# Updated Studies of the Ozone Temperature-Correlation in the Upper Stratosphere

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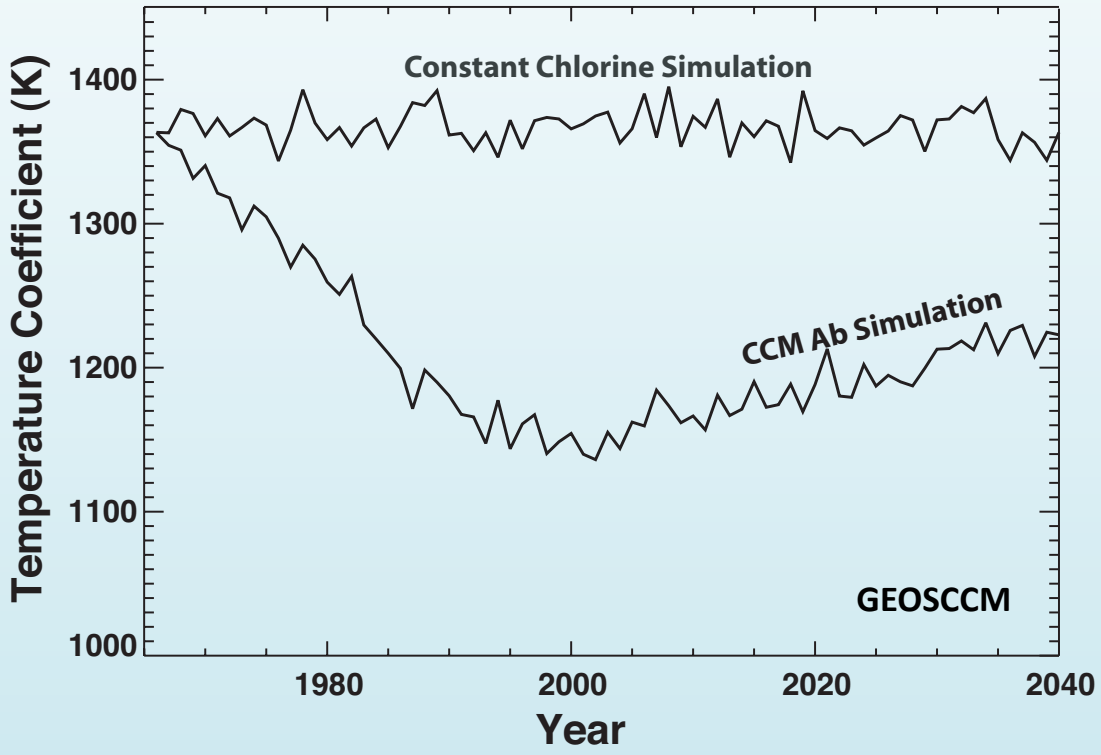
# The Problem

- **Detection and ATTRIBUTION of ozone recovery**
- **Future Ozone should increase due to**
  - **Chlorine decrease**
  - **GHG cooling**
- **Upper stratosphere is photochemical region**
- **Ozone/temperature correlation provides method to separate chlorine decrease from GHG cooling**

**(1 hPa 45-50°S)**

# Model Simulation of B Coefficient in Seasonal Relationship of $O_3$ with T

$$O_3 = O_{3o} \exp(B/T)$$




**Chlorine amount matters – Greenhouse gases don't matter**

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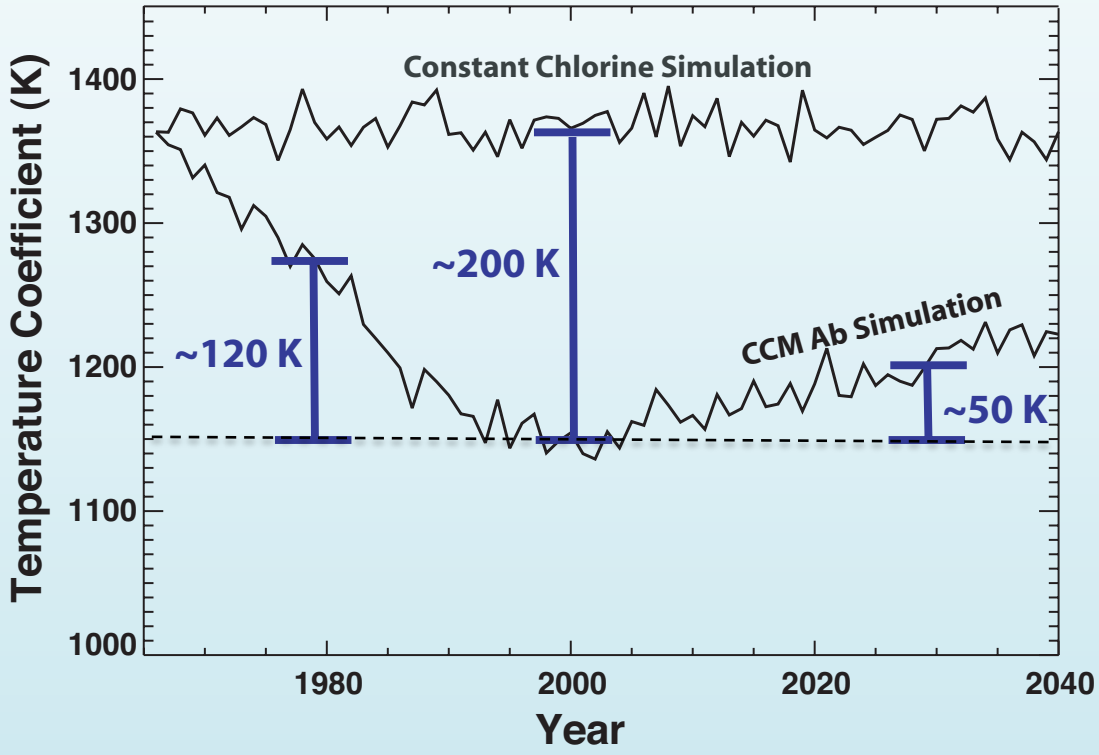


**120 K change since 1979**
**50 K change expected by 2030**

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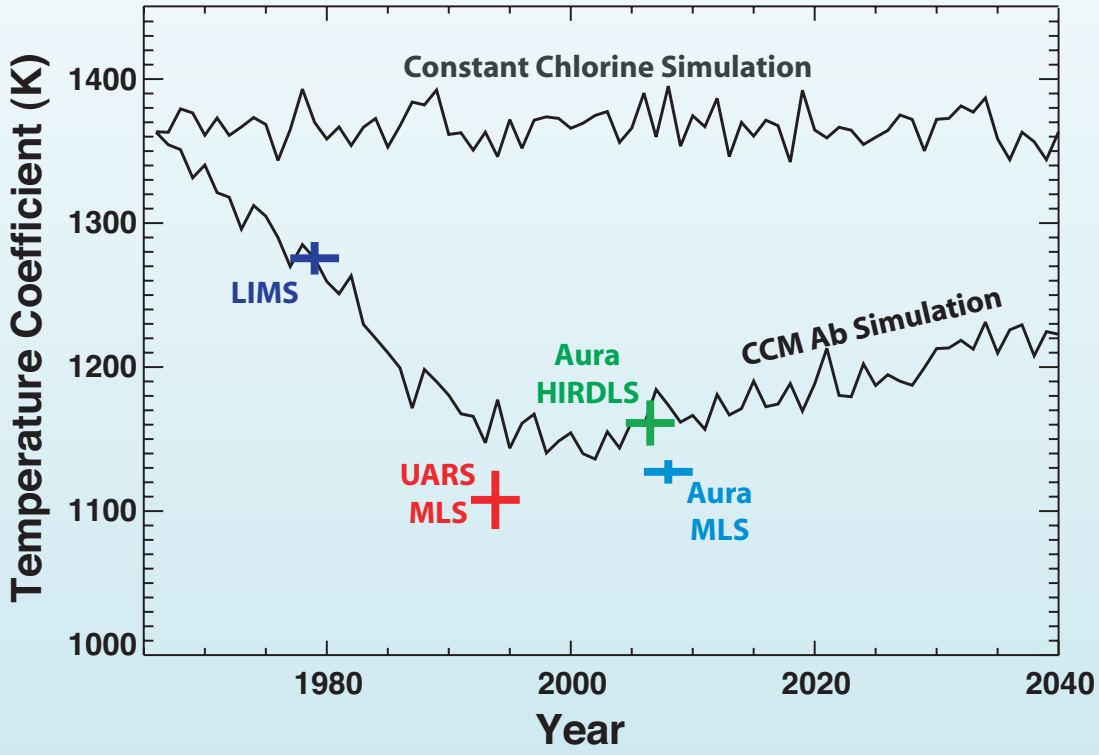
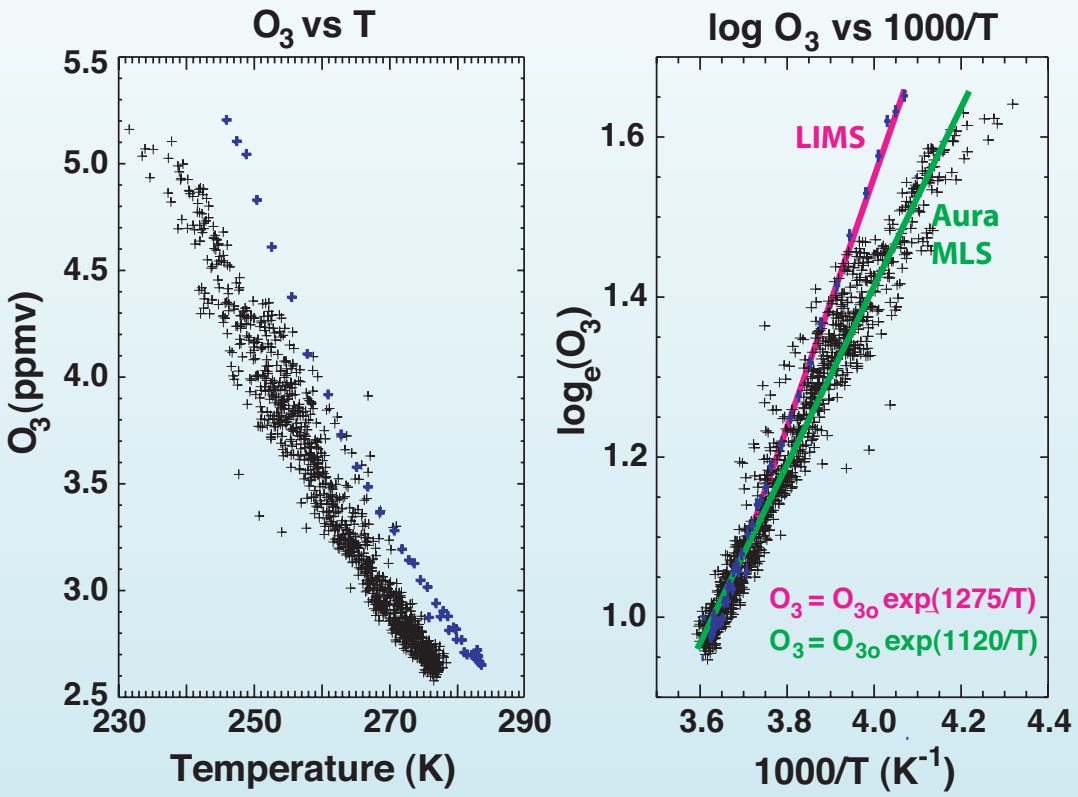



**Data confirms change since 1979**

**Aura HIRDLS and MLS are different by ~40 K**

# $O_3$ vs T for LIMS (1979) and Aura MLS (2005-2010)

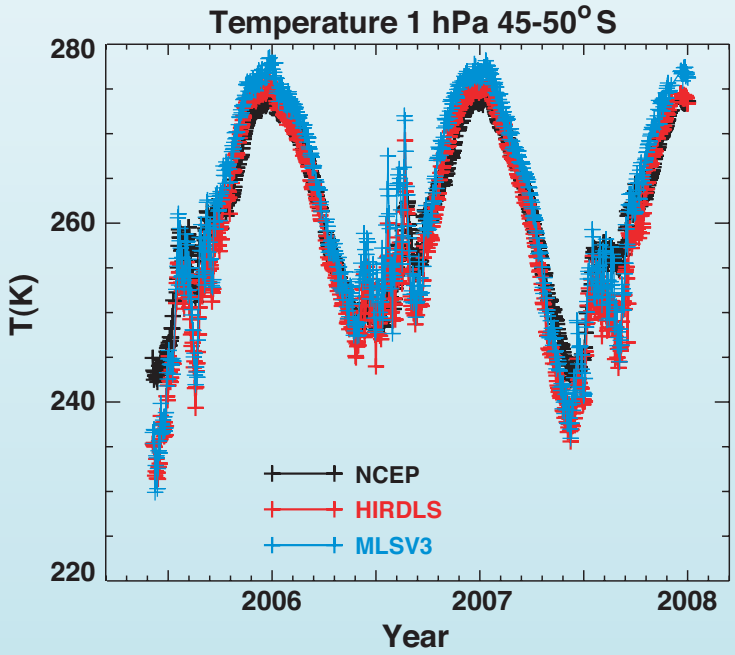


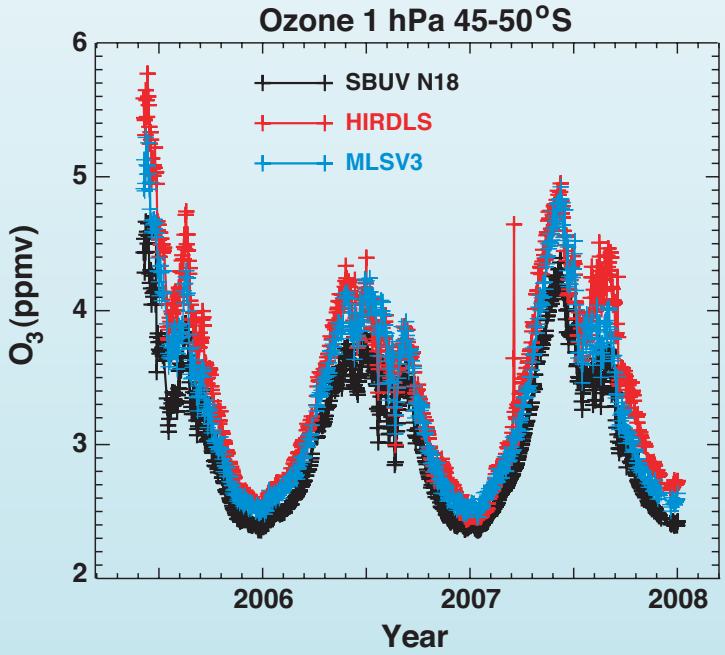

**Illustrates that 1979-present difference (~120 K) can be seen in data**

**Can we see ~50 K difference expected by 2030?**

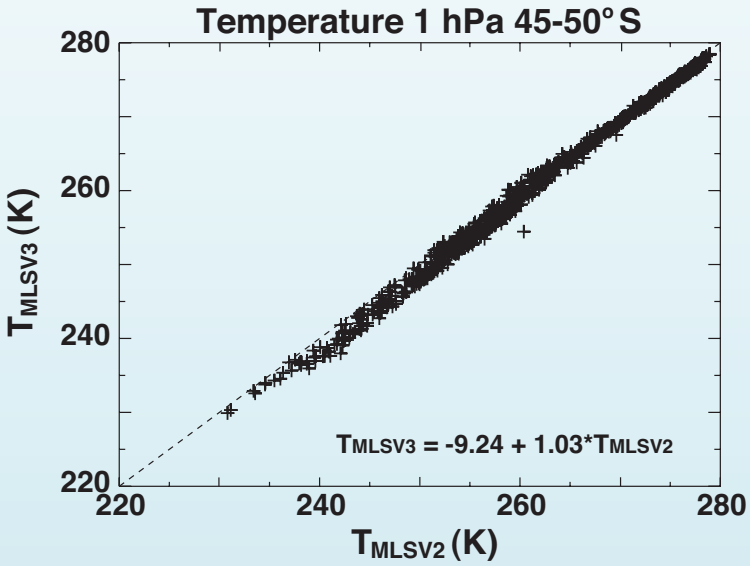
# Comparison of Daily Ozone and Temperature Measurements

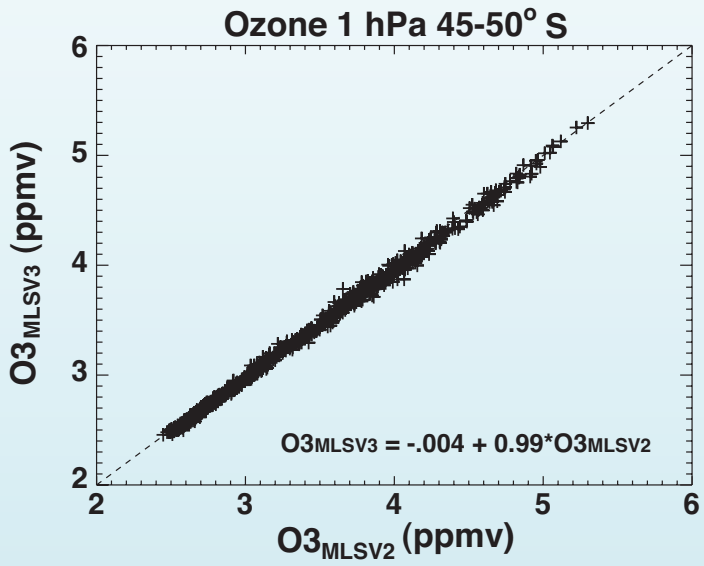
- **Time period: 5 June 2005 to 1 January 2008**
- **864 days with measurements**
  - **Ozone from HIRDLS, MLS (v2.2 and 3.3), and NOAA 17, 18 SBUV**
  - **Temperature from HIRDLS, MLS (v2.2 and 3.3) and NCEP reanalysis**



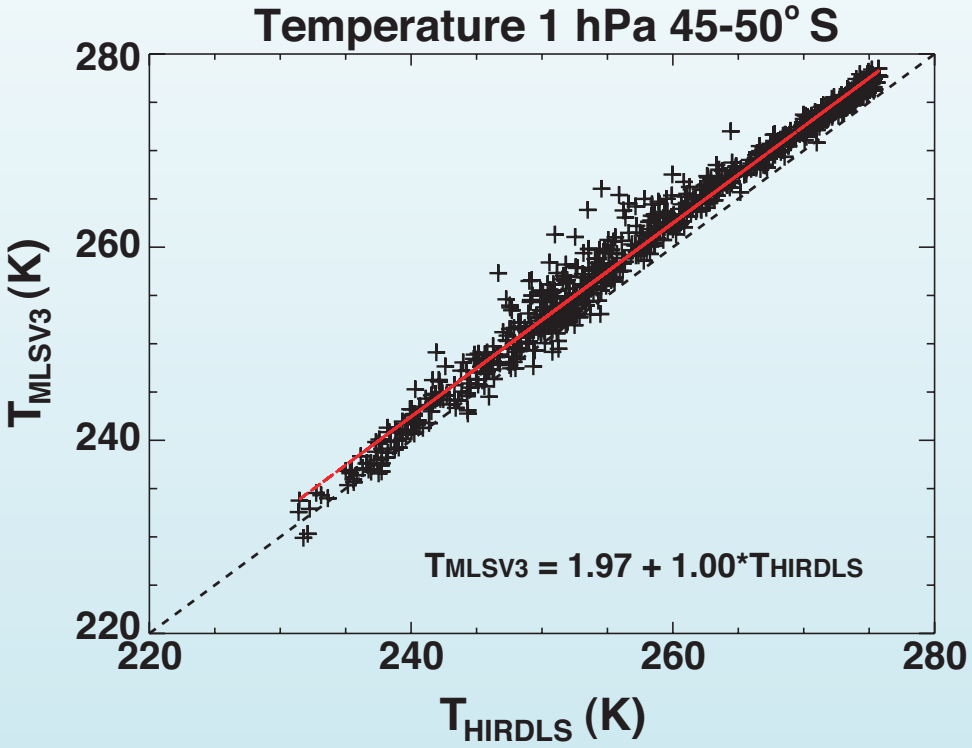
# MLS Version 2.2 vs MLS Version 3.3 at 1 hPa



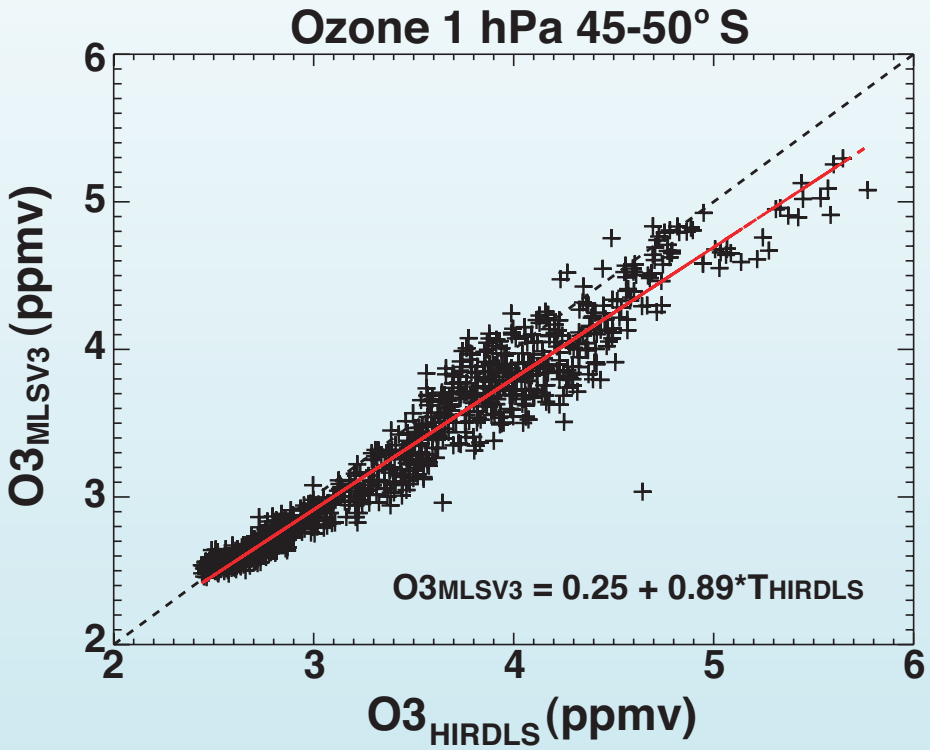

- **3% change in temperature slope (mostly at lower Ts)**
- **Virtually no change in ozone**

# MLS Version 3.3 vs HIRDLS Temperatures at 1 hPa



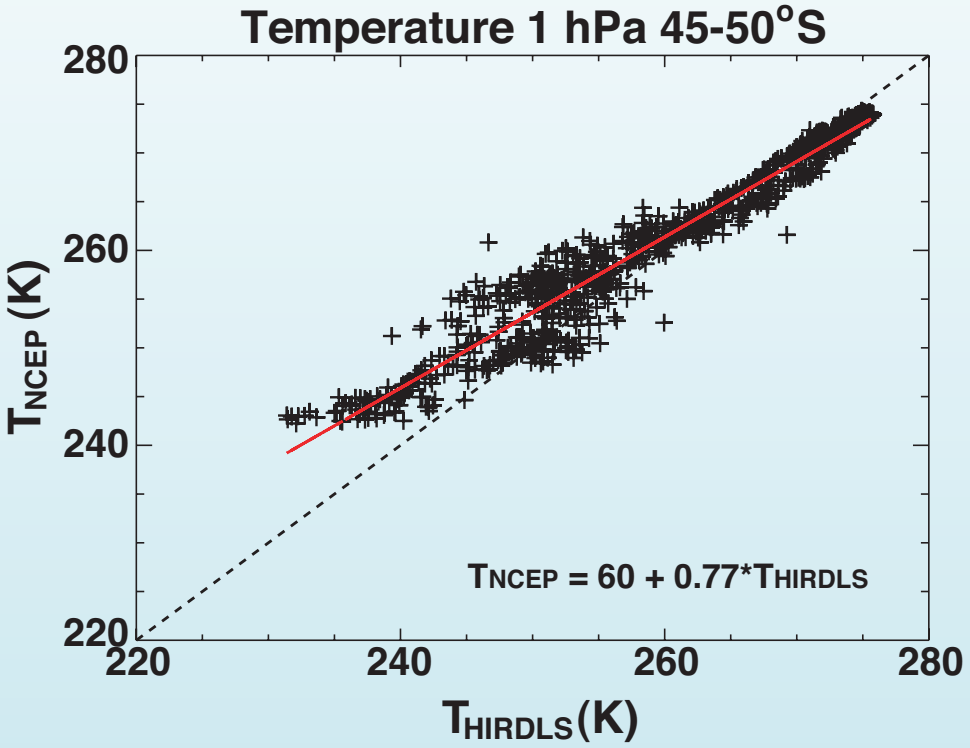

- 1-1 slope
- ~ 2K offset

# MLS Version 3.3 vs HIRDLS Ozone



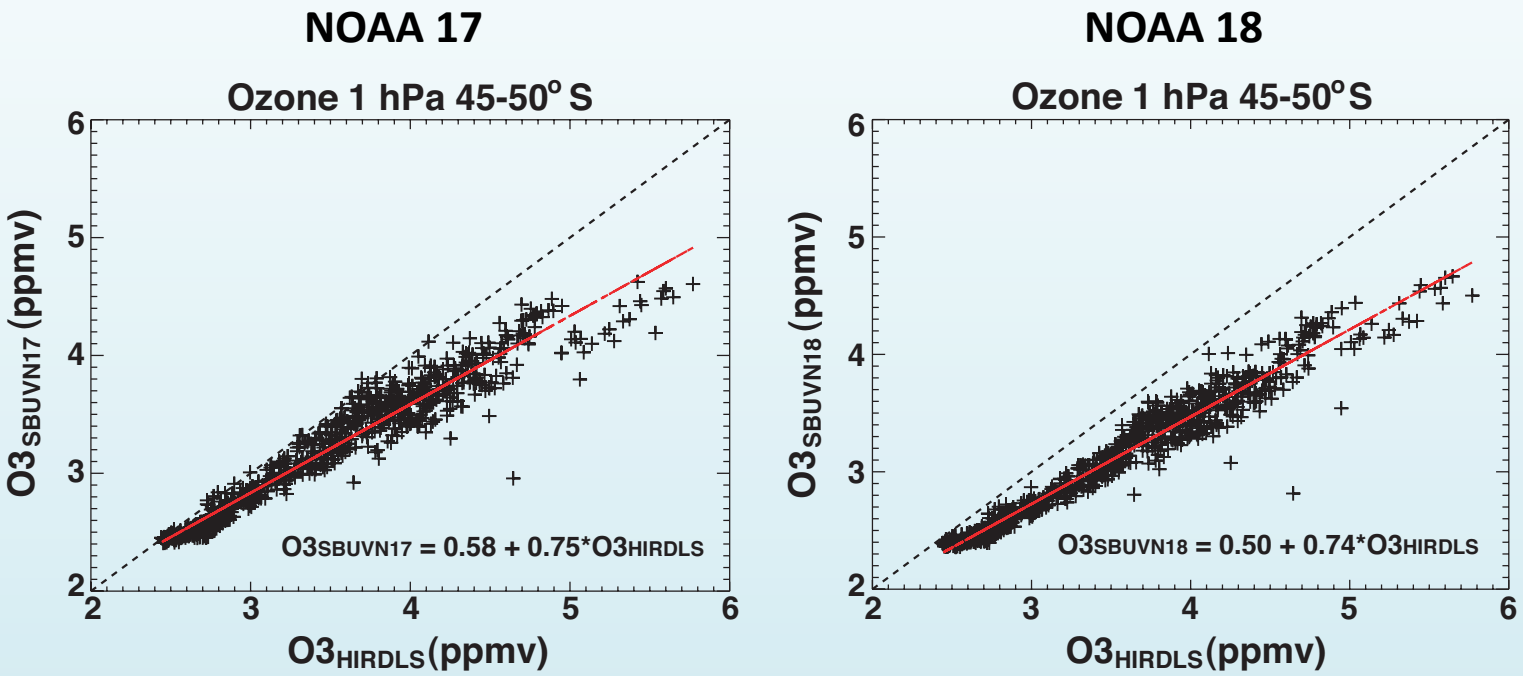

- **Significant slope 0.89**
- **Mostly different at high ozone (low T)**

# NCEP vs HIRDLS Temperatures




- **Significant slope (0.77)**
- **Mostly different at low temperatures**

# SBUV vs HIRDLS Ozone




- **NOAA 17 and NOAA 18 SBUVs show similar slope with respect to HIRDLS (0.75 and 0.74)**

# B Coefficient Using Various $O_3$ and T Data Sets

$$O_3 = O_{3o} \exp(B/T) \qquad B \pm 1\sigma$$

| 20050605-20080101 | $O3_{SBUV\ N17}$ | $O3_{SBUV\ N18}$ | $O3_{MLSV2}$ | $O3_{MLSV3}$ | $O3_{HIRDLS}$ |
|---|---|---|---|---|---|
| $T_{NCEP}$ | 1242 ± 12 | 1258 ± 10 | 1397 ± 10 | 1398 ± 10 | 1435 ± 16 |
| $T_{MLSV2}$ | 1029 ± 8 | 1040 ± 7 | 1134 ± 10 | 1143 ± 9 | 1204 ± 10 |
| $T_{MLSV3}$ | 987 ± 8 | 999 ± 6 | 1093 ± 9 | 1100 ± 8 | 1152 ± 10 |
| $T_{HIRDLS}$ | 993 ± 7 | 1004 ± 5 | 1101 ± 7 | 1106 ± 6 | 1165 ± 8 |

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- MLS v3.3 or HIRDLS T yield same result
- MLS v3.3 and HIRDLS $O_3$ yield 50K difference
- NCEP T or SBUV $O_3$ yields larger difference
- B increases with lower resolution of T
- B decreases with lower resolution of $O_3$

# Conclusions

- **Ozone-temperature correlation at 1 hPa can be used to attribute ozone recovery to chlorine (by ~2030)**
- **Requires ability to detect ~50K change in slope B in relationship $O_3 = O_{3o}\exp(B/T)$**
- **That detection requires high vertical resolution of both ozone and temperature**
- **Detection is not strongly dependent on absolute calibration or long-term maintenance of calibration**

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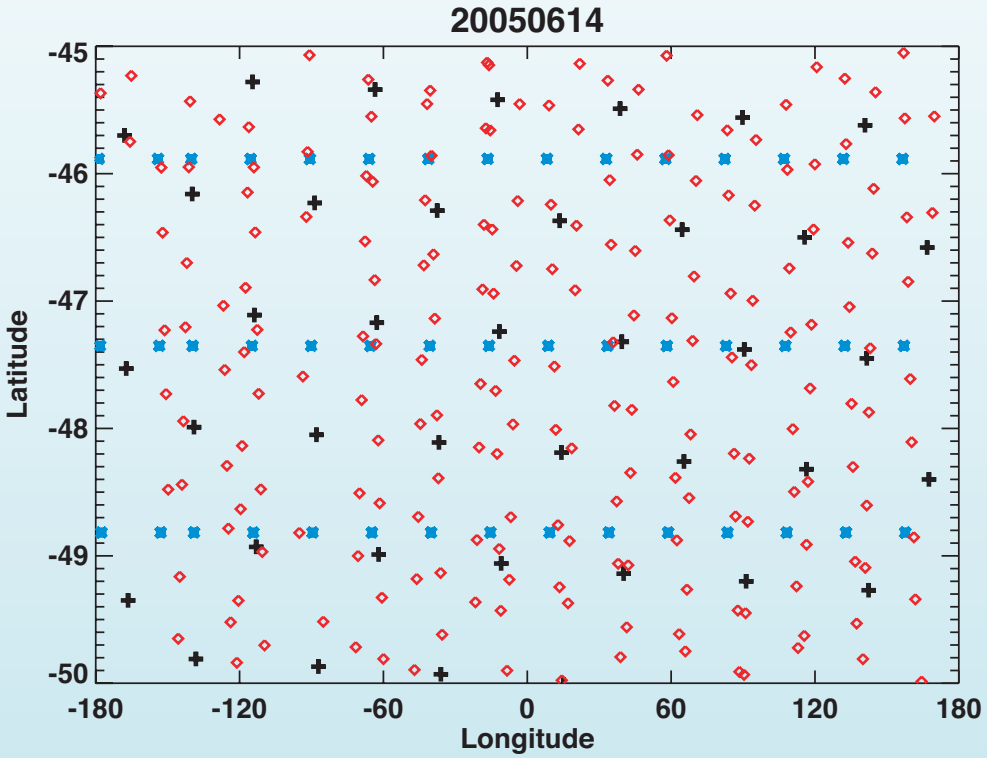
# The End


Stolarski 9/12/2011 Aura Sci Team

# Extra Slides

# Daily Measurement Sampling at 1 hPa 45-50°S

**14 June 2005**




**Black + SBUV**

**Blue * MLS**

**Red ◇ HIRDLS**

# Temperature Coefficient vs Latitude and Altitude