



Simulating ALMA observations

Sandra Burkutean, Italian ARC node





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The simulators and cycle 7 proposals

Available simulators

Overview of the CASA simulator

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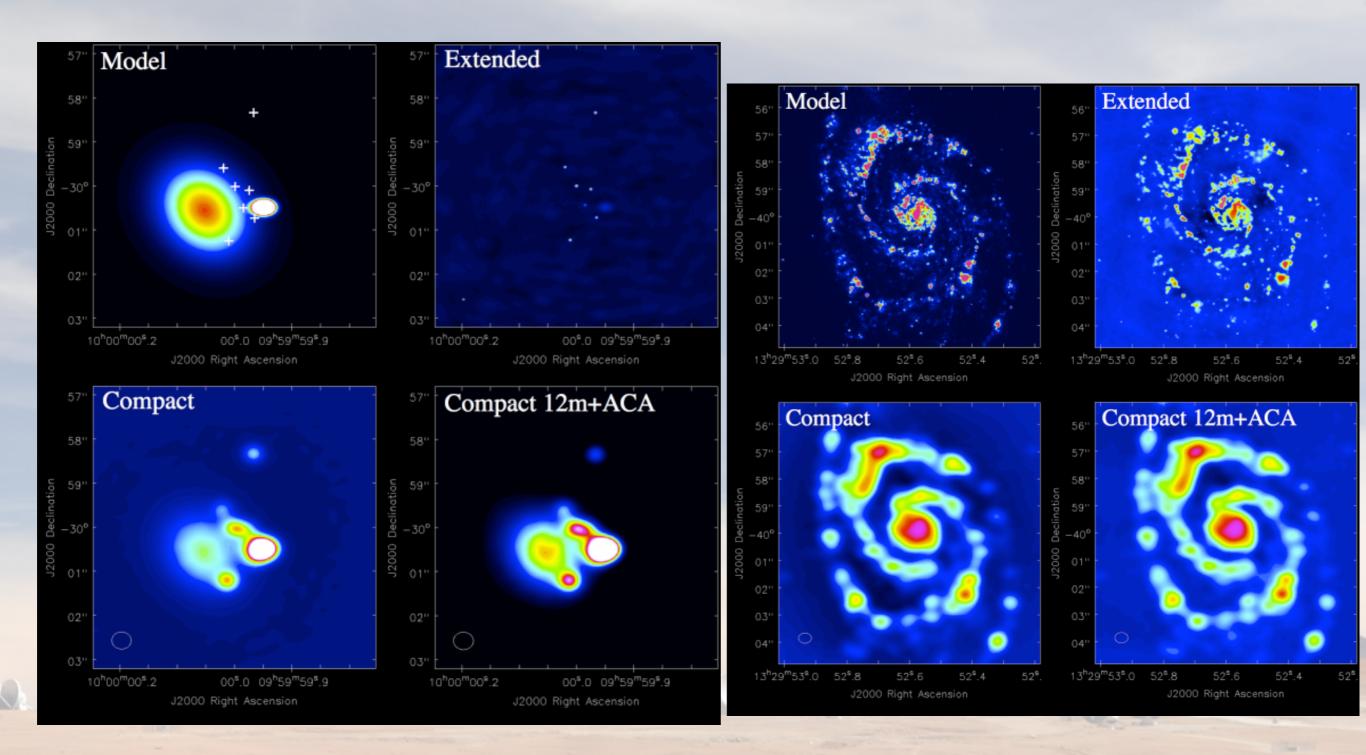
Why should I do an ALMA simulation ?

• 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 or, indeed, ACA-only observations.

Why should I do an ALMA simulation ?



source: CASA simulator pages

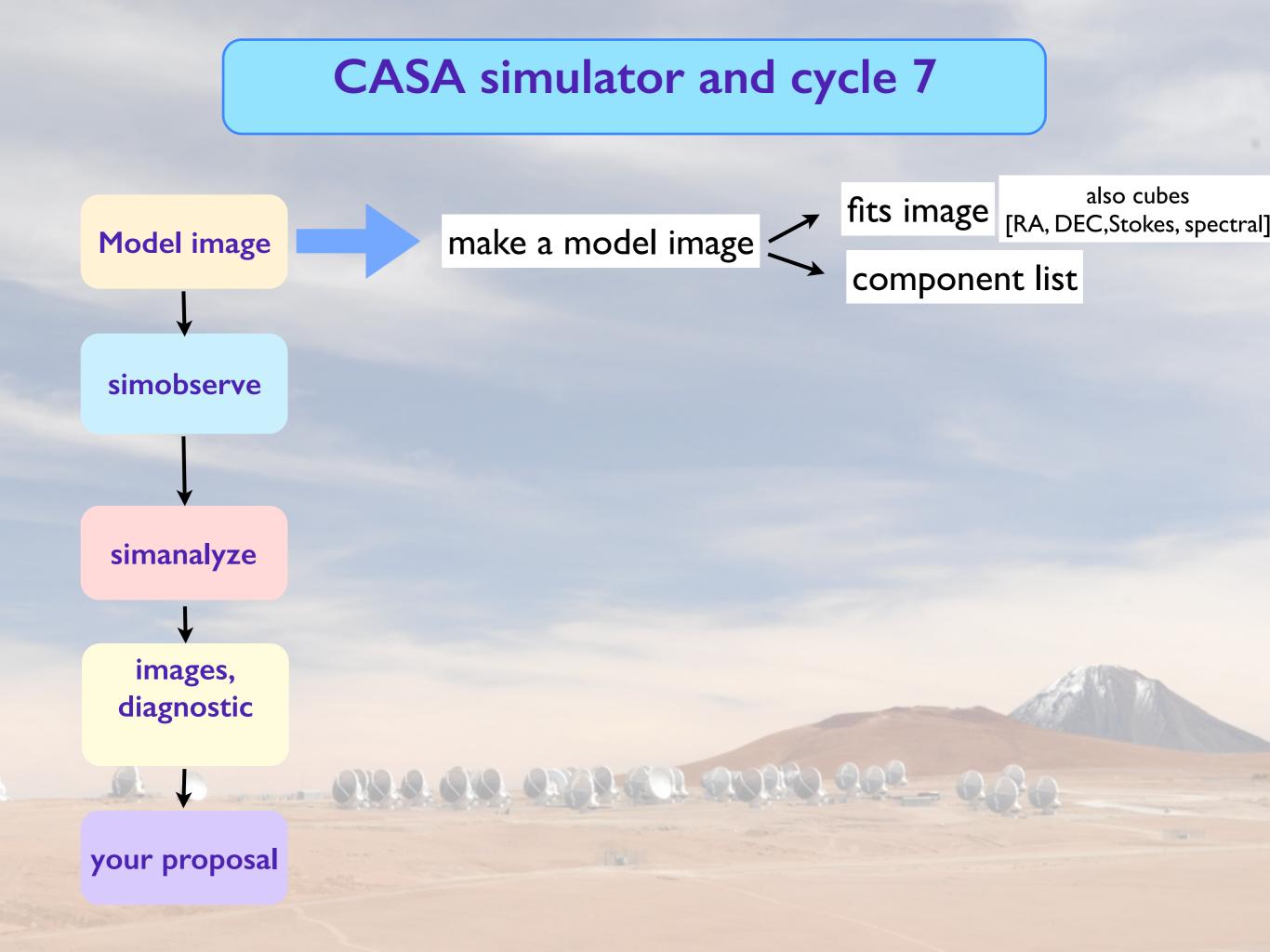
Available simulators

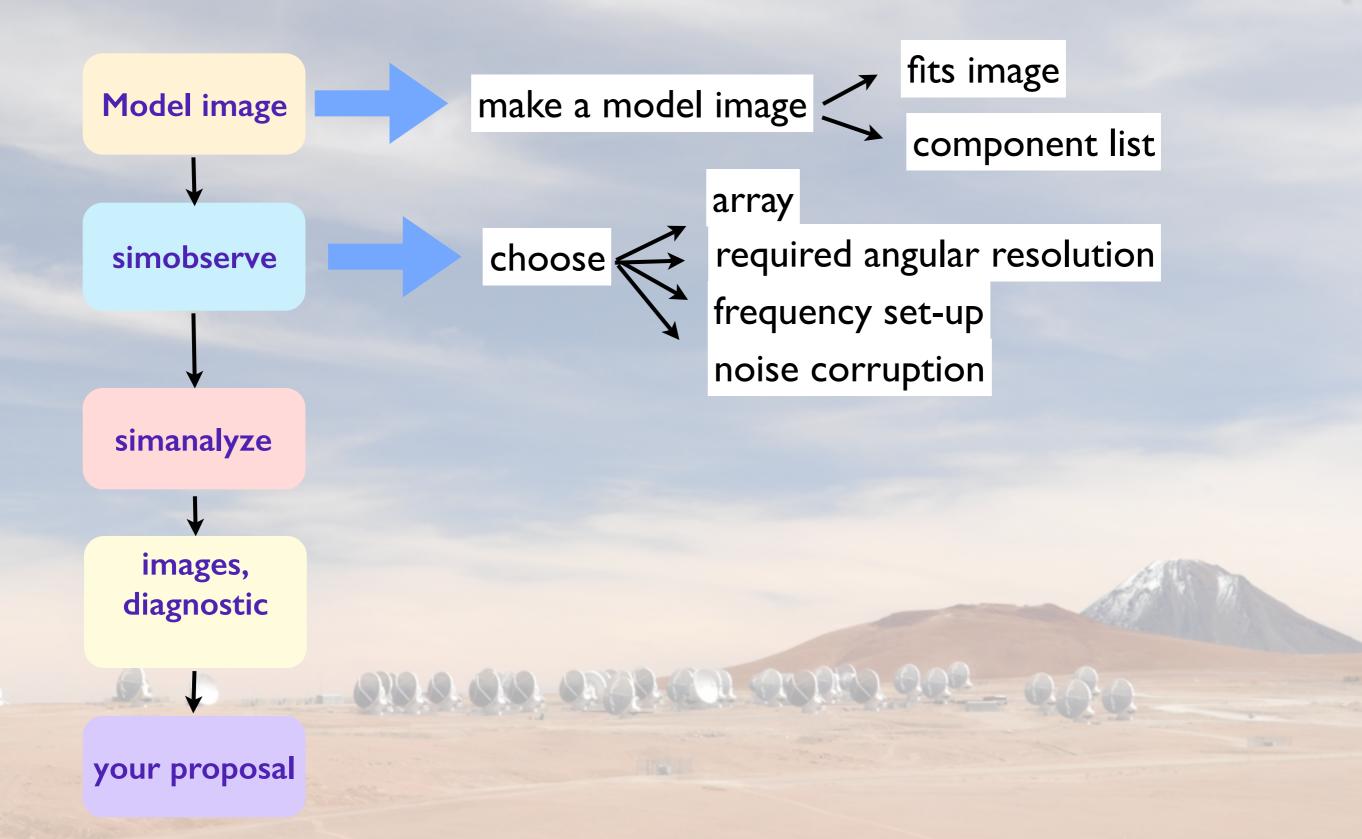
CASA simulator

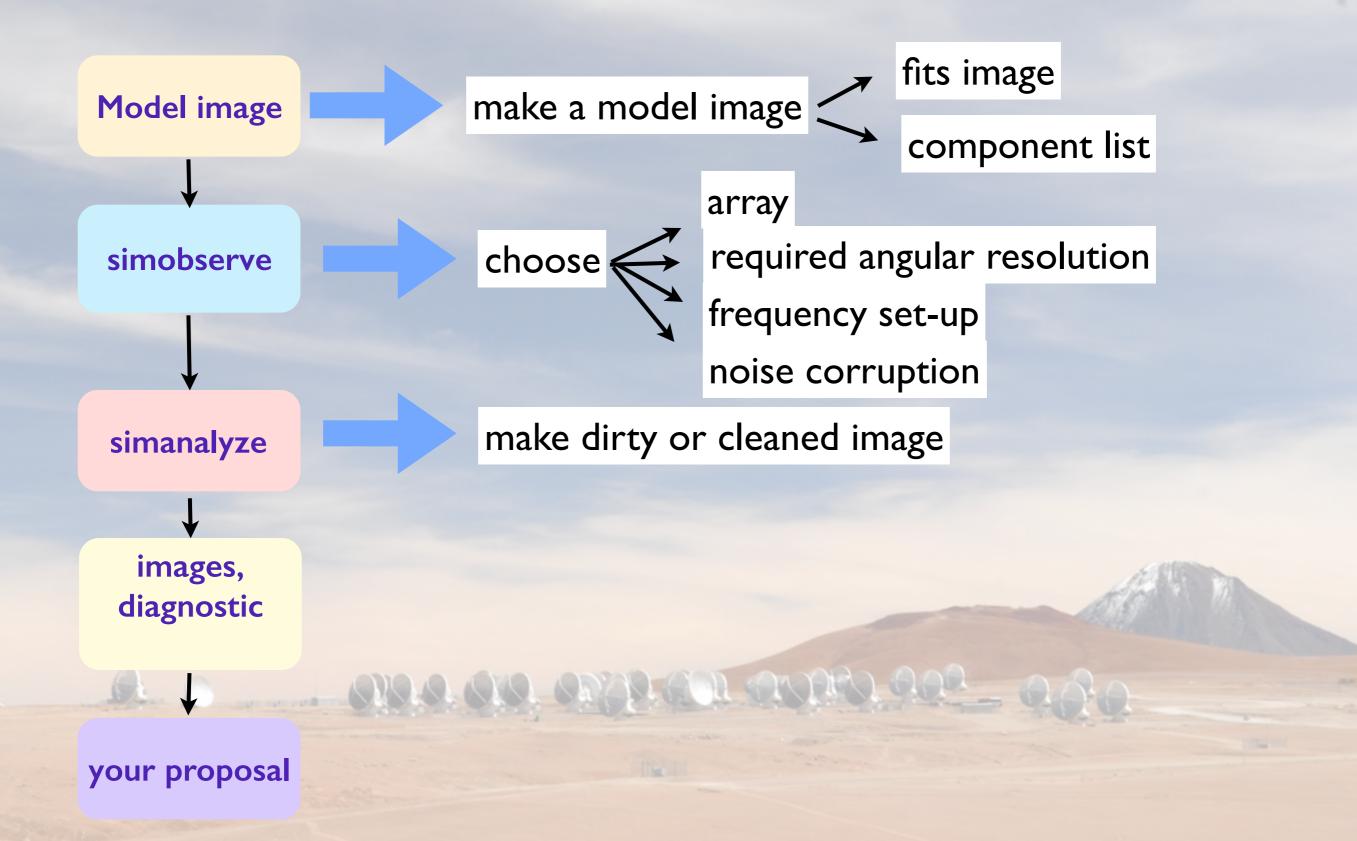
ALMA Observation Support tool

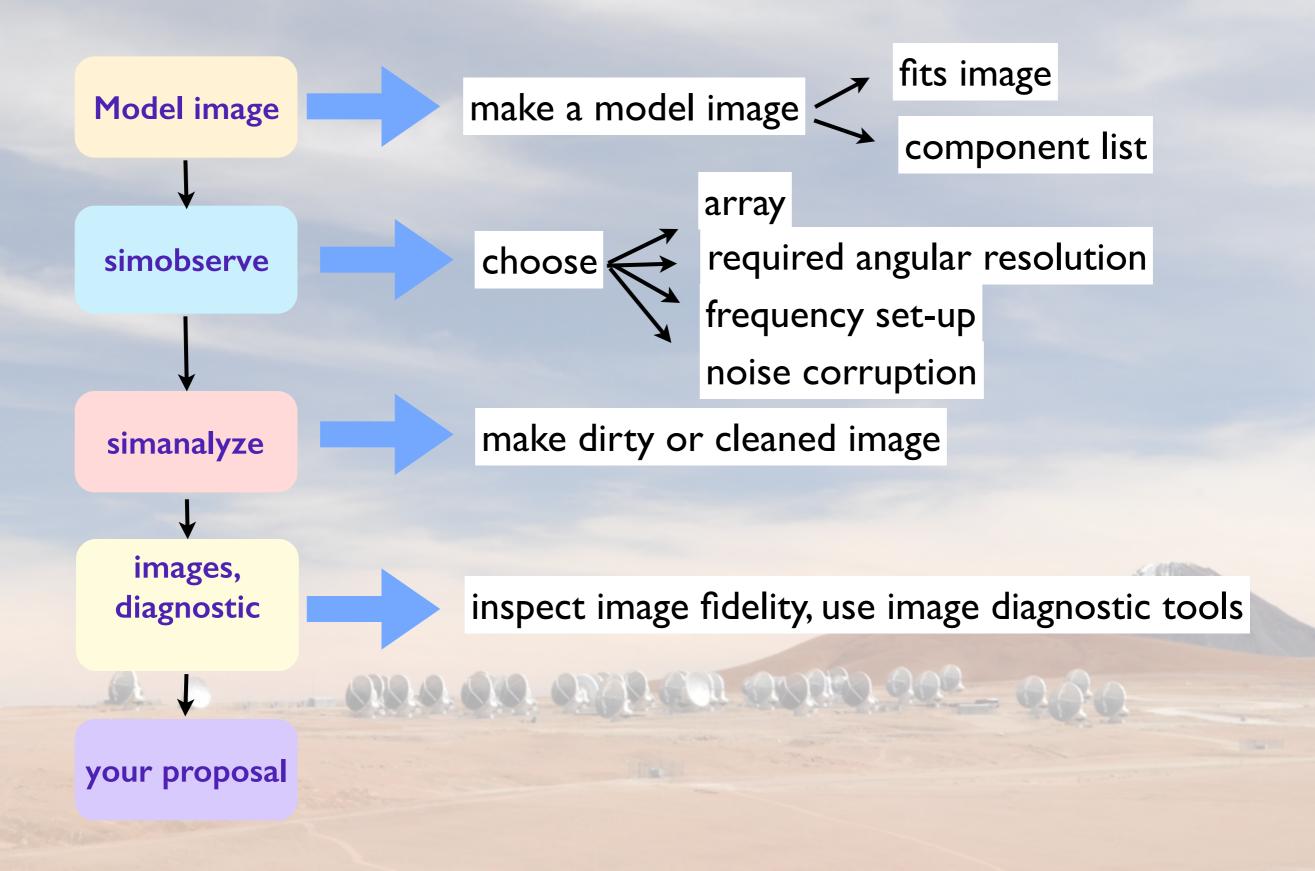
roject	=	'sim'		root prefix for output fil	e names
kymodel		Odor.fits'		model image to observe	
inbright		0.06mJy/pixel'			f brightest pixel e.g. "1.2Jy/pixel"
indirection					e.g. "J2000 19h00m00 -40d00m00"
incell	= '0	.15arcsec'	#		
incenter	=	'230GHz'	# #		r channel e.g. "89GHz" (required even for
inwidth	=	'2GHz'	#	set new channel width e.g.	"10MHz" (required even for 2D model)
omplist	=		#	componentlist to observe	
etpointings	=	True			
integration	=	'600s'		integration (sampling) tim	
direction	=			"J2000 19h00m00 -40d00m00"	
mapsize	=	['', '']		angular size of map or ""	to cover model
maptype		opographic'	#	hexagonal, square, etc	
pointingspacir	1g =		#	spacing in between pointin	gs or "0.25PB" or "" for 0.5 PB
bsmode	=	'int'		observation mode to simula	
			#	[int(interferometer) sd(s	
antennalist	= '/	usr/lib64/casa	py/s #		.cycle0.compact.cfg' # interferometer
refdate	- '7	012/05/21'		1	critical unless concatting simulations
hourangle		transit'			center e.g3:00:00, or "transit"
totaltime	_	'7200s'		total time of observation	
caldirection	_	12005		pt source calibrator [expe	
calflux	2	'1Jy'	#	pt source catibrator (expe	Time(reac)
Catitux	-	15 y			
hermalnoise	=				m tsys-manual ""]
eakage	-	0.0			rometer only)
raphics	_	'both'		and the second second	age to [screen file both none]
erbose	_	False			age to [sereen[rite]both[hole]
verwrite	_	True		State State	th \$project
SVNC	_	False			e started using simobserve()
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					6440 00000 (D.C.
	and and				
		-		CASA	And the second
				Common Astronomy	and the second se
				Software Applications	
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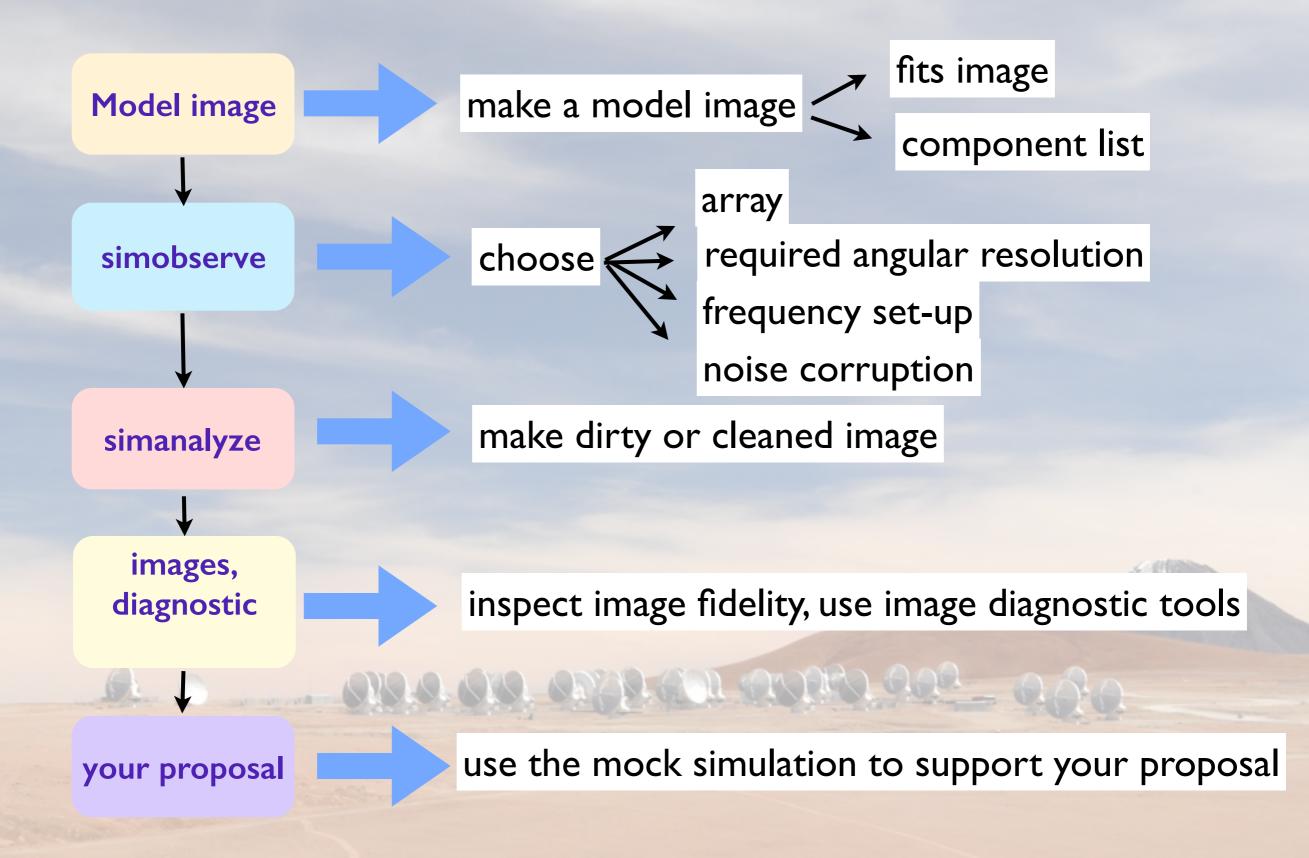
EUROPEAN ARC ALMA Regional Centre UK ALMA Observation S	ALMA Observation Su
OST NEWS HELP QUEUE LIBRARY ALMA HELPDESH	(
Important information on the new OST version.	
Array Setup:	
Instrument: ALMA \$	Select the desired ALMA antenna configuration.
Sky Setup:	
Source model: OST Library: Central point source +	Choose a library source model or supply your own
Upload: Choose File no file selected	You may upload your own model here (max 10MB)
Declination: -35d00m00.0s	Ensure correct formatting of this string (+/-00d00m0
Image peak / point flux in mJy + 0.0	Rescale the image data with respect to new peak v
	Set to 0.0 for no rescaling of source model.
Observation Setup:	
Observing mode: OSpectral Continuum	Spectral or continuum observations?
Central frequency in GHz: 93.7	The value entered must be within an ALMA band.
Bandwidth in MHz +: 32	Select the total bandwidth for continuum observation
	Enter 7.5 GHz to select ALMA recommend full conti
Number of polarizations: 2 +	This affects the noise in the final map.
Required resolution in arcseconds: 1.0	OST will choose array config based on this value if
Pointing strategy: Mosaic +	Selecting single will apply primary beam attenuation
On-source time in hours ÷ : 3	Per pointing for mosaics.
Start hour angle: 0.0	Deviation of start of observation from transit.



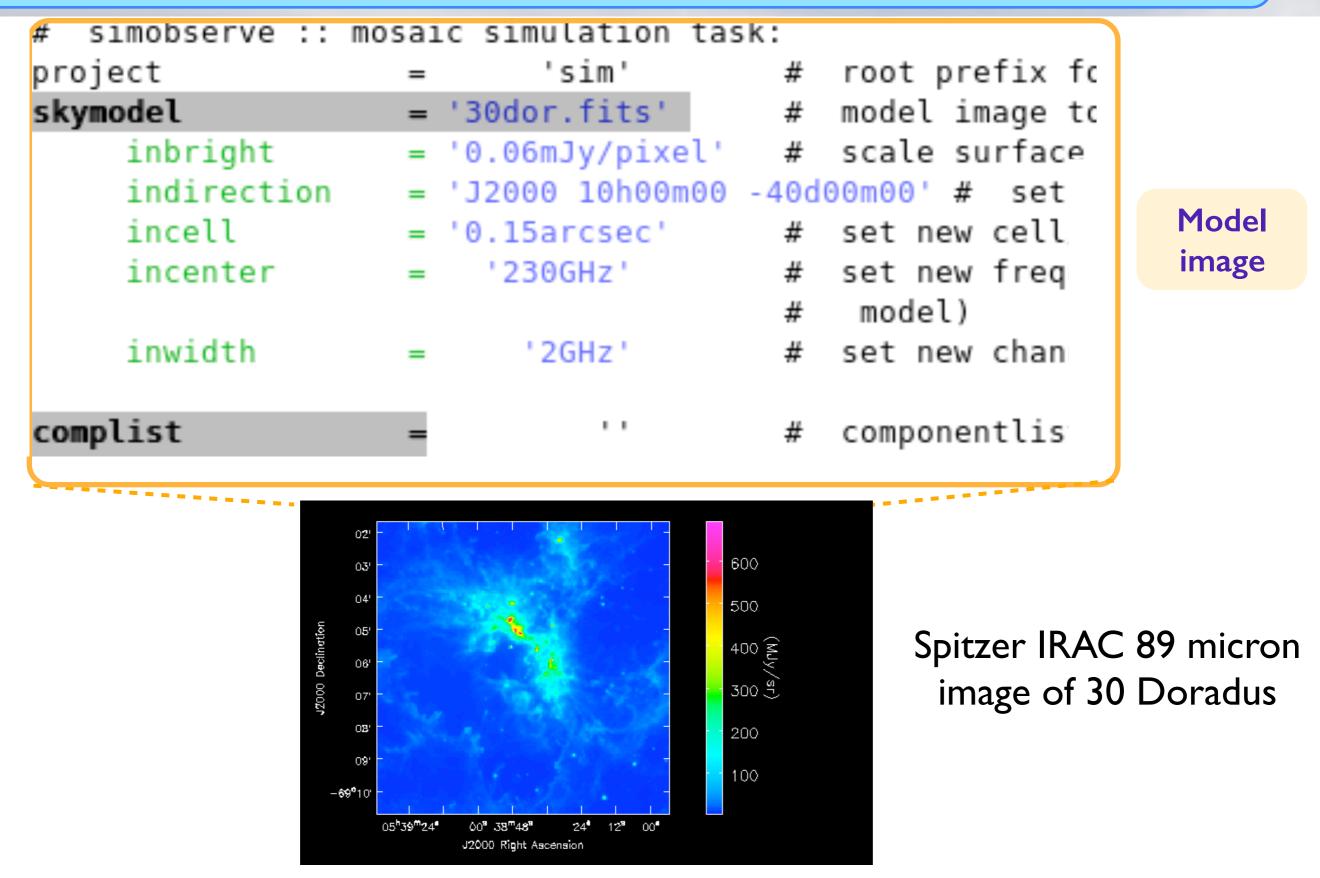








<pre># simobserve :: mo</pre>	osai			
project		'sim'		root prefix for output file names
skymodel	=	'30dor.fits'	#	model image to observe
inbright	=	'0.06mJy/pixel'	#	scale surface brightness of brightest pixel e.g. "1.2Jy/pixel"
indirection	=	'J2000 10h00m00	-40d	00m00' # set new direction e.g. "J2000 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
			#	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
pointingspacir	ng =		#	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/casa	apy/s	<pre>table/data/alma/simmos/alma.cycle0.compact.cfg' # interferometer</pre>
			#	antenna position file
refdate	=	2012/05/21	#	date of observation - not critical unless concatting simulations
hourangle	=	'transit'	#	hour angle of observation center e.g3:00:00, 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()



https://casaguides.nrao.edu/index.php/Simulation_Guide_for_New_Users_(CASA_4.4)

interferometer (int) or single-dish (sd)

		•		
obsmode	=	'int'	#	observation mode to simulate
			#	[int(interferometer) sd(singledish) ""(none)]
antennalist	= '	/usr/lib64/cas	apy/st	table/data/alma/simmos/alma.cycle0.compact.cfg'

Cycle 7 representative configurations files

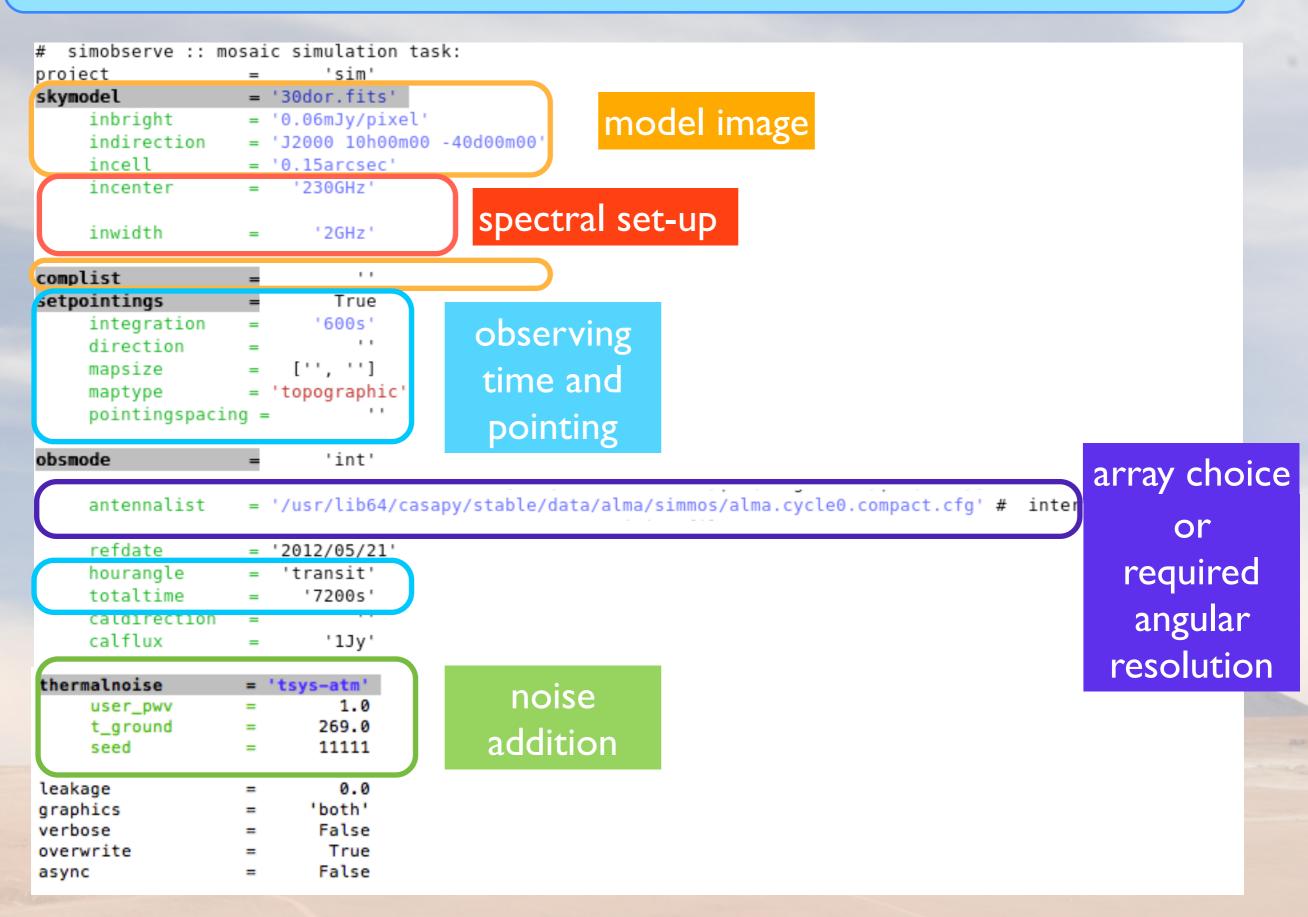
https://almascience.eso.org/documents-and-tools/cycle7/alma-configuration-files

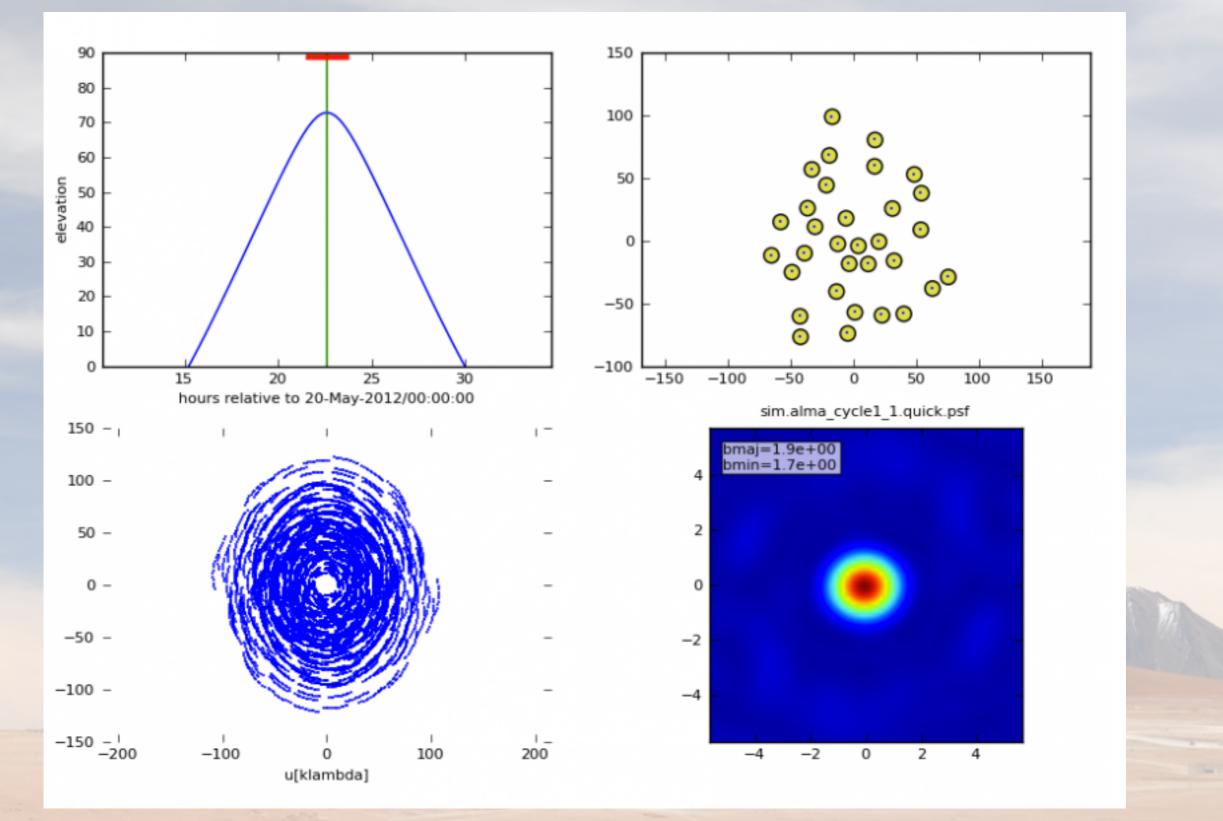
or, give the required angular resolution "alma;0.5arcsec" (only works for full ALMA !)



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incenter	=	'230GHz'	
inwidth	=	'2GHz'	spectral set-up
complist	=		
setpointings	=	True	
integration	=	'600s'	
direction	=		
mapsize	=	['', '']	
maptype		rectangle or he	exagonal X
pointingspaci	ng =		
the simi	ulato	or allows yo	ou to
		test	observing
several	роі	nting scena	rios time and
	-	-	pointing





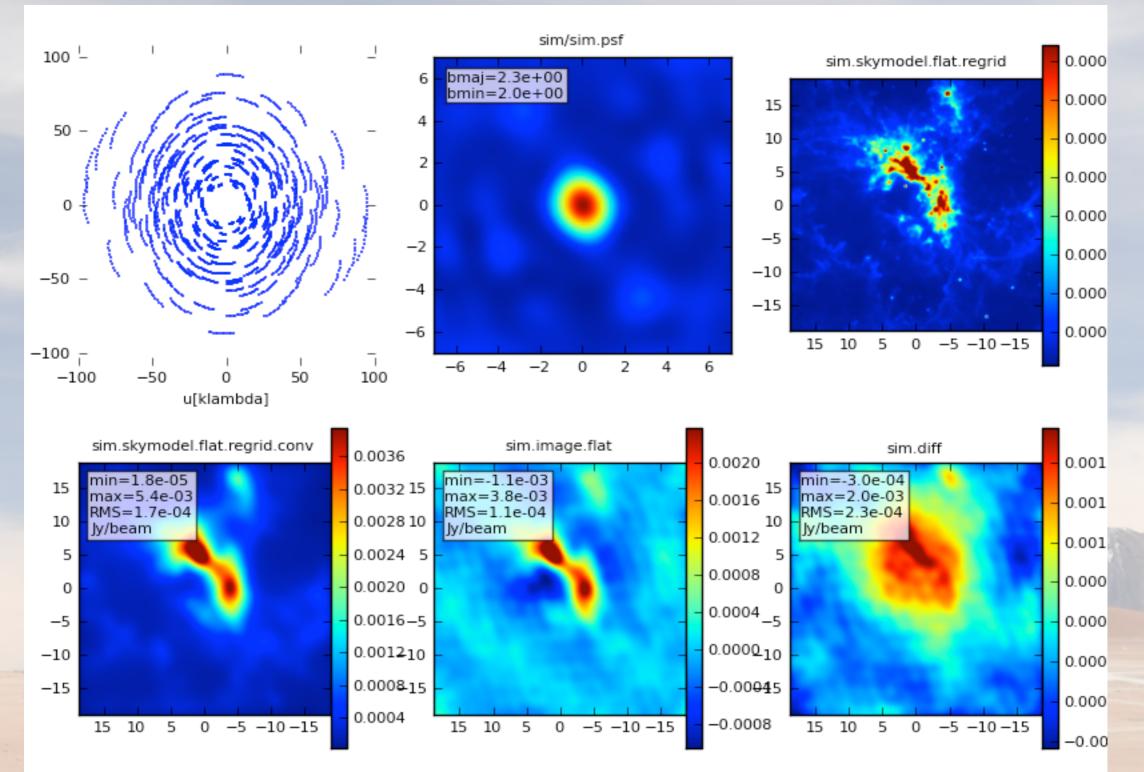
https://casaguides.nrao.edu/index.php/Simulation_Guide_for_New_Users_(CASA_4.4)

Imaging step

simanalyze

- +0P17				
<pre># simanalyze :: in</pre>	nage	and analyze	simulat	ed 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	#	
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
Shonar				
showpsf	=	True	#	display synthesized (dirty) beam (ignored in single dish simulation)
	=		# #	display synthesized (dirty) beam (ignored in single dish simulation) display sky model at original resolution
showpsf	=	True		
showpsf showmodel	=	True True	#	display sky model at original resolution display sky model convolved with output beam display the synthesized image
showpsf showmodel showconvolved	=	True True False	# #	display sky model at original resolution display sky model convolved with output beam display the synthesized image
showpsf showmodel showconvolved showclean showresidual showdifference	= = = =	True True False True	# # #	display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation) display difference image
showpsf showmodel showconvolved showclean showresidual	= = = =	True True False True False	# # #	display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation)
showpsf showmodel showconvolved showclean showresidual showdifference showfidelity	= = = = =	True True False True False True True	# # # #	display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation) display difference image display fidelity
showpsf showmodel showconvolved showclean showresidual showdifference showfidelity graphics	= = = = =	True True False True False True True	# # #	display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation) display difference image
showpsf showmodel showconvolved showclean showresidual showdifference showfidelity graphics verbose	= = = = = =	True False True False True True 'both' False	# # # #	<pre>display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation) display difference image display fidelity display graphics at each stage to [screen file both none]</pre>
showpsf showmodel showconvolved showclean showresidual showdifference showfidelity graphics	= = = = =	True True False True False True True	# # # #	display sky model at original resolution display sky model convolved with output beam display the synthesized image display the clean residual image (ignored in single dish simulation) display difference image display fidelity

Simanalyze imaging output

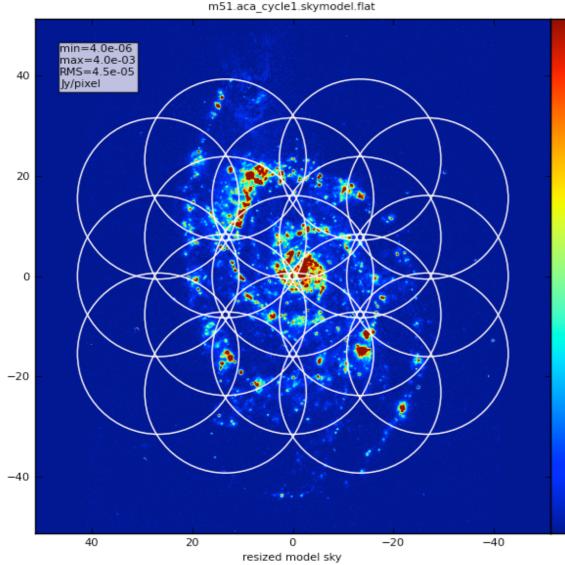


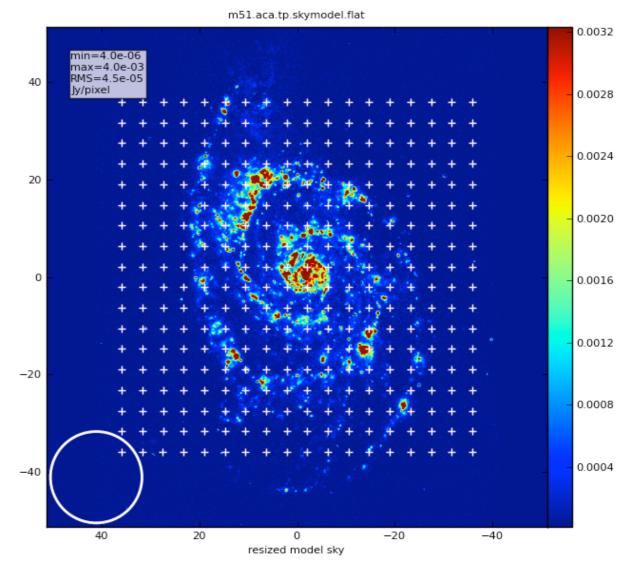
https://casaguides.nrao.edu/index.php/Simulation_Guide_for_New_Users_(CASA_4.4)

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

input model and pointing

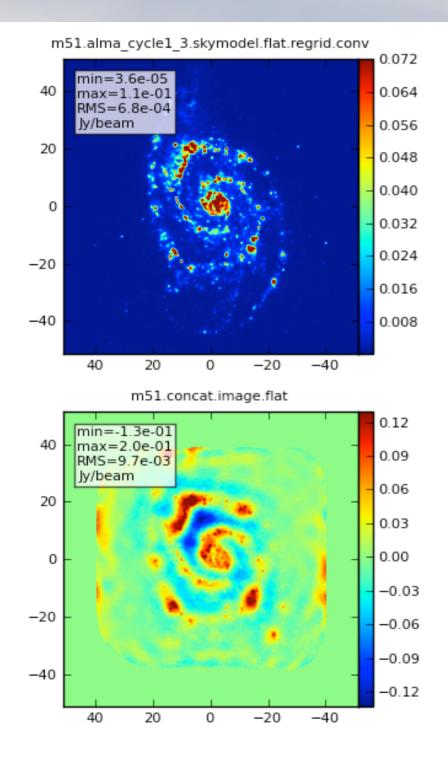
M51 input

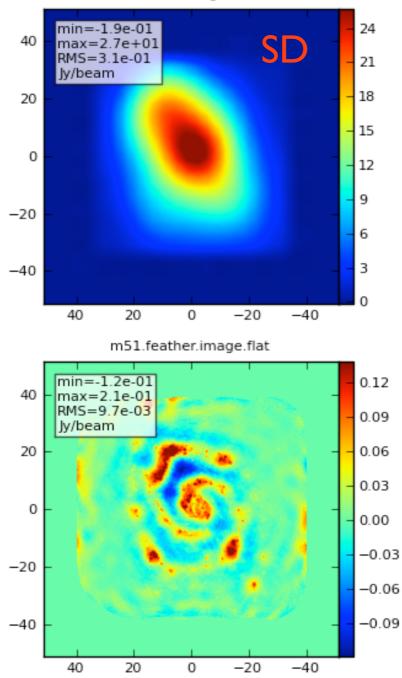




https://casaguides.nrao.edu/index.php/Simalma (CASA 4.4)

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





m51.sd.image.flat

https://casaguides.nrao.edu/index.php/Simalma_(CASA_4.4)

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 greate

Protoplanetary Disk Simulation (CASA 4.3)

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

Simulation Guide Component Lists (CASA 4.3)

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)

* stated script that simulates the face of Einstein as seen by ALMA. This simulation is particularly useful for those we interferometer, 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 vide 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.

gatial filtering by an

36000

30000

24000

18000

12000

6000

6000

.cfg8_1n.

more complicated sims

Use the simulator tool for:

phase delay variations

gain fluctuations and drift

cross-polarization

(soon also bandpass and pointing errors) more flexibility in adding thermal noise Thermal noise addition

<u>https://safe.nrao.edu/wiki/pub/ALMA/SimulatorCookbook/</u> <u>corruptguide.pdf</u>

simple: specify simplenoise="1Jy" to get random Gaussian noise with 1Jy RMS

- tsys-atm: use environment temperatures, antenna parameters, and the aatm library to create a model of the troposphere and add random noise of the appropriate magnitude to the visibilities
- tsys-manual: specify atmospheric brightness temperature and optical depth yourself (rather than let aatm calculate it for you) and apply noise of the corresponding magnitude.