

Earth

Application for processing and analysing Earth observation data



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Introduction

Earth is an image processing application that contains more than 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 is written in the C programming language, and is easily extensible, with additional numerical routines. This is free and unencumbered software released into the public domain, that has only been tested under Ubuntu Linux.

1) Download the tarball from www.github.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 successfully.

```
$ 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
-mking	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	Concatenate 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
-ushort2short	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
-complex2Reallmag	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 irradiance 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 - Flips images left to right about the x axis

```
earth -xflip inImg outImg xdim [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 xdim [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

```
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

```
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

```
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

georeference - 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

```
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

```
earth -mosaic mosaicImg inImg mosaicXdim inXdim xoff yoff  
bytesPerPixel
```

mosaicImg	Mosaic image to be overwritten
inImg	Input 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.

```
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 irradiance 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
dy             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

```
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 -modeFilter 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 -meanFilter 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]
```

<code>infile</code>	Input image
<code>outfile</code>	Output image

`byte2bits` - convert from byte to bits to conserve space. Zero padding 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]
```

<code>infile</code>	Input image
<code>outfile</code>	Output image
<code>zero_padding</code>	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 in 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 irradiance 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, minutes 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
```