SCIENCE FOCUS: Land-Ocean Interactions

The Papagayo Wind

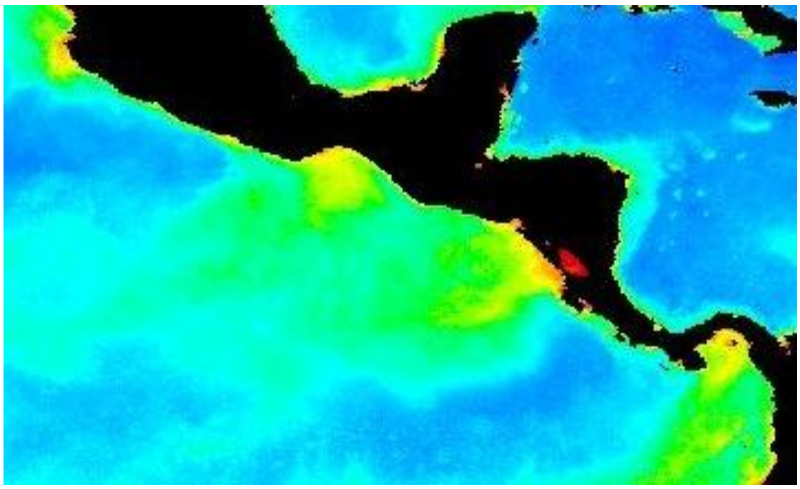


Figure 1. SeaWiFS winter (2000-2001) Level 3 chlorophyll image, showing the increased productivity corresponding to the Tehuano (south of Mexico), Papagayo (west of Nicaragua), and Panama (south of Panama) wind jets.

In many places around the world, a particular type of wind has a name. In California, **Santa Ana** winds blow hot out of the desert through Santa Ana Pass, drying the brush and then fanning the flames of wildfires. In the Adriatic Sea, they speak of the cold **Bora** from Hungary. The Rocky Mountains of the United States experience **Chinook** winds, abrupt warming breezes that follow a cold snap. The famous **Mistral** winds are cold, dry winds from the north that blow over the Mediterranean Sea. And there are many more.

In the Central American winter, they feel **Tehuanos** and **Papagayos**: gale-force winds from the Gulf of Mexico and Caribbean Sea that funnel through narrow breaks in the Cordillera, gusting to wind speeds normally found only in major hurricanes. The Papagayo wind shrieks over the lakes of Nicaragua, a jet of wind that pushes far out over the Gulf of Papagayo on the Pacific coast.

Figure 2. Central American topographic map derived from Shuttle Radar Topography Mission (SRTM) data. The Papagayo wind blows across the low elevations near Lake Nicaragua from the Caribbean Sea. Chivela Pass in Mexico, which spawns the Tehuano winds over the Gulf of Tehuantepec, is just north of this map. Map courtesy of NASA Jet Propulsion Laboratory.

And when the Papagayo blows, the sea follows. The wind mixes the normally warm surface waters with colder, nutrient-rich water that lies beneath the shallow thermocline near the coast. Algal blooms propagate in the path of the Papagayo, fueled by the banquet of nutrients. An entire food chain, ascending to the majestic marlin and sailfish sought by sport fishermen, depends on the episodic Tehuano and Papagayo events.

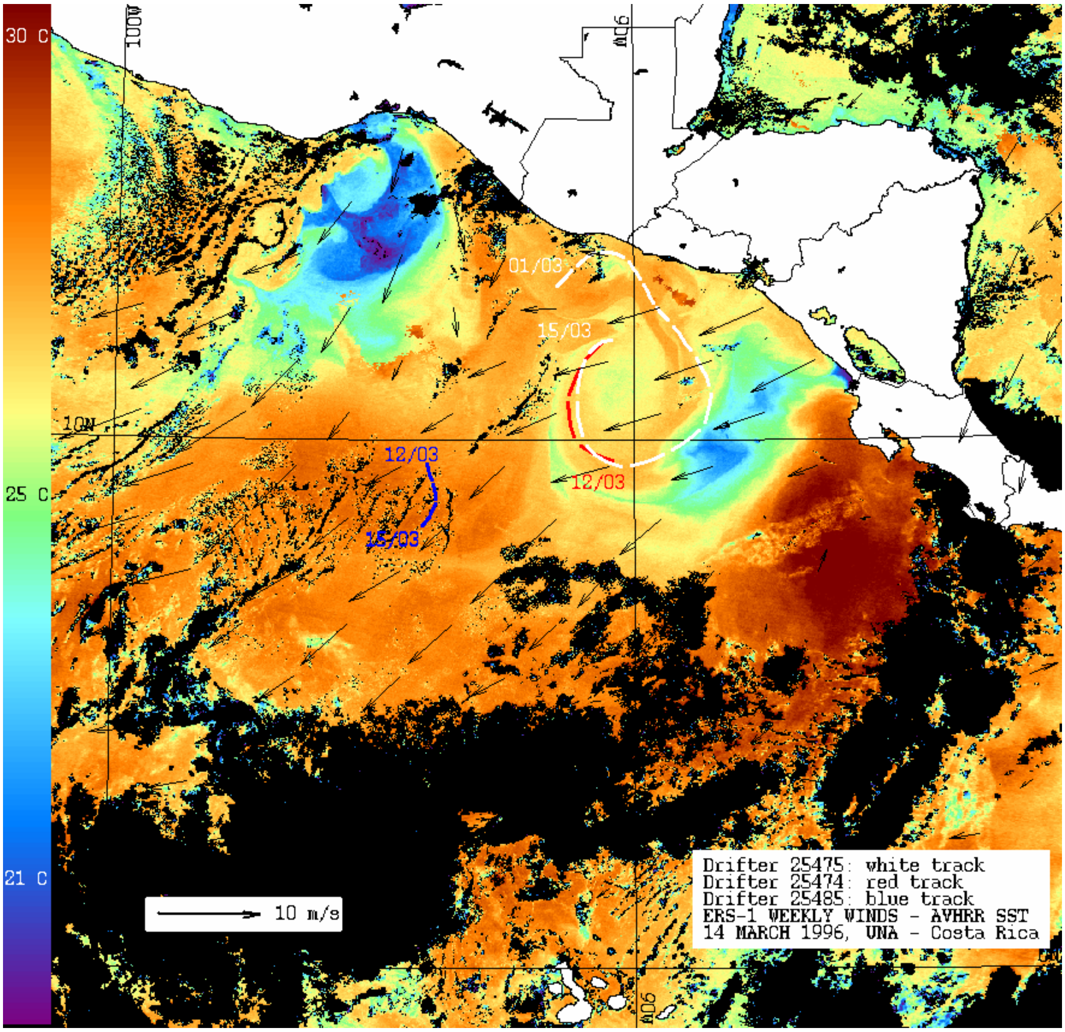


Figure 3. Sea surface temperature image showing the cold upwelling areas associated with the Tehuano and Papagayo winds. Wind vectors are from the ERS-1 scatterometer. Image courtesy of D. Ballestero and E. Coen, Universidad Nacional, Costa Rica.

The meteorological mechanism that causes Tehuano and Papagayo winds is relatively simple. In the winter, cold high-pressure weather systems move southward from North America over the Gulf of Mexico. These high pressure systems create strong pressure gradients between the atmosphere over the Gulf of Mexico and the warmer, moister atmosphere over the Pacific Ocean. Just as a river flows from high elevations to lower elevations, the air in the high pressure system will flow "downhill" toward lower pressure, but the Cordillera mountains block the flow of air, channeling it through Chivela Pass in Mexico, the lake district of Nicaragua, and also Gaillard (Culebra) Cut in Panama (which also holds the Panama Canal). Many times, a Tehuano wind is followed by Papagayo and Panama winds a few days later as the high pressure system moves south.

The arrival of these cold surges, and their associated anticyclonic circulation, strengthens the trade winds at low latitudes, and this effect can last for several days. The wind flow over Central America is actually composed of the confluence of two air streams; one from the north, associated with cold surges, and the other from the northeast, associated with trade winds north of South America.

The wind jets cause a localized, narrow entrainment of cold deep water containing dissolved nutrients that foster increased productivity. The sea surface temperature can drop 10 degrees Centigrade in a single day when the wind jets blow over the ocean surface.

The SeaWiFS Level 3 composite image for the winter of 2000-2001 (Figure 1) shows the effect of the episodic wind events as increased productivity on the Pacific coast of Central America, most pronounced where the Tehuano and Papagayo winds originate. The two high-resolution SeaWiFS images below show a particularly intense Papagayo wind-induced event on January 7 and January 14, 2001.

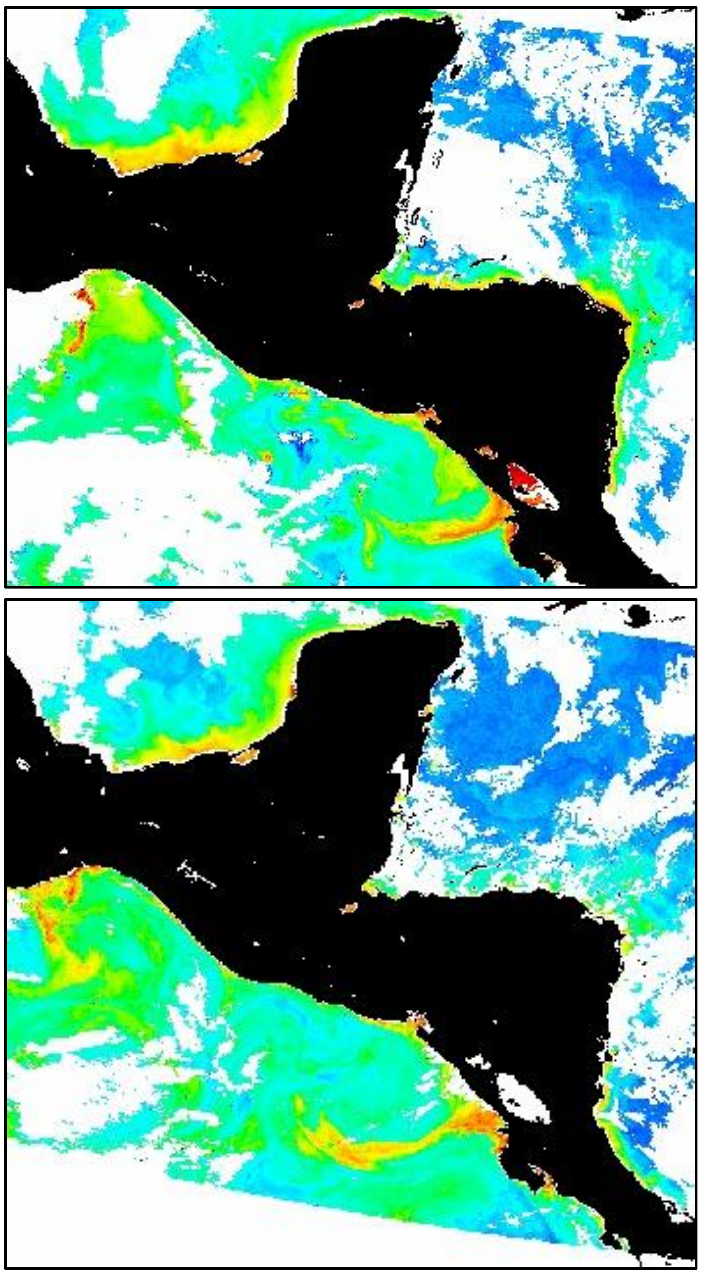
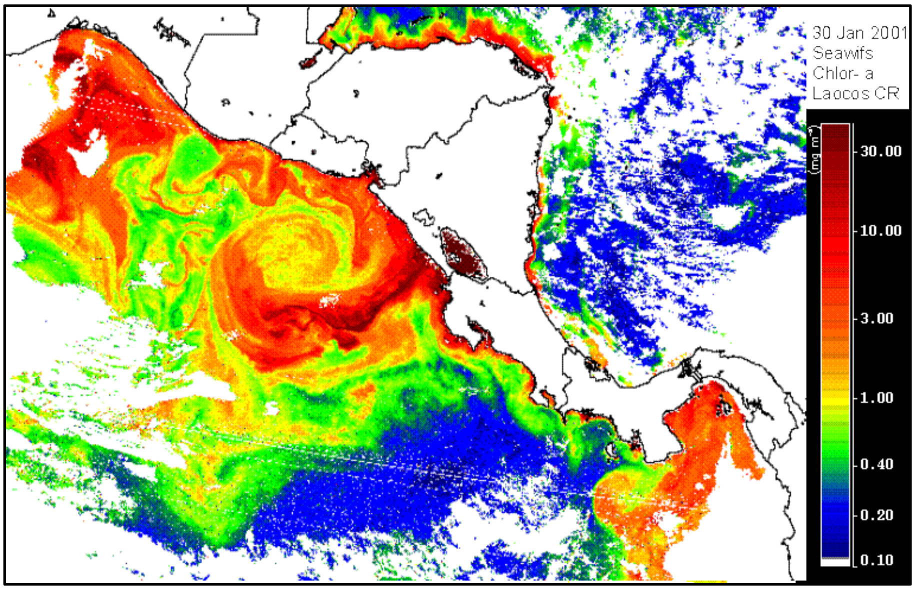


Figure 4. SeaWiFS chlorophyll images for January 7 (top) and January 14, 2001 (bottom), showing a narrow Papagayo wind-induced zone of productivity extending westward from the Nicaraguan coast. The satellite ground station at the University of Puerto Rico-Mayaguez acquired the data for these images.

January 2001 was a particularly active month in this region, as demonstrated by the SeaWiFS Level 3 image at the top of the page. The month ended with another major event, illustrated by the two images below (provided by Enrique Coen of the Laboratorio de Oceanografiay Manejo Costero, Universidad Nacional, Costa Rica). The upper image is for January 30, 2001, and the lower image is a five-day composite for January 26-30, 2001. These images serve to further illustrate how the episodic Tehuano, Papagayo, and Panama winter winds are critical to the productivity of the Pacific ocean waters west of Central America.



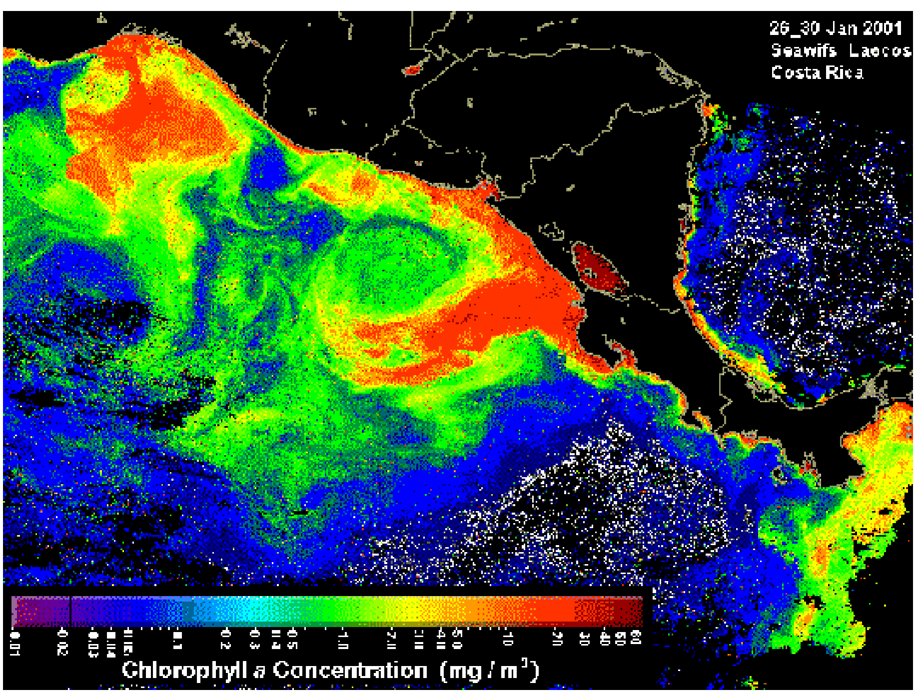


Figure 5. SeaWiFS chlorophyll images for January 30, 2001 (top) and five-day composite for January 26-30, 2001 (bottom) showing high productivity off the Central American Pacific coast corresponding to the Tehuano, Papagayo, and Panama wind jets. Note that the color scales are slightly different for each image.

One of the reasons scientists observe oceanic productivity and connect it to its physical causes in the atmosphere and ocean is to determine if climate change will affect the productivity of the ocean. In the case of the Papagayo wind, a warming climate may reduce the frequency of cold air masses from North America that reach the Gulf of Mexico and the Caribbean Sea. In turn, this would lead to reduction in the frequency and intensity of the episodic upwelling events driven by the Tehuano and Papagayo winds, with the net effect of a reduction of oceanic productivity in this region.

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Links
Shuttle Radar Clears the Air on Central America's Topography
Non-Inertial Flow in NSCAT Observations of Tehuantepec Winds
Satellite Observations of the Wind Jets off Central America

References
The linked documents are PDF documents.

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