

Discovery of the Stratosphere

11km, Tropical Atlantic (20N, 65W), August

stratosphere

troposphere

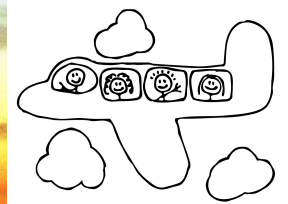
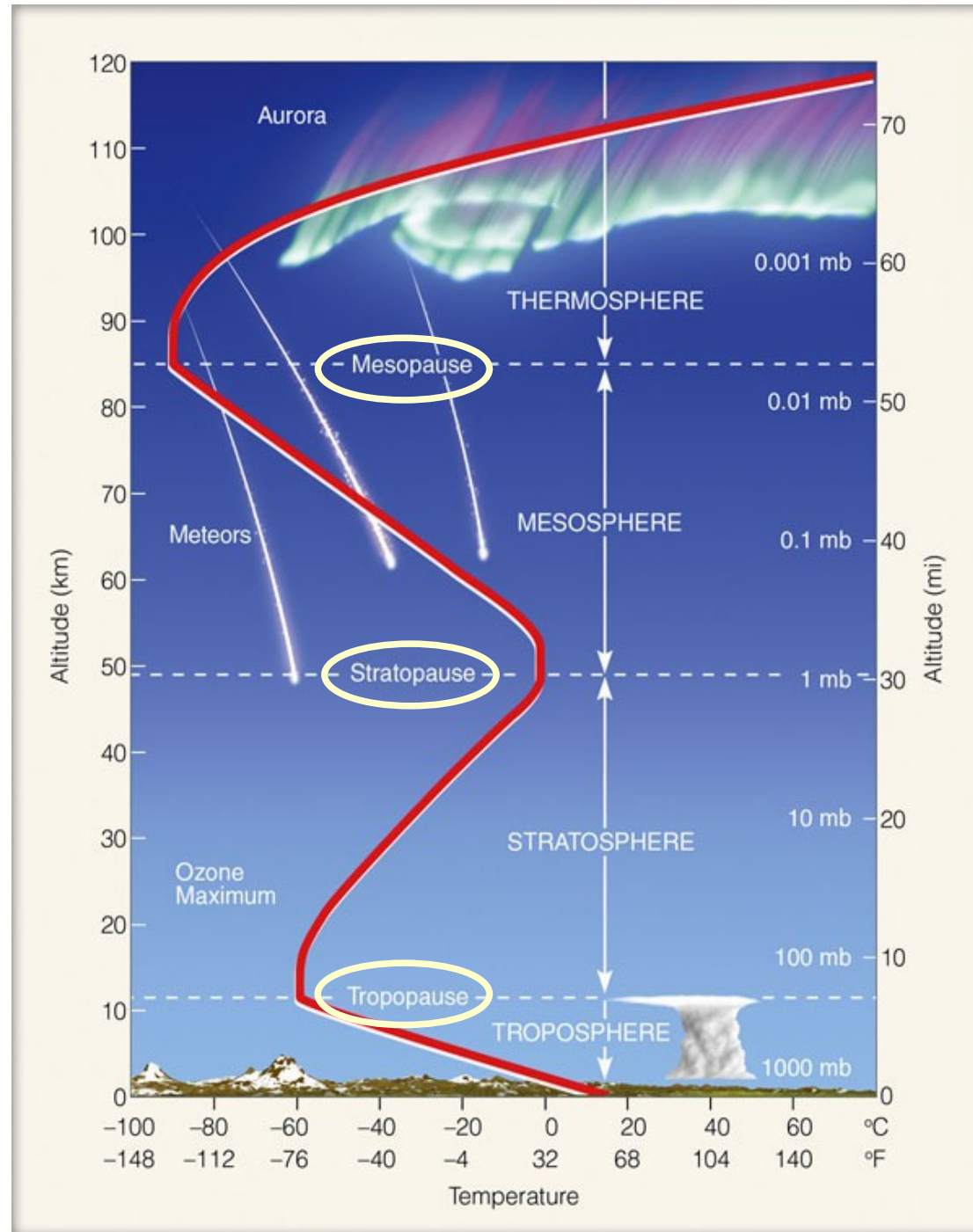


photo courtesy Andrew Gettelman, NCAR

Temperature Structure

- The atmosphere is layered according to its temperature structure
- In some layers temperature increases with height
- In others it decreases with height or is roughly constant

... "pause" is a level
... "sphere" is a layer



Discovery of the Stratosphere: 1902

PHYSIQUE DU GLOBE. — Variations de la température de l'air libre dans la zone comprise entre 8^{km} et 13^{km} d'altitude. Note de M. L. TEISSERENC DE BORT, présentée par M. E. Mascart.

Variations of the temperature of the free air in the zone between 8 and 13 km of altitude

Über die Existenz eines wärmeren Luftstromes in der Höhe von 10 bis 15^{km}.

Von Prof. Dr. RICHARD ASSMANN
in Berlin.

On the existence of a warmer airflow at heights from 10 to 15 km



Fig. 5. Léon Teisserenc de Bort (Photo by courtesy of Michel Rochas, Météo-France, Trappes).

Isothermal Layer

Upper Inversion

Teisserenc de Bort

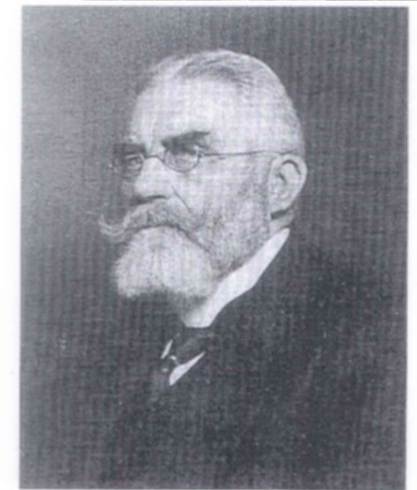


Fig. 6. Richard Assmann in 1915 (taken from PEPPLER 1940).

Richard Assmann

- 200 years ago steady temperature drop with height was known from observations at mountain tops
- this would result in 0 K (absolute zero) somewhere between 30–40 km (~20 mi) altitude
- It was assumed that rate of temperature drop diminishes, but temperature still decreases with height throughout the atmosphere

“It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.”

-- Richard Feynman

Discovering the 3rd Dimension (around 1900)

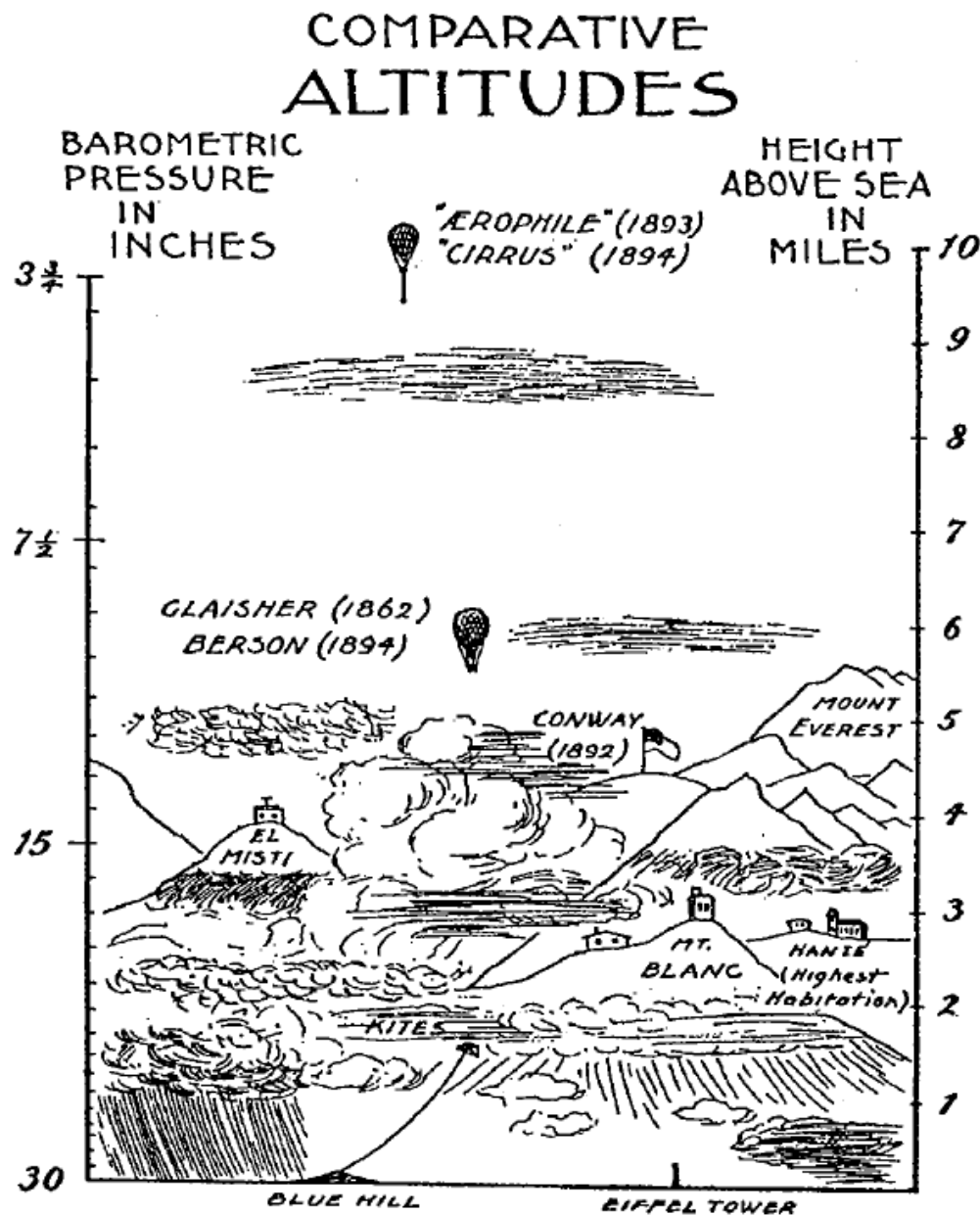


Fig. 3. Upper-air research at the end of the 19th century (taken from ROTCH 1896).

from Hoinka (1997)

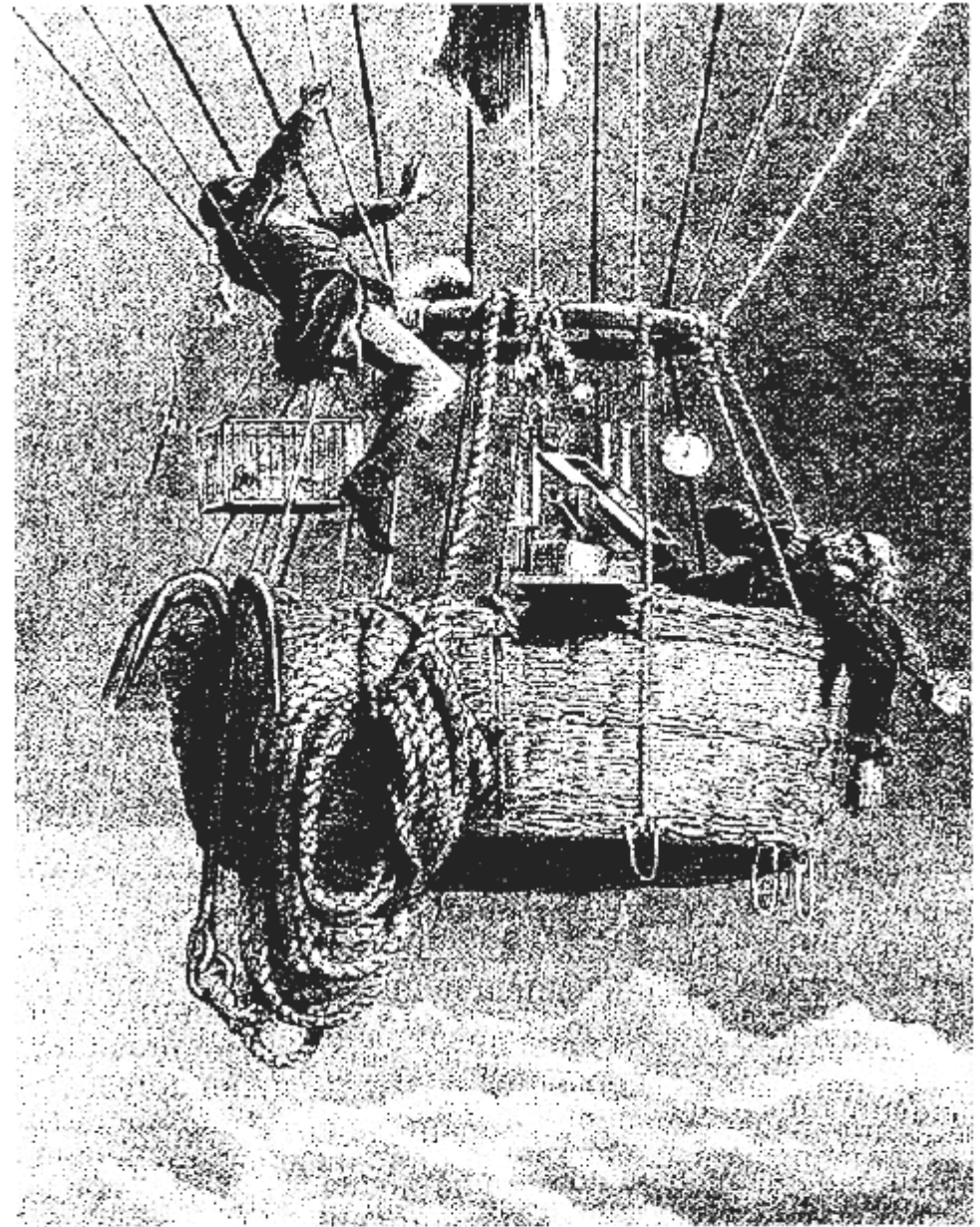


Fig. 1. Contemporary sketch of the dramatic situation when Coxwell and Glaisher became unconscious during their flight in an aerostat in 1862 (taken from FLAMMARION 1885).

- First balloon soundings during 1890's
- Reached stratospheric altitudes, but warm temperatures above ~12 km were adjusted (“corrected”) to match expected temperature drop
- Teisserenc de Bort took over 200 soundings within ~10 years, carefully examining possible measurement errors
- Only then did he announce the discovery of the stratosphere to the French Academy of Science (on 28 April 1902, Assmann announced essentially the same discovery to the German Academy of Science on 1 May 1902)

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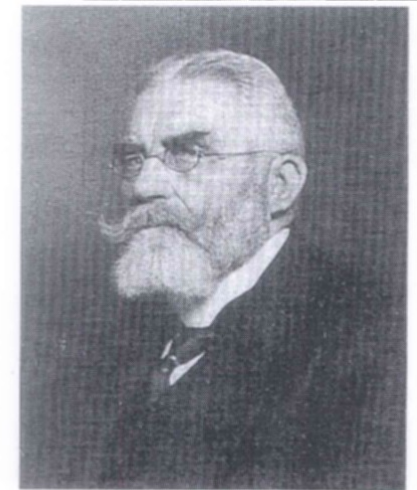
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Teisserenc de Bort

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- Terms troposphere and stratosphere were coined by Tesserenc de Bort
- Term tropopause was popularized by Sir Napier Shaw around 1920

- Radiation error (absorption of solar radiation, also related to lack of ventilation)
 - soundings during day vs. during night
 - aspiration psychrometer due to Assmann (ventilated thermometers enclosed in polished metal tubes)
- Balloon material:
 - paper, treated silk, goldbeater's skin
 - rubber introduced by Assmann (in collaboration with Continental)
- Balloons were filled with hydrogen

M.O. 074.

O. H. M. S.

INTERNATIONAL INVESTIGATION OF THE UPPER AIR.

5 SHILLINGS REWARD.

DELICATE METEOROLOGICAL APPARATUS.

This instrument is the property of the Meteorological Office, London. The above reward will be paid for the instrument if it is not tampered with. The finder is requested to pull out the piece of red string (with the match end attached), to put the instrument away in a safe place and to write to the Director, Meteorological Office, London, S.W., when instructions, and if desired, information, will be sent.

The balloon need not be returned.