# Astronomy from Ridge A, Antarctica

## *+ a 3D view of [CI] 809 GHz*


*Geoff Sims – 4th February, 2014*
*Nanten2 Consortium Workshop*
*Adelaide, South Australia*

# Collaborators

**University of NSW**
Michael Burton
Catherine Braiding
+ PLATO collaboration (remote power generation, robotics and communication)

**University of Arizona**
Craig Kulesa
+ HEAT collaboration (sub-mm/THz telescope)

# Outline

## Sub-mm astronomy from Antarctica

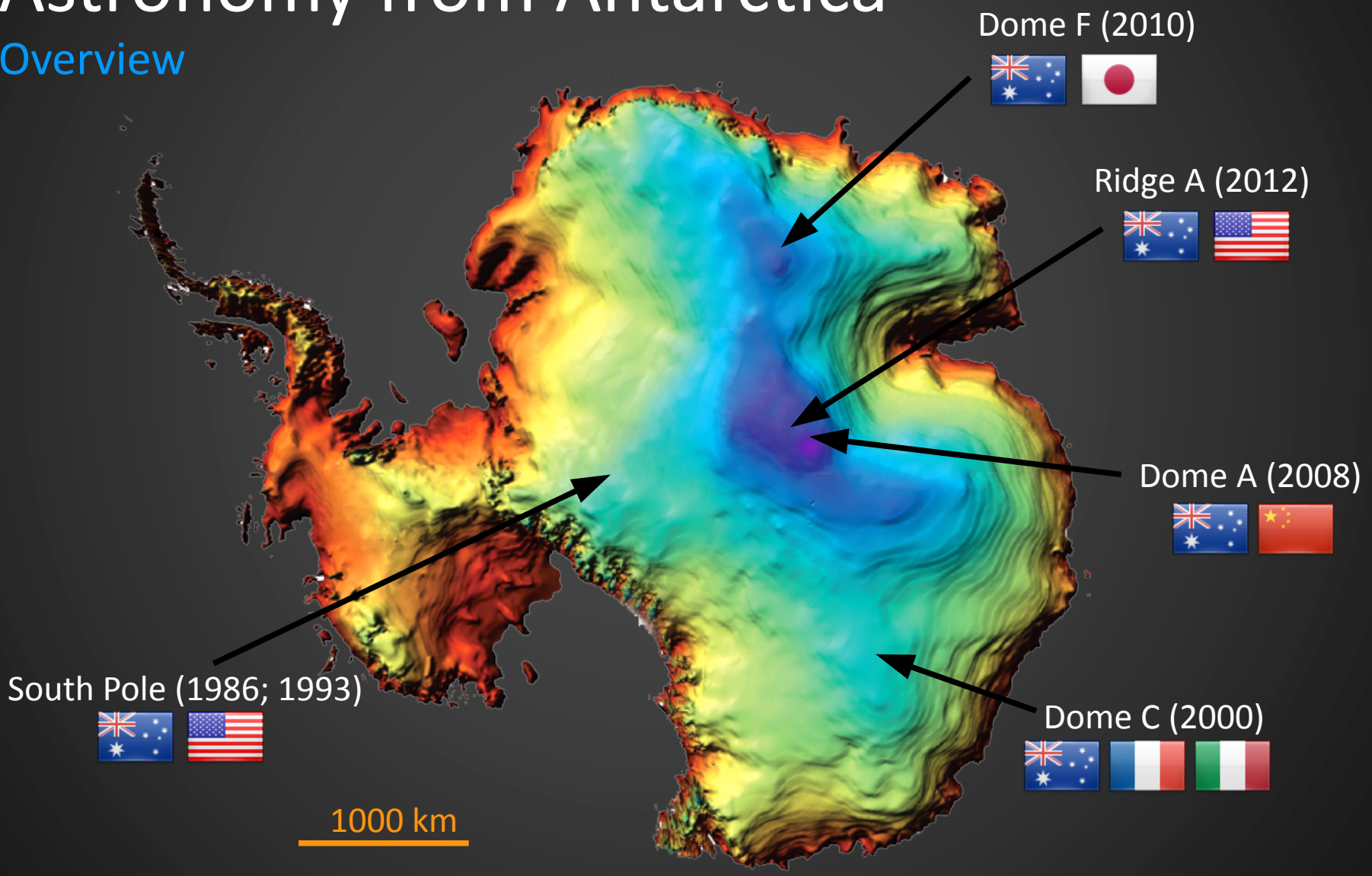
- overview of Antarctica
- the newest site on the plateau “Ridge A”
- HEAT telescope & survey

## Visualisation techniques for radio cubes

- available software
- scripts
- 3D visualisation examples

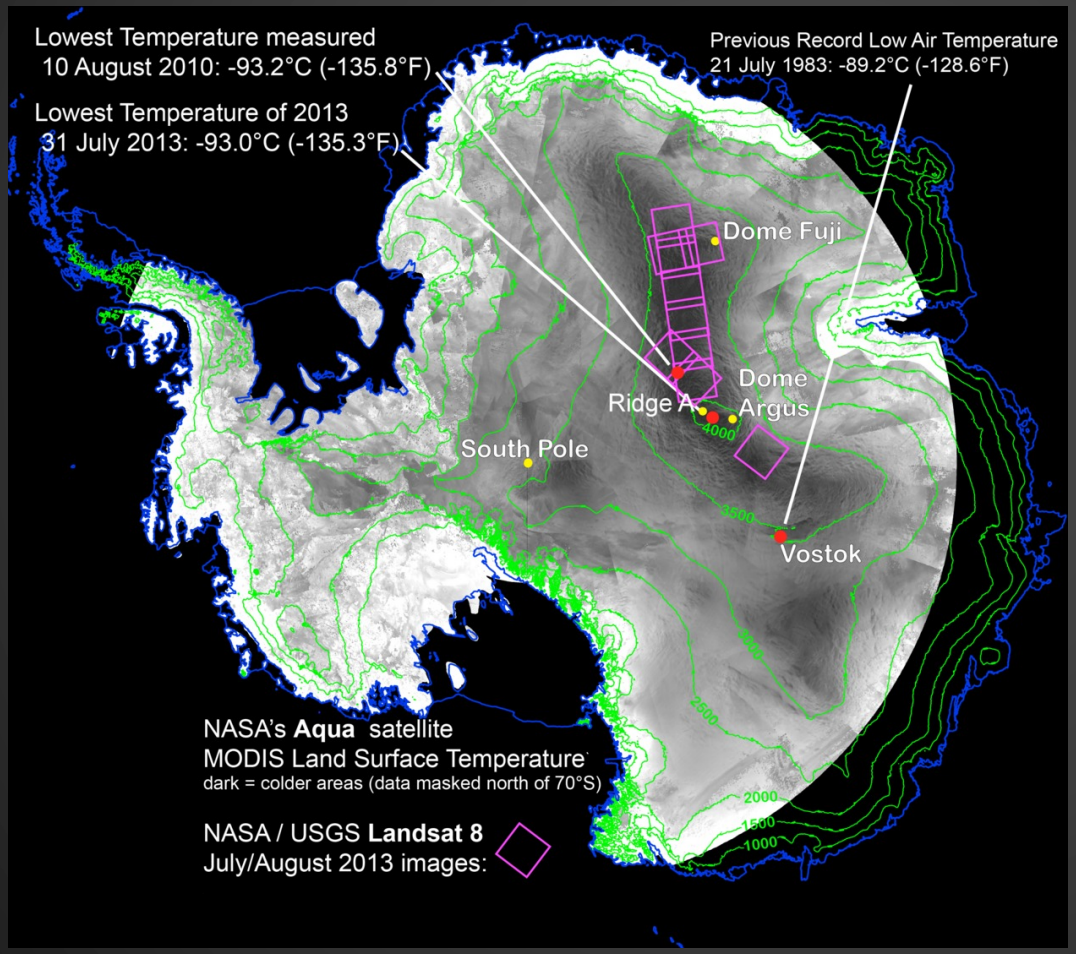
# Astronomy from Antarctica

## Overview



# Astronomy from Antarctica

## Overview – coldest place?



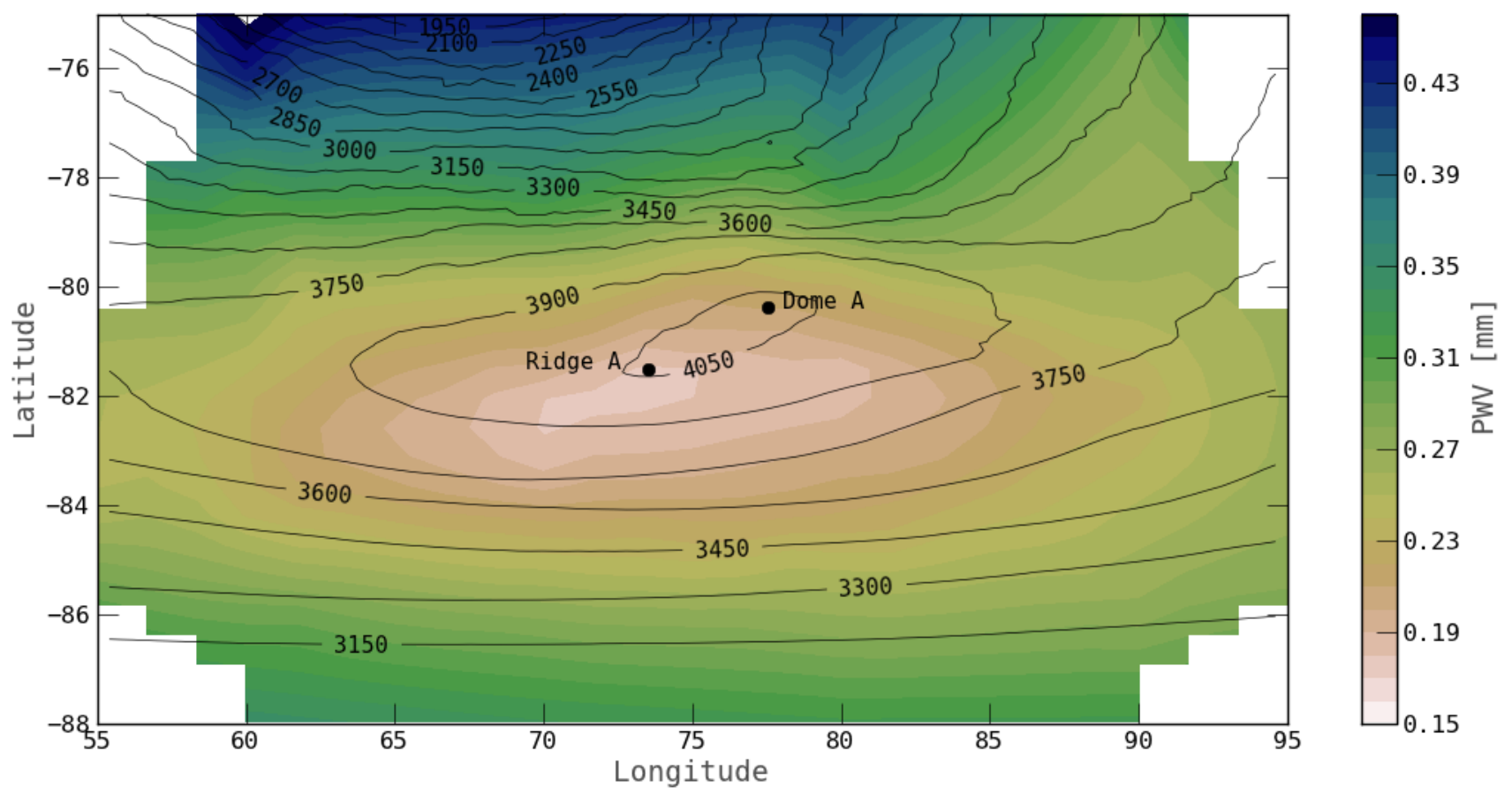

Ted Scambos (NSIDC)

"getting an air tempertature will be difficult work ... we'd need the right instrumentation ... "

Dome A AWS reported
-75C air temp at 2m (c.f.
2013 yearly minimum
-93C ground level)

# Astronomy from Antarctica

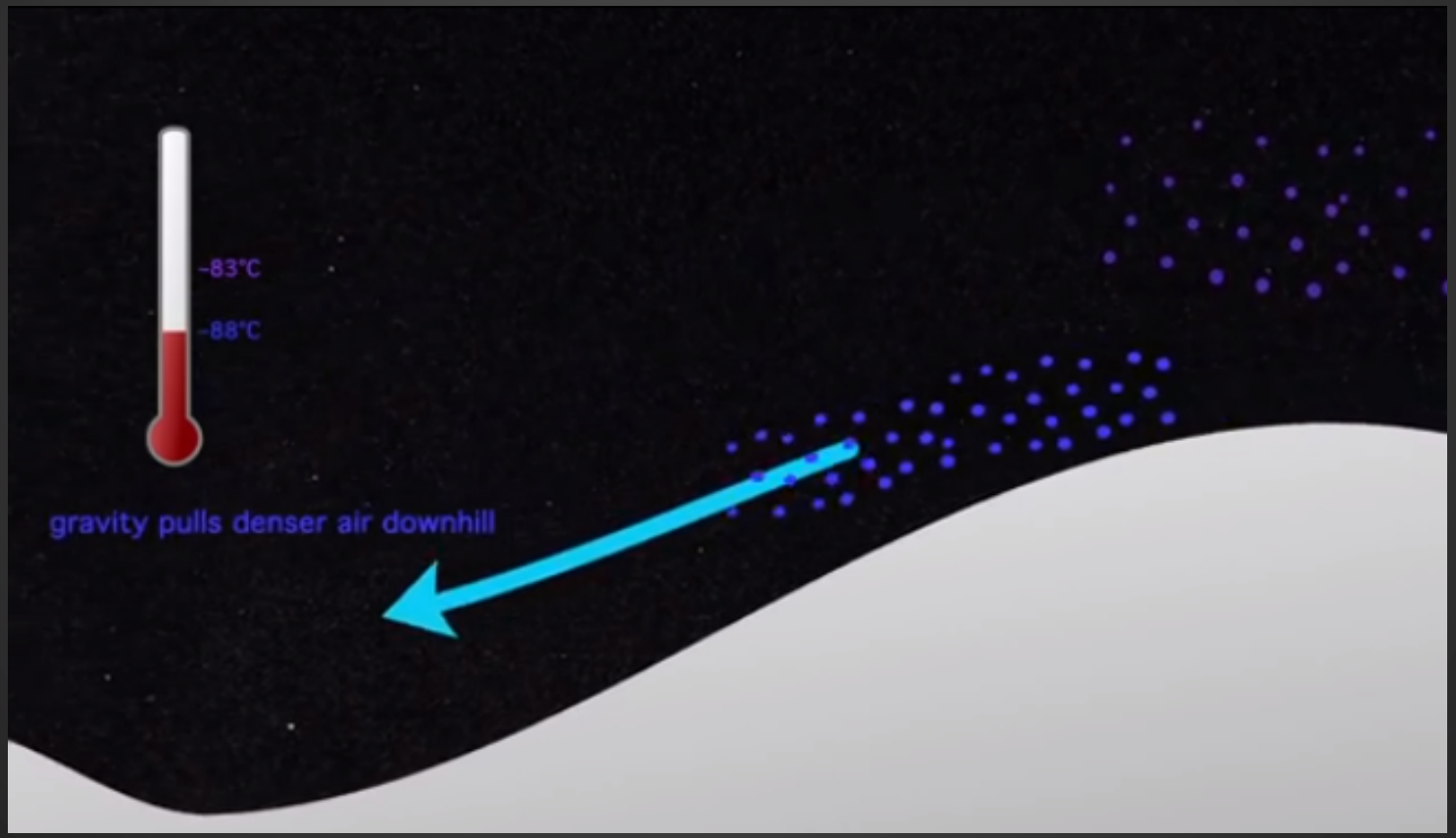
## Premise for Ridge A – satellite PWV data




Data from the MHS on NOAA-18 ("Where is Ridge A?"; Sims et al. 2012)

# Astronomy from Antarctica

## Ridge A – possible mechanism for cold temps / low PWV



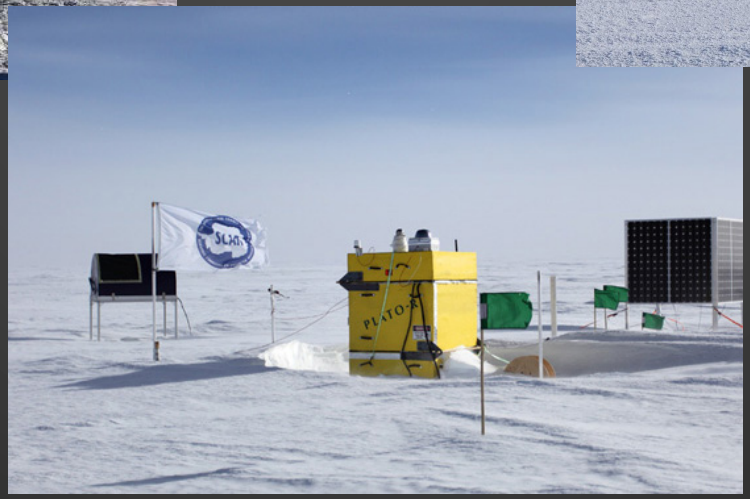

Ted Scambos (NSIDC)

# Astronomy from Antarctica

## Ridge A – entering it's 3rd year of operation!

2012 (C. Kulesa)

2014 (N. Bingham)



2013 (G. Sims)

# Astronomy from Antarctica

## HEAT (High Elevation Antarctic Terahertz) telescope

- 60 cm telescope mapping carbon in the Milky Way
- 1-2 arcminute resolution; 1 km/s velocity resolution

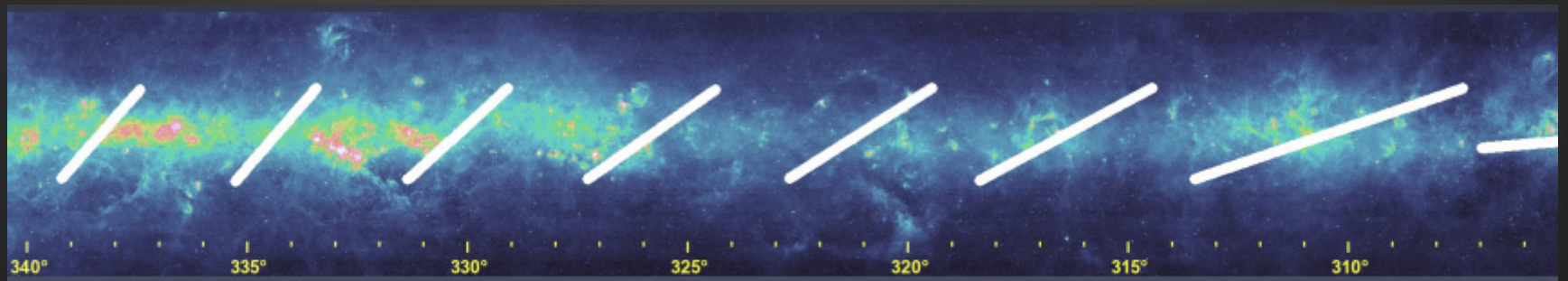
2012, 2013: [CI] @ 492 and 809 GHz

2014: [CI] @ 809 GHz; [NII] @ 1461 GHz

# Astronomy from Antarctica

## HEAT data so far (mostly 809 GHz)

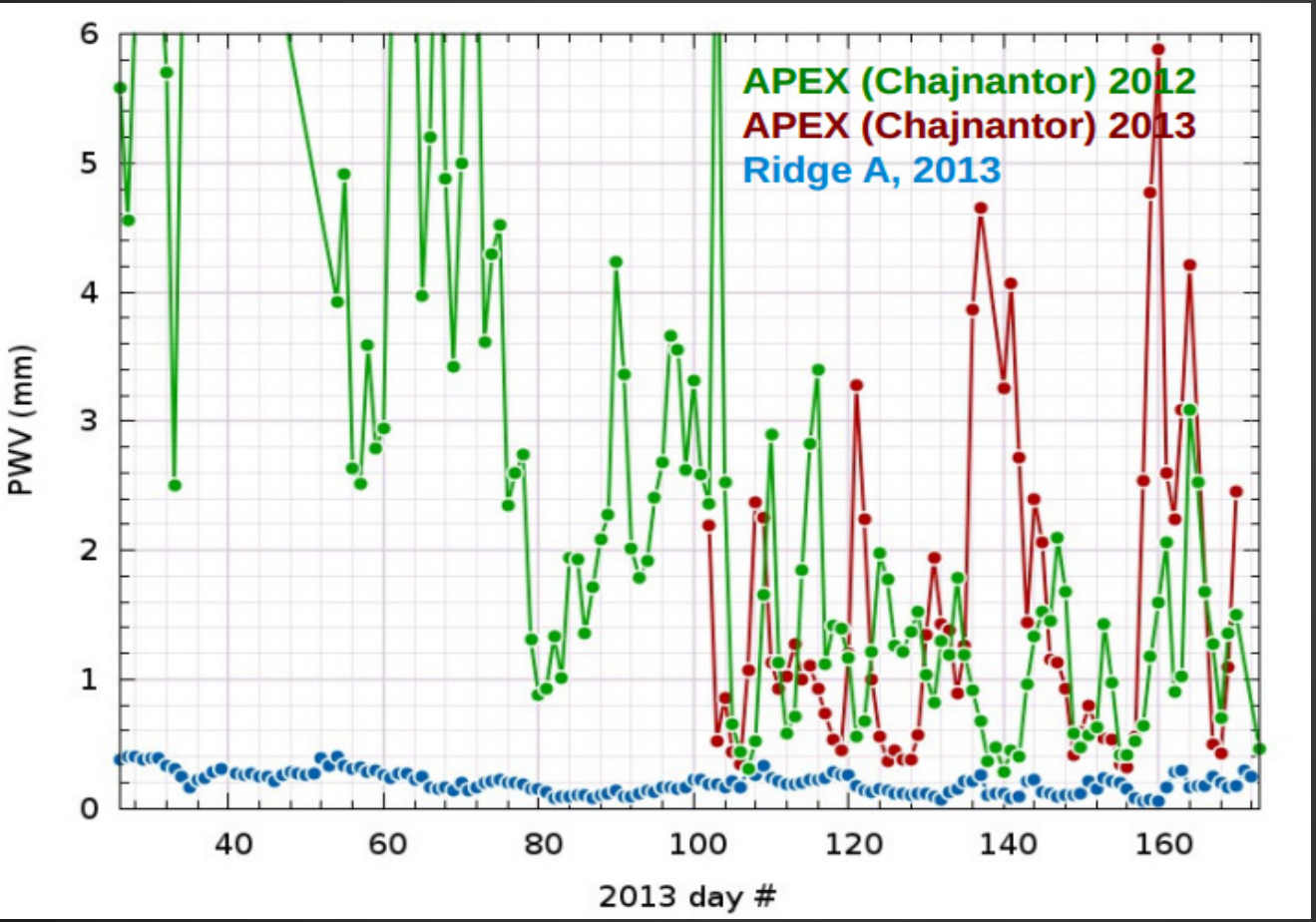
- A deep 0.6 square degree map at Galactic longitude 328
- Strip maps through the Plane of the Galaxy from l=330 to l=290
- One deep strip map through the LMC
- Site testing data (sky dips) of the sky at 809 GHz (370 um)




*8 of the 15 Galactic strip maps observed by HEAT, atop 8 um MSX*

# Astronomy from Antarctica

## HEAT site performance




Sub-mm (< 1 THz) conditions 100% of the time.

Super-THz (> 1 THz) conditions ~25% of the time.

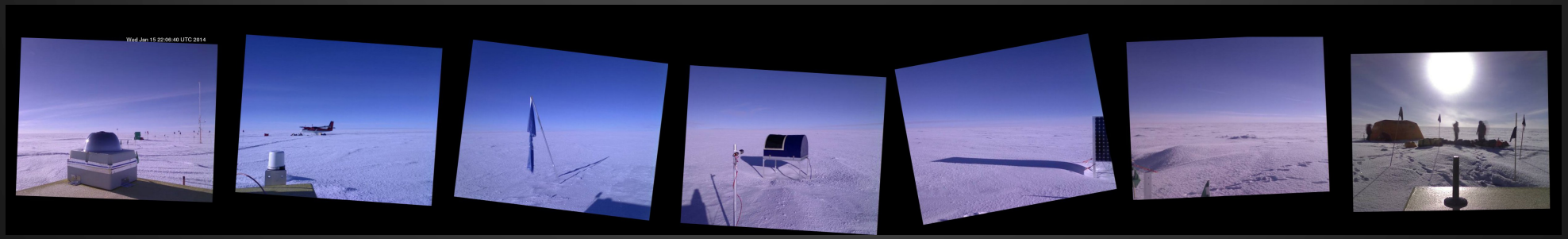
80 useable days/year at 1.5 THz (200 um).

# Astronomy from Antarctica

## HEAT website and webcam

http://loke.as.arizona.edu/~ckulesa/HEAT

- Data! (currently only G328 region; 0.6 x 0.6 degree cube)
- Near live instrument status and weather
- Near live webcam (~hourly)

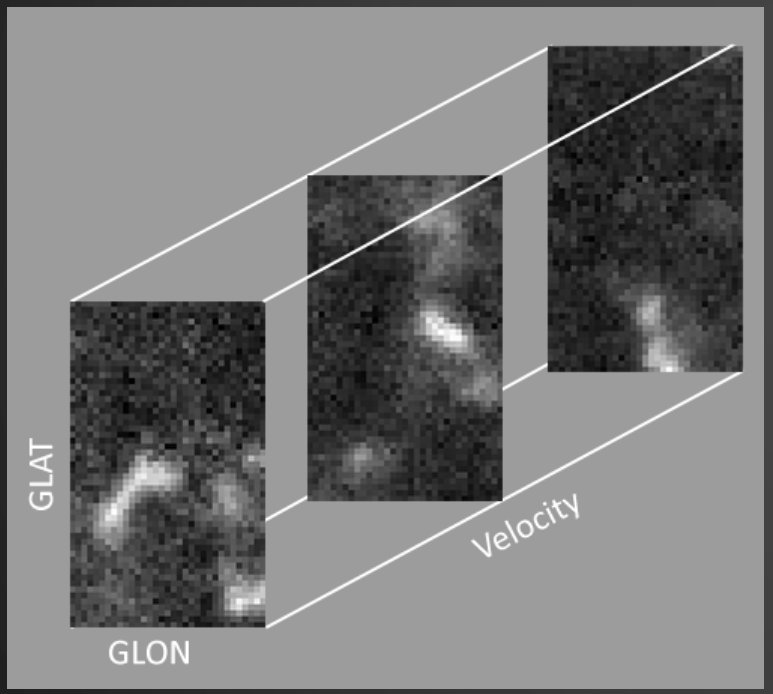


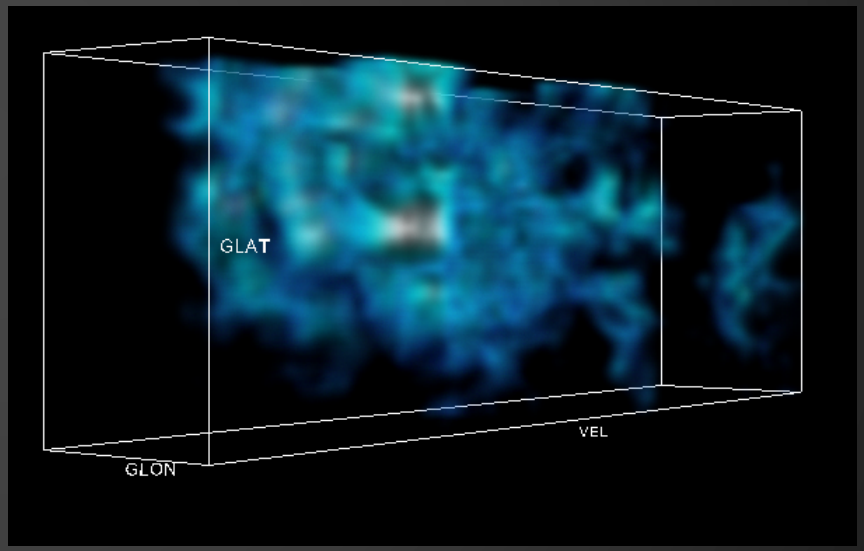
# Astronomy from Antarctica

## Portraits from Ridge A

# Data cube visualisation

## "Astroinformatics"



# Data cube visualisation

## Software – all freeware

- 3D Slicer ("Astromed" project discontinued, no good)

- Blender (not designed for this use)

- Paraview (reasonable, though I can't volume render)

- yt (very beautiful, but hard to install, tricky to use)

- MayaVi2 (simple to use, slightly clumsy GUI)

- VisIt (nice GUI, Python integration cumbersome)

# Data cube visualisation

## Data formats

- Paraview (FITS > VTK)

- yt (FITS > 3D numpy Array > ?)

- MayaVi2 (FITS > 3D numpy Array)

- VisIt (FITS > VTK)

# Data cube visualisation

Data formats – Python script FITS > VTK (for Paraview, VisIt)

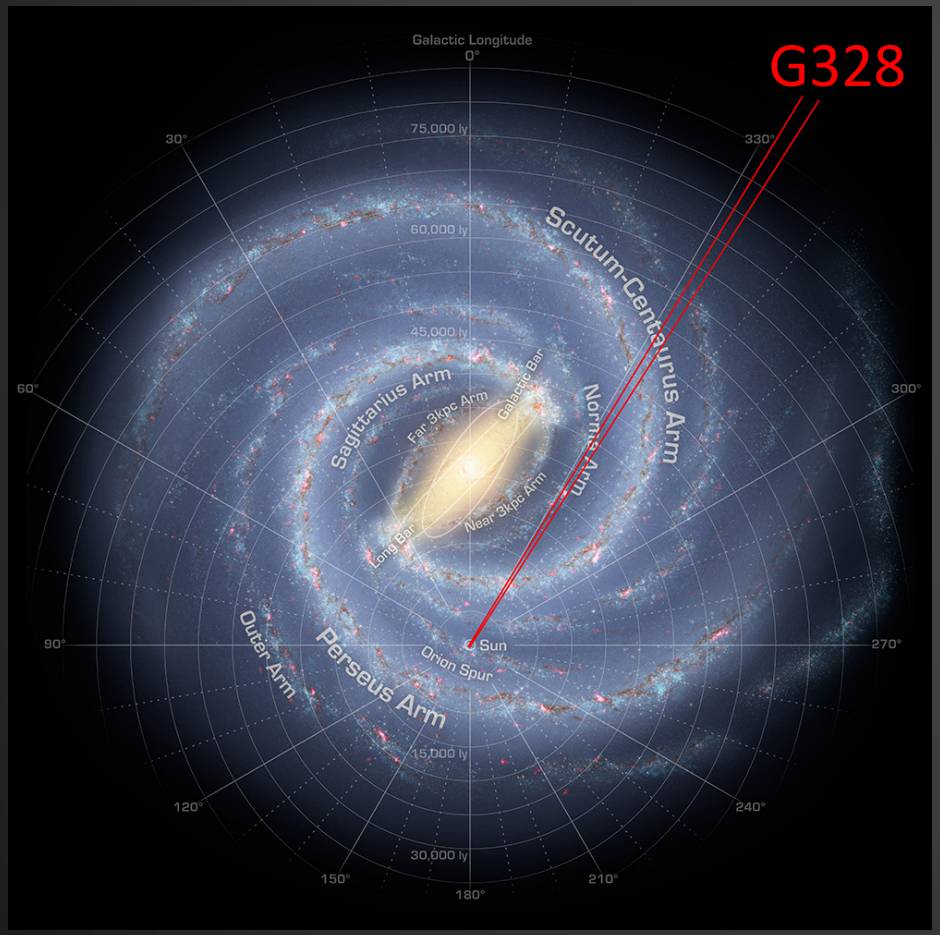
http://tinyurl.com/olordzd

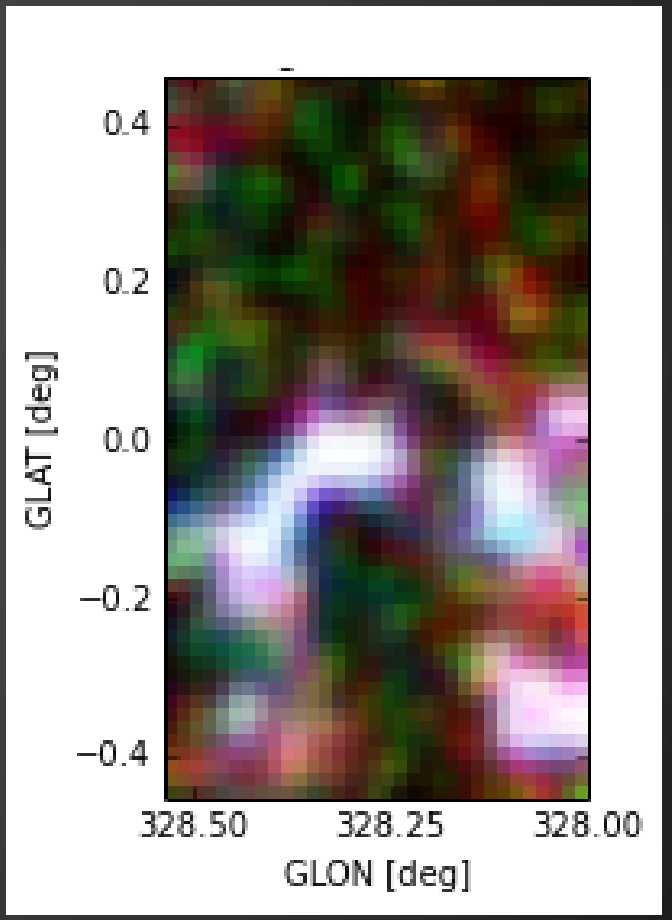
```
# vtk DataFile Version 2.0
Written using 'fits2vtk.py' by Geoff Sims
ASCII
DATASET RECTILINEAR_GRID
DIMENSIONS 2 3 4
X_COORDINATES 2 float
0.000 1.000 2.000 3.000
Y_COORDINATES 3 float
28.000 29.000 30.000
Z_COORDINATES 4 float
96.000 97.000 98.000 99.000

POINT_DATA 24

SCALARS 12CO float
LOOKUP_TABLE default
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

SCALARS 13CO float
LOOKUP_TABLE default
 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
```

# Data cube visualisation

http://tinyurl.com/olordzd

## Sample output – G328 [CI] data from HEAT; 809 GHz

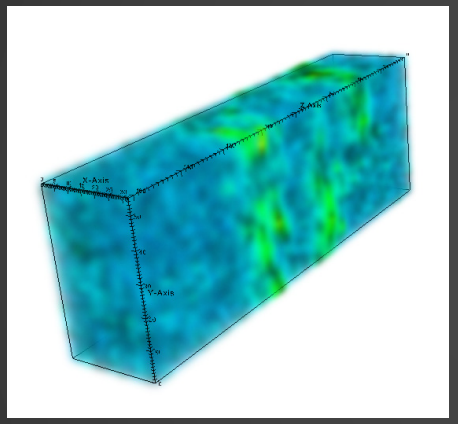


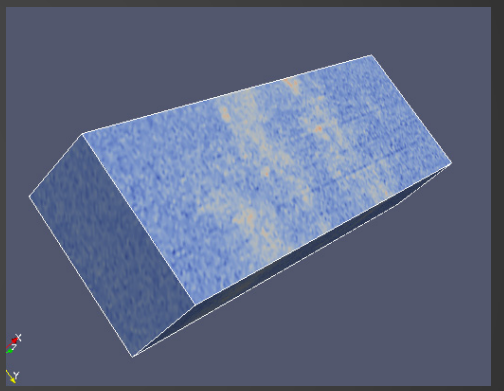
# Data cube visualisation

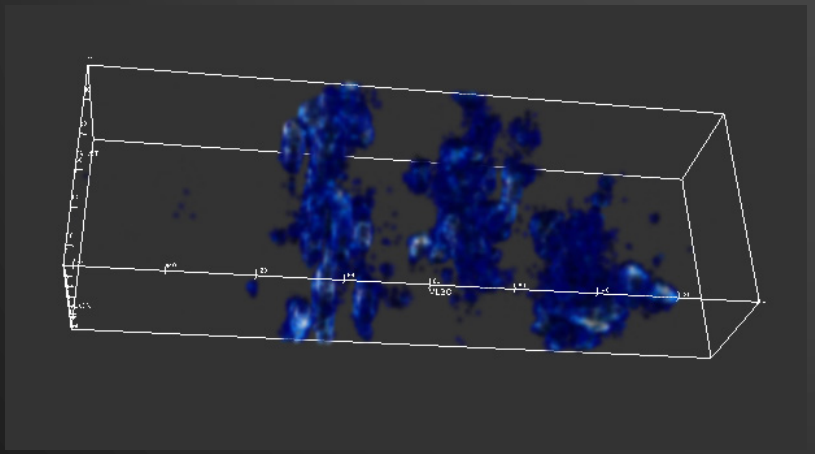
## Sample output – G328 [CI] data from HEAT; 809 GHz

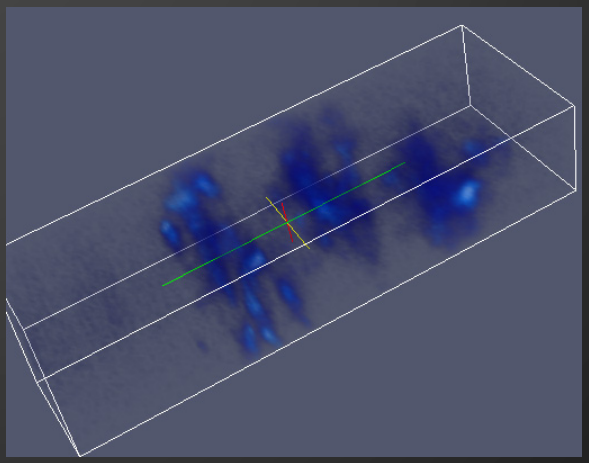
VisIt (VTK)



Paraview (VTK)





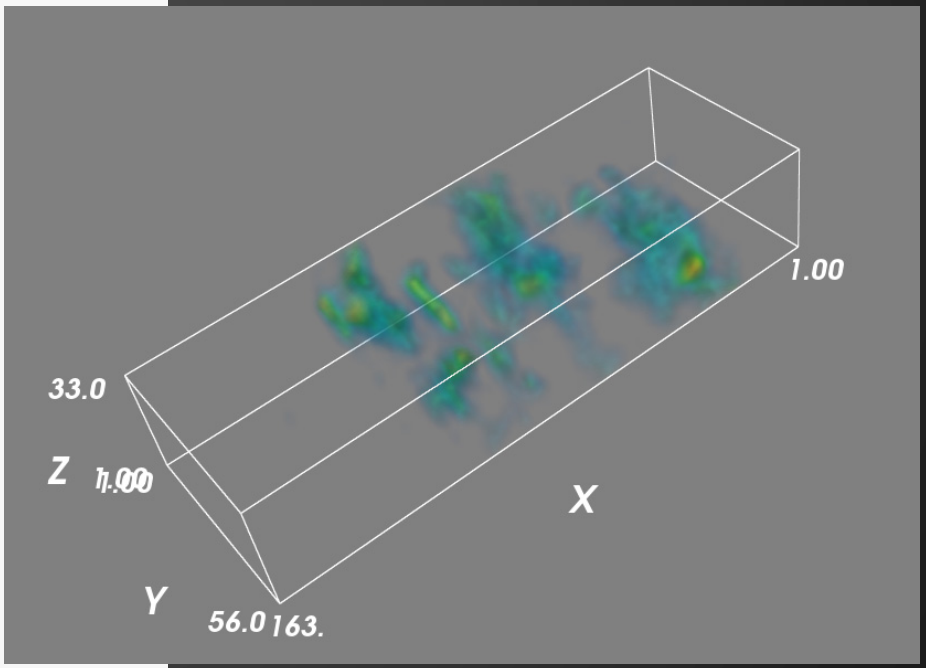


# Data cube visualisation

## Sample script for MayaVi

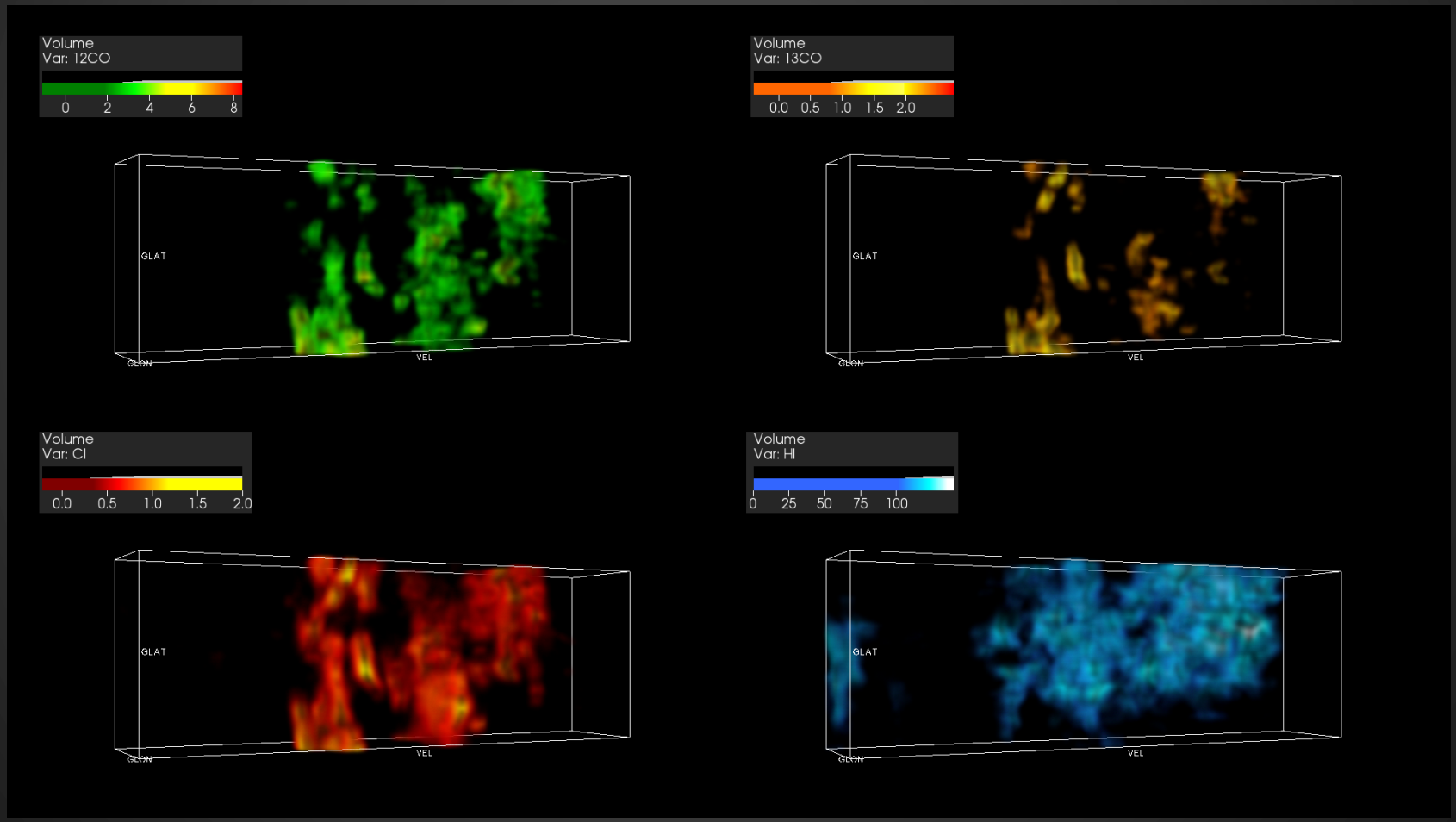
- Requires Python (Anaconda?), NumPy, PyFITS, MayaVi

```
# Import libraries
from mayavi import mlab
import pyfits
import numpy as np

# Load the FITS image
hdu = pyfits.open("img.fits")
img = hdu[0].data

# Setup MayaVi to plot
src = mlab.pipeline.scalar_field(img)
mlab.pipeline.volume(src, vmin=0.2, vmax=2)

# Show axes, border box, and display the plot
mlab.axes()
mlab.outline()
mlab.show()
```



# Data cube visualisation

## Sample output – 12CO, 13CO (Mopra), CI (HEAT), HI (Parkes/ATCA)



# Data cube visualisation

Sample output – 12CO, 13CO (Mopra), CI (HEAT), HI (Parkes/ATCA)

# Summary

## Sub-mm astronomy from Antarctica

- ~Ridge A is **the** best terrestrial 'region' for sub-mm/THz astronomy
- Data will soon be available online
- Lots of science collaborations w/ Nanten2 possible:
  - [CI] 0.809 THz (2012-2014)
  - [NII] 1.461 THz (2014, fingers crossed)
  - [CII] 1.901 THz (2015+, hopefully!)

## Visualisation techniques for radio cubes

- Many free options available to visualise any radio cube
- Easy (now!) to convert FITS > VTK for (e.g.) VisIt & Paraview
- MayaVi & yt also show great potential


Questions?