# Simulating observations

### Helping us to see what ALMA sees

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# Why simulate ALMA observations?

### **Proposal preparation**

- Test your technical case i.e. can you detect your source / resolve the relevant structure with a realistic ALMA setup?
- Strengthen your science case showcase what ALMA will be able to detect with your proposed setup, and how this links to your science.

### Comparing numerical simulations with real data

 Comparing idealised (model) data and real (observed) data is crucial. With synthetic ALMA observations, simulated data can be 'corrupted' with observational noise and artefacts in order to make a fairer comparison, and ultimately strengthen models.

#### Education

### How to simulate ALMA observations?

There are several methods available in CASA

#### <u>simobserve</u>

• Simulates observation (12m/7m/TP), returns visibilities

#### <u>simanalyze</u>

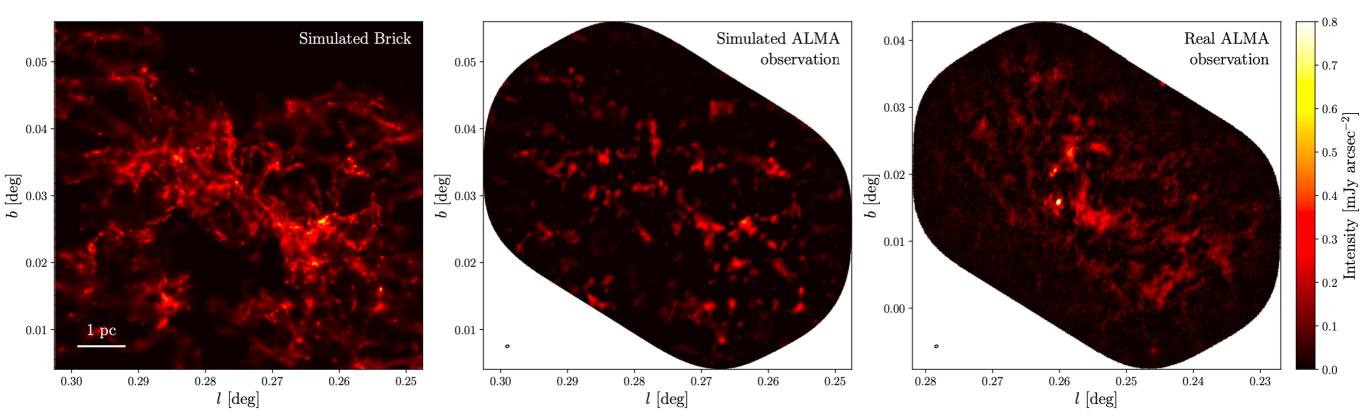
- Clean the simulated visibilities, returns images
- Also compares input vs. output, returns results
- If you want more control over imaging, use simobserve + tclean

<u>simalma</u>

Combines simobserve & simanalyze for you

### How to simulate ALMA observations?

- Snapshot of numerical simulation of a cloud (left)
- Real (Cycle 0, 3mm) ALMA 12m + 7m continuum (right)
- simobserve + tclean simulated observation (centre) replicating real observation



### The ALMA Observation Support Tool (OST)

- An online ALMA simulator to create a synthetic observation of a given source image
- Set up an observation by defining some basic parameters (e.g. frequency, resolution, time-on-source)
- Provide your own FITS image to 'observe', or choose from one of the examples

https://almaost.jb.man.ac.uk

EUROPEAN ARC ALMA Regional Centre    UK	ALMA Observation Support Tool			
ALMA Observation Support Tool				
Version 9				
OST NEWS HELP QUEUE LIBRARY ACKNOWLED	GE ALMA HELPDESK			
WARNING: Issues with Gmail accounts. (more info). OST Team				
Array Setup:				
Instrument: ALMA	Select the desired ALMA antenna configuration. Full ALMA means the simulations will be done with the full capabilities ALMA will			
	achive in the future (e.g. observing with 50 antennas, or Band 10 Configuration 1 observations); some of these may not yet be offered in the current cycle.			
	Selecting cycle-specific configurations will simulate the capabilities of ALMA in that cycle, and therefore some observations might be restricted (you will be			
	notified if this is the case). Please, refer to the ALMA documentation for each			
	cycle capabilities.			
Sky Setup:				
Source model: OST Library: Watchmen logo	Choose a library source model or supply your own.			
Upload: Choose file No file chosen	You may upload your own model here (max 10MB). This must be a FITS file with			
	the extension .fits included in the name of the file, e.g. model.fits.			
Declination: -35d00m00.0s	Ensure correct formatting of this string (+/-00d00m00.0s).			
Image peak / point flux in mJy v 0.0	Rescale the image data with respect to new peak value.			
	Set to 0.0 for no rescaling of source model.			
Observation Setup:				
Observing mode: O 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.			
	Enter 7.5 GHz to select ALMA recommend full continuum setup.			
Use full Stokes parameters: O Yes  No	If your input image contains more than one Stokes plane use them all (Yes), or just Stokes I (no/default).			
Number of polarizations: 2 V	This affects the noise in the final map. Ignored in continuum mode if "Use full			
	Stokes parameters" is set to yes.			
Required resolution in arcseconds: 1.0	OST will choose array config based on this value if <i>instrument</i> is set to ALMA.			

### The ALMA Observation Support Tool (OST)

- When you submit a job, you'll see a page like this with a link to your results page (you'll also get an email)
- You'll receive a follow up email when your simulation finishes (or dies)



#### Job ID: 20240508101242DIfBj / Submitted by: daniel.walker-2@manchester.ac.uk

Your result will appear here: 20240508101242DIfBj

Your simulation has entered the OST queue and has 0 jobs infront of it.

You will receive further notifications via email.

Thank you!

# How realistic is the OST?

The OST is an idealised observation, with some differences, e.g.:

- Only atmospheric water vapour is considered, and it is a static value. In reality, this will change during a real observation, along with other weather effects that are not considered (e.g wind speed).
- Scan spacings may differ in real observations (i.e. the cycling between observing the science target, phase calibrator, amplitude calibrator)

Overall, the OST gives an accurate\* approximation of what ALMA will see, but it is important to keep caveats in mind — real data will not be identical.

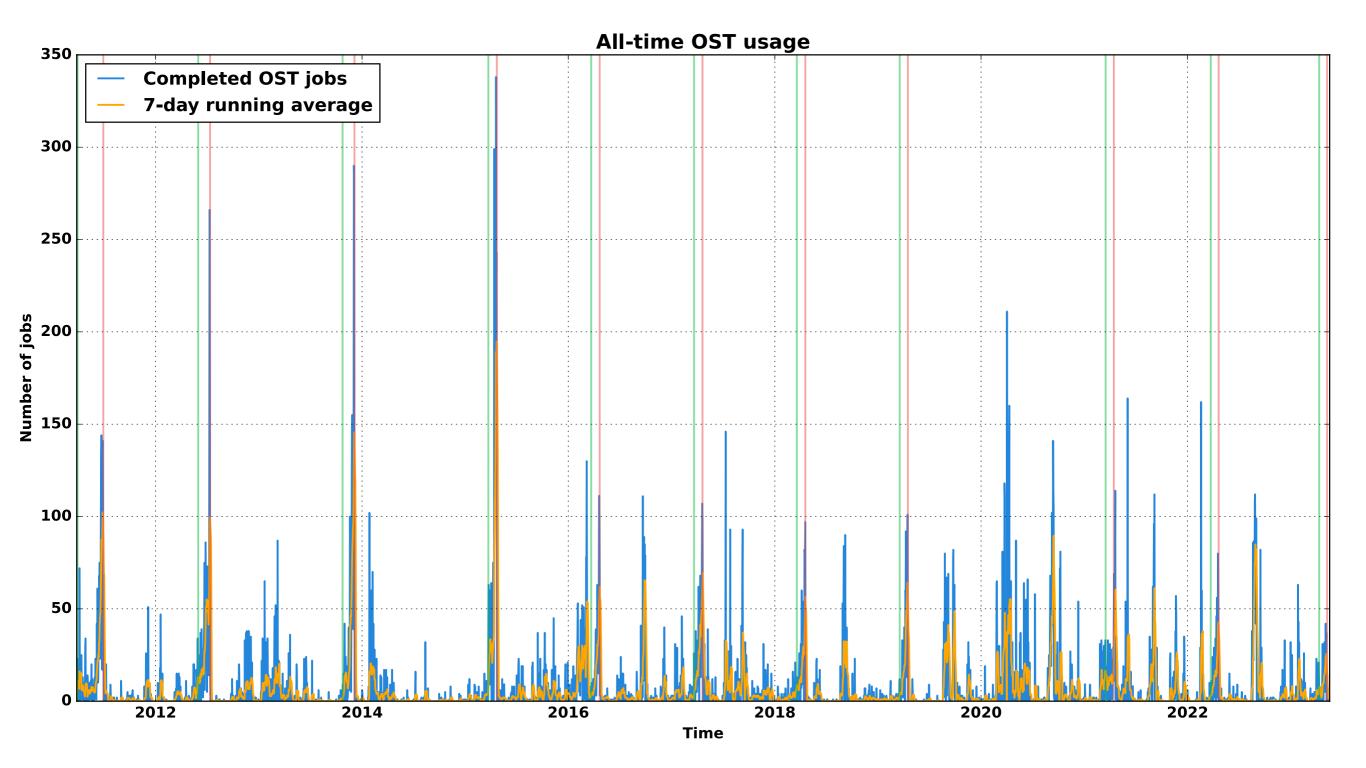
(Note: if you want further control, you can run simulated ALMA observations in CASA using the tasks <u>simobserve</u> or <u>simalma</u>)

<sup>\*</sup> provided user inputs are sensible! :)

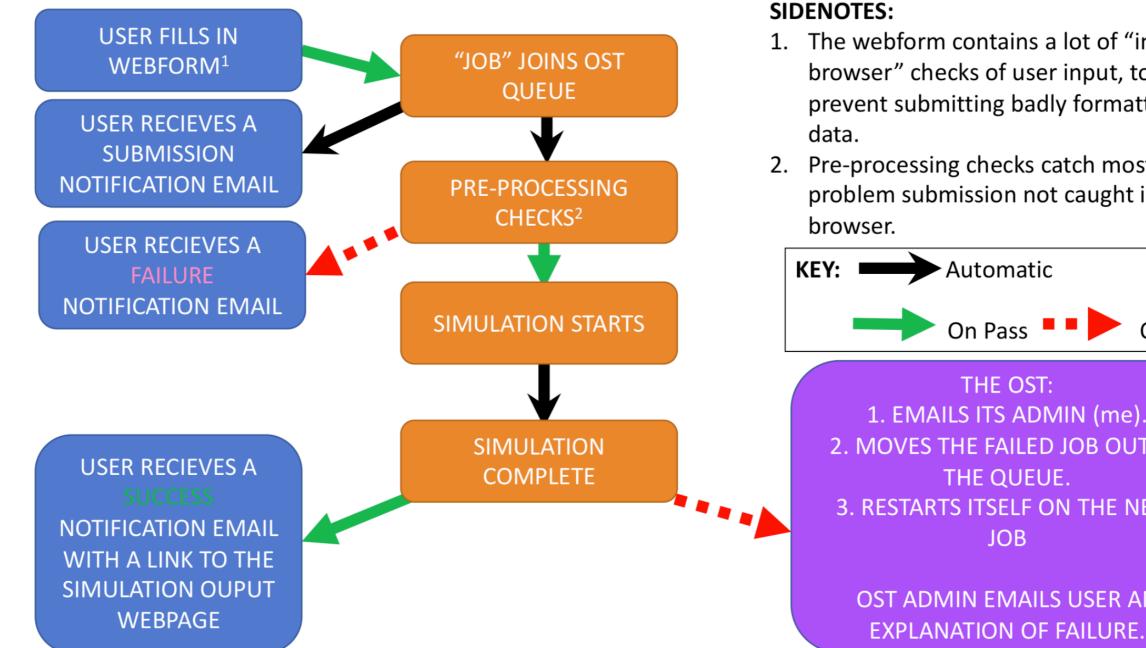
# A brief history of the OST

- Became available to the public on 28-Mar-2011 (Cycle 0)
- Original version by Ian Heywood (2010), upgraded and maintained by Adam Avison\* (2011-2021), Ana Karla Díaz-Rodríguez (2021-2022), and me (2022-now)
- It has processed > 30,000 simulations for users in at least 42 different countries to date
- Regularly updated to add functionality, and to account for new ALMA capabilities and antenna configurations
- The OST is undergoing a refactor to improve stability and to make is easier to add new functionality. If you have any thoughts on what you'd like to see, please let us know!

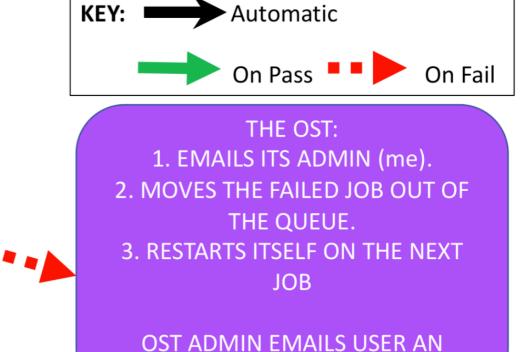
## **OST usage vs. time**



# **OST** workflow



- 1. The webform contains a lot of "in browser" checks of user input, to prevent submitting badly formatted
- 2. Pre-processing checks catch most problem submission not caught in



# Using the OST

Some examples to try, but feel free to experiment!

- 1. Continuum observation of a point source
- 2. A slightly more complex continuum
- 3. A spectral line/cube demonstration

### https://almaost.jb.man.ac.uk

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OST PARAMETER	DEMO 1: Point Source Continuum	DEMO 2: Full BW Model Image Continuum	DEMO 3: Spectral Cube
INSTRUMENT	ALMA	ALMA Cycle 9 C-2 & C-6	ALMA Cycle 9 C-6
SOURCE MODEL	OST Library: Central Point Source	OST Library: Protostellar Cluster	OST Library: Test Cube 64x64x16
DECLINATION	-40d00m00.0s	-25d30m00.0s	-35d00m00.0s
IMAGE PEAK/POINT FLUX	0.5mJy	0.0mJy	0.0mJy
OBSERVING MODE	Continuum	Continuum	Spectral
CENTRAL FREQ. IN GHZ	230	333.0	90
BANDWIDTH	0.5GHz	2.2GHz [SPW 0: 328.0 / BW 0: 1.1] [SPW 1: 338.0 / BW 1: 1.1]	144.8kHz
USE FULL STOKES PARAMETER?	No	No	No
NUMBER OF POLS.	2	2	2
REQUIRED RES. IN ARCSEC	0.2	1.0*	1.0*
POINTING STRATEGY	Single	Mosaic	Mosaic
ON-SOURCE TIME	2hours	4hours	2hours
START HOUR ANGLE	-1.0	+1.0	0.0
NUMBER OF VISITS	1	2	1
CYCLE TO PHASE CALIBRATOR?	No	Yes [Phase Cycle: 300s / On Phase: 30]	No
ATMOSPHERIC CONDITIONS	0.913mm (3 <sup>rd</sup> Octile)	0.472mm (1 <sup>st</sup> Octile)	5.186mm (7 <sup>th</sup> Octile)
IMAGING WEIGHTS	NATURAL	BRIGGS	UNIFORM
PERFORM DECONVOLUTION	YES	YES	YES
OUTPUT IMG FORMAT	FITS	FITS	FITS
EMAIL	<your email=""></your>	<your email=""></your>	<your email=""></your>

Note: currently Gmail addresses do not work due to authentication issues