



# THE SMOG SPIES

BY LINDA VERGNANI

Safari 2000 is the biggest study ever undertaken of the cloud of pollution that hangs over Southern Africa. Data obtained will facilitate disaster management and provide missing pieces to the puzzle of global atmospheric change.



ABOVE Professor Harold Annegarn with Nasa's ER-2 research plane at Pietersburg airport.

earing a bright yellow spacesuit, the pilot waddles slowly across the tarmac of Pietersburg airport and into the rocket-shaped cockpit of the ER-2 aircraft.

He has already selected various flavours of mushy food, made by baby-food producer Gerber, to suck through a straw in his helmet during the six-hour reconnaissance flight over the Mozambique channel.

As the aircraft taxis down the runway, an excited group of scientists, photographers and journalists clamber over a newly excavated ditch and across the airfield to get a good view of the take-off. Based on the U-2 spy plane, the scientific aircraft swoops up steeply, disappearing in seconds into the brown haze of pollution that blankets the Highveld.

It is this ugly brew of pollution that hangs not just over Gauteng but the entire subcontinent that is a major focus of Safari 2000, the Southern African Regional Science Initiative. The biggest study ever undertaken of the atmosphere and environment in Southern Africa, it involves some 200 scientists from universities and research institutions in Africa, North America and Europe. They are conducting over 90 different projects that will give a better understanding of the effects of atmospheric pollution and natural emissions, not only on the region but also on the global environment.

Covering nine sub-Saharan countries, the study will help refine and improve remote sensing observations from a new generation of earth-observing

satellites, especially the National Aeronautics and Space Administration's (Nasa) recently launched *Terra*. By focusing on changes occurring over Africa, Safari 2000 will fill in missing pieces of the puzzle of global environmental change, including global warming.

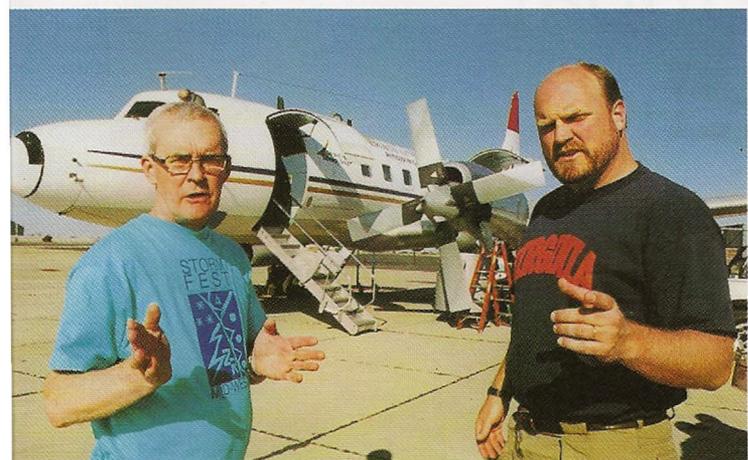
One of Safari 2000's South African coordinators, Professor Harold Annegarn, head of the Atmosphere and Energy Research Group at the University of Witwatersrand, comments: "The direct results as well as the satellite information from this study will be used over the next 10 to 15 years as a basis for both science and policy-making in Southern Africa."

It could help government and decision-makers to plan by providing data on strategic issues like trans-boundary air pollution and water catchment management. Information from the project will also be fed into the National Disaster Management Centre, so that in future it will be able to predict and cope with disasters like the massive floods this year.

The study has been jointly funded by the South African government, the CSIR (formerly known as the Council for Scientific and Industrial Research), Eskom, and local and overseas donors including Nasa.

Safari 2000 has already shown that the heavy winter blanket of pollution many Highveld inhabitants blame on local factories, mines and cars is sometimes boosted by smoke from thousands of fires in Namibia, Botswana, Angola and Zambia.

Annegarn says for two weeks in September a "river of smoke" from these fires covered the northern parts of South Africa, darkening



LEFT Peter Hobbs of the University of Washington and United States Safari coordinator Bob Swap of the University of Virginia.

the skies and making the sun appear scarlet an hour before sunset. "In this region everyone is downwind of everyone else."

For days and sometimes weeks in winter, polluted air is trapped and circulated over the subcontinent in a giant gyre or anticyclone. When the weather breaks, it is spewed out over either the Atlantic or Indian Ocean. Annegarn comments: "The perception is that South Africa is the big industrial power and the big polluter, but really we are exchanging pollution through this atmospheric conveyor belt."

Professor Bob Swap, research assistant professor in the Department of Environmental Sciences at the University of Virginia, explains: "It is like potjiekos – this big African pot where you throw different things in, put the lid on and let it simmer a while and then you get the product out." He says in this case the ingredients are man-made and natural emissions, and the pot is the gyre in which they are heated by the sun.

Swap, one of two American Safari coordinators, says contributing to this potjiekos are industrial emissions from the Highveld, which has "five of the world's 10 largest coal-fired power plants", and pollution from the copper belt of Zambia and the Congo. Added to this are natural emissions like dust from the deserts, smoke from fires and gases from plants.

One of the aims of Safari's six-week winter airborne campaign, which ended in September, was to analyse the ingredients of this atmospheric stew and its effects.

During the campaign Pietersburg airport was abuzz with activity as the ER-2 plus the University of Washington's flying laboratory, *Husky One*, and two South African Weather Bureau Aerocommanders took off on regular missions across the region. Swap says at times the aircraft flew "like a stack of pancakes" below *Terra* to take scientific measurements.

Throughout the campaign, Nasa officials took groups of pupils and preschoolers into the hangar to see the ER-2 and pose alongside the aircraft.

The charming Walter Klein, mission manager for the ER-2, boggled some youngsters' minds with his explanation of why the pilots

had to wear spacesuits: "In the event of emergency decompression at 65 000 feet, the blood boils and the pilot would die without the pressure suit."

But much of the action took place in offices that were closed to the public. Dozens of scientists beavered away on computers interpreting data as it was produced and putting it out in real time on the Safari 2000 website.

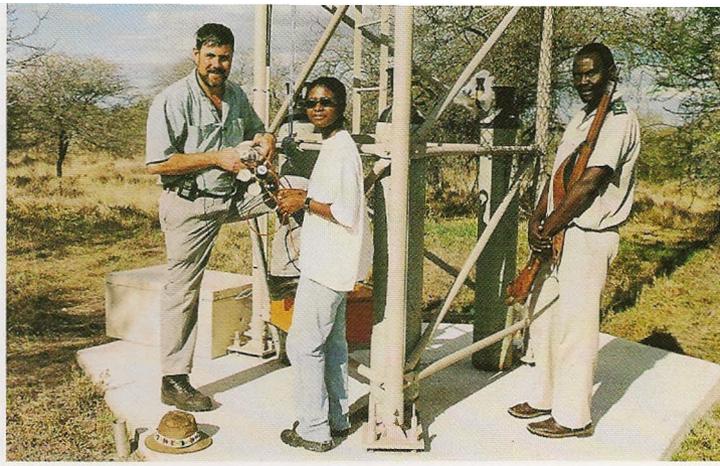
Within the first week, remote sensing geologists contracted to Safari 2000 enhanced satellite images to reveal smoke columns hundreds of kilometres long being blown from hundreds of fires across southern Angola and northern Namibia. By early September around a million hectares had burnt in Angola and the fires were still raging.

Dr Rob Harris, who works for Geodatec, and Reinet Moolman, who was contracted to the project by Rand Gold, worked with a University of Witwatersrand student to get the first false colour pictures of the vast smoke columns. Harris says: "A lot of the fires were started along roads. It seems they were deliberately caused by humans in the war zone in Angola." Harris describes the fires in Angola as "very big and largely out of control. They cover huge patches and burn for days and days."

In contrast the blazes in nearby Botswana and Zambia were small "star-like" fires used by villagers to clear agricultural land.

Harris says it was hard to tell whether the Angolan fires had spread from camp fires or whether they related to some military purpose or even formed part of a scorched earth policy. "One of the ER-2 pilots who flew close to Angola said the only fires he had seen that extensive were the Kuwait oil fires. The difference was that in Kuwait the smoke was black and in Angola it was grey."

Annegarn notes: "What was truly dramatic was that for 10 days in September, South Africa was under a river of smoke that



ABOVE Safari 2000 coordinator Dr Bob Scholes, student Musa Mavundla and research assistant Johan Baloyi.

turned southwards from fires in central Africa." He said the sky in the Highveld was dark and the sun turned blood red an hour before sunset.

"Fires are part of the natural cycle, but the frequency is increasing. We don't yet fully understand the results of burning every other year rather than every 10 years."

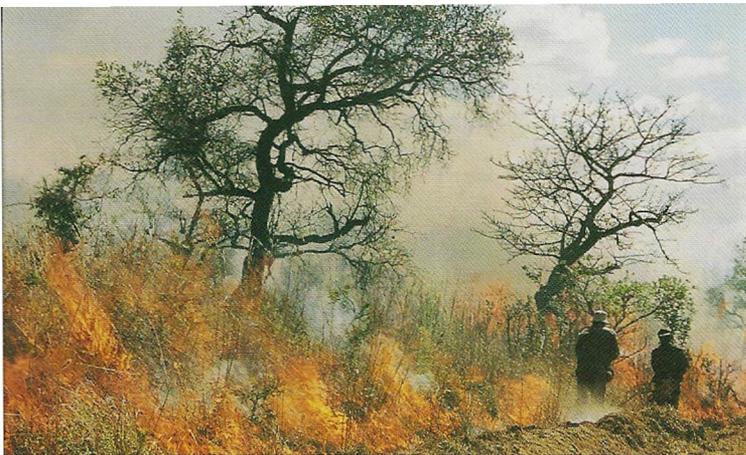
Peter Hobbs, professor of atmospheric sciences at the University of Washington, flew through some of the smoke columns in *Husky One* during the campaign. Hobbs was surprised to find that even above the supposedly pristine South Atlantic Ocean off the coast of Namibia, there was black sooty material from biomass burning and industry. The polluted air, similar to that in highly industrialised nations, was "very absorbing of solar radiation" and could promote global warming.

Hobbs says *Husky One* is probably the "best instrumented aircraft in the world for measuring gases and particles in the atmosphere and the effect on air pollution and climate change".

"What we do quite often is fly beneath the ER-2 and get *in situ* measurements, which are

BELOW Wearing a spacesuit, a pilot prepares to board an ER-2 aircraft, which is capable of flying up to 65 000 feet.





ABOVE *Kruger National Park research assistants start a fire as Safari 2000 aircraft and the Terra satellite pass overhead.*

really truth measurements,” explains Hobbs. “By comparing these truth measurements, you can decide what can reliably be deduced from remote sensing mechanisms in the satellites. We are sometimes called the bottom feeders – we are the guys that work in all the junk down at the bottom, like bottom-feeding fish.”

Scientists on *Husky One* have travelled across the world studying air pollution and climate change. Hobbs says: “Last year we flew over the Arctic Ocean for two months looking at long-range pollution from Europe and how it affects the Arctic.” Among previous trips was one to the Amazon Basin to examine the effects of smoke pollution.

Parikhith Sinha, a University of Washington Masters student who monitored instruments aboard *Husky One* during the Safari campaign, says: “I’ve got to say the flying is pretty tough but it’s very exciting to be in another part of the world. It’s usually pretty rough because we often fly at around 9 000 to 10 000 feet in turbulent air. We fly over the sources of pollution and through the smoke.”

Certain flights were coordinated with experiments on the ground. For example controlled burns were set in the Kruger National Park and other game reserves to coincide

BELOW *Kruger National Park research assistant Velly Ndlovu watches over a controlled blaze.*



with the passage of *Terra* and research craft overhead.

Those involved in Safari 2000 emphasise that not everything that goes into the atmospheric stew is negative. For example areas of natural forest and veld can absorb carbon dioxide and help slow global warming.

In a Safari field expedition in March, a caravan of academics plus 30 students from all over the world trekked over 1 200km south from the miomba woodlands in Zambia to the Kalahari desert in Botswana to survey the density of vegetation and absorption of sunlight in different ecosystems. This month a similar caravan of researchers will move east to west, studying the vegetation from Zambia through to Mozambique.

On a smaller scale, three special “flux towers” packed with delicate instruments have been set up to take atmospheric readings in unspoiled areas of South Africa, Botswana and Zambia.

Taking a group of journalists to the flux tower near Skukuza in the Kruger National Park, Dr Bob Scholes, a fellow at the CSIR, warned that we would have to walk the last few hundred metres. This was so that exhaust from the vehicle did not disturb the atmosphere and hence the sensitive readings.

An armed guard accompanied us to the tower, where students recently encountered a pride of lions. Scholes said the instruments housed on the tower “measure the earth breathing in and out carbon dioxide”. The tower was set up in a square kilometre area of savannah, which coincides with 16 pixels of an image from one of *Terra*’s instruments, the Moderate Resolution Imaging Spectroradiometer (Modis).

Scholes said that with 60 percent of Africa covered with savannah, it was vital to interpret exactly what the satellite pictures depict. One of the things he and his students are measuring around the tower is patterns of vegetation growth, down to the exact number of leaves on individual trees in

different seasons. The ground readings are compared to the 42 band colour pictures taken by Modis. So where Modis might show a particular shade of green, Scholes’ team will be able to show that it actually depicts a particular species of tree coming into leaf or blossom.

Scholes says: “Universities and other institutions are struggling to understand how you study things at the scale of the whole world. The way we are doing it is to put long transects cutting across the continent so we can understand the context.”

The project serves as a training ground for a new generation of Southern African scientists. Musa Mavundla is doing a Masters in botany at the University of Witwatersrand, which will contribute to Safari 2000. She is studying soil respiration and the environmental factors that affect it in the area around the Skukuza flux tower. Mavundla sometimes has to avoid elephants while trying to get to her equipment, but she is not fazed. “I feel honoured to be involved in something that is so big and internationally recognised. It’s scary at times but a good experience.”

Annegarn sees Safari 2000 as an example of converting swords into ploughshares. “Satellite technology was originally driven by the need for military surveillance. Now the new earth science satellites are specifically designed for monitoring the health of planet Earth.” Ironically the Pietersburg airfield was originally used as an attack base for the apartheid government. “Now it is being used for the peaceful purpose of an international collaborative project.”

Reporting to Cabinet on the progress of the study in September, the Safari 2000 coordinators were surprised to receive an ovation. Annegarn says one of the reasons the study was so well received was that while the Government had given the project a R3m grant, international partners had contributed an additional R35m. “When we told the Cabinet we were not there to solicit funds, [finance minister] Trevor Manuel put up his fist and said: ‘Right on!’”

Now Annegarn and his partners are determined to see the Safari results translated into better environmental management policies for the region. ▲