Revised 11/19/2015

Cloud Physics ATM-415

Tuesday & Thursday 2:00 to 3:30 Room (TBD)
Instructor: Dr. Javier Fochesatto
Office: Akasofu 317
Email: foch@gi.alaska.edu
Phone: 474-7602
Office Hours: Tuesday & Thursday 3:30-5:00 PM following class and by appointment
Course texts:
"A Short Course on Cloud Physics" Rogers and Yau
"Microphysics of Clouds and Precipitation" Pruppacher and Klett
"Physics and Dynamics of Clouds and Precipitation" Wang
"Thermal Physics of the Atmosphere" Ambaum
Course Notes and Lectures

Course Overview
Cloud physics develops the thermodynamic phases of water in the atmosphere from microscale to macroscale processes. The understanding of clouds and their role in the earth system requires knowing fundamental thermodynamic properties of condensed water vapor, atmospheric aerosols, nucleation, condensation and growth of water droplets and ice crystals and development of precipitation. The major topics of this course are ice and mixed-phase clouds, anthropogenic and non-anthropogenic modification of cloud and cloud radiative influences. The course will also cover the topics of thunder cloud, fog and ice-fog formation. Remote sensing and laboratory techniques and their importance in cloud physics research are highlighted. The course includes the collection and analysis of polarimetric Lidar data and laboratory microscopic examination of ice crystals.

Grading
Grades will be determined by combining scores obtained in the exams as well as based on homework/paper reading assignments. The grade breakdown is given below. Exam duration is scheduled for 1.5 hours duration.

	ATM-415
Homework/paper assignment	40%
Exam 1	15%
Exam 2	15%
Exam 3	30%

Cumulative (%)	**Grade**
97 - 100%	A^+
92 - 96%	A
88 - 91%	A^-
84 - 87%	B^+
80 - 83%	B
76 - 79%	B^-
73 - 75%	C^+
69 - 72%	C
65 - 68%	C^-
62 - 64%	D^+
58 - 61%	D
54 - 57%	D^-
<54%	F

Exams and Homework
Homework comprises basic numerical problems combined with occasional topics requiring further development. Your homework needs to be submitted in electronic form using the publication template of the *American Meteorological Society* including figures, tables, formulas and references. Latex format is also accepted.
Exams 1 and 2 cover material from previous weeks while **exam 3** is cumulative. It is important for you to elaborate the exams in detail so that a partial grade can be assigned in case the point has not been fully developed. Describing your rationale behind the response is important even if a numerical answer was not achieved. Students enrolled in ATM-415 will be required to solve only 4 out of 5 total questions for all exams.

Ethics

I encourage originality in your paper development as well as correct behavior during exams. Plagiarism and cheating are matters of serious concern for students and academic institutions. This is true in this class as well. The UAF Honor Code (or Student Code of Conduct) defines academic standards expected at the University of Alaska Fairbanks, which will be followed in this class. Plagiarism and cheating will be graded with an automatic F.

Disabilities

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. We will work with the Office of Disabilities Services (203 WHIT, 474-7043) to provide reasonable accommodation to students with disabilities.

Important Dates

Drop Day 1/29
Las day for Withdrawals 03/25
Mid-Term Exams Tentative dates: 02/11 and 3/29

Class Schedule

Week	Dates	Topic	Reading Material
1	01/14	Course overview and Introduction. Cloud description and classification	Course preface. CH1 (Wang). CH1 (Pruppacher and Klett)
2	01/19-21	Methodologies for cloud and aerosol research. Active and passive remote sensing. Optical and microwave. HW1	Cloud and Aerosol Research Papers (Najera et al, 2008; Fochesatto et 2004, 2008), CH2 (Pruppacher and Klett).
3	01/26-28	Thermodynamic properties of cloud. Statistical mechanics and turbulence in cloud	CH1, 2 (Ambaum), CH1, 2 (Rogers and Yau)
4	02/2-4	Aerosol deliquescence, cloud droplets, nucleation, condensation and coalescence. HW2	CH 9,13,14 (Pruppacher and Klett); CH7, 10 (Wang); CH7(Ambaum)
5	02/9-11	Cloud formation. Cloudiness cycle. Cloud radiative properties and role in climate	CH6,7,8 (Rogers and Yau), CH9 (Ambaum)
6	02/16-18	Exam 1. Ice nuclei, growth and aggregation	CH9 (Rogers and Yau); CH9 (Wang)
7	02/23-25	Formation of crystals. Observation methods and radiative properties. HW3	CH9 (Rogers and Yau); CH9 (Wang)
8	03/1-3	Cirrus cloud formation, properties and structure analysis	CH10 (Pruppacher and Klett)
9	03/8-10	Mixed-phase cloud characteristics and properties.HW4	CH10 (Wang) , CH4, 8 (Rogers and Yau).
10	03/15-17	Spring recess (no classes)	----
11	03/22-24	Mixed-phase cloud models and challenges	CH12, 15 (Pruppacher and Klett)
12	03/29-31	Exam 2. Continental and marine stratocumulus cloud. Boundary-Layer clouds	Papers (Wood et al 2011; Allen et al 2011), CH12 (Wang)
13	04/5-7	Precipitation and observation methodologies	CH12 (Rogers and Yau); CH8, 11(Wang)
14	04/12-14	Analysis of remote sensing data ground base and satellite	Geophysical Institute Lidar Observatory and Satellite Remote Sensing platforms.
15	04/19-21	Thunder cloud and lightning. Weather modification: contrails, ice fog, biological and artificial clouds	Ch17,18 (Pruppacher and Klett); CH14, 15 (Wang)
16	04/26-28	Review and Exam 3	----
17	05/3-5	Paper presentations	----

Allen, G., Coe, H., Clarke, A., Bretherton, C., Wood, R., Abel, S. J., Barrett, P., Brown, P., George, R., Freitag, S., McNaughton, C., Howell, S., Shank, L., Kapustin, V., Brekhovskikh, V., Kleinman, L., Lee, Y.-N., Springston, S.,

Toniazzo, T., Krejci, R., Fochesatto, J., Shaw, G., Krecl, P., Brooks, B., McMeeking, G., Bower, K. N., Williams, P. I., Crosier, J., Crawford, I., Connolly, P., Allan, J. D., Covert, D., Bandy, A. R., Russell, L. M., Trembath, J., Bart, M., McQuaid, J. B., Wang, J., and Chand, D. 2011: "South East Pacific atmospheric composition and variability sampled along 20° S during VOCALS-Rex". *Atmos. Chem. Phys.*, 11, 5237-5262, doi:10.5194/acp-11-5237-2011, 2011.

Wood R., C. S. Bretherton, C. R. Mechoso, R. A. Weller, B. Huebert, F. Straneo, B. A. Albrecht, H. Coe, G. Allen, G. Vaughan, P. Daum, C. Fairall, D. Chand, L. Gallardo Klenner, R. Garreaud, C. Grados Quispe, D. S. Covert, T. S. Bates, R. Krejci, L. M. Russell, S. de Szoeke, A. Brewer, S. E. Yuter, S. R. Springston, A. Chaigneau, T. Toniazzo, P. Minnis, R. Palikonda, S. J. Abel, W. O. J. Brown, S. Williams, G. J. Fochesatto, and J. Brioude. 2011: "The VAMOS Ocean-Cloud-Atmosphere-Land Study Regional Experiment (VOCALS-REx): goals, platforms, and field operations". *Atmos. Chem. Phys.*, 11, 627–654, 2011.

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Student Learning Outcomes

Upon completion of this course the students will:

1) Understand and explore thermodynamics processes in the atmosphere related to aerosol cloud interaction, cloud formation, microphysics and dynamics.
2) Express these processes into equations; understand and solve fundamental problems related to atmospheric thermodynamics in the context of cloud research and quantitatively describe typical microscale and macroscale (e.g. nucleation, freezing, supercooled clouds, etc).
3) Acquire skills to analyze and interpret lidar, radar and satellite data and identify microphysical and dynamic processes. This includes application of learned material to different problems or putting learned material together in a new context to solve a problem where atmospheric thermodynamic variables plays a fundamental role.
4) Through the course the student will be exposed to read, understand and critically discuss journal articles in the mainstream of cloud and aerosol physics scientific literature.
5) Be able to apply concepts from this class to their own research where applicable.

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Cloud Physics ATM-615

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Homework/paper assignment	20%
Exam 1	15%
Exam 2	15%
Exam 3	30%
Research Paper	20%

Cumulative (%)	**Grade**
97 - 100%	A^+
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Research paper comprises a research topic of interest that you will select and discuss with me. The paper needs: 1) Introduction and topic background including references obtained from a comprehensive literature search; 2) Description of methodology or theory; 3) Data processing or data discussion highlighting how this work has advanced or can advance cloud and aerosol research; 4) Discussion and conclusions. Topics of interest are available

for your selection. Research paper is due the week before the end of classes and can be submitted at any time. The paper will be defended either in the departmental seminar or in class.

Ethics
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3. Acquire skills to analyze and interpret lidar, radar and satellite data and identify microphysical and dynamic processes. This includes application of learned material to different problems or putting learned material together in a new context to solve a problem where atmospheric thermodynamic variables plays a fundamental role.
4. Be exposed to read, understand and critically discuss journal articles in the mainstream of cloud and aerosol physics scientific literature.
5. Be able to apply concepts from this class to their own research where applicable (to pass comprehensive exam in Cloud Physics for ATM Ph.D. program).