Weather Forecasting: Lecture 1

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University of Utah

Spring 2017

Overview

Introductions

About Me: Professional

- Ph.D., Meteorology, University of Oklahoma, Dec. 2012.
- Research Assistant Professor
  Mechanical Engineering
  Jan. 2016.
- Work with Rob Stoll and Eric Pardyjak in the Computational and Environmental Fluid Dynamics Research Group.

Since I am a meteorologist from Oklahoma ...

Tornado in the Texas panhandle in 2007

About Me: Research Interests

- numerical tools and methods
- theoretical, observational, and numerical studies of atmospheric boundary-layer flows
- parameterization of boundary-/surface-layer interactions
- numerical studies of slope flows and low-level jets
- other general aspects of geophysical fluid dynamics
- open source LES: MicroHH (http://microhh.org)

Why so formal?

Now that you know my degree and job, save some time talking and writing – just call me Jeremy.

Who are you?

- Your name
- Where are you from?
- Why did you choose meteorology?
- What is your academic standing?
- Do you have any experience forecasting?

Syllabus

Instructor

How to contact me:

- Email: jeremy.gibbs@utah.edu
- Office: MEK 2566
- Hours: By appointment (email or stop by)

Course websites:

- Canvas - (grades, notes, etc.)
- http://gibbs.science/forecasting - practicum, notes, etc.

Meeting Times

Class schedule:

- Class will be held in WBB 711, Mon and Wed, 11:50a - 1:10p
- We will miss two classes due to holidays. No class:
  - Monday, Jan. 16 (Martin Luther King, Jr. Day)
  - Monday, Feb. 20 (Presidents' Day)

Course Description

- This class provides you with an introduction to the tools and techniques used for contemporary weather forecasting.
- You will analyze and forecast the weather in each class, while I provide a guiding hand and stimulate discussion of forecast issues and techniques.

Course Objectives

- At the end of this course, you should be able to effectively use meteorological observations, numerical weather analysis and prediction models, and statistical forecast tools to produce site-specific sensible weather forecasts in a time-constrained environment.

Class Format

- Two traditional lecture classes
- Practice forecasting
- Forecasting, forecasting, forecasting!

Grading

- Forecast Practicum (accuracy) - 50%
- Participation/Weather Briefing - 25%
- Labs (4 or 5) - 25%

No exams!

Forecast Practicum

- You will produce in-class forecasts for the Salt Lake City International Airport (KSLC) and a floater site selected each morning before class.
- For each site, you will produce a multi-variable forecast covering three sensible weather categories: temperature, precipitation, and wind.
- Forecasts are evaluated using traditional forecast accuracy metrics.

Weather Briefings

- As part of the preparation for the forecast practicum, you will separate into teams.
- Each team will present a total of two forecast briefings over the course of the semester.
- The briefings will be held at the start of each class and should last no longer than 10-15 minutes.

Course Outline

- Jan 09: Lecture 1
- Jan 11: Lecture 2
- Jan 16: No Class
- Jan 18: Forecast Practice
- Jan 23: Forecast Practicum
- Jan 25: Forecast Practicum
- Jan 30: Forecast Practicum
- Feb 01: Forecast Practicum
- Feb 06: Forecast Practicum
- Feb 08: Forecast Practicum
- Feb 13: Forecast Practicum
- Feb 15: Forecast Practicum
- Feb 20: No Class
- Feb 22: Forecast Practicum
- Feb 27: Forecast Practicum

Advice

Advice

- This class will probably feel uncomfortable for you
- You might think of it as a baptism by fire

Advice

- Forecasting is a mixture of science, art, and experience
- This class emphasizes learning by doing
- The best way to learn how to ride a bike is to hop on
- I can help get you started, but how much you learn will depend on your level of engagement

Advice

- Start making practice forecasts now!
- Read the NWS forecast discussions
- Look at model output and statistics
- Use websites and/or Python/IDV/etc
- Examine COMET MetEd modules (see lab 1, due Jan 20) and other online resources

Advice

- Attend class and review material
- Work together
- Share information
- Swap knowledge
- Profit (okay, 4/5 is not bad)

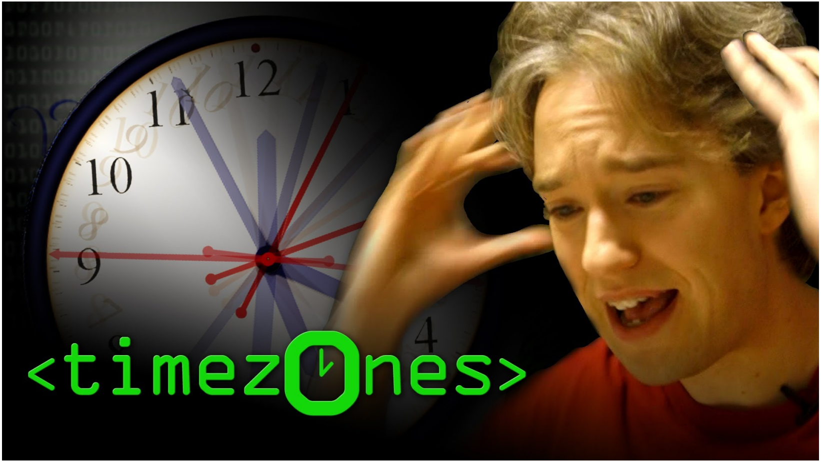
Forecast Practicum

Objectives

- Provide a realistic, time-constrained weather analysis and forecasting experience
- Gain experience with forecast validation, including assessments of forecast accuracy
- Create an environment that simultaneously promotes individualism and teamwork
- Have fun!

Time Conversion

- Time conversion can seem so simple, but can ruin your day



Time Conversion

- MST = Mountain Standard Time
- MDT = Mountain Daylight Time
- Local time is MST in winter (until March 12, 2017) and MDT in summer (until November 5, 2017)
- MDT = MST + 1 (spring ahead, fall back)

Time Conversion

- UTC = Coordinated Universal Time
- UTC is also known as GMT (Greenwich Mean Time)
- UTC is also called “Z” or “Zulu Time”
- MST = UTC - 7 hours
- MDT = UTC - 6 hours

Time Conversion - Examples

0000 UTC 10 Jan

- = 1700 MST 09 Jan
- = 5 PM MST 09 Jan
- = 1800 MDT 09 Jan
- = 6 PM MDT 09 Jan

1200 UTC 09 Apr

- = 0600 MDT 09 Apr
- = 6 AM MDT 09 Apr
- = 0500 MST 09 Apr
- = 5 AM MST 09 Apr

Forecast Categories

- Max Temp (°F, Today, 12Z - 06Z)
- Min Temp (°F, Tonight, 00Z - 18Z)
- Max Temp (°F, Tomorrow, 12Z - 06Z)
- POP(%, 00Z - 12Z)
- POP(%, 12Z - 00Z)
- Wind Speed (kts, 00Z)
- Wind speed (kts, 12Z)

Forecast Accuracy vs. Forecast Value

- Accuracy is the correspondence between forecast and observation
- Value means the economic (or other) benefit to the end user
- We will focus on accuracy, but value is just as important in the real world

Measuring Forecast Accuracy

- Absolute Error and Mean Absolute Error

$$AE = |\text{Forecast} - \text{Observed}|$$

$$MAE = \frac{1}{N}\sum_{i=1}^{N} |\text{Forecast} - \text{Observed}|$$

- Example: you forecast a high of 54°F and 57°F is observed

$$AE = |54 - 57| = 3°\text{F}$$

- The next day you forecast a high of 63°F and 69°F is observed

$$AE = |63 - 69| = 6°\text{F}$$

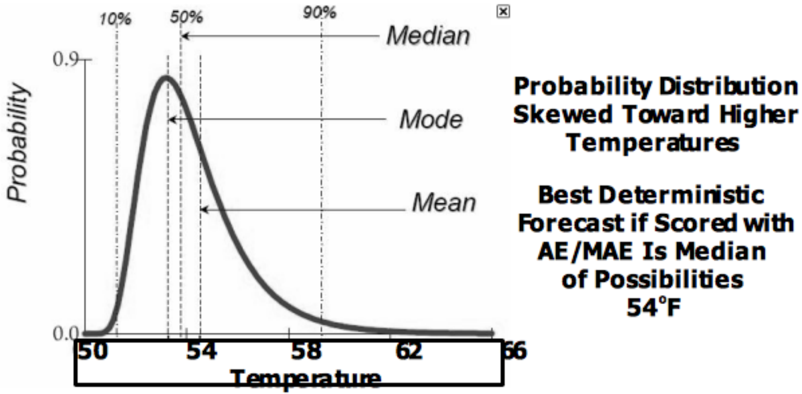
$$MAE = \frac{3 + 6}{2} = 4.5°\text{F}$$

Use of AE and MAE

- For temperature, we will use AE and MAE
- For POP, we will use AE$*10$ and MAE$*10$
- For wind speed, we will use AE/2 and MAE/2

Minimizing AE and MAE

- Forecast the median event of the predicted probability distribution



Measuring Forecast Accuracy

- Square Error and Mean Square Error (Brier Score)

$$SE = (\text{Forecast} - \text{Observed})^2$$

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(\text{Forecast} - \text{Observed})^2$$

- Example: you forecast a high of 54°F and 57°F is observed

$$SE = (54 - 57)^2 = 9^\circ\text{F}$$

- The next day you forecast a high of 63°F and 69°F is observed

$$SE = (63 - 69)^2 = 36^\circ\text{F}$$

$$MSE = \frac{9 + 36}{2} = 22.5^\circ\text{F}$$

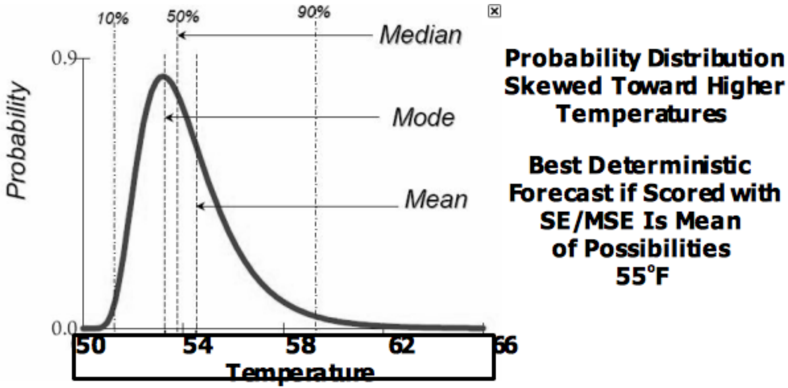
- This strongly penalizes outliers!

Use of SE and MSE

- For temperature, we will use SE and MSE
- For POP, we will use SE$/10$ and MSE$/10$
- For wind speed, we will use SE and MSE

Minimizing SE and MSE

- Forecast the mean event of the predicted probability distribution



Minimizing SE and MSE

- For POP and other possibilities, why not go with 0% or 100%
- Imagine a 1/6 chance of precipitation (like rolling a die). If you go with 0% every time, then you are correct 5/6 times, giving an average error of:

$$(0-0)^2+(0-0)^2+(0-0)^2+(0-0)^2+(0-0)^2+(0-100)^2 = 10,000$$

- If instead you go with 17% each time, then the average error is:

$$(17-0)^2+(17-0)^2+(17-0)^2+(17-0)^2+(17-0)^2+(0)^2 = 8,334$$

- The best forecast is an accurate estimate of the mean of what is possible. Do not go out on a limb.

Questions?