Scientists probe huge bands of vapor that make or break droughts

February 17 2015, by Bettina Boxall, Los Angeles Times

Finally, it had arrived: the long band of atmospheric water vapor from the tropics that scientists were eager to examine from every conceivable angle.

"This is the big blockbuster event," Cmdr. Mark Sweeney said shortly before he guided a federal research plane called Miss Piggy into a puffy, pewter-colored blanket of clouds that spread across Northern California.

The P-3 Orion aircraft was part of a research effort that sampled and measured two atmospheric river storms that gave half the state a welcome soaking the week before last. Four planes, a ship, ground equipment and satellites collected a mountain of data as the sky rivers rolled in from the Pacific Ocean.

Atmospheric rivers form all over the world. But there has been growing interest in the West Coast storms as scientists recognize the vital role they play in the yo-yo water supply of the nation's most populous state. Their presence or absence can break or make a drought. Knowing when and where they will arrive and how much rain and snow they are likely to dump is crucial for water managers.

A strong sky river can carry a load of water vapor equivalent to more than 10 times the flow of the lower Mississippi River. When the ribbons of moisture slam into California's coastal ranges and the Sierra Nevada, they rise and condense into rain and snow, delivering on average 40 percent of the state's annual precipitation. Atmospheric rivers have

ended roughly a third or more of state droughts since the middle of the last century, according to a recent study.

The two storms that hit Northern California over four days weren't big enough to bust the current prolonged drought. But they dumped as much as 15 inches of rain on the mountains of Shasta County. After a parched January, they pushed precipitation totals back to normal levels for this time of year in the northern watersheds that supply some of the state's most important reservoirs.

Miss Piggy, a federal "Hurricane Hunter" plane loaded with meteorological instruments bolted to the floor, took off from McClellan Airfield at 7 a.m.

On board were four research scientists and the blue-suited flight crew from the National Oceanic and Atmospheric Administration. For the next seven hours they would fly through, under and above the sky river, traveling roughly 2,000 bumpy miles back and forth over the Pacific Ocean, the Coast Range and the Sacramento Valley.

All the while, radar equipment mounted on the aircraft's exterior measured precipitation and cloud thickness. Probes attached to the wings measured the number and size of liquid cloud droplets. Another of the plane's radar devices measured the height of ocean waves.

At various points over the Pacific, the NOAA crew loaded two types of disposable instruments into a chute and released them from Miss Piggy's fuselage.

Dropsondes, compact cylinders outfitted with sensors that transmit data back to the plane in real time, measured temperature, atmospheric pressure, humidity and winds as they parachuted 8,000 feet to the white-capped sea.

Larger cylinders called airborne expendable bathythermographs, or AXBTs, opened up when they hit the water, unfurling probes that transmitted the temperature at the ocean surface and more than 1,000 feet below it.

All that was just one part of the scientific attack mounted that day. "This is an unprecedented interrogation of an atmospheric river event in landfall," said Ryan Spackman, an atmospheric chemist and NOAA contractor from Boulder, Colo., who was the lead researcher on the flight.

Three other federal research planes were also in the air. On the Pacific, a NOAA research vessel collected weather and ocean data about 230 miles offshore. A satellite measured surface winds over the sea, and the International Space Station focused a laser beam on the clouds to discern how dust aerosols were mixing over the ocean. Meanwhile, a ground-based network of instruments sampled conditions at various locations.

Scientists involved in the effort say no atmospheric river has been as thoroughly poked, dissected and analyzed as the one that hit Northern California on Feb. 6.

The view didn't change much as Sweeney directed Miss Piggy along a rectangular fight path that started over the Pacific west of the Bay Area and then shot inland to the northeast. Rivulets of water slid across the portals as the plane cut though pale clouds, flying alternately at 8,000 and 10,000 feet above the soggy landscape.

For one long stretch over the ocean, Sweeney spiraled down to 1,000 feet, bringing the swells of the dark, choppy Pacific into view.

For the researchers monitoring instruments on board, riding the river as it made landfall was a thrill of their careers. "Flying the dream,"

Spackman wrote in a message to other mission scientists.

The complex choreography of research craft was years in the making - part of a federal-state project that is studying atmospheric rivers and the role that aerosols play in California's snow and rainfall. The first phase ran from 2009 to 2011. The second phase began last year and will last until 2018.

This year's field campaign, which began in January and will end in March, is costing roughly $10 million, most of it provided by the federal government.

Scientists from NOAA, the Department of Energy, NASA, Scripps Institution of Oceanography, the state Department of Water Resources and other agencies are trying to better understand how atmospheric rivers evolve as they encounter the state's up-and-down topography. They are also researching how the composition of aerosols, which can be natural or man-made, influences the amount of rain and snow that clouds release.

The rich array of data being collected "will give us all the pieces of the puzzle to really start to take our understanding of things to the next level," said project co-leader Kim Prather, a Scripps scientist who is studying aerosols this winter at a Bodega Bay site.

The researchers hope to improve forecasting that can help California water managers plan for big storms that could cause flooding or suddenly swell reservoirs. They hope to also better understand how climate change will affect atmospheric rivers and the state's water supply.

Shortly after 2 p.m., Miss Piggy landed at McClellan in a steady rain. Spackman was smiling as the flight crew and researchers gathered for a short debriefing before walking down the stairs onto the wet runway.

"We made history," he said.