Measurements of Ozone in SEAC^{4}RS

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Ozone (O_3) is a key atmospheric trace gas that is produced and transported in both the troposphere and stratosphere. Stratospheric O_3 protects the biosphere by absorbing harmful ultraviolet (UV) radiation from the sun. Measurements of O_3 for SEAC^{4}RS onboard the NASA ER-2 will help elucidate the dynamics of the upper troposphere and lower stratosphere, including strat-trop exchange and convective redistribution, in Southeast Asia during the monsoon season. These measurements will be carried out using a recently developed O_3 photometer.

The NOAA-2 O_3 photometer design is illustrated in Figure 1 and a photo of the instrument is shown in Figure 2. Briefly, ambient and O_3-scrubbed air flows are directed alternately into two identical absorption cells. 253.7-nm UV light from a mercury lamp is split into two beams that are directed into the absorption cells. Since O_3 strongly absorbs photons at 253.7 nm, the UV beam passing through the cell containing ambient ozone is attenuated more that the beam passing through the scrubbed cell. Knowing the O_3 absorption cross section (σ) and absorption path length (L), the O_3 partial pressure (p_{O_3}) can be obtained using Beer's law. In our photometer design, a novel optical system was developed that folds the UV beam inside the absorption cells and, thereby, doubling the optical path for a given physical cell length. To achieve this, the unpolarized output of the Hg lamp is collimated by a lens and passed through a 254-nm bandpass filter before entering a polarizing beam splitter (PBS1). The vertically polarized component is then split into two beams using a non-polarizing polka-dot beam splitter (BS) and mirror (M1) combination, with half of the light entering each of the absorption cells unimpeded through another polarizing beam splitter (PBS2 and PBS3, respectively). On the distal end of each cell, the polarized light is reflected and rotated by 90° using precision quarter-wave plate and mirror combinations (WP1, M2 and WP2, M3). After the return pass through the absorption cells, the now horizontally polarized light is reflected into silicon photodiode detectors by PBS2 and PBS3.

Table 1. Specifications of the NOAA-2 O_3 instrument

Data rate	2 Hz
Accuracy	3%
Precision with sample flow	1.1 x 10^{10} O_3 molecules cm^{-3}
Size	48 cm x 34 cm x 22 cm
Weight	18 kg
Power (28 VDC)	~200 W (peak); ~50 W (normal)

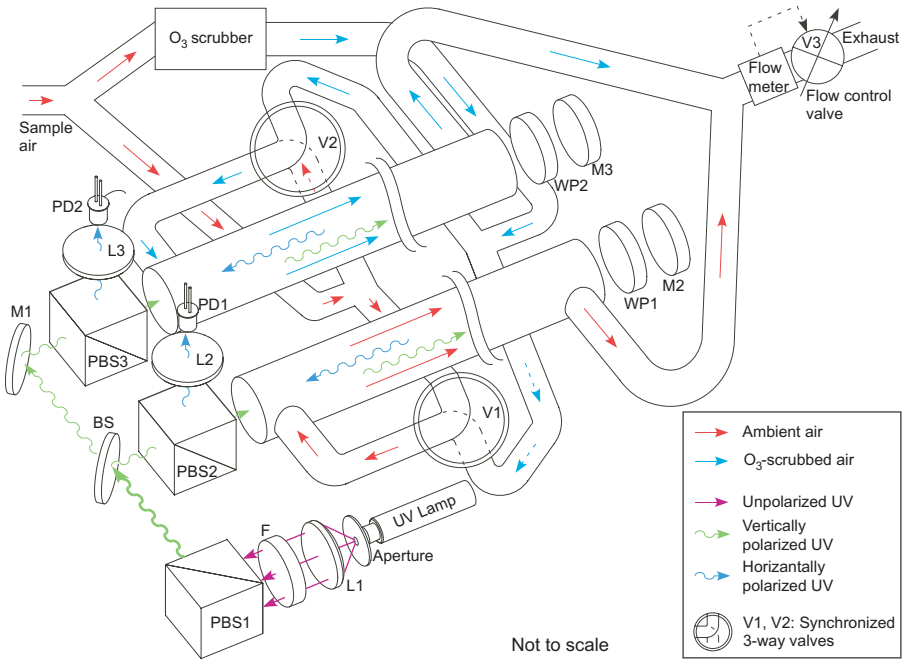

Figure 1. Schematic of the new NOAA-2 O_3 instrument showing the configuration of the key optical and air flow components: Ln: lens; F: UV filter; PBSn: polarizing beam splitter; BS: polka-dot 50-50 beam splitter; Mn: mirror; WPn: quarter-wave plate; PDn: silicon photodiode detector; V1 and V2: synchronized 3-way flow-control valves; V3: flow-control valve. Schematic is not to scale. The legend indicates how the polarizations of the UV beams, and scrubbed and unscrubbed sample air are illustrated.

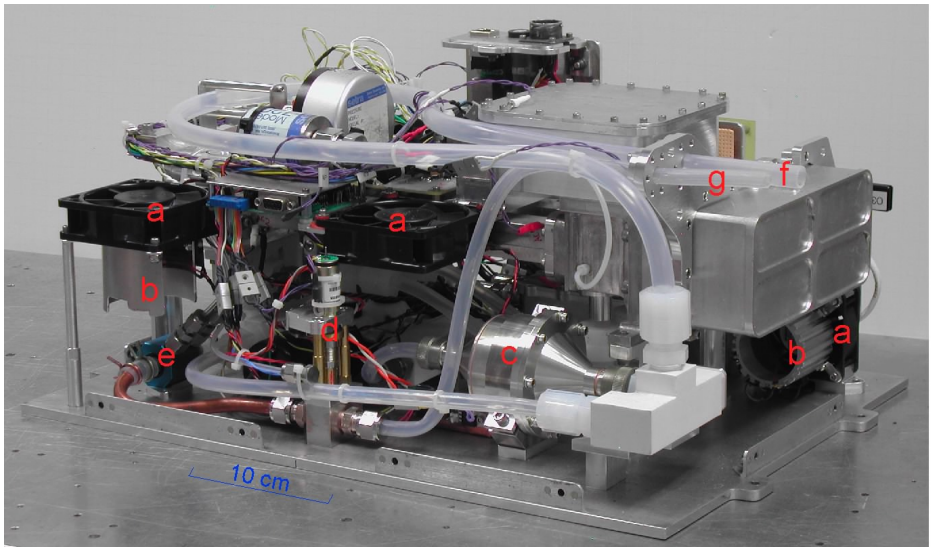

Figure 2. A photo of the NOAA-2 O_3 instrument (without its enclosure) showing a: fans; b: heaters; c: catalytic scrubber; d: flow control valve (V3); e: sample flow sensor; f: sample line; g: exhaust line.