1992 CEDAR Workshop

Boulder, CO

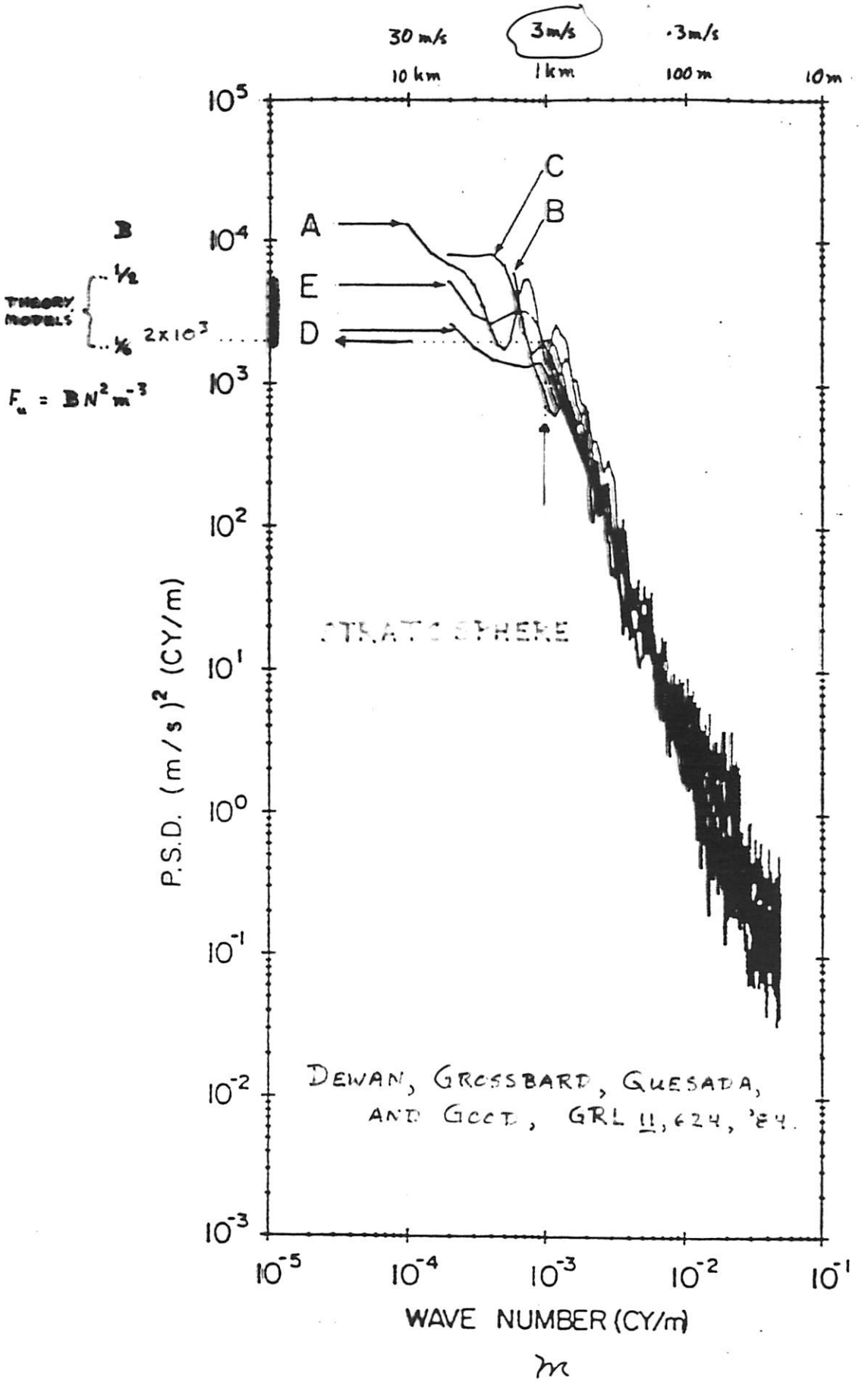
June 21-26, 1992

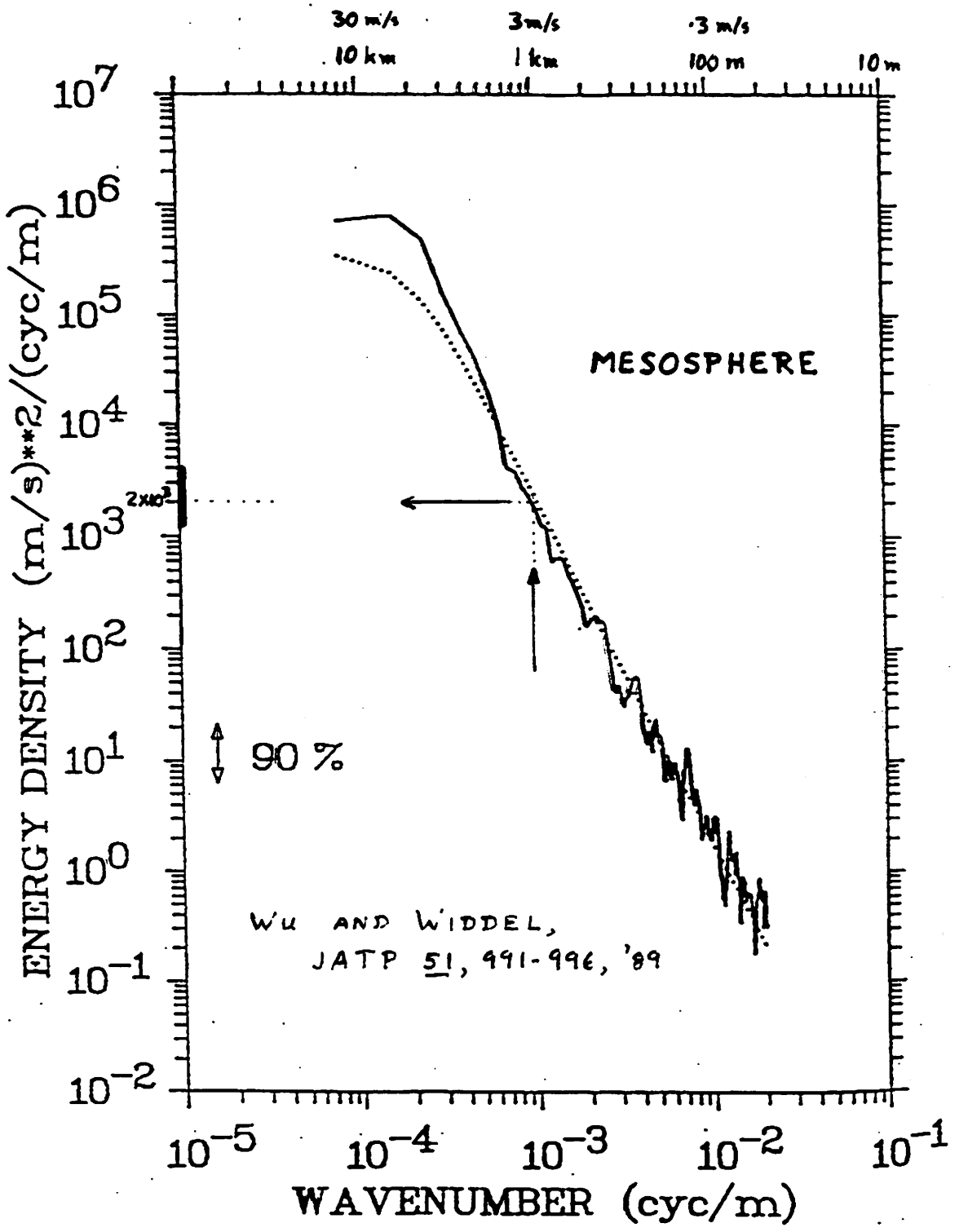
CEDAR Prize Lecture

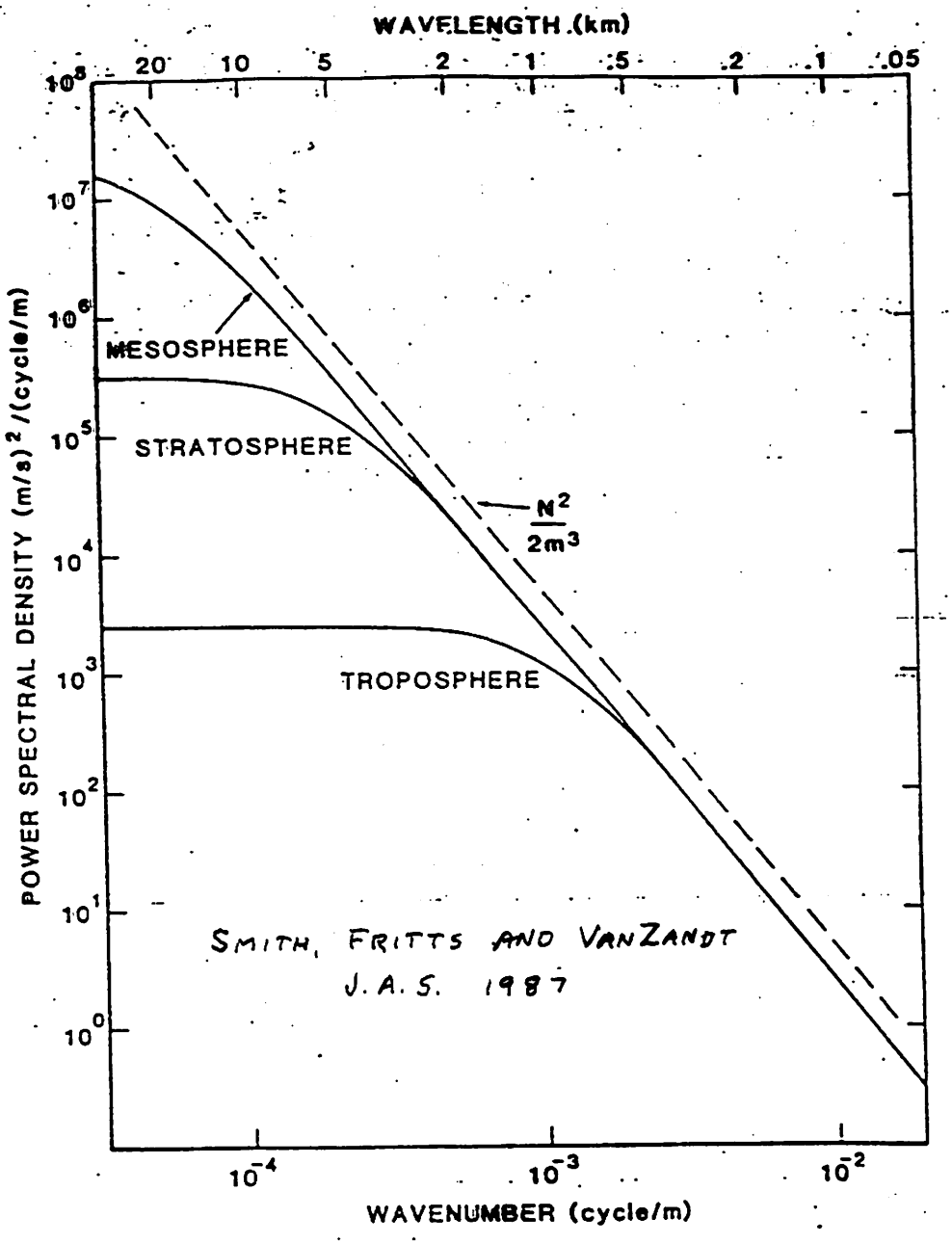
by Colin Hines

Arecibo Observatory

The Doppler Spreading Theory of Gravity Wave Spectra


30 m/s
3m/s
·3m/s
10 km
1km
100 m
10m
A
B
C
D
E
B
THEORY MODELS
1/2
1/6
2x10³
F_u = BN²m⁻³
STRATOSPHERE
P.S.D. (m/s)² (CY/m)
WAVE NUMBER (CY/m)
DEWAN, GROSSBARD, QUESADA, AND GOOD, GRL 11, 624, '84.


30 m/s
10 km
3 m/s
1 km
.3 m/s
100 m
10 m
MESOSPHERE
90 %
WU AND WIDDEL,
JATP 51, 991-996, '89
ENERGY DENSITY (m/s)**2/(cyc/m)
WAVENUMBER (cyc/m)


WAVELENGTH (km)
20
10
5
2
1
.5
.2
.1
.05
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
POWER SPECTRAL DENSITY $(m/s)^2/(cycle/m)$
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
$\frac{N^2}{2m^3}$
SMITH, FRITTS AND VANZANDT
J.A.S. 1987
10^{-4}
10^{-3}
10^{-2}
WAVENUMBER (cycle/m)

Theorists in search of Truth

ARTIST : D.C. FRITTS

GRAND

UNIFIED

THEORY OF

SATURATION

$$D/Dt \equiv \partial/\partial t + \boxed{v \cdot \nabla}$$

$$\boxed{+}$$

$$\boxed{\text{DISSIPATION @ LARGE } m}$$

(via instability or molecular diff^{n})

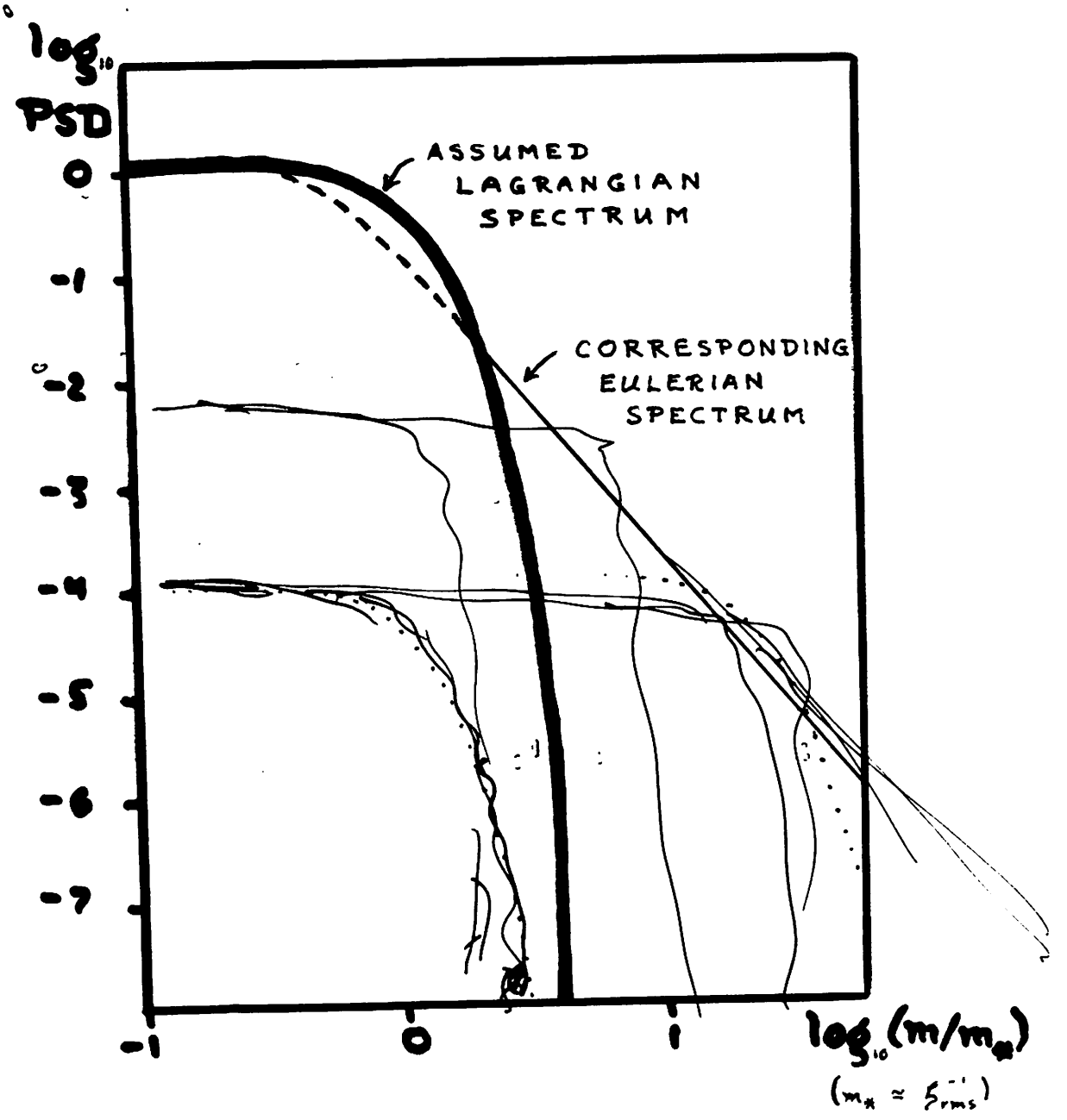
EULERIAN : $D/Dt \equiv \partial/\partial t + \underline{v}.\nabla$

LAGRANGIAN : d/dt

PRESCRIPTION FOR CONVERSION:

K.R. ALLEN AND R.I. JOSEPH
A CANONICAL STATISTICAL THEORY OF
OCEANIC INTERNAL WAVES
J. FLUID MECH., 204, 185-228, 1989.

$$\frac{N}{m} \doteq \frac{\omega}{k}$$



See Allen and Joseph, J. Fluid Mech. 204, 185, 1989

$$(\partial/\partial t + \mathbf{v}\cdot\nabla)\, e^{i(\omega t - kx - mz)}$$

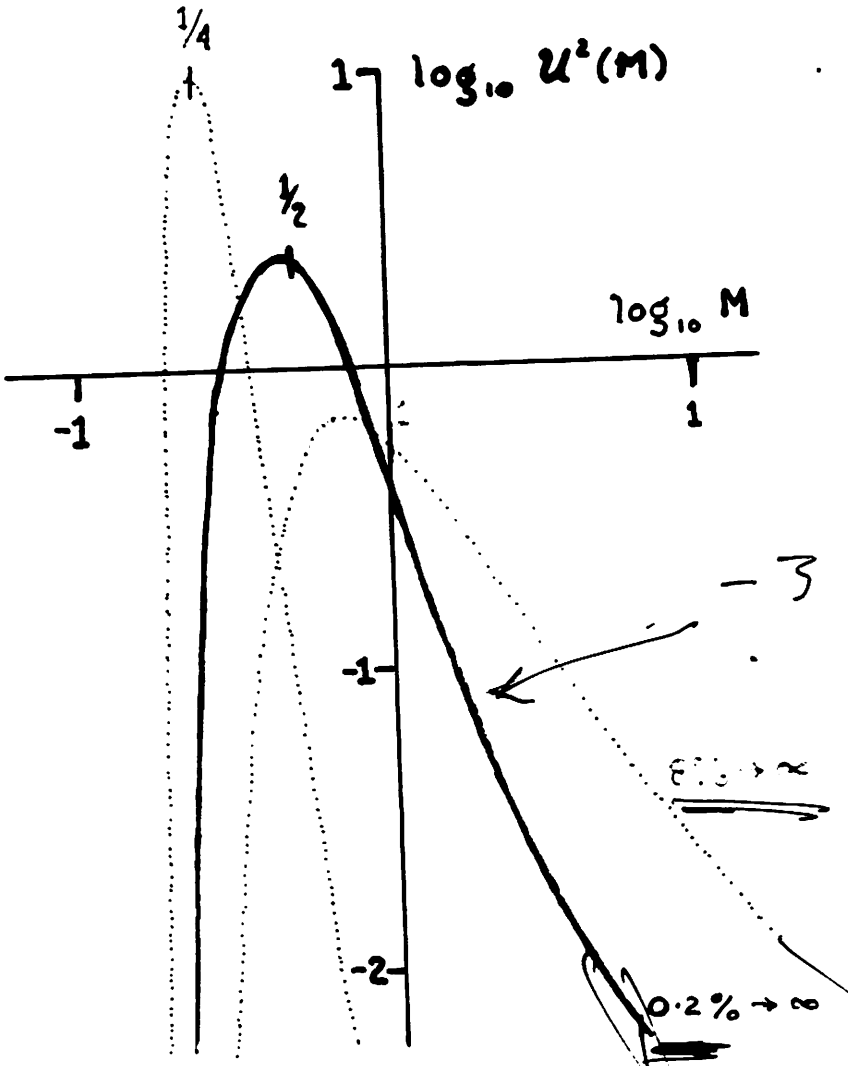
$$= i(\omega - uk - \cancel{vm})\, e^{i(\omega t - kx - mz)}$$

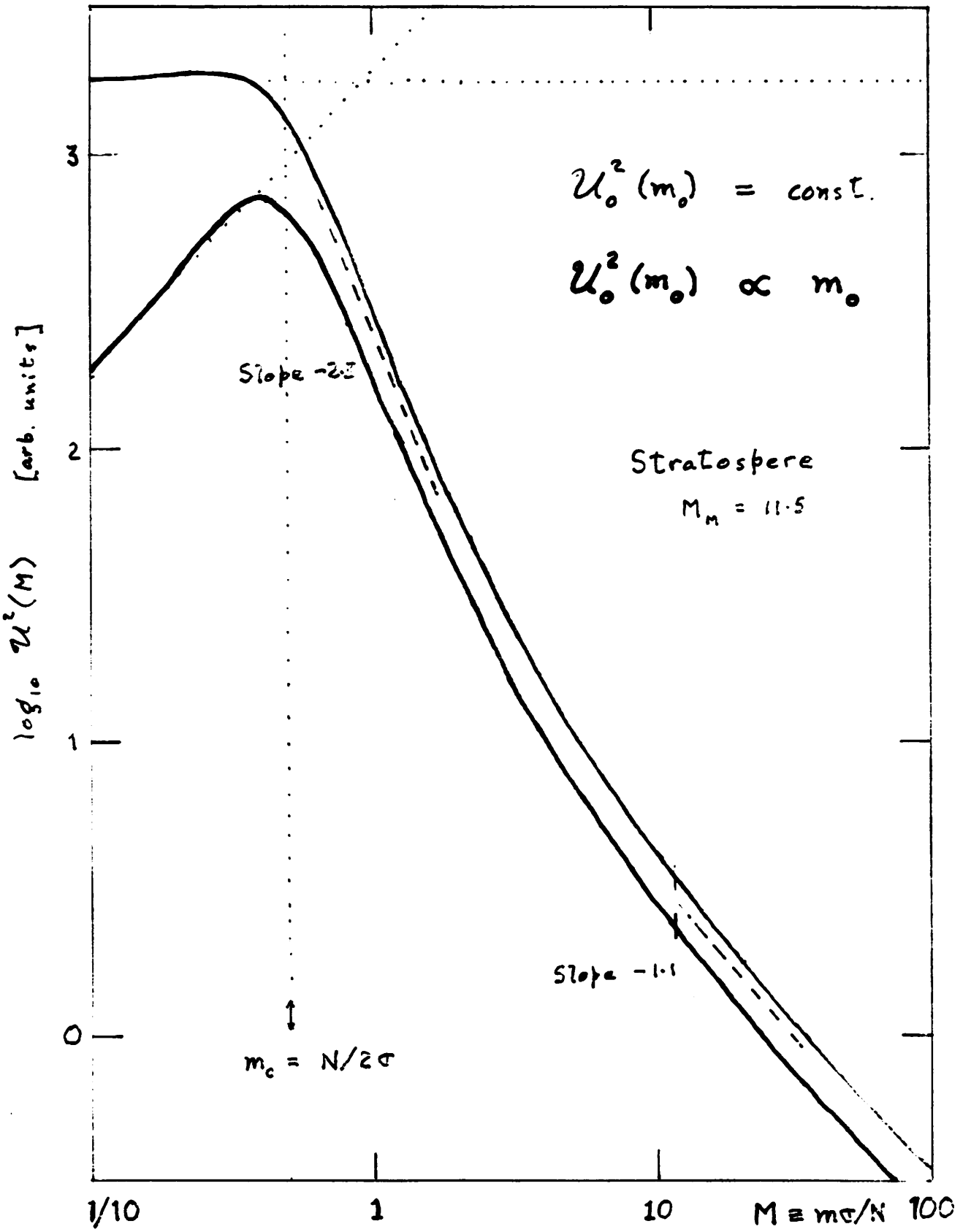
$$\rightarrow i(\omega - u_0 k)\, e^{i(\omega t - kx - mz)}$$

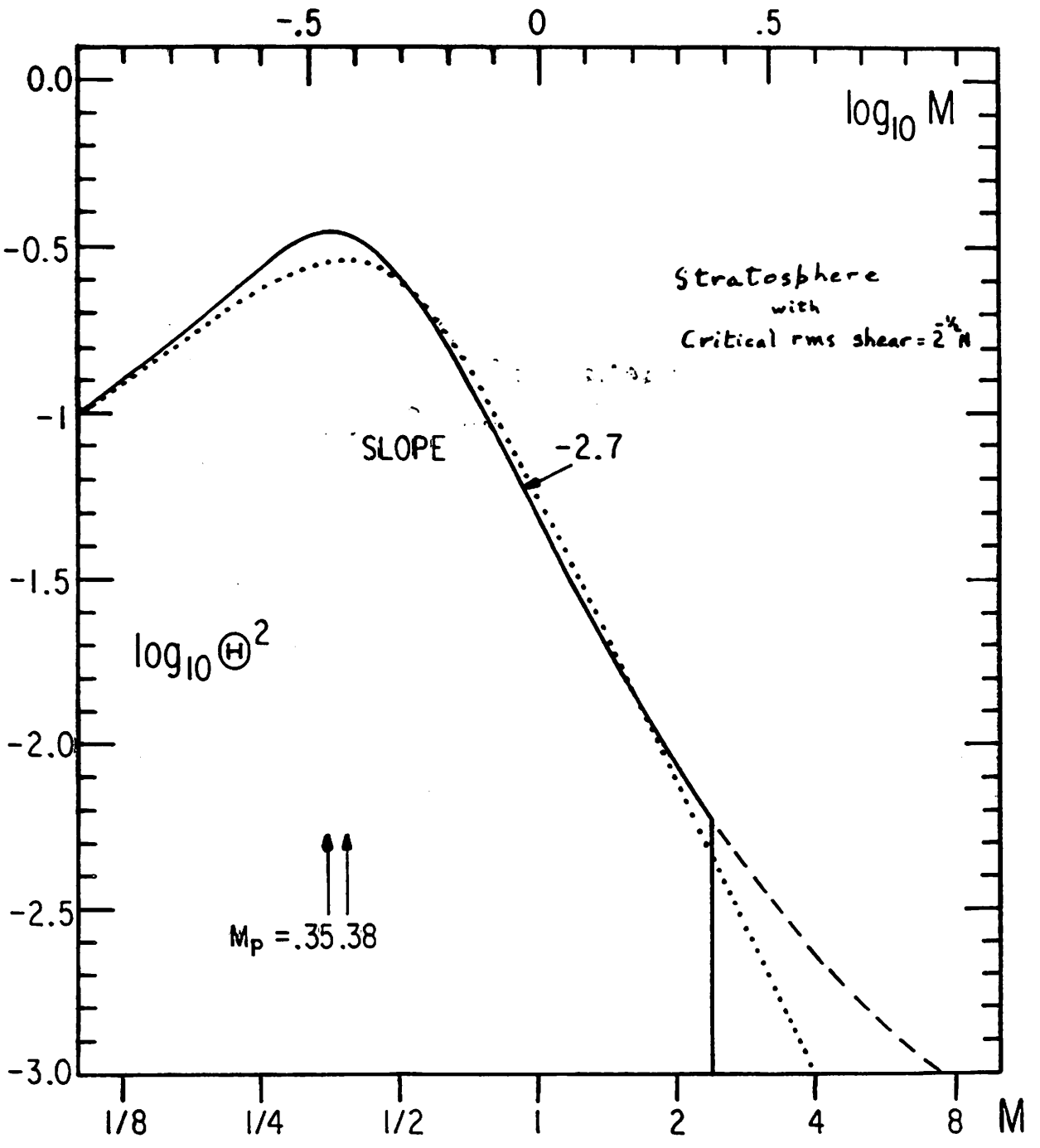
$$= i\underline{\underline{\Omega}}\, e^{i(\omega t - kx - mz)}$$

Dispersion relation: $N/\underline{\underline{m}} = \Omega/k$

$$M = m\sigma/N = \sigma/(\omega/k)$$




$\mathcal{U}_o^2(m_o)$ = const.
$\mathcal{U}_o^2(m_o) \propto m_o$
Stratosphere
M_m = 11.5
Slope -2.2
Slope -1.1
$m_c = N/2\sigma$
$\log_{10} \mathcal{U}^2(M)$ [arb. units]
3
2
1
0
1/10
1
10
100
$M \equiv m\sigma/N$



$M \doteq m\sigma/N$

$\doteq \sigma/(\omega/h)$