# *Atmospheric Explorations*

**Science Museum of Minnesota**
**The Center for Atmospheric and**
**Space Sciences at Augsburg College**

**Front-End Evaluation**
**Phase I**

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## EXECUTIVE SUMMARY

### Introduction

Selinda Research Associates conducted a front-end evaluation of the Atmospheric Explorations project. The purpose of Phase One of this front-end evaluation was to 1) assess visitor knowledge about weather and climate systems; 2) determine visitor interest in these topics; 3) identify any preconceptions visitors have about the topics; and 4) reveal appropriate entry points, or personal connections to the proposed topics.

This study used Naturalistic Inquiry methodology. The methods used in this research included depth interviews, concept mapping, and pile sorts. During the depth interviews, visitors were asked content-based questions and questions designed to elicit the personal connections they had to weather and climate.

Interviews were conducted from November through December, 1998 at the Field Museum in Chicago. Twenty groups were interviewed, comprising a total of 47 individuals. Groups consisted of 1 to 4 people, and interviews ranged in length from 20-45 minutes.

### Results

**A. Common Ways of Thinking about Weather and Climate.** Respondents tended to classify weather and climatic phenomena as *natural disasters* (i.e. tornadoes, blizzards), *processes affecting the environment* (i.e. global warming), and *visible signs of weather* (i.e. lightning, clouds).

**B. Visitor Understandings about Climate.**

1. Most respondents understood that weather and climate are two distinct, but related, phenomena.
2. The most common causes of climatic differences cited by respondents were altitude and distance from the equator.
3. A few visitors suggested that the tilting of the earth on its axis and trade winds also affect climate.
4. Landforms such as mountains and lakes were also thought to influence climate.

**C. Visitor Understandings about Weather.**

1. Most respondents talked about weather as something they can feel, see, hear, and touch.
2. Most respondents understood that high and low pressure systems, and warm and cold fronts are associated with changes in weather, though they could not provide detailed explanations for these processes.
3. All respondents understood that weather moves, and many explained that weather moves from west to east.
4. Some respondents were familiar with the jet stream and the role it plays in generating weather patterns.

**D. Weather Maps and Terminology**.

1. Most respondents had a moderate to high degree of familiarity with standard weather symbols used in daily weather forecasts.
2. Most respondents easily identified areas of precipitation and relative temperature on weather maps.
3. Respondents found it more difficult to identify wind direction and weather movement on a weather map than to identify areas of precipitation and relative temperature.
4. Meteorological terms such as "climate" were often used imprecisely by respondents.

**E. Visitor Understandings about Global Warming and Climate Change.** All respondents were familiar with the concept of global warming. Respondents expressed three points of view about global warming:

1. Global warming is caused by human activity and is potentially harmful to the Earth and human life.
2. While global warming probably exists, and most likely can be attributed to human activity, not enough evidence has been collected to prove its existence definitively.
3. Global warming is part of the Earth's natural cycle of cooling and warming, and is beyond human control and influence.

**F. Visitor Understandings about Ice Ages.**

1. Interviews revealed a low level of scientific understanding about ice ages.
2. Respondents tended to associate ice ages with glaciation, changes in topography over long periods of time, cave-men, and extinct animals.
3. Most respondents were familiar only with the most recent ice age, and very few were able to identify any causes for glaciation.

**G. Where Visitors Get their Weather Information.**

1. Most respondents indicated that they get their weather information from the TV, especially the Weather Channel. A few visitors mentioned reading weather reports in newspapers.
2. Several respondents explained that they had their own methods for predicting weather which they found to be as reliable as meteorological methods.

**H. Personal Connections to Weather.**

1. Respondents explained that weather affects their clothing choices, recreation, transportation, and local economies. Respondents explained that weather also affects their moods and emotions.
2. Respondents tend to think of weather as a natural process with a temporal component.
3. Some respondents said that the weather is a force of nature beyond human control.

**I. Visitor Interest in Weather.** Most respondents expressed more interest in natural disasters and global warming than in general weather processes. While respondents explained that weather is important because it affects their daily lives, they were not immediately intrigued by the topic of weather. However, once visitors were engaged in a conversation about their own beliefs and personal connections to weather, they became more enthusiastic.

**Recommendations.** Specific recommendations are included in this report.

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## INTRODUCTION

The Science Museum of Minnesota (SMM) and the Center for Atmospheric and Space Sciences (CASS) at Augsburg College are currently developing three exhibit clusters on weather and climate systems. The goal of the exhibit is to help visitors understand the large-scale processes that affect the climates we live in and the weather around us.

Each exhibit cluster will contain a computer-based exhibit that runs a program of a weather system; a 3-D "meteorological diorama" that illustrates key concepts of the exhibit; a physical interactive that illustrates related physical phenomena; and appropriate illustrations and photographs of the system. One cluster will be designed for two to three visitors to use at a time to encourage interaction among members of a visitor group.

## OVERVIEW OF EVALUATION

SMM and CASS have contracted with Selinda Research Associates to conduct front-end evaluation for the project. The purpose of this front-end evaluation is to assist the exhibit advisory committee in deciding which of four topics should be addressed in the exhibit clusters. Proposed topics include: 1) cyclones and weather, 2) ice ages, 3) global warming, and 4) the effect of landforms on weather and climate.

Phase One of the front-end evaluation explores visitors' general knowledge, interest, and preconceptions about these topics. The Phase One evaluation report will be used by the project team to determine which three topics will be included in the exhibition. Phase Two will commence after the three topics for the exhibit clusters have been selected.

## RESEARCH QUESTIONS

The purpose of phase one of this front-end evaluation is to 1) assess visitor knowledge about weather and climate systems; 2) determine visitor interest in these topics; 3) identify any preconceptions visitors have about the topics; and 4) reveal appropriate entry points, or personal connections to the proposed topics.

Early in the project, a topical framework was developed to guide the data collection. This framework outlines the issues to be explored during the study (see Appendix A).

## METHODOLOGY

This evaluation used Naturalistic Methodology to collect and analyze the data (Lincoln & Guba, 1985). Naturalistic Inquiry is a systematic approach of conducting research and evaluation in non-laboratory settings. This method relies on depth interviews and elicits narratives in people's own words. Narratives, as opposed to forced-choice responses, are essential for revealing a range of experiences about the topic under consideration. This methodology was chosen for this study because the expected audience for this exhibit (family visitors, adults, and junior high school students), is diverse in its knowledge and personal experiences with weather and climate.

## METHODS

The methods used in this research included depth interviews, concept mapping, and pile sorts. Depth interviews resulted in rich narratives about weather and climate. These narratives described the multitude of ways visitors think and feel about the topic. In keeping with naturalistic inquiry, interviews were conducted with visitor groups, since most visitors experience exhibits in a social group.

During the depth interviews, visitors were asked two different kinds of questions: content based questions, (i.e. their understandings about weather and climate); and questions designed to elicit the personal connections they have with weather and climate, (i.e. how they feel about and connect with weather and climate). Together, these questions revealed areas of visitor interest and possible entry points for the exhibit.

Interviews were conducted from November through December, 1998 at The Field Museum in Chicago, Illinois. Twenty visitor groups were interviewed for a total of 47 individuals. Groups consisted of one to four people, and interviews ranged in length from 20-45 minutes (see Appendix B for a description of the visitor groups). All interviews were tape recorded with permission. A debrief was written at the conclusion of each interview, and transcripts were prepared.

In selecting respondents for this study, we used purposive sampling methods (Lincoln & Guba, 1985). Purposive sampling is a deliberate selection of the next respondent (as opposed to random sampling). Respondents were selected to represent as wide a range as possible of perspectives and experiences, including age, gender, race, ethnicity, social and economic background, and configuration of the social group with whom they were visiting. By employing purposive sampling, we obtained a broad visitor sample.

Depth interviews were supplemented with two other methods used in cognitive anthropology and psychology: concept mapping and pile sorts. In cognitive anthropology, researchers study:

> *...how peoples of different cultures acquire information about the world,...how they process that information and reach decisions, and how they act on that information in ways that other members of their culture consider appropriate (Bernard 1995: 238).*

Methods such as pile sorts and concept mapping reveal how and why people organize information into various "cognitive domains" (i.e. weather phenomena), and what they think about the items included in these domains.

Eleven interviews incorporated pile sorts as part of the interview. Visitors were given 25-30 index cards on which weather and climate-related words were printed (see Appendix C for a list of words used). Visitors were then asked to sort the cards into piles in a way that made sense to them, and to explain why they made their sorting decisions.

Three interviews utilized concept mapping. In each case, visitors were provided with a blank sheet of paper with the word "weather," "climate," or "climate change" written in the center. Visitors were then asked to free associate with the word, and to construct a visual representation illustrating how the concepts and phenomena on their map were connected.

In addition of pile sorts and cognitive mapping, five groups were presented with a weather map of the United States. Interviews using the map allowed visitors 1) to explain their understandings of the symbols used in meteorology; 2) to visually demonstrate how weather moves, and 3) to identify what factors contribute to weather formation.

## LIMITATIONS OF THIS STUDY

While every attempt was made to obtain as diverse a sample as possible, most of the respondents in this study were adults or teenagers. Few young children were interviewed. This limitation has two implications for exhibit design. First, we may be overestimating the level of familiarity visitors have with the scientific aspects of weather and climate. Younger family members may know less about the scientific principles of weather and climate than those respondents interviewed for this study. Secondly, we know that much of the informal learning in museums takes place during social group interactions. In fact, children often teach their parents as they experience an exhibit. For this reason, it will be important to include a number of children in our sample for Phase Two of this evaluation.

Because these interviews were conducted over a relatively short period of time in the winter, many of the visitors' comments revolved around winter weather phenomena. If these interviews had been conducted during the summer, we might have learned about a different set of personal connections to weather and climate. Therefore, interviews for Phase Two of this study will most ideally be conducted during the spring or summer.

## RESULTS

The following section describes our results in some detail. In Naturalistic Inquiry, we aim to elicit a range of responses from visitors and to describe the range of visitor experiences rather than the percentage of people that acted in or thought a certain way. Because this is a qualitative endeavor, we use terms such as *all, most, many, some, few,* and *none,* when referring to quantities of visitor who held a particular viewpoint.

### Common Categories for Weather and Climate

Eleven visitor groups were asked to complete a pile sort using weather/climate related concepts. Three groups were asked to free associate given the prompts "weather," "climate," and "climate change," and to draw on paper how their ideas are related to each other. Discussions with the visitors during these exercises revealed insights about visitor familiarity with weather phenomena, causes of and processes involved in weather phenomena, and categories of weather phenomena.

We found that some of the categories elicited by the pile sort and concept mapping were remarkably consistent among visitor groups. Most respondents repeatedly made a pile containing the following words:

| |
|---|
| tornado |
| hurricane |
| cyclone |
| blizzard |
| typhoon |

When asked to name this pile, visitors responded with descriptors such as "disastrous weather," "fast effects," and "nasty weather type stuff." One visitor explained that these terms belong together because *"[A]ll of them destroy. You've got death, mass destruction-- people die from that."*

A second recurring pile was one related to what respondents saw as things harmful to the environment. It included the following terms:

| |
|---|
| environment |
| greenhouse gas |
| greenhouse effect |
| global warming |
| ozone layer |
| ozone hole |

One respondent explained that this pile *"relates to things that are bad. Things that are changing the environment."* Another respondent said that these terms were "*things that affect the environment."*

Frequently, but to a lesser extent than the above examples, respondents made a category of weather phenomena that are visible. They grouped together the following terms:

| |
|---|
| sunshine |
| rain |
| lightning |
| clouds |

When asked to describe this pile, one visitor group explained that these terms *are "visible weather going on, or visible signs of weather."* Another group said that these terms *"are all about the weather."*

Thus, pile sorts and concept maps provided us with an better understanding of visitors' conceptions of weather and gave us a starting point for our conversations with respondents. The rest of the interview explored what the visitor knew and opined about specific weather related topics.

## Visitor Understandings About Weather

The knowledge assessment component of the research explored the range of visitors' understandings about a) the causes and processes of weather and climate; b) the impact of landforms on weather and climate; c) global warming and ozone depletion; and d) ice ages and climate change. Interviews revealed a wide range of understandings.

- ***High and Low Pressure Systems***

Most respondents understood that high and low pressure systems and warm and cold fronts are associated with changes in weather. Many visitors associated "high pressure" with "good weather" (warm or cold), "sunny weather," and a lack of clouds. Many visitors associated "low pressure" with "bad weather," storms, and precipitation. Many visitors also explained that the collision of high and low pressure systems creates storms. "Tornado Alley" was mentioned a few times as an example of a place where high and low pressure systems frequently collide, creating storms. Several visitors explained that the mixing of cold and warm air, or wet and dry air, creates storms. One visitor explained this in more detail:

> *[Storms happen when] you usually have wet air meeting dry air, or warmer air meeting colder air, and you get turbulence in the atmosphere, and thunderstorms along the front....You probably get a change in the [electric] charge in the air, [creating a storm].*

Most respondents could not explain why collisions of air masses cause storms. However, one woman ventured an explanation. She explained that high pressure systems are associated with cold air because the air molecules are more tightly packed together. She explained that low pressure systems are associated with warm air because the molecules move further apart.

- ***The Jet Stream and the Movement of Weather***

All respondents appeared to understand that weather moves. Most respondents stated that storms and weather move from west to east. We asked visitors how they knew that weather moves from west to east. Most of their explanations were based on personal experiences. For example, one woman said that she works with people in New York who always ask her if it is raining in Chicago. They ask her about the weather in Chicago because they want to know if it will rain tomorrow in New York. A couple from Colorado explained that *"Chicago gets its weather from us."*

Of those visitors who were familiar with the jet stream, most explained that it is a "stream of air" or a "river of air" that flows in a recognizable pattern from west to east across the United States.

"Jet stream" often was placed in the same pile as "weather pattern" or "front" during pile sorts. Several respondents said that the jet stream "creates" weather or "brings" weather, but no visitors could explain the process in detail. Most conversations about the jet stream were carried on at the level of this visitor's:

*Q: Have you ever heard of the jet stream?*

*A: I want to say it's like the little snaky part they show on a weather map, you know, like the air coming through. But I don't know if that's it.*

*Q: Do you have any ideas about what that might have to do with weather?*

*A: Make it rain.*

*Q: Rain. And how would it make it rain?*

*A: I think that's when the change in the air occurs, and when you get the warm and the cold clashing together, it creates precipitation.*

A few visitors explained that the location of the jet stream changes with the seasons. One respondent explained that the rotation of the earth has something to do with the direction of the jet stream. Another visitor said that she thought the jet stream affects low and high pressure areas.

Only one visitor mentioned the discovery of the jet stream. Her explanation of the jet stream was more detailed than most of the other respondents':

*I think that it's only a relatively recent discovery that there is a jet stream. Because it's so high, we weren't aware of it. I remember reading a book about Everest, and how Everest sticks up above the jet stream. And that's one of, I think, the only places you can experience it because it's so high. And it's a pattern of movement of air that's up above the normal atmosphere...It goes from one direction to the other, and it's constantly moving. And it's a rather stable pattern. The jet stream can vary. It can come down or it can go up, but it's a fairly stable pattern across the, in the stratosphere. I think it's the stratosphere. It goes from west to east. That's where the patterns come from across the weather map.*

- ***Weather Maps and Terminology***

Five interviews were conducted using a weather map of the United States. While all respondents had seen such a map before on televised weather broadcasts or in the newspaper, these interviews revealed various levels of familiarity with weather symbols and ability to interpret a weather map. From these interviews, we can draw some preliminary conclusions:

1. *Visitors were familiar with standard weather symbols used in daily weather forecasts.*

   Most of the visitor groups could identify the areas of high and low pressure, as indicated by the "H" and "L." All of the visitors indicated that the front lines indicated some change in weather. Most visitors could explain that the map depicts three different kinds of fronts. A few visitors could explain the difference between an occluded front, a warm front, and a cold front. Several visitors correctly explained that areas of precipitation are located along front lines. When asked how they learned these symbols, all visitors said they watched televised weather broadcasts.

2. *Areas of precipitation and relative temperature were the most easily interpreted features on weather maps, in part because respondents drew on their own experience with climatic zones in the U.S..*

   Respondents were asked to identify relatively warm and cold areas, and areas of precipitation on the sample map. Some of the respondents correctly identified areas of precipitation as well as areas of warm and cold air. When asked how they knew that information, they explained that the southeast portion of the country is always warmer than northern areas. Respondents also tended to be most interested in temperature and precipitation, since these things affect their lives on a daily basis.

3. *Respondents found it more difficult to identify wind direction and weather movement.*

   Respondents had a difficult time explaining where there would be wind on the sample map, and in what direction the weather would be moving. In some cases, questions about wind elicited a discussion about the jet stream. Few respondents were able to say what kind of precipitation, and what time of year this map depicts. One respondent hypothesized that this map is a winter map, since the cold front was located so far south.

4. *Respondents attributed a very particular meaning to the word "cyclone."*

   While meteorologists use the term "cyclone" to indicate any low-pressure system that creates precipitation and clouds, almost all the respondents explained that "cyclone" is a synonym for "tornado." Many respondents said "cyclone" is the word used for "tornado" in the western part of the United States. Several respondents compared this regional variation in terminology to the difference between "typhoon" and "hurricane." They explained that a typhoon is a hurricane located in the Pacific, since hurricanes occur only in the Atlantic.

## Visitor Understandings about Climate and Landforms

One of the first issues we explored with visitors is the relationship between weather and climate. When asked directly, respondents explained that weather and climate are distinct phenomenon. Most respondents described weather as day-to-day changes in temperature, precipitation, and cloud cover. Climate was described as the relatively stable, long term patterns in temperature and precipitation over time. One respondent described the distinction in this way:

*I would say climate describes the general type of weather in a given region of the globe over the long run. I guess, the long run being probably a couple thousand years, or something like that. Whereas, weather pertains to the expected changes within that climate, which would occur from day-to-day, or even hour-to-hour. So climate is sort of the general expectations of what it's going to be like in a given region.*

A few respondents addressed specific connections between weather and climate. For example, one respondent explained that the warm, hot and humid climate in Florida creates the frequent afternoon showers found in that region.

A few people recalled climatic types from school such as "tropical, temperate, arctic," but most respondents used descriptors such as "hot," "cold," "rainy," or "dry" for climates that prevail in a given region. A few respondents explained that "plant life differences" distinguish one climatic region from another. For example, one visitor pointed out that tundra can be found on the mountains in Colorado as well as the arctic. While these regions are located at different latitudes, they have similar elevations and therefore similar plant life.

Respondents proposed several explanations for differences in climate. The most frequent answers were altitude and distance from the equator. Areas near the equator were thought to have a warmer climate, while those nearer the poles were thought to be cooler. Respondents also thought that high elevations tended to have cooler climates than lower elevations. A few respondents explained that the tilt of the Earth has something to do with climate. This teenager explained,

*It's the tilt--the tilt of the earth. In the winter Chicago is farther from the sun than Florida. I learned this in geography this year. [Interviewer: So Chicago is farther from the sun, and so therefore it's colder?] Yeah, because the sun has a greater angle to hit the earth at. And its rays have a longer time to lose all of their kinetic energy. It's all related.*

Most respondents could not explain in great detail the underlying reason for their observations.

One respondent explained that there can be variations within a climatic zone. For example, Seattle is at the same latitude as Chicago, but it is much warmer. He believed this was because the "Japanese current" moderates the temperature. Another visitor gave this example:

*Weather--I would constitute as like rain and snow and storms and if it's sunny or not. And I would constitute that more on a daily basis. Whereas, climate would be more of a constant sort of regional thing. Although [within one climatic region there might be]... rain in certain [areas] like the rain forests in the northwest.*

Several respondents suggested that geographical landforms such as oceans, lakes, rivers, and mountains affect climate.[1] The Pacific Ocean and the Gulf Stream were mentioned a few times as factors which "moderate" the climate and increase rainfall along coastal areas. For example, one visitor group explained:

> *Visitor #1: [T]rade winds like carry storms, and if you have mountains in the way, they're going to ram one side and not the other. I learned that in geography this year.*
>
> *Visitor #2: They [Californians] have the sea winds and the mountains, and the sea winds like trap anything that would try and get out of there, so that's why they have all that pollution. It's like trapped between the sea winds and the mountains.*
>
> *Visitor #3: And then in Seattle, why it's always raining, because it's on this side of the mountains, and then on the other side there's nothing.*
>
> *Visitor #4: And then desert. There's always desert on the side of the mountains where there's not sea, so the Rocky Mountains block it.*

As in this example, respondents often mentioned that mountains "trap" storms on one side, leaving the other side dry.

Because most of the respondents interviewed were from the Midwest, "lake effect snow" was cited frequently as an example of how landforms can affect weather and climate. Explanations for the lake effect usually resembled this visitor's statement:

> *The lake effect [is] picking up moisture, going across [the lake]. The Canadian air blows across the lake, picks up moisture, and then dumps it on the land.*

Overall, respondents saw a correlation between weather and landforms, although their understandings were general and they were unable to explain some processes in detail.

### Visitor Understandings about Global Warming and Climate Change

All of the respondents defined global warming as a process whereby the Earth is "warming up." Respondents expressed three points of view about global warming, which were not necessarily mutually exclusive. Most respondents said that global warming is a reality with potentially harmful effects. They tended to think that global warming is the outcome of human action. These respondents used a wide range of evidence to support their belief that global warming is a reality. Milder winters and decreased snowfalls over the last several decades were cited frequently in these interviews as support for global warming theories.

[1] Interestingly, forests were never mentioned as a landform affecting weather or climate.

A few respondents were skeptical about the quality and quantity of evidence for global warming. These visitors were not sure if global warming is a reality at this time, though they did not deny the possibility that it might exist in the future. A third view, espoused by only a few respondents, argues that climate change is a natural and inevitable process. These respondents argued that global warming is part of a natural warming and cooling cycle. These respondents believed that humans have little effect on global temperatures.

Almost all of the respondents who believed that global warming is already occurring attributed the phenomena to human-made pollution. Most respondents explained that the "burning of fossil fuels" causes global warming. CFCs, spray cans, production of methane gas by cattle, and cars were frequently cited as culprits. Descriptions of the connections between pollution and global warming were diverse, and often confusing. Most visitors espoused the human-caused model for global warming and tended to lump global warming, the greenhouse effect, and the ozone hole together, describing these phenomena as human-caused processes which interact to raise temperatures. Below are some examples of visitor explanations for global warming, illustrating the wide range of understandings and areas of confusion:

**EXAMPLE 1**

*A:* *Well, the ozone hole is what we're causing from all the — I can't think of a technical term — from all the gases that we're emitting. You have the climate change because of global warming. We are losing our ozone layer.*

*Q:* *So climate is changing because of global warming?*

*A:* *Oh, the greenhouse effect. We're not able to release the heat. The heat is being trapped. We're not releasing the heat any more from the earth.*

*Q:* *Okay. So we can't release the heat because of the greenhouse effect? And so what's happening?*

*A:* *Because of the loss of the layer, the ozone layer, the loss of it, we're, it's sending in more UV rays. I hope I remember this right. We're sending more UV rays, and it just, it's making us heat up more.*

*Q:* *And so we're getting hotter. And then, you were saying something about the heat gets trapped. Why does that happen?*

*A:* *What I remember is it's just reflecting back off where the ozone layer is.*

*Q:* *So the heat's getting trapped because the heat is reflecting off--*

*A:* *It's rising, but just it reflects back down and keeps us [warm]....So that's where the climate change comes in, I guess.*

**EXAMPLE 2**

*If we made a lot of the hot air on the earth, like the car or something, the air-conditioner, like that, our earth will become very warm....I don't think it's good. Because if you made a lot of the warm weather and the earth will become very warm, and it will influence the weather change...Because [with global warming] the sunshine goes through to the earth directly. The ice laying on the pole, the North Pole and the South Pole will become melt[ed]. It cannot adjust, the weather cannot adjust [to] that, so it would make the global warming.*

**EXAMPLE 3**

*Well, there's more people and there's more industry, and that's produced more pollutants that have gone up into the atmosphere and created a layer in the ozone, and stopped the temperature from being able to change quite as drastically as it used to. Or it's made it warmer. It's caused the ice caps to melt and the oceans to expand.*

**EXAMPLE 4**

*Q:* *Now how about the other one? Global warming. What have you heard about that one?*

*Visitor #1:* *Is that when like the icebergs and stuff are going to melt over time?*

*Visitor #2:* *The temperature's going to increase.*

*Visitor #1:* *The icebergs will melt or something.*

*Visitor #2:* *And it will cause flooding or something, I guess.*

We also talked to a few respondents who believed that global warming is part of a natural cycle of the Earth. Some of these respondents acknowledged a human factor in global warming, but asserted the inevitability of periods of warming and cooling. One woman explained:

*And climate change is being blamed [for global warming]…Ah, climate changes all the time, from Ice Ages to global warming. And the pollution is blamed for that, El Niño is blamed for that. I think it's just cyclical, and it happens, and as much as we try to affect the atmosphere, I think that the whole idea of weather is probably bigger than what we are. That weather happens, no matter what we do to hurt or help it. And it would be better if we didn't hurt it, but climate change is going to happen.*

Visitors were asked about the potential impact of global warming on their lives and the Earth. Many respondents explained that global warming will result in flooding and the melting of the ice caps. One respondent acknowledge that she has already been impacted by global warming and said that some of her trees have died because of increased pollution, and that her flower growing season has lengthened. Several respondents also mentioned concerns about increased cancers due to the ozone hole.

One of the most interesting interviews about global warming was with a couple who believed that ozone depletion and global warming are interconnected. They were particularly worried about health effects. The man also acknowledged his confusion and the impact of media reports on his awareness of the issues.

*A: I think I've heard it [global warming] so much that I don't even notice it anymore.*

*Q: You hear it all the time?*

*A: I think it exists. I feel it exists very definitely when I feel the [sun]. [I]t appears that the sun itself,...all year round is more intense....I wear sun glasses all year round. It's not a disease, not a problem. But my eyes are very light sensitive, and I feel like the glare and the harshness of the sun is more. I'm much more protective of my skin with sun tan lotion. It definitely takes a much shorter time to tan or burn, especially unprotected. Face, nose, shoulders, and so forth. There's no doubt in my mind. Now that's a matter of ozone, I believe...So, you know, my take on it is that with a more intense sun, that is also contributing to the global warming in that we have a more harsh direct heat during the day. But I guess with the lack of.....you can tell that I'm not a professional here at all about the weather....See, if we had ozone then the heat would be trapped in. I guess I don't know exactly how that works. I'm a little bit a victim of pop culture, plus words that they throw out. I thought I understood it at one time, and now I've forgotten it too, and so on and so forth.*

## Visitor Understandings about Ice Ages

Respondents were asked to talk about what they knew about "the Ice Age" or "ices ages," and what kinds of associations they made with the term. Some of the images elicited during the interviews included:

- Cave-men frozen in blocks of ice
- The carving out of lakes due to glaciation
- Local topography in Wisconsin and Michigan
- Glaciers receding due to global warming
- Thin topsoil and rocky deposits in Michigan due to glaciation

- The contrast between global warming and global cooling
- Animals of the Ice Age
- Human adaptations to the Ice Age
- A frozen landscape
- Dinosaurs

Most respondents talked about *The* Ice Age and tended to associate "The Ice Age" with the most recent ice age. Most respondents, however, were unable to provide dates for the ice age they were describing. Some people suggested that the ice age occurred "before the dinosaurs." Others suggested that the ice retreated about 10,000 years ago. Other guessed that the most recent ice age ended 60,000 to 1 million years ago.

A few respondents were more familiar with the topic. One school boy explained that there have been several ice ages during the Earth's history. He drew what looked like a sine curve in the air, and said that we are at the peak of a warm period, in between cold periods. One other respondent suggested that the "cooling and warming of the Earth is a cyclical phenomenon." Another respondent explained that fossilized sea material found in Minnesota proves that there has been more than one ice age.

Respondents were also asked to comment on some of the possible causes for an ice age. Most visitors were unable to suggest hypotheses about the causes of ice ages. However, a few respondents had some ideas about the causes of glaciation:

- Not enough sun
- Changes in how many degrees the Earth is tipped on its axis; the rotation of the galaxy creates dust clouds around Earth which caused ice ages; continental drift and ocean currents [All from the same visitor]
- A meteor striking the Yucatan peninsula

In general, respondents were largely unfamiliar with the causes of glaciation. When asked directly if there has been more than one ice age, some respondents said they remembered learning that there have been several "ice ages," though they could not provide any details. Only one or two visitors expressed an understanding of the term "periodicity," though in these cases, they correctly defined the term in the context of cycles of global cooling and warming.

### Where Visitors Get Their Weather Information

Most respondents indicated that they got their weather from the TV, especially the Weather Channel. A few visitors mentioned reading weather reports in the newspaper. Our sample also included two respondents who obtain information about weather from other sources. One was a teenage boy whose family volunteers as weather observers for a local TV station. This respondent regularly collects his own weather data. A second visitor listened to the Weather Channel on his radio and installed a weather alert system on his motorcycle. He said that he has escaped severe storms on several occasions by listening to the storm warnings.

Most visitors respondents listened to the weather to get information about temperature and precipitation, and said that they were reasonably pleased with their sources of information. In contrast to these weather consumers, several respondents voiced negative opinions about the reliability of weather forecasting, and the choice of topics on the weather broadcasts. For example, this visitor respondent had strong opinions about weather forecasting:

> *I don't like wind chill reports. I think it's stupid, you know... [L]eave out wind chill...Well, I like to know the current and expected temperature. If it's windy and of course if it's humid, precipitation or not, then I can kind of ascertain from there just how comfortable I'm gonna be....I need to know more than just the wind chill. What is your effect on bare skin? Well, we're all pretty well covered up. And if you've been alive this long and you don't know to cover up, well, then, you know, either your parents didn't teach you, or you're a kid and your parents should teach you, or something. The wind chill is just a flashy hype. It's kind of annoying, actually.*
>
> *There's one guy in town, he does a fabulous job. But he gets into these wild charts of isobars and barometric pressure. He's got the whole North American continent...I don't understand what he's saying, but it really is entertaining. But he gets to barometric pressure and isobars and stuff. I think they're related. And his map. It's really impressive. And he does explain it, you know. But if I didn't see that, I don't think I would be missing anything from what I need to know about the weather.*

Several people talked about how the media hype around El Niño has adversely affected their confidence in weather forecasting. Several respondents observed that over the course of the last year or two, meteorologists "blamed" all unusual weather events such as mudslides, heavy rains, and strange temperatures on El Niño. These respondents believed that no one really understands El Niño, and they expressed their frustration at hearing so much about it:

> *Well, I think we've been El Niño'ed to death...It was explained a lot better, I think, through the weather channel and other news programs in the last couple of years about...It's almost a given cliché.*

A second visitor had similar thoughts:

> *I think [El Niño] it's some guy that everyone blames everything on....[I] hear a lot [about it], and when nobody knows the answer, that's who they blame.*

Several respondents explained that they had their own methods for predicting weather, which they find to be as reliable as those used by meteorologists. One visitor said he likes to use what he calls the "old way" of predicting weather. He recited the following rhyme by way of explanation: *Red sky at night, sailor's delight. Red sky in the morning, sailors take warning.* He explained that when the sunset is red, the next day will be clear, not overcast. If the sky is red in the morning, a storm is approaching. He said that he doesn't have much faith in the second half of the rhyme, but the first part is quite accurate in his view.

Another visitor from Colorado explained that she gets up every morning and looks west over the mountains for her forecast:

*Visitor #1:* *I find at least in Colorado, one of the best ways to find out what the weather's going to be is to look over the mountains and see what's over there...It can clear up a lot of questions for you...We look west. We're on the east side of the mountains, we look west. And the weather comes from the west...And they can have a lot of fancy forecasts, but usually if you look towards the west, you'll know if it's going to be windy later in the day, and a lot of different things.*

*Visitor #2:* *You can see if thunderstorms develop.*

*Visitor #1:* *You can see the snow coming.*

*Q:* *How do you know if it's going to be windy?*

*Visitor #1:* *There's thin, very thin--*

*Visitor #2:* *A wall of clouds, right behind [the mountains]. A very dense, dense straight wall of clouds.*

*Q:* *That means wind?*

*Visitor #2:* *Wind.*

*Visitor #1:* *And there's also the thin, the real thin clouds, is when it's really coming...And we don't fool around with the wind there. This is wind...Serious wind. Yeah, we get 100 mile an hour winds.*

Respondents also mentioned pain in joints and bones, the color of the clouds, and *"when my hair stands up on my arms"* as good methods for predicting weather changes. One of the other popular means of predicting weather involved animals. A few respondents explained that farm animals such as cows always lie down when they sense an impending storm. Other respondents mentioned their housepets' activities as good predictors of impending storms. Finally, a few respondents mentioned their faith in the predictive ability of the Farmers' Almanac.

## Personal Connections to Weather

We were also interested in gauging how respondents felt about weather and what sorts of connections they had to the topic. The following section describes visitors' associations with weather.

Weather Narratives and Descriptions of Weather

Respondents tended to describe current weather as "good weather" or "bad weather." For the most part, "good weather" connoted sunny skies, and relatively warm temperatures. "Bad weather" indicated rain, storms, and high humidity. A few visitors explained that their assessment of the weather depends on what kind of activity they had planned for the day:

*Visitor #1:* *Well, if I wanted to go skiing and it was sunny and warm, that would be bad weather. But I would never, never want to go skiing, so to me that would never be bad weather.*

*Visitor #2:* *For me, yesterday, it could be like that all year round and that would be perfect.*

*Q:* *Is there a time when you ever think of it as perfect?*

*Visitor #1:* *I like it a little warmer than that, like 70s, low 80s, low humidity.*

*Visitor #2:* *I try to ride my motorcycle as much as I can, so when it's just, you know, 65, 70 degrees, it's perfect. It's not too hot, it's not too cold, the sun's out. It's great.*

When asked to talk about their own experiences with weather, respondents tended to tell stories about unusual weather occurrences, large storms they witnessed, and hardships incurred by weather. We heard a number of stories about blizzards, floods, and lightning. We also heard some weather folktales. One Taiwanese visitor, for example, related an ancient Chinese legend told by parents to their children about a typhoon that will "come and get them" if they misbehave.

Weather as an Experience That Can Be Felt, Seen, and Heard

Many respondents thought of weather first and foremost as something which can be felt, seen, and heard. In other words, respondents described weather as a natural phenomenon with a sensory dimension. One mother, for example, explained to her son that "storms" and "blizzards" belong in the "weather pile" because they are things that you can observe, as opposed to low pressure which is invisible. Another respondent explained that rain, lightning and storms are her favorite part of weather because they excite her senses:

*[T]hat's the part of the weather that I like the best, because it's dramatic and you can feel it, you know, it's this sensual kind of experience....[Y]ou use your other senses besides just your sight. It's hearing the sound, and the feel of the rain, and the wind. All the different [senses]...*

How Weather Affects Visitors' Lives

All of the respondents found it easy to talk about the ways in which weather affects their lives. Most explained that the weather affects what they wear, what kinds of activities they will do that day, where they will go, and their choice of transportation. A few respondents also spoke of the impact of the weather on business and the economy. For example, one woman works in a community where winter sports fuel the local economy. She explained that when her community has a warm winter or little snow, the community suffers economically.

Respondents also mentioned the impact of weather on their choice of recreation, i.e. skiing, hiking, outdoor sports, and travel. A few visitor groups also talked about some of the Hollywood movies dealing with weather, namely *Twister* and *Waterworld.* The special effects in these movies were popular with these visitors.

Temporal Frameworks

Our interviews revealed that some respondents think of weather as a natural process with a temporal component. Over the course of the interviews, we were able to identify several temporal frameworks structuring how some people think and talk about weather.

1. ***The seasons***. The most common way of talking about the connections between time and weather was to speak about "the seasons." During the pile sort, many visitors placed "seasons" with "climate change," explaining that the climate changes annually in a given locale over the course of a year. For example, when we asked one visitor to predict what the weather will be like in Chicago in December 1999, he said that it would be cold and snowy because December is in the winter, and winter is snowy and cold.

2. ***Storm season***. The second temporal framework associates seasons and storms. Some respondents placed the word "seasons" in a pile with the words, "tornado," "hurricane," "blizzard," and "typhoon." These respondents explained these catastrophic storms occur during certain months of the year, on an annual basis. They used terms such as "hurricane season," and "tornado season." One visitor described catastrophic storm events as "short term" weather events, while seasons and climate change are longer term processes.

3. ***Visitors' life-cycle.*** The third framework is a life-cycle framework. Several respondents made comparisons between contemporary weather and what they remember about the weather when they were a child. We discovered that most adult respondents claimed that the weather of their childhood was different from the weather in adulthood. When asked to elaborate, people talked about big snow storms and floods they remembered from childhood.

   A number of respondents also explained that as they get older, they become more affected by the weather. Their choice of daily activities become more dependent on the weather.

4. ***Methods of comparison***. We also discovered that respondents used several methods for comparing the weather from year to year. Some of the most popular gauges include the

number of snow school days, the number of times they could engage in their favorite outdoor activity last year, and the number of days over 100 degrees.

Mood and Emotion

Several respondents explained that the weather affects their mood and emotions. Most of these respondents explained that bright sunny days, both warm and cool, made them feel active or happy. Cold, rainy, dark days tended to be associated with depression, "hibernation," and rest. Storm seasons were also associated with fear and unease.

**Example 1**

*Q: And how do you describe the weather today?*

*A: Disgusting.*

*Q: What do you find disgusting about it today?*

*A: It's very depressing. It isn't like rain. No, I like rain. I love rain. I don't like wet without rain.*

**Example 2**

*Q: How do you all think that weather affects you on a day-to-day basis?*

*A: It affects personality. Like if it's gloomy, you don't want to go out or anything, you just want to stay in. If it's sunny, you just want to be active outside.*

**Example 3**

*[ We can also talk about] how they've affected, people's moods. I mean, it's truly gray out. If it weren't warm out right now, I'd be a little depressed. I'm one of those people, I need light, like sunlight. And we don't get enough sunlight. And, what's that sunlight disorder. SAD. Sunlight Affected Disorder, or something.*

A few respondents also talked about the aesthetic value of weather, and the changing seasons:

*I like to see change in scenery, change in weather. The first snow fall is always so pretty to see. Even ice, when we have an ice storm and it coats everything. It's so beautiful even if it's like the most dangerous time to go out. And change of leaves. I lived in California for awhile, so you didn't have very much change of weather. And it did get boring.*

The Forces of Nature

While no respondents talked about the connection between religious beliefs and weather, a few visitors volunteered their thoughts on the relationship between humans and weather. These respondents explained that the weather is a force of nature beyond human control. In most instances, these visitors were the same people who believed that global warming is a natural cycle of the earth:

*A: I wish we could control it [global warming], because then we could move the warm air to the places where it would be needed. And maybe create rain, where there's drought, and maybe get the deserts to flower, and make added living room. I think we have to learn to understand our atmosphere, and in whatever ways we can, to control it and manipulate it. We're not big and strong enough yet to manipulate it. We're just trying to catch up to reporting it.... And we should be a little bit in awe of it.*

*Q: Can you maybe tell me some story or experience you had when you felt in awe of the weather?*

*A: I was in the Grand Canyon, and here's an east coast person that has to look at concrete all the time. All of a sudden, I had all this enormous space around me. And I could see, like, hundreds of miles. And I could see a thunderstorm happening off in the distance, and see how that changed the color...I can just see the rain coming down on the one area and how it affected the color, and the way the light hit the canyon. It was just so <u>big</u>.*

## VISITOR INTEREST IN WEATHER

At the conclusion of each interview, respondents were asked to identify what aspects of weather and climate they would like to learn more about. They were then asked how their interests could be integrated into an exhibit about weather and climate.

Many of the interviews for this project took place during a warm spell in November and early December. Because of the unseasonably warm temperatures, we found respondents eager to talk about what they saw as unusual about the weather. Many respondents described the warm spell as "strange," "crazy," and "weird." Some respondents explained that this unusual period was part of a larger trend of global warming.

Of the topics discussed during our interviews, catastrophic weather events and global warming were cited by respondents as the most interesting topics, and ones they would like to see explored in an exhibit. Tornadoes, hurricanes, and lightning were repeatedly cited as the most interesting aspects of weather. Respondents were especially curious about the causes of these phenomenon. When asked why this topic holds such appeal, visitors explained that these events are *"something different from the norm,"* or *"something I haven't been through."* A group of teenage boys even suggested focusing on *"weird weather facts"* such as *"the largest hail ball ever."* They also suggested that "before and after" pictures of major storms would be interesting.

A few respondents explained that an exhibit about weather and climate would be interesting if it were to address the global connections among weather phenomena  For example, one respondent expressed curiosity about the connection between forest fires, volcanoes, and global weather.

Respondents repeatedly expressed their interest in the topic of global warming and climate change. They were especially interested in predictions about what will happen if global warming continues, and how it might affect their lives.

A few respondents suggested including something about the interaction between human culture and the environment into the exhibit. One respondent expressed interest in the monsoons in India, especially how people in India adapt their life style to cope with the monsoon season. Another visitor said she is interested in how material culture is influenced by weather and climate.  She cited as an example the development of Goretex to protect people from rain, and the different types of houses people construct to protect them from the elements.

A few respondents also expressed interest in learning more about how weather is created, and learning more in depth about what they see on TV weather broadcasts. In particular, these visitors were interested in the causes of high and low pressure systems and fronts.

No respondents expressed interest in the effect of landforms on weather and climate.  A few respondents expressed interest in glaciation and how glaciation shapes the landscape.

## RECOMMENDATIONS

Recommendations as to exhibit content and design follow. We have also included some suggestions for the next phase of front-end evaluation.

- **Help visitors connect with the topic of weather.**

  Most respondents did not find the topic of weather immediately interesting. One way to ensure visitor interest is to incorporate some of the personal connections people have to weather and climate into the exhibit content. Examples of folklore about weather, and local knowledge systems used in forecasting, could easily be integrated into the prospective topics identified by the design team.

  For example, the exhibit team might want to incorporate an oral history project into the exhibit. A small audio library of true and amazing stories about weather could be recorded and made available to visitors. Visitors could also be encouraged to record (in writing, audio tape, or video tape) their own weather story while at the museum.

  Since respondents seemed to enjoy talking about forecasting, the development team may want to develop a kiosk comparing meteorological forecasting and "traditional" forecasting. The team could select some of the folk knowledge uncovered in this study and explain the scientific basis for these common sense forecasting methods. For example, one part of the exhibit might talk about how the Farmer's Almanac is written. Another part might attempt to explain why cows lie down before a storm.

- **Use sensory experiences to attract visitors.**

  As noted earlier, respondents connected with the sensory experience of weather (i.e., things they could hear and see). Some respondents suggested making the exhibit interactive, with wind, rain, and lightning, in order to get people inside the exhibit to learn more.

- **Incorporate a section on catastrophic weather events.**

  Respondents had a very high level of interest in finding out more about catastrophic weather phenomena such as tornadoes, hurricanes, and lightning storms. The exhibit team should consider adding a component that allows visitors to explore the causes and consequences of such events.

- **Include an exhibit cluster exploring global warming and climate change.**

A large number of respondents thought of global warming and the depletion of the ozone layer as related phenomenon. These respondents also expressed concern for the long term effects of global warming and the depletion of the ozone layer. Respondents expressed interest in

seeing an exhibit cluster which addresses both phenomena. This exhibit cluster could also address some of the misperceptions held by respondents about these phenomena.

Such an exhibit might explore issues of responsibility for the causes of and prevention of further climate change.

- **Realize that an exhibit cluster about glaciation may be more difficult for visitors than natural disasters and global warming.**

Most visitors demonstrated little understanding about the causes of glaciation and had little interest in the topic. This suggests that visitors' "starting point" on this subject will be much lower than for the other topics under consideration. Visitors may need more information and "input" from the exhibit in order to interact in any significant way with a computer simulation.

- **Consider incorporating information on El Niño.**

  We found a high level of familiarity with El Niño, though most respondents could not explain what it is, how it works, or its relationship to weather and climate. Perhaps one exhibit cluster could examine the limits of scientific knowledge of El Niño.

  Interviews also revealed a wide range of opinions about the capability of modern meteorological forecasting. This issue, while not identified in the topical framework, is important to visitors. Perhaps this issue could be addressed in the context of an examination of El Niño.

- **Expand the interview sample and time frame for interviewing for Phase Two.**

  In Phase Two, we would like to interview children about their beliefs and knowledge about weather. As we discussed earlier, the number of small children was limited in this sample. Since the exhibit will be designed for family groups, it will be important to incorporate children's points of view and levels of understanding into the design of the exhibit clusters.

  We also plan to interview family groups about weather during warmer weather. Since we conducted these interviews over the course of a two month period this winter, many of the discussions with respondents touched on winter weather phenomena. Conducting some front-end interviews during warmer weather may help to increase our understanding of vistiors' understandings and personal connections to spring and summer weather.

  We should also consider conducting interviews with classroom teachers, since they are a primary target audience for this exhibit. These interviews would need to be conducted either in the school or over the phone, since school teachers are too busy to be interviewed while at the museum.

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**APPENDIX A**
**Topical Framework**
**Atmospheric Explorations**

## I. Visitor Understandings

### A. General

1. How do visitors think about weather and climate?
2. In what ways do they describe the differences and similarities between and among weather and climate?
3. To what extent and in what ways are they interested in weather and climate?
4. What kinds of associations do visitors make among climate, weather, landforms, and oceans?
5. Possible words for a card sort activity: high pressure, low pressure, front, cirrus clouds, stratus clouds, cumulonimbus, rain, jet stream, thunderstorm, blizzard, pressure gradient, ozone layer, greenhouse effect, periodicity, blizzard, pattern, climate change, storm, cyclone.

### B. Weather

1. How do visitors tend to think about weather?
2. Given a weather map, how do they interpret it? To what extent and in what ways do they feel confident in their ability to interpret a weather map?
3. What is the range of ways visitors tend to get their weather information?
4. To what extent and in what ways do visitors understand the following weather concepts:
   - ✓ The jet stream
   - ✓ The relationship between the jet stream and the weather
   - ✓ The movement of storms and weather patterns
   - ✓ Daily weather changes
   - ✓ Highs, lows, and fronts
   - ✓ Rain and clouds
5. What are the indicators that visitors use to gauge changes in weather and to make predictions about weather?

### C. Climate

1. How do visitors tend to think about climate? What about climatic influences?
2. To what extent and in what ways do they think about climate change over time? How do they think about the causes of climate change?
3. How do visitors think about Ice Ages? Global warming? The Greenhouse Effect? The relationship between oceans and climate?
4. To what extent and in what ways are visitors aware of the scientific and political controversies surrounding global warming? What opinions do they have?

## II. Personal Connections

1. What are the range of ways visitors think about weather and climate?
2. Where do visitors tend to get their information about weather?
3. How do visitors feel about weather?
4. How does weather affect the day-to-day life of visitors?
5. What emotions and memories do visitors associate with weather and climate?
6. What connections do visitors draw between weather, climate, human health, making a living, human survival, habitat, extinction, and religion?
7. How strong are these connections?

## III. Visitor Interests

1. What kinds of questions do visitors have about weather and climate?
2. What do visitors think is confusing about weather and climate?
3. Which weather and climate topics are interesting to visitors?

## APPENDIX B
## Visitor Groups Interviewed

| Respondent | Age | Sex | Ethnicity/Race | Social Group | Socioeconomic Status | Home Town |
|---|---|---|---|---|---|---|
| **112801** | 40, 18, 15 | 3 males | white | father and sons | biology teacher and high school students | Iowa |
| **112802** | 35 | 1 female | white | lone female | monitors clinical trials for medicines | Atlanta |
| **112803** | early 40s | 1 male, 1 female | white | married couple | middle class; probably college educated | Waukegan |
| **112901** | late 20s | 1 female | white | lone, waiting for friend | assistant manager of a development company | N. Michigan |
| **112902** | mid 50s | 1 female, 1 male | white | married couple | middle management; computer industry; both with university degrees | Colorado |
| **112903** | early 20s | 1 female, 1 male | white | girlfriend and boyfriend | teacher, and motorcycle salesman; army reserve | Valparaiso, IN |
| **120101** | late 30s, 5th grade | 1 male, 1 female | white | mom and son | mom self employed | Detroit |
| **120102** | 70s | 1 male | white | man with son (but son was not interviewed) | owns a cash register company; big motorcycle fan | Rockford, IL |
| **120103** | 18, 17 | 1 male, 1 female | African American | girlfriend/ boyfriend | college, just graduated high school | Chicago |
| **120501** | 11, 15, 18 | 3 males | white | with boy scout troop | in school | Kenosha WI |
| **120502** | mid 30s, 11, 11 | 2 males, 2 females | white | adult brother and sister, sister's daughter and daughter's pen pal | sister in army, kids in school | Alabama; brother from IL |
| **120503** | 14, 9, 8, 9 | 4 males | African American | brothers and friend | school | Chicago |
| **120504** | early 20s | 1 female, 3 males | 1 white, 3 Asian American | college friends | college students | Indiana |
| **120601** | early 20s | 3 females | white | college friends | college students | Columbus Ohio |
| **120602** | early 40s, 6th grade | 2 female, 1 male | white | parents and their daughter | mom is a radiologist, dad a high school counselor, daughter in school | Appleton, Wisconsin |
| **121601** | early 20s, mid 40s | 1 male, 1 female | white | mom and son | buyer for a tool company, college student recently graduated | Chicago |
| **121701** | mid 40s | 1 female | white | adult visitor | food scientist | Cincinnati |
| **121702** | mid 20s | 2 females | Taiwanese | two friends | one graduate student, one child educator | Kalamazoo, MI and Taiwan |
| **121703** | 16, 16, 16 | 3 males | 2 white, one Asian American | friends in town for All State Orchestra | high school students | Dallas, TX |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | contest | | |
| **121801** | 16, mid 20s | 2 females | African American | sisters | high school student, digital artist | Chicago |

| | |
|---|---|
| Total number of groups interviewed | 20 |
| Total number of individuals interviewed | 47 |
| Number of groups with children under 18 | 8 |

| **Respondents by Race/Ethnicity** | |
|---|---|
| Asian American | 4 |
| White | 33 |
| African American | 8 |
| Taiwanese (foreign) | 2 |
| **Total** | **47** |

## APPENDIX C

### Concepts Used in the Pile Sort

Visitors were presented with a stack of index cards, each of which had a word printed on it related to weather and climate. Visitors were then asked to sort these cards into categories which made sense to them, and to explain why they did so. This method revealed respondents' understandings of weather and climate, and the connections they made between the various concepts.

The concepts used in the pile sort included:

| | | | |
|---|---|---|---|
| greenhouse effect | atmosphere | environment | ozone hole |
| front | weather | weather pattern | climate change |
| low pressure | sunshine | high pressure | El Niño |
| storm | blizzard | clouds | climate |
| typhoon | glaciers | ice age | ozone layer |
| rain | lightning | periodicity | global warming |
| seasons | pressure gradient | glaciation | jet stream |
| hurricane | tornado | | |

## APPENDIX D
## Weather Map Used in Interviews

**See Next Page**