

# Determining the Water Vapor overburden for SOFIA observations from in situ measurements and satellite data

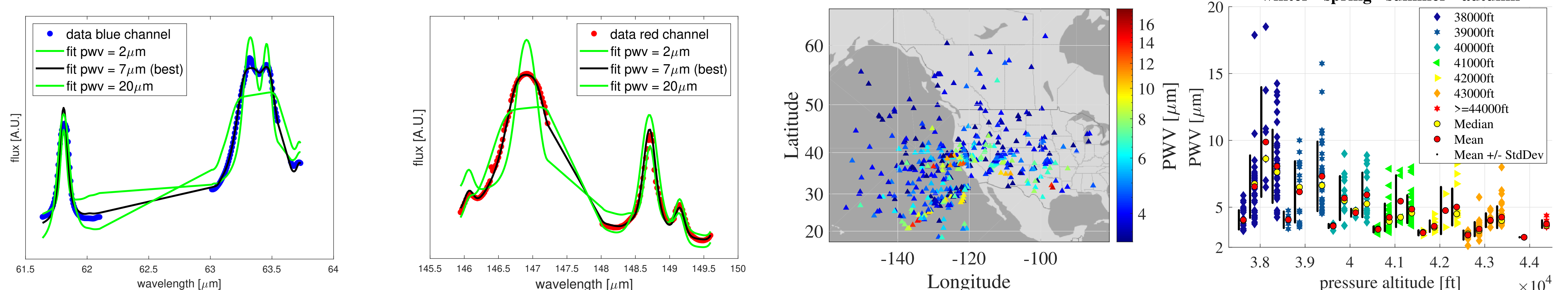
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## Abstract

Knowledge of the current atmospheric transmission is essential to achieve good calibration for airborne observations, particularly for spectroscopic observations at certain wavelengths. To determine the total upward precipitable water vapor, PWV, in the line of sight of SOFIA we use FIFI-LS (Fischer et al. 2018). About 10 PWV measurements were carried out on each SOFIA/FIFI-LS flight (Fischer et al. 2021). While the quality of the results is excellent, more data points per flights are highly desirable since the PWV value can change on the time scale of a few minutes. Therefore the derived FIFI-LS PWV values are compared to atmospheric model data from the European Centre for Medium-Range Weather Forecasts, ECMWF, revealing a simple linear correlation (Iserlohe et al., 2021 and 2022). The ECMWF model data deviates on all of SOFIA's flight altitudes by less than 10%. This does provide high accuracy PWV values for the correction of all FIFI-LS data taken with SOFIA including data taken before PWV measurements were started in 2018.

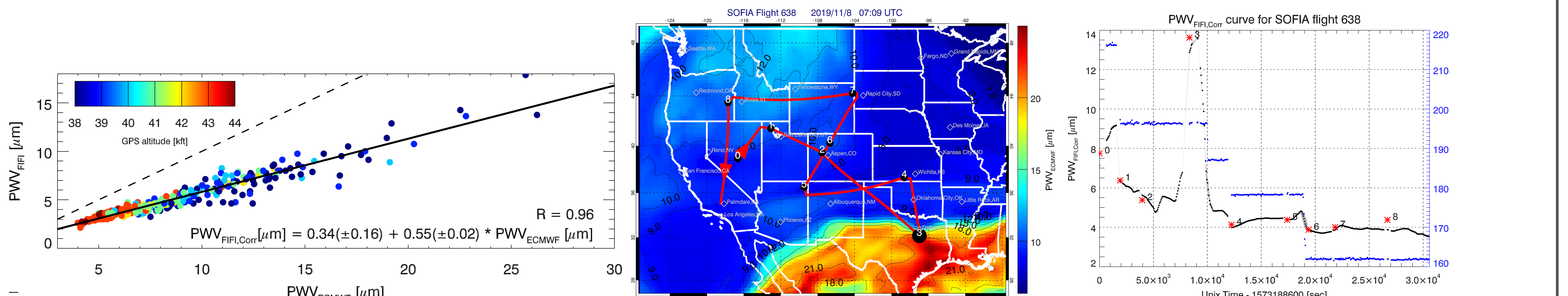
## in-situ measurements



Example of an emission model fit: *Left panel:* The measured data (blue) in the blue channel overlaid with the best fit (black) as well the fits for 2  $\mu\text{m}$  and 20  $\mu\text{m}$  (green) *Right panel:* The same for the red channel.

*Left panel:* All FIFI-LS measured values plotted over a map at the position they have been taken. *Right panel:* All measured values plotted separated into the 4 meteorological seasons as well as pressure altitudes.

## Determination from satellite data



Correlation of the  $\text{PWV}_{\text{FIFI}}$  with  $\text{PWV}_{\text{ECMWF}}$  for all 350 FIFI-LS PWV measurements. Color indicates the GPS altitudes. The black dashed line indicates a 1-1 correlation. The black solid line indicates the linear regression fit.

*Left panel:* Correlated PWV ECMWF map for SOFIA flight 638 at 39000ft pressure altitude *Right panel:* Correlated PWV ECMWF curve for SOFIA flight 628 (black dots) as a function of time. The ambient pressure is plotted with blue dots. FIFI-LS PWV measurements are indicated by red crosses

## Conclusions

- FIFI-LS measurements provided high quality PWV values in the SOFIA LoS (independent red and blue channel values within 7% or  $0.3\mu\text{m}$ )
- Measured PWV values can be used for data reduction, but strong gradients caused by e.g. weather can be missed and/or on sky observing time is reduced by additional PWV measurements
- Some trend analysis for (altitude, latitude, season), but limited statistics and bias due to flight path restrictions
- ECMWF satellite data provides much finer grid to resolve the flight paths with a linear correlation with the measured data points
- ECMWF data provides PWV values for all FIFI-LS data and can be correlated with other instruments (Vacca et al., 2023)

## Acknowledgement

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## Literature

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