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- Google's ‘A Passage of Water' Brings NASA's Water Data to Life (2023/11/30 17:50)
  In Brief: This immersive experience leverages satellite data to illustrate how climate change is impacting Earth’s water cycle. As part of the long-standing partnership between NASA and Google, NASA worked with Google Arts & Culture and artist Yiyun Kang to create an interactive digital experience around global freshwater resources titled “A Passage of Water.” This immersive experience leverages data from the Gravity Recovery and Climate Experiment (GRACE) satellites and new high-resolution data from the Surface Water and Ocean Topography (SWOT) mission to illustrate how climate change is impacting Earth’s water cycle. A digital version of “A Passage of Water” will be released online on Thursday, Nov. 30, ahead of the beginning of the United Nations’ Climate Change Conference of Parties (COP 28) in Dubai, United Arab Emirates. Google also will host a physical installation of the visualization project in the Blue Zone at COP 28. “NASA is the U.S. space agency that provides end-to-end research about our home planet, and it is our job to inform the world about what we learn,” said Kate Calvin, NASA’s chief scientist and senior climate advisor in Washington. “Highlighting our Earth science data in the installation of ‘A Passage of Water’ is a unique way to share information, in a digestible way, around the important connection between climate change and the Earth’s water cycle.” For six decades, NASA has been collecting data on Earth’s land, water, air, and climate. This data is used to inform decision-makers on ways to mitigate, adapt and respond to climate change. All of NASA’s Earth science data is available for scientists and the public to access in a variety of ways. “NASA studies our home planet and its interconnected systems more than any other planet in our universe,” said Karen St. Germain, director of NASA’s Earth Science Division. “‘A Passage of Water’ provides an opportunity to highlight the public availability of SWOT data and other NASA Earth science data to tell meaningful stories, improve awareness, and help everyday people who have to make real decisions in their homes, businesses, and communities.” A collaboration between NASA and the French space agency CNES (Centre National d’Études Spatiales), SWOT is measuring the height of nearly all water on Earth’s surface, providing one of the most detailed, comprehensive views yet of the planet’s freshwater bodies. SWOT provides insights into how the ocean influences climate change and how a warming world affects lakes, rivers, and reservoirs. Get NASA's Climate Change News “The detail that SWOT is providing on the world’s oceans and fresh water is game-changing. We’re only just getting started with respect to data from this satellite, and I’m looking forward to seeing where the information takes us,” said Ben Hamlington, a research scientist at NASA’s Jet Propulsion Laboratory in Southern California. The Google project also uses data from the GRACE and GRACE Follow-On missions –the former is a joint effort between NASA and the German Aerospace Center (DLR), while the latter is a collaboration between NASA and the German Research Centre for Geosciences (GFZ). GRACE tracked localized changes to Earth’s mass distribution, caused by phenomena including the movement of water across the planet from 2002 to 2017. GRACE-FO came online in 2018 and is currently in operation. As with GRACE before it, the GRACE-FO mission monitors changes in ice sheets and glaciers, near-surface and underground water storage, the amount of water in large lakes and rivers, as well as changes in sea level and ocean currents, providing an integrated view of how Earth’s water cycle and energy balance are evolving. “A Passage of Water” is the most recent digital experience created under NASA’s Space Act Agreement with

Google, with resulting content to be made widely available to the public free of charge on Google's web platforms. This collaboration is part of a six-project agreement series that aims to share NASA's content with audiences in new and engaging ways. Learn more about SWOT, GRACE, GRACE-FO, and NASA's Earth Science missions at: https://science.nasa.gov/earth To learn more about NASA Partnerships, visit: https://www.nasa.gov/partnerships News Media Contact Katherine Rohloff NASA Headquarters, Washington 202-358-1600 katherine.a.rohloff@nasa.gov Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov

- NASA to Showcase Earth Science Data at COP28 (2023/11/28 00:05)
  With 26 Earth-observing satellite missions, as well as instruments flying on planes and the space station, NASA has a global vantage point for studying our planet's oceans, land, ice, and atmosphere and deciphering how changes in one drive change in others. The agency will share that knowledge and data at the 28th U.N. Climate Change Conference of the Parties (COP28), which brings international parties together to accelerate action toward the goals of the Paris Agreement and the U.N. Framework Convention on Climate Change. COP28 will be held at the Expo City in Dubai, United Arab Emirates from Thursday, Nov. 30 to Tuesday, Dec. 12. All U.S. events at COP28 are open to the local press and will be live-streamed on the U.S. Center at COP28 website and the U.S. Center YouTube channel. Get NASA's Climate Change News NASA takes a full-picture approach to understanding all areas of our home planet using our vast satellite fleet and the data collected from their observations. The agency's data is open-source and available for the public and scientists to study. NASA is showcasing the data at COP28 to share the different ways it can be used globally. The agency's complete collection of Earth data can be found here. The scientific research and understanding developed from NASA's Earth observations are made into predictive models. Those models can be used to develop applications and actionable science to inform individuals including civic leaders and planners, resource managers, emergency managers, and communities looking to mitigate and adapt to climate change. These satellites and models are augmented by the observations made from the International Space Station. The inclined, low Earth orbit from the station provides variable views and lighting over more than 90 percent of the inhabited surface of the Earth, a useful complement to sensor systems on satellites in higher-altitude polar orbits. Closer to the surface, NASA's aviation research is focused on advancing technologies for more efficient airplane flight, including hybrid-electric propulsion, advanced materials, artificial intelligence, and machine learning. Technological advances in these areas have the potential to reduce human impacts on climate and air quality. Hyperwall At the U.S. Center at COP28, in-person visitors can see the NASA Hyperwall where NASA scientists will provide live presentations showing how the agency's work supports the Biden-Harris Administration's agenda to encourage a governmentwide approach to climate change. During the hyperwall talks, NASA leaders, scientists and interagency partners will discuss the agency's end-to-end research about our planet. This includes designing new instruments, satellites, and systems to collect and freely distribute the most complete and precise data possible about Earth's land, ocean, and atmospheric system. A full schedule of the NASA's hyperwall talks at the conference can be found here. News Media Contact Katherine Rohloff Headquarters, Washington 202-358-1600 katherine.a.rohloff@nasa.gov
- NASA Analysis Finds Strong El Niño Could Bring Extra Floods This Winter (2023/11/08 19:46)
  In Brief: Such high-tide flooding that inundates roads and buildings along the west coast of the Americas tends to be uncommon outside of El Niño years, but that could change by the 2030s. An analysis by NASA's sea level change science team finds that if a strong El Niño develops this winter, cities along the western coasts of the Americas could see an increase in the frequency of high-tide flooding that can swamp roads and spill into low-lying buildings. El Niño is a periodic climate phenomenon characterized by higher-than-normal sea levels and warmer-than-average

ocean temperatures along the equatorial Pacific. These conditions can spread poleward along the western coasts of the Americas. El Niño, which is still developing this year, can bring more rain than usual to the U.S. Southwest and drought to countries in the western Pacific like Indonesia. These impacts typically occur in January through March. The NASA analysis finds that a strong El Niño could result in up to five instances of a type of flooding called a 10-year flood event this winter in cities including Seattle and San Diego. Places like La Libertad and Baltra in Ecuador could get up to three of these 10-year flood events this winter. This type of flooding doesn't normally occur along the west coast of the Americas outside of El Niño years. The researchers note that by the 2030s, rising seas and climate change could result in these cities experiencing similar numbers of 10-year floods annually, with no El Niño required. Data from the SWOT satellite shows sea level anomalies – how much higher or lower sea levels are compared to the average height – off the coast of Ecuador and Peru on Aug. 12, 2023, and Oct. 3, 2023. The data indicates the development of an El Niño along the west coast of the Americas. Credit: NASA/JPL-Caltech "I'm a little surprised that the analysis found these 10-year events could become commonplace so quickly," said Phil Thompson, an oceanographer at the University of Hawaii and a member of NASA's sea level change science team, which performed the analysis. "I would have thought maybe by the 2040s or 2050s." Ten-year floods are those that have a one in 10 chance of occurring in any given year. They're a measure of how high local sea levels become: The extent of flooding in a particular city or community depends on several factors, including a region's topography and the location of homes and infrastructure relative to the ocean. Ten-year floods can result in what the National Oceanic and Atmospheric Administration classifies as moderate flooding, with some inundation of roads and buildings, and the possible need to evacuate people or move belongings to higher ground. NASA's coastal flooding analysis finds that by the 2030s, during strong El Niño years, cities on the west coast of the Americas could see up to 10 of these 10-year flood events. By the 2050s, strong El Niños may result in as many as 40 instances of these events in a given year. Get NASA's Climate Change News Watching Sea Levels Rise Water expands as it warms, so sea levels tend to be higher in places with warmer water. Researchers and forecasters monitor ocean temperatures as well as water levels to spot the formation and development of an El Niño. "Climate change is already shifting the baseline sea level along coastlines around the world," said Ben Hamlington, a sea level researcher at NASA's Jet Propulsion Laboratory in Southern California and lead for the agency's sea level change science team. Sea levels are rising in response to planetary warming, as Earth's atmosphere and ocean are heating up and ice sheets and shelves melt. This has already increased the number of high-tide, or nuisance, flooding days coastal cities experience throughout the year. Phenomena like El Niños and storm surges, which temporarily boost sea levels, compound these effects. Missions that monitor sea levels, including the Surface Water and Ocean Topography (SWOT) satellite and Sentinel-6 Michael Freilich, help to monitor El Niños in the near term. SWOT in particular, collects data on sea levels right up to the coast, which can help to improve sea level rise projections. That kind of information could aid policymakers and planners in preparing their communities for rising seas in the next decades. "As climate change accelerates, some cities will see flooding five to 10 times more often. SWOT will keep watch on these changes to ensure coastal communities are not caught off guard," said Nadya Vinogradova Shiffer, SWOT program scientist and director of the ocean physics program at NASA Headquarters in Washington. To learn more about how NASA studies sea level, visit: https://sealevel.nasa.gov/ See how SWOT captures sea levels around the globe News Media Contacts Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov

- NASA Flights Link Methane Plumes to Tundra Fires in Western Alaska (2023/11/02 15:57)
  In Brief: Methane 'hot spots' in the Yukon-Kuskokwim Delta are more likely to be found where recent wildfires burned into the tundra, altering carbon emissions from the land. In Alaska's largest river delta, tundra that has been scorched by wildfire is emitting more methane than the rest

of the landscape long after the flames died, scientists have found. The potent greenhouse gas can originate from decomposing carbon stored in permafrost for thousands of years. Its release could accelerate climate warming and lead to more frequent wildfires in the tundra, where blazes have been historically rare. The new study was conducted by a team of scientists working as part of NASA's Arctic-Boreal Vulnerability Experiment (ABoVE), a large-scale study of environmental change in Alaska and Western Canada. Researchers found that methane hot spots were roughly 29% more likely to occur in tundra that had been scorched by wildfire in the past 50 years compared to unburned areas. The correlation nearly tripled in areas where a fire burned to the edge of a lake, stream, or other standing-water body. The highest ratio of hot spots occurred in recently burned wetlands. The researchers first observed the methane hot spots using NASA's next-generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) in 2017. Mounted on the belly of a research plane, the instrument has an optical sensor that records the interaction of sunlight with molecules near the land surface and in the air, and it has been used to measure and monitor hazards ranging from oil spills to crop disease. Methane bubbles pop on the surface of an Alaskan lake being studied by scientists with NASA's Arctic-Boreal Vulnerability Experiment. A potent greenhouse gas, methane is released in bubble seeps when microbes consume carbon released from thawing permafrost. Credit: NASA/Kate Ramsayer Roughly 2 million hot spots – defined as areas showing an excess of 3,000 parts per million of methane between the aircraft and the ground – were detected across some 11,583 square miles (30,000 square kilometers) of the Arctic landscape. Regionally, the number of hot spot detections in the Yukon-Kuskokwim Delta were anomalously high in 2018 surveys, but scientists didn't know what was driving their formation. Ice and Fire To help fill this gap, Elizabeth Yoseph, an intern at the time with the ABoVE campaign, focused on a methane-active region located in a wet and peaty area of the massive delta. Yoseph and the team used the AVIRIS-NG data to pinpoint hot spots across more than 687 square miles (1,780 square kilometers), then overlaid their findings on historical wildfire maps. "What we uncovered is a very clear and strong relationship between fire history and the distribution of methane hot spots," said Yoseph, lead author of the new study. The connection arises from what happens when fire burns into the carbon-rich frozen soil, or permafrost, that underlies the tundra. Permafrost sequesters carbon from the atmosphere and can store it for tens of thousands of years. But when it thaws and breaks down in wet areas, flourishing microbes feed on and convert that old carbon to methane gas. The saturated soils around lakes and wetlands are especially rich stocks of carbon because they contain large amounts of dead vegetation and animal matter. "When fire burns into permafrost, there are catastrophic changes to the land surface that are different from a fire burning here in California, for example," said Clayton Elder, co-author and scientist at NASA's Jet Propulsion Laboratory in Southern California, which developed AVIRIS-NG. "It's changing something that was frozen to thawed, and that has a cascading impact on that ecosystem long after the fire." Rare but Increasing Risk Because of the cool marshes, low shrubs, and grasses, tundra wildfires are relatively rare compared to those in other environments, such as evergreen-filled forests. However, by some projections the fire risk in the Yukon-Kuskokwim Delta could quadruple by the end of the century due to warming conditions and increased lightning storms – the leading cause of tundra fires. Two of the largest tundra fires on record in Alaska occurred in 2022, burning more than 380 square miles (100,000 hectares) of primarily tundra landscapes. More research is needed to understand how a future of increasing blazes at high latitudes could impact the global climate. Arctic permafrost holds an estimated 1,700 billion metric tons of carbon – roughly 51 times the amount of carbon the world released as fossil fuel emissions in 2019. All that stored carbon also means that the carbon intensity of fire emissions from burning tundra is extremely high, said co-author Elizabeth Hoy, a fire researcher at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Tundra fires occur in areas that are remote and difficult to get to, and often can be understudied," she noted. "Using satellites and airborne remote sensing is a really powerful way to better understand these phenomena." The scientists hope to continue

exploring methane hot spots occurring throughout Alaska. Ground-based investigation is needed to better understand the links between fire, ice, and greenhouse gas emissions at the doorstep of the Arctic. The study was published in the journal Environmental Research Letters. News Media Contacts Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov

- See SWOT Mission's Unprecedented View of Global Sea Levels (2023/10/30 16:15)
  This animation shows global sea level data collected by the Surface Water and Ocean Topography satellite from July 26 to Aug. 16. Red and orange indicate higher-than-average ocean heights, while blue represents lower-than-average heights. Credit: NASA/JPL-Caltech In Brief: Data on sea surface heights around the world from the international Surface Water and Ocean Topography mission yields a mesmerizing view of the planet's ocean. The Surface Water and Ocean Topography (SWOT) satellite is sending down tantalizing views of Earth's water, including a global composite of sea surface heights. The satellite collected the data visualized above during SWOT's first full 21-day science orbit, which it completed between July 26 and Aug. 16. SWOT is measuring the height of nearly all water on Earth's surface, providing one of the most detailed, comprehensive views yet of the planet's oceans and freshwater lakes and rivers. The satellite is a collaboration between NASA and the French space agency, CNES (Centre National d'Études Spatiales). The animation shows sea surface height anomalies around the world: Red and orange indicate ocean heights that were higher than the global mean sea surface height, while blue represents heights lower than the mean. Sea level differences can highlight ocean currents, like the Gulf Stream coming off the U.S. East Coast or the Kuroshio current off the east coast of Japan. Sea surface height can also indicate regions of relatively warmer water – like the eastern part of the equatorial Pacific Ocean during an El Niño – because water expands as it warms. The SWOT science team made the measurements using the groundbreaking Ka-band Radar Interferometer (KaRIn) instrument. With two antennas spread 33 feet (10 meters) apart on a boom, KaRIn produces a pair of data swaths (tracks visible in the animation) as it circles the globe, bouncing radar pulses off the water's surface to collect surface-height measurements. "The detail that SWOT is sending back on sea levels around the world is incredible," said Parag Vaze, SWOT project manager at NASA's Jet Propulsion Laboratory in Southern California. "The data will advance research into the effects of climate change and help communities around the world better prepare for a warming world." More About the Mission Launched on Dec. 16, 2022, from Vandenberg Space Force Base in central California, SWOT is now in its operations phase, collecting data that will be used for research and other purposes. SWOT was jointly developed by NASA and CNES, with contributions from CSA (Canadian Space Agency) and the UK Space Agency. JPL, which is managed for the agency by Caltech in Pasadena, California, leads the U.S. component of the project. For the flight system payload, NASA provided the KaRIn instrument, a GPS science receiver, a laser retroreflector, a two-beam microwave radiometer, and NASA instrument operations. CNES provided the Doppler Orbitography and Radioposition Integrated by Satellite (DORIS) system, the dual frequency Poseidon altimeter (developed by Thales Alenia Space), the KaRIn radio-frequency subsystem (together with Thales Alenia Space and with support from the UK Space Agency), the satellite platform, and ground operations. CSA provided the KaRIn high-power transmitter assembly. NASA provided the launch vehicle and the agency's Launch Services Program, based at Kennedy Space Center, managed the associated launch services. To learn more about SWOT, visit: https://swot.jpl.nasa.gov/ News Media Contacts Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov
- NASA-ISRO Radar Mission to Provide Dynamic View of Forests, Wetlands (2023/10/27 15:53)
  In Brief: NISAR will help researchers explore how changes in Earth's forest and wetland ecosystems are affecting the global carbon cycle and

influencing climate change. Once it launches in early 2024, the NISAR radar satellite mission will offer detailed insights into two types of ecosystems – forests and wetlands – vital to naturally regulating the greenhouses gases in the atmosphere that are driving global climate change. NISAR is a joint mission by NASA and ISRO (Indian Space Research Organisation), and when in orbit, its sophisticated radar systems will scan nearly all of Earth's land and ice surfaces twice every 12 days. The data it collects will help researchers understand two key functions of both ecosystem types: the capture and the release of carbon. Forests hold carbon in the wood of their trees; wetlands store it in their layers of organic soil. Disruption of either system, whether gradual or sudden, can accelerate the release of carbon dioxide and methane into the atmosphere. Tracking these land-cover changes on a global scale will help researchers study the impacts on the carbon cycle – the processes by which carbon moves between the atmosphere, land, ocean, and living things. "The radar technology on NISAR will allow us to get a sweeping perspective of the planet in space and time," said Paul Rosen, the NISAR project scientist at NASA's Jet Propulsion Laboratory in Southern California. "It can give us a really reliable view of exactly how Earth's land and ice are changing." Pictured in this artist's concept, NISAR, short for NASA-ISRO Synthetic Aperture Radar, marks the first time the U.S. and Indian space agencies have cooperated on hardware development for an Earth-observing mission. Its two radar systems will monitor change in nearly all of Earth's land and ice surfaces twice every 12 days. Credit: NASA/JPL-Caltech Tracking Deforestation Forestry and other land-use changes account for about 11% of net human-caused greenhouse gas emissions. NISAR's data will improve our understanding of how the loss of forests around the world influences the carbon cycle and contributes to global warming. "Globally, we do not understand well the carbon sources and sinks from terrestrial ecosystems, particularly from forests," said Anup Das, an ecosystems scientist and co-lead of the ISRO NISAR science team. "So we expect that NISAR will greatly help address that, especially in less dense forests, which are more vulnerable to deforestation and degradation." The signal from NISAR's L-band radar will penetrate the leaves and branches of forest canopies, bouncing off the tree trunks and the ground below. By analyzing the signal that reflects back, researchers will be able to estimate the density of forest cover in an area as small as a soccer field. With successive orbital passes, it will be able to track whether a section of forest has been thinned or cleared over time. The data – which will be collected in early morning and evening and in any weather – could also offer clues as to what caused the change, such as disease, human activity, or fire. It's an important set of capabilities for studying vast, often cloud-covered rainforests such as those in the Congo and Amazon basins, which lose millions of wooded acres every year. Fire releases carbon into the air directly, while the deterioration of forests reduces the absorption of atmospheric carbon dioxide. The data could also help improve accounting of deforestation and forest degradation – as well as forest growth – as countries that rely on logging try to shift toward more sustainable practices, said Josef Kellndorfer, a member of the NISAR science team and founder of Earth Big Data LLC, a provider of large data sets and analytic tools for research and decisions support. "Reducing deforestation and degradation is low-hanging fruit to address a substantial part of the global carbon emission problem," he added. To show the kind of imagery NISAR will produce, researchers pointed to this composite that uses data from two Japanese L-band SAR missions to reveal land-cover change in Brazil's Xingu River basin between 1996 and 2007. Black shows forest areas converted to farmland before 1996, and red shows additional areas cleared by 2007. Credit: Woodwell Climate Research Center/Earth Big Data LLC. Data courtesy of METI and JAXA. Monitoring Wetland Flooding Wetlands present another carbon puzzle: Swamps, bogs, peatlands, inundated forests, marshes, and other wetlands hold 20 to 30% of the carbon in Earth's soil, despite constituting only 5 to 8% of the land surface. When wetlands flood, bacteria go to work digesting organic matter (mostly dead plants) in the soil. Through this natural process, wetlands are the planet's largest natural source of the potent greenhouse gas methane, which bubbles to the water's surface and travels into the atmosphere. Meanwhile, when wetlands dry out, the carbon they store is exposed to oxygen, releasing

carbon dioxide. NISAR will track wetland flooding to study how these carbon-rich ecosystems are reacting to climate change. It will generate images like this one from an airborne radar that flew over Peru in 2013. Black indicates water, gray is rainforest, green is low vegetation, and red and pink are flooded plants. Credit: NASA/JPL-Caltech “These are huge reservoirs of carbon that can be released in a relatively short time frame,” said Erika Podest, a NISAR science team member and a carbon cycle and ecosystems researcher at JPL. Less well understood is how changing temperature and precipitation patterns due to climate change – along with human activities such as development and agriculture – are affecting the extent, frequency, and duration of flooding in wetlands. NISAR will be able to monitor flooding, and with repeated passes, researchers will be able to track seasonal and annual variations in wetlands inundation, as well as long-term trends. By coupling NISAR’s wetlands observations with separate data on the release of greenhouse gases, researchers should gain insights that inform the management of wetland ecosystems, said Bruce Chapman, a NISAR science team member and JPL wetlands researcher. “We have to be careful to reduce our impact on wetland areas so that we don’t worsen the situation with the climate,” he added. NISAR is set to launch in early 2024 from southern India. In addition to tracking ecosystem changes, it will collect information on the motion of the land, helping researchers understand the dynamics of earthquakes, volcanic eruptions, landslides, and subsidence and uplift (when the surface sinks and rises). It will also track the movements and melting of both glaciers and sea ice. More About the Mission NISAR is an equal collaboration between NASA and ISRO and marks the first time the two agencies have cooperated on hardware development for an Earth-observing mission. JPL, which is managed for NASA by Caltech in Pasadena, leads the U.S. component of the project and is providing the mission’s L-band SAR. NASA is also providing the radar reflector antenna, the deployable boom, a high-rate communication subsystem for science data, GPS receivers, a solid-state recorder, and payload data subsystem. ISRO’s U R Rao Satellite Centre in Bengaluru, which is leading the ISRO component of the mission, is providing the spacecraft bus, the S-band SAR electronics, the launch vehicle, and associated launch services and satellite mission operations. To learn more about NISAR, visit: https://nisar.jpl.nasa.gov/ News Media Contacts Andrew Wang / Jane J. Lee Jet Propulsion Laboratory, Pasadena, Calif. 626-379-6874 / 818-354-0307 andrew.wang@jpl.nasa.gov / jane.j.lee@jpl.nasa.gov

- International Ocean Satellite Monitors How El Niño Is Shaping Up (2023/10/19 19:35)
  In Brief: Sentinel-6 Michael Freilich is the latest satellite contributing to a 30-year sea level record that researchers are using to compare this year’s El Niño with those of the past. Not all El Niño events are created equal. Their impacts vary widely, and satellites like the U.S.-European Sentinel-6 Michael Freilich help anticipate those impacts on a global scale by tracking changes in sea surface height in the Pacific Ocean. Water expands as it warms, so sea levels tend to be higher in places with warmer water. El Niños are characterized by higher-than-normal sea levels and warmer-than-average ocean temperatures along the equatorial Pacific. These conditions can then propagate poleward along the western coasts of the Americas. El Niños can bring wetter conditions to the U.S. Southwest and drought to regions in the western Pacific, including Indonesia. This year’s El Niño is still developing, but researchers are looking to the recent past for clues as to how it is shaping up. There have been two extreme El Niño events in the past 30 years: the first from 1997 to 1998 and the second from 2015 to 2016. Both caused shifts in global air and ocean temperatures, atmospheric wind and rainfall patterns, and sea level. The maps above show sea levels in the Pacific Ocean during early October of 1997, 2015, and 2023, with higher-than-average ocean heights in red and white, and lower-than-average heights in blue and purple. Sentinel-6 Michael Freilich captured the 2023 data, the TOPEX/Poseidon satellite collected data for the 1997 image, and Jason-2 gathered data for the 2015 map. By October 1997 and 2015, large areas of the central and eastern Pacific had sea levels more than 7 inches (18 centimeters) higher than normal. This year, sea levels are about 2 or 3 inches (5 to 8 centimeters) higher than average and over a smaller area

compared to the 1997 and 2015 events. Both of the past El Niños reached peak strength in late November or early December, so this year's event may still intensify. "Every El Niño is a little bit different," said Josh Willis, Sentinel-6 Michael Freilich project scientist at NASA's Jet Propulsion Laboratory in Southern California. "This one seems modest compared to the big events, but it could still give us a wet winter here in the Southwest U.S. if conditions are right." More About the Mission Launched in November 2020, Sentinel-6 Michael Freilich is named after former NASA Earth Science Division Director Michael Freilich. The satellite is one of two that compose the Copernicus Sentinel-6/Jason-CS (Continuity of Service) mission. Sentinel-6/Jason-CS was jointly developed by ESA (European Space Agency), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), NASA, and the U.S. National Oceanic and Atmospheric Administration, with funding support from the European Commission and technical support on performance from the French space agency CNES (Centre National d'Études Spatiales). To learn more about Sentinel-6 Michael Freilich, visit: https://www.nasa.gov/sentinel-6 News Media Contacts Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov

- NASA-Led Study Pinpoints Areas of New York City Sinking, Rising (2023/09/27 18:11)
  In Brief: Scientists using space-based radar found that land in New York City is sinking at varying rates from human and natural factors. A few spots are rising. Parts of the New York City metropolitan area are sinking and rising at different rates due to factors ranging from land-use practices to long-lost glaciers, scientists have found. While the elevation changes seem small – fractions of inches per year – they can enhance or diminish local flood risk linked to sea level rise. The new study was published Wednesday in Science Advances by a team of researchers from NASA's Jet Propulsion Laboratory in Southern California and Rutgers University in New Jersey. The team analyzed upward and downward vertical land motion – also known as uplift and subsidence – across the metropolitan area from 2016 to 2023 using a remote sensing technique called interferometric synthetic aperture radar (InSAR). The technique combines two or more 3D observations of the same region to reveal surface motion or topography. Much of the motion they observed occurred in areas where prior modifications to Earth's surface – such as land reclamation and the construction of landfills – made the ground looser and more compressible beneath subsequent buildings. Get NASA's Climate Change News Some of the motion is also caused by natural processes dating back thousands of years to the most recent ice age. About 24,000 years ago, a huge ice sheet spread across most of New England, and a wall of ice more than a mile high covered what is today Albany in upstate New York. Earth's mantle, somewhat like a flexed mattress, has been slowly readjusting ever since. New York City, which sits on land that was raised just outside the edge of the ice sheet, is now sinking back down. Mapping vertical land motion across the New York City area, researchers found the land sinking (indicated in blue) by about 0.06 inches (1.6 millimeters) per year on average. They also detected modest uplift (shown in red) in Queens and Brooklyn. White dotted lines indicate county/borough borders. Credit: NASA/JPL-Caltech/Rutgers University The scientists found that on average the metropolitan area subsided by about 0.06 inches (1.6 millimeters) per year – about the same amount that a toenail grows in a month. Using the radars on the ESA (European Space Agency) Sentinel-1 satellites, along with advanced data processing techniques, they mapped the motion in detail and pinpointed neighborhoods and landmarks – down to an airport runway and tennis stadium – that are subsiding more rapidly than the average. "We've produced such a detailed map of vertical land motion in the New York City area that there are features popping out that haven't been noticed before," said lead author Brett Buzzanga, a postdoctoral researcher at JPL. David Bekaert, a JPL scientist and lead investigator of the project, said that tracking local elevation changes and relative sea level can be important for flood mapping and planning purposes. This is especially critical as Earth's changing climate pushes oceans higher around the world, leading to more frequent nuisance flood events and exacerbating destructive storm surges. Local Changes The team identified two notable hot spots of subsidence co-

located with landfills in Queens. One, runway 13/31 at LaGuardia Airport, is subsiding at a rate of about 0.15 inches (3.7 millimeters) per year. The scientists noted that the airport is undergoing an $8 billion renovation designed in part to alleviate flooding from the rising waters of the Atlantic Ocean. They also identified Arthur Ashe Stadium, which is sinking at a rate of about 0.18 inches (4.6 millimeters) per year and required construction of a lightweight roof during renovation to reduce its heaviness and amount of subsidence. The team pinpointed hot spots: left, runway 13/31 at LaGuardia Airport in Queens, is subsiding at a rate of about 0.15 inches (3.7 millimeters) per year; right, part of Newtown Creek, a Superfund site in East Williamsburg, Brooklyn, is rising unevenly by about 0.06 inches (1.6 millimeters) per year. Credit: NASA/JPL-Caltech/Rutgers University Other subsidence hot spots include the southern portion of Governors Island – built on 38 million square feet (3.5 million cubic meters) of rocks and dirt from early 20th century subway excavations – as well as sites near the ocean in Brooklyn's Coney Island and Arverne by the Sea in Queens that were built on artificial fill. Similar levels of subsidence were observed beneath Route 440 and Interstate 78 in suburban New Jersey, which traverse historic fill locations, and in Rikers Island, expanded to its present size by landfilling. The scientists also found previously unidentified uplift in East Williamsburg, Brooklyn – rising by about 0.06 inches (1.6 millimeters) per year – and in Woodside, Queens, which rose 0.27 inches (6.9 millimeters) per year between 2016 and 2019 before stabilizing. Co-author Robert Kopp of Rutgers University said that groundwater pumping and injection wells used to treat polluted water may have played a role, but further investigation is needed. "I'm intrigued by the potential of using high-resolution InSAR to measure these kinds of relatively short-lived environmental modifications associated with uplift," Kopp said. The scientists said that cities like New York, which are investing in coastal defenses and infrastructure in the face of sea level rise, can benefit from high-resolution estimates of land motion. The JPL-led OPERA (Observational Products for End-Users from Remote Sensing Analysis) project will detail surface displacement across North America in a future data product. To do that, it will leverage InSAR data from ESA's Sentinel-1 and from the upcoming NISAR (NASA-Indian Space Research Organization Synthetic Aperture Radar) mission, set to launch in 2024. Information from OPERA will help scientists better monitor vertical land motion along with other changes connected to natural hazards. News Media Contacts Jane J. Lee / Andrew Wang Jet Propulsion Laboratory, Pasadena, Calif. 818-354-0307 / 626-379-6874 jane.j.lee@jpl.nasa.gov / andrew.wang@jpl.nasa.gov