IMPACT PROFILE
RESEARCH AT THE UNIVERSITY OF MARYLAND

RAGHU MURTUGUDDE

Climate and Living Things

Reading the news sometimes raises the question of how the climate, and changes in climate, might affect living things. Raghu Murtugudde, associate professor of atmospheric and oceanic science with a joint appointment in Earth System Science Interdisciplinary Center, flips that question around and asks how living things affect climate—as he calls it, the Gaia hypothesis (wherein the Earth itself is considered a living organism) on a small scale.

Murtugudde studies the effects of the ocean's microscopic floating plants, or phytoplankton. He has discovered that, in aggregate, phytoplankton produce enough heat to affect large-scale weather patterns. In work funded by NASA and the National Oceanic and Atmospheric Administration, or NOAA, Murtugudde has discovered that climate models must take into account the effects of phytoplankton to predict El Niños and La Niñas.

Marine Ecosystems

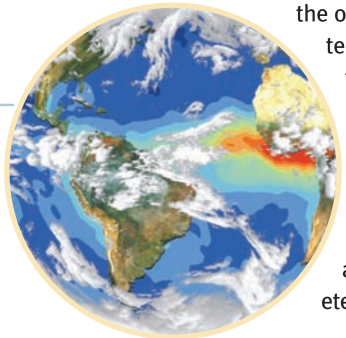
"I'd always conjectured that phytoplankton generate heat," he says. "Not accounting for this source of heat explains a large part of the biases that climate models tend to have."

El Niños and La Niñas are climatic phenomena affecting all the world's continents. During El Niños, unusually heavy rains fall on the Pacific coasts of North and South America, while Asia, Australia, and parts of Africa and Europe are subject to drought. During La Niñas, the opposite is true, with droughts in the Americas and floods in the eastern hemisphere.

These far-ranging effects arise from temperature variations in the Pacific Ocean. Normally, the eastern part of the Pacific Ocean, bordering the Americas, is cold, whereas the western part, rimming Asia, is warm. This pattern results from the prevailing winds, which blow from east to west over much of the tropical Pacific. Pushed by the wind, ocean water also moves westward. In the eastern Pacific, cold water rises up to replace displaced surface water. "The water brings nutrients from the ocean floor, nourishing lots of rich fisheries," says Murtugudde.

During El Niños, warm water moves eastward instead of westward, Murtugudde explains. Nutrient-rich water does not rise along the American coast, so fish there die, as do the birds that feed on them. Warm water brings about cloudiness and rain in the American west. Meanwhile, cooler water near Asia leads to drought and forest fires. In contrast, La Niñas stem from a stronger than typical pattern of westward water movement.

Like other plants, phytoplankton contain chlorophyll pigments and absorb light, converting solar energy into sugar and heat. Murtugudde has used satellites to measure the amount of chlorophyll in the sea and has shown that the levels of chlorophyll affect the temperatures of the oceans and, consequently, wind patterns. "There's very intricate interaction between ocean circulation and biology," Murtugudde says.



By understanding how living things affect climate, Murtugudde has been able to supplement existing climate models run by NOAA and NASA with important new parameters about phytoplankton. The refined models have better powers of prediction. In the short term, the models can yield information useful to fisheries and farmers. In the long term, the models can better forecast changes in climate.

"There's biological feedback to climate," Murtugudde says. Living things are "not just responding but actively interacting with the system." Improved models should be able to predict the coming of the next El Niño at least half a year in advance, and perhaps as much as 12 months beforehand.

In fall of 2006, Murtugudde is starting a project to evaluate how warming of the oceans is affecting the population of phytoplankton. In the past half century, the surfaces of the oceans have been getting warmer. Meanwhile, ocean depths remain cool, and the increased temperature stratification impedes water circulation. Murtugudde hypothesizes that suppressing the rise of nutrients from the ocean's depths is lowering the population of phytoplankton.

Continuing the loop, understanding phytoplankton population trends will help foretell their effects on atmospheric carbon dioxide levels. A good grasp of what's going on in the base of the food chain will help researchers project the populations of economically important fish, like tuna. Understanding exactly how biology interacts with climate is also crucial to understanding the long-term effects of greenhouse gas emissions on global temperature. NOAA is funding this research, which promises to improve fish stock assessments.

Any model should be able to represent present conditions, reproduce past data, and simulate an event that abruptly changed climate in the past. "We hope that if we build a model, it is in fact able to produce all these different scenarios," says Murtugudde. That's good evidence that the researchers who created the models understand the underlying processes that guide nature. Murtugudde recently finished a tuna population model that reproduces the last 50 years of variation in tuna populations. In the next phase of this project, he will use the model to predict future fish yield, since predicting the future is always the point. —*Karin Jegalian*

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