

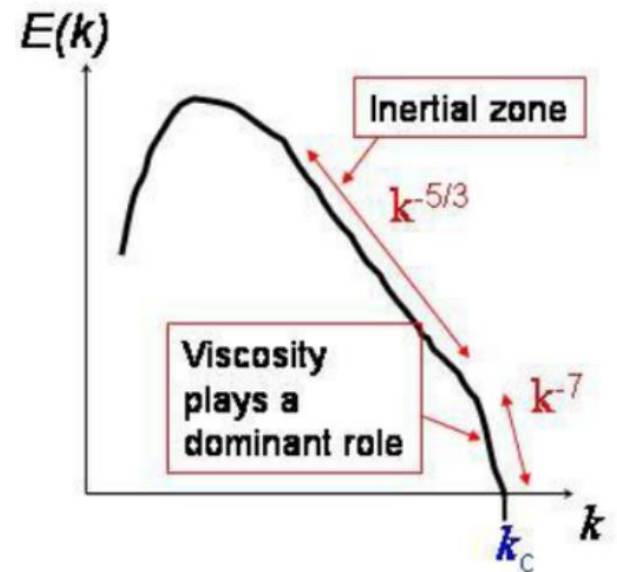
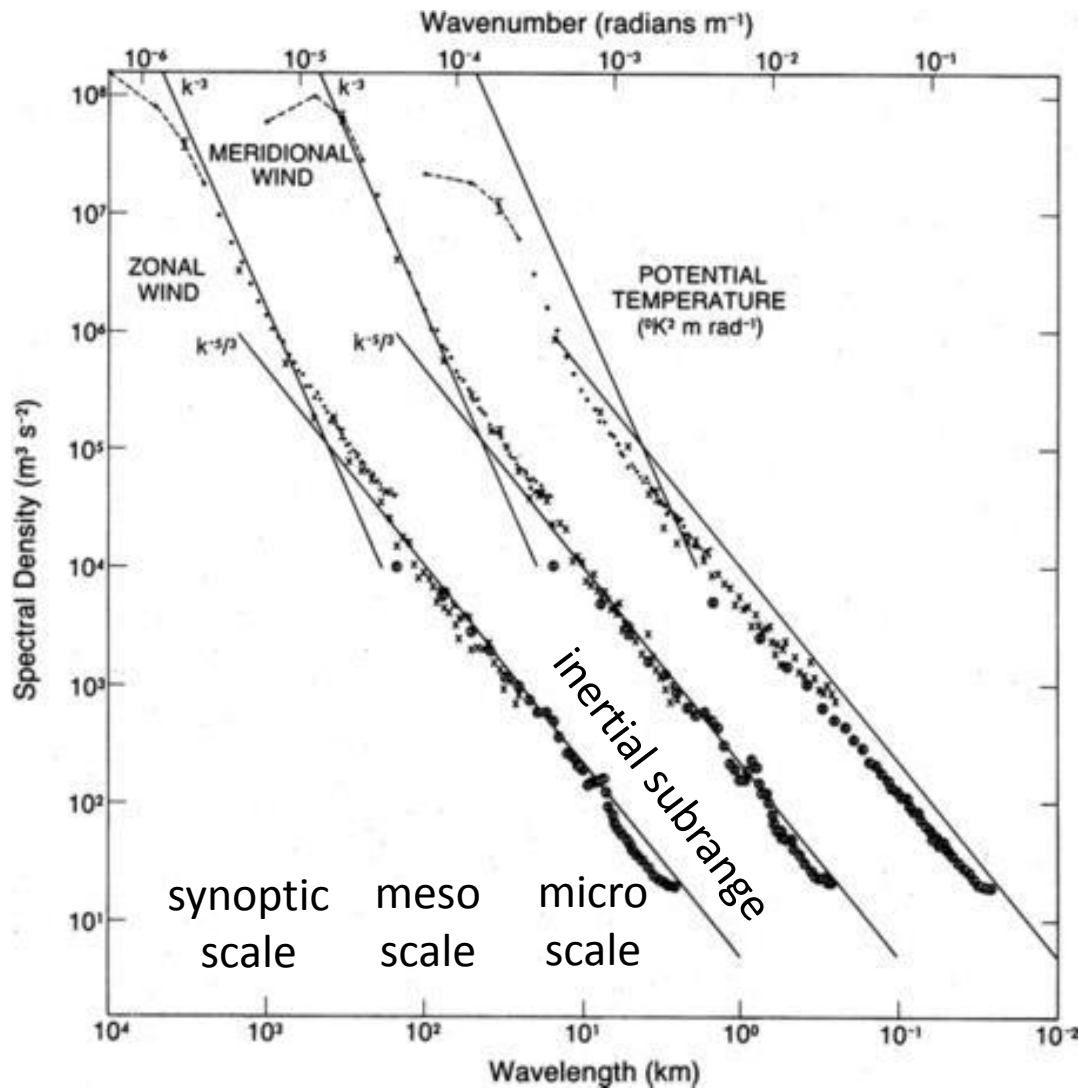
C-RITE Session 3

Free tropospheric flows and turbulence

Bart Geerts, University of Wyoming

Andrew Detwiler, South Dakota School of Mines and Technology

Energy spectra



$v(\theta)$ are displaced to the right by 1 (2) orders of magnitude, to avoid overlap

TKE sources and sinks

$$TKE/m = \bar{e} = \frac{1}{2}(\overline{u'^2} + \overline{v'^2} + \overline{w'^2}) = \frac{1}{2}\overline{u_i'^2}$$

$$\underbrace{\frac{\partial \bar{e}}{\partial t}}_I + \underbrace{\bar{U}_j \frac{\partial \bar{e}}{\partial x_j}}_{II} = \underbrace{\delta_{i3} \frac{\overline{u'_i \theta'_v}}{\bar{\theta}_v} g}_{III} - \underbrace{\overline{u'_i u'_j} \frac{\partial \bar{U}_i}{\partial x_j}}_{IV} - \underbrace{\frac{\partial \overline{u'_j e}}{\partial x_j}}_V - \underbrace{\frac{1}{\bar{\rho}} \frac{\partial (\overline{u'_i p'})}{\partial x_i}}_{VI} \underbrace{- \epsilon}_{VII}$$

I: TKE tendency

II: TKE 3D advection (by mean wind)

III: buoyancy source/sink

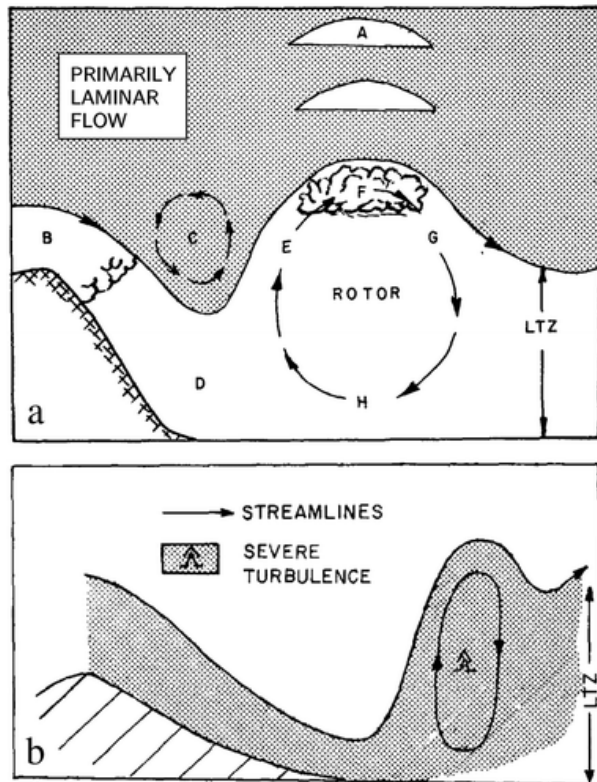
IV: shear (mechanical) source/sink

V: TKE 3D turbulent transport

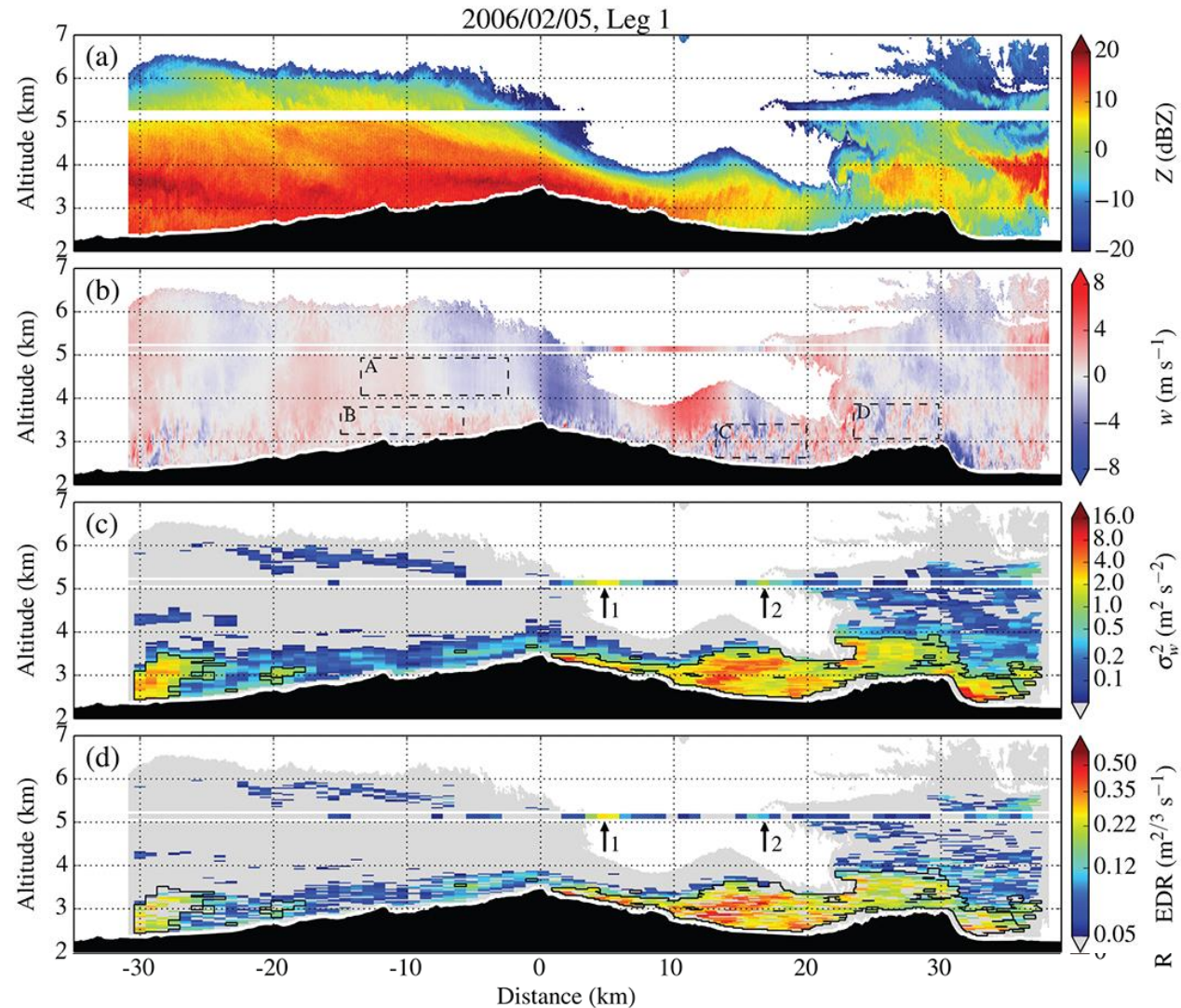
VI: pressure perturbation source/sink

VII: viscous dissipation of TKE

Downslope windstorm, wave breaking, boundary layer separation, and severe turbulence



Lester and Fingerhut 1974, MWR



Strauss et al. 2016, QJRMS

Mountain winds and turbulence

speaker: James Doyle

- PhD Atmospheric Science, Penn State
- Head, Mesoscale Modeling Section, Marine Meteorology Division, Naval Research Laboratory
- He is one of the lead developers of the Navy's COAMPS modeling system,
- He has led and participated in many field programs
 - orographic gravity waves: T-REX, DEEPWAVE, MAP
 - tropical cyclone programs: HS3, SHOUT, TCI, T-PARC
 - extratropical cyclones: NAWDEX, COAST, CalWater



Mountain winds and turbulence

moderator: Vanda Grubišić

- PhD Atmospheric Science, Yale
- Director, NCAR EOL
- played a lead role in several major field campaigns focusing on mountain lee waves and rotors, atmospheric wakes, and orographic precipitation, such as T-REX



Turbulence in clouds

speaker: Pavlos Kollias

- PhD Atmospheric Science, Univ. of Miami
- Professor at Stony Brook University School of Marine and Atmospheric Science, and research scientist at DOE Brookhaven National Lab
- Expertise in cloud microphysics and dynamics, cloud radar meteorology and technology, environmental remote sensing.



Turbulence in clouds

moderator: Bart Geerts

- PhD Atmospheric Science, Univ. of Washington
- Professor at University of Wyoming
- Little expertise in turbulence



Clear-air turbulence

speaker: Robert Sharman

- Ph.D. Atmospheric Science, UCLA
- Project Scientist at NCAR RAL, Aviation Application Program
- Applied research interests includes aircraft scale turbulence in the free atmosphere: observations and forecasting strategies.



Clear-air turbulence

moderator: Stan Trier

- Ph.D. Atmospheric Science, Colorado State University
- Project Scientist at NCAR M³
- Research interests include general aspects of MCSs and their environments.
- Applied research interests include the problem of aviation turbulence - in particular clear-air-turbulence as a remote effect of deep convection.



Topic 3: Free Troposphere Flows and Turbulence

POC Leads: Andrew Detwiler andrew.detwiler@sdsmt.edu, Bart Geerts Geerts@uwyo.edu

Lead Rapporteur: Dave Bodine, bodine@ou.edu



Mountain winds and turbulence	Speaker	Jim Doyle	NRL
	Break-out moderator	Vanda <u>Grubišić</u>	NCAR/EOL
	Rapporteur	<u>Rosimar Rios Berrios</u>	ASP, SUNY Albany

Turbulence in clouds	Speaker	<u>Pavlos Kollias</u>	SUNY Stony Brook
	Break-out moderator	Bart Geerts	U. Wyoming
	Rapporteur	Dave Bodine	U. Oklahoma



Clear-air turbulence	Speaker	Robert Sharman	NCAR/RAL
	Break-out moderator	Stan Trier	NCAR/MMM
	Rapporteur	<u>Rochelle Worsnop</u>	U. Colorado



Session III: Free Troposphere Flows and Turbulence (All plenary sessions in CG Auditorium)

8:30- 8:40: Plenary - Goals and expectations of Free Troposphere Flows and Turbulence (Bart Geerts)

8:40- 9:40: Overview Presentations (three 20 min presentations)

- | | | |
|----------------------------------|----------------|---|
| 1. Mountain Winds and Turbulence | Jim Doyle | links with session “PBL over complex terrain” |
| 2. Turbulence in Clouds | Pavlos Kollias | links with session on convection |
| 3. Clear-air Turbulence | Robert Sharman | links with session on SBL, CBL |

9:40-10:00: Discussions

10:00-10:15: *Break (move to breakout rooms)*

10:15-11:30: Session III Breakout Groups

- | | | |
|----------------------------------|----------------|-------------------------|
| 1. Mountain Winds and Turbulence | Vanda Grubišić | (CG1 South Auditorium) |
| 2. Turbulence in Clouds | Bart Geerts | (CG1 Center Auditorium) |
| 3. Clear-air Turbulence | Stan Trier | (CG1 room 3150) |

11:30-12:15: Plenary - Summary from each breakout session and brief discussion/clarifications

registration distribution

topic	# people registered	Room (max seating)
mountain winds and turbulence	~34	CG Auditorium South (capacity: 50)
turbulence in clouds	~50	CG Auditorium Center (capacity: 60)
clear-air turbulence	~16	CG 3150 (capacity: 30)