How accurate are NIWA's UVI cloud forecasts?

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Abstract. We report on the accuracy of NIWA's cloudy UV forecasts at 5 UV observing sites. The UV forecasts area as calculated using short-range cloud forecasts from NIWA's two operational forecast models; NZLAM (and NZCSM. For the comparison period (8 January 2018 through 3 March 2018) NZCSM outperformed NZLAM over all 5 sites. Additionally, in this presentation we report on recent operational developments in provision of forecasts to MetService, NIWA's web-page, the uv2Day app and the application of NZLAM cloud UV forecasts to Myrtle Rust spore dispersion modelling.

Introduction

NIWA has been providing clear-sky UV forecasts for over 50 New Zealand locations to MetService since 1998; since 2005 it has supplied clear-sky and cloudy-sky forecasts for NIWA's own webpage, and since 2015 to NIWA's EcoConnect forecast delivery platform for desktops as well as for the uv2Day mobile phone app. The NWP models providing the cloud forecasts on which cloud UV transmission factors are based have been RAMS 2005-2006 (Turner et al. 2006) , NZLAM 2006-present (Turner 2014), and NZCSM 2015-present (EcoConnect only).

Methods

UV Index observations at 5 sites in New Zealand – Leigh, Paraparaumu, Christchurch, Lauder, and Invercargill – were compared against clear-sky UVI calculations and cloudy UVI forecast values where cloud coverage was from either NZLAM (12-km grid) or NZCSM (1.5-km grid). For a number of technical reasons, the only recent common period for which comparisons between the models can be made was from 8 Jan 2018 onwards. However, comparisons with observations for NZCSM were also made from 3 Jul 2017. Observations are recorded at 10-minute intervals and calculations of cloudy UVI are made at 5-minute intervals, so a comparison of 10-minute values was possible. Turner (2014) details the methods for calculating the clear-sky and cloudy UVI values from NZLAM and NZCSM cloud forecasts. For details on NZLAM and NZCSM radiation schemes and NZ configuration, please refer to Edwards et al. (2004) and Webster et al. (2008).

Results

Table 1 provides correlations (r^2) of observed UV values against UV Clear and Cloudy NZLAM and NZCSM forecasts for various periods and UV thresholds. Generally we see that NZCSM significantly outperforms NZLAM for all sites and also improves over clear sky (except for Leigh where correlations are slightly less). Biases are generally within 6%, except for Leigh and Lauder. Much of the correlation can be attributed to simply getting the diurnal clear-sky variation correct and the fact that 2017/18 summer was characterised by extended periods of fine weather. However, NZCSM was an improvement for clear sky, whereas NZLAM was not. In previous years, NZLAM cloud forecast had outperformed clear-sky forecasts when comparison against peak UV had been assessed.

Table 1. Correlations (r^2) of observed UV values against UV Clear and Cloudy NZLAM and NZCSM forecasts for various periods and UV thresholds. Biases for cloud forecasts are shown in square brackets

Location	Clear Sky UV	Cloudy UV NZCSM	Cloudy UV NZLAM
	All		
Leigh	0.839	0.791	NA
Paraparaumu	0.851	0.902	NA
Christchurch	0.853	0.922	NA
Lauder	0.833	0.872	NA
Invercargill	0.833	0.867	NA
	Clear sky UV > 0.3		
Leigh	0.766	0.703/[0.89]	NA/[0.83]
Paraparaumu	0.785	0.859/[1.04]	NA/[0.96]
Christchurch	0.789	0.888/[0.98]	NA/[0.96]
Lauder	0.760	0.818/[0.82]	NA/[0.84]
Invercargill	0.765	0.813/[1.06]	NA/[1.06]
	Clear sky UV > 3		
Leigh	0.500	0.416	NA
Paraparaumu	0.511	0.694	NA
Christchurch	0.502	0.748	NA
Lauder	0.467	0.623	NA
Invercargill	0.502	0.621	NA
	(0000-2350 NZDT 8 Jan to 3 Mar 2018)		
Leigh	0.802	0.776	0.467
Paraparaumu	0.781	0.884	0.662
Christchurch	0.799	0.901	0.686
Lauder	0.809	0.853	0.591
Invercargill	0.800	0.835	0.625
	(0600-1900 NZDT 8 Jan to 3 Mar 2018)		
Leigh	0.703	0.656	0.308
Paraparaumu	0.667	0.825	0.555
Christchurch	0.692	0.851	0.585
Lauder	0.706	0.777	0.614
Invercargill	0.702	0.757	0.516

For Lauder (Fig 1 – upper panel) this bias appears to be an issue with the clear-sky values, an alternative model trialed performs much better (Orange dots) ,and reasons for this are still being investigated at the time of the workshop. However, for Leigh (Fig 1 – lower panel) it is likely due to (i) an overestimation of cloud cover by the models, (ii) an underestimate of clear-sky UV in shoulder hours, and (iii) not accounting for cloud albedo effects on partly cloudy days.

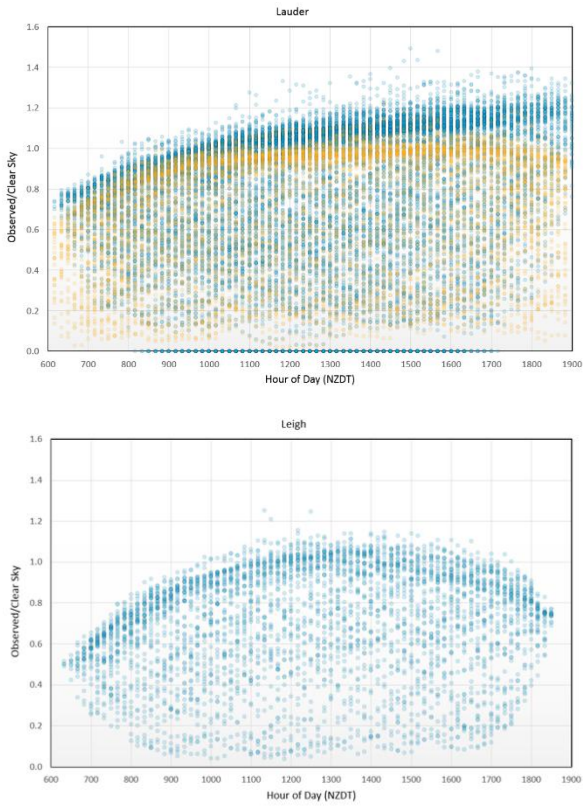

Figure 1. Scatter plot of observed UVI divided by Clear Sky UVI forecast versus time of day for Lauder (upper panel) and Leigh (Lower panel) for the period 3 July 2017 to 3 March 2018.

Table 2. Bias, correlation, and skill scores of cloudy UV operational forecasts for various summer seasons at Lauder since 2005/2006. The skill score of 64% for NZCSM is the score if a simple bias correction is made.

Summer	Model	Bias	Correl	Skill
2005/06	RAMS	0.6	0.72	36%
2012/13	NZLAM	0.97	0.77	56%
2013/14	NZLAM	1.04	0.71	58%
2017/18	NZCSM	0.81	0.79	57%/64%

Table 2 shows how forecasts for Lauder have improved over the past 12 years as more complex physical models and higher resolutions have been used at NIWA. Employment of a simple bias correction will raise the skill score from +57% to +64%. In past years this would not have been necessary as the biases were not large at Lauder. This is not an NZCSM issue as the bias was also seen in the NZLAM forecasts.

Figure 2 which shows the time-series of observed UVI and forecast clear and cloudy UV for 2017/18 summer is included here for comparison with plots presented at previous workshops (Turner et al, 2006 and Turner 2014)

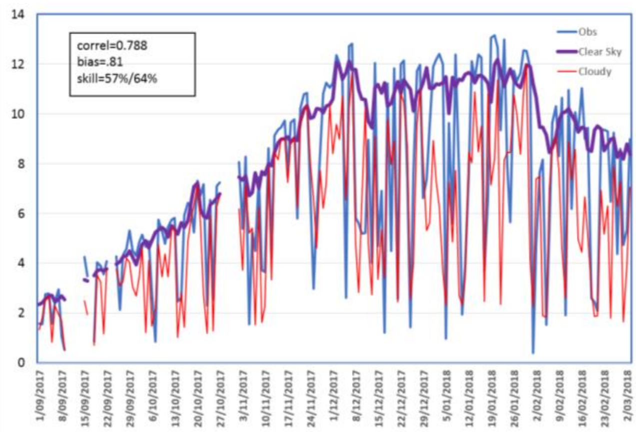

Figure 2. Observed clear sky and cloudy uv forecasts at 1230 NZST at Lauder for period 1 Sep 2017 to 3 Mar 2018**.**

Validation against observation is an important part of the quality control when issuing forecasts and assessing improvements when models, methods and operational workflows change. It is encouraging to see the improvements made in skill and correlations since NZCSM cloud forecasts have been started. This justifies a planned (winter 2018) switch to NZCSM cloud based UV forecast for UV2DAY and the NIWA website.

Other uses of cloudy UV forecasts.

In 2017, Myrtle Rusts disease was found in New Zealand. Exposure to high levels of UV-A and UV-B reduces the germinability of the rust spores (Kim and Beresford, 2008).

Accumulated daily UV exposures (MJ m^{-2}) based on short-range NZLAM cloudy UV hourly forecasts were used as a key input into assessing possible airborne dispersal of Myrtle rust (*Austropuccinia psidii*) spores to New Zealand from Australia (Turner et al. 2017). A sample daily exposure map is shown in Figure 3.

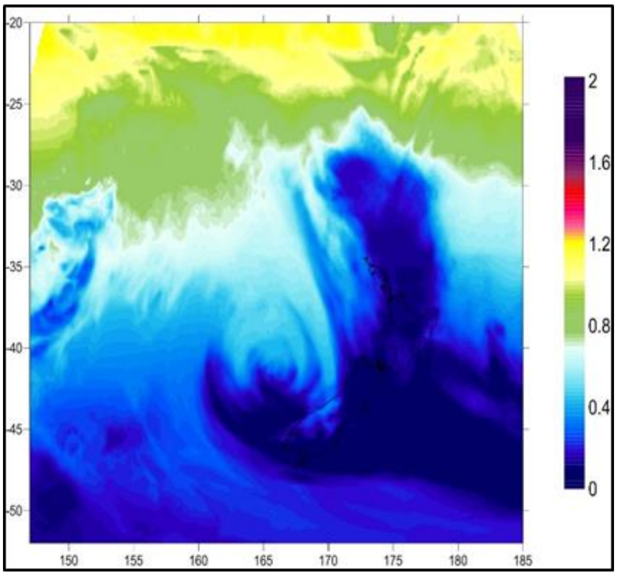

Figure 3. Accumulated daily UV exposure (broader spectrum) in MJ m^{-2} based on NZLAM cloud forecasts for 12 April 2017.

References

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