Phase Reading Flags in *mloc*

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Background

The MNF file format for earthquake arrival time data files includes the concept of "usage flags", in column 3 of phase reading records. Usage flags are used by *mloc* (in combination with explicit commands and built-in logic) to determine which phase readings are available to be used for relocation. This document describes the meanings of the available flags.

The absence of a flag (blank in column 3 of an MNF phase readings record) indicates that the there are no known reasons to avoid using it, but this does not guarantee that a particular reading will be used in the relocation. For example, the HD algorithm requires that a station-phase be observed more than once, so that a travel-time difference can be calculated, in order to use it to estimate the cluster vectors. If a reading is the only sample of a particular station-phase in the data set, it might still be used for estimating the hypocentroid, but if it does not meet the criteria (e.g., epicentral distance) for use in the hypocentroid, it will play no role in the relocation analysis. There are also circumstances in which it is deemed helpful to restrict the distance range over which phase readings will be used for estimating cluster vectors (command CLIM).

Do-Not-Use Flags

Any phase reading with one of the flags defined below in column 3 of its phase record will not be used by *mloc* for either the hypocentroid or cluster vectors of an HD analysis.

Flag	Summary	Explanation
d	duplicate	The reading has been judged to be a duplicate reading. There is some rudimentary logic in *mloc* that attempts to identify duplicate readings automatically, but it is far from thorough. Duplicates can also be flagged manually. Multiple samples of the same station-phase from the same event are not duplicates if they are actually independent estimates.
m	missing station	No coordinates are available for the given station code.

p	phase	The phase name of the reading is problematic. It could be that the phase identification algorithm in *mloc* fails to associate the reading with a known seismic phase, or it may be that the phase, while known, is one for which it is not possible to calculate a theoretical travel time (e.g., PPP, pwP).
s	skip	Readings can be flagged to not be used on the basis of phase name, station or author, or a combination of these parameters. This is controlled by the SKIP command.
t	timing	The station is known or suspected to have timing problems. There is documentation of timing problems for a few stations during known periods, and *mloc* has logic to check for corresponding readings and flagging them automatically. The flag can also be applied manually.
x	outlier	A reading may be determined as an outlier and flagged manually during analysis of empirical reading errors with the utility program "rstat" or through inspection of one of the ".phase_data" files, or it may be flagged semi-automatically as a result of running the "lres" or "xdat" utilities. The concept "outlier" can be either relative (to other samples of the same station-phase) or absolute (with reference to a theoretical travel time model).

Timing Flags

Two flags are defined that are used to adjust the observed arrival time of a phase reading. These correct for the well-known "one minute" errors which were rather common in seismological bulletins before recording systems and phase picking came to be done digitally. *mloc* also contains logic that attempts to catch such errors (± 5 seconds from a one-minute residual) and correct them automatically.

Flag	Summary	Explanation
k	plus 1 minute	The reported arrival time is increased by one minute
l	minus 1 minute	The reported arrival time is reduced by one minute