

***Tellus* recommends the use of SI units in atmospheric chemistry**

An examination of units for use in atmospheric chemistry by the Commission on Atmospheric Chemistry of the International Union of Pure and Applied Chemistry has recently been published (Schwartz and Warneck, 1995). The document reviews the quantities pertinent to atmospheric chemistry, with particular emphasis on quantities used to express abundances of substances (mixing ratios, concentrations), reaction rates, and exchange rates between compartments (emission and deposition rates and fluxes, etc.), and presents recommendations for units for these quantities.

The document examines the utility and suitability of the International System of Units (Système International, SI) as a framework for units in atmospheric chemistry, and presents recommendations regarding use of these units in reporting atmospheric chemistry data consistent with the special requirements of this subdiscipline. In general, SI is well suited for application to atmospheric chemistry; specifically, the wide range of magnitudes that are encountered can be dealt with by the prefixes denoting multiples and submultiples of units, and the application of SI units leads automatically to consistency in unit calculus.

Key recommendations include the following.

- The use of SI units to denote quantities pertinent to atmospheric chemistry is recommended. The use of special names and symbols for units that are not part of the SI, and are not products of powers of SI base units is discouraged; examples are atmosphere, Dobson unit, and hectare. However, continued use of such units (especially the Dobson unit) alongside SI units is advisable for a time until the SI units become more familiar. This can often readily be accomplished by using double labels on axes of graphs, e.g., Dobson units in addition to the SI unit mol m^{-2} .
- The use of amount-based units is preferable to mass-based units for expressing abundances, emission and deposition rates, and the like, in order to better convey chemically meaningful relationships among these quantities. The chemical formula of the entity should be unambiguously specified.
- Local abundances of substances in air may be expressed as mixing ratios or concentrations. Mixing ratio has the advantage of being insensitive to changes in pressure or temperature; concentration has advantages in describing reaction kinetics and material transport.
- The dimensionless unit mol per mol of air is recommended to denote the mixing ratio of a substance in air, e.g. nmol/mol, in lieu of the customary parts per billion (ppb). It is necessary to specify whether a mixing ratio refers to dry or moist air. Reference to dry air is recommended, provided there is no loss in accuracy or precision associated with the conversion from mixing ratio referred to moist air.
- Expressing mixing ratios as “reduced concentrations” pertinent to standard conditions of pressure and temperature leads to ambiguity and should be avoided wherever possible.
- Gas-phase concentrations may be expressed on the basis of either mole (mol m^{-3}) or molecule (molecule m^{-3} ; SI: m^{-3}). The universal use of a single set of units for gas-phase concentration does not seem forthcoming in the immediate future, although the use of mol m^{-3} affords advantages of consistency and convenience.
- A special need for non-SI units exists in atmospheric chemistry with regard to time periods that are predetermined by the clock and the calendar. Minute, hour, day and year are acceptable units and should be employed where suitable. Month should be avoided because of unequal lengths of calendar months.

An extensive table is presented listing recommended symbols and units for quantities commonly encountered in atmospheric chemistry. The table presents SI units for these quantities as well as common units convenient for routine use, which are derived from SI units by use of prefixes for decimal multiples and submultiples.

As SI units are increasingly employed in the broader atmospheric and environmental research community, as well as in laboratory research, it is hoped that the increased use of these units by scientists in all these disciplines will foster cross-disciplinary understanding and communication. It is thus hoped SI units will gain broader use in atmospheric chemistry.

Tellus has adopted these recommendations and requests authors submitting papers to this journal to employ SI units.

REFERENCE

Schwartz, S. E. and Warneck, P. 1995. Units for use in atmospheric chemistry, *Pure Appl. Chem.* **67**, 1377–1406.

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