A spaceborne lidar for global observation of metallic atoms in the mesopause region

C. Nagasawa

(Tokyo Metropolitan University)

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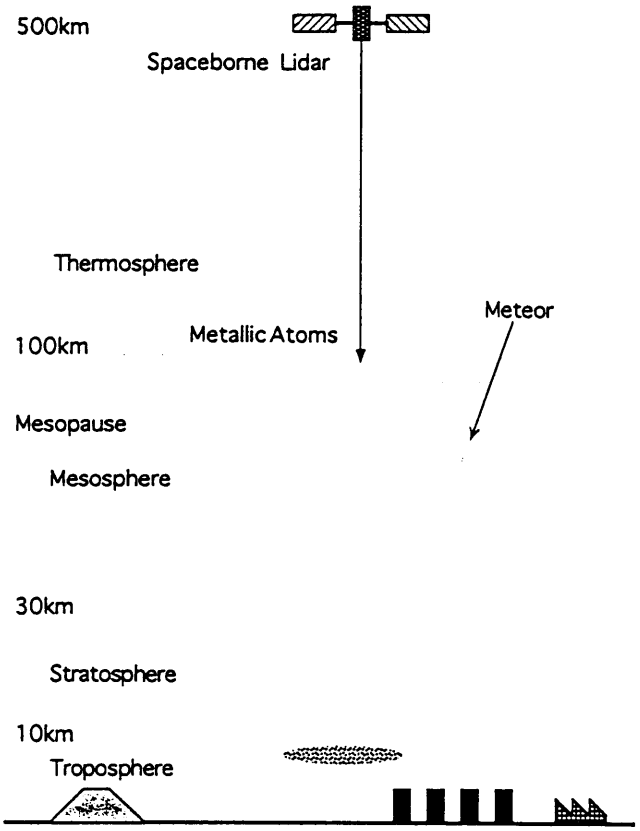
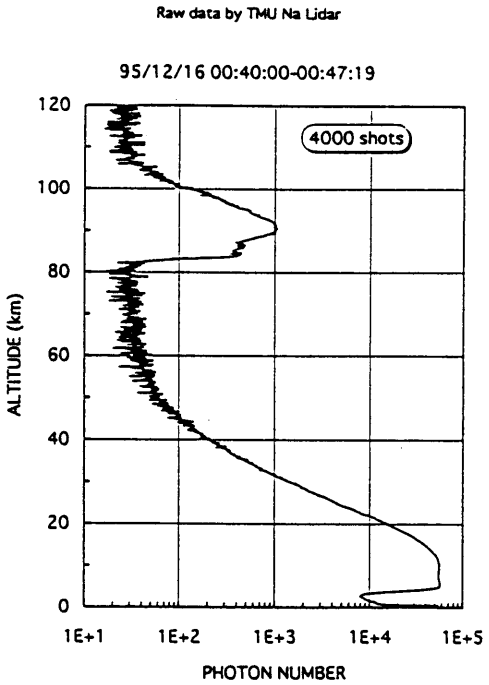
Chikao Nagasawa, Makoto Abo (Tokyo Metropolitan University),
Akio Nomura (Shinsyu University),
and Hiroshi Fukunishi (Tohoku University)

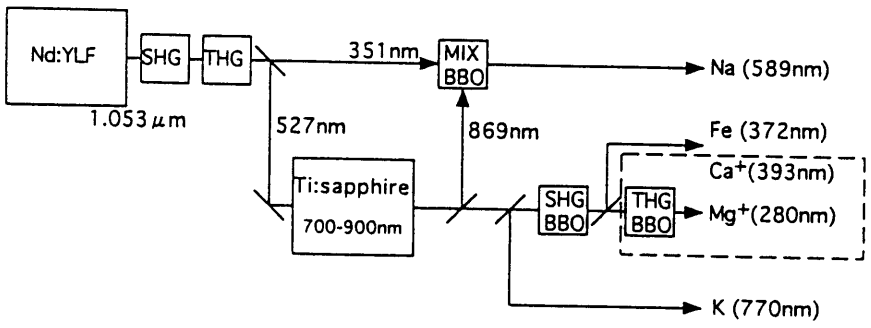
As a transition region between the thermosphere or the ionosphere and the mesosphere, the mesopause region is of very importance for the understanding of solar-terrestrial physics. This region is also the least understood region of the atmosphere. Observations of this region must be made by direct or in situ rocket measurements or through satellite and ground-based remote sensing techniques. One remote sensing technique used to observe this region is the lidar technique. One of the most successful areas of ground-based atmospheric lidar research has been the observations of the metallic atoms such as sodium, potassium, iron and so on. The observation of the metallic layers is not only important to study the structure of them but useful as the tracers of the internal atmospheric gravity wave and the tidal wave in the mesospheric region. Therefore, it is believed that their global observations from space are very important to make progress the investigation of the mesopause region.

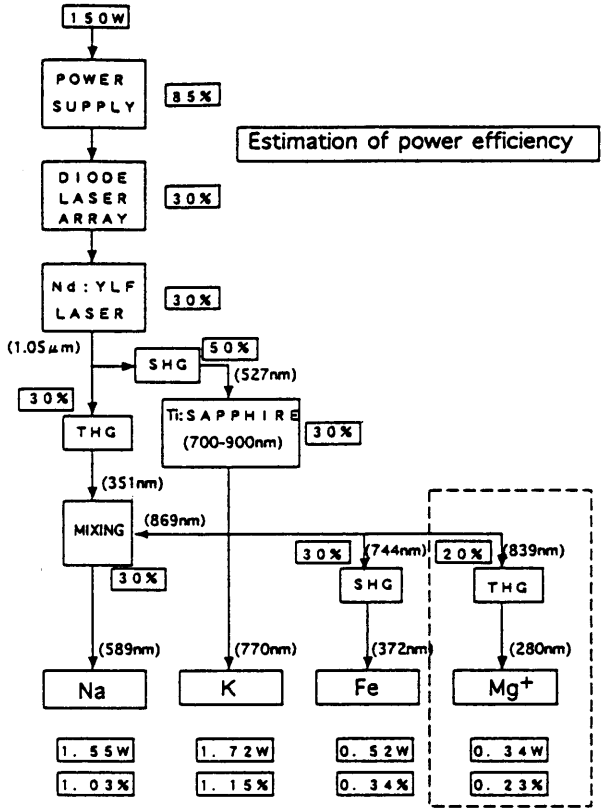
We have proposed a space lidar plan to observe the metallic layers in the mesopause region for ISAS (Institute of Space and Astronautical Science). Objects of our global observations are sodium, potassium and iron layers in the mesopause region. The transmitter of our spaceborne lidar consists of a Ti:sapphire laser pumped by an all solid Nd:YLF laser. The fundamental wavelength(770nm) of the Ti:sapphire laser is used for observations of the potassium layers, the second harmonic wavelength(372nm) of the Ti:sapphire laser is used for observations of the iron layers and the wavelength(589nm) mixed between the third harmonic wavelength (351nm) of the Nd:YLF laser and the Ti:sapphire laser(869nm) is used for observations of the sodium layers.

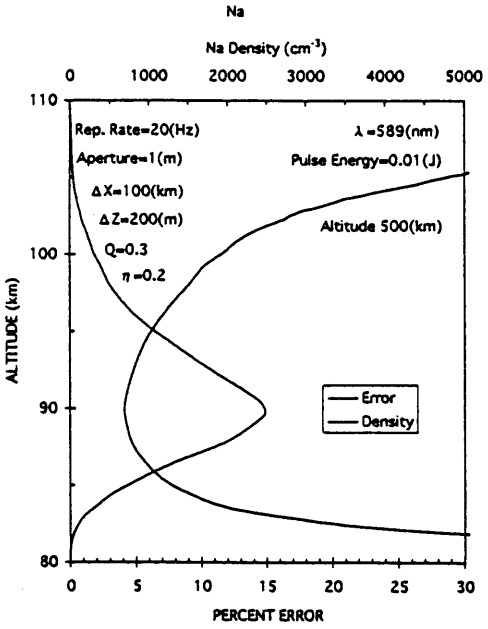


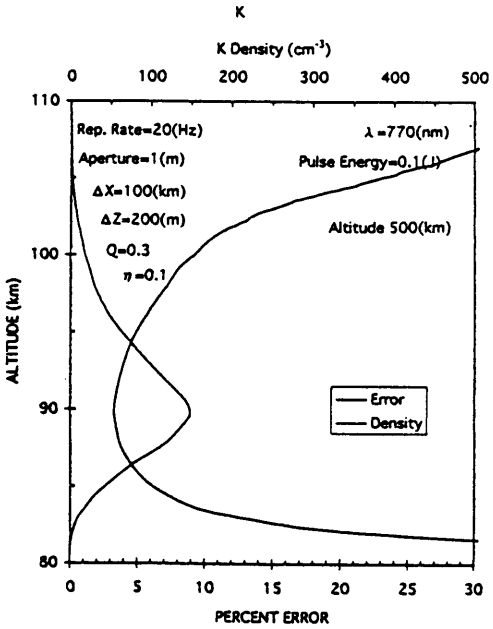


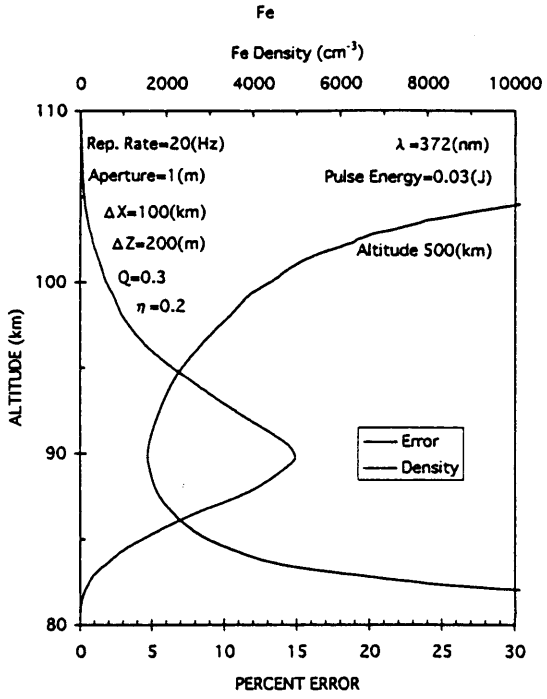
Block diagram of the laser system in the spaceborne lidar




150W
POWER SUPPLY
85%
Estimation of power efficiency
DIODE LASER ARRAY
30%
Nd:YLF LASER
30%
(1.05μm)
SHG
50%
(527nm)
30%
THG
Ti:SAPPHIRE (700-900nm)
30%
(351nm)
MIXING
(869nm)
30%
(744nm)
20%
(839nm)
30%
SHG
THG
(589nm)
(770nm)
(372nm)
(280nm)
Na
K
Fe
Mg+
1.55W
1.03%
1.72W
1.15%
0.52W
0.34%
0.34W
0.23%


Na
Na Density (cm-3)
0
1000
2000
3000
4000
5000
110
100
90
80
ALTITUDE (km)
Rep. Rate=20(Hz)
Aperture=1(m)
ΔX=100(km)
ΔZ=200(m)
Q=0.3
η=0.2
λ=589(nm)
Pulse Energy=0.01(J)
Altitude 500(km)
Error
Density
0
5
10
15
20
25
30
PERCENT ERROR


K
K Density (cm-3)
0
100
200
300
400
500
110
100
90
80
ALTITUDE (km)
Rep. Rate=20(Hz)
Aperture=1(m)
ΔX=100(km)
ΔZ=200(m)
Q=0.3
η=0.1
λ=770(nm)
Pulse Energy=0.1(J)
Altitude 500(km)
Error
Density
0
5
10
15
20
25
30
PERCENT ERROR



Schedule for a spaceborne metallic lidar

1997	Fundamental development
1998-1999	Construction of pilot model
2000-2001	Construction of flight model
2002	Integration and test
2003	Launch (ISAS*) * Institute of Space and Astronautical Science