On larger scales, the effects of aerosols on precipitation are often mediated via aerosol-induced changes in circulation. These effects have been investigated using global climate models (GCMs) for over a decade. A few recent studies have suggested that the simulated response to aerosol forcing is much richer when the model includes a full dynamical ocean (as opposed to a much simpler “slab” ocean model).

We have performed multiple simulations of 20th and 21st Century climate change using a coupled atmosphere-ocean GCM. In the 20th Century runs, we have turned forcings on and off individually, to enable separation of the effects of anthropogenic aerosols from other forcings. These runs can then be compared with projections of 21st Century climate, in which the response is dominated by increasing levels of greenhouse gases.

We find that changes in the pattern of tropical Indo-Pacific sea-surface temperatures and the induced changes in circulation and rainfall are very different in 20th Century runs that exclude changes in anthropogenic aerosols, compared to runs that include “all forcings”. On the other hand, runs that exclude changes in aerosols show a similar pattern of response to the greenhouse gas-dominated pattern that is seen in the 21st Century projections.

Our results indicate that aerosols may have substantially “masked” changes in circulation and rainfall induced by increasing greenhouse gases. Anthropogenic aerosol emissions are projected to decrease sharply in the next few decades, and this may cause an acceleration of the effects of increasing greenhouse gases on circulation and rainfall.