WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR

GLOBAL CHANGE HYDROLOGY PROGRAM

BACKGROUND

The documentation of measurable changes in the Earth's atmosphere from satellite, atmospheric, and ground-based observations has made the public more aware of the potential effects of human activities on the global environmental. Among the most significant and frequently cited measurements are those documenting an increase in the concentration of atmospheric carbon dioxide (CO_2) and methane (CH_4) and a decrease in the concentration of stratospheric ozone. Carbon dioxide and methane have the ability to absorb energy reflected back from the Earth and are known as "greenhouse gases." Currently, the understanding needed to confidently predict future changes in the concentrations of these gases and the effect on climate, water resources, ecosystems, and society is inadequate.

Starting in 1988, several Federal agencies joined formally under the Committee on Earth and Environmental Sciences (CEES) to create the U.S. Global Change Research Program (USGCRP). Since the beginning of the USGCRP, the U.S. Geological Survey (USGS) has participated in particular aspects of the program that are consistent with its mission and for which it has specialized expertise. The Global Change Hydrology Program (GCHP) is a significant component of this USGS effort.

PURPOSE

The GCHP was begun in 1990 to develop data, understanding, and predictive capabilities related to water and associated aspects of carbon and the greenhouse gases as they interact with global systems. Water moves across and through the Earth in an endless cycle, playing a central role in many of the physical, chemical, and biological processes that regulate the Earth's environment. The movement of water regulates climate and, in turn, climate controls the movement of water. Consequently, changes in climate will certainly influence the occurrence of floods and droughts. Water is also a key regulator of the carbon cycle. The movement of carbon through the atmosphere, plants, soil, ground water, and rivers is significantly controlled by the movement of water. Thus, predicting the future concentrations of greenhouse gases (which contain carbon) is helped by understanding the hydrology, geochemistry, and ecology of lakes, wetlands, soils, the unsaturated zone, estuaries, permafrost, and river systems.

ACTIVITIES

Activities of the program focus on four major themes:

- Water and Carbon Cycle Studies—Field-oriented research on the movement of water and carbon between the land and the atmosphere.
- Sensitivity of Water Resources to Climate Variability and Change—Development of computer-modeling capabilities that can be used to predict how global climate changes can influence the availability of water in specific river basins.
- Studies of Past Hydrologic Variations—Studies of the behavior of hydrologic systems (rivers and aquifers) in response to past climatic variations and changes (from decades to hundreds of thousands of years).
- Global Modeling—Provide hydrological and geochemical expertise in efforts to develop predictive models of the global climate and global carbon systems.

ACCOMPLISHMENTS

During its first three years, a number of significant results and accomplishments have been produced by the GCHP, including:

- Completion of a study that developed methods of evaluating the sensitivity of water resources to

climate variability and change in the Delaware River Basin.

- Establishment of a series of intensive field investigations of water, energy, and biogeochemical budgets at five geographically and ecologically diverse research sites to improve understanding of water and carbon exchanges to and from the land surface.
- Discovery that the conversion of forests to agricultural land in tropical environments diminishes the ability of the soil to remove methane from the atmosphere. This may, in part, account for documented increases in atmospheric methane (CH_4).
- Development of a precisely-dated, 500,000-year long terrestrial climate record from the southwestern U.S. that challenges the concept that glacial/interglacial fluctuations in climate are due to variations in the Earth's orbit and rotation.
- Demonstration of a conceptual inconsistency in the way that evapotranspiration is modeled in general circulation models. Computer modeling experiments have demonstrated that resolving this conceptual problem results in more realistic simulations. Specifically, soil moisture amounts during the dry season increase in the revised simulations, while air temperatures become cooler.
- Discovery that bacteria in an oxygen-free environment degrades freons (CFC-11 and CFC-12), the fluorinated hydrocarbons used chiefly as refrigerants, which might play a significant long-term role in reducing the atmospheric concentration of these heat-absorbing, ozone-destructive gases.

In addition, the research supported by the GCHP has resulted in the publication of nearly 100 scientific articles in journals and books, some of which follow:

Hostetler, S., and Benson, L.V., 1990, Paleoclimatic implications of the high stand of Lake Lahontan derived from models of evaporation and lake level: Climate Dynamics, v. 4, p. 207–217.

Sundquist, E.T., 1990, Long-term aspects of future atmospheric CO_2 and sea-level changes, *in* Revelle, R., ed., Sea Level Change, Washington, National Research Council, p. 193–207.

Swetnam, T.R., and Betancourt, J.L., 1990, Fire-Southern Oscillation relations in the southwestern United States: Science, v. 24, p. 1017–1020.

Gloersen, P., and Campbell, W.J., 1991, Recent variations in Arctic and Antarctic sea-ice covers: Nature, v. 352, p. 33–36.

Hay, L.E., et al., 1991, Simulation of precipitation by weather-type analysis: Water Resources Research, v. 27, p. 493–501.

McCabe, G.J., and Wolock, D.M., 1991, Effects of climatic change in the Delaware River basin on the Thornthwaite moisture index: Climatic Change, v. 20, p. 143–153.

Hostetler, S.W., and Giorgi, F., 1992, Use of a regional atmospheric model to simulate lake-atmosphere feedbacks associated with Pleistocene Lakes Lahontan and Bonneville: Climate Dynamics, v. 7, p. 39–44.

Oremland, R.S., and Culbertson, C.W., 1992, Importance of methane-oxidizing bacteria in the methane budget as revealed by the use of a specific inhibitor: Nature, v. 356, p 421–423.

Sarmiento, J.L., and Sundquist, E.T., 1992, Revised budget for the oceanic uptake of anthropogenic carbon dioxide: Nature, v. 356, p. 589–593.

Winograd, I.J., et al., 1992, Continuous 500,000-year climate record from vein calcite in Devils Hole, Nevada: Science, v. 258, p. 255–260.

Striegl, R.G., et al., 1992, Consumption of atmospheric methane by desert soils: Nature, v. 357, p. 145–147.

Milly, P.C.D., 1992, Potential evaporation and soil moisture in general circulation models: Journal of Climate, v. 5, p. 209–226.

Further information regarding the GCHP and its products can be obtained from:

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