



O_3 -CO Correlations in Boreal Biomass Burning Plumes During ARCTAS-B Observed by TES

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Not all boreal smoke plumes have enhanced O₃

Reference	Platform	Location	Age (h)	#	$\Delta O_3/\Delta CO$
Goode <i>et al.</i> , 2000	Aircraft	Alaska	2 - 3	1	7.9% \pm 2.4%
Wofsy <i>et al.</i> , 1992	Aircraft	Alaska	24 - 48	1 of 3	17.5%
Mauzerall <i>et al.</i> , 1996	Aircraft	E. Canada	Aged (NO _x /NO _y < 20%)	4 of 9	10% \pm 20% (2.3% - 66%)
Wotawa & Trainer, 2000	Surface and Aircraft	SE US	~ 50	1	11%
Honrath <i>et al.</i> , 2004	Surface	Azores	300-360	4	40% - 90%
Val Martin <i>et al.</i> , 2006	Surface	Azores	150-360	9	20% (-40% - 90%)
Pfister <i>et al.</i> , 2006	Surface	Azores	150-360	-	23%-28%
Real <i>et al.</i> , 2007	Aircraft	E. Canada, Azores, France	120-240	1	-1% 8%
Bertschi <i>et al.</i> , 2005	Aircraft	Washington State	170-240	5	44% \pm 30%
Verma <i>et al.</i> , 2009	TES	Siberia	0-120	32	~0% (mean)

ARCTAS-B: O₃ Formation in Smoke

	Age	# Corr.	Mean±1σ (%) ^a	Range (%)
ΔO ₃ /ΔCO	Fresh	4 of 14	0.2±1.2	-2.9 to +2.4
	Aged	2 of 13	-6±22	-78 to +3
	Old	4 of 6	-70±135	-225 to +113

^a Uncorrelated plumes included in average with enhancement of 0.

- O₃ correlated with CO ~1/3 of the time.
 - Consistent with Wofsy *et al.*, 1992 and Mauzerall *et al.*, 1996
- Negative values
 - Val Martin *et al.*, 2006 and Real *et al.*, 2007 also reported negative values; Verma *et al.*, 2009 also saw depleted O₃
- Very little O₃ formation in fresh smoke plumes

CO – G. Diskin (NASA)

O₃ – A. Weinheimer (NCAR)

ARCTAS data available at <http://www-air.larc.nasa.gov/cgi-bin/arcstat-c>

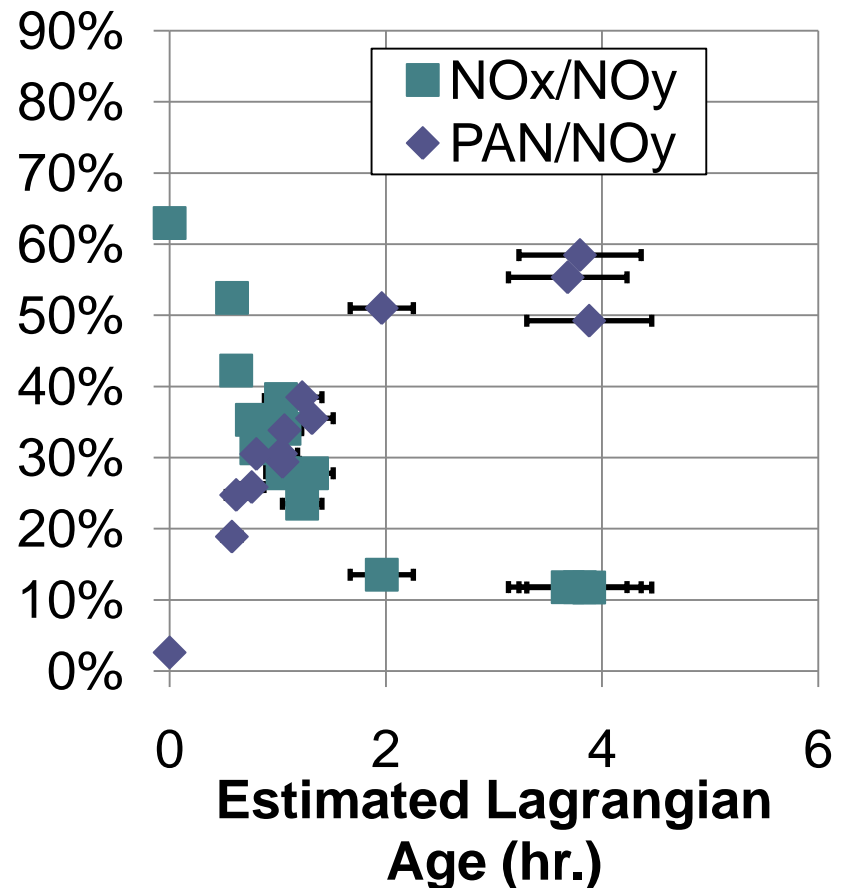
ARCTAS-B: NO_x and PAN in Smoke

NO_x emissions lower than previous reports

- ARCTAS-B, Fresh Smoke
 - $\Delta\text{NO}_x/\Delta\text{CO} = 0.28\% \pm 0.40\%$
 - Nance *et al.*, 1993: 1.2%
 - Goode *et al.*, 2000: ~4% (1.4-1.8% as NO)
 - $\Delta\text{PAN}/\Delta\text{CO} = 0.25\% \pm 0.19\%$

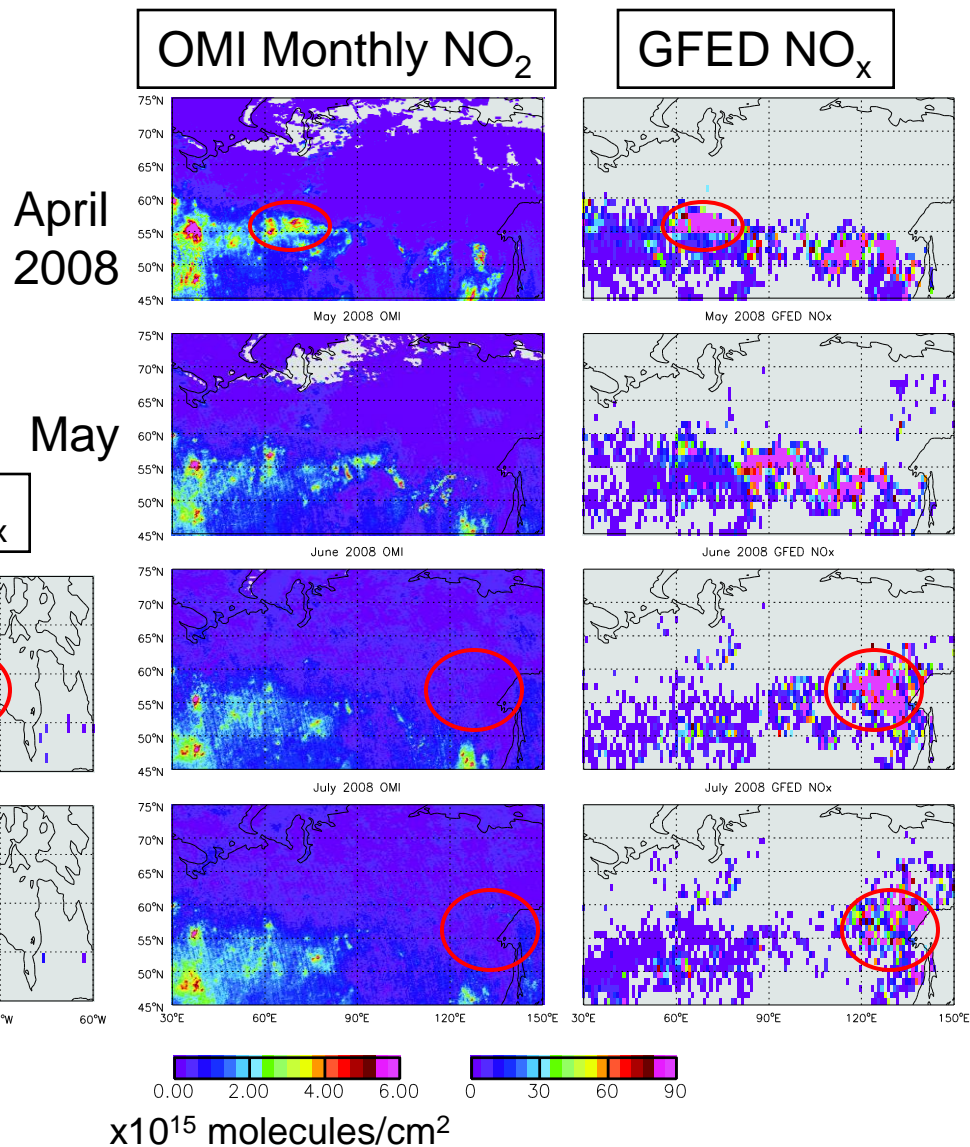
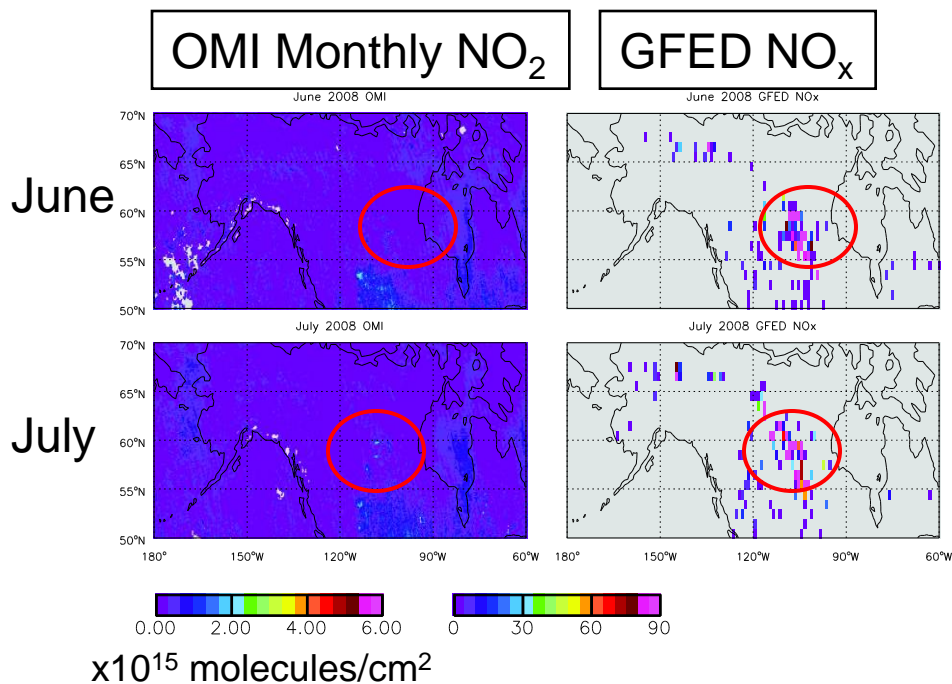
CO	– G. Diskin (NASA)
NO _{x,y}	– A. Weinheimer (NCAR) and R. Cohen (Berkeley)
PAN	– G. Huey (Georgia Tech.)

PAN forms in 1 to 2 hours



OMI NO₂

- Strong Signal from April fires in Kazakhstan
- Little signal from June and July fires in Siberia or N. America



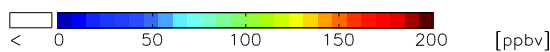
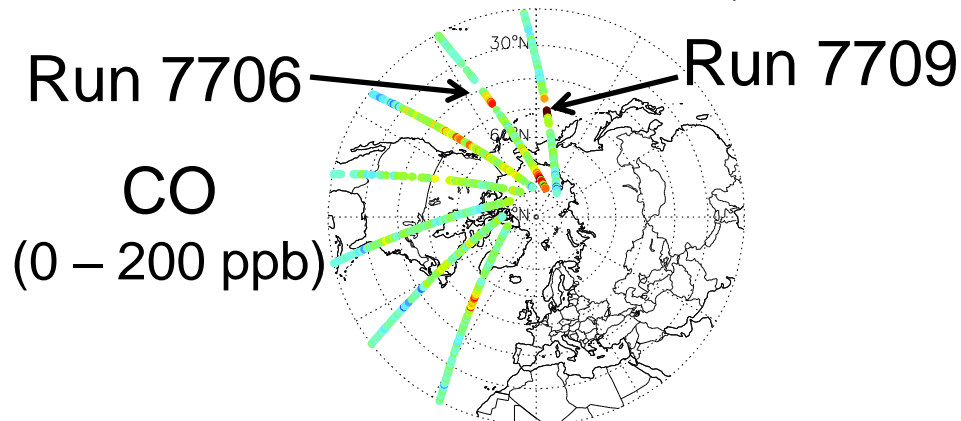
This Study

- Transport from Siberian fires in July 2008
- Use TES O₃ and CO Special Observations (v3)
 - ~0.4° latitude resolution
- Compare to GEOS-Chem NRT simulation
 - Full chemistry, 2°x2.5° resolution (J. Mao *et al.*, 2009, in prep.)
- Sensitivity Study: Lower NO_x Emission
 - Reduce NO_x from 0.1 to 0.017 mol/kg DM for extratropical forest
 - Add PAN emissions of 0.017 mol/kg DM
 - New emissions start January 1, 2008

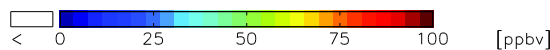
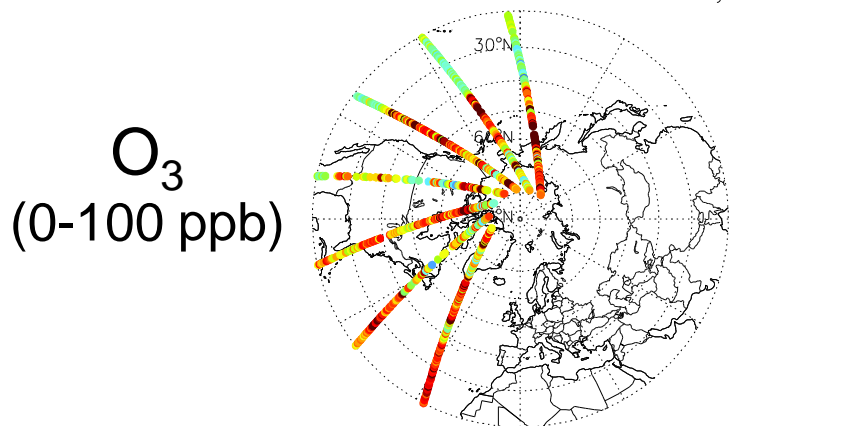
July 3 and 4, 2008

TES at 510 hPa

20080703 CO at 510.898 hPa observed by TES

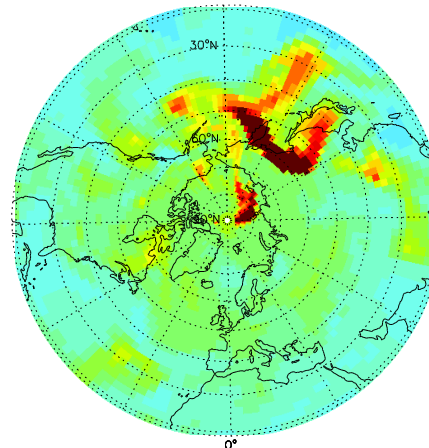


20080703 O₃ at 510.898 hPa observed by TES

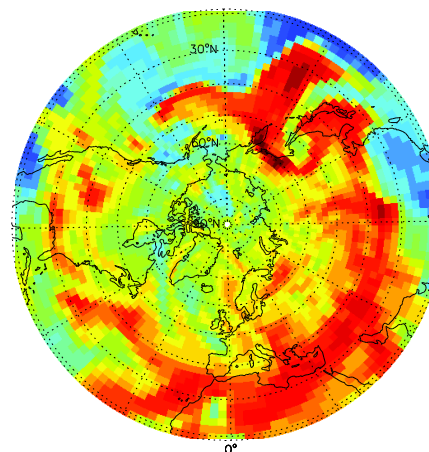


GEOS-Chem at 510 hPa w/out TES AK

CO at 510 hPa, July 4 00 UTC



O_x at 510 hPa, July 4 00 UTC



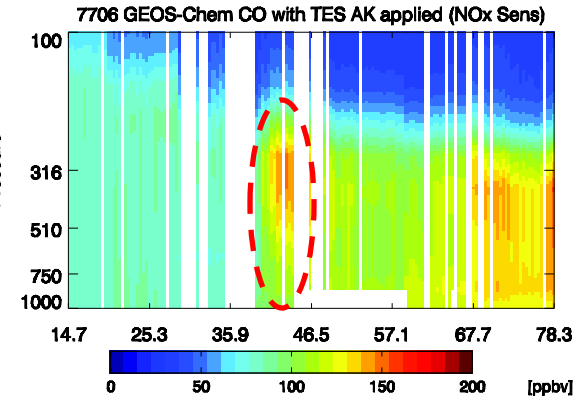
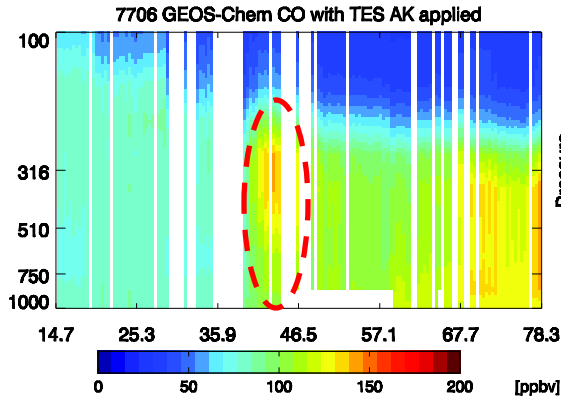
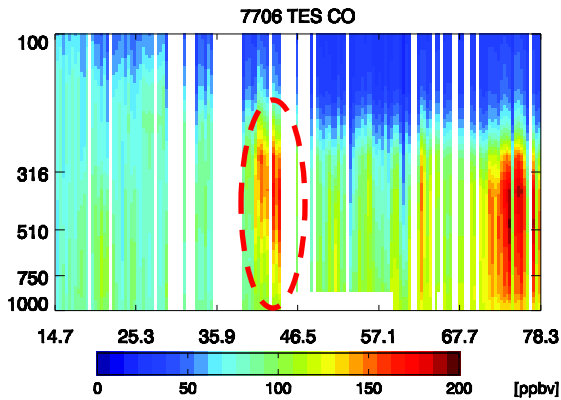
July 3, 2008 - TES Run 7706

TES

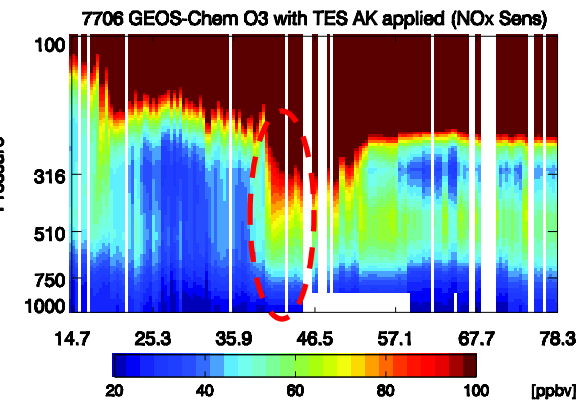
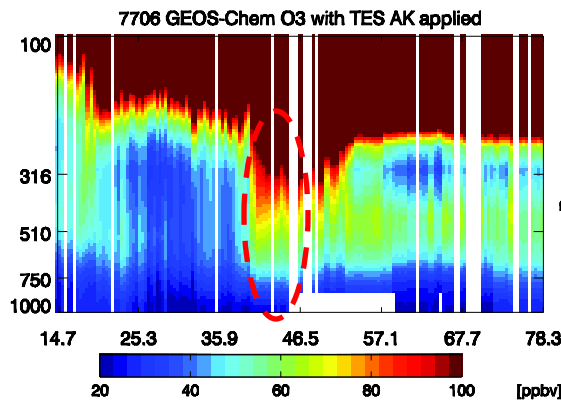
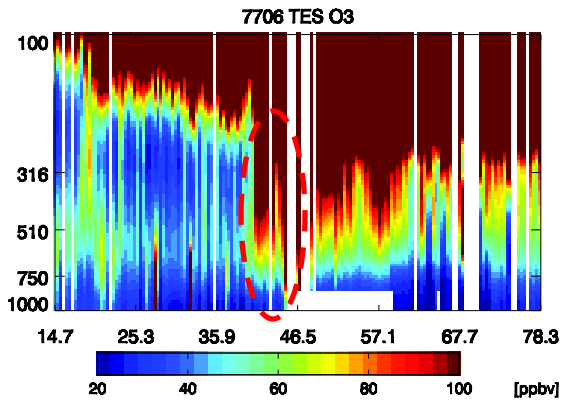
GEOS-Chem w/ TES AK

Low NO_x GEOS-Chem

CO



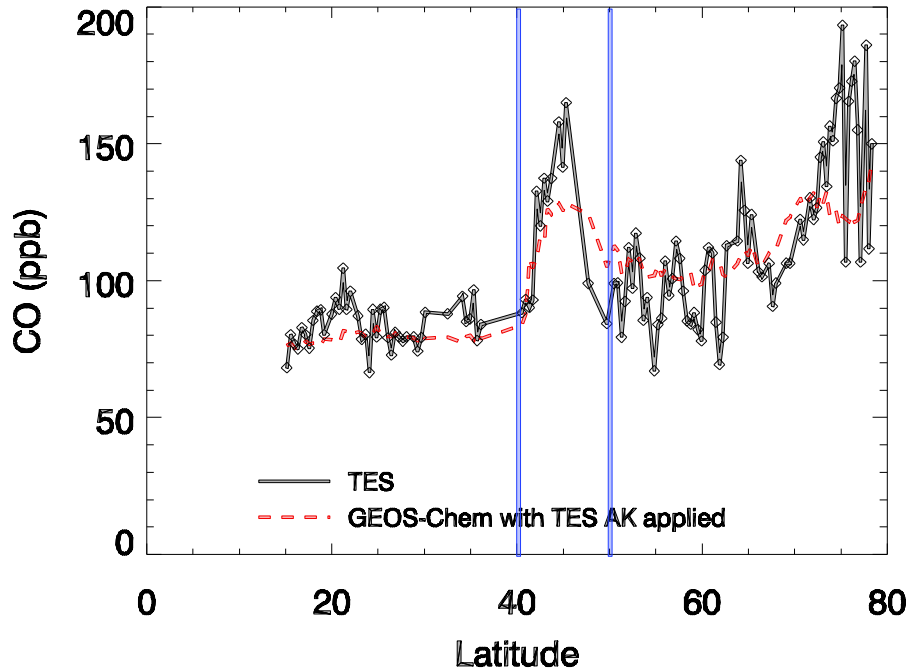
O₃



July 3, 2008 - TES Run 7706, 510 hPa

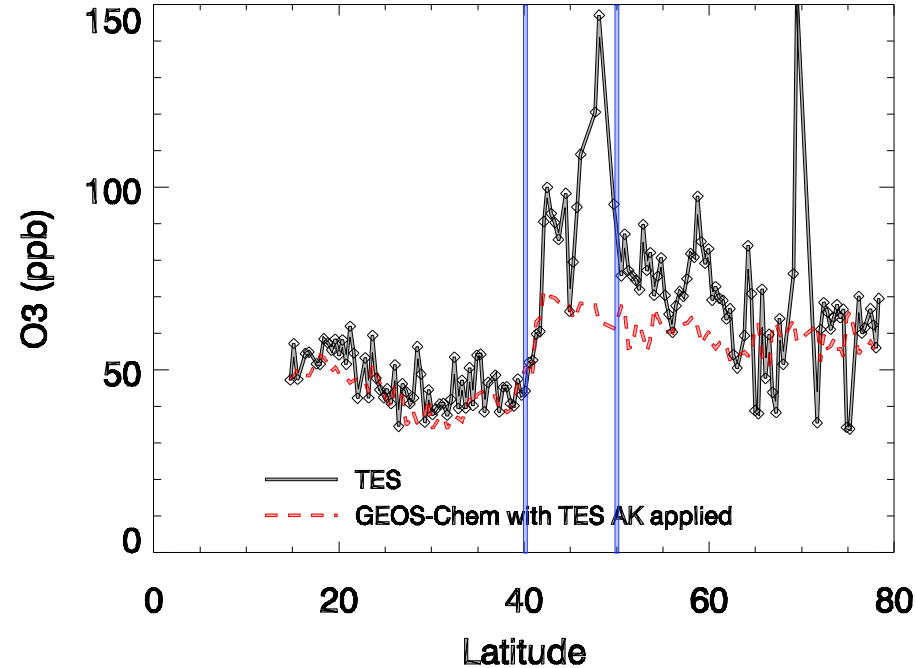
CO

CO at 510.898 hPa in run #7706



O₃

O3 at 510.898 hPa in run #7706



Black line = TES

Red line = GEOS-Chem w/ TES AK

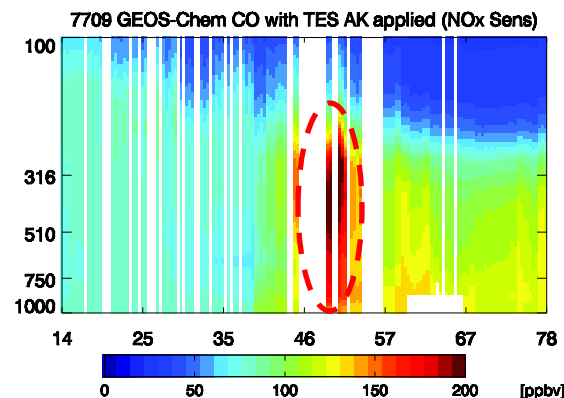
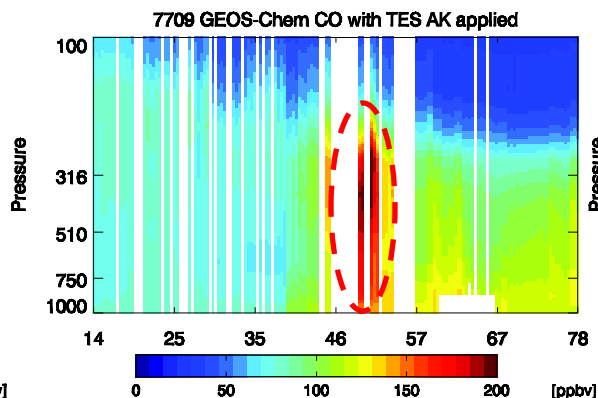
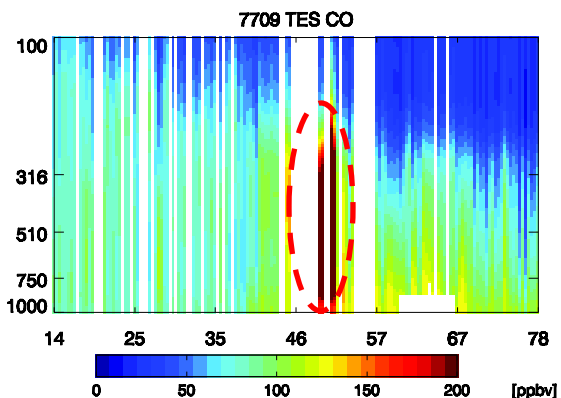
July 4, 2008 - TES Run 7709

TES

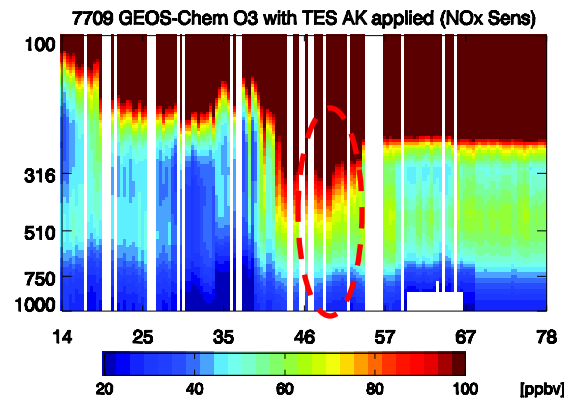
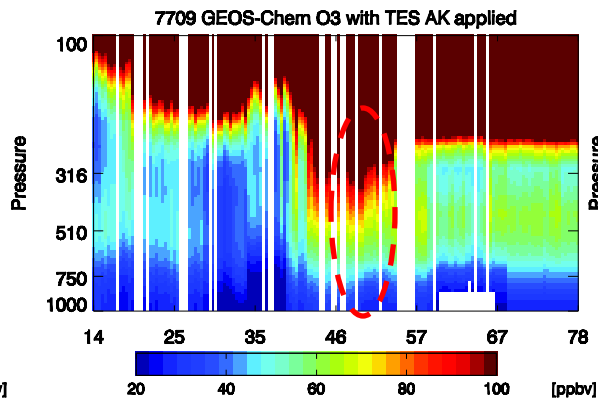
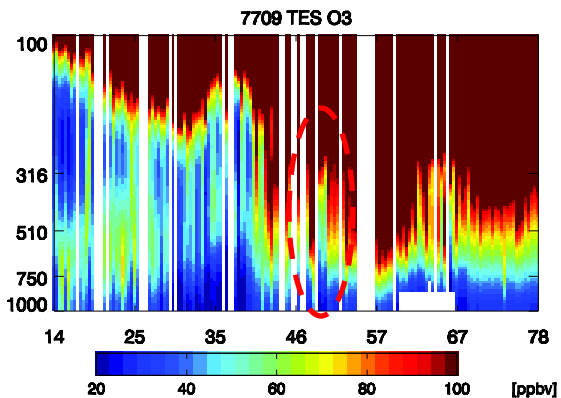
GEOS-Chem
w/ TES AK

Low NO_x
GEOS-Chem

CO



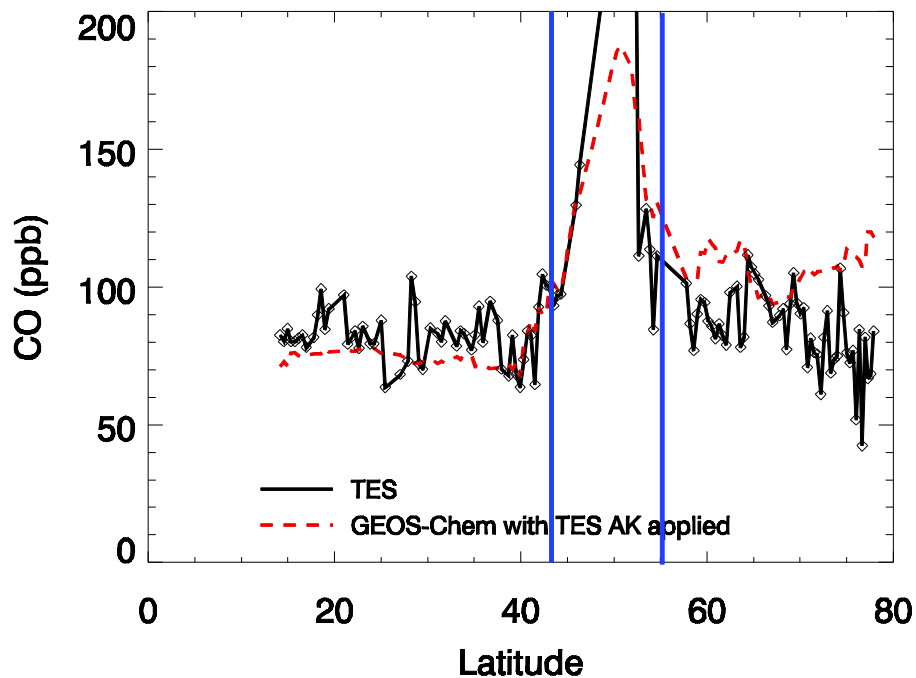
O₃



July 4, 2008 - TES Run 7709, 510 hPa

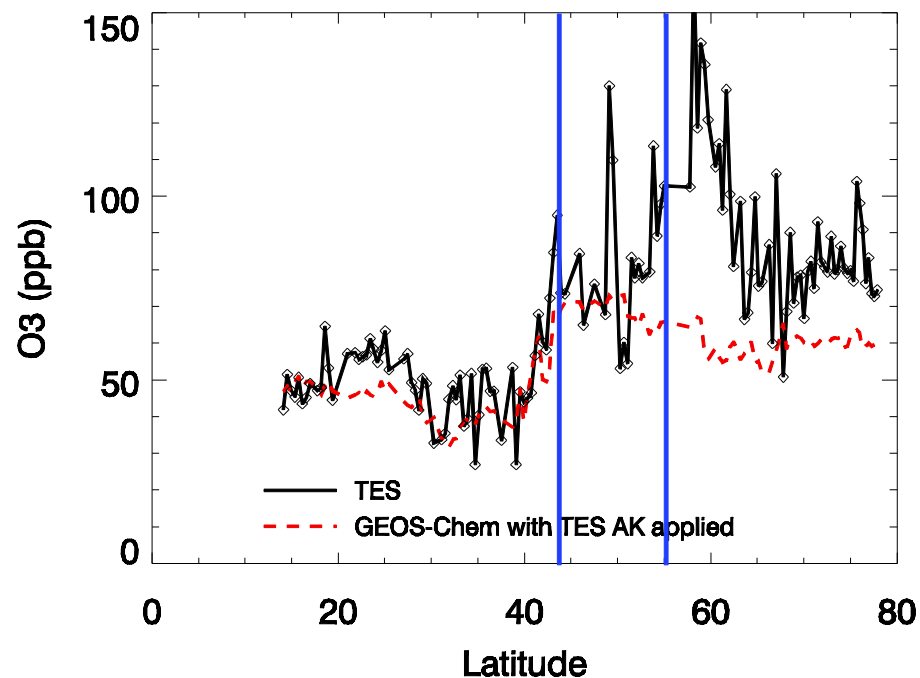
CO

CO at 510.898 hPa in run #7709



O₃

O3 at 510.898 hPa in run #7709



Black line = TES

Red line = GEOS-Chem w/ TES AK

Summary of other runs

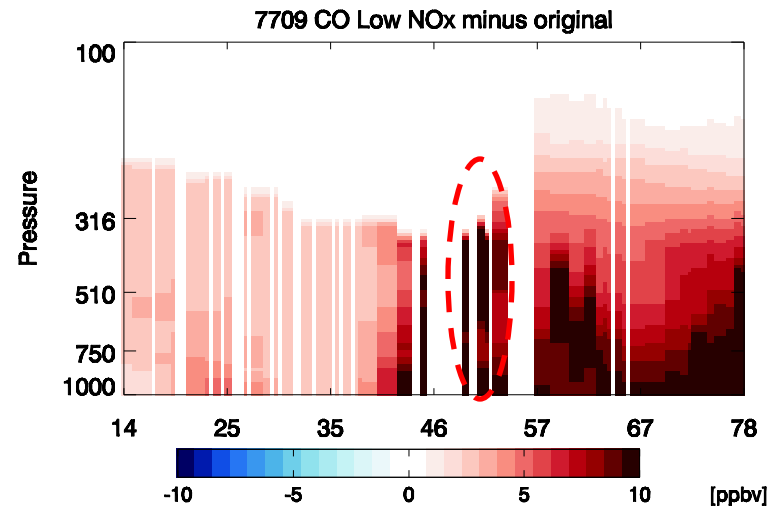
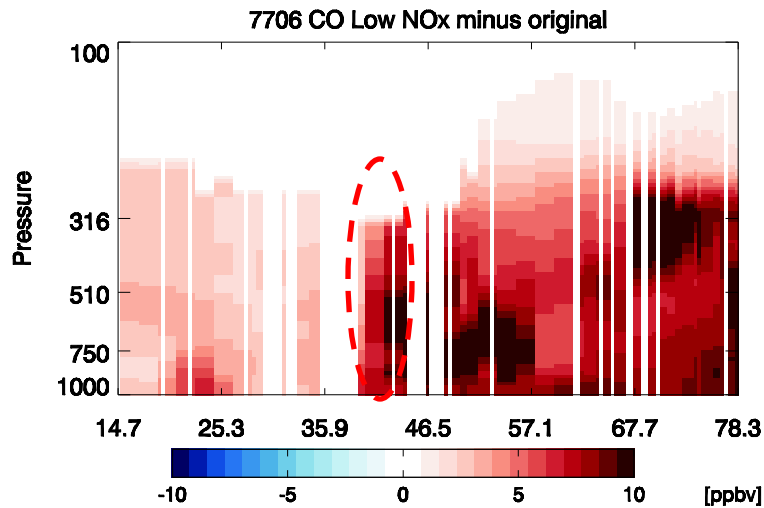
Run	Date	Observation
7706	July 3, 2008	O ₃ higher in plume
7709	July 4, 2008	No change in O ₃
7741	July 5, 2008	O ₃ higher in plume, but high O ₃ continues north outside of plume
7752	July 7, 2008	No change in O ₃
7773	July 7, 2008	O ₃ lower in plume
7776	July 7, 2008	No change in O ₃
7779	July 8, 2008	O ₃ higher in plume

Impact of lower NO_x emissions (Low NO_x - original)

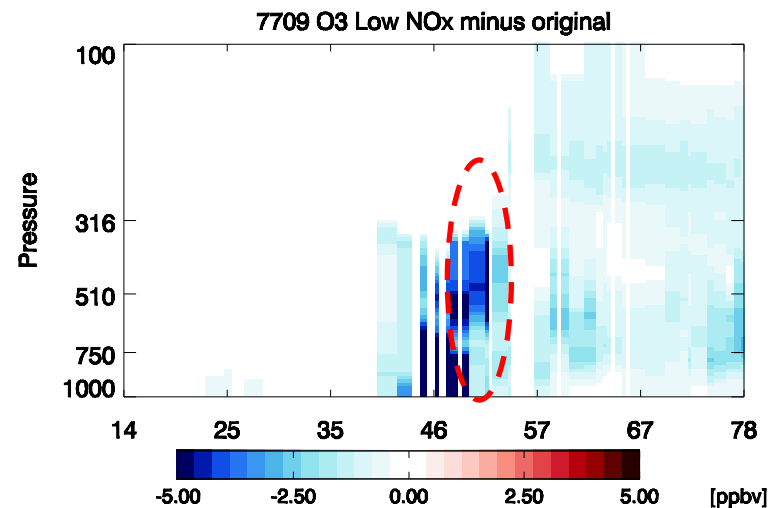
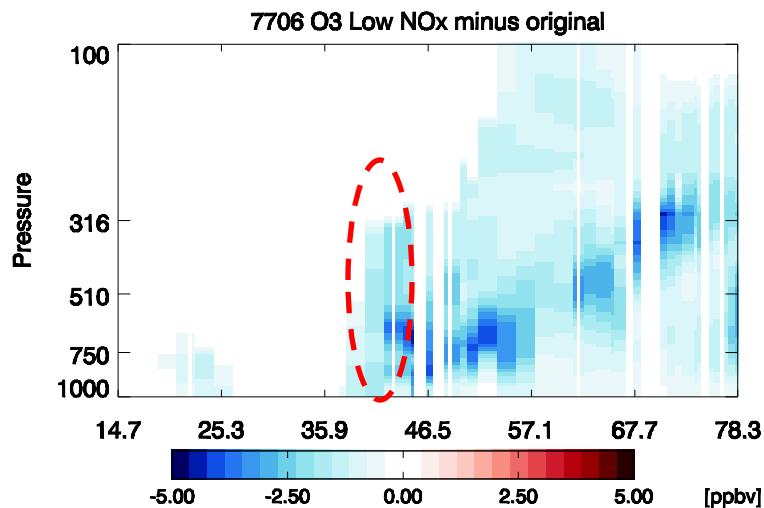
Run 7706

Run 7709

CO



O_3



Conclusions

- TES shows O₃ increasing in some plumes, no change or decreasing in others.
 - Consistent with Verma *et al.*, 2009 and ARCTAS-B.
- No strong monthly-mean NO₂ signal from the July Siberian and N. American fires, in contrast to the April Kazakhstan fires.
 - ARCTAS-B also had low NO_x enhancement
- Reduced NO_x from fires decreases O₃ and increases CO within plumes; has similar, smaller effects throughout the Arctic (+10 ppb CO, -2 ppb O₃).

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 - G. Diskin (NASA LaRC)
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