

# Dry Ice and Alcohol FPH

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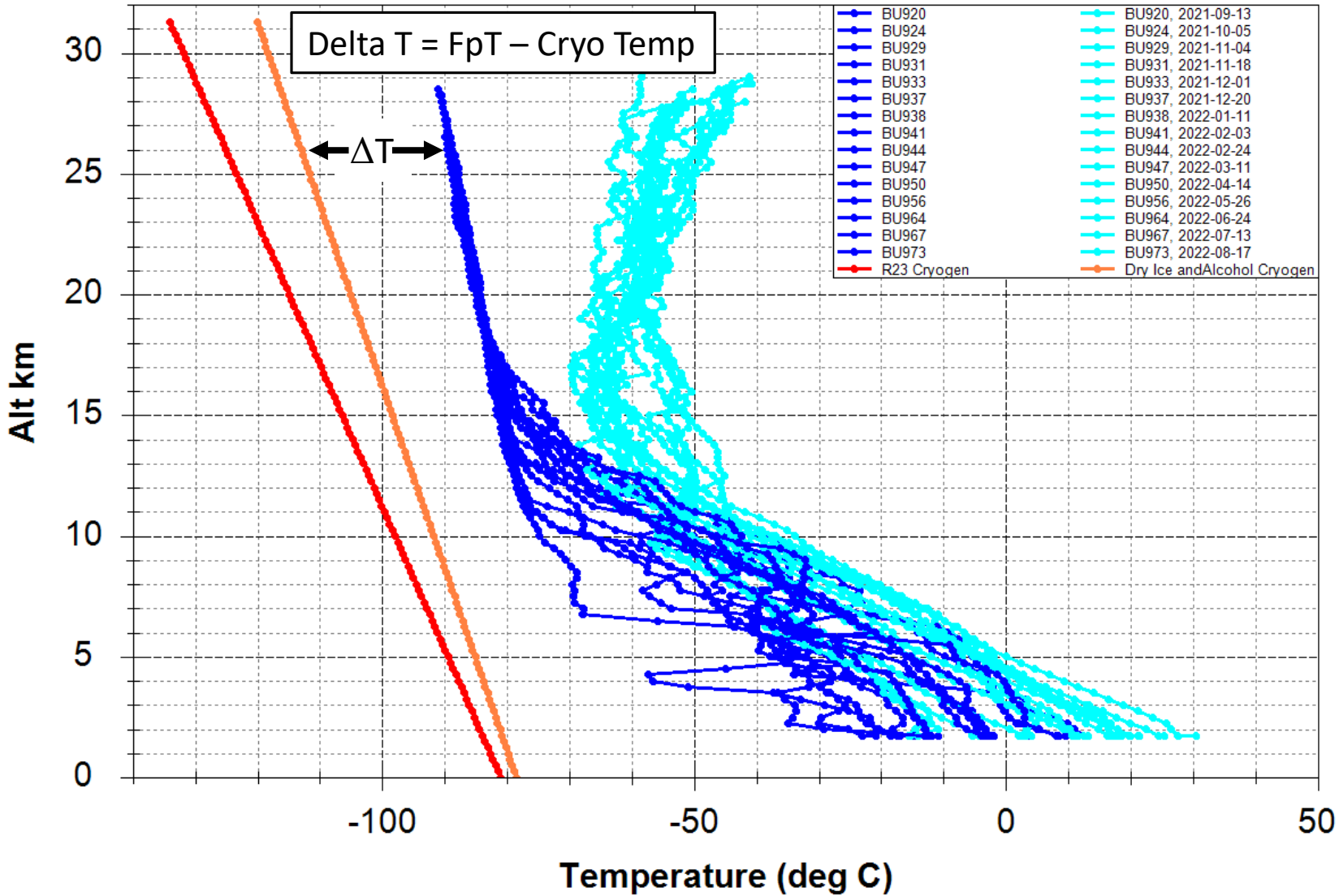
GRUAN ICM-14

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Photo: Patrick Cullis

# Alternative Cryogen Challenges

## R23, DIA, Frost Point, and Air Temperatures, Boulder, Colorado



## New Cryogen Requirements

- Non-toxic
- Low GWP & ODP (R23 has a large GWP of 14,800)
- Provide cooling for long FPH valved balloon profiles (3.5-4 hours)
- Easily accessible and inexpensive
- Provide enough cooling at the tropopause and stratosphere ( $\Delta T$ )

## Dry Ice and Alcohol (ethanol)

- Dry ice and Alcohol (DIA) are warmer than R23 throughout the profile
- Smallest  $\Delta T$  located near the tropopause
- Successful profiles in Boulder, Co with minimum  $\Delta T \sim 16 \text{ }^\circ\text{C}$
- DIA FPH should work at similar locations to Boulder
- Tropical profiles will have smaller  $\Delta T \sim 12 \text{ }^\circ\text{C}$  (need future tests flights)

# DIA vs R23 FPH Flights in Boulder, Colorado

- Successful DIA FPH flights from Boulder since Feb 2020
- Have used both dry ice pellets and blocks in **ethanol** as cryogen
- Performed 2 dual balloon launches in the past year with good agreement
- Finalizing DIA FPH design
- Optimizing DIA FPH PID gains
- Planning dual DIA/R23 balloon launches at other NOAA/GML sites in 2023
- Perform tropical test flights

