Section 1

Your Name

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Section 1

The Gnuplot script for this plot is as follows:

```
reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma

set style line 99 lt 0 lw 1.5 pt 0 ps 1.0
set style line 1 lt 1 lw 1.5 pt 1 ps 1.0
set style line 2 lt 2 lw 1.5 pt 2 ps 1.0
set style line 3 lt 3 lw 1.5 pt 3 ps 1.0
set style line 4 lt 4 lw 1.5 pt 4 ps 1.0
set style line 5 lt 5 lw 1.5 pt 5 ps 1.0
set style line 6 lt 6 lw 1.5 pt 6 ps 1.0
set style line 7 lt 7 lw 1.5 pt 7 ps 1.0
set style line 8 lt 8 lw 1.5 pt 8 ps 1.0

set style function lines

# Section 1.1

# Set output file
outfile1 = 'Section1.1.eps'
set out outfile1
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Define Gaussian function
f(x) = 1/(sqrt(2*pi)*sigma) * exp(-(x-mean)**2 / (2*sigma**2))
```

```
# Set initial guesses for sigma and mean
sigma = 1.0
mean = 1.0

# Fit the function to the data in columns 1 and 3
fit f(x) 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' using 1:3 via sigma, mean
# Plot data and fit
set title "Turbulent Density PDF"
set xlabel "ln(density/density_0)"
set ylabel "PDF"

# Plot column 1 vs column 3 as crosses
p 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' u 1:3, f(x)

print outfile1." created."

reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma

# Section 1.2
# Set titles and labels
set title "Turbulent Density PDF with Gaussian Fit"
set xlabel "ln(density/density0)"
set ylabel "PDF"

# Set legend position
set key top right


# Set output file
outfile2 = 'Section1.2.eps'
set out outfile2
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Plot again to save the output
p [-10:10] 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' u 1:3 with points pt 7 t
     f(x) with lines lc 'black' lw 2 title 'Gaussian Fit'
```

Figure 1 shows the resulting volume-weighted PDF.

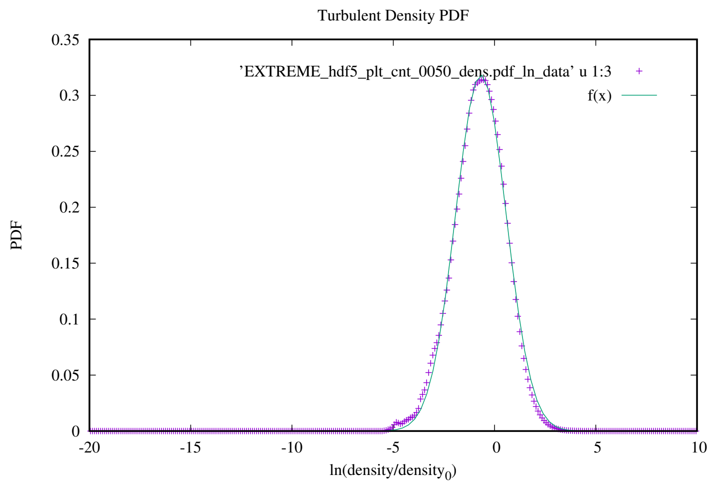

Figure 1: Volume-weighted turbulent density PDF from simulation data.

A Gaussian function is fitted to the data in the Gnuplot code. This step fits a Gaussian curve to the data and adjusts the parameters 'mean' and 'sigma' to match the data. Figure 2 shows the data along with the fitted Gaussian.

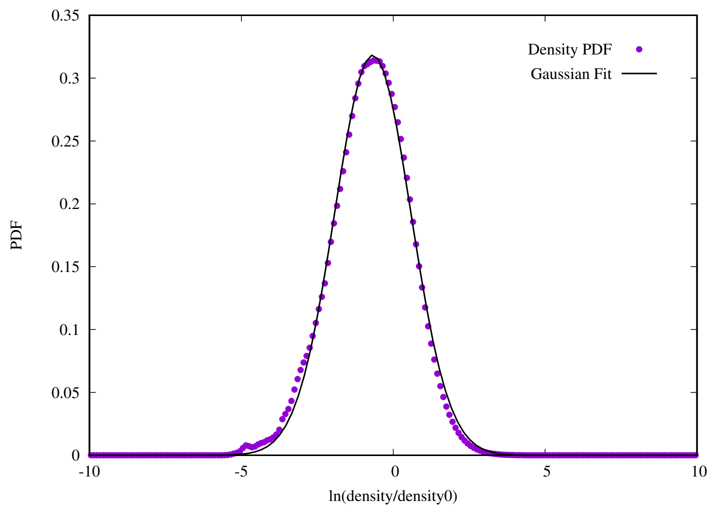

Figure 2: Volume-weighted turbulent density PDF with Gaussian fit.

Section 2

To compute the mass-weighted PDF, we multiply the volume-weighted PDF by the density, $\rho = \exp(x)$. The Gnuplot script for this transformation is:

```
reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma

set style line 99 lt 0 lw 1.5 pt 0 ps 1.0
set style line 1 lt 1 lw 1.5 pt 1 ps 1.0
set style line 2 lt 2 lw 1.5 pt 2 ps 1.0
set style line 3 lt 3 lw 1.5 pt 3 ps 1.0
set style line 4 lt 4 lw 1.5 pt 4 ps 1.0
set style line 5 lt 5 lw 1.5 pt 5 ps 1.0
set style line 6 lt 6 lw 1.5 pt 6 ps 1.0
set style line 7 lt 7 lw 1.5 pt 7 ps 1.0
set style line 8 lt 8 lw 1.5 pt 8 ps 1.0

set style function lines

# Section 2.1
# Set output file
outfile3 = 'Section2.1a.eps'
set out outfile3
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Set plot title, labels, and ranges
set title "Turbulent Density PDFs"
set xlabel "ln(density/density0)"
set ylabel "PDF"
set xrange [-10:10]
set yrange [1e-5:2]
set logscale y

# Plot data with different colors and point styles
p 'EXTREME_hdf5_plt_cnt_0020_dens.pdf_ln_data' u 1:3 with points pt 7 lc rgb "re
     'EXTREME_hdf5_plt_cnt_0030_dens.pdf_ln_data' u 1:3 with points pt 7 lc rgb
     'EXTREME_hdf5_plt_cnt_0040_dens.pdf_ln_data' u 1:3 with points pt 7 lc rgb
```

```
print outfile3." created."

reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma

# Set output file
outfile4 = 'Section2.1b.eps'
set out outfile4
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Set plot title, labels, and ranges
set title "Turbulent Density PDFs"
set xlabel "ln(density/density0)"
set ylabel "PDF"
set xrange [-10:10]
set yrange [1e-5:2]
set logscale y

# Plot data with shifting factors
p 'EXTREME_hdf5_plt_cnt_0020_dens.pdf_ln_data' u 1:3 with points pt 7 lc rgb "re
     'EXTREME_hdf5_plt_cnt_0030_dens.pdf_ln_data' u 1:($3*2) with points pt 7 lc
     'EXTREME_hdf5_plt_cnt_0040_dens.pdf_ln_data' u 1:($3*4) with points pt 7 lc

print outfile4." created."
```

The transformation allows for the generation of mass-weighted PDFs, shown in Figure 4.

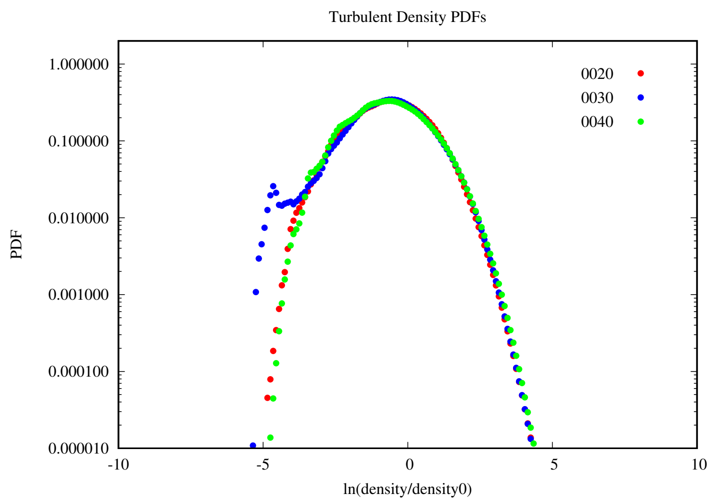

Figure 3: Mass-weighted turbulent density PDF before transformation.

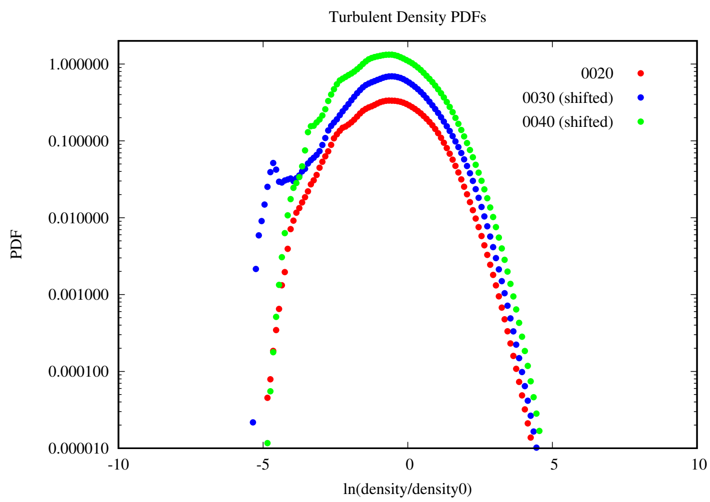

Figure 4: Mass-weighted turbulent density PDF after transformation.

Similar to the volume-weighted case, we fit a Gaussian to the mass-weighted PDF. The script used is:

```
# Section 2.2

reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma
```

```
# Set output file
outfile5 = 'Section2.2.eps'
set out outfile5
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Set plot title, labels, and ranges
set title "Mass-Weighted Turbulent Density PDF"
set xlabel "ln(density/density0)"
set ylabel "Mass-Weighted PDF (exp(ln(density)) * PDF)"
set xrange [-10:10]
set yrange [1e-5:2]
set logscale y

# Plot column 1 vs exp(column 1) * column 3 for mass-weighted PDF
p 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' u 1:(exp($1)*$3) with points pt 7

print outfile5." created."

reset
set term post eps color enhanced dashed dashlength 3.3 linewidth 1.5 "Times-Roma
```

This produces the Gaussian fit for the mass-weighted PDF, shown in Figure 5.

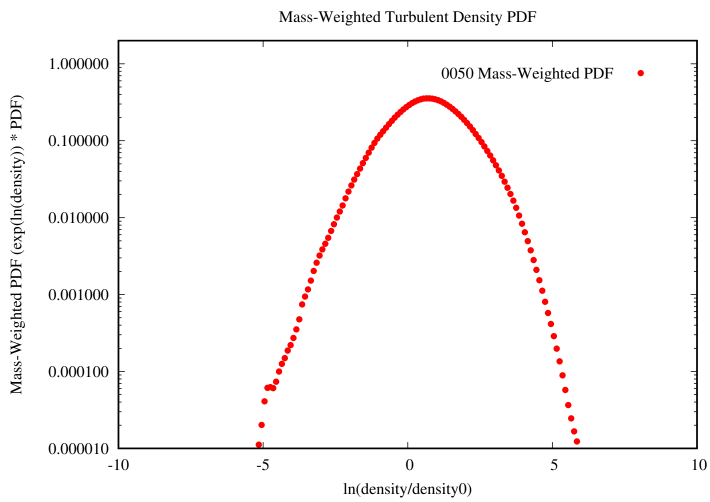

Figure 5: Mass-weighted turbulent density PDF with Gaussian fit.

Section 2.3

The final Gaussian fit of the mass-weighted PDF yields a mean of 0.71 and a standard deviation of 1.14. These values reflect the transformation applied to convert from volume-weighted to mass-weighted PDFs as shown in Figure 6.

```
    # Section 2.3

# Set output file
outfile6 = 'Section2.3.eps'
set out outfile6
unset title
set key spacing 1.5 samplen 3
set key at graph 0.95, graph 0.95

# Set plot title, labels, and ranges
set title "Fitted Mass-Weighted Turbulent Density PDF"
set xlabel "ln(density/density0)"
set ylabel "Mass-Weighted PDF (exp(ln(density)) * PDF)"
set xrange [-10:10]
set yrange [1e-5:2]
set logscale y

# Define Gaussian function for fitting
f(x) = 1/(sqrt(2*pi)*sigma) * exp(-(x-mean)**2 / (2*sigma**2))

# Set initial guesses for sigma and mean (values should be close to the expected
sigma = 1.14
mean = 0.71

# Fit the function to the mass-weighted PDF data (column 1 vs exp(column 1)*colu
fit f(x) 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' using 1:(exp($1)*$3) via s

# Plot the data and the fitted Gaussian
p 'EXTREME_hdf5_plt_cnt_0050_dens.pdf_ln_data' u 1:(exp($1)*$3) with points pt 7
  f(x) with lines lc 'black' lw 2 title 'Fitted Gaussian'

# Print the fitted mean and standard deviation to the Gnuplot shell
print sprintf("Fitted mean = %.4f", mean)
print sprintf("Fitted standard deviation = %.4f", sigma)
```

```
print outfile6." created."

reset
```

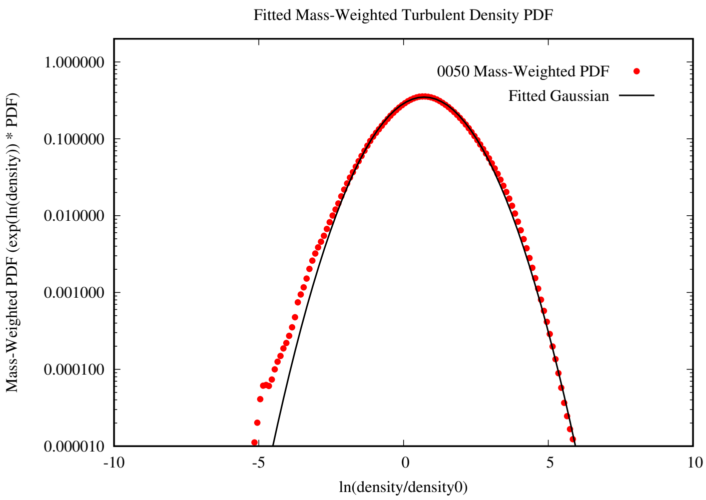

Figure 6: new mass-weighted PDF