while for D1 we have \( p = 0 \) and \( v_{\text{gas}} \propto \sigma^{-1} \). Case D1 thus features significantly higher gas velocities at small radii, explaining why radiation pressure is ineffective in this case.

Our two cases with an inflow rate of \( 10^{-10} M_\odot \, \text{yr}^{-1} \), C2 and D2, and intermediate between the more and less rapidly accreting cases. Examining C2, Figure 11, we see that radiation is able to flow the inflow at small radii, leading to the buildup of a region of enhanced surface density near the star, unlike in case C1. However, it is unable to push this ring back from the star, as happens in case C3. Similarly, in D2, Figure 14, we see that radiation has little on the larger grains, except for creating a small density bump at the smallest radii, but efficiently repels grains in our smallest size bin from the star, leading to a central hole in small grains only. Thus the outcome in case D2 is similar to that in D1 for large grains (i.e., radiation has no effect and the disc remains steady), and similar to that in D3 for small grains (i.e., a hole opens).

Figure 11. Same as Figure 5 (case A2), but for the run with \( M = 10^{-10} M_\odot \, \text{yr}^{-1} \) (case C2 in Table 2); note how the outcome in this case is intermediate between that of case C1 (\( M = 10^{-9} M_\odot \, \text{yr}^{-1} \)) and A2 (no laminar accretion). An animated version of this figure is included in the Supplementary material (online).

Figure 12. Same as Figure 5 (case A2), but for the run with \( M = 10^{-11} M_\odot \, \text{yr}^{-1} \) (case C3 in Table 2); note that the two figures are nearly identical, indicating the minimal effect of laminar accretion at \( 10^{-11} M_\odot \, \text{yr}^{-1} \). An animated version of this figure is included in the Supplementary material (online).

5 DISCUSSION

5.1 Astrophysical Implications

First consider the results in the absence of a laminar accretion flow. In our simplified one dimensional case, we found that grains clear faster than they accrete for a dimensionless parameter \( \chi \gtrsim 10 \) (Equation 44). Considering now the 2D models of Section 4, it is helpful to keep in mind that the accretion timescale \( t_{\text{acc}} \) in physical units was \( \sim 3 \) Myr for our relatively low viscosity parameter \( \alpha = 10^{-4} \), so a more relevant criterion for whether radiative dust clearing is significant is arguably whether the clearing timescale \( t_{\text{clr}} \) is on the same order of magnitude as the \( \sim 0.1 \) Myr timescale for the transitional disk phase as constrained by population studies (Alexander et al. 2014). This timescale \( t_{\text{clr}} \) has no dependence on \( \alpha \) for high \( \chi \), and is proportional to \( \epsilon^2 f_d \) (Equation 54, noting that \( \rho_g \propto \epsilon \)). For our case with gas surface density power law index \( p = -1.5 \), in our most gas- and dust-rich case, case A1, we have \( \epsilon^2 f_d / 0.01 = 10^{-4} \), while the values are \( 10^{-5} \) for case A2 and \( 10^{-6} \) for case A3.