

CASTNET Ozone Measurements: Network Precision, Comparability, and Transitioning to 40 CFR Part 58, Appendix A



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CASTNET/SLAMS Collocated Pairs

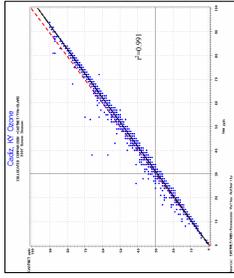


Figure B

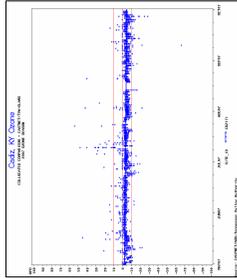


Figure C

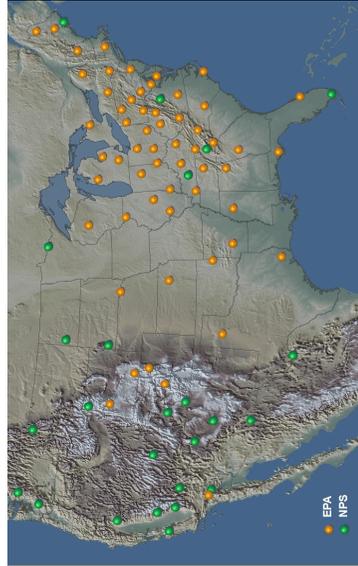
ABSTRACT:

Ground-level Ozone (O₃) is measured at over 1300 sites across the U.S. in both urban and rural areas. There are two main types of ozone concentration measurements: data that is collected by the State and local Air Quality Monitoring Stations (SLAMS) and data that is collected by the State and local CASTNET/SLAMS stations. CASTNET/SLAMS sites are mostly urban-based and data is stored and managed by the Air Quality System (AQS) whereas; CASTNET ozone measurements are regionally representative and data are managed by EPA and accessible on EPA's Web site: <http://airdata.epa.gov/aqdata/>. Both networks have consistent and comprehensive quality assurance protocols with data extending back two decades. Understanding the comparability of the data from these two sources is important for assessment purposes and for uses of these data in evaluating emission control strategies, providing data for input to run and evaluate models, and for measuring overall progress of air pollution control programs. Combining data from both SLAMS and CASTNET provide greater spatial coverage and allows for assessment of transport from metropolitan areas to regional areas. Understanding any differences provides data users with the necessary information to perform more comprehensive ozone air quality assessments. CASTNET provides valuable information for evaluating various national and regional air pollution control programs and is the primary source for regionally representative, rural ozone measurements.

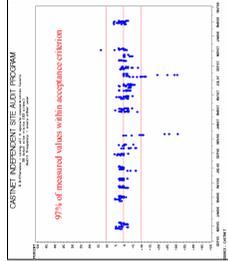
- 1) Comparisons of collocated pairs of ozone monitors operated by SLAMS and CASTNET are provided with information on overall precision estimates for each network.
- 2) Results on accuracy from the CASTNET site audit program and evaluating single point precision checks for each network.
- 3) Progress and plans for transitioning CASTNET ozone monitoring operations to meet 40 CFR, Part 58 (Appendix A) requirements.
- 4) Interpolated map of using data from both CASTNET and AQS (SLAMS) sites.

* (SLAMS includes the subset of National Ambient Monitoring Stations (NAMS), NCMS, and PAMS which measure ozone)

CASTNET: 84 Dry Deposition and Rural Ozone Monitoring Sites



System and performance audits are performed at all network sites by an independent contractor (third-party) on a biannual basis. The CASTNET ozone inlet is sited at 10-meters with a particle filter. Each ozone analyzer is challenged with ozone-free air and four up-scale concentrations. Two challenges are in the range of 50-80 ppb, and one in each of 150-200 ppb, and 300-450 ppb. The ozone analyzers are calibrated using gas packs are introduced at 0.5-minute sample interval, through all filter the sample train. The ozone accuracy criterion for %difference is $\leq \pm 1\%$ -10% of the test gas concentration.



Collocated Pairs and Network Precision

CASTNET has operated collocated monitoring at eleven sites for network precision since its inception in the late 1980s. Currently, two collocated sites are maintained with identical sampling system configurations. The systems are located at Macksville, KY (MCK131/231) and Rocky, Mountain NP, CO (ROM206/ROM406).

Collocated precision for CASTNET ozone measurements is calculated here using equation 10 of 40 CFR Part 58, Appendix A for each collocated pair to provide a relative percent difference (RPD) d_r . The coefficient of variation CV% is calculated using equation 11 (figures 1 and 2). Pairs with values less than 10 ppb were removed from collocated analysis.

$$x = \text{primary analyzer} \quad \text{Equation 10}$$

$$y = \text{collocated analyzer}$$

$$d_r = \frac{x_i - y_i}{(x_i + y_i)/2} \cdot 100$$

The Macksville systems are both operated by common site operators and calibrators and provide intra-system comparison while the Rocky Mountain N.P. systems are operated by independent site operators and calibrators and providing inter-system comparison between EPA and NPS sponsored sites.

CASTNET historic (1990-2006) network precision for Ozone from collocated pairs is estimated to be 5%. This is typically calculated using a mean absolute relative percent difference (MARPD) at quarterly and annual aggregations.

Network precision for SLAMS sites is determined primarily from on-site NIST traceable precision point checks that are run at least bi-weekly. Comparison between SLAMS and CASTNET regarding single point precision is limited due to differences in quality assurance protocols of QC checks therefore a CV was not calculated for CASTNET precision point checks. Results from 2006 are presented for all analyzers in each network as percent differences using equation 1 and 2 of 40 CFR Part 58, Appendix A (figures 3 and 4).

Analyzer Precision Checks

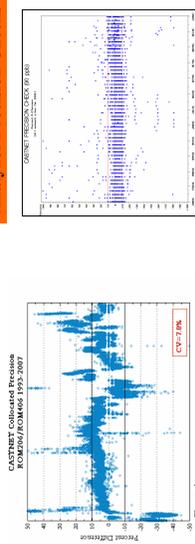


Figure 1

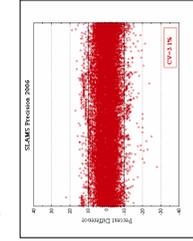


Figure 4

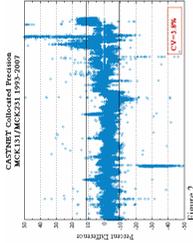


Figure 2
 Note: concentrations pairs ≤ 10 ppb were removed from data in figures 1 and 2.

The Tennessee Valley Authority (TVA), State of Kentucky, and EPA CASTNET have been cooperatively supporting monitoring at Cadiz, KY (CDZ17) for over two years. Cadiz has collocated ozone analyzers one run by CASTNET and the other by EPA (SLAMS). The relative percent differences are plotted for the 2007 ozone season (figure A). The plot trends indicate the relationship of 74-10%, but indicate a negative bias. A regression is also presented for the 2007 ozone season with a 1:1 line (figure B).

Another relatively close ozone CASTNET/SLAMS pair is in Beltsville, MD. The sites are approximately four miles apart. A simple linear regression with a 1:1 line is provided for the time period June 2005 to October 2007 (figure C). Greater variance in the data can be partly attributed to the 4 miles distance between sites and their proximity to metropolitan activities.

Part 58, Appendix A Transition

EPA is planning to transition CASTNET ozone monitoring operations to fully meet those outlined in 40 CFR, Part 58. This involves upgrading analyzers and data loggers to newer more reliable models and upgrading to the appropriate software. The transition will occur over the next two years. The table below discusses the current status of the network.

SITE ID	SITE NAME	STATE	ANALYZER	INLET CHECK (ppb)
Sites proposed for compliance 2008 ozone season				
BE1116	Beltsville	MD	49	daily
BE1117	Beltsville	MD	49	daily
BE1441	Indian River Lakes	FL	49	daily
SM1156	Sumatra	FL	49	daily
HW1132	Horseshoe	ME	49	daily
Sites submitting to AIR Sys				
ME128	Ardenville	PA	49	every other day
NC123	Candler	NC	49	every other day
CA188	Cummins Station	CA	49	49
CA189	Cummins Station	CA	49	49
LA1117	Lamar Hill	LA	49	49
LA1117	Lamar Hill	LA	49	49
PD1108	Prince Edward	VA	49	49
PD1165	Pondale	VA	49	49
SP1111	Spotswood	VA	49	49
UN1124	Unsworth	TN	49	49
UN1124	Unsworth	MI	49	49
WV1144	Wade Crossing	WV	49	49
CA1175	Chickadee	NY	49	49
CA1175	Chickadee	NY	49	49
CA1185	Chickadee Station	OK	49	49
CA1185	Chickadee Station	TX	49	49

Conclusions:

- Collocated pairs of CASTNET sites provide a relatively good measure of network precision and is estimated to be 4-7% over 14 years (low concentration pairs, ≤ 10 ppb, were removed from analysis). More than two collocated sites are recommended for larger (over 50 ppb) networks. Based on QA precision check data, SLAMS ozone monitor precision is estimated to be 3.1% for the year 2006.
- Despite differences in how each network (CASTNET and SLAMS) determines precision and the significantly larger network size of SLAMS, the precision of the two networks is comparable.
- Where CASTNET and SLAMS sites are collocated together (physically at the same site) the data indicate very good correlation and low RPDs as demonstrated at the Cadiz, KY site. However, monitors located just 5-6 km apart indicate more variability as demonstrated by the Beltsville, MD comparison.
- CASTNET Accuracy Audit Results
- CASTNET ozone measurement accuracy as determined by CASTNET's independent site audit program provides evidence that network monitors are operating consistently with no bias compared to audit test gas concentrations. All sites will be audited annually beginning in 2009.
- A nationally representative subset of EPA sponsored CASTNET monitors will meet SLAMS/AQS requirements this year and all ozone operations and quality assurance will meet 40CFR Part 58, Appendix A by the end of 2009.

A more rigorous analysis of the two networks is necessary to further demonstrate the comparability of the two networks and understand the quality of each dataset; however, based on the estimated network precision and direct collocated comparisons there is evidence of good overall comparability with regard to ozone measurements.