5.6B VHF RADAR MEASUREMENTS DURING MAP/WINE

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In the past ten years, a new type of sensitive Doppler radars has been developed which operate in the very high frequency (VHF) band, usually near 50 MHz (wavelength $\lambda \sim 6$ m). These radars can measure profiles of background winds, tides, atmospheric gravity waves and turbulence at tropospheric, stratospheric and mesospheric heights. Their ability to observe simultaneously large- and small-scale processes makes them unique instruments for studying not only each process separately but also their nonlinear interactions.

The radar echoes are produced by scattering from refractive index structures with scales equal to $\lambda/2$ and partial reflections from refractive index gradients. Refractive index variations in turn are due to changes in temperature, pressure, humidity and free electron concentration. Free electrons play a major role only at mesospheric heights. In the troposphere and stratosphere, the radar echo power decreases strongly with height due to the exponential decrease of the air density whereas in the mesosphere, the free electrons may produce one or more local power maxima. Depending on geographic latitude, daytime and mode of radar operation, there is always a more or less extended height range around the stratopause yielding no radar echoes.

The distance at which a radar signal is scattered or reflected is obtained from the signal travel time and the speed of light. Doppler radars are phase coherent so that transmitted and received signals can be compared to get both amplitude and phase of the echoes. The usual procedure is to find the echo power as a function of the Doppler shift from the transmitter frequency. This Doppler spectrum contains all necessary information about the intensity of the refractive index variations at scales equal to $\lambda/2$, the mean velocity of the scattering volume in the direction of the antenna beam (radial velocity) and the distribution of random velocities within the scattering volume. The 3-dimensional velocity vector can be obtained by operating the radar in three independent antenna beam directions. The optimum temporal and spatial resolutions are about 1 min and 150 m, respectively.

The mobile VHF radar to be used during the MAP/WINE campaign on Andoya is a modified version of the SOUSY VHF radar being in operation for six years in the Harz Mountains (ROTTGER et al., 1978). The main system parameters are shown in figure 1a, paper 6.4B, this volume. The radar controller, which is programmed by a 16-bit computer, is the central unit. It holds 1024 program steps in core and controls the whole system: the master oscillator (OSCILL), the transmitter, the transmit-receive-switch (T/R-switch), the receiver, the analog-digital converter (ADC), and the hardware adder.

The transmitter operates as a class-C push-pull amplifier with a bandwidth of 3 MHz. The maximum pulse peak power is 200 kW with a duty cycle of 4%. The pulse length can be varied from 1 to 100 μs corresponding to a height resolution of 150 m to 15 km. To increase the signal-to-noise ratio, a pulse coding technique is applied (for details see SCHMIDT et al., 1979). The pulse length, coding and repetition frequency are easily adjustable to the requirements of the different observational programs by software instructions. The transmitter, the receiver and the antenna are connected to a high-speed transmit-receive-switch with a recovery time of less than 10 μs, corresponding to a minimum radar range of 1.5 km.

The antenna array consists of 576 four-element Yagis with a total gain of 35.5 dB and a half power beam width of 3°. By means of a system of 110 four-port coaxial relays, the antenna diagram is steerable in three independent directions. To reduce interference and clutter, the suppression of sidelobes of the antenna pattern is about 25 dB at angles close to the zenith and about 40 dB for low deviation angles.

REFERENCES

Rottger, J. (1978), Naturwissensch., 65, 285.

Schmidt et al. (1979), IEEE Trans. Geosci. Electr., GE-17, 154.