Facts, values and climate change[1]

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Abstract

Facts are statements about the world as it is. Values are implicit in normative statements, i.e. statements indicating how one would like the world to be. It is often stated that one should make a distinction between facts and values, because facts are 'hard' and values are 'soft'. However, the justification of facts and values involves both facts and values. Therefore, facts and values are entangled, and facts are less objective and values less subjective than is often suggested.

I define scientific facts as descriptive statements that are justified by scientific reasoning, and discuss the different types of rules and values (both epistemic and non-epistemic) that govern scientific reasoning. This is applied to climate science to illustrate the influence of non-epistemic values on the formulation of factual statements about the climate system and their (un)certainty estimates.

Although facts and values are entangled, it remains fruitful to be aware of the distinction, because this could help resolve - or clarify - conflicts.

Facts and values play an essential role in the climate policy debate, both directly and because of their mutual substantiation. A better understanding of the epistemological meaning of facts and values might be helpful in improving the quality of this debate.

[1] An earlier version (in Dutch) was published on Klimaatverandering.

Contents

1. Introduction

Purpose

This note is about the difference between facts and values and what it means for the climate change debate. It is not a scientific paper, but a summary of my current understanding. It is neither complete nor very original. My approach implies some limitations from the outset, because it presupposes that the concepts 'fact' and 'value' are useful. My caveat is that both are constructions, which may have limited usefulness if one wants to understand the underlying cognitive processes and what they mean for our understanding of reality. However these processes, are (for the time being?) too complex for full analysis. Therefore I believe that it is insightful to discuss the role of facts and values in the climate change debate.

It is obvious that facts are underlying values. Care for the environment is related to the fact that we depend on our environment. A central issue in the present discussion is the question which values legitimately underlie the establishment of scientific facts.

Dichotomy

Facts describe the world as we see it. They are often formulated as 'is statements'. Values say something about the way we would like to see the world. Values are implicit in imperatives and normative 'ought statements'. Therefore, facts and values are different. This is sometimes called the fact/value dichotomy, which actually started with another dichotomy, formulated by the Scottish philosopher Hume (1711 - 1776) as "you can never derive an 'ought' from an 'is' ". This distinction[2] was also stressed by the logical positivists. The fact/value dichotomy has led to much discussion among philosophers (see e.g., Niiniluoto, 2008 and Been and Taekema, 2012). Some of this will be reviewed in § 2 which contains a discussion of the dual nature of facts and values, and their entanglement, i.e. the role facts play in the justification of values, and the role of values in the justification of facts. This naturally leads to a discussion of the role of values in epistemology.

Commonly, facts are seen as objective and values as subjective. It is clear that this does not make sense. Facts may be less objective and values less subjective than one might expect. Nevertheless, it is fruitful to be aware of the distinction between facts and values, even if they are entangled, because this awareness could help resolve - or clarify - conflicts.

Facts and science

Facts are justified by scientific reasoning. Even if the ideal of a value free science does not hold, one might argue that social and ethical values should not play a role in scientific reasoning (Heather Douglas, private communication). Criticism of this revised value free ideal is discussed, as is the distinction between epistemic and non-epistemic values.

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[2] See also https://en.wikipedia.org/wiki/Fact%E2%80%93value_distinction
http://www.beyondintractability.org/essay/facts-values

In § 3 the general ideas of § 2 are applied to the issue of climate change. Particular attention is given to the role of non-epistemic values. In § 4 some of the consequences for the climate debate are explored.

2. Facts and values

Facts are about the world as it is, values about the world as one would like it to be. Facts and values are expressed in different ways. Compare:

- Fact: The sun heats the earth
- Value: Caring about our environment

One can also compare factual and normative statements

- The sun heats the earth
- One should (ought to) care for the environment

Usually a distinction can be made (because factual statements are statements about the world as we see it, and normative statements are statements about the world as we would like to see it), but one should be aware of so-called 'thick concepts' which are at the same time descriptive and value laden.

Hilary Putnam (1981) became an important critic of the fact-value distinction. His main point is that facts and values are entangled, i.e. "in generating and supporting them, facts and values are both involved in the production of each. Thus, factual statements are part of (but not all of) the support of value statements, and value statements are part of (but not all of) the support of factual statements."(Heather Douglas, private communication).

On closer examination it is less clear what is exactly meant by the words 'fact' and 'value'. Therefore, in the next two sections I will begin by discussing some of the problems and giving my working definitions.

2.1. **Facts**

Many discussions on internet (see e.g., http://plato.stanford.edu/entries/facts) clearly show the complexity of the issue. Some of this is laid out in a more accessible way on https://en.wikipedia.org/wiki/Fact. For the sake of our discussion I propose to consider this definition:

> A factual (descriptive) statement is a *fact* if it really occurred or is actually the case. The usual test for a statement of fact is verifiability—that is, whether it can be demonstrated to correspond to experience.

Examples:

- Someone who hallucinates and observes a spider (while others don't see this spider) might say "I observe a spider". This is a statement about the world as seen by the speaker. But in reality there is no spider. So, the spider is not a fact. The hallucination itself is a fact.
- When I say Lennart Bengtsson has an extensive scientific track record, then I base my statement on facts: my conversations with him, his publications and his functions in science, and values expressing what I found valuable in these conversation, publications and functions, but it is a statement of my perception of the world as it is, not about the world as I would like to see it. If others have the same perception you could say that it is a fact that Bengtsson has an extensive track record[3]. Of course, others might dispute this fact.

Facts are statements about the world as it is. Therefore one has to be clear as to what is meant by the world. I would include both physical, psychological and social phenomena. In terms of Poppers terminology this includes his *World 1 (*physical objects and processes), *World 2* (mental states of individual human minds), and *World 3* (artefacts and other cultural and institutional products of human social action).

Wikipedia defines scientific facts as "verified by repeatable careful observation or measurement (by experiments or other means)". With this definition much of climate science is unscientific. Therefore, I prefer the following definition: "descriptive ('factual') statements are called *scientific facts* if justified by *scientific reasoning."*

So:

- Justified descriptive ('factual') statements are called *facts.*
- Descriptive statements are called scientific facts if justified by scientific reasoning.

Scientific reasoning will be discussed in § 2.5.

Scientific uncertainty complicates matters. Evidence is often incomplete, in particular in the case of unique complex systems. This leaves room for alternative explanations. When it comes to weighing competing explanations, one can apply a method called abduction or 'inference to the best explanation'. Abduction[4] begins by clearly identifying and stating all the competing hypotheses with clarity and precision. One then goes on to consider the evidence in favour of each hypothesis. Once the evidence is evaluated, one goes on to compare the competing hypotheses, weighing them according to criteria of adequacy, such as: fruitfulness, scope, simplicity and alignment with things that we already know are true. The hypothesis that scores the highest—that fits the most criteria to the highest degree—is said to be the most adequate, and thus is the hypothesis that it is justified to believe.

[3] I originally used the adjective 'impressive' in my example, but saying that Bengtsson has an impressive track record is more like a thick statement, so I changed it into 'extensive' which is more descriptive.
[4] I derive this description from Johnson (2016).

Alternatively scientists can attempt to characterise the uncertainty with the help of probabilistic means. This leads to statements of the type:

It is likely that X occurred

I would be hesitant to call this a fact (other than the fact that this statement is made), although it is a descriptive statement about the world as it is rather than a statement about the world as we would like to see. For lack of a better word I would call this type of statement a *scientific descriptive statement* if justified by scientific reasoning.

2.2. **Values**

In ethics, *value* denotes something's degree of importance, with the aim of determining what action of life is best to do or live (deontology), or to describe the significance of different actions (axiology). (https://en.wikipedia.org/wiki/Value_(ethics)). My interpretation: values indicate what is good, useful, important, beautiful, desirable, etc. Values are usually vague and general rather than specific preferences. Values are implicit in normative statements (oughts). Reversely, values underlie normative statements.

According to Niiniluoto (2008) the values of an agent may be hedonistic (happiness), vitalistic (health), economic (wealth), political (power, liberty, peace), social (love, friendship, equality, justice), epistemic (knowledge), aesthetic (beauty), religious (holiness), and ecological (sustainability, biodiversity). In choice situations involving alternative actions, the agent usually has to balance between the relevant values. Niiniluoto continues by considering the structure of typical valuations in more detail. According to him the basic form of *value propositions* is the following:

X values A,
or
A is valuable for X,

where the subject X is a person, group, community, or culture, and the object A is a thing, fact, or act. Values can also be expressed by

A is good/right for X.

See further Niiniluoto (2008).

Values can be made explicit in two different ways: 1. People may say what their values are (if asked). 2. You can also try to reconstruct the value(s) that underlie a particular normative statement. The first method uncovers the values that a person is aware of and is willing to share. Method 2 is a more indirect determination and prone to subjective judgment.

Sometimes the concept of unconscious value is introduced. This might be a useful notion, but it is not clear to me how it could be operationalized. What really matters is the fact that reasoning (and behaviour) is a complex process determined by many factors (see the remark on motivated reasoning at the end of § 2.4.)

Several points are worth noting:

- Values can be seen as providing guidance for action. Cognitive science and (social) psychology study to what extent this actually happens. The relation is often found to be relatively weak.
- Reversely, introduction of values as concepts can be seen as an attempt to make certain aspects of behaviour accessible for discussion
- There are many different values, e.g. personal (google on {list, values}), sometimes called virtues or vices, and social, epistemic and non-epistemic.
- Values can be seen as facts in Poppers world 3. As such they can be subject of scientific study.

2.3. **How are values justified?**

One often makes a distinction between instrumental values and intrinsic values. This distinction was first discussed by Plato in the 'Republic'. An instrumental value is worth having as a means towards getting something else that is good (e.g., a radio is instrumentally good in order to hear music). An intrinsically valuable thing is worth having for itself, not as a means to something else. See also https://en.wikipedia.org/wiki/Value_theory#Intrinsic_and_instrumental_value.

This distinction has been discussed and criticized. For an overview see e.g. Niiniluoto (2008), who defined an *axiological system* as a triple <V,B,I>, where V is a hierarchical ordering of intrinsic values (valuable in themselves without relation to other aims), B is a system of beliefs, and I the set of instrumental values (values serving, according to B, as tools for reaching the intrinsic values V).

I believe that intrinsic values cannot be justified as such, although inquiry can give insight in their occurrence and their interrelations. Instrumental values can be justified on the basis of their usefulness in the past, or more general on the basis of our understanding of the world. In particular, the pattern of instrumental values may change if the beliefs are changed due to scientific research.

In most cases emotions, personal beliefs and personal experiences also play a role.

Several points are worth noting:

- Different (instrumental) values may be contradictory and one particular instrumental value may be useful for one particular aim and adverse for another aim.
- Both values and oughts can be nuanced verbally. Compare "it might be useful to .. " and "it is essential and urgent to. .", and "it could be valuable", and "it is of paramount value". The relative weight one gives to values can be ranked with the help of a Likert-scale.

- Complex relationships between different values can be addressed with the help of a values tree. A value tree identifies and organises the values of an individual or group with respect to possible decision options. It structures values, criteria, and corresponding attributes in a hierarchy, with general values and concerns at the top, and specific attributes at the bottom. http://www.belspo.be/belspo/ssd/science/reports/sepia_finrep_final.ml.pdf http://www.iiia.csic.es/files/pdfs/NormClassification.pdf]

2.4. **How are facts justified?**

Descriptive statements can be justified by scientific reasoning. So what is scientific reasoning? Paul Feyerabend is famous for his rejection of the existence of universal methodological rules. Even so many many people believe that there it is possible to further specify what is meant by scientific reasoning

Heather Douglas (private communication) gave the following definition: "scientific reasoning is reasoning about what to make of evidence, properly constrained by respect for the evidence".

People could have different views of what constitutes respect for the evidence. My interpretation is: taking measurements, theories, models and publications serious. I am not sure whether you could consider the track record of the messenger as evidence.

Boghossian (2008) specifies scientific reasoning as reasoning *following epistemic rules*. Epistemic rules are rules that tell us in some general way what it would be most rational to believe under various epistemic circumstances.

One could also define *scientific reasoning* as that what scientists do when they argue, where I would define scientists loosely as people with a scientific education, working in a research institutions and/or publishing books or scientific papers in peer reviewed journals.

Cognitive science and social psychology study what scientists really do when they are reasoning[5]. The outcomes of motivated reasoning derive from "a biased set of cognitive processes — that is, strategies for accessing, constructing, and evaluating beliefs. The motivation to be accurate enhances use of those beliefs and strategies that are considered most appropriate, whereas the motivation to arrive at particular conclusions enhances use of those that are considered most likely to yield the desired conclusion." (Kunda, 1990). This is clearly at variance with a quest for truth, as propagated e.g. by Bertrand Russell when he wrote: "Many questions, formerly obscured by the fog of metaphysics, can be answered with precision, and by *objective methods* which introduce nothing of the philosopher's temperament except the desire to understand." Heather Douglas wrote: "You should not engage in values acting in the place of (or in the same mode as) evidence". Therefore, I will discuss the values that underlie scientific reasoning in more detail in § 2.5.

[5] https://en.wikipedia.org/wiki/Motivated_reasoning

Intuitively, it seems attractive to give the hard physical sciences a special treatment, because it is relatively easy, for example, to determine the charge of an electron by performing Millikan's oil drop experiment. If one does it correctly, and prepares identical conditions one always obtains more or less the same number. This is much harder or impossible when one studies human behaviour. Even so, I believe there is no sharp or fundamental distinction between behavioural sciences and scientific domains studying complex and unique systems, such as economics, ecology and climate science.

According to the logical positivists facts could be ascertained. They considered facts as the only fit subject of science (along with analytic statements like '1 plus 1 equals 2' that were true by definition). Facts were empirical and could be based on pristine observations (House, 2001). A similar view was held by the sociologist Max Weber (1864 - 1924) who introduced the concept 'Value-Free Ideal'. Later, when philosophers pointed out that values do play a rol in science, the Value-Free Ideal had to be dropped. This will be further discussed in the next section.

2.5. **Which values govern scientific reasoning?**

Often a distinction is made between epistemic values and non-epistemic values. This distinction is not sharp, but loosely speaking it should distinguish between what Russell called 'objective methods' and 'other values', such as (Niiniluoto, 2008): hedonistic, vitalistic, economic, political, liberty, social, aesthetic, religious and ecological.

In an attempt to save something of the Value-Free Ideal it was replaced by the idea that social and ethical values should not play a role in scientific reasoning. This has led to extensive discussions on the role and allowability of non-epistemic values in scientific reasoning. Heather Douglas, e.g., argued that scientific reasoning must consider social values. I will come back to this after first discussing epistemic values in some more detail.

Epistemic values

There is no agreement on what are exactly epistemic values[6]. To me these are first of all the values that are implicit in our basic epistemic rule. ("Scientific reasoning is reasoning about what to make of evidence, properly constrained by respect for the evidence."). This implies respect for the evidence, but also respect for the rules of argumentation, from which one can derived two oughts, namely

- one ought to reason correctly,
- the evidence ought to be respected.

This can be made more specific in different ways. Personally, I like this (possibly incomplete) list:

- Hypotheses and models should be tested against observations and internal consistency. If needed knowledge has to be revised.

[6] 'Epistemic value' is also used, in different meanings, e.g., to indicate how useful a theory or cognitive process is for de development of our understanding.

- Observations and logic should be leading.
- This whole process must be transparent: data and models have to be well documented, and available for others, so that results can be reproduced.

Thomas Kuhn (1977) approached it differently. He argued that the following values are important:

- Accurate – a theory should be empirically adequate with experimentation and observation
- Consistent – a theory should be internally consistent, but also externally consistent with other theories
- Broad Scope – a theory's consequences should extend beyond that which it was initially designed to explain
- Simple – the simplest explanation should be preferred, principally similar to Occam's razor
- Fruitful – a theory should disclose new phenomena or new relationships among phenomena

In scientific practice still other values play a role. For example, in order to minimize scientific fraud, transparency and reproducibility are seen as important.

Personal psychological values ('virtues' and 'vices') are also relevant. Bertrand Russell mentioned the desire to understand. There seems to be quite some literature on the role of personal values. I believe that curiosity, doubt (in the sense of sincere scepticism), eagerness to understand, integrity, willingness to consider alternative explanations, willingness to change one's mind are all relevant.

I would speculate that epistemic values are broadly supported because they have been successful in the past.

Non-epistemic values

I found a clear overview of research on non-epistemic values and the value free ideal in a recent paper by David Ludwig of the Free University in Amsterdam. In this paper 'Ontological Choices and the Value-Free Ideal', he summarizes four arguments. I quote:

1. The *first argument* is based on the general assumption that the underdetermination of theories by evidence leaves room for non-epistemic values in theory choice (e.g. Longino, 2002; cf. Brown, 2013).
2. The *second argument* challenges VFI by pointing out that scientific inferences often involve a high degree of uncertainty and by suggesting that an evaluation of the "inductive risk" in theory choice requires non-epistemic values (e.g., Douglas, 2009; John, 2015).
3. The *third argument* questions the very distinction between epistemic or non-epistemic values. While philosophers of science have often assumed that only the former are legitimate in theory choice because they "promote the attainment of truth" (Steel, 2010, p17), a breakdown of the distinction would undermine VFI (Rooney, 1992; Longino, 1996; Machamer and Douglas 1999).

4. According to the *fourth argument*, scientists often have to employ "thick ethical concepts" in which factual and normative components are inextricably entangled (e.g., Putnam, 2002). If it is not possible to separate these aspects, then it is neither possible to evaluate or justify scientific theories independently of values.

In his paper Ludwig adds a fifth argument. In my own words:

5. The validity of scientific statement often depends on ontological choices (say, how you define which concepts), and those choices involve non-epistemic values.

As I understand it, these are meant to be arguments for allowable - or at least unavoidable - values that play a role in scientific reasoning. In § 3.3 I will explore what this might mean for climate research. In that section I will also consider some additional psychological (personal) values.

3. Facts and values in discussions about climate and climate change

In this section I will very briefly enumerate the facts and values that are relevant in discussions about climate and climate change. I find it useful to consider - in addition to personal values - values *governing policy* options (including social values) and *values governing scientific reasoning.* I will begin with the facts.

3.1. **What facts are relevant?**

Facts about the physical climate system, such as summarized in IPCC working group 1. Facts about the larger earth system, including the biosphere (wg2) and the socio-economic system (wg3), supplemented with some obvious facts (Smeets, private communication) such as the *risks* of global warming, the COP21 and other agreements and the Urgenda verdict; and the fact that decision making (even deciding on choosing or not choosing) involves values.

The climate system is a typical example of a complex and unique system, such as discussed at the end of § 2.1. This means that IPCC has given many descriptive statements in probabilistic form ("It is likely that X occurred").

3.2. **Values governing policy options**

Overarching for many is the wellbeing of humans and their habitat. There are many secondary values, such as intergenerational justice, but also fostering respect for science, and respect for democracy. This could perhaps be made more transparent and explicit with the help of a values tree. When it comes to decision making and implementation, legal and constitutional values come into play.

3.3. **Values in scientific reasoning about climate**

Traditionally one makes a distinction between epistemic values and non-epistemic values.

Epistemic values

I believe the discussion of § 2.5 fully applies.

Somewhat special are the probabilistic statements of IPCC, discussed in § 2.1 and 3.1. An example of such a statement is: "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century". Betz (2013) argued that this type of statement would be free from non-epistemic values because of its probabilistic nature. This was disputed by John (2012), because (in my words) expert judgment plays a role in the determination of the probabilities, and this does involve non-epistemic values, such as trust in climate models.

Non-epistemic values

Ludwig (§ 2.5) gave 5 arguments for a role for non-epistemic values in scientific reasoning. The first two were related to uncertainty. The others were the role of social values, the use of 'thick ethical concepts' and the role of ontological choices.

Ontology [7] (in according to one definition) deals with questions concerning what entities exist or may be said to exist, and how such entities may be grouped, related within a hierarchy, and subdivided according to similarities and differences. This process is also known as framing.

It is not so clear whether thick concepts (at the same time descriptive and value laden) play a role in climate research, but I will speculate on their occurrence when discussing uncertainty

Before discussing framing, uncertainty and social values, I will start by considering the role of personal values.

Personal values

There are a number of personal values that play a role in science and also in climate research. Some of these should not be allowed to influence scientific reasoning, for others this may be unavoidable.

Personal values that might play a role are: securing income and/or financial profit, competition, desire to dominate over others, desire to convince, desire to learn, wish to conform, wish to deviate, etc. That all of these factors play a role in scientific practice is in line with the anarchistic view of Feyerabend, but that does not mean that they should be accepted as evidence in a scientific disquisition.

One challenge in climate research is its complexity. This implies that it is impossible for an individual to check all claims. This makes it unavoidable to trust the authority of colleagues. Trust in authority is fed by a mixture of facts and values.

[7] https://en.wikipedia.org/wiki/Ontology

The same complexity implies that many choices have to be made when interpreting observations and during the development of models (Frigg et al, 2015). Some of these choices are practical, but it is unlikely that personal biases would not play a role. In fact, this is explicitly acknowledged by IPCC where it speaks of expert judgment.

Framing choices

The climate system is the earth system, i.e. the full biogeosocio-economic system, with external forcing by solar radiation and cosmic rays. Framing of the relevant questions is a highly non-trivial matter. IPCC, for example, typically spends about one year on questions related to the framing of each of their reports. Many choices have to be made, particularly in the socio-economic domain. An example, mentioned by Brigandt (2015), is the introduction of the concept of 'utility' as a measure of global wealth in climate management models.

But also in the physical domain framing is non-trivial. In fact, the very concept of climate is a construction with poor epistemic justification. The definition as 30-year weather average is a compromise between different countries, some having long observational records and others having only relatively short records. Similarly, the concept of climate change is value-loaded, which resulted in IPCC and UNFCCC using different definitions (IPCC: irrespective of the cause; UNFCCC: a change attributable to human influence). Yet another example is the attribution concept. IPCC working group 1 reserves this for attribution of climate change to a particular cause; its working group 2 to the attribution of observed changes to climate variations irrespective of their cause. Other constructed concepts play a central role, such as climate sensitivity and radiative forcing. Neither of these is defined in observable terms. Instead, they refer to model behaviour in idealized numerical experiments.

Uncertainty

Uncertainty does play an important role in climate science. Researchers have developed very advanced tools for quantifying uncertainties, and IPCC has made considerable effort in dealing with uncertainty. I quote: "Confidence in the validity of a finding is based on the type, amount, quality, and consistency of evidence (e.g., data, mechanistic understanding, theory, models, and expert judgment) and the degree of agreement. Probabilistic estimates of quantified measures of uncertainty in a finding are based on statistical analysis of observations or model results, or both, ***and expert judgment.***" Italics are mine. An example is the famous attribution statement from the 5th assessment report: "Anthropogenic drivers are extremely likely to have been the dominant cause of the observed warming since the mid-20th century." This statement has an epistemological underpinning, but the 'extremely' (rather than 'very likely', for example) also relies on the value judgment of the authors. As such it might be considered a thick statement.

Social values

a. In the case of climate research socioeconomic values had considerable impact on funding. They also influence the framing of the problem.

b. Large scale environmental experiments face practical difficulties, but they also raise ethical questions, as the outcome is in general poorly predictable. Massive controlled release of CO_2 to test the warming response of the earth would be considered immoral.
c. Social values play an essential role in socioeconomic climate studies. An example is discounting, which quantifies the value of current behaviour for future generations, and has an enormous impact on the outcome of cost-benefit analyses. Ideally, this leads to hypothetical imperatives. In such cases it is important that the assumptions are made explicit.
d. Fourth, social values matter in establishing the 'adequacy of a claim'. Is there enough evidence to point at the risks of climate change? There seems to be broad agreement that this is the case, but the discussion then shifts to important details, such as how the message is formulated and what is the risk of erring on the side of least (or most) drama. This becomes a very serious problem when one tries to write summary assessments.

4. How does this impact on the scientific and public climate debate?

A better understanding of the epistemological meaning of facts and values, such as laid out in this paper, might be helpful in improving the quality of the climate debate[8].

Climate scientists expect that climate will change due to human interference. There is uncertainty about the magnitude, but the risks are real. This has led to intense discussion about the soundness of the science, the vulnerability, and adaptation and mitigation options. Values play an important role in decision making[9].

There are large differences between the scientific and the public debate, but there is no strict separation between both arenas. When a scientist publishes a claim, it is in the public domain, and many scientists take part in the public discussion. Moreover, in both arenas the same facts and the same values are relevant.

A public discussion on the certainty of climate facts is legitimate in my opinion, as are public discussions on the reliability of climate science. Scientists could help debunk pseudoscepticism by stressing the importance of epistemic rules. At the same time they should be better aware of the value ladenness of their claims, in particular when they try to summarize their findings. A more explicit discussion of values might also be enlightening.

5. Acknowledgments

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[8] See also http://klimazwiebel.blogspot.nl/2013/11/can-philosophy-enlighten-climate.html
[9] See also Hulme (2009).

6. References

I included some additional references, not discussed in the text.

Been, Wouter de en Sanne Taekema. 2012. De verstrengeling van feiten en waarden: onjuist of onvermijdelijk? in: E.T. Feteris e.a. (red), *Gewogen oordelen. Essays over argumentatie en recht*, Den Haag: Boom, pp. 327-337.

Betz, Gregor. 2013. In defence of the value free ideal. European Journal for Philosophy of Science 3, 207–220.

Boghossian, Paul. 2008. Epistemic rules. Journal of Philosophy 105, 472-500. https://www.academia.edu/241405/Epistemic_Rules.

Brigandt, Ingo. 2015. Social values influence the adequacy conditions of scientific theories: beyond inductive risk. Canadian Journal of Philosophy. 45, 326-356.

Climate Services Partnership Working Group on Climate Services Ethics, 2015. Toward an ethical framework for climate services. White paper (http://www.climate-services.org/wp-content/uploads/2015/09/CS-Ethics-White-Paper-Oct-2015.pdf).

Douglas, Heather. 2009. Science, policy and the value free ideal. University of Pittsburgh Press, 2009, 210pp, ISBN 9780822960263.

Douglas, Heather, 2013. The Value of Cognitive Values. Philosophy of Science. 80, 796-806.

Douglas, Heather. 2015. Politics and Science: Untangling Values, Ideologies, and Reasons. Annals of the American Academy of Political and Social Science. 658, 296-306.

Douglas, Heather. 2015. Values in Science. Forthcoming in the Oxford Handbook in the Philosophy of Science.

Douglas, Heather. 2015. The Role of Democratic Publics in Evidence-Based Decision-Making. Lecture. CSPC Symposium November 25, 2015.

Frigg, Roman, Erica Thompson and Charlotte Werndl, 2015. Philosophy of Climate Science Part II: Modelling Climate Change. Philosophy Compass 10/12, 965 - 977.

Harris, Robert A, 2005. A Summary Critique of The Fact/Value Dichotomy. http://www.virtualsalt.com/int/factvalue.pdf

Hicks, Dan. 2014. A new direction for science and values. Synthese 191, 3271-3295.

House, Ernest R, 2001. Unfinished Business: Causes and Values. American Journal of Evaluation, 22, p313.

Hulme, Mike. 2009. Why we disagree about climate change. Cambridge University Press.

Intemann, Kristen, 2015. Distinguishing between legitimate and illegitimate values in climate modelling. European Journal for Philosophy of Science, 5, 217-232.

IPCC, 2014. Fifth Assessment Synthesis Report. http://www.ipcc.ch/

John, Stephen, 2012. 'Mind the Gap', essay review of Science, Policy and the Value Free Ideal by Heather Douglas. Studies in History and Philosophy of Science A43, 218–220.

John, Stephen. 2015. The example of the IPCC does not vindicate the Value Free Ideal: a reply to Gregor Betz. European Journal for Philosophy of Science. 5, 1-13.

Johnson, David Kyle, 2016. Justifed Belief in the Existence of Demons is Impossible. (https://www.academia.edu/21642443/Justified_Belief_in_the_Existence_of_Demons_is_Impossible)

Katzav, Joel and Wendy S. Parker, 2015. Introduction to Assessing climate models: knowledge, values and policy. European Journal for Philosophy of Science. 5, 141-148.

Kuhn, Thomas, 1977. Objectivity, Value Judgment, and Theory Choice. In:The Essential Tension: Selected Studies in Scientific Tradition and Change. University of Chicago Press. pp. 320–339.

Kunda, Z, 1990. The case for motivated reasoning. Psychological Bulletin 108, 480 - 498. doi:10.1037/0033-2909.108.3.480. PMID 2270237.

Ludwig, David. 2015. Ontological Choices and the Value-Free Ideal. Forthcoming in Erkenntnis.

Niiniluoto, Ilkka, 2008. Facts and values – a useful distinction, in Sami Pihlström and Henrik Rydenfelt (eds.), Pragmatist Perspectives, Acta Philosophica Fennica 86, Philosophical Society of Finland, Helsinki, 2009, pp. 109-133.

Noko, Joseph , 2014. On facts and values: critique of the fact-value dichotomy in economics. Real-world economics review, issue no. 66, 30-37.

Parker, Wendy. 2015. Values and Uncertainties in Climate Prediction, Revisited. Studies in History and Philosophy of Science Part A 46 (2014): 24-30.

Paternotte, Cédric and Milena Ivanova. 2016. Virtues and Vices in Scientific Inquiry. (Forthcoming in Synthese – penultimate draft, January 2016).

Petersen, A. C. 2012. Simulating Nature: A Philosophical Study of Computer Simulation Uncertainties and their Role in Climate Science and Policy Advice. Boca Raton, FL.: CRC 1742 Press.

Putnam, Hilary, 2002. The Collapse of the Fact/Value Dichotomy: And Other Essays . (Cambridge: Harvard University Press)

Rudner, Richard, 1953. The Scientist Qua Scientist Makes Value Judgments, Philosophy of Science, 20, 1-6.

Russell, Bertrand. 1945. History of western Philosophy. Simon & Schuster.

Winsberg, Eric, 2012. Values and Uncertainties in the Predictions of Global Climate Models. Kennedy Institute of Ethics Journal. 22, 111-137.