Investigation IV: Seasonal Precipitation and Seasonal Surface Runoff in the US

**Purpose**
Students will consider the seasonality of precipitation and surface runoff and think about how the time of year can impact these variables. Students will observe the seasonal surface runoff and consider how this process changes through the seasons. They will compare the seasonal data across the different parameters and consider other variables that can influence the rates.

**Overview**
Students should be ready to consider the seasonality of precipitation and surface runoff, having made predictions about precipitation across the US and explored the patterns of annual precipitation, evaporation and surface runoff during the previous investigation. In this investigation, students will explore the seasonality of precipitation and surface runoff and then begin to consider some regions where the amounts of seasonal precipitation and surface runoff are not consistent. Students will be collecting quantitative data and recording it in a data table and using these data to support the answers they give to questions included in the activity. Students will begin to recognize the effect of factors such as type of precipitation, ground cover and topography on the patterns of seasonal precipitation and surface runoff.

**Student Outcomes**
- Discover how precipitation varies on a seasonal (winter, spring, summer, fall) basis in different regions of the US.
- Discover how surface runoff varies on a seasonal (winter, spring, summer, fall) basis in different regions of the US.
- Compare and analyze maps showing different subsets of data with Map Tables.

**Time**
One 45-50 minute class period

**Level**
Secondary

**Materials and Tools**
- Computers (1 computer for each student preferred) with access to the Internet (access to url http://fieldscope.us/fs3).
- Student guide and student response sheets (optional)

**Preparation**
Make copies of student pages as necessary

**Prerequisites**
Investigation II: Annual Precipitation in the United States and Investigation III: Annual Precipitation, Evaporation and Surface Runoff in the US

Review the following with students before doing activity.

**Background**
Does the same amount of precipitation fall during winter, spring, summer, or fall where you live? In Investigation II students examined total annual precipitation. In this investigation students will look at how precipitation varies on a seasonal basis in different regions of the US.

In Investigation III students learned about the patterns of annual surface runoff. In this investigation students will examine patterns of seasonal surface runoff. We will try to understand the timing and quantity of surface runoff and compare it to seasonal precipitation patterns.

Seasons are defined by calendar months in this investigation rather than by solar dates.
- Winter—December, January, February
- Spring—March April, May
- Summer—June July, August
- Fall—September, October, November
Teaching Notes

As part of this investigation students fill out a table of seasonal precipitation and surface runoff for four pre-selected cities as well as three of their choice. As in Investigation III, an extension of this activity is to graph the data using Excel or other graphing/charting program. One important relationship for them to observe is how precipitation changes seasonally in the different cities as well as how seasonal surface runoff is affected by seasonal precipitation.

An Excel spreadsheet has been created for this purpose named Water Availability.xls and it available for download at http://www.globe.gov/projects/watersheds/h2oavailability. After downloading and opening, click on the Investigation IV tab at the bottom of the sheet to open the appropriate table and chart. Blank cells are in the table to add the students selected cities. Below is an example of the data from the four pre-selected cities in the Investigation. Because of the difference in scales, 0-60 cm for precipitation and 0-6 cm for surface runoff, it may be better to have students create two separate graphs (See figures 1 and 2).

![Figure 1, Seasonal Precipitation (cm)](image1)

![Figure 2, Seasonal Surface Runoff (cm)](image2)
Questions:
1. During which season does the place where you live receive the greatest amount of precipitation? The least amount?

   *Student answers will vary depending on location.*

2. During which season do you think the Rocky Mountains in Colorado receive the greatest amount of precipitation? Which season do you think is the wettest for Orlando, Florida? Explain your reasoning for each answer.

   *Student answers will vary.*

3. What is the range of values for Seasonal Precipitation shown on the scale bar at the bottom of each of the maps in the map table? Why do you think this range is different from the range of 0 to 150 cm used in Investigation II: Annual Precipitation?

   *Seasonal precipitation values range from 0-40 cm on the seasonal precipitation map table scale bar. The range is different from the range for annual precipitation because each pane of the map table considers one quarter of the year.*

4. Record the amount of precipitation by season in the data table below. You should write in the name of your city in the first row of the data table and the names of the two cities you chose in Investigation III for the last two rows.

<table>
<thead>
<tr>
<th>City</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denver</td>
<td>2.9</td>
<td>14.1</td>
<td>15.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Seattle</td>
<td>41.8</td>
<td>24.6</td>
<td>8.6</td>
<td>29.5</td>
</tr>
<tr>
<td>Miami</td>
<td>12.4</td>
<td>24.6</td>
<td>55.2</td>
<td>40.7</td>
</tr>
<tr>
<td>Tucson</td>
<td>7.9</td>
<td>3.8</td>
<td>13.2</td>
<td>7.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>City</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.17</td>
<td>0.44</td>
<td>0.35</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td>1.0</td>
<td>0.23</td>
<td>0.93</td>
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<tr>
<td></td>
<td>0.19</td>
<td>0.34</td>
<td>0.61</td>
<td>0.70</td>
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<tr>
<td></td>
<td>0.29</td>
<td>0.19</td>
<td>0.50</td>
<td>0.26</td>
</tr>
</tbody>
</table>

5. Which regions of the country have the highest amounts of winter precipitation? The lowest amount?

   *The highest winter precipitation amounts are observed in the Pacific Northwest and the Northern Rocky Mountain regions. The lowest winter precipitation amounts are found in the Northern and Central Plains States. Examples of these extremes include Seattle with 30.5 cm of precipitation in the winter and Bismarck, ND with 3.3 cm of winter precipitation.*
6. During which season(s) does the Pacific Northwest appear to get high amounts of precipitation?

The Pacific Northwest receives the highest amounts of precipitation during the winter with 30.5 cm, however it receives high amounts during all seasons with the exception of summer. (Spring 20.1 cm and fall 29.5 cm.)

7. Describe the seasonal precipitation patterns for the Southeast region.

Portions of the Southeast receive high amounts of rainfall all year, but fall appears to be the overall driest season. For example, Jackson, MS receives 36.7 cm in the winter, 37.0 cm in the spring, 32.4 cm in the summer and 27.6 cm in the fall. The Mississippi River portion of the region receives high precipitation during winter and spring. Florida and the Gulf Coast receive high precipitation primarily during the summer. Orlando receives 62.0 cm in the summer but only 22.0 cm in the spring.

8. Which regions receive high amounts of precipitation (>=20 cm) during the majority of the seasons throughout the year?

The Southeast receives a high amount of precipitation all year round as well as the Northeast. Most of the Midwest receives high precipitation in the spring and summer, but it decreases in the fall and winter.

9. Which regions receive low amounts (<20 cm) of precipitation year round?

The Desert Southwest receives low amounts of precipitation year-round. For example, students should note that from the data table that Phoenix receives a high of 6.1 cm in the winter and low of 3.0 cm in the spring.

10. Which regions have the highest surface runoff during the winter?

Areas with high winter surface runoff include the Southeast, the Pacific Northwest, the Rocky Mountain West, the upper part of the Northeast, and the region around the Great Lakes. Examples include: 3.7 cm in Seattle, around 6 cm in Maine, 5 cm in northern Wisconsin and over 10 cm in some areas of the Rocky Mountains.

11. Record the amount of surface runoff by season in the table in Question #4.

See data table

12. During which season is surface runoff lowest across the US? Highest?

As a whole, surface runoff is lowest during summer and fall. Surface runoff is highest during winter and spring.

13. Explain why you think the patterns of surface runoff you described in question 12 exist.

For many, though not all areas, high surface runoff occurs in the same time period when there is high precipitation. The high amounts of surface runoff are accentuated in the spring by snowmelt fed runoff.

14. How are the patterns of seasonal precipitation and season surface runoff similar across the US? How are they different?

There are some similarities; such as the Southeast has high precipitation and high surface
runoff, but in other places, like the Rocky Mountain West, there is high runoff when there is only moderate precipitation. So while there are some similarities, the relationship is not perfect, thus raising the issue that other factors must influence the amount of surface runoff.

15. What factors and processes do you think account for the high surface runoff in the Rocky Mountains during the winter and spring?

*Most of the precipitation that falls in the Rocky Mountains during winter and spring is snow, though rain does occur at lower elevations. Much of this precipitation apparently runs off as surface water, perhaps because of the steep terrain and other geologic factors. Also, water that infiltrates into the ground high up in the mountains reappears as surface water in the lower elevations of the mountains.*

16. How are the patterns of summer / fall precipitation and summer / fall surface runoff similar across the US? How are they different? (Do high amounts of precipitation coincide with high amounts of surface runoff? Do low amounts of precipitation coincide with low amounts of surface runoff?)

*In general, it appears that high runoff areas are also high precipitation areas, although there are exceptions. For example Florida receives high amounts of precipitation in the summer, but has low total surface runoff. The Rocky Mountain region has higher surface runoff in the summer months than fall in general. Areas with low annual precipitation tend to have low amounts of surface runoff.*

17. How is the pattern of precipitation and surface runoff for the summer / fall seasons in the Rocky Mountains different than for the winter / spring seasons?

*Most of the precipitation the Rocky Mountain region receives during the winter and spring is snow. The surface runoff is highest during the spring when the snow melts. Residual snowmelt and later spring storms contribute to the elevated amount of summer surface runoff for the region. Precipitation and surface runoff amounts decline again in the fall.*