NOAA Global Monitoring Laboratory

Virtual Global Monitoring Annual Conference (eGMAC)

MONITORING AND UNDERSTANDING TRENDS IN SURFACE RADIATION, CLOUDS, AND AEROSOLS

June 19, 2020, *8:30 am MDT*

Register for the eGMAC at https://www.esrl.noaa.gov/gmd/annualconference/
to receive webinar information

Session Overview: This session will focus on studies that involve the exchange of energy at Earth's surface where weather and climate begin. This exchange is strongly influenced by changes in the distributions of clouds and aerosols in Earth's atmosphere, which in turn are driven in part by perturbations from greenhouse gas and aerosol emissions and changes in atmospheric circulation. Understanding the variability and trends in this complex system is extremely important if weather prediction and climate projections are to be improved at all scales. Talks in this session will address the variability and trends that start with high-quality, well distributed, long-term observations of Earth-system characteristics that drive the system, most notably radiation at Earth's surface and changes in atmospheric constituents.

Session Chair: Diane Stanitski
Chat Moderators: Laura Riihimaki (radiation) and Pat Sheridan (aerosols)

All times below are in Mountain Daylight Time (UTC -6)

Time	Title / Abstract	Presenter and Affiliation
0830-0850	**Solar and IR radiative flux observations from research vessels and buoys**	**Christopher Fairall** NOAA Physical Sciences Laboratory
0850-0910	**An examination of dimming and brightening over the U.S. through 2019**	**John Augustine** NOAA Global Monitoring Laboratory
0910-0930	**Trends of UV radiation in Antarctica**	**Germar Bernhard** Biospherical Instruments, San Diego
0930-0950	**From a polar to a marine environment: has the changing Arctic led to a shift in aerosol optical properties?**	**Dominic Heslin-Rees** Stockholm University, Sweden
0950-1010	**First global overview on the representation of water uptake by ten Global Climate Models using a new in-situ benchmark hygroscopicity dataset**	**Maria Burgos** Stockholm University, Sweden
1010-1030	**Dust in the Great Plains and Northern Rockies: Trends and Influences from Land Use**	**Andy Lambert** University of Utah

SESSION ABSTRACTS

MONITORING AND UNDERSTANDING TRENDS IN SURFACE RADIATION, CLOUDS, AND AEROSOLS

0830-0850 **Christopher Fairall, NOAA ESRL Physical Sciences Laboratory, Boulder, CO; Robert Weller and Albert Plueddemann, Woods Hole Oceanographic Institution (WHOI), Woods Hole, MA**

Title: Solar and IR radiative flux observations from research vessels and buoys

Abstract: For 25 years NOAA and WHOI have been cooperating on measurements of the components of the surface energy budget over the ocean including sensible and latent heat turbulent fluxes and radiative fluxes. Long time series of solar and IR fluxes have been obtained by WHOI from Flux Reference Buoys at three open ocean locations: 1000 km west of the Chilean coast, 100 km north of Hawaii, and 900 km east of Barbados. PSL has deployed radiative flux sensors on research vessels in various field programs since 1990, including on the ships servicing the Flux Reference Buoys. We have worked with GML on calibration, quality control, and interpretation of the radiation measurements and made extensive use of the calibration facility at DSRC. Investigation of different calibration approaches, data logging methods, accuracy of different commercial sensors, pitch-roll stabilization, effects of non-cosine behavior, dome heating/cooling, and environmental contamination has led to steady improvements in the accuracy of the long time series.

0850-0910 **John Augustine, NOAA Global Monitoring Laboratory**

Title: An examination of dimming and brightening over the U.S. through 2019

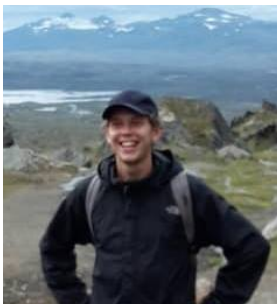
Abstract: The surface radiation climatology for the U.S. has been extended through 2019 using SURFRAD network data. Brightening of +7.3 Wm^{-2}/decade from the beginning of the network (1996) through 2012 is followed abruptly by dimming of -3.9 Wm^{-2}/decade from 2013 through 2019. This pattern is seasonally consistent, but is more exaggerated in the warmer months. Total surface net radiation shows similar behavior except that the reversal from increasing to decreasing occurs earlier and more gradually owing to the response of net-surface-longwave to the changing solar input. Aerosol optical depth decreases throughout the entire period, revealing an insensitivity to solar tendencies at the surface. However, changes in cloud cover are physically consistent with brightening and dimming. The source of systematic changes in cloud cover over the continents is investigated by comparing well-documented surface solar trends to decadal-scale variability of North Atlantic and North Pacific sea surface temperatures (SST). Dimming in the U.S. and Europe from the 1950s through the mid-1980s corresponds to declining SSTs in both the North Pacific and North Atlantic. Analogously, brightening from the late 1980s to 2012 corresponds to increasing SSTs. The new dimming period in the U.S. appears to follow this paradigm. Meteorological forcing by SSTs in flux and its effect on continental cloud cover is visualized through composites of 20th Century Reanalysis sea-level pressure and middle-level geopotential heights over the dimming and brightening periods.

0910-0930 **Germar Bernhard, Biospherical Instruments, San Diego; Scott Stierle, NOAA Global Monitoring Laboratory**

Title: Trends of UV radiation in Antarctica

Abstract: A recent study has demonstrated the success of the Montreal Protocol in curbing increases in harmful solar UV radiation at Earth's surface. This study also provided evidence that the UV Index (UVI) measured at the sites of NOAA's Antarctic UV Monitoring Network (South Pole, McMurdo and Palmer) is now decreasing. For example, a significant (95% confidence level) downward trend of 5.5% per decade was reported at McMurdo for summer (December through February). However, it was also noted that these measurements are potentially affected by long-term drifts of approximately 1% per decade. To address this issue, we have reviewed the chain of calibrations implemented at the three sites between 1996 and 2018 and applied corrections for changes in the scale of spectral irradiance (SoSI) that have occurred over this period. This analysis resulted in an upward correction of UVI data measured after 2012 by 1.7%, plus smaller adjustments for several shorter periods. Corrections to account for drifts in the SoSI reduced decadal trends in UVI on average by 1.5% at the South Pole, 1.0% at McMurdo and 0.8% at Palmer Station. The decadal trend in UVI calculated from the corrected dataset for summer at McMurdo is –4.5% and remains significant at the 95% level. Analysis of spectral irradiance measurements at 340 nm suggests that this trend is caused by changes in sea ice cover adjacent to the station. For South Pole, a significant (95% level) trend in UVI of –4.1% per decade was derived for January. This trend can partly be explained by a significant positive trend in total ozone of about 3% per decade. Our study provides further evidence that UVIs are now decreasing in Antarctica during summer months. Reductions have not yet emerged during spring when the ozone hole leads to large UVI variability.

0930-0950 **Dominic Heslin-Rees, Stockholm University, Sweden**



Title: From a polar to a marine environment: has the changing Arctic led to a shift in aerosol optical properties?

Abstract: The study of long-term trends in aerosol optical properties is an important task to understand the underlying aerosol processes influencing the change of climate. The Arctic, as the place where climate change manifests most, is an especially sensitive region of the world. Within this work, we use a unique long-term data record of key aerosol optical properties from Zeppelin Observatory, Svalbard, to ask the question of whether the environmental changes of the last two decades in the Arctic are reflected in the observations. We perform a trend analysis of the measured particle light scattering and backscattering coefficients and the derived scattering Ångström exponent and hemispheric backscattering fraction. In contrast to previous studies, the effect of in-cloud scavenging and potential sampling losses at the site is taken explicitly into account in the trend analysis. The analysis is combined with a back trajectory analysis and satellite-derived sea ice data, to support the interpretation of the observed trends. We find that the optical properties of aerosol particles have undergone clear and significant changes in the past two decades. The scattering Ångström exponent and the particle light scattering coefficient exhibit statistically significant decreasing of between -4.9 and -6.3 % per year and increasing trends of between 2.3 and 2.9 % per year (at a wavelength of lambda=550 nm), respectively. The magnitudes of the trends vary depending on the season. These trends indicate a shift to an aerosol dominated more by coarse-mode particles, most likely the result of increases in the relative amount of sea spray aerosol. We show that changes in air mass circulation patterns, specifically an increase in air masses from the south-west, are responsible for the shift in aerosol optical properties, while the decrease of Arctic sea ice in the last two decades had only a marginal influence on the observed trends.

0950-1010 Maria Burgos, Stockholm University, Sweden

Title: First global overview on the representation of water uptake by ten Global Climate Models using a new in-situ benchmark hygroscopicity dataset

Abstract: The uptake of water by atmospheric aerosols has been evaluated by a comprehensive model-measurement evaluation of the particle light scattering enhancement factor, *f*(RH), within the AeroCom Phase III experiment. The comparison uses simulations from 10 Earth system models and a global dataset of surface-based in situ measurements. The models exhibited large variability and diversity in the simulated *f*(RH), with a tendency to overestimate. Differences in the model parameterizations of hygroscopicity and model chemistry are driving some of the observed diversity in simulated *f*(RH). Another factor that impacts the model evaluation is the definition of dry conditions, pointing to the sensitivity in the model parameterization of hygroscopic growth at low RH (e.g. effects of particle hysteresis). Models show a significantly larger discrepancy with the observations if RH=0% is chosen as the model reference RH compared to when RH=40% is used. Recommendation on updates for hygroscopic growth parameterizations, and new possible experiments to further evaluate the influence of other relevant variables are also proposed.

1010-1030 Andy Lambert, University of Utah

Title: Dust in the Great Plains and Northern Rockies: Trends and Influences from Land Use

Abstract: Climate change and anthropogenic land use are altering the U.S. landscape, allowing for increases in windblown dust. These increases influence soil fertility, snow melt rate, cloud optical properties, visibility, and human health. Trends in dust loading in the Great Plains and Rocky Mountain regions are investigated by combining coarse mode aerosol observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard the Terra satellite and the Aerosol Robotic Network (AERONET) and Interagency Monitoring of Protected Visual Environments (IMPROVE) aerosol monitoring networks. Increasing trends are observed throughout the Great Plains and Northern Rockies, reaching 5% increases per year in MODIS aerosol optical depth (AOD) during dust events (AOD_{dust}) for observations when the Ångström exponent is less than 0.75 (2000-2018).

Cropland coverage has increased 5-10% over the majority of the Great Plains (2008-2018) and positive monthly trends in IMPROVE and AERONET coarse mode 0.9^{th} quantile observations coincide with planting and harvesting seasons of corn, soybeans, and winter wheat. Positive correlations appear between AOD_{dust} trends and cropland change when cropland change lags AOD_{dust} trends to the southeast, suggesting cropland expansion is affecting downwind regions to the northwest. Meanwhile, in the Rockies and Northern Great Plains, oil and gas well construction is positively correlated with AOD_{dust} observations.

These findings give a picture of an increasingly dusty Great Plains and Northern Rockies region and suggest these changes are indeed related to rapid agricultural expansion and oil and gas development. In a region where the influence of climate change on drought is highly uncertain, policy changes related to these methods of land use may be imperative to avoid the risk of regional-scale desertification and adverse effects on human health and environmental resources.