

Solar Dimming & Brightening And Airborne Particulate Matter

Vicky Kelly, Charles Canham,
Kathleen Weathers, Gary Lovett
Cary Institute of Ecosystem Studies

The context

- Surface Solar Radiation (SSR) declined till late 1980's "Dimming"
- SSR then increased in many locations "Brightening"
- Dimming & Brightening trend not universal globally
- Cause- anthropogenic changes in pollution emissions- economic development followed by air pollution regulations
- Mechanism- change in diffuse radiation caused by changes in aerosols and clouds
- Relative importance of aerosols, clouds, aerosol-cloud interactions unknown
- Implications- global climate change

The Mechanism

- SO_2 emissions \rightarrow airborne SO_4^{2-} particles
- $(\text{NH}_4)_2\text{SO}_4$ & other particles scatter & reflect radiation, affecting the level of diffuse radiation.
- Clouds & water vapor also scatter & reflect radiation.
- Particles can act as nuclei for water vapor condensation.

Global Shortwave Radiation



Eppley Model 8-48

Diffuse Shortwave Solar Radiation

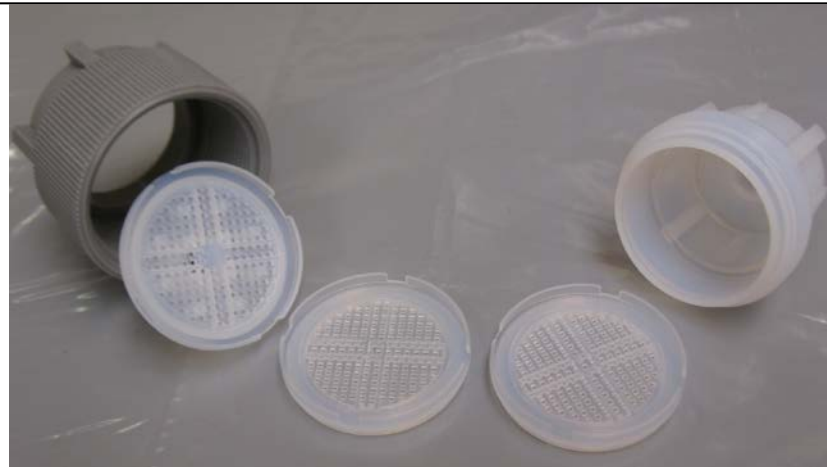
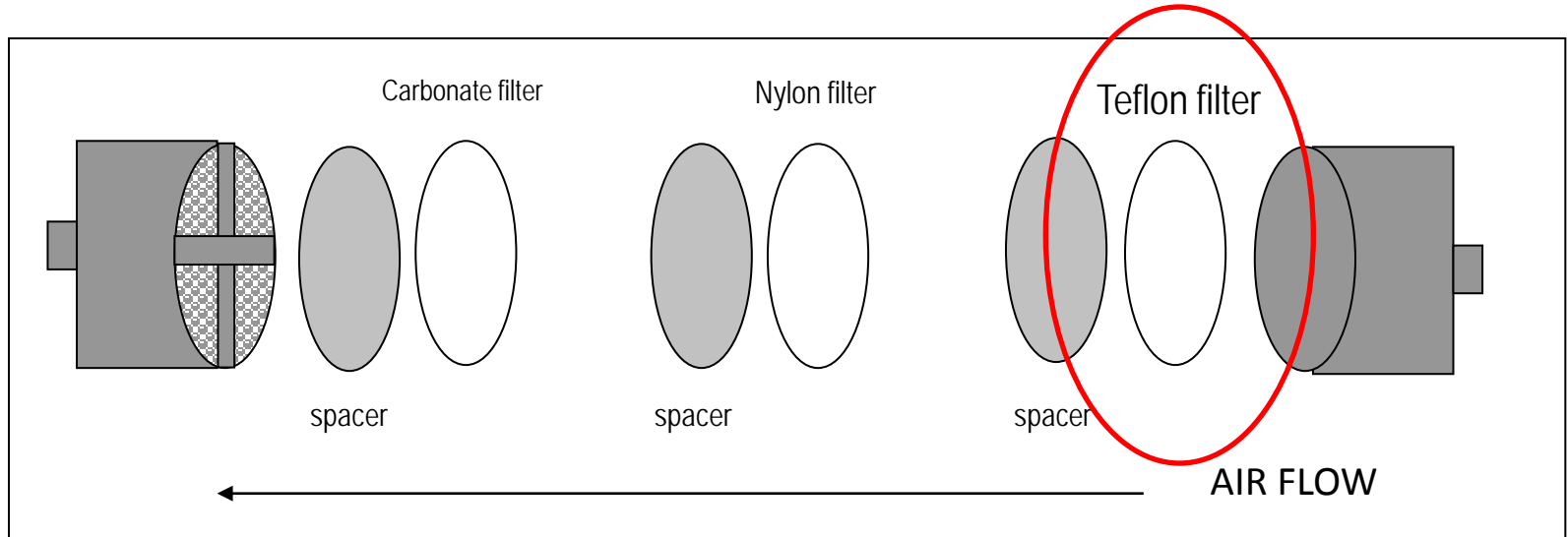


Eppley Model 8-48

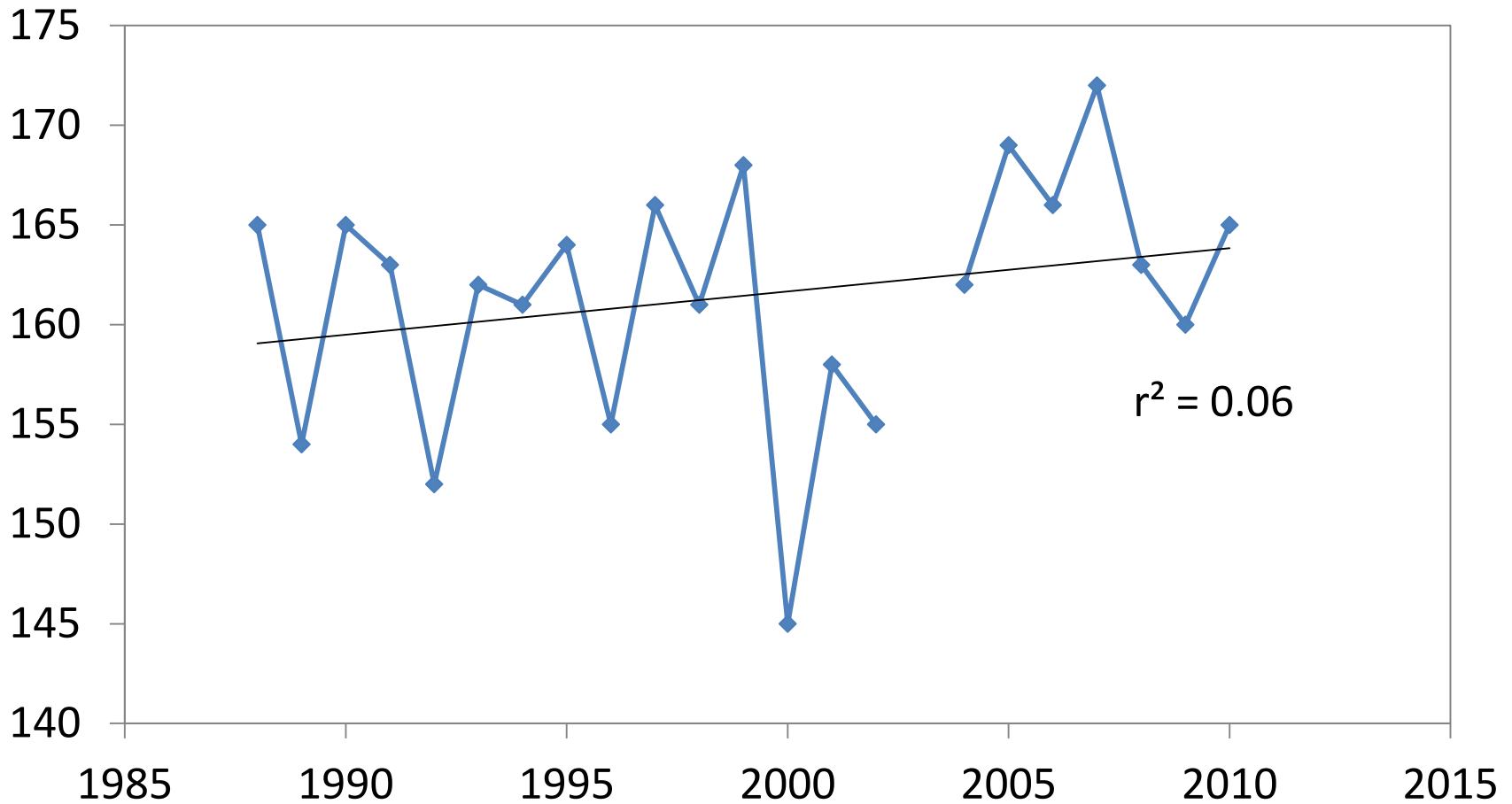
Particle Data



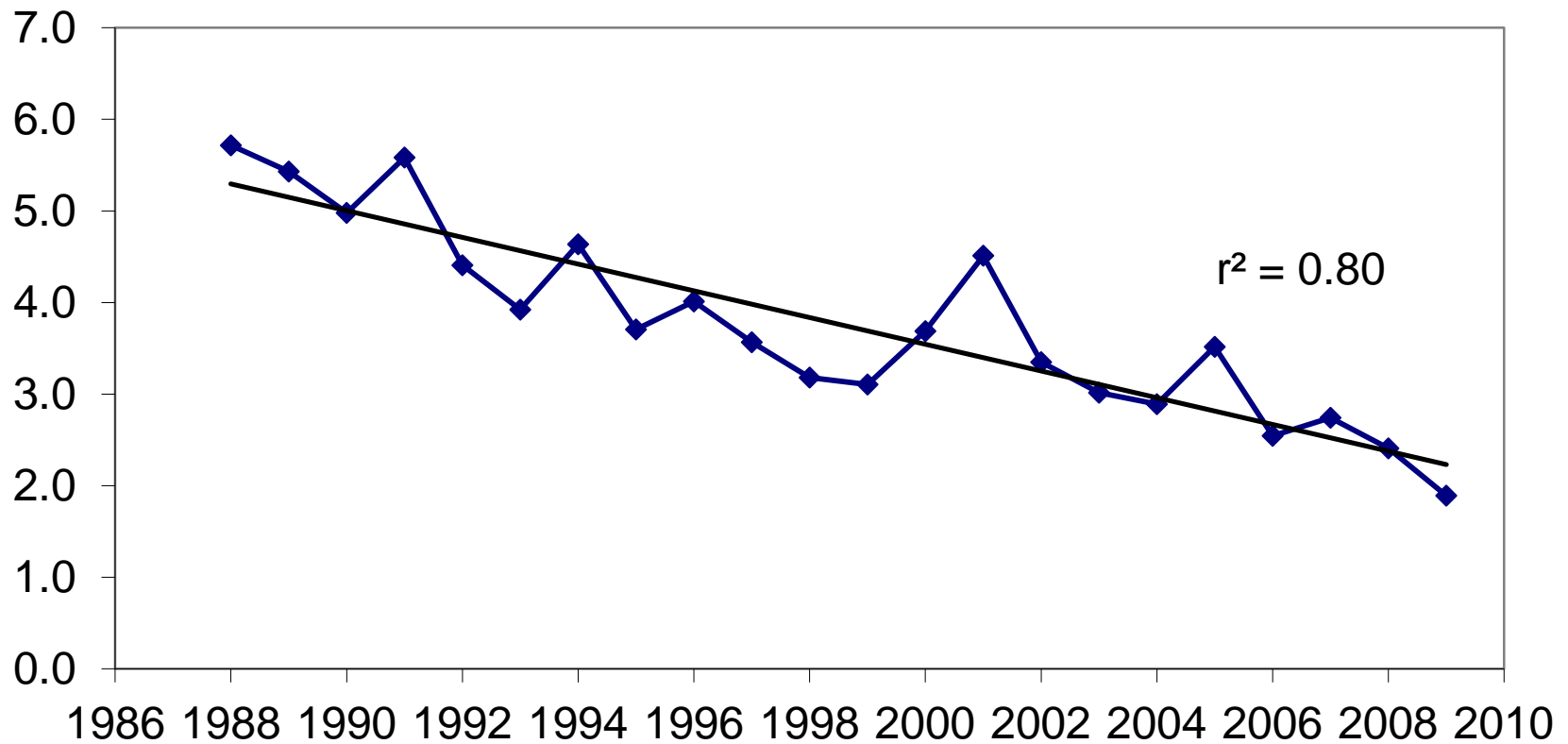
Teflon Filter Collects SO_4^{2-} , NO_3^- , NH_4^+ Particles



Average Global Shortwave Radiation (W/m²) at the Cary Institute

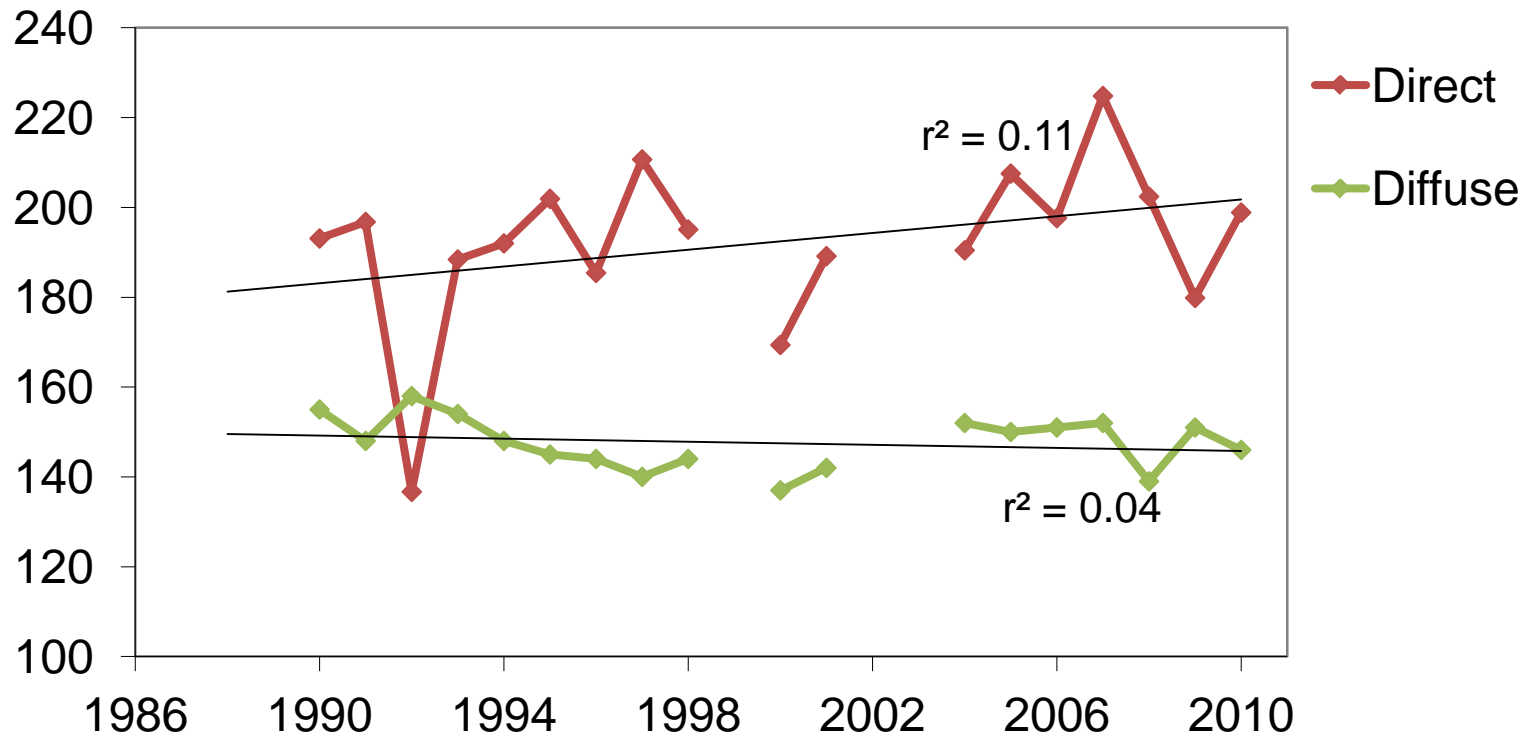


Average Particulate SO_4^{2-} ($\mu\text{g}/\text{m}^2$) at the Cary Institute

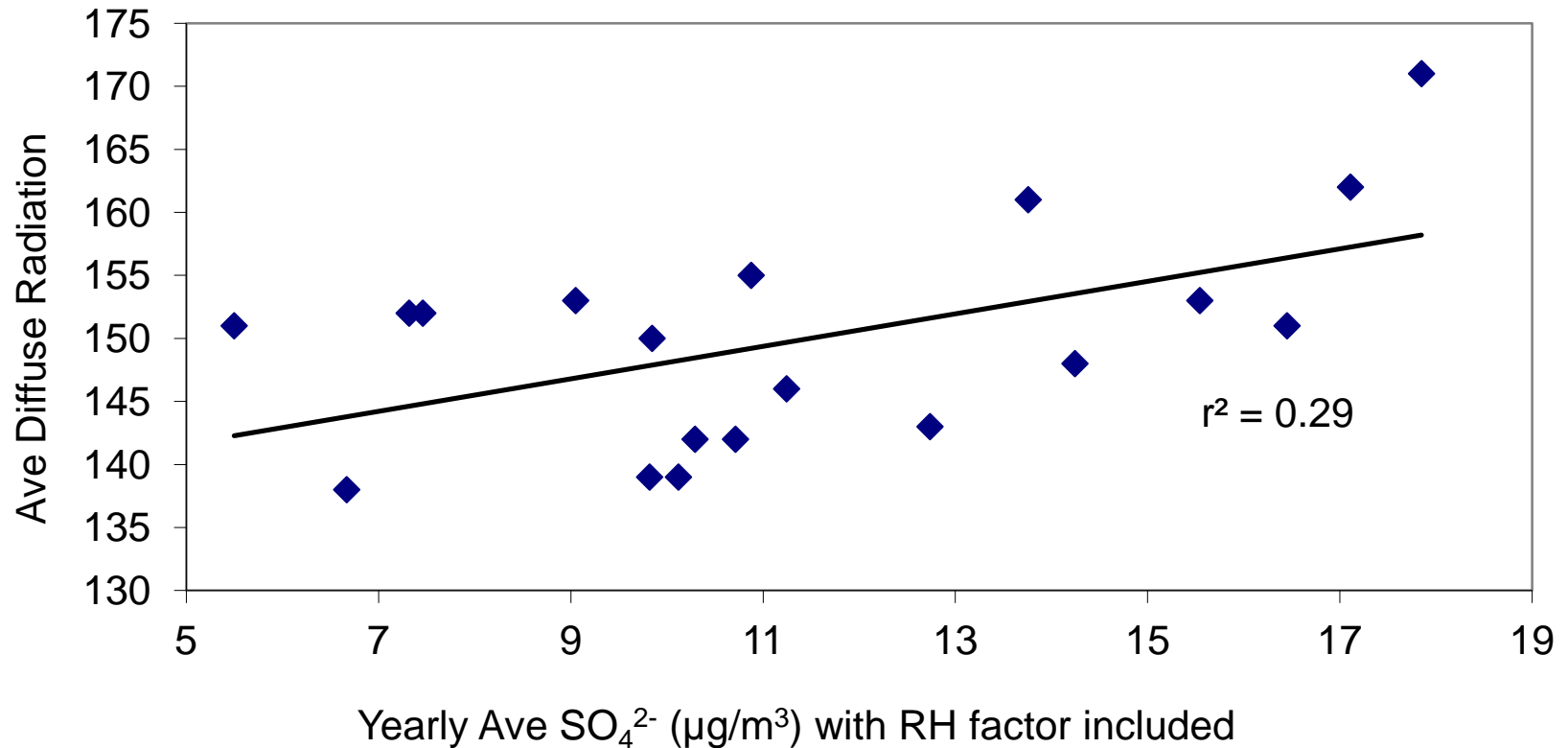


Average Shortwave Radiation (W/m²)

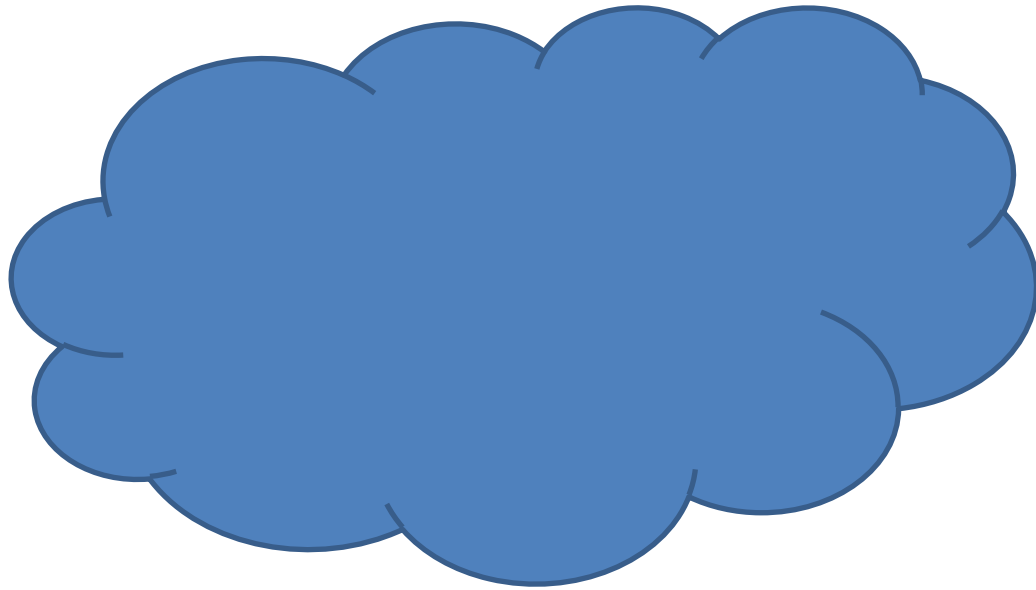
Hours 0800-1800 EST



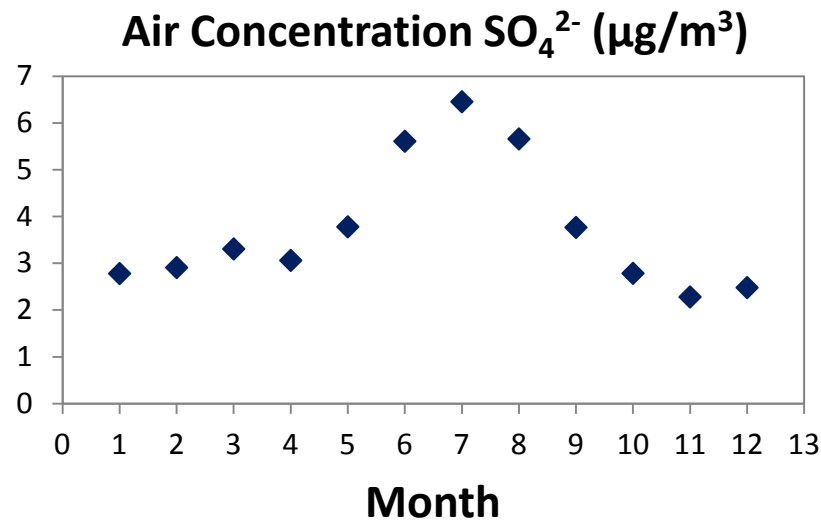
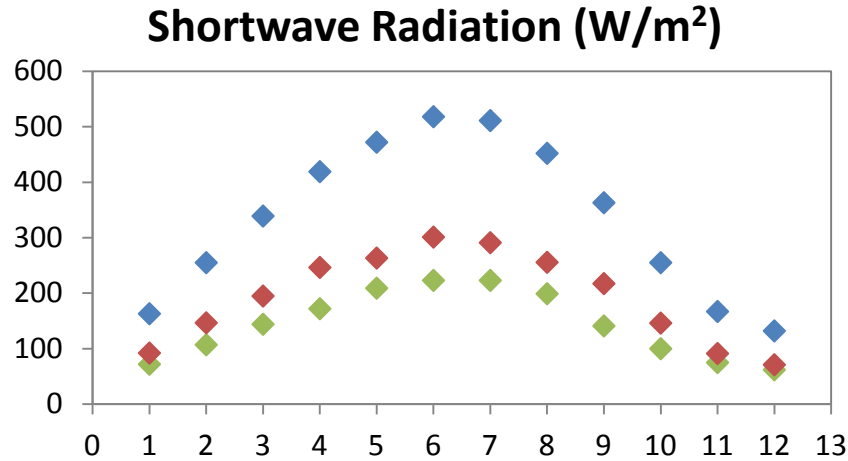
Diffuse Shortwave Radiation as a Function of SO₄*RH Particles



What about clouds?

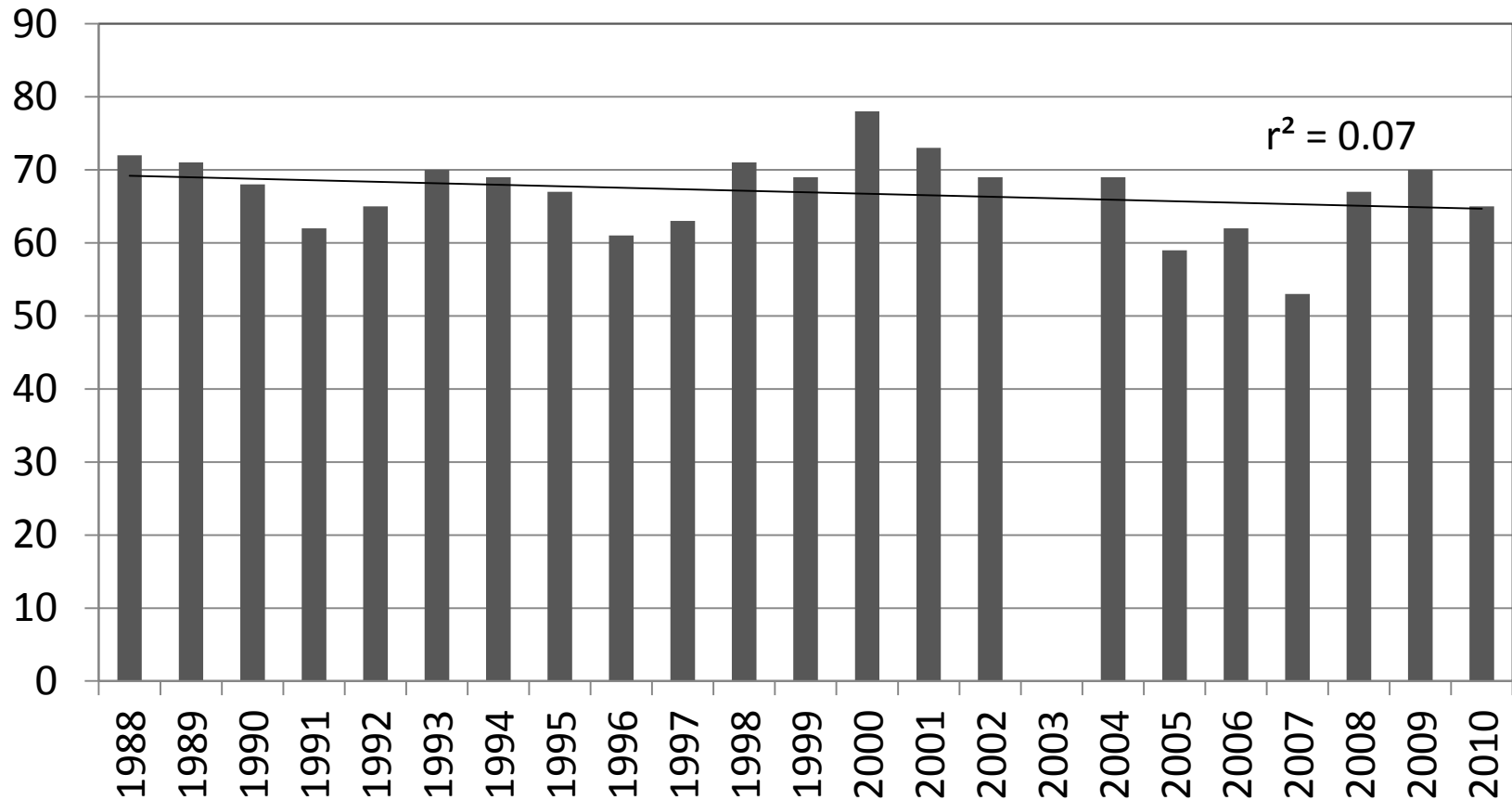


Monthly Average

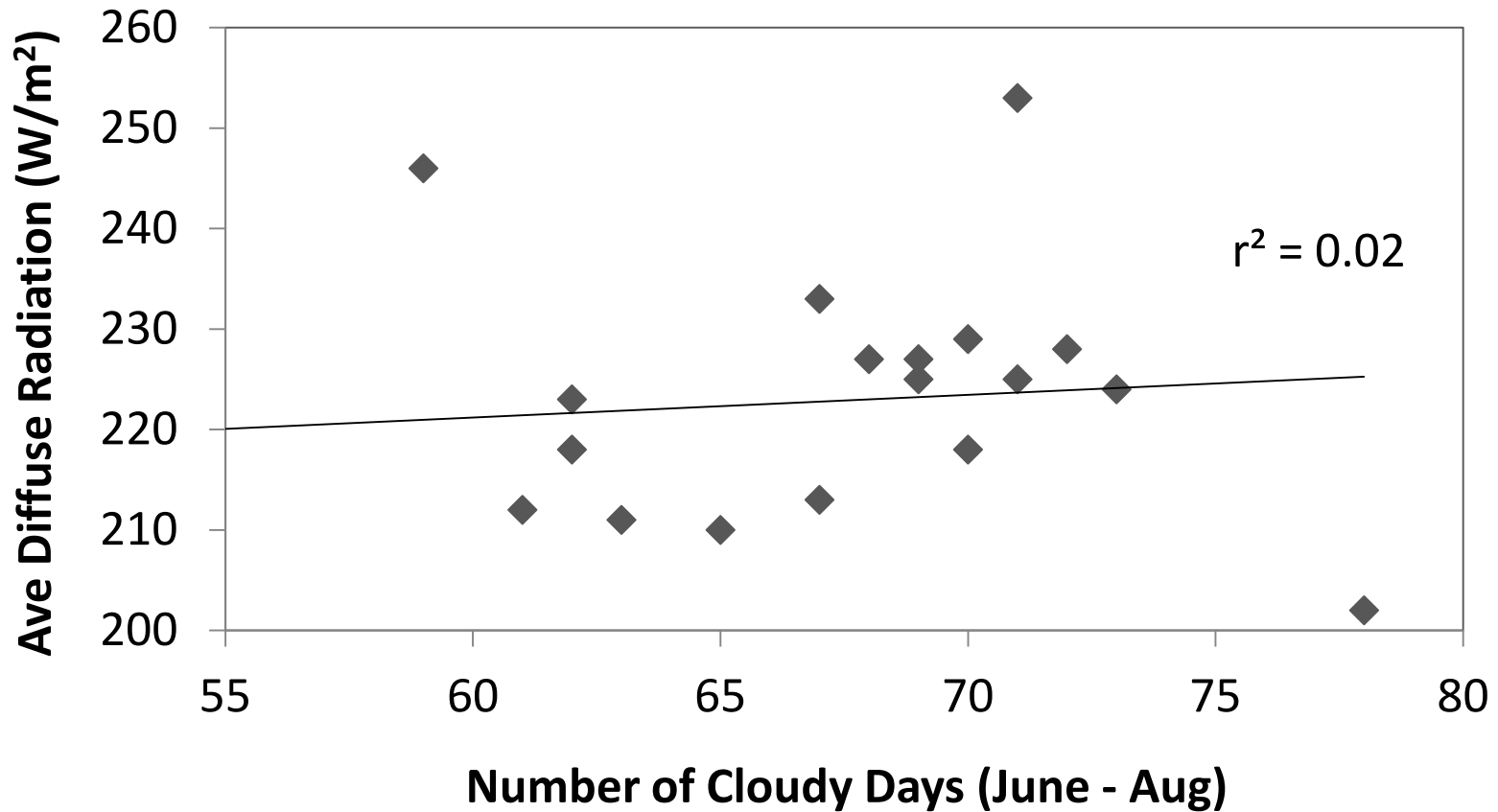


Number of Cloudy Days (June – Aug)

Kt<65%

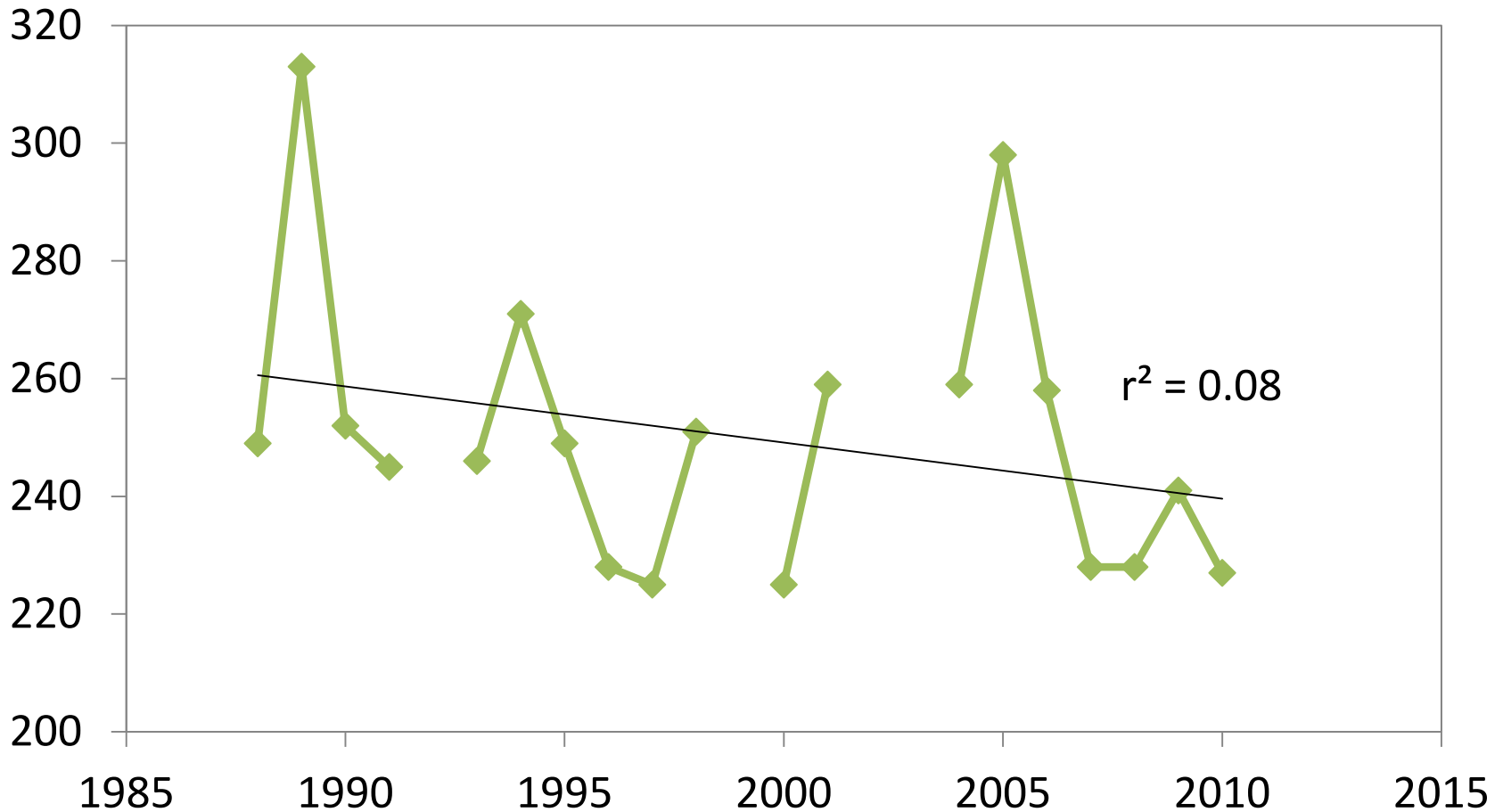


Diffuse Shortwave Radiation as a Function of Cloudiness

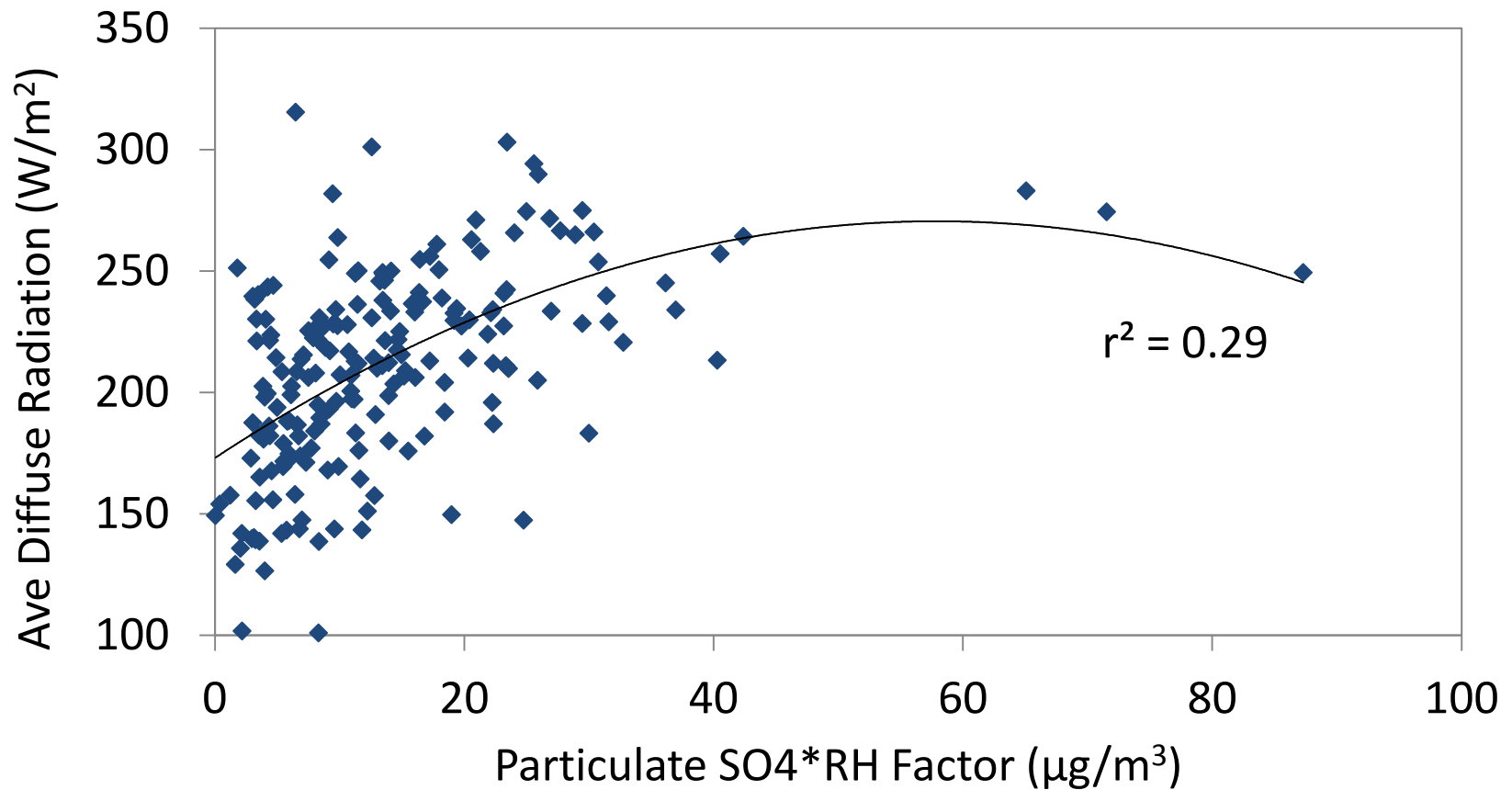


Diffuse Shortwave Radiation (W/m²)

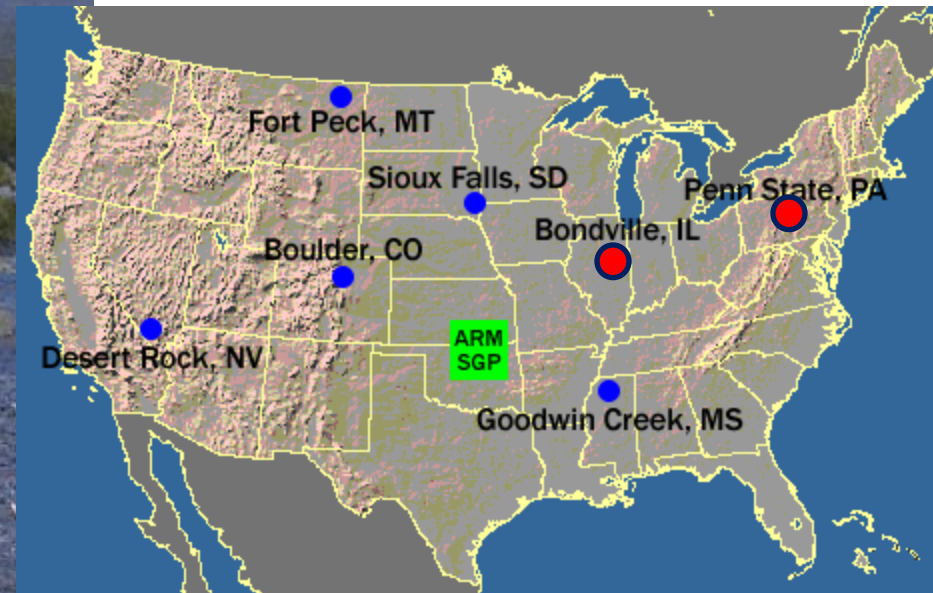
Clear Days Only, June - Aug



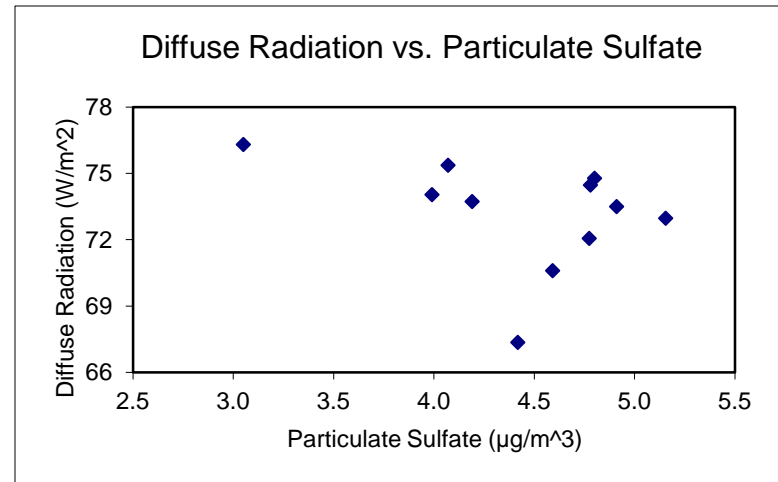
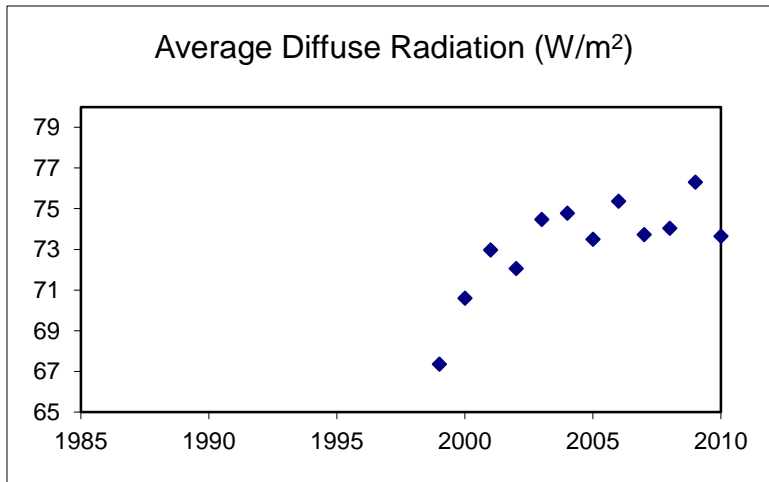
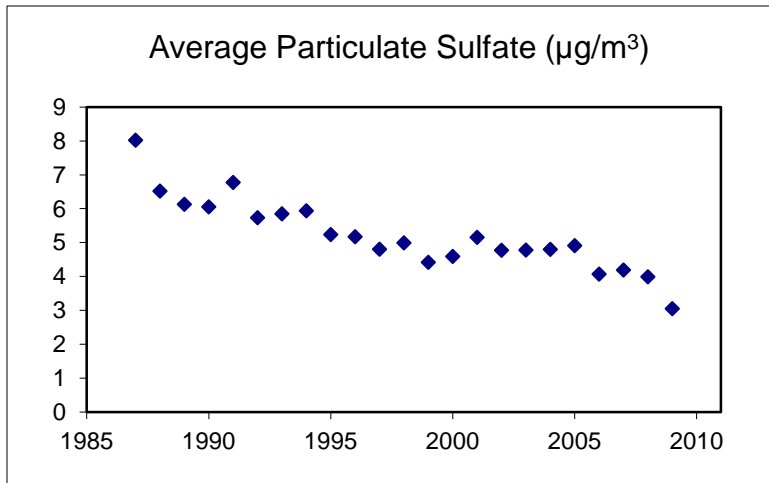
Average Diffuse Shortwave Radiation for Clear Weeks vs. SO4*RH particles



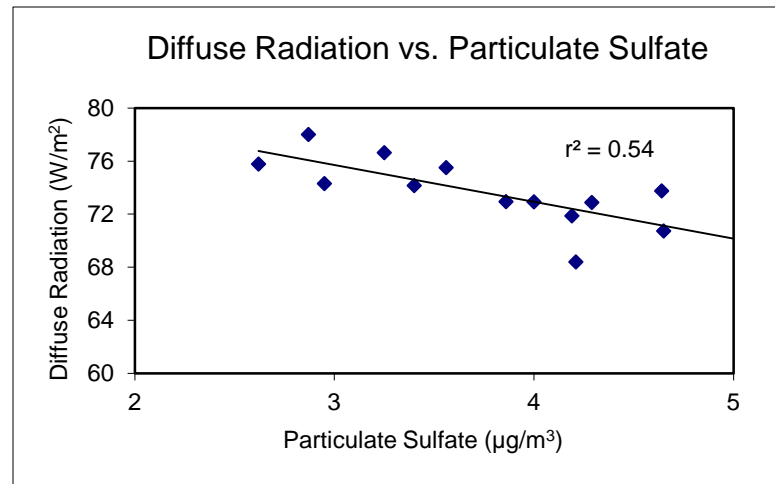
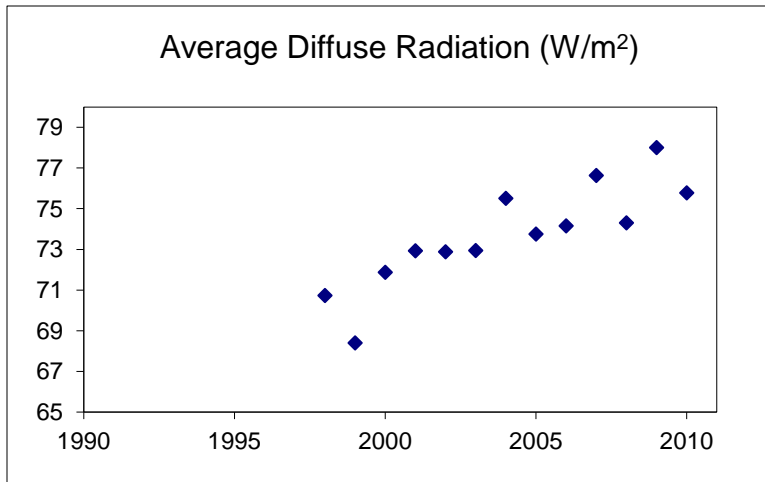
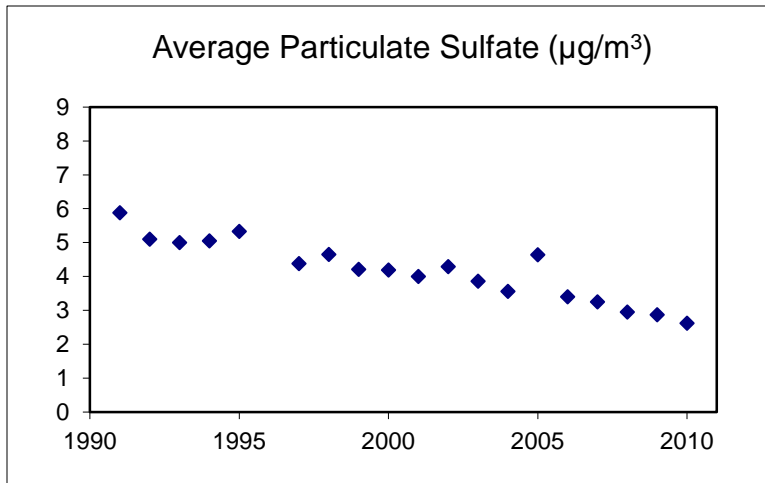
NOAA SURFRAD (Surface Radiation) Network



Penn State CASTNET, SURFRAD




Bondville, IL CASTNET, SURFRAD



Conclusions

- Global SSR is increasing & Diffuse SSR is decreasing at Cary Institute
- 30% of variation in diffuse SSR is explained by particulate SO_4^{2-}
- Changes in diffuse SSR aren't explained by cloudiness
- Relationship between diffuse SSR and SO_4^{2-} particles not corroborated at other sites in eastern US



THANK YOU!
QUESTIONS / COMMENTS...