Applying A 2D Binning Method To The Simple Biosphere Model (SiB) For Improving The Representation Of Soil Moisture Heterogeneity

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Motivation

- Representing the spatial heterogeneity of soil moisture over length scales of General Circulation Model (GCM) grid areas is a continuing challenge.

- Using a finer GCM spatial resolution may never resolve the scaling problem, and other methods need to be used to represent the subgrid variability and surface dependent nonlinear processes.

- For this study, the methods of *Sellers et al.* (2007) are applied to lower atmospheric forcings used in the Simple Biosphere Model (SiB).

Applying The Methods

- The Methods of *Sellers et al.* (2007) were used with SiB point by point (pbp) runs for a one month period (July) at the ARM site in north central Oklahoma.
- Sellers applied these methods to soil moisture values for a highly simplified toy model, but for this study, the methods were applied to all lower atmospheric forcings (temperature, relative humidity, wind, pressure, short wave radiation, long wave radiation, convective precipitation, and stratiform precipitation).
- Seven complete driver sets of lower atmospheric forcings for the month of July were extracted from a seven year record (January 2001-December 2007) at the ARM site.
- All of the driver sets were forced with the same amount of monthly precipitation that occurred at different times and at different rates for each set. The precipitation events were based on observations and artificial storms.

Method I (Area Integrated)

- An arbitrary grid area (normalized to a unit area (1.0)) was divided into 100 cells each defined by a SiB pbp run.

- The grid area was then divided into seven different fractional areas, and each fractional area was assigned a driver set.

- The individual cells within each fractional area used their assigned driver set to run SiB. For every time step (10 minute time step), a SiB pbp run occurred for every cell (100 individual runs) and output was area integrated to give a single grid area value.

- This method was expensive computationally and cost wise, and was taken as the standard for judging the other methods.

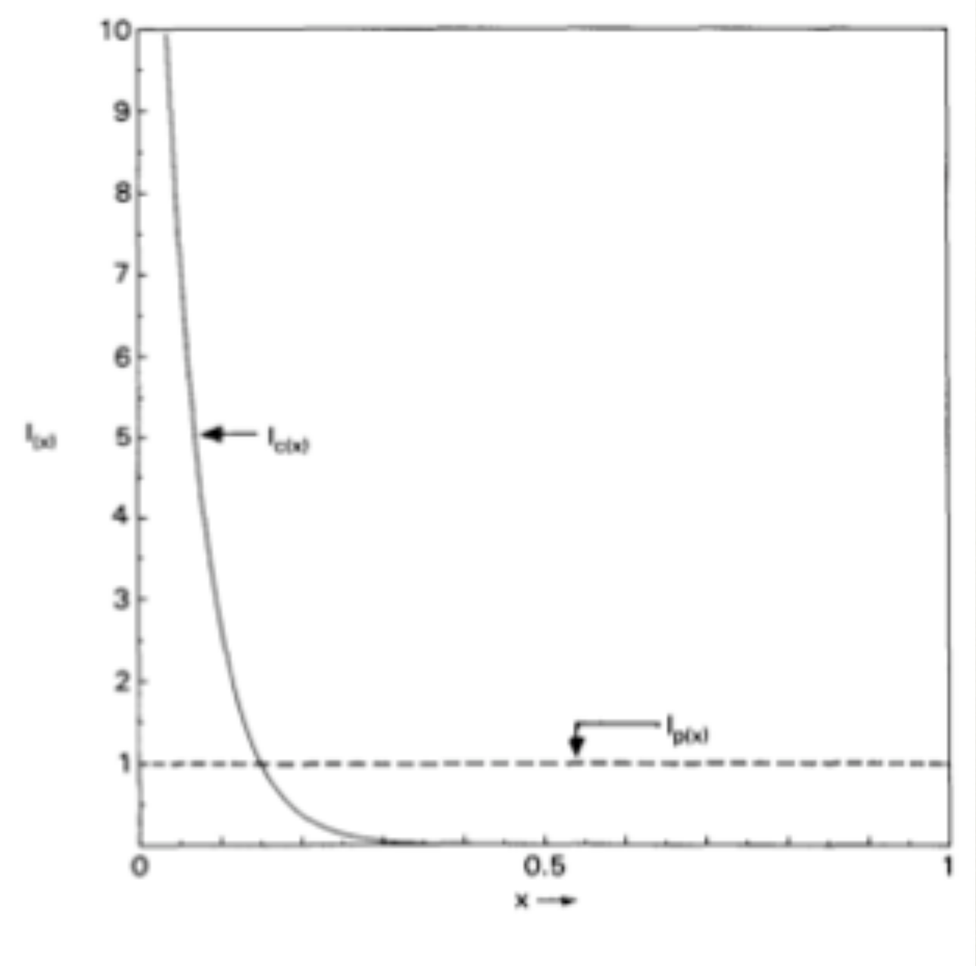
Method II (Area Averaged)

- The grid area was defined by a single SiB pbp run.
- For every time step, an area weighted average of the lower atmospheric forcings for the 100 driver sets used in method I was calculated, and only a single SiB pbp run occurred.
- The output from that single SiB run gave a value for the entire grid area.
- This method was the cheapest computationally and cost wise.

Method III (Binned)

- The grid area was divided into 5, 10, and 20 (bin size) individual SiB pbp runs.
- For every time step, precipitation was binned for the 100 driver sets used in method I, and all lower atmospheric forcings associated with each precipitation value were assigned to the same bin.
- SiB was run bin number of times, and the output from the runs was multiplied by the appropriate fractional area and summed to give a single grid area value.
- This method was not the cheapest computationally and cost wise, but gave results that were very close to those of method I.
- These methods were used for two experimental precipitation events over the grid area for the preliminary results of this study.
- The first experiment used all convective precipitation and the second used all stratiform precipitation.

Precipitation In SiB



Precipitation area-amount relationship used in SiB. The variable x refers to fraction of the grid area, the variable I(x) refers to the relative amount of precipitation. Note that the large scale precipitation I_p (x), is almost invariant over the grid area while convective precipitation, I_c(x), is non-uniformly distributed.

Sato et al. (1989b)

Preliminary Findings

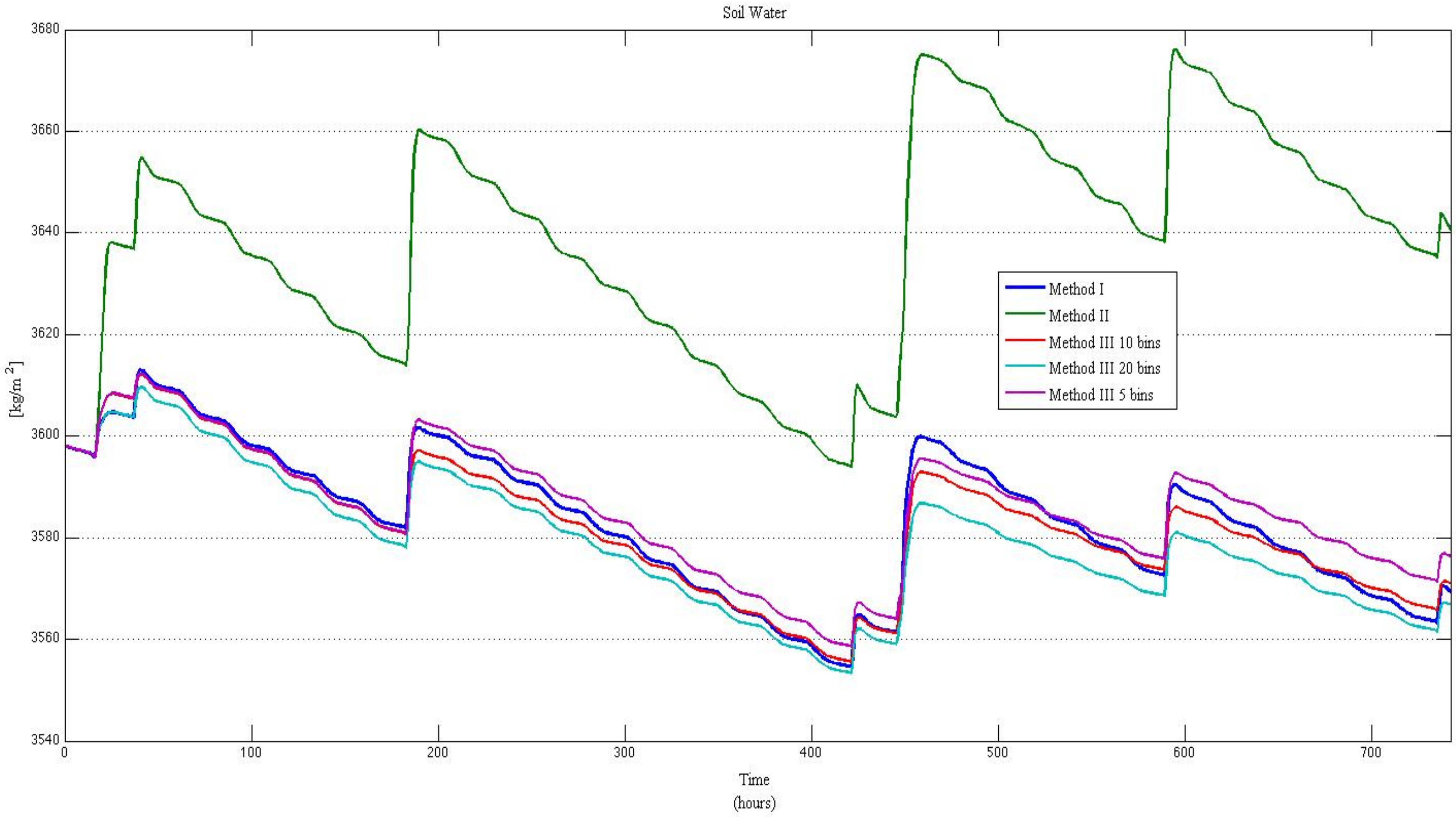


figure 1. Time series of integrated soil water as calculated by the different methods for the convective precipitation experiment.

Preliminary Findings

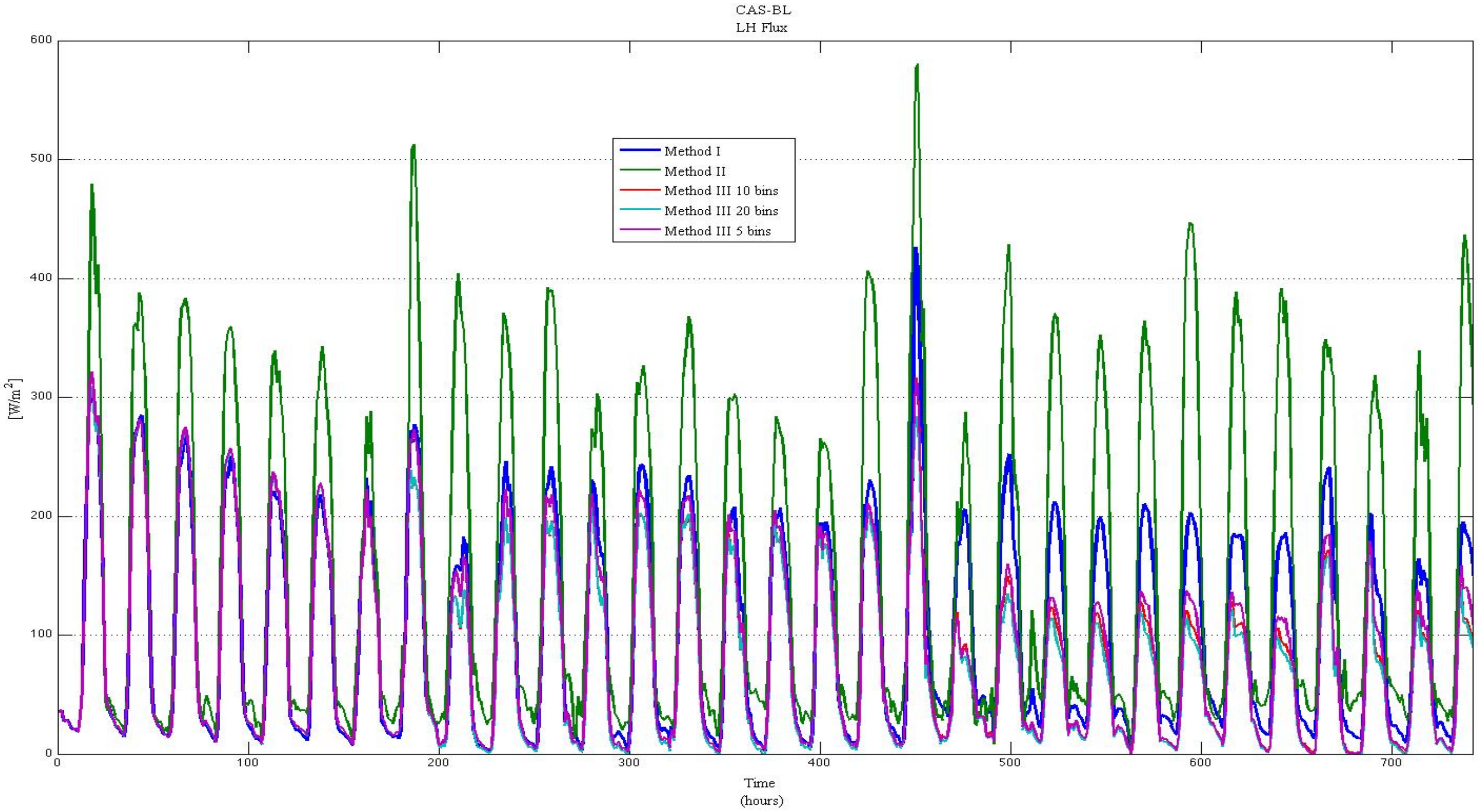


figure 2. Time series of the CAS-BL LH flux as calculated by the different methods for the convective precipitation experiment.

Preliminary Findings

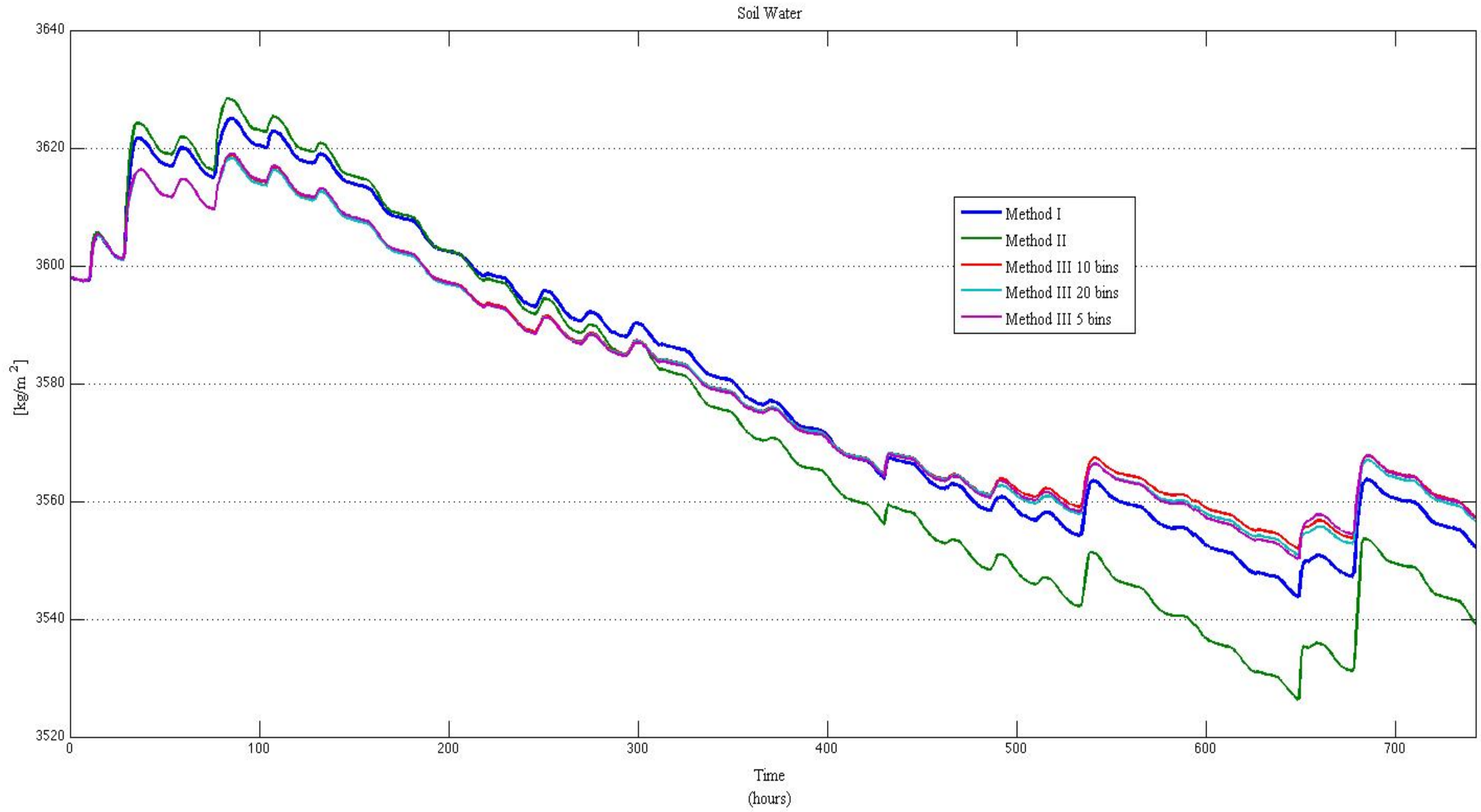


figure 1b. Time series of integrated soil water as calculated by the different methods for the stratiform precipitation experiment.

Preliminary Findings

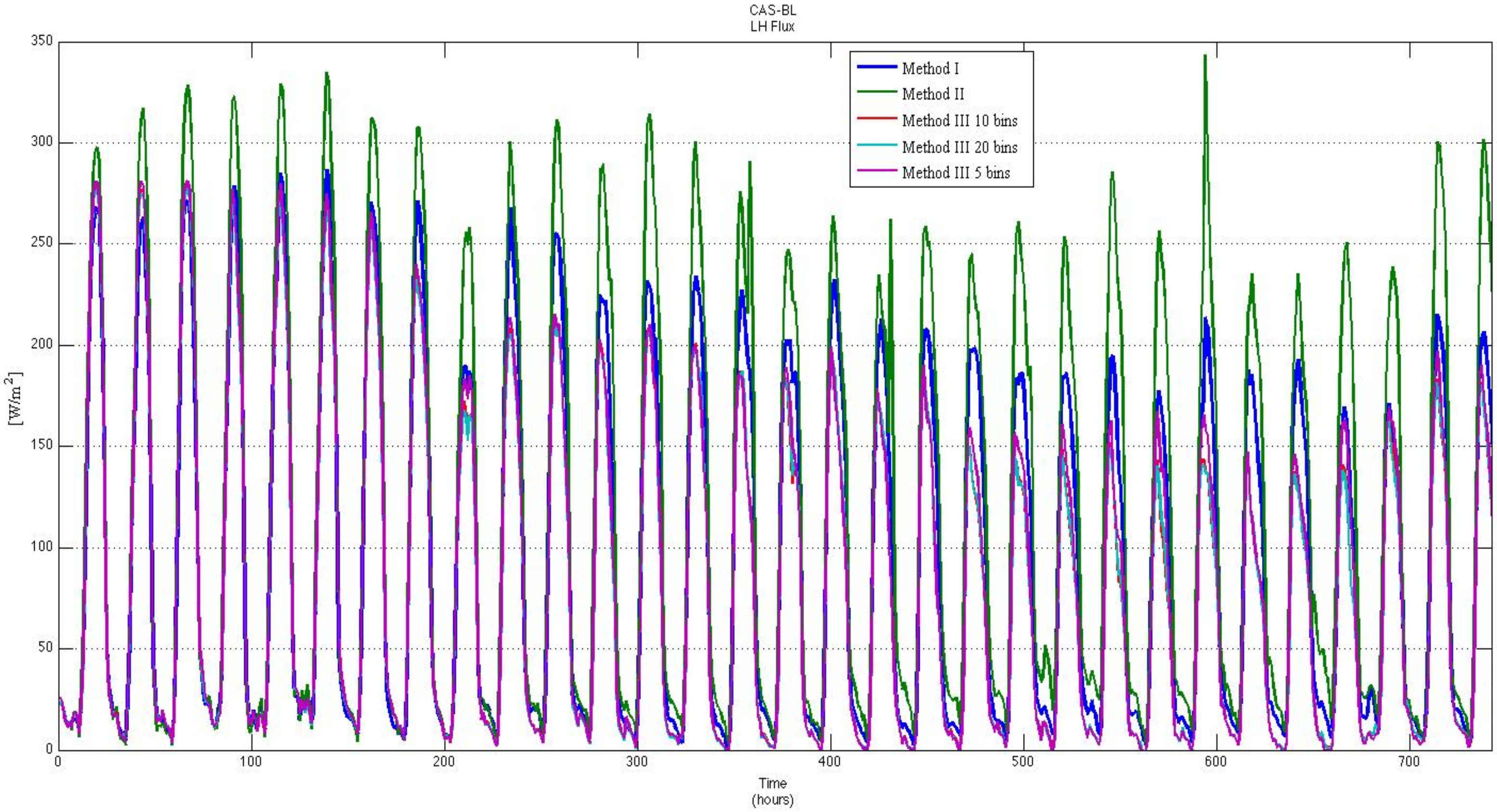
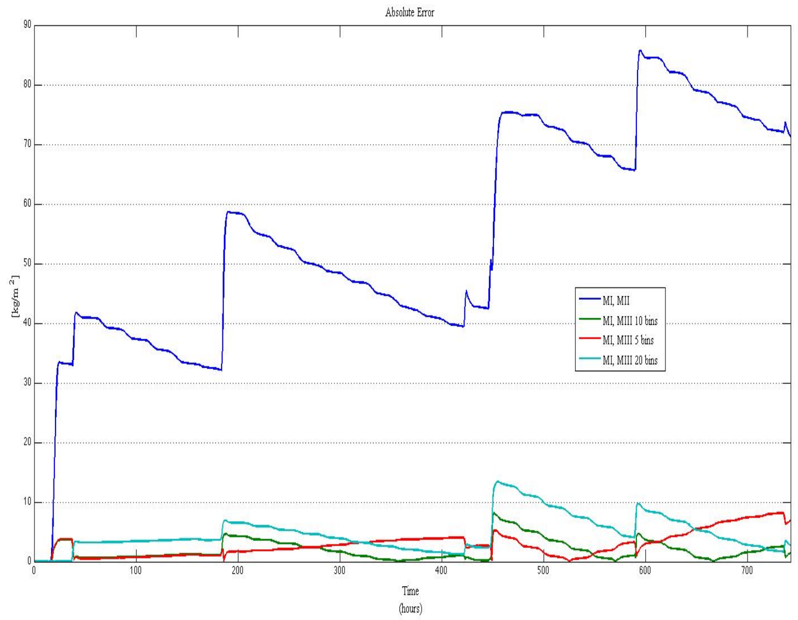
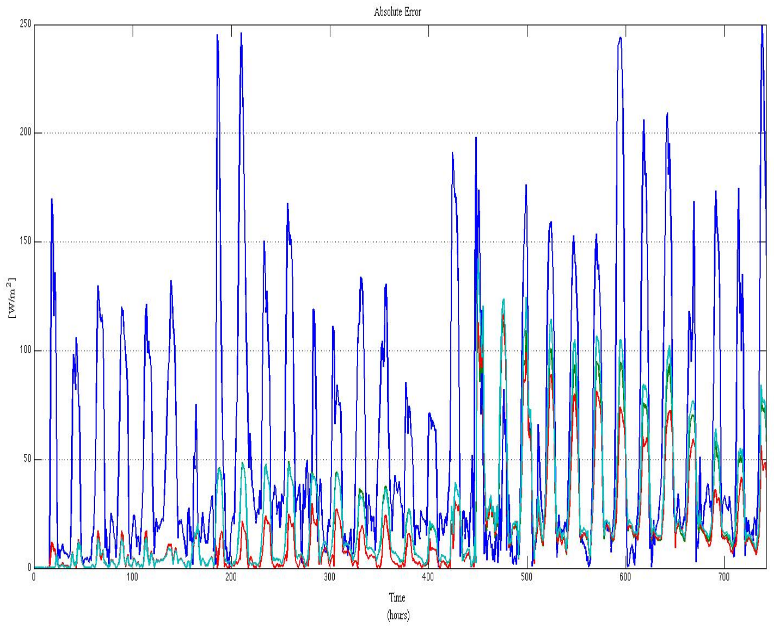


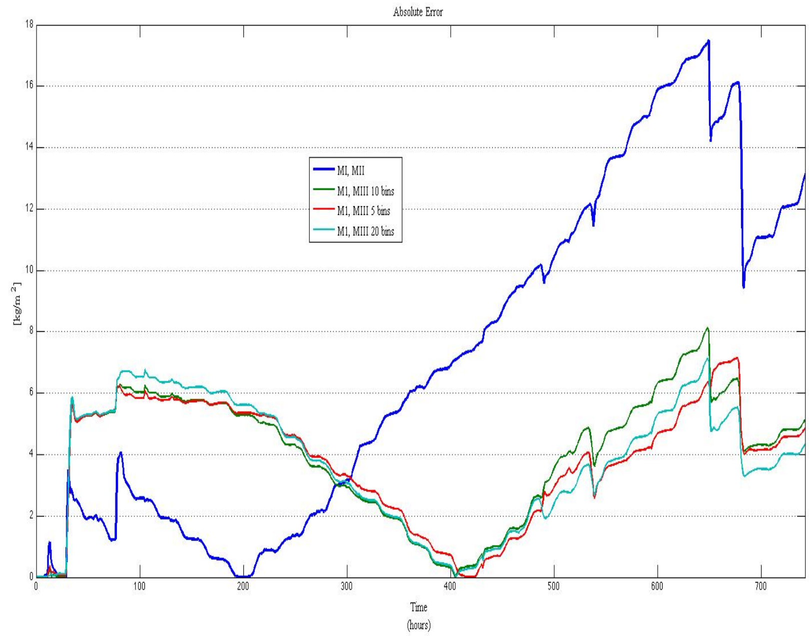
figure 2b. Time series of the CAS-BL LH flux as calculated by the different methods for the stratiform precipitation experiment.

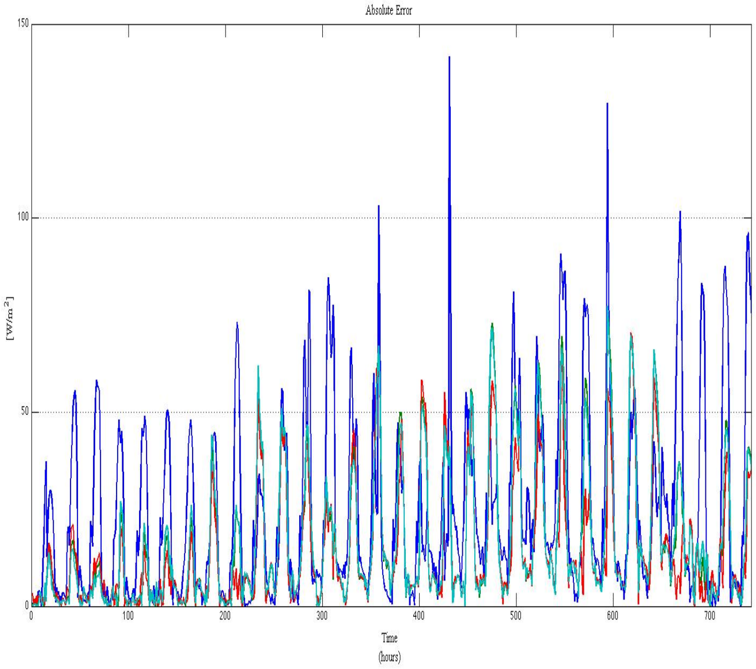
Absolute Errors





Absolute Errors





Summary/Continuing Work

- Preliminary results indicate that simple area averaging, as used with GCMs (method II), of lower atmospheric forcings is more problematic when convective precipitation occurs.
- After comparing all methods to method I and calculating absolute errors, method III is better at estimating soil water and CAS-BL fluxes.
- As this research continues, we hope to find similar results when a statistical weather generator is applied to the grid area.
- The weather generator will supply time series of lower atmospheric forcings that will be different for every SiB pbp defining the grid area (100 pbp's).
- This will allow for great variability both in the lower atmosphere and land surface.
- With this research we hope to improve the representation of soil moisture and CAS-BL fluxes by using method III and avoiding the high computational cost of method I and erratic behavior of method II.

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