Verification Methods and Overview of Basic Thunderstorm Structure

Mt417 – Iowa State University – Week 4

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How can you tell which forecast was better?

- Suppose 80 storms happen
- Forecaster A issues 200 warnings and gets 60 correct
- Forecaster B issues 100 warnings and gets only 40 correct
- Who is better?

Contingency Table scores

FORECASTS

OBS

	YES	NO
YES	A = hits (correct YES forecasts)	B = missed events (unwarned storms)
NO	C = false alarms (cry wolf)	D = correct NO – we don't usually care for rare events like storms

Contingency Table scores

- POD (Probability of Detection) = a/(a+b) [correct warned events out of total observed events]   1 is perfect
- FAR (False Alarm Ratio) = c/(a+c) [falsely warned events out of all warnings] 0 is perfect
- CSI (critical success index) = a/(a+b+c) [correct warned events out of all warnings issued and unwarned events]

- CSI is also called the Threat Score, and it varies from 0 (bad) to 1 (good).
- Heidtke Skill score or Equitable Threat Score removes the effect of chance

ETS = (a – ch) / (a + c – ch) where “ch” is some measure of correct forecasts by chance

ETS can vary from negative (bad) to 1 (good)

Back to our example…

- Forecaster A would have a table like

60	20
140	-

POD = 60/(60+20) = .75

FAR = 140/(140+60) = .70

CSI = 60/(60+20+140) = .27

Back to our example…

- Forecaster B would have a table like

40	40
60	-

POD = 40/(40+40) = .50 [worse than A]

FAR = 60/(40+60) = .60 [better than A]

CSI = 40/(40+40+60) = .29 [slightly better than A]

But….

- How you evaluate forecast performance may depend on what you most care about.
- Do you really MIND false alarms for tornadoes, or is it worse to be hit without warning (missed events)?
- Might be better in some cases to have high POD even though it requires high FAR (Current state of tornado warnings)

Examples of verification scores

HAIL

	POD	FAR	CSI
• dBZ>60 at 3 km	.90	.13	.80
• Echo top > tropo	.59	.66	.27
• Echo top > 35K ft	.91	.94	.06

First rule woks well. POD is low for echo top above tropopause meaning hail often occurs without storms that tall. 35K rule works better to identify more hailstorms but MANY storms that tall do NOT produce hail, so FAR is terrible

Examples of verification scores

WIND

	POD	**FAR**	**CSI**
• Bow Echo	.59	.27	.49
• Echo top > tropo	.75	.95	.05

Bow echo rule works much better than storm top rule, but still misses lots of wind events (POD is only .59). Low FAR means if you see a bow echo, it is VERY LIKELY you'll see damaging wind

Examples of verification scores

TORNADO

	POD	**FAR**	**CSI**
• Hook Echo	.38	.16	.36
• Echo top > tropo	.83	.89	.10
• Echo intensity	.92	.96	.04

Low FAR for hook echoes means if you see one, it is VERY likely to produce a tornado. But, low POD means not all tornadoes come from hook echo storms

Other examples

- Precipitation forecasts from numerical models typically have CSI values of .1 to .3 (worse in summer), POD of .1 to .9, and FAR of .5 to .8 (high POD and high FAR indicates models are too aggressive with precipitation)
- Thickness algorithm for precip type:

	POD	FAR	CSI
SN	.5	.02	.5
IP	.3	.8	.1
ZR	.9	.6	.4
RA	.9	.7	.3

More examples

- Tornado warnings:

	POD	FAR	CSI
1990	.44	.7	.18
Now	.78	.76	.25

- Tulsa NWS Svr Storm vs Tornado warnings in 1998:

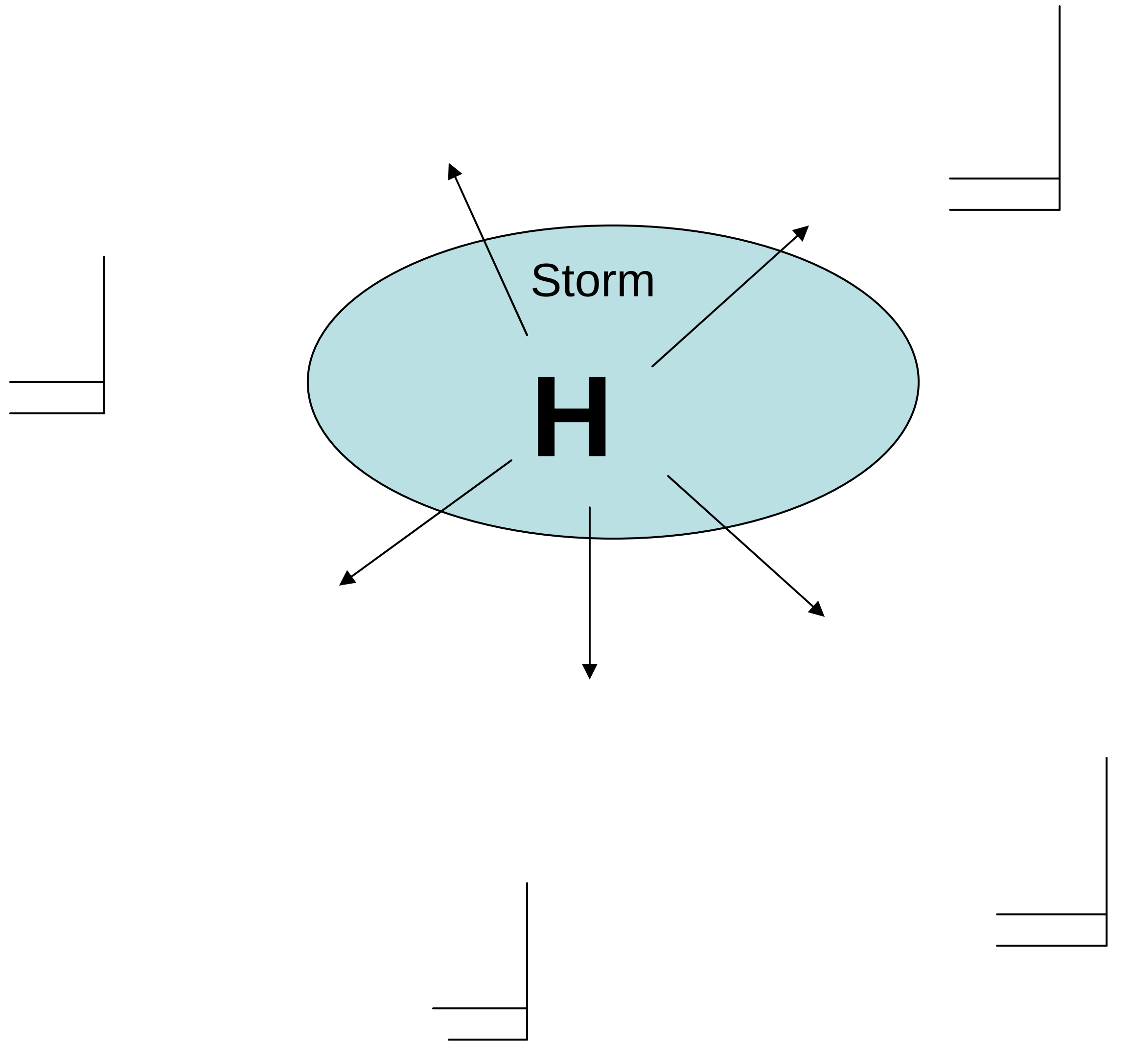
	POD	FAR	CSI
Svr	.92	.35	.62
Tor	.91	.85	.15

Thunderstorm Impacts on Environment

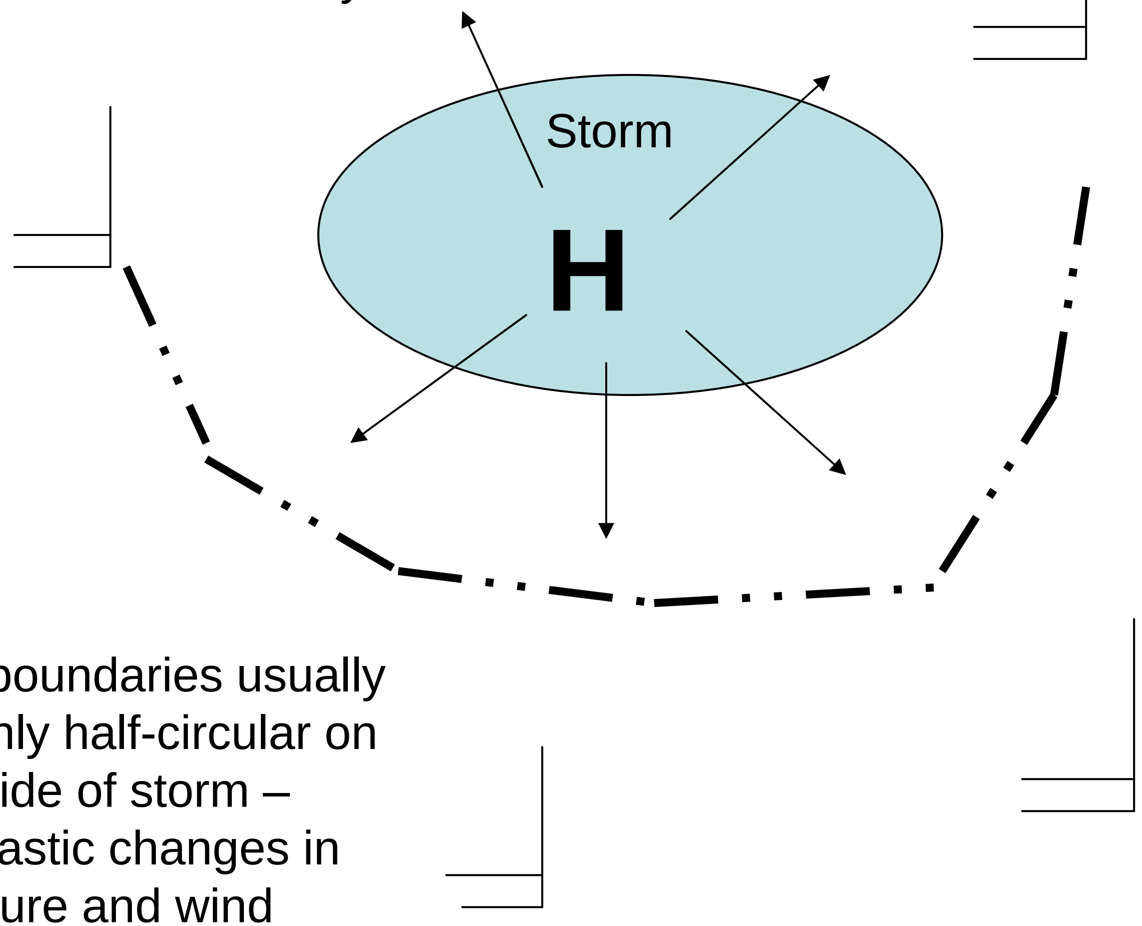
- Three basic ingredients for thunderstorms:
  Instability, Moisture, Lift to trigger it
- Basic evolution is Towering Cumulus, Mature, Dissipation
- Evaporation of falling rain and downdraft lead to cold pool of air under storm
- Cold air is heavier and will try to spread out in cold bubble – how it does depends on other things like ambient flow

Thunderstorm Outflow

- An outflow boundary, like a front, should show where a big change happens in winds/temperatures (large gradients)
- Consider where such gradients would likely be strongest and persist longest – usually where thunderstorm flow is opposing ambient flow


Storm
H

To the north, the t.storm flow is in roughly same direction as ambient wind, so cold pool would be smeared out and weaker there – less drastic changes in weather parameters, so no boundary drawn



Outflow boundaries usually are roughly half-circular on upwind side of storm – where drastic changes in temperature and wind happen

How to tell where outflow boundaries are located

- Temperature drops after passage
- Dew point --? Usually goes up a little after passage, but in very humid places like Iowa in summer, the air is so much cooler that dew points drop a little (can't have Td>T)
- Winds – change direction and sometimes speed
- Pressure rises after passage