

Outline

Preface

- 0. Overview: our convecting atmosphere
 - 0.1. Sun-heated surface, IR-cooled air, H₂O's 2 height scales
 - 0.2. Top-down vs. bottom-up convection
 - 0.3. More asymmetry: saturated drafts in clear stratification
 - 0.4. Conditionality of moist convective instabilities
 - 0.5. Unlikelihood, fitness, and the ecology of convection
 - 0.6. Observability and cognitive biases
 - 0.7. The pull of interests: extremes vs. large scales

Part I: Essentials of the fundamentals

- 1. Keeping track of stuff in space
 - 1.1. Units for space, time, and “stuff”
 - 1.2. Conservation of the most fundamental stuff: mass
 - 1.2.1. Aside on mathematical expression culture
 - 1.3. Conservation of *specific* (per unit mass) other stuff
 - 1.3.1. Specific momentum and its physical source terms
 - 1.3.2. Other specific stuff: humidity and ‘heat content’
 - 1.3.3. *Specific X*, or *mass mixing ratio* of X?
 - 1.3.4. Advection and the material time derivative
 - 1.4. Now about density...problems
 - 1.5. Solutions to problems
- 2. Good enough equations
 - 2.1. Good-enough thermodynamics of moist air
 - 2.1.1. Density and the ideal gas law
 - 2.1.2. Virtual temperature, density temperature
 - 2.1.3. First Law: internal energy and the quest for warmth
 - 2.1.4. Latent vs. ‘diabatic’ heating and moist adiabaticity

- 2.1.5. Static energy vs. entropy vs. potential temperatures
- 2.2. Good-enough fluid dynamics
 - 2.2.1. Gravity becomes buoyancy, PGF is univariate
 - 2.2.2. Ubiquitous simplest motions: buoyancy waves
- 2.3. Good-enough moisture and microphysics
- 2.4. Properties of an equation set: problems and solutions

3. Accounting scales of motion

- 3.1. One size cut: molecular vs. macroscopic
- 3.2. Another cut: 'large-scale flow' vs. small 'eddies'
- 3.3. On anomalies, deviations, perturbations, eddies, etc.
- 3.4. Fourier decomposition and (logarithmic) 'scale'
- 3.5. A downscale energy transfer: shear instability
- 3.6. Upscale energy transfer: upshear momentum flux
- 3.7. Spectral energetics and the cascade fallacy
- 3.8. Multiscale information, DOFs, and macro-entropy
- 3.9. Problems and solutions

Part II: Entities and elements of convection

4. Parcels: the buoyancy of lifted air

- 4.1. Graphical analysis for moist thermo and probability
- 4.2. Conserved variables in lifted air
- 4.3. Parcel diversity, dilution, and detrainment profiles
- 4.4. Problems and computer exercises

5. Kinematic flow entities for the buoyant drivers

- 5.1. Thermals, bubbles, starting plumes
 - 5.1.1. Size and geometry effects on vertical acceleration
 - 5.1.2. The multi-bubble convective 'cell'
 - 5.1.3. Dynamic entrainment
- 5.2. Downdrafts and condensation-evaporation asymmetries
- 5.3. 2D entities: slabs, jumps, squalls
- 5.4. Problems and exercises

- 6. Mass 'trains': bulk irreversible flux and mixing
 - 6.1. Plumes and entrainment and detrainment
 - 6.2. Bulk plumes as pseudo-ensemble means
 - 6.3. Entrainment dilemmas and alternative mixing models
 - 6.4. The whole convecting layer as an entity

Part III: Envelopes and larger-scale interactions

- 7. The dispatcher function and multi-cellular entities
 - 7.1. Dispatch probability, survival, and reproduction
 - 7.2. Near field effects: impacts of the convected air
 - 7.3. Shear's help: focus, 2-dimensionality, supercell lift
 - 7.4. Mid-distance interactions I: mesovortex effects
 - 7.5. Mid-distance interactions II: waves of low-level T'
 - 7.6. Problems and exercises
- 8. Non-contiguous 'systems' based on pooled far-field impacts
 - 8.1. Wave dynamics, dynamic meta-entrainment, and GMS
 - 8.2. Deep tropospheric dynamics and large-scale 'entities'
 - 8.2.1. SLP and frictional convergence
 - 8.2.2. Advection of moisture
 - 8.2.3. Taking charge of surface flux over ocean
 - 8.2.4. Synoptic momentum instabilities
 - 8.3. Problems and exercises
- 9. The great game: competition and coexistence
 - 9.1. The Lotka-Volterra predator-prey equation
 - 9.2. Ecosystems: niches, trophic levels, hierarchy
 - 9.3. Information, macro-entropy, and unlikely structures
 - 9.4. Telos and Free Energy: efficiency vs. likelihood
 - 9.4.1. Thermo too weak, bio too strong, conv just right
 - 9.5. Coexistence of competitors: the spectrum
 - 9.5.1. Succession illuminates climax
 - 9.5.2. Interpreting spectral slopes
 - 9.6. Interestingly wrong: lessons from and for modeling

- 9.6.1. popcorn v. typhoon
- 9.6.2. dilemmas and too-small frameworks

10. Epilogue: synthesis, and back to the detail mines

- 10.1. Categorization for models: dyn, rad, conv, cld, trb,...
- 10.2. Thermodynamics and microphysics
- 10.3. Radiation
- 10.4. Dynamics and turbulence
- 10.5. Entities and ecologies
- 10.6. Observations and interpretations
- 10.7. Scale-truncated modeling
- 10.8. Teleology and closure courage
- 10.9. Applications and further couplings

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