Reply

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We are pleased to hear of the experiences of Kurihara and Tuleya using lower-precision arithmetic in numerical computations. We recognize that the importance of the precision will be very strongly model- and code-dependent, and we do not mean to imply in any sense that our results are general.

Concerning our results, we cannot assume that the pressure difference shown in our Fig. 6 is caused by the precision difference of the integrations regardless of whether the difference represents a difference in mass or a difference in temperature. As seen in the figure, a very similar difference exists between the control integration and the random perturbation experiment, both of which were carried out with full 48-bit mantissa arithmetic. Thus, a pressure difference of the size indicated is within the natural variability of the model. The importance of considering the natural variability of a model in assessing the significance of experimental results has recently been discussed by Leith (1973) and Chervin et al. (1974).

We should point out that the NCAR model does not a priori perfectly conserve mass due to the details of the computational algorithms. Possible computational mass sources and/or sinks are the longitudinal linear interpolation used in conjunction with the reduction of the number of grid points in the longitudinal direction near the poles, the computation of the pressure at the poles, the filtering or smoothing function applied to the pressure, the mountain blocking procedure which uses first-order differencing near the mountains, and the convective adjustment algorithm. These computations are specified in detail in Olliger et al. (1970). We do not know which, if any, of these algorithms are non-negligible computational sources of mass change.

We are currently developing a new version of the Global Circulation Model using fourth-order horizontal differences with longitudinal Fourier filtering near the

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poles (Williamson and Browning, 1973) and a transformed vertical coordinate (Kasahara, 1974). This new formulation will eliminate most of the computational problems outlined above.

REFERENCES


