Chamber Research to Enable New Weather Modification Products Evaluation of Commercially Produced Ice Nuclei Project David J. Delene, Principal Investigator Bruce Boe, Project Director Neil Brackin, President

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## **Scientific Weather Modification Methods**





**Ground Generator** 





### **Preliminary Research Data**



#### Agl Ground Generator (4 November 2015, 13:53:40 – 13:54:59 CST)





**Particle Diameter [nm]** 

### **Objective: Effectiveness of Ice Nuclei**

- Document the effectiveness of current and new types of seeding pyrotechnics to produce active ice nuclei.
- Develop, test, and employ a system for injection of cloud seeding material produced by silver iodide flares.



Schematic of the cloud-nuclei injection system for burning flares that enables sampling with a scanning mobility particle sizer (SMPS) and a condensation particle counter (CPC), along with injection of cloud nuclei into a chamber.



### **Technology Advancement**

- Develop system for injecting ice nuclei into a chamber.
  - Design system that works with the Pi Cloud Chamber.
  - Build the cloud-nuclei injection system.
  - Determine particle concentration range produced by the cloud-nuclei injection system.
- Conduct experiments in laboratory chambers.
  - Conduct tests using UND's aerosol chamber.
  - Conduct initial Pi Cloud Chamber test.



#### **Expected Results**

Background Ice Nuclei (IN), Pyrotechnics, Ground Generator



## **Weather Modification Motivation**

- Water is critically important for many human and economic activities.
  - The largest issues facing society are energy and water (Professor Richard Smalley – Our Energy Challenge)
- Weather modification has a low cost to benefit ratio if it can increase precipitation on the order of 10 percent.
- Weather modification has not been rigorously proven; however, there have been positives scientific results.

## **Weather Modification Markets**

- Projects are typically sponsored by agricultural organizations, municipalities and hydroelectric utilities.
  - \$558,000 Spent on UAE cloud-seding.
  - Alberta hail suppression program cost ~
    \$4 million a year.
  - State of Maharashtra in India conducted a \$4.5 million cloud seeding program in 2015.
  - State of Wyoming recently conducted a nine-year, \$14 million weather modification study.

## **Economic Impacts**

- Maintain world leadership in seeding pyrotechnics.
  - Important selling point.
- Market size for sale of cloud seeding pyrotechnics.



- Winter cloud seeding in 11 of the 17 western states.
- Many countries around the world have active weather modification projects.



#### **Scope of Weather Modification Projects**



Map created by Timm Uhlmann using information from Bruintjes (2013).

### **Proposed Project Details**

- Three Year Project
  - Build Cloud-nuclei Inject System
  - Measure Ice Nuclei Size Spectrum at UND
  - Measure Ice Nucleation Capability using Cloud Chamber
- Total Budget \$223,540
  - 50 % Match (\$111,770)



# Questions Comments Discussion