

# Enhanced Stability of Isotopic Gas Mixtures in Non-refillable Cylinders

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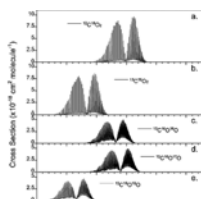
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## Understanding Changes in the Earth's Climate

- **Long term and high-precision measurements of GHG are necessary to understand changes in the Earth's climate**
  - Stable reference gas standards with low uncertainties and metrological traceability provide coherence and confidence to meet Meteorology Organization and regulatory requirements
- **NDIR and CRDS are 2 of the most prominent methods to measure atmospheric CO<sub>2</sub>**
- **If the CO<sub>2</sub> and matrix have a different isotopic signature than the sample, erroneous results may be obtained**
  - Different isotopologues of CO<sub>2</sub> have different absorption bands

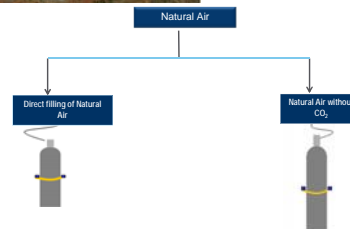


• CO<sub>2</sub> in the environment has many isotopologues

Y. Tohjima et al., Journal of Geophysical Research: Atmospheres, 2009

## Tropospheric Natural Air

- **Synthetic Air vs. Natural Air Standards**
  - The synthetic air has an isotopic concentration different from the atmospheric natural air
  - Natural Air collected at an altitude >2300 meters
- **Target Uncertainties**
  - World Metrological Organization Data Quality Objectives between 0.01% and 0.05% relative
- **Alphagaz™ Natural Air**
  - Correct Isotope Ratio <sup>13</sup>C/<sup>12</sup>C for CO, CO<sub>2</sub>, CH<sub>4</sub>, as well as, N<sub>2</sub>O and SF<sub>6</sub>
  - Purification to eliminate traces of CO<sub>2</sub>



## Scientific Questions

### 1 Concentration Uniformity

- Do cylinders from the same batch have the same δ values?



|              | $\delta^{18}\text{O}$ avg | $\delta^{18}\text{O}$ stdev |
|--------------|---------------------------|-----------------------------|
| A1           | -3.143                    | 0.067                       |
| A2           | -3.152                    | 0.045                       |
| A3           | -3.140                    | 0.064                       |
| <b>Total</b> | <b>-3.145</b>             | <b>0.059</b>                |

### 2 Transfilling

- Mother to Daughter Cylinder

**Mother (‰, VPDP)**

| $\delta^{13}\text{C}$ in CO <sub>2</sub> |
|--|
| -24.96                                   |

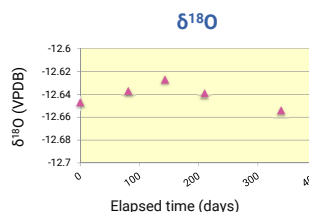
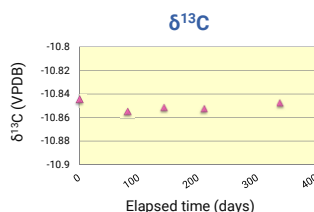
transfill →

**Daughter (‰, VPDP)**

| $\delta^{13}\text{C}$ in CO <sub>2</sub> |               |
|--|---------------|
| 1  | -24.96        |
| 2  | -24.97        |
| 3  | -24.98        |
| 4  | -24.97        |
| 5  | -24.97        |
| 6  | -24.98        |
| 7  | -24.98        |
| 8  | -24.98        |
| 9  | -24.96        |
| 10                                       | -24.97        |
| <b>Avg</b>                               | <b>-24.97</b> |

**Fractionation is not an issue during either cylinder filling or transfilling**

### 3 Stability of $\delta^{13}\text{C}^{18}\text{O}_2$



## Summary

- **The use of Natural Air and standards made with Natural Air as the matrix decreases errors in environmental measurements**
- **Stable isotopic mixtures can be made without fractionation if the correct methodologies and equipment are used**