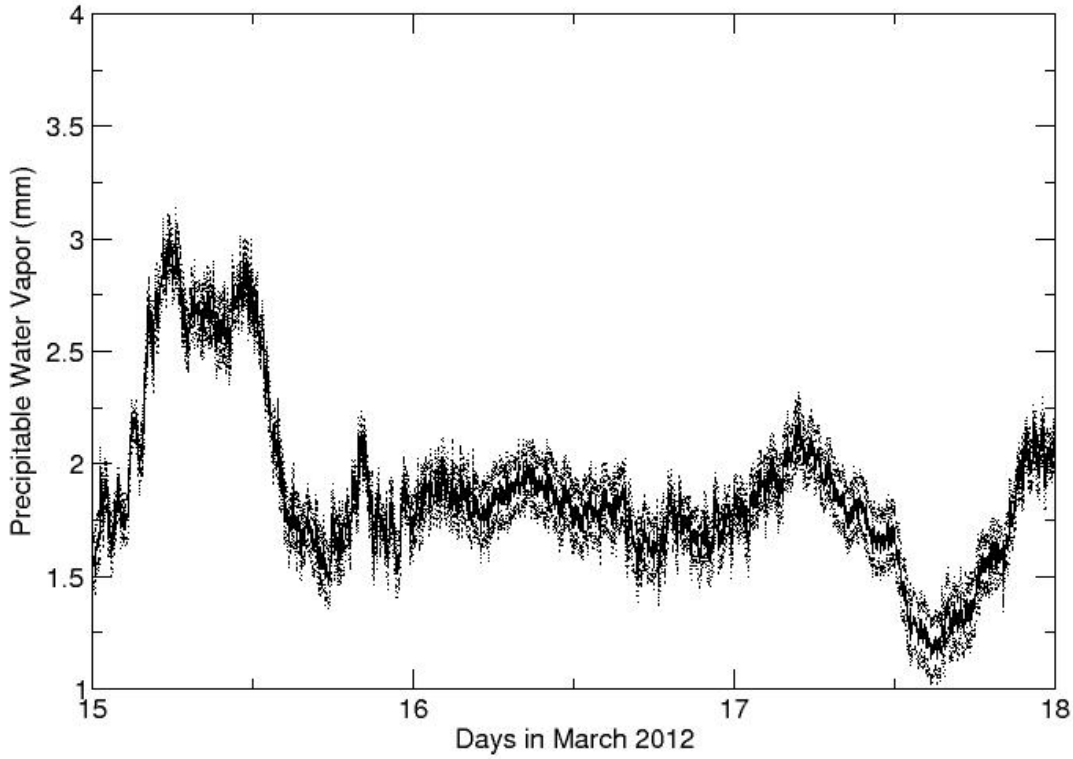


Figure 1. Precipitable water vapor retrieved from GVR data in March 2012. Dotted lines show the retrieval uncertainty (1 standard deviation).

6.0 References

Cadeddu, MP, DD Turner, and JC Liljegren. 2009. "A neural network for real-time retrievals of PWV and LWP from arctic millimeter-wave ground-based observations." *IEEE Transactions on Geoscience and Remote Sensing* 47(7): 1887–1900.

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