# UV Spectral Irradiance measurements at Lauder, New Zealand

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**Abstract.** In order to monitor long term ozone changes and its effects, a UV spectrometer was installed NIWA, Lauder, Central Otago (45ºS, 170ºE, 370m alt). First measurements began in December 1989. Since deployment, data have been obtained with a high success rate. The instrumentation and data-processing comply with the exacting standards required by the international groups. Here we present time series of data products from this spectrometer (e.g., erythemally-weighted UV irradiance ($UV_{Ery}$), Ozone) to illustrate the causes for variabilities, and to illustrate differences in the UV climatology between New Zealand and other locations.

## Introduction

The aims of NIWA's UV radiation program are to quantify the variability of UV radiation in New Zealand, to relate this to other locations, to understand the causes of its variability, and to monitor long term trends. The cornerstone of this research has been measurements of the spectral distribution of UV irradiance, firstly at Lauder, starting in 1989, and more recently at other locations. These spectral measurements at Lauder are calibrated against NIST radiation standards via transfer standards maintained by IRL. The measurements comply with the exacting standards required by the International Network for the Detection of Atmospheric Composition Change (NDACC – formerly the NDSC). More details of the measurement program can be found elsewhere [*McKenzie et al.*, 2005; *McKenzie et al.*, 1997; *McKenzie et al.*, 2001a; *McKenzie et al.*, 1996; *McKenzie et al.*, 1998; *McKenzie et al.*, 2001b]. The program is supported by a range of broad-band measurements in the South Pacific Region, and by radiative transfer calculations that use the wide variety of input parameters, such as ozone column amounts, profiles of ozone and temperature, and aerosol optical depth data that are available from other programs at Lauder. Here we illustrate the range of data products with time series data over several different time scales

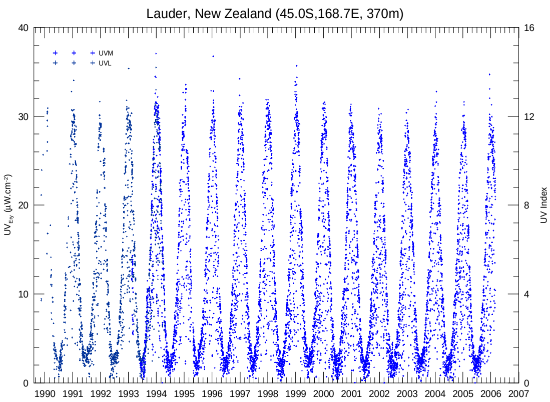


**Figure 1.** Time series of noon erythemal irradiances

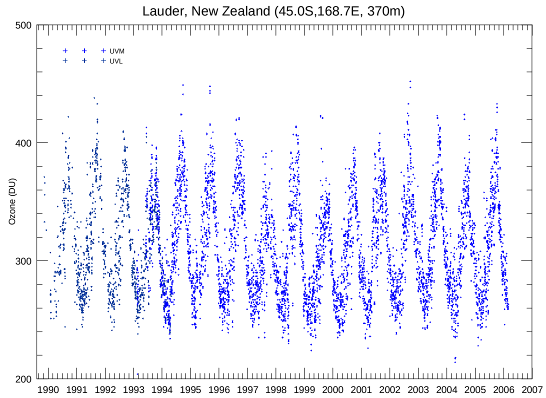


**Figure 2.** Time series of retrieved ozone

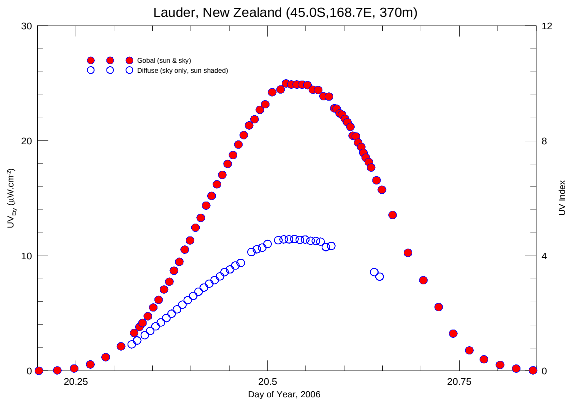


**Figure 3.** Variation in global and diffuse erythemal irradiances over a clear day.

| Location | Latitude (°N) | Altitude (m) | Winter | Summer |
|---|---|---|---|---|
| Boulder, Colorado, USA | 40.0 | 1650 | 0.73 | 4.45 |
| Tokyo, Japan | 35.7 | 57 | 0.69 | 4.21 |
| Mauna Loa Obs, Hawaii, USA | 19.5 | 3400 | 3.68 | 7.45 |
| **Lauder, New Zealand** | **-45.0** | **370** | **0.33** | **4.70** |

**Table 1.** Summer maxima and winter minima mean daily dose (in $kJm^{-2}$per day averaged over a month) of erythemally weighted UV measured by Spectrometer under all weather conditions at four sites during 2004-2005. Note that $1kJm^{-2}$ = 10 SED (Standard Erythemal Dose).

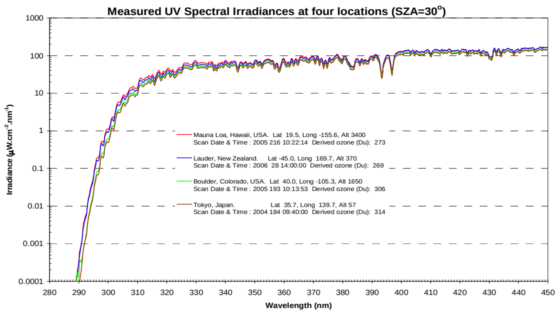


**Figure 4.** Spectral irradiances at several sites for SZA=30º.

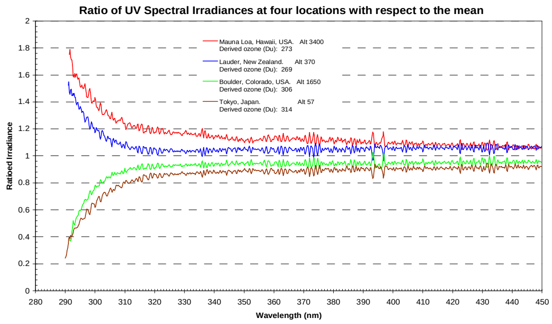


**Figure 5.** Ratios of the spectral irradiances in Fig 4.

## Results and Discussion

High quality data have been continuously maintained at Lauder for more than 16 years. (Fig 1). Scans are taken at 1 nm resolution over the spectral range 290-450nm, at 15 minute intervals over the midday periods, and at 5-degree steps in SZA (Solar Zenith Angle) until after sunset (SZA=95º), with an additional scan of night-sky irradiances at midnight.

Seasonal variations in UVI are large at Lauder, with peak summer values ~ 13, reducing to ~ 1 in winter (Fig 1).

Clouds can reduce the UVI below the clear-sky values by more than 90%, and on average, the cloud attenuation is approximately 30%. However, clouds effects can also lead to increases in UV (Fig 1). Cloud-free observations can be seen from the banding of data in (Fig 1) corresponding to measurements at the same SZA

Ozone column amounts can be derived from the data (Fig 2). The observed seasonal and day to day variabilities in peak UVI show the expected anti-correlations with ozone. (not shown)

For high sun conditions, the direct beam component of UVI is ~50% of the total global irradiance. The proportion of diffuse irradiance increases for larger SZA (i.e., for lower sun elevation (Fig 3)).

When clear-sky spectra for high sun (SZA=30°) are compared, the irradiances in the UVA at Lauder are similar to those at the high altitude Mauna Loa Observatory but are greater in the UVB region. These irradiances are significantly greater than the other two Northern Hemisphere sites despite their lower latitude (and in the case of Boulder its higher altitude). The relative differences become larger towards shorter wavelengths (Figs 4 and 5, Table 1).

There is large inter-annual variability in ozone and UV, and this makes calculations of trends difficult (Figs 1 &2) With the exception of the high altitude tropical site, the summer UVI is relatively high at Lauder compared with the other Northern Hemisphere sites. In contrast, the wintertime UVI is relatively low at Lauder. (Table 1).

The value of these data sets increase as a function of the length of record. We plan to continue these measurements at Lauder and the other sites that are part of the Network for the Detection of Atmospheric Composition Change (NDACC – formerly the NDSC).

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