even further (Shields & Hamann 1997; Gabel et al. 2005). The location of these absorbing material is uncertain. Models of X-ray absorbers in AGN place them in a wide range of distances from the central source, from winds originated at the accretion disk (Murray et al. 1995; Elvis 2000), out to the dusty (∼1 pc) torus (Krolik & Kriss 2001) and beyond the narrow-line region (e.g., Ogle et al. 2000).

In the Seyfert galaxy NGC 3783 the 900 ks *Chandra* spectrum of Kaspi et al. (2002) allows the precise measurements of radial velocities and widths of the lines. It is seen that the velocity shift of lines from Fe XXIII-Mg XII covers a range of ∼60–600 km s^{-1} while the low-ionized lines Si XIII-O VII cover velocities ∼500–1000 km s^{-1} (see Figure 6 in Ramírez, Bautista, & Kallman 2005). The average velocity of the warm absorber outflow of NGC 3783 is around ∼500 km s^{-1}. The spectrum also reveals that the line profiles are asymmetric (Kaspi et al. 2002), in such a way that approximately 90% of the lines have extended blue wings. Such asymmetries were quantified by Ramírez et al. (2005). In terms of ionization, mostly high ionization species are seen in the short-wavelength portion of the spectrum ∼4–12 Å. Here, resonant lines from Fe XXIII, Fe XXII, Fe XXI, S XVI, S XV, Si XIV, and Mg XII cover ionization parameters ξ from ∼630 to ∼150 erg cm s^{-1}. The longer wavelengths of the spectrum, ∼10–20 Å, are dominated by lower ionization lines from Si XIII, Fe XVIII, Ne X, Mg XI, Fe XVII, Ne IX, O VIII, and O VII that span ionization parameters ξ from ∼125 erg cm s^{-1} down to ∼8 erg cm s^{-1}.

Thus, photoionization modeling shows that the observed spectrum is hardly explained by a single ionization parameter. Rather two or three components are needed, and this has been the subject of well-detailed studies (Krongold et al. 2003; Netzer et al. 2003; Krongold et al. 2005). In these papers two/three components in pressure equilibrium are enough to account for all the charge states seen in the spectra. At the start of these simulations, the ionization parameter is not kept constant throughout the cloud but made to vary in a self-consistent way. On the other hand, Steenbrugge et al. (2003) used a nearly continuous distribution of ionization parameters that spans three orders of magnitude. In reality both approaches do not need to be contradictory. We just have to look at the possibility of introducing species between the components proposed by Krongold et al. (2003); Netzer et al. (2003); Krongold et al. (2005); and this immediately leads us to the discussion of whether the material absorbing is clumpy or not. And this is in part the goal of the present work. We present both possibilities, continuous *vs* clumpy flows, with their physical implications.

Although there is no evident correlation between the ionization of the absorption species and the velocity shifts of lines (Kaspi et al. 2002), Ramírez et al. (2005) suggested the possibility for such relationship to exist, as the lines are consistent with being originated from an outward flowing wind. In that work a wind velocity law was adopted (Castor, Abbott, & Klein 1975), with an ionization fraction that goes as a power-law of the ionization parameter $q \sim \xi^{\eta}$ with $\eta > 0$ for all ξ and all lines. Further, $q \sim \xi^{\eta}$ and an optical depth of the form proposed by the SEI method from Lamers, Cerruti-Sola, & Perinotto (1987) were used to fit the lines in the spectrum and to study the possible relationship between the profiles and the expansion velocity of the flow.

Here, in this theoretical approach no analytical dependence of q with ξ is assumed, but it is computed self-consistently using the photoionization code XSTAR with modifications of the optical depth of the lines to work with an expanding outflow.

It is the aim of the present paper to further study the wind scenario for the warm absorber of NGC 3783 by modeling a photoionized wind flow and trying to reproduce the main features in the spectrum in terms of both equivalent widths and line profiles. The model consists of a spherically symmetric gas flow with velocity increasing with radius according to the wind velocity law of Castor et al. (1975). The microphysics of the plasma is then solved in detail along the wind, and radiative transfer is treated for the flowing plasma including Doppler shift effects on the emerging spectrum. This kind of approach has been used previously in studies of the ionization and thermal properties of O stars by Drew (1989), on cataclysmic variables by Drew & Verbunt (1985) and in an evaluation of absorption line profiles from winds in AGN by Drew & Giddings (1982).

Self-consistent hydrodynamic modeling of AGNs has been performed in the past (see e.g., Murray et al. 1995) who qualitatively predict the same β-velocity law, where $v(r) \sim (1 - r_0/r)^{\beta}$, as adopted here. However, these models did not include a detailed treatment of the thermal and spectral processes that lead to synthetic spectra.

The present paper is organized as follows: In § 2 we discuss the statistical significance of the X-ray lines under study. Later in § 3, we present the theoretical method we have used in this work. In § 5 we present the main results of our work. We present