Evaluation of OMI Surface UV Irradiance in the Continental United States: Implication for TEMPO

Thursday, June 7, 2018

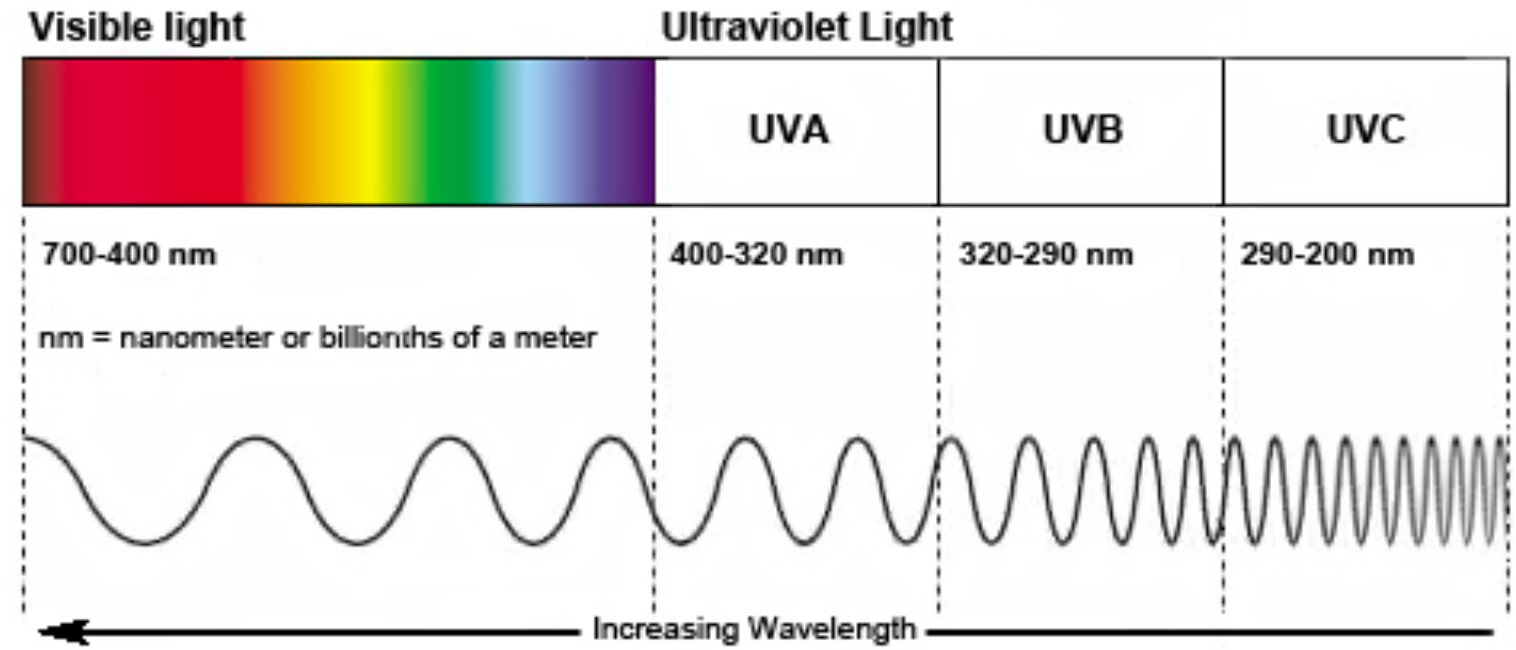
Huanxin(Jessie) Zhang[1,2], Jun Wang[1,2], Lorena Garcia[1,2],Yang Liu[3]

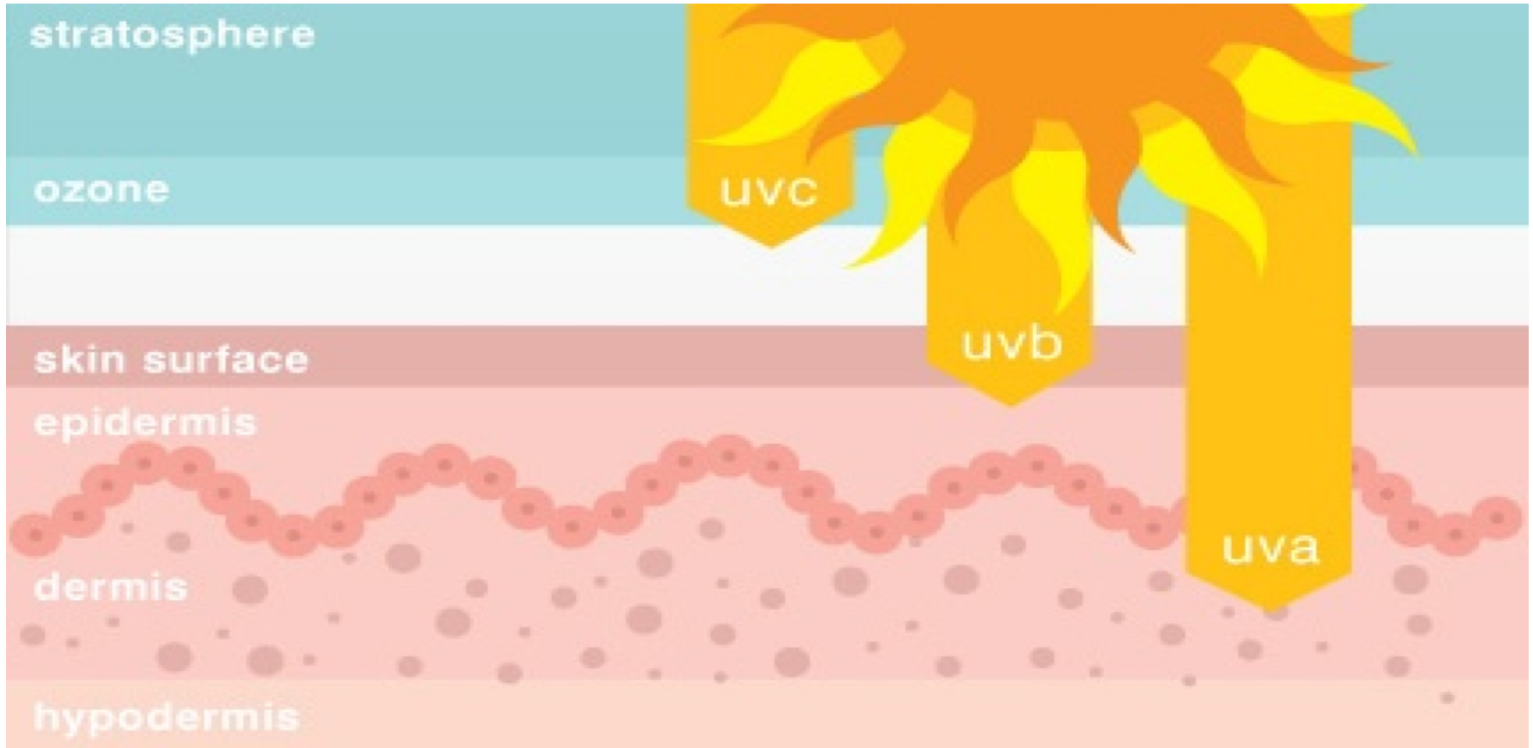
[1]Department of Chemical and Biochemical Engineering, The University of Iowa
[2]Center for Global and Regional Environmental Research, The University of Iowa
[3]Rollins School of Public Health, Emory University

THE UNIVERSITY OF IOWA

Atmospheric Chemistry

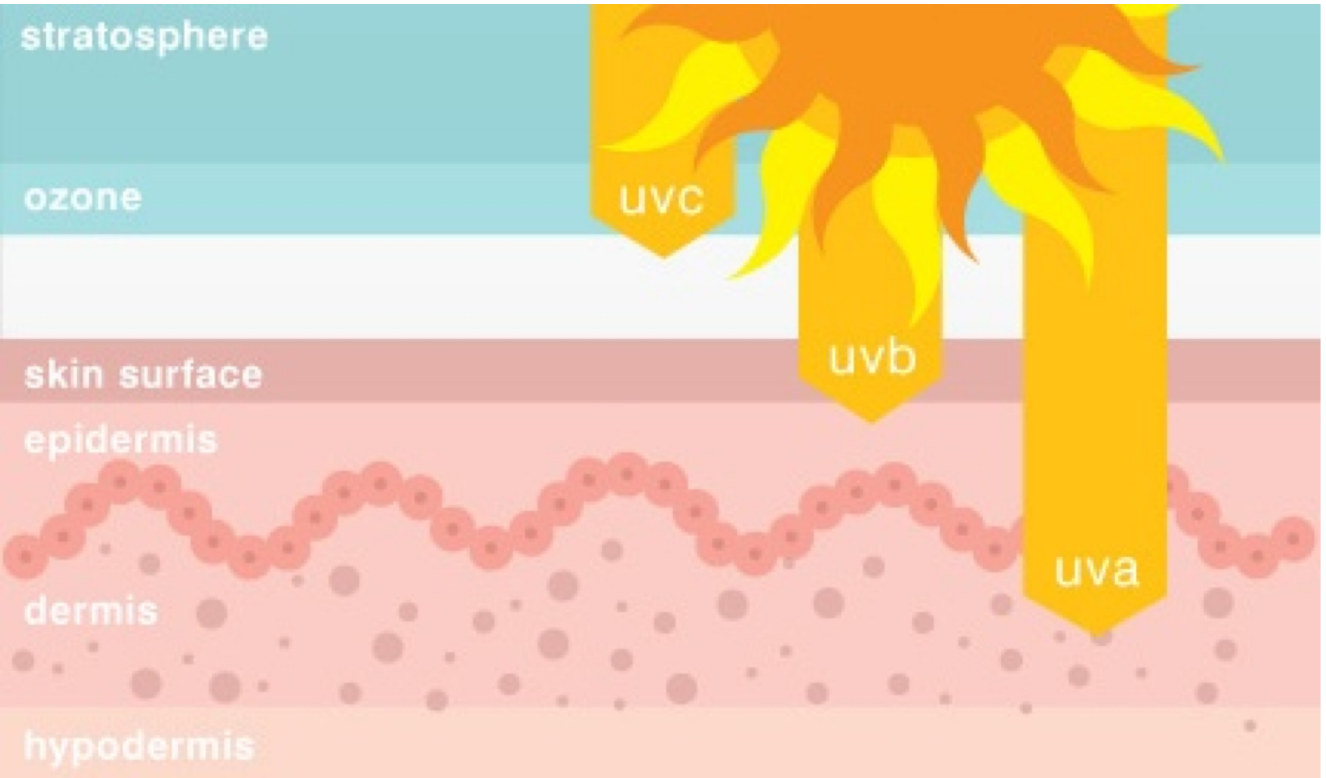
Skin Cancer

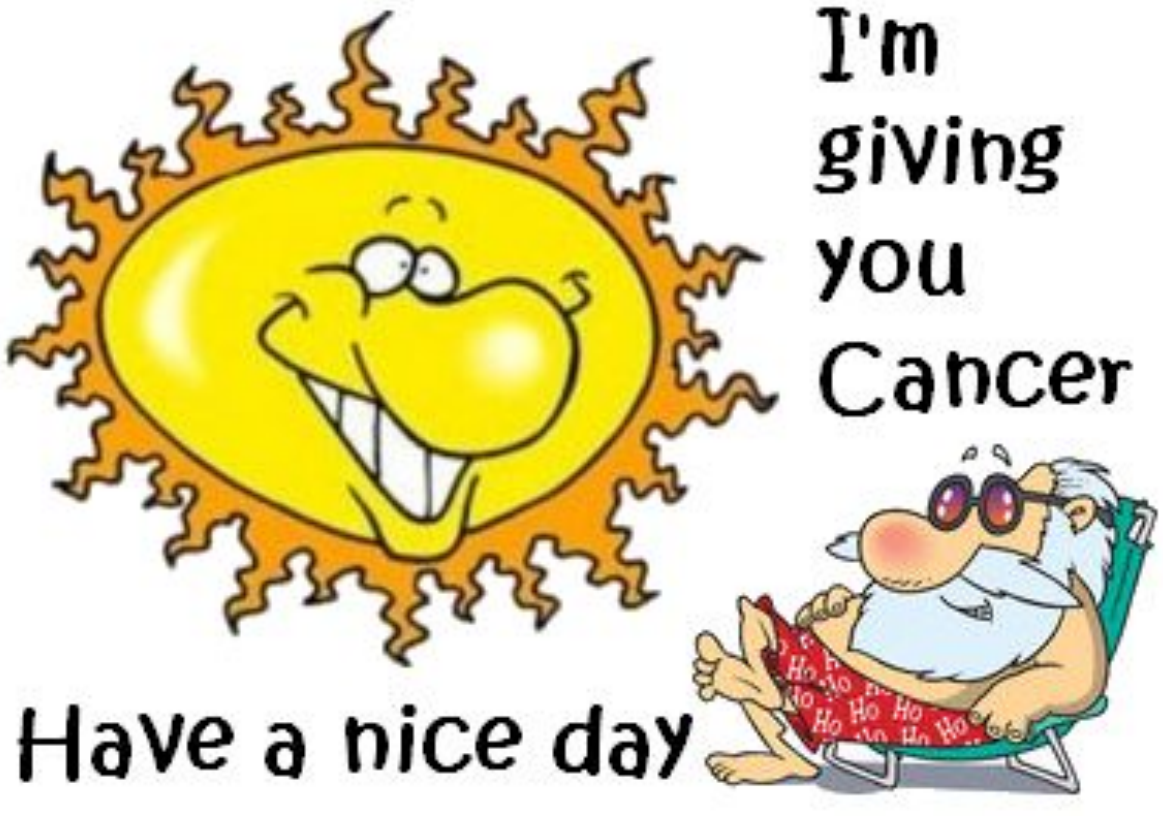




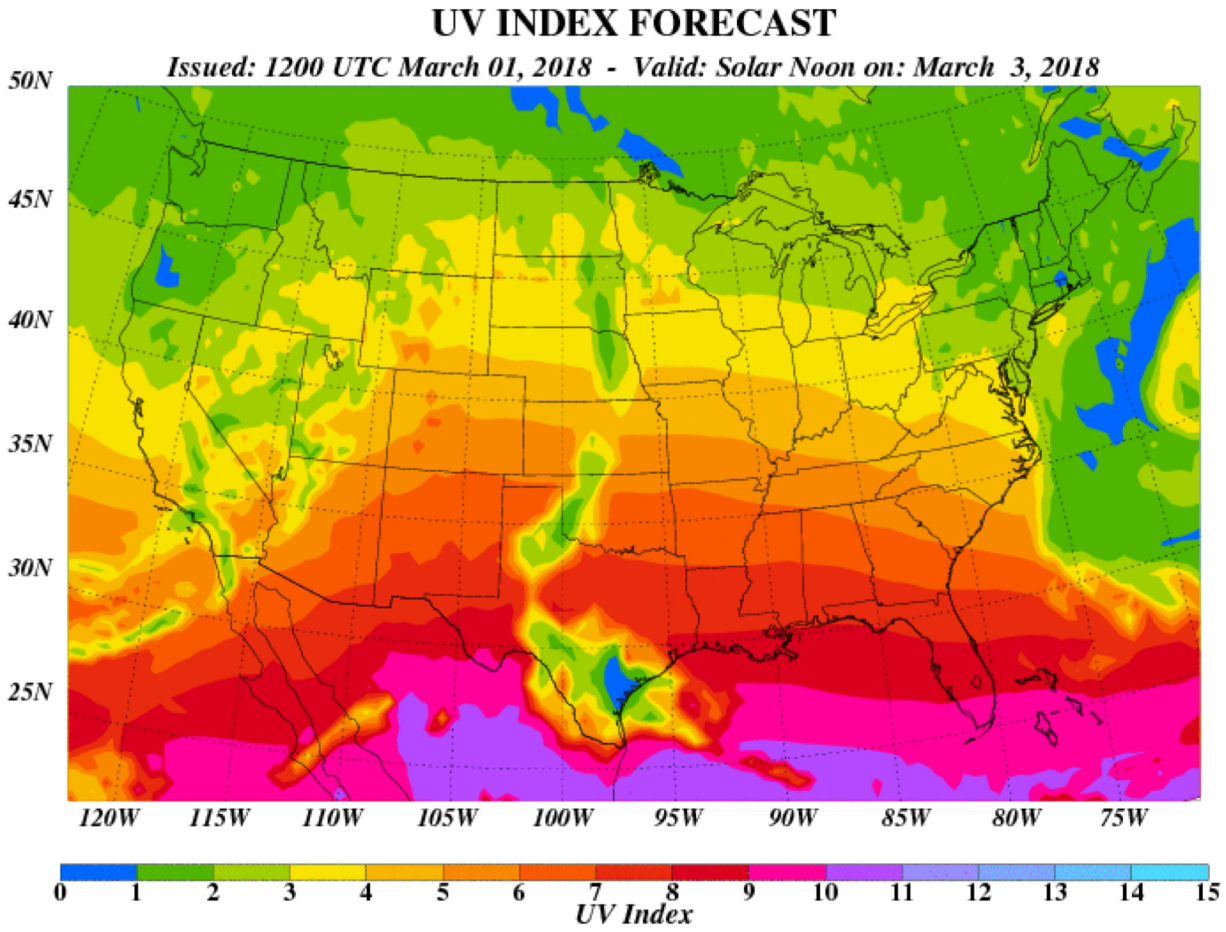
- ***The annual cost of treating skin cancers in the U.S. is estimated to be at $8.1 billion ($4.8 billion for nonmelanoma skin cancer and $3.3 billion for melanoma) (Guy et al., 2015)***

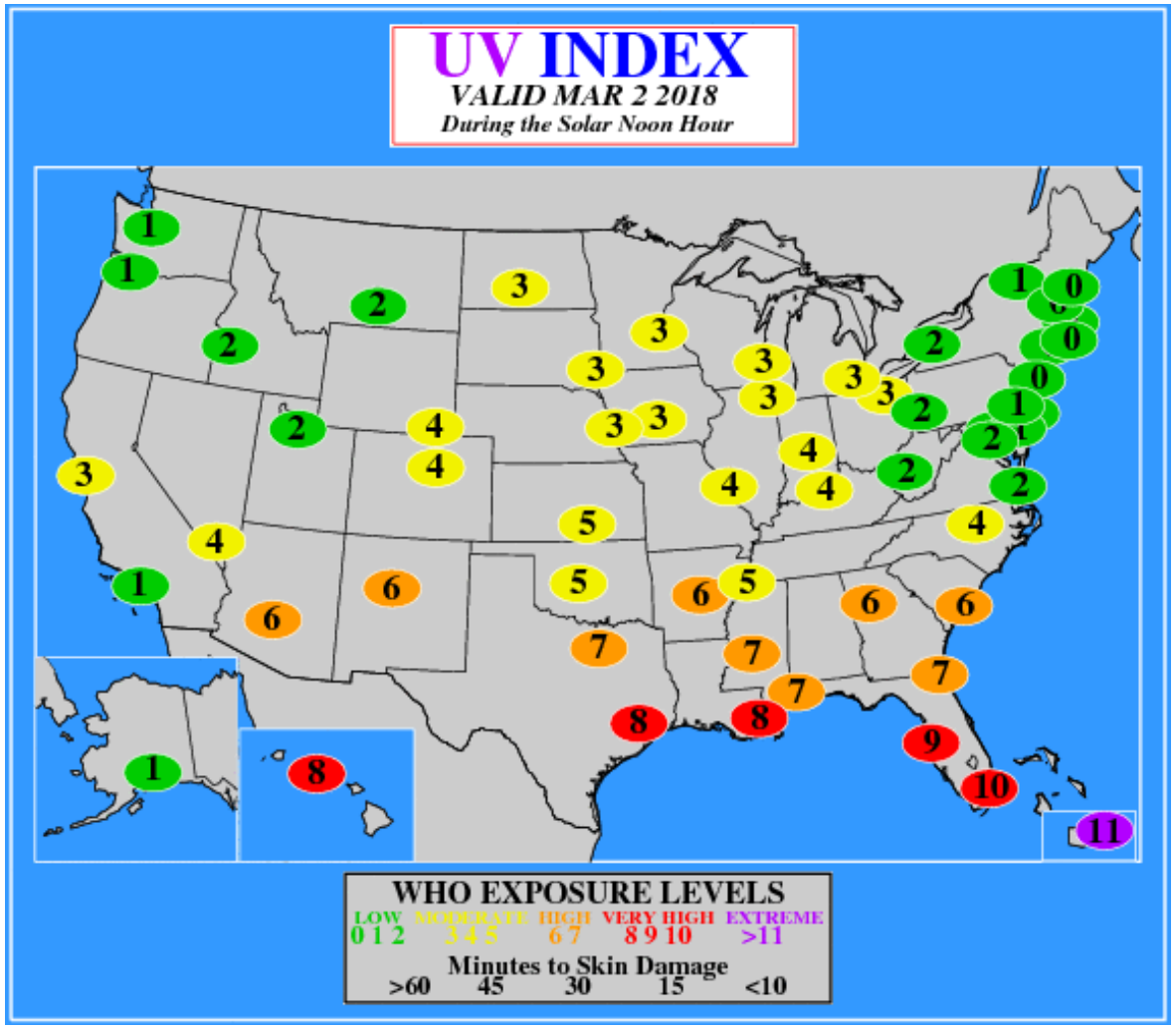
- ***About 90% of nonmelanoma skin cancers are associated with exposure to UV radiation from the sun***





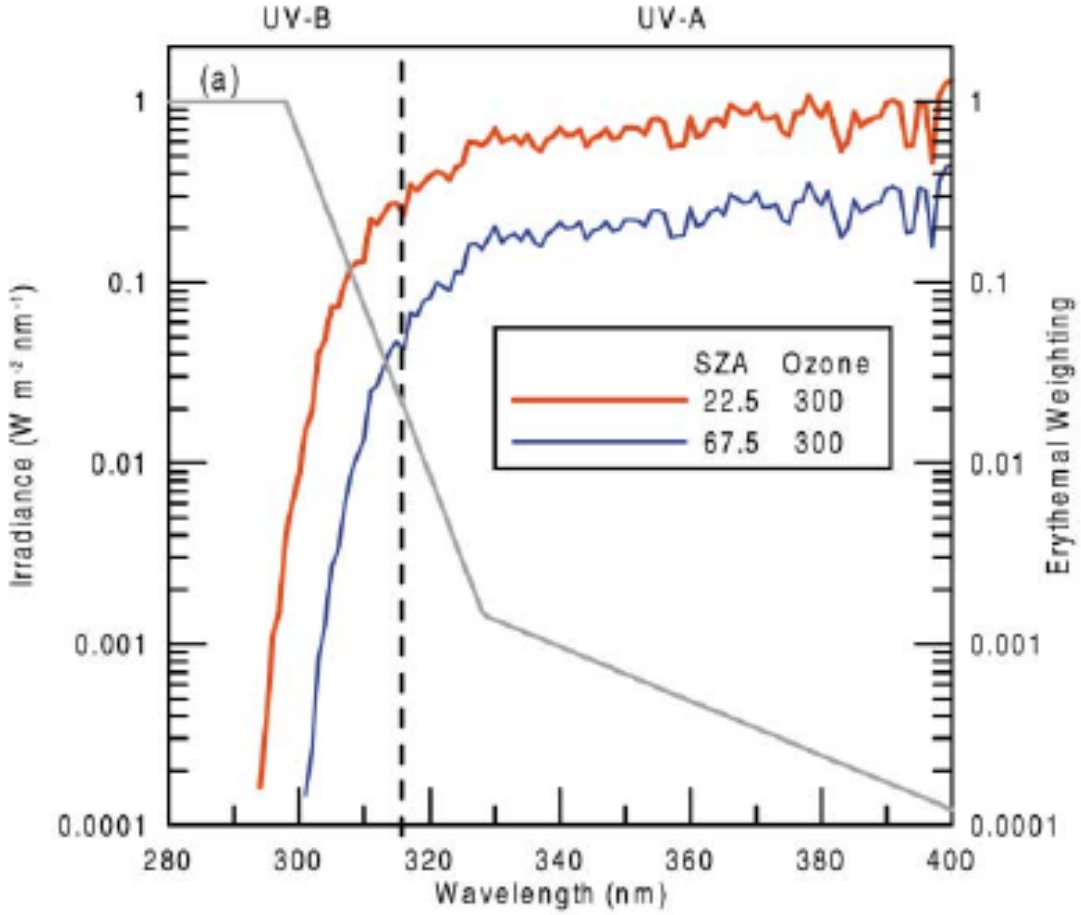
Current UV Index Forecasting System

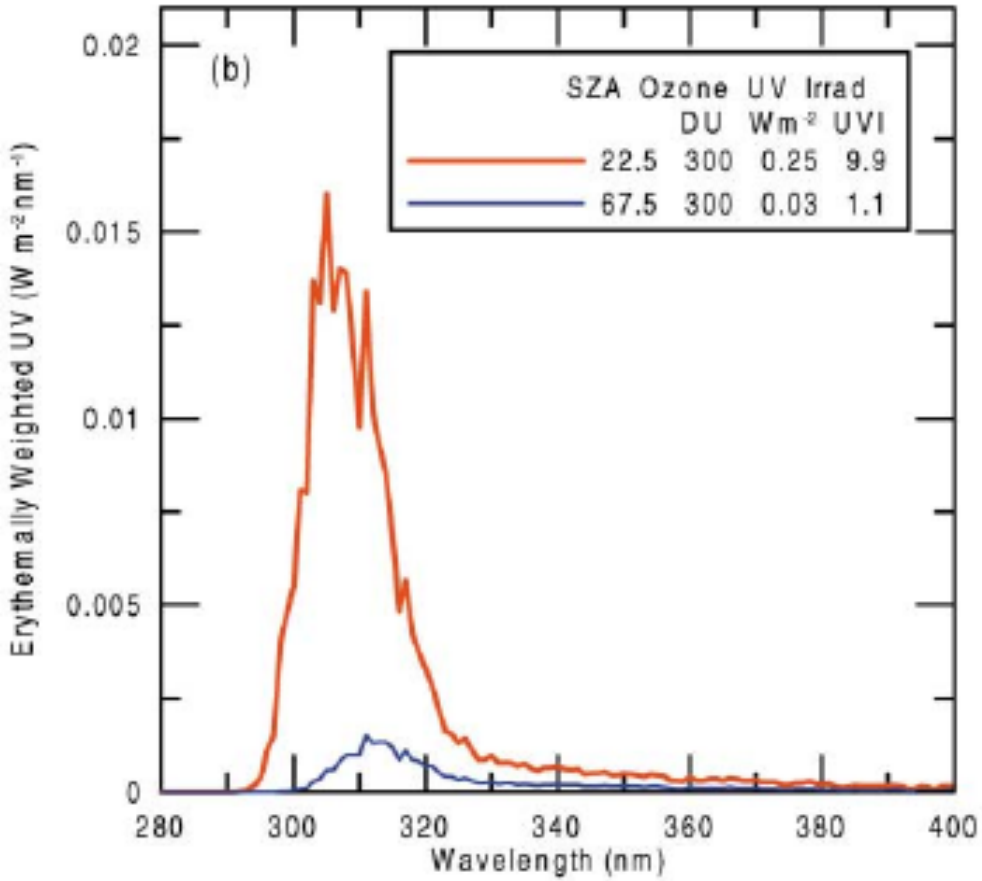




(U.S.EPA sun safety)

Erythemal Weighted Irradiance





UV index = Erythemal Weighted Irradiance / 25 mWm^{-2}

(McKenzie et al., 2004)

- In the past, most of the surface UV (TOMs or OMI) irradiance evaluation has been done in Europe, high latitude or tropical region.

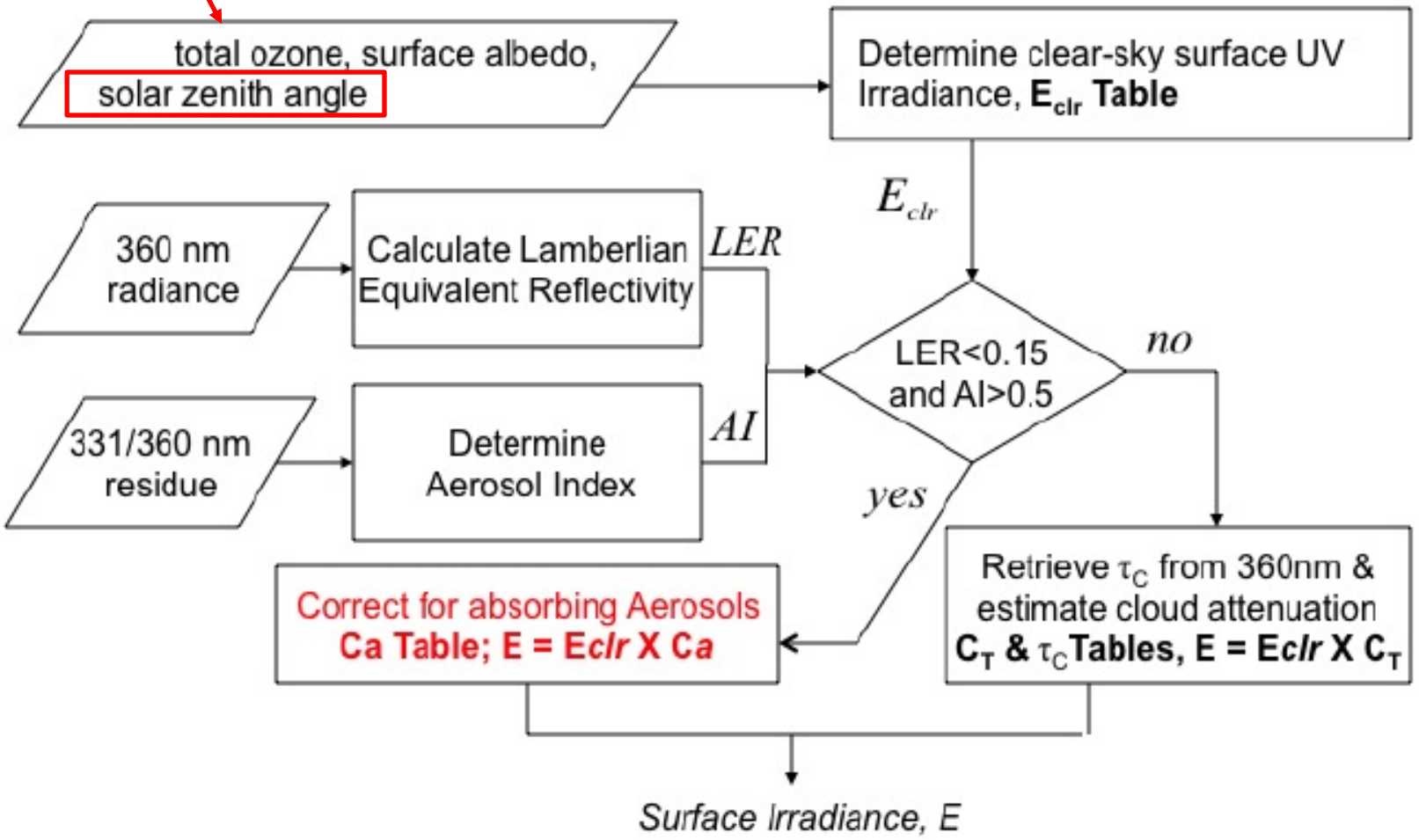
- In this work, we will evaluate OMI surface UV irradiance in the Continental U.S.

OMI surface UV data

- Spectral irradiance ($Wm^{-2}nm^{-1}$) at 305, 310, 324, 380 nm: local solar noon time, satellite overpass time
- Erythemal dose rate (Wm^{-2}): full-sky local solar noon time (Noon_FS), full-sky satellite overpass time (OP_FS)
- Erythemally weighted daily dose (Jm^{-2}): daily
- Level 2 products, 13 x 24 km^2 at nadir

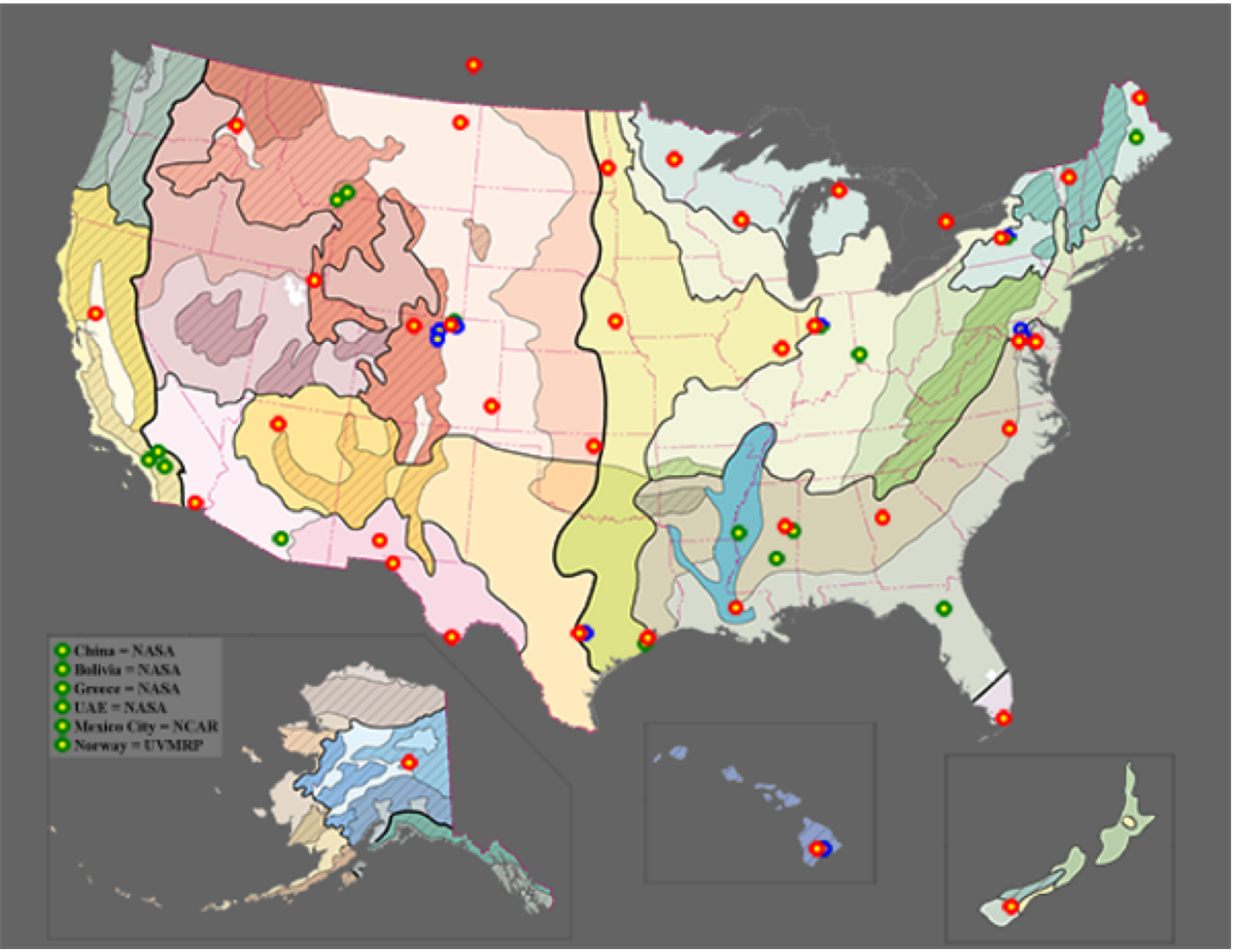
OMI surface UV algorithm

Constant atmospheric profile



(Arola et al., 2009; Tanskanen et al., 2006)

UV-B Monitoring and Research Program (UVMRP)

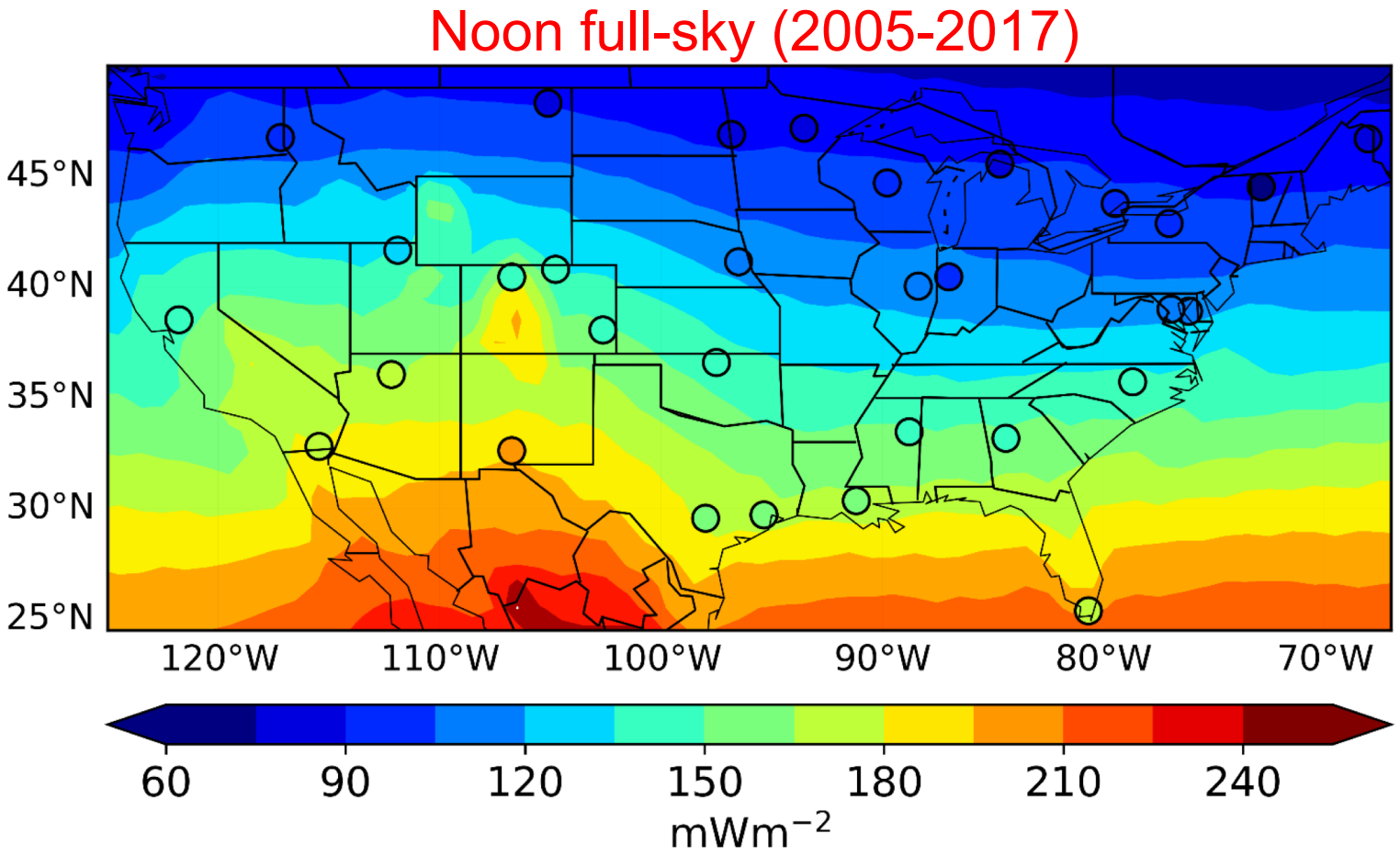


(http://uvb.nrel.colostate.edu/UVB/index.jsf)

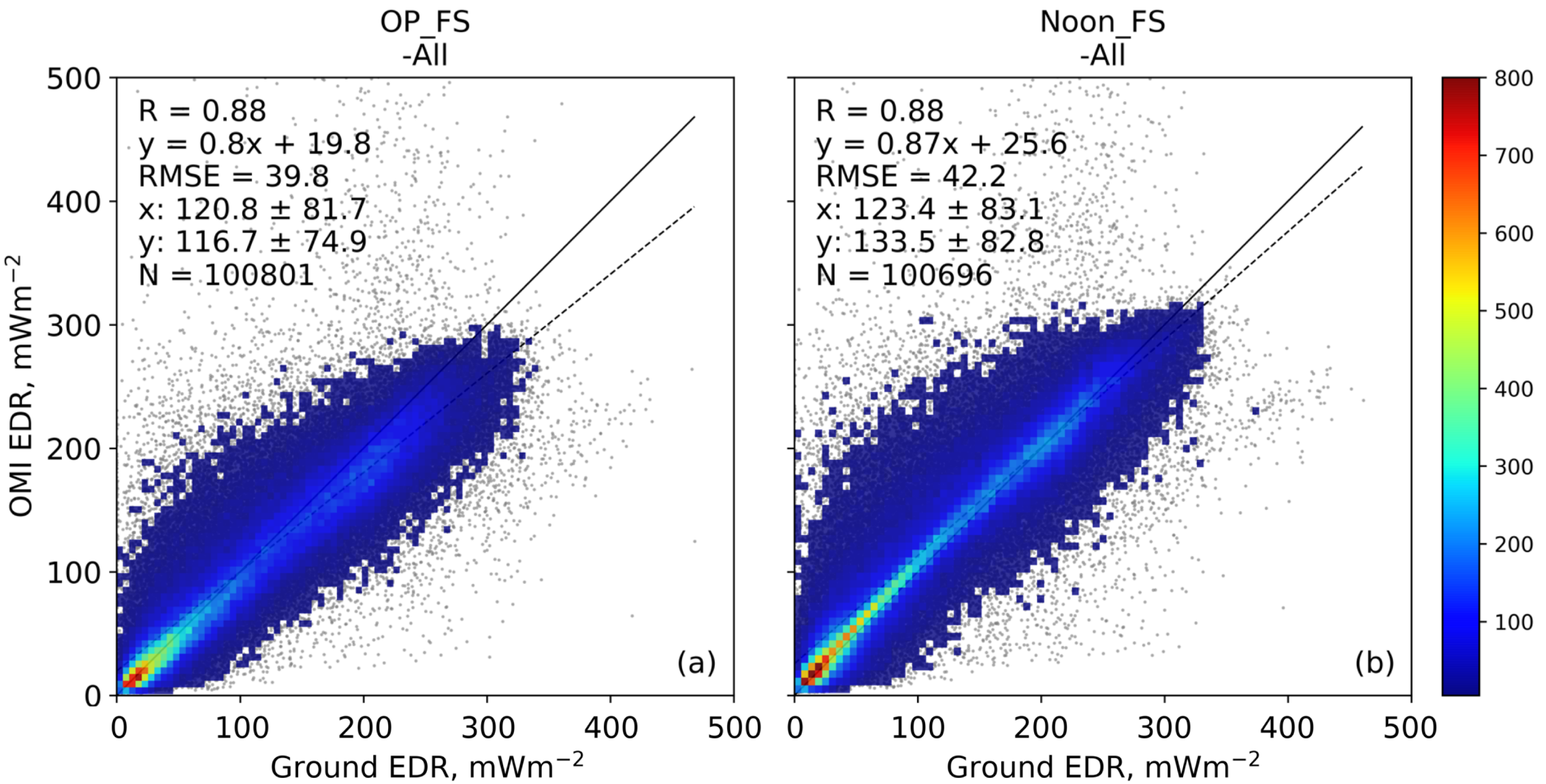
Data Matching

- 31 ground sites with 3-min averaged erythemal weighted irradiance data are used in this study
- Data from both OMI and ground sites are from January 2005 to December 2017
- For each day, each ground site is matched with the single OMI ground pixel within different distances (D = 50, 25, 10 km)
- The observation is then matched for local solar noon time and overpass time with different temporal averaging window length ($\Delta T = \pm 5, 10, 30, 60$ minutes)

Spatial and Temporal Inter-comparison



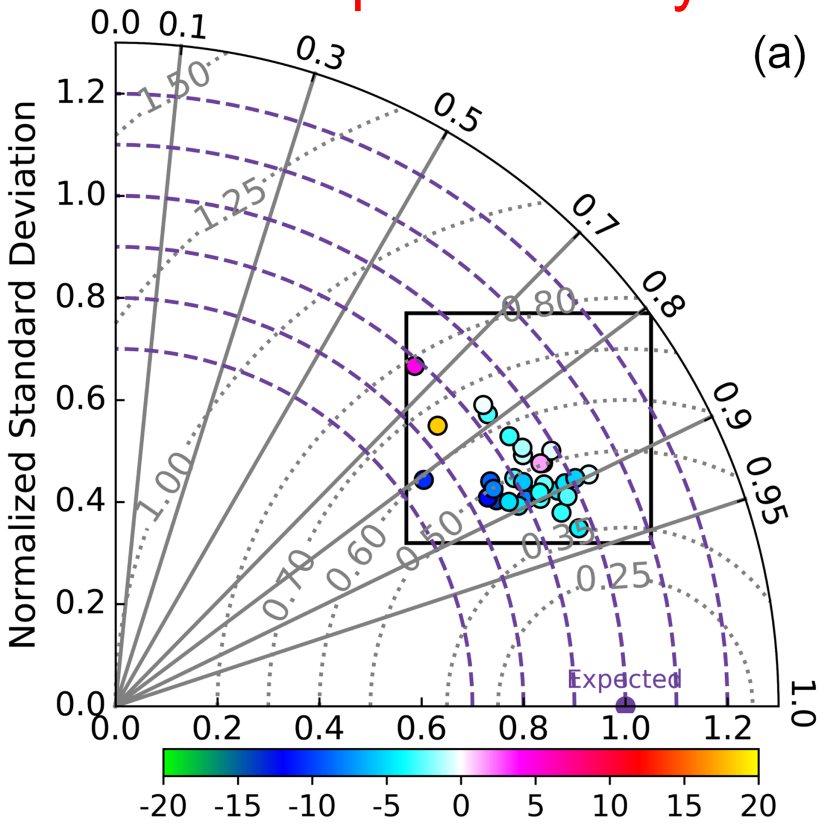
- The ground observation can generally capture the OMI meridional gradient well in the U.S.



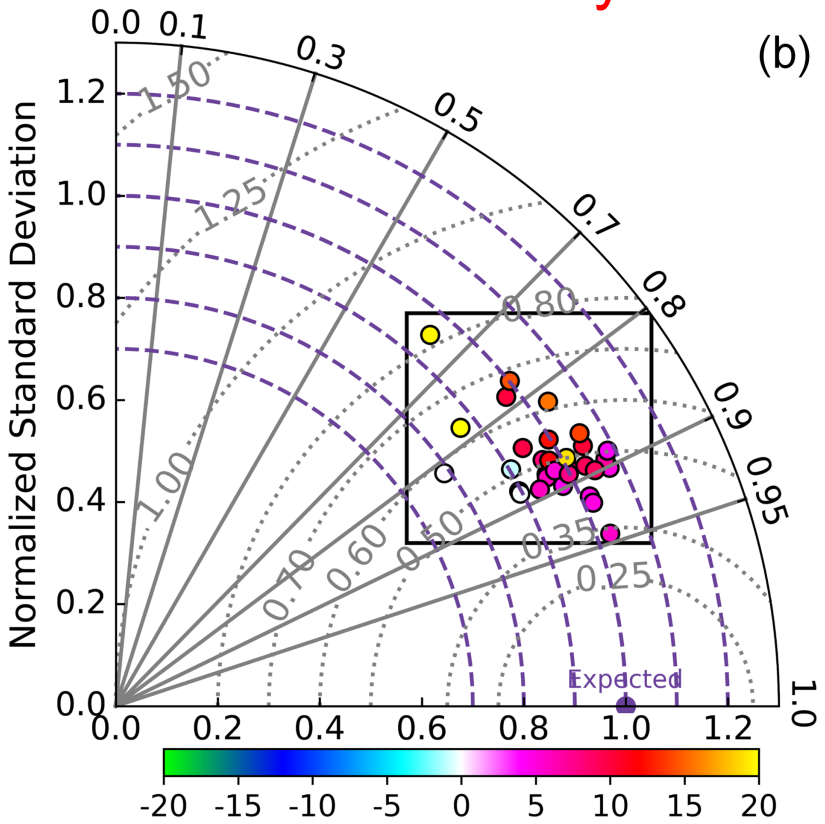
- Overall, good correlation of 0.88 is found for both OMI OP_FS and Noon_FS.

Impacts of Temporal Averaging

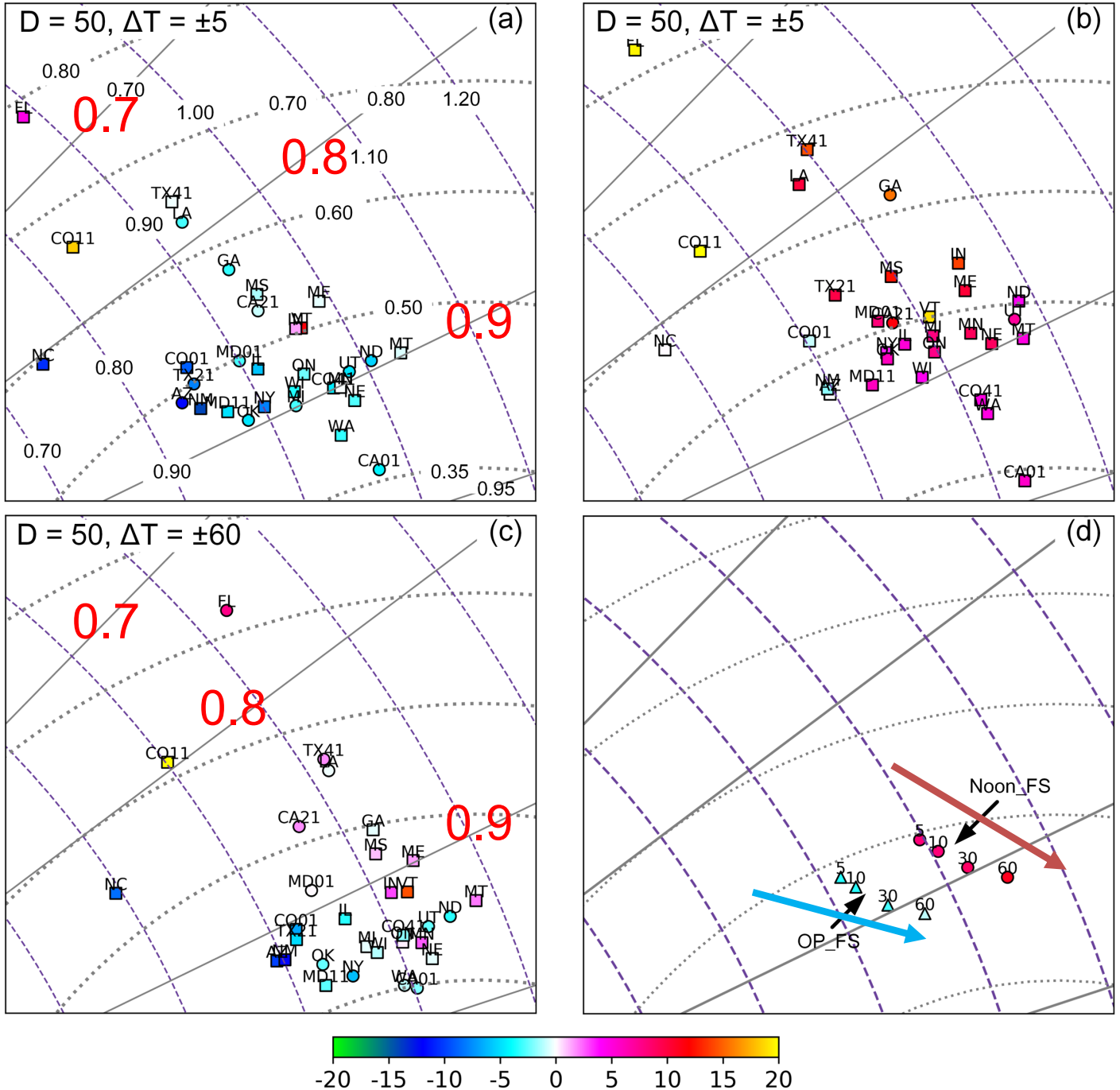
Overpass full-sky



Noon full-sky

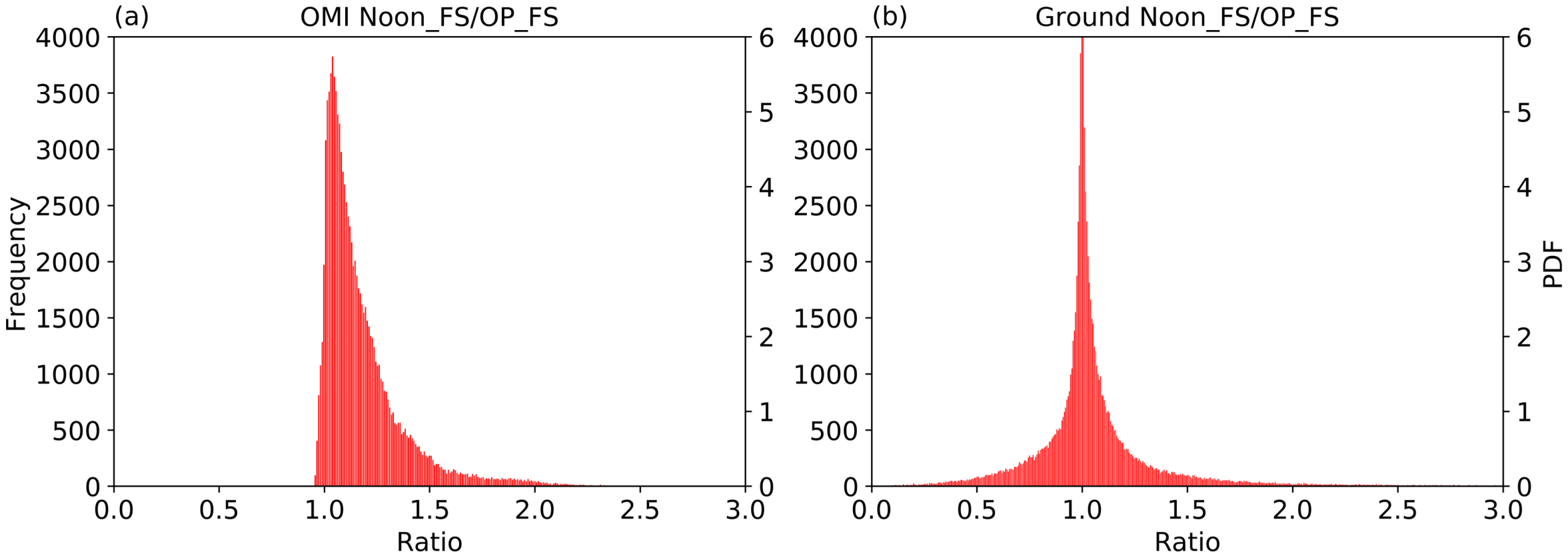


- Most sites show good correlation between 0.7 ~ 0.9 except for Florida.
- OP_FS underestimates ground data by ~4% while Noon_FS overestimates by ~8%.



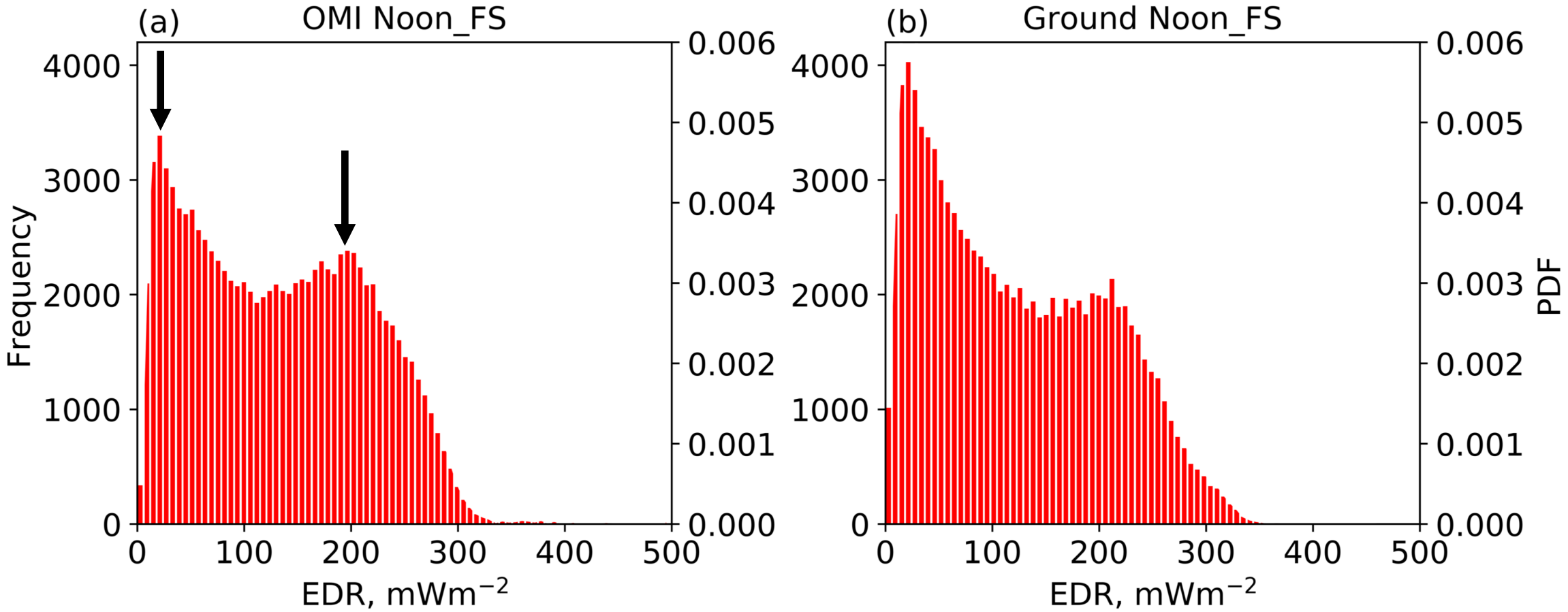
- Increasing ΔT leads to the change in the sign of the bias at some sites for OP_FS.
- Increasing ΔT results in the increase in the correlation.

Impacts of Constant Atmospheric Profile



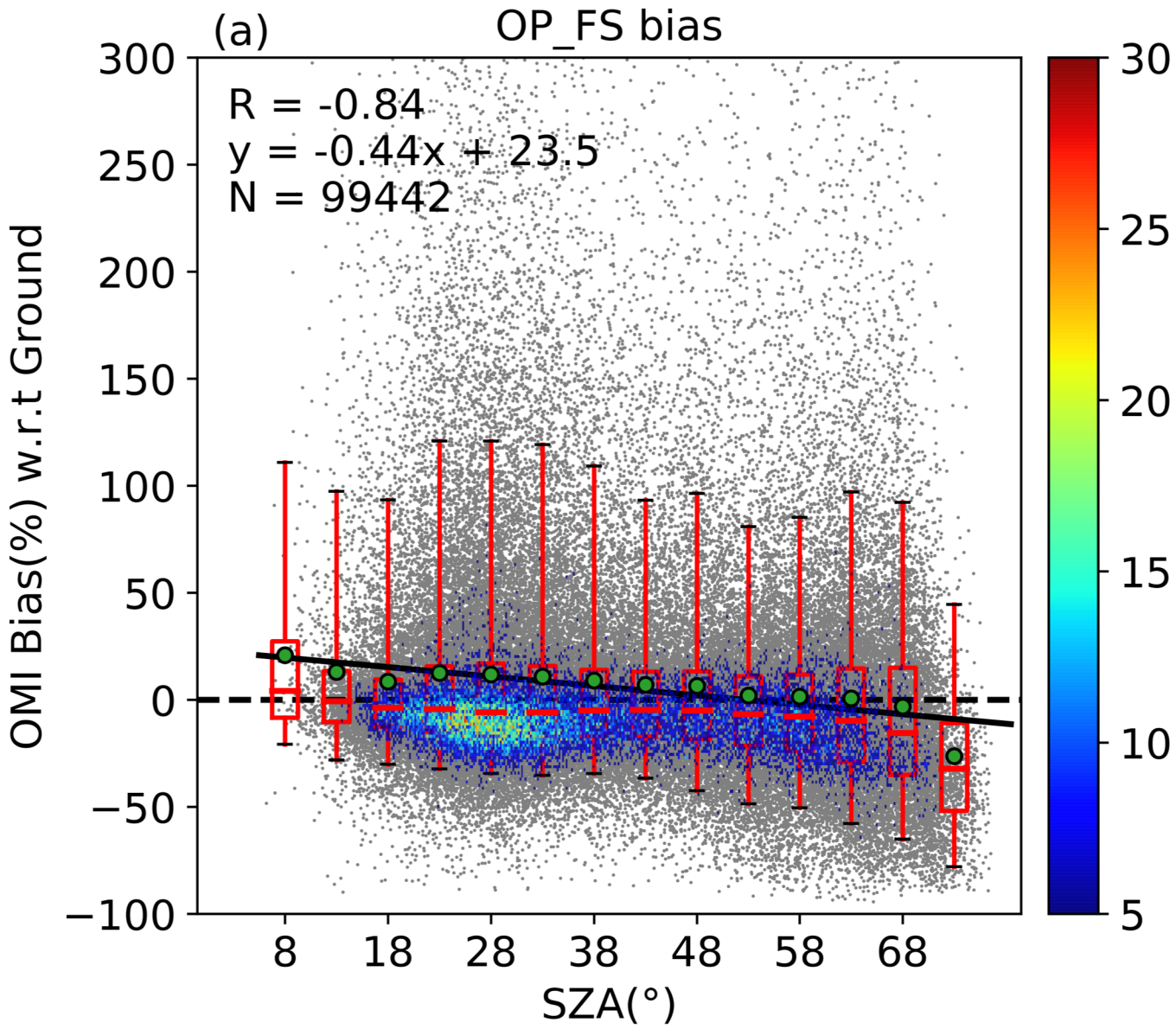
- About ~95% of the OMI ratio is > 1.0 while the ground ratio is almost equally distributed around 1.0.

Impacts of SZA



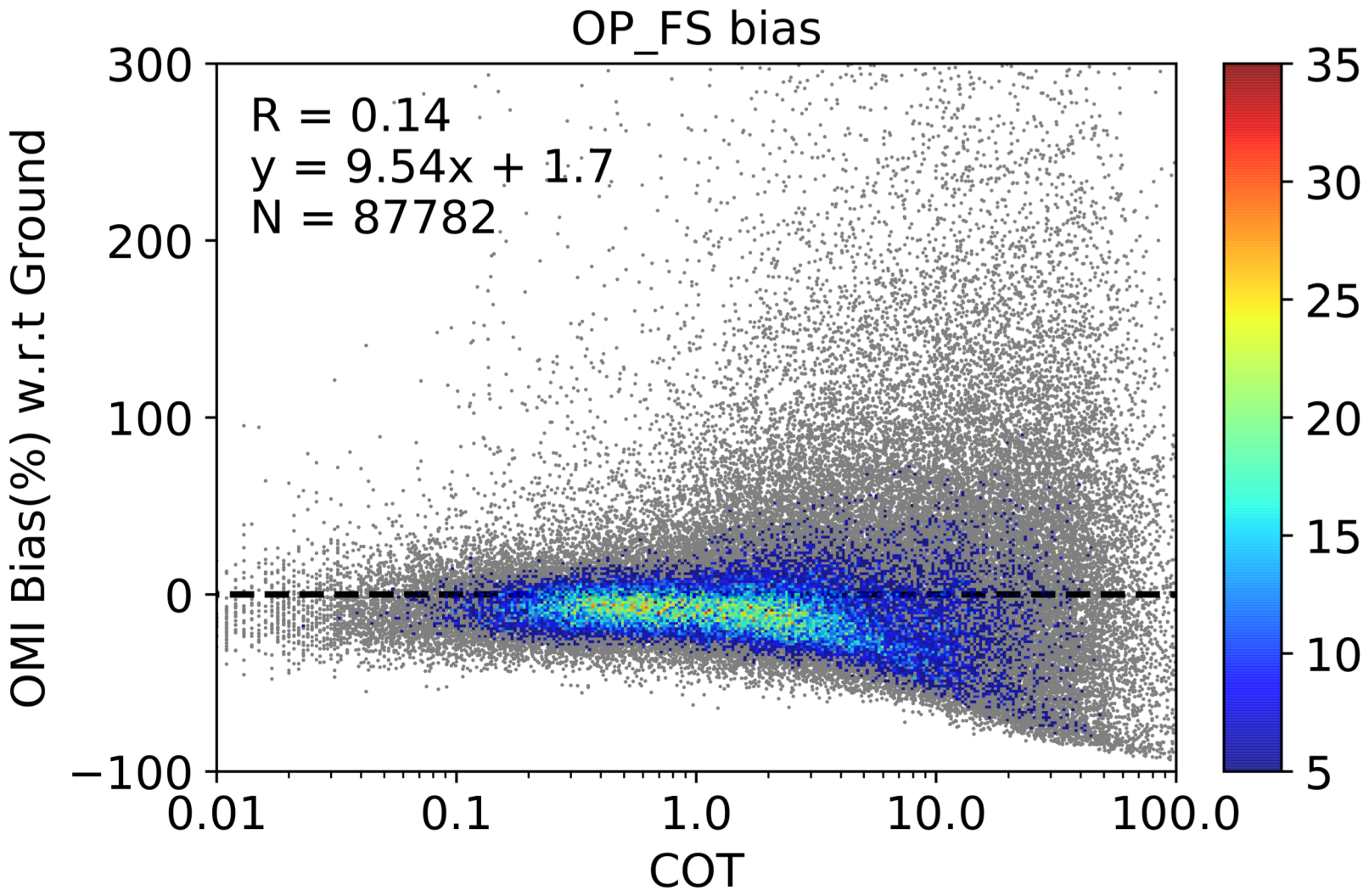
- Surface EDR shows two peaks, one around 20 and another one around 200 mWm^{-2}.

Impacts of SZA



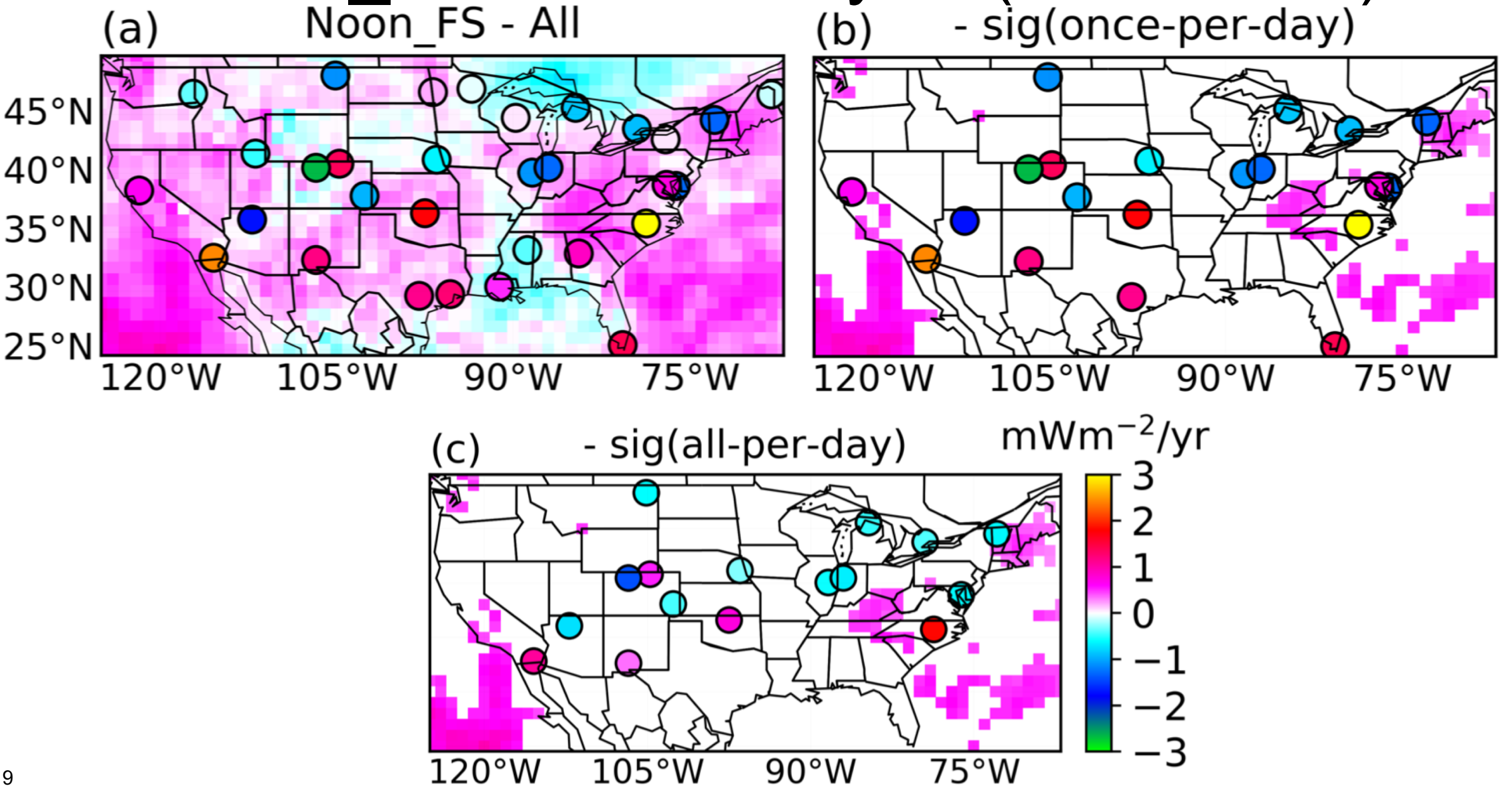
- The OP_FS bias shows moderate dependence on SZA; the mean relative bias gets larger (up to -30%) when the SZA is greater than ~65º.

Impacts of Clouds

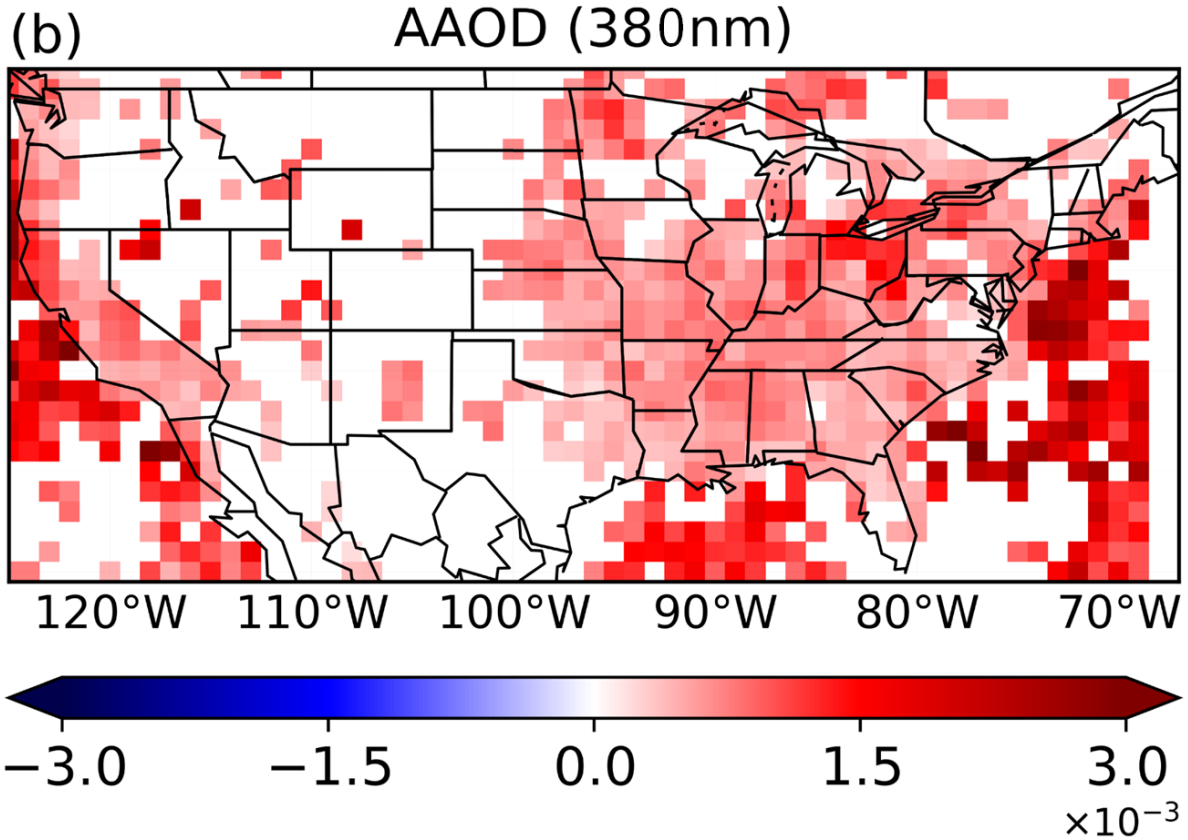


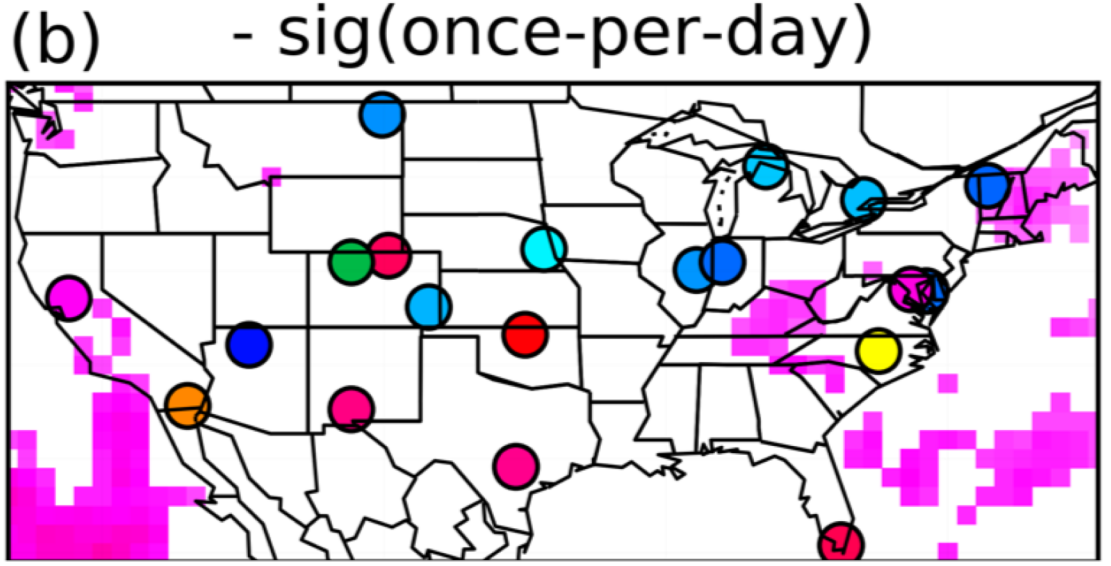
- The OP_FS bias shows slight difference on COT. At larger COT values, the distribution of the bias gets wider.

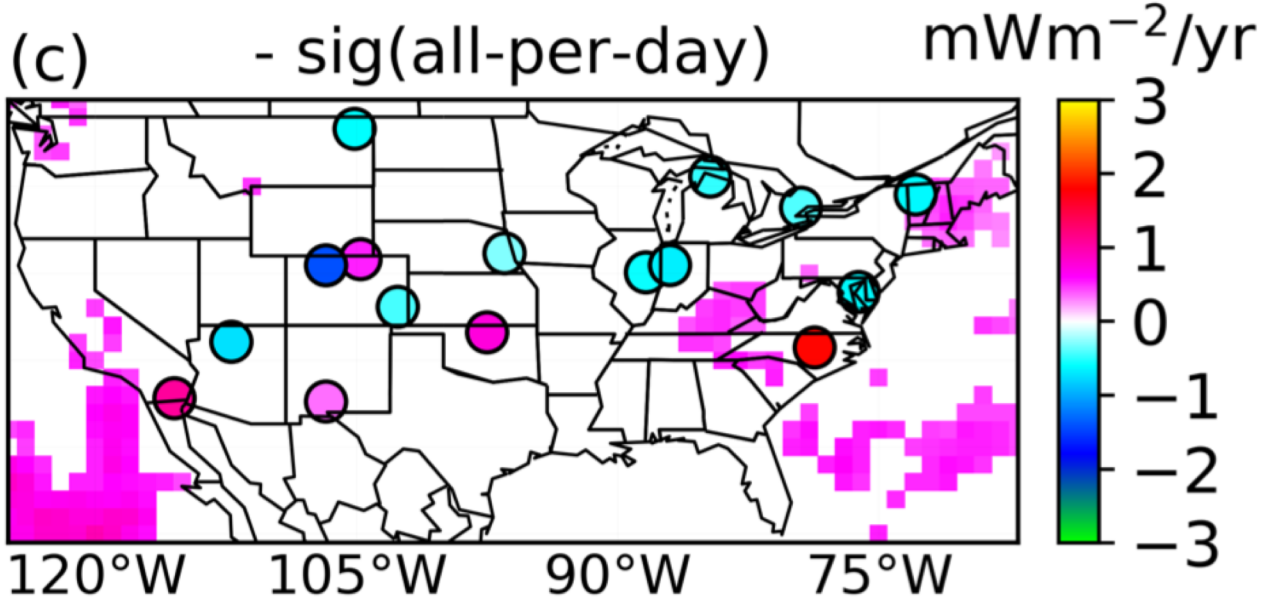
Noon_FS Trend Analysis (2005-2017)



Noon_FS Trend Analysis (2005-2017)







Summary

- Both OMI OP_FS and Noon_FS show good correlation (~0.88). OMI OP_FS underestimates by ~4% and Noon_FS overestimates by ~8%.
- Increasing temporal average window length improves the comparison.
- The assumption of a constant atmospheric profile between overpass time and local solar noon time could induce errors.
- The OMI OP_FS bias shows some moderate dependence on SZA and slight dependence on COT.
- The estimated surface UV trend from OMI and ground data differ in spatial patterns and magnitude.
- Future higher resolution data such as **TEMPO** would help resolve these discrepancies.

Thank you!