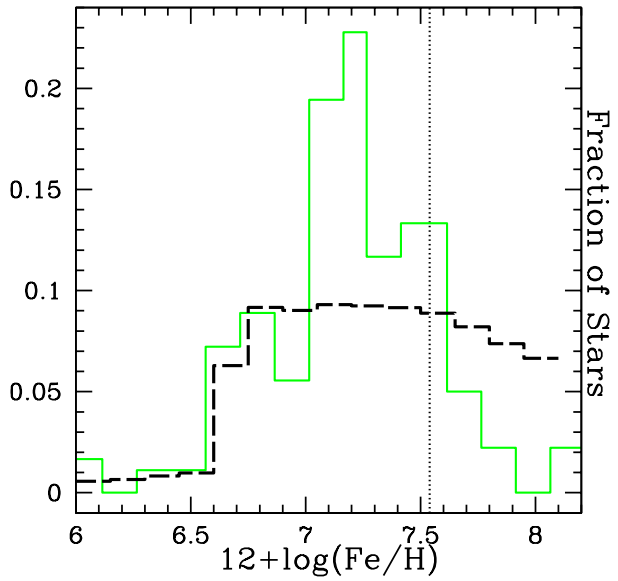

Fig. 11. Iron distribution function. Predictions for $r = 3$ kpc model that assume IWY (long-dashed black line) until 7 Gyr. Observed distribution for the outermost fields ($b = -12$) along the bulge minor axis by Zoccali et al. (2008) (continuous green line). Dotted line: protosolar Fe/H value from Asplund et al. (2009). The color figure can be viewed online.

is due mainly to LIMS, while the C/O rise from −0.5 dex to 0.0 dex is due to both massive stars and LIMS.

In Figure 10 (O/Fe-Fe/H and time-Fe/H panels), we included the chemical abundances determined by Bensby et al. (2010b) in microlensed dwarf and subgiant stars of the Galactic bulge. In order to convert the data of Bensby et al. (2010b) to abundances by number, we used their solar abundances. The stellar ages were normalized to the age of the model ($t = 13.0$ Gyr).

Our model at $r = 3$ kpc successfully reproduces the O/Fe-Fe/H obtained by Bensby et al. (2010b), but the time-Fe/H relation is only partially reproduced. Our model explains all old-metal-poor stars and two young stars, but not the oldest metal-rich star in their sample (see the square at 12+log(Fe/H)∼7.9) which behaves like a common bulge star, see Ballero et al. (2007). The youngest and more metal-rich stars would be disk stars that formed at $r < 3$ kpc.

Since Fe is produced by massive stars and binary systems of LIMS, to a first approximation Fe behaves like C, which is produced by MS and single LIMS, see for example Akerman et al. (2004), and the C/O-O/H discussion presented above can be used to explain the O/Fe-Fe/H and time-Fe/H panels of Figure 10.

Bensby et al. (2010a) have studied red giant stars in the inner Galactic disc and find that the abundance trends of the inner disc agree very well with those of the nearby thick disc, and also with those of the Galactic bulge. Based on the stellar results of the thick and thin disks of the solar vicinity, of the inner Galactic disc, and of the Galactic bulge (Bensby & Feltzing 2006; Bensby et al. 2010a,b), they suggest that the bulge and the disk have had similar chemical histories. Moreover, Alves-Brito et al. (2010) also suggest that the bulge and local thick disk stars formed over similar timescales with similar star formation rates and initial mass functions.

Cescutti et al. (2009) present a Galactic bulge model, computed by Ballero et al. (2007), in which, in order to reproduce the total stellar mass, the iron distribution function, and the α/Fe-Fe/H relations (all constraints obtained from giant stars) they assume: a formation time scale of ∼0.1 Gyr, as well as a star formation efficiency one order of magnitude higher and an IMF flatter for $m > 1\ M_{\odot}$ than those considered in our models. This model, with a SFR as long as 0.5 Gyr, cannot explain the ages of the youngest bulge dwarfs found by Bensby et al. (2010b).

Note that, if we focus only on the C/O-O/H and O/Fe-Fe/H relations determined in dwarf stars of the Galactic bulge, we cannot distinguish between a scenario with a very rapid infall, efficient star formation, and a high relative formation of massive stars –that by Cescutti et al. (2009)– and another scenario with an order of magnitude less rapid infall, an order of magnitude less efficient star formation, and a lower relative formation of massive stars – the one presented in this paper.

Nevertheless, if we focus on the age-Fe/H relation shown by bulge dwarf stars, our model, with an extended bulge formation time and therefore an extended star formation history, produces a better fit to the data than that by Cescutti et al. (2009).

In Figure 11 we show the iron distribution function predicted by the IWY model for $r = 3$ kpc in the Galactic disk from 0 to 7 Gyr. Since there are no good abundance determinations for the inner parts of the Galactic disk, we compare our model with the 104 stars that belong to the outermost field along the bulge minor axis at $b = -12$, see lower panel of Figure 14 by Zoccali et al. (2008). We have used $12+\log(\mathrm{Fe/H})_{\odot} = 7.50$ to convert the [Fe/H] values of the Zoccali et al. (2008) sample to Fe/H abun-