First tropospheric δD data observed by ground- and space-based remote sensing and surface in-situ measurement techniques at MUSICA's principle reference station (Izaña Observatory, Spain)

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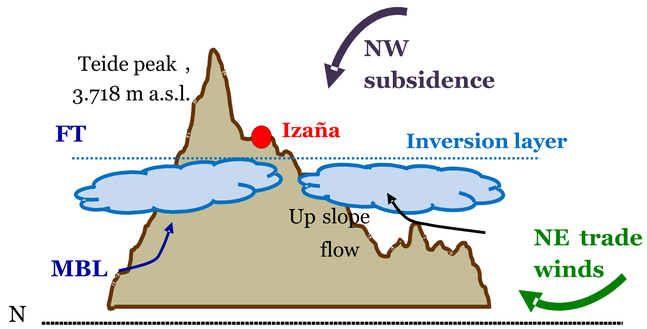
The main goal of the project MUSICA (Multiplatform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric water) is the generation of a quasi global tropospheric water vapour isototopologue dataset of a good and well-documented quality. Therefore, ground- and space-based remote sensing observations (NDACC-FTIR and IASI/METOP) are combined with in-situ measurements (Picarro L2120-I). Here we trace back the remote sensing data to the continuously calibrated in-situ data.

1. Location and instrumentation.



IASI: sensitivity mainly in the middle troposphere.
Precision≈ 30‰ (for H_2O: 10-30%)

FTIR: can distinguish between lower and middle/ upper troposphere.
Precision≈ 25‰ (for H_2O: 1-2%)

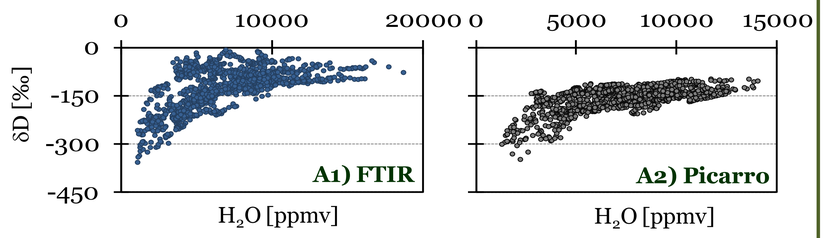
Picarro: Influenced by the upslope flow prompts the mixing between MBL and low FT during daylight.
Precision:<13.5‰ at 500ppmv, <2‰ at 4000ppmv (0.6 Hz)

2. Measurement-to-measurement validation: FTIR-vs.-Picarro.

• FTIR validation is carried out by comparing the FTIR at 2.400 m a.s.l. with the in-situ (Picarro) data. Figures A1) and A2) show the H_2O-vs.-δD relationship for FTIR and Picarro 10' averaged common data set.

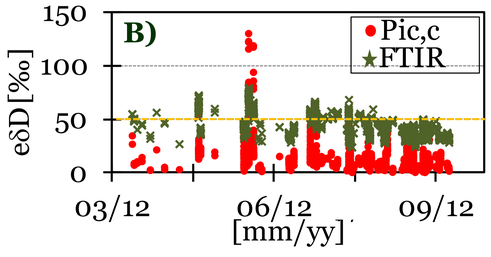
$$\delta D = 1000\,‰ \times \left(\frac{HD^{16}O / H_2^{16}O}{SMOW} - 1 \right)$$

SMOW=$3.1152 \cdot 10^{-4}$ (standard mean ocean water)



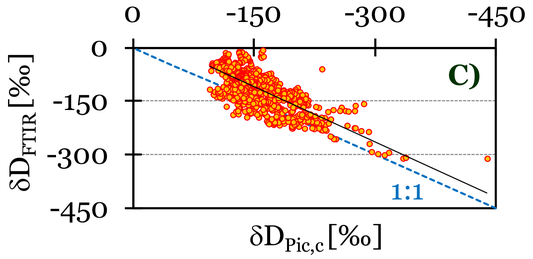
• Assuming that each system measures the same air mass under FT and MBL conditions, in the case of mixing δD_{FTIR} and δD_{Pic} follow the next equation. The error on δD_{FTIR} and $\delta D_{Pic,c}$ is depicted in Figure B and the inter-comparison in Figure C.

$$\delta D_{Pic,c} = \frac{\delta D_{Pic} \cdot H_2O_{Pic}}{H_2O_{FTIR}} - \frac{\delta D_{MBL} \cdot (H_2O_{Pic} - H_2O_{FTIR})}{H_2O_{FTIR}}$$



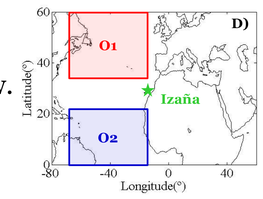
Valid data for the comparison:
eδD<50‰
(75% of the raw data)

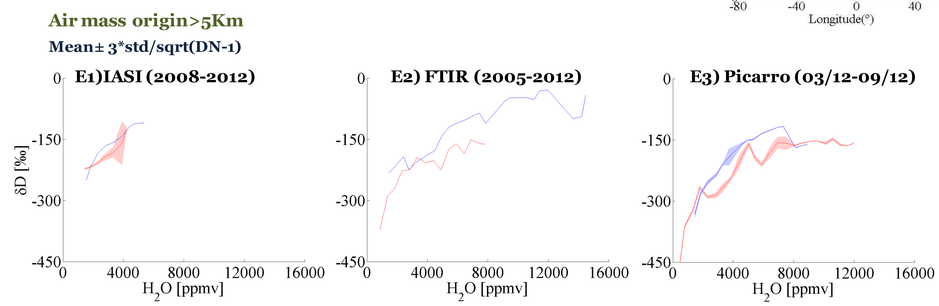
Slope=1.03 ± 0.03
Intercept=44 ± 34, r²=0.56



3.The added value of isotopologue observations.

• H_2O-vs.-δD plots of the 3 sensing instruments from extratropical and tropical air mass origins are shown below.
• The data set were binned in increments of 500 ppmv .
• Mean values and 98% of confidence interval are shown.





Conclusions:
→ The first comparison between δD MUSICA observations at the Izaña Observatory shows a good agreement (R~0.75).
→ The instruments observe similar systematic differences between the isotopic fingerprints of tropical and extratropical middle/upper tropospheric water vapour (confidence level of 98%). Tropical middle/upper tropospheric water vapour is significantly more enriched in $HD^{16}O$ than extra-tropical middle/upper tropospheric water vapour.

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