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UC RISA Program

Please tell us about the UC RISA Program and your role in the program.

The RISA program stands for Regional Integrated Sciences and Assessments; it's a NOAA program; there are about 8 or 9 of these programs or projects underway and there are different combinations of states. The idea behind the RISA program is to look more intensively into what people want, how they are affected by climate, how they want information about climate to appear"...". There are many, many things that are affected by climate and weather in the United States. The typical estimate that you hear, is of the 10-12 trillion dollar economy that we have, 1 or 2 trillion of that is modified or affected by the weather and climate in some way. So, it's a pretty big financial thing; it has implications all the way across the board.

What kinds of human induced climate impacts are we already experiencing in California?

The odds are pretty good that some of the changes we are seeing have something to do with climate change. ... "We are seeing that the state as a whole has started to warm up since the early 80s, late 70s; it's warmed up about ½ degree Centigrade or 1 degree Fahrenheit. We're seeing this throughout the western states. We're seeing this warming pattern in the United States much more; much more in the western states than the eastern states; a little bit more in the north than the south; although in the west, in the southwest; the Colorado River basin seems to be the hot spot. California has several types of climate that range from the coastal to the interior to the mountain and they don't necessarily have to warm up in the same way.

(Precipitation)

If we talk about other elements of climate, like precipitation, it's far harder to access whether precipitation is changing because of climate change reasons because precipitation is so variable to begin with. California, especially southern California, has the most variable precipitation climate in the United States in the sense that one year being different from another.

How are California and other western states being affected by climate change?

...it turned out oddly enough that the western states are being affected much more than the rest of the continental United States, by the warming that we're seeing than any other part. In fact, in parts of the east there is relatively little or even no warming and in some cases even a little bit of cooling over the past 30 years or so. There's a strong asymmetry in the heating and cooling patterns in the United States; the west is being picked on for some reason... In addition, the seasons aren't being affected uniformly; spring probably has the greatest trends in temperature; winter has some; summer hasn't been doing much until just lately, about the past 10 years or so we've had a whole spate of pretty warm summers in the western states; fall has been kind of nondescript, it hasn't done much of anything, just a tiny little bit in little pockets here and there; so, there's seasonal asymmetries. We've been trying to figure out what could be behind why the western United States should be warming up more than the eastern part. There are a couple of thoughts here. One is that there are natural patterns that occur and we don't have any realizations of these, maybe one or two, that take 30 or 40 or 50 years to go through; there are natural slow oscillations in climate and we need to satisfy ourselves that, it's not something like that, that is disguised as climate change. It could be something from a naturally occurring

phenomenon; there is some possibility of that; there is some stuff that goes on in the ocean that takes 40 to 60 years to go through a cycle. Another thing is El Nino and the southern oscillation, El Nino and La Nina; California is affected by this, especially the southern part of the state. There have been changes through time where we get into regimes where we get lots of El Ninos, then we revert to lots of La Ninas. Those have different effects on the state. That can happen all by itself, without any people at all. Another thing that we're seeing when we try to explain and understand California climate, we have to look up wind and we end up looking up wind a long, long way; we've got this giant body of water out there, 7,000 miles across, and it turns out that a lot of things that go on, on the other side of the ocean, over there in Indonesia, have strong effects on what goes on along the west coast of North America. That area has been slowly warming up over the past 50 or 60 years; but it's done it in chunks, it hasn't been a straight progression. We've undergone one of these increases in the last dozen years or so where that area has gone up in temperature. There is some preliminary work being done by some of the other NOAA labs, like the one in Boulder Colorado, that are showing that when the western Pacific warms up, it has an asymmetric effect on the United States; it affects the western part more than the eastern part. There is some thought, this is not definitive, there's pretty good evidence or reason for speculation that the asymmetries in the patterns in the warming of the Pacific ocean will express themselves in North America in the United States and more specifically in California, in such a way that it isn't the whole country that warms up in a uniform way."

How is our climate in California going to be affected; will the Mediterranean climate in southern California be shifted to the north?

In terms of how climate might change, I don't think that the over all climate of California, even the Mediterranean types climate of a wet winter and a dry summer, probably won't change. It will still be wet in the winter and dry in the summer. But summer might last longer; winter might be shorter and more compact but still get precipitation, still get some snow. The idea of translating a temperature regime that's now found in let's say Bakersfield, but Bakersfield moves up to Sacramento or Willows; there's a little bit to that, it's not a bad way of visualizing it in your head; also moving up hill, moving Bakersfield up to Sequoia National Park, that's quite an altitude rise. But in effect, moving our zones uphill, that will probably happen too. So, what's found in one part of the state might be found in another part of the state..." We are going to continue to see mixed in with things that would accompany changes in climate, mixed in with those things, we're going to see the same old stuff; snow storms, wind storms. We're seeing a really good example of it in the winter of 2007-2008; there's examples all over the world of big snow storms in China, very cold temperatures that have been occurring in the Northern Hemisphere this winter; people are saying, "there's your evidence, it's not happening". I don't look at it quite that way because I feel we are going to continue to see these cold spells and outbreaks that we've seen in the past; it's just the frequency in which you see those things..." The kinds of winters and other phenomenon that we've seen in the past, aren't going to go away, they're just going to shift in the frequency with which we see them. We might see a few new things mixed in as well."

Is it true that the impacts of climate change will be most evident during summer and winter when temperatures are at their greatest extremes?

Spring has a lot of warming in the western states; fall has nearly none. It's really hard to find a climate change signature in fall. We've been trying to figure out why that might be the case. It seems to relate to the atmospheric circulation pattern that are present; the way these patterns

change through time have accentuated warming in the spring and they've counter acted it in the fall. I think we would notice changes in the extreme months, in the winter and in the summer, because they are more extreme; so when it's really hot and it gets a little bit hotter, you will notice that, if it's the hottest it's ever been. In the wintertime it's a little bit different situation because you notice the lack of things, the lack of cold, the pipes don't freeze as often, your joints don't creak quite as loud, or whatever it might be. It's easier to notice extremes in an extreme season; but that's not to say out in the natural world there aren't things taking place all year long. It could be just as much a perception issue on our part in what we are tuned to notice versus what the rest of nature is tuned to notice which is everything.

Could you talk more about why you think spring might be a critical season of concern in California?

There is a variety of things about spring; one is obviously is that it's the melt season and we have been noticing that springs have been getting warmer, the freezing level in the spring has been going up. Normally the time of maximum snow accumulation in the Sierra Nevada and in much of the west is around April 1. That has always been used as an indicator about what the conditions are like then and spells out how the rest of the year is going to be for the community that depends on water supply, be it agriculture or urban. What we've been noticing is that the time of the maximum snow pack is accumulating seems to be backing up in the year, becoming earlier in the year by a week or maybe two weeks.... "The thing that's happening in the Sierras and the mountains is the snow has to build up, the temperature has to reach freezing all the way through the depth of the snow pack; when that finally happens the runoffs starts to occur pretty rapidly; it ramps up in just a few days when a warm spell comes in. The snow sort of lets loose all around the west and in a good part of the Sierra Nevada almost all at once. You can nail this down typically to just a few days or even a single day in a year. People have come up with measures of that which are basically dates on a calendar; you take that date each year, the spring snow melt pulse and stream flow, when the streams start to come up, and you look at the date over the past 20, 30 50 years and it's been shifting earlier in the year.

Is there a relationship between the huge southern California fires that we experience last summer/fall and climate change?

Fires have complex causes and the situation in California this year and a few years ago with the other recent big fires, drought is definitely a component of that. In the western states in the last five or six years we have seen the biggest fire in history in four or five western states. In every one of those situations, where those fires occurred was among one or two of the driest periods in their history; so there is a strong correlation with drought ...” There is some possibility that some aspect of this fire situation in California in the fall of 2007 may have had a component related to climate change; but the statistics on these is such that the only way to say definitively is in retrospect; we're going to have to turn around and look at this problem in the rearview mirror from the standpoint that down the road, 5, 10, 15 years from now, and we look backward and we'll say we started to see more of this or that back then.

“One of the key issues with climate and the variability with climate is that the old variability that we're use to, the variations in climate, are not going to go away. Many of the things we're seeing fit inside the envelope of what the past brought us. When we clearly emerge from what the past brought us to some sort of new situation, I don't think is going to become very clear perhaps for some time to come for certain types of things like temperature and fire, sort of rare things.

How is sea level rise likely to affect California in the future?

There are some important issues in San Francisco with utilities, with their storm drainage system. Right now it's susceptible because the sea level has gone up and events come along like El Nino which raises the sea level for some number of months, storms come along, add on top of that sea level itself is going up as a general thing. When the combination of these things reaches the right point, you can get salt water going into system that weren't designed to receive it. The system is built right near sea level; the outlets for the storm drainage system and the treatment plant in California can get salt water going into those systems and they take a heck of a lot of work to clean them out after an event. We could be seeing these more often. There may be even a need to redo some portion of the storm drainage system in San Francisco which is an elaborate and not to mention expensive operation.

How will precipitation in California likely be affected?

I might say one other thing about the global changes in the precipitation pattern, one way of thinking of it is that to the first approximation the world will probably get somewhat wetter if the temperature warms up; the more evaporation occurring therefore that what goes up, must come down; so we get more precipitation. But it's the patterns of precipitation that matter just as much as anything else. It does appear that the places that are now wet might get wetter; the places that are now dry might get drier. There will be some shifting of patterns; places that are now wet will get a little bit drier and visa versa. These are movements of the zones of precipitation on the earth. But, by and large, California mostly lies in an area which extends a little bit north of the equator to the mid latitudes such that a change in the climate would probably expand the subtropical high pressure zone which suppresses precipitation, by and large, and it moves that zone northward. Hence we see this pattern in the United States of somewhat less precipitation in the southern half and somewhat more in the northern half as that zone shifts northward.

You have worked on the US Climate Reference Network; How do we reliably monitor climate change in the US and California?

The whole issue of monitoring is very important..." We are not going to obtain an understanding of how that world works unless we have some observations about what it's doing and that we tie to some other thoughts about why it should be doing it..." If we look at the United States, it has not had a climate observing system that was set out to detect climate change; we have sites around that were setup to watch climate in its ups and downs. "Because we have such a hodgepodge of things in the observing system in the United States, this concept of a climate reference network came up and this consists of about 120 sites, scattered around the United States. ..." We have deliberately chosen places that we feel, for the next 50 to 100 years, are going to remain unchanged in their local circumstances, nothing new within a quarter mile of the station, relatively natural surroundings, mostly of these are in National Parks or on public lands, conservation easements, areas that have been set aside where no KMarts or large parking lots are going to be built in the vicinity.

What more needs to be done to understand how climate will change both locally and globally?

"... we need better observations of what happens at different altitudes, and more elements like temperature and precipitation, but also, other things like wind, solar radiation, humidity; these have effects on industry and on the way plants grow, winds especially have effects on upwelling which is an important part of the California climate and also it has important implications for fisheries, and land fisheries like salmon that spend part of their lives inland and part out in the

ocean.” ...” Another particular thing is the coastal zone has millions of people packed right up against the coast ... “They’re as close as they can possibly get without actually living in the water. So, knowing what goes on in the thin coastal strip, which is very different climatically from just a few miles inland, the transition is really abrupt and that’s governed by things like the coastal currents and small scale things; so we have to have better understanding of that. ...” Climate change is about more than greenhouse gases; it has elements of land use, the central part of California of all the states in the United States, a part of the state that use to be brown in the summertime is now green because of irrigation. This has changed the climate of the central valley and it’s hard to disentangle that from the natural changes that are taking place. Another thing that is really vital for climate is the role of **aerosols**, these tiny particles that float around in the sky that are put out by humans, smoke stacks, tires being ground up on the freeways, and lots of other reasons. The aerosols reflect solar radiation, they are a cooling influence on the earth in general, they have some heating aspects too. They also change clouds, the brightness of clouds and the way clouds work, whether clouds produce precipitation or not. In general, pollution of these tiny aerosols causes clouds to not be as good, as efficient at producing precipitation as they were before... “I think some of the reasons why the climate forecasters have some problems with them, some errors, is probably because we don’t have aerosols accounted for correctly in spatial distribution and the magnitude for the effect that they have which can be fairly substantial actually. We don’t have good measurements of these, as good as we’d like or for as long as we’d like.

You have done research on snowfall and precipitation; where are some of the interesting findings for California?

We’ve been doing some studies on trees, the blue oaks especially in California which are really great recorders of the climate. They really pick up on precipitation very, very well; especially in the drier parts of the central valley. Quite conveniently, they grow in a nice bathtub ring between about 2-300 feet to 3-4,000 feet in a ring all the way around the central valley from the north to the south. They sit there and record the climate; some of the older ones live to be 4-600 years old. So, we’ve been able to reconstruct what the climate of the central valley has done over the winter months back to around the year 1500 or 1400 pretty faithfully. One of the things these show is that California frequently gets periods of 5, 6, 7, 8 years where it’s kind of wet and then other periods where it’s kind of dry, there are more extended wet periods and dry periods that last around 6 to 8 years. There’s another set of them that last around 15 years;” ... “these tree rings have shown us that the kinds of periods of drought in the early 80s to 90s, then we went into a wet period, then we had a drier period; we have been getting over the past quarter century to about the past 30 years, the state has had it’s wettest winter in its history, its driest winter in its history and a huge amount of variability, quite a bit more than we saw in the prior 30 years.”

Please tell us about your work at the Western Regional Climate Center (<http://www.wrcc.dri.edu/>) and the California Climate Tracker (<http://www.wrcc.dri.edu/monitor/cal-mon/index.html>).

“We’re doing a fair amount of work for the state of California specifically in helping to understand what’s going on with the climate of the state. One of the things we specialize in is observations, both the making of observations and the interpreting of observations and how they work. Putting those into some kind of digestible form that is of interest to and understandable by the public.” ... “We decided to put something together that we hoped, in relatively simple form, would show what’s going on in the state of California; we call it the California Climate Tracker.

The number one motivation for this was we're seeing all these stories in the news and everywhere else about the state warming up and climate change and we didn't see anyplace to go readily to find if it's really happening or not; where the average person could get an answer to that quite simple question. So we undertook a study, divided the state into 11 regions and did an extensive amount of work on what co-varies with what and in what seasons and how would we come up with reasons for the state....Each month we go through and update these things with nice simple colors, blue and red. It's geared towards someone that doesn't have much time to look into things; but if you want to you could spend a lot of time looking at it. Kids like this sort of stuff for class projects. Everybody is interested in the weather; that's the thing we really have going in our favor in our particular discipline."

Now that the severity of climate change is widely recognized, what new programs are being implemented?

We can talk about these numbers, like a global temperature, US temperature, even a California temperature; but what really matters and how climate change and the variability of climate are expressed is basically by what happens in your backyard. How does all this grand stuff that we think about over the whole earth translate into something that matters to you and me and going about our daily lives."...". It really takes a tangible change in things that you can see for yourself before you'll start to say maybe they really know what they're talking about. Since we're talking about a thing that has never been seen before in the history of people, that's an especially big issue; when you're forecasting something for the very first time, that people can come along and change the climate of the earth, that's a pretty wacky concept when you first encounter it. So, it needs quite a bit of proving to people that the people who are saying that know what they're talking about."

What are some of the impacts we are likely to see that people are not anticipating?

We are barely able to predict and project complicated things like the weather, which is a very complicated phenomenon; climate has even more things that cause climate to happen. There are more parts of the earth that participate; all the way from the deep oceans to the ice caps to aerosols in the high atmosphere and so forth. Everything in the kitchen sink is mixed in the climate process. ...When you have really complicated things going on, all interacting, we have to take our predictions with a grain of salt; we probably need to be expressing things in probabilistic terms rather than being definite and say, Wednesday it's going to be 37 degrees for a high temperature; we express in terms of likelihood of things happening. This is what a lot of climate prediction is about, expressing things in terms of risk and the odds of certain types of things happening. I think definitive statements are probably not the way to go. It gives us a false sense of confidence that we know more than we think we do.

How will rainfall be affected by climate change in California?

... the northern part of the state will probably become a little bit wetter over the next 30-50 years; this is using lots of models, about 15-20 of them with a number of emission scenarios,"..." Even if the over all precipitation doesn't change, we may be seeing an increased likelihood of heavier and more precipitation during the heart of winter, November, December, January, February; and then a lightening during March, April, May, June, on into the dry season in the summer, all the way to the following fall. A more concentrated wet period, with a longer dry period, is one of the things that could be in the cards. Very periodically, this could lead to more floods and droughts because these wetter periods in the wintertime with freezing levels higher, that means more rain, less snow, and that runs off quicker." ..." Right now the Sierra gets 20-25

storms a year that drop a moderate amount of precipitation, about a foot of snow, it has to be about a foot before it's even worth talking about. Imbedded within a typical year, are 3 to 5 storms that do more than their share; we had a good one in early January 2008. We need storms like that but then we need a bunch of the others to fill in all the gaps. If we get less of those storms we basically have a drought. We have to wait all the way until next year before we get a chance to get them again. Those are some of the things we are looking at, either projecting and watching to see if in fact we are starting to see the early manifestations of that kind of shift in our precipitation regime."

What can we do as individuals to address climate change?

It seems like the solutions fall more or less into two camps; we certainly need a mixed portfolio in a mutual funds sense, we don't want all our eggs in one basket; it probably won't work anyway. So there are some things that you might loosely call behavioral or attitudinal and others that you might call more technological. It's probably some combination of those; the way we view things and how we go about our own daily lives. ... "This is a kind of problem to me and it's really emblematic of the many problems we face in the world right now; they came into being bit by bit." Unless we have a bit by bit aspect to some of the solution process, they just seem too overwhelming and too big; what's little old me going to do about something like this. It has to be put into something that is tangible to an individual. ... "This problem is not going to go away; we are committed to a certain amount of things no matter what. Part of the genie can't be called back into the bottle so we are stuck with that already; there's still more of it to come. It's already in the pipeline..." I have never myself, in the past, been a great believer that we are going to get out of this issue technologically but I'm starting to think a little differently about that subject. There's bright, inventive people out there, if the incentives are put there, they will probably figure out some ways we can do certain things sort of despite ourselves, if we don't change our habits entirely, we contribute less to these problems. I think if we encourage those types of people to come into existence and do their things, through the way that we encourage the entrepreneurial spirit that makes this country work, to have a go at it; and come up with things; to elect the politicians, to use the power of the ballot box, that's something every citizen has. ... "It's a real mixed bag on what can be done about this. We have to encourage not getting too negative about it, we can't do anything, because that's a self-fulfilling prophecy."

What more should happen at the state level to address climate change?

From my own experience in dealing with all the states in the United States, California has really been pushing the whole climate change issue much more than any other state and more than the federal government.

What should California or the rest of the world be doing differently?

... Much of the world looks to the United States, especially to California where all the movies are made and television; that's their model for what they want to be like; be like Mike. So, what sort of example are we providing to the world; it's a little bit of everything right now, you can see it yourselves. We have these burgeoning countries, these huge economies that are growing up in China, in India and all around the world..." I think this is a great opportunity; it's a golden opportunity for a state like California to maybe help change the way we are viewed in the world, especially with what's been going on over the last several years with our stature in the world has really taken some hits. This is a way we have it within ourselves to make a difference to show the relationship of humans and the environment that sustains them; there's other ways of going about this, as you're building up your economy over in this country or that country,

driving way more cars, that there's a different way of doing it. We can be an example, in some ways, of what not to do and also of what to do; sort of take both ends of those lessons and apply them to other parts of the world. The state is filled with people who are very influential and have the ability to do this; it's just a matter of seeing this in yourself. I think this is every bit a possibility. "

Are you optimistic that we will act quickly and effectively enough to avoid catastrophic climate change?

The big problem with the greenhouse warming, especially something like carbon dioxide and the greenhouse gases, is once we put them in the air, they're there for at least about 100 years or so, especially carbon dioxide; methane lasts about 8 or 9 years, that's a very potent greenhouse gas. There are a bunch of greenhouse gases that constitute about one third of the effects carbon dioxide is only about two-thirds of it. The time frame that it requires, this commitment, of the climate is going to warm up from what we put in the air, it's going to keep warming up; we're basically fated to keep warming up some more even if we cut our emissions completely to zero today, entirely, it's still going to warm up because it takes awhile for the earth's energy balance to get back into balance, for the checkbook to start balancing. My own sense is that we will probably undergo a process like this which I described earlier of getting right up to the brink; the thing is we're probably close to the brink right now; we're probably don't have that much time to act because the consequences of what we do or don't do today are going to be felt; it's like compound interest, especially for your retirement, what you do in your early years often makes quite a bit of difference later on because there are so many years that the compounding has to work

What needs to be done both directly and indirectly to address climate change?

With respect to the greenhouse gas issue, whatever we can do to reduce emissions will help this issue both at the individual level, trying to be more efficient in the way we do things; encouraging, whether we do it our selves or encourage other people to do it, harnessing technology and the innovative spirit of this country. We have proven to ourselves, when this country puts its mind to something it can do a bang up job of dealing with it. We decided to go to the moon one day and we just did it. This isn't quite as easy as going to the moon; it's a more complicated kind of problem. Once you decide to do something, a whole bunch of things start to line up; once you make that commitment to do something. The United States as a country has this kind of spirit, that if it's put as the right kind of challenge, it's something we are quite capable of rising to; it would be nice to see this. Maybe this is to Polly Annish to think this might happen but I think the people of this country really believe in what they can do; this is the kind of thing that would really constitute true leadership of new ways of thinking about things.... Who's better equipped, who's got the wealth, the knowledge base, the history, the temperament to do this than the people in this country, especially in this state which has such a reputation, a history of being an integral part of this process in the United States. "