Video Transcription:

[Applause]

Good evening thank you guys for taking your precious evening time to join me I'm happy to be here to talk to you about Arctic issues.

But before I begin, I actually have a little confession to make. I can't operate the slides.

[laughter]

Alright, so here's my confession and

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to use to kinda frame my story tonight. So not only am I a southerner who sometimes travels to the north for a variety of work purposes but I'm also an American.

I started working in the Canadian north as a young adult, as an undergrad researcher and I've never looked back. So fast forward several decades later and I am now a scientist and I'm a mom of 3 young children.

So here's my paradox, the first of several, how can a very family oriented person, someone who cherishes her young children leave their family several times a year to travel great distances to the north? That's my first paradox is my own paradox. And this is the easiest one to answer of tonight.

You know I do this in my personal life because the north really calls to me, it's really become a fundamental component of my fibre and I think it's really fundamental to the social fibres of many Canadians. We look to the north as a source of purity, of wilderness of adventure, but I also do this in my personal life because I believe really strongly in the research questions that we're asking, and what I want to talk about today is how an an issue of change in Canadian land that affects really fine scales, small scale organisms, and land and water movement can feed back and scale up to affect the entire globe.

So what I'm going to do today is define Canada as a permafrost nation. and I do this because permafrost covers most of Canada so more than half of the Canadian land base in some form or another is underlain by permafrost. Permafrost is just perennially frozen stuff in the ground, it can be soil, it can be sediment, it can be rock and it stays frozen year round and we call this permafrost.

So in the north, in the far Arctic its continuous, it underlays all of the land and as we move further south in Canada this permafrost becomes patchy, it becomes discontinuous. So in one

form or another all of these different zones of permafrost region, total up to more than 50% of our country we truly are a permafrost nation simply by area, by distribution.

But even in the far north, were permafrost is continuous, it's pretty patchy stuff, so this is just a cartoon diagram looking into the earth, into a soil column, you can see it's made up of different kinds of earth materials, we've got frozen rocks intermixed perhaps with these massive ice wedges, all of it is frozen, but it's very heterogeneous.

The other really important thing to remember about permafrost is it's underground it's subsurface, so permafrost is not something you can see from walking around the tundra or a boreal Forest it's underneath an active layer or seasonally thawed layer of soil of peat, or sediment.

Because it's subsurface, it's actually pretty hard to measure permafrost we can't see it, we have to go digging for it. Luckily, several decades ago that's exactly

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a network of permafrost scientists did they dug

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all over the far north of Canada and Russia and started measuring permafrost temperatures at depth. What I'm showing you here are some of the most famous borhal temperatures in Alaska, ranging from sort of discontinuous, sort of warm quote on quote permafrost temperatures all the way up to the far Arctic, the far north slope of Alaska, and across all of these boreholes what you can see is a pretty similar trend, despite starting at different temperatures, 20 meters beneath the earth's surface, we're seeing this warming trend no matter where we go in Alaska, temperatures of deep permafrost are warming.

And when you look at the relationship between these permafrost temperatures and the kind of warming that we're seeing at the surface of the earth, they're pretty strongly correlated with one another.

So permafrost is becoming warmer as a result of climate change, now there are some wiggles in each one of these records they're not a nice straight line there are some irregularities and we understand why permafrost might respond a little bit differently to surface warming its a number of factors driven by the ecology, by the snow different factors at the surface of the earth, like snowpack, peak thickness these are blankets that can act as insulating blankets on top of that permafrost. Some of these factors help explaisome of those irregularities, but in general were seeing the same kind of movement no matter what bore hole we look at.

With warming at the surface of the earth, we see warming of permafrost temperatures we sort of know what's coming here.

Woo! We have all these spaghetti diagrams in science, this is actually really interesting results of a model study that we organized within the network that I founded called the permafrost carbon network.

Not all climate models simulate permafrost, so not all of them can look at permafrost, but of the ones that do, we started a study just to try to understand how they differ from one another in terms of making predictions about permafrost into the future. And this is the result of that model comparison study, lots of vacation, each line, each colour here represents an individual model, there's a couple of Canadian models represented here and there's a lot of wiggles and there's a lot of spread.

But again, we can explain some of that spread because we understand why some of those models differ from one another some include vegetation differently than others some are being driven by climate a little bit differently than others so to some extent we expect some variation, but look at the trends here across all of these models, they're all predicting widespread loss of permafrost area, and this is a direct result of the kind of permafrost warming that I showed you in those borehole records.

So here's a great example of science, we have observations, long term observations from borehole records, model simulations that are both converging on the same story, permafrost is becoming vulnerable to climate change, it’s warming it's thawing, we’re losing permafrost area.

And we can see it, we see already the consequences of permafrost thaw, you take one visit to the north, and you can see it.

This is what we find, permafrost thaw affecting the infrastructure of the north, roads collapsing as a result of frost heave, we see any kind of linear feature like railroads, trails all kind of slumping and heaving as a result of those irregular thaw patterns.

This is in the parking lot of the university of Alaska Fairbanks where I hold adjun status and this is where I would normally park our field vehicle, massive ice wedge failure course a collapse of a big part of their parking lot and you know this is amusing because some of the worlds best permafrost engineers work at this university, they built a parking lot on top of a massive ice wedge feature and they out half of their parking lot overnight.

Some of these things are really tricky to predict, even in the places where we need to predict them the most.

The combination of permafrost thaw on land with global sea level rise of the ocean, mean that storm surges are having more dramatic influence on coast line, because of the Canadian

arcapelga we have more coastline in this country than any other Arctic nation and that coastline is becoming really vulnerable to massive erosional events.

Again this is the combination of thawing permafrost on land triggering these instabilities so that when these storm surges come, we literally see big chunks of earth falling into the ocean.

There are settlements in places like northern a last where they're sacred lands are falling into the ocean, settlements are being relocated in Alaska because of these kind of changes on the coastline, we don't have the same kind of coastal communities in Canada so this is isn't in the front burners of the government as it is in Alaska, but nonetheless we have a ton of terrestrial material that is being deposited at mass into the ocean and we know very little about the fate about this terrestrial material over time, is buried? Does it affect marine life? We really don't know.

We traveled to northern communities and engage with elders and other in the community to understand what their concerns are, they may say “we’re not interested in permafrost thaw” but ultimately the conversation always comes back to some of their concerns about loss of frozen ground.

How permafrost thaw is even influencing the perception of land use is really important in terms of driving the way we do research, we know that instability and slumping of permafrost near fisheries is influencing the quality of spawning sites, very important interaction along rivers that are used for access just travel to the land.

The bottom picture here shows a community member in the Northwest Territories that we work with very frequently in and he is standing next to his cross generational, so a very long term trap line, this used to be a trap line that was forested and they would hunt for mammals for generations

In a period of about 5 or 6 years this permafrost underlaid Forrest turned into a very soupie, muskeg, what we call a collapsed *scarbog.*

It is impassable in the summer, you can’t walk across it you can’t drive across it with a skidoo, it's impassable, and so he is no longer able to access his land that's been in his family and used for generations.

Not only does permafrost influence land use, but traditional knowledge is influential in how we study permafrost.

There's a really nice feedback between ways of living in the north and scientific studies, for example, there have been several instances where community members have sent our research group photos.

This used to be a lake, we used to fish here the elders have stories about fishing here, look at it now.

It's drained, when you go and use remote sensing to go look at that place on earth we see it the lake has completely disappeared within one years time.

So traditional land use has helped clue us into where the big changes are happening in land or water. In places like Russia and Finland, ice cellars, permafrost freezers, you know we store our beers that way in the field but these are used for preservation of food!

Much more important uses of permafrost and we have a lot of temperature records from these kinds of ice cellars where they're not actually cold enough to safely preserve food anymore.

So this is another area where traditional knowledge and data collected by community members can actually help fill in gaps in our understanding.

And so this brings me to my second paradox, the first paradox was within myself, the second paradox that I want to introduce to you is that in a lot of circumstances, northern ways of living simply rely on cold temperatures in the winter.

We are just at the start of our spring, we're very happy to be seeing the change in temperature, the sun just feels warmer doesn't it?

And I think a lot of ours are ready to celebrate. But when you work in the north and you live in the north the end of winter actually makes life very difficult sometimes.

So in the winter the whole ground is frozen, the whole ground is accessible, weather it'd be for trucking, medicine and food to northern communities along ice roads and maybe some of you are fans of "ice road truckers" surely these are communities that are fly in access only in the summer, but they're drivable in the winter, and families make use of this.

There have been several times where I have literally felt that I had been in the middle of nowhere in the north, i've skidoo'ed in to sample in the winter we do less damage that way.

I feel like there's nobody around me for miles and miles and miles, and I love that feeling. And then a minivan drives up behind me full of kids and full of moms taking their kids down to the big city to do some shopping.

The world is more connected than you think.

That kind of access only happens in the winter, individuals traveling across their land, across their traplines, much easier in the winter, lot of northern living revolves around winter sports.

They embrace the cold and in fact, when you work long enough in the north you hear this phrase: “we have the right to be cold”, and that is because northern ways of living, are defined by cold conditions, cold conditions in the air, cold conditions in the ground.

And yet through our day to day actions we are taking away their right to be cold.

What happens in the north, does not stay in the north, what I want to shift to now, is how these changes in northern communities and northern carbon pools, can influence the whole global climate system.

What I've done here is i’ve just grabbed snapshots of media, media story headlines that have happened in the last 10 years and actually the Washington Post just featured a big article about permafrost and methane emissions that was featured yesterday and had a similar kind of scary headline,

“The Climates Tipping Time Bomb”

“We’re scarily close to this tipping point”

“The upside to thawing permafrost is… Nothing, it’s bad”

“Society is doomed, say scientists”.

Now, I work really closely with a really good group of journalists, we work really closely to make sure the science is well represented, but even the best story, for example this Washington Post story, I thought was very accurate, gets taken over by a headline editor, entirely different journalist I have never worked with a headline editor and they come up with these flashy articles meant to grab their attention.

So what is this all about? There is a

-[Cuts Out]-

between permafrost and the amount of carbon this is basically dead mammoth and plant material from the plasticine era, early holastine era that has been stored in permafrost soils, it’s been frozen for millennia, maybe thousands of years, and now it's being exposed to warmer conditions.

There's a potential feedback between that carbon pool sitting in permafrost, which is twice as much carbon as is contained in the atmosphere today's and how that carbon might influence the global climate.

I'm just gonna walk you though this potential feedback, it is known to be one of the most likely feedbacks between the biosphere, between earth and the global climate system and the coming in a few centuries, and is known as the permafrost carbon feedback to climate.

And it's a positive feedback so let me walk you through this, again we have our little permafrost ecosystem at the centre, we've got our thawing soils at the surface, so this is the seasonal thawed material, it's frozen in the winter and then it thaws out in the summer, but as you dig deeper and deeper down you hit that perennially frozen ground that is called permafrost.

What were seeing as a result of climate change is that, active layer, that seasonally thawed zone, is starting to push deeper and deeper into surface permafrost.

And so that is exposing surface permafrost layers, again it's been frozen locked up in an ice box for a very long time, and it's allowing microbes in the soil, to start waking up, they're there, they're in the permafrost we know it from microbial genomics, they're there, and they are ready, poised and ready when things warm up, they start firing their respiration engines.

Microbial respiration of soil and organic matter produces 2 greenhouse gases, carbon dioxide under oxygen rich or aerobic conditions, and when oxygen becomes depleted, anaerobic bacteria can produce both CO2 Carbon Dioxide and Methane CH4.

Methanes are really potent greenhouse gas. The diffusional gradient for these greenhouse gases is up, and so these soil gases diffuse right through the soil column, up through the vegetation layer and into the atmosphere where those greenhouse gases contribute to the greenhouse gas effect, more warming, more thawing of permafrost.

It's positive, positive, positive effects all the way around the circle.

This is what we call a positive feedback cycle, the media likes to call it the "runaway train scenario", and i've tried not to encourage that and yet sometimes the headline editors do take over.

Now that's one kind of permafrost thaw that's slow gradual deepening of that surface, permafrost that seasonal active pushing into the surface permafrost and that's happening all over the north, slow gradual rates of warming of surface permafrost.

There's a second kind of permafrost thaw, we often call it abrupt thaw, the more technical term is thermokarst.

thermokarst just means slumping, thermo means temperature.

This I is slumping of the land surface that happens when permafrost thaws and this happens in areas when permafrost has a lot of ice in it.

So when you get permafrost underlying wetlands or P.D systems or lakes, that permafrost actually has a lot of water in it, and what happens when that water starts to melt and thaw out is the whole land just collapses right down.

An ice cube takes up more volume than water in its liquid state.

So here's a massive ice wedge in Russia, this is just awesome we rarely get an exposed face of soil to be in view like this this is on a riverbank that's been kind of eroded away and it's exposed this massive wedge feature.

100% ice, a ltitle dirty, but 100% ice, just think of what's gonna happen to the soil on top of that ice wedge, when that ice starts to melt out, the whole thing literally collapses and that's exactly what we see in a lot of our field sites.

Forests thawing, undergoing slumping due to the thermokarsts turn into this, these are called thaw lakes, these can form as quickly as within a year, to a couple of years, it's a complete ecosystem state change, trees used to be present in this area of water, all the trees that used to be present start to fall over and they're all underneath water and they get buried.

So this has been a big uncertainty, this is a known unknown.

"there are no known and there are no knows".

[laughter]

So this is clearly a known, unknown, no global scale or even regional scale model, will currently touch this issue of thermokarsts it's too complicated it happens vertically and it happens horizontally and it leads to these abrupt state changes in all aspects of the ecosystem.

And the modellers that I work with just laugh nervously and sort of walk away, when I raise this issue.

So right now they are modelling very simple representations of permafrost thaw, they're not measuring this kind of abrupt thaw.

And so I have take it on as a personal mission to convince the global modelling community that if they don't bring this into their situation frameworks, their missing the boat on the permafrost carbon feedback.

What my lab has done over the last 5 or 6 years is we've tackled a number of simple questions, but they've been really difficult to answer.

The first question is,

Where is thermokarsts happening now?

And where is it likely to happen in the future?

So this is work that a postdoctoral at my lab David Olefeldt, he's now in a faculty position of his own at the university of Alberta, we set together to create a spatial mapping and modelling framework to understand all the way across the circum Arctic where thermokarsts is likely to occur.

So we call these vulnerability maps. And what we have as a result of this study is a pretty good sense of what regions of the Arctic have ice ridge permafrost and are vulnerable to these kinds of abrupt state changes.

So once we got a better sense of where this was happening we could start to ask questions like:

How much of the Arctic is vulnerable to thermokarsts?

It’s about 15%. These are narrow components of the land that have a lot of ice ridge permafrost vulnerable to this process.

I'm not gonna show you data on this but what I'm currently working on is trying to link this up with a global carbon model so we can actually measure carbon fluxes as ecosystems undergo that state change so when they go from that nice stable permafrost to that thaw lake, like in that picture that I showed you earlier.

But then those systems, they undergo change just like all ecosystems do, they undergo ecological succession, they maybe start to recover and accumulate carbon again though biomass.

I’m an ecologist, I'm interested in that full life cycle of ecosystem carbon behaviour.

So, we're linking what we know about thermokarst today to these simple carbon models. And what I can tell you is that I think now the global modelling community is taking, taking us seriously because what we can show is that even though thermokarst are these abrupt thaw mechanisms affect only 10-15% of the arctic.

They release as much carbon to the atmosphere as that really simple, gradual active layer deepening that happens everywhere in the arctic.

So, these are truly large hot spot emissions. Hard to represent, of course. Hard to represent in a simulation framework. But worth the investment. So, now we're working with a number of different global scale models to bring this information and it's very exciting.

Ok. I want to introduce you to one of my colleagues, Katie Walter-Anthony. But I'm going to zoom forward, sorry Katie.

Methane is a very potent greenhouse gas. The molecule of methane is 25 times stronger than carbon dioxide. Methane is formed in millions of lakes around the arctic where permafrost is thawing.

And each year these lakes omitting tremendous amounts of methane. When you look at how much carbon is in permafrost still frozen and the potential for that permafrost to thaw in the future, we estimate that more than 10 times the methane that is right now in the atmosphere will come out of these lakes.

So, I wanted to show you that methane clip. Katie and I often pair up. She measures methane fluxes from arctic lakes. We measure methane fluxes from arctic wetlands.

We can light our methane on fire as well but we can't stand on the surface of our lakes. But, it's a really critical issue because this gets at the heart of what this Washington Post article was about yesterday.

We can make projections about the total amount of permafrost carbon that's likely to leave the soil and sediment and move into the atmosphere. We have those projections, we're narrowing down the window of uncertainty or sort of the realm of possibility.

But that's not enough.

We need to know what total carbon is going to be emitted as CO2 versus methane. They have very different impacts on the atmosphere. Methane is 30-50 times more powerful in how it can trap radiation and contribute to the greenhouse gas effect relative to CO2.

So, how we partition those fluxes in our models and in our measurements between CO2 and methane, they really matter. And we have absolutely no agreement in the scientific community on this.

The measurements and estimations in the literature vary by several orders of magnitude. So, this is going to be the next challenge for our international research network.

I think we've done a great job narrowing down how much carbon might be lost but now we need to work on partitioning that carbon. It's a big uncertainty. Again, a known-unknown for us.

I mean this is all doom and gloom, right? All of those headlines sound kind of eerily fitting for the kind of story I just gave you.

I will say that there is some good news in the permafrost carbon feedback to climate. About 15 years ago there were some model projections suggesting that there would be enough carbon released from the North to cause disruptive climate change.

So, you know the movie The Day After Tomorrow? That kind of stuff. Those were what the early scientific estimations were. They were that scary. We've completely revised those estimates. So, losses of carbon are going to be very large from the North.

They're equivalent to about another industrial China on top of emissions. But they are going to be rather gradual and slow building up over the next century or 2. We like to call this a knob or a dial on the current climate change system.

We're going to turn up that dial. We are not actually going to cause a new abruptly different climate system. That's actually a breakthrough. We did not know that about 10-15 years ago.

So, we still have to deal with this issue but it's not, we're not all completely doomed. There's still hope. And in fact, if we curve our emissions and curve it to some of the more modest IPCC scenarios we can actually prevent a lot of that carbon from coming out of the soils at all in the North. So, we still have hope.

So, I want to talk about some of the better good news aspects of climate change because it isn't all doom and gloom. And when we work in the North, you know, we get questions equally from Northerners about perennial frozen ground and how's that going to affect my family.

But also some of these opportunities, they're very hopeful in the North. So, there are a lot of good news scenarios. And one, is that the North is being increasingly seen as a potential agricultural frontier and every Northern government has this pinned to their desk and they're all working on agricultural productivity as a potential economic opportunity.

So, I do research in the Northwest Territories, their one of the few Northern governments that's released a formal food policy and that policy recognizes agriculture as a very small economic sort of viable route today. But it projects it to grow 10 fold in the next few decades.

They don't know how they're going to get there but they know they need to reach out to researchers to do this in a smart way. So, we are engaged in a lot of series of talks with the government of the Northwest territories about what expanding crop ranges with warming means for their land.

And how they can embrace this.

There's a dyer food insecurity problem in the North right now. Highest straits of food insecurity of food in Canada are Northern, largely indigenous households.

And I didn't sort of phrase this as a paradox but communities that become connected by the road system become much less stable and much less food secure. So, food and security in the North is actually linked to road access.

And it's because communities become detached from what we call country foods from traditional harvesting of foods and these are some of the communities that are really facing hunger and poverty issues.

Their driving to the store, they have access to purchasing food but a gallon of milk costs 25 dollars.

Solving that food security and creating a new economic opportunity in the north is extremely attractive as you can understand to Northern government. But there is very little data on how we can manage this.

Particularly because most of these soils are underlain by permafrost. You know, we talk about permafrost farmers and I work with permafrost farmers. They're a hearty bunch of farmers.

They're there and they have great ways of managing permafrost soils, but how this can ever be expanded to a large scale is a little bit difficult to conceive of right now.

And we only have to look to the last global agricultural frontier to take some important lessons how. When I was a student, if you told me you could build a viable economic industry farming tropical peat soils I would have laughed.

And yet, over the past 10-20 years that's exactly what's happened in places like Malaysia. Most of tropical peat lands today have actually been converted for plantation farming. And there's a variety of different crops grown on tropical soils.

Peat soils, when you drain them, when you warm them up they have a lot of organic matter and they have a lot of nitrogen. They're very productive. And so certainly tropical peat lands have seen this kind of increase in economic viability.

But it comes at a cost.

You can't have production on tropical peat soils without getting rid of the water. So they drain these peat soils or muck soils and then you can grow crops on them. There's nothing that burns better than drained peat soils.

And so when you hear about tropical peat fires in Malaysia shutting down airports, causing havoc on human health conditions in places like Malaysia that is these drained peat lands catching fire and they smolder so they burn for many many months.

It's a big air quality issue in the tropics. We also see it in global atmospheric carbon concentrations In years where tropical peats kept fire it releases so much carbon that we can detect an impact on the atmosphere.

We have all of those same conditions in the North. So this is a picture of a wildfire creeping eerily close to the apex sites. This is a long term experimental site that my group works in outside of Fairbanks.

This is a really wet, peaty, musky area. We have a ton of infrastructure. And this wildfire is getting really, really close. Peat in the north burns when it's dry enough. So if we have northern farming that diverts water away from those peat soils to make them more productive we have all those same elements that play like the tropical system.

We have large ranging wildfires, we have a lot of organic matter in the soils. Under the right kinds of dry conditions those will burn, our fires also last for months. So fire has to be part of this story of developing northern agriculture in sustainable ways.

And so, we're talking actively with northern governments about pilot studies to think about how to embrace carbon smart production. What carbon smart agriculture will mean in the north is going to be extremely different than what it means down here in Ontario.

We cannot import the same lessons that we've learned about organic matter management from Ontario soils for example. We can't simply export those to the north, some of these have to be bred in the north for the north kind of solution.

But there's a lot of interest in doing this. So, there will be a lot of work ongoing starting this summer and some of this is in affiliation with the Arrell Food Institute here at the University of Guelph.

And so, we often hear something called the paradox of northern climate change or the arctic paradox. And this is the good news bad news play on climate change. To many, when they here climate change in the arctic they think doom and gloom, loss of infrastructure, massive loss of permafrost carbon to the atmosphere disrupting Earth's climate.

Those are the gloom scenarios. But others see opportunity. Going to play this back and forth. Here are changes over a couple years period of ice in the northern passage. So just a few years, look at that.

The northern passage is patchy but its been ice free and it's been navigable every year since 2007. Okay and we're obviously losing that ice every year more and more. With that comes massive economic opportunity and big opportunities for development.

Again, sustainability is going to be at the heart of these kinds of discussions. So, I think we're learning more about those known-unknowns. We've greatly downscaled or reduced the estimates of permafrost carbon losses to the atmosphere.

We know now that it's not going to be nearly the kind of catastrophic loss of carbon that it was first projected to be. It's still going to be large, but it's nowhere near total global fossil fuel emissions.

Again, it's sort of like adding another China. So, that's a pretty big addition to global fossil fuel emissions. But, we're not going to double anthropogenic emissions.

Probably becoming more important to me as time goes on, permafrost thaw and just changes on the land affects every aspect of northern ways of living and it's just fascinating to work on a topic that is so cross cutting.

It cuts across society, infrastructure, ecology, you know it's really one of these themes that just kind of unifies all aspects of northern ways of living together. And you know, that really kind of grabs me. Keeps bringing me back to the north.

And so obviously our work really engages northerners. I think we're tightly couple with stakeholder needs in the north. But because what happens in the north does not stay in the north, you know, our work on northern carbon fluxes links us all together.

The climate change from emissions that we're causing here in southern Canada is affecting northern carbon fluxes. Those carbon fluxes in the north are affecting climate change all around the world. So we really are in this together.

This is a closed system folks, so we're all integrated through things like carbon fluxes and that's why I come back to Canada as a permafrost nation. It's really a play on words in a number of different ways.

And so, this is my last paradox and I will use these sticky notes pretty soon. How can something so old and rugged and just, I mean, vistas like this, the north is full of rock and plasticine mammoth bones falling out of the soil.

You know, big sky, northern lights. It feels impenetrable. But these ecosystems are so incredibly sensitive to climate change. You know, we're starting to get a better sense of how ecosystems may cope with some levels of climate change but in some ways we know we've totally outpaced northern community change already.

So, this kind of balance between ruggedness and sensitivity is my final paradox. So, here's where I kind of want to get your thoughts. I want you to finish this sentence for me, bring your own perspectives to the table.

I know just from chatting around the room, I mean some of you guys work with me in the north. So I know you've been to the north. Some of you've worked in the north in other contexts. Even if you haven't, even if you want to go to the north, bring your perspectives and your world view to this sentence for me.

And then we're going to go around my little helpers, and we're going to try to group these. And I know we'll have some chance for questions/answer period after that. But hopefully I can get your thoughts on that sentence right now.

Those are all great questions and I'm happy to continue this conversation, this is my only similarity with Donald Trump. I do use twitter to directly engage with people. I promise to be more sane and well spoken.

But I was going to say, of some of you I'm linked with already, if you're on twitter please link up with me because I'm going to do conceptual mapping of your sticky notes and create some type of word cloud with it.

I'm really interested in sort of this paradox of the good and the bad and so I'll be curious to think of your responses within the context of that paradox. And so, if you link up with me you can see what comes about about.

You're welcome to email me as well on campus.

I'll stick around for a few more minutes but thank you guys very much for coming, for organizing.....