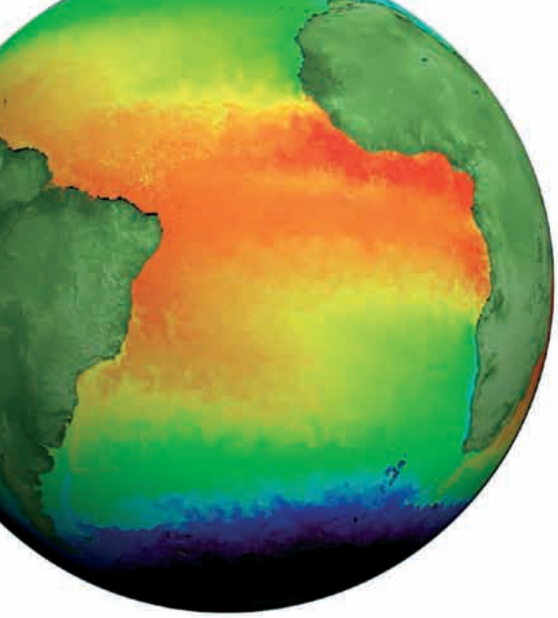


# Remote control

Soaring sea-surface temperatures led to unprecedented sea-ice loss during the 2007 Arctic summer. Without satellites, say **David Llewellyn-Jones** and **Matt Pritchard**, we may never have known the true extent of the loss.

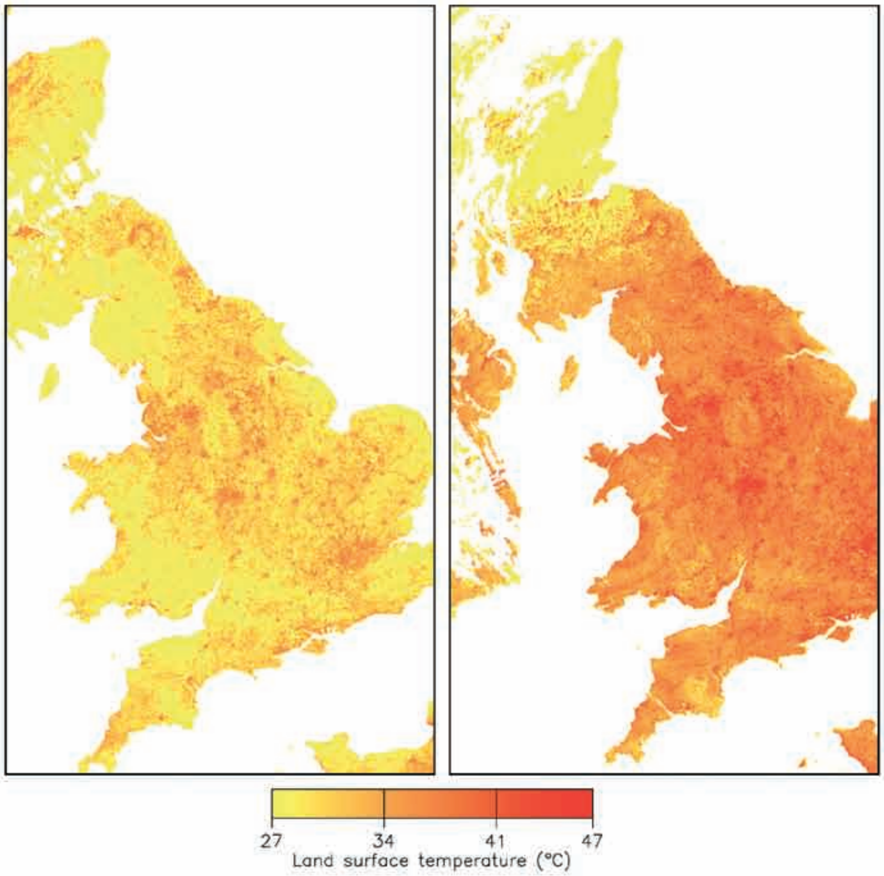
During the summer of 2007, Gary Corlett, a scientist from the University of Leicester who is responsible for validating sea-surface temperature satellite data, received an unusual phone call. The caller said the satellite Gary monitored was throwing out exceptionally high sea-surface temperature data in the Arctic. He wanted to know if the satellite instrument was malfunctioning.

It wasn't. The Advanced Along-Track Scanning Radiometer (AATSR) was working perfectly, as it and its predecessors have done for 16 years. What it was measuring, though, was highly unusual. Sea-surface temperatures between the Bering Straits and the North Pole had rocketed to between 8 and 10°C above expectation – by any standards a huge and unprecedented anomaly, and a major environmental event. That summer, extraordinary amounts of Arctic sea ice disappeared from the region.

Scientists blamed the unusually cloud-free conditions in the early summer, resulting in non-stop solar heating of the ocean surface. But, we're still waiting for a full explanation of the underlying reasons. The major scientific question is: 'was this a fluctuation in local behaviour or was this a manifestation of climate change?' This year's observations will attract huge interest.

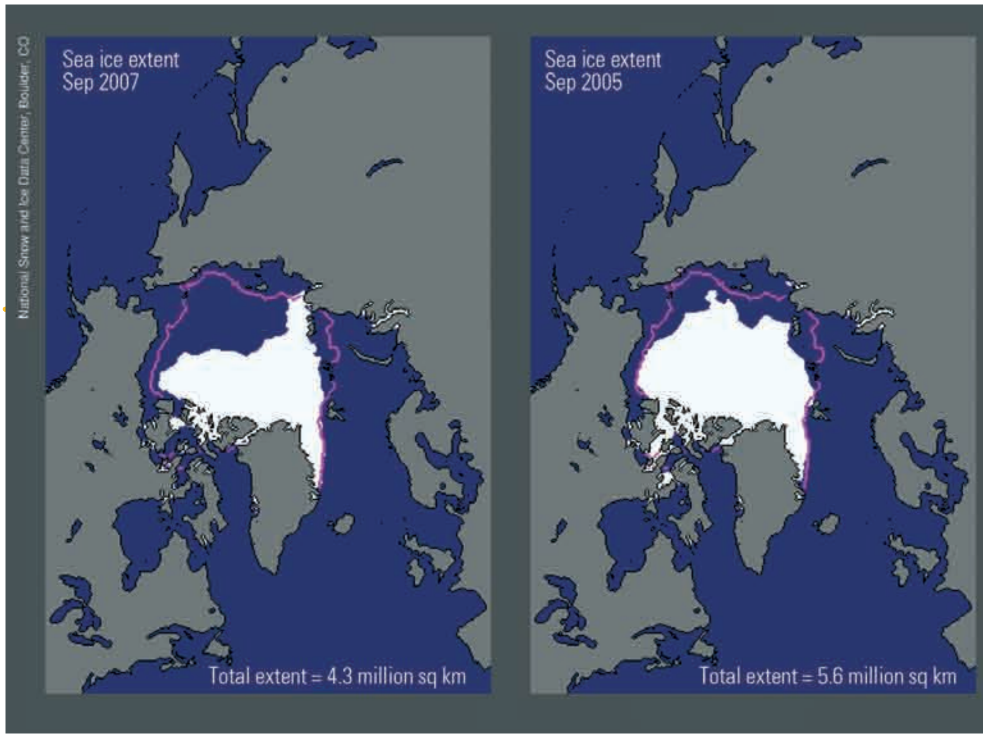
This is a striking example of how a satellite instrument can add to our knowledge of natural processes on a global scale. The AATSR instrument is the third in a series of similar instruments originally proposed and designed by the UK research community and largely funded by NERC in the early stages. It is now the gold standard for sea-surface temperature measurements and has spawned several hundred articles in scientific journals.

The instrument is not limited to ocean temperatures. It can also measure land-surface temperature. In contrast to the oceans, land-surface temperatures are highly diverse and complex, sparking off fundamental questions about what we actually mean by the temperature of, say, a forest, a cabbage field or a desert surface. There are some serious scientific challenges in interpreting land-surface temperature data, but we can already appreciate its power. Take, for example, land-surface temperatures over the UK during the heat-waves of summer 2006. The AATSR data not only show unusually high temperatures but, more importantly, they also reveal changing temperature patterns and gradients over time. Such information is important to meteorologists because the land surface is the bottom boundary of the atmosphere and so can help forecast systems, as well as aiding hydrologists examining the relationships between heating rates and




Meteorologists can use land-surface temperatures to improve weather forecasts. 2006 heat wave: land surface temperature retrieved from the AATSR instrument on 15 July (left) and 18 July (right) 2006.

Images provided by the University of Leicester.




NASA and NSIDC

Massive sea-ice loss during the 2007 Arctic summer.

amounts of ground moisture.

The story of the AATSR goes back to the late 1970s, when UK climate researchers called for accurate, systematic global measurements of sea-surface temperatures. Only monitoring from space would offer the required coverage, consistency and continuity.

The research community were setting satellite engineers a difficult problem: could a space-borne remote-sensing instrument achieve the required accuracy? Laboratory radiometers – instruments that can measure the heat radiating from an object – could certainly achieve this, but doing it from space with an intervening atmosphere? After some deep thought, a UK consortium of atmospheric scientists and space engineers, proposed the Along-Track Scanning Radiometer (ATSR) which used a novel two-angle view of the Earth's surface to correct for atmospheric effects. By observing each point on the Earth's surface via two different paths through the atmosphere, researchers can remove the effect of the atmosphere on the measurements.

The European Space Agency accepted the UK's proposal and launched the instrument on board its European Remote Sensing (ERS-1) satellite in 1991. Its success led to a second instrument, ATSR-2, which was launched on the ERS-2 satellite in 1995.

**Sea-surface temperatures rocketed 8-10°C above expectation.**

Later, with ATSR-2 proving its worth, the Department for Environment, Food and Rural Affairs (Defra) funded a third instrument on board the European Space Agency's Envisat satellite, the largest Earth observation satellite ever built. The third sensor – the Advanced ATSR – marked the evolution from research instrument to operational observing system with real-life applications.

The latest validation results demonstrate that AATSR can measure global sea-surface temperature to about two-tenths of a degree – to measure the temperature of your own bath water to that accuracy would be quite impressive! This level of accuracy is required for climate research because rates of heat transfer between oceans and the atmosphere, which influence our weather and climate, are particularly sensitive to small changes in water temperature, especially in the tropics. Also, the changes in sea-surface temperature which may indicate global change are typically a few tenths of a degree per decade, requiring great precision and stability in any measuring system.

Recently, we've seen a step-change in the exploitation of AATSR data when the Met Office introduced sea-surface temperature data into its weather forecasting system. This major development is not only due to the AATSR's accuracy and reliability, but also down to efforts to provide the data in the form operational users like the Met Office need.

The AATSR is a key player in a pilot scheme (www.ghrsst-pp.org) to provide sea-surface temperature data, from many sensors not just satellites, to more operational users like the Met Office. The service is tailored to individual users' particular requirements. In some cases, scientists are using the AATSR instrument to verify the accuracy of measurements taken by buoys on the ocean surface: a truly remarkable achievement for an instrument 800km above the Earth. ✿

NERC with Australian partners funded the first two instruments: ATSR-1 and ATSR-2. The AATSR instrument is funded by the UK Department for Environment, Food and Rural Affairs (Defra), with significant contributions from Australia.

One of five new satellites proposed as part of the European Commission and European Space Agency's Global Monitoring for Environment and Security (GMES) programme – see Sat-nav in this issue – will carry an ATSR-style instrument. This will maintain the continuity of the ATSR dataset.

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To access 16 years of high-quality sea-surface temperature data visit: www. neodc.rl.ac.uk