大气自动监测系统监测数据"有效性"讨论

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摘要 根据统计理论推导出有效日均值允许缺测时数与允许误差和全日时均值均方差的理论关系式,应用于北京市大气自动监测系统冬季二氧化硫小时浓度监测资料,计算出95%置信度下随机缺测允许最大时数为6h,与目前国家环保局要求75%数据捕获率相一致。

关键词 大气自动监测系统,监测数据有效性,北京市。

在大气自动监测过程中,常会发生某些时次的监测数据缺测。为充分利用监测资料,必须确定在允许的误差范围内,至少要获得多少时次的监测数据,其计算出的日平均值才有效。国内外文献中对此问题没有一个统一的标准和判断确定办法:有的允许缺测12h[1],有的允许缺测8h[2],有的允许缺测6h[3,4]。

本文根据统计理论推导出一个理论关系式,根据此式可以对日平均值、月平均值、季平均值、年平均值等进行有效性判别和处理。

1 有效性判别公式的导出

设某种污染物某日的小时浓度理论监测数据序列为:

$$c_1, c_2, \ldots, c_N \quad (N=24) \tag{1}$$

实际监测小时浓度数据序列为:

$$c_1, c_2, \ldots, c_n \quad (n<N) \tag{2}$$

缺测的 m 小时浓度数据序列为:

$$c_{n+1}, \ldots, c_N \quad (m=N-n\geqslant 0) \tag{3}$$

记 $\bar{c}_N$、$\bar{c}_n$、$\bar{c}_m$ 分别为上述3个数据序列的日平均值,则实际监测数据序列与理论监测数据序列日平均值的误差为:

$$\begin{aligned}\triangle c &= \bar{c}_n - \bar{c}_N = \frac{1}{n}\sum_{i=1}^{n} c_i - \frac{1}{N}\sum_{i=1}^{N} c_i \\ &= \frac{m}{n}(\bar{c}_N - \bar{c}_m)\end{aligned} \tag{4}$$

由(4)式可知误差 $\triangle c$ 与缺测数 m 成正比,与实际监测数 n 成反比,与污染物浓度日变化性成正比。

假定缺测数 m 是随机的,则 $\triangle c$ 也是随机的。如果在 P 置信度下 m 的取值满足:

$$|\triangle c| \leqslant |\triangle c'| \tag{5}$$

这里 $\triangle c'$ 为给定的允许误差。

即:

$$\left|\frac{m}{n}(\bar{c}_N - \bar{c}_m)\right| \leqslant \triangle c' \tag{6}$$

考虑到大气污染物浓度多服从对数正态分布,将浓度监测数据取对数后则服从正态分布。为方便起见,仍记 $\bar{c}_N$、$\bar{c}_m$ 为几何平均值,则有:

$$U = \frac{\bar{c}_m - \bar{c}_N}{\sigma_N/\sqrt{m}} \sim N(0,1) \tag{7}$$

即:

$$U = -\frac{n\triangle c}{\sigma_N/\sqrt{m}} \sim N(0,1) \tag{8}$$

式中:U 为标准化正态变量,σ_N 为全日时均值的均方差。由

$$P\{-\frac{n\triangle c'}{\sigma_N\sqrt{m}} \leqslant U \leqslant \frac{n\triangle c'}{\sigma_N\sqrt{m}}\} = P \tag{9}$$

可求得置信水平为 P 时,误差小于给定允许误差 $\triangle c'$ 的允许缺测数 m。

取 $P=95\%$,由 $N(0,1)$ 正态分布有

$$\frac{n\triangle c'}{\sigma_N\sqrt{m}} = 1.96 \tag{10}$$

把 $n=N-m$ 代入(10)并整理得:

$$m^2 - m[2N + (\frac{1.96}{\triangle c'})^2\sigma_N^2] + N^2 = 0 \tag{11}$$

考虑到 $m\leqslant N$ 才有意义,则 m 的唯一解为:

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$$m = N + \frac{1}{2}(\frac{1.96}{\triangle c'})^2\sigma_\lambda^2 - (\frac{1.96}{\triangle c'})^2\sigma_\lambda^2\sqrt{\frac{1}{4}(\frac{1.96}{\triangle c'})^2\sigma_\lambda^2 + N} \quad (12)$$

式(12)中给定 N，$\triangle c'$，则可求得 m 与 σ_λ 的关系。由实际监测数据确定 σ_λ 后，就可得到95%置信度(修改1.96即可得其它置信度)下允许最大随机缺测数 m。

从上面推导可知，只要统计时段内污染物浓度符合近似对数正态分布，则(12)式均适用。因此，(12)式不仅适用于大气污染物日平均值，也可推广到月平均值、季平均值和年平均值等(改变 N 值)。

2 应用实例分析

把公式(12)应用于北京市大气自动监测系统冬季 SO_2 小时浓度监测数据，可推算出该系统各子站允许最大随机缺测时数(见表1)。

由表1可知：

表1 北京市大气自动监测系统各子站允许最大随机缺测时数(h)

子站号	1#	2#	3#	4#	5#	7#	8#	9#
子站位置	背景站	城区	中心区	中心区	城区	东北郊	西北郊	西郊
95%置信度	14	6	6	6	6	9	6	8
98%置信度	13	6	5	5	6	8	6	7

(1)大气自动监测系统各子站允许最大随机缺测时数是不同的。

(2)在95%置信度下，北京市大气自动监测系统日均值数据有效性标准为：最大随机缺测不超过6h。

(3)24h连续采样最大随机缺测不超过6h，即相当于日采样小时数据捕获率为75%。这个判据和国家环保局要求大气自动监测系统有效日均值的一次值数据捕获率为75%相一致[7]。

3 结论

由前面导出的理论关系式可知：监测数据的有效性与系统要求的日均值准确度有关。只要统计时段内污染物浓度近似符合对数正态分布，依据本文导出的理论关系式可对监测数据进行适当处理和判断。同样的原则，也适用于对月均值、季均值和年均值进行有效性判别和处理。

研究表明，大气自动监测系统不同子站的最大允许随机缺测时数是不同的。对大气自动监测系统不同子站数据捕获率的要求可有所不同，以利于充分利用监测资料。

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Abstracts

of Huhhot and the grassland belt in Siziwan Qi (a county), Inner Mongolia, as a control site in both winter and summer with a sampler using a polyurethane foam plug and a glass-fiber filter, both of which were then extracted with solvents. The extracts were analyzed with GC/MS, GC and HPLC to identify the organic pollutants in both vapor phase and particulate phase. Eighty eight pollutants in three kinds of organic compounds (n-alkanes, aromatic nydrocarbons and phthalate esters) were qualitatively identified and 45 of them were quantified. The results show that the Huhhot City is an area polluted with higher concentrations of organic pollutants in the atmosphere in its urban area.

Key words: atmospheric pollution, organic pollutant, vapor phase, particulate phase.

Study on the Assay of the Acute Toxicity and Mutagenicity of Industrial Wastewaters by Using the Bacterial Luminescence Test and the Ames Test. Huang Zheng and Wang Jialing (Institute of Environ. Medicine, Tongji Medicine University, Wuhan 430030): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 70—71

The industrial wastewaters from the Yijiadun and Huangxiaohe Wastewaters Irrigated Areas in Wuhan City were comparatively investigated for their acute toxicity and mutagenicity by using the bacterial luminescence test and the Ames test. At the same time, the composition of organic pollutants in the wastewaters was determined with the GC/ MS technique. The results show that, of four channels studied, the Luojiaqu Channel has the strongest acute toxicity and mutagenicity in its wastewater flow. The pollutants responsible for the acute toxicity of the wastewater mainly include phenol, benzyl benzoate, etc., and the pollutants responsible for the mutagenicity and carcinogenicity of the wastewater were found to be biphenyl, naphthalene. etc.

Key words: industrial wastewater, acute toxicity, mutagenicity, Gc/MS.

Validity of the Data from Automatic Air Quality Monitoring Systems. Fan Shaojia et al. (Dept. of Atmospheric Sciences, Zhongshan University, Guangzhou 510275): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 72—73

Based on the theory of statistics, a theoretical formula in which the acceptable missing hours and acceptable errors of validable daily averages are related to the variance of daily hourly averages has been derived. The monitored data on hourly concentrations of sulfur dioxide in winter from the Beijing Automatic Air Quality Monitoring System were taken to perform a calculation based on the derived formula and it was found that at a confidence of 95% the maximum random missing 6 hours were acceptable and in compliance with 75% of data captured as required by the National Environmental Protection Agency for a data validity check.

Key words: automatic air quality monitoring system, validity of monitored data, Beijing.

Homogeneous Reaction Mechanisms of Nitrous Oxide Formation and Decomposition in the Fluidized Bed of Coal Combustion. Chen Hongwei, Jin Baoshen et al. (Institute of Heat Energy, Southeast University, Nanjing 210018): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 74—78

The homogeneous reaction mechanisms of nitrous oxide formation and decomposition in the fluidized bed of coal combustion were studied, indicating that the paths of nitrous oxide (N_2O) formation from nitrogen contained in fuel mainly include: $NCO + NO \longrightarrow N_2O + CO$ and $NH + NO \longrightarrow N_2O + H$; and the main reaction of N_2O decompesition are: $N_2O + H \longrightarrow N_2 + OH$. An analysis was also made for the effects of the factors such as composition of fuel-bounded nitrogen compounds in volatiles, kinds of coal, temperature in the fluidized bed, coefficient of excess air, number of stages, and the combustion pattern in a single stage, on the emission of N_2O from the fluidized bed coal combustor.

Key words: fluidized bed combustion, coal, nitrous oxide, reaction mechanism.

Advance in the Study on Compounded Pollutions. He Yongtian and Xiong Xianzhe (Institute of Applied Ecology, Chinese Academy of Sciences, Shen' yang 110015): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 79—83

Based on reviewing the current status of domestic and international research efforts in the field of compounded pullutions as a universal phenomenon of environmental pollution, this article dealt with the concepts and classifications of compounded pollutions, and the types of interactions of compounded pollutions and the criteria for their judgements, focusing on the factors affecting the ecological effects of compounded pollutions (i. e., pollutants factors, biological factors, and environmental factors) and the action mechanisms of compounded pollutions (i. e., influencing the structures of biotic cells, disturbing physiological activities and functions, competing for active sites, and complexing or chelating).

Key words: compounded pollutions, environmental pollution, ecological effects, review.