

The role of climate scientists in the post-factual society

Erlend M. Knudsen and Oria J. de Bolsée

Set-up of response

We thank the reviewer for her suggestions on the manuscript. With the changes explained below, we feel that the paper is strengthened compared to its first submission.

In the following, we go through each comment by the reviewers (reproduced here in gray text for your reference) and explain our choices of changes in accordance with these. Where changes to the text in the manuscript are made, the relevant excerpt is reproduced from the .pdf manuscript to this .docx response in *italic text*, with changes written in *italic green text*.

Response to the review by Rhian Salmon

Reframing the manuscript

The second half of the paper was, to me, far more interesting – which focused more on the experience of the authors and situated this journey as one of a number of outreach initiatives about climate change that they're involved in. I would recommend reframing the paper in this context – as a case study of the experience of young climate scientists at this particular (and very important) time in history. In that context, the bike ride, the march for science and the other outreach activities all tell a collective story – most importantly, that of the emerging climate scientists in this day and age (and possible changes to their training).

We appreciate you sharing your opinions and recommendations on this matter, which we believe help us strengthen the manuscript. We have therefore tried to follow your suggestions as much as possible in the updated manuscript. Here, we tell the story of being young environmental scientists having tried to actively bridge what we see as a widening gap between science and populism, building on our experiences from Pole to Paris (the two authors ran about 2450 km and 750 km of the Northern Run in addition to backing other parts of the project, including the Southern Cycle) and other environmental awareness projects that we have been involved in.

In line with this, we have done several changes to the text, as explained below and highlighted in the updated manuscript. We have also changed the manuscript title to reflect this storyline, from “The role of climate scientists in the post-factual society” to “The role of climate scientists in the post-factual society: Reflections from the awareness campaign Pole to Paris”. With these changes, we hope and believe that the manuscript now tells a clearer story, in which we share our experiences to contribute to the scientific discussion on what role climate scientists should consider playing in the 21st century.

Reflection on how to improve

Were there an opportunity to expand on the length of this paper (which I don't necessarily encourage), then I would also like to see greater reflection on how the initiatives could be improved, and how the authors would learn from their experiences, were a similar opportunity to arise.

Based on your suggestion, we have added two paragraphs to the end of Sect. 4 that read:

Common for all these initiatives is the eagerness to communicate science in ways that engage the layperson. To help us – and the reader of this manuscript – learn from our efforts, we ideally would have set up a more standardized feedback scheme for our audiences during the active period of Pole to Paris. The feedback we did receive – in personal conversations and in online commentary fora – were most likely anomalously positive and negative, respectively. We could surely also have benefitted from more planning before undertaking these journeys, but this might have compromised the journeys themselves. Being the only two fully “working” (i.e., without getting paid) on the project, the two climate scientists of Pole to Paris – the lead cyclist and runner – had just completed their PhDs before taking on the journeys, while the other eight in the team had full time commitments to studies or employers to balance, which did not provide much room for further planning. This, along with the widely varying time zones the team members were based in and often lack of internet accessibility out on the Southern Cycle and Northern Run, meant that team meetings were less regular than what would have been ideal for making sure we were all pulling in the same direction.

Passion united the team and contaminated our various audiences, creating better dialogues in a positive feedback loop (Nisbet, 2018). We cycled and ran out with rough plans and adapted along the way as engagement created opportunities (e.g., the Global Voices events and United Nations program partnerships) or disasters imposed limitations (e.g., the Nepal earthquake and Paris terror attacks). Similarly, even though we had scientific and communicational training to start with, we learned a lot by doing. Most importantly, by meeting our audiences in running shoes, on a bicycle or over a beer, we connected as humans, which is critical for effective science engagement (Nisbet, 2018). While we strongly acknowledge the need for publishing research papers to further develop scientific questions, we emphasize that the findings thereof are incomplete if not shared with the society at large.

Justification of title

I really like the title, and the aspiration of the paper to explore/ argue that the “scientific community was not prepared for the intense politicization of climate change” (para 2), but I don’t think the paper in its current form lives up to these. Furthermore, considering “post-factual society” is a phrase used in the title, little time is given to defining or exploring this important concept.

Thank you for pointing out the mismatch between the title and the manuscript itself. In the updated manuscript, we have changed the title from “The role of climate scientists in the post-factual society” to “The role of climate scientists in the post-factual society: Reflections from the awareness campaign Pole to Paris”. Furthermore, we have expanded the first paragraph in Sect. 1 into three to better explain what is meant with politicization and polarization of climate change and a post-factual society.

As a result, the first three paragraphs in Sect. 1 now read:

*The role of climate science in the public sphere has changed significantly since the mid-1980s. **Ensu**ing the formation of the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Senate testimony of James Hansen in 1988, climate science has increasingly become a topic of political debate, media coverage and part of the daily discourse in our societies (Bolin, 2007; Ungar, 2016). **Simultaneously**, the scientific*

understanding of climate change has been rapidly expanding, with the number of climate change papers published per year exponentially growing (McSweeney, 2015) and the confidence in humans as the main cause of global warming has gone from insufficient to “extremely likely” (as defined by the IPCC First to Fifth Assessment Reports; Houghton et al., 1990; Stocker et al., 2013).

A corresponding increase has neither been seen in climate change legislation (Townshend et al., 2013), media coverage of climate change topics (Boykoff et al., 2018) nor in public perception of climate change (Capstick, et al., 2015; Zhao et al., 2016; Saad, 2017). Instead, the politicization and polarization of climate change has been growing, with the former referring to how the science behind political decisions increasingly are promoted and attacked by advocates and opponents and the latter referring to the growing division between elites, organisations and political parties viewing climate change as a negative consequence of industrial capitalism and those opposing such views (McCright and Dunlap, 2011). This trend is arguably most notable in the U.S. (Capstick et al., 2015; Carmichael et al., 2017), where the partisan divide on environmental voting score (as defined by the League of Conservation Voters) grew from about 25 in 1970 to about 85 in 2015 (Dunlap et al., 2016). Since then, Donald Trump was elected as the country’s 45th president and has repeatedly been questioning climate science, actively working against environmental legislation and funding of his predecessor and generally making the work of climate scientists more challenging (De Pryck and Gemenne, 2017; Alderman and Inwood, 2018; and references therein). A post-factual society has arisen, in which part of its members rather accept an argument based on their emotions and beliefs than one based on scientific facts (Alvermann, 2017).

A post-factual political scene is not isolated to the U.S. alone; Brexit in the U.K. and the (re-)elections of Rodrigo Duterte in the Philippines, Andrzej Duda in Poland, Viktor Orbán in Hungary, Recep Tayyip Erdogan in Turkey and Jair Bolsonaro in Brazil are all examples of populist solutions trumping science-based ones (Postel-Vinay, 2017). Furthermore, the rise of social media has meant that everyone can act as journalists and editors in choosing what to post, where algorithms make sure to share posts from those with similar opinions, thus creating filter bubbles (Pariser, 2011; Alvermann, 2017; Bail, 2018). Conventional media can also reinforce filter bubbles by presenting scientific news within pre-existing worldviews of their audiences (Theel et al., 2013; Carmichael et al., 2017). Similar bubbles exist within academia, where scientists are trained to write for an already highly educated and specialized audience (Stiller-Reeve et al., 2016). Scientists are thus often seen as an elite without touch to the rest of society (Townson, 2016). For this reason, it is, more than ever, crucial to establish dialogues with those outside of academia in order to help trigger positive global changes (Leshner, 2007; Barnosky et al., 2016). Doing so, we, as scientists, need to choose our role within society carefully in consideration of the consequences for us individually and as a community (Pielke Jr., 2007; Vraga et al., 2018).

Furthermore, we have added a sentence to the 3rd paragraph in Sect. 5, which now reads:

For scientists at the beginning of their academic career, we support the notion by Leshner (2007), Brownell et al. (2013), Rauser et al. (2017) and Nisbet (2018) that engaging in outreach activities helps shape the research questions, giving more effective tools for narrowing the widening gap between academia and the rest of society, and eventually providing a more constructive input for policy formulation on climate change. As we see it, this will act to reduce politicization and polarization of climate change, while also depressing the breeding ground for post-factual movements. Within academia, outreach training gives

us better tools in teaching, mentoring of younger students and taking part in scientific discussions, as well as contributing to better written research proposals and journal publications (Stiller-Reeve et al., 2016, and references therein).

Breadth of references

The number is appropriate but the breadth could be expanded – the majority of these references come from physical/ climate science/communication journals. Considering the focus of this article, I would expect to see a few more references from the field of Public Engagement with Science, especially related to dialogue and two-way interaction, which is referred to several times.

Based on your suggestion, we have added several new references to the manuscript with a special focus on the field of public engagement with science. While we do not provide a complete list of new references here (these are highlighted in the updated manuscript), we emphasize the most relevant ones.

Excerpt of the 2nd paragraph in Sect. 1:

For this reason, it is, more than ever, crucial to establish dialogues with those outside of academia in order to help trigger positive global changes (Leshner, 2007; Barnosky et al., 2016).

Excerpt of the 2nd paragraph in Sect. 2:

Crucially, along the way, we held talks in schools, universities and many other public venues and were joined by other cyclists and runners for part of the distances. This created a two-way communication, in which we openly engaged the public to hear their perspectives and concerns about climate change before respectively responding to them, as suggested by Leshner (2003).

Excerpt of the 1st paragraph in Sect. 4:

Engaging in two-way interaction with a range of audiences – from farmers to senators, from preschool children to retirees and from Norwegians to Bangladeshis – provided invaluable insight to our own research questions, as also highlighted by Nisbet (2018). Fortunate with these encounters, we faced questions and concerns often far from ours, which opened our eyes and ears and widened our perspectives. As reported by Nisbet (2018) and references therein, we improved our communication and listening skills and extended our professional and social network.

Excerpt of the 2nd paragraph in Sect. 4:

Moreover, fostering constructive public conversations about science and society can, among others, improve decision-making, promote trust and credibility in scientific findings and strengthen democratic processes (Wooden, 2006; Nisbet, 2018), ultimately counteracting politicization and polarization of science and post-factual movements, respectively.

Excerpt of the 4th paragraph in Sect. 4:

Similarly, as suggested by Wooden (2006), the collaboration with local partner institutions (e.g., Gateway Antarctica in New Zealand, the Bjerknes Centre for Climate

Research in Norway, the UK Youth Climate Coalition in the UK and Climate Generation in USA) offered experience for successful ways of science communication within each country.

Excerpts of the last paragraph in Sect. 4:

Passion united the team and contaminated our audiences, creating better dialogues in a positive feedback loop (Nisbet, 2018).

Most importantly, by meeting our audiences in running shoes, on a bicycle or over a beer, we connected as humans - critical to effective science engagement (Nisbet, 2018).

Excerpt of the last paragraph in Sect. 5:

When done carefully, we have the potential, regardless of audience's political predilection, to provide trustworthy information to the climate change discourse (Leshner, 2003; MacInnis et al., 2015; Hamilton, 2016).

These references are:

- Leshner, A. I.: Public engagement with science, *Science*, 299, 977, doi: 10.1126/science.299.5609.977, 2003.
- Leshner, A. I.: Outreach training needed, *Science*, 315, 161, doi:10.1126/science.1138712, 2007.
- MacInnis, B., Krosnick, J. A., Abeles, A., Caldwell, M. R., Prahler, E., and Dunne, D. D.: The American public's preference for preparation for the possible effects of global warming: impact of communication strategies, *Climatic change*, 128, 17–33, doi:10.1007/s10584-014-1286-x, 2015.
- Nisbet, M.: Scientists in civic life: facilitating dialogue-based communication, American Association for the Advancement of Science, https://www.aaas.org/sites/default/files/s3fs-public/content_files/Scientists%2520in%2520Civic%2520Life_FINAL%2520INTERACTIVE%2520082718.pdf, 2018.
- Wooden, R.: The principles of public engagement: at the nexus of science, public policy influence, and citizen education, *Soc. Res.*, 73, 1057–1063, 2006.

Arguing for low preparedness of climate science politicization among scientists

In this commentary, we argue that the scientific community was not prepared for the intense politicization of climate change science (as defined by Zürn, 2014), which has occurred over the past several decades.

This is an interesting paper, but I'm not convinced that you argue this point in it

Please see Justification of title above.

Pole to Paris target group

The aim of the initiative was to raise awareness of the threats posed by climate change.

raise awareness to whom?

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

The aim of the initiative was to raise awareness of the threats posed by climate change, to people on our path as well as those reached virtually.

Thus, in an attempt to galvanize **public support** for a new global climate agreement, the Pole to Paris project was purposefully timed to lead on the road ending in Paris.

which publics?

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

Thus, the Pole to Paris project was purposefully timed, ahead and leading to COP 21, in an attempt to galvanise support for a new global agreement in our wide society, as public awareness of climate change in a country is positively related to the unconditional climate mitigation targets of that country, as later suggested by Drummond et al. (2018).

The reference is:

- Drummond, A., Hall, L. C., Sauer, J. D. and Palmer, M. A.: Is public awareness and perceived threat of climate change associated with governmental mitigation targets?, *Climatic Change*, 149, 1–13, doi:10.1007/s10584-018-2230-2, 2018.

Undergird vs. underpin

*However, it separated itself from other climate outreach actions by attempting to highlight the human-induced consequences of climate change rather than focusing on the pure scientific facts that **undergird** the reality of Earth's dynamic climate system.*

need a better word. underpin?

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

*However, it separated itself from **most** climate outreach actions by attempting to highlight the human-induced consequences of climate change rather than focusing on the pure scientific facts that **underpin** the reality of Earth's dynamic climate system.*

View on COP 21

*Following the unexpected collapse of the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the 2015 21st COP (COP 21) in Paris **was regarded by many in the scientific and political communities** as the last opportunity to begin to tackle climate change as a global community.*

would expect this to be better referenced

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

*Following the unexpected collapse of the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the 2015 21st COP (COP 21) in Paris was regarded by many in the scientific, political **and civil society** communities as the last opportunity to begin to tackle climate change as a global community (Bäckstrand and Lövbrand, 2016; de Moor, 2017).*

The road to Paris

*Thus, in an attempt to galvanize public support for a new global climate agreement, the Pole to Paris project was purposefully timed to **lead on the road ending in Paris**.*

language? this doesn't really make sense to the un-initiated.

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

Thus, the Pole to Paris project was purposefully timed, ahead and leading to COP 21, in an attempt to galvanise support for a new global agreement in our wide society, as public awareness of climate change in a country is positively related to the unconditional climate mitigation targets of that country, as later suggested by Drummond et al. (2018).

The reference is:

- Drummond, A., Hall, L. C., Sauer, J. D. and Palmer, M. A.: Is public awareness and perceived threat of climate change associated with governmental mitigation targets?, *Climatic Change*, 149, 1–13, doi:10.1007/s10584-018-2230-2, 2018.

Abstractness of climate change

The nature of the problem – being a long-term process on a planetary scale – makes it difficult for individuals to grasp it and engage with it. In an attempt to remove this abstractness, two journeys from the poles were mapped out: the 10,000-km long bicycle ride – the Southern Cycle – from Christchurch (New Zealand) and the 3,000-km long run – the Northern Run – from Tromsø (Norway), both finishing in Paris during COP 21 (Fig. 1).

not entirely clear how or why two long distance bike rides removes the abstractness of the concept of planetary scale climate change (but I don't really see how you'll change this either - it's a basic premise of the paper that I struggle with). See below comment (and general comment) about a suggested restructure/ reframing, which would remove the need to justify the bike ride in this way.

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

The nature of the problem – being a long-term process on a planetary scale – makes it difficult for individuals to grasp and engage with. In an attempt to remove this abstractness, we, as scientists, decided to hit the road in order to share climate science knowledge with people on the ground as well as collect their stories of experienced changes to share them through our platforms. Two journeys from the poles were mapped out: the 10,000-km long bicycle ride - the Southern Cycle - from Christchurch (New Zealand) and the 3,000-km long run - the Northern Run - from Tromsø (Norway), both finishing in Paris during COP 21 (Fig. 1).

Coincidentally vs. in real time

The public were invited to get behind these journeys and actively become engaged in the climate dialogue coincidentally.

in real time

Based on your suggestion, the relevant excerpt in Sect. 2 now reads:

The public were invited to get behind these journeys and actively become engaged in the climate dialogue in real time.

[View on COP 21](#)

Crucially, along the way, we held talks in schools, universities and many other public venues, **achieving two-way communication**.

lots of opportunity here to reference dialogue literature

Please see Breadth of references above.

Reach of Pole to Paris

A **conservative estimation** is that more than one million people in 45 countries were reached through conventional and social media, which included close to 250 media outlets (e.g., airing on CNN and TNN Thailand 24 and published in The Guardian and National Geographic) and almost 500,000 and 250,000 reached per Facebook post and Twitter tweet, respectively.

is it possible for some explanation of how the numbers were estimated?

Based on your suggestion, we have moved this sentence to its own paragraph at the end of Sect. 2, where we provide some more background on the estimated number. This paragraph now reads:

A conservative estimation is that more than one million people in 45 countries were reached through conventional and social media, which included close to 250 media outlets and almost 500,000 and 250,000 reached per Facebook post and Twitter tweet, respectively. While it is probable that some of our followers on Facebook, Twitter and Instagram overlapped, the breadth of conventional media coverage meant that we were able to reach a wider span of the society. For example, our story was featured five times on CNN in English, Spanish and Arabic, while Norwegian Broadcasting Corporation aired us 14 times. None of these are likely to be seen by the average Thai, Chinese or Indonesian, but our appearance in the Thai news channel TNN24, the China News Service or the Indonesian Jawa Pos might. Similarly, where coverage in the English-language news actors The Guardian, The Huffington Post or The Daily Star plausibly caught the attention of those already aware of human-induced climate change, the more domestic-focused Le Parisien in French, la Repubblica in Italian or Correio Braziliense in Portuguese almost certainly brought climate change into new light among their readers. Additionally, we gave 80 presentations in five languages along the running route alone.

Air pollution and climate change

Looking into these numbers in more detail, the authors in 2018 conducted a statistical analysis on the reach of the videos created by Pole to Paris and shared through Facebook. These videos spanned from 20 seconds to 6 minutes in length and showcased the life on the road from the Poles to Paris (i.e., challenges and joys of the run and bike ride), the various direct or indirect impacts of climate change along the way (e.g., on coral bleaching in Australia, on **air pollution in China** from the carbon-intensive coal use, and on glacial melt in Antarctica, Norway, and the European Alps), and on the importance of climate action at COP 21 and home. Of the total of 42 videos, we focused the analysis on the 32 in the most active period from June to December 2015. Figure 2 shows some of its key results.

is this an indirect impact of climate change?

We agree that air pollution is not an impact of climate change, neither directly nor indirectly. Instead, it results from coal use, which is one of the strongest contributors to anthropogenic climate change. Hence, we realize that our original wording was misleading on this issue, thank you for pointing that out and have changed the wording in the updated manuscript accordingly.

Based on your suggestion, the relevant excerpt in Sect. 3 now reads:

*Looking into **the social media** numbers in more detail, the authors in 2018 conducted a statistical analysis on the reach of the videos created by Pole to Paris and shared through Facebook. These videos spanned from 20 seconds to 6 minutes in length and showcased the life on the road from the Poles to Paris (i.e., challenges and joys of the run and bike ride), the various impacts **associated with** climate change along the way (e.g., coral bleaching in Australia **from raising CO₂ levels and temperature**, air pollution in China from carbon-intensive coal use, and glacial melt in Antarctica, Norway, and the European Alps **from shifting precipitation patterns and increasing summer temperatures**), and on the importance of climate action at COP 21 and home. Of the total of 42 videos, we focused the analysis on the 32 in the most active period from June to December 2015. Figure 2 shows some of its key results.*

Sentence structure on video views

*Of the 226 346 total video views after three seconds, 56 130 (25 %) and **16 703 (7 %)** were still there at 30 seconds and at 95 % of the video length, respectively (Fig. 2a).*

move this later in the sentence - sentence structure needs attention

Based on your suggestion, the relevant excerpt in Sect. 3 now reads:

*Of the 226 346 total video views after three seconds, 56 130 (25 %) were still there **after 30 seconds and 16 703 (7 %)** at 95 % of the video length (Fig. 2a).*

Statement on viewers watching movies several times

*Of these views, 89 % (after three seconds) to 97 % (at 95 % of the video length) were unique (not shown), meaning that almost all videos were watched once and **that the once watching the videos over, only watched parts of them again.***

doesn't make sense - please clarify

Thank you for pointing out that this clause was not clear. We also realize that we have drawn a too hasty conclusion here. Hence, we have removed this clause from the relevant sentence in the updated manuscript.

Generation Z

*Possibly more interestingly, the second largest group of followers was made of **Generation Z**, pointing to the added reach of social media compared to other science communication tools, as also pointed out by Bowman et al. (2015).*

define

Based on your suggestion, the relevant excerpt in Sect. 3 now reads:

Possibly more interestingly, the second largest group of followers was made of Generation Z (people born in the mid-1990s to the mid-2000s), pointing to the added reach of social media compared to other science communication tools, as also pointed out by Bowman et al. (2015).

Interpretation of the social media survey

Several of the 37 respondents highlighted more than one aspect, with 14 answers favouring the actual journeys from the Poles to Paris, 16 the same for the physical challenge of running and biking, 18 the scientific message on climate change, and 17 the human face that Pole to Paris put on climate change through stories from the ground.

37 respondents out of HOW MANY (thousands of) followers? Is this in any way statistically significant or a representative sample of your followers? Surely there's a high level of self-selection and bias in these respondents.

this is in contrast with stats presented above, suggesting that this is not a representative sample

The social media survey had 37 respondents out of more than 6,200 followers on Facebook, 1,200 on Twitter and 650 on Instagram. The number of followers is given in the second last paragraph before the paragraph that this sentence is part of (in Sect. 3). We do neither consider the respondents a significant proportion nor representative sample of our followers, which we also did not claim. Rather, we highlighted the limitations of this survey in the second paragraph following the paragraph that this sentence is part of.

Even with a low sample of our followers (less than 1 %, as written in the manuscript), we chose to include what we saw as the main results of the social media survey in the manuscript. This decision was based on the request from the journal's chief editor Dr. Sam Illingworth. In hindsight, we acknowledge that we should have thought of this earlier, as we would have expected a much higher response rate during the active period of the project than three years after (as discussed in the manuscript).

The 14 answers favouring the actual journeys from the Poles to Paris are indeed not in contrast to the statistics on the Facebook videos presented above this excerpt. Of the four answers (favouring the actual journeys from the Poles to Paris, favouring the physical challenge of running and biking, favouring the scientific message on climate change, and favouring the human face that Pole to Paris put on climate change through stories from the ground), this answer was the least popular, just as the Facebook videos on the journeys from the Poles to Paris were, as discussed in the third last paragraph before the paragraph that this excerpt is part of (in Sect. 3).

In line with the statistical analysis of the Facebook videos, the fact that the scientific message was seen more interesting than the journeys themselves, indicates that a project like Pole to Paris can find success in disseminating scientific information to a wider audience. Among other key findings from the survey, 84 % of the respondents reported that Pole to Paris inspired them in some way. This is also a strong indicator that unconventional projects in the vein of Pole to Paris can find success in connecting with non-scientific audiences in positive ways. Moreover, more than half (54 %) indicated that they learned

something new through Pole to Paris, signalling the potential scientists have in bridging the gap between academia and the general public on fundamental societal issues.

Considering the size of your followers, and the very small response rate, I don't see how you can usefully compare response rates of 17 to 14 and read anything into this. Doesn't seem in any way statistically significant.

with only 37 respondents, makes more sense to use actual numbers here rather than a %. Or use both

this sentence is highly problematic. 54% of 37 people is about 20 people. This project would not be deemed a success if it only reached 20 people. Secondly, this is the first time you have mentioned that the cyclists are scientists - and have presented no evidence that it matters that they are scientists. Why do you think this response would be different than if it was any young activists on an adventure?

Please see our reply above.

Following your suggestion, we have replaced percentages by numbers in the relevant excerpt. This now reads:

In line with the statistical analysis of the Facebook videos, the fact that the scientific message was seen more interesting than the journeys themselves, indicates that a project like Pole to Paris can find success in disseminating scientific information to a wider audience. Among other key findings from the survey, 31 out of 37 respondents reported that Pole to Paris inspired them in some way. This is also a strong indicator that unconventional projects in the vein of Pole to Paris can find success in connecting with non-scientific audiences in positive ways. Moreover, more than half (20 out of 37) indicated that they learned something new through Pole to Paris, signalling the potential scientists have in bridging the gap between academia and the public on fundamental societal issues.

Please note that we do not claim Pole to Paris to be a success based on the number of respondents to the social media survey that indicated that they learned something new. Rather, the manuscript aims to discuss what role climate scientists might want to take on in the 21st century. We aim to contribute to this discussion by sharing the experiences from Pole to Paris. In line with the requests of the journal's chief editor, Dr. Sam Illingworth, we use the numbers we have to discuss success without stating that a particular number in itself is an answer to whether or not Pole to Paris was successful. For example, we share numbers on conventional media outlets (close to 250), views of our most popular video (more than 100,000), Twitter tweet reach (almost 250,000) and estimated total reach (more than 1 million) but devote an own section to unquantifiable benefits of Pole to Paris (Sect. 4).

The number of respondents indicating that they learned something new through and that got inspired by Pole to Paris (20 and 31 out of 37, respectively), as we see it, indicate that almost half of our followers already were literate on climate change issues but did not know what to do about it. We managed to inspire them to a large degree. This interpretation is included in a newly written 4th paragraph in Sect. 4 along with a discussion on how we were able to reach people not scientifically literate and how our scientific credibility helped in our success. It reads:

The nature of the Pole to Paris campaign allowed us to build an audience, which did not necessarily have a high interest in science nor necessarily a belief in climate change. This was purposefully done through several means: being on the road and therefore also meeting people who would not otherwise go to a talk about science on climate change; meeting university and school students of all grades and consequently discussing with students who often had barely heard of the science behind climate change; and finally, running and biking, which invited participants for the physical challenge that would stay over for the following talk on climate change and reached by a message they were not initially seeking. This point is also suggested by the number of the social media survey respondents indicating that they learned something new through and that got inspired by Pole to Paris (20 and 31 out of 37, respectively), which indicate that almost half of our followers already were literate on climate change issues but did not know what to do about it. Even though the knowledge and interest in science differ between sociodemographic groups, as suggested by Schäfer et al. (2018), we found that all our audiences had a similar interest in learning about practical actions and solutions they could put in place at a personal level.

The reference is:

- Schäfer, M. S., Füchslin, T., Metag, J., Kristiansen, S., and Rauchfleisch, A.: The different audiences of science communication: A segmentation analysis of the Swiss population's perceptions of science and their information and media use patterns, *Public Underst. Sci.*, 27, 1–21, doi:10.1177/0963662517752886, 2018.

Interpreting these numbers, one should keep in mind that the survey respondents already were followers of the climate awareness project Pole to Paris and thus not necessarily representative of the average population. The three year lag of this feedback to the project compared to its most active period also introduce some uncertainty of remembrance and probably explain why less than 1 % of our social media followers responded to the survey. Similarly, the time passed since their publications limited the statistical analysis here to Facebook videos, as other social media data no longer were available. Even so, the numbers presented offer valuable insight on the worthiness of time spent on Pole to Paris and can help the outreach community in learning from our efforts.

or of the followers... they're not representative of anything!

don't think the survey has any validity unless you can in some way show it is representative of your followers, which you haven't

really? from 20 people?

Please note that due to the large span of target group, considering geography, age and backgrounds, of Pole to Paris, it is very hard to say what a typical follower looks like. We have also addressed this indirectly throughout the manuscript when talking about the reach of the project to audiences in different countries, speaking different languages, in different media and with different cultural and educational backgrounds. We hope that these are constructive answers to your two first claims.

The third claim or question is unfortunately missing our intended meaning. We hope that we have clarified what we mean with the highlighted excerpt above, which does not refer to the

fact that 20 respondents learned something new through Pole to Paris, but rather to all other numbers presented from Pole to Paris at this point and the added benefits - for us, our audiences and the scientific community - to be presented in the section that follows.

Based on your suggestions, we have rewritten the relevant excerpt in Sect. 3. It now reads:

Interpreting these numbers, one should keep in mind that the survey respondents already were followers of the climate awareness project Pole to Paris and thus not necessarily representative of the average population. The three-year lag of this feedback to the project compared to its most active period also introduce some uncertainty of remembrance and probably explain why less than 1 % of our social media followers responded to the survey. This small respondent rate meant that the answers not necessarily represented those of a typical follower. Moreover, the time passed since most of our social media posts were published limited the statistical analysis here to Facebook videos, as other social media data no longer were available. Even so, we believe the numbers presented in this manuscript offer valuable insight on the worthiness of time spent on Pole to Paris and can help the outreach community in learning from our efforts.

Two-way interaction

As also mentioned by Barnosky et al. (2014), the direct success of an initiative like Pole to Paris is however almost impossible to quantify. Indirectly, the Pole to Paris team members took great value from being able to deliver vital information to the public. Engaging in two-way interaction with a range of audiences – from farmers to senators, from preschool children to retirees and from Norwegians to Bangladeshis – provided invaluable insight to our own research questions. Fortunate with these encounters, we faced questions and concerns often far from ours, which opened our eyes and ears and widened our perspectives.

This is more about the value the experience gave to the team members than the people they spoke with - which is not to be underestimated. "Two-way" interaction implies genuine two-way dialogue, but this sounds more like it was the adventurer-scientists telling the people they met what they knew about climate change... so more like education than 2-way interaction.

We acknowledge that this excerpt was written poorly, making it sound that we were delivering information to our audiences without a two-way communication. This was far from the truth. We did indeed share knowledge of climate science and experiences from the road to Paris with our audience, but we equally listened to our audiences' experiences of climate change and answered their questions on climate science. By rephrasing the relevant wording on our dialogue approach, we hope and believe that we have been able to better highlight this vital part of Pole to Paris in the updated manuscript.

Based on your suggestion, the 2nd-3rd sentence in the 2nd paragraph in Sect. 2 now reads:

The nature of the problem – being a long-term process on a planetary scale – makes it difficult for individuals to grasp and engage with. In an attempt to remove this abstractness, we, as scientists, decided to hit the road in order to share climate science knowledge with people on the ground as well as collect their experienced changes and share them through our platforms.

Based on your suggestion, the relevant excerpt in Sect. 4 now reads:

*As also mentioned by Barnosky et al. (2014), the direct success of an initiative like Pole to Paris is however almost impossible to quantify. Indirectly, the Pole to Paris team members took great value from being able to **share climate science with our audiences and listen to their experiences of climate change**. Engaging in two-way interaction with a range of audiences – from farmers to senators, from preschool children to retirees and from Norwegians to Bangladeshis – provided invaluable insight to our own research questions. Fortunate with these encounters, we faced questions and concerns often far from ours, which opened our eyes and ears and widened our perspectives.*

The Paris Agreement as a success factor

The Paris Agreement, of which Pole to Paris was one of many numerous initiatives building public support for, was arguably a better outcome of COP21 than the climate science community could have hoped for.

This is problematic as well - while I don't disagree with this sentence, I don't quite get the connection between this sentence and the previous paragraph (which makes an important point about the immeasurable, multiple and qualitative benefit of the journey).

Based on your suggestion, the relevant excerpt in Sect. 4 now reads:

*The Paris Agreement, of which Pole to Paris was one of numerous initiatives building public support for, was arguably a better outcome of COP21 than the climate science community could have hoped for **and, as later similarly suggested by Drummond et al. (2018), might have been influenced by that awareness raised among people.***

The reference is:

- Drummond, A., Hall, L. C., Sauer, J. D. and Palmer, M. A.: Is public awareness and perceived threat of climate change associated with governmental mitigation targets?, *Climatic Change*, 149, 1–13, doi:10.1007/s10584-018-2230-2, 2018.

Critization and credibility of science communicators

Schimid and Petri (2017) have argued that those in the scientific community who actively attempt to communicate the seriousness of climate change to a wide audience often are met with attempts “to discredit their scientific credibility, or to criticize the studies that are used or their underlying methods and models.” As communicators of the scientific consensus, we inevitably experienced these tactics from climate sceptics in online fora. Mostly, the criticisms were from individual citizens and directed at us personally. Out on the roads to Paris, however, fact-based messaging was immensely welcomed. Considering the politicized division of the media themselves (e.g., Brüggemann and Engesser, 2017), this positive experience of direct engagement supports the suggestion by Gauchat et al. (2017) that science participation and outreach could rebuild the credibility among communities most critical of scientists.

This is a nice, and important, paragraph

Thank you!

Professional credibility and climate change communication

Hence, we worked hard to keep our credibility as researchers (Nordhagen et al., 2014), not partnering with organizations or initiatives on either of the climate advocacy fringes, and not favouring one political party over another. We experienced a boost in personal and public credibility, more than outweighing a loss in professional credibility from our publication record hiatus while on the road, thus overall enhancing our researcher credibility. We saw our role as awareness-raisers, increasing the understanding of climate science within all societal groups.

the loss of professional credibility associated with climate change communication is not usually about a reduced number of publications, but rather the apparent politicisation of "objective" scientists.

In writing this excerpt, we used the definitions and discussions in Nordhagen et al. (2014) on a researcher's credibility, which they separate into professional, public and personal credibilities. There, they define professional credibility as the credibility a researcher has across academic (and non-academic) research communities of various scales, public credibility as the credibility a researcher has in the wider population (including policymakers, media and "lay people") and personal credibility as the credibility a researcher has from relationships with self, family, friends and close associates.

According to Nordhagen et al. (2014), "[a]n academic researcher gains professional credibility by obtaining academic qualifications and adhering to common research principles [...] such as observing ethical standards (e.g., acknowledging funding, avoiding interest conflicts), publishing peer-reviewed research, methodological transparency, and data availability". Under public credibility, they write that "[t]here is a difference between engaging on issues of science and those of policy; one must not conflate views of 'things done in the name of science' with views of science itself [...]. While scientific papers and grants commonly emphasise policy-relevance and include policy recommendations, these rarely translate into policy-making involvement. Indeed many argue this ought be avoided as potentially damaging to the researcher's professional and public credibility." Furthermore, for the personal credibility of a climate researcher, they write that "aspects of their personal behaviour (and associated carbon footprint) cannot be viewed in isolation from their professional expertise."

Nordhagen et al. (2014) then go on to discuss the conflict between professional and public credibilities: "Often drawn to climate change research by personal interest and belief in the necessity of curbing emissions, researchers may find themselves disagreeing with particular government actions/inactions and feel compelled to join public calls for stronger action. This contrasts with the common academic view that professional credibility demands researchers set aside their citizens' rights/responsibilities to hold the government accountable on their area of expertise. [...] This could, by some arguments [...], damage the overall scientific credibility of climate change research if researchers are seen as having an agenda. Yet one can also argue that while the researcher should not undermine scientific credibility of research, entering the profession does not annul their right to petition/protest: concern over 'credibility as a scientist' should not cause the scientist to 'disregard his credibility as a human being and voter with genuine convictions'".

Hence, as we see it, we could have written much more on the topic in the light of the discussion in Nordhagen et al. (2014). However, considering that we do not wish to lengthen our manuscript more than strictly necessary, we originally kept this discussion short by referencing Nordhagen et al. (2014). Nevertheless, to accommodate the important point you brought up, we have added a bit more discussion on the topic in the updated manuscript.

Hence, based on your suggestion, the relevant excerpt in Sect. 4 now reads:

Consequently, we worked hard to keep our credibility as researchers (Nordhagen et al., 2014), not partnering with organizations or initiatives on either of the climate advocacy fringes, and not favouring one political party over another. Based on the feedback received, this scientific background and endeavour to remain objective allowed us to partner with organisations otherwise not within reach, like the United Nations Development Programme (UNDP) and the World Meteorological Organization. Following the definitions by Nordhagen et al. (2014), we experienced a boost in personal and public credibility, more than outweighing a loss in professional credibility from our publication record hiatus while on the road, thus overall enhancing our researcher credibility. By being open about what role we played in public, we strove to negotiate the tension between our professional and public credibilities discussed by Nordhagen et al. (2014), in which our goal of stronger climate action on governmental level to some degree was challenged by the common academic view that researchers should remain detached from public policies. We saw our role as awareness-raisers, increasing the understanding of climate science within all societal groups.

Framing of climate change

Spanning the cultural differences within these groups, we tailored the message to the audiences in line with the suggestions by Somerville and Hassol (2011). These included framing climate change as a human and not only an environmental issue, focusing on the now instead of the decades ahead, leading with what we know, using a language adapted to a public discourse, being passionate, and connecting the dots between climate change and the personal experiences of the audience themselves.

this is nice.

Thank you!

Backgrounds in and set-up of the Pole to Paris team

While having a global focus, the ten languages spoken by the highly international group members allowed us to personally engage with a wide range of people on the road from the polar regions to Paris.

Until this point in the paper, I had assumed there were two people biking, on two different routes. Now it seems there were several people on the journeys - in which case much earlier in the piece you need to explain the absolute basics about the journey - who, when, how many people, what they do in their day jobs (since this apparently becomes relevant later on), age, demographic, nationality etc.

Thank you for pointing out that the backgrounds and set-up of the Pole to Paris team was not clear before this excerpt (in Sect. 4). For this reason, we have added more information about the Pole to Paris team in the beginning of Sect. 2.

Please note that just one of the two routes was cycled. The 3,000-km long Northern Run was run. We hope that the added text on the Pole to Paris team clarifies the journeys in Sect. 2 and Fig. 1.

Hence, based on your suggestion, the 1st–3rd paragraphs in Sect. 2 now read:

In early 2015, the authors co-established the non-governmental organization Pole to Paris. The aim of the initiative was to raise awareness of the threats posed by climate change, to people on our path as well as those reached virtually. However, it separated itself from most climate outreach actions by attempting to highlight the human-induced consequences of climate change rather than focusing on the pure scientific facts that underpin the reality of Earth's dynamic climate system. Following the unexpected collapse of the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the 2015 21st COP (COP 21) in Paris was regarded by many in the scientific, political and civil society communities as the last opportunity to begin to tackle climate change as a global community (Bäckstrand and Lövbrand, 2016; de Moor, 2017). Thus, the Pole to Paris project was purposefully timed, ahead and leading to COP 21, in an attempt to galvanise support for a new global agreement in our wide society, as public awareness of climate change in a country is positively related to the unconditional climate mitigation targets of that country, as later suggested by Drummond et al. (2018).

The Pole to Paris project focused on reshaping the way scientists engage with the public on climate change issues. The nature of the problem – being a long-term process on a planetary scale – makes it difficult for individuals to grasp and engage with. In an attempt to remove this abstractness, we, as scientists, decided to hit the road in order to share climate science knowledge with people on the ground as well as collect their stories of experienced changes to share them through our platforms. Two journeys from the poles were mapped out: the 10,000-km long bicycle ride - the Southern Cycle - from Christchurch (New Zealand) and the 3,000-km long run - the Northern Run - from Tromsø (Norway), both finishing in Paris during COP 21 (Fig. 1). These journeys were led by two climate scientists, who left Christchurch and Tromsø shortly after completing their PhDs in Antarctic and Arctic climate change, respectively. 7.5 and 4 months later, respectively, they reached Paris. They were supported by the eight other Pole to Paris team members, whose backgrounds ranged from environmental and political science to web and product design. While all members actively contributed to Pole to Paris by various means from their locations around the world, five of them also joined the main cyclist and runner for part of the journeys. Of the ten team members, only the main cyclist and runner were working full-time on the project (i.e., without getting paid), while the others had studies or jobs to balance simultaneously. Whereas we were all in our 20s, the four female and six male team members represented eight different countries.

The public were invited to get behind the Southern Cycle and Northern Run journeys and actively become engaged in the climate dialogue in real time. The adventure component also helped to attract media attention, giving the project a platform to communicate the facts about climate change and the importance of COP 21 to the wider audience by engaging them in the journeys. Crucially, along the way, we held talks in schools, universities and

many other public venues and were joined by other cyclists and runners for part of the distances. This created a two-way communication, in which we openly engaged the public to hear their perspectives and concerns about climate change before respectively responding to them, as suggested by Leshner (2003). We collaborated with our partners to create events, and we shared stories from the road through conventional and social media. This provided a unique opportunity to interact with members of society not usually reached by the scientific discourse. In line with O'Neill and Nicholson-Cole (2009) and Stoknes (2015), we highlighted the opportunities and inspiration of acting on climate change now rather than later. We communicated the ongoing and expected consequences of climate change, but in terms of relevant and experienced changes rather than fear rising from their cognitive dissonance following Extended Parallel Processing Model theory (Witte, 1992).

Physical and online followers of Pole to Paris

Furthermore, these language skills helped spread our messages to people that were unable to follow the journeys physically, as suggested by the 62 % followers on Facebook speaking English, 16 % Indonesian, 6 % Norwegian, 4 % French, 3 % Spanish and 2 % German.

what does this mean? Only the cyclists participated physically, surely all other followers/audiences followed virtually or through in-person interaction along the way

Thank you for pointing out this ambiguity. Based on your suggestion, the relevant excerpt in Sect. 4 now reads:

Besides, these language skills helped spread our messages even further, as suggested by the 62 % followers on Facebook speaking English, 16 % Indonesian, 6 % Norwegian, 4 % French, 3 % Spanish and 2 % German.

Local partner institutions and Global Voices

Similarly, the collaboration with local partner institutions offered tools of experience for successful ways of science communication within each country. This collaboration also allowed us to organize Global Voices events outside of the Northern Run and Southern Cycle (Fig. 1), during which youth came together to learn about climate change and how they could act upon it.

can you say who this is?

Is this separate from the bike ride? I think a focus on both the bike rides AND these events could be really interesting as a "case study" for how scientists were trying to raise awareness in the lead up to the Paris meeting.

Based on your suggestions, the relevant excerpt in Sect. 4 now reads:

Similarly, as suggested by Wooden (2006), the collaboration with local partner institutions (e.g., Gateway Antarctica in New Zealand, the Bjerknes Centre for Climate Research in Norway, the UK Youth Climate Coalition in the UK and Climate Generation in USA) offered experience for successful ways of science communication within each country. This collaboration also allowed us to organize what we called the Global Voices events with our partner UNDP. These were set up outside the routes of the Northern Run and Southern Cycle (Fig. 1), during which youth came together to learn about climate change and how they could act upon it.

Sentence on other climate change awareness campaigns

*The experiences from Pole to Paris were, however, not unique. Other initiatives have been launched over the **lasts years to increase awareness on climate changes and train scientists in science communication.***

check grammar, spelling and sentence structure for intended meaning.

Based on your suggestion, the relevant excerpt in Sect. 4 now reads:

*The experiences from Pole to Paris were, however, not unique. Other initiatives have been launched over the last **few** years to increase climate change **awareness** and train scientists in **more effective** science communication.*

Reference to Editorial (2017)

*However, March for Science has also been criticized, as it runs the risk of creating a false picture of scientists being more driven by ideology than evidence (**Editorial, 2017**).*

check this is correctly referenced

Thank you for pointing out this erroneous citation. This reference refers to the editorial in Nature on April 11, 2017 (<https://www.nature.com/news/nature-supports-the-march-for-science-1.21804>). Unfortunately, no author is listed. As far as we understand, the first couple of words in the title of the editorial should then be given as an in-text citation. In the biography, we have added the day and month too.

Hence, based on your suggestion, the relevant excerpt in Sect. 4 now reads:

*However, March for Science has also been criticized, as it runs the risk of creating a false picture of scientists being more driven by ideology than evidence (**Nature supports the March for Science, 2017**).*

Similarly, the relevant reference in the biography now reads:

Nature supports the March for Science, [Editorial], Nature, 544, 137, doi:10.1038/544137a, 11 April 2017.

Reference to Will You Hear Us

*Furthermore, the authors have been involved in other more or less politically charged outreach projects. Climate Communication Cologne is an effort launched at the University of Cologne whose main objective is to facilitate science communication to a wide non-academic audience. This takes place in various forms, such as workshops, stand-up comedy or videos, and in various arenas, from schools and universities to pubs and online communities. **Will You Hear Us is a documentary on the tradition of caged birds in Indonesia, which has become unsustainable due to the ever-increasing demand for wild songbirds and poses a huge threat on biodiversity.***

On its own like this, this sentence is a bit of a non-sequitur. However, this is becoming a much more interesting story when you present Pole to Paris as one of a number of outreach initiatives you are involved in - to me, that is a much more interesting story to tell, keep it autobiographical/ auto-ethnographic, and use your supporting data to help illustrate the

experience rather than suggesting it is particularly compelling data/ evidence on its own. It's VERY hard to measure impact, but very useful to tell a story.

Thank you for pointing out the little coherence in this paragraph. Based on your suggestion, the relevant excerpt in Sect. 4 now reads:

Furthermore, the authors have been involved in other more or less politically charged outreach projects. For instance, Climate Communication Cologne is an effort launched at the University of Cologne whose main objective is to facilitate science communication to a wide non-academic audience. This takes place in various forms, such as workshops, stand-up comedy or videos, and in various arenas, from schools and universities to pubs and online communities. Another example is Will You Hear Us, a documentary on the tradition of caged birds in Indonesia, which has become unsustainable due to the ever-increasing demand for wild songbirds and poses a huge threat on biodiversity. Both authors are currently also writing comic books on climate change adaptation and mitigation and on biodiversity loss for high-school and elementary school students, respectively.

Reference to Pielke Jr. (2007)

In our current society, we argue that the role of the 'pure scientist' (as defined by Rapley and De Meyer, 2014) is outdated and the need of the 'science communicator' is rising.

worth also reading Pielke: The Honest Broker

Based on your suggestion, the relevant excerpt in Sect. 5 now reads:

In our current society, we argue that the role of the 'pure scientist' (as defined by Rapley and De Meyer, 2014) is outdated and the need of the 'science communicator' and 'the honest broker of policy alternatives' (as outlined by Pielke Jr., 2007) is rising.

The advancement of science

The advancement of science is completely pointless if it is ignored by government as well as the general public and not suitably utilised by an educated society.

Be careful here - are you specifically talking about science related to climate change? If so, keep that clear... otherwise you're somewhat arrogantly dismissing all blue skies "pure science" in completely different disciplines.

Based on your suggestion, the relevant excerpt in Sect. 5 now reads:

The advancement of science might be of little significance if it is ignored by government as well as the laypeople and not suitably utilised by an educated society.

Grammar on the benefits of engaging in outreach activities

For scientists at the beginning of their academic career, we support the notion by Brownell et al. (2013) and Rauser et al. (2017) that engaging in outreach activities helps shaping the research questions, giving more effective tools for narrowing the widening gap between academia and the general public, and eventually providing a more constructive input for policy formulation on climate change.

check grammar

Based on your suggestion, the relevant excerpt in Sect. 5 now reads:

For scientists at the beginning of their academic career, we support the notion by Leshner (2007), Brownell et al. (2013), Rauser et al. (2017) and Nisbet (2018) that engaging in outreach activities helps shape the research questions, giving more effective tools for narrowing the widening gap between academia and the rest of society, and eventually providing a more constructive input for policy formulation on climate change.

Adapting and playing our new role as climate scientists

Now it is up to us to adapt and play our new role objectively while keeping our credibility.

This is a loaded sentence, probably best avoided or edited unless you're going to expand on what that would look like - to be objective, retain credibility, and adapt to the political climate. Probably too complex for this short commentary.

Based on your suggestion and referring to the excerpts from Nordhagen et al. (2014) in our reply to Professional credibility and climate change communication above, we have added a sentence after the highlighted sentence. The relevant excerpt in Sect. 5 now reads:

Now it is up to us to adapt and play our new role objectively while keeping our credibility (as discussed by Nordhagen et al., 2014). According to Rapley and De Meyer (2014), this has the potential to remove climate science from the direct firing line to leave the authority, responsibility and accountability for decisions transparently with the policymakers and the public.

The role of climate scientists in the post-factual society: Reflections from the awareness campaign Pole to Paris

Erlend M. Knudsen^{1,2,a} and Oria J. de Bolsée²

¹Institute for Geophysics and Meteorology, University of Cologne, Albertus-Magnus-Platz, 50923 Köln, Germany

²Pole to Paris, Christchurch, New Zealand

^anow at: StormGeo, Nordre Nostekaien 1, 5011 Bergen, Norway

Correspondence to: Erlend M. Knudsen (eknudsen@uni-koeln.de)

Abstract. The politicization of and societal debate on climate change science has increased over the last decades. Here, the authors argue that the role of climate scientists in our societies needs to adapt in accordance with this development. We share our experiences from the awareness campaign Pole to Paris, which engaged non-academic audiences on climate change issues on the roads from the polar regions to Paris and through conventional and social media. Based on these experiences, as well as those from other science communication initiatives, we suggest a way forward for climate scientists in the post-factual society.

Slettet: the general public

1 Background

The role of climate science in the public sphere has changed significantly since the mid-1980s. Ensuuing the formation of the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Senate testimony of James Hansen in 1988, climate science has increasingly become a topic of political debate, media coverage and part of the daily discourse in our societies (Bolin, 2007; Ungar, 2016). Simultaneously, the scientific understanding of climate change has been rapidly expanding, with the number of climate change papers published per year exponentially growing (McSweeney, 2015) and the confidence in humans as the main cause of global warming has gone from insufficient to "extremely likely" (as defined by the IPCC First to Fifth Assessment Reports; Houghton et al., 1990; Stocker et al., 2013).

Slettet: Since

Slettet: With this development, it is, more than ever, crucial to establish dialogues with those outside academia in order to help trigger positive global changes (Barnosky et al., 2016).

A corresponding increase has neither been seen in climate change legislation (Townshend et al., 2013), media coverage of climate change topics (Boykoff et al., 2018) nor in public perception of climate change (Capstick, et al., 2015; Zhao et al., 2016; Saad, 2017). Instead, the politicization and polarization of climate change has been growing, with the former referring to how the science behind political decisions increasingly are promoted and attacked by advocates and opponents and the latter referring to the growing division between elites, organisations and political parties viewing climate change as a negative consequence of industrial capitalism and those opposing such views (McCright and Dunlap, 2011). This trend is arguably most notable in the U.S. (Capstick et al., 2015; Carmichael et al., 2017), where the partisan divide on environmental voting score (as defined by the League of Conservation Voters) grew from about 25 in 1970 to about 85 in 2015 (Dunlap et al., 2016). Since then, Donald Trump was elected as the country's 45th president and has repeatedly been questioning climate science, actively working against environmental legislation and funding of his predecessor and generally making the work of climate scientists more challenging (De Pryck and Gemenne, 2017; Alderman and Inwood, 2018; and references therein). A post-factual society has arisen, in which part of its members

rather accept an argument based on their emotions and beliefs than one based on scientific facts (Leshner, 2007; Alvermann, 2017).

A post-factual political scene is not isolated to the U.S. alone; Brexit in the U.K. and the (re-)elections of Rodrigo Duterte in the Philippines, Andrzej Duda in Poland, Viktor Orbán in Hungary, Recep Tayyip Erdogan in Turkey and Jair Bolsonaro in Brazil are all examples of populist solutions trumping science-based ones (Postel-Vinay, 2017). Furthermore, the rise of social media has meant that everyone can act as journalists and editors in choosing what to post, where algorithms make sure to share posts from those with similar opinions, thus creating filter bubbles (Pariser, 2011; Alvermann, 2017; Bail, 2018). Conventional media can also reinforce filter bubbles by presenting scientific news within pre-existing worldviews of their audiences (Theel et al., 2013; Carmichael et al., 2017). Similar bubbles exist within academia, where scientists are trained to write for an already highly educated and specialized audience (Stiller-Reeve et al., 2016). Scientists are thus often seen as an elite without touch to the rest of society (Townson, 2016). For this reason, it is, more than ever, crucial to establish dialogues with those outside of academia in order to help trigger positive global changes (Leshner, 2007; Barnosky et al., 2016). Doing so, we, as scientists, need to choose our role within society carefully in consideration of the consequences for us individually and as a community (Pielke Jr., 2007; Vraga et al., 2018).

In this manuscript, we argue that the scientific community was not prepared for the intense politicization of climate change science (as defined by Zürn, 2014), which has occurred over the past several decades. However, we also contend that while climate polarization has reached new levels in the last few years (Dunlap et al., 2016), it is not too late for scientists to adapt to the highly charged political environment in which the very science of climate change is often discussed. Rapley and De Meyer (2014) argue that there is a gap between the role of the climate science community and the needs of society. As young environmental scientists having actively tried to bridge this gap, we here share our experiences from climate change awareness initiatives, discuss their pros and cons, and discuss possible ways forward for the climate science community in terms of its interaction with society at large.

Slettet: commentary

2 Our initiative: Pole to Paris

In early 2015, the authors co-established the non-governmental organization Pole to Paris. The aim of the initiative was to raise awareness of the threats posed by climate change, to people on our path as well as those reached virtually. However, it separated itself from most climate outreach actions by attempting to highlight the human-induced consequences of climate change rather than focusing on the pure scientific facts that underpin the reality of Earth's dynamic climate system. Following the unexpected collapse of the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the 2015 21st COP (COP 21) in Paris was regarded by many in the scientific, political and civil society communities as the last opportunity to begin to tackle climate change as a global community, (Bäckstrand and Lövbrand, 2016; de Moor, 2017). Thus, the Pole to Paris project was purposefully timed, ahead and leading to COP 21, in an attempt to galvanise support for a new global agreement in our wide society, as public

Slettet: .

Slettet: other

Slettet: undergird

Formatert: Hevet

Formatert: Hevet

Slettet: and

Slettet: .

Slettet: galvanize public

awareness of climate change in a country is positively related to the unconditional climate mitigation targets of that country, as later suggested by Drummond et al. (2018).

Slettet: agreement, the Pole to Paris project was purposefully timed to lead on

Slettet: road ending in Paris.

The Pole to Paris project focused on reshaping the way scientists engage with the public on climate change issues. The nature of the problem – being a long-term process on a planetary scale – makes it difficult for individuals to grasp and engage with. In an attempt to remove this abstractness, we, as scientists, decided to hit the road in order to share climate science knowledge with people on the ground as well as collect their stories of experienced changes to share them through our platforms. Two journeys from the poles were mapped out: the 10,000-km long bicycle ride – the Southern Cycle – from Christchurch (New Zealand) and the 3,000-km long run – the Northern Run – from Tromsø (Norway), both finishing in Paris during COP 21 (Fig. 1). These journeys were led by two climate scientists, who left Christchurch and Tromsø shortly after completing their PhDs in Antarctic and Arctic climate change, respectively. 7.5 and 4 months later, respectively, they reached Paris. They were supported by the eight other Pole to Paris team members, whose backgrounds ranged from environmental and political science to web and product design. While all members actively contributed to Pole to Paris by various means from their locations around the world, five of them also joined the main cyclist and runner for part of the journeys. Of the ten team members, only the main cyclist and runner were working full-time on the project (i.e., without getting paid), while the others had studies or jobs to balance simultaneously. Whereas we were all in our 20s, the four female and six male team members represented eight different countries.

Slettet: it

Slettet: it

Slettet: two

Slettet: 1). The public were invited to get behind these journeys and actively become engaged in the climate dialogue coincidentally.

The public were invited to get behind the Southern Cycle and Northern Run journeys and actively become engaged in the climate dialogue in real time. The adventure component also helped to attract media attention, giving the project a platform to communicate the facts about climate change and the importance of COP 21 to the wider audience by engaging them in the journeys. Crucially, along the way, we held talks in schools, universities and many other public venues, and were joined by other cyclists and runners for part of the distances. This created a two-way communication, in which we openly engaged the public to hear their perspectives and concerns about climate change before respectively responding to them, as suggested by Leshner (2003). We collaborated with our partners to create events, and we shared stories from the road through conventional and social media. This provided a unique opportunity to interact with members of society not usually reached by the scientific discourse. In line with O'Neill and Nicholson-Cole (2009) and Stoknes (2015), we highlighted the opportunities and inspiration of acting on climate change now rather than later. We communicated the ongoing and expected consequences of climate change, but in terms of relevant and experienced changes rather than fear rising from their cognitive dissonance following Extended Parallel Processing Model theory (Witte, 1992).

Slettet: and

Slettet: , achieving

Slettet: .

Slettet: along the way

Slettet: focused on

Slettet: that lie in

Slettet: action

Slettet: spreading fearful messages

Slettet: .

A conservative estimation is that more than one million people in 45 countries were reached through conventional and social media, which included close to 250 media outlets and almost 500,000 and 250,000 reached per Facebook post and Twitter tweet, respectively. While it is probable that some of our followers on Facebook, Twitter and Instagram overlapped, the breadth of conventional media coverage meant that we were able to reach a wider span of the society. For example, our story was featured five times on CNN in English, Spanish and Arabic, while Norwegian Broadcasting Corporation aired us 14 times. None of these are likely to be seen by the average Thai, Chinese or Indonesian, but our appearance

Slettet: (e.g., airing on CNN and TNN Thailand 24 and published in The Guardian and National Geographic) and almost 500,000 and 250,000 reached per Facebook post and Twitter tweet, respectively

in the Thai news channel TNN24, the China News Service or the Indonesian Jawa Pos might. Similarly, where coverage in the English-language news actors The Guardian, The Huffington Post or The Daily Star plausibly caught the attention of those already aware of human-induced climate change, the more domestic-focused Le Parisien in French, la Repubblica in Italian or Correio Braziliense in Portuguese almost certainly brought climate change into new light among their readers. Additionally, we gave 80 presentations in five languages along the running route alone.

3 Direct successes

Looking into the numbers from social media in more detail, the authors in 2018 conducted a statistical analysis on the reach of the videos created by Pole to Paris and shared through Facebook. These videos spanned from 20 seconds to 6 minutes in length and showcased the life on the road from the Poles to Paris (i.e., challenges and joys of the run and bike ride), the various impacts associated with climate change along the way (e.g., coral bleaching in Australia, from raising CO2 levels and temperature, air pollution in China from carbon-intensive coal use, and glacial melt in Antarctica, Norway, and the European Alps from shifting precipitation patterns and increasing summer temperatures), and on the importance of climate action at COP 21 and home. Of the total of 42 videos, we focused the analysis on the 32 in the most active period from June to December 2015. Figure 2 shows some of its key results.

Of the 226 346 total video views after three seconds, 56 130 (25 %) were still there after 30 seconds and 16 703 (7 %) at 95 % of the video length (Fig. 2a). Of these views, 89 % (after three seconds) to 97 % (at 95 % of the video length) were unique (not shown), meaning that almost all videos were watched once. Similarly, the organic viewers (as compared to the ones reached through ads) were more enduring, accounting for 74 % of the views at 95 % video length compared to 58 % after three seconds (Fig. 2a). Sorted by topic, the climate action videos were on average by far the most popular, making up 82-87 % of the watched videos at the three video lengths (Fig. 2b). In comparison, the videos on the effects of climate change became relatively less popular over the length of the videos, comprising 11 % after three seconds and 8 % at their 95 % length. This contrasts the videos on the journeys themselves, which correspondingly rose from 6 % to 11 % of watched videos at the respective times.

The three most popular videos were thus, unsurprisingly, videos that promoted action on climate change through hopeful messages. The by far most popular video (with more than 100,000 views and a reach of nearly 500,000) focused how young inhabitants of Southern Pacific islands feel the effects of climate change through ongoing rising sea levels and get together to fight against it. This positive message of a younger generation working for an act on climate was the common theme for these three videos, which also included a more simply produced video on the motivation for why the main runner and cyclist left their offices in climate research to engage with the society at large (with almost 40,000 views and a reach of nearly 150,000). Out of our social media followers (more than 6,200 on Facebook, 1,200 on Twitter and 650 on Instagram), most of the Facebook ones were in the age group 25-34. This is perhaps explained by the fact that we were ourselves a team of millennials. Possibly more interestingly, the second largest group of followers was made of Generation Z.

Slettet: these

Slettet: direct or indirect

Slettet: of

Slettet: on

Slettet: , on

Slettet: the

Slettet: on

Slettet: and 16 703 (7 %)

Slettet: at

Slettet: , respectively

Slettet: and that the once watching the videos over, only watched parts of them again.

Slettet: -

Slettet: general public

Slettet: -

Slettet: ,

(people born in the mid-1990s to the mid-2000s), pointing to the added reach of social media compared to other science communication tools, as also pointed out by Bowman et al. (2015).

Generally, the later videos in the analysis period were more popular, also pointing to the increasing reach of Pole to Paris as the awareness project gained traction with kilometres covered, events held along the way, and mentions in the media. Even when the project reduced its activity after COP 21, the influence was still there, as exemplified by reaches of more than 100,000 on the less frequent Facebook posts in early 2016.

Correspondingly, while not posting regularly anymore, the authors were still able to reach some of Pole to Paris' followers via our still active social media channels with a survey in 2018. The survey asked a range of questions. These included whether respondents followed Pole to Paris online, whether they learned anything new as a result of Pole to Paris, whether they found Pole to Paris to be a source of inspiration. Interestingly, one of the key findings was that respondents were fairly evenly split on what they considered to be the most interesting aspects of the project. Several of the 37 respondents highlighted more than one aspect, with 14 answers favouring the actual journeys from the Poles to Paris, 16 the same for the physical challenge of running and biking, 18 the scientific message on climate change, and 17 the human face that Pole to Paris put on climate change through stories from the ground.

In line with the statistical analysis of the Facebook videos, the fact that the scientific message was seen more interesting than the journeys themselves, indicates that a project like Pole to Paris can find success in disseminating scientific information to a wider audience. Among other key findings from the survey, 31 out of 37 respondents reported that Pole to Paris inspired them in some way. This is also a strong indicator that unconventional projects in the vein of Pole to Paris can find success in connecting with non-scientific audiences in positive ways. Moreover, more than half (20 out of 37) indicated that they learned something new through Pole to Paris, signalling the potential scientists have in bridging the gap between academia and the public on fundamental societal issues.

Interpreting these numbers, one should keep in mind that the survey respondents already were followers of the climate awareness project Pole to Paris and thus not necessarily representative of the average population. The three-year lag of this feedback to the project compared to its most active period also introduce some uncertainty of remembrance and probably explain why less than 1 % of our social media followers responded to the survey.

This small respondent rate meant that the answers not necessarily represented those of a typical follower. Moreover, the time passed since their publications limited the statistical analysis here to Facebook videos, as other social media data no longer were available. Even so, we believe the numbers presented in this manuscript offer valuable insight on the worthiness of time spent on Pole to Paris and can help the outreach community in learning from our efforts.

Slettet: 84 %

Slettet: the

Slettet: 54 %)

Slettet: general

Slettet:

Slettet: Similarly

4 Indirect successes

As also mentioned by Barnosky et al. (2014), the direct success of an initiative like Pole to Paris is almost impossible to quantify. Indirectly, the Pole to Paris team members took great value from being able to share climate science with our audiences and listen to their experiences of climate change. Engaging in two-way interaction with a range of audiences – from farmers to senators, from preschool children to retirees and from Norwegians to Bangladeshis – provided invaluable insight to our own research questions, as also highlighted by Nisbet (2018). Fortunate with these encounters, we faced questions and concerns often far from ours, which opened our eyes and ears and widened our perspectives. As reported by Nisbet (2018) and references therein, we improved our communication and listening skills and extended our professional and social network. Both academic and non-academic members of society, especially the younger ones, expressed their enthusiasm regarding the project. Both shared how it inspired them to find the courage needed to make changes in their own lives. The Paris Agreement, of which Pole to Paris was one of numerous initiatives building public support for, was arguably a better outcome of COP21 than the climate science community could have hoped for and, as later similarly suggested by Drummond et al. (2018), might have been influenced by that awareness raised among people.

Schimid and Petri (2017) have argued that those in the scientific community who actively attempt to communicate the seriousness of climate change to a wide audience often are met with attempts "to discredit their scientific credibility, or to criticize the studies that are used or their underlying methods and models." As communicators of the scientific consensus, we inevitably experienced these tactics from climate sceptics in online fora. Mostly, the criticisms were from individual citizens and directed at us personally. Out on the roads to Paris, however, fact-based messaging was highly welcomed. Meeting people where they are, in their own communities, communicating with them in their own terms, constantly trying to adapt our language to our audience, undeniably contributed to this. Considering the politicized division of the media themselves (e.g., Brüggemann and Engesser, 2017), this positive experience of direct engagement supports the suggestion by Gauchat et al. (2017) that science participation and outreach could rebuild the credibility among communities most critical of scientists. Moreover, fostering constructive public conversations about science and society can, among others, improve decision-making, promote trust and credibility in scientific findings and strengthen democratic processes (Wooden, 2006; Nisbet, 2018), ultimately counteracting politicization and polarization of science and post-factual movements, respectively.

Consequently, we worked hard to keep our credibility as researchers (Nordhagen et al., 2014), not partnering with organizations or initiatives on either of the climate advocacy fringes, and not favouring one political party over another. Based on the feedback received, this scientific background and endeavour to remain objective allowed us to partner with organisations otherwise not within reach, like the United Nations Development Programme (UNDP) and the World Meteorological Organization. Following the definitions by Nordhagen et al. (2014), we experienced a boost in personal and public credibility, more than outweighing a loss in professional credibility from our publication record hiatus while on the road, thus overall enhancing our researcher credibility. By being open about what role we

Slettet: however

Slettet: deliver vital information to the public.

Slettet: .

Slettet: Members of the general public

Slettet: academia

Slettet: both

Slettet: many

Slettet: "

Slettet: ."

Slettet:

Slettet: immensely

Slettet: Hence

Slettet: We

played in public, we strove to negotiate the tension between our professional and public credibilities discussed by Nordhagen et al. (2014), in which our goal of stronger climate action on governmental level to some degree was challenged by the common academic view that researchers should remain detached from public policies. We saw our role as awareness-raisers, increasing the understanding of climate science within all societal groups. Spanning the cultural differences within these groups, we tailored the message to the audiences in line with the suggestions by Somerville and Hassol (2011). These included framing climate change as a human and not only an environmental issue, focusing on the now instead of the decades ahead, leading with what we know, using a language adapted to a public discourse, being passionate, and connecting the dots between climate change and the personal experiences of the audience themselves.

The nature of the Pole to Paris campaign allowed us to build an audience, which did not necessarily have a high interest in science nor necessarily a belief in climate change. This was purposefully done through several means: being on the road and therefore also meeting people who would not otherwise go to a talk about science on climate change; meeting university and school students of all grades and consequently discussing with students who often had barely heard of the science behind climate change; and finally, running and biking, which invited participants for the physical challenge that would stay over for the following talk on climate change and reached by a message they were not initially seeking. This point is also suggested by the number of the social media survey respondents indicating that they learned something new through and that got inspired by Pole to Paris (20 and 31 out of 37, respectively), which indicate that almost half of our followers already were literate on climate change issues but did not know what to do about it. Even though the knowledge and interest in science differ between sociodemographic groups, as suggested by Schäfer et al. (2018), we found that all our audiences had a similar interest in learning about practical actions and solutions they could put in place at a personal level.

The ten languages spoken by the highly international Pole to Paris group members helped in this way by allowing us to personally engage with a wide range of people on the roads from the polar regions to Paris. Besides, these language skills helped spread our messages even further, as suggested by the 62 % followers on Facebook speaking English, 16 % Indonesian, 6 % Norwegian, 4 % French, 3 % Spanish and 2 % German. Similarly, as suggested by Wooden (2006), the collaboration with local partner institutions (e.g., Gateway Antarctica in New Zealand, the Bjerknes Centre for Climate Research in Norway, the UK Youth Climate Coalition in the UK and Climate Generation in USA) offered experience for successful ways of science communication within each country. This collaboration also allowed us to organize what we called the Global Voices events with our partner UNDP. These were set up outside the routes of the Northern Run and Southern Cycle (Fig. 1), during which youth came together to learn about climate change and how they could act upon it.

The experiences from Pole to Paris were, however, not unique. Other initiatives have been launched over the last few years to increase climate change awareness and train scientists in more effective science communication. We were some of the 1.07 million people globally to take part in March for Science April 22, 2017. The series of rallies and marches defending the vital role science plays in our everyday lives was a direct result of the opposing direction on science policy taken by the current administration in the White House compared with its

Slettet: While having

Slettet: global focus, the

Slettet: allowed

Slettet: road

Slettet: Furthermore

Slettet: to people that were unable to follow the journeys physically even further

Slettet: tools of

Slettet: lasts

Slettet: on climate changes

predecessor. However, March for Science has also been criticized, as it runs the risk of creating a false picture of scientists being more driven by ideology than evidence (Nature supports the March for Science, 2017).

Slettet: Editorial

Furthermore, the authors have been involved in other more or less politically charged outreach projects. For instance, Climate Communication Cologne is an effort launched at the University of Cologne whose main objective is to facilitate science communication to a wide non-academic audience. This takes place in various forms, such as workshops, stand-up comedy or videos, and in various arenas, from schools and universities to pubs and online communities. Another example is Will You Hear Us, a documentary on the tradition of caged birds in Indonesia, which has become unsustainable due to the ever-increasing demand for wild songbirds and poses a huge threat on biodiversity. Both authors are currently also writing comic books on climate change adaptation and mitigation and on biodiversity loss for high-school and elementary school students, respectively.

Formatert: Skrift: Ikke Kursiv

Slettet: is

Common for all these initiatives is the eagerness to communicate science in ways that engage the layperson. To help us – and the reader of this manuscript – learn from our efforts, we ideally would have set up a more standardized feedback scheme for our audiences during the active period of Pole to Paris. The feedback we did receive – in personal conversations and in online commentary fora – were most likely anomalously positive and negative, respectively. We could surely also have benefitted from more planning before undertaking these journeys, but this might have compromised the journeys themselves. Being the only two fully “working” (i.e., without getting paid) on the project, the two climate scientists of Pole to Paris – the lead cyclist and runner – had just completed their PhDs before taking on the journeys, while the other eight in the team had full time commitments to studies or employers to balance, which did not provide much room for further planning. This, along with the widely varying time zones the team members were based in and often lack of internet accessibility out on the Southern Cycle and Northern Run, meant that team meetings were less regular than what would have been ideal for making sure we were all pulling in the same direction.

Passion united the team and contaminated our various audiences, creating better dialogues in a positive feedback loop (Nisbet, 2018). We cycled and ran out with rough plans and adapted along the way as engagement created opportunities (e.g., the Global Voices events and United Nations program partnerships) or disasters imposed limitations (e.g., the Nepal earthquake and Paris terror attacks). Similarly, even though we had scientific and communicational training to start with, we learned a lot by doing. Most importantly, by meeting our audiences in running shoes, on a bicycle or over a beer, we connected as humans, which is critical for effective science engagement (Nisbet, 2018). While we strongly acknowledge the need for publishing research papers to further develop scientific questions, we emphasize that the findings thereof are incomplete if not shared with the society at large.

5 An adapted scientist

Based on these experiences, we identified some key components for successful science communication with non-academic audiences:

- Relevance

Slettet: - d

Make sure your message is relevant to your audience and engage with them in familiar setting, with a familiar format and through a familiar language.

- Listening

Let the audience ask questions and put forward their understanding.

- Positivity

Smile and try to focus on the possibilities rather than the doomsday.

- Perseverance

Learn by doing; all experiences are valuable.

- Passion

Knowledge of the topic is the door to communicating science, passion for it the key.

Formatert: Innrykk: Venstre: 1,27 cm, Ingen punktmerking eller nummerering

Slettet: ↴

Formatert: Innrykk: Venstre: 1,27 cm, Ingen punktmerking eller nummerering

Slettet: ↴

Formatert: Innrykk: Venstre: 1,27 cm, Ingen punktmerking eller nummerering

Slettet: ↴

Formatert: Innrykk: Venstre: 1,27 cm, Ingen punktmerking eller nummerering

Slettet: ↴

Formatert: Innrykk: Venstre: 1,27 cm, Ingen punktmerking eller nummerering

Slettet: 'pure scientist'

Slettet: 'science communicator'

Slettet: is completely pointless

Slettet: general public

Slettet: .

In our current society, we argue that the role of the 'pure scientist' (as defined by Rapley and De Meyer, 2014) is outdated and the need of the 'science communicator' and 'the honest broker of policy alternatives' (as outlined by Pielke Jr., 2007) is rising. The advancement of science might be of little significance if it is ignored by government as well as the Jaypeople and not suitably utilised by an educated society. Publishing an academic paper is unfinished business. As Barnosky et al. (2014) argue, it is only the beginning if our aim is to help society solve problems. However, current training of becoming scientists is not fulfilling the current need of society for clear science communication and policy engagement (Leshner, 2007). Thus, we argue that more emphasis should be put on communication and media, policymaker and pseudoscepticism interaction training and less on the published record.

For scientists at the beginning of their academic career, we support the notion by Leshner (2007), Brownell et al. (2013), Rauser et al. (2017) and Nisbet (2018) that engaging in outreach activities help shape the research questions, giving more effective tools for narrowing the widening gap between academia and the rest of society, and eventually providing a more constructive input for policy formulation on climate change. As we see it, this will act to reduce politicization and polarization of climate change, while also depressing the breeding ground for post-factual movements. Within academia, outreach training gives us better tools in teaching, mentoring of younger students and taking part in scientific discussions, as well as contributing to better written research proposals and journal publications (Stiller-Reeve et al., 2016, and references therein).

Slettet:) and

Slettet: helps shaping

Slettet: general public

Slettet: this

Whether we like it or not, climate science and scientists have become part of the daily political and media discourse. Now it is up to us to adapt and play our new role objectively while keeping our credibility (as discussed by Nordhagen et al., 2014). According to Rapley and De Meyer (2014), this has the potential to remove climate science from the direct firing line to leave the authority, responsibility and accountability for decisions transparently with the policymakers and the public. When done carefully, we have the potential, regardless of audience's political predilection, to provide trustworthy information to the climate change discourse (Leshner, 2003; MacInnis et al., 2015; Hamilton, 2016). To prepare us for such a "wicked" problem (as defined by Lorenzoni et al., 2007), we argue that communication training with actors beyond academia is indispensable.

Slettet: .

Slettet: audience's

Slettet: "

Slettet: "

Author contributions

EMK led the design and writing of the manuscript and carried out the statistical analysis. OJdB helped writing and designed the social media survey.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgements

We would like to thank the whole Pole to Paris team and everyone we encountered along the way. We also acknowledge the support from the Transregional Collaborative Research Center (TR 172) "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC)3", which is funded and by the German Research Foundation (Deutsche Forschungsgemeinschaft: DFG) and allowed EMK to write about our experiences for the benefit of science communicators globally.

References

- Alderman, D. H., and Inwood, J. F. J.: The need for public intellectuals in the Trump era and beyond: Strategies for communication, engagement, and advocacy, Prof. Geogr., 1–7, doi: 10.1080/00330124.2018.1452617, 2018.
- Alvermann, D. E.: Social media texts and critical inquiry in a post-factual era, J. Adolesc. Adult Lit., 61, 335–338, doi:10.1002/jaal.694.
- Bäckstrand, K., and Lövbrand, E.: The road to Paris: contending climate governance discourses in the post-Copenhagen era, J. Environ. Pol. Plan., 1–19, doi: 10.1080/1523908X.2016.1150777, 2016.
- Bail, C. A., Argyle, L. P., Brown, T. W., Bumpus, J. P., Chen, H., Hunzaker, M. B. F., Lee, J., Mann, M., Merhout, F., and Volfovsky, A.: Exposure to opposing views on social media can increase political polarization, P. Natl. Acad. Sci. USA, 115, 9216–9221, doi:pnas.1804840115, 2018.
- Barnosky, A. D., Hadly, E. A., Dirzo, R., Fortelius, M., and Stenseth, S. C.: Translating science for decision makers to help navigate the Anthropocene, The Anthropocene Review, 1, 160–170, doi:10.1177/2053019614533670, 2014.
- Barnosky, A.D., Ehrlich, P.R., and Hadly, E.A.: Avoiding collapse: Grand challenges for science and society to solve by 2050, Elementa-Sci. Anthropol., 4, doi:10.12952/journal.elementa.000094, 2016.
- Bolin, B.: A history of the science and politics of climate change: The role of the Intergovernmental Panel on Climate Change, Cambridge University Press, 1, 1–292, ISBN:978-0-521-88082-4, 2007.
- Bowman, S. R., Biermans, G., Hicks, A., Jevtić, Rodriguez-Gil, J. L., and Brockmeier, E. K.: A guide for using social media in environmental science and a case, Environ. Sci. Eur., 27, 32, doi:10.1186/s12302-015-0062-5, 2015.
- Boykoff, M., Daly, M., Fernández-Reyes, R., McAllister, L., McNatt, M., Nacu-Schmidt, A., Onk, D., and Pearman, O.: World newspaper coverage of climate change or global

[warming 2004–2018, Media and Climate Change Observatory Data Sets, Center for Science and Technology Policy Research, Cooperative Institute for Research in Environmental Sciences, University of Colorado, doi:10.25810/4c3b-b819, 2018.](#)

Brownell, S. E., Price, J. V., and Steinman, L.: Science communication to the general public: why we need to teach undergraduate and graduate students this skill as part of their formal scientific training, *J. Undergrad. Neurosci. Educ.*, 12, E6–E10, 2013.

Brüggemann, M., and Engesser, S.: Beyond false balance: How interpretive journalism shapes media coverage of climate change, *Global Environ. Chang.*, 42, 58–67, doi:10.1016/j.gloenvcha.2016.11.004, 2017.

[Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., and Upham, P.: International trends in public perceptions of climate change over the past quarter century, *WIREs Clim. Change*, 6, 35–61, doi:10.1002/wcc.321, 2015.](#)

[Carmichael, J. T., Brulle, R. J. and Huxster, J. K.: The great divide: understanding the role of media and other drivers of the partisan divide in public concern over climate change in the USA, 2001–2014, *Climatic change*, 141, 599–612, doi:10.1007/s10584-017-1908-1, 2017.](#)

[de Moor, J.: The 'efficacy dilemma' of transnational climate activism: the case of COP21, *Environ. Polit.*, 27, 1079–1100, doi:10.1080/09644016.2017.1410315, 2018.](#)

[De Pryck, K., and Gemenne, F.: The denier-in-chief: climate change, science and the election of Donald J. Trump, *Law Critique*, 28, 119–126, doi:10.1007/s10978-017-9207-6, 2017.](#)

[Drummond, A., Hall, L. C., Sauer, J. D. and Palmer, M. A.: Is public awareness and perceived threat of climate change associated with governmental mitigation targets?, *Climatic Change*, 149, 1–13, doi:10.1007/s10584-018-2230-2, 2018.](#)

Dunlap, R. E., McCright, A. M., and Yarosh, J. H.: The Political Divide on Climate Change: Partisan Polarization Widens in the U.S., *Environment: Science and Policy for Sustainable Development*, 58, 4–23, doi:10.1080/00139157.2016.1208995, 2016.

[Gauchat, G., O'Brien, T., and Miroso, O.: The legitimacy of environmental scientists in the public sphere, *Climatic Change*, 143, 297–306, doi:10.1007/s10584-017-2015-z, 2017.](#)

Hamilton, L. C.: Where is the North Pole? An election-year survey on global change, *The Carsey School of Public Policy at the Scholars' Repository*, 285, 2016.

[Houghton, J. T., Jenkins, G. J., and Ephraums, J. J. \(Eds.\): *Climate change: The IPCC scientific assessment*, Intergovernmental Panel on Climate Change \(IPCC\), Cambridge, UK, 1990.](#)

[Leshner, A. I.: Public engagement with science, *Science*, 299, 977, doi:10.1126/science.299.5609.977, 2003.](#)

[Leshner, A. I.: Outreach training needed, *Science*, 315, 161, doi:10.1126/science.1138712, 2007.](#)

Lorenzoni, I., Jones, M., and Turnpenny, J. R.: Climate change, human genetics, and post-normality in the UK, *Futures*, 36, 65–82, doi:10.1016/j.futures.2006.03.005, 2007.

[MacInnis, B., Krosnick, J. A., Abeles, A., Caldwell, M. R., Prahler, E., and Dunne, D. D.: The American public's preference for preparation for the possible effects of global warming: impact of communication strategies, *Climatic change*, 128, 17–33, doi:10.1007/s10584-014-1286-x, 2015.](#)

[McCright, A. M., and Dunlap, R. E.: The politicization of climate change and polarization in the American public's views of global warming, 2001–2010, *Sociol. Quart.*, 52, 155–194, doi:10.1111/j.1533-8525.2011.01198.x, 2011.](#)

Slettet: Editorial: Nature supports the March for Science, *Nature*, 544, 137, doi:10.1038/544137a, 2017.¶

McSweeney, R.: Analysis: The most 'cited' climate change papers, Rosamund Pearce/Carbon Brief, <https://www.carbonbrief.org/analysis-the-most-cited-climate-change-papers>, 2015.

Nature supports the March for Science, [Editorial], *Nature*, 544, 137, doi:10.1038/544137a, 11 April 2017.

Nisbet, M.: Scientists in civic life: facilitating dialogue-based communication, *American Association for the Advancement of Science*, https://www.aaas.org/sites/default/files/s3fs-public/content_files/Scientists%2520in%2520Civic%2520Life_FINAL%2520INTERACTIVE%2520082718.pdf, 2018.

Nordhagen, S., Calverley, D., Foulds, C., O'Keefe, L., and Wang, X.: Climate change research and credibility: balancing tensions across professional, personal, and public domains, *Climatic Change*, 125, 149–162, doi:10.1007/s10584-014-1167-3, 2014.

O'Neill, S., and Nicholson-Cole, S.: "Fear won't do it": Promoting positive engagement with climate change through visual and iconic representations, *Sci. Commun.*, 30, 355–379, doi:10.1177/1075547008329201, 2009.

Pariser, E.: The filter bubble: How the new personalized web is changing what we read and how we think, The Penguin Press, New York, USA, ISBN:978-1-101-51512-9, 2011.

Pielke Jr., R. A.: The honest broker: making sense of science in policy and politics, Cambridge University Press, New York, USA, ISBN:978-0-521-87320-8, 2007.

Postel-Vinay, K.: How neo-nationalism went global, *The Conversation*, <http://theconversation.com/how-neo-nationalism-went-global-74095>, 2017.

Rapley, C., and De Meyer, K.: Climate science reconsidered, *Nat. Clim. Change*, 4, 745–746, doi:10.1038/nclimate2352, 2014.

Rausser, F., Alqadi, M., Arowolo, S., Baker, N., Bedard, J., Behrens, E., Dogulu, N., Domingues, L. G., Frassoni, A., Keller, J., Kirkpatrick, S., Langendijk, G., Mirsafa, M., Mohammad, S., Naumann, A. K., Osman, M., Reed, K., Rothmüller, M., Schemann, V., Singh, A., Sonntag, S., Tummon, F., Victor, D., Villafuerte, M. Q., Walawender, J. P., and Zaroug, M.: Earth System Science Frontiers: An Early Career Perspective, *B. Am. Meteorol. Soc.*, 98, 1119–1127, doi:10.1175/BAMS-D-16-0025.1, 2017.

Saad, L.: Global warming concern at three-decade high in U.S., *Gallup*, <https://news.gallup.com/poll/206030/global-warming-concern-three-decade-high.aspx>, 2017.

Schmid-Petri, H.: Politicization of science: how climate change skeptics use experts and scientific evidence in their online communication, *Climatic Change*, 145, 523–537, doi:10.1007/s1058, 2017.

Schäfer, M. S., Füchslin, T., Metag, J., Kristiansen, S., and Rauchfleisch, A.: The different audiences of science communication: A segmentation analysis of the Swiss population's perceptions of science and their information and media use patterns, *Public Underst. Sci.*, 27, 1–21, doi:10.1177/0963662517752886, 2018.

Somerville, R. C. J., and Hassol, S. J.: Communicating the science of climate change, *Phys. Today*, 64, 48–53, doi:10.1063/PT.3.1296, 2011.

Stiller-Reeve, M. A., Heuzé, C., Ball, W. T., White, R. H., Messori, G., van der Wiel, K., Medhaug, I., Eckes, A. H., O'Callaghan, A., Newland, M. J., Williams, S. R., Kasoar, M., Wittmeier, H. E., and Kumer, V.: Improving together: better science writing through peer learning, *Hydrol. Earth Syst. Sc.*, 20, 2965–2973, doi:10.5194/hess-20-2965-2016, 2016.

Stocker, T., Qin, D., Plattner, G.-K., Tignor, M., Allen, S., Boschung, J., Nauels, A., Xia, Y., Bex, V., and Midgley, P. (Eds.): Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental

Slottet: Won't Do It"

Slottet: Positive Engagement With Climate Change Through Visualpositive engagement with climate

Slottet: Iconic Representations

[Panel on Climate Change, Intergovernmental Panel on Climate Change \(IPCC\), Cambridge, UK and New York, USA, 2013.](#)

[Stoknes, P. E.: What we think about when we try not to think about global warming: Toward a new psychology of climate action, Chelsea Green Publishing, Vermont, USA, ISBN:978-1-60358-583-5, 2015.](#)

[Theel, S., Greenberg, M., and Robbins, D.: Study: media sowed doubt in coverage of UN climate report, Media Matters for America, <https://www.mediamatters.org/research/2013/10/10/study-media-sowed-doubt-in-coverage-of-un-clima/196387>, 2013.](#)

[Townshend, T., Fankhauser, S., Aybar, R., Collins, M., Landesman, T., Nachmany, M., and Pavese, C.: How national legislation can help to solve climate change, Nat. Clim. Change, 3, 430–432, doi:10.1038/nclimate1894, 2013.](#)

[Townson, S.: Why people fall for pseudoscience \(and how academics can fight back\), The Guardian, <https://www.theguardian.com/higher-education-network/2016/jan/26/why-people-fall-for-pseudoscience-and-how-academics-can-fight-back>, 2016.](#)

[Ungar, S.: The rise and \(relative\) decline of global warming as a social problem, Sociol. Q., 33, 483–501, doi:10.1111/j.1533-8525.1992.tb00139.x, 2016.](#)

[Vraga, E., Myers, T., Kotcher, J., Beall, L., and Maibach, E.: Scientific risk communication about controversial issues influences public perceptions of scientists' political orientations and credibility, Roy. Soc. Open Sci., 5, 170505, doi:10.1098/rsos.170505, 2018.](#)

[Witte, K.: Putting the fear back into fear appeals: The extended parallel process model, Commun. Monogr., 59, 329–349, doi:10.1080/03637759209376276, 1992.](#)

[Wooden, R.: The principles of public engagement: at the nexus of science, public policy influence, and citizen education, Soc. Res., 73, 1057–1063, 2006.](#)

[Zhao, X., Rolfe-Redding, J., and Kotcher, J. E.: Partisan differences in the relationship between newspaper coverage and concern over global warming, Public Underst. Sci., 25, 543–559, doi:10.1177/0963662514558992, 2016.](#)

[Zürn, M.: The politicization of world politics and its effects: Eight propositions, Eur. Polit. Sci. Rev., 6, 47–71, doi:10.1017/S1755773912000276, 2014.](#)

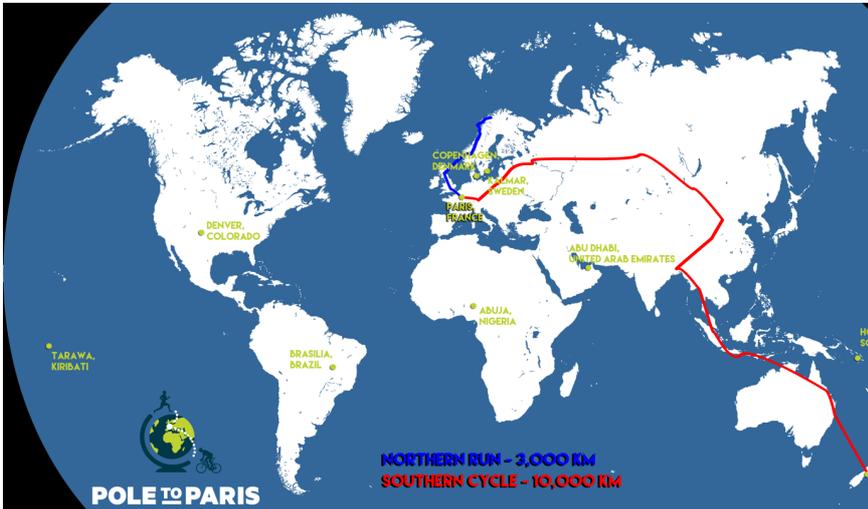


Figure 1: Map of the two Pole to Paris journeys: the Northern Run (blue trajectory) and the Southern Cycle (red trajectory); as well as the Global Voices events organized in collaboration with partners (green dots).

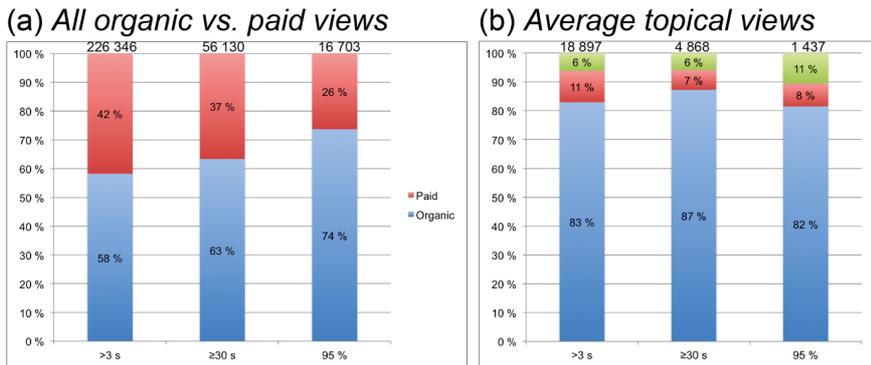


Figure 2: Percentages of total Facebook video views after three seconds (>3 s), at 30 seconds (or to the end, whichever came first; ≥ 30 s), and at 95 % of the video length (including people that skipped to this point; 95 %) for (a) organic (i.e., not paid; blue columns) and paid (red columns) views and (b) videos on climate action (blue columns), climate change (red columns) and the journeys themselves (green columns). Numbers above the columns in (a) and (b) represent total and average views, respectively.