ATM 525: Troposphere-Stratosphere Interactions

Spring 2020 Syllabus

Instructor: Prof. Andrea Lopez Lang
alang@albany.edu
518-442-4558

Office Hours: ES 323
Mon & Wed 10:30-11:30 am
or by appointment

Credits: 3

Class Number: 9696

Class Location and Time: HU 127, Tu & Th 11:45 am – 1:05 pm

Website: http://www.atmos.albany.edu/facstaff/andrea/courses/atm525.html

Course Description:

This course will provide an introduction to the structure, composition, dynamics, chemistry and radiational properties of the stratosphere. We will analyze the two-way interaction between the troposphere and stratosphere in the tropics, extra-tropics and high latitudes and the implications of troposphere-stratosphere interactions on both weather and climate timescales.

This course is the combination of several parts, a lecture-based component, a student led journal article discussion component and a group project component. The lecture-based component will be weighted toward the beginning of the semester, it will provide you with the background to fully appreciate the research articles that you will choose and discuss with the class. Finally, the project-based component will build upon information from the lectures and the article discussions in an analysis of a recent case of stratosphere-troposphere interaction.

Relevant Texts:

Middle Atmosphere Dynamics (1987), D. G. Andrews, J. R. Holton and C. B. Leovy
An Introduction to Dynamic Meteorology (2012), J. R. Holton and G. J. Hakim
Stratosphere-Troposphere Interaction (2008), by K. Monanakumar
Journal articles will be provided throughout the semester

Grading: A-E

Homework (~4): 35% Quizzes (3): 30 % Journal Disc: 10%
Final Project Paper: 15% Final Project Presentation: 10%

Student-Led Paper Discussions: Students will pick a relevant journal article and facilitate a class discussion centered on topics highlighted in the article. All students are expected to participate in the discussions led by their peers. In preparation, the students leading the discussion will create a one page summary sheet (i.e., infographic, mini-poster, …) about the article they've picked. The collection of summary sheets you accumulate throughout the semester will be a quick reference for topics in troposphere-stratosphere interaction after you leave the class. A component of your grade for these discussions will be from your peers.

Final Project: The final project will be a case study of a recent stratospheric event (e.g., SSW, QBO disruption, strong vortex event, final warming). Students will work in groups to investigate and present their analysis of the troposphere-stratosphere interaction and coupling that occurred in their case of interest. The analysis will be due, as well as presented, on the last day of class.

Tentative Course Topics:

1. Structure and Composition of the Lower and Middle Atmosphere
    a. Tropopause definitions (tropical, dynamic, ozone)
    b. Seasonal climatologies (wind/polar vortex, temperature)
    c. Greenhouse gases and aerosol residence times

2. Chemistry of the Stratosphere
    a. The Chapman Cycle, Catalytic loss
    b. Ozone Depletion and the Antarctic Ozone Hole
    c. Polar Stratospheric Clouds (PSCs)
    d. Brewer-Dobson Circulation

3. Radiative Processes in the Troposphere and Stratosphere
    a. Stratospheric cooling and ozone heating
    b. Solar variability and volcanic impacts

4. Phenomena in Stratosphere-Troposphere Interactions
    a. Extratropical: Sudden Stratospheric Warmings (SSW), Strong vortex events, …
    b. Tropical: Quasi-Biannual Oscillation (QBO)

5. Dynamics of the Troposphere and Stratosphere
    a. Mean meridional overturning circulation
    b. Charney-Drazin Criterion

6. Waves in the Troposphere and Stratosphere
    a. Wave dynamics
    b. Index of refraction characteristics
    c. Energetics of vertically propagating waves
    d. Role of vertically propagating waves in QBO and SSW

7. Stratosphere-Troposphere Exchange
    a. Brewer-Dobson circulation (deep)
    b. Exchange processes near the mid-latitude and tropical tropopauses (shallow)

8. Stratospheric influences on tropospheric weather and climate
    a. Role of QBO in tropics and extratropics
    b. AO, SSWs, downward wave coupling and "downward control"
    c. Predictability and processes in models

Tentative Spring 2020 Schedule

Spring 2020	**Tuesday**		**Thursday**	
January Week 1	**21**	*No class: Last day of winter break!*	**23**	Intro and Welcome & Topic: Structure & composition of the lower/middle atmosphere
Week 2	**28**	Topic: Structure, composition, chemistry, and stratospheric phenomena	**30**	Topic: *The Ozone Hole*
February Week 3	**4**	Topic: Chemistry of the stratosphere	**6**	Topic: Chemistry/Radiative processes of the stratosphere
Week 4	**11**	Topic: Chemistry/Radiative processes of the stratosphere	**13**	Topic: Antarctic ozone…the world avoided
Week 5	**18**	Topic: Chemistry-dynamics coupling	**20**	**Quiz 1**
Week 6	**25**	Topic: Dynamics of the mean flow in the troposphere & stratosphere	**27**	Topic: Wave dynamics in the troposphere & stratosphere
March Week 7	**3**	Topic: Wave dynamics in the troposphere & stratosphere	**5**	Topic: Dynamics of Wave-Mean flow interaction
Week 8	**10**	Topic: Wave-Mean flow interaction in the extratropics	**12**	Topic: Wave-Mean flow interaction in the tropics
Spring Break!	**17**	***No Class:*** *Spring Break*	**19**	***No Class:*** *Spring Break*
Week 9	**24**	Topic: Stratosphere-troposphere exchange	**26**	**Quiz 2**
April Week 10	**31**	Topic: Stratospheric influence on tropospheric weather	**2**	Topic: Stratospheric influences at sub-seasonal timescales
Week 11	**7**	Topic: The role of the stratosphere in prediction models	**9**	Topic: Stratospheric influences on tropospheric climate
Week 12	**14**	Topic: Stratospheric in a changing climate	**16**	Topic: Stratospheric influences on tropospheric weather & climate - cases
Week 13	**21**	**Quiz 3**	**23**	Topic: Stratospheric influences on tropospheric weather & climate - cases
Week 14	**28**	Topic: Implications of troposphere-stratosphere coupling	**30**	Topic: Research directions in troposphere-stratosphere coupling
May Week 15	**5**	**Last Day of Class**: Presentation Day, Papers Due	**7**	*No Class: Finals week!*