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Cloudy with a Chance of Drizzle [1]

by Amanda Leigh Haag

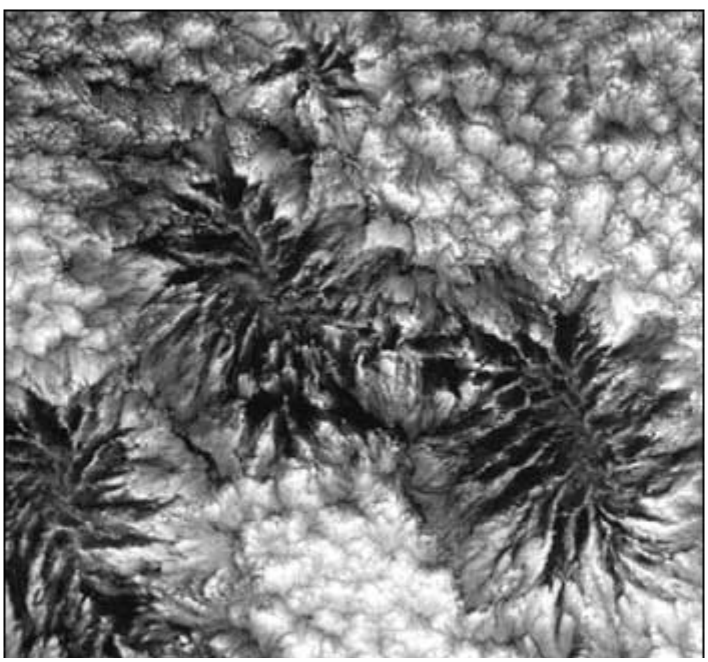
By analyzing data from the MISR instrument, scientists discover that a unique type of cloud formation is much more prevalent than was previously believed.

- AboutNASA Langley Research Center Atmospheric Science Data Center (LaRC) [2]

Ask just about anyone who's lived along the Southern California coast what it's like to plan a picnic or a day at the beach during the months of May and June. Chances are they'll warn you about the seemingly endless chain of dreary, overcast days known locally as "May Gray" and "June Gloom." The heavy cloud banks rolling in off the ocean do little more than spoil an otherwise perfect sunny day and drop a harmless drizzle from time to time. To someone hoping to spend a day basking in the sun and surf, these clouds are just gray, gloomy, and boring.

But scientists who study cloud behavior are learning that these dismal clouds hold a lot more interest than meets the eye. Researchers are finding that the western coasts of continents where May Gray and June Gloom-type cloud systems occur are bountiful hunting grounds for unique formations called actinoform clouds. Named after the Greek word for "ray" due to their radial structure, these previously overlooked clouds are only now coming into focus as scientists use satellite data to better understand their complexity.

Children around the world learn that clouds take on unique shapes in the sky and that cloud patterns often foretell the oncoming weather. Yet scientists still know very little about what determines the shape of individual clouds. Michael Garay, a graduate student at the University of California, Los Angeles (UCLA), is one of a handful of experts who are trying to discover what gives actinoform clouds their complex shape and what role they play in climate and weather systems. "In a general sense, we understand that stratus clouds are formed by one type of process and one type of atmospheric conditions, while cumulus — the puffy clouds — are formed by another process," said Garay. "But when it gets down to the details of 'why does this cloud look like a bunny and this cloud look like a horse,' that's really hard to understand."



Feedback

MISR captured this image of an actinoform cloud in the Southern Hemisphere in August 2001. (Image courtesy of NASA/GSFC /LaRC/JPL, MISR Team)

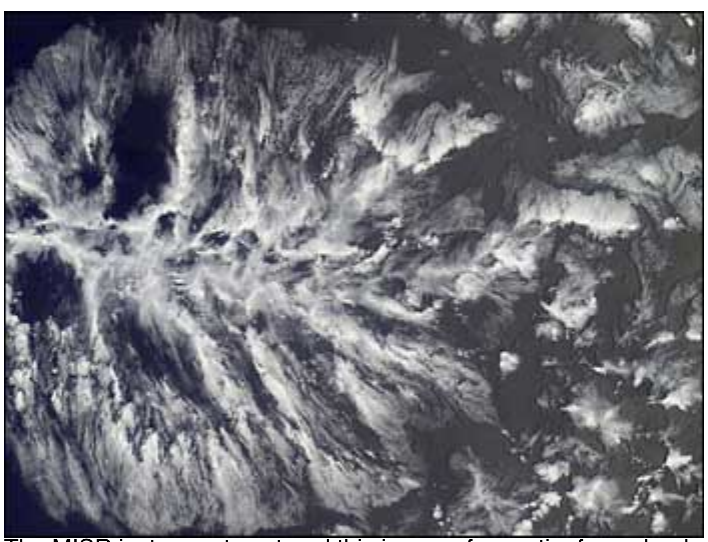
But the actinoform clouds that Garay and his colleagues are studying are not the kind that you can see while gazing at the sky. They are actually cloud fields — collections of clouds that can be up to 300 kilometers across, an area roughly the size of the state of South Carolina and a field of view too large to see with the naked eye. In addition, they can form "trains" that are up to six times the length of the original cloud field, yet they maintain their own, distinct identity. Using satellite data from the Multi-angle Imaging SpectroRadiometer (MISR) — one of five instruments onboard NASA's Terra spacecraft — scientists are finding these clouds to be much more prevalent and complex than they originally thought.

When viewed in a satellite image, actinoform clouds look like distinct leaf-like or spokes-on-a-wheel patterns that stand out from the rest of the low-lying cloud field. Bjorn Stevens, a meteorology professor at UCLA, describes them as being similar to a "leaf floating in a pond." Embedded within the low-lying clouds that give rise to what Southern Californians call May Gray and June Gloom, actinoform clouds have a distinct pattern that doesn't fade away towards infinity, he said. "Imagine your grandmother's quilt where one of the squares really stands out as being something different," said Stevens. Like the square in the quilt, the cloud will hold its shape and stand out from the rest, he explained. "It will move with the wind, but it doesn't grow or contract very much — it just has its own life," he said.

Actinoform clouds are not a recent discovery; they appeared in meteorological literature as far back as the early 1960s, when the first weather satellites began sending back images. But until the late 1990s, scientists had dismissed them as merely a transitional form between other, more familiar types of clouds, and they were all but forgotten. In fact, the term "actinoform" isn't included in the 2000 edition of the Glossary of Meteorology, which is considered to be the comprehensive reference manual for meteorologists. "There's also a recent review of all the research that's been done in the past 20 years on low-level clouds and they don't even mention actinoform clouds," said Garay. "People just kind of forgot they were there."

The NASA Langley Atmospheric Sciences Data Center (LaRC) played an important role in the rediscovery of actinoform clouds. Garay recalled that his advisor, Roger Davies, now at the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., was looking through imagery from the MISR instrument, which is archived and distributed by the LaRC Distributed Active Archive Center (DAAC).

MISR collects data on the sunlit side of the Earth, using cameras that look in nine different directions simultaneously. The change in reflection at different viewing angles enables researchers to distinguish different types of atmospheric particles (aerosols), cloud forms, and land surface covers. Davies noticed a giant, leaf-shaped cloud that took up almost the entire width of one image, recalled Garay. "This sent me on a very interesting chase through the meteorological literature looking for pictures of these clouds, because as good as these database searches are — and they get better all the time — it's hard to put in a search term like 'cloud that looks like a leaf' and get the right information, much less come up with the right picture," said Garay.



The MISR instrument captured this image of an actinoform cloud on November 16, 2001. The identification of this cloud, which looks very much like a leaf, prompted a search for more examples of this cloud type in the MISR data. (Image courtesy of NASA/GSFC/LaRC/JPL, MISR Team)

Garay eventually tracked down satellite images of actinoform clouds taken by early weather satellites in the 1960s. But what he uncovered about the clouds themselves was quite unexpected. Actinoform clouds had been thought to be a relatively uncommon transitional form. However, by sifting through MISR images of the western coast of Peru, Garay found that actinoform-like clouds showed up roughly a quarter of the time as distinct formations within the more common, stratocumulus clouds in that region. Closer examination showed that actinoform clouds occur worldwide in nearly every region where marine stratus or stratocumulus clouds are common, particularly off the western coasts of continents — especially Peru, Namibia in Africa, Western Australia, and Southern California. Such cloud systems are persistent year-round off the coast, yet in certain seasons they blow ashore and create the gloomy "May Gray" effect on land.

And to Garay's astonishment, the closer he looked at the clouds, the more complex he found their patterns of organization to be. "This is something you wouldn't expect," said Garay. "We don't have a good understanding of why they have this radial structure to them and why it's fairly common."

So what might these elaborate features mean to weather systems and climate patterns? Unfortunately, there's no simple answer, according to Garay. "Clouds trace atmospheric motion, so they're responding to the atmosphere in a complicated way," said Garay. Clouds are complex: they change in response to small-scale effects, like the presence of a hill or the local wind, but they also respond to large-scale weather systems, such as cold fronts and the presence of the jet stream, said Garay.

Stevens, who studies a closely related cloud form dubbed "pockets of open cells," or POCs, has a theory that may begin to explain the complex interactions between clouds and the climate system. Both POCs and actinoform clouds have a compact and distinct shape embedded within low-level marine stratus clouds. But the taxonomy to determine the exact relationship between actinoform clouds and POCs hasn't yet been worked out. "How similar they are is an open question," said Stevens.

Feedback

The open cells that Stevens studies are one of two well-known types of stratocumulus cloud formations: open and closed cells. Open cells resemble a honeycomb, with clouds around the edges and clear, open space in the middle. Closed cells are cloudy in the center and clear on the edges, similar to a filled honeycomb. Like actinoform clouds, the 'cells' in this case do not refer to a single cloud but to the system of associated clouds. Previously, researchers believed that actinoform clouds represented a transitional form between open and closed cells, but the recent findings on actinoform clouds show that they are clouds in their own right.

Each year, Southern Californians experience a long cycle of dreary, overcast days known as May Gray and June Gloom. Scientists are learning that regions where these systems occur are good hunting grounds for actinoform cloud formations. (Image from Photos.com)

Stevens' observations from field studies in the Pacific seem to indicate that when marine stratus clouds exist alone, in the absence of these open cells, the cloud formations are associated with little, or no, drizzle. Yet when the open cells are present — and likewise actinoform clouds — there seems to be a corresponding increase in drizzle. Thus, his data suggests that the presence of POCs and actinoform clouds is related to the onset of precipitation. "The shape of the cloud field reorganizes itself when the clouds begin to rain," said Stevens. In fact, Stevens has been able to mirror this reorganization using a computer model of a drizzling cloud field.

Stevens' findings suggest that clouds play an important role in regulating climate. Clouds reflect incoming sunlight, and they also act as a blanket that slows the upward movement of heat from Earth's surface back into space. This is why cloudy days are generally cooler than sunny days, but cloudy nights are generally warmer than clear nights. Thus, cloud cover is instrumental in setting Earth's energy balance and controlling its internal "body" temperature. "It makes the observation of these peculiar cloud forms, which seem to be linked to the development of precipitation, more interesting than they would've otherwise been," said Stevens.

So for those of us who spent some of our childhood days lying with our backs in the grass and gazing at the sky, the prevalence of unexpected cloud features in the sky might not come as a particular surprise. But for scientists, it raises the question of whether looking for patterns in the clouds might help unveil some of the deeper mysteries of the climate system. Either way, it appears that these clouds will continue to puzzle children and scientists alike. "It's really kind of fascinating," said Garay. "You'd expect these clouds to be sort of round or flat. But looking like a wheel with spokes coming out of them is just kind of surprising."

Reference(s)

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Related Link(s)

- MISR (Multi-angle Imaging SpectroRadiometer) [3]
- NASA Langley Atmospheric Sciences Data Center DAAC [4]
- Clouds are Cooler Than Smoke [5]
- Tracking Clouds [6]
- Clouds in the Balance [7]
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