US Army Corps
of Engineers
North Central Division

Great Lakes Update

No. 119 June 2, 1995

Water and Climate Change

This is a continuation of the series we began last month on climate change. We will discuss some basics regarding "Greenhouse Gases." Again, this material is taken from "Reporting on Climate Change, Understanding the Science," published by the Environmental Health Center, National Safety Council, in November, 1994.

Almost all (99 percent) of Earth's atmosphere consists of two main gases: nitrogen (about 78 percent) and oxygen (21 percent, by volume). They play almost no role in regulating the climate. The remaining one per-cent or so of Earth's atmosphere is made of small amounts of a number of "trace" gases. One of the most abundant of these is argon, which for climate purposes can also be ignored. Other trace gases include water vapor, carbon dioxide, nitrous oxide, methane, chlorofluorocarbons (CFCs), and ozone -- all of which are involved in theories dealing with climate change. Trace gases are very important because pollution and other forces resulting from human activities can alter their proportions.

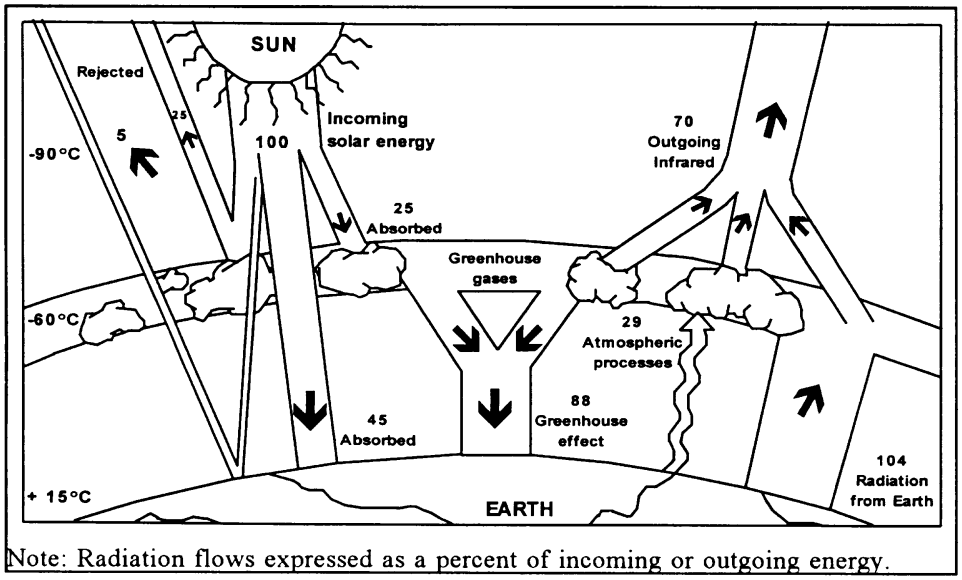
This and subsequent articles will look at some of the "radiatively active" trace gases -- those that absorb or reflect infra-red energy -- also known as the "greenhouse gases." The most important "gas" purported to cause greenhouse warming is not normally thought of as a gas at all: water (H_20). The water vapor in the atmosphere is essentially steam very thinly diluted among the gaseous nitrogen and oxygen molecules that make up about 99 percent of the atmosphere. Water vapor plays a critical role affecting both climate and weather. The amount of water vapor in the atmosphere is not uniform; it changes abruptly, often in a matter of a few hours, to cause, for example, thunderstorms.

It takes a considerable amount of energy to evaporate water. A molecule of water vapor "contains" much more energy than a molecule of liquid water. A lot of water evaporates every day, making it one of the most important "storehouses" of energy resident in the atmosphere and in the climate system.

Water loses energy when it condenses into clouds, or into larger drops which fall as rain. The energy does not disappear, but instead heats the atmosphere. Thus, energy is redistributed by the processes of evaporation and condensation.

When water forms as clouds, it "shades" the Earth's surface and lower atmosphere. In the Greenhouse analogy, rolling down a shade over the greenhouse would cool off the interior, just as it would a cool room warmed by the sun. (Cloud formation is an important process in the climate system, but is hard to quantify and model.) When clouds shade the Earth, some of the incoming solar energy is reflected back into space. Some also is absorbed by the clouds and reradiated upward and downward. Thus, some of the energy is caught at altitudes above the Earth's surface, but still in the atmosphere (see Figure 1).

Water vapor's "greenhouse effect" is explained by the fact that it is relatively transparent to shorter wavelengths of the light spectrum (the form of most incoming solar



Note: Radiation flows expressed as a percent of incoming or outgoing energy.

Figure 1 Earth's Radiation Energy Balance

Source: ***Office of Technology Assessment,*** **Changing by Degrees: Steps to Reduce Greenhouse Gases,** ***February 1991.***

energy) but readily absorbs longer wavelengths of light from the Earth's surface. This traps heat in the lower atmosphere (troposphere). As such, water vapor is analogous to the heat-trapping "glass" in the greenhouse, causing temperatures of the lower atmosphere to be greater than they would be without it.

Human activities both subract and add to atmospheric water vapor, but in amounts insignificant when compared to those resulting from natural processes. Water vapor is nonetheless important because its atmospheric-warming effects are huge, and because the effects are hard to quantify, model, and predict. In fact, the amount of water vapor in the atmosphere is determined by the climate at the same time that it strongly affects the climate -- a classic "feedback loop."

The next installment on this subject will talk about carbon dioxide and its relevance to climate change. Meantime, you are invited to turn to Page 3 to review some information on climate change. Assess each statement as "Fact," "Myth," or "Opinion." Our answers will be given in the next issue.

Meeting With the Public

The International Lake Superior Board of Control will hold a meeting with the public this month. The meeting is to inform you of the Board's responsibilities and current activities and to hear your comments and suggestions. The open house meeting will be at 7:00 p.m., Tuesday, June 27, 1995 at the Civic Center, 99 Foster Drive, Sault Ste. Marie, Ontario.

Do You Know?

The answer to last month's query is: Up to 25 million people in the United States and Canada obtain their drinking water from the Great Lakes.

This month's question is: How many ton-miles of water-borne freight is handled annually on the Great Lakes?

(a) Up to 10 million
(b) Up to 1 billion
(c) Up to 100 billion

The answer will be provided in the next Update.

Mailing List Changes

The mailing list for the Monthly Bulletin of Lake Levels for the Great Lakes and the Great Lakes Update is being revised. Please take a few minutes to review the information provided on Page 5, fill out the form provided and return it to the address shown.

Keith R. Santos, LTC
for **RICHARD W. CRAIG**
Colonel, EN
Commanding

Climate Change: Fact, Myth or Opinion

Last month we provided 12 statements about climate change. Statements 2, 4, 7, 8, 11, and 12 were facts; statements 1, 3, 5, 6, and 10 were myths; and statement 9 was opinion. Try your hand at the following statements:

1. The seas are rising -- and rising faster today than before the Industrial Revolution.
   Fact ____ Myth ____ Opinion ____

2. We are very certain of the temperature increase in the post-industrial era, because we have precise and consistent temperature measurements worldwide since 1850.
   Fact ____ Myth ____ Opinion ____

3. The world has already started warming significantly since the beginning of the industrial era.
   Fact ____ Myth ____ Opinion ____

4. It is possible that there could be a "runaway greenhouse effect" on Earth as a result of current human activity.
   Fact ____ Myth ____ Opinion ____

5. Ozone in the stratosphere benefits humans, because it protects Earth from too much of the harmful kinds of ultraviolet radiation.
   Fact ____ Myth ____ Opinion ____

6. CFCs can't deplete atmospheric ozone because they are heavier than air and therefore can't rise above the atmosphere.
   Fact ____ Myth ____ Opinion ____

7. Rather than aerosol sprays, vehicle air conditioners become the single largest use of CFCs in the U.S., accounting for 16 percent of total U.S. CFC use in 1989.
   Fact ____ Myth ____ Opinion ____

8. Computer models are theories, not facts. Models can tell us only the implications of what we think we already know about how natural climate processes work. They, too, must be verified.
   Fact ____ Myth ____ Opinion ____

9. Computer models can prove or disprove scientific theories.
   Fact ____ Myth ____ Opinion ____

10. Things can be predicted scientifically, so that the probability of their occurring is known. Global warming has been scientifically predicted.
    Fact ____ Myth ____ Opinion ____

Table 1

Possible Storm Induced Rises (in feet) at Key Locations on the Great Lakes June 1995

	Degrees of Possibility				
	20%	10%	3%	2%	1%
LAKE SUPERIOR					
Duluth	0.6	0.7	0.8	0.8	0.9
Grand Marais	0.5	0.6	0.7	0.8	0.9
Marquette	1.2	1.5	1.8	2.1	2.4
Ontonagon	0.7	0.9	1.2	1.4	1.7
Point Iroquois	0.7	0.9	1.0	1.1	1.1
Two Harbors	0.6	0.8	1.1	1.3	1.5
LAKE MICHIGAN					
Calumet Harbor	1.3	1.5	1.7	1.9	2.0
Green Bay	1.5	1.8	2.1	2.3	2.5
Holland	0.5	0.6	0.7	0.7	0.8
Kewaunee	0.7	0.8	1.0	1.1	1.2
Ludington	0.6	0.7	0.8	0.9	1.0
Milwaukee	0.9	1.1	1.3	1.4	1.6
Port Inland	0.9	1.1	1.4	1.5	1.7
Sturgeon Bay	0.7	0.8	0.9	1.0	1.1
LAKE HURON					
Detour Village	0.4	0.5	0.5	0.6	0.6
Essexville	1.4	1.6	1.8	2.0	2.1
Harbor Beach	0.6	0.7	0.9	1.0	1.2
Harrisville	0.5	0.6	0.7	0.8	0.9
Lakeport	0.8	1.0	1.3	1.5	1.8
Mackinaw City	0.6	0.7	0.8	0.8	0.9
LAKE ST. CLAIR					
St. Clair Shores	0.4	0.4	0.5	0.6	0.6
LAKE ERIE *					
Barcelona	1.1	1.2	1.4	1.5	1.6
Buffalo	2.1	2.4	2.8	3.0	3.3
Cleveland	1.0	1.2	1.5	1.8	2.0
Erie	1.0	1.1	1.2	1.3	1.3
Fairport	0.7	0.8	0.9	0.9	1.0
Fermi Power Plant	1.3	1.6	1.9	2.2	2.5
Marblehead	1.0	1.2	1.5	1.7	1.9
Sturgeon Point	1.3	1.6	1.8	2.1	2.3
Toledo	1.8	2.2	2.6	2.9	3.2
LAKE ONTARIO					
Cape Vincent	0.5	0.6	0.7	0.8	0.9
Olcott	0.3	0.4	0.5	0.7	0.8
Oswego	0.5	0.6	0.7	0.8	0.9
Rochester	0.5	0.5	0.6	0.7	0.8

* The water surface of Lake Erie has the potential to tilt in strong winds, producing large differentials between the ends of the lake.

Note: The rises shown above, should they occur, would be in addition to the still water levels indicated on the Monthly Bulletin. Values of wave runup are not provided in this table.

Dear Reader:

During the winter months many readers head for warmer climates without notifying us of their new address. As a result, their copies of the Monthly Bulletin are returned marked **"Postage Due"**. To eliminate the additional cost to Government and/or delay in receiving your copies, we are modifying our mailing list to allow for a reader to specify two seasonal addresses, if necessary.

Let us know what address(es) you would like your copy of the Monthly Bulletin to be delivered to during the months **May through October** and **November through April**. Please take a few moments to fill in the information requested in the blanks below, fold, seal with tape, and place a stamp as indicated and return this page, to the following address: **Department of the Army, Detroit District, Corps of Engineers, ATTN: CENCE-EP-HI (Bulletin), P.O. Box 1027, Detroit, MI 48231-1027**, as indicated on the reverse side.

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Milwaukee	0.7	0.8	0.9	1.0	1.1
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Buffalo	1.9	2.2	2.5	2.7	2.9
Cleveland	0.9	1.1	1.3	1.4	1.5
Erie	0.8	1.0	1.1	1.2	1.3
Fairport	0.6	0.6	0.7	0.8	0.9
Fermi Power Plant	0.9	1.5	3.0	4.6	6.7
Marblehead	0.8	0.9	1.0	1.1	1.1
Sturgeon Point	1.2	1.4	1.5	1.6	1.7
Toledo	1.6	1.9	2.3	2.6	2.8
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Great Lakes Basin Hydrology

During the month of June precipitation was below average on the Lake Superior, Michigan-Huron, Erie and Ontario basins. For the year to date, precipitation is about 7% below average for the entire Great Lakes basin. The net supply of water to ea[illegible] of the Great Lakes in June was below average. Table 2 lists June precipitation and water supply information for all of the Gr Lakes.

In comparison to their long-term (1918-1994) averages, the June monthly mean water level of Lakes Superior and Ontario were each 6 inches below average, while Lakes Michigan-Huron, St. Clair and Erie were 2, 6 and 6 inches above average respectively. Shoreline residents are cautioned to be alert whenever adverse weather conditions exist, as these could cause rapid short-term rises in water levels. Should the lakes approach critically high levels, further information and advice will be provided by the Corps of Engineers.

TABLE 2
GREAT LAKES HYDROLOGY[1]

PRECIPITATION (INCHES)								
BASIN	JUNE				YEAR-TO-DATE			
	1995[2]	Average (1900-1991)	Diff.	% of Average	1995[2]	Average (1900-1991)	Diff.	% of Average
Superior	1.3	3.3	-2.0	39	11.6	13.1	-1.5	89
Michigan-Huron	1.9	3.1	-1.2	61	14.0	14.6	-0.6	96
Erie	3.2	3.4	-0.2	94	17.5	17.1	0.4	102
Ontario	1.4	3.1	-1.7	45	12.7	16.7	-4.0	76
Great Lakes	1.9	3.2	-1.3	59	13.7	14.8	-1.1	93

LAKE	JUNE WATER SUPPLIES[3] (CFS)		JUNE OUTFLOW[4] (CFS)	
	1995[2]	Average (1900-1989)	1995[2]	Average (1900-1989)
Superior	72,000	158,000	66,000	78,000
Michigan-Huron	121,000	204,000	184,000[5]	193,000
Erie	21,000	30,000	212,000[5]	214,000
Ontario	21,000	42,000	234,000	261,000

[1]Values (excluding averages) are based on preliminary computations.
[2]Estimated.
[3]Negative water supply denotes evaporation from lake exceeded runoff from local basin.
[4]Does not include diversions.
[5]Reflects effects of ice/weed retardation in the connecting channels.

CFS = cubic feet per second.

For Great Lakes basin technical assistance or information, please contact one of the following Corps of Engineers District Offices:

For NY, PA, and OH:
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Cdr, Buffalo District
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Buffalo, NY 14207-3199
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For IL and IN:
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