Course Syllabus

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Catalog Description: Atmospheric chemistry that impacts and is impacted by climate change, including processes related to aerosol microphysics and carbon cycle. Atmospheric applications of will focus on aerosol growth and sinks, aerosol-cloud interactions, atmospheric lifetimes of long-lived gases, ocean and land carbon cycling, and isotopes relevant for climate diagnosis. The course will include problem solving with computational tools.

Pre-Requisite Requirements: This course is taught as part of a series intended for first-year graduate studies in climate sciences. As such, it builds on courses in the series (specifically SIO217a and SIO217b) that address the thermodynamics of phase changes, the fluid mechanics of flow in the continuum regime, the differences between laminar and turbulent flow, and the mechanism of diffusion.

Course Structure: The course focuses on the chemical compounds and processes that affect the Earth's atmosphere. The topics include aerosols, clouds, greenhouse gases, and other climate-relevant aspects. The course objectives are developing a quantitative understanding of (i) the microphysical mechanisms that regulate aerosol concentrations and evolution in the atmosphere; (ii) the physical and chemical interactions of aerosols with clouds and their effects on climate; (iii) the anthropogenic controls on greenhouse gases, with a focus on recent rises in CH_4, N_2O, and CO_2; and (iv) the fundamentals of isotopes in relation to climate change. Students are expected to participate regularly in discussions related to these topics.

Lectures and Readings: The lectures are presented in person, with podcast recordings available after each class. Both parts of the course use chapters from the 2016 edition of *Atmospheric Chemistry and Physics* by Seinfeld and Pandis, which is available online from **UCSD Library (https://search-library.ucsd.edu/discovery/fulldisplay?docid=alma991009397959706535&context=L&vid=01UCS_SDI:UCSD&lang=en&search_scope=MyInstitution&** and selected chapters are posted with the modules. Supplementary reading materials for each topic are also posted for **Aerosols (https://canvas.ucsd.edu/courses/63391/modules/374233)** and **Carbon Cycle (https://canvas.ucsd.edu/courses/63391/modules/374237)** .

Learning Objectives: The problem sets, discussions, and exam are designed to support you in completing the following learning objectives on Aerosols for the course:

1. Describe graphically and numerically the size distribution of atmospheric aerosols.
2. Evaluate the physical and chemical processes that affect the transfer of gases to particles and characterize particle-phase reactions.
3. Compare quantitatively the dynamical processes that control aerosol populations and their evolution.
4. Evaluate how drop activation affects and is affected by aerosol size distributions.
5. Quantify the brightening of clouds from increased aerosol concentrations.

Assignments and Grading: The course is divided equally between the topics of Aerosols and Carbon Cycle. The course grade is based on homework problem sets and in-class discussions as well as a final exam for each topic as follows:

- **Aerosol Problems and Discussion (30%)**: The homework assignments provide students the opportunity to use computational tools to apply the concepts presented in class to specific problems.
- **Carbon Cycle Problems and Discussion (30%)**: The homework assignments provide students the opportunity to use computational tools to apply the concepts presented in class to specific problems.
- **Aerosol Final Exam 20%**: The final exam consists of a take-home set of questions and an in-person oral set of questions, scheduled for the designated final exam date. The take-home part of the final exam is based on the homework, and the oral exam allows students to expand or correct the answers given in the written exam.
- **Carbon Cycle Final Exam 20%**: The final exam consists of a take-home set of questions and an in-person oral set of questions, scheduled for the designated final exam date. The take-home part of the final exam is based on the homework, and the oral exam allows students to expand or correct the answers given in the written exam.

Schedule: The schedule of the readings, lectures, and problem sets is designed for continuity and exploration of Aerosol and Carbon Cycle concepts, as well as for practical logistics.

Date		Time	Ch	Instr.	Hmwk	Topics
7-Jan	Tu	9:30	SP8.1-2	LR		Aerosol Size Distributions: Quantification and Comparisons
9-Jan	Th	9:30	SP7.3,5	LR		Aerosol Size Distributions: Composition, Moments, and Losses
14-Jan	Tu	9:30	WF6.1-6.3	RK	Set1(LR)	Aqueous Chemistry of CO2
16-Jan	Th	9:30	WF6.1-6.3	RK		Aqueous Chemistry of CO2 - continued
21-Jan	Tu	9:30	SP11.1-3	LR	Set2(RK)	Aerosol Formation and Reactions: Nucleation
23-Jan	Th	9:30	SP12.1-2	LR		Aerosol Formation and Reactions: Aqueous Reactions
28-Jan	Tu	9:30	SP13.2-3	LR	Set3(LR)	Aerosol Population Dynamics: Condensation and Coagulation
30-Jan	Th	9:30	Pandis	LR		Aerosol Population Dynamics: Differentiating Processes
4-Feb	Tu	9:30	SP17.1,5	LR	Set4(LR)	Aerosol-Cloud Microphysics: Activation and Supersaturation
6-Feb	Th	9:30	Kreidenweis	LR		Aerosol-Cloud Microphysics: Kappa and Hoppel Minimum
11-Feb	Tu	9:30	SP17.1,5	RK	Set5(LR)	Atmospheric CO2 Phenomenology and Controls
13-Feb	Th	9:30	SP22.1-2	RK		Atmospheric CO2 Phenomenology and Controls - continued
18-Feb	Tu	9:30	SP22.1-2	RK	Set6(RK)	GHG Lifetimes and Global Warming Potential

20-Feb	Th	9:30		RK		CH4 and N2O Budget and Controls
25-Feb	Tu	9:30	A7.1-7.2	RK	Set7(RK)	Isotope Basics
27-Feb	Th	9:30	A7.3.3,7.5.1	RK		Isotopes and Hydrological Cycle
4-Mar	Tu	9:30	Broecker	RK	Set8(RK)	Radiocarbon
6-Mar	Th	9:30	WF6.6	RK		Air-Sea Gas Exchange
11-Mar	Tu	9:30	SP24.8	LR		Aerosol-Cloud Impacts: Aerosol-Cloud Indices
13-Mar	Th	9:30	Dedrick	LR		Aerosol-Cloud Impacts: Forcing and Adjustments
18-Mar	Tu	8:00				Final Exam (Take-Home and Oral 8:00-11:00)

Policies and Information

Our Classroom. I hope you will join me in creating a classroom that upholds UCSD Community Principles to support our learning as a group. For more information, please visit: **http://diversity.ucsd.edu (http://diversity.ucsd.edu) .** All UC San Diego students are part of the UC San Diego community and are expected to follow university and UC-wide policies, including the **Student Conduct Code (https://studentconduct.ucsd.edu/procedures/index.html)** . The UC San Diego Student Conduct Code represents the pride and values that define our community, and include the **UC San Diego Principles of Community (https://ucsd.edu/about/principles.html)** , which further illustrate the expectations for all members of our community.

Academic Integrity and Artificial Intelligence. In this course, we expect honest, objective, and polite participation. We do not allow cheating or misrepresentation of others' work as your own. In this course, you may use artificial intelligence tools, such as Google search and ChatGPT, as an aid to finding answers to homework and exam questions, if you clearly cite these sources. However, answers are considered correct based on the course material rather than cited sources, so please be sure that you verify information from other sources in the context of the course material. Reports of alleged violations of academic integrity will be handled under the policies and procedures set forth in the **UCSD Policy on Integrity of Scholarship (https://senate.ucsd.edu/Operating-Procedures/Senate-Manual/Appendices/2)** .

Rescheduling. Changes to exam or other due dates for reasons beyond your control are accommodated to the best of our ability with support from one of the four "Ds": a doctor, a divinity, a dean, or the DoD.

Non-Discrimination and Sexual Harassment. The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate based on race, color, national origin, religion, sex, gender identity, pregnancy, physical or mental disability, medical condition (cancer related or genetic characteristics), ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services. The University also prohibits harassment on any of these bases, including sexual harassment, as well as sexual assault, domestic violence, dating violence, and stalking. This nondiscrimination policy covers admission, access, and treatment in university programs and activities. If students have questions about student-related nondiscrimination policies or concerns about

possible discrimination or harassment, they should contact the Office for the Prevention of Harassment and Discrimination (OPHD) at (858) 534-8298, ophd@ucsd.edu or **reportbias.ucsd.edu (http://reportbias.ucsd.edu)** . Students are encouraged to seek assistance as soon as possible, as time limits may apply to complaint resolution processes. Reports of alleged violations involving sex offenses, including sexual assault and sexual misconduct, will be handled under the policies and procedures set forth in the **University of California's Sexual Violence and Sexual Harassment Policy (https://catalog.ucsd.edu/about/policies/policies-on-shpp/index.html)** .

Land Acknowledgement. UC San Diego was built upon the territory of the Kumeyaay Nation. From time immemorial, the Kumeyaay people have been a part of this land.

Grading Criteria. Letter Grade: UC San Diego student will be provided a grade between A+ and F that reflects your performance in the course, which is included in your grade point average (GPA) calculation. A passing grade of C- or higher counts toward your earned credit hours.

Resources. UCSD provides important services to support you in completing this course, including those listed below.

Learning and Academic Support

- **Ask a Librarian: Library Support (https://library.ucsd.edu/ask-us)** Chat or make an appointment with a librarian to focus on your research needs
- **First Gen Student Success Coaching Program (https://successcoaching.ucsd.edu/)** Peer mentor program that provides students with information, resources, and support in meeting their goals
- **Office of Academic Support & Instructional Services (OASIS) (https://oasis.ucsd.edu/)** Intellectual and personal development support
- **Writing Hub Services in the Teaching + Learning Commons (https://commons.ucsd.edu/academic-support/writing/index.html)** One-on-one online writing tutoring and workshops on key writing topics
- **Supplemental Instruction (https://aah.ucsd.edu/supplemental-instruction-study-group/)** Peer-assisted study sessions through the Academic Achievement Hub to improve success in historically challenging courses

Support for Well-being and Inclusion

- **Basic Needs at UCSD (https://basicneeds.ucsd.edu)** Any student who has difficulty accessing sufficient food to eat every day, or who lacks a safe and stable place to live is encouraged to contact: **foodpantry@ucsd.edu (mailto:foodpantry@ucsd.edu)** | **basicneeds@ucsd.edu (mailto:basicneeds@ucsd.edu)** | (858) 246-2632
- **Counseling and Psychological Services (https://wellness.ucsd.edu/caps)** Confidential counseling and consultations for psychiatric service and mental health programming

- **Triton Concern Line (https://blink.ucsd.edu/instructors/advising/concern/)** Report students of concern: (858) 246-1111
- **Office for Students with Disabilities (OSD (https://disabilities.ucsd.edu/)**) Supports students with disabilities and accessibility across campus

Community and Resource Centers

- **Office of Equity, Diversity, and Inclusion (https://diversity.ucsd.edu/)** As part of the **Office of Equity, Diversity, and Inclusion (https://diversity.ucsd.edu/)** , the campus community centers provide programs and resources for students and contribute toward the evolution of a socially just campus (858).822-.3542 | **diversity@ucsd.edu (mailto:diversity@ucsd.edu)**
- **Get Involved (https://getinvolved.ucsd.edu/)** Student organizations, clubs, service opportunities, and many other ways to connect with others on campus
- **Undocumented Student Services (https://uss.ucsd.edu/)** Programs and services are designed to help students overcome obstacles that arise from their immigration status and support them through

Course Summary:

Date	Details	Due
Mon Jan 6, 2025	**217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160163&include_contexts=course_63391)**	3:30pm to 4:30pm
Tue Jan 7, 2025	**SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160158&include_contexts=course_63391)**	11am to 12:30pm
Thu Jan 9, 2025	**SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160155&include_contexts=course_63391)**	11am to 12:30pm
Mon Jan 13, 2025	**217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160164&include_contexts=course_63391)**	3:30pm to 4:30pm
Tue Jan 14, 2025	**SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160146&include_contexts=course_63391)**	11am to 12:30pm

Date	Details	Due
	Set1(LR) - Aerosol Size Distributions (https://canvas.ucsd.edu/courses/63391/assignments/879789)	due by 11pm
Thu Jan 16, 2025	Set1(LR) - Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879780)	due by 9am
	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160147&include_contexts=course_63391)	11am to 12:30pm
Mon Jan 20, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160165&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Jan 21, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160156&include_contexts=course_63391)	11am to 12:30pm
	Problem Set 2 (Keeling) (https://canvas.ucsd.edu/courses/63391/assignments/879792)	due by 11am
Wed Jan 22, 2025	Problem Set 2 on Aqueous Carbon (Keeling) - Problem 2 Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879779)	due by 11am
Thu Jan 23, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160160&include_contexts=course_63391)	11am to 12:30pm
Mon Jan 27, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160166&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Jan 28, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160150&include_contexts=course_63391)	11am to 12:30pm

Date	Details	Due
	Set3(LR) - Aerosol Formation & Reactions (https://canvas.ucsd.edu/courses/63391/assignments/879790)	due by 11pm
Thu Jan 30, 2025	Set3(LR) - Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879781)	due by 9am
	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160159&include_contexts=course_63391)	11am to 12:30pm
Mon Feb 3, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160167&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Feb 4, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160144&include_contexts=course_63391)	11am to 12:30pm
	Set4(LR) - Aerosol Population Dynamics (https://canvas.ucsd.edu/courses/63391/assignments/879791)	due by 11pm
Thu Feb 6, 2025	Set4(LR) - Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879782)	due by 9am
	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160142&include_contexts=course_63391)	11am to 12:30pm
Mon Feb 10, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160168&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Feb 11, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160148&include_contexts=course_63391)	11am to 12:30pm
	Set5(LR) - Aerosol-Cloud Microphysics	due by 11pm

Date	Details	Due
	(https://canvas.ucsd.edu/courses/63391/assignments/879794)	
Thu Feb 13, 2025	Set5(LR) - Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879783)	due by 9am
	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160149&include_contexts=course_63391)	11am to 12:30pm
Mon Feb 17, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160169&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Feb 18, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160143&include_contexts=course_63391)	11am to 12:30pm
	Problem Set 6 (Keeling) (https://canvas.ucsd.edu/courses/63391/assignments/879793)	due by 11am
Wed Feb 19, 2025	Problem Set 6 on Atmospheric CO2 (Keeling) - Problem 3 Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879778)	due by 11am
Thu Feb 20, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160145&include_contexts=course_63391)	11am to 12:30pm
Mon Feb 24, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160170&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Feb 25, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160152&include_contexts=course_63391)	11am to 12:30pm
	Problem Set 7 (Keeling) (https://canvas.ucsd.edu/courses/63391/assignments/879796)	due by 11am

Date	Details	Due
Wed Feb 26, 2025	Problem Set 7 (Keeling) - Problem 3 Discussion (https://canvas.ucsd.edu/courses/63391/assignments/879784)	due by 11am
Thu Feb 27, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160157&include_contexts=course_63391)	11am to 12:30pm
Mon Mar 3, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160171&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Mar 4, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160154&include_contexts=course_63391)	11am to 12:30pm
	Problem Set 8 (Keeling) (https://canvas.ucsd.edu/courses/63391/assignments/879797)	due by 11am
Wed Mar 5, 2025	Problem Set 8 (Keeling) - Problem 3 Discusion (https://canvas.ucsd.edu/courses/63391/assignments/879785)	due by 11am
Thu Mar 6, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160151&include_contexts=course_63391)	11am to 12:30pm
Mon Mar 10, 2025	217D - Office Hours (https://canvas.ucsd.edu/calendar?event_id=1160172&include_contexts=course_63391)	3:30pm to 4:30pm
Tue Mar 11, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160153&include_contexts=course_63391)	11am to 12:30pm
	SIOC 217D - Aerosol Review Session (https://canvas.ucsd.edu/calendar?event_id=1160139&include_contexts=course_63391)	1pm to 2pm

Date	Details	Due
	217D - Extra Office Hour (Lynn) (https://canvas.ucsd.edu/calendar?event_id=1160140&include_contexts=course_63391)	2:30pm to 3:30pm
Thu Mar 13, 2025	SIOC 217D - Lecture/Discussion (https://canvas.ucsd.edu/calendar?event_id=1160141&include_contexts=course_63391)	11am to 12:30pm
	SIOC 217D - Aerosol Review Session (https://canvas.ucsd.edu/calendar?event_id=1160162&include_contexts=course_63391)	1pm to 2pm
Tue Mar 18, 2025	Keeling Exam (Written Part) (https://canvas.ucsd.edu/courses/63391/assignments/879788)	due by 11pm
	Russell Exam (Written Part) (https://canvas.ucsd.edu/courses/63391/assignments/879799)	due by 11pm
Thu Mar 20, 2025	SIO217D Oral Final Exam (https://canvas.ucsd.edu/calendar?event_id=1160161&include_contexts=course_63391)	11:30am to 2:30pm
	Russell Exam (Oral Part) (https://canvas.ucsd.edu/courses/63391/assignments/879798)	due by 2:30pm
Fri Mar 21, 2025	Course Grade (https://canvas.ucsd.edu/courses/63391/assignments/879787)	due by 11:59pm