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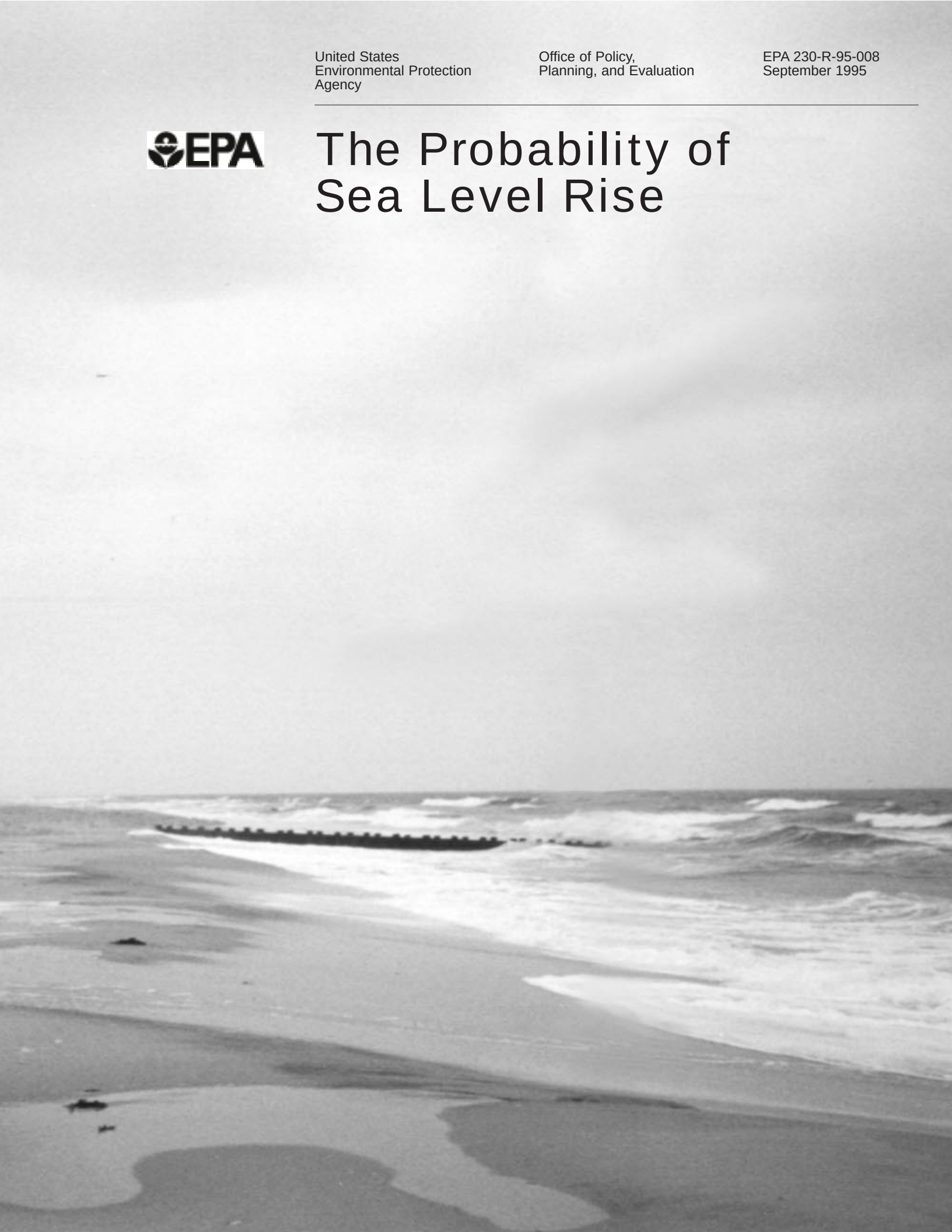

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THE PROBABILITY OF SEA LEVEL RISE

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SUMMARY

The Earth's average surface temperature has risen approximately 0.6˚C (1˚F) in the last century, and the nine warmest years have all occurred since 1980. Many climatologists believe that increasing atmospheric concentrations of carbon dioxide and other gases released by human activities are warming the Earth by a mechanism commonly known as the "greenhouse effect." Nevertheless, this warming effect appears to be partly offset by the cooling effect of sulfate aerosols, which reflect sunlight back into space.

Climate modeling studies generally estimate that global temperatures will rise a few degrees (C) in the next century. Such a warming is likely to raise sea level by expanding ocean water, and melting glaciers and portions of the Greenland Ice Sheet. Warmer polar ocean temperatures could also melt portions of the Ross and other Antarctic ice shelves, which might increase the rate at which Antarctic ice streams convey ice into the oceans. Warmer polar air temperatures, however, would probably increase annual snowfall, which would partly offset the rise in sea level caused by warmer temperatures. Along much of the United States coast, sea level is already rising 2.5-3.0 mm/yr (10 to 12 inches per century).

By ratifying the United Nations Framework Convention on Climate Change, more than 120 countries have agreed to implement measures for adapting to rising sea level and other effects of changing climate. Because the design and location of coastal structures involve decisions that cannot be easily reversed, people responsible for these activities must either plan now or risk losing the opportunity for a meaningful response. Nevertheless, the value of planning for sea level rise depends upon the probability that the sea will rise by a given magnitude.

This report develops probability-based projections that can be added to local tide-gauge trends to estimate future sea level at particular locations. It uses the same models employed by previous assessments of sea level rise. The key coefficients in those models are based on subjective probability distributions supplied by a cross-section of climatologists, oceanographers, and glaciologists. The experts who assisted this effort were mostly authors of previous assessments by the National Academy of Sciences and the Intergovernmental Panel on Climate Change (IPCC).

The estimates of sea level rise are somewhat lower than those published by previous IPCC assessments, primarily because of lower temperature projections. This report estimates that global temperatures are most likely to rise 1˚C by the year 2050 and 2˚C by the year 2100, that there is a 10 percent chance that temperatures will rise more than 4˚C in the next century, and a 90 percent chance that they will rise by at least the 0.6˚C warming of the last century. By contrast, IPCC (1992) estimated that a warming of 2.8˚C was most likely. Our temperature estimates are lower because (a) we assume lower concentrations of carbon dioxide; (b) we include the cooling effects of sulfates and stratospheric ozone depletion; and (c) our panel of experts included a scientist who

doubts that greenhouse gases will substantially increase global temperatures.

Based on the aforementioned assumptions, which this report explains in detail, our results can be summarized as follows:

1. *Global warming is most likely to raise sea level 15 cm by the year 2050 and 34 cm by the year 2100*. There is also a 10 percent chance that climate change will contribute 30 cm by 2050 and 65 cm by 2100. These estimates do not include sea level rise caused by factors other than greenhouse warming.

2. *There is a 1 percent chance that global warming will raise sea level 1 meter in the next 100 years and 4 meters in the next 200 years.* By the year 2200, there is also a 10 percent chance of a 2-meter contribution, and a 1-in-40 chance of a 3-meter contribution. Such a large rise in sea level could occur either if Antarctic ocean temperatures warm 5˚C *and* Antarctic ice streams respond more rapidly than most glaciologists expect, or if Greenland temperatures warm by more than 10˚C. Neither of these scenarios is likely.

3. *By the year 2100, climate change is likely to increase the rate of sea level rise by 4.2 mm/yr*. There is also a 1-in-10 chance that the contribution will be greater than 10 mm/yr, as well as a 1-in-10 chance that it will be less than 1 mm/yr.

4. *Stabilizing global emissions in the year 2050 would be likely to reduce the rate of sea level rise by 15 percent by the year 2100, compared with what it would be otherwise*. These calculations assume that we are uncertain about the future trajectory of greenhouse gas emissions.

5. *Stabilizing emissions by the year 2025 could cut the rate of sea level rise in half*. If a high global rate of emissions growth occurs in the next century, sea level is likely to rise 6.2 mm/yr by 2100; freezing emissions in 2025 would prevent the rate from exceeding 3.2 mm/yr. If less emissions growth were expected, freezing emissions in 2025 would cut the eventual rate of sea level rise by one-third.

6. *Along most coasts, factors other than anthropogenic climate change will cause the sea to rise more than the rise resulting from climate change alone*. These factors include compaction and subsidence of land, groundwater depletion, and natural climate variations. If these factors do not change, global sea level is likely to rise 45 cm by the year 2100, with a 1 percent chance of a 112 cm rise. Along the coast of New York, which typifies the United States, sea level is likely to rise 26 cm by 2050 and 55 cm by 2100. There is also a 1 percent chance of a 55 cm rise by 2050 and a 120 cm rise by 2100.

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