Class title	Upper Atmosphere (고층대기)	**Credit**	3

Lecturer	In-Sun Song (송인선)	**Affiliation**	Dept. Atmos. Sci. (대기과학과)
Office	Room 548, Science Hall (과548)	**Contact**	02-2123-5650
Email	songi@yonsei.ac.kr	**Web**	https://mapl.yonsei.ac.kr

Level	Graduate students in atmospheric science, space science or other disciplines
Objectives	Introduction to dynamical and chemical processes that determine the mean states and perturbations of wind, temperature, and plasma density in the upper stratosphere, mesosphere, thermosphere, and ionosphere. Understanding of physical processes required for whole atmosphere global modeling and potential impacts of the solar and upper atmospheric processes in near-surface climate.
Pre-requisites	Undergraduate-level knowledge of thermodynamics, dynamic meteorology and electromagnetism can help (e.g., Ideal gas law, thermodynamic energy equation, Navier Stokes equation, hydrostatic and geostrophic balances, Rossby and gravity waves, Lorentz force, conductivity, and electromagnetic induction).
References	R1: The Earth's Ionosphere: Plasma Physics and Electrodynamics (2009), 2nd edition, Academic Press by Michael C. Kelley. R2: Middle Atmosphere Dynamics (1987), Academic Press by David G. Andrews, James R. Holton, and Conway B. Leovy. R3: Modeling the Ionosphere-Thermosphere System (2013), AGU Geophysical Monograph 201, AGU by Jeseph Huba, Robert Schunk, and George Khazanov. R4: SCI(E) papers on solar variability, energetic particle precipitation, or middle atmosphere ozone chemistry

Week	Contents
1	Backgrounds and structure of atmosphere and ionosphere
2	Basic equations for neutral air and plasma
3	Electric and magnetic field in the steady-state ionosphere
4	Tides, Rossby normal modes, and planetary waves
5	Planetary waves and atmospheric gravity waves
6	Atmospheric gravity waves
7	Equatorial ionosphere - Introduction
8	Mid-term exam
9	Equatorial ionosphere: F region
10	Equatorial ionosphere: E region - I
11	Equatorial ionosphere: E region - II
12	Thermospheric winds and high-latitude dynamics
13	High-latitude dynamics
14	Energetic particle precipitation and D-region chemistry
15	Potential impacts of solar and geomagentic activities in near-surface climate
16	Final exam