Topics for today:

Hurricanes and Forecasting

Anatomy of a Hurricane

Fig 12-4 Weather A Concise Introduction
Aircraft observations of Hurricane Matthew

https://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=3470&page=5

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Tropical Cyclone: Wind Damage

Winds on the left side blow in the opposite direction as the hurricane is moving. Subtract the two speeds.

Hurricane winds can be increased or reduced along path
Can spin off tornadoes

Fig 11-16 Essentials of Meteorology

Winds on the right side blow in the same direction as the hurricane is moving. Add the two speeds together.

Tropical Cyclone: Seawater

Wind and Pressure Components of Hurricane Storm Surge

Ocean water “piles up” in front of storm due to winds and low pressure

http://www.nhc.noaa.gov/surge/
Tropical Cyclone: Seawater

Storm surge can combine with normal tidal variations
Surge can greatly erode beaches

http://www.nhc.noaa.gov/surge/

Weather Forecasting

People have been trying to predict the weather for thousands of years.

In the past, forecasts were based on experiences and passed down from one generation to the next

“Red sky at night, sailor’s delight
Red sky in the morning, sailors take warning”

This is an example of a folklore forecast but what does it mean?
Folklore forecast

“The higher the clouds, the finer the weather”

“Ring around the moon? Rain or snow soon”

These forecast don’t have to rhyme

“Cows lay down ahead of storms”

“Wooly caterpillars predict severe winters”

“The fat squirrel survives the winter”

Persistence forecast

“The weather tomorrow will be like the weather today”
Persistence forecast

“The weather tomorrow will be like the weather today”


Probability forecast

“The probability of weather on a specific day will be like the long–term average of weather for that day”

Probability of snow on December 25th

Assumes short term variations are “averaged out” and there is little long-term variation in climate.

Fig 9.8: Essentials of Meteorology
Climatology forecast

“The weather this season will be like the long–term average of weather for this season”

http://www.erh.noaa.gov/lwx/Historic_Events/DC-Winters.htm

Types of Forecasts

Folklore: based on traditional proverbs, sometimes accurate. Uses behavior of animals and other creatures as predictors of future weather.

Persistence: assumes that the weather will not exhibit large day to day fluctuations. The weather tomorrow will be like the weather today

Probability/Climatology: assumes the weather for a day or a season will be close to the average weather for that day or season.

Wide brown stripe = mild winter
Cows lie down before weather to save warm, dry spot
Problems with these forecasts

Persistence: we know that, at some point, this will be wrong because eventually the weather WILL change

Probability/Climatology: we know that, at some point, this will be wrong because eventually the weather WILL deviate from the average

We know that weather changes at a particular spot because weather features move… but do the weather features themselves change?

Trend Forecast

Recognizes that weather causing patterns move but assumes the following remain unchanged:

- speed
- intensity
- size
- direction

http://ww2010.atmos.uiuc.edu/(G!)/guides/mtr/fcst/mth/trnd.xhtml
Analog Forecast

Recognizes that weather causing patterns change but assumes:

- weather will always behave the same way under a specific set of conditions

In other words, weather repeats itself

If you find the last time current conditions existed, you can use the historical data to determine how conditions will change

The weather today is “analogous” to weather at a time in the past

Fig 13-4  Meteorology: Understanding the Atmosphere
**Statistical Forecast**

Uses *Model Output Statistics* (MOS)

Statistically weighted analog forecast

- looks at model output that best forecasted past events to make future predictions

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**Numerical Weather Prediction**

Astronomers could predict eclipses 100’s of years before meteorologist started to predict weather

Why?
Numerical Weather Prediction

Uses a series of equations (prognostic equations) that represent the physics of the atmosphere to predict atmospheric conditions in the future.

Need to understand current conditions (a.k.a. “initial conditions”) to make predictions

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How can you use information to make predictions?

Example: You know where a car is right now and you know how fast it’s moving.

With this information you can predict where the car will be at some time in the future.

Numerical Weather Prediction: Observations

Step 1: Collect observations

- ASOS
- sondes
- ships
- buoys
- aircraft
- satellites
- wind profilers
- etc.
**Numerical Weather Prediction: Assimilation**

**Step 2: Data Assimilation**

- Data does not cover the entire globe at all times
- Data is smoothed and interpolated to model grid

**Numerical Weather Prediction: Integration**

**Step 3: Model Integration**

- Assimilated data is used to solve equations that describe the atmosphere
- Determines state of atmosphere at next time step
Step 4: Tweaking and Broadcasting

- Analyze model output accounting for known biases in models
- Combine model output with knowledge of local weather (small scale winds that models can’t predict) to create forecasts

Forecast Range

<table>
<thead>
<tr>
<th>Forecast Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nowcasting</td>
<td>A description of current weather parameters and 0-2 hours description of forecasted weather parameters</td>
</tr>
<tr>
<td>Very short-range weather forecasting</td>
<td>Up to 12 hours description of weather parameters</td>
</tr>
<tr>
<td>Short-range weather forecasting</td>
<td>Beyond 12 hours and up to 72 hours description of weather parameters</td>
</tr>
<tr>
<td>Medium-range weather forecasting</td>
<td>Beyond 72 hours and up to 240 hours description of weather parameters</td>
</tr>
<tr>
<td>Extended-range weather forecasting</td>
<td>Beyond 10 days and up to 30 days description of weather parameters, usually averaged and expressed as a departure from climate values for that period.</td>
</tr>
<tr>
<td>Long-range forecasting</td>
<td>From 30 days up to two years</td>
</tr>
</tbody>
</table>

Ensemble forecasts:

- Run model numerous times for slightly different initial conditions
- Perform statistical analysis of all the model runs
Why aren’t forecasts perfect?