Simulating radio observations with *CASA*

Dirk Petry (ESO), April 2010

CASA simulations

simdata and **sdsim**

- Create Measurement Sets of simulated data
(and for convenience: analyse the simulated MS to create simulated image)

- Input:

a) FITS image

b) "antenna list" file describing your interferometer (incl. site name)

sites: *browsetable(os.getenv("CASAPATH").split(' ')[0]+"/data/geodetic/Observatories")*
arrays: *ls os.getenv("CASAPATH").split(' ')[0]+"/data/alma/simmos/"*

c) observation setup parameters
(central direction, time, mosaicing, spectral, integration time, etc.)

d) corrupting effect parameters
(thermal noise from atmosphere and receiver)

- *uses realistic site-dependent troposphere model*
- *knows about ALMA and EVLA receiver parameters*
- *phase noise and gain drift can be applied to the MS later via CASA tools*

e) for convenience: clean task parameters for output image creation

CASA simulations

Since release 3.0.1: brief simdata documentation in the cookbook

Main documentation is still at http://casaguides.nrao.edu

Several new simulations features in CASA 3.0.1:

- Import of multiple pointings via external text file
  (set parameter *direction* to a text file name)
- *mosaicsize* parameter for specifying the angular size of sky to observe,
  independently of *cell* and *imsize*
- new *caldirection* and *calflux* parameters to add calibrator observation
  interleaved with the science target
- more robust transformation of input model image cubes into the internal 4-d format
- improved single dish simulations: **sdsim** task
  (needs asap_init)

CASA simdata

IPy casa-bologna2010/simdata-demo

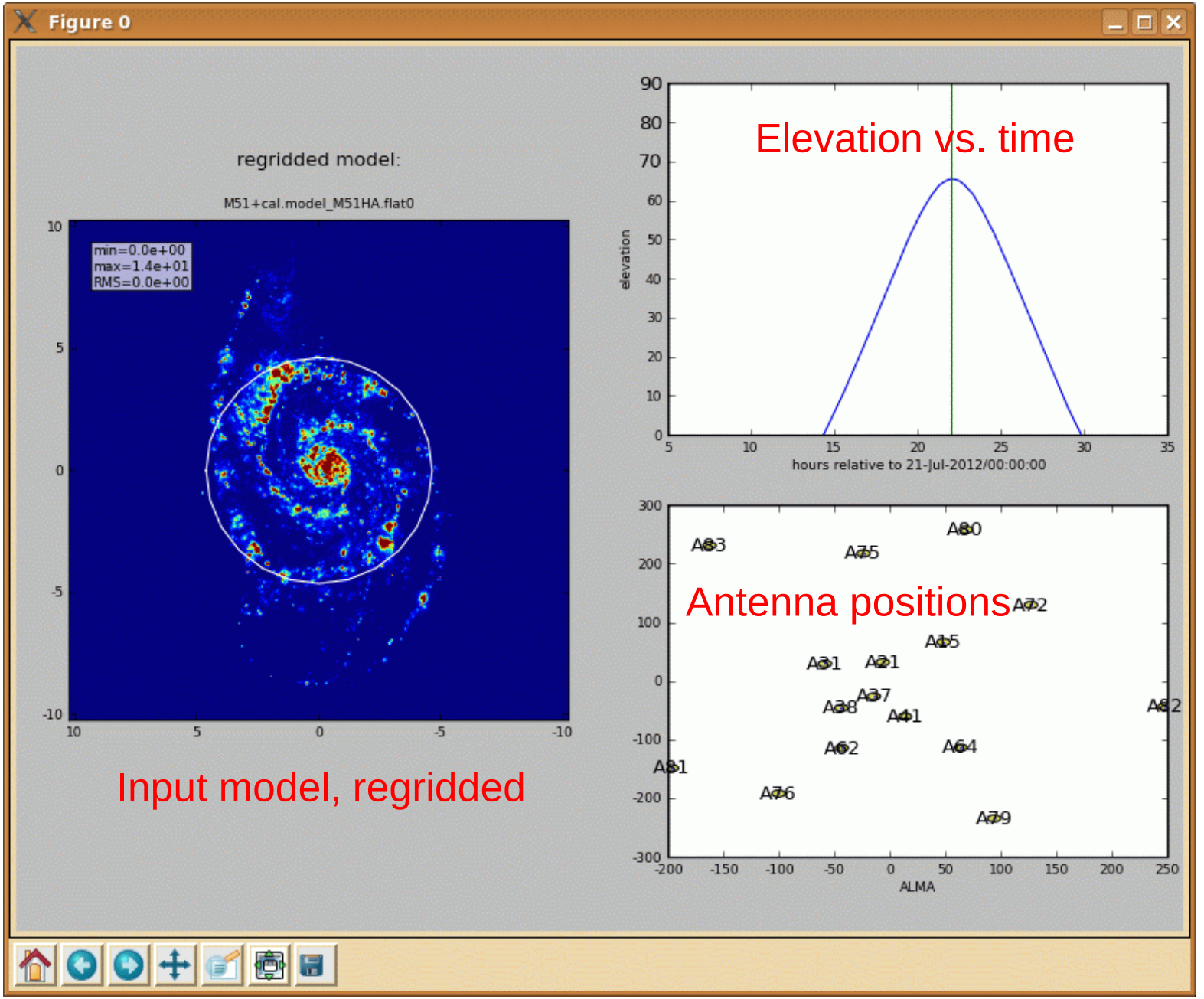
Example input parameters

```
CASA <36>: inp
---------> inp()
#  simdata :: simulation task:
project             =  'M51+cal'          #  root for output files
complist            =          ''         #  [optional] componentlist table to observe
modelimage          = 'model_M51HA.fits'  #  model sky image name
inbright            = 'unchanged'         #  set peak surface brightness in Jy/pixel or "unchanged"
ignorecoord         =       True          #  change model coordinates
startfreq           = '668.0GHz'          #  [only if ignorecoord=T] frequency of first channel
chanwidth           =   '8.0GHz'          #  [only if ignorecoord=T] channel width
refdate             = '2012/07/21/22:00:00' #  center time/date of observation *see help
totaltime           =    '1095s'          #  total time of observation
integration         =      '30s'          #  integration (sampling) time
scanlength          =         1           #  number of integrations per pointing in the mosaic
direction           = 'J2000 13h29m52.37 -47d11m40.8' #  mosaic center, or list of pointings
pointingspacing     =  '1arcmin'          #  spacing in between beams in mosaic
mosaicsize          = ['1.0arcmin', '1.0arcmin'] #  angular size of desired area to map [*NEW*]
caldirection        = 'J2000 13h29m52.37 -47d10m40.8' #  pt source calibrator [experimental]
calflux             =      '1Jy'
checkinputs         =      'yes'          #  graphically verify parameters [yes|no|only]
antennalist         = '/home/dpetry/temp/casa-from-tarball/casapy-30.1.11097-001/data/alma/simmos/alma.early.med.cfg'
                                           #   a position file
noise_thermal       =       True          #  add thermal noise
     noise_mode     = 'tsys-atm'          #  tsys-atm: set PWV and use ATM library; tsys-manual: set t_sky and tau
     user_pwv       =        1.0          #  Precipitable Water Vapor in mm [tsys-atm only]
     t_ground       =      269.0          #  ambient temperature
     t_sky          =      263.0          #  atmospheric temperature [tsys-manual only]
     tau0           =        0.1          #  zenith opacity [tsys-manual only]

cell                = '0.04arcsec'        #  output cell/pixel size
imsize              = [400, 400]          #  output image size in pixels (x,y)
threshold           = '0.01 mJy'          #  flux level (+units) to stop cleaning
niter               =     10000           #  maximum number of iterations
psfmode             =   'hogbom'          #  minor cycle PSF calculation method
weighting           =   'briggs'          #  weighting to apply to visibilities
     robust         =        0.0          #  briggs robustness parameter
     npixels        =          0          #  number of pixels to determine uv-cell size 0=> field of view

uvtaper             =      False          #  apply additional uv tapering of  visibilities.
stokes              =        'I'          #  Stokes params to image
fidelity            =       True          #  Calculate fidelity images
display             =       True          #  Plot simulation result images,figures
verbose             =       True
async               =      False          #  If true the taskname must be started using simdata(...)

CASA <37>:
```

CASA simdata

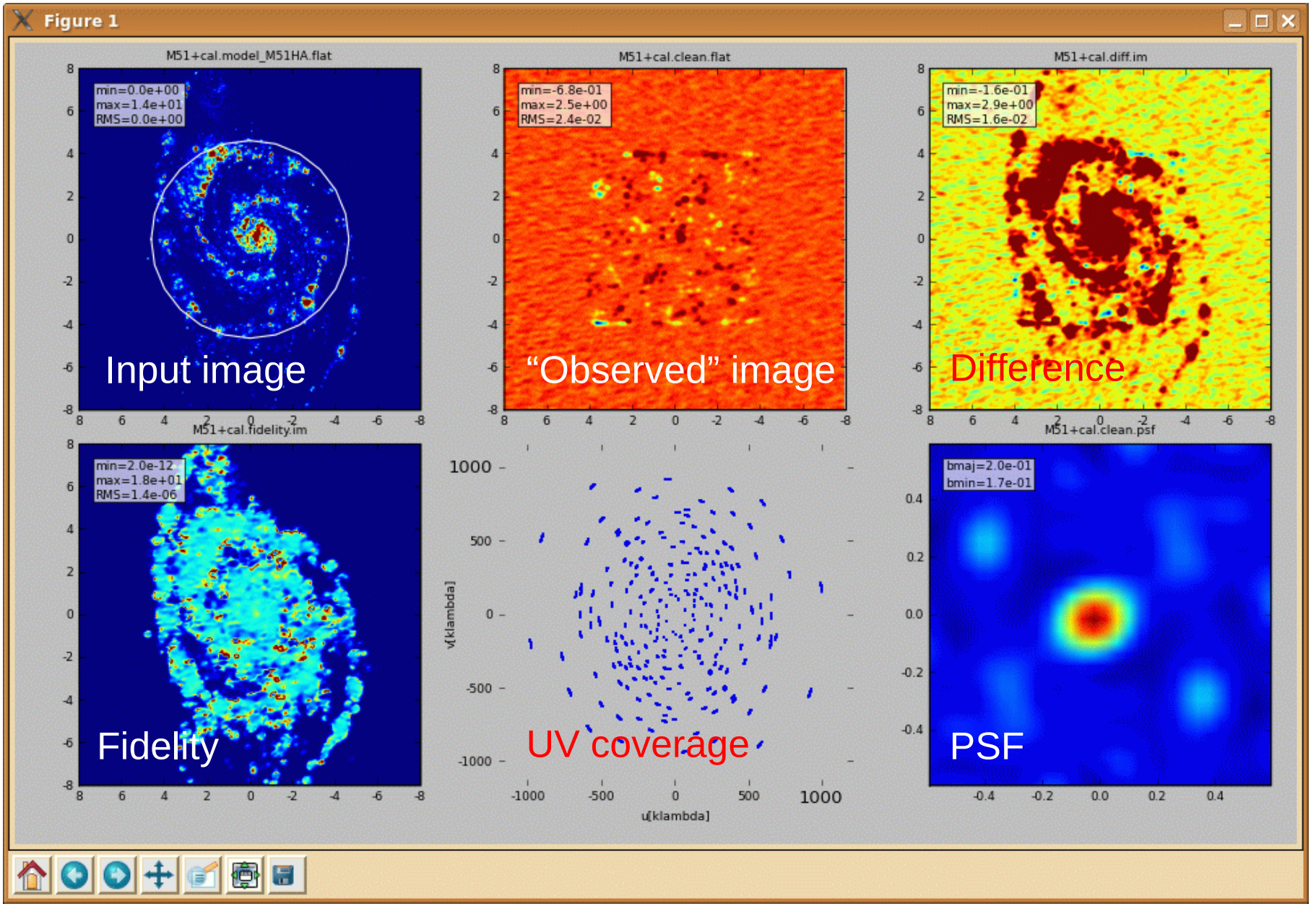
Simdata output:

1) your input for verification



CASA simdata

Simdata output:
2) results



CASA simdata

Fidelity:

Fidelity comes in two flavors, image plane and *uv* plane. As provided in ALMA Memo 398 (Pety, Gueth, and Guilloteau 2001), the image plane fidelity is

$$f_{im}(\vec{x}) = \frac{|C(\vec{x})|}{\max(|E(\vec{x})|, 0.7E_{rms})} \quad (1)$$

where C is the input image convolved with a gaussian matching the configuration's resolution, and

$$E = C - S \quad (2)$$

where S is a deconvolved image made from the simulated observation, restored to match the configuration's resolution.

CASA simulations

Note: export of simulated MS to UVFITS and ASDM formats possible

using tasks

exportuvfits

and

***exportasdm* (beta)**