Directed Volcano
Getting the most out of your simulations

Gregory Ecker Ravindra Dwivedi Ilan Gabai
Blue Sky Studios *

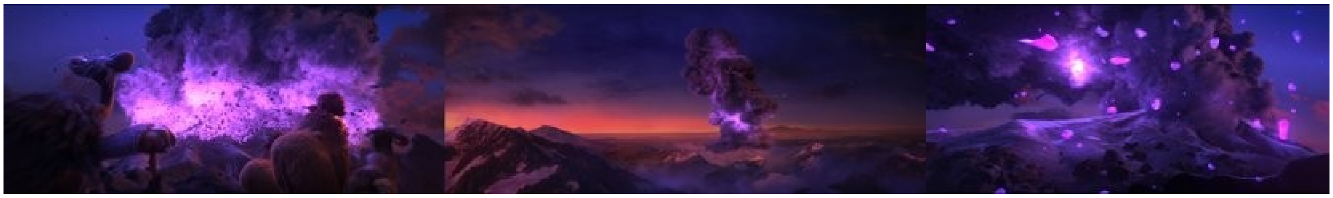

Figure 1: *Volcano Shots, Ice Age Collision Course © 2016 Twentieth Century Fox Film Corporation. All Rights Reserved.*

Abstract

In Ice Age Collision Course (2016), a volcanic eruption was central to the story. Our task was to craft a volcanic plume large and detailed enough to cover the frame for a sequence of shots, yet specific enough in its motion to evolve over a short period of time into a predetermined shape. It quickly became clear that the requirements were not going to be met within the confines of a single simulation. Simulation times in excess of 2 weeks with resolution exceeding 4 billion voxels were necessary, so we needed to make sure we were getting the most out of the simulations we were running. In order to accomplish this we developed a pipeline and set of tools to deal with the heavy volumetric data. We post processed each simulation using a variety of methods.

Keywords: volume deformation, retime, augmentation

Concepts: • ***Computing methodologies ~ Volumetric models;*** *Mathematics of computing ~ Interpolation;*

1 Volume Deformation

The simulations were run at a high level of detail, and then deformed into the shapes desired by the Directors. We used a volumetric deformation technique which involved sampling density values to points centered on each voxel, deforming the resulting point cloud using standard geometric deformation, and then transferring the values from the points into the new volume.

2 Volume Retime

Due to extensive simulation times, the ability to meet our Directors' notes regarding the speed of a simulation without changing the look or shape was of paramount importance. We implemented the two-sided evolution interpolation technique as described in the paper 'A Mass Spring Model for Hair Simulation' [Selle, Lentine and Fedkiw 2008]. With this approach we advect density using semi-Langrangian advection both forward and backward and then interpolate between the results. The output of this method was promising but there was a slight jitter when transitioning from an interpolated frame to the non-interpolated frame. To overcome this problem, we shifted the interpolation fraction by a slight amount. As a result, whenever we reached the non interpolated frame, we used the shifted fraction to interpolate it with the next nearest frame. This helped minimize the interpolation discontinuities and gave smoother results.

*e-mail:{gregorye, ravindrad, igabai}@blueskystudios.com

SIGGRAPH '16 Talks, July 24-28, 2016, Anaheim, CA
ACM: 978-1-4503-4282-7/16/07
http://dx.doi.org/10.1145/2897839.2927454

3 Combining and Extending

Even our largest simulations were not big enough to be viewed full frame in some of the shots at the resolutions required without seeing the bounds, or limits of the simulation. We used several methods to overcome this problem.

A:) "Frankensteining" : This involved combining several similar simulations using openvdb combination methods to produce a relatively seamless volume.

B:) "Fig leafing": We employed a "Fig Leaf" approach to cover up small undesirable artifacts. This involved placing procedural volumes which approximated the look of the simulation in the appropriate places.

C:) Extension: Simulations were extended with procedural volumes to hide artifacts and make the volumes larger. These procedural volumes were created by adding pyroclastic noise to a volume created by animating spheres in the shape of the extension.

3 Conclusion

This sequence took a significant amount of calculation and disk space to complete. The methods we've outlined enabled us to post process a few basic simulations to match the art direction and get the most out of our simulations, without having to resort to making one off simulations for each shot.

References

SELLE, A,. LENTINE M. AND FEDKIW, R. 2008. A MASS SPRING MODEL FOR HAIR SIMULATION. ACM SIGGRAPH 2008 (SIGGRAPH '08), ACM, NEW YORK, NY