JOHN HOREL

Salt Lake City, Utah

An Interview by

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THIS IS AN INTERVIEW WITH JOHN HOREL ON OCTOBER 25, 2013. THE INTERVIEWER IS BECKY B. LLOYD. THIS IS THE GREAT SALT LAKE ORAL HISTORY PROJECT. TAPE No. u-3238.

BBL: This is an interview with John Horel at his office on the University of Utah campus. Today's date is October 25, 2013. This is part of the Great Salt Lake Oral History Project that is supported by the Utah Humanities Council and the Utah History Association. My name is Becky Lloyd.

John, I want to just start by getting some background information about you personally. Why don't you tell me when and where you were born?

JH: I was born in Eureka, California, which is almost in Oregon. So it was October 17, 1955.

BBL: You had a birthday a short time ago.

JH: Yeah.

BBL: What was your family doing in Eureka?

JH: Well, several generations there. On my mother's side they were pre the Oklahoma migration, so they moved out from Oklahoma in the early '20s rather than in the '30s. So it wasn't the dust bowl era, but it was kind of similar economic issues. Eureka was a big logging area, so most of that is in redwood forests and all that sort of thing. So my grandfather on the maternal side was a barber and was until over the age of 100. Pretty scary dealing with the grandkids with, "Just give them a trim. Just give them a trim, Papa" (laughs).

On my dad's side, my grandfather, who passed away before I was born, worked in the logging industry. My parents owned a second-hand and antique store. So I spent most of my youth ruining peoples' fortunes if they ever watch the Antiques Road Show,

because I stripped the finish off furniture (laughs). So whenever they talk about that rich patina of old wood, I took that stuff off (laughs).

BBL: So you grew up your entire time in Eureka?

JH: Yes.

BBL: And where did you go to college?

JH: I started at Humboldt State, which is close by, and then went to San Jose State to finish my undergrad requirements. I went to graduate school at University of Washington. Then was hired as an assistant research professor at Scripps Institute of Oceanography. I came here in 1986. The primary driver as to where to live was my wife's decision—she drew a circle as far as the distance from Eureka that we could go. So this is as far east (laughs); Seattle in the north, San Diego in the south, Salt Lake on the east. That was as far as we could get away from Eureka. Plus the housing costs. We could buy a house here for less than what our rent was in San Diego at the time.

BBL: That's interesting. How did your interest in meteorology develop?

JH: Well, it wasn't anything planned, so I use this story for our students. In meteorology and atmospheric science, the largest fraction of students know from the time that they were five years old that they wanted to be the weather guy. Students who have grown up watching the weather channel, they're exposed to a lot of that. I didn't have that. It was entirely when I was transferring from Humboldt State to San Jose State that I showed up to look at the school in August. I'd arranged an appointment in the physics department to go and talk to an advisor and the advisor stood me up. So I'm looking through the catalog for what's another major that kind of matches the prerequisites that I already had. Meteorology. Didn't know what it was. So went in, sat down, and talked to

the department chair at the time. He looked at my transcript, "Sure, we'd love to have you." So I started taking classes. There always is a fraction of people who fall into the field versus the ones who know what they want to do from knee high. And I'm one of the ones who fell into it and has enjoyed it.

My graduate level research was in climate variability. So I did a lot with El Nino and the Southern Oscillation. That's what got me my position at Scripps. I kind of skipped over doing a postdoc. And that's what got me my position here at Utah as I was going to do short-term climate variability stuff. But, I really have a relatively short attention span. When you're dealing with things that change from one year to the next, you can make all kinds of hypotheses as you wait for the next big event that's going to happen in three or four years. So when I came here to Utah, there was just so many other research topics that didn't require me to wait three or four years to see when the next El Nino was going to happen that my scale of research has gone from this very large planetary scale down to scales of individual valleys, the Great Salt Lake, mountains and those kind of things. There's just a lot of different kind of research issues here in the Intermountain region relative to worrying about climate variability. Although I still do some of that type of research.

BBL: That's good. So when you came here to Utah, or before you came when you were looking at coming, was the fact that there was the Great Salt Lake here as something to study, was that a real draw or was that something you sort of discovered after you got here?

JH: Had no interest or anything at all related (laughs) to the Great Salt Lake. When I first came to Salt Lake City, what do people want to do? They want to go out and see the

Great Salt Lake. Well, that wasn't really high on my priority list (laughs), to take people to the Great Salt Lake because it's one of the oddities of the Great Salt Lake that the locations where the public interfaces with the Lake really aren't very attractive much of the time. So the south shore of the Great Salt Lake, you're driving along I-80 and you get this awful smell and you have the flies. You go out to Antelope Island, you know, the beach is nice except when you're there when the brine flies are just swarming everywhere. So it really wasn't until I was doing the research that I could start to appreciate the beauty of the Lake once you get away from the immediate south shore or the north shore of Antelope Island that there really are a lot of pretty places around the Lake (laughs) and being out on the Lake that you would just go, "Oh, it doesn't really stink all the time; it's not the Lake that stinks" (laughs).

BBL: So maybe we could move to some of your personal experiences on the Lake. And you told me before we started that you haven't spent a ton of time out there, but I'd be interested to know the times that you have spent out there and your experiences.

JH: Well, really, again, as the focus of my research changed to more regional issues, the biggest issue was that we didn't have a way to do research in atmospheric science as there were just a whole bunch of disconnected networks of surface observations around the area. Things like the State Department of Air Quality and the State Department of Transportation and the Weather Service. And this wasn't anything new.

At the same time in Oklahoma they were starting up what is now considered the gold standard of mesonets, the Oklahoma Mesonet, where they basically put a weather station out in every county and have quite a bit of infrastructure associated with it. Basically, they were able to sell it on a state level because of the importance of weather

information for agriculture. So that was a lot of the initial driver for the Oklahoma Mesonet.

So in the early '90s, after I'd been here for about six or seven years, well, okay, we can create the Utah Mesonet. But our approach was different. Instead of trying to find somebody to fund putting out weather stations every place, it was to take advantage of all the data that was already being collected, but just that nobody was bringing it into one location. So that's when, if you looked at a map of the state and you looked at where all the observations were, the one place that was clearly lacking was out over the Great Salt Lake. And with our collaborations with the National Weather Service, for them to improve their forecasting they needed to know what the conditions were upstream of Salt Lake City. So it was a natural to put weather equipment out on the Great Salt Lake. But, again, it's very inaccessible.

It really wasn't until one of the folks with the Department of Natural Resources, Paul Birdsey, came to us and said he had money to put weather equipment out near the Great Salt Lake, but he didn't know anything about how to do it. So we collaborated on putting weather stations out at both Hat Island and Gunnison Island, and I think this was in 1998. At that time, the National Weather Service had already invested in radio communication that made it practical to put stations out over the Great Salt Lake and to be able to communicate with them remotely from a location up on Promontory Point. That was the first real connections with the Great Salt Lake for me, just to get that equipment installed out on the islands. At that time, both of them were islands; now Hat is just now part of the salt playa rather than an island.

We always described visiting the islands as sort of the Gilligan's Island three hour tour because you can only go out to these islands during very narrow windows of opportunity because Hat Island is a seagull rookery and Gunnison Island is a pelican rookery. In the years when we first started going out to Hat, and it's seagulls, they're not very attractive, clean birds, so the island is not exactly an attractive location. On the other hand, Gunnison is just this gorgeous location in the north part of the Lake—south part, Gilbert Bay; north part, Gunnison—and it's still surrounded by water now. The pelicans are cool because they're there nesting and then they have to fly off all the way to Locomotive Springs or out to the Bear River Refuge in order to get fresh water and food for all the little baby birds. But we're restricted when we go, especially to Gunnison—you can only land at a particular location not to disturb the birds. We can only go out in a certain timeframe when they're not nesting. Then we only go up to where the weather station is.

When we first were sighting the weather station there—and I'll show you pictures of them outside there—when we first were sighting it, you want a location which is at a high point. So we climb up to the southeastern corner of the island which is not used by the pelicans. So we're setting up the weather station using a galvanized steel tripod. Then there's a rain gauge that we attach and we usually attach it to a post. We're looking around and right near where we're putting up this weather station there's this post with this pile of rocks. It's a four-by-four. We're, *huh, should we do our own or should we…heck, this one's here*? Then fortunately, we decided not to touch that pile of rocks or that four-by-four post and we put our stuff off to the side. When I was doing a presentation a couple of years later for people interested in the Lake, describing this post,

there was an audible gasp. Somebody came up afterwards, "You don't know what that post was?" "No." "Well, that's the original survey marker of Captain Stansbury (laughs) back in 1848 or whatever. Since then, we don't touch that one (laughs). But all our pictures, you can see the survey marker next to where the weather station is and it's for the same purpose: they needed to get up there in order to finish the survey of the Salt Lake at that time.

When I give talks on the Great Salt Lake about the weather, the Captain Stansbury led expedition are the first weather observations out over the Great Salt Lake. We're fortunate because the Department of Natural Resources allows us to piggyback on when they're going out to survey for getting a sense of what the conditions are on the Lake as far as brine shrimp productivity. So they literally drop us off and then they *will* come back in three hours (laughs). So you can imagine them [Stansbury's group] out there in their row boats and they describe… (we go out there on days when it's very, very placid) and they're describing being out there in the middle of a cold front coming across the Lake. If you had a row boat, it wouldn't take you that long to row from Gunnison back to the shoreline, but they describe how it took them a half a day because they're fighting and bailing and doing everything they can in order to not die out there.

Gunnison is still surrounded by water, so it's still isolated, but Hat is now exposed and on part of the playa. That means we're fortunate again with the Department of Natural Resources people that they go out with us on ATVs when we have to go out and work on the station. So that is a little bit simpler, but it's still, you're going way out there.

It's been interesting, and this is way outside my area of expertise, but for many, many years, we have solar panels to charge the weathers stations. And even though it's

seagulls, they really never messed with the weather station. But all of a sudden a couple of years ago, after the Lake had been down enough and the Lake had been exposed that it became apparent that the ecology of Hat Island has changed because now there's raptors that are sitting on our weather station doing their business, watching for little critters and things around there.

Hat, when we first put the weather station out there, we'd leave from the marina at Antelope Island and go across the Lake. For Gunnison, it's a little bit different because you have to get on the north arm of the Great Salt Lake. For the first couple of times we were able, actually, to go through the causeway because the water level was so high and actually it was like a river coming from the south arm into the north arm. But now there's a boat launch ramp on the north end, just to the side of the causeway on Promontory and that's still accessible and deep enough to be able to get out there.

During one of the first years visiting Hat, there were still plenty of seagulls on the island. So we pull the boat around and then the Natural Resources people drop us off and they're going to go off and do their thing. As they're pulling the boat out, here's this little Cessna plane flying over the island. There isn't a whole lot of action out on the Great Salt Lake, so the pilot is bored and he decides to circle around and see what this boat's doing out near Hat Island. So as he comes around, he comes around and makes a circle and then he's going to be friendly, so he tips his wings and he toots his horn. Well, you have a thousand seagulls on an island and they don't hear noises like the toot-toot of a Cessna, so they're startled and they take off and they let fly (laughs). We're kind of ducking. Amazingly enough, nobody got hit (laughs).

I have to say, my students now get to share the joy of experiencing Hat Island (laughs). I hate to turn down trips to Gunnison. I actually didn't go to Gunnison this year either, but Gunnison I like to visit. Hat, it brings back bad memories (laughs).

In addition to that, we have other stations around the Lake that are not as remote. One of them is at the extreme northern end of the Lake at what we refer to as Locomotive Springs, even though it's not actually at the springs. There's a very small company that's leased land to extract salts out in that area. But compared to Morton Salt, this is a very small operation. They only have a couple of acres of facility there. When we put the weather station out there in the late '90s, the weather station was right next to the Lake. Now, you can't even see the water at that location. In order for them to continue to pump the lake water into their ponds, they have one person on staff whose job is basically to continually dredge out this trench which now extends several miles long in order to still have water come all the way up to where they can pump it out to the ponds.

Then we have another station that's out on the Hill Air Force Base test range. That one is remote as well as difficult just in terms of the security access in order to be out there.

But, Gunnison is probably one of the most remote spots in the country to have weather observations from because just the accessibility of it is so difficult. But, that information is used then year round for protection of life and property by the Weather Service. They can see when the storms are coming through and what the changes in conditions are as they come over the Lake, which becomes really important.

BBL: That's interesting. Is the weather station on the west side of the Lake on the Hill Air Force Base property, is that pretty far out onto their bombing range?

JH: It's actually on the first range as you come off of the playa. So it's on their eastern boundary, but it's a very active area. So we have to time when when they're not doing some testing at that location.

At various times, there have been field projects that have been related to the Great Salt Lake. The first one that Jim Steenburgh in our department was the lead PI for was called the Intermountain Precipitation Experiment in 2000. For that, in addition to the permanent sites, we went out and deployed additional temporary weather stations as well. So we had one at Rozel Point, near the Spiral Jetty. And we had ones on the west side, way up on the shore side of Gunnison Island. The idea there was to get the first real look at lake effect snowstorms. In the late '90s was when the Weather Service installed the Doppler radar that's at the point on Promontory, which is the primary tool to be able to look at lake effect snow bands and those kind of things. Prior to that and prior to us having any observations out over the Lake, all you had was satellite imagery in order to be able to see what was approaching Salt Lake City. So the radar has had a significant impact in terms of improvement on forecasting in the Wasatch Front area.

BBL: That leads us, time wise anyway, to the 2002 Olympics and you were really involved in the weather forecasting efforts there. Do you want to talk about that some?

JH: Yeah. So, that field project was intended to lead up to the Olympics. Larry Dunn, who's the meteorologist in charge at the Salt Lake City forecast office, he had participated in the weather support for the Atlanta Games, the Summer Games. So that was one of the first times where they were trying to use new technologies for a sporting event like that, for weather prediction. The Doppler radars were just being deployed. The models were getting better. Now it's become almost an industry standard that when you

have an Olympics, then the research community comes out to trot out all their fancy toys because they will get a lot of visibility. So there's kind of a parallel track. There's what you need to improve the operations for the weather support for an Olympics, and then there's all the fun research stuff. Atlanta was sort of the first one that had that.

Larry had, working at the forecast office, much more interest in the operational support aspects of this. I have to admit, I thought there was going to be a lot more fun stuff associated with the Olympics, and actually we did do a lot of novel things. But the approach was a little bit different. We didn't have a whole lot of researchers come in for the Olympics because at that time there was a lot of pressure on who should handle the weather support for a sporting event like that. There was a creative tension in our field at that time between weather information that's provided by the government versus weather information that's provided by the private sector. So for the weather support for the Olympics here was a unique partnership where there was actually forecasters that were from the private sector, as well as government forecasters. So in the Atlanta case it was all government, it was all National Weather Service. Salt Lake City was much more of a blend between the two.

Mark Eubank who'd been on air for many, many years and a team of meteorologists provided private weather support for the Olympics. They had forecasters at each venue, which was also unique. Then the mission of the weather service, the government side, was to provide the basic protection of life and property—larger scale issues. The very specific sort of forecast requirements that are needed: Are you going to run a downhill ski event right now? Are the conditions right for that? That would be handled by a private forecaster. Then the needs of: Is this storm going to come in and

cause a major logjam as everybody's trying to get to the Olympics? That was the National Weather Service.

Then we were the research component and the infrastructure component. Jim Steenburgh and I were the University part of it. So Jim was dealing with: How do you improve models, simulations that can be used for operational forecasting for the Olympics on a very fine scale? We did a lot more installation of sensors and would put them out at the venues so that they would have weather information at each of the venues. That was kind of the impetus as well for putting stations out around the Lake in order to get more information on the upstream conditions.

I figured that if you put out all this weather equipment, then you'd be able to watch the Olympic events. I spent the most time at the cross country venue out at Soldier Hollow. If you visit Soldier Hollow now it's a gorgeous facility, golf courses and cross country ski trails. At that time, it was just cow pasture, muddy cow pasture. The person in charge of designing the course was into weather information, John Aalberg. He went on from the Salt Lake Olympics to design the course for the Vancouver Olympics and I think he had a hand in Russia, too. We spent a lot of time hauling weather stations around and putting them in different, muddy spots as they would change their design of (laughs) where the layout of the course was.

But then, 9/11 happened right before the Olympics, and that changed the security framework. Prior to that time, I thought, *cool! I'm going to be able to stand by my weather station and watch all the cross country athletes go by because I need to make sure that that weather station's really working.* Uh, no! (laughs). We had one contract employee, Dan Judd, who's done a lot of our installations and he has his own company

and has worked with the ski industry for years and years. He was the only one that went to the venues to have to deal with any of the weather equipment and many squirrely things happened. He would drive up and have the dogs sniff his truck and security people verify what's coming in and going out. So my only connection to the actual games was buying tickets just like everybody else (laughs). And given how expensive they were, we only went to a couple of them (laughs).

What we had to do here in this office complex, we had to have an operations center for all the weather information to make sure that all the data was flowing and the models were running. We had students have most of those lovely midnight to 8AM shifts. And Tom Potter, who used to be part of our mountain meteorology group, was actually the lead spokesperson for the weather support activities. He was former director of western region of the National Weather Service, but he also had a lot of ties in the commercial sector. He was a really good person to lead the Olympic weather support efforts.

We were fortunate in the sense that weather really was a nonissue for the Olympics. Our biggest wintertime problems in terms of wintertime, air quality. The air quality stunk up until the day before the Olympics. I mean, it would have been a horrendous disaster…NBC would have gone through the roof if it had been like a couple of the winters that we've had recently.

A lot of what we were trying to do was get Olympic staff aware of what the weather conditions could be like, you know, strong down slope windstorms and what the impact of that would be. We couldn't talk them out of building a park and ride lot in the worst possible location you could imagine, which is at that mouth of Weber canyon. In

that case, if we had had a down slope windstorm, you'd have had 10,000 people on their way up to Snowbasin getting dumped off, parking their car and waiting for a bus in sub-freezing conditions and the wind's blowing fifty miles an hour. Not a very bright decision. But, they managed to luck out on things like that. So we always felt kind of fortunate.

And one of the main weather stories for the Olympics was actually Closing Ceremony, because there were thunderstorms that came through and lightning could have been a big issue. It just managed to miss the Closing Ceremony, so they didn't have to evacuate the stadium.

I didn't have tickets for Closing Ceremony. So we were here in this building and our department is also over in the Browning Building and NBC had a camera on the Browning Building roof, pointing down to the stadium. That's where you would get the shots of all the fireworks going off. And up until the last fifteen minutes, security was really tight, and then we were able to sneak up onto the roof and watch the fireworks of Closing Ceremony (laughs).

But we felt fortunate. As minor as the weather things were, it was cold, they had snow stacked up so that all the events were pretty much not impacted by weather and travel wasn't an issue.

In addition to us here on the campus, also the seismograph station group was monitoring earthquake conditions 24/7, again, hoping that there wasn't going to be an event, but they still had to be there just in case. So they were also up on the roof for the Closing Ceremony (laughs). We all got our fifteen minutes of imagining what it would be like to be in the stadium (laughs).

BBL: Then did you actually, because of the change after 9/11, did you not get to do some of the research that you had originally planned?

JH: Well, the Olympics are interesting because the organizers have control of the venue until about the week before the event, and then after that, the world changes. One of our novel things was to have a sled with an infrared sensor to measure the snow temperature along the cross country venue. We were able to do that until the week before the games. But when the Olympics happen, the organizers actually lose control of the venues to the professionals who run the event. Then all of a sudden, the rules change and there are new people in charge, so you don't goof around at that point.

BBL: Everything had to be done by then.

JH: Yeah.

BBL: I see.

JH: Actually, I had a graduate student who was a professional cross-country skier for the U.S. team and she did her master's research on measuring snow temperature at Whistler, building on what we did here. The Canadian government didn't have the pressure to not have the government running the entire weather support team and neither does Russia have the problem that the U.S. had at the time here. So they went back to the model of, *hey, if you've got cool stuff, bring it along*. They were collecting a lot more data during the Olympics for research applications than what we did during the Olympics here. Everything here was very focused on the operational, making sure everything was going to work, and that the forecasters had the tools that they needed in order to do the best forecasting that they could.

BBL: Did you enjoy that, then, at least the part that you were involved in?

JH: Oh, yeah, but it was nice when the Olympics were over (laughs). It was fun going to the few events that we saw. We dodged a bullet. Nobody was severely impacted by the weather. And you can see that with the Sochi games coming up here, weather could be as significant a factor there as it was at Whistler. They had very warm, wet conditions and not a lot of snow and a lot of cancelled events and that creates a lot of stress.

BBL: Right. I thought maybe you could take credit for that nice storm that came through right before the opening and cleared everything out, and put a nice layer of snow down.

JH: Uh, no (laughs).

BBL: That wasn't you (laughs).

JH: (laughs) Never take credit nor blame for weather. It doesn't do you any good.

BBL: I wanted to ask more about the MesoWest. You started talking about that and some of the stations that you put out.

JH: Well, MesoWest, we manage ten stations that we own. Again, that's…

BBL: We, meaning this department?

JH: Yeah.

BBL: Okay.

JH: And even a lot of that, again, is equipment that somebody else may purchase and we're just handling the communication or maintenance. Again that's different from the gold standard of the Oklahoma Mesonet, with now I think something like nearly a hundred stations that they're constantly dealing with all the time. But as a result of the Olympics, we've morphed from sort of the Utah Mesonet to MesoWest, rebranding it.

So meso means middle or middle scale and it refers for the atmosphere to a scale on which terrain, mountains and the Great Salt Lake start to have a real significant influence. The models at the time, back in the '90s, couldn't resolve things on the mesoscale, so that's where a lot of the research was at the time. Jim Steenburgh was one of the first running mesoscale models at that time. So mesonets, mesoscale networks, were kind of the thing to do. Our approach, was different in the sense that around here there were so many people that were deploying equipment for their own purposes that it made more sense just to collect all that information through software, rather than deploy new stations out there. But the difference is it's a very heterogeneous environment because everybody puts weather stations out for their own reasons. They put them out to monitor conditions related to fire weather, the state of the fuels that it could lead to extreme fire behavior. Air quality issues.

Because of the destruction of chemical weapons in the Tooele Valley, there still is a remnant of one of the most extensive and dense mesonets in the country because of the potential for an *oops*! When they put that chemical weapons facility out there—they also put out, it's the only place in Utah that I'm aware of that has what's common in other parts of the country, warning sirens—because if something happened they wanted to know which way the winds were blowing that would be carrying bad stuff towards the population. So you drive around Tooele County, down in Rush Valley, you'll still see the warning sirens, even though now they're done. Then, Dugway. The Army Proving Grounds has a very extensive network.

And then more and more people are just adding weather stations in their houses. So we developed software that collects all of that. Again, the focus initially was Utah and

it was a few hundred stations. But now we deal with, over the country as a whole, with something over 30,000 observing stations in the U.S. and then also Canada, Mexico and every once in a while something will pop up some place else. And it's not just weather information. It can be soil conditions and pavement conditions. We do a lot with road weather kind of applications. There's just so many diverse applications and needs for environmental information, where road weather, fire weather, air quality, hydrologic kind of things, that everybody has sort of their own standards. It becomes sort of an issue of how you take it all in. So we're taking in hundreds of tiny little feeds and then turning around and giving it to people in one pipe, so it makes it easier for other people.

Now the downside of that is people then think we own it, you know, because they get the data from us. So we'll get several emails a week of, "Hey this station is busted. How come you don't get out there and fix it?" So we have to apologize and say "I'm sorry, but we don't actually own that station, but we'll certainly pass along the information." So people become very possessive of the stations that they use for their weather information.

And there are just a lot of recreational applications. The ski areas all have weather equipment for snow making as well as again protection of people when they're there. Avalanche control and all those kind of things. The hang gliders, the paragliders down at the flight park, live and die by which way the wind's blowing and what the conditions are like. We have a station down there at the south end of the flight park because it's actually an interesting location to do research as well, because there's a lot of flow between Utah County and Salt Lake County.

BBL: So you say 30,000 different stations across the country?

JH: Yes.

BBL: You integrate that beyond just the West?

JH: Yeah. And we're actually in an exercise right now as far as how to rebrand MesoWest because originally it was focused just on, you know, went from Utah Mesonet to MesoWest, so people think it's just in the Western U.S. But it's actually nationwide because after a certain point we actually work very, very closely with many other government agencies that are doing this, that are doing all this aggregation. So we're, when I say again, our group is responsible for aggregating about 6,000 of those 30,000 stations, the other 24,000 are coming to us from somebody else who aggregates it, but doesn't necessarily make it in a convenient enough format. So it's still easier for people to get some of that data from us in many cases. So we then have software that acquires it, stores it in databases, and then makes it available for people.

BBL: So compiles it in useable form.

JH: Yes.

BBL: So you say that's something that the University owns? It's a private company now? It's a spinoff?

JH: Well, that's kind of why the rebranding part is going on. The University is collaborating with another commercial firm so we've spun off a company that will take on some of the responsibilities for dealing with the commercials aspects of this effort. But the basic mission that we have, in terms of providing weather information for safety, for education, for the public to be able to use it, that's not going to change. But in order to align it more with, for example, now, cars, you can monitor whether the windshield wipers are on and off. That's useful. You have cars going along the highway and telling

you, gee, all of a sudden, ninety-nine out of a hundred cars have their windshield wipers on. Well, now you know it's raining or something's happening in that stretch of highway. So there's a lot of work to use a lot of new novel technology for these things. So that part of it, in terms of research and development, we'll still be doing.

The commercial application is, for example, a trucking firm. They want to know, *okay, do I need to reroute my trucks around an area where there are storms?* This has been used in the airline industry for years. You're flying along and all of a sudden they say, *well, we have to go around this stuff.* The same…before, truckers just plowed through whatever was happening. Now there are commercial companies that are providing them information on, *hey, stay off I-80 right now. Take a different route that will be better for you over the next two days*.

BBL: Yeah. So there are parts of it that are available for free access, but what you're trying to develop now is the commercial part where you can actually make some money on it?

JH: Yes.

BBL: Okay. That's interesting. Will you be involved in that too?

JH: Yes.

BBL: That's good.

All right. I wonder if we can talk, then, some about the specific research you've done related to Great Salt Lake. A couple of the papers that you sent me, one was dealing with the surface water temperature and another was talking about sea breezes. It sounds like there is some connection between that. Maybe you could talk about that research as it relates to the Great Salt Lake and the impact it has locally.

JH: Yeah. It's convenient when we have a number of faculty and researchers to take problems and slice them into different areas. So I deal with dry weather and Jim Steenburgh deals with wet weather. Jim is an avid skier. He'll be having a book coming out on Utah weather. So he's done a lot of research on lake effect snowstorms. One of the things that's associated with getting a lake effect snowstorm is knowing the difference between the lake temperature and then the conditions aloft. So there's always a need for the lake temperature information for that aspect of it.

The dry side of it is things where we're not dealing with precipitation processes. So those typically revolve around air quality issues more than storm kind of issues. So for that, that's where the Great Salt Lake has a very distinctive lake breeze, which is very similar to sea breezes; it's just a matter of scale. So just the amount of water mass that's associated with the Great Salt Lake. It's still a substantive body of water, you know, eighty plus miles long and twenty-plus miles wide when you think about where the core of the deep water is. So that's enough to create thermal contrasts between the lake water and then the surrounding terrain. The thing that makes it interesting here is then you also have all the mountains. Mountains also induce these kind of thermal contrasts. Typically the mountains are going to cool off faster at night and then the cold air drains down into the valley. So even if the Lake weren't there, we would still see a lot of the same behavior, the changing of the winds every day.

Normally in the morning, the winds are blowing down the Salt Lake Valley from the south to the north out towards the Lake. Some of that is just due to the terrain and then part of it is also due to the Lake because the lake at night will be warmer than the surrounding land because the heat capacity of the water means it's storing energy from

the sun that's collected during the day and it doesn't lose it as fast as the land surface does. So the land cools off once the sun sets. Here in the fall, this is when we get these really well-developed kind of periods and then again in the spring as well because as the length of day shortens, you get a lot more cooling of the land surface relative to the ocean. We get pretty strong lake breezes here in the afternoon. So what that causes is, because all of a sudden then in the afternoon the land heats up and the Lake pretty much stays the same temperature, that drives the wind the other direction; it's going to where the heat is. So you have a reversal in the wind direction.

In the mornings, the pollution is kind of vented out of the valley out towards the Lake. In the fall, like right now, normally you'll see this thin layer of nitrous oxide pollution, so it's a brownish haze in the Salt Lake Valley and you look out over the Lake and you say, "Whoa, it looks a lot darker and thicker out there." Well, part of that is because you're transporting a lot of that pollution out over the Lake. Then during the afternoon, the ground heats up and the thickness of our boundary layer, the air in which the pollution is trapped, deepens, and you won't see all that brown. It will turn into more of a milky white color and part of that is optics and part of that is just how some of the photochemistry is going on. A lot of that pollution that was out over the Lake now may come back. So there's some really interesting, unfortunately for the people living here, complex ways in which the air pollution is transported as a function of what the lake temperature is relative to the land temperature.

The research that Eric Crossman did as a PhD student, and now he's a postdoc here, was the first long-term look at using satellite estimates of lake temperature. Wally Gwynn and the group from the Utah Geologic Survey, USGS, and Paul Birdsey and Jim

Van Leeuwen from the Department of Natural Resources, they've been collecting profiles of data at particular locations around the Lake, but nobody really had a sense of the overall distribution of lake temperature. For the atmosphere, it's the integration of the entire Lake that becomes the important issue, not necessarily what is happening at a point. Using remote sensing provides a way to see what's happening all over.

On one level, the Lake isn't that complicated, because it's a closed body, it's not like the ocean where you have huge currents going all over the globe, but the Lake still has a lot of peculiarities. You have the causeway, so you have a difference in salinity between the north arm and the south arm and that affects the heat capacity of the water itself, so the temperature structure is going to be different in the north arm versus the south arm. When we have good spring runoff that brings a lot of fresh water in through the Bear River area. And fresh water, because it's lighter than the salt water, will float out onto the surface of the salt water. If you then have intense heating, just a few days with clear skies, that fresh water can get really hot really quick, much more than the salt water will. So you get these thin lenses of really sharp warm temperatures, and then the fresh water will cool off a little bit more at night. So there's interesting diurnal patterns in the temperature over the Lake.

Then there's interesting structures in the temperature with depth. When the Lake was deeper, and a lot of the research that the USGS and UGS did back at the height of the peak of the water level in the '80s, showed just these really interesting profiles of this deep, dense saline water down at the bottom that would have a completely different temperature structure than what's closer to the surface. The atmosphere doesn't know anything about that deep water until it actually gets mixed up to the surface.

For lake effect storms, there's an asymmetry in sort of their distribution with time of year in that we get more lake effect storms in the fall and in the spring because, again, of that strong contrast in water temperature that the storms come over. The hypothesis has been that basically the fall ones tend to be a little bit more energetic. In the spring the surface layer may be really warm, again because you've got fresh water sitting on top. The sun is just heating a thin layer near the top and the rest of the water down below is cold. So when you're dealing with a lake effect storm, that means there's wind and it's going to stir up all that water. Even if we look at a satellite image right before a lake effect snow storm in the spring, the water temperature of that could be completely erroneous because once the wind starts blowing you're going to get those cold temperatures from down below. But in the fall, the temperatures are more isothermal, meaning that it's constant temperature with depth. So it doesn't really matter how fast the wind is blowing, you're just going to be stirring up the temperature at the same, at roughly the same temperature. So that's why the lake temperature ends up being important for both lake effect storms and air quality. And that's why these are still things that are active research areas, because we don't really understand it completely.

And as the lake level changes, then that changes a lot of the ways that the atmosphere interacts with the Lake as well. So that's where models come into it because then you can do "what if" things. What happens if you took out the Lake? What would the wind patterns be like? We have other researchers in our department, Court Strong, who's looking at the hydrologic balance of the entire Lake area and trying to get a sense of how future climate could be changed. As we look at climate scenarios, how could that

affect the Lake and how changes in the Lake could affect the atmosphere on longer scales as well?

BBL: That's interesting. So you said that even if the Lake weren't here, we still have mountain winds that really affect us. But would we notice a difference if the Lake weren't here? Would there be a huge difference in our weather?

JH: Oh, yeah. This is work that Jim Steenburgh and his students have spent a lot of time doing, trying to categorize what fraction of, say, snowstorms in the ski areas of Big and Little Cottonwood Canyon, what's the role of the Lake. And the impact of the Lake on specific snowstorms is a little boost kind of thing. You still have to have the conditions to have a good storm. Then it's the vagaries of the wind patterns and just the structure of it depends on who gets it and who doesn't. On an integrated basis, the impact of the Lake in terms of lake effect storms is not huge; it's a ten-fifteen percent increase in total water. You can argue about the numbers. So it's not like if the Lake weren't here, it wouldn't ever snow in Alta; that's not the issue. But it does have an impact on that.

And the wind, in the afternoon when the lake breeze comes through, again it's a moderating impact in the sense that it cuts down the temperatures, instead of continuing to climb late in the afternoon. Again, the hang gliders like it because there will be a pulse of strong wind that will go down to the south end of the Salt Lake Valley and beyond. So it has a variety of impacts. Typically in the summertime, air coming out from off of the Lake will be cleaner than what we have in the valley, so it also will help to reduce air pollution. At other times of year, that isn't necessarily the case because again you could have stockpiled particulates and things out over the Lake. This time of year, October, again, when you look out there, you can see that continue into the afternoon, where you'll

see the brown nitrous oxide layer continuing over the Lake when it's vented here in the valley. So that stuff is bringing in higher pollution.

BBL: Kind of looking at the future and maybe some changes, one thing that Wally Gwynn mentioned is a push to maybe draw more fresh water from the tributaries that feed into the Great Salt Lake. That was something that was really concerning to him. Because you talked about the influence of fresh water on the Lake in terms of the surface water temperature, would that concern you to see less fresh water coming in?

JH: Well, yes, on the simplest scale, the lake level of the Great Salt Lake is just kind of a canary signal of our whole regional climate system because the lake level's responding to what is the total precipitation in the basin minus evaporation from the Lake. So more precipitation, more fresh water inflow; less precipitation into the basin, less fresh water inflow. Then you throw people into the mix, and that's, I think what Wally's getting at, is you have the potential of climate variability that could affect how much total precipitation there is. But then you have the changes in allocations in usage of fresh water. To what extent do you value making sure that a certain amount of flow makes it into the Great Salt Lake? There's a diverse ecological community in the Great Salt Lake, even though on the simplest levels, as a non-ecologist, it sounds simple. Then you talk to them and you realize it's a lot more complicated (laughs). We have all the bird populations that are controlled by this as well.

So there are great issues from an atmospheric science standpoint as well. As the lake level drops, then you expose more of the salt playa and the salt playa can contain a lot of hazardous materials, mercury, arsenic and these things. And as the playas dry up, then all that gets blown around and people start to see increased levels of hazardous

chemicals. So there are some real serious issues as far as the lake level dropping. The one thing at this point is that as our climate models try to deal with how climate changes on the macro scale, on the global scale, how is that going to influence the precipitation balance on a scale of the Great Salt Lake basis? We don't have that level of certainty. So we know globally temperatures are rising; there's no question of that. We know that interior land areas, like the Intermountain West, are going to heat up more than coastal areas, so the impact on our area is going to be substantive. That doesn't mean that it's going to stop snowing at Alta, but what it means is that the level at which the rain/snow line is in an average storm could change to the point where you see more precipitation falling as rain and less as snow. That has a significant impact on the hydrologic reservoir system that's been built up, which is focused on you're using the snowpack to hold all of this water. Then you fill up your reservoirs in the spring and then you discharge it through the rest of the growing season. When you start moving more into a rain pattern, the reservoirs can't sustain that. You have to let more of that water go, so you have less capacity to hold the water. We don't know whether the precipitation is going to go up or down here, necessarily. But even if it were to go up, that's not necessarily a bonus if it ends up coming in inopportune times when you can't really use the water. That, in some respects, is good for the Lake because anytime there's excess, then it's not going to be gobbled up and stored in reservoirs and released to somebody else. It's just going to end up going into the Lake. So it's not simple—if this happens, then you know this is going to happen with the Lake. Because of economic policies, usage of water, and just the growing population and the increased needs for water, we don't have enough water naturally coming in the Salt Lake basin to sustain the population. That's why the Central

Utah Project imports water in from the Green River drainage. So all of those things factor into it.

BBL: Right. A lot of variables.

One issue that comes up that I've read about is the Snake Valley water and the push by Las Vegas to get that water brought down to them. There was a lot of opposition here in Salt Lake Valley saying that that would increase the amount of dust blowing through our valley and that would have an impact on the weather, ultimately, and possibly the snow in the mountains.

JH: And, again, Jim Steenburgh has been more involved in that. We had a faculty member in geography, Tom Painter, who kind of energized a lot of the people around here for looking at the dust on snow issue and there's still quite a bit of that research going on. If you look at dust events, they are very episodic, typically late spring. You've got to get the soils dried out enough in order to loft the soils. It really boils down to a relatively small number of kinds of soil types that are the type that can cause dust storms, they just really get picked up and lofted and carried a long way. Unfortunately, we're downstream of a lot of those kinds of sources, so you definitely don't want to be adding any more sources to those, in those kinds of situations.

The Milford fire that got out of hand a number of years ago, and then the land use policies after that to try to mitigate that event, the regrowth and chewing up the soil, they've created something that's going to affect us every time it blows. You drive down along I-15 and you look out there and you can see the plumes coming off of that area. So it's a serious issue. I'm not an expert on ground water, but it doesn't really take a whole lot of common sense to recognize it's probably not a good idea to take a desert

environment and export what little water you have to another area. So the dust is just going to be part of the issues that fall out of that if it ever happens.

BBL: Well, I think I'm coming to a close here. I just wanted to ask you, if you can—it's far-fetched and you may say "I'm not even going to answer this,"—but is there some kind of pattern in the history in the Great Salt Lake where you can tell us when there's going to be another series of high water years?

JH: I've described my research career when I dealt with things on long term climate variations, I don't really do a lot of that research myself. We have people in our department that are really into that, Court Strong. There are these recognizable long-term climate fluctuations like the Pacific Decadal Oscillation. There's a group of researchers up at Utah State that have looked at this quite a bit and even back in the '80s, a hydrologist whose now no longer at Utah State had forecast what it would be like out thirty years. I've never really gone back and looked to see how well his research verified. I deal a lot with statistics and I'm a very conservative sort of statistician in the sense that, when you have a relatively small sample size of events, it becomes a little easier to make pronouncements and then people kind of lose track until that next independent event comes along and then you just fine-tune your explanation: "Oh, I forgot this!" Now you include that one. Now you've got another few years before you do that. That's why I really can't get into the Decadal stuff because I know, okay, they've only got ten of them, let's say, over the last hundred years—and it's actually less than that maybe you've only got five independent events—so you can come up with a lot of theories when you only have a small sample size in order to do it. That doesn't say that there isn't something to it.

So, yes, there are suggestions of what long-term, what could happen in the Great Basin, but I think it's just premature to attach a whole lot of credence to these because we just have a lot of unintended consequences going on. Again, it can be just water usage in the metropolitan area, those kind of things. There's a lot of tradeoffs. I have this discussion with my wife a lot as far as, well, do you cut down your water bill for your personal decrease in your water bill and xeriscape? Okay, it makes lots of sense both for you and for our society to cut back on water use. However, we're living in a non-native environment. We're living in an urban forest. Our air conditioning usage is diminished because people are overwatering and cooling off the air in the urban area. So as you xeriscape a community, and if you don't have a lot of additional large trees or something to provide shading and those kind of things, you have the potential of increasing your air conditioning costs. So these are the kind of things when you start talking about what's going to happen with the lake level, you don't know how all of these unintended consequences of the policies that we make.

There's just no question that if you take the analogy of the health of the Great Salt Lake is sort of a canary for the whole climate system of our basin, you don't really want to mess with it to the point where you change it dramatically. Having seen the difference, the lake level has dropped eight feet since I first started going out there. And it's cool to see at places like Hat Island, and ask "So, now that the water's dropped, how come I can see a road coming up to the shoreline that used to be under water?" And it was explained to me, "Oh, well, when they were doing guano extraction," because that was one of the industries back in there, "they would come, they'd drive up and haul it off" (laughs). So we go through these kind of ups and down and you just don't want to have it be a

complete down. We want to see it come up here. The Lake's a lot prettier when the water level's up higher, too (laughs).

BBL: Sure. Good answer.

So, I'm asking everybody this. When you've been out to the lake, have you seen the Great Salt Lake monster or any other interesting phenomena that others have talked about?

JH: No. But, again, as I said, I always regret that most people can't see the way the Lake is away from the shoreline. And it goes through this really interesting seasonal change and it has an impact as well, and that is because of the brine shrimp, well, the whole ecologic cycle, because of when the sun comes up in the spring, all of a sudden you get this huge algae bloom and you get different algae in the south arm than the north arm, that's why the colors are different. So initially if you go out on the Lake in the spring, you can't see more than a couple of feet down into the water and it's kind of this algae soup kind of thing. And, you know, that's not really very attractive (laughs). But as the brine shrimp wake up, because they're in their cyst form overwintering, once they wake up and they start gobbling all of the algae, then the lake transparency increases immeasurably. When we're out there in the late summer, into the fall, it's like you're in a lake in the Uintas. You look down and you can see six, ten feet down into the water. What people expect with the Lake is that it's this nasty, sludgy kind of thing down there. It's this gorgeous mix of this fossilized brine fly, brine shrimp rock stuff that is down there, and sand. So it's really a very pretty lake once you get out there, especially if you visit it in the late summer into the fall when the water's cleared out and the brine shrimp have finished eating all they possibly can. So, yeah, I'm constantly fascinated by things

like that. I'm not a geologist, so I have to have people tell me what kind of rock this stuff is. And there's fresh water springs; you can see water bubbling up through, underneath the salt water. You can feel it as you're walking along and all of a sudden it's really cold compared to how warm the water can be. So it's just a really fascinating place.

My best story about the color of the Lake is, I come from the West, so the water's pretty clean in most lakes and you expect a lake to be blue on a sunny day. I took one of my graduate students out and I proudly took her over the hill past Golden Spike down towards Rozel Point and I said, "Look, the Lake is purple. Isn't that the coolest color?" And she said, "In Oklahoma, every one of the lakes is that color" (laughs). But it's for different reasons (laughs).

BBL: (laughs) Yeah. That's funny.

Okay. Is there anything else you'd like to include in this that I haven't asked you that you think might be important to put on?

JH: No, I think you've gotten all the anecdotes that I can think of (laughs).

BBL: This has been really great. Really interesting. I'm glad you gave me your time to do this. I'll go ahead and turn it off.

END OF INTERVIEW