MUSICA-update: MUSICA v2015, IASI retrieval, and FTIR series

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Introduction

The project MUSICA (Multi-platform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric Water) integrates tropospheric water vapour isotopologue remote sensing and in situ observations. The H_2O and δD remote sensing products are generated from ground-based FTIR (Fourier transform infrared) spectrometer and space-based IASI (infrared atmospheric sounding interferometer) observations. These data are validated with in situ measurements made during a flight campaign in the area of the Canary Islands in 2013 aboard an aircraft (200-6800 m a.s.l.) by the ISOWAT instrument and by two Picarro L2120-I water isotopologue analysers on the Tenerife Island (Izaña, 2370 m a.s.l. and at Teide, 3550 m a.s.l.). To improve the global data consistency and to minimise the bias, the MUSICA retrieval has been revised. In the following, the new MUSICA setup v2015 and its resulting new FTIR and IASI datasets are presented.

MUSICA v2015

- old MUSICA setup: HITRAN 2008, PROFFIT96, 11 microwindows *(Schneider et al., 2012)*
- changes for MUSICA v2015:
  - HITRAN 2012 with modified line parameters
  - 9 microwindows (→ prevent saturation for humid sites, additional $H_2{}^{18}O$ window)
  - same a priori for all gb sites and for IASI retrieval (LMDZiso, *Risi et al., 2012*)
- in situ data of flight campaign 2013 used for calibration δD bias with old setup +60‰, v2015 unbiased (*Dyroff et al., Schneider et al., 2015*)

Fig. 1: Table of modifications in the line parameters (line intensity and pressure broadening) made with respect to HITRAN 2012.
Fig. 2: MUSICA microwindows, top: MUSICA 2011, bottom: MUSICA v2015 (black: measurement, red: calculation, blue: difference).
Fig. 3: Comparison of flight campaign data FTIR vs. ISOWAT (in situ) data, top: using HITRAN 2012 (only first meas. In the morning), bottom: using improved line parameters (all morning meas. Before flight)& microwindows; red line: 1:1 diagonal shifted by +60‰.

Line centre [cm^{-1}]	isotopologue	ΔS [%]	Δγ [%]
2660.511700	$HD^{16}O$	-5.52	+3.96
2663.285820	$HD^{16}O$	-5.53	+4.00
2713.862650	$HD^{16}O$	-5.53	+4.07
2732.493160	$H_2{}^{16}O$	+12.26	+9.35
2819.449040	$H_2{}^{16}O$	-3.07	+4.52
2879.706660	$H_2{}^{16}O$	-8.26	+6.84
2893.075920	$H_2{}^{16}O$	-9.07	+9.64
3019.824500	$H_2{}^{18}O$	-5.40	-0.72
3052.444870	$H_2{}^{18}O$	-6.32	-0.71

Fig. 1

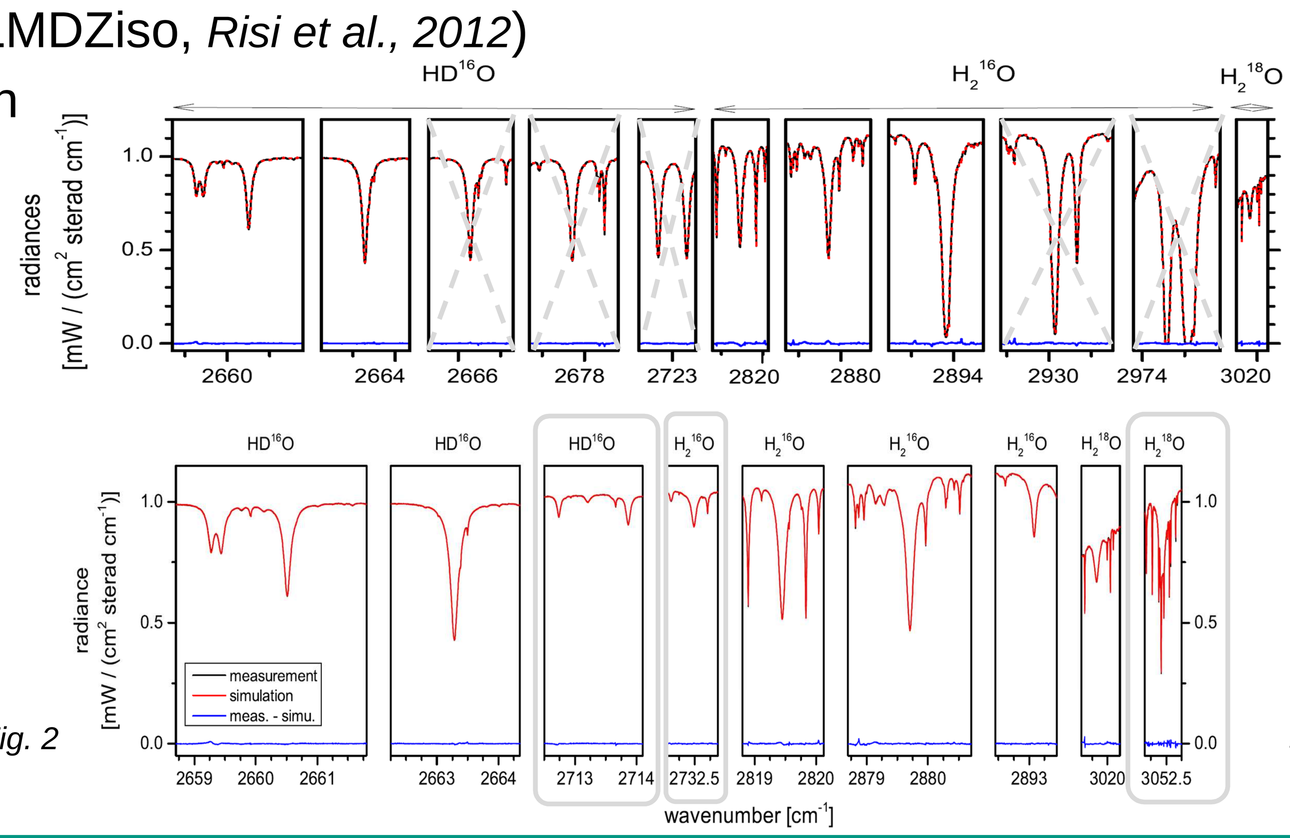

Fig. 2

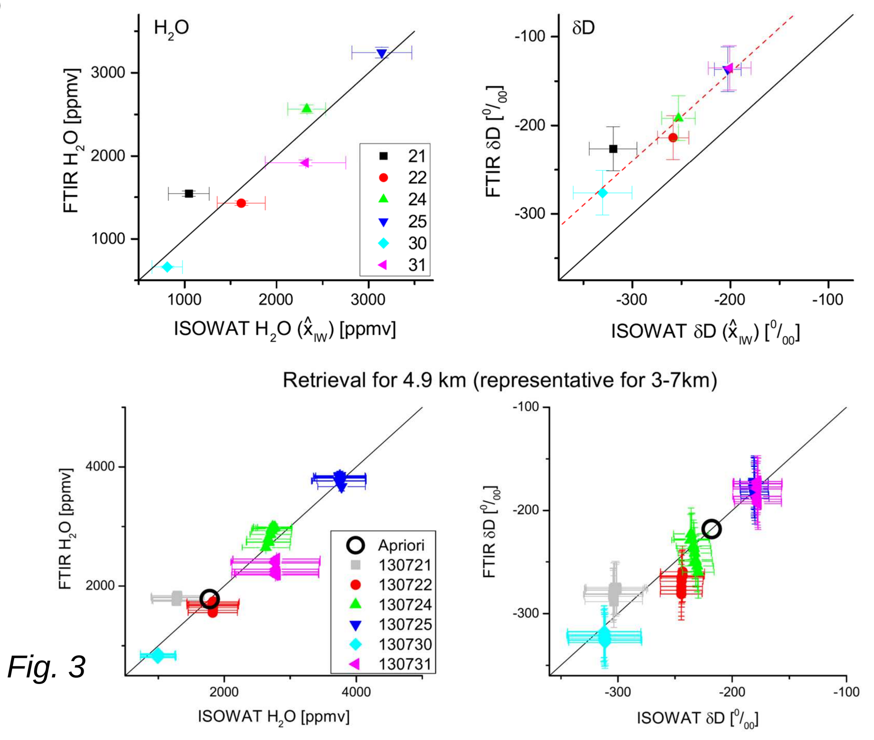

Fig. 3

IASI-retrieval

- analysis performed with PROFFIT96 nadir *(Schneider & Hase, 2011, Wiegele et al., 2014)*
- first global IASI maps for δD and H_2O available
- high resolution in time (> 1e^6 meas. / day)
- sensitivity (5km) and DOFs filter applied
- gaps due to clouds and quality filter

→ high data effort: so far a few days available / still not operational

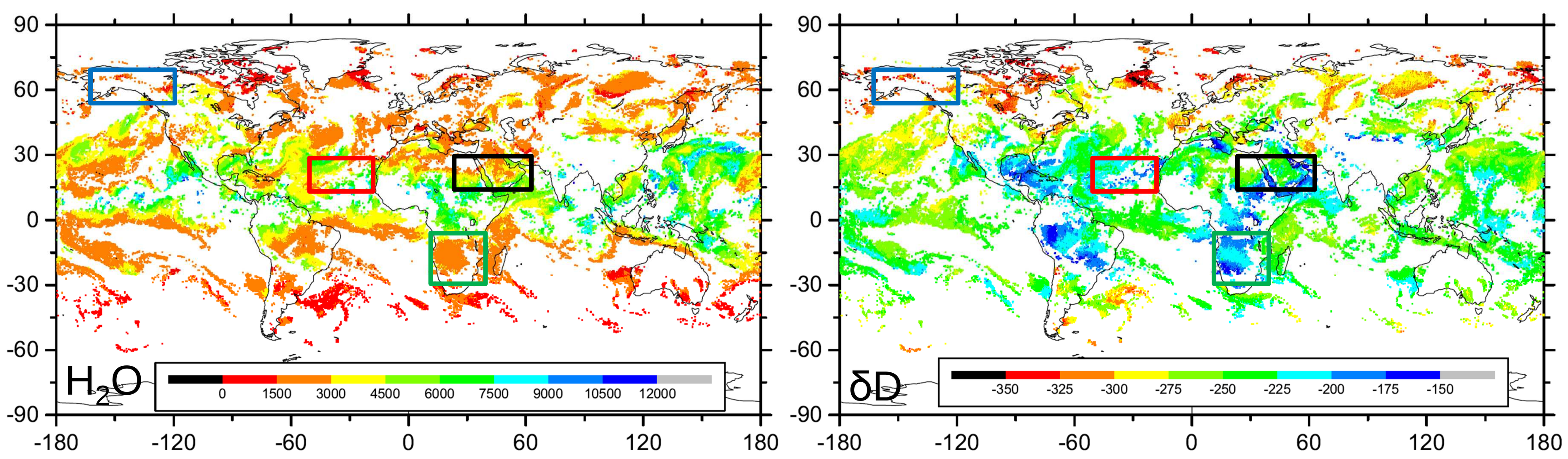

Fig. 4: First global maps of IASI H2O [ppmv] (left) and δD values (right) at 5 km for IASI A and B quality filtered Type 2 retrieval results for morning overpass on 16 Aug.2014. Coloured boxes used for Fig. 5.

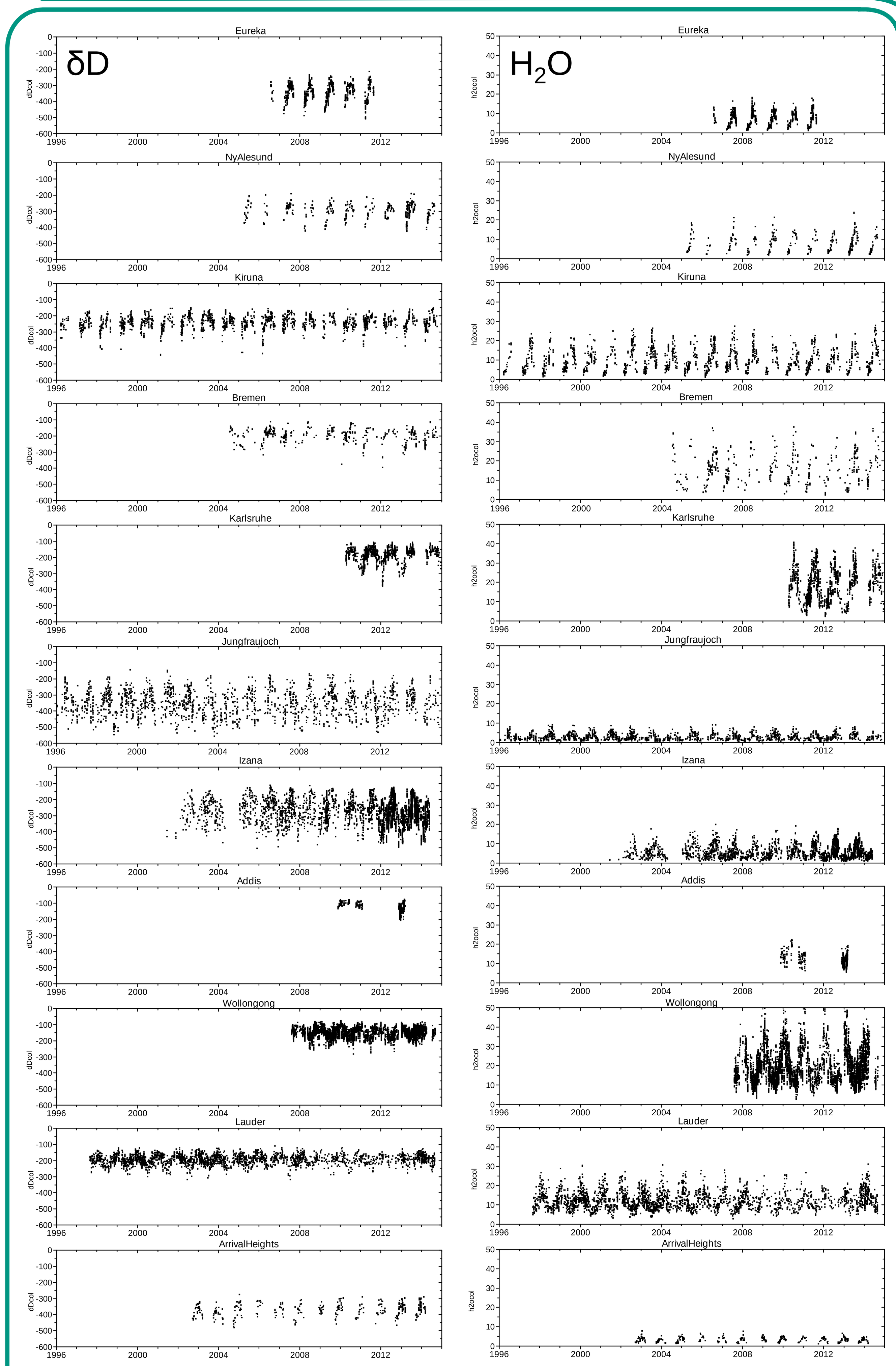

Fig. 6: FTIR time series of column integrated H_2O (left) and δD (right) for 11 sites participating in MUSICA.

Identification of humidity-controlling processes:

(1) humid but often strongly depleted air indicating rain evaporation
(2) humidity arriving at high latitudes has experienced significant drying by condensation (depletion via Rayleigh distillation) since origin is in the low latitude ocean. This depleted air can then form rain and evaporate
(3) strong mixing between weakly depleted boundary layer humidity and free tropospheric humidity (dry convection over arid areas)
(4) drying caused by mixing with very dry air from UT. Very low fractionation might also indicate plant transpiration as humidity source

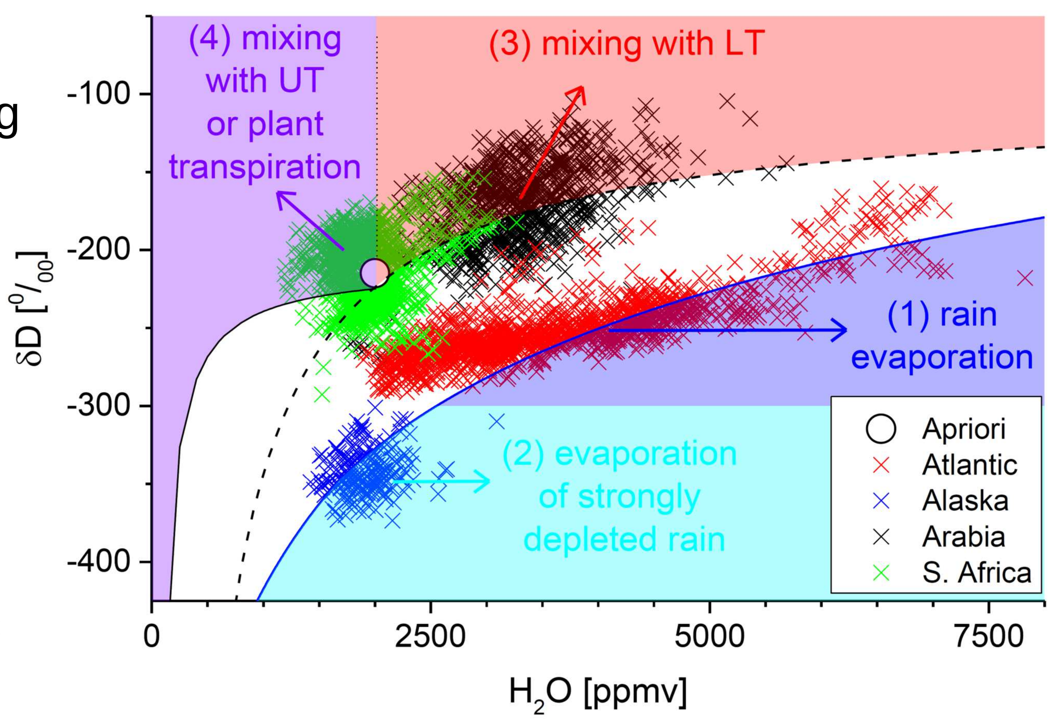

Fig. 5: IASI Observations of δD, H_2O distributions and their interpretation for 4 different regions on 5 September 2008. The different lines represent simulations of air mass mixing and Rayleigh distillation for evaporation over the (sub-)tropical ocean (black circle: a priori).

FTIR series

- 11 FTIR sites (80°N-78°S)
- data analysed between 1996 and 2015 (>30000 observations)
- new v2015 settings applied (same a priori for all sites)
- quality check with XCO_2 *(Barthlott et al., 2015)*

→ dataset good for satellite validations and long-term studies (*e.g. Sheepmaker et al. 2015, Lacour et al. 2015, Schneider et al. 2012*)

Conclusion & Outlook

- validation with in situ data of flight campaign
- changes for v2015: set of microwindows, line parameters and the same a priori for all retrievals
- global IASI retrieval for several days available
- FTIR data of 9 years for 11 sites analysed
  - → FTIR data will be made public available
  - → More global IASI retrievals & model validation
  - → MUSICA ends 2016, application for funding for future work

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