ON THE SPECTROSCOPIC DETECTION OF VOLATILES AND ORGANICS ON ASTEROIDS AND OTHER SMALL BODIES. C. A. Hibbitts[1], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, Md. 20723, karl.hibbitts@jhuapl.edu,.

Introduction: Volatile molecules such as CO_2, CO, NH_3, H_2O_2 and organics such as CH_4, alcohols, and CN-beraring compounds have yet to be definitively detected on main belt or Trojan asteroids from ground-based telescopic measurements. However, several of these materials have been positively identified on the icy Galilean and Saturnian satellites via measurements from the Galileo and Cassini missions [e.g. 1,2,3]. These materials possess spectrally broad, but shallow, solid-state infrared absorption features between approximately 2.5 – 5 µm. If present on main belt or Trojan asteroids, they may have escaped detection from ground and airborne observatories because of telluric contributions at these same wavelengths (Figure 1). However, they may be able to be detected via observations above the Earth's atmosphere.

Spectral Detection: The mid-IR (~ 2.5-5 µm) is ideally suited for the detection of organics and volatiles. Refractory organic materials, such as C-H bearing materials are responsible for the 3.2-3.5 –µm bands and CN-bearing materials induce bands near 4.5 µm and possibly near 2.42 µm. Ammoniated phyllosilicates absorb near 2.9 µm, and phyllosilicates (if crystalline) have diagnostic cation-OH stretch vibrations near 2.7µm. More volatile materials such as CO, CO_2, H_2O_2 have strong absorption band near 4.7µm, 4.25 µm, and 3.5 µm, respectively.

However, the detection of mid-IR absorption features in the mid-IR on main belt asteroids is hampered by thermal emission that reduces the spectral contrast of absorption bands in reflected sunlight. However, thermal emssion should not erase all spectral features, even for NEAs (Figure 2). Detection will require extremely high signal-to-noise, again suggesting that these bands would be extremely difficult to detect from the ground.

Thermal Stability: Refractory organics are not expected to be volatile, however, CO_2, CO_2, CH_4, etc. would rapidly sublime at temperatures that are well above 100K and would thus not normally be expected to be present. However, CO_2 has been detected in the surfaces of the Galilean satellites with surface temperatures approaching 160K [1,2] and may be stable on geologic time[4]. Laboratory studies attempting to explain this unusually high thermal stability suggest a generic physical mechanism such as simple electrostatic attraction which can occur with any volatile molecule, does significantly increase the thermal stability of CO_2 and CO adsorbed onto in nonice materials [5, 6]. These materials may stable in surfaces well above 150K, possibely even as warm as 200K, though quickly subliming during warming to 300K. Thus, if one is to look, it may not be surprising to discover CO_2 and other volatiles and organics present in the surfaces of outer main belt asteroids.

References:

[1] Carlson et al. (1996) *Science, 274,385-388.* [2] McCord et al. (1998) JGR, 103,8603-8626. [3] Clark et al., (2005) 435, Nature, 66-69. [4] Hibbitts et al., (2002), JGR, 107, 5084. [5] Hibbitts and Szanyi, (2007), Icarus, 191,371-380. [6] Hibbitts, unpublished data.

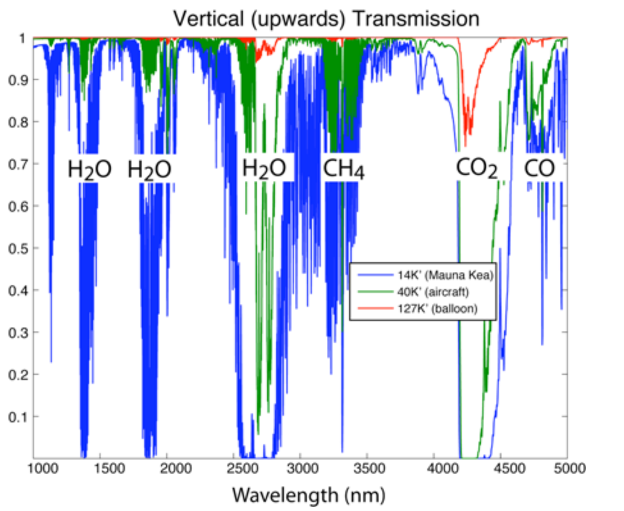

Figure 1. Species in the Earth's atmosphere are similar to those of interest on small bodies obscure many essential portions of the mid-IR spectral region, and at > 3µm contribute significantly to downwelling radiance.