# ACTIVITY: The Atmospheric Pipeline

**I. INTRODUCTION:** Atmospheric storm systems can be a nuisance for picnics, a welcome relief to a drought, or disastrous flooding - bringing everything from joy to inconvenience to untold hardship and destruction. These storms are an integral part of the Earth's weather and climate system and the water cycle. A strong spring storm in 1993 brought widespread rain and heavy snow to the Gulf and East Coasts of the United States. Some news reports termed it the "Blizzard of 1993" or even the "Storm of the Century". Several states were plagued by crippled transportation due to deep, wet snows and widespread flash flooding, both from heavy rains and subsequent snow-melt. In all over 200 people died from this one storm.

The following activity looks at this storm to examine the atmosphere's ability to transport water substance. Liquid water is evaporated from the surface. Atmospheric circulation patterns transport this water vapor to other locations where storm systems convert the vapor back to its liquid and solid phases forming clouds and precipitation. The precipitation is returned to the surface, renewing our fresh water resources and completing the cycle. This activity will allow you to calculate the approximate amount of water that falls from a major storm system. The accompanying map shows selected total precipitation amounts (in inches) from the storm. Snowfall amounts have been converted to comparable rainfall amounts. In most areas the ground was already saturated or still frozen, so that precipitation and melt-water become "runoff".

## II. OBJECTIVES:

- To calculate the approximate volume of storm precipitation;
- To estimate the surface water evaporated to supply the storm;
- To evaluate the amount of fresh water runoff from the storm;
- To explain how topographic features affect precipitation amounts;

## III. PROCEDURE:

1. From the displayed total precipitation amounts on the map, estimate to the nearest half inch (0.5, 1.0, 1.5, etc.) the average amount of precipitation for the entire area of each state.
    - Ignore states where no precipitation is given.
    - Fill in the column in the data table with the averages from each state.

2. Multiply the number across each row of the data table to obtain products.
    - The approximate state areas, in square miles are given.
    - The area times the precipitation depth will be the water volume in given units of square miles inches.

3. Sum the products for the states listed in the table to obtain a grand total volume.

4. Complete the activities in the **Computation** section and in the **Analysis and Comprehension** section.

## IV. DATA TABLE: AVERAGE PRECIPITATION AMOUNTS PER STATE

| STATE | AREA ($mi^2$) | AVG. PRECIP. (in) | PRODUCT |
|---|---|---|---|
| ALABAMA | 51,000 | | |
| CONNECTICUT | 5,000 | | |
| DELAWARE | 2,000 | | |
| FLORIDA | 54,000 | | |
| GEORGIA | 58,000 | | |
| KENTUCKY | 40,000 | | |
| LOUISIANA | 45,000 | | |
| MAINE | 31,000 | | |
| MARYLAND | 10,000 | | |
| MASSACHUSETTS | 8,000 | | |
| MISSISSIPPI | 47,000 | | |
| NEW HAMPSHIRE | 9,000 | | |
| NEW JERSEY | 7,000 | | |
| NEW YORK | 47,000 | | |
| NORTH CAROLINA | 49,000 | | |
| OHIO | 41,000 | | |
| PENNSYLVANIA | 45,000 | | |
| RHODE ISLAND | 1,000 | | |
| TENNESSEE | 41,000 | | |
| TEXAS | 262,000 | | |
| VERMONT | 9,000 | | |
| VIRGINIA | 40,000 | | |
| WEST VIRGINIA | 24,000 | | |

GRAND TOTAL: ____________________

V. COMPUTATION: Compute the answers to the problems below and write them in the spaces provided.

1. The Gulf of Mexico with a surface area of approximately 600,000 square miles serves as a vapor source region for many eastern U.S> storms. If you assume that all the water for this storm was originally evaporated from the Gulf of Mexico, the depth of water needed may be found by dividing the grand total above by 600,000 ($6 \times 10^5$). This is the depth equivalent of water evaporated from the entire Gulf area in inches.

Equivalent depth of evaporated water ______________________inches

2. To determine the weight of water precipitated from this storm:
   - Multiply the grand total volume by 2,323,200 ($2.3232 \times 10^6$) to convert the total into cubic feet. [The multiplying number is the number of square feet in a square mile divided by 12 inches per foot.]
   - Multiply this total by 62.4 pounds per cubic foot (density of fresh water) to obtain the total weight of water precipitated by the storm.

Total weight of storm water ______________________________ pounds

3. To determine the volume of fresh water runoff from this:
   - Divide the total cubic feet of water found above by $1.47 \times 10^{11}$, the number of cubic feet in a cubic mile.
   - This number of cubic miles of water may then be compared to the 116 cubic mile volume of fresh water in Lake Erie by taking the number of cubic miles of storm water and dividing by 116. This is the equivalent fraction of Lake Erie that would be filled by water running off from this one major storm.

Volume of fresh water runoff _____________________ cubic miles.

Equivalent fraction of Lake Erie volume _______________________.

## VI. ANALYSIS AND COMPREHENSION:

1. What is the greatest amount of precipitation (at a single station) shown on the map?

2. In what state did it occur?

3. Is the heaviest precipitation concentrated in a single area or does it occur in several disconnected areas?

4. Using a topographic or relief map, can you find a general relationship between elevation and the larger precipitation amounts?

5. What does this relationship appear to be?

6. How does your calculated average depth of water evaporated from the Gulf of Mexico compare to the average depths of precipitation you estimated for the states?

7. How do the areas of the Gulf of Mexico and the Eastern United States compare, roughly?

8. What does this imply about the transport of water from ocean to land locations by storms?

9. Is it reasonable that this transport occur from warm tropical ocean areas to higher cooler land areas? Why or why not?

10. Atmospheric storms differ in intensity, frequency and location around the globe. Assume that this storm is somewhat typical in moving water substance, and was the sole disturbance occurring during this one week. How much total depth of water would be evaporated/precipitated in a year?

# TOTAL PRECIPITATION (INCHES) AS A RESULT OF SPRING STORM MARCH 11-13,1993