Excitation of Internal Gravity Wave (IGW)

Stable Layer (buoyancy) in the atmosphere, B-V frequency $N > 0$

Earth $N \approx$ 3 mHz
Jupiter (troposphere) $N \approx$ 5 to 15 mHz

Supports Internal Gravity Waves (IGW)

larger $N \rightarrow$ faster wave speed, U

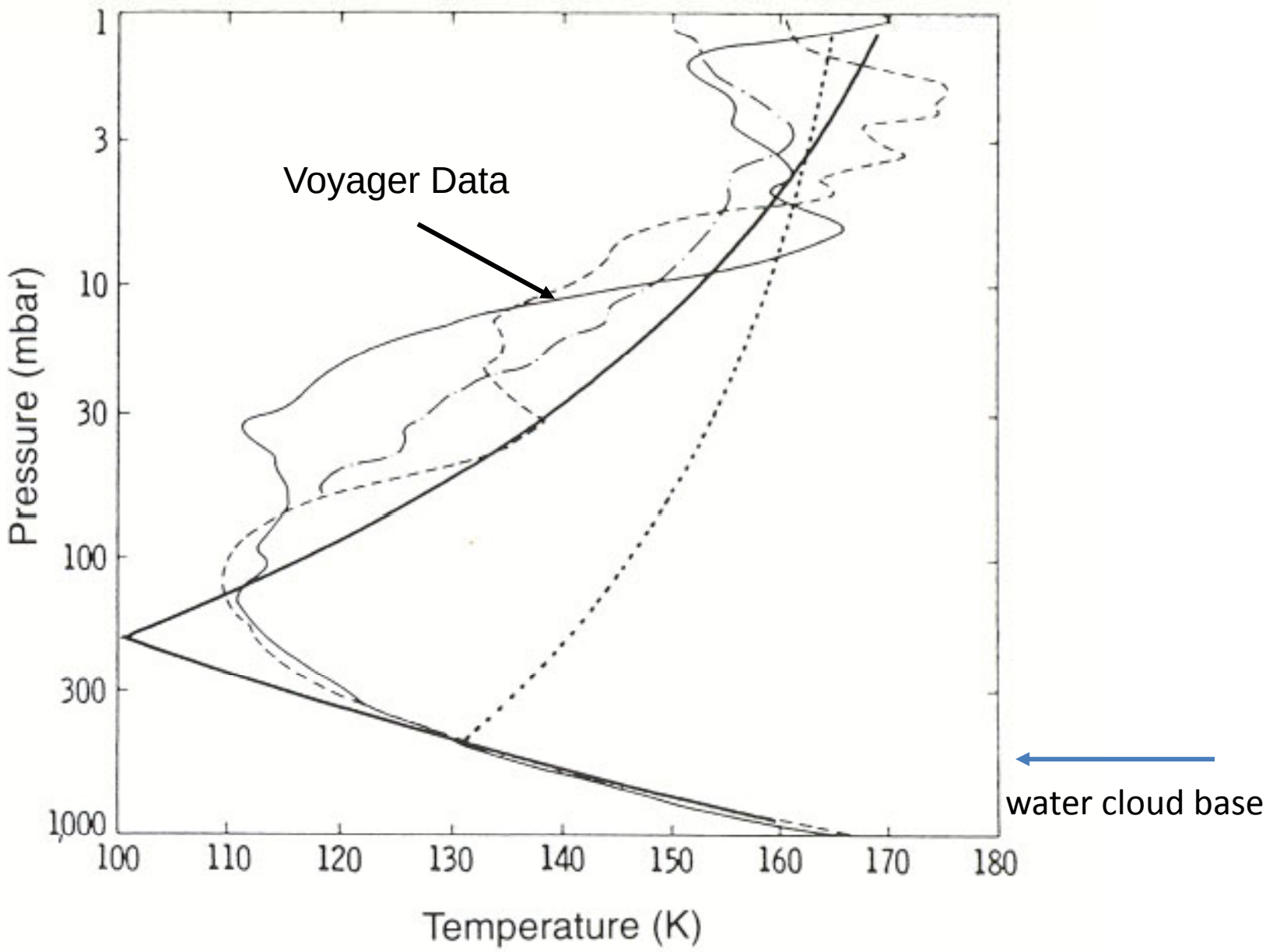
Model axisymmetric (r, z), long wave

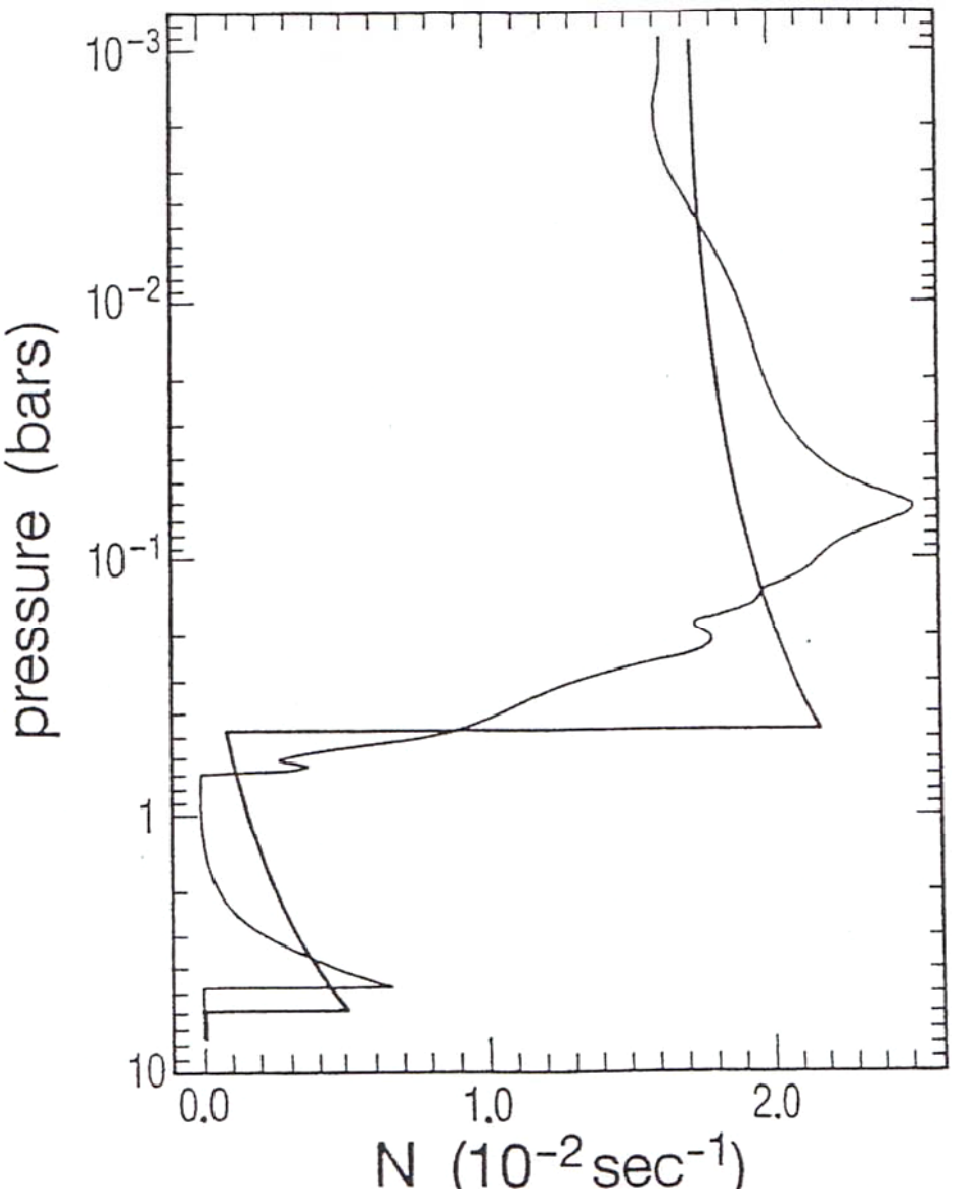
Excitation line source $E=10^{20}$ J

Vary N (deviation of temperature profile from dry adiabat)

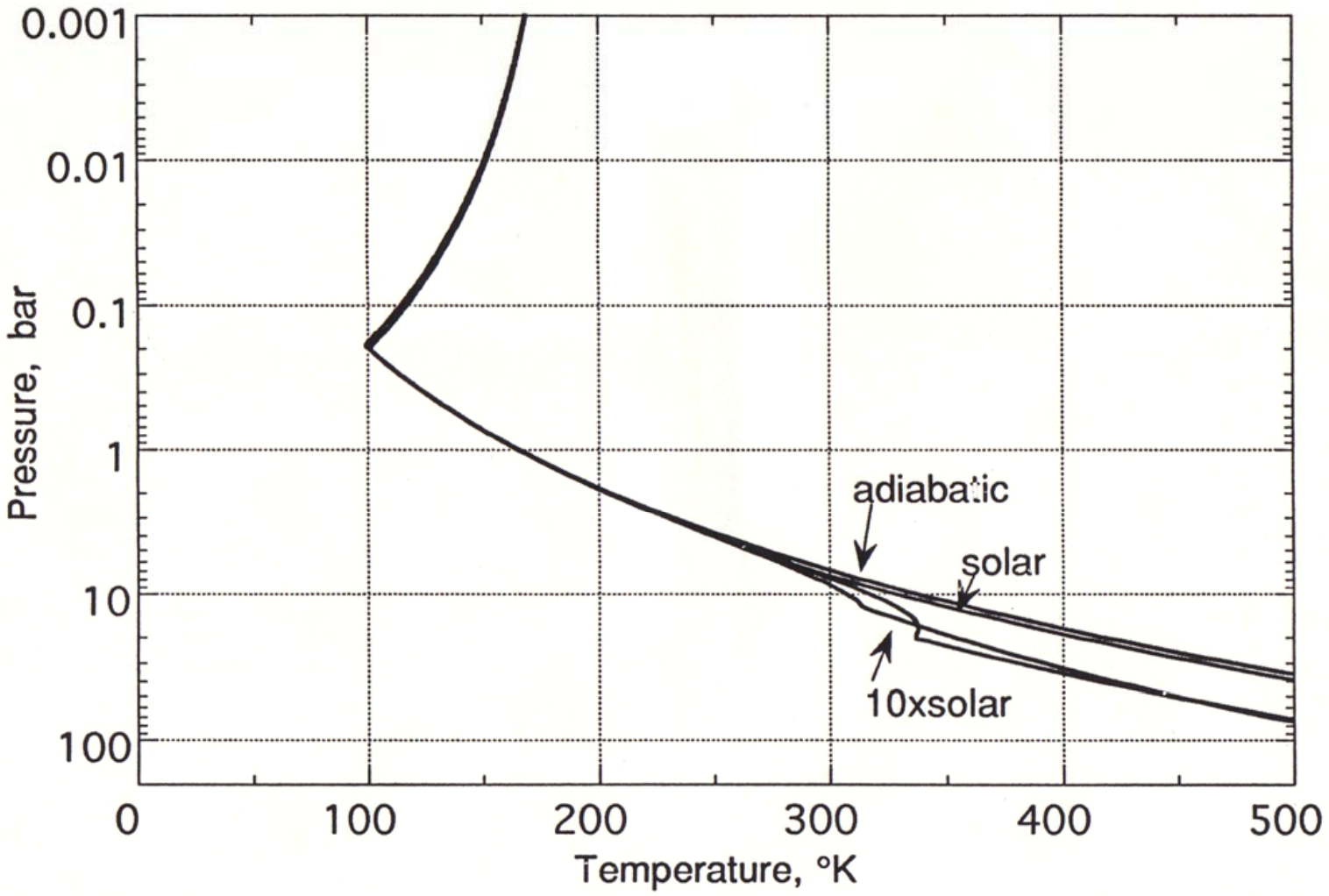
$\rightarrow$ U? , Amplitude of ΔT?

Temperature Profile in Jupiter's Atmosphere

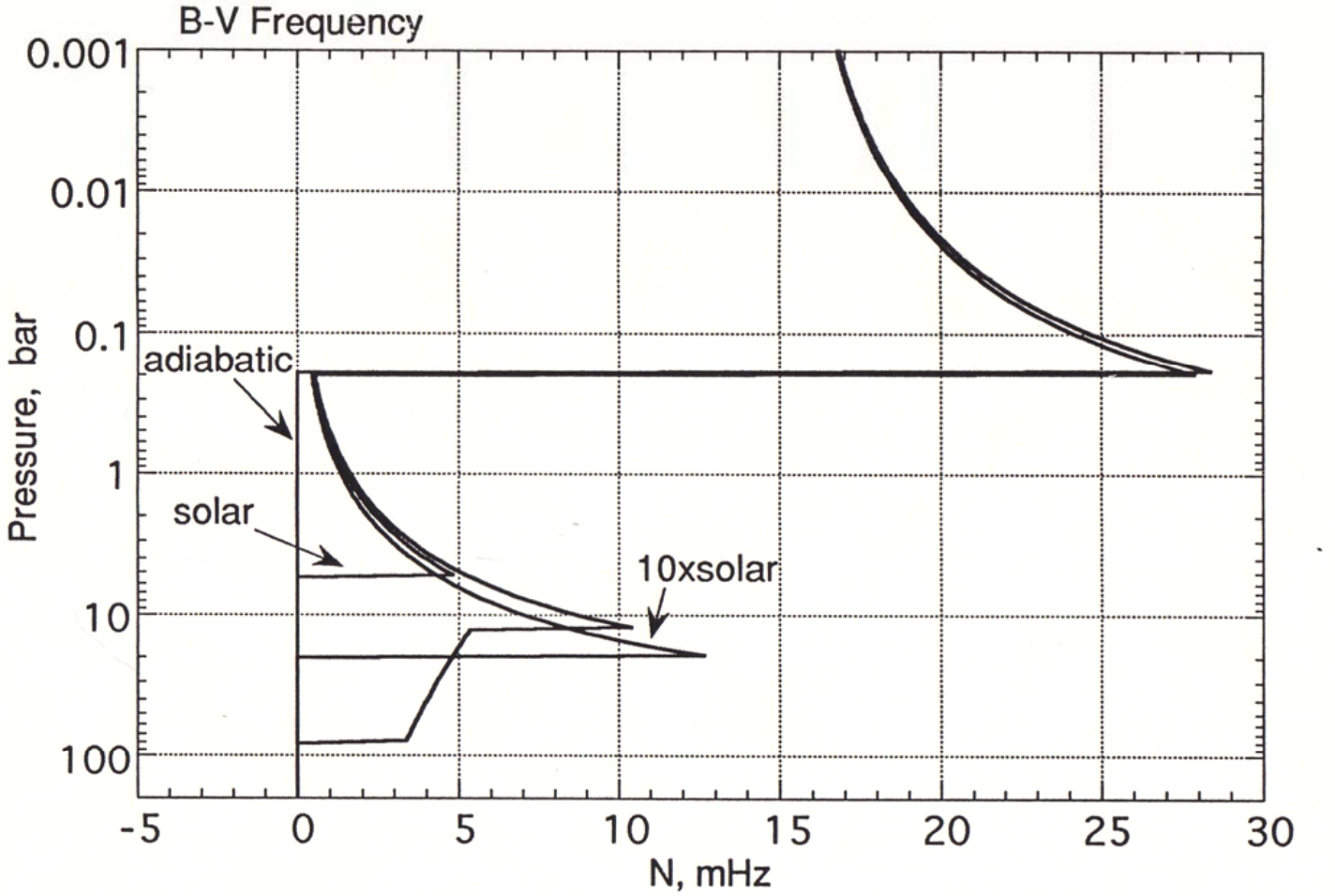




Water cloud base, vary O/H



Ingersoll and Kanamori (1995)



Ingersoll and Kanamori (1995)

Independent variables (isobaric coordinate) $p,\ r,\ t$

Dependent variable geo-potential $\Phi(p, r, t)=gz=\phi(p)\Gamma(r,t)$

temperature $T' = -\dfrac{p}{R}\dfrac{\partial \Phi}{\partial p}$

Hydrostatic condition assumed. T → σ

Source $\dot{Q}(p,r,t) = \eta(p)\delta(r)\delta(t)$ $\eta(p)$: vertical heating profile

$$\frac{\partial}{\partial t}\left[\left(\frac{\partial^2\Gamma}{\partial t^2}+f^2\Gamma\right)\frac{\mathrm{d}}{\mathrm{d}p}\left(\frac{1}{\sigma}\frac{\mathrm{d}\phi}{\mathrm{d}p}\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\Gamma}{\partial r}\right)\phi\right]$$

$$=-\left(\frac{\partial^2\delta(t)}{\partial t^2}+f^2\delta(t)\right)\frac{\mathrm{d}}{\mathrm{d}p}\left(\frac{\kappa\eta(p)}{\sigma p}\right)\delta(r)\ .$$

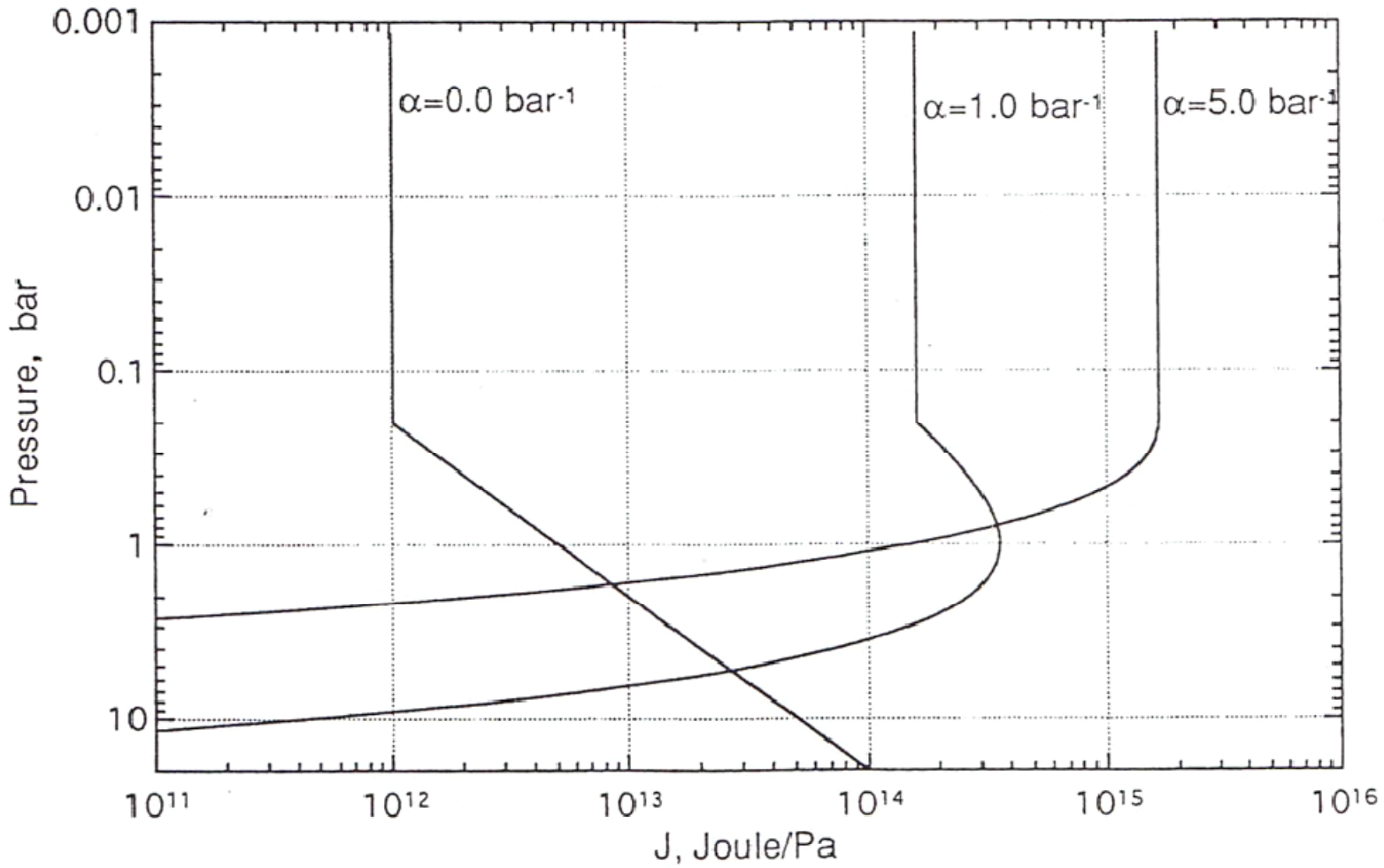
This structure suggests vertical normal modes

$$\frac{\mathrm{d}}{\mathrm{d}p}\left(\frac{1}{\sigma}\frac{\mathrm{d}\phi}{\mathrm{d}p}\right)=-\frac{1}{c^2}\phi(p)$$ with c_i and $\phi_i(p)$ eigen values and eigen functions (discretized)

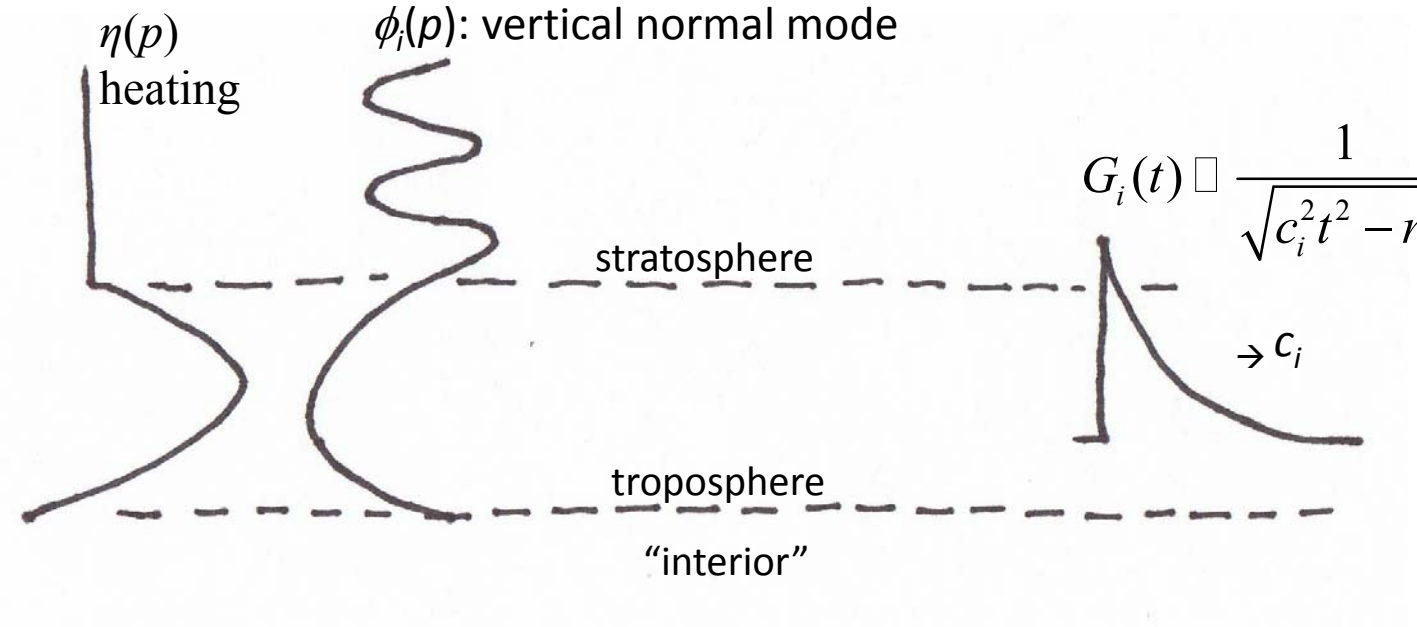
$$\Phi(p,r,t)=\sum_{i=0}^{\infty}\frac{a_i c_i}{2\pi}\phi_i(p)\frac{\partial}{\partial t}\left[\frac{1}{\sqrt{c_i^2t^2-r^2}}\right]$$

(f=0 assumed above, but the method can be extended numerically to the case $f\neq 0$.)

Heating source, Total energy, 10^{20} J



Schematic figure showing IGW (Poincare) wave excited by an impulsive source

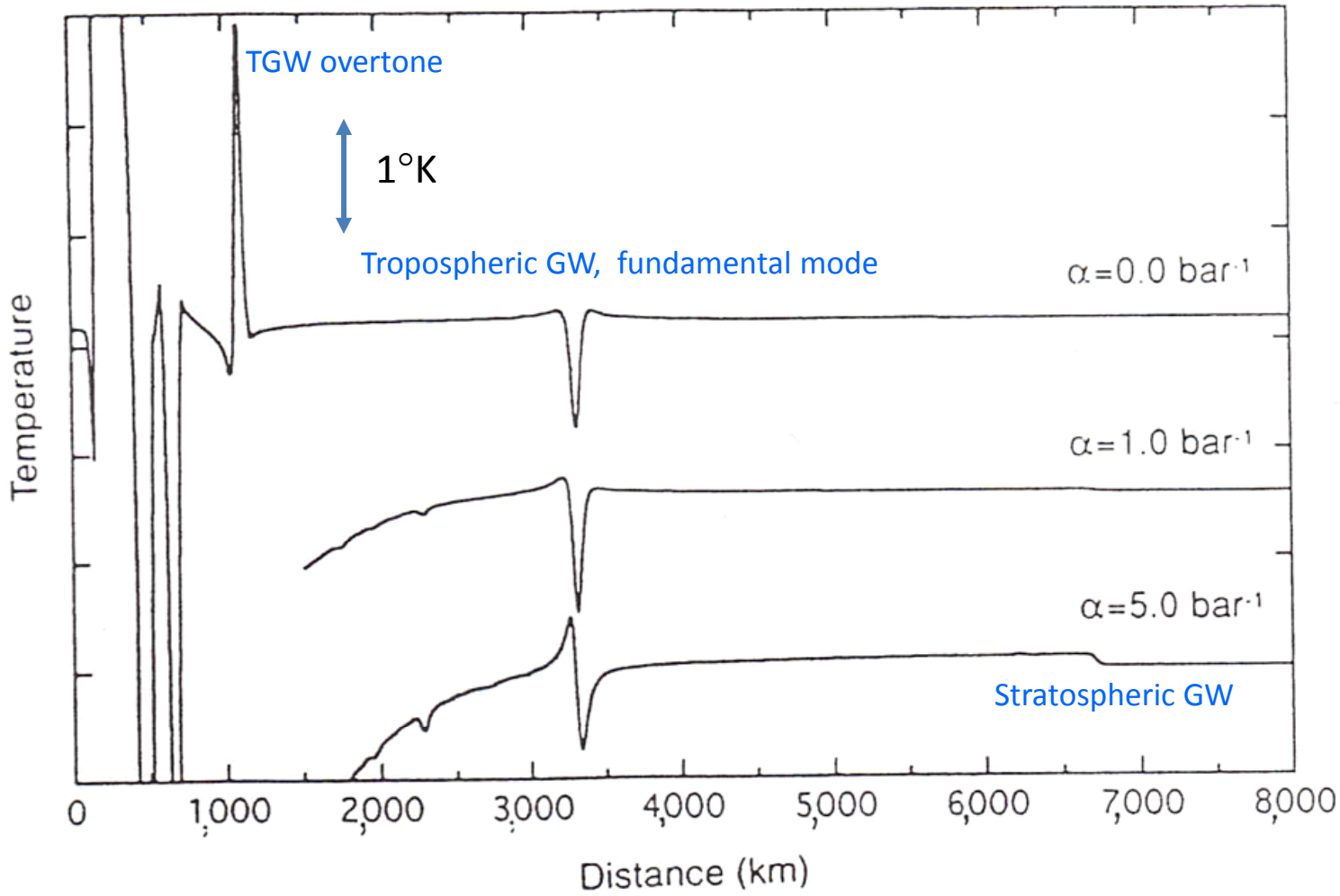


$$\Phi(p,r,t) \sim \sum_i \phi_i(p) E(c_i) \frac{\partial G_i}{\partial t}$$

c_i : horizontal wave speed

$E(c_i)$: Excitation given by $\eta(p)$

Lagrangian temperature perturbation profile at 2 hours for 3 heating profiles (at 45 mb level)



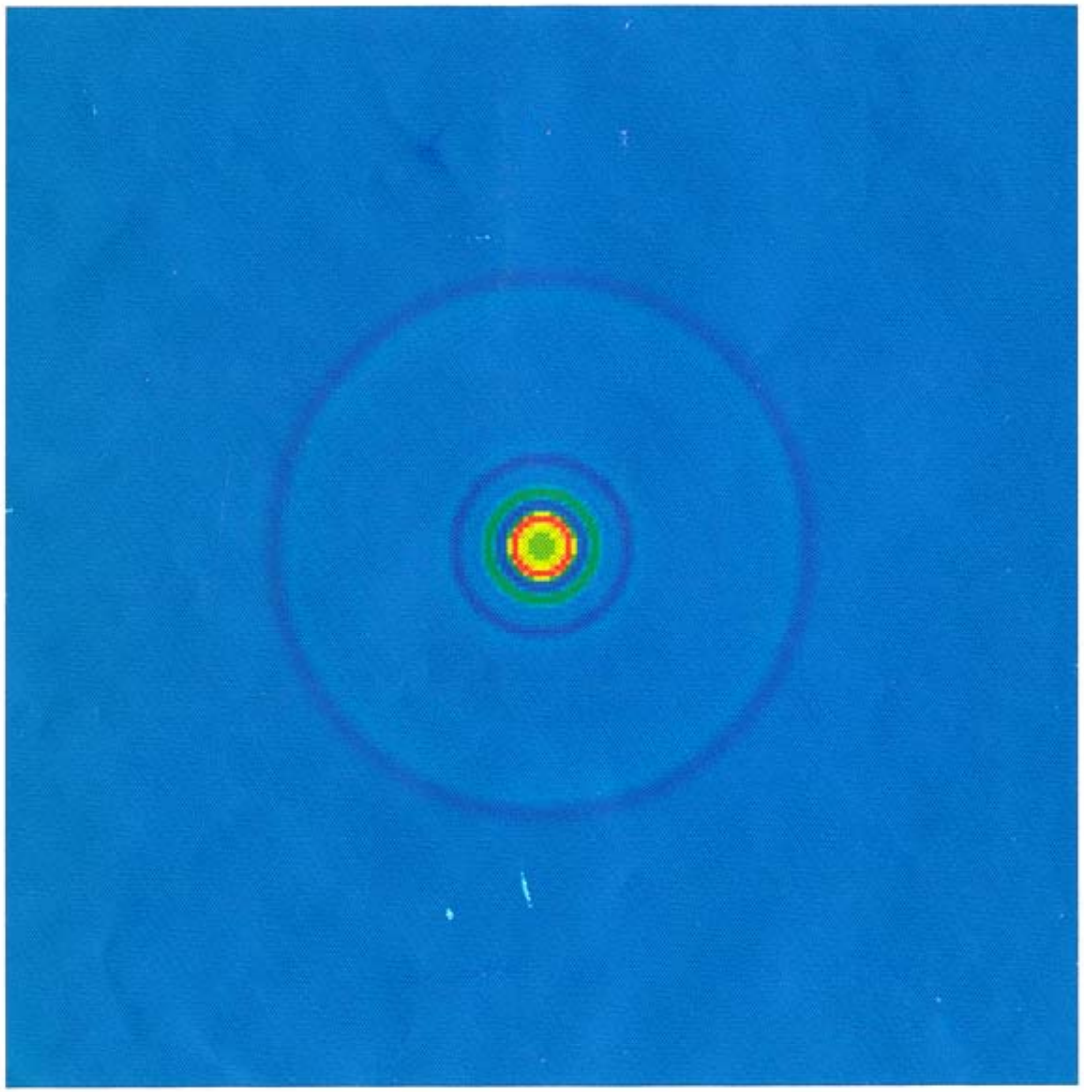
Non-dispersive wave, slower overtone than the fundamental mode

Ingersoll and Kanamori (1995)

Snap Shot of Internal Gravity Waves in Jovian Atmosphere

Outer ring :
fundamental mode

Inner rings :
overtones



at t=5400 sec

10000 km

nature

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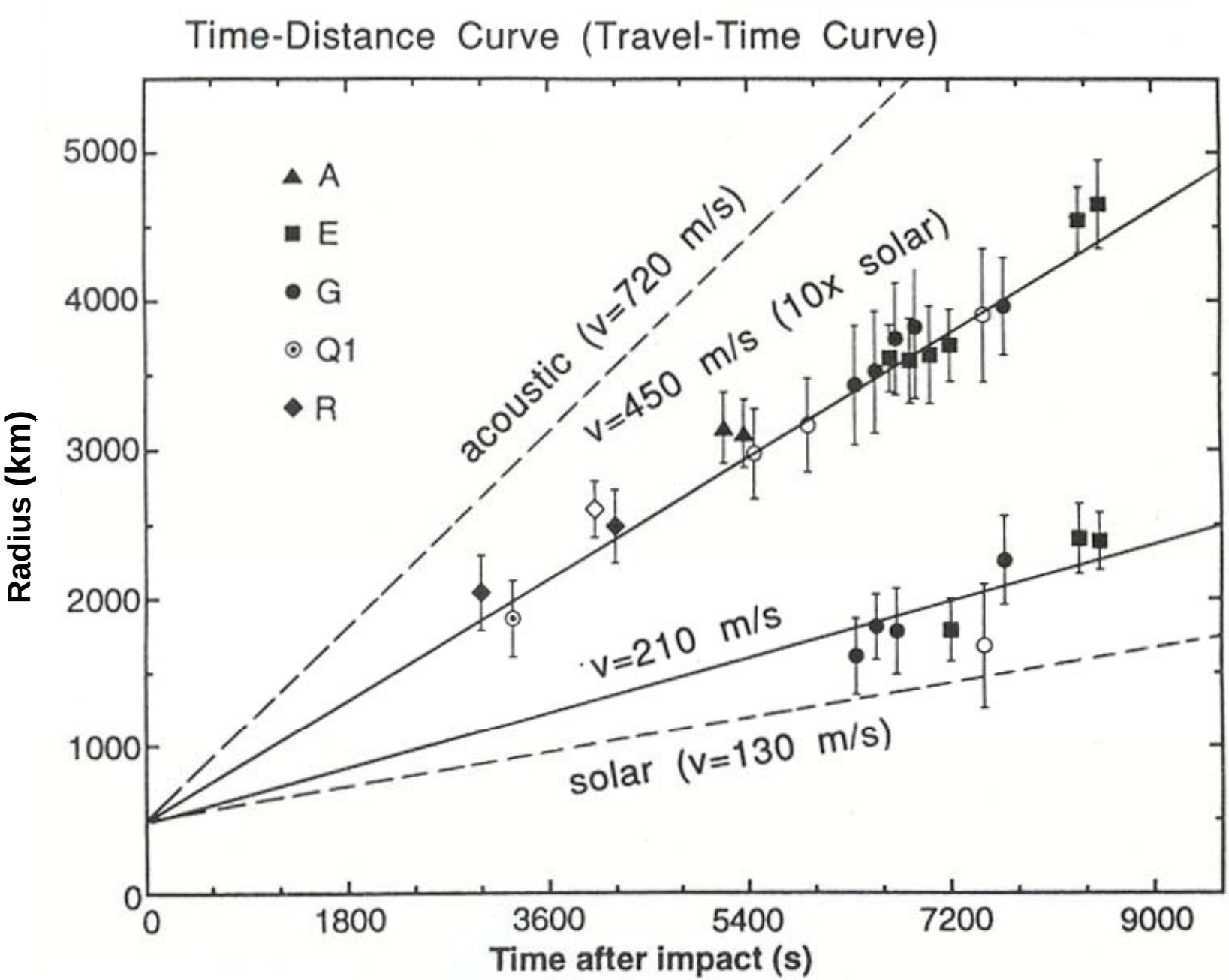
Crest of a jovian wave

Quick shifts of the geomagnetic field

Nitrate trapping by a bacterial mat

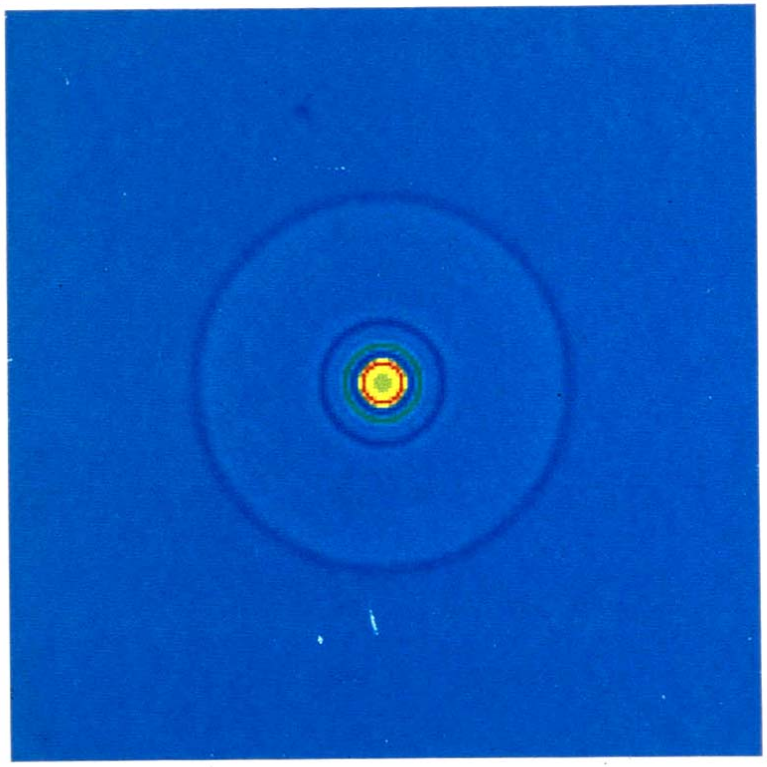
Molecular defect in *reeler* mice

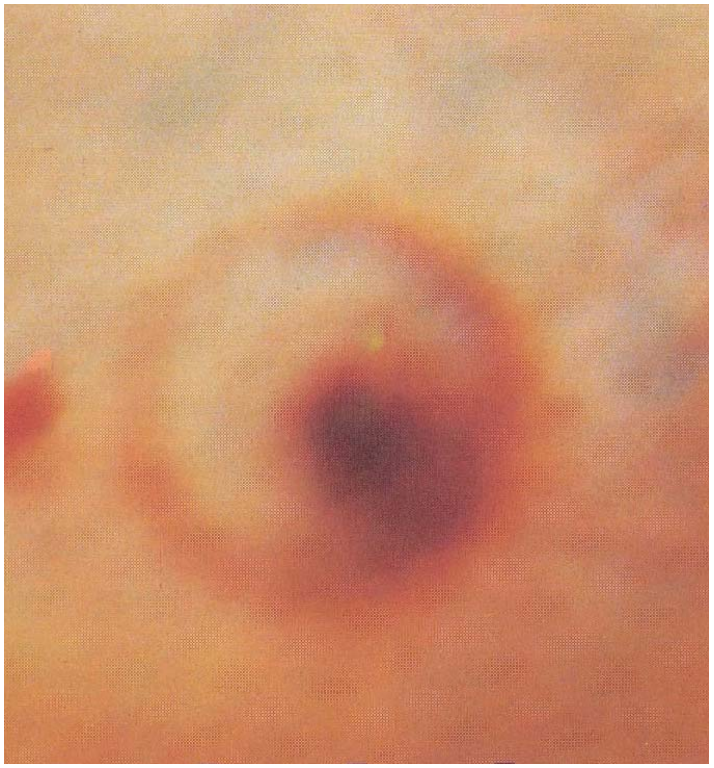
Immunology/ monoclonals
PRODUCT REVIEW



Hammel et al., 1995

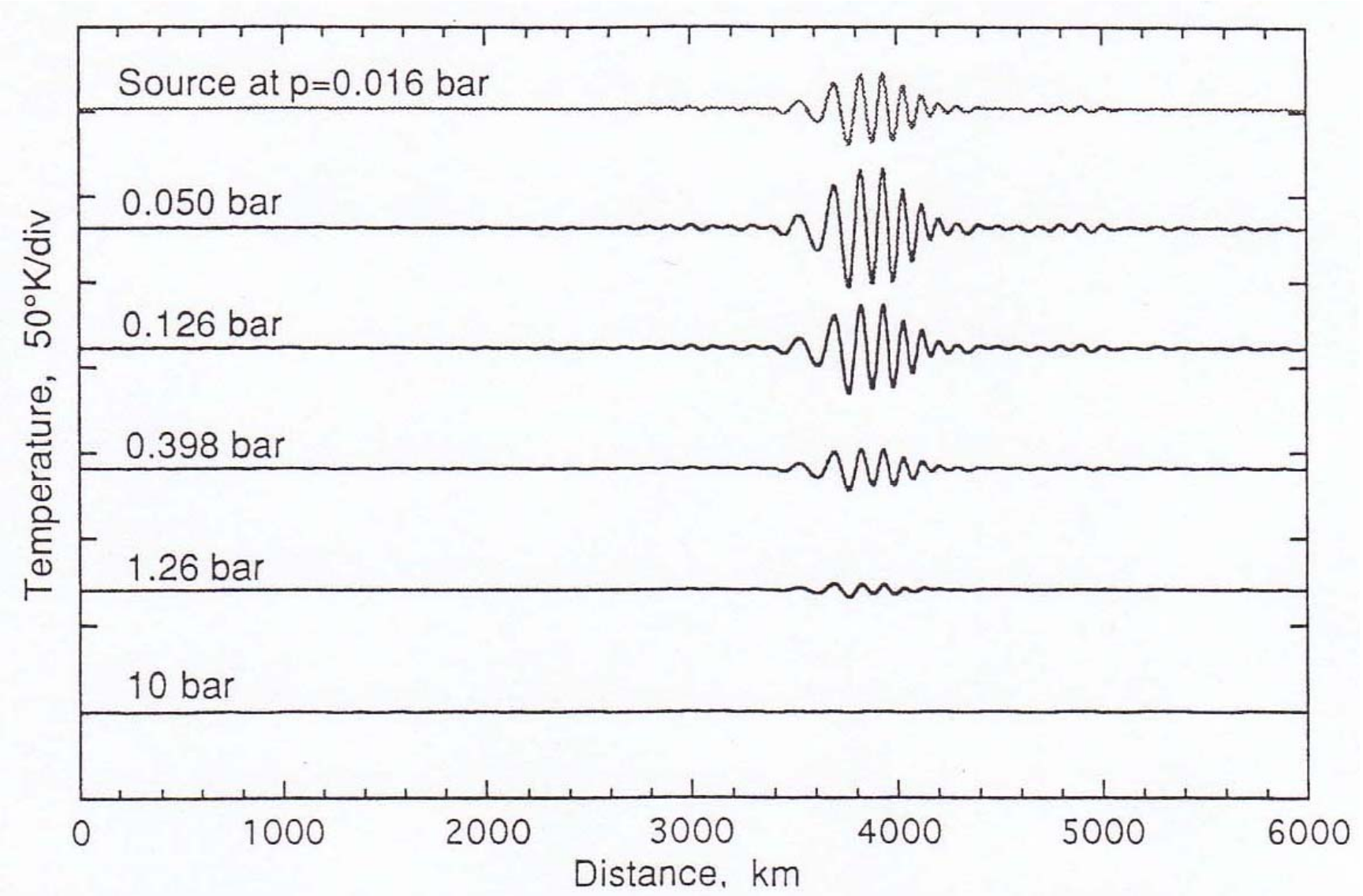
Internal Gravity Waves in Jovian Atmosphere





10000 km

Acoustic wave (at 1.5 hours, at 126 mb) V=750 m/s



End