Progressive null-tracking for volumetric rendering

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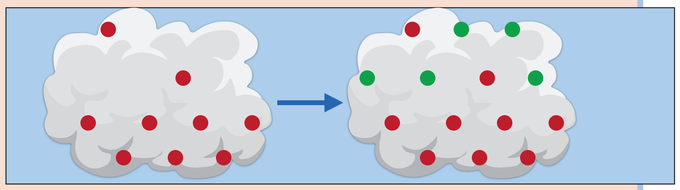
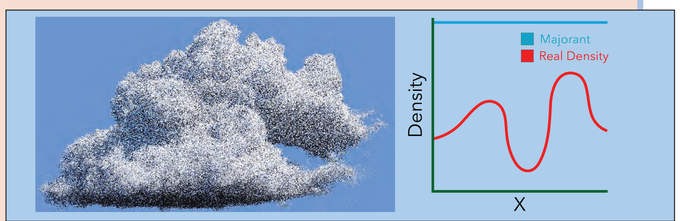
Motivation

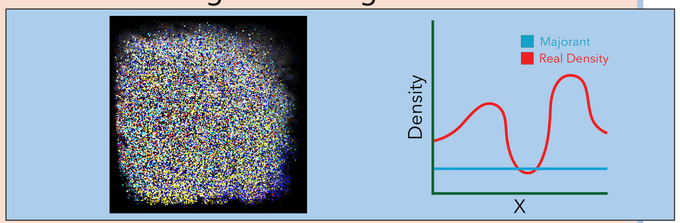


Volumetric rendering algorithms based on null-tracking inject null density into participating media to homogenize it.

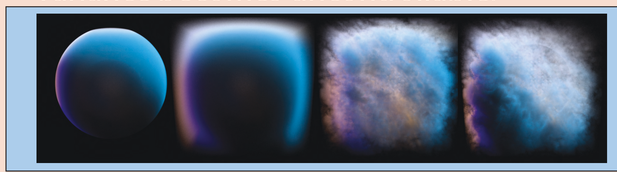
the combined null + real density is commonly referred to as the majorant.



When the majorant is too loose. Renders take too long to converge.



When the majorant is non-bounding. Variance becomes uncontrollable.

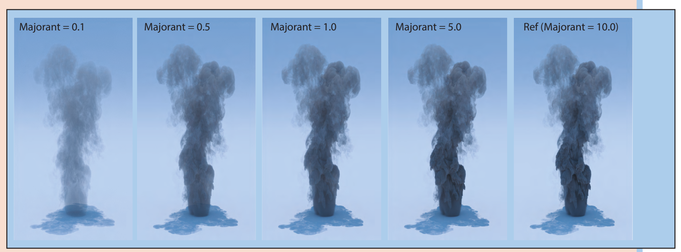


Rendering procedural media when majorants are not readibly available is a prohibitive problem in production.

Our Solution

To avoid explosions in variance, we first choose to clamp the real density

to our initial choice for the majorant.
This introduces bias in return for avoiding uncontrollable variance.



bias decreases as the majorant increases
Unbiased when the majorant is bounding.

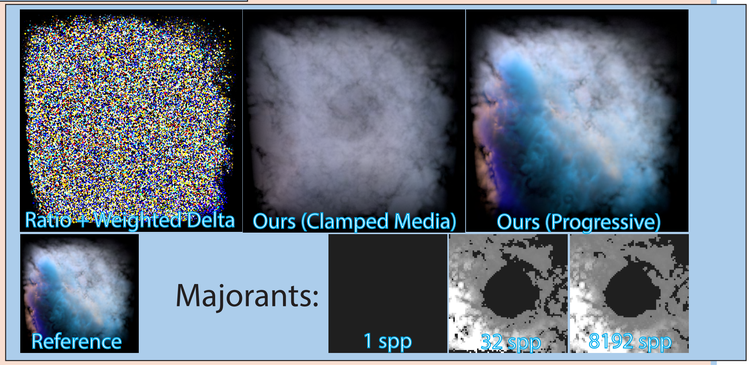
Update the majorant after density calls.

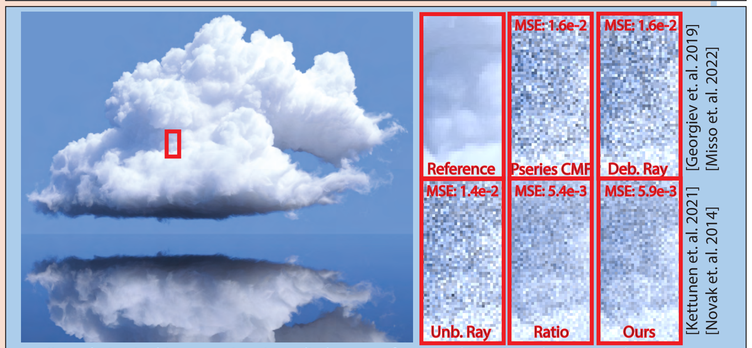
Maj = Max(Density + C, Maj)

$$I = \lim_{n\to\infty} \frac{1}{n} \sum_{k=1}^{n} \left\langle I(\mu_t^{(k)}) \right\rangle$$

A bounding majorant will be found in finite time and bias will progressively disappear in the infinite limit of work.

Results





Our solution in this comparison is applied on top of ratio tracking. Our solution introduces negligible performance losses in return for making prior work resilient to negative densities in an equal extinction call comparison.