

SIO 173: DYNAMICS OF THE ATMOSPHERE AND CLIMATE

Spring 2024

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| Instructor: Nick Lutsko nlutsko@ucsd.edu | Time: Tu/Th 11am–12:20pm |
| TA: Philipp Arndt parndt@ucsd.edu | Location: Keck 101 |

Introduction to the dynamical principles governing the atmosphere and climate, with an emphasis on large-scales, the processes that control Earth's climate and California weather and climate. The course will focus on fundamental principles, with observations used to illustrate key concepts. No background in meteorology or oceanography is assumed.

Grading Criteria: 30% homeworks/30% project/30% final exam/10% class participation.

Lectures: Lectures will be given in person and will be a mixture of blackboard derivations, lecture slides and plotting sessions using Jupyter notebooks (hosted on Google Colab). Lecture notes will take the form of Jupyter notebooks and will be posted after each lecture.

Attendance Expectations: Students are expected to attend every class. Please let us know if you will be absent or require accommodations. The UCSD Office for Students with Disabilities has resources at <https://osd.ucsd.edu/students/index.html>, including information on how to request accommodations and what kinds of accommodations are available.

Office Hours: Philipp will arrange a weekly time for office hours.

Homeworks: Homework assignments will be posted on Canvas and should be turned in through Canvas. They may be turned in one class later than they are due without penalty, but they will be accepted later than this only in exceptional circumstances.

Projects: Working in teams of two, students will conduct a literature review of a major climate feature (e.g., the ENSO cycle) and its expected changes under global warming. Each team will meet with Philipp or Nick to come up with a project topic. Further details will be provided in class.

Final Exam: The final will be a three-day take-home, targeted to take about 3 hours. It will be made available on Canvas during the exam week (date TBD). The UCSD policy on religious accommodation for examinations is available at: <https://catalog.ucsd.edu/academic-regulations.html>.

Collaboration: Students may collaborate on homework exercises, but no collaboration is allowed on the final exam. It is expected that each student will pursue their academic goals honestly and be personally accountable for all submitted work. The UCSD Academic Integrity Policy is available at: <https://academicintegrity.ucsd.edu/process/policy.html>.

Course Textbooks:

John Marshall & R. Alan Plumb (2007) *Atmosphere, Ocean and Climate Dynamics: An Introductory Text*. Academic Press, 1st Edition.

Further Reading:

Dennis L. Hartmann (1994) *Global Physical Climatology*. Academic Press, 1st Edition.

Jonathan E. Martin (2006) *Mid-Latitude Atmospheric Dynamics: A First Course*. Wiley, 1st Edition.

John M. Wallace, John and Peter V. Hobbs (1977) *Atmospheric Science: An Introductory Survey*. Academic Press, 1st Edition.

Course Schedule:

04/02 — Introduction, set-up Google Colab, Earth's geometry (MP 1.1), atmospheric composition (MP 1.2)

04/04 — Equations of state for moist and dry air (MP 1.3), vertical structure of atmosphere (MP 2.1)

04/09 — Hydrostatic balance (MP 3.2), scale height (MP 3.3)

04/11 — Instability (MP 4.1), buoyancy (MP 4.2.1)

HW1 due: 04/12

04/16 — Dry convection, potential temperature (MP 4.3)

04/18 — Gravity waves, surface inversions (MP 4.4)

04/23 — Moist convection (MP 4.5), clouds

04/25 — Plotting Session 1 (Skew-T, CAPE, LCL)

HW2 due: 04/26

04/30 — California Weather and Climate – Marty Ralph guest lecture

05/02 — Eulerian and Lagrangian descriptions of flow (MP 6.1), gravity (MP 6.2.1)

05/07 — Pressure gradient force and friction (6.2.1)

05/09 — Coriolis force, centrifugal force (MP 6.6)

HW3 due: 05/10

05/14 — Governing equations (MP 6.4), hydrostatic balance (MP 6.2.3)

05/16 — Geostrophic balance (MP 7.1), thermal wind (MP 7.3)

05/21 — Plotting Session 2 (Meridional structure of the atmosphere, MP 5)

05/23 — Global Energy Balance Models (MP 2.1, 2.3)

HW4 due: 05/24

Project Titles due: 05/26

05/28 — Climate Feedbacks – Philipp Arndt guest lecture

05/30 — Polar Amplification – Lily Hahn guest lecture

06/04 — Climate Variability

06/06 — Review Session

Final Project due: 06/14

Final: TBD