Development of Spatial Data Management System to Estimate Regional Evapotranspiration Using a Land Surface Parameterization

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1. Introduction

A land surface parameterization has been used to simulate influences of the terrestrial surface on the atmosphere. A simple biosphere model (SiB2), one of land surface parameterization, calculates exchange of radiation, sensible heat, latent heat, and momentum between the surface and the atmosphere (Sellers, et al., 1996). Especially, SiB2 utilizes not only soil property that has spatial variability but also vegetation state and phenology that vary in time and space. Input data that include site-specific information, therefore, makes it inconvenient to estimate energy fluxes within a region using SiB2. However, application of geographic information system makes it easy to use SiB2 by automating generation of input data set for SiB2. In this study, a data management system for SiB2 was developed to estimate regional evapotrasnpiration (ET) in Kyunggi province, South Korea.

2. Materials and Methods

A spatial data management system (ArcVDM) consisted of a graphic user interface (GUI) and function libraries based on object oriented programming (Figure 1). The GUI and the libraries were written in Microsoft Visual Basic 6.0 and Visual C++ 6.0, respectively. ArcVDM library included objects to process grid, text, and data for SiB2. First, a grid input object read data at a (I, J) point from multiple grids and assigned the values to variables of SiB2 objects. Then, text output objects generated two kinds of SiB2 input files, called Data1 and Data2. A Data1 file contained time-invariant parameters that included phenological, optical, and physiological property of a canopy as well as soil property at a given site. Especially, an NDVI grid, which generated from remote sensing data, was used to estimate parameters to describe vegetation state and phenology. Soil property and vegetation cover grids were also used to create Data1 files. Data 2 files was generated from grids that contained hourly forcing variables, which were air temperature, solar radiation, precipitation, water vapor pressure, and wind speed. Once SiB2 input files were prepared, a SiB2 program based on DOS (disk operating system) was executed for every site within the region using the GUI. Since the SiB2 program was used to estimate ET at each site, numerous output files were generated. Thus, text input and grid output objects were utilized to collect output text file and generate grids for hourly latent heat flux, respectively.

2.2. Estimation of ET in Kyunggi area

Grids associated with input data of SiB2 were prepared to estimate ET in Kyunggi region (Figure 2). For Data1, a vegetation cover and soil property grid was obtained from Ministry of Environment and Korea Agricultural Science and Technology Institute, respectively. A NDVI grid was prepared using NOAA data. Hourly forcing grids for Data 2 were produced by spatial interpolation using standard weather data from Korea Meteorology Administration during periods from June 27 to July 4 and from August 18 to 26.

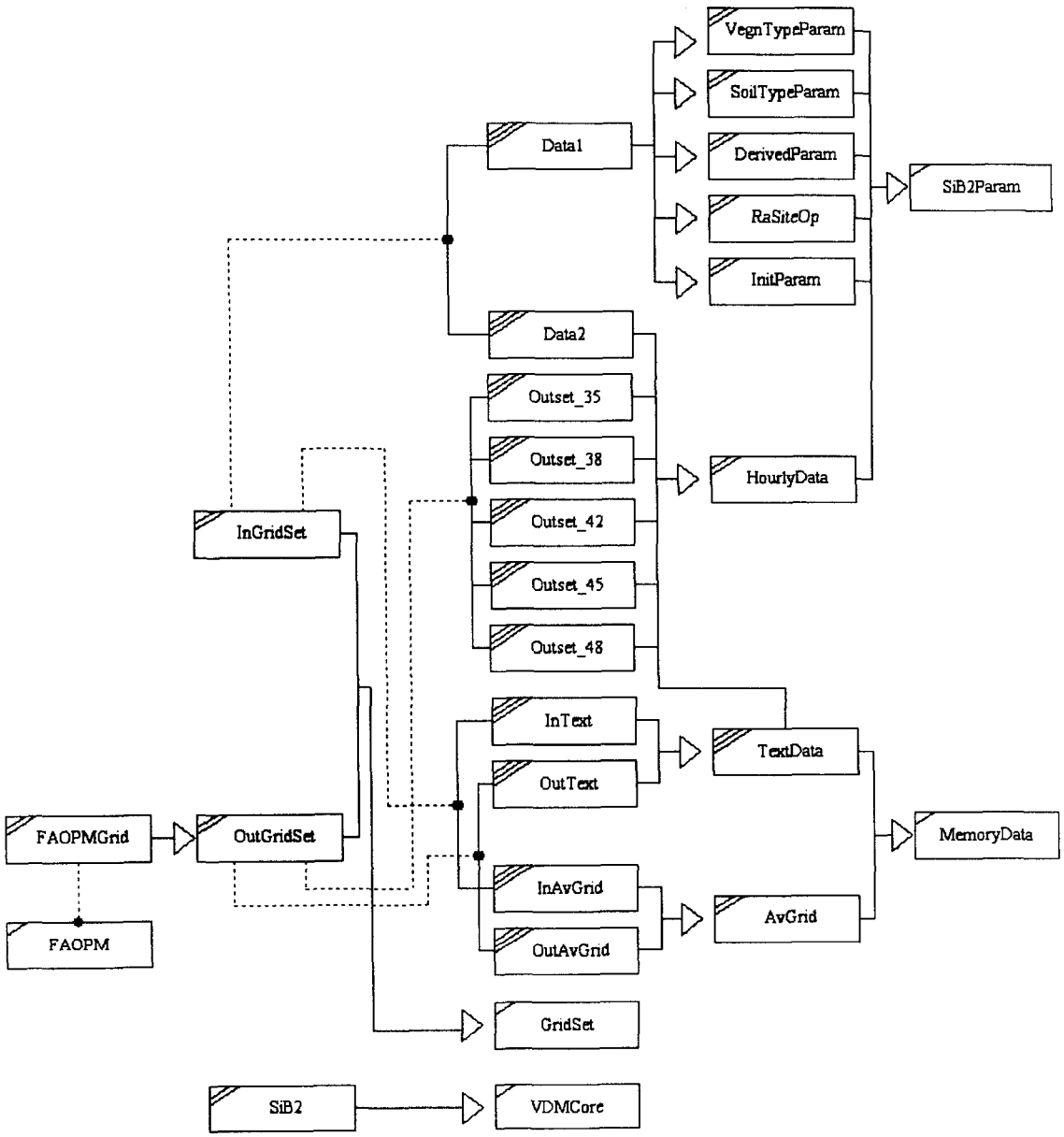

Figure 1. Hierarchy of ArcVDM classes. ▷ indicates inheritance between parent and child classes.

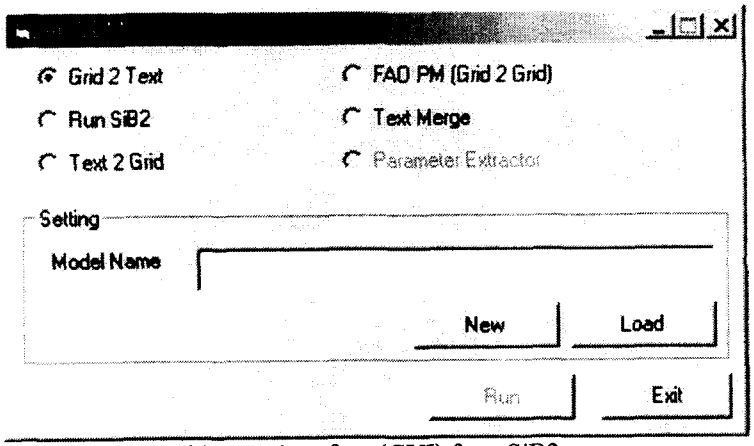

Figure 2. A graphic user interface (GUI) for a SiB2 program

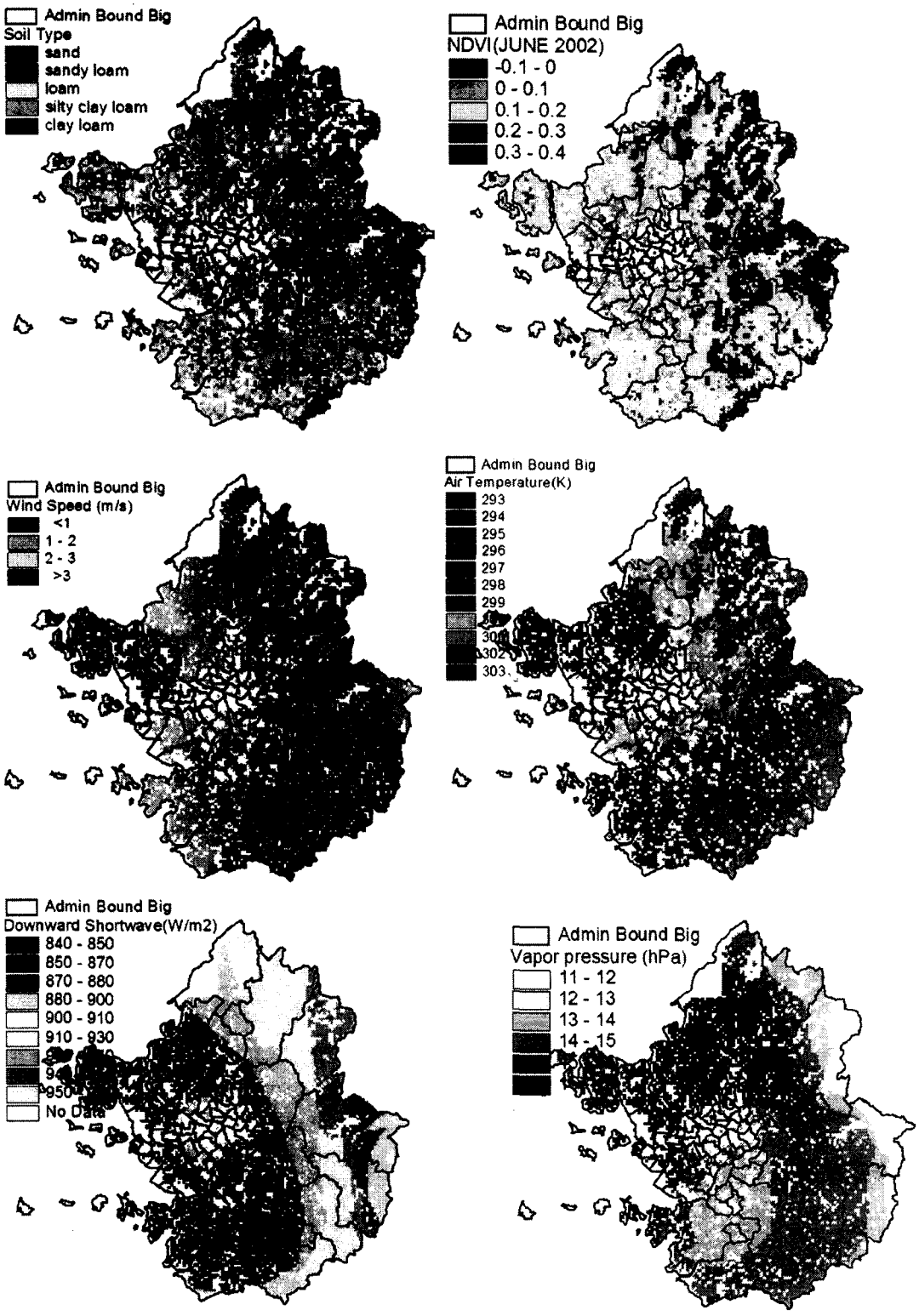

Figure 3. An example of input grids for SiB2. Grids for air temperature, solar radiation, water vapor pressure, and wind speed was obtained from spatial interpolation.

3. Results

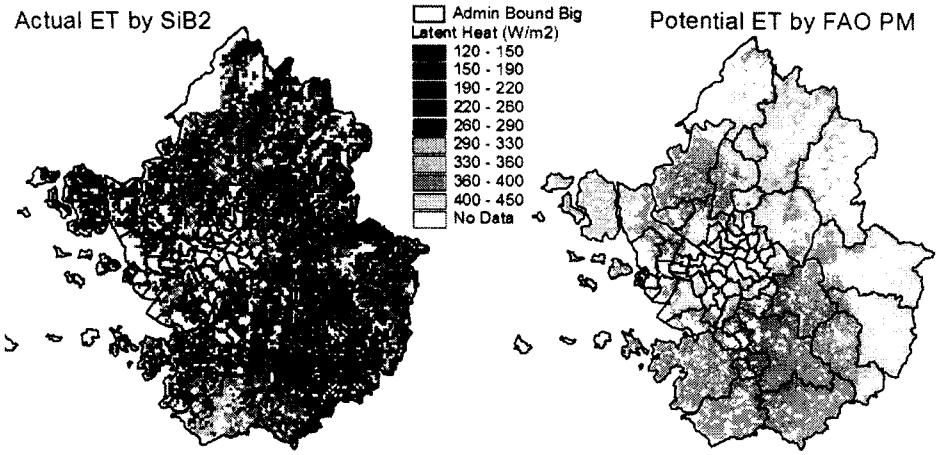

Figure 4. output grids of ArcVDM to estimate evapotranspiration (ET) using SiB2 and FAO PM equation at 1pm on June 27 2002.

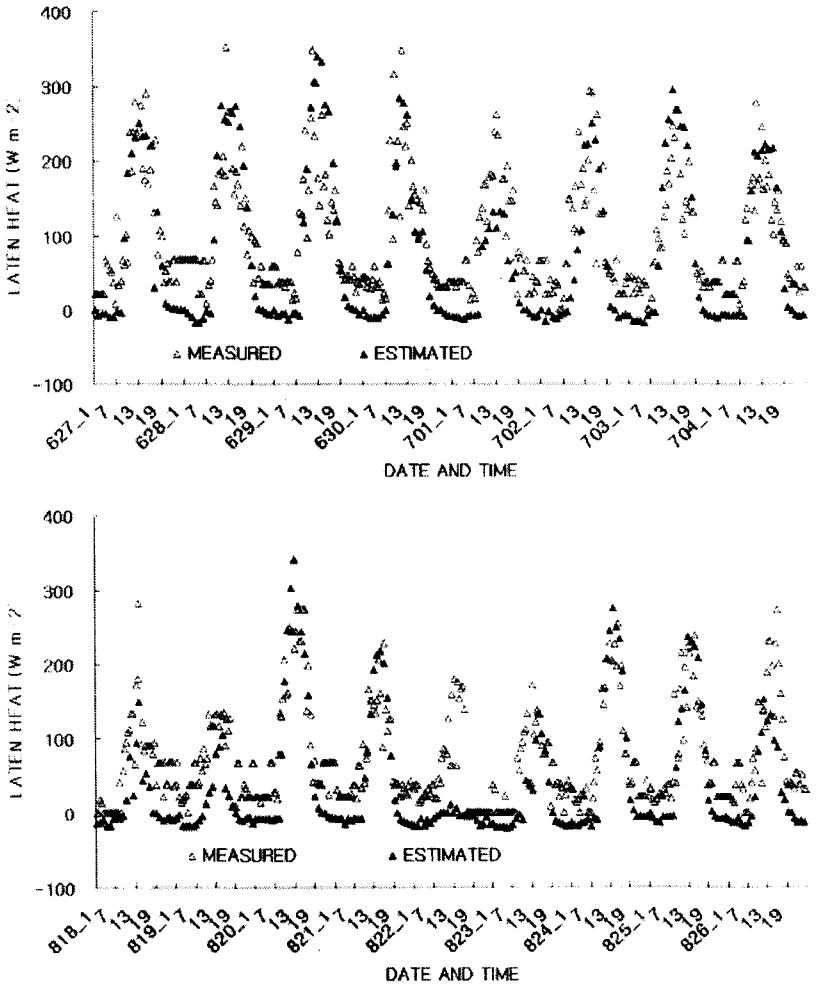

Figure 5. Comparison of latent heat flux measurement and estimates of SiB2 using input data generated by ArcVDM

4. References

P. J. Sellers, D. A. Randall, g. J. Collatz, J. A. Berry, C. B. Field., 1996: A Revised Land Surface Parameterization (SiB2) for Atmospheric GCMs. Journal of Climate 9:676-705.