first Rensselaer expedition, in 1826, was a geological tour during which faculty and students traveled the entire length of the Erie Canal. The students gave free science lectures to townspeople along the way, thus spreading awareness of the school and advancing their own skills at the same time.

Eaton's influence extended beyond the Rensselaer School. Many of his pedagogical innovations were reflected in the Troy Female Seminary, a nearby school managed by his friend Emma Willard, and he wrote widely used textbooks in botany, zoology, chemistry, and geology. Between 1817 and 1840, his *Manual of Botany* went through eight editions. Many of the graduates of Rensselaer and Troy Female Seminary became schoolteachers who encouraged science curriculums in the schools where they taught.

Eaton's own public lectures also promoted a wider interest in science, while his lobbying the state legislature helped to bring about the New York Natural History Survey from 1836 to 1842, an extensive tracing of the geological and natural land formations and resources of the state. Eaton died on May 10, 1842, in Troy, New York.

Charles Boewe

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Espy, James Pollard (1785–1860)

Known as the "Storm King" or "Storm Breeder" for his request to the U.S. government for funds to conduct rainmaking experiments (he was turned down), the meteorologist James Pollard Espy contributed significantly to the early understanding of thermodynamics, cloud formation, and movement of air within storms. Born on May 9, 1785, in Westmoreland County, Pennsylvania, and raised in Kentucky and Ohio, Espy initially studied classical languages and law. In 1817, he moved to Philadelphia and began working at the Franklin Institute, where his interests and work shifted to meteorology.

In 1834, while serving as chair of a joint committee of the American Philosophical Society at the Franklin Institute, Espy established a network of weather stations, which, by 1843, grew to 110 in number. In 1842, Espy unsuccessfully lobbied Congress for a national weather service. He was, however, appointed meteorologist for the U.S. government under the office of the U.S. Army surgeon general and, later, the U.S. Navy. (The first national weather service was formed in 1870 as part of the U.S. Army Signal Service, after petitioning by Increase A. Lapham, who had been one of Espy's observers.)

In 1835, Espy co-founded the Franklin Kite Club, whose members met weekly to conduct scientific kite-flying experiments. Espy was known among his peers as being steadfast and outspoken. In 1838, he made a formal request before Congress for funding to conduct rainmaking experiments that would involve setting a series of controlled wildfires in the western United States in the hope of spawning rain over the eastern portion of the country. Congress did not approve the request, not for logistical or scientific reasons but due to a lack of funds.

Espy was one of the first to conduct scientific surveys of storm damage. In 1835, along with fellow meteorologist and rival theorist William Redfield, he surveyed the damage caused by a tornado that struck New Brunswick, New Jersey. Espy theorized that, based on the alignment of trees uprooted by the tornado, its winds must have spiraled inward.

The differing views of Espy and Redfield on the nature of wind rotation in storms made them the focus of an ongoing public debate during the 1830s known as the "storm controversy." While Redfield claimed that storm systems consisted of winds that rotate counterclockwise in a circular manner around the storm's center, Espy argued that storms were driven by thermodynamics, acting like large chimneys with air rushing toward the center from all directions and then rising upward.

While some aspects of Espy's theory were flawed, others were correct, including his concept of convection: warm rising air cooling, condensing, and releasing latent heat to form clouds and promote storm development. Espy described

his theory in his seminal work *The Philosophy of Storms,* published in 1841. Later in the decade, Espy was instrumental in establishing a "Circular on Meteorology," which proposed a plan to use the telegraph to warn of approaching storms. Espy died in Cincinnati, Ohio, on January 26, 1860.

Sean Potter

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Geologic Time

Geologic time is a chronological concept invented by European scientists and refined by geologists from the United States and around the world as a means of describing Earth's history. Often shown in the form of a time scale, this scientific tool is continuously modified as increments of geologic time are more precisely defined. The concept of geologic time was chiefly the work of the nineteenth-century British Earth scientist Charles Lyell; he relied heavily on ideas developed in the preceding two centuries by Danish scholar Nicholas Steno and Scottish scientist James Hutton. Steno and Hutton proposed the theories of stratigraphic superposition, which posits that the deepest layers of sediment are the oldest, and uniformitarianism, which posits that geological phenomena have the same causes and effects throughout natural history. In 1913, British geologist Arthur Holmes created the first geologic time scale based on radiometric dating, which is the estimate of the age of a geologic sample based on the rate of decay of chemical isotopes.

The geologic time scale divides Earth's roughly 4.5 billion years of existence into increments known as *eons, eras, periods, epochs,* and *ages.* The longest of these divisions are the four *eons*—the Hadean, Archaen, Proterozoic, and Phanerozoic. Within the most recent 500 million years, increments called *eras* span hundreds of millions of years. *Periods* are subdivisions lasting tens of millions of years. The shortest of the increments are *epochs,* which are stratigraphic units of time, and ages, which cover periods in the development and evolution of life. The divisions or subdivisions of the geologic time scale are named after specific geographic locations where archetypal rocks of a particular age were first studied, or where certain rock units, often fossil bearing, that exemplify a particular phase of geologic history are found. The original elements of the geologic time scale were named principally after important British and European geologic locations. With the growth of geological science in the United States during the nineteenth century, American scientists began to have a greater influence on the geologic time scale and added several epochs and stages that were representative of the North American geologic landscape. In 1869, Alexander Winchell, a geologist and University of Michigan professor, formally proposed a new epoch within the existing Carboniferous Period: the Mississippian, represented by a thick layer of limestone laid down in a shallow sea that existed roughly 340 million years ago in what is now the Mississippi River Valley region. Henry Shaler Williams, a Cornell University professor of paleontology, divided the Carboniferous Period into the Pennsylvanian and Mississippian Epochs in 1891. Throughout the nineteenth century, other American scientists added North American names to the geological time scale, until it differed quite markedly from the European version.

In 1977, the International Union of Geological Sciences created the International Commission on Stratigraphy. With the aim of making the geologic time scale more descriptive, more precise, and more international in scope, the commission set about establishing a globally applicable stratigraphic scale. It periodically publishes updates on the standard geologic time scale and maintains a detailed Web site on the subject.

Todd A. Hanson

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