#  Script for Climate Change: Sea Level Rise (SLR)

#  Herman Sievering, Global Monitoring Div., NOAA-ESRL, Boulder USA & Internat’l. Panel on Climate Change (IPCC)

This script is designed to help science educators and SOS presenters utilize the Climate Change: Sea Level Rise (SLR) program for presentation on the Science On a Sphere (SOS). Prior familiarity with this script, including links among the SLR SOS playlist datasets and associated SLR Power Pt. slides, will significantly enhance SOS presentations of this Climate Change program. Each SOS dataset (**A.** through **E.**) is listed in the left-hand column along with dataset notations. The center column identifies the Power Point slides (1, 2, etc.) associated with each SOS dataset. Key points relating slides to SOS datasets are found in the center column below each identified slide. The right-hand column contains key points and suggested directions for public presentations that were found useful during development of this program. This script material can readily be adapted to fit individual science educator’s and SOS presenters needs.

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| **Dataset:** | **Power Point Slide:** | **Key Points and Suggested Directions:** |
| **A.** Blue Marble, Earth at 23° tilt\*White areas of ice, as well as clouds, reflect much of sun’s incoming energy back into space.Composite shows average ice cover for the 1980s. **B.** Earth surface air temps, 1884-2012 \*1960’s temps are a white baseline\*3.5 °F human body temperature increase is seen as a high fever.\*3.5 °F surface air temp increase will cause similar problems for the Earth\*More than 90% of our greenhouse warming energy since the 1960s has gone into the oceans.\*Note: Arctic region heating of more than °4 F in many places. Mention of some Arctic impacts fits in well here. **C.** Arctic Sea Ice Minimum, 1987-2012\*Comparison of 1987 and 2012; highlighting these two extremes works well\*Ice loss over Arctic land areas; not just over Arctic Ocean\*Solar energy, that once was reflected back to space, is now absorbed by the dark Arctic Ocean waters. This adds to the expansion of the ocean’s waters and, therefore, to SLR **D.** Earth at night with 1-meter Sea Level Rise (in red)\*Note again 1-meter & 1-yard relation\*Use Zoom function to focus on Florida first, then the Carolinas and then NYC area**D.** continuedNote that 1-m Sea Level Rise continues to be displayed in red on this SOS dataset*Several other SOS datasets could be used here to address questions that may arise before or during the break. E.g.,* \*Hurricane Sandy  SOS Dataset\*1, 2, 3, 4, 5 and  6-m Sea Level  Rise Dataset **E.** Blue Marble, 23 Degree Tilt   | 1. Climate Change: Sea Level Rise (SLR), author affiliations 2. CO2 South Pole and Mauna Loa 3. CO2 and Methane air concentrations over past 400,000 years 4. Fossil Fuels Carbon Emissions5. Global Warming… Climate Change… Sea Level Rise (SLR)5. Global Warming… Climate Change… Sea Level Rise - continued6. “The Big Three” Contributions to SLR: *Science* Handout sheet7. SLR: How much? How soon?8. (slide 5 revised) Global Warming… Climate Change…Sea Level Rise… **Super-storm Sandy: a near-term SLR impact example**9. Super-storm Sandy impact at NYC 911 site.10. 1 ft. water depth due to human-caused SLR (as of 2012)11. NYC Sandy super-storm case study12. Regional Sea Level Rise: 2091-2100 mean vs. 190013. Super-storm Sandy and Human-Caused Climate Change14+. Several example solutions slides are provided | A. Blue Marble related:  a. Oceans are the focus, given this is an SLR talk. However, note that the white areas, clouds and ice, reflect solar energy and cool the planet. Greenhouse gases trap this reflected energy, adding heat energy to the Earth as a whole. b. All information on Sphere is DATA. There is only one futures projection; it’s on a Power Point slide. c. Heat trapping greenhouse gases are contributing to the observed increase in Earth’s temperature. d. Our use of fossil fuels has dramatically increased CO2 and other greenhouse gases in our atmosphere resulting in human-caused contribution to climate change. e. SLR (again SLR = sea level rise) sums up many global warming/climate change impacts: two bottom lines may be of particular interest. f. SLR to displace about 10-20 million, globally, by 2050 and 50-250 million, globally, by 2100. The marked increase in people displaced, 2100 vs. 2050, could be an important discussion point. g. 9% of Florida will be under water with 1 meter SLR. Showing meter and yard sticks together helps many in the public with appreciating “1 meter”. It is valuable to clarify “1 meter” since this dominates visually on the 4th SOS dataset used here.B. 1884-2012 surface temps SOS dataset related: a. Heating and Expansion of the Oceans’ waters causes about 1/2 of total SLR. (show heating of air over the oceans) b. Glacier and Arctic region ice melt together contribute only about half as much to SLR as does ocean expansion c. There is only one in 900 chance that a 4 °F average surface temp increase over the Arctic could be “natural” (ie., within the range of temps during first half of 20th century). d. If human-caused greenhouse warming stayed in the atmosphere (vs. going into oceans), Earth’s average surface air temperature would be roughly 40 degrees higher than it actually is today.Orca (killer) whale impacts on mammals in Hudson Bay could be mentioned here.C. Sea Ice over Arctic region related:1. Heat expansion of oceans is causing about ½ of the present per year SLR
2. Glacier and Arctic melt contributes about ¼ of present per year SLR

 1. Greenland and Antarctic melt is presently almost 1/4 of per year SLR. *Science* article handout: 2005-2010 Greenland ice melt is 480% faster than in the early 1990’s. Mention the scientific consensus that had to take place to arrive at agreement.
2. Killer whales often seen, previously not, in Hudson Bay will sharply reduce bears, walruses, even other whales and majorly upset Arctic region’s ecology.

1. Mean Global Sea Level Rise
2. *8 in.; measured\**

 *2050 1 ft. 9 in.* *2100 3 ft. 4 in.* *\*the 20th Century rate of rise is much faster* *than it had been for 1000s of years.* NOTE: the range of 2100 SLR prediction is 2’ to 4’1. Insidious rise: there will be about 1 ft. further SLR due to slow Earth system feedbacks even if coal and oil burning emissions stop right now.

D. 1-meter SLR related:1. SLR of **1 & ¾ ft.**, equal to ⅟2 m, would displace 5 to 12 million people and is projected to occur by 2050.
2. SLR of **3 & 1/3 ft.**, equal to 1 m, would displace 60 to 240 million people. This is projected to occur by 2100.
3. 1 million Florida homes will have to be abandoned with 1-m SLR. (This does NOT count homes on the 65% of Florida’s < 1m-above-sea-level land set for development.)

1. Discussion of carbon emissions reduction that it will take to hold SLR to the ⅟2 m level. Use of IPCC emissions scenarios and projections of SLR are recommended.
2. At this point it is useful to mention a present-day SLR impact; not just mid- and end-of-century (2050 & 2100) cases. The following page presents a 2012 super-storm Sandy impact on New York City (NYC) case study.
3. Other near-term alternatives include the consideration of enhanced Greenland ice melt or, less likely, West Antarctic Ice Sheet collapse.

 D. 1-meter SLR related:*(photo)*NYC’s 1 ft. SLR since 1900 contributed to the flood water level at many NYC locations during Super-storm Sandy. Photo is of NYC subway.Super-storm Sandy: Us Climate Change Teaching Moment1. Human-caused SLR was 1 ft. of NYC 10 ft. surge due to Sandy. Previous peak surge was about 6 ft. (300 yr. record at Battery)
2. By 2100 NYC’s predicted SLR is about 4 ft.; somewhat greater than global mean due to regional SLR. The USNE coastline will have greater SLR given that Greenland melt and Gulf Current “bump into” each other.
3. Range of 3-5 ft. SLR is predicted for NYC by 2100
4. Substantially higher surface ocean temperatures in the Sandy birth region are partially due to human-caused climate change.
5. Energy derived from enhanced ocean surface water temps due to human-caused greenhouse warming along Sandy’s path to NYC contributed to the magnitude of this super-storm.
6. Yes, human-caused global warming contributed to the severe damages inflicted upon humans and infrastructure in the NYC area by super-storm Sandy. However, it is impossible to say how much of the damage was caused by us.
7. What can we do about Sea Level Rise to hold it to <=2 ft. by 2100? A variety of solutions, added together, may do the job. Examples in the governmental, private and individual sectors are on the included P.Pt slides.
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