Particle dynamics class, SMS 618, Emmanuel Boss

Acoustic Doppler Velocimeter (ADV) lab:

<u>Material:</u>
ADV.
Large tank with recirculating water.
Matlab routine to analyze files.

<u>Method:</u>
Measure 3-D velocity and acoustic signal for at least 3minutes at 4 depths above bottom (2, 4, 6, & 8cm above bottom) and at a rate of no less than 20Hz.
Compute the time mean and fluctuating velocities and acoustic signal (‘concentration’) <u>, <v>, <w>, <c>, <u’>, <v’>, <w’>, <c’>, where u is along channel (arm marked in red), and w the vertical velocity.

<u>Questions:</u>
1. How do the magnitude perturbation velocity (<u’u’>$^{1/2}$ etc’)compare with mean velocities at different depths?

2. Plot u’ vs. w’ for the different depths and compare it to Fig. 2.3 for Dade et al., 2001.

3. What is the mean profile of velocity as function of depth? Is it as you would expect?

4. What is the mean profile of acoustic signal as function of depth? Is it as you would expect? What does it indicate regarding the particle’s buoyancy?

5. What is the shear velocity as function of depth u*=<u’w’+v’w’>$^{1/2}$? Is it as you would expect?

6. How do the concentration Reynolds flux (<c’u’>, <c’v’> & <c’w’>) compare? Is it as you would expect?

7. What is the vertical eddy diffusion coefficients of along tank momentum (k_z=-<u’w’>/{d<u>/dz}})? The eddy diffusion of particles (k_z=-<c’w’>/{d<c>/dz})?How do they compare? How do they vary with depth? Is it as you would expect?

8. Assuming turbulent dissipation balances turbulent advection of vertical shear, compute ε from: ε=-<u’w’>d<u>/dz-<v’w’>d<v>/dz

9. What is the decorrelation time of velocity fluctuation? What is the decorrelation time of concentration fluctuation? Are they similar? Does it vary with depth? Is it as you would expect?

```
%program to analyze ADV data
clear all

%time between measurements (seconds, 1/sampling frequency in Hz)
delta_t=0.05;

%load data
amp=load('test3.amp');
vel=load('test3.vel');

%plot data:
m=length(vel(:,5));
figure(1)
subplot(2,1,1)
plot(delta_t*[1:m],vel(:,5),'-k',delta_t*[1:m],vel(:,6),'-b',delta_t*[1:m],vel(:,7),'-r');
xlabel('time [sec]')
ylabel('velocity [cm/s], x-black, y-blue, z-red');

subplot(2,1,2)
plot(delta_t*[1:m],amp(:,5),'-k',delta_t*[1:m],amp(:,6),'-b',delta_t*[1:m],amp(:,7),'-r');
xlabel('time [sec]')
ylabel('amplitude, x-black, y-blue, z-red');

%calculate mean and perturbation of velocity.
avg_velx=mean(vel(:,5));
avg_vely=mean(vel(:,6));
avg_velz=mean(vel(:,7));

pert_velx=vel(:,5)-avg_velx;
pert_vely=vel(:,6)-avg_vely;
pert_velz=vel(:,7)-avg_velz;

%plot w' vs u':
figure(2)
plot(pert_velx,pert_velz,'.');
xlabel('u_{prime} [cm/s]')
ylabel('w_{prime} [cm/s]')

%compute the shear velocity:
u_star=mean(sqrt(pert_velx.*pert_velz+pert_vely.*pert_velz));

%calculate mean and perturbation of acoustic amplitude (combining all, given redundency).
amp3=(amp(:,5)+amp(:,6)+amp(:,7))/3;
avg_amp=mean(amp3);
pert_amp=amp3-mean(amp3);

%compute the velocity Reynolds stresses:
uw=mean(pert_velx.*pert_velz);
vw=mean(pert_vely.*pert_velz);
uv=mean(pert_velx.*pert_vely);
uu=mean(pert_velx.*pert_velx);
vv=mean(pert_vely.*pert_vely);
ww=mean(pert_velz.*pert_velz);

%compute the concentration Reynolds stresses:
uc=mean(pert_velx.*pert_amp);
vc=mean(pert_vely.*pert_amp);
wc=mean(pert_velz.*pert_amp);

%plot data to estimate decorrelation times:
figure(3)
A=xcorr(pert_velx,'coeff');
plot(delta_t*[1:m],A(m:2*m-1));
xlabel('lag time [sec]');
ylabel('correlation coefficient, velocity');

figure(4)
B=xcorr(pert_amp,'coeff');
plot(delta_t*[1:m],B(m:2*m-1));
xlabel('lag time [sec]'); ylabel('correlation coefficient, amplitude');
```