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3.2 ENHANCING CLIMATE LITERACY

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Awareness of the impacts of climate variability and change has grown over the past decade (Krosnick et al. 2006). With increasing frequency, news stories cover climate change and climate scientists receive requests for presentations on the topic. Out of this increased awareness of climate issues has grown the concept of climate literacy (National Oceanic and Atmospheric Administration 2008). Climate literacy is aimed at increasing the public's awareness of the causes of climate change and aiding their ability to integrate climate information into their own plans and activities.

To address this growing need, the Oklahoma Climatological Survey (OCS) developed a one-day "climate training" workshop, funded by National Oceanic and Atmospheric Administration (NOAA) Sectoral Applications Research Program). The workshops were designed to distill basic concepts of climate and weather, discuss causes of climate change, assist participants in finding further climate information, and relate climate to tangible events such as drought and other natural hazards. These workshops were offered at several venues across Oklahoma during the late fall and early winter of 2008.

An evaluation was conducted as part of the workshops. Evaluation instruments included a test that was administered at the beginning of the workshop's instruction (pre-test) and repeated at the end (post-test). This repeated test offers a direct assessment of how well participants were able to absorb and interpret the information presented during the workshops. It also provides guidance to staff conducting the workshops as they revise materials prior to further workshops. In addition to the pre-test and post-test, a participant profile was completed detailing the occupations, prior experience with weather or climate workshops, and extent of interaction with the public. This profile enables further sub-division of results that may guide development of workshops for other targeted sectors.

The sections that follow detail the concept of the workshops, the materials that were developed, evaluation methodology, and preliminary results. Further work includes follow-up interviews or surveys with those who attended the workshops and replication of the workshops in two other states to test transferability of materials, procedures, and findings.

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1. PURPOSE OF THE WORKSHOPS

NOAA's Communications and Education Program in their Climate Programs Office has led development of a framework for climate literacy, in recognition the need for a more informed public on issues related to environmental stewardship and climate change. NOAA (2008) defined a climate-literate person as one who:

- Understands the essential principles of all aspects of the Earth system that govern climate patterns;
- Knows how to gather information about climate and weather, and how to distinguish credible from non-credible scientific sources on the subject;
- Communicates about climate and climate change in a meaningful way; and
- Makes scientifically informed and responsible decisions regarding climate.

The workshops developed under this grant share these goals. The workshops address fundamental concepts of climate and weather, assist participants in finding sources of climate information and encourage them to apply their knowledge to assist others as they make decisions in which climate may influence outcomes.

Many local and regional planners are not aware of the causes of climate change and variability, nor do they know where to find information about climate that may be integrated into their operations. Brief presentations at workshops do not allow sufficient time to relay complex information; more than an hour or two is needed. More formal outreach activities tend to be oriented toward multi-day workshops. While these longer workshops provide much more detail and equip decision-makers well for using climate information, the investment of time is too great for many managers.

Commensurate with a developing climate literacy initiative, OCS developed one-day workshops to focus on fundamentals of climate and weather, sources of climate information, climate change, and special topics such as drought and weather hazards. The workshops build upon the successful multi-day training courses used by OCS' K-12 and public safety outreach programs with information distilled to a level appropriate for a one-day course.

One reason behind the multiple training methodologies is that all users do not require the same level of support. Generally, users of climate information fit into one of four categories:

(1) Those who know what they want and where to find it;
(2) Those who know what they want but don't know where to find it;
(3) Those who need information but are not sure of what
(4) Those who do not know they need information.

The first category of users includes those already immersed in the topics, who need little additional training or assistance. Many in this group have degrees in a related discipline or many years of practical experience. They use trusted sources of information integrated into an operational framework. Most of their climate-related questions can be resolved through brief, direct conversations.

Users in the second category may have similar concepts of how to apply information but may be unaware of the sources and characteristics of data or information. Often, these users' needs can be addressed through brief presentations or direct assistance, such as pointing them to a website or publication. This one-time, one-way interaction would fit the classical definition of climate services (National Research Council, 2001).

The third category takes more effort. Not only do data sources need to be discussed, but the concepts of how to apply the information must also be presented. For this category, more formal, rigorous training methods are needed. Depending upon the degree to which they self-identify with this category, the training may be more or less elaborate. Those who have a keen awareness of their need for information may be more willing to invest a substantial amount of time in a multi-day training course, while those who have less awareness may be less willing to invest much time or travel.

Those in the fourth category may have an interest in climate or weather, but not realize how they can benefit from use of weather and climate information. These types of individuals would be best served by brief presentations, where their awareness level can be raised to the point that some of them will move into the third category of users and be amenable to further, more in-depth training.

Most climate services or educational outreach initiatives tend toward either brief presentations on particular topics or toward extended workshops. Brief workshops are inadequate to address the needs of many of the users in the third category, and even some of those in the second category who may benefit from hearing the latest knowledge on climate issues. These individuals have an expressed need for not just data, but training on how to apply that information. Furthermore, because their information needs are not as clearly defined, they may be less willing to attend an extended workshop due to time and travel constraints.

In addition to reaching a willing audience, the material covered must be relevant to them. Each audience, each sector will vary in their perspective of relevance. Therefore, materials and topics must be flexible enough to be adaptable to each audience without having to undergo substantial revision. The materials developed for these workshops were designed to cover base concepts with additional materials that may be substituted depending upon the audience.

Increasing resilience to the effects of climate is not possible without the development of conduits for information exchange between the climate science community and decision-makers. Chagnon (1992) noted that climate predictions were used primarily for "general planning". They were rarely incorporated into decision-process models, budgeting, operations, or marketing. Chagnon identified three impediments to the use of climate information: (1) lack of ability to integrate it into operations, (2) lack of faith in accuracy of the products, and (3) content and format issues. In addition to awareness of climate products, Chagnon noted that even if predictions were improved, there remained difficulties integrating them into operations.

No doubt climate forecasts have improved since Chagnon's study, but qualitative evidence suggests that the barriers of integration and confidence remain. A decade later, the American Meteorological Society's (2003) Policy Forum, *Improving Responses to Climate Predictions* echoed similar concerns. Among their findings was that "Climate predictions and information are not provided in the most useful way to decision-makers." The report noted that users needed evaluations of climate prediction models before they would be willing to adopt changes in their practices, echoing the concept of confidence in the products found by Chagnon. The report called for more interaction between providers of climate information and decision-makers and the development of specialized training for professionals to communicate with the decision-makers.

One means of influencing the adoption of new practices is to reach decision-makers through trusted change agents. In the context of drought, such change agents include personnel from organizations such as the cooperative extension service, Farm Service Administration (FSA) and conservation districts. These individuals are embedded in the communities in which agricultural producers operate and are usually held in high regard. They are from time-to-time called upon to provide or interpret climate-related information for agricultural producers or others who happen to stop by their offices. The construct was designed to increase collaboration between the climate sciences community and such organizations with the anticipated outcome of increasing decision-makers' trust in the information, thus creating new opportunities for changing management practices.

2. WORKSHOP DESIGN

The objectives of the course were to enhance climate literacy among non-technical audiences and to document how the workshops affect utilization of climate and weather information. During the workshops, the participants were exposed to a variety of topics on fundamental concepts of climate and weather, climate variability, climate change, sources of information, and specific topics such as drought. It is unlikely that participants left as experts, but material was tailored in such a way that the participants would learn key concepts, discover different types of information and networks and how to access data from those networks, and gain an understanding of uncertainty and forecast limitations. This was viewed as the beginning of an ongoing interaction between the participants and OCS, as envisioned by the AMS (2003) policy forum document.

Workshops were offered regionally, through Oklahoma's Career Technology Centers, to minimize travel required by decision-makers to attend the workshops. At each workshop, participants were given a binder containing printed copies of the presentations, a CD-ROM of the presentations so that they could follow links embedded within the presentations at their leisure and additional materials to help them find climate information.

Materials were drawn partly from existing materials used by OCS' other outreach activities, including its EarthStorm (K-12) and OK-FIRST (public safety) programs and the Oklahoma Mesonet's AgWeather program for agricultural applications of weather data (McPherson et al. 2007; Morris et al. 2001; McPherson and Crawford 1996). EarthStorm and OK-FIRST both feature multi-day courses that detail basic atmospheric processes, radar interpretation, and event case studies. Hands-on companion activities or laboratory exercises that reinforce the subject matter also are included. Specific presentation topics covered in the courses include:

- Basic meteorology
- Global weather patterns
- Factors that determine climate
- Thunderstorm development
- Radar fundamentals
- Interpretation of radar data and products
- Interpreting maps and graphs
- Heat, drought, and fire weather
- Heavy precipitation
- Winter weather
- Forecasting

The remainder of the climate workshop materials were built from University of Oklahoma Speaker Service talks developed by project staff as well as from weather and climate textbooks. The information was distilled and simplified for a general, non-scientific audience.

The climate workshops were designed around a core sequence and one or more special topics. The core sequence conveys basic concepts of climate, climate monitoring, climate prediction, climate and weather variability, climate change, and where to locate climate and weather information. Drought and natural hazards were featured as special topics. Special topics in the future may include tornadoes, floods, regional climate, wildfires, documenting severe storms, and using climate and weather for event planning. For example, if the workshops were given to a group of insurance adjusters, the special topics may focus upon documenting severe storms and natural hazards. A group of city planners may be more interested in regional climate and event planning. Furthermore, with interchangeable special topics sessions, these workshops are designed for future flexibility. Two stand-alone climate activities were developed to provide breaks from the powerpoint-based instruction, provide additional information in a fun, hands-on manner and to reinforce material presented earlier.

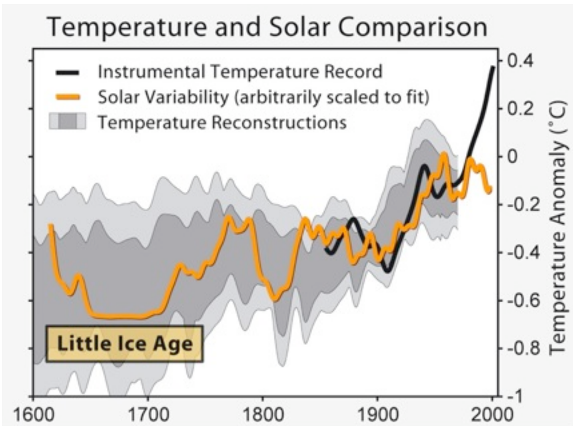
The workshop schedule consisted of the following topics:

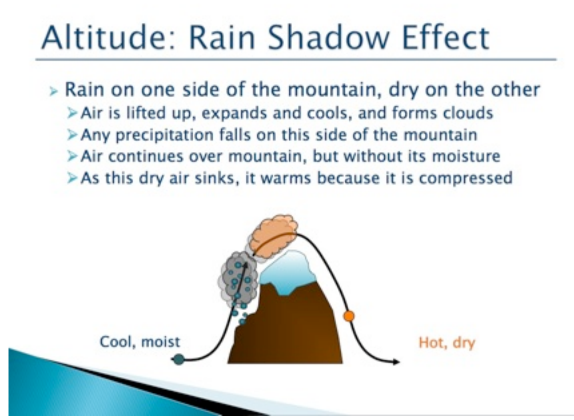
- Climate Basics
- Weather Basics
- ENSO Activity
- Finding Climate Information

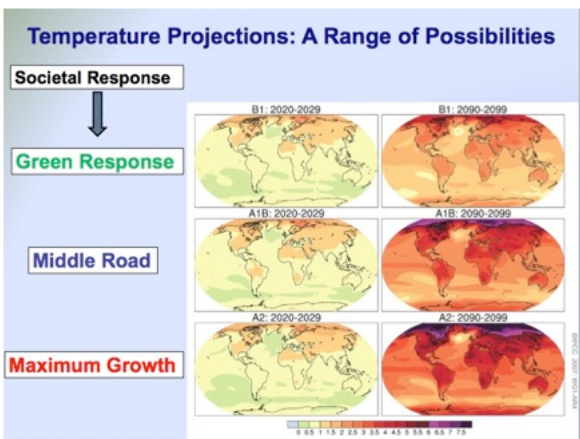
- Climate Change
- Tree Ring Activity
- Drought
- Natural Hazards

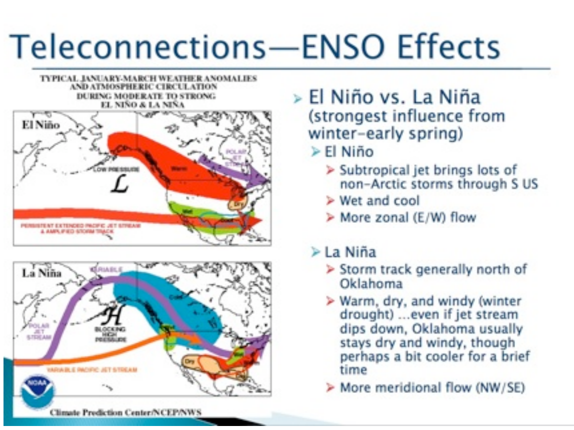
Figure 1 shows some examples of presentation materials. A summary of key concepts presented in the modules is included in the appendix.

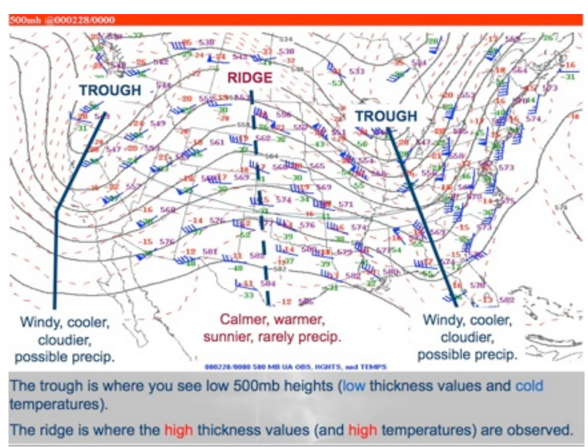
Figure 1. Examples of presentation materials.











The workshops were offered in six different locations around Oklahoma (Ada, Ardmore, Norman, Ponca City, Tulsa and Weatherford). This allowed for broader participation, without participants having to travel very far in order to attend. While this added some travel costs for the project, experience suggests that both participation and enthusiasm are higher when workshops are held closer to the participants' hometowns. Oklahoma's Career Technology Centers were chosen as venues for the workshops as they offered both classroom and computer laboratory capabilities for web-based activities.

An additional advantage of taking the workshops 'on the road' was that some content could be tailored to regions, making the presentations more relevant to the audience. For example, data from the site in which the workshop was held was used to provide local and regional context to assessing and interpreting climate data.

Workshop attendees were asked to complete a Participant Profile questionnaire that asked for information about work experience, sources of weather or climate information and frequency of acquisition, their experience providing information to end users, and any prior weather or climate training. Of the 62 workshop attendees, 59 completed the Participant Profile. A slight majority of respondents who identified their occupation (53%) were from agriculture or related fields. Most fell within the target demographic of people in county or state offices who work with agricultural producers. Fifty-eight percent of the participants had five years or less experience with their current organization; nearly one in four (24%) had one year or less experience.

Most (61%) indicated that they consulted weather or climate information on a daily basis (37%) or several times each week (24%). The sources most frequently cited as being used on a daily basis or several times each week were television (86%), National Weather Service (61%) and newspapers (58%). The sources most frequently cited as being used no more than once per month or never were the Climate Change Science Program (80%), Climate Prediction Center (76%), and the Drought Monitor (66%).

The development and implementation of regional workshops was the first phase of the project. A second phase is to conduct these same workshops in two other locations outside of Oklahoma. This second phase is designed to test how easily materials can be transferred to other geographical locations and institutions, including the extent to which materials need to be modified for their region and differences in culture or presentation styles.

The workshops are viewed as the beginning of sustained interaction between the participants and the project staff. It is anticipated that the workshops will generate interest in the community that can be drawn into existing service and outreach activities offered through OCS and the Oklahoma Mesonet's agricultural outreach program. These resources will be available for answering questions, providing more specific training and presentations, and developing new products to address user needs. Findings from the evaluation also will assist in the refinement and development of future products.

3. EVALUATION DESIGN

Each of the workshops included an evaluation component, consisting of pre-test and post-test instruments to assess the degree of learning that took place, an overall workshop assessment administered as part of the session wrap up, and a follow-up survey to be administered five months after the workshop to document use of the information by the participants and any changes in end user (agricultural producers) practices. The general evaluation protocol builds off a previous design used to evaluate the OK-FIRST Program for Oklahoma public safety officials (James et al. 2000). In the OK-FIRST Program, the real-time assessments provided opportunities for program staff to adjust materials during the multi-day workshops based on feedback from the participants and the long-term follow up documented utilization.

The purpose of the workshop evaluation is to determine the degree to which such an activity can enhance the knowledge of change agents (e.g., county extension agents, Farm Service Agency staff) concerning climate topics, sources of climate information, and the use of this information to aid agricultural producers when making decisions about farming practices, particularly under drought conditions. If the change agents attempt to use the information they acquired in order to inform producers, the evaluation also will document the degree to which this information has an effect on decisions about farming practices.

Short-term Outcomes (Training Assessment): At each workshop, participants were asked to complete a pre-test and a post-test instrument in order to assess learning during the training. Workshop participants completed a pre-test instrument to collect demographic information and to test their knowledge of climate and weather concepts. A post-test was administered immediately following the workshop to again measure knowledge of climate and weather topics. The knowledge items on the pre- and post-tests were identical and were developed by workshop designers to reflect the material presented during the training.

At the end of each workshop, a short instrument was administered as part of the workshop wrap-up to gather feedback about the content and implementation of the workshop, such as: format, quality and quantity of the materials, likely usefulness of the information, overall strengths of the workshop and suggestions for improvement.

Results from the participant profiles, pre-test and post-test comparisons, and summary workshop evaluations were provided to project staff. The time between each workshop did not allow sufficient time for substantial revisions to the materials. However, feedback from the evaluator and participants provided program staff with guidance areas where time could be saved to accommodate expansion of other topics where needed. The results are being used to refine the materials before they are made publicly available to others or used in further workshops.

The procedures described so far pertain largely to the direct and immediate effectiveness of the training. The results of the knowledge questions and general feedback can be used to highlight areas in which training material can be fine tuned, if necessary, and workshop implementation improved. The follow-up survey will be used to test retention of the concepts presented during the workshop.

Intermediate-Term Outcomes and Long-term Impacts: Program evaluations distinguish between short- and intermediate-term outcomes and long-term impacts. The outcomes are the direct result of the program's activities and are the effects for which the program can be held responsible. The long-term impacts are the program's goals but which it cannot accomplish alone. For example, a long-term impact for an agricultural producer could be reducing losses during drought years.

It often is difficult to establish a direct causal link between short- and intermediate-term outcomes (e.g., the acquisition, transfer, and use of climate information) and the long-term impacts (minimizing losses due to climate conditions). A multitude of other factors can play upon those impacts. However, an evaluation can establish the relationship between program activities (the workshops), the short-outcomes, and the intermediate-term outcomes.

For example, if workshop participants learn how to access and interpret climate information (short-term outcome), they could change the type of information they provide and modify the way in which they interact with end users (e.g., agricultural producers). This, in turn, is expected to inform and improve the quality of the decisions and actions taken by end users (intermediate outcomes).

These intermediate outcomes will help accomplish the desired long-term impacts that also can be affected by factors outside the control of the participants. Thus, a county extension agent learns how to access and interpret climate information and then transfers this information to a local agricultural producer. The producer then uses this information to help improve crop management decisions (e.g., what crops to plant in coming years and likely irrigation requirements). Hopefully, this helps avoid potential losses due to expected drought conditions. In some cases, the "change agent" link might not exist if end users are among the workshop participants.

As noted above, data can be collected through pre- and post-tests to document the degree to which short-term learning outcomes are achieved. Information also can be collected pertaining to the ability of workshop participants to communicate what they learned to end users and the degree to which the end users applied that information to inform decisions and actions. A follow-up instrument will be completed by workshop participants approximately five months after the workshops and will include items to measure retention of workshop material and to collect feedback concerning the degree to which and how knowledge gained from the workshop affects the advice participants give to agricultural producers.

If technical assistance actually is provided to agricultural producers by workshop participants, feedback will be solicited from the end users about the degree to which the information affected decisions about their farming practices. Contact information will be solicited for any end users with whom workshop participants shared what they learned. These individuals also will be contacted to discuss the degree to which the information influenced their decisions and actions. This discussion will provide an opportunity for end users to provide qualitative assessments of alternative outcomes with and without the knowledge provided through the project.

4. PRELIMINARY RESULTS

At this time, only the training assessment portions (short-term outcomes) of the evaluation have been completed. Therefore, this discussion relates only to the short-term, or immediate effectiveness of the workshops, and not to the eventual use of that information to change agricultural practices.

Overall, feedback from participants and data from the pre- and post-test indicate that the workshops were successful. Based on the workshop evaluation forms completed by participants at the end of each workshop, all of the responding participants were very (79%) or somewhat satisfied (21%) with the workshop and indicated that, overall, the information would be very (60%) or somewhat useful (40%). Nearly all respondents (98% to 100%) were very or somewhat satisfied with the quantity of information presented (71% very satisfied), quality of information presented (90% very satisfied), content or type of information presented (81% very satisfied), the way in which the information was presented (75% very satisfied), and the organization of the workshop (70% very satisfied).

When asked about specific topics covered during the workshop, participants reported that five of the eight substantive content areas covered (basics of climate, basics of weather, climate variation and change, finding climate information, and drought) would be either very or somewhat useful in helping advise agricultural producers (100% of respondents reporting). Those saying the information was very useful ranged from 54% (climate variation and change) to 74% (finding climate information). For the three remaining categories (tree ring activity, ENSO activity, and natural hazards), the percentages reporting that the topics would not be very useful in advising agricultural producers was small (18%, 13% and 5%, respectively).

While the participants provided positive feedback about the workshops, a more definitive indication of the success of the workshops in enhancing climate literacy can be determined by comparing pre-test responses to post-test responses. These instruments were knowledge tests with right and wrong answers and consisted of matching (match terms to a list of definitions) and multiple choice items. Some multiple choice questions had more than one correct answer (indicated by a “check all that apply” direction) and participants were scored as correct or incorrect for each of the responses provided and again for the overall question. A total of 70 items were scored as correct or incorrect. Of the 62 participants, 59 completed a pre-test and/or a post-test; three declined to participate in this exercise. Of the 59, 50 completed both the pre- and the post-tests. Some people had to leave the workshop prior to the administration of the post-test and some only completed one of the instruments. The analyses reported below are based on the responses of the 50 participants who completed both instruments.

Table 1: Percent Correct Pre-test and Post-test

	Pre-test Correct	Post-test Correct
N	44	44
Mean	60%	69%
Median	59%	70%
Std. Deviation	.090%	.095%
Range	43%	37%
Minimum	36%	47%
Maximum	79%	84%

The results of the analyses of change from the pre-test to the post-test also paint an encouraging picture. Of the 50 participants, 44 had no change (12 participants) or a higher score (32 participants) on the post-test compared to the pre-test; six participants actually had a lower score after the workshop than before. The mean percent correct on the pre-test was 60% and this increased to 69% on the post-test. This change also is reflected in the differences in the minimum and maximum scores. The lowest score on the pre-test was 36% correct compared to 47% correct on the post-test. The highest score increased five percentage points between the pre- and post-tests, from 79% to 84% correct.

Looking at the pre- and post-test scores divided into quintiles indicates how participants within a particular range of scores changed from before the workshop to after the workshop. No scores appeared in the first quintile (1-20 percent correct) at either the pre- or post-test. Only one person had a score in the second quintile at the time of the pre-test and that individual’s scored increased sufficiently to appear in the fourth quintile at the time of the post-test. Most of the participants (54%)

Table 2: Changes by Quintile from Pre-test to Post-test

	3rd Quintile 41-60	4th Quintile 61-80	5th Quintile 81-100	Total
2nd Quintile 21-40	0 .0%	1 100.0%	0 .0%	1 100.0%
3rd Quintile 41-60	12 44.4%	15 55.6%	0 .0%	27 100.0%
4th Quintile 61-80	2 9.1%	16 72.7%	4 18.2%	22 100.0%

had scores in the third quintile on the pre-test. Of those, 56% increased to the fourth quintile on the post-test. Sixteen participants had scores high enough on the pre-test to appear in the fourth quintile at the time of the pre-test. Most of them (32%) stayed in that quintile with their post-test score. Four (18%) appeared in the highest quintile after the workshop; however, the scores of two (9%) people decreased enough to drop them down one group to the third quintile on the post-test. Although the scores of 12 participants decreased from the time of the pre-test to the post-test, 10 of them remained in the same quintile at both points.

Although placing scores into quintiles helps us examine the movement of people in one group (quintile) to some other group, the analysis still lacks precision. A person could move from the fourth quintile to the fifth quintile by increasing their score by one point—from 80 to 81. Another person could remain in the fourth quintile but increase their score from 61 to 79—a substantial increase but they stay in the same quintile. Further a similar gain (e.g., 10 percentage points) might not be equivalent, depending on the starting point. It might be easier for somebody with a very low pre-test score (e.g., mid 30s) to increase 10 points than it is for another person who already has a relatively high score (e.g., mid 80s). An alternative is to calculate a normalized gain score. The score is derived by taking the amount of gain from pre-test to post-test and dividing by the gain that is possible (100-pre-test score). Thus, the score reflects the percentage of possible gain or increase for the participants that actually was accomplished.

((post percent correct - pre percent correct) / (100 - pre percent correct))

Using the data from Table 1, to calculate the normalized gain score, we have:

$$((69 - 60) / (100 - 60)) = 22.5$$

Since the overall mean on the pre-test was 60% correct, the possible gain to reach a perfect 100% correct was a 40 percentage points increase at the time of the post-test. The gain of nine points from 60% to 69% correct represents a gain of 22.5% of what was possible.

In addition to overall comparisons, the pre-test and post-test analyses revealed specific areas in which there was substantial improvement in knowledge, areas in which further improvement is needed, and areas in which confusion may have been increased. The data below indicate the number of participants who chose the correct answer, out of a possible total of 50 participants who completed both the pre-test and post-test. The mean increase in correct answers from pre-test to post-test was 4.5 (also the mode).

The greatest increases from pre-test to post-test scores were on the following subjects:

- Number of years to calculate a normal value (+26; 7 correct pre-test, 33 correct post-test)
- How El Nino affects Oklahoma's weather patterns (+19; 11 pre-test, 30 post-test)
- Causes of drought (+13; 14 pre-test, 27-post-test)
- Major influences on climate – multiple choices (+11; 25 pre-test, 36 post-test)
- How events in one region affect other regions (+10; 35 pre-test, 45 post-test)
- How the Drought Monitor is calculated (+10; 27 pre-test, 37 post-test)

Although overall scores increased, there were clearly some subjects for which more training is needed, or perhaps more time to reflect upon the material presented in the workshops. Subjects for which fewer than 30 of the 50 respondents (fewer than 60%) chose a correct answer on the post-test included:

- Definition of weather - matching (20 correct pre-test; 29 correct post-test)
- Definition of normal - matching (21 pre-test; 23 post-test)
- Definition of outlook - matching (23 pre-test; 26 post-test)
- Definition of oscillation - matching (30 pre-test; 26 post-test)
- Definition of gradient - matching (24 pre-test; 29 post-test)
- Difference between weather and climate (10 pre-test; 5 post-test)
- Limits of predictability (34 pre-test; 28 post-test)
- Causes of climate change – multiple choices (6 pre-test; 2 post-test)
- Climate variability (29 pre-test; 24 post-test)
- Seasonal outlooks (28 pre-test; 22 post-test)
- Documenting weather or climate events (16 pre-test; 19 post-test)
- Pacific Ocean influences on Oklahoma's climate – multiple choices (10 pre-test; 9 post-test)
- Why scientists use tree rings – multiple choices (16 pre-test; 18 post-test)
- Oklahoma's most severe drought (4 pre-test; 9 post-test)
- Causes of drought – multiple choices (14 pre-test; 27 post-test)
- End of drought – multiple choices (5 pre-test; 13 post-test)
- Most deadly U.S. hazard (14 pre-test; 22 post-test)
- Most costly Oklahoma hazard (14 pre-test; 23 post-test)

Several of these items showed improvement: definitions of weather and gradient, Oklahoma's most severe drought, causes and end of drought, and most deadly and costly hazards. However, the level of knowledge for these items was low at the time of the pre-test and remained low on the post-test. This suggests that the training had some effect but needs to be fine-tuned.

For several items, post-test scores actually declined: definition of oscillation, difference between weather and climate, limits of predictability, causes of climate change, climate variability, seasonal outlooks, and Pacific Ocean influences on Oklahoma's climate. Even though material on all these subjects was included in the presentations, due to time constraints, some subjects may have received insufficient attention. Some factors included: not enough time to cover complex information; technical wording on the evaluation instruments; insufficient clarity of explanations; and missing presentation materials. As presentations were shortened to accommodate time constraints, some critical material may have actually been removed. However, topics such as climate change and seasonal outlooks were emphasized during the presentations; consequently the results suggest that modifications are needed in both the presentations and the evaluation instruments.

In addition to those already cited, subjects in which the post-test scores declined included:

- Definition of latitude - matching (50 pre-test; 46 post-test)
- Definition of altitude - matching (49 pre-test; 48 post-test)
- Definition of a watch (38 pre-test; 33 post-test)

The declines for these three items are small but surprising. Every participant correctly matched "latitude" to its definition on the pre-test and all but one did the same for "altitude." The number of correct answers declined by four and one, respectively, on the post-test. Given the nature of these concepts, it is surprising that anybody got them incorrect, on the pre- or the post-test. The differences between watches, warnings, and outlooks were covered in the presentations so the decline in the number who correctly identified the definition for a "watch" was unexpected. The definitions may be attributable to people switching choices in the list or, perhaps, carelessness in marking their answers.

5. CONCLUSIONS

The net result of these preliminary findings is that, in general, the workshops successfully improved knowledge of relationships between weather patterns in one part of the globe with another, drought, and basic climatology (particularly in use of normals). The findings are particularly impressive given the entire workshop was completed in a single day and the participant had no time to study the three inch binder of material provided to them or think about the presentations and let them sink in. They were tested immediately before the workshop started and again immediately following the conclusion of the presentation. The degree of learning demonstrated by comparison of pre- and post-test data was accomplished by hearing presentations, seeing power point material, retaining often complex concepts and principles, and giving that material back on a test with no further study. Revisions and clarifications are needed in the areas of distinctions between weather and climate, predictability, climate change and variability, organizations that may help support decisions, and differentiation among outlooks, watches, and warnings.

Overall, these workshops showed that a complex topic such as climate can effectively be condensed into a one-day workshop. Although there were areas of needed improvement, the presentations and discussions led to increased levels of knowledge on most of the concepts. Responses on workshop evaluations were positive, with the greatest challenge mentioned being time management. It was a lot of material to cover in the time allotted. Building upon these findings, these workshops provide a foundation for further climate literacy efforts.

The workshops also demonstrate the need and value of systematically evaluating such efforts. The findings with respect to process (workshop summary evaluation) and immediate outcomes provide the detailed feedback that is critical to continued improvement and enhanced success. The next phase of the evaluation is important to document that, not only can very technical information be provided to nontechnical audiences, but they can use it to improve their ability to provide information and technical assistance to eventual end users, in this case agricultural producers, in order to help inform their decisions that could affect long-term impacts.

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Appendix: Summary of key concepts presented in each of the modules

1. Climate Basics
    - Differences between weather and climate
    - Primary factors governing Earth's climate
    - Fundamentals of the Greenhouse Effect
    - Climate zones and regions
    - Teleconnections
    - Air masses
    - Oklahoma's climate

2. Weather Basics
    - Pressure and height
    - Heating and cooling
    - Troughs and ridges
    - Daily variations
    - Cloud types
    - Fronts
    - Severe storms
    - Outlooks, watches and warnings

3. ENSO Activity
    - Definitions
    - Air-Ocean interactions
    - How to classify El Nino, La Nina or Neutral events
    - Typical impacts of El Nino / La Nina
    - Diagnose phases from past examples
    - Determine current phase
    - Additional Resources

4. Finding Climate Information
    - Data sources (NWS Cooperative Observer, ASOS, Mesonet, Storm Reports, publications)
    - Interpreting CPC Seasonal Outlooks
    - Drought Monitor and Drought Outlook
    - ENSO, PDO, NAO and PNA Outlooks
    - Hazards and climate extremes

5. Climate Change
    - Definitions of climate variability and anthropogenic climate change
    - Natural causes of long-term climate change
    - Milankovitch Theory
    - Intergovernmental Panel on Climate Change (IPCC)
    - Paleoclimatology
    - Observational evidence of warming
    - Projected changes
    - Implications for Oklahoma

6. Tree Ring Activity
    - Terminology
    - Describes basic relationships between precipitation and tree growth
    - How scientists use tree rings to piece together the climate record pre-instrumentation
    - Additional Resources

7. Drought
    - Defining drought
    - Historical drought episodes in Oklahoma
    - Drought Indices
    - U.S. Drought Monitor and Drought Outlook
    - Drought Impact Reporter
    - Drought.gov website
    - Oklahoma Rainfall Update website
    - Oklahoma Water Resources Bulletin publication

8. Natural Hazards
    - Weather-related hazards affecting Oklahoma
    - Regional vulnerability to hazards / disasters
    - Tornadoes
    - Severe Winds
    - Hail
    - Lightning
    - Floods
    - Drought
    - Extreme Heat
    - Wildfires
    - Winter Storms
    - Tropical Cyclones