

Fronts & Forecasts: Workshop

Introduction for the Presenter

We have all been let down by a local forecast that did not accurately predict rain at some point in our lives. Weather forecasting is a difficult, inexact science. On a global scale, colliding air masses drive weather systems, but how those systems play out local is a factor of geography added to the local and global pressure, temperature, and moisture differences playing out,

While accurate weather prediction is difficult, there are some methods for prediction that provide usable, if not perfectly accurate, results. This presentation focuses on the “trends” method of weather forecasting. In the trends method, forecaster identifies a front moving towards the area, looks at the speed at which that front is moving, and calculates when that front will arrive at his or her location. Students experiencing this presentation learn to identify fronts and learn that the speed and direction in which a front is moving can give you a starting point for predicting weather.

Learning Objectives

- Students will understand that fronts form where air masses collide.
- Students will identify fronts in satellite data.
- Students will predict whether or not a front will make landfall in the Bay Area.

Estimated Time

40 minutes

Playlist

Fronts & Forecasts: Title Screen
Fronts & Forecasts: Introduction to Scenario
Fronts & Forecasts: IR Clouds to March 24
Fronts & Forecasts: GLAPS Surface Temperatures
Fronts & Forecasts: Fronts Animation – Cold Front
Fronts & Forecasts: Fronts Animation – Warm Front
Fronts & Forecasts: Fronts Animation – Occluded Front
Fronts & Forecasts: IR Clouds with Fronts
Fronts & Forecasts: Color Enhanced IR Clouds
Fronts & Forecasts: Equitemporals
Fronts & Forecasts: March 24 Punchline View Cam
Fronts & Forecasts: Punchline Satellite View
Real Time: Color Enhanced IR Clouds
Fronts & Forecasts: Credits

Presentation Script

Stage directions in italics

Load Fronts and Forecast Docent Playlist. Load title screen.

Presenter: Welcome to _____. My name is _____. Today, we will be using the Science on a Sphere to predict the weather. Science on a Sphere was developed by the National Oceanic and Atmospheric Administration. The image you see is projected from four projectors

Presenter points towards the projection towers.

Presenter: The sphere its self is a six-foot diameter fiberglass sphere.

Pause here for any questions about the SOS.

1. Title Screen and Setting up the Story

Presenter: And now, let's get started with Fronts and Forecasts....

Move to Fronts & Forecasts: Introduction to Scenario

2. Clouds over the last few days

Load & Pause Dataset:

Presenter: Let's start by looking at the clouds during the few days leading up to this event. These images of clouds are created by measuring the infrared light emitted from the Earth's surface. When there are clouds, they absorb the radiation emitted by the Earth below and emit their own radiation at a much cooler temperature. Any area that has clouds shows up cooler than the ground, allowing us to digital model these clouds.

Let's watch what happens over the few hours up to the afternoon we are trying to make the decision.

Load: Fronts & Forecasts: IR Clouds to March 24

Presenter: So what are your initial thoughts? Do you think it is going to rain?

Give the students a chance to share their ideas about whether or not it will rain. Ask students to explain their reasoning. If it does not come up in discussion ask the following question.

Presenter: Do clouds in the sky always mean that it is going to rain?

Give students a chance to explain that they have seen clouds in the sky that did not lead to rain.

Presenter: We're going to step back from our local forecast for a bit and look at some patterns effecting weather that will help us recognize cloud systems that are more likely to lead to rain.

3. Uneven heating of the earth

Load Fronts & Forecasts: GLAPS Surface Temperatures

Presenter: You are looking at an image of the air temperature for the few days before the concert. What do you think the colors indicate? What patterns do you notice in temperature

Give students a chance to share that red is warm, blue is cold, warmer at equator than at poles.

Presenter: The uneven heating of the earth means that there are large masses of air that are cold that move down from the poles and warm air moving up from the equator. The United States is located right where these air masses tend to collide.

Presenter: Now we are going to see what happens when cold air and warm air collide.

*This is where we complete **Hands-on Demonstration: Front Boxes**. Full instructions appear at the end of the script. Break the students into as many groups as you have front box stations. Assign an adult to be with each group as possible.*

4. Cold Front

Load Fronts & Forecasts: Fronts Animation - Cold Front

Presenter: Let's look at how colliding air masses play out in the atmosphere. Here are three examples. The first is when a cold air mass overtakes a warm air mass. As the cold air catches up with the warm wet air, the warm air is pushed into the upper atmosphere. The air cools rapidly, the water condenses, and sudden heavy rainfall and thunderstorms occur. Tornadoes can occur when the temperature difference between the two air masses is particularly large

5. Warm Front

Load Fronts & Forecasts: Fronts Animation - Warm Front

Presenter: Now let's look at what happens when a warm air mass overtakes a cold air mass. As the warm air runs into the cold air, it rises slowly over the top of the cold air mass, cooling slowly. Warm fronts can produce light rain over a long period of time.

6. Occluded Front

Load Fronts & Forecasts: Fronts Animation - Occluded Front

Presenter: This is called an occluded front – when a cold front immediately follows a warm front. This kind of front can lead to a lot of rain.

7. Fronts in the IR Cloud Data

Presenter: Let's look at what fronts look like in the satellite data. In our satellite cloud data, you can't tell whether it is a warm front or a cold front, but you can identify fronts.

Load Fronts & Forecasts: IR Clouds with Fronts Highlighted

Presenter: We are going to watch some cloud formations to get a sense of what front look like. Blinking purple lines will appear on some sample fronts. What do you notice about the shape of the fronts?

Give the students a chance to share what they notice about the shape of the fronts.

Presenter: Fronts generally show up as a clear line of clouds, some times straight, sometimes with the ends curving and being to wrap in on itself. Let's take a look at the days right before our concert and see if we can find some fronts coming into California.

Load: Fronts & Forecasts: IR Clouds to March 24

Presenter: What do you notice? Do you see any fronts off the coast of California?

Give students a chance to point out fronts.

8. IR Color Enhanced Clouds

Load: Fronts & Forecasts: Color Enhanced IR Clouds

Presenter: This infrared image has been color-enhanced to give us more detail about the data. Remember that we can model the location and shape of clouds in

the infrared because they are cooler than the surface of the earth. Temperature can also be used to give us even more information. The height of clouds is inversely proportional to temperature, meaning that the tallest clouds are the coldest. It is often the tallest clouds that bring the most severe weather. In this image, the white clouds are low lying, the purple clouds are taller, and the blue clouds are the highest and most likely connected to severe weather.

Now that we can recognize fronts and we know that fronts tend to bring rain, we are going to use a simple weather forecasting method called “trend forecasting” to decide whether or it will rain during our outdoor concert. In trend forecasting, you need to know the direction a front is traveling and how quickly it is moving towards your location.

9. Making the Call

Load: Fronts & Forecasts: Equitemporals

Presenter: It’s 11 am on March 24, and we are trying to decide whether a concert happening outdoors starting at 7:00 pm is going to get enough rain to make it worth paying extra for weather proofing the set. We’ve got a front moving towards us and based on how quickly it’s moved in the last 12 hours, we are able to estimate it’s speed over then next 14-16 hours if nothing changes. The lines on the map show where we predict the front might be using trend forecasting. The zero line is our location right now. Each number lined shows us how many hours from now that weather will reach our location at the Greek Theater in Berkeley.

What do you think? Should our tour manager spend extra money weather proofing the band’s equipment?

Give the students a chance to share whether or not they would cancel the concert and why.

18. Punchline

Presenter: Okay let’s see what happens over the next 8 hours and find out if you made the right decision.

Load: Fronts & Forecasts: March 24 Punchline View Cam

Presenter: Clear blue skies at 11:00 am when you are trying to decide. Now lets watch the rest of the afternoon play out..... 7 pm, it’s getting cloudier. And halfway through the band’s second set – rain, thunder, and lightening and the crowds run back to their cars.....

19. Punchline with Satellite

Load: Fronts & Forecasts: Punchline Satellite

Presenter: Here is the same series in time again from the satellite view. What do you notice about the front as it moves through the San Francisco Bay Area?

Give the students time to share what they notice.

Presenter: Watching the weather change in these two views, the ground camera and the satellite view, shows you how difficult it can be to predict the weather. As the front moves, it changes, stacking up more or fewer clouds and creating ever changing pockets of extreme weather. The kind of forecasting we used in this program is often called “Now-casting” as it is best used for predicting what will happen in the next few hours. As more time elapses, more changes about the weather. Predicting the weather long term involves additional factors and more complex modeling. Small changes in conditions can lead up to big changes over time.

20. Real Time Data

Load: Real Time Data: Color Enhanced IR Clouds

Presenter: Now that you have some practice in recognizing fronts and trend forecasting, take a look at this real time data. You are looking at the clouds over the last month to 2 hours ago. What predictions do you have about what the weather will be like tomorrow where you are?

Give students a chance to share their ideas.

Presenter: There are many more factors effecting weather than we looked at in this presentation. Meteorologists use mathematical models that take temperature, wind speed, changes in air pressure, and other factors into account when making their forecass. Weather is complicated. Small changes in conditions can lead to big changes in outcomes over time.

21. Credits

Thanks, everyone, for participating in today’s presentation and trying your hand at weather forecasting. Keep an eye out tomorrow and see if your predictions are right. And next time you are looking at satellite pictures in your local forecast or online, keep a look out for fronts headed toward your area.

Hands-on Demonstration: Front Boxes

Description: This hands-on demonstration involves mixing warm, wet air and cold air in a clear, plastic box. It works best if everyone in the workshop is able to be right next to a box. We recommend four stations for a group of 20-35.

Materials Needed for each station

- *Two clear plastic boxes, without lids, of equal size.*
- *A container for holding boiling water*
- *A container for holding dry ice*
- *Boiling Water*
- *Dry Ice*



Instructions for doing as one station demonstrations

1. Set each box on its side with the open tops facing each other.
2. Place an open container of boiling water inside one box, and an open container of dry ice in the other one.
3. Have volunteers feel the air temperature in each box with their hands, cautioning them not to touch the ice or the water directly.
4. Push the boxes together. Have the volunteers describe what is happening in the boxes as the two air mass mix.
5. Open the boxes and have the volunteers feel the condensation on the inside of the box. Explain that as the warm wet air is cooled by the cold air mass, the water vapor condenses into droplets.
6. Bring everyone back to the SOS to see what this looks like in the atmosphere.

Instructions for coordinating four or more stations

1. Assign an adult to each station as available.
2. Bring dry ice to each station first and instruct students to feel the air inside the box, but not to touch the ice directly.
3. Bring hot water to each station next, place in the box, and instruct the students to feel the air inside the box. Again, remind them not to touch the water directly.
4. Once all stations have the materials, give instructions to all groups over a microphone.
5. Instruct the groups to push the two halves of the boxes together and describe what they see to the others in the group.
6. Instruct the groups to open the boxes and feel the condensation on the inside of the box.
7. Bring everyone back to the SOS to see what this looks like in the atmosphere.