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3.1A A SIMPLE MODEL FOR TESTING THE EFFECTS OF GRAVITY-WAVE-PRODUCED VERTICAL OSCILLATIONS OF SCATTERING IRREGULARITIES ON SPACED-ANTENNA, HORIZONTAL DRIFT MEASUREMENTS

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INTRODUCTION

It has been suggested that the velocities produced by the spaced antenna partial-reflection drift experiment may constitute a measure of the vertical oscillations due to short-period gravity waves rather than the mean horizontal flow. The contention is that the interference between say two scatterers, one of which is traveling upward, and the other down, will create a pattern which sweeps across the ground in the direction (or anti-parallel) of the wave propagation. Since the expected result, viz. spurious drift directions, is seldom, if ever, seen in spaced antenna drift velocities, this speculation is tested in the following model.

MODEL

Figure 1 illustrates the geometry of the model, which is very similar to that developed by WRIGHT and PITTEWAY (1978). Forty point scatterers are placed randomly within the aperture of the antenna system. Amplitudes are summed at all receiver antennas every 0.5 s, after which the scatterers are moved according to:

$$\vec{V}_i = \vec{U} + \vec{V}_{gw} \cos(\omega t + \vec{k}\cdot\vec{r}_i),\ \vec{r}_i = 0.5\vec{V}_i + \vec{r}_i$$

where i refers to the i^{th} scatterer. The amplitudes are also varied randomly in a staggered fashion, a complete update takes place over 7 samples. If a scatterer moves out of the aperture in the horizontal direction, it is replaced by one at the opposite side; if it moves out vertically, it is not included in the amplitude summation until it re-enters. At 50 m/s, the whole pattern would be replaced in 10 min. "Records" are 5 min in length.

Simulations were done for several values of GW perturbation velocity and periods, and a range of azimuth angles. The background flow was 50 m/s eastward.

DISCUSSION AND CONCLUSIONS

It can be seen from Table 1 that the drift directions are very close to the mean background flow (90°). The true velocities are low, possibly because the model does not fit the analysis assumptions (viz. Gaussian spatial and decay time correlations). The major effect of the GW is to lower the characteristic time in the pattern.

Another test (not shown) with the aperture and GW wavelength reduced by 1/2, but the same rf wavelength, did exhibit major perturbations in the correlations and resulting drift velocities which are not yet understood. The distortion of the correlations caused at least half the data to be rejected on the basis of the normalized time discrepancy -- that is, the correlation peaks did not indicate a pattern motion. The effect appears to depend on the relation between the aperture and the radio wavelength. If so, then the results found in the present model (λ = 135 m, antenna beam = 20°) can be scaled to VHF (λ ~ 6 m) by reducing the beam width to 4° (the difference in range between the

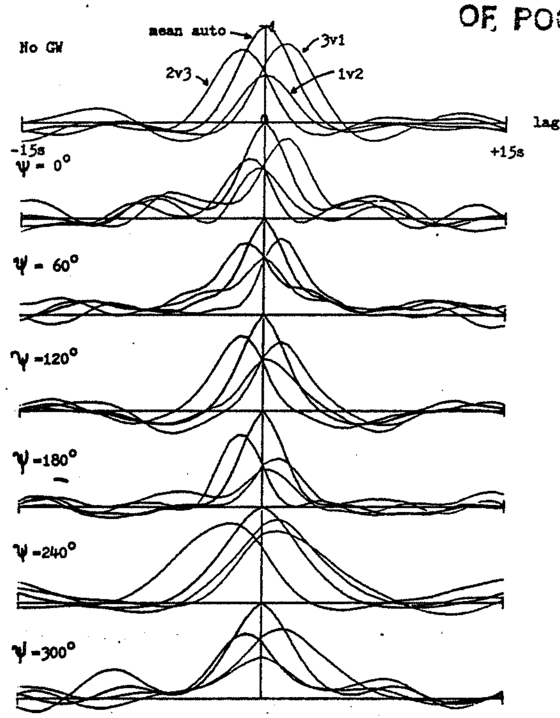

Figure 1. Geometry of scattering model.

center and edge of the scattering layer is made the same number of wavelengths).

Consequently, although the velocities may be perturbed by gravity waves, no spurious values (depending only on the GW) are expected, and this is what is found in practice.

An expansion of the model to simulate MF doppler experiments is planned for the future.

REFERENCE

Wright, J. W. and M. L. V. Pitteway (1978), Radio Sci., 13, 189.

Table 1. Results of drift analysis for various azimuth angles and wavelengths of gravity waves.

Gravity wave			Drift analysis							
V_{gw} (m/s)	λ_{gw} (Km)	Azim. E of N	V_{ap} (m/s)	ϕ_{ap} EofN	V_{tr} (m/s)	ϕ_{tr} EofN	τ_c (sec)	A (m)	B (m)	tilt EofN
-	-	-	54	103°	47	89°	3.6	163	129	53°
GW period = 5.2 min										
5	20	0°	55	91	45	88	3.6	153	140	73
5	20	60	59	88	47	90	3.4	178	162	168
5	20	120	57	93	45	88	3.3	163	148	42
5	20	180	57	87	42	89	2.6	127	112	97
5	20	240	58	91	50	86	3.6	150	129	68
5	20	300	61	100	49	89	3.1	163	127	67
20	20	0	72	96	47	84	2.0	160	129	41
20	20	60	59	87	41	93	2.8	176	149	158
20	20	120	84	98	37	79	1.6	167	119	43
20	20	180	70	98	38	98	2.0	180	140	9
20	20	240	74	91	37	92	1.8	167	136	1
20	20	300	72	93	38	87	2.0	161	142	31
GW period = 10.1 min										
20	60	0	63	74	48	71	2.7	153	144	39
20	60	60	67	91	48	87	2.6	173	155	22
20	60	120	61	99	46	97	2.8	157	144	19
20	60	180	62	103	43	107	2.3	136	121	123
20	60	240	45	118	34	98	4.2	270	162	42
20	60	300	67	84	37	86	2.8	188	134	88

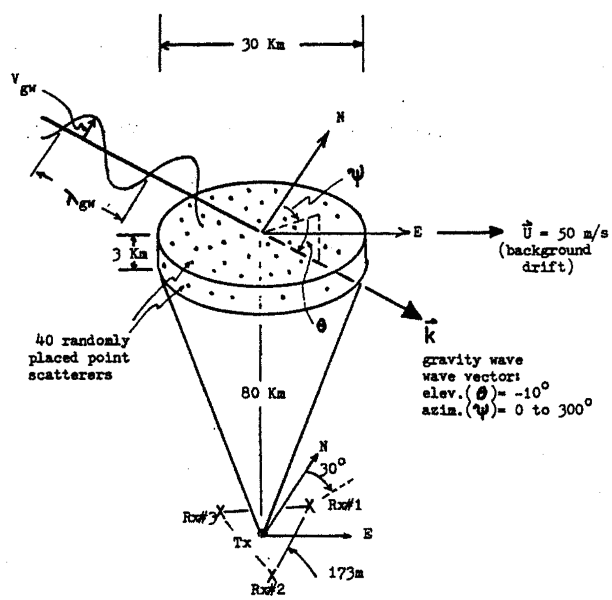

Figure 2. Auto- and cross-correlations for V_{gw} = 20m/s, λ_{gw} = 60 km. period = 10.1 min, for the data used in Table 1.