Real-Time Simulation of Cumulus Clouds through SkewT/LogP Diagrams

Extended Abstract

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Figure 1: Overview of the SkewT/LogP system: 1 input atmospheric sounding data collected by weather forecasting agencies around the planet; 2 sounding data feed the skewT/logP diagram in order to estimate atmospheric parameters associated to a set of clouds; 3 sounding data also allows us to generate the wind profile associated to a set of clouds; 4 particles of each air parcel that originates a cloud rise in the atmosphere; 5 each air parcel starts the condensation process at some point in the atmosphere, so that the corresponding cloud becomes visible and needs to be rendered on screen.

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The realistic simulation of clouds in synthetic environments has always been an important research topic in computer graphics. However, simulation of clouds on computer is a complicated task since they have physics-dependent dynamic shapes that evolve over time. Cloud simulation involves two distinct fields: computer graphics and meteorology. While the first focuses on representing clouds in a visually appealing way, the second focuses on the physics of clouds and weather forecasts. Both perspectives are integrated in our cloud simulator. It takes advantage of SkewT/LogP (Skewed Temperature and Logarithmic Pressure) diagrams [1], also known as thermodynamic diagrams, from which we take temperature and pressure values as inputs to feed the cloud motion equation — without the need for solving partial differential equations — that regulates the flow of clouds as fluids in the atmosphere, as well as to generate cloud shapes and dynamics that can be easily integrated in flight simulators or computer games. As illustrated in Fig. 1, the main contributions of our work are as follows:

• SkewT/LogP diagrams. To our best knowledge, this is the first cloud simulator that uses SkewT/LogP diagrams in computer graphics. In fact, we have built a visual tool for 2D SkewT/LogP diagrams that allows us to inspect, control and simulate the thermodynamic process of ascending clouds in the atmosphere, as well as a 3D synthetic environment where clouds are advected by buoyant forces.

• Solving the equation of motion for clouds in real-time. By using SkewT/LogP diagrams, we are able to explicitly determine the vertical rising force required to solve the equation of motion of an air parcel (mass of air) in the atmosphere, without solving its differential equations.

• Automated generation of clouds that adapt to weather conditions. By using real weather data (including wind data) mapped onto SkewT/LogP diagrams, we are able to generate realistic synthetic clouds from the ground to their equilibrium level (EL) in the atmosphere.

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REFERENCES