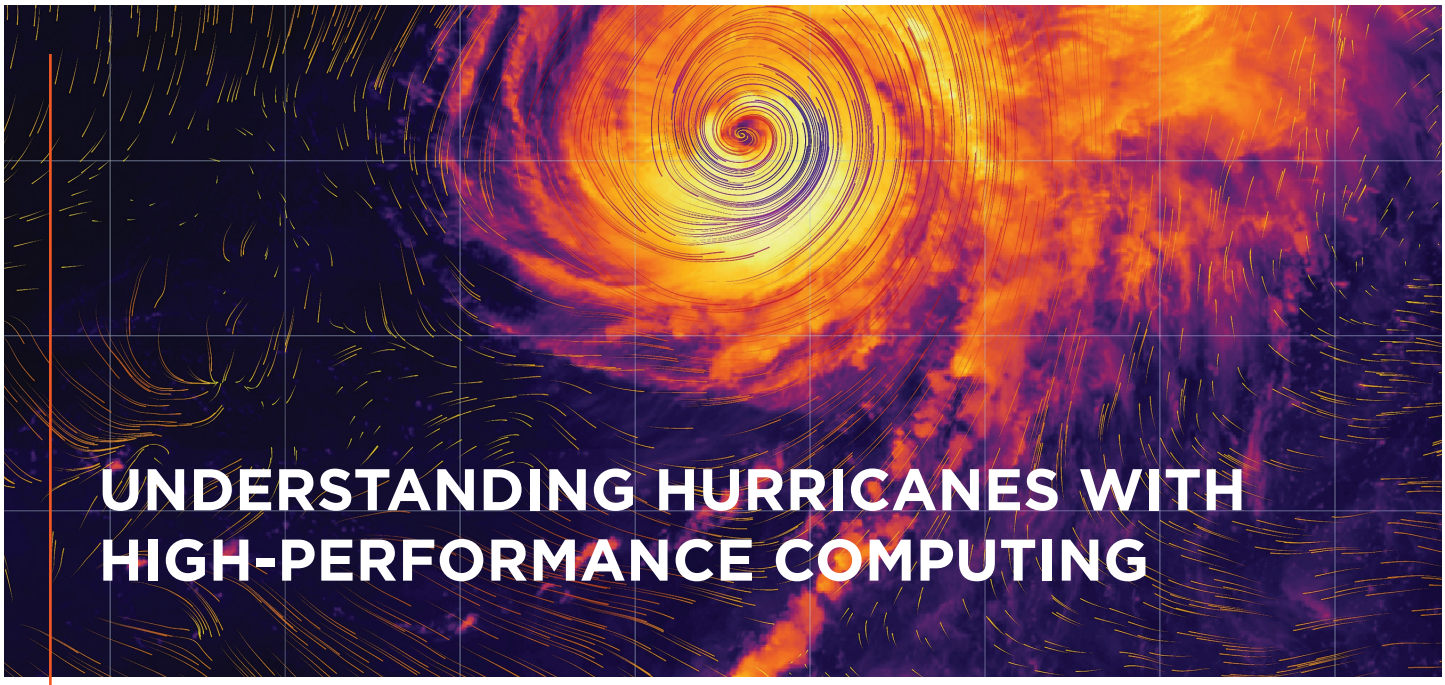
SOLUTIONS FLYER



UNDERSTANDING HURRICANES WITH HIGH-PERFORMANCE COMPUTING

Weather and climate centers worldwide rely on the power of high-performance computing (HPC) to analyze, understand, and predict severe weather events — including hurricanes, which exact a toll in human lives and cost billions of dollars each year. Modeling the Earth's weather and climate patterns is a challenge that requires top-of-the-line HPC systems and software that can orchestrate the most complex workloads.

The Destructive Power of Hurricanes

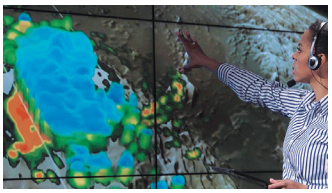
According to the U.S. National Weather Service, an average of 10 tropical storms develop over the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico each year — and six become hurricanes (known in different parts of the world as cyclones and typhoons). Around five hurricanes strike the U.S. coastline in a typical 3-year period, killing dozens of people. On average, two of these are considered major hurricanes, with winds exceeding 110 miles per hour. Hurricanes form over warm water where moist air rises and cools. As the temperature of rising air drops it forms clouds and leaves a low-pressure area below, where cool air fills the void. This process repeats, creating a dangerous cycle of swirling winds.

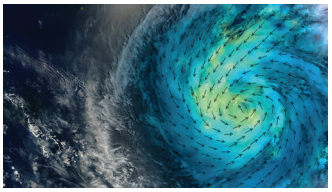
Understanding the Behavior of a Powerful Storm

Because so many factors are involved in a hurricane's formation and lifespan, it's not easy to determine when and where one will strike and what impact it'll have on lives, infrastructure, and property. Prediction requires powerful HPC that can handle some of the world's biggest, most complex computational workloads. Organizations like the U.S. National Science Foundation National Center for Atmospheric Research (NSF NCAR) and Australia's Bureau of Meteorology rely on HPC to simulate, model, and better understand this powerful and destructive weather phenomenon.

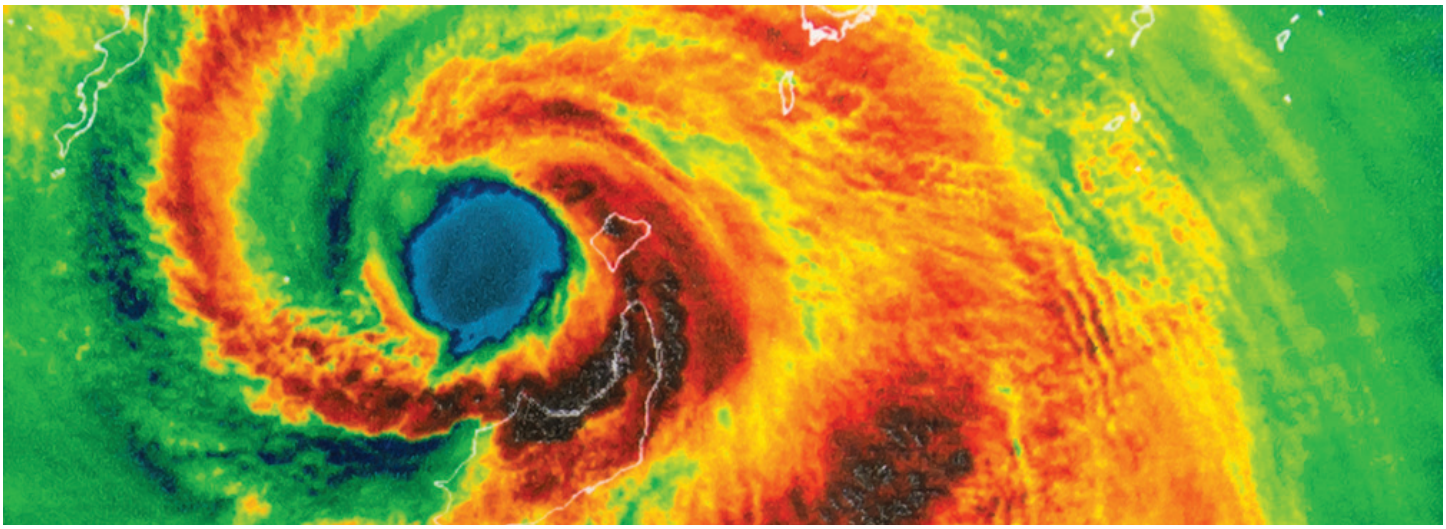
HPC Powers Hurricane Research

Large weather centers often divide their computing resources between operational weather models — which perform the crucial up-to-the-minute weather and climate forecasting we rely on every day — and developmental or research models. When significant weather events such as hurricanes, wildfires, and tsunamis occur, weather centers reallocate more computing power towards time-sensitive operational models — up to 100% of system capacity when needed. They may also utilize cloud resources to expand computational power. In addition to powerful hardware, weather centers need top-flight software solutions to ensure their complex, demanding workloads run quickly and efficiently and maximize expensive computing time and resources.





Weather organizations worldwide use Altair technology to enable sophisticated HPC in the realm of climate and weather science



Orchestrating Demanding Weather Simulations

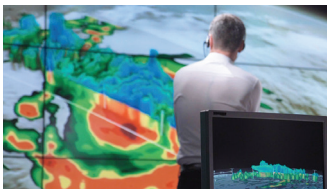
Weather centers around the world trust Altair's solutions for workload orchestration, resource management, user access, and analytics. The industry-leading Altair® PBS Professional® workload manager ensures weather and climate modeling and simulation workloads run quickly and efficiently and maximize HPC resources. Altair® NavOps® maximizes business impact and enables global operations with optimized, cost-efficient HPC in the cloud. Altair also offers a complete weather solution featuring PBS Professional and the Cylc workflow engine.

Hurricane Prediction in Action

Climate researchers rely on the HPC tools provided by world-class atmospheric and Earth systems sciences research centers weather agencies like NSF NCAR, which utilizes both PBS Professional and NavOps to provide the U.S. science community with state-of-the-art computing resources. Its 19.87-petaflops "Derecho" system — named after a powerful type of windstorm — and other supercomputing resources are used to simulate hurricanes, explore their impact, and improve early warning systems. Researchers are also using NSF NCAR systems and their artificial intelligence (AI) and neural network capabilities to identify complex spatial patterns and thermodynamic fields that are often the telltale signs of intense storms.

On the other side of the world, Australia's Bureau of Meteorology employs petaflop-scale computing to provide the continent with expertise about natural phenomena including droughts, floods, storms, and tropical cyclones. On average, 11 cyclones form in the region each season, accounting for around 13% of the world's total. Half of these become severe, threatening life and property.

These and other weather organizations worldwide use Altair technology to enable sophisticated HPC in the realm of climate and weather science. Doing so helps us better predict and understand powerful storms, ultimately creating a better, safer future.



Understanding hurricanes requires powerful HPC that can handle some of the world's biggest, most complex computational workloads

Weather and climate centers worldwide rely on the power of HPC to analyze, understand, and predict severe weather events.