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Tutorial Lecture

by Eric Jensen  
NASA Ames Research Center

Noctilucent Clouds:  
An Indicator of Global Change?

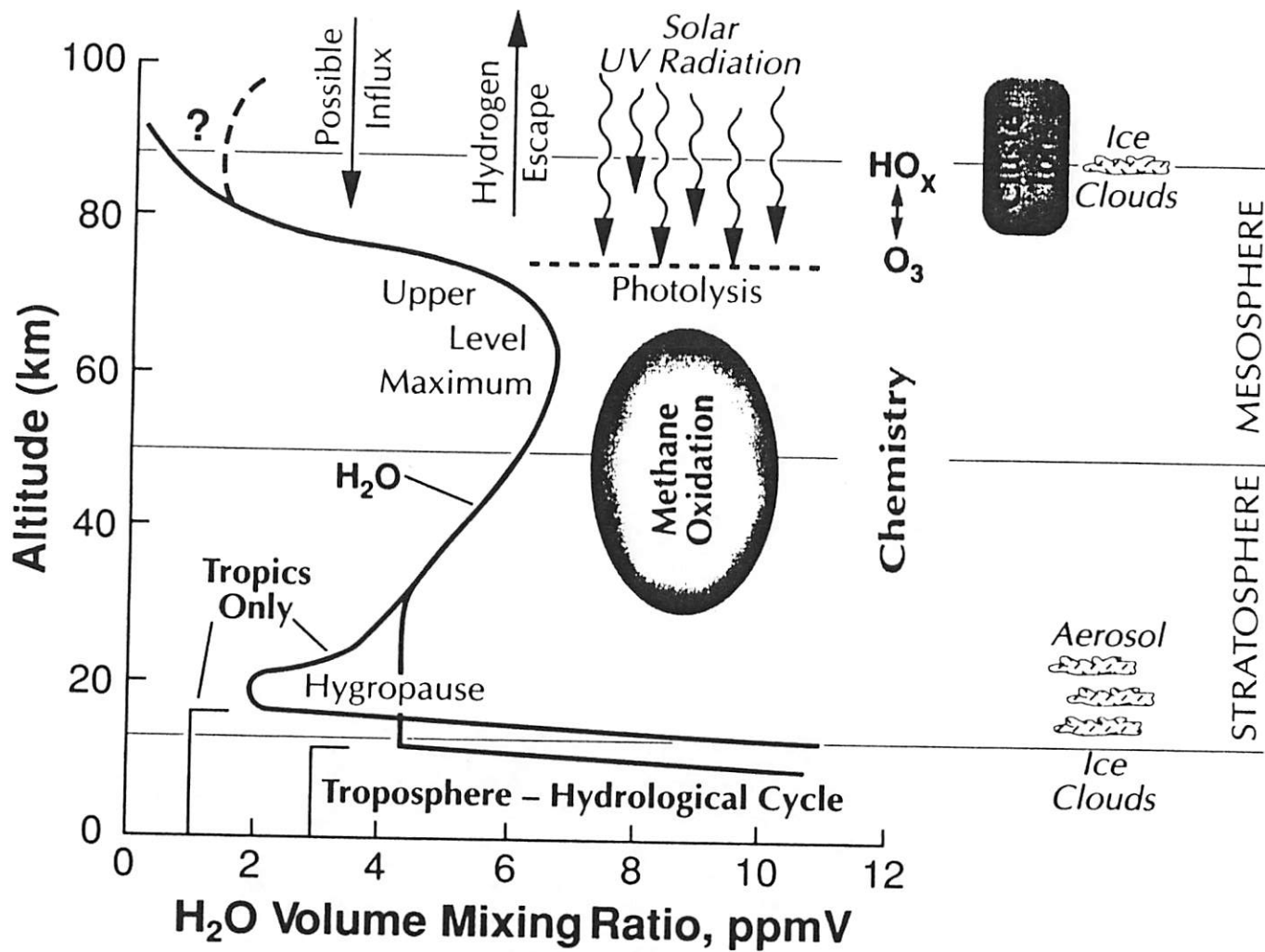
# **Noctilucent Clouds: An Indicator of Global Change?**

Gary E. Thomas, University of Colorado

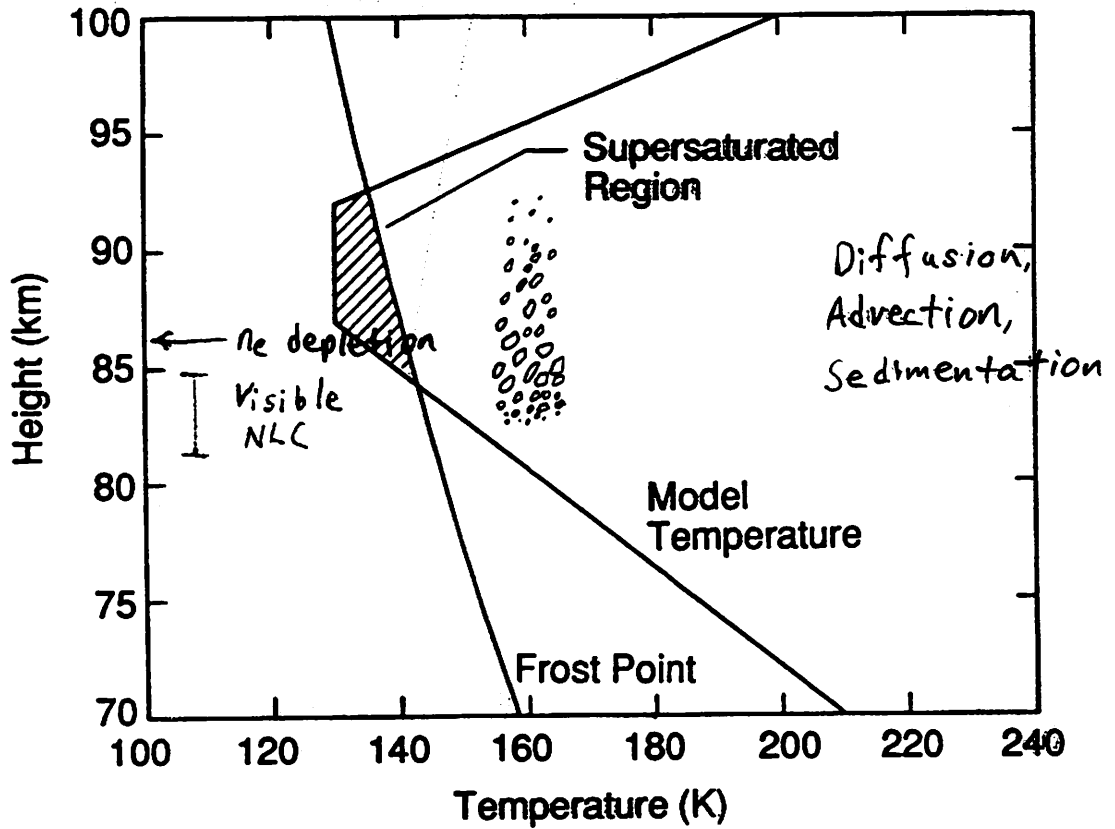
Eric J. Jensen, NASA Ames Research Center

John J. Olivero, Pennsylvania State University

- Noctilucent Clouds– Secular Trends
- Possible Causes
  - Atmospheric methane, water vapor increase
  - Mesospheric temperature decrease
- Importance of gravity waves
- Conclusions



Nucleation centers: meteoric smoke particles?  
Proton hydrates  $H_3O^+(H_2O)_n$ ?



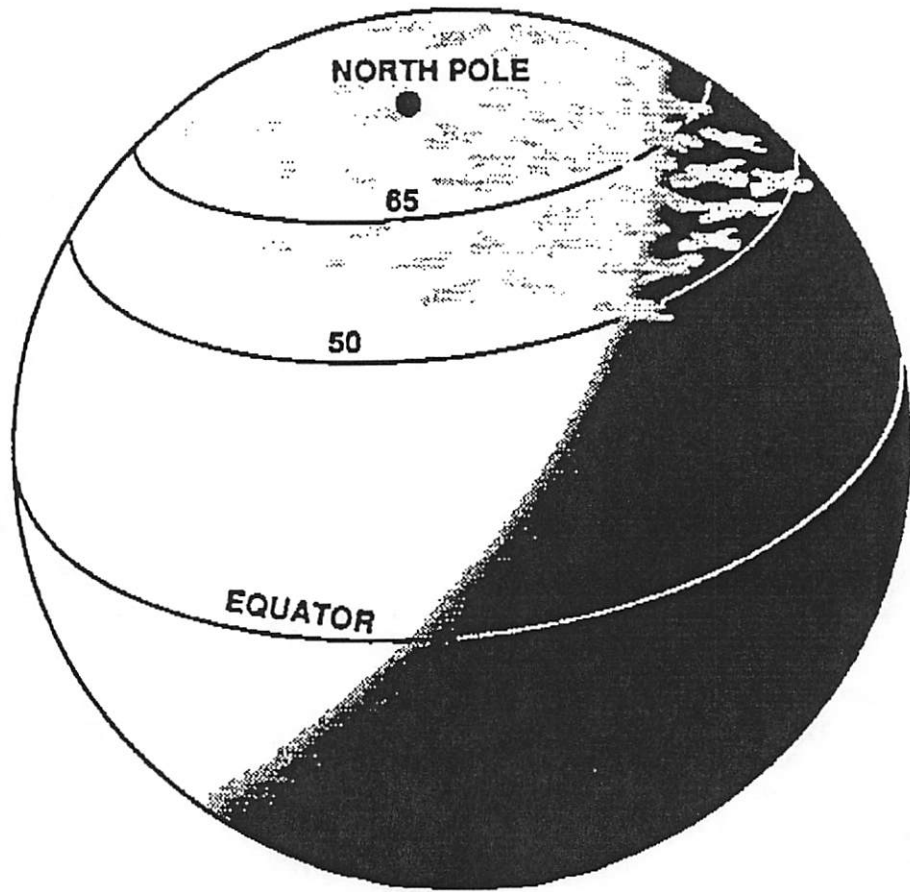


Fig. 3

## Discovery of Noctilucent Clouds

- NLC were first observed in June, 1885 by observers in Germany, Europe, Great Britain, and Russia.
- No NLC observations were reported before this date.
- Why?
  - Krakatoa: 1883
  - Increasing NLC brightness

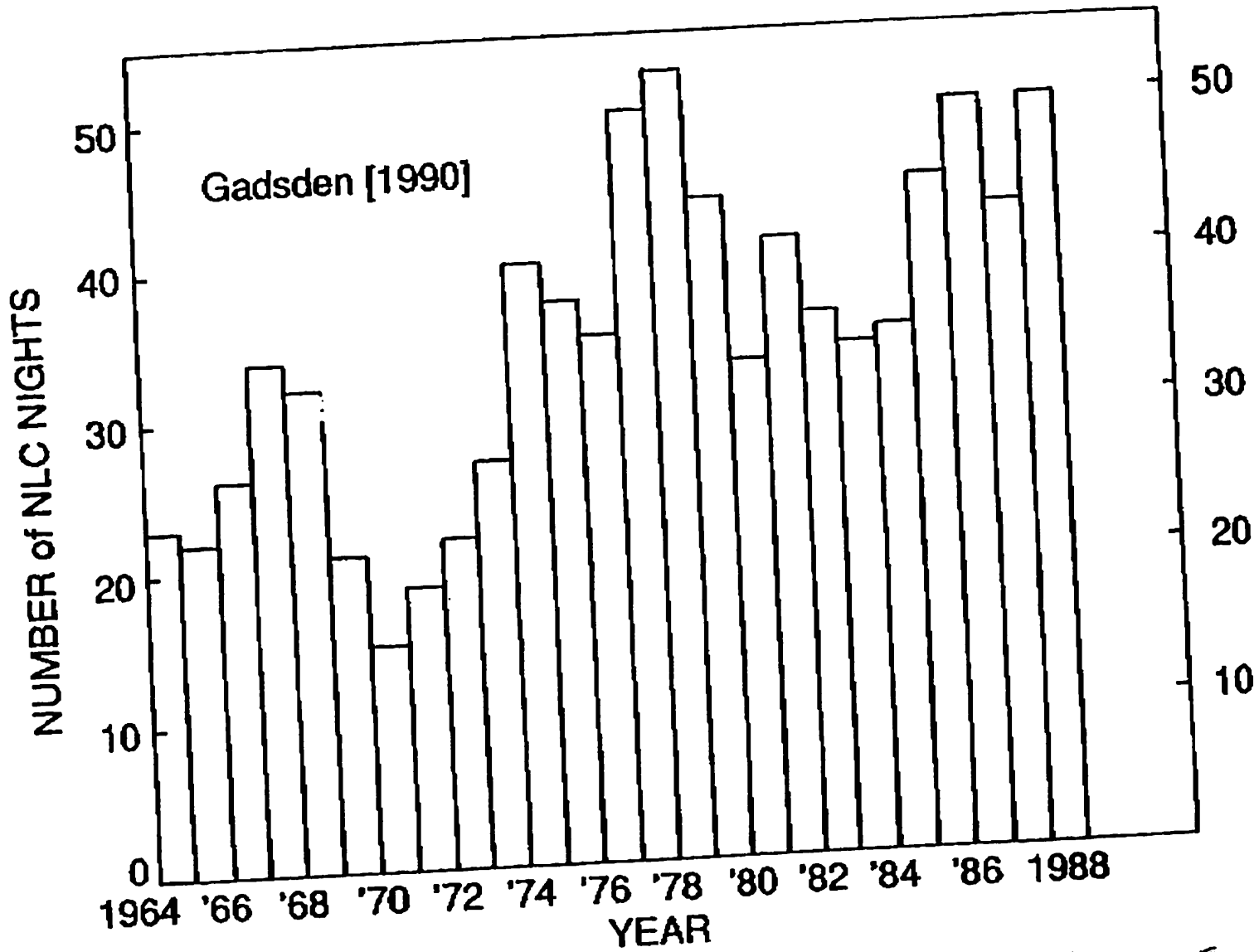
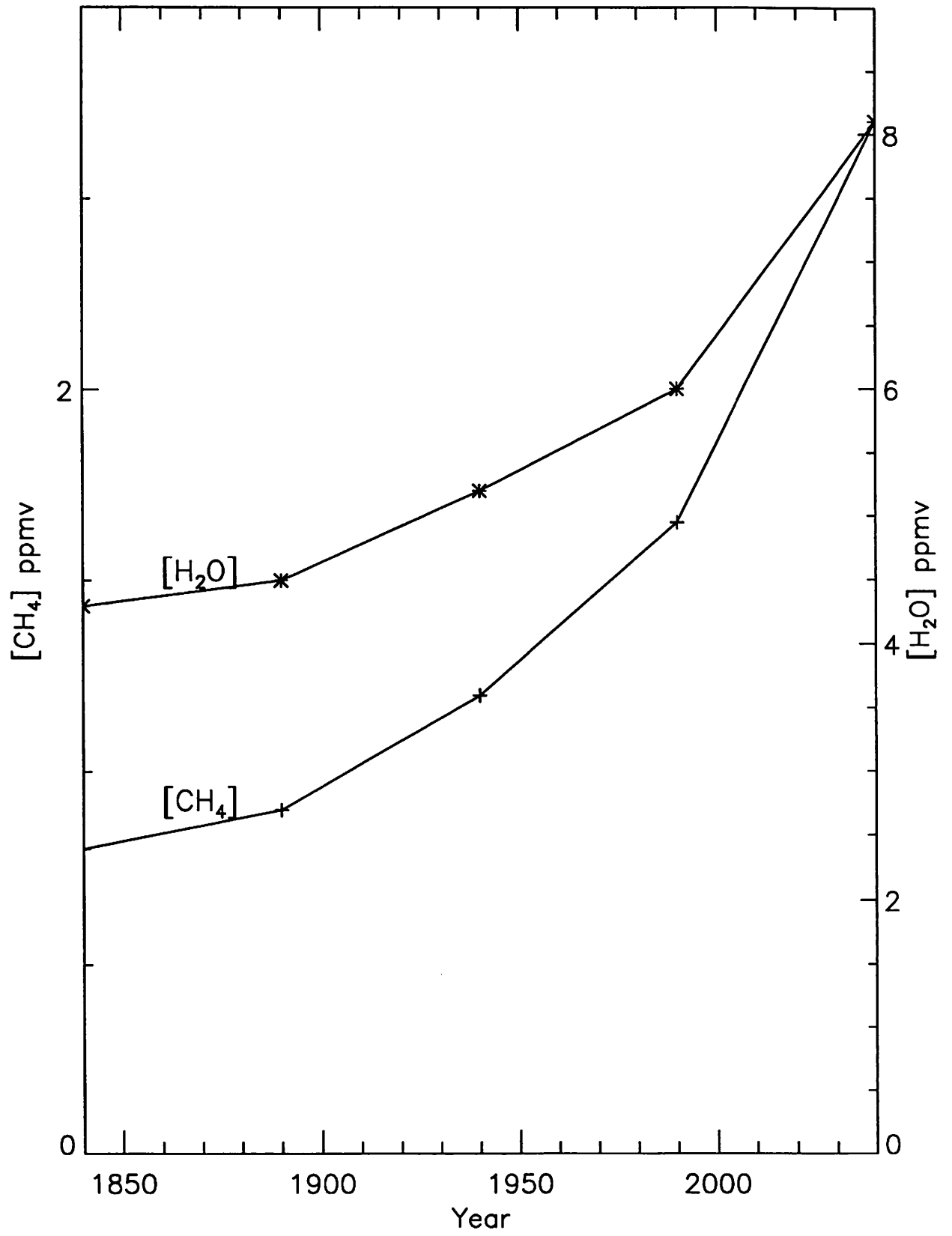


Figure 6

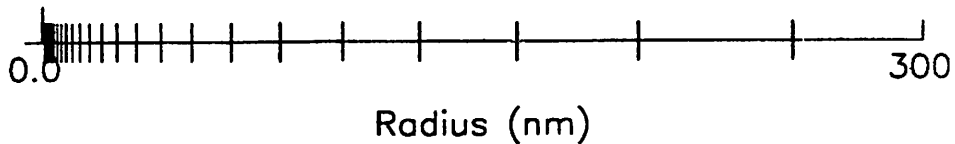
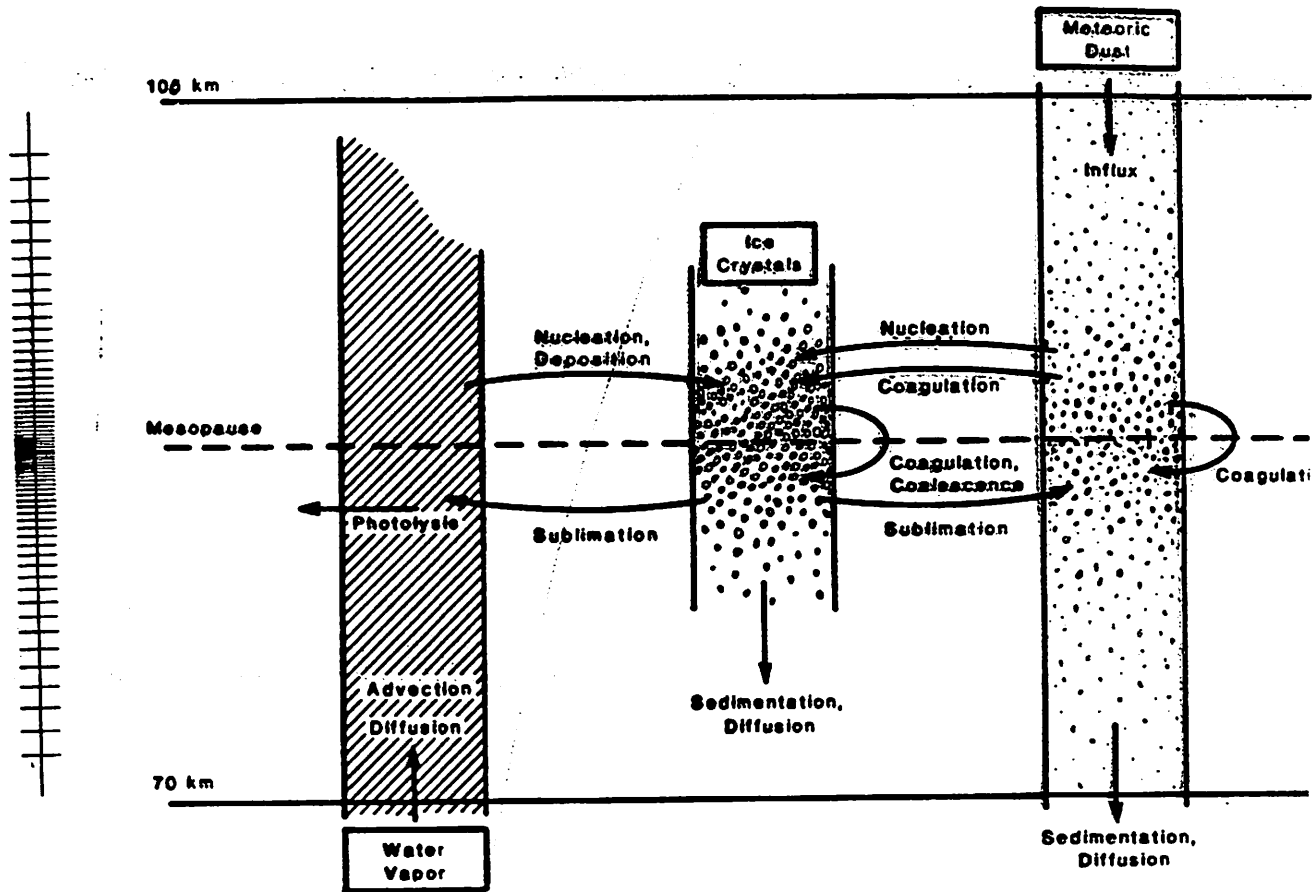
## Increasing Methane ( $\text{H}_2\text{O}$ ) Hypothesis

- Methane increase established from ice core measurements.
- Roughly 2  $\text{H}_2\text{O}$  molecules are produced from oxidation of every  $\text{CH}_4$  molecule.
- $\text{H}_2\text{O}$  mixing ratio may have increased from 4.5 to 6 ppmv over the past 100 years.
- Problems:
  - [ $\text{H}_2\text{O}$ ] albedo variation at time of NLC discovery too slow.
  - Estimated NLC albedo increase may be too slow to account for observed frequency of occurrence over past 30 years.

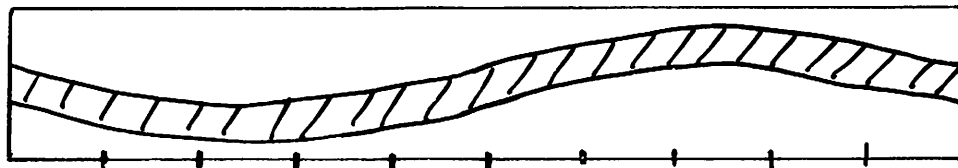




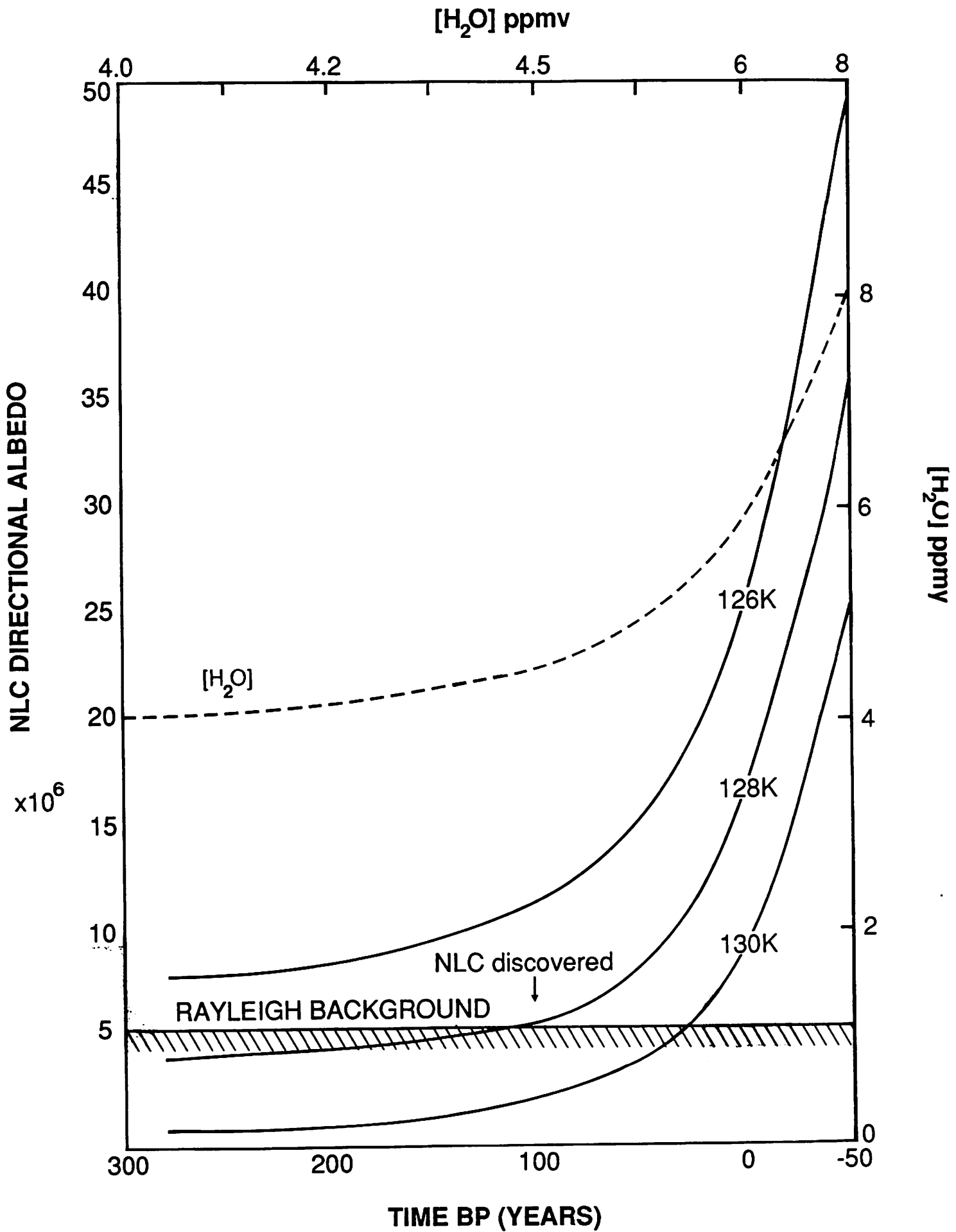
No ion nucleation



- Horizontal domain: 1 wavelength

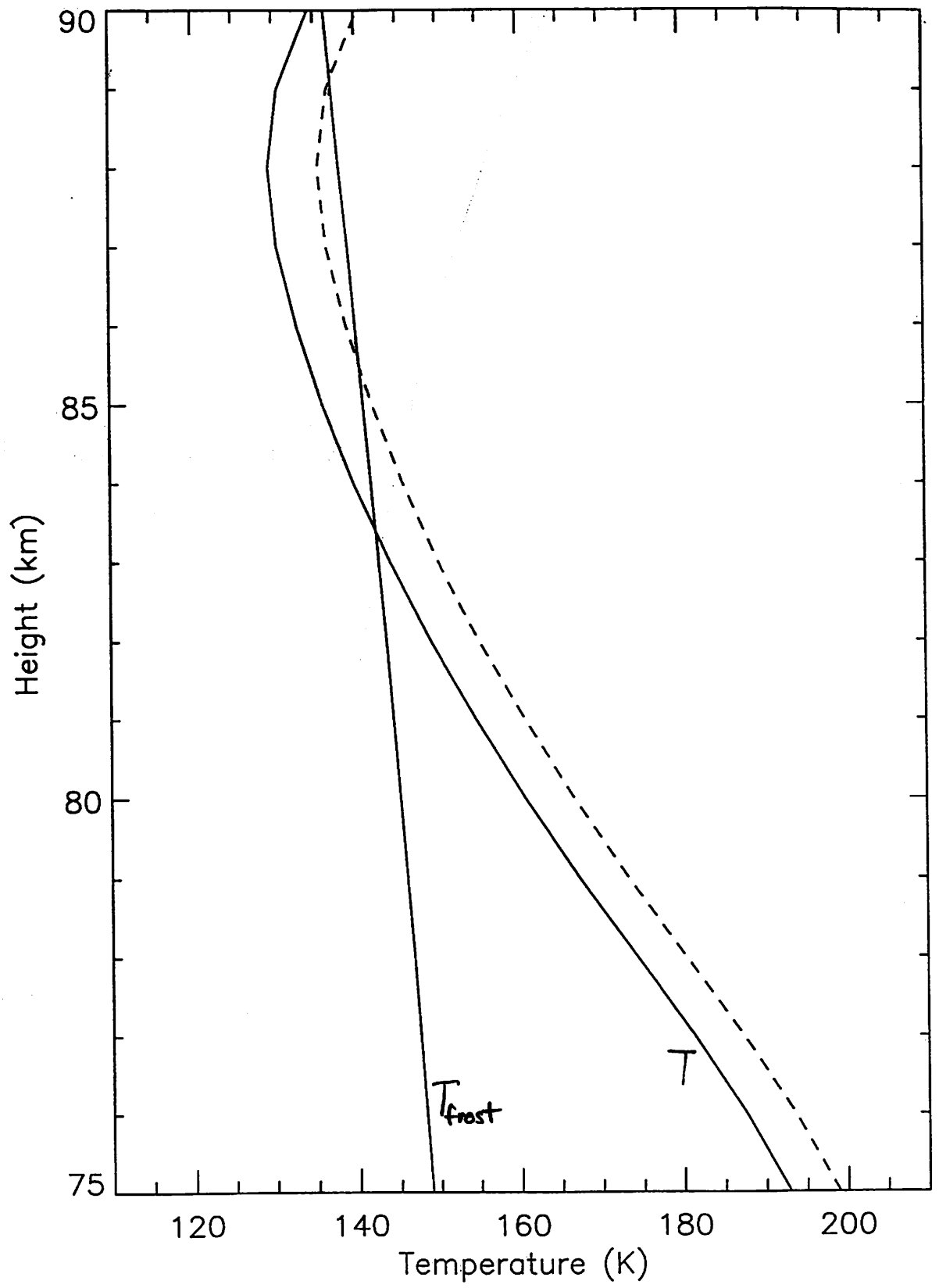


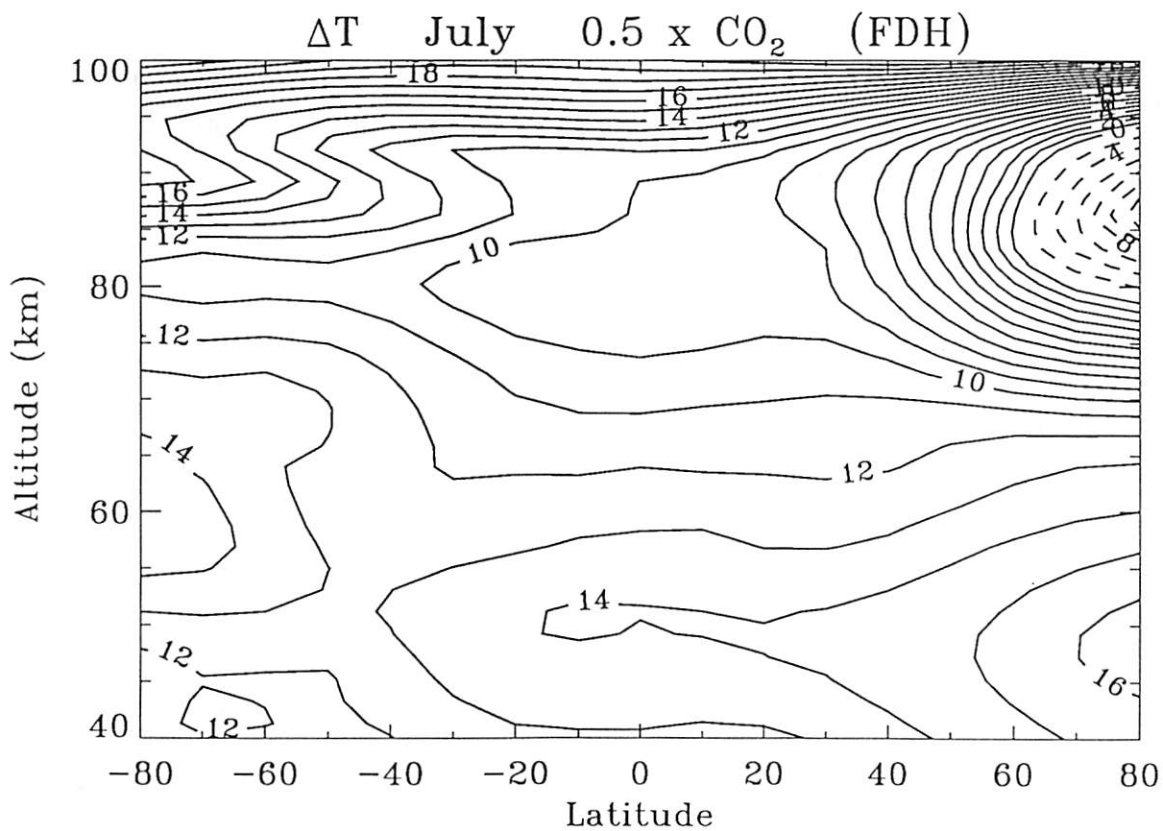
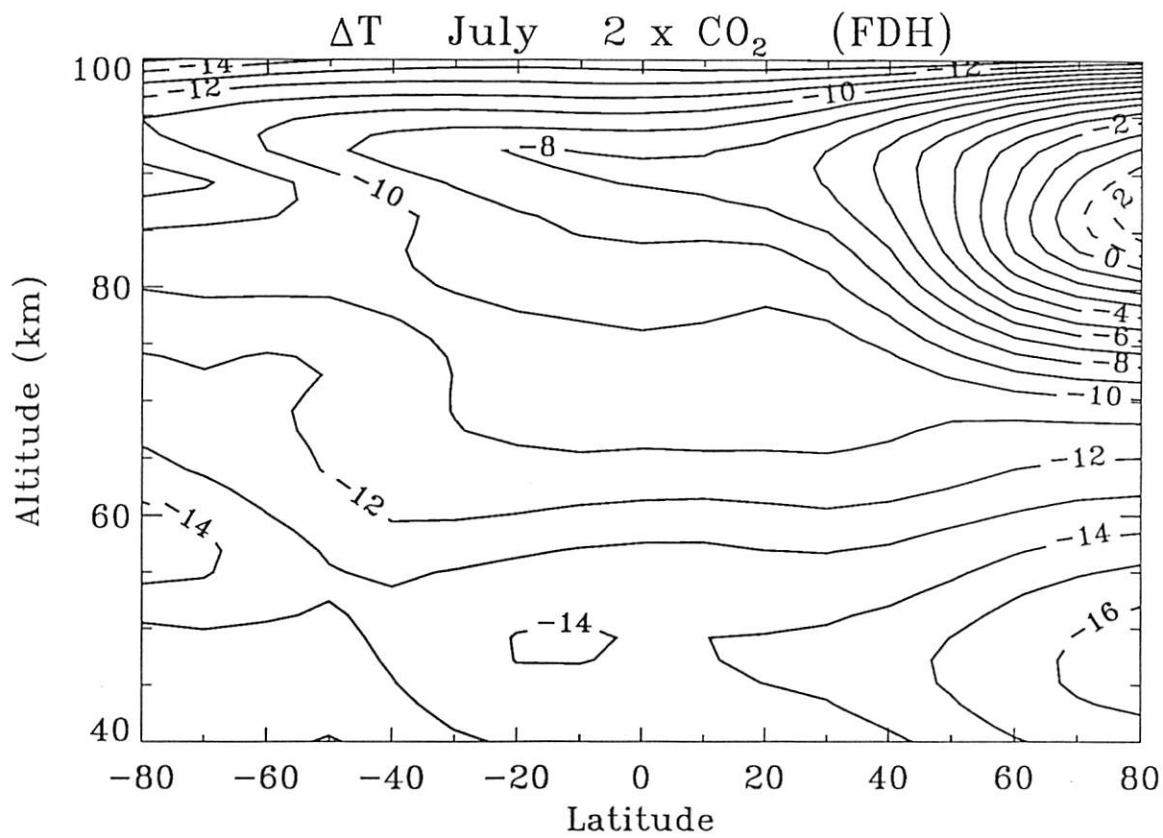
- Periodic boundary conditions

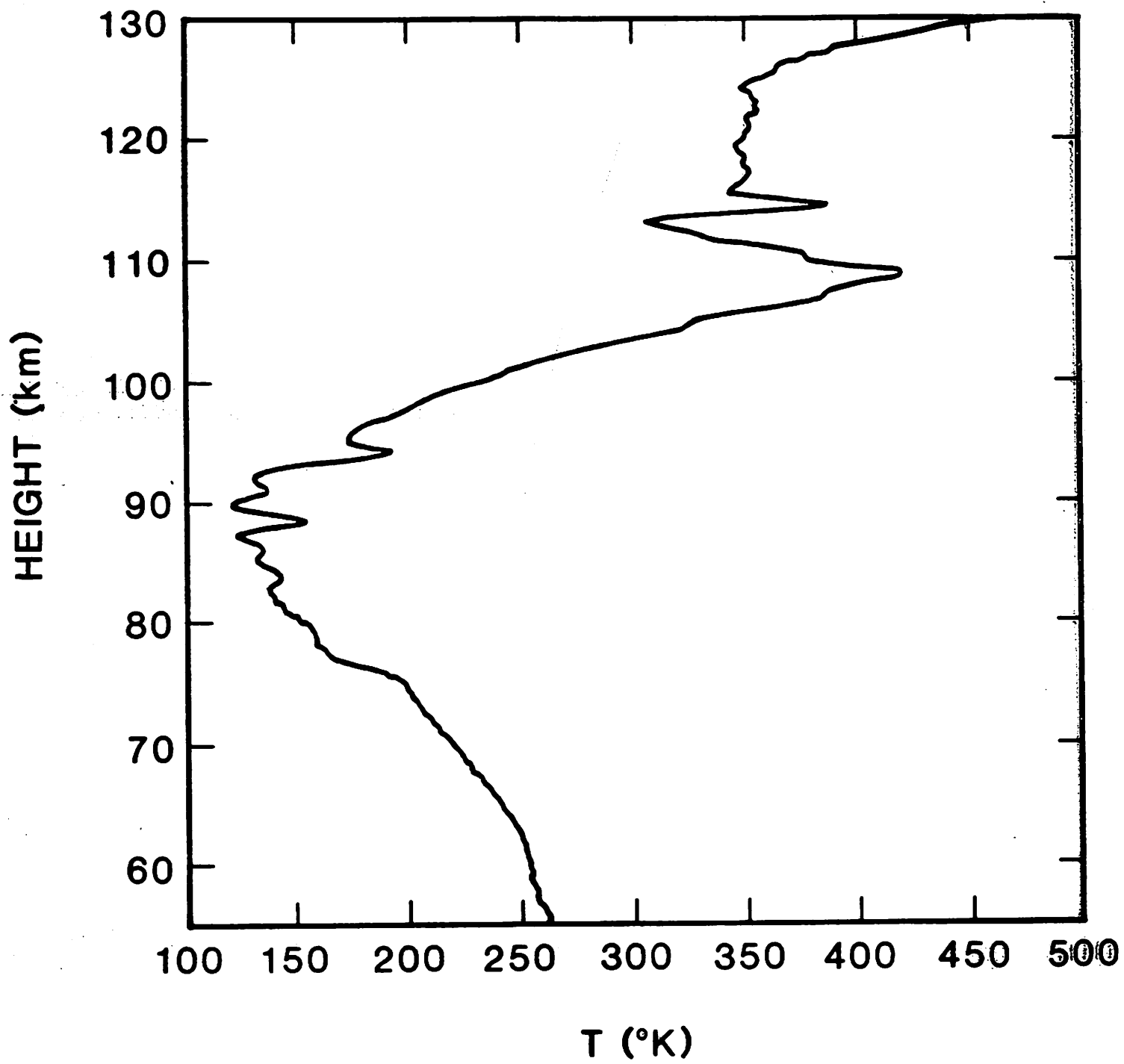


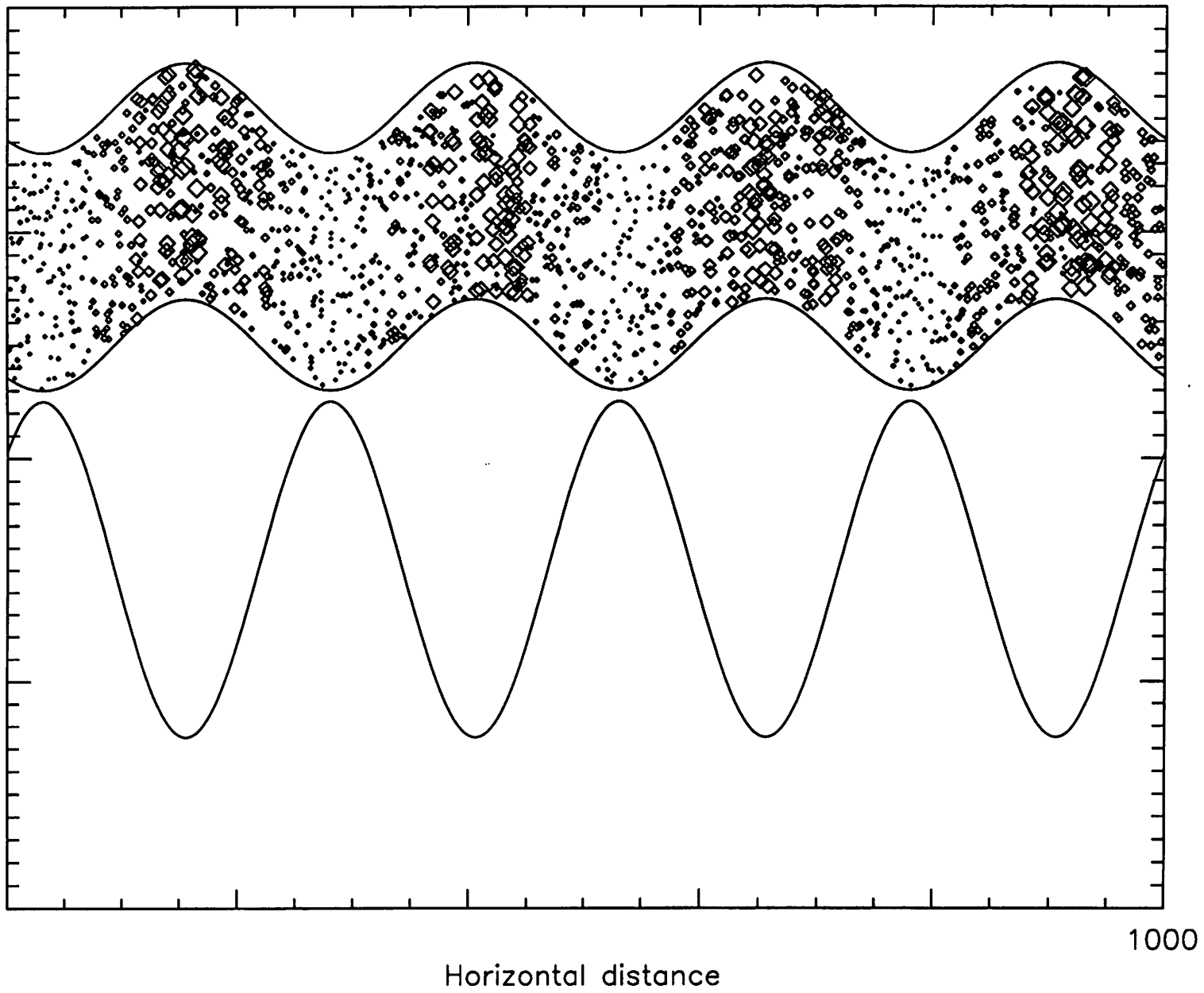
## Decreasing Temperature Hypothesis

- Both long-term trend and solar cycle variation could be explained by changes in mesospheric temperature.
- Assuming NLC occurrence is triggered by a sufficiently low mesopause temperature, Gadsden [1990] concluded that the mesopause temperature may have decreased by about 7 K over the last 30 years.
- Problems:
  - No clear evidence that summer polar mesopause temperatures are decreasing.
  - Model calculations suggest that  $T_m$  may slightly increase with increasing CO<sub>2</sub>.
  - No change in NLC height has been observed.

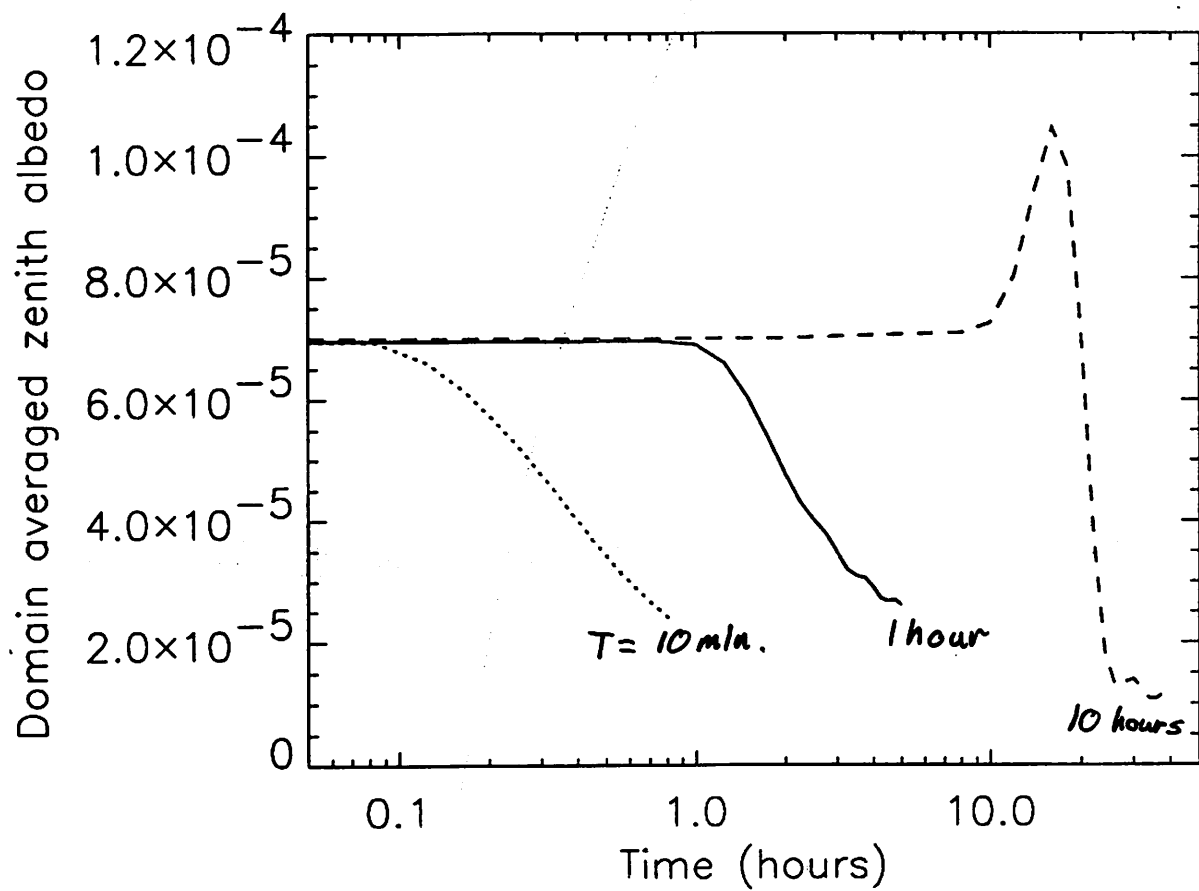












## Summary

- Lack of NLC reports before 1885 and recent amateur observations suggest increase in NLC occurrence frequency over time and solar cycle variation.
- NLC changes may be caused by either temperature or water vapor variations.
- Long-term observations of NLC optical properties are needed.