Calculating particle size distributions

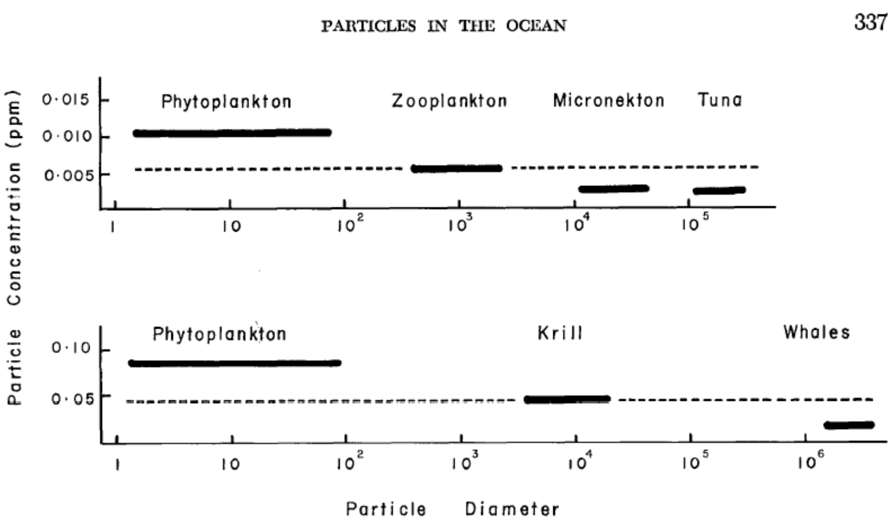
Meg Estapa

Ocean Optics Class 2025

Particle size dependent processes?

Methods to measure particle size directly

Optical proxies for particle size

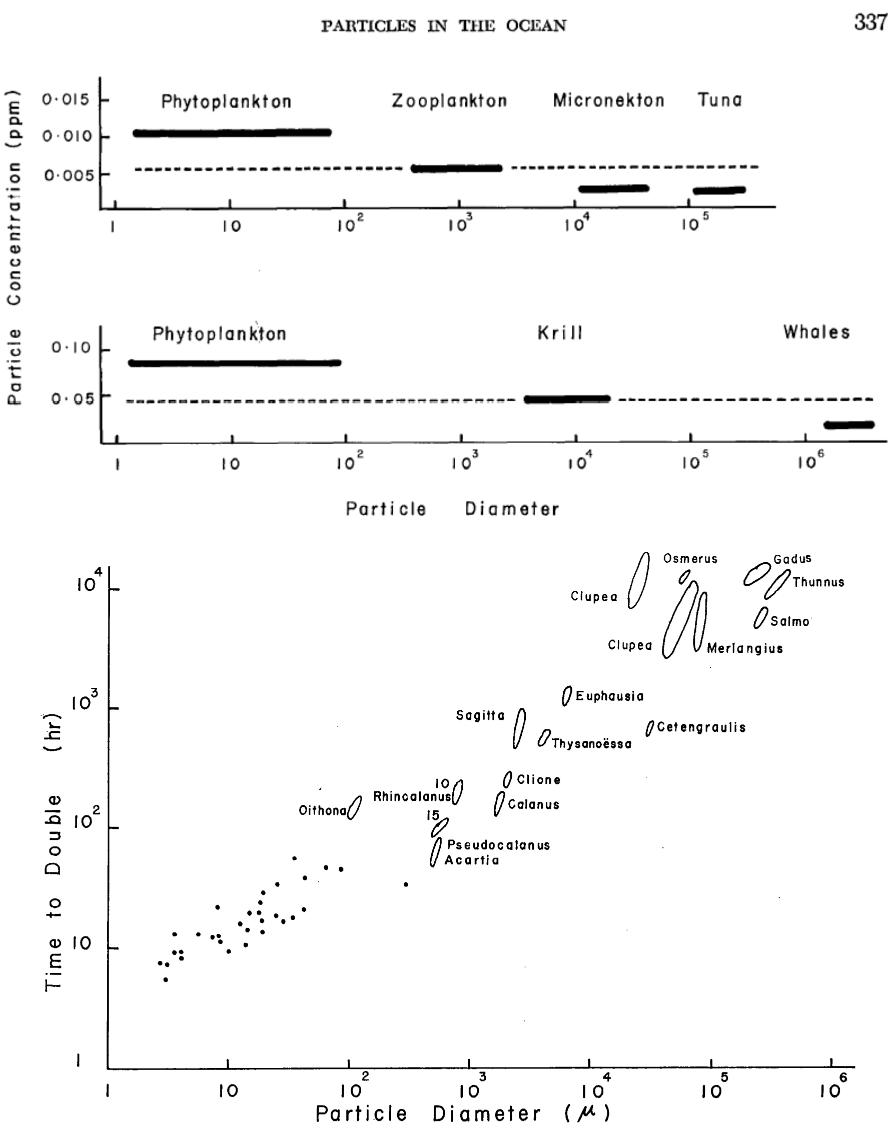


Size distributions in the ocean

Sheldon et al., 1972:

- To first order, there are roughly equal amounts of material in particles of all sizes ranging logarithmically **“from 1 μ to about 10^6 μ, i.e. from bacteria to whales”**
- Consistent with $n(D) \sim D^{-4}$

Figures: Sheldon et al., 1972. *L&O*, 17(3): 327-340.



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- Consistent with $n(D) \sim D^{-4}$

- Has important ecological implications: growth rates must be inversely related to particle size, if this canonical value holds everywhere

Things to consider when interpreting particle size distribution data

- What is the instrument's sample volume, and how many "rare" particles are there in that volume?
- What is the method's lower size detection limit? Does this manifest as a roll-off of particle counts or a rapid increase?

Figure: Jackson et al., 1997. *Deep-Sea Res. I.* 44(11): 1739-1767.

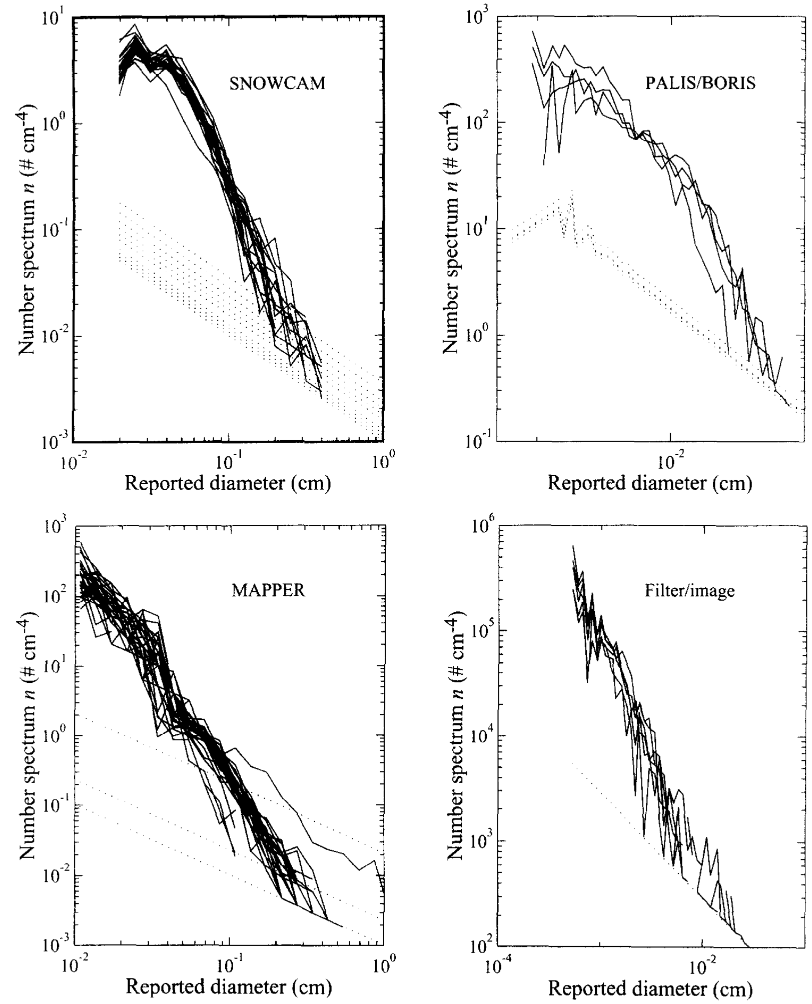


Fig. 4. Particle size spectra for the different imaging instruments as a function of size compared with the minimum detectable size spectra, n_{min}. Continuous lines represent reported spectral values; dotted lines represent n_{min}. Data represent more depths than the three emphasized in this paper. Sample volumes were not always constant between depths. Diameters are those reported for the instruments, with no attempt to convert to a common basis.

Particle size distribution slope depends on where and how you look

$$N(D) = N(D_0)*(D/D_0)^{-\xi}$$

- Hawaii Ocean Timeseries Study
- Profiles (suspended) and sediment trap (sinking) particle observations with LISST and IFCB
- Sinking particles have flatter slopes (more larger particles) than suspended particles
- No real depth trend in sinking particles
- Suspended particles increased in size below euphotic zone

Figure: Cael and White, 2020. 10.1029/2020GL087825

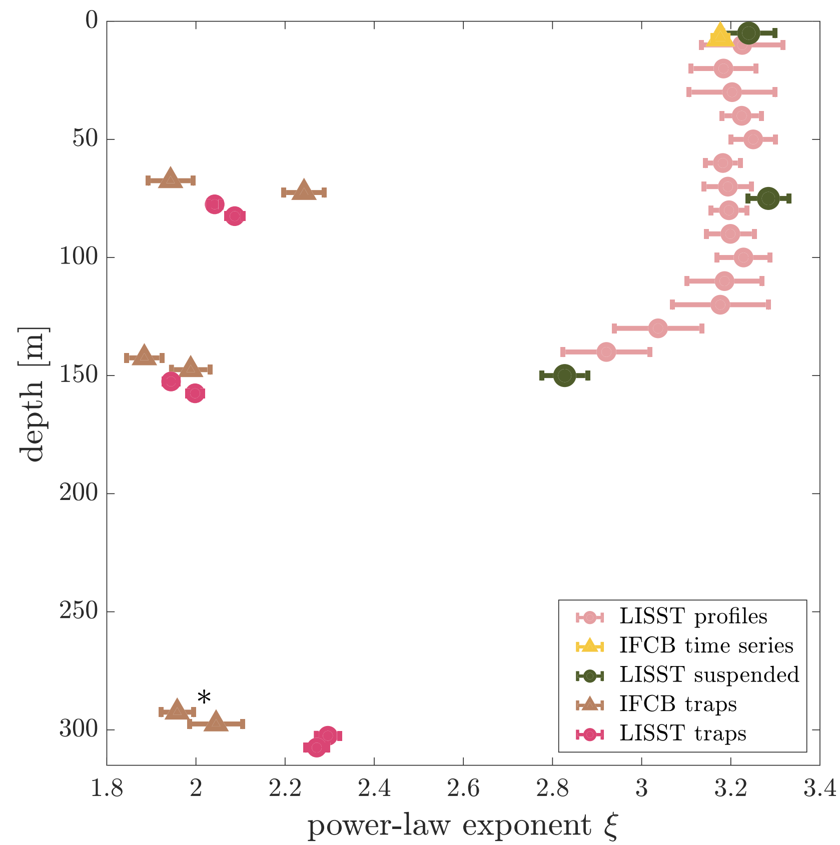


Figure 3. PSD exponent ξ of sinking and suspended material for different depths, deployments, and instruments. Error bars in all cases are standard error of the grand mean. Trap-derived ξ values are plotted vertically offset for visual aid; all measurements were made from sediment traps deployed at the same three depths (75, 150, and 300 m). *We have low confidence in the IFCB-derived ξ values at 300 m as these are based on small sample sizes, ≤10 particles/ml.

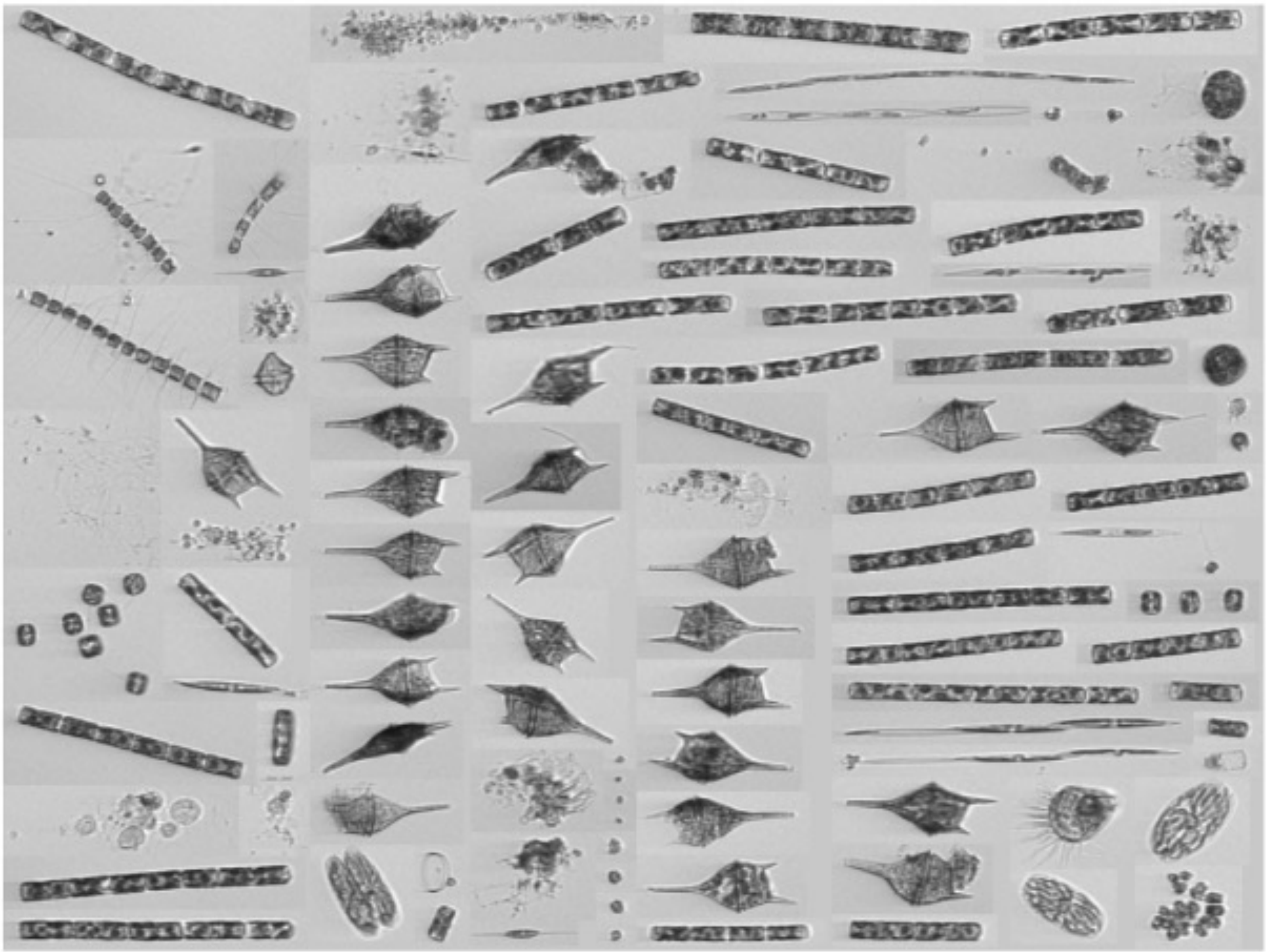
Processing and interpreting particle size data

Goals:

1. Work through a simple example of binning IFCB particle size data into size classes, visualizing uncertainty, and fitting a power-law model to the data

2. Demonstrate a (relatively) straightforward use of Matlab scripting to carry out the above steps

3. Regular and "live" versions of the Matlab scripts and data file are in class drive, feel free to download and follow along, translate to another language, or use for an example later. All files must be together in one folder to work properly.



Example of IFCB images.
Taylor Crockford, WHOI.
https://oceanobservatories.org/2024/04/historic-continuing-collaboration/