

Brains On (APM) | Brains On! Weather watching: The birth of forecasts 01E2H13K6T5KF96YYT6Z8A31V6

HONOR: You're listening to *BrainsOn*,

POEM: Where we're serious about being curious.

HONOR: *Brains On* is supported in part by a grant from the National Science Foundation.

MONICA: Wow, nice sandals, Mark.

MARK: Thanks, Monica.

MONICA: Are they made out of newspaper?

MARK: Yes, they are. I made them myself. You know what I say, recycle, reuse, and look really cool doing it. And as long as I can steer clear of sharp rocks, stay away from fire pits, and look out for pebbles, they are super comfortable.

MONICA: OK. Oh hey, I was going to tell you--

MARK: Wait, what happened to the birds?

MONICA: Yeah, they stopped singing.

MARK: And those cows, they're all huddled together.

MONICA: Weird. Ooh hey, check it out. Have you ever seen ants do this? It's kind of like they're covering up the entrance to their home.

MARK: Hold on-- no chirping, cows in bunches, and ants protecting the entrance to their holes? All these creatures must be tuning into rain. Oh no, I can smell the rain coming, too.

MONICA: Oh yeah, hey, that's what I was going to mention.

MARK: My sandals, they're doomed! I have to get back to *Brains On* headquarters and put on my galoshes made from recycled bike tires instead. Don't worry, Monica. I'll bring back an umbrella!

MONICA: Huh, I guess he didn't realize I'm carrying an umbrella. And I'm wearing my rain jacket. And I'm wearing my galoshes. I mean, I did check the weather app before I left the house this morning.

[MUSIC PLAYING]

MOLLY BLOOM: You're listening to *Brains On* from American Public Media. I'm Molly Bloom. And with me today are Honor and Poem from Atlanta. Hi, you two.

HONOR: Hi.

POEM: Hello, Molly.

MOLLY BLOOM: So Honor, this episode was inspired by a question that you sent to us. You wrote, "How did weather forecasting come to be, and what did people used to use to predict the weather?" So I'm just wondering, how did this idea pop in your head?

HONOR: Well, weather men came to our school and told us how they predict weather today with satellites and radar. But I was wondering how they did it a long time ago when they didn't have those tools.

MOLLY BLOOM: It's a really, really good question. So do the two of you check the weather forecast often?

HONOR: Well, we sometimes have to, since we play soccer, like for practices and games, if they're going to be rained out or not.

MOLLY BLOOM: Are there signs that you look for beyond the weather forecast to tell you what the weather is going to be like?

POEM: Sometimes I look at the frost on the windows. And sometimes when I wake up in the morning I can hear the birds chirping outside my window, or I can look at the clouds. And if there's a lot of clouds, maybe it's going to rain that day.

MOLLY BLOOM: So if there are birds chirping, what are the birds chirping tell you?

POEM: Usually they don't chirp when it's about to rain, so sunny weather.

HONOR: Do you hear that?

MOLLY BLOOM: Oh yeah, it looks like Mark is trying to get our attention. Come in, Mark.

HONOR: Yeah, come in.

MARK: Oh hey, pals. I wasn't interrupting anything important, was I?

MOLLY BLOOM: I mean, we are taping an episode as we speak, so--

POEM: It's about how people used to predict the weather.

MARK: Great, then this interruption is surprisingly on topic.

MOLLY BLOOM: Unlike the time you interrupted our ant episode taping to tell me that you found your missing contact lens in your belly button.

MARK: All right, all right. Look, Molly, I thought you'd want to know. Whatever. I was going to tell you that I smelled ozone outside, so don't forget your umbrellas when you head out.

MOLLY BLOOM: Ozone?

MARK: Yeah, ozone is a gas with a sweet kind of sharp smell. It sort of tingles the nostrils. It's made by bolts of electricity, like lightning. So if you smell ozone, there's a good chance a thunderstorm's a-comin'. And then after the rain, there's a different smell. Honor, Poem, how would you describe that smell after the rain?

POEM: I think it smells sort of damp and not like it's been sunny at all.

MARK: Honor, how about you?

HONOR: I would say kind of wet.

MARK: Yeah, kind of wet, damp, and kind of earthy and cozy. And there's a name for that. It's called "petrichor." It happens when raindrops kick up stuff that's been dried up on the ground, stuff like oils and plant material and bacteria. Sometimes you can even smell petrichor when it's raining somewhere nearby if the wind is blowing in your direction.

People have been paying attention to signs like this from the natural world in order to predict the weather for tens of thousands of years. Poem, can you think of any reasons why weather prediction has been such a hot topic for so long?

POEM: Well, weather is really important. Like when it snows, you can get buried in the snow if there's a lot of snow.

MARK: Yeah, you don't want that. How about you, Honor?

HONOR: Well, because you just want to know what temperatures and stuff.

MARK: Yeah, you got to be prepared. Before cars or books or even concrete was invented, people were watching the skies to try to predict the weather. The Babylonians used the stars. And the ancient Chinese astronomers used the moon. Those Chinese astronomers invented a lunar calendar that predicted seasonal changes, like major heat or cold dew and my favorite, clear and bright.

But none of this was very precise. You might figure out when the best time of the year to plant a crop is. But you wouldn't know it's going to be rainy later that day at 3:00 PM in the afternoon.

[THUNDERSTORM]

The ancient Greeks had gods who they saw as controlling different realms of weather. For example, there was Iris. She was in charge of rainbows. Helios, he controlled the sun. And Poseidon, the god of the sea, he controlled the storms over the ocean. And his brother Zeus was kind of the god of all gods and sometimes even called "the god of thunder." But really, he pretty much controlled everything in the sky.

Down in the mortal world, Greek philosopher Aristotle was trying his best to understand what caused different weather patterns. He wrote a treatise called *Meteorology*. Does that word sound familiar to you? Have you ever heard it before?

HONOR: Yeah.

POEM: Yes, I've heard it before.

MARK: So the Greek meaning of meteorology translates to "of the atmosphere." And meteorologists as we know them study changes in our atmosphere. They study rain, wind, heat, snow, all that stuff. I'm sure you've seen meteorologists on TV.

Well, other cultures used Aristotle's writings to make more weather theories for thousands of years after he first wrote about them. And in the 1600s, two new measuring tools really changed the game. That's when we get the barometer and the thermometer.

MOLLY BLOOM: Right, those are some quality "ometers," and we're going to be talking about those in a bit.

MARK: Hang on, you smell that? Ozone. I got to go find my galoshes. Bye. [SCREAMS]

POEM: Goodbye?

MOLLY BLOOM: [LAUGHS]

HONOR: Well, at least his interruption was on-topic today.

MOLLY BLOOM: That is a very good point. Now before this downpour hits, let's soak up some sounds. It's the-- [SPACE SOUNDS]

HONOR: Mr. Sound.

MOLLY BLOOM: Here it is.

[WHIRRING AND FLAPPING SOUNDS]

All right, what is your guess? Let's start with you, Poem.

POEM: So that kind of sounded like something getting crushed to me, like something rolling and crushing something else and things crashing into each other.

MOLLY BLOOM: Excellent listening. What about you, Honor? What did you hear?

HONOR: It sounded kind of like something flapping in the wind, like at a beach, like a tent flapping at the beach.

MOLLY BLOOM: Well, we're going to be back with the answer a little bit later in the show.

MARK: (SINGING) Ba-ba, ba-ba, ba-ba, ba-ba-ba, *Brains On.*

MOLLY BLOOM: Let's get back to those two measuring tools that Mark mentioned.

POEM: The barometer.

HONOR: And the thermometer. Thermometers measure the temperature. That's how hot or cold the air is.

POEM: And barometers measure atmospheric pressure or air pressure. It's basically telling us how much the air is pushing down on us.

MOLLY BLOOM: When the temperature changes, that changes the atmospheric pressure.

HONOR: Warm air likes to rise, and cold air likes to sink.

MOLLY BLOOM: But the atmosphere wants everything to be balanced. So if there is a low pressure somewhere, air will want to rush over there to even it out. That makes wind and moves clouds around.

POEM: For more on this, check out our episode, "How Do Meteorologists Predict The Weather?"

MOLLY BLOOM: Different temperature and air pressure combos add up to make different weather patterns. And if you can measure those two pieces, you can get a pretty good idea of what weather is on the way.

HONOR: That's why the invention of the barometer and the thermometer are a pretty big deal.

MOLLY BLOOM: They were both invented in the 1600s in Italy.

PAULINA But it took 250 years for someone to figure out how to use these tools to predict the weather.

VELASCO:

MOLLY BLOOM: Oh hi, Paulina. Honor and Poem, this is reporter Paulina Velasco.

POEM: Hi, Paulina.

PAULINA Hey Molly, hey Poem, hey Honor. I'm dropping by to tell you the tale of the first modern weather forecaster,

VELASCO: Admiral Robert FitzRoy.

[TRIUMPHANT MUSIC]

ROBERT Ahoy, me hearties.

FITZROY:

PAULINA Hi, FitzRoy.

VELASCO:

ROBERT Blimey if this isn't a great crew to be joining on deck.

FITZROY:

PAULINA Thanks, Fitz, though you know we're not currently on a ship.

VELASCO:

ROBERT Aye, right you are. But I spent so long on ships that it's a force of habit.

FITZROY:

PAULINA As you can tell, FitzRoy was a sailor. He was actually the captain of the *HMS Beagle*.

VELASCO:

MOLLY BLOOM: That's the ship that carried Charles Darwin to the Galapagos.

PAULINA Exactly. Admiral FitzRoy spends over 20 years sailing around the world from Europe to what's now Argentina to
VELASCO: New Zealand, and eventually settles back in England in the 1850s, where he's put in charge of a new department in the British government that collects weather data at sea.

ROBERT Thank heavens. I'd gotten really tired of being out at sea. And this was a perfect combination of my interests,
FITZROY: science and sailing, sailing and science. I guess that's kind of it.

PAULINA So FitzRoy's collecting data about storms and conditions at sea for the government. But no one's really doing
VELASCO: much with it, until tragedy strikes.

[IRISH MUSIC PLAYING]

It was October, 1859. A huge storm hit the Irish Sea off the coast of Wales. A steamboat called the *Royal Charter* sunk. Hundreds of people died.

ROBERT Wrecks like this happened all the time. It's tragic. All those lives could have been saved, if we could have warned
FITZROY: them about the storm.

PAULINA So that's what FitzRoy set out to do. The government gave him the authority to officially issue storm warnings and share them with the world.

MOLLY BLOOM: And how did he do that in the 1850s? I mean, there were no radios or TVs or phones even.

PAULINA True, but there was plenty of new technology. After all, it was the height of the Victorian era.

VELASCO:

[VICTORIAN MUSIC PLAYING]

The first modern railroad was built. New sewing machines were invented. Photography was taking off. And we got the first electric telegraph.

MOLLY BLOOM: The telegraph? That's like the beepy thing that sends telegrams.

PAULINA Exactly, so back in that day, you didn't have cell phones, texts, or FaceTime. You had to send letters. And that took a long time.

VELASCO:

The telegraph on the other hand, it was nearly instantaneous. If you had an emergency, you could send an electric message from your telegraph to a telegraph station in a far-off place. It was just a series of beeps. But someone on the other end would interpret the beeps, transcribe the message into words, and then deliver the message to the person you were trying to reach right away.

ROBERT And what I did was I combined the use of the barometer and the genius of the telegraph to send out warnings when storms were coming, like a forewarning, a forecast. What a great word, "forecast." Forecast, forecast, forecast. It really rolls off the tongue, doesn't it?

FITZROY:

PAULINA Well, we still use it today, Admiral.

VELASCO:

ROBERT Yes!

FITZROY:

PAULINA FitzRoy started using maps to put together weather charts. He sent out barometers that they called "FitzRoy storm barometers" to small fishing villages around Britain. And those people would telegraph him with data from those barometers, which let him know if a storm was brewing in that area.

VELASCO:

ROBERT Then I'd use the telegraph to send urgent messages back to them. If I calculated that a storm was heading their way, then they could batten down the hatches.

FITZROY:

PAULINA And he'd also forward the weather reports to the newspaper.

VELASCO:

ROBERT August 1, 1861, and I quote, "In the north, moderate, westerly wind, and the forecast, fine."

FITZROY:

PAULINA That was the first ever weather forecast published in the *Times* newspaper. It had predictions for several cities-- London, Liverpool, Copenhagen in Denmark, Bayern in France.

VELASCO:

ROBERT And I was right.

FITZROY:

PAULINA You were. And don't be shy, you also became very famous.

VELASCO:

ROBERT Oh, please. Oh, just a tad famous.

FITZROY:

PAULINA People became obsessed with forecasts. Farmers could figure out how to take care of their crops better. Sailors and fishermen could stay safer out at sea. People used them to plan outdoor fairs and even to pick their outfits. And the queen herself once asked for a weather prediction for one of her trips.

ROBERT That's right, *the* Queen.

FITZROY:

PAULINA These scientific weather forecasts were the basis for our weather reports today. But now we have other tools, too, like satellites and computers.

ROBERT Com-puters? What?

FITZROY:

PAULINA Don't worry about it, Admiral. Thanks for all your hard work.

VELASCO:

MOLLY BLOOM: Yeah, we owe a lot to you and your forecasts.

ROBERT Oh, blimey. Thanks, you two.

FITZROY:

MOLLY BLOOM: And thanks for telling us this story, Paulina.

PAULINA My pleasure. Come on, Admiral, let's get out of here.

VELASCO:

ROBERT Weigh anchor and hoist the mizzen. Have I ever told you about the time we ran afoul of some icebergs in the Strait of Magellan?

MOLLY BLOOM: Do you have a question you want to hear answered on the show?

POEM: Or a mystery song you think can stump us?

HONOR: Maybe a drawing.

MOLLY BLOOM: Send them all to us at brainson.org/contact.

POEM: That's where we were sent this question.

GLORIA: "My name is Gloria from Shanghai, China. My question is if hair is dead, how does it grow?"

HONOR: We'll have an answer to that during our "moment of um."

MOLLY BLOOM: And we'll read the most recent list of names to be added to the brain's honor roll.

POEM: All at the end of the show.

HONOR: So keep listening.

MOLLY BLOOM: You're listening to Brains On from American Public Media. I'm Molly.

POEM: I'm Poem.

HONOR: And I'm Honor.

MOLLY BLOOM: And it's time to hear the mystery sound again. Here it is, one more time.

[RUSTLING AND FLAPPING]

The last time we heard like crushing, crashing, wind, beach. Do we have any new thoughts?

HONOR: I think that I'm going to-- I definitely heard some wind there in the end. So I'm going to say it's some wind.

POEM: And maybe like the waves, and wind in the waves.

MOLLY BLOOM: Excellent guess.

HONOR: I'm going to stay with my first.

MOLLY BLOOM: Can you remind us what your guess was?

HONOR: It was like a tent flapping at the beach in the wind.

MOLLY BLOOM: Excellent hearing. All right, let's hear the answer.

ZACHARY: That was the sound of--

ISABELLA: Us camping on the beach with 20 mile an hour winds. Hi, our names are Isabella--

ZACHARY: And Zachary. We're From Norcross, Georgia.

ISABELLA: We are camping on the beach at Thornhill Brown campground in California.

ZACHARY: The wind was fast and it made the temperature feel colder. Camping was fun, because the stars and the moon were so bright, we didn't need flashlights. And we got to go into the ocean.

ISABELLA: Bye.

MOLLY BLOOM: Really excellent work. Honor, you were completely correct, a tent blowing on the beach. How did you do that?

HONOR: I don't know.

MOLLY BLOOM: Have you been in a tent during a windy time before?

HONOR: Well, we haven't been--

POEM: We haven't been camping. But we've had a beach tent before.

MOLLY BLOOM: So that is like a situation you have found yourself in before where there is something being blown about on the beach.

HONOR: Yeah.

SPEAKER: Brains, brains, *Brains On*.

MOLLY BLOOM: We have another little game for you to play. It's called--

[TRUMPETS PLAYING]

TOWN CRIER: "The lore of yore."

MOLLY BLOOM: The way it works is our town crier is going to say a piece of weather lore. And I want you to say what weather event the town crier is talking about. So here is the first piece of lore.

TOWN CRIER: "Red sky at night, sailor's delight. Red sky at morning, sailors, take warning."

MOLLY BLOOM: So does this describe one, the fact that sailors hate red, because it clashes with their uniforms, two, red sky in the morning shows that a high pressure system has passed but at night it shows that one is on its way toward you, or three, "red sky at night" means snow in the morning. Poem, what is your guess, one, two, or three?

POEM: I think I'm going to go with the second one.

MOLLY BLOOM: Honor, do you agree?

HONOR: Yeah.

[TRIUMPHANT MUSIC PLAYING]

MOLLY BLOOM: You are correct. It is number two. So the way the sun is seen through dust trapped by high pressure systems will make the sky appear red. And if it's in the morning, that means it's already by. It's in the east. But if it's in the west, that means it's on its way toward you. All right, here is piece of lore number two.

TOWN CRIER: "When windows won't open and the salt clogs the shaker, the weather will favor the umbrella maker."

MOLLY BLOOM: OK, [LAUGHS] so does that refer to number one, the high humidity before a rainstorm, number two, pranks pulled by local umbrella makers, or number three, high winds make it tricky to pour salt and open windows. So we're talking about one, high humidity, two, pranks, or three, high winds. What do you think, Honor?

HONOR: I think it's one.

MOLLY BLOOM: Poem, do you agree?

POEM: Yes.

[TRIUMPHANT MUSIC PLAYING]

MOLLY BLOOM: You are both correct. High humidity makes windows harder to open. And salt gets moist and clumps together. So when it's more humid, that means there's more moisture in the air. And it's more likely to rain. OK, here is lore number three.

TOWN CRIER: "When March blows its horn, your barn will be filled with hay and corn."

MOLLY BLOOM: OK, so does this describe number one, hay and corn grows better when serenaded by trumpets, number two, if March is windy, you better fill your barn with hay and corn to keep it from blowing over, or three, if March is full of thunderstorms, your crops will do well? So that's number one, hay and corn like to hear trumpets, number two, if it's windy, you need to keep your barn from falling over, or three, thunderstorms means your crops are going to do well. Poem, what do you think?

POEM: I think it's number three.

MOLLY BLOOM: Honor, what do you think?

HONOR: Sure, I don't know.

[TRIUMPHANT MUSIC PLAYING]

MOLLY BLOOM: You are right. It is number three. So thunderstorms happen when there's big temperature differences between the sky and the ground. So that means if it's unusually warm in March, it could mean a better growing season. Very nice work, Honor and Poem.

TOWN CRIER: Good morrow to you.

[TRUMPETS PLAYING]

MOLLY BLOOM: So as we've talked about, before people had weather apps where they could see a 10 day forecast, they looked to nature for signs of what the weather would bring.

HONOR: We wanted to learn more about what looking at plants and animals can still tell us about weather and climate.

POEM: So we asked Theresa Crimmins to join us.

MOLLY BLOOM: She's an ecologist and the director of the USA Phenology Network.

HONOR: Welcome, Theresa.

THERESA Thank you so much.

CRIMMINS:

HONOR: What is phenology?

THERESA Phenology is all about when things happen seasonally in nature. It refers to not only the leaves coming out on trees, but it's when those things happen-- things like when flowers open, when birds migrate, when insects hatch from their insect eggs. So it has to do with when those things happen, because it happens at different times in different states or different parts of the world. And also, it can vary from year to year.

HONOR: So what kind of behaviors and patterns do you look for?

THERESA So on the most basic level, we are keeping track of when things are happening all year long, ideally all across the country. And so we run a program called Nature's Notebook that anybody can participate in. And how that works is you go out into your backyard, say, or your front yard, and you choose a couple of plants that you're interested in keeping track of. And you can keep track of animals as well.

And what you do is multiple times over the course of the year, like maybe once a week or every couple of weeks, you'll go out and look at those plants and look for those animals. And if you see them, then you write down what you see. And you indicate whether you do see open flowers or ripe fruits, or whether the seeds are blowing around, or whether those animals have babies with them. And we're able to analyze those data to be able to understand how things are changing and what's happening in a given year.

POEM: Do you just try and figure out when it's going to happen? Or do you also try and figure out how they're doing things?

THERESA Yes, both, because if we can figure out how-- the "how" is really what are the conditions that are associated with that thing happening. So for example, if we think about, say, lilacs, what is it that actually will push a lilac to finally open its flowers? Researchers have identified that generally it has a lot to do with how warm it is. And it's a certain amount of warmth that we have to have that plant be exposed to to trigger its opening its flowers.

And once we're able to figure that out and say it has to be exactly this warm for this many days in a row and then that plant will flower, that is information that we can use to predict or forecast into the future when it might flower in other years or in other locations. And so we actually have several forecasts that you can view on our website that show you when things might happen, like when lilacs might flower or when different insect pests might be active.

There's a common one called Eastern tent caterpillar that you might be familiar with. They are little caterpillars that make really big-- they look like spider webby nests, kind of in the crotches of branches of trees. And they can eat the leaves of the trees that you want to keep. And so people generally tend to think of them as not their favorite species.

And we make maps that help predict when those guys are going to be out and about. So then if you're interested in trying to control them, then you can anticipate when they are going to be out and crawling and try to take action and maybe capture them.

POEM: So what can we learn from phenology?

THERESA Phenology is a great indicator for when things are happening and how things are changing. It's one of the best indicators that we have of how plants and animals are responding to especially changing climate conditions. And it's really valuable for figuring out and planning when to take management actions, like again, if you want to control for those Eastern tent caterpillars or other pest insects, or even when to start taking your allergy medicine, because if it's an early spring like this year, you're probably going to see an early start to the allergy season, because what triggers allergies is flowers opening and pollen flying around. And that tends to happen earlier in a warm spring year. So really keeping track of these very simple events occurring in nature can affect a multitude of aspects of our lives, everyday lives.

POEM: Thanks for being here today, Theresa.

THERESA Thank you, Poem and Honor. It's been so fun to chat with you.

CRIMMINS:

[MUSIC PLAYING]

HONOR: Humans have been looking for weather patterns for thousands of years.

POEM: The invention of the thermometer and barometer helped us better predict storms.

MOLLY BLOOM: And the telegraph helped us share those early predictions far and wide.

HONOR: We can still tell a lot about weather and climate from watching nature, though. That's called phenology.

MOLLY BLOOM: That's it for this episode of *Brains On*.

POEM: *Brains On* is produced by Marc Sanchez, Sanden Totten, Menaka Wilhelm, and Molly Bloom.

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HONOR: *Brains On* is a nonprofit Public Radio podcast.

POEM: Find out how you can support the show by visiting brainson.org/fans.

HONOR: Now before we go,

POEM: It's time for our moment of--

(SINGING)

ALL: Ummmmmmmm, ummmmm, um.

POEM: If hair is dead, how does it grow?

MOLLY BLOOM: That's a really great question. While your hair itself is actually dead, the follicle from which it grows from in your scalp is alive.

ROXANA DANESHJOU: I'm Dr. Roxana Daneshjou. I am a dermatologist, which is a doctor that takes care of your skin, your hair, and your nails. A hair follicle is the part of the hair that's living. It's like the seed from which the hair grows. It's a collection of cells.

And these cells and proteins work together to sort of create the hair, which gets pushed out. By the time the hair grows out of the skin, at that point, it's just a collection of proteins. It's not really alive anymore, which is why it doesn't hurt when you cut your hair.

As hair gets pushed up through the skin, it passes by an oil gland. And this oil gland adds oil to the hair to keep it soft and is the reason that hair is shiny. But this oil also makes your hair greasy, which is why you've probably noticed that you need to wash your hair.

ALL: Um, um.

MOLLY BLOOM: The hairs on the back of my neck are standing with excitement, as I get ready to read the latest group of listeners to join the *Brain's* honor roll. These are the friends who fuel our show by sending in questions, drawings, and mystery sounds.

[LISTING HONOR ROLL]

[ELECTRONIC MUSIC PLAYING]

POEM: We'll be back soon with more answers to your questions.

HONOR: Thanks for listening.