Contents

1 Introduction

These simulations are created to study the phenomenon of common envelops, where a massive point-like star (such as a white dwarf or neutron star) companies a red giant star. and both stars lies in the "atmosphere" of the red giant.

At frame 0, both runs only have a red giant with a core that is considered to be a point mass, the radius of the red giant is 3.35×10^{12} cm ($48.17 R_\odot$)

At later frame, we added a second 'point mass' to be the secondary, the location of the second mass is 3.409×10^{12} cm from the center of the right giant

A rough comparison between the runs is shown is the following table

run#	accretion	box size	Damping	refinement region	softening length
143	No	8×10^{13} cm	No	Large	$2.4 R_\odot \rightarrow 1.2 R_\odot$
132	Yes	4×10^{13} cm	Yes	Small	$2.4 R_\odot$

1. Accretion determines if we allow matter to 'accrete' on the point mass
2. Damping: The damping term is added to the entire box. When turned on, Some time are allowed in the simulation to cancel slight fluctuation in the box (especially inside the red giant) by adding a damping term to wherever the system has an unexpected fluctuation.
3. refinement region: The radius where the simulation grid are smaller, indicating the simulation being more precise (and more time-consuming)
4. softening length: The length where we manually change the effect of gravity by setting the gravitational force inside the softening length radius to be a certain value rather than calculated using Newton's law. We used 5 softening lengths in this simulation. Such manipulation will help us to avoid the effect that a particle get scattered too much if it get too close to the point mass. In addition to the softening length, some methods are used at the boundary to ensure energy conservation during spiral-in

2 Some information about method used

In this document four comparison methods are used: pseudocolor color plot, the lineout data along the line connecting the center of both stars, maximum value of each frame and the percentage difference between the maximum values.

The pseudocolor color plots are generated using VisIt, the figure is a cut of the box along the center of the z-axis, resulting in a figure of the x-y plane where both star lies.

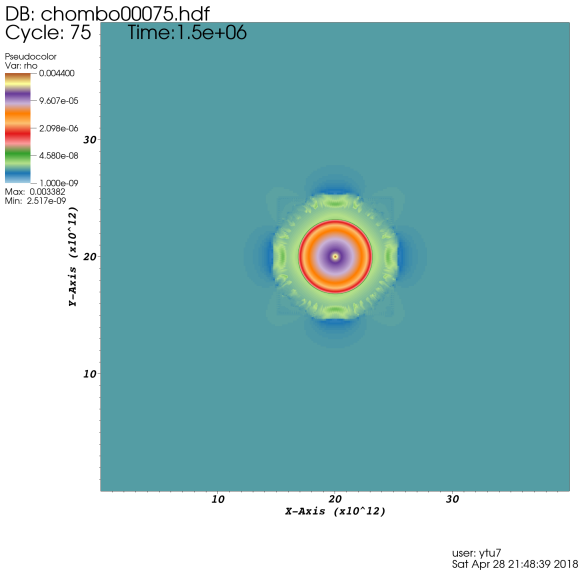
The lineout figures draws a line connecting the center of the primary and the secondary. This is done with a script that moves the stars onto a line so the lineout would be percise. The radius of the lineout is $130 R_\odot$ from the secondary, which completely covered the area of interest. However, the reported lineout figure used data from $-80 R_\odot$ to $-20 R_\odot$, which covers the central region of the red giant. Note, the center of the red giant is not necessarily the centure of the lineout plots. The figures are generated with python

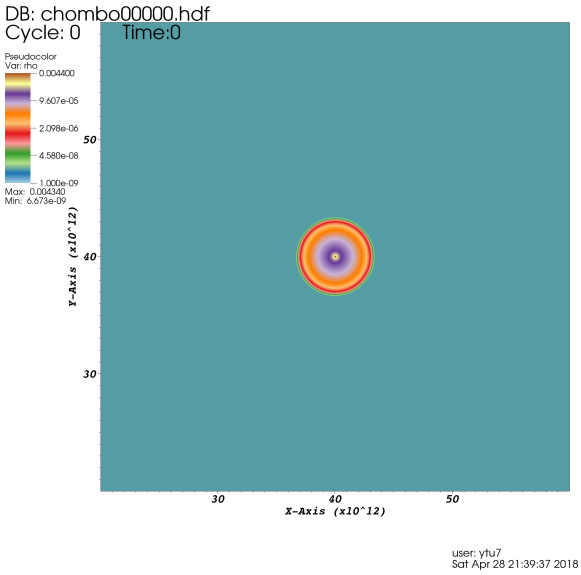
The Maximum plot compares the values of the maximums and the locations of the maximums.

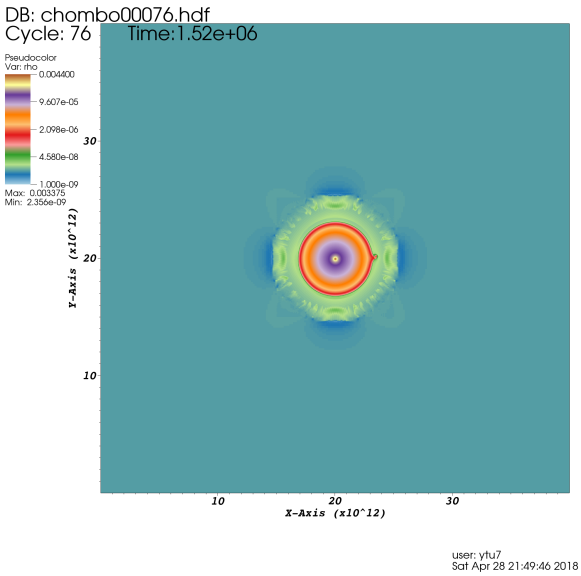
The percentage difference plot calculates $\frac{\max 143 - \max 132}{\max 143}$. The reported value is in percentage, which means the values are $\frac{\max 143 - \max 132}{\max 143} * 100\%$

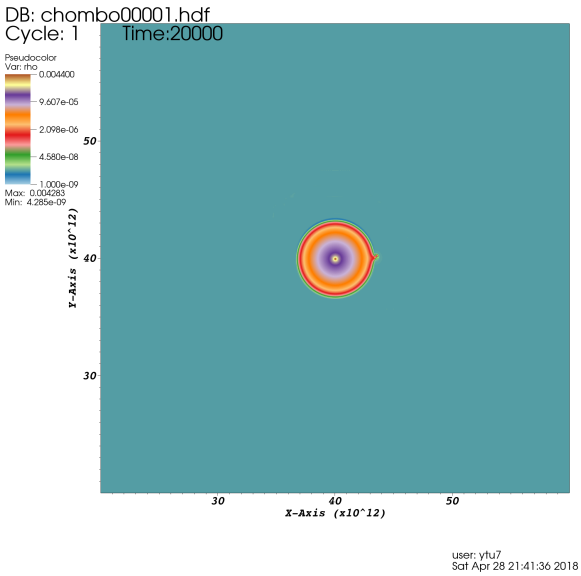
3 ρ comparison

3.1 ρ pseudocolor

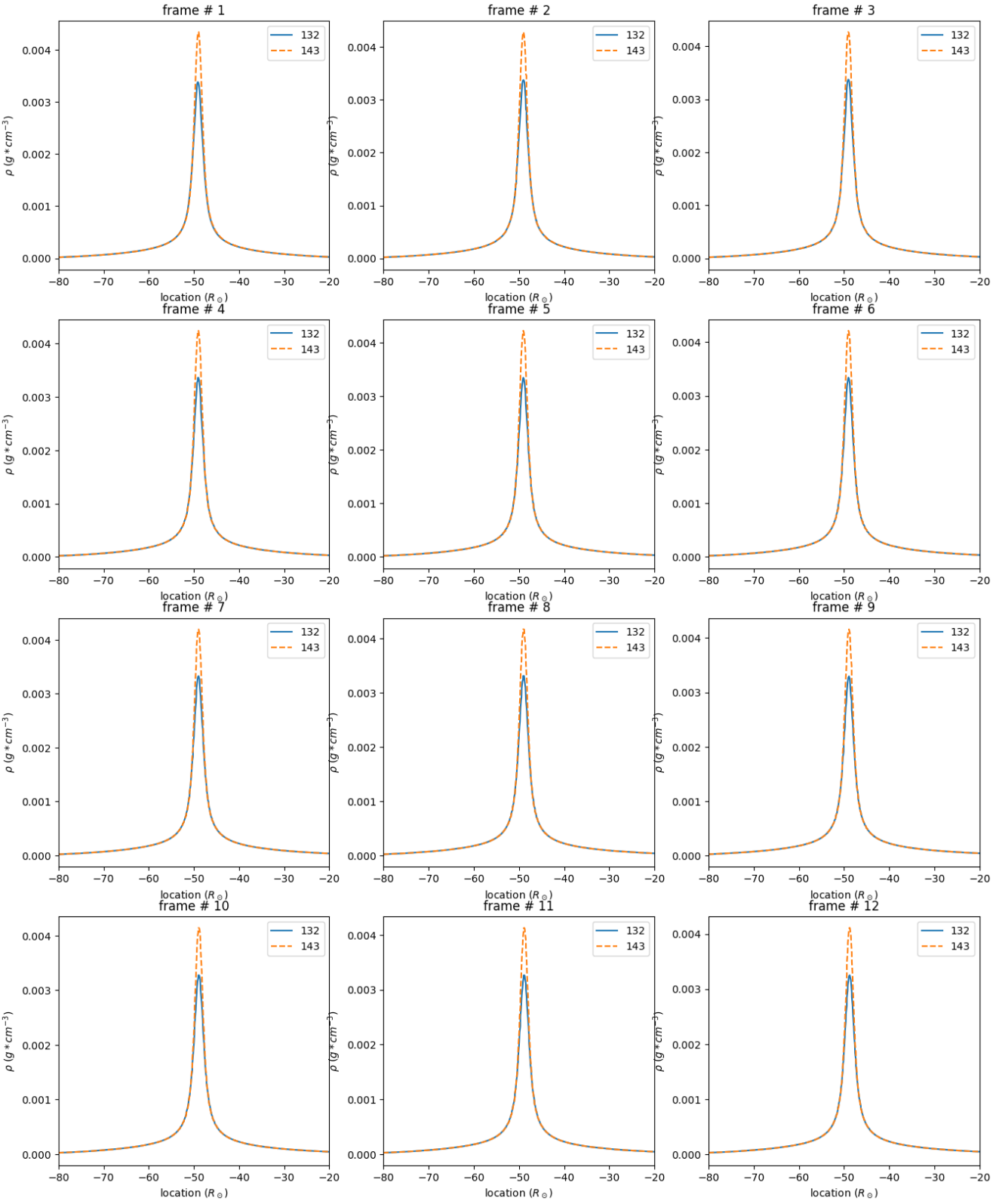




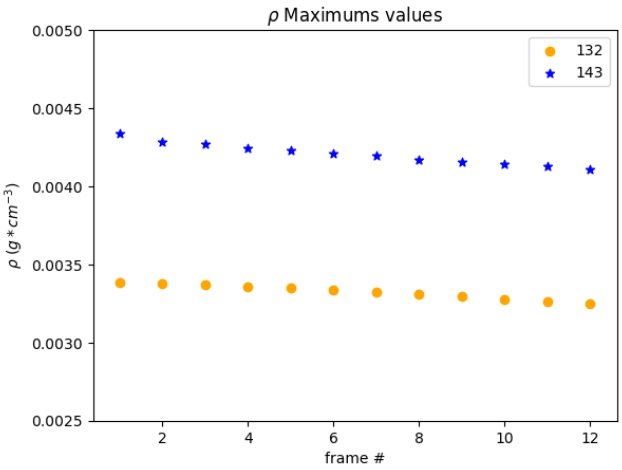


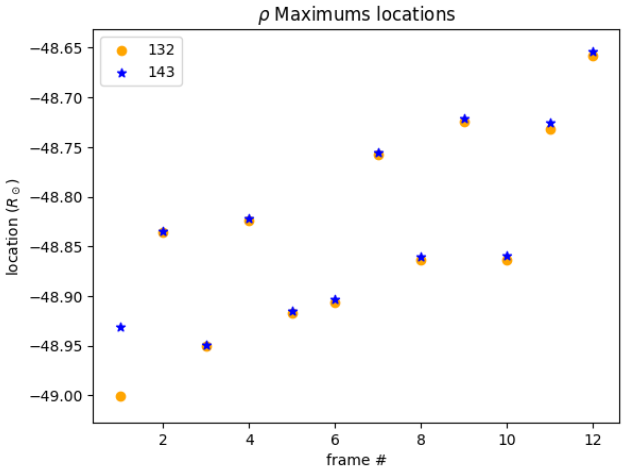


3.2 ρ each frame comparison



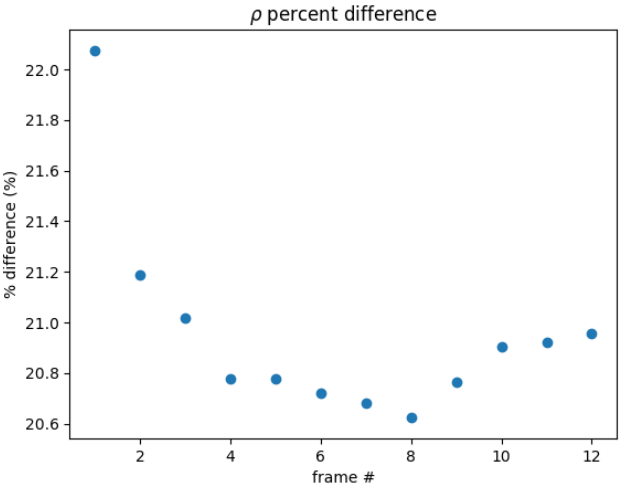
3.3 ρ maximum comparison





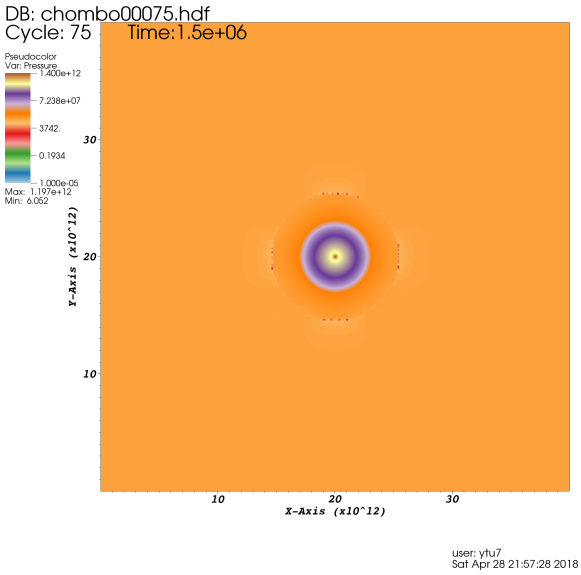
3.4 ρ percent difference

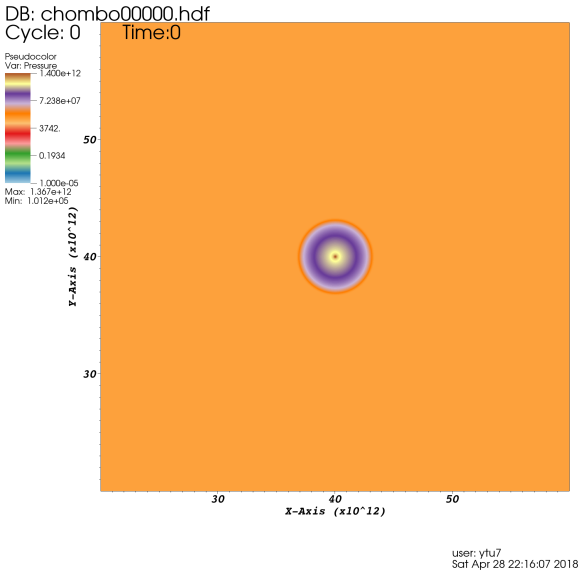
remark: The values reported is $\frac{\max 143 - \max 132}{\max 143}$ in percentage

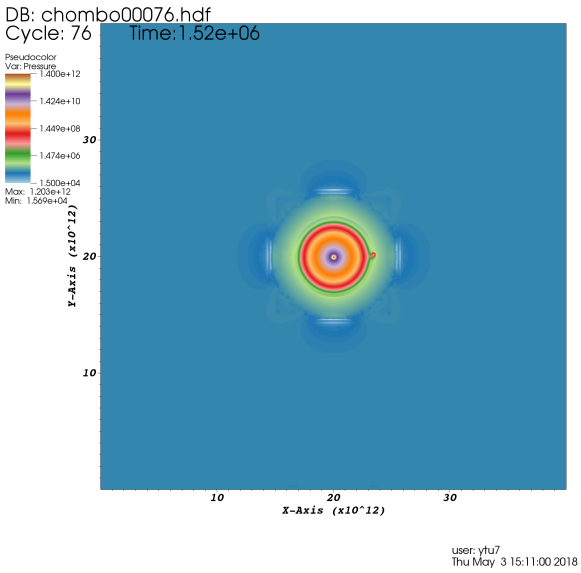


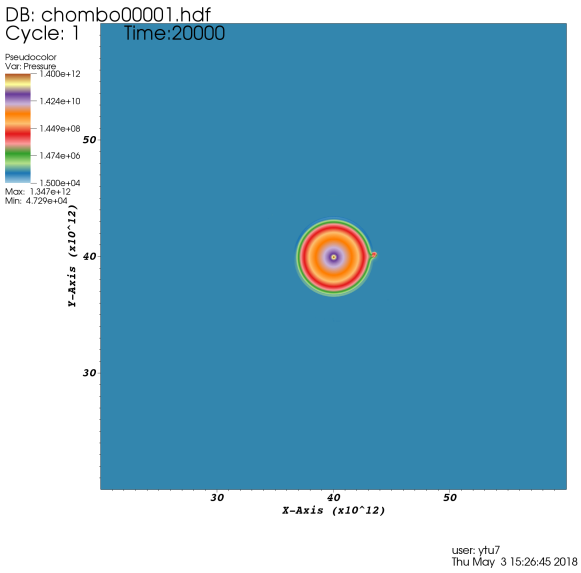
4 pressure comparison

4.1 pressure pseudocolor

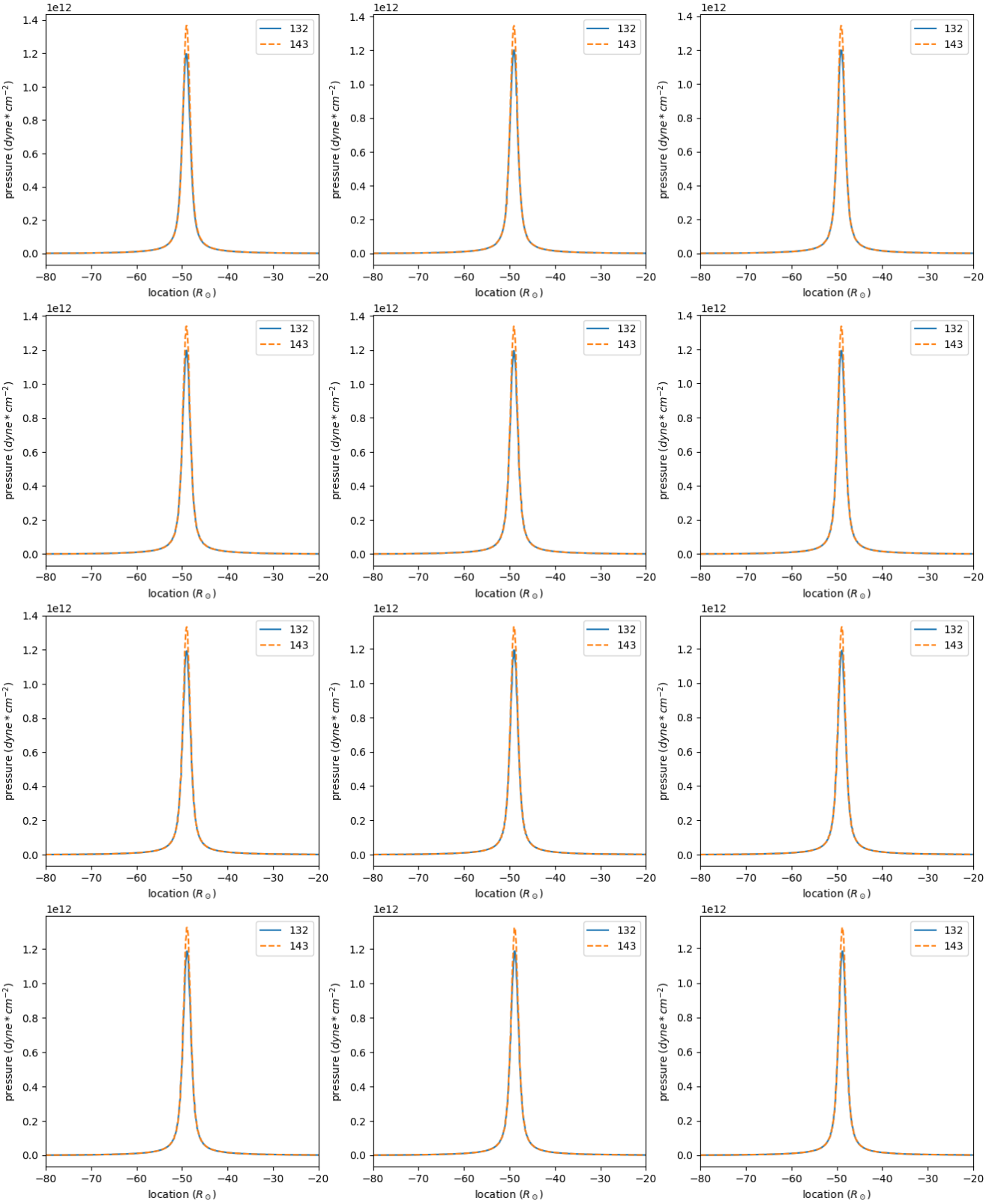




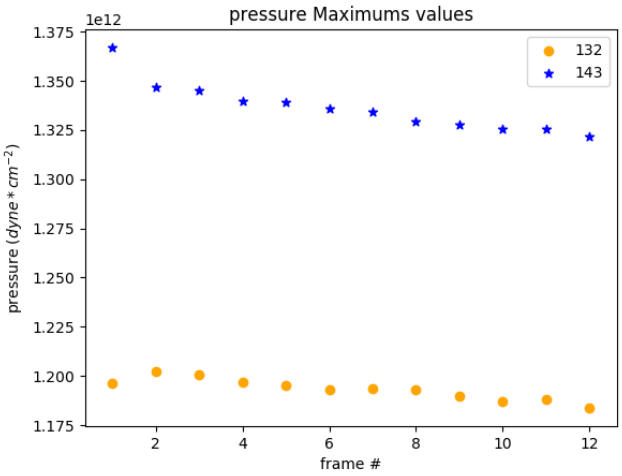


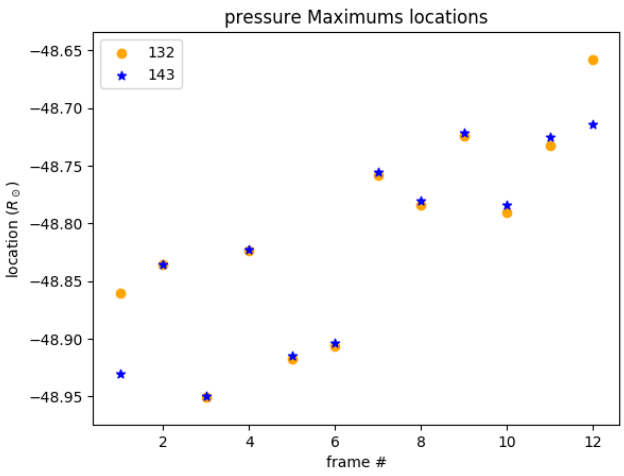


4.2 pressure each frame comparison



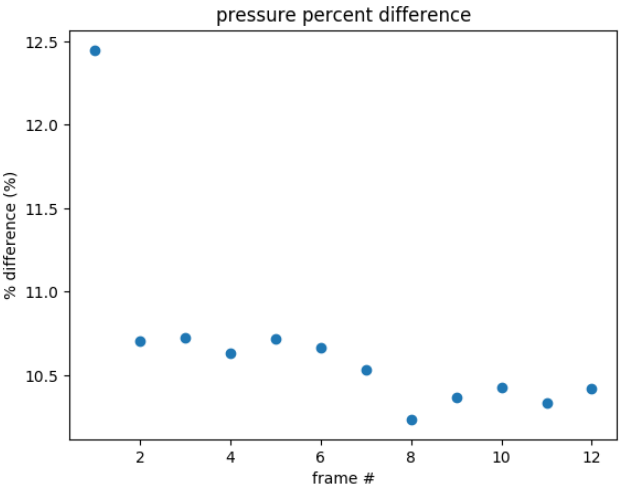
4.3 pressure maximum comparison





4.4 pressure percent difference

remark: The values reported is $\frac{\max 143 - \max 132}{\max 143}$ in percentage



5 mach comparison

5.1 mach pseudocolor