RAIN ENHANCEMENT TECHNOLOGIES

CASE STUDY | A SUMMARY OF FINDINGS FROM A 6-YEAR TRIAL

# IONIZERS AND RAINFALL ENHANCEMENT IN OMAN


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Based on technical papers published by the Royal Statistical Society after peer-review*


A randomized trial of a ground-based rainfall enhancement technology, involving a network of ionization stations, was conducted in the Hajar Mountains of Oman during 2013-2018.

The trial was predicated on the assumption that natural aerosols, when ionized through exposure to an operating ionizer, would lead to larger raindrop formation downwind, and thus heavier rainfall than what would have occurred without intervention.

Installation in Oman

The experimental approach to the trial involved operating ionizers on a balanced randomized operating schedule, during which ionizers were switched on and off daily. This led to an approximately equal number of ionizers being in operation, or not, over the course of the 6-year trial. The design of the study resulted in, on any given day, a random half of the installed ionizers being in operation, with the other half switched off. The intent of the design was to ensure treatment-control balance in exposure to daily—and varying—meteorological conditions. Assuming that prevailing weather conditions were uniformly distributed across the trial area on any given day, this testing approach could be expected to generate an approximately equal number of target gauge-day observations (downwind of operating ionizers) and gauge-day observations (downwind of non-operating ionizers).

The observation unit was a “gauge-day,” with positive gauge-days defined as a target rainfall value when the gauge was downwind of one or more operating ionizers. Otherwise, the observation unit was classified as a control rainfall value. Target values are viewed as “treated” values, while control values are “untreated.”

- **6-Year Rigorous Scientific Trial** - Conducted in Oman's Hajar Mountains with randomized control methodology and peer-reviewed results published by the Royal Statistical Society
- **15-18% Average Rainfall Increase** - Statistically significant enhancement demonstrated across 488 rain days, with results confirmed through multiple analytical methods
- **Proven Technology for Arid Regions** - Results indicate strong potential for deployment in other water-scarce areas

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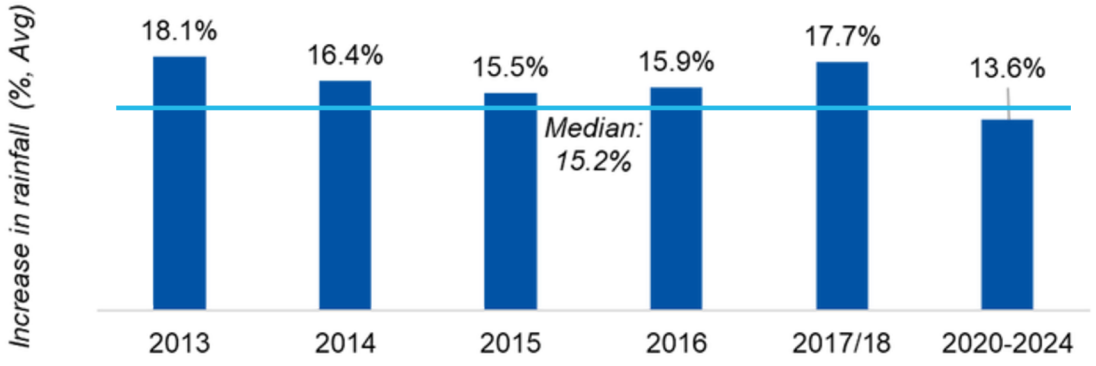
## Proven Results

Though the 6-year trial spanned a total of 849 days, the statistical assessment of impact was restricted to 740 days, for which wind direction data were available for analysis. (Wind data were missing for 109 of the trial's total days—all in the last 3 years of the trial—due to issues with the operation of the radiosonde at Muscat International Airport). Positive rainfall was quantified by the gauge network downwind of the installed ionizers on 488 days. On these "rain days," 4,168 gauge-day values of positive rainfall were recorded.

### Historical Oman Trial Results




Source: Royal Statistical Society and International Statistical Institute Journals

For the 488 days on which rainfall was observed downwind, the model-based analysis indicated that the use of ionization devices led to an average increase of 15% to 18% in rainfall. This translates to a "highly significant" average increase of 0.576 mm, or 0.023 inch, per gauge per day of rainfall for target gauge-days when ionizers were in use—or 143 gallons of water on a lawn 100 ft squared. A "double robust method" of assessment applied to the same gauge data also showed an enhancement in rainfall of over 10%.

The study noted that "it seems reasonable to conclude that the ionization-based rain enhancement technology used in the Hajar Mountain trial did lead to increases in rainfall." Moreover, results from the trial offer "quite significant implications for the use of this technology in other arid areas like those that exist in Oman."

## About The Author

George Bomar is the former Texas State Meteorologist with 46 years of experience in weather modification. He led the development of Texas's statewide rain-enhancement program, establishing 12 cloud-seeding projects covering more than 37 million acres and administering $13.7 million in state grants.

Mr. Bomar served as Past President of the Weather Modification Association and Chairman of the North American Weather Modification Council. He is the author of "Texas Weather" and "Weather in Texas" published by University of Texas Press, and a recipient of the National Weather Service's Thomas Jefferson award for outstanding meteorological observations.

*Source: Chambers, R., Ranjibar, S., Salvati, N., & Pacini, B. (2022). Weighting, informativeness and causal inference, with an application to rainfall enhancement. Journal of the Royal Statistical Society, 185, 1584-1612. https://rss.onlinelibrary.wiley.com/doi/10.1111/rssa.12873