NOAA/NESDIS Cooperative Research Program (CoRP) Annual Science Symposium

POSTER ABSTRACTS

Batzli, Sam (CIMSS): ***RealEarth: Visualize Your Data***

Authors: Sam Batzli, Dave Parker, Russ Dengel, Nick Bearson, Tommy Jasmin, and Dave Santek

RealEarth is a data discovery and visualization platform developed at the Space Science and engineering Center at the University of Wisconsin-Madison to support outreach and collaboration efforts of scientists. This poster introduces RealEarth and provides information about its features. What began as an effort to bring near real-time weather information and land remote sensing visualization together in one intuitive map interface has expanded to offer time-series animation of aerial photography and early warning notifications for hazards and severe weather. The core infrastructure is comprised of 12 servers hosting 18 virtual machines (VMs), but its federated and modular architecture is extensible and scalable. New VMs are added regularly. Now over 550 imagery products are processed and available for display at any given time. Visit https://www.ssec.wisc.edu/realearth It supports a robust API and several mobile apps for both iOS and Android.

Bruckner, Margaret (CIMSS, attending UW–Madison, Advisors: Brad Pierce and Steve Ackerman): ***Indirect Validation of OMPS Limb Ozone Retrievals***

Author: Margaret Bruckner

The onset of stratospheric ozone recovery is projected to become apparent between 2017 and 2021. Alongside this onset, there is turnover occurring in the satellite instrumentation which measures ozone, with older instruments such as the NASA Ozone Monitoring Instrument (OMI) and Microwave Limb Sounder (MLS) being replaced by next generation instrumentation such as the Ozone Mapping Profiler Suite (OMPS). Chemical re-analyses have been developed using OMI and MLS retrievals. For continued use in investigation of ozone interannual variability and trends associated with ozone recovery, the re-analyses must be able to assimilate OMPS limb and nadir retrievals. To assimilate this data into re-analyses such as the Real-time Air Quality Modeling System (RAQMS) re-analysis, a good estimate of the observation error for OMPS limb is necessary. This study develops the framework for carrying out an indirect validation of OMPS utilizing the RAQMS Aura reanalysis, ozonesondes, and retrievals from the Atmospheric Chemistry Experiment (ACE), focusing on the 2016 Antarctic Ozone Hole.

Bruno, Jack (CIMSS, attending Ohio University, Advisor: Dr. David Drabold): ***Lake Breeze Analysis from the Lake Michigan Ozone Study***

Author: Jack Bruno

Sheboygan County, Wisconsin on the coast of Lake Michigan has consistently been registering much higher levels of surface ozone and ozone precursors than would be expected given the lack of significant urban pollution in the area. Nonattainment of NAAQS for ozone on the Lake Michigan coastline motivated the Lake Michigan Ozone Study (LMOS), a collaborative field campaign to gather remote sensing and in situ data of these non-attainment events to better understand the mechanisms at play as well as to identify model failings. This work focuses specifically on measurements taken at the Sheboygan, Wisconsin site. Analysis is made of remote sensing data from The University of Wisconsin-Madison's Space Science Engineering Portable Atmospheric Research Center (SPARC). This includes data from the Atmospheric Emitted Radiance Interferometer (AERI), High Spectral Resolution Lidar (HSRL), and Doppler Lidar. This data is compared to NAM-CMAQ model data focusing on the Lake Breeze event of June 2nd, 2017 as a case study of the Lake Breeze phenomena connected with observed ozone spikes in the area. These data offer insight into some of the potential factors associated with the underprediction of ozone nonattainment events in the Sheboygan region.

Calderella, Cassandra (CREST, attending City College of New York, Advisors: Reza Khanbilvardi and Tarendra Lakhankar): ***Derivation of Drought Index for the Continental United States using Satellite Based Soil Moisture and Vegetation Indices***

Authors: Cassandra Calderella, Tarendra Lakhankar, and Reza Khanbilvardi

The effects of drought on the continental United States have become apparent. Lack of precipitation and high temperatures can lead to human and animal fatalities, as well as the destruction of vegetation that depends on both rainwater and root water in order to sustain itself. One solution is to create systems that can monitor these drought events more effectively by examining both the soil moisture content and vegetation indices of the Continental United States by using remote sensing data. The soil moisture product is produced using AMSR2 sensors on the GCOM-W1 satellite platform, and the NDVI platform on the MODIS satellite is used at a visible/infrared frequency to measure vegetation indices. Water demand data measured at the county level from the United States Geological Survey is also a vital part of determining the best model to use.

Due to the data being processed in a rectangular grid, it is very difficult to study individual counties. One solution is to convert this data into county grids using an area-based weighted statistical method in ArcGIS. This analysis of soil moisture content, vegetation indices, and water demand leads to creating an indices scale from 1 to 10 based on how high the drought risk is for all United States counties.

Choi, Seohyun (SAGE, attending UW–Madison, Advisor: Dr. Tracey Holloway): ***Examining PM2.5 Data Apples-to-Apples: Comparative Analysis of CDC WONDER, Environmental Tracking Network and Dalhousie University's maps***

Authors: Seohyun Choi and Tracey Holloway

PM2.5 has been garnering much attention in air quality and health research due to its correlation with human morbidity and mortality. The term 'PM' refers to particulate matter, which is a combination of solid particles, and liquid droplets that are suspended in the air. PM can be classified into two categories, PM are typically classified into two categories, PM10 and PM2.5. PM10 refers to particles that are 10 micrometers or smaller in aerodynamic diameter, while PM2.5 refers to particles that are 2.5 micrometers or smaller in aerodynamic diameter. Particles larger than PM10 are generally not inhaled. In contrast, because PM2.5 can be much smaller than one-thirtieth of the diameter of human hair, it has the ability to travel long distances, and affect regions far from the emission source.

There is a dire need for datasets that have sufficient coverage of global PM2.5 estimates and bear close resemblance to surface-level PM2.5. For example, ground-based data does not have sufficient coverage to show an overall picture of particulate pollution over the United States, let alone globally. Models can collaborate with satellite data to closely resemble surface-level PM2.5 using derivation from AOD, but there are still discrepancies when compared with differently sourced datasets, which show that the combination of satellite data and models are not able to perfectly capture surface-level PM2.5. This underscores the need for a review that will compare, contrast and evaluate different methodologies and results of PM2.5 datasets.

My research examines three different PM2.5 datasets from major public health organizations such as CDC WONDER, CDC EPHTN, and Dalhousie University's Atmospheric Composition Analysis Group from 2011 (Dalhousie data is an average of 2010 - 2012), and put them all on the same scale at county-level for apples-to-apples comparison. The purpose of my research is to compare and contrast these datasets to see which discrepancies exist in the datasets, which datasets exhibit more consistent findings so that such analysis can help health researchers recognize a need for a more consistent, comprehensive PM2.5 dataset.

Dixon, Austin (CIMSS, attending UW–Madison, Advisor: Leigh Orf): ***The Streamwsie Vorticity Current in a High Resolution Simulation of a Tornadic Supercell Thunderstorm***

Authors: Austin Dixon, Leigh Orf, and Kelton Halbert

The streamwise vorticity current (SVC) is a horizontal, helically rotating current of streamwise vorticity located along the forward flank downdraft

boundary (FFDB) of a supercell thunderstorm. It flows rearward along the FFDB, where it is eventually tilted upward into the updraft. This feature resides on the cool side of this boundary where baroclinic generation of vorticity is relatively large. However, this feature is comprised of vorticity generated by other terms considered in the vorticity equation including stretching and tilting. Model data fields, both two and three dimensional, are shown for the above vorticity terms. The primary interest of this feature is that it appears to play an important role in intensifying the low-level updraft via non-linear dynamic pressure perturbations. Intensifying the low-level updraft aids in the tornado-genesis process. While these model fields are important research, it is aimless if not of use to observational and operational applications. It is important to investigate the possibility of detecting the SVC using remote sensing techniques, particularly radar. Radar data is simulated to demonstrate what the SVC may look like in a Range Heigh Indicator (RHI) field, and other useful radar fields.

Gamarro, Harold (CREST, attending The City College of New York, Advisor: Jorge Gonzalez): ***Urban WRF - Solar Validation and Potential for Power Forecast in New York City***

Authors: Harold Gamarro, Jorge E. Gonzalez, and Luis E. Ortiz

Recent developments in the Weather Research and Forecasting (WRF) Model have made it possible to accurately approximate solar power through the implementation of WRF-Solar. This study couples the WRF-Solar module with a multi-layer urban canopy and building energy model in New York City (NYC) to create a unified WRF forecasting model called uWRF-Solar. Hourly time resolution forecasts are validated against ground station data collected at eight different sites. The validation is carried out independently for two different sky conditions: clear and cloudy. Results indicate that the uWRF-Solar model can forecast solar irradiance considerably well for the global horizontal irradiance (GHI) with an R squared value of 0.93 for clear sky conditions and 0.76 for cloudy sky conditions. Results are further used to directly forecast solar power production in the NYC region, where a power evaluation is done at a city scale. The outputs show a gradient of power generation produced by the potential available solar energy on the entire uWRF-Solar grid. In total, for the month of July 2016, NYC had a city PV potential of 233 kW/day/m2 and 7.25 MWh/month/m2.

Gartzke, Jessica (CIMSS): ***Near-real time CAPE East of the Rockies combining Hyperspectral IR Satellite Sounding and ASOS Surface Stations: Validation at the ARM SGP Site***

Authors: Jessica Gartzke, Steve Ackerman,and Robert Knuteson

Near-real time satellite data can give forecasters the extra edge they need to issue timely and accurate watches and warnings. The Convective Available Potential Energy (CAPE) is a measure of atmospheric instability computed from vertical profiles of temperature and water vapor used the National Weather Service Storm Prediction Center (NWS SPC). CAPE can give forecasters valuable information as to the stability of the atmosphere and therefore the potential for severe weather. The value of using satellite vertical soundings from hyperspectral infrared sensors has been recognized at the NOAA Hazardous Weather Testbed workshops held at the NWS SPC http://hwt.nssl.noaa.gov/ . Satellite overpass times from EUMETSAT METOP IASI at 10:30am/pm and NASA AQUA AIRS, Suomi-NPP CrIS, and JPSS J1 at about 1:30am/pm occur conveniently between the operational 0 and 12 UTC NWS radiosondes. Since the day's first in-situ measurements are taken in the early morning there is a need for forecasters to see the SkewT vertical profiles of temperature and water vapor updated from the 6am (0 UTC) soundings. In addition to more temporal coverage, satellite date can provide spatial coverage between NWS radiosonde launch sites. Automated Surface Observing System (ASOS) stations currently operate routinely as U.S. airports and provide surface meteorological measurements at 1 minute intervals reported in METAR format.

In this study, a comparison of CAPE is made for the U.S. Southern Great Plains region using a combination of Department of Energy ARM radiosondes, ERA model reanalysis fields, and hyperspectral infrared retrievals from NASA AIRS and EUMETSAT IASI sensors. The CAPE is computed using the SHARPpy python open source software http://sharppy.github.io/SHARPpy/documentation.html

which has been validated against the same algorithms used by the NWS SPC. The CAPE is evaluated for a ten-year period from 2005-2014.

Lack of correlation of the CAPE estimated from AIRS satellite soundings and from coincident radiosondes was found to be due to differences in the estimate of the surface parcel dewpoint temperature. A journal paper summarizes the results of the CAPE climatology and correlation study. This Part I paper illustrates a potential solution by using the radiosonde surface data as a substitute for the AIRS surface estimate. The application of this new method to surface meteorological stations east of the Rocky Mountains is presented in Part II of this two-part paper.

Halbert, Kelton (CIMSS, attending UW–Madison, Advisor: Leigh Orf): ***Using Graphical Processing Units for Massively Parallel Computations of Fluid Parcel Trajectories***

Authors: Kelton Halbert, Leigh Orf, and Austin Dixon

Graphical Processing Units, or GPUs, are devices that can accelerate computationally expensive code by leveraging a hardware architecture that supports massively parallel execution. GPU accelerators are built into many current supercomputing architectures, such as the Blue Waters, Titan, and Cheyenne machines, but leveraging the potential speed increases requires writing code that can be executed on the GPU. The NVIDIA CUDA architecture is one such way of accomplishing this parallelism, which allows for the writing of parallel code in familiar languages (C/C++/FORTRAN) that executes on a GPU and is controlled by the CPU. While ongoing work is being done to accelerate high performance numerical simulations such as the Weather Research and Forecasting model (WRF), it is not currently common practice in the atmospheric sciences to accelerate data analysis code in this manner. The power and flexibility of using the CUDA architecture for writing parallel code on GPUs is demonstrated by showing the performance and scalability of parcel trajectory integration code that is written in this framework, being able to integrate millions of individual fluid parcels on a single desktop GPU instead of having to re-compute trajectories in the parent simulation of interest, requiring supercomputer allocations, as is the current standard. This programming framework can be applied to an array of problems in the atmospheric sciences and reduce the computation costs and lengths of time required to compute, suggesting that further effort should be put into writing parallel code in this framework.

Najafi, Ehsan (CREST, attending City College Of New York-NOAA CREST, Advisor: Reza Khanbilvardi): ***Understanding the Changes in Global Crop Yields Through Changes in Climate and Technology***

Authors: Ehsan Najafi, Naresh Devineni, Reza Khanbilvardi, and Felix Kogan

During the last few decades, the global agricultural production has risen and technology enhancement is still contributing to yield growth. However, population growth, water crisis, deforestation, and climate change threaten the global food security. An understanding of the variables that caused past changes in crop yields can help improve future crop prediction models. In this article, we present a comprehensive global analysis of the changes in the crop yields and how they relate to different large-scale and regional climate variables, climate change variables and technology in a unified framework. A new multilevel model for yield prediction at the country level is developed and demonstrated. The structural relationships between average yield and climate attributes as well as trends are estimated simultaneously. All countries are modeled in a single multilevel model with partial pooling to automatically group and reduce estimation uncertainties. El Niño-southern oscillation (ENSO), Palmer drought severity index (PDSI), geopotential height anomalies (GPH), historical carbon dioxide (CO2) concentration and country-based time series of GDP per capita as an approximation of technology measurement are used as predictors to estimate annual agricultural crop yields for each country from 1961 to 2013. Results indicate that these variables can explain the variability in historical crop yields for most of the countries and the model performs well under out-of-sample verifications. While some countries were not generally affected by climatic factors, PDSI and GPH acted both positively and negatively in different regions for crop yields in many countries.

Sledd, Anne (CIMSS, attending UW–Madison, Advisor: Tristan L'Ecuyer): ***Effects of Surface Cover Variability on the Arctic Energy Balance using the Arctic Observations and Reanalysis Integrated System***

Authors: Anne Sledd and Tristan L'Ecuyer

With Arctic sea ice declining rapidly and Arctic temperatures rising faster than the rest of the globe, a better understanding of the Arctic climate and ice cover-radiation feedbacks is needed. Here we present the Arctic Observation and Reanalysis Integrated System (ArORIS), a collection of satellite, reanalysis, and in-situ datasets to facilitate studying the Arctic. The data include cloud properties, radiative fluxes, meteorology, precipitation, and surface properties, to name just a few. Each dataset in ArORIS has uniform grid-spacing, time-averaging, and naming conventions for ease of use between products. One intended use of ArORIS is to assess Arctic radiation and moisture budgets. Following that goal, we use a single-layer model of solar radiation to investigate the individual responses of surface and planetary albedos to changes in surface cover using radiative fluxes from CERES-EBAF and sea ice and snow cover fractions from NSIDC. By partitioning the planetary albedo into surface and atmospheric contributions, we find that the atmospheric contribution to the planetary albedo is less sensitive to changes in sea ice area than the surface contribution. Since the atmosphere contributes more to the planetary albedo than the surface, changes in surface cover are damped in the planetary albedo. Further comparisons are made between observations and reanalyses using the available datasets in ArORIS.

Wang, Likun (CICS-MD): ***Vector-based Fast and Accurate Collocation Software for GEO and LEO instruments***

Authors: Likun Wang and Changyong Cao

Collocation of the measurements from two satellite sensors (either on the same satellite platform or not) involves pairing measurements from two sensors that observe the same location on the Earth but with different spatial resolutions, which involves finding overlapped measurements from two sensors. The collocation of satellite measurements and products is not only important for combination of different satellite measurements for geophysical parameter retrieval, but also is fundamental for inter-calibration applications.

Most of current collocation schemes are carried out the Earth surface and thus have to face two challenges. First, it is hard to deal with off-nadir field of view distortion. Second, the collocation involves time consuming search process. In this study, an accurate and fast collocation method directly based on line-of-sight (LOS) pointing vectors is developed and discussed in details. We demonstrate that this method is not only accurate and precise in mathematic essence and but also is straightforward to implement. Several examples will be presented to show that, this collocation method can be easily implemented for 1) imager and sounder collocation on the same (e.g., VIIRS and CrIS) and different (GOES-16 ABI and CrIS) satellite platform and 2) imager and imager collocation on the different platforms (e.g. MODIS and VIIRS, VIIRS and GOES-16 ABI).The K-D tree based search is also used for algorithm optimization in order to meet operational requirements.

Yin, Jifu (CICS-MD): ***Impact of Bias-Correction Methods on Effectiveness of Assimilating SMAP Soil Moisture Data into NCEP Global Forecast System Using the Ensemble Kalman Filter***

Authors: Jifu Yin, Xiwu Zhan, Mitch Schull, Jicheng Liu, and Li Fang

Improving numerical weather prediction was one of the main justifications for National Aeronautics and Space Administration's Soil Moisture Active/Passive (SMAP) Mission. The ensemble Kalman filter (EnKF) has been extensively applied to assimilate the SM observations into numerical weather predication models. Implementation of EnKF requires the observations and model simulations to be Gaussian distributed and not biased from each other. In this letter, we tested the impacts of three bias-correction methods on effectiveness of assimilating SMAP retrievals into the National Oceanic and Atmospheric Administration—National Centers for Environmental Prediction Global Forecast System (GFS). They are: 1) global cumulative distribution function (CDF) matching with only one CDF for all grids and time series; 2) monthly CDF matching with one CDF for each grid; 3) the linear transformation technique that matches

monthly mean and standard deviation of the SMAP retrievals and model simulations for each grid; and 4) assimilating SMAP SM data into GFS without any bias correction procedure. With respect to the global land data assimilation (DA) system precipitation product, the results demonstrate that the effectiveness of assimilating SMAP retrievals into GFS is significantly impacted by the bias-correction methods. Relative to other DA cases, the monthly CDF matching produces the best precipitation forecast performance. Improvements of the three hourly GFS precipitation prediction with SMAP assimilation using the monthly CDF matching can reach to 8% and 10% in sparsely and densely vegetated areas, respectively, and marginally positive in medium vegetation areas. Based on these results, assimilating SMAP retrievals into the GFS with the EnKF algorithm using the monthly CDF matching method is suggested for enhancing accuracy of the precipitation forecasts.