largest vesicular (bulk density = 1000 kg/m^3) pyroclasts which can be transported out of the vent by the gas flow speeds give on the left-hand axes. The pyroclast sizes, which are typically a factor of 20 larger than those which would be involved on Earth for a given magma volatile content, are calculated using the appropriate ambient atmospheric pressure and magma volatile species in each case. They represent the largest clasts which could be erupted if they were present. We stress that these large clasts (sizes up to many tens of meters are allowed) may well not be present; indeed, for some combinations of magma gas content and mass eruption rate, the predicted maximum clast size is larger than the width of the conduit through which the eruption would be taking place. In such cases the conduit width would of course set the upper clast size limit, and any attempt to eject clasts with sizes approaching the limit would in any case lead to strong, transient nonuniformities in the eruption conditions [Wilson et al., 1980].

On the upper axes of Figure 10 are plotted the heights of convecting eruption clouds (when these can remain stable) corresponding to the mass discharge rates on the lower axes. The dashed curve in each part of the figure is the stability criterion for convection to occur, taken from equation (28): convecting clouds are stable for all sets of conditions above this line and a collapsed cloud, or fountainlike structure, of the kind assumed to act as the source of large-scale pyroclastic flows, will form for all sets of conditions below it. It will be noted that both kinds of activity can occur at all mass eruption rates and at all surface pressures on Venus for the H_2O-rhyolite combination but that for the other combinations (H_2O-basalt and CO_2-any magma) there are wide ranges of mass eruption rates, especially at lowland sites on Venus, where the stability criterion for eruption clouds is always satisfied and so pyroclastic flows can never form. This phenomenon, which does not occur on Earth (or Mars, see Figure 1 of Wilson et al. [1982], is another consequence of the high Venusian atmospheric pressure suppressing explosive activity unless the magma volatile content is significantly higher than on Earth.

When pyroclastic flows do form, it would be useful to be able to predict their run-out distances from the vent. However, no general model of the ranges of pyroclastic flows (which may in some cases travel to more than 200 km from the vent on Earth) has yet been developed, despite recent work on the conditions governing their formation [Wilson et al., 1978] and subsequent motion [C.J.N. Wilson, 1980, 1984]). We may argue in general terms, however, that since eruption velocities on Venus are less by a factor of about 2 for a given magma volatile content than those which would occur on Earth and since it seems plausible that the travel distance of a pyroclastic flow will be determined by energy losses and so will be proportional to the initial kinetic energy, pyroclastic flows on Venus should have run-out distances about 4 times less than those of pyroclastic flows on Earth. Also, it seems very likely that much of the mobility of a pyroclastic flow is due to the ingestion and heating of atmospheric gases at its front [C.J.N. Wilson, 1980; Wilson and Head, 1981], and since the atmospheric temperatures on Venus are much higher relative to magmatic temperatures than is the case on Earth, there should be relatively less fluidization of pyroclastic flows on Venus, thus reinforcing the tendency toward shorter run-out distances.

In cases where Plinian eruptions on Venus produce air fall deposits from stably convecting eruption clouds, we can give a good indication of the extent of pyroclast dispersal. Calculations and observations of eruption cloud shapes on Earth suggest that the widths of clouds in their upper parts are approximately equal to their maximum heights [Wilson, 1976; Walker et al., 1984]. Figure 10 shows that for magma volatile contents up to a few weight percent, stable cloud heights can take on any values up to 40-50 km; we therefore anticipate that air fall deposits formed by the downwind drift of pyroclasts released from such clouds will have widths extending over a similar range of values. The downwind extents of air fall deposits are less well defined, however, being controlled by eruption cloud height, mean wind speed, and pyroclast size [Wilson, 1976]. In an attempt to give an impression of the maximum extent of a Plinian air fall deposit on Venus we have simulated a cloud arising from an eruption in which the magma is a rhyolite exsolving 7 wt % H_2O and the mass eruption rate is 10^{10} kg/s, yielding an eruption cloud height of 45 km. We have used a mean wind speed of 3 m/s to calculate the downwind transport of clasts, a value which may well be something of an overestimate [Counselman et al., 1980; Seiff et al., 1980]. Figure 11 shows the variation of upward gas velocity and maximum entrained particle size with height in the cloud and also the maximum size of vesicular (density = 1000 kg/m^3) pyroclasts in the resulting deposit as a function of distance from the vent. It is clear that the fine-grained parts of air fall deposits may extend for distances well in excess of 100 km from the vent. However, clasts with sizes of the order of a few hundred millimeters, capable of causing noticeable roughness signatures at the wavelengths used by currently employed radar systems, will be confined to regions extending no more than 15-20 km downwind of the vent. Figure 12 shows the variation of maximum grain size with position in the deposit resulting from the above model calculation. Few Plinian deposits on Venus should have a more extensive dispersal of clasts than that shown in Figure 12.

It has recently been suggested [Esposito, 1984] that sulfur dioxide levels in the middle atmosphere of Venus may be fluctuating on a time scale of decades as a result of episodic volcanic injections of this gas. The proposed mechanism would require convecting eruption clouds to reach a height of approximately 50 km. Examination of Figure 10 shows that there is always an upper limit to the height that can be reached by an eruption cloud produced in an eruption having any particular magma-volatile combination: if the mass flux increases beyond the limit corresponding to the critical cloud height, convective instability sets in, a collapsed eruption cloud forms, and it is inferred that pyroclastic flow production begins. Cloud heights of 50 km can in fact be reached by all of the magma-volatile combinations shown in Figure 10, though the magma must exsolve at least 4.5, 7.5, or 5 wt % gas for the water-basalt, water-rhyolite, and CO_2-any magma combina-