

# Ozone Measurements during HIPPO

Ru-Shan Gao, Ryan Spackman



*Chemical Sciences Division*  
*NOAA Earth System Research Laboratory*  
*and*  
*CIRES, University of Colorado*  
*Boulder, Colorado*



# NOAA CSD Ozone Data Summary

- **Final data** have been submitted for all 5 deployments
- NOAA O<sub>3</sub> Classic instrument performed well:
  - 1 s data were **not** recorded for the last part of RF02 and entire RF03 of HIPPO-1 and HIPP-4
    - 1 s data at every 10 s are available for these 4 flights
- Instrument accuracy: 5%
- Precision:  $1.5 \times 10^{10}$  molecules/cm<sup>3</sup> (approximately 1 ppb at 5 km, 2 ppb at 10 km)
- The instrument has not been changed for a long time. No future modifications are planned.

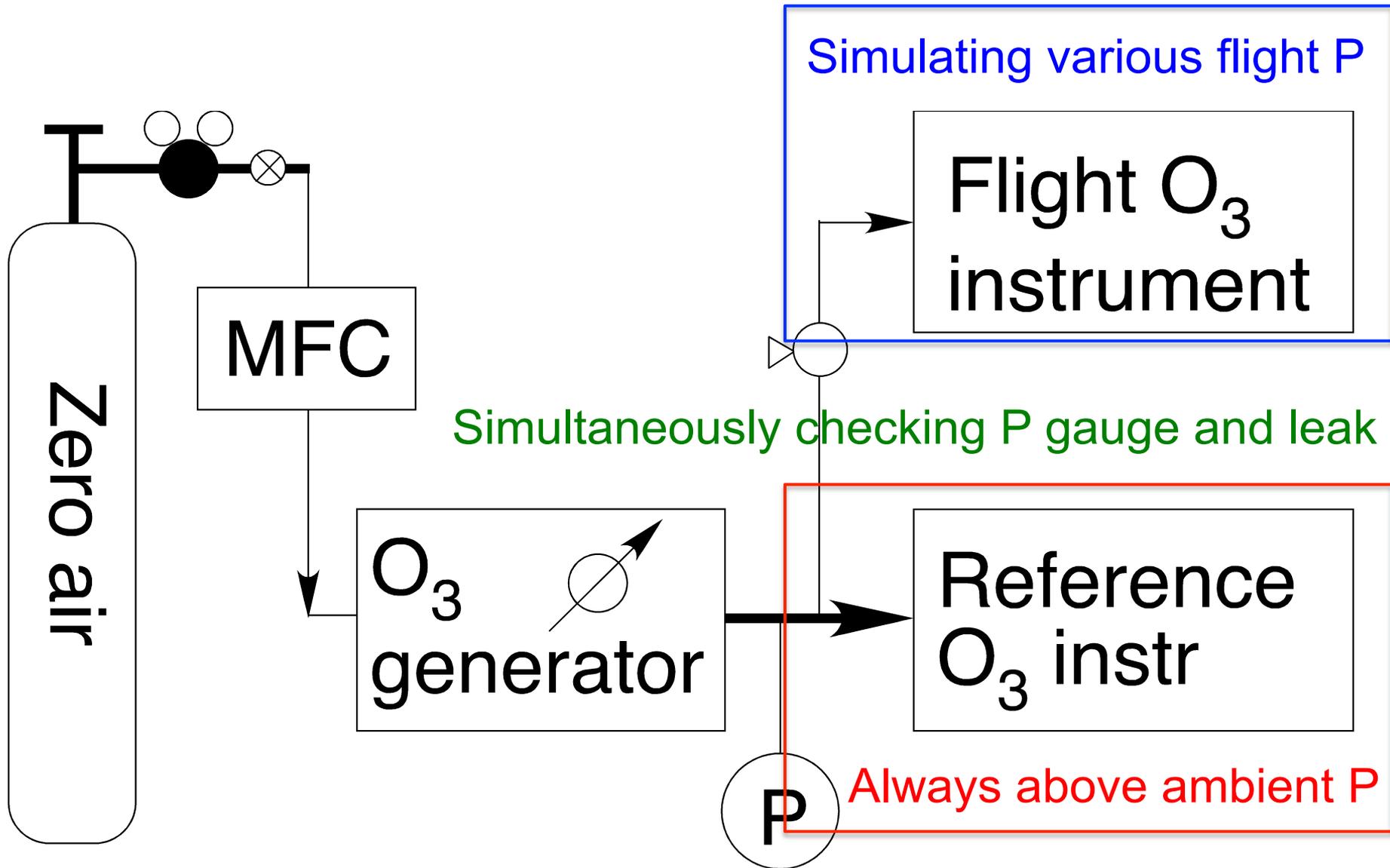
# Ozone Instrument Intercomparison

- NOAA O<sub>3</sub> Classic instrument is based on O<sub>3</sub> UV differential absorption technique and is theoretically absolute
- Direct calibration is difficult and is not performed in our lab
- This type of instrument is usually validated through intercomparisons with other O<sub>3</sub> instruments
- O<sub>3</sub> Classic has been intercompared with at least one other O<sub>3</sub> instrument before every deployment (NOAA UAS O<sub>3</sub>, two TECOs)
- Rigorous leak checks have been performed in the lab and also before the de-installation at the end of HIPPO-1

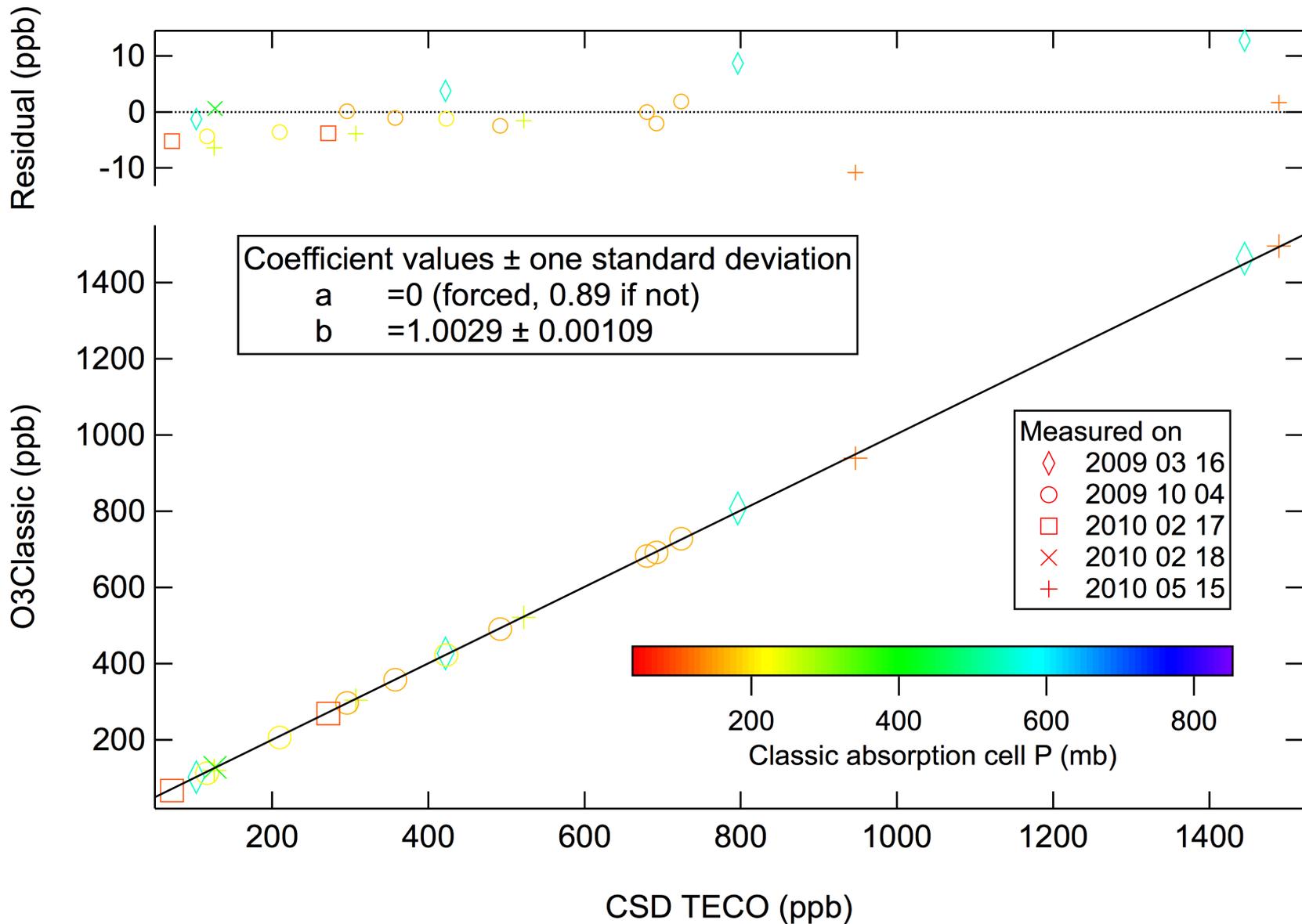
# Science Plan

- Measurement-Model intercomparison
  - Harvard GEOS-CHEM, NOAA RAQMS, ...
- O<sub>3</sub>/N<sub>2</sub>O correlations in the stratosphere
  - Try to see if there is a change from 90's
  - Also include GloPac and ATTREX data

# Ozone Instrument Intercomparison Approach

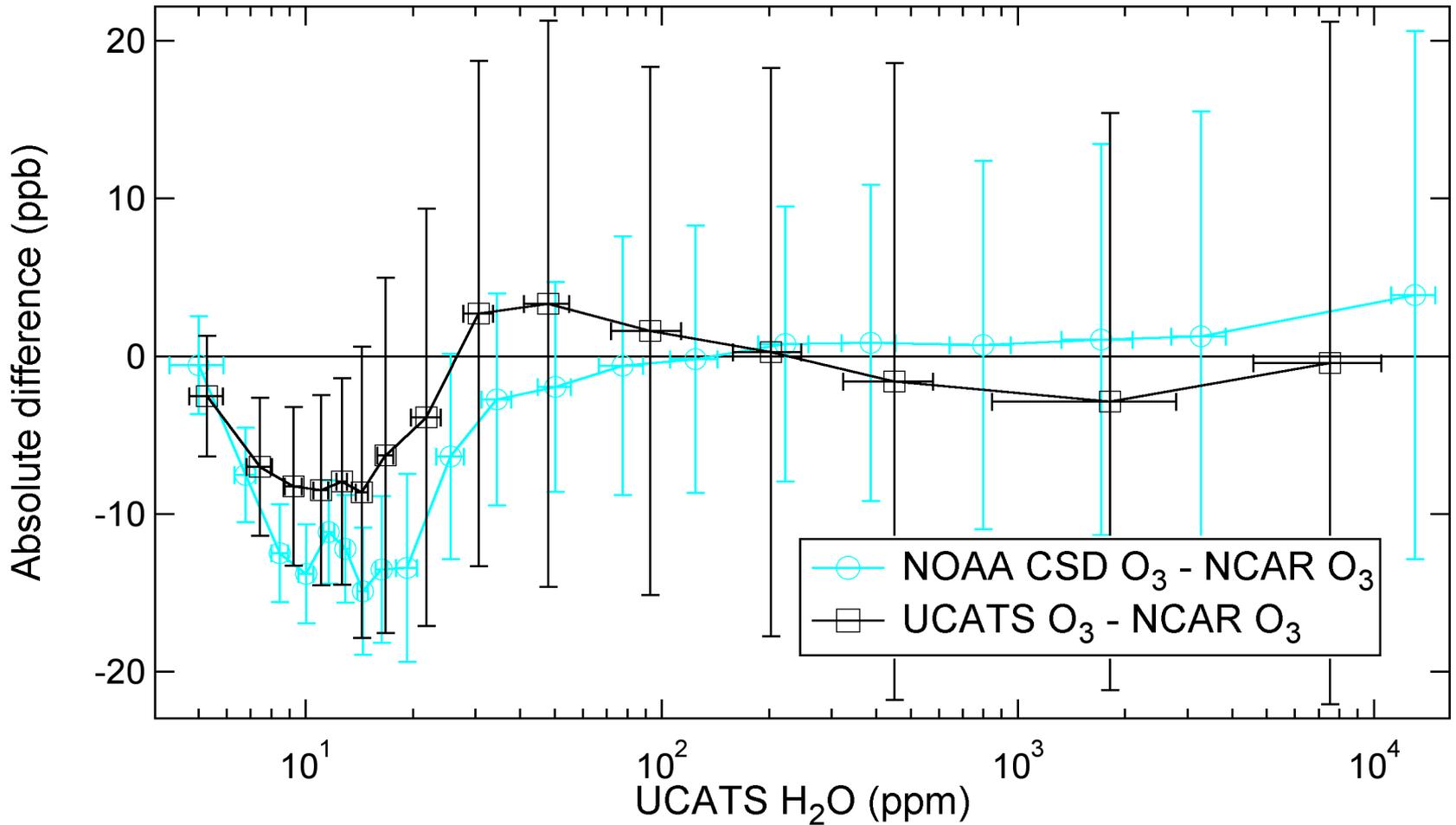


# Ozone Instrument Intercomparison Summary



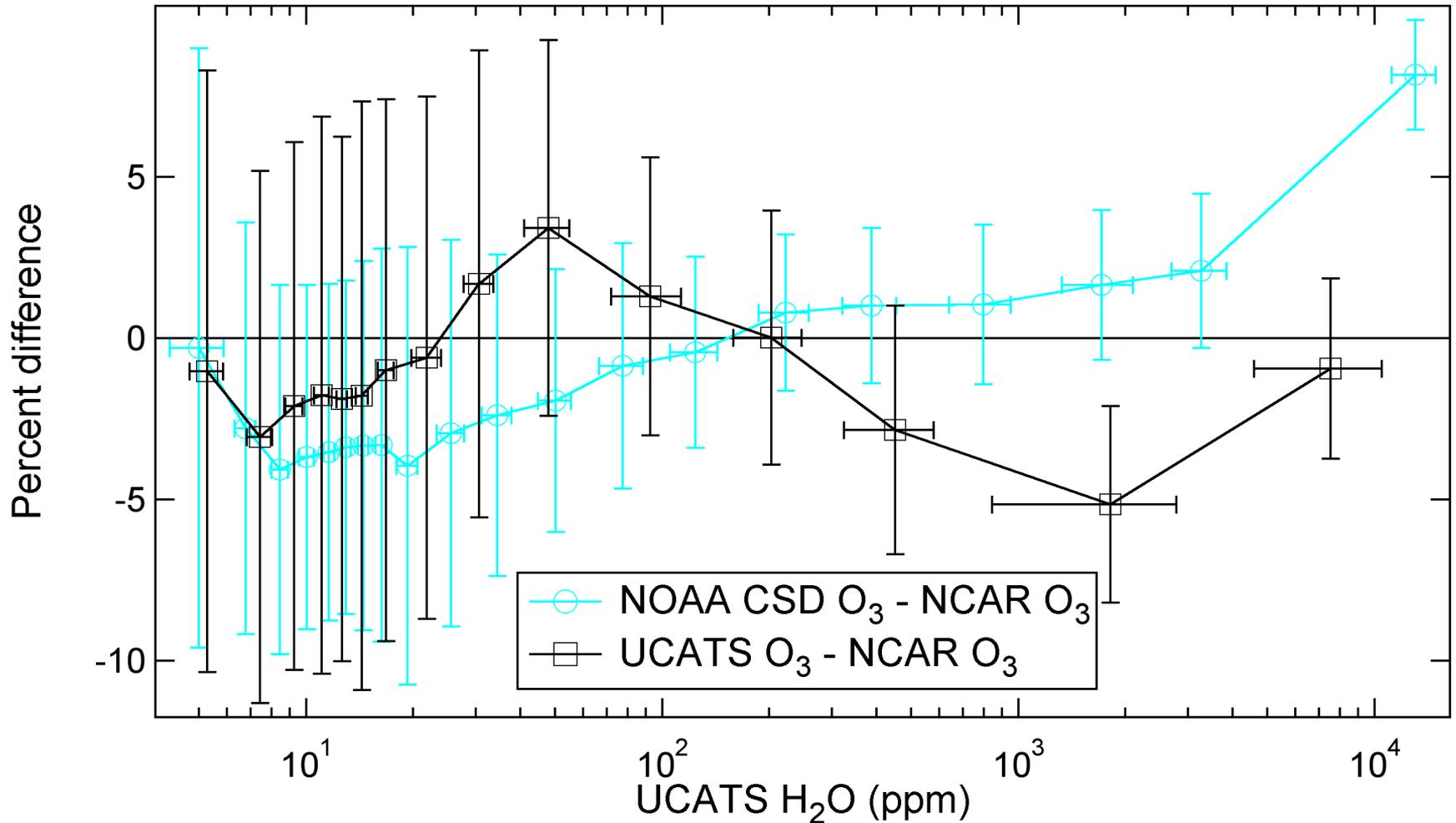
# In-Flight Intercomparison from START08

- Largest differences likely from high-to-low H<sub>2</sub>O concentration transitions



# In-Flight Intercomparison during START08

- All measurements are consistent to within 10% ( $1\sigma$ )



# In-Flight Intercomparisons during HIPPO-1

- **HIPPO-1**: NOAA CSD O<sub>3</sub> and UCATS O<sub>3</sub> sometimes did not correlate with each other (CSD O<sub>3</sub> lower by up to 40 ppb):
  - Occurred on ascent from high H<sub>2</sub>O environments
  - Happened in 9 out of 11 flights
- Possible CSD O<sub>3</sub> instrument problems during **HIPPO-1**:
  - Pressure and temperature sensor drifts and catalyst degradation:
    - ✓ Ruled out using in situ data and post-mission lab work
  - Leaks in the instrument or in the sample line:
    - ✓ No significant leak was found during post-mission check
  - H<sub>2</sub>O artifact:
    - ✓ Laboratory tests with H<sub>2</sub>O: Possible artifact < 10 ppb
    - ✓ Limited evidence for artifact during START08/Pre-HIPPO and HIPPO-2

## In-Flight Intercomparisons during HIPPO-2

- **HIPPO-2:** A different, more systematic disagreement:
  - UCATS O<sub>3</sub> was higher than CSD O<sub>3</sub> in the first half of the mission by 10–40 ppb with the larger differences at higher ambient O<sub>3</sub> mixing ratios
  - After changing a Hg lamp, UCATS O<sub>3</sub> was lower than CSD O<sub>3</sub> in the second half of the mission by 10–30 ppb, with the larger differences at higher ambient O<sub>3</sub> mixing ratios
  - See Eric Hintsa's intercomparison talk on Friday for details
- **HIPPO-3:** no in-flight intercomparisons
- CSD O<sub>3</sub> has not changed its configuration since START08
- In-flight intercomparison with NOAA UAS O<sub>3</sub> will occur in March – April 2011 on NASA WB-57F