VIDEO	AUDIO
SOS Visual: Various pictures of flooding in the U.S.	(Start program, let music play and end. Pictures will continue to show on the SOS. Introduce program.) FACILITATOR (Facilitator enters) I'm going to start our program now. The pictures of flooding that you've been watching here were all taken in the United States. You might have noticed people from all walks of life are shown in these photographs, all of them vulnerable to the effects of flooding. Today's program, called Rising Waters, looks at conditions for precipitation, current and future increases in flooding, and the impacts of global flooding on people. (Short question and answer with audience about flooding - what do they know? Is flooding on the increase? How does this affect the local community? The global?)
1. SOS Visual: Blue Marble with Clouds	FACILITATOR Let's start by taking a look at the earth. This is the view we would have if we were astronauts out in space. These are the true colors of the earth. The white shows the clouds, the dark blue is the waters of the world and the tan and green areas are the continents. What do you notice about our Earth? (Take answers from the audience and lead discussion to the fact that most of the Earth is covered with water) Exactly, in this view you can see how much of the earth is water. About seventy percent of the earth is covered by oceans. The oceans are the source of precipitation on the

VIDEO	AUDIO
	earth. Check out the green places on the continents. These are the places that receive the most rainfall. We're going to look at some of the conditions for precipitation and how precipitation patterns are expected to change with a changing climate. The land, oceans and atmosphere we can see here form our global climate system. And we feel that locally in the form of weather. So, let's start with the weather. It affects us everyday. What we decide to wear, the activities we choose, and how we travel to those activities is all determined in part by the weather. (Looking up to the Sphere) But what drives the weather? What makes it do what it does?
2. SOS Visual: NASA Sea Surface Temperatures	SOS VOICE-OVER The earth is unevenly heated. The tropics are heated more directly by the sun than the polar region. (Facilitator rotates SOS and uses laser pointer to show equator and poles) The uneven heating plus the rotation of the earth set the wind and sea currents in motion. The uneven heating is the fundamental cause of all weather. This picture shows the temperature of the sea surface. The red colors are warmest like around the equator and the blue colors shown at the poles are the coldest. Notice that the colors don't stay put. The temperatures do shift on the earth to some degree.

VIDEO	AUDIO
2a. SOS Visual: NASA Sea Surface Temperatures	FACILITATOR (Orient the SOS to NA and use laser pointer) Let's look at seasonal changes. The East Coast of the U.S. warms steadily during the summer months and then cools in the fall and winter. Ocean currents are also visible, like the Gulf Stream, which transports warm Gulf of Mexico water up the East Coast. That's the reason why it's much nicer to swim along the east coast than it is to swim off the west coast. The ocean currents, which are the reason for these swirling eddies that you're seeing, help to mix ocean water and even out the heating somewhat. Now, let's look at what these different temperatures on the earth mean in terms of the weather. Meteorologists use many tools to observe the weather: radar, ocean buoys, satellites, weather balloons, among others. These tools were used to produce the pictures you are seeing today. Meteorologists use these observations, knowledge of past storms and computer models to predict future weather. We're going to look now at some weather data called total precipitable water, as measured over the last year.

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3. SOS Visual: Real-time Total Precipitable Water	<u>SOS VOICE-OVER</u> (facilitator rotates SOS) Total precipitable water represents the moisture in the air. Essentially, this is how much water the atmosphere holds that could turn into rain if conditions are right. Focus your eyes on the green color which is where the total precipitable water is greatest or where the air is wettest. Warm air holds more moisture than cold air. So it is no coincidence that the green areas, the wettest areas, are found mostly around and near the equator, which is where there are high levels of ocean evaporation due to the heat and warmer air.
3a. SOS Visual: Real-time Total Precipitable Water	<u>FACILITATOR</u> Notice the correlation between the green areas showing high amounts of total precipitable water and the green, vegetated areas on the continents, which indicate places of the world that get the most precipitation. So, this is why it rains a lot in the rain forest. It's warm there. (facilitator turns SOS to poles) At the poles, the air is generally too cold to hold enough moisture for it to rain or snow much. Antarctica is one of the driest places in the world. The snow and ice that does accumulate just doesn't melt, so glaciers have formed over millions of years. Here in the eastern United States where we are, it is not wet like the equator. But it is still wet. For instance, we have much more rain here than in the western part of the U.S. (facilitator rotates SOS to NA and uses laser pointer) Let's look now at another way that meteorologists look at weather patterns, an infrared satellite image of cloud cover over the last month.

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4. SOS Visual: Real-time Infrared Satellite Over land	SOS VOICE-OVER (READ SLOWLY) Infrared satellite images are used to determine where clouds are. We 're going to look at cloud cover over the last month. The lowest clouds are a very light gray and the highest clouds are bright white. (Facilitator rotates SOS and highlights areas with laser pointer) Focus on the bright white clouds and specifically, the ones that look like cotton balls, rather than those that are more scattered. (Facilitator highlights areas with laser pointer) These cotton ball-like clouds are high Cumulonimbus clouds (or thunderstorms) associated with the most severe weather. Notice that you see many of these clouds around the equator. That's because it is warm there and so the wet atmosphere produces more rain. There are some exceptions to this. Deserts for instance often have warm air. The dry conditions in these areas however are because of their unique geographic location and weather patterns.
4a. SOS Visual: Real-time Infrared Satellite Over land	FACILITATOR In our area, we can draw from our own experience with thunderstorms. Where we live, thunderstorms mostly happen in the summer, when it's warmest. And they are most likely in the heat of the afternoon. So again, warm air can hold more water and can mean more rain. And we can see where this is true on the earth by looking again at the green areas of the continents, the places with the most

VIDEO	AUDIO
	precipitation.
	FACILITATOR So we've seen that warm air holds more moisture than cold air. Make sense? We've been talking about the weather. The weather is what happens in the short term. It's what's happening over the next several days. Today it's...(insert current weather here i.e. "sunny," "cold," "rainy." etc) and next week it might rain (or snow, or be sunny, etc). That's the weather. Now we're going to take a look at climate. Climate is based on the long-term weather record. It's the synthesis of all weather events on record. Scientists use computer models to predict both the weather and climate. We're going to look at a climate computer model next that will show what the temperature on the earth is expected to look like in the future.
1. SOS Visual: IPCC Temperature Anomaly (computer model)	FACILITATOR (Invite audience to explain what they think models do) Computer models are used to predict what might happen. They are based on data that is measured and known and then a number of scenarios are tested. There is also some uncertainty associated with computer models. Often times computer models are used to look at something complicated that requires a number of lengthy equations that can be solved quickly by a computer. (Facilitator starts bouncing a paddle ball) For instance, how far will this

VIDEO	AUDIO
	ball go if I hit it with the paddle? We could build a computer model to try to answer that question. We can measure the mass of the ball, the elasticity of band, and the force of the hit. Using these measurements, we could make equations to develop a computer model to test any number of scenarios, to tell us how far the ball will go with each hit. Like how far does it go if I hit it with middle of racket vs. more on the edge. And what happens if we hit it up toward the ceiling vs. down toward the floor. (Facilitator demonstrates examples.) For every computer model, there is some uncertainty. In our example, the elasticity of the rubber band might change with temperature. It could be more elastic when it ’s warmer than when it’s colder. Every computer model is tested, in part, by how well the model predicts what has already happened or what is already known. If it predicts the past well, then we can assume that it might also predict what will happen in the future. We are going to look now at a computer model that will show what the temperature on the earth is expected to look like in the future.

VIDEO	AUDIO
1a. SOS Visual: IPCC Temperature Anomaly (computer model)	SOS VOICE-OVER Computer models that are used by scientists to look at what the climate might do in the future are also based on measured data, tested scenarios, and some uncertainty. There are many computer models that scientist use to predict how the temperature might increase in the future. We're going to look at this one. This computer model looks at temperature change from 1870 through 2100. You'll see the date change here. You'll also see the carbon dioxide level change here with the date. PPM stands for parts per million. And in case you're wondering, GFDL stands for NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, which created this model. The A1B stands for a future scenario where there is a balanced use of energy sources. The temperatures you'll see are all compared to temperatures in 2000. Blue tones represent temperatures cooler than those in 2000, while yellow and red tones represent temperatures warmer than those in 2000. You'll see the model run and then start over again. We'll let it run a few times so you have a chance to take it in.
1b. SOS Visual: IPCC Temperature Anomaly (computer model)	(Facilitator starts model, let's it rotate a couple times and then orients the SOS to NA and starts the model) Virtually all climate scientists agree that the planet is warming. They base this on independent temperature data from the atmosphere, the ground, and the oceans, combined with evidence such as melting snow, ice and permafrost, and rising sea levels.

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	World climate is complicated and many models are used to help scientists estimate what the future could hold. Like weather models, climate models are based on measurable data to try to predict what will happen in the future. The measurable data for this model includes the historical record of greenhouse gases, sulfate aerosol concentrations, volcanic emissions, historical solar irradiation, and land use, since all of these things affect world climate. The computer model assumes a global population that reaches 9 billion in 2050 and a balanced emphasis on all energy sources, among other things. According to this computer model, whose predictions fall somewhere in the middle of other models, global mean warming is predicted to reach about 5 degrees F above present by 2100. Warming in North America is predicted to reach almost 9 degrees F. Notice that the continents warm more than the oceans. This is because it takes longer to heat water than land. It also takes water longer to cool down. You'll notice how the coastlines are slower to heat than the interiors of the continents because they are buffered somewhat by their proximity to the ocean. We've seen that higher temperatures allow for more rain producing moisture to enter the atmosphere. This is because as the world's oceans heat up, even a little, the water molecules near the sea surface become more energetic and tend to evaporate into the atmosphere more readily. Thus, the air gains water vapor. The effect gets stronger

VIDEO	AUDIO
	for each additional degree of warming. At the same time, higher temperatures draw more water out of the parched terrain where it hasn't been raining. So, the net effect for the future is that, in general, the wet places will be wetter and the dry places drier. The northeast is a wet place that is expected to get wetter. FACILITATOR (This segment only shown in Easton) So we've seen that a warmer atmosphere will likely mean more intense precipitation and therefore more flooding for certain parts of the world. Now, let's look at a 3-minute interview with a man named Paul Knight who is the Pennsylvania State Climatologist. He's going to talk about changing weather patterns and flooding in Pennsylvania and what the future may look like.
2. Paul Knight Video Clip (Easton Only)	FACILITATOR We've been talking a lot about rain. Another way in which we expect wetter conditions is along our coastlines due to sea level changes.
3. SOS Visual: Suggest shots of the ocean and shore with people and shoreline structures.	FACILITATOR Sea level can rise in two different ways with respect to climate change. The first is the expansion of the sea water as the oceans warm due to an increasing global temperature. Things expand when they are heated. Think about a jar with a lid that's stuck. What do you do? That's right. Run it under hot water, so that it expands. Sea water is the same. The second way that sea level is expected to rise is due to the melting of land-based glaciers, which then adds water to the ocean. (Looking to the Sphere)

VIDEO	AUDIO
	What does a rise in sea level mean to us?
3.a SOS Visual: Suggest shots of the ocean and shore with people and shoreline structures.	SOS VOICE-OVER Sea level has been rising throughout the 20th century at a rate of about 1.5-2 mm/yr as measured by long term records. In the 21st century, sea level rise is already 3 mm/yr. For your reference, a dime is roughly the thickness of a millimeter. The Intergovernmental Panel on Climate Change or IPCC is a unique team of scientists that draws on the work of more than one thousand climate scientists to look at what the climate might do in the future. In their last report, the IPCC states that "Sea level is projected to rise at an even greater rate in this century." by 2100, sea level is expected to be between o.8 and 2 meters higher than it is now, with most scientists predicting near the low end of that range.
4. SOS Visual: Sea Level Rise	SOS VOICE-OVER This picture shows how much of the land surface would be covered if the sea level rose by 1 meter or about 3 feet above current sea level, so it is close to what most scientists are currently projecting. The land that would be covered by water is shaded first black, then red to show the decrease in land as the waters rise. So the people living along the coastlines, who are already exposed to flooding, could be placed further in harms way in the future. (Docent shows the top of the railing around the SOS as the height of 1 meter))

VIDEO	AUDIO
5. PIP on SOS showing zoom in of northeast	FACILITATOR Here is a closer look our area and surrounding states. The red indicates land covered by one meter of water, which, again, is about what scientists are currently predicting by 2100. You can see how the coastline and also tidal rivers will be impacted. Note how much of the land area of the Chesapeake Bay would be covered. Land development patterns in the future will help determine people's risk to flooding not only along the coastline, but also places along waterways.
	FACILITATOR So we've seen that a warmer climate could create wetter conditions in two different ways: through increased rainfall intensity and through rising sea level. Now we're going to look at how this might affect people.
1. SOS Visual: Surface of Earth and Nighttime Lights	FACILITATOR Depending upon where we live, the weather affects and impacts us in different ways. Here, you are seeing the earth at night, as if the whole earth were dark at one time. Areas of high population and economic development are generally covered with white lights. The differences in population between the eastern and the western parts of the United States are clearly visible. (Facilitator rotates SOS to NA) Areas along coasts tend to be well

VIDEO	AUDIO
	populated as well as along major waterways. Does anyone have ideas about why that is? Early industry settled along rivers. Communities formed and grew around that industry and along those same rivers. There are about 7 billion people living on Earth and that population is roughly visible here. Current projections show that the population is expected to reach around 9 billion in the year 2050. So, there will be many more people along the coastlines and rivers and more white lights in the future, around cities, exposing more people to the risks of flooding. Let's take a look at where flooding has happened globally over one decade.
2. SOS Visual: Global Flooding (overlay on earth at night.)	<u>SOS VOICE-OVER</u> All of the bright orange dots represent places that have experienced major flooding from 2000-2009. Each of these dots represents a large flood that has caused significant damage. The flood areas are overlaid on the lights at night, to give a sense of how people have been affected. Flooding affects people who live near waterways. When it comes to floods, the character of the precipitation is what counts. How often is rain concentrated in short, intense bursts that produce flash floods, or in multi-day torrents that can cause much more severe flooding over entire regions? Or is the rain and snow falling in more

VIDEO	AUDIO
	gentle, non-destructive ways? Heavy rain is the most common cause of flooding but there are other causes such as snow melt, ice jams, and tidal surges to name a few. Floods are the most common and costly natural disaster Over the last century, data indicate more intense rain events and models predict that this trend will continue. As our population increases, more people will be vulnerable to the impacts of flooding.
3. SOS Visual: Various shots of life along waterways and shorelines mixed with shots of flooding	People have lived along waterways since the very beginning and it's safe to assume that we'll continue to do so in the future. If, as the data suggests, global flooding will increase in the future, then what can we do to support human resiliency in the face of flooding? If the past is any indication of the future, then it's our collective imagination and capacity for innovation that makes us resilient.
4. SOS Visual: Various solutions being used today	FACILITATOR Here are some pictures of things some communities are already putting into action. Here's a green roof that can capture roof water, a preserved floodplain that can fully function during a flood, a constructed wetland where stormwater is directed and contained, a street side curb planter that collects stormwater and runoff and allows it to soak into the ground as the soil and vegetation filter pollutants, a parking lot with a place for storm water to soak in, a community forum where people are discussing solutions as a community,

VIDEO	AUDIO
	waterfront development with some naturalized green space, a rain barrel that collects roof runoff for reuse, a rain garden planted with water-loving plants and used for the same reason, and an urban vegetable garden that absorbs rainwater. These are just a handful of examples of what some communities are doing to reduce flooding and/or the human footprint on the earth. These solutions are specific to each of these communities.

VIDEO	AUDIO
	FACILITATOR Today we've explored the conditions for precipitation, current and future increases in flooding, and the impact of global flooding on people. It's our hope that the knowledge science provides informs our discussions and gives wing to ideas and innovations to act on these issues as a community.