

Mt. Pinatubo as a Test of Climatic Feedback Mechanisms

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The June 15, 1991 Mount Pinatubo eruption was a large but relatively short-lived shock to the climate system. It thus provided an excellent opportunity to study its workings, to test climate models, and to examine the impacts of climate change on life. By working with observations and climate model simulations, we have been able to validate models that are used for global warming and ozone depletion calculations. In this talk we examine the water vapor feedback using the Geophysical Fluid Dynamics Laboratory (GFDL) R30 climate model and new satellite observations. When forced with observed aerosols, the model reproduces the observed cooling and drying of the atmosphere for several years after the Pinatubo eruption. By comparing model simulations with and without water vapor feedback, we demonstrate the importance of the atmospheric drying in amplifying the temperature change, and show that without the strong positive feedback from water vapor the model is unable to reproduce the observed cooling. These results provide quantitative evidence of the reliability of water vapor feedback in current climate models. This confirmation of climate model physics and sensitivity, combined with our other work on climate system dynamics and connections between stratospheric and tropospheric circulation give strong validation to the models used for attribution and projection of anthropogenic effects on climate. I will also review other work on the impacts of the Pinatubo eruption on coral, polar bears, and vegetation. Death of coral in the Red Sea in the winter of 1991-1992, and an unusually large number of polar bear cubs in the summer of 1992 both were responses to the characteristic winter and summer temperature responses of the climate system. Enhanced vegetation growth from more diffuse and less direct solar radiation took more carbon dioxide out of the atmosphere than normal, temporarily reducing the observed long-term increase in carbon dioxide. Continued research on the Pinatubo eruption and its aftermath will undoubtedly bring additional understanding of the mysteries of the climate system.