Atmospheric Science Program as a link for hypotheses on the changing Arctic System

Nicole Mölders,

University of Alaska Fairbanks, College of Natural Sciences and Mathematics - Atmospheric Science Program

Mission Statement

The University of Alaska Fairbanks (UAF) Atmospheric Science graduate program provides students at the postgraduate levels with the training and insight to understand and explore physical, chemical and dynamical processes of the atmosphere, to prepare them for professional careers in the various fields of atmospheric science in research, education, consulting and the weather service.

Degree Program and Structure

The UAF Atmospheric Science Program offers MS and PhD degree programs in atmospheric science. Five core classes (Introduction to Atmospheric Science, Atmospheric Chemistry, Cloud Physics, Dynamics, Radiation), a variety of special classes (Turbulence, Atmospheric Boundary Layer Physics, Atmospheric Thermodynamics, Numerical Modeling and Parameterization Methods, Remote Sensing, Climate Variability and Change, Middle and Upper Atmosphere, Synoptic, Hydrometeorology, Mesoscale Dynamics, Introduction to Computational Meteorology, Chemical Fate and Transport) and two seminar series are offered (right). MS students take four core classes, 6 thesis credits and typically two special classes plus seminars. PhD students take all five core classes, various special classes related to their research, seminars and 18 thesis credits. Introduction to Atmospheric Science is mandatory for both MS and PhD students. As a service for the university, the program offers a 100-level class with lab (Alaska Weather and Climate) that can be taken in fulfillment of the core requirements of non-scietific majors.

Financial Aid

Research assistantships, fellowships and short-term teaching assistantships are available for graduate students on a competitive basis. All support includes a stipend and a tuition waiver.

IARC building (Photo by J. Moss)

Members of the Japan Alpine Club assist servicing the UAF/IARC weather station on Mt. McKinley (just below the summit at 18,700 ft). Photo by T. Saito

Lidar measurements at Poker Flat under the aurora (Photo by Jakeshi Matsuo)

Programs/Structures within and beyond Departments

The Atmospheric Science Program faculty have joint appointments with the College of Natural Sciences and Mathematics and with either the International Arctic Research Center (IARC) or the Geophysical Institute. Faculty has collaborative efforts both with respect to education and research on campus and beyond. Committees often have faculty members from different disciplines with expertise that covers one of the student's research aspects (e.g. a volcanologist on a committee of a student who examines volcanic ash transport). Collaboration of the faculty who teaches the class Alaska Weather and Climate with faculty from Native Linguistics and Anthropology made the class more Alaska releveant by including Native knowledge on Alaska weather and climate and how weather and climate affects the Natives' life style. The class Introduction to Atmospheric Science is coordinated with the other core classes (upper middle). The faculty who teaches this class has to spend a lot of time to discuss with other faculty teaching the other core and special classes to cover required prerequists. This is a continuous process because curricula, special classes offered, research foci and books change.

Some classes are cross-listed with other disciplines. For instance, the class Chemical Fate and Transport serves chemistry and atmospheric science students. Some classes are stacked, i.e. they can be taken at the undergraduate or graduate level. Both methods serve to bundle resources and enlarge the number of courses offered. The class Introduction to Computational Meteorology, which helps students to develop the computational skills required to get their research started/done, takes the burden from faculty to have to teach these skill to each of their advisees separately. Faculty share teaching the class.

Faculty, graduate student and staff offices are located in the IARC building (upper left). Lectures and teaching laboratories are conducted in the Natural Sciences Facility and the IARC building. Program faculty and students have access to world class research facilities including the Arctic Region Supercomputing Center and Poker Flat Research Range (bottom left), and several observational networks (middle left). Students can gain international exposure because many of the research activities are carried out in close cooperation with scientists from all over the world. Our location in the sub-arctic positions us perfectly for Arctic research. Additionally, the local environment provides an excellent location for observation of unique scientific phenomena and outdoor exploration.

Our program was ranked 9th place nationwide by Academic Analytics. The program holds high expectations in class work, examinations, comprehensive examinations and theses. Faculty supports students in writing papers and actively involves them in their research and labs. Faculty are located on the same floor as the students, i.e. faculty are easy accessable and can quickly provide feedback.

The dean grants a teaching award to one faculty of a department each year to promote high quality teaching. The directors grant awards for scientific performance. Faculty is evaluated each year on teaching, research and service. Some directors and the dean give faculty more credit for peer-reviewed papers that were written together with a graduate student as first author. Departments are evaluated every five years with respect to quality (student learning outcome assessment, number of graduates, time to degree in program, student to faculty ratio, peer-reviewed articles, funding acquired, etc.). The assessments serve to improve the programs.

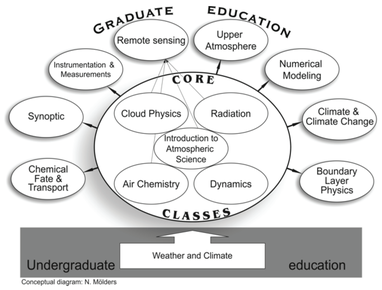
An interdisciplinary REU program is in place. Many REU students became graduate students at UAF later. At a party every first week of a semester,new students are introduced and assigned a 1st or 2nd year student as a mentor. The party also creates a group feeling among students, faculty and staff.

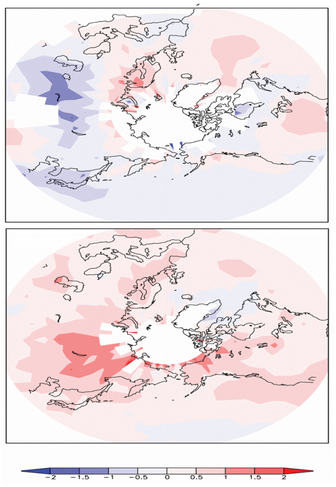
Our faculty has a diverse background with respect to education, gender, age and ethnic. This means that there is a variety of role models available, an important prerequiste for student success, especially for a minority serving university with many non-traditional students.

Research

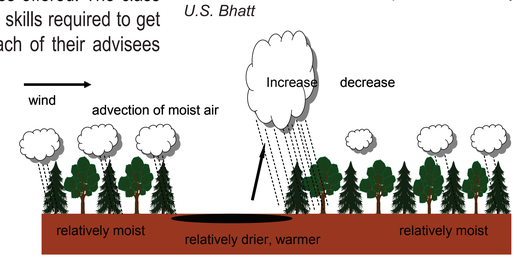
The atmospheric science research program strives to understand the polar atmosphere and its role within the earth system. Our research projects are generally in conjunction with UAF's Geophysical Institute and International Arctic Research Center. Projects utilize a variety of observational, modeling and remote sensing techniques and can be divided into:

Atmospheric Remote Sensing
Atmospheric Chemistry
Chemistry Transport Modeling
Cloud/Aerosol Physics
Climate Variability and Change
Hydrometeorology
Mesoscale Modeling
Middle and Upper Atmosphere

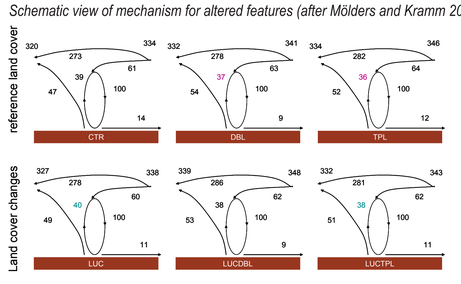




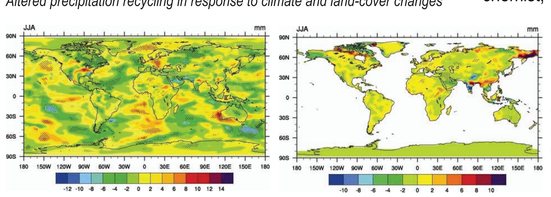
Spatial pattern of Arctic Warming in the 1930's and 1990's as seen in air temperature. Plots by U.S. Bhatt



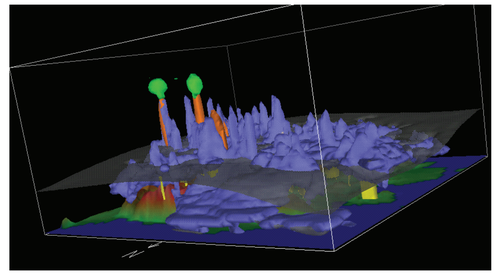
Schematic view of mechanism for altered features (after Mölders and Kramm 2007)



Altered precipitation recycling in response to climate and land-cover changes



30-year average of evapotranspiration under reference climate conditions (second bottom left) and differences in 30-year average evapotranspiration (third bottom left) in response to wildfire scars in Siberia, Alaska, southern Canada and the Southwest of the US.



Three dimensional graphic of results obtained by a regional atmospheric model showing cloud water (blue), rain water (yellow), ice (green) and snow (amber). Simulation and graphic by G. Kramm

Examples of Atmospheric Science Being Involved in Building Hypotheses on the Arctic System

Development of alogorithms to forecast aircraft icing (upper right): Team of 1 engineer, 2 atmospheric scientists, 1 atmospheric science graduate student

Investigation of mechanisms leading to Arctic Warming (left): Team of 1 oceanographer, 1 atmospheric scientist, 1 atmospheric science graduate student, 1 statistic graduate student

Investigation of the impact of volcanic eruption on flight weather, local weather, climate and air quality: Team of atmospheric scientists, volcanologists, air chemists, computer scientists, graduate students from atmospheric science, environmental chemistry, volcanology and remote sensing

Investigation on waves for naval safty and coastal protection from erosion, oil spills, etc.: Team of atmospheric scientists, oceanographers, engineers, computer scientists, 2 atmospheric science graduate students

Understanding the physical, dynamical and chemical mechanisms of the aurora (bottom most left): Team of space scientists, physicists, engineers, atmospheric scientist, graduate students from atmospheric science, engineering and space physics

Eye-safe lidar development and measurements for investigation of aerosol distribution in the atmospheric boundary layer: Team of engineers, mathematician, atmospheric scientist, chemist, 1 engineering graduate student

Dynamical and statistical downscaling of climate and weather forecast model data to examine glacier mass changes: Team of glaciologists, atmospheric scientists, 1 atmospheric science graduate student

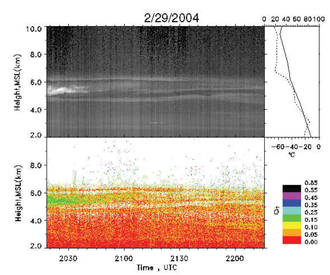
Investigations on the interaction between climate, premafrost and ecosystem changes (bottom middle): Team of biologists, 1 geologist, atmospheric scientist, graduate students from atmospheric science and geology

Process studies on wildfire caused impacts on weather (Schematic view left), climate (second bottom middle) and air quality and prediction of fire weather and fire plumes: Team of atmospheric and computer scientists, air chemists, climatologists, graduate students from atmospheric sciences, environmental chemistry, and computer science

Investigation of the role of sea-ice distribution for ecosystem changes: Team of biologist, atmospheric scientist, geophysicist, oceanographer, graduate students from biology and atmospheric science

Pollen weather and forecast: Team of biologist, atmospheric scientist, climatologist, 1 atmospheric science graduate student

Indirect aerosol effects on clouds (right): Team of atmospheric scientists, engineers, remote sensing scientist, 1 chemist, 1 atmospheric science graduate student



Lidar measurements and sounding of the atmosphere over Alaska (K. Sassen 2005, Nature)

Acknowledgements

I thank the faculty, students and staff of the atmospheric science program for fruitful discussion. Special thanks to those who provided photos and figures.