**Exploring Atmospheric Dust & Climate**

*Facilitator Script*

| Engage the audience: Would you like to learn about atmospheric dust and how it can affect the Earth’s climate? Great!  Here we see the movement of dust across the Earth over the period of one year.   * Yellows indicate a higher volume of dust, greens are moderate dust, and blues are lower dust volume.   Note: The visualization loops from January to December of 2018.  Ask: Have you heard of atmospheric dust before?   * It’s not the dust bunnies that collect under your bed! * This dust comes from erosion, mostly from the Earth’s deserts. Dust is tiny particles of rock that are small enough to be carried by the wind. * At any given time, there are between 17-20 million tons of dust suspended in the atmosphere!   Ask: What do you notice? What stands out to you?  Some noticings might include:   * Some parts of Earth are dustier than others. North Africa (the Saharan Desert) is the largest dust source in the world! * The dust is moving in patterns (because it is carried by the winds). * Certain times of year are dustier than others. From about February through May, the Northern Hemisphere is really clouded with dust!   Dust doesn’t stay in the air forever - eventually, it settles back to the surface, and a lot of it ends up in the ocean.  So, what happens when dust gets into the ocean? | * Aerosol Optical Thickness: Dust - 2018 |
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| It turns out that the dust is full of iron, and iron is a nutrient that is needed by all living things. So when a bunch of iron-rich dust settles into the ocean, some interesting things can happen!  Here we see the concentration of iron in the ocean.   * Darker red indicates a high concentration of iron, while lighter red/white indicates a low concentration of iron.   Ask: Where do you see the most iron in the ocean?   * Notice that the Atlantic ocean is quite red - there is almost always lots of iron in the Atlantic. * Notice the iron concentration is less uniform in the North Pacific. At certain times of the year, we see swirling plumes of red as dust enters the water.   Note: Iron enters the ocean in other ways too. In addition to dust settling on the surface, erosion from the edges of the continents and hydrothermal vents on the ocean floor also add iron to ocean waters.  So, in places with a limited amount of iron, like the North Pacific, dust settling in the ocean can provide a valuable source of nutrients to help marine life thrive.  Phytoplankton, in particular, benefit from this added iron in the ocean.  Ask: Have you heard of phytoplankton before?   * Phytoplankton are tiny organisms that live near the surface of the ocean. * They are photosynthetic, which means they use energy from the Sun to make their food. | * Iron Concentration - 2015     *Orient to view the Atlantic Ocean*  *Orient to view the North Pacific region* |
| So, now we’re looking at the concentration of chlorophyll in the ocean. The chlorophyll is inside the phytoplankton, so wherever there is chlorophyll, there is also phytoplankton.   * Dark green means that there’s lots of chlorophyll there. And the lighter green means less chlorophyll.   Ask: Why might we be interested in looking at the chlorophyll and phytoplankton in the ocean?   * Chlorophyll is present anytime photosynthesis is taking place. * ***When photosynthesis is happening, carbon dioxide is being removed from the atmosphere.***   Ask: Does anyone know why removing carbon dioxide from the atmosphere is a good thing?   * CO2 is a greenhouse gas that is causing our climate to warm. * By burning fossil fuels, humans are adding too much CO2 to the atmosphere, so anytime we can remove CO2 from the atmosphere, that is a good thing!     So, phytoplankton remove CO2 from the atmosphere, which can help to cool down the climate. And phytoplankton need iron, which is delivered to the ocean in the form of dust.  Fortunately, there’s a lot of photosynthesis happening in the ocean! Let’s take a look at where the highest concentrations of chlorophyll are.   * Point out North Atlantic, North Pacific, Southern Ocean, and around the edges of continents   The concentration of phytoplankton (or chlorophyll) changes throughout the year. We see an increase in phytoplankton in the North Pacific Ocean during the spring months, which is also when a bunch of iron-rich dust enters the water there (remember those swirling red areas we saw before).  Nutrient runoff from agriculture and pollutants also causes phytoplankton to grow, which is why you see lots of dark green around the edges of the continents year round.  Remember that the Atlantic ocean was quite red when we were looking at iron concentration- there is almost always lots of iron in the Atlantic, so why don’t we see lots of dark green (phytoplankton) here?  Perhaps there's another part to this story! | * Chlorophyll Concentration - 2015     *Orient to view the North Pacific region*  *Orient to view coastlines*  *Orient to the Atlantic Ocean* |
| Iron isn’t the only nutrient that phytoplankton need. In addition to sunlight, nitrates are also important!  Here we see the concentration of nitrates in the ocean.   * Darker blues indicate higher concentration, while lighter blue/white indicates low concentration or no nitrates.   Note: Nitrates become available as marine organisms decompose in the water and are part of runoff pollution along the coasts.  Ask: What do you notice about nitrate concentration in the world’s oceans?   * In contrast to iron concentration, nitrate levels are low in the Atlantic and higher in the North Pacific (opposite of iron concentrations). * The Southern Ocean is also high in nitrates.   So, perhaps the concentration of nitrates in the ocean is also an important factor in determining the growth of phytoplankton populations. | * Nitrate Concentration - 2015 |
| Let’s take another look at chlorophyll in the North Pacific ocean (remember that those are our phytoplankton).  Recall that in this area, we have lots of nitrates, but not very much iron, so we see this area of dark green grow in size as iron is added to the ocean here - the phytoplankton have everything they need!  But what do we see if we look at the Atlantic Ocean, where we have lots of iron but fewer nitrates? When the dust settles into the ocean here, it doesn’t result in a big change in the amount of phytoplankton because we’re still limited by the amount of nitrates. Notice that we don’t get the really dark green color covering a large area here.  So it seems like we need both high concentrations of iron and nitrates for phytoplankton to flourish! | * Chlorophyll Concentration - 2015     *Orient to view the North Pacific Ocean*  *Orient to view the Atlantic Ocean* |
| So let’s think about what all this could mean for Earth’s warming climate. If adding dust to the ocean causes phytoplankton to grow in some places, and phytoplankton remove CO2 from the atmosphere, could this be a viable solution to climate change?  Indeed, dust can play an important role in the ocean. It stimulates what is called the “biological pump” in the ocean by making nutrients available in places where they are otherwise limited.  However, it’s not quite that simple!  Adding iron to the ocean, which is called iron fertilization, doesn’t always result in more of the carbon-dioxide-loving-phytoplankton. And there are some concerns about how the ocean ecosystems might be affected by adding a bunch of iron to the water. For example, we know that phytoplankton blooms can lead to dead zones in the ocean.  Note: Dead zones are areas where the waters are oxygen depleted, which makes them unable to support life.  Dust also influences cloud formation, which can affect storms and surface temperatures. So it plays an important role in the atmosphere too.  Understanding how dust affects our climate is really important as we work to slow down climate warming. Could we somehow help the ocean to draw down more carbon dioxide and cool the planet? Possibly, but we have many more questions that remain to be answered! | * Aerosol Optical Thickness: Dust - 2018 |