Last Updated:
October 14, 2008

Level 0 - CIPS Images -
(first light, primary science, last light)

Get Dark Correction Maps

1. For the current camera, get the most recent pair of good dark images. To be "good," darks can't have missing packets and need to have corresponding HK temperatures. Dark images are taken at the beginning and end of every third orbit for each camera.

2. If any pixels have zero values, set to NaN.

DARK IMAGE ELECTRICAL OFFSET CORRECTION:
3. Get each dark image's electrical offsets by finding the minimum value from the dark image's first readable row.
4. Subtract the electrical offset from each pixel of the corresponding dark image.

DATA RATE CONVERSION:
5. dark_image = dark_image / integration_time

Level 0 - Housekeeping: temperatures

Electrical Offset Correction

1. To calculate electrical offsets for each science image: interpolate over temperature to the dark images' electrical offsets.
2. Subtract the electrical offsets from each corresponding science image on a pixel by pixel basis

Calculate Corrected DN Rate

CORRECT FOR NON-LINEARITY:
1. Get coefficient for current camera (currently using):
    px: -2.976535E-10
    mx: -4.26872E-10
    py: -4.02602E-10
    my: -3.92884E-10
2. Determine sensitivity divisor:
    4x8 binning: sens_divisor = 64
    2x2 binning: sens_divisor = 8
    2x4 binning: sens_divisor = 16
    no binning: sens_divisor = 1
3. non_linearity_correction = coefficient / sens_divisor
4. DN(true) = DN(obs) / (1 + (non_linearity_correction * DN(obs)^2)

DN RATE CONVERSION:
5. Divide each resulting science image by its integration time.

DARK CORRECTION:
6. Get a dark image (as a dark data rate) for each science image by interpolating the current orbit's darks over temperature. Note that since dark pairs are taken every third orbit, occasionally an image temperature will be outside the range of the dark pair temperatures (e.g. orbit ends). Interpolating in this case, results in a dark with lots of negative valued pixels. When that happens, rather than interpolating to get a new dark, use the dark that's closest to the temperature of the image being corrected.

7. Subtract dark correction maps on a pixel by pixel basis from the science image being corrected.

8. Resulting image is DN_RATE_CORR

Level 0 - Housekeeping: CCD temperature, voltage

Calculate Albedo

CALCULATE INTENSIFIER TEMPERATURE and GAIN:
Pre-flight testing indicated that both the high voltage and temperature gain corrections can be made by multiplying all pixel images with a single value for each camera. The correction can be determined from the following equation:

G(HV, T) = A0 * (a3 +a4 * T) *e^(a1*(HV-700)+a2*(HV-700)^2)

    px:
        a1 = 0.0161378
        a2 = -9.61494e-06
        a3 = 1.02859
        a4 = -0.00418869
    mx:
        a1 = 0.0163646
        a2 = -9.77719e-06
        a3 = 1.02406
        a4 = -0.00441509
    py:
        a1 = 0.0153218
        a2 = -1.02052e-05
        a3 = 1.01431
        a4 = -0.00450727
    my:
        a1 = 0.0149232
        a2 = -9.55688e-06
        a3 = 1.03924
        a4 = -0.00477110

    A0 = (a3 + 25.0*a4)^(-1)

CALCULATE RADIOMETRIC SENSITIVITY:
1. Get sensitivity coefficient for current camera (currently using):
    px: 23.2067
    mx: 40.6623
    py: 19.3341
    my: 18.6405
2. Determine sensitivity multiplier:
    4x8 binning: sens_multiplier = 32
    2x2 binning: sens_multiplier = 4
    2x4 binning: sens_multiplier = 8
    no binning: sens_multiplier = 1
3. sensitivity_correction = coefficient * sens_multiplier
4. R = sensitivity_correction * G(HV, T) * (spacecraft's distance from the sun in AU's)^2)

CALCULATE ALBEDO:
Albedo = DN_RATE_CORR / R

Flatfield Correction

LAB FLAT:
1. Get the lab flat that corresponds to the camera and season being processed.
2. Lab flats are 1360x1360. So, window and bin flats to get the region of the camera that corresponds with the current image.
3. Multiply each image by the resulting flatfield correction map.
4. Rotate/flip images to correct orientation

DELTA FLAT:
5. Get the delta flat correction map that corresponds to the camera and season being processed.
6. Multiply each image by the delta flat correction map.

DELTA FLAT NORMALIZATION:
7. Get the delta flat normalization correction (single value per camera per season) that corresponds to the camera and season being processed.
8. Multiply each image by the delta flat normalization correction.

Calibrated Albedo Images