

Name of research institute or organization:

Climate and Environmental Division, Physics Institute, University of Bern

Title of project:

Water isotope measurements with a PICARRO Laser instrument

Project leader and team:

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Project description:

During the CLACE campaign 2011, a Picarro H₂O isotope instrument was installed at the 2nd level of the Sphinx Laboratory connected to the inlet systems of the Paul Scherrer Institute. The major goal was to obtain high precision water isotope measurements on a continuous basis of water vapor, liquid water and potentially solid water present in clouds. The measuring principle is a cavity ring-down spectroscopy and allows combined determination of both water isotopes ($\delta^{18}\text{O}$ and δD).

We ran the instrument from June 27 to September 5, 2011. In the following we focus to two short periods in July, the first period with rather constant conditions regarding the total water content, the second with strongly decreasing total water content. At first glance the agreement between the condensed water content determined by the Paul Scherrer Institute (PSI CWC), expressed as mg H₂O/m³ and the difference of total to vapor water content measured by the Picarro system (Difference Total-Vapor), measured as ppm H₂O (parts per million) and converted to mg H₂O/m³ is fair (figure 1).

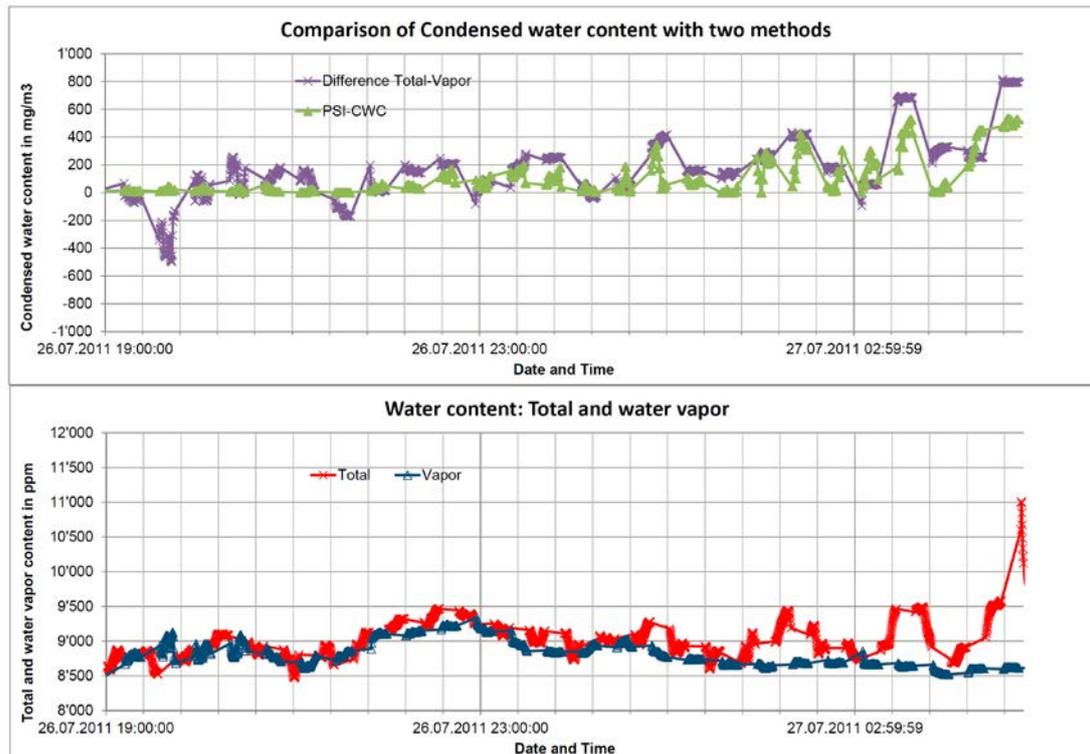


Figure 1a. Condensed water content (top panel) measured by PSI and calculated based on the difference between total and vapor water content (bottom panel).

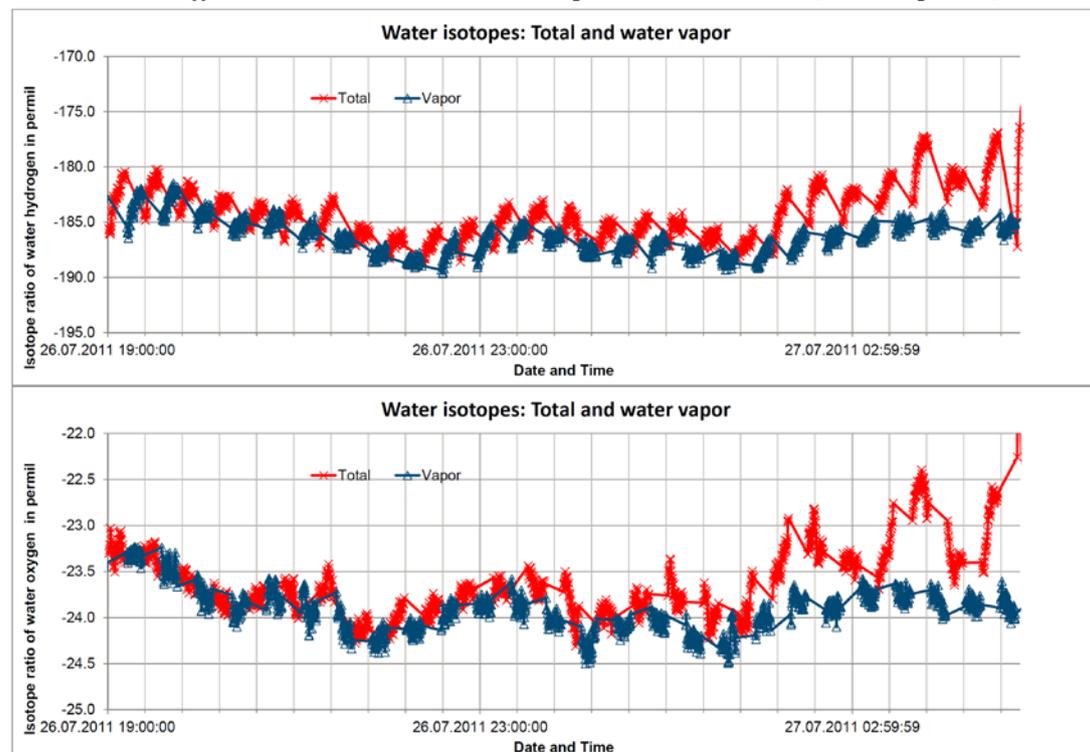


Figure 1b. Water isotopes for the same period. Deuterium (δD) values for total and vapor water content (top panel) and oxygen isotopes ($\delta^{18}O$, bottom panel).

Regarding the isotopes, measurements show isotopically enriched values for the total water and conditions of higher condensed water content (towards the end of the first period). This is expected since the heavier isotopes prefer the condensed phase.

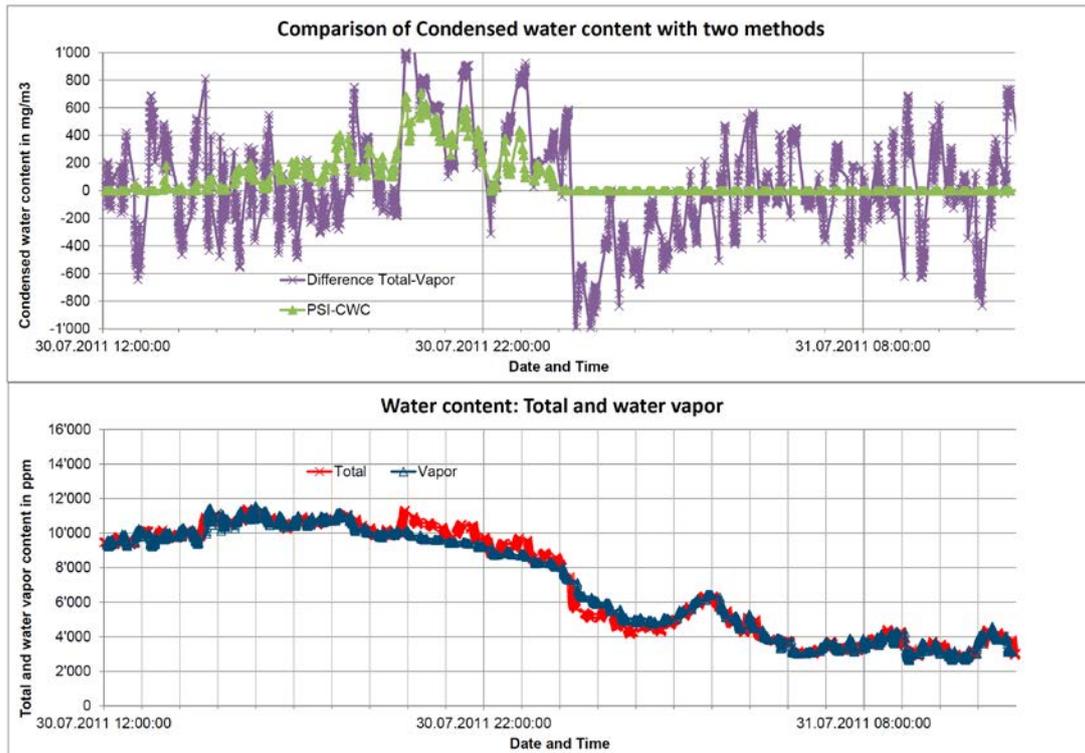


Figure 2a. Condensed water content (top panel) measured by PSI and calculated based on the difference between total and vapor water content (bottom panel).

The second period shows an obvious problem of this comparison. By definition the total water content is larger than the water vapor content only. However, the difference as measured by the Picarro system does not show this behavior. Several causes may account for this unexpected result: (i) the Picarro system suffers from a memory effect due to the switching between the two inlet systems, i.e. total and vapor inlet; (ii) the switching procedure did not work properly or the cycle composer program ran faulty; (iii) the two inlets do not allow immediate quantitative H₂O transfer; (vi) the two inlet systems exhibit different total water contents due to construction differences. At present all of these causes are being discussed with representatives of the Paul Scherrer Institute.

Regarding the isotopes, there is an excellent agreement between total and water vapor isotopes for periods when total and water vapor content are equivalent, i.e. no condensed water present. However, significant differences in both isotopes ($\delta^{18}\text{O}$ and δD) occur when the two inlets show different water loadings, i.e. condensation and or evaporation present. In depth analyses will show, whether it is possible to learn more about the fractionations associated with nucleation processes (water droplets, ice crystals).

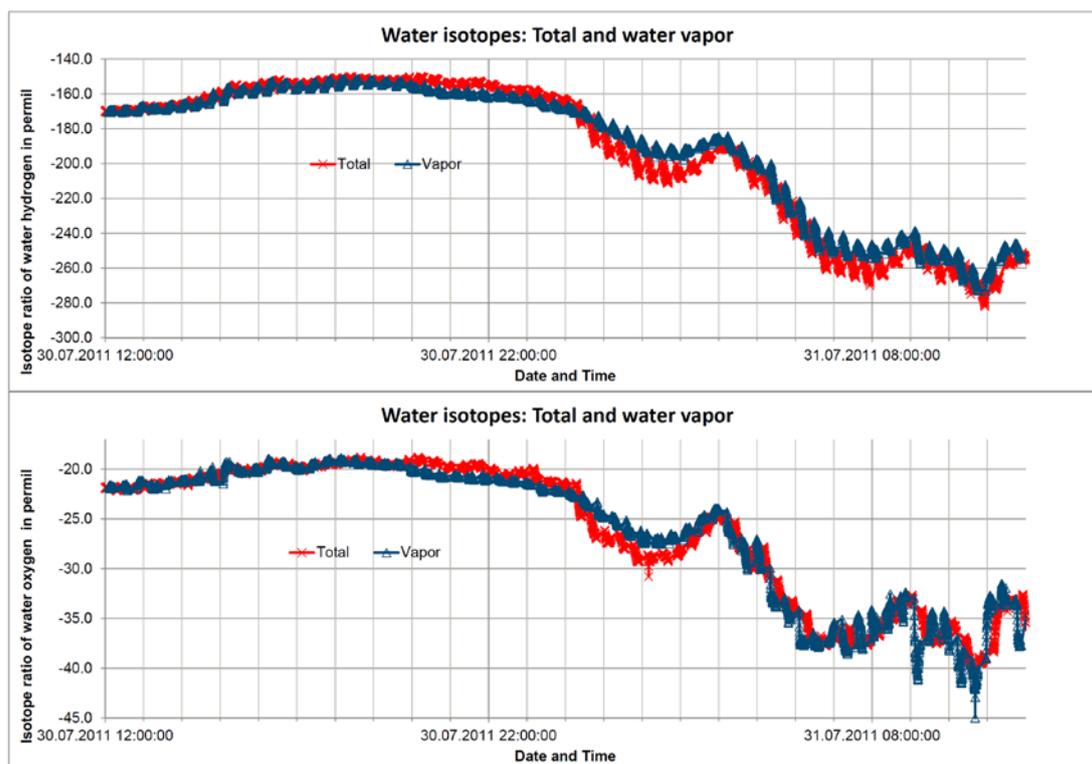


Figure 2b. Water isotopes for the same period. Deuterium (δD) values for total and vapor water content (top panel) and oxygen isotopes ($\delta^{18}O$, bottom panel).

Key words:

Isotope, water isotopes, Picarro, fractionation, condensed water content

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