Introduction: Recent observations have revealed that many large (>~1000 km in diameter) Kuiper belt objects (KBOs) exhibit features of crystalline water ice in their surface spectra [1]. Some may even exhibit amorphous ice features [2]. In addition, some of these objects show distinct spectral features of volatile ices, such as Methane and Ethane [3,4] and even Ammonia [5,6].

The presence of such features of organic ices could be explained as a consequence of atmospheric escape of these compounds [7]. The crystalline ice features on the surface suggest a thermal processing history, which would increase the rate of volatile lose. An interesting question is how to get mixed reservoirs of water and volatile organic ices close to the surface, so it can be either observed directly, or be subjected to a thermal escape mechanism.

Modeling Issues: We model the KBOs in question as icy, cometary-like, bodies. These are considered to be porous aggregates of ices and dust [8]. Modeling the internal evolution of such bodies takes into account various heat sources, the most important being, crystallization and radioactive decay (of either short-lived radionuclides or long-lived ones). In terms of composition, these models deal with a composition of refractory silicate-mineral solid grains and a mixture of volatiles, either in solid or gaseous state. Here we restrict our simulations to consider only CH4, NH3 and CO2, as representatives of the volatile species, other than water. The equations that govern the structure and evolution are those of mass and energy conservation, coupled with a hydrostatic scheme, for a 1-D spherical body [9].

We combine in our models the thermal processing of ices, due to radioactive heating, insolation (may be negligible for surface compositions in the outer Solar System and Trans Neptunian region) and crystallization of amorphous water ice (as a triggered source of internal energy), and the treatment of gas flow and densification of a varying porous medium [10]. The presence of organic compounds inside KBOs affects the internal heat balance and phase transitions of water [11]. This is examined self-consistently, as the abundances and locations of these compounds evolve.

Results: We show that under certain conditions, layers of crystalline water ice, amorphous water ice and CH4 or NH3 ice can co-exist (see Fig. 1). In some cases it is possible to reach thermodynamical states that favor the melting of water ice and retention of the liquid phase (see Fig. 2).

The intermittent layers of ices, which are a part of an overall semi-stratified internal structure, may also exist ‘close enough’ to the surface. By ‘close enough’ we mean that at a depth of 1-5 % of the object’s radius, a mixed composition can survive. This depth is slightly higher than the roughness scale found for Ceres [12], a dwarf planet, which resembles large KBOs, but is a Main Belt Asteroid (MBA). However, we should note that KBOs probably contain more ices than MBAs, implying lower densities and corresponding higher porosities, at layers near the surface.

The above mentioned consideration could mean that deep depression features may easily arise on surfaces of KBOs (either as primordial topography or as impact cratering), exposing water and volatile ice spectral signatures. The fraction ratios deduced from irradiative surface models, may indicate the mass fraction of ices exposed and the physical characteristics of the depression feature.

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**Figure 1:** “Snapshot” of internal structure at the end of a long-term simulation run for (136472) Makemake. Stratified ice structure is shown as mass fraction of ices vs. relative depth, below the surface (0). We focused here on the region around the maximum abundance of Methane ice.

**Figure 2:** Level of saturation (volume occupied by liquid water per void volume inside pores) as a function of relative depth. Shown here are KBOs (136199) Eris (black circles), (50000) Quaoar (red squares) and (20000) Varuna (green diamonds). Below the level of ~1% in our model, saturation is practically negligible.