

OK except  
in lines 5-7  
on page 2  
B. V. August

author, do  
you intend US  
above, or world?

of

1 TORNADO, ~~tor-nado~~, a small, extremely in-  
2 tense whirlwind formed by a severe thunderstorm.  
3 Making a noise like a jet squadron, a tornado  
4 descends as a funnel-shaped extension from its  
5 parent cloud. If it reaches the ground, its high  
6 causes almost complete destruction of everything  
7 in its path.

8 Tornadoes kill thousands of people and de-  
9 stroy property valued at about a billion dollars  
10 every year. With their enormous power, they have  
11 been known to break trees many feet thick, drive  
12 straws into pieces of wood, and lift cattle and  
13 even automobiles high into the air.

14 Occurrence. Although tornadoes are rare,  
15 they occur in all parts of the world  $\frac{1}{m}$  with the  
16 possible exception of the polar regions. In the  
17 United States, about 600 or 700 tornadoes are  
18 reported each year, <sup>they are</sup> ~~the storms being~~ most preva-  
19 lent in <sup>the</sup> a region known as "Tornado Alley" that  
20 extends through the central plains states.

21 The storms can occur at all times of the  
22 year and at any time of day or night, but are  
23 most likely in the spring and summer and in the  
24 afternoon and early evening. They usually last  
25 only minutes and have damage paths only a few  
26 hundred feet wide and a few miles long. However,  
27 some large tornadoes persist for hours, with  
28 paths up to a mile (about  $1 \frac{1}{2}$  km) wide and hun-  
29 dreds of miles long. Usually the funnel moves  
30  $\frac{1}{m}$  along with the parent thunderstorm  $\frac{1}{m}$  in an easter-

Approved For Publication  
with alterations

Signed.....

Date.....

(+1)

winds and the sudden  
drop in air pressure  
as it passes

author  
OK?

1 ly direction, at speeds of up to 70 miles (110  
 2 km) per hour. Estimates of the wind speed in the  
 3 funnel itself range from 200 up to 600 miles  
 4 (320 to 1,000 km) per hour.

by

5 Cause. Scientists agree that the character-  
 6 istic funnel is caused by the formation of a  
 7 cloud of water drops in a storm, in the region  
 8 of low pressure and temperature that exists in  
 9 the core of a high-velocity vortex. There are  
 10 differences of opinion as to why such a vortex  
 11 should form. Some scientists think that vortexes  
 12 are caused by vigorous updrafts in a thunder-  
 13 cloud, and some think that the cause is falling  
 14 hail. Others suggest that very intense electri-  
 15 cal activity in a storm, as evidenced by unusual  
 16 lightning displays and by radio and television  
 17 static, may provide the tornado's energy.

see detailed  
 comments in  
 enclosed letter  
 BV

by

18 Control. Meteorologists issue tornado alerts  
 19 when they recognize conditions that are likely  
 20 to produce the unusually severe thunderstorms  
 21 that spawn tornadoes. These conditions include  
 22 warm, moist air at low levels, with high winds  
 23 and cold air at higher levels <sup>1</sup>/<sub>4</sub> a situation that  
 24 arises along cold fronts and, occasionally, on  
 25 the periphery of hurricanes. Then, when obser-  
 26 vers see a funnel cloud or recognize a character-  
 27 istic "hooklike" echo on weather radar, warn<sup>ing</sup>s  
 28 are broadcast for people to take cover.

29 Ideas have been proposed for destroying tor-  
 30 nadoes by gunfire, rockets, or explosives. It

1 has also been suggested that tornadoes might be  
2 prevented by introducing "seeding" agents, elec-  
3 trical conductors, or gases into the parent  
4 storms. Such measures have yet to be proved ef-  
5 fective, and at present no practicable method of  
6 tornado control exists. See also winds.

7 Bernard Vonnegut

8 State University of New York at Albany

9 Further Reading: Brooks, Edward M., "Tornadoes and  
10 Related Phenomena," in Compendium of Meteorology, ed. by  
11 Thomas F. Malone (Boston 1951); Flora, Snowden D., Tor-  
12 nadoes of the United States (Norman, Oklahoma, 1958);  
13 Vonnegut, Bernard, "Inside the Tornado," Natural History  
14 Magazine, vol. 77, pp. 673-680, April 1968.

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DEPARTMENT OF  
ATMOSPHERIC SCIENCE

STATE UNIVERSITY OF NEW YORK AT ALBANY  
1400 WASHINGTON AVENUE  
ALBANY, NEW YORK 12203

14 August 1970

Mr. Steven Moll  
Science Editor  
The Encyclopedia Americana  
575 Lexington Avenue  
New York, New York 10022

Dear Mr. Moll:

Thank you for your letter and for the edited version of my manuscript on tornadoes. In general I approve of it. There are a few points, though, that deserve discussion. On line 5, page 1, your description of the concept of the effect of air pressure is okay, although in my view it may be somewhat redundant, for I do not see how one can really differentiate between the effects produced by velocity and those by pressure.

The figure on damage I give of one billion dollars annually I agree is surprisingly high, but it may not be too far off. In the National Summary of Climatological Data, the Annual issue for 1969 (Vol. 20, No. 13), published by ESSA, it is stated that the property damage from tornadoes in the U.S. is somewhere between .5 and 5 billion dollars (page 59) for that year. When one considers that the U.S. by no means has a monopoly on tornadoes, a billion dollars may be realistic for a worldwide figure.

On page 2 the sentence beginning line 5 could give the erroneous impression that the tornado funnel is the result of a cloud of water drops somewhere in the storm. Probably in my version I did not make myself clear. What I am attempting to say is that the tornado vortex is rendered visible by the cloud of minute water drops that form in the region of low pressure and temperature in the core of the vortex. I am afraid that the present version is likely to lead the reader to think that the cloud of water drops gives rise to the vortex, when this is certainly not the case. How would it be if we changed this sentence to read, "Scientists agree that the tornado funnel is rendered visible by the cloud of fine water drops that condenses in the region of low pressure and temperature in the core of the high velocity vortex. Except for this point, I approve of the present version.

Sincerely yours,

Bernard Vonnegut

BV:smp

PHONE: 518 • 457-3987 • 457-3988

1 TORNADOES. Tornadoes are small, extremely in-  
2 tense whirlwinds that are formed by severe thun-  
3 derstorms. Making a noise like a jet squadron,  
4 they descend as a funnel shaped extension from  
5 the parent cloud, and when they reach the ground,  
6 cause almost complete destruction of everything  
7 in their path. Annually they kill thousands of  
8 people and destroy property valued at a billion  
9 dollars. They produce damage unknown in other  
10 winds, twist off large trees many feet in dia-  
11 meter, pluck all the feathers from chickens  
12 without killing them, drive straws into pieces  
13 of wood, and lift men, cattle, and even auto-  
14 mobiles high into the air. Tornadoes, though  
15 a rare phenomenon, occur in all parts of the  
16 world, with the possible exception of the polar  
17 regions. Approximately 600 or 700 tornadoes are  
18 reported annually in the U.S., and although they  
19 are known in all the 50 states, they are most  
20 prevalent in a region known as "Tornado Alley"  
21 in the central plains. Tornadoes can occur dur-  
22 ing all seasons of the year and at any time of  
23 day or night, but they are most likely in the  
24 spring and summer in the afternoon and early  
25 evening. Most tornadoes last only minutes and  
26 have damage paths only a few hundred feet wide  
27 and a few miles long, but occasionally they per-  
28 sist for hours with paths as much as a mile wide  
29 and hundreds of miles long. Usually the tor-  
30 nado funnel moves along with the thunderstorm

1 in an easterly direction at speeds ranging from  
2 a few to as high as 70 miles per hour. Esti-  
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4 range from 200 to as high as 500 or 600 miles  
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6 Meteorologists issue tornado alerts when they  
7 recognize situations likely to produce the un-  
8 usually severe thunderstorms that spawn torna-  
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11 cold fronts and occasionally on the periphery  
12 of hurricanes. Then, when observers see a fun-  
13 nel cloud or recognize a characteristic hook-  
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15 people to take cover are broadcast on radio and  
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18 Scientists agree that the characteristic tor-  
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26 hail. Others suggest that intense thunderstorm  
27 electrical activity, evidenced by unusual light-  
28 ning and radio and television static, may pro-  
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30 Ideas have been proposed for destroying tor-

1 nadoes by gunfire, rockets, or explosives and  
2 for preventing them by introducing seeding  
3 agents (See Cloud Seeding), electrical conduc-  
4 tors, or gases into the parent storms. Such  
5 measures have yet to be proved effective, thus  
6 no practicable tornado control method exists at  
7 present.

8 Bernard Vonnegut  
9 Atmospheric Sciences Research Center  
State University of New York at Albany

10 SUGGESTED FURTHER READING

11 Tornadoes of the United States, Snowden D.

12 Flora, University of Oklahoma Press (Norman,  
13 Oklahoma, 1958).

14 Inside the Tornado, Bernard Vonnegut, Natural  
15 History Magazine, Vol. LXXVII, No. 4, April,  
16 1968, pp 26-33.

17 Tornadoes and Related Phenomena, Edward M.

18 Brooks, Compendium of Meteorology, Thomas F.  
19 Malone, ed., American Meteorological Society  
20 (Boston, 1951), pp 673-680.

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# THE ENCYCLOPEDIA AMERICANA

## COMMISSIONING AGREEMENT

To: **Dr. Bernard Vonnegut**

Date: **17 March 1970**

The Encyclopedia Americana hereby commissions you to prepare the following article(s):

TITLE	NO. OF WORDS	DATE DUE	SUGGESTIONS
<b>TORNADO</b>	<b>550</b>	<b>4 May 1970</b>	<b>see letter</b>

TOTAL NUMBER OF ARTICLES..... **1** .....

TOTAL NUMBER OF WORDS ASSIGNED..... **550** .....

The Americana Corporation agrees to pay you \$ **40** on receipt and acceptance of your manuscript(s). It is understood that each article, being a contribution to a collective work, is a "work made for hire" within the terminology of the Copyright Law, and that the Americana Corporation shall have all the rights to it including those of copyright and copyright renewal, and the privilege of referring to you in promotional and advertising material as one of our valued contributors. It is further understood that each article will be an original work that has not previously appeared in print, and that it will be free of any unauthorized extractions from other copyrighted sources.

Commissioning Editor..... *Stu M.A.* .....

Please sign your name below, indicate your designation or affiliation as you prefer to have it appear in our List of Contributors, list the books you have written and major awards you have received, and provide your Social Security Number.

To: The Encyclopedia Americana

I agree to prepare the article(s) listed above, and I accept the conditions of this agreement as stated above.

Signature..... Date .....

Designation or affiliation.....

Books and major awards (use back of sheet if necessary) .....

Social Security Number..... (required by Internal Revenue Service regulations)



# THE ENCYCLOPEDIA AMERICANA

575 LEXINGTON AVENUE, NEW YORK, N. Y. 10022



OFFICE OF THE EDITOR  
(Tel: 212-751-3600)

17 March 1970

Dr. Bernard Vonnegut  
Department of Atmospheric Science  
State University of New York at Albany  
1400 Washington Avenue  
Albany, New York 12203

Dear Dr. Vonnegut:

I was very pleased to receive your letter of acceptance; I hope that you will find the writing of this article on tornadoes for the Encyclopedia Americana an interesting assignment. Two copies of the commissioning agreement are enclosed, one copy of which should be filled out and returned to me.

The manuscript should come to 74 lines on the enclosed copy paper. A suggested outline is:

Introduction (what tornadoes are, their destructive power)	8 lines
Cause (conditions of formation, where such conditions occur)	20 lines
Nature (size, structure, wind speeds, duration, etc.)	25 lines
Study (how observed, possible preventative steps)	15 lines
Signature, affiliation, and titles of two or three books for further reading	6 lines

But this outline is intended only as a general guide. As for illustrations, we would have room for one dramatic photo that would show the funnel of a tornado very clearly. If you have specific recommendations, we shall be very glad to receive them; perhaps we should have one vertical and one horizontal photo to choose from. (If you have any photos from your own files, we shall reimburse you for their use.) Our photo researchers will also carry out a search for photos on their own.

With best wishes,

Sincerely,

*Steven Moll*

(Mr.) Steven Moll  
Science Editor



DEPARTMENT OF  
ATMOSPHERIC SCIENCE

STATE UNIVERSITY OF NEW YORK AT ALBANY  
1400 WASHINGTON AVENUE  
ALBANY, NEW YORK 12203

11 March 1970

Dr. Steven Moll  
Science Editor  
The Encyclopedia Americana  
595 Lexington Avenue  
New York, New York 10022

Dear Dr. Moll:

I wish to thank you for your letter of February 26th requesting that I prepare an article for The Encyclopedia Americana dealing with the subject of tornadoes.

I would be very pleased to do this for you, and I look forward to receiving from you a tentative outline, a commissioning agreement, and the copy paper.

Please let me know if you would be interested in using any illustrations for this article, and I shall begin looking around for good pictures.

Sincerely,

Bernard Vonnegut

BV:smp

# THE ENCYCLOPEDIA AMERICANA

575 LEXINGTON AVENUE, NEW YORK, N. Y. 10022



OFFICE OF THE EDITOR  
(Tel: 212-751-3600)

26 February 1970

Dr. Bernard Vonnegut  
State University of New York at Albany  
Atmospheric Sciences Research Center  
P.O. Box 7185  
Albany, New York 12224

Dear Dr. Vonnegut:

As part of the continuing revision program of the Encyclopedia Americana we are planning to include a new entry on TORNADO. We should be very pleased to have you prepare this article for us.

The manuscript is to be about 550 words long, and is intended to describe the nature and destructive power of tornadoes, as well as mentioning something about the study of these storms and the preventive measures taken against them. As you may recall from having written previously for the Americana, we are preparing our material for the interested layman rather than for the specialist in whatever area is concerned. I very much hope that an assignment of this nature will interest you.

The fee for the article is \$40, and we should like to receive the completed manuscript by May 4 if possible. However, we can discuss these terms further if you are interested. If you have any questions before deciding whether or not to accept, please let me know. (If you wish, you could call me collect at the above telephone number, extension 211.) On receiving a favorable reply I would send a tentative outline, a commissioning agreement, and the copy paper you would need. I look forward to hearing from you.

Sincerely,

*St. Moll*

Steven Moll  
Science Editor

# THE ENCYCLOPEDIA AMERICANA

575 LEXINGTON AVENUE, NEW YORK, N. Y. 10022



OFFICE OF THE EDITOR  
(Tel: 212-751-3600)

5 August 1970

Dr. Bernard Vonnegut  
Department of Atmospheric Sciences  
State University of New York at Albany  
1400 Washington Avenue  
Albany, New York 12203

Dear Dr. Vonnegut:

Enclosed is the edited version of your manuscript on tornadoes, for your inspection and approval. Please make changes directly on the copy, which should then be initialed and returned to me.

I added the phrase on line 5 of the first page because I wanted to get in at least some slight indication of the matter of air pressure. A query was raised as to the figures provided in the second paragraph. They seem somewhat high for the United States alone; are they world totals?

Thank you again for carrying out this assignment for the Americana. With best wishes,

Sincerely,

St Moll

Steven Moll  
Science Editor

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2 tense whirlwinds that are formed by severe thun-  
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8 Bernard Vonnegut  
9 Atmospheric Sciences Research Center  
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10 SUGGESTED FURTHER READING

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13 Oklahoma, 1958).

14 Inside the Tornado, Bernard Vonnegut, Natural  
15 History Magazine, Vol. LXXVII, No. 4, April,  
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# THE ENCYCLOPEDIA AMERICANA

575 LEXINGTON AVENUE, NEW YORK, N. Y. 10022



OFFICE OF THE EDITOR  
(Tel: 212-751-3600)

3 September 1970

Dr. Bernard Vonnegut  
Department of Atmospheric Sciences  
State University of New York at Albany  
1400 Washington Avenue  
Albany, New York 12203

Dear Dr. Vonnegut:

Thank you for the return of the approved edited copy of your article on TORNADO, with your corrections. I changed the statement as you wished, concerning "fine water drops" etc., and we are going ahead with the billion-dollar figure as originally stated.

The real reason I had for sticking in the phrase on the drop in air pressure, I suppose, is that this was always made a point of in the semi-tornado country where I grew up. We were supposed to keep at least two windows on opposite sides of the house open slightly, to permit the air pressure to equalize with pressure outside **if the tornado** passed overhead. And so on and so on. I don't know what reassuring figures there would be on house-survival-in-path-of-funnel for those who took such measures, but at least it seemed to be part of the folklore of tornadoes. And since **you said it is not inaccurate to mention the drop in air pressure, even if it is redundant, I'll leave the statement in.** (No tornado ever struck our house, by the way.)

It was a pleasure to have your assistance in preparing another article for the Americana.

With best wishes,

Sincerely,

*St Moll*

Steven Moll  
Science Editor