The Hebrew University of Jerusalem

Syllabus

plant-atmosphere gas exchange investigation - 71987

Last update 18-03-2025

HU Credits: 4

Degree/Cycle: 2nd degree (Master)

Responsible Department: Soil and Water Sciences

Academic year: 0

Semester: 2nd Semester

Teaching Languages: English

Campus: Rehovot

Course/Module Coordinator: Dr. Eran Tas

Coordinator Email: eran.tas@mail.huji.ac.il

Coordinator Office Hours: By appointment

Teaching Staff:

Dr. Eran Tas,
Mr. borys beznoshchenko

Course/Module description:

The course will focus on acquiring theoretical knowledge and practical tools (field measurements and modeling) for studying the exchange of a wide range of gases between vegetation and the atmosphere, which play a key role in agriculture, air pollution, and climate change. Tools will be provided for analyzing the environmental conditions' impact, in general, and the atmosphere in particular, on gas exchange rates and the influence on key processes such as evaporation, photosynthesis, air pollution processes, and the sustainable development of green cities, crop yield reduction, and climate change. The course will include lectures, exercises, and a laboratory component.

In the laboratory, students will be experienced in and acquire basic tools for:

Utilizing real results obtained from micrometeorological measurements for the study of surface layer gas fluxes, including the separation of fluxes into buoyant and non-buoyant components.

Employing atmospheric chemical and physical models relevant to air pollution and climate change.

Course/Module aims:

Acquisition of knowledge and tools for studying the exchange rates of gases between the vegetation and the atmosphere for applications in precision agriculture, analysis of the impact of vegetation on air pollution and climate change, and proper utilization of vegetation for the sustainable development of green cities. Acquisition of basic knowledge and tools necessary for modeling atmospheric gas concentrations concentrations.

Learning outcomes - On successful completion of this module, students should be able to:

1. Acquisition of the necessary knowledge for using micrometeorological methods to calculate fluxes of a wide range of gases between vegetation and the atmosphere.

2. Basic ability to use models for analyzing chemical and physical processes in the atmosphere with relevance to air pollution, atmospheric chemistry, and climate change.

3. Basic proficiency in running air pollution dispersion models.

4. Ability to analyze the impact of vegetation on air pollution and climate change, as well as the influence of air pollution on natural and agricultural vegetation.

5. Sustainable development of green cities.

Attendance requirements(%):
80%

Teaching arrangement and method of instruction: Lecture, exercise, lab

Course/Module Content:
1. Scientific Background:
Structure and Composition of the Atmosphere, Thermodynamics of Dry and Moist Air, Basic Characteristics of Air Pollution

2. Atmospheric Chemistry:
• Gas Kinetics (Photochemical Reactions, Temperature-Dependent Reactions, Pressure-Dependent Reactions) and Particles in the Atmosphere
• Particle Characteristics and Their Impact on Radiation Scattering, Cloud Formation, and Their Influence on Atmospheric Chemical Processes
• Atmospheric Lifetime and Influencing Factors
• Key Atmospheric Chemical Cycles: Sulfur, Nitrogen, Volatile Organic Compounds, Tropospheric and Stratospheric Ozone, Aerosols, Climate Change, and Global Warming

3. Effects of Gas and Particles Exchange between Vegetation and the Atmosphere:
• Ozone: Removal and Formation by Vegetation, Ozone's Impact on Agricultural Yield Reduction, and Its Effect on Natural Vegetation
• Volatile Organic Compounds: Environmental Conditions' Influence on Emission Rates, Emission's Consequences on Air Pollution and Climate
• Particles: Impact on Vegetation, Removal by Vegetation
• Natural and Agricultural Vegetation's Influence on Climate Change and Global Warming
• Summary and Implications for Green Cities

4. Control and Mitigation of Air Pollution Effects:
• Regulations, Monitoring, and Air Pollution Reduction Measures
• Atmospheric Chemistry, Climate, and Air Quality Models: Lifetimes, Transport and Diffusion Equations, Box Models, 1-D Models, 2-D Models, 3-D Models, Gaussian Dispersion Models

5. Micrometeorological Methods for Gas Exchange Measurement between Vegetation and the Atmosphere – Theoretical and Applied Aspects:
• Micrometeorology and Turbulent Fluxes in the Surface Layer
• Different Approaches to Estimate Fluxes (bottom-up, top-down, direct), Electrical Circuit analogy
• Basic Bottom-Up Models: Big-leaf model, Dual big-leaf model, Multilayer big-leaf model
• Estimating Fluxes by Leaf-Level Measurements
• Estimating Fluxes by Canopy-Level Measurements
• Up-scaling Fluxes from Leaf and Canopy Level to Forest/Crop/Field Scale
• Methods for Separating Canopy Fluxes from Total Fluxes (Isotopic Methods, Separating Carbon Fluxes, Water, and Ozone)
• Micrometeorological Measurements – Practical and Theoretical Aspects
• Gradient Method and Monin-Obukhov Similarity Theory
• Eddy Covariance and Disjunct Eddy Covariance Methods
• Modified Bowen Ratio Method

Required Reading:
None

Additional Reading Material:
1. Thomas Foken, Springer, micrometeorology
2. Jacob, Daniel J. Introduction to Atmospheric Chemistry, Princeton University Press, 1999
3. Finlayson-Pitts, Barbara J. and Pitts, James N. Chemistry of the upper and lower atmosphere, Academic Press, 2000
4. Seinfeld, John H. and Pandis, Spyros N. Atmospheric Chemistry and Physics - From Air Pollution to Climate Change, John Wiley & Sons, 2006
5. Campbell, G.S. and J. M. Norman, 1998. An introduction to Environmental Biophysics. Second edition. Springer. Chapters 10, 11 and 15. Pdf file on course website.
6. FAO 56 - Crop Evapotranspiration
(Food and Agriculture Organization)
http://www.kimberly.uidaho.edu/ref-et/fao56.pdf
7. Baldocchi, D. Biometeorology course: From website:
https://nature.berkeley.edu/biometlab/index.php?scrn&eq;espm129

Grading Scheme:
Written Exam % 40
Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 60 %

Additional information:
A minimum attendance of 80% is required

Up to 5 points as bonus for active participation