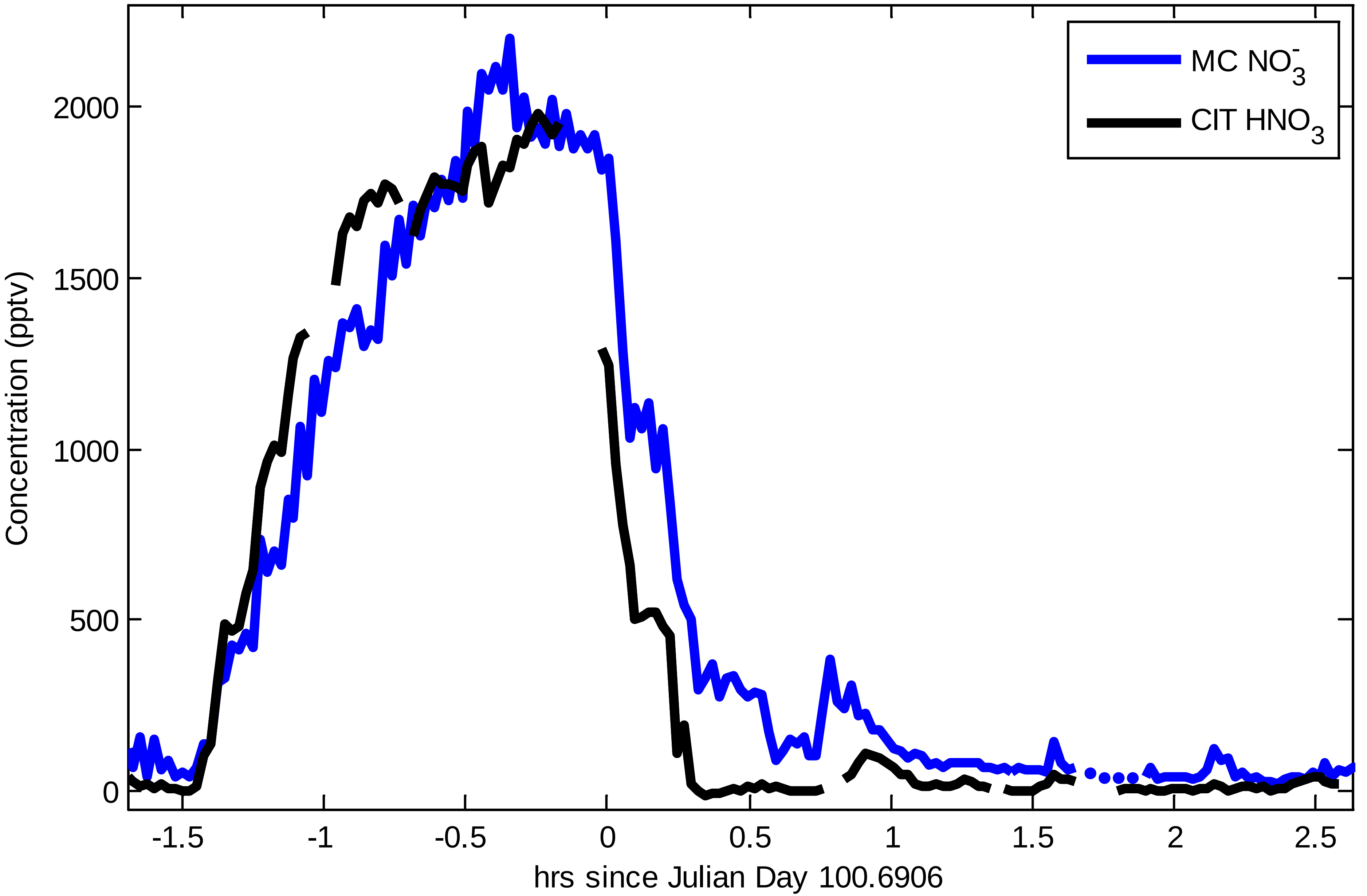
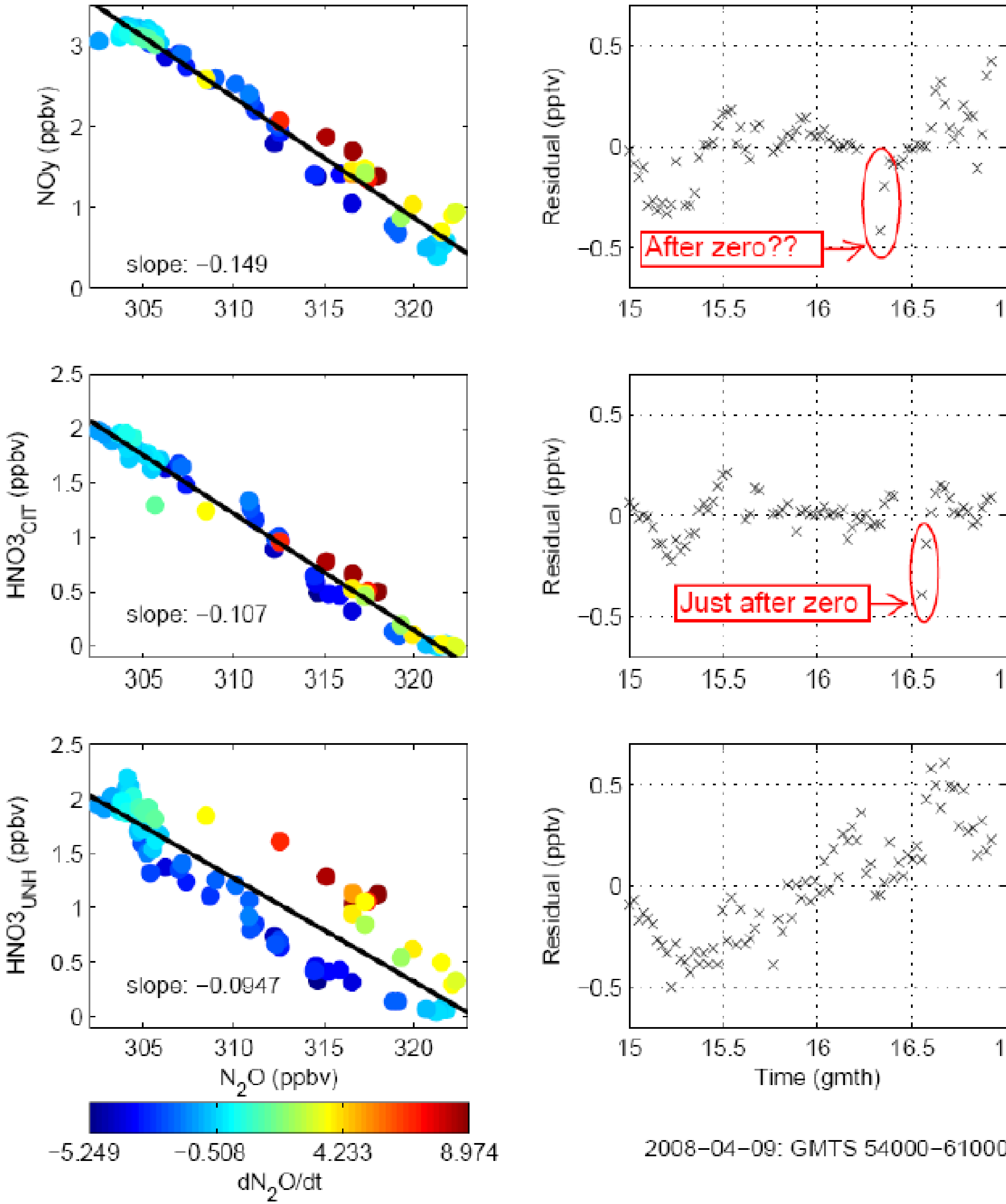
Difference in time response: MC and CIMS



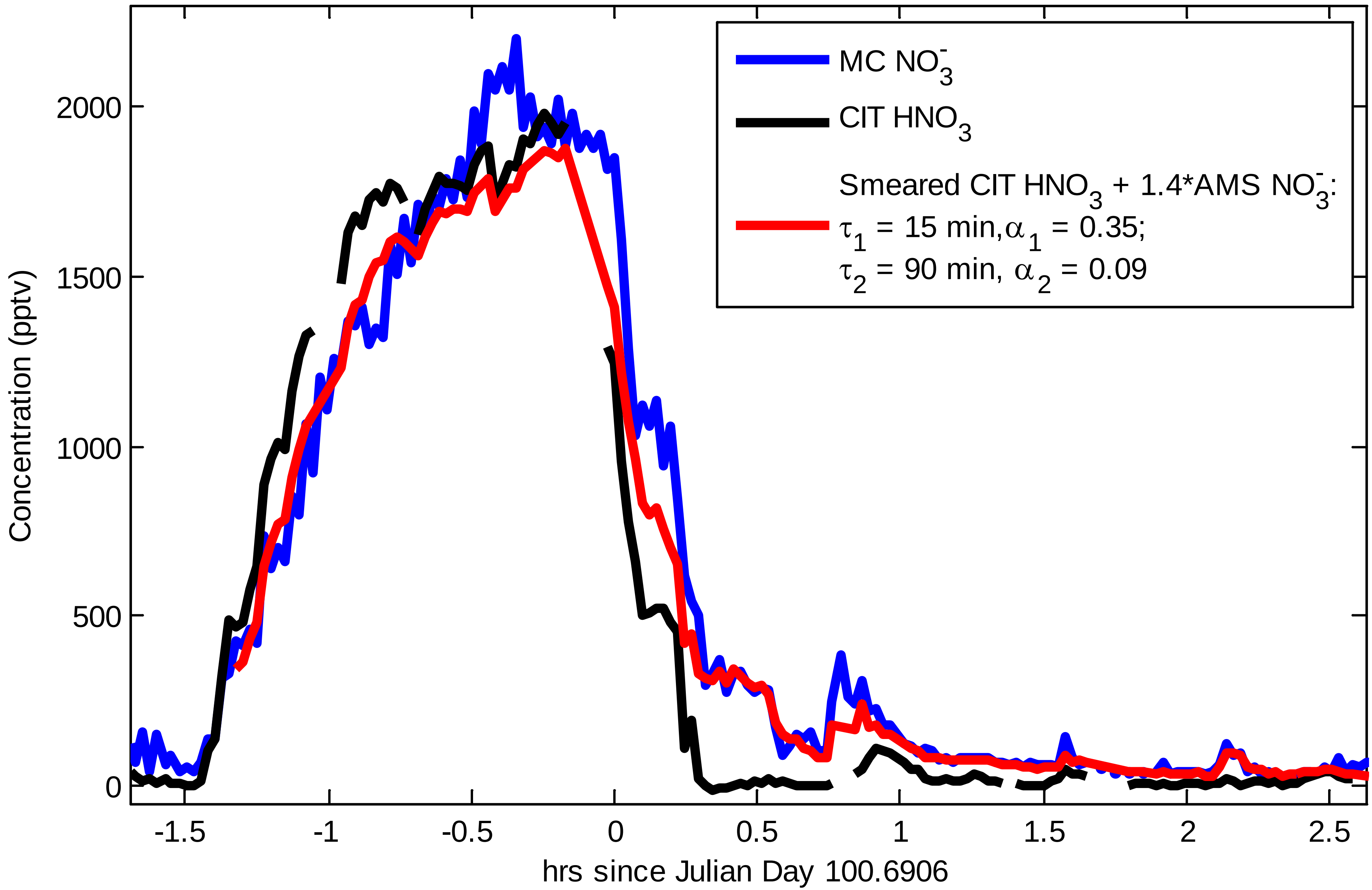

NOy (ppbv)
slope: −0.149
Residual (pptv)
After zero??
HNO3CIT (ppbv)
slope: −0.107
Just after zero
HNO3UNH (ppbv)
slope: −0.0947
N2O (ppbv)
Time (gmth)
−5.249
−0.508
4.233
8.974
dN2O/dt
2008−04−09: GMTS 54000−61000

Response function

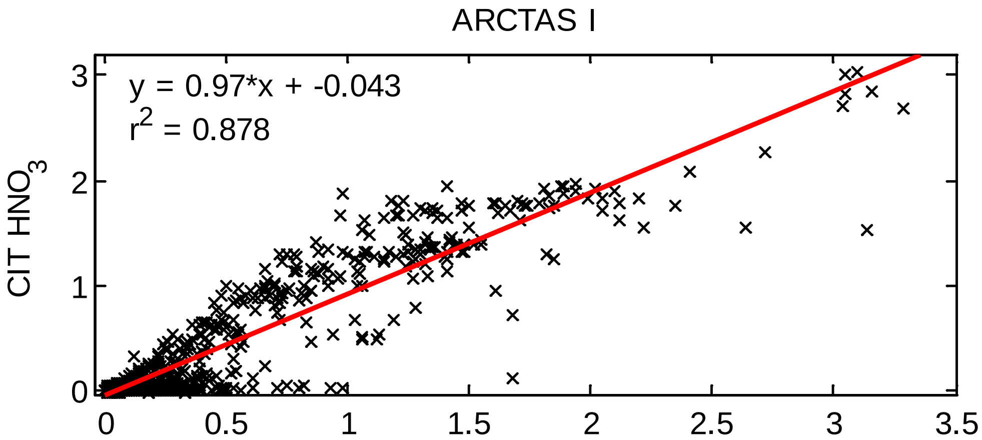
$$C(t) = (1-\alpha_1-\alpha_2)CIT(t) + \alpha_1 \frac{\int_{t-2\tau_1}^{t} CIT(t_i)\exp(-(t-t_i)/\tau_1))dt}{\int_{t-2\tau_1}^{t} \exp(-(t-t_i)/\tau_1))dt} + \alpha_2 \frac{\int_{t-2\tau_2}^{t} CIT(t_i)\exp(-(t-t_i)/\tau_2))dt}{\int_{t-2\tau_2}^{t} \exp(-(t-t_i)/\tau_2))dt}$$

The time response of the CIMS HNO_3 signal has been degraded by the a bi-exponential to best match the MC nitrate signal for a stratospheric plume on 4/9/2008.

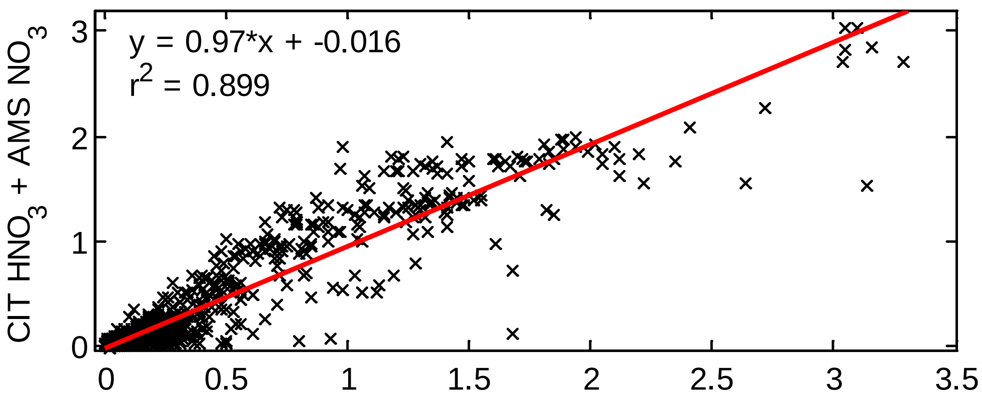
We find τ_1 = 15 and τ_2 = 90 min.



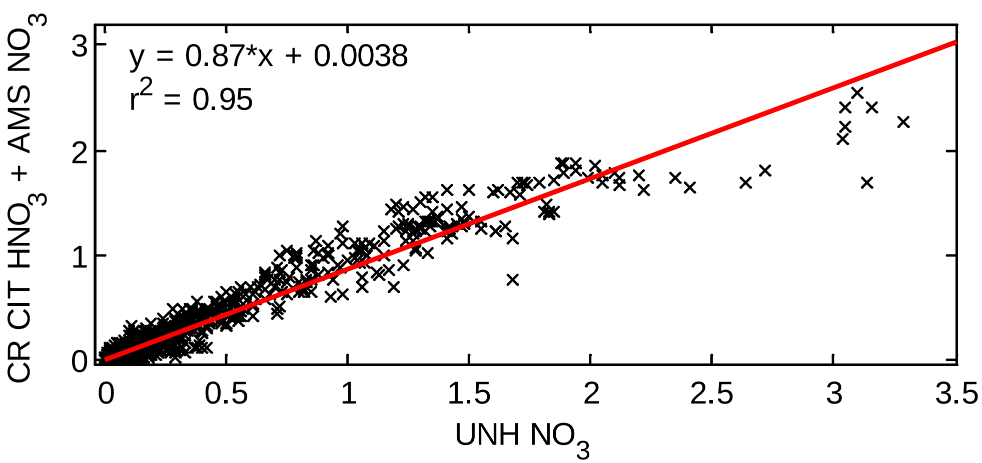
MC NO_3^-
CIT HNO_3
Smeared CIT HNO_3 + 1.4*AMS NO_3^-:
τ_1 = 15 min, α_1 = 0.35;
τ_2 = 90 min, α_2 = 0.09
Concentration (pptv)
0
500
1000
1500
2000
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
hrs since Julian Day 100.6906



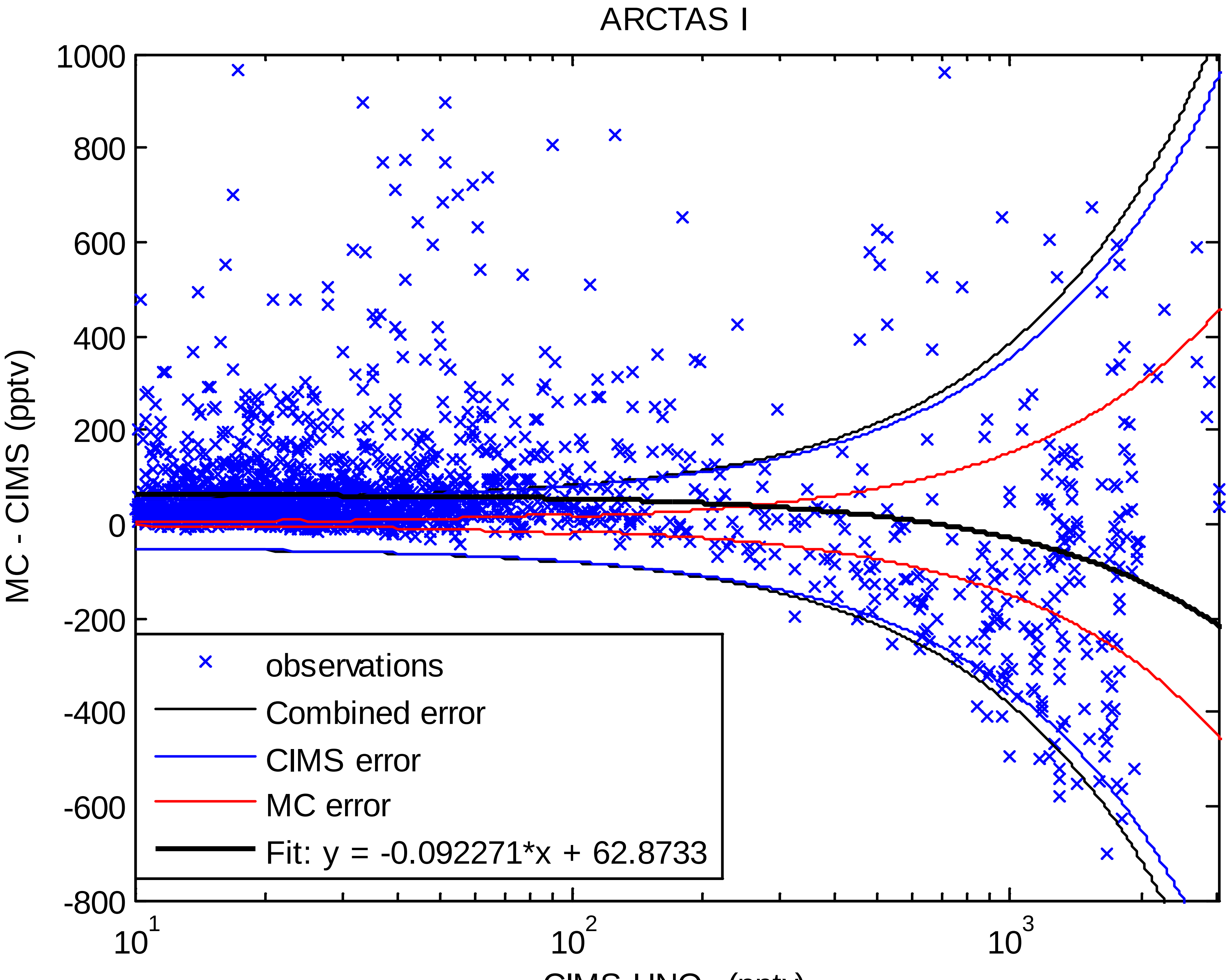
One-to-one figure shows bias both positive and negative. Poor correlation.



We apply the same time-constants to the AMS NO_3^- as was determined by CU for SO_4^-. Additionally, we find that the AMS NO_3^- must be multiplied by 1.4, perhaps due to evaporation of NH_4NO_3 in the AMS inlet, to minimize the differences that correlate with aerosol.

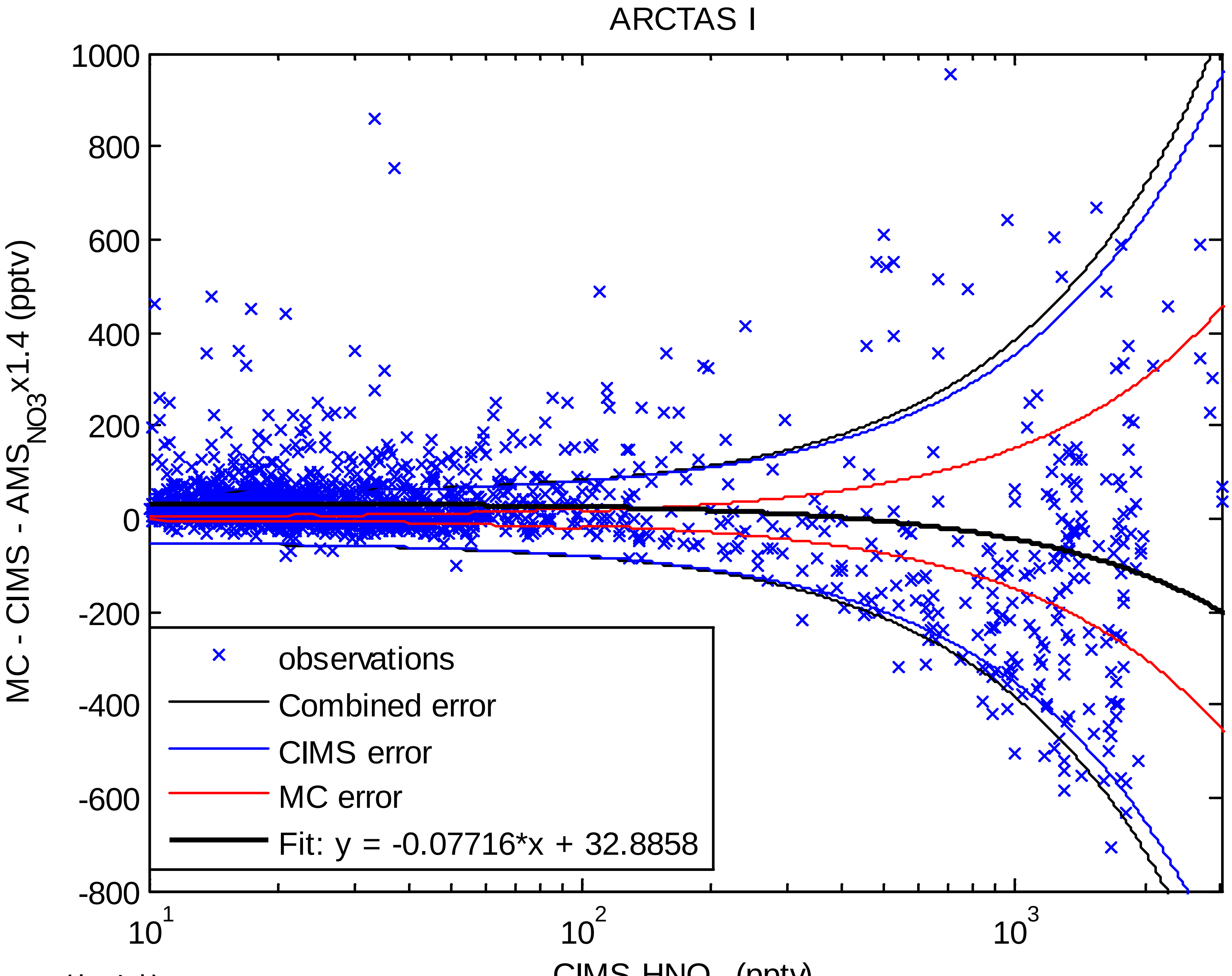


Applying both the aerosol and time-constant corrections removes most of the bias. Although the correlation is substantially improved, there appears to be a ~15% bias between the instruments. Although well within the stated uncertainly, we believe that this bias may reflect an error in the CIMS calibration.

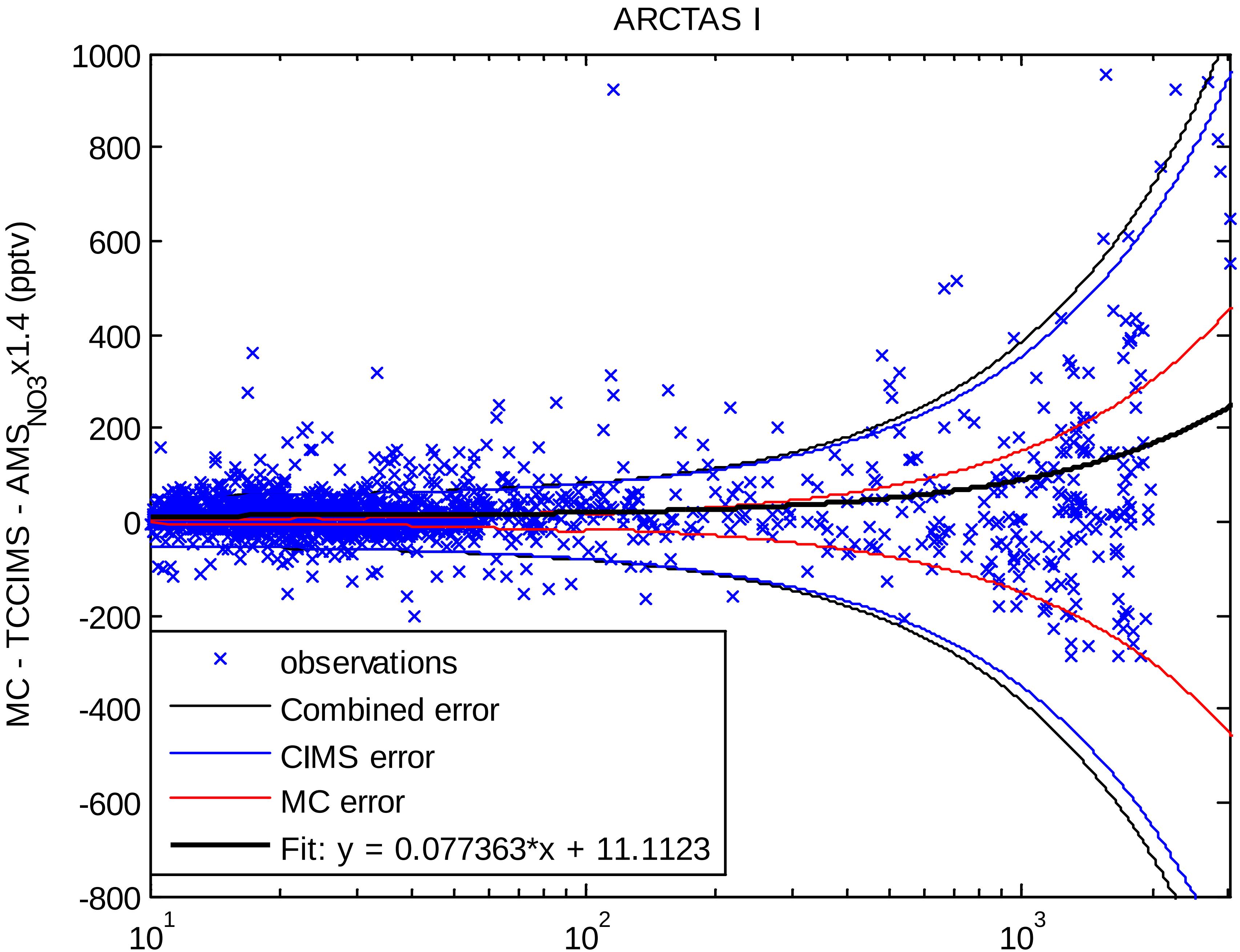


mean(|a-b|) = 83.2 pptv

CIMS uncertainty: 30% + 50 pptv



mean(|a-b|) = 62.2 pptv

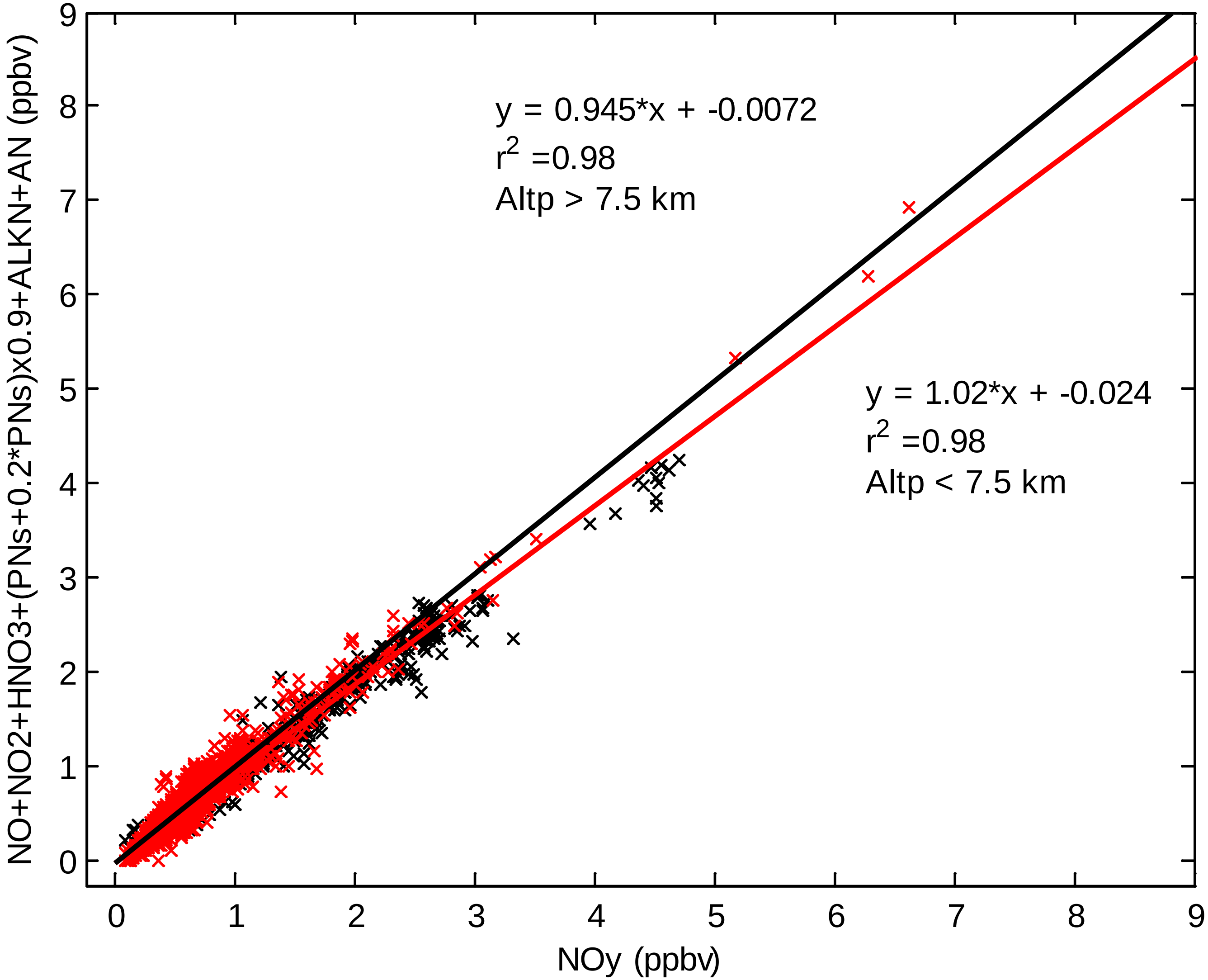


mean(|a-b|) = 43.4 pptv

Comment

- The response time-constants used here do not work perfectly for all plumes – it is likely that the time response of the inlets vary with other parameters (e.g. temperature, humidity) – Nevertheless, they (together with the aerosol correction) work reasonably well – substantially explaining most of the differences between the MC and the CIT CIMS observations.

NOy budget – ARCTAS I



$NOy = NO + NO2 + 1.15*HNO3_{CIT} + (PNs + 0.2*PNs)*0.9 + ClONO2 + N2O5$

NOy Comments

- HNO_3 scalar derived from CIMS/MC bias assuming the error is in CIMS
- PN scalar derived from UCB/NCAR NO_2 comparison during ARCTAS I. Alkyl nitrates estimated to be 0.2xPN consistent with ARCTAS II and III
- Stratospheric $ClONO_2$ estimated to be 50% of Cl_y which is calculated from loss of CFC's (max $ClONO_2$ = 130 pptv). This estimate from ACE-FTS observations at this time of year.
- N_2O_5 estimated from Langley box model (max N_2O_5 = 50 pptv).