REVIEW (MID-TERM)

MAIN TOPICS:

1. SCALE CONSIDERATIONS:
   TOPOCLIMATE: OBSERVATIONS IN MOUNTAINS

2. EFFECTS OF LATITUDE, CONTINENTALITY:
   - ON RADIATION, TEMPERATURE

3. ALTITUDE EFFECTS:
   PRESSURE
   WATER VAPOR } EXPONENTIAL DECREASE

RADIATION - SOLAR (U.V.) - OPTICAL DEPTH SCATTERING - CLOUDS

- INFARED
- NET

TEMPERATURE : ELR. DALR/SALR : POTENTIAL TEMP.

SUMMIT vs. FREE – AIR ; PLATEAUS

MASS ELEVATION

AIR, SOIL TEMP. VARIATION

WIND - BERNOULLI, FRICTION

SPEED – UP OVER LOW HILLS

S (STATIC STABILITY) = $g(\Gamma - \gamma)/T$

2. R. LONG (1955) Lab experiments; FROUDE No. criterion

$$F \text{ (Froude No.)} = \frac{\text{Inertial Forces}}{\text{Buoyancy}} \qquad \frac{\text{(Viscous)}}{\text{(Gravitational)}}$$

$$F_t = \frac{U}{N \cdot h} \quad ; \qquad \text{ALSO} = \frac{U}{h(S)^{1/2}}$$

$F_t < 1$: BLOCKED

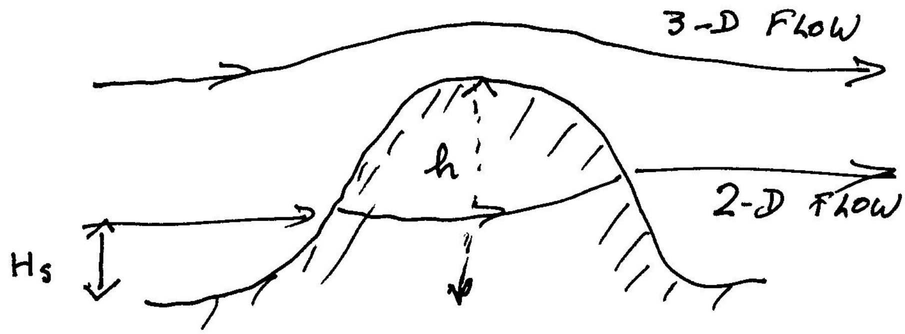
$F > 1$: SHOOTING FLOW $\qquad [{}^{1}/_{\ell} = {}^{U}/_{S^{1/2}}]$ Scorer Param. For Lee Waves

Note Brunt Väisälä Frequency for natural vertical oscillations $N = \sqrt{S}/2\pi$

3. J. HUNT & SNYDER (1980) Lab experiments; 'Dividing Streamline' Concept

Critical Streamline height for flow over obstacle is:

$$H_s = h\,(1 - F)$$



OTOGRAPHIC EFFECTS

PRINCIPLES OF FLOW OVER MOUNTAINS –

- K.E. REQUIREMENT
- FROUDE No. CRITERION - BLOCKING
- DIVIDING STREAMLINE

SCALES:

PLANETARY - CONSERVATION OF POTENTIAL VORTICITY

SYNOPTIC - FRONTS
BARRIER WINDS
LEE CYCLOGENESIS

MESO SCALE { FREE, FORCED WAVES
LEE WAVES - SCORER PARAM.
KARMAN VORTEX STREET

DYNAMICALLY – FORCED WINDS

- (BARRIER WINDS)
- FALL WINDS - CHINOOK (FÖHN)
- BORA

THERMALLY – FORCED (DENSITY GRADIENT, g)

- SLOPE WINDS – ANA/KATABATIC
- MOUNTAIN/VALLEY WINDS

<u>MOUNTAIN CLIMATOL: REVIEW, PART 2</u>

<u>TOPOCLIMATE/MICROCLIMATE:</u>

- **<u>SCALES</u>**
- **<u>FACTORS</u>**
  - **SLOPE (orientation, angle, curvature)**
  - **SKY VIEW, SHELTER**
  - **LOCAL AIRFLOW**
  - **SURACE RADIATIVE PROPERTIES (albedo)**
  - **SOIL THERMAL PROPERTIES**

- **<u>MODELLING</u> SLOPE RADIATION (sun path diagram, geometry)**
  - **APPLICATIONS**

- **<u>TOPOCLIMATES</u>**
  - **THERMAL BELT**
  - **'SHELTER' – local, large scale**

<u>MICROCLIMATE</u>

- **RADIATION**
- **WIND EXPOSURE, SHELTER**
- **SNOW DEPTH**
- **VEGETATION**
- **SOIL PROPERTIES**

<u>CLIMATIC CHARACTERISTICS</u>

1. **<u>ENERGY BUDGETS</u> – Rn = S(1-α) + L↑ - L↓**

   Rn = H + LE + Є – Niwot examples

   <u>EVAPORATION</u> – OBS. (Pan, Lysimeter, Eddy Correlation

- **CALCULATION**
  - **Aerodynamic (profile)**
  - **Energy Budget**

    (note: H/LE = β)
- **TYPICAL BUDGETS – wet/dry surfaces**

2. **<u>CLOUD REGIMES</u>**
   - **Lapse rates**
   - **Bergeron (feeder/seeder)**
   - **Convective, stratiform clouds**
3. **<u>PRECIPITATION</u>**
   - **OBS. ERRORS, NETWORKS**
   - **Precip. Types, - <u>OROG. COMPONENT</u>**

     - Processes
   - **Models – condensation rate, vertical motion**
   - **Snowfall, - Snow transport (modes)**
   - **Condensation – RIME; fog precip.**
   - **Snow Sublimation**

BIOCLIMATE:

I. **WEATHER HAZARDS**

4. HYPOXIA – physiological/medical aspects-inspired oxygen, working capacity, hemoglobin saturation, cardiac output
5. HYPOTHERMIA, WINDCHILL
   Vaso-constriction/dilation
   Basal metabolic rate
6. OTHER – Blowing snow/white-out; avalanche, lightning
   Foehn – pressure waves

II. **INDIGENOUS POPULATIONS**

Adaptations – to hypoxia (Tibet, Peru, Colorado)

Acclimatization – athletes, climbers

Loss of ventilatory adjustment (Soroche CMS)

Effects of altitude – health, births

III. **POLLUTION**

Emission – Transport – Deposition

Types/sources

Plumes – wind/stability effects

Large-scale – Synoptic Weather - Inversions

Mixing Depth: convection

Orog. Effects: Channeling

Flow blocking/Separation

Slope/Valley Airflows

Scavenging/Seeder-feeder role

Orog. Clouds

Acid rain/Snow

<u>REGIONAL CASE STUDIES</u>

BASIC ROLES OF:

LATITUDE – annual/diurnal T-range

Global Wind Belts (surface, upper air)

Continental/Maritime

1. **<u>EQUATORIAL/TROPICAL</u>**

   <u>NEW GUINEA</u> – seasonal wind changes (SE/NW)

   Precip. – decrease with height

   Snowfalls at 4km

   <u>VENEZUELA</u> – Dominant E'lies

   Complex precip. Profiles

   Max. at 1km on E-slope of Andes

   Thermal-Blome zones

   Cloud forest

   Glaciers 5 km

   <u>HIMALAYA</u> – Summer monsoon

   Precip. Max. in foothills (decr. to N and W)

   Circulation Change – ocean/Tibet roles

   Winter cyclones in NW Himalaya

   Mountain snowfall, large glaciers

REGIONAL CLIMATES (continued)

Tibet – 'Plateau Monsoon" (Compare to S.W. USA high plateau) – summer heat low (shallow)
Precipitation decreases from SE to NW
Mostly summer convective precipitation (nocturnal)
Mean altitude 4500 m – extensive permafrost

MID-LATITUDES

Basic controls: westerlies, storm tracks; latitude maritime/continental effects.
"snow climates" in Pacific NW, Colorado . . .

1.) Colorado Rocky Mountains – west/east contrasts in precipitation gradients.
    a. Strong westerly winds
    b. Topoclimates-esp. low elevation
2.) Alps – dry interior regions.
    a. Contrasting annual precipitation regimes (mainly N/S)
    b. Foehn effects
3.) Scottish Highlands – ultra – maritime. Steep precipitation gradient to west.
    a. Short and variable snow season

CLIMATIC CHANGE

European Observatories – temp. records – similarities to hem. trend (winter warming)

Spatial gradients complicate mt/lowland comparison

Glacier recession – integrated record. (post – L.I.A) accelerating retreat
Snow cover responses to change in T
Impacts of changes in mountains