Scientists are building a sophisticated observatory to measure and study environmental change. The goal is to obtain long-term data from the tropical atmosphere and oceans so we can improve our understanding of the environment. **Douglas Wallace** of TENATSO explains more

Observing Global Change in the Tropics

The tropics play an important role for our global climate. Tropical sunshine evaporates water from the oceans and drives powerful motions in both the atmosphere and the ocean that distribute heat towards the poles.

The importance of the tropics to weather and climate is illustrated by their role in the generation of hurricanes, the significance of El Niño to global weather patterns, and the effect sea surface temperature has on rainfall in drought-threatened sub-saharan Africa.

The tropical atmosphere acts as a kind of global waste incinerator. Here, intense sunlight and humidity combine to create high concentrations of the OH radical. This extremely reactive chemical cleanses the atmosphere of pollutants as well as some key greenhouse gases (e.g. methane). These gases are delivered from sources in the north and south and are then destroyed in the tropical band.

Tropical winds on the western sides of continents push surface ocean waters away from the coast and drive upwelling of nutrient-rich sub-surface waters. When these waters reach the sunlit surface of the ocean, microscopic algae grow in abundance, fuelling the ocean's food chain. The eastern sides of tropical oceans sustain some of the most productive and economically important fisheries on earth (e.g. off Peru and also off Mauritania). These upwelling zones are, in effect, vast natural "fish farms".

Every one of these natural processes is highly sensitive to temperature, sunlight and wind (i.e. to climate). Climate change has the potential to:

- Alter the intensity and frequency of weather phenomena like El Niño and the African monsoons.
- Alter the rate at which pollutants and greenhouse gases accumulate in our atmosphere
- Alter marine food chains. This could have an extremely adverse effect on the food supply and, in particular, the economies of coastal nations.

The key is to establish common scientific interests and infrastructure which sustain a commitment from international scientists to work with their regional partners

Bridging the infrastructure gap

Despite their significance for and sensitivity to global change, tropical regions are remarkably little studied.

Most tropical nations, especially those in Africa, are unable to afford the sophisticated scientific infrastructure, equipment and training required for modern climate, ocean and atmospheric research. Even the utility of the research infrastructure used to study marine ecosystems remains limited in many tropical waters, despite decades of heavy fishing by richer nations. There are sophisticated atmospheric measurement stations, scientific logistical bases and fisheries research laboratories dotted throughout the richer countries of Europe, North America and Asia, as well as the uninhabited ice-covered regions of the world. However, they remain rare in the tropics – particularly in Africa.

Since 2002, a team of scientists from Germany and the UK have been trying to improve the situation. Six years ago the twin issues of the logistical difficulty of conducting global change research in the West African coastal region and the lack of data were recognised, thus prompting key researchers to ask the Volkswagen Foundation to support a workshop to explore Cape Verde's potential for long-term observation. The workshop was hosted by two Cape Verde institutions and the results were more positive than could possibly have been imagined. They revealed a cadre of highly motivated scientists within both Cape Verde's National Institute for Meteorology and Geophysics (for the atmosphere), and the National Institute for the Development of Fisheries (for the ocean).

The local scientists explained their needs to the visiting European scientists, while similarly the Europeans explained theirs to the locals. It became clear that the European interest in research into environmental change was compatible with the Cape Verdean

needs for enhanced scientific capacity. Word travels fast within the scientific community, and it was soon realised that Cape Verde represented the ideal location to establish a long-term field site to study interactions between the ocean and the atmosphere. TENATSO (the Tropical Eastern North Atlantic Time-Series Observatory) was born.

What is TENATSO?

The TENATSO Observatory – supported by the EU, Germany and the UK – has two key elements: an atmospheric site and an oceanic site, both based on, or near, São Vicente – the second most populous island in the Cape Verde archipelago.

The atmospheric scientists chose a site, the "Cape Verde Atmospheric Observatory Humberto Duarte Fonseca", named in honour of a Cape Verdean climatologist of the last century, on an ancient lava field close to the ocean, on the windward side of the island of São Vicente. Here, steady North Eastern trade winds bring air directly from the ocean to the measurement systems without any risk of land-based contamination. A road has been built to the site, power lines established, and a 30-metre high sampling tower constructed. Furthermore, custom laboratories – housed within shipping containers – have been installed. Currently there are five container labs on the site, housing a wide variety of sophisticated instruments.

The ocean site is located 40 nautical miles "upwind" of the atmospheric site. The small Cape Verde research vessel *Islandia*, which has been completely rebuilt for the task, will run regular day trips out to the site. Continuous measurements are made from both an oceanographic mooring and also an unmanned glider, the latter of which sails around the mooring. The mooring is a cable which extends from an anchor on the sea floor to floats located 40 metres below the surface of the sea. A series of instruments are attached to the cable and the mooring is recovered and redeployed approximately every 12-18 months. The glider is a torpedo-type sensor platform with wings that sails on a pre-programmed course, sampling the ocean from the surface all the way down to a depth of 1,000 metres. Every few

Atmospheric Station at São Vicente Island, Cape Verde. Each container is a specialised laboratory for different atmospheric measurements.

Cape Verdean research vessel Islandia off the São Vicente Island during an instrument calibration exercise in March 2008.

days it comes to the surface and relays its most recent data to the shore via a satellite before returning to its mission.

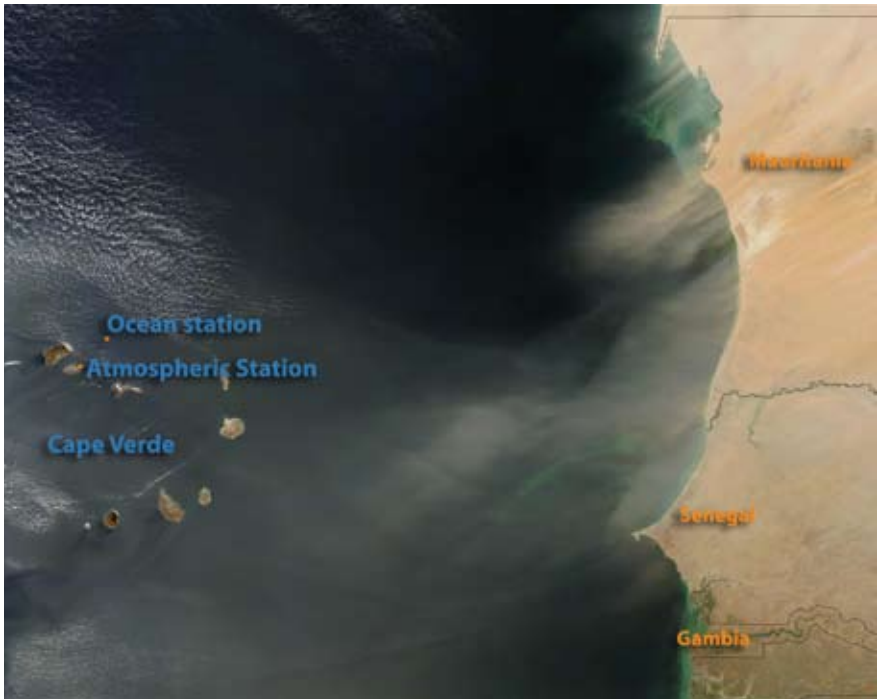
The autonomous systems provide long-term data for basic parameters. More complex biological and chemical measurements depend on water sampling by the Islandia. Samples are then returned to the newly-equipped, shore-based laboratory for processing.

Training, education and capacity building

With an eye on long-term sustainability, the Observatory has already trained and employed four Cape Verdeans as site-managers and technicians.

Indeed, an increasing number of Cape Verdean scientists are closely involved in both site operations and the associated science. This is a trend boosted further by work promoting international cooperation. For example, in 2007 the Observatory hosted a major atmospheric research campaign involving long-term visits by scientists from Europe and North America. Research vessels from the USA, Netherlands, Germany, France and the UK now sample the ocean site and visit Mindelo (the capital of São Vicente) regularly. These extended visits and the regular contact they facilitate are being used to establish new scientific and educational links with Cape Verde institutions, including the newly-established Cape Verde University. Indeed, specialised training workshops have already been held, while efforts to finance graduate training opportunities for Cape Verdean Masters and PhD students – particularly in those scientific projects associated with the Observatory – are very much underway.

The project partners believe that a long-term commitment to science in the region will provide them with an excellent opportunity for capacity building; not just for Cape Verdeans, but also for other West African nations. The key is to establish common long-term scientific interests and infrastructure which sustain a commitment from international scientists to work closely with their regional partners. With the number of extended research visits and collaborations within the West African region growing, there is a corresponding growth in opportunities for capacity-building, education and participation in new projects. Importantly, the associated education can be conducted *within the region*, instead of in Europe and North America. This in turn promotes the retention of trained individuals within the region who can address the regional issues associated with environmental change and development pressures. ★



Satellite image showing a dust storm from the Sahara desert approaching the Cape Verde Islands. Image source: Visible Earth, MODIS Rapid Response Team.

At a glance

Objectives:
To establish the pre-operational basis required for making long-term observations of atmospheric and oceanographic conditions in the tropical eastern North Atlantic region.

Partners:
Leibniz-Institut für Meereswissenschaften, Germany; University of York, United Kingdom; Instituto Nacional de Meteorologia e Geofísica, Cape Verde; Instituto Nacional de Desenvolvimento das Pescas, Cape Verde; Max-Planck-Institut für Biogeochemie, Germany; Leibniz-Institut für Troposphärenforschung, Germany

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