



ULH Water Vapor Measurements during ATTREX Autumn 2011 Deployment

Bob Herman (JPL) and ULH team:
R. Troy, D. Fu, D. Natzic, J. Landeros
ATTREX Science Team Meeting



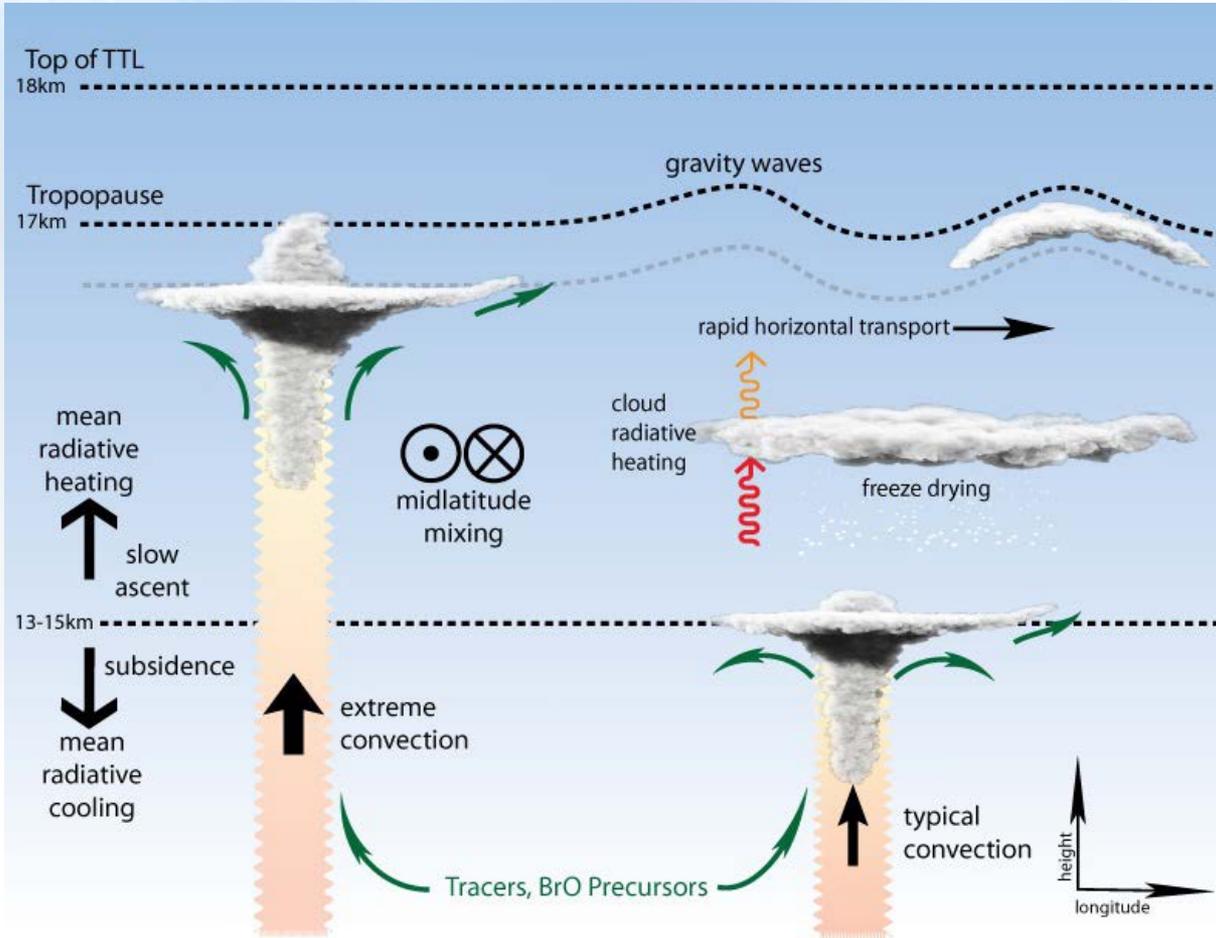


Outline

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Overview

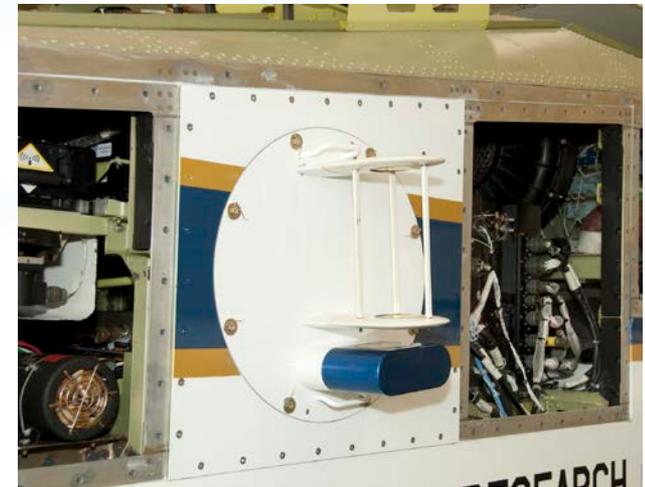
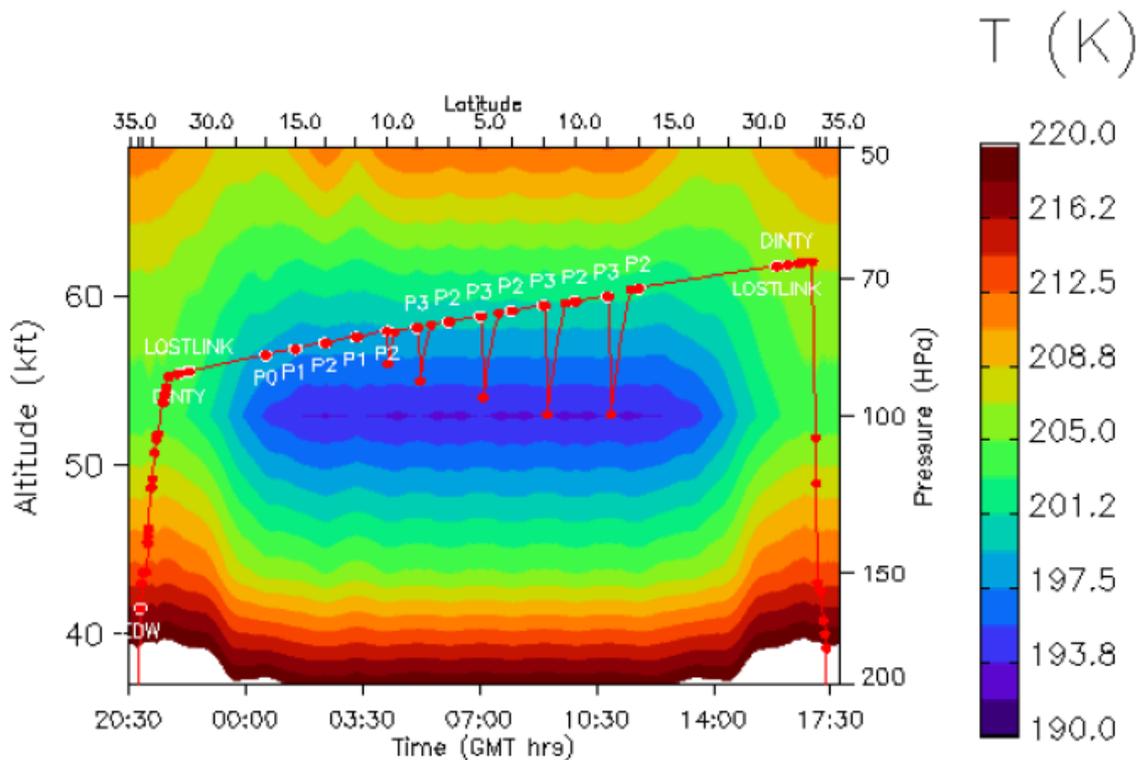


- Why is water important?
- TTL water has disproportionate impact on climate (e.g. Solomon et al., Science, 2010).
- Water vapor and clouds are key measurements during ATTREX.

Schematic of the Tropical Tropopause Layer (TTL) from 13-18 km.

Overview

- ATTREX EV-1 mission on the NASA Global Hawk (right).
- ULH measures in-situ stratospheric water.
- Scientific Goals for Oct-Nov 2011 flights:
 1. Intercept the tropical Cold-Point Tropopause (CPT)
 2. Measure the relation between cirrus, water, Temp.
 3. Evaluate atmospheric model predictions.



Left: sample flight plan to probe the CPT in a series of dips by the NASA Global Hawk.





Instrument Description

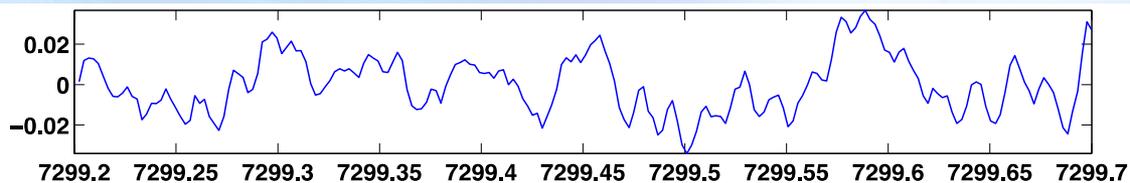


- UAS Laser Hygrometer (ULH) is a single-channel open-path laser spectrometer.
- Measurement: in-situ water vapor (1 Hz).
- Technique: tunable diode laser.
- Optical cell: Herriott folded-path (left). Nominal solution is 54 multipasses, yielding 11.37-meter total optical pathlength.
- Internal path < 4 cm.
- Accuracy: 10% expected
- Precision: 0.15 ppmv on 9 Nov flight.

Electronics package inside Zone 13:



Near-Infrared Spectroscopy



Fit observed spectrum with a Voigt lineshape. Use Beer's Law and MMS P,T to calculate water volume mixing ratio.

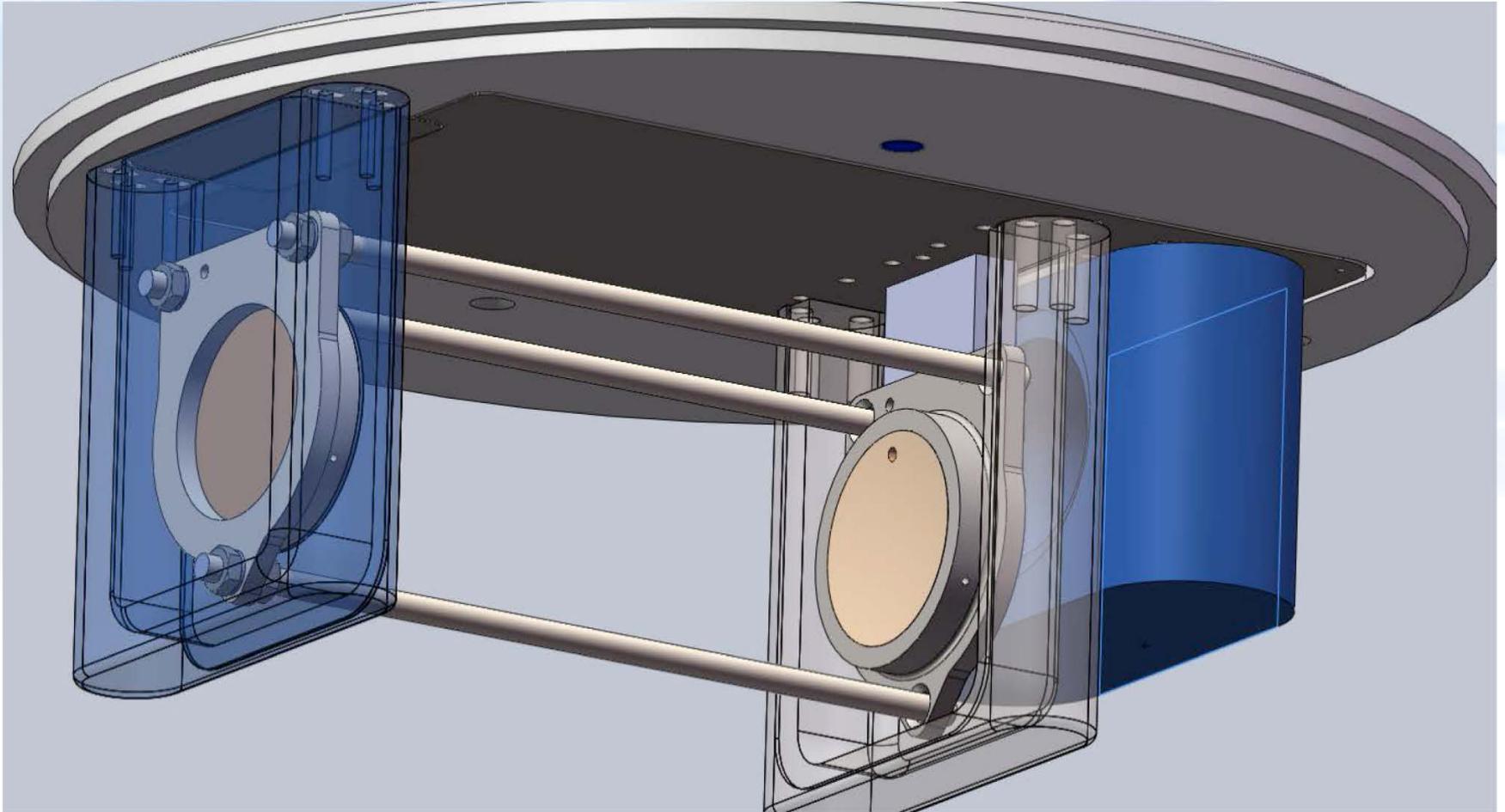


Instrument Issues

- Data archived for Oct 28 and Nov 9 science flights.
- Loose laser cable on Nov 5, repaired for Nov 9 flight.
- Continued loss of optical alignment at $T < 205$ K.
- Through data analysis, we conclude that on significant portions of the flights, the optical signal was a mixture of the nominal path (54 passes) and the adjacent optical solution (100 passes). Stratospheric data from 9 Nov are from the 100-pass pathlength.
- Plan to mitigate this issue: athermalized mirror holders(next page). It is being tested at low temperature in our lab this month, and will fly during SEAC4RS in Aug-Sept 2012.



Athermalized Mirror Holders



MACPEX optical bench (flexure mounts) plus new Invar mirror holders





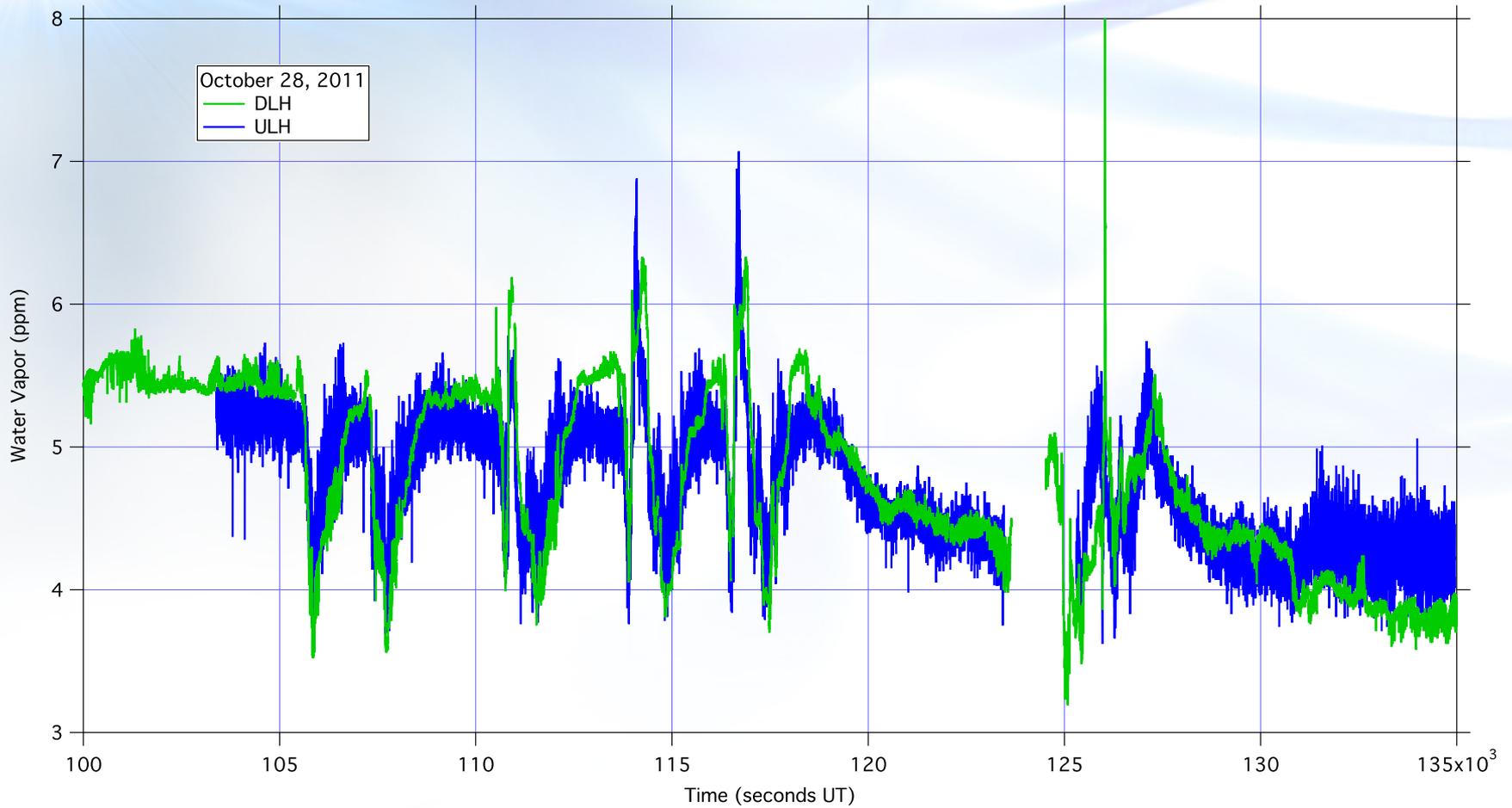
Water Measurements

- Our focus has been on the Oct 28 and Nov 9 flights



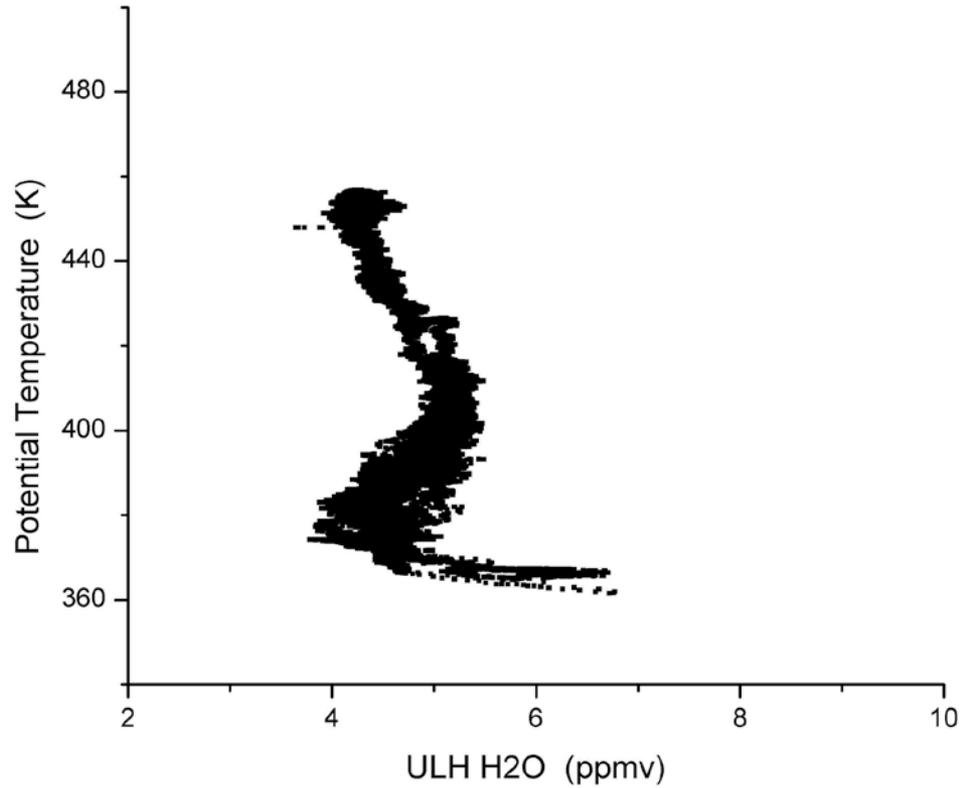


10/28 time series



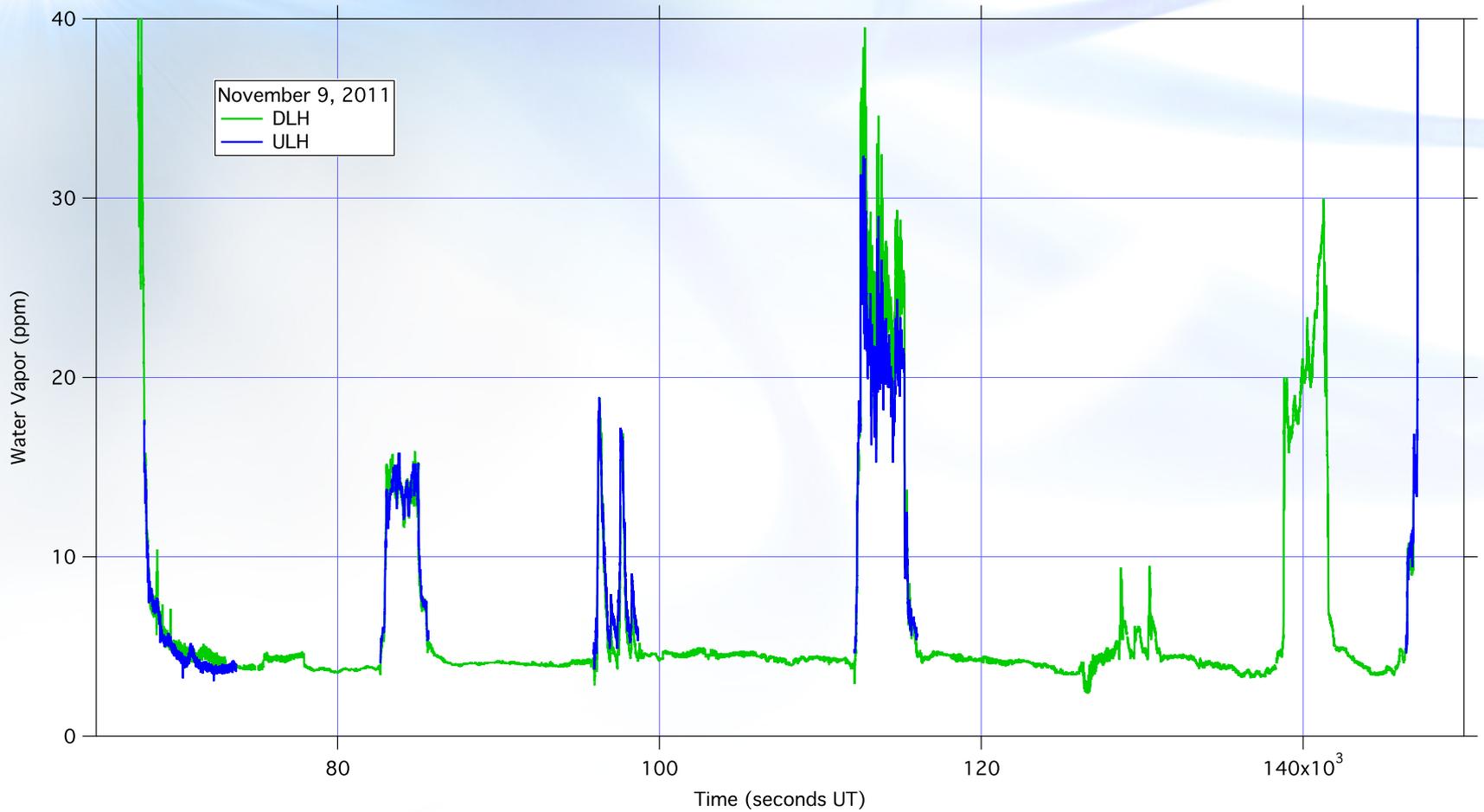


10/28 vertical profile



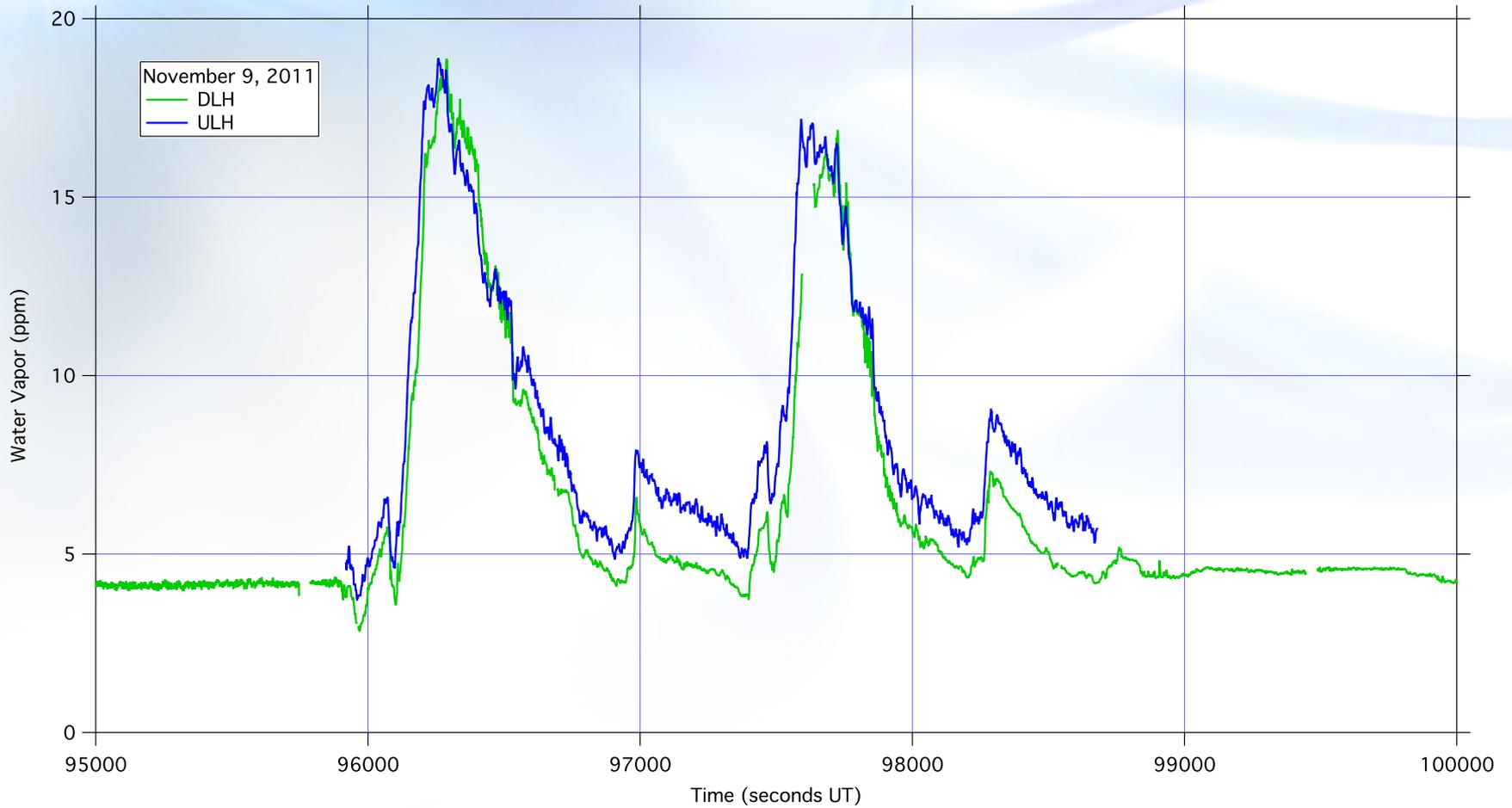


11/09 time series

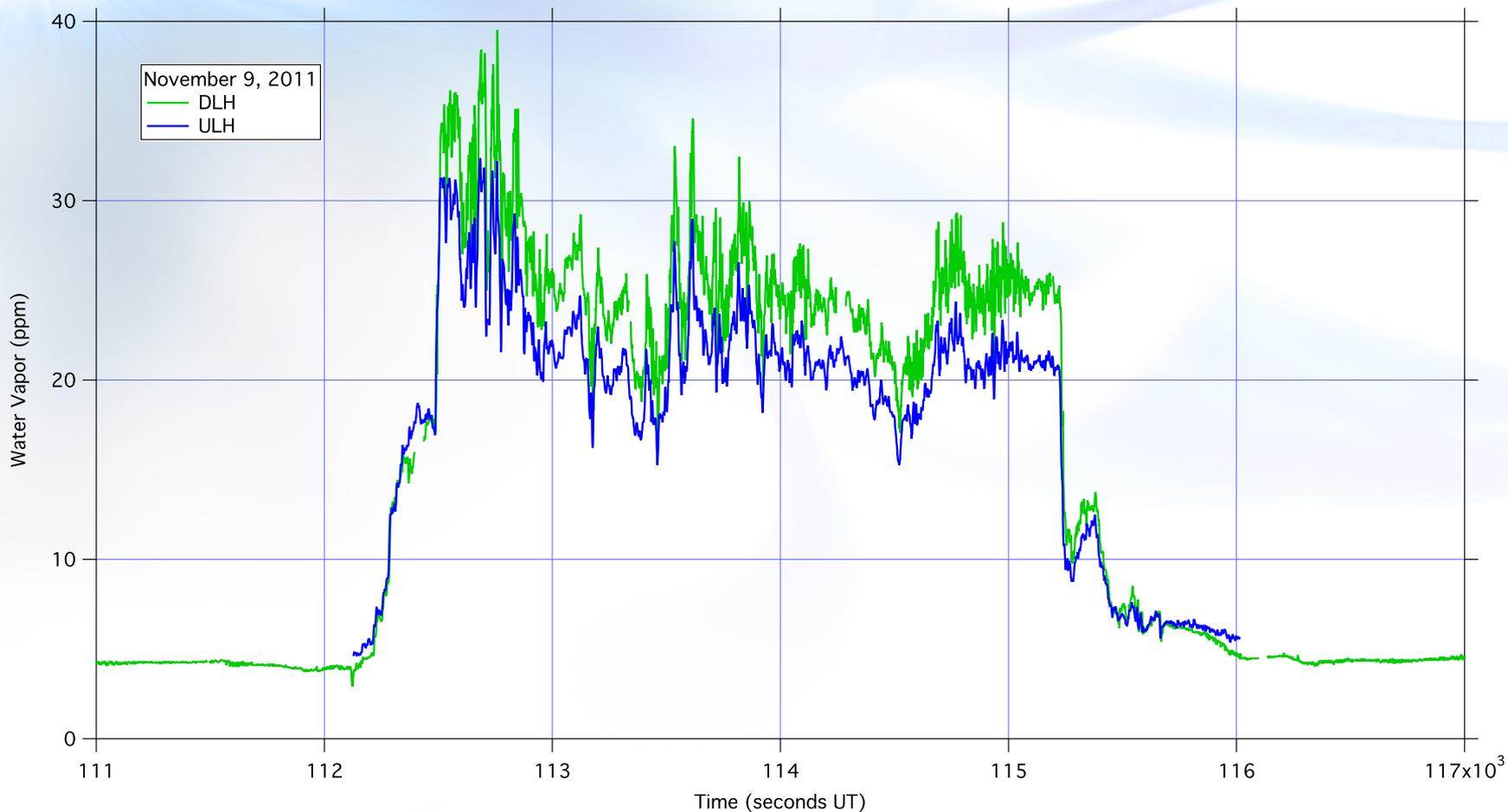




11/09 second dive

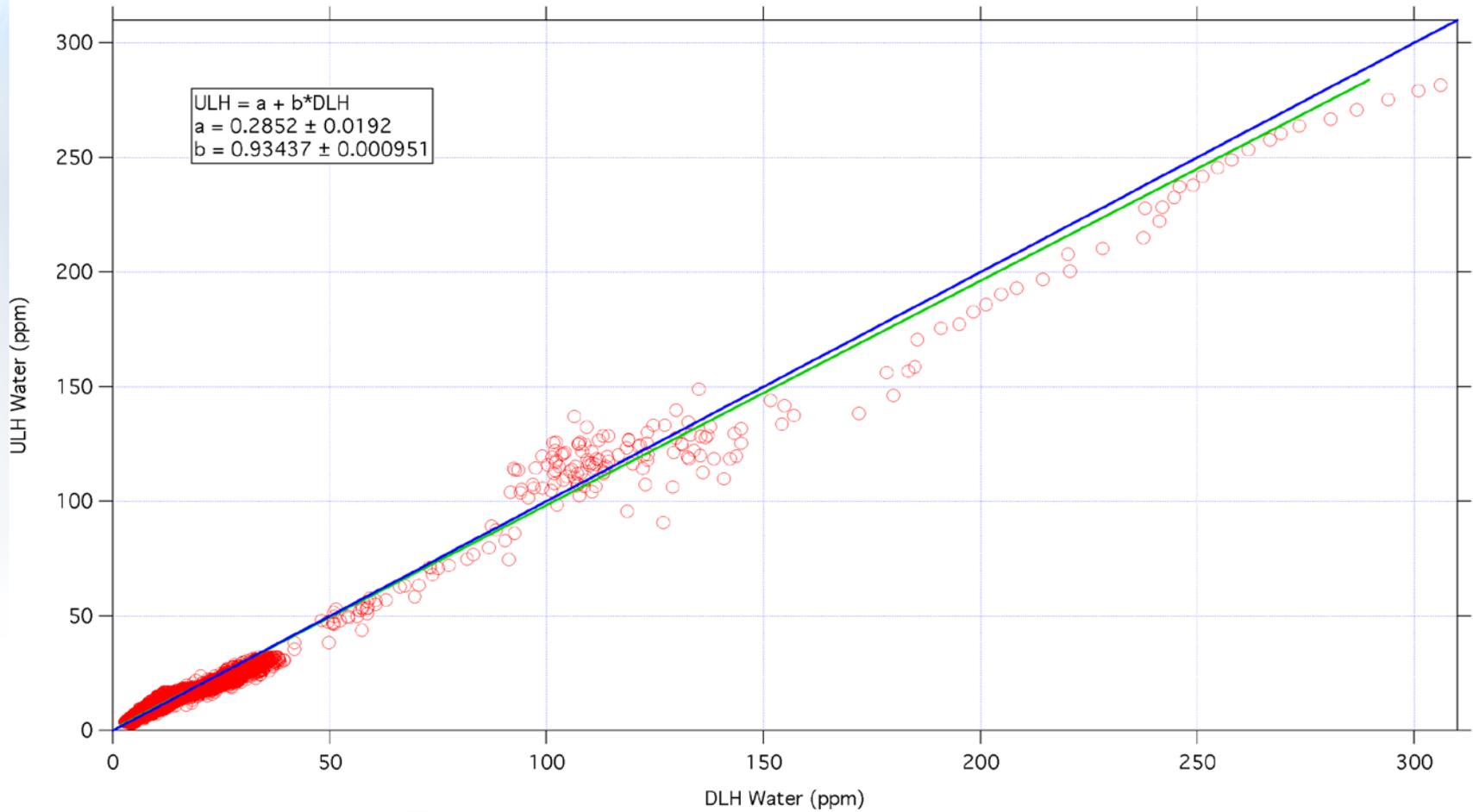


11/09 third dive: ice saturation



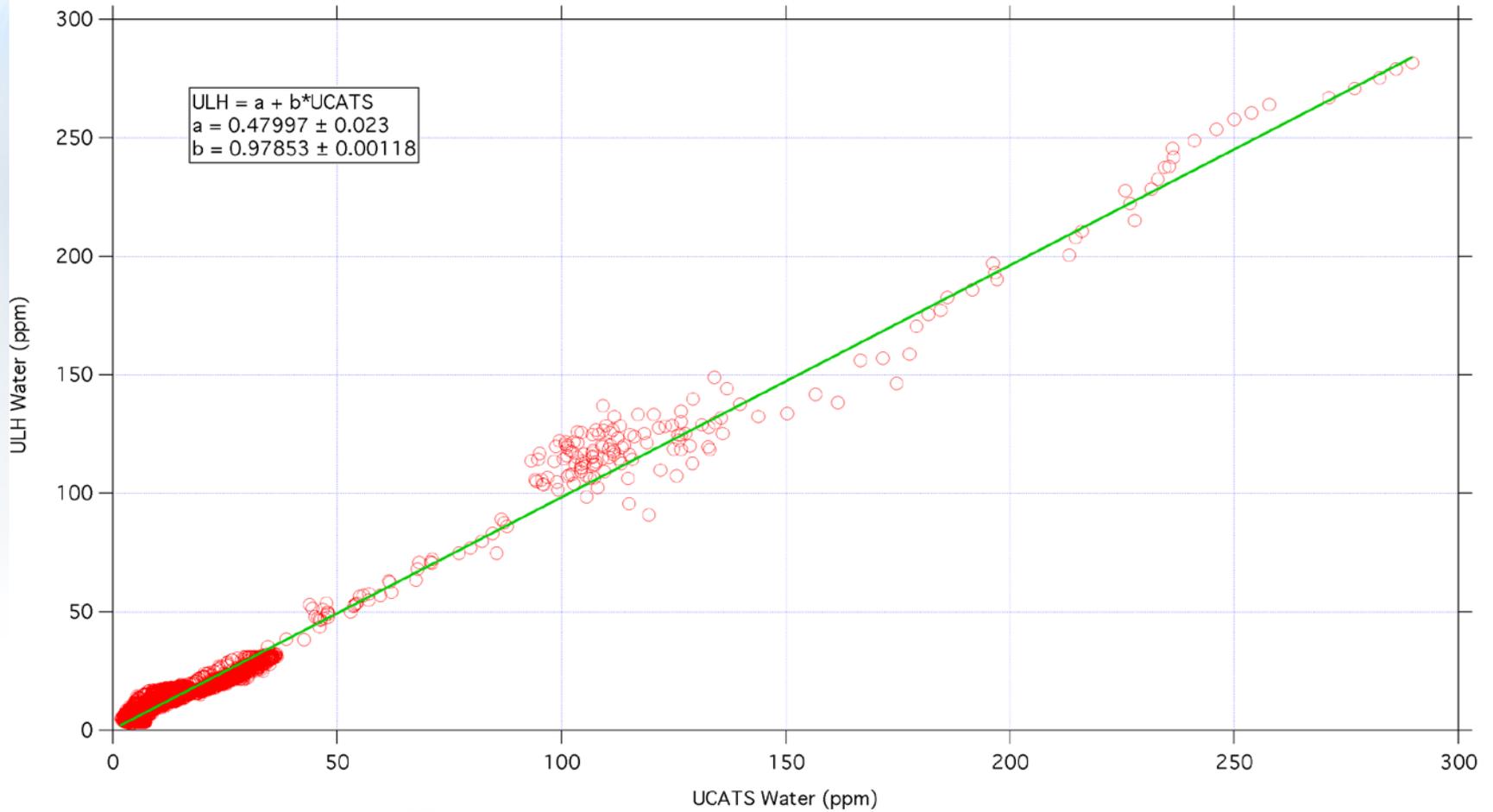


ULH vs DLH, Nov 9





ULH vs UCATS, Nov 9



Preparations for Jan 2013



- More stable optical mounting (already implemented for SEAC4RS).
- We plan to fly JLH in SEAC4RS (direct comparison with Harvard H₂O) and then in ATTREX.
- Narrow-band optical filter installed on detector.
- Expectation: 10% accuracy and 0.05 ppmv precision.





Acknowledgments

- ATTREX and UARP for financial support.
- Eric Hintsa for providing intercomparison plots.

