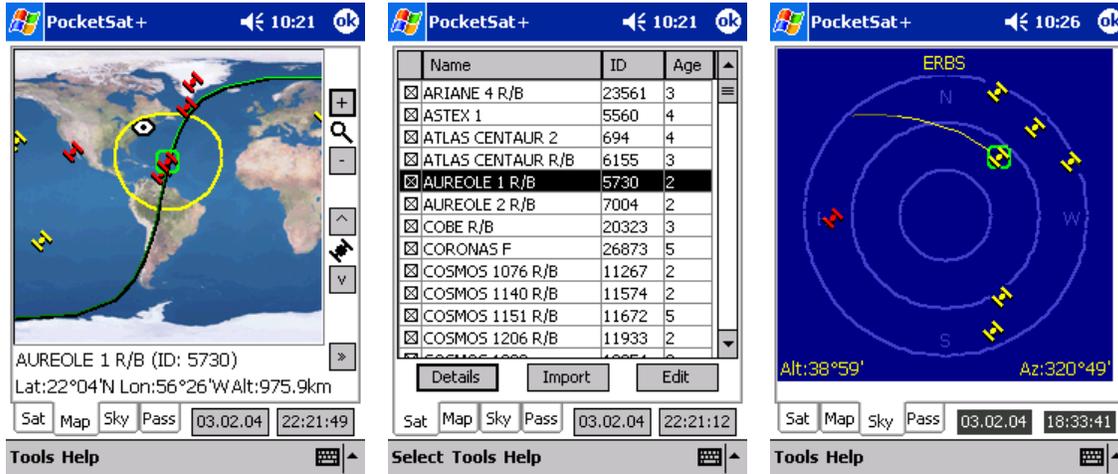# PocketSat+ for Pocket PC

Version 1.3 (30 March, 2003)

Introduction

Overview

PocketSat+ is a full-featured satellite tracking application for Pocket PC devices. It is designed to be usable by both experienced satellite trackers as well as novices who are interested in knowing when they can simply look up and see satellites.

PocketSat+ can display real-time plots of multiple satellites on both Earth maps and Sky charts. It also includes tools to predict when satellites will pass overhead and potentially be visible.

Features of PocketSat+ include:

- Configurable to compute satellite visibility from any location on Earth.

- Track and plot real-time positions of up to 20 satellites simultaneously.

- Map view shows satellite position and orbit track on an Earth map.

- Sky view shows satellite position and path in the Sky.

- Flexible application clock can be set to any date and time as well as clock rate, allowing "what happens when…" experiments. You can make time stand still or even go backwards if you wish. A single button press restores the clock to current system time.

- "Pass" mode allows pre-calculation of satellites that will pass over a particular location during a given time span, including filters for minimum altitude and whether or not a satellite is lit by the Sun.
- Uses full SGP4 and SDP4 orbit propagation algorithms, allowing accurate tracking of any satellite.

Installation

There are different versions of PocketSat+ for Pocket PC 2000 and Pocket PC 2002 devices. If you don't know which kind of device you have, check the PocketSat+ website at www.bigfattail.com for details. The Pocket PC 2000 version will run on a Pocket PC 2002 device, but is not optimal.

To install PocketSat+ from a PC running Windows, run PSPlusSetup2k.exe (for Pocket PC 2000) or PSPlusSetup2k2.exe (for Pocket PC 2002), agree to the end-user agreement, and choose the default installation location.

A shortcut to the app will be installed in the Start Menu Programs folder.

In addition to installing the application, you will probably also want to install some satellite data. You may want to get current data from the PocketSat+ web site (www.bigfattail.com/software/pocketsatplus) or, if you just want to see how it works, I have included a sample data file: **sample.tle**. **Note that this database will almost certainly be out-of-date by the time you use it, and will probably give inaccurate results**, but you can still use it to get a feel for PocketSat+ and how it works.

Using the ActiveSync "Explore" button, copy this file onto your Pocket PC in the "My Documents" folder or one of its subfolders.

Obtaining Satellite Data

The orbital data for a satellite changes with time. While a given set of data is accurate for at least a few weeks to a couple of months for low-accuracy naked-eye observation, you will eventually have to update it. Fortunately, there are quite a few sources for the web for up-to-data orbital elements. Check out the PocketSat+ web site for pointers to some of them.

PocketSat+ reads data stored in the popular TLE (Two Line Element) text format. See the section on importing data later in this manual for more details.

Registering

PocketSat+ is a shareware application and will run for 21 days in "trial" mode before it expires. **I very strongly recommend installing it and getting it working before you register** – it is a complicated application and I would hate for anyone to spend money on it only to discover that it wasn't really what that they wanted.

A registration code for PocketSat+ costs US$25 and can be obtained at the PocketSat+ website (www.bigfattail.com/software/pocketsatplus).

Once purchased, registration codes will be valid for any future updates of PocketSat+.

Quick Start

So don't want to slog through the docs, but you want to see what PocketSat+ can do. Try this:

Install

First install PocketSat+ and copy the **sample.tle** data file that is included with the distribution onto your Pocket PC. You can put it anywhere in the "My Documents" folder tree. (Hint: If you don't know how to get a file onto your Pocket PC, start the "ActiveSync" application on your PC and click on the "Explore" button. You can then drag files from your PC into that window, which puts them on your Pocket PC.)

Note that the **sample.tle** file may contain old data by the time you read this. If this is the case then predictions won't be as accurate, but you can still use the data. The alternative is to find some newer data (see: Obtaining Data above.)

Start PocketSat+ on your Pocket PC.

Set your location

For PocketSat+ to tell you where to look to find satellites, it needs to know where you are. If you really want a quick start, skip this section and PocketSat+ will assume you are in Maynard, MA USA.

Otherwise, select "Tools->Observer Location..." press "New" and enter the name of your location. Now enter the correct Latitude, Longitude and Altitude. If you can't find your altitude either make a reasonable guess or just enter 0 for sea level. Predictions will still be pretty close.

Also enter the current Time Zone, expressed as an offset from GMT (US Eastern Standard Time is -5, EDT is -4, PST is -8, PDT is -7).

Hit OK.

Import Satellite data

Press "Import" and select the TLE file that you copied onto the Pocket PC. A dialog will tell you how many satellites were imported and you should see them in the list.

Where is the International Space Station?

Scroll down the list until you see "ISS" (it may be listed as "ISS (Zarya)." Tap on that line of the display (make sure not to "uncheck" the box next to it. ISS is now your "current" satellite.

Tap the "Map" tab and you should see a map of the world with ISS displayed on it. The curved line extending from either side of it is its orbital path and the deformed "circle" drawn around it encloses the part of the Earth for which it is above the horizon. If the "eye" icon is in side this circle then it can be seen from your currently set location.

What are all of the satellites above the horizon for me right now?

Press the "Sat" tab to go back to the satellites list. Choose "Menu: Select-> Select Above Horizon." Note that most of the check boxes have become unselected. Scroll up and down the list – any that are checked are above the horizon (or nearly so) for you right now.

Select the "Map" tab and press "up" and "down" to cycle through the "checked" satellites – those without check in the satellites list will be skipped over.

Press the "+" button to show a zoomed in view. Note that the "eye" icon is inside the circle.

Press the "sky" tab to see where in your sky the satellite is. "Up" and "down" work the same way as in the map view.

I want to see more than one at a time.

Select "Menu: Tools -> Preferences..." and choose the "App" tab. Set "Displayed Sats" to 10 and hit "Done."

Check out the Map and Sky views. The "current" satellite is the one with the little ring around it. In addition to the up and down buttons, you can also tap on a satellite to select it.

I want to see a satellite with my own eyes.

OK, here's the real meat of the program. Many satellites can be seen with the naked eye. The tricky bit is that in order for a satellite to be visible the observer must be in the dark (you can't see stars in the daylight) but the satellite must be in the light (or it'll appear dark, and you won't be able to see it, even though it'll be there.)

Go back to the satellite list and select all of the satellites (Menu: Select -> Select All)

Now press the "Pass" tab.

Select "Menu: Tools -> Preferences..." and choose the "Pass" tab.

Make sure they read: Search for: "Visible Passes", Min Culmination "20 deg", Twilight: "Nautical" and check the "Always clear pass list" box. Select Done.

Click on the "From" box and press "Now". If it is currently after sunset then press the down arrow until the time is around 16:00 or so. Press OK.

Click on the "Thru:" Box, press "Now" and then click "up" until a little after midnight. 02:00 is good. Press OK.

Now press "Calc." A progress dialog will appear and run through the satellites as they are checked.

Hopefully there will now be a list of "passes" which met the preferences criteria, meaning that they are most likely all visible to the naked eye (the sample database contains relatively big, bright satellites.)

Press "Plot" to see the currently selected pass in a sky view. If you plot a pass while it is actually occurring, the satellite's position will be plotted as well. Use the "up" and "down" buttons to cycle through the passes. Note that where the path is dark the satellite is not being lit by the Sun and so will not be visible.

To actually see a satellite requires a little luck, but you should be able to take your Pocket PC outside and look in the indicated part of the sky at the right time and see a satellite pass. The hard part is that, with a few exceptions, satellites a relatively dim.

I want to see the ISS

The International Space Station is one of the brightest satellites in the sky and is easy to see if you know when and where to look.

Go back to the satellites list view and "Select None".

Scroll down to the ISS and select it (tap its check box).

Go back to the pass list view and press "From" and choose "Now"

Press "Thru" and press "Now" and then press the "Date" button. Select a date 2 weeks in the future and hit OK.

Press "Calc". If you don't get any listings then press "Thru" again and try a couple more weeks in the future. Unless you're really unlucky or just too far North or South for ISS to ever be visible you should get a couple of hits.

Go outside when it says to and look where it shows. It's pretty bright.

Using PocketSat+

Selecting Modes

PocketSat+ is made up of four basic operational modes, which are accessible by using the buttons along the bottom of the screen. These include:

- **Satellite Selection.** Use this screen to specify which satellites are to be included in calculations performed by the other modes. It is also where you import, modify, update and view satellite data.

- **Map.** This mode displays a zoomable Mercator projection map of the Earth. Overlaid on the map are the positions of satellites, their orbit tracks and visibility zones (areas on the Earth for which they are above the horizon.)

- **Sky.** This mode displays a plot of the overhead sky at the currently specified observer location. If any selected satellites are above the horizon their positions are plotted as well as their path across the sky.

- **Pass.** This more enables you to calculate in advance times when satellites will pass overhead at the specified observer location. Passes are listed, ranked by "goodness" and can be plotted.

Setting the Observer Location

In order for PocketSat+ to determine when and where you should look in order to view satellites, it is necessary for you to tell it where you are on the Earth. Select your current location from the dropdown list.

To enter a new location, first select "New" and enter the location name. A new location will be created containing data copied from the previously displayed location. Now you must enter the following information:

- **Latitude.** Can range from 90 degrees South to 90 degrees North.

- **Longitude.** Can range from 180 degrees West to 180 degrees East. Note that locations in North and South America have West longitudes.

- **Altitude.** Above sea level, in meters. If you don't know, a reasonable guess is probably good enough.

- **Time zone**. The local offset from Greenwich Mean Time. Eastern Standard Time (EST) is GMT-5, Pacific Standard Time (PST) is GMT-8. How this setting is used is determined the settings in the "Clock Preferences" panel.

   For those locations where there are half-hour time zones, you can select the '+/- .5' box to add a half hour to the time zone (or subtract a half hour from a negative one.) Quick-witted readers will notice that you can't enter a time zone of GMT-1/2 hour. No one has needed it yet…

Select the "Delete" button to remove the currently displayed location from your list of available locations.

If you only have one location in the list, you cannot delete it.

The PocketSat+ Clock
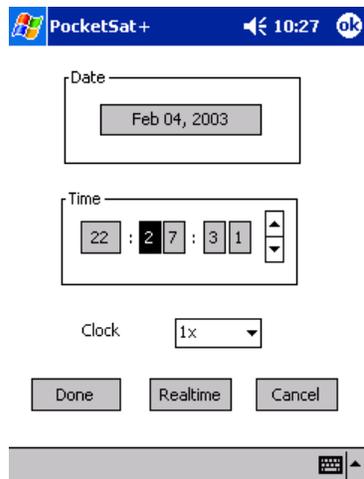
The PocketSat+ clock is the heart of the application, and drives everything else. Visible at the lower right corner of the screen in all program modes, it can be set by tapping either the date or time display.

Using the "Set Program Time" dialog, you can set the clock to any time and date, and can set its speed. You can even set the speed to zero or to go backwards! Pressing the "Realtime" button in the dialog sets the clock rate to normal and the time and date to the system time and date.

The time is always displayed in 24 hour format as hh:mm:ss and the date is always displayed as yy.mm.dd (I apologize if that's not your favorite format, but dots take up less space than slashes, and I was out of screen room…) When the clock is not set to real time, the date and time display is inverse-video to remind you.

Loading Satellite Data

PocketSat+ keeps an internal database containing satellite orbital data. As the data ages, it is periodically necessary to replace it with new data. This is done by pressing the "Import" button on the main Satellites view. If an imported dataset includes a satellite that is already in the PocketSat+ database, the old data will simply be overwritten, so there is no need to delete old data before performing an import.

To import data, press the "Import" button and select the data file. A dialog will appear to tell you how many satellites were imported/updated.
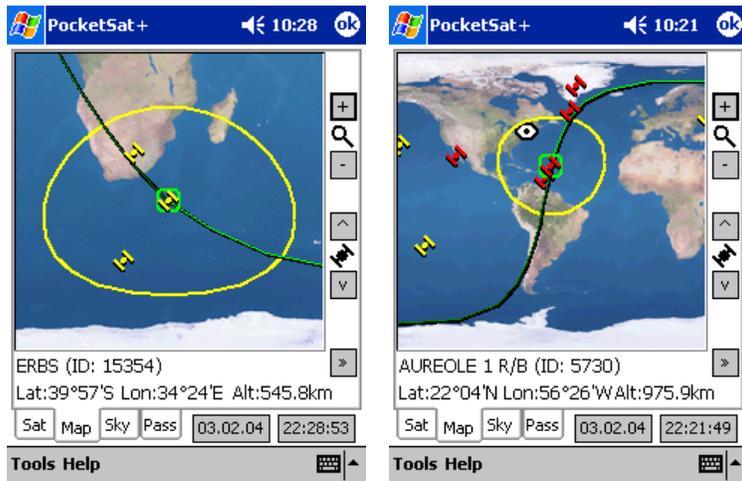
Selecting Satellites
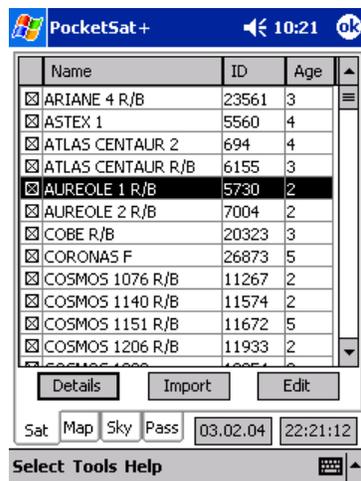
All calculations performed throughout the PocketSat+ application are performed only on satellites that have been "selected" using the main Satellites form. Satellites can be selected and unselected either by tapping the box to the left of their names, or by using the "Select All" and "Select None" menu options.

There is also a menu item to "Select Above Horizon" which does exactly that: it goes through every satellite in the displayed list and selects its check box only if it is currently above the horizon for the current observer position at the current PocketSat+ clock time. Any satellite higher than 5 degrees below the horizon and on its way up will also be selected.

One further thing worth mentioning is the concept of the "current" satellite, which is the one that will be displayed preferentially in the map and sky views. A satellite is made current by being in the list, being checked **and** being highlit in the list (by tapping it.) If the currently highlit satellite is not checked, the closest checked one to it on the list is made current when leaving Satellite list mode.

Using the Map

After selecting a satellite (or some satellites) press the "Map" button at the bottom of the screen to go into Map mode.

The current satellite will be displayed on a Mercator projection of the Earth along with the observer position (the "eye" icon.) Also on the map is a warped-looking circle enclosing the area of the Earth that can currently see the satellite. If the satellite is currently lit by the Sun it will appear light colored – if unlit it will be dark.

As time passes, the orbital path of the satellite will "creep" out from the satellite icon until it extends forwards and backwards to show a full orbit. The "forwards" direction is lighter colored than the "backwards" direction

The map will scroll to try to keep the current satellite centered.

Press the "+" button to magnify the view and the "-" button to zoom back out.

The buttons above and below the satellite icon on the right make current the previous and next selected satellites in the main list, respectively. The "Up" and "Down" D-Pad directions do this as well.

The current satellite's name, ID and some information about its position are displayed at the bottom of the screen. By default, latitude, longitude and altitude above sea level are displayed. Pressing the "page" button to the right of this information will switch the bottom line to display current Azimuth, Range and closing speed (dR.) Pressing "page" again will cycle back to the original display.

If more than one satellite is being tracked (see "Preferences") the neighboring satellites to the current one on the list will also be shown - how many being a function of the preferences choice. If the option is selected to do so, their orbit tracks will also be shown. The current satellite can be distinguished from the others by the extra ring around it.

The current satellite is always updated at the rate selected in the main preferences screen, and any other satellites are updated in round-robin fashion, one at a time between each current satellite update. For this reason if you are

tracking a large number of satellites it can be quite a while between updates for the non-selected ones.

In addition to using the up and down buttons to make a satellite current, you can also tap on its icon to accomplish the same thing.

Using the Sky View
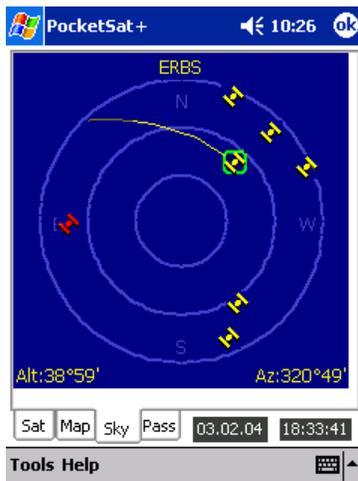
Once you've decided that a satellite is above the horizon, either because you used the "Select Above Horizon" tool or because the observer location icon appeared within the visibility circle on the map, or for whatever reason, select Sky mode by pressing the "Sky" button at the bottom of the screen.

You will see a representation of the whole overhead sky, with the cardinal points labeled, and rings to show 0, 30 and 60 degrees of elevation. Superimposed on this plot will be the current satellite (bright if lit, dark if unlit) as well as its future path across the sky extending from it. The path is also bright in color where the satellite will be lit and dark where it will be in shadow.
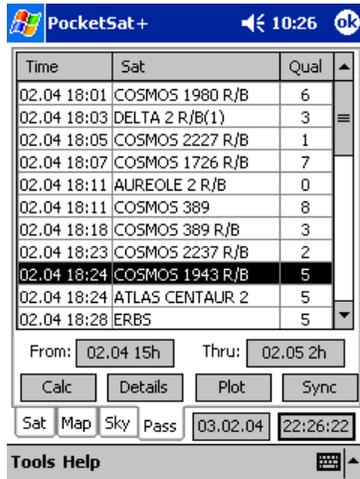
To use the sky plot, go outside and face in the direction of the label closest to the bottom of the screen. Now hold your Pocket PC up and try to visualize the circle extending up overhead (the center of the circle is the zenith, or the point directly overhead) and over behind you. The outer circle represents the horizon and the inner ones represent 1/3 and 2/3 of the way to the zenith, respectively.

To look in different directions you can either rotate the Pocket PC itself, or you can rotate the view by pressing the left and right buttons on the Pocket PC. Each press will rotate 90 degrees in the specified direction. It is generally much easier to view a satellite when it lies in the "bottom" half of the plot.

Pressing the "up" or "down" button on the Pocket PC makes current the previous or next selected satellite in the main list, just as it does in Map mode.

Also, as in map mode, if you are tracking more than one satellite, tapping on a satellite's icon will make it current.

Satellite Passes

Calculating Passes

Calculating satellite passes is one of the most complex functions of PocketSat+. Select Pass mode by pressing the "Pass" button at the bottom of the screen.

The concept here is that as satellites orbit around the Earth, and the Earth turns under them, they occasionally "pass" overhead at any given location. If it happens to be after dark at that location, and the satellite is high enough to be lit by the Sun (out of the Earth's shadow, really) then there's a good chance that the satellite can be seen, in many cases with the naked eye.

Pass Calculation determines those times when satellites will be overhead, and, if asked to do so, will also filter out passes that occur during the daylight, when the satellite is not lit, or when it doesn't pass high enough in the sky.

To specify the beginning and ending times for the calculation, tap the "From:" and "Thru:" fields. A dialog will appear allowing you to set the time and date for each. You will not be allowed to specify a "Thru" time which comes before the "From" time.

Assuming your Observer Location is set, and there are satellites selected (see "Selecting Satellites") you should now press the "Calc" button and calculation will begin. As it proceeds, the name of the satellite that is being checked will appear in a dialog along with a line showing total progress.

To interrupt calculation, press the "Cancel" button.

Examining Passes

When calculation is complete, any passes found will be listed in the table. For each pass there are 3 columns:
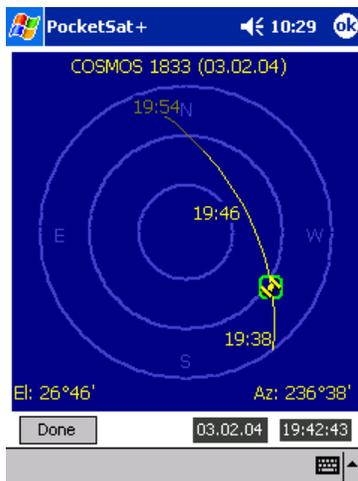
- Time
- Satellite name

- Pass "quality"

The "quality" of a pass is an estimate of how 'good' the pass is, taking into account overall altitude and how long it is lit. For visible passes, it ranges from 0 (worst) to 9 (best) or D (daylight) or N (night, but satellite unlit and invisible.) If "All Passes" is selected in Preferences, this number is just a measure of the maximum pass altitude, and visibility is disregarded.

If a pass is selected in the table, pressing the "Details" button will bring up a dialog which displays information it. The dialog consists of a list of observations, one per row. Each row consists of the following columns:

- Date/Time

- Elevation (degrees)

- Azimuth - or bearing (degrees from North)

- Status - either Daylight, Visible or Night (unlit)

Plotting Passes

Pressing the "Plot" button brings up a plot of the sky that shows the satellite's path across the sky during the pass. This plot is in most ways identical to the Sky mode, the only real difference being that rise, set and culminations times for the pass are displayed on the plot.

As with Sky mode, the idea is that you hold the Pocket PC out in front of you, facing the direction indicated at the bottom of the plot. You can rotate the plot to the left and right, respectively with the left and right directional buttons on the device until the desired direction is at the bottom.

You can also select the previous or next pass by pressing the 'up' or 'down' button.

Preferences

The behavior of PocketSat+ is in many ways controlled by settings that the user selects in the Preferences screens. These screens are accessed by choosing the "Preferences" menu item from any of the main modes.

App Preferences

These options control program behavior in all of the modes:

- **North.** (Default: true) If "Magnetic" is selected, magnetic variation will be applied to all displayed azimuth values. Magnetic variation is calculated using the WDM2000 geomagnetic model.

- **Displayed Sats.** (Default: 1) PocketSat+ can track more than one satellite at a time and display them in Map and Sky modes. This value determines how many are tracked. If it is more than one, satellites other than the "current" one will be calculated round-robin style in between its calculations. The maximum value is 20.

- **Calc Interval.** (Default: 1 sec) This value determines how long an interval PocketSat+ will wait between calculations of the current satellite. Setting it to a larger number will increase battery life. Note that if more than one satellite is tracked, the current one is still tracked at this rate – other satellites are fit in between.

- **(X) Button.** (Default: Exit) Defines what happens when the Smart Minimize (X) button at the upper-right of the screen is pressed. By default PocketSat+ will exit when it is pressed. If you prefer, you can change the setting to "Smart Minimize" for the default Pocket PC behavior.

Clock Preferences
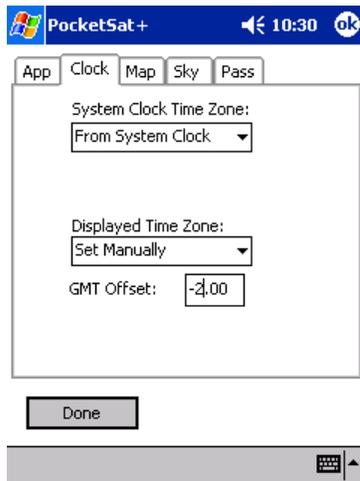
These options define the time zones used by PocketSat+.

System Clock Time Zone

This setting is used by PocketSat+ to determine when "now" is for realtime position calculations. It is important that it always be set to match the time zone for which your Pocket PC clock is set. Possible settings include:

- **From System Clock.** This is probably the choice that you want. It asks the operating system for the time zone and Daylight Savings Time offset.

- **From Obs Location.** This choice will use the time zone set in the Observer Location form for the currently selected location.

- **Zulu Time.** This choice assumes your Pocket PC clock is set to Zulu Time (GMT).

- **Set Manually.** This choice allows you to manually set the GMT offset.

Displayed Time Zone

This setting is used for all time displays in the program. The options are the same as for System Clock Time Zone. In general the best bet is to have this set to "From Obs Location" so times will be show as local to the observer, unless you always have your observer location set to where you really are. Many observers will want to chose "Zulu Time" to have all times displayed as GMT.
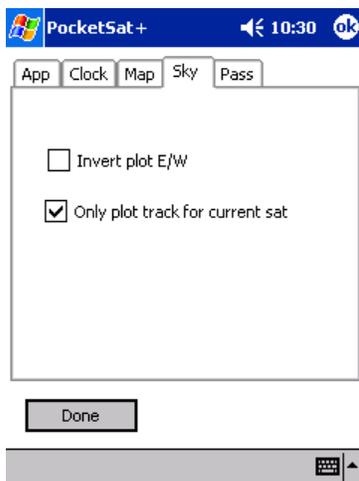
Map Preferences

This option affects the Map display:

- **Only plot orbit for current sat.** (Default: true) If more than one satellite is being tracked, this option prevents PocketSat+ from plotting the orbit tracks for satellites other than the current one. If it is unchecked, the display can get pretty crowded, but it can also be pretty interesting if used sparingly.

- **Plot visibility footprint.** (Default: true) If true, the current satellite is displayed on the map along with the circle that defines the region of the Earth for which it is above the horizon.

Sky Preferences

These options affect the Sky display:

- **Invert Plot E/W.** (Default: false) Some people would rather that the Sky display be presented looking from the top down – more like a map than a sky chart. Selecting this option reverses East and West in the display,

effectively accomplishing this. This choice also affects the Pass plot display.

- **Only plot track for current sat.** (Default: true) If more than one satellite is being tracked, this option will prevent the display of the paths of any satellites other than the current one.

Pass Preferences

These options define the behavior of pass calculations. They are **very** important in determining the results of calculations, so you should take some time to understand their use. Seeming discrepancies between PocketSat+ and other satellite tracking tools often result from these settings.

- **Search for.** (Default: All passes) If "Visible Passes" is selected, only passes that occur at night (defined by the "Twilight" option) **and** when the satellite is lit by the Sun are listed. These passes are potentially visible. If "All Passes" is selected then all passes will be listed, including those during the daylight and when the satellite is in shadow.

- **Min Culmination.** (Default: 10 degrees) This filter defines the minimum culmination (highest point) that a pass can have and still be listed. Since trees and building can limit a site's horizon this filter can limit "false positives": passes that don't ever get high enough for you to really see. Using this option aggressively can speed up calculation considerably, but it can also result in disagreement between PocketSat+ and other programs (many of which have no such filter.)

- **Twilight.** (Default: Nautical – 12 degrees) There are different definitions of the term "Twilight," differing in the angle of the Sun below the horizon. The three most common are: Civil (6 degrees), Nautical (12 degrees) and Astronomical (18 degrees) From a practical point of view this selection determines how dark the sky must be before it is considered "night." Depending on your location, it may be too light to actually see a satellite at Civil twilight, in which case you should make a more conservative choice.

- **Always clear pass list.** (Default: true) If selected, any passes in the list will be deleted when a new calculation is performed. If false, you will be asked if previous passes should be cleared.

Contact Info

The PocketSat+ website can be found at:

http://www.bigfattail.com/software/pocketsatplus

Please address comments, feature requests and bug reports to Jim Berry at: jim@bigfattail.com.