# Global ISW Significance: An Exercise in Method & Hubris

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25 May 2006

# It Seemed Like a Good Idea at the Time...

Date: Fri, 5 May 2006 17:54:32 -0400 (EDT)
From: Ryan Scranton <scranton@bruno.phyast.pitt.edu>
To: Albert Stebbins <stebbins@fnal.gov>

Hey Albert...

As for the conference, I'm not entirely certain what I'm going to talk about. I'm toying with the idea of doing a global measurement of the ISW using 2MASS, SDSS, and FIRST/NVSS using the Teragrid. Given the fact that I was able to do the LRG stuff in less than 24 hours, I think I can do it all by the end of next week.

-Ryan

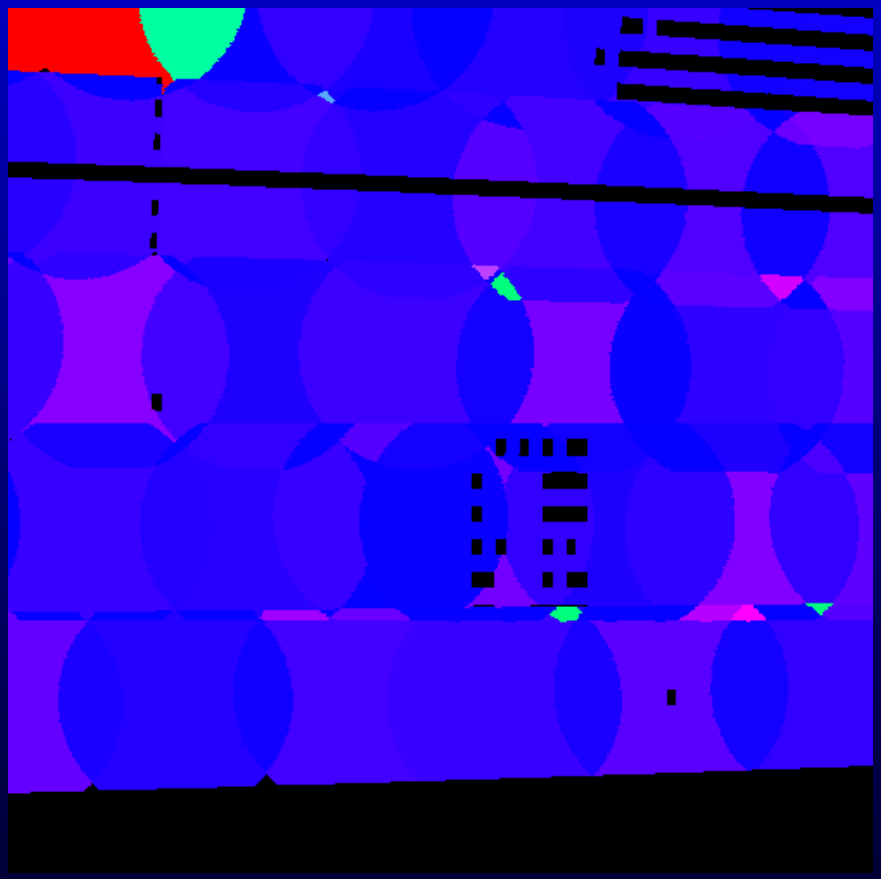
# The Plan

- Collect footprints & galaxy data from 2MASS, SDSS, FIRST and NVSS
- 15 total maps covering $0 < z < 2.5$:
  - ⋆ 3 2MASS magnitude limited samples ($10.5 < k < 11.5$, $11.5 < k < 12.5$, $12.5 < k < 13.5$)
  - ⋆ 5 magnitude limited SDSS galaxy samples over $16 < r < 21$
  - ⋆ 3 SDSS LRG redshift slices
  - ⋆ NVSS radio galaxies
  - ⋆ 2 FIRST samples (star forming galaxies with flux $< 10$ mJy, AGNs with flux $> 50$ mJy)
  - ⋆ Photometric SDSS QSOs with $1 < z < 2.5$
- Cross-correlate with smoothed 3 year WMAP w channel map
- Generate global covariance matrix using 10,000 CMB realizations on Teragrid

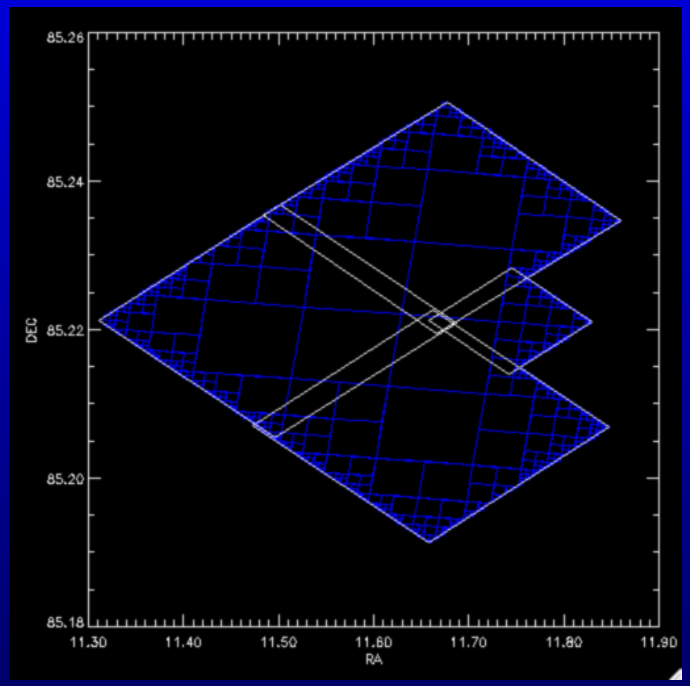
# STOMP: Space and Time Ordered Mapping Package

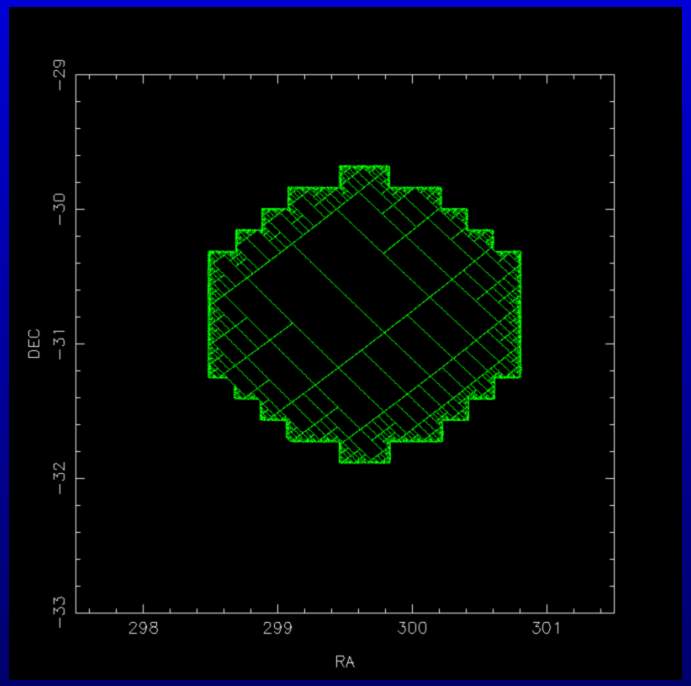
## http://nvogre.phyast.pitt.edu/gestalt/

- All cosmological statistics are measurements of spatial properties (area, angular distance, density)
- Describe complex geometries on the sphere and possibly spatial variations
- Find unions, intersections, and overlaps between large numbers of observations
- It has to be fast



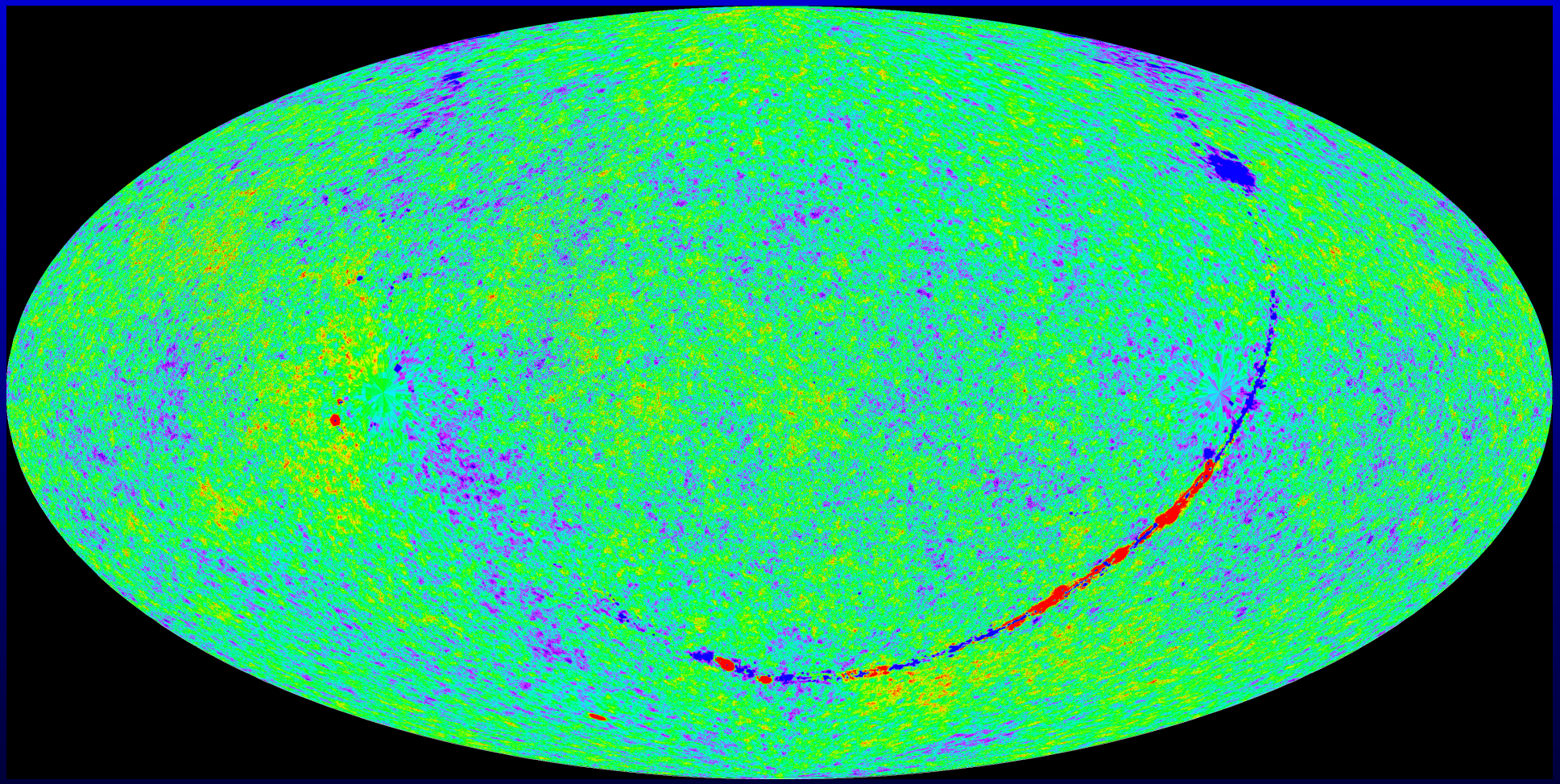
# STOMP: Space and Time Ordered Mapping Package



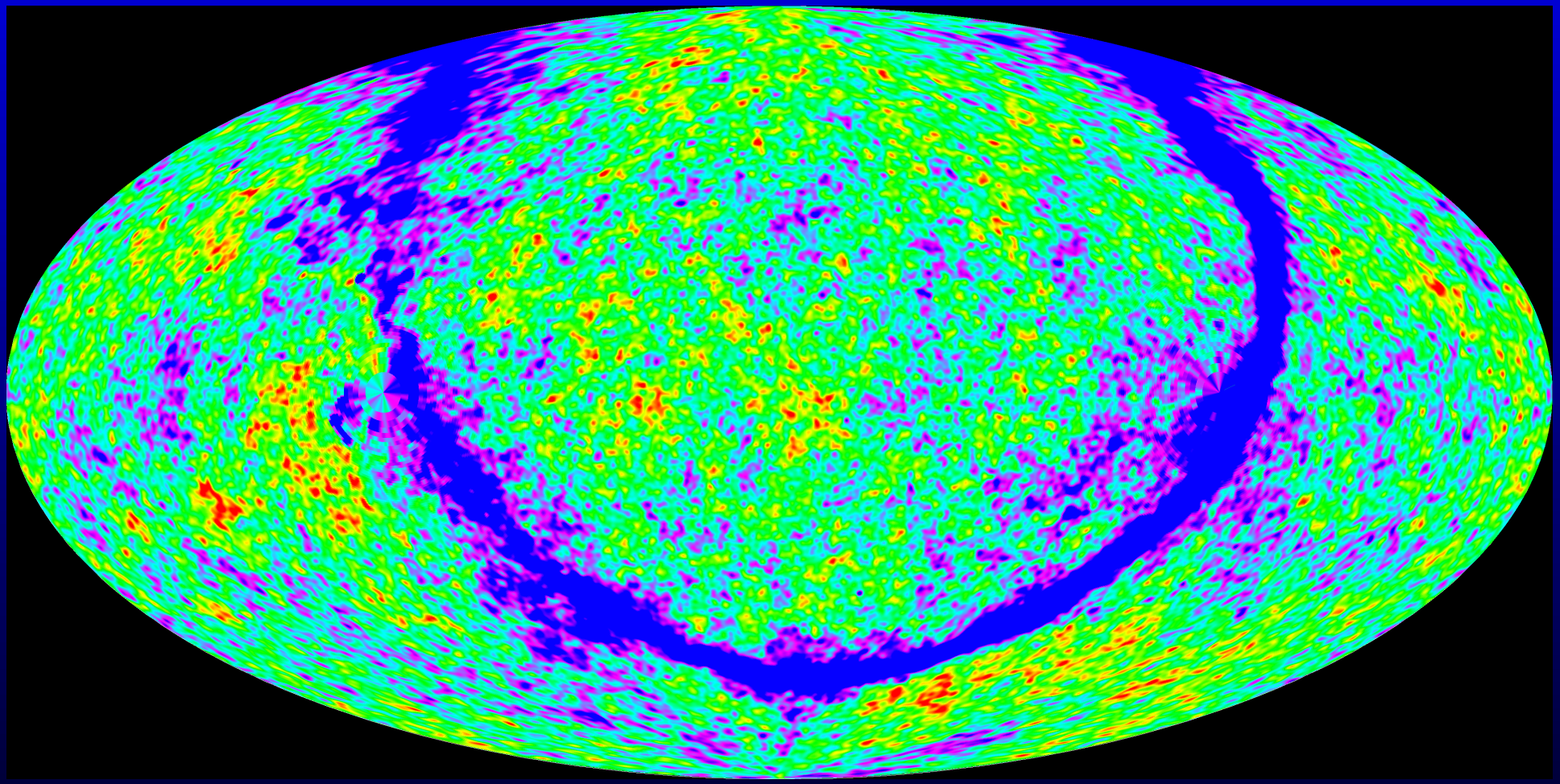

- Pixelize arbitrary survey footprints with 1" resolution
- Hierarchical scheme: extremely rapid localization & efficient angular statistics.
- All footprints & analysis done with current STOMP code

# CMB Side



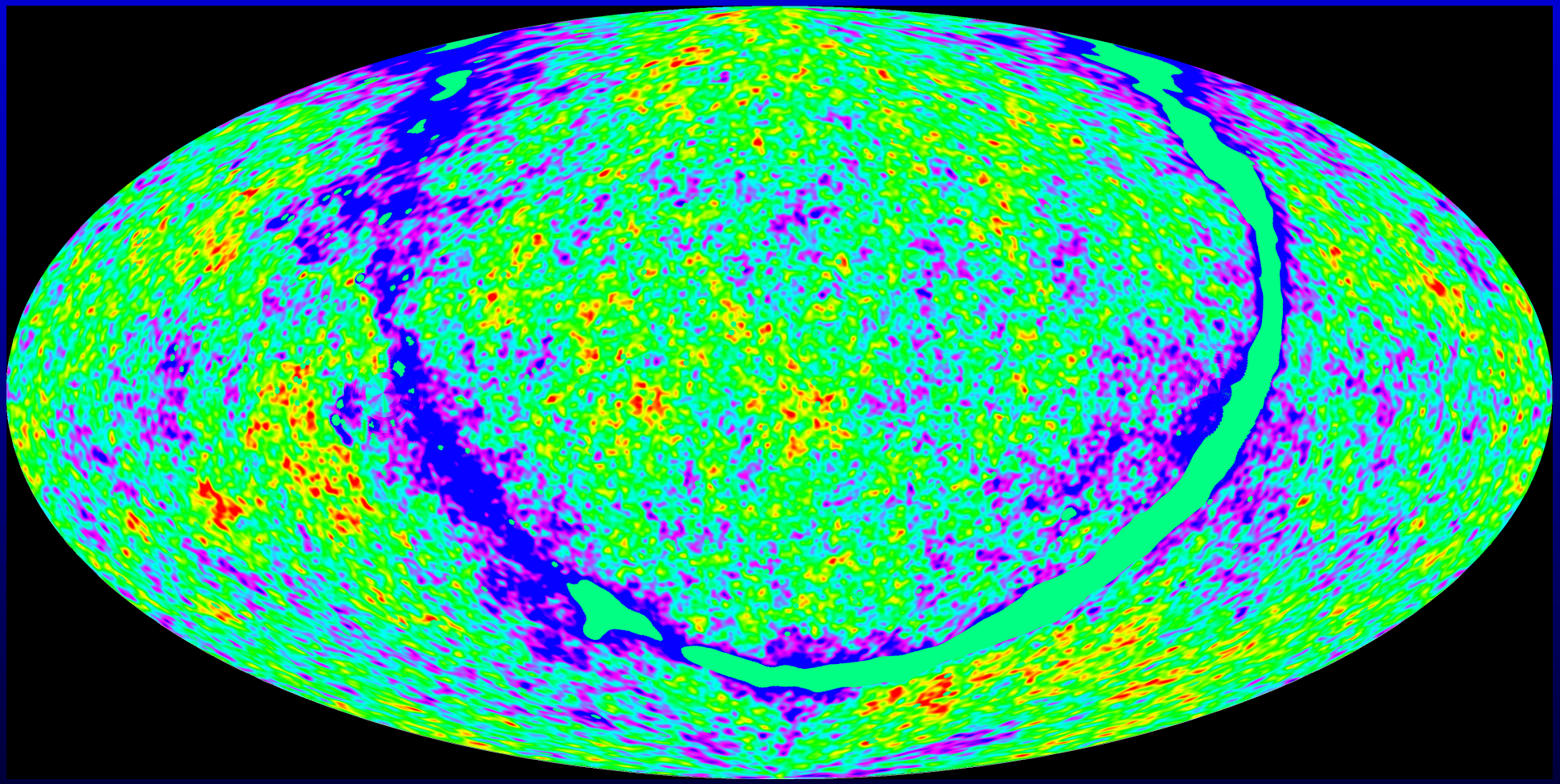
WMAP w channel

# CMB Side



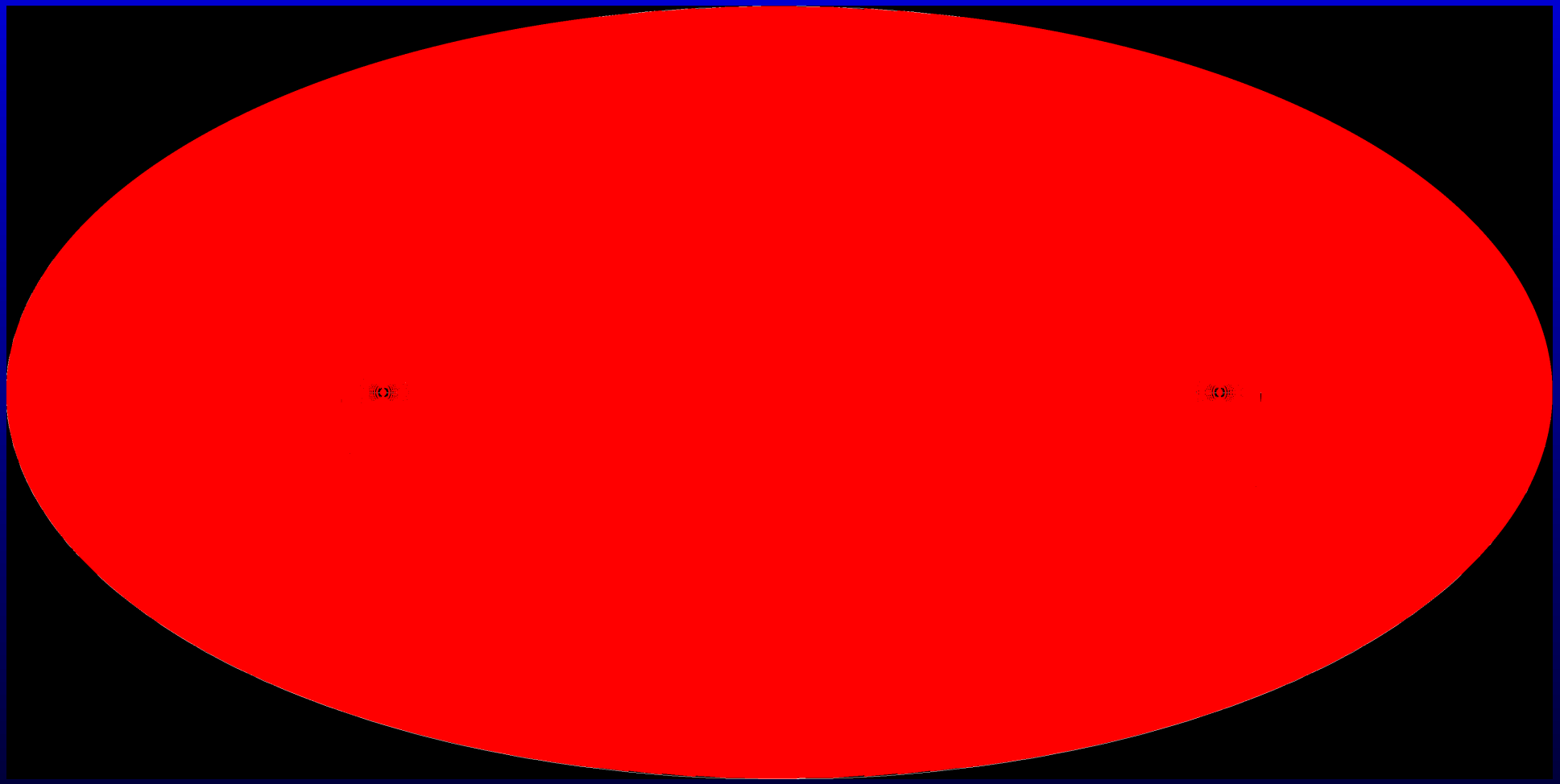
WMAP w channel – smoothed to $1^\circ$

# CMB Side



WMAP w channel – smoothed & masked (??)

# 2MASS



2MASS

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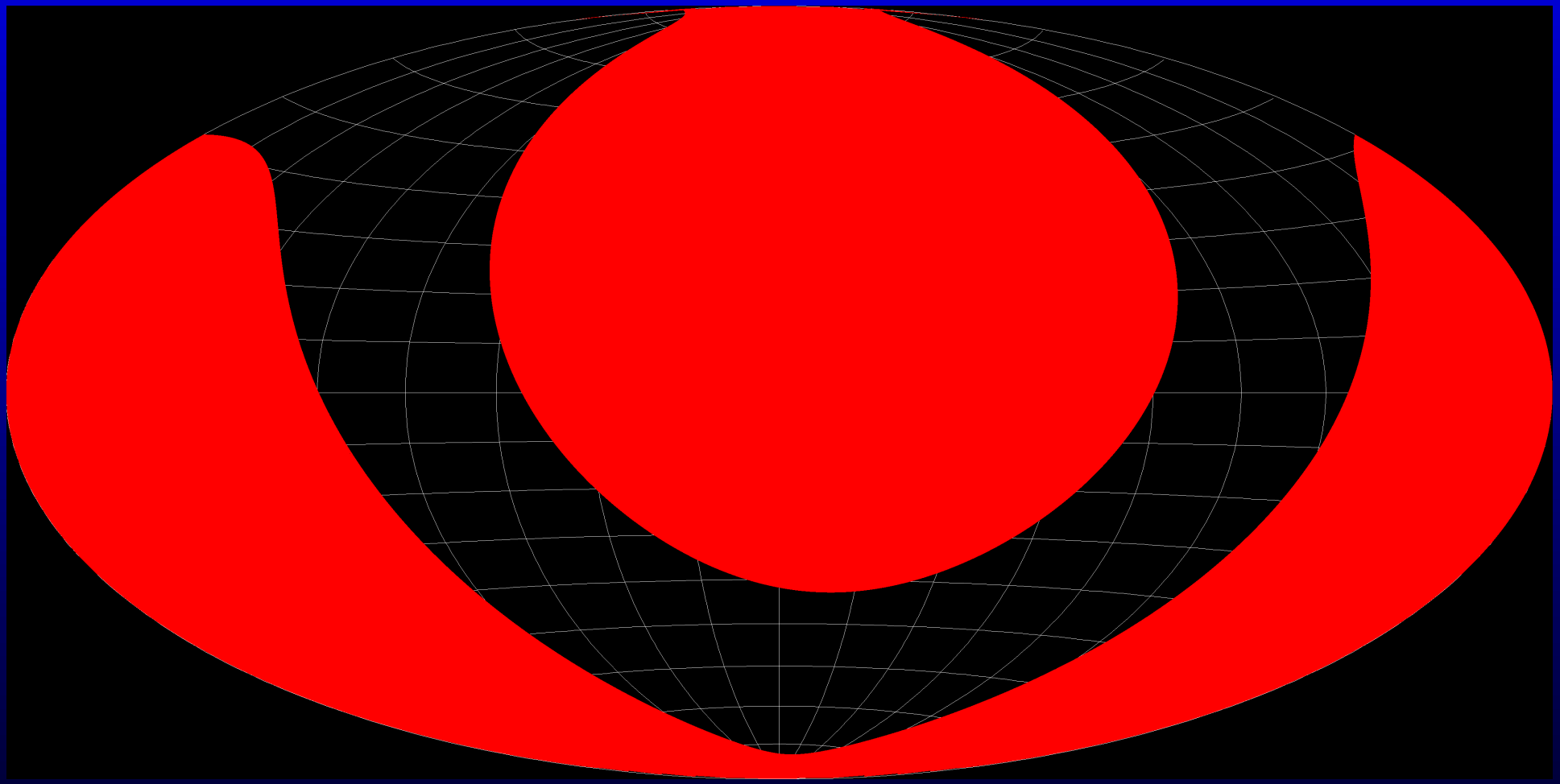
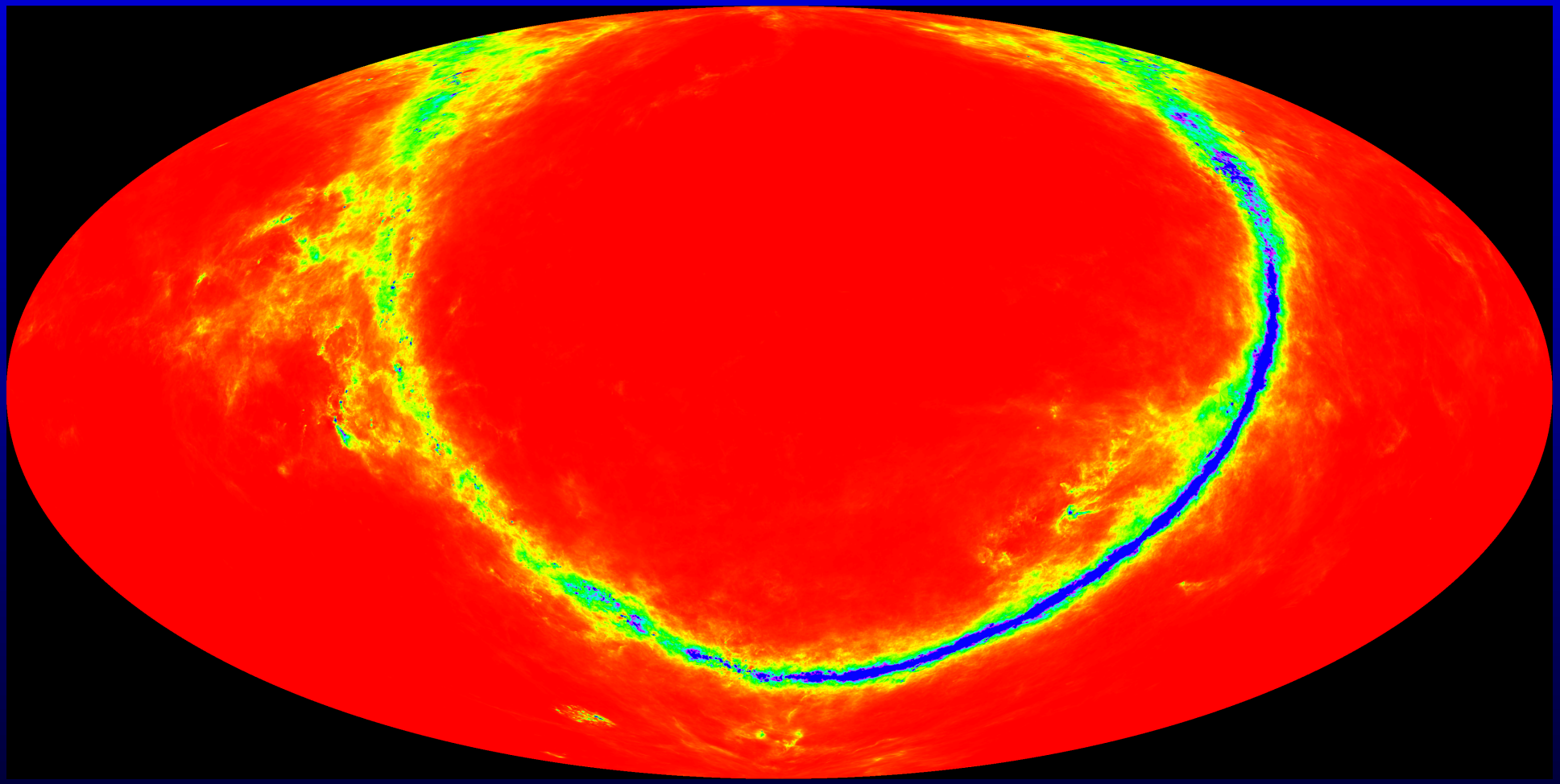


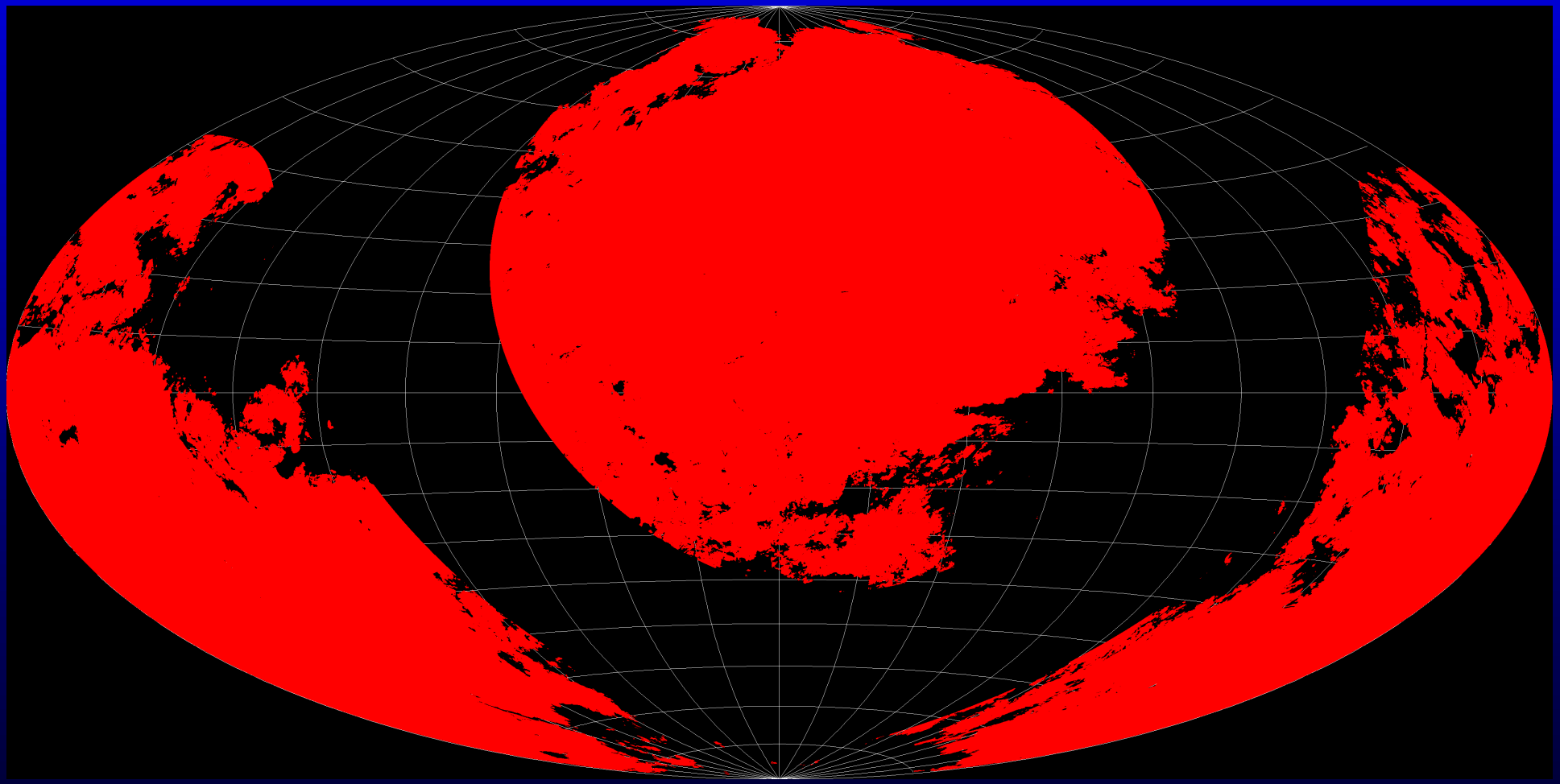
2MASS – $|b| > 20$

# DIRBE



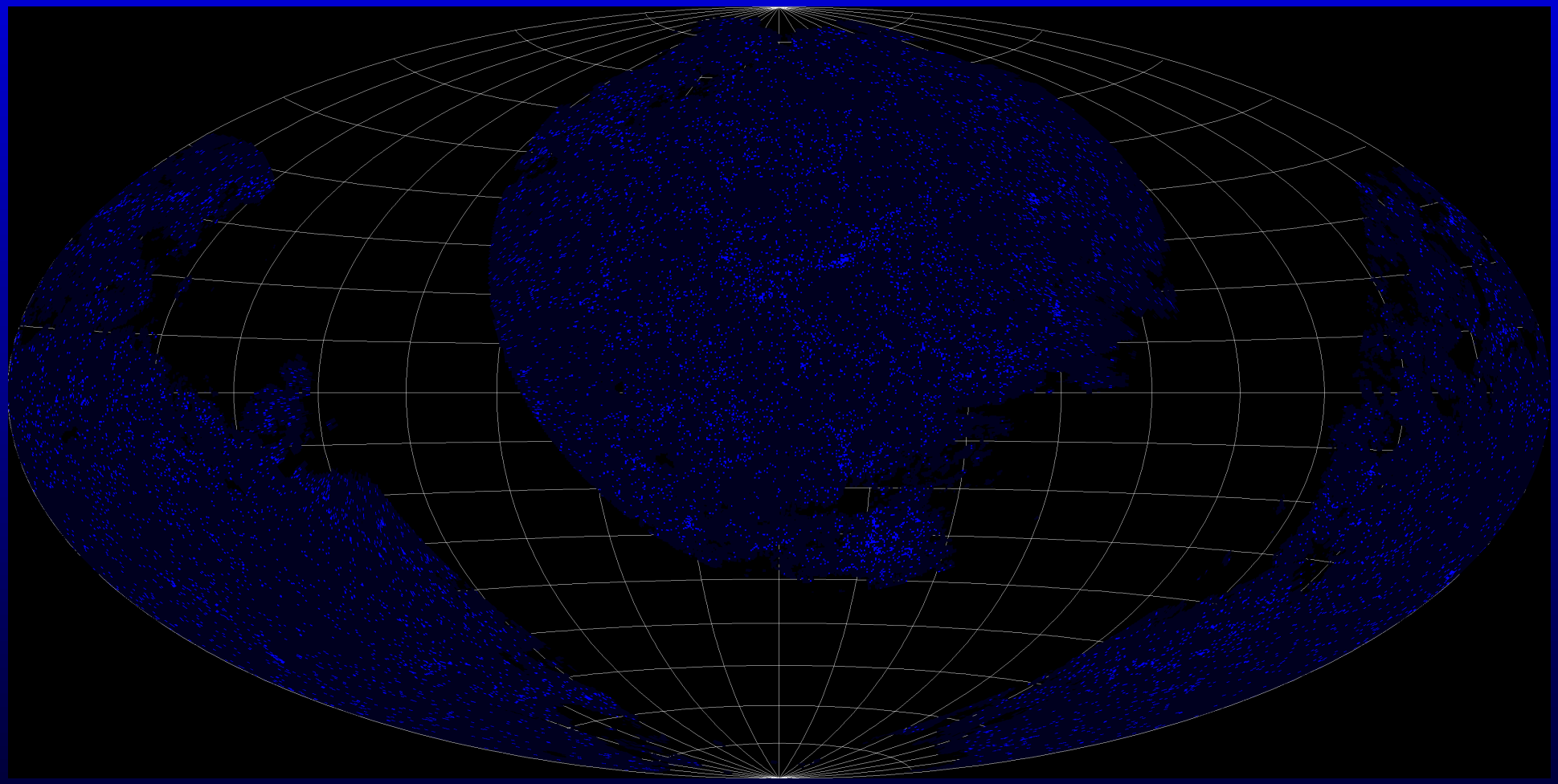
SFD E(B-V) dust emission

# 2MASS



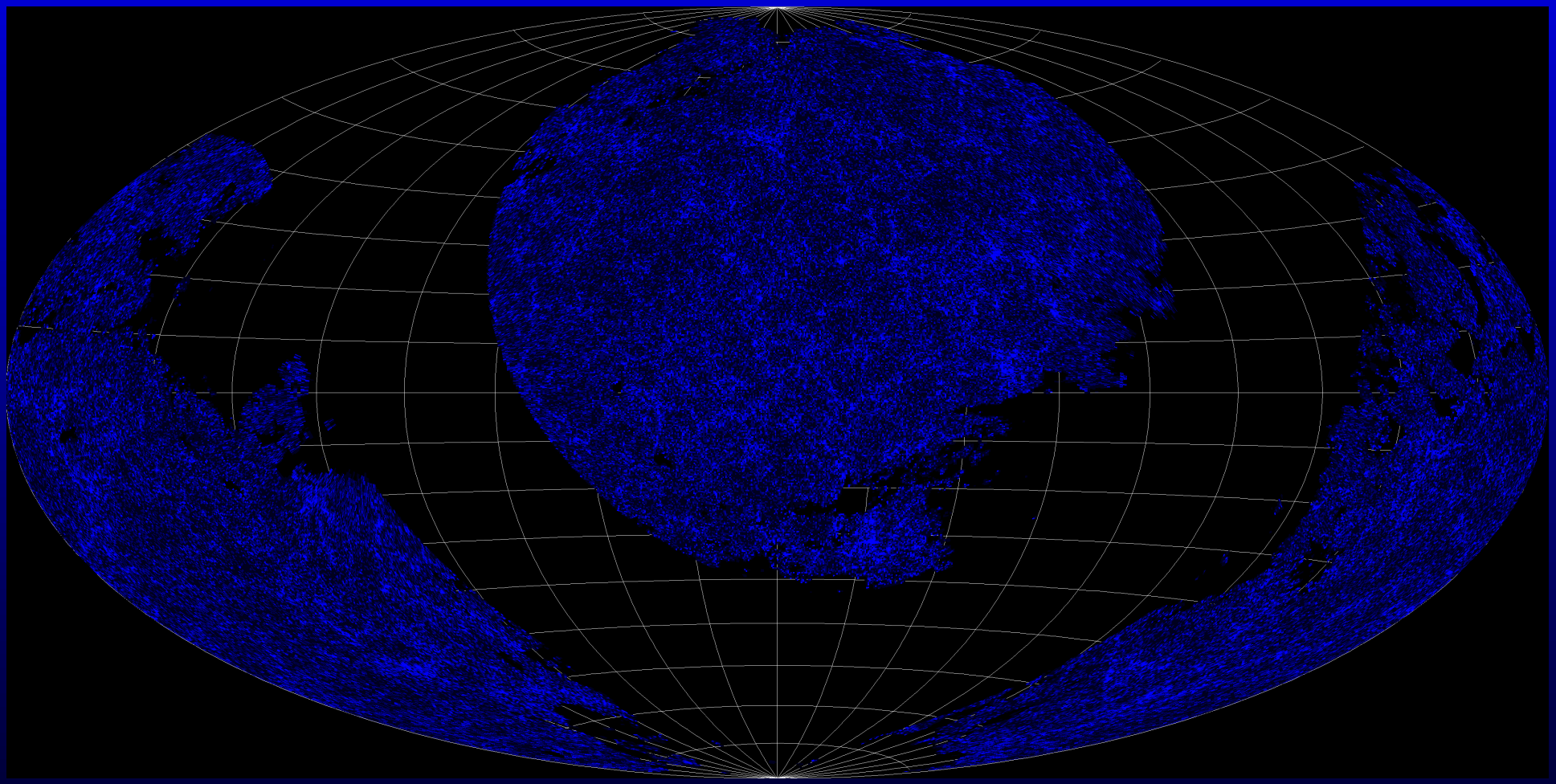
2MASS – $|b| > 20,\ A_k < 0.03$

# 2MASS



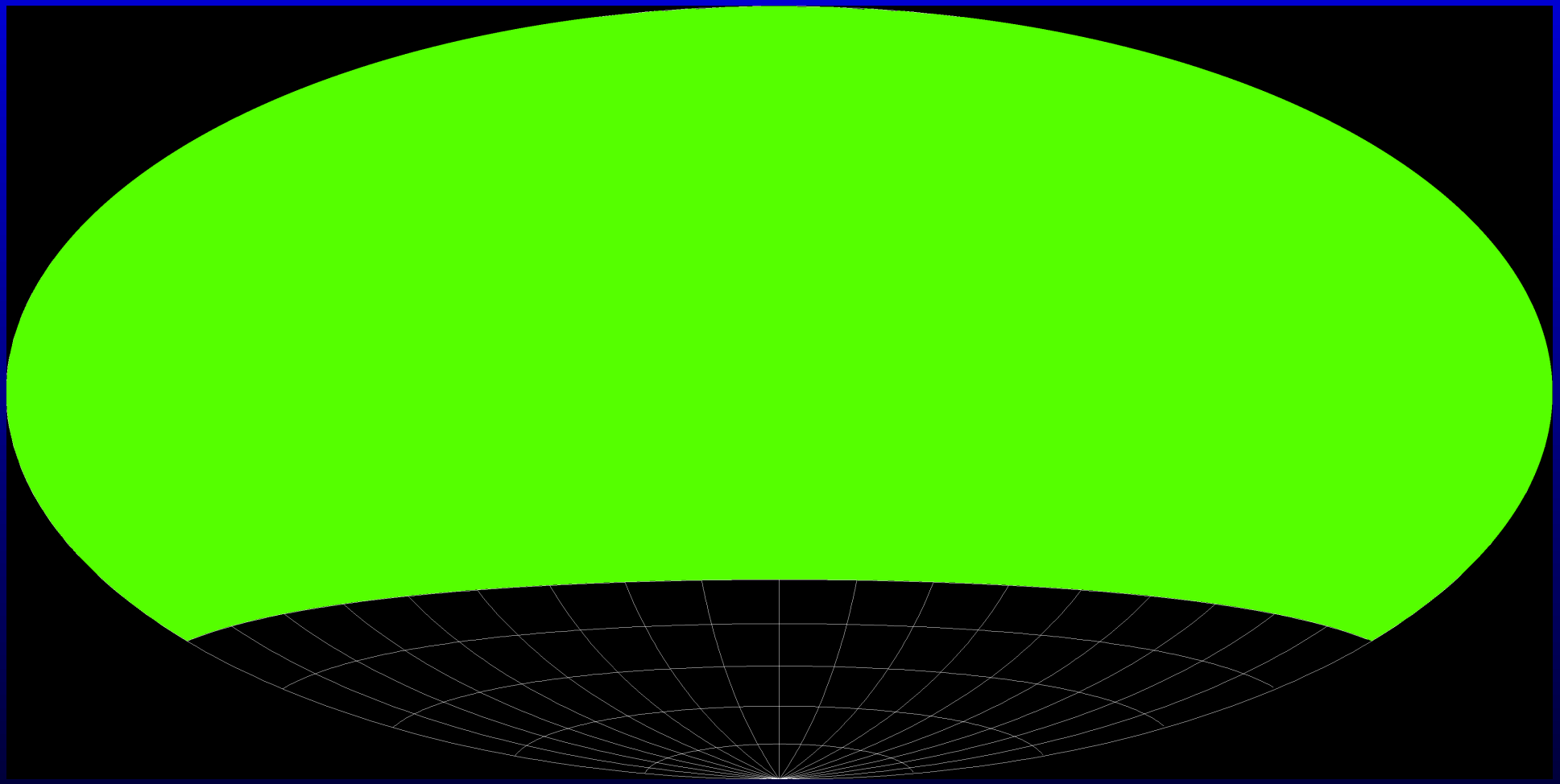
2MASS Over-Density – $10.5 < k < 11.5,\ z \sim 0.05$

# 2MASS



2MASS Over-Density – $12.5 < k < 13.5,\ z \sim 0.1$

# NVSS



NVSS

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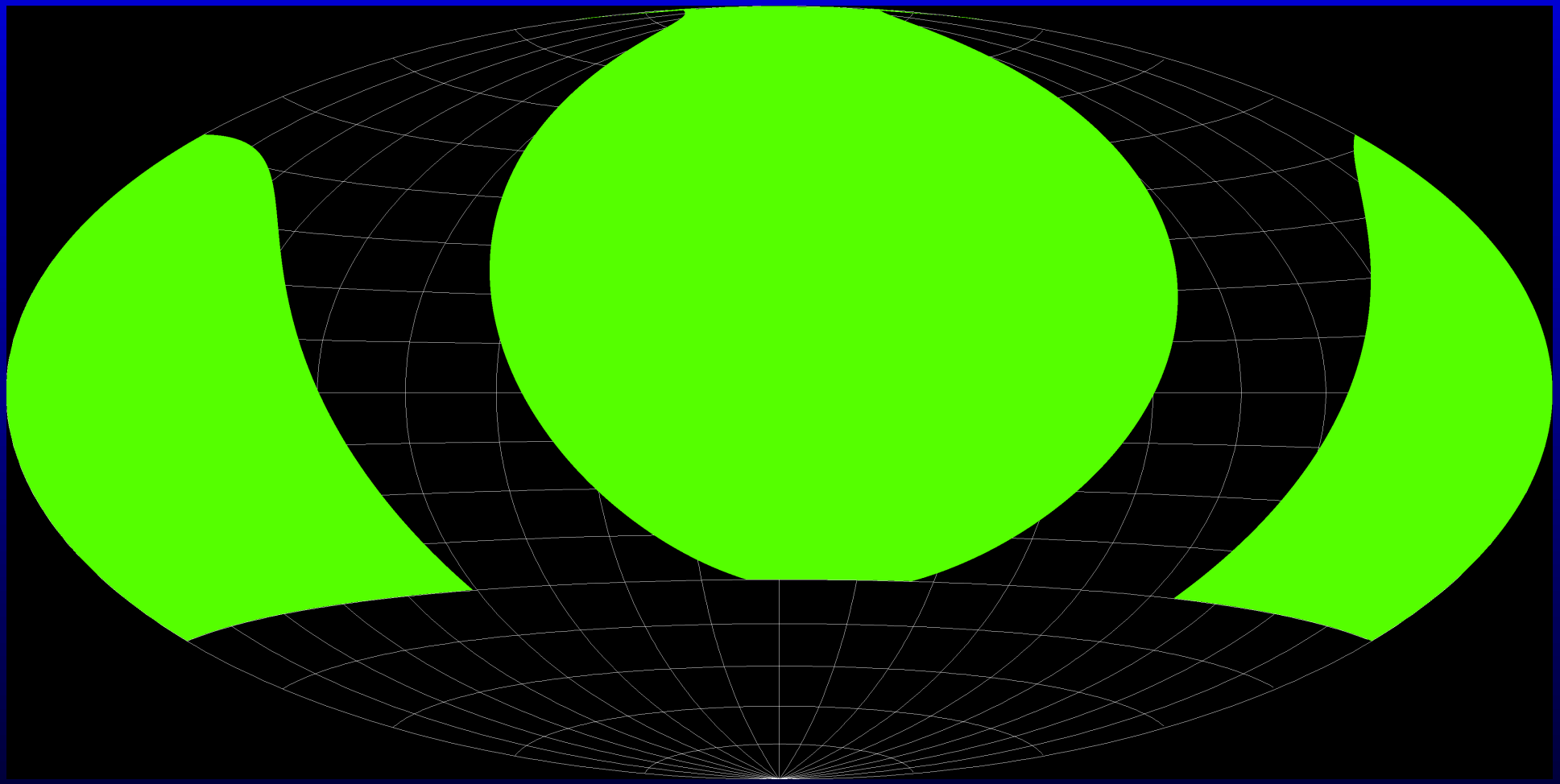
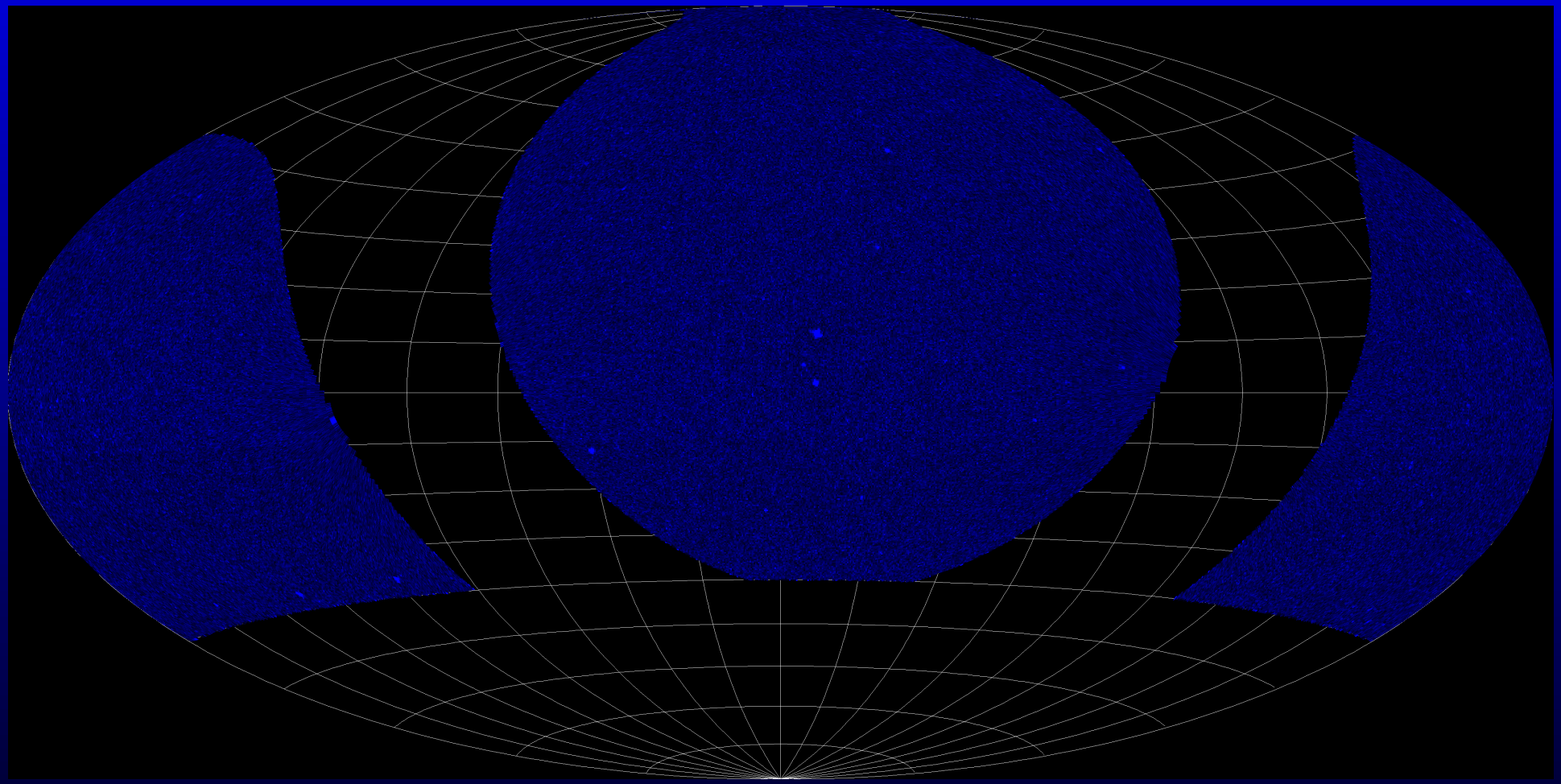


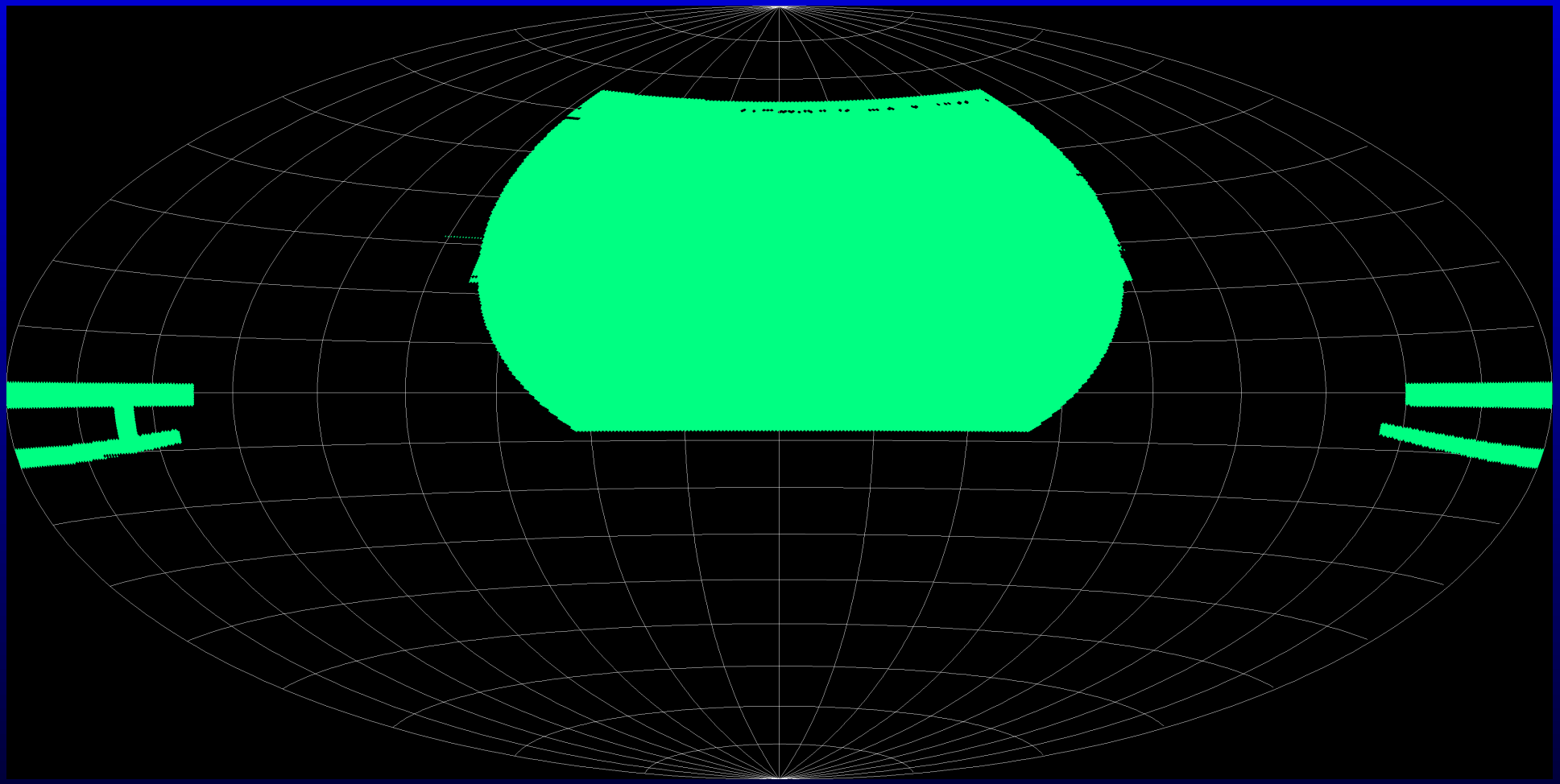
NVSS – $|b| > 20$

# NVSS



NVSS Over-Density – $|b| > 20$

# FIRST



FIRST

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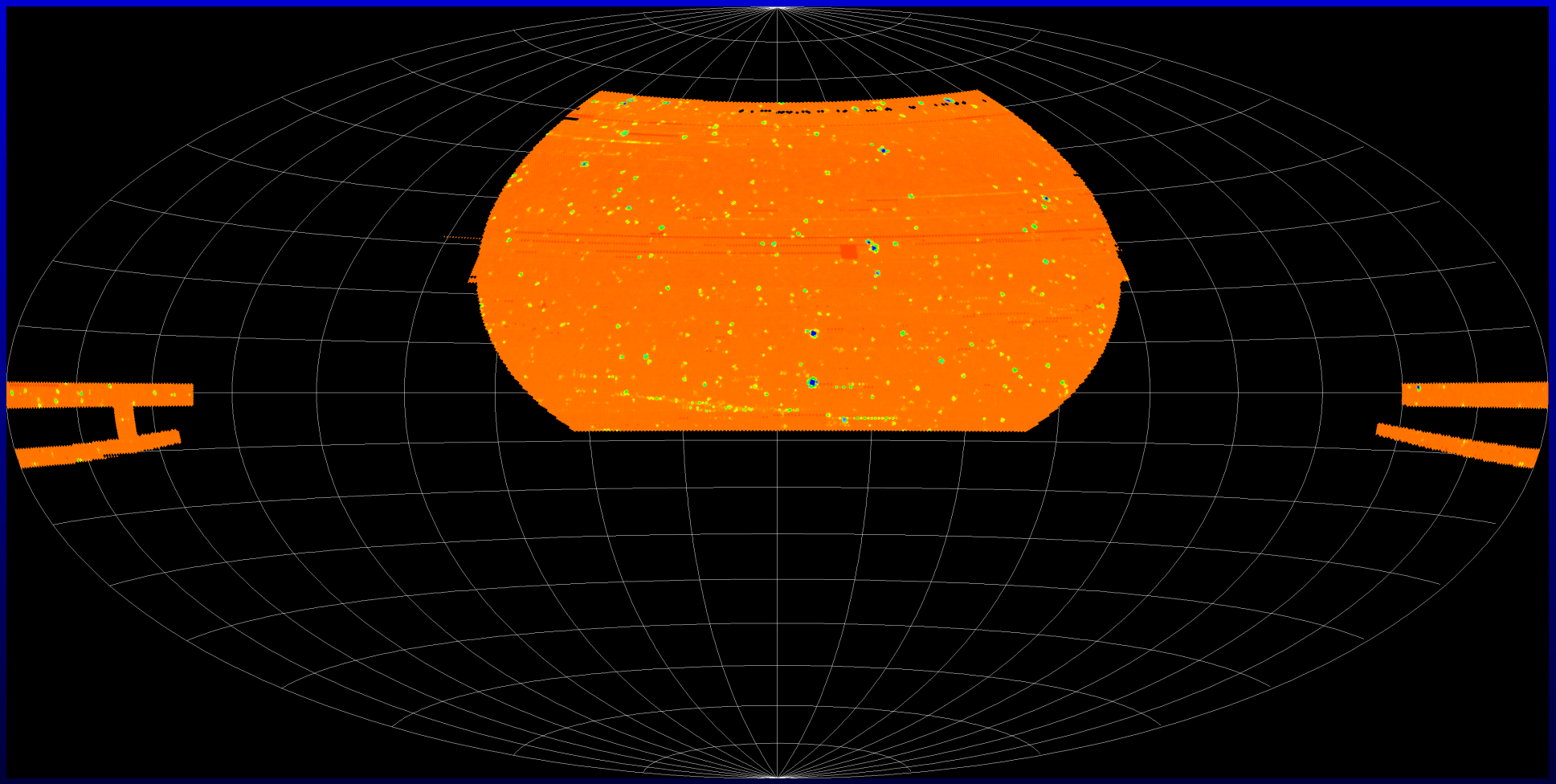
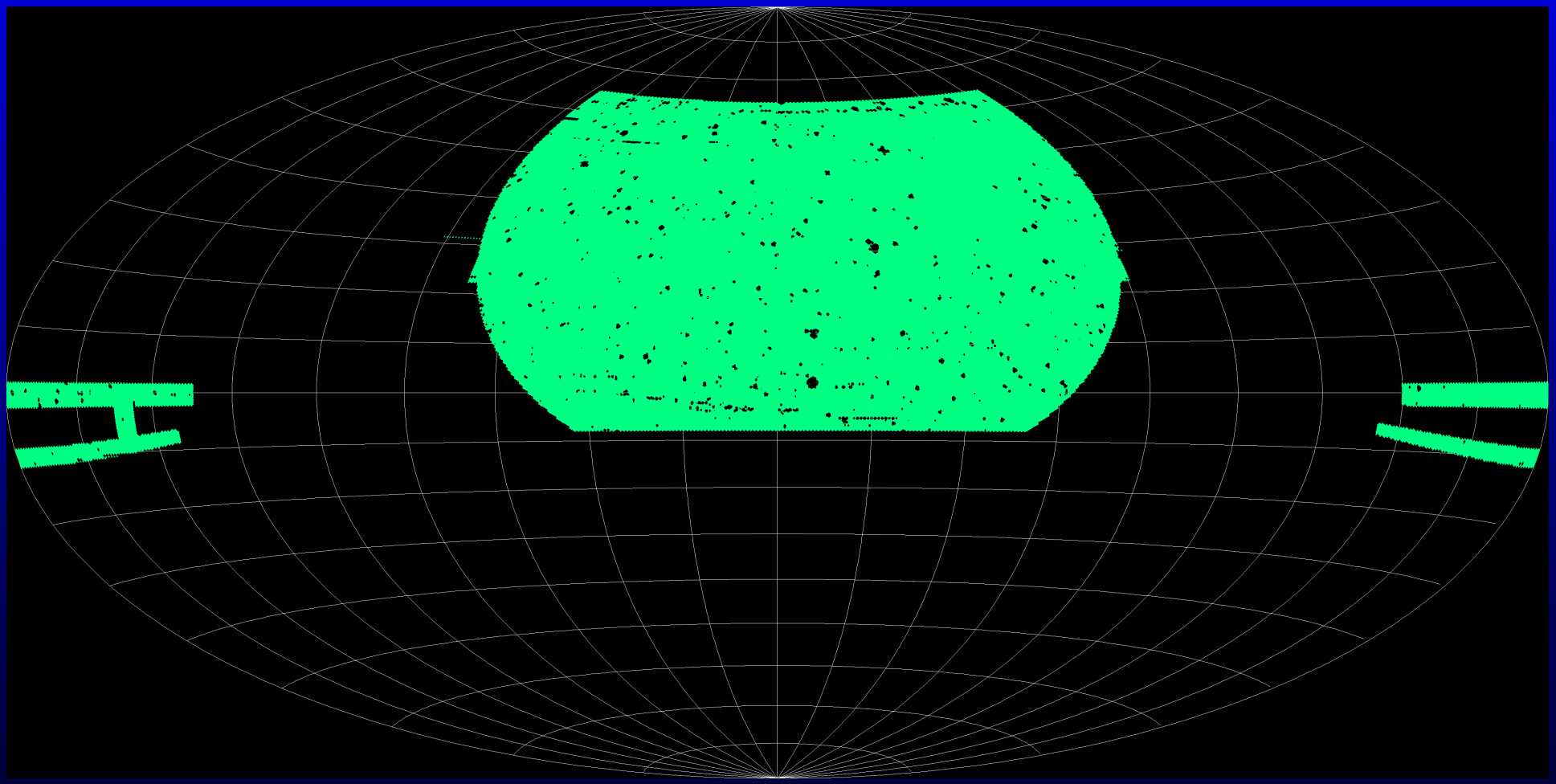


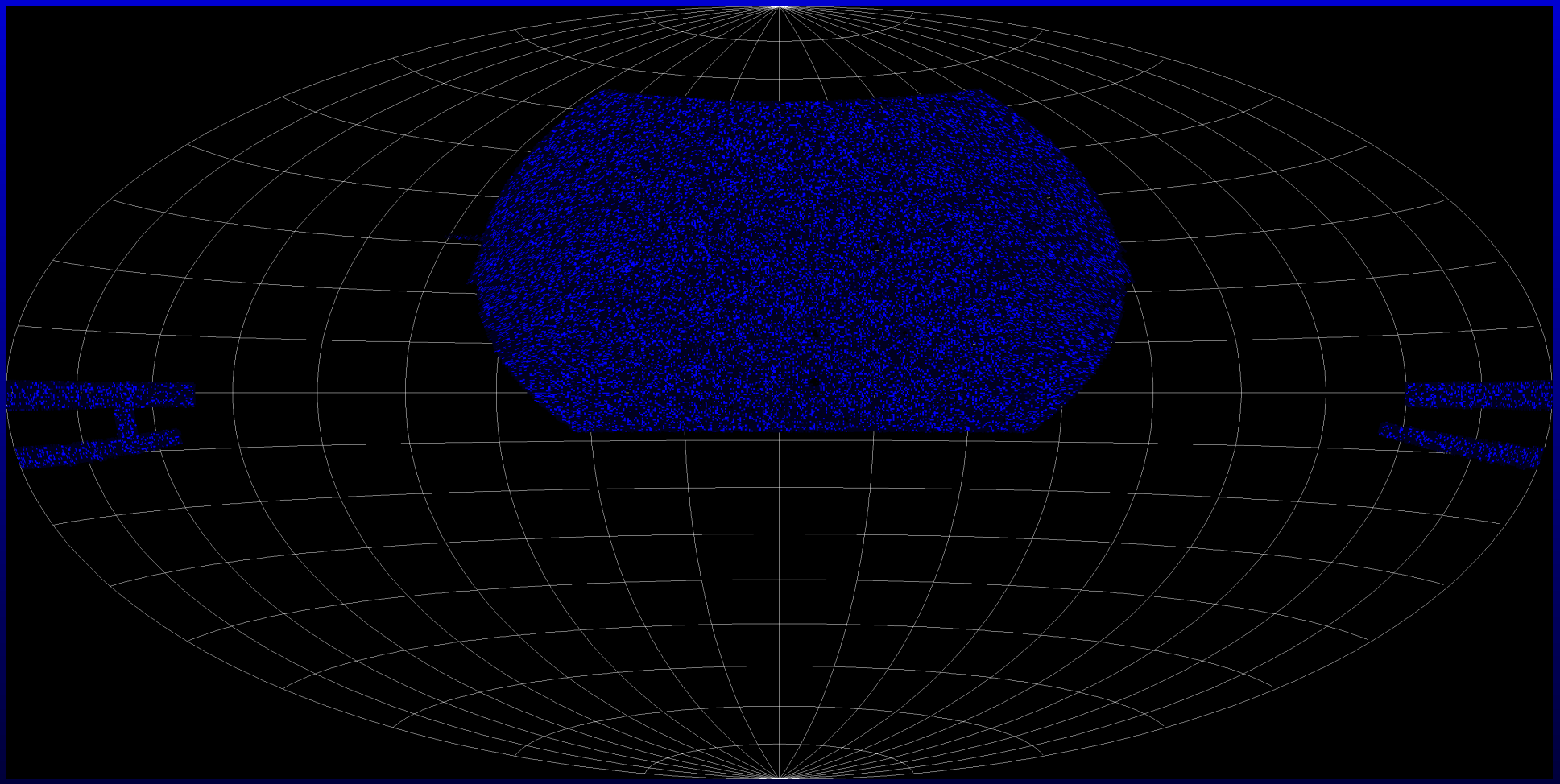
FIRST Background Flux

# FIRST



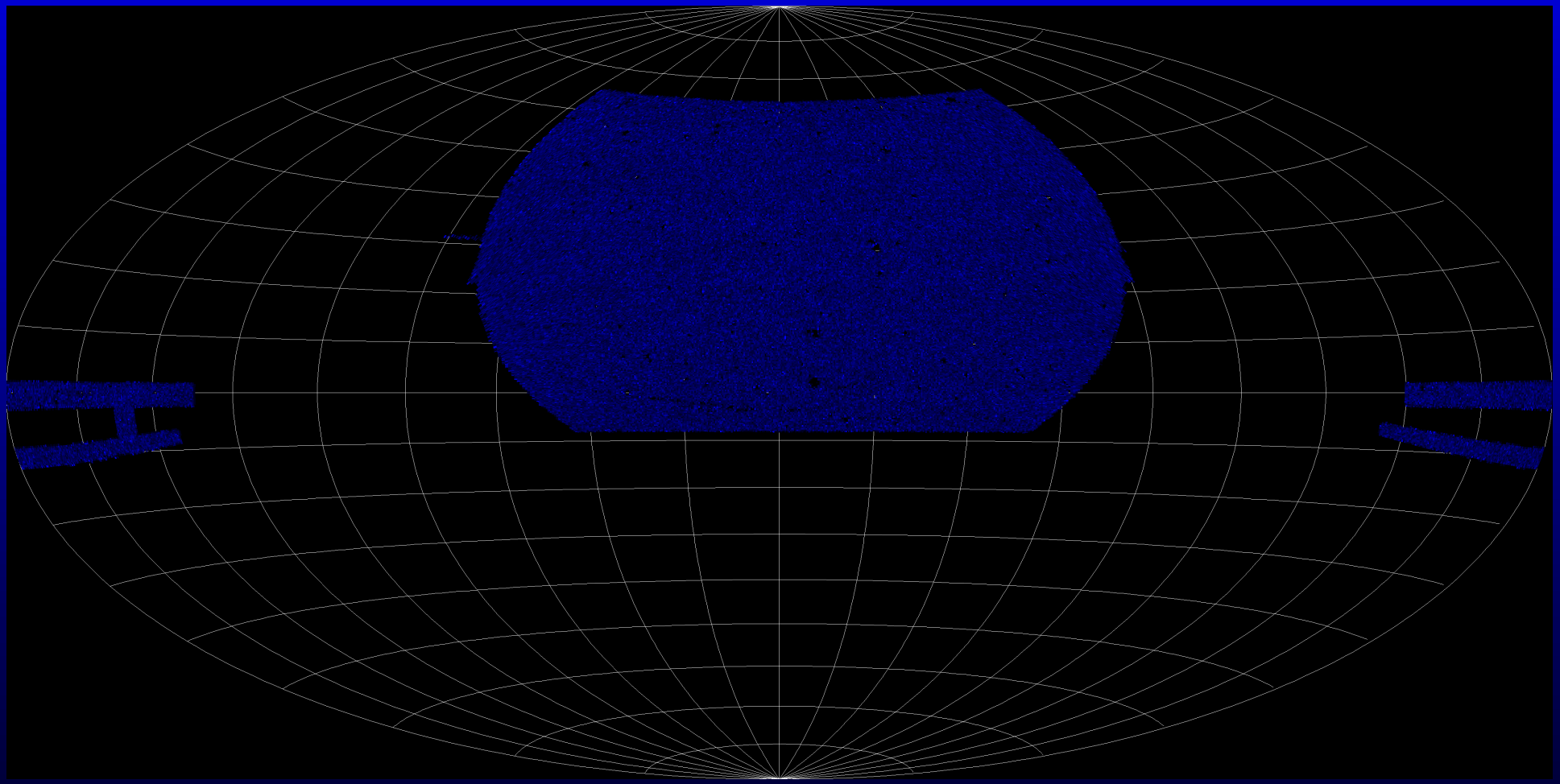
FIRST – background flux $< 0.17$ mJy

# FIRST



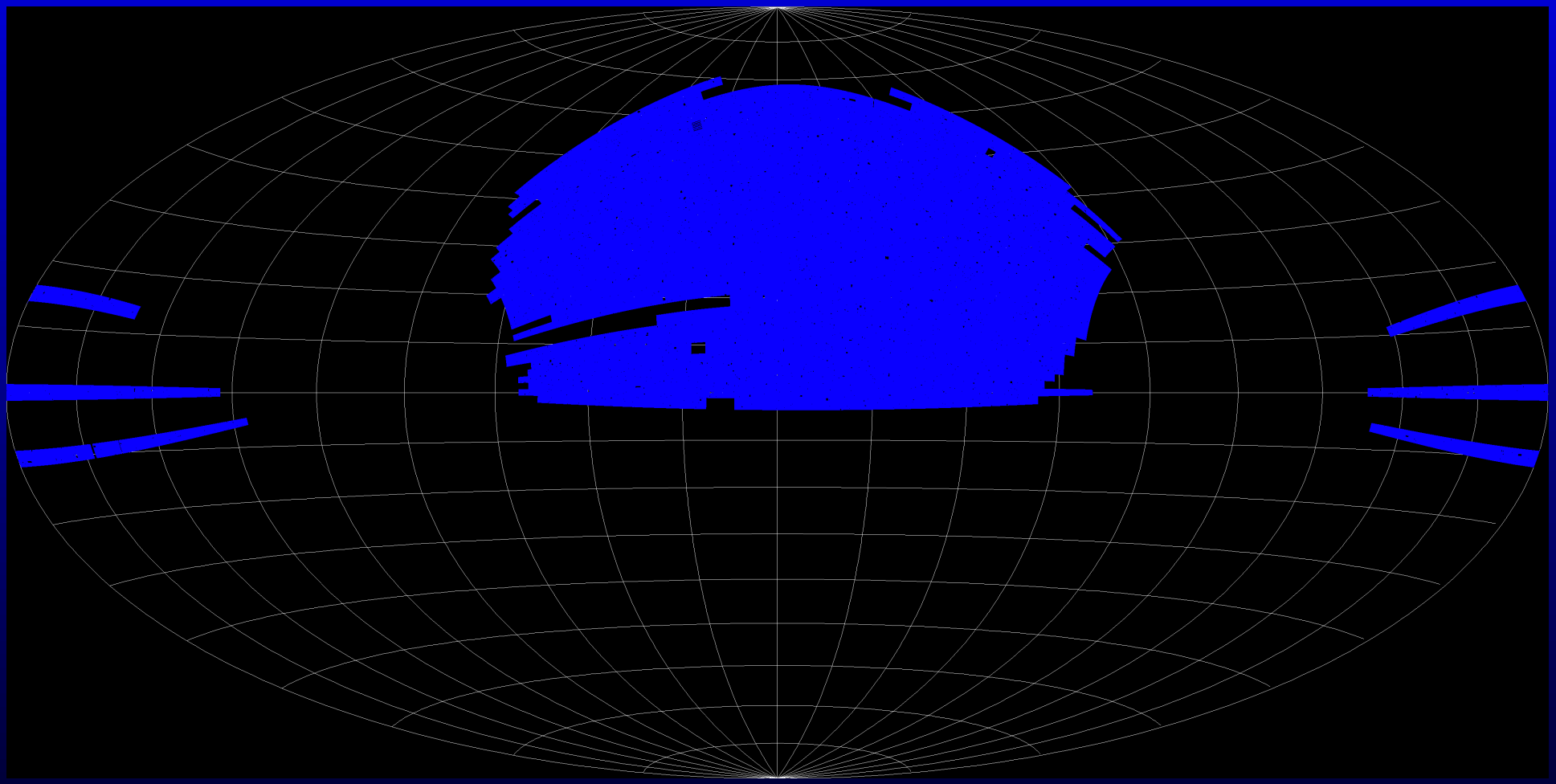
FIRST – flux $> 50$ mJy (AGNs with $z \sim 1.5$)

# FIRST



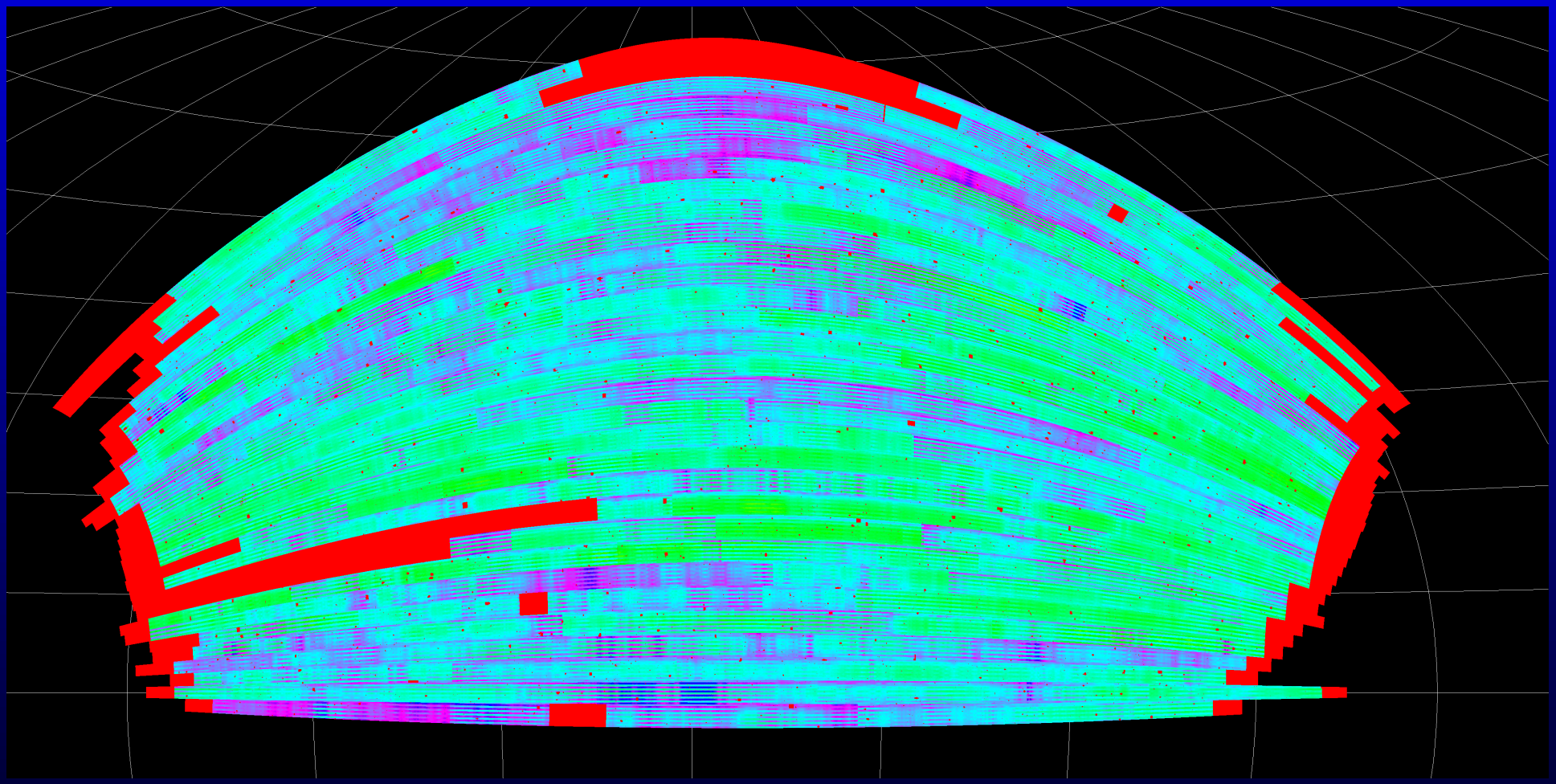
FIRST – flux $< 10$ mJy (star-forming galaxies with $z \sim 1$)

# SDSS



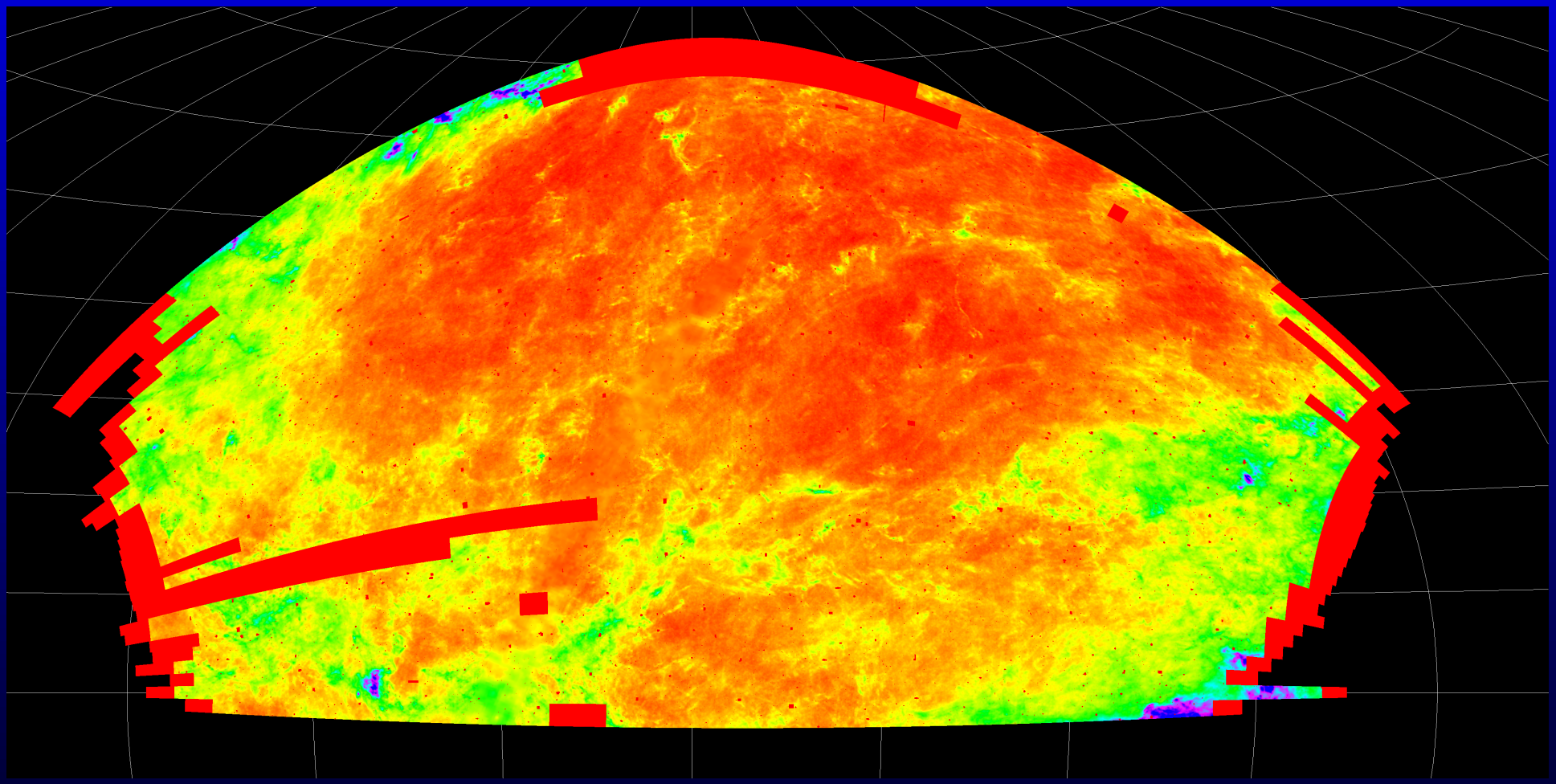
SDSS DR5 Photometric Survey

# SDSS



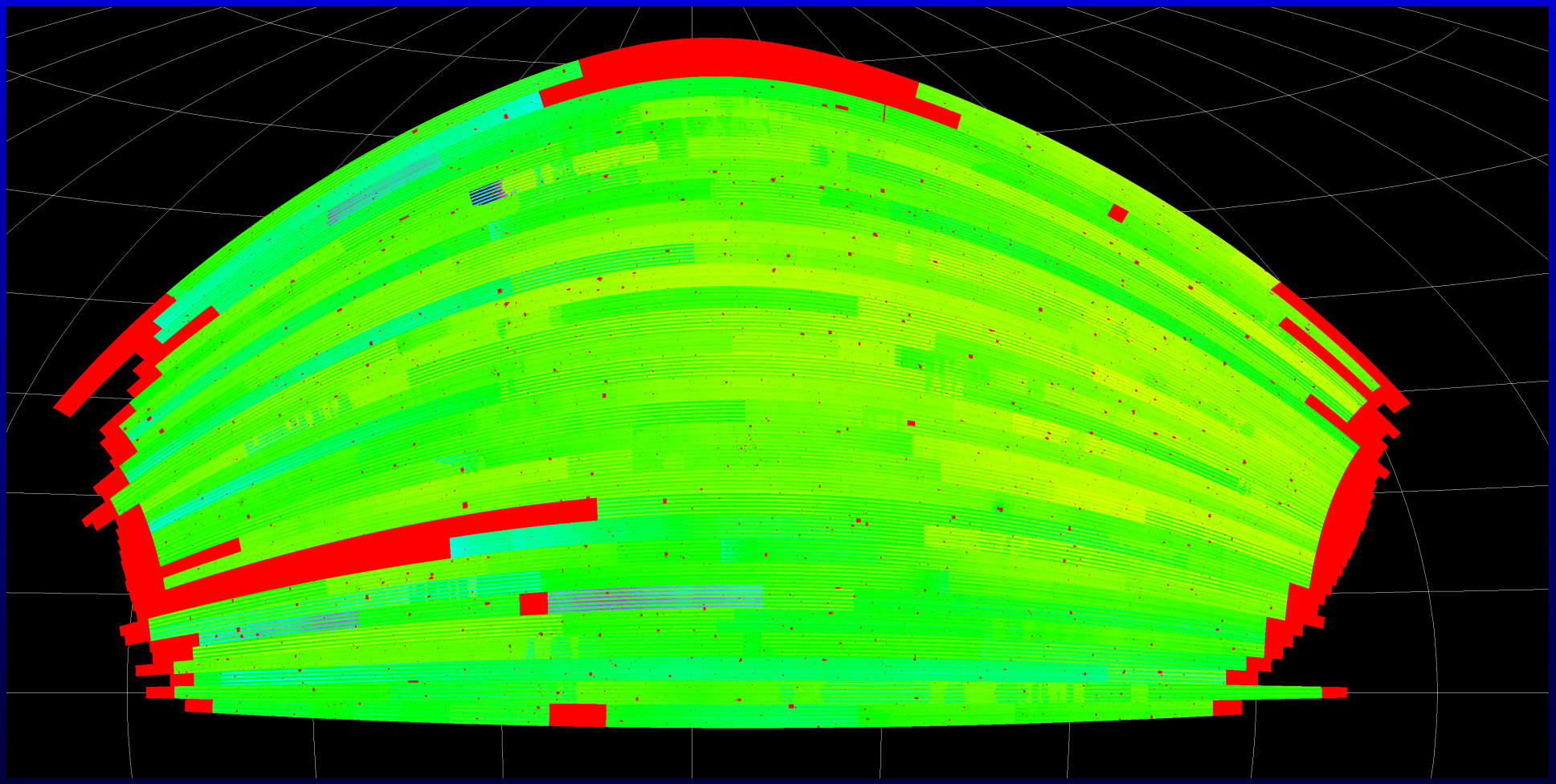
SDSS DR5 Photometric Survey – Seeing

# SDSS



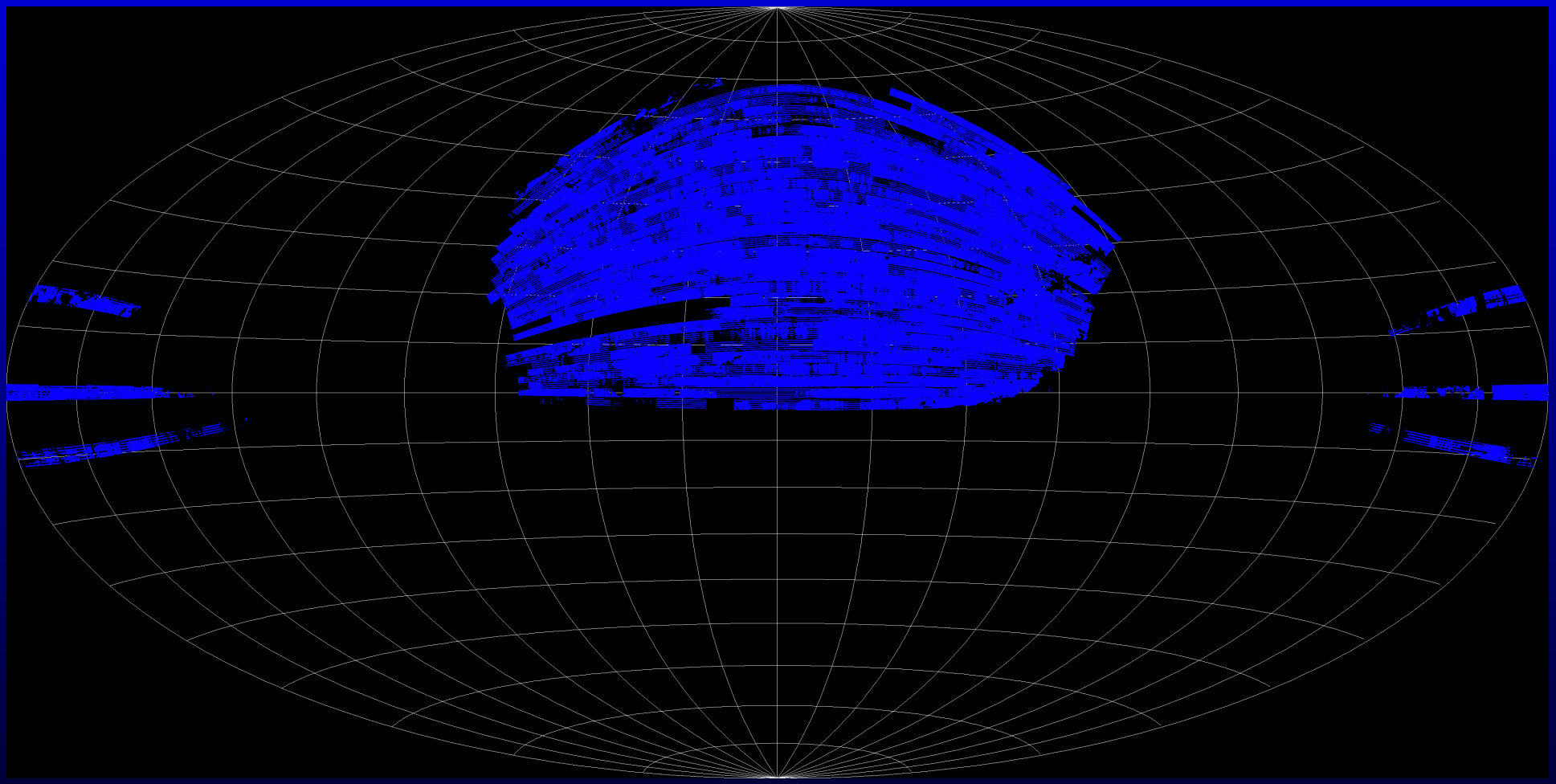
SDSS DR5 Photometric Survey – Reddening

# SDSS



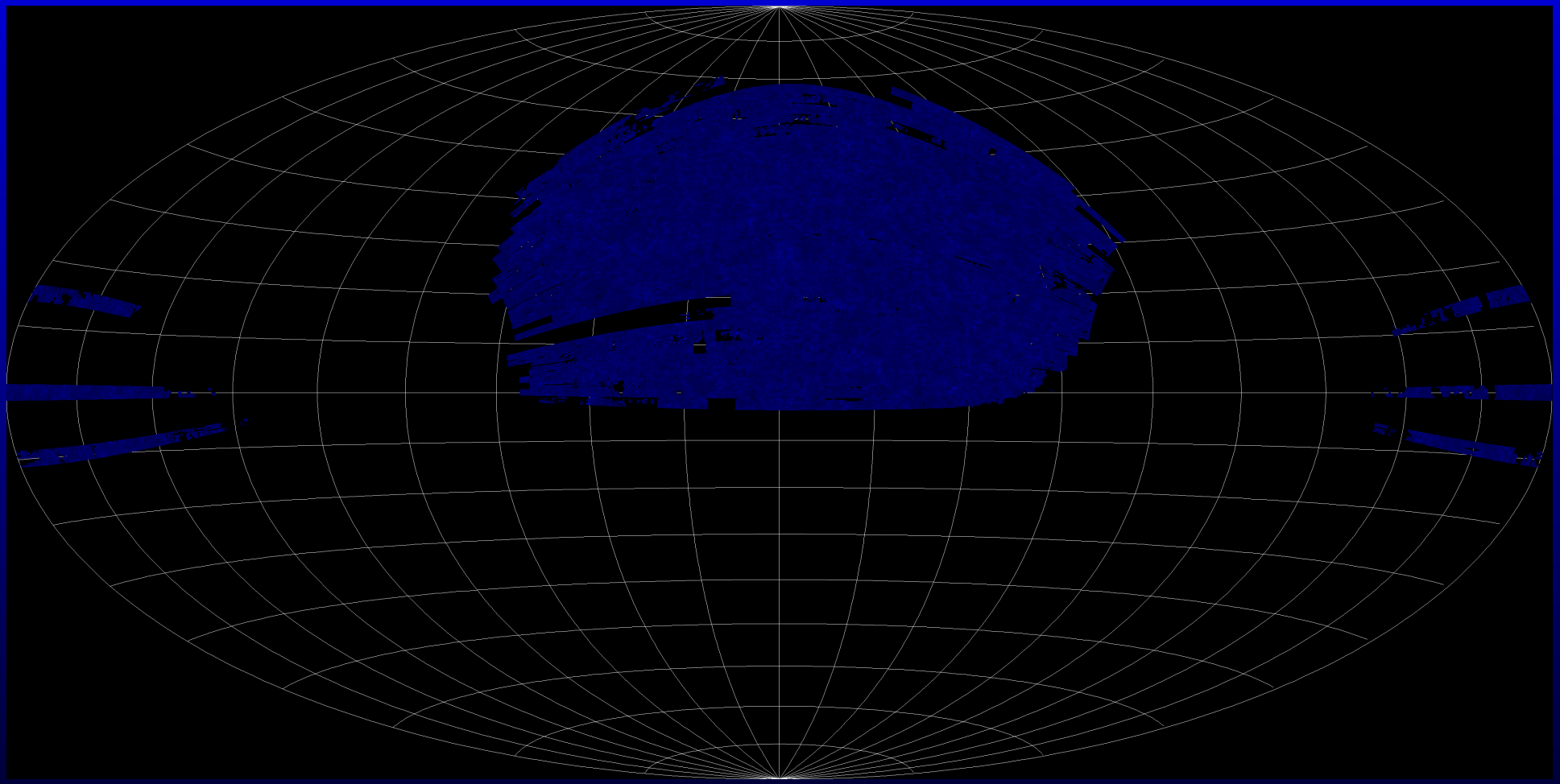
SDSS DR5 Photometric Survey – Sky Brightness

# SDSS



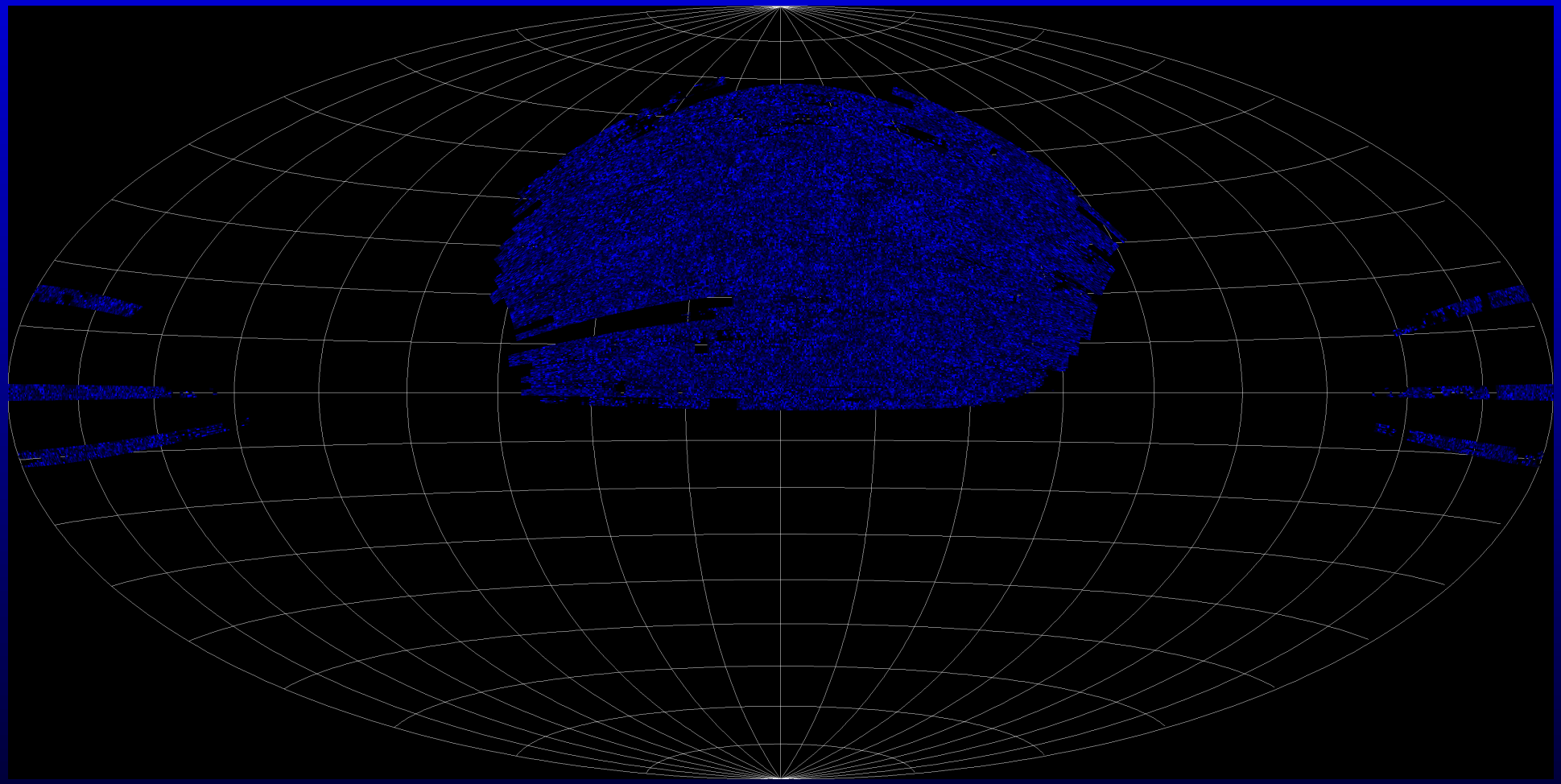
SDSS DR5 Photometric Survey – Masked against systematics

# SDSS



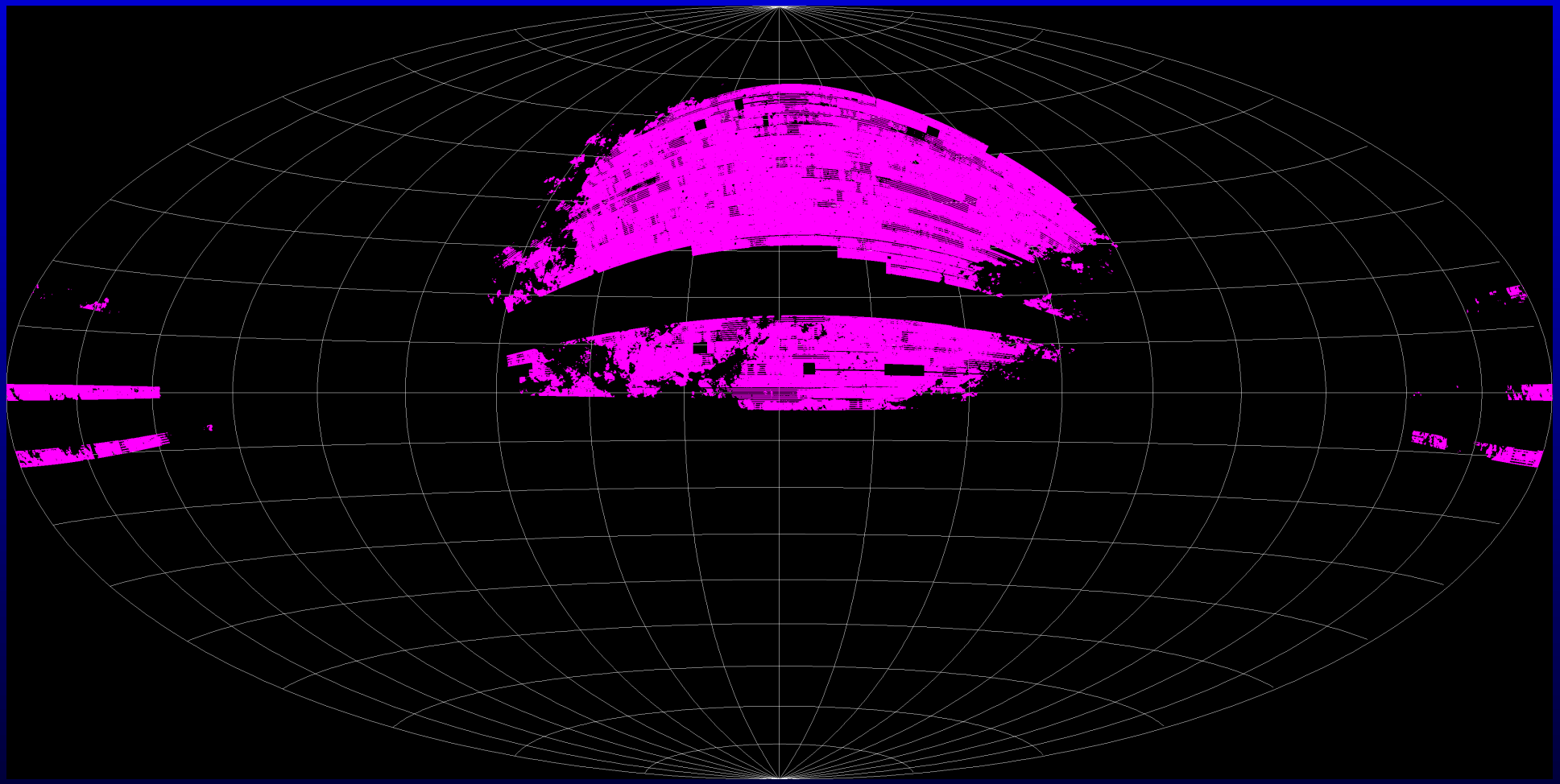
SDSS DR5 Magnitude-Limited ($20 < r < 21$, $z \sim 0.3$)

# SDSS



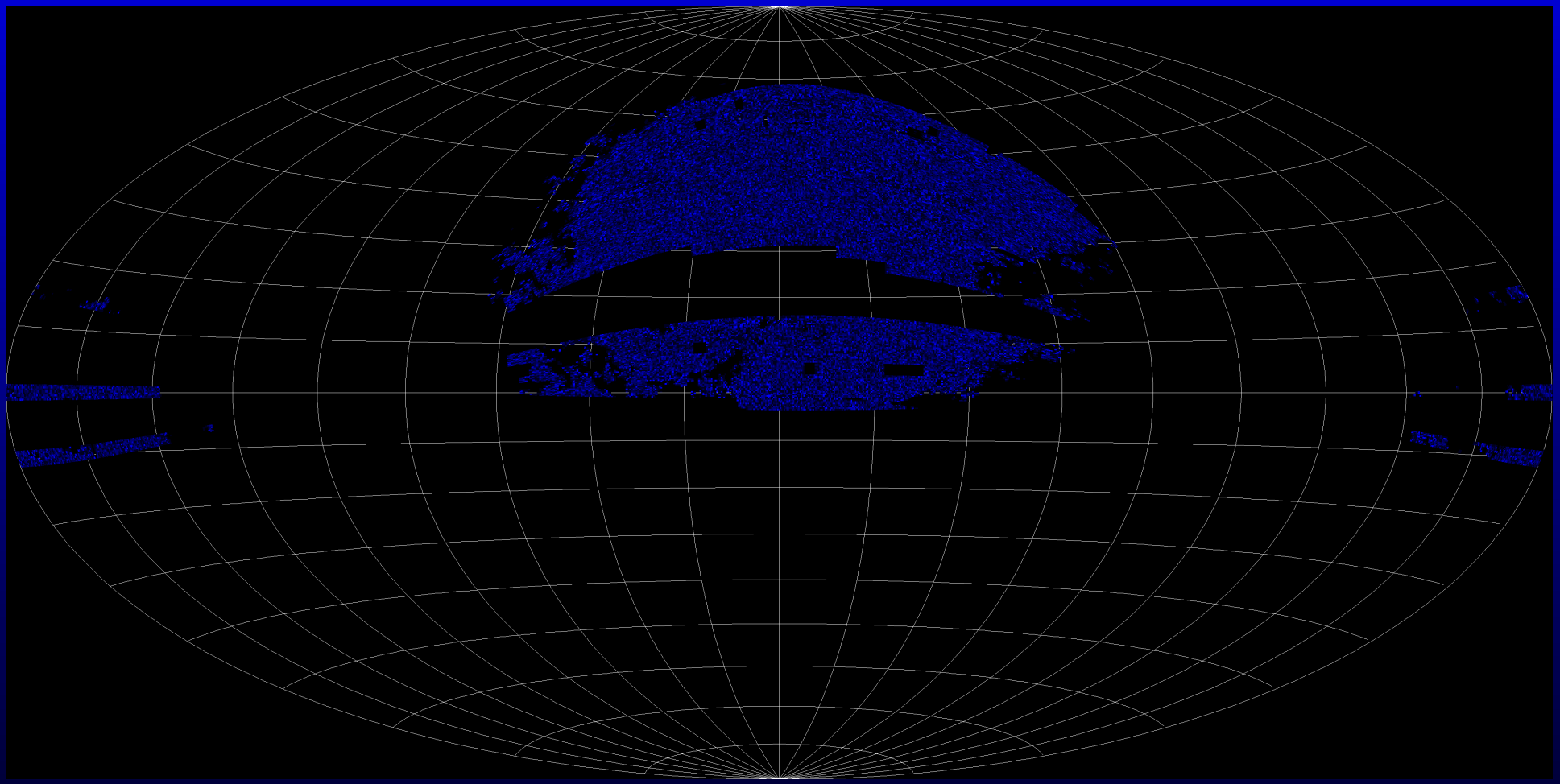
SDSS DR5 LRG ($z \sim 0.55$)

# SDSS Photometric QSOs



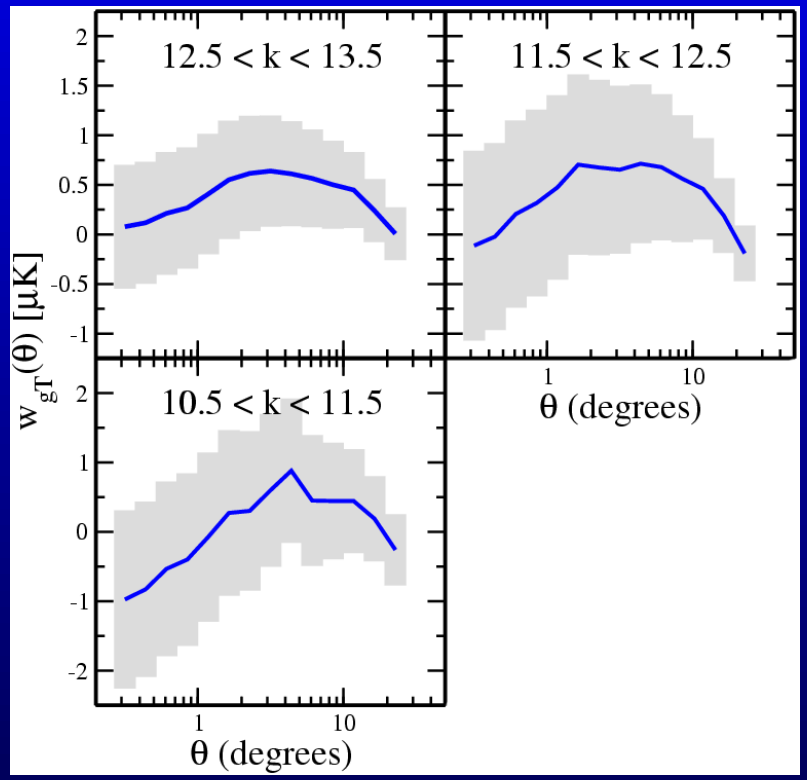
SDSS DR4 Photometric Survey – $A_g < 0.15$

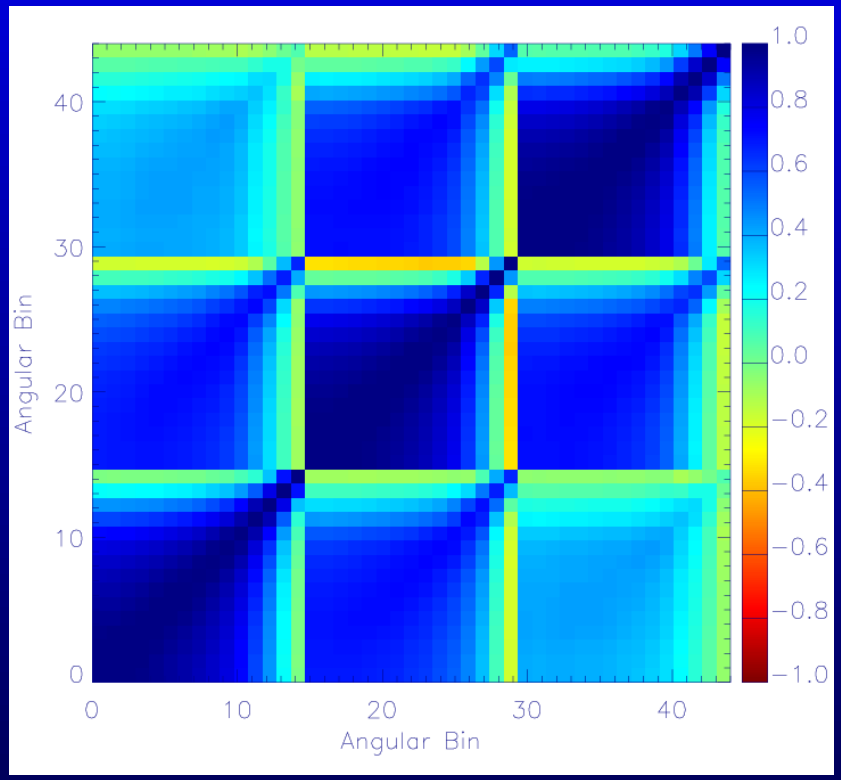
# SDSS



SDSS DR4 Photometric QSOs ($1 < z < 2.5$)

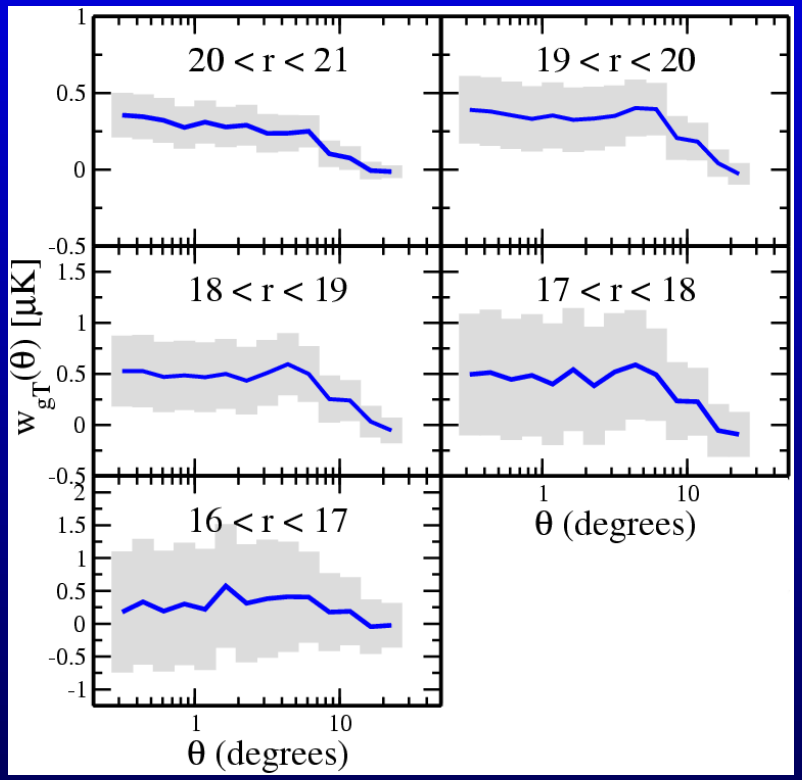
# Results: 2MASS

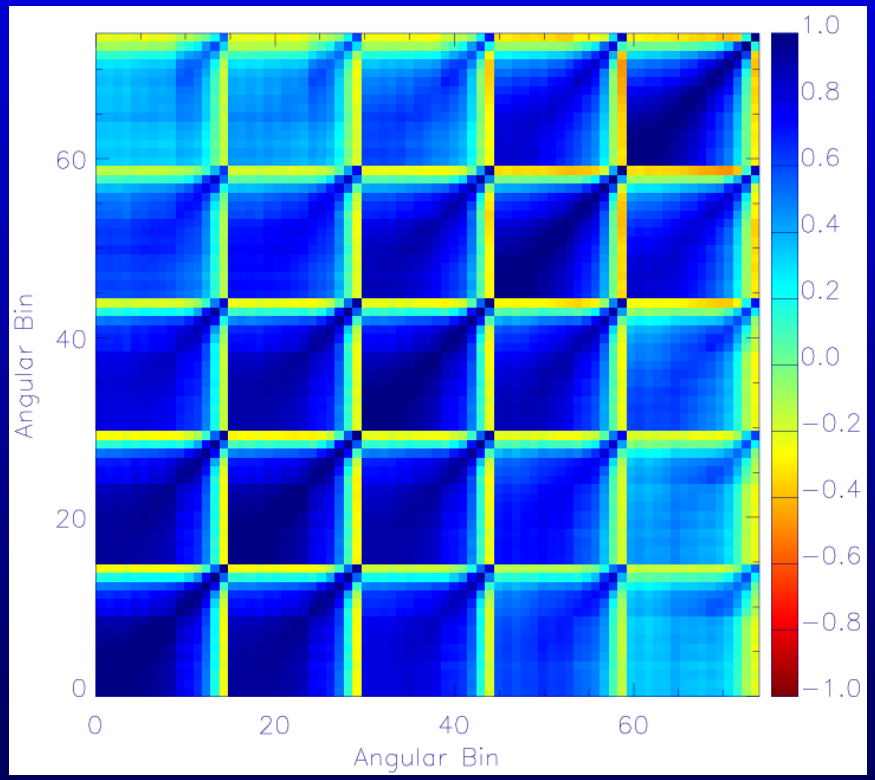



- Strong SZ signal at small angles; increasing as $z \to 0$
- $\chi^2 = 59.8$ for 45 angular bins: $1.3\sigma$

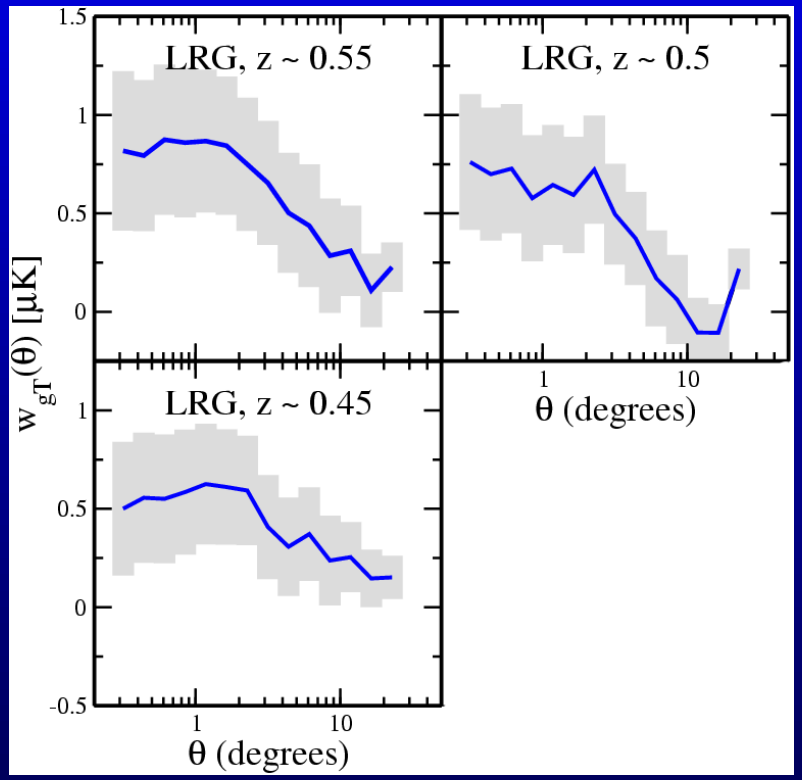
# Results: SDSS Magnitude Limited

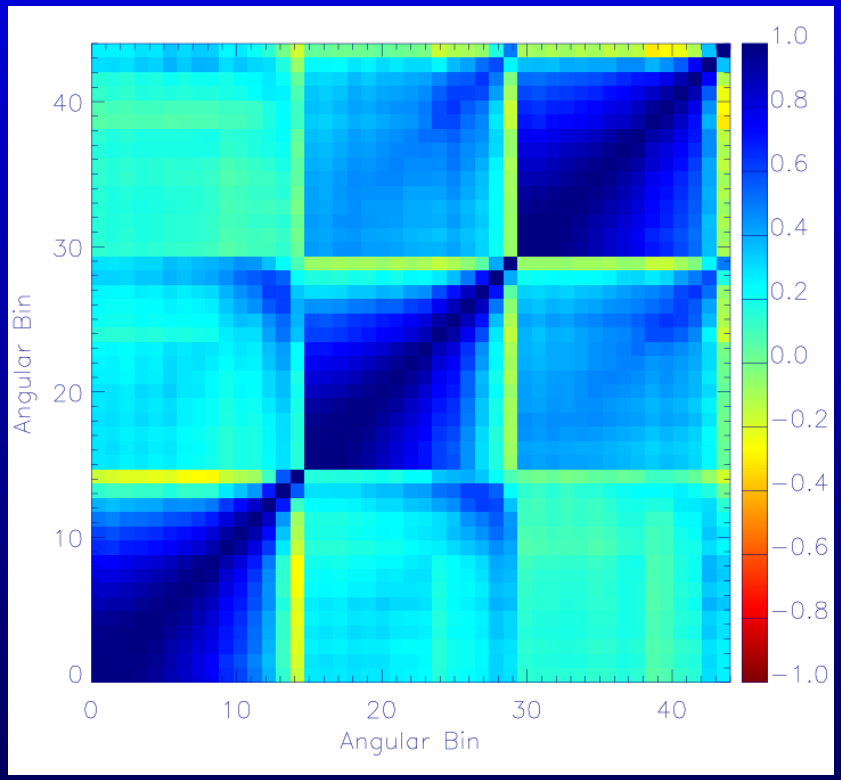



- Increasing S/N as $z$ increases
- $\chi^2 = 136.4$ for 75 angular bins: $3.0\sigma$

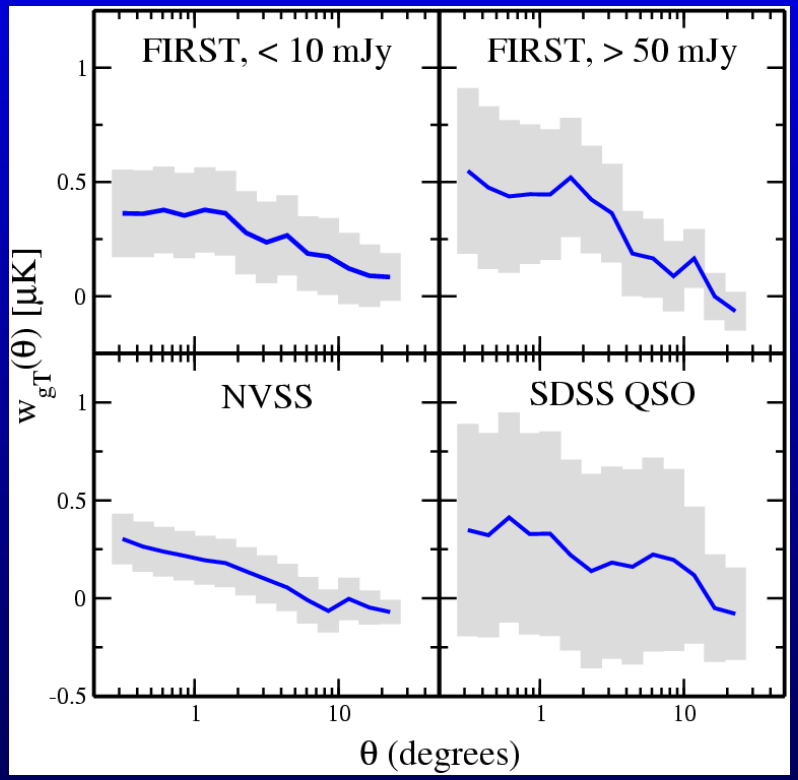
# Results: SDSS LRGs

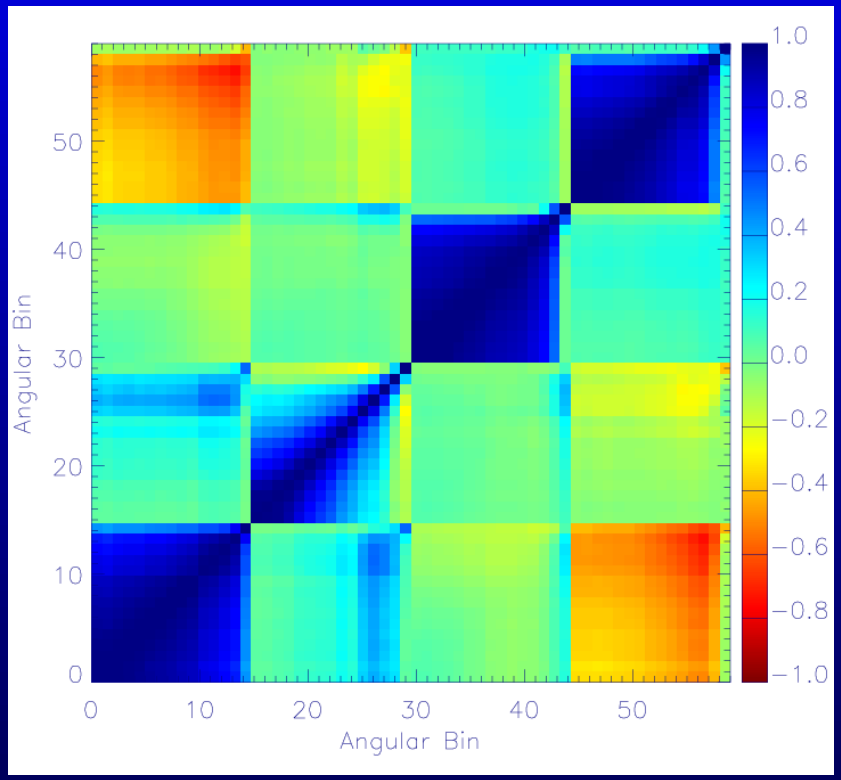



- Dropped lowest redshift bin from Scranton et al (2003); lower S/N
- $\chi^2 = 87.2$ for 45 angular bins: $2.7\sigma$

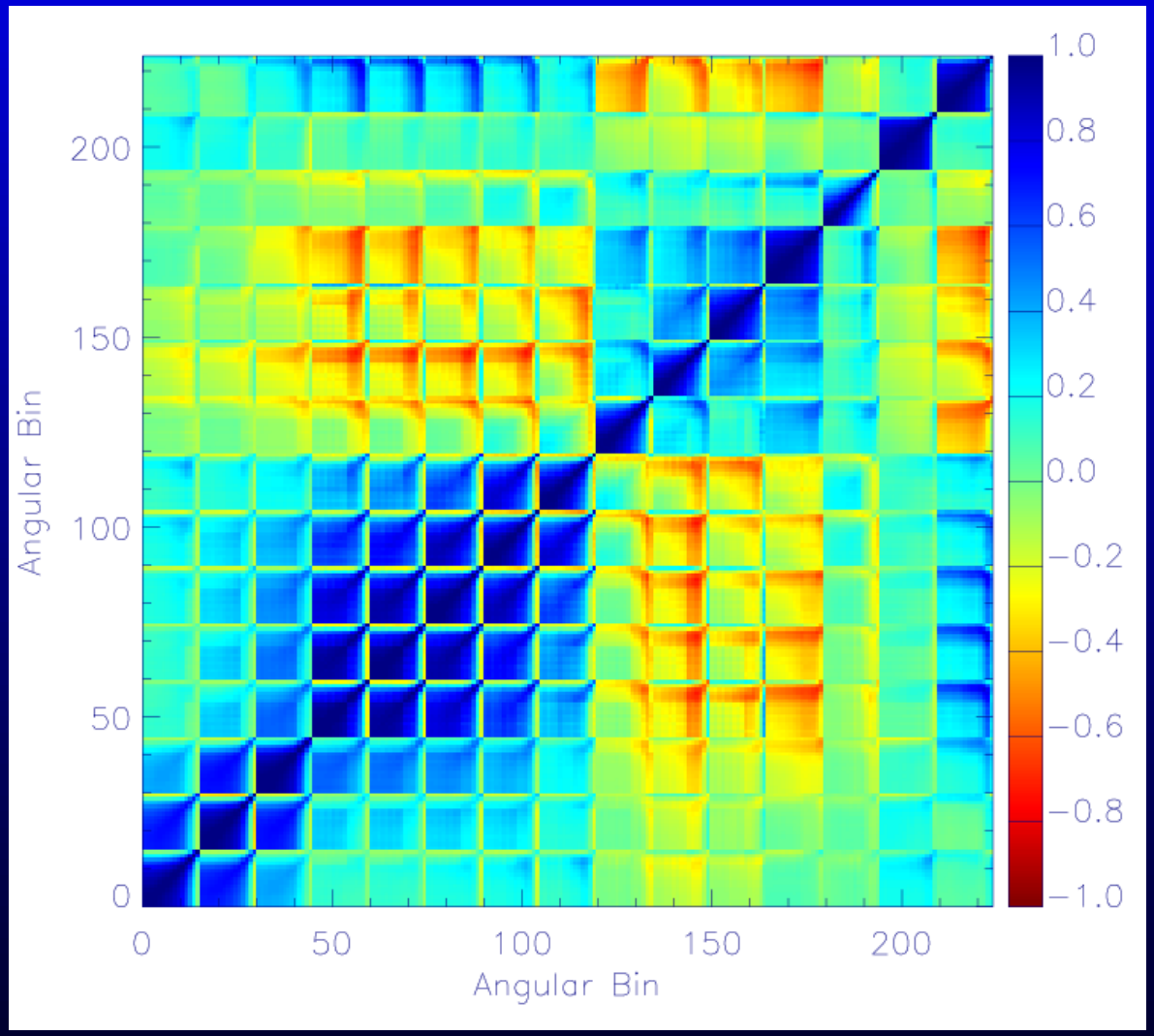
# Results: High Redshift



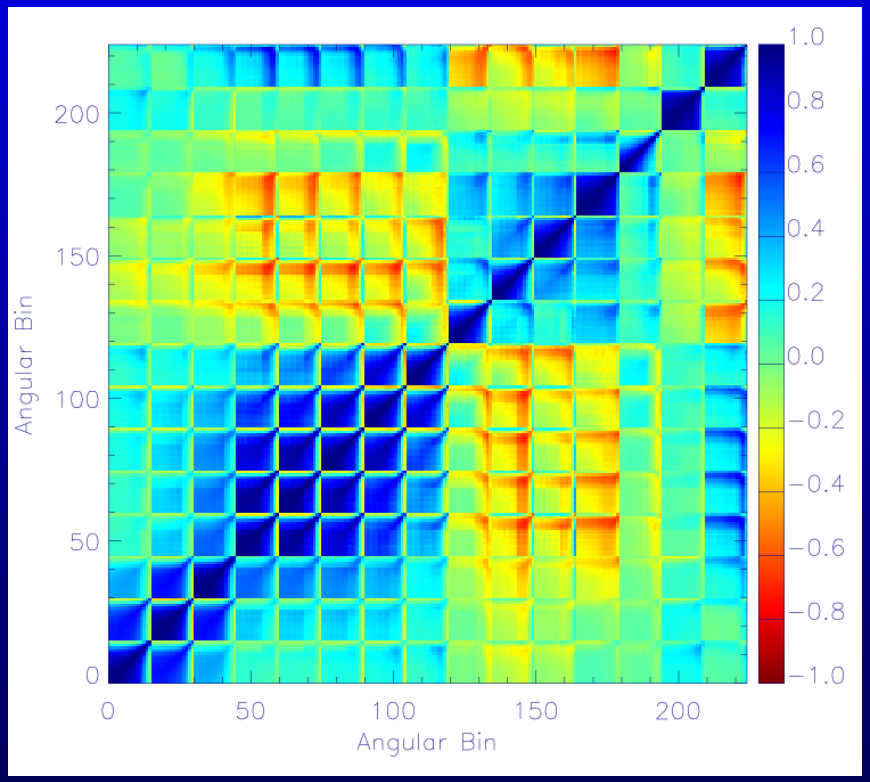




- Huge $\chi^2$ for NVSS; probably contaminated.
- $\chi^2 = 130.7$ for 60 angular bins: $3.6\sigma$

# Results: Global Sample $0 < z < 2.5$



# Results: Global Sample $0 < z < 2.5$




- Significant anti-correlations; magnification bias?
- $\chi^2 = 461.5$ for 225 angular bins: $6.2\sigma$ ($5.3\sigma$ w/o NVSS)

# Summary

- Current set of surveys all demonstrate ISW signal to one degree or another, but the S/N of any given survey remains relatively small.
- Combining the detections from multiple surveys increases the overall S/N to roughly $5\sigma$
- Part of this increase appears to be due magnification bias between samples at different redshifts.
- While the tools and resources exist to do this measurement quickly and efficiently, one should probably budget more than 20 days next time.