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Re Staff Workshop on Advancing Precipitation Enhancement

Additional submitted attachment is included below.

EAGLE ROCK ANALYTICS

October 13, 2022

Dr. Martine Schmidt-Poolman
Energy-Related Environmental Research
California Energy Commission
Sacramento, CA

Re: Staff Workshop on Advancing Precipitation Enhancement

Dear Ms. Schmidt-Poolman:

Weather modification through cloud seeding has a long history in California. Whether it is a long and storied history or a long and troubled one depends on who is crunching the numbers. A comprehensive meta-analysis of historic and ongoing cloud-seeding operations is a critical first step towards CEC's goal of advancing science-based strategies for precipitation enhancement, which should precede investment of ratepayer funds in implementation and technology development research.

1. What would improve the focus of the effort, given the total of $2 million available?

Neutral evaluation of efficacy claims. As California considers all options to address climate induced water shortages, decision makers need reliable and trustworthy information on the efficiency of cloud seeding activities. Studies of cloud seeding efficacy are too often performed by organizations involved in cloud seeding operations or members of industry associations (e.g., Weather Modification Association). Hence, much of the evidence base for cloud seeding efficacy in California comes from sources with potential conflicts of interest (Silverman 2009; Griffith et al. 2005), a troubling finding which has been highlighted in reviews of cloud seeding efficacy (Rauber et al. 2019). Neutral, publicly funded studies in states such as Wyoming (Rasmussen et al. 2018) and Idaho (Tessendorf et al. 2019) on their cloud seeding programs provide the bulk of recent, independent scientific evidence for cloud seeding. However these states may have different climate conditions and goals than programs in California (for example, WY and ID programs focus on enhancing winter snowpack), and results from these programs may not generalize to efforts in California.

California needs a rigorous metastudy of pre-existing and ongoing cloud seeding efficacy to inform the basis for funding, as well as to determine potential climate impacts. Opportunities to assess cloud seeding efficacy and potential impacts on a future high-renewable grid exist within ongoing energy system research supported through EPIC funds as part of California's Fifth Climate Assessment.

Calls for increased total funding. At the Staff Workshop held on September 29, 2022, multiple commenters provided oral statements implying that $2,000,000 was insufficient for cloud seeding efficacy studies, whereas additional comments noted that statewide modeling efforts cost $10,000,000 to perform. Increasing the budget for this work, particularly for considering deployment strategies and optimizing

equipment, is premature. A baseline understanding of the efficacy of existing operations, establishment of maximum potential impacts, and an understanding of how future climate change will impact cloud seeding (i.e., a shifting isothermal window of seeding opportunity) is strongly recommended before additional research tasks are executed, and is achievable at or below CEC's proposed budget. We urge CEC to not increase the total amount of funding available before such a metastudy is thoroughly completed and reviewed.

2. How can the effort outlined best complement, build on or leverage other relevant efforts (pilots, projects, data, research, etc.)?

Assessment of the historical execution and potential future role of cloud seeding in the functioning of California's electric grid can be accomplished by building on or augmenting the Scope of Work of current EPIC funded projects:

Ongoing Climate Projections. CEC should request that downscaled runs of future climate in California (supported by EPC-20-006) include variables such as total integrated liquid cloud water and temperature at levels targeted in cloud seeding (i.e., 700 hPa), which can be used to evaluate future suitability of conditions for cloud seeding (Pokharel et al. 2021).

Hydroelectric Resource Potential Profiles. The modeling framework in development for EPC-21-037 can receive gridded fields of precipitation (and other weather inputs) from seeded and non-seeded events (in both past and future climates) and the impacts on hydroelectric functionality, and impacts to grid operations, can be directly assessed.

Meta-Analysis. With sufficient data from EPC-20-006, the Cal-Adapt: Analytics Engine (i.e., EPC-20-007) can execute a thorough meta-analysis of historical and future efficacy of cloud seeding operations in California, in an open and transparent manner, which is of timely concern to future performance and development of precipitation enhancement efforts specific to California's climate and energy systems.

Timely response. EPIC funding is an incredible resource which advances understanding of energy-climate interactions, however it can be a prolonged process to go from funding availability to project onset. Significant effort and staff time is needed to advance an idea from funding to a grant funding opportunity, to generation of proposals, to selection of proposals, and ultimately agreement development. In contrast, current agreements can be augmented quickly, and teams are in place to perform the work in a quick manner. A more targeted, more science-based GFO could be developed based on the timely results from existing project groups, without the need for additional CEC staff time oversight and agreement development.

Respectfully,

Owen Doherty, Ph.D.

Work Cited.

Griffith, D. A., Solak, M. E., Almy, R. B., & Gibbs, D. (2005). The Santa Barbara Cloud Seeding Project in Coastal Southern California, Summary of Results and Their Implications. The Journal of Weather Modification, 37(1), 1.

Pokharel, B., Wang, S.-Y. S., Gu, H., LaPlante, M. D., Serago, J., Gillies, R., Meyer, J., Beall, S., & Ikeda, K. (2021). A modeling examination of cloud seeding conditions under the warmer climate in Utah, USA. Atmospheric Research, 248, 105239. https://doi.org/10.1016/j.atmosres.2020.105239

Rasmussen, R. M., Tessendorf, S. A., Xue, L., Weeks, C., Ikeda, K., Landolt, S., Breed, D., Deshler, T., & Lawrence, B. (2018). Evaluation of the Wyoming Weather Modification Pilot Project (WWMPP) Using Two Approaches: Traditional Statistics and Ensemble Modeling. Journal of Applied Meteorology and Climatology, 57(11), 2639–2660. https://doi.org/10.1175/JAMC-D-17-0335.1

Rauber, R. M., Geerts, B., Xue, L., French, J., Friedrich, K., Rasmussen, R. M., Tessendorf, S. A., Blestrud, D. R., Kunkel, M. L., & Parkinson, S. (2019). Wintertime Orographic Cloud Seeding—A Review. Journal of Applied Meteorology and Climatology, 58(10), 2117–2140. https://doi.org/10.1175/JAMC-D-18-0341.1

Silverman, B. A. (2009). An evaluation of the San Joaquin operational cloud seeding program using Monte Carlo permutation statistics. *The Journal of Weather Modification*, *41*(1), 15-22.

Tessendorf, S. A., French, J. R., Friedrich, K., Geerts, B., Rauber, R. M., Rasmussen, R. M., ... & Bruintjes, R. (2019). A transformational approach to winter orographic weather modification research: The SNOWIE Project. *Bulletin of the American Meteorological Society*, *100*(1), 71-92.