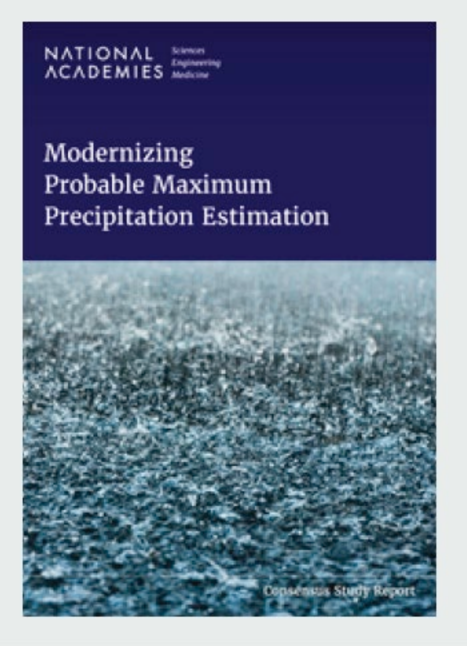
Science Challenges for Modeling Extreme Warm Season Rainfall in Mountainous Terrain

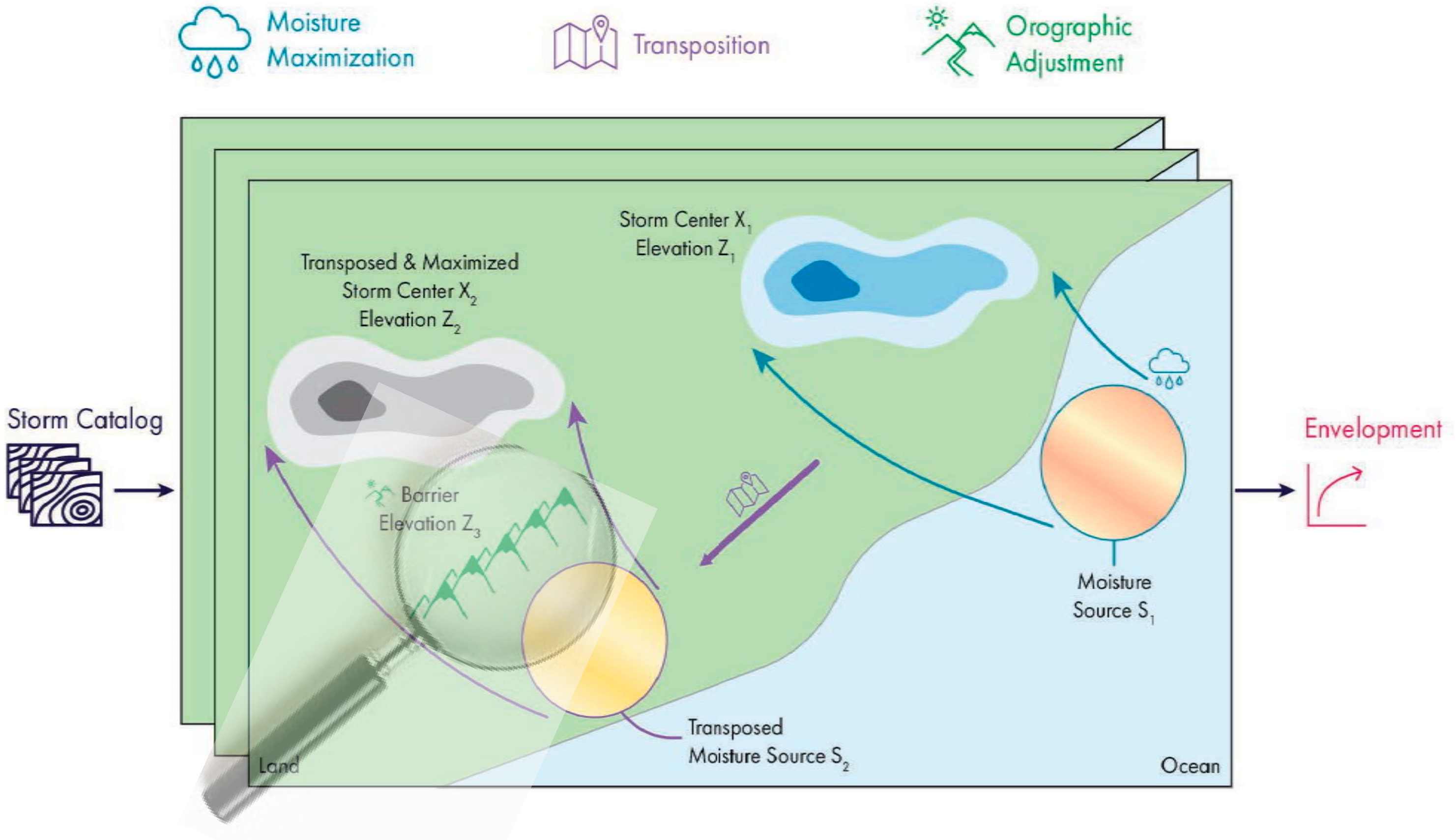
Richard Rotunno

NSF | NCAR Operated by UCAR

Probable Maximum Precipitation

2024





Probable Maximum Precipitation

The depth of precipitation for a particular duration, location, and areal extent, such as a drainage basin, with an extremely low annual probability of being exceeded, for a specified climate period.

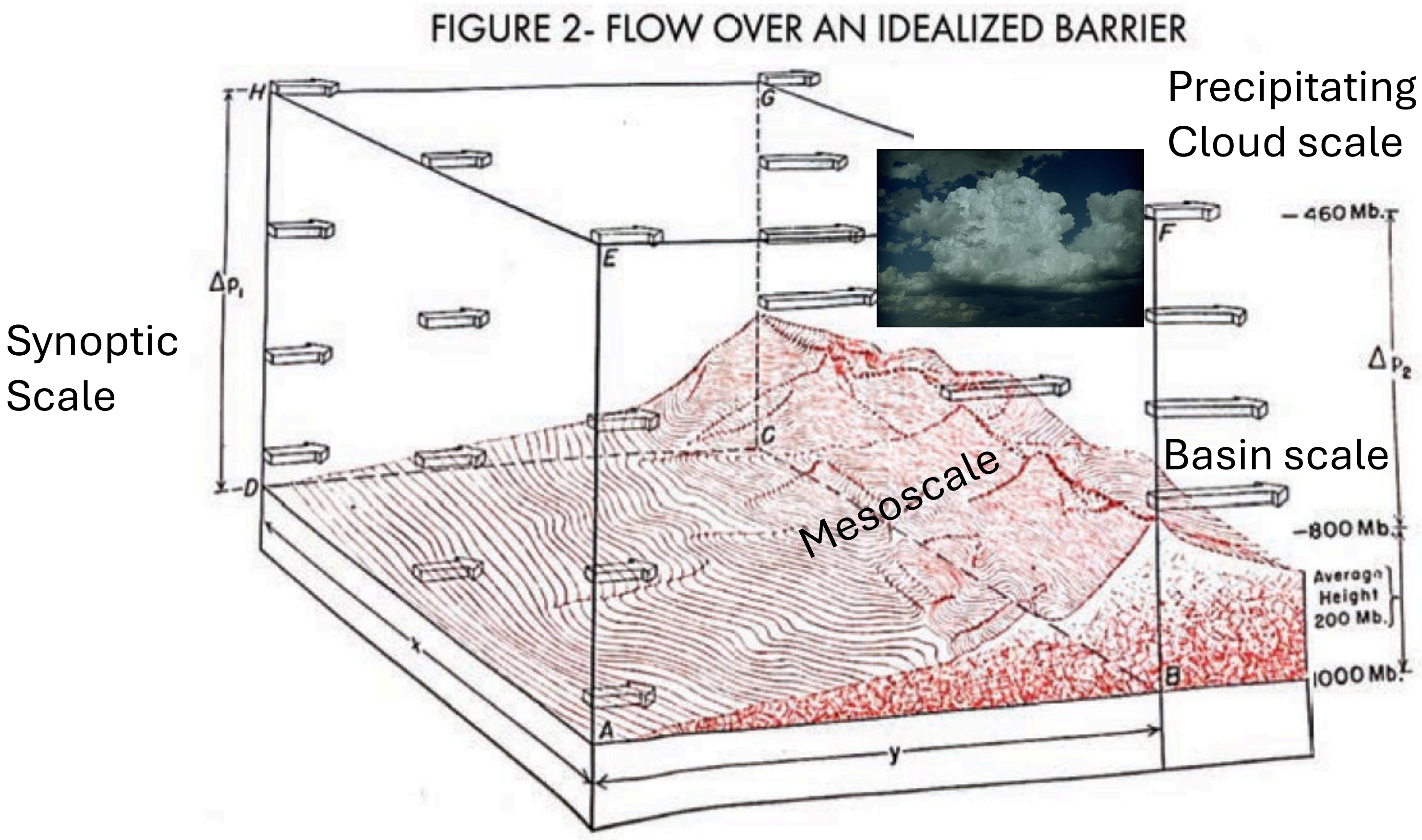


FIGURE B-2 Conceptual orographic model for PMP based flow over a ridge.
SOURCE: HMR 21B (USWB, 1945), Figures 1 and 2.

Depth of Precip. =
Duration x Rain rate
(Synoptic) (Clouds → Precip)

Location and Areal extent →

"It matters where it lands"

(Cloud growth and movement)

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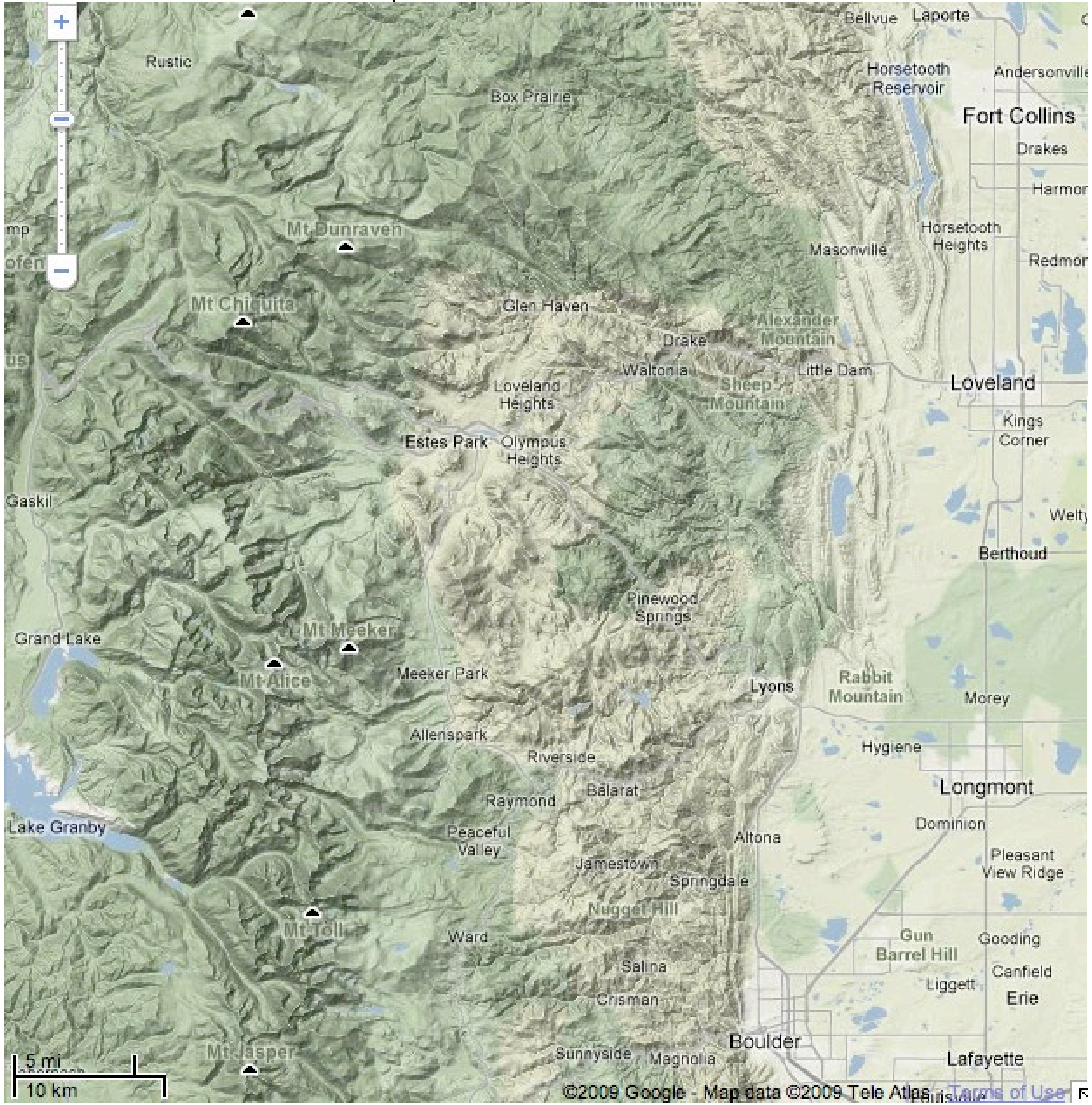
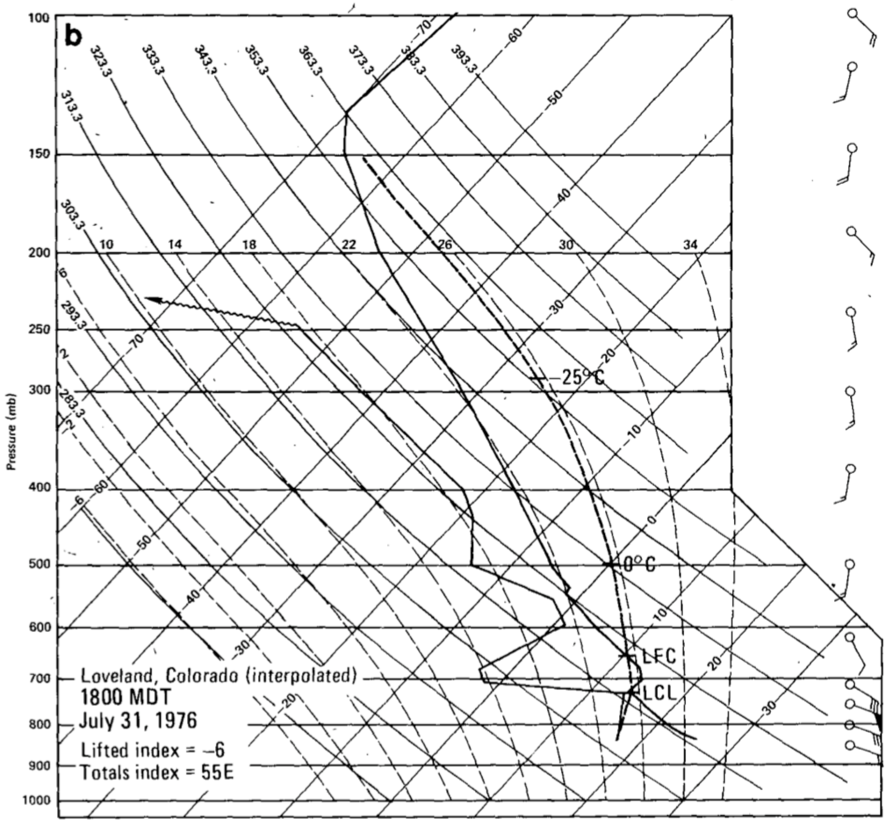
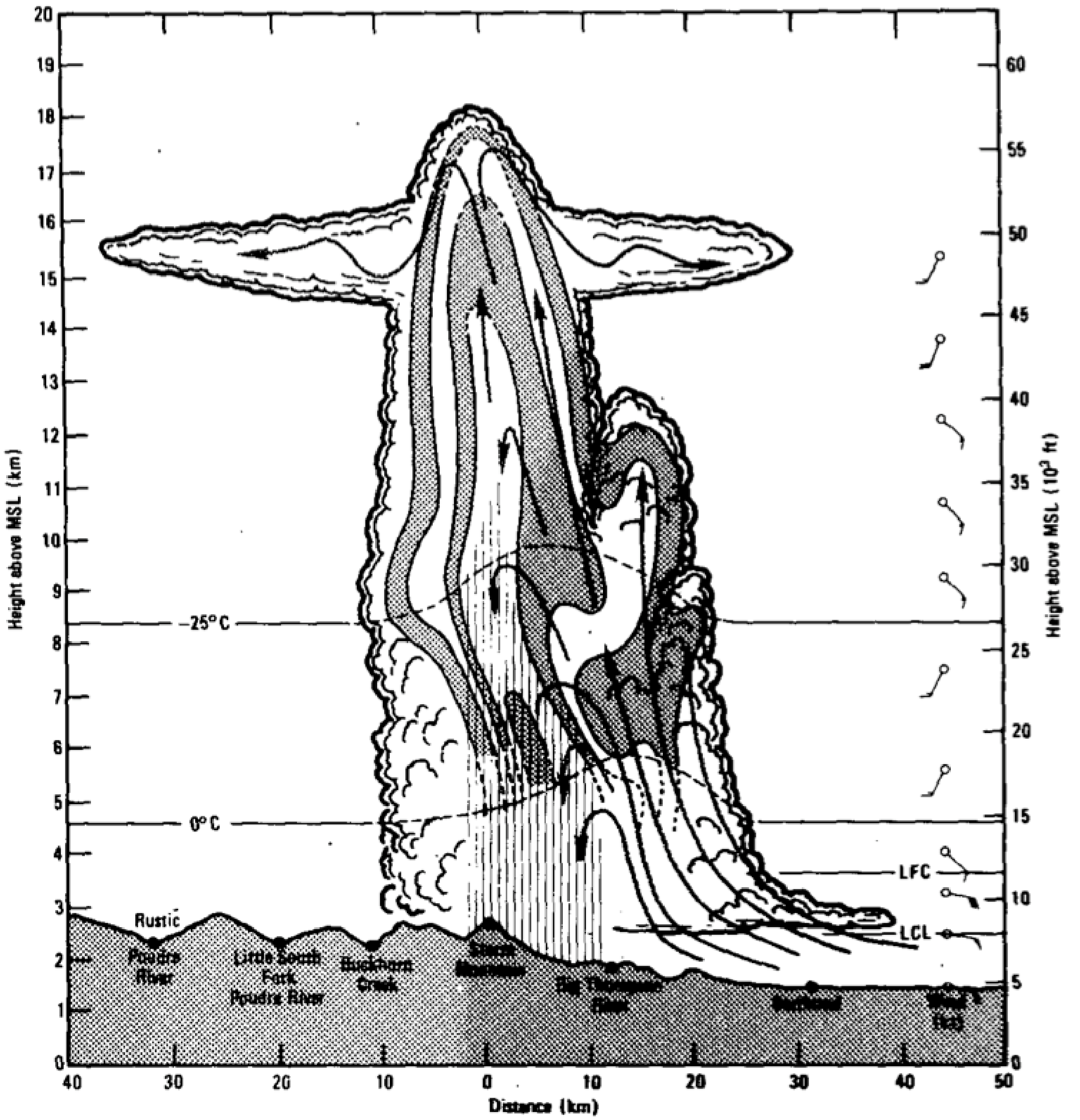
Big Thompson Flood Colorado, 1976



low-level flow



Big Thompson Flood Colorado, 1976



Caracena et al. (1979, *Mon Wea Rev*)

170mm in several hours

JANUARY 1979 CARACENA *ET AL.* 3

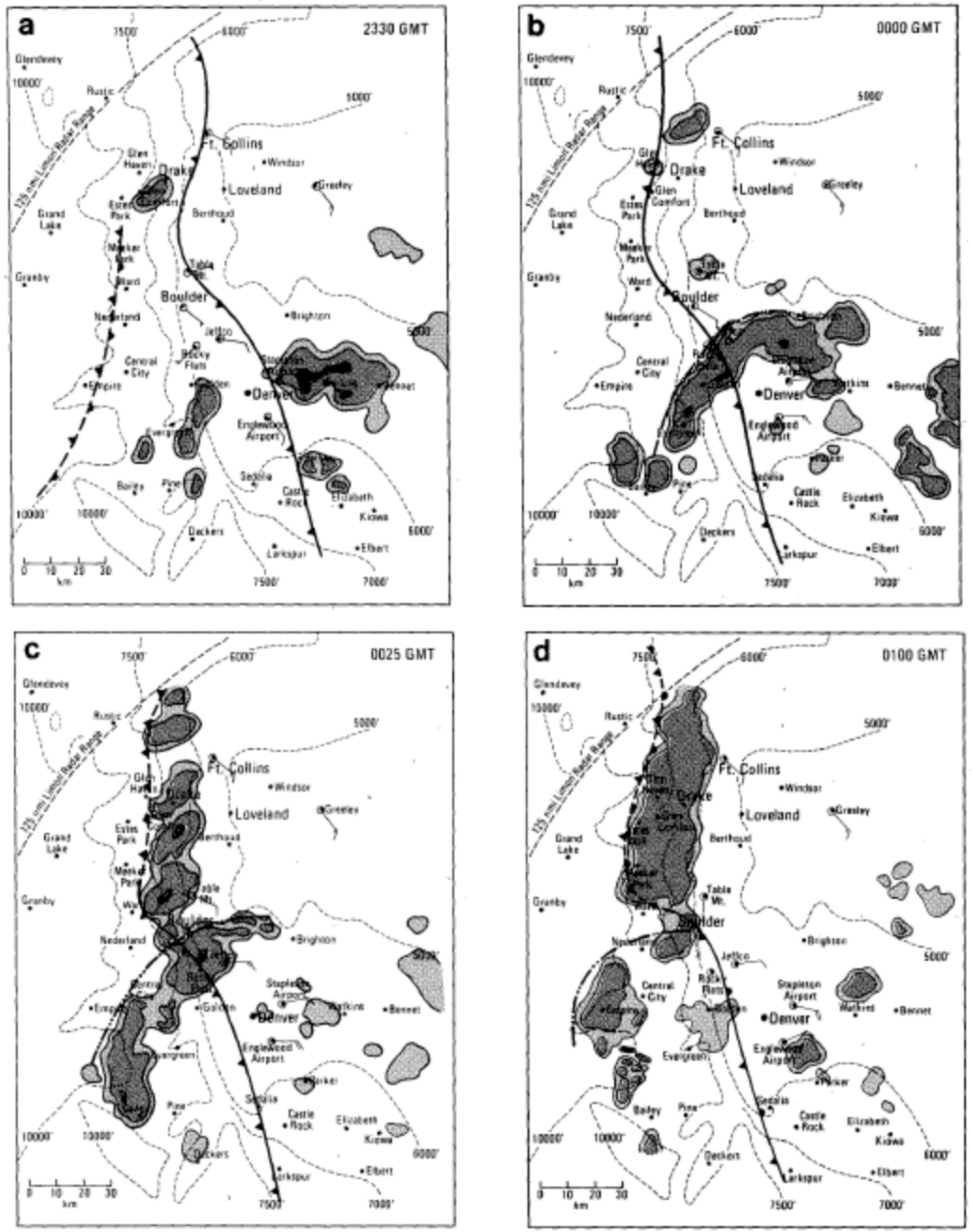
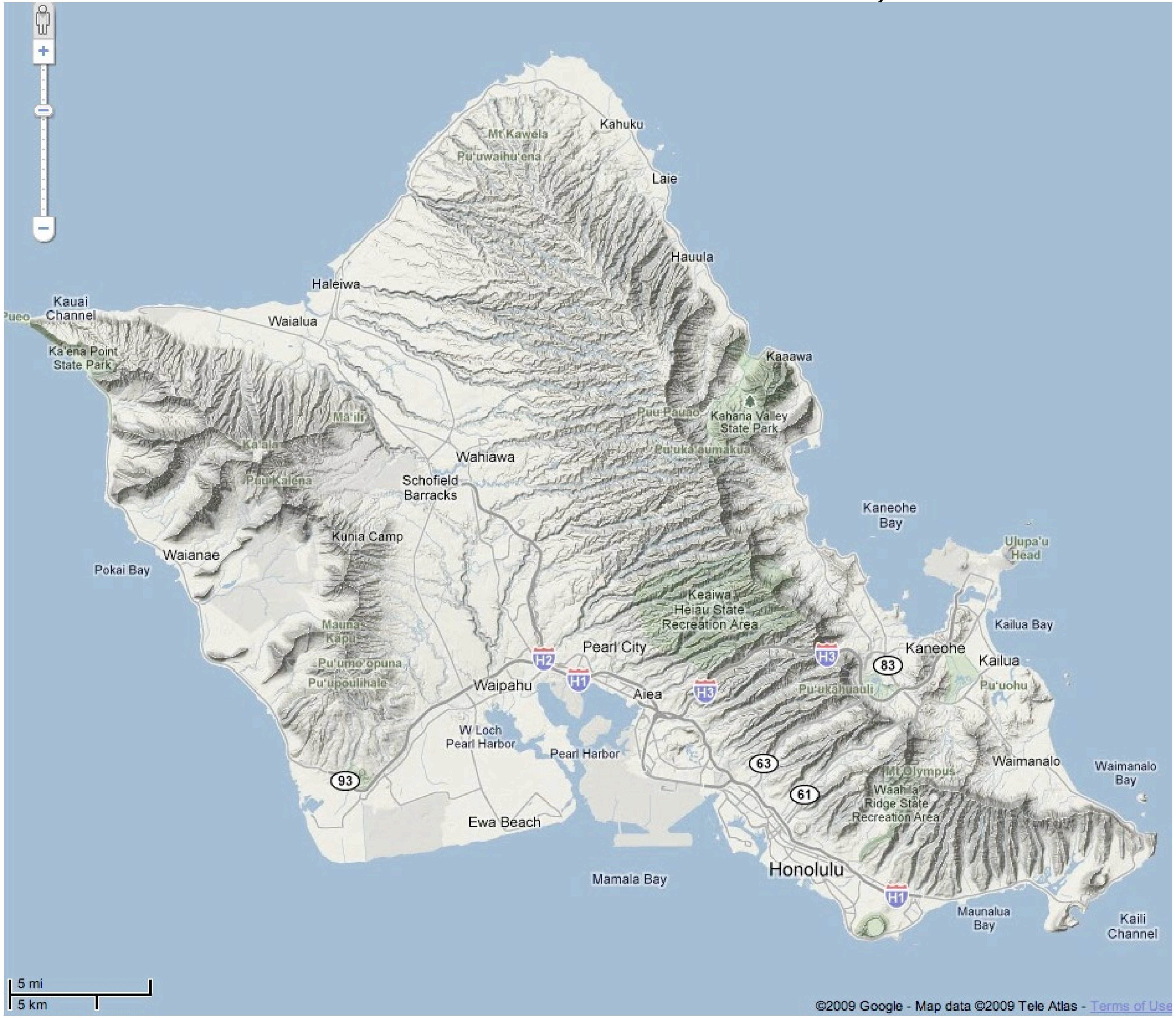


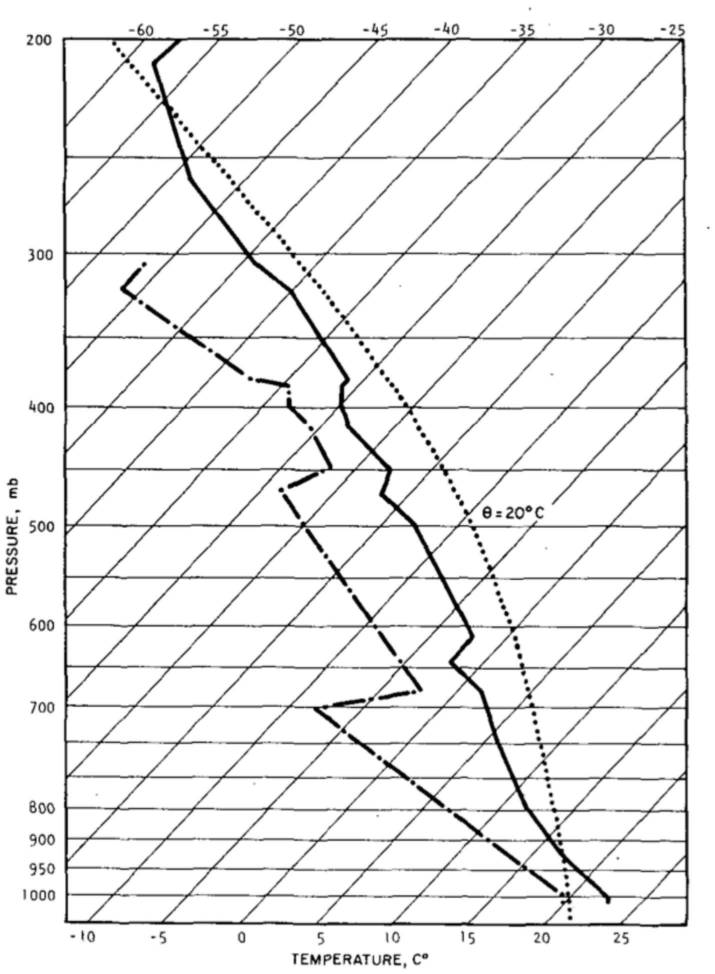
FIG. 1. Local-scale surface analyses. Frontal positions and reported winds are in black; Limon radar echoes are shown with VIP level 1 return shaded light gray, level 2 shaded medium gray and level 3 shaded dark gray. (a) 2330 GMT 31 July 1976, (b) 0000 GMT 1 August 1976, (c) 0025 GMT 1 August 1976, (d) 0100 GMT 1 August 1976.

Cells drifting up from the south and amplifying over the Big Thompson River Drainage

Caracena et al. (1979, *Mon Wea Rev*)

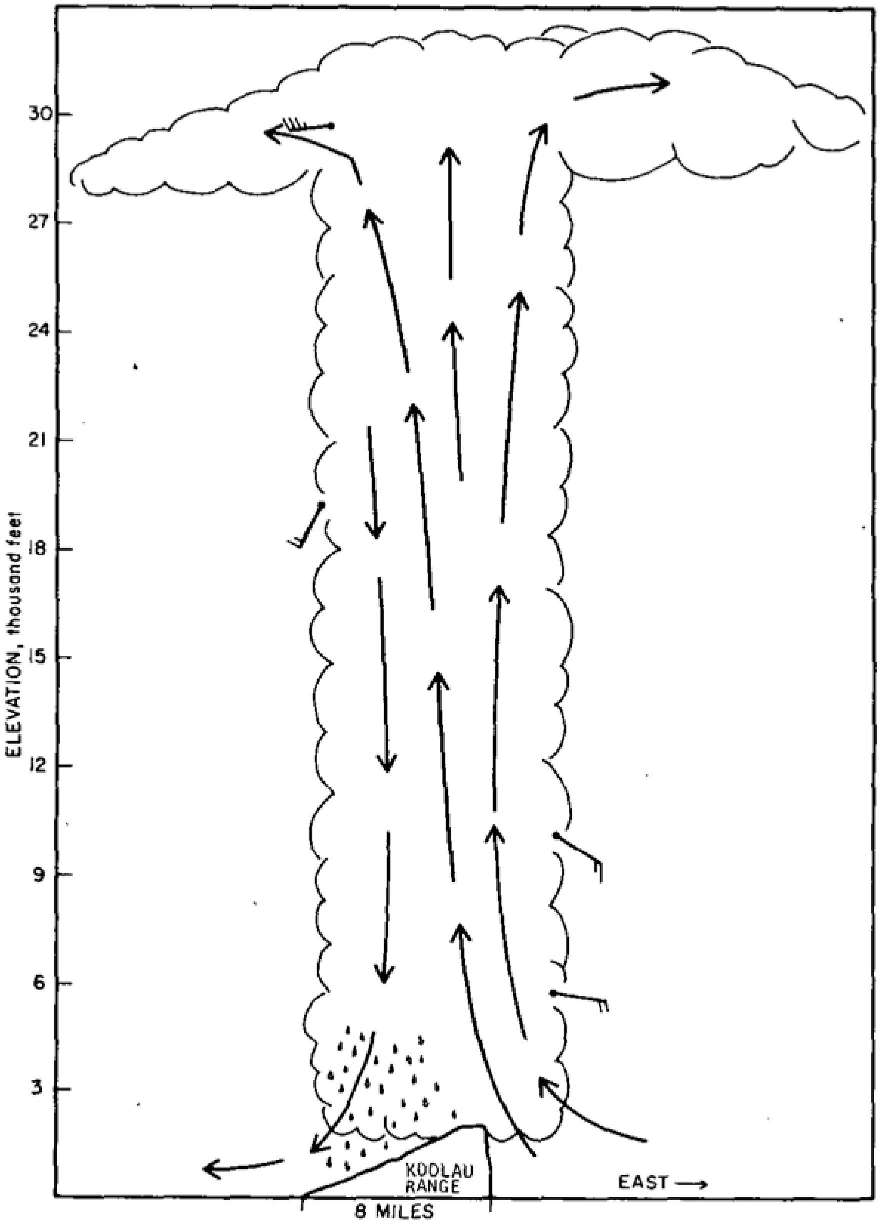
Oahu Flood, Hawaii 1974





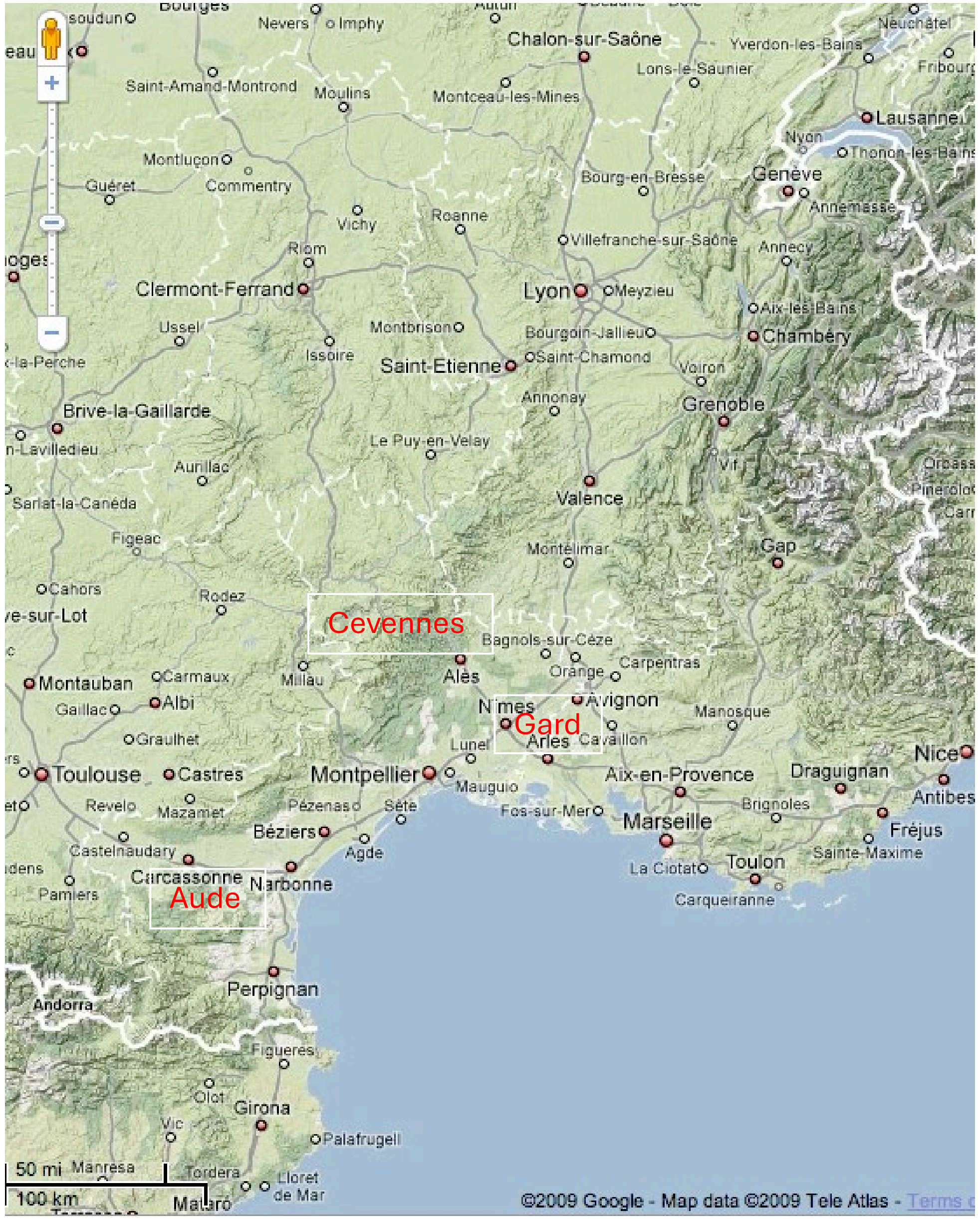
low-level flow

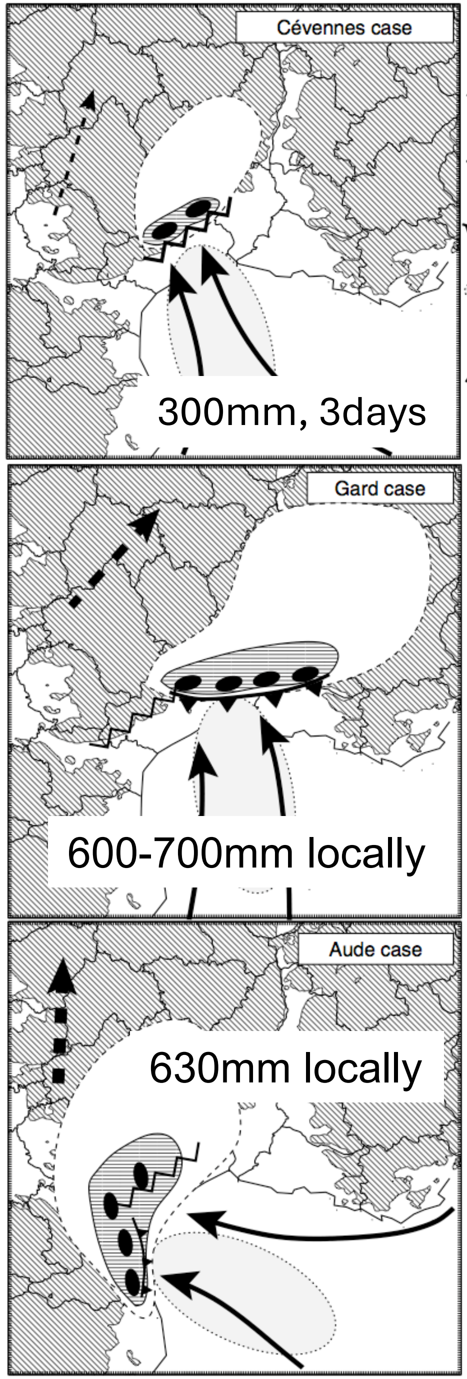
Oahu Flood, Hawaii 1974

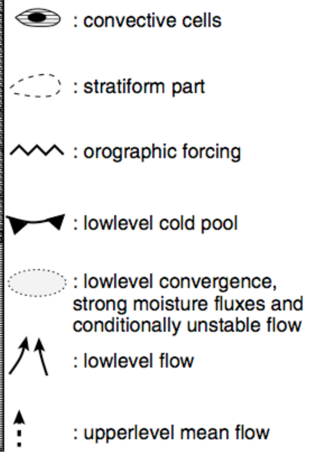


Schroeder (1977, *Mon Wea Rev*) 250mm in several hours

Floods in Southeastern France







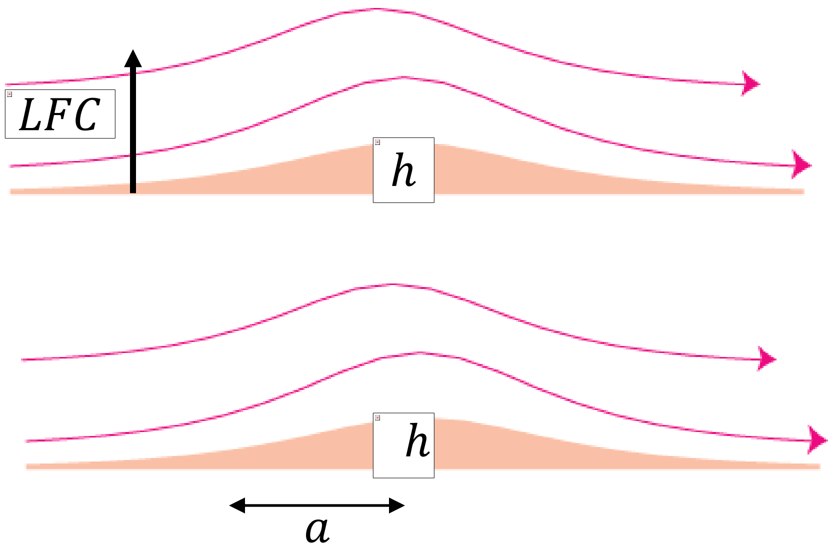
Ducrocq *et al.* (2008, *QJRMS*)

Three nondimensional parameters emerge as most important:

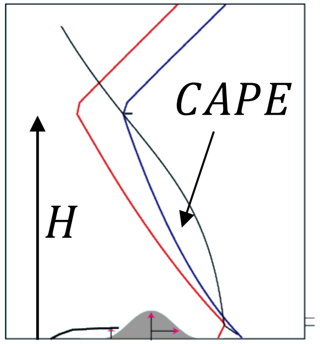
1. Triggering: $\frac{h}{LFC} > 1$

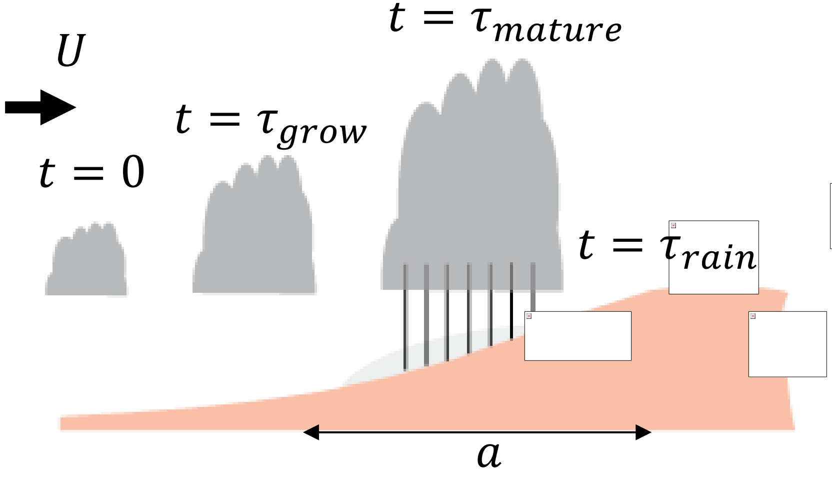
2. Orographic forcing: $\frac{h}{a}$

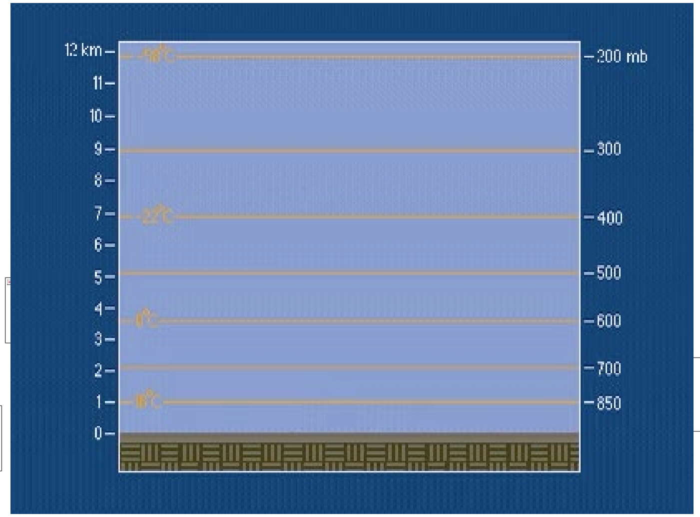
$$\left(\frac{w}{U} \propto \frac{h}{a}\right)$$



3. Ratio of advective to convective time scale:





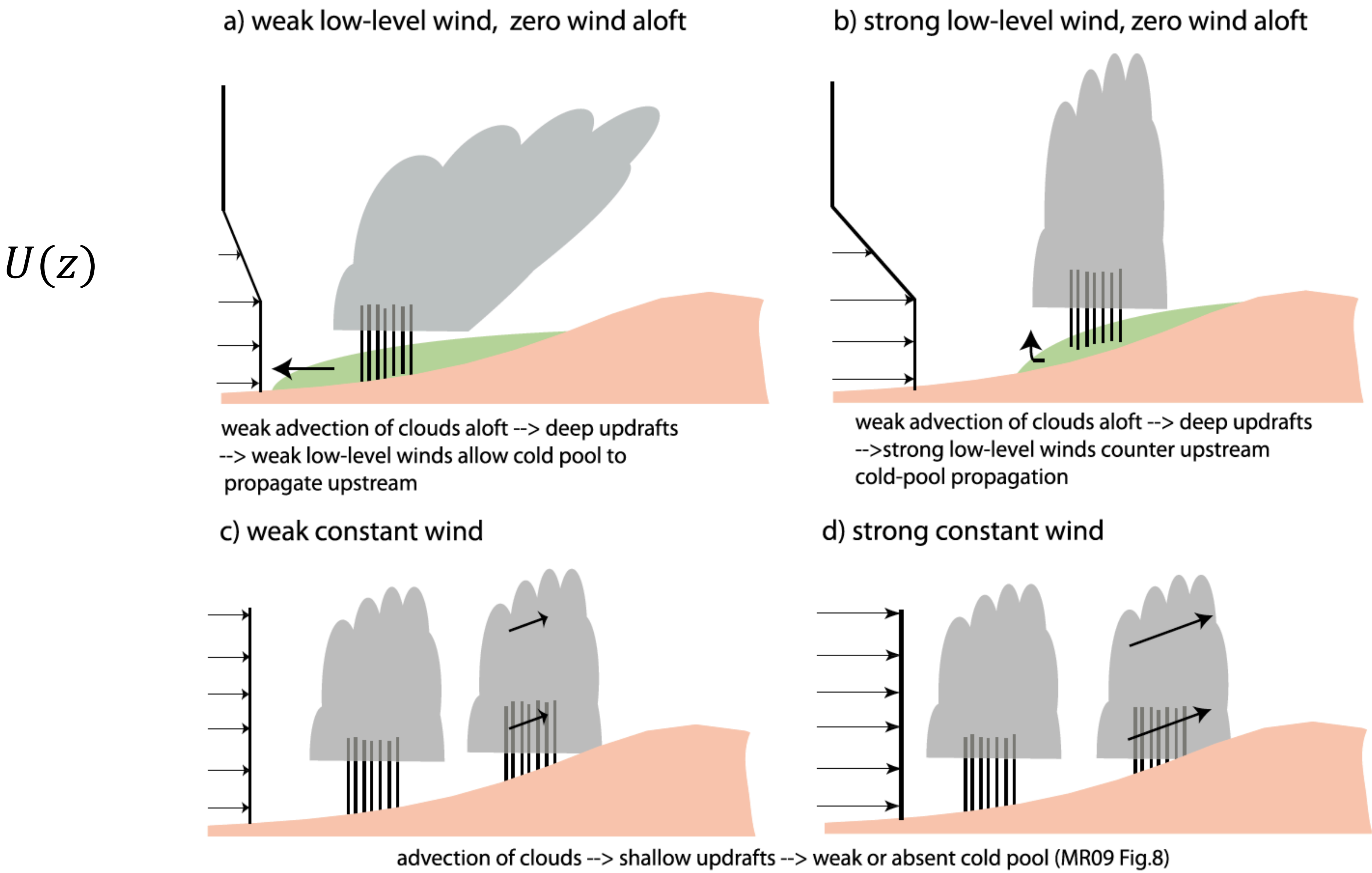


$$\frac{\tau_{adv}}{\tau_{conv}} \propto \frac{a/U}{\tau_{conv}}$$

$$\tau_{conv} = \tau_{grow} + \tau_{mature} + \tau_{rain}$$

(Miglietta and Rotunno, 2009 *J Atmos Sci)*

Effects of Upstream Wind Variation with Height



(Miglietta and Rotunno, 2014 *J Atmos Sci)*

Science Challenges for PMP

- Ensembles of Large Eddy Simulations of Precipitating Clouds for Past Floods with Actual Orography
- Ditto with possible Synoptic/Thermodynamic Environment(s) in Future Climate