UVI Forecasts with Clouds

R. W. Turner, J.A. Renwick

National Institute of Water and Atmospheric Research, NIWA, Greta Pt., Wellington, New Zealand

R. L. McKenzie

National Institute of Water and Atmospheric Research, NIWA, Lauder, New Zealand

Abstract. The introduction of cloud effects on daily forecasts of the UV Index in New Zealand started in September 2005. The methodology on how this forecast product was derived is briefly described and results from the validation for the inaugural summer forecasts are presented. Results of the ongoing validation of ozone and clear-sky UV Index forecasts, which started in 2001, are also presented.

UV Index Forecasting with Cloud

NIWA has provided UV Index (see [WMO, 1994] information to the New Zealand public via the internet (www.niwascience.co.nz/services/uvozone), and by distribution to the media via MetService™ for the past several years [Marks and McKenzie, 1997, and McKenzie and Renwick, 2002].

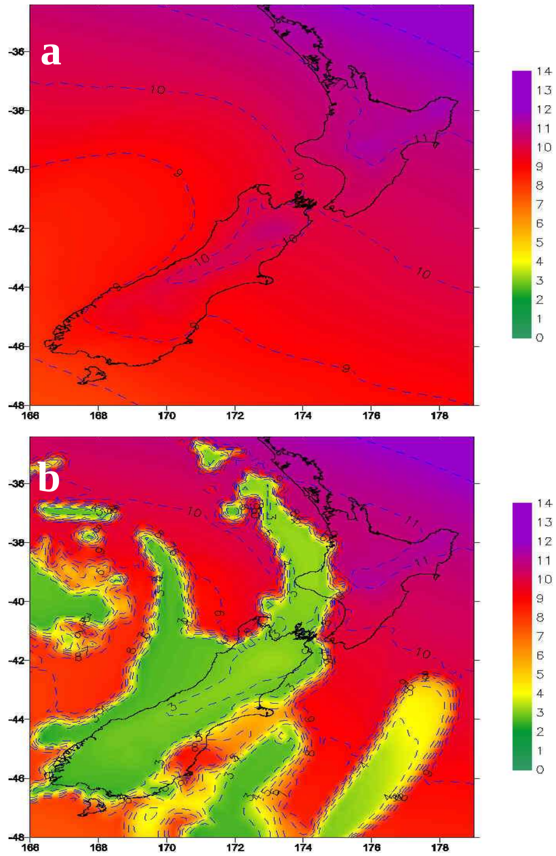

Figure 1. 24 hr forecasts of (a) clear-sky UV index, and (b) UV index with RAMS forecast cloud effects included for a validation time of 00 UTC 8 Feb 2006.

In September 2005 it was decided to provide to the public additional UV Index forecast maps which included the effects of cloud cover on the clear-sky UV index. Each day a RAMS (see Pielke, et.al. 1992) numerical weather forecast was made for the New Zealand region. For each model grid point we extracted the model short wave (SW) radiation at the ground in 3 'solar bands' (limits of 0.245-0.70, 0.70-1.53, and 1.53-4.64 microns), and then divided this by the known SW radiation at the top of the atmosphere (TOA) to get a transmissivity factor, *tr*, for each band. After Oct. 1 (see fig 3c) the minimum value of *tr* was restricted to 0.2). The band-averaged transmissivity was then multiplied by the clear sky UV index to obtain a 'cloudy UV index'. Contour maps and hourly time series were then generated and distributed, along with ozone and clear sky UV index maps. Figure 1 provides examples of the 24 hr the clear sky and cloud UV Index forecast maps as calculated for 1300 (NZDT) on 8 Feb 2006.

Validation of Forecasts

The main motivating factors behind the decision to provide the 'cloudy UV index' maps were improved accuracy and usability of the information provided to the public. While we can assess the accuracy of the forecasts we also hoped that the more 'interesting' cloudy UV index maps were of greater appeal to the public. The RAMS model grid spacing was 20 km so many small scale cloud features that could affect hourly variations of local UV index will not be represented in the forecast. This point is illustrated in Figure 2 where we see a well forecast reduction in UV index before 1400 NZST, but much less hourly variability than observed.

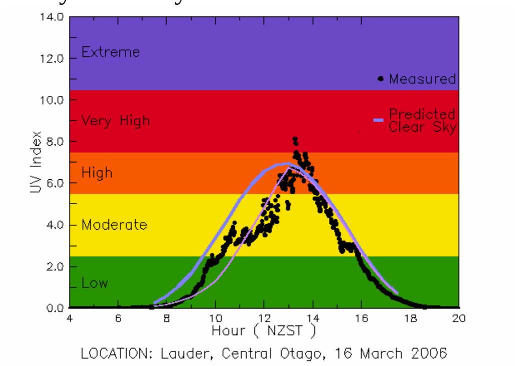

Figure 2. Time series of observed UV index (black dots), the forecast (+18 to +30 h) clear-sky UV index (Thick blue line), and the forecast (+18 to + 30 h) 'cloudy' UV index (thin purple line) for March 16, 2006 at Lauder**.**

The performance of the ozone and UV forecasts was tested against measurements of ozone and UV at Lauder, and the most recent method was found to be the best (see Table 1). The results for 24 hour forecasts of ozone, clear and cloud sky UV indices over the 2005/06 summer period are summarized in Figure 3.

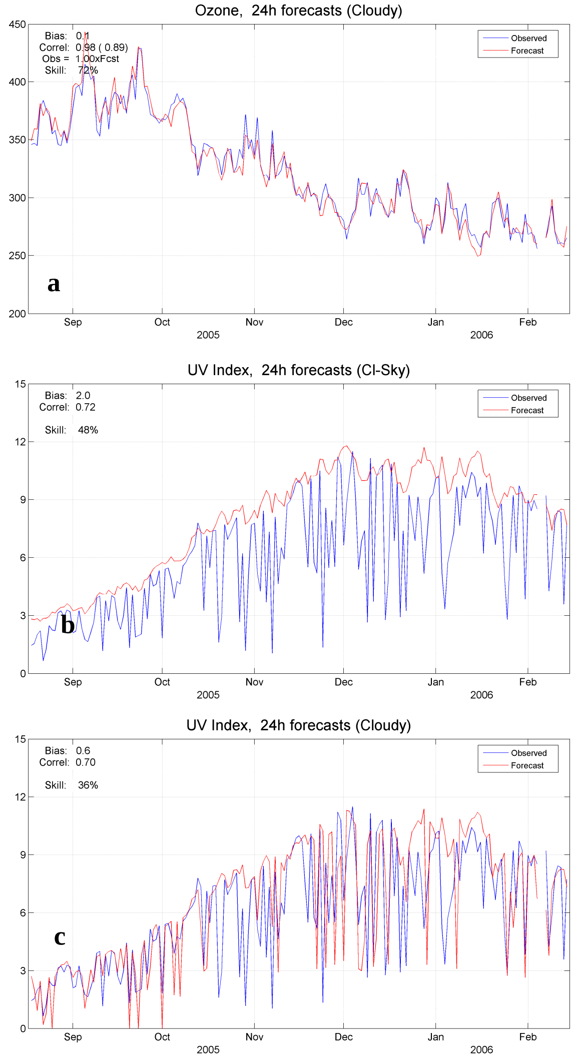

Figure 3. Time series of 24 hour forecasts and observations of (a) Ozone, (b) clear sky UV index, and (c) cloudy UV index.

Tables 1 and 2 summarize the correlation and bias statistics for the season. While it would appear from the correlation and skill statistics that the addition of clouds did not result in an improvement in accuracy, the improved bias scores and an examination of figures 2, 3b, and 3c suggest the contrary. We conclude that the severe penalty for timing errors (a feature of correlation based skill statistics) in the cloud forecasts are the cause for the apparent slight degradation in forecast accuracy.

One other point to note from Table 2 is the slight loss of ozone throughout the 48 hour period of the forecasts.

Forecast Quantity	Correlation / Skill		
	0 hr	24 hr	Skill/+24
Ozone	0.99	0.98	72%
UV Index Clear Sky	0.72	0.72	48%
UV Index Cloudy	0.69	0.70	36%

Table 1. Short term correlation between forecast ozone, clear sky and cloud UV indices and the respective measurements at Lauder after removing seasonal cycles. The last column shows the skill over persistence for the 24 hr forecast.

Forecast Quantity	Bias		
	0 hr	24 hr	48 hr
Ozone (Dobson Units)	1.9	0.1	-1.3
UV Index Clear Sky (UVI)	1.9	2.0	2.0
UV Index Cloudy (UVI)	0.7	0.6	1.1

Table 2. Bias of forecast ozone and measured ozone clear sky and cloud UV indices at Lauder after removing seasonal cycles.

Future Work

Preliminary examination of NZLAM a new numerical weather prediction model now being used in NZ with ΔX=12 suggest superior cloud forecasts to RAMS will soon be available, see Fig 4. In Summer 2006/07 we plan to use these NZLAM forecasts in place of RAMS.

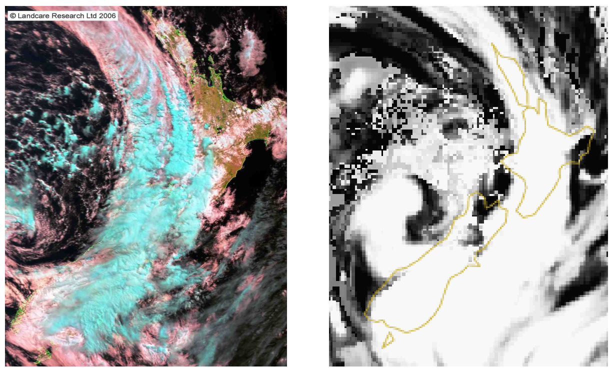

Figure 4 a) AVHRR satellite image at approx 2100 UTC 7 Feb, 2006 and b) +6 hr forecast of NZLAM total cloud verifying at 00 UTC 8 Feb, 2006.

References

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