Desert storms

Strong winds whip Saharan sand high into the air, influencing cloud formation and even hurricanes. **Tony Slingo** is investigating how North Africa affects the planet's heating system.

An intense African dust storm sending a massive dust plume northwest over the Atlantic Ocean.The thick dust plume extends more than 1,000 miles, covering a vast swath of ocean extending from the Cape Verde Islands (above), off the coast of Senegal, to the Canary Islands (top) off the coast of Morocco.

Jacques Descloitres, MODIS Rapid Response Team, NASA GSFC

Dust and sand, wildfires, sea-salt spray and particles from exhaust gases all affect climate. These tiny particles floating in the atmosphere, known collectively as aerosols, influence how much heat is kept in our atmosphere and how much is given out to space. Some of these particles absorb moisture and can change how clouds grow and whether they produce rain. Dust from the Sahara has an enormous influence on how sunlight is scattered and absorbed. The scale is immense: dust storms are clearly visible from space. Ferocious winds can whip up huge dust storms that sweep out over the eastern Atlantic. These dust storms produce stunning sunrises on the Canary Islands and Cape Verde. Some of the dust ends up in the ocean and being rich in iron it acts rather like fertiliser on a lawn encouraging the growth of microscopic plants known as plankton.

Clouds also have a crucial impact on climate; of course, we all know that they provide rain, but they also reflect sunlight back to space and contribute to the greenhouse effect by trapping heat radiation from the surface. Understanding how greenhouse gases, aerosols and clouds control the radiative heating and cooling of our planet is vital if we are to build more accurate climate models.

To do this we devised a project that would allow us to study all of these processes from one place, from above and below, for a whole year. The choice of location was easy: Niamey, the capital of Niger, which is the centre of operations this year for a massive international experiment, called the African Monsoon Multidisciplinary Analysis (AMMA). This involves scientists from the UK, France, the US and many African nations who are studying the West African monsoon,

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using surface observations, satellites and aircraft, including the NERC/Met Office BAe146, which made measurements of the aerosol during the dry season in January and of the convective clouds during the monsoon in July and August.

In our project, we want to understand how aerosols and clouds affect the balance between radiation coming into the atmosphere from the sun and heat radiation leaving the atmosphere to space. The space data come from NERC's Geostationary Earth Radiation Budget (GERB) instrument, on the Meteosat weather satellite. The satellite's orbit is such that it appears to hover above Africa, giving us a continuous view of Niamey. The surface data come from a sophisticated new mobile laboratory, developed by the US Atmospheric Radiation Measurement (ARM) programme. They agreed to put the facility in Niamey for the whole of 2006; this is a huge commitment to the project. The result is that we have the first continuous observations of the heat radiation and other data, both from space and from the surface, for a whole year, together with aircraft measurements for a few key periods. The project has been running since the beginning of the year and we have been getting some excellent results.

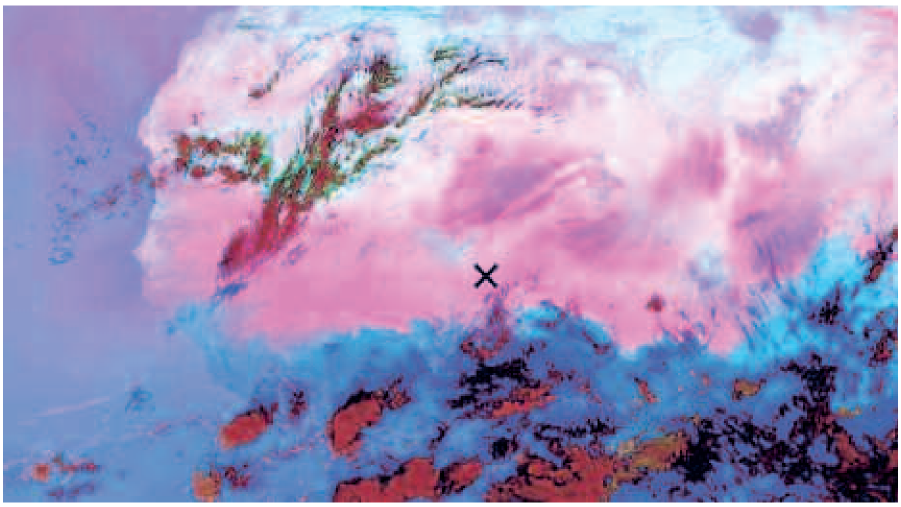
One reason that this project is unusual is the length of time available. Field experiments often last at most a few weeks, and the atmosphere does not always provide the weather we need. By observing for a whole year, we can wait for the right conditions to arrive and then select events for detailed study later. Over the course of a year, Niamey experiences huge changes in its weather as the cloud-free skies of the dry season, with its frequent dust storms, give way to the humid wet season when the monsoon arrives from the south. This lets us sample a very wide range of events, simply by waiting for the seasons to change.

The aircraft provided stunning views of the arid landscapes on the edge of the Sahara, known as the Sahel. We had some time to visit some villages in the Sahel, where the farmers eke out a precarious existence, and we took a boat ride to see the hippos in the River Niger (from a very respectful distance).

We got some exciting data when a large dust storm passed through Niamey in March. The satellite image on 8 March clearly shows the dust storm; the dust is coloured pink and covers the whole of North Africa. This storm had a huge impact on radiation in the atmosphere. But in many ways the less spectacular, but more modest aerosol clouds that typify the dry season are just as important for the local climate. Our instruments can pick up many different layers of aerosols in the atmosphere which change height as the wind moves them around. The lowest layers tend to be dust and the higher ones are smoke from fires as farmers burn last season's dead vegetation before crops are planted in readiness for the monsoon rains. As the monsoon approaches, our instruments record deep clouds building.

Our measurements of the sunlight and heat radiation provide the data we need to test the climate models. We run the computer codes in these models that calculate the transfer of sunlight and heat radiation in the atmosphere and compare the results with the measurements. These comparisons allow us to identify the strengths and weaknesses of the models. We then feed this information back to the scientists working on the models, so they can make the models more realistic thus improving our understanding of the atmosphere and improving climate predictions this century.

X marks the spot – Niamey, Niger's capital city during a dust storm. The dust is coloured pink.



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For more information on the project see: http://radagast.nerc-essc.ac.uk/Home.htm