Solar Ultraviolet (UV) Radiation: A Cold Weather Hazard

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Background

- 3 Types of UV Radiation: UVA; UVB – some penetrates ozone; UVC – cannot penetrate ozone
- Sources: Natural – sunlight (direct and non-direct); artificial – tanning beds, lasers, black lights etc.
- Effects:
  - Negative – tumor initiator and promoter; cancer; sunburn; premature skin aging; immune system regulation disruption; eye damage
  - Positive – stimulate vitamin D production; treat seasonal affective disorders; relieve psoriasis; increase melanin deposition; antiproliferative/inflammatory by downregulating T-cell response to antigens
- UV can reflect off surfaces.

Protective Measures

- The use of:
  - Sunscreen with SPF (follow instructions for use)
  - Sunglasses with side panels and UV protection
  - Wide-brimmed hats
  - Tightly woven long sleeved clothing
  - Shade
- Natural protection provided by melanin coupled with acclimatizing
- Limit time in the sun and avoid peak exposure times: 10am – 4pm

Who is Exposed?

EVERYONE

- Occupations that research typically focuses on:
  - Gardeners
  - Construction workers
  - Agricultural workers
  - Culture/Art/Social science workers (travel, time in field) i.e. Anthropologists
  - Groundskeepers
- Occupations to also keep in mind:
  - Teachers, coaches, police officers, firemen, paramedics, waiters/waitresses, dogwalkers, nannies/babysitters, stay at home moms/dads

Previous UV Studies

Mean Daily Standard Erythemal UV Dose (SED) in France

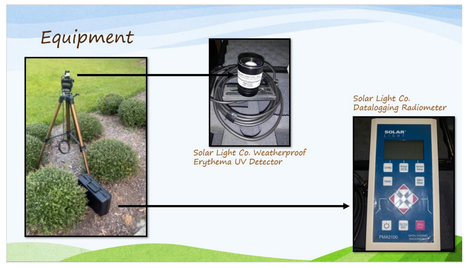
- Recommended 1-1.3 SED
- Gardeners (1.9 SED); Construction workers (0.92 SED); Agricultural workers (0.95 SED); Culture/art/social science workers (0.92 SED)
- Groundskeepers in Eastern North Carolina
  - Exposure at noon and afternoon exceeded ACGIH TLVs for 30 mins, 2-hr, 4-hr, and 8-hr
  - Highest exceedance in June: 30-min = 90.8% exceedance; 2,4,5-hr: 100% exceedance

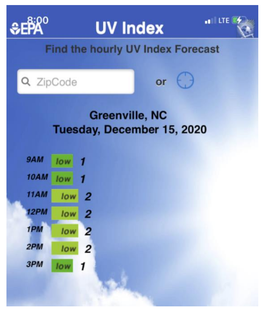
UV Exposure and the Cold Temperature

- Extreme cold converts chlorine into its reactive form, depleting ozone.
  - Greater UV radiation during warmer months due to depleted ozone during cold months
- Typically, more cloud coverage in the winter to reflect UV radiation, causing lower levels of erythema effective UV radiation exposure
- UV exposure risk depends on seasonal habits, i.e., people spend less time outdoors and wear more articles of clothing.
- Altitude, sun position, environmental and atmospheric conditions affect UV radiation exposure.
- Temperature is not indicative of UV exposure risk – applies to hot and cold temperatures.

UV Monitoring Methods

- Solar Light Co. Weatherproof Erythema UV Detector measures UV Effective Irradiance (Uv_{eff} in mW/cm^2)
- Hourly and Daily average and maximum means calculated
  - Compared to ACGIH TLVs
    - 1-hr: 0.0008 mW/cm^2
    - 8-hr: 0.0001 mw/cm^2
- Pearson Correlation Test





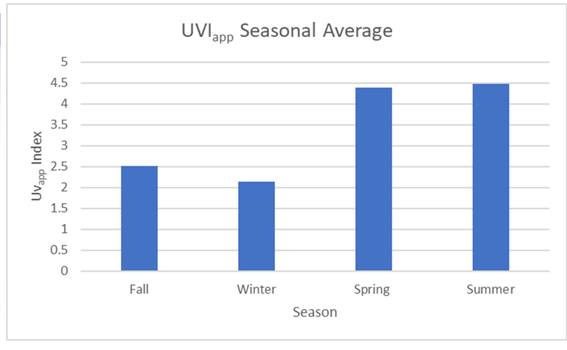


Figure 1. EPA UV Index App & Graph of Average UV_{app} index by season, Greenville, NC, October 2020 to September 2021

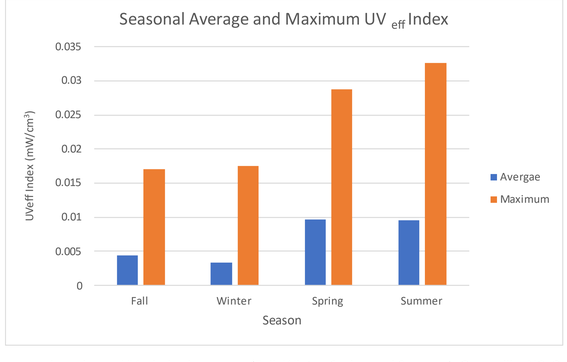


Figure 2. Average and maximum UV_{eff} index by season (Fall, Winter, Spring and Summer), Greenville, NC, October 2020 to September 2021

ACGIH Threshold Limit Value (TLV) Exceedance

Parameter	Hourly Mean UV_{eff} Index (mW/cm^3)	Hours Monitored (N)	Hours Exceeding TLV[a]		Daily Mean UV_{eff} Index (mW/cm^3)	Days Monitored (N)	Days Exceeding TLV[b]	
Month			n	%			n	%
October	0.0057 ± 0.0042	200	175	87.5	0.0057 ± 0.0015	20	20	100
November	0.0031 ± 0.0025	150	117	78.0	0.0031 ± 0.0007	15	15	100
December	0.0020 ± 0.0018	150	94	62.7	0.0020 ± 0.0006	15	15	100
January	0.0021 ± 0.0018	109	80	73.4	0.0022 ± 0.0004	11	11	100
February	0.0034 ± 0.0033	140	104	74.3	0.0035 ± 0.0018	14	14	100
March	0.0056 ± 0.0039	160	144	90	0.0056 ± 0.0013	16	16	100
April	0.0097 ± 0.0061	210	208	99	0.0096 ± 0.0022	21	21	100
May	0.0102 ± 0.0063	60	59	98.3	0.0102 ± 0.0021	6	6	100
June	0.0115 ± 0.0067	150	148	98.7	0.0115 ± 0.0028	15	15	100
August	0.0010 ± 0.0056	90	90	100	0.0010 ± 0.0012	9	9	100
September	0.0077 ± 0.0051	160	158	98.8	0.0077 ± 0.0016	16	16	100
Season								
Fall	0.0044 ± 0.0039	510	410	85.3	0.0044 ± 0.0021	51	51	100
Winter	0.0034± 0.0032	1061	967	91.1	0.0034 ± 0.0017	107	107	100
Spring	0.0096 ± 0.0061	440	433	98.4	0.0096 ± 0.0026	44	44	100
Summer	0.0095 ± 0.0061	230	229	99.6	0.0095 ± 0.0025	23	23	100

[a] ACGIH TLV for 1-hr exposure duration = 0.0008 mW/cm^3

[b] ACGIH TLV for 8-hr exposure duration = 0.0001 mW/cm^3

Correlation Between Temperature and UV Effective Irradiance

- Positive, moderate correlation
- There is a relationship, but the outliers are proof it is not indicative
- Does not prove when temperature is low, the risk of UV exposure is zero

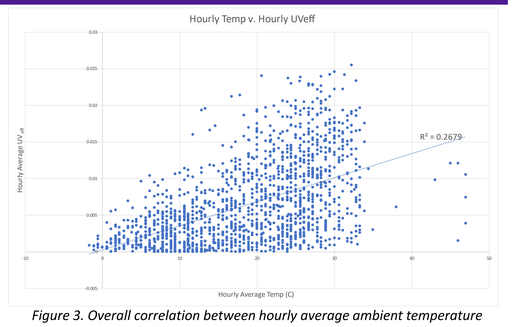


Figure 3. Overall correlation between hourly average ambient temperature (°C) and hourly average UV effective irradiance, UV_{eff} (mW/cm^2), Greenville< NC, October 2020 to October 2021

Conclusion

- UV exposure in the winter and fall are significantly lower than in the spring and summer.
  - There is still a risk for UV exposure and overexposure during cold months.
- UV exposure in spring and summer is not significantly different.
  - Protective measures need to be implemented year-round because the temperature is low during a portion of the spring .
- Solar UV exposure during the cold seasons exceeds the ACGIH TLV.
- There is a false sense of security when the temperature is low.
- This research will aid to better inform workers, employers and the general public of the risk of UV exposure and hopefully minimize any UV related illnesses.

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