

# **Snow Hydrology with Dr. Ned Bair**

## **Ologies Podcast**

### **January 14, 2019**

Oh hey, it's that blueberry bagel that tastes like onions 'cause it pressed its face into an everything bagel. Alie Ward, back with another episode of Ologies. It's the middle of January, and here in the northern hemisphere, lips are chapped, feet are cold, parkas are on. I'm here to give you a snow job.

But first, thank you to everyone who supports on Patreon, and who gets merch, including the new black t-shirts (yes!) at OlogiesMerch.com. Of course, thanks to everyone who rates and subscribes, who leaves reviews on iTunes, you know I read them. You know I read them. For example, this week, thank you to Evie, who said,

*In the hopes of Alie noticing me [heeyyy], I gotta say that this podcast just recently got me through some pretty bad flying anxiety. So thank you.*

Thank you for taking me into the sky with you, Evie. Also, EvanDK, I hope you and your pops are feeling okay.

Okay, so: snow. Snow! Not just snow, but big cold crumbly scary dangerous avalanches. What the hell are they? I searched far and wide for a snow expert, and I connected with a dude who got his Ph.D. in Environmental Science and Management from University of California, Santa Barbara, a place Steven Ray Morris and I both attended, but this guy is primarily based up near Mammoth Mountain, which is technically a giant lava dome complex. Freakin' volcano, near Yosemite. It's chill. He does not live in L.A. because hello, there's no snow here. But he would be passing through LAX on a six-hour layover. I coincidentally was also flying into LAX that night. We had plans to meet up in a terminal, and then my flight was delayed because of snow. Cute, snow! Cute!

So we made another plan. He had another layover at LAX a few weeks later, right before the holidays, and I drove down there, and I waited on a bench outside LAX for him, with my Zoom rolling, to rendezvous at high noon and talk snow. One issue: my phone was dying. And LAX is huge. Some days I'm like, why am I such garbage? Also, just a little audio note. As mentioned, this was recorded on a bench at LAX, and so there were a lot of ambient noises that we were competing with, and so as not to be annoying, we tried to cut around them as best we could, but it's a little bit less smooth than most episodes. If this is the very, very first episode you're listening to, the audio is a little different on this one, please bear with us, forgive us, the contents are totally worth it.

As you're going to hear, it was an adventure. You're about to learn about the beauty and architecture of snowflakes, why they're so bright white, what to do if you're stranded in snow, how avalanches happen, how to survive one, Digging Out Your Car 101, and the best snow for a snowball fight. Also, how climate change affects snowpack, and the really riveting backstory of skier, avalanche expert, and Snow Hydrologist, Dr. Ned Bair.

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Pre-interview:

I thought that was Ned, that wasn't Ned. My phone is at 2%. I am at the appointed meeting place. It is 11:59. I do not see Ned. My phone has 2% for us to meet up with each other before this gets real tragic. *[laughing]* Oh, god. How was it not plugged in? My lord.

My phone is now at one percent. I see someone walking. Please be Ned, please be Ned.

Are you Ned? Yeeessss! *[laughing]* Hi Ned!

Interview:

**Alie Ward:** And where did you grow up? Because you're based in Santa Barbara? Or you work out of UCSB.

**Dr. Ned Bair:** I do, I work for UCSB, I live in Mammoth Lakes.

**Alie:** And where are you from, originally?

**Ned:** Alexandria, Virginia.

**Alie:** Do they have snow there?

**Ned:** No, not much.

**Alie:** Ohhh! How did this happen?

**Ned:** I grew up skiing in Wintergreen, Virginia, a thousand vertical feet. Something like thirty inches of annual snowfall. I went to school in Maine, I went to Bowdoin College and skied more there, and then after college, I went, and my parents weren't too happy about this, became a ski patroller and did that for ten years.

**Alie:** Were they like, can you not break all of your bones?

**Ned:** Yeah, well, that's not really what they wanted me to go to college to do. *[both laughing]* And yeah, not the safest job either. But I loved it.

**Alie:** Have you been called a ski bum by your family?

**Ned:** Yeah, yeah. I've always had that. I've wanted to live in a ski town for as long as I can remember. I've sort of managed to do that with a professional career. I wind up traveling a fair bit, but also just a lot of time on the computer.

**Alie:** How did you make the leap from being ski patrol, for you said, ten years, to – you have a Ph.D. in Snow Hydrology.

**Ned:** Yes.

**Alie:** How did you go from like air quotes ski bum to doctor snow dude?

**Ned:** It's kind of a long story, but I was working as a patroller, and part of that was I was doing my Ph.D. while I was still ski patrolling at the end. But I had a friend on ski patrol who was sort of a mentor for me, his name is Walter Rosenthal, he was an old patroller. He was in his mid-fifties. He kind of took me under his wing and taught me a lot about snow and digging these massive snow pits. Sierra snowpack is really deep. It varies, but it can be very deep, and so we would be digging these pits and doing these crystal identification and stuff like that, I mean really deep, and he just loved it. He's probably one of the only people I've ever met who liked to dig more in the snow than to do anything else. He's kind of like a human backhoe.

Anyway, Walter was my friend on ski patrol, and he taught me a lot about the snow. I was patrolling, I was kind of looking for something a little more cerebral to do. I loved working as a ski patroller. I should say this – Walter had a history, he was a scientist also, also worked at UC Santa Barbara, and he had done a bunch of work with remote sensing, and satellite based mapping of the snowpack, and stuff that I'm doing now. But what he really liked to do is avalanche research. Which there's almost no funding for in the U.S. really. It's what I like to do, it's what I wrote my dissertation on.

Walter got an NSF grant with his advisor Jeff Dozier to study centering mechanisms in the snowpack. So, how snow grains bond together. He was looking at soluble impurities in the snowpack and using the scanning electron microscope and looking at the geometric structure, and now the necks form between them and stuff like that.

Anyway, Walter had just got this NSF grant, and then in April of 2006 he was killed with three other ski patrollers when a volcanic vent on Mammoth Mountain collapsed.

**Alie:** Oh, my god!

**Ned:** Yeah. It was a really rough time. It happened right next to me.

**Alie:** [*gasps*]

**Ned:** I was there when it happened. And he was actually killed trying to rescue the other patrollers. It was really, it was a tough time in my life. An experience that I have had a really hard time getting over. But, anyway, Walter's advisor Jeff came to me and asked me if I wanted to go to grad school on his NSF grant that no longer had a Ph.D. student to do the research.

**Alie:** Wow. What an impact that must have had on you!

**Ned:** It did. It had a pretty big impact on me. After college I was a ski patroller, and I was a climbing guide, and I was kind of a climbing bum, ski bum. Pretty soon after that I got married and started not living out of my truck as much. Now I have two little kids. It was a tough experience. I guess I should mention, James Juarez and Scott McAndrews were the two other patrollers who were killed.

**Aside:** While fencing off the area from skiers, Scotty and James fell through the snow twenty feet into the volcanic vent, and Walter, who wasn't supposed to be working, but had returned because of the storm, went after Scotty and James to save them. All three died of asphyxiation in the volcanic gasses, namely the heavier CO<sub>2</sub>. Several others were injured in the rescue efforts. And I just learned that when volcanic gasses reach noxious strengths, they're called a mazuku, which in Swahili means 'evil wind'. It's dangerous.

**Ned:** So, if you ever ski at Mammoth Mountain, there's a thing called a fumarole, it's on Chair Three area, and it spews out volcanic gasses. Hydrogen sulfide, which is really toxic, lots of carbon monoxide, carbon dioxide. It's sort of fine if it's not capped over, if it's open and venting, but this year was a really large snow year, this was April of 2006, and it actually capped over for the first time that a lot of people who had been there for decades could remember. These gasses sort of just sat there and actually formed an underground chamber that we didn't really know, and the snow bridge collapsed. We were pulling up fencing, because there's fencing to keep skiers out of the fumarole.

**Aside:** There are tons of videos on YouTube of skiers and snowboarders stopping at this fenced off plume to sort of wonder at it, and many pay their respects. A stone memorial is up at Mammoth Summit to remember the three, and even ten years after the incident, hundreds gathered at Mammoth to observe the anniversary. The community is still pretty rocked by it.

**Alie:** Did you have a hard time because it was maybe such a visceral and traumatic experience, to go back to this kind of science? Or did it make you more passionate about the safety of it?

**Ned:** I think both. It's sort of a complicated question. I wasn't going to change my life radically and go off and live in a city and do that. I wouldn't have been happy doing that. But yeah, it certainly made me think a lot about the mountains and taking risks. This snow bridge collapsed right next to me. It was a couple feet away. So, it could have very easily been me falling into the fumarole.

**Alie:** Wow. And you're a young person, too.

**Ned:** Yeah, I was twenty-six.

**Alie:** So what is it about snow that you love? What keeps bringing you back to it?

**Ned:** Growing up, it was always sort of an ephemeral thing and I didn't get to see it very much. I think all kids love snow. It's obviously, no school, at least in the DC area, so it has nice early memories and impressions for me. I think later on – well, I loved the avalanche part of it. The avalanche world is fascinating and there are a lot of avenues that haven't been explored scientifically.

**Aside:** This is where I find out what ski patrolling means. I honestly thought it was just like buzzing around the slopes, making sure everyone was okay, kind of like a lifeguard, but with no Speedos, and more skis. Turns out, I did not know anything about ski patrolling.

**Ned:** You go out with explosives, and you set off avalanches –

**Alie:** Wait.

**Ned:** - and you throw dynamite out of your hand.

**Alie:** Oh, I didn't know that!

**Ned:** Yeah!

**Alie:** I thought you were just making sure no one bailed.

**Ned:** No, no no no. You do active avalanche control. Shoot howitzers...

**Alie:** Oh my God!

**Ned:** Throw dynamite. It's fun.

**Aside:** A howitzer, by the way, is a friggin' World War II cannon, you guys. It's a cannon. [*far away voice*] I had to look it up.

**Ned:** Avalanches are very difficult to predict, and it's not always so clear what causes a really large one versus a small one. They're just sort of spectacular, too, just the size of them. [*thundering avalanche sound*] The debris, and the large blocks. The damage they can cause, you can see all kinds of markings on... You know, mostly in the Sierra, and most of United States, most of these happen in wilderness areas, so it's trees that are destroyed. [*more thundering sounds*] It's not like in the Alps, where there's more infrastructure, they have a lot of history of damage to buildings and things like that.

**Aside:** This is no joke. Each year, around a hundred people are killed by Alpine avalanches, but due to really crazy snowfall lately, twenty-six lives have been lost, just this past month. Just a few days ago, two ski patrollers in France were killed detonating explosives to trigger an avalanche. So, this shit is risky.

**Alie:** How many avalanches are there per year, do you think?

**Ned:** In Mammoth? I don't know, a couple thousand.

**Alie:** Really?!

**Ned:** Yeah

**Alie:** Oh my god, I had no idea.

**Ned:** Yeah, when they're triggered like that, you have a lot more of them. Throughout the U.S., I don't know, a hundred thousand a year, something like that.

**Alie:** My god. What's the death toll there?

**Ned:** Well it's been going down. It's in sort of the mid-twenties. It's actually been staying steady or going down, which is probably due to a number of factors: airbags, better education, better awareness. The avalanche centers do a great job with warning people during these high snowfall periods, and other times when metamorphism has produced layering that's unstable.

**Alie:** Wow.

**Aside:** Okay. More on those airbags in a bit. As for avalanches, these "metamorphisms in layering" just mean that there's less stability with a snow shelf, depending on what kind of layers are underneath it. Maybe some wetter, warmer snow, or a layer of refrozen ice kind of stacking and stacking, kind of like an icy club sandwich. So, a steep slope, heavy snow cover, a weak layer in the snow, plus some kind of trigger, and you have a slide that can vary from pretty harmless Size 1, to a Size 2, that can bury a person. A 3 can bury a car, and a 4 can destroy structures and go up to 80 miles per hour within a few seconds. Which is about twice as fast as my 2007 Prius, and thus deserves much more respect. [*wimpy car horn beeping*]

**Ned:** They're exciting, but also, just snow is a really fascinating material. As Walter always used to say, snow is hot, which means that it's very close to its melting temperature, almost everywhere on Earth. Because Earth is pretty warm, compared to the rest of the planets in our solar system. Well, at least the ones past Earth.

**Alie:** Going back to a really basic question: what is snow? What's the deal with snowflakes? Are they all unique? If I know nothing about snow, what are the basics? I know this is a stupid question, but I don't care.

**Ned:** Right. My advisor, Jeff Dozier, he had a thing where he went to Disney for the *Frozen* movie [*clip from Frozen, slowed down: "Let it go! Let it go!"*] he had some consulting work where he

showed up and gave them some pointers on snowflakes, which I thought were pretty good. And Carl Berklund [phonetic] who's actually also on my Ph.D. committee, I thought between them they had some pretty good points.

**Aside:** Are you ready for this beautiful icy point? It's going to melt your brains.

**Ned:** Jeff made the point that snowflakes grow by accretion, meaning condensation nuclei, dust, they grow out of that, so you can't have ones with holes in the middle, which you see a lot. Especially around now, when people are making snowflake decorations for Christmas.

**Alie:** Yeah. [laughs]

**Ned:** So, no holes in the middle. They have to have six sides. Okay, no pentagons or anything like that. They grow from six-sided hexagonal water crystals.

**Aside:** [far-away sounding voice] So if a kindergartner is out there making a paper snowflake with a hole in the middle, definitely yell at them. Just mercilessly. Because frankly, they're never going to learn otherwise. Humiliate them. [Regular voice] Don't do that.

Also, for a four-second lesson on hexagonal water crystals, how's this? Water is two hydrogens, and an oxygen atom, and because of how much molecules slow down in the cold, the hydrogen bonds allow the water molecules to link up in such a way that they form a hexagonal lattice structure. Which is, of course, why some snowflakes have six sides!

Okay, what else did the scientist tell the mouse at Disney? [slowed down recording of Frozen: "Let it goooooo"]

**Ned:** Carl also made the point that you cannot yell and cause a snow avalanche. It doesn't happen. I guess it happened in the movie *Heidi*...

**Aside:** I just spent like an hour digging all over for this *Heidi* clip, but he may have been thinking of another mountain movie, which, incidentally, an *I Love Lucy* episode cited.

[Clip from *I Love Lucy*]

*Lucy:* Now don't make a sound.

*Ricky:* What's the matter, honey?

*Lucy:* All that snow hanging over our heads! A loud noise would cause an avalanche!

*Ricky:* [laughing]

*Lucy:* It's true, I read it in a book! And you remember that picture *Seven Brides for Seven Brothers*? Yeah, that's right! Somebody shot a pistol and it caused a great big avalanche! Yeah. Now, don't anybody move!

Okay, also, I went and looked up *Seven Brides for Seven Brothers*, and from what I can gather, it involves a bunch of related horny frontiersmen who romantically straight-up kidnap women. So, I feel like yes, this pistol triggering an avalanche plot point is problematic, but not as much as its kind of lighthearted musical take on human trafficking.

**Ned:** You want to try and stop that urban, rural legend from perpetuating.

**Alie:** So that's a big debunker of flimflam. That's flimflam. You can't scream and cause an avalanche.

**Ned:** Nope.

**Alie:** Okay. So scream your head off in the mountains if you need to.

**Ned:** Ahhhh, yes.

**Alie:** Okay, good to know. Sometimes that's why you go to the mountains, is just to scream your head off. And then you go back and say, "Everything's fine!"

**Ned:** Yeah.

**Alie:** Right? Okay, where does snow form in the atmosphere? Does it form right above our heads? Does it form waaayyy above us? When does a snowflake become a snowflake?

**Ned:** Pretty high up. It depends on the level of the clouds and how deep the storm is, and where the moisture is. This is all the lower atmosphere, if you're an atmospheric scientist, but for people like me who study what's going on, on the ground, pretty high up. Kilometers [*laughs*] above our heads.

**Alie:** Ooo!

**Ned:** It starts off frozen actually, because it's cold up there. But it turns to rain if it's not cold enough.

**Aside:** So, to recap: water vapor and cold temperatures turns to ice crystals around a piece of dust or pollen, aka "condensation nuclei", and then it falls through the air and tumbles and grows. And in warmer air, it'll melt a little at the edges, and form clumps with other flakes, resulting in heavier, wet, fluffy snow. And if it falls through colder air, it's less likely to stick together, and it falls as smaller, drier, and powdery snow.

Also, side note, I just went down some YouTube holes trying to see different size snowflakes, and one thing I didn't need to know about, was a video of a guy silently scratching dandruff. Which, quote, falls like snow. And has forty-thousand views, mine now being one of them. Human beings. We're all a little different, and to each their own.

**Alie:** Snowflakes being unique, yes or no?

**Ned:** Um, yes. You can find snowflakes that are pretty similar. But they all grow by this pretty complex accretion process, where there's just a lot of water vapor condensing, it's called "deposition" when it's going straight from vapor to solid like that. Usually what people are referring to, I think, when they talk about how no two snowflakes are alike, is that the weather is kind of constantly changing, so that causes a difference in the crystal "habits" they call them, that are coming out of the sky. Wilson Bentley was taking pictures of snowflakes over a hundred years ago, or around a hundred years, in Vermont. There's been all sorts of people photographing snowflakes.

**Aside:** Wilson Bentley of Vermont, by the by, was a pioneer in the field of teeny, tiny weather photography, and snapped his first snowflake picture in the late 1880s, by attaching a camera to a microscope. He famously was the one that argued that no two snow crystals were alike. And then he died at the age of 66 after walking six miles in a blizzard. Oh man. Snow is a bitchy mistress. But what makes all of these [*slowed down*] glimmering icy flakes so fancy?

**Ned:** It has to do with the temperature and super-saturation, so relative humidity. You get sort of a different snowflake form, and they can be anything from dendrites, like the classic snowflake, to needles, to capped columns, to there's a number of different sector plates.

**Alie:** I didn't know that!

**Ned:** Ken Libbrecht has a nice coffee table book of snowflakes.

**Aside:** Okay, so Ken Libbrecht is a Cal Tech physics professor, who is probably the world's best snowflake photographer. He can say, hands down, it's him. Among his many books are: *Snowflakes: Winter's Frozen Artistry*, and *Ken Libbrecht's Field Guide to Snowflakes*. If you're like "Yesss! I'm ordering those right now! But Alie Ward, I need to see photographs immediately, before my books are delivered!" I understand, and I direct you toward his website [snowcrystals.com](http://snowcrystals.com), which also lays out all the different types of snowflakes such as stellar dendrites, which sounds like a European electronica band, but they're actually the classic pretty star-shaped ones. And then there's capped columns, which are snowflakes that look like a hand weight, from the gym, or like a tiny, tiny icy Thai fighter, and then there's these shimmering diamond dust crystals. There are triangular snowflakes. So, looking through the gallery, one can't help but say, [*echoey voice effect*] "Snowflakes! I had no idea!"

**Alie:** Are you ever irked by people using the term snowflake politically, as an insult?

**Ned:** [*laughs*] I haven't thought about that. No, it doesn't bother me. I guess, you know, it makes sense. It's a funny question. The classic snowflake, that we were talking about, the dendrite, those are delicate, and they do fracture and break apart easily. That's not so much the case

in the Sierra for instance, or most mountain ranges where it's windy. The snow that falls there [*clip of wind building up in the background*], well for one thing, it's not really falling, it's usually coming sideways, because the winds are so strong. There's a process called fragmentation by the wind, where the crystals are mechanically blown apart.

**Alie:** Oh, wow.

**Ned:** So, they might start off in the clouds as nice dendrites, but by the time they get to the surface, they're blown apart.

**Aside:** Kind of like how, at the beginning of the night, you might be perfectly orderly. Just a complex and symmetrical vision. But then, it's 1 a.m., and one shoe broke, and an eyelash fell off, and you got redeposited at a diner, instead of a disco. If you will.

**Ned:** Snowflakes can actually be pretty durable, and they look different. They're small, they're like little specks, versus larger – you know, all snowflakes probably look small to people.

**Alie:** Right.

**Ned:** Some are much smaller, like an order of magnitude smaller, especially when they're disaggregated like that.

**Alie:** What's happening with a hail stone? What's the difference there?

**Ned:** A hail stone is something that's liquid, but then because of updraft, it comes back up and is refrozen, and there's a lot of turbulence.

**Alie:** Oooo! Wow. So it's a raindrop that almost hits the ground and then it's like "Nope! I'll head up to the clouds!"

**Aside:** Hailstorms, I just learned, are different from graupel, which is when supercooled water forms around a snowflake, and it looks like hail, but it's not. Kind of like a ball of ice, made up of tiny balls of ice encasing symmetrical ice crystals that formed around a speck of something. It's just layers and layers of drama.

**Alie:** And at the center of each snowflake is there a speck of dust?

**Ned:** There's some kind of condensation nuclei. It could be like salt. But yeah, it's basically dust, for the most part.

**Alie:** And then, let's get back a little bit to your patrol days, and avalanches. What is causing an avalanche? How much snowpack do you have to have, to cause an avalanche? And what is it, essentially, is it a shelf of snow that just slips off a mountain?

**Aside:** That was an avalanche of questions, I'm sorry. [*cartoon umpire: "Yooooou're out!"*]

**Ned:** The ground is pretty much always right around freezing, so zero Centigrade, 32 Fahrenheit. But the snow surface can really vary, in fact right at the surface is where all the radiative transfer takes place, so that it can get really cold –

**Aside:** You're like, quick, let me look at your notes on "radiative transfer". But I gotta admit, dog, I just copied these off Wikipedia's test, but okay. Radiative transfer is "the physical phenomenon of energy transfer in the form of electromagnetic radiation". So, the surface of the snow can melt and then get very cold again? I think that's what that means.

**Ned:** - that can grow different crystals. That's where you can get snow that changes once it's on the ground and becomes weaker, because of the metamorphic process, and there's all kinds of different ones. And also new snow is just, it's much weaker than older snow typically, so if you're on a steep enough slope, it can avalanche.

But there's a lot to the avalanche. It has to form a slab, which is sort of a cohesive shelf, like you were talking about. That is much more dangerous. Then you can also have avalanches that are like something you'd see on a sand pile. It's like a slough. That's where it's not so well stuck together. Snow is inherently like a lot of geologic materials, it's a layered medium, depending on what happened with the weather, and how it fell, and all that. It has different layers and can have different strengths. If you get the correct layering, you get the block, or shelf, that slides downhill. And then the slope angle matters.

**Alie:** So, what causes most avalanches? If not people screaming at them?

**Ned:** Well, new snow. And this goes back to Monty Atwater in the fifties, and his ten contributory factors.

**Aside:** Okay, so side note. Montgomery Atwater, of Alta, Colorado, is the granddaddy of avalanche research. He is the dude. He's also the first one who thought, "Well, holy hell! Shit, let's launch small missiles at a mountain to make controlled avalanches happen!" Everyone's like, "Monty, dope idea." Now, his was not a work I was familiar with, but among the ten contributory factors are things like old snow depth, new snow depth, slope angle, temperature, and Atwater's work has now become Avalanche 101. Like, the "no doi" of icy nar-nars.

**Ned:** We've known this for a long time. When you have new snow, especially a lot of new snow, it stresses the snowpack. That's when you get avalanches. There's other things; skiers, it's stress really. Skiers can exert stress through what's called a stress-ball; they're affecting the weak layers. But yeah, the avalanche hazard really goes up with a lot of new snow.

**Alie:** Oof. So, tell me a little bit about your work blowing up these shelves of ice.

**Ned:** When I was a ski patroller, and ski patrollers all across the country, and all across the world, do this every time it snows a significant amount at big ski resorts in the western U.S. and the Alps, they throw explosives at the snowpack to trigger avalanches [*high-pitched scream*] so they don't come down on the guests who are skiing there.

It's very much an old-fashioned cowboy way of controlling the hazard, because you light these sticks of dynamite in your hand. Mammoth still uses dynamite, but a lot of places use some kind of cast primer, anyway, it's a high explosive, and throw it, and watch it go off, and see what happens. A lot of time, nothing happens.

**Alie:** Hoo! What does that sound like? The whole shebang?

**Ned:** It's very loud. You want to watch out and not damage... you try to cover your ears as well as you can, but of course you need to be able to talk on the radio and stuff like that. It's hard to keep your ears plugged all the time.

**Alie:** What does an avalanche sound like itself?

**Ned:** I get that question a lot. Usually they're silent.

**Alie:** What?!

**Ned:** Yeah. I've talked about this with other people, who have seen bigger avalanches than I have, and they say you can hear them when they're really big. Especially when they're breaking stuff, you hear the stuff they're breaking, like trees. There's a lot of frictional heating and stuff with these massive avalanches. But most avalanches, size scale 1 to 5 for destructive size, most of the avalanches I've seen are destructive size 2 to 3, and pretty silent. [*man whispering: "Silent but deadly."*]

**Alie:** Oh my gosh. Have you ever triggered one that surprised you? That was like, oh that was bigger than I thought!

**Ned:** Oh yeah. I got caught in a couple of them as a ski patroller. It's just one of the hazards of the job. I think a lot of the public don't know what sort of risks ski patrollers are subjecting themselves to, to get that mountain open. It can be really dangerous because, for one thing, after you're done with the explosives, the slopes will be ski-cut –

**Aside:** PS – I did have to look up what "ski-cutting" is. It's when a ski patroller intentionally skis across a dangerous pocket to maybe start an avalanche, a.k.a., an actual nightmare. They do actual nightmares. Did I mention they're not just hanging out in case you need a BandAid?

**Ned:** - to clean up. There's some places you don't want to ski-cut, and you won't ski-cut, but sometimes there's just little pockets that have to be dealt with. There's sort of a systematic

process for doing that. But it means you can be really exposed. That's how I've gotten caught in the few avalanches that I've been in. It's always been ski-cutting.

**Alie:** Did you dig your way out?

**Ned:** I didn't get fully buried. Mostly just went for a ride.

**Alie:** [*horrified sound*]

**Ned:** You know, a couple hundred feet, buried up to my waist, that kind of thing. But I've never gotten hurt in an avalanche.

**Alie:** That was just like a Tuesday at the office for you?

**Ned:** I guess, yeah. It's a hard thing with the ski-cutting. It's kind of a controversial practice, but if you really think about it, it's something you can't get away from as a ski patroller. There are certain areas you're always going to have to ski-cut.

**Alie:** Oooh man. What do you do to warm up when you've done this? Is there a part of working in snow that involves going to a lodge and drinking cocoa, or is that just a fantasy that I have?

**Ned:** It depends on where you are. When I was ski patrolling, there were ski patrol shacks where you "sit bump", which means you wait for someone to get hurt, and you try to keep one or two people up there at all times, because you want to go downhill to get people.

When you're out in the field doing snow research, for instance I'm involved in this NASA SnowEx experiment, which is a large field campaign for validating some instruments that are being flown on planes. If you're in that wilderness setting, there's nowhere to go, so you just try to really bring a lot of warm clothes. Moving around is the best thing you can do if it's really cold. But sometimes it just sucks. You're just really cold, and you bring extra gloves, especially when you're doing a lot of snow-pit work, your gloves get soaking wet. So, you bring multiple pairs of gloves, and switch them. Sometimes it's just cold and miserable. My hands get cold. I'm not sure they get especially cold, but I definitely have problems with that. It can be no fun sometimes. You can be freezing cold in some pretty cool places, I guess.

**Alie:** [*laughs*] I guess that's a trade-off.

**Ned:** "Cool" is a poor choice of words. [*rimshot*] There's a lot of beauty, I guess that makes up for it.

**Alie:** What does the research you're doing right now focus on?

**Ned:** What I do now, is I do large scale hydrologic remote sensing work, so I'm doing snowpack estimates across large areas, and concentrating in high mountain Asia, particularly in the

western parts of high mountain Asia, like Afghanistan, and Pakistan. The upper Indus River, which is a huge source of drinking water. Particularly Afghanistan, and the upper Indus, share a lot of climatological similarities with California, in that they have kind of a wet winter. It's more continental. Dry summer. It's not monsoon dominated. It's mostly water resources work to estimate snowpack volumes. The snow sort of acts as a reservoir, because it's frozen up there. If you're in a place like Afghanistan or in California, it conveniently starts melting in the summer, which is the dry season, and feeds the rivers.

Going back to the stuff about the spatial variability in the snowpack, it's a tough thing to figure out how much snow is up there, and the two big problems are how much is up there, and how fast is it going to melt? When's it going to melt? But in a place like Afghanistan, there's no snowpack measurements, so the rivers will just go dry in September, and it's a humanitarian crisis. We can kind of help out with that a little bit with remote sensing, by giving an idea of what sort of run-off to expect, based on how much snow is up there. That can be really useful for humanitarian aid and lead times.

**Alie:** And, stupid question, favorite or least favorite movie about snow, or ice, or avalanches?

**Ned:** Least favorite? Or favorite?

**Alie:** Whatever you have a reaction to.

**Ned:** I'm trying to remember the name of the movie, but it was really bad. Josh Hartnett was in it, and there was this guy who got lost off the back of Mammoth Mountain.

**Aside:** Okay, I looked into it, and it was *Six Degrees: Miracle on the Mountain*, about a guy who loses his way. I think meth is involved, and then is like maybe I'll clear my head shredding on some fresh powder. [clip from *Six Degrees: Miracle on the Mountain*, with dramatic music in the background: Man, "I just gotta get away." Woman, "Enjoy the mountain air." Man, "Always do!"] Any-hoozle. A storm comes, but it's not just the winter that's harsh. This movie scored a 22% with critics on *Rotten Tomatoes*.

**Ned:** I was not a big fan of this film. I don't think it even made it to the theatres. It's not worth even remembering. This happened while I was patrolling, they made a movie out of it. There were wolves... and it's like, yeah, there are no wolves.

**Alie:** [laughing]

**Ned:** I think maybe a better filmmaker could have made the story more convincing. But of course, my all-time favorite movie is *Aspen Extreme*, which is a ski film from the mid-'90s [clip from *Aspen Extreme*: Woman, "There's always about a hundred guys, maybe two make it 'til spring."]

**Aside:** Okay, so *Aspen Extreme*, from 1993, features cool dudes with borderline mullets, and as fate would have it, it too scored a 22% on *Rotten Tomatoes*.

**Ned:** It was just more formative for me when I saw it, because I was younger.

**Alie:** An inspiring opus, perhaps?

**Ned:** *[laughing]* Yeah, yeah. Those are the two, just off the top of my head. There have been a lot of terrible ski movies, that people love.

**Alie:** That's a good point.

**Ned:** I guess that's one of mine.

**Alie:** Okay, I have questions from listeners.

**Ned:** Oh, okay.

**Alie:** You ready?

**Ned:** Sure.

**Alie:** Here we go. A lot of questions, people are excited about snow. So I'm just going to list these off. Several people, Marisa Brewer, May Merrill, and Juan Pedro Martinez, wanted to know: What makes the snow white?

**Ned:** That's a good question. The snow is white in visible wavelengths, because that's what we see in. It actually wouldn't be if we could see into the near-infrared. It actually gets really dark. Which is one way you can figure out what you're looking at when you have a satellite or a spectrometer, something that senses in multiple wavelengths, multi-spectral instrument. But it's white just because snow has a very low what's called a complex index of refraction. So, it's very transparent. What that means actually, is that it tends to scatter light that comes into it, instead of absorb it.

**Alie:** Oh!

**Ned:** And absorbing is what makes something dark. The photons are coming in, and they bounce around in a snowpack, and then come back out. *[angels singing]* And that's bright -

**Alie:** Ah! *[slowed down: Oooooohhh!]*

**Ned:** It's all the wavelengths getting scattered back at you.

**Alie:** Ahhh! So, it doesn't absorb it well.

**Ned:** That's right, in the visible wavelengths.

**Alie:** Got it!

**Ned:** Exactly.

**Alie:** Ah! There you go! A ton of people had avalanche questions, obviously, and I will list them all in an aside, because there's a lot of names.

**Aside:** Okay. They are: Tony Benvenuti, Olaf Doschke, Brook Bissone, Barbara Blackie, Grace Gonzalez, Henry Strong, Wendy Fick, Christopher Enber, Dani Buchheister, Greer Nelson, Dustin Parish. Also, please remember, we're sitting on a bench outside an airport, so do enjoy the ambient sounds of a few trucks rumbling past. Also his layover was almost up. Oh, and here's that info about airbags, that I promised you earlier.

**Alie:** Jane Ennis essentially asked: What is the best way to survive an avalanche other than not being in one?

**Ned:** I think the avalanche airbags have been a revolution in personal protective equipment is what they call it, which for a ski patroller, used to be a CPR mask, and gloves, and now include helmets and avalanche airbags. Interesting story about it, the guy who invented the airbag system, ABS, was a German hunter who had been in a couple avalanches. One time he had a chamois, which is like a little European deer –

**Alie:** Oh, wow!

**Ned:** - slung around his neck, and he rode to the top of the avalanche and figured, hey this worked pretty well. He thought it was a surface area thing, that's not quite right, it's an effect called inverse segregation, but it's the Brazil-nut effect, shake a can of nuts and basically all the little nuts fill in the holes and make the big nut, the Brazil nut, rise to the top.

**Aside:** And remember how ice floats in a glass? I also read that icy snow is less dense than your watery human body, and so you'll sink in it fast. So having a large, light airbag, which kind of looks like a u-shaped pillow you'd use to take a nap on an airplane, but four times as big, can float you right up to the top of the slide. If you don't have an airbag, another way to survive an avalanche is just to try to move to the side of it, as quickly as possible, and to struggle to get your head above the snow once the movement is slowing down. So, you want to get your head up; those first fifteen minutes after an avalanche are critical. Now, another strategy, is just to never go outside, ever again. Ever. Stay warm, watch *That '70s Show* on cable, even if you don't really like it. Or yeah, airbags.

**Ned:** So, those are, I think, the biggest safety improvement that I've seen in my lifetime. I ski with an airbag. It doesn't add too much weight. It's like maybe four pounds extra or so in a pack.

**Alie:** Ah. Did... did you say he had a deer around his neck?

**Ned:** Yeah, a chamois.

**Alie:** Is that a living deer?

**Ned:** A dead one, because he was a hunter.

**Alie:** Oooohhhh! Oh my god. Okay, I was like, you just ski with one of these?

**Ned:** No, you just bring it home.

**Alie:** Got it! Okay, you just walk around with a live, cute deer on your – okay, that makes more sense.

**Ned:** Well they're littler, too. I don't know too much about chamois.

**Alie:** *[laughing]* I'll look into it.

**Aside:** A chamois is a European goat-antelope. *[clip from infomercial: "Sham WOW!"]*

**Alie:** Em Mauer and Cynthia Bartz both had igloo questions: How can an igloo keep you warm, when it's made of tiny frozen water droplets?

**Ned:** Snow is actually a great insulator, because it's got a lot of air in it. If you think about it, any material that has a lot of air in it, can work as a good insulator. Think of a straw bale or something like that. That's the idea, if you build up blocks like that. And also, they keep out the wind. It's actually a pretty good insulate. That's why snow sticks around for so long.

**Alie:** Oh, because there's so much air in it?

**Ned:** It's a good insulator.

**Alie:** I didn't know that, so if they were blocks of ice, an igloo wouldn't be as warm? But the snow, because there's more air in the snow...?

**Ned:** That's true. Solid blocks of sea ice would not work as well. Although they would still provide shelter from the wind. Which helps a lot.

**Aside:** I just learned that "igloo" in some Inuit languages can mean broadly, a house or a home, built out of any material, and that the snow house that's typically called an "igloo" actually has a much more specific name. And yes, linguists have studied a bunch of Arctic regional languages, and yup, there's a ton of words for different kinds of snow. The Sami people of northern Scandinavia and Russia? They've got a thousand words just for reindeer!

How boss is that? Also, pardon the planes taking off. Did I mention that we recorded this on a bench outside of LAX? I feel like I did. Okay, let's talk eating snow, which was asked by patrons Elisa Norman, Jason Steinhoff, and Em Mauer.

**Alie:** A lot of people had questions about eating snow. Kristen Long in particular asked: As a child I was never sure if it was okay to eat snow – obviously not the yellow kind. Or if it really was full of chemicals due to the smog in the atmosphere. Does where you live make a difference on whether or not it's okay to eat snow?

**Ned:** Yeah, it does. It's all that stuff in the atmosphere, condensation nuclei and all that stuff we were talking about. You can definitely have impurities in the snowpack. And then you also get deposition from dust, for instance, on the snow, that's a big issue in the western U.S. That's once it's on the ground. They get these big dust storms in southern Colorado, and more of these continental areas. You know, we just have the ocean. And most of the dust, like from China, is not making it over here, but they have local sources of dust that they can trace, and they get these apocalyptic looking dust storms. Especially the older, and longer the snow has been there, it tends to get stuff on top. Like there's an algae that grows on the snow, *Chlamydomonas nivalis*.

**Alie:** That's no bueno.

**Ned:** Yeah. I think it's a fungus – no, it's an algae I think. Anyway, it makes you sick if you eat too much of it.

**Aside:** I looked this up, and it's called watermelon snow because of this pink blush that the algal blooms cause. And it even smells like watermelon! But don't eat it. Now of course, just like snail m\*, it somehow popped up as an ingredient in way-too-expensive face serums. Because, I don't know, maybe a drop of snow algae juice will make me look younger! So somebody loves me! And I don't die alone, with my mini-Schnauzer left to devour my corpse. [*Far-off echoey voice effect: I think that's the thinking behind it.*]

**Alie:** So maybe don't. Now, what if you are kind of stranded, like Jason Steinhoff asked: Is it true that a stranded human cannot eat snow fast enough to stay properly hydrated? And Em Mauer asked: Is eating snow actually dehydrating because you spend more energy melting the snow than you get from drinking the water?

**Ned:** Yeah, you're definitely better off melting it, if you have fire, or a stove. That's pretty standard in most expeditions. Getting it to go through that phase change does require a lot of energy, so it's not the most efficient way, but you are still getting the water. Yeah, if you're desperate... it'll make you really cold!

**Aside:** So, what if you have nothing to melt snow with? Okay, I spent way too long on survivalist message boards, and apparently, if you have a canteen, you fill it up with snow and you tuck it between your layers of clothing, and you let your body heat melt it. Just let

your body do it! Or, you can suck on smaalll amounts of snow at a time, just don't eat ice like it's pudding. Also, one thread said you could pee in a bucket of snow, and just melt it that way. So you wouldn't be *eating* yellow snow. I guess, technically at that point, it would be a beverage. What's my point? Just bring a canteen. Or, stay inside forever.

**Alie:** A lot of questions about climate change, Madeline Heising wanted to know: I live in Boston, last winter we had a bomb cyclone storm that everyone was freaking out about. And she's embarrassed to say: I really don't know what that means. What is a bomb cyclone? And who gets to make up these dramatic names?

**Ned:** Boy, I don't know. I don't know what a "bomb cyclone" is. It sounds bad. I think you'd want to talk to an atmospheric scientist about that one.

**Alie:** Okay, [*laughing*] I'll look it up.

**Ned:** Doesn't sound too good though.

**Aside:** Okay, my friends, I looked this up, and a "bomb cyclone" is also known as explosive cyclogenesis, a weather-bomb, meteorological bomb, explosive development, mid-latitude cyclone, cyclone bomb, or bombagenesis, or snowmageddon. Or, a nor'easter. If you're counting, linguists, that is 10 English terms for just one kind of storm, and it means the pressure drops a bunch, at least 24 millibars, in a short amount of time (24 hours). It's when a mass of cold air meets warm air, and the storm gathers intensity really quickly. But it ain't a blizzard unless the winds are at least 35 mph, visibility is reduced to a quarter mile or less, and this thing lasts at least three hours. And yes, climate change affects the amount of warm air that slams into cold air. Slightly warmer air can also hold more moisture. We may be seeing shorter snow seasons, but heavier snow dumps because of that. So. Climate change. The unnatural Earth puberty that nobody wants.

**Alie:** In terms of fake snow, what are your feelings – Jordan Merrifield wants to know: What are your feelings on artificial snow made for ski resorts?

**Ned:** You know, I think they really help the ski resorts, the artificial snow helps the ski resorts maintain a more consistent product, as they'd call it. At Mammoth, they missed their opening day by one day this year, for the first time since they'd installed snow making, it was just one day since the early '90s. So it doesn't have to snow at all, they can still have skiing, and it can supplement. In some places, it's pretty much all they have, like where I grew up, in Wintergreen, Virginia. I certainly think it's okay.

One thing that's come up with the fake snow, is people somehow think that water use is all-consumptive, and it's just gone. But the truth is, it just runs off when the snow melts, and it goes right back into the watershed, or down into ground water. Mostly it's the energy. I'd say the consumptive part of it, where it uses up the most energy, you have to ionize the snow. So, big air compressors. It's a lot of electricity to run the compressor houses.

**Aside:** I was curious how these work, and I just watched a bunch of videos of huge hoses using compressed air or fans to blast tiny water droplets high up in the sky, so that they freeze, and then flutter down into powder. And apparently this can be an overnight job. Kind of like the snow fairy comes at night in a beanie and a Northface parka, and unleashes its giant hose-arm-octopus-creature to cover the mountain in frozen confetti while you sleep. Cute!

**Alie:** Caroline Lewis and Asriel King both want to know: Are there any ways to better clear snow off your car, walkway, etc., aside from scraping and shoveling? As a snow expert...

**Ned:** Yeah, I don't have any good answers.

**Alie:** *[laughing]*

**Ned:** I don't like to use the salt, because pets can... and it sort of marks things. I kind of enjoy it though, it's kind of a good way to get some exercise when you're stuck inside.

**Alie:** Right. It's Crossfit. Winter Crossfit.

**Ned:** Yeahhh...

**Alie:** Kind of?

**Ned:** You gotta watch your back, that's the main... They even teach in avalanche classes, a thing called strategic shoveling, which is more about how to most quickly extract people, it has to do with tiered levels, and stuff like that. You don't want to just dig straight into the ground. Just like any working at your desk, there are correct ways to sit, correct ways to shovel, correct ways to hold your... so you don't damage your back while shoveling.

**Alie:** So when you're digging someone out of an avalanche, it's almost like terraced levels?

**Ned:** Yeah, this was something that Bruce Edgerly came up with, which is great. The strategic shoveling, for one thing, if they're on a steep slope, you want to shovel in towards them, not straight down at them, because it's the fastest way to shovel out, is to excavate. Also, usually, it depends on what kind of setting you're in, but especially if you're at a ski resort, where there are a lot of people, you have more than – chances are you can only have one or two people up front doing fast shoveling. Then there's going to be other people who maybe aren't doing anything, so if they can get behind them on like a terrace, if you can imagine steps going down, and shovel out that debris from the first group.

**Alie:** Ohhh, right.

**Ned:** That's the most efficient way to dig.

**Aside:** Also, if your car is snowed in, I did see some tips like using a lighter to heat your key if your lock is frozen. Or, putting on a pre-snow car cover, so you can just remove that sucker, do a little less scraping. Another option is just to never go outside again. Now, main advice, lift with your legs, and not your back. And, if you're my Dad, please wait until I can come up and help you. Please. Thank you, sir. Also, a lot of you had a similar question, and I'm just going to say your names with my mouth now: Spencer Gillespie, Billy Marino, Carla Hickenlooper, Lauren Harter, Sarah Clark, Barbara Blackie, and Eva.

**Alie:** A lot of people had questions about climate change. Are you seeing your work change a lot in the last ten years?

**Ned:** Yeah, in the last ten years, that's a particularly interesting period of time. There's strong evidence that from snow radars, for instance Ben Hatchett is doing some great work, he's at the Desert Research Institute at UNR, they've got these snow radars that they can look at the snow levels, and they've had a huge increase, statistically significant, over the last ten years. One problem is these snow radars haven't been around that long, so it's hard to place that in context. It could be that this is just a warm ten-year episode, that might not all be due to climate change, or partly due to climate change. It's unclear, but anyway, what that has meant, even at Mammoth, which has a pretty high elevation. The base is 9,000 feet at main lodge. There's tons of mid-winter rain now. Even up higher up on the mountain, which used to never happen. They've had some interesting wet snow avalanches – you get different kinds of avalanches when the snow's wet like that, and it's raining on it. And stuff that a lot of patrollers have never seen before.

**Alie:** Really.

**Ned:** Yeah, it's definitely warmer, the climate projections are pretty dismal over the next fifty, especially a hundred years. It's a time to definitely think about, for California especially, think about the way that we depend on snowmelt to give us the stream flow that we need throughout the summer. It'll basically mean that the snow starts melting earlier, it'll coincide with more snowmelt during the wet season.

**Alie:** Oh, got it.

**Ned:** So, more rain on snow, then it's flooding. A lot of things like that. And just less water throughout the summer. And we've already seen that with forest fires. Soil moisture is very important to whether or not forest fires occur, and that's a direct – you know, if you have snow sitting on top of that soil for longer, and it melts later, there's more moisture. So we know that the dwindling snowpacks have a lot of far-reaching effects.

**Alie:** Right.

**Aside:** So, snow hydrology work is not just about skiing and avalanches. We need data that folks like Ned are collecting and crunching, to figure out how much water we can expect the

rest of the year. Another very scientific question; Gillian Leach wants to know: What scientifically is the best kind of snow for snowballs?

**Ned:** The warm and dense kind.

**Aside:** Zero hesitation there. Yesss.

**Ned:** Colorado tends to get the lightest snow, sort of at least in the mountain regions in the U.S., that and the Upper Peninsula of Michigan, and some of the lake effect areas. But not so much in the Sierra or the Cascades, or some of these maritime areas, that dense, heavy snow is what you want, because it'll pack better into a snowball. As it gets closer to freezing, it's easier to make snowballs with.

**Alie:** Do snow hydrologists ever have snowball fights?

**Ned:** Ahhhh... nooo. [*sad trombone*] When I'm with my kids, yeah.

**Alie:** You don't get beamed in the face by a colleague?

**Ned:** No...

**Alie:** You're like, "Mark! What are you doing?!"

**Ned:** No.

**Alie:** Okay.

**Ned:** I think that's just a... you sort of get used to everything, and get used to being around a lot of snow.

**Alie:** That makes sense. Two last questions: what's the worst thing about your job?

**Ned:** The worst thing is I don't get outside as much as I would like to. I'm not in the snow as much as I want to be, because scientific research can be really tough. Writing and being in front of a computer is not always the easiest thing to do. Anyone who's being honest would say that. It can be very rewarding in a lot of other ways. I would like to be in the snow more, so to speak. [*R&B track: "Let it snoooowwww..."*]

**Alie:** Do you get to ski a lot when you're up there in Mammoth?

**Ned:** I do, yeah. I get out quite a bit, I do cross-country skiing, skate-skiing, I do a lot of back country skiing. It depends on the year. This year looks like a good one so far.

**Alie:** What is your favorite thing about snow or about your job?

**Ned:** My favorite thing about snow or my job, two sort of different questions I guess, but for me, it's that I get to work on something that I love, but I love being out there, and the physical parts of working with snow, and on the snow, and the places that I've been to do that. It also, intellectually, is just a really interesting material. It's one of the brightest substances on earth. It exists near its melting temperature, it's extremely weak compared to any other material. I think those are some of the reasons why people find snow fascinating in the first place. You peel that onion, it just seems to have more and more layers and interesting things about it.

**Alie:** I wonder, why does snow have a smell?

**Ned:** A smell?

**Alie:** Yeah.

**Ned:** It shouldn't. *[laughs]*

**Alie:** Okay. There you go.

**Ned:** Sometimes, like when it's really quiet, it sounds like it's quiet in a snowstorm, it's because the snow is acting like a baffle, a sound baffle. So maybe the same thing is going on with smells. So whatever, if your long underwear smells terrible or whatever, it's just kind of coming back at you when it's snowing.

**Alie:** *[laughing]* That's funny. That was a Patreon question. Thank you so much for doing this!

**Ned:** Sure!

**Alie:** For meeting me essentially in a parking lot at LAX.

**Ned:** Yeah, no problem. *[piano music begins playing in the background as voices fade out]*

**Alie:** It's probably one of the weirdest parts of your job.

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Okay, so email a stranger, find a bench, and ask smart people stupid questions. Because they have such good stories! And you'll never see snow the same! Now, Ned is not on social media, but Ologies is, it's @Ologies on [Instagram](#) and [Twitter](#), I'm @alieward on both ([Twitter](#) or [Instagram](#)), there are more links up at [alieward.com/ologies](#), and to support via Patreon and submit Ologist questions before I record, and to see some behind the scenes videos of my closet, where I am currently recording this, you can head to [Patreon.com/ologies](#).

Thank you Boni Dutch and Shannon Feltus for managing [ologiesmerch.com](http://ologiesmerch.com), where you can get pins, and hats, and totes, and shirts. Thanks Erin Talbert and Hannah Lipow for adminning the [Facebook Ologies group](#).

Thank you to the vulvasaurus on Twitter for gently letting me know, when talking about the benefits of having episode transcripts, “deaf” and “hard of hearing” is preferred over the term “hearing impaired”, which many folks consider offensive. I’m so sorry, I had no idea, thank you for upgrading my brain with that info!

Extra editing help was done this week by Jarrett Sleeper of the mental health podcast *My Good Bad Brain*, also his Instagram stories while shopping at Ross are my favorite. [Jarrett Sleeper on Instagram](#).

Main editing was done by Ologies top Brazil nut, Steven Ray Morris of the podcasts *The Purrrcast*, and *See Jurassic Right*. Those are about cats, and dinos. Thank you Steven, you’re the best.

Once again, a donation was made this week to [esavalanche.org](http://esavalanche.org) in memory of Walter Rosenthal.

Now, if you listen to the end of the episodes, you know I tell you a secret. And this week, my secret is, I had a dream that I bought a Costco-sized box of Frosted Flakes, and I was *so pissed* to wake up and realize it wasn’t real. And I was so horny for cereal, I crumbled up a bunch of rice cakes, and then I poured vanilla coffee creamer over them, and I was like, “This is pretty tight!” And then I had another bowl. And by bowl, I mean mug. This all happened in a mug.

Anyway, live your life, cut your own hair, pick an obscure color like umber, or vermillion, and then type it into Google image search. You deserve it. I love you. Okay, berbye. Stay warm!

[saucy parody from *Let it Go*: “*Fuck it up, fuck it up/ Don’t give a shit anymore....*”]

*Transcribed by Lauren Fenton.*

***Some links which may be of use:***

[\*A Mammoth memorial, ten years after\*](#)

[\*Stone memorial at Mammoth’s Summit\*](#)

[\*Let’s aim ..cannons at the slopes?\*](#)

[\*Here’s some nice yodeling.\*](#)

[\*TV tropes of avalanche triggers\*](#)

[Some fumarole information for you](#)

[And a video of a volcanic vent](#)

[Kenneth Libbrecht knows his damn crystals](#)

[Because you probs wanna learn more about radiative transfer](#)

[Types of snowflakes WARNING THEY ARE PRETTY](#)

[Anti-avalanche tips:](#)

[Language and snow](#)

[Words for snow, there are many:](#)

[Don't eat snow because it's very cold:](#)

[Global warming and snow: they can exist at the same time](#)

*For comments and enquiries on this or other transcripts, please contact [OlogiteEmily@gmail.com](mailto:OlogiteEmily@gmail.com)*