

## MODEL FOR CALCULATING CONSUMPTIVE USE (IDSCU)

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### ABSTRACT

The Integrated Decision Support Group at Colorado State University has been working with a group of water users from the South Platte in Colorado to develop different tools to meet their modeling and data needs. As part of this effort a consumptive use model called the Integrated Decision Support Consumptive Use Model (IDSCU) has been developed. The model calculates water use using multiple ET equations, can compare the results of different ET equations, and shows how water supplies and weather combine to form the depletions of ground and surface water for each modeling area. Users can enter water supplies from multiple sources such as wells or ditches. IDSCU can generate an irrigation schedule based on the user-supplied information such as crop characteristics, soil characteristics and crop rooting depth. IDSCU can also be used to determine the amount of groundwater irrigation that is required if the user has surface water that is augmented by well water. The model has the ability to access weather data on the internet from Coagmet (Colorado), Northern Colorado Water Conservancy District (Colorado), ET Toolbox (New Mexico), AZMET (Arizona) and CIMIS (California). The user can setup templates with weather and crop information for an area, which can be used as the basis for new datasets covered by the same area. Templates store crop characteristics, crop coefficients, water supplies from ditch diversion records and weather information. It can be downloaded from the web [www.ids.colostate.edu/projects/idscu](http://www.ids.colostate.edu/projects/idscu). The presentation will give an overview and provide examples of applications of the model.

### INTRODUCTION

The Integrated Decision Support Group at Colorado State University has been working with a group of water users from the South Platte in Colorado to develop tools to meet their modeling and data needs. As part of this effort a consumptive use model called the Integrated Decision Support Consumptive Use Model (IDSCU) has been developed. The model has the capability of calculating the water use by means of multiple ET equations, comparing results if different ET equations are used, determine the water demand for multiple fields (the model allows the user to enter either individual fields, groups of fields (farms) or whole canal systems). The users can enter water supplies from multiple sources (wells or ditches) and the IDSCU will calculate a water budget for each field. In addition, the IDSCU can generate an irrigation schedule based on the user-supplied information regarding maximum allowable depletion for each crop, soil characteristics and rooting depth. The IDSCU can also be used to determine the amount of supplemental irrigation that is required if the user has surface water available (diversion records) that is

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being augmented by well water. Currently this model has the ability to automatically access weather data (assuming the user is connected to the internet) from Coagmet (Colorado), Northern Colorado Water Conservancy District (Colorado), ET Toolbox (New Mexico), AZMET (Arizona) and CIMIS (California).

The IDSCU Model can compute monthly CU using the SCS Blaney Criddle, Calibrated Blaney-Criddle, Hargreaves, and Pochop methods. Daily CU estimates can be computed by the model using the Penman-Monteith, Kimberly-Penman, Penman 1948 and the new ASCE standardized reference evapotranspiration equation. In addition the model allows the user to enter a user supplied ET which is currently being use to compare the results from ET calculated from remote sensing by importing the ET estimates from models such as the Remote Sensing of ET (ReSET) developed by Elhaddad and Garcia (2008).

The IDSCU Model has a Graphical User Interface (GUI), and the main window is shown in Figure 1. On the lower right hand side of the main screen are a number of buttons that allow the user to access pop-up screens for entering or modifying crop characteristics, crop coefficients, weather data, surface water supplies, modeling area information, well information, and the weather stations that apply to each modeling area.

The IDSCU Model allows users to generate data based on historical data. The user may generate pre- or post-historical data by averaging selected years, repeating a selected year, or repeating a sequence of years (Figure 2). The model is also capable of generating input and output displays for all year types (calendar, irrigation, and water).

Weather data is needed to calculate reference ET, so the user must input the latitude and longitude, elevation, and height of temperature and wind measurements of each weather station. Depending on the ET method, the model uses yearly frost dates, daily minimum and maximum temperature data, precipitation, solar radiation, and wind speed. The user then associates a group of weather stations to each modeling area by assigning a weight based on each station's influence on the area.

The model can calculate CU or Irrigation Water Requirements (IWR) with or without using soil moisture. The model can use supplies from ditch allotments and apply them to the consumptive use computed for crops. If the crop is still short of water, the balance is assumed to come from ground water wells or be shown as a shortage depending on the options selected in the well information window. The GUI allows users to compare the CU computed with different methods and computes ratios between the different methods. This allows users to evaluate the difference between ET methods as well as provide some guidance for users if they are interested in calibrating a monthly method based on the differences between the monthly aggregated values of daily ET methods.

When pumping records are available, users may enter either monthly or total annual pumping. If the user enters total annual pumping the model will distribute the pumping into monthly values based on whether the well is agricultural or non-agricultural. The model also allows the user to enter a Presumptive Depletion Factor (PDF) for each well. The PDF is a calculated factor that estimates the amount of pumping that is used to meet CU. If the user provides values for pumping and a PDF, the model calculates the

depletions of groundwater to meet crop CU as pumping multiplied by PDF. The amount of groundwater depletion can also be calculated based on the ET method(s) and a water budget. The depletions of groundwater based on both PDF and ET can be compared to check if the two values of depletion of groundwater are similar.

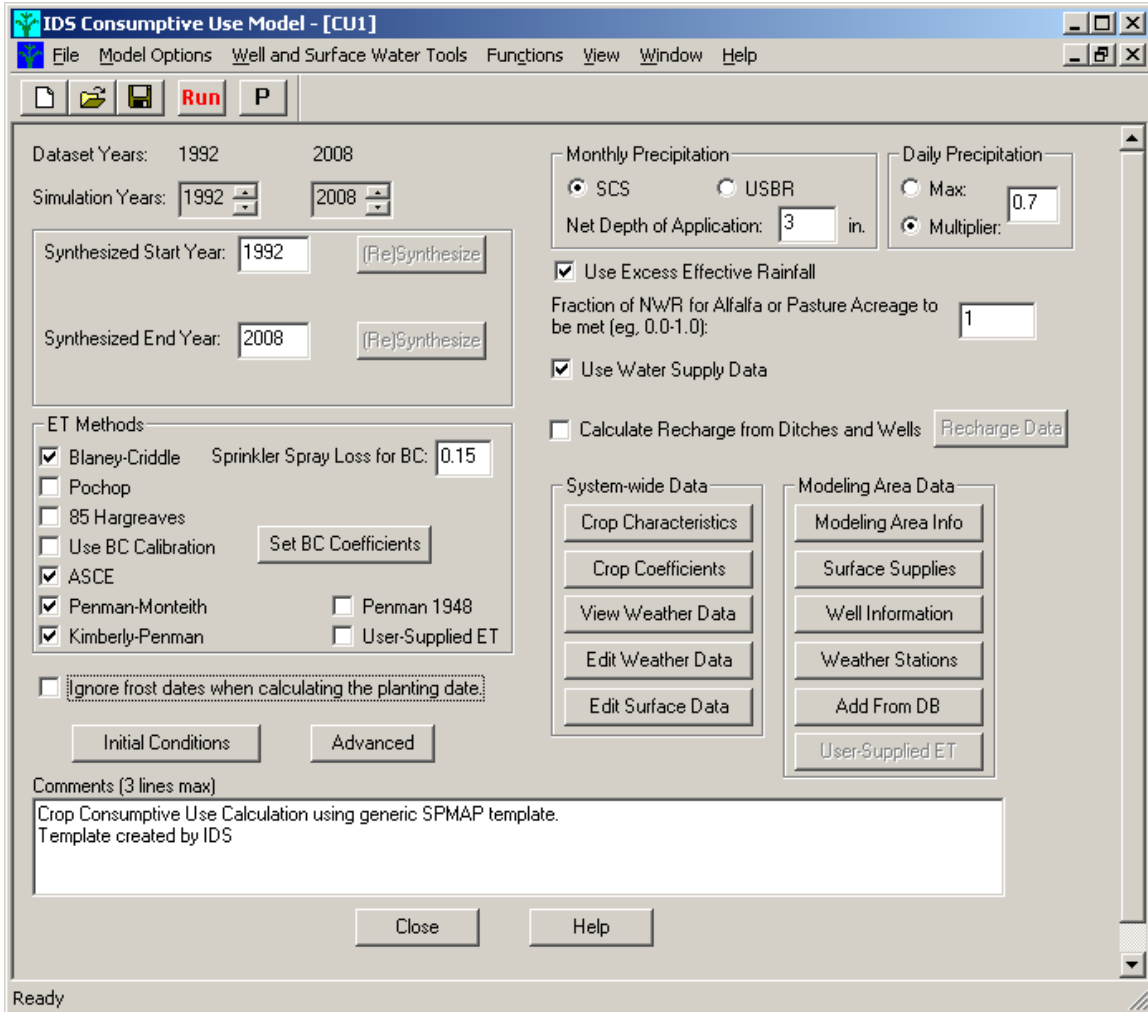


Figure 1. IDSCU Main Interface Window.

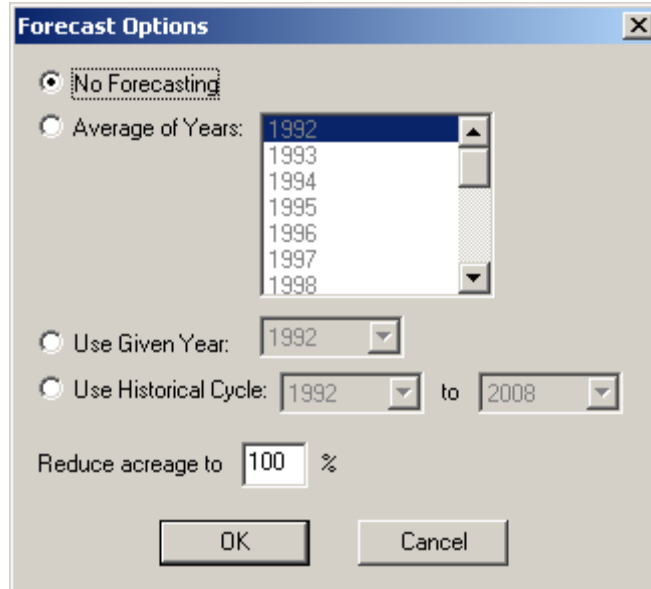


Figure 2. IDSCU Forecasting Options.

## QUANTIFICATION OF WATER SUPPLIES

Water supplies are normally from two sources, surface water and groundwater pumping. The model allows users to query the State Engineers Office database for Colorado (Hydrobase) to generate a set of diversion records for different ditches or diversion structures. Users may also build a set of diversion records for different ditches or diversion structures by entering the diversion records manually. The surface supply for each modeling area is then calculated by assigning one or more surface supply ditches or structures to it. The IDSCU Model requires users to enter the shares for each ditch or structure that are owned by each modeling area (Figure 3). The amount of shares for a particular ditch that are assigned to a modeling area can vary from year to year enabling users to evaluate the impact of leasing water in certain years. In the event that the user has headgate diversion records, these can be entered for each modeling area.

For groundwater pumping, users may enter monthly groundwater pumping, or if the user only has total annual pumping, the model has the ability to distribute annual pumping into monthly values for agricultural and non-agricultural wells.

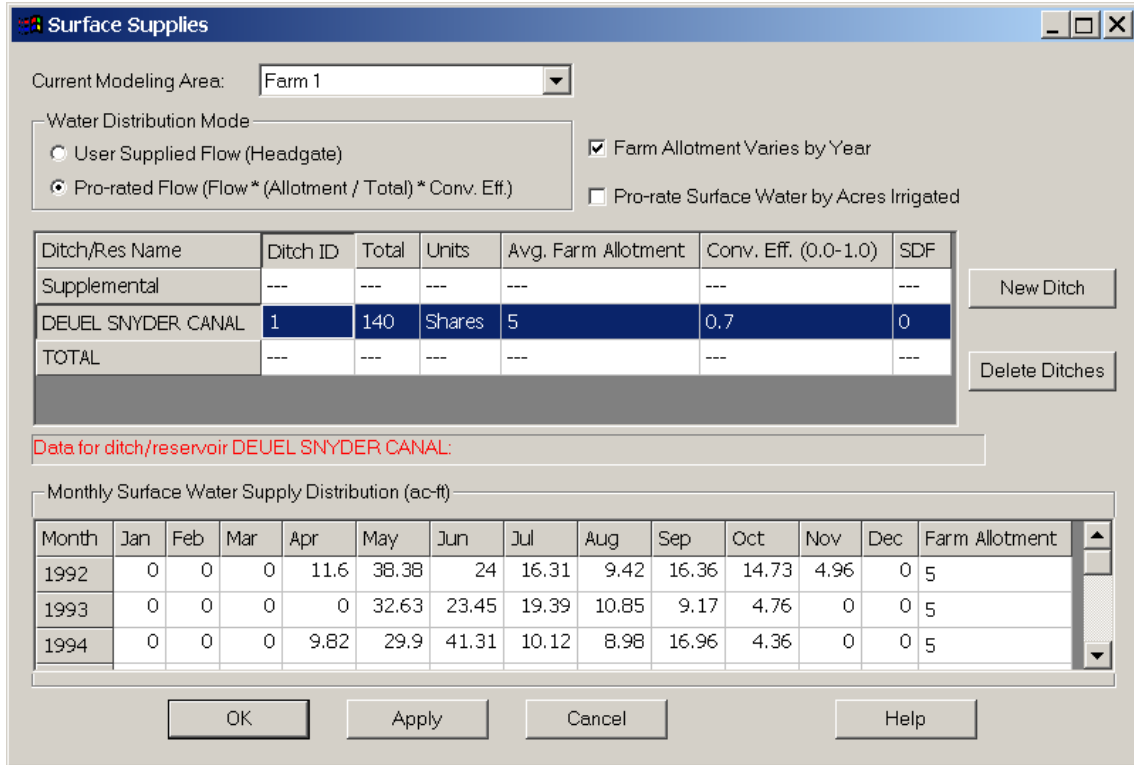


Figure 3. IDSCU GUI for Surface Supply Options

**QUANTIFICATION OF DEPLETION OF GROUNDWATER**

After obtaining an estimate of the water demand and supply, the IDSCU model can compute depletions of both surface and groundwater with or without a soil moisture budget (Figure 4). Users may evaluate the impacts of the groundwater depletions based on whether the groundwater is a primary or supplemental source of water and if the well’s efficiency is based on a PDF. The model allows the user to display all components of the water budget. The user has the option of evaluating a water budget with or without soil moisture. Once the user selects either with or without soil moisture the model displays a window (Figure 5) with all components of the water budget. The user can then select to view different components of the water budget but selecting the different components from the upper right side of Figure 5. As the user select different components those components are shown on the bottom part of the screen. The user has multiple options of the time step to see the data (daily, monthly or yearly). The results may be plotted with the click of a button using the IDSCU Model’s built-in graphics package (Figure 6). Users may compare the results of different ET methods (Figure 7) by selecting two methods and displaying the ET estimates for each method as well as the ratio of the two methods.

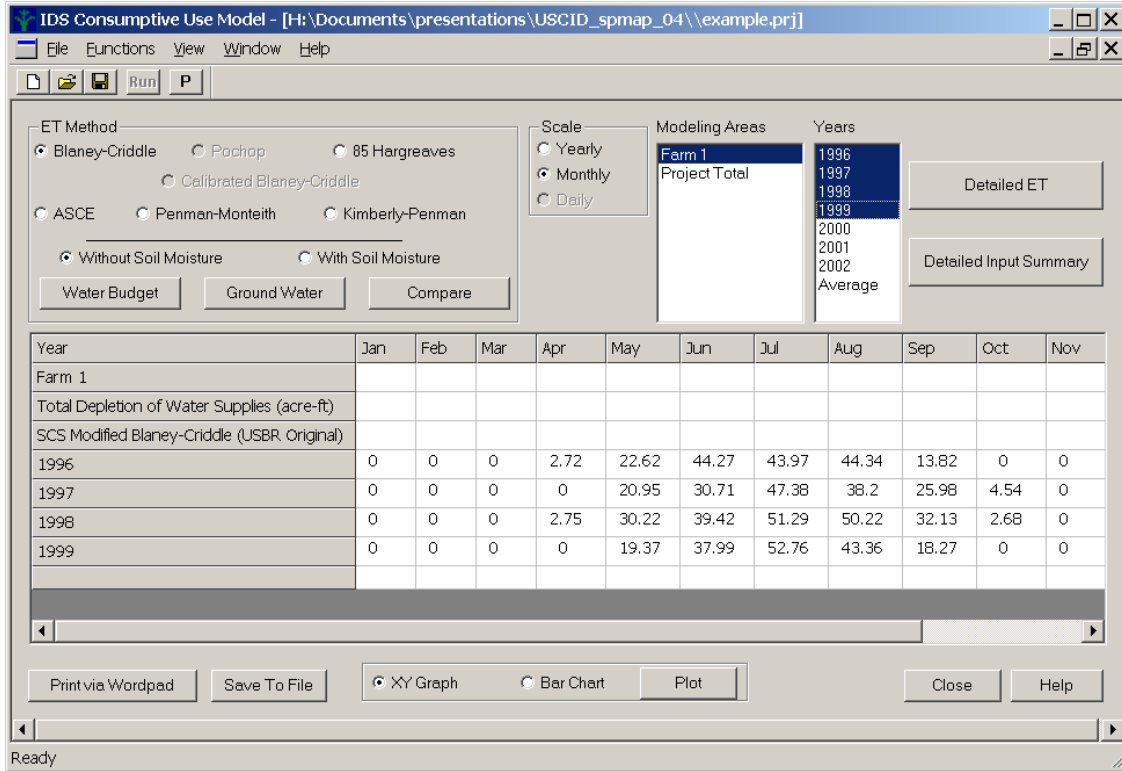


Figure 4. IDSCU GUI General Output Screen.

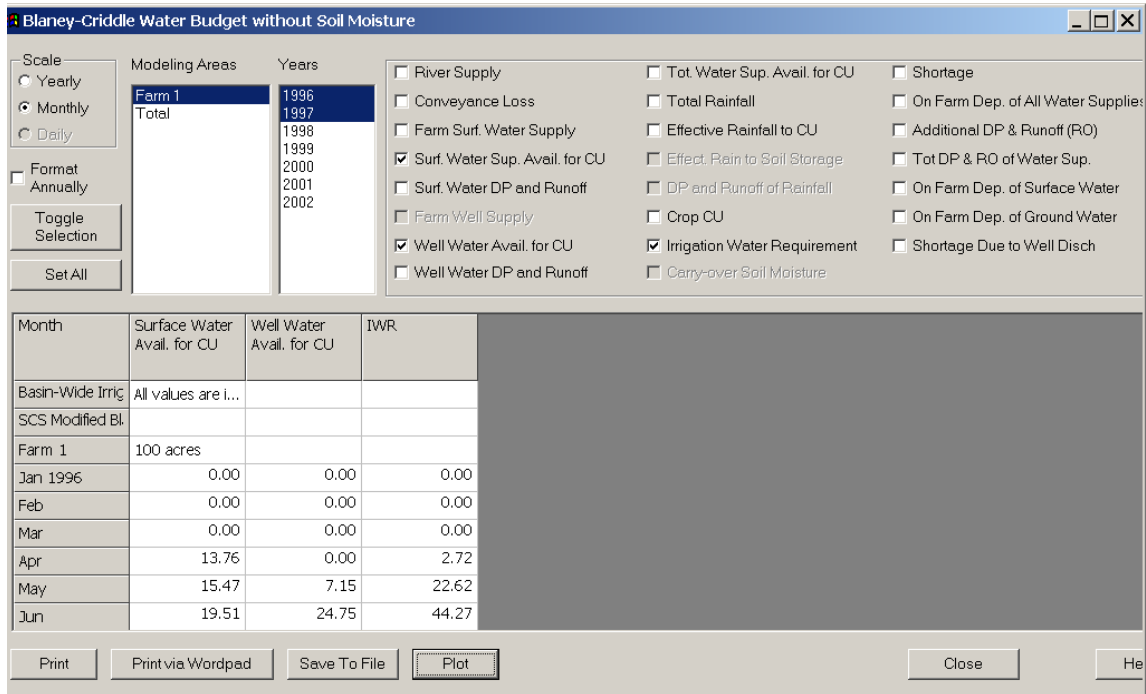


Figure 5. IDSCU GUI for Water Budget Output Screen.

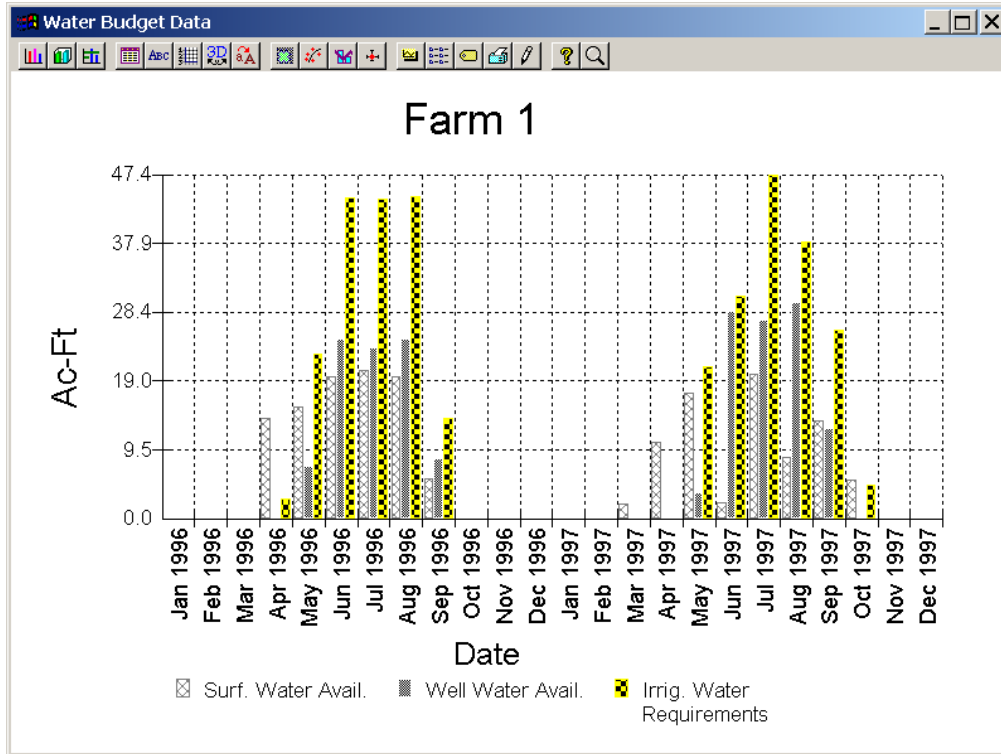


Figure 6. IDSCU GUI Water Budget Sample Plot.

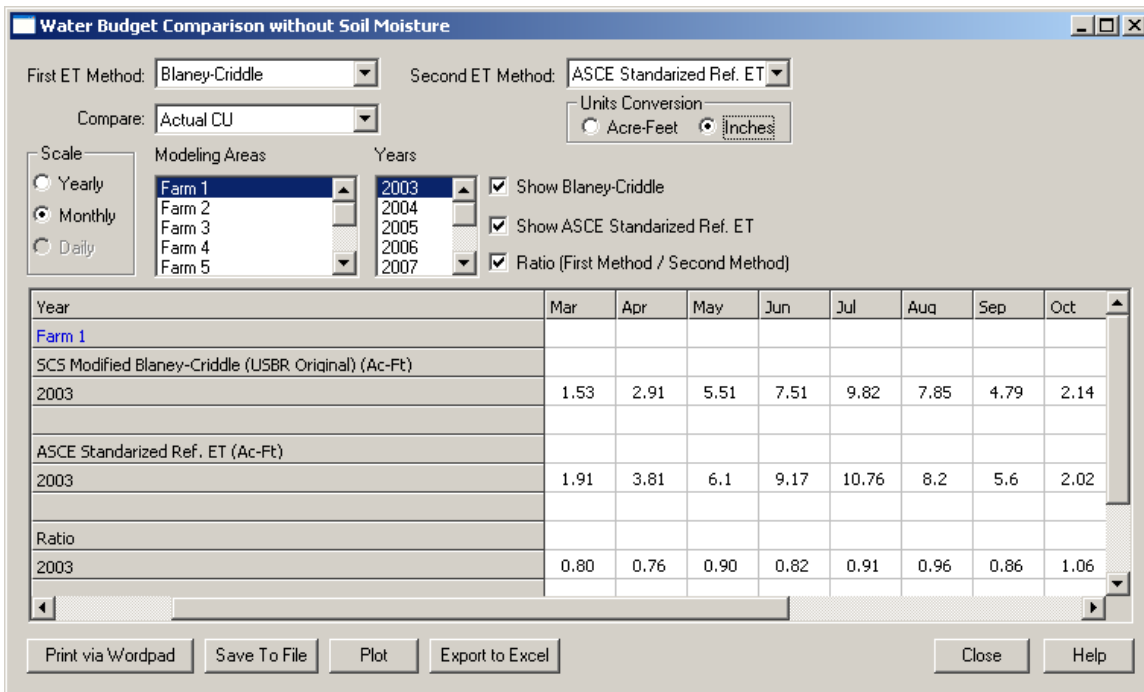


Figure 7. IDSCU GUI of Comparison of ET Method Results

The interface can also display the detailed output from each ET method such as the reference ET, the start and end of crop growth, the effective rain, and the crop CU on a daily or monthly time step (Figure 8).

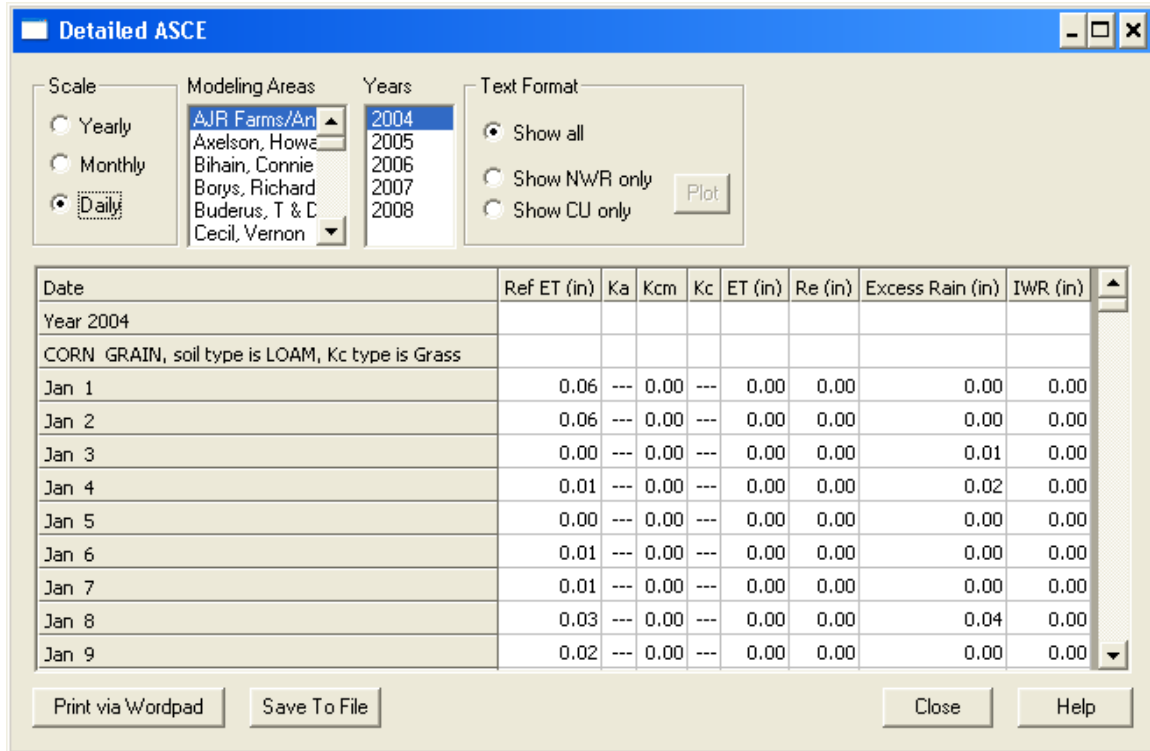


Figure 8. IDSCU GUI Detailed ET Output.

The IDSCU model was initially created as a response to the needs of water users in the South Platte of Colorado. The capabilities of the model have been expanded and the model has been applied in several states around the western US. The model has the ability to access weather data on the internet from Coagmet (Colorado), Northern Colorado Water Conservancy District (Colorado), ET Toolbox (New Mexico), AZMET (Arizona) and CIMIS (California) as well as the user can enter or import (by cutting and pasting or entering manually) their own weather data. The model is free and can be downloaded from the web at the following [URL:www.ids.colostate.edu/projects/idscu](http://www.ids.colostate.edu/projects/idscu) At the webpage for downloading the model there is a changelog file that users can download which tracks any updates and bug fixes with the different versions of the model. In addition the model has an interactive help (Figure 9) that provides the user with information about the different options of the model.



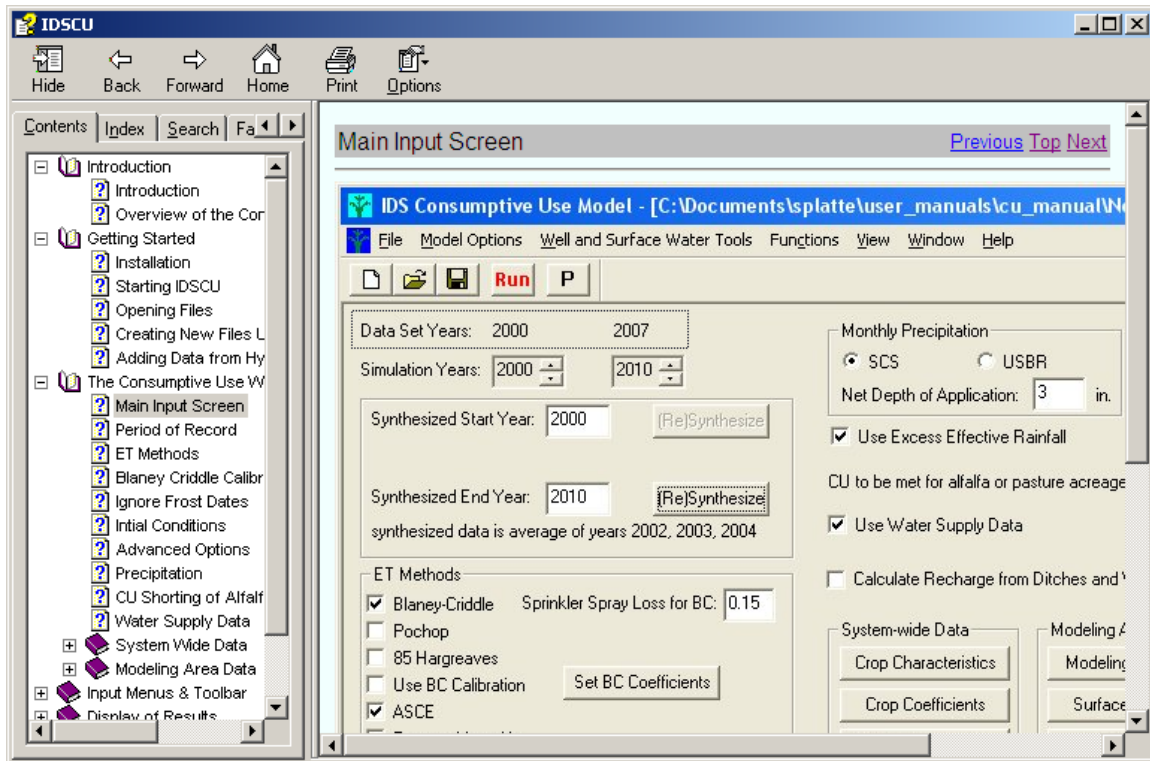


Figure 9. IDSCU Help Screen

### ACKNOWLEDGMENT

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