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

simobserve

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

simanalyze

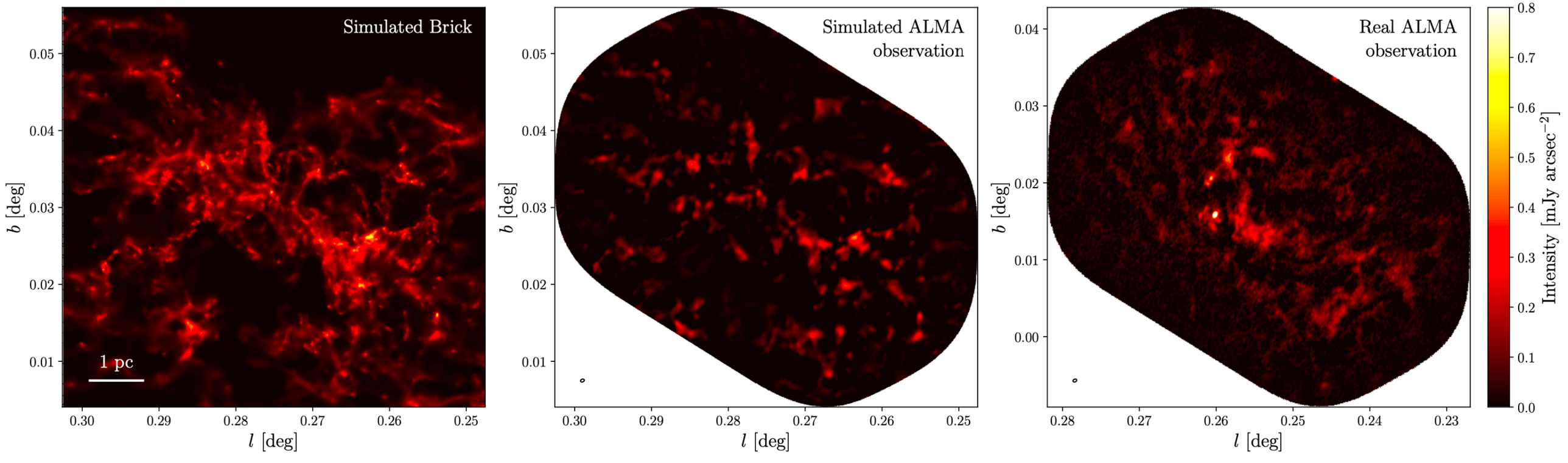
- Clean the simulated visibilities, returns images
- Also compares input vs. output, returns results
- If you want more control over imaging, use simobserve + tclean

simalma

- Combines simobserve & simanalyze for you

How to simulate ALMA observations?

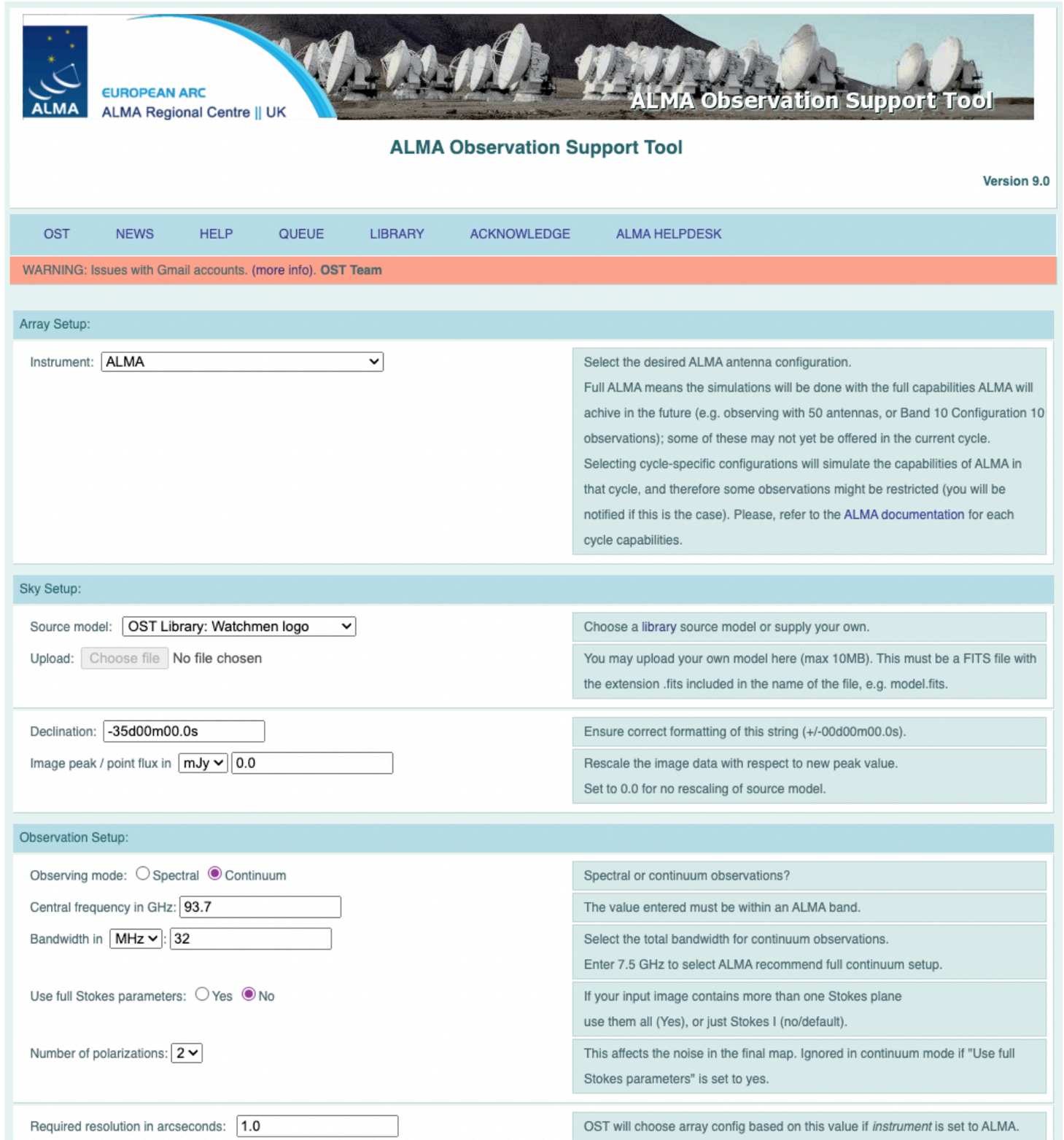
- Snapshot of numerical simulation of a cloud (left)
- Real (Cycle 0, 3mm) ALMA 12m + 7m continuum (right)
- `simobserve` + `tclean` simulated observation (centre) replicating real observation



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



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 simobserve or simalma)

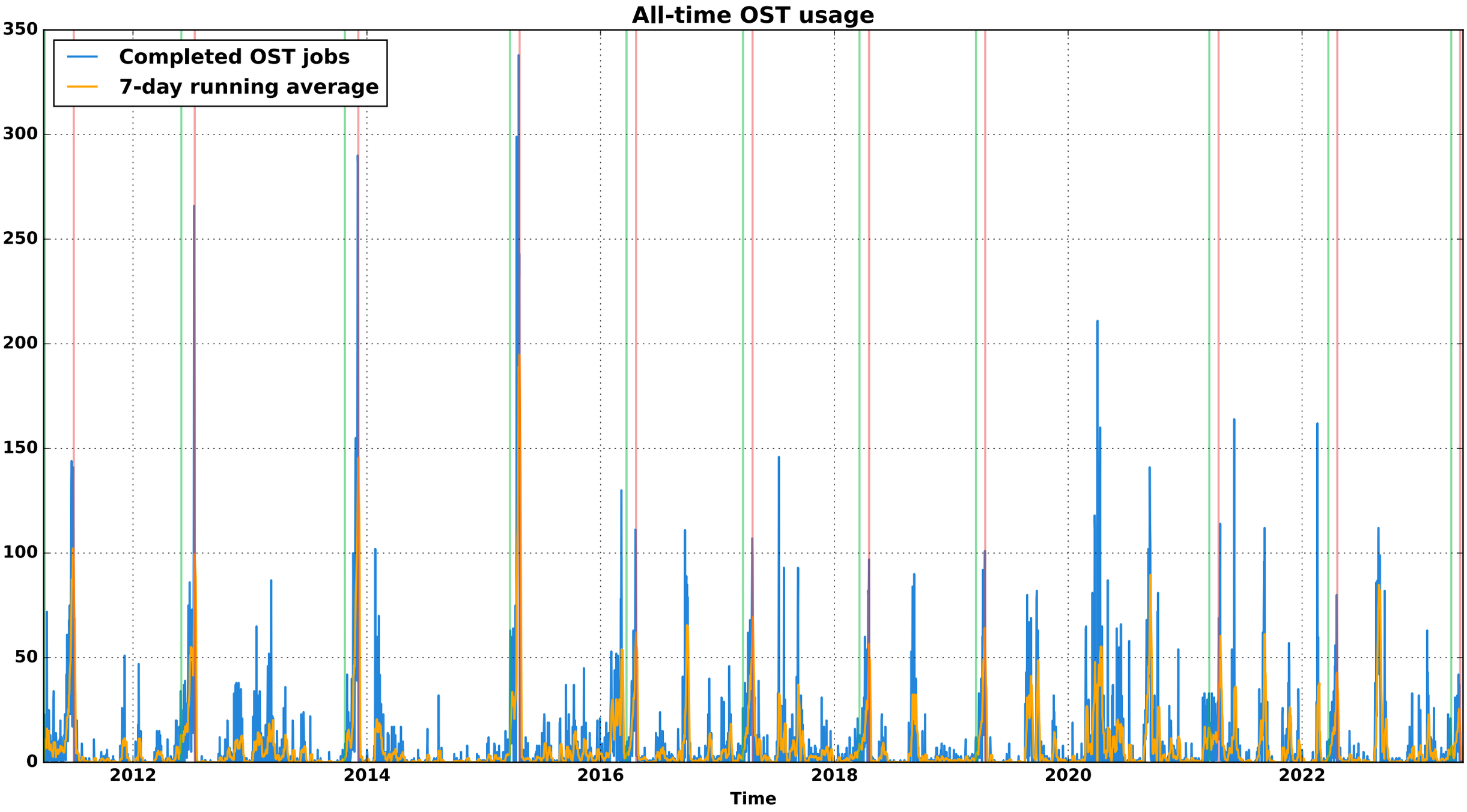
* provided user inputs are sensible! :)

A brief history of the OST

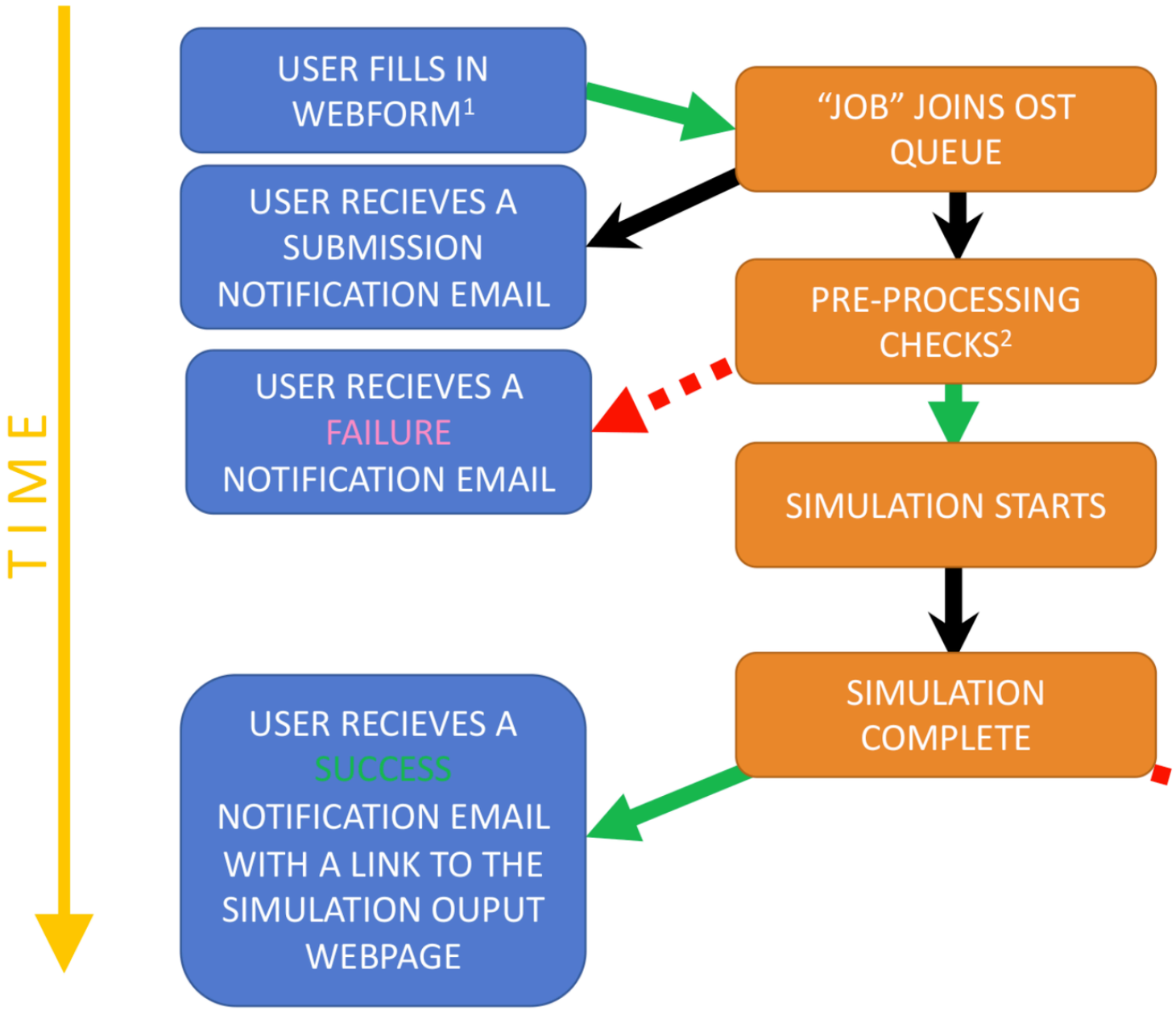
- Became available to the public on 28-Mar-2011 (Cycle 0)
- Original version by Ian Heywood (2010), upgraded and maintained by Adam Avison* (2011-2021), Ana Karla Díaz-Rodríguez (2021-2022), and me (2022-now)
- It has processed > 30,000 simulations for users in at least 42 different countries to date
- 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!

* watch Adam's I-TRAIN video

OST usage vs. time



OST workflow



SIDENOTES:

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

KEY: Automatic; On Pass; On Fail

Courtesy of Adam Avison

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 (3rd Octile)	0.472mm (1st Octile)	5.186mm (7th Octile)
IMAGING WEIGHTS	NATURAL	BRIGGS	UNIFORM
PERFORM DECONVOLUTION	YES	YES	YES
OUTPUT IMG FORMAT	FITS	FITS	FITS
EMAIL	<YOUR EMAIL>	<YOUR EMAIL>	<YOUR EMAIL>

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