## Ocean Temperatures, Ice and Flows

Thanks to

Nova "Earth from Space"

https://www.youtube.com/watch?v=aU0GhTmZhrs

NASA

And the

European Space Agency

Starting new picture emerging of Earth from Space

Earth is one huge system all linked though space and time.

Over the last dozen years, NASA has launched a series of satellites – known collectively as the Earth Observing System (EOS) – that has provided critical insights into the dynamics of the entire Earth system: clouds, oceans, vegetation, ice, solid Earth and atmosphere. Now NASA is helping to create a new generation of satellites to extend and improve upon the Earth system data records established by EOS.

Suomi National Polar-orbiting Partnership (NPP)

Understanding, monitoring, and predicting the course of long-term climate change AND short-term weather conditions remain tasks of profound importance. Economic competitiveness, human health and welfare, and global security all depend in part on our ability to understand and adapt to global environmental changes.

Suomi National Polar-orbiting Partnership, formerly known as the NPOESS Preparatory Project, will serve as a bridge between the EOS satellites and the forthcoming series of Joint Polar Satellite System (JPSS) satellites. Suomi NPP represents a critical first step in building this next-generation satellite system. The JPSS satellites, previously called the National Polar-orbiting Operational Environmental Satellite System (NPOESS), will be developed by NASA for the National Oceanic and Atmospheric Administration (NOAA).

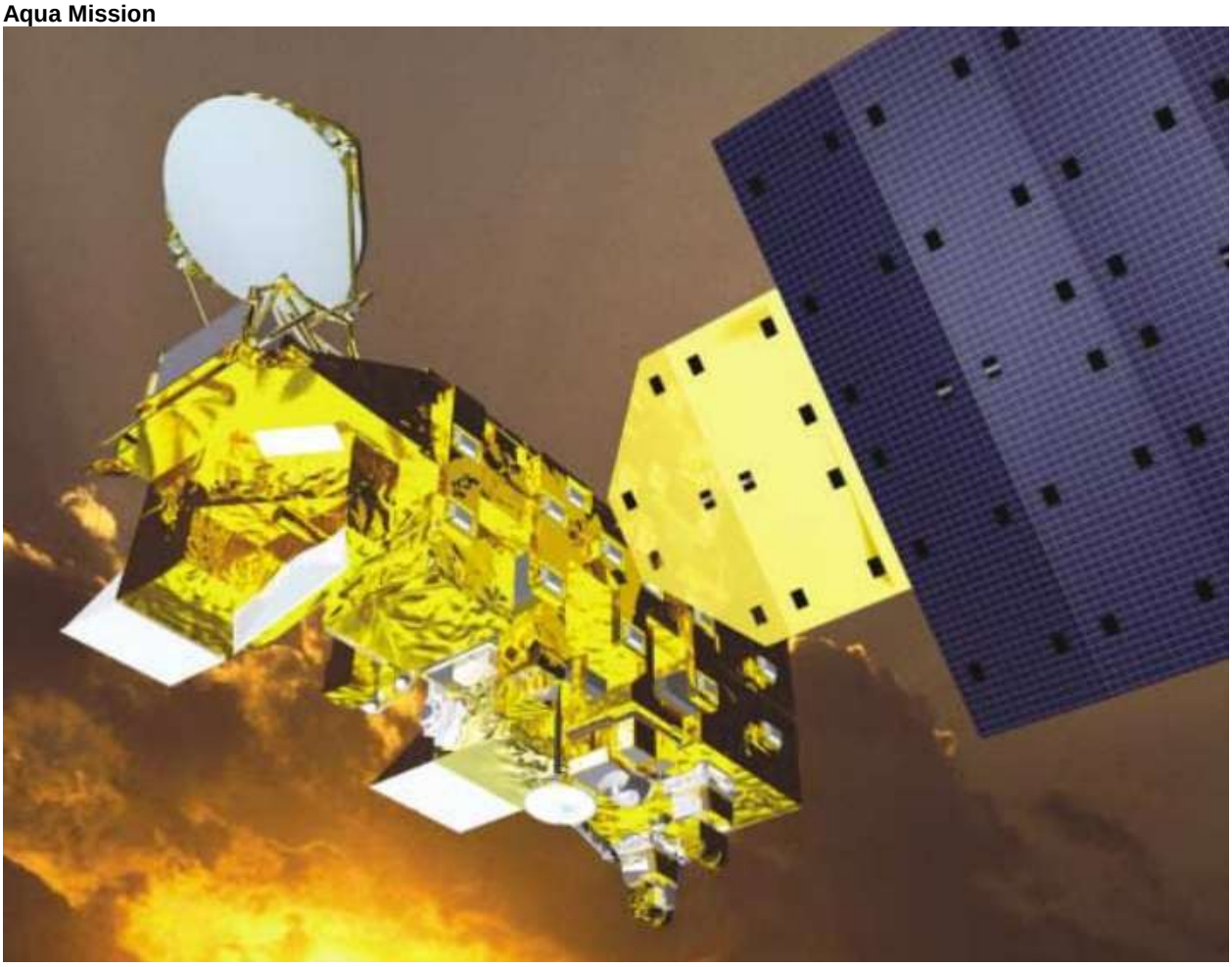
Suomi NPP carries five science instruments and test key technologies for the JPSS missions. Suomi NPP is the first satellite mission to address the challenge of acquiring a wide range of land, ocean, and atmospheric measurements for Earth system science while simultaneously preparing to address operational requirements for weather forecasting.

Suomi NPP also represents the gateway to the creation of a U.S. climate monitoring system, collecting both climate and operational weather data and continuing key data records that are critical for global change science.

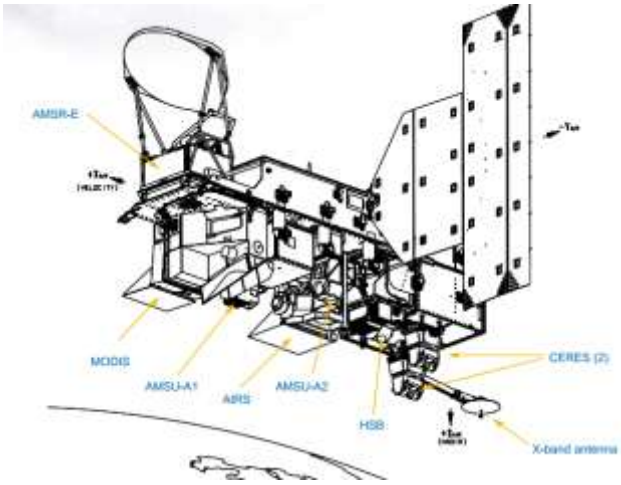
**Key science objectives and capabilities of Suomi NPP include:**

- Climate change -- contribute to long-term records of global environmental data critical for understanding the dynamics of climate change
- Health of the ozone layer -- daily measurements of the atmospheric ozone layer that will determine whether the ozone layer is recovering as expected
- Natural disasters -- monitor wildfires, volcanic eruptions, snowstorms, droughts, floods, hurricanes and dust plumes
- Weather predictions -- a sounding instrument will collect information about cloud cover, atmospheric temperatures, humidity and other variables critical to accurate weather prediction
- Vegetation -- map global land vegetation and quantify changes in plant productivity to understand the global carbon cycle and monitor agricultural processes to predict and respond to food shortages and famines
- Global ice cover -- monitor changes to Earth’s sea ice, land ice and glaciers to track the pace of climate change
- Air pollution -- monitor the spread of health-sapping pollutants such as soot, particulate matter, nitrogen dioxide and sulfur dioxide
- Temperatures -- maintain a global record of atmospheric, land surface and sea surface temperatures critical to understanding the long-term dynamics of climate change
- Earth’s energy budget -- make measurements to determine how much energy is entering and exiting Earth's atmosphere

**Aqua Mission**



Aqua is a major international Earth Science satellite mission centered at NASA. Launched on May 4, 2002, the satellite has six different Earth-observing instruments on board and is named for the large amount of information being obtained about water in the Earth system from its stream of approximately 89 Gigabytes of data a day. The water variables being measured include almost all elements of the water cycle and involve water in its liquid, solid, and vapor forms. Additional variables being measured include radiative energy fluxes, aerosols, vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans, and air, land, and water temperatures.




Line drawing of the deployed Aqua spacecraft, with the six Earth-observing instruments and the X-band antenna labeled. As indicated, the Advanced Microwave Sounding Unit (AMSU) has two physically separated parts, the AMSU-A1 and the AMSU-A2; these work together as a single unit. Also, the solar array in the upper right portion of the drawing extends outward much farther, about 14 m, when fully deployed. (Line drawing courtesy of TRW, with labels added later.)

The Sun is 93 million miles away and warms the earth.  NASA's Suomi satellite launched in 2011 is 500miles above the earth and orbits 18 times a day.  Suomi measures clouds and earth energy.  Suomi creates heat maps of earth accurate to faction of degree. At poles light reflected and oblique angle and mostly reflected by white ice.  At equator there is no ice so even more heat is absorbed that triggers weather events around the world.

Coastal waters at cape Verdi off the cost of West Africa near the equator.  Heat is relentless builds up large cloud formations and storms. NASA's AQUA satellite studies water on earth oceans and ice.  Cape Verdi one million square miles of ocean reaches 80 degrees F and turns to water vapor.  AQUA shows vapor created in vast columns rising from the sea along with heat from the sun.  Water vapor is like little solar collectors carrying and gaining heat.  Water vapor turns to water droplets releasing heat resulting in storms.  The worst storms generate heat greater than earth's electrical generation capacity.

Below is a visualization of water vapor rising from the ocean and creating clouds using AQUA data.

And Storm clouds over the equator.

## TRMM Tropical Rainfall Measuring Mission

One of the great challenges facing mankind in the 21st century is the threat of global warming due to increased levels of carbon dioxide and other greenhouse gases in the atmosphere. Is the threat real? Computer models that predict the future climate still differ in some very substantial ways with some models predicting little or no warming while others predict temperature increases that would substantially alter our way of life. Without more data and better understanding of the current climate system, there is little hope that we can understand the differences among our current models and both sides in the environmental debate will continue to press for their viewpoints.

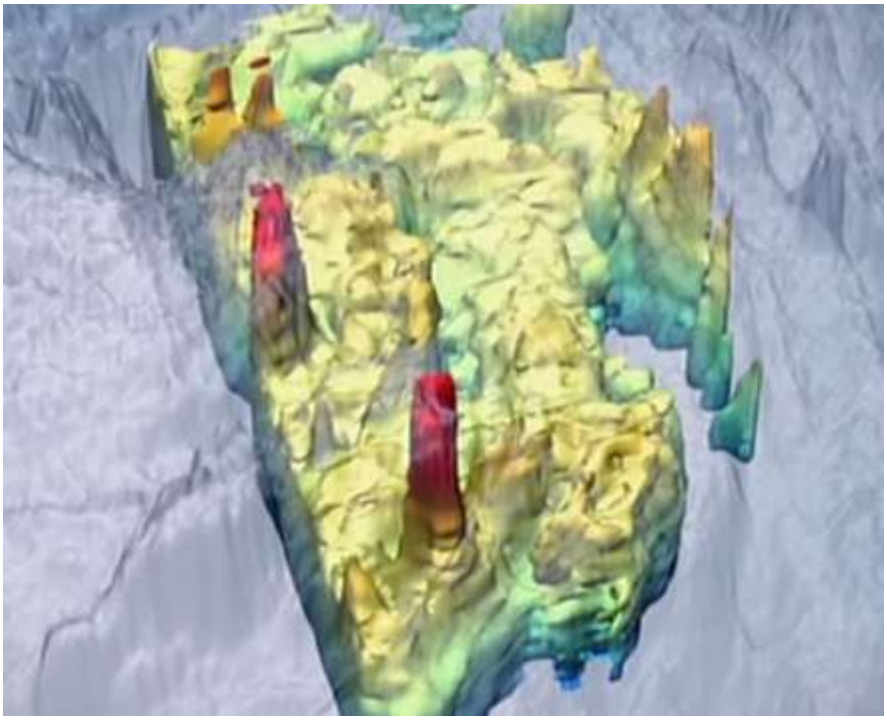
TRMM is a research satellite designed to help our understanding of the water cycle in the current climate system. By covering the tropical and semi-tropical regions of the Earth, TRMM provides much needed data on rainfall and the heat release associated with rainfall. It will not single-handedly provide the solution to the climate change debate - it will, however, contribute to our understanding of how clouds affect climate and how much energy is transported in the global water cycle. In coordination with other satellites in NASA's Mission to Planet Earth, TRMM will begin the process of understanding the interactions between water vapor, clouds and precipitation that is central to regulating the climate system.

The energy balance of the global atmosphere shows that only about one fourth of the energy needed to drive the global atmospheric circulation comes from direct solar energy. The other three fourths of the energy is transferred to the atmosphere by evaporating water - mainly from the ocean. As the water vapor rises from the surface, it carries with it the energy it takes to turn liquid water into water vapor - the "Latent Heat of Evaporation". Most of this latent heat is released into the atmosphere in huge equatorial cloud clusters when the vapor condenses to form cloud- and raindrops. The latent heat energy contained in the clouds cannot be seen or measured directly. Rainfall, however, is the product of the release of this energy, and rainfall can be measured. Responsible for three quarters of the energy that drives the global atmospheric circulation, tropical rainfall can be said to Drive the Climate Machine. Unfortunately, there are still uncertainties of as high as 50% in the amount of tropical rainfall. Unless we can better define the amount of rainfall and the energy released when rain occurs, we stand little chance of putting the climate models through the rigorous tests we need to gain confidence in their predictions.

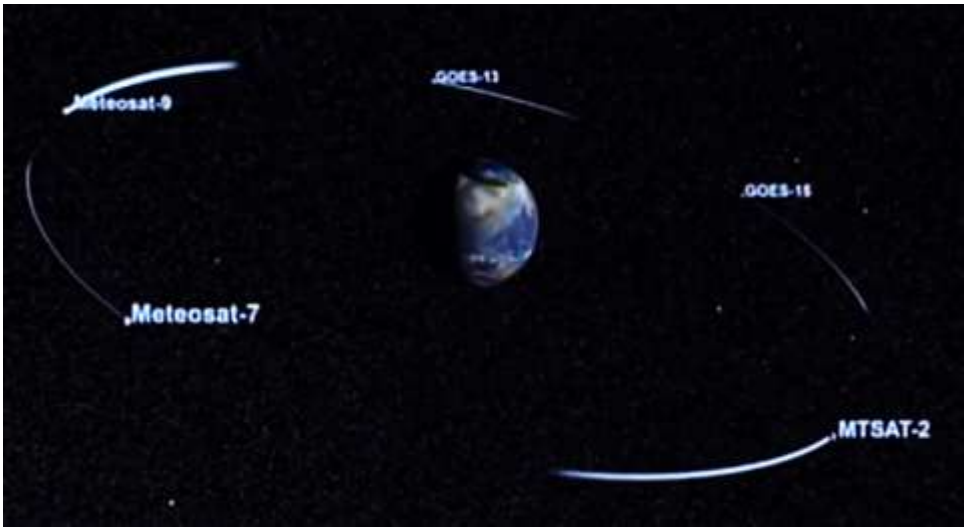
TRMM Instruments:

- Precipitation Radar (PR)
- TRMM Microwave Imager (TMI)
- Visible and InfraRed Scanner (VIRS)
- Cloud and Earth Radiant Energy Sensor (CERES)
- Lightning Imaging Sensor (LIS)

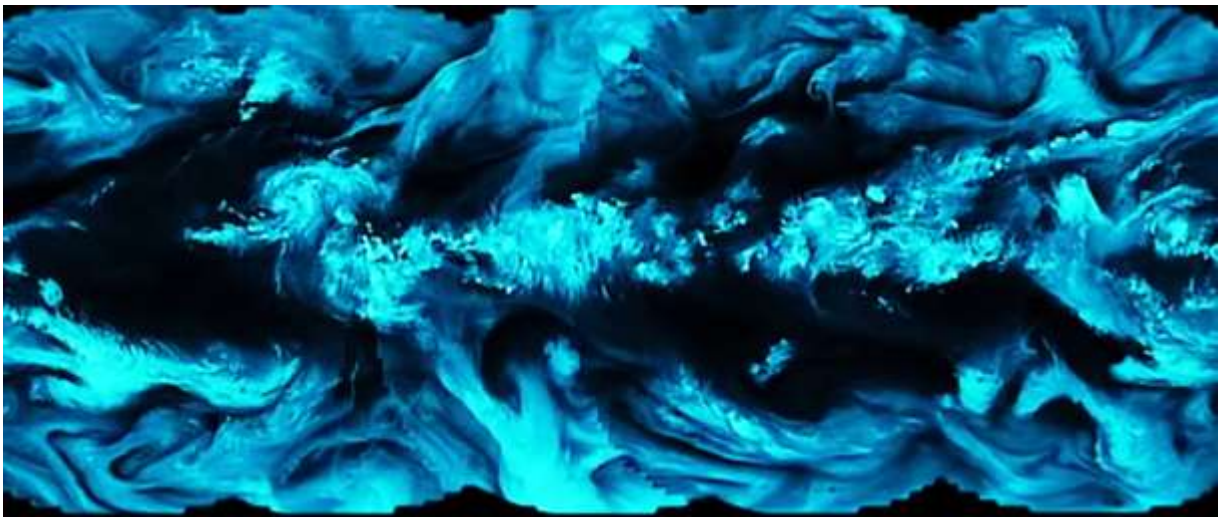
The 2005 Catrina Hurricane measurements from NASA's TRMM satellite, measures hurricane structures and shows huge vertical columns of water vapor adding energy into heart of the hurricane called hot towers. The hot towers draw more water vapor from ocean in a feedback loop getting stronger and stronger. Hurricanes are a direct result of the power of the sun. The Gulf coast was inundated 90,000 square miles, and over 1 million people displaced.



The sun drives water around the earth with different effects in different places. A day in July NY sweltering, 7000 miles away in Mumbai India torrential rains with streets flooded in hours, in Chillie the desert of the Atacama is bone dry. These are connected events. NASA's 5 satellites GOESTESAT "geostationary environmental", by having 5 they can see all points of the earth at one time. Water processes are the same but outcomes are different in different places. Can see all water vapor on earth and how it moves. Water vapor produced at equator moves towards the poles with local effects due to topography.




The picture below is of the entire earth showing only the water vapor. This is a live moving picture.



In India water vapor from the ocean rises to high altitude and the difference between land and sea temperatures take effect. Water vapor cools over the land and turns into the monsoons moving to the east over India and China to grow rice. That rice provides food for 3 billion people almost half the earth's populations.

In South America west bound water vapor cools over the Andes mountain ranges turning to snow and leaving the Atacama Desert in Chile bone dry on the other side of the Andes.

In east us hot moist air from gulf of Mexico goes from Memphis to New York causing sweltering heat.

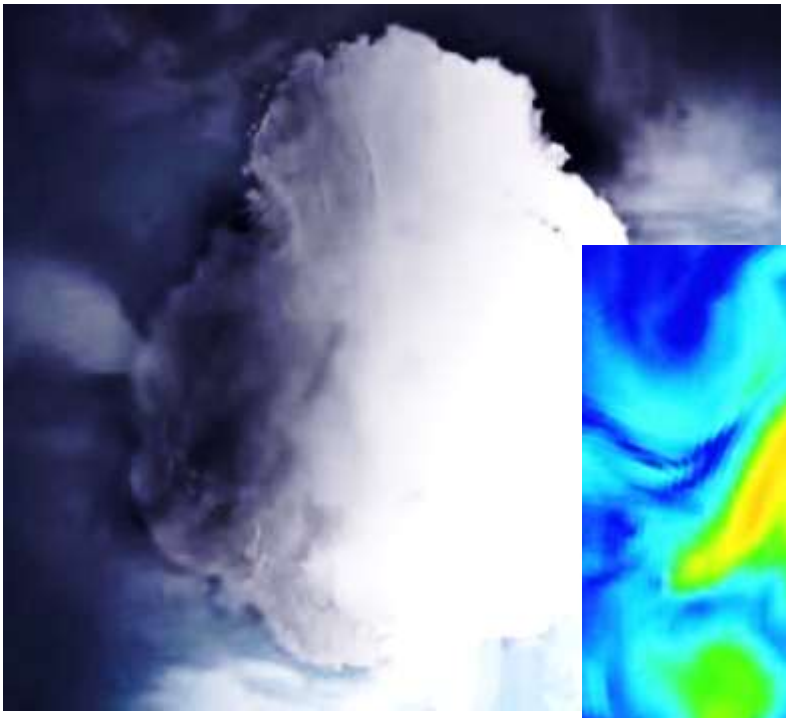
This vast cycle of water and land is one pattern among many.

A greater cycle involves extreme cold.

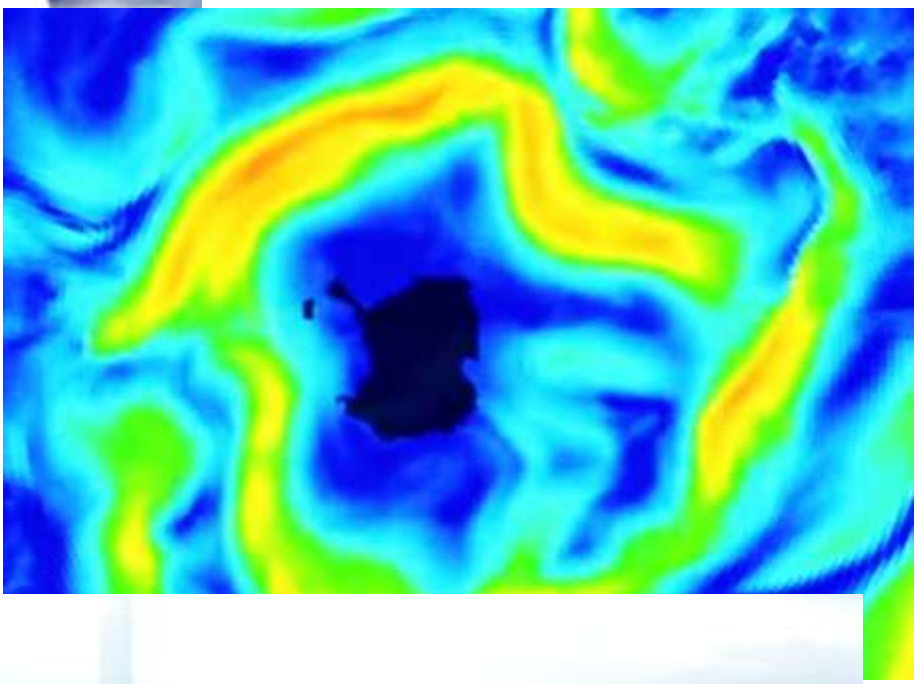
Antarctica is the coldest place on earth.  Antarctica is the last great wilderness.  The whole continent is plunged into darkness for six month of the year to -110 F with incessant blowing wind.  On average Antarctica is 43 degrees colder than North Pole.  Antarctica's ice controls much of the earth's climate.

Suomi satellite shows that poles reflect light back out into space, part of why Antarctica is cold.  A swirling maelstrom of clouds circles the Antarctic.  Looking at the heat of Antarctica and computer modeling shows that warm tropic air meeting the cold Antarctic air causes a 4,000 mile diameter storm that rotates around Antarctica at 200 miles per hour.  The polar jet a ceaseless clockwise circle of wind causes an ocean jet almost 2.5 miles deep around Antarctica "The

Antarctic circumpolar current". Storms rage every day of the year. AQUA pieces tighter this information on Antarctica. The movement of air and water isolates the continent from the rest of the earth.



Left shows the clouds, below shows the water currents.



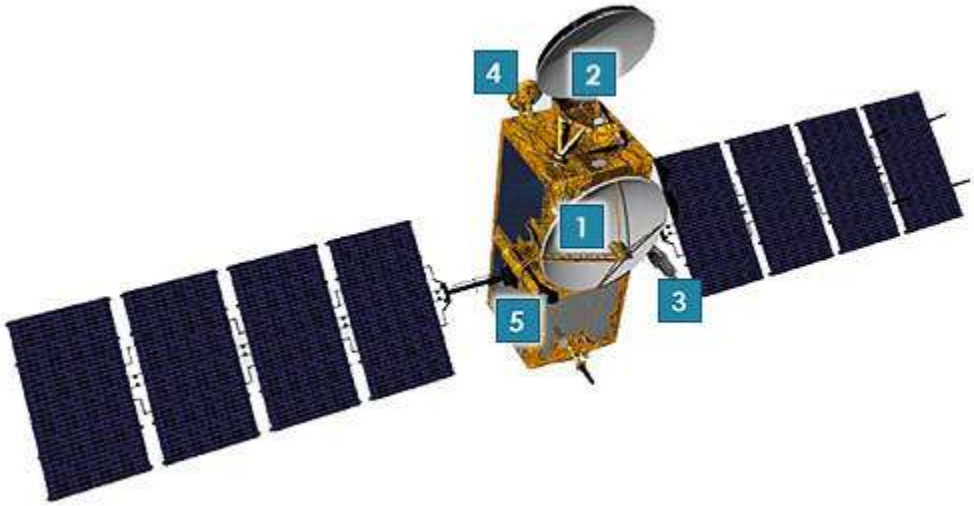
Below shows the roughest seas on the plant around Antarctica named the screaming 60's.

AQUA looks at ice in Antarctica can take measurements where we cannot go. In summer Antarctica is one and a half time as large as the US. In winter 5.5 million miles of ice is added. Antarctica grows to the size of Africa. The Wattle Sea in Antarctica, once the Wattle Sea falls below 29 F the surface begins to freeze. Below the ice crystals grow and expel

salt into the water. The Salt forms brine that drips down tubes in the ice and sinks downward, being heavier than water. Soon large slicks appear on surface, what starts as a microscopic process can be seen from space. Trillions of tons of brine sink below the sea. Where does it go?


Wattle bay shown to the left.

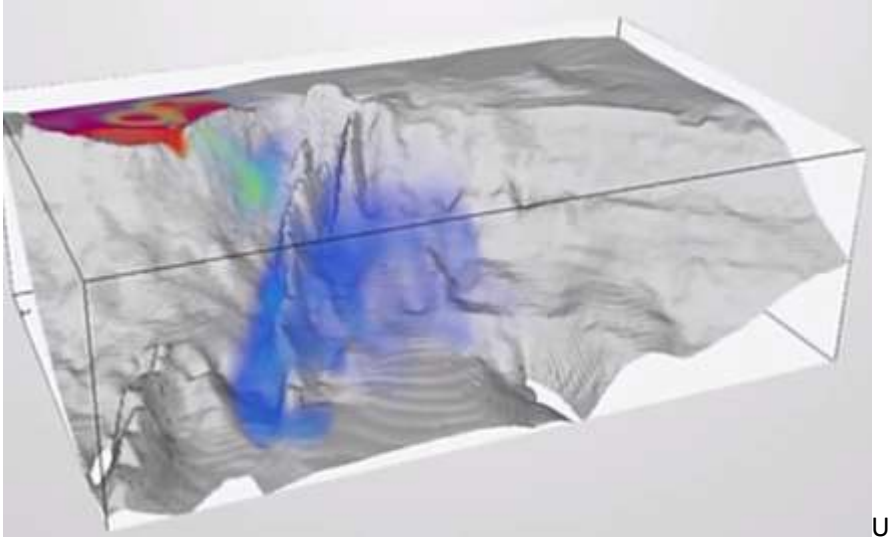
**JASON-2 Satellite**




JASON is jointly operated by NASA and the French Space Agency. JASON's instruments are:

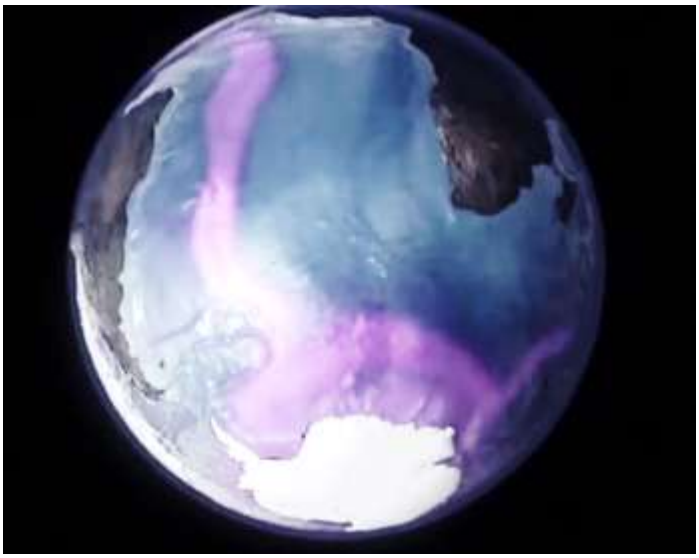
1. Poseidon-3 dual frequency altimeter - The Poseidon-3 radar altimeter is the main instrument on the Jason-2 mission. Derived from the Poseidon-1 altimeter on TOPEX/Poseidon and the Poseidon-2 on Jason-1, it measures sea level, wave heights and wind speed.
2. Advanced Microwave Radiometer (AMR) - The Advanced Microwave Radiometer (AMR), is an enhanced version of the Jason-1 Microwave Radiometer (JMR). Like the JMR, it acquires measurements via three separate frequency channels to determine the path delay of the altimeter's radar caused by atmospheric water vapor.
3. DORIS -The DORIS instrument onboard Jason-2 will provide real-time location and precise orbit determination. DORIS measurements are also used for geophysical studies.
4. Global Positioning System Payload (GPSP) -The GPSP is a tracking system that receives dual-frequency navigation signals continuously and simultaneously from 16 GPS satellites to determine the exact position of a transmitter
5. Laser Retroreflector Array (LRA) - The LRA is an array of mirrors that provide a target for laser tracking measurements from the ground. By analyzing the round-trip time of the laser beam, we can locate where the satellite is on its orbit.

The JASON-2 satellite measures the sea floor from space by measuring the sea surface over time with very accurate radar. JASON can map the ocean floor to within ½ inch of accuracy from 500 miles above. (Similar to a camera in NY city looking at people in Boston and being able to say if their toes are over the curb or not.) Computers make a 3d map under the Wattle sea reveals a vast chasm 2 miles deep off the continental shelf brine falls over this cliff.



Under the Wattle sea floor pictured left.

Other sensors on sea floor track the brine. Combining data from under sea instruments and satellite data can track 1 trillion gallons per hour go under the sea and over the chasm in a vast under water brine fall equivalent to 500 times the size of Niagara Falls. The brine falls slowly and silently and will not resurface for 100's of years. What happens next is still under investigation but we know the brine flows towards the equators along the sea floor.



The picture shows in purple the brine flowing away from Antarctica toward the equator.

All the water in every ocean has its start within 6 miles of Antarctica. Brine becomes part of worldwide circulation system of cold water. The cold bottom current mixes and warms and rises to return south and freeze again completing the cycle. This loop is critical to the planet. The temperature of the brine causes a conveyor belt that controls the average temperatures of the ocean to within one degree. Long-term stability gave time for life to flourish on earth. Antarctica sustains conditions for life on earth.

The ocean and atmosphere is connected. The Gulf Stream takes warm water north generating warm air. The Crosio current carries warm air north east from china to japan. The Gulf Stream warms the east coast and takes route in Antarctica.