**Earth**

Application for processing and analysing Earth observation data



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**Introduction**

*Earth* is an image processing application that constains more that 120 tools for data processing and analysis. Whilst it is primarily designed for handling Earth observation data it can also be used for processing other Earth science datasets. The tools have been forged in the furnaces of climate change and Earth observation research, and as such the tools are highly practical and also innovative. As yet, *Earth* does not have a means of visualising images, but the power of *Earth* lies in its ability to be run from the command line thereby allowing automated and repetitive processing of huge volumes of data. The native file format is flat file raw binary. The tools are broadly categorised into one of ten groups:

* Image manipulation tools
* Statistical analysis tools
* Text processing tools
* Classification tools
* Filter tools
* Format conversion tools
* Type conversion tools
* Radar tools
* Digital Elevation tools
* Miscellaneous tools

**Installation**

*Earth* can be downloaded from [www.github.com/wmfgrey/earth](http://www.gthub.com/wmfgrey/earth)is written in the C programming language, and is easily extensibe, with additional numerical routines. This is free and unencumbered software released into the public domain, that has only been tested under Ubuntu Linux.

1) Dowload the tarball from [www.github.com/wmfgrey/earth](http://www.gthub.com/wmfgrey/earth)

2) Untar

|  |
| --- |
| $ tar -zxvf earth.tgz |

3) Change directory into the earth root folder

|  |
| --- |
| $ cd earth |

4) Compile using make

|  |
| --- |
| $ make |

5) Do a test of earth. It will print out the usage help if it has compiled succesfully.

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| --- |
| $ bin/earth |

**List of tools**

**Image manipulation tools**

-xflip Flips images left to right

-yflip Flips images up to down

-swap Byte swapping from little endian to big endian and vice versa

-crop Extract sub area of an image

-rotate Rotate images

-resample Resamples raw binary image data using nearest-neighbour interpolation

-linear2Dinterp Perform 2D linear interpolation to upscale image

-shiftMeridian In global datasets shift meridian from middle to edge

-georeference Georeference Earth observation images

-mkimg Create a single value raw binary image file

-mosaic Mosaic images

-getPixel Extract pixel value from image

-transect Extract pixel values along a transect between two points

-diff Calculate the difference between two images

-add Add two images

-ratio Divide pixels values in image 1 by values in image 2

-ndvi Calculate normalised difference vegetation index

-regression Calculate regression between 2 images

-modulus Make all pixel values positive

-mask Apply mask to image

-thresh Apply threshold to image

-calibrate Apply gain and offset to image pixels

-rad2ref Convert from radiance values to reflectance

**Statistical analysis tools**

-covariance Calculate covariance and correlation matrix between channels

-stats Calculate univariate statistics of image channels

-hist Calculates histogram of multi channel input data file

-histoArea Calculates histogram of multi-channel input data file for each region

-anomalies Subtract image mean from pixel values

-standardise Subtract image mean from pixel values and divide by standard deviation

-addNoiseImg Box Muller transform to add Gaussian noise to image

-areaCounter Count pixels in 1/0 binary value byte image

-meanArea Calculates the statistics with regions

-mean Calculate mean of sequence of input images

-maxImg Calculate maximum pixel value of sequence of input images

-minImg Calculate minimum pixel value of sequence of input images

-stdev Calculate standard deviation of sequence of input images

-areaCalc Calculate area

-kriging Kriging interpolation

-kriging\_point Get Kriged estimate of a point

-autoregressive AR over sequence of images

**Text processing tools**

-getNumLines Get number of lines in a file excluding blank lines

-getNumLinesAll Get number of lines in a file including blank lines

-calcTotalMean Calculate total and mean of a text file

-univariate Calculate univariate statistics of a 1 column text file

-histText Calculate histogram of a 1 column text file

-bivariate Calculate bivariate statistics of a 2 column text file

-sideCat Concatonate 2 text files side by side

-rows2cols Converts rows to columns in text files

-addNoise Box Muller transform to add Gaussian noise to text file

-interpText Perform linear interpolation on column in a text file

-ar Calculate AR between 2 columns of data

-meanWindow Perform smoothing using mean filter

-tsspec Calculate time series spectra

-crosspec Calculate cross spectra of time series data

**Classification tools**

-confusion Calculate confusion matrix for classified image

-classify Classify images using basic box classifier

-separability Calculate separability between classes for any number of channels

-trainCA Train transition rules for cellular automata

-automata Run Cellular Automata Markov simulation

-reassign Reassign values within byte image

-eval\_clusters Evaluate accuracy of change images

-remove\_big\_clusters\_int Remove big clusters (Integer)

-remove\_small\_clusters\_int Remove small clusters (Integer)

-remove\_small\_clusters\_byte Remove small clusters (char)

-remove\_big\_clusters\_byte Remove small clusters (char)

-count\_clusters\_byte Counts clusters in a 1 / 0 binary image for char

-count\_clusters\_int Counts clusters in a 1 / 0 binary image fir integer

**Filter tools**

-modeFilter Apply mode (majority) filter to byte image data

-meanFilter Apply mean filter

-texture Apply texture filter

**Format conversion tools**

-bsq2dimap Convert from band sequential image to dimap

-dimap2bsq Convert from dimap to band sequential image

-bip2bsq Convert from byte interleave by pixel to band sequence

-bil2bsq Convert from byte interleave by line to band sequence

-bil2bip Convert from byte interleave by line to byte interleave by pixel

-bip2bil Convert from byte interleave by pixel to byte interleave by line

-byte2text Convert from char to ASCII text

-short2text Convert from short int to ASCII text

-float2text Convert from float to ASCII text

-float2textRow Convert from float to ASCII text as row

-float2textSN Convert from float to ASCII text in scientific notation

-text2float Convert from ASCII text to float

-byte2pgm Converts from binary byte data to pgm

-byte2ppm Converts from binary byte data to ppm

-byte2ppm3 Converts from 3 channel byte data to ppm

-ppm2byte Converts ppm to binary byte data

-pgm2byte Converts pgm to binary byte data

**Type conversion tools**

-byte2short Convert from signed char to signed short integer

-byte2float Convert from signed char to float

-byte2long Convert from signed char to signed long integer

-float2byte Convert from float to signed char

-long2float Convert from signed long integer to float

-long2byte Convert from signed long integer to signed char

-short2byte Convert from signed short integer to signed char

-short2float Convert from signed short integer to float

-short2long Convert from signed short integer to signed long integer

-long2short Convert from signed long integer to signed short integer

-ushort2float Convert from unsigned short integer to float

-ubyte2float Convert from unsigned char to float

-ubyte2ushort Convert from unsigned char to unsigned short integer

-ushort2ubyte Convert from unsigned short integer to unsigned char

-float2ubyte Convert from float to unsigned char

-long2ulong Convert from long to unsigned long

-ulong2long Convert from unsigned long to long

-short2ushort Convert from short to unsigned short

-ushout2short Convert from unsigned short to short

-ubyte2byte Convert from unsigned char to char

-byte2ubyte Convert from char to unsigned char

-byte2bits Convert from bits to bytes

-bits2byte Convert from bytes to bits

**Radar tools**

-linear2dB Convert radar data from linear to dB values

-dB2linear Convert radar data from dB to linear values

-complex2RealImag Convert complex radar data to real and imaginary

-complex2PwrPhase Convert complex radar data to power and phase

**Digital Elevation Model tools**

-demSlope Calculates the slope and aspect from an input DEM float image

-demShade Creates shaded relief map from DEM

-demVolume Calculate volume of a DEM difference

**Miscellaneous tools**

-copy Copy binary data file

-header Create ENVI header file

-spectralResponse Calculate broad band spectral response given irriadiance and spectral response function

-degConv Convert between decimal degrees and degrees, minutes and seconds

-solpos Calculate solar azimuth and zenith angles

**Image manipulation tools**

**xflip** - Flops images left to right about the x axis

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| --- |
| earth -xflip inImg outImg xdims [bpp] [channels]  infile input image  outfile output image  xdim number of pixels per row  bpp bytes per pixel: 1,2,4, or 8  channels Number of channels |

**yflip** - Flips images up to down about the y axis

|  |
| --- |
| earth -yflip inImg outImg xdims [bpp] [channels]  infile input image  outfile output image  xdim number of pixels per row  bpp bytes per pixel: 1,2,4, or 8  channels Number of channels |

**swap** - Byte swapping from little endian to big endian and vice versa

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| --- |
| earth -swap infile [outfile] [bpp]  infile Input image  outfile Output image  bpp bytes per pixel (2,4,8) |

**crop** - Extract sub area of an image

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| --- |
| earth -crop inImg cropImg xdim xoffset yoffset xsize ysize bytesPerPixel [channels]  inImg Input image  outImg Output crop image  xdim Number of pixels per row  xoffset Start pixel in x  yoffset Start pixel in y  xsize Cropped image number of pixels in x  ysize Cropped image number of pixels in y  bytesPerPixel Bytes per pixel: 1,2,4, or 8  [channels] Number of channels |

**rotate** - Rotate images

|  |
| --- |
| earth -rotate infile outfile xdim [angle] [bpp] [channels]  infile input image 1  outfile output image  angle angle of rotation  bpp Bytes per pixel  channels Number of channels |

**resample** - Resamples raw binary image data using nearest-neighbour interpolation

|  |
| --- |
| earth -resample inImg outImg xdim factor [channels] [bytesPerPixel]  inImg Input image  outImg Output image  xdim Number of pixel in x dimension  factor Resampling factor  channels Number of channels (default =1)  bpp Bytes Per Pixel (default =1) |

**linear2Dinterp** - Perform 2D linear interpolation to upscale image

|  |
| --- |
| earth -linear2Dinterp inImg outImg xdim xscale yscale [channels] [dataType]  inImg Input image  outImg Output image  xdim Number of pixels per row  xscale Scale in x  yscale Scale in y  [channels] Number of channels (default=1)  [dataType] Float Only |

**shiftMeridian** - In global datasets shift meridian from middle to edge

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| --- |
| earth -shiftMeridian inImg outImg xdims [bpp] [channels]  infile input image  outfile output image  xdim number of pixels per row  bpp bytes per pixel: 1,2,4, or 8  channels Number of channels |

**georefernce** - Georeference Earth observation images

|  |
| --- |
| earth -georeference infile outfile xdim gcpFile [bytesPerPixel]  infile Unregistered input image 1  outfile Georeferenced output image 2  xdim Number of pixels in x dimension  gcpFile Text file of GCP points  dataType 1 char; 2 short; 3 long; 4 float; double 8 |

**colocate –** Find offset between pairs of images

|  |
| --- |
| earth -colocate inImg outImg xdim [skip] [correl\_winsize]  inImg1 Input image (byte)  inImg2 Output image (byte)  xdim Number of xdim per row  skip Window size; odd only Default: 3  correl\_winsize default=15 |

**mkimg** - Create a single value raw binary image file

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| --- |
| earth -mkimg outImg xdim ydim dataType pixVal [channels]  outImg Name of image to create  xdim Number of pixels in x dimension  ydim Number of pixels in y dimension  dataType 1:byte (default), 2:short, 3:long, 4:float,  8:Double  pixVal Pixel value  [channels] Number of channels |

**mosaic** - Mosaic images where images can be inserted into the master image

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| --- |
| earth -mosaic mosaicImg inImg mosaicXdim inXdim xoff yoff bytesPerPixel  mosaicImg Mosaic image to be overwritten  inImg Imput image  mosaicXdim Number of pixels per row in mosaic image  inXdim Number of pixels per row in input image  xoff Start pixel in x  yoff Start pixel in y  bytesPerPixel Bytes per pixel: 1,2,4, or 8 |

**getPixelValue** - Extract pixel value from image

|  |
| --- |
| earth -getPixelValue inImg xdim xpos ypos dataType [channels]  inImg Input image  xdim Number of pixels per row  xpos x position of pixel  ypos y position of pixel  dataType 1:byte; 2:short; 3:long; 4:float; 8:double  channels Number of channels (default=1) |

**transect** - Extract pixel values along a transect between two points

|  |
| --- |
| earth -transect inImg xdim xpos1 ypos1 xpos2 ypos2 [dataType] [Channels]  inImg Input image  xdim Number of pixels per row  xpos1 x position of pixel 1  ypos1 y position of pixel 1  xpos2 x position of pixel 2  ypos2 y position of pixel 2  [dataType] 1:byte; 2:short; 3:long; 4:float; 8:double  [channels] Number of channels |

**diff** - Calculate the difference between two images

|  |
| --- |
| earth -diff infile1 infile2 outfile [data\_type]  infile1 input image 1  infile2 input image 2  outfile output image  data\_type 1:byte (default), 2:short, 3:long, 4:float,  8:Double |

**add** - add two images

|  |
| --- |
| earth -add infile1 infile2 outfile [data\_type]  infile1 input image 1  infile2 input image 2  outfile output image  data\_type 1:byte (default), 2:short, 3:long, 4:float,  8:Double |

**ratio** - divide pixels values in image 1 by values in image 2

|  |
| --- |
| earth -ratio infile1 infile2 outfile [data\_type]  infile1 input image 1  infile2 input image 2  outfile output image  data\_type 1:byte (default), 2:short, 3:long, 4:float,  8:Double |

**ndvi** - Calculate normalised difference vegetation index. This is a standard index that is calculated by subtracting the red channel from the green channel and dividing by the red channel plus the green channel.

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| --- |
| earth -ndvi infile1 infile2 outfile [data\_type]  infile1 input image 1  infile2 input image 2  outfile output image  data\_type 1: byte (default), 2: short, 3: long, 4:  float, 8: Double |

**regression** - Calculate regression between 2 images

|  |
| --- |
| earth -regression infile1 infile2 [outfile] [dataType]  infile1 input image 1  infile2 input image 2  outfile output image  data\_type 1:byte (default), 2:short, 3:long, 4:float,  8:Double |

**modImg** - Make all pixel values positive

|  |
| --- |
| earth -modImg infile outfile [dataType]  infile input image 1  outfile output image  dataType 1:byte (default), 2:short, 3:long, 4:float,  8: Double |

**mask** - Apply mask to image

|  |
| --- |
| earth -mask infile maskfile (Byte) outfile [data\_type]  infile input image  mask file mask image  outfile output image  data\_type 1:byte (default), 2:short, 3:long, 4:float, 8:Double |

**thresh** - Apply threshold to image

|  |
| --- |
| earth -thresh infile outfile max\_thresh min\_thresh [data\_type]  infile input image 1  outfile output image  threshold (max) upper threshold value  threshold (min) lower threshold value  data\_type 1:byte (default), 2:short, 3:long, 4:float,  8:Double |

**calibrate** - Apply gain and offset to image pixels

|  |
| --- |
| earth -calibrate inImg outImg gainOffsetFile [dataType] [channels] [ignoreZeroValue]  inImg input image  outImg output image  gainOffsetFile File containing gain and offset for each  channel:  outputVal = offset + gain \* inputVal  dataType 1:byte (default), 2:short, 3:long, 4:float,  8:Double  channels Number of channels (default=1)  ignoreZeroValue Ignore zero values (default=No(0)) |

**rad2ref** - Convert from radiance values to reflectance

|  |
| --- |
| earth -rad2ref inImg outImg szaImg irradianceFile [dataType] [channels] [scale]  inImg input radiance image  szaImg input solar zenith angle image for each pixel  outImg output reflectance image  irradianceFile Text file of solar irrandiance values for each  band  dataType 1: byte (default), 2: short, 3: long, 4: float,  8: Double  channels Number of channels  scale Scale value if required default=1.0 |

**Statistical analysis tools**

**covariance** - Calculate covariance and correlation matrix between channels

|  |
| --- |
| earth -covariance inImg [channels] [bytesPerPixel]  inImg Input image  channels Number of channels  dataType 1:byte (default), 2:short, 3:long, 4:float, 8:Double |

**stats** - Calculate univariate statistics of image channels

|  |
| --- |
| earth -stats inImg [channels] [dataType]  inImg Input image  channels Number of channels  dataType 1:byte (default), 2:short, 3: ong, 4:float, 8: Double |

**hist** - Calculates histogram of multi channel input data file

|  |
| --- |
| earth -hist inImg [channels] [dataType] [Nbins]  inImg Input image  channels Number of channels  dataType 1:byte (default), 2:short, 3:long, 4:float, 8: Double  Nbins Number of bins in histogram |

**histArea** - Calculates histogram of multi-channel input data file for each region

|  |
| --- |
| earth -histoArea inImg inCls [channels] [bytesPerPixel]  inImg Input image  inCls Input classified image  channels Number of channels  dataType 1:byte (default), 2:short, 3:long, 4:float, 8: Double  Nbins Number of bins in histogram |

**anomalies** - Subtract image mean from pixel values

|  |
| --- |
| earth -anomalies inImg outImg [dataType] [channels] [IgnoreValue] [nullValue]  inImg input image  outImg output image (float)  dataType 1:byte (default), 2:short, 3:long, 4:float,  8: Double  channels 1 (default)  IgnoreValues 0: No (default), 1: yes  nullValue 0.0 (default) |

**standardise** - Subtract image mean from pixel values and divide by standard deviation

|  |
| --- |
| earth -standardise inImg outImg [dataType] [channels] [IgnoreValue] [nullValue]  inImg input image  outImg output image (float)  dataType 1:byte (default), 2:short, 3:long, 4:float,  8: Double  channels 1 (default)  IgnoreValues 0: No (default), 1: yes  nullValue 0.0 (default) |

**addNoiseImg** - Box Muller transform to add Gaussian noise to image

|  |
| --- |
| earth -addNoiseImg inImg outImg sigma [dataType]  inImg input image  outImg output image  sigma add standard deviation such that r = sigma \* z + mu  dataType 1:byte (default), 2:short, 3:long, 4:float, 8:Double |

**areaCounter** - Count pixels in 1/0 binary value byte image

|  |
| --- |
| earth -areaCounter inImg  inImg input image (byte) |

**meanArea** - Calculates the statistics with regions

|  |
| --- |
| earth -meanArea inImg inCls [channels] [bytesPerPixel]  inImg Input image  inCls Input classified image  channels Number of channels  dataType 1:byte (default), 2:short, 3:long, 4:float, 8:Double |

**mean** - Calculate mean of sequence of input images

|  |
| --- |
| earth -mean infile outfile [dataType] [IgnoreValue] [nullValue]  infile input textfile of image list  outfile output image  dataType 1:byte (default), 2:short, 3:long, 4:float,  8:Double  IgnoreValues 0: No, 1: yes (default)  nullValue 0.0 |

**maximg** - Calculate maximum pixel value of sequence of input images. Similarly for **minImg** it calculates the minimum from a sequence of images.

|  |
| --- |
| earth -maxImg infile outfile [dataType] [IgnoreValue] [nullValue]  infile input textfile of image list  outfile output image  dataType 1: byte (default), 2: short, 3: long, 4:  float, 8: Double  IgnoreValues 0: No, 1: yes (default)  nullValue 0.0 |

**stdev** - Calculate standard deviation of sequence of input images

|  |
| --- |
| earth -stdev infile outfile [dataType] [IgnoreValue] [nullValue]  infile input textfile of image list  outfile output image 2  dataType 1:byte (default), 2:short, 3:long, 4:float,  8:Double  IgnoreValues 0: No, 1: yes (default)  nullValue 0.0 |

**areaCalc** - Calculate area

|  |
| --- |
| earth -areaCalc inimg xdim spacing [dataType]  inimg Input img image  spacing Pixel spacing (m)  xdim Number of pixels is x dimension  dataType 1: byte (default), 2: short, 3: long, 4: float, 8: Double |

**kriging** - Kriging interpolation

|  |
| --- |
| earth -kriging pointFile outImg outErr [Model] [Lag\_tolerance] [nugget] [dx] [dy]  pointFile Vector file of points in text format  outImg Output kriged image  outErr Output kriged variance image  model 1: linear (default), 2: exponential, 3:spherical, 4: gaussian  lag\_tolerance Semivariogram lag tolerance (default=1.0)  nugget Include nugget: 1, yes; 2, no (default=1)  dx pixel size in x  dx pixel size in y |

**kriging\_point** - get Kriged estimate of a point

|  |
| --- |
| earth -kriging\_point pointFile xpos ypos [Model] [Lag\_tolerance] [nugget]  pointFile Vector file of points in text format  xpos pixel location in x  ypos pixel location in y  model 1: linear (default), 2: exponential, 3:spherical, 4: gaussian  lag\_tolerance Semivariogram lag tolerance (default=1.0)  nugget Include nugget: 1, yes; 2, no (default=1) |

**autoregressive** - AR over sequence of images

|  |
| --- |
| earth -autoregressive infile1 infile2 outfile [arNum default=0] [dataType] [IgnoreValue] [nullValue]  infile1 input textfile of image list 1  infile2 input textfile of image list 2  outfile output image  arNum Auto Regression shift  IgnoreValues 0: No, 1: yes (default)  nullValue 0.0 |

**Text processing tools**

**getNUmLines** - Get number of lines in a file excluding blank lines

|  |
| --- |
| earth -getNumLines inputtextfile  inputtextfile Input text file |

**getNumLInesAll** - Get number of lines in a file including blank lines

|  |
| --- |
| earth -getNumLinesAll inputtextfile  inputtextfile Input text file |

**calcTotalMean** - Calculate total and mean of a text file

|  |
| --- |
| earth -calcTotalMean inputtextfile  inputtextfile Input text file |

**univariate** - Calculate univariate statistics of a 1 column text file

|  |
| --- |
| Usage: earth -univariate pointFile  pointFile: x file |

**histText** - Calculate histogram of a 1 column text file

|  |
| --- |
| Usage: earth -histText pointFile Nbins  pointFile: x file  NBins: Number fo bins |

**bivariate** - Calculate bivariate statistics of a 2 column text file

|  |
| --- |
| Usage: earth -bivariate pointFile  pointFile: x file |

**sideCat** - Concatonate 2 text files side by side

|  |
| --- |
| earth -sideCat inputtextfile1 inputtextfile2 outputtextfile  inputtextfile1 Input text file 1  inputtextfile2 Input text file 2  outputtextfile Output text file |

**row2cols** - Converts rows to columns in text files

|  |
| --- |
| earth -rows2cols inImg outImg  inImg input text image  outImg output text image |

**addNoise** - Box Muller transform to add Gaussian noise to text file

|  |
| --- |
| earth -addNoise inputTextfile outputTextfile sigma  inputTextfile Input text file  outputTextfile Output text file  sigma Standard deviation of error |

**interpText** - Perform linear interpolation on column in a text file

|  |
| --- |
| earth -interpText inFile outFile startVal interval endVal col skip  inFile Input text file  outFile Output text file  startVal Start Value  interval Interval  endVal End value  cols Number of columns to process  skip Skip lines at start of file |

**ar** - Calculate AR between 2 columns of data

|  |
| --- |
| earth -ar inputtextfile1 inputtextfile2 outputtextfile  inputtextfile1 Input text file 1  inputtextfile2 Input text file 2  outputtextfile Output text file |

**meanWindow** - Perform smoothing using mean filter

|  |
| --- |
| earth -meanWindow inputtextfile outputtextfile [winlen]  inputtextfile Input text file  outputtextfile Output text file  winlen Window size |

**tsspec** - Calculate time series spectra

|  |
| --- |
| earth -tsspec infile outfile alpha  infile Input file  outfile Output file  alpha Parameter required for cosine taper (default=0.05) |

**crosspec** - Calculate cross spectra of time series data

|  |
| --- |
| earth -crosspec infile1 infile2 outfile alpha  infile1 Input file 1  infile2 Input file 2  outfile Output file  alpha Parameter required for cosine taper (default=0.05) |

**Classification tools**

**confusion** - Calculate confusion matrix for classified image

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| --- |
| earth -confusion groundTruthImage classifiedImage outputTextFile  groundTruthImage Input ground truth image  classifiedImage Input classified image  outputTextFile Output confusion matrix |

**classify** - Classify images using basic box classifier

|  |
| --- |
| earth -classify inImg outImg inTextFile channels classes  inImg Input image  outImg Output image (byte)  inTextFile Input class file  dataType 1:byte (default), 2:short, 3:long, 4:float, 8:Double  channels Number of channels  classes Number of classes |

**-separability** - Calculate separability between classes for any number of channels

|  |
| --- |
| earth -separability inputtextfile <lines> <channels>  inputtextfile Text file of histograms (class i band  1,2,3....class j band 1,2,3  lines Number of lines  channels Number of channels |

**trainCA** - Train transition rules for cellular automata

|  |
| --- |
| earth -trainCA classifiedImage1 classifiedImage2 outputTextFile nClasses timesteps  classifiedImage1 Input classified image 1  classifiedImage2 Input classified image 2  outputTextFile Output probability matrix  nClasses Number of classes  timesteps Number oftimesteps between images (typically 1 per year) |

**automata** - Run Cellular Automata Markov simulation

|  |
| --- |
| earth -automata inImg outImg transitionMatrixFile xdim timesteps  inImg Input classified image  outImg Output classified image 2  transitionMatrixFile Transition Matrix file from trainCA  xdim Number of pixels  timeSteps Number of timesteps to run simulation |

**reassign** - Reassign values within byte image

|  |
| --- |
| Usage: earth -reassign inImg inImg inputTextFile  inImg Input image (byte)  outImg Output image (byte)  inputTextFile Input two columns of ascii |

**eval\_clusters -** Evaluate accuracy of change images

|  |
| --- |
| earth -eval\_clusters infile infile2 xdim flag  infile1 ground truth image (unsigned int)  infile2 classified change map (unsigned int)  xdim Number of pixels in width  flag default 0: clusters only have to be touching to be correctly classified  1: clusters have to overlap to be correctly classified |

**remove\_big\_clusters\_int** - Remove big clusters (Integer)

**remove\_small\_clusters\_int** - Remove small clusters (Integer)

**remove\_small\_clusters\_char** - Remove small clusters (char)

**remove\_big\_clusters\_char** - Remove Big clusters (char)

|  |
| --- |
| earth -remove\_big\_clusters\_int infile outfile xdim size  infile Change map  outfile Modified change map  xdim Number of pixels in width  size Remove clusters smaller than or equal to size xdim  or bigger: default=5 |

**count\_clusters** - Counts clusters in a 1 / 0 binary image byte and integer

|  |
| --- |
| earth -count\_clusters\_byte infile outfile xdim size  infile Change map  outfile Modified change map  xdim Number of pixels in width  flag flag=1 will print stats (default=0) |

**Filter tools**

**modeFilter** - Apply mode (majority) filter to byte image data

|  |
| --- |
| earth -modeFlter inImg outImg xdim [winsize]    inImg Input image (byte)  outImg Output image (byte)  xdim Number of pixels per row  winsize Window size; odd only Default: 3 |

**meanFilter** - Apply mean filter

|  |
| --- |
| earth -meanFlter inImg outImg xdim [winsize] [dataType]  inImg Input image (byte)  outImg Output image (byte)  xdim Number of pixels per row  winsize Window size; odd only Default: 3  dataType 1:byte (default); 2:short; 3:long; 4:float; 8: double |

**texture** - Apply texture filter

|  |
| --- |
| earth -texture inImg outImg xdim [winsize] [dataType]    inImg Input image (byte)  outImg Output image (byte)  xdim Number of pixels per row  winsize Window size; odd only Default: 3  dataType 1:byte (default); 2:short; 3:long; 4:float; 8: double |

**Format conversion tools**

**bsq2dimap** - Convert from band sequential image to dimap

|  |
| --- |
| earth -bsq2dimap infile outdir [channels]  infile input image  outdir output directory  [channels] default = 3 |

**dimap2bsq** - Convert from dimap to band sequential image

|  |
| --- |
| earth -dimap2bsq indir outfile  indir input path (Dimap folder) 1  outImg output image |

**bip2bsq** - Convert from byte interleave by pixel to band sequence

|  |
| --- |
| earth -bip2bsq infile outfile xdim [channels] [bytesPerPixel]  infile input image  outfile output image  xdim number of pixels per line  channels number of bands: default=3  bytesPerPixel default=1 (byte) |

**bil2bsq** - Convert from byte interleave by line to band sequence

|  |
| --- |
| earth -bil2bsq infile outfile xdim [channels] [bytesPerPixel]  infile input image  outfile output image  xdim number of pixels per line  channels number of bands: default=3  bytesPerPixel default=1 (byte) |

**bil2bip** - Convert from byte interleave by line to byte interleave by pixel

|  |
| --- |
| earth -bil2bip infile outfile xdim [channels] [bytesPerPixel]  infile input image  outfile output image  xdim number of pixels per line  channels number of bands: default=3  bytesPerPixel default=1 (byte) |

**bip2bil** - Convert from byte interleave by pixel to byte interleave by line

|  |
| --- |
| earth -bip2bil infile outfile xdim [channels] [bytesPerPixel]  infile input image  outfile output image  xdim number of pixels per line  channels number of bands: default=3  bytesPerPixel default=1 (byte) |

**byte2text** - Convert from char to ASCII text

|  |
| --- |
| earth -byte2text infile outfile xdim  infile Input image  outfile Output image  xdim Number of pixels in x dimension |

**short2text** - Convert from short int to ASCII text

|  |
| --- |
| earth -short2text infile outfile xdim  infile Input image  outfile Output image  xdim Number of pixels in x dimension |

**float2text** - Convert from float to ASCII text

|  |
| --- |
| earth -float2text infile outfile xdim  infile Input image  outfile Output image  xdim Number of pixels in x dimension |

**float2textRow** - Convert from float to ASCII text as row

|  |
| --- |
| earth -float2textRow infile outfile xdim  infile Input image  outfile Output image  xdim Number of pixels in x dimension |

**float2textSN** - Convert from float to ASCII text in scientific notation

|  |
| --- |
| earth -float2textSN infile outfile xdim  infile Input image  outfile Output image  xdim Number of pixels in x dimension |

**text2float** - Convert from ASCII text to float

|  |
| --- |
| earth -text2float infile outfile  infile Input image  outfile Output image |

**byte2pgm** - Converts from binary byte data to pgm

|  |
| --- |
| earth -byte2pgm inImg outImg xdim nColours  inImg input byte image  outImg output pgm image  xdim number of pixels per row  nColours number of colours |

**byte2ppm** - Converts from binary byte data to ppm

|  |
| --- |
| earth -byte2ppm infile (byte) outfile (pgm) xdim  infile input byte image  outfile output pgm image  xdim number of pixels per row |

**byte2ppm3** - Converts from 3 channel byte data to ppm

|  |
| --- |
| earth -byte2ppm3 infile (byte) outfile (pgm) xdim  infile input byte image  outfile output pgm image  xdim number of pixels per row |

**ppm2byte** - Converts ppm to binary byte data

|  |
| --- |
| earth -ppm2byte infile outfile  infile input ppm image  outfile output byte image |

**pgm2byte** - Converts pgm to binary byte data

|  |
| --- |
| earth -pgm2byte inImg outImg  inImg input pgm image  outImg output byte image |

**Type conversion tools**

There are a comprehensive set of tools for converting between different raw image file formats that are listed above. The syntax for the use of one of the tools is given below. The syntax for all the others is just the same.

Example: we use **byte2short** to convert from signed char to signed short integer we use. The square brackets denote an optional argument. If the argument is not specified the output image name is the same as the input name with the *.out* suffix.

|  |
| --- |
| earth -byte2short infile [outfile]    infile Input image  outfile Output image |

**byte2bits** - convert from byte to bits to conserve space. Zero pading will add additional bits and remove additional bits if required. This is because the number of bits in a byte is 8. For converting the other way use bits2byte.

|  |
| --- |
| earth -byte2bits infile [outfile]    infile Input image  outfile Output image  zero\_padding Default=0, value between 0-7 |

**Radar Tools**

There are a limited set of tools for processing synthetic aperture radar data.

**linear2dB** - Convert radar data from linear to dB values

|  |
| --- |
| earth -linear2dB inImg outImg [null value]  inImg input image (float)  outImg output image (float)  null value default: 0.0 |

**dB2linear** - Convert radar data from dB to linear values

|  |
| --- |
| earth -dB2linear inImg outImg [null value]  inImg input image (float)  outImg output image (float)  null value default: 0.0 |

**complex2RealImag** - Convert complex radar data to real and imaginary

|  |
| --- |
| earth -complex2RealImag complexfile realfile imagfile  complexfile input complex image  realfile output real image  imagfile output imaginary image |

**complex2PwrPhase** - Convert complex radar data to power and phase

|  |
| --- |
| earth -complex2PwrPhase complexfile realfile imagfile    complexfile input complex image  realfile output power image  imagfile output phase image |

**Digital Elevation Model tools**

**demSlope** - Calculates the slope and aspect from an input DEM float image

|  |
| --- |
| earth -demSlope inDEM outSlope outAspect xdim spacing  inDEM input DEM image  outSlope Output slope image  outAspect Output aspect image  xdim Number of pixels in x dimension  spacing Pixel spacing (m) |

**demShade** - Creates shaded relief map from DEM

|  |
| --- |
| earth -demShade inSlope inAspect outShade azimuth zenith  inSlope input slope image  inAspect input aspect image  outShade Output shade image  azimuth Solar azimuth position (0-360)  zenith Solar zenith (0-90) |

**demVolume** - Calculate volume of a DEM difference

|  |
| --- |
| earth -demVolume inDEM xdim spacing zres  inDEM input DEM image  xdim Number of pixels is x dimension  spacing Pixel spacing (m)  zres Resolution in height (m) |

**Miscellaneous tools**

**copy** - Copy binary data file

|  |
| --- |
| earth -copy inImg [outImg]  inImg Input image  [outImg] Output image |

This is the same as the unix *cp* command.

**header** - Create ENVI header file

|  |
| --- |
| earth -header filename xdim ydim channels dataType [byteOrder]  filename Name of header file to create  xdim Number of pixels in x  ydim Number of pixels in y  channels Number of channels  dataType 1: char, 2: short, 3: long, 4: float, 8: double  [byteOrder] 0: Little endian 1: Big endian |

The native file format of Earth is the same as ENVI. Thus if header files are created then data are easily viewed in ENVI,

**Example use:**

|  |
| --- |
| $ earth -header earthImg.hdr 100 200 10 2 0 |

Creates a header file for an short integer image named *earthImg* that is 100 by 200 pixels in x and y dimensions respectively and contains 10 channels.

**SpectralResponse** - Calculate broad band spectral response given irriadiance and spectral response function

|  |
| --- |
| earth -spectralResponse srfFile [spectraFile/planck]  srfFile Spectral response function file  spectraFile For surface or atmospheric spectra / planck model |

**degConv** - Convert between decimal degrees and degrees, minuts and seconds and vice versa

|  |
| --- |
| earth -degConv <degrees> [minutes] [seconds] |

**Example use:**

|  |
| --- |
| $ earth -degConv -101 45 0  output: -101.75  $ earth -degConv -95 45 0  output: -95.75  $ earth -degConv -1 45 0  output: -1.75  $ earth -degConv 54 45 0  output: 54.75    $ earth -degConv 54.75  output: 54:45:0 |

**solpos** - Calculate solar azimuth and zenith angles

|  |
| --- |
| earth -solpos month day hour minute latitude  month  day  hour  minute  latitude |