EOSDIS Earth Observing System Data and Information System

Linking Boundary-Layer Circulations and Surface Processes during FIFE 89. Part I: Observational Analysis [1]

Published in 1994

The Oak Ridge National Laboratory (ORNL) provides information about the Earth's biogeochemical dynamics to the global change research community. The ORNL DAAC includes data from many of NASA's ground-based research programs, including the First ISLSCP Field Experiment (FIFE). The paper summarized here demonstrates the value of having data for many factors for a common place and time collected by many investigators readily available from a single source.

The primary objective of the FIFE investigation, which was conducted from 1987 through 1989, was to document the surface and atmospheric factors which link conditions at the surface to boundary-layer circulations. The experimental area is within the Flint Hills region of eastern Kansas, which has a mean elevation of 400 m. The specific focus was on a 15- by 15-km region within and around the Konza Prairie Natural Area which is a tall-grass prairie LTER site owned by The Nature Conservancy.

Observational evidence during the 1989 FIFE field investigation indicated that the combined vegetation and soil moisture distribution led to a localized and diurnally oscillating thermally-forced circulation which persisted under variable synoptic conditions throughout the three-week field campaign. This study addressed the question of whether or not the strength of the feedback between the otherwise undisturbed land surface and the boundary layer at a given site will be ultimately tied to the spatial and year-to-year variability in weather systems passing through an area, as much as it is to the local physical characteristics of the terrain and the distribution of biophysical surface elements. Although the observation study described here does not absolutely determine which of the two controls is most important at the FIFE study area, it does seek to establish that a local diurnal circulation developed in response to the specific combined vegetation and soil moisture distribution pattern that evolved during the late summer of 1989.

Until the last decade, land surface interactions in virtually all limited-area, numerical weather prediction, and GCM models were overly simplified and did not adequately address the fact that surface-atmosphere interactions are a two-way feedback process. In more recent years the development of biosphere-atmosphere interface models has stimulated considerable research with GCMs concerning the role of detailed surface phenomena on the hydrological cycle, particularly the explicit controls of vegetation and soil moisture on evapotranspiration and the surface energy budget. In fact, some studies have suggested that soil moisture and vegetation represent the determining factors controlling fluxes of mass, energy, and momentum into the planetary boundary layer. Such studies also suggest that neglect of sub-grid-scale temperature and soil moisture variations can lead to substantial errors at the grid-scale because of inherent nonlinear relationships.

The FIFE study area was heavily instrumented with numerous fixed and portable surface energy flux measuring systems. In addition, there was constant surveillance by research aircraft and satellites making measurements in the solar, thermal infrared, and microwave spectra, as well as the gamma ray spectra for determining soil moisture. The analysis of these data indicated that the distribution of vegetation and soil moisture had a pronounced influence on the thermodynamic properties of the surface, the distribution of heat and moisture fluxes, and the local boundary-layer circulation throughout the experimental period. Satellite imagery identified a distinct vegetation gradient across the site indicating that the SE quadrant contained relatively greener and denser cover, while the NW quadrant contained a sparser and more moisture stressed cover. Quadrant-based analysis of the antecedent and ongoing precipitation suggested that the gradient was maintained both before and during the 1989 experiment. The surface net radiation patterns over the site were more variable in time than in space, and in essence show that available heating for turbulent fluxes was nearly constant across much of the site throughout the experiment.

Reference(s):

Smith, E. A., M. M.-K. Wai, H. J. Cooper, and M. T. Rubes. 1994. *Journal of Atmospheric Sciences*. 51:1497-1529.

Source URL: http://earthdata.nasa.gov/featured-stories/featured-research/linking-boundary-layer-circulations-and-surface-processes-during-fife-89-part-i-observational

Links:
[1] http://earthdata.nasa.gov/featured-stories/featured-research/linking-boundary-layer-circulations-and-surface-processes-during-fife-89-part-i-observational