MAST 467/667: Introduction to Arctic Oceanography (Fall 2014)

Oct.-23, 2014

Workshop/Homework-8: Surface Velocity, Probabilities, and Scales

Data: Ice-Tethered Profiler (ITP) at http://www.whoi.edu/website/itp/overview

Introduction. Scalar (such as temperature) and vector (such as velocity) fields in the Arctic and elsewhere often have stochastic properties, that is, they vary in random or unpredictable ways. This inherent property of ice, ocean, and atmospheric dynamics leads to a range of variation or uncertainty that must be quantified as part of credible scientific work.

Goal. Estimate probabilities and scales of ice velocity using ITP buoy data.

Assignment.

1. Generate a clean time series of ice velocity with components u(t) and v(t).

2. Decompose (u,v) into mean (U,V) and fluctuating flow (u',v'), e.g., u(t)=U+u'(t)

3. Depict fluctuating currents (u',v') as a histogram by counting the number of observations that fall in 1 cm/s bins, e.g., between -9 and -8 cm/s, -8 and -7 cm/s, etc. Such a histogram is a rough estimate of the probability density function used to make statistical statements on flow.

4. Find the velocity range for u' and v' within which 90% of all your velocity observations fall by reading off 5% and 95% values from the normalized cumulative histogram. Compare this with the commonly employed "standard deviation."

5.* Calculate the time-lagged auto-correlation function

$$R(\tau) = \langle u'(t)\, u'(t+\tau)\rangle / \langle u'(t)\, u'(t)\rangle$$

For both u' and v' where τ is the lag time between to observations and < > indicates the average over all observation pairs from t=0 to t=T-τ where T is the record length.

6.* Plot $R(\tau)$ and find a first estimate of the integral time scale T_D of motion by integrating $R(\tau)$ from zero to its first zero-crossing. The ratio of T/T_D gives you degrees of freedom in your (Lagrangian) velocity data set.

(*) PhD students only; further details in the context of an Arctic circulation and mixing study in the East Siberian Sea that employs these methods are

Muenchow, A., T.J. Weingartner, and L.W. Cooper, 1999: The summer hydrography and surface circulation of the East Siberian Shelf Sea, J. Phys. Oceanogr., 29, 2067-2182.