GOLD Stellar Occultation timing errors

The onboard clock is used to assign UT time stamps to individual measurements in the GOLD Level 1A processing. For the occultation (OCC) data processing these time stamps are then used to generate the geolocation information (primarily tangent point latitude, longitude, and altitude) for the target star as it passes through the GOLD slit. The onboard clock time drifts relative to true time, with errors that depend on temperature and can be of either sign. Generally, the clock drift accumulates slowly and systematically but the drift rate can accelerate during times of increased daily temperature variations such as during eclipse season. The clock offset is monitored and when it gets large enough an offset is applied to zero it out. The magnitude of the timing error has reached 3 sec twice during the GOLD mission but is generally less than 2 seconds.

The primary impact of the time stamp error is to cause an error in the slant path tangent altitude grid assigned to the L1C OCC data. This altitude offset is essentially constant for a given event and maps directly into the normalized atmospheric transmission profiles generated from the L1C irradiance data and used as input to the L2 O2DEN algorithm.

The magnitude of the tangent altitude error can be estimated from the known clock drift using the following equation:

$$\Delta Z = (-1)\Delta t \left(3\frac{km}{s}\right)\cos(\varphi)\, sign(\lambda) \qquad (Eq.\,1)$$

where ΔZ is the error in km, Δt is the clock drift in seconds, 3 km/s represents the altitude rate of change across the slit for a star rising or setting at the equator, φ is the occultation latitude, and λ is the occultation longitude (longitude is a proxy for distinguishing star rise events – East limb/positive longitude – from star sets – West limb/negative longitude). ΔZ is generally within 5-7 km for most of the GOLD data, but has occasionally reached as high as 10 km.

It is worth emphasizing again that the error calculated from Eq. 1 applies to the L1C slant path tangent altitudes. This propagates through the retrieval algorithm, resulting in errors in the geometric altitude grid assigned to the retrieved O_2 density profile. Due to the limb inversion process the final altitude errors in the O_2 profile are not identical to what is calculated from Eq. 1.

Nevertheless, as a first order correction to the current v03 data set, users can apply the correction calculated from Eq. 1 directly to the O_2 profiles archived in the Level 2 O2DEN data files. The clock drift as a function of UTC time is available as a CSV file from the GOLD website on the "Tools" page: https://gold.cs.ucf.edu/data/tools. The file has the average clock drift (in msec) over 15-minute increments. To calculate the altitude correction, you would find the UTC time in

the file that is closest to the time of the occultation and use the corresponding clock drift in the equation above.

A fix for the clock offset error is planned for a future release. This will result in accurate UTC times, and hence geolocated altitudes, for all GOLD occultation data. At that point the O2DEN data will be reprocessed, and a new version released.