POC export at meso- and submesoscales

Melissa Omand, URI

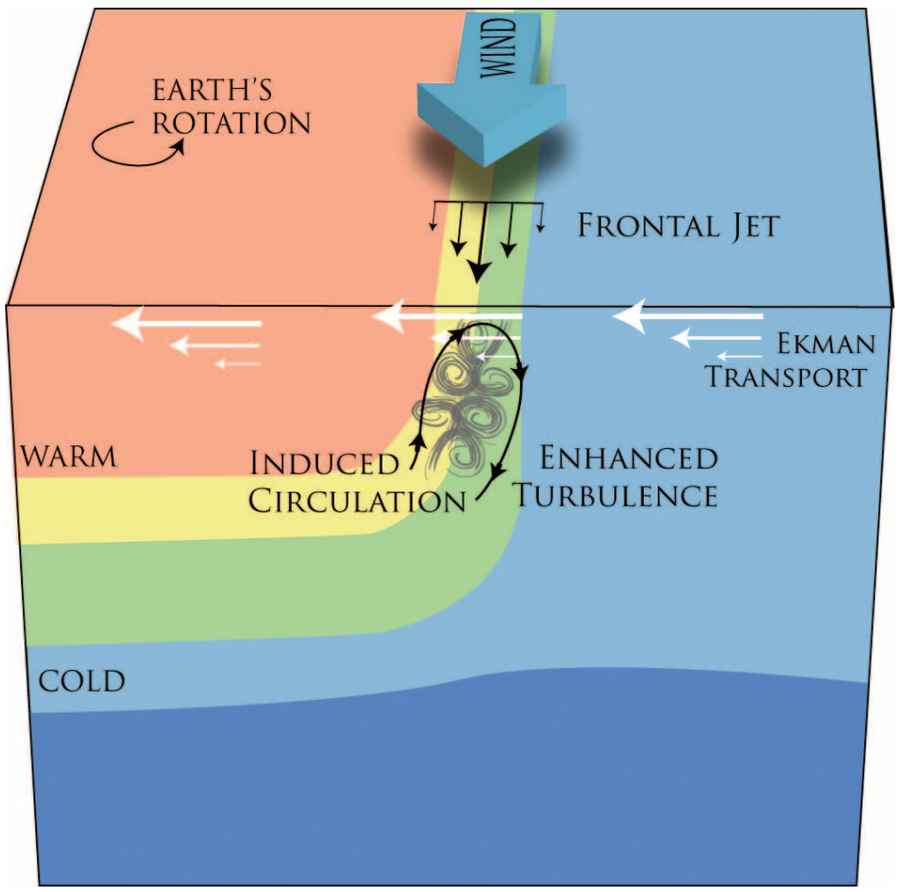
Meso- and Submesoscale instabilities

Visualizing 3D export of non-sinking POC

What about long-term sequestration?

What about sinking particles?

Meso- and Submesoscale instabilities



(D'Asaro, 2011)

Generally arise in regions of strong lateral buoyancy gradients (at fronts)

1) Baroclinic instabilities, frontogenesis
2) Mixed Layer instabilities
3) Symmetric Instabilities (eg. Ekman buoyancy flux)
4) Gravitational instabilities

The temporal and spatial scales, and BGC impacts vary for each.

There are also lots of sources of variability at small scales

Observing these processes is an active area in PO, much has been learned through numerical models

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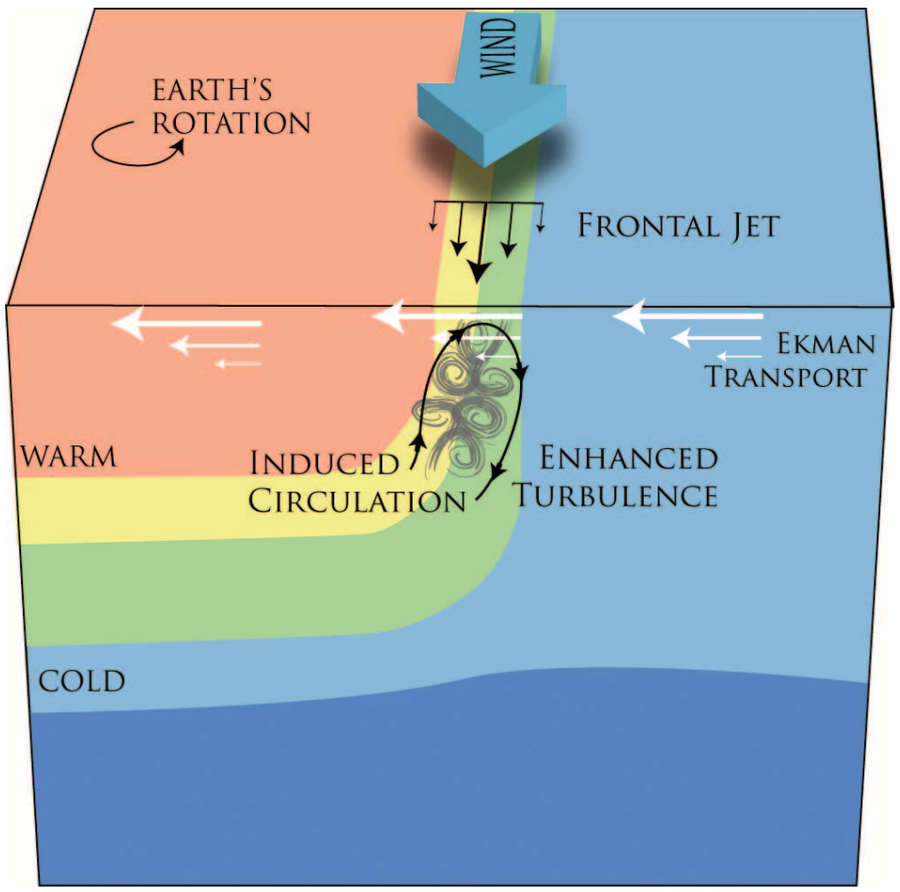

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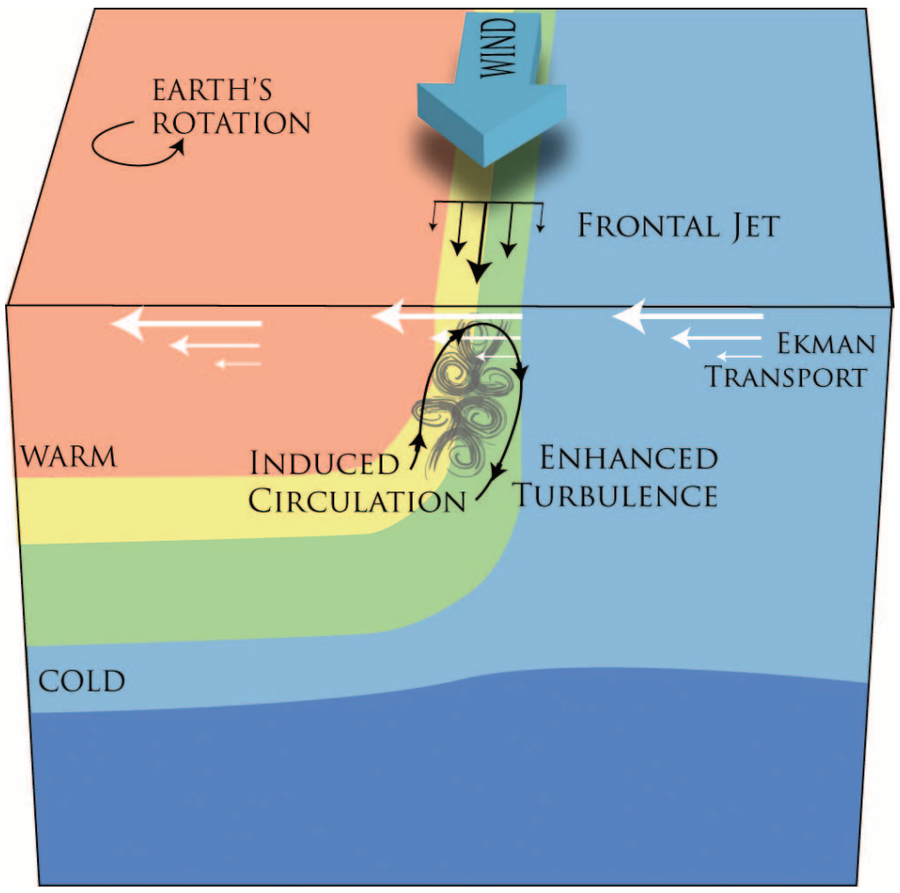

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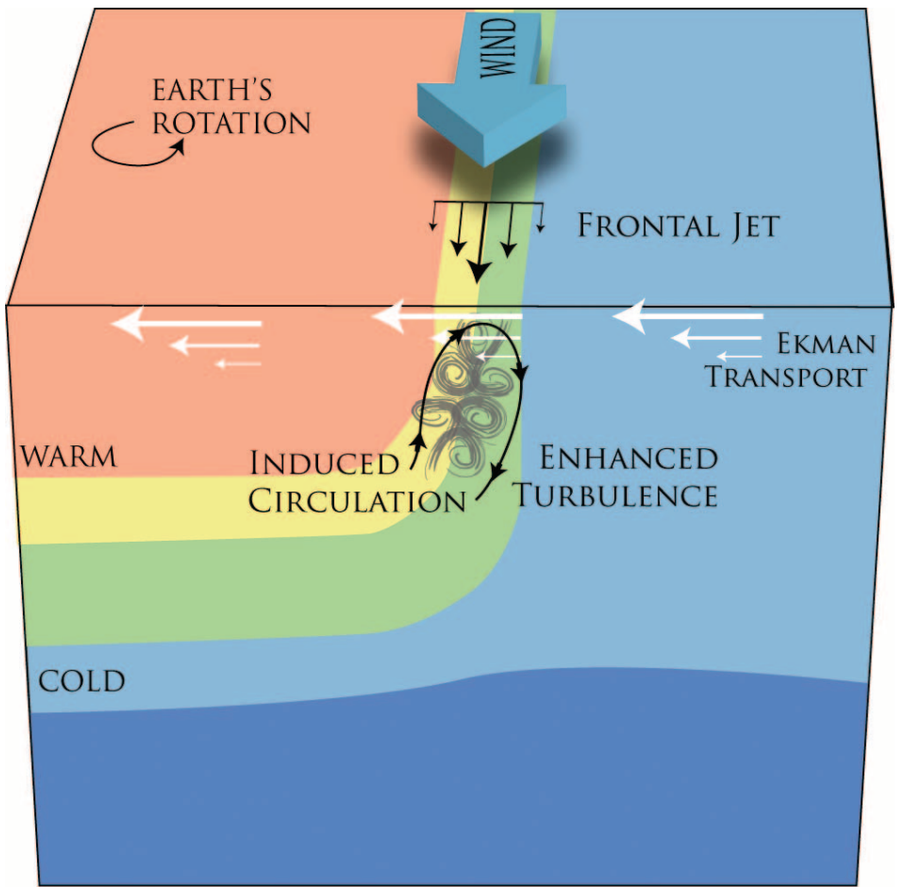

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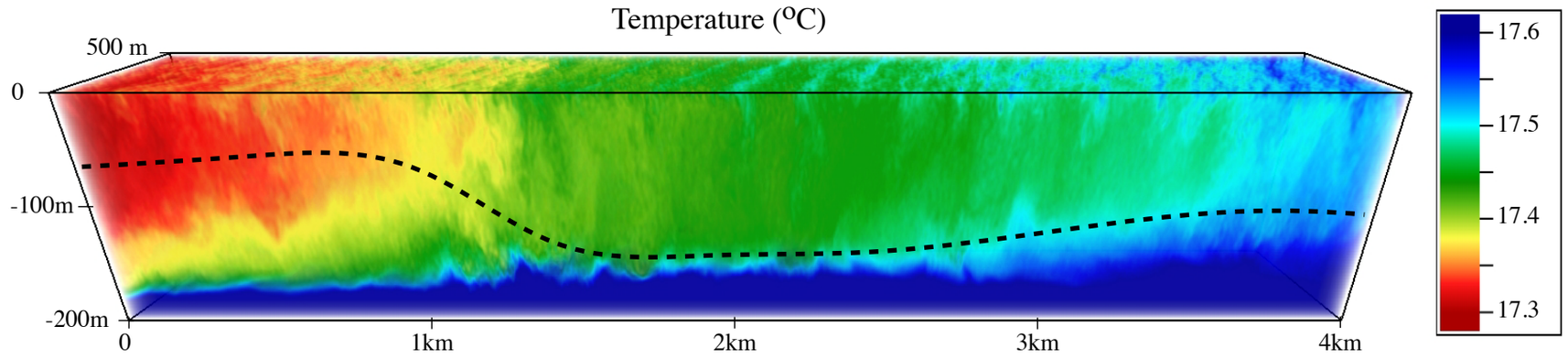

Isopycnals (isotherms) tilt upwards in a region of frontal intensification, MLD varies

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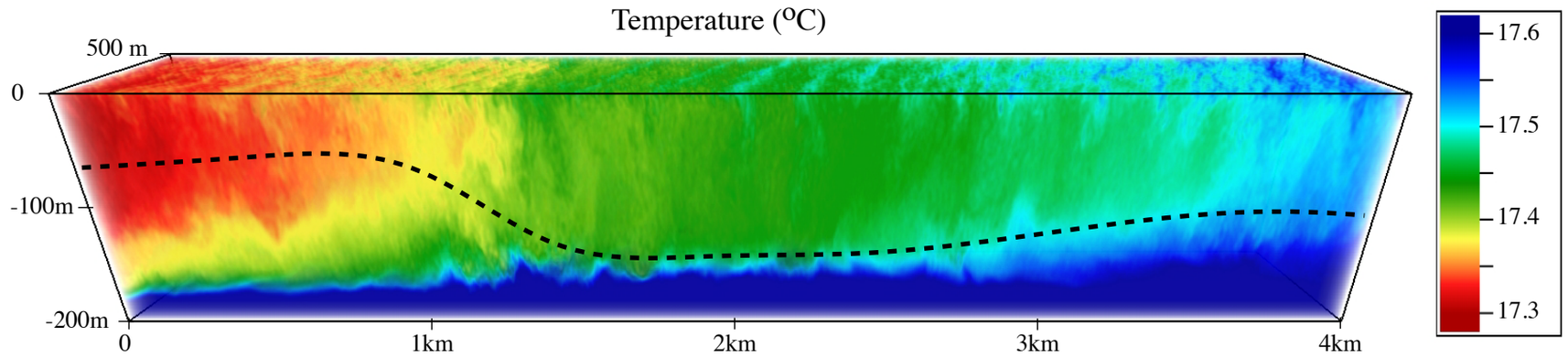

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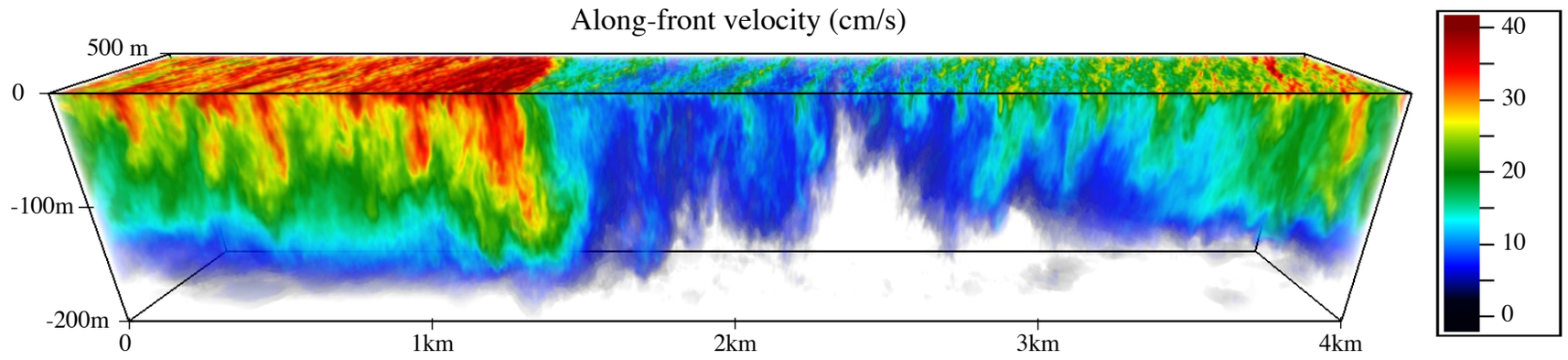

Tilting isopycnals set up a vertical shear in the along-front direction

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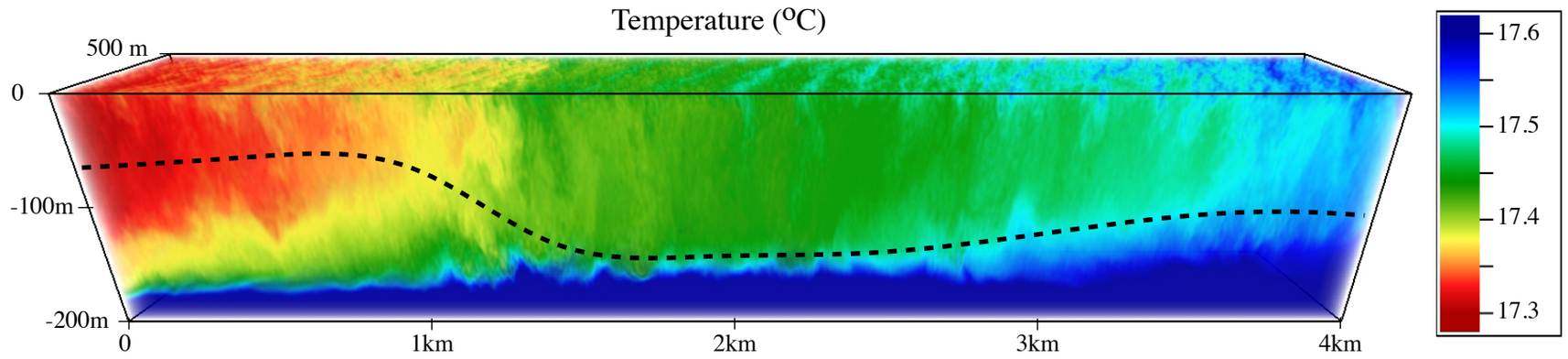

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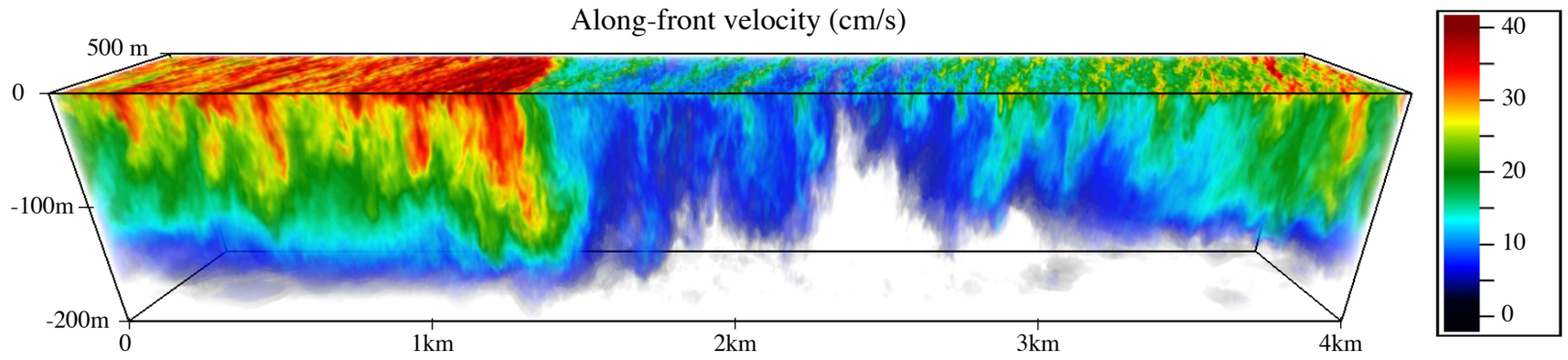

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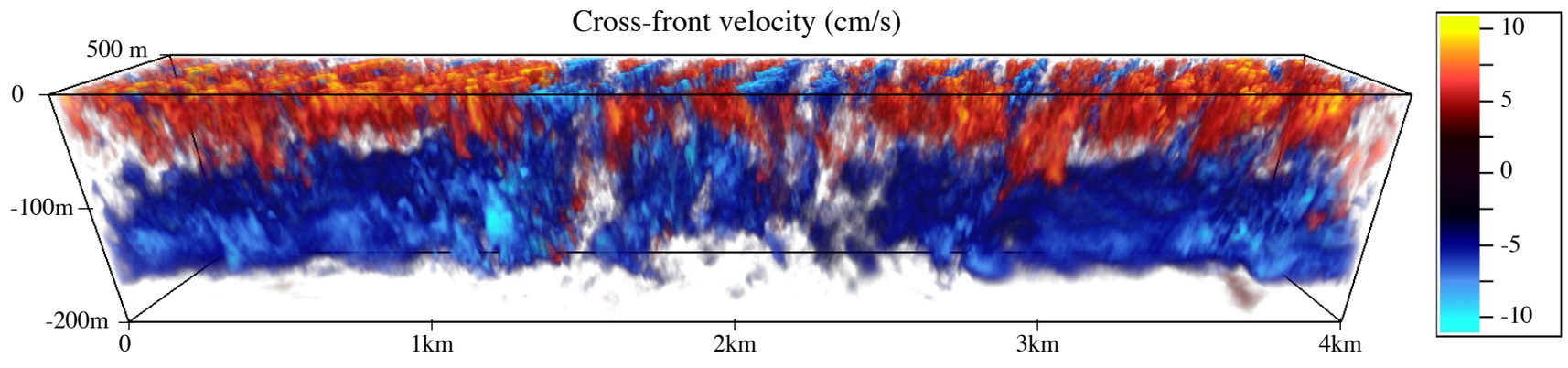
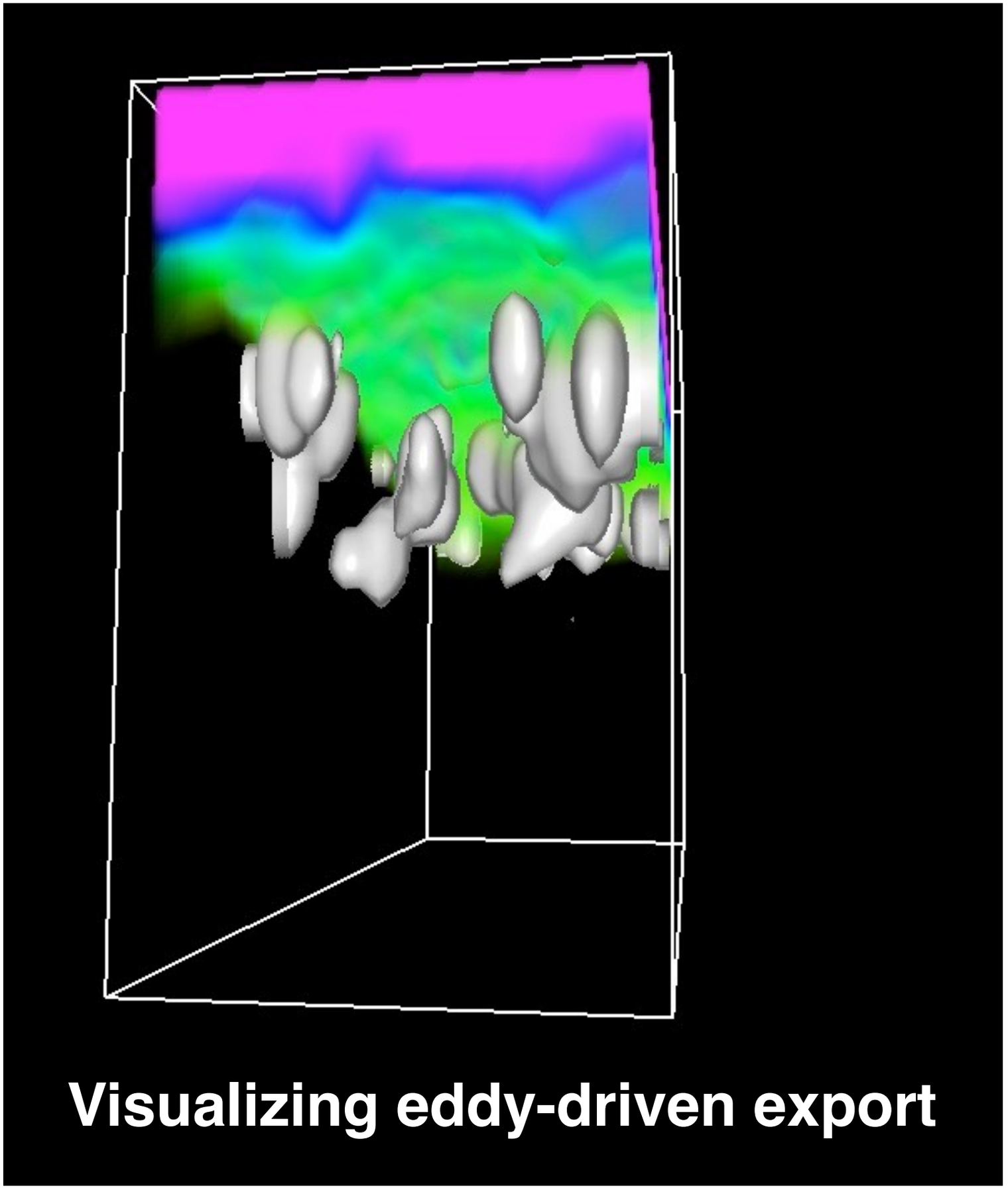
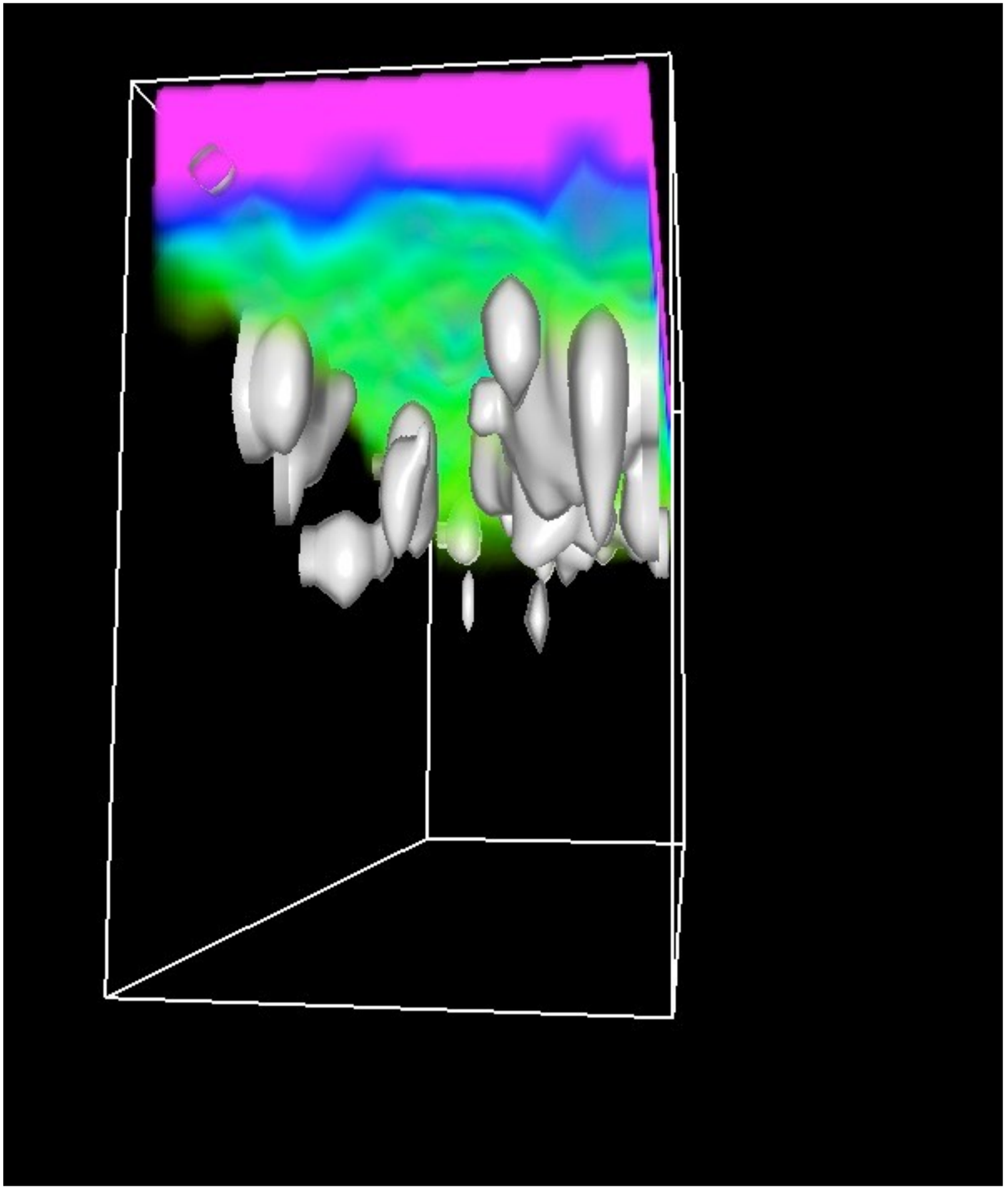
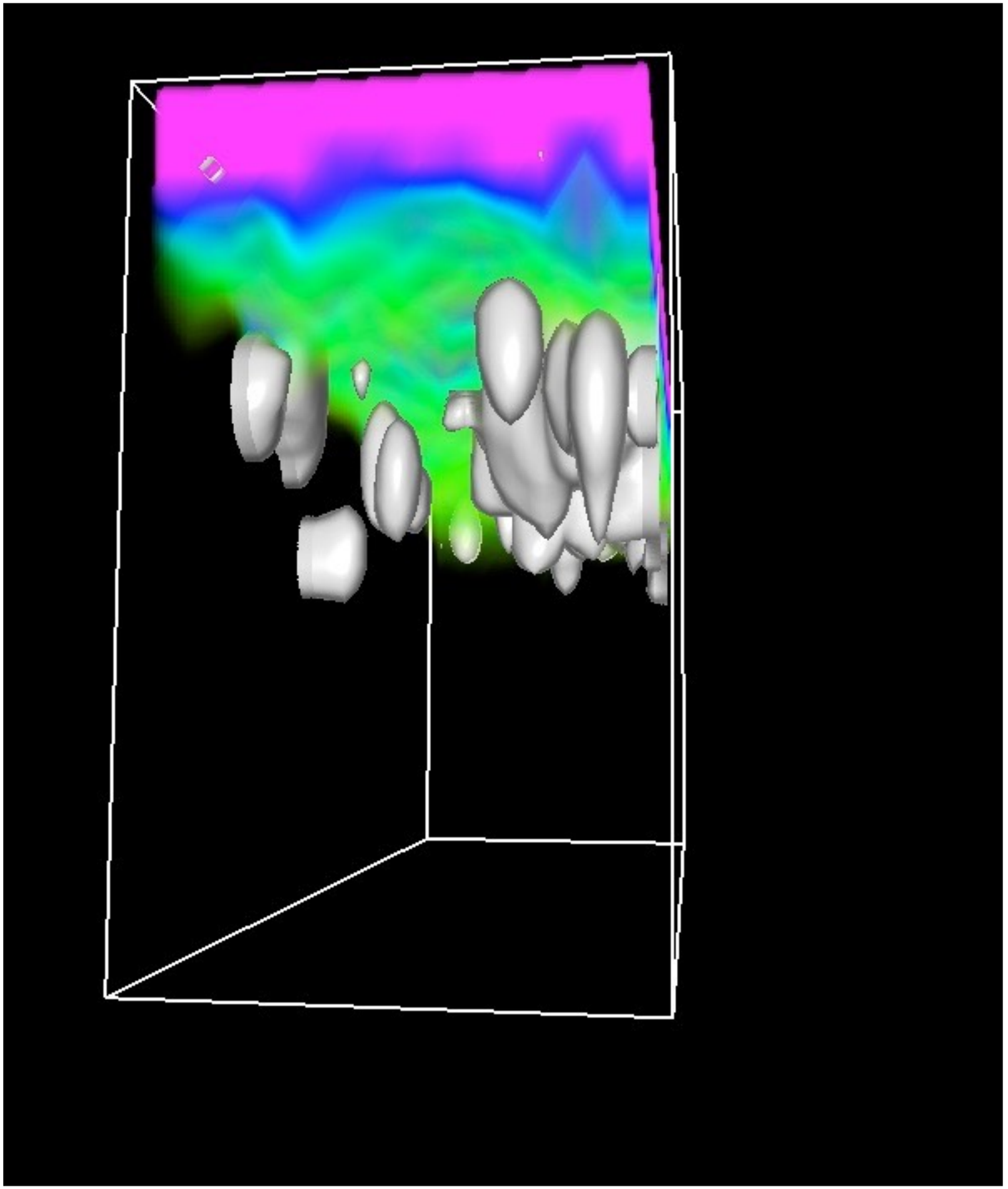
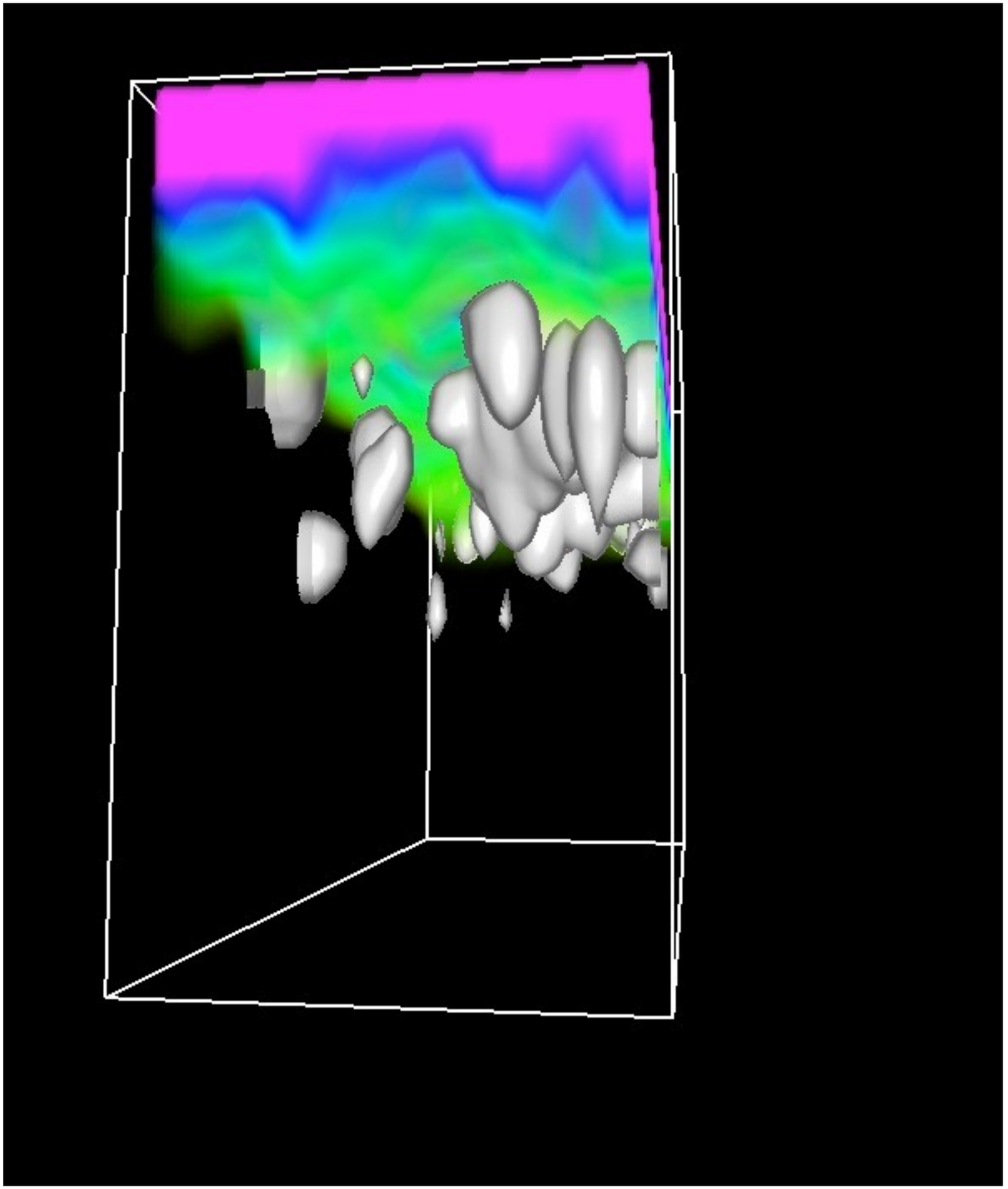


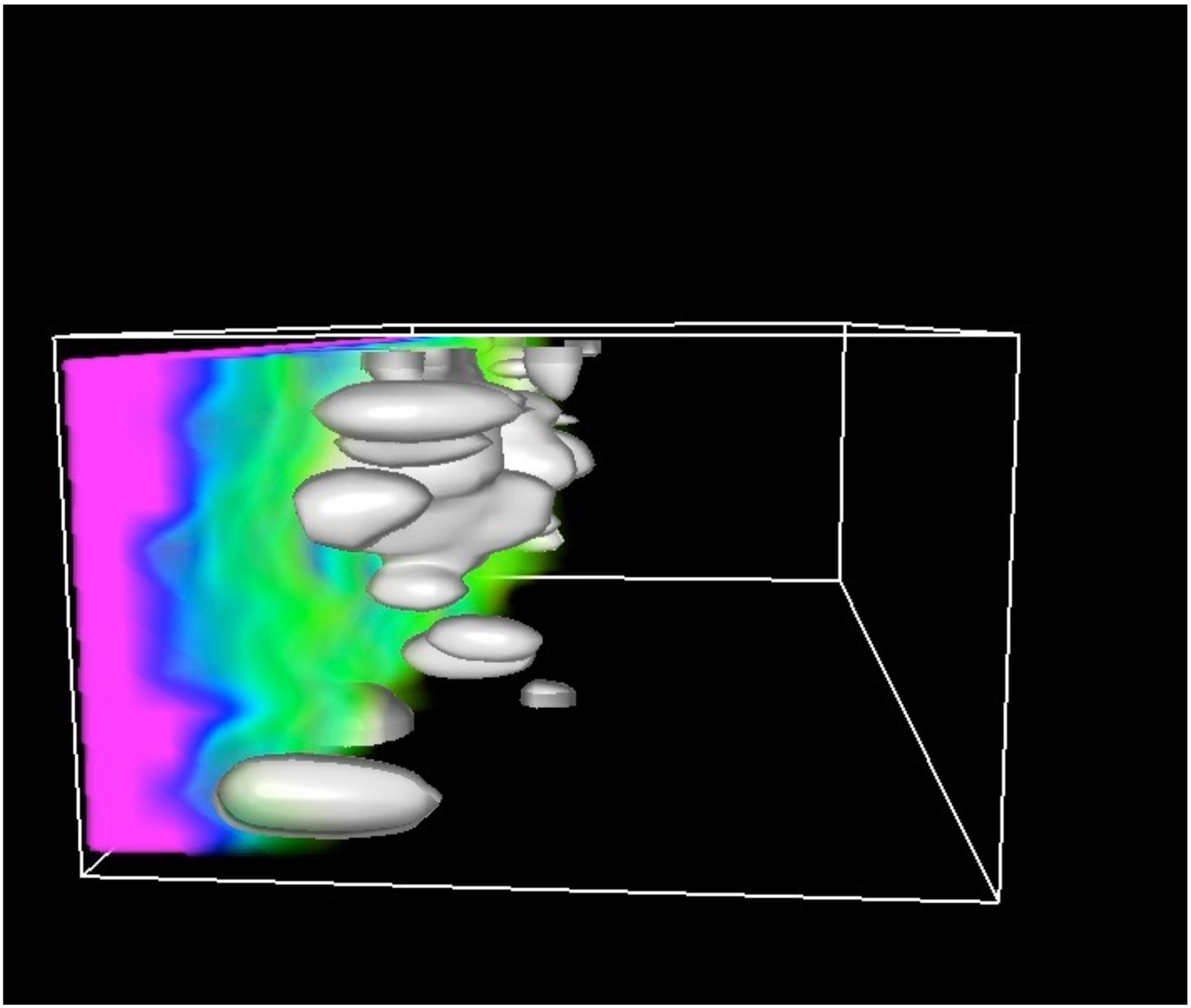
, Ageostrophic motion drives a cross-front circulation, creating downward velocity on the cold side

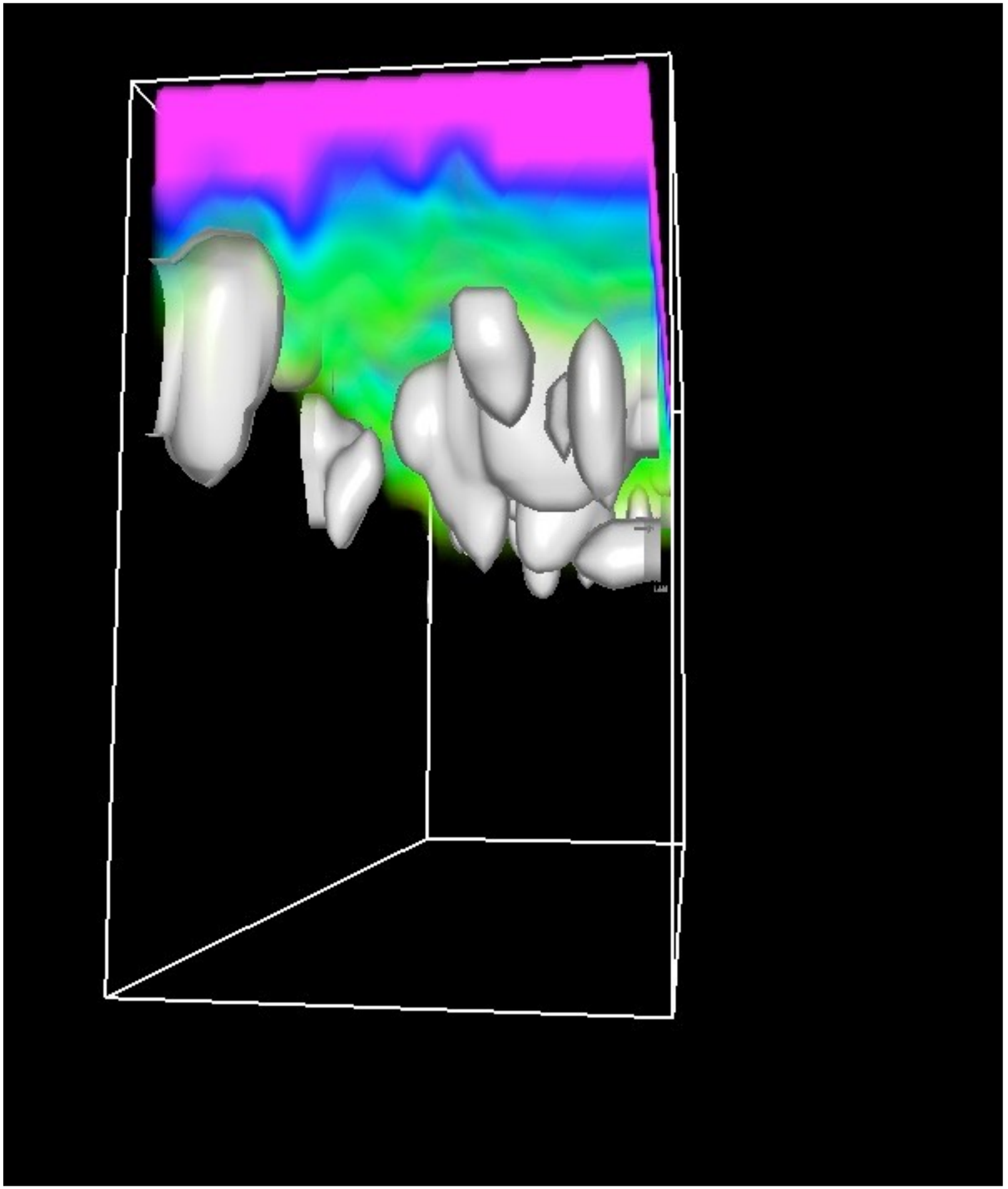

Visualizing eddy-driven export

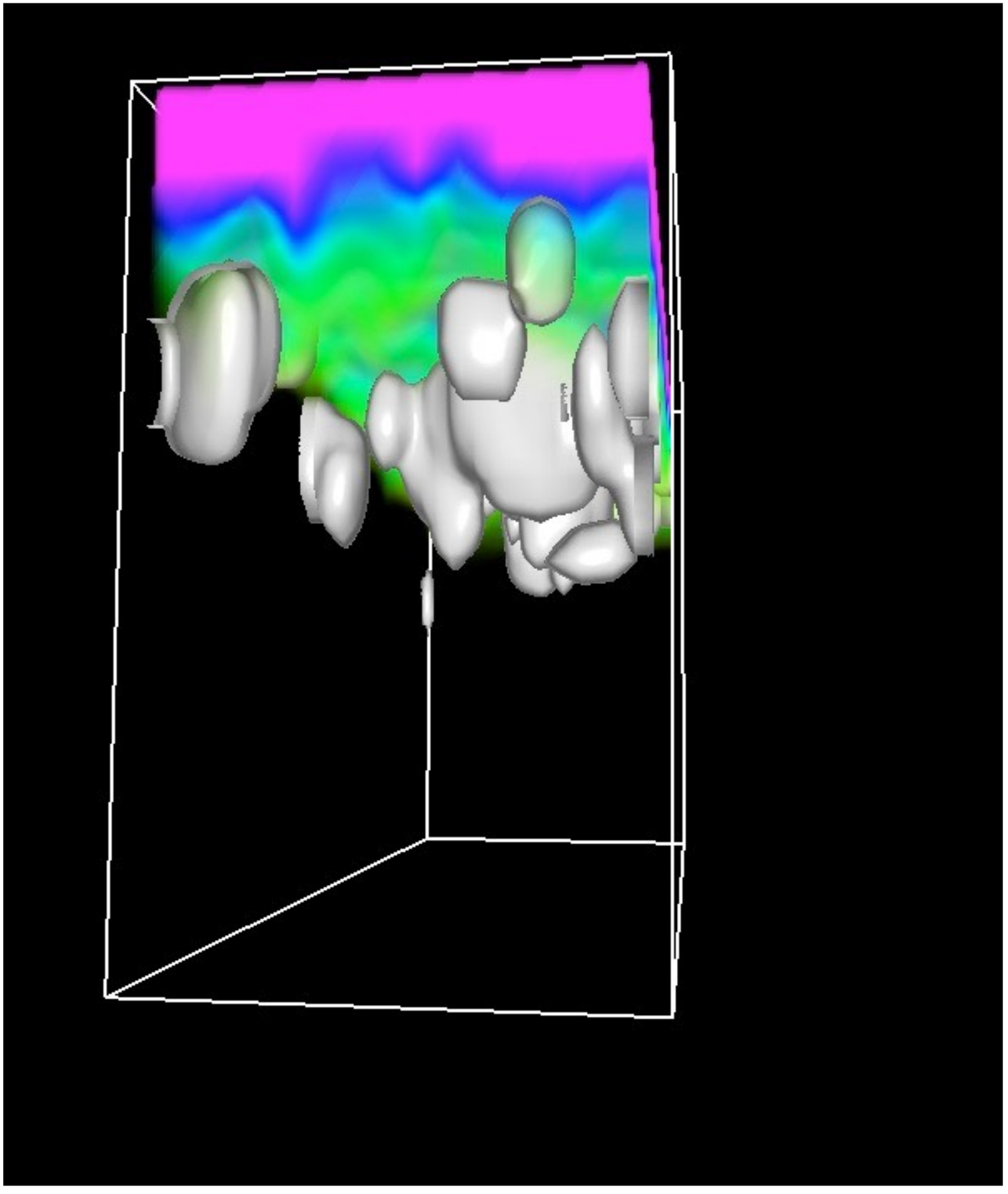


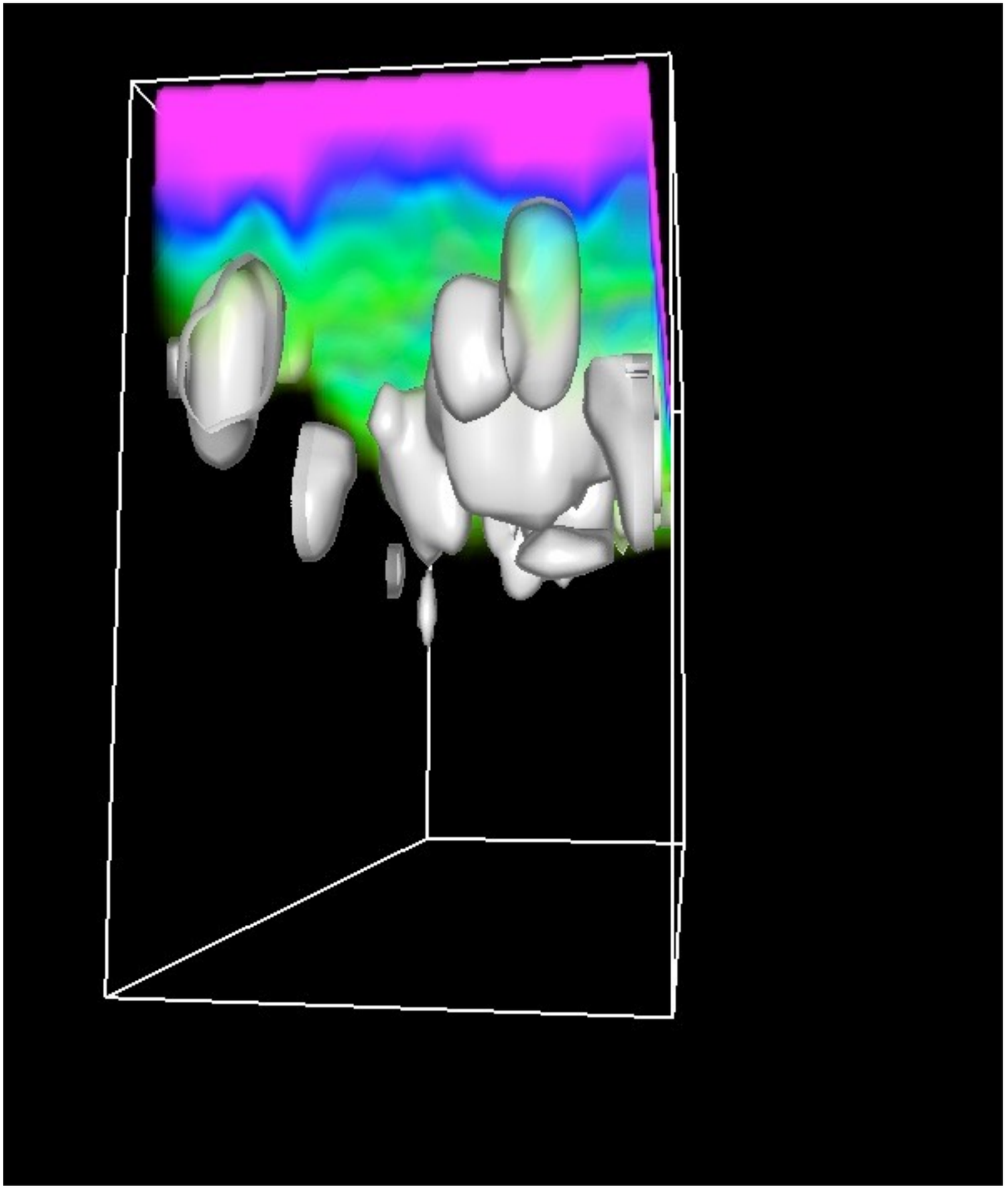


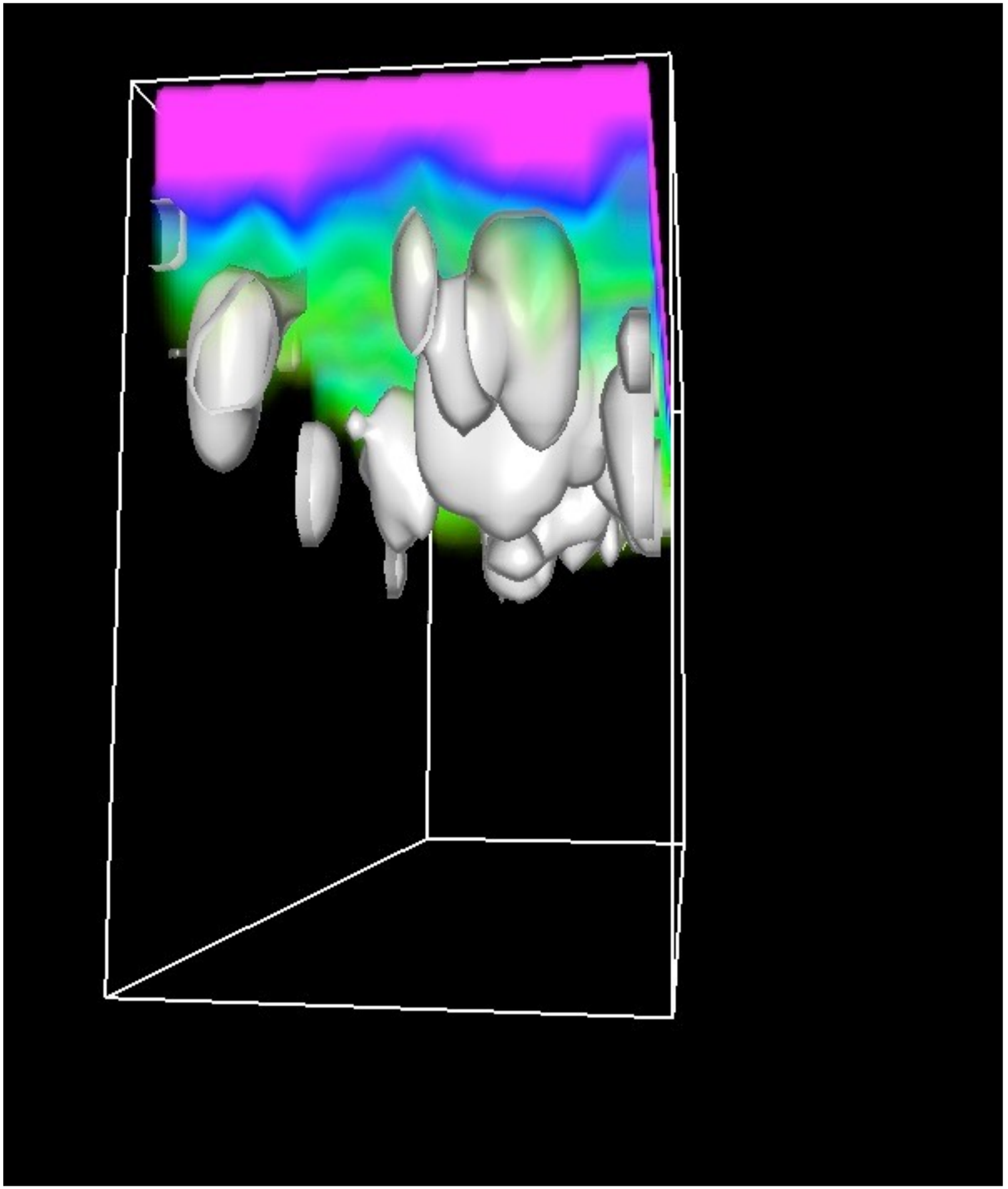


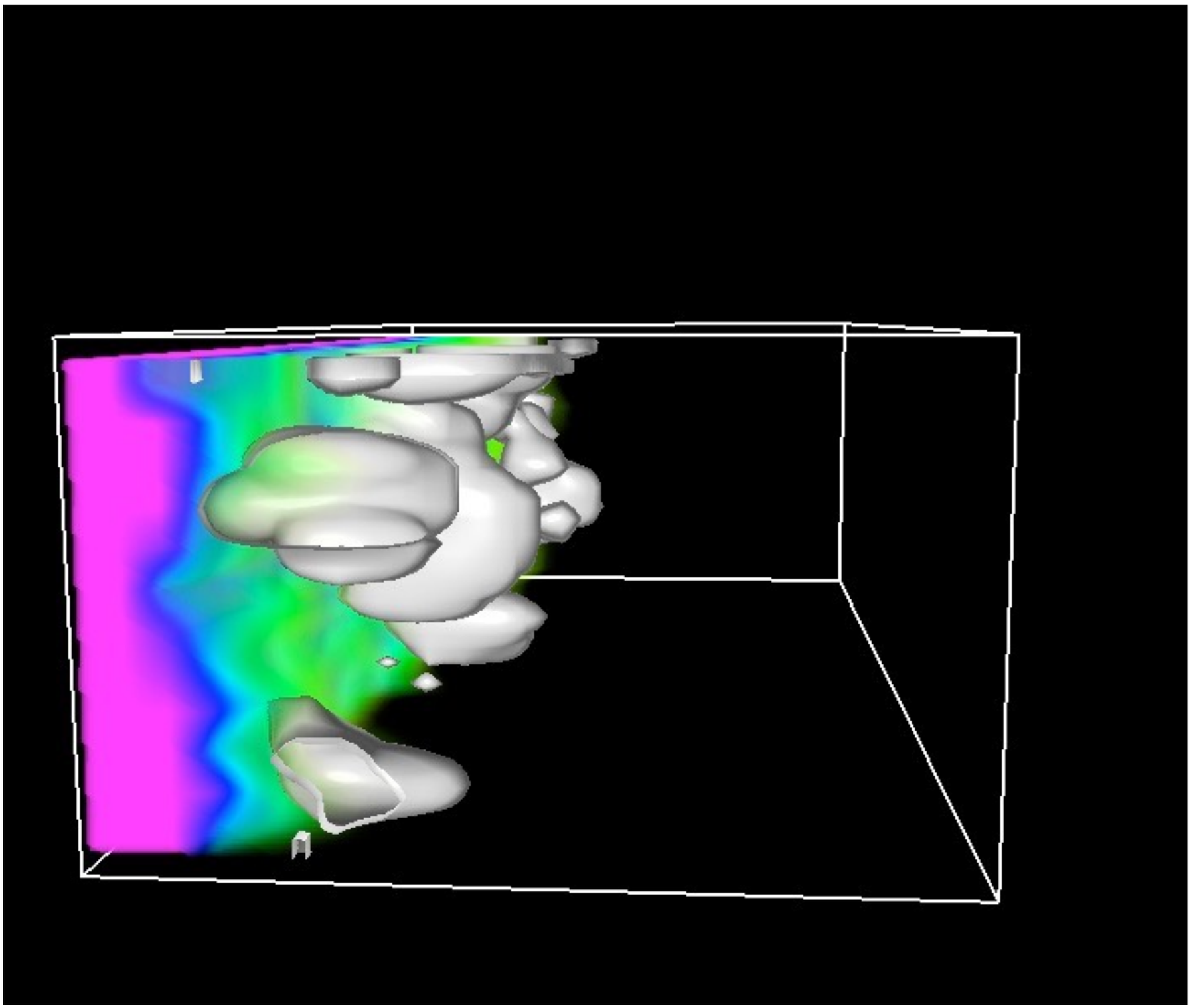


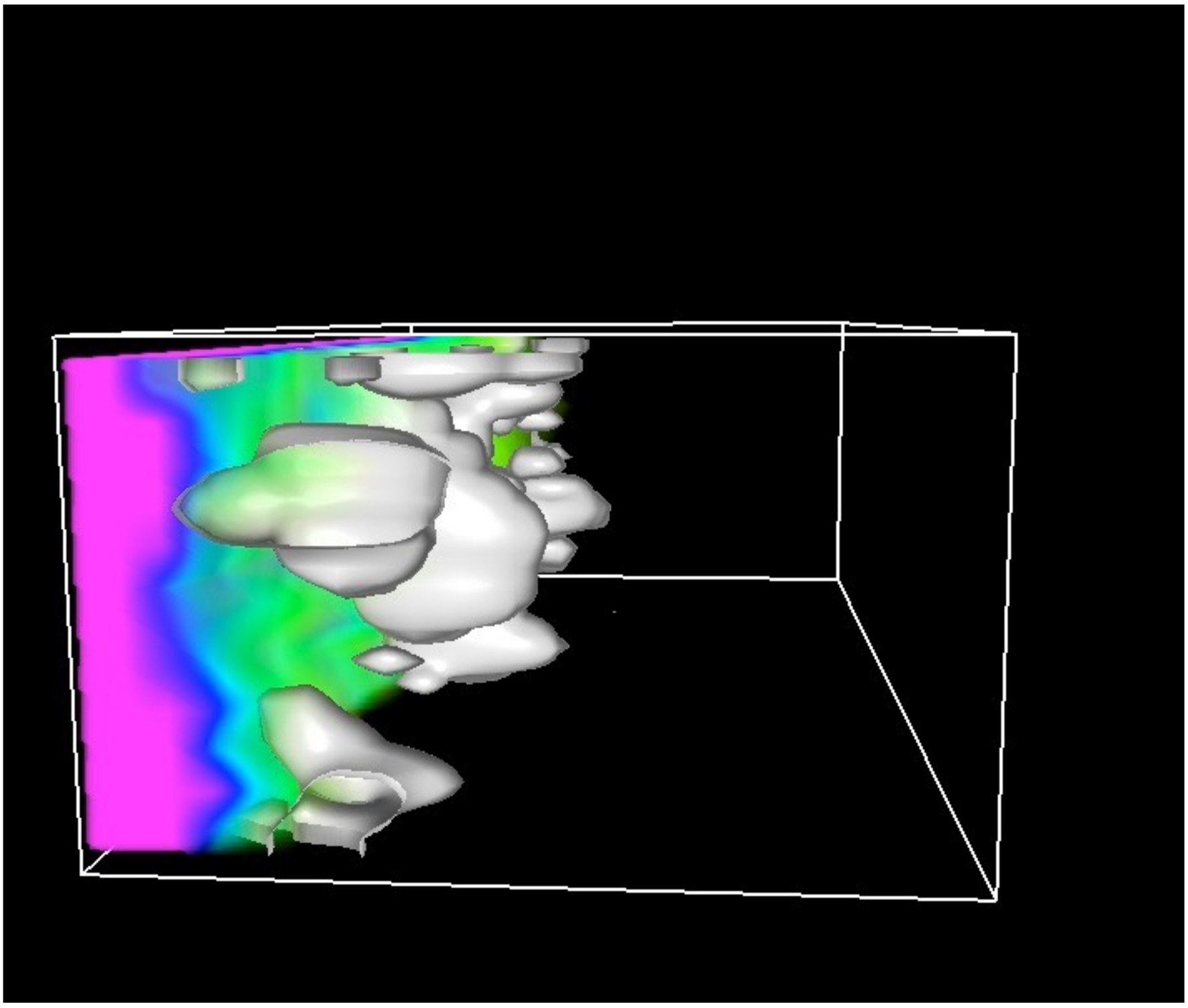


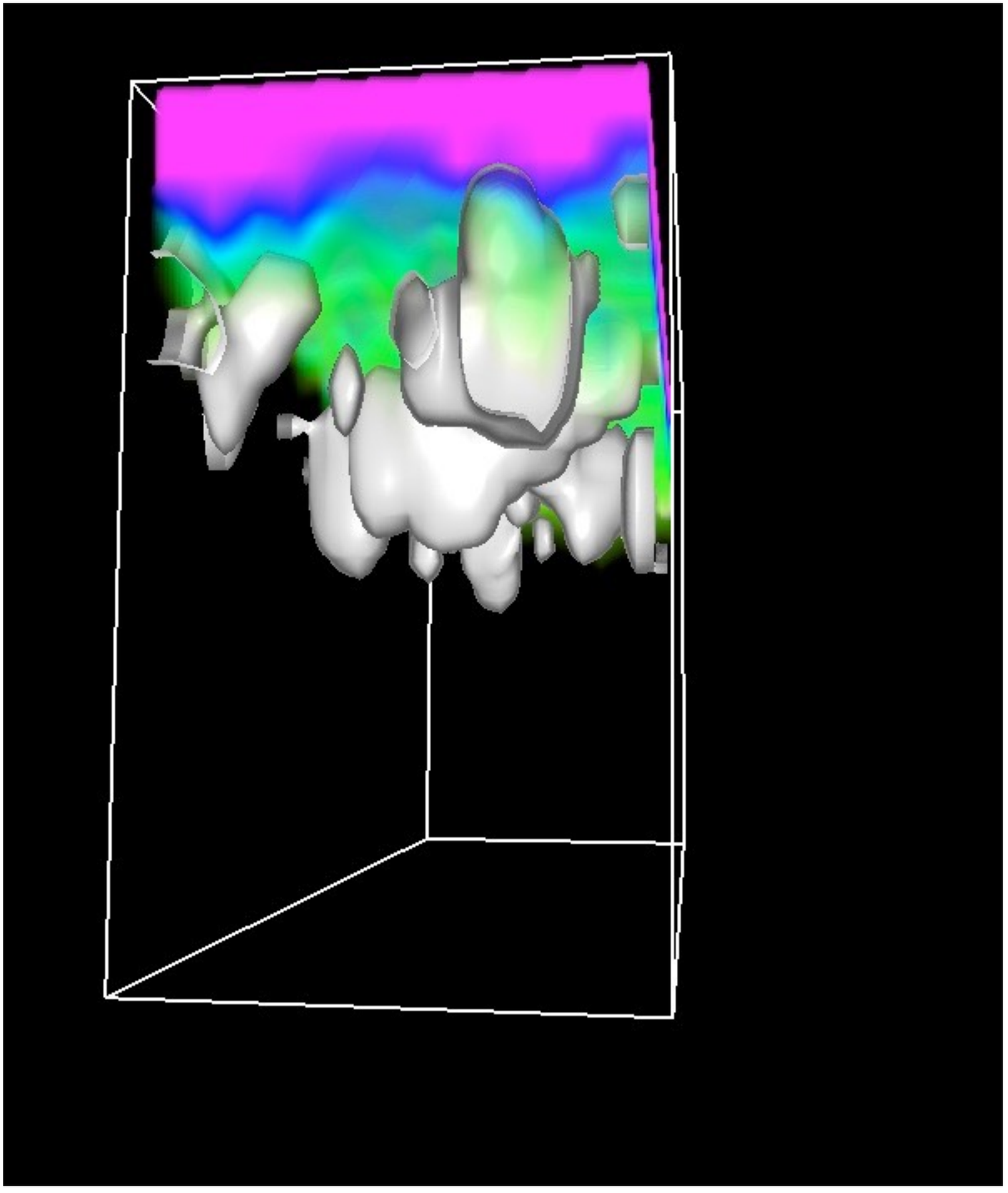


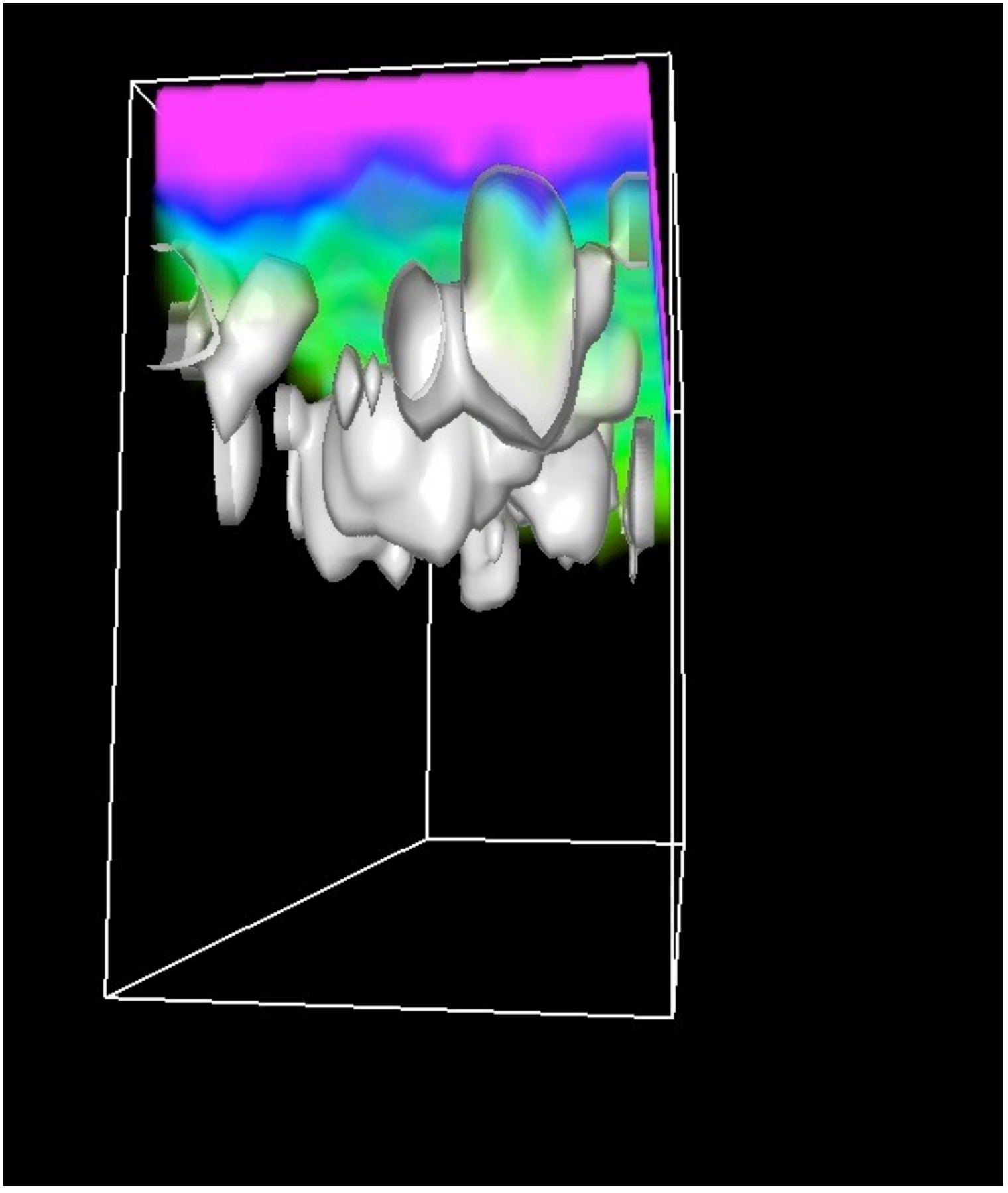


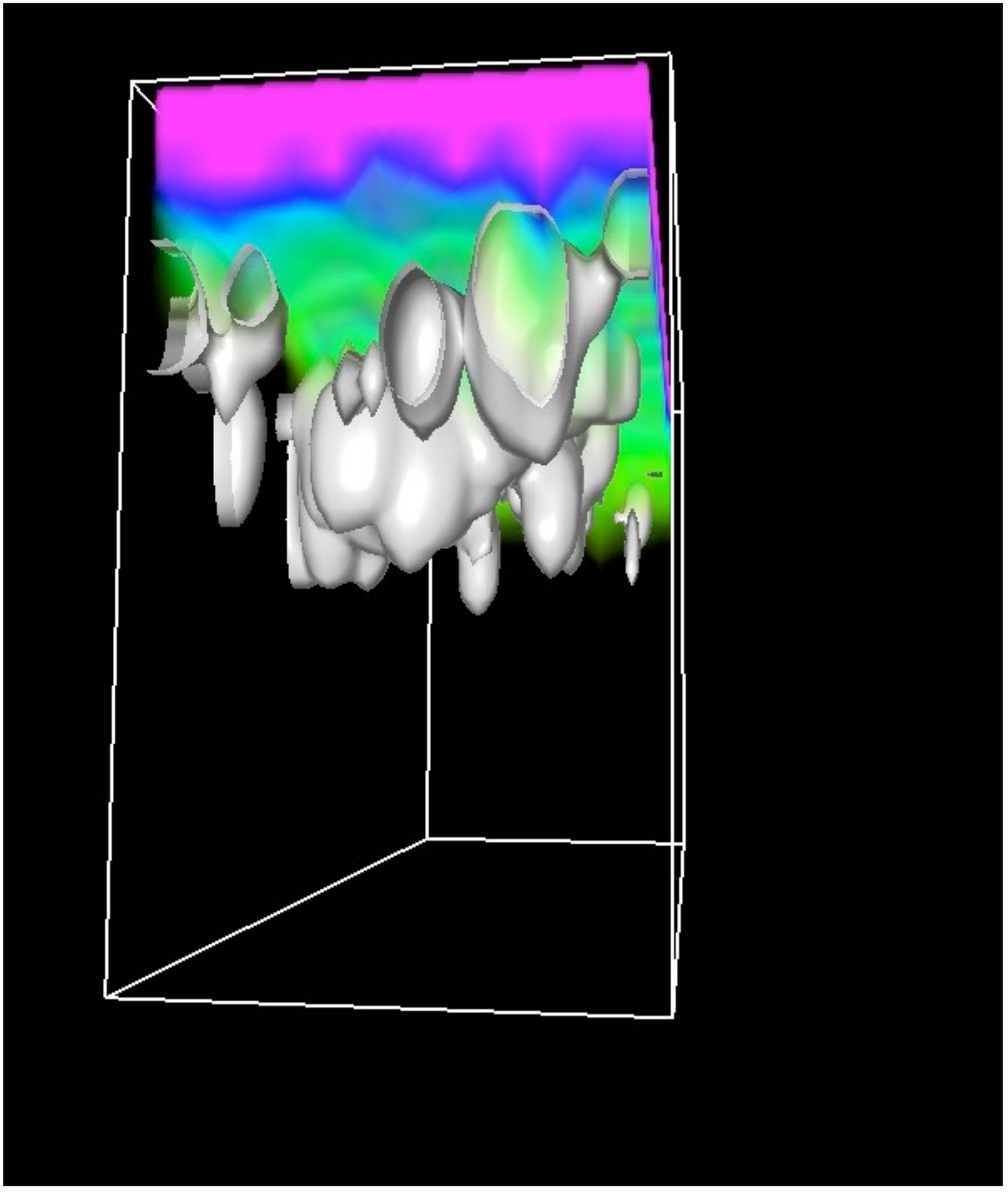


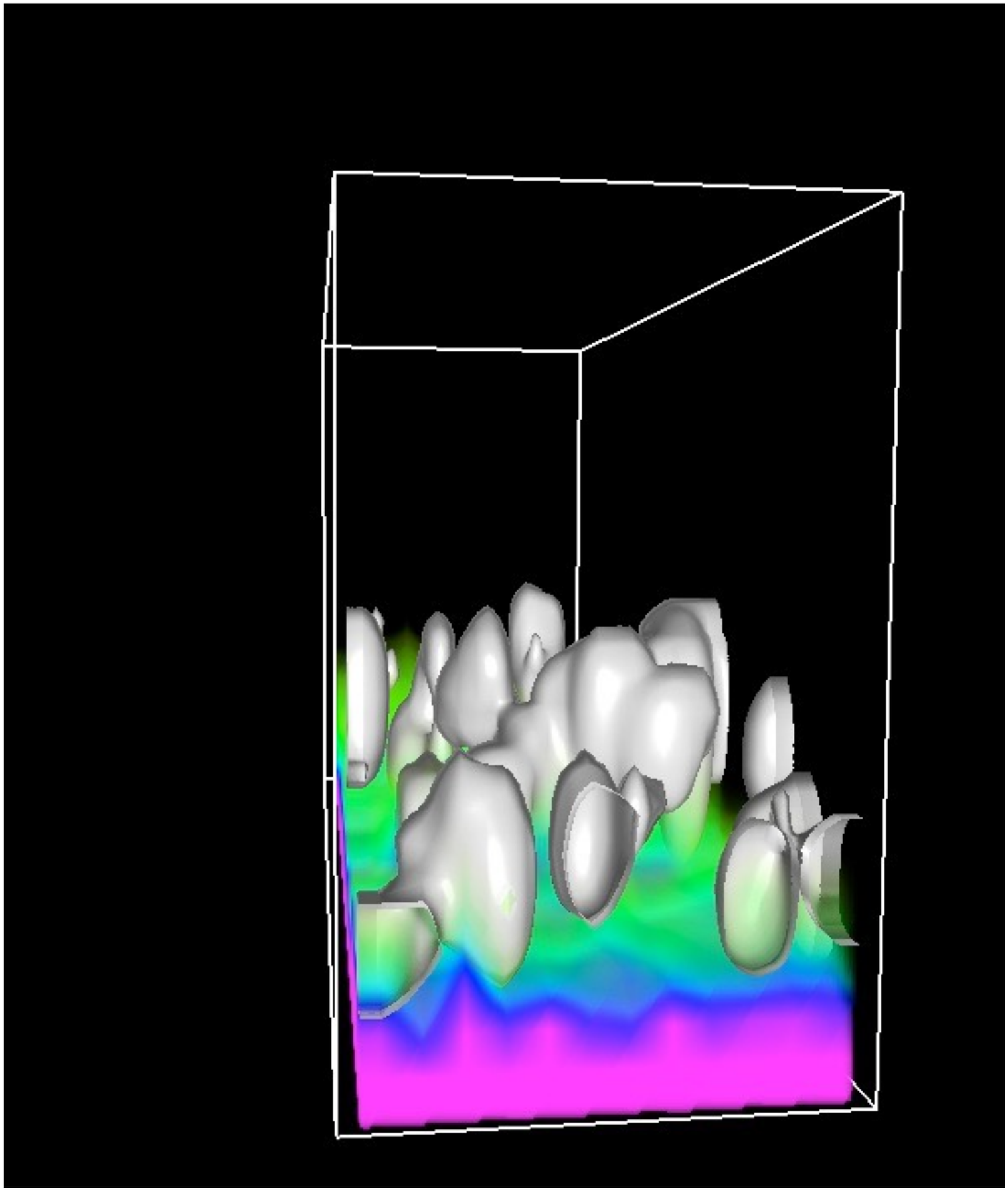


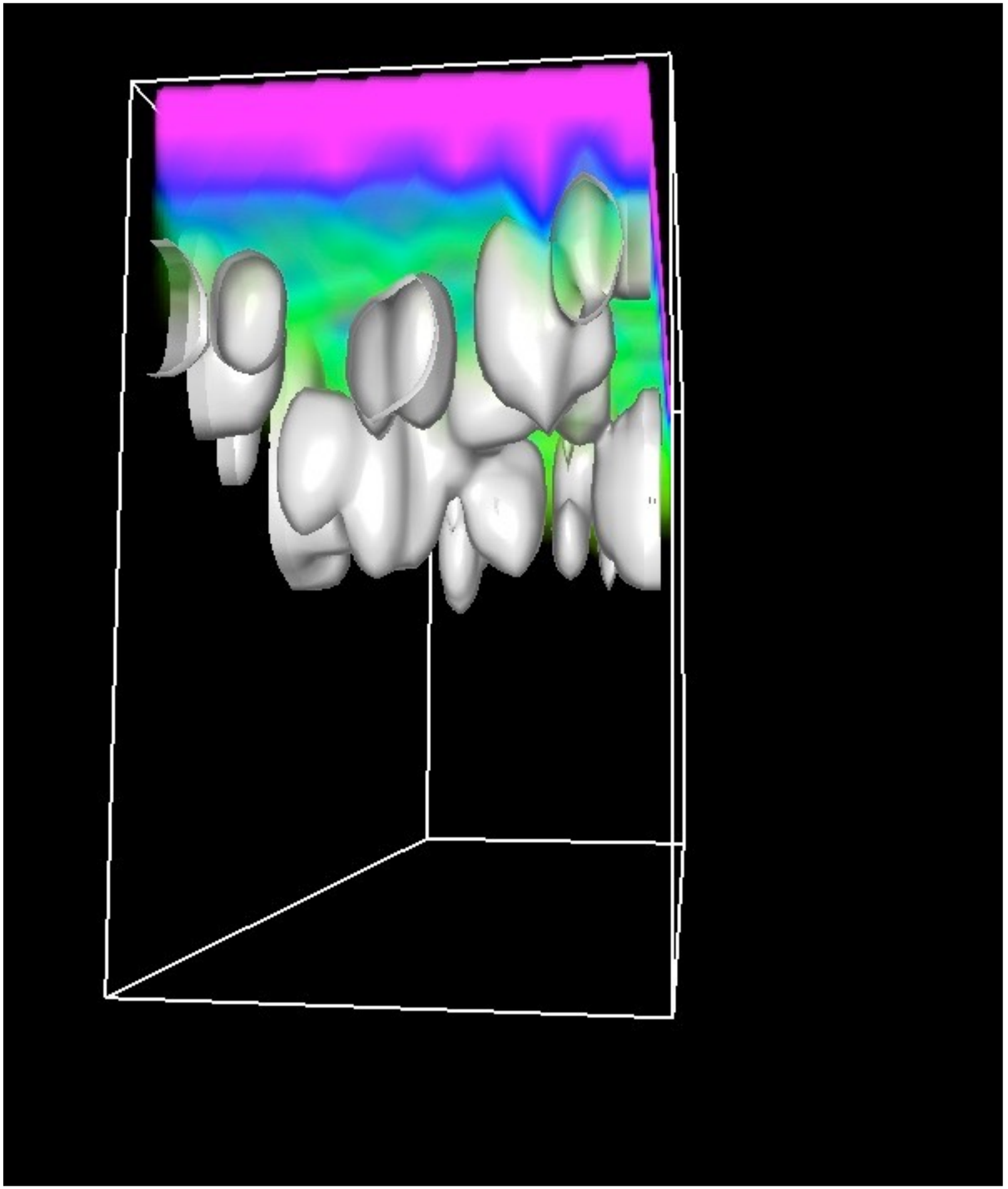


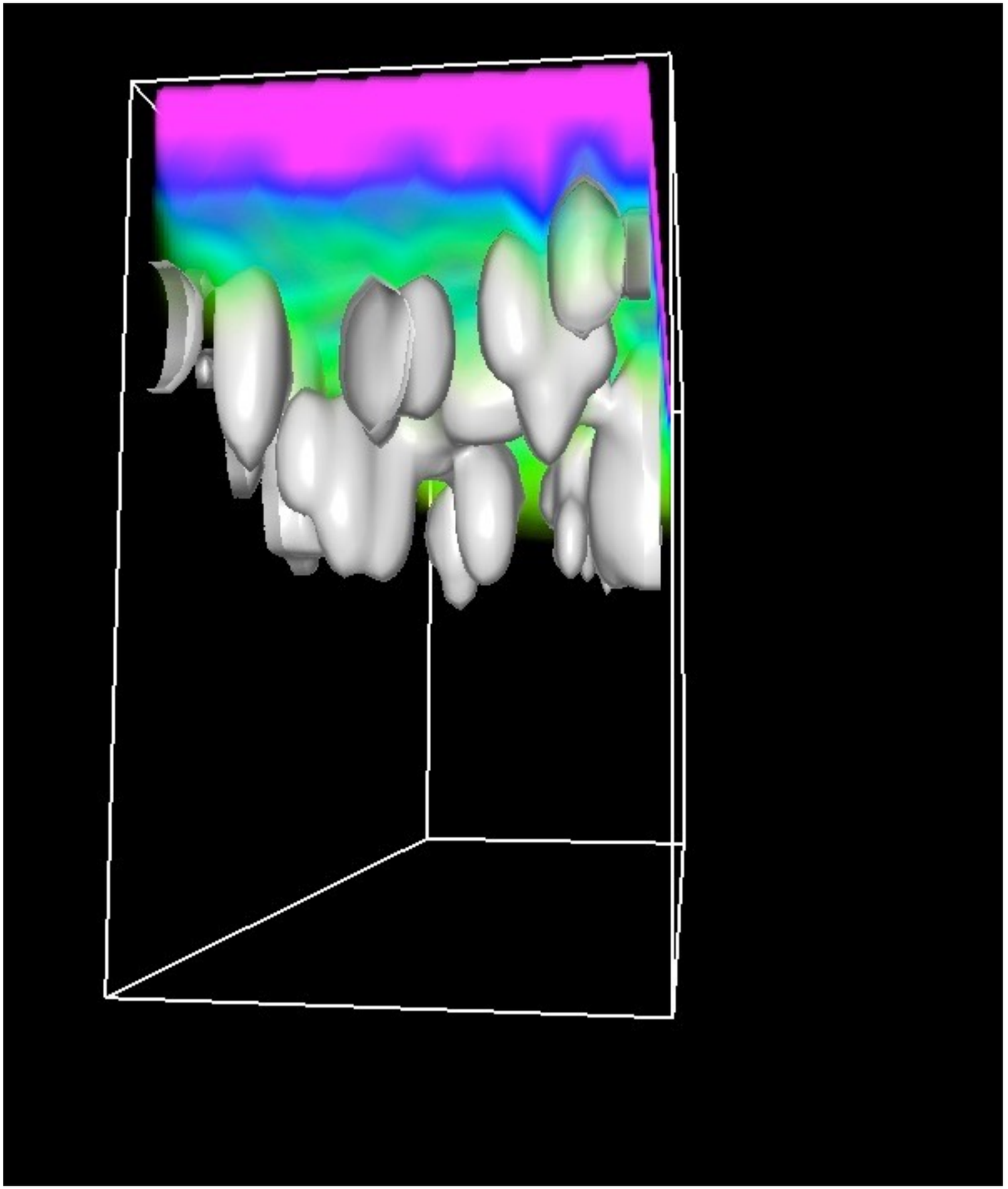


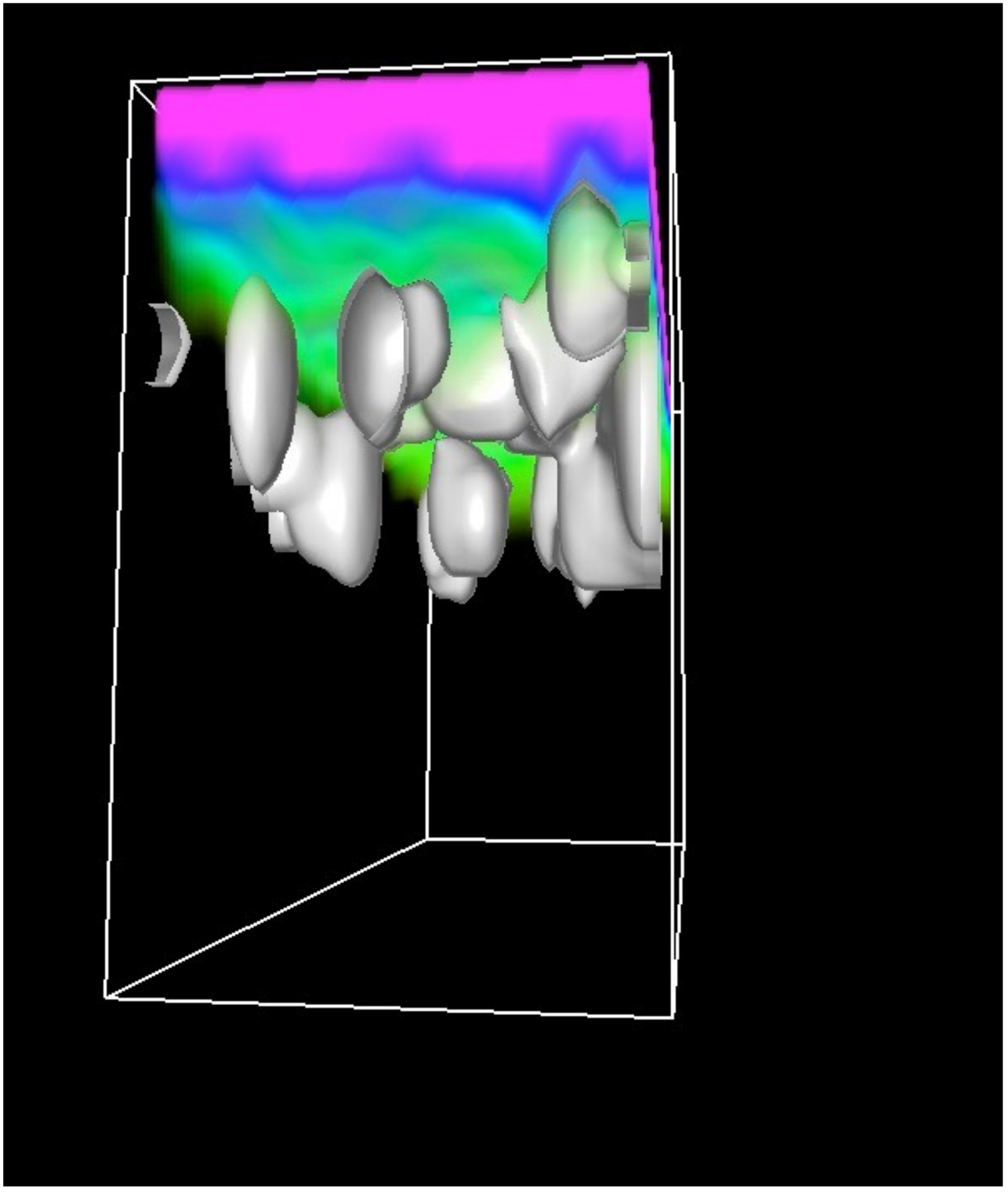


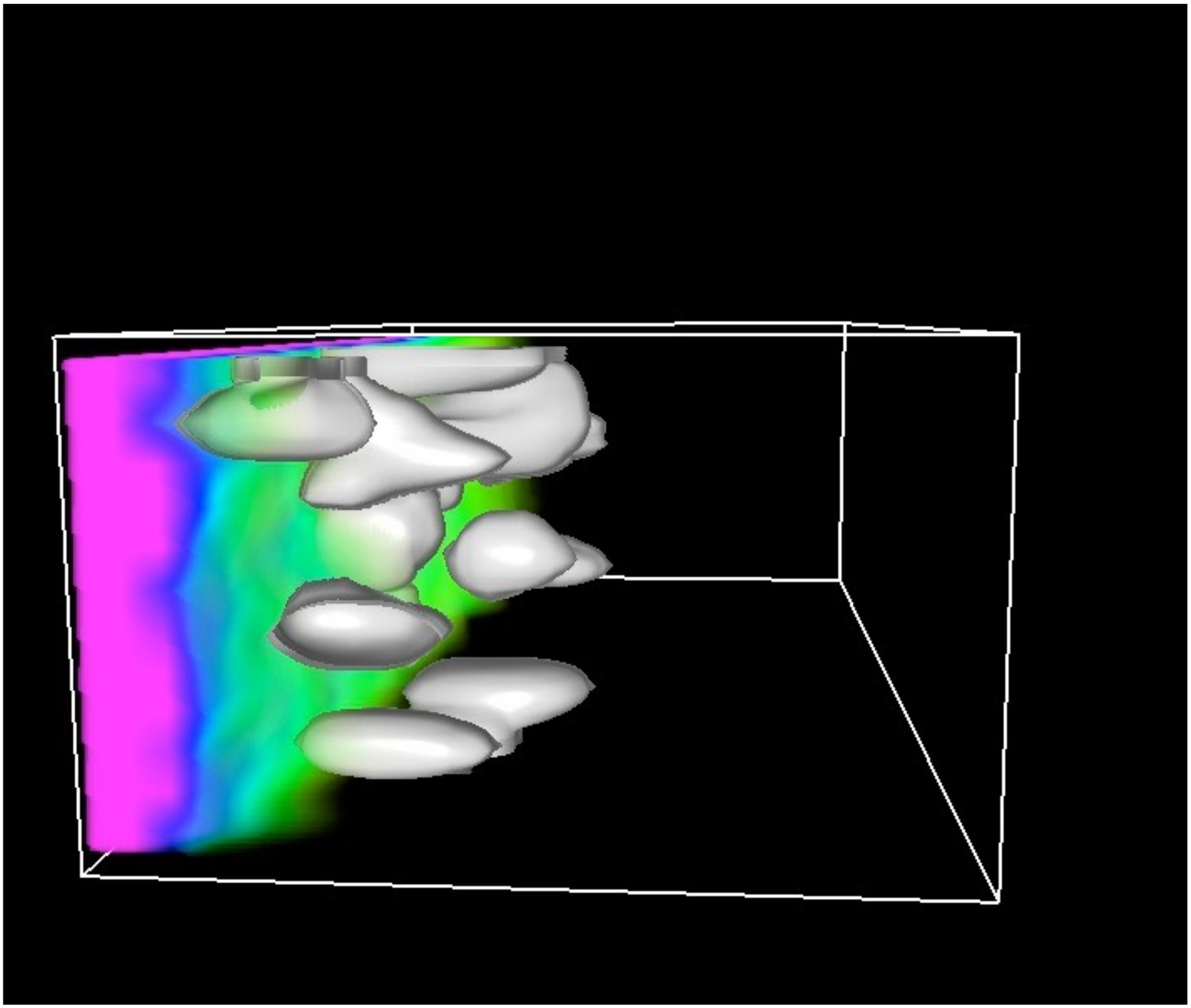


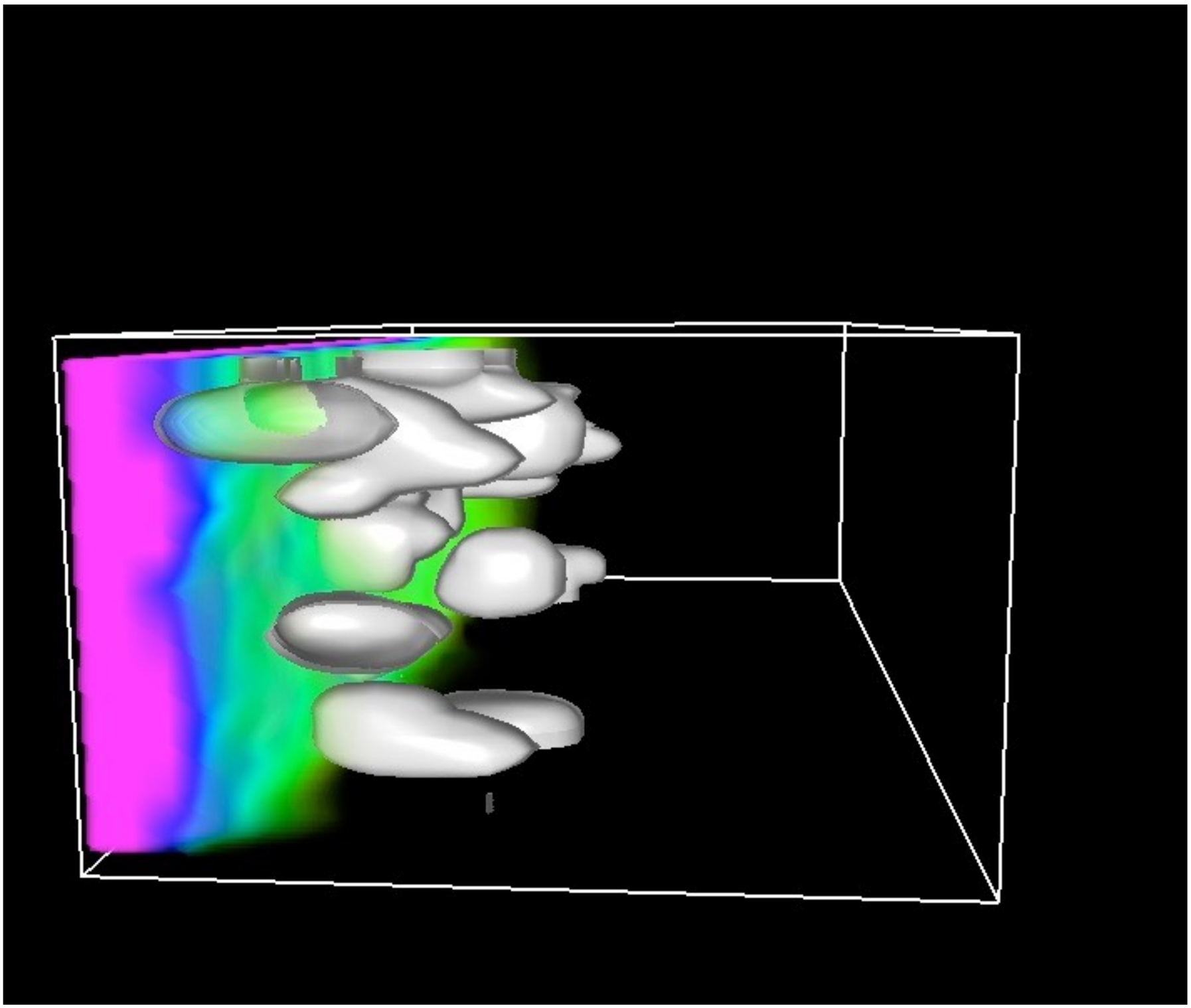


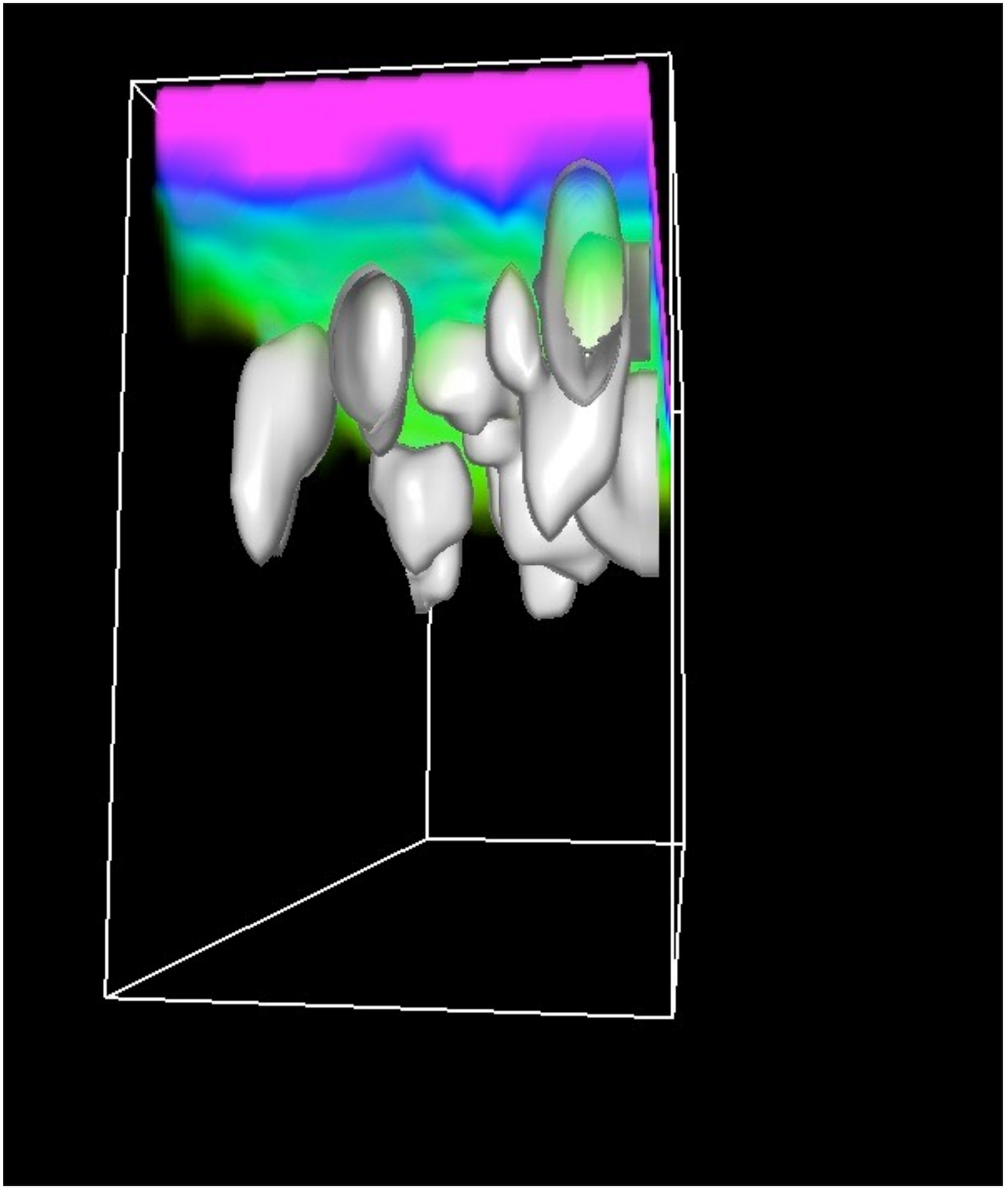


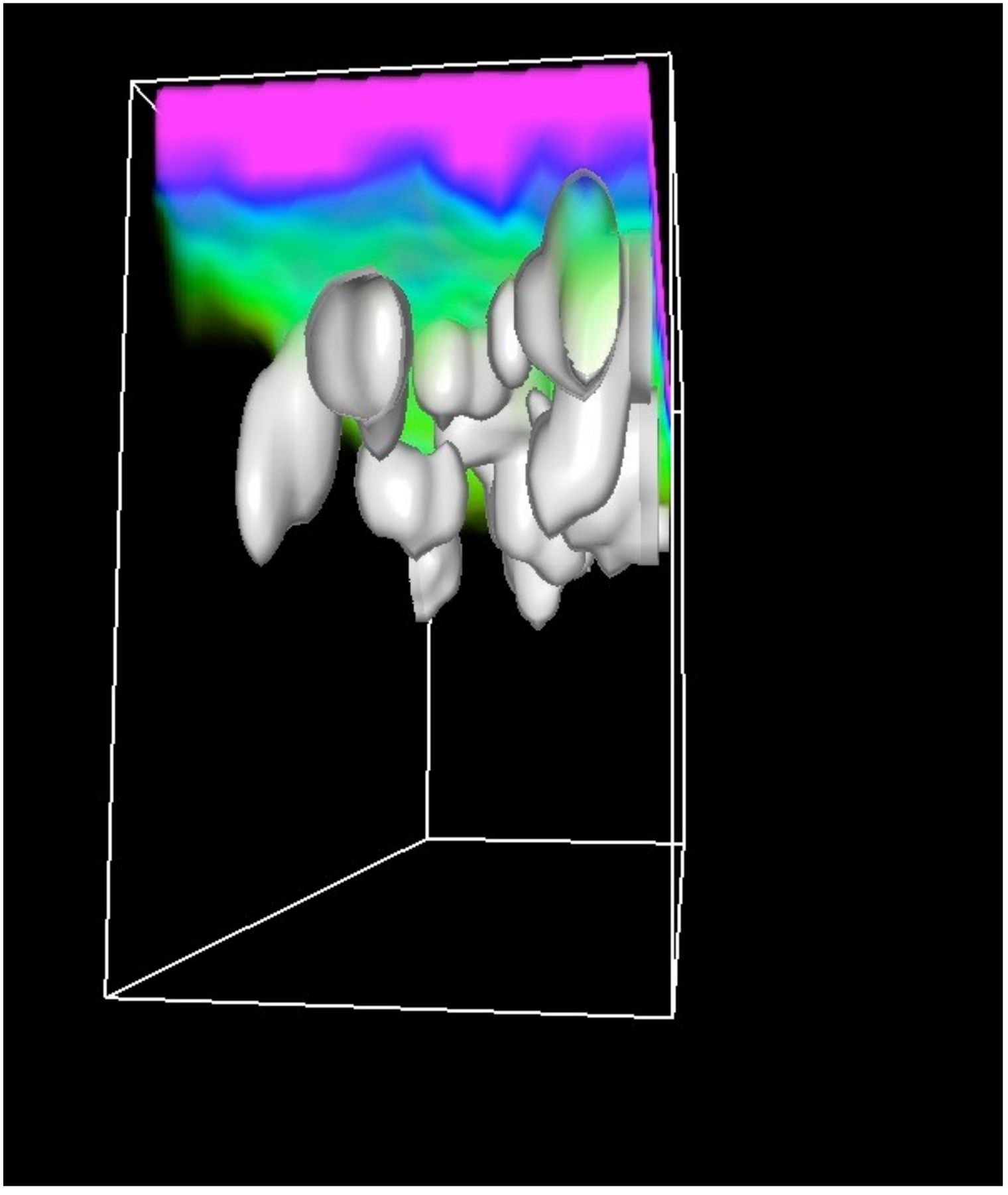


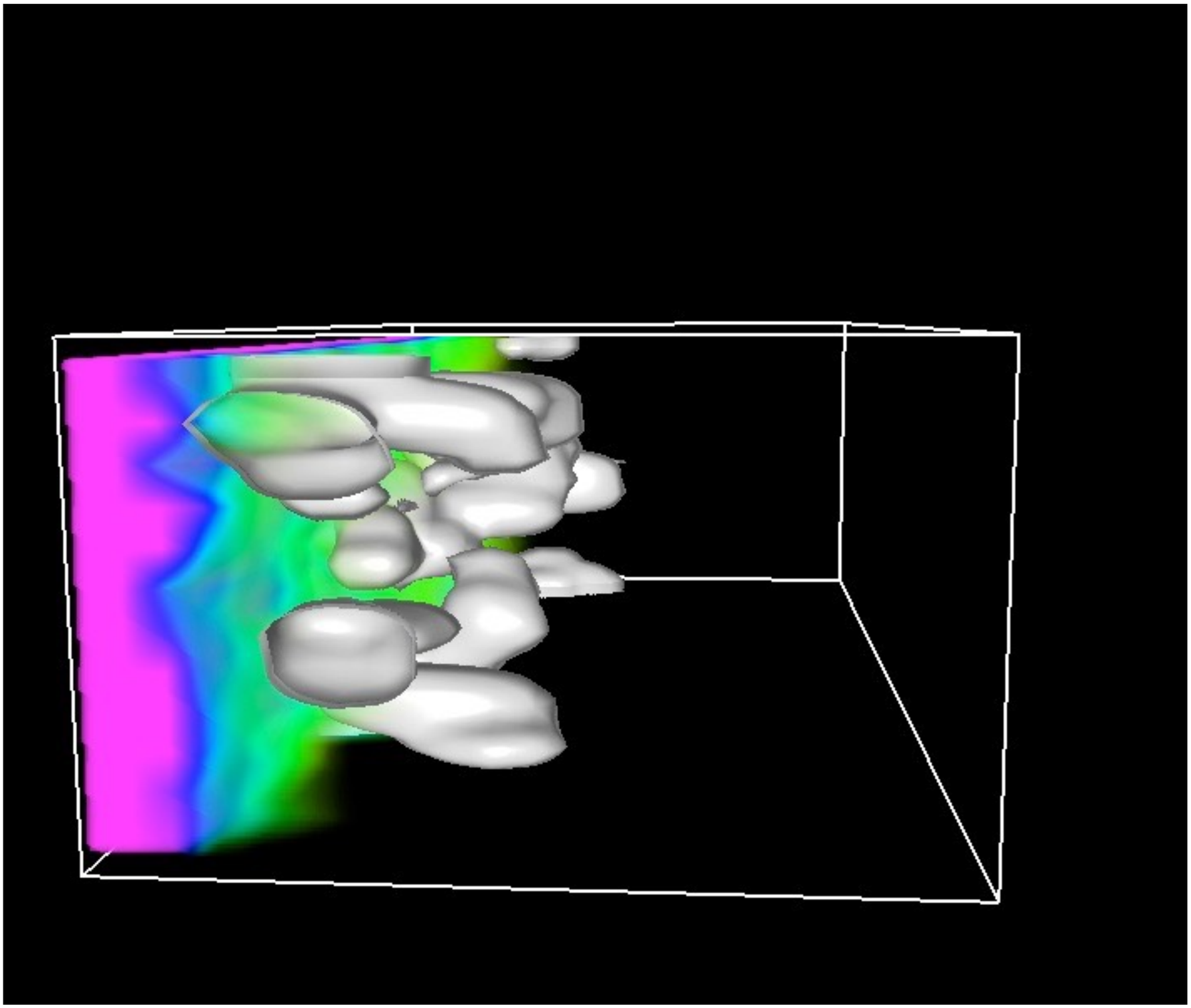


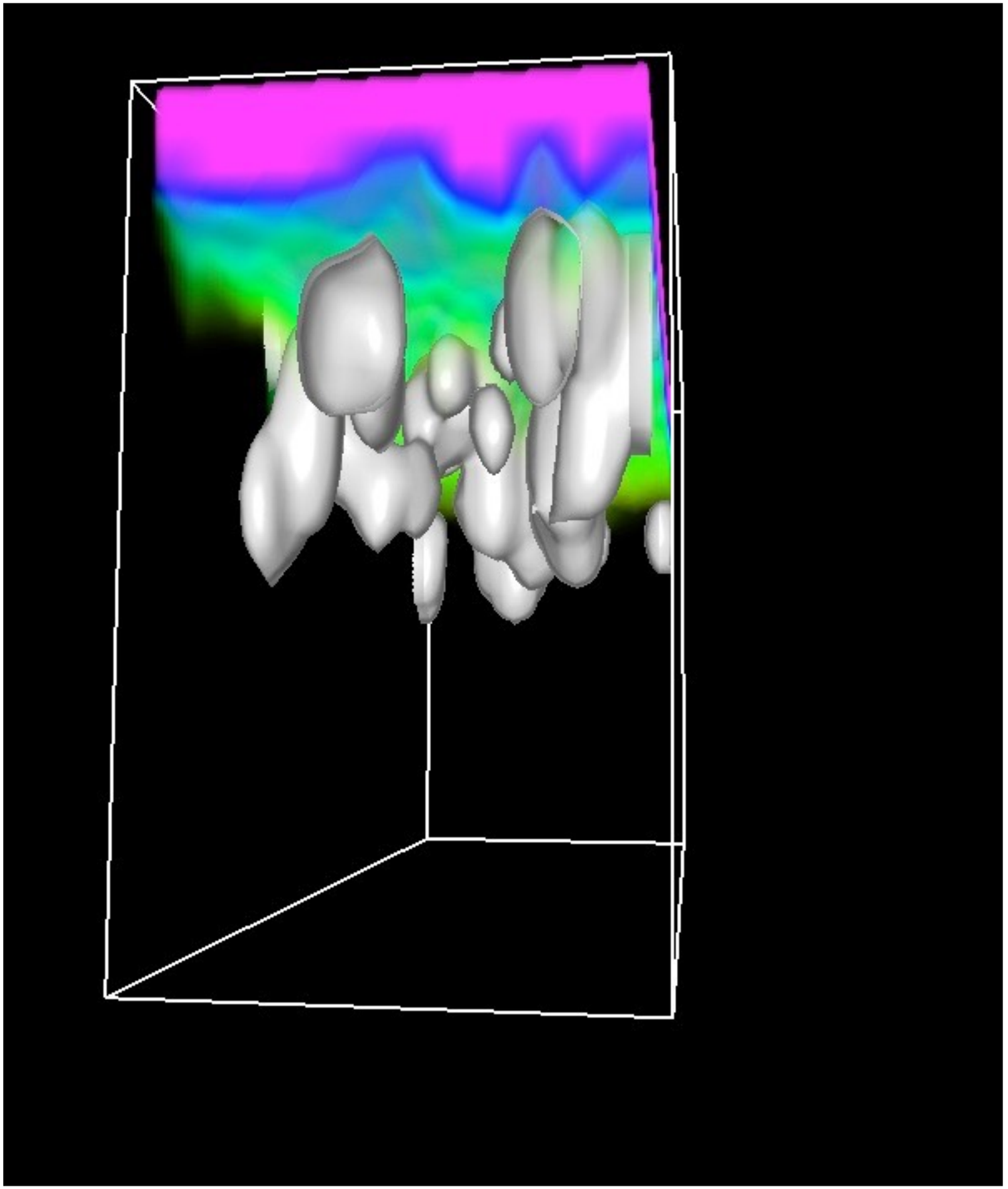


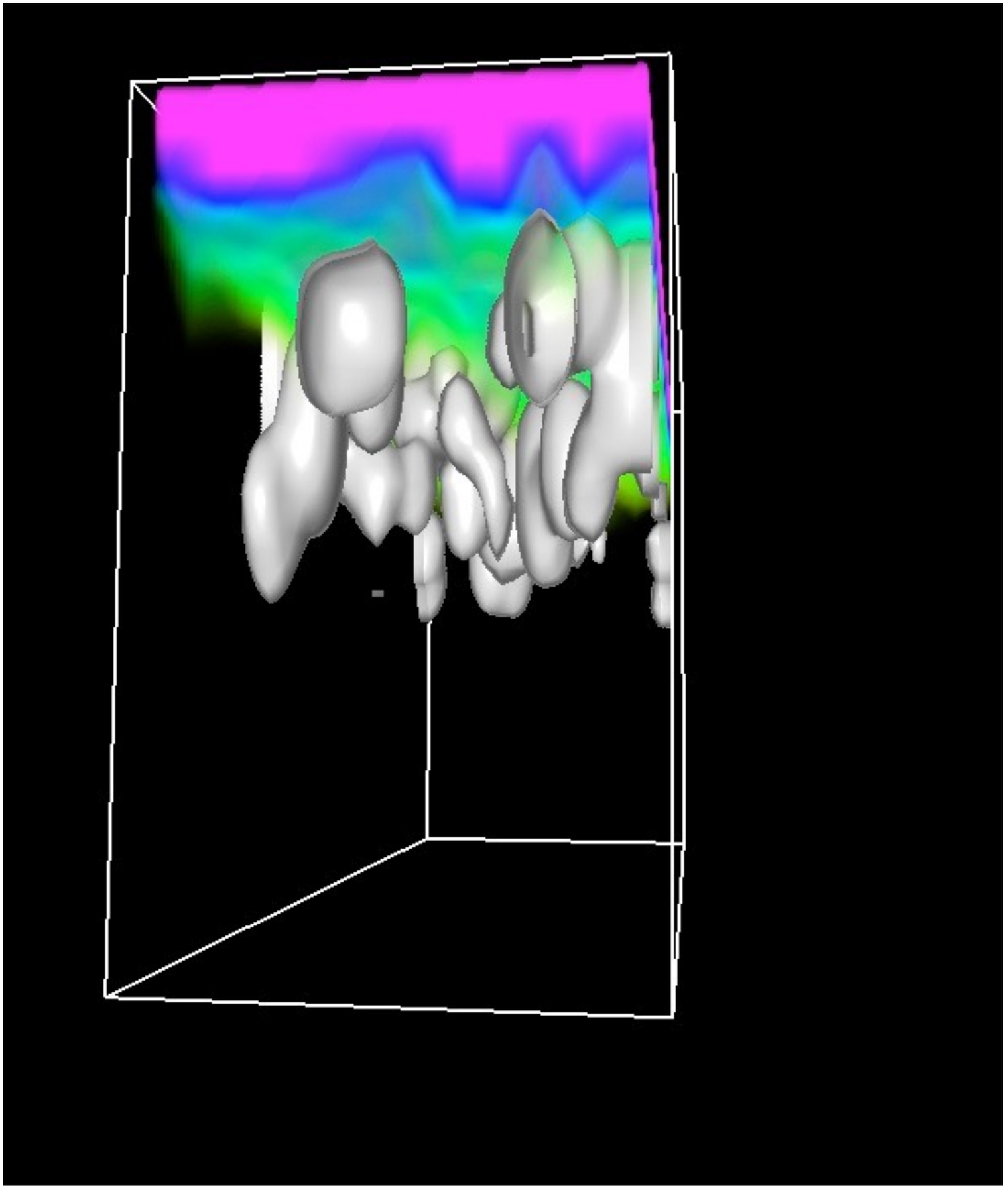


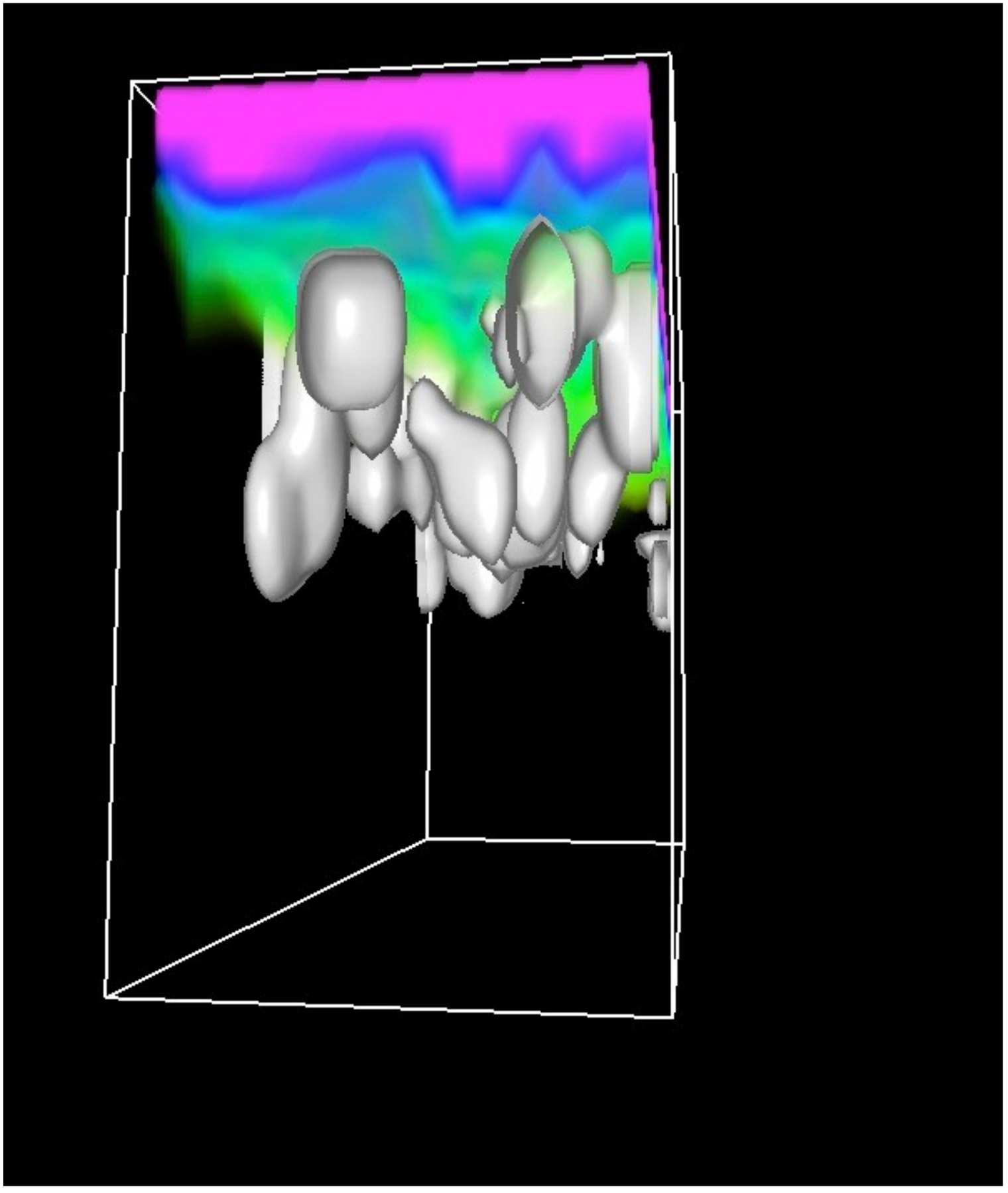


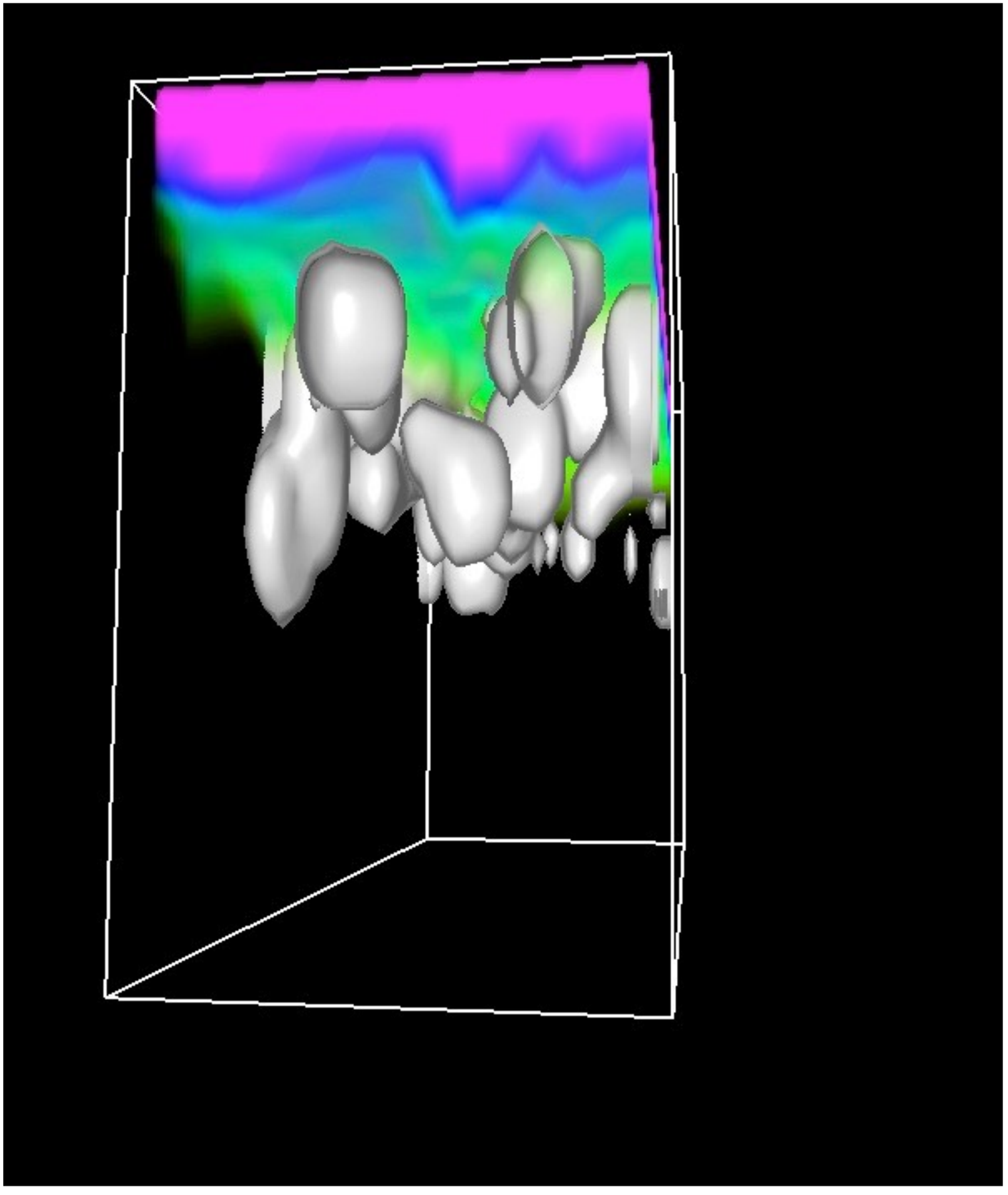


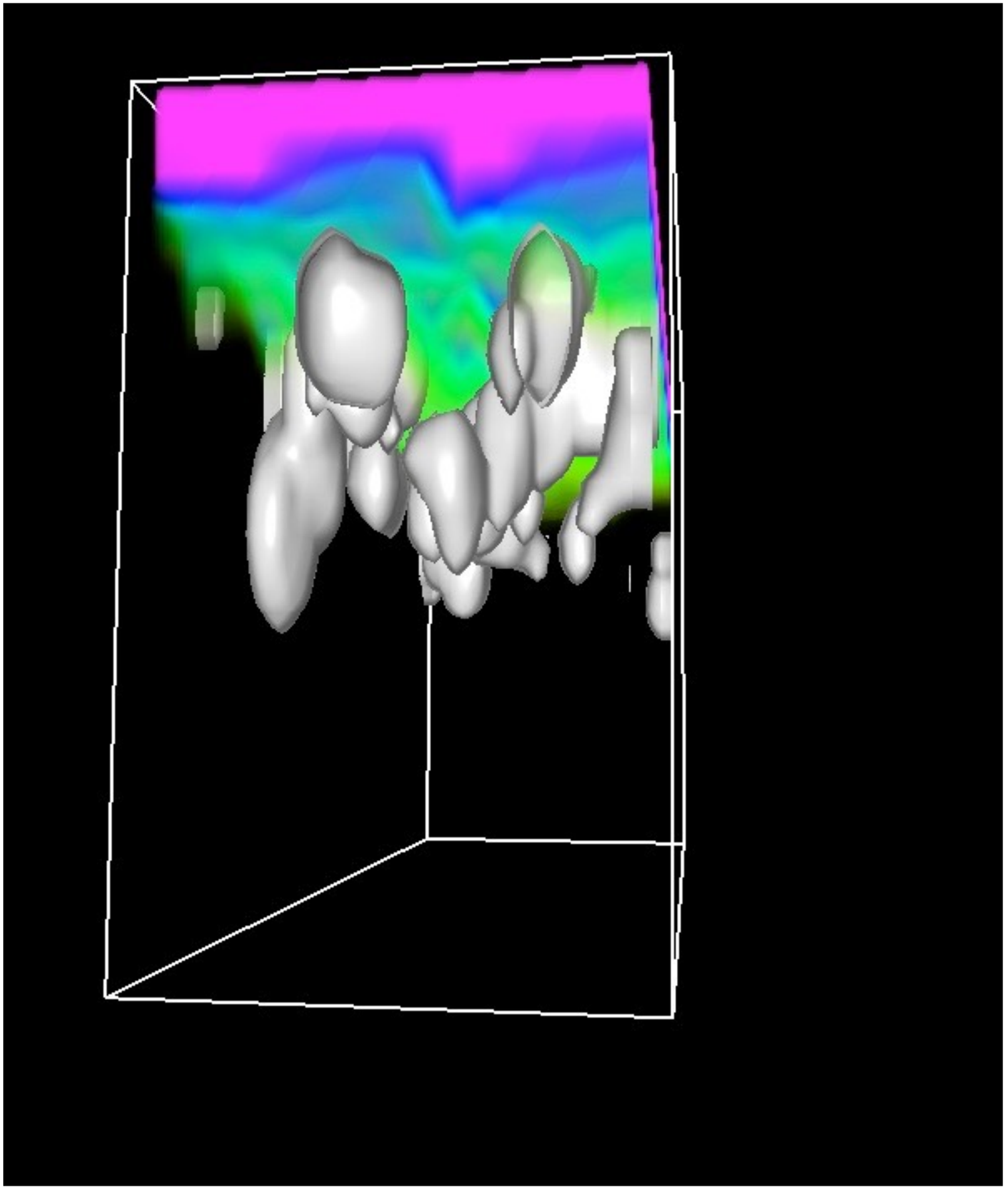


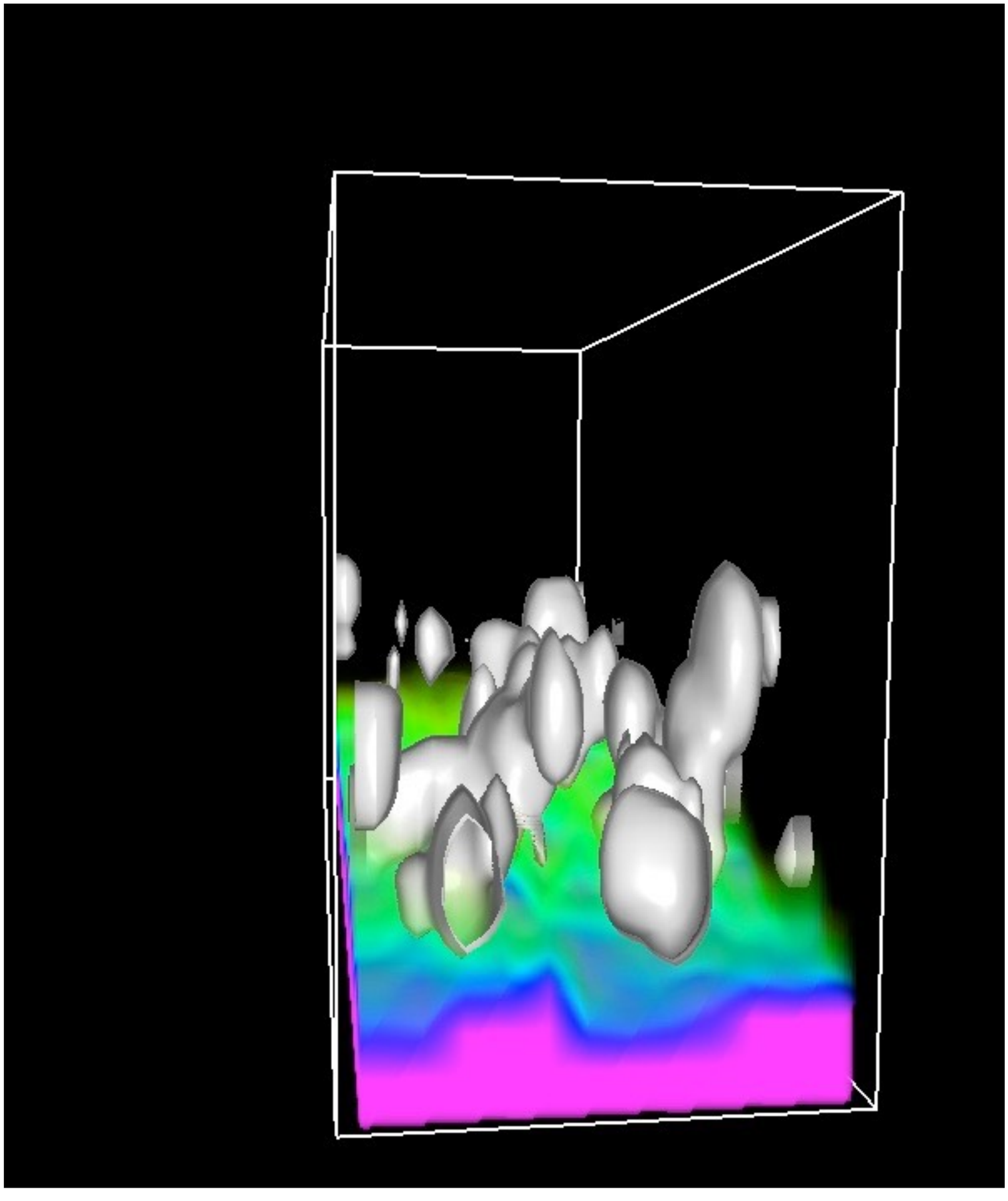


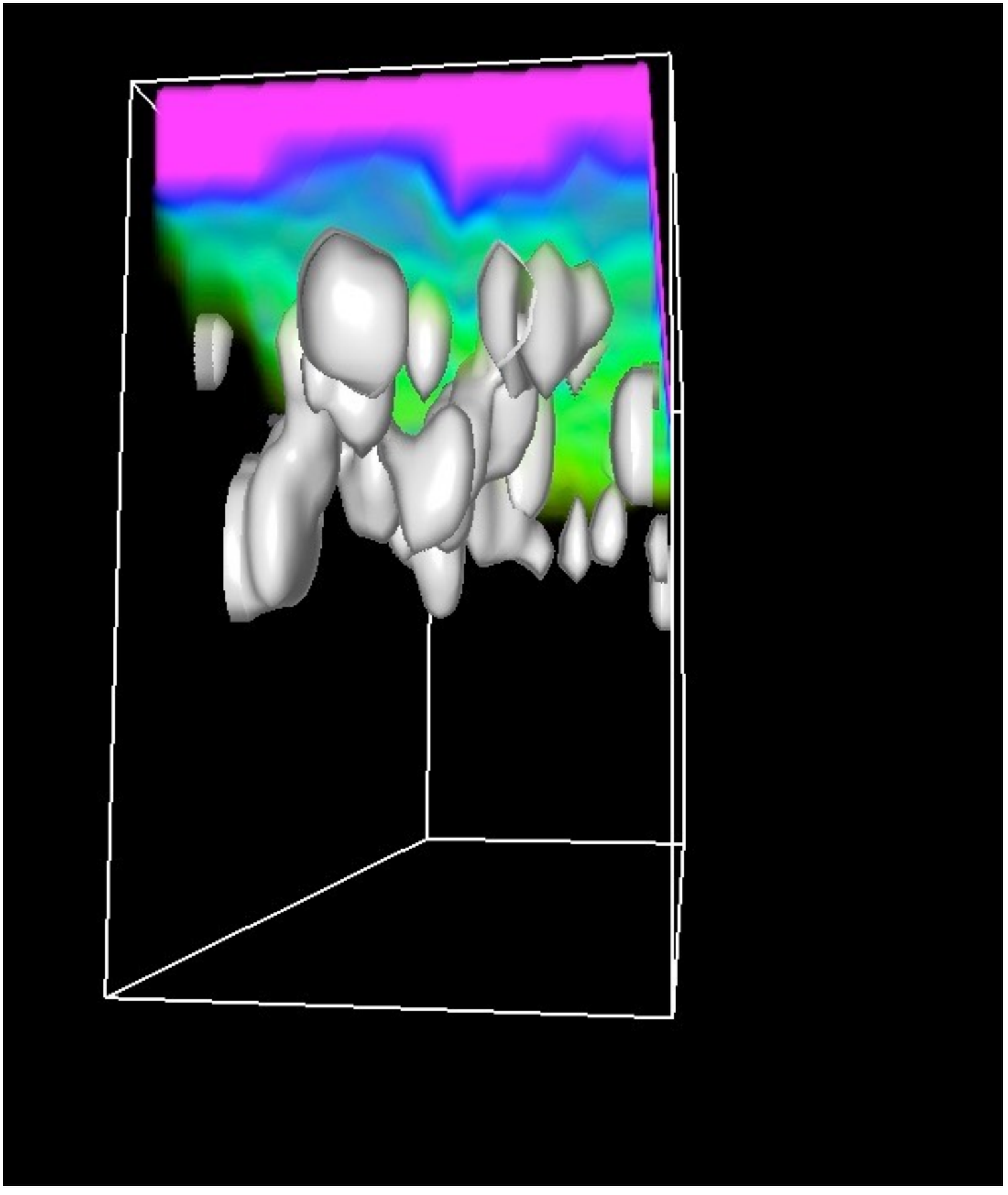


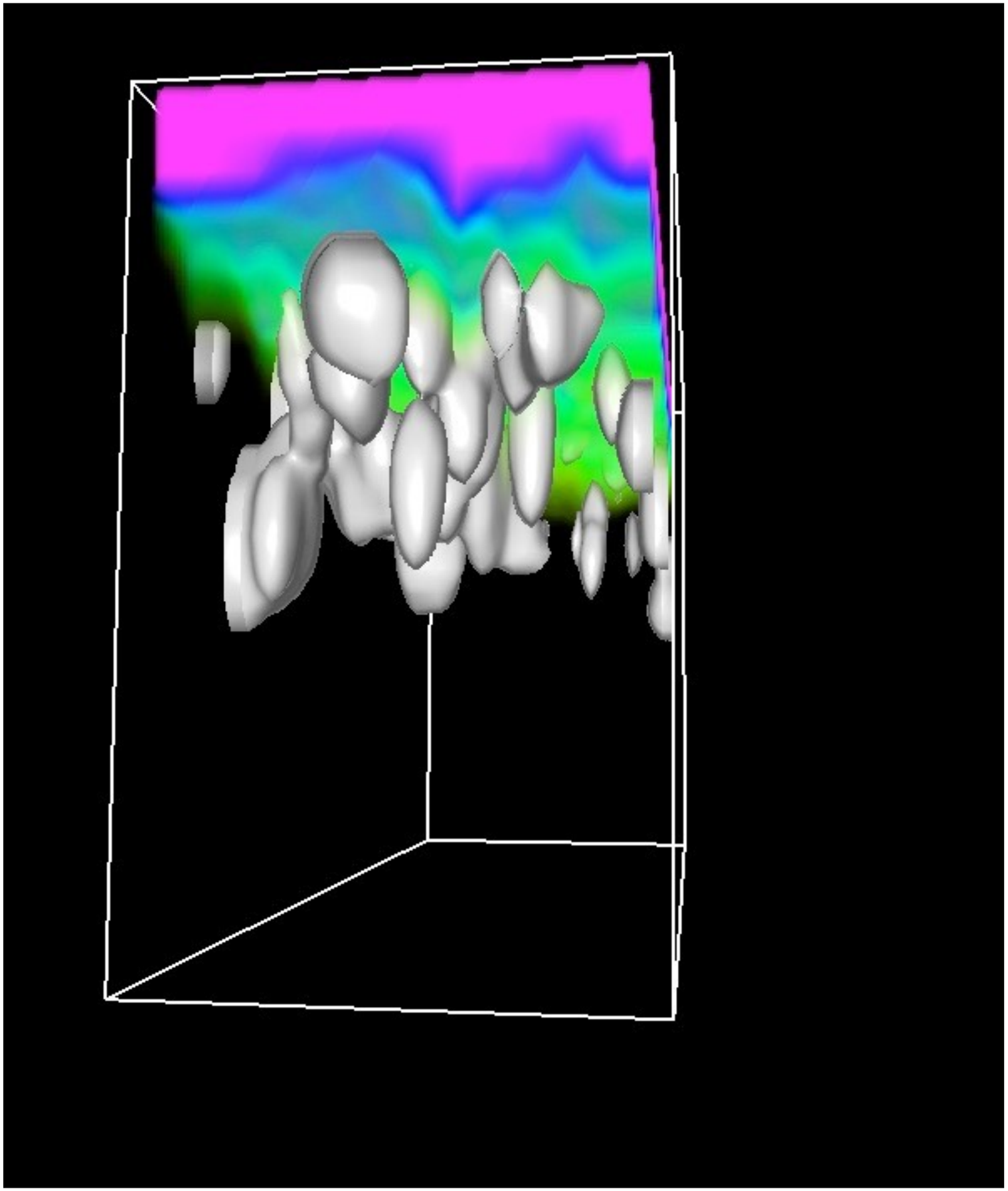


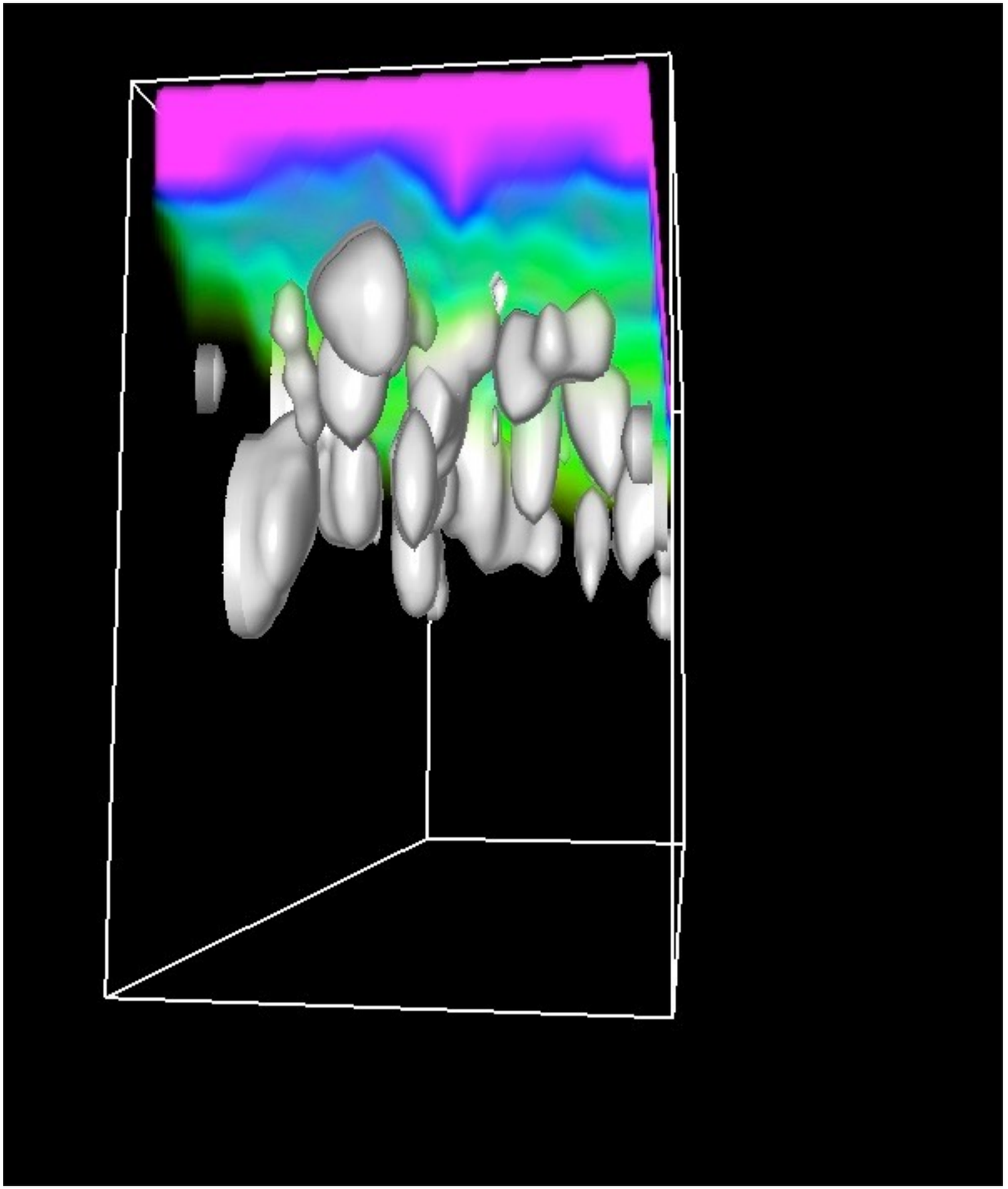


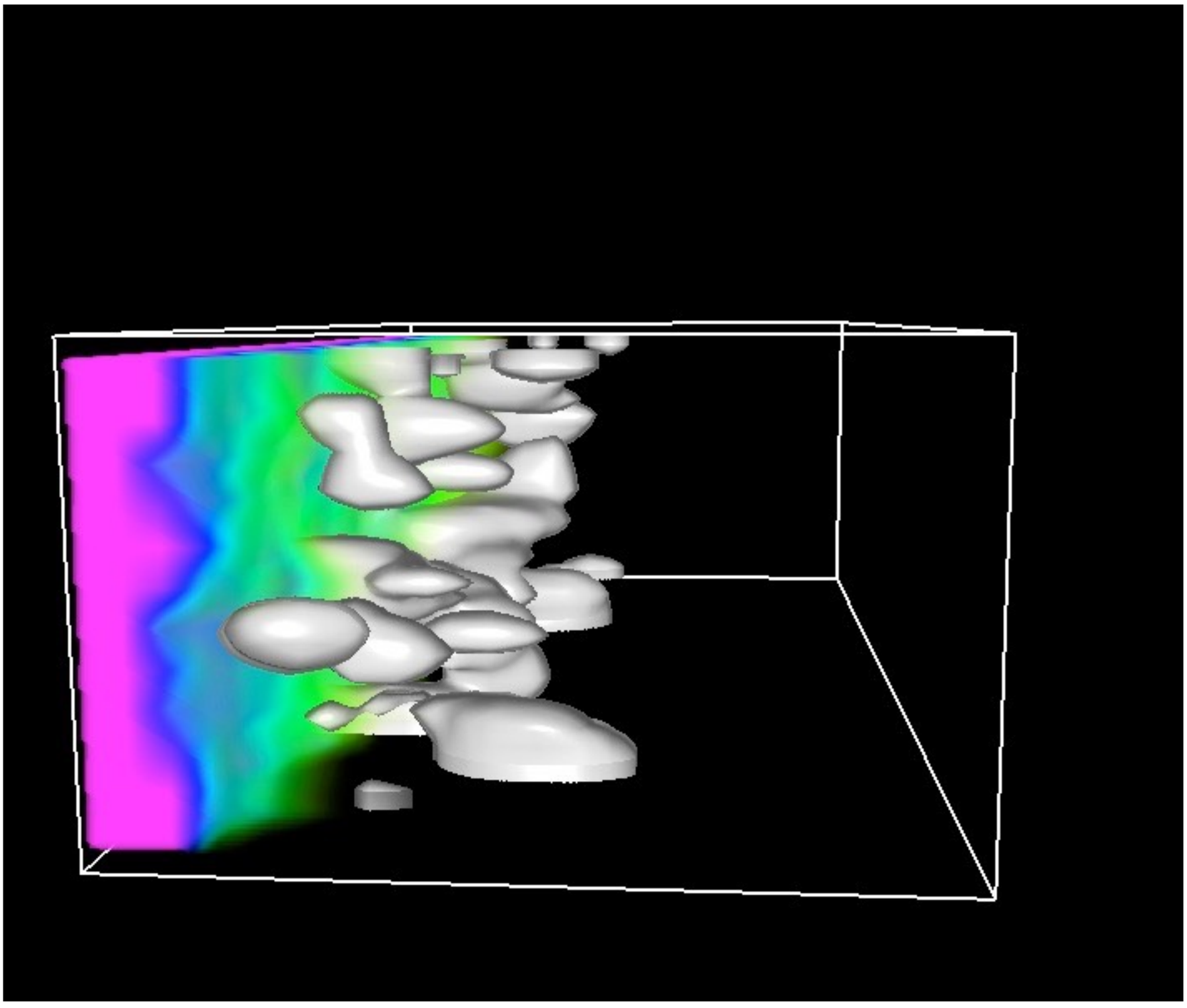


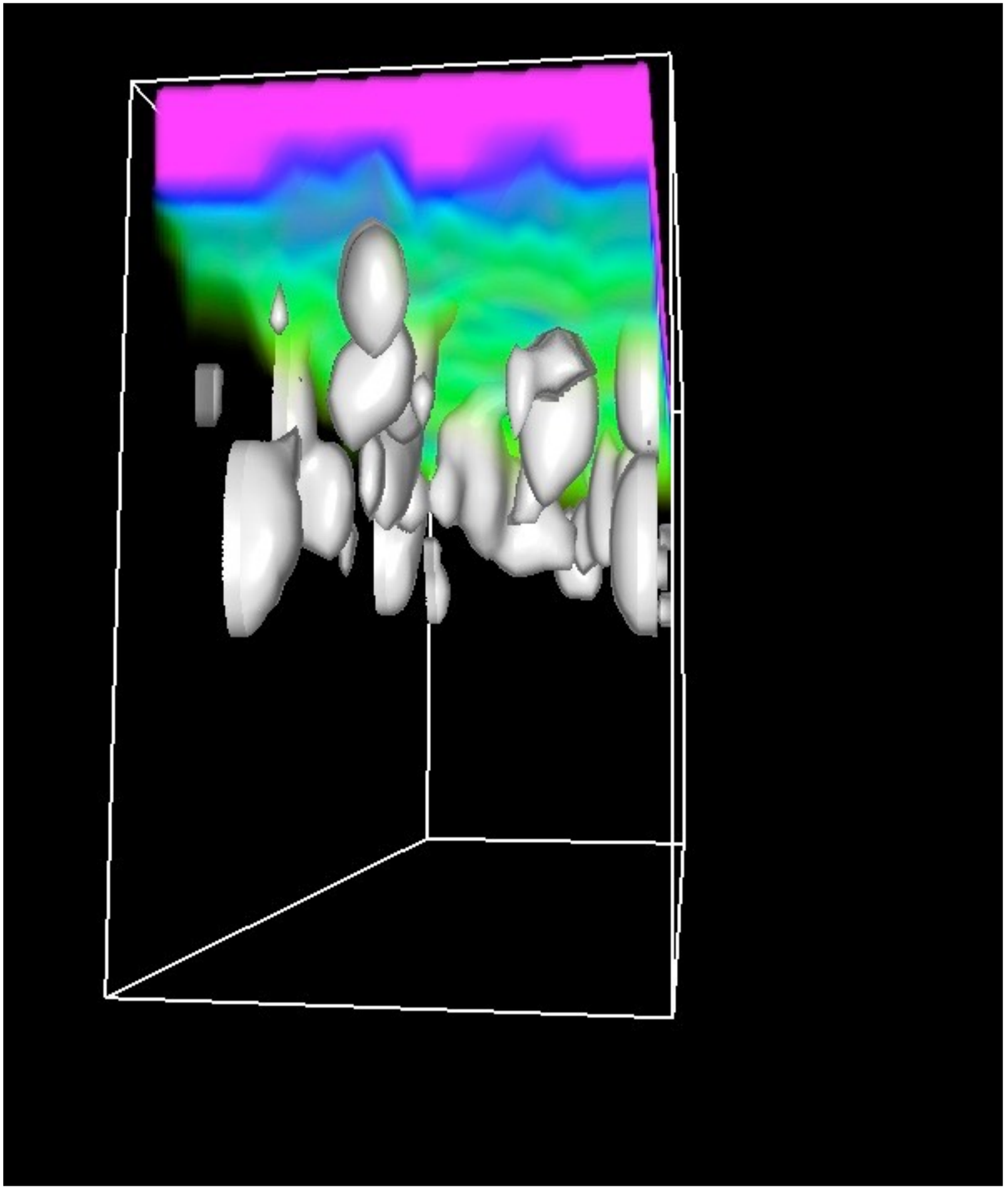


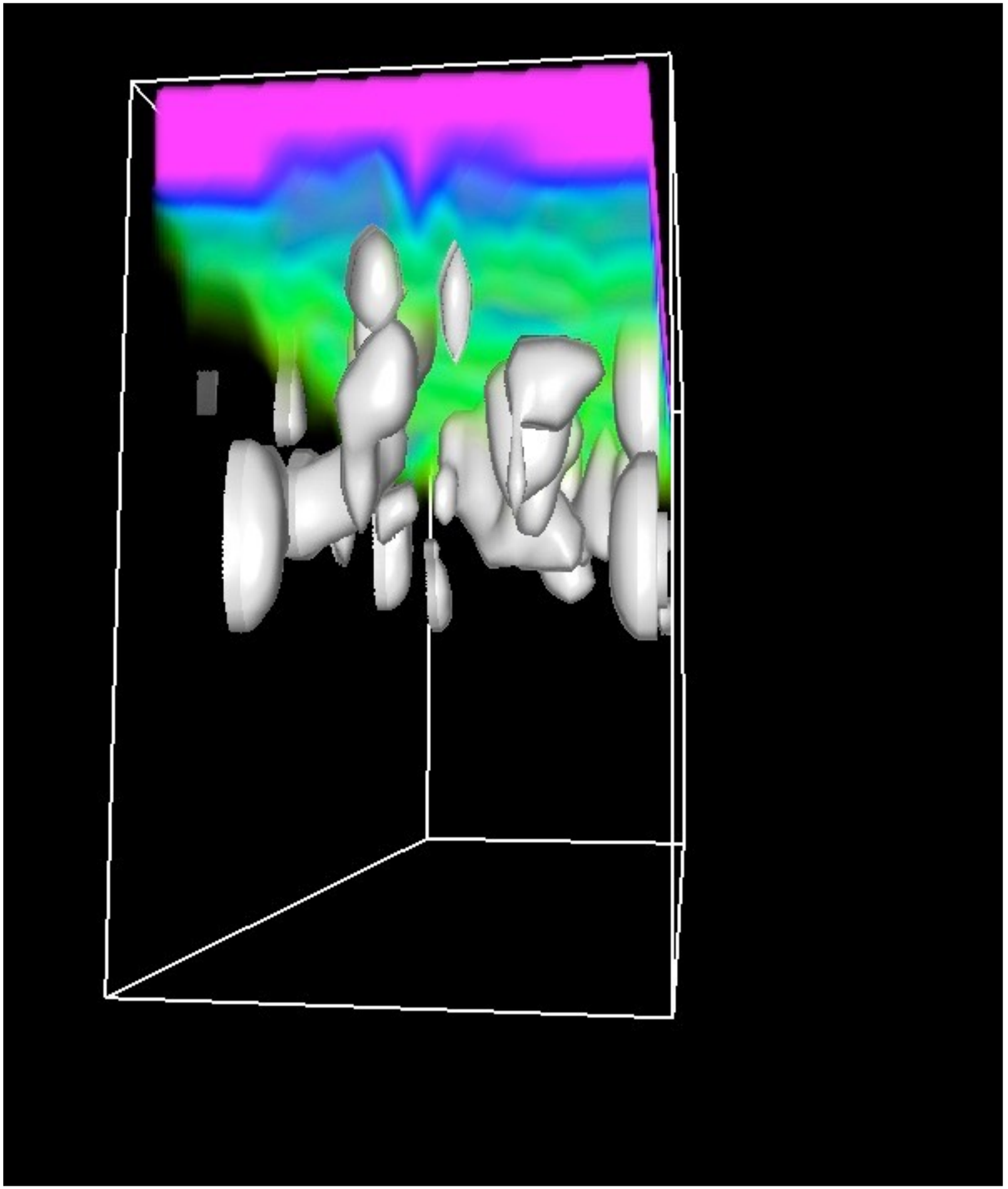


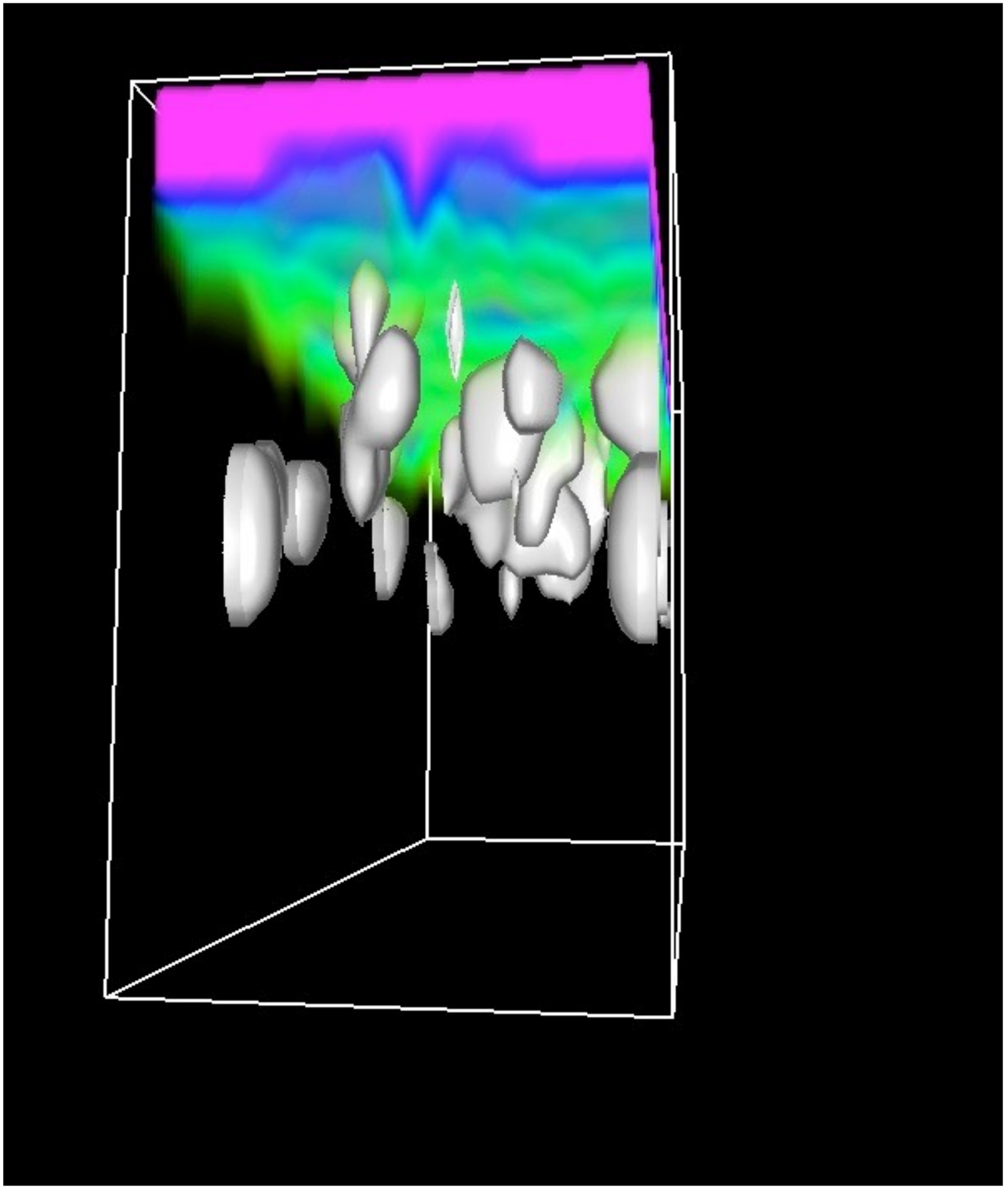


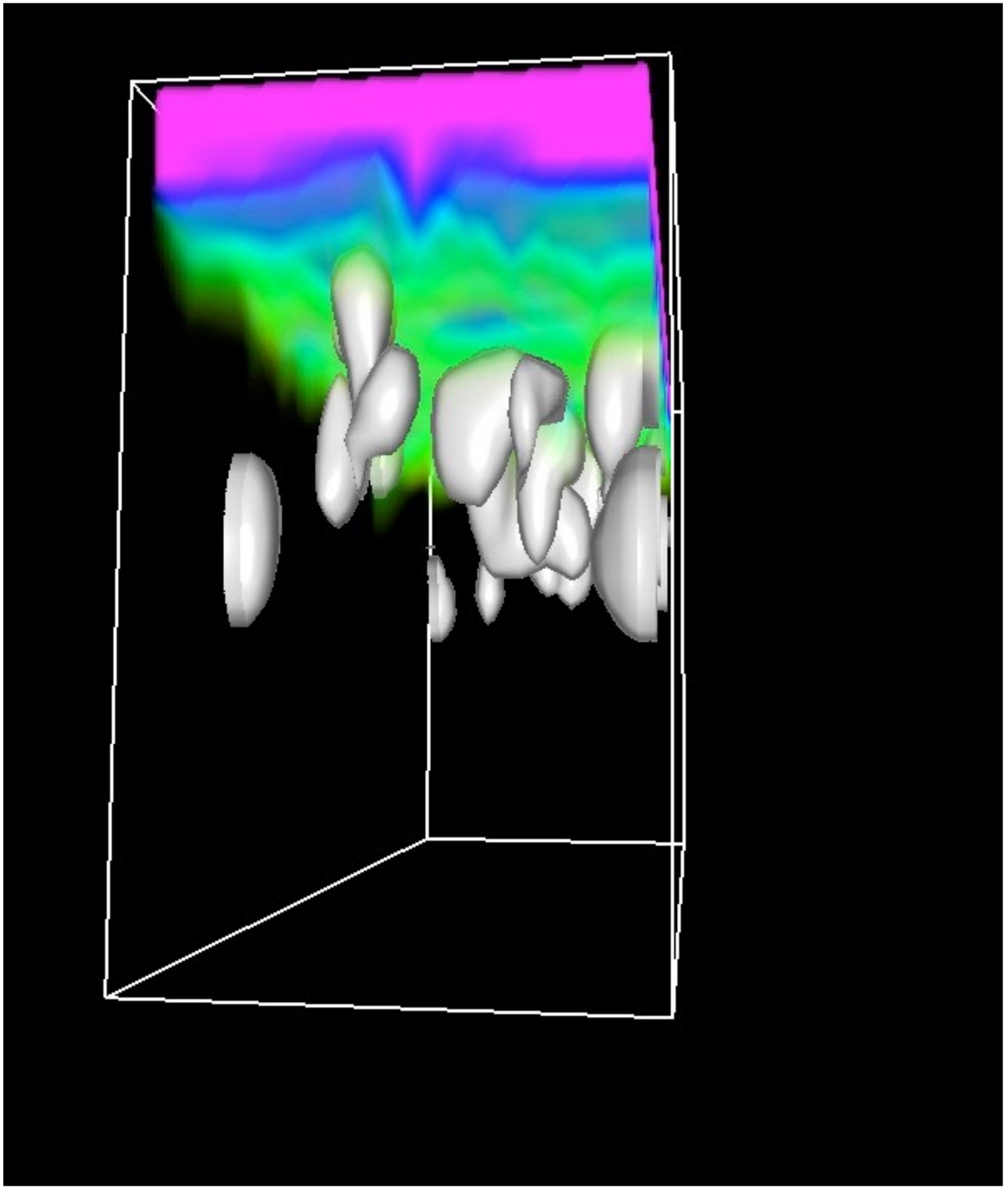


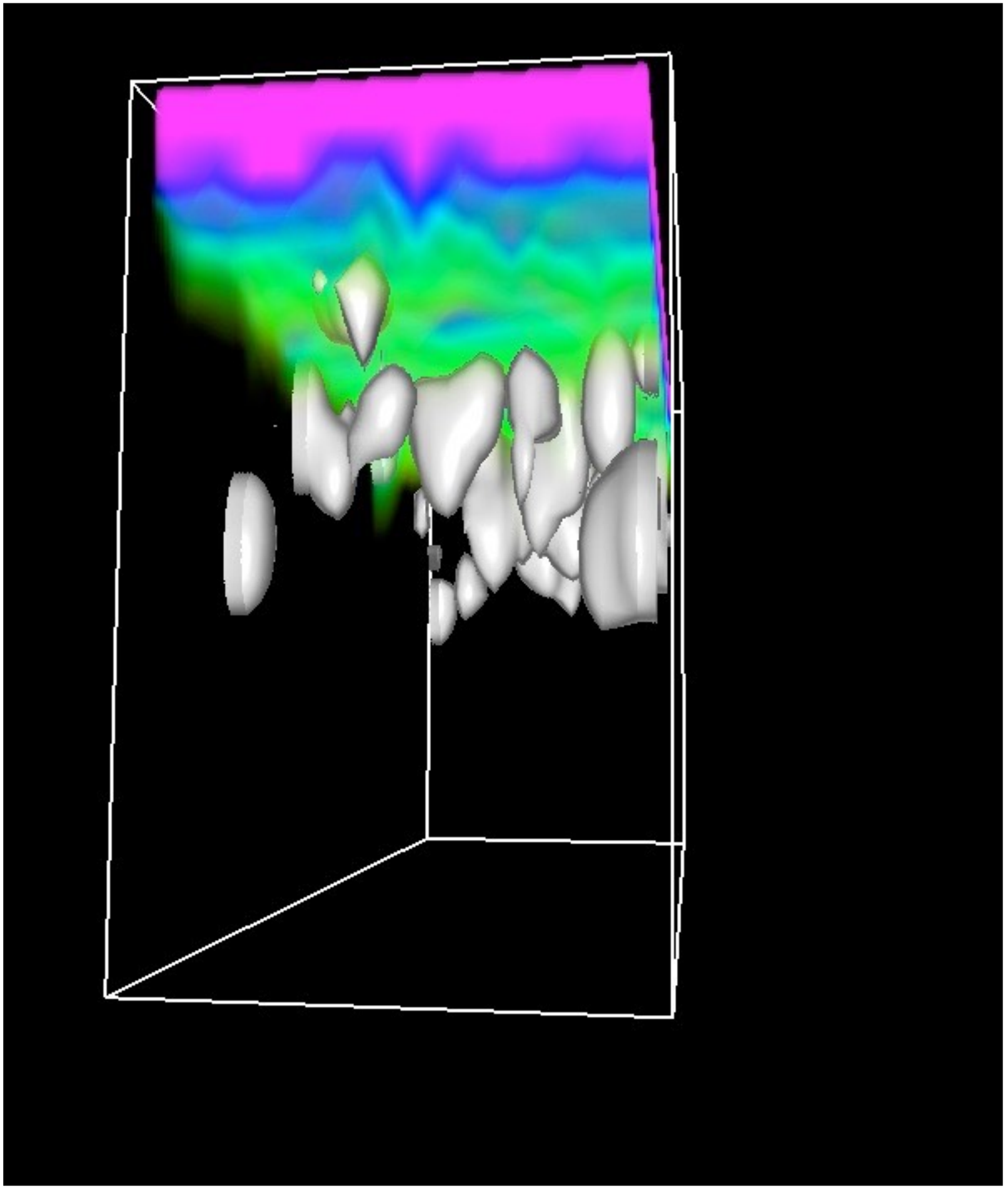


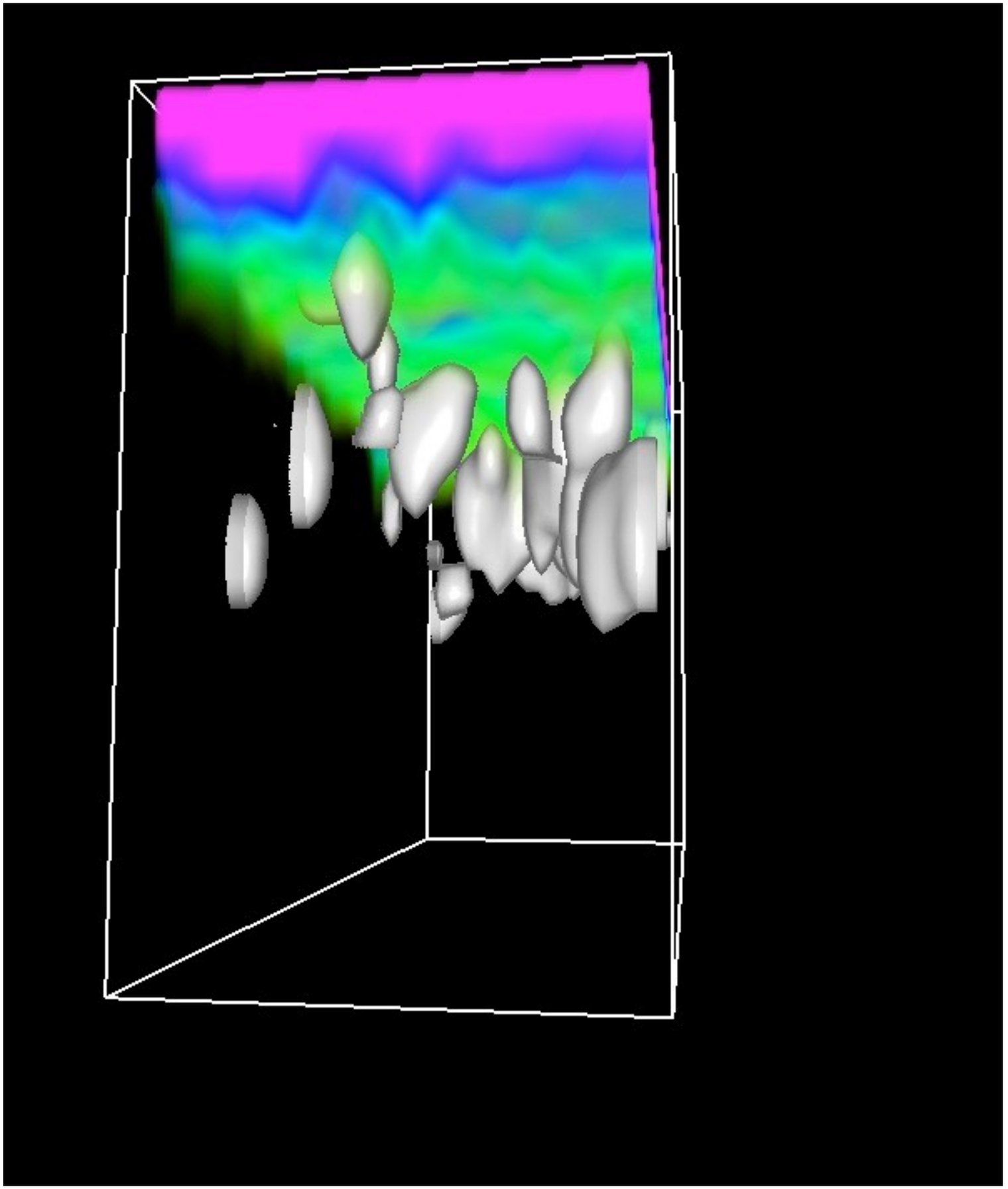


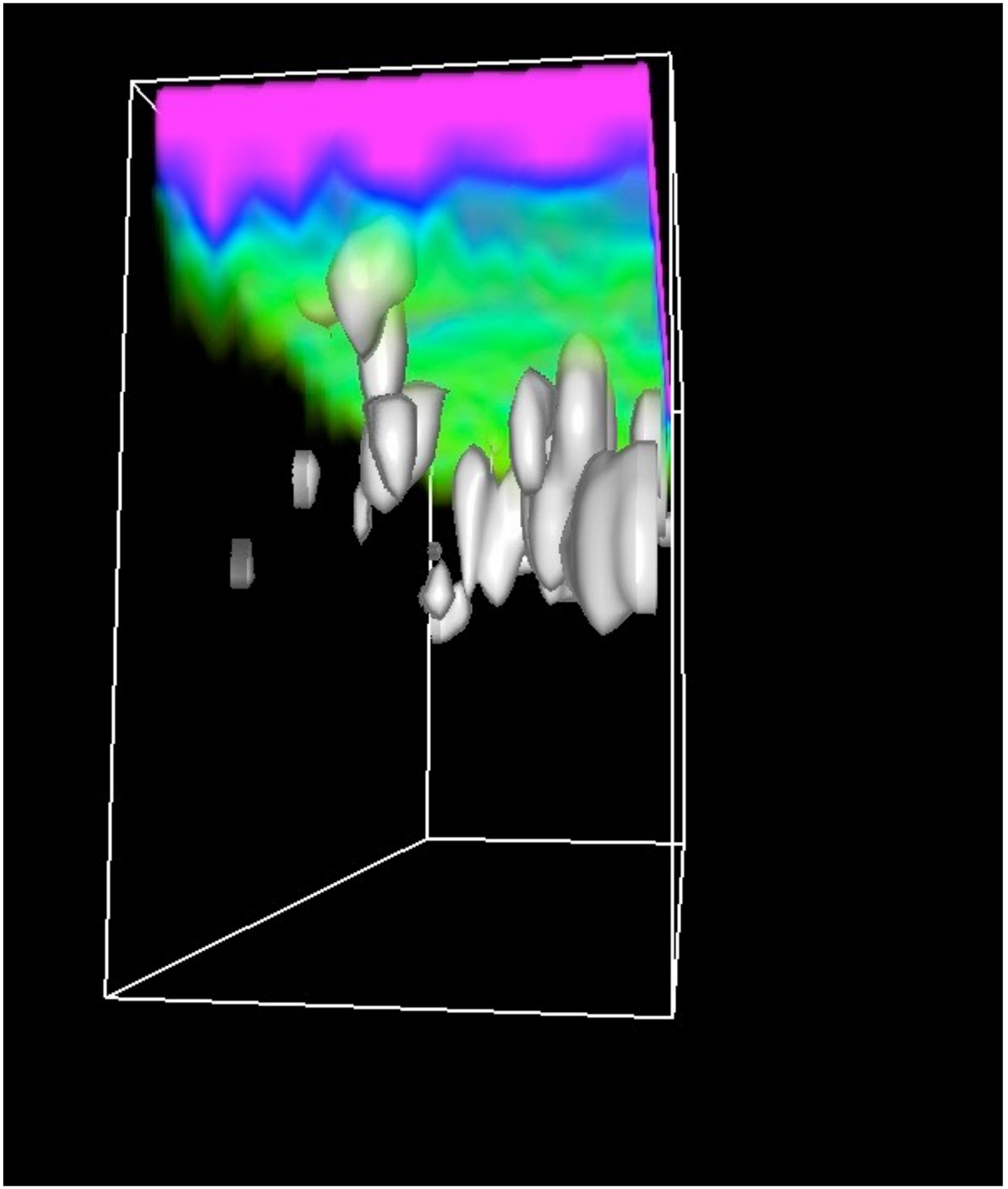


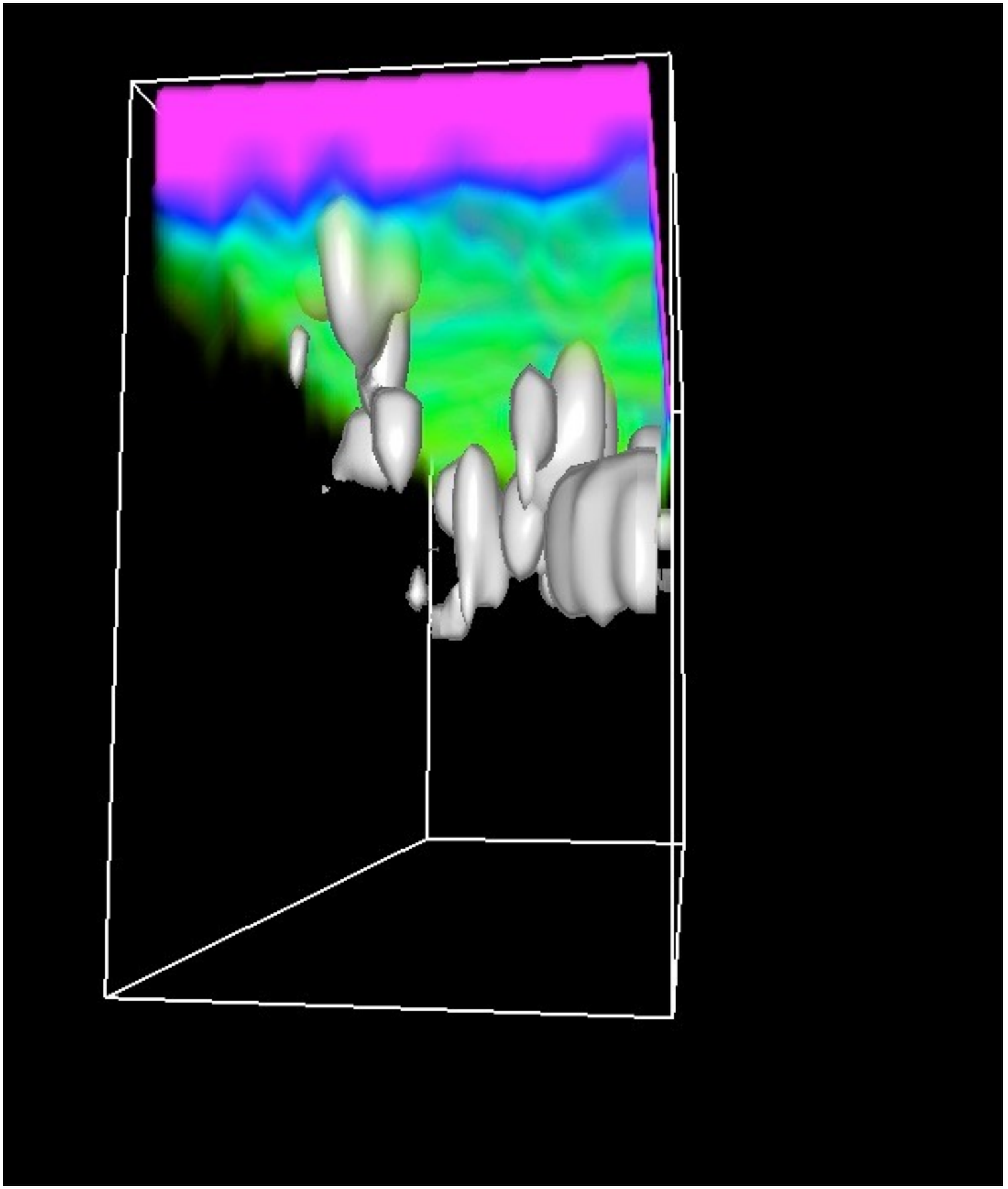


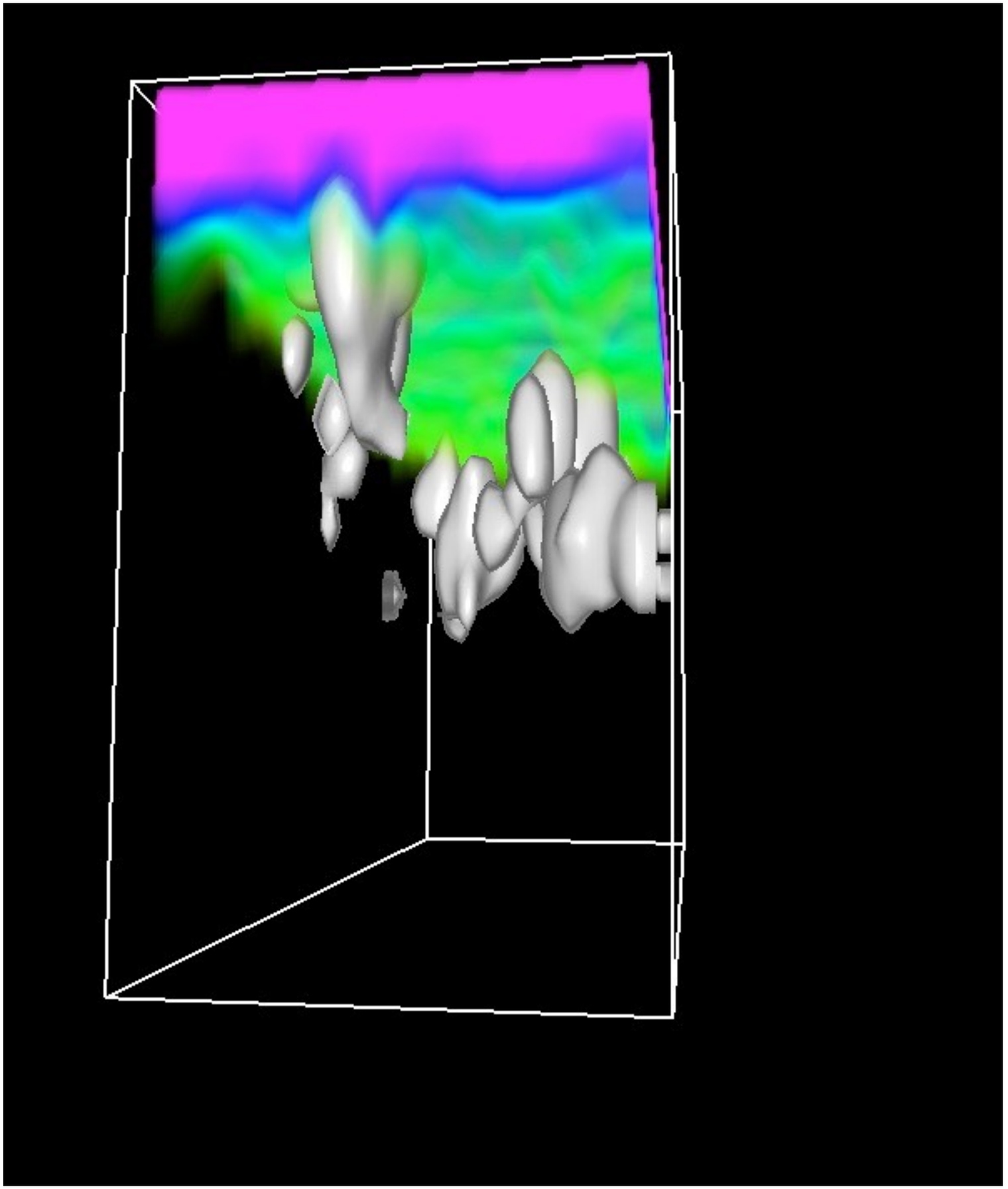


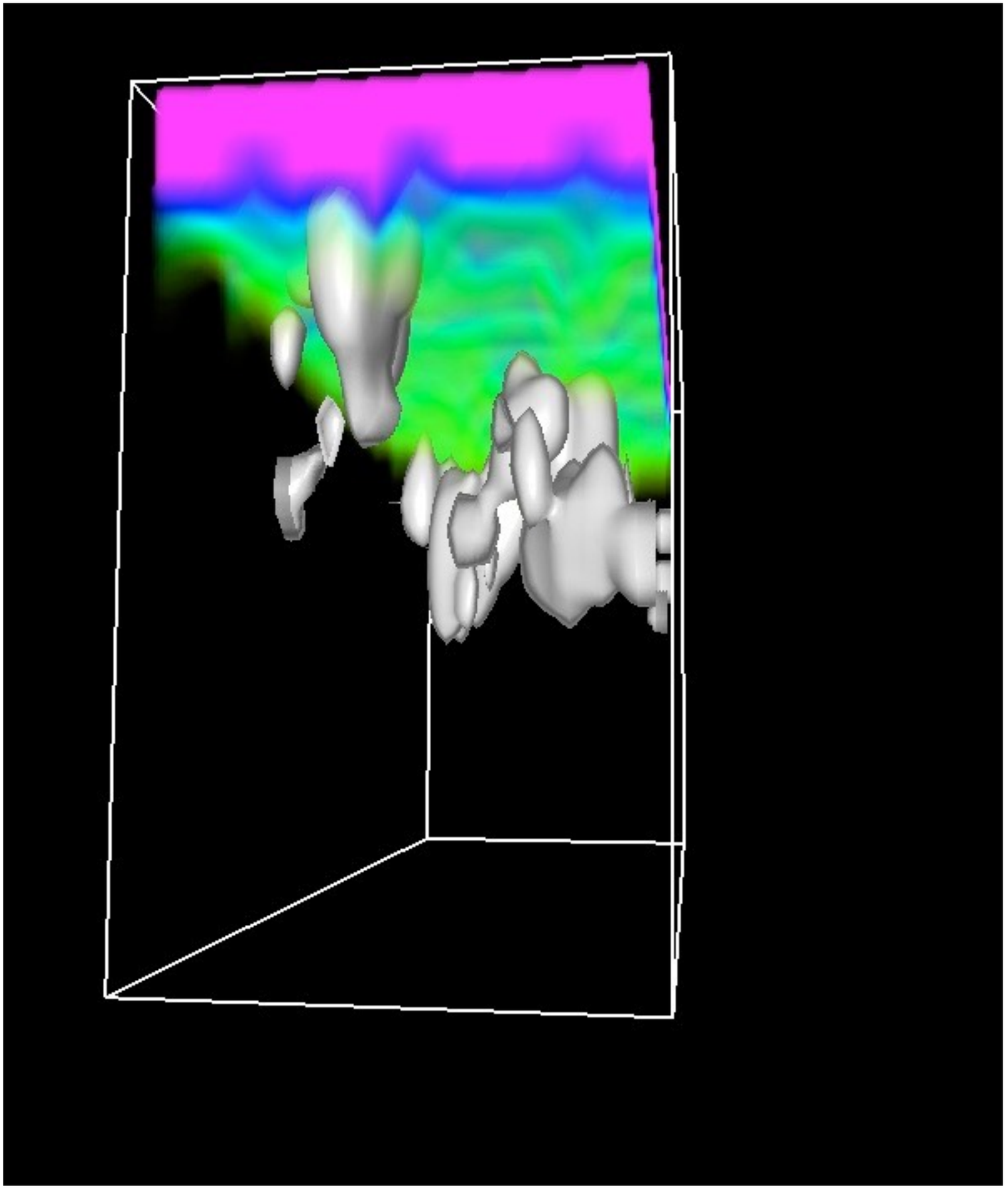


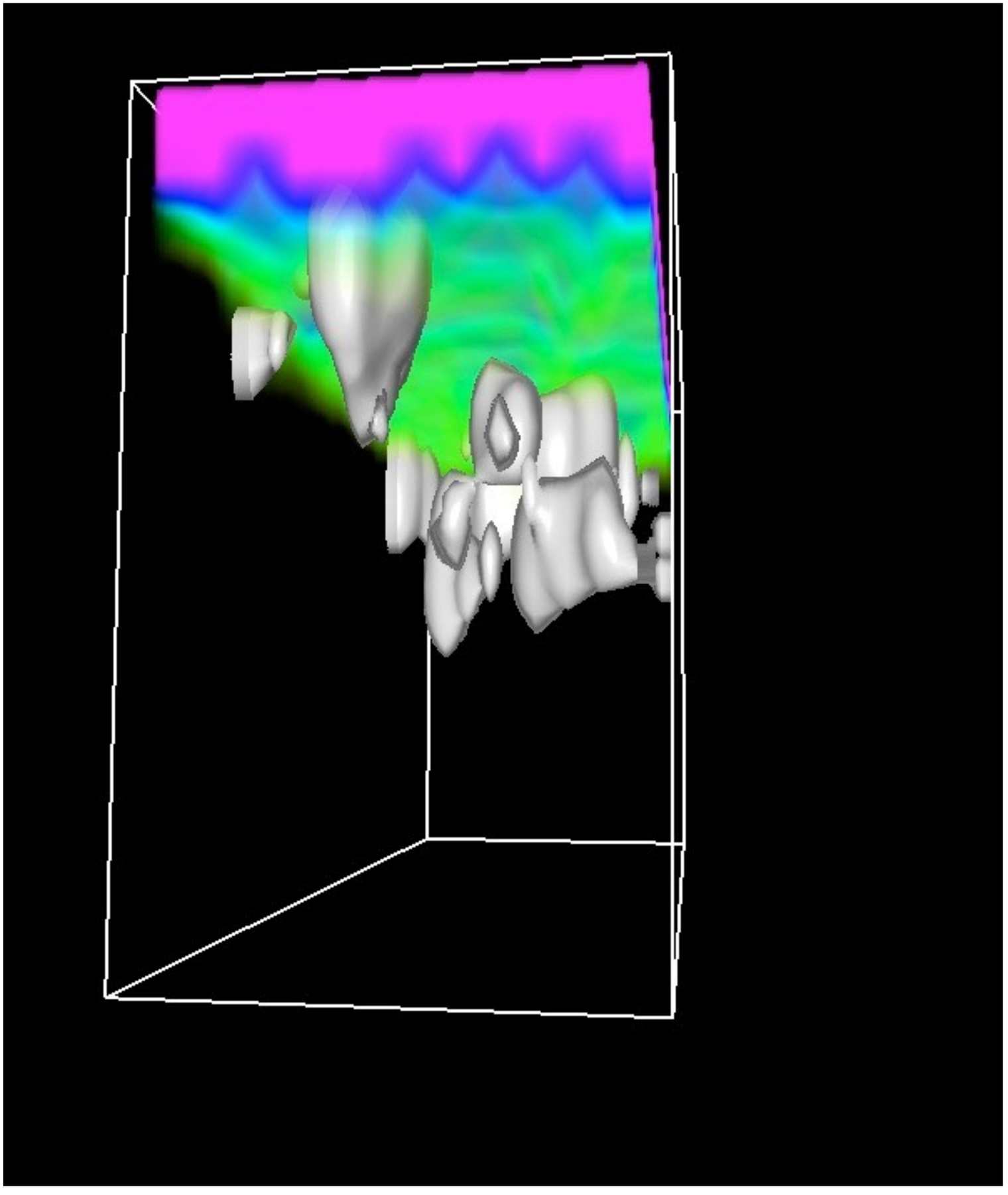


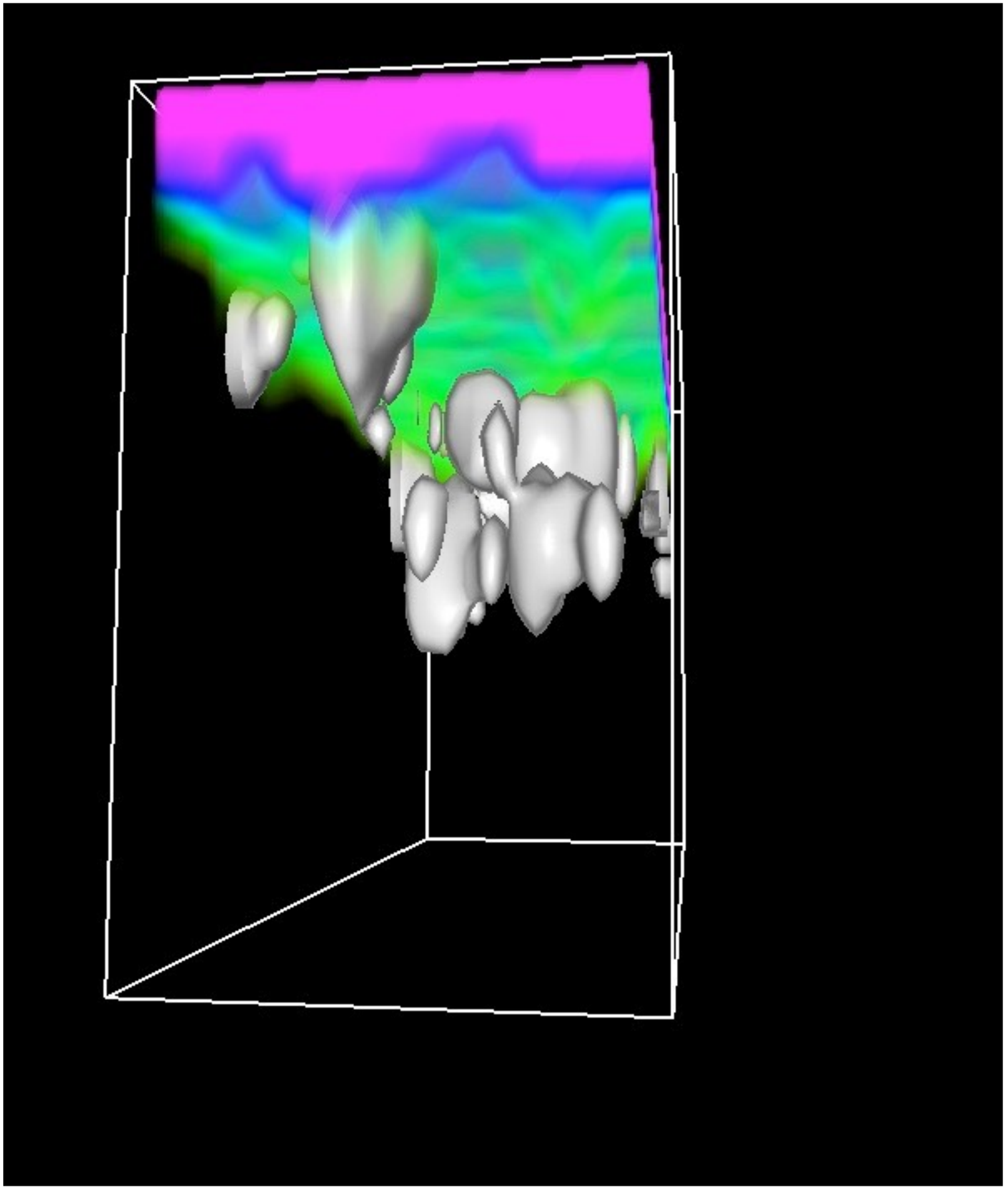


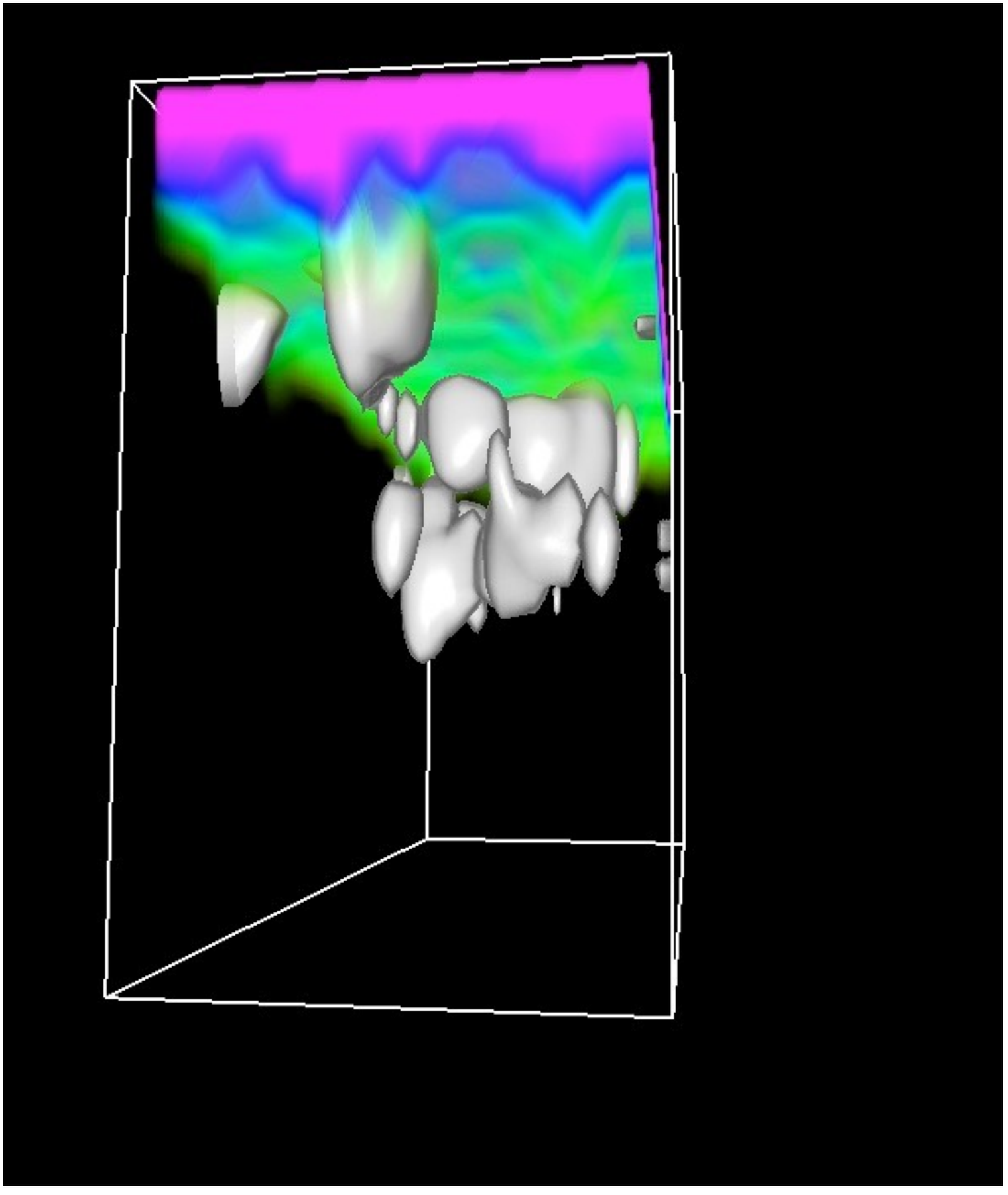


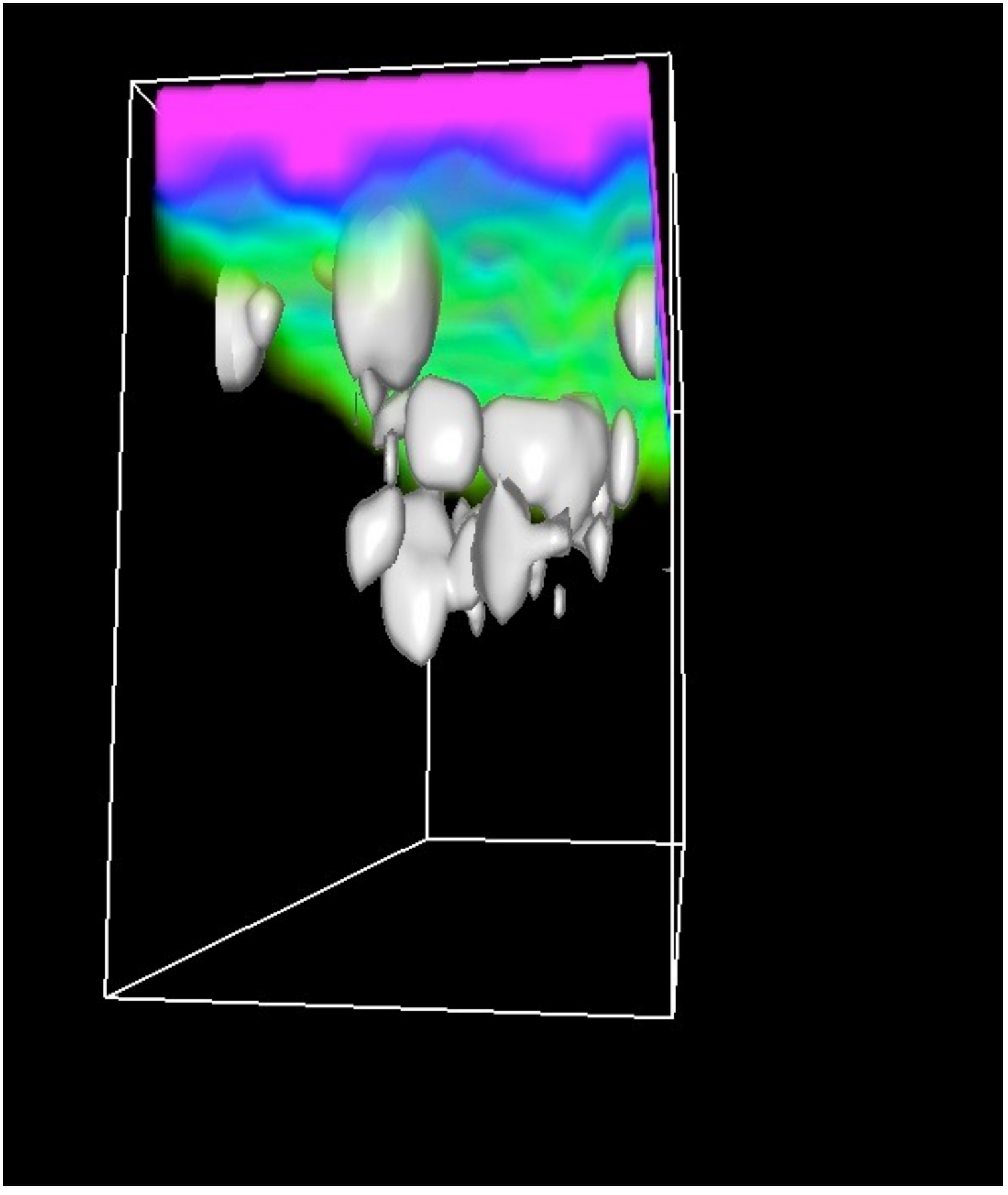


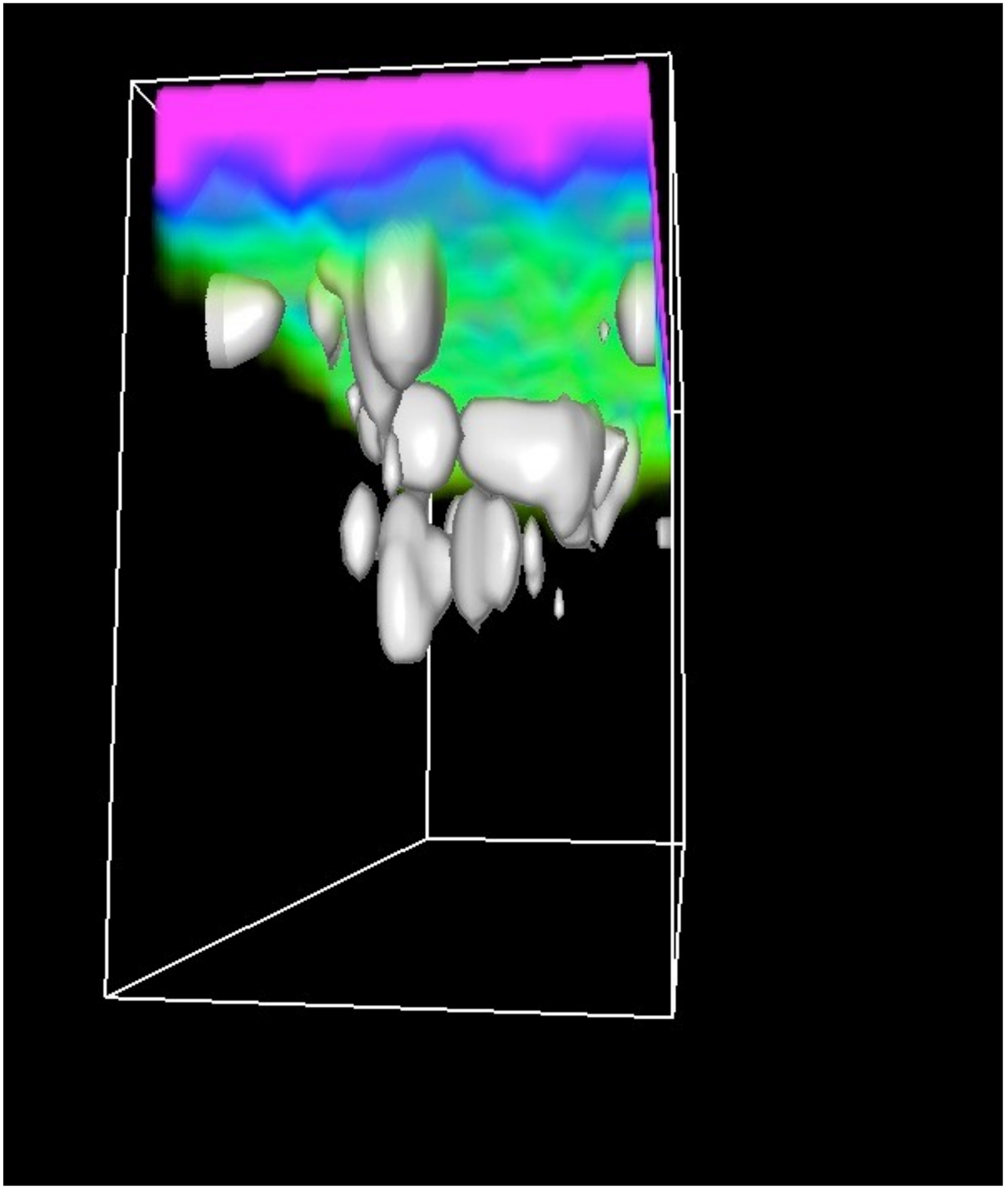


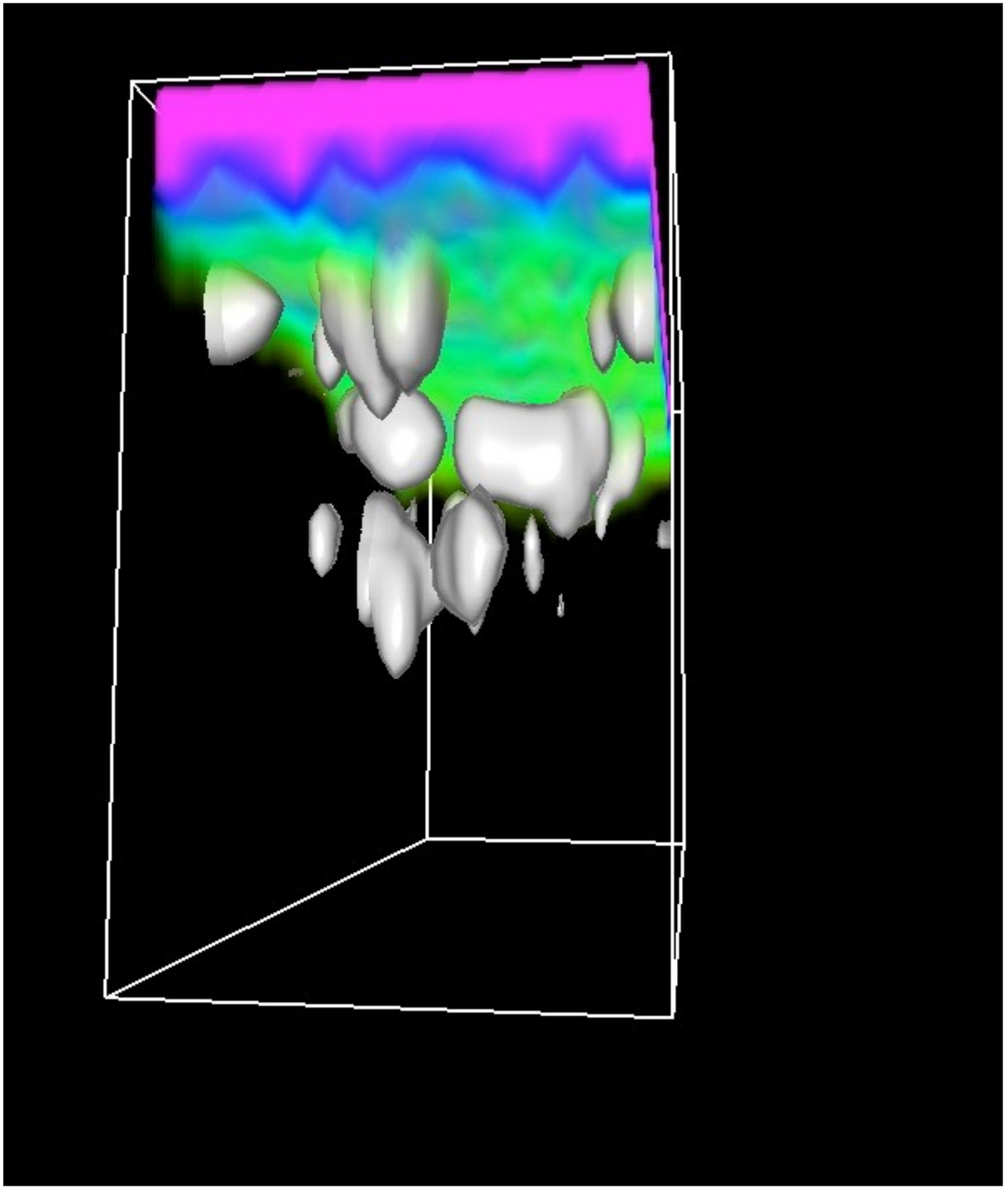


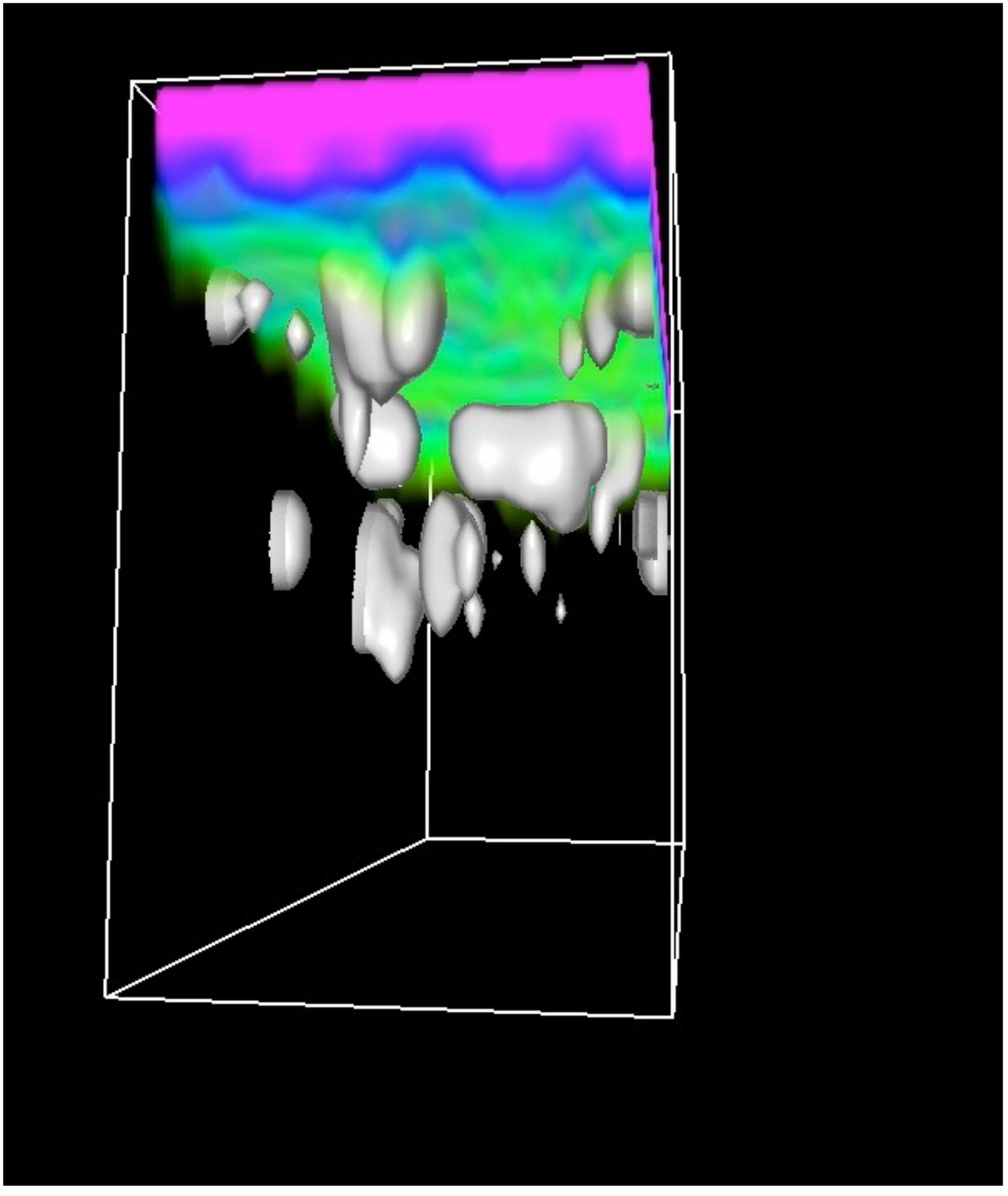


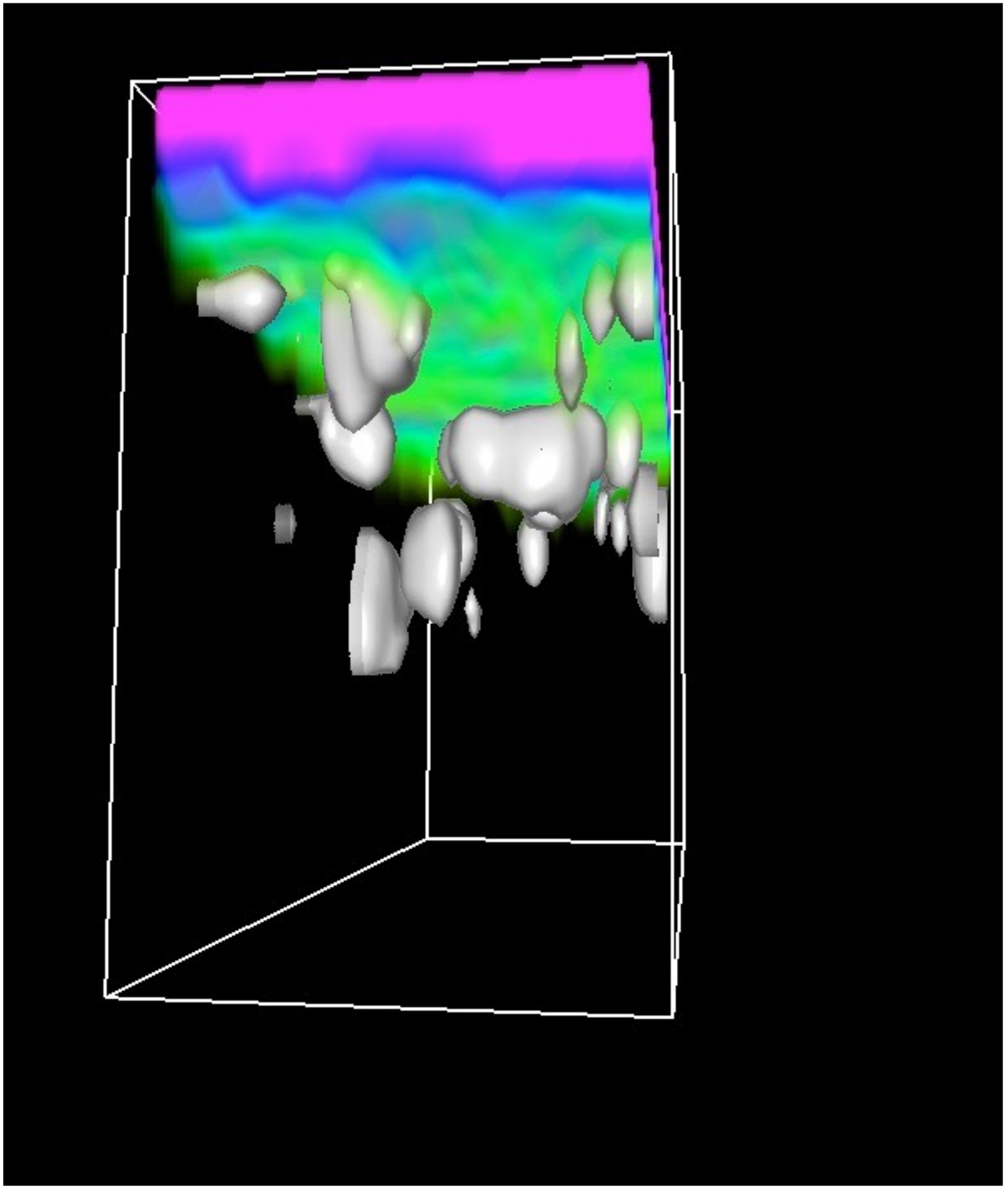


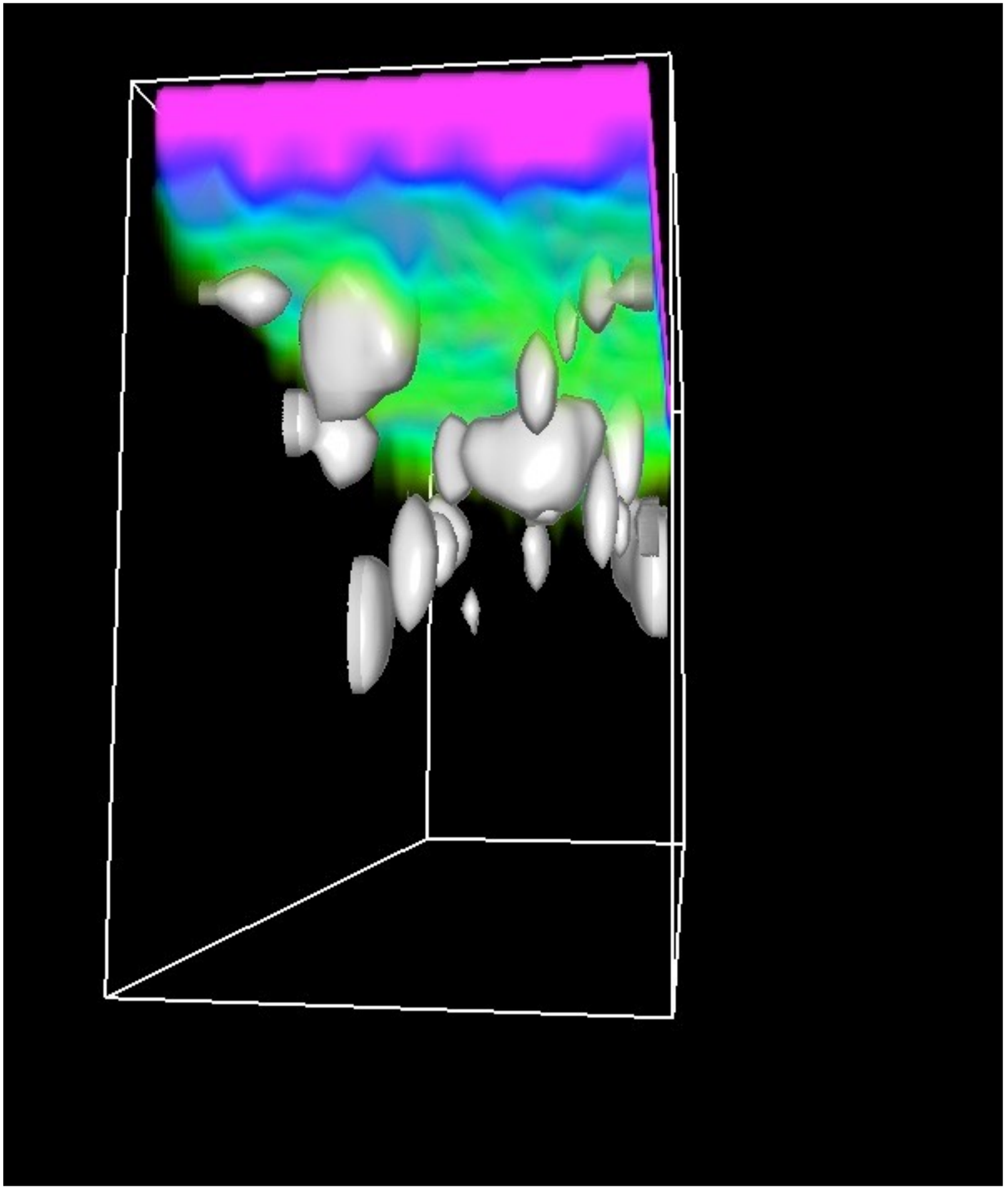


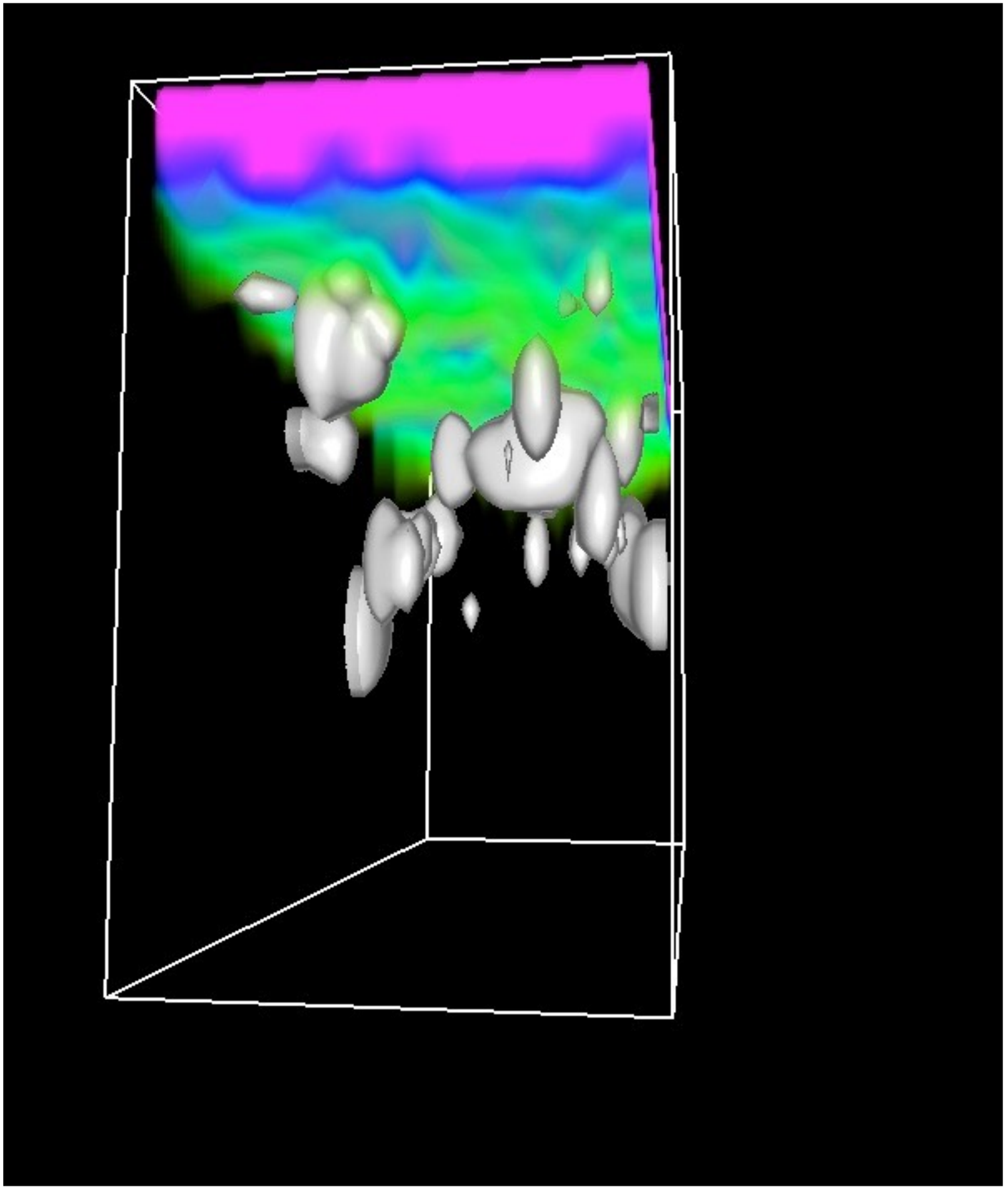


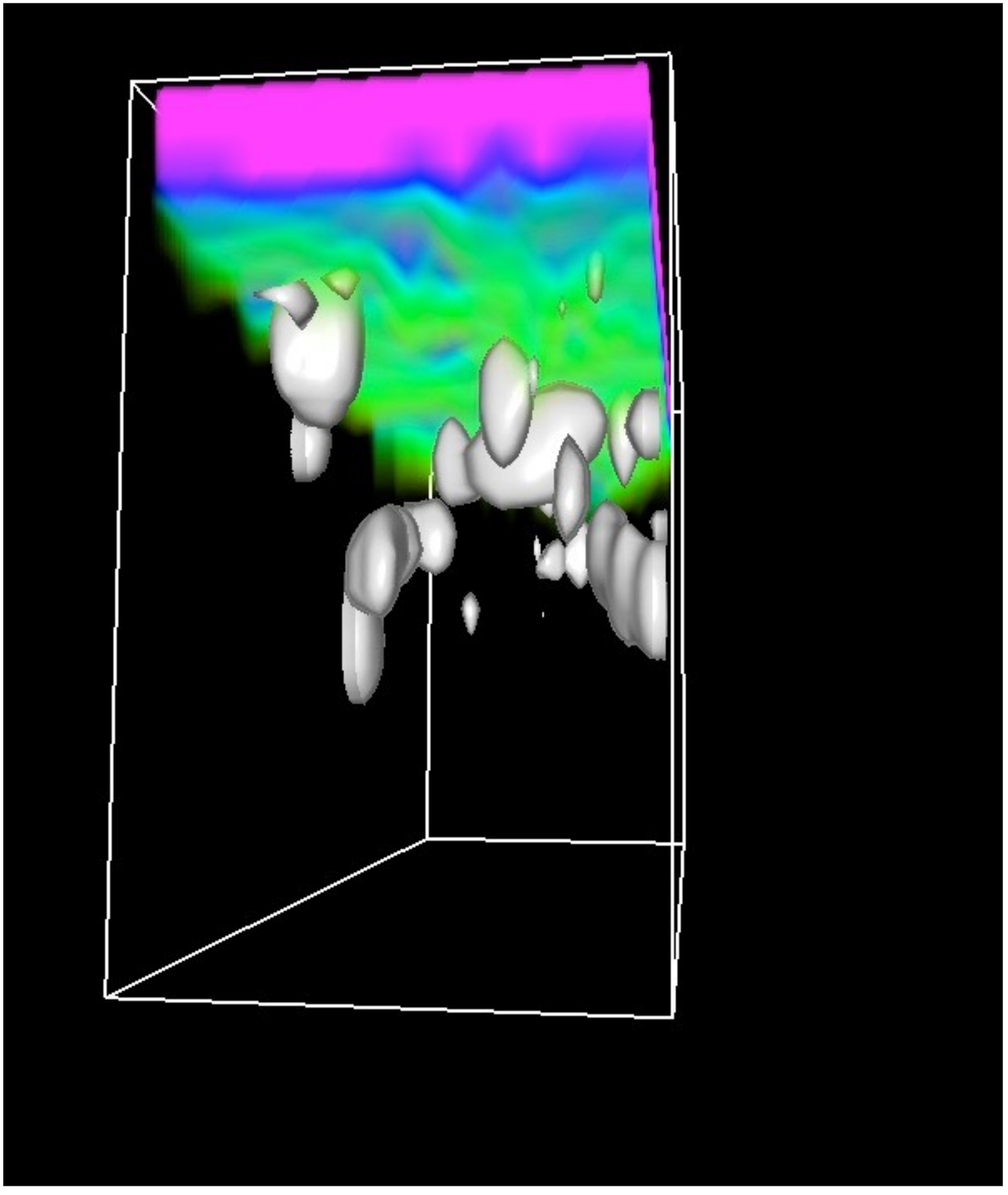


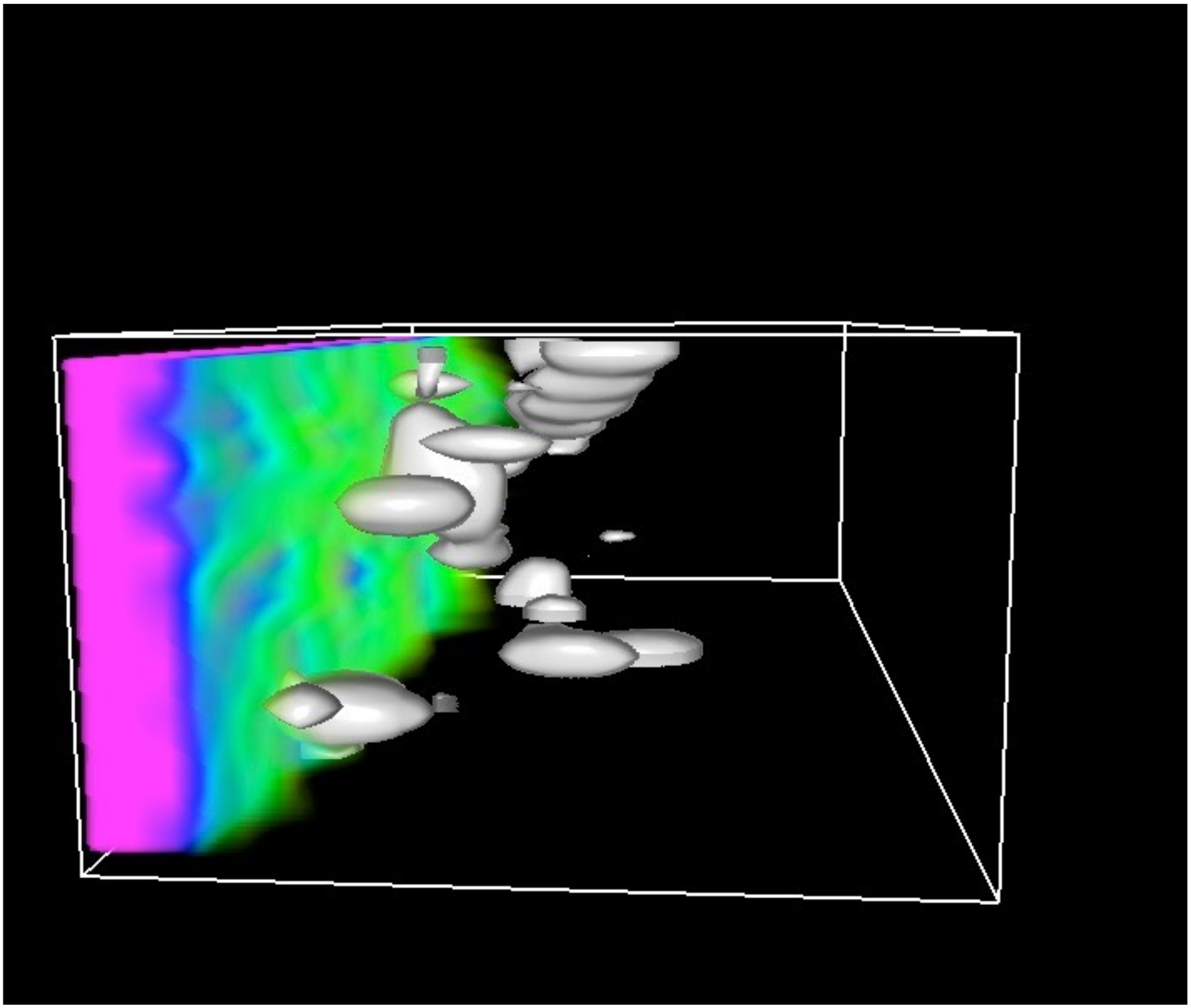


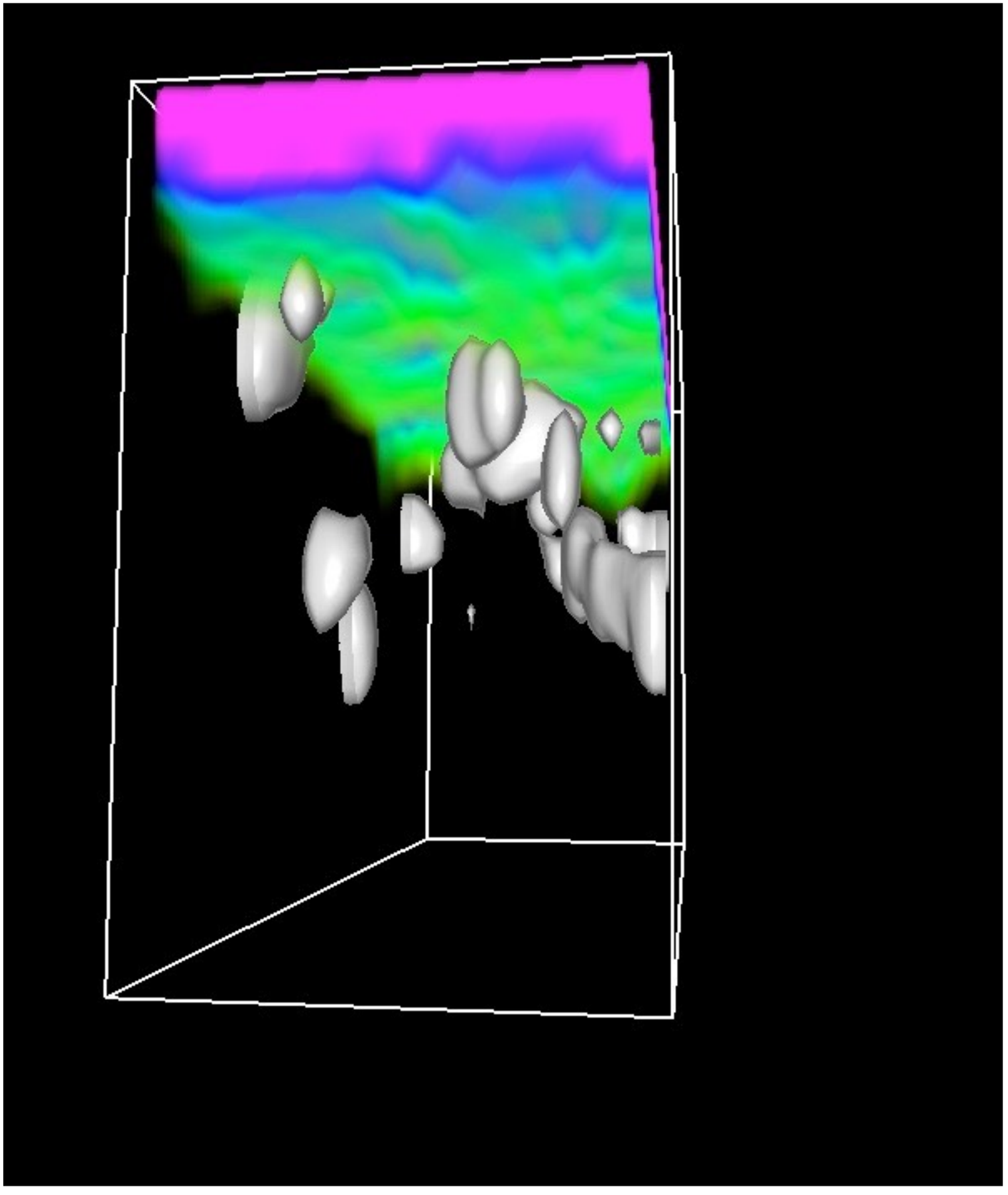


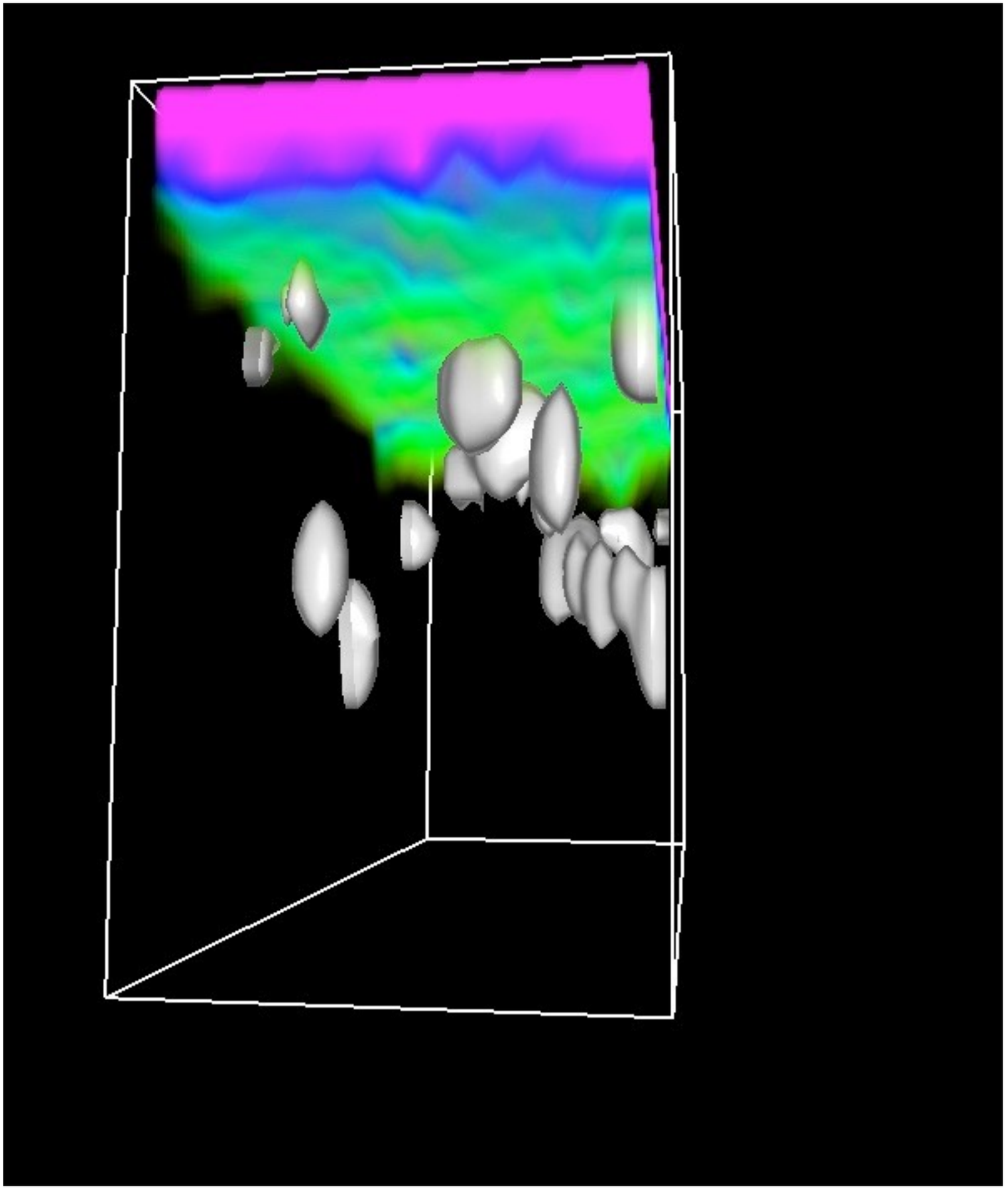


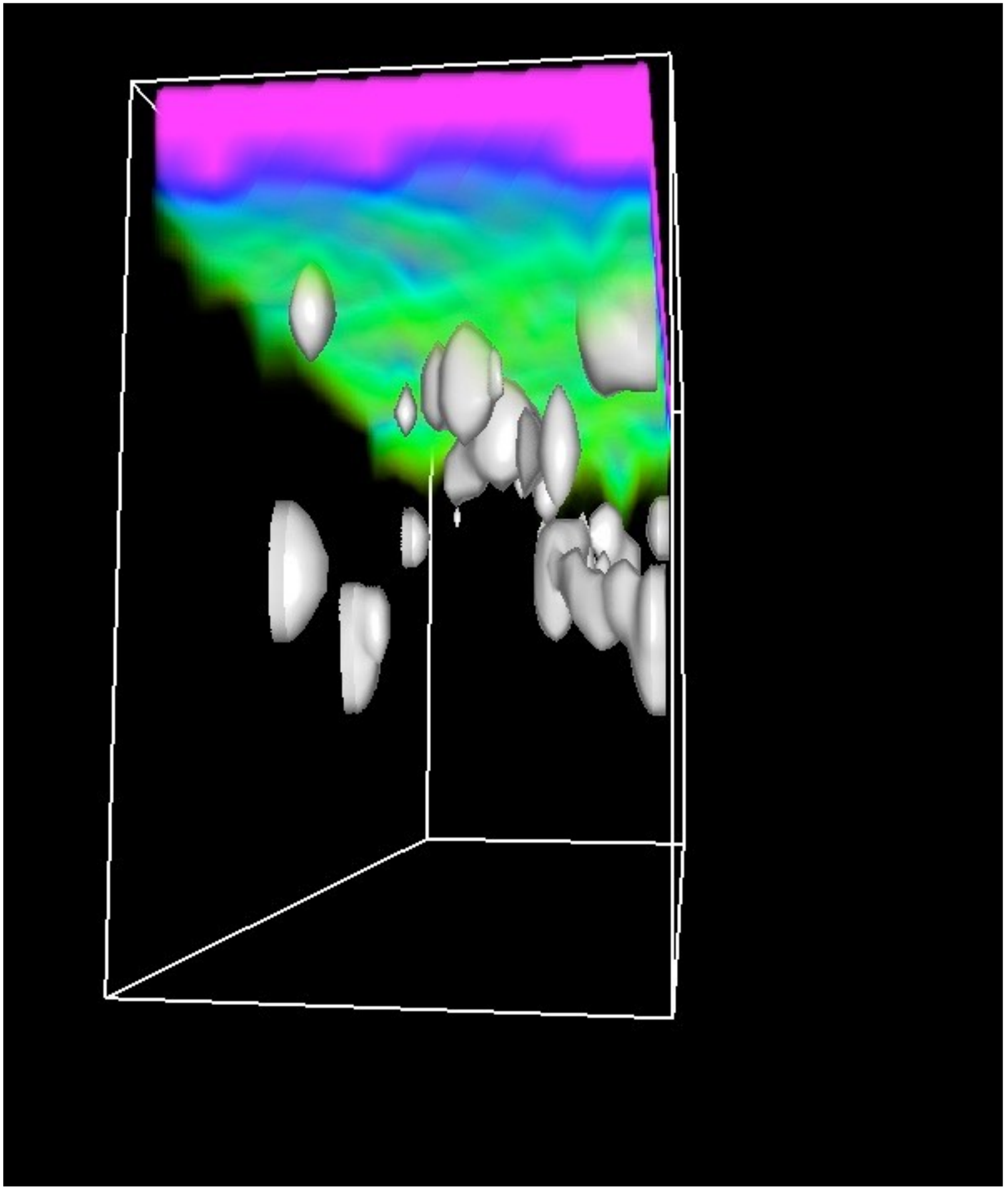


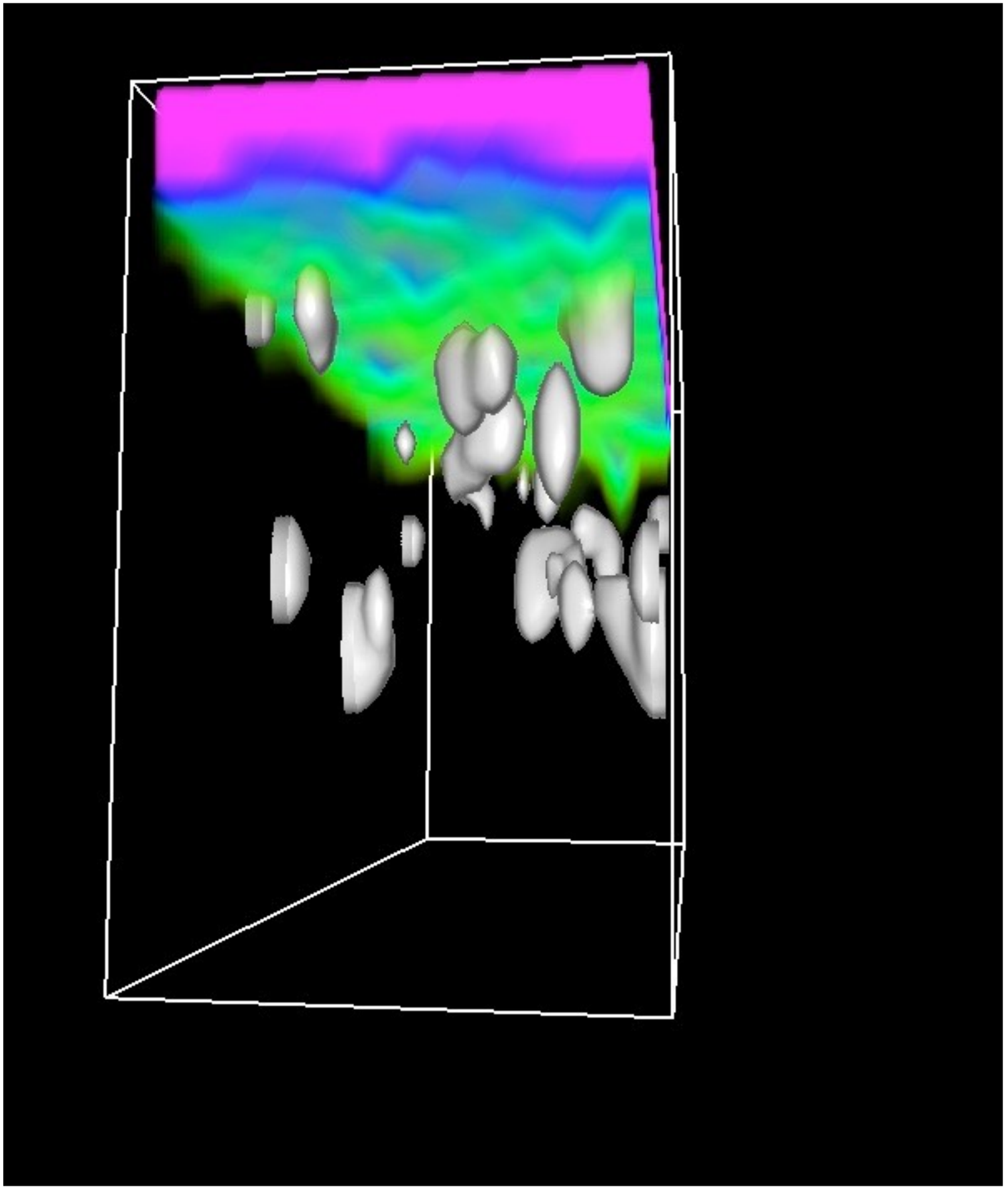


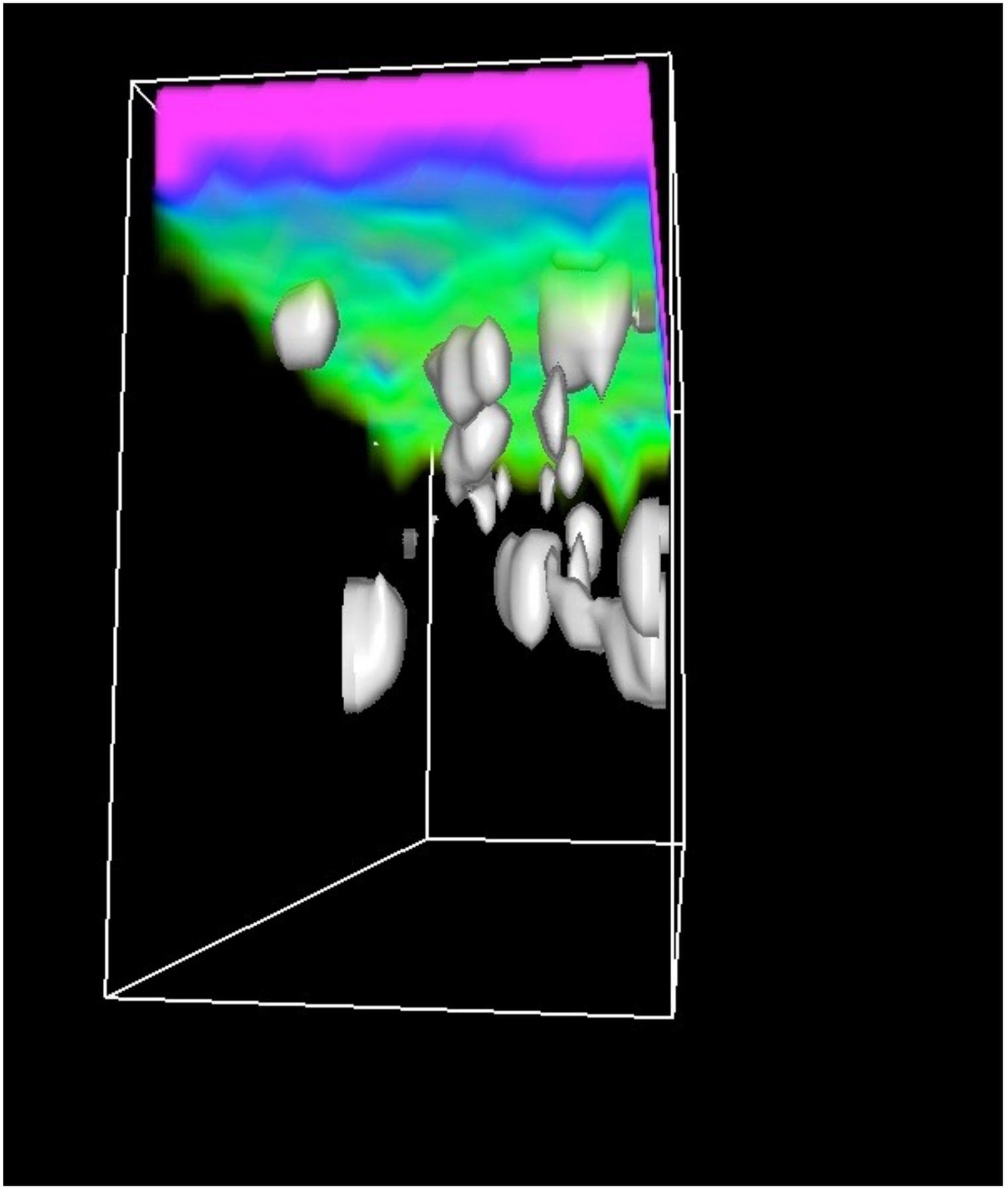


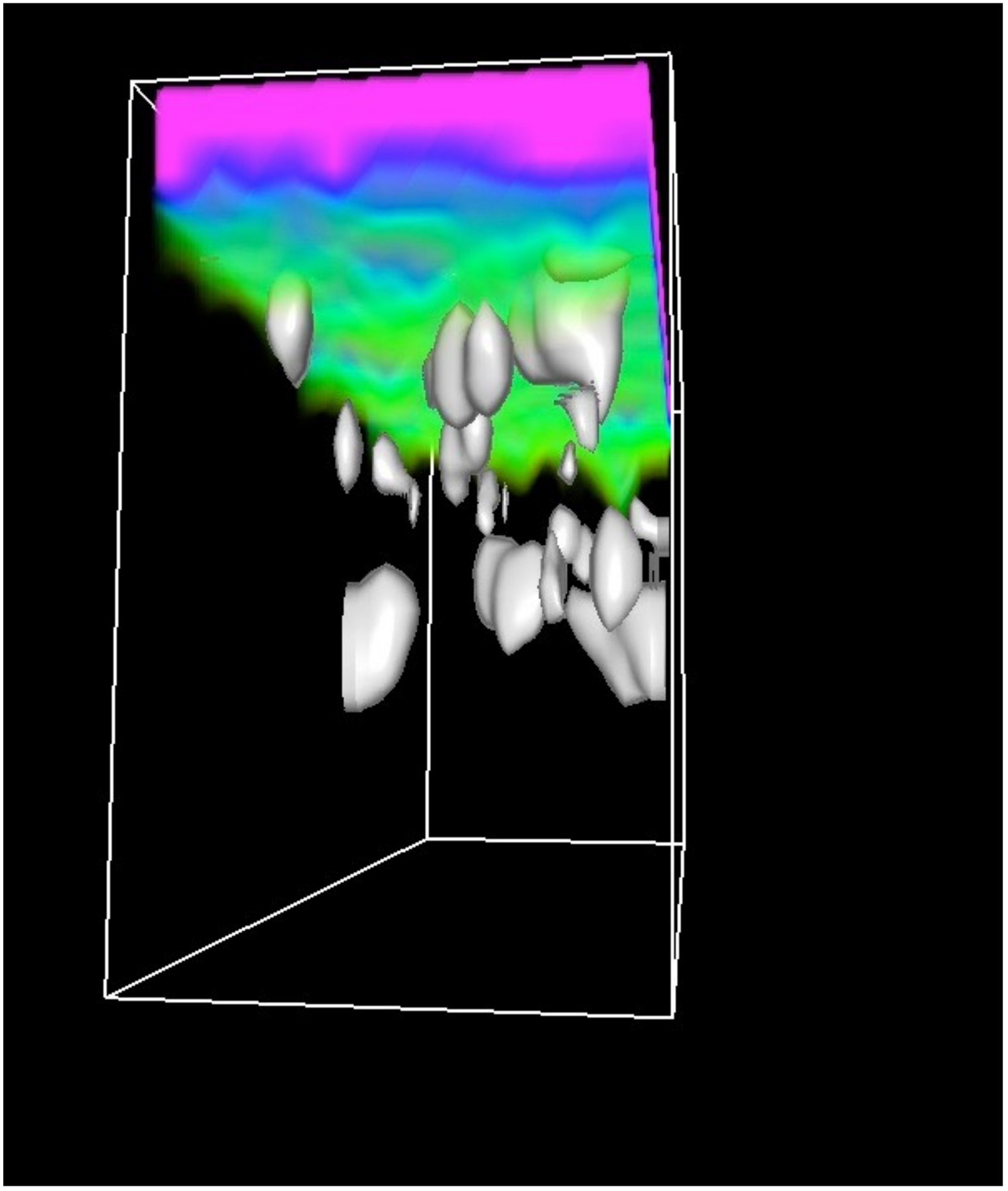


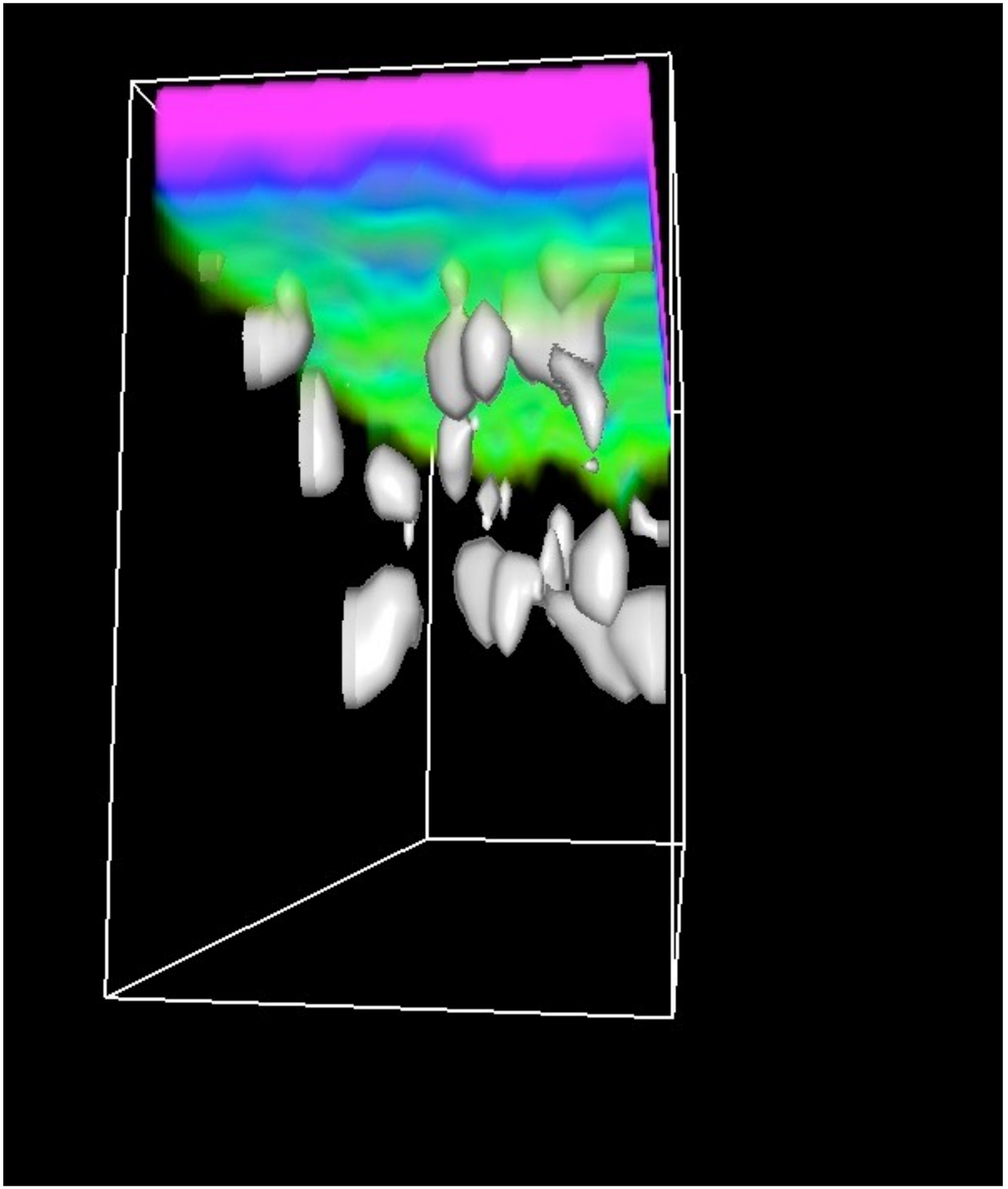


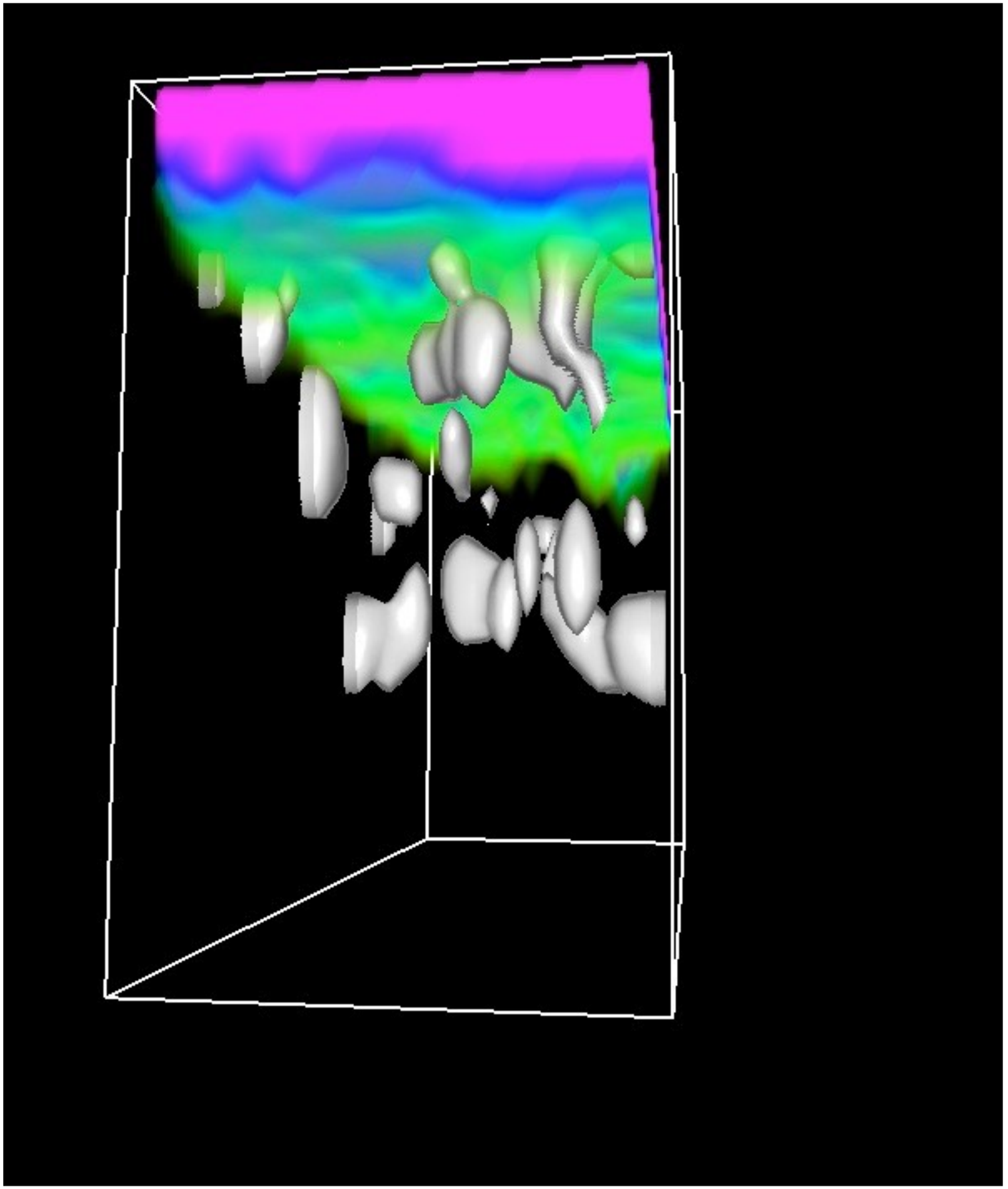


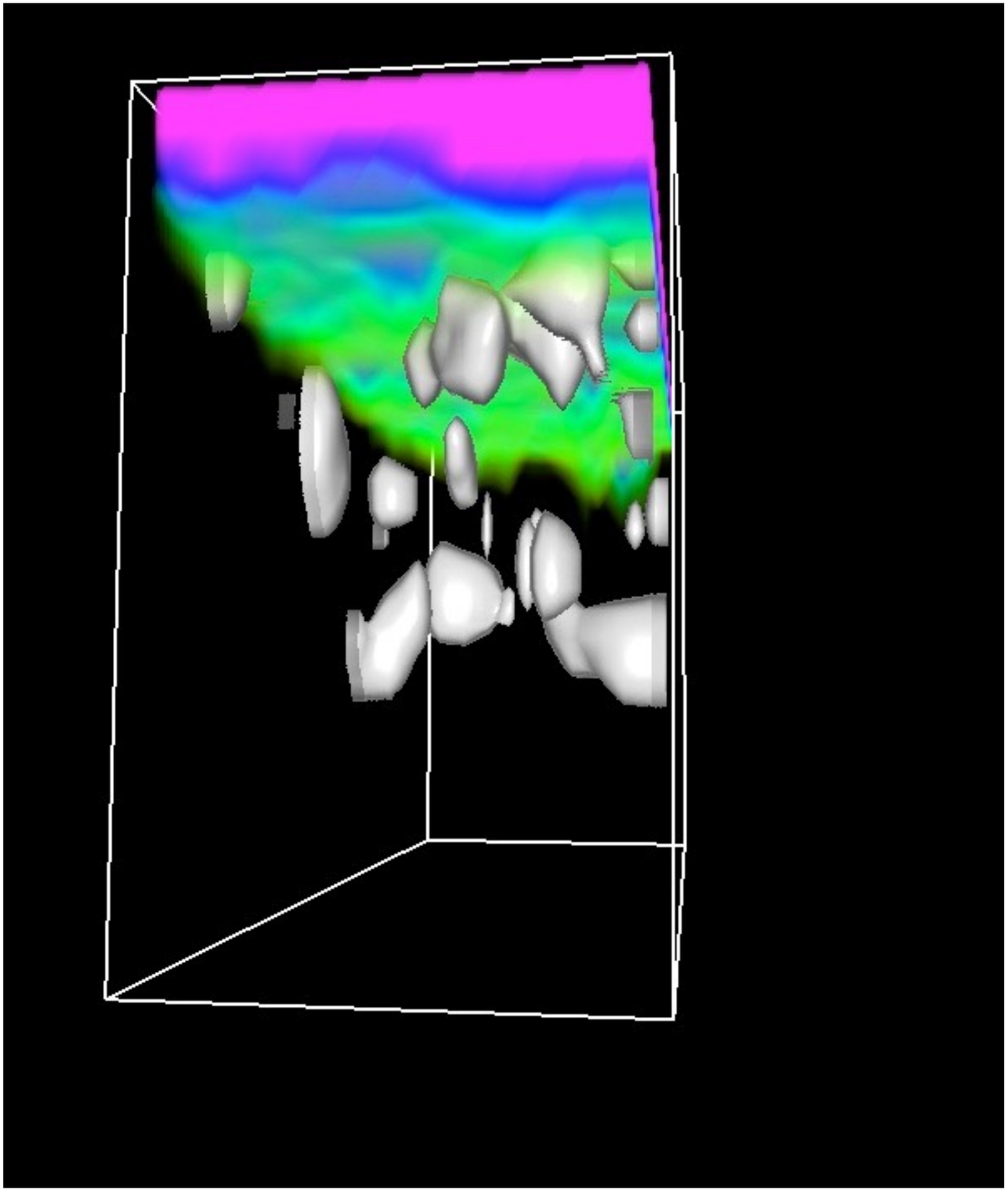


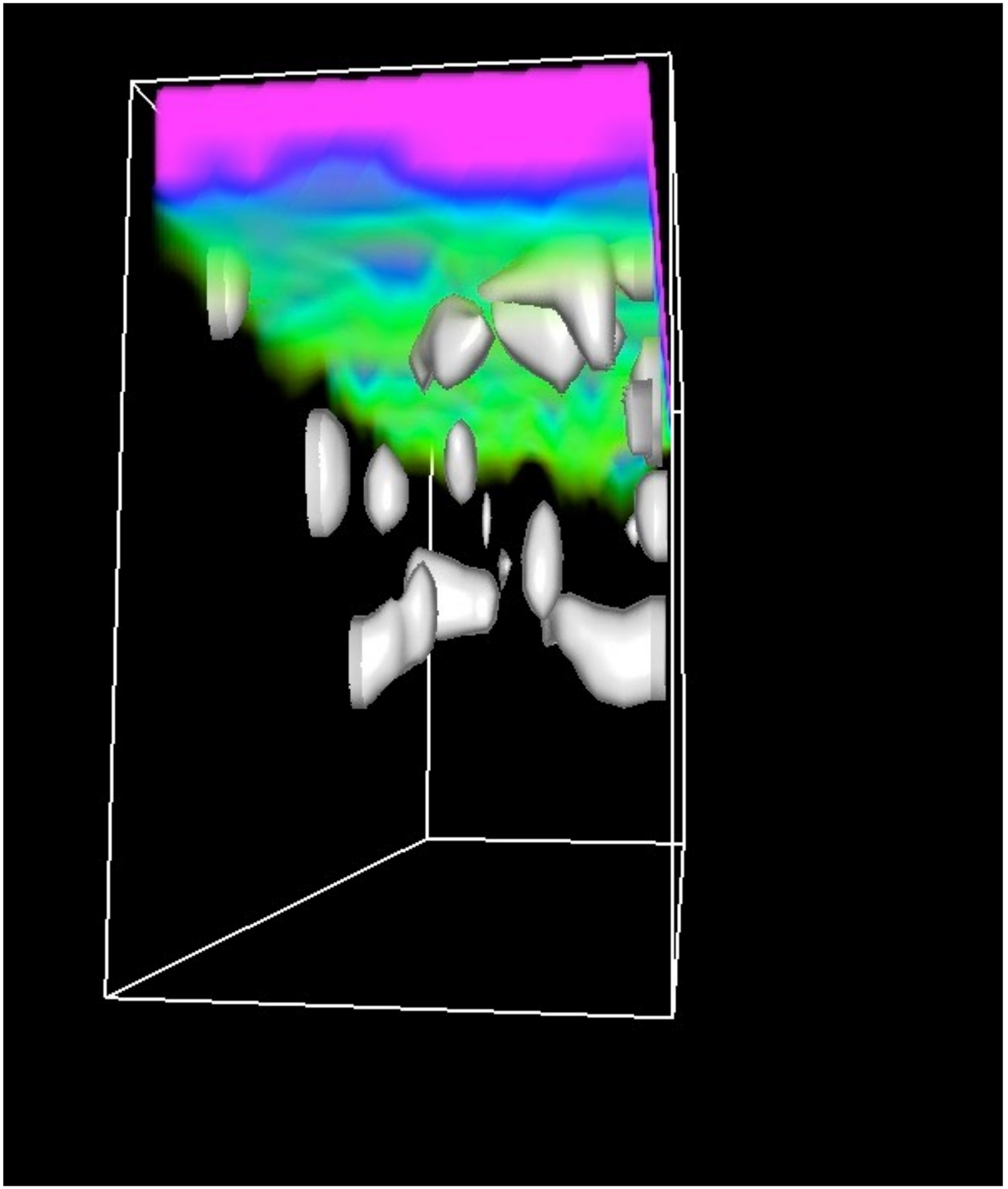


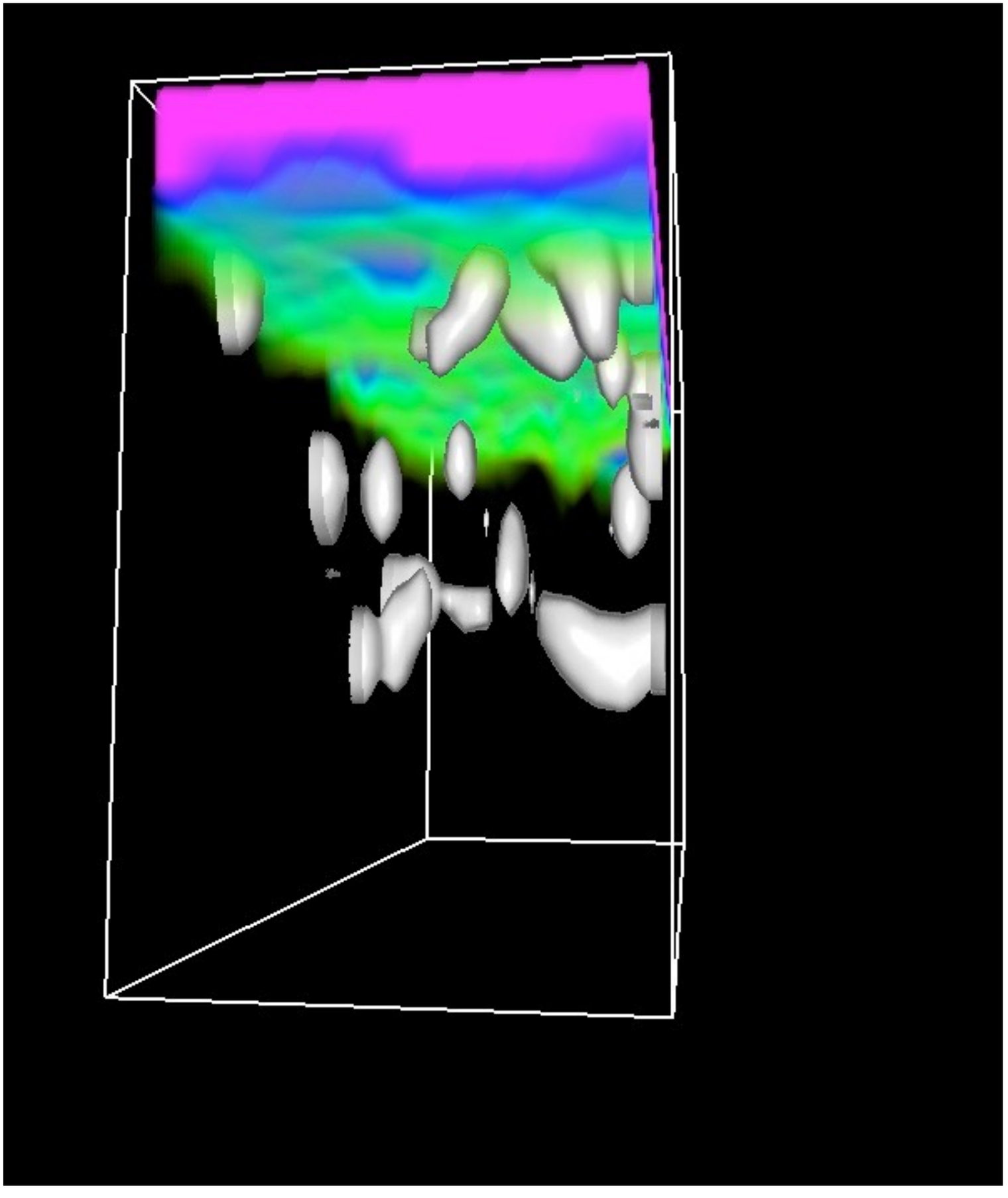


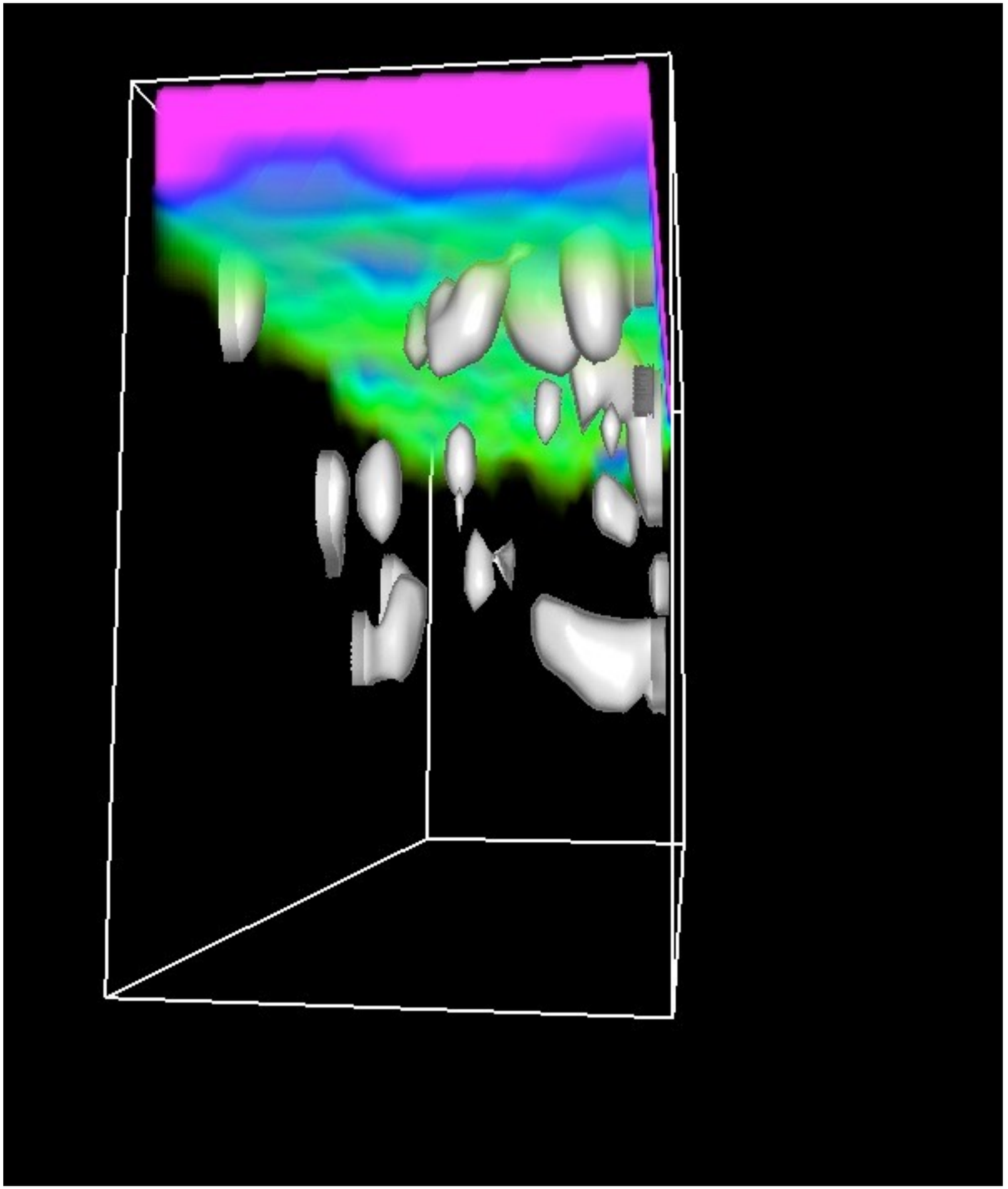


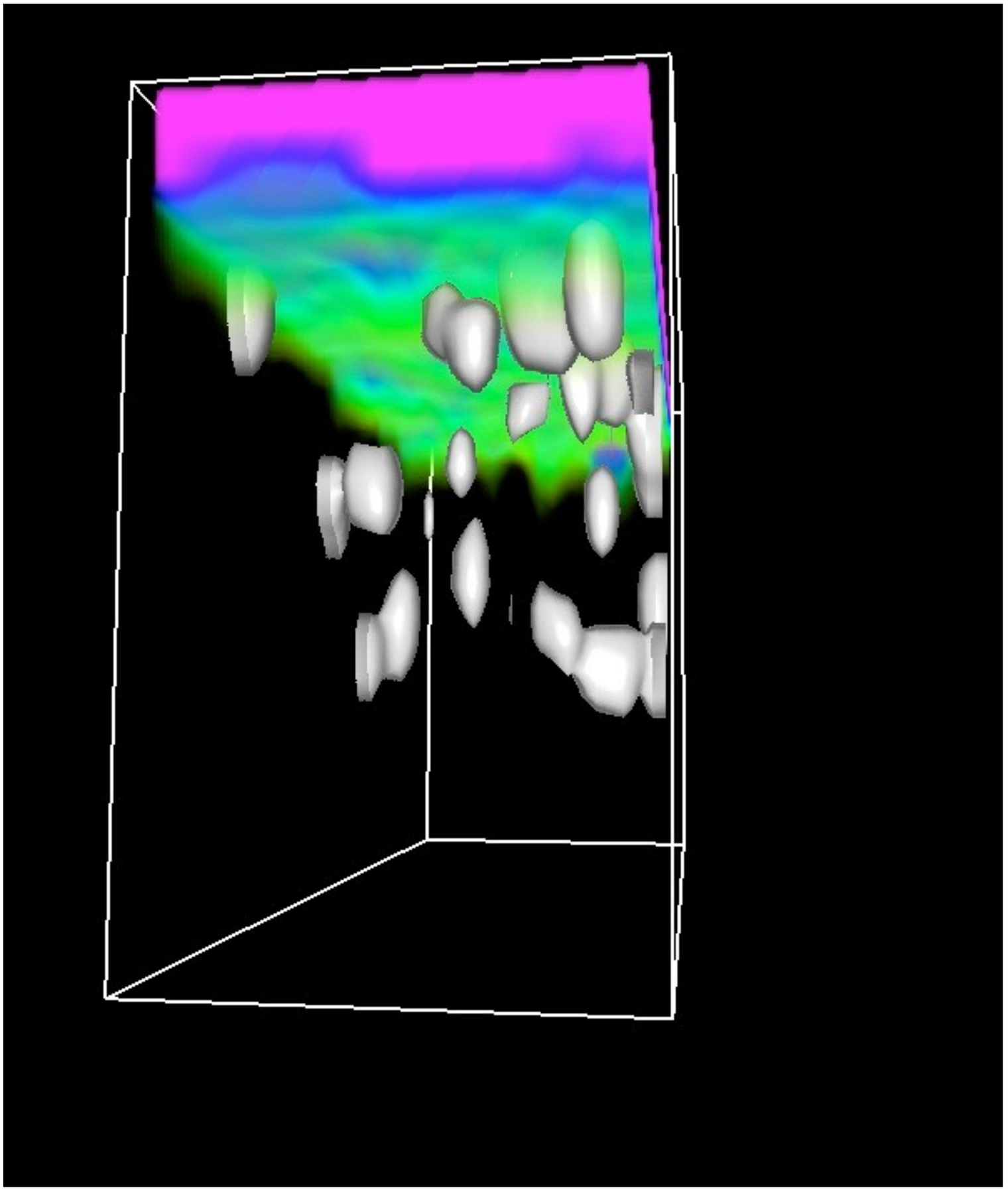


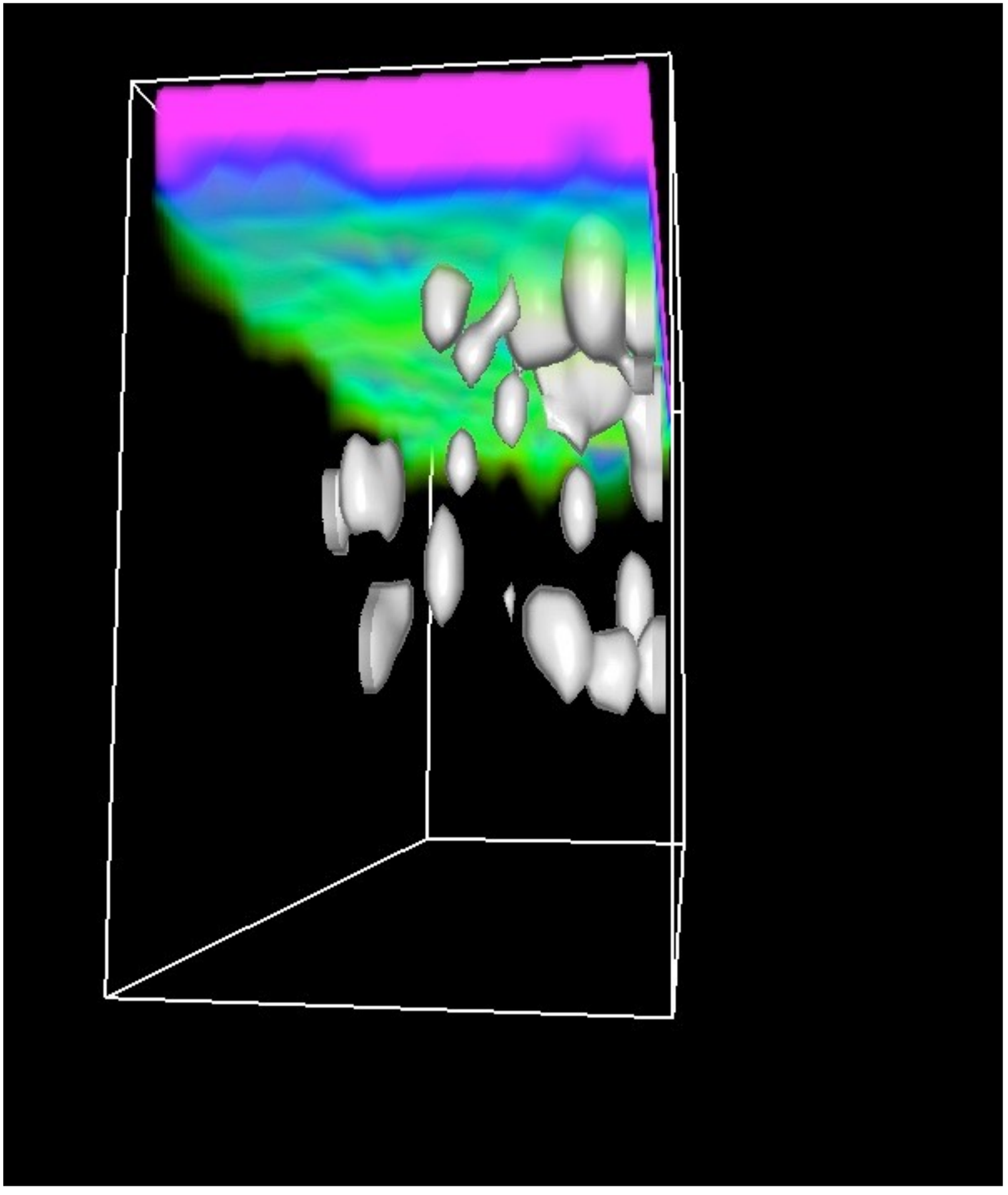


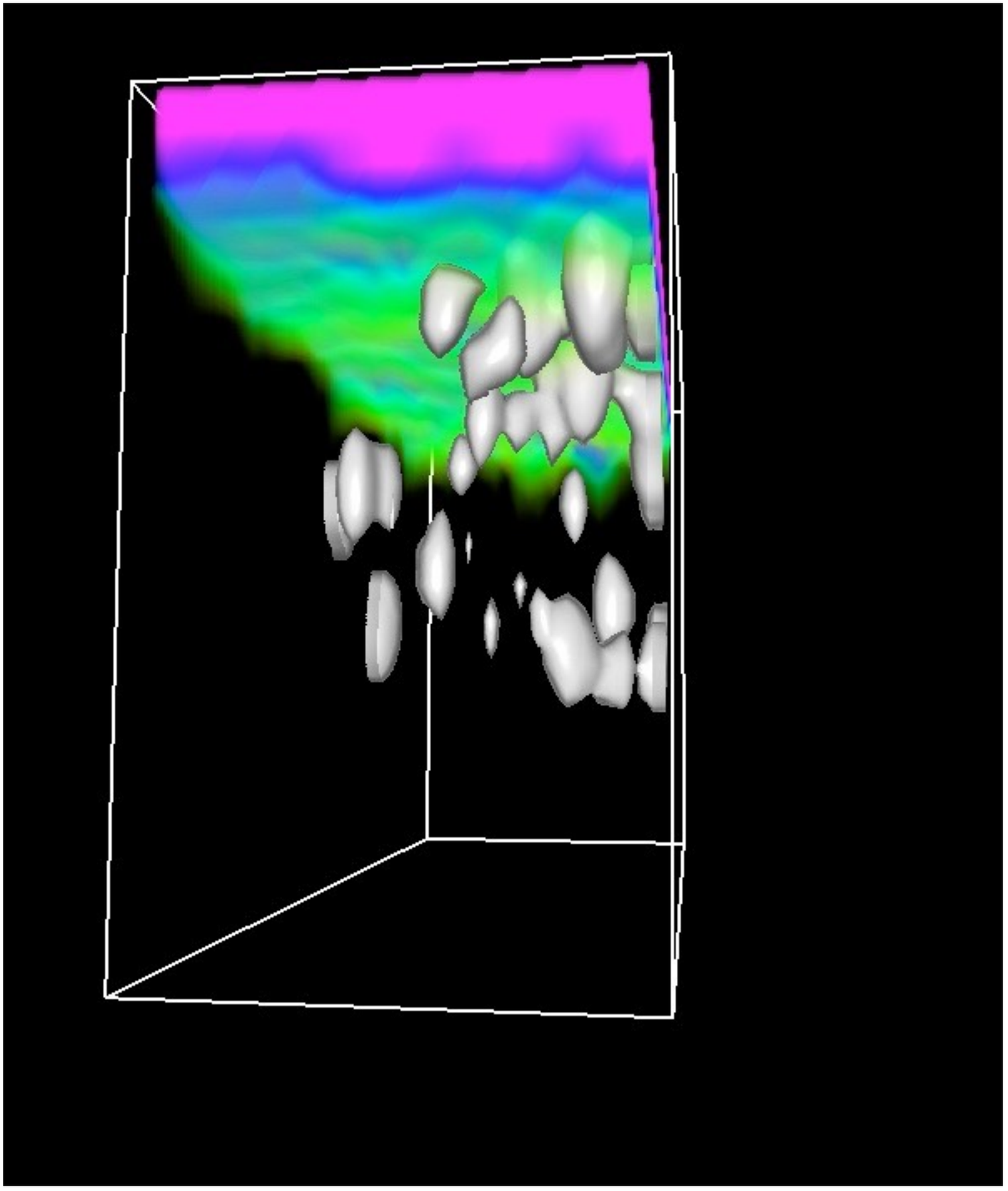


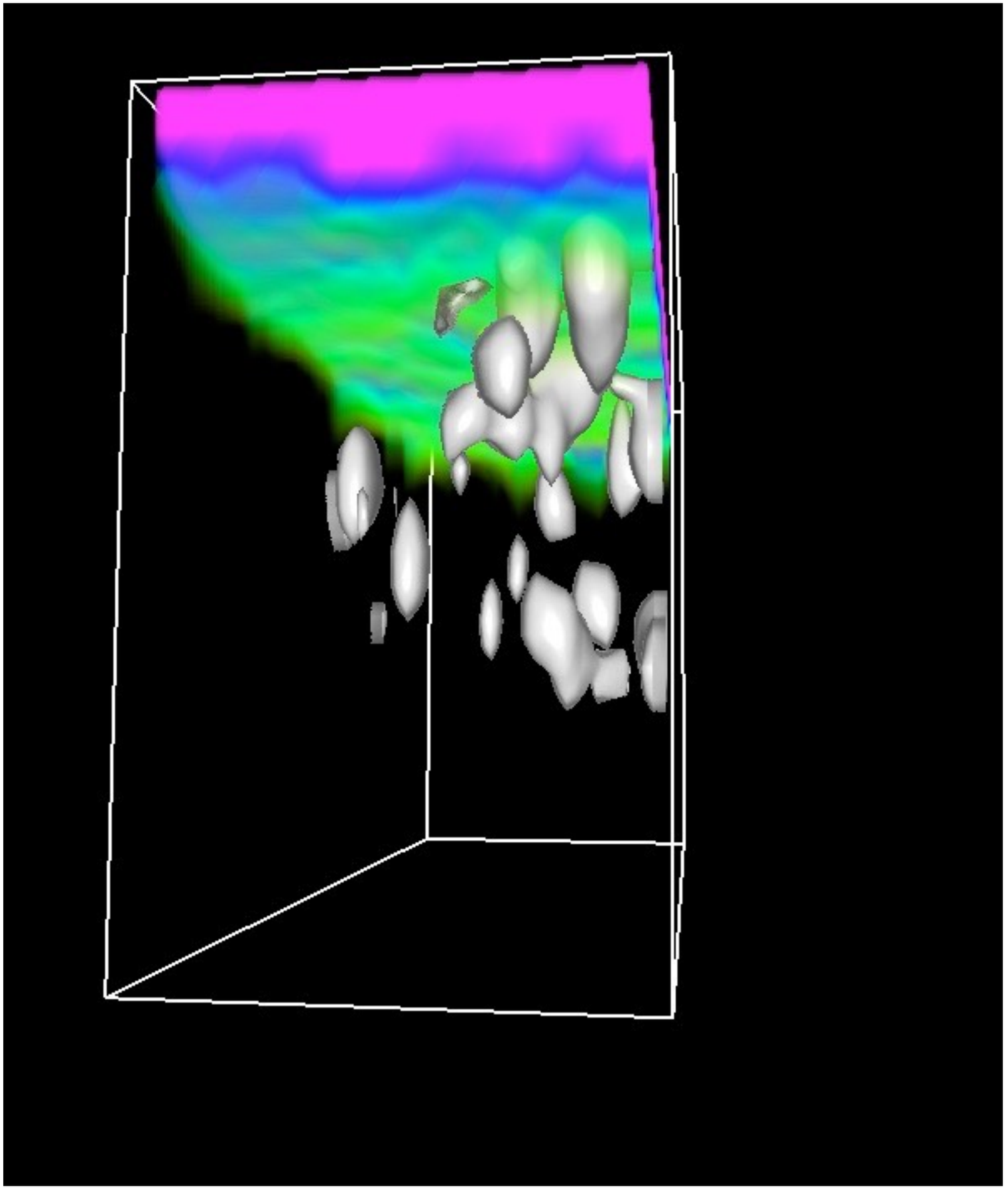


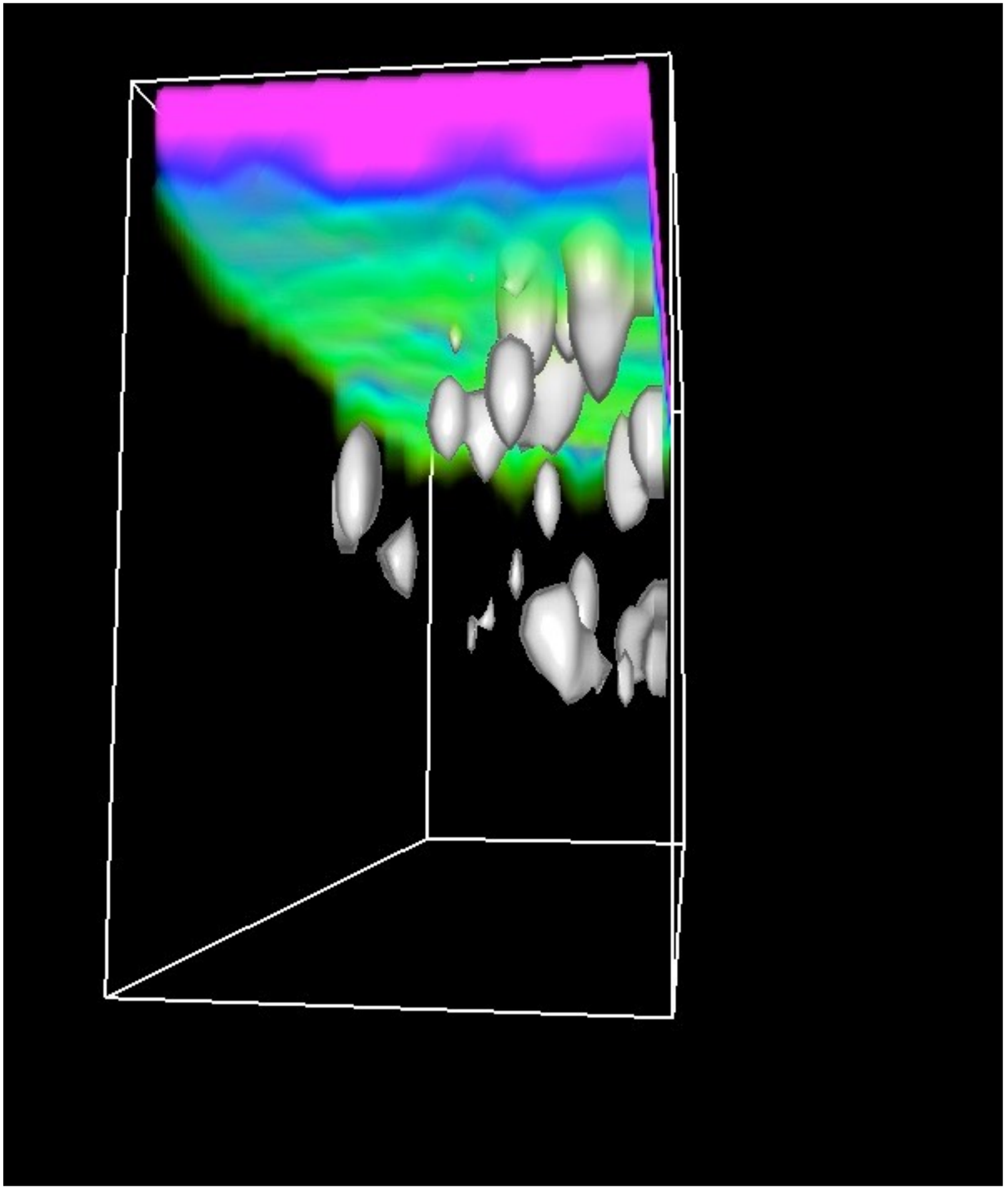


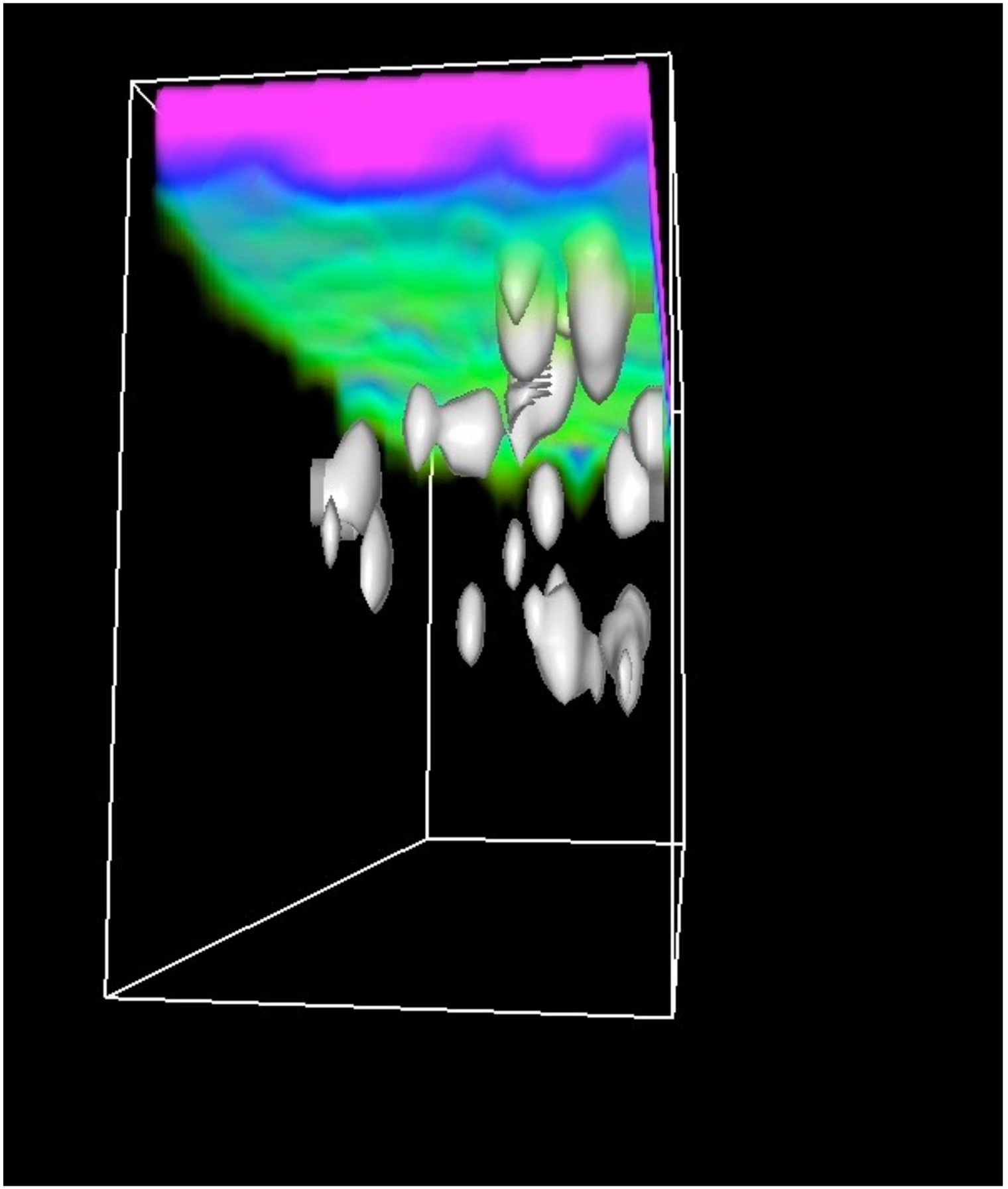


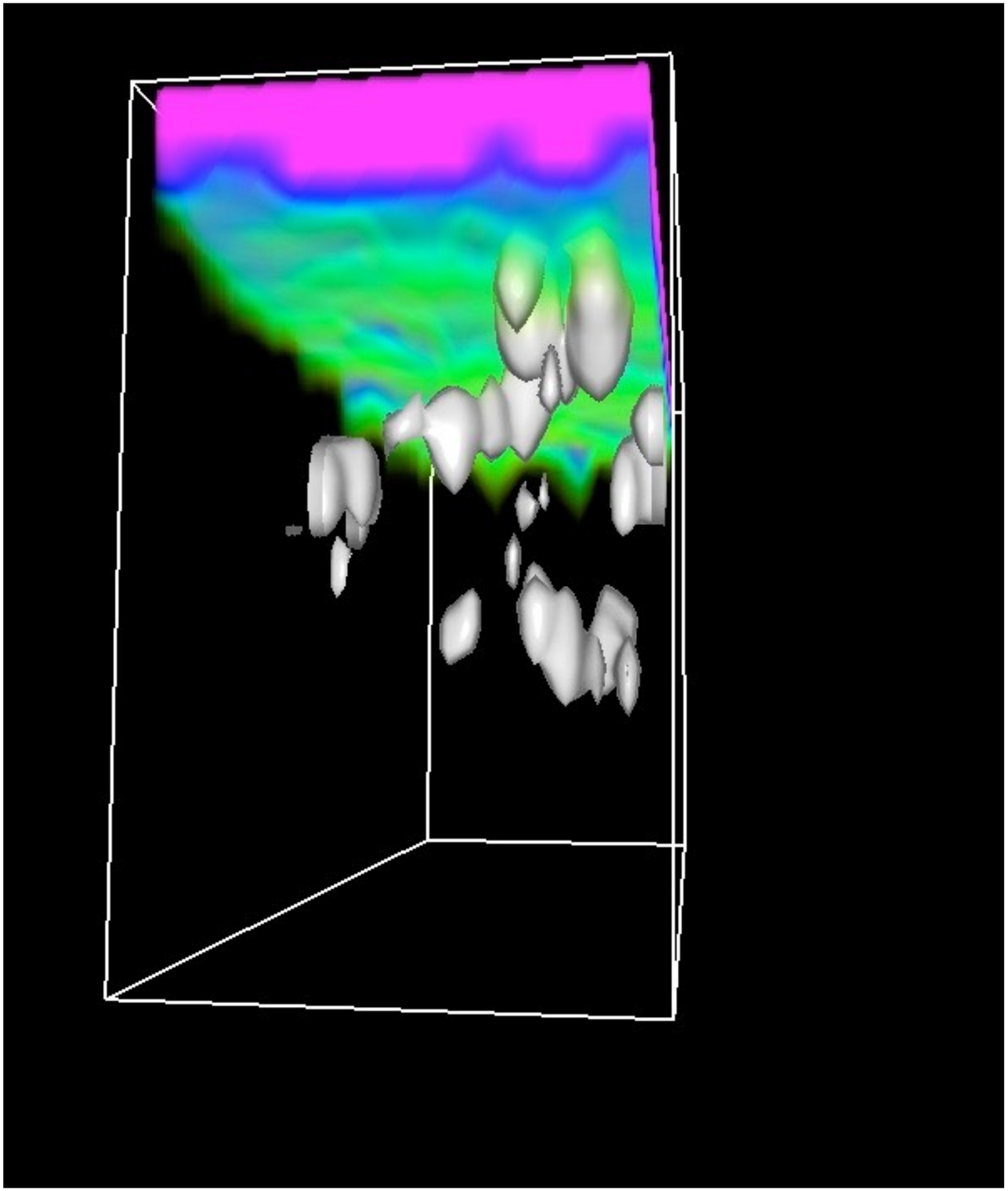


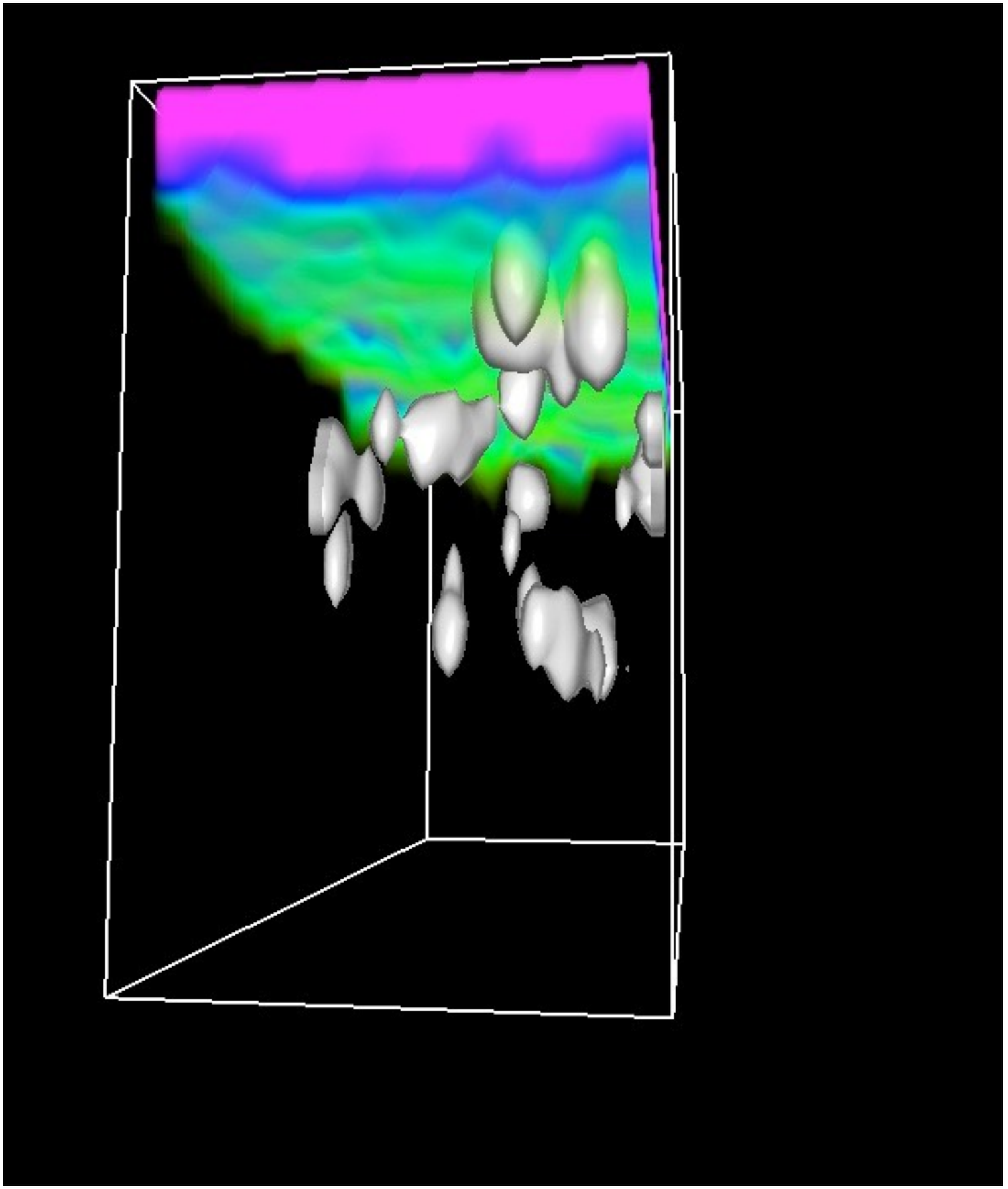


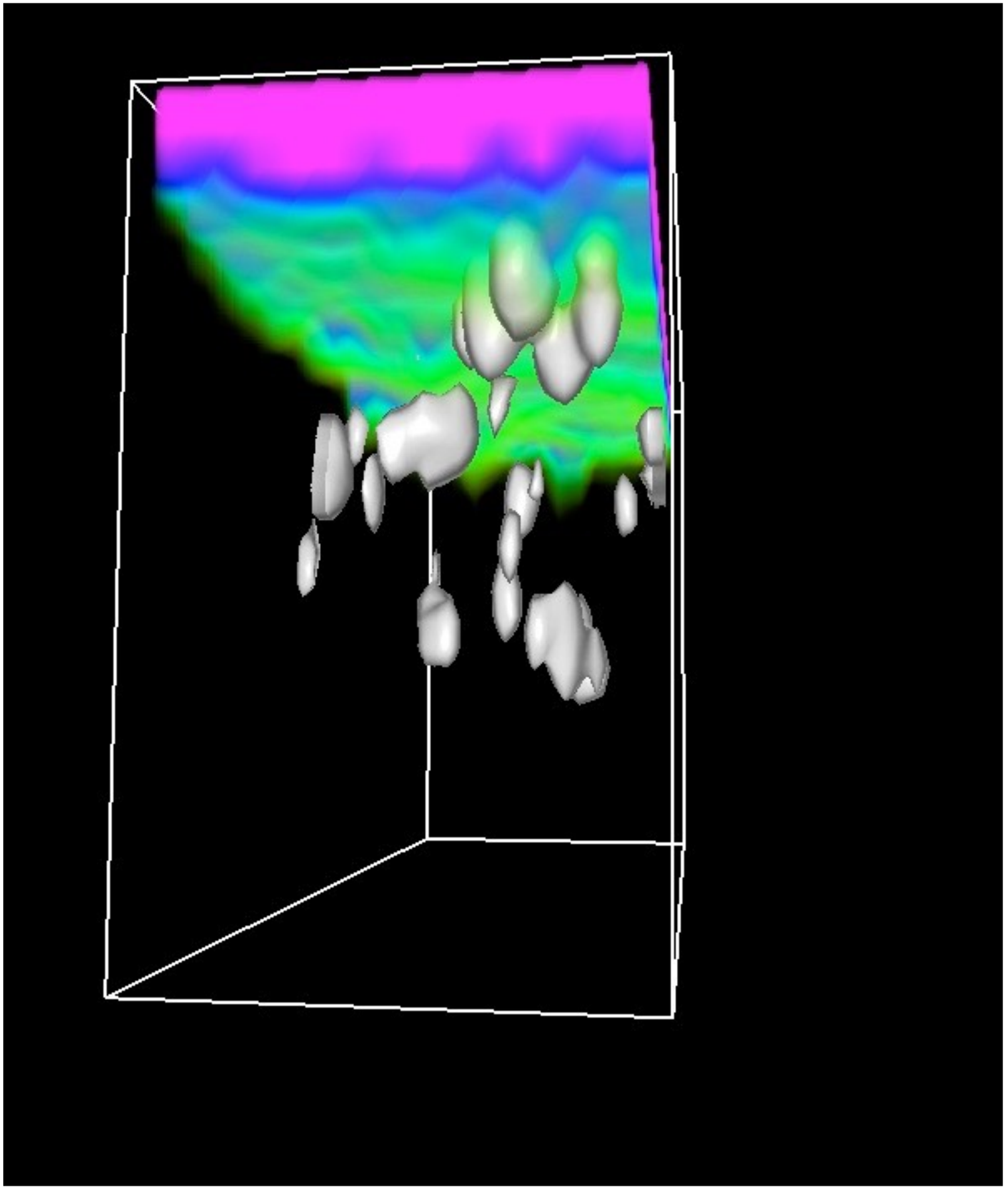


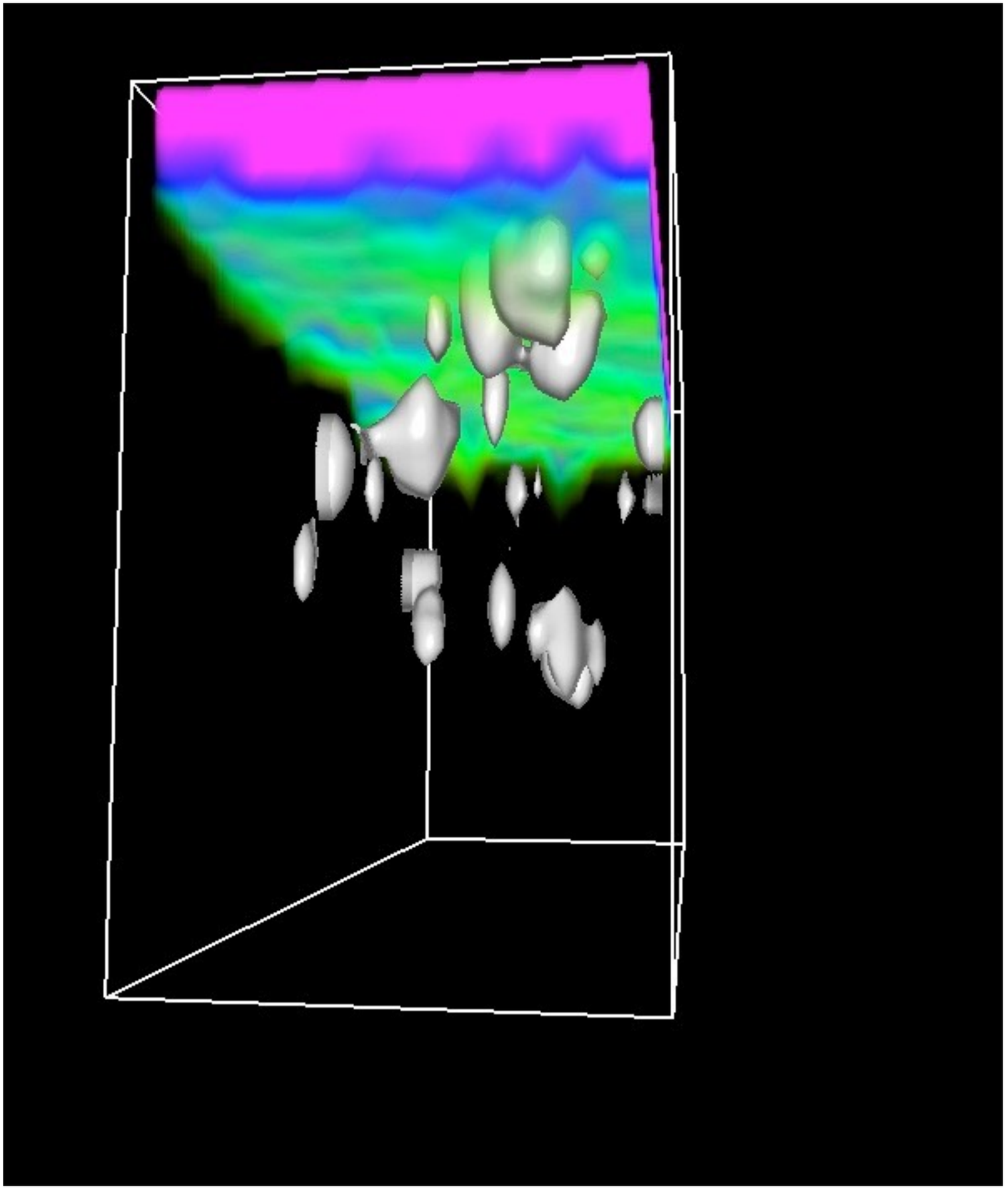


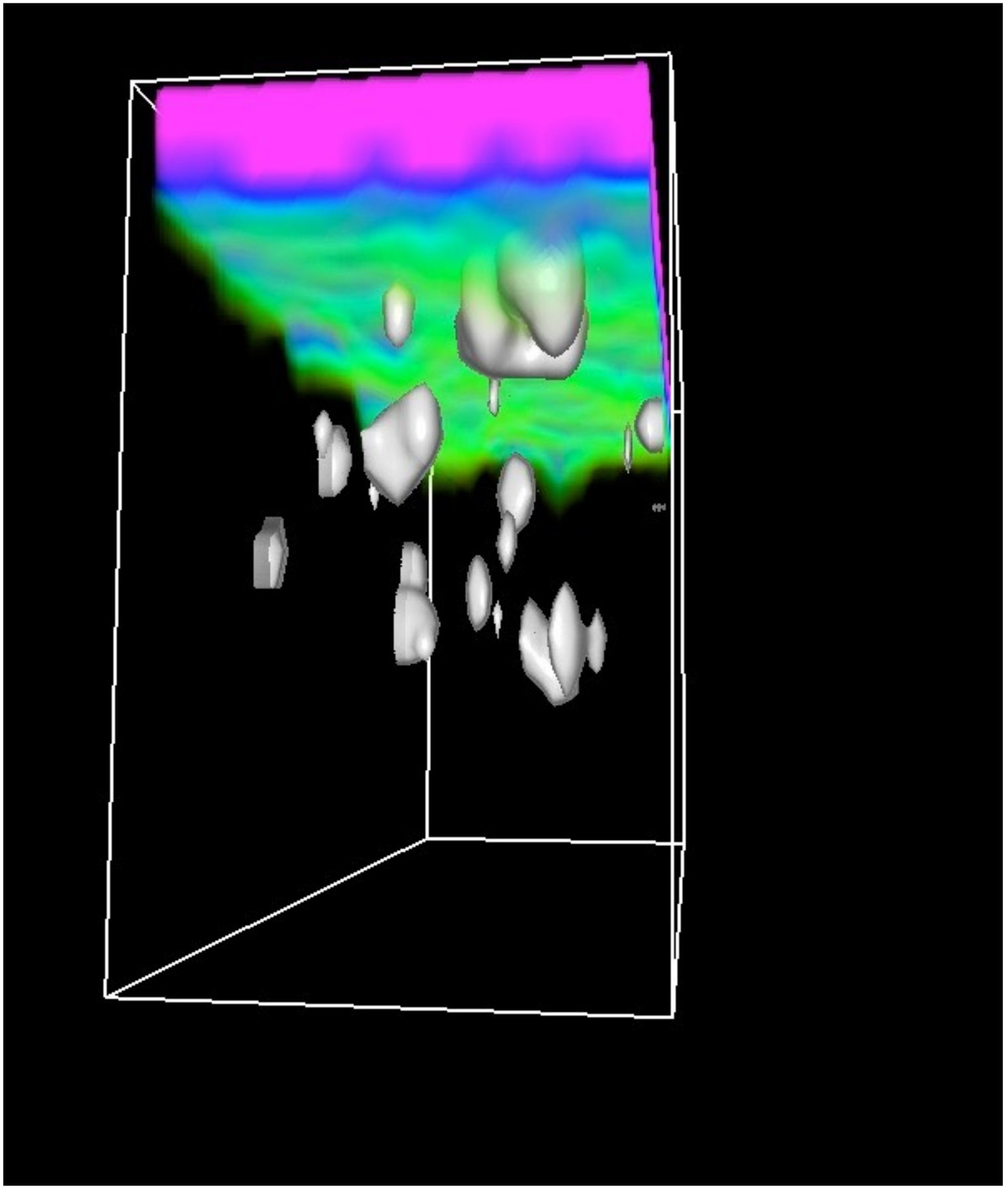


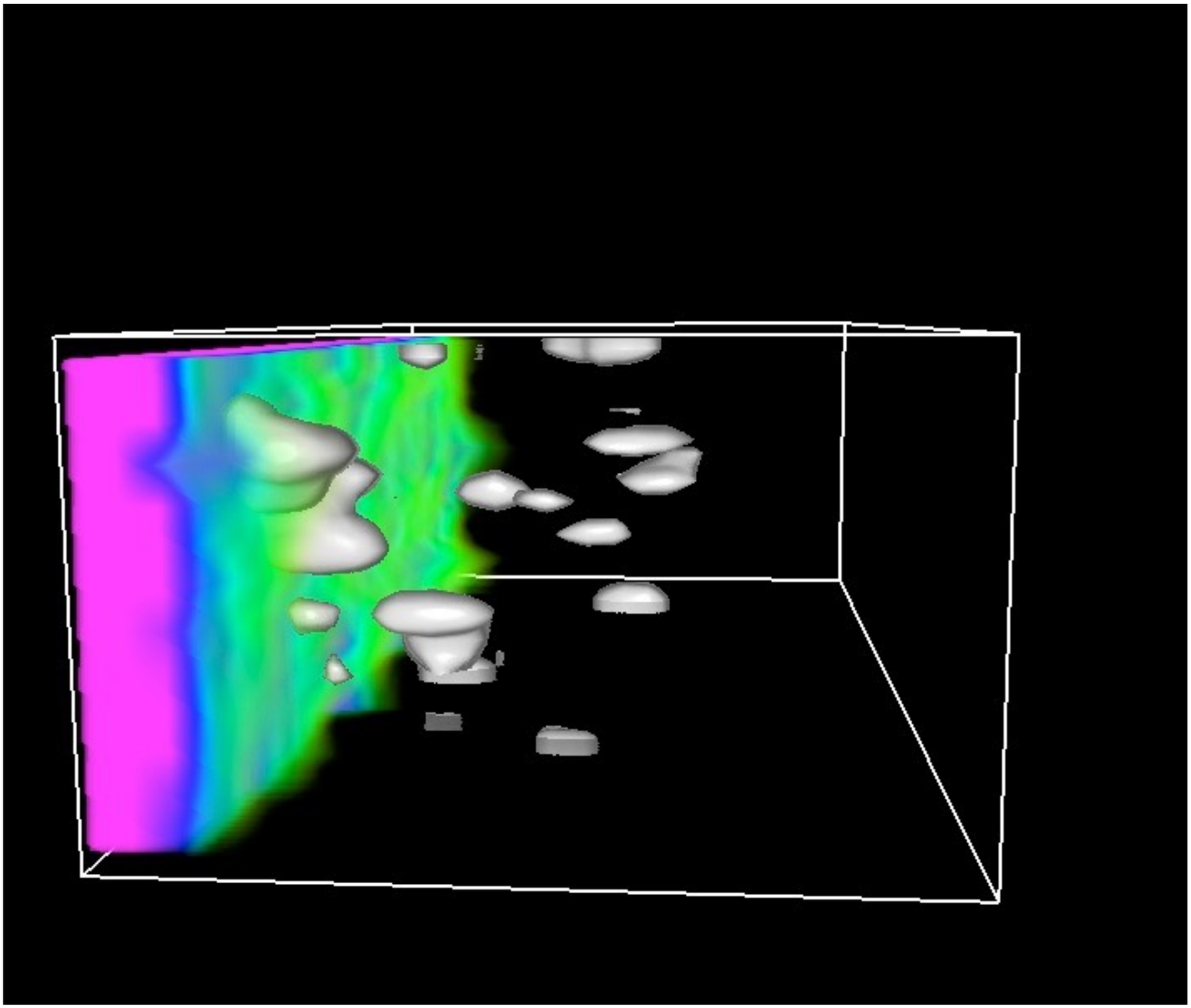


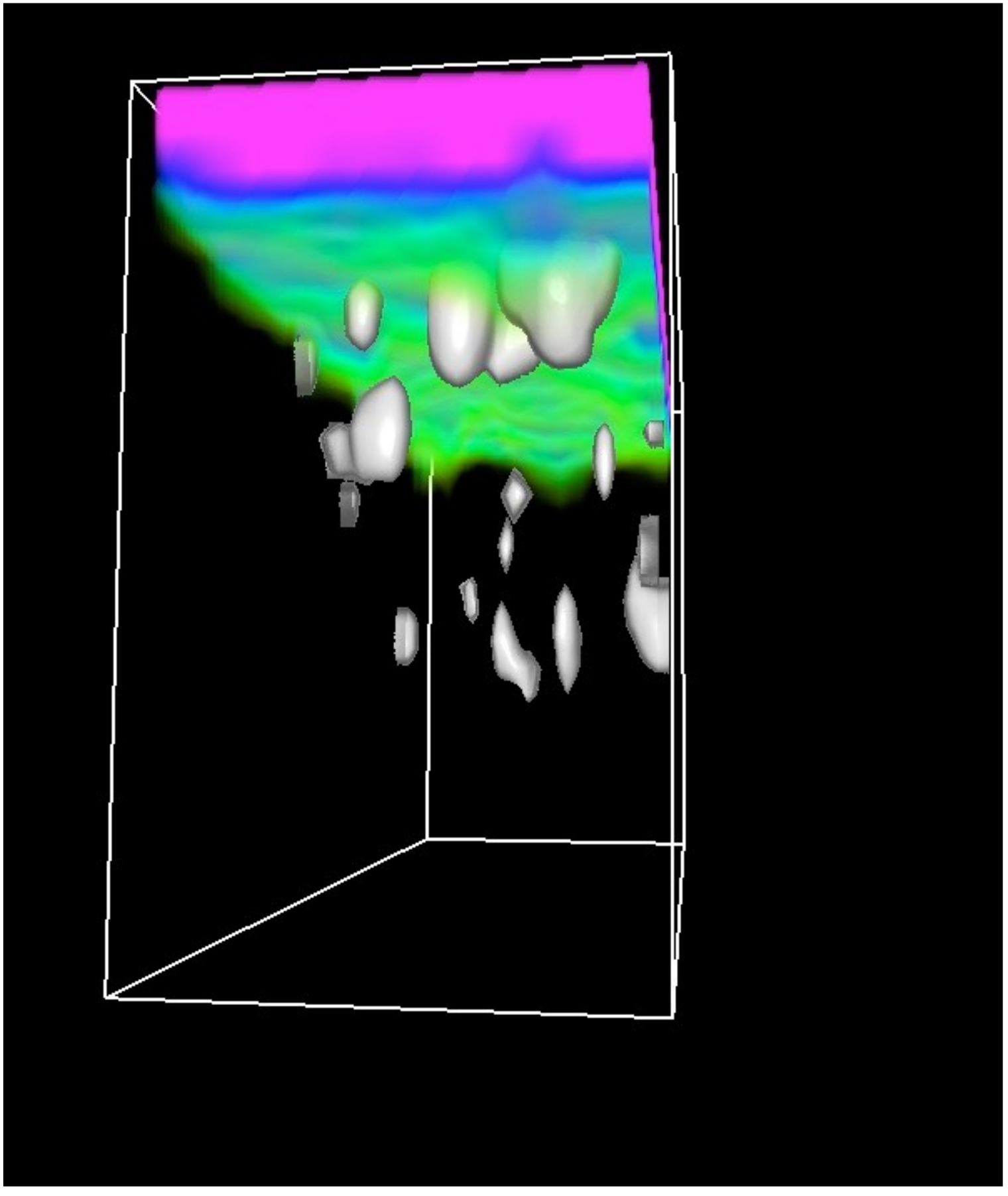


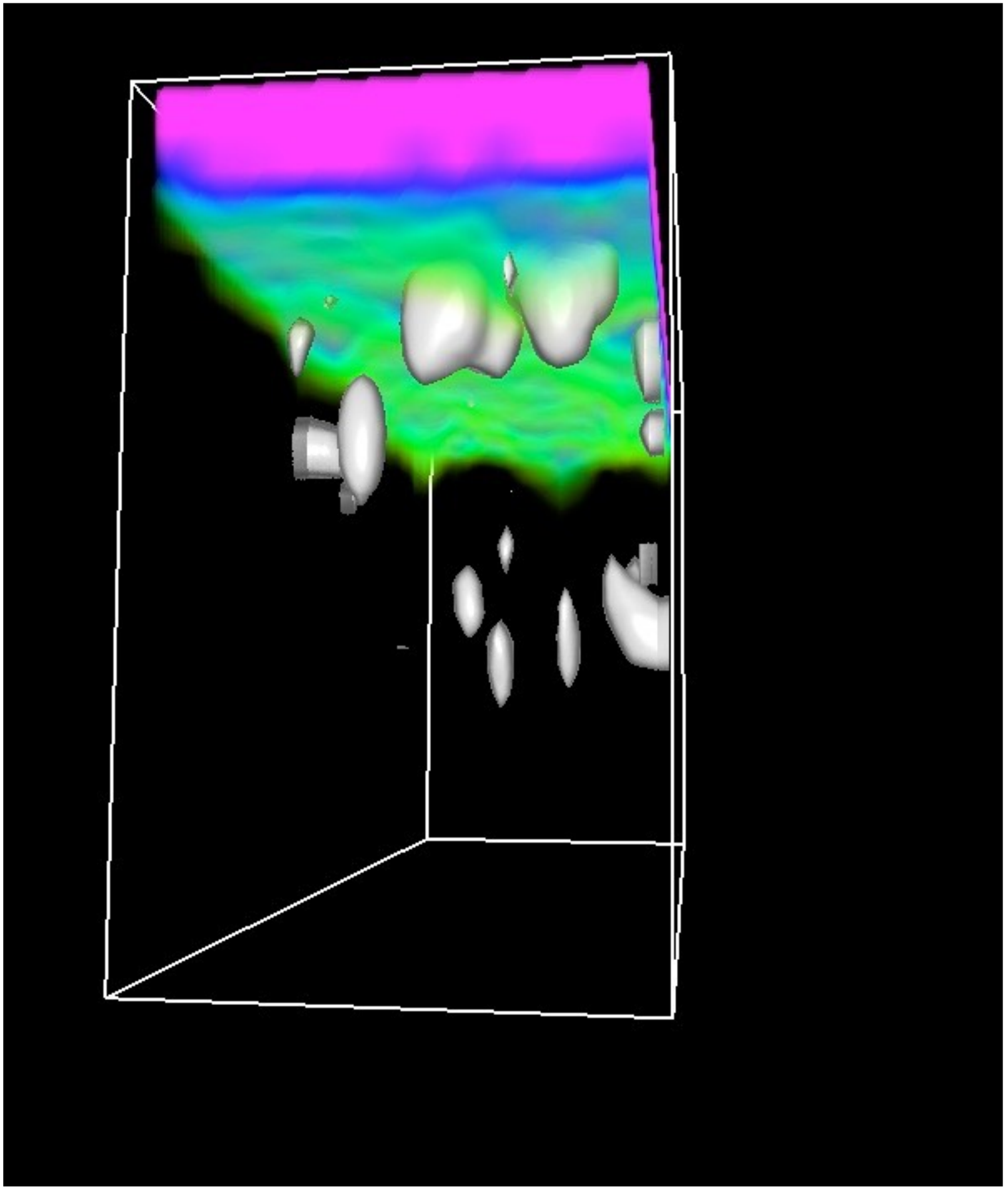


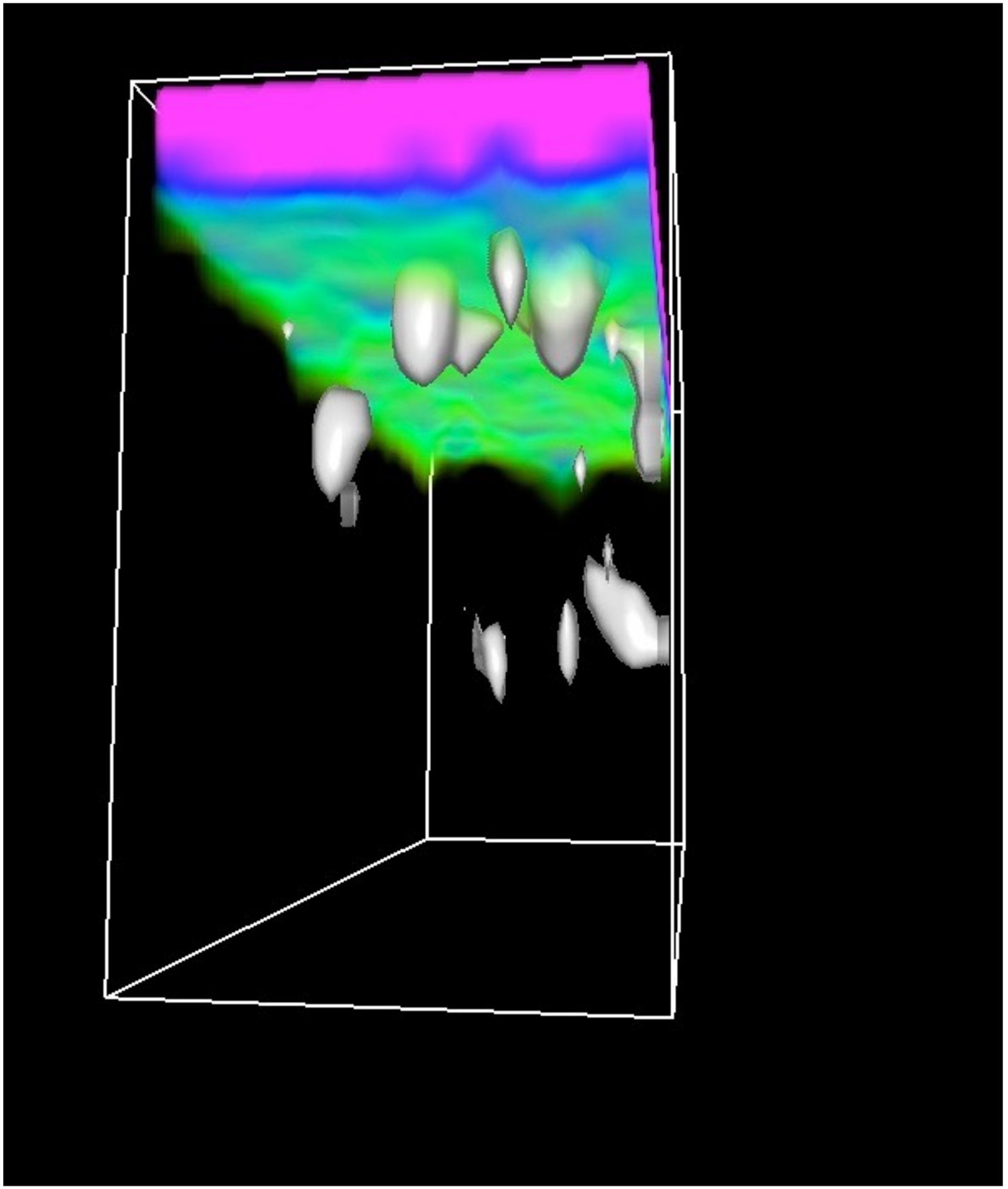


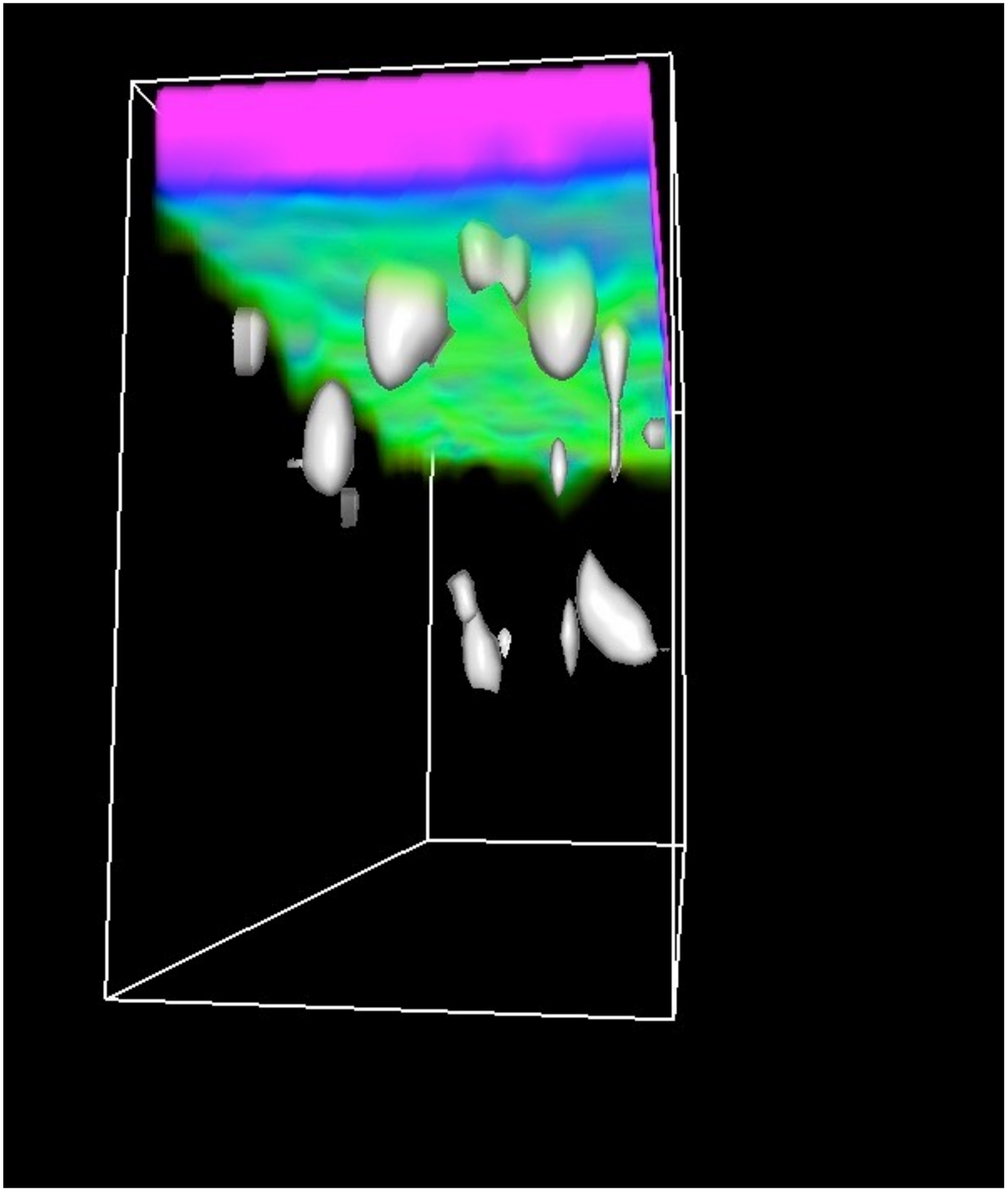


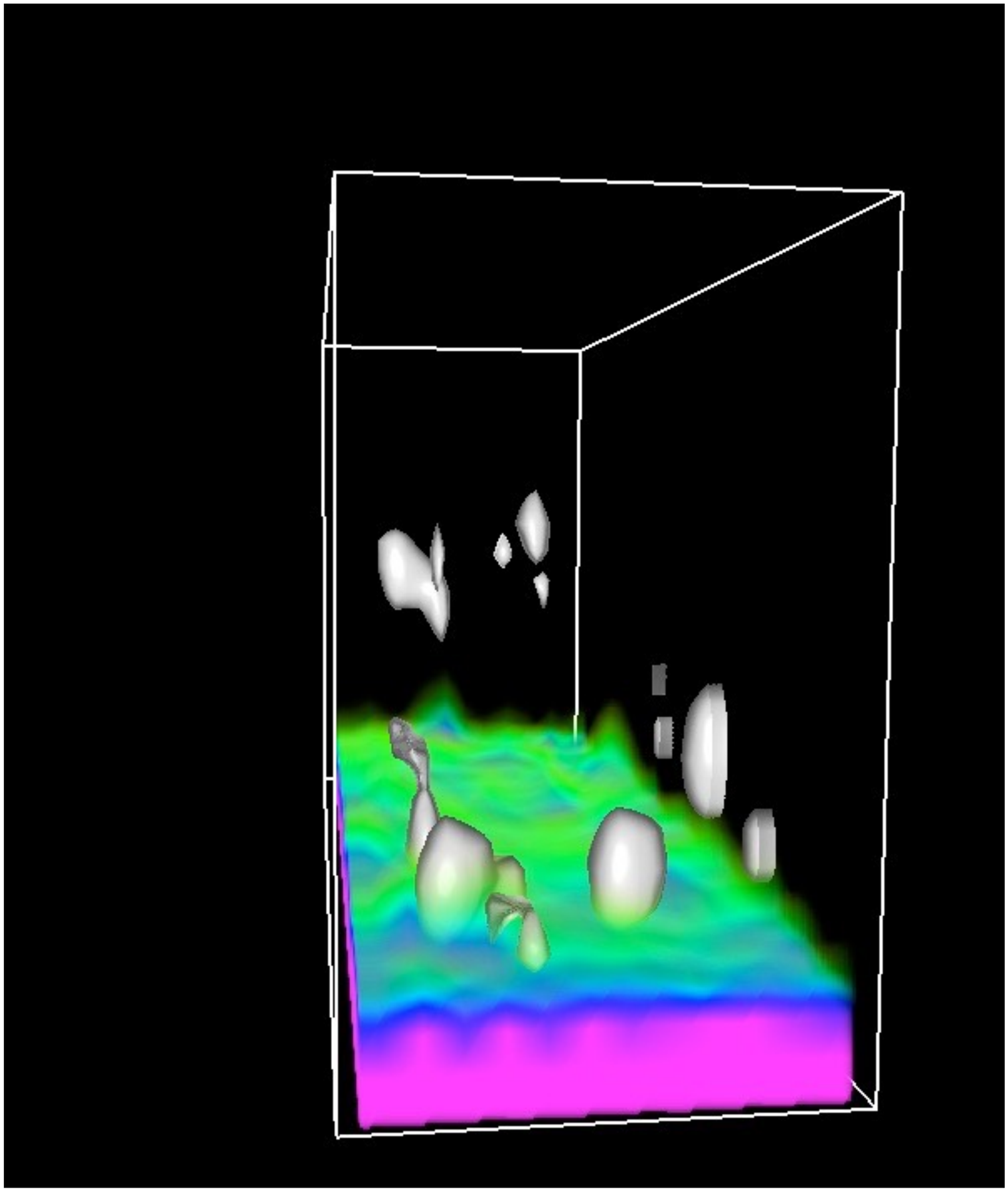


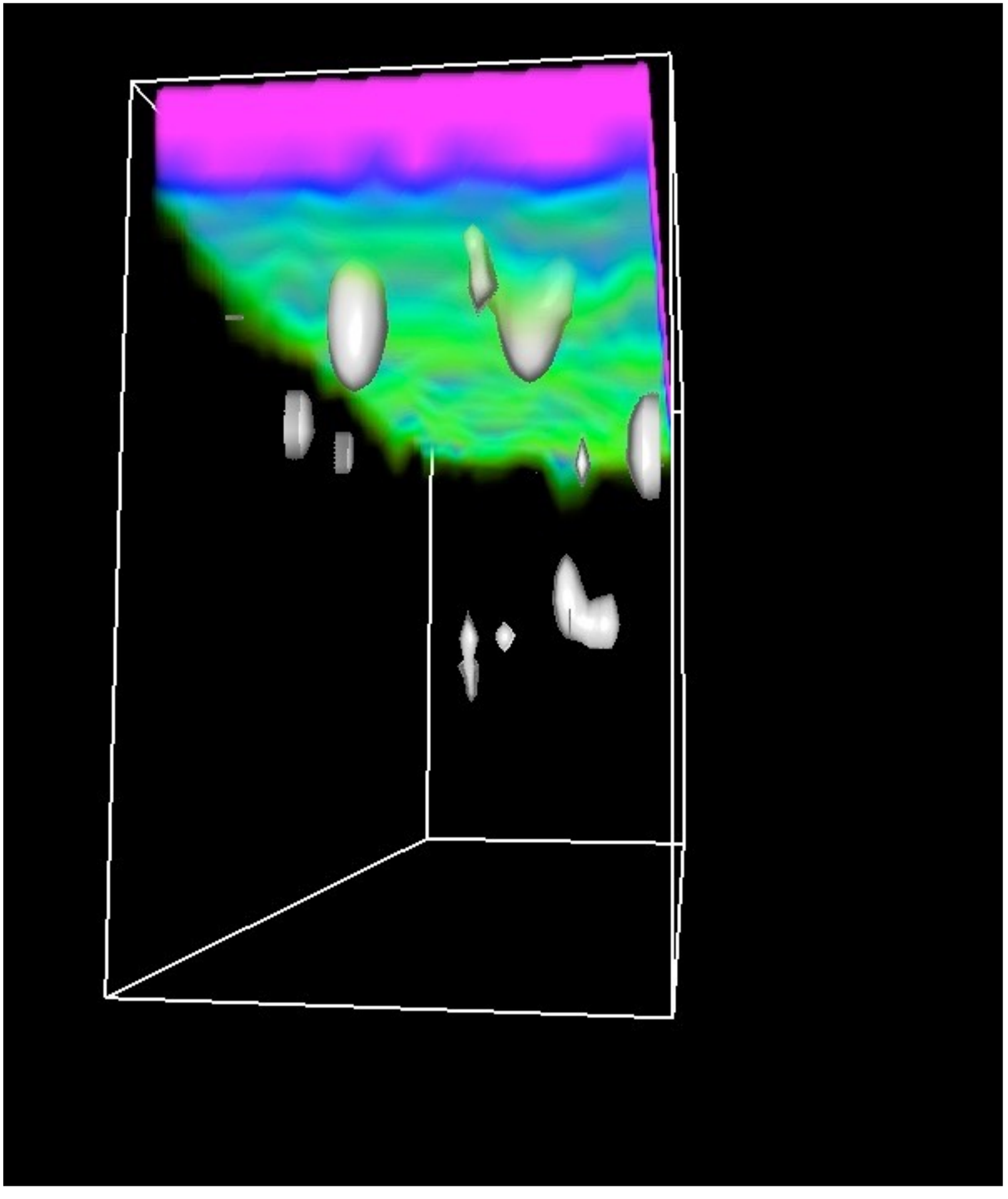


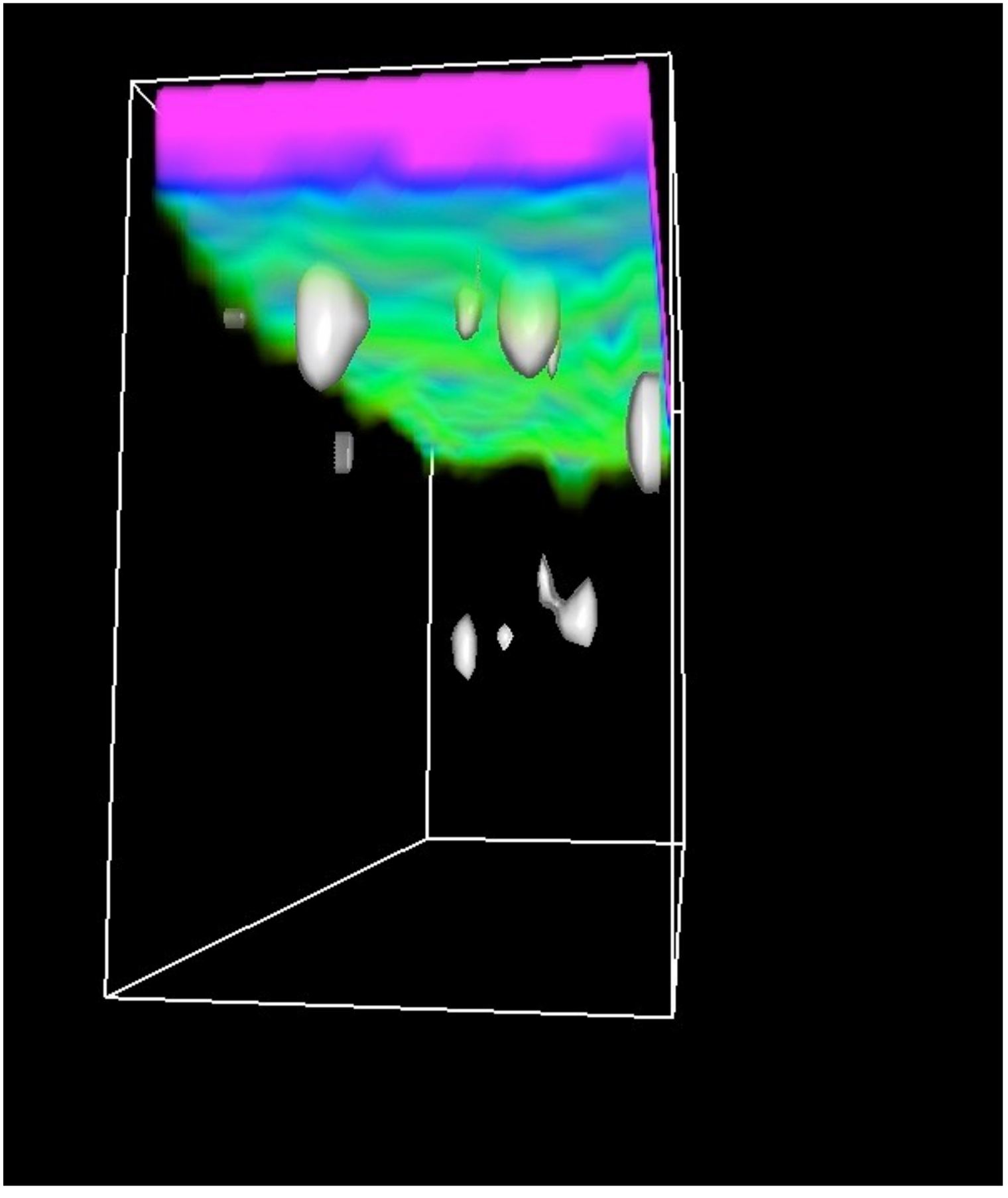




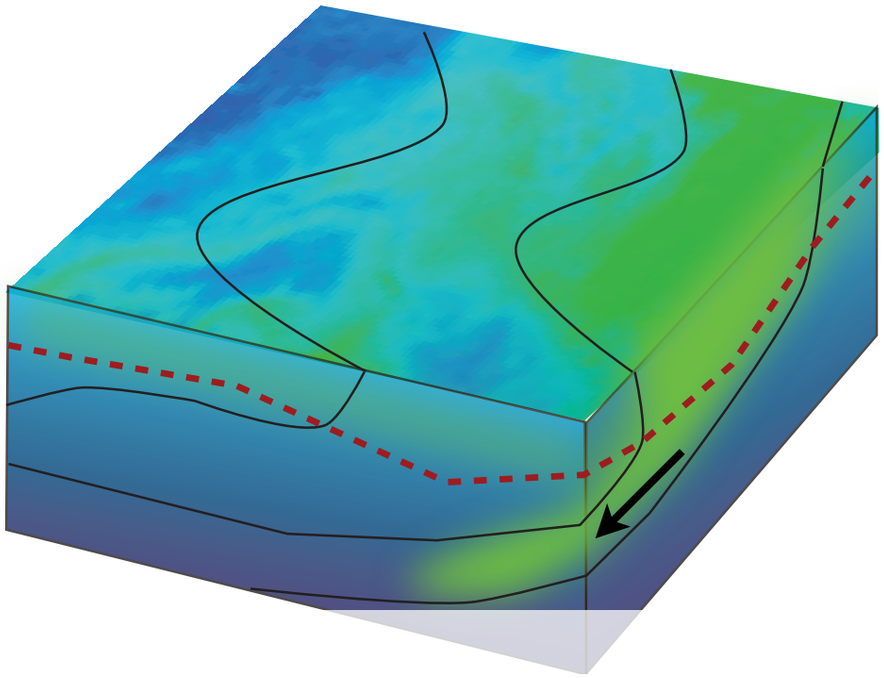








What about long-term sequestration?



In these simulations, the along-isopycnal eddy-driven flux does not move carbon deeper than the deep winter mixed layer.

Carbon was exported through becoming trapped below the mixed layer as summertime warming intensified stratification.

Aggregation, slow sinking, large-scale circulation are likely important for POC exported by eddies to remain sequestered over years

We need observations that can track and observe particle transformations on subducted water over weeks to seasons.

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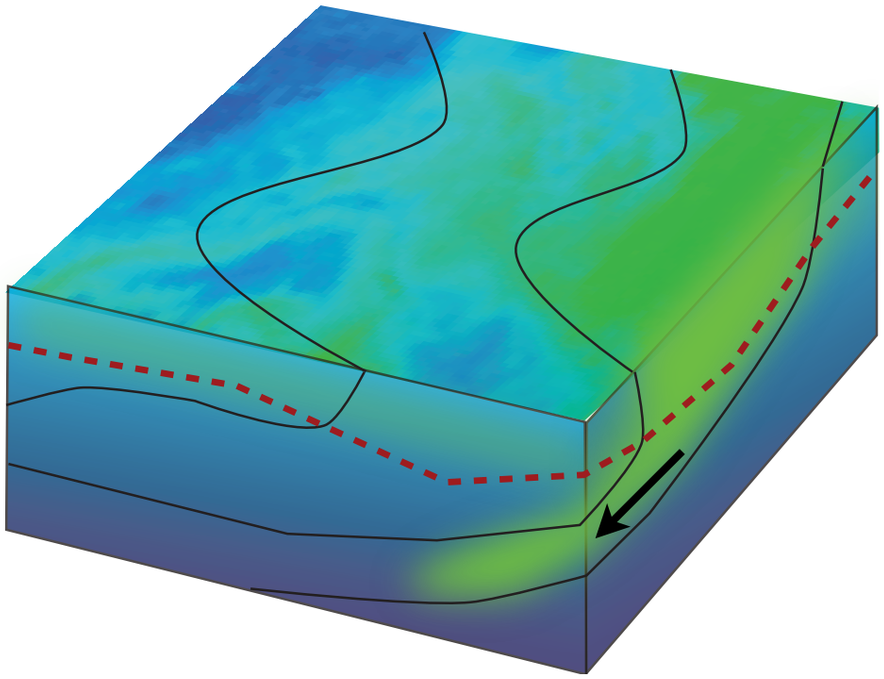

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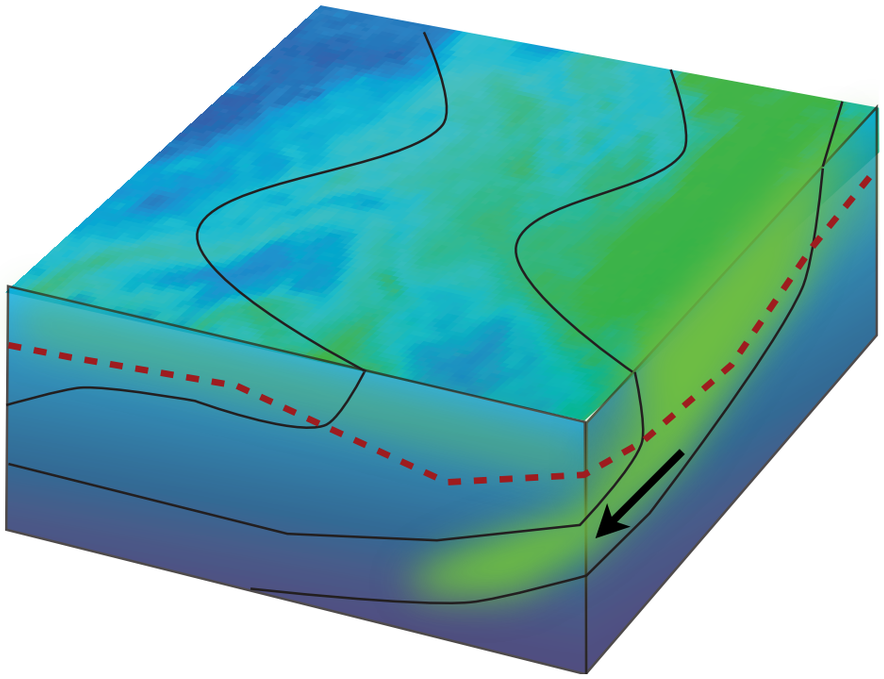

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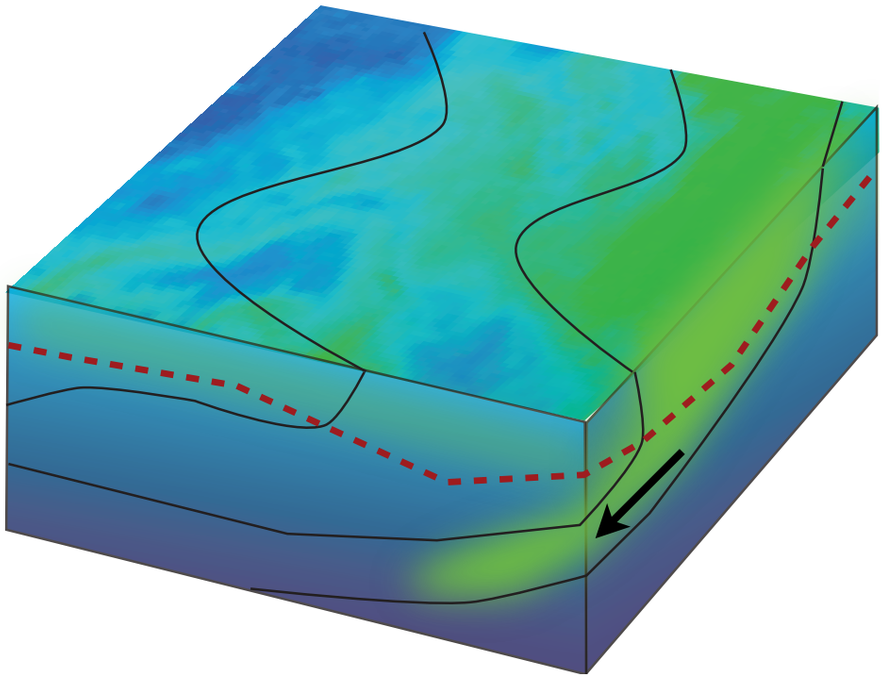

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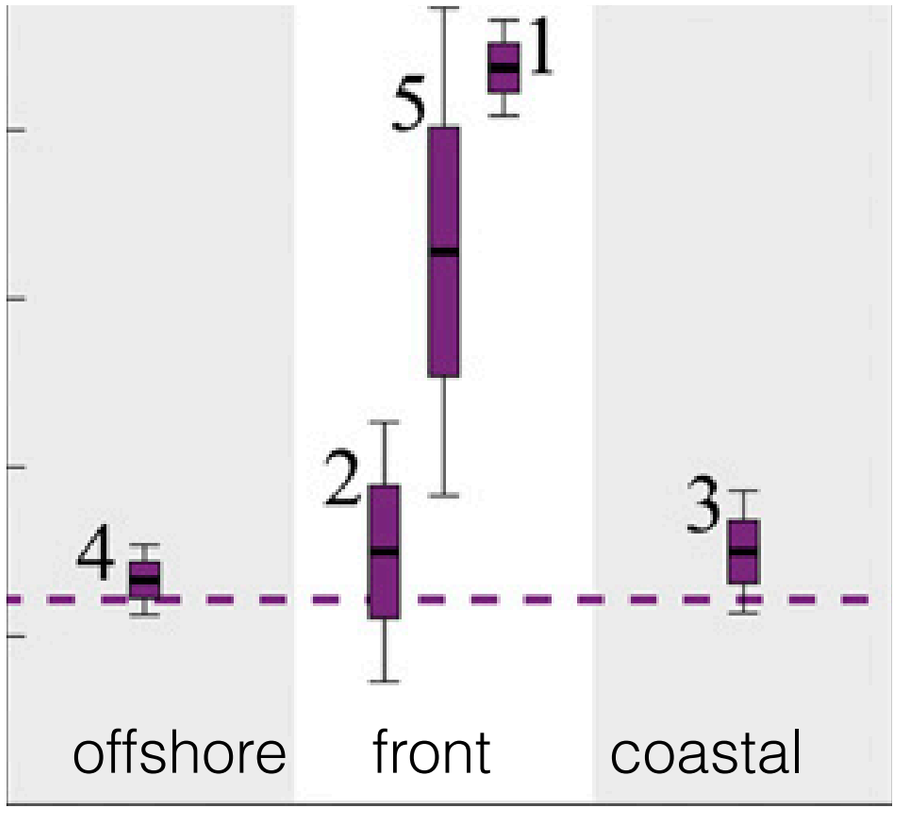
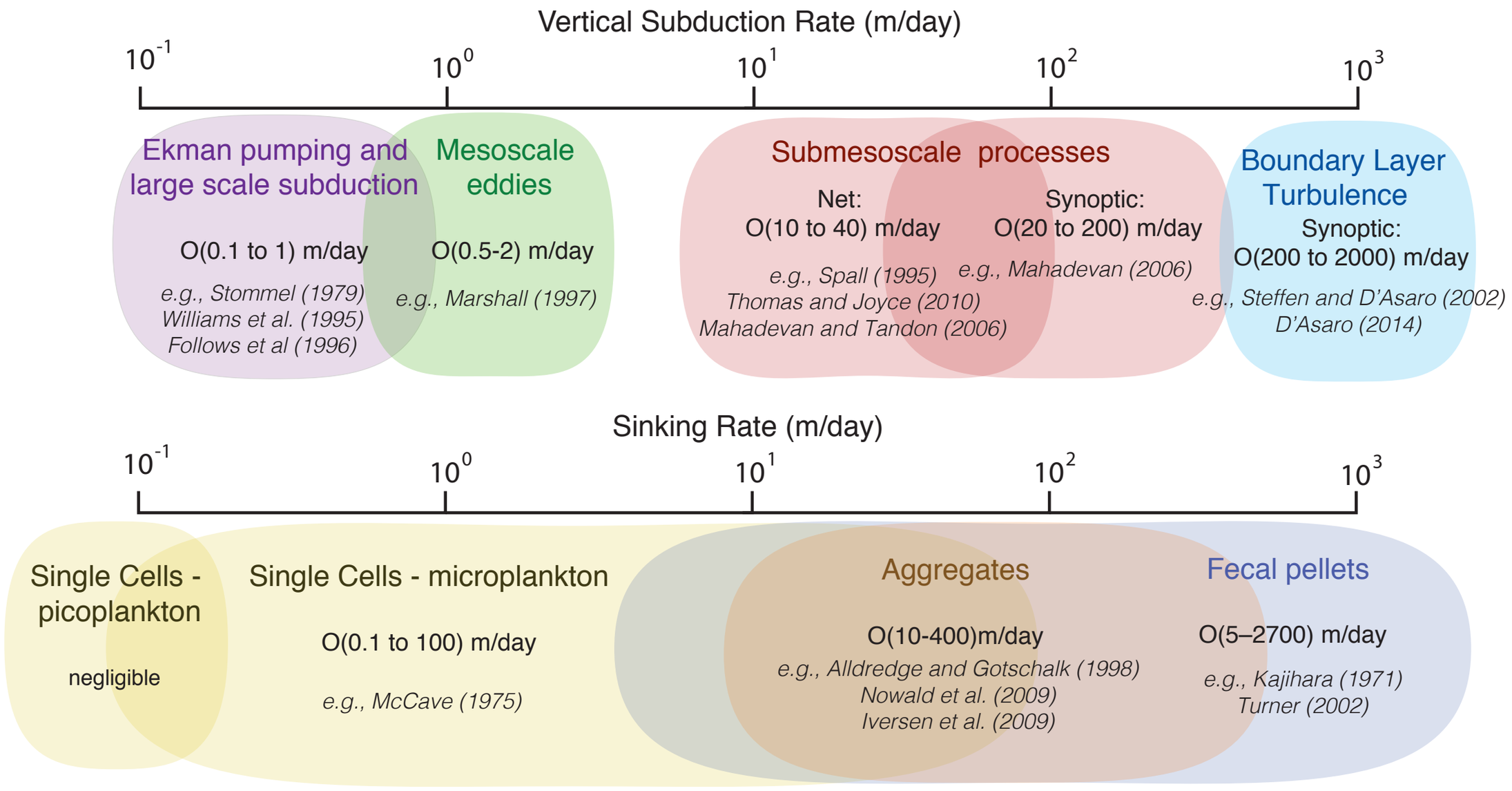
What about sinking particles?

High variability in sinking export is seen at submesoscales (Estapa et al. 2015) and enhanced at fronts (Stukel et al. 2017)



(Stukel et al. 2017)

The sinking rates of most particles overlaps with the vertical velocities of many physical processes



Instruments that can resolve sinking particle abundance and types over km and days (eg. Bishop et al. 2016) can provide clues as to physical and/or biological sources of small-scale variability

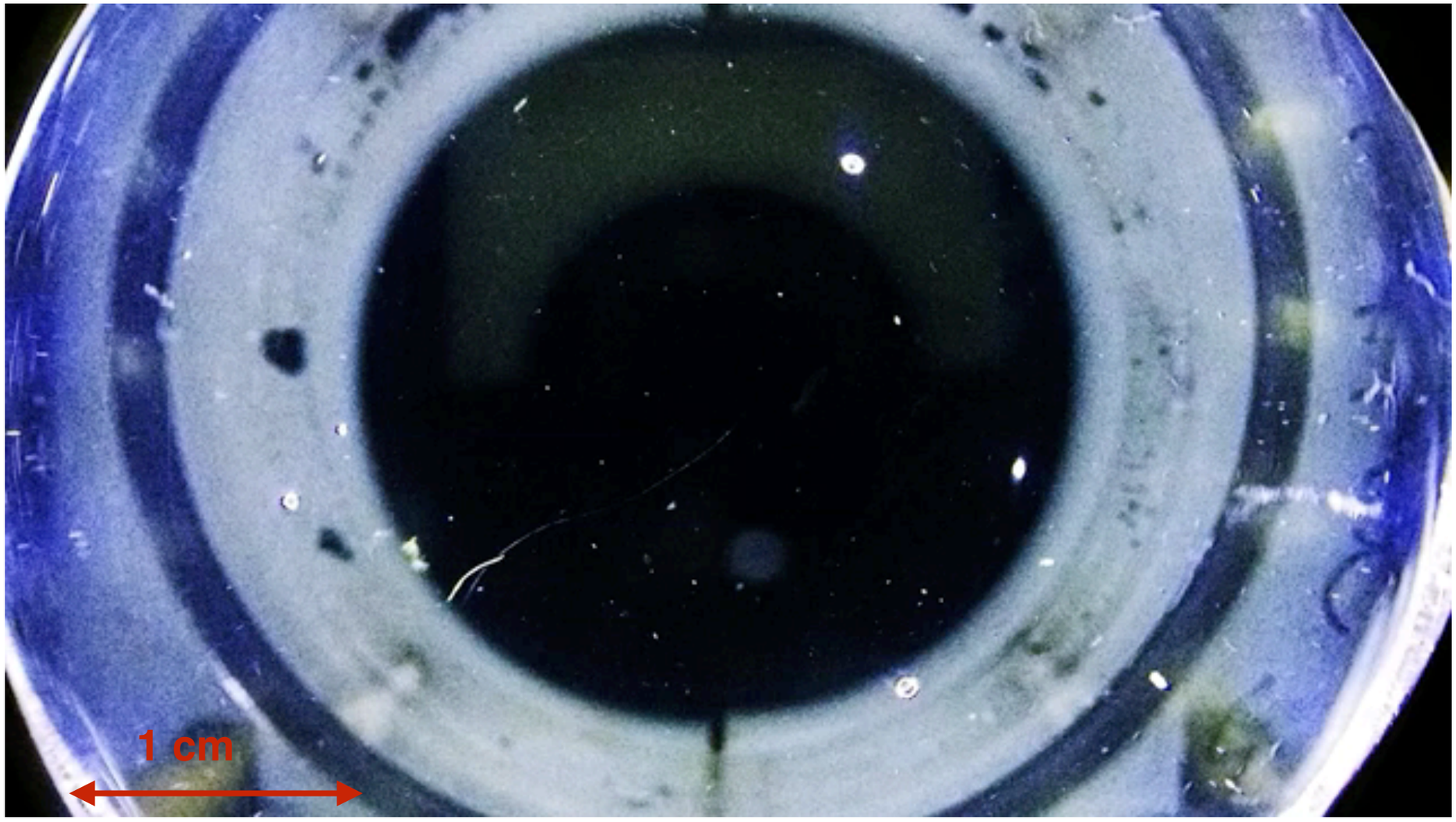
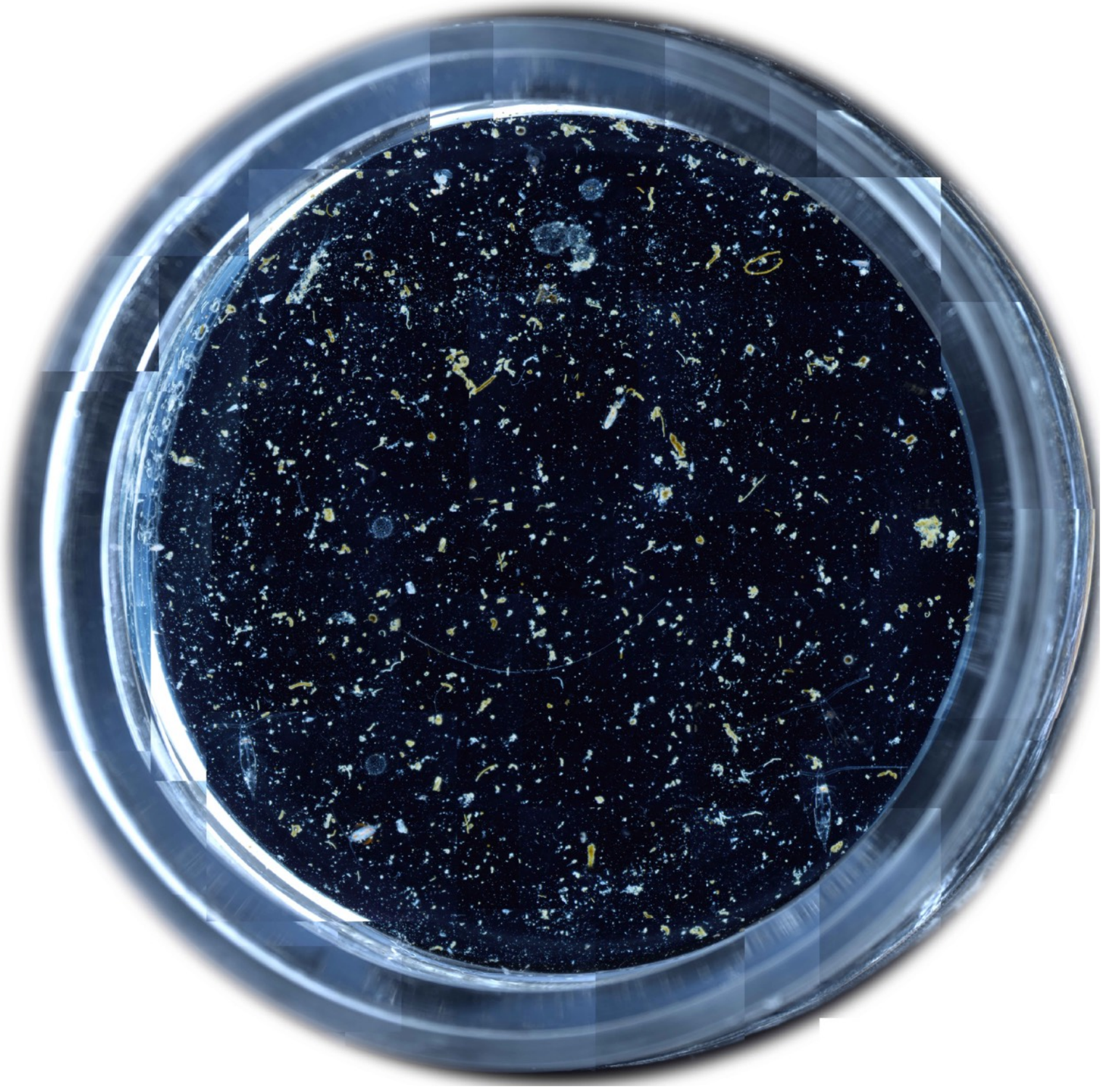


photo every 20 min, 60 hrs total



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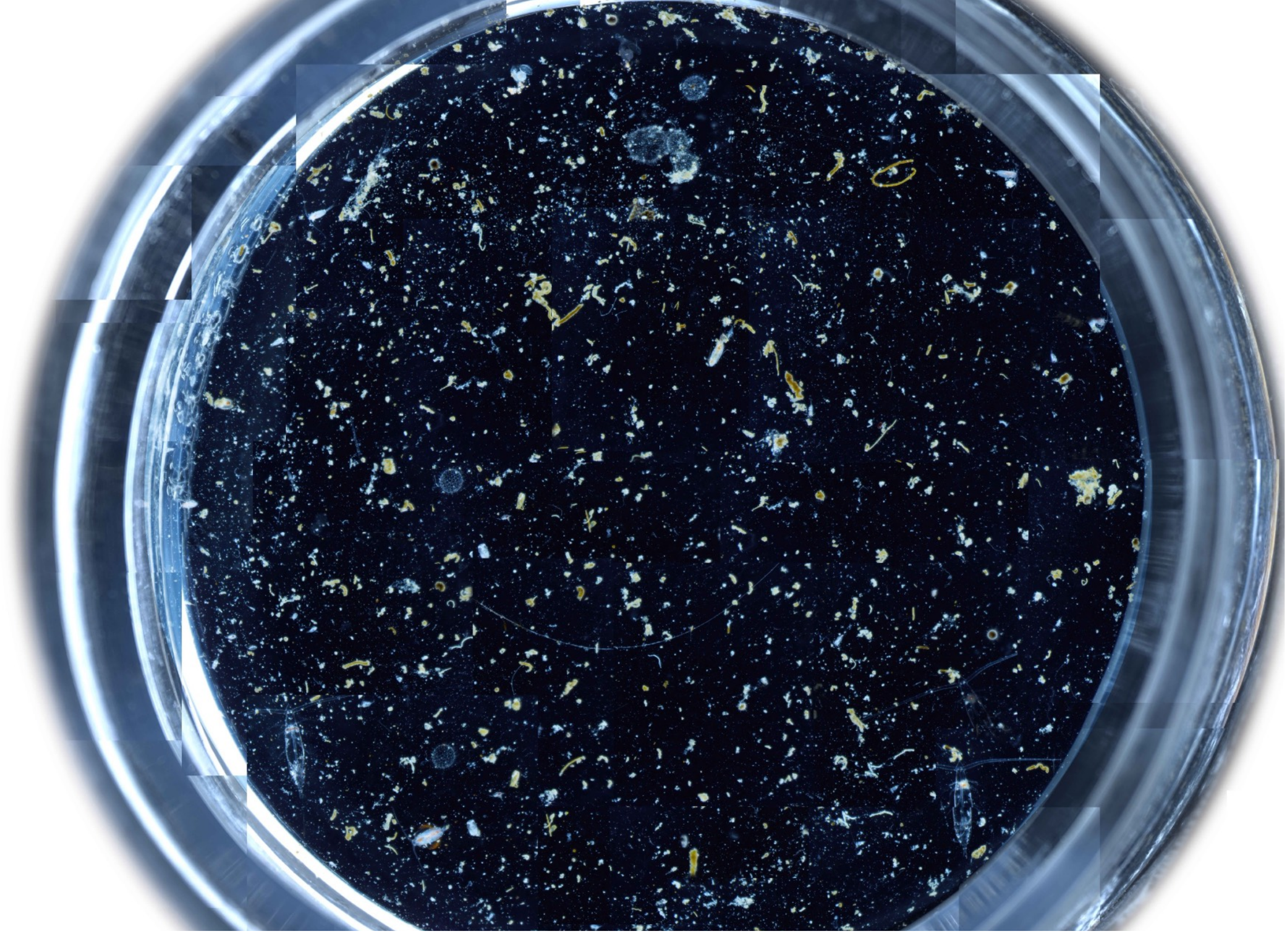

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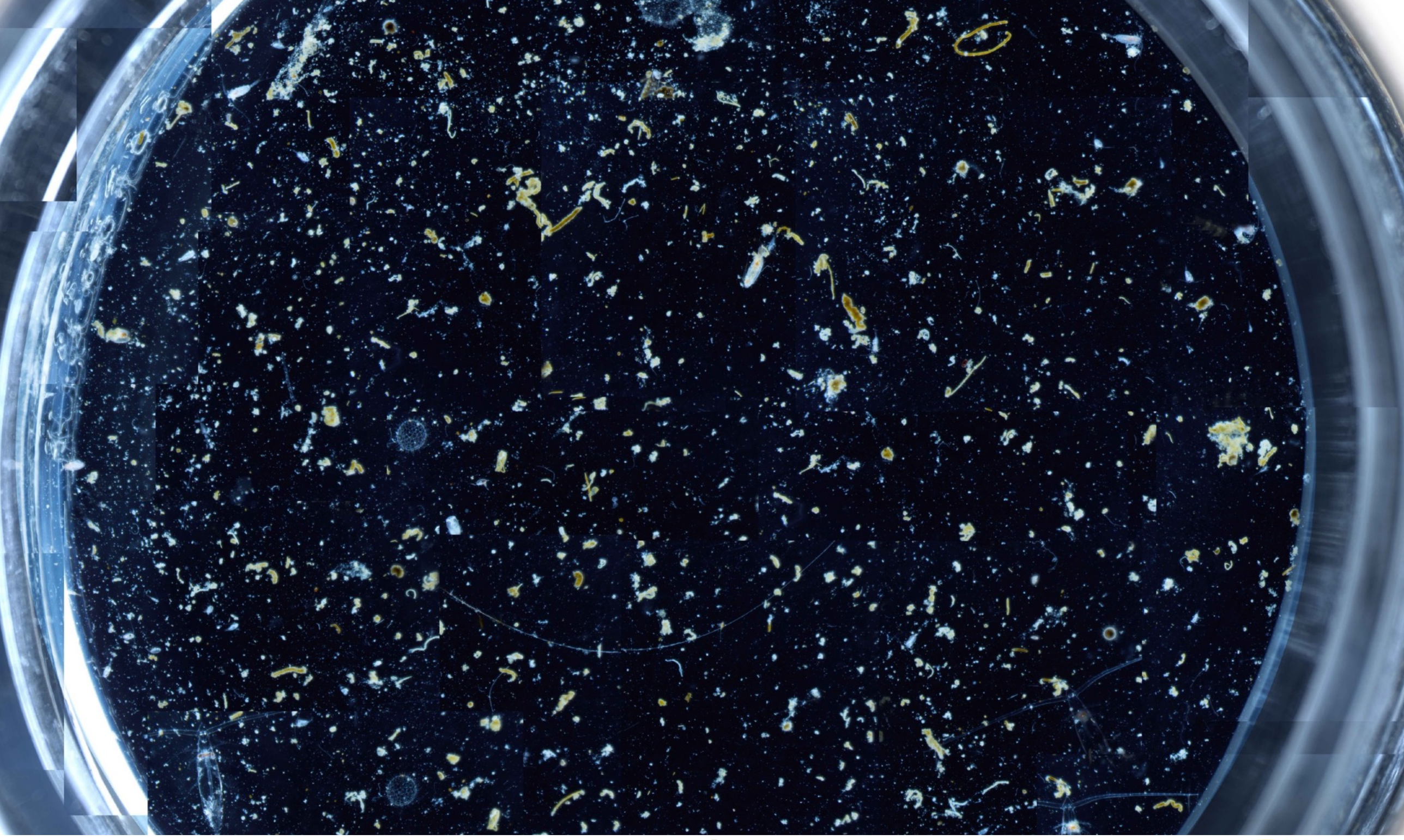

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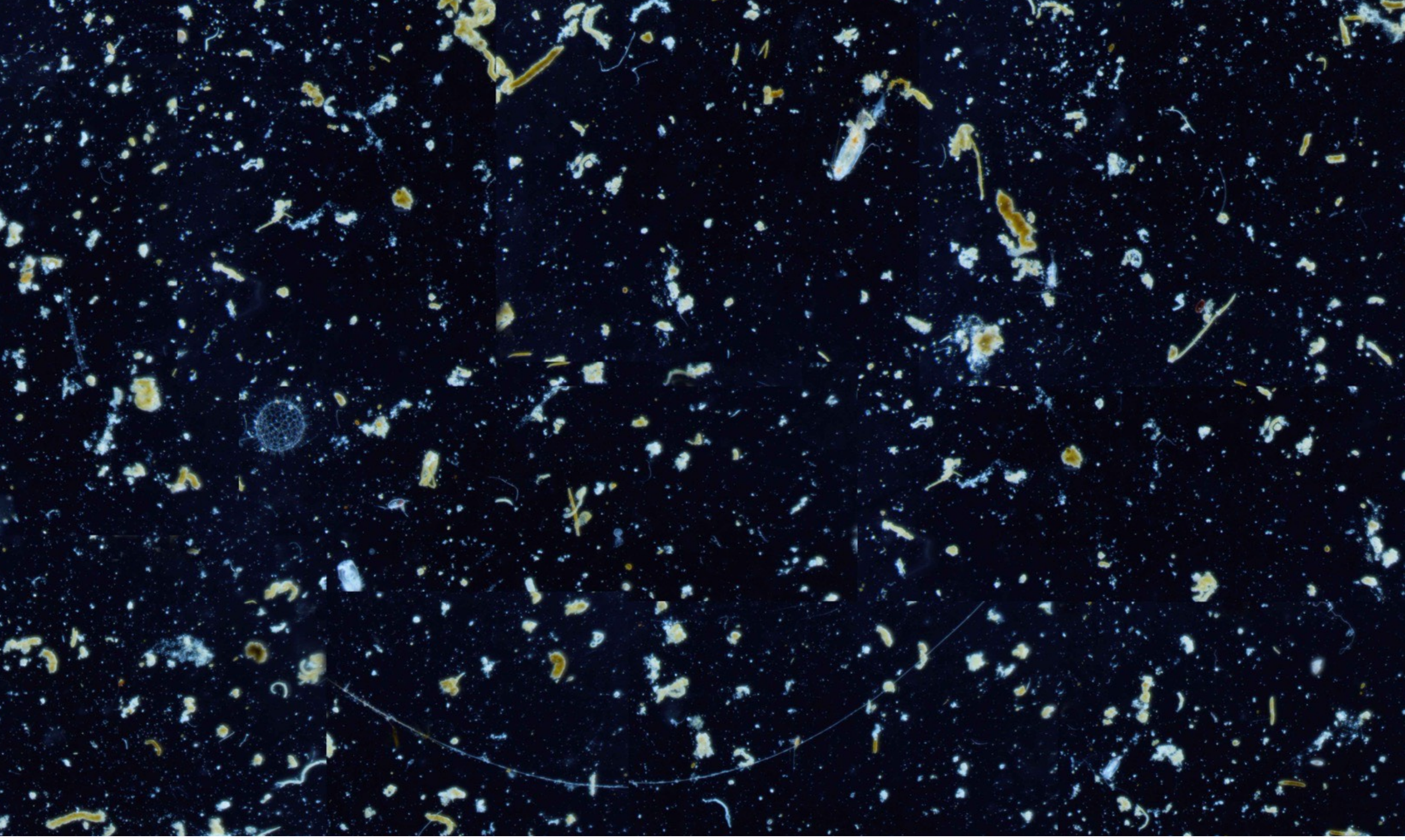

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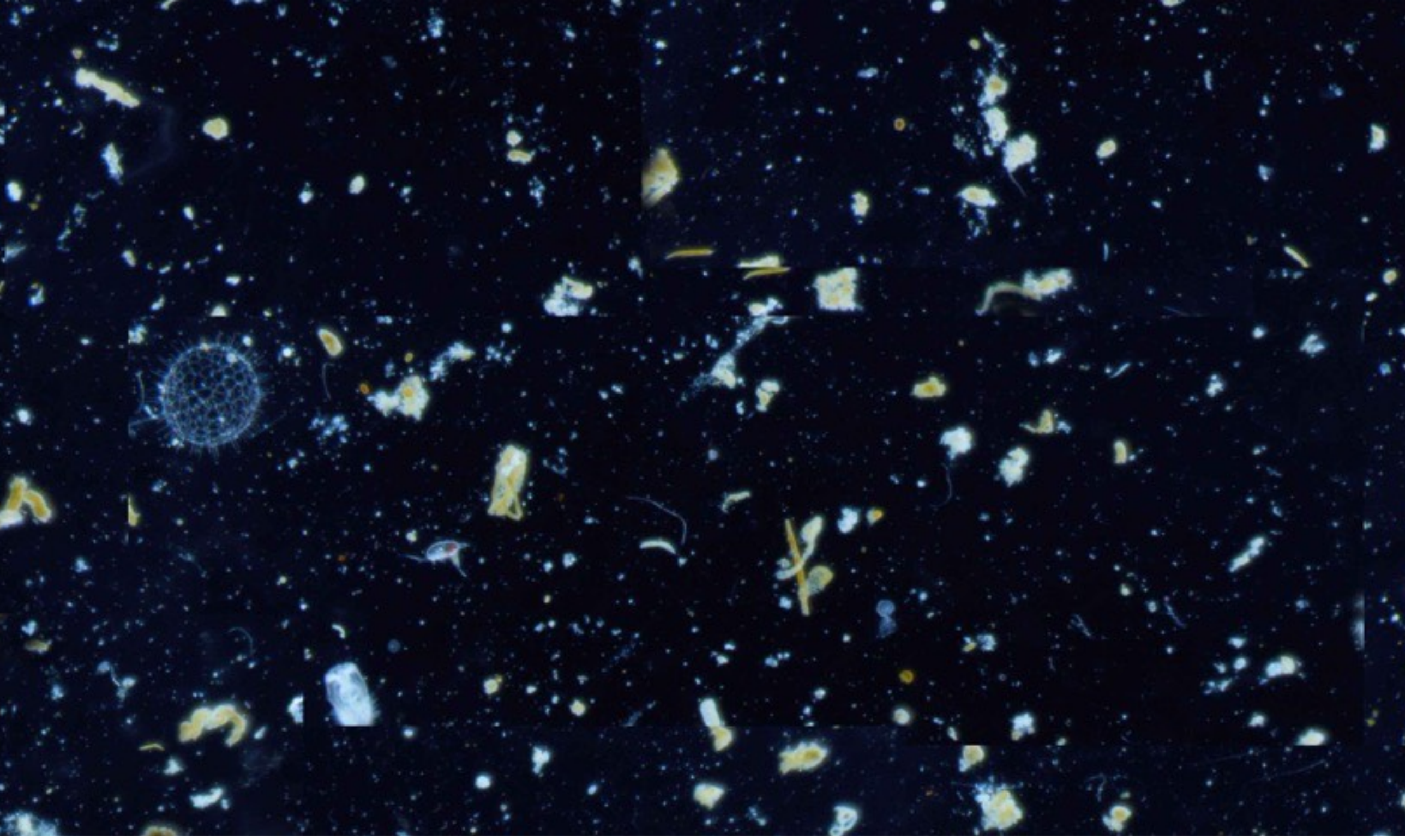

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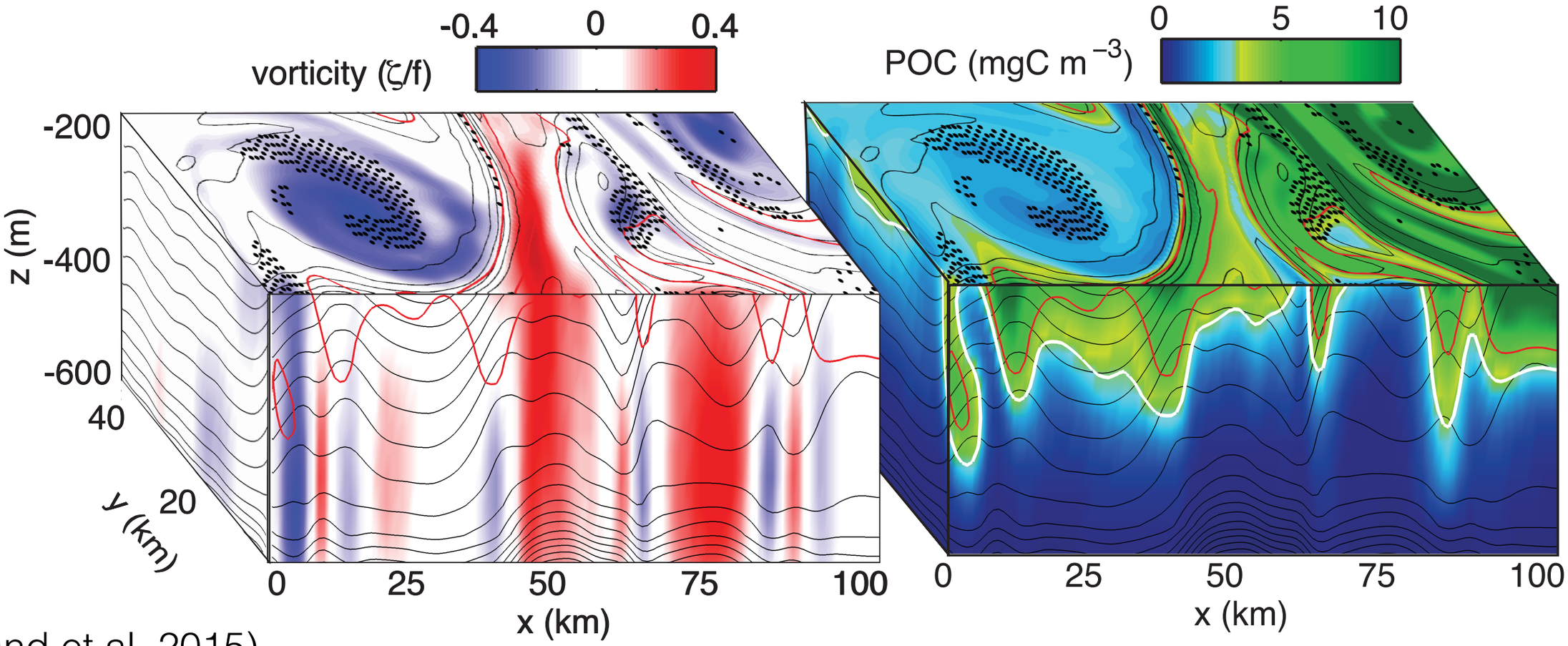

(Omand et al, 2015)

Models and observations suggest that submesoscale subducted features are often co-located with regions of negative relative vorticity