Is Consensus the Goal of Science (and Should it Be?)

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Why be concerned about consensus?

Because for many years, skeptics have challenged the scientific evidence of anthropogenic climate change.

One form this challenge has taken has been to deny the existence of a consensus.

August 2003, Christine Whitman, discussed changes made to EPA report on climate change…

"As [the report] went through review, there was less consensus on the science and conclusions on climate change."

The New York Times

Thursday, June 19, 2003, A1.

While Whitman may have been accurately describing a lack of *political* consensus in the Bush administration, or even among administrators at EPA, this was not an accurate characterization of the state of climate science

Scientists *had* a clear scientific consensus: Earth was warming up, and human activities were the main reason.

Can we prove that there was a scientific consensus?

Yes

1. Consensus statements of major scientific bodies

"Human activities…are modifying the concentration of atmospheric constituents…that absorb or scatter radiant energy. [M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."

--IPCC, Climate Change 2001,

Impacts, Adaptation and Vulnerability, p. 21.

Similar statements issued by major scientific societies

- American Geophysical Union (2003)
  "Human impacts on climate"
- American Meteorological Society (2003)
  "Statement on Climate Change Research
- U.S. National Academy of Sciences Report, Climate Change Science: 2001.

AGU Statement on Climate Change was particularly strong, from perspective of a historian of science (few qualifiers or caveats)

"Human activities are increasingly altering the Earth's climate. …It is virtually certain that increasing atmospheric concentrations of carbon dioxide and other greenhouse gases will cause global surface climate to be warmer… Some impacts have already occurred…The unprecedented increases in greenhouse gas concentrations, together with other human influences on climate … constitute a real basis for concern…"

--AGU December 2003

American Association for the Advancement of Science, 2000

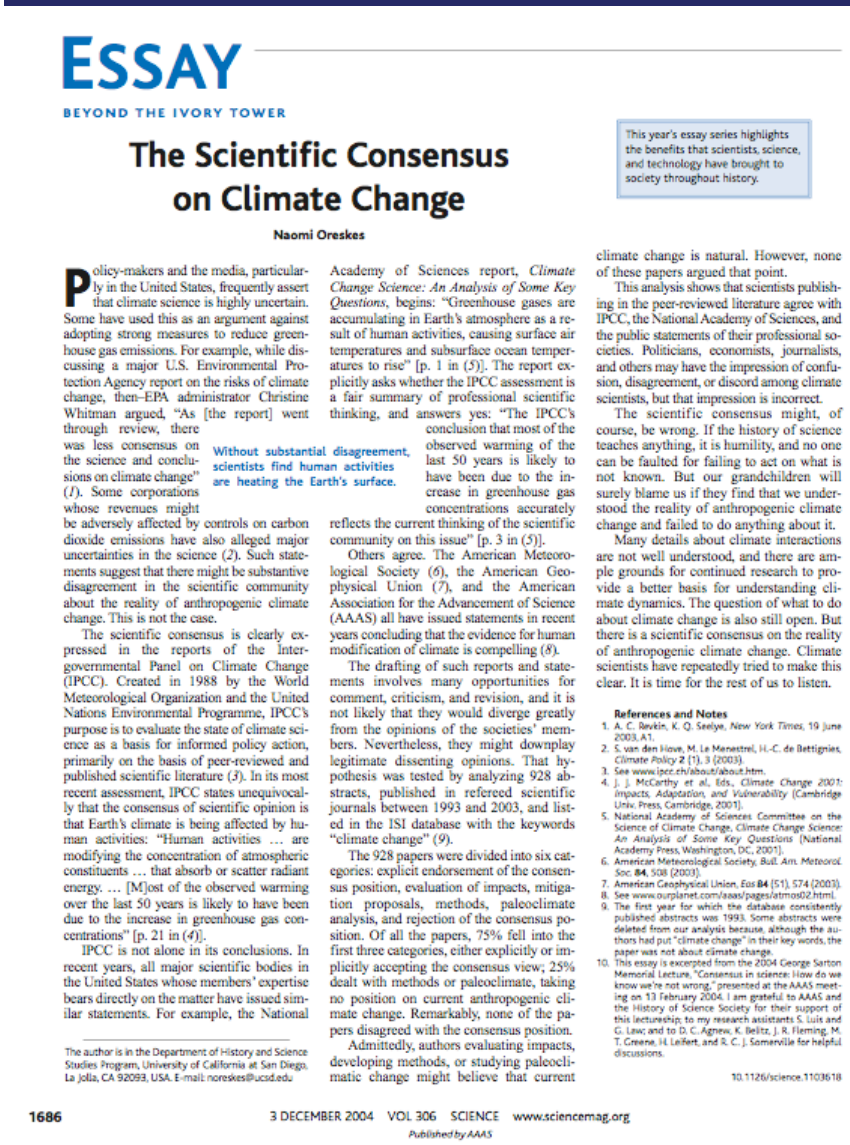
The world is warming up. Average temperatures are half a degree centigrade higher than a century ago. The nine warmest years this century have all occurred since 1980, and the 1990s were probably the warmest decade of the second millennium. Pollution from "greenhouse gases" such as carbon dioxide (CO_2) and methane is at least partly to blame.

http://www.ourplanet.com/aaas/pages/atmos02.html

2. Analysis of publications

Leadership could be out of step with rank and file. We can test that hypothesis, and I did….

The Scientific Consensus on Climate Change (2004)



ESSAY

BEYOND THE IVORY TOWER

The Scientific Consensus on Climate Change

This year's essay series highlights the benefits that scientists, science, and technology have brought to society throughout history.

Naomi Oreskes

Policy-makers and the media, particularly in the United States, frequently assert that climate science is highly uncertain. Some have used this as an argument against adopting strong measures to reduce greenhouse gas emissions. For example, while discussing a major U.S. Environmental Protection Agency report on the risks of climate change, then–EPA administrator Christine Whitman argued, "As [the report] went through review, there was less consensus on the science and conclusions on climate change" (*1*). Some corporations whose revenues might be adversely affected by controls on carbon dioxide emissions have also alleged major uncertainties in the science (*2*). Such statements suggest that there might be substantive disagreement in the scientific community about the reality of anthropogenic climate change. This is not the case.

Without substantial disagreement, scientists find human activities are heating the Earth's surface.

The scientific consensus is clearly expressed in the reports of the Intergovernmental Panel on Climate Change (IPCC). Created in 1988 by the World Meteorological Organization and the United Nations Environmental Programme, IPCC's purpose is to evaluate the state of climate science as a basis for informed policy action, primarily on the basis of peer-reviewed and published scientific literature (*3*). In its most recent assessment, IPCC states unequivocally that the consensus of scientific opinion is that Earth's climate is being affected by human activities: "Human activities … are modifying the concentration of atmospheric constituents … that absorb or scatter radiant energy. … [M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations" [p. 21 in (*4*)].

IPCC is not alone in its conclusions. In recent years, all major scientific bodies in the United States whose members' expertise bears directly on the matter have issued similar statements. For example, the National Academy of Sciences report, *Climate Change Science: An Analysis of Some Key Questions*, begins: "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise" [p. 1 in (*5*)]. The report explicitly asks whether the IPCC assessment is a fair summary of professional scientific thinking, and answers yes: "The IPCC's conclusion that most of the observed warming of the last 50 years is likely to have been due to the increase in greenhouse gas concentrations accurately reflects the current thinking of the scientific community on this issue" [p. 3 in (*5*)].

Others agree. The American Meteorological Society (*6*), the American Geophysical Union (*7*), and the American Association for the Advancement of Science (AAAS) all have issued statements in recent years concluding that the evidence for human modification of climate is compelling (*8*).

The drafting of such reports and statements involves many opportunities for comment, criticism, and revision, and it is not likely that they would diverge greatly from the opinions of the societies' members. Nevertheless, they might downplay legitimate dissenting opinions. That hypothesis was tested by analyzing 928 abstracts, published in refereed scientific journals between 1993 and 2003, and listed in the ISI database with the keywords "climate change" (*9*).

The 928 papers were divided into six categories: explicit endorsement of the consensus position, evaluation of impacts, mitigation proposals, methods, paleoclimate analysis, and rejection of the consensus position. Of all the papers, 75% fell into the first three categories, either explicitly or implicitly accepting the consensus view; 25% dealt with methods or paleoclimate, taking no position on current anthropogenic climate change. Remarkably, none of the papers disagreed with the consensus position.

Admittedly, authors evaluating impacts, developing methods, or studying paleoclimatic change might believe that current climate change is natural. However, none of these papers argued that point.

This analysis shows that scientists publishing in the peer-reviewed literature agree with IPCC, the National Academy of Sciences, and the public statements of their professional societies. Politicians, economists, journalists, and others may have the impression of confusion, disagreement, or discord among climate scientists, but that impression is incorrect.

The scientific consensus might, of course, be wrong. If the history of science teaches anything, it is humility, and no one can be faulted for failing to act on what is not known. But our grandchildren will surely blame us if they find that we understood the reality of anthropogenic climate change and failed to do anything about it.

Many details about climate interactions are not well understood, and there are ample grounds for continued research to provide a better basis for understanding climate dynamics. The question of what to do about climate change is also still open. But there is a scientific consensus on the reality of anthropogenic climate change. Climate scientists have repeatedly tried to make this clear. It is time for the rest of us to listen.

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References and Notes

1. A. C. Revkin, K. Q. Seelye, *New York Times*, 19 June 2003, A1.
2. S. van den Hove, M. Le Menestrel, H.-C. de Bettignies, *Climate Policy* **2** (1), 3 (2003).
3. See www.ipcc.ch/about/about.htm.
4. J. J. McCarthy *et al.*, Eds., *Climate Change 2001: Impacts, Adaptation, and Vulnerability* (Cambridge Univ. Press, Cambridge, 2001).
5. National Academy of Sciences Committee on the Science of Climate Change, *Climate Change Science: An Analysis of Some Key Questions* (National Academy Press, Washington, DC, 2001).
6. American Meteorological Society, *Bull. Am. Meteorol. Soc.* **84**, 508 (2003).
7. American Geophysical Union, *Eos* **84** (51), 574 (2003).
8. See www.ourplanet.com/aaas/pages/atmos02.html.
9. The first year for which the database consistently published abstracts was 1993. Some abstracts were deleted from our analysis because, although the authors had put "climate change" in their key words, the paper was not about climate change.
10. This essay is excerpted from the 2004 George Sarton Memorial Lecture, "Consensus in science: How do we know we're not wrong," presented at the AAAS meeting on 13 February 2004. I am grateful to AAAS and the History of Science Society for their support of this lectureship; to my research assistants S. Luis and G. Law; and to D. C. Agnew, K. Belitz, J. R. Fleming, M. T. Greene, H. Leifert, and R. C. J. Somerville for helpful discussions.

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Published by AAAS

- IPCC v.
- NAS
- AMS
- AGU
- AAAS
- Data base analysis of the published scientific literature.
- No significant disagreement about basic reality of GW and its human causes

Analysis of abstracts of 1025 papers listed in Web of Science, 1991-2003, with key words "global climate change"

- How many disagreed with IPCC statement: " [M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations."
- Answer : None.
- Overwhelming consensus among publishing research scientists that anthropogenic climate change was occurring.

- Research question was not if warming was occurring, but what are its impacts?
- How soon and how fast additional changes will occur?
- Do models give us a reliable basis for prediction?
- Similar to debates about evolution in 1940s—not whether, but how. “Tempo and mode.”

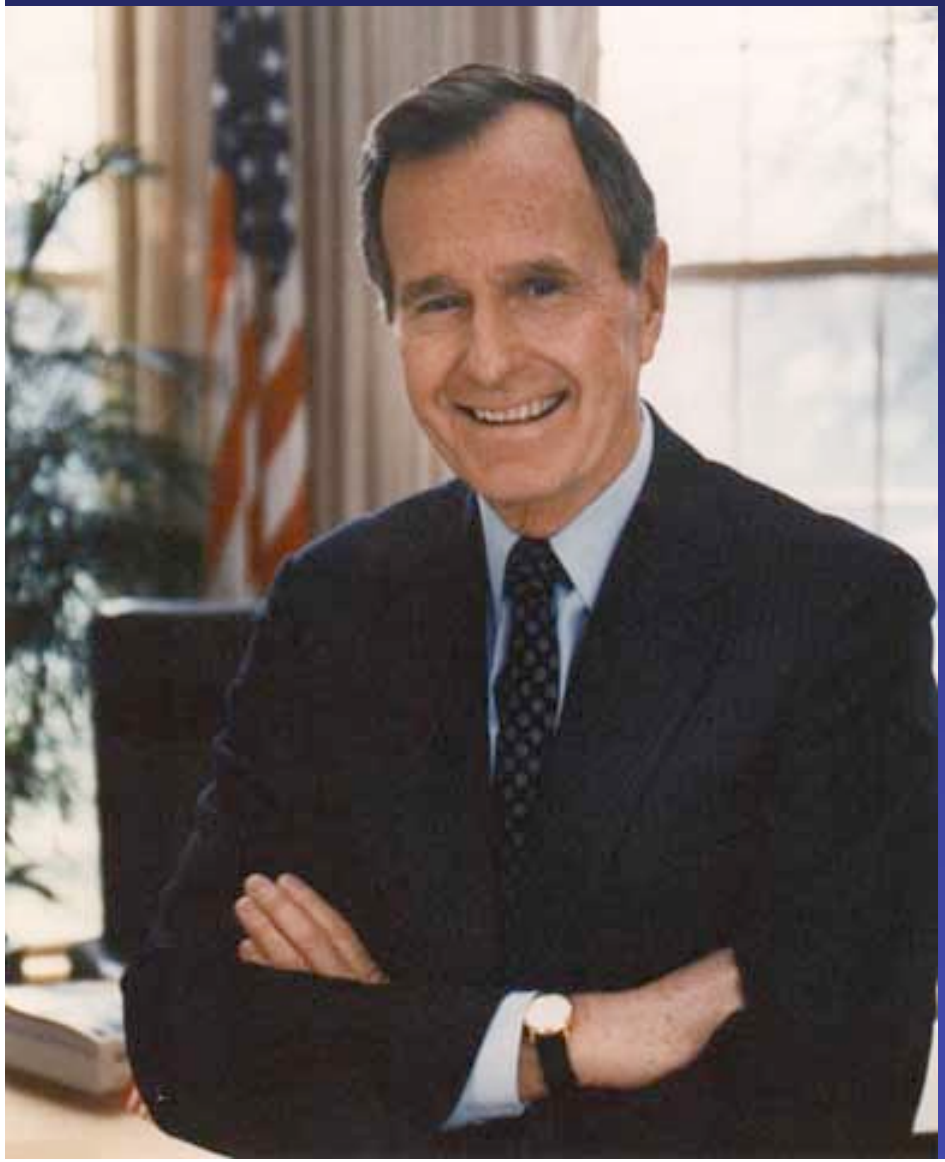
Whoever doubters were, they were tiny minority (did not appear in sample), or they were not research scientists publishing in peer reviewed literature.

Skeptics were not actually climate scientists.

Or had gone outside the established procedures and protocols for evaluating scientific evidence and claims. Weren't publishing their skeptical claims in peer-reviewed scientific journals.

Result of long-standing consensus came as a surprise to many people, but it shouldn’t have…

U.N. Framework Convention on Climate Change (1992)



Called on world leaders to translate the written document into "concrete action to protect the planet."

1995: IPCC Second Assessment Report

There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.

The SAR concluded: "The balance of evidence suggests a discernible human influence on global climate". That report also noted that the anthropogenic signal was still emerging from the background of natural climate variability. Since the SAR, progress has been made in reducing uncertainty, particularly with respect to distinguishing and quantifying the magnitude of responses to different external influences. Although many of the sources of uncertainty identified in the SAR still remain to some degree, new evidence and improved understanding support an updated conclusion.

- There is a longer and more closely scrutinised temperature record and new model estimates of variability. The warming over the past 100 years is very unlikely[7] to be due to internal variability alone, as estimated by current models. Reconstructions of climate data for the past 1,000 years (Figure 1b) also indicate that this warming was unusual and is unlikely[7] to be entirely natural in origin.
- There are new estimates of the climate response to natural and anthropogenic forcing, and new detection techniques have been applied. Detection and attribution studies consistently find evidence for an anthropogenic signal in the climate record of the last 35 to 50 years.
- Simulations of the response to natural forcings alone (i.e., the response to variability in solar irradiance and volcanic eruptions) do not explain the warming in the second half of the 20th century (see for example Figure 4a). However, they indicate that natural forcings may have contributed to the observed warming in the first half of the 20th century.
- The warming over the last 50 years due to anthropogenic greenhouse gases can be identified despite uncertainties in forcing due to anthropogenic sulphate aerosol and natural factors (volcanoes and solar irradiance). The anthropogenic sulphate aerosol forcing, while uncertain, is negative over this period and therefore cannot explain the warming. Changes in natural forcing during most of this period are also estimated to be negative and are unlikely[7] to explain the warming.
- Detection and attribution studies comparing model simulated changes with the observed record can now take into account uncertainty in the magnitude of modelled response to external forcing, in particular that due to uncertainty in climate sensitivity.
- Most of these studies find that, over the last 50 years, the estimated rate and magnitude of warming due to increasing concentrations of greenhouse gases alone are comparable with, or larger than, the observed warming. Furthermore, most model estimates that take into account both greenhouse gases and sulphate aerosols are consistent with observations over this period.
- The best agreement between model simulations and observations over the last 140 years has been found when all the above anthropogenic and natural forcing factors are combined, as shown in Figure 4c. These results show that the forcings included are sufficient to explain the observed changes, but do not exclude the possibility that other forcings may also have contributed.

In the light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely[7] to have been due to the increase in greenhouse gas concentrations.

Furthermore, it is very likely[7] that the 20th century warming has contributed significantly to the observed sea level rise, through thermal expansion of sea water and widespread loss of land ice. Within present uncertainties, observations and models are both consistent with a lack of significant acceleration of sea level rise during the 20th century.

"The balance of evidence suggests a discernible human impact on global climate."

Scientists have understood the nature of the issue since early 1990s

Actually, quite a bit earlier than that…

1979 NAS "Charney" report was a summary of work already done:

"A plethora of studies from diverse sources indicates a consensus that climate changes will result from man's combustion of fossil fuels and changes in land use."

National Academy of Sciences Archives, An Evaluation of the Evidence for CO_2-Induced Climate Change, Assembly of Mathematical and Physical Sciences, Climate Research Board, Study Group on Carbon Dioxide, 1979, Film Label: CO_2 and Climate Change: Ad Hoc: General

There was *already* a consensus in 1979 that global warming would happen.

These insights led to the creation of IPCC (1988)

1988 James Hansen declares 99% certain that climate change now detectable.

In 1988, Hansen was minority.

What was new in the 1990s was the consensus that warming was starting to happen.

Staged consensus:

1970s: That global warming *would* occur, but in the future

1980s: That it was serious enough to warrant international attention (IPCC)

1990s: That it was happening

Today: that action is urgent

But why focus on consensus?

Skeptic argument

- Some skeptics have claimed that consensus is unscientific
- That true science fosters dissent, disagreement, open discussion, and emphasizing consensus shuts down discussion.
- Impolite form of this argument: accuse me of being “Stalinist” for describing the existing consensus

Setting aside the rude and silly comments

- It's a fair question:

- Does it shut down legitimate debate if we focus too much on areas of agreement, rather than areas of disagreement?

Is consensus the goal of science?

What is the goal of science?

What is the goal of science?

Most historians, philosophers, sociologists:

"Reliable representation of the natural world."

Scientists: What about *truth*?

- Well, that may be the ultimate goal, but history shows that scientific truths are perishable.

- If truth, in an absolute sense, were the goal of science, we'd have to say that science, as an enterprise, has failed

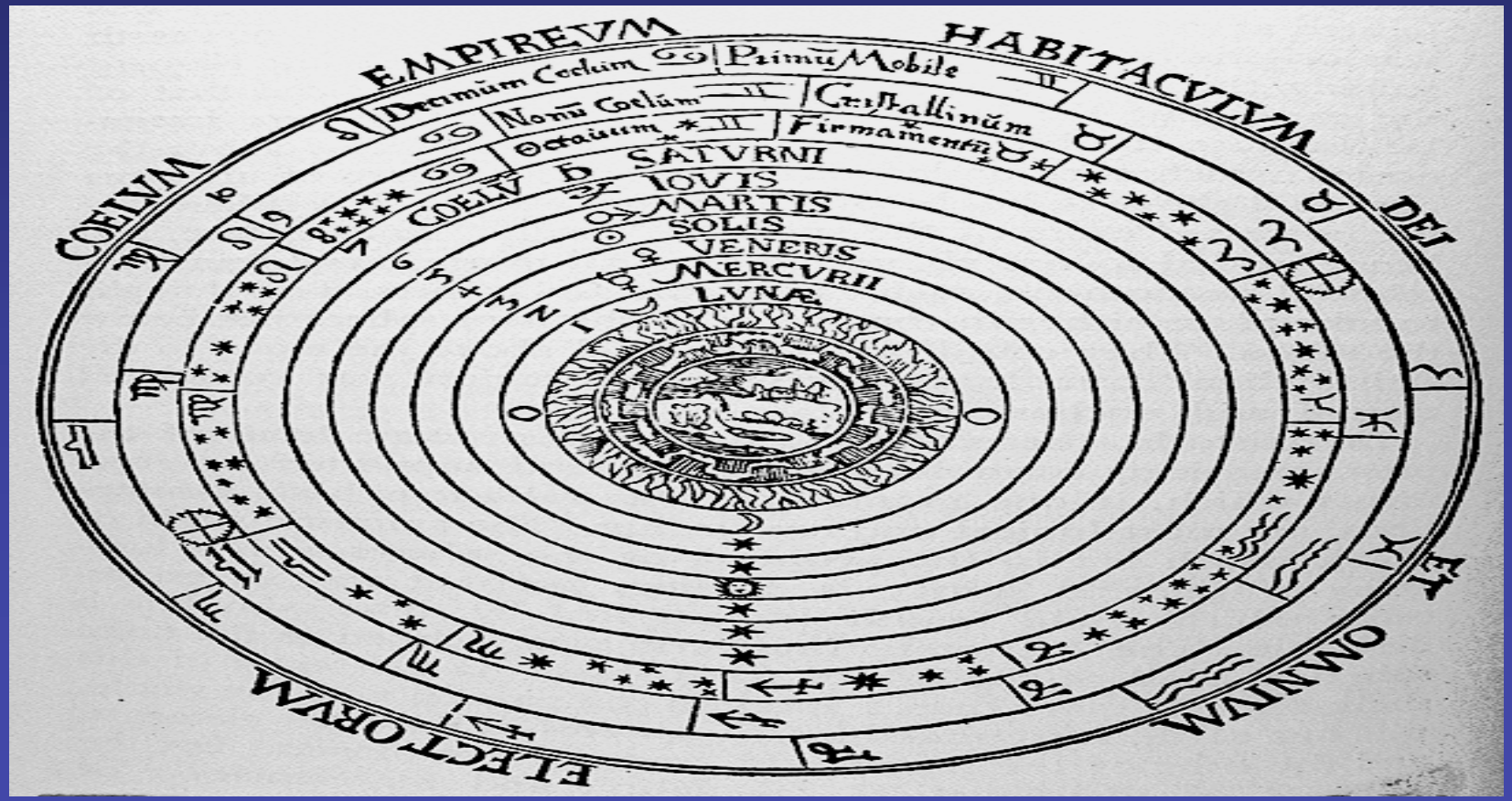
Few people would say that

- So goal of science cannot be truth, in the absolute sense…

- One popular alternative: truth in a pragmatic sense of reliable—truths that work, that enable us to account for the world around us, explain it, and understand it, and to use that understanding to do things in the world.

- Problem: to know truth when we see it…
- We'd like to believe that we know truth when we see it, but do we?
- May seem trivial, or even stupid, but history shows that it is not

Many successful past theories have been overthrown



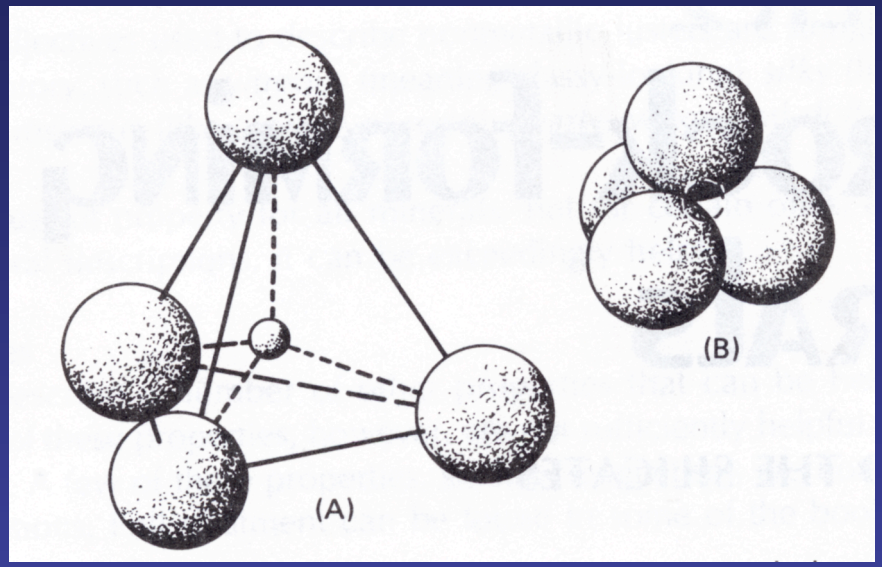
Van Fraassen's argument

Compares the problem of scientific and artistic renderings of the world.

Both science and art represent the world

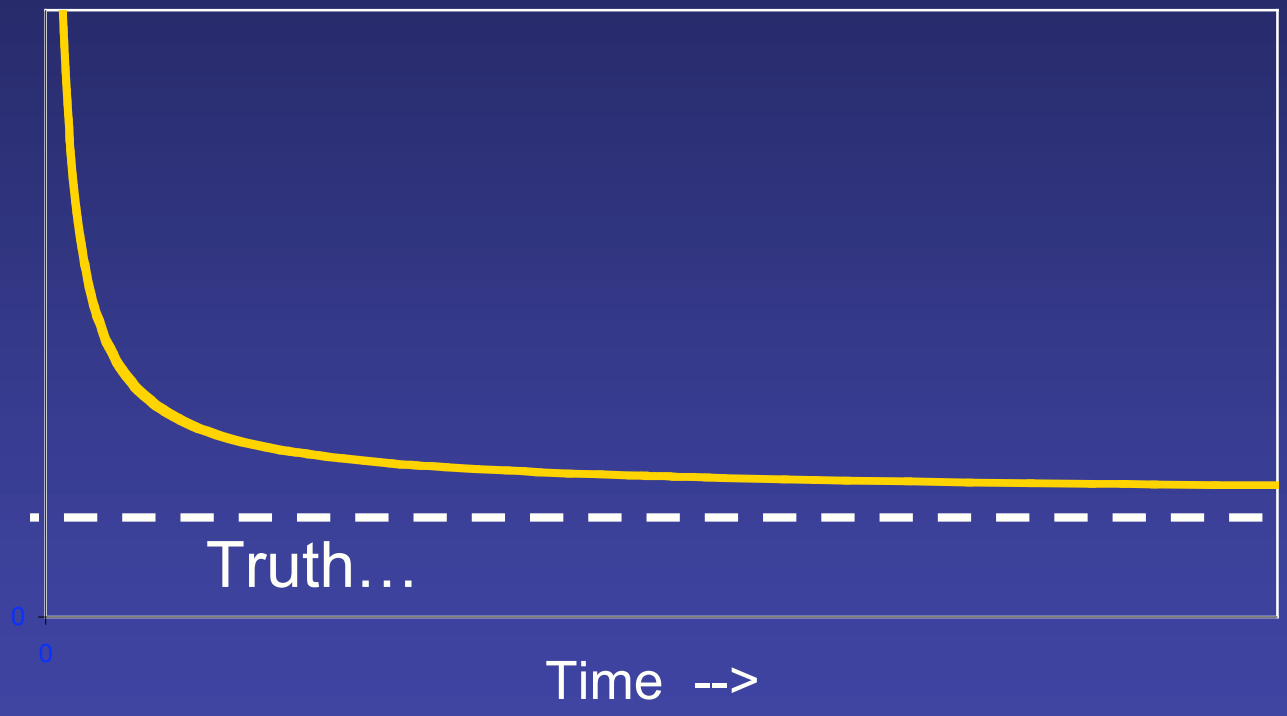
- In artistic representations, we can compare image with the object and judge the likeness.
- We have access to them both.

Comparison problem (in science)



- In scientific representation, no independent access to the world other than the information upon which picture is based.
- We can compare one theory to another, but we cannot directly compare the theory with the world, without invoking the evidence that led to the theory (circular).

Another way of putting this… (C. S. Peirce)



We strive to approach truth, but there is no way to know just where we are on the graph.

Various attempts to solve this problem and establish means to evaluate the truthfulness of scientific theories

- Methodological criteria
- Evidentiary standards

But they've all failed…

For any proposed standard, we can identify difficulties and exceptions

This difficulty that leads us to focus on consensus

- Since there is no absolute standard by which to judge whether scientists have converged on truth, we ask, simply, instead
- Have they converged?
- Has our knowledge been stable over some period of time?

We see a concern for consensus throughout history of science

As early as 1665, in a debate over comets, Henry Oldenburg, Secretary of Royal Society, urged Johannes Hevelius to bring his ideas into conformity with his colleagues

hold each 25 or 30 pounds, and these they expose to clear Nights; and if there be any impurity remaining, it will fall to the bottom: Afterwards they break the Pots, and dry the Salt in the Sun. One might make vast quantities of Saltpetre in these parts; but the Country People seeing that *We* buy of it, and that the *English* begin to do the same, they now sell us a *Maon* of 6 pounds for two *Rupias* and a half, which we had formerly for half that price.

An Account of Hevelius *his* Prodromus Cometicus, *together with some Animadversions made upon it by a* French *Philosopher.*

This excellent *Dantiscan* Astronomer, *Hevelius*, in his *Prodromus* (by him so call'd, because it is as a Harbinger to his *Cometography*, which hath already so far passed the Press, that of twelve Books there are but three remaining to be Printed) gives an Account of the Observations he hath made of the *First* of the two late Comets; reserving those he hath made of the *second*, for that great Treatise, where he also intends to deliver the Matter of this *first* more particularly and more fully then he hath done here.

In this Account he represents the Rise, Place, Course, Swiftness, Faces and Train of this Comet, interweaving his Conceptions both about the Region of Comets in general (whether it be the *Air*, or the *Æther*?) and the Causes of their Generation: In the search of which latter, he intimates to have received much assistance from his *Telescope*.

He observed this Comet not before *Decemb.* $\frac{4}{5}$, (though he conceives it might have been seen since *Novem.* 23. *st. n.*) & he saw it no longer then *Febr.* $\frac{1}{2}$: though several others have seen it both sooner, and later: and though himself continued to look out for it till *March* 7. *st. n.* but fruitlesly, whereof he thinks the reason to have been its too great distance and tenuity.

He

Hevelius was in a bitter debate with French Astronomer, Auzent, over interpretation of paths of comets

It was not that Oldenburg thought that Hevelius was *incorrect*…

Indeed, he rather liked Hevelius's views…

Oldenburg wrote to Robert Boyle:

” 'Tis, me thinks, very pleasant to read, and built upon an Hypothesis, [which] is ingenious, full of speculation, and appearing sufficient to solve all ye phaenomena of Comets.”

Nevertheless, upon the *Society's* judgment *against* Hevelius's theory, Oldenburg wrote to Hevelius to ask him to fall into line.

He insisted that this should not be too difficult to do, because, after all, other's observations were consistent with his, his theoretical views on matter should be consistent, too…

”…as the observations of the French, the Italians, and the Dutch (in so far as they are known to us) agree wonderfully well with our own, we are quite confident that you will fall in with this consensus of opinion.”

Oldenburg to Hevelius,

27 January 1665/6, O.S., CHO

Correspondence of Henry Oldenburg 3:30.

Three hundred years later, a similar thought was expressed in response to another dissenting theory: the theory of continental drift

"Can we call geology a science when …it [is] possible for such a theory as this to run wild?"

--Rollin T. Chamberlin (1928, p. 83).

In history of science, we often see that scientists view disagreement, or proliferation of hypotheses, as a *problem*…

A sign that something isn't right.

These patterns—of scientists actively and consciously striving to find areas of agreement—and being unhappy about open disagreement—that led Thomas Kuhn to his theory of the central role of paradigms in science

Structure of Scientific Revolutions

Introduced the idea of a paradigm as a form of consensus:

An agreed-upon set of beliefs, concepts, types of problems worth working on, and types of acceptable answers

Kuhn's notion of a paradigm

Paradigm is the consensus of a community *at a given time.* Several components

- Accepted theory
- Accepted realms of investigation
- Accepted methods of investigation
- Accepted models for satisfactory answers

A consensus about facts and theories

A consensus about how to do science.

Work that falls outside the scope of the paradigm is not recognized as science

(or at least not *that* science)

Who enforces this?

- Community of active practitioners
  - Persons who are actively doing scientific work
- Mechanisms include
  - Textbooks and graduate training
  - Conferences and workshops
  - Peer review

Is consensus the goal of science, for Kuhn?

- Not exactly. It's not the *purpose* of science to achieve consensus.
- Sort of the opposite: consensus is *necessary* for science to exist, as organized, progressive inquiry
- Consensus comes first, then further science produces new consensus… and so on…

- For Kuhn, paradigms are essential to scientific *progress*.
- Without this agreement about what is known and settled, there'd be endless wheel re-invention.
- Without agreement about aims and methods, endless arguments about whether people were doing the right work in right way.

“Pre-paradigmatic science” was oxymoron.

No real science without a paradigm.

Consensus *distinguishes* science from other intellectual activities

- Early 20th century, logical empiricists worried a lot about demarcation criteria. Science v. superstition. Physics v. metaphysics.

- Logical positivists: Empirical verification. Science dealt only with statements that could be proved true or false through empirical evidence

- Karl Popper: Falsification. Science dealt only with statements that could be proven false through empirical evidence

While Kuhn broke with the logical empiricist tradition, he too believed there was a demarcation between science and other domains of human intellectual activity: Consensus, as expressed in paradigms.

Scientists make progress *because* they agree.

Poets and painters don't—not in any ordinary sense—and that's OK.

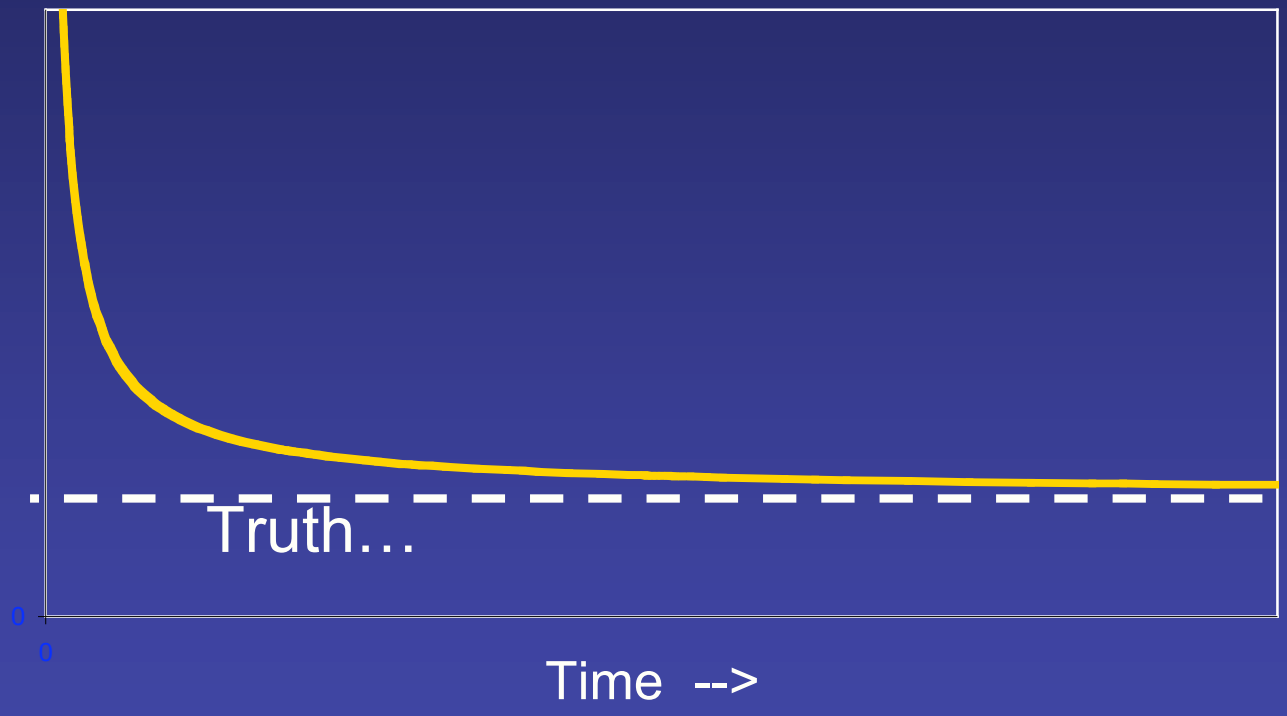
Art is about free expression, it doesn't require agreement. In fact, it might suffer from it.

But science *does* require agreement

- Science progresses *because* of agreement, which permits scientists to move forward and work on new things.

- It may not be truth in an absolute sense, but it's what we do.

Return to Peirce: Convergence is important because it's a sign of a stable consensus



Why history matters: Only way to judge how stable our knowledge is.

Consensus is a sign of success

- Consensus is *highly* relevant for policy purposes, because it tells us where are the domains of stabilized knowledge. What scientists have to offer policy-makers.

- Dissent remains important, too, because it tells us where are the domains of continued research. (Expect disagreement at research frontier).

So how should we think about dissent?

- Kuhn's is not the only picture of science.
- Other philosophers have paid a good deal of attention to disagreement and dissent, to role of skepticism in science, or in life (Mill, Nietzsche, Feyerabend)
- Popular accounts: "Heroes" of science are almost always portrayed as dissenters, challenging received wisdom. (Galileo as exemplar, but also Darwin, Einstein, Wegener…)

- Clearly, disagreement is essential to free exchange of ideas, part and parcel of science.
- Scientific conferences are often characterized by extensive *argument* and sometimes rather impolite disagreement.
- Peer review is process in which skeptical colleagues are *invited* to challenge data and claims

But…Irony or Paradox…

In science, the goal of disagreement is to come to agreement.

Argument and peer review are processes designed to separate the correct from the incorrect, to enable scientists to settle on what they believe is warranted by evidence.

Through skepticism and disbelief, scientists come to agreement and belief.

At the point of agreement—the point of consensus—scientists move on to other questions.

Further skepticism is no longer "healthy" or productive. It becomes corrosive and unproductive.

Skepticism and disbelief reach their limits.

Merton: “Organized skepticism”

- Skepticism is a crucial part of science, but within bounds.
- Not “anything goes”—but rather organized into agreed-upon formats—conference proceedings, peer review, journal discussions and replies.
- Not permitted to run amok. Disorganized skepticism would be just a mess.

Stuart Hampshire, *Justice is Conflict (2000)*

- Justice and fairness require established procedures. We accept outcomes more readily when we believe the process that led to them was consistent and fair.

- “Because there will always be conflicts, there is everywhere a well-recognized need for procedures of conflict resolution.” (p. 5)

- Hampshire refers to this as “procedural justice.”

- Science embraces “procedural skepticism.”

There are established procedures for both how data are presented and how they are challenged.

Dissent is an important part of science, but when it goes outside these procedures,
then it isn't *scientific* dissent.

Why climate skeptics are disingenuous…

- By going outside peer reviewed literature, they do not subject their claims to the same scrutiny as the claims they object to.
- They don’t play by rules of science.
- But they want to have it both ways: to reject the rules of science, yet insist their results are scientific, and therefore deserve equal time and respect.

Is that the end of the story?

Not quite…

Potential worry:
Enforced consensus?

- Kuhn: consensus emerges naturally through success of paradigms.
- Enforced consensus would be a paradox.
- One would not want to create organizations or mechanisms that *enforce* consensus.
- And such organizations may exist…

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Goal: To develop consensus statements on controversial issues in medical practice

Recent conferences

- Acupuncture
- Celiac disease
- Tobacco use
- Benefit of taking multi-vitamin supplements
- Management of Hepatitis B.
- Cesarean Delivery on Maternal Request\Total Knee replacement
- Improving end of life care

To communicate state of science to health care practitioners who may not have time or resources to keep up with latest medical research

Clearly valuable, but…

Potential problem with enforced consensus

Set format: 3 day conference

- 2 days public sessions with presentations, webcasts
- Followed by 1 day closed session
- Production of the consensus statement by end of the three day working period.
- So what happens if group fails to reach consensus?

That is not permitted to happen

- Every conference concludes with a consensus document.
- In principle, participants could refuse, but web site gives no examples.

In defense of NIH…

- Reports do report areas of uncertainty and disagreement
- Goal is to establish care standards, help practitioners.
- But still…
- The format doesn't encourage members to say, wait, we're not ready.
- Once document is formed, it becomes the "official" state of the science. So it remains until re-examined.

Potential problems

- What happens if a doctor disagrees? Could she be subject to malpractice suit?
- Diminution of discretion of health care provider who knows details of individual patient's case.
- Could insurance companies refuse to pay for alternative treatments?

Enforced consensus?

- Bas Van Frassen argued that goal of science is theories that are "empirically adequate"—consistent with all available evidence.

- Elsewhere I've criticized some modeling practices—calibration to achieve model fit—as a form of enforced empirical adequacy.

Risk of a “consensus development” program is enforced consensus

Factors that increase risk of enforced conformity

- Small number of people involved
- National (rather than international) character
- Tight and inflexible time constraint
- Affirmative language “Consensus development” (as opposed to: assessment, characterization, summary)
- Government sponsorship? Perhaps not here, but one could imagine…

Where does this leave us in relation to climate change?

- Consensus is not the *goal* of science, but it is an outcome of the normal course of scientific research, and arguably a desirable one.
- Some institutional mechanisms may run the risk of fostering “pre-mature” consensus.
- Scientists (and the public) should worry about that…

However, if consensus has emerged through the normal course of scientific research, that is nothing to be ashamed of! Consensus *is* scientific.

If a scientific consensus has been stable over time, then it may well provide a good basis for public policy in cases, like climate change, where the scientific evidence is relevant.

Shameless plug:

We need history to be able to evaluate the stability of scientific knowledge over time.

We need history and philosophy to judge whether or not dissenters are playing by the rules.