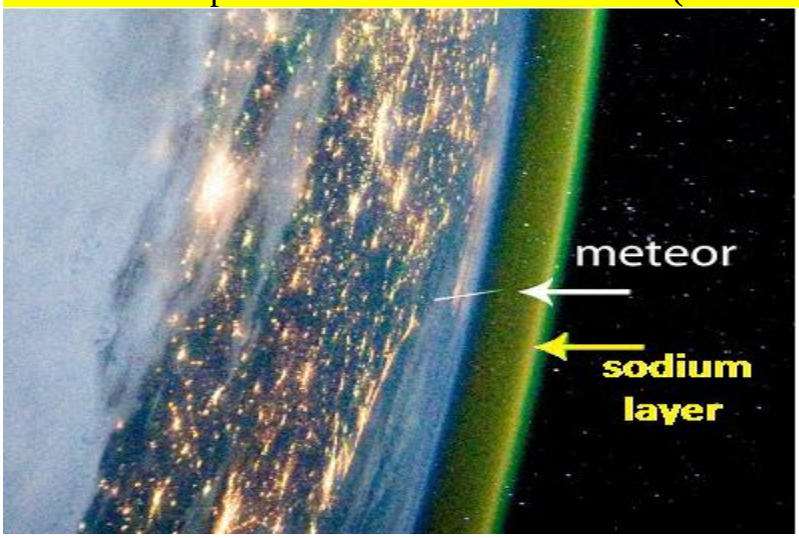
# METALLIC VAPOR LAYERS

## The Sodium Layer

A natural global layer (usually about 3 miles thick) of sodium atoms exists between about 50 and 65 miles (80 and 105 km) altitude. The sodium originates from the ablation of meteors. The atoms are naturally excited and emit a weak glow near a wavelength of 589 nm (yellow) known as "the sodium D lines". Above the layer, sodium exists in its ionized form (which does not emit yellow light) and below the layer, sodium exists as chemical compounds such as sodium oxide (which also do not emit yellow light).




## Applications

Although originally a curiosity, the sodium layer has been found to have useful applications:

- The sodium emission may be stimulated artificially by an appropriately tuned laser, as in the sodium lidar system at Colorado State, to provide information on mesospheric winds and temperature. For further useful info on sodium lidar systems see pages for the Purple Crow Lidar and FISAT. The lineshape of the sodium emission depends strongly upon the temperature. If the hyperfine structure is probed in a few places, a least squares fit can be done to the data to obtain temperature. Doppler shifts of the spectrum also allow one to calculate the horizontal wind speeds in the mesosphere when the lidar system looks at an angle sufficiently off-zenith.

- Astronomers use the background sodium layer to create an artificial laser guide star for the adaptive correction of telescope optics for atmospheric effects. See also Lick Observatory's Guide star page
- The layer may be useful in the study of climate change.
    - The rate at which sodium ions are converted to sodium atoms is thought to be governed by the ratio of carbon dioxide to atomic oxygen. If this is in fact the case and if one can measure that conversion rate, one may be able to infer the concentration of the important greenhouse gas, carbon dioxide, near 90 kilometers altitude for use in global climate models.
    - Any long-term changes in the altitude of the layer may be an indicator of global change.

## Other Metallic Vapor Layers

Other metals such as iron (Fe), potassium (K) and calcium (Ca) have also been observed to form metal layers. The iron layer is typically about 55 miles (88 km) altitude and about 2 miles thick.

## Sudden Sodium Layers

Occasionally certain areas may experience a sudden appearance of an enhanced layer of sodium (Sudden Sodium Layer) or other metallic atoms such as iron or potassium (more generally called a Sudden Atom Layer). The cause of Sudden Atom Layers is not known; the leading explanation is that these layers result from the neutralization of descending sporadic E layers.

## Historical Outline

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| 1929 | Sodium (Na) layer discovered by Vesto Melvin Slipher |
| 1939 | Chapman proposes theory to explain layer |
| 1960's | Routine observations begin |
| 1969 | Lidar observations begin |
| 1976 | Iron (Fe) layer detected |
| 1985 | First extensive laboratory studies of Na atom chemistry relevant to atmosphere |
| 1989 | Lidar observations of iron layer begin |