# THE HIGH RADIO FREQUENCY VARIABILITY OF BRIGHTEST CLUSTER GALAXIES

With OVRO, KVN, NIKA2, SCUBA2 and ALMA


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Question: how variable are the cores of brightest cluster galaxies at high radio frequencies, where in they past they've not been observed in enough detail?



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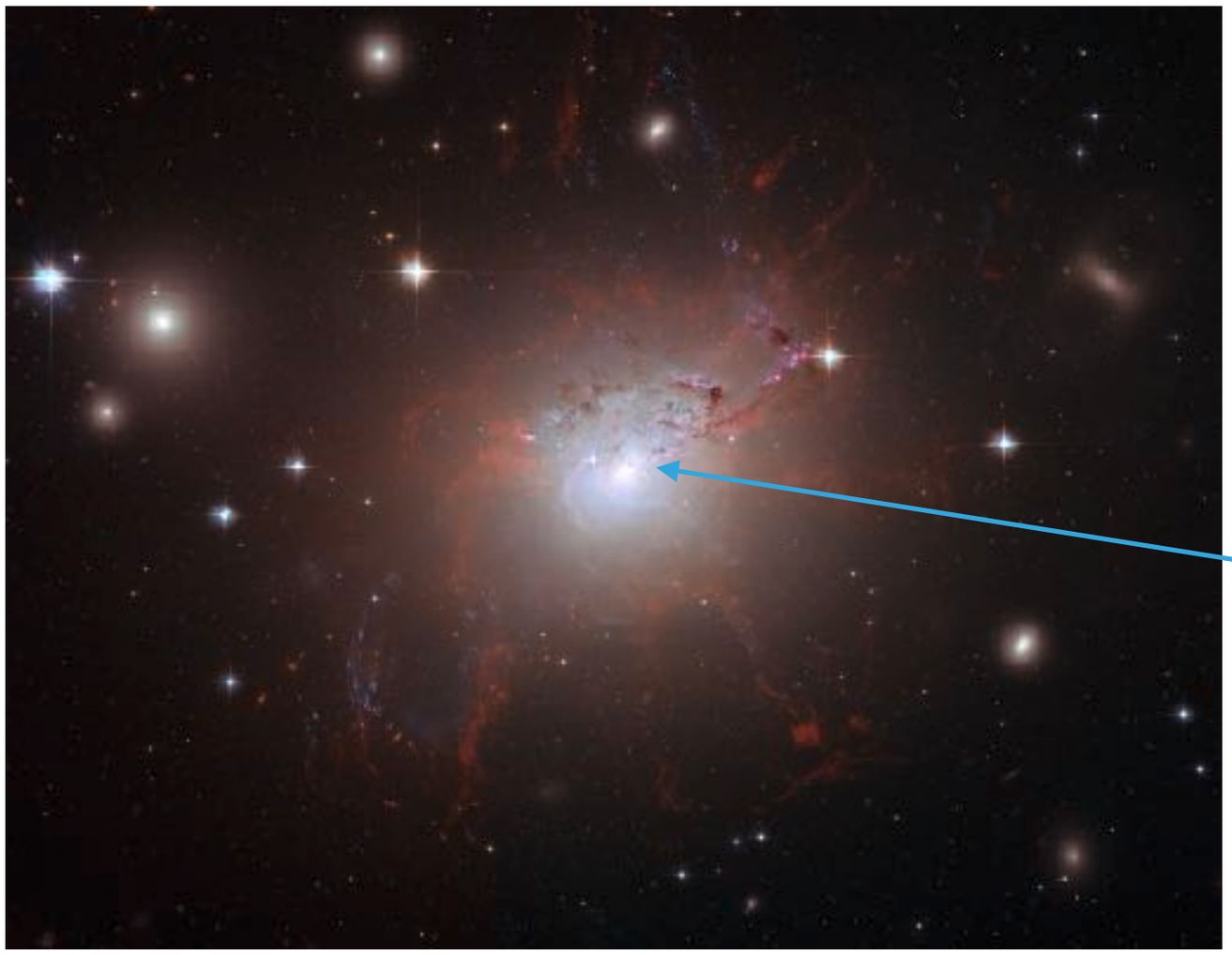
# NGC 1275, BCG OF THE PERSEUS CLUSTER

- Archetype of a brightest cluster galaxy in a cool-core
- Gamma-ray detected radio galaxy
- BLLac/AGN hybrid



High radio frequency variability has been observed for ~60 years

At 2mm, the core radio source has varied by a factor of ~15 over the last 60 years

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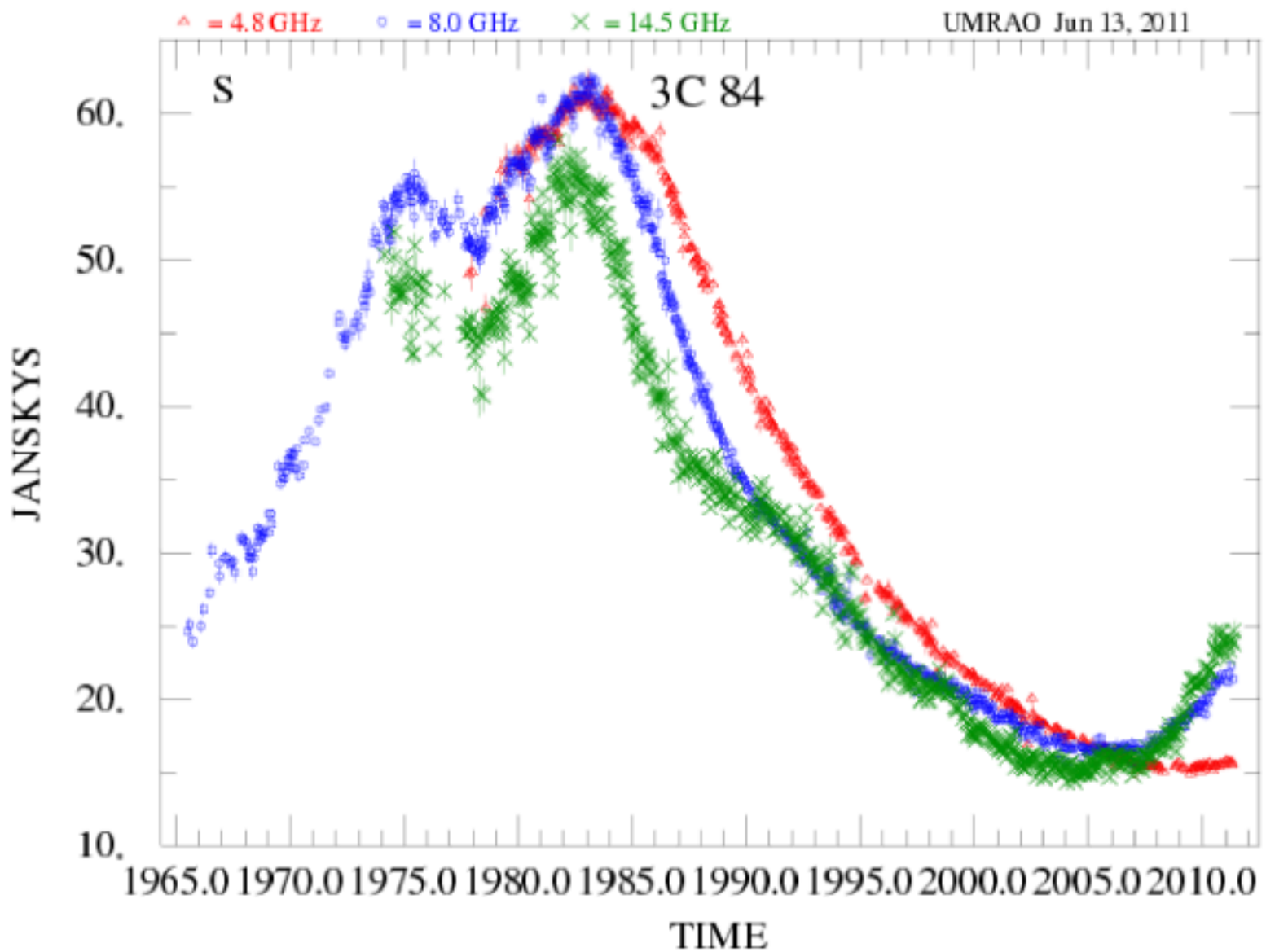
# UMRAO MONITORING OF NGC1275

- NGC 1275 varied by a factor of 15 at 5 GHz between ~1983 and 2003

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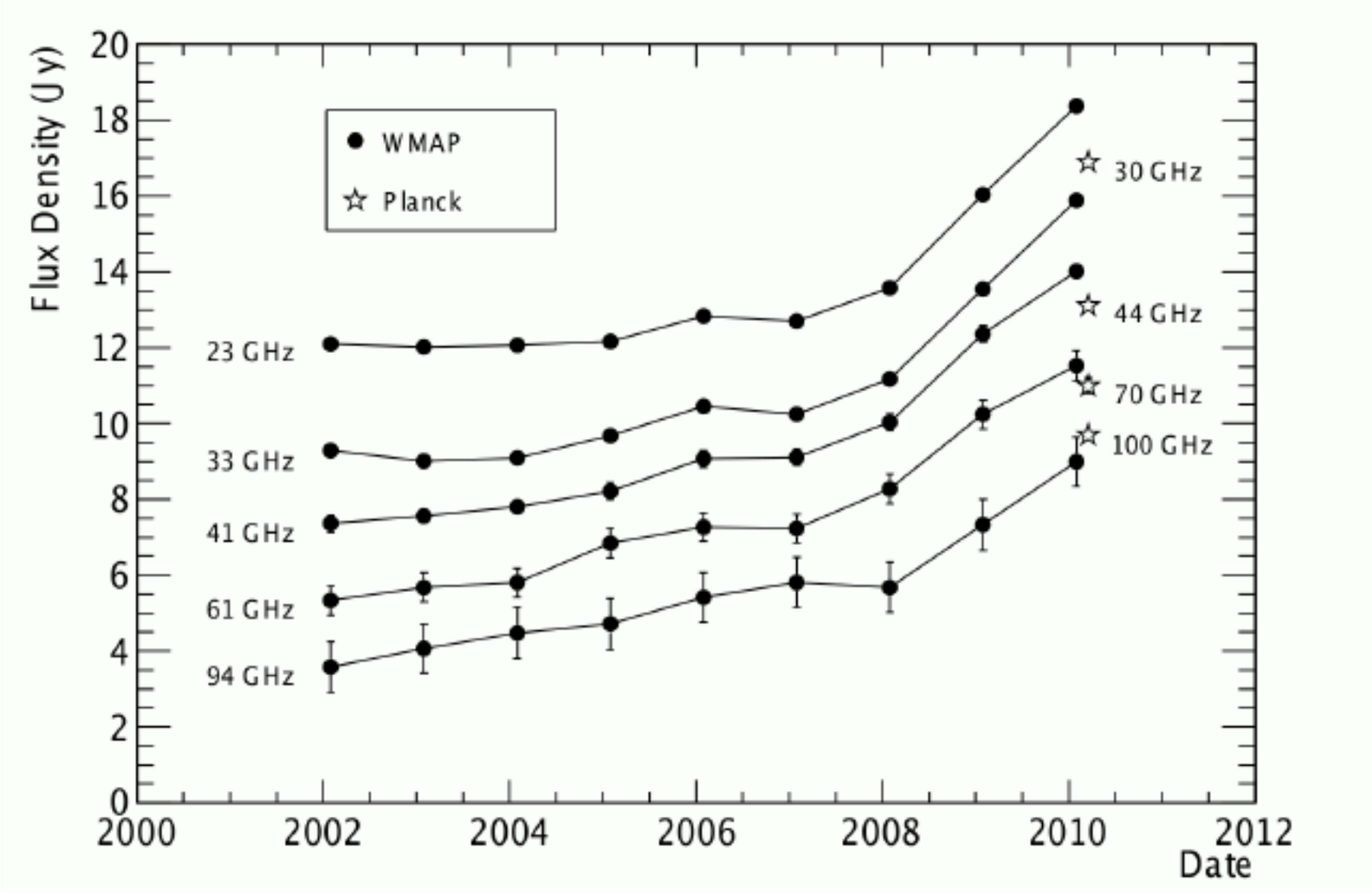
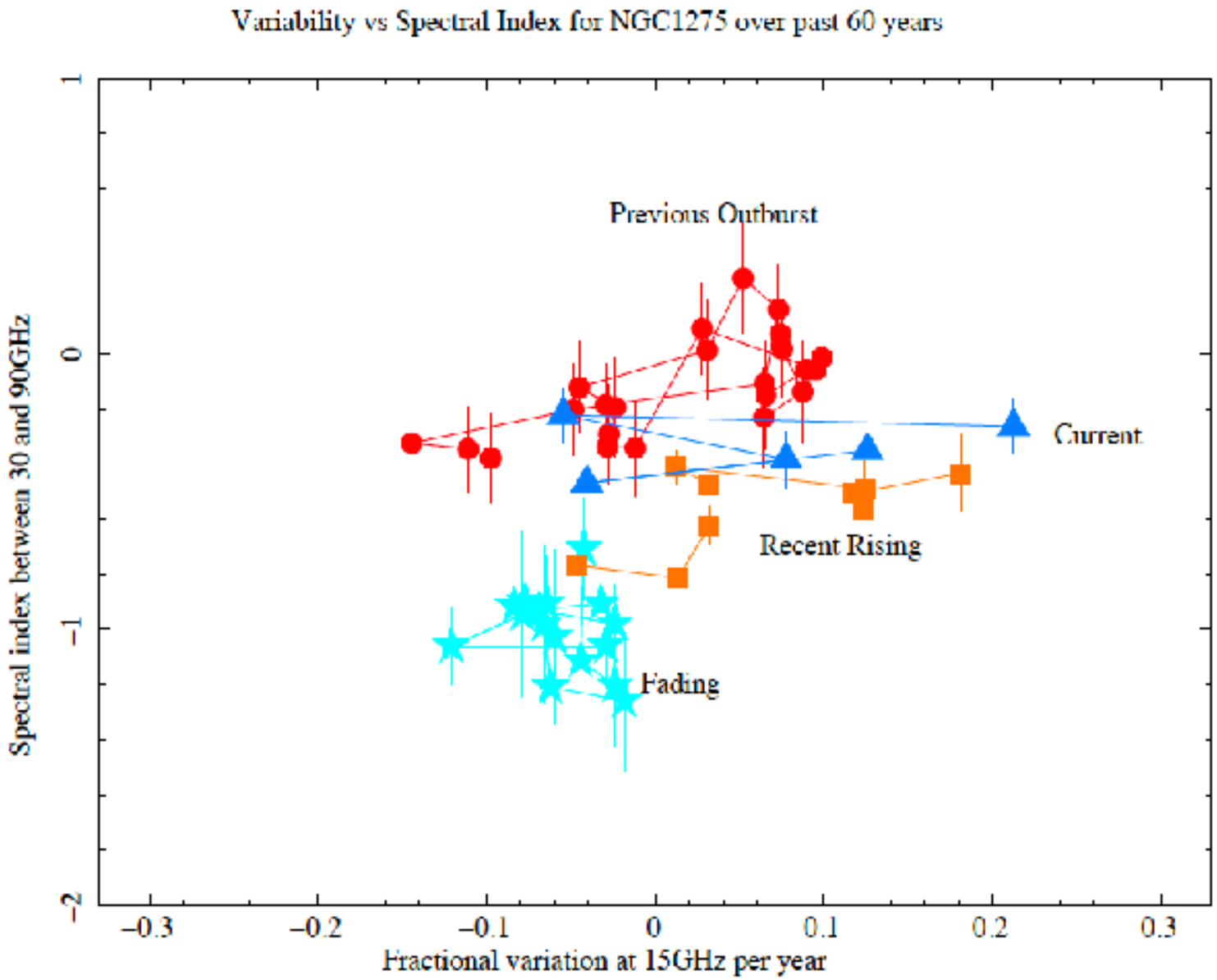
# NGC1275 AT 30 TO 100 GHZ

- Higher frequency monitoring of NGC1275 monitoring (from 2002 to 2012, Dutson+ 2014)



# LINKING SPECTRAL INDEX CHANGES TO VARIABILITY

- Spectral index changes of the core relate to the variability
- Fading periods have a steeper spectral indices than outbursts

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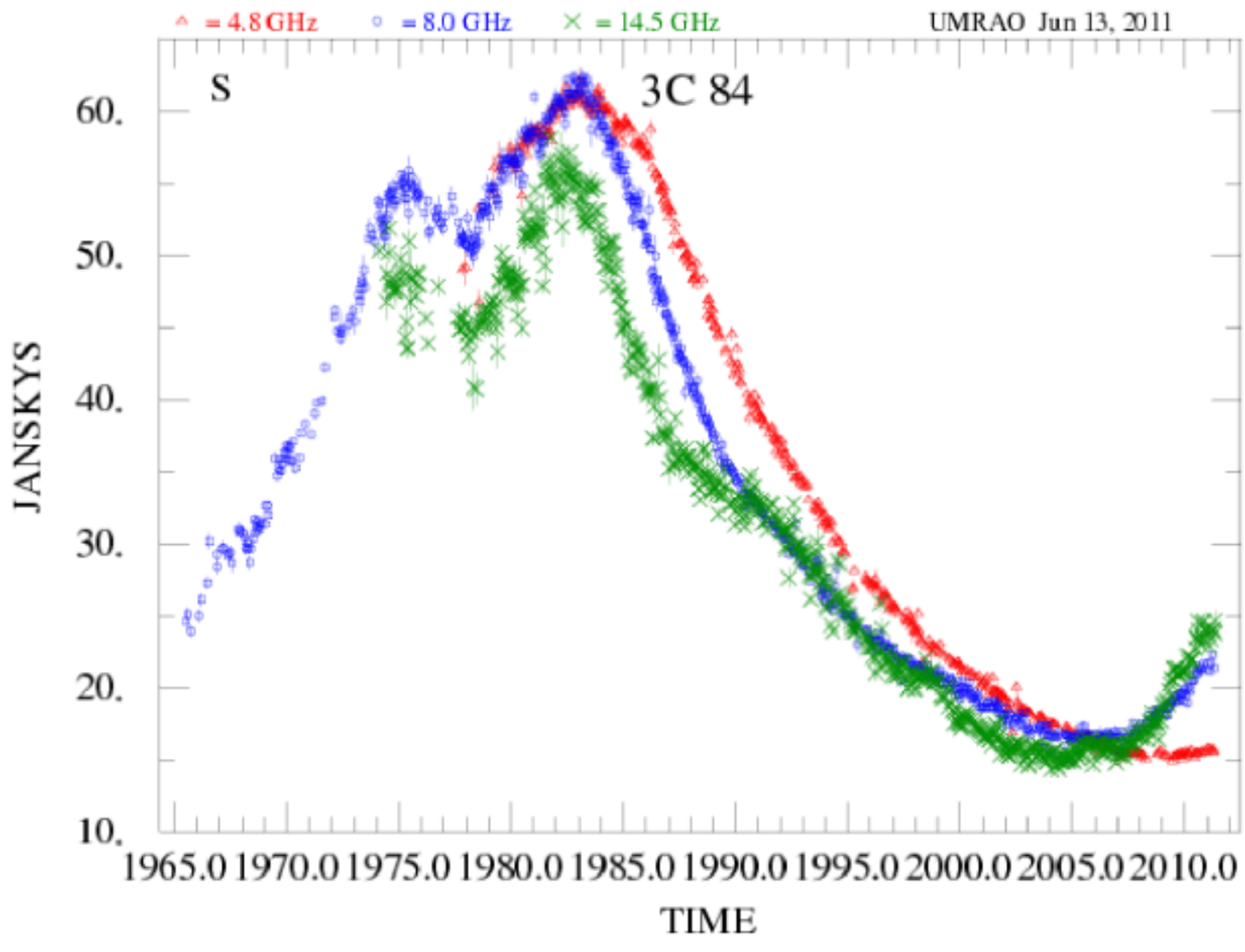


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# MONITORING A LARGER SAMPLE OF BGCs

- NGC 1275's core clearly varies a lot, but it's an exception in having been observed over such a long period
- Is the variability of its radio core typical for a large galaxy?
- Is the variability related to the spectral index properties?

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## SOLUTION:

- An OVRO 40m campaign from 2009 to the present day monitoring the 15 GHz variability of 20 X-ray selected BCGs
- Combined with NIKA2, SCUBA2 (353 GHz), ALMA (100-200 GHz), and KVN (22 and 43 GHz) observations to monitor spectral index changes

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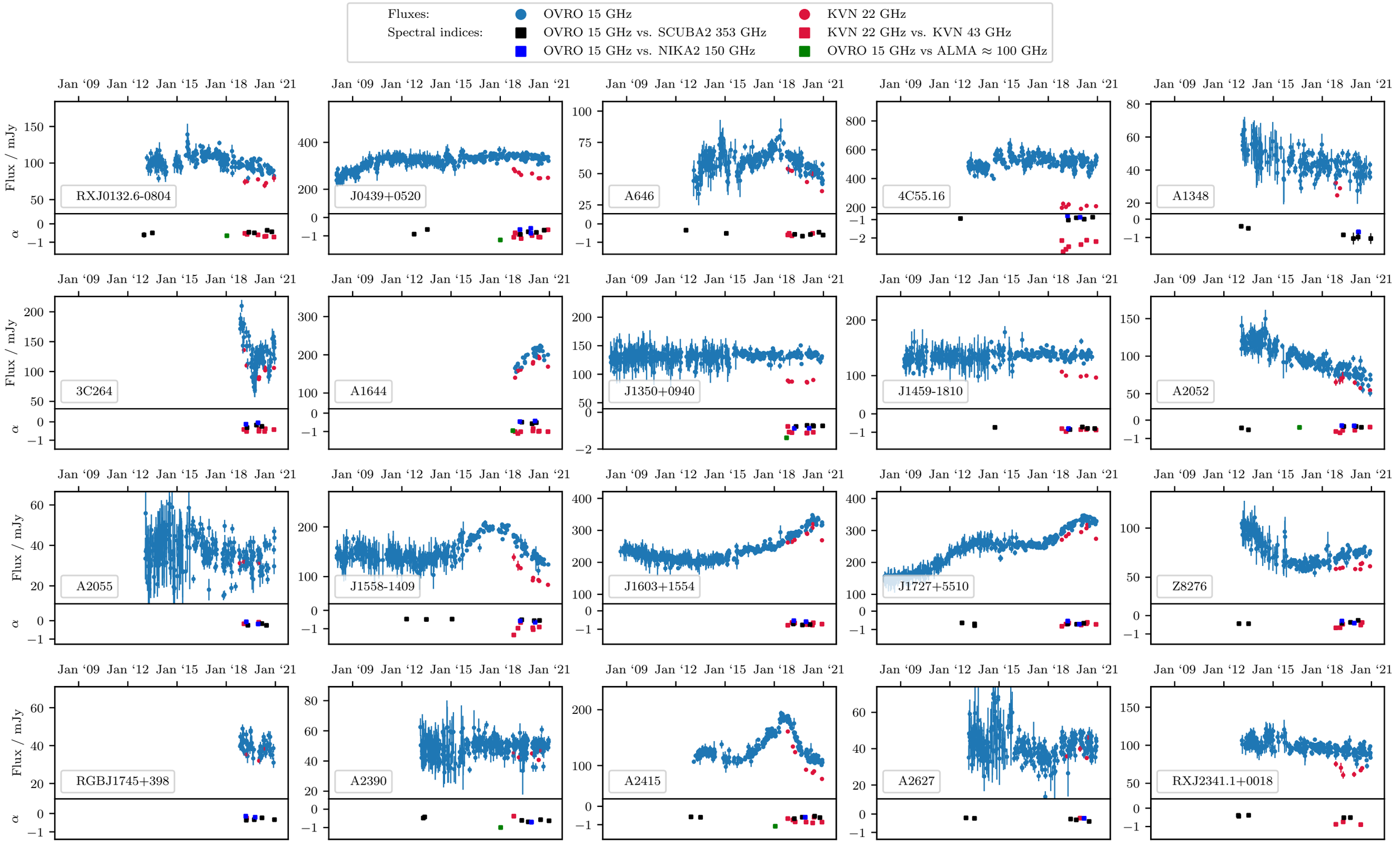
# 15 GHz LIGHTCURVES OF COOL CORE BCGs – LOTS OF VARIABILITY

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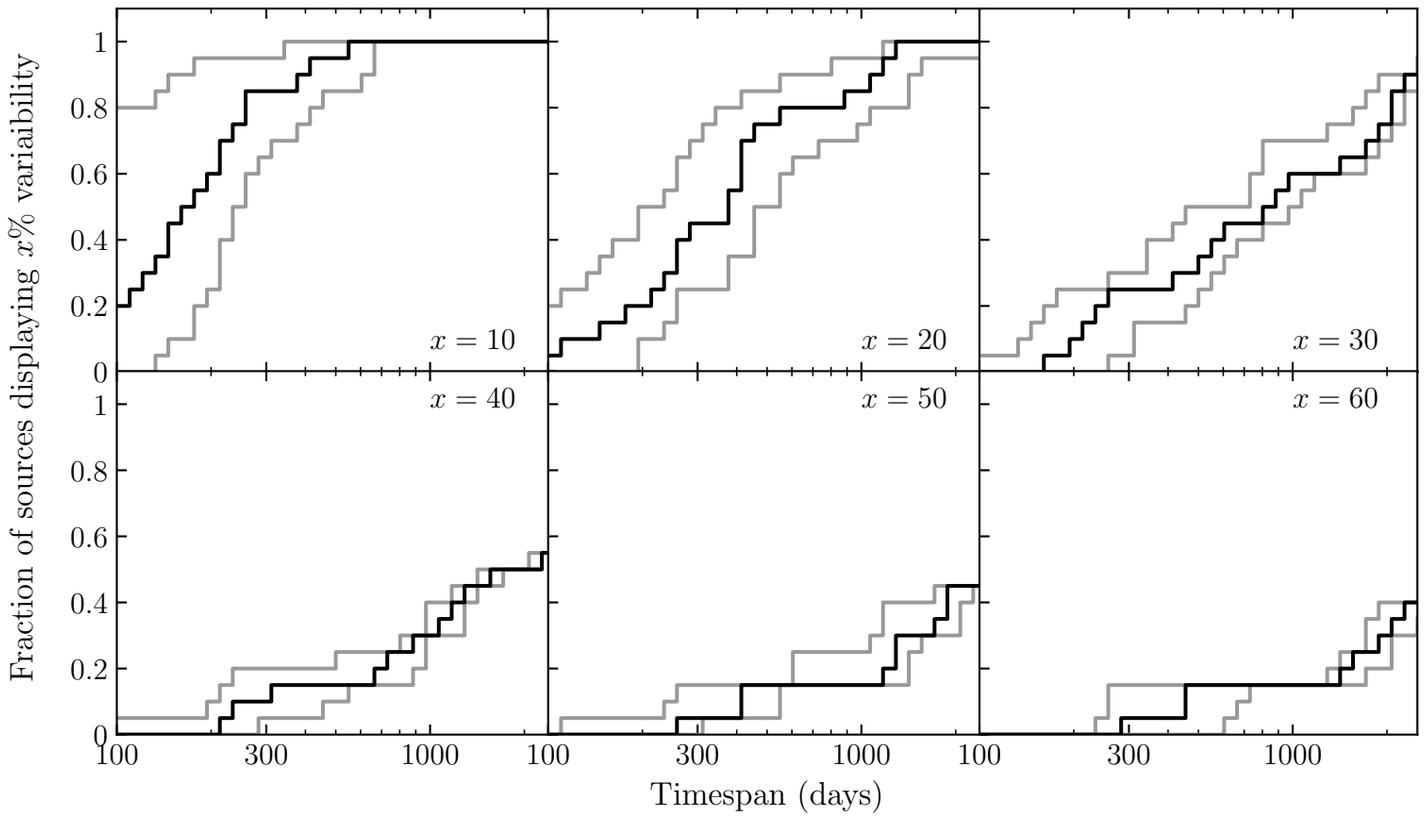
# VARIABILITY IS A UNIVERSAL FEATURE OF BCGs

- All 20 BCGs show 20% variability on 3 year timescales
- At least a third vary by 60% on 3 year timescales




Variability is a universal feature, even for ‘flat’ spectrum sources.

In SZ calculations, it’s dangerous to assume any BCG point source to be constant

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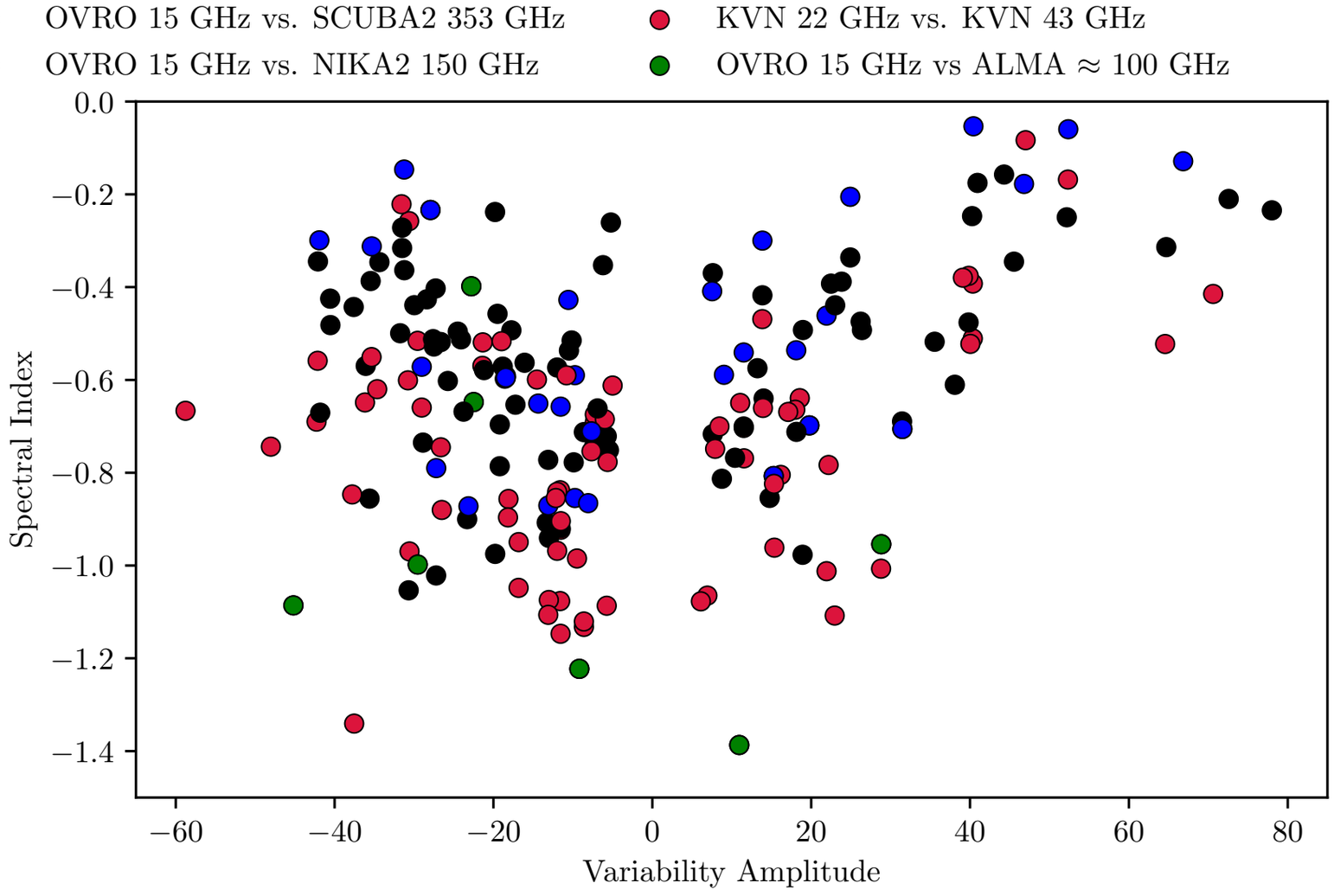
# LINKING VARIABILITY TO SPECTRAL INDEX CHANGES

- Sources rising the most have flatter spectral indices
- For SZ studies requiring the subtraction of a continuum source, extrapolating from a lower frequency flux density made a few years earlier could involve a significant error due to variability *and* associated spectral index changes

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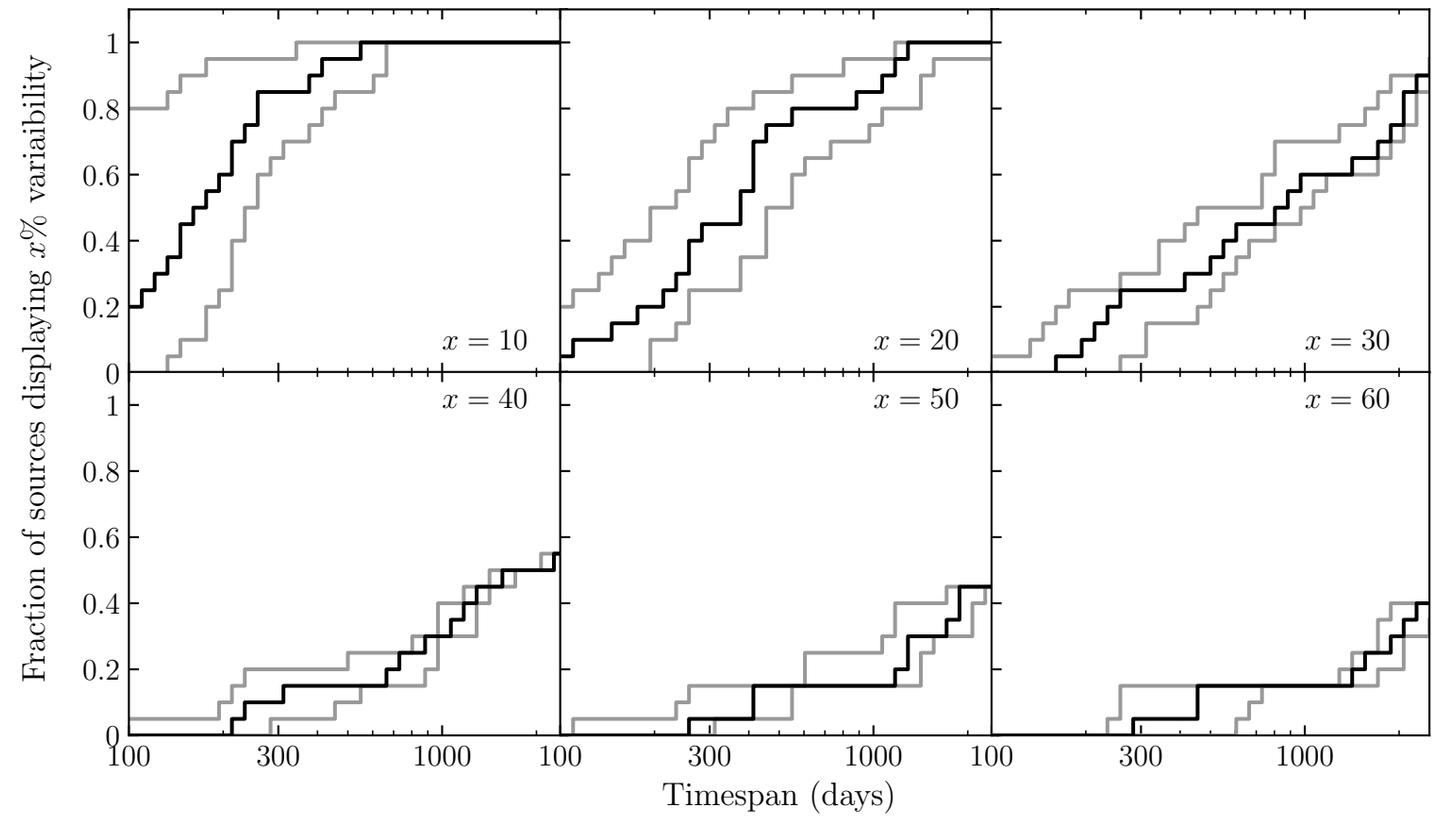
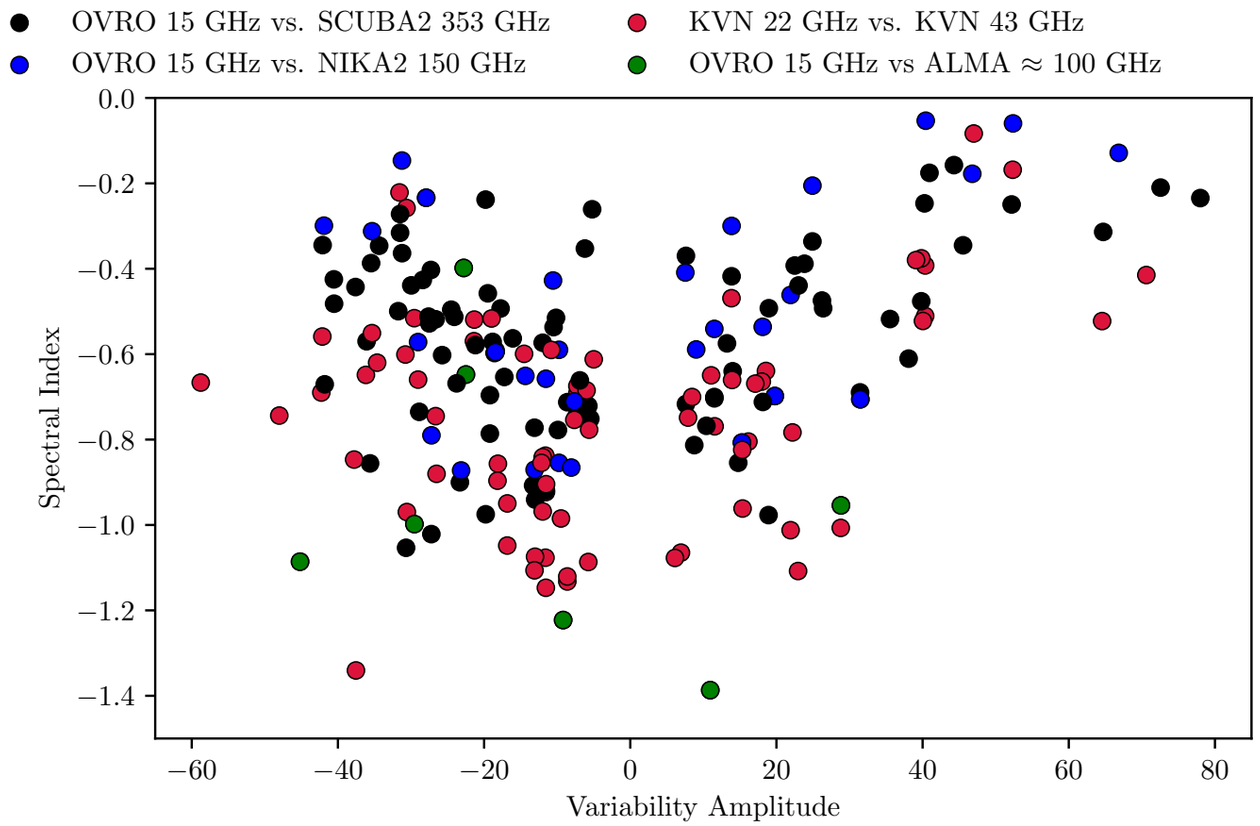
# CONCLUSIONS




- All 20 BCGs show 20% variability on 3 year timescales
- At least a third vary by 60% over several years
- Variability is a universal feature, even for ‘flat’ spectrum sources.
- In SZ calculations, it’s dangerous to assume any BCG point source to be constant




- Sources rising the most have flatter spectral indices…
- … so making spectral index estimates is very unreliable when flux measurements are separated by a few years, even in ‘flat’ spectrum sources

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