

Display of SAR and InSAR images

The use of the DISP package

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Scope of presentation

The DISP is the module of the GAMMA Software that allows to display images and create quick-look images. Scope of this presentation is to introduce the audience to the functionalities of the programs of the DISP module. At first, an overview of the different elements of the DISP module will be given by the lecturer, then the course participants will exercise by running a series of examples interactively.

Overview

- Introduction to the DISP module, basic elements of the DISP programs
- Use of DISP to display different types of SAR and InSAR images
 - SLC
 - Intensity or power images (referred to as multi-looked images, MLI)
 - InSAR phase
 - Coherence
 - Unwrapped InSAR phase (v. wrapped InSAR phase)
- Summary

What is DISP? What can DISP do?



The Display (DISP) module consists of programs to

- **Display radar image data and interferometric data sets**
- **Generate raster images (Sun raster or BMP) for these data**
- **Create GeoTIFF images, RGB raster images**
- Selection of ground control points
- Operate on files (real to complex, complex to real, arithmetic operations, byte swapping)
- Transform images (copy, fill, flip, value replacement)
- **Generate KML files for Google Earth**

(bold: addressed in this course)

What is DISP? What can DISP do?

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The software offers two types of screen display

- Family of “dis” programs: basic display of image
- Family of “vis” programs: display with zooming options + possibility to create horizontal or vertical colorbars + generation of image files in different formats to be inserted in documents

The screen display and raster generation programs are parallel in terms of functionality. For example the program for screen display of detected intensity images is called *dispwr*, while the program for generation of a raster images of the same data set is called *raspwr*.

The raster images can be displayed using either the *disras*, *visras* programs part of the DISP package or other image file viewer.

The DISP package is a standard package, delivered with whatever module combination

Syntax of DISP programs

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```
*** DISP dismph: display of magnitude/phase of complex image ***
```

```
*** Copyright 2002, Gamma Remote Sensing, v1.4 3-Sep-2002 clw ***
```

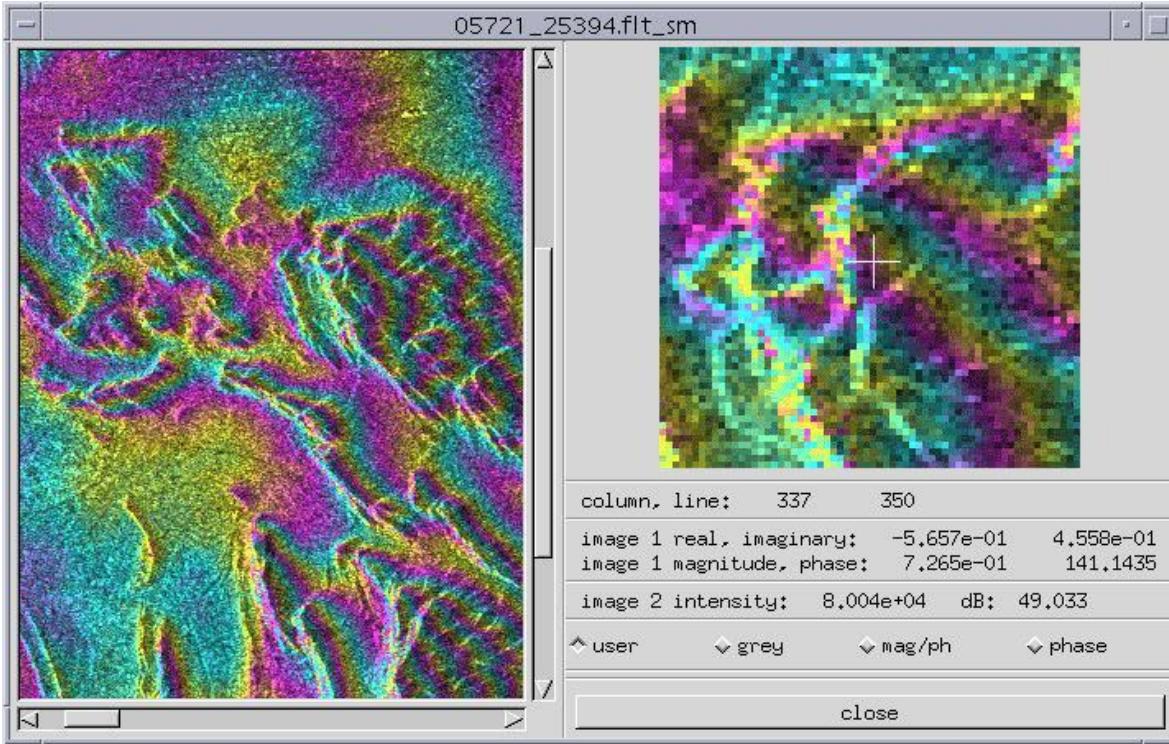
```
usage: dismph <cpx> <width> [start] [nlines] [scale] [exp] [data_type]
```

input parameters:	
cpx	complex data (FCOMPLEX or SCOMPLEX data type)
width	complex samples per row
start	starting lineto display (default=1))
nlines	number of lines to display (default=0: to end of file)
scale	display scale factor (default=1.0)
exp	display exponent (default=.35)
data_type	input data type (default=0) 0: FCOMPLEX (pairs of floats) 1: SCOMPLEX (pairs of short integers)

$$\text{Output_image} = \text{scale} * (\text{input_image})^{\text{exp}}$$

Basic elements of the DISP display

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- Image display window
- Zoom window
- Zoom window position
- Data values at the zoom window center
- Color table selection radio bar

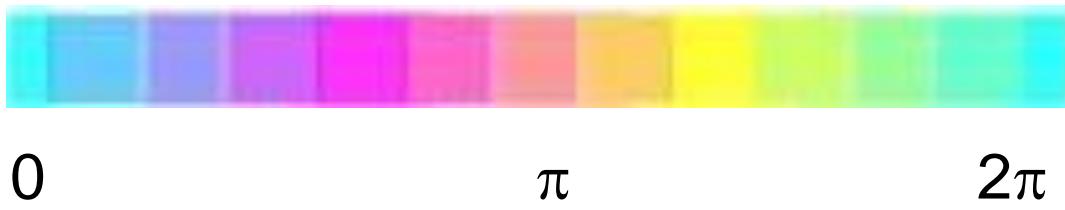
Left mouse button to move around image in image display window
Scroll bars to select another area of the image

Color bar

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In SAR images and SAR interferometric images the phase is wrapped modulo 2π in the sense that we only have values between 0 and 2π (or $-\pi$ to π).

To help interpretation of the phase the GAMMA software uses the following color bar



This color bar is also used for unwrapped interferometric phase, as well as for height and displacement maps. In this case we can use a scale factor for the color cycle, i.e. decide on the span of the color cycle. Defining the span of color cycle corresponds to defining the repetition cycle of the colors in the image.

Example: For the unwrapped interferometric phase a scale factor of 1 means that the color cycle covers an interval that is 2π radians wide. A value equal to 2 means half of the span, i.e. the color cycle covers an interval that is π radians wide. On the contrary a value of 0.5 means that the color cycle cover an interval that is 4π wide.

Which program for which image type?

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IMAGE TYPE	DISP program
Raw data	disbyte
SLC	disSLC
MLI	dispwr, dis_dB
Interferogram	dismph, mismph_pwr
Coherence	discc
Unwrapped phase	disrmg, disdt_pwr24
Elevation map, displacement map (if DEM_par file available)	dishgt, disshd (for shaded relief) disdem_par
Any image in SUNraster or bmp format	disras
Generic float format image (in linear scale)	dis_linear, disdt_pwr24
Geocoded product (in SUNraster or bmp format)	disras_dem_par

Simultaneous display of 2 images of the same type can be done with the programs starting with “dis2” (e.g. dis2SLC, dis2pwr, dis2mph etc.)

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Display of SLC data

J

*** DISP disSLC: display of SLC image ***

*** Copyright 2005, Gamma Remote Sensing, v1.4 26-May-2005 clw ***

usage: disSLC <SLC> <width> [start] [nlines] [scale] [exp] [data_type]

input parameters:

SLC (input) single-look complex image (fcomplex or scomplex data type)

width complex samples per row of the SLC

start starting line (default=1)

nlines number of lines to display (default=0: to end of file)

scale display scale factor (default=1.)

exp display exponent (default=.5)

data_type input SLC data type

0: FCOMPLEX

1: SCOMPLEX (default)

Example

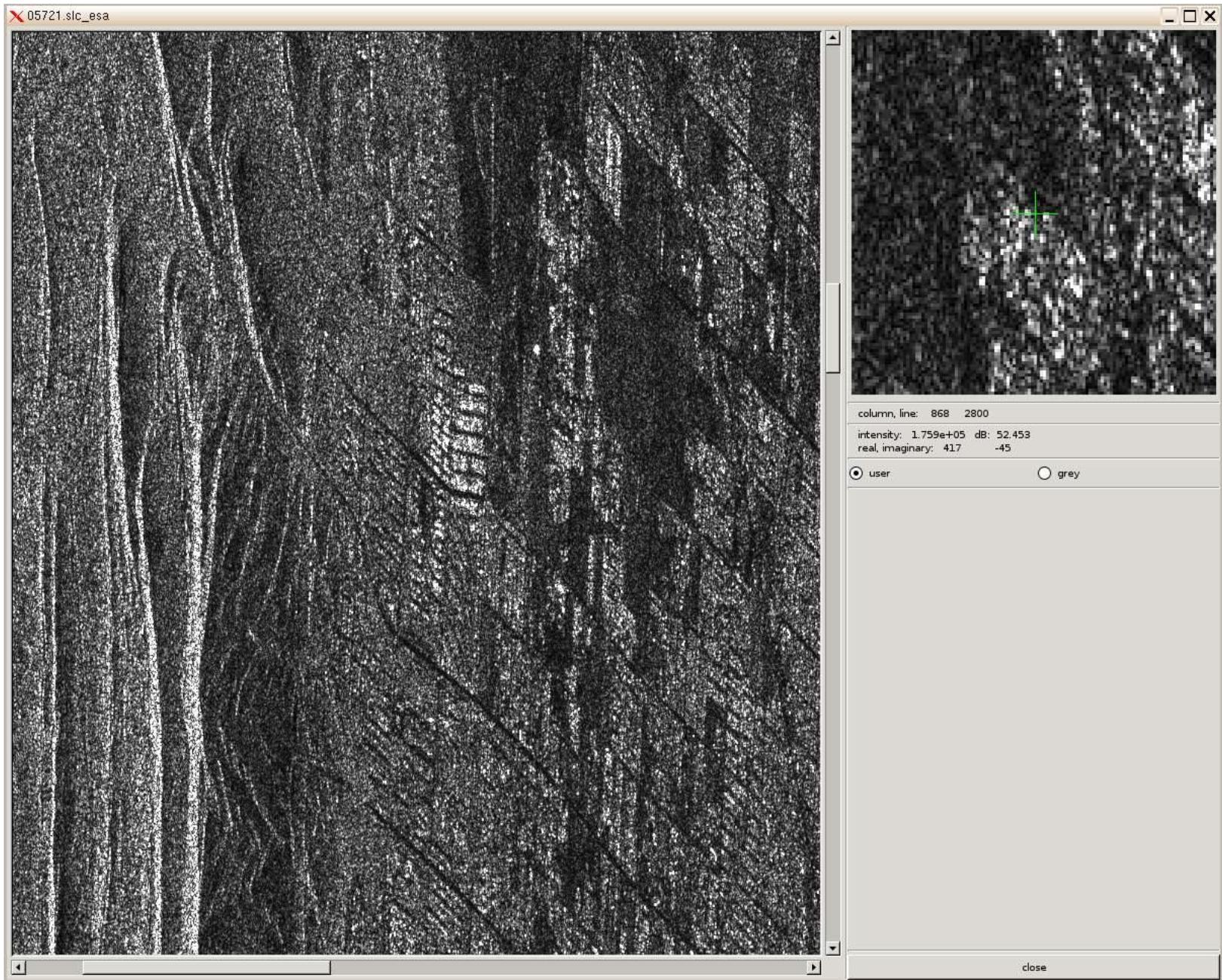
SLC acquired over Las Vegas on 24th May 1996 along orbit 05721 by ERS-2.

Number of samples per row: 2500 , data type: SCOMPLEX

disSLC 05721.slc 2500 1 0 1.0 0.5 1 → full command line

disSLC 05721.slc 2500 → alternative, when all default values are accepted

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Display of SAR intensity data

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*** DISP dispwr: display of intensity image (power-law scaling) ***

*** Copyright 2005, Gamma Remote Sensing, v1.5 24-Aug-2005 clw ***

usage: dispwr <pwr> <width> [start] [nlines] [scale] [exp] [data_type] [hdrz]

input parameters:

pwr (input) intensity image (FLOAT or SHORT INTEGER data type)
width samples per row
start starting line to display (default=1)
nlines number of lines to display (default=0: to end of file)
scale display scale factor (default=1.)
exp display exponent (default=.35)
data_type input data type
 0: FLOAT (default)
 1: SHORT INTEGER

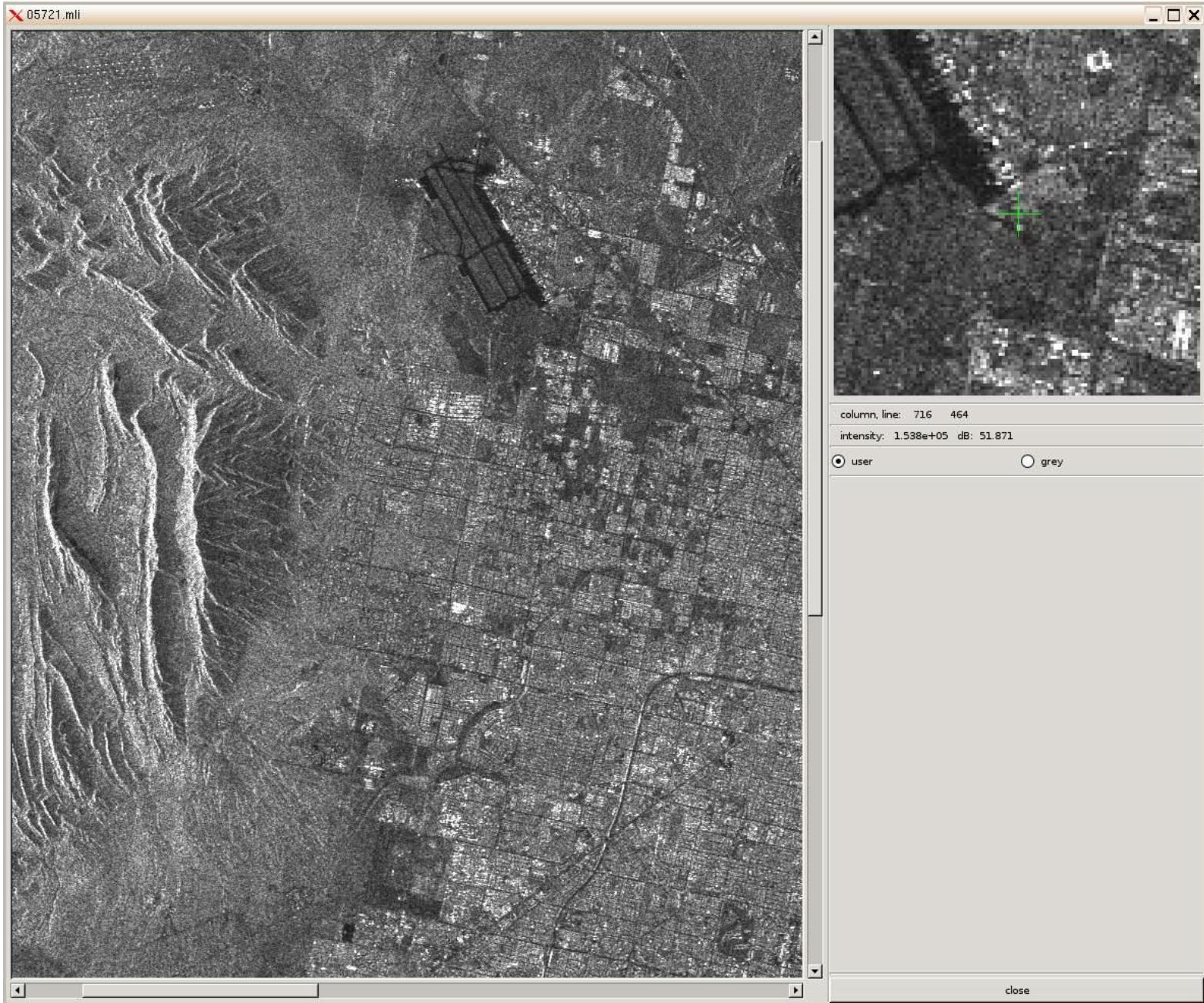
Example

From the SLC acquired over Las Vegas I generated a 1x5 multi-look SAR intensity image

Number of samples per row: 2500 , data type: FLOAT

dispwr 05721.mli 2500 → will display the whole intensity image

J



Generation of SUNraster image



*** DISP raspwr: generate raster image of intensity image (power-law scale) ***

*** Copyright 2008, Gamma Remote Sensing, v2.5 11-Sep-2008 clw ***

usage: raspwr <pwr> <width> [start] [nlines] [pixavr] [pixavaz] [scale] [exp] [LR] [rasf]
[data_type] [hdrsz]

input parameters:

pwr (input) intensity image (FLOAT or SHORT INTEGER data type)
width samples per row
start starting line to display (default=1)
nlines number of lines to display (default=0: to end of file)
pixavr number of pixels to average in range (default=1)
pixavaz number of pixels to average in azimuth (default=1)
scale display scale factor (default=1.)
exp display exponent (default=.35)
LR left/right flipping flag, (default=1: normal, -1: mirror image)
rasf (output) raster image (enter - for default = *.ras: SUN raster format, *.bmp: BMP format)
data_type input data type (default=0)
 0: FLOAT
 1: SHORT INTEGER
hdrsz line header size in bytes (default=0, ESA PAF for PRI products=12)

Example

raspwr 05721.mli 2500 1 0 5 5 1.0 0.35 1 05721.mli.ras 0 0 → full command line

raspwr 05721.mli 2500 - - 5 5 - - - 05721.mli.ras → when accepting default values

Generation of SUNraster image



*** DISP raspwr: generate raster image of intensity image (power-law scale) ***

*** Copyright 2008, Gamma Remote Sensing, v2.5 11-Sep-2008 clw ***

usage: raspwr <pwr> <width> [start] [nlines] [pixavr] [pixavaz] [scale] [exp] [LR] [rasf]
[data_type] [hdrz]

Example

- 1) raspwr 05721.mli 2500 1 0 5 5 1.0 0.35 1 05721.mli.ras 0 0
full command line, 5x5 multilook applied, SUNraster generated, with file name given by the user
- 2) raspwr 05721.mli 2500 - - 5 5 - - - 05721.mli.ras
command line when all default values are accepted, 5x5 multilook applied, SUNraster generated with file name given by the user
- 3) raspwr 05721.mli 2500 - - 5 5
Equivalent to 2, file name of SUNraster determined by program (input file name.ras)
- 4) raspwr 05721.mli 2500 - - 5 5 - - - 05721.mli.bmp
command line as in 2), bmp generated with file name given by user
NOTE: if output should be bmp, the file name must be specified

DISPLAY of SUNraster or bmp file with the program disras:

disras 05721.mli.ras

Exercise

J

Let's learn how to use some of the DISP programs.

Now you try:

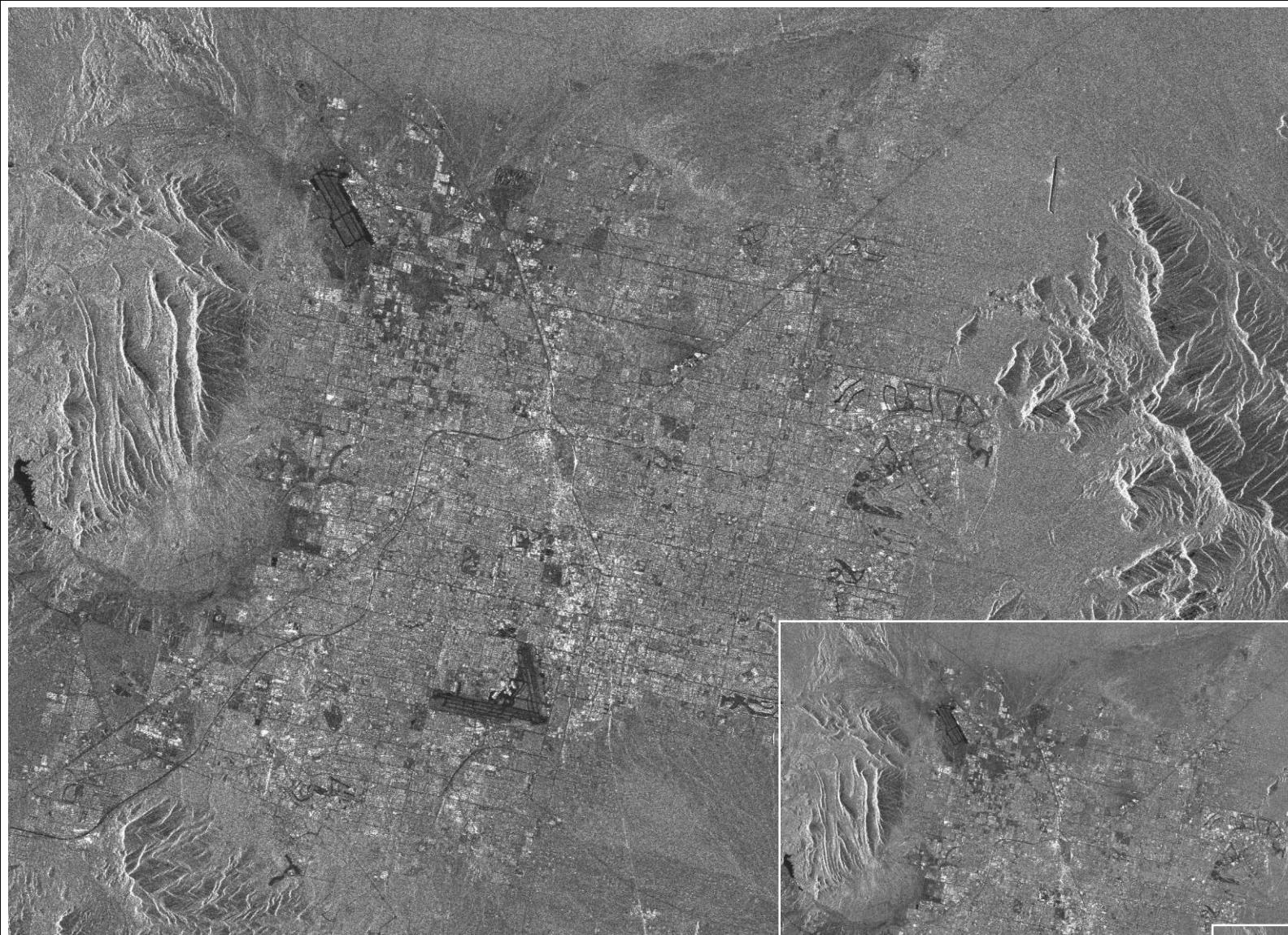
- 1) disSLC 05721.slc 2500
- 2) dispwr 05721.mli 2500
- 3) dispwr 05721_2_10.mli 1250
- 4) dispwr 05721_4_20.mli 625

First of all, is it clear what you are doing?

Then, do you see any difference between the images?

What are the differences between the images?

J

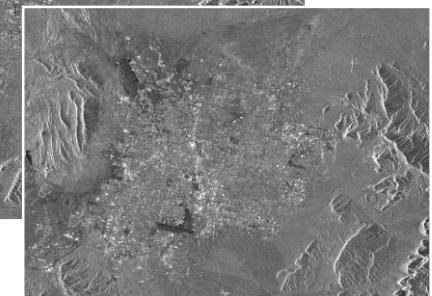
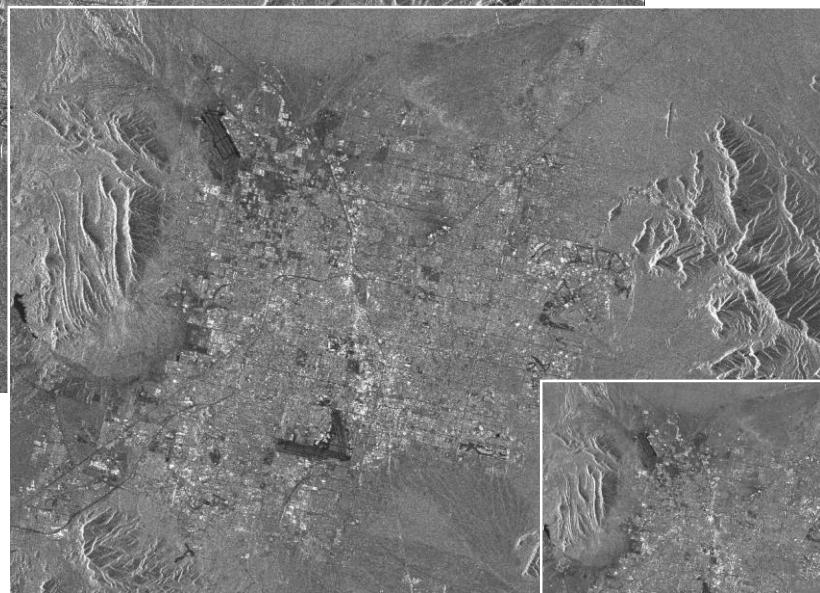


20 m x 20 m

Pixel size

40 m x 40 m

80 m x 80 m



Display of magnitude/phase of complex image

J

*** DISP dismph: display of magnitude/phase of complex image ***
*** Copyright 2005, Gamma Remote Sensing, v1.8 10-Oct-2005 clw ***

usage: dismph <cpx> <width> [start] [nlines] [scale] [exp] [data_type]

input parameters:

cpx (input) complex data (FCOMPLEX or SCOMPLEX format)
width complex samples per line
start starting line to display (default=1)
nlines number of lines to display (default=0: to end of file)
scale display scale factor (default=1.)
exp display exponent (default=.35)
data_type input data type
 0: FCOMPLEX (default)
 1: SCOMPLEX

Example

Interferogram from 2 SLCs acquired over Las Vegas.

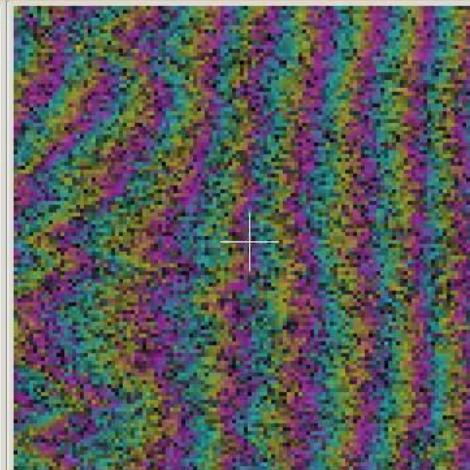
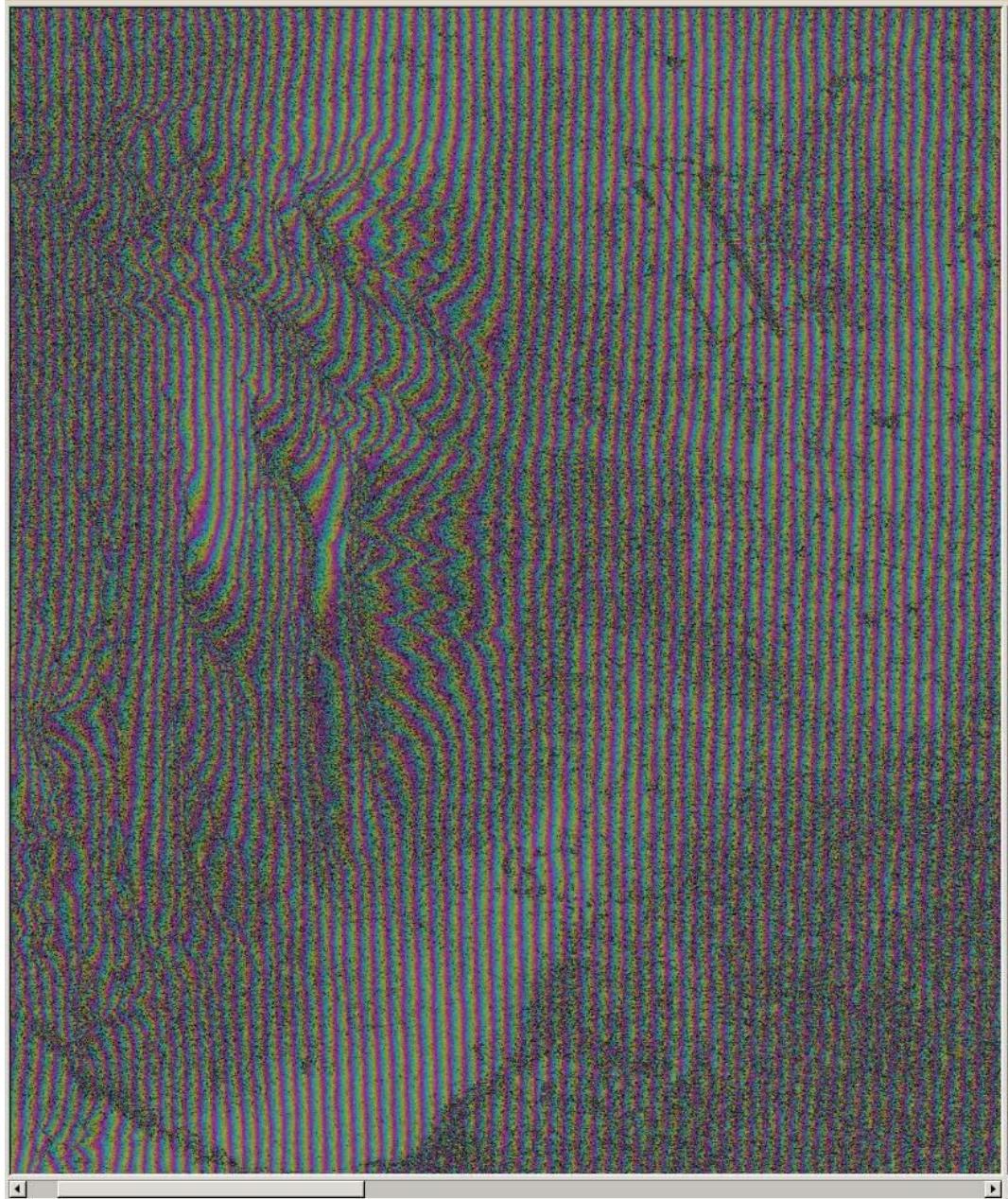
ERS-1/2 pair formed by images acquired on 23-24 May 1996

Number of samples per row: 2500 , data type: FCOMPLEX

dismph 05721_25394.int 2500 → displays the InSAR phase and the correlation

J

X 05721_25394.int



column, line: 477 596

real, imaginary: 2.856e-01 -7.322e-02

magnitude, phase: 2.948e-01 -14.3804

user grey mag/ph phase

close

Display of InSAR phase + intensity data

*** DISP dismph_pwr: display of interferogram phase + intensity image ***

*** Copyright 2005, Gamma Remote Sensing, v1.5 24-aug-2005 clw ***

usage: dismph_pwr <cpx> <pwr> <width> [start_cpx] [start_pwr] [nlines] [scale] [exp]

input parameters:

cpx (input) complex image (fcomplex, e.g. interferogram)
pwr (input) intensity image (float, enter - if not available)
width samples per row of cpx and pwr
start_cpx starting line of cpx (default=1)
start_pwr starting line of pwr (default=1)
nlines number of lines to display (default=0: to end of file)
scale intensity display scale factor (default=1.)
exp intensity display exponent (default=.35)

Example

As before we use the interferogram from 2 SLCs acquired over Las Vegas.

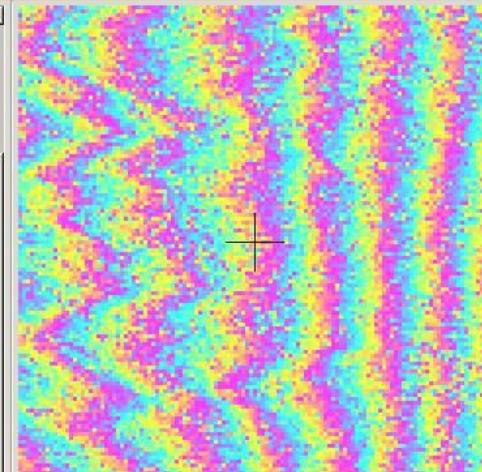
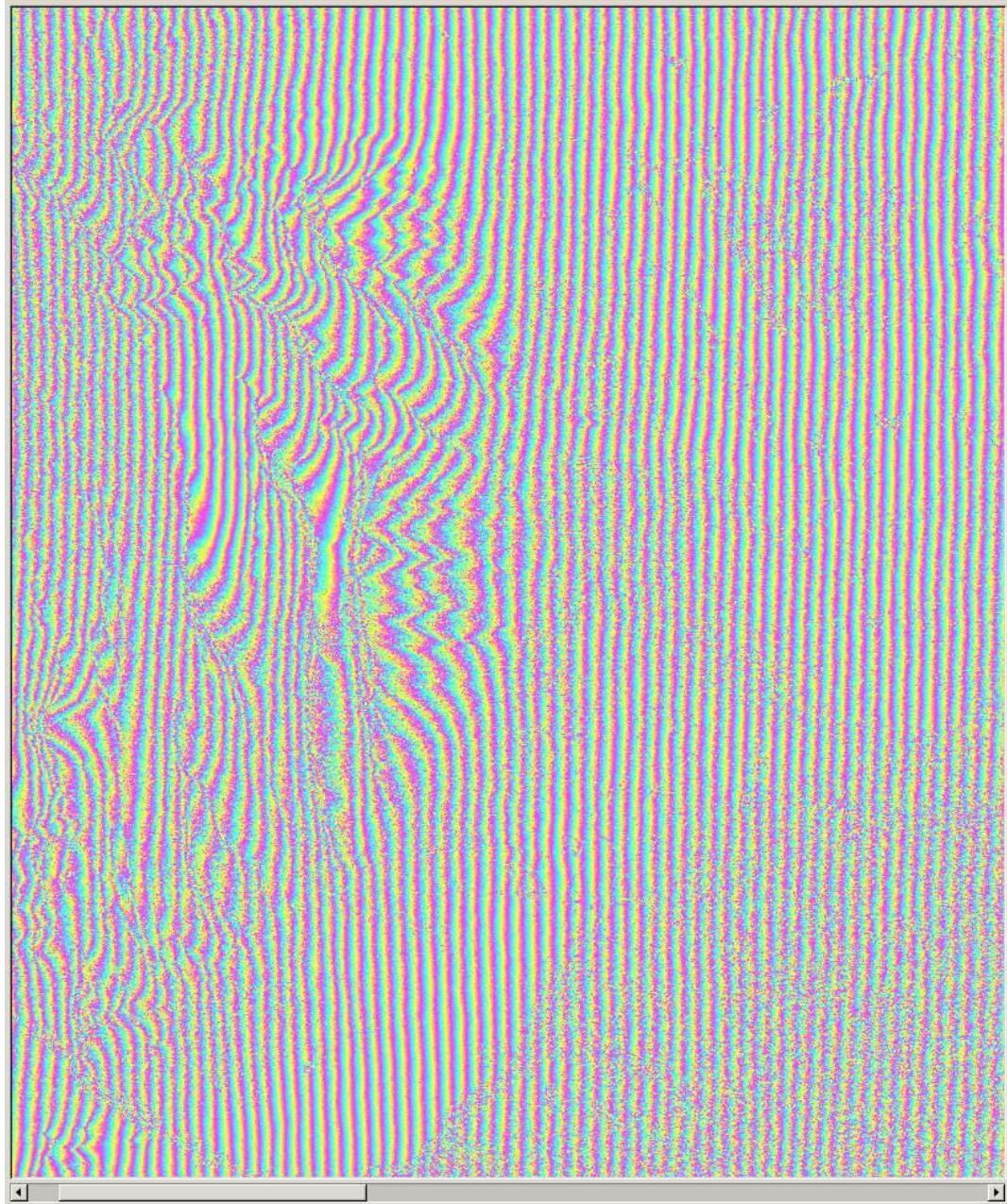
Number of samples per row: 2500 , data type: FCOMPLEX

dismph_pwr 05721_25394.int – 2500 → Will display the InSAR phase

Type the command. Let's have a look at the image.

Keep in mind the previous image

X 05721_25394.int



column, line: 456 667

image 1 real, imag: -8.752e-01 -1.736e-01
image 1 mag., phase: 8.922e-01 -168.7805

image 2: -

user grey phase

close

Exercise

J

usage: *dismph_pwr <cpx> <pwr> <width> [start_cpx] [start_pwr] [nlines] [scale] [exp]*

Now try the following

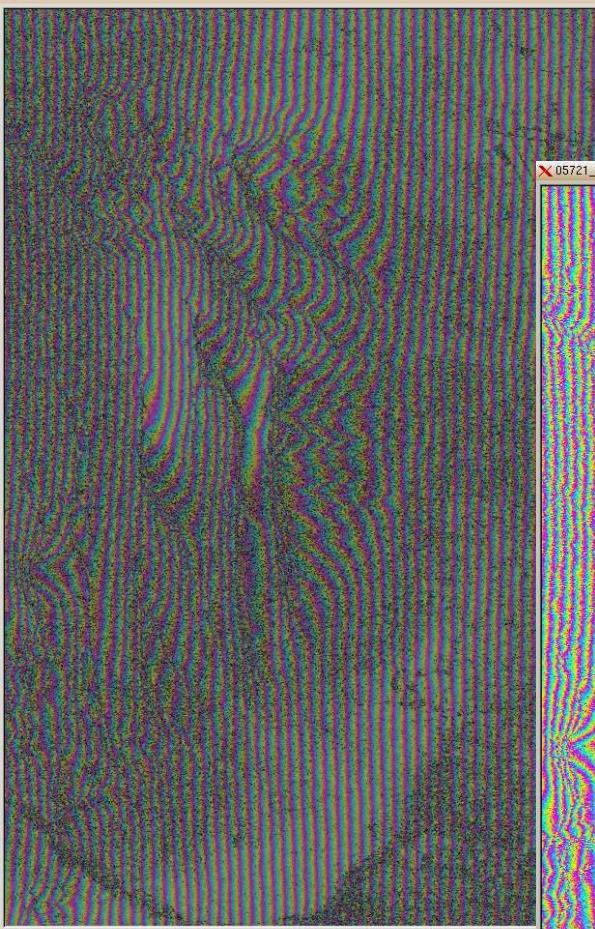
`dismph_pwr 05721_25394.int 05721.mli 2500`

What is different compared to the previous image?

And with the one showed using *dismph*?

*For your reference here is the command we used before
(dismph_pwr 05721_25394.int - 2500)*

How does each representation help you?



dismph

InSAR phase + correlation

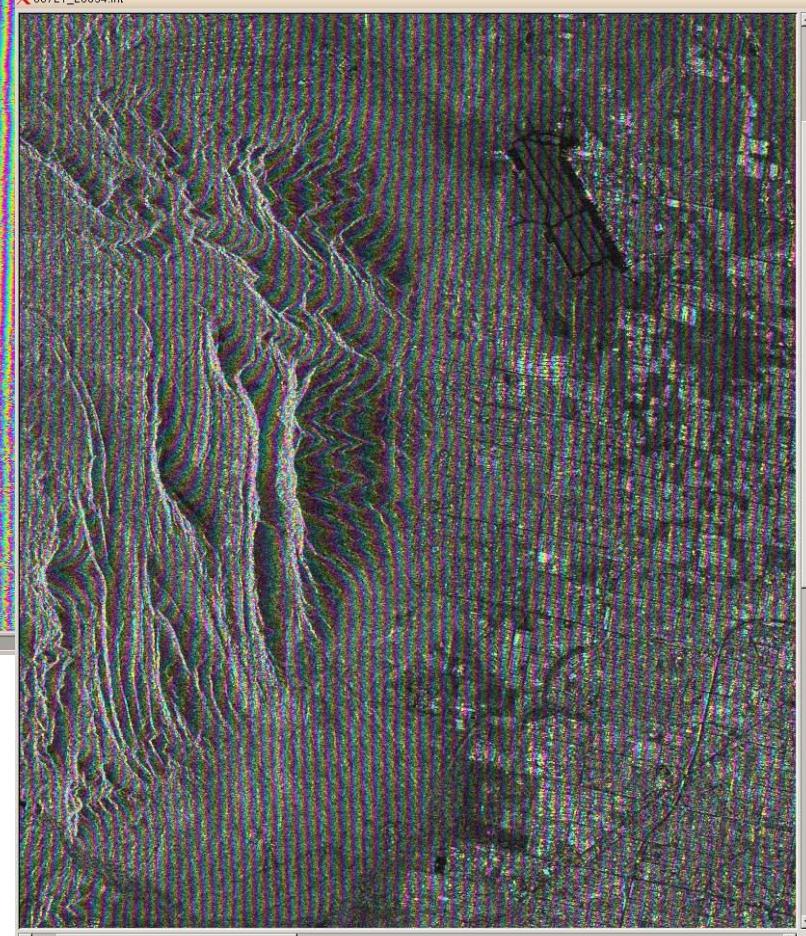


dismph_pwr

InSAR phase

dismph_pwr

InSAR phase + intensity



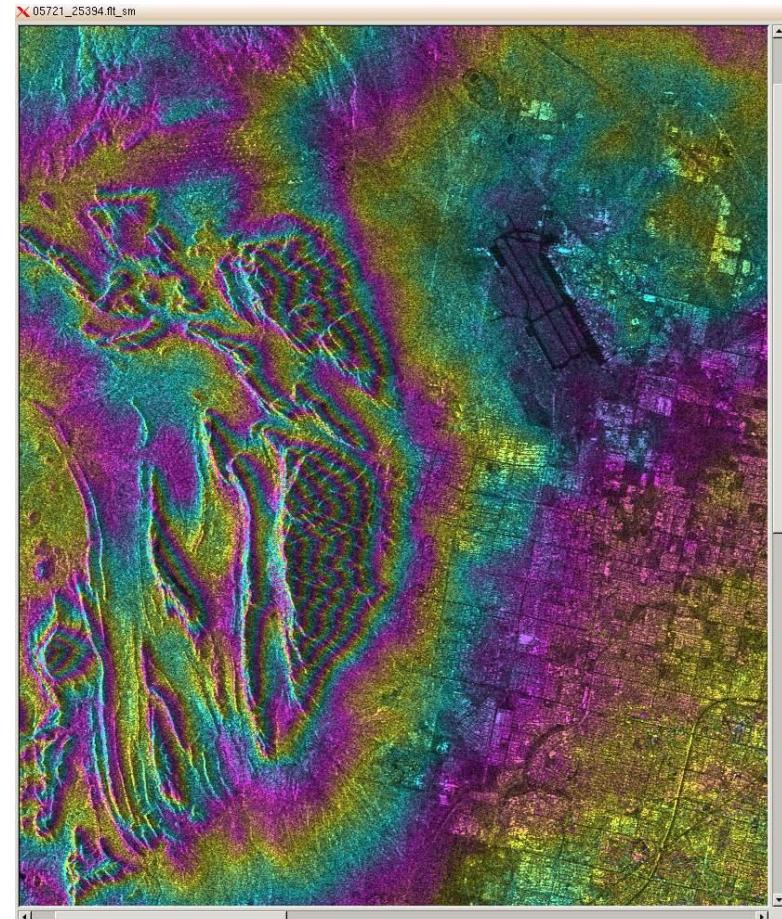
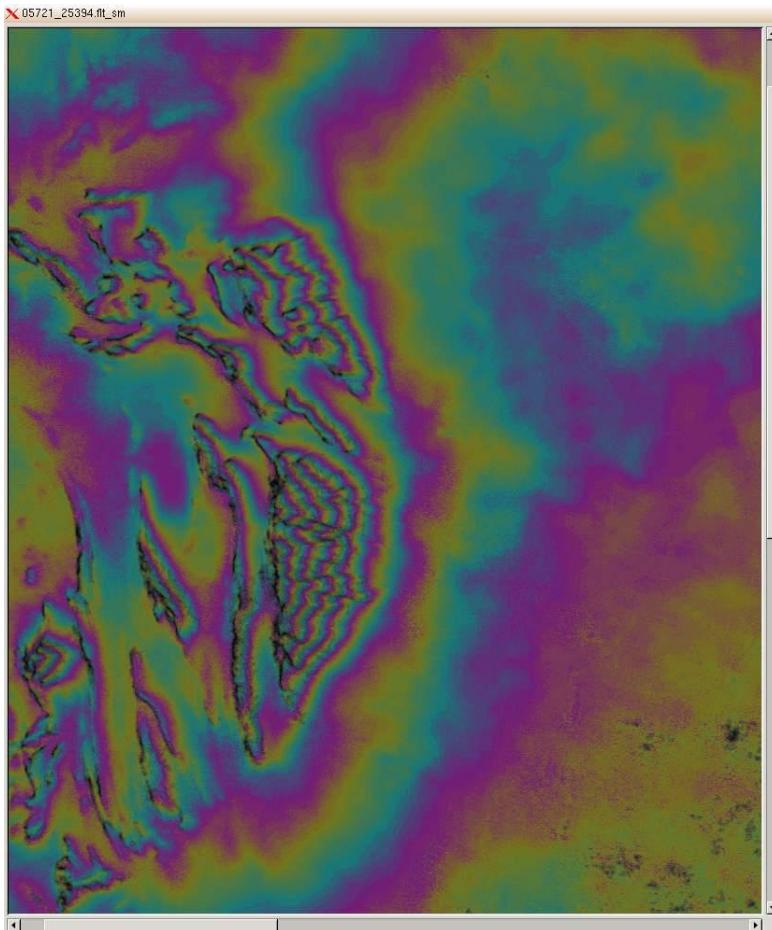
Exercise

J

And now display the following: what happens?

dismph 05721_25394.flt_sm 2500

dismph_pwr 05721_25394.flt_sm 05721.mli 2500



Display of coherence + intensity data

J

*** DISP discc: display of coherence + intensity image ***

*** Copyright 2005, Gamma Remote Sensing, v3.1 24-Aug-2005 clw ***

usage: discc <cc> <pwr> <width> [start_cc] [start_pwr] [nlines] [min_corr] [max_corr] [scale] [exp]

input parameters:

cc	(input) coherence image (float)
pwr	(input) intensity image (float, enter - if not available)
width	samples per row of cc and pwr
start_cc	starting line of cc (default=1)
start_pwr	starting line of pwr (default=1)
nlines	number of lines to display (default=0: to end of file)
cmin	minimum coherence value used for linear cc display (default=.1)
cmax	maximum coherence value used for linear cc display (default=.9)
scale	pwr display scale factor (default=1.)
exp	pwr display exponent (default=.35)

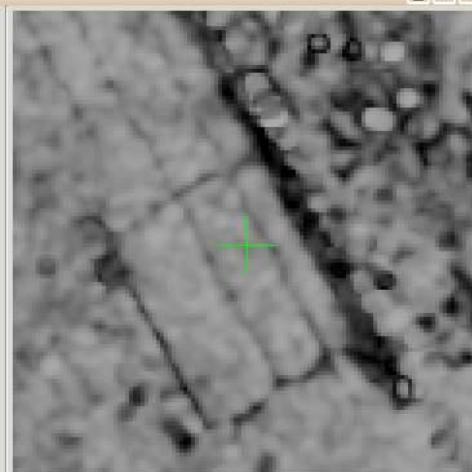
Example

*Coherence image from interferogram based on the 2 SLCs acquired over Las Vegas.
Number of samples per row: 2500*

discc 05721_25394.cc – 2500 → will display the coherence image

J

X 05721_25394.cc



column, line: 665 417

image 1 corr.: 0.7168

image 2: -

user

grey

phase

close

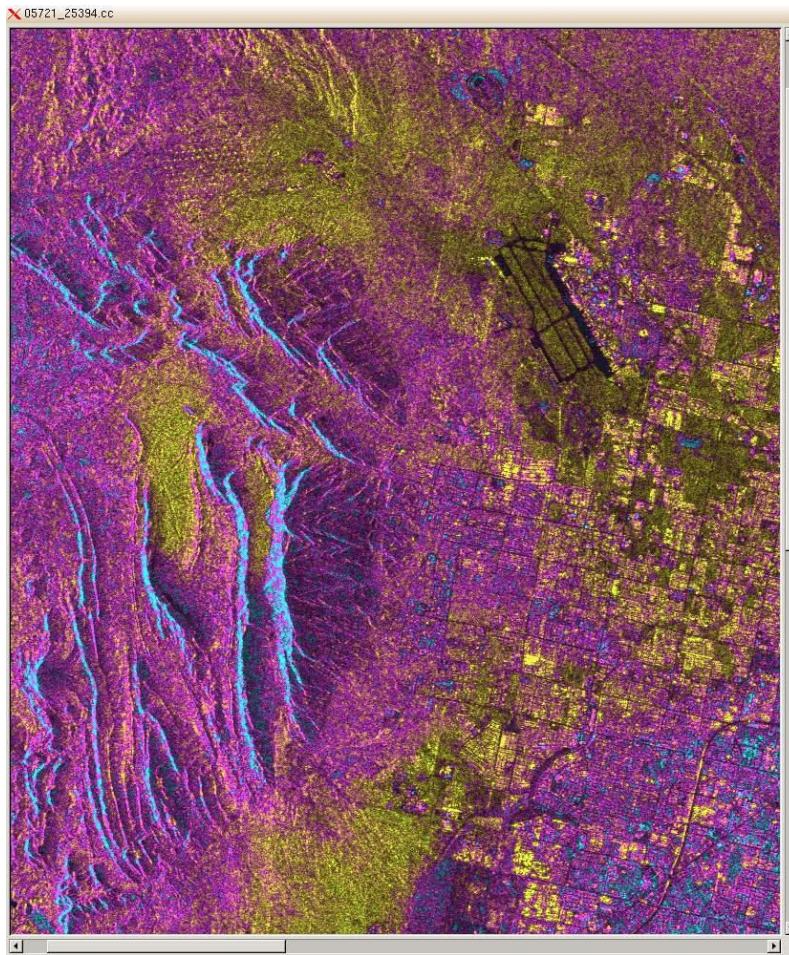
Exercise

J

usage: discc <cc> <pwr> <width> [start_cc] [start_pwr] [nlines] [min_corr] [max_corr] [scale] [exp]

What happens if we instead use the following? Where is the difference? Try!

discc 05721_25394.cc 05721.mli 2500



Display of unwrapped phase + intensity image

J

*** DISP disrmg: display of unwrapped phase + intensity image ***

*** Copyright 2005, Gamma Remote Sensing, v1.2 24-Aug-2005 clw ***

usage: disrmg <unw> <pwr> <width> [start_unw] [start_pwr] [nlines] [ph_scale] [scale] [exp] [ph_offset]

input parameters:

unw (input) unwrapped phase image (float)

pwr (input) intensity image (float, enter - for none)

width samples per row of unw and pwr

start_unw starting line of unw (default=1)

start_pwr starting line of pwr (default=1)

nlines number of lines to display (default=0: to end of file)

ph_scale phase display scale factor (default=.33333)

scale pwr display scale factor (default=1.)

exp pwr display exponent (default=.35)

ph_offset phase offset in radians subtracted from unw (default=.0)

Example

Unwrapped phase from the interferogram over Las Vegas

Number of samples per row: 2500

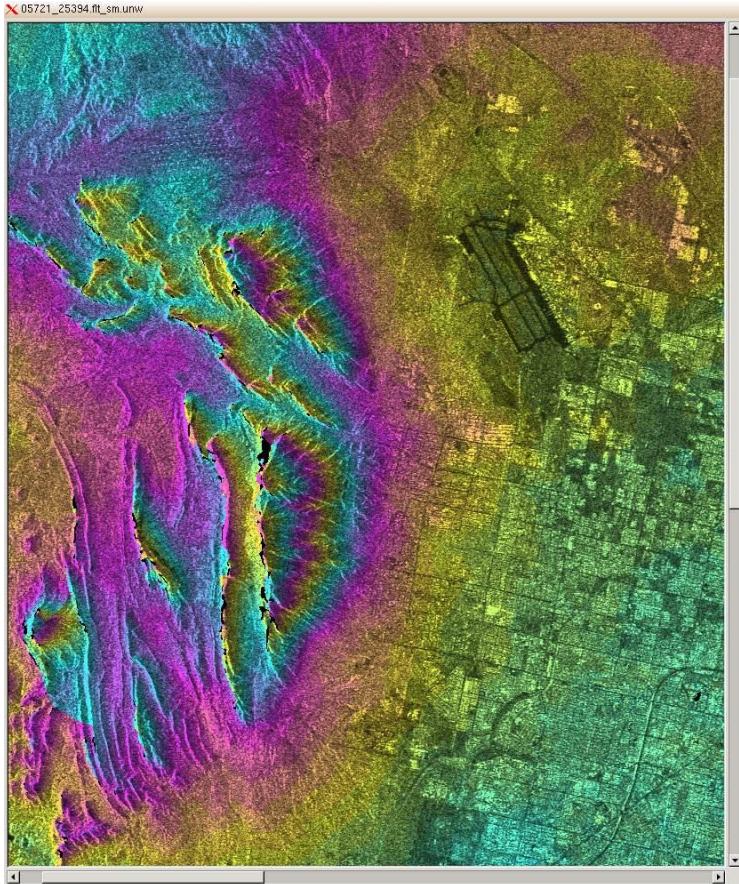
disrmg 05721_25394.flt_sm.unw 05721.mli 2500 → displays the unwrapped phase with intensity

Display of unwrapped phase + intensity image

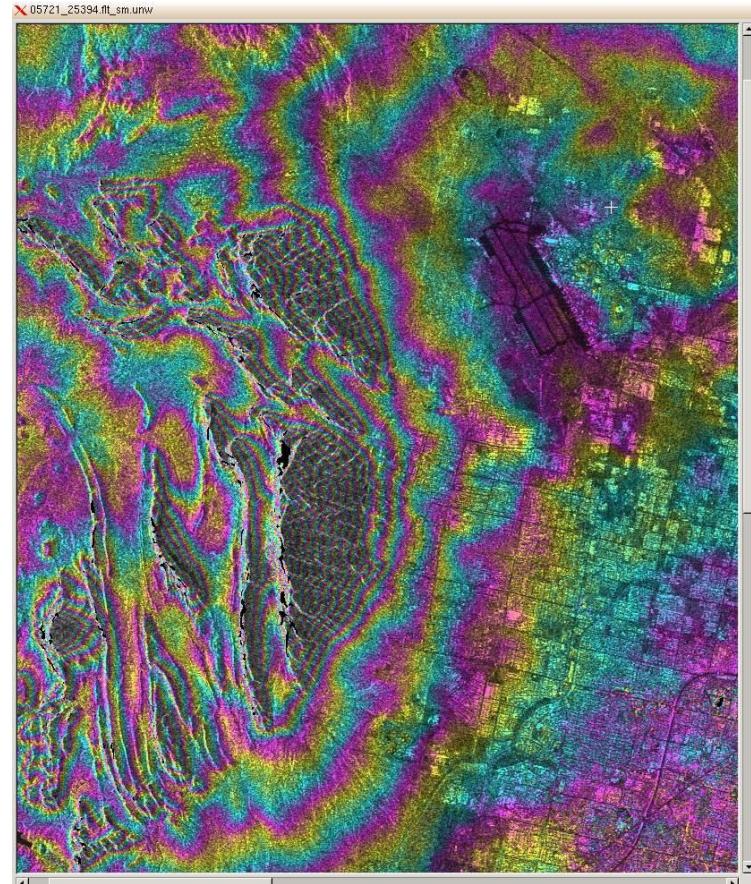
J

In this case the default phase scale factor of 0.333 radians has been used, i.e. the phase interval of a color cycle is 6π . Try the following command and see what happens

```
disrmg 05721_25394.flt_sm.unw 05721.mli 2500 - - - 2
```



Phase scale color = 0.333 (default)



Phase scale color = 2

Introducing the “vis” programs to display images

Python display tools

20th September 2017 at 3:37pm

DISP Reference Manual



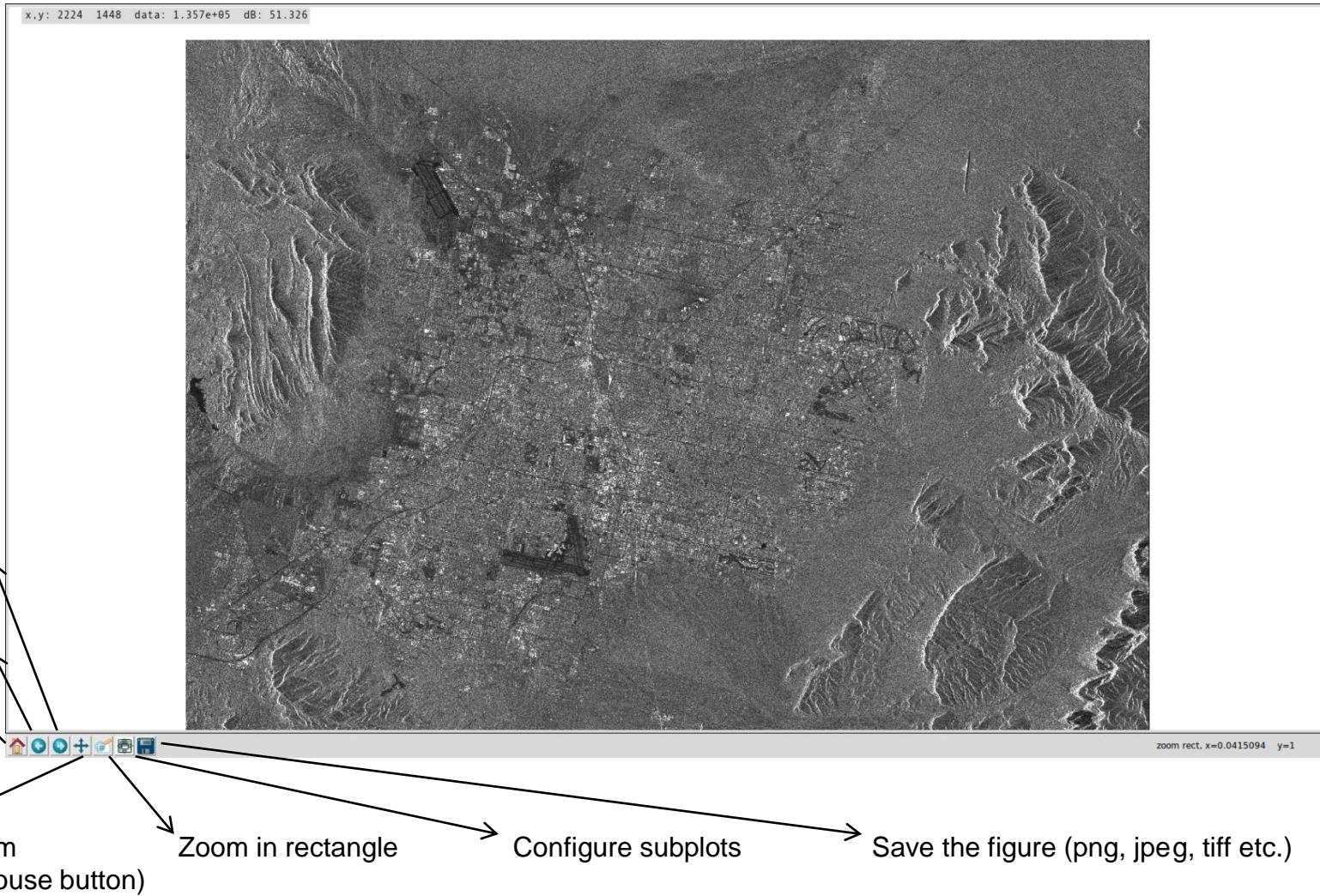
The programs listed here are based on the Python Matplotlib package. The tools consist of display programs for different data types and the program [vis_colormap_bar.py](#) that is used to create horizontal or vertical colorbars. The display programs initially present an overview of the entire image, if a sub region of the image has not been specified on the command line. Included with the image display is a navigation tool bar that permits, panning, zooming, selection of a rectangular image subregion. It is also possible to cycle through past image views.

Program	Function
visbyte.py	Display of unsigned byte data
viscpx.py	Display of complex data intensity, real, imaginary, magnitude, or phase
visdt_pwr.py	Display of float data (e.g. displacement, unwrapped phase, offset, or correlation) combined with intensity
vismph_pwr.py	Display the phase of float complex data combined with intensity
vispwr.py	Display of intensity, deformation, unwrapped phase, correlation or other parameter
visras.py	Display raster images (BMP, EPS, GIF, JPEG, PNG, TIFF, or PPM format)
vis_colormap_bar.py	Generate horizontal or vertical colorbar with scale from colormap file or registered colormap

The display of a “vis” program

vispwr.py 05721.mli 2500

Note: all options of vispwr (subsetting, scaling, saving) become visible when writing “vispwr.py” at the command line or in the Reference Manual



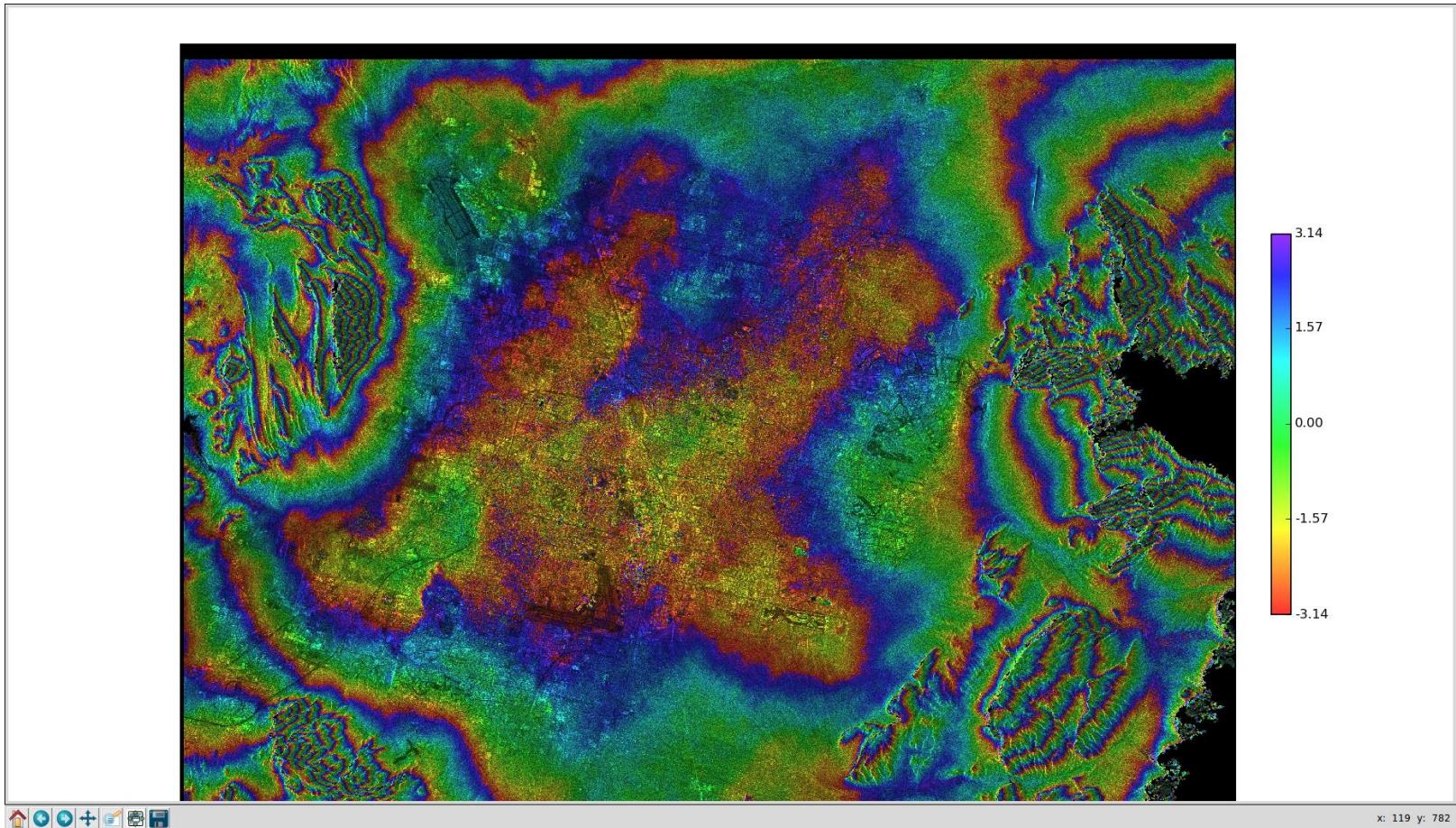
Display of unwrapped interferogram

visdt_pwr.py 05721_25394.flt_sm.unw 05721.mli 2500 -m hls.cm -c 6.28 -b

Option: colour bar

Option: color cycle

Option: display color bar



x: 119 y: 782

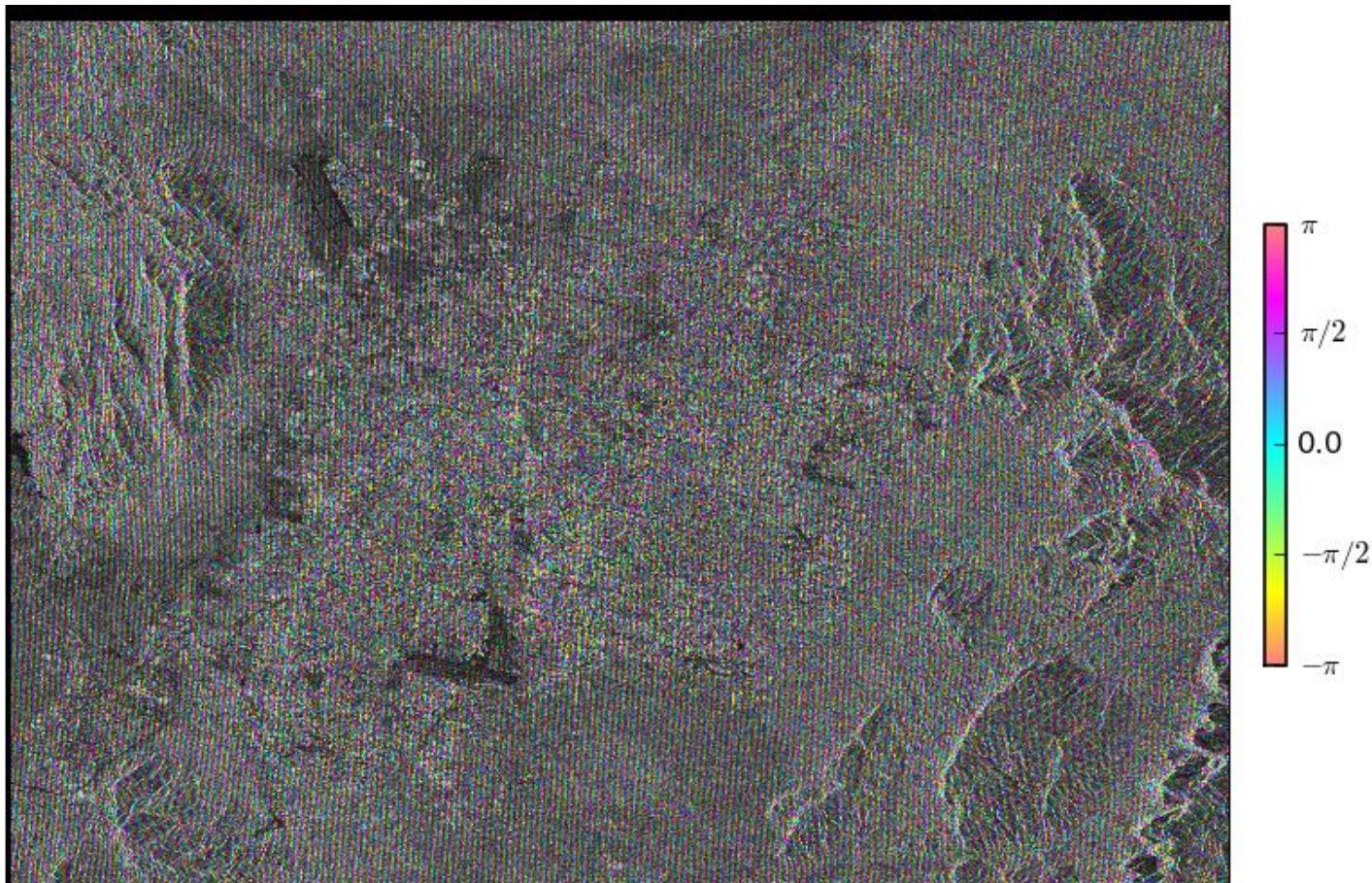
Save figure with interferogram and colorbar

J

```
vismph.py 05721_25394.int 05721.mli 2500 -b -p 05721_25394.int.png
```

Option: display colour bar

Option: save figure

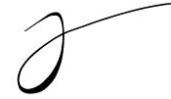


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Summary



You have learnt in this section

- How to use some of the commands of the DISP software
- How to display and interpret SAR intensity images
- How to display an interferogram in different ways (just the fringes, fringes+correlation, fringes+intensity)
- How to display and interpret a coherence image
- How to display and interpret an unwrapped interferogram
- How to use “dis” and “vis” commands