NOAA Global Monitoring Laboratory Virtual Global Monitoring Annual Conference (eGMAC)

UNDERSTANDING THE PLANETARY BOUNDARY LAYER
June 29, 2020, 8:30-11:15 am MDT

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

8:30 - 8:40 - Introduction
Arlyn Andrews

8:40 - 9:00 - Coordinating Boundary Layer and Land-Atmosphere Research within NOAA
David D. Turner and Tilden P. Meyers

Numerical weather prediction and climate models need to represent the range of interactive processes between the atmospheric boundary layer (ABL) and the land surface. These land-atmosphere (LA) interactions include the terrestrial component (which include processes such as how changes in soil moisture, vegetation, snow cover, etc. control the partitioning of the net radiation into sensible and latent heat fluxes) and the atmospheric component (which addresses how changes in surface latent and sensible heat fluxes influence boundary layer thermodynamic and wind profiles, clouds, precipitation, and downwelling radiation). These two components are connected in a range of different feedback loops. One example of such a loop is that precipitation (or lack thereof) will affect the soil moisture, which changes the partitioning of the latent and sensible heat fluxes, which impacts the dynamics and moisture content in the planetary boundary layer, which will then impact precipitation.

Many NOAA laboratories are tackling aspects of the ABL and LA problem as part of their mission. This has resulted in the development and deployment of instruments, models, and other tools to study LA interactions and ultimately improve their representation in models used for short-term and S2S forecasting. To address the inadequacies in the ABL and LA interactions / feedbacks within the new NOAA unified forecast system (UFS) prediction system, a strategic and coordinated observation and modeling approach is needed. This presentation outlines our recent activities to realize this unified effort.

9:00 - 9:15 - The State of the Science of Modeling Boundary Layer Physics in Support of the Unified Forecast System: Overview of the MYNN-EDMF
Joseph B. Olson, Jaymes S. Kenyon, John M. Brown, Wayne M. Angevine, David D. Turner

The Mellor–Yamada–Nakanishi–Niino (MYNN) Eddy Diffusivity-Mass Flux (EDMF) planetary boundary layer (PBL) scheme is used in the operational High-Resolution Rapid Refresh (HRRR), which provides operational short-range convection-allowing forecasts for the contiguous United States (CONUS). This scheme has been selected for inclusion within the set of advanced experimental physical parameterizations in support of the Unified Forecast System (UFS). This requires further development for improving clouds, solar radiation, and many other sensible weather variables in regions beyond the CONUS. The MYNN-EDMF uses a combined statistical cloud PDF and a mass-flux scheme to provide subgrid-scale (SGS) cloud information to the radiation scheme and help regulate local and nonlocal mixing. Efforts continue to generalize the SGS cloud representation to improve both polar and tropical applications. This presentation will overview key features of the MYNN-EDMF and highlight some performance examples, with the intention to help set up the following talk (on testing and developing of the MYNN-EDMF). Successes and remaining challenges are identified for further research.

9:15-9:30: Modeling of clouds and tracer transport in WRF and NOAA's future models with MYNN-EDMF

Wayne M. Angevine, Joseph Olson

The MYNN-EDMF scheme handles turbulent mixing and shallow cumulus in the operational RAP/HRRR models and is available in WRF. We evaluate its performance in a single column context for a large number of cases from the LASSO datasets. Results are evaluated primarily against LES. The scheme reproduces cloud liquid water path well over several orders of magnitude. The results point to possible further improvements by way of increasing vertical resolution and small changes to critical parameters in the scheme. Evaluation within the Community Common Physics Package Single Column Model (CCPP-SCM) gives similar but interestingly different results. Chemical and tracer transport for WRF-Chem consistent with the turbulent and cloud mixing is available, and we call for collaboration in testing this capability.

9**:30 - 9:45: The Great Coupling: Advancing boundary-layer research at flux tower observatories and experiments**

Ankur R Desai

Over the past decades, significant investment has been made in eddy covariance flux towers, including at observatories like Ameriflux, NEON, and ICOS, and intensive field projects such as CHEESEHEAD19, HiWATER-MUSOEXE, and FESSTVaL. Enhanced with PBL profile observations, they may serve as useful observatories for atmospheric research. I'll review the current state of these observatories, introduce recent experiments, and a new whitepaper that reviews this topic in more detail.

9:45 - 10:00: Boundary layer observations, ensembles, and their use in improving greenhouse gas flux inversions: Result from the ACT-America mission.

Kenneth J. Davis and colleagues

Regional- to continental-scale studies of greenhouse gas fluxes and transport rely heavily on numerical simulations of boundary layer processes. ACT-America research flights obtained ABL observations including meteorological properties and greenhouse gases that span dozens of midlatitude weather systems, encompass four seasons, and extend from the Great Plains to the Gulf of Mexico to the MidAtlantic coast. Model-data comparisons are underway to evaluate and improve the representation of the boundary layer in the numerical models used to simulate atmospheric greenhouse gas transport in the region. I will describe the ACT observations, the ongoing analyses of data and models supported by ACT, and the vision for ongoing model evaluation and development using the mission observations.

10:00 - 10:15: Boundary layer observations using Doppler lidar during INFLUX

Sunil Baidar, Yelena Pichugina, Kenneth Davis, Alan Brewer

Doppler lidars are increasingly being used for boundary layer observations for air quality, greenhouse gas emissions, wind energy and NWP model improvement applications. A Doppler lidar was deployed during the Indianapolis Flux Experiment (INFLUX) from 2013-2019 to measure profiles of the mean horizontal wind and the mixing layer height for quantification of greenhouse gas emissions from the urban area. To continuously and autonomously measure mean horizontal winds, atmospheric turbulence profiles and mixing height, a new Doppler lidar scanning routine was implemented. A composite fuzzy logic approach that combines information from various scan types, including conical and vertical-slice scans and zenith stares, to determine a unified measurement of mixing height and its uncertainty was developed. This talk presents Doppler lidar measurements during INFLUX and its applications to highlight the benefit of Doppler lidar observations of boundary layer for greenhouse gas studies and other studies of the boundary layer.

10:15-10:30: Ongoing boundary layer research facilitated through GML-GRAD observations

Joseph Sedlar, Kathy Lantz, Laura Riihimaki, Tilden Meyers

The Radiation, Aerosols and Clouds research group (GRAD) within NOAA GML has been responsive to the long-term monitoring effort of the surface radiative budget across the continental U.S. In recent years, the network has received additional instrumentation, including the installation of automated ceilometers, co-located eddy covariance systems, and surface-based aerosol property monitoring. These efforts have reinforced GRAD’s capacity to provide important observational insights into how the daytime boundary layer responds to clouds and the feedback between clouds, surface energy fluxes and boundary layer structure. This talk highlights a few of the ongoing applications being developed to understand how clouds, surface energy partitioning, and boundary layer evolution interact over heterogeneous terrain. We make use of observations from the intensive CHEESEHEAD19 field campaign to introduce how GRAD observations and data products are being used to improve understanding of the daytime boundary layer evolution.

10:30 - 10:45 Opportunities for monitoring PBL properties using the GGGRN Aircraft Network
Kathryn McKain, Isaac Vimont, Philip Handley, Bianca Baier, Jack Higgs, Sonja Wolter, Colm Sweeney

The NOAA Global Greenhouse Gas Reference Network (GGGRN) Aircraft Program is comprised of 13 sites over North America where private pilots flying small aircraft collect vertical profile measurements in the mid-afternoon 1-2 times per month, yielding up to ~250 vertical profiles per year for the past 15+ years. Air samples are collected in glass flasks at fixed altitudes up to 5-8 km asl and are analyzed for CO_2, CH_4, and more than 50 other trace gases. In addition to flask air samples, vertical profiles of temperature and humidity are measured on each flight. Trace gas vertical profiles from the aircraft network have been used extensively to evaluate modeled atmospheric transport for greenhouse gas studies, but not to diagnose boundary layer height specifically. In this talk, we explore the potential for the aircraft network trace gas and meteorological datasets to be used to diagnose boundary layer heights and evaluate model simulations. Additionally, we describe a new research and development project to use accelerometer measurements on aircraft network flights as an indicator of mixing height by measuring the change in atmospheric turbulence as the aircraft transitions between the turbulent boundary layer into smoother, upper-atmospheric air when flying vertical profiles.

10:45 - 11:00 Using small unmanned aircraft systems to improve boundary layer sampling: Insights from recent field studies
Temple R. Lee, C. Bruce Baker, Tilden P. Meyers, Michael Buban, and Edward Dumas

Earth's atmospheric boundary layer (ABL) has traditionally been difficult to sample, yet adequate characterizations of it are essential to weather forecasting. In recent years, small unmanned aircraft systems (sUAS) have been used to sample the ABL to close this significant observation gap. Since 2015, NOAA/ARL/ATDD has conducted 447 sUAS flights to support NOAA and NSF-funded field campaigns focused on land-atmosphere interactions. In this presentation, we highlight key results from several of these campaigns, and we discuss ongoing work using sUAS to assist forecasters at local NWS Weather Forecast Offices.

11:00 - 11:15 Wrap up - Comments, Next Steps
Arlyn Andrews and Kathy Lantz