Obituary
Reflections on the contributions of Bob Scholes† to atmospheric science

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The untimely passing of Bob Scholes (28th April 2021) is a loss to the global science community. His understanding of the interconnectedness of Earth systems is in the tradition and on the scale of Alexander von Humboldt, one of the first scientists to comprehend and articulate the complexities and interactions of earth, water, air and the biosphere. Specifically, von Humboldt, already in 1836 during an epic journey through South America, had observed how deforestation for tillage had changed the local climate (Wulf 2016). After a few years, the cleared land had become barren, and the previously copious rainfall had ceased. In this, Von Humboldt had presaged the contemporary understanding of Global Change wrought by anthropogenic activities. Similarly, Bob Scholes had encompassed an understanding of many diverse disciplines into an integrated understanding of the dynamic interactions that sustain, and could disrupt, the natural order.

Bob started his academic career as a savannah rangeland ecologist. I recall a visit we paid to Bob and Mary during Bob's internship on the Oppenheimer's Klaserie private reserve. Bob had dug a -3-m cubic pit and meticulously recorded the number of roots and rootlets through the soil profile – investigating the secret underground life of plants. To reach the site, we travelled in a beat-up skedonk open Landover (with no operating brakes), pausing and dodging wandering herds of elephants along the way.

These early investigations into the interchanges between the geo- and biospheres on the micro-scale later expanded to include large-scale interchanges between bio-, geo-, hydro- and atmospheres. Realising that plot-scale observations provided fragmented insights, Bob's investigations now focussed on the dynamics of the Miombo woodlands of southern Africa and the African savannah grasslands. In this context, one of the many international collaborations that Bob established was with systems ecologist Hank Shugart of the Environmental Sciences Department, University of Virginia (UVA), Charlottesville. Through this link with UVA, a chance encounter led to one of the most extensive environmental field campaigns to have taken place in Southern Africa – the SAFARI 2000 Regional Science Initiative.

In February 1998, I had attended an atmospheric sciences conference in Arizona. My return routing was to take me through Washington D.C. on route to Johannesburg. Bob Swap, a young

Distinguished Professor Bob Scholes. Photo credit: University of the Witwatersrand

post-doc who had recently returned to UVA from a yearlong fellowship at Wits University, invited me to drop by UVA, seeing as I was passing so close by (actually 200 km). On the day I arrived, I was pressed into attending a meeting in progress between researchers from UVA and NASA. The purpose of the gathering was to plan a proposed field campaign in Southern Africa in support of a soon-to-be-launched Earth-observing satellite – Terra. To my surprise, when I arrived at the meeting, I found my long-time friends and Wits colleagues Bob and Mary Scholes (and their young son Stirling) also in attendance. (They were also visiting UVA at that time to work with Han Shugart.)

We (the South Africans) listened with rapt attention to the plans for a sophisticated field campaign involving surface measurements of land cover, fires, and airborne sampling utilising an instrumented aircraft from the University of Washington. As the morning progressed, we became anxious – *Was this to become another scientific exploitation mission in which international teams arrived in our African territories, collected their data and returned home with their scientific loot, to publish or perish, with African scientists and students participating as fetchers and carriers?* Walking with Bob alone during the lunch

break, I broached how and whether we should manage this situation to avoid scientific colonialism. In his trademark wise counsel, Bob advocated that we welcome the international visitors and facilitate their endeavours. Nevertheless, we agreed to emphasise that opportunities should be created to ensure meaningful participation by South African and other African scholars (despite the disparity of resources invested by the respective parties). On this same stroll, we coined the name of the campaign – SAFARI 2000. We returned to the planning meeting in a buoyant mood and persuaded the UVA and NASA teams that we would not only welcome their efforts but would be happy to host them and expand the scope of their proposed mission. This auspicious day led to the *Southern African Regional Science Initiative* (SAFARI 2000). Bob assumed the leading role in coordinating an interdisciplinary, multi-institutional team in South Africa and successfully raised funding through a Department of Science grant. Bob generously ensured that funding was proportionally distributed among the several participating institutions.

Notable scientific contributions by Bob and colleagues to SAFARI was the Kalahari Transect experiment – examining the effect of climate along a ~2 000-km long N-S transect of a uniform geological substrate (the Kalahari sands) on the vegetation and land cover. Bob's intellectual insights guided researchers to explore novel linkages between the biosphere and the atmosphere from this macro-scale to the micro-scale of measuring gas exchanges of CO_2 and organic gases from individual leaves.

Although we did not intend SAFARI 2000 to focus on wildfires, the dominant effect of wildfires during the southern African spring meant that atmospheric trace chemistry was dominated by wildfire smoke, much of it imported from Angola and Zambia. Several of the terrestrial experiments involved studying fire ecology and emissions. While I was responsible for the management and coordination of the airborne sampling (involving five aircraft – the NASA ER2 high altitude surveillance plane, the University of Washington Convair CV-58, the U.K. Met Office C-13 and two Weather Service Aerocommander 690As), Bob managed all the ground-based operations. For the fire studies, this involved deliberately setting fires, often in protected areas. This task required precise timing for ground-based teams to set and control fully developed fires to coincide with the satellite overpass at 10:20 SAST. To this end, Bob assigned one of his students, Tobi Landman, to be the game park pyromaniac. All the fire intensity and smoke monitoring equipment had to be in place. For remote sensing observations and atmospheric sampling, the ER2 and other aircraft had to be on station simultaneously with the satellite overpass.

The SAFARI 2000 campaign evolved into a significant surface, airborne and spaceborne field campaign across five countries, covering a broad range of issues involving biogeochemical functioning of the southern African system. The campaign ultimately involved sixteen countries, over 180 scientists in the field during August and September 2000. The careers of countless African academic and students were advanced in profound ways by the experiences and opportunities from SAFARI 2000 and its aftermath. Bob, as South African Principal Investigator, handled the whole campaign with natural leadership and calm assuredness. Overall, both hosts and guests comprised a happy group. Bob was a significant author of many of the resulting journal publications, and handled the chore of funding reports with dispatch and minimal fuss.

Bob moved on to further innovative systems studies stemming from SAFARI 2000, including the Africarbon campaign, and coordinated a set of long-term observations from the SAFARI 2000 flux towers in Skukuza and Mongu, Zambia. These large-scale global interest campaigns gave expression to Bob's evolved insight into the global ecological systems. Indeed, only in the last few years, aspects of Bob's scientific output have become recognised as central issues in understanding the role of atmospheric chemistry in driving global change, for instance, the importance of black carbon and methane as short-term climate forcers.

Bob had that innate ability, a characteristic of many great scientists, to see on the other side of the horizon. His science progressed not through "Eureka" moments of sudden or accidental insights but by insightful systems analysis across many contributing threads. Bob drew much from atmospheric sciences (I know from his many probing and often difficult questions that he posed to me as an atmospheric physicist) and contributed much to the discipline. We understand much more about the atmosphere as the conveyor belt of moisture, carbon gases, and trace elements across Africa and the planet through his work. Bob also contributed to creating a whole new generation of atmospheric scientists who have revitalised the discipline in South and southern Africa.

We who had the privilege can celebrate the opportunity to work with Bob as part of this eventful era in South African atmospheric science. To our students and other colleagues, we hope that we can pass on the traits of Bob's inquiring intellect and engaging personality. This man dedicated his life to science and the sharing of knowledge. We share our condolences with his wife Mary, who has made her independent contributions to atmospheric and biological sciences, and their son Stirling.

Reference

Wulf A. 2016, *The Invention of Nature: Alexander von Humboldt's New World*, Vintage Books, New York.