Simulating ALMA observations

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Simulating ALMA observations

Motivation

- Investigate proposal feasibility

- Determine optimal configuration/sensitivity

- Improve quality of your proposal
  (highly appreciated by the TAC)

Tools:

- CASA simulator (terminal)

- Observation Support Tool (OST) (web)

CASA simulator (I): description

CASA command tools (terminal)

- **simobserve** → simulate visibilities
- **simanalyze** → simulate imaging
- **simalma** = simobserve + simanalyze in one go
- Possible inputs:
  templates, gaussian components, user's image
- CASA (5.4) guide (incl. examples):

https://casaguides.nrao.edu/index.php/Simulating_Observations_in_CASA_5.4

CASA simulator (II): inputs

- ## simobserve parameters

```python
# simobserve: Basic Configuration
#
# Initialize simanalyze
default("simobserve")                                        # Start sibobserve
# Basic info
project       =   "mysimulation"                             # Project name
skymodel      =   "HD163296_continuum_conv.image"            # Input image
# Pointings
setpointings  =   False                                      # Let CASA guess the pointings?
ptgfile       =   "HD163296_pointings.dat"                   # Poitings positions
# Observing mode
obsmode       =   "int"                                      # Observing mode
antennalist   =   "alma.cycle7.5.cfg"                        # ALMA configuration (e.g.| Cycle7+C41-5)
totaltime     =   "1000s"                                    # Integratio time
graphics      =   "both"                                     # Show plots
# Run simobserve
simobserve()
```

*simobs.py   ×   simanalyze.py

```
CASA <220>: execfile('simobs.py')
```

CASA simulator (II): inputs

- simanalyze parameters

```
# simanalyze: Basic Configuration
#
# Initialize simanalyze
default("simanalyze")
# Basic info
project             =   "myproject"                     # Project name
vis                 =   "myproject.alma.cycle7.5.ms"     # visibilities produced by simobs
# CLEAN parameters
imsize              =   [300,300]                        # Map size
cell                =   '0.01arcsec'                     # cell spacing
niter               =   2000                             # Number of iterations
threshold           =   "5mJy"                           # CLEANing threshold
weighting           =   "natural"                        # CLEAN weight
# Graphical parameters
analyze             =   True
showpsf             =   True
showresidual        =   False
showconvolved       =   True
# Run simanalyze
simanalyze()|
```

```
CASA <220>: execfile('simanalyze.py')
```

CASA simulator (III): outputs

Graphic interface
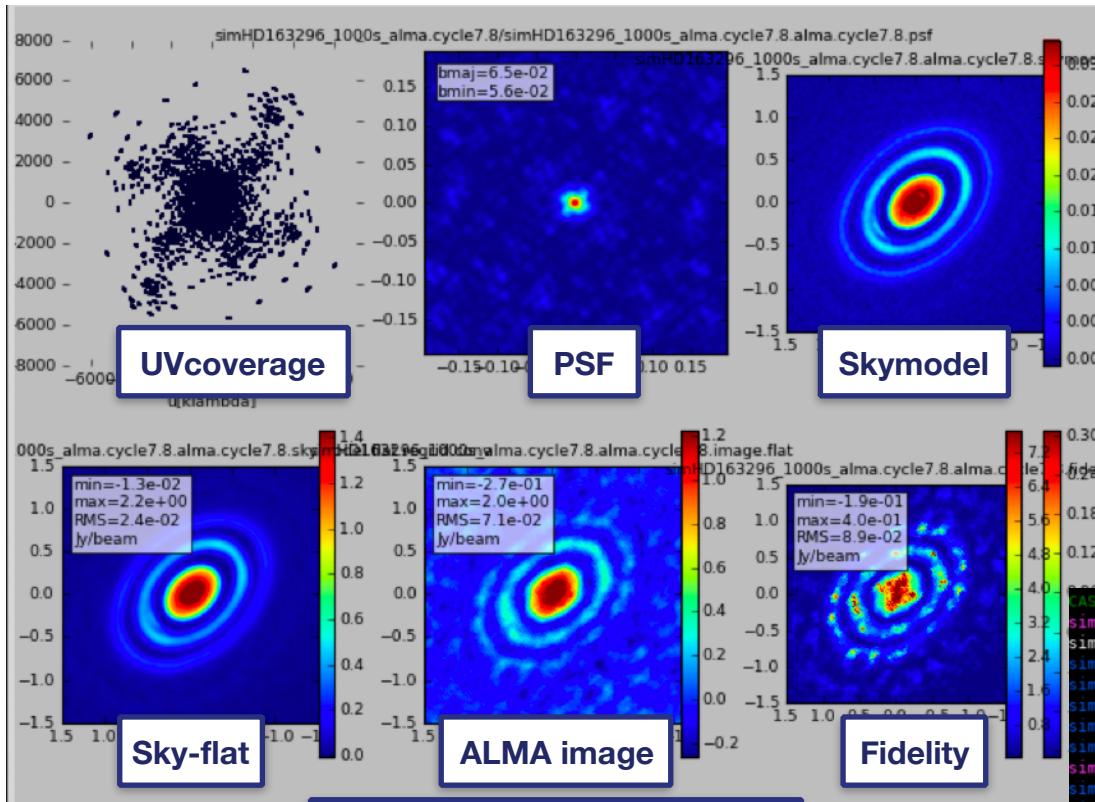
Output files:

- Sky model
- Simulated images
- Dirty beam (PSF)
- …

CASA simulator (IV): simalma

simalma = simobserve + simanalyze

- CASA 5.1+
- same I/O
- All in one go
- Allows array combination

Skymodel

Sky-flat

ALMA image

Residuals
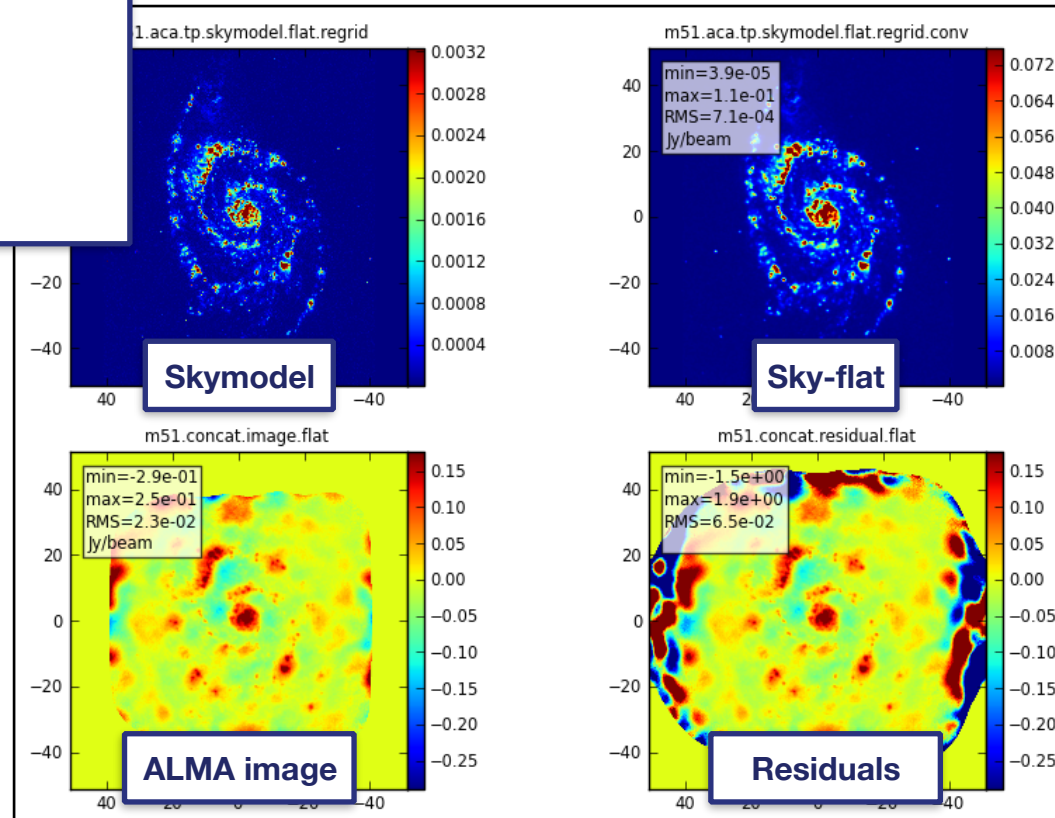
Graphic interface

OST (I): Description

Observation Support Tool (OST)

- Developed by the UK ARC node
- Web interface: http://almaost.jb.man.ac.uk/
- Runs CASA simulator in their servers

OST (II): inputs

Instrument = ALMA configuration

OST (II): inputs

OST (II): inputs

OST (II): inputs

OST (II): inputs

Observation Setup:

Observing mode: ○ Spectral ● 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 observations.

Use full Stokes parameters: ○ Yes ● No

Number of polarizations: [2 ▼]

Required resolution in arcseconds: 1.0

Pointing strategy: [Single ▼]

On-source time in [hours ▼] : 3

Start hour angle: 0.0

Number of visits: 1 — How many times the observation is repeated.

Include cycling to phase calibrator?: ○ Yes ● No — This affects the *uv*-coverage of your simulation.

Atmospheric Corruption:

Atmospheric conditions: [PWV = 0.472 mm (1st Octile) ▼] — Determines level of noise due to water vapour.

Observing setup:
- Frequency
- Bandwidth + spec.res.
- Mapping strategy
- Integration time
- …

OST (II): input values

Weather conditions (PWV) will determine noise level

Atmospheric Corruption:		
Atmospheric conditions: PWV = 0.472 mm (1st Octile)		Determines level of noise due to water vapour.
Imaging Product:		
Imaging weights: Natural		This allows a resolution / sensitivity trade-off.
Perform deconvolution?: No (Return dirty image)		Apply the CLEAN algorithm to deconvolve the image.
Output image format: FITS		CASA format images are returned as a tar file
Submission:		
Your email address is Your EMAIL here!		Submit (Information on how we use your email address here).

OST (II): input values

Atmospheric Corruption:

Atmospheric conditions: PWV = 0.472 mm (1st Octile)

Imaging Product:

Imaging weights: Natural

Perform deconvolution?: No (Return dirty image)

Output image format: FITS

Submission:

Your email address is Your EMAIL here!

Submit (Information on how we use your email address here).

Requested outputs:
- Dirty vs Clean images
- Weights
- Format

OST (II): inputs

OST (III): output
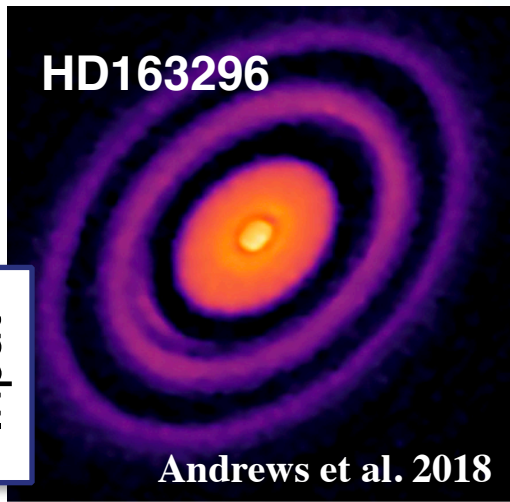
After few minutes you will get an automatic email with a link to the OST results:

- Sky model (input)
- Simulated (dirty/clean) images
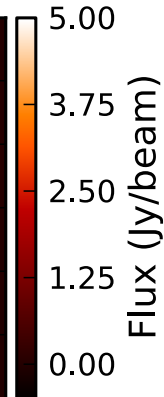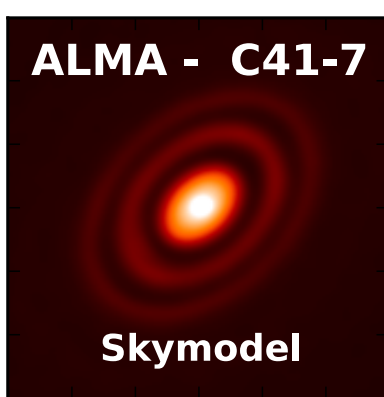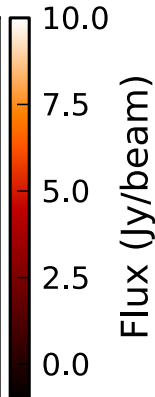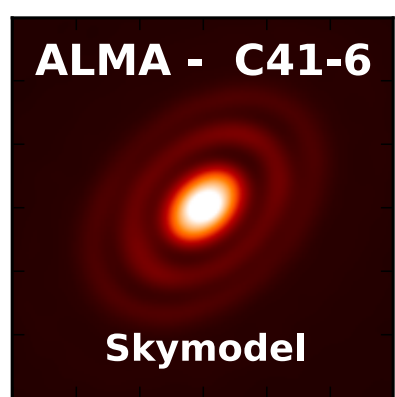- Dirty beam (PSF)
- UV-coverage

Simulation examples

HD163296

Input

Andrews et al. 2018

Expected emission

ALMA - C41-6
Skymodel
Flux (Jy/beam)
10.0 / 7.5 / 5.0 / 2.5 / 0.0

ALMA - C41-7
Skymodel
Flux (Jy/beam)
5.00 / 3.75 / 2.50 / 1.25 / 0.00

ALMA - C41-8
Skymodel
Flux (Jy/beam)
2.0 / 1.5 / 1.0 / 0.5 / 0.0
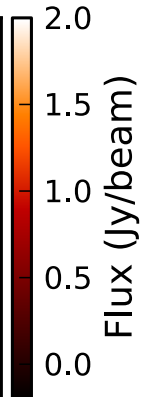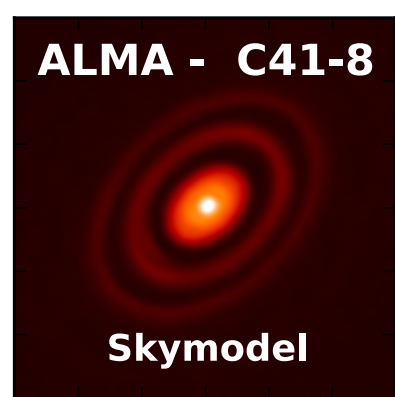
Simulated ALMA observation

ALMA image
Flux (Jy/beam)
10.0 / 7.5 / 5.0 / 2.5 / 0.0

ALMA image
Flux (Jy/beam)
5.00 / 3.75 / 2.50 / 1.25 / 0.00

ALMA image
Flux (Jy/beam)
2.0 / 1.5 / 1.0 / 0.5 / 0.0

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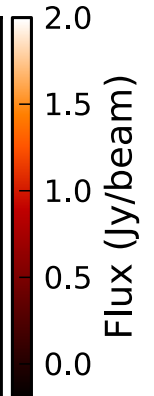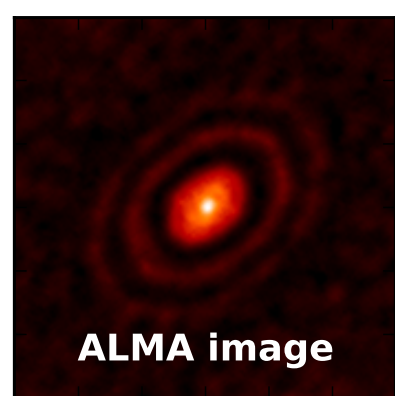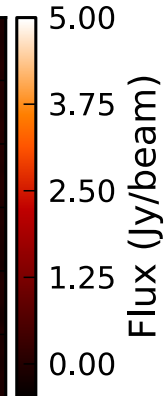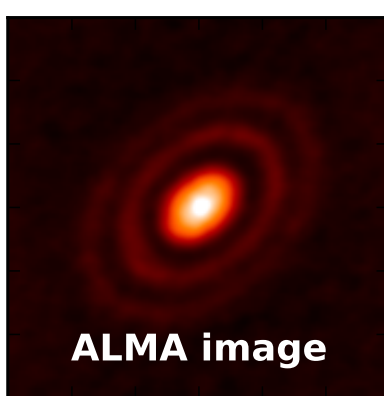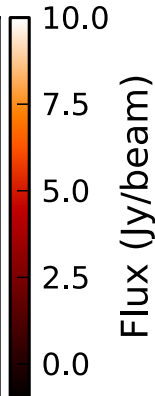
ALMA Proposal Preparation

Allegro toolbox:

- https://www.alma-allegro.nl/toolbox

Allegro videos available online

- ALMA CfP & Capabilities
- Dual-anonymous review
- Observing Tool (OT)
- Simulating ALMA observations

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ALMA Regional Centre || Allegro

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Information & news

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