SERA – Small Environmental Research Aircraft
The future of affordable airborne environmental research

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Many important environmental measurements are now possible from small, single-engine aircraft because of miniaturization and advances in instruments, computers, and aircraft over the past ten years. Examples of research applications include air-surface exchange, air-contaminant dispersion, and remote sensing. We refer to this new high-technology mix of sophisticated aircraft design, with modern sensors and powerful computers as the Small Environmental Research Aircraft (SERA). The costs associated with using a SERA in a research study is considerably less than that of larger aircraft. The significant cost reduction and the associated simplification in logistical complexity open aircraft-based research to a wider scientific community, in particular projects with limited budgets.

In concept, we define the SERA as the clever integration of modern science sensors, powerful computers, and modern small aircraft – often of composite structure and fitted with a modern, clean and quiet engine - which becomes a powerful tool when applied by scientists in their investigations. Due to the simple nature of the small aircraft and the direct involvement of the scientist, the SERA is adaptable and easily deployed.

“Simple” is strongly distinguished from “unsophisticated”. Indeed, it is the sophistication of the technology that allows the simplicity of operation. The emphasis in operation of the SERA is on science and engineering, keeping current with technology in computers, sensors and aircraft design. Operating this simple, sophisticated aircraft removes the focus from the aircraft’s needs in terms of infrastructure and cost and allows resources to be shifted to the increasing complexity of scientific instrumentation, onboard data acquisition systems and data reduction software. In fact, in most cases the value of the instrumentation exceeds the value of the aircraft by a factor of 2 to 10.

Examples of SERAs and typical sensor installations are shown in Figure 1.

There are currently two SERAs available in Australia which can be fitted with with an extensive range of sensors and sensor systems. Both SERAs are operated by ARA- Airborne Research Australia, Australia’s Research Aircraft Facility hosted by Flinders University in Adelaide. The SERAs are:

the Grob G109B (VH-HNK) which has been the research platform in many field studies all over Australia for more than 15 years;

the new ECO-Dimona (VH-EOS) which has just been set up.

Parameters that can be measured from these aircraft include:

- atmospheric state parameters (air temperature, humidity, pressure); wind and turbulence
- turbulent fluxes of water vapour, CO_2, momentum and other quantities
- concentrations of trace gases (e.g. CO_2, Ozone) and pollutants (e.g. NO_2, NO_x, NO_y, HNO_3, PAN, Ox, CO, SO_2, CH_4, NMHC), including VOCs and speciated hydro-carbons
- particles and aerosols
- remotely sensed soil moisture in the root zone and sea surface salinity
- radiative parameters, such as up- and down-welling long and short-wave radiation
- spectral irradiances and derived parameters such as ndvi; IR-surface temperature

Instruments and sensors available to measure these parameters include:

- the BAT-probe (Best Aircraft Turbulence Probe)
- GPS and INS navigation and attitude systems
- gas analysers and Gas chromatographs; flask sampling apparatus
- Tri-, multi-and hyper-spectral scanners, IR-imagers, digital cameras and video cameras
- Scanning polarised microwave radiometers
- Particle counters, nephelometers and aerosol spectrometers
- Laser altimeters and Lidars

At the Conference, some examples of research projects using SERAs will be presented.

Figure 1 Examples of SERAs (left column) and sensor installations (right column). Top to bottom: Turbulence probe and IR-gas analyser on ARA's G109B (ARA/Flinders University/Adelaide); BAT-probe and INS on ARA's ECO-Dimona; k-Band radar in NOAA's LongEZ (NOAA/Idaho Falls/USA); gas-chromatograph and gas analyser on MetAir's ECO-Dimona (MetAir AG/Switzerland); spectrometers on SDSU's SkyArrow (San Diego State University/USA); aerosol and particle instrumentation on the Research Centre Karlsruhe's Enduro (Research Centre Karlsruhe/Germany).