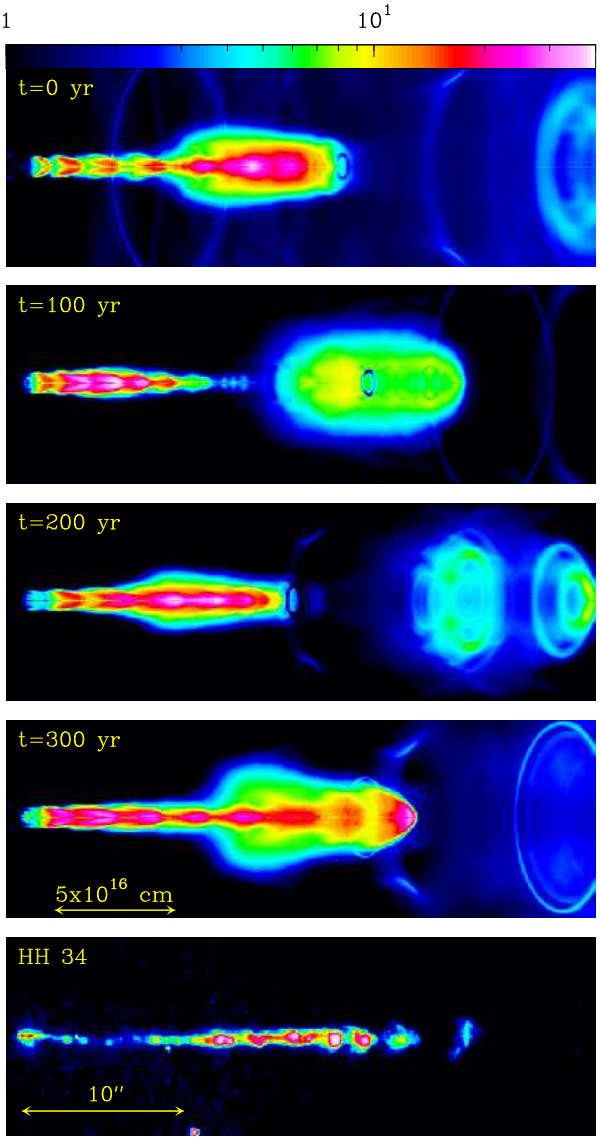

Fig. 7. The same as Figures 5 and 6 but for the $\sigma = 0.5$, 3-mode jet model (see § 4). The color figure can be viewed online.

In order to quantify these variations, we have defined segments along the [S II] tracings, incorporating the emission of the better defined knots. The positions and lengths of these segments were defined on the 1998 image (top frame of Figure 10), and were displaced $0''.7$ in the $+x$ direction for calculating the knot intensities in the 2007 frame (except for the segment incorporating the emission around the outflow source, which was not displaced). This displacement corresponds to the average motion of the knots along the HH 34 axis between the two epochs (corresponding to a proper motion of $\approx$170 km s^{-1}, consistent with previous measurements of proper motions in this outflow). In the bottom frame of Figure 10, we plot the 2007/1998 intensity ratios for the successive knots (defined above), showing that some of the knots have had intensity variations of up to a factor of $\sim$2.

From Figures 8 and 9 we notice that intensity variabilities similar to the observed ones are also seen in the predicted intensity maps over 10–20 yr time-intervals. For example, from $t = -60$ to $t = -50$ yr and $t = -40$ yr we see that the main knots have intensity changes (with the brightest knot becoming fainter, and some of the other knots brighter). Also, a systematic brightening of the region close to the source is seen from the $t = 0$ to the $t = 60$ yr time-frames, with clear changes over each decade.

None of the predicted intensity maps show [S II] emission structures that one could even attempt to compare quantitavely with the HH 34 knots. However, it is clear that several of the time-frames from the model do show structures which resemble the observed knots (see Figures 8 and 9).

5. CONCLUSIONS

We have presented a systematic study of the effect of having a non-top hat velocity cross section in the ejection of a variable jet. We have chosen a parabolic velocity cross section, with an edge-to-center velocity ratio $\sigma = 0.25 \rightarrow 1.0$.

For a jet with a single-mode, sinusoidal ejection velocity variability (see equation 1), we find that for larger edge-to-center velocity contrasts (i.e., for lower σ values) the internal working surfaces develop bow shapes with progressively more extended wings. These bow wings appear as extensions to the [S II] emission from the knots, filling in the gaps between the knots (see Figure 3).

We then compute a model with the three sinusoidal modes deduced from observations of the HH 34 jet by Raga et al. (2002). We find that a model with $\sigma = 0.75$ produces a chain of knots close to the source which better resembles the HH 34 [S II] emission than models with $\sigma = 1$ (i.e., with a top-hat ejection cross section) and with $\sigma = 0.5$ (this model producing a chain of knots with a too low intensity contrast between the knots and the inter-knot regions).

Finally, we present a time-sequence of the [S II] emission of the knots predicted from the $\sigma = 0.75$, three-mode model, and compare the maps with two epochs of HST images of HH 34 (with a $\approx$10 yr time interval). We find that the model predicts knot structures with reasonable qualitative similarity to