Cryogenic Frostpoint Hygrometer (CFH) Launch Activities at the ARM Southern Great Plains (SGP) Site: 2018 Updates, Data Evaluation, and Opportunities

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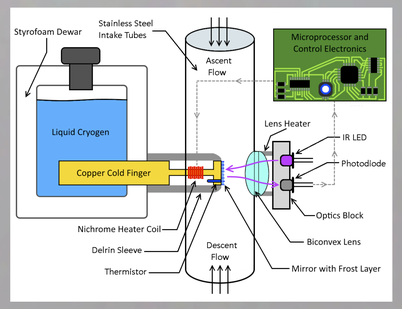
Background

The ARM Cryogenic Frost Point Hygrometer (CFH) has been established as a baseline instrument at the ARM Southern Great Planes (SGP) Climate Research Facility. CFH balloon launches are conducted once a month to measure tropospheric and stratospheric water vapor with increased accuracy and sensitivity. The CFH, which uses a temperature-controlled chilled mirror to directly measure the ambient frostpoint, is particularly useful for studying the dry conditions of the lower stratosphere due to the instrument's sensitivity within a few parts-per-million mixing ratios. CFH data are used for validating observations from radiosondes and from space based remote sensors. ARM CFH measurements are conducted in coordination with the Global Climate Observing System (GCOS) Reference Upper-Air Network (GRUAN).

Measurement Uncertainty

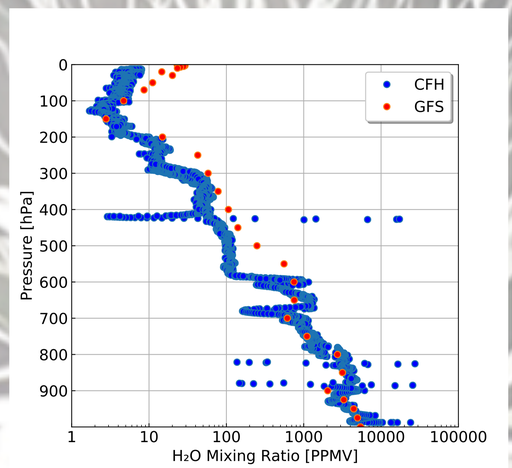
Most of the uncertainty of CFH mirror temperature measurements is related to the stability of the feedback controller, which activates the cooling or heating of the CFH mirror. Systematic CFH errors were quantified to be less than 0.1 K, while total uncertainties are described to be better than 0.2 K under good conditions.

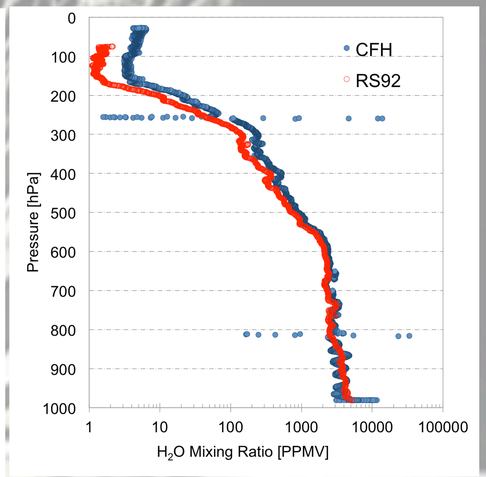


CFH Principle: The instrument measures the temperature of a chilled mirror that is cooled to generate a thin and constant layer of condensate on the mirror. The temperature of the mirror in this condition (of condensation) equals the frost or dew point temperature of the air passing by the mirror.

Deployment History

Currently we launch one CFH package at ARM SGP per month, twenty-eight successful CFH launches have been performed since September 2014.





CFH launches from March 2, 2018 (left) and January 30, 2017 (right). The water vapor mixing-ratio profiles from combined CFH and Vaisala RS-92/iMet radiosonde measurements reveal a typical dry bias observed with radiosondes. The water mixing ratio as derived from the CFH as well as from the Global Forecast System (GFS) model is shown (left panel). The dry bias has been removed in operational numerical weather models.

CFH Specifications and Accuracies

Measured Parameters	Ambient frost point
Derived Parameters	Relative humidity, mixing ratio
Technique	Temperature-controlled chilled mirror
Uncertainty	< 4% in tropical lower troposphere
Measurement	< 10% in middle stratosphere
	< 9% in tropopause
Altitude range	0 - 35 km
Weight	< 400 g (without coolant)
Dimensions	~6.5"Wx12"Dx5"H

Acknowledgements

NOAA's National Centers for Environmental Information (NCEI) coordinates the US GRUAN sites. NOAA's U.S. Climate Reference Network (USCRN) Program Manager Howard Diamond provides the funds for the CFH instruments and accessories used at ARM SGP.

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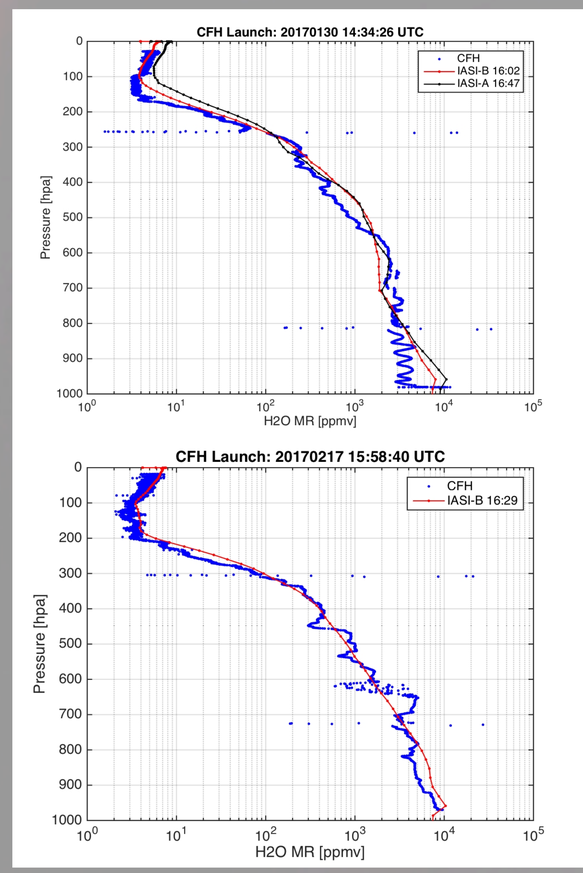
Launch package consisting of the CFH, iMet, and the RS-92 radiosonde combination.

CFH support for RIVAL

CFH launches have been coordinated with overpasses of the MetOp polar orbiting meteorological satellites to validate Infrared Atmospheric Sounding Interferometer (IASI) data. Future CFH packages will include Vaisala RS-41 sondes for **R**adiosonde **I**ntercomparison & **Val**idation (RIVAL).



IASI derived water vapor mixing ratio compared with CFH observational data from 01/30/2017 and 02/17/2017