EDITORIAL

Adoption of Système International (SI) Units in AMS Publications

Beginning with the 1975 issues of AMS journals, editors will enforce usage of the International System of Units (Système International d'Unités—SI). Basic units are the meter (m), kilogram (kg), second (s), and the kelvin (K) denoting thermodynamic temperature. Contributors to the JOURNAL OF PHYSICAL OCEANOGRAPHY are urged to submit manuscripts consistent with SI units hereafter, to avoid delays caused by return of manuscripts for conversion of units. The new policy is described in full in the August 1974 issue of the BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY.

One of the main changes from earlier practice will be in the use of energy and power units. Those who have been accustomed to expressing thermal energy and energy flux in terms of calories and langleys per minute respectively will now have to become familiar with the use of joules (J) and watts per square meter (W/m^2), respectively. The advantage is obvious when intercomparing mechanical and thermal energy. For purposes of conversion from source material in caloric units, note that three different caloric units exist:[1]

1 calorie (I.T.) = 4.1868 J
1 calorie (15°C) = 4.1855 J
1 calorie (thermochemical) = 4.1840 J

The caloric unit commonly used in existing oceanographic and meteorological literature is the 15°C calorie.

With respect to density of sea water, the change is only a matter of decimal point; for example, a density of 1.0253 gm/cm^3 corresponds to 1025.3 kg/m^3. A happy note is that the density anomaly, sigma-*t*, is already in units of kg/m^3.

A complete listing of SI units including units of electricity, magnetism and illumination is given in the BAMS article cited above. An excerpt of those SI units which will be most used by contributors to the JOURNAL OF PHYSICAL OCEANOGRAPHY is given in

[1] The Royal Society Conference of Editors, 1968: *Metrification in Scientific Journals*, London, The Royal Society, 8 pp.

TABLE 1. Examples of SI derived units.

Quantity	Name	Symbol		
		In terms of SI base units[a,b]	For special name[b]	In terms of other units[a,b]
area	square meter	m^2	—	—
volume	cubic meter	m^3	—	—
speed, velocity	meter per second	$m \cdot s^{-1}$	—	—
acceleration	meter per second squared	$m \cdot s^{-2}$	—	—
divergence; vorticity	per second	s^{-1}	—	—
wavenumber	1 per meter	m^{-1}	—	—
geopotential; dynamic height	meter squared per second squared	$m^2 \cdot s^{-2}$	—	$J \cdot kg^{-1}$
density	kilogram per cubic meter	$kg \cdot m^{-3}$	—	—
specific volume	cubic meter per kilogram	$m^3 \cdot kg^{-1}$	—	—
frequency	hertz	s^{-1}	Hz	—
force	newton	$m \cdot kg \cdot s^{-2}$	N	—
pressure; stress	pascal	$m^{-1} \cdot kg \cdot s^{-2}$	Pa	$N \cdot m^{-2}$
energy	joule	$m^2 \cdot kg \cdot s^{-2}$	J	$N \cdot m$
power	watt	$m^2 \cdot kg \cdot s^{-3}$	W	$J \cdot s^{-1}$
dynamic viscosity	pascal second	$m^{-1} \cdot kg \cdot s^{-1}$	—	$Pa \cdot s$
moment of force	meter newton	$m^2 \cdot kg \cdot s^{-2}$	—	$N \cdot m$
surface tension	newton per meter	$kg \cdot s^{-2}$	—	$N \cdot m^{-1}$
heat flux density	watt per square meter	$kg \cdot s^{-3}$	—	$W \cdot m^{-2}$
entropy	joule per kelvin	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$	—	$J \cdot K^{-1}$
specific heat capacity	joule per kilogram kelvin	$m^2 \cdot s^{-2} \cdot K^{-1}$	—	$J \cdot kg^{-1} \cdot K^{-1}$
specific energy	joule per kilogram	$m^2 \cdot s^{-2}$	—	$J \cdot kg^{-1}$
thermal conductivity	watt per meter kelvin	$m \cdot kg \cdot s^{-3} \cdot K^{-1}$	—	$W \cdot m^{-1} \cdot K^{-1}$
energy density	joule per cubic meter	$m^{-1} \cdot kg \cdot s^{-2}$	—	$J \cdot m^{-3}$

[a] Use of the centered dot indicating multiplication of units is encouraged, but it may be omitted (with a space instead) where this does not lead to ambiguity. Also see paragraph on alternative forms of expression.
[b] Note that unit symbols derived from proper names are capitalized.

TABLE 2. Most common prefixes for decimal multiples and submultiples of SI units.

Multiple	Prefix	Symbol	Submultiple	Prefix	Symbol
10^6	mega	M	10^{-1}	deci	d
10^3	kilo	k	10^{-2}	centi	c
10^2	hecto	h	10^{-3}	milli	m
10^1	deka	da	10^{-6}	micro	μ

Table 1. The most commonly used decimal prefixes are given in Table 2. The new policy permits some flexibility in statements of units, so long as ambiguity is avoided. Use of the solidus (/) is permitted, but is generally not advantageous when complex combinations of units are employed. Thus, authors may express speed in terms of m/s or m s^{-1} according to their preference, and acceleration as m/s^2 or m s^{-2}. Multiple use of the solidus is never justified. Thus, for example, the physical unit for specific heat (joule per kilogram per kelvin) may be written

$$\text{J kg}^{-1}\text{ K}^{-1} \quad \text{or} \quad \text{J/(kg K)},$$

but not

$$\text{J/kg/K} \quad \text{or} \quad \text{J/kg K}.$$

Exceptions. The International Committee on Weights and Measures (CIPM), while recommending the SI, recognized that some users will wish to employ certain units which, although not part of SI, are important and widely used. (For example, oxygen content is traditionally given in terms of amount per liter). In general, the use of non-SI units for time, in stating physical quantities, is to be avoided.

The AMS permits use of some units not recommended by the CIPM. While the pascal (Pa) is the recommended unit of pressure, the decibar is permitted (1 db = 10^4 Pa). Stress should be expressed in pascals (1 Pa = 10 dynes/cm^2). Since decimal prefixes may be employed, velocity may still be expressed in cm/s as well as in m/s.

Use of some non-metric units such as knots (kt) is allowed for a limited time, because of the familiarity of this unit and the fact that wind speeds are at present given in knots. Where speeds are discussed in the context of (say) kinetic energy, SI units should be used consistently throughout the text. Statute miles should never be used, nor, in general, other English measures. The degree Celsius (°C) is permitted by SI, but the degree Fahrenheit (°F) is not.

In the presentation of tabular data or graphs, SI units should be used unless there is a defensible reason for other units. Where diagrams are reproduced from earlier works, the necessary conversion may be done by substitution of a new abscissa or ordinate scale (or, if preferred, an SI-unit scale in addition to the scale of units in the original diagram). If extensive tables are reproduced, these may be retained in their original form if in metric units (such as CGS), although in general conversion to SI units is preferred. Authors should make every effort to promote the adoption of a uniform system of units by adhering to SI units unless there is a substantial reason for using variants.

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