# The 3D-Printed Automatic Weather Station (3D-PAWS)

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## Introduction

Many surface weather stations across the globe suffer from incorrect siting, poor maintenance and limited communications for real-time monitoring. To expand observation networks in sparsely observed regions, the 3D-PAWS (3D-Printed Automatic Weather Station) initiative has been launched by the University Corporation for Atmospheric Research (UCAR) and the United States (US) National Weather Service International Activities Office (NWS IAO), with support from the USAID Office of US Foreign Disaster Assistance (OFDA).

Objectives

- Build capacity to reduce hydrometeorology-related risk in data-sparse regions
- Observe and communicate weather and climate information to rural communities
- Develop observation networks and applications to reduce weather related risk

Benefits

- Use 3D printers – inexpensive technology
- Use low-cost, reliable micro-sensors
- Design a system that that can be assembled locally in country
- "Print and replace" components when systems fail
- Enable local agencies to take ownership in building and maintaining observation networks

## System Overview

A very high quality 3D-PAWS surface weather station can be manufactured in about a week, at a cost of only $200-400, using locally sourced materials, microsensor technology, low-cost single board computers, and a 3D printer. 3D-PAWS sensors currently measure pressure, temperature, relative humidity, wind speed, wind direction, precipitation, and visible/infrared/UV light. The system uses a Raspberry Pi single-board computer for data acquisition, data processing, and communications. New sensors have also been developed to monitor water level (stream gauging), soil moisture and temperature, and air quality.

## Sensor Evaluation

3D-PAWS sensors were evaluated NSF NCAR UCAR Marshall Research Facility in Boulder, Colorado and the NOAA Testbed facility in Sterling, Virginia. The Boulder site provides sampling conditions in a high-altitude semi-arid environment with subfreezing temperatures and frozen precipitation. The NOAA site provides sampling for a more temperate and humid climate

near sea-level. COMET is currently collaborating with World Meteorological Organization (WMO) and the Turkish State Meteorological Service (TSMS) to deploy a 3D-PAWS network with the focus on testing and evaluation.

**Data Access**

3D-PAWS real-time data are available on the CHORDS project data server. CHORDS (Cloud-Hosted Real-time Data Services for Geosciences) is a US National Science Foundation (NSF) EarthCube initiative to provide a platform for sharing geosciences datasets. It is supported and managed by the UCAR/National Center for Atmospheric Research (NCAR) Earth Observing Laboratory (EOL).

**Station Networks**

3D-PAWS systems have been deployed in 17 countries, including the United States, Canada, Kenya, Uganda, Zambia, Barbados, Curacao, Senegal, Germany, Austria, and countries within the Caribbean, Central America, Africa, and Asia. COMET has partnered with schools, radio stations, NGO's, non-profit organizations, national meteorological and hydrological services, First Nations, and international research institutes to expand 3D-PAWS networks.

**Applications**

The 3D-PAWS systems can be used for a variety of applications including:

Regional weather forecasting

Observations from the 3D-PAWS network can be assimilated into regional numerical weather prediction systems such as the Weather Research and Forecast (WRF: http://www.wrf-model.org) model to improve mesoscale weather forecasts.

Early alert and regional decision support systems

Real-time monitoring of precipitation in ungauged or minimally gauged river basins can provide input to flash flood guidance and early warning decision support systems to support delivery of flood alerts.

Agricultural monitoring

3D-PAWS can support water resource management tools to improve reservoir operation for fresh water supplies and the generation of hydroelectric power. Other applications include operation of irrigation systems (e.g., center pivots) and agricultural crop monitoring.

Health monitoring

3D-PAWS can help monitor conditions leading to outbreaks of diseases such as meningitis and malaria.

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More information on 3D-PAWS
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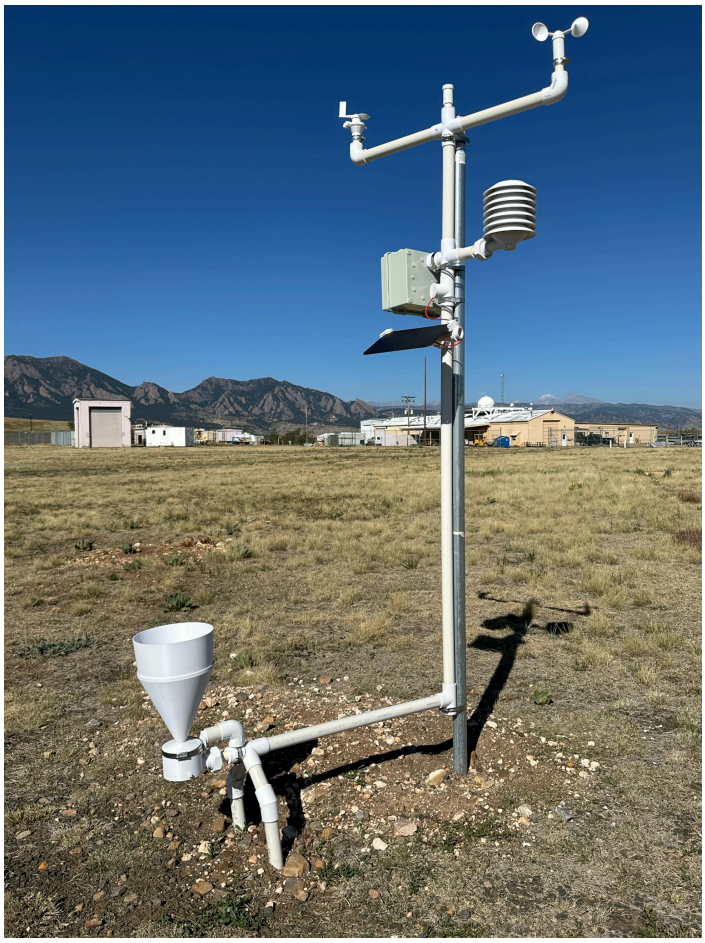
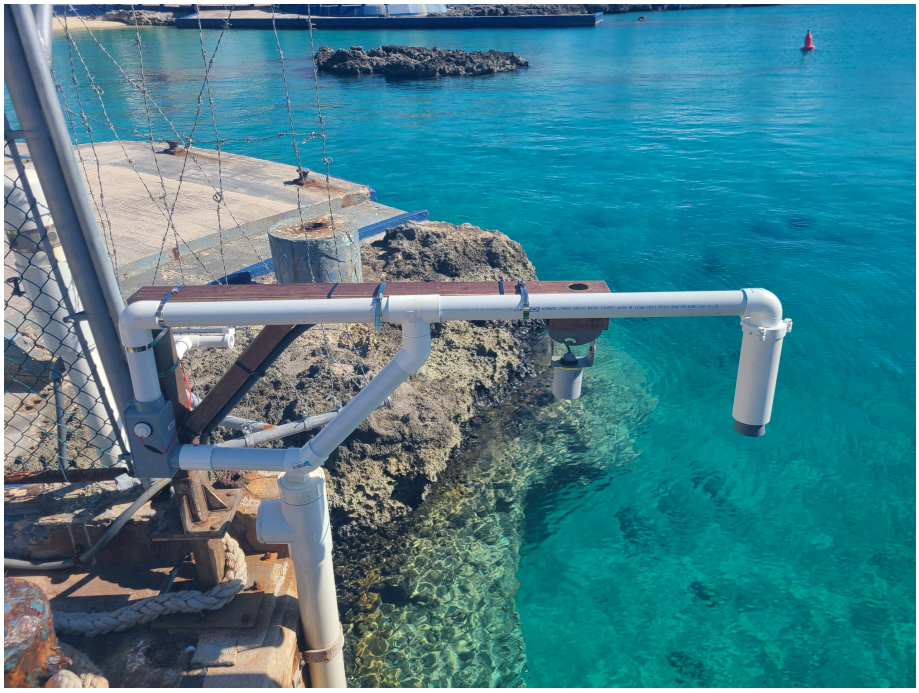
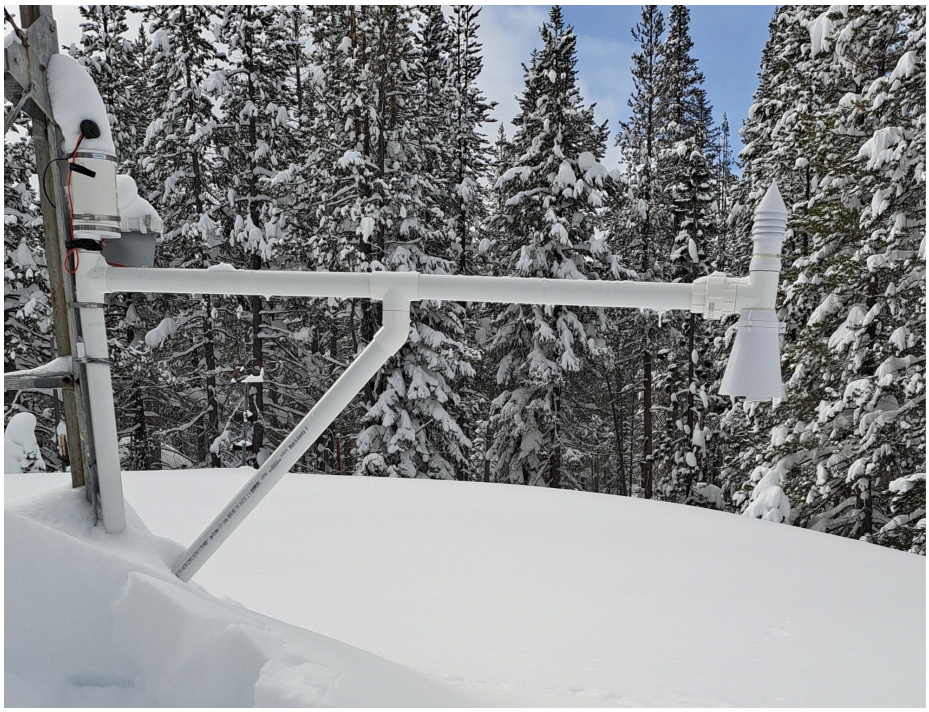


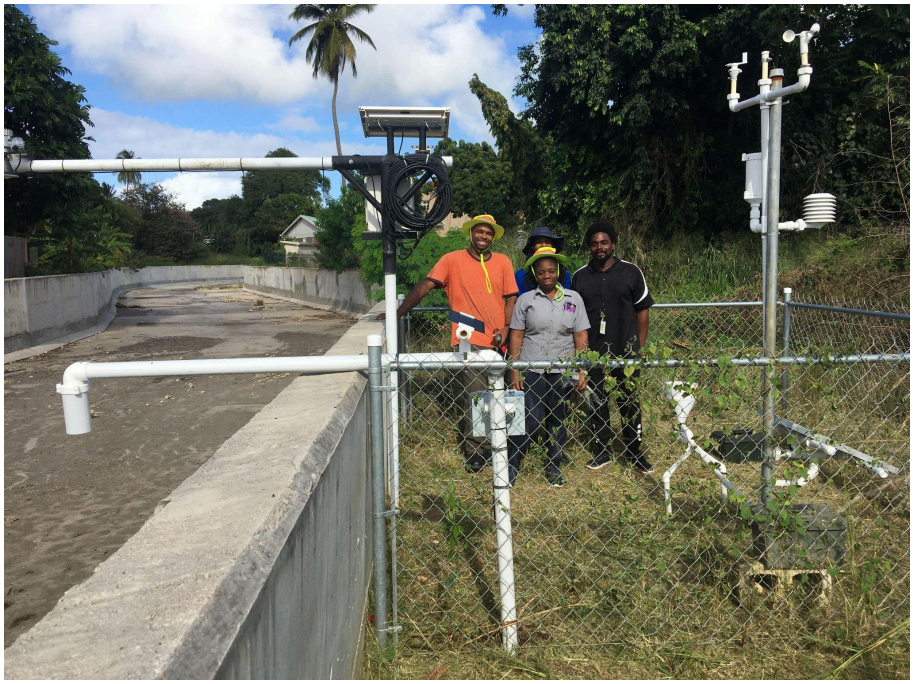
A 3D-PAWS unit at the NSF NCAR UCAR Marshall Research Facility in Boulder, CO.



The storm surge sensor detects changes in water levels to provide early warning of inundation hazards.



The snow depth sensor provides early detection of seasonal changes and snowmelt.



A 3D-PAWS stream gauge sensor at the Speightstown stormwater canal in Barbados next to the standard 3D-PAWS.