Progress Report
Year Two

Monitoring and Modeling of Land-Surface Energy and Water Fluxes Using an Enhanced Pathfinder Data Base

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The Cooperative Institute for Meteorological Satellite Studies (CIMSS)
at

The Space Science and Engineering Center (SSEC)
University of Wisconsin-Madison
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Preliminary

Prepared By

George R. Diak
Senior Scientist
CIMSS/SSEC

John R. Mecikalski
Associate Researcher
CIMSS/SSEC

I. Accomplishments

The central objective of this proposed work is to produce a continuous record of land-surface fluxes of water and heat for the continental United States by linking the land-surface energy balance remote sensing model (ALEXI) with the forecast component of the CIMSS regional assimilation system (CRAS) to perform daily, real-time evaluations. The CIMSS model (CRAS) has a built-in compatibility with ALEXI because ALEX (the forward version of ALEXI) is used for the model land-surface component.

Beginning in Spring 2000, we began running the ALEXI in real time over about one third of the continental United States to generate four surface flux components (sensible, latent, ground fluxes and net radiation), both for the central United States and independently for Oklahoma. These fluxes are computed at the end of the day, once GOES observations of surface radiometric temperature are available at the second observation time (5.5 hours after local sunrise) across the domain. Vegetation amounts are updated approximately weekly as new NDVI information becomes available from the USGS AVHRR compilation. Currently, surface fluxes are computed on a 5 km-resolution grid centered on Oklahoma (specifically for comparisons with Oklahoma Mesonet fluxes), and on a 10-km resolution grid over the central US.

A central objective of this year's work has been to validate fluxes derived using ALEXI with the large array of flux measurements made by the Oklahoma Mesonet, with whom we have a cooperative agreement. Collaboration with the University of Oklahoma and the researchers who collect and maintain the Oklahoma Mesonet has provided an excellent flux validation data set for our ALEXI flux estimates. For the 2000 and 2001 growing seasons, Mesonet fluxes for several clear-sky days in the Oklahoma region were directly compared with ALEXI 5-km flux estimates.

ALEXI sensible (H), latent heat (LE), soil heat (G) and net radiation (Rnet) are compared to those obtained from the 114-station Mesonet for these days. Figure 1 shows flux comparisons for approximately 20 Mesonet stations that use either Bowen ratio or eddy covariance methods (the Mesonet "SuperSites") to obtain fluxes. The relatively high scatter about the 1:1 line is characteristic of results obtained when trying to validate large-scale (5-km) measurements to point-value in situ instrumentation results. The most probable reason for the disparity is that the in situ measurements are not representative of the conditions over 5 km (an ALEXI pixel), due to differences between the local land cover characteristics in the near-vicinity of a Mesonet station.

Given the disparity of scales, the results presented in Fig. 1 are very encouraging. Despite the scatter, there is no significant bias error in these results, suggesting that when many stations and longer time averages are considered, we are adequately representing the flux partitioning on scales near the GOES instrument's resolution. The results are generally in line with the 15-50% uncertainty in measurements made at the surface. The sensible heat, net radiation and soil flux comparisons are similarly unbiased.

As of Summer 2001, software development, increased computational capabilities, and general improvements to the ALEXI method allowed us to expand the domain of these flux estimations to the entire United States, utilizing data from both the GOES-8 and GOES-10 satellite platforms. Plans for early 2002 are for to maintain continuous 10-km flux budgets for both for this domain under both clear and cloudy circumstances. As previously stated, the ALEXI model is limited to clear-sky conditions, however to maintain surface budgets between clear observation times, relationships must be developed to estimate surface fluxes under the cloudy conditions between ALEXI clear evaluations.

A prototype algorithm has been developed to estimate fluxes on cloudy days, when GOES-based surface temperatures are unavailable and ALEXI cannot be used. In this method, it is assumed that on cloudy days, available water in the top 5 cm of soil and in the root zone is depleted by an amount consistent with the previous day's evapotranspiration (ET). Available water fractions in these water "pools" are used to estimate actual soil and canopy ET from potential values given by the Penman-Monteith equation. These available water fractions are updated by ALEXI every time a clear day is encountered.

Updates will correct errors in depletion and any rainfall/drainage that may have occurred during the intervening cloudy period.

This algorithm is currently being tested with flux and surface temperature observations collected at several sites in Oklahoma during the Southern Great Plains (SGP) '97 field experiment. Preliminary results at the Little Washita site in southern Oklahoma are encouraging. The overall goal of this portion of the ALEXI project will be to generate a running climatology of fluxes across the US. From this, we may provide to numerical forecast models (like CRAS) estimates of soil moisture, as well as flux partitioning and evaluations of their land-surface parameterizations.

II. Conferences and Publications

Two journal articles are almost complete and will be submitted to the Journal of Applied Meteorology by the end of March 2002. This work was presented at two American Meteorological Society conferences in late 2001/early 2002. One of these posters is included as part of this report (a PowerPoint presentation) which outlines the main achievements, components and outputs of this project.

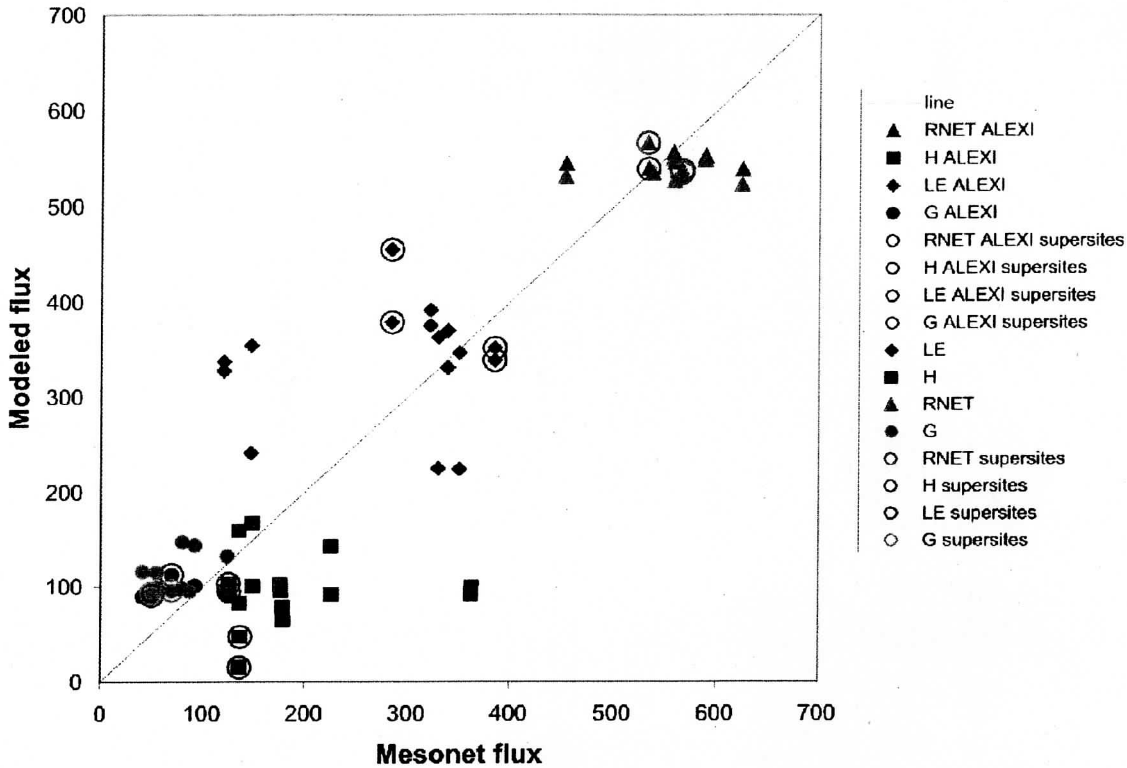
The papers are listed as follows:

Mecikalski, J. R., M. C. Anderson, G. R. Diak, J. M. Norman, S. J. Richardson, and J. A. Brotzke, 2002: The Atmospheric Land EXchange–Inverse (ALEXI) Model: Part I: Validation of Daily, Regional Land-Surface Flux Estimates from ALEXI. In progress for *J. Appl. Meteor.*

Mecikalski, J. R., R. D. Torn, J. M. Norman, M. C. Anderson, G. R. Diak, S. J. Richardson, and J. A. Brotzke, 2002: The Atmospheric Land EXchange–Inverse (ALEXI) Model: Part II: Disaggregation of 5-km ALEXI Fluxes to a 30-meter scale using LandSat-7 data. In progress for *J. Appl. Meteor.*

Diak, G. R., J. R. Mecikalski, M. C. Anderson, J. M. Norman, R. D. Torn, and J. Hoss, 2001: Realtime remote sensing-based modeling and in situ validation of land surface energy and water fluxes. In *11th Conf. Satellite Meteor. and Oceanography*, Madison, WI, Amer. Meteor. Soc., pp 39-42.

Mecikalski, J. R., R. D. Torn, J. M. Norman, M. C. Anderson, S. J. Richardson, and J. A. Brotzke, 2002: Remote estimates of surface energy fluxes on the 30-meter spatial scale. In *First Amer. Meteor. Soc. Student Conf. Special Poster Session*, Orlando, FL, Amer. Meteor. Soc.



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