TAbMEP Report: ICARTT NO Measurements

1. Introduction

Here we present the results from the nitrogen oxide (NO) measurement comparisons conducted on four aircraft platforms during the summer 2004 ICARTT field campaign [*Fehsenfeld et al.*, 2006, *Singh et al*., 2006]. This report is based upon the five wing-tip-to-wing-tip intercomparison flights conducted during the field campaign. Low NO conditions encountered during the comparisons prevent us from carrying out a meaningful assessment, thus recommendations are not given in terms of the measurement uncertainties. This report serves as a record for ICARTT NO measurement comparisons.

2. ICARTT NO Measurements

Four different NO instruments were deployed on the four aircraft. It is noted here that the designated DC-8 instrument experienced serious malfunctions and had to be replaced during the campaign with a commercial grade instrument. Table 1 summarizes these techniques and gives references for more information.

Table 1. NO measurements deployed on aircraft during ICARTT

Aircraft	Instrument	Reference
NASA DC-8	NO Chemiluminescence Detector (NO CLD)	Contact PI: brune@meteo.psu.edu
NOAA WP-3D	NO Chemiluminescence Detector (NO CLD)	*Ryerson et al.* [1998]
FAAM BAe-146	NO Chemiluminescence Detector (NO CLD)	Contact PI: m.j.evans.ac.uk
DLR Falcon	NO Chemiluminescence Detector (NO CLD)	Contact PI: hans.schlager@dlr.de

3. Summary of Results

Figure 1 shows the time series plots for comparisons between NASA DC-8 and NOAA WP-3D NO measurements. Between these two measurements, the DC-8 measurement PI reports significantly higher uncertainties. As all three comparisons were conducted at relatively low NO conditions, over 90% of the reported DC-8 values were under LODs (limit of detection), denoted by the grey symbols. The LOD value is defined as the 2 times the 1σ uncertainty reported by the PI. This severely limits our ability to make a meaningful assessment because the ICARTT intercomparison between DC-8 and WP-3D does not provide sufficient data to conduct any robust statistical analysis. It should be clarified here that WP-3D reported values are generally above their LOD and the observed NO trends were found to be correlated with other chemical tracers, e.g., CO. Table 2 provides a summary of the PI reported uncertainties for each of the instruments involved in the intercomparisons. Please note the point by point uncertainty given by PI is a strong function of NO value itself.

Table 2. ICARTT NO PI reported uncertainty for intercomparison period

Aircraft/Instrument	Reported 1σ Uncertainty
NASA DC-8 NO CLD	Point by point, average: 37% for NO values above LOD
NOAA WP-3D NO CLD	5 pptv + 2.5%
FAAM BAe-146 NO CLD	Point by point, average: 41% for NO values above LOD
DLR Falcon NO CLD	2.5%

[a]The average encompasses only the comparison periods for DC-8/WP-3D and DC-8/BAe-146
[b]The average encompasses only the comparison periods for DC-8/BAe-146 and BAe-146/Falcon

Taking the data at face value, the DC-8 NO measurement is, on average, about 32% higher than those of WP-3D for DC-8 NO levels above 10 pptv. The average reported 1σ uncertainty for DC-8 above LOD intercomparison points is 41%; while the WP-3D 1σ uncertainty is reported as 34% on average for the intercomparison points. For comparison between the NASA DC-8 and FAAM BAe-146, Figure 2 displays a very similar situation to what is displayed in Figure 1. Most of the comparison data points fall under 2σ LODs. Again, the LOD values for DC-8 and BAe-146 are defined as 2 times the 1σ uncertainties reported by the corresponding PIs. For DC-8 NO higher than 10 pptv, the average difference between the DC-8 and BAe-146 measurements is 52%, DC-8 being higher. The average reported 1σ uncertainty for DC-8 above LOD intercomparison points is 33%; while the average for BAe-146 1σ uncertainty above LOD is 40%. Figure 3 shows that low NO conditions were again encountered during the FAAM BAe-146 and DLR Falcon comparison. Less than 3% of BAe-146 data are above 2σ LODs. On average, the Falcon NO measurement is about 14% lower than those of the BAe-146 for BAe-146 NO levels above 10 pptv. The average reported 1σ uncertainty for BAe-146 above LOD intercomparison points is 42%; while the PI reported Falcon uncertainty is 2.5% (1σ).

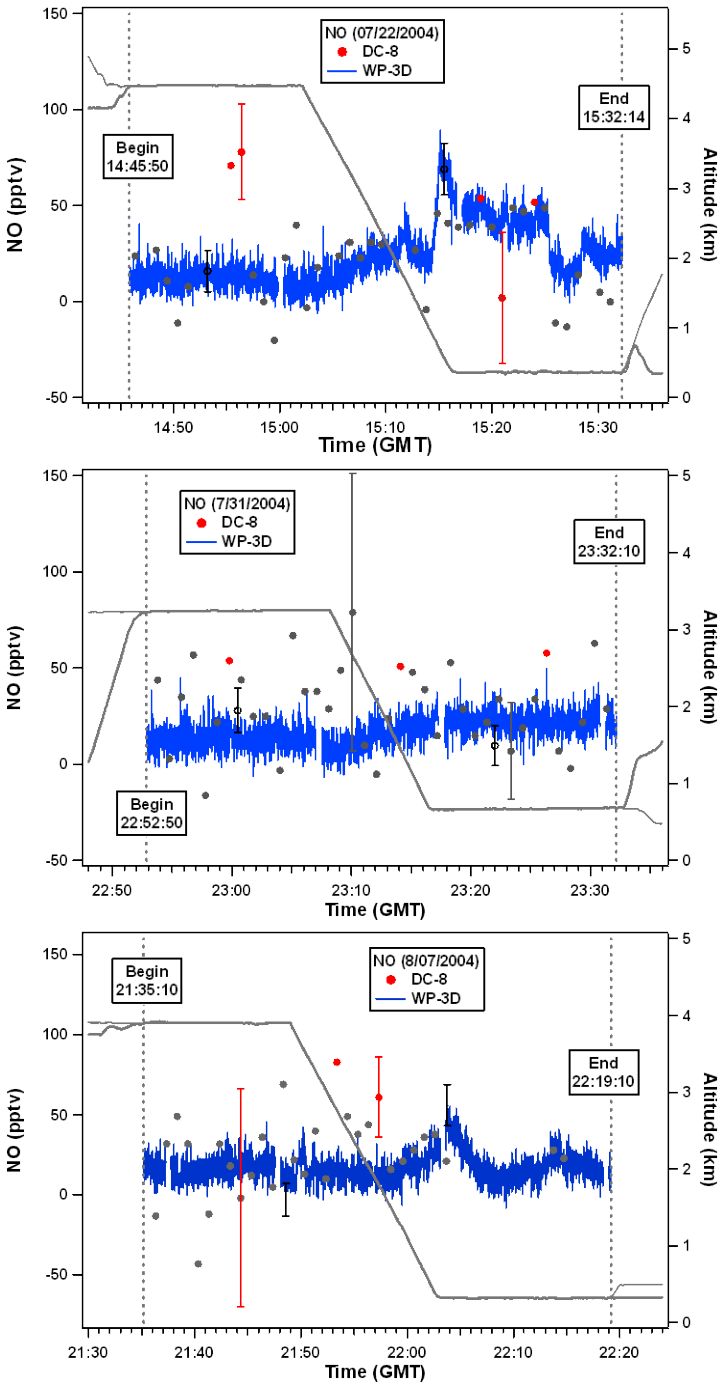

Figure 1. Time series of NO measurements and aircraft altitudes from the three intercomparison flights between the NASA DC-8 and the NOAA WP-3D. Error bars represent the PI reported uncertainty. Gray symbols represent DC-8 measurements that are under limit of detection (LOD). The LOD level is defined as 2 times the 1σ uncertainty reported by PI.

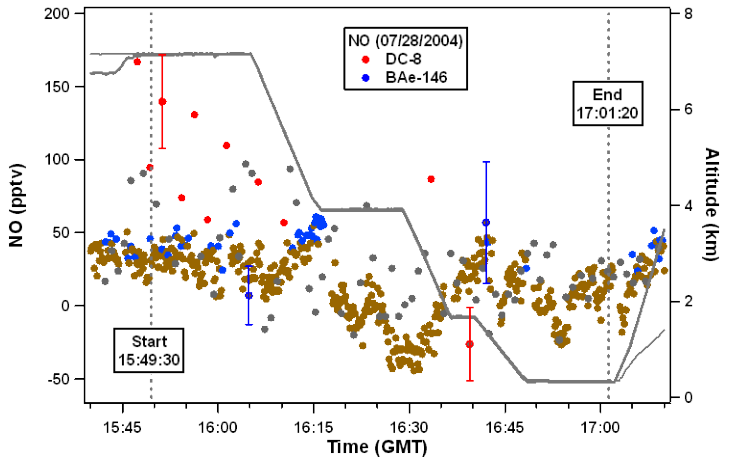

Figure 2. Time series of NO measurements and aircraft altitudes from the intercomparison flight between the NASA DC-8 and the FAAM BAe-146. Error bars represent the PI reported uncertainty. Gray and brown symbols, respectively, represent DC-8 and BAe-146 measurements that are under limit of detection (LOD). The LOD level is defined as 2 times the 1σ uncertainty reported by PI.

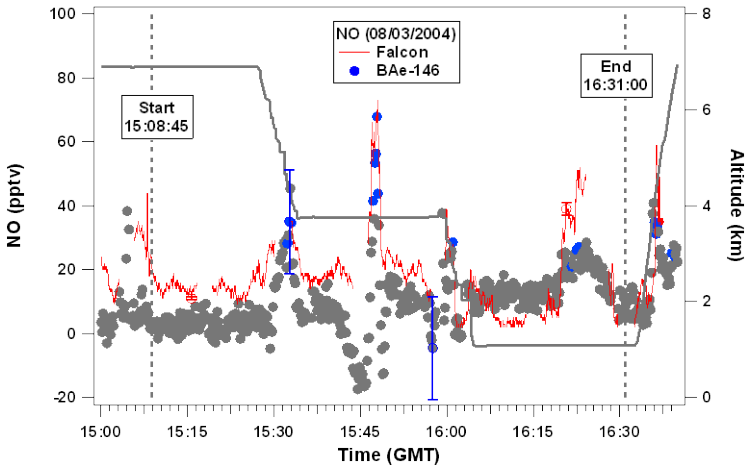

Figure 3. Time series of NO measurements and aircraft altitudes from the intercomparison flight between the FAAM BAe-146 and the DLR Falcon. Error bars represent the PI reported uncertainty. Gray symbols represent BAe-146 measurements that are under limit of detection (LOD). The LOD level is defined as 2 times the 1σ uncertainty reported by PI.

References

Fehsenfeld, F. C., et al. (2006), International Consortium for Atmospheric Research on Transport and Transformation (ICARTT): North America to Europe—Overview of the 2004 summer field study, *J. Geophys. Res., 111*, D23S01, doi:10.1029/2006JD007829.

Ryerson, T.B., et al. (1998), Emissions lifetimes and ozone formation in power plant plumes, *J. Geophys. Res., 103*, D17, 22569-22583

Singh, H. B., et al. (2006), Overview of the summer 2004 Intercontinental Chemical Transport Experiment-North America (INTEX-A), *J. Geophys. Res., 111*, D24S01, doi:10.1029/2006JD007905.