PART I

GENERAL DESCRIPTION

Welcome to Simsphere, a state-of-the-art Soil-Vegetation-Atmosphere Transfer (SVAT) model for use by the general scientific community. Simsphere is the product of 30 years of continuous use by my students and myself at Penn State. That means it has been thoroughly tested under many different conditions and almost never crashes when reasonable parameters are used as input.

Simsphere is a one-dimensional model that simulates the transfer of heat and moisture among plants, soil and atmosphere over a time period specified by the user. The model demonstrates the evolution of the sensible, latent, radiative and other energy fluxes among a vegetated or bare soil surface, the soil and the atmosphere. Simsphere also describes the evolution of the atmospheric sounding, moisture, temperature and wind during the course of a day.

Three decades after its launch, Simsphere is still one of the best models of its kind. Feel free to use the model any way you please. You may download the codes (written in Fortran and C), incorporate any or all of the components (subroutines), cannibalize them into new models or simply use the present version. You might need to adapt some code to current I/O on newer computers.

You don't need to know much about meteorology, plant physiology or soil dynamics to use Simsphere. However, the resulting mathematical descriptions of these processes are detailed and complex. The following describes some of its components

The workbook is a Simsphere tutorial. An interactive online workbook leads users on a step-by-step tour of increasing complexity through the model. Chapters illustrate features such as the behaviour of plants under stress, the creation of the turbulent mixing layer in the atmosphere and the drying of soils. The workbook provides a mathematical description of the model components and an extensive background description,

including a discussion of the science behind the equations. Each chapter concludes with illustrative simulations executed or suggested by the user.

Note that the full Simsphere code has many facets not accessible in the web version, such as plant water storage, alternate stomatal resistance formulations, water content as a function of height in the soil, etc. If you choose to work with the full version of Simsphere from the original code, you may choose to explore or modify these components.

Simulations provided in this workbook are not fully tested due to their complexity. If one does not work properly, please contact me. A common reason for crashing the model is untenable initial parameters. Such a result can teach the user a valuable lesson about situations that are not possible in a real biosphere.

Tables of the I/O parameters needed for execution of the model are included. This shows a short and a long version of the input variables. The short table includes maximum and minimum values for operation The output shows a number of variables, such as heat and moisture fluxes, at half-hour intervals (the model operates at 3-minute intervals). The columns are truncated, but you can view the full label, including units, by dragging the column borders to expand the field width.

We also include some other codes, a C++ listing showing the entire web code. Be aware that this and the earlier Fortran 77 codes contain some minor errors that were removed from the Fortran 90 version.

Various published papers relevant to understanding Simsphere:

A: Validation of Simsphere: a paper by George Petropoulos et al. describing the output of simulations made with Simsphere versus actual measurements.

B: 1990 paper by Lynn and Carlson addressing a derivation of plant components in Simsphere.

C: 1991 paper by Carlson and Lynn addressing a derivation of the plant water storage component in Simsphere.

D: 1996 paper by Olioso et al. addressing simulations by Simsphere over cotton and comparisons with measurements.

E: 1999 paper by Grantz et al. addressing simulations made over cotton and the effects of ozone on stomatal resistance, including a comparison with measurements.

The user is free to download all the material on this site, although the web material itself is read-only. I welcome all who wish to contact me for help in understanding Simsphere. I once knew every line in the code and every equation in the model, but I may no longer remember every facet of Simsphere, including compilation procedures for the code. Although I might not be able to help you with machine or I/O problems, I urge you to contact me about the science or applications of Simsphere. My email is **tnc@psu.edu** and my office phone is 814-863-1582. Leave a message on my phone, as I am usually away from my desk.