R-Plume: Behavior of Mid-to-Large Underground Leaks

PHMSA sponsored project

Focus

- Mid to large leak scenarios (20 + scfh)
- High resolution field tests by using above/ below ground sensors to characterize gas migration speed and distance at high leak rates and concentrations above explosive limits

Objectives:

- Characterize gas migration behavior at the surface and in the subsurface, under a range of environmental conditions
- Develop methods to use readily-obtained gas concentration measurements & environmental observations to estimate extent and speed of gas migration
- **Extend measurements using modeling for additional scenarios**
- **Link understanding with first responder and leak detection protocols**

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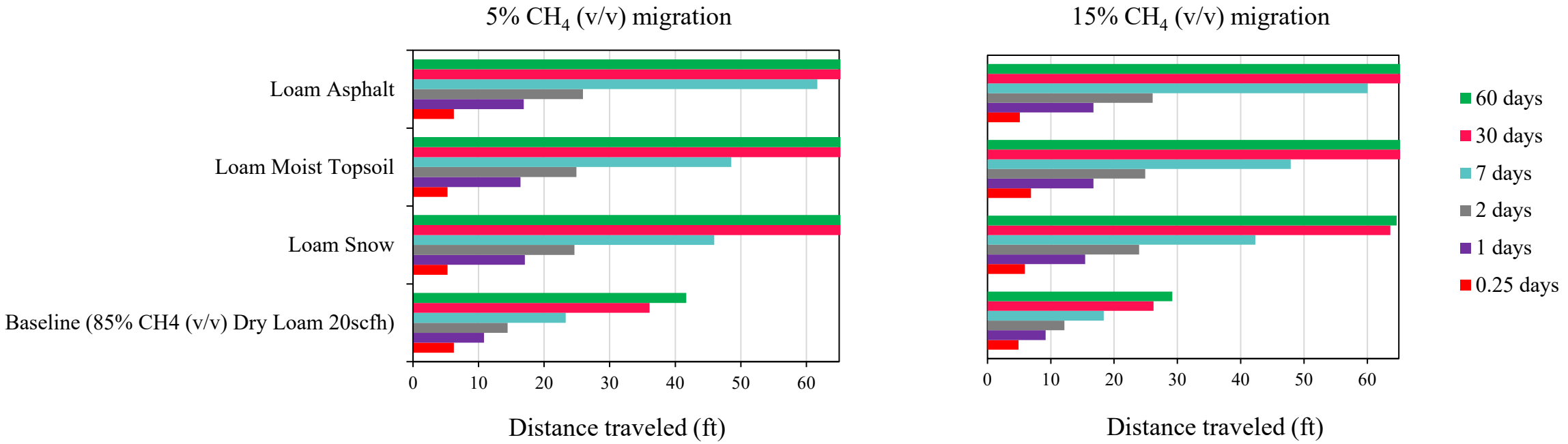
Impact of surface condition on migration rate & distance



At ~ 30-days, a change in surface conditions can increase the 5% CH_4 (v/v) migration rate and distance by a factor of 1.85, 15% by a factor of 2.5 (compared to Baseline)

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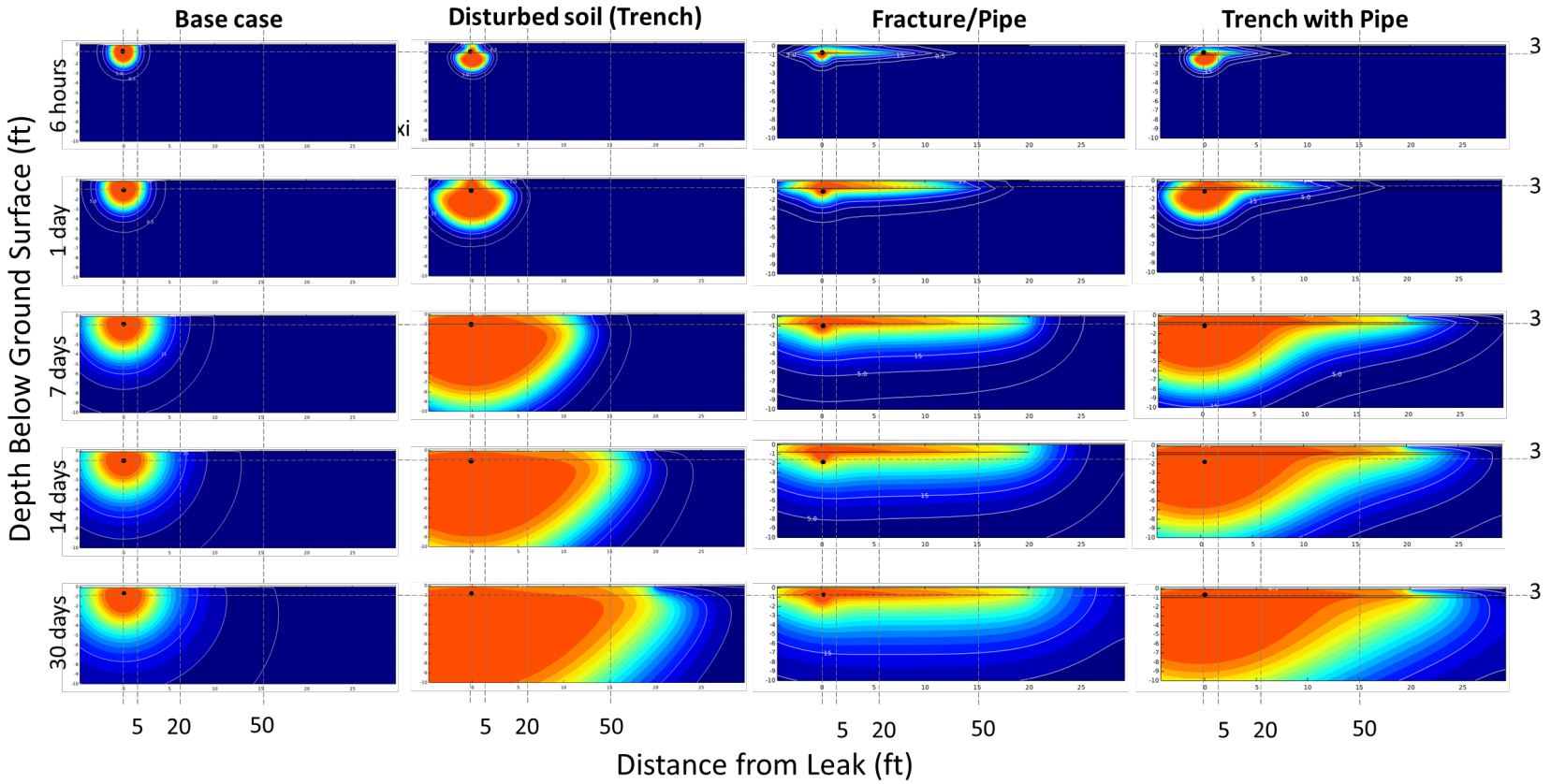
Subsurface complexity: disturbed soil & fracture/ pipe



- Complexity increases migration distance and rate by a factor of 1.85 for 5% CH_4 (v/v) contour and 2.5 for 15% CH_4 (v/v) contour
- Soil disturbance increased both lateral and downward migration
- Fracture acts as a preferential pathway for gas transport

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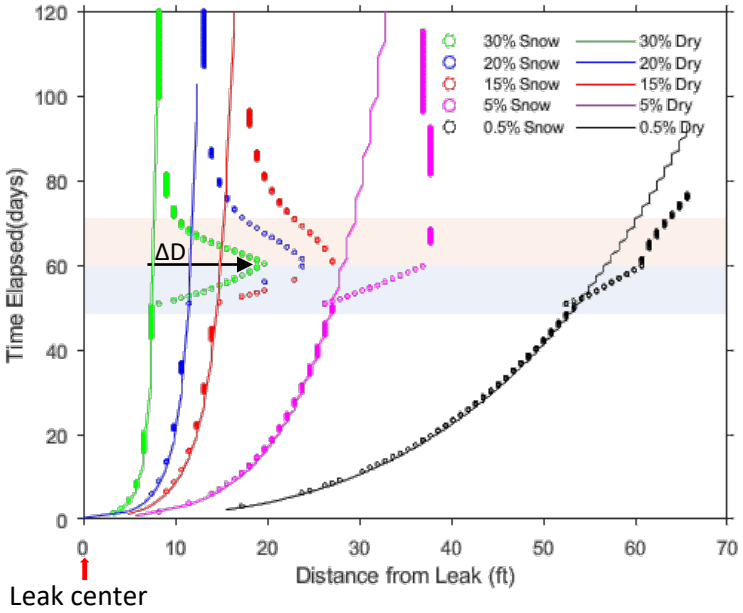
Impact of Surface Condition on leak classification– Small leak rate (2 scfh) – One Cyclic Scenario

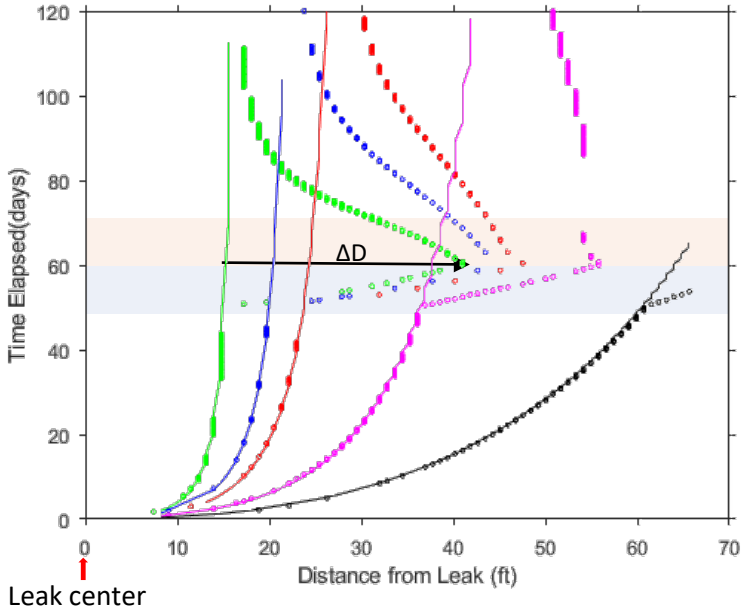
However, Snowfall is a cyclic process with snowfall – freezing/thawing – moist topsoil

Melting Snow
Snow Covered

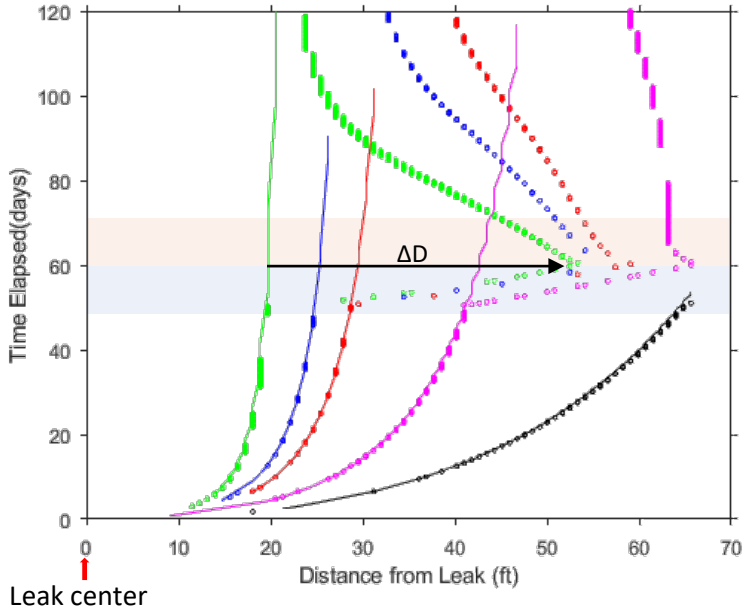
2scfh (1slpm)



10scfh (5slpm)



20scfh (10slpm)



- » High concentrations are highly impacted
- » Small concentrations are least impacted
- » Plume keeps expanding after soil surface clears from snow and soil moisture
- » High impact on high leak rates

EXAMPLE ONLY FOR DISCUSSION! NOT FINAL, NOT REAL LEAK DATA!