Science AMA Series: We're a team of researchers who've created a tool to estimate the greenhouse gas emissions of 75 different global oils. AUA!

Oil-Climate$_{R}esearch^{1}andr/ScienceAMAs^{1}$

[1]Affiliation not available

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WRITE A REVIEW

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I would like to know the greenhouse impact of heavier chains of hydrocarbons as opposed to lighter hydrocarbons. I.e. Burning natural gas as opposed to a heavy oil. And specifically the effects in between, is the relationship linear or exponential?

Ne0111001001100100y

Debbie here. Sorry this got buried because you posted early. There seems to be a lot of interest in this question. If you are referring to hydrocarbon products, EPA assigns GHG emission factors. (Remember to add CO2, CH4, and N2O, according to their GWP). See here: https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

Emissions are about linear for most refined petroleum products, except for the lightest and heaviest hydrocarbons. Petrochemical feedstock and asphalt are assumed to be zero CO2 emitting as they aren't combusted when they are used. Natural gas is lower emitting than oil products, IF methane isn't leaked. If methane leaks, its emissions can be as high or higher than coal. And petroleum coke (petcoke), a residual co-product from refining heavier oils, has very high GHGs, similar to that of coal.

Now if you're question is talking about oil's GHGs (and not marketable products), that's what the OCI aims to assess. See: OCI.carnegieendowment.org

Does my choice of gasoline brands matter?

For example, BP's clearly doing a lot of offshore and arctic drilling, whereas CITGO (purportedly) comes from shallow Venezuelan crude. But then, apparently all of the gasoline in my region comes out of a single pipeline, regardless of its "brand".

I'd rather not buy from any company that's in the tar sands game, but if it all comes out of a single tap, does my choice make any difference at all?

cortechthrowaway

Jon here: This is one issue that is hard to get a handle on. Our focus is on the oil supply chain, but because of the complexity of how oil flows within the refining and retail sectors, it's hard to give good advice on consumer choices (schismtomynism alludes to this complexity also). We're not focused on the consumer side much at this point.

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cortechthrowaway

Adam Brandt here: Agreed that this is a challenging issue. Data do not exist in the public domain to be able to say definitively that one company is better than another. Also, once one knows about the operations of a particular company upstream, that has little to do with the crude that you buy at a pump bearing their name. Crude are sold in complex arrangements on global markets, so not guarantee that an Exxon station actually sells crude produced by Exxon upstream.

That said, a promising avenue of future research is to try to gather data that would allow company-specific performance to be measured.

Some crudes with high development and extraction costs like Canadian bitumen or shale oil also have very low exploration costs. Others with high exploration and development costs, like deepwater light crude, have relatively low "lifting" costs. All of these presumably have emissions effects. Do your calculations account for the greater carbon emissions spent exploring in more remote regions, for more extensive geophysical surveys and dry wells for basins with smaller and less identifiable reservoirs, and for the higher development and maintenance emissions of deepwater fields?

I'd imagine the pre-tax/royalty financial costs for exploration and development in a basin, incorporating dry well expenses, amortized over production and added to extraction costs, might serve as a better proxy for emissions than measures of direct fuel expenditures for development (eg, drilling & fracking) and extraction (eg, SAGD & upgrading). I've read Canadian syncrude embodies an additional up to 0.5-6 bbl worth of emissions, but its been developed while basins with still higher breakevens like like deepwater Brazil haven't.

Sanpaku

Adam Brandt from Stanford here:

1. You are correct that exploration costs vary a lot between different kinds of oils. Our upstream tool (OPGEE) does account for exploration in the newest model version, but only in a rough fashion. From first pass estimates, evidence suggests that exploration is much less important than requirements that must be put in for each barrel. So lifting costs are more important than exploration.

2. There is definitely some relationship between cost and emissions. For example, SAGD operations (as you note) much purchase large volumes of gas, which is both climate damaging and expensive. However, the linkage here is somewhat tenuous and challenging to measure, as there are lots of crude that are expensive without necessarily being high emissions (ultra-deepwater Brazil being a good example as you mention).

Without revealing TOO MUCH, what kind of mathematical strategies/formulas that go into this tool? And what were some obstacles that first made things difficult in assessing emission rates? (I'm a math major with an interest in environmental studies and the effects of greenhouse gasses)

ElNegro1121

Yes, it's all open source. Go to http://oci.carnegieendowment.org and look at the methods tab.

Without revealing TOO MUCH, what kind of mathematical strategies/formulas that go into this tool? And what were some obstacles that first made things difficult in assessing emission rates? (I'm a math major with an interest in environmental studies and the effects of greenhouse gasses)

ElNegro1121

Adam Brandt from Stanford here: You can find complete models and documentation on our website:

https://pangea.stanford.edu/researchgroups/eao/

Can you alredy reveal which Oil is the 'best' in terms of greenhouse gasses? And what do you think will be the impact of your research?

evaruh

There are graphs here that can help you answer that question: http://oci.carnegieendowment.org

Hey guys Not a science question but perhaps more of a morality question...

I'm an Australian and really dissappointed in the fact that our government is simply ignoring the fact about climate change. Eg, they don't believe the Great Barrier Reef is being bleached, so they just approved the countries biggest coal mine (because, profits).

Without getting political, how does it make you feel when people blatantly refuse to accept your work as valid? What do you, as scientists and professionals, say to naysayers?

philbilly86

Adam Brandt from Stanford here:

We aim to produce fair, transparent, and accurate science. There is not much for us to do about someone who refuses to engage at the level of verifiable facts.

Hey guys Not a science question but perhaps more of a morality question...

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Without getting political, how does it make you feel when people blatantly refuse to accept your work as valid? What do you, as scientists and professionals, say to naysayers?

philbilly86

Jon here: How we feel isn't important. People who deny the existence of climate change are misguided and foolish. Every decade since the 1970s has been hotter than the last, and the past couple of years were the hottest on record. http://www.skepticalscience.com

What do you say to those that believe that global warming is inevitable and human-related impact is minimal in the grand scheme of things? I have read conflicting views as of recent. Some completely debunking the theory, some saying the numbers are being stretched, and some who full heartedly believe it and credit the effects of global warming directly to human-related impact.

Ne0111001001100100y

Here's your best source to debunk incorrect beliefs about climate change: http://www.skepticalscience.com

Assuming that we should transition off oil to other energy sources in order to reduce GHG emissions, which applications should we be switching first, and which are lower priority?

For example, at a personal level, in my region of New England, most houses are heated with oil and people depend heavily on cars and light trucks for personal transportation. Cold climate heat pumps and electric vehicles are becoming viable options. Which should be a higher priority to switch?

I am interested beyond personal choices as well: aviation, shipping, etc.

tuctrohs

Adam Brandt from Stanford here:

This is a broad question, and one that has been the focus of a fair amount of research over the years.

From an economic perspective, the best way to think about this is in terms of "supply curves" for CO2 mitigation. These rank mitigation opportunities from least to most expensive, accounting for the size of each opportunity. The IPCC tabulates these, and many have been generated in different years and for different regions.

In general, efficiency improvements are very affordable, with effective "negative costs" of abatement. Fuel switching from coal to other sources like wind and natural gas is often the cheapest supply side option (or nearly so).

Have you found anything from the extraction side that you think is particularly notable or could be used to implement different techniques in order to reduce emissions/environmental impact at least in the short term (ie before fossil fuels can be phased out).

If so, why do you think that the industry has not adopted these methods?

cullybum

Adam Brandt from Stanford here:

A few obvious options exist on the extraction side.

1. Reduce flaring of associated gas. A large amount of natural gas is produced from some fields that are far to market. From a strictly economic point of view, this gas is often worth less than it would cost to get it to market, so it is flared rather than sold. Policies to encourage gathering and use of gas rather than its flaring would help to reduce this waste. Alberta has a good regulatory example of this, requiring installation of gathering equipment on projects where the cost would be less than $50,000 after accounting for gas sales.

2. Reducing fossil fuel use for thermal recovery of heavy oil. Heavy oil is viscous and challenging to extract from the ground. Therefore, steam is generally injected to "loosen" the oil and allow it to flow. This steam is generally produced by burning natural gas or crude oil. We can, instead, shift

away from heavy crude oil or shift to solar thermal systems to generate steam. GlassPoint is a company doing the latter in California and Oman, creating the world's largest solar thermal plants to avoid burning gas.

3. Avoiding fugitive emissions and controlling methane releases. Because methane has a high GWP, even small releases matter. Including better vapor control systems in oil operations can greatly reduce these emissions and get the gas to market so that it can be burned.

Do you think it's possible that deforestation and removal of plants for human expansion could be greatly exacerbating climate change?

praiserobotoverlords

This is Jon: Yes, but burning fossil fuels is the largest cause. Go here to learn more (based on NASA data): http://www.bloomberg.com/graphics/2015-whats-warming-the-world/

If there is one overarching takeaway from your project, what is it?

epicluke

Debbie here. To my mind, the overarching takeaway from the OCI is that we need greater data transparency. Information makes markets function better. Historically, climate change has not been central to markets. That is changing. Open-source data allows oils to be run through the OCI. This information will lead to better industry decision-making, more strategic investment, more effective policy design, a smarter tax (if and when a carbon tax is adopted), and ultimately greater innovative capacity both in the oil sector and its competitors.

If there is one overarching takeaway from your project, what is it?

epicluke

This is Jon: The oil supply chain really matters, and smart choices about the oil we extract, refine, and use can have big impacts on GHG emissions from oil.

If there is one overarching takeaway from your project, what is it?

epicluke

Adam Brandt from Stanford here:

Takeaway: attention to crude oil source and improved production methods can result in significantly lower emissions as we transition to a non-fossil fuel economy.

Hi! What is Phase II of the project? The linked research seems to be dated from before the first AMA. Is there any new research or analysis available? Thanks!

effitdoitlive

Joule here: Phase II expanded the set of crudes from 30 test crudes (presented in Phase I which is still accessible at: http://oci1.carnegieendowment.org/) to 75 crudes (available at: http://oci.carnegieendowment.org/). Phase II also provides additional capability to view and assess the

pathways.

Hi! What is Phase II of the project? The linked research seems to be dated from before the first AMA. Is there any new research or analysis available? Thanks!

effitdoitlive

Debbie here. You can also see details of OCI Phase 2 and planned Phase 3 in the methodology tab: http://oci.carnegieendowment.org/#methodology

There is a surprising amount of people who don't believe in climate change. What do you say to them when they won't listen to the facts?

gjo80401

Jon here: There are a lot of people who won't listen to facts. 25% of people think the sun goes around the earth. http://time.com/7809/1-in-4-americans-thinks-sun-orbits-earth/ Hard to know what to say to people who can't reason well.

There is a surprising amount of people who don't believe in climate change. What do you say to them when they won't listen to the facts?

gjo80401

Joule here: Tough one and not really the focus our work. However, here is a link that might help: http://www.skepticalscience.com/

In your minds, what is the most dubious aspect about climate science that a reasonable person*could* use to actually make an argument against climate change/global warming and still be factually accurate?

EttenCO

This is Jon: There's nothing dubious about climate science. We've known for almost two centuries that greenhouse gases warm the climate, and our knowledge has only gotten better over time. http://www.skepticalscience.com

How can I best explain, to my climate change denying friends, that climate change IS a problem?

KodaFett

Joule here: Not really the focus of our work but here is a link that might help: http://www.skepticalscience.com/

How do you feel about the emphasize on oil as far as climate changes goes when there are other culprits out there such as the agricultural industry that no one seems to be worried about?

It seems odd that everyone wants to point fingers at the oil industry, their CEOs, their policies, etc when green house gas emissions from the red meat industry are just as bad, if not worse (according to

some).

blorgensplor

It's Debbie. Climate mitigation requires attention to all sectors that produce GHGs. There's no silver bullet. Agriculture is certainly important. We chose to drill down on oil because it's our expertise. But it's also important to realize that the national climate commitments (NDCs) at Paris did not fully consider the oil sector. This is where the OCI comes in. Oil dominates globally over all energy sources in terms of its share of consumption. Gains in renewables will not readily reduce growing demand for oil in the short- to mid-term. In 2015, oil gained market share for the first time since 1999. Dealing squarely with oil to address climate change is a pressing need.

For marine fuels, can you ELI5 the differences in environmental effects between "Bunker C" (aka "Number 6 fuel oil" aka "PS-400") and "Marine Gas Oil" (aka "Number 2 fuel oil")? There are a lot of regulations coming into effect for transitioning from the former to the latter, it's a painstaking process, and I'd like to feel like it is worth it.

shtepi42

Adam Brandt from Stanford:

Number 2 fuel oil is similar to diesel. Number 6 fuel oil is the "bottom of the barrel", with the highest viscosity and highest concentrations of pollutants. These hetero-atoms (sulfur and metals) concentrate in the heaviest fractions and result in a very dirty fuel.

Are cow farts really the leading cause for climate change?

mrshenrymississippi

Joule here: Not really the focus of our work but here is a link that might help: http://www.skepticalscience.com/

In my home country, Norway, a recurring argument for continued oil extraction is the "environmental-friendliness" of Norwegian-based offshore oil production. Compared to sources of oil from other countries, it is supposedly less polluting, thereby justifying the continuation - potentially also opening up new areas outside Lofoten islands and in the Arctic closer to the Svalbard region.

How much of the co2 emissions from the use of oil can be ascribed to the extraction of the resource? Would you care to share any opinions on such type of argumentation?

0oflife

Adam Brandt from Stanford here:

Norwegian oil does look very good on our scale. This is for a few reasons: prolific offshore fields, tight emissions regulations, and easy-to-refine chemistry that enables fuels to be produced with little energy use.

The breakdown of emissions by extraction, refining, etc. can be determined from our figures on the OCI site. See above.

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How much of the co2 emissions from the use of oil can be ascribed to the extraction of the resource? Would you care to share any opinions on such type of argumentation?

0oflife

Debbie here. Upstream emissions from the 75 oils we tested in OCI 2.0 have a factor of 10 difference in their absolute emissions. And as a share of total emissions, see this curve on the OCI web tool: http://oci.carnegieendowment.org/#analysis?opgee=run000&prelim=run01&showCoke=1&ratioSelect=perBarrel&xSelect=upstream&ySelect=ghgTotal

If you go to this link you can hover over the oils and see which ones they are. There are 3 Norwegian oils in our OCI 2.0 sample.

My dad doesn't think rising CO2 is a problem. He also doesn't think man made climate change is real. And on top of all this he doesn't think Bill Nye the Science Guy is a real scientist. What do I do to shift his opinion?

chloemeows

Joule here: here is a link that might help: http://www.skepticalscience.com/

Is it too late to save our planet?

Qaswqqqq

This is Jon: It's never too late to get started. We need to reduce emissions as much as possible, as quickly as possible, starting as soon as possible.

Is it too late to save our planet?

Qaswqqqq

Adam Brandt from Stanford here:

This is not a useful question, and can lead to excessive despair. We are all faced each day with many challenges that are seemingly large and outside of our control (climate or otherwise).

In the face of such challenges, the rational choice is for all of us to work as hard as we can to make things better.

No-one guarantees success at this or any other endeavor. However, feeling like it is "too late" is a sure-fire recipe for failure.

Q: To what extent do different methods of transportation account for the total well to wheels emissions for each type of crude?

Do railways amount to much higher contributions to the overall life cycle emissions of crude oils than pipelines?

Do synthetic diluents amount to significantly higher emissions for heavier cruces?

How does bunker fuel shipping emissions compare to rail and pipeline? One contextual example is comparing Venezuelan oil by ship going to US refineries vs Canadian crude by pipeline. Another is Can crude to Eastern Can refineries vs Saudi oil by ship.

SwiftSpeed7

Transport tends to be a small contributor, as we noted in other comments. This is because large ships and pipelines are actually quite efficient compared to other processes using in extracting and refining crude oil.

Railways have higher emissions, but do not drive huge trends in overall impacts.

We do include a number of synthetic and diluted crudes. These tend to have higher emissions on both upstream (extraction) and downstream (refining). Joule can certainly explain more.

Bunker fuel contains a large fraction of the "hetero-atoms" contained in crude, such as sulfur, vanadium, nickel, etc. Therefore, upon combustion a lot of non-GHG pollution is created. This is a major issue, and one that shipping companies are starting to address. A big challenge there is that most shipping energy use takes place away from national regulatory jurisdictions in the open oceans.

Thank you for doing this AMA! Does the team think the tool was generally a success? Did anyone have any predictions, and did they find anything that surprised them? Does anyone think their findings confirm or disprove claims about climate change caused by humans based on GHGs, and why? What are some challenges the team faced? Did any of the team recieve any opposition from oil companies? Does the tool agree with most other studies/tools on GHGs? *Edit: One more question! Has anyone from the team heard of the blue whirl, and does anyone think it could be a viable way to use oil as a cleaner fuel source if used in a cheap and efficient manner?

Andreas_Bruticus

It's Debbie. Your question provides a good jumping off point for background on the Oil-Climate Index (OCI) project. At the outset, we were curious about climate impacts from the whole barrel of oil, not just individual fuels. No one had asked this question from this perspective before. We combined 3 models that run in sequence -- upstream production GHGs, midstream refining GHGs, and downstream end use. It's all open source. And it's been very successful. There are a lot of different stakeholders using the OCI -- industry, investors, policymakers, academics, NGOs, nations. We did not predict that the GHGs between different oils would be as large as they are. That surprised us. We did not think it would be as hard as it is to get oil assays to run PRELIM, the refining model. We did not realize how much emissions in different parts of the supply chain vary. We did not realize how many innovative approaches there are to reducing oil's GHG emissions. The largest challenge has been obtaining the complete set of open source data to model individual oils. Oil companies have generally not opposed the OCI, and some have shared data, which we can now make open source. The industry is very interested in the results and using this knowledge to better compete in the marketplace. The OCI is the only full barrel-forward assessment of GHGs that accounts for all emissions. The component parts, however, do generally agree with other studies. I hope this helps set the stage. P.S. I haven't heard of Blue Whirl

Have you had any response from mentioned companies regarding this?

Ickleslimer

It's Debbie. Yes, there has been interest from oil companies. And as you would guess, they do not

speak with one voice. In fact, even within a company, there are different responses, depending on who you're talking to. In other words, this isn't a monolithic industry and even the companies themselves have different perspectives. The most constructive have provided data and engaged on a substantive level. All seem interested in better understanding their own oil's climate impacts, something they have been working to better understand. Remember though, the OCI analyzes oils, not companies. It's the resource itself that contains GHGs. We're hoping that the OCI tool can help inform which oils companies choose to develop, how well they manage their operations, and what climate innovations they invest in.

Who sponsors your research?

JohannaAuto

Joule here - please see our responses to SoloAxe above.

As an Albertan, I have to ask: how does the oil created from our bitumen compare?

Thanks for your time and for doing this important work.

8Milesofshade

Debbie here. Bitumen -- oil sands -- have to be especially well managed. There is tremendous innovative potential that U Calgary is working on. The biggest challenge is the high level of carbon contained naturally in these and other extra-heavy oils.

Using the OCI web tool, here's how an Albertan oil sand compares to a light-tight Bakken oil that flares its associated gas when both are not well managed in terms of their GHG emissions: http://oci.carnegieendowment.org/#compare/canada-athabasca-dc-sco/u.s.-bakken-flare

Here's the comparison when both are better managed, using technologies we have today (e.g., not burning the petcoke in the oil sand and not flaring the gas in the light tight oil). Note that the emissions differences that remain are entirely in production that requires even better management and operational innovations: http://oci.carnegieendowment.org/#compare/canada-athabasca-dc-sco/u.s.-bakken-no-flare?opgee=run000&prelim=run01&showCoke=0

As an Albertan, I have to ask: how does the oil created from our bitumen compare?

Thanks for your time and for doing this important work.

8Milesofshade

On the following page you can see the comparison of life cycle GHG emissions for 75 different crudes including several oil sands pathways.

How much are you being paid by the chinese conspiracy?

84Dublicious

Adam Brandt here:

Millions upon millions. I am relaxing in a bathtub filled with $100 dollar bills as we speak.

If you would like a serious answer, I am happy to help. Try again and we can start over.

I feel that far too often people are led on this topic by what their representatives in politics believe and for me this seems like the blind leading the blind.

Do you think a prominent climate change scientist holding a public role would be a more effective way to implement changes in policy required to save our environment?

(I'm not criticising the work you guys are doing I applaud it, I just think we should try different tactics to encourage the world see what many already take as fact)

PossumOfDoom08

Debbie here. My basic working assumption on public policy is that we cannot manage what we do not know. (The OCI helps us manage oil-climate impacts better than we otherwise could without this comparable tool.)

While it matters that we have intelligent public agents, regardless of who your representatives are: Information is key and transparency is king.

What effect would we see if we converted the top 25 most massive ships from heavy fuel oil to nuclear?

PHealthy

Adam Brandt from Stanford here:

Large ships often burn residual fuels that carry large amounts of sulfur and metals. These "bottom-of-the-barrel" fuels trade at a discount and are often difficult to handle and clean up. Therefore they are burnt at sea where no government has regulatory authority.

We have not studied these ships in detail, but have included shipping GHG emissions from tanker transport. As a first pass, the transport emissions are small compared to other parts of the value chain. Counting non-GHG emissions would likely change that result significantly.

How do you respond to scientists who say that the impact of human CO2 emissions on global temperature has been exaggerated or miscalculated? How probable is it that the data could be reflecting mostly natural warming cycles, since models have typically predicted greater warming than was later recorded, indicating the climate models might overestimate CO2 sensitivity?

jakkkthastripper

This is Jon: They are wrong. http://www.skepticalscience.com addresses these and other common misconceptions.

Given the amount of misleading, inaccurate or sensationalized headlines about climate change, what is a good resource of accurate information that the average person can understand? The questionable accuracy of science journalism in the press and blogosphere make fact-checking difficult since they tend to dominate search results.

cbbuntz

Joule here: Not really the focus of our work but here is a link that might help: http://www.skepticalscience.com/

Can't we just fix things by putting high albedo particles into orbit instead?

jddbeyondthesky

Adam Brandt from Stanford:

Outside the scope of this project. A world expert on this topic is David Keith of Harvard, who was a previous advisor of our team member Joule Bergerson. His papers will give you a place to start, see here:

https://scholar.google.com/citations?user=PfciJkgAAAAJ&hl=en

Can't we just fix things by putting high albedo particles into orbit instead?

jddbeyondthesky

Jon here: While some have discussed this as a possible emergency stopgap solution, it doesn't address the root cause and has lots of other problems. Even if you can cool the earth with particles the oceans will still acidify and cause huge problems. We can't escape having to reduce emissions.

How hot could the earth get if the atmosphere was the most greenhousey atmosphere? Like Venus

arsug

Joule here: Not really the focus of our work but here is a link that might help:
http://www.skepticalscience.com/

Do you ever feel stress or depression when people deny the facts and don't want to accept the fact climate change exists and it's happening right now? EDIT: Also, do you think veganism makes as big of an impact as vegans say? I have heard some sources state that animal agriculture is responsible for up to 50% of greenhouse gas emissions. Additionally, is methane really that much better than CO2 at capturing heat in our atmosphere? If so, by how much? Thanks for the AMA OP!

wooki_cooki

Joule here: Not really the focus of our work but here is a link that might help:
http://www.skepticalscience.com/