

# **Acoustic tomography, physical oceanographers, and scientific disagreement: An essay**

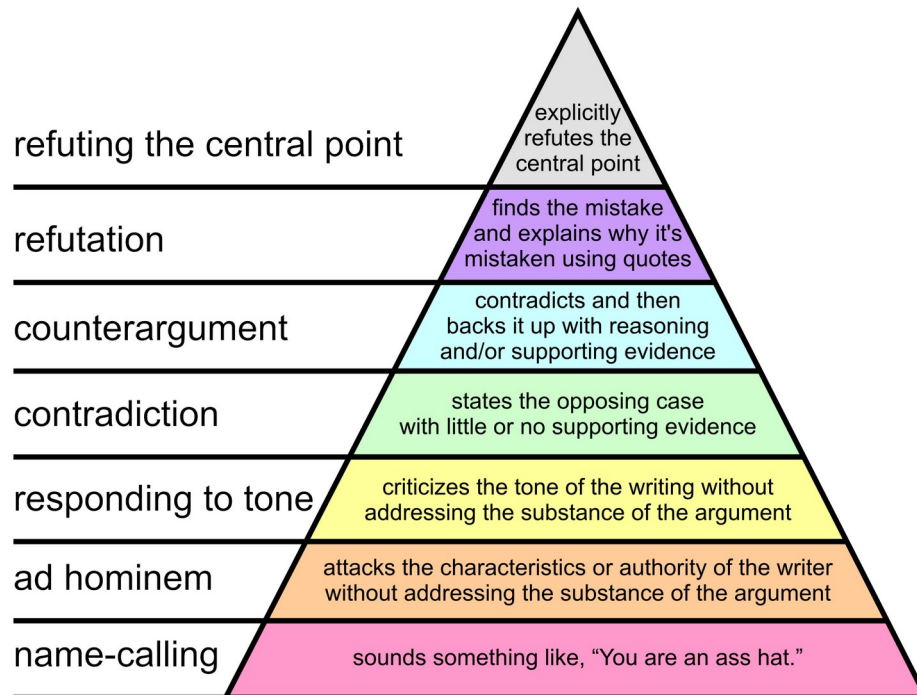
Brian Dushaw, Applied Physics Laboratory, University of Washington, Seattle, WA

April 2022

The advocacy for acoustic tomography, as a tool for scientific research or as a component of the global ocean observing system, and its opposition, present the physical oceanographic community with a scientific disagreement. The disagreement over whether such measurements should be sustained has persisted for decades now, though common practice has been to ignore the disagreement. The resolution of such a disagreement is straightforward, as prescribed by basic standards of scientific discourse. The issue could be readily resolved through careful, quantitative scientific analysis, with the conclusions published in high quality journals. The failure to resolve the question, and it is not resolved after decades, points to a weakness in the science, a weakness that the world can presently ill-afford.

The spectrum of arguments pertaining to tomography over the past decades can perhaps be assessed with the aid of Paul Graham's "Hierarchy of Disagreement" (Graham 2008). This hierarchy, given in a blogging essay by computer scientist and essayist Graham, ranks the quality of an argument in a disagreement (Figure). Arguments like name calling, "ad hominem," and simple, dogmatic contradiction ("ipse dixit") are of low quality, while those like "finding the error in the opposing argument and explaining why it is mistaken" are of higher quality. Because higher quality arguments are more challenging and require more work, they are less common, and the hierarchy could be thought of as forming a pyramid. According to all the standards of scientific discourse I am aware of, professional scientists should in all cases engage in arguments in the upper tiers. Arguments in the lower tiers are not consistent with scientific standards, hence they are, by definition, unethical. Arguments such as "Argo is all we need," and similar, are examples of "ipse dixit" arguments. Lower-tier arguments that have been employed by those in opposition to tomography have endless; this is the level of discourse I have experienced.

I have tried to adhere to upper-tier arguments in my career. In the sound speed equation disagreement, that between the Chen-Millero and Del Grosso equations, we not only showed by data that the latter equation was more accurate, I also found the source of the error in the Chen-Millero analysis, and we published those results. After repeatedly hearing the assertion that Argo obviates the need for tomography, I did a quantitative analysis to test that assertion in the North Atlantic, found that it was wrong, and published those results. Note that in science, one does not have to disprove the hypotheses of others. Our task is only to prove or disprove that our own hypotheses are correct, otherwise we will be reduced to endlessly chasing the erroneous hypotheses of others. Those that have advocated the hypothesis that Argo obviates the need for tomography have had a scientific obligation to provide data, argument, and publication to support that hypothesis; that hypothesis has no scientific support, however. It has now been refuted, subject to some future analysis or argument that shows otherwise.



*Figure 1: A schematic pyramid scheme depicting Graham's Hierarchy of Disagreement. Arguments appropriate for professional scientists are refuting the central point, refutation, or counter argument. Simple contradiction (ipse dixit), responding to tone, ad hominem, and name-calling are poor, fallacious arguments. (Image from Wikipedia 2021, public domain)*

There are other arguments than those of the above hierarchy. One such argument could be ranked the lowest of any argument, which is to ignore the opposing view altogether, to deny the existence of the dispute. Another is to make a fictional or erroneous statement about the question at hand, and then spend the remaining argument discussing why the fictional statement is wrong. Often a counter argument gets short-circuited to a non-sequitur; in discussions regarding tomography, Argo proponents often quickly provide a defense of the Argo profiling float system. That is not the issue. Although I and others have pointed out deficiencies of that system, we do not question the existence of, or challenge the support for, Argo. I have heard all these of these poor forms of argument in opposition to acoustic thermometry. No doubt the possibilities for poor argument are endless, limited only by the creativity of Man.

A good strategy in a disagreement is to repeat the objections of others, perhaps even reformulating them in a stronger fashion to avoid the "straw man" fallacy. Then provide quality counter arguments to refute the objections. In a recent publication, I attempted this approach, but the arguments I repeated (the only ones available) were of such poor quality that reviewers deemed my approach entirely unacceptable.

It is a truism that publications are important in science. When we talk to our peers or colleagues, they say, "If you want our respect, you must have publications." The administrations of our institutions regularly admonish us, "If you want pay raises and promotions, you must have publications." Our funding agencies similarly admonish us, "If you want to continue to receive grant funding, you must have publications." We require our doctoral students to publish their research in a dissertation and

present a formal defense of the work; these are the standards of scientific discourse. Publications have such value, such currency, not only because they are the formal archive of the work, but also because they are how scientific disagreements formally get resolved. The reader may by now be overwhelmed by tedium, but I ask, finally, why is it that with the world in climatological peril, when adherence to rigorous scientific standards is more important than ever, the publication standard with respect to acoustic tomography has been thrown out the window? This is a plea to the oceanographic community to remedy the situation; the world deserves better.

## REFERENCE

P. Graham, How to disagree, PaulGraham.com, <http://www.paulgraham.com/disagree.html>, 2008.

For discussions of "ad hominem", "ipse dixit", or "straw man" arguments, Wikipedia is a good source.