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Letters to the Editor

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GENERALIZED SCORER PARAMETER

Scorer (1949) had shown that the perturbation vertical velocity (w'), induced by a semi-infinite ridge, for a basic flow normal to the ridge, satisfy the following equation :

$$\frac{\partial^2 \hat{w}}{\partial z^2} + \left(l_S{}^2 - k^2 \right) \hat{w} = 0 \qquad (1)$$

where,

$$\hat{w}(k,z) = \int_{-\infty}^{\infty} w'(x,z)\, e^{-ikx}\, \mathrm{d}x$$

is the one dimensional Fourier transform of $w'(x,z)$. In his two dimensional study of mountain wave, Scorer (1949) considered unidirectional basic horizontal flow at any level and unidirectional horizontal wave number vector.

Thus in vector notation, the basic horizontal flow $\vec{V}_H = [U(z),0]$ and the horizontal wave number vector $\vec{\kappa}_H = (k,0)$. In Eqn. 1, $l_S{}^2$ is the Scorer's parameter, given by,

$$l_S{}^2(z) = \frac{\frac{g}{\overline{\theta}}\frac{\mathrm{d}\overline{\theta}}{\mathrm{dz}}}{\overline{U}^2} - \frac{1}{U}\frac{\mathrm{d}^2 U}{\mathrm{dz}^2} \qquad (2)$$

Again Sawyar (1962) obtained the following vertical structure equation :

$$\frac{\partial^2 \hat{w}_0}{\partial z^2} + \left(\frac{N^2(k^2+l^2)}{(kU+lV)^2} - \frac{k\frac{\partial^2 U}{\partial z^2} + l\frac{\partial^2 V}{\partial z^2}}{kU+lV} - (k^2+l^2) \right)\hat{w}_0 = 0 \qquad (3)$$

where,

$$\hat{w}_0(k,l,z) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} w'(x,y,z)\, e^{-i(kx+ly)}\, \mathrm{d}x\mathrm{d}y$$

is the two dimensional Fourier transform of $w'(x,y,z)$.

Now, Sawyar (1962), in his three dimensional mountain wave study, considered the basic horizontal flow $\vec{V}_H = [U(z),V(z)]$ and horizontal wave number vector $\vec{\kappa}_H = (k,l)$

Now the concept of generalized Scorer parameter may be thought of as follows :

Let, $N^2 = \frac{g}{\overline{\theta}}\frac{\mathrm{d}\overline{\theta}}{\mathrm{dz}}$

$\vec{V}_H = [U(z),V(z)]$ is the horizontal basic wind vector.

$\vec{\kappa}_H = (k,l)$ is the horizontal wave number vector.

So, $\vec{\kappa}_H \cdot \vec{\kappa}_H = k^2 + l^2 = |\vec{\kappa}_H|^2$

$\vec{\kappa}_H \cdot \vec{V}_H = kU + lV$ and

$$\vec{\kappa}_H \cdot \frac{\partial^2 \vec{V}_H}{\partial z^2} = k\frac{\partial^2 U}{\partial z^2} + l\frac{\partial^2 V}{\partial z^2}$$

Hence, the first two terms in the parenthesis of Eqn. 3 may be written as

$$\frac{N^2 |\vec{\kappa}_h|^2}{(\vec{\kappa}_H \cdot \vec{V}_H)^2} - \frac{\vec{\kappa}_H \cdot \frac{\partial^2 \vec{V}_H}{\partial z^2}}{\vec{\kappa}_H \cdot \vec{V}_H} = l_G{}^2 \text{ (say).}$$

In the following table, $l_S{}^2$ and $l_G{}^2$ are given at different levels using the RS data of Santacruz for some values of k, l :

Height (km)	U (m/s)	V (m/s)	θ (^{0}K)	$l_s{}^2$ (10^{-6}m^2)	$l_G{}^2$ (10^{-6}m^2)	$l_G{}^2$ (10^{-6}m^2), when l=0
1	13.6	9.9	301.15	3.03	2.17	3.03
2	10.7	15.6	306.20	4.43	3.32	4.43
3	5.5	10.3	311.36	0.51	-1.17	0.51
4	9.6	9.9	317.12	1.65	0.55	1.65
5	6.0	7.4	325.06	3.73	1.26	3.73
6	8.6	4.75	330.81	2.53	1.98	2.53
7	8.5	5.6	334.76	1.85	1.47	1.85
8	4.3	5.4	339.84	3.65	1.85	3.65

So, it is clear that when $l = 0$ and $V(z) = 0$, then $l_G{}^2 = l_S{}^2$. Hence, $l_S{}^2$ can be obtained from $l_G{}^2$ as a special case when $l = 0$ and $V(z) = 0$.

Thus $l_G{}^2$ may be treated as generalized Scorer parameter.

References

Sawyar, J. S., 1962, "Gravity waves in the atmosphere as a three dimensional problem", *Quarterly Journal of Royal Meteorological Society*, **88**, 412-425.

Scorer, R. S., 1949, "Theory of waves to the lee of mountains", *Quarterly Journal of Royal Meteorological Society*, **75**, 41-56.

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