Boundary Layer Meteorology
Chris Bretherton UW

Course Description:

Turbulence and turbulent fluxes, averaging. Convection and shear instability. Monin-Obukhov similarity theory, surface roughness. Wind profiles. Organized large eddies. Convective and stably stratified boundary layers. Measurement technologies. Large-eddy simulation. Boundary-layer parameterization. Energy fluxes at ocean and land surfaces (including soil and vegetation interactions), diurnal cycle. Cloud-topped boundary layers.

Recommended Text: The Atmospheric Boundary Layer, by J. R. Garratt, 1992, Cambridge University Press, 316 pp.

- Lecture 1 and slides: Introduction; instabilities. Flow Instabilities. Please also watch the NCFMF video Flow Instabilities.
- Lecture 2 and slides: Turbulent flow. Please also watch the NCFMF video Turbulence.
- Lecture 3: Turbulent fluxes and TKE budgets
- Lecture 4 and slides: Boundary layer turbulence and mean wind profiles; mixing-length theory; observing technologies; LES.
    - LES animations of a stratocumulus topped boundary layer (courtesy Bjorn Stevens, MPI): Vertical cross-section of w and horizontal view of cloud albedo in a 4 x 4 km domain.
    - LES animation of Cu rising into stratocumulus in a 6 x 6 km domain (courtesy Irina Sandu, ECMWF; white is cloud; grey blobs are rain).
- Lecture 5 and slides: Surface roughness and the logarithmic sublayer
- Lecture 6 and slides: Monin-Obukhov similarity theory. MOex.m: Matlab example. Makes plot MOex.png
- Lecture 7 and slides: BL wind profiles and large eddy structure in convective and neutral BLs
- Lecture 8 and slides: K-theory and HOC parameterizations of BL turbulence
- Lecture 9 and slides: Nonlocal parameterizations of BL turbulence
- Lecture 10 and slides: Surface energy balance
- Lecture 11 and slides: Surface evaporation and soil moisture
- Lecture 12 and slides: Diurnal cycle over land; mixed layer modeling of CBL growth
- Lecture 13 and slides: Stable/nocturnal boundary layers, katabatic flow, and nocturnal jets
- Lecture 14 and slides: Oceanic and cloud-topped BLs - observations.
- Lecture 15 and slides: Sc physical processes
- Lecture 16 and slides Mixed layer modeling of Sc
- Lecture 17 and slides. Shallow cumulus convection and Sc-Cu transition. Time-lapse video from CSET flight RF06 from CA to HI through Sc-Cu transition (courtesy NCAR EOL and Hans Mohrmann)

National Committee for Fluid Mechanics Films (NCFMF)
https://web.mit.edu/hml/ncfmf.html