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Progress to Date

Regional Forest-ABL Coupling: Influence on CO_2 and Climate

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This progress report serves as the final report for the portion of this project conducted at the University of Minnesota with Dr. Davis worked there as a member of the faculty of the Department of Soil, Water, and Climate.

A National Center for Atmospheric Research Integrated Sounding System (ISS) was deployed about 5km east of the WLEF-TV tower in the Chequamegon National Forest. The tower is instrumented for high-precision, high-accuracy CO_2 mixing ratio measurements at six levels up to 396m above ground (Bakwin et al, 1998) and continuous eddy-covariance flux measurements at three levels up to 396m (Berger et al, 2001). The ISS, including boundary layer radar profiler, radio acoustic sounding system, and rawinsonde system was operated at WLEF from March through October of 1998 and 1999. The NCAR ISS was also deployed at the Walker Branch flux tower in Oak Ridge, Tennessee from March through November of 1999. Continuous observations of atmospheric structure including radar reflectivity and horizontal wind profiles were collected at each site and rawinsondes were launched at midday once per week.

Boundary layer depths were derived from the radar reflectivity data at WLEF and Walker Branch. A combination of tall tower and radar boundary layer depths from WLEF were used to describe the seasonal evolution of the diurnal mixing depth and its relationship to local turbulent forcing and synoptic conditions (Yi et al, 2001). These depths have been compared to model predictions from the Colorado State University general circulation model. Boundary layer depths for March through October of 1998 are available on-line for the WLEF site (http://cheas.psu.edu). Laser ceilometer observations of cloud base height and cloud fraction have been collected at WLEF during both years, and National Weather Service ceilometer data for Oak Ridge, Tennessee were purchased. Both data sets have been analyzed for continuous, hourly cloud base height and cloud fraction (1998 and 1999) and will be on-line shortly. Cloud base data collection continues through the present day. Interactions between ABL development, cloud formation and surface exchange of CO_2 have not been fully explored to date.

Our proposed method of computing the jump in CO_2 mixing ratio across the convective boundary layer top was tested on a short period of available WLEF flux and NOAA radar boundary layer depth data from September, 1995. Results have been presented in

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conference proceedings (Davis et al, 1998) and a journal publication is in preparation. The method appears to function well on a monthly mean basis.

A paper describing the comparison between CSU GCM boundary layer depths and our observations, as well as the covariance between mixing depth and surface fluxes (the forcing for the rectifier effect) has been drafted and is in revision within our research group. The comparison shows that the rectifier effect forcing predicted by the CSU GCM (see Denning et al., 1995) is similar to or less than that observed at the WLEF tower. Analyses for Walker Branch are underway.

Data were collected and analyzed during the 1999 and 2000 CO_2 Budget and Rectification Airborne study (COBRA). COBRA's flights provide a test for direct validation of our CO_2 profile work. Analyses are underway.

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Ni Zhang (Ph.D. student, Colorado State University)

Project-related journal publications:

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