AtSc 252 Applied Weather Modification

**Study Guide: Spring 2022 - Exam 3**

# Section I

## Weather Modification Projects and Aircraft Research Experience

North Dakota Cloud Modification Project Location, Flight Hours, and Partners

Aircraft Seeding Equipment and Activities

Types of Aircraft Flight Activities

Research Aircraft Projects, Activities and Objectives

## Weather Modification History **and Critical Thinking**

Weather Modification Pioneers

First Test: Results and Experiments

Operational Programs Locations

Analyze to Formulate Conclusions/Opinions

## Legal, Environmental and Sociological

Licenses/Permits, Laws, and Liability

Water Rights

Cloud Seeding Environmental Impacts

Effect of Silver Iodide (AgI)

Public Awareness, Concerns and Fears

## Economics **and Inadvertent Modification**

Costs and Benefits

North Dakota Economic Impacts

Scale of Possible Effects

Possible Mechanisms for Inadvertent Effects

Urban and Rural Impacts

## Evaluation of Weather Modification Projects

Black Box and Physical

Operational Evaluations Issue

Distribution, Hypothesis Testing and P-values

Statistical Evaluation Methods

Evaluation of North Dakota Cloud Modification Projects

## Aerosols, Water and Nucleation

Aerosol, Cloud Condensation Nuclei (CCN) and Ice Nucle (IN) Concentrations and Sizes

Atmospheric Aerosols Vertical, Horizontal and Temporal Distribution

Sources, Sinks and Composition

Energy and Phases of Water

Saturation and Changes

Equilibrium of Water

Mechanisms of Ice Crystal Nucleation

Ice Nucleation Activity as a Function of Temperature

# Section II

## Droplet Growth and Ice Nuclei Activation

* 1. Solute and Curvature Effects
  2. Köhler (Koehler) Curve
  3. Growing Droplets and Cloud Formation
  4. Effectiveness of Ice Nuclei
  5. Activation of Ice Nuclei

## Ice Crystal Growth

* 1. Equilibrium Vapor Pressure
  2. Mixed Phase Clouds

## Basic Clouds

* 1. Convective Clouds
  2. Ice Clouds

## Cloud Dynamics

* 1. Cold Rain Process
  2. Warm Rain Process

## Conceptual Models

* 1. Updraft Speed

## Precipitation Models

* 1. Microphysical Seeding
  2. Dynamic Seeding
  3. Over-seeding
  4. Orographic Precipitation Enhancement

## Hail Suppression Conceptual Models

* 1. Hail Growth
  2. Precipitation Augmentation
  3. Types of Hail Suppression Conceptual Models
  4. National Hail Research Experiments

## North Dakota Cloud Modification Project (NDCMP) Conceptual Model

* 1. Natural Hail Process
  2. Cloud Seeding Hypothesis
  3. Feeder and Mature Cells
  4. Multi-cell Storms

# **Section III**

## **Fog Abatement**

* 1. Types of Fog
  2. How to modify different types of fog?

## **Lightning Suppression**

* 1. Fair Weather Charge Field
  2. Cloud Charging Mechanisms
  3. Lightning Modification Concepts

## **Hurricane Modification**

* 1. Hurricane Characteristics
  2. Project Stormfury Results
  3. Possible Modification Theories

## **Seeding Materials**

* 1. Types of Cloud Seeding Materials
  2. Types of Cloud Seeding Equipment
  3. Cloud Seeding Efficiency, Activity, Activation, Deactivation

## **Dry Ice as Seeding Agent**

* 1. History of Dry Ice Seeding
  2. How does Dry Ice work?
  3. Where and When to Use Dry Ice
  4. Using Dry Ice

## **Seeding Agent Dispersal**

* 1. Release of Cooling Agents
  2. Release of Ice Nuclei

## **Seeding Equipment and Methods**

* 1. Airborne and Ground based Seeding
  2. Cloud Top and Cloud Base Seeding
  3. Pyrotechnic Methods
  4. Reaction Times of Seeding Agents

## **Radar for Weather Modification**

* 1. Radar Measurements and Detection
  2. Radar Measurements from Aircraft
  3. Components of a Radar System
  4. Types of Radar Displays
  5. Characteristics of Electromagnetic Radiation
  6. Radar Terms and Types
  7. Dependence of Radar Echos
  8. Levels of Radar Reflectivity
  9. Height of Radar Beams
  10. Radar Attenuation
  11. Radar Beam Characteristics
  12. Doppler Radar

## **Record-keeping (PARS System)**

* 1. Components and Cost of Seeding Solution
  2. Reason for Record-keeping
  3. Pilot/Co-pilot Typical Roles and Employment
  4. Peak Aircraft Launch Times for NDCMP