TEMPO surface and underwater UV Irradiance (UVI)

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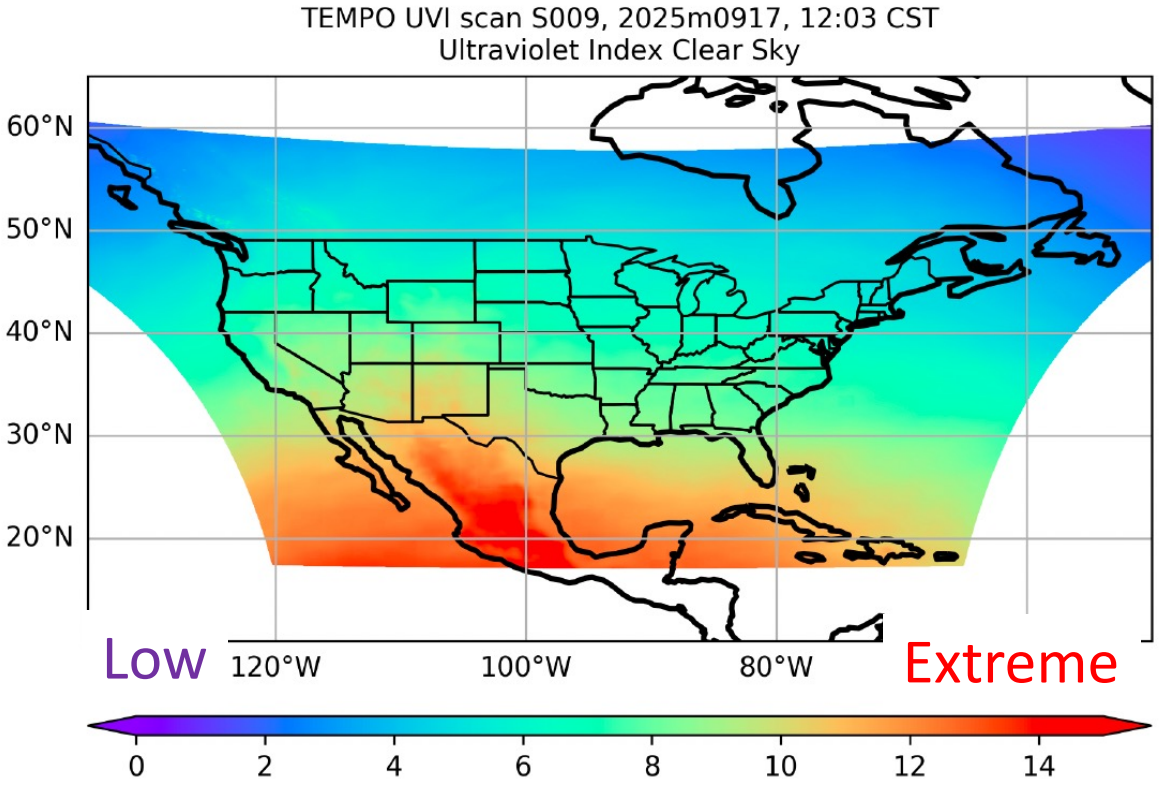
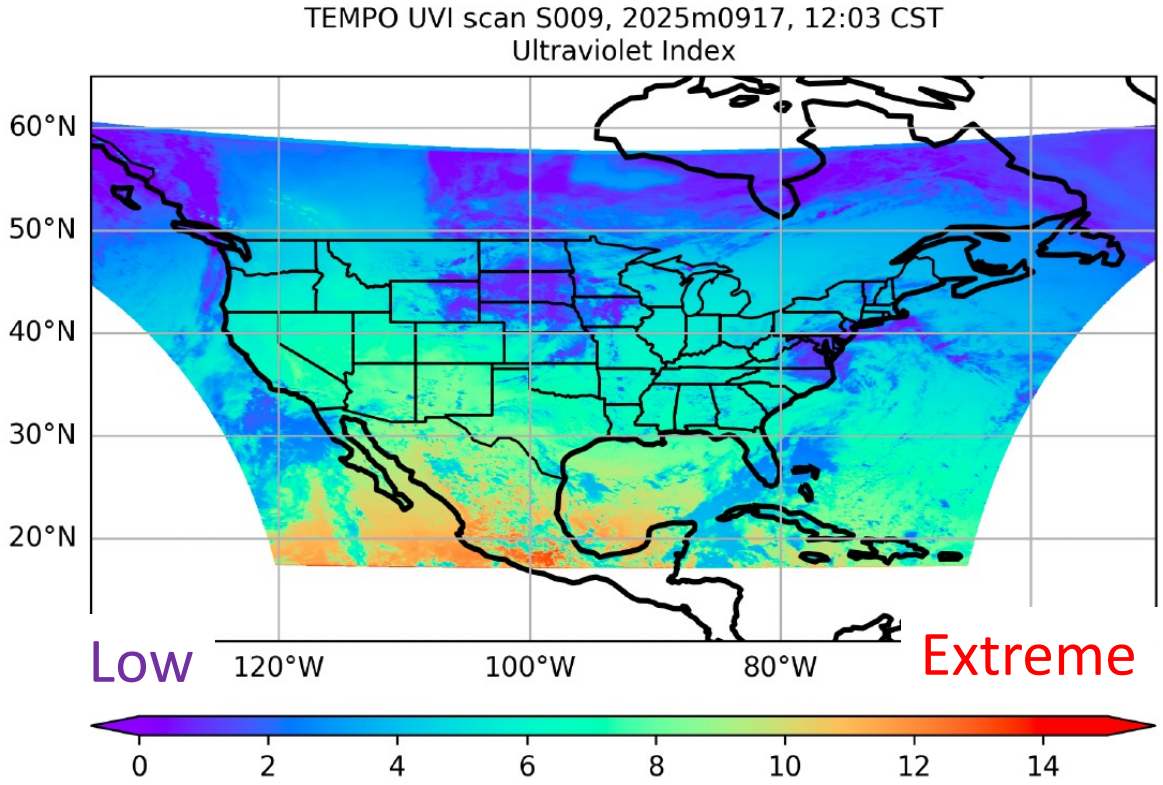
TEMPO Surface and Underwater UV Irradiance

- **Heritage**: adapted from NASA's OMI daily L2 product [Krotkov et al., 2025]
- **Updated for TEMPO hourly scans (L2) and re-gridded to TEMPO L3 grid**



Clear sky UV Index

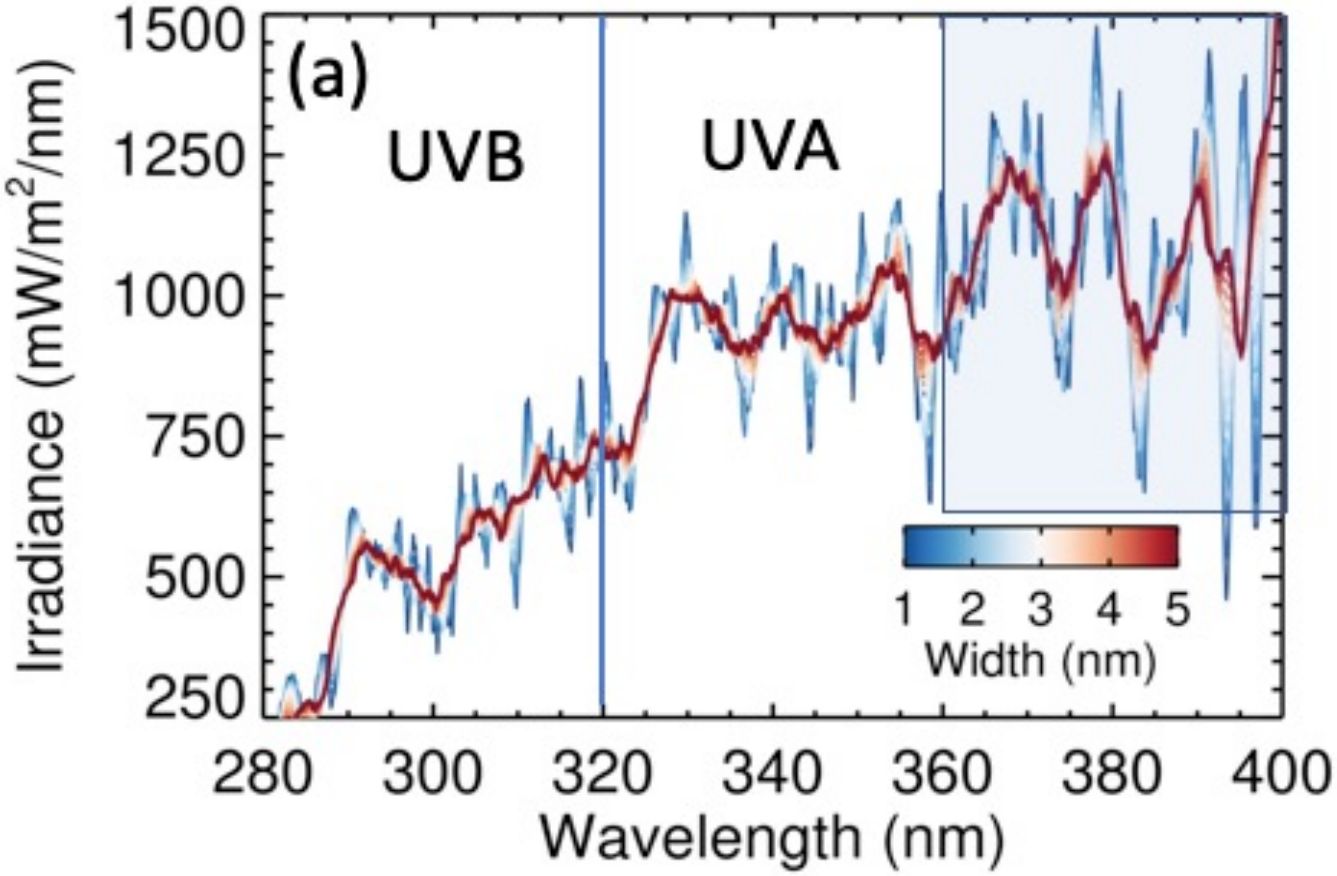


All sky UV Index

Surface UV Irradiance

$$E(\lambda, \theta_0, P_t, \Omega, A_s) = E_{clr} \times C_T \times C_a$$

- $F_0(\lambda)$ – Extraterrestrial solar irradiance adjusted for Sun-Earth distance
- $E_{clr}(\lambda, \theta_0, P_t, \Omega, A_s)$ – clear-sky Irradiance
- $C_T(\lambda, \theta_0, A_s, \tau_c)$ – combined cloud/non absorbing aerosol correction factor
- $C_a(\lambda, \theta_0, \tau_{abs})$ – aerosol absorption correction factor
- A_s - Lambertian surface albedo climatology (380nm) with adjustments using IMS snow/ice mask (L1b)
- θ_0 - Solar zenith angle, P_t - Surface pressure (L1b)
- Ω - TEMPO (O3TOT) and filled with GEOS-CF O3TOT
- τ_c – Effective cloud/aerosol optical thickness(COT) derived from *TEMPO UV reflectance at 360nm*
- τ_{abs} – new SNWG TEMPO Aerosol Absorption Optical Depth (AAOD) product (PI Omar Torres)



$F_0(\lambda)$: Total and Spectral Solar Irradiance Sensor (TSIS-1) Hybrid Solar Reference Spectrum (HSRS) [Coddington et al., GRL 2021] smoothed with 5 nm boxcar rolling filter, plot courtesy David Haffner

Spectral Convolution: Action Spectra Weighted UV Dose Rates (UV Indices)

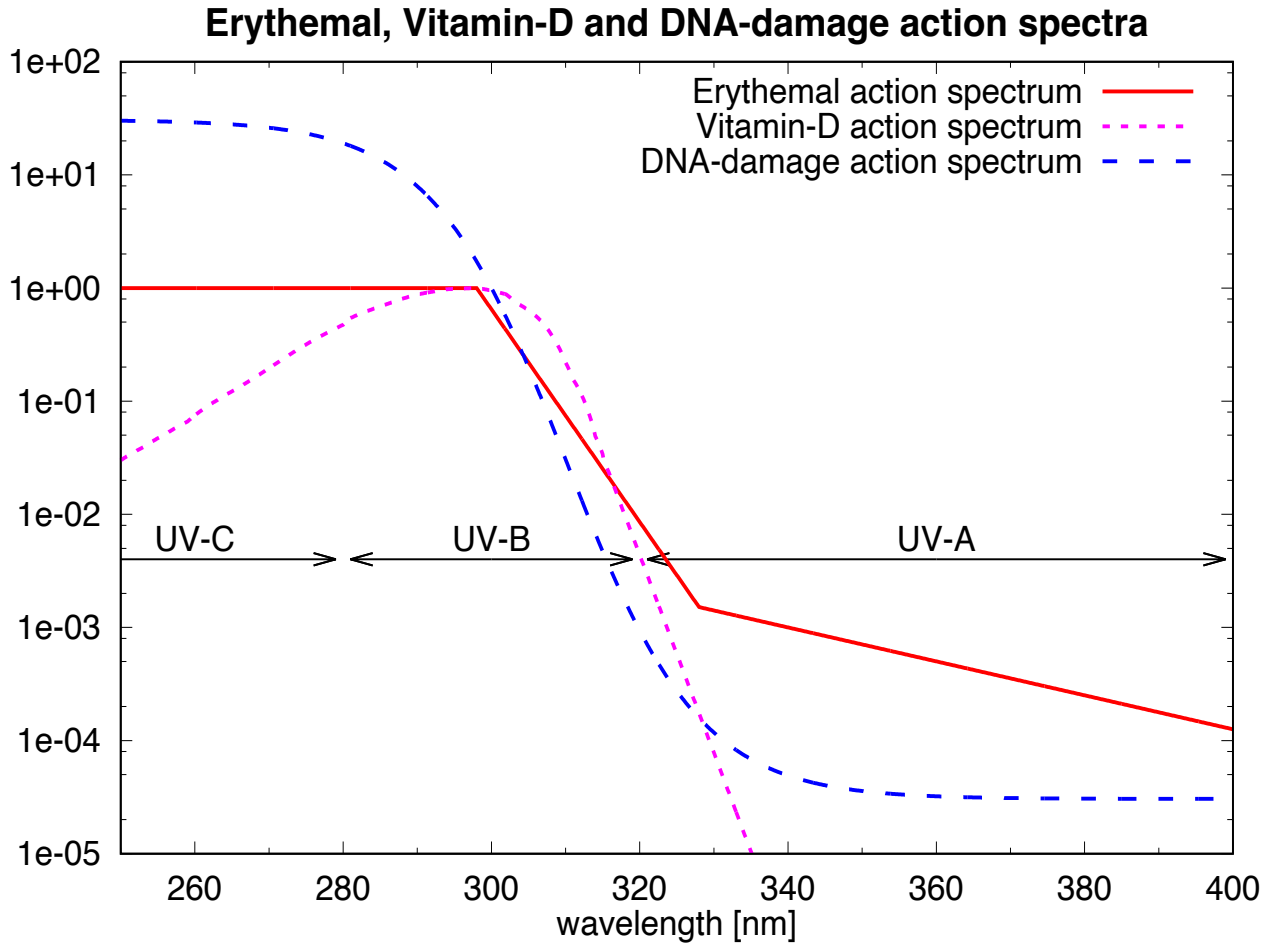
Aura/OMI UV irradiance products are available 110 individual wavelengths.

An action spectrum describes the wavelength dependent response to UV radiation of a certain biological or environmental effect.

•The UV dose rates are computed for 4 different health and environmental effects:

- Erythema (same as UV Index),
- DNA-damage
- Plant damage
- vitamin-D production in the skin (CIE-174)

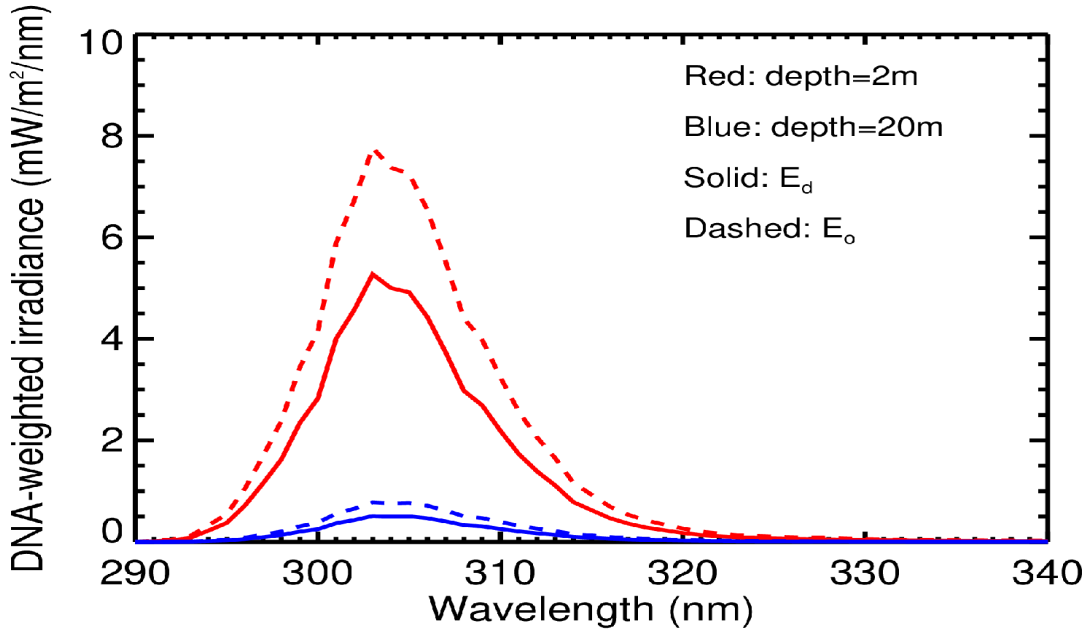
•The UV index (UVI) is based on the International Commission on Illumination (CIE-98) Erythemal action spectrum for the susceptibility of the Caucasian skin to sunburn (erythema).

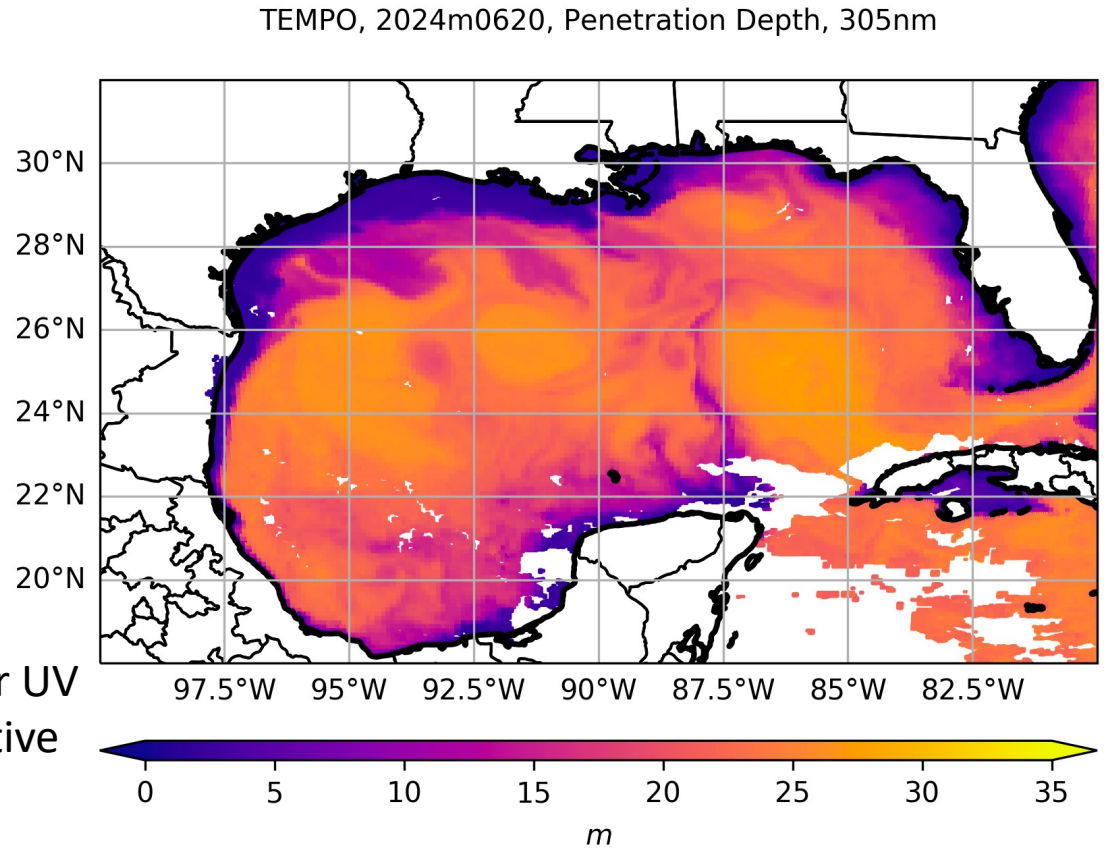


TROPOMI Action spectra
https://www.temis.nl/uvradiation/product/action.html

L2 Underwater UV Irradiance *
*depends on TEMPO ChI product (PI Zachary Fasnacht)

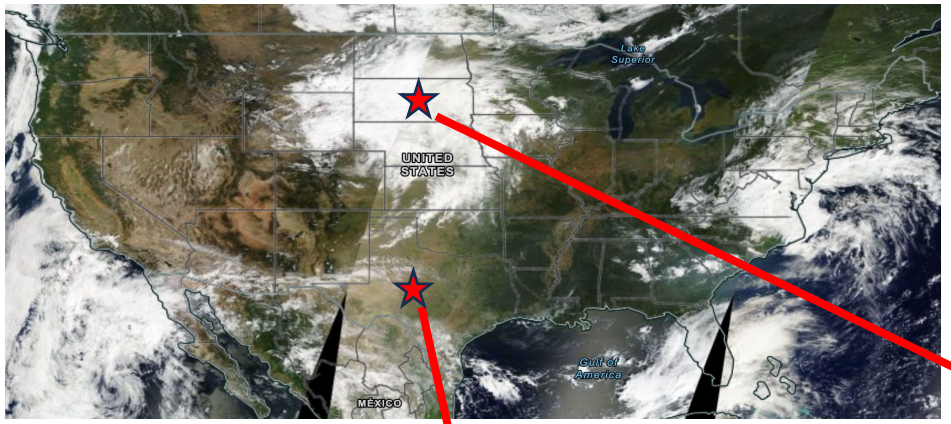
- Planar and scalar (actinic flux) irradiances computed with Hydrolight RTM [Mobley 1994].
  - Scale the above surface irradiance by TEMPO-retrieved $\boldsymbol{E(\lambda, \theta_0, P_t, \Omega, A_s)}$
  - Use Inherent Optical Properties ChI parameterization for Case 1 [Vasilkov et al., 2005; 2022]
  - Use TEMPO – retrieved chlorophyll concentration, ChI using ML algorithm trained with MODIS ChI
- Calculate Diffuse attenuation coefficient and 10% penetration depth as function of $\boldsymbol{\lambda}$

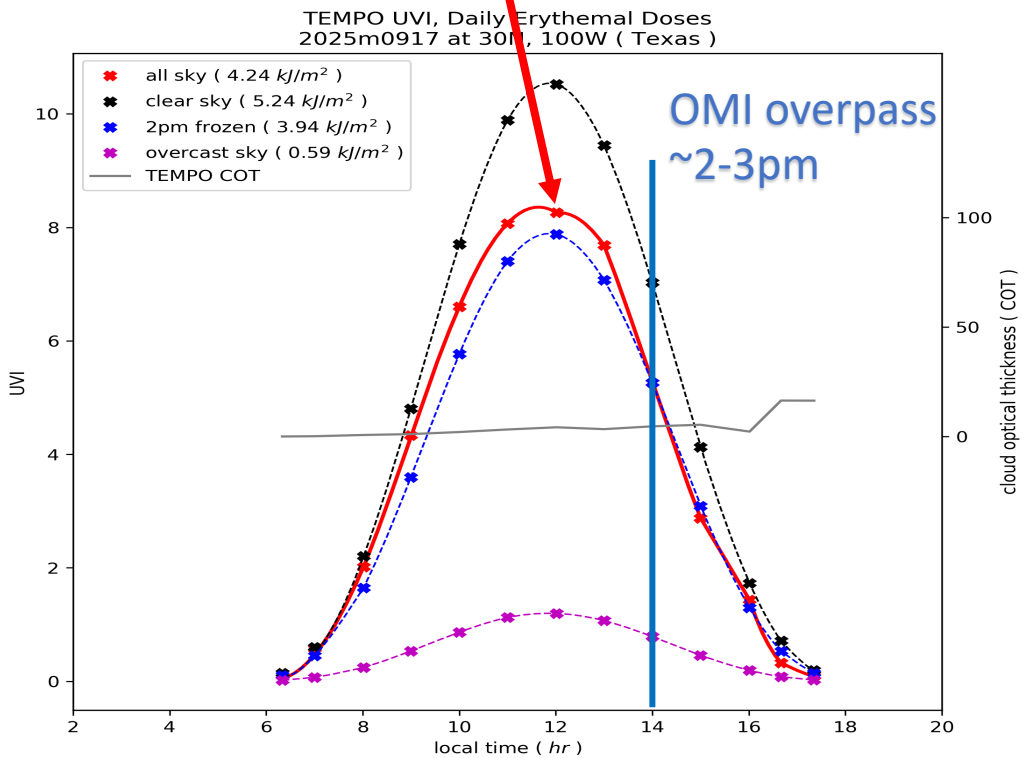


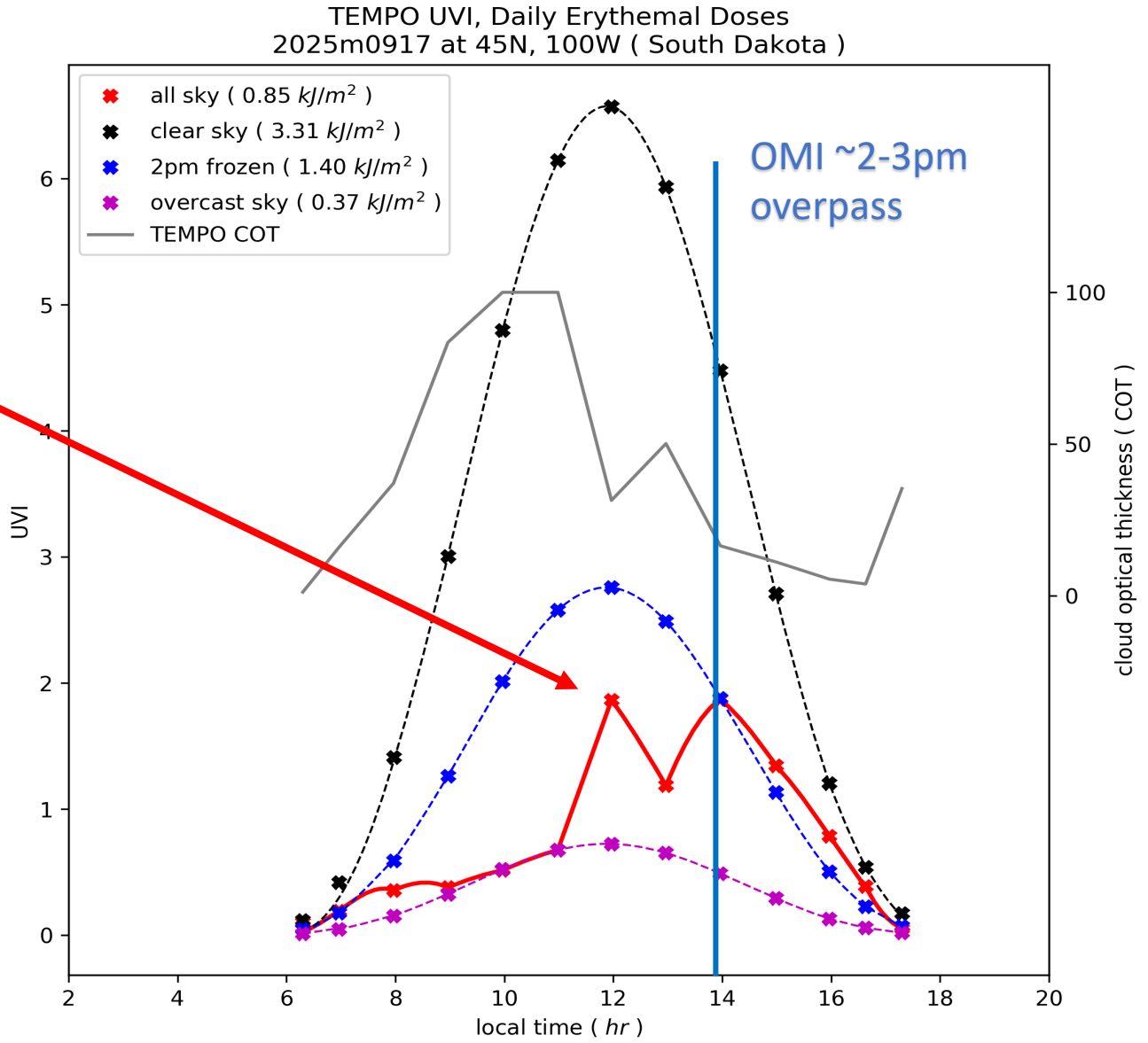


Vasilkov et al., Estimates of Hyperspectral Surface and Underwater UV Planar and Scalar Irradiances from OMI Measurements and Radiative Transfer Computations, Remote Sensing, 2022.

Time Integration: Erythemally Weighted Daily Dose on TEMPO L3 grid



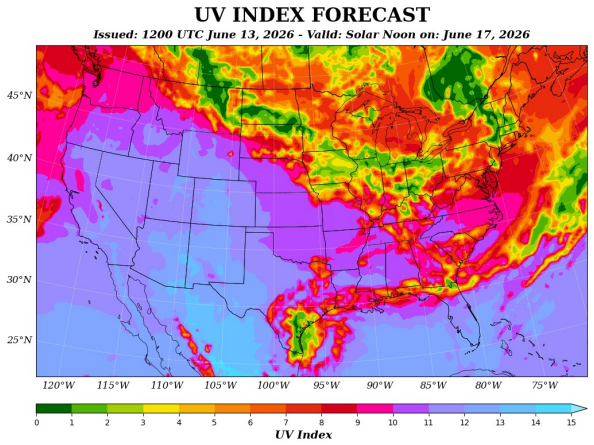




Applications of TEMPO UV Indices

- On-going collaboration with USDA UVB Measurement and Research Program (Wei Gao, Director) https://uvb.nrel.colostate.edu/UVB/

- **Potential stakeholders**:
  - NOAA Center for Weather and Climate Prediction - UVI forecasts: https://www.cpc.ncep.noaa.gov/products/stratosphere/uv_index/uv_current.shtml
  - EPA's Sun Safety web page: https://www.epa.gov/sunsafety
  - Universities
  - Public health institutes
  - Chemical manufactures



- **Applications/UV Indices**:
  - agricultural crop modeling
  - human health research (skin cancer, eye damage, DNA damage, vitamin D3 skin production)
  - commercial materials testing
  - Phytoplankton, CDOM, coral bleaching research
  - degradation of microplastic research