## COMPETENCY 1.0 UNDERSTAND THE GENERAL RELATIONSHIPS AND COMMON THEMES THAT CONNECT MATHEMATICS, SCIENCE, AND TECHNOLOGY.

### SKILL 1.1 Analyze similarities among systems in mathematics, science, and technology (e.g., magnitude and scale, equilibrium and stability, optimization)

Math, science, and technology have common themes in how they are applied and understood. All three use models, diagrams, and graphs to simplify a concept for analysis and interpretation. Patterns observed in these systems lead to predictions. Another common theme among these three systems is equilibrium. Equilibrium is a state in which forces are balanced, resulting in stability. Static equilibrium is stability due to a lack of changes and dynamic equilibrium is stability due to a balance between opposite forces. Scale is a ratio of size. For example, a map may have a scale of true miles per every inch drawn on the map. A model drawn to scale is a representation of something that is larger or smaller than its actual size. There is also the very literal interpretation of scale. In this context the scale would be used to measure mass, and would often be called a balance.

### SKILL 1.2 Apply concepts and theories from mathematics, biology, chemistry, and physics to an Earth Science system

#### Earth Science and Biology

Over the course of Earth's history, living things have been greatly affected by Earth processes. Volcanic eruptions, plate tectonics, and climate change have affected whether living things have survived or how they have had to adapt in order to survive. At least four of the major mass extinctions have been caused by a climatic change triggered by some Earth event interconnecting geology, meteorology, and biology. The working explanation for the Cretaceous Tertiary extinction, the extinction that killed dinosaurs, is a climate change triggered by a large asteroid hitting the Earth 65 mya (million years ago). This impact threw great amounts of dust into the atmosphere causing a cool down of the climate. It is also believed that this impact may have triggered massive volcanic eruptions contributing to the cooling effect. In this extinction, many marine families and some of the land vertebrae went extinct. There is a debate as to what caused the worst mass extinction of Earth's history, the Permian Triassic extinction, which occurred 251 mya. The working theories include a meteorite impact and massive volcanic eruptions. During this time, 95% of all species were killed. The remaining species had to adapt to the cooling climate in order to survive.

Earth processes have also affected how humans live. The most fertile land for farming is at the base of volcanoes. We have developed technologies to irrigate farmland, build “safe” buildings in earthquake prone areas, and prevented low lying areas from flooding. Currently, human impact on the environment is being widely criticized.

**Earth Science and Chemistry**

Earth science and chemistry are tightly woven. In geology, the chemical composition of the rocks and the temperature and pressure at which crystals form are an obvious connection between chemistry and Earth science. In addition, chemistry and oceanography are connected inherently. The salinity of Earth’s oceans are affected by the temperature at which water freezes, the density of water, and the solubility of certain chemical compounds. Chemistry and meteorology are connected through the chemical makeup of the atmosphere and the effects that human released chemicals have on the atmosphere (i.e. CFC’s effect on the ozone layer and carbon dioxide’s role in climate change).

**Earth Science and Physics**

Earthquakes, plate tectonics, and meteorology are all related to physics. Fault production and earthquakes are caused by large-scale plate tectonics forming small-scale zones of weakness in the crust. The pressure builds up along fault lines due to increases in fault stress. At some point in time, the stress on the fault line will exceed the static frictional force of the fault line, and seismic waves will be released. The frictional force and the dynamics of the Earth’s motion during earthquakes are all related to physics.

Meteorology and physics are closely related. Changes in atmospheric pressure cause winds, updrafts, and storms. These pressure changes are caused by changes in temperature. Warm, moist air rises because it is less dense than the air surrounding it. As air rises and cools, it condenses, thus forming cloud systems. When meteorologists predict the weather, the physics of the interactions between volume, humidity, temperature, and pressure are studied in detail.

**Earth Science and Mathematics**

Mathematics can be used to solve many problems in Earth science. Examples of how mathematics can be used in Earth science include finding the relative humidity, the distance to stars, the residence time of materials in the soil, and discharge of water.

## SKILL 1.3 Analyze the use of Earth science, mathematics, and other sciences in the design of a technological solution to a given problem

Science and technology are interdependent as advances in technology often lead to new scientific discoveries and new scientific discoveries often lead to new technologies. Scientists use technology to enhance the study of nature and to solve problems that nature presents. Technological design is the identification of a problem and the application of scientific knowledge to solve the problem. While technology and technological design can provide solutions to problems faced by humans, technology must exist within nature and cannot contradict physical or biological principles. In addition, technological solutions are temporary and new technologies typically provide better solutions in the future. Monetary costs, available materials, time, and available tools also limit the scope of technological design and solutions. Finally, technological solutions have intended benefits and unexpected consequences. Scientists must attempt to predict the unintended consequences and minimize any negative impact on nature or society.

The problems and needs, ranging from very simple to highly complex, that technological design can solve are nearly limitless. Disposal of toxic waste, routing of rainwater, crop irrigation, and energy creation are but a few examples of real-world problems that scientists address or attempt to address with technology. The technological design process has five basic steps:

1. Identify a problem
2. Propose designs and choose between alternative solutions
3. Implement the proposed solution
4. Evaluate the solution and its consequences
5. Report results

After the identification of a problem, the scientist must propose several designs and choose between the alternatives. Scientists often utilize simulations and models in evaluating possible solutions.

Implementation of the chosen solution involves the use of various tools depending on the problem, solution, and technology. Scientists may use both physical tools and objects as well as computer software.

After implementation of the solution, scientists evaluate the success or failure of the solution against pre-determined criteria. In evaluating the solution, scientists must consider the negative consequences as well as the planned benefits.

Finally, scientists must communicate results in different ways – orally and written, and through models, diagrams, and demonstrations.

Example:

Problem – toxic waste disposal
Chosen solution – genetically engineered microorganisms to digest waste
Implementation – use genetic engineering technology to create organism capable of converting waste to environmentally safe product
Evaluate – introduce organisms to waste site and measure formation of products and decrease in waste; also evaluate any unintended effects
Report – prepare a written report of results complete with diagrams and figures

**SKILL 1.4 Use a variety of software (e.g., spreadsheets, graphing utilities, statistical packages, simulations) and information technologies to model and analyze problems in mathematics, science, and technology**

Scientists use a variety of tools and technologies to perform tests, collect and display data, and analyze relationships. Examples of commonly used tools include computer-linked probes, spreadsheets, and graphing calculators.

Scientists use computer-linked probes to measure various environmental factors including temperature, dissolved oxygen, pH, ionic concentration, and pressure. The advantage of computer-linked probes, as compared to more traditional observational tools, is that the probes automatically gather data and present it in an accessible format. This property of computer-linked probes eliminates the need for constant human observation and manipulation.

Scientists use spreadsheets to organize, analyze, and display data. For example, conservation ecologists use spreadsheets to model population growth and development, apply sampling techniques, and create statistical distributions to analyze relationships. Spreadsheet use simplifies data collection and manipulation and allows the presentation of data in a logical and understandable format.

Graphing calculators are another technology with many applications to science. For example, scientists use algebraic functions to analyze growth, development, and other natural processes. Graphing calculators can manipulate algebraic data and create graphs for analysis and observation. In addition, scientists use the matrix function of graphing calculators to model problems in genetics. The use of graphing calculators simplifies the creation of graphical displays including histograms, scatter plots, and line graphs. Scientists can also transfer data and displays to computers for further analysis. Finally, scientists connect computer-linked probes, used to collect data, to graphing calculators to ease the collection, transmission, and analysis of data.

**COMPETENCY 2.0 UNDERSTAND THE HISTORICAL AND CONTEMPORARY CONTEXTS OF THE EARTH SCIENCES AND THEIR APPLICATION TO EVERYDAY LIFE.**

**SKILL 2.1 Analyze the significance of key events in the history of the Earth sciences (e.g., the development of solar system models, the discovery of a galactic universe, the development of the plate tectonics model)**

**History of tectonic theory**

At the beginning of the 20th century, most scientists accepted the view that the Earth's materials were largely fixed in their position because rock was thought to be too hard and brittle to permit much movement. However, in 1906, Alfred Wegener became intrigued by how the shape of the continents seem to have at one time fit together. In 1910, he began a lifelong pursuit of supporting evidence for what eventually became known as his theory of Continental Drift. Over the ensuing years of his research efforts, Wegener became convinced that the landmasses had—at one point in history—been connected, forming a giant super-continent that he later dubbed Pangea. As his research progressed, he collected data and offered evidence of this theory, most of which is still included in the proofs offered for modern tectonic theory. Not surprisingly, his controversial theory of moveable continents was not readily accepted. Starting in the late 1950's and early 1960's, some scientists began to reexamine Wegener's impressive collection of data, and much to their surprise, they discovered that Wegener's old data, as well as the new data they had collected, both supported the theory of Continental Drift. Modern geology owes much to Alfred Wegener's initial postulations. The advent of new technologies has made it possible for science to verify most of his observations, and additional, new data has expanded Wegener's original concept into the widely accepted, modern theory of tectonics.

**Discovery of a galactic universe**

In the late 1700's early astronomers studied hazy objects in the sky that weren't stars. However, it wasn't until the 1850's that telescopes became powerful enough to discern that the hazy objects had a spiraling structure. Almost a hundred years would pass before their identity was solved. In 1924, American astronomer Edwin Hubble determined that the objects were farther away than previously thought. This meant that for us to even see them, they must have a greater luminosity than a single star. The conclusion was obvious; the objects were other galaxies, each composed of billions of stars. Our galaxy is but one of billions of galaxies in the universe.

**Formation of Earth and the solar system**

Most cosmologists believe that the Earth is the indirect result of a supernova. The thin cloud (planetary nebula) of gas and dust from which the Sun and its planets are formed, was struck by the shock wave and remnant matter from an exploded star(s) outside of our galaxy. In fact, the stars manufactured every chemical element heavier than hydrogen. The turbulence caused by the shock wave caused our solar system to begin forming as it absorbed some of the heavy atoms flung outward in the supernova. In fact, our solar system is composed mostly of matter assembled from a star or stars that disappeared billions of years ago. The Nebula spun faster as it condensed and material near the center contracted inward. As more materials came together, mass and gravitational attraction increased, pulling in more mass. This cycle continued until the mass reach the point that nuclear fusion occurred and the Sun was born. Concurrently, the Proto-sun's gravitational mass pulled heavier, denser elements inward from the clouds of cosmic material surrounding it. These elements eventually coalesced through the process of accretion: the clumping together of small particles into large masses. The planets of our solar system were created.

The period of accretion lasted approximately 50 to 70 million years, ceasing when the Proto-sun experienced nuclear fusion to become the Sun. The violence associated with this nuclear reaction swept through the inner planets, clearing the system of particles, ending the period of rapid accretion. The closest planets (Mercury, Venus, and Mars) received too much heat and consequently did not develop the planetary characteristics to support life as we know it. The farthest planets did not receive enough heat to sufficiently coalesce the gasses into a solid form. Earth was the only planet in the perfect position to develop the conditions necessary to maintain life.

**SKILL 2.2 Recognize the impact of society on the study of the Earth sciences (e.g., increasing commercial demand for more accurate meteorological analyses; growing populations in earthquake-prone regions; expanding markets for oil, gas, and other nonrenewable resources)**

Society has had a significant influence on the Earth Sciences. Public safety personnel, farmers, and business people all make decisions based on weather patterns. Civil engineers in earthquake prone areas depend on knowledge of seismic activity to properly design roadways and buildings. The use of a dwindling supply of non-renewable resources has caused increased search for new sources of oil, gas, and coal. The study of the Earth Sciences responds to the demands of the needs of society.

**Commercial demand for meteorological analyses**

Commercial demand for studying weather patterns and accurate forecasting has increased over the last fifty years. Insurance companies use trends in storm tracks and flooding events to analyze risk. Businesses in the tourism industry rely on accurate information about weather in order to make decisions and predictions on their potential profits. Citizens rely on accurate information in the forecast to plan their lives. The demands for accurate forecasts for business and public safety have forced a dramatic increase in the power of forecasting computers. Mathematical models have improved forecasting accuracy. Furthermore, the study of storm systems from the inside (from aircraft sensors, etc.) has improved understanding of major storms and the effects of their conditions on storm tracks.

**Growing populations in earthquake prone regions**

As populations grow in earthquake prone regions, the demand for earthquake analysis and improved engineering techniques increases. Although prediction of an exact time and place for earthquakes will be forever elusive, the likelihood of rupture in a general time frame can be estimated. By studying stress and strain in the bedrock, scientists can indicate the fault lines that should be monitored for potential seismic activity. Through the study of how seismic waves react in different soil types, engineers have been able to build and fortify structures based on their location and type of soil present. Active earthquake engineering is employed when a structure is built to react to seismic waves. In some active engineering buildings, a seismograph is located in the foundation. As the earthquake occurs, the seismic wave frequency and intensity are measured. A computer then sends information to a series of pistons in the building, moving the building accordingly to avoid structural collapse. As more and more information is gathered about the nature of earthquakes, more improvements in the engineering of structures can be made.

## SKILL 2.3 Assess the implications for society of Earth science phenomena in a variety of regions (e.g., volcanoes, earthquakes, erosion, rising sea levels)

An important topic in science is the effect of natural disasters and events on society and the effect human activity has on inducing such events. Naturally occurring geological, weather, and environmental events can greatly affect the lives of humans. In addition, the activities of humans can induce such events that would not normally occur.

Nature-induced hazards include floods, landslides, avalanches, volcanic eruptions, wildfires, earthquakes, hurricanes, tornadoes, droughts, and disease. Such events often occur naturally, because of changing weather patterns or geological conditions. Property damage, resource destruction, and the loss of human life are the possible outcomes of natural hazards. Thus, natural hazards are often extremely costly on both an economic and personal level.

While many nature-induced hazards occur naturally, human activity can often stimulate such events. For example, destructive land use practices such as mining can induce landslides or avalanches if not properly planned and monitored. In addition, human activities can cause other hazards including global warming and waste contamination. Global warming is an increase in the Earth's average temperature resulting, at least in part, from the burning of fuels by humans. Global warming is hazardous because it disrupts the Earth's environmental balance and can negatively affect weather patterns. Ecological and weather pattern changes can promote the natural disasters listed above. Finally, improper hazardous waste disposal by humans can contaminate the environment. One important effect of hazardous waste contamination is the stimulation of disease in human populations. Thus, hazardous waste contamination negatively affects both the environment and the people that live in it.

The most fertile land for farming is at the base of volcanoes. Obviously, this is a dangerous area for people to live, although farming communities sometimes thrive there. An inactive volcano provides fertile ground and less (if any) danger to those who live nearby.

Some scientists have estimated that if global warming continues, the polar ice caps will melt. Our sea levels would rise to enormous heights, estimated at an increase of 50 to 150 feet. Much of the present day United State's coastal shorelines would be underwater. New York City would be gone. Most of Florida would be submerged. Major California cities would be inundated with water. World wide, a warmer world would result in shifts in the Rain Belts. Crop failures would occur and be associated with famine. The mid-west United States would have a climate like present day Arizona and Canada would become a major agricultural source. The warming of the oceans could cause exceptionally strong hurricanes and typhoons.

**SKILL 2.4 Analyze Earth's hazards (e.g., earthquakes, volcanoes, hurricanes, tornadoes, drought) and their effects upon humans to develop plans for emergency preparedness**

**Earthquake**: The sudden movement of Earth materials in relation to other Earth materials, caused by the rupture of the Earth's materials. The rupture originates underground in the brittle lithospheric material. The sudden breaking of the rock material causes a release of energy. The movement of the tectonic plates causes stress on the rock. Because rock has a limited ability to stretch before breaking, the interior of a plate can move while its edges do not. The energy caused by the stress placed on a bending rock is called Elastic Energy. As tectonic plates try to move past one another, rock near the plate boundary stretches and stores elastic energy (elastic deformation). When the elastic energy overcomes the frictional forces that are resisting the movement of the rock, the rock materials "jump" along the fault. As the rocks "jump" they try to spring back to their original dimensions—elastic rebound—and they release the stored elastic energy. This causes motion in the rock that sets up vibrations that travel through the Earth. These vibrations are felt as an Earthquake or Seismic Slip.

**Effects of Earthquakes**

Ground Movement

**Shaking:** The extent of the shaking is dependent on the type of material the seismic wave encounters. Soft material amplifies the shaking.

**Ground Displacement**: The ground literally drops away. Vertical displacements of over 20 feet occurred during the 1964 Anchorage, Alaska earthquake.

**Ground Cracks**: Cracks can open either several inches or several feet.

**Landslides**: Loose material is set into motion by the Earthquake.

**Fire**: Gas and electric lines break during an earthquake, sparking and feeding fires. Water mains also are often broken, limiting the means to fight the fires. Fire accounts for 95% of all earthquake damage.

**Liquefaction**: In an earthquake, sand and silt liquefy, developing the consistency of quicksand. Packed sand and silt have trace amounts of water between the grains. As the shaking occurs, these move apart and more water enters. If there is a low water table, the grains eventually become flooded with water in the spaces. As the material liquefies, the structures built upon them sink. However, the material doesn't have the same rate of liquefaction, and only parts of the buildings sink, causing their structural collapse.

**Tsunamis** (Tidal Waves): Earthquakes can trigger an underwater landslide or cause sea floor displacements that in turn generate deep, omni-directional waves.  Far out to sea these waves may be hardly noticeable. However, as they near the shoreline, the shallowing of the sea floor forces the waves upward in a springing type of motion.  The tidal waves formed by the upward motion can grow to be quite immense and powerful depending on the topography of the sea floor and the magnitude of the earthquake.

**Structural Damage**: The shaking in an earthquake often breaks the man-made structures in the area. The structures collapse, killing, injuring, or trapping the people inside.

**Elevated Roadways:** Straight rebar (unfinished steel) was widely used as reinforcement for concrete support columns. In an earthquake, these bars were prone to spalling (flaking off of concrete sections), causing the sudden collapse of the entire elevated structure.

**Buildings**: Ground motion through building foundations often sets up a swaying motion throughout the entire structure. As the sway intensifies, the building materials fail, causing collapse of the structure.

**Volcanoes**

**Magma**: the molten liquid or semi plastic Earth material located beneath the Earth's crust. Magma is produced at Hot Spots, Spreading Centers, and Subduction Zones and varies in composition according to where it is produced.

**Pyroclasts or Tephra**: the angular, high velocity, quickly cooling globules of ejected material that adapts aerodynamic shapes of differing sizes.

**Blocks**: Large chunks of lava.

**Bombs**: Big pieces of lava, shaped similar to a spindle or lens.

**Lapilli**: Walnut sized bits of lava.

**Cinders**: Pea sized lava, 4 to 32 mm.

**Dust and Ash**: Fine particles.

Accompanying the pyroclastic ejecta is a huge release of gas that forms into a glowing gas cloud that moves rapidly down the side of the volcano. This gas cloud, the **Nuée Ardente**: a glowing, highly heated mass of gas-charged lava, travels at 600 mph when first expelled and is still moving at 200 mph when it reaches the bottom of the cone. The Nuée Ardente is very deadly. Besides being scorching hot, it causes a smothering effect by displacing or burning up all oxygen in its path. The Nuée Ardente released in the 1902 eruption of Pelée in Martinique destroyed the entire town of Saint Pierre, killing an estimated 40,000 people. The Nuée Ardente also creates extremely strong winds that can affect areas as much as 20 miles away from the volcano. You also get **Lahars**: a flowing slurry of volcanic debris and water. These mudflows have the consistency of wet concrete and can cause widespread devastation.

**Hurricanes** are produced by temperature and pressure differentials between the tropical seas and the atmosphere. Powered by heat from the sea, they are steered by the easterly trade winds and the temperate Westerlies, as well as their own incredible energy. Hurricane development starts in June in the Atlantic, Caribbean, and Gulf of Mexico, and lasts until the end of hurricane season in late November. Hurricanes are called by different names depending on their location. In the Indian Ocean they are called **Cyclones**. In the Atlantic, and east of the international dateline in the Pacific, they are called Hurricanes. In the western Pacific they are called **Typhoons**. Regardless of their name, a hurricane can be up to 500 miles across, last for over two weeks from inception to death, and can produce devastation on an immense scale.

**Hurricane Damage**

The destruction and damage caused by a hurricane or tropical storm can be severe. **Storm surge** causes most of the damage as the winds push along a wall of rising water in their path, and this rising effect is amplified on low sloping shorelines such as those found on the Gulf Coast. The intense winds can also cause damage.

**Tornado**: an area of extreme low pressure, with rapidly rotating winds beneath a cumulonimbus cloud. Tornadoes are normally spawned from a Super Cell Thunderstorm. They can occur when very cold air and very warm air meet, usually in the Spring. Tornadoes represent the lowest pressure points on the Earth and move across the landscape at an average speed of 30 mph. The average size of a tornado is 100 yards, but they can be as large as a mile wide. A tornado's wind speed ranges from 65 to 300 mph and has an average duration of 10 to 15 minutes, but has been known to last up to 3 hours. Tornadoes usually occur in the late afternoon (3 to 7 p.m.) in conjunction with the rear of a thunderstorm. Most tornadoes spin counter-clockwise in the northern hemisphere, and clockwise in the southern hemisphere. Worldwide, the U.S. has the most tornadoes. Texas has the most tornadoes, but Florida has the largest number per square mile. Roughly 120 deaths each year are from tornadoes.

## Drought

Droughts are the result of changes in climate, changes in water sources, overgrazing of land (lack of vegetation causes water to run-off and not infiltrate back down in the ground), and over irrigation (this literally pumps the sources dry). Although we cannot do anything about the climate, improved agricultural and animal husbandry techniques have greatly aided in the retention of top cover that holds moisture. Likewise, crop rotation allows a natural replenishment of soil nutrients that help hold vegetation in place. Awareness of over irrigation has also helped to ease the problems of human-produced drought factors. Water intensive crops in many areas have been replaced with hardier, less water needy substitutes. Unfortunately, not all countries practice these improved techniques. As a result, human induced droughts remain a major threat for many underdeveloped nations.

## Natural disaster preparedness

To be prepared for all natural disasters, people should:

1.) Practice evacuation from the house or building.
2.) Find the safest areas outside of the building and away from possible falling debris.
3.) Have non-perishables (including water) on hand.
4.) Have an out-of-state point of contact that everyone in the family knows in the event that people are separated.
5.) Have a plan for pets in case of an emergency.
6.) Have a second exit from each room if possible.
7.) Mark utility switches for water, gas, electric, etc. in case they need to be accessed.
8.) Have account numbers, medical information, insurance policy information, birth certificates, etc. in a plastic bag (to protect from water damage) and placed in a fire proof safe.

## Government preparedness

Hurricane Katrina was a civics lesson on how to proceed with emergency management plans in the case of a natural disaster. Local and state governments need to be prepared with a realistic evacuation plan, shelters, non-perishables, and means of rescue.

**Earthquake preparedness**

1.) Secure heavy objects such as bookshelves to the wall.
2.) Practice an exit plan.
3.) In the event of an earthquake, crawl under a sturdy table or desk.
4.) If a table or desk is not available, cover your face and stand in a doorway or inside corner.

**Hurricane preparedness**

1.) Board up windows and doors.
2.) Stay away from windows.
3.) Evacuate if you are told to do so.
4.) Get to higher ground if you live in a low lying area, flood prone area, or manufactured housing.
5.) Make sure that you have plenty of non-perishables and a NOAA weather radio on hand.

**Tornado preparedness**

1.) Get below ground if there is a tornado warning for your area.
2.) If you are unable to get below ground, get away from windows on the interior of the house (preferably remain in a bathroom).
3.) If you don't have time to go underground, get into the bathtub and then cover yourself with a mattress.

**SKILL 2.5 Recognize the applications of Earth science related technology to everyday life (e.g., GPS, weather satellites, cellular communication)**

One relatively recent technology that can be used to locate points on the Earth is the **global positioning system (GPS)**. Over 20 GPS satellites broadcast signals that allow GPS receivers to obtain exact longitude, latitude, and altitude data. In the past 2 decades, GPS technology has become invaluable for navigation, military use, surveyors, and outdoor enthusiasts. Though GPS will not replace maps, these tools are incredibly powerful when used together.

**Satellites**: The National Weather Service heavily depends on its network of weather satellites (i.e. GOES Satellite), to provide a wide-area coverage of the Earth. These satellites primary provide infrared, water vapor, and photographic data and are used to track the formation, development and motion of major meteorological events such as hurricanes and tropical storms. In terms of orbit, there are two types of satellites: Geostationary and Polar Orbiting. Geostationary satellites move with the Earth's rotation. Since they always look at the same point, this allows for a view that shows changes over periods of time. Polar Orbiting satellites follow an orbit from pole to pole. The Earth rotates underneath the satellite and gives a view of different areas. In effect, it produces slices of the Earth.  The GOES Satellite is a key source of weather information. GOES is a geostationary satellite that primarily scans the Atlantic Ocean & U.S. East Coast. There are 4 detection bands on the GOES satellite.

Cellular communication has been advanced by studies in astronomy. Bursts of energy from the Sun can disrupt wireless cell communications several times each year, usually in correlation with the solar maximum, the most active portion of the Sun's 11year cycle. The first solar radio bursts were detected inadvertently by radars deployed during World War II. After the war, solar radio studies became a recognized field of astronomical research, and the Air Force was active in collecting data. Continued research will help in the design of future wireless platforms.