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Technical note on uncertainty for GHG global mean mole fractions by WDCGG

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1. Introduction

The global mean mole fractions of major greenhouse gases (GHGs) are calculated by WDCGG using observation data from the GAW global network as described by Tsutsumi et al. (2009). Based on the Meeting of the WMO/GAW Scientific Advisory Group on Greenhouse Gases held in October 2011 in Wellington, WDCGG began providing information on uncertainty in related global annual means. The uneven geophysical distribution of observation stations has proven to be a major source of uncertainty in such means. This technical note describes the method for estimation of such uncertainty.

2. Uncertainty estimation

The method described by Conway et al. (1994) is employed to determine uncertainty using only the dataset adopted for global means themselves. In global mean calculation, some observation stations are excluded using the method of Tsutsumi et al. (2009), and remain unused throughout the determination. Accordingly, the term “GAW global network” here consists only of unexcluded stations.

3. Calculation

(i) Select n stations randomly from the GAW global network, with at least one station from each of six latitudinal bands of 30° width (90 – 60°N, 60 – 30°N and so on) included. Stations may appear more than once in the set of n. In this analysis, n is set as the number of stations in the GAW global network (see 4-1).

(ii) Calculate the global mean for the n stations selected in (i) using the method of Tsutsumi et al. (2009).

(iii) Repeat steps (i) and (ii) m times and refer to the global mean in the m-th iteration as M_m. In this analysis, m = 200 (see 4-2).

(iv) Calculate the standard deviation for the set of M_m and define it as the uncertainty for the global mean in WDCGG analysis.

4. Parameter determination

WDCGG determined the parameters *n* and *m* based on the dataset used for calculation of the global means published in WMO Greenhouse Gas Bulletin #7 (WMO, 2011). This section describes the relevant procedures. The criteria for parameter determination here were adopted for uncertainty estimation in later years based on the fact that the parameters are insensitive to moderate changes in mole fractions of gases and the total number of stations.

4-1. Number *n* of randomly selected stations

Figure 1 shows the standard deviation for the global annual mean of CO_2 against the parameter *n*. This deviation stabilizes with increasing values of *n*. While any large number is satisfactory, WDCGG sets the value of *n* to the number of stations in the GAW global network (in this case, *n* = 117). The value of *n* changes year by year depending on the number of stations adopted in the calculation of global means.

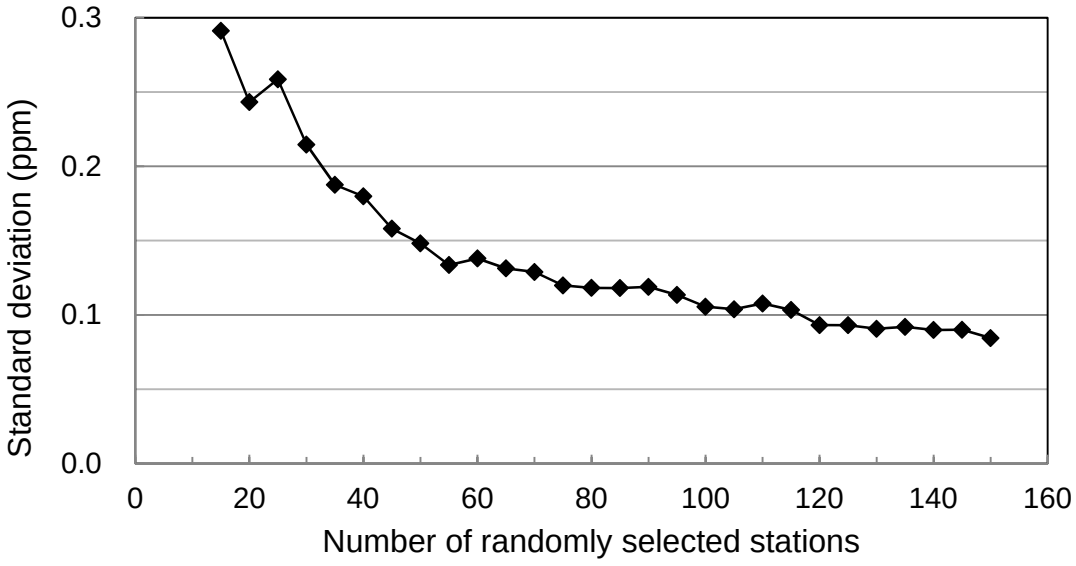

Figure 1. Standard deviation of the global annual mean of CO_2 against the number *n* of randomly selected stations

4-2. Number of repetitions *m*

Figure 2 shows the standard deviation for the global annual mean of CO_2 against the number of repetitions *m*. The deviation is relatively stable for *m* values larger than around 200. Similar dependence on *m* is seen for CH_4 and N_2O. Hence, *m* = 200 is adopted for CO_2, CH_4 and N_2O.

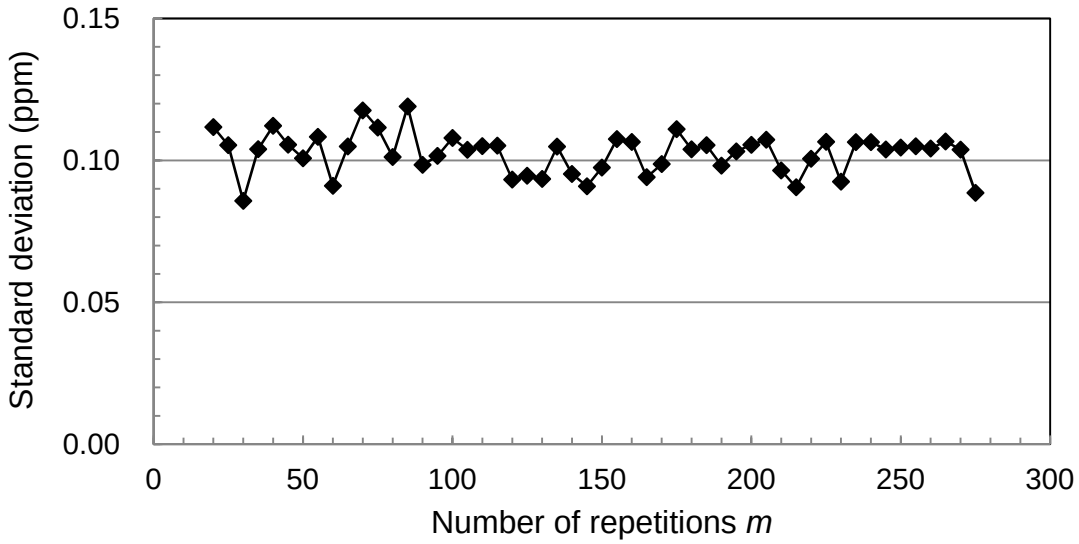

Figure 2. Standard deviation against the number of repetitions *m* for CO_2

5. Uncertainty for global annual means in WDCGG analysis

Table 1 lists standard deviations in global annual means for CO_2, CH_4 and N_2O.

Table 1. Standard deviations in global annual means

	Global mean in Bulletin #7	Standard deviation	Number of randomly selected stations *n*
CO_2	389.0 (ppm)	0.1 (ppm)	117
CH_4	1,808 (ppb)	2 (ppb)	120
N_2O	323.2 (ppb)	0.1 (ppb)	28

6. References

Conway, T. J., P. P. Tans, L. S. Waterman, K. W. Thoning, D. R. Kitzis, K. A. Masarie and N. Zhang, Evidence for interannual variability of the carbon cycle from the NOAA/CMDL global air sampling network, J. Geophys. Res., Vol. 99, 22,831 – 22, 855, 1994.

Tsutsumi, Y., K. Mori, T. Hirahara, M. Ikegami and T. J. Conway, Technical report on a global analysis method for major greenhouse gases by the World Data Center for Greenhouse Gases, WMO TD No. 1473, 2009.

WMO, WMO Greenhouse Gas Bulletin #7, 2011.