NEWS IN FOCUS

RUPAK DE CHOWDHURI/REUTERS

The Indian monsoon can bring damaging floods, but also has a crucial role in ensuring an adequate water supply for people and crops.

ATMOSPHERIC SCIENCE

Mysteries of Indian monsoon probed

Research plane and ships aim to gather the most detailed data yet on rainfall variations.

BY ALEXANDRA WITZE

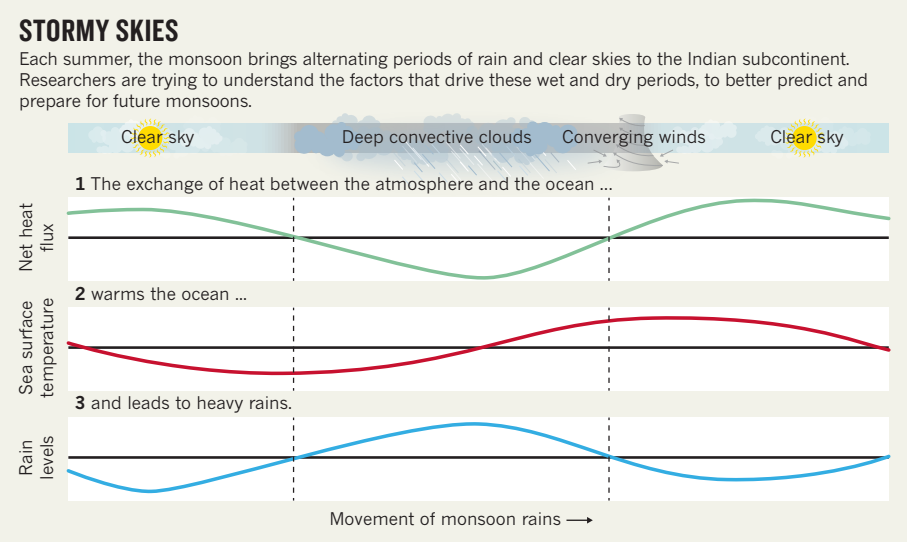
Heavy rains and seven-metre-high waves pummelled the research vessel *Thomas G. Thompson* in the Bay of Bengal this month, routinely drenching the oceanographers on deck. But that was just fine with the scientists. Their entire plan involved getting as wet as possible, in order to directly measure what happens where the air and the sea meet in a summer storm.

The team is part of a multinational group of researchers who are descending on the Indian Ocean this summer to study its seasonal monsoon. They intend to gather the most detailed observations yet on the wet and dry periods that alternate roughly every 10–50 days during the monsoon season, which lasts from June to September.

If modellers could better predict these varying patterns — called monsoon intra-seasonal oscillations, or MISOs — then officials could better prepare for the monsoon each year. That includes timing the planting of crops in concert with the rains, storing water behind dams for hydropower, and preparing for floods and other natural disasters.

"One billion people on the Indian subcontinent depend on planning for water resources," says Harindra Fernando, a mechanical engineer at the University of Notre Dame in Indiana and one of the project's leaders. "When people are waiting for rain, it's important to know when you will get it and when you won't."

MISOs represent the monsoon's 'active' and 'break' periods, in which weeks of heavy rainfall give way to brilliant sunshine before starting all over again. The patterns of rainfall generally track northwards over the Bay ▶



SOURCE: HARINDRA FERNANDO

of Bengal, and sometimes veer towards the Indian subcontinent — where they can cause serious damage. In 2017, a powerful MISO brought torrential rain and landslides to Sri Lanka, killing more than 200 people.

Weather and climate models have not been able to accurately predict MISOs[1]. Strong and frequent interactions between the atmosphere and the ocean seem to help get them started[2], as warm ocean waters feed energy into the air above (see 'Stormy skies'). A study published this year suggests that certain ocean processes, such as a type of wave that helps warm the topmost waters, could play a big part in kicking off many MISOs[3]. Having direct measurements from within a MISO will help modellers to pinpoint the exact conditions that drive them, says lead author Jason West, an atmospheric scientist at the University of Colorado Boulder.

The Bay of Bengal project aims to measure the microphysics of energy flows between the ocean and the atmosphere once MISOs are under way. It builds on a long history of international field campaigns to understand the intricacies of the Indian Ocean monsoon, so that neighbouring countries can better prepare for it[4]. Funders of the five-year study, which is known as MISO-BOB, include the Indian Ministry of Earth Sciences and the US Office of Naval Research, working with institutions such as Sri Lanka's National Aquatic Resources Research and Development Agency (NARA).

MISO-BOB's aerial component started on 15 June from an air base in Colombo, Sri Lanka. Scientists have been flying aboard the US Air Force's hurricane-hunter C-130 plane, which carries equipment to measure the properties of clouds and the atmosphere. It is releasing instrument packages called dropsondes that measure temperature, pressure and wind speed as they plummet towards the sea.

The *Thompson*, meanwhile, left Chennai, India, on 4 June for the first of two research legs to gather data on ocean conditions. Scientists on board — mostly students and early-career researchers — have deployed a variety of instruments to measure temperature, salinity, currents and other factors at different depths and locations across the Bay of Bengal. They have also released radiosondes, which are instrument packages carried upward by weather balloons to gather meteorological data.

"We want to observe the conditions across the air–sea interface cleanly, which is a challenging thing to do," says Emily Shroyer, an oceanographer at Oregon State University in Corvallis, who led the first leg. The second leg will take another group of scientists on board and will wrap up by 22 July. This team will travel farther to the south, and an associated group will take measurements near Sri Lanka with the NARA research vessel *Samudrika*, says NARA oceanographer Priyantha Jinadasa.

With enough data and analysis, MISO forecasts could improve in perhaps five or ten years, says team member Debasis Sengupta, a monsoon expert at the Indian Institute of Science in Bangalore.

Project scientists are already planning a second, longer season of field observations for next summer. Details have not yet been finalized, but the team will continue to target how energy flows between the air and the sea during the monsoon. "There's constantly this game going on between the atmosphere and the ocean," says Amit Tandon, an oceanographer at the University of Massachusetts in Dartmouth. "It's every bit as exciting as a World Cup match between two nations." ■

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3. West, J. B., Han, W. & Li, Y. *J. Geophys. Res. Oceans* https://doi.org/10.1019/2017JC013564 (2018).
4. Mahadevan, A. *et al. Oceanography* **29**, 14–17 (2016).

TRADE

US–China trade war rattles labs

Trump puts tariffs on Chinese technology and China retaliates with taxes on US chemicals.

BY ANDREW SILVER

Scientific research in the United States could become collateral damage in the country's escalating trade dispute with China. Both nations went head-to-head in mid-June over tariffs on a long list of goods that includes lab equipment and reagents. That is likely to increase the cost of scientific research, and the impact could be felt more keenly in US labs.

The latest skirmish in the ongoing trade war between the world's two largest economies began on 15 June, when the United States announced a 25% tax on 818 goods imported from China. The list includes equipment used by scientists, such as basic electrical parts, microscopes and geological-survey devices. President Donald Trump said the tariffs, which will start on 6 July, are intended to reduce China's dominance in industries such as robotics, new materials and information and communications technology, and will level the playing field for US firms. The Trump administration is considering tariffs on a further 284 industrial goods, including chemicals.

A day after the US announcement, China's Ministry of Commerce responded with its own set of tariffs on 545 US products imported to China, which will also start on 6 July. The government will apply taxes in the future to another 114 US imports — including basic chemicals and medical devices, such as magnetic resonance imaging (MRI) machines — although it has not announced a date.

Scientists in the United States were quick to denounce Trump's latest round of tariffs. "I am opposed to these seemingly ad hoc tariffs because it will further stretch the already anaemic scientific research budgets in this country," says Thomas Lapen, a geochemist at the University of Houston, Texas. Equipment