Airglow Imaging and Instability Structures

Kelvin-Helmholtz (KH) billows, which have been known for over 100 years occur in any fluid that becomes unstable. In the atmosphere they occur when a large wind shear causes a narrow altitude regime to become dynamically unstable. They are difficult to study experimentally, and much of the progress on their properties has occurred from complex computer simulations (e.g. Fritts et al., 1996).

Passive optics though has recently been shown to be a viable means to study this century old process. The OH Meinel airglow originates in the 85 to 90 km region and emits throughout the visible and near IR wavelengths State of the art lidars have revealed the large wind shears and temperature gradients result in frequent unstable regions in the 80 to 100 km altitude regime. These instabilities give rise to KH billows which appear as wavelike ripple patterns in images of the OH Meinel airglow (e.g. Hecht,2004).

Figure 1 shows stability of the atmosphere as a function of altitude and time on 7/15/02 based on measurements taken by the MAUI/MALT Na wind temperature lidar system deployed at Mt. Haleakala, Maui. Regions of red and green are dynamically unstable. Figure 2 shows the difference between two OH Meinel airglow images, each exposed for 1.5 s at 1550-1700 nm, taken 1 minute apart at the MAUI/MALT Observatory on 7/15/02. The field of view is approximate 73 degrees or 60 km at 85 km altitude. The phase fronts labeled KH1 are KH billows due to the unstable regions near 86 km altitude. KH billows should be aligned perpendicular to the wind shear vector and move with the wind. The lidar wind data showed (1) that the wind shear vector was, as is shown, pointed perpendicular to the KH1 phase fronts and (2) that the motion of the KH1 phase fronts was, as is shown, in the direction of the wind (Hecht et al., 2004).

Airglow imaging thus is a powerful new method to remotely study the presence of unstable regions and the formation and evolution of instability structures in the upper mesosphere and lower thermosphere.

![Figure 1](image1.png)  ![Figure 2](image2.png)
References

