

## AGU Grammar and Style Guide

1. Hyphenation . . . . .	1
1.1. Attributive Adjectives . . . . .	1
1.2. Nouns . . . . .	5
1.3. Words Formed With Prefixes . . . . .	6
1.4. Words of Equal Weight . . . . .	7
2. Commas . . . . .	8
2.1. Examples of Correct Usage. . . . .	8
2.2. AGU Style . . . . .	9
2.3. Comma Usage at Beginning of Sentence . . . . .	9
2.4. Some Parts of Speech and Common Examples . . . . .	10
3. Additional Grammar/Punctuation Rules . . . . .	11
3.1. Adjective/Adverbial Phrases . . . . .	11
3.2. Comprise Versus Compose . . . . .	11
3.3. Singular Versus Plural With Certain Nouns. . . . .	11
3.4. Other Rules . . . . .	12
4. Spelling . . . . .	14
4.1. Alternate Spellings . . . . .	14
4.2. Commonly Used Proper Names . . . . .	14
4.3. Countries . . . . .	15
5. Capitalization . . . . .	16
5.1. Geographical Terms . . . . .	16
5.2. Text Capitalization . . . . .	17
5.3. Stratigraphic Divisions . . . . .	18
6. Numbers . . . . .	19
6.1. Cardinal Numbers/Arabic Numerals . . . . .	19
6.2. Ordinal Numbers . . . . .	19
6.3. Miscellaneous Style for Numbers . . . . .	19
7. Miscellaneous Style Rules . . . . .	20
8. Special Notations. . . . .	22
8.1. Astronomical Notation for Dates and Time. . . . .	22
8.2. Degrees, Minutes, and Seconds of Arc. . . . .	22
8.3. Units of Measure . . . . .	22
8.4. Dimensions. . . . .	25
8.5. Seismology. . . . .	25
8.6. Mineralogy. . . . .	26
8.7. Ranges. . . . .	26
8.8. Ships and Spacecraft. . . . .	26
8.9. Comets. . . . .	27
8.10. Temperature. . . . .	27
8.11. Times. . . . .	27
8.12. Storms. . . . .	27
8.13. Biology. . . . .	27
9. Word List . . . . .	28

# 1. Hyphenation

The main reason for hyphenation is increased clarity.

## 1.1. Attributive Adjectives

**Always hyphen.** The following should always be hyphenated as attributive adjectives:

### 1. Noun + present or past participle

English-speaking people	U-shaped tube
sulfate-containing aerosols	<i>e</i> -folding layer
sediment-filled streams	hand-drawn graphs
V-shaped weir	

If the noun in the combination is modified, AGU preference is no hyphen unless you are trying to match a similar combination elsewhere in the paper; then use a hyphen between the modifier and the noun and between the noun and the participle. For example, if "field-aligned" appears in the paper, you should hyphen "magnetic-field-aligned":

magnetic-field-aligned irregularity or magnetic field aligned irregularity

Office style considers some noun + present or past participle combinations in the predicate to be passive verb forms, so they must be hyphenated to make it clear that they are performing as a unit:

sediment-filled	Fourier-transformed
Doppler-shifted	band-pass-filtered

### 2. Adjective + present or past participle (except compass directions)

straight-sided vessel	coarse-textured grain
lunar-orbiting satellite	good-sized sample

Do not hyphen if the adjective is modified by an adverb:

more coarse textured grain  
very fine grained

3. Verb + preposition or adverb (unless closed up or opened in dictionary (use the current *Webster's Collegiate Dictionary* and then *Webster's Third International Dictionary* and the Addendum)(see pp. 230-231 in *Words Into Type* 1974 edition (WIT))

hollowed-out  
speeding-up

### 4. "Well," "ill," or "little" + past participle

well-known theorem	ill-defined term
little-known derivation	

Do not hyphen if the combination is being used as a predicate adjective or if well (ill, little) is modified by an adverb:

very well known model  
less well defined terms

### 5. Preposition + noun or adjective

near-surface reaction	behind-arc spreading
near-normal wave mode	

## 6. "Quasi" + adjective or adverb (Also hyphenate as a predicate adjective.)

quasi-linear expression

When quasi is used with a two-part adjective, quasi can stand by itself:

quasi steady state system  
quasi self-consistent model

## 7. "Self" compounds (Also hyphenate as a predicate adjective. Check the dictionary for approved closed forms.)

self-sustaining reaction

## 8. "Cross" compounds (Check dictionary for approved closed forms.)

cross-*L* sweep                      cross-section(al) diagram  
cross-correlation function

## 9. "All" compounds (Also hyphen if the combination is being used as a predicate adjective.)

all-inclusive program  
all-salt deposit

## 10. "No" compounds (Also hyphen if the combination is being used as a predicate adjective.)

no-flow boundaries

## 11. Fractions

two-thirds part  
half-rate measurement

## 12. Temporary compounds formed by adjective + noun indicating number, dimension, or quality. These examples are not all-inclusive.

Cardinal number + noun or adjective

zero-base budgeting  
one-dimensional figure (*k*-dimensional model)  
two-fluid response

Ordinal number + noun

*n*th-order equation                      second-order equation

Single, double, triple, multiple, half, etc., + noun

single-chain reaction  
multiple-layer modelHigh, middle, low, medium, long, short, large, small, intermediate, etc., + noun (but not upper and lower)  
(hot/cold and/or thick/thin may be hyphenated, follow usage)high-energy particles  
middle-latitude stations

Follow the author for combinations such as the following (do not hyphen if adjective is modified by an adverb: very high frequency signals):

low-*P* region  
low-Mg samples

If you have both combinations in a paper (one modified by an adverb and one not, such as "high-frequency waves" and "very high frequency waves"), do not treat them similarly (i.e., do not hyphen both or leave both open). The presence of the adverb in the second combination makes the difference. For combinations such as the following, preference is for no hyphen unless you are trying to match a similar combination elsewhere in the paper; then use two hyphens. For example, if "high-resolution" appears in the paper, hyphen "high-vertical-resolution."

Also hyphen regular -er and -est comparatives and superlatives of these adjectives when they are used in combination with nouns:

higher-energy particles  
lowest-latitude sample

### 13. Colors in combination

bluish-green overlay  
blue-gray particle

### 14. Attributive adjectives formed by a noun plus one of the following or similar words:

-type	-soluble	-specific
-(in)dependent	-rich	-only
-free	-wide(check dictionary for solid words)	-scale
-odd	-synchronous	-variable
-invariant	-inclusive	-size

For example,

pH-dependent finding  
Fe-rich deposit (very Fe-rich deposit; very is modifying Fe rich, not just Fe)  
C- and N-rich deposits (but do not use C-rich and -poor deposits)  
grain-size measurements

These combinations are also hyphenated if they are used as predicate adjectives.

**Never hyphen.** The following combinations should never be hyphenated as attributive adjectives:

#### 1. Irregular comparatives or superlative + participles or nouns

best known theorem  
worst liked person  
least known derivation

#### 2. Foreign phrases

a priori solution  
per mille basis  
in situ technique

#### 3. Adverbs ending in -ly + adjective or participle

slowly flowing stream  
highly complex approach

#### 4. Chemical compounds

ferric oxide layer  
sulfuric acid residue

## 5. Light or dark + colors

light blue house  
dark red hue

## 6. Compounds indicating direction or placement

north central Utah  
upper right corner

## 7. Adverbs ending in -ward + participle

westward moving currents

## 8. Compass directions + present or past participles

northeast trending  
south directed

## 9. Temporary compounds used as attributive adjectives formed by noun + noun or adjective + noun (see Word List at end of guide and dictionary for exceptions)

plasma flow region  
wake surface potential

## 10. Permanent compounds (formed by noun + noun or adjective + noun that are used so often that they can be considered permanent compounds; many may be listed in the dictionary or the Word List)

solar wind	computer programing	electric field
magnetic field	data processing	ion cyclotron
cosmic ray	pitch angle	steady state
soil water	atomic oxygen	quiet time
linear programing	atomic nitrogen	sporadic <i>E</i>
molecular oxygen	molecular nitrogen	V notch
<i>F</i> region	$\gamma$ ray	<i>x</i> component
<i>P</i> wave	<i>x</i> axis	

**Hyphen optional.** In a given paper, follow usage to hyphenate or not hyphenate the following categories of attributive adjectives.

## 1. Phrases that act as attributive modifiers

signal-to-noise ratio  
month-by-month computation  
order-of-magnitude change

If phrases are listed in the dictionary with hyphens, the hyphens are mandatory and should be added:

day-to-day variation  
one-to-one basis

## 2. A hyphen in past/present participle + noun combinations should be left to avoid ambiguity:

charged-particle fluxes OR charged particle fluxes

## 3. Numeral + unit of measure

2-cm pipe	5-foot (~1.5 m) booms
1-km-wide trench	5-year-old record
6-mm-diameter tube	9-year-old pine plantation
6-mile-wide highway	10- to 20-km-wide area

Note that two hyphens should be used only when the second word is a dimension (diameter, wide) or involves age (old), but do not hyphen 9 Ma as attributive: the 9 Ma trench. Do not hyphenate with compound units: 15 km s<sup>-1</sup> velocity.

## 1.2. Nouns

In general, new compound nouns are spelled without hyphens. Check dictionary for permanent compounds listed there. If word is not in the dictionary and is not in the "Always hyphenate" or "Close up" categories below, open up as two words.

**Never hyphenate.** The following combinations should always be open when they act as nouns in sentences:

1. Noun + gerund

problem solving

data logging

2. Fractions

one half

two thirds

**Always hyphenate.** The following combinations should always be hyphenated:

1. "Self" compounds

self-knowledge

2. Quasi + noun (unless open or closed in the dictionary)

quasi-response

quasiperiodic

When quasi is used with a two-part noun, quasi can stand by itself:

quasi steady state

quasi self-help

3. Verb + preposition (unless closed up in the dictionary)

short-out

drop-off

4. Noun or adjective + "like"

floor-like or floorlike

kelyphite-like or kelyphitelike

but taillike (see dictionary)

Hyphen if the noun ends in "ll" or is a proper noun:

bell-like, not belllike

Mars-like, not Marslike

**Close up.** The following combinations are always closed up:

1. "Fold" compounds

tenfold	multifold
---------	-----------

Use numeral and hyphen if a hyphenated number would precede fold:

125-fold

2. "Glow" compounds

dayglow	nightglow	airglow
---------	-----------	---------

3. "Side" compounds

dayside	duskside	frontside
nightside	noonside	backside
downside	topside	underside

### 1.3. Words Formed With Prefixes

1. The following are some common prefixes:

pre-, post-	un-, non-	re-
intra-, extra-	semi-	multi-
infra-, ultra-	pseudo-	micro-, macro-
sub-, super-	supra-	mini-, maxi-
pro-, anti-	co-	mid- (but mid-ocean)

This is not an inclusive list. Check dictionary for other prefixes and closed up forms. Note that “over” is a prefix, but “under” is not. Also, “fore” is a prefix, but “back” is not. Up and down are not prefixes.

2. Spell all words formed with these prefixes closed unless (1) the prefix precedes a capitalized word or a numeral (mid-Cretaceous, post-1950); (2) a homograph is formed (recover versus re-cover, to cover again; remark versus re-mark, to mark again); or (3) the same vowel would be repeated (intra-aggregate, semi-infinite), except co-, de-, pre-, pro-, and re- may be set closed even when a double vowel forms (preexist); but hyphenate if triple vowel results. Check dictionary for hyphenated words (un-ionized).

3. Use an en dash if the second element is a proper noun or proper adjective consisting of more than one word (pre–World War II, post–Civil War period).

4. Use two hyphens if the second element consists of more than one word (hyphenated) (non-time-homogeneous equation, non-English-speaking people).

5. If the second element contains more than one word and is a combination that we never hyphen, match the solution to the type of prefix:

(1) Post-, pseudo-, and mid- can stand alone if necessary (i.e., can function as adjectives or adverbs); therefore use

pseudo magnetic field
post cosmic ray event

(2) Other prefixes are only in the dictionary as combined forms and cannot stand alone:

In some cases the meaning will permit the prefix to be attached to the first word of the second element: nonsteady state.

In other cases, use an en dash or rephrase: pre–solar wind or before the solar wind. Another option is to use two hyphens even though the element containing two words is not usually hyphenated (e.g., pre-main-sequence).

6. When multiple prefixes precede the same base word, the prefixes should not stand alone; e.g., use preseismic and postseismic, not pre- and postseismic. Change mid- and high-latitude (as adjectives) to midlatitude and high-latitude or middle- and high-latitude.

#### **1.4. Words of Equal Weight**

A hyphen is used to connect words of equal weight. Usually, they are connected because they have an "either-or," "from-to," or "between-and" relationship:

wave-particle interaction

air-sea interface

desorption-absorption

noon-midnight value

north-south range

precipitation-dissolution

plant-soil system

time-space plot

## 2. Commas

A comma should be used to clarify meaning. AGU uses the open punctuation style, that is, using only as much punctuation as necessary for clarity. Do not use balancing commas. Generally, commas are used around, before, and after nonrestrictive clauses and phrases. A nonrestrictive clause or phrases is one that could be omitted without changing the meaning of the sentence. Because of the technical nature of the material in AGU journals, it is sometimes difficult to be sure if a phrase or clause is nonrestrictive; follow usage in these cases. This section lists correct usage examples and house style. See WIT and *Chicago Manual of Style* for grammatical rules concerning comma usage.

### 2.1. Examples of Correct Usage

#### Use a comma

After the results were computed, we made a log plot of the data. (introductory adverb clause)

Using the data, we constructed a graph. (participial phrase)

To confirm the results, a second experiment was planned. (infinitive phrase)

The results being in question, the experiment was repeated. (nominative absolute)

In general, the results from the two studies are in agreement. (sentence modifier)

Initially, the current meters produced ambiguous data. (adverb ending in -ly)

After launching the satellite, scientists followed its trajectory by radar. (no strong natural break)

In the references above, the reader may find further details of the methodology used here. (could be misread)

After reweighing, the samples were subjected to further tests. (ends in verb form)

We performed the experiment at room temperature, but the results were not as good. (compound sentence)

In the cool, humid climate the plants thrived. (coordinate adjectives)

The samples were collected in a glass beaker, which had been washed, dried, and weighed. (nonrestrictive)

The data, the number of echo soundings per second, were entered into the computer. (nonrestrictive appositive)

The distance per unit time, or velocity, is important to this calculation. (nonrestrictive appositive)

While a few were sandstone, the rocks were mostly granite. (introductory subordinate clause)

Papers based on data from Pioneers 10 and 11 conclude that a magnetic field decreases, while papers based on the data from Voyagers 1 and 2 are consistent with the Parker model. (nonrestrictive clause)

At the mountaintop, where the air is thin, it is necessary to wear oxygen masks.

The altitudes above 120 km, where  $O_3(v)$  fluorescence was too weak to be observed, provided data considered irrelevant for this study.

This follows the theory of *Smith and Ames* [1980], who solved the full MHD equations. (nonrestrictive phrase)

We interpreted a measurement of, say, 15 dbar to indicate that the system was at equilibrium. (independent element)

The expedition was a joint effort of American, Canadian, and French scientific societies. (series)

Thus, although in the first case the temperature is lowered, it did not affect the results.

If the lava flow were emplaced in this 550-year period, it would also have been entirely submarine. (If, then)

One hundred starting models are generated using a predefined set of velocity nodes, with a fixed window of allowable depth variations between nodes.

#### Do not use comma

In the absence of clear measurements it became necessary to extrapolate values for  $L$ . (strong natural break)

The results were uncertain; hence we did not use them.

Nappes therefore appear to have common history.

We dismissed data having excessively high or low values and plotted the remaining data on a  $T$ - $S$  grid. (compound verb)

An examination of Figure 4 indicates that the midlatitude values are relatively low for this parameter and that high-latitude values are quite divergent. (parallel dependent clause)

In the area of the stratosphere where  $O_3$  molecules are densest, damage by aerosols was the greatest. (restrictive phrases)

It was understood that given the above constraints, agreement would be tenuous. (before or after "that")

Virtually all the Mauna Loa lavas encountered are interpreted to be subaerially emplaced. (exception to after -ly)

## 2.2. AGU Style

**With parameters.** It is not necessary to set off variables in text with commas (or parentheses) if they directly follow the parameter for which they stand (follow author if usage is consistent):

The modeling equations can be closed by specifying the constitutive equations for the stress tensor  $\mathbf{T}$  of gas and solids, drag  $D$ , and heat transfer  $Q$ .

However, if a phrase separates the variable and the parameter, then retain enclosures (either commas or parentheses but be consistent within a paper):

The enthalpy ( $h$ ), the thermal conductivity ( $k$ ), and the volumetric heat transfer coefficient for the exchange of heat between the gas and pyroclasts ( $Q$ )....

**Serial comma.** Use a serial comma; that is, in a list of three or more, use comma before conjunction. In a numbered in-text list, a comma is sufficient to separate parts.

**Numerals.** Use comma only in numerals with five or more digits, including pages in reference list, except in tables (add comma to four-digit numerals if in column with five- or more digit numerals): 50,000, but use 5000 to 34,000 years in text.

**Jr. and III.** Do not use commas around or before Jr., Sr., or III except in reference list for first author in inverted order: House, J. H., Jr., and ....

## 2.3. Comma Usage at Beginning of Sentence (this list is not inclusive)

### Always Use a Comma

Again  
Also  
At the same time  
For example  
Furthermore  
However  
In addition  
In any event  
In contrast  
Indeed  
In essence  
In general  
So far

In other words  
In particular  
In practice  
Instead  
Moreover  
Nevertheless  
Nonetheless  
Of course  
On the other hand  
Rather  
That is  
In fact

### Optional

For this reason  
In turn  
Next  
Then  
In this case  
In this study  
In this paper

### (Almost) Never Use a Comma

Here  
Hence  
Now  
So  
Therefore  
Thus  
Yet

## 2.4. Some Parts of Speech and Common Examples

### 1. Parts of speech (note that some words can function in more than one way) (not inclusive)

<u>Prepositions</u>		<u>Compound Prepositions</u>	<u>Coordinating Conjunctions</u>
about	off	according to	and
above	on	apart from	but
across	onto	owing to	or
after	out	as to	nor
against	outside	on account of	yet
along	over	aside from	so
amid	past	because of	
among	regarding	instead of	<u>Correlative Conjunction</u>
at	respecting	out of	not only....but (also)
before	since		both...and
behind	through	<u>Adverbs</u>	either...or
below	throughout	-ly	neither...nor
beneath	till	hence	whether...(or)
beside	to		
between	toward	thus	<u>Subordinating Conjunctions</u>
beyond	under	therefore	although
by	underneath	so	where
concerning	until	yet	when
during	up	moreover	since
except	upon	accordingly	though
excepting	with	consequently	so that
for	within	as	while
in	without	then	whereas
inside			because
into			if
of			that

### 2. Strong natural breaks (do not use comma after introductory prepositional phrase followed by a natural break unless ending in a verb form)

indefinite articles:	a, an
definite article:	the
demonstrative or definitive adjectives or pronouns:	this, that, these, those
indefinite adjectives:	each, both, either, such, some, many
distributive pronouns:	each, every, everyone, either, neither
indefinite pronouns:	both, any, few, many, none, one, some, such, several, most
personal pronouns and their declined forms:	I, he, she, it, we, you, they, my, mine, his, her, your, yours, their, theirs, ours, our, his, hers

### 3. Additional Grammar/Punctuation Rules

#### 3.1. Adjectival/Adverbial Phrases

1. The following are adjectival (adjective + preposition), which can only modify a noun.

**Due to:** Since due to is an adjective, it needs a noun or pronoun to modify. To assure this functioning, the safest place for due to is after a form of the verb to be because there it always serves as an adjective: "The cancellation was due to bad weather" (due modifies the noun cancellation). "My failure to pay promptly was due to an oversight" (due modifies failure). The most dangerous placement of due to is at the head of a sentence. In "Due to rain" or in "Due to the lateness of the hour" or in "Due to a cold I was unable to attend," due to is treated as an adverbial phrase. This is a misuse. A test to determine whether due to is being used correctly is to replace it with "caused by" or "attributed to," which is what due to means. If the replacements make sense, due to is correctly used, as it is in "The explosion was due to [caused by or attributed to] carelessness."

His failure was due to insufficient study.

**Compared to** (or compared with): Use compared to for unlike objects: Shall I compare thee to a summer's day. Use compared with for like objects: Shall I compare thee with my ex-husband.

2. The following are adverbial (adv + prep), which can modify a verb, an adjective, or another adverb: Owing to (because of, on account of), in comparison to, in relation to

He failed owing to [because of] insufficient study.

This paper was short in comparison with the previous one.

Height in relation to depth was the important factor.

#### 3.2. Comprise Versus Compose

1. Whole (subject) comprises parts (object) (must be active verb): The book comprises five chapters.
2. Parts (subject) compose (make up) a whole (object):

These chapters compose this book.

This book is composed of three chapters.

Never use comprised of; change to composed of.

#### 3.3. Singular Versus Plural With Certain Nouns

1. Number: "A" takes plural verb: A significant number of points are in large disagreement with (2) and (3).  
"The" takes singular verb: From Table 3 it is apparent that the number of points over which averages are taken varies considerably between data divisions.
2. Set and group (collective nouns) should take singular verb unless the individuals of the group are to be emphasized. Authors often have either one intention or the other, so it is best to follow the author's usage unless it is found to be totally incorrect.

A set of points, such that  $N$  and  $X$  are both ... are defined as feasible designs for satisfying the information demand of the  $n$ th parameter.

Furthermore, the set of nonzero Lagrange multipliers represents the set of trade-off ratios between the principal objective and each of the constraining objectives.

3. "Data" must take the plural verb; however, "geodetic datum" is singular, and "geodetic datums" is plural.
4. "Series" can take singular verb if individuals in series are not emphasized:

A series of models have been constructed that approximate the measured horizontal disturbance at the Earth's surface derived by *Langel* [1973].

The series that we used helps to identify the position of the vector.

5. "The" percentage always takes a singular verb. "A" percentage can take either a plural or singular verb depending on object of preposition: A substantial percentage of these individuals are quite sure that they have made the best decision.

6. Percent can take either plural or singular verb depending on object of preposition: Roughly 8% of all proton velocities were contoured./About 9% of the field was rejected.

7. Total takes a singular verb:

A total of 98 field stations was established with an elevation range from 4400 to 9000 m.

8. Chain takes a singular verb: The changes in neutral composition trigger a complex chain of events, which affects not only the distributions but also the emission rates.

9. Proportion can take either plural or singular verb depending on object of preposition: A relatively larger proportion of bound  $H_2$  molecules emerge and flow from the hotter dayside to the cooler nightside.

10. Sequence takes a singular verb: The following sequence of boundary conditions is therefore obtained for the free surface geometry.

11. Part (determine singular or plural sense)

Part of the results of the simple model are compared with magnetic field mappings of Imp and Mariner 5.

The part that we used was not properly verified.

12. Fraction (determine singular or plural sense)

A large fraction of the reports available are clustered over the continent.

A fraction will be chosen that is indicative of the actual cost per person.

### 3.4. Other Rules

1. Retain subjunctive mood, but do not change the verb to the subjunctive: e.g., It is required that the glass container be airtight. (See WIT (3rd ed., pp. 34-343) for a discussion of the subjunctive mood.)
2. Punctuation before i.e. (comma versus semicolon) varies depending on what function the material following i.e. plays in the sentence. If it is a noun or a phrase, a comma should be used. If it is an independent clause, a semicolon is necessary and change i.e. to "that is."

We have used only data in which the difference is larger than 30%; that is, we have used only data...

We have used only data in which the difference is larger than 30%, i.e., only those over 20.3.

The first example is an independent clause, and the second is a noun (the direct object).

3. So that of purpose versus so that of result: So that of purpose (i.e., in order to) is not preceded by a comma ("that" may be understood): Andy put on his sun glasses so that he could see.

So that of result (i.e., as a result) is preceded by a comma ("that" may be understood): John stepped in the wet cement, so he ruined his new shoes.

4. Do not use colons after forms of the verb "to be," after prepositions, or to separate a verb from its object. Colons may be used after forms of "to follow." If you want to retain the colon for any of the above cases, insert "as follows" or "in the following" or "for the following." Capitalize word after colon for independent clauses.
5. AGU style is to avoid em dashes. They should be changed to either commas or parentheses if there are two or to a colon if there is one.
6. AGU style does not use understood verbs.

Change the following from "The group of incompatible elements that form ore deposits are related to S-type granites and the more compatible to I-type granites." to "The group of incompatible elements that form ore deposits are related to S-type granites, and the more compatible are related to I-type granites." (Repeat verb and add a comma.)

Also watch for understood verb forms such as infinitives in a series. Change "The electronic data from the abstract will be used to create databases, new alerting services, and to develop products for scientists" either to "The electronic data from the abstract will be used to create databases, to create new alerting services, and to develop products for scientists" or to "The electronic data from the abstract will be used to create databases and new alerting services and to develop products for scientists"

After equations a list variables and their definitions may be given in paragraph format. If "is" or "denotes" is used for the first and last but left out for the in-between ones, add the verb for all or rephrase to delete all. For example,

$$x = (ba + c)/[(d - 1) + m],$$

where  $x$  is the random variable,  $b$  the balloon,  $a$  the area,  $c$  the content,  $d$  the distance, and  $m$  is the mean.

Change to "where  $x$  is the random variable,  $b$  is the balloon,  $a$  is the area,  $c$  is the content,  $d$  is the distance, and  $m$  is the mean." Or reword to delete all verbs: "where the variables are defined as follows:  $x$ , random variable;  $b$ , balloon;  $a$ , area;  $c$ , content;  $d$ , distance; and  $m$ , mean." (These can also be changed to in-text notations lists if more than three variables are listed.)

## 4. Spelling

Any variant spelling listed in the dictionary may be used as long as it is consistent throughout the paper. If spelling is not consistent, make it consistent by making all occurrences of the word conform to the spelling used most often. Either spelling in the pairs that follow is acceptable according to the dictionary:

### 4.1. Alternate Spellings

#### Acceptable

aesthetic/esthetic	anaerobic/anerobic	matrixes/matrices
alignment/alinement	appendixes/appendices	sulfur/sulphur
analog/analogue	indexes/indices (but always indices for scientific/mathematical indi- cators, dictionary, index 8)	sparce/sparse
supersede/supercede		imbalance/inbalance
subtract/subtract		grey/gray
spatial/spacial	synthesize/synthetize	
coterminous/conterminous	terrain/terrane (see dictionary; different meanings)	

#### Not acceptable (but do not fix figures)

1. Double final consonants before endings (inflections); use the shorter form in text if both forms are given in the dictionary:

equaled	not equalled (but controlling)
focuses, biases	not focusses, biasses
focused, biased	not focussed, biassed
pluses	not plusses
modeling	not modelling

2. Suffixes "-ment" and "-able"; use the shorter form in text if both forms are given in the dictionary:

judgment	not judgement
acknowledgment	not acknowledgement
sizeable	not sizeable (but noticeable)

3. American versus British spellings; use the American rather than the British spelling in text:

behavior, favor, color	not behaviour, favour, colour
advertise	not advertize
meter, center	not metre, centre
inflection	not inflexion
analyze	not analyse
draft	not draught

### 4.2. Commonly Used Proper Names (unusual spellings or accented letters)

If accents are consistently not used, do not add them.

Alfvén	Milankovitch
Avé Lallemand (author)	Mohorovičić (Moho, no accents with "discontinuity")
Bénard (associated with cells or convection)	Murnaghan (as in Birch-Murnaghan equation)
Bouguer (gravity anomaly)	Néel
Chappuis (band)	Poisson (ratio, sigma)
Debye (theory, constants) (in combination w/Scherrer)	Rayleigh (wave, number)
Eötvös	Savonius (rotor)
Grüneisen (parameter - gamma)	Toksöz
Kirchhoff	Larmor
Kolmogorov-Smirnov (goodness of fit test)	Brunt-Väisälä
Lagrange (constant)	von Kármán
Lamé (constant)	Clapeyron
Laplace	Boltzmann
Le Pichon (author: first initial X (Xavier))	Crank-Nicolson (no "h")

### 4.3. Countries

#### 1. Former Soviet Union Countries

The following is a list of spellings used by Webster's and the State Department for the Baltic States and the Republics which were formerly part of the Soviet Union. Change to these spellings.

<u>Name</u>	<u>Adjective</u>	<u>Capital</u>
Armenia (Hayastan, use Armenia)	Armenian	Yerevan
Azerbaijan	Azerbaijani	Baku
Belarus	Belarus	Minsk
Estonia	Estonian	Tallinn
Georgia	Georgian	Tbilisi
Kazakstan	Kazak	Almaty
Kyrgyzstan	Kyrgyz	Bishkek (formerly Frunze)
Latvia	Latvian	Riga
Lithuania	Lithuanian	Vilnius
Moldova	Moldovan	Chisinau (formerly Kishinev)
Russia	Russian	Moscow
Tajikistan	Tajik	Dushanbe
Turkmenistan	Turkmen	Ashgabad
Ukraine	Ukrainian	Kyyiv (Kiev)
Uzbekistan	Uzbek	Tashkent

#### 2. Prefectures of Japan With Their Capitals

<u>Prefecture</u>	<u>Capital</u>	<u>Prefecture</u>	<u>Capital</u>
Aichi	Nagoya	Miyazaki	Miyazaki
Akita	Akita	Nagano	Nagano
Aomori	Aomori	Nagasaki	Nagasaki
Chiba	Chiba	Nara	Nara
Ehime	Matsuyama	Niigata	Niigata
Fukui	Fukui	Ōita	Ōita
Fukuoka	Fukuoka	Okayama	Okayama
Fukushima	Fukushima	Okinawa	Naha
Gifu	Gifu	Ōsaka	Ōsaka
Gumma	Maebashi	Saga	Saga
Hiroshima	Hiroshima	Saitama	Urawa
Hokkaidō	Sapporo	Shiga	Ōtsu
Hyōgo	Kōbe	Shimane	Matsue
Ibaraki	Mito	Shizuoka	Shizuoka
Ishikawa	Kanazawa	Tochigi	Utsunomiya
Iwate	Morioka	Tokushima	Tokushima
Kagawa	Takamatsu	Tōkyō	Tōkyō
Kagoshima	Kagoshima	Tottori	Tottori
Kanagawa	Yokohama	Toyama	Toyama
Kōchi	Kōchi	Wakayama	Wakayama
Kumamoto	Kumamoto	Yamagata	Yamagata
Kyōto	Kyōto	Yamaguchi	Yamaguchi
Mie	Tsu	Yamanashi	Kōfu
Miyagi	Sendai		

## 5. Capitalization

Because AGU is interdisciplinary, the capitalization scheme of each discipline within the geophysics community cannot be followed. The exception would be a group of papers appearing in a special section (or companion papers). A decision should be made on how to treat certain words, based on office style, or perhaps an editor's preference, and capitalize/lowercase consistently in all papers in the SI. (See *Words Into Type* (WIT) for treatment of questions not considered here.)

### 5.1. Geographical Terms

1. The following may be either capitalized or lowercased except as indicated under point 2 below. If usage in a paper is inconsistent, lowercase underwater or geological features (anticline, arc, bank, basin, butte, channel, crater (e.g., on Earth, the Moon, or Mars), fault, fold, formation, geyser, glacier, mount, plate, plateau, ridge, rill, strait, syncline, trench, trough, volcano) unless they are part of the legally recognized name of the feature in question; this can be verified by checking *Webster's Geographical Dictionary* or an atlas. Terms such as convergence, divergence, currents, swells, and water masses have varying degrees of importance to different types of authors (biologists, chemists, geologists).

2. The following is AGU style for commonly occurring geographical terms. This is not an inclusive list. Check atlas for recognized geographic features. Note that generic terms such as lake, mountain, river, or valley are capitalized when used with a proper name no matter how they are listed in an atlas or gazetteer, except if “the/a river” precedes the proper name: the river Elbe. Also, Hudson River valley. Capitalize plurals of geographic features, e.g., Atlantic and Pacific Oceans, if they are capitalized when singular.

Africa, North, East, West, but central	Mediterranean Sea
Alps, Southern, Eastern, and Western, but northern and central; also Southern Alps for New Zealand	Mediterranean, western/eastern, but Arctic mediterranean seas (mediterranean in this case is generic in meaning, i.e., land-locked or mostly land-locked, here referring to several seas within the Arctic as a group)
Andes, sub-Andes, central Andes	Middle East (or Mideast)
Arctic Ocean	Midwest
Asia, Southeast, central, southeastern	Mojave Desert
Atlantic Ocean, North, South, but northern, southern, central	the Moon, but lunar
Caspian Sea (not divided, east, west, north, south)	Negev (desert, if used, is lowercased)
China, south	New York City (but follow author for adding “City”)
Coastal Plain (U.S.)	Nordic seas
Earth (as planet rather than substance), but earthward and terrestrial	North Africa
East Africa	Northern Hemisphere (Earth only)
East Antarctica	North Pole (Earth’s only)
East Antarctic Ice Sheet	North Sea
East China Sea	open ocean
east coast, but West Coast	Pacific Northwest (but northwest Pacific)
eastern Mediterranean Sea	Pacific Ocean, North, South, but northern, southern
east Greenland	Pan-African
East Siberian Sea	Pan-American
equator, equatorial	plate (follow author within paper for capitalization):
Europe, central, eastern, and western (capitalize Eastern and Western Europe only in political sense, rare)	African, Antarctic, Arabian, Australian, Caribbean, Cocos, Eurasian, Farallon, Indian, Juan de Fuca, Nazca, North American, Pacific, Philippine, Scotia
Faeroe Islands (or Färoe)	Sahara (desert, if used, is lowercased)
Gobi desert	Sea of Japan (preferred), or Japan Sea
the Himalayas (or the Himalaya), Outer, Greater, Lesser, but central, middle, lower	solar system
Iceland-Greenland-Norwegian Seas (order may vary)	Southern Hemisphere (Earth only)
Indo-Pacific	south China
island of Hawaii (or Hawai’i) (follow au for accent except when referring to the state of Hawaii, no accent)	South China Sea
Jupiter, Jovian, Jovicentric, Jovigraphic	Southeast Asia, but southeastern Asia
Mars, Martian	Southern Ocean
	South Indian Ocean
	South Pole (and South Pole Station) (Earth’s only)

South Shetland Islands	Victoria Land
the Southwest (only when referring to southwestern United States)	West Antarctica
sub-Saharan, subalpine, sub-Andean	West Africa
the Sun, but sunward and solar	west Australia
Takla Makan, use Taklimakan	Western Australia (if state meant)
Taklimakan desert	western Siberia
Tibetan Plateau or Plateau of Tibet (aka Qinghai-Xizang Plateau) but not Tibet Plateau	west Greenland
transatlantic	world ocean
Venus, Venusian, Venus'	the West (of U.S.) the North, the South, the East, and West Coast

3. Use the following for both nouns and adjectives: Arctic and Antarctic (however, arctic may be lowercased in papers that do not use Antarctic; follow author). Use subarctic and subantarctic as adjectives, but sub-Arctic and sub-Antarctic as nouns. Note that Antarctica is the continent and Antarctic is the region.

4. Use state of Washington, but use Washington State.

## 5.2. Text Capitalization

1. In level 1-4 heads, capitalize all words of more than three letters.

2. Capitalize adjectives derived from proper names: Kelvin, Martian, Lambertian, Stokes.

3. In text, capitalize Figure 2 and Table 1 but lowercase model 1, section 1, and equation (2) (and related examples). However, follow usage for capitalization of Ocean Drilling Program's (formerly Deep Sea Drilling Project) Hole, Site, Leg when used with number, e.g., Site 43, Hole 128, Leg 26.

4. Protected trademarks are capitalized (Teflon, Plexiglas, Pyrex, Freon, etc.). When a trademark is used, do not capitalize the common noun portion (Pyrex beaker). See WIT, 3rd ed., p. 172 for now unprotected former trademarks (use lowercase).

5. Lowercase law, such as Snell's law.

6. Lowercase is preferred for experiments, watersheds, instruments, models, and the like, but follow usage for well-known experiments. The general rule for instruments is to lowercase them when they are generic terms (i.e., there are several of such instruments). If unique, capitalize (usually on satellites).

7. Follow usage for rock names. Both capital and lowercase may be used for the same rock within a paper, as they have different connotations. For example, Westerly Granite is a granite with a specific chemical composition, whereas Westerly granite is a more generic term. Also, follow author for Groups and Members.

8. Explosions are initial cap only, e.g., Cowboy, Salmon, Sterling.

9. Capitalize Hurricane/Typhoon when used with a specific name: Hurricane Andrew, Typhoon June.

### 5.3. Stratigraphic Divisions

Capitalize the attributive adjective (e.g., early, lower) only if it appears here as an officially recognized subdivision; otherwise, use lowercase: late Cenozoic, early Paleozoic, early Pleistocene, Late Jurassic, Upper Permian. See p. 949 of *Webster's Third International Dictionary* for spelling of smaller units.

Era	Period	Epoch
Cenozoic (variation: Cainozoic)	Quaternary	Recent (Holocene) Pleistocene
	Tertiary	Pliocene Neogene[Neocene] Miocene } Oligocene Eocene Paleogene Paleocene
70 m.y. ago (70 Ma)		
Mesozoic	Cretaceous	Upper (Late) Lower (Early)
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)
	Triassic	Upper (Late) Middle (Middle) Lower (Early)
160 m.y. ago (160 Ma)		
Paleozoic 230 m.y. ago	Permian	Upper (Late) Lower (Early)
	Pennsylvanian	Upper (Late) Middle (Middle) Lower (Early)
	Mississippian	Carbonif- erous Systems Upper (Late) Lower (Early)
	Devonian	Upper (Late) Middle (Middle) Lower (Early)
390 m.y. ago		
	Silurian	Upper (Late) Middle (Middle) Lower (Early)
	Ordovician	Upper (Late) Middle (Middle) Lower (Early)
	Cambrian	Upper (Late) Middle (Middle) Lower (Early)
500 m.y. ago		
Precambrian 620-2300 m.y. ago	Proterozoic Archeozoic	Upper (Late) Middle (Middle) Lower (Early)

## 6. Numbers

### 6.1. Cardinal Numbers/Arabic Numerals

#### Use numerals

1. For 10 or higher; write out under 10, except as indicated below.
2. With units of measure (abbreviate units if possible).
3. To make numbers under 10 consistent with larger numbers in a series:

We used data from 6 experiments in the first graph and from 12 to 14 experiments in the second and third graphs, respectively.

4. With divisions (part, paragraph, section, rule, model): model 1, section 2, log 1, case 1 (do not change from roman to arabic if roman numerals are used in figures or if from a non-AGU source).
5. When implying an arithmetical manipulation: a factor of 7, 4 orders of magnitude, magnification of 50 (50X, use capital "ex" closed up to number), 5 times the height; use either 2 or two standard deviations (follow usage but be consistent).

#### Write out

1. For one through nine except as indicated above.
2. At the beginning of sentences, a head, or a title (if followed by a unit of measure, spell it out too: Ten kilometers...; or rephrase so that the number (and its unit of measure) does not begin the sentence, head, or title). If necessary to write out, hyphenate (both as noun and adjective) cardinal and ordinal numbers if compound: e.g., twenty-one, twenty-first. However, one hundred is not hyphenated (see number table in the dictionary).

### 6.2. Ordinal Numbers

Spell out ordinal numbers (first, second, third, etc.) unless hyphenated (e.g., twenty-first, use 21st) in text. If nonhyphenated form used in conjunction with hyphenated, use numbers for all: 21st, 50th, 92nd. Use the numeral and suffix form (1st, 2nd, 3rd, etc.) in references (e.g., 1st ed.). Use *n*th, (*n* - 1)th, etc. (i.e., "th" is on line and not italic).

### 6.3. Miscellaneous Style for Numbers

1. Give full ranges for pages or years; for example, change 801-6 to 801-806 and change 1979-80 to 1979-1980.
2. Mixed forms are permissible for very large numbers: 5 million; 2.3 billion or use  $5 \times 10^6$ ;  $2.3 \times 10^9$ .
3. Insert a zero before the decimal point in a numeral less than unity; 0.002, not .002. However, do not add a zero after decimal point (e.g., 20.), but do retain decimal; adding a zero would change the degree of precision of the measurement.
4. Do not use roman numerals in names of artificial satellites, rockets, etc.: Explorer 8, Vanguard 3, Surveyor 1, OGO 3.
5. Do not use roman numerals for figure numbers or table numbers: Figure 5 and Table 2.
6. Spell out a number that directly precedes or follows a numeral: ten 2-m strips; 136 two-hour lectures (see WIT, p. 127)

## 7. Miscellaneous Style Rules

1. For direct questions it is okay to capitalize the question: The question is raised, How reliable are the results?
2. Do not begin sentences with lowercase Roman or Greek letters or numerals. Enclosures are ok, e.g., [, <, (, as are capital Greek letters, e.g., Δ, Φ.
3. Latin phrases are not italicized except genus and species names. Use *a priori*, *aposteriori*, *in situ*, *ad hoc*, *ab initio*, but translate *sensu* (in the sense of), *sensu strictu* (in a strict sense), *inter alia* (among other things), and *nota bene* or N.B. (note that). This is not a complete list.
4. Italics (or boldface or all capitals) are not used for emphasis or definition (double quotes may be used for definition; see below).
5. Use double quotes, not single quotes. If used frequently, delete after first use around a specific word or phrase in both abstract and text.
6. Periods and commas go inside closing quotes; semicolons and colons go outside.
7. AGU date format. Never use, e.g., 1/3/80, 010380, or 1-3-80. Use 1 March 1980 (not the 1st of March):

1–3 March 1980,  
 between 1 and 3 March 1980, we observed...  
 1 March to 1 April(not 1 March–1 April)  
 March 1980 to August 1981  
 March–April 1991

En dashes should only be used between like things: 1–12 March 1983; but change 1 March–10 April to 1 March to 10 April.

8. Use 1980s for decades (not 1980's).
9. Do not use the word “number” (or no. or #) if it can be avoided without affecting meaning. However, for sand or grit it is permissible to use #: #5 sand and #3 grit. Another permissible use is for Mg #. In most usages, number can be eliminated, e.g., for run no. 5, run 5 is quite sufficient. Use, e.g., model 1, run 5, experiment 3, well 5, sample 2568D5, borehole 356, Site/Hole 835. Sometimes context may indicate a substitute for “number,” e.g., for “Three earthquakes occurred in the 1980s, #385, #886, and #589,” the term “event” can be substituted for #: “Three earthquakes occurred in the 1980s, events 385, 886, and 589.”
10. It is permissible to use “(?)” after stratigraphic division (closed up).
11. Use “the notation section.”
12. When an author cross-references numbered observations, trends, etc., parentheses are not used (i.e., “observation 1,” not “observation (1)”). Parentheses are reserved for equations and reactions.
13. Delete “s” in -ward words: toward, northward, etc.

14. In text, spell out fractions. Use "two thirds of the people" (noun form) and "two-thirds the width of the table" (attributive adjective).

15. Always use degree sign with N, S, E, W: 24°N not 24N.

16. Write out N, S, E, and W when used alone (N-S, E-W okay). Okay to use NNW, etc. (don't change to N-NW; see the dictionary), e.g., air masses from the east, SE, and NW; also N20°E okay.

17. "Not only" must be followed by "but [also]" (the "also" is optional):

Correct: The day is not only long but also very hot.

Incorrect: The day is not only long, but also it is very hot.

Note that the "but also" may be interrupted. Use comma only if independent clause. Be sure "also," if used, is placed correctly, i.e., parallel construction.

18. Use "between..and": between 5 and 10 days but not between 5-10 days.  
Use "from...to": from 5 to 10 days, not from 5-10 days.

19. "Respectively" (surrounded by commas) should be as close to the end of the statement as possible:

*H* and *D* are the height and depth, respectively, of the trench.

Not

*H* and *D*, respectively, are the height and depth of the trench.

20. Further versus farther: Use farther when indicating a physical direction or movement:

The point is farther from *x* than it is from *y*.

Use further otherwise:

Further reseach should explain this discrepancy.

21. Don't use contractions.

22. Use of "a" versus "an" before abbreviations: follow usage before an abbreviation that would take an "an" if pronounced as the abbreviation, e.g., FFT, but would take an "a" if full form used, e.g., fast.

23. Use "of the order of" for mathematical usages indicating. e.g., order, rank, category. Use "on the order of" only to mean "approximately" or "similar to."

## 8. Special Notations

### 8.1. Astronomical Notation for Dates and Time

Astronomical notation for days is sometimes given in the form 0.1. Such notation should be changed to a numeral plus "day(s)" as follows: 0.1 day. Also in astronomy, notation of the form 1.8 April may be used. The numeral to the left of the decimal point refers to the day of the month; the numeral to the right of the decimal point refers to tenths of a day. Thus 1.8 April is 1 April and 8/10 of 24 hours. This notation should be changed to AGU style (the time should be rounded off to the nearest hour). Thus 1.8 April should be written as 1900 hours on 1 April.

### 8.2. Degrees, Minutes, and Seconds of Arc

The symbols  $^{\circ}$ ,  $'$ , and  $''$  pertaining to expressions of latitude and longitude stand for degrees, minutes of arc, and seconds of arc, respectively. All three symbols may be used with numerals in geographic coordinates (e.g.,  $146^{\circ}31'14''\text{E}$ ,  $78^{\circ}27'06''\text{S}$ ) and may be used with numerals in expressions (e.g.,  $23^{\circ}$  of latitude,  $32'$ , or  $14''$ ).

European notation for degrees, minutes, and seconds of arc should be changed to our style as follows:  $3^{\circ}8'$  (European) should be changed to  $3.8^{\circ}$ ,  $5'6''$  to  $5.6'$ ,  $7''28$  to  $7.28''$ .

### 8.3. Units of Measure

1. Units of measure must be abbreviated after numerals. Write out single units of measure within text where no numerical value is given (for example, "a length of 9 km," but "a length of several kilometers"). If used parenthetically (in parentheses or commas), units may be abbreviated, e.g.,  $v$  ( $\text{m s}^{-1}$ ),  $n$  ( $\text{s}^{-1}$ ),  $T$  ( $^{\circ}\text{C}$ ), and  $d$  ( $\text{m}$ ) or  $D$ , in  $\text{m}$ ;  $T$ , in  $^{\circ}\text{C}$ ; and  $n$ , in  $\text{s}^{-1}$ . Abbreviate units in combination or nonsensical units, e.g.,  $\text{m s}^{-1}$ ,  $\text{cm sr}^{-1} \text{s}^{-2}$ ,  $\text{cm}^6$ , and  $\text{s}^{-1}$ . Write out unit of measure with written-out number at beginning of sentence.

2. Note that "hour," "day," and "year" are not abbreviated after a numeral unless they are in combination or the inverse (3 hours, but  $3 \text{ km h}^{-1}$  or  $6 \text{ h}^{-1}$ ; 6 days, but  $6 \text{ d}^{-1}$ ; and 30 years, but  $30 \text{ kg yr}^{-1}$ ).

3. The abbreviation for a unit of measure is both singular and plural; for example, "cm" stands for both centimeter and centimeters. Be aware that "Gal" and "bar" are not abbreviations (1 Gal and 2 Gals, but 3 mGal; 4 bars, but 5 mbar). Other standard units that are not abbreviations are darcy (darcies, but mdarcy), erg, ohm, torr (plural of torr is torr).

4. There should be a space between the numeral and the abbreviation (5 m, 6 s/m), except degree, percent, and per mil symbols ( $30^{\circ}$ , 5%, 60‰); however, there is no space between a numeral and an algebraic quantity: 16y.

5. It is not necessary to repeat units of measure in ranges or series except for degrees:

40–50%  
40–60 km  
25°C–30°C  
10, 20, 30, and 40 mg  
between 75 and 100 km  
from 25 to 35 cm/h

Use 25 km x 25 km.

6. AGU publications require the use of metric units but recommend the use of the International System of Units (SI), which is a rationalized system of metric units based on the meter, kilogram, second, ampere, kelvin, and candela. Although the SI scheme capitalizes abbreviations of units derived from a person's name, the written-out forms of those units are lowercase (e.g., Hz, hertz; W, watt; K, kelvin; and A, ampere). The following units are no longer in use, provide conversion factors at first use or convert to SI throughout:

atmosphere (atm), torr (torr), kilowatt hour (kWh), or calorie (cal). Bohr is the standard measure of length in atomic and solid-state physics (1 Bohr = 52.92 picometers). The following information regarding SI units has been provided by National Institute of Standards and Technology [1990]. The SI is constructed from seven base units for independent quantities plus two supplementary derived dimensionless units:

length	meter	m	amount of substance	mole	mol
mass	kilogram	kg	luminous intensity	candela	cd
time	second	s	plane angle	radian	rad
electric current	ampere	A	solid angle	steradian	sr
thermodynamic temperature	kelvin	K			

#### Examples of SI-derived units expressed in terms of base units

area	square meter	$m^2$
volume	cubic meter	$m^3$
speed, velocity	meter per second	m/s
acceleration	meter per second squared	$m/s^2$
wave number	reciprocal meter	$m^{-1}$
density, mass density	kilogram per cubic meter	$kg/m^3$
specific volume	cubic meter per kilogram	$m^3/kg$
current density	ampere per square meter	$A/m^2$
magnetic field strength	ampere per cubic meter	$A/m^3$
concentration	mole per cubic meter	$mol/m^3$
luminance	candela per square meter	$cd/m^2$
unit of work	dyne centimeter/erg	J

#### SI-derived units with special names

frequency	hertz	Hz	magnetic flux density	tesla	T
force	newton	N	inductance	henry	H
pressure, stress	pascal	Pa	Celsius temperature	degree Celsius	$^{\circ}C$
energy, work,	joule	J	luminous flux	lumen	lm
power, radiant flux	watt	W	illuminance	lux	lx
electric charge	coulomb	C	activity (of radionuclide)	becquerel	Bq
electric potential	volt	V	absorbed dose, etc.	gray	Gy
capacitance	farad	F	dose equivalent	sievert	Sv
electric resistance	ohm	$\Omega$ (or ohm)			
electric conductance	siemens	S			
magnetic flux	weber	Wb			

## Examples of SI-derived units expressed by means of special names

electric resistance	ohm meter	$\Omega$ m
dynamic viscosity	pascal second	Pa s
moment of force	newton meter	N m
surface tension	newton per meter	N/m
heat flux density, irradiance	watt per square meter	W/m <sup>2</sup>
heat capacity, entropy	joule per kelvin	J/K
specific heat capacity	joule per kilogram kelvin	J/(kg K)
specific energy	joule per kilogram	J/kg
thermal conductivity	watt per meter kelvin	W/(m K)
energy density	joule per cubic meter	J/m <sup>3</sup>
electric field strength	volt per meter	V/m
electric charge density	coulomb per cubic meter	C/m <sup>3</sup>
electric flux density	coulomb per square meter	C/m <sup>2</sup>
permittivity	farad per meter	F/m
permeability	henry per meter	H/m
molar energy	joule per mole	J/mol
molar entropy	joule per mole kelvin	J/(mol K)
exposure (X and $\gamma$ rays)	coulomb per kilogram	C/kg
absorbed dose rate	gray per second	Gy/s
angular velocity	radian per second	rad/s
angular acceleration	radian per second squared	rad/s <sup>2</sup>
radiant intensity	watt per steradian	W/sr
radiance	watt per square meter steradian	W/(m <sup>2</sup> sr)

SI prefixes may be added to any basic unit in the metric system to indicate that the unit has been multiplied by some power of 10; for example, km = m, mg = 10<sup>-3</sup> g, and MHz = 10<sup>6</sup> Hz. The following prefixes may be used with any basic unit to designate decimal fractions or multiples of a unit:

Y, yotta	(10 <sup>24</sup> )	k, kilo	(10 <sup>3</sup> )	n, nano	(10 <sup>-9</sup> )
Z, zetta	(10 <sup>21</sup> )	h, hecto	(10 <sup>2</sup> )	p, pico	(10 <sup>-12</sup> )
E, exa	(10 <sup>18</sup> )	da, deka	(10)	f, femto	(10 <sup>-15</sup> )
P, peta	(10 <sup>15</sup> )	d, deci	(10 <sup>-1</sup> )	a, atto	(10 <sup>-18</sup> )
T, tera	(10 <sup>12</sup> )	c, centi	(10 <sup>-2</sup> )	z, zepto	(10 <sup>-21</sup> )
G, giga	(10 <sup>9</sup> )	m, milli	(10 <sup>-3</sup> )	y, yocto	(10 <sup>-24</sup> )
M, mega	(10 <sup>6</sup> )	$\mu$ , micro	(10 <sup>-6</sup> )		

## Units in use with SI:

minute (time)	min	metric ton	t
hour	h	hectare (land area)	ha
day	d	electronvolt	eV
degree (angle)	°	unified atomic mass unit	u
minute (angle)	'		
second (angle)	"		

## Units in use temporarily with SI: (subject to future review)

nautical mile	n. mi	knot	knot(s)	roentgen	R
ångström	Å	are (land area)	are(s)	rad (absorbed dose)	rad(s)
barn	b	bar	bar(s)	rem (dose equivalent)	rem(s)
Gal (acceleration)	Gal(s)	curie	Ci		

5. Use of Ma versus Myr (or m.y.): Use Ga, Ma, or ka for a specific time: Boundaries of the Late Cretaceous currently are calibrated at 63 Ma and 96 Ma. Mono Lake was formed at ~700 ka. The Easter microplate appears to have formed around 5.25 Ma. Use Gyr (or b.y.), Myr (or m.y.), or kyr for a duration of time: The interval of time represented by this epoch is 33 Myr. Mono Lake is at least 700 kyr old. The Easter microplate appears to have formed around 5.25 Myr ago. [According to the North American Stratigraphic Code from the North American Commission on Stratigraphic Nomenclature, Ma (mega-annum,  $10^6$  years) may be used to represent a specific year before present (1950 A.D.); therefore "such qualifiers as 'ago' or 'before the present' are omitted after the value because measurement of the duration from the present to the past is implicit in the designation. In contrast, the duration of a remote interval of geologic time, as a number of years, should not be expressed by the same [i.e., Ma] symbol."]

6. Either the km/s or  $\text{km s}^{-1}$  format should be used consistently. If complicated (i.e., more than 1 slash), convert to the inverse (i.e.,  $^{-1}$ ), e.g., change g/s/m to  $\text{g s}^{-1} \text{m}^{-1}$ . If either complicated or single inverse ( $\text{s}^{-1}$ ) units are used, then also use  $\text{km s}^{-1}$ .

7. Do not use center dots or dashes in units of measure: Incorrect:  $2 \times 10^4 \text{ particles} \cdot \text{cm}^2 \cdot \text{s}^{-1}$ ; correct:  $2 \times 10^4 \text{ particles cm}^2 \text{ s}^{-1}$ . Incorrect:  $\text{particles/cm}^2\text{-s-sr-keV}$ ; correct:  $\text{particles cm}^2 \text{ s}^{-1} \text{ sr}^{-1} \text{ keV}^{-1}$  or  $\text{particles (cm}^2 \text{ s sr keV)}^{-1}$  or  $\text{particles/(cm}^2 \text{ s sr keV)}$ .

8. The following may be used: km 30 for specific depth levels in seismographic records.

9. Usage such as 1982.7 is permitted.

10. Tenths of hour may be used when referred to an interval of time rather than a specific time, i.e., it took 2.3 hours for the....

#### 8.4. Dimensions

In notation lists and hydrology papers, variables may be defined in terms of their dimensions. The most common are length, time, and mass. The symbols  $L$ ,  $T$ , and  $M$  represent these dimensions; use either  $L/M$  or  $L M^{-1}$ . The number 1 means dimensionless (e.g., a ratio is dimensionless). In notation lists, symbols for dimensions should follow the variable definition and units of measure (if any) and should be preceded by a comma or placed in parentheses or brackets. In text, dimensions may also appear in parentheses or brackets. Be consistent throughout a paper.

#### 8.5. Seismology

Always italicize wave designations ( $PcP$ ,  $P$ ,  $S$ ,  $ScS$ ,  $Pn$ ,  $Pg$ ,  $PmP$ ,  $Pi$ , etc.; note lowercase letters may be superscripted), magnitude variables ( $m_b$ ,  $M_s$ ,  $m$ ,  $M_w$ , etc.), and crystallographic axes ( $a$ ,  $b$ ,  $c$ , etc.). Wave designations may have subscripts and superscripts. There may be letters (unknowns) or numbers. Letters should be italic.

A mode is a "stationary vibration pattern of an oscillatory system" (*Glossary of Geology*). Notation for modes may take the following form (the subscripts are mode designations): "spheroidal modes  ${}_0S_{2-0}S_{63}$ , the fundamental toroidal modes  ${}_0T_{2-0}T_{46}$ ."

For earthquake magnitudes, either  $M = 6$ ,  $M 6$ , or  $M6$  format may be used, but usage should be consistent, although, e.g.,  $M 6$  and  $M\sim 6$  may both be used. The Richter scale, also called the local magnitude scale, is abbreviated  $M_L$ ; the body wave magnitude scale is abbreviated  $m_b$ ; the surface wave magnitude scale is abbreviated  $M_s$ ; the moment magnitude scale is abbreviated  $M_w$ .

## 8.6. Mineralogy

Do not italicize mineralogical phases (gl, opx, px, ol, sp, etc.), cation sites (M1, M2, etc.), model or site designations (geomagnetic model E, site A), and component parts of minerals (Wo, En, Fs, Fo, An, etc., with or without subscripts; these are not chemical elements and should not be confused with chemical element symbols).

For capitalization of abbreviations of mineralogical phases, cpx, Cpx, and CPX, are all acceptable abbreviations for clinopyroxene, but one form should be used consistently (define at first use in text or in a table). For capitalization of components of minerals, both En and EN (for enstatite) are acceptable.

The subscript numerals that are appended to the names or abbreviations of mineral components denote the percentage of that component in the mineral being analyzed and may be placed as subscripts or on line, as long as one form is followed consistently throughout the paper. For example, all the following are correct: enstatite<sub>82</sub>, enstatite 82, En<sub>82</sub>, En 82, EN<sub>82</sub>, EN 82).

It is permissible to leave signs of operation in text between mineral names: garnet + chromite.

**Common prefixes and suffixes added to rock names:** Prefixes: clino, ortho, and ferro. Suffix: ite.

**Common rock systems:**  $\alpha$  quartz,  $\beta$  quartz are not hyphenated, but  $\alpha$ -Ni<sub>2</sub>SiO<sub>4</sub>-FeO<sub>2</sub>Ti<sub>4</sub> is hyphenated;  $\alpha$ ,  $\beta$ ,  $\gamma$  refer to stability temperatures, and mineral phases.

## 8.7. Ranges

In a range of values, enclosures have specialized meanings. Brackets around a range of values mean that end points are included; parentheses mean that end points are not included. The combination of an open bracket and a close parenthesis, or vice versa, is possible. Thus [1, 10] means from 1 to 10, including 1 and 10; (1, 10) means the range of values between 1 and 10; [1, 10) means the range of values from 1 to 10, including 1 but not 10; and (1, 10] means the range of values from 1 to 10, excluding 1 but including 10.

## 8.8. Ships and Spacecraft

**Satellites.** Either cap and lowercase or all caps may be used for abbreviations designating satellites depending on official name of satellite. A satellite name that has an appended letter and is sometimes spelled out (e.g., Atmosphere Explorer A) and sometimes abbreviated (e.g., AE-A) should have the hyphen only when the abbreviated form is used and is unpronounceable. Some satellite names are really acronyms (e.g., OGO A) but do not have the hyphen. For U.S. satellites, numerals appended to satellite names should always be arabic and should be preceded by a space (e.g., Alouette 2) unless the name ends in a numeral (e.g., OV3-3), in which case a hyphen should be used. For plurals, use Dynamic Explorer 1 and 2 or Voyager 1 and 2, not Voyagers 1 and 2. OV3-3 and OV3-4 (repeat OV3). For non-U.S. satellites, retain hyphens and roman numerals.

**Space shuttle.** Lowercase "space shuttle." If name of shuttle is used, initial cap and italicize, e.g., space shuttle *Columbia*.

**Orbiters, landers, probes, and deployers.** Lowercase orbiters, landers, probes, and deployers if used alone; if used with numeral, capitalize, e.g., Lander 1.

**Ships.** Italicize ship names but not the designator, such as R/V. Do not use all caps for ship names; change to initial cap and italicize. Deep-sea research vessels, such as *Alvin*, are italicized, not all capped. At first mention in text, full name and designator should be used: R/V *James Madison*. Subsequent references may be to shortened version, e.g., *Madison*.

### 8.9. Comets

In discussion of comets, lowercase the generic term comet and capitalize the proper name, e.g., comet Kohoutek. Comets are classified according to order of discovery in a particular year and also by order of perihelion passage. For example, comet Donati is also called comet 1858f or 1858VI. A "P/" preceding comet name indicates a periodic comet.

### 8.10. Temperature

The notations °C and °K are ordinarily closed up to the numeral (e.g., 10°C). However, when the numeral has a superscript, a space should precede °C and °K (e.g., 10<sup>-2</sup> °C) so that the degree symbol will not be confused with a zero. A space precedes K (kelvin) when it is used without the degree symbol.

### 8.11. Times

Use 0811 and 0811:20 UT, not 08:11:20 UT and not 08h 11m 20s. This system of notation applies to all times: 08:11, 08:11:20 and 08h 11m 20s are not acceptable.

Z and GMT (meaning Greenwich mean time; retain GMT if geomagnetic time is meant but define at first use) are sometimes used to denote universal time, e.g., 1330 GMT or 1400 Z, and should be changed to UT, e.g., 1330 UT, 1400 UT.

A.M. and P.M. should be converted to 0800 hours format (LT or UT) except in WRR (e.g., 9:00 P.M. EST, give standard time designator, e.g., EST, at first occurrence). Midnight is 0000. LT is not equivalent to clock time; it is time on the meridian.

### 8.12. Storms

Capitalize Hurricane/Typhoon when used with a specific name: Hurricane Andrew, Typhoon June. The Saffir-Simpson Hurricane Intensity Scale is as follows: Category 1 hurricane: winds of 74 to 95 mph, minimal damage; category 2 hurricane: winds of 96 to 110 mph, moderate damage; category 3 hurricane: winds of 111 to 130 mph, extensive damage; category 4 hurricane: winds of 131 to 155 mph, extreme damage; category 5 hurricane: winds of 156 mph and up, catastrophic damage.

### 8.13. Biology

Genus and species are italicized. Also, italicize in reference list in titles. Descriptive information after species should not be italicized.

Write out genus in title, heads, and first use in abstract and text. Abbreviate after first use by using the first initial of the genus and writing out the species. Do this even if two genera have the same initial letter (e.g., *Pinus contorta* and *Pice sitchensis* should be abbreviated as *P. contorta* (italics) and *P. sitchensis*, respectively).

## 9. Word List

The following is a list of words commonly occurring in AGU papers and their treatment (hyphenation, spelling, capitalization, etc.) according to AGU style. This is meant as a quick reference (versus researching meaning and consulting dictionaries, atlases, source books, etc.). Note that (n, adj) should be assumed if not otherwise indicated. If (adj) given, assume open as noun and verb.

aboveground (adj)	belowground (adj)	clear-sky (adj)
above mentioned	bench mark vs. benchmark (see the dictionary)	close-up
acoustic-gravity wave	best fit (adj)	cloud base
advection-dispersion (n)	best-case (adj)	cloud top
advective-dispersive (adj)	bio-optical	cold-core (adj) (also warm-core)
airborne (adj)	blackbody	colocate vs. collocate (follow au)
air fall	blowup (n) blow up (v)	computer programing
airflow	body wave	convection-diffusion (n)
airglow	borehole	convective-dispersive (adj)
air gun	bottom hole (n)	core hole
air mass	bottom-hole (adj)	cosmic ray
airstream	bottom water	cost-effective (adj)
all-sky (adj)	boundary element (adj)	cost-effectiveness (n)
alongshore (adj)	boundary layer	counterexample
along track (n) along-track (adj)	bow shock	counterstreaming
a priori	breakout (n, adj), break out (v)	country rock
arc length	breakpoint	coworker
ashfall	breakup (n, adj) break up (v)	creep meter
ash flow	bright-field (adj)	crisscross (n, adj, v)
aspect angle	broadband (frequency)(adj)	cross-correlated
atomic nitrogen	broadleaf	cross correlation (n)
atomic oxygen	buildup (n, adj) build up (v)	cross-correlation (adj)
back arc	bull's-eye	crosscut (n, adj, v)
backprojection (time)	burnout (n) burn out (v) burn-out (adj)	cross-fold
back projection (space)	bypass (n, adj, v)	crossover
backscatter (n)	by-product	cross plot (n) cross-plot (adj)
back slip	calc-alkaline (adj)	cross section (n), cross-section (adj, v)
back thrusting (adj)	caprock	cross-sectional (adj)
back trail (n, adj) backtrail (v)	centerline	cross track (n) cross-track (adj)
band-pass (adj), band pass (n)	centroid depth	cutbank
bandwidth	centroid moment	cutoff (n, adj) cut off (v)
bank-full (adj)	check shot	dark-field (adj)
base flow	chi-square (not "squared")	dashpot
baseline	clay stone	database
beam width	clear-cut (n, adj, v)	
bed form		
bed load		

data logger	italic)	$\gamma$ ray
data pool	equal-area (adj)	gasdynamics
data processing	exceedance (n)	gage, change to gauge
data set	falloff (n) fall off (v)	Geodimeter (trademark)
datasonde	far-field (adj)	(hyphenate as Geo-dim-eter)
date line vs. dateline (n, ✓ meaning), dateline (v)	far-reaching (adj)	Geodolite (trademark)
day-to-day (adj)	farside	goodness of fit (n)
dead end (n) dead-end (adj)	(however, ✓ meaning)	gradient drift
deacrate (v)	fast spreading (adj)	gravel bed
de-air (adj)	fault plane	gravity-capillary wave
deep sea (n) deep-sea (adj)	fault slip	gray body
deep water (n), deepwater vs. deep water (adj)(✓ meaning)	fault-trench (adj)	gray scale
Digisonde (instrument, cap)	fault zone	great circle
dipmeter	fiber optic (n),	grid point
dip slip (n) dip-slip (adj)	fiber-optic (adj)	groundmass
Doppler radar	field of view (n)	ground track
double couple (n)	(follow au as adj)	groundwater
double-couple (adj)	fine structure (adj)	ground wave
downdip	finite difference	gyro- (closeup, prefix)
downgoing (adj)	finite element	gyrofrequency
downleg	fission track	gyroperiod
downrange	flare-up	gyroradius
downscale	floodplain	half-cell
drawdown (n, adj), draw down (v)	flowchart	half-length
drill hole	flow field	half-life
drop-off (n, adj), drop off (v)	flow line	half plane
dropout	flowmeter	half-space
dropsonde, dropwinsonde	flow path	halfway (adj, adv)
dry land (n, adj) dry-land (adj) or dryland (adj) (see Web)	flow rate	half width (n) half-width (adj)
earth-atmosphere (adj)	fluxgate	H alpha, use H $\alpha$
easting (see Web 10)	flyby	hanging wall
echolocation	foot points	head-on (adj, adv)
echo sounder	footwall	headwater
electric field	forearc	head wave
e-mail	foredeep	heat flow
end-member	free air (n) free-air (adj)	heavy-duty
end point vs. endpoint (see Web 10)	free fall (n) free-fall (adj, v)	highstand
en echelon (adj, adv)(not	freeze-up	hillslope
	<i>F</i> region	hot spot
	frequency domain	hourglass
	freshwater (adj) (also as noun meaning lake)	ice core
	<i>F</i> test	ice raft (n, adj), ice-raft (v)
		ice sheet

ice stream	lognormal	nonsteady state
in-between (n, adj)	log-periodic (antenna)(adj)	northing (see Web 10)
in between (adv, prep)	log transmissivity	now casting (v)
in-depth (adj)	long-lived	null-space
infill (v)	longwave vs. long wave (n)	oceangoing
in-flight	longwave vs. long-wave (adj)	Octol (trademark)
inflow	(follow au)	off-line (adj, adv)
in-house	loss cone	offshore
inphase (adj)	low-pass (adj)	onboard (adj)
in-place (adj)	lunisolar	on board (otherwise)
inshore	magnetic field	online
in situ (not italic)	main shock	ongoing
intermediate-depth (adj)	main stem	O-ring
intra-aggregate	mainstream	output
Invar (trademark)	makeup (n, adj) make up (v)	outward-bound (adj)
ion cyclotron	man-made	ovendry (adj) oven-dry (v)
island arc	mass balance	ozonesonde
jet stream	mass transfer	paddy land
Kapton (protected	Matlav (trademark)	passband
trademark)	mean square	pastureland
knickpoint	melt-rock (adj)	path length
kriging	meltwater	path line
lab frame	midlatitude	path loss
lag gravel	mid-ocean	payback (n, adj) pay back (v)
landfill	midpoint	peatland
landform	molecular nitrogen	pickup (n, adj), pick up (v)
landmass	molecular oxygen	piecewise
land use (adj)	monthlong	piggyback
latewood	moveout (n, adj), move out (v)	pileup
leapfrog (n, adj, v)	mudflow	pitch angle
least cost	mudstone	pitch-up
least squares	multi-instrument	plane-parallel
(not "square")	narrow band (n)	plane wave
left-lateral (adj)	narrowband (adj)	planform
light-duty	near-field (adj)	plan view
linear programming	nearshore	plasmopause
line of sight (n)	nearside	plasma sheet
(follow au for adj)	needleleaf	plasmasphere
line source	the Net	playback (n, adj) play back (v)
log conductivity	Netherlands (no "The" per	Plexiglas (trademark)
log likelihood	research 1/26/93)	pore fluid
log linear	nighttime	pore pressure
log-log	non-ice (adj)	pore size

pore water	rockfall	side scan
power law	rock mass	side-scan sonar
present-day (adj)	rock salt	side scatter
pull-apart	roll-off	sidewall
pulse width	rollover (n, adj) roll over (v)	signal-to-noise ratio
<i>P</i> wave	room temperature	siltstone
quasiperiodic	Rosby-gravity wave	sine taper
quick flow	round off (v)	sky wave
quiet time	run-up	slack water (n)
radio astronomy	saltwater (adj) salt water (n)	slack-water (adj, v)
radio decay	sandbar	slipstream
radio echo	sandblow	slope wash
radiolocation	sand-shale (adj)	slow spreading (adj)
radio physics	sandstone	snow cover
radio source	saw cut	snow line
radio wave	scale length	snowmelt
rainband	scatterplot	snowpack
raindrop	SeaBeam	so-called (adj)
rainfall-runoff	seabed	soft water
rain flag	seafloor	solar-terrestrial (adj)
rain forest	sea level	solar wind
rain gauge	SeaMARC I and II	solid-state (adj)
rain splash	seamounts	source time
rainwater	sea salt (n) sea-salt (adj)	spaceborne (adj)
rare earth	seawater	spatiotemporal (adj)
ray path	seismic reflection	spillover
readout (n, adj) read out (v)	semi-infinite	spin-up
real time (n) real-time (adj)	setup (n) set up (v)	sporadic <i>E</i>
real-world (adj)	shallow mixing layer	stage-by-stage (adj)
red beds	shear hole	stage-discharge
reefal (adj) (don't use reef)	shear wave	stair-step (adj)
resource management	ship track	standoff (n, adj)
rest frame	short-lived	stand off (v)
right-hand (adj)	short-period (adj)	standpipe
right-lateral (adj)	shortwave vs. short wave (n) & shortwave vs. short-wave (adj)	state of the art (n) (follow au for adj)
ring beam	(follow au)	state space (adj)
ring current	shot point	steady state
ring width	shut-in (n, adj) shut in (v)	stemflow
risetime	sidearm (except guns)	step-by-step (adj)
river flow	sideband	step over
rock burst	sidelobe	stepwise
rocket-borne	side-looking (adj)	stick slip (n) stick-slip (adj)
rocketsonde		

stillstand (n, adj, v)	time-lapse photography	waveform
stockwork	time period	wave front
storm flow	timescale	wave function
storm water	time series	wave group
straight line (n)	time step	waveguide
straight-line (adj)	topsoil	wavelength
strain meter	Tovex	wave mode
strain rate	trace element	wave number
strandline	track line	wave packet
stream bank	trade-off (n, adj)	wave path
streambed	trade off (v)	wave power
streamflow	trade winds	waveshape
stream function	travel time	wave speed
streamline (n, adj, v)	tree line	wave train
stream sediment	tree ring	wave vector
stream water	trimline	weighted-residual
strike slip (n)	turnoff (n) turn off (v)	well-being
strike-slip (adj)	turn-on (n) turn on (v)	well bore
strong motion	tweeks (JGR-A)	wellhead
Sun photometer	Umkehr (return reversal	wellhole (n) well-hole (adj)
sunspot	effect)	well-known (adj)
surface water	under way (adv)	well known (otherwise)
<i>S</i> wave	underway (adj)	well water
tailrace	un-ionized	whistler mode
tailwater	upcrossing	whole rock
takeoff (n, adj) take off (v)	updip	wide-angle
terrain vs. terrane (see AGI	upgoing	wideband (adj)
Glossary of Geology)	upleg	wide-ranging
test ban	upscale (n, adj, v)	wind-borne (adj)
test bed	up-to-date	wind field
thermite (generic)	V notch	wind forcing (adj)
thermomechanical (adj)	velocity-depth (adj)	wind speed
thin sheet	velocity space	wind stress
throughfall	vice versa	wind-wave tank (only)
through flow (except	volcanos (or volcanoes)	wire line
Indonesian Throughflow)	wall rock	World Wide Web (the Web)
throughgoing	wastewater	worst-case (adj)
tie line (or tie-line for phone	water mass	X ray (n), X-ray (adj)
lines)	water rights	<i>x, y, z</i> (axis coordinates)
tiltmeter	watershed	yearlong (adj)
time-consuming (adj)	water table	year-round (adj)
time delay	wave band	zeros or zeroes (spelling)
time domain	wave field	