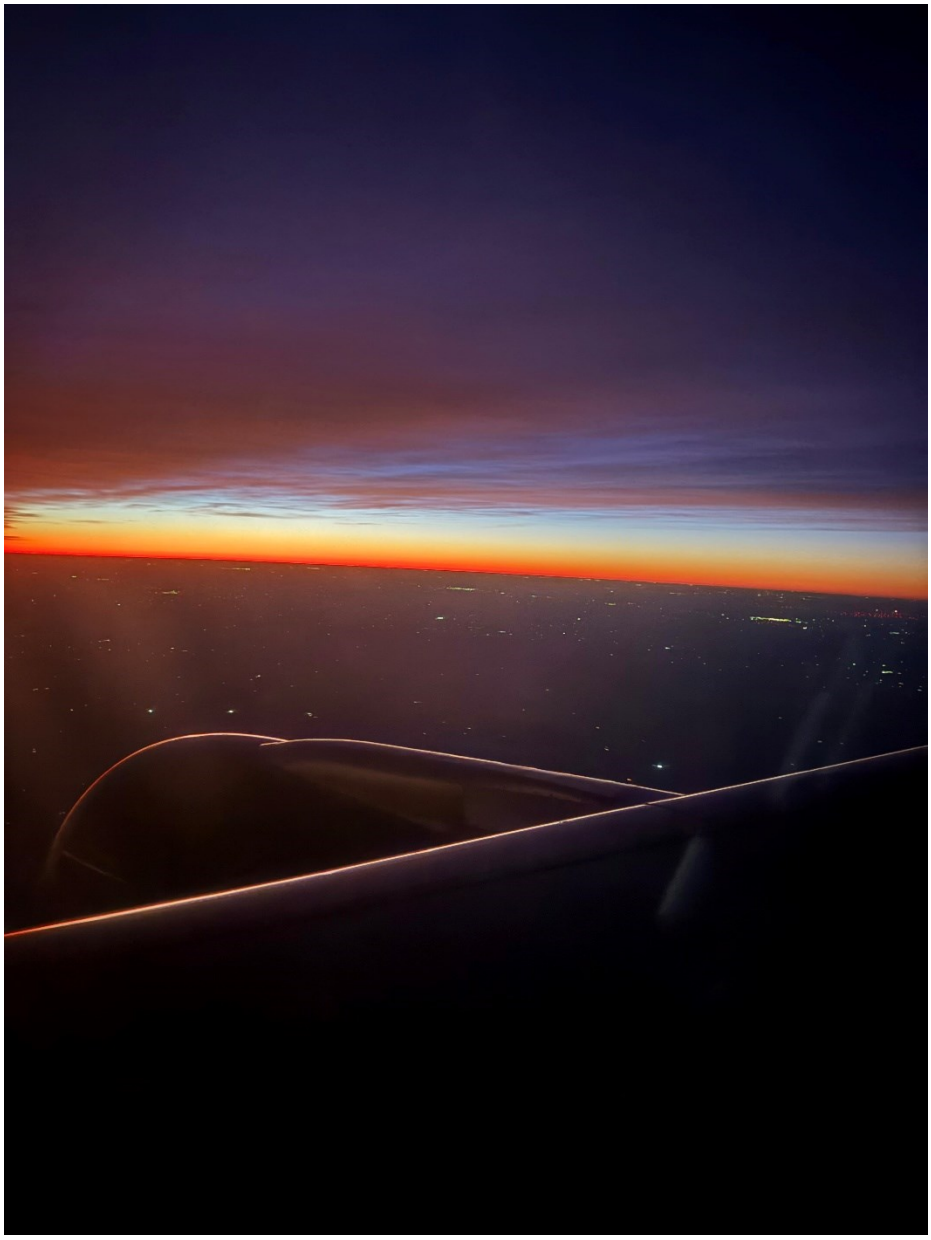
Cloud Two: Dawn over Chicago



Final photo showing Dawn.

Context and purpose

his picture views a breathtaking moment from an airplane window at dawn, showing the stratified layers of clouds and the atmospheric gradients while flying over Chicago towards the northeast. While the primary motivation for the photo was to document the beauty of the early morning light and its interaction with the atmosphere and cloud layers, it also provided a great opportunity to analyze the fluid dynamic phenomena responsible for the layering and gradients

in the sky. The image shows, through the interplay of light and flow, how the atmosphere behaves as a fluid that changes due to temperature, pressure, and density.

Context and Observation

This picture was taken from a cruising altitude of about 15,000 feet, giving an enormous view of the horizon where the curvature and stratification of the Earth's atmosphere could be seen. The major feature is the color gradient, ranging from deep blue in the upper atmosphere to bright orange and yellow near the horizon, caused by the scattering of sunlight during dawn.

Further, various layers of clouds can be defined in the lower atmosphere. These form due to temperature inversions and different moisture content at different altitudes. Darker areas above the horizon most likely represent thicker cloud coverage while scattered lights visible near the surface correspond to the Chicago metropolitan area.

Flow Dynamics Analysis

The stratified cloud layers in this image are produced by atmospheric stability, wherein vertical mixing is inhibited by a temperature, and hence light gradient. This behavior is typical for laminar flow in which fluid layers move parallel to each other without significant turbulence.

With less convection in the atmosphere at dawn, the Earth's surface is cooler by then, there is a stabilization in the layers. The temperature inversion, just a warmer air layer on top of cooler air provides the mechanism for air masses to not mix too much and produce well-defined cloud layers.

Color gradients can be explained by Rayleigh scattering, where shorter wavelengths of light, like blue and violet, are scattered more than longer wavelengths, red and orange. At low angles for example, at dawn the sunlight travels through an appreciably thicker layer of the atmosphere, which scatters away most of the shorter wavelengths and leaves the vivid oranges and reds near the horizon.

Visualization Technique

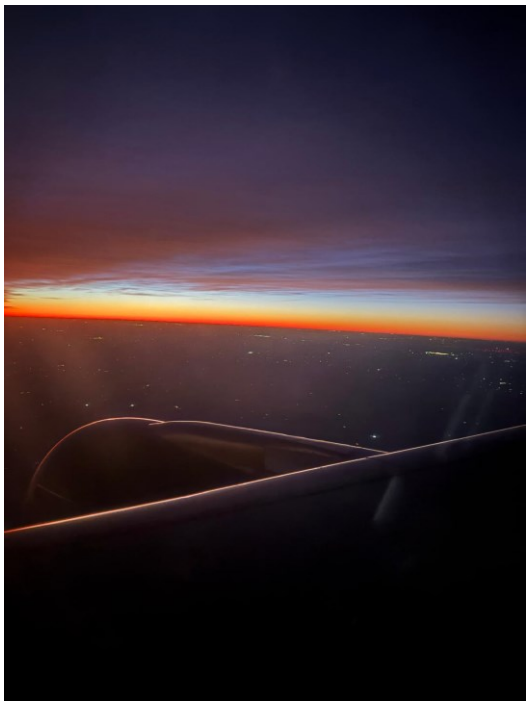
The visualization was highly enabled by natural lighting at dawn: because of the low sun position, it was a peculiar opportunity to capture the interaction of light with the atmosphere and clouds. This passage from dark to light is a smooth gradient that underlines the layering of the atmosphere. The picture shows the right airplane wing and the engine, anchoring the viewer into this perspective of being in flight. The scattered city lights below add another dimension to this, highlighting the contrast between the stillness of the upper atmosphere and the activity below.

Photographic Technique

The following shot was taken by the camera of a smartphone, which used the following parameters:

- **Camera**: iPhone 12 Pro
- **Lens**: Available with an integrated wide-angle lens
- **Field of View**: ~15 km horizontally
- **Distance from Subject**: Roughly 30,000 feet above the earth's surface
- **Resolution**: 3024 × 4032 pixels
- **Exposure settings**: Automatic mode

The picture is taken through the window of the airplane, trying carefully to avoid glare and reflection as much as possible. The image was minimally post-processed for brightness and contrast enhancement to bring out the gradients and structures of the clouds better. No cropping was done in order not to lose all the expense of the scene. The picture edits included only minor changes to the contrasts to show the purple color gradient on the top part of the picture.



Unedited picture

Image Analysis and Reflection

It was taken in the morning to capture that beauty and complication of the atmosphere, mingling both the artistic and scientific aspect of this moment: color gradients indicating the impact of Rayleigh scattering, cloud layers revealing the stability of the atmosphere during early morning hours. Adding the airplane wing frames this image with contextual information on scale and allows the viewer to feel present in a flying experience.

The image successfully meets its objective of visualizing atmospheric fluid dynamics while showcasing the interplay of light and flow. In future attempts, experimenting with different times of day or focusing on specific cloud formations could add additional depth to the analysis. Similarly, using a polarizing filter could help reduce reflections and enhance the clarity of the sky.

References

1. "Rayleigh Scattering and Atmospheric Optics." Atmospheric Chemistry and Physics. Available at: https://www.atmos-chem-phys.net.
2. "Cloud Formation and Atmospheric Stability." National Weather Service. Available at: https://www.weather.gov/.
3. "Light and Color in the Atmosphere." NASA Earth Observatory. Accessed at: https://earthobservatory.nasa.gov.