Recommendations for Future

Research in Riyadh, Saudi Arabia



David J. Delene Atmospheric Sciences Department University of North Dakota

Motivation for Weather Modification Research

- Water Resource Stresses
- Severe Weather Hazards
- Inadvertent Weather Modification
- New Observational, Computational, Statistical Technologies
- Operational Programs with insufficient Scientific Basis

Possible Methods

• Statistical Methods

A randomized experiment conducted to determine the effect of a weather modification technique.

• Process Methods

Conduct experiments to determine how the precipitation process and how weather modification technique modify the precipitation process.

Statistical Methods

• Advantages

Quantifies an amount of a seeding effect.

• Disadvantages

Takes several years, possibly a decade to get statistically meaningful results. Hence, required long term research commitment.

Limited value in understanding what is the research of an effect or lack of an effect.

Process Methods

• Advantages

Provides understanding in to why a weather modification technique work or does not work.

• Disadvantages

Requires a well planned measurement program to collect focused observations.

Requires a large set of instruments, including radars and aircraft.

Modelling

 When and to what extent can precipitation in Saudi Arabia be successfully modelled using a 4-D model such as the Weather Research and Forecasting (WRF) model.

If we really understand the precipitation formation process, models that agree well with observation are possible.

Accurate models can be used to predict how well seeding techniques work.

Models can provide guidances to operational cloud seeding.

Research Objective: Hydro

- What is the distribution of the change of cloud droplet size with height above cloud base.
- What is the distribution of cloud base CCN concentration.
- How does the super-micrometer aerosol size distribution from a hygroscopic flare burned at cloud base compare to the natural cloud base aerosol size distribution.
- How hygroscopic are the supermicrometer aerosol that natural occur at cloud base.

Research Objective: AgI

- What is the statistical distribution of super-cooled liquid water in Saudi Arabia clouds?
- How much more effective is AgI seed at producing ice that natural conditions?
- What is the statistical distribution of updraft velocity in conditions of super-cooled liquid water.

Research Objective: General

- Quantitatively, how well do current models do at predicting precipitation.
- How can the models be tuned to work better in the Saudi Arabia region.
- Can the model predict unusual field project observations. For example, the 9 April 2009 'Brown' Ice.
- What is largest uncertainty which caused model to not be able to predict precipitation amount in Saudi Arabia.

Personnel Training Objective

Single most important component to a successful weather modification project is to have highly trained personnel.

- Should have train personnel in the areas of radar, aircraft measurement and seeding techniques, and modelling.
- Training outcome is limited by the initial knowledge level of the students.
- The student's initial knowledge level varies greatly, hence a successful training program requires a targeted instruction which requires a lot of teacher time.



- What do you want to get out of a training program?
 - Who determines the particulars of a training program in terms of mentoring, subject matter and evaluation?
 - Should there be more more extensive in country training?
 - Are University credits important in the training program?
 - Does/should a training contract be tried to an operational program or research program?
- What do you want to get out of a research field project?

Important Parameters

- Cloud Droplet Distribution
- Cloud Phase
- Cloud Condensation Nuclei Spectrum
- Cloud Supersaturation
 - Cloud Base Updraft Velocity