Tracking Cloud Features on Venus using Images acquired by the Venus Monitoring Camera on Venus Express Orbiter

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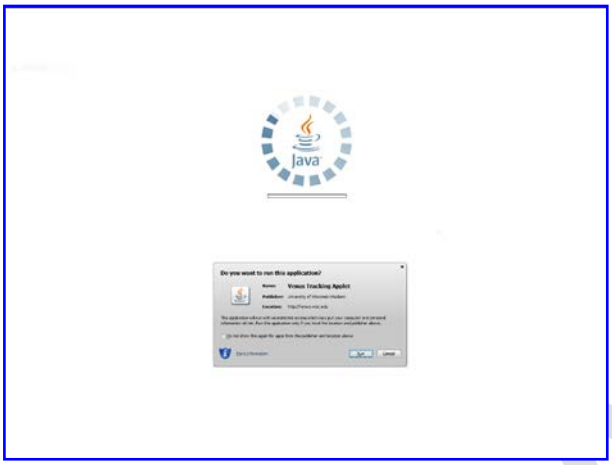
Tracking Cloud Features on Venus Using Venus Express Data

LOADING THE APPLET



When you load the applet for the first time from *venus.wisc.edu/tracking/venus.html*, the following window will appear presenting a notice from Java (Figure 2). The notice informs you that the applet will run with unrestricted access to your computer, and you must click with the mouse on the "RUN" button to run the application, or, "Cancel" to not run the application. Clicking on "More Information" will inform you further that the publisher name (University of Wisconsin) has been verified by a trusted certificate authority (Figure 3).

Figure 1. Loading the applet for the first time

The only access to your computer from this applet is to place a cookie so that next time you return to the applet, it can use the information to run the application if you check the box labeled "Do not show this again for apps from the publisher and location above" (Figure 2). No information is read from your computer or used by the applet.

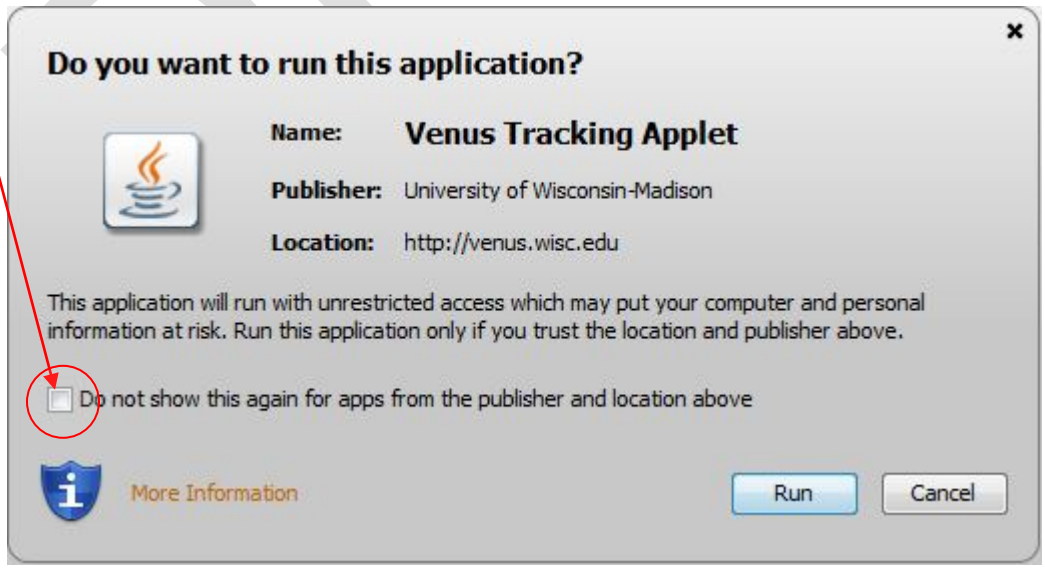


Figure 2. Give permission to the applet to run.

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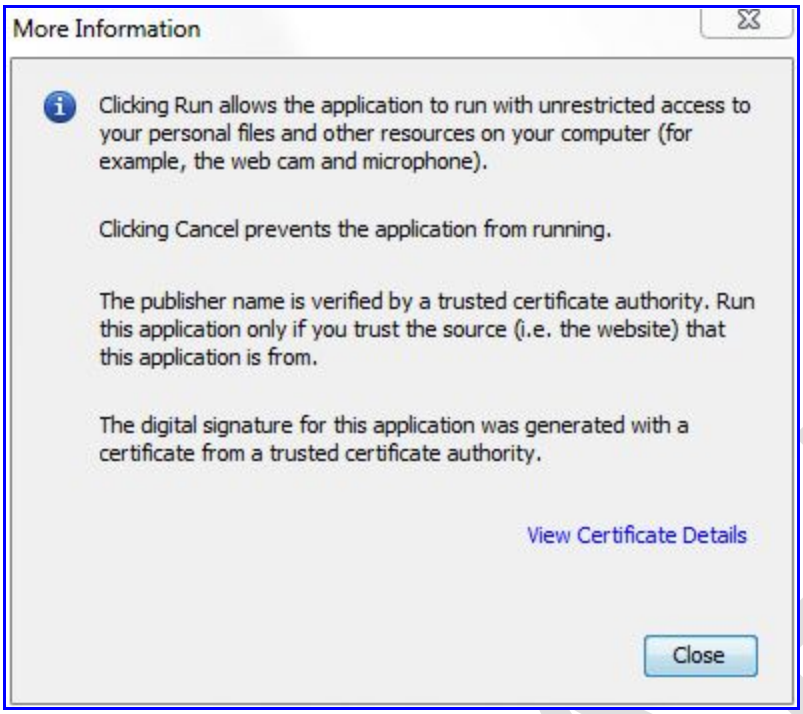

Figure 3. ***More Information window.*** *Clicking on the View Certificate Details link will provide more information about the Certificate issued to the University of Wisconsin.*

USING THE APPLET TO ANIMATE VENUS IMAGES AND TO TRACK CLOUD FEATURES ON VENUS TO MEASURE THEIR SPEED AND DIRECTION OF MOTION

This applet uses mapped images of Venus taken by the Venus Monitoring Camera on Venus Express Orbiter. The images have been remapped into a latitude-longitude map with a fixed scale such that 5 pixels equal one degree of latitude in the vertical direction and one degree of longitude in the horizontal direction. With this applet, you can:

(i) animate a time ordered sequence of mapped images for viewing,

(ii) select a small number of images to track a chosen cloud feature over the duration of the time covered by the images by selecting the feature in each image.

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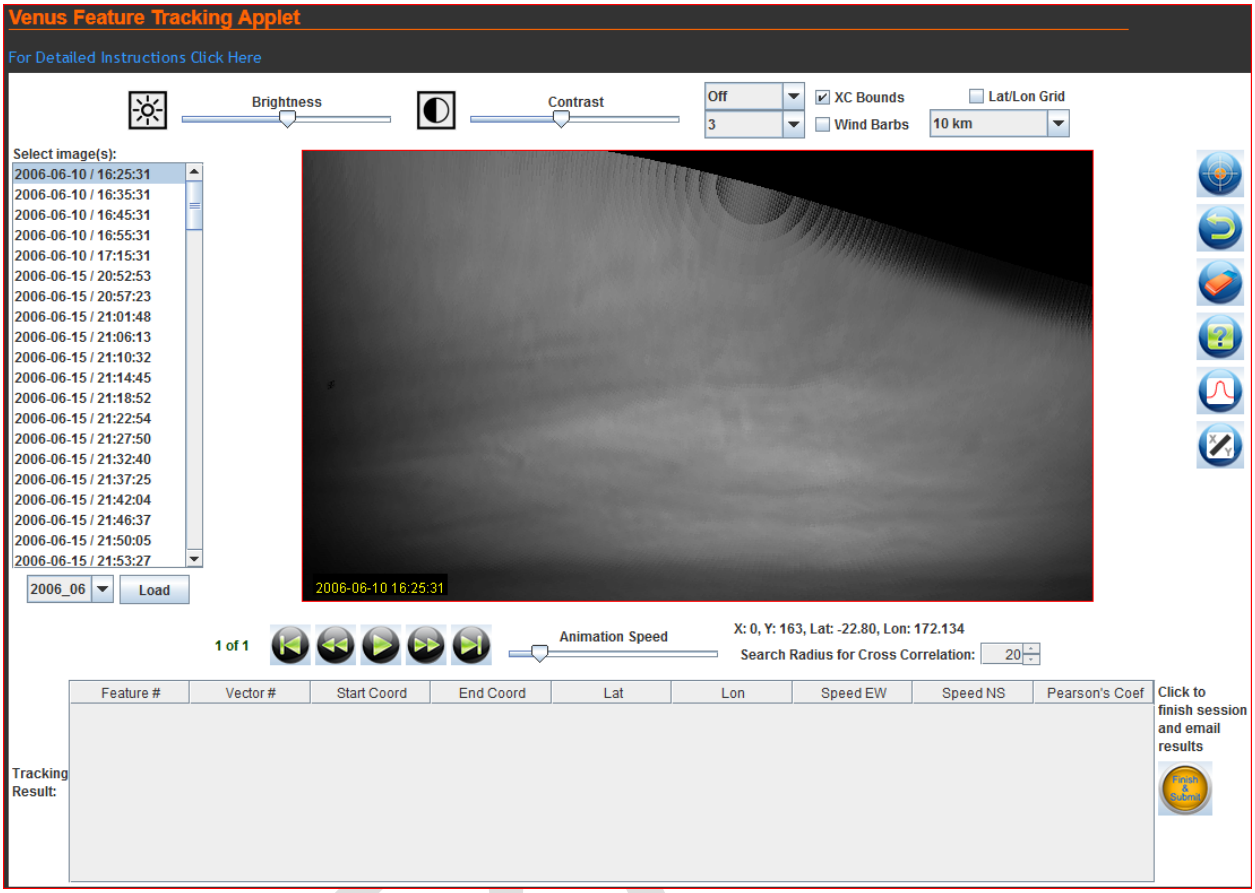

Figure 4. Applet loaded displaying the image selection menu on the left, the image in the center, the image display brightness/ contrast controls and enhancement controls on the top and the applet action buttons on the right. The animation control buttons appear below the image. Output of the measurements is displayed in the window at the bottom. The buttons to right of the output window deal with the tracking process and results.

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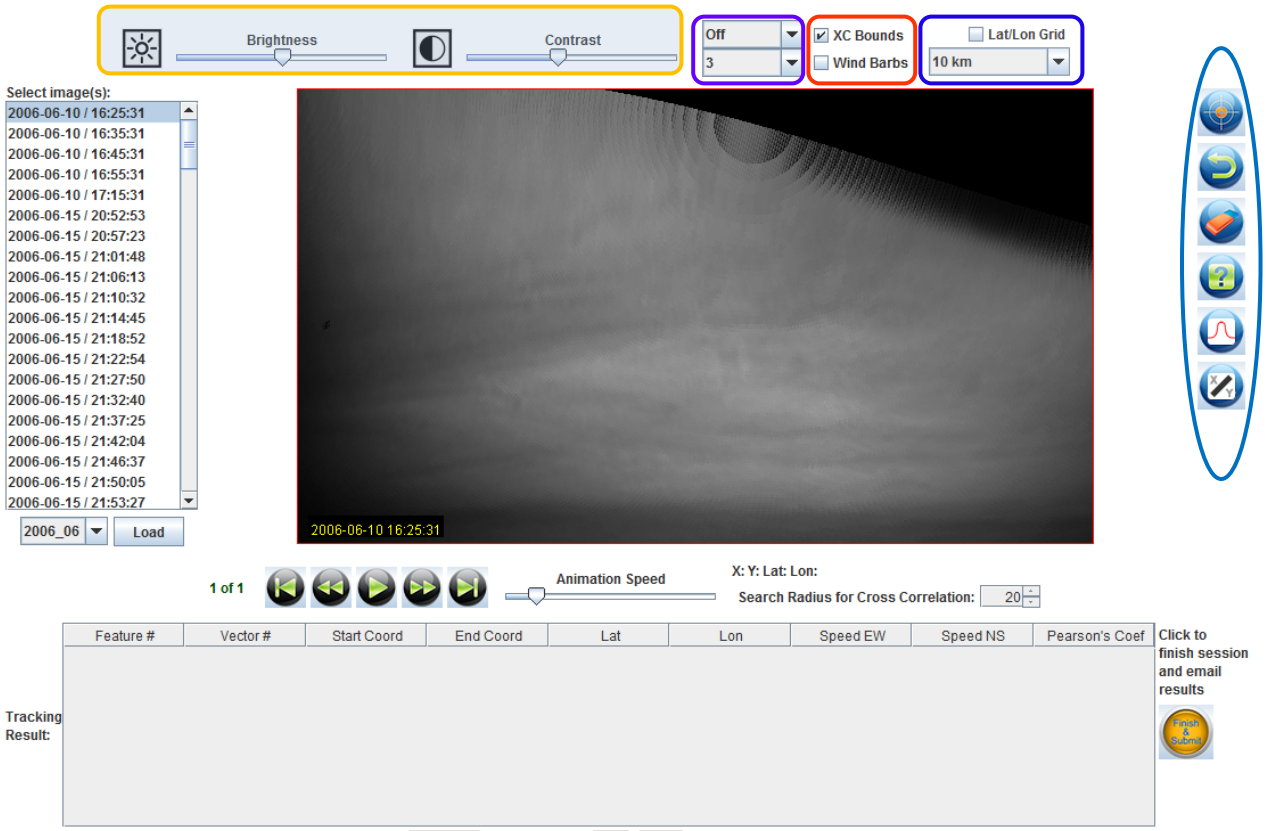

IMAGE SELECTION WINDOW: *ON THE LEFT HAND SIDE OF THE SCREEN. ALLOWS SELECTION AND LOADING OF ONE OR MULTIPLE IMAGES BY YEAR AND DATE.*

IMAGE DISPLAY CONTROLS: *AT THE TOP OF SCREEN. ENABLES CUSTOMIZED CONTROL OF IMAGE(S) BRIGHTNESS AND CONTRAST. THE CONTROLS NEXT TO THE CONTRAST SLIDER IS A DIGITAL FILTER SELECTION ALLOWING FOR IMPROVED VISIBILITY OF INDIVIDUAL FEATURES.SEARCH WINDOW AND LAT/LONGITUDE GRIDS MAY BE TURNED OFF OR ON WITH SPECIFIED SCALE (KM).*

ANIMATION CONTROLS: *BELOW THE IMAGE. ENABLE CONTROL OF ANIMATION SPEED AND CONTROL OF FEATURE TRACKING.*

APPLET FUNCTIONS: *ON THE RIGHT HAND SIDE OF THE SCREEN. THE 1^{ST} BUTTON ALLOWS ADDITION OF A VALID EMAIL ADDRESS. THE 2ND BUTTON ALLOW TO "UNDO" AN ACTION, THE 3RD BUTTON ALLOWS REMOVAL OF CURRENT SET OF TRACKING MARKERS, AND THE 4TH BUTTON IS A POP UP "HELP BUTTON." THE 5TH BUTTON IS A POP UP HISTOGRAM BUTTON AND THE 6^{TH} BUTTON PLOTS RESULTS.*

EMAIL RESULTS AND FINISH BUTTON: *BOTTEM RIGHT OF SCRREEN. WHEN A VALID EMAIL ID HAS BEEN ADDED(1^{ST} APPLET FUNCTION BUTTON), THE "FINISH" BUTTON WILL EMAIL RESULTS OF MEASUREMENTS.*

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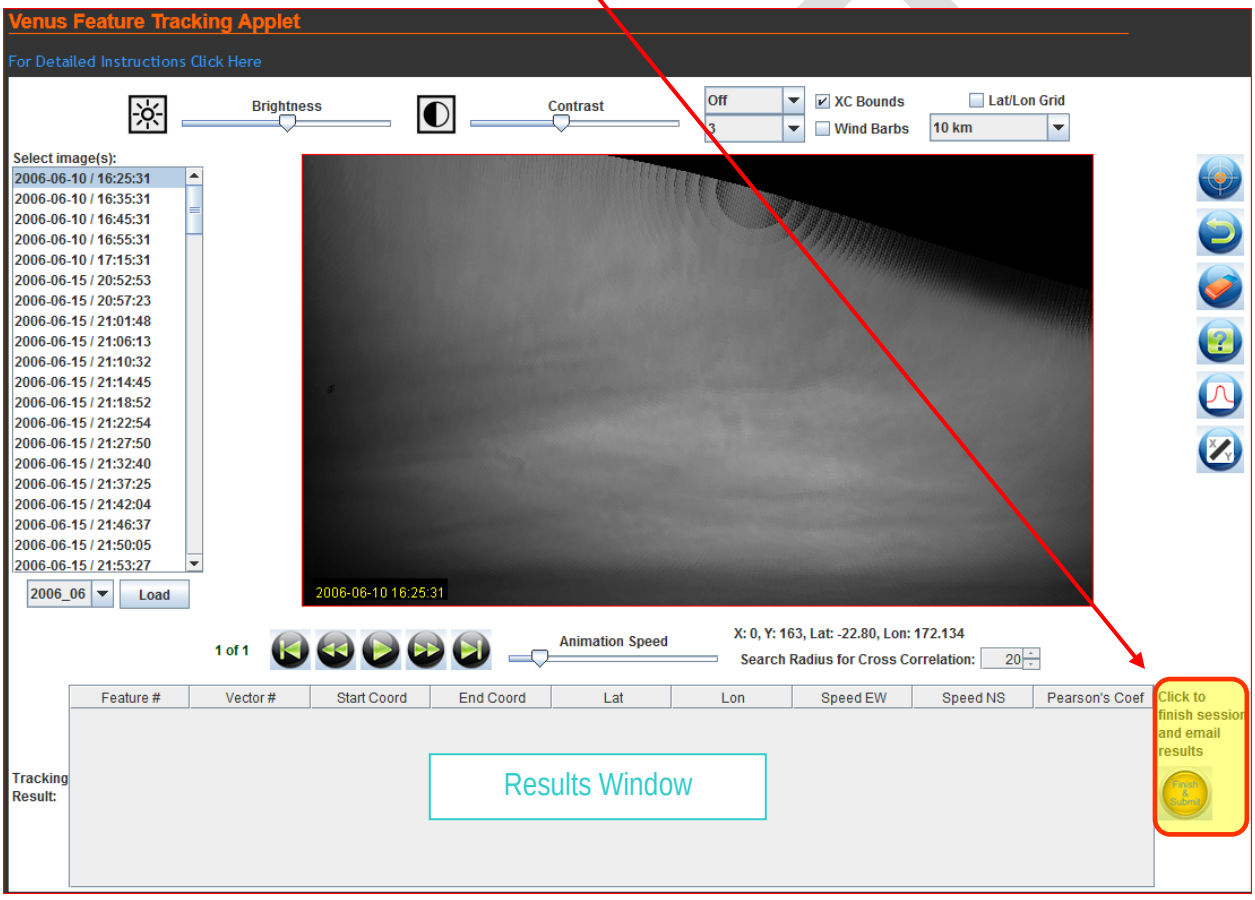
APPLET SCREEN DISPLAY COMPONENTS

On each side of the image display are shown the different component of the applet. On the left is the image selection window. To the right are applet action functions. On the top are display controls, and below the image display the animation and feature tracking controls are located. At the bottom is the display window where the results of the cloud feature motion measurements are displayed. On its right is the Finish button which, when clicked, will e-mail the results of your measurements once the e-mail id is provided.



MAKING AND VIEWING AN ANIMATION OF SELECTED IMAGES

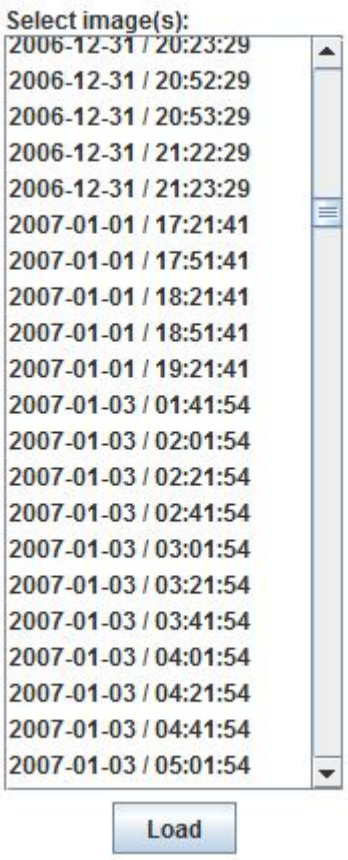
1. Select the images:

The dates and times when images were taken by the Venus Monitoring Camera can be seen in the Select Images window on the left. The format is (from left to right):

Year (four digits)-Month (2 digits) – Date (two digits) /HH:MM:SS

The scroll bar on the right of this window will allow you to see the images later in the Venus Express observation period.

Hold down the SHIFT Key on your key-board and click on the first and the last images you wish to animate. Any images that you wish to exclude from the sequence can be selected using the CTRL key with a mouse-click on the desired images (date/time).



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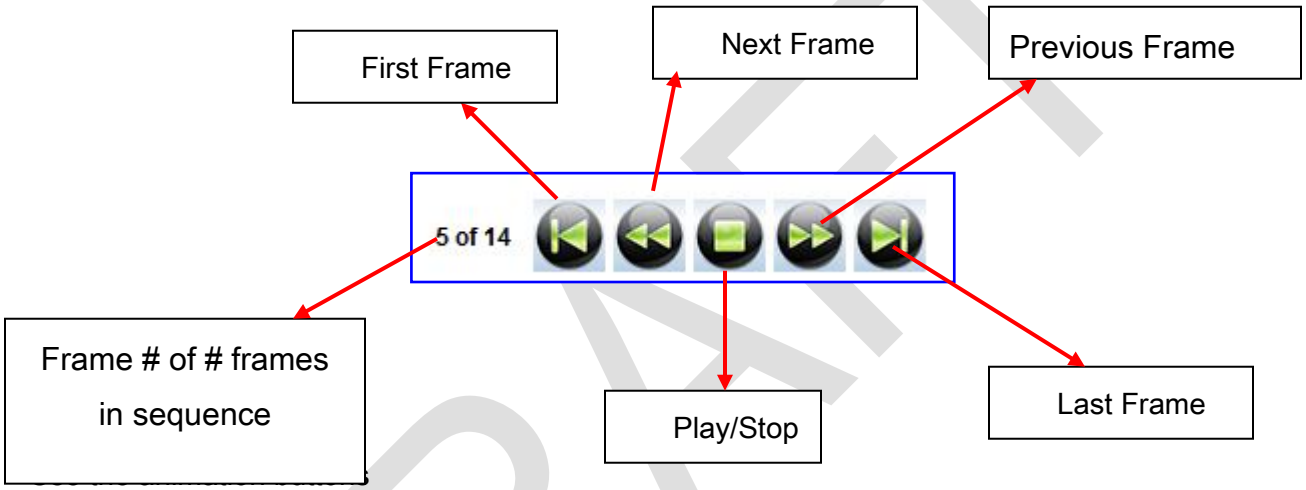
2. Retrieve the images

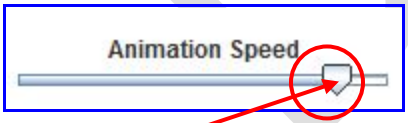
Click on the LOAD button below the window to tell the applet to retrieve the selected images from the server. The wait time for this request to be satisfied will depend on the speed of your internet access and the number of images selected! Be careful!

NOTE: You cannot save the images locally on your computer using this applet.

3. View the animation



to play/stop using the middle button. The animation speed can be varied by clicking and holding down with the mouse and dragging the speed button along the slide bar.



Click, hold and drag along the slider bar to slow down (drag to the left) or speed up (drag to the right) the animation

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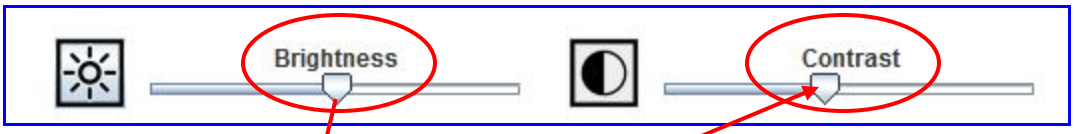
IMAGE BRIGHTNESS AND CONTRAST CONTROLS



Click, hold and drag along the slider bar decrease (drag to the left) or increase (drag to the right) the image display brightness or contrast

ENHANCING THE IMAGES TO IMPROVE THE VISIBILITY OF TRACKABLE FEATURES

Five enhancement options are available – four digital and one for brightness histogram stretch. The digital filters are RMS/AVG, High Pass, Gradient and Edge Detection and use a sample box size of 3,5,7 or 9 pixels about a pixel to enhance each pixel of the image data by using the values within that box. The filter can be turned off or on after selecting the images for tracking.

CHANGING THE BRIGHTNESS/CONTRAST USING THE HISTOGRAM

Use this button to generate a histogram of the brightness values in the displayed image.

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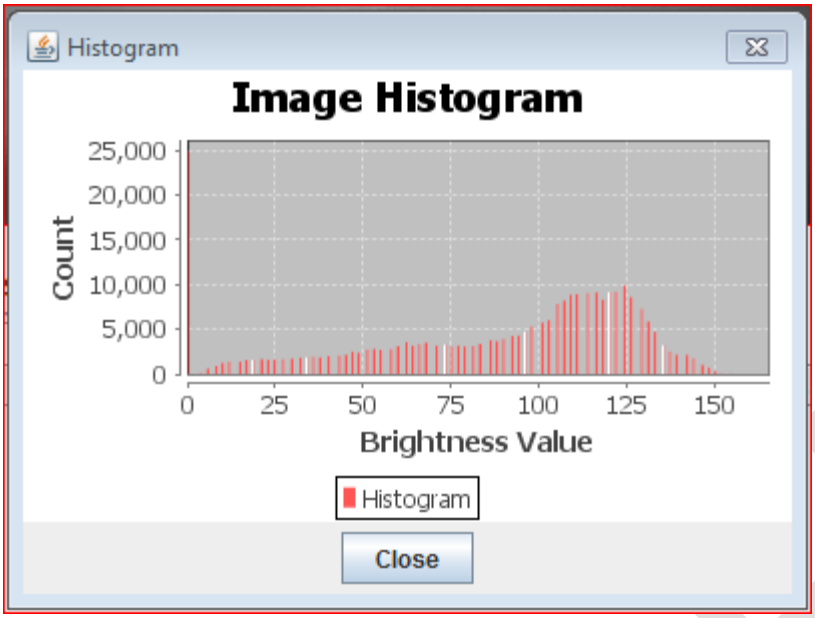

Then chose the DN STRETCH from the Digital Filter Controls and enter the lower and upper values to stretch the brightness values.

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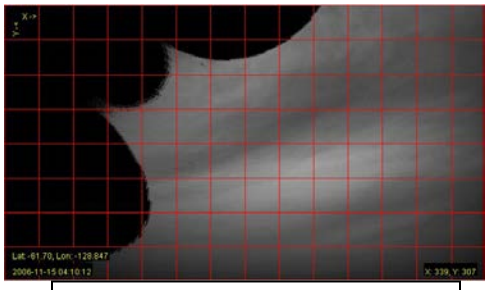
GRAPHICAL OVERLAY OPTIONS

1. Latitude and Longitude Lines

Lat/Lon Grid Box Unchecked



Lat/Lon Grid Box checked

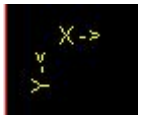
2. Wind-speed and Direction

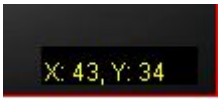
Once a feature's locations in two consecutive images of the chosen sequence are chosen, the applet computes the speed and direction of the feature and an arrow (un-checked box) or a wind-barb (if box is checked) is displayed at the mid-point of the feature movement over the two images as an overlay. More information about tracking cloud features is in the next section.

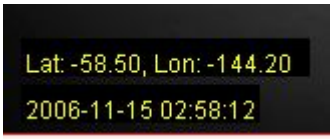
3. Target Search Box in the tracking frames

MEASURING THE SPEED AND DIRECTION OF CLOUD FEATURES

The speed of a cloud feature is measured as the distance traveled by the cloud over the time interval between the same cloud can be identified in two images separated by an **appropriate** interval of time (i.e. the granularity must be small compared to the speed of the feature, but the time interval should not be so long that the feature evolves too much). The applet can determine the latitude and longitude of the cursor when it is within the image display window. The display coordinate system is indicated in the upper left corner of the display and the image line and sample position of the cursor is shown in lower right. Corresponding latitude and longitude coordinates are shown in the lower left corner of the image display. As you roam over image with the cursor, you can watch these co-ordinates change.







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CHOOSING THE IMAGES FOR TRACKING

Because the smallest distance that can be measured using the cursor with the mapped images the applet uses is 0.2 degrees in latitude or longitude (equivalent to about 21.38 km on Venus a the cloud level of about 70 km) per image line and decreasing with each image element position from this value at equator, the granularity of the measured speed is determined by the time interval between images. Thus, the minimum time interval between images chosen for feature tracking should be not be less than about one hour to keep the granularity small enough (~ 6 ms^{-1}). Since the cloud features on Venus change constantly, a longer interval will make them difficult to identify in successive images, and hence the images should be selected carefully.

For beginners, it is best to begin with only a pair of images. Three images separated by an hour each are recommended.

Small, discrete features (light or dark) are expected to be good tracers of the ambient flow, and are preferred as targets for tracking. Larger features indicate other than ambient flow (compare the movement of a hurricane or a storm with the winds prevailing in them).

You can try the RMS/AVG, Gradient or Edge Filters to improve the visibility of the features for selection and tracking in the following frame(s).

It is best to view the animation so that the motions of the cloud features, then pause the animation to select the features on the first frame of the sequence using the mouse and clicking (left button if it is a two button mouse). The display will automatically advance to the next frame when the server responds, at which time you can move the cursor to the location

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of the feature in that frame and record it with the mouse-click. If it is the last frame of the sequence, the calculated speed in the East-West and North-South direction will appear in the results window at the bottom. Otherwise, the display will advance to the next image in the sequence and you should record the feature position and repeat this process until the feature location in the last image of the sequence is recorded.

This procedure can then be repeated for another target until no more features can be tracked. At this point you can select a new sequence of images and repeat the procedure.

By measuring features over the available latitudes and longitudes in many such sequences, it is possible to get an idea of the atmospheric circulation indicated by these features. The results can be e-mailed to you at the end of your session by clicking on the FINISH and Submit Button to the right of the results window. **You can return at a later point to the applet to track other image sequences.**

PLOTTING YOUR RESULTS

Use the PLOT Button to generate a plot on-line by selecting the x and y axis quantities. You can also control the plot options by using the right mouse click on the plot, print it to an installed printer or save it as an image. You can of course generate plots later using the tracking results mailed to you using a spreadsheet program on your computer.

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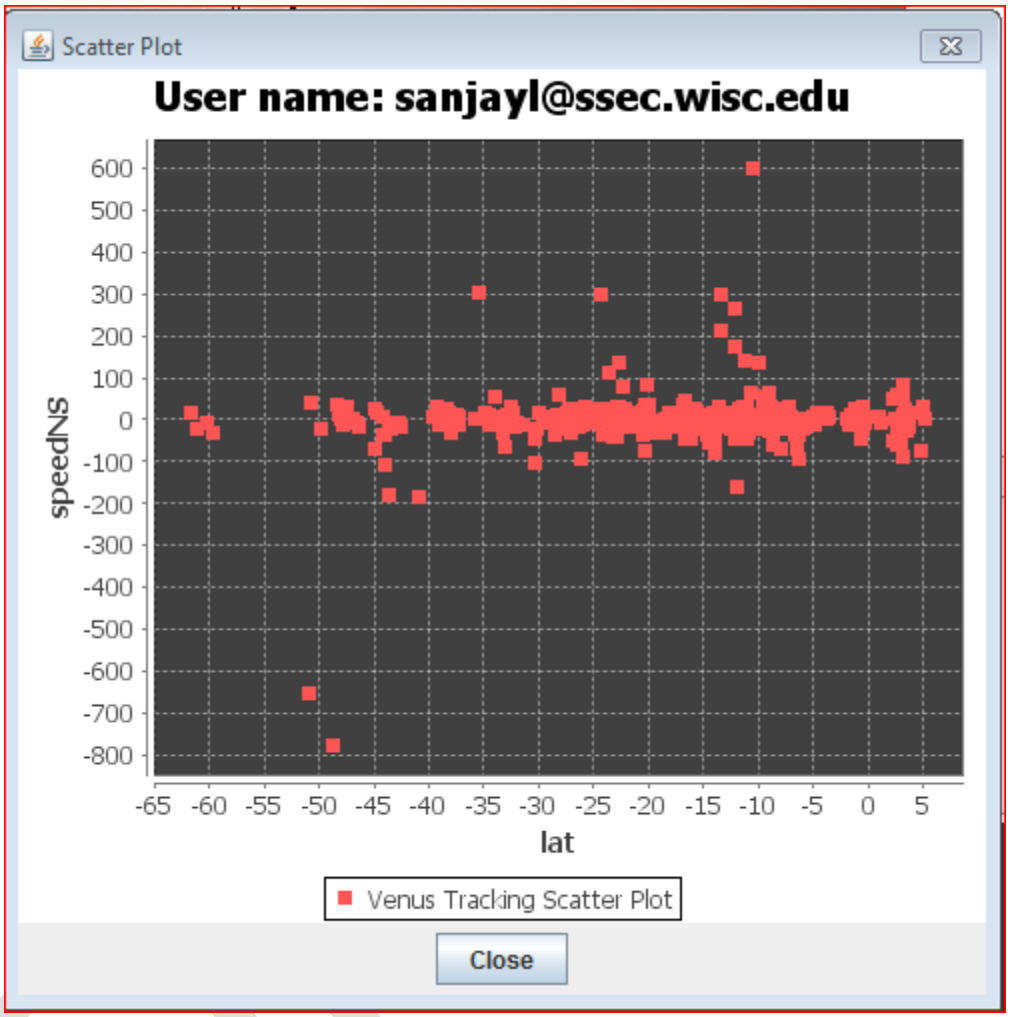
Scatter Plot
User name: sanjayl@ssec.wisc.edu
speedNS
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-65 -60 -55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5
lat
Venus Tracking Scatter Plot
Close