Background

Cold air accumulates nearly every night of the year in the floor of mountain valleys. Persistent cold air pools (PCAPs) are common in winter months, especially when there is snow cover. The common assumption is that there is minimal atmospheric mixing during these PCAPs.

We are preparing to better quantify atmospheric mixing in the unique geography of our mountain valley. Cache Valley, UT has a surface area of only about 800 km² and is bordered by mountain ranges. This confined valley is ideal for studying atmospheric mixing.

We are developing a network of weather stations at multiple elevations that use aspirated shields for precision measurements of air temperature, sonic anemometers for measurement of vertical and horizontal air movement, and infra-red gas analyzers to measure atmospheric CO₂. Because we can accurately estimate the sources and location of wintertime CO₂ emissions in our closed valley we are using CO₂ as a tracer gas to study atmospheric mixing.

Our initial data indicate that there is more atmospheric mixing during PCAPs than commonly thought.

Calculated CO₂ increase per day

Total CO₂ input
Molar volume of air (100 m deep) 118 x 10⁸ moles CO₂ per day
90 x 10⁸ moles of air
3 x 10⁻⁴ moles per mole
30 x 10⁻⁴ moles per mole
30 ppm per day

CO₂ input on coldest winter days (24 hours)

Natural gas use for Cache Valley:
- Winter peak: 80,000 MCF/day = 80 x 10⁸ m³/day * 3.2 m³/m³ =
- Total input: 96,000

Vehicles:
- 80,000 cars = 25 miles/day = 2,000,000 miles/day = 10 x 10⁸ m³/day
- Total input: 20,000

Volume of air in inversion layer
- Surface area: 20 x 50 km = 1000 km² = 10 m³
- Volume: 100 m³
- Moles of air: 39

* Molar density of air is 39 moles per m³ at 1.405 m³ per meter elevation = 30°C