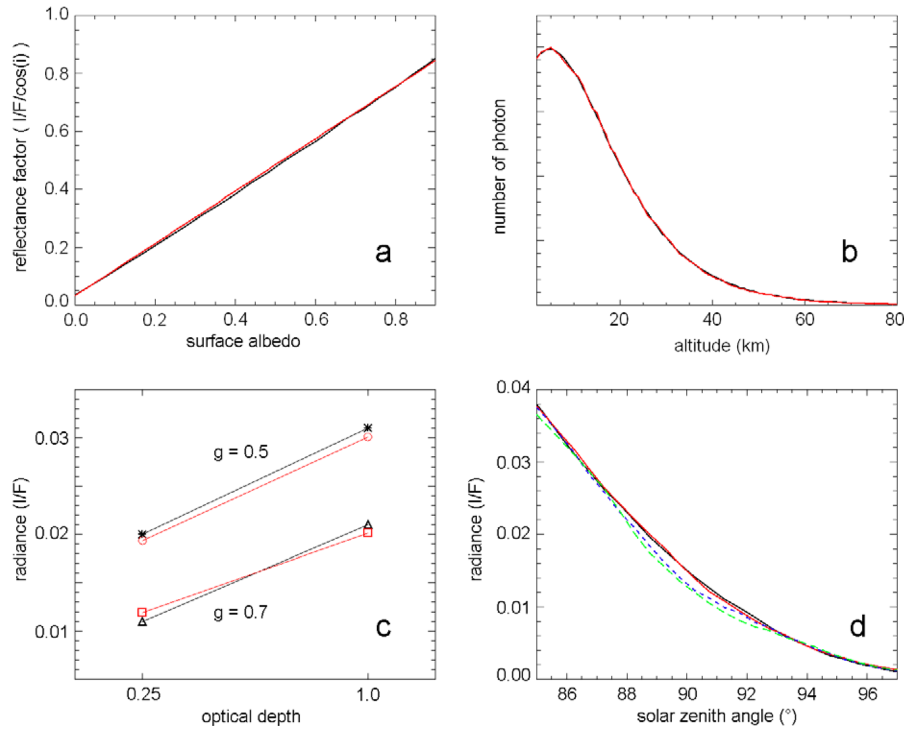

Fig. 7. Model validations. Panels a and b: comparison between the 3D spherical code (red) and the plane-parallel code of Vincendon et al. (2007) (black), in the common validity domain of the two models. (a) Variations of the apparent reflectance in a nadir viewing geometry as a function of the surface albedo for an optical depth of 0.2 and a solar zenith angle of 66°. (b) Number of photons that reach the surface as a function of the altitude of the first interaction with aerosols for a solar zenith angle of 75° and an optical depth of 0.5. A total of 4×10^6 photons are used for the plane parallel model, 2×10^7 for the spherical model. The two models give similar results. Panel c: comparison between the 3D spherical code (red, circles or squares) and the results computed with another spherical model as published by Kattawar and Adams (1978) (black, stars or triangles). A solar zenith angle of 84.25° is used. The predicted radiances of the aerosols layer are compared for two values of the optical depth and of the asymmetry parameter g of the aerosols phase function. Both spherical models predict observed radiances which differ by only a few %. Panel d: sensitivity of the model results to the spatial sampling of the pre-calculated array (Fig. 2). The radiance as a function of the solar zenith angle is shown for four samplings: case 1 (black line), sampling of Fig. 2 (1 km/10 km/1 km); case 2 (red line), sampling two times lower (2 km/20 km/2 km); case 3 (blue dotted line) and case 4 (green dashed line), sampling four times and eight times lower respectively. Similar model results are obtained for a high sampling (cases 1 and 2). Model results are affected around the terminator if the sampling is too low (cases 3 and 4). Martian properties are used for panels a,b and d (see Table 1). Earth atmosphere properties as described in Kattawar and Adams (1977) are used in panel c. An emission angle of 0 (nadir pointing) is considered for all panels. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

clude in some case a portion of the night side. These observations have been obtained in either a nadir pointing geometry or with moderate emission angles (<30°). We focus on the near-IR wavelengths that do not contain strong gas absorption bands. This corresponds to wavelengths of 1.08 μm, 1.28 μm, 1.60 μm and 2.03 μm for VIMS and of the (1 μm–2.6 μm) range for OMEGA, where for the latter the gas absorptions can be corrected using the method of Langevin et al. (2007).

3.2. Modeling assumptions

We choose to approximate the surface scattering law by a Lambert law. This simplification is relevant if specular and anti-solar phase angles are not considered (for Mars, see e.g. Johnson et al., 2006), particularly given the large fraction of diffuse light present in our observations (Vincendon et al., 2009). The single scattering parameters for the aerosols in the near-IR (albedo and phase function) have been constrained by previous studies (Ockert-Bell et al., 1997; Tomasko et al., 1999, 2008; Vincendon et al., 2007; Määttänen et al., 2009; Wolff et al., 2009). On Titan, those properties have been reported to vary slightly with altitude (Tomasko et al., 2008). On Mars, while it is expected that they also are a function of altitude, many aerosol retrievals have generally assumed them to be constant especially when one is observing the entire aerosol layer (e.g., Wolff et al., 2009). For simplicity, we adopt the same assumption. The employed values are summarized in Table 1. The vertical structure of the optical depth will be represented by a constant scale height in an exponential atmosphere $\tau_V(z) = \tau \exp(-z/H)$. On Titan, this model provides a first approximation of the observed vertical variations at wavelengths greater than 1 μm (Tomasko et al., 2008, Fig. 50). On Mars, this hypothesis relies on two main underlining assumptions: that dust is "well-mixed" with gas and that the temperature of the atmosphere is constant with altitude. Dust is usually observed to be well-mixed in the bottom scale height or two, where one typically find most of the optical depth (Lemmon et al., 2004; Zasova et al., 2005), and temperature variations over that altitude range are smaller than 20% (Smith, 2008). Each observation is thus characterized at each wavelength by three free parameters: the surface albedo (A), the aerosols optical depth (τ), and the scale height of aerosols (H). For each planet we built a look-up table of apparent reflectance as a function of these three

Table 1
Selected optical parameters for aerosols in the near-IR (1 μm–2.5 μm).

Single scattering albedo	Phase function
Mars	
0.974 (Vincendon et al., 2007)	Henyey–Greenstein, asymmetry of 0.63 (Ockert-Bell et al., 1997)
Titan	
0.984 (1.1 μm), 0.974 (1.3 μm), 0.954 (1.6 μm), 0.93 (2.0 μm) (Tomasko et al., 2008)	Phase functions from Tomasko et al. (2008), Table 1a