"Tornado Alley"

IMAX Film

Theme: Documenting and Predicting Tornadoes!

The educational value of NASM Theater programming is that the stunning visual images displayed ***engage*** the interest and desire to learn in students of all ages. The programs do not substitute for an in-depth learning experience, but they do facilitate learning and provide a framework for additional study elaborations, both as part of the Museum visit and afterward.

Traversing the "severe weather capital of the world," "Tornado Alley" documents two unprecedented missions seeking to encounter one of Earth's most awe-inspiring events—the birth of a tornado. Filmmaker Sean Casey's personal quest to capture the birth of a tornado with a 70mm camera takes viewers on a breathtaking journey into the heart of the storm. A team of equally driven scientists, the VORTEX2 researchers, experience the relentless strength of nature's elemental forces as they literally surround tornadoes and the supercell storms that form them, gathering the most comprehensive severe weather data ever collected. This science adventure reveals the beauty and the power of some of our planet's most extreme—and least understood—weather phenomena.

"Tornado Alley" showcases the teamwork that makes scientific discovery and advancement possible. In this case, an international team of scientists have joined together to pool their resources and efforts in an attempt to understand tornadogenesis—the birth of a tornado from a supercell storm cloud. They converge on the area of the United States known as Tornado Alley during the prime tornado seasons of 2009 and 2010.

Learning Goals for K-12 Students:

- To understand where Tornado Alley is located
- To understand the tools that scientists use to study tornadoes
- To understand how scientists work together to gather data, make observations, and draw conclusions about severe weather events.

Learning Elaboration While Visiting the National Air and Space Museum

An essential connection between *"Tornado Alley"* and the Steven F. Udvar-Hazy's collection is the understanding of how all types of weather impact aviation. Airplanes are designed to be able to fly through, around or above various weather phenomena. You might also consider visiting the Lighter than Air gallery at the National Air and Space's Museum on the National Mall related to weather monitoring.

National Science Education Standards

"Tornado Alley" can be used to support student learning as called for by the National Science Education Standards. The following presentation offers details of where the content aligns.

UNIFYING CONCEPTS AND PROCESSES – K-12

STANDARD: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

SYSTEMS, ORDER, AND ORGANIZATION

The natural and designed world is complex; it is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions for the convenience of investigation. The units of investigation can be referred to as "systems." A system is an organized group of related objects or components that form a whole.

EVIDENCE, MODELS, AND EXPLANATION

Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work.

CONSTANCY, CHANGE, AND MEASUREMENT

Although most things are in the process of becoming different—changing—some properties of objects and processes are characterized by constancy, including the speed of light, the charge of an electron, and the total mass plus energy in the universe.

Changes might occur, for example, in properties of materials, position of objects, motion, and form and function of systems. Interactions within and among systems result in change. Changes vary in rate, scale, and pattern, including trends and cycles.

CONTENT STANDARD D – EARTH AND SPACE SCIENCE

GRADES K-4:

CHANGES IN THE EARTH AND SKY

- The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.
- Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.

GRADES 5-8:

STRUCTURE OF THE EARTH SYSTEM

- The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement influence local weather.

GRADES 9-12:

ENERGY IN THE EARTH SYSTEM

- Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

CONTENT STANDARD E – SCIENCE AND TECHNOLOGY

GRADES K-4:
UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems. Trying to determine the effects of solutions helps people avoid some new problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results. This understanding focuses primarily on teams working together and secondarily, on the combination of scientist and engineer teams.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

GRADES 5-8:
UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed.
- Technology also provides tools for investigations, inquiry, and analysis.

GRADES 9-12:
UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

- Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.
- Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt, and fulfill human aspirations. Technological solutions may create new problems. Science, by its nature, answers questions that may or may not directly influence humans. Sometimes scientific advances challenge people's beliefs and practical explanations concerning various aspects of the world.

CONTENT STANDARD F – SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

GRADES K-4:

CHANGES IN ENVIRONMENTS

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and their quality of life.
- Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad. Some environmental changes occur slowly, and others occur rapidly.

SCIENCE AND TECHNOLOGY IN LOCAL CHALLENGES

- People continue inventing new ways of doing things, solving problems, and getting work done. New ideas and inventions often affect other people; sometimes the effects are good and sometimes they are bad. It is helpful to try to determine in advance how ideas and inventions will affect other people.

GRADES 5-8:

NATURAL HAZARDS

- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids.

RISKS AND BENEFITS

- Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions).

SCIENCE AND TECHNOLOGY IN SOCIETY

- Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.
- Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.

GRADES 9-12:

PERSONAL AND COMMUNITY HEALTH

- Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological—that can reduce and modify hazards.

NATURAL AND HUMAN-INDUCED HAZARDS

- Some hazards, such as earthquakes, volcanic eruptions, and severe weather, are rapid and spectacular.
- Natural and human-induced hazards present the need for humans to assess potential danger and risk. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

CONTENT STANDARD G – HISTORY AND NATURE OF SCIENCE

GRADES K-4:
SCIENCE AS A HUMAN ENDEAVOR

- Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood. Science will never be finished.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

GRADES 5-8:
SCIENCE AS A HUMAN ENDEAVOR

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.

NATURE OF SCIENCE

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

GRADES 9-12:
SCIENCE AS A HUMAN ENDEAVOR

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.

NATURE OF SCIENTIFIC KNOWLEDGE

- Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public. Explanations on how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific.