UNIVERSITY OF NORTH DAKOTA

ATSC 252 Applied Weather Modification

2026 Spring | On Campus Face to Face

Meeting Information

Class Credits: 3 Undergraduate Credits
Pre-requisites: AtSc 110: Meteorology
Class Meeting Time: 4:00 PM - 5:15 PM
Class Meeting Location: Odegard Hall, Room 103
Zoom Link - https://und.zoom.us/j/97550283777;
Web - http://www.openscienceassociates.com/delene/AtSc252_Spring2025/index.html

Course Information

The syllabus describes the requirements and procedures for the Applied Weather Modification (AtSc 252) class. Students are responsible for knowing the class syllabus material; hence, please read the syllabus carefully. Any changes are announced using the University of North Dakota (UND) Blackboard site and during class meetings. Students are responsible for keeping up to date with class material. Continued enrollment in the course is your implicit agreement to abide by the class requirements. The Blackboard site is used for taking quizzes, exams, and for students' grades. Website(s) contain links, videos (Zoom, etc.), and presentation material related to the class.

About the Professor & Contact Information

David Delene
Title: Research Professor and Aerospace Research Fellow
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Office Location
Clifford Hall 420
Student Hours: Tuesday/Thursday 3:00 - 4:00 pm. or by Appointment

I would like to welcome you to AtSc 252 - Applied Weather Modification. I have been actively involved in the weather modification field since 2007. I have conducted field projects in North Dakota, Mali, and Saudi Arabia. During these field projects, I have flown with some of the most experienced weather modification pilots in the world and worked with some of the best people. Additionally, I have conducted weather modification workshops for Burkina Faso, Morocco, and Saudi Arabia. I have presented invited presentations in South Korea, China, India, and the United Arab Emirates on weather modification topics. I have published peer-reviewed papers on using aircraft measurements and rain-gauge data to assess weather modification projects. Research projects have included the evaluation of hygroscopic cloud seeding, glaciogenic cloud seeding, and hail suppression operations. My research projects have obtained and analyzed aircraft-based, cloud micro-physical measurements for the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), National Science Foundation (NSF) and private companies. I am a past (2012-2021) Editor of the Journal of Weather Modification from 2012 to 2021. I have been teaching the applied weather modification class at the University of North Dakota since the Spring of 2021.

Course Description

This is a semester-long course designed to provide a broad understanding of applied weather modification operations as currently conducted around the world. An important component of developing a long-term, sustainable weather modification project is personnel training. Conducting an operational program that involves an airborne cloud seeding program is a highly technical undertaking that combines the fields of aviation and meteorology. Without technically trained personnel with an understanding of the scientific fundamentals of weather modification, it is unlikely that the program's objectives can be obtained. Having educated personnel with the necessary technical knowledge enables programs to conduct cost-effective and productive operations. A broad background in weather modification methods enables personnel to understand and adapt

to technical and scientific advances, which can occur rapidly in the weather modification field. For example, new observation methods, equipment development, and computer models are continuously being developed and incorporated into weather modification programs.

The University of North Dakota (UND) has a long history of weather-related research, including weather modification and cloud physics, which "took off" in 1974 when the school acquired its first weather radar. Additionally, the State of North Dakota has a long history of funding a co-pilot internship program where UND students can be involved with the North Dakota Cloud Modification Project (NDCMP) each summer. The University of North Dakota (UND) has a formal memorandum of understanding (MOU) in place whereby co-pilot interns work on the NDCMP. Additionally, UND students have the opportunity to be project meteorological interns each year. While the meteorological interns are not exclusive to UND like the co-pilot interns, many non-UND meteorological interns learned about UND's Graduate School because of the program. Several of these students have attended and graduated from the Atmospheric Sciences Graduate Program at UND. The UND co-pilot internship program has a long history, which started with a National Science Foundation grant in 1973. Since then, more than 400 UND student pilots have participated in the internship program. See the "[Leading Research IN THE CLOUDS](#)" AeroCom Summer 2019 article for additional information.

Course Objectives/Learning Outcomes

Provides a comprehensive introduction to basic concepts of weather modification as currently practiced around the world. Topics include a study of cloud physics, seeding theory, a review of past and current programs, and a discussion of related legal, societal, economic, and environmental issues. The class provides students with exposure to the practical aspects of weather modification operations, including operational program design and evaluation, care and use of seeding materials and equipment, identification of seeding opportunities, and methods of airborne delivery of seeding materials. The course goals are:

- To learn how cloud weather modification projects are established and conducted.
- To learn the theoretical basis for weather modification.
- To learn how weather forecasting contributes to weather modification programs.

- To learn how to effectively participate in operational programs.

By the end of this course, students should be able to demonstrate the learning outcomes:

- State why and where weather modification operations are conducted.
- Recognize the overall context and factors affecting the application of cloud seeding.
- Explain the theoretical basis and assumptions for weather modification.
- Explain what constitutes a seeding opportunity.
- Identify cloud seeding opportunities and select appropriate conditions for treatment.
- Describe how cloud seeding equipment works and its operational limitations.
- Conduct cloud seeding operations safely and effectively.
- Distinguish between valid and false claims of cloud seeding effectiveness.

Applied Weather Modification is a specialized field that does not have a physical textbook available. Hence, this course makes use of open educational resources (OER). Open educational resources are freely accessible, openly licensed documents and media that are useful for teaching and learning. These required resources are available to students at no cost and will be used in place of physical textbooks.

Technical Requirements & Assistance

Whether you're taking courses in the classroom or online, it's important to have the right technology and equipment. Visit the UND Technical Requirements webpage for more information. Students are expected to use their official UND email in the course. For technical assistance, please contact UND Technical Support. Visit the University Information Technologies (UIT) website for their hours, help documents, and other resources.

Visit the Knowledge Base for additional support and information about general tech requirements for students including information about devices, operating systems, software, internet connection, and major-specific tech requirements.

Student Success Resources

UND cares about your success as a student. For more information, visit the [Student Resources Page](#) for additional information. Students have access to assistance from the [UND Writing Center](#), [Tutoring and Learning Services](#), [Academic Services](#), and more.

Students also have access to the UND Student Resource Site via Blackboard. It is recommended that you become familiar with the tools and tutorials within Blackboard to better equip you in navigating the course and [Educational Technologies](#).

Minimum Technical Skills

To succeed in this course, you should be able to:

- Navigate in and use Blackboard functions like submitting an assignment, taking a quiz, and locating resources
- Download and open electronic documents
- Create, save, and upload/attach electronic documents
- Send, receive, and manage email

Visit the [Knowledge Base](#) for additional supports and information about general tech requirements for students including information about devices, operating systems, software, internet connection, and major-specific tech requirements.

Access & Log In Information

To get started with the course, please go to: http://blackboard.UND.edu and log in with your NDUS.Identifier (Username and Password). If you do not know your NDUS Identifier or have forgotten your password, please visit Your [NDUS Account Webpage](#) on the [UIT website](#).

Course Structure

This course contains 5 blocks of lessons designed to focus your study of applied weather modification and to assist you in achieving the course learning objectives and outcomes. You will work through a combination of required readings, view captioned videos, take quizzes and exams.

Block 1 (Introduction)

- Introduction, Course Syllabus, and Overview
- History of Weather Modification
- Critical Thinking and Legal Aspects
- Environmental Concerns and Sociological Issues
- Economic Impacts
- Exam I (Block 1)

Block 2 (Theory)

- Unintended Weather Modification
- Statistical Evaluations
- Atmospheric Aerosols
- Atmospheric Water Vapor
- Particle Nucleation
- Droplet Growth
- Ice Crystal Growth
- Exam II (Blocks 2 and 1)

Block 3 (Application)

- Basic Clouds and Cloud Formation
- Precipitation Processes
- Cloud Dynamics
- Conceptual Models
- Precipitation Conceptual Models
- Hail Suppression Conceptual Models
- North Dakota Cloud Modification Project (NDCMP) Model
- Exam III (Blocks 3, 2, and 1)

Block 4 (Methods)

- Winter-time Precipitation Enhancement

- Fog Abatement

- Lightning Suppression

- Hurricane Modification

- Seeding Materials

- Dry Ice as Seeding Agent

- Exam IV (Blocks 4, 3, 2, and 1)

Block 5 (Operations)

- Seeding Agent Dispersal

- Seeding Equipment and Methods

- Radar for Weather Modification

- Record Keeping and iPARS

- Weather Forecasting and SkewT Basics

- Daily Operations and Opportunity Recognition

- Flight Safety

- Case Example: Put All Together

- Final Exam (Blocks 5, 4, 3, 2, and 1)

Assessment Details

This course is made up of a series of quizzes and exams, which will be graded. Exams and the final exam are comprehensive of the class material covered. There are quizzes for each topic covered. Each course block has an exam, with the final exam including block 5. The exams are in class, with a sign-out sheet, using the Respondus Exam Authoring Tool.

Grading Scale

Grading Scale that shows the breakdown for A, B, C, D

Grading Scale

Grading Scale	
A	90% - 10
B	80% - 8
C	70% - 7
D	60% - 6
F	0% - 5

Breakdown of individual assignments/actives and associated point values.

Assignment/Activities	Breakdown
Quizzes	20 %
Exams	60 %
Final Exam	20 %

For more information on grading review [UND Grading Policies](#).

Course Evaluation

Near the end of the semester, you will be asked to complete an online course evaluation form.

- When the time comes, please let me know which aspects of the course helped you learn— and which aspects might be modified to help future students learn more effectively.
- Please note that the course evaluations are anonymous and that I won't see the results until after the grades for the course are submitted, allowing you to provide honest and constructive feedback.

Course Logistics

Assignment and Late Work Policy

Due dates for each quiz or activity will be posted in Blackboard. All quizzes must be submitted by the due date and time posted in the course. All times are posted in the Central Time Zone.

The acceptance of late assignments is at the discretion of the instructor. If extenuating circumstances arise, it is your responsibility to contact the instructor before the due date and

request an extension. All requirements for this course must be completed during the course dates.

Class Participation

Participation and presence in class are paramount for students to learn the material and be successful. Students are required to log in regularly to the online class site. Students are also required to participate in all class activities.

Incompletes

It is expected that students will complete all requirements for a course during the time frame of the course. For reasons beyond a student's control, and upon request by the student or on behalf of the student, an incomplete grade may be assigned by the instructor when there is reasonable certainty the student will complete the course without retaking it. The mark "I," Incomplete, will be assigned only to the student who has been in attendance and has done satisfactory work up to a time within four weeks of the close of the semester, including the examination period, and whose work is incomplete for reasons satisfactory to his or her instructor. More information regarding UND's Incomplete policy can be found on [The Grading System Webpage](#).

Technology Statement

In this class, we will have a technology policy that is designed to support your attention to one another and to the course material. We will spend the majority of our time engaged in activities that depend upon you being present and attentive to one another, and the course content we will study. We are all challenged these days by how our digital devices—including laptops, tablets, phones, and watches—can steal our attention away from our immediate surroundings. Technology should be used for educational purposes only during scheduled class times.

Netiquette

Always use professional language (no netspeak) in your assignments and emails. Please always be respectful of others, even if you disagree with their ideas or do not get along. Here are a few basic points to remember when communicating in this course:

- Be scholarly. Use proper language, grammar, and spelling. Explain your thoughts, justify opinions, and credit the ideas of others by citing or linking to scholarly resources. Avoid misinforming others when you are unsure of the answer. When discussing something and supplying a guess, clearly state that.

- Be respectful. Respect the privacy of others. Do not share personal or professional information about others unless permission has been granted. Respect diversity and opinions that differ from their own. Be tactful when you communicate.
- Be professional. Everyone should strive to give their best impression online. Truthfulness, accuracy, and running a final spell check are appropriate expectations for university students. Writing in a legible font and limiting the use of emoticons is considered professional behavior. Profanity and participation in hostile interactions are unprofessional as well as disruptive.
- Be polite. Students should be addressing professors and instructors by the appropriate title or requested name. Students should interact online politely, just as they would be expected to do in a physical environment. Sarcasm, rudeness, and writing in all capital letters should be avoided.

Collaboration and Recording (For Online, Hybrid, Hyflex courses)

Sharing personal experiences and opinions is an important part of the learning process. In the (hybrid, hyflex, synchronous, etc.) environment of this course, our interactions may be recorded and shared with students in the course. If you have questions or concerns about any recordings, please contact me.

Artificial Intelligence (AI)

For more information on AI Policies, please visit [Artificial Intelligence Resources](#).

Names and Pronouns

Everyone should feel included and respected at UND.

I recognize that preferred names may change during the semester. If at any point during the semester, you would like to be addressed differently, please let me know.

As part of our commitment to inclusion in this course, it is important that all students in this class are respectful of their peers. Mistakes in addressing one another may happen. If you make a mistake or are corrected, please briefly apologize and correct yourself.

If you have experienced discrimination or harassment or have concerns about using another student's preferred name or pronoun, please contact the [Equal Opportunity & Title IX Office](#) for assistance.

University of North Dakota Academic Policies

Attendance Policy

Attendance and participation in class activities are considered integral parts of a university education. It is the University policy that attendance in classes is expected of all students. If attendance and/or participation are required and will impact grading, it is the responsibility of the instructor to communicate clearly that policy to students during the first week of class in the course syllabus.

Even in situations where an instructor might excuse a class absence, e.g., severe medical situations, family emergencies, military service, or authorized University activities, it is the responsibility of the student, whenever possible, to inform the instructor ahead of time.

Incomplete Policy

It is expected that students will complete all requirements for a course during the time frame of the course. For reasons beyond a student's control, and upon request by the student or on behalf of the student, an incomplete grade may be assigned by the instructor when there is reasonable certainty the student will successfully complete the course without retaking it. The mark "I," Incomplete, will be assigned only to the student who has been in attendance and has done satisfactory work up to a time within four weeks of the close of the semester, including the examination period, and whose work is incomplete for reasons satisfactory to his or her instructor. More information regarding UND's Incomplete policy can be found on [The Grading System Webpage](#).

Academic Grievance Policy

If you have a concern about this course, you should first contact your instructor. If you would like to initiate a formal academic grievance, defined by [UND's Code of Student Life](#) as "a statement expressing a complaint, resentment, or accusation lodged by a student about an academic circumstance (such as assessment, grading, testing, quality of instruction) which is thought by the student to be unfair," please review the college's grievance process. If you have any questions, contact the college dean's office.

Final Exam Policy

If a student has three or more finals scheduled the same day, the student may request an accommodation regarding final exams by contacting their instructors by the deadline to establish a mutually acceptable time to reschedule one or more of the exams. A student who is absent from a regularly scheduled examination without an excuse considered valid by the instructor is

normally given an F for the course. If the excuse is valid, the policy on incompletes will apply. [Review the full final exam policy](#).

Communication

The main way to communicate is by attending class. Please attend office hours or discuss items after class with the professor.

University of North Dakota Compliance Policies

Accessibility Statement

The University of North Dakota is committed to providing equal access to students with documented disabilities. To ensure access to your classes and program, please contact [Student Disability Resources](#) to engage in a confidential discussion about accommodations for the classroom, clinical and/or online course settings.

Accommodations are not provided retroactively. Students are encouraged to register with [Student Disability Resources](#) at the start of their class/program. More information can be obtained by email; UND.sdr@UND.edu, or by phone at 701.777.2100.

Religious Accommodations

UND offers religious accommodations, which are reasonable changes in the academic environment that enable a student to practice or observe a sincerely held religious belief without undue hardship on the University. Examples include time for prayer or the ability to attend religious events or observe a religious holiday. To request an accommodation, complete the [student religious accommodation request form](#). To learn more, please consult [UND's Religious Accommodations Policy](#) or contact the [Civil Rights & Title IX Office](#).

Pregnancy Accommodations

Students who need assistance with academic adjustments related to pregnancy or childbirth may contact the [Civil Rights & Title IX Office](#) or Academic Affairs to learn about your options. Additional information and services may be found at [Pregnancy Resources](#) and in [UND's Protections for Pregnant and Parenting Students and Employees Policy](#).

Notice of Nondiscrimination

It is the policy of the University of North Dakota that no person shall be discriminated against because of race, religion, age, color, gender, disability, national origin, creed, sexual orientation, gender identity, genetic information, marital status, veteran's status, or political belief or affiliation and the equal opportunity and access to facilities shall be available to all. Concerns regarding Title IX, Title VI, Title VII, ADA, and Section 504 may be addressed to Donna Smith, Assistant Vice President for Civil Rights and Title IX/ADA Coordinator, 314 Twamley Hall, 701.777.4171, UND.civilrights@UND.edu or the Office for Civil Rights, U.S. Dept. of Education, 230 S. Dearborn St., 37th Floor, 500 West Madison, Suite 1475, Chicago, IL 60611 or any other federal agency.

The full Notice of Non-discrimination is available online through Civil Rights & Title IX.

Reporting of Discrimination, Harassment, or Sexual Misconduct

If you or a friend has experienced sexual misconduct, such as sex-based harassment, domestic violence, dating violence, or stalking, please contact the Civil Rights & Title IX Office or UND's Title IX Coordinator for assistance at 701.777.4171.

You may also contact the Civil Rights & Title IX office if you or a friend has experienced discrimination or harassment based on a protected class, such as race, color, national origin, religion, age, disability, sex, sex characteristics, sexual orientation, gender identity, genetic information, pregnancy, marital or parental status, veteran's status, or political belief or affiliation.

Faculty Reporting Obligations Regarding Discrimination, Harassment, or Sexual Misconduct

It is important for students to understand that faculty are required to share with UND's Civil Rights & Title IX Office any incidents of potential sexual misconduct or of discrimination or harassment based on a protected class that they become aware of, even if those incidents occurred in the past or are disclosed as part of a class assignment. This does not mean an investigation will occur if the student does not want that, but it does allow UND to provide resources to help the student continue to be successful at UND. If you have been impacted by discrimination, harassment, or sexual misconduct, you can find information about confidential support services at the Civil Rights & Title IX webpage.

Health and Safety

UND is committed to maintaining a safe learning environment and asks students and instructors to be flexible when necessary to promote quality learning experiences.

Please do not attend an in-person class or lab if you are feeling ill or if you have been directed by health professionals to stay home.

- If you are not able to attend class or lab, please notify your instructor as soon as possible and discuss options for making up any missed work.
- If you will have an extended absence due to serious illness or other uncontrollable circumstances, you may request an absence notification through [Community Standards and Care Network](#).
- If your instructor is ill, they may need to cancel class or temporarily move your course to online delivery.

Please contact [Student Health Services](#) if you have health questions by calling 701.777.4500 or visiting [myhealth.UND.edu](#)

Course Policies

Academic Integrity Course Policy

Students are expected to complete all academic work honestly and responsibly. For more information read the Code of Student Life. The instructor will provide guidance on academic integrity in the course and on specific assignments. If you have any questions about what constitutes appropriate collaboration, citation, or use of sources, please ask before submitting your work.

Violations of academic integrity may be reported to the [Community Standards and Care Network](#). Please see the [Code of Student Life](#) for more information.

Artificial Intelligence (AI) Course Policy

The instructor will provide guidance on the use of AI in this course and on specific assignments. Please ask your instructor if you have any questions.

Exam/work Make-Up/Retake Policy

Please contact your instructor with questions about make-up work and retaking missed exams.

Submission of Late Work Policy

Due dates for each assignment or activity will be posted in Blackboard and/or within this syllabus. All assignments must be submitted by the due date and time posted in the course. All times are posted in the Central Time Zone.

The acceptance of late assignments is at the discretion of the instructor. If extenuating circumstances arise, it is your responsibility to you contact the instructor prior the due date and

request an extension. All requirements for this course must be completed during the course dates.

UND Cares Program and Additional Resources

UND Cares Program

The Care Team is available to assist with incidents involving UND students 24 hours a day, seven days a week. Examples of such incidents include, major accidents, missing students, death, suicidal ideations, situations involving self-harm, psychological trauma and sexual violence.

The purpose of the Care Team is to facilitate communication between the students, families and the university. For more additional information, please visit the UND Cares Program Webpage.

Additional Resources

If, at any point, you feel like the information covered in this class elicits thoughts, feelings, or concerns that you would like to discuss further, don't hesitate to reach out to your instructor or the UND Counseling Center (701.777.2127).

Further, if you experience extenuating circumstances, sexual violence, identity-based harm, or any other personal crisis during the semester, reach out to your instructor so they can provide academic assistance in this course, and put you in contact with the appropriate resources and services (if needed).

- UND Care Team: 701.777.2664 (8:00 AM to 4:30 PM M-F) or 701.777.3491 (evenings and weekends)
- UND Campus Police: 701.777.3491·UND Student Health: 701.777.4500
- UND Civil Rights & Title IX Resources: 701.777.4171
- Abuse and Rape Crisis Hotline (CVIC): 701.746.8900 (24 hours)
- Grand Forks Police Department: 701.787.8000 (24 hours)
- Altru Hospital Emergency Room: 701.780.5280
- UND Student Diversity and Inclusion: 701.777.6985
- Food For Thought Pantry: (Wilkerson Commons Room 169; 701.777.4200)
- National Suicide Prevention Lifeline: (1.800.273.8255)