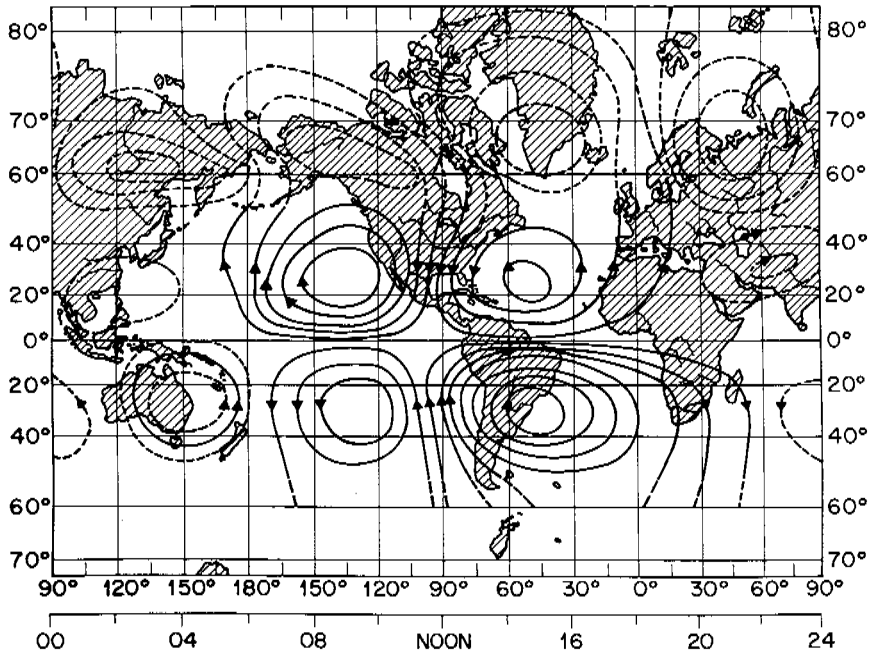


FIGURE 16.1 Planetary-scale distribution of telluric currents according to Gish (1936a, 1936b) at 1800 GMT.

could carry currents flowing in the entire region over which the relatively short lengths of wire extended. In this case, the pipe network was the receiving "antenna," even more than the lengths of wire. Recent evidence of the effect of telluric currents, integrated over a planetary scale, has been provided by analysis of MAGSAT data. Langel (1982) reported an analysis of the data in terms of separation, by spherical harmonic expansion, of the external- and internal-origin geomagnetic field. The analysis was done for different sets of data, depending on the value of the Dst index (a measure of the particle ring current in the Earth's magnetosphere and, therefore, of the level of disturbance of the geomagnetic field). Figures 16.3(a) and 16.3(b) show that the lowest order and degree terms (i.e., dipole terms), denoted $g_1^0$ and $q_1^0$ (external and internal, respectively) change with the level of Dst. The internal term increases with decreasing Dst, unlike $g_1^0$, a consequence of the fact that induced currents must flow in the direction opposite to the inducing currents.

Summarizing, accurate knowledge of telluric current patterns in the Earth on a planetary scale still remains a basically open problem even though the subject has a long history. In addition to the actual role of ocean water and sediments, largely unknown is the influence of localized conductivity anomalies (such as fold belts, mid-oceanic ridges, and trenches and subduction zones) on such patterns. The current patterns will obviously be different for different periods of the external inducing field. The higher-frequency patterns will be highly time variable because of the temporal and spatial variability of the external-origin fields, variabilities that are not yet amenable to accurate predictive modeling. Nevertheless, given all the foregoing caveats, we present in the following sections additional discussions of many of the relevant issues, as well as some implications for practical concerns.

## THE NATURAL ENVIRONMENT

### *The Physical Problem: Hydrology, Geology, Geothermics, and Tectonics*

Except during a lightning strike to Earth, essentially negligible electric current flows between the air and the ground (integrated over the Earth, the fair-weather current amounts to some 1000-2000 A). Therefore, the Earth's surface is a natural surface across which electromagnetic coupling occurs via an electromagnetic field. This implies that it is possible in many cases to treat the coupling problem in terms of scalar potentials (at least for frequencies lower than those used in audio magnetotelluric studies). An attempt by Berdichevsky and Fainberg (1972, 1974) to evaluate, on a global scale, possible currents between ground and air suffered large uncertainties from the approximations used. As noted briefly in the Introduction, the cause of telluric currents is either electromagnetic induction by the time-varying geomagnetic field produced by the ionosphere and/or magnetosphere or by water movement across the permanent