Comments on "A Proposed Standard Fog Collector for Use in High-Elevation Regions"

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1. The flat panel collector

Schemenauer and Cereceda (1994) recently proposed a standard fog (cloud water) collector for use in high-elevation areas. We would be less troubled by some of the gauge design features had the authors simply proposed its use for coastal fog deserts such as those of Chile where it was developed. We believe the major design limitations of the proposed gauge for high-elevation applications include

1) Fixed orientation. For fog/cloud water recovery studies in coastal deserts where advection fogs off the ocean are typically associated with a relatively constant wind direction, a fixed orientation gauge is desirable. In this environment, the gauge has clearly defined windward and leeward sides that must be fixed to simulate fog/cloud water catch from much larger arrays. For most mountainous terrain, however, both wind direction and speed can be quite variable and it is difficult to see how a single panel mounted in a fixed direction could be expected to accurately record fog/cloud water catch under all wind conditions. As wind direction changes from perpendicular to the panel, the cross-sectional area of the gauge exposed to the wind will decrease and the calibration for the instrument will be lost (i.e., it will underrepresent fog catch). The authors have suggested an "omnidirectional" version of their fixed panel mounted on bearings with a large wind vane. Such a configuration seems an unwieldy and expensive alternative to a simple cylindrical screen collector.

2) Separation of vertical and horizontal precipitation. The proposed gauge provides no mechanism for separating the horizontal and vertical components of precipitation, which seemingly should be the primary objective of a fog gauge. As wind speed and rainfall increase, output from the device will become increasingly exaggerated. The authors suggest that the vertical rainfall component could be determined using concurrent wind and rain gauge data and subtracted from gauge output, although they provide no supporting calibration data for the instrument's screen and trough behavior under different wind and rainfall conditions. Because of the complex nonlinear relationships between raindrop size, wind speed, and angle of inclination, it is likely that any mathematical expression developed to eliminate vertical precipitation in the results will introduce considerable uncertainty. This is particularly the case in both tropical and temperate montane environments where precipitation episodes frequently consist of the full range of droplet sizes. The proposed gauge was developed for use in the Chilean coastal desert where precipitation episodes are almost exclusively fog episodes. This represents an exceptional situation not typical of most montane environments.

3) Choice of screen material. The authors' proposed screen material seems an odd choice for an international standard. While the mesh shade cloth suggested is effective and inexpensive for fog collection, it has a variable catchment surface density and is not the most efficient collection material. The authors say that the mesh area depends on the mesh tension, implying that a uniform tension would be necessary for all installations, the sort of theoretical requirement that often gets overlooked in practical application. Other materials, such as a more rigid cylindrical-filament shade cloth, plastic or metal mesh, stamped sheet metal (louvered), or plastic filaments (harps) provide a uniform surface catchment density without need of special installation procedures. Also, a standard gauge should be as efficient a collector as possible to provide the greatest possible sensitivity to all fog conditions. While we do not want to denigrate the utility or quality of the Chilean shade cloth, it seems logical that a number of materials should be tested before any one of them is adopted as a standard. An additional problem with adopting any commercial shade cloth as a standard is the possibility of subtle product specification changes altering fog/cloud water catch characteristics; the manufacturer's produce shade cloth to provide a fixed shading percentage regardless of material design.

2. An alternative: The cylindrical collector

The fundamental purpose of a fog/cloud water collector is to compliment rainfall (vertical precipitation)

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measurements by providing a measure of the rate of interception of horizontally moving water droplets (horizontal precipitation) by vegetation or artificial catchment structures. It must support three major types of studies: 1) intersite comparison, 2) vegetation interception, and 3) water supply potential of large-scale fog collection. The instrument should possess several qualities:

1) It should present the same silhouette and catchment surface configuration to the prevailing wind, independent of the wind direction.
2) It should separate horizontal from vertical precipitation with a reasonable degree of accuracy for most wind conditions.
3) The material should have a semirigid structure, definable surface area, and high collection efficiency.
4) It should be inexpensive and of durable construction.

We suggest a cylindrical fog gauge of a type used in studies of Hawaiian mountain fog for over four decades that we believe meets the above criteria (Juvik and Ekern 1978). The collection surface is a louvered aluminum cylinder, 12.7 cm in diameter by 40.6 cm in height (see Fig. 1). As the material is manufactured from a single stamped aluminum sheet, it's surface area is exactly known, a useful parameter when calibrating a standard instrument. The louvered screen also has a high collection efficiency and good drainage characteristics, ensuring that a high percentage of intercepted fog water eventually ends up in the recorder or reservoir. In addition, the material has been manufactured in an unaltered form for over 40 years and is widely available.[1]

In past studies, we have left the top of the fog gauge open to rainfall and subtracted out the rainfall component from accompanying rain gauge data. In canopy throughfall studies in Hawaiian montane forests, we found that our models relating open-site rainfall and cloud water collection to throughfall broke down when the wind speed exceeded 2 m s^{-2}, approximately 15% of the episodes at our study site (Juvik and Nullet 1995). We are currently testing a gauge with a conical cap to eliminate the necessity for a rainfall correction and believe any standard must include a cover as well.

Our proposed instrument has many advantages over the Shemenauer–Cereceda model. It is an omnidirectional gauge without the need for bearings and other moving parts that could fail mechanically. The collection surface has a semirigid structure so the fog collection characteristics will not vary from instrument to instrument. It provides a better measure of horizontal precipitation. It is compact, lightweight, requires little assembly, and is easily mounted within the orifice of a standard rain gauge or other funnel collector. The gauge is also relatively inexpensive.

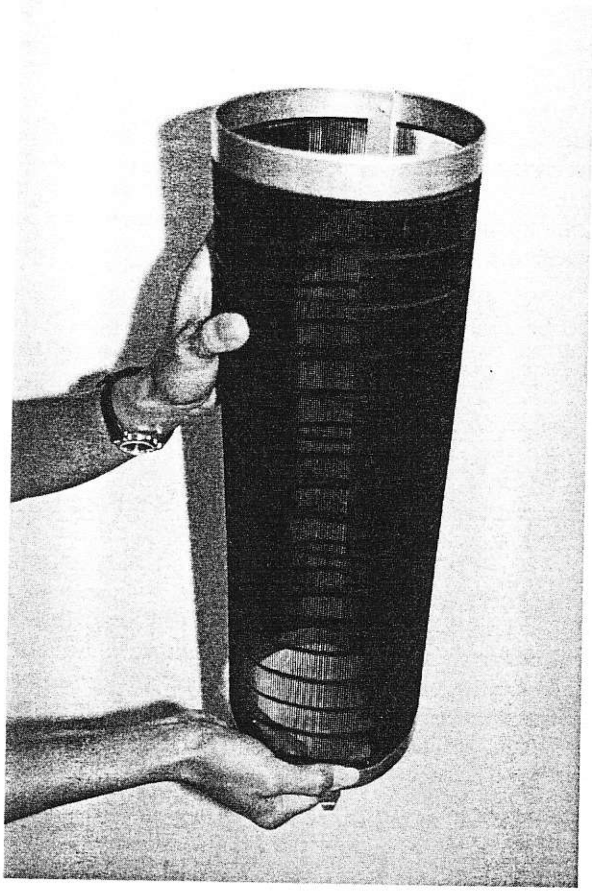

FIG. 1. An alternative fog/cloud water collector. Louvered screen collection material is manufactured from sheet aluminum (0.216-mm thickness). There are seven louvers per centimeter, each 23.1 mm long by 1.4 cm wide, angled at 17°. The cylinder, with louvers aligned vertically, is 12.7 mm in diameter and 40.6 cm in height (515.6-cm^2 silhouette area). It is designed to mount inside the orifice of a 15-cm-diameter recording rain gauge or funnel.

What we suggest is basically a larger version of the Grunow gauge that, as Shemenauer and Cereceda correctly point out, had shortcomings. The problems of nonvertical rainfall are overcome with the addition of a cap. The poor drainage characteristics are solved with the use of a material with superior drainage capability. And we have found the instrument to be highly correlated with fog water collection by vegetation in studies in Hawaii.

A fog gauge should provide a standardized indicator of horizontal precipitation conditions and not attempt to exactly mimic cloud water interception by any particular object (e.g., trees, shrubs, or large-scale fog water collectors). Application of fog gauge

[1] Kaiser SHADESCREEN, distributed by Phifer Wire Products, Inc., P.O. Box 1700, Tuscaloosa, AL 35403.

information requires comparative studies with the object under investigation. We feel that this gauge will provide consistent and comparable measurements of horizontal precipitation in all environments, from coastal deserts to tropical cloud forests to alpine mountains. If anyone is interested in testing one of these gauges or comparing it with an existing installation, we have a limited number available for distribution at no charge.

REFERENCES

Juvik, J. O., and P. C. Ekern, 1978: A climatology of mountain fog on Mauna Loa, Hawaii Island. Water Resour. Res. Center Tech. Rep. No. 118, University of Hawaii, Honolulu, Hawaii.

——, and D. Nullet, 1995: Relationships between rainfall, cloud-water interception, and canopy throughfall in a Hawaiian montane forest. *Tropical Montane Cloud Forests,* L. S. Hamilton, J. O. Juvik, and F. N. Scatena, Eds., Springer-Verlag, 165–182.

Schemenauer, R. S., and P. Cereceda, 1994: A proposed standard fog collector for use in high-elevation regions. *J. Appl. Meteor.,* **33,** 1313–1322.