

## Longstanding Discrepancies in Stratospheric Water Vapor Measurements Revisited During the 2011 Mid-latitude Airborne Cirrus Properties Experiment (MACPEX)

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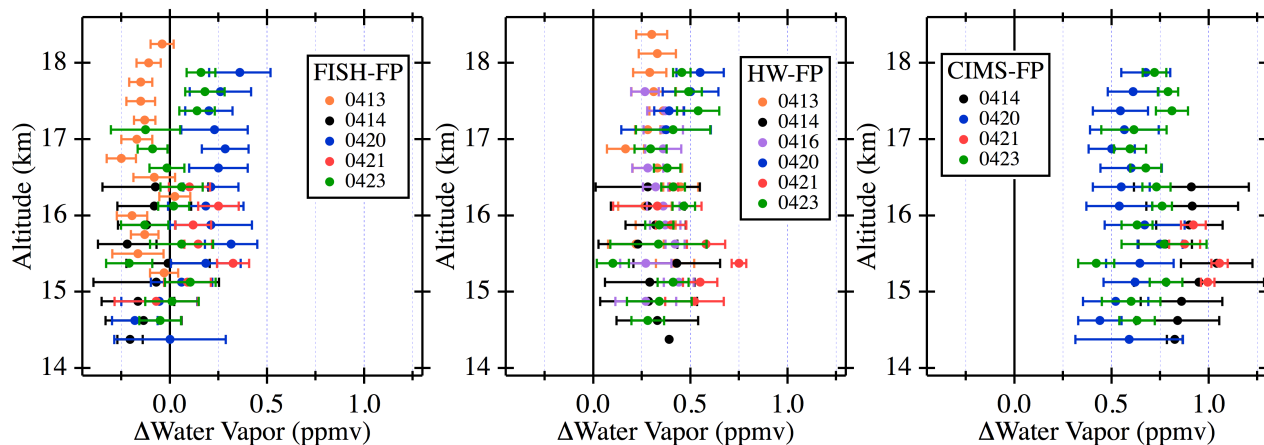
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For two decades, significant (15 to 60%) differences have persisted between the *in situ* stratospheric water vapor measurements by several well-established aircraft- and balloon-borne instruments. Attempts to reproduce and understand the measurement discrepancies in the laboratory have been largely ineffective.

The Mid-latitude Airborne Cirrus Properties Experiment (MACPEX) in April 2011 provided a fresh opportunity to reexamine existing measurement disparities and to compare measurements by new aircraft-based instrumentation. Here we compare water vapor measurements in the lower stratosphere by five different instruments during MACPEX. Three instruments (Harvard water, FISH, and NOAA CIMS) were aboard the NASA WB-57 aircraft, while two frost point hygrometers (CFH and NOAA FPH) were launched on balloons. Balloons were launched during six WB-57 flights for the purpose of comparing the *in situ* water vapor measurements. Aircraft and balloon flight paths were coordinated in space and time to maximize measurement coincidences. In most cases, the aircraft performed spiral descent maneuvers near balloons as they slowly descended ( $\sim 5 \text{ m s}^{-1}$ ) through the stratosphere.

Water vapor mixing ratios measured by these five instruments during MACPEX generally fall into three groups. Those from the CFH, NOAA FPH and FISH are in good agreement, while Harvard water and NOAA CIMS were consistently 0.3 ppmv (8%) and 0.7 ppmv (18%) higher, respectively. Though these discrepancies appear to be large, they are considerably smaller than most of the longstanding differences between Harvard water and the frost point hygrometers, which during previous aircraft campaigns were as large as 60%.



**Figure 1.** Measurement differences from the balloon-borne frost point hygrometers for (a) FISH, (b) Harvard water and (c) NOAA CIMS in 250-m altitude bins for each of six MACPEX flights. Error bars portray one standard deviation of the bin means for individual flights.