JP1.10 ASSESSMENT OF IMPLEMENTING SATELLITE-DERIVED LAND COVER DATA IN THE ETA MODEL

Nicole P. Kurkowski[1,2] and David J. Stensrud[2]
[1]The University of Oklahoma, Norman, Oklahoma
[2] NOAA / National Severe Storms Laboratory, Norman, Oklahoma

1. INTRODUCTION

One of the challenges in land surface modeling involves specifying accurately the initial state of the land surface. Most efforts have focused upon using multi-year climatologies to specify the fractional coverage of vegetation. For example, the National Center for Environmental Prediction (NCEP) Eta model uses a five-year satellite climatology of monthly Normalized Difference Vegetation Index (NDVI) values to define the fractional vegetation coverage, or greenness, at 1/8 degree (approximately 14 km) resolution. These data are valid on the 15th of every month and are interpolated temporally for daily runs. Yet vegetation characteristics change from year-to-year and are influenced by short-lived events such as fires, crop harvesting, and hailstorms that will be missed using a climatological database.

Crawford et al. (2000) show that using near real-time satellite-derived values of fractional vegetation coverage and leaf area index improved the 2-m temperature simulations of the Penn State - National Center for Atmospheric Mesoscale Model version 5 (MM5) when using the Parameterization for Land-Atmosphere-Cloud Exchange (PLACE; Wetzel and Boone 1995) to simulate the land surface. To further explore the importance of the initial state vegetation characteristics to numerical weather forecasts, we examine how the Eta model responds to a similar method of initializing fractional vegetation coverage, namely by deriving vegetation fraction only from NOAA's Advanced Very High Resolution Radiometer (AVHRR) data. This approach may allow for near real-time estimations of fractional vegetation coverage to be used routinely. Numerical forecasts of the Eta model, using both climatological and near real-time values of fractional vegetation coverage, will be compared to examine the potential importance of variations in vegetation to forecasts of 2m temperatures and surface fluxes.

2. METHODOLOGY

Normalized Difference Vegetation Index images provided by the EROS Data Center are used to derive the fractional vegetation coverage. The AVHRR data used to construct these images are acquired from NOAA's polar-orbiting Television Infrared Observation Satellites (NOAA-11 and NOAA-12). Channels one and two are used to sample surface properties. Channel one measures radiation in the visible portion of the electromagnetic spectrum (approximately 0.5 micrometers), while channel two evaluates the near infrared region at approximately 0.75 micrometers. These channels are used because photosynthetically active vegetation is more reflective in the near infrared than in the visible, with the differential reflectance in the two bands a measure of the health and spatial density of the plants (Cotton and Pielke 1992). Thus, the NDVI is calculated in the following manner:

$$\mathrm{NDIV} = (\mathrm{ch2} - \mathrm{ch1})/(\mathrm{ch2} + \mathrm{ch1})$$

Not only does NOAA-11 obtain data in the early afternoon and NOAA-12 in the early morning, but the AVHRR sensor captures data across a wide swath of approximately 2,400 kilometers. Thus, when the data from multiple passes are combined and the maximum value of NDVI selected for each pixel over a two-week period, nearly cloud free images can be created. The United States Geological Survey (USGS) receives these images and then processes and distributes them. Bi-weekly NDVI composites may be acquired at: ftp://edcftp.cr.usgs.gov/orders/01ndvius/. Figure 1 is an example of one such image.

These images are then imported into a geographical information system, where they can be navigated and displayed. Once the NDVI composites are displayed, the vegetation fraction can be calculated. The vegetation fraction coverage (fVEG) used in this study is the same as that in Crawford et al. (2000) from the relationship derived by Chang and Wetzel (1991):

$$\mathrm{fVEG} = \begin{cases} 1.5\,(\mathrm{NDVI} - 0.1), & \mathrm{NDVI} \le 0.547 \\ 3.2\,(\mathrm{NDVI}) - 1.08, & \mathrm{NDVI} > 0.547. \end{cases}$$

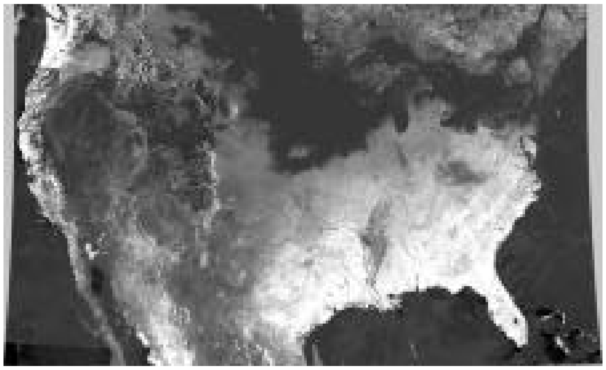

Fig 1. NDVI composite for Aug3-16, 2001

Recall that the Eta model has a spatial resolution of approximately 22 km, while the AVHRR data resolution is 1km. Thus, an objective analysis is performed on those points from the AVHRR data. Data points of fVEG within a 10-km radius of each Eta grid point are averaged and then applied to that Eta grid point.

These new values for fVEG are then placed into the Eta model. The results of the model run will be compared with that of the operational runs using the climatological values for fVEG. An example of a fractional vegetation greenness map is displayed in Figure 2 (http://www.agribiz.com/weather/visual.html). It is hypothesized that, for some cases, there will be a significant change in forecasted 2 -meter temperatures and sensible and latent heat fluxes.

3. Discussion

Several case studies will be performed for this project. Days in which a greater portion of the US is not covered in clouds will be used.

It has already been discovered that small changes, as low as ten percent, in fractional vegetation coverage result in significant changes of 2-meter temperatures, and sensible and latent heat fluxes. This clearly has an impact on differential heating. It is anticipated that implementing the near real- time fractional vegetation cover into the Eta model will result in better forecasts near the surface and within the boundary layer.

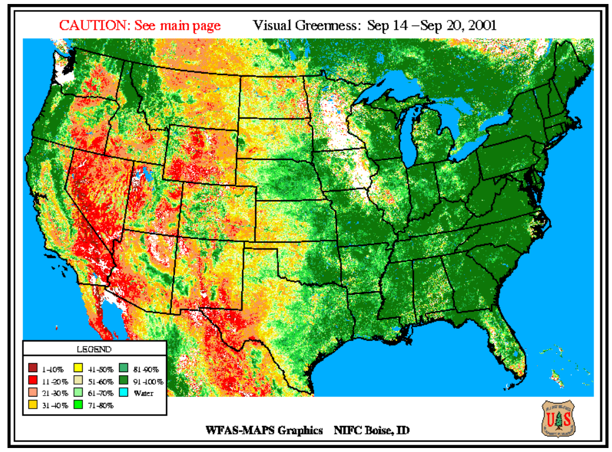

Fig 2. Greenness map for Sept 14-20, 2001

Acknowledgments. Normalized Difference Vegetation Coverage composites obtained from USGS/EROS. Thanks to the National Severe Storms Laboratory for providing the necessary equipment and software for this project. A special thanks is due to Mike Baldwin of the Storm Prediction Center for his assistance in running the Eta model.

References

Chang, J., and P.J. Wetzel, 1991: Effects of Spatial Variations of Soil Moisture and Vegetation on the Evolution of a Prestorm Environment: A Numerical Case Study. ***Monthly Weather Review***, **119**, 1368-1390.

Crawford, T.M., D.J. Stensrud, F. Mora, and J.W. Merchant, 2001: Value of incorporating satellite-derived land cover data in MM5/PLACE for simulating surface temperatures. ***J. Hydrometeor., 2***, 453-468.

Cotton, W.R., and R. Pielke, 1992: ***Human Impacts on Weather and Climate***. Aster Press, 85-110.

Gutman, G., and A. Ignatov, 1998: The derivation of the green vegetation fraction from NOAA/AVHRR data for use in numerical weather prediction models. ***International Journal of Remote Sensing***, **19**, 1533-1543.

Mecikalski, J.R., and G.R. Diak, 1998: Estimating Fluxes on Continental Scales Using Remotely Sensed Data in an Atmospheric-Land Exchange Model. ***Journal of Applied Meteorology***, **38**, 1352-1369.