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RPPR Final Report
as of 21-Oct-2021

Agency Code: 21XD

Proposal Number: 74245EVREP

Agreement Number: W911NF-19-1-0478

INVESTIGATOR(S):

Name: Daniel Fernandez
Email: dfernandez@csumb.edu
Phone Number: 8315823786
Principal: Y

Organization: **California State University - Monterey Bay**

Address: 100 Campus Center, 86C, Seaside, CA 939558001

Country: USA

DUNS Number: 082412920

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Report Date: 15-Dec-2020

Date Received: 17-Mar-2021

Final Report for Period Beginning 16-Sep-2019 and Ending 15-Sep-2020

Title: High Spatial and Temporal Resolution Characterization of Fog and Effectiveness of Fog Water Capture

Begin Performance Period: 16-Sep-2019

End Performance Period: 15-Sep-2020

Report Term: 0-Other

Submitted By: Daniel Fernandez

Email: dfernandez@csumb.edu

Phone: (831) 582-3786

Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: 0

STEM Participants: 40

Major Goals: Purchase of the following equipment:

Two FM-120 fog droplet sensors with adjustable wind vanes. (vendor: Droplet Measurement Technologies)

Eight HP Probook laptops to allow direct communication with the firmware of the below devices. (vendor: HP)

Two cloud ceilometers (vendor: Mesotech)

Three chilled mirror hygrometers (vendor: Kahn Instruments)

Three 2-D sonic anemometers (vendor: LCJ Capteurs)

One 3-D sonic anemometer. (vendor: Gill Instruments/ Novalynx)

Accomplishments: All purchases were made.

Training Opportunities: In addition, the grant allowed me to travel to Droplet Measurement Technologies, which is the manufacturer of the FM-120 fog droplet sensors, just prior to the COVID lockdown. This took place in mid-February, 2020. This was a very important step in giving me added background and technical connections to allow me to do basic service on the FM-120 instruments, to enhance my understanding of the data structures associated with the output of the instrument, and to know whom to best address technical questions associated with FM-120 instrumentation.

Results Dissemination: A poster was presented on the early results of the deployment. Please see the attached materials.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI

Participant: Daniel Martin Fernandez

Person Months Worked: 1.00

Funding Support:

Project Contribution:

RPPR Final Report
as of 21-Oct-2021

National Academy Member: N

Participant Type: Graduate Student (research assistant)

Participant: Theodore Robinson

Person Months Worked: 3.00

Funding Support:

Project Contribution:

National Academy Member: N

CONFERENCE PAPERS:

Publication Type: Conference Paper or Presentation

Publication Status: 0-Other

Conference Name: American Geophysical Union

Date Received: Conference Date: 17-Dec-2021

Date Published: 17-Dec-2021

Conference Location: virtual

Paper Title: FM-120 and Standard Fog Collector Measurements of Mesh Efficiency

Authors: Theodore Robinson, Daniel Fernandez

Acknowledged Federal Support: **Y**

Partners

I certify that the information in the report is complete and accurate:

Signature:

Signature Date:

Report of DoD Project No. W911NF1910478

PI: Daniel M. Fernandez, Professor

Institution: CSU Monterey Bay

First of all, I want to thank the DoD Army Research Labs for providing the support to procure the requested equipment. Through this grant, we purchased the following:

Two FM-120 fog droplet sensors with adjustable wind vanes. (vendor: Droplet Measurement Technologies)

Eight HP Probook laptops to allow direct communication with the firmware of the below devices. (vendor: HP)

Two cloud ceilometers (vendor: Mesotech)

Three chilled mirror hygrometers (vendor: Kahn Instruments)

Three 2-D sonic anemometers (vendor: LCJ Capteurs)

One 3-D sonic anemometer. (vendor: Gill Instruments/ Novalynx)

The final device was purchased with the funds remaining as a result of slightly lowered costs of the above instrumentation.

In addition, the grant allowed me to travel to Droplet Measurement Technologies, which is the manufacturer of the FM-120 fog droplet sensors, just prior to the COVID lockdown. This was a very important step in giving me added background and technical connections to allow me to do basic service on the FM-120 instruments, to enhance my understanding of the data structures associated with the output of the instrument, and to know whom to best address technical questions associated with FM-120 instrumentation.

The above purchases and the training visit in February 2020 satisfied the requirements of the grant funding. In addition, as described below, I was able to manage a very fruitful deployment at a local field site using the FM-120 cloud droplet sensors, beginning in July 2020 and extending through November 2020.

As a result of the COVID lockdown, it was not possible to engage most of my students in hands-on activities related to setup of the equipment. However, I was able to deploy, with one authorized graduate student, the FM-120 droplet sensors at a local site that has ancillary meteorological equipment, including a cloud ceilometer, anemometers, and temperature and humidity sensors. This site also has three of what are known as "Standard Fog Collectors." These devices collect and measure the amount of fog that can be collected as liquid water. By deploying one of the FM-120's on the windward side of the array of fog collectors and the other directly behind one of them (see photo), we were able to obtain data spanning multiple fog events where we could examine the liquid water content in the air both fore and aft of the fog collectors. This provides a very opportune data set for determination of the efficiency of the fog collector mesh in a variety of different fog conditions.

This project was described as a part of the original proposal and I am very satisfied that we were able to carry it through and obtain meaningful data, despite COVID. My graduate student, Ted Robinson, is currently presenting our preliminary results at the virtual American Geophysical Union conference.

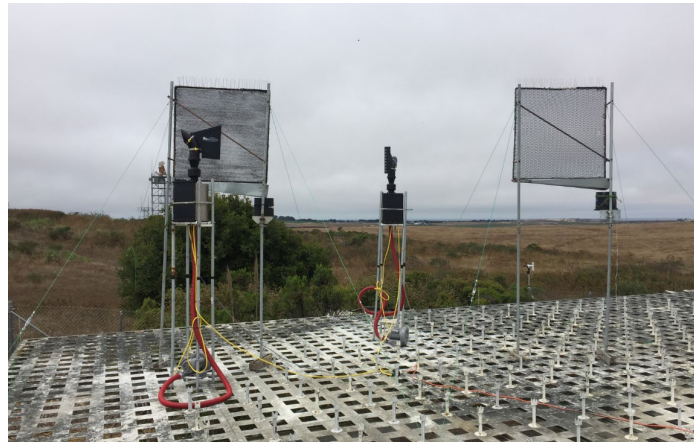


Fig. 1: Two standard fog collectors (square mesh) deployed near the two FM-120 instruments, which are the instruments with the wind vanes.

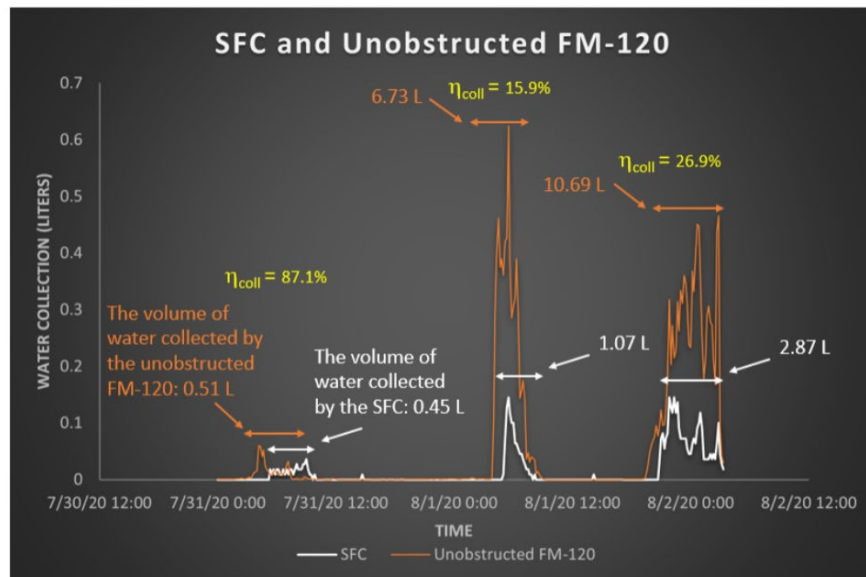


Fig. 2: A graph of the data collected from the FM-120's shown in conjunction with the water measured over the same period of time by the standard fog collectors. Calculated fog water collection efficiencies are also shown on the figure.

Future work will continue to seek an enhanced understanding of the variables associated with different efficiencies in fog water collection from a variety of mesh types. Additionally, by deploying the FM-120 units at distinct locations along with the ceilometers, chilled-mirror hygrometers and sonic

anemometers, we hope to gain a better representation of the spatial development and dissipation of advective fog events. This will require more intensive instrumentation deployment and collaboration to establish and will be more feasible to do following the end of the COVID epidemic.

An additional topic of research pursuit with the FM-120 units is in the potential characterization of aerosols generated by individual human activity, e.g. breathing, talking, and singing, since these are believed to be the primary vectors by which the COVID virus is transmitted. While not directly related to fog nor to the initial intention for the purpose of the proposed instrumentation, this equipment may offer a unique means to assess and quantify the degree and distance by which human-generated aerosols can be spread through the air in different ambient conditions.

There are no patents associated with this funding.