



# Simulating ALMA observations

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on behalf of the German ARC node



ALMA community days, 26.03.2015

# Outline

The simulators and cycle 3 proposals

Available simulators

Overview of the CASA simulator





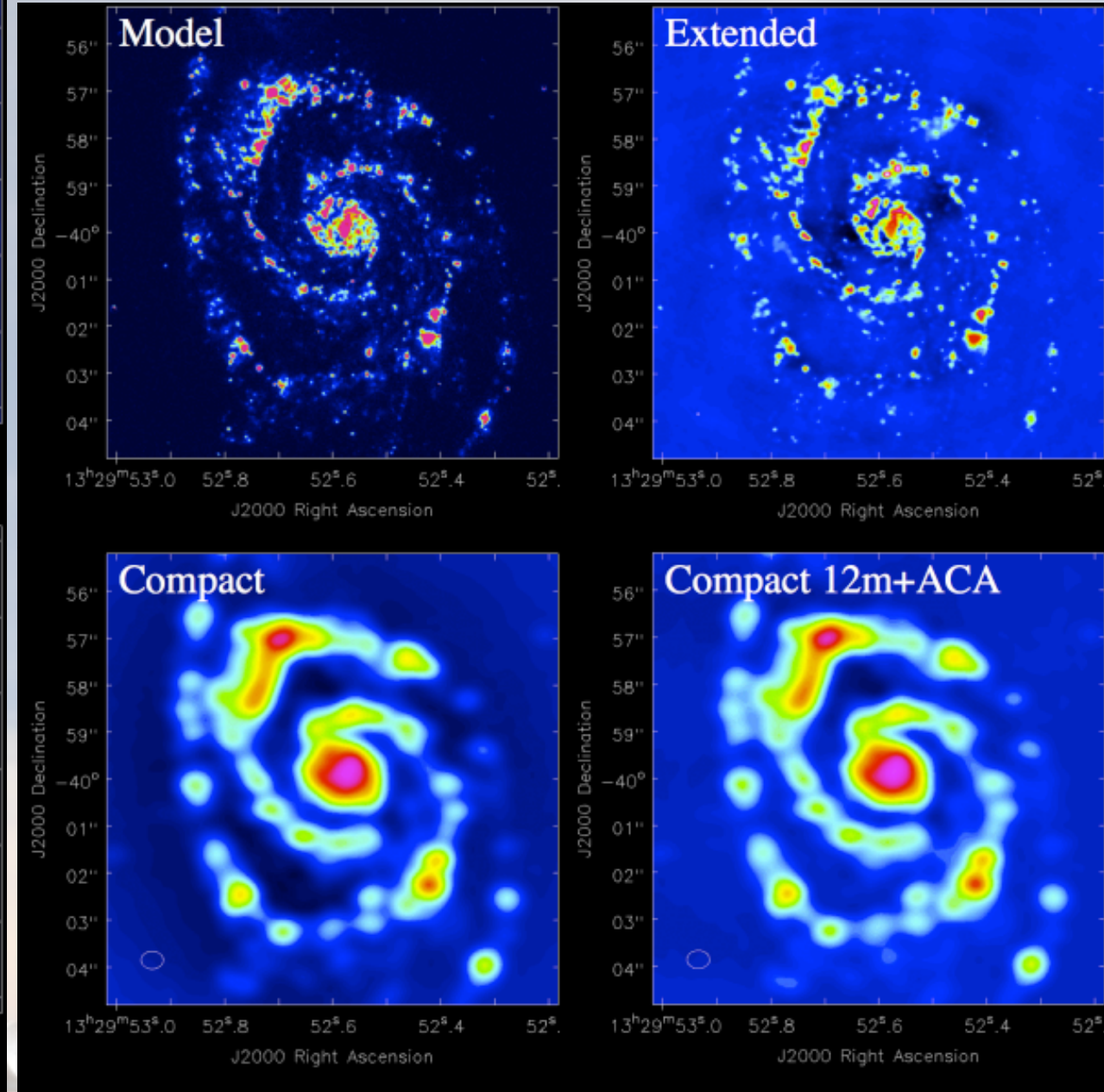
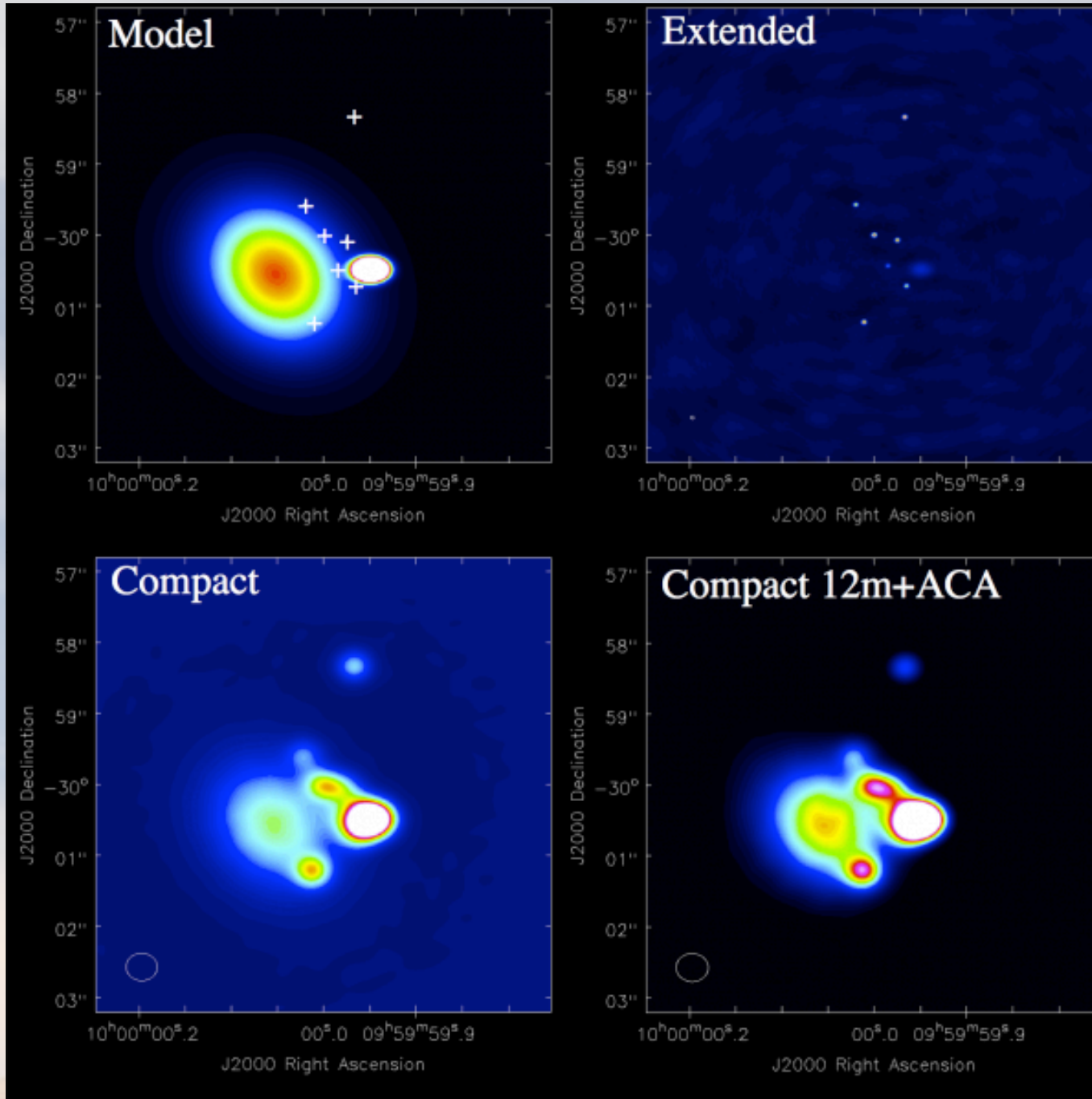
# Why should I do an ALMA simulation ?

- You can try out different ALMA configurations and, for a given model, this might help you decide on the required angular resolution and maximum angular scale.
- A simulation can help support the required technical set-up in your proposal
- In particular, it can help you justify the need for complementary ACA/TP observations.





# Why should I do an ALMA simulation ?





# Available simulators

## CASA simulator

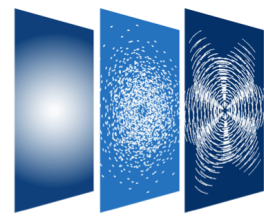
## ALMA Observation Support tool

```
# simobserve :: mosaic simulation task:
project = 'sim' # root prefix for output file names
skymodel = '30dor.fits' # model image to observe
  inbright = '0.06mJy/pixel' # scale surface brightness of brightest pixel e.g. "1.2Jy/pixel"
  indirection = 'J2000 19h00m00 -40d00m00' # set new direction e.g. "J2000 19h00m00 -40d00m00"
  incell = '0.15arcsec' # set new cell/pixel size e.g. "0.1arcsec"
  incenter = '230GHz' # set new frequency of center channel e.g. "89GHz" (required even for 2D model)
  inwidth = '2GHz' # set new channel width e.g. "10MHz" (required even for 2D model)

complist = '' # componentlist to observe
setpointings = True
  integration = '600s' # integration (sampling) time
  direction = '' # "J2000 19h00m00 -40d00m00" or "" to center on model
  mapsize = ['', ''] # angular size of map or "" to cover model
  maptype = 'topographic' # hexagonal, square, etc
  pointingspacing = '' # spacing in between pointings or "0.25PB" or "" for 0.5 PB

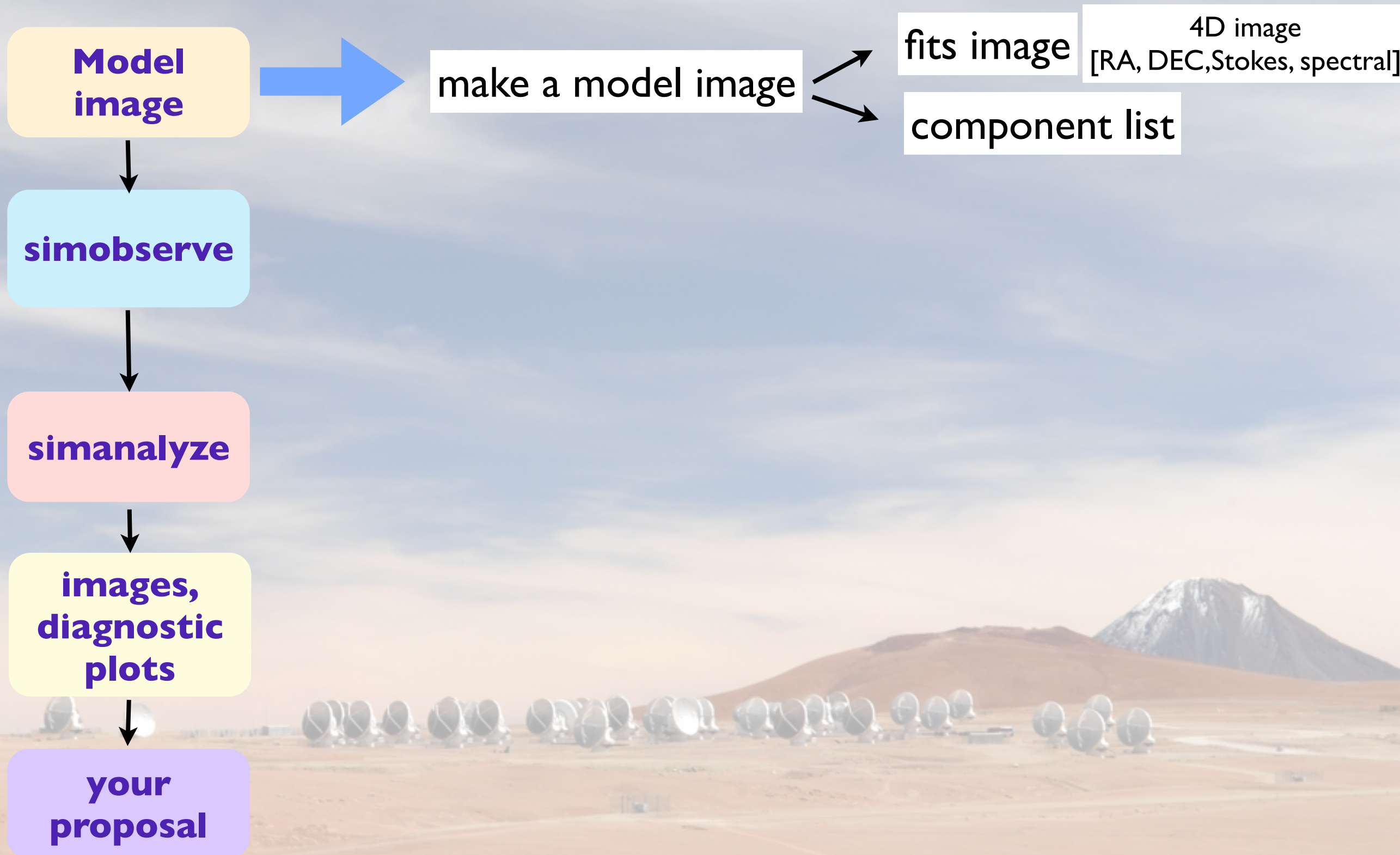
obsnode = 'int' # observation mode to simulate
  # [int(interferometer)|sd(singledish)|""(none)]
  antennalist = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # interferometer
  # antenna position file
  refdate = '2012/05/21' # date of observation - not critical unless concatting simulations
  hourangle = 'transit' # hour angle of observation center e.g. -3:00:00, or "transit"
  totaltime = '7200s' # total time of observation or number of repetitions
  caldirection = '' # pt source calibrator [experimental]
  calflux = '1Jy'

thermalnoise = ''
leakage = 0.0
graphics = 'both'
verbose = False
overwrite = True
async = False
```



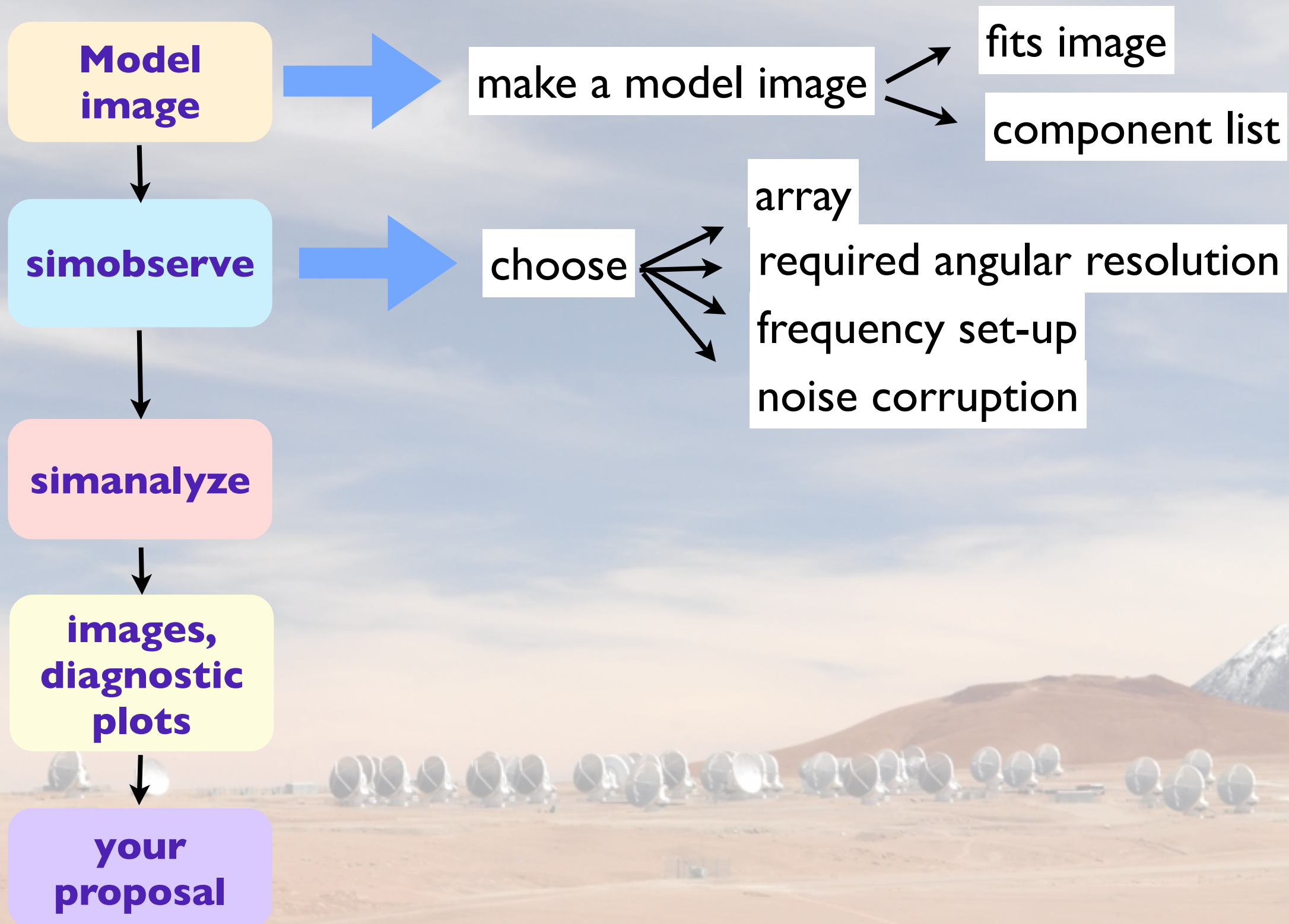
**CASA**  
Common Astronomy  
Software Applications

# CASA simulator and cycle 3

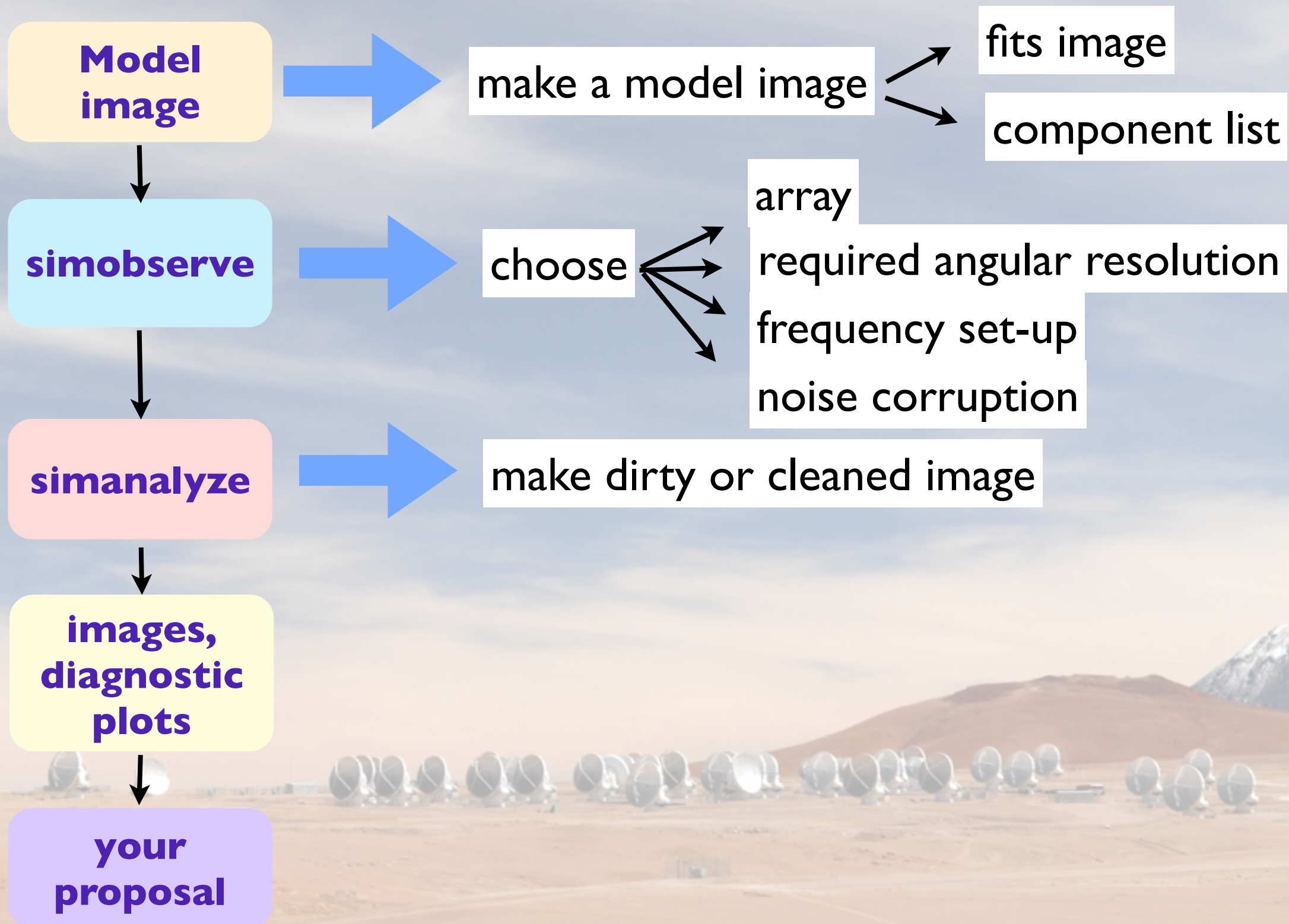




# CASA simulator and cycle 3

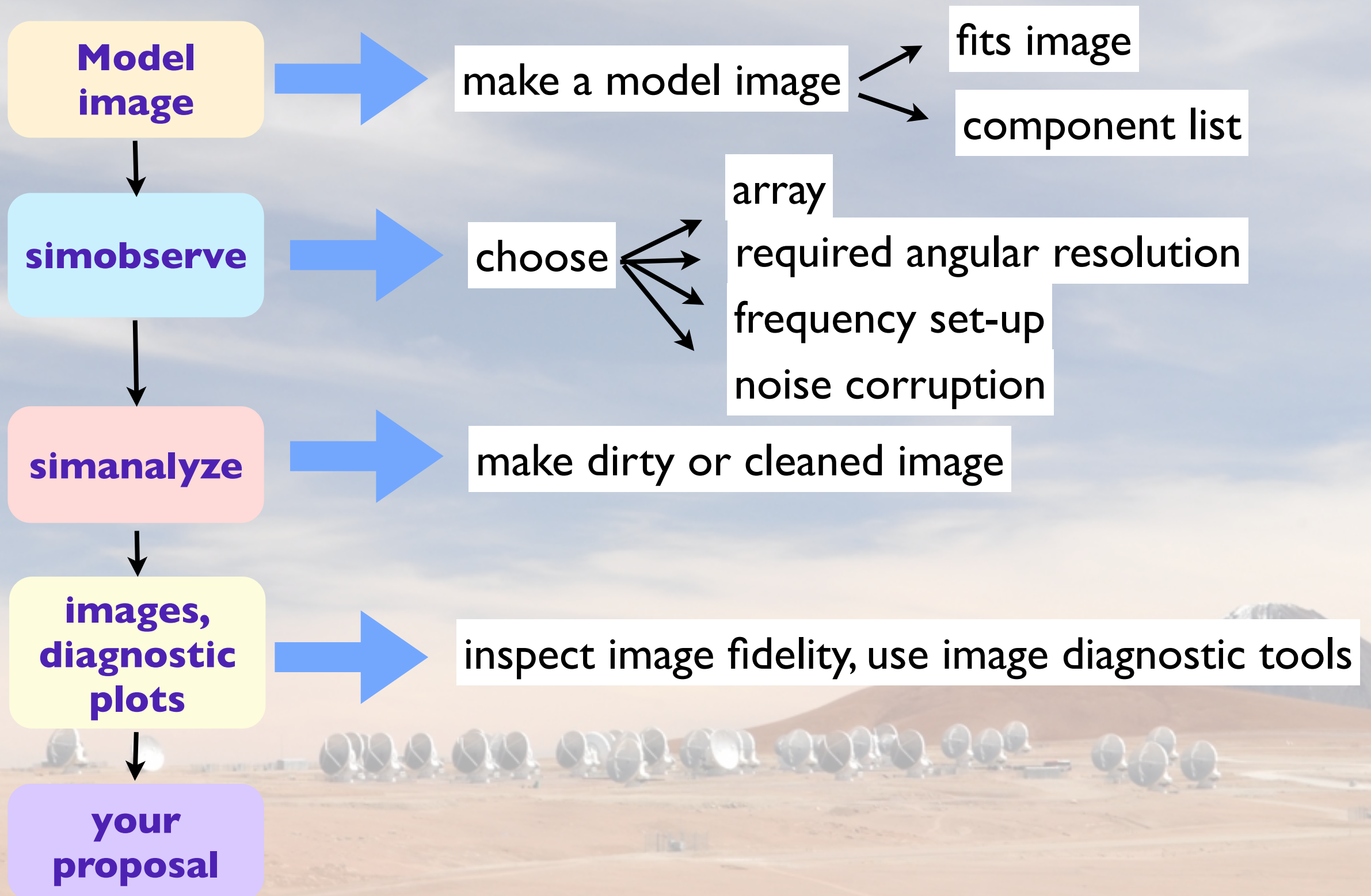


# CASA simulator and cycle 3

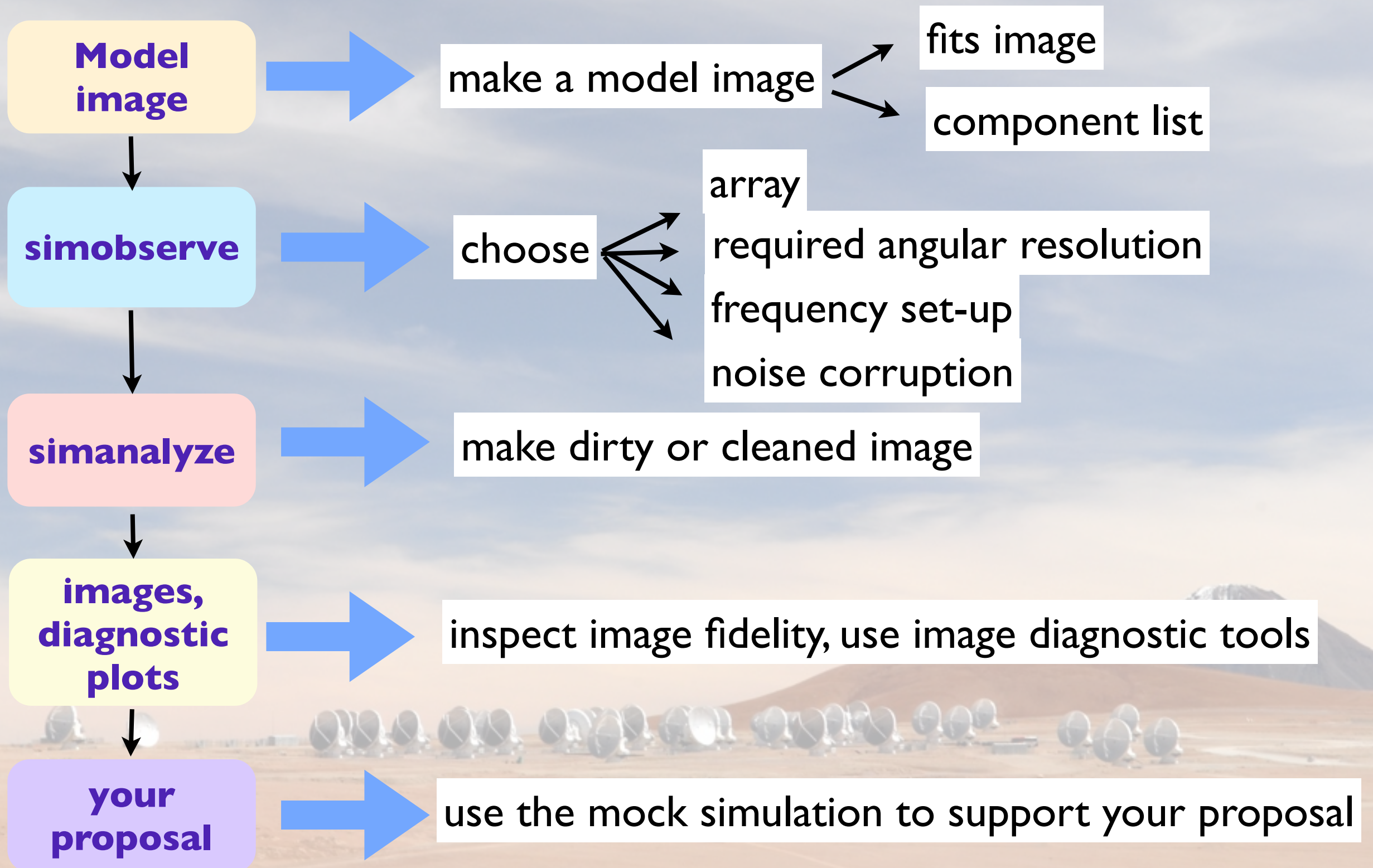




# CASA simulator and cycle 3



# CASA simulator and cycle 3





# Simobserve

```
# simobserve :: mosaic simulation task:
project          = 'sim'          # root prefix for output file names
skymodel         = '30dor.fits'   # model image to observe
  inbright       = '0.06mJy/pixel' # scale surface brightness of brightest pixel e.g. "1.2Jy/pixel"
  indirection    = 'J2000 10h00m00 -40d00m00' # set new direction e.g. "J2000 19h00m00 -40d00m00"
  incell         = '0.15arcsec'   # set new cell/pixel size e.g. "0.1arcsec"
  incenter       = '230GHz'      # set new frequency of center channel e.g. "89GHz" (required even for 2D
  # model)
  inwidth        = '2GHz'        # set new channel width e.g. "10MHz" (required even for 2D model)

complist         = ''            # componentlist to observe
setpointings     = True         #
  integration    = '600s'       # integration (sampling) time
  direction      = ''           # "J2000 19h00m00 -40d00m00" or "" to center on model
  mapsize        = ['', '']     # angular size of map or "" to cover model
  matype         = 'topographic' # hexagonal, square, etc
  pointingspacing = ''          # spacing in between pointings or "0.25PB" or "" for 0.5 PB

obsmode          = 'int'        # observation mode to simulate
  # [int(interferometer)|sd(singledish)|""(none)]
  antennalist    = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # interferometer
  # antenna position file
  refdate        = '2012/05/21' # date of observation - not critical unless concatting simulations
  hourangle      = 'transit'    # hour angle of observation center e.g. -3:00:00, or "transit"
  totaltime      = '7200s'     # total time of observation or number of repetitions
  caldirection   = ''          # pt source calibrator [experimental]
  calflux        = '1Jy'

thermalnoise     = ''          # add thermal noise: [tsys-atm|tsys-manual|""]
leakage          = 0.0         # cross polarization (interferometer only)
graphics         = 'both'      # display graphics at each stage to [screen|file|both|none]
verbose          = False
overwrite        = True       # overwrite files starting with $project
async            = False      # If true the taskname must be started using simobserve(...)
```

# Simobserve

```
# simobserve :: mosaic simulation task:
project          = 'sim'
skymodel         = '30dor.fits'
  inbright       = '0.06mJy/pixel'
  indirection    = 'J2000 10h00m00 -40d00m00' # set new direction e.g. "J2000 19h00m00 -40d00m00"
  incell         = '0.15arcsec'
  incenter       = '230GHz'

  inwidth        = '2GHz'

complist         = ''
setpointings    = True
  integration    = '600s'
  direction      = ''
  mapsize        = ['', '']
  matype         = 'topographic'
  pointingspacing = ''

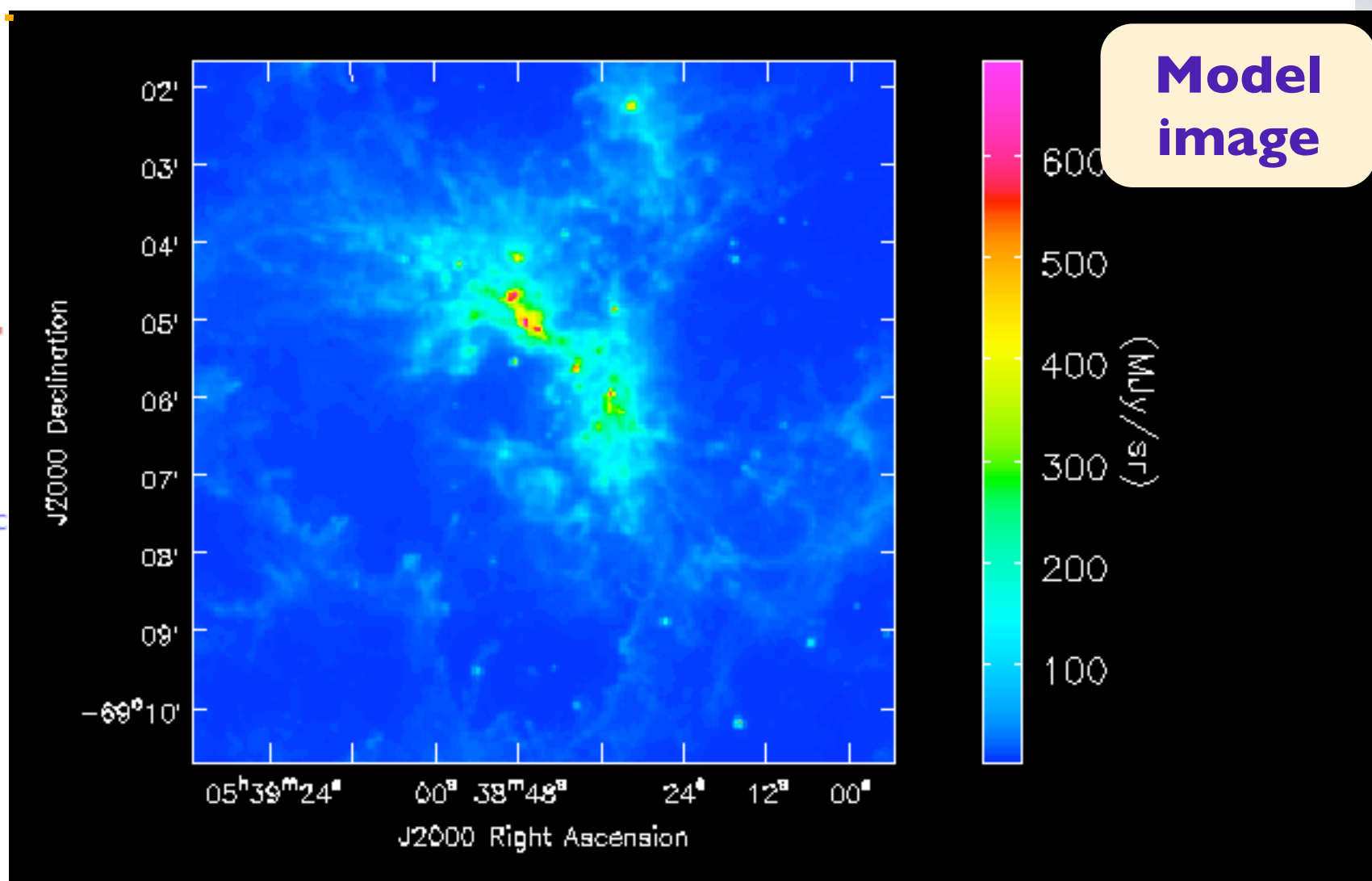
obsmode         = 'int'

  antennalist    = '/usr/lib64/c

  refdate        = '2012/05/21'
  hourangle      = 'transit'
  totaltime      = '7200s'
  caldirection   = ''
  calflux        = '1Jy'

thermalnoise    = 'tsys-atm'
  user_pwv       = 1.0
  t_ground       = 269.0
  seed           = 11111

leakage         = 0.0
graphics        = 'both'
verbose         = False
overwrite       = True
async           = False
```



Spitzer IRAC 8 micron image of 30 Doradus, v



# Simobserve

```
# simobserve :: mosaic simulation task:
project          = 'sim'
skymodel       = '30dor.fits'
  inbright       = '0.06mJy/pixel'
  indirection    = 'J2000 10h00m00 -40d00m00'
  incell         = '0.15arcsec'
  incenter       = '230GHz'

  inwidth        = '2GHz'

complist      = ''
setpointings = True
  integration    = '600s'
  direction      = ''
  mapsize        = ['', '']
  maptype        = 'topographic'
  pointingspacing = ''

obsmode       = 'int'

  antennalist  = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # inter
  refdate        = '2012/05/21'
  hourangle      = 'transit'
  totaltime      = '7200s'
  caldirection   = ''
  calflux        = '1Jy'

thermalnoise = 'tsys-atm'
  user_pwv       = 1.0
  t_ground       = 269.0
  seed           = 11111

leakage          = 0.0
graphics         = 'both'
verbose          = False
overwrite        = True
async            = False
```

model image

array choice  
or  
required  
angular  
resolution

# Simobserve

```
# simobserve :: mosaic simulation task:
project          = 'sim'
skymodel       = '30dor.fits'
  inbright       = '0.06mJy/pixel'
  indirection    = 'J2000 10h00m00 -40d00m00'
  incell         = '0.15arcsec'
  incenter       = '230GHz'
  inwidth        = '2GHz'
complist      = ''
setpointings = True
  integration    = '600s'
  direction      = ''
  mapsize        = ['', '']
  maptype        = 'topographic'
  pointingspacing = ''
obsmode       = 'int'
  antennalist    = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # inter
  refdate        = '2012/05/21'
  hourangle      = 'transit'
  totaltime      = '7200s'
  caldirection   = ''
  calflux        = '1Jy'
thermalnoise = 'tsys-atm'
  user_pwv       = 1.0
  t_ground       = 269.0
  seed           = 11111
leakage          = 0.0
graphics         = 'both'
verbose          = False
overwrite        = True
async            = False
```

model image

spectral set-up

array choice  
or  
required  
angular  
resolution



# Simobserve

```
# simobserve :: mosaic simulation task:
```

```
project = 'sim'  
skymodel = '30dor.fits'  
  inbright = '0.06mJy/pixel'  
  indirection = 'J2000 10h00m00 -40d00m00'  
  incell = '0.15arcsec'  
  incenter = '230GHz'  
  inwidth = '2GHz'
```

model image

spectral set-up

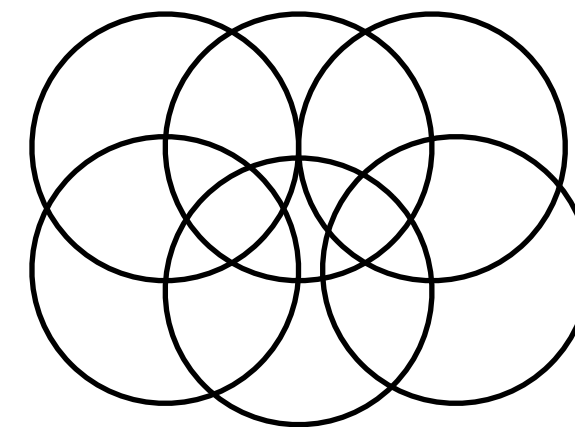
```
complist = ''  
setpointings = True  
  integration = '600s'  
  direction = ''  
  mapsize = ['', '']  
  maptype = 'topographic'  
  pointingspacing = ''
```

observing  
time and  
pointing

```
obsmode = 'int'  
antennalist = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # inter  
refdate = '2012/05/21'  
hourangle = 'transit'  
totaltime = '7200s'  
caldirection = ''  
calflux = '1Jy'
```

```
thermalnoise = 'tsys-atm'  
  user_pwv = 1.0  
  t_ground = 269.0  
  seed = 11111
```

```
leakage = 0.0  
graphics = 'both'  
verbose = False  
overwrite = True  
async = False
```



array choice  
or  
required  
angular  
resolution

# Simobserve

```
# simobserve :: mosaic simulation task:
```

```
project = 'sim'
```

```
skymodel = '30dor.fits'
```

```
inbright = '0.06mJy/pixel'
```

```
indirection = 'J2000 10h00m00 -40d00m00'
```

```
incell = '0.15arcsec'
```

```
incenter = '230GHz'
```

```
inwidth = '2GHz'
```

```
complist = ''
```

```
setpointings = True
```

```
integration = '600s'
```

```
direction = ''
```

```
mapsize = ['', '']
```

```
maptype = 'topographic'
```

```
pointingspacing = ''
```

```
obsmode = 'int'
```

```
antennalist = '/usr/lib64/casapy/stable/data/alma/simmos/alma.cycle0.compact.cfg' # inter
```

```
refdate = '2012/05/21'
```

```
hourangle = 'transit'
```

```
totaltime = '7200s'
```

```
caldirection = ''
```

```
calflux = '1Jy'
```

```
thermalnoise = 'tsys-atm'
```

```
user_pwv = 1.0
```

```
t_ground = 269.0
```

```
seed = 11111
```

```
leakage = 0.0
```

```
graphics = 'both'
```

```
verbose = False
```

```
overwrite = True
```

```
async = False
```

model image

spectral set-up

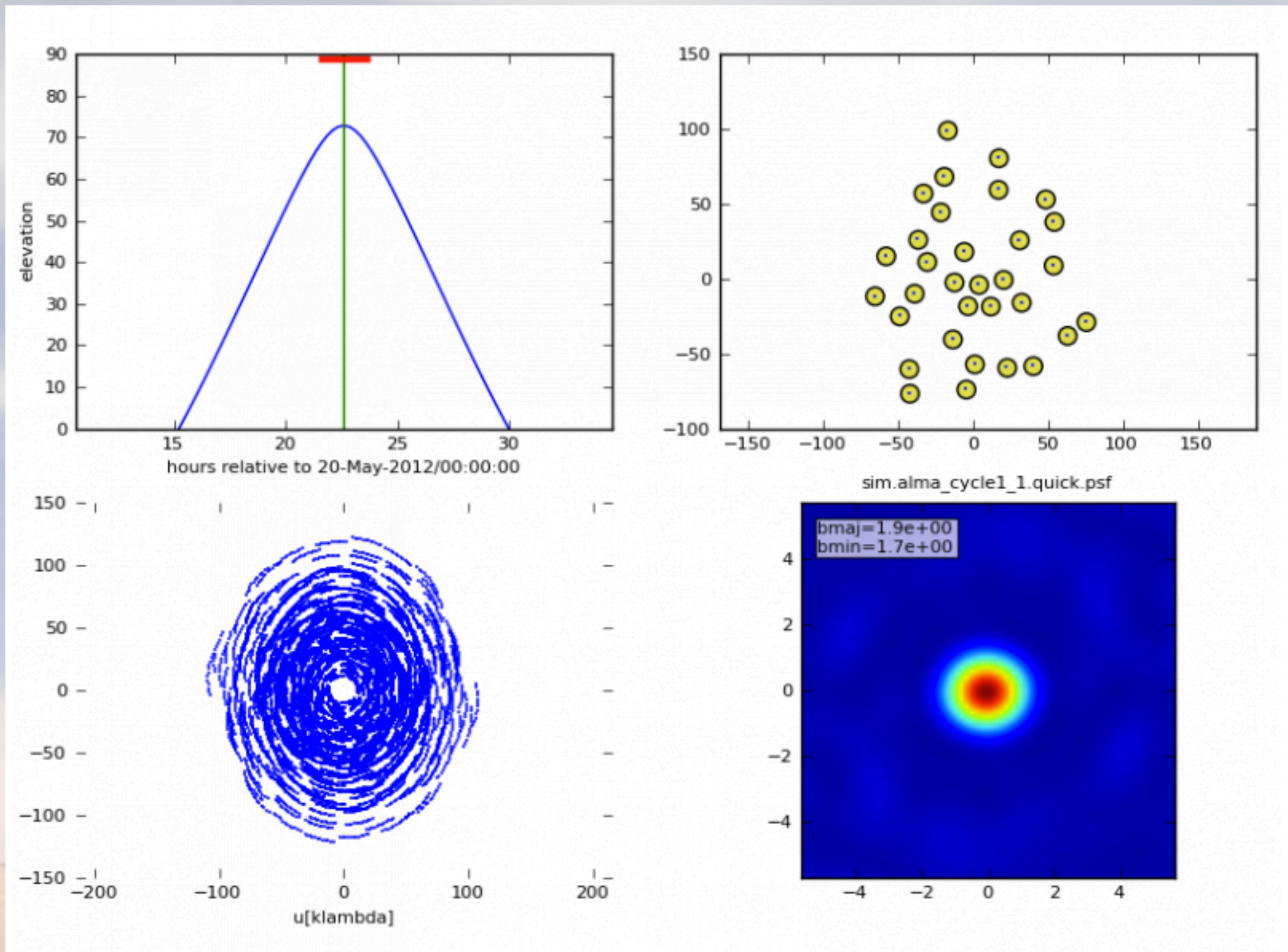
observing  
time and  
pointing

array choice  
or  
required  
angular  
resolution

noise  
addition



# Simobserve



# Imaging step

## simanalyze

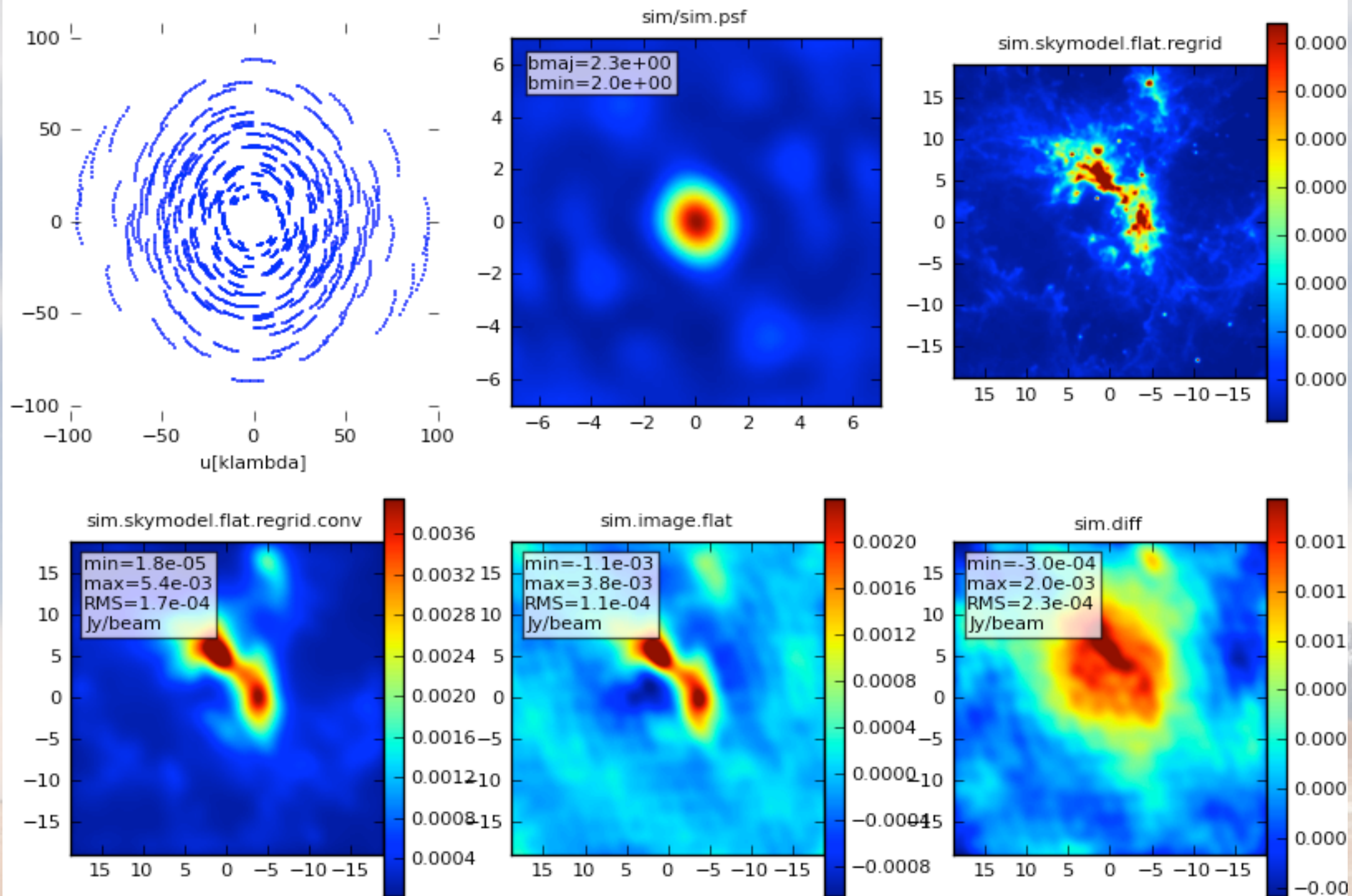
```
image and analyze simulated datasets
project      = 'sim'          # root prefix for output file names
image       = True          # (re)image $project.*.ms to $project.image
  vis       = 'default'     # Measurement Set(s) to image
  modelimage = ''          # prior image to use in clean e.g. existing single dish image
  imsize    = 0             # output image size in pixels (x,y) or 0 to match model
  imdirection = ''        # set output image direction, (otherwise center on the model)
  cell      = ''          # cell size with units or "" to equal model
  niter     = 500          # maximum number of iterations (0 for dirty image)
  threshold = '0.1mJy'     # flux level (+units) to stop cleaning
  weighting = 'natural'    # weighting to apply to visibilities
  mask      = []          # Cleanbox(es), mask image(s), region(s), or a level
  outertaper = []         # uv-taper on outer baselines in uv-plane
  stokes    = 'I'         # Stokes params to image

analyze     = True         # (only first 6 selected outputs will be displayed)
  showuv    = True        # display uv coverage
  showpsf   = True        # display synthesized (dirty) beam (ignored in single dish simulation)
  showmodel = True        # display sky model at original resolution
  showconvolved = False   # display sky model convolved with output beam
  showclean = True        # display the synthesized image
  showresidual = False    # display the clean residual image (ignored in single dish simulation)
  showdifference = True   # display difference image
  showfidelity = True     # display fidelity

graphics   = 'both'       # display graphics at each stage to [screen|file|both|none]
verbose    = False
overwrite  = True         # overwrite files starting with $project
async     = False        # If true the taskname must be started using simanalyze(...)
```



# Simanalyze imaging output



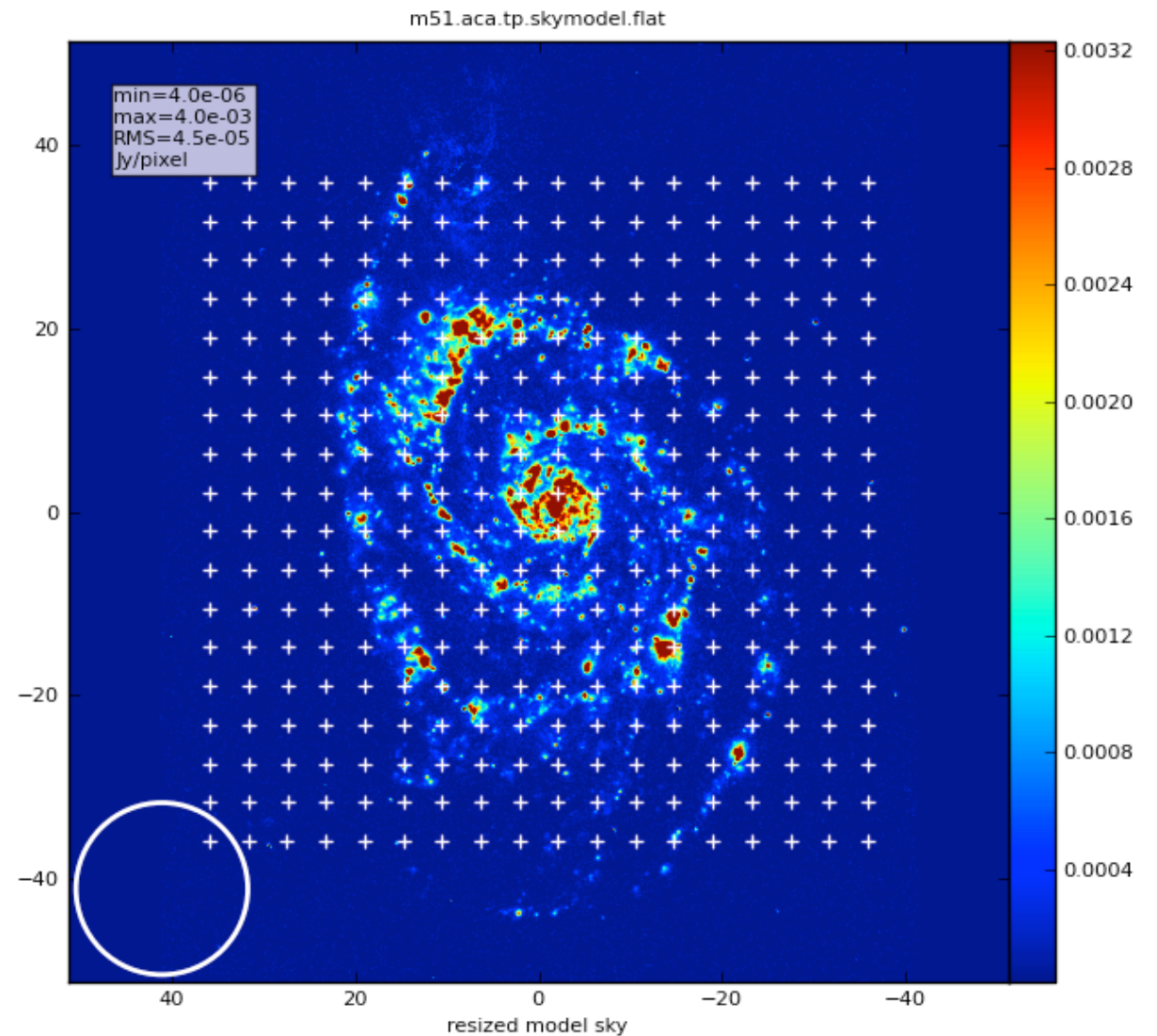
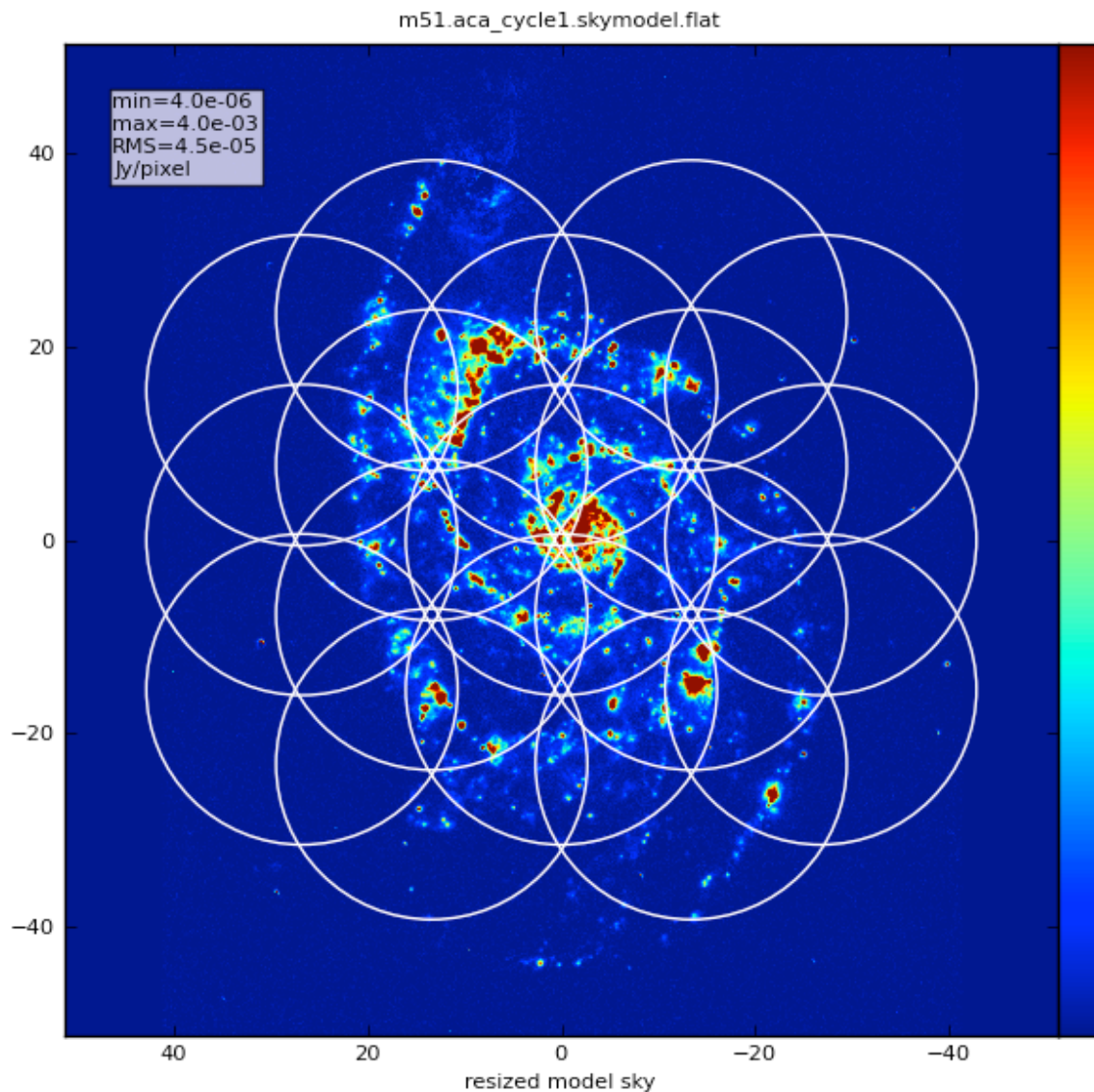


# Simalma - combination of SD/ACA/ALMA during de-convolution

input model and pointing

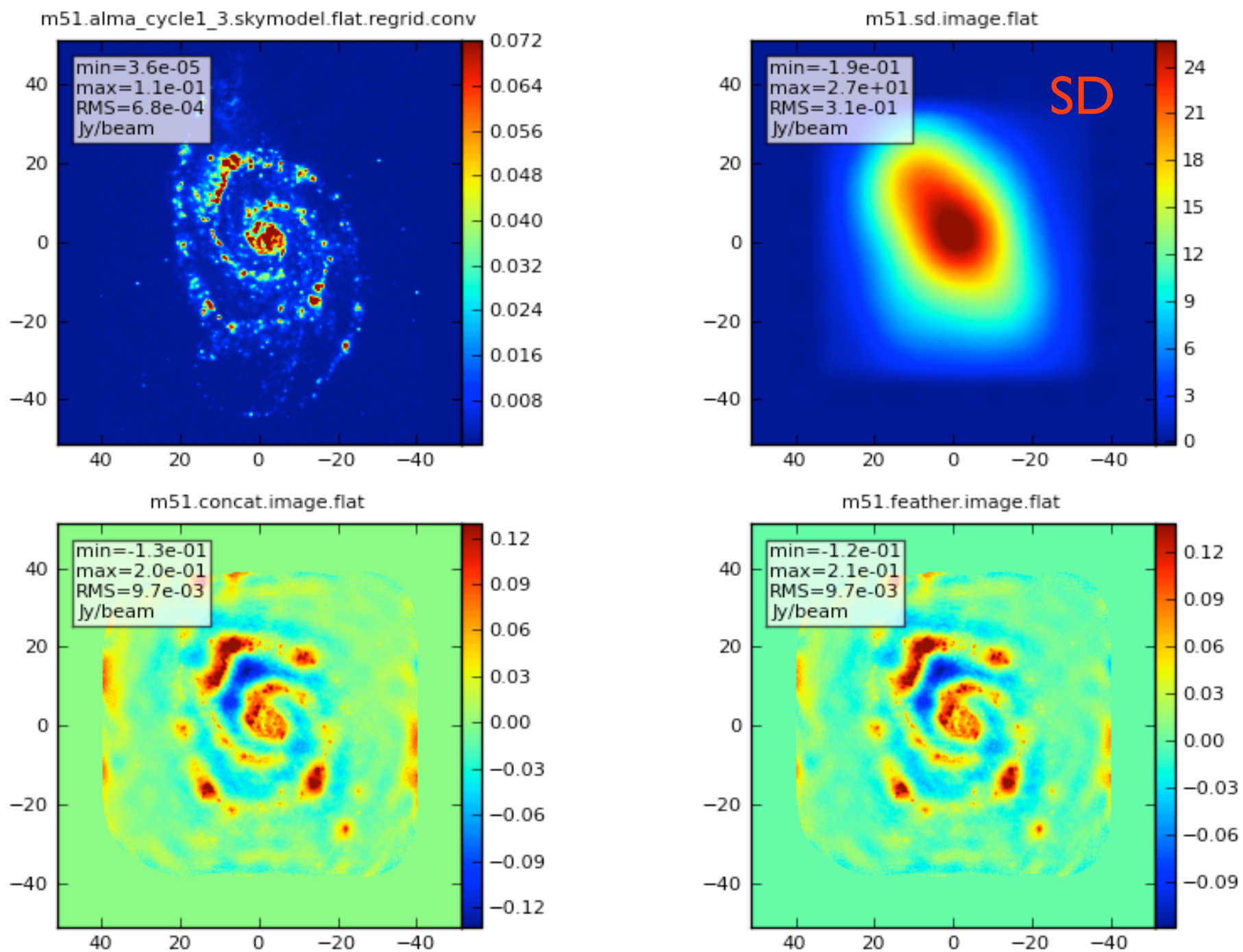


M5 I input





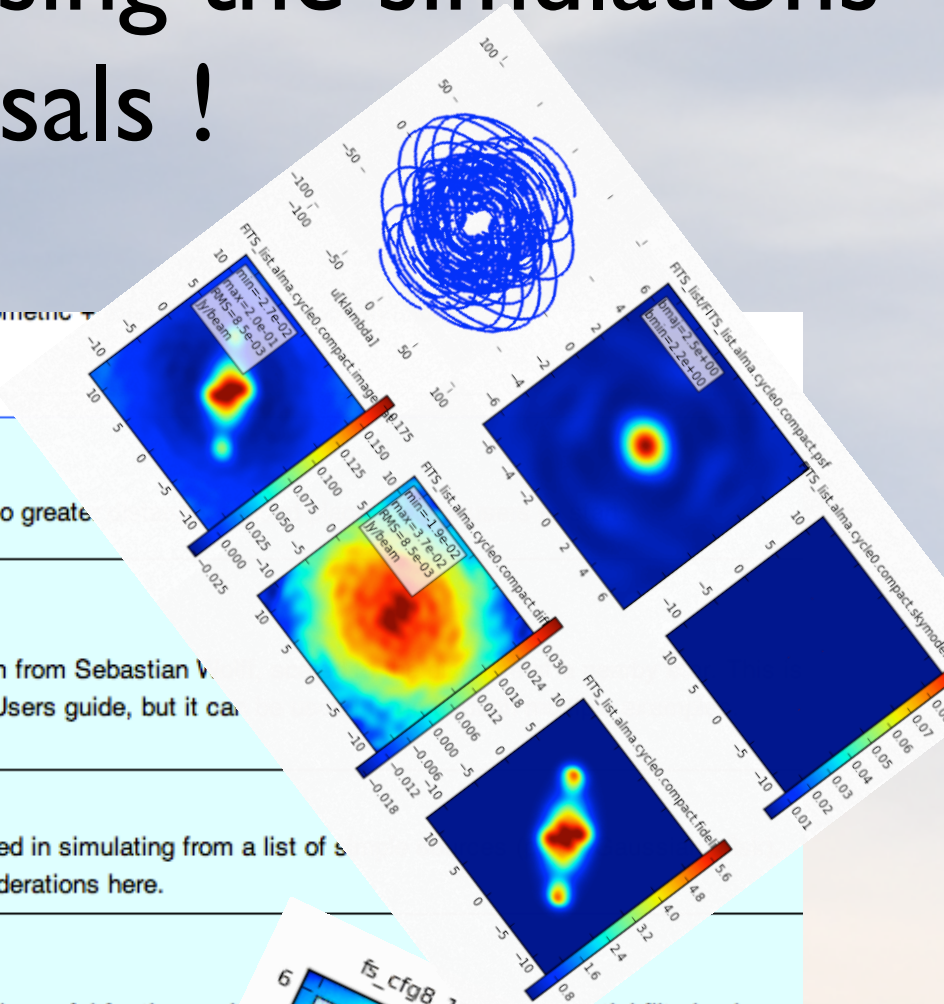
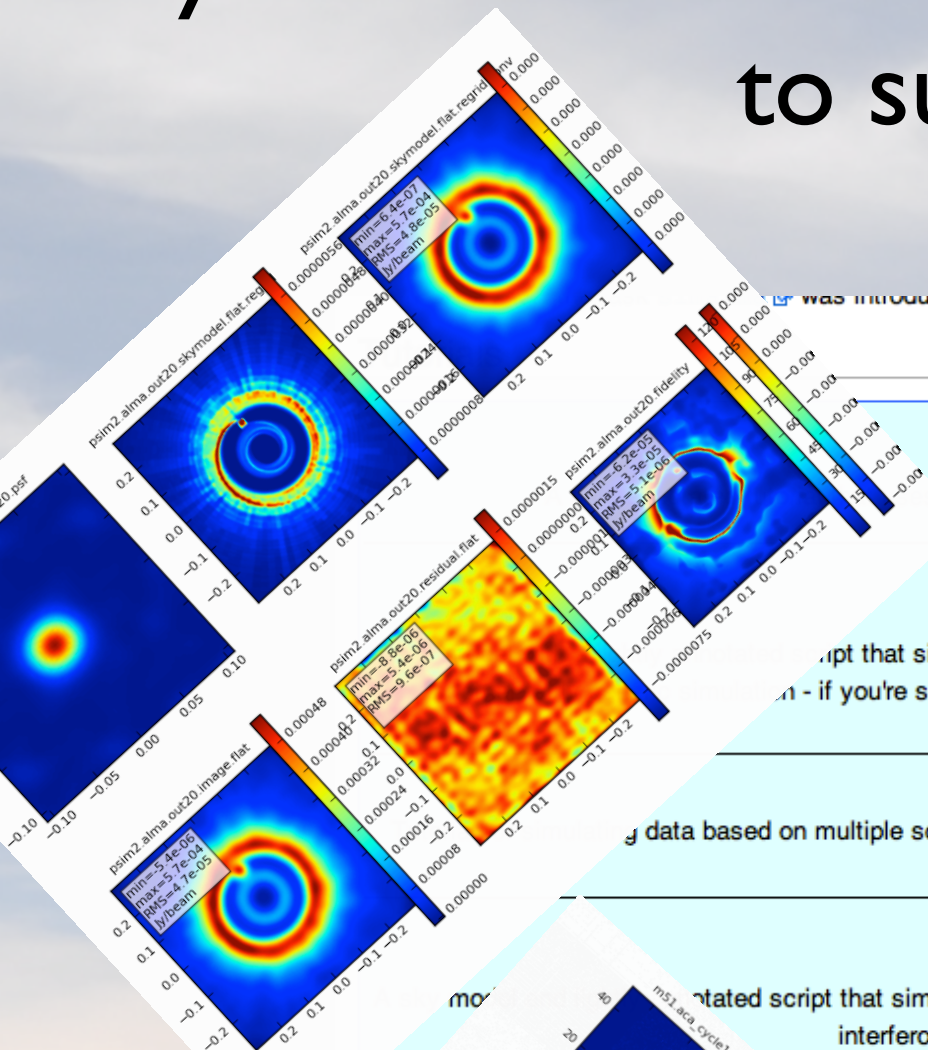
# Simalma - combination of SD/ACA/ALMA during de-convolution





# Useful examples

Try out the simulators and have fun using the simulations to support your proposals !



## Simulation Guide for New Users (CASA 4.3)

a Spitzer SAGE 8 micron continuum image of 30 Doradus and scales it to create

## Protoplanetary Disk Simulation (CASA 4.3)

script that simulates a protoplanetary disk. Uses a theoretical model of dust continuum from Sebastian W. - if you're short on time, you probably don't need to go through this one and the New Users guide, but it ca

## Simulation Guide Component Lists (CASA 4.3)

g data based on multiple sources (using both a FITS image and a component list). If you are interested in simulating from a list of s rather than or in addition to a sky model image, then read the considerations here.

## Einstein-Face (CASA 4.3)

mo- nated script that simulates the face of Einstein as seen by ALMA. This simulation is particularly useful for those w/ nterferometer, but doesn't demonstrate new capabilities of the simulation tasks beyond those describ

## ACA Simulation (CASA 4.3)

that use multiple configurations or use the 12-meter array in combination with the ALMA Cor provide is of particular interest to those wishing to explore using the 12-m array in combinat from multiple 12-m array configurations.

## Simalma (CASA 4.3)

simplifies simulations that include the main 12-m array plus the AC those wishing to explore multi-component ALMA observations.

