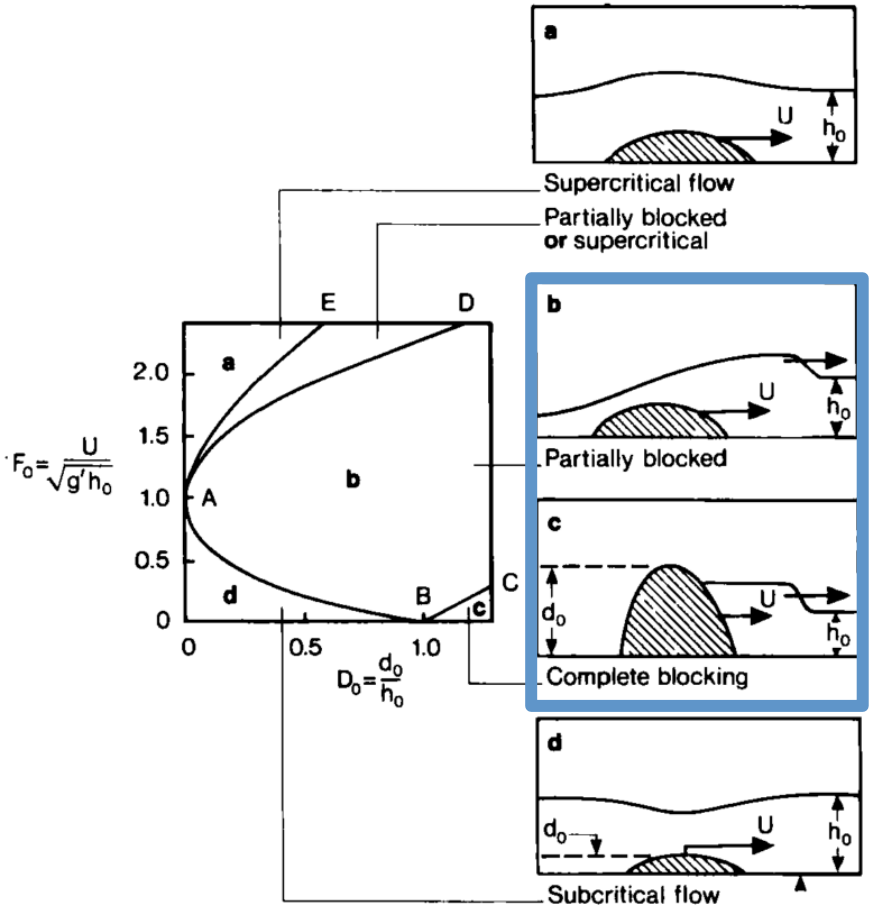
Developing the Infrastructure for Forecasting Bores

Knowledge a forecaster would like to provide the PECAN PIs

1. Generation of bore -> Yes or no?
2. Speed of Bore
3. Direction of Bore propagation
4. Duration of Bore

Step 1: Determine the flow regime



Must determine the flow regime. Bores will form in the partially or completely blocked regime.

Flow Regime

$$F = \frac{\left(U - C_{gc}\right)}{C_*} = \frac{\left(U - C_{gc}\right)}{\sqrt{g\,\Delta\theta\, d_{gc}/\theta_{vw}}}$$

Bore-Relative Froude #

d_o/h_o

Ratio of density current height to inversion height

$$\mu = \frac{C_0}{C_{gc}} = \frac{2Nh_0/\pi}{C_{gc}}$$

Ratio of Long-Period Gravity wave to gravity current

$$F = \frac{(U - C_{gc})}{C_*} = \frac{(U - C_{gc})}{\sqrt{g\,\Delta\theta\, d_{gc}/\theta_{vw}}}$$

Bore-Relative Froude #

d_o/h_o

Ratio of density current height to inversion height

U: Mean wind-speed below inversion top.

-Calculated from sounding

C_{gc}: Speed of gravity current.

ρ_w : density of ambient air

ρ_c: density of cold pool (gravity current)

-Obtained from surface measurements

$$C_{gc} = \sqrt{2gd_o \cdot \frac{\rho_c - \rho_w}{\rho_w}}$$

$\Delta\theta_v$: $\theta_{inv.\ top} - \theta_{inv.\ bottom}$

-Obtained from sounding

$d_{dc} = d_o$ = depth of density(gravity) current

T_{vw}: Virtual temperature of ambient air

T_{vc} : Virtual temperature of cold pool

Δp: $p_c - p_w$

-Obtained from surface measurements

$$d_o = \frac{T_{vc}\Delta p}{\rho_w g\,[(p_c/p_w)T_{vw} - T_{vc}]}$$

θ_{vw} = mean virtual temperature of ambient air below the inversion

-Calculated from sounding

$$\mu = \frac{C_0}{C_{gc}} = \frac{2Nh_0/\pi}{C_{gc}}$$

Ratio of Long-Period Gravity wave to gravity current

According to Koch: *When μ <0.7 (the"supercritical regime"), the gravity current propagates faster than any gravity waves and a well-defined feeder flow is present. When the value of μ increases to near 0.7, but still within this supercritical regime, undular bores may form. Bores and solitary waves are spawned when μ >0.7 (the "subcritical regime") as the gravity wave propagates considerably faster than the gravity current.*

N : Brunt Väisälä

θ_{vw}: mean ambient air below inversion

dθ: inversion strength

dz : inversion depth

-Calculated from sounding

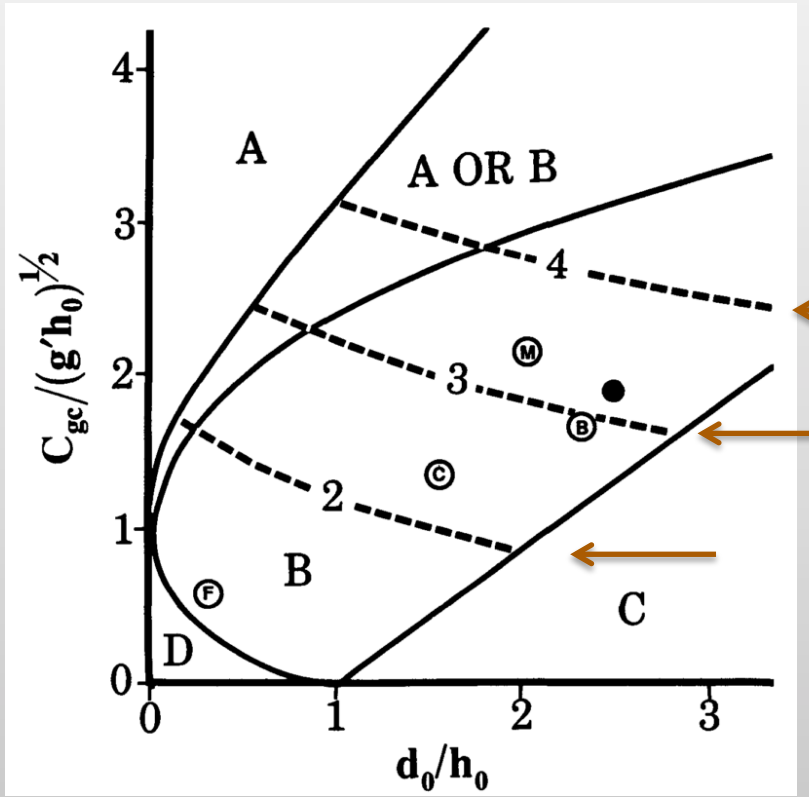
$$N = \sqrt{\frac{g}{\theta_{vw}}\frac{d\theta}{dz}}$$

h_o: height of inversion above ground level.

-Calculated from sounding. ($d\theta^+/dz \rightarrow 0$; $d\theta^-/dz$ is large)

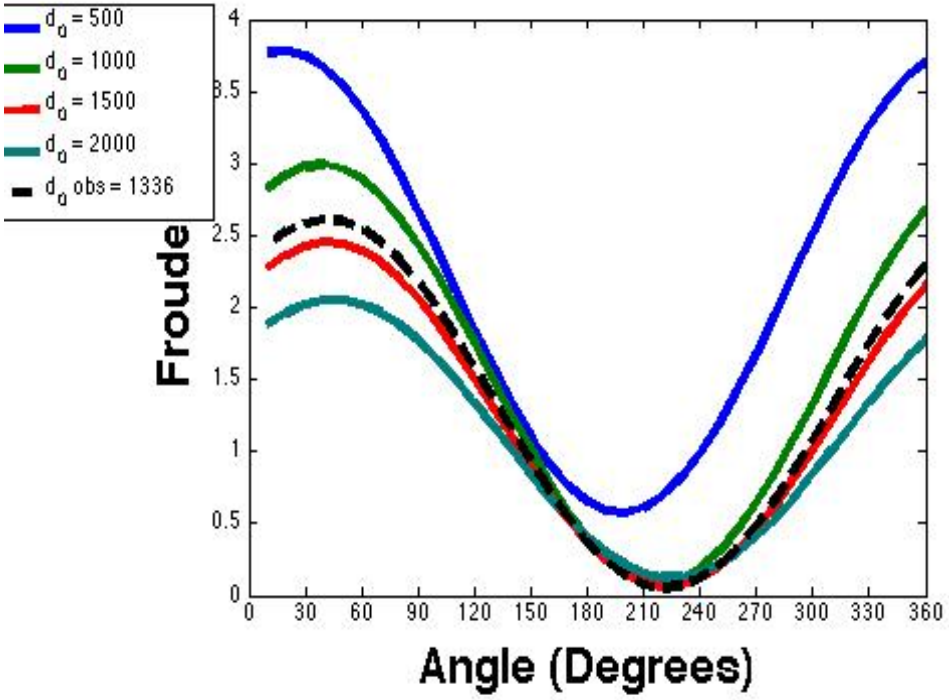
Speed of Bore

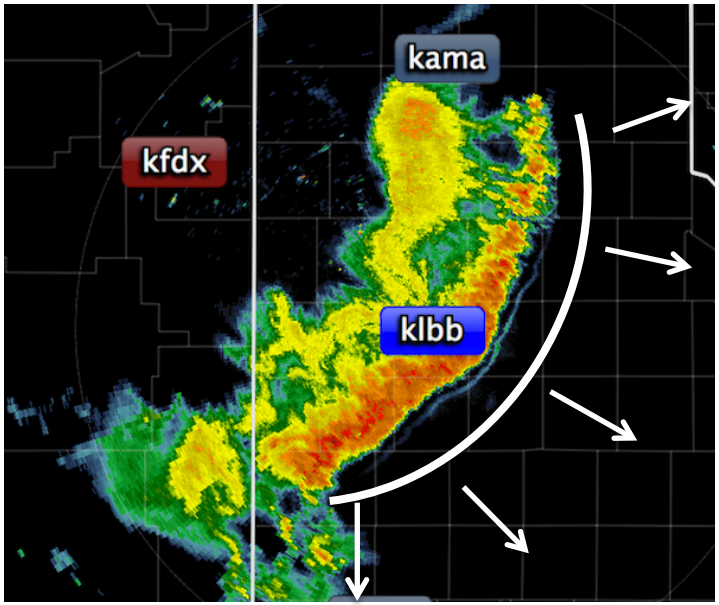
$$C_{gw} = \left[g\left(\frac{\Delta\theta_v}{\theta_v}\right) h_0 \right]^{1/2}$$



$$C_{bore} / C_{gw} = \left[0.5\left(d_b/h_0\right)\left(1 + d_b/h_0\right) \right]^{1/2}$$

Direction of bore propagation

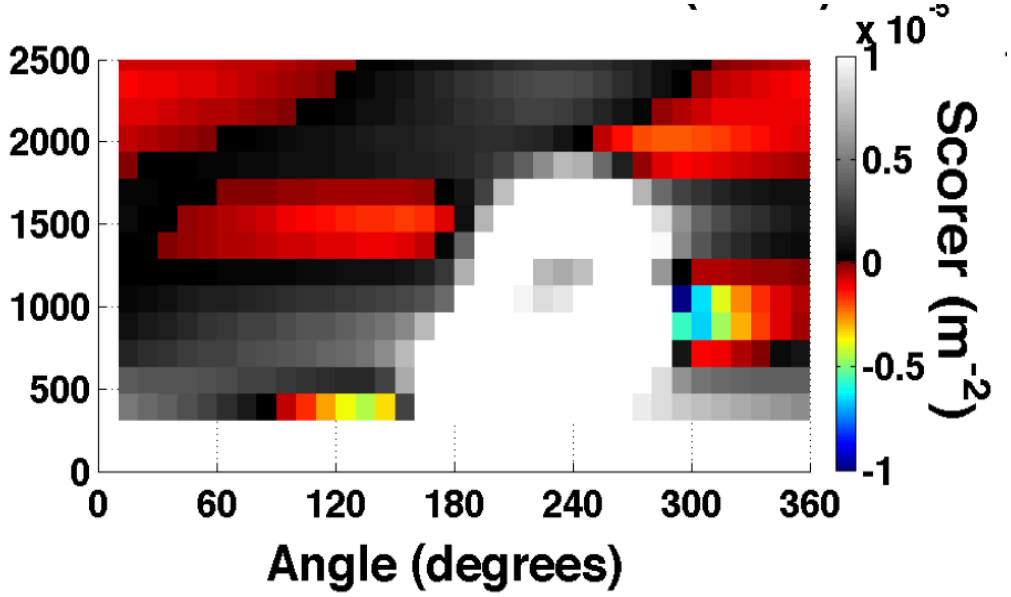




The Froude # is dependent upon the direction.

Calculations done for all possible directions.

Duration of Bore



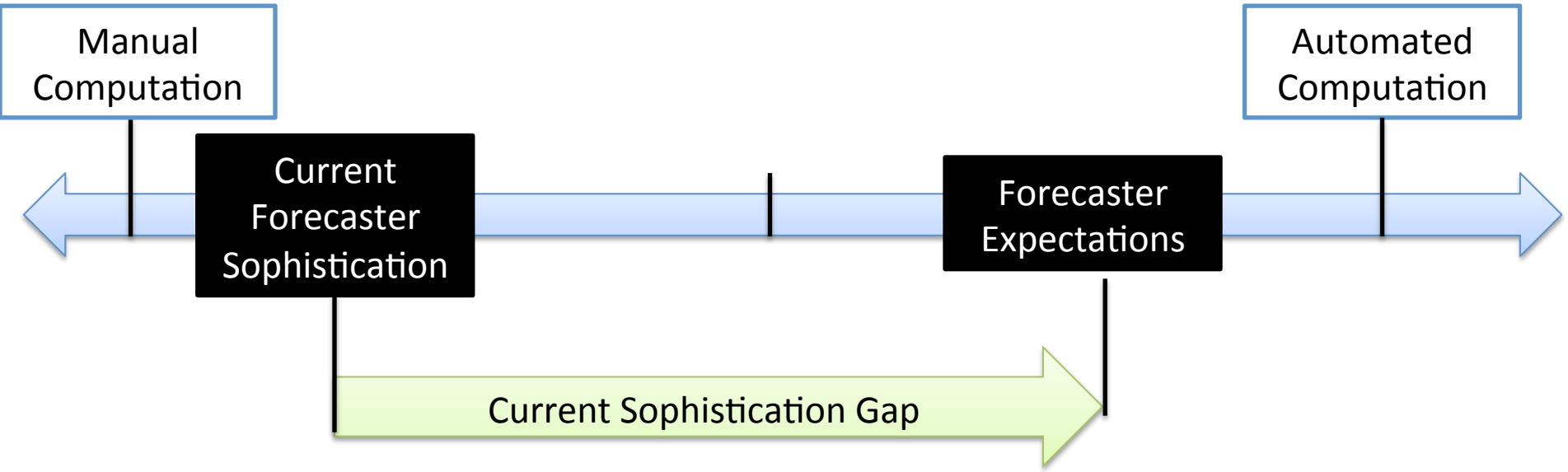
$$m^2 = \frac{N_m^2}{(U - C_{bore})^2} - \frac{\partial^2 U / \partial z^2}{(U - C_{bore})} - k^2$$

where $m^2 = l^2 - k^2$

Will the atmospheric bore become ducted?

Assumptions about forecasters

- Limited time and experience forecasting bores
- Familiar with computer models
- Do not have software to diagnose environment for bores



Questions

1. What are the expectations of the forecasters in terms of available forecast tools?
2. How much time will the forecasters spend forecasting?
3. What forecasting tools/models will they use?
4. How will the forecasters communicate the confidence of a bore forecast to the PIs?
5. Who will be needed to accomplish these goals?