

**Supplementary Data for**

**Critical Appraisal of Data Used to Infer Record UVI in the Tropical Andes**

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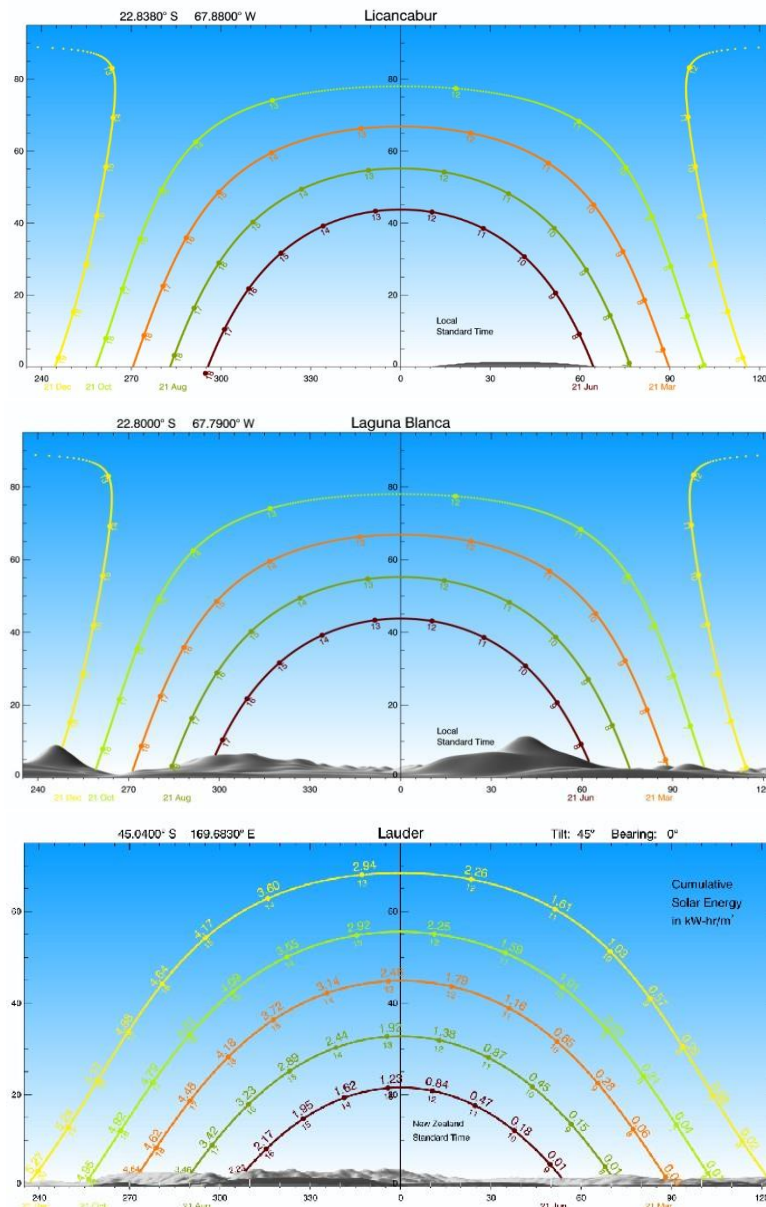
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## Comparing Horizons and Solar Trajectories

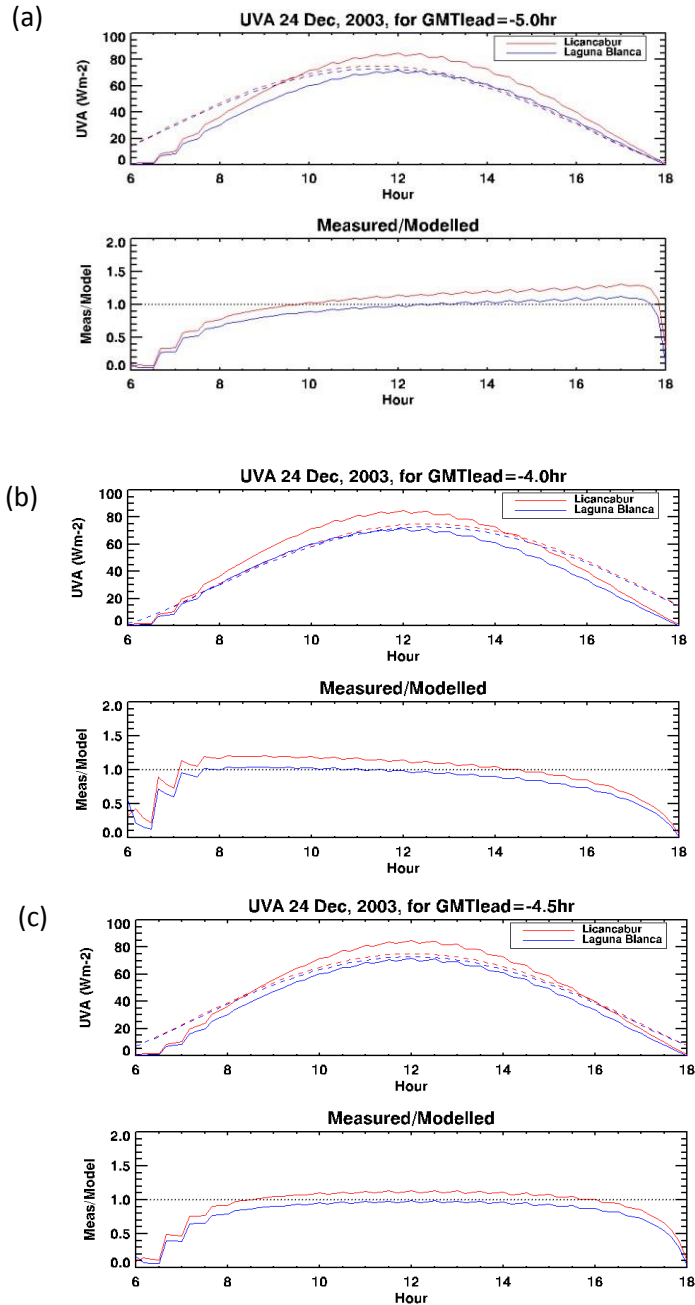
The solar trajectories as observed from tropical sites such as Licancabur and Laguna Blanca are very different from those at typical mid-latitude sites such as Lauder. NIWA's Solarview tool (<https://solarview.niwa.co.nz/>), which is designed to estimate the available solar energy at any site, was used to display the solar trajectories and horizons as seen from each site. Results are shown in Fig. S1. Note that the topography data are at 1 km resolution worldwide, but at 100 m resolution for New Zealand sites, including Lauder. At the tropical sites, the sun can be nearly directly overhead for azimuth angles close to 90°. That combination does not occur at mid-latitude sites, where the 90° solar azimuth occurs closer to sunrise and sunset. Horizon obscuration is minimal at Licancabur and Lauder, but not at Laguna Blanca.



**Fig. S1** Horizons and solar trajectories (Solar zenith angle as a function of Solar azimuth angle) for the 21<sup>st</sup> day of 5 months of the year, as seen from the three Eldonet sites at (top) Licancabur, Chile, (centre) Laguna Blanca, Bolivia, and (bottom) Lauder New Zealand, the latter also showing cumulative energy received on a surface tilted to the latitude angle.

## Eldonet Clock Errors

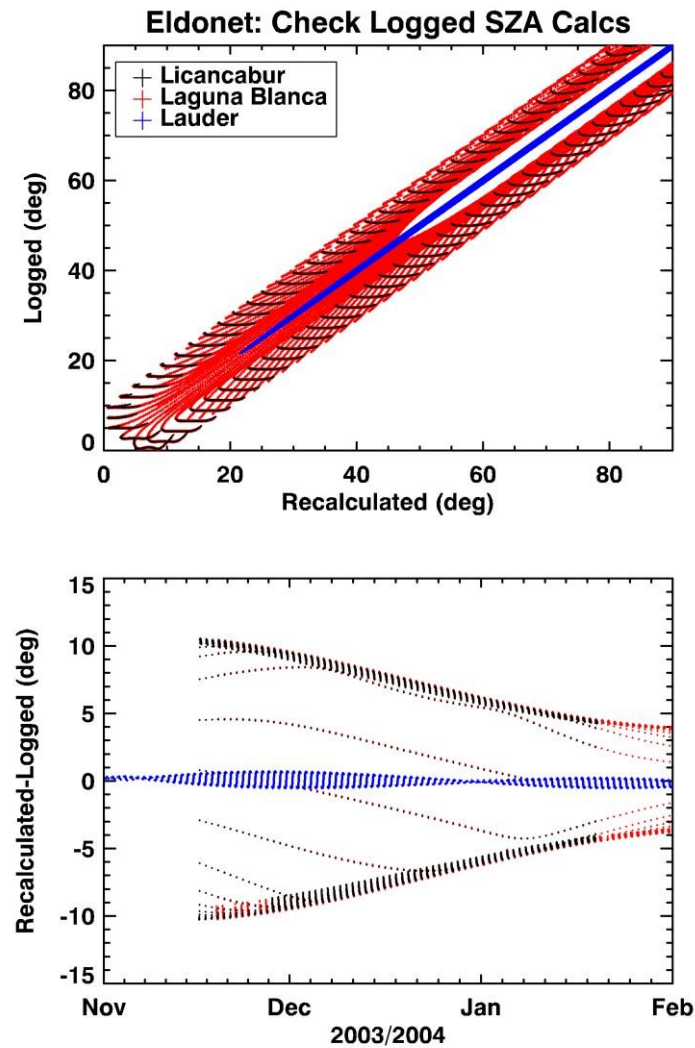
We were advised by the authors C14 that there was a 1 hour error in the time stamps in their data, as published. Diurnal symmetries in ratios of model to measured values shows that the error was in fact 0.5 hours (i.e., the time setting was GMT -4.5)



**Fig. S2** Measured UVA and calculated UVA values (upper panels) and their ratios (lower panels) on a clear sky day, assuming offsets from GMT of (a) -4 hours (as logged), (B) -5 hours (as advised), and (c) -4.5 hours (as deduced for the correct offset)

### Recalculation of Solar Zenith Angle

Because of the clock errors discussed above, the logged SZAs are also incorrect. Fig. S5 below shows the differences. Note that for Lauder, where the time zone was correctly specified, small differences in the calculated SZAs remain, probably because of differences in the calculation algorithm. The algorithm we used is accurate to within  $0.01^\circ$ . It is possible that equation of time corrections have not been correctly implemented in the Eldonet data.



**Fig. S3** Comparison of logged SZA compared with those recalculated with our own algorithm. Data are restricted to SZA <  $90^\circ$



## Data

Processed data files include the parameters shown in Table 1

Eldonet data for the full deployment period at Licancabur and Laguna Blanca are shown for each site in Figs S4 and S5 respectively.

In these plots, the units are as provided in the data file (Table 2). The temperatures logged are unrealistic for Licancabur, where they appear to be at least 100 times too large. This may have affected the temperature control. The temperatures at Laguna Blanca look reasonable, assuming that the external sensor is exposed to solar radiation. The minimum temperatures can be extremely low, dropping to less than -30C. With our choices of y-axis ranges, some of the highest irradiance values have been clipped, especially for Laguna Blanca.

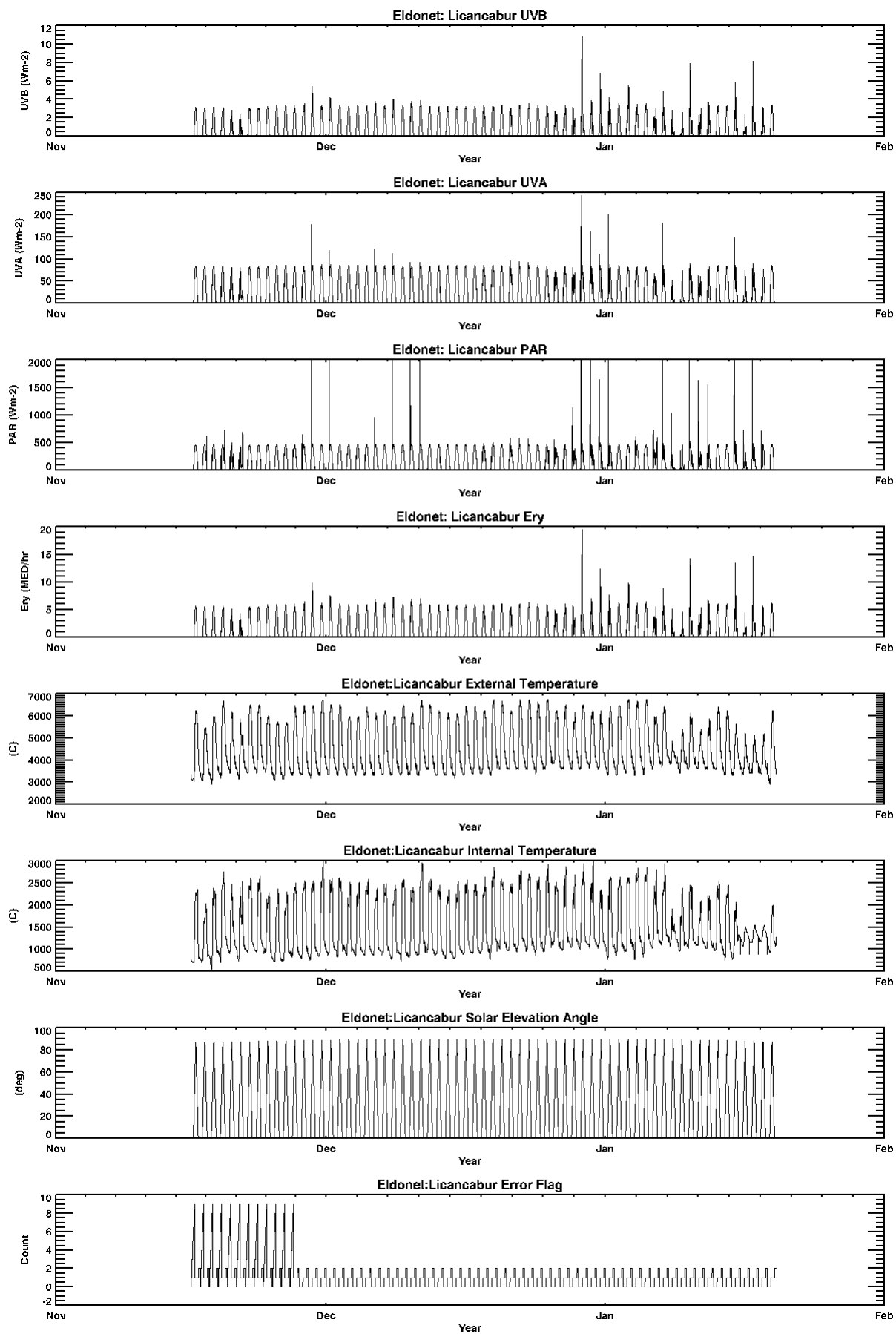
As noted in Table 1, each line of Eldonet data includes a data quality flag. The flag criteria are not specified, but statistics for the first 10 values are shown in Tables S1 and S2. In the analysis, we considered data with flags of 0 or 1 only, representing 95% of all daytime Licancabur data, and 83% of all daytime Laguna Blanca data. There is a significant data loss for flag=2, but these are all night-time measurements.

**Table S1.** Statistics of data flags at Licancabur 9357 data points (from 65 days)

Flag	Data Points	% Total	SZA Range (°)		Max PAR (Wm <sup>-2</sup> )		Max UVA (Wm <sup>-2</sup> )		Max UVB (Wm <sup>-2</sup> )	
			Min	Max	Meas	Calc	Meas	Calc	Meas	Calc
0	3184	34.0	27	138	6299.6	476.2	243.7	65.3	9.0	2.7
1	3971	42.4	0	134	725.3	550.8	95.7	75.1	10.8	3.5
2	1632	17.4	104	138	1.0	0.0	0.1	0.8	0.0	0.0
3	72	0.8	106	117	0.8	0.0	0.0	0.8	0.0	0.0
4	72	0.8	94	105	0.8	0.0	0.0	0.8	0.0	0.0
5	72	0.8	81	92	0.8	53.6	0.8	6.9	0.0	0.0
6	72	0.8	68	79	168.2	165.1	8.6	22.5	0.1	0.3
7	72	0.8	54	66	376.1	283.0	36.2	39.2	0.5	1.0
8	72	0.8	41	52	381.2	391.3	53.1	54.0	1.4	1.8
9	72	0.8	27	39	392.3	477.5	68.8	65.5	2.3	2.6

**Table S2.** Statistics of data flags at Laguna Blanca 50533 data points (from 351 days)

Flag	Data Points	% Total	SZA Range (°)		Max PAR (Wm <sup>-2</sup> )		Max UVA (Wm <sup>-2</sup> )		Max UVB (Wm <sup>-2</sup> )	
			Min	Max	Meas	Calc	Meas	Calc	Meas	Calc
0	15787	31.2	27	179	1219.0	467.5	96.0	63.5	16.1	2.6
1	20590	40.7	0	167	746.2	538.8	84.1	72.9	6.6	3.4
2	6922	13.7	104	177	5.9	0.0	1.1	0.8	0.0	0.0
3	346	0.7	106	140	0.8	0.0	0.0	0.8	0.0	0.0
4	346	0.7	94	126	0.7	0.0	0.0	0.8	0.0	0.0
5	331	0.7	81	113	11.2	52.9	1.1	6.7	0.0	0.0
6	363	0.7	68	99	291.3	162.0	10.6	21.9	0.1	0.3
7	383	0.8	54	87	423.7	277.5	68.6	38.2	14.0	0.9
8	384	0.8	41	75	398.4	383.3	63.4	52.4	2.4	1.7
9	384	0.8	27	64	467.7	467.5	75.1	63.5	3.7	2.4



**Fig. S4** Raw data from Licancabur

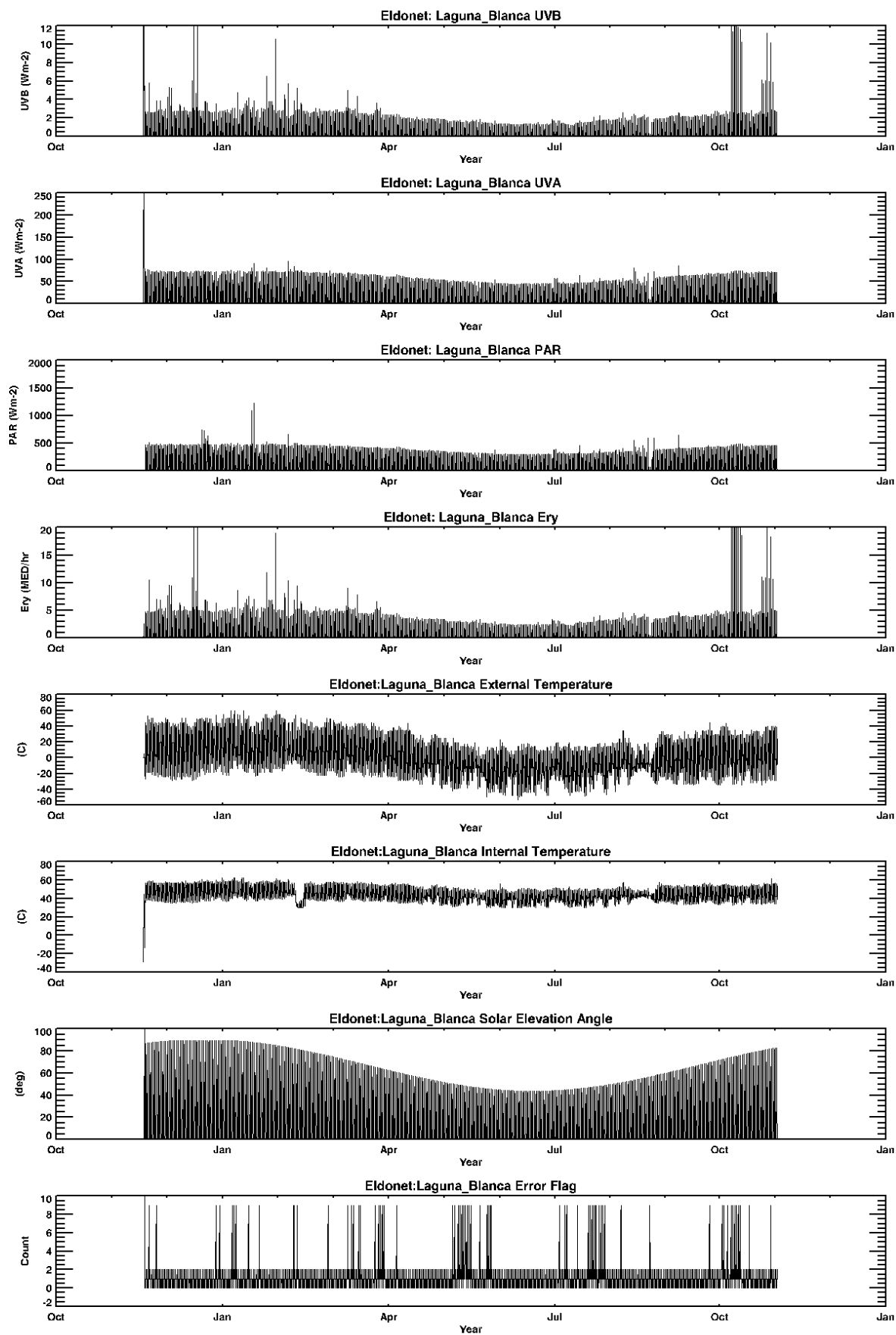
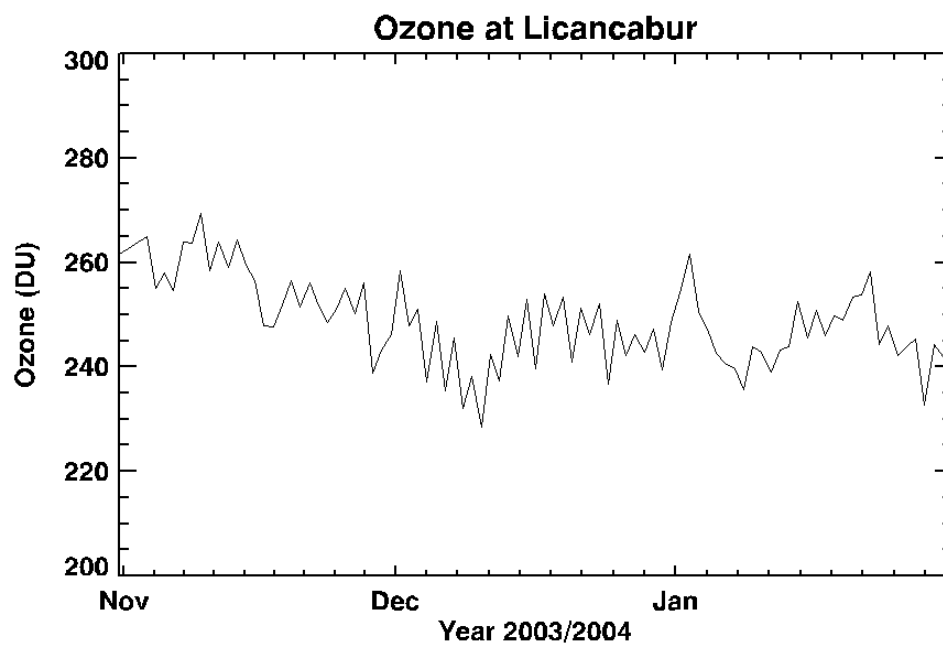
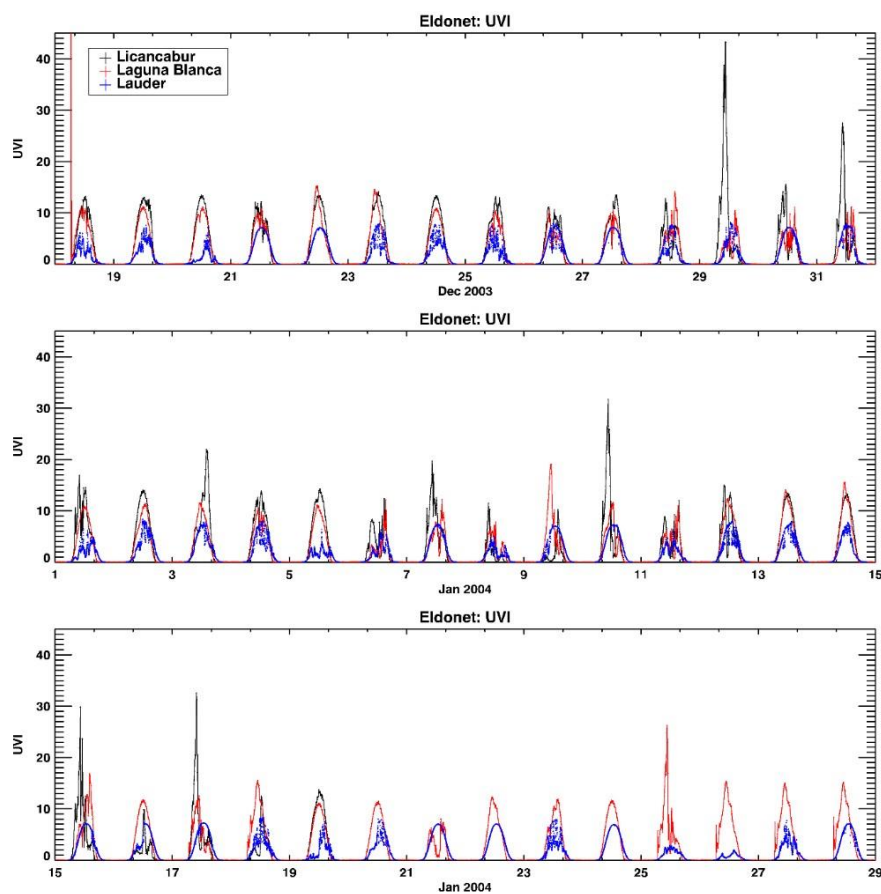


Figure S5 Raw data from Laguna Blanca



**Fig. S6** Ozone values from the EP-TOMS satellite instrument, as archived in the NIWA/Bodeker ozone data assimilation. Note that in this region and time period, overpass data are available typically every second day, and missing values are interpolated. At the satellite data resolution, ozone values for Laguna Blanca are essentially the same.

Fig. S7 displays the UVI values from the Eldonet instruments from both sites for the period of interest, compared with Eldonet data from Lauder, New Zealand. No observations were available at Licancabur after 19 Jan 2004.



**Fig. S7** Time series of UVI reported by Eldonet instruments. Each panel shows 2 weeks of data. The Ery values have been scaled to match the UVI values as published by C14. The scale factor in this conversion is  $40 \times 2 \times 100 / (60 \times 60)$  to convert to UV Index, which assumes 2 SED per MED.

## Conversion from UVB to Erythemally-Weighted UV

**Table S3.** Calculated factors, as functions of SZA and Ozone Amount (TOZ) to convert UVB to  $UV_{Ery}$ . In the highlighted cell  $1/0.133 = 7.5$ , corresponding to a typical conversion factor from UVB to  $UV_{Ery}$ .

Note that these factors are sensitive to choice of the lower wavelength limit of the integration, especially at low wavelengths. Here we have assumed a lower wavelength limit of 280 nm.

SZA TOZ	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
100	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.21	0.20	0.20	0.19	0.18	0.17	0.15	0.15	0.14	0.13
150	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.13	0.13	0.13	0.14
200	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.14	0.16
250	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.16	0.20
300	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.15	0.18	0.25
350	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.15	0.17	0.22	0.31
400	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.15	0.16	0.19	0.26	0.39
450	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.16	0.18	0.22	0.31	0.50
500	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.15	0.17	0.21	0.26	0.38	0.63
550	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.15	0.17	0.19	0.23	0.31	0.47	0.80
600	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.15	0.16	0.18	0.21	0.26	0.36	0.57	1.00

## Examples of Full Days of Data

In **Fig. S8**, which continues over multiple pages, we show daily plots of all of the Eldonet data for the period of overlap between Licancabur (Lic) and Laguna Blanca (Lag), from 19 Nov 2013 to 19 Jan 2004 (62 days), with one page per day. In some cases with extreme outliers, data has been truncated, and in cases where there is missing data, a straight line interpolation is used.

