# HIT Processing Part 2

## Question 4

### a.

#### i.

A blue and yellow image of a space

AI-generated content may be incorrect.

**Figure 1:** Instantaneous pseudo-dissipation at frame 180

The color plot of the instantaneous pseudo-dissipation clearly shows that it is contained in the small scales. It appears in highly localized, highly concentrated regions, with small tendrils of lower regions extending throughout the field. In magnitude, the instantaneous pseudo-dissipation is almost zero everywhere except the few localities where it is high.

#### ii.

A screenshot of a color plot

AI-generated content may be incorrect.

**Figure 2:** Time-averaged dissipation

#### iii.

The time and space-averaged pseudo-dissipation value is .

### b.

#### i.

A graph of a function

AI-generated content may be incorrect.

**Figure 3:** Four Compensated Structure Functions

#### ii.

Based on averaging the plateaus in all 4 compensated structure functions from l=0.015m to l=0.045m, a value for dissipation is obtained as .

### c.

Estimating dissipation based on the rms velocity and Longitudinal length scale gives .

### d.

An approximation of the production term can be used to estimate the dissipation. The space-averaged production is assumed to be equal to the dissipation, which yields a value of .

### e.

|  |  |
| --- | --- |
| Method | Dissipation estimate (m^2/s^3) |
| Direct Calculation | 0.5532 |
| Compensated Structure Functions | 0.9071 |
| Production via RMS Velocity | 0.9169 |
| Production Direct Calculation | 1.1412 |

**Table 1:** Comparison of dissipation estimates between methods

There are no underlying assumptions in the approximation via the first method, direct calculation, since it is the true definition of dissipation. However, it requires resolving gradients of fluctuating quantities. This requires resolution at extremely fine scales, which doesn’t exist in this dataset. On top of that, at small scales measurements are more sensitive.

In the second method, the assumptions are made that Kolmogorov’s scaling arguments hold. Under these arguments the structure function in the inertial subrange follows a power law scaling and depends on dissipation, and the compensated structure function corrects for the power law scaling to estimate dissipation as the plateau value in the inertial subrange. Because no gradients need to be resolved in this method, it is less sensitive.

In the third method, the assumption is made that production is equal to dissipation (ie neglecting transport of TKE). A dimensional argument can be used to derive a form for dissipation based on flow statistics. Empirical measurements in the past yield the constant for the dimensional argument. This method relies on statistics and once again, no gradients are resolved.

In the final method, the assumption is again made that production is equal to dissipation. However, production is calculated directly. In this method, mean flow gradients are required, but fluctuating gradients are not. This method is therefore less sensitive and does not require measurements at as small a scale as the first method.

In my opinion, of all the methods, the first is the least accurate. The others are roughly clustered together. I chose the second method, dissipation calculated via compensated structure functions. It does not require the resolution of any gradients, which is a sensitive process both in measurement and calculation.

## Question 5.

### a.

The calculated Kolmogorov scales are:

### b.

#### i. Calculating the Taylor microscale based on rms velocity and dissipation yields:

#### ii. The Taylor microscale can also be calculated by fitting a parabolic function to the first few points of the normalized transverse velocity correlations. Averaging the values obtained from the and correlations gives

#### iii. The values for the Taylor microscales are exactly the same, out to the .