There are other large-scale, quasi-steady circulations in the tropics, such as the Walker Cell. The Walker Cell is an East-West oriented circulation in the Pacific Ocean region where one sees generally ascent over Indonesia, as we saw in the last slide, here, and descent over the eastern equatorial Pacific. And these are the two branches of a big circulation cell called the Walker circulation, which basically exists because the ocean temperatures are warmer in the western part of the Pacific than in the eastern part of the Pacific.

This is a bit of a chicken and egg problem. The Walker circulation drives water itself, ocean water, westward across the ocean, which causes it to pile up and sink in the western part of the ocean basin, return at depth, and then upwell in the eastern part of the ocean basin. So here we have upwelling cold water, downwelling warm water. This serves to maintain the temperature gradient across the Pacific. It's that temperature gradient that drives a similar gradient in the atmosphere, which the Walker circulation basically eliminates by transporting warmer air eastward, across the Pacific Ocean. So the Walker circulation is part of a gigantic, coupled atmosphere-ocean East-West circulation in the Pacific Ocean.

Another example of a quasi-steady, large-scale overturning circulation is in the monsoon. But the monsoons are very strongly seasonal. Let's look at the monsoon in this satellite-derived precipitation product by comparing the months of December through February in this same range of years, 1998 to 2006, with June through August. So the top chart is December through February; the bottom chart is June through August.

And we'll see that the Intertropical Convergence Zone in the eastern Pacific and the Atlantic changes a little bit. It's basically a fairly subtle shift in latitude. But I want you to focus on the region around Southeast Asia and India. Very dry in the northern hemisphere winter, December through February. Not much rain at all. Lots and lots of rainfall, on the other hand, in the northern hemisphere summer.

You can also see kind of a monsoonal precipitation pattern in Africa. Lots of rain in the summer, not much rain in the winter. This is a Sub-Saharan Africa I'm talking about. These are circulations which are driven to some extent by land-sea contrasts. In the case of the Indian monsoon, the circulation exists to some extent because the Himalayas, which run along here, pretty much, block the flow of very dry, cool air from the north into the region, allowing the air to get very hot in the northern part of India and

Southeast Asia. Hot air rises and sinks to the south of the equator. But in that rising air, one gets a lot of clouds and rain.