

ATM S 103

# Hurricanes and Thunderstorms

Their Science and Impacts





# Instructor



B.S. 2003  
Ph.D. 2010



2010-2013



2014-present

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  - Assistant Professor in the Department of Atmospheric Sciences
  - Office: ATG 608
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  - Office hours: Wednesday 2-3pm and Thursday 1-2pm, or by appointments

# Teaching Assistant

- Litai Kang
  - Graduate student in the Department of Atmospheric Sciences
  - Office hours: Monday and Tuesday 1:30-2:30pm (ATG 402)
  - Three CLUE sessions before exams: Thursday April 25th, Thursday May 16th, & Thursday June 6th 6:30-8:00pm (MGH 231)
  - E-mail: [kanglt@uw.edu](mailto:kanglt@uw.edu)

# Organizational Details

- Class [website](#) (canvas)
- Slides will be posted *after* class
  - Not before: they contain answers to the in-class polling questions
- In-class polling scores are 10% of your grade
  - These are to **help you learn** the material
  - Uses PollEverywhere (username: **atms103**)
  - Either on the website or with app, log in first
  - Give your full UW email address there, then you will see “Log in with University of Washington” button
  - Click the button and log in with your UW NetID



# Polling Score

- Broken into 5 segments (each 2 weeks)
- Within each segment
  - 1 point for a wrong answer, 2 points for correct answer.
  - Full credit of 2% toward the final grade is awarded for every period when you get **half** the possible points.
- You would get full credit if
  - You answer every question and get nothing correct.
  - You answer only half the time, but get everything correct.
- **Polling scores cannot be “made up” after absences**
  - Allowance for absences is built into the scoring system.

W

Do you have to answer almost every question correctly to get full polling credit?

Yes

No

Start the presentation to see live content. Still no live content? Install the app or get help at [PolleEv.com/app](https://PolleEv.com/app)

Total Results



# Answer: False

- You can miss them all if you answer them all!

# Exams and Homework

- **Midterms** on Wednesdays, May 1st and May 22nd (in class)
- **Final exam** on Thursday, June 13th (8:30~10:20am)
- **Homework** will be due on Fridays
  - First one will be posted before this Friday will be due next Friday (June 12)
  - Multiple choice
    - Science mostly from lectures
    - History, Impacts, ... from reading and lectures
  - Large assignments: 21 questions
  - Medium assignments: 14 questions
  - **Answer at least one question to be able to see the answers for later study!!!**

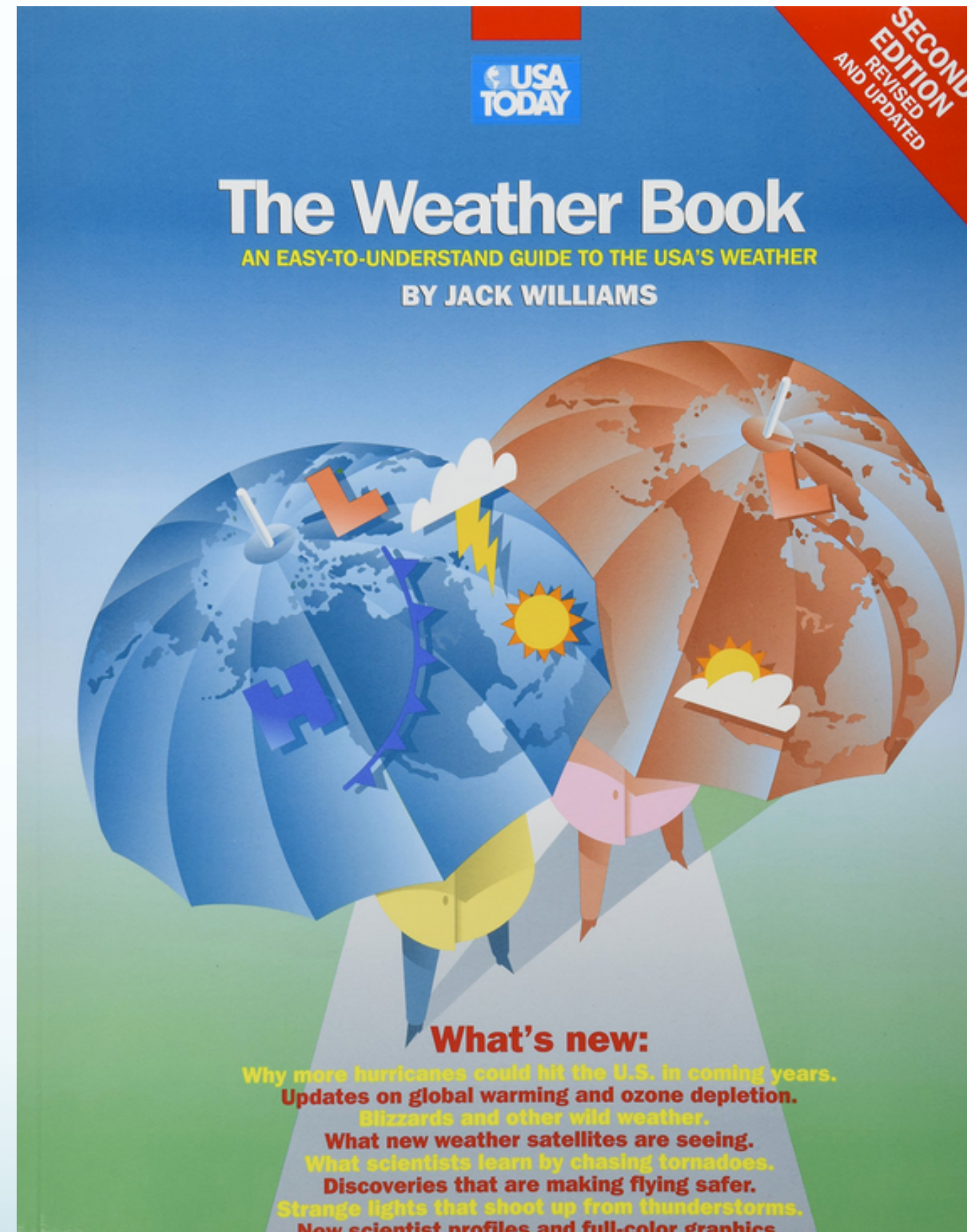


# Final grade percentages

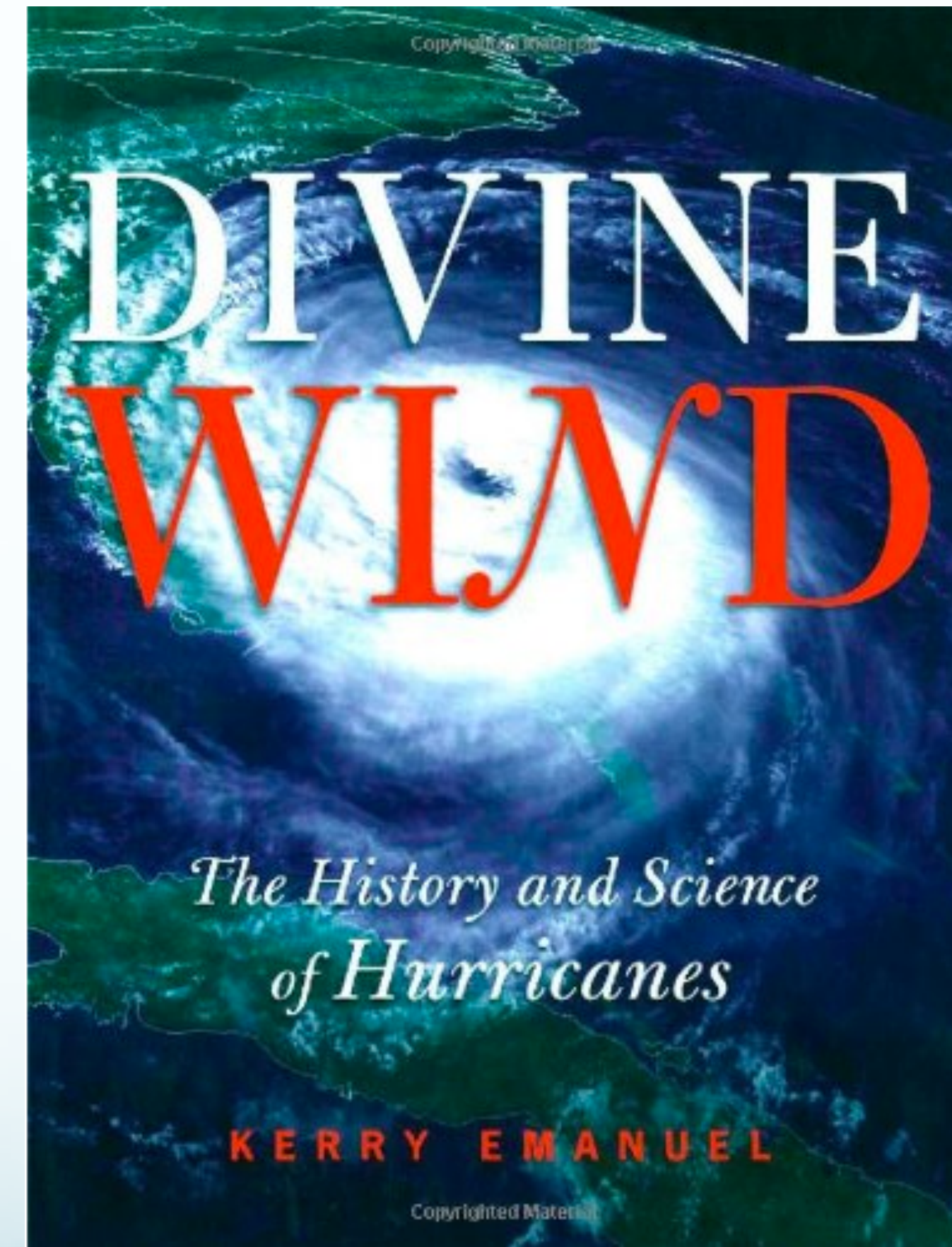
- 10% Poll Everywhere
- 20% each: 2 mid-terms
- 25%: Homework (weekly)
- 25%: Final exam



# Textbooks



For the science of  
thunderstorms and hurricanes



For hurricane history and  
impacts



# Class Overview

- Goal: To explore science, history, and impacts of thunderstorms and hurricanes
  - Clouds (Weeks 1-2)
  - Thunderstorms (Weeks 3-5)
  - TORNADOS (Weeks 6-7)
  - Hurricanes/Tropical Cyclones (Weeks 8-10)



# Observing Clouds





By the end of the quarter,  
you will have answers to questions like:

How do **clouds** form?

Why are some **clouds** growing upwards?



Why do **clouds** sometimes stop  
growing and spread laterally?



# A Bit Later



CC3

19:38:40 Tue Jul 26 2005



# Supercell Thunderstorm : Nature at its awesome best

Beth Allan's supercell video

[Leoti, Kansas: May 21, 2016](#)



By the end of the quarter,  
you will have answers to questions like:

How do the clouds organize to  
form **thunderstorms**?

Why do **thunderstorms** bring  
**lightning** and **hail**?

What are the odds of getting hit  
by **lightning**? What should you  
do when **thunderstorms** are  
nearby? (personal safety)





It's raining hard. There's thunder.  
Should you take shelter under a tree?

**W** It's raining hard. There's thunder. Should you take shelter under a tree?

Yes

No

Start the presentation to see live content. Still no live content? Install the app or get help at [PollEv.com/app](https://PollEv.com/app)

Total Results



Answer:





# Tornados

- Extreme up-close video of tornado



By the end of the quarter,  
you will have answers to questions like:



Where and when do we observe  
**tornados** most often? What are  
the favorable conditions for  
**tornado** breakout?

**Tornados** are extremely dangerous. What  
can (should) we do as an individual and as  
a society to minimize their impacts?  
(Impacts and Adaptation)





# Tornado Impacts and Adaptation

## (Mini-Preview)

Moore, OK, 1999



Storm Cellar





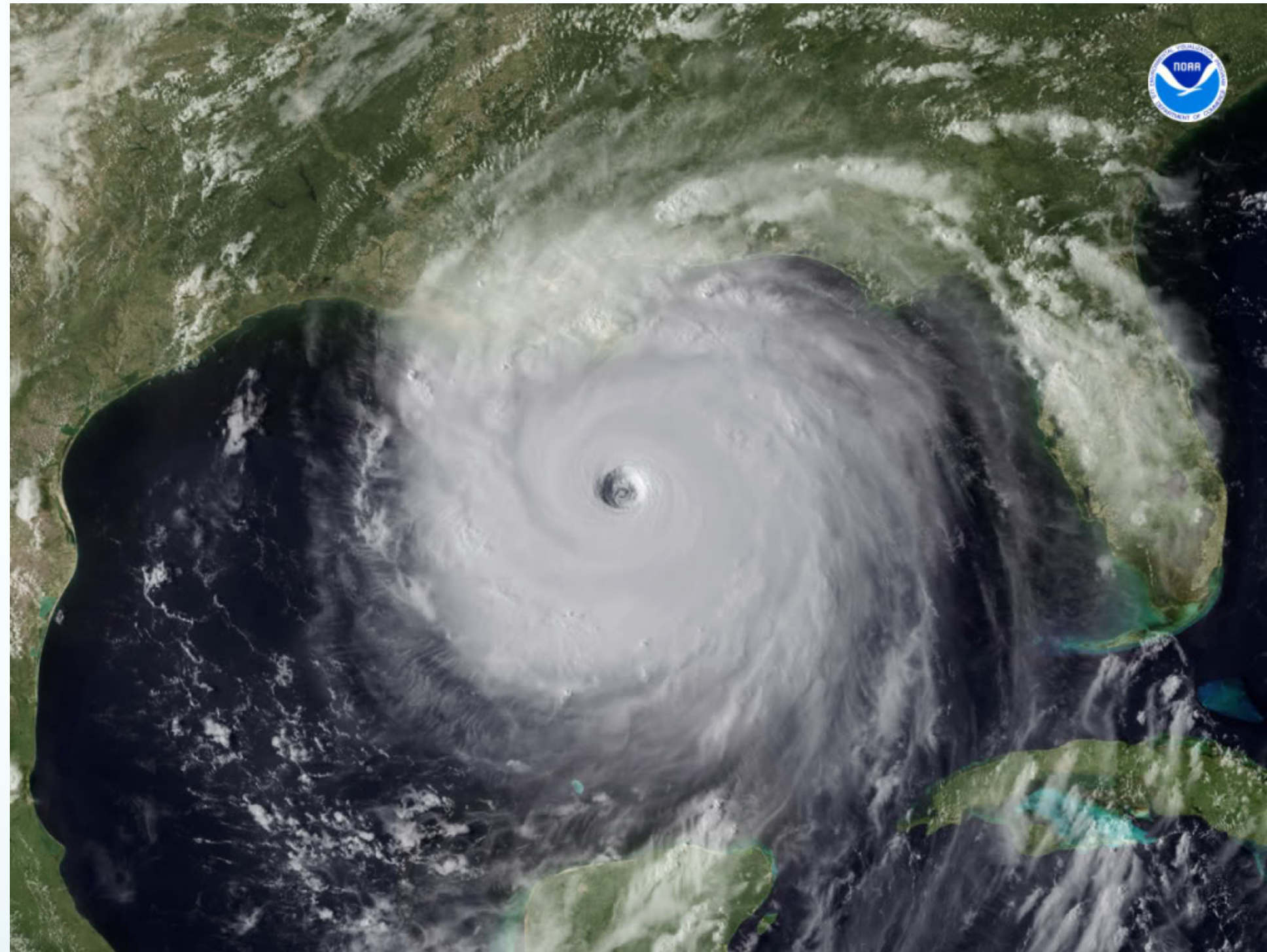
# Hurricane Katrina (2005)

- Storm surge and damages from high-wind



By the end of the quarter,  
you will have answers to questions like:

What are the aftermaths of some historical **hurricane** events? What did we learn from those events? (Impacts and Adaptation)



**Hurricanes:** How do they form? When they intensify and when they make a landfall?





# Historical Impacts of Tropical Cyclones

(Mini-Preview)

神風

(Divine wind, kamikaze)



## Mongol Fleet, 1274 and 1281



13,000 of Kublai Khan's men drowned in a typhoon in 1274

Fleet of 140,000 was repelled with help from another typhoon in 1281



## USS Pittsburgh, 1945



this ship was damaged by a typhoon, bow completely fell off



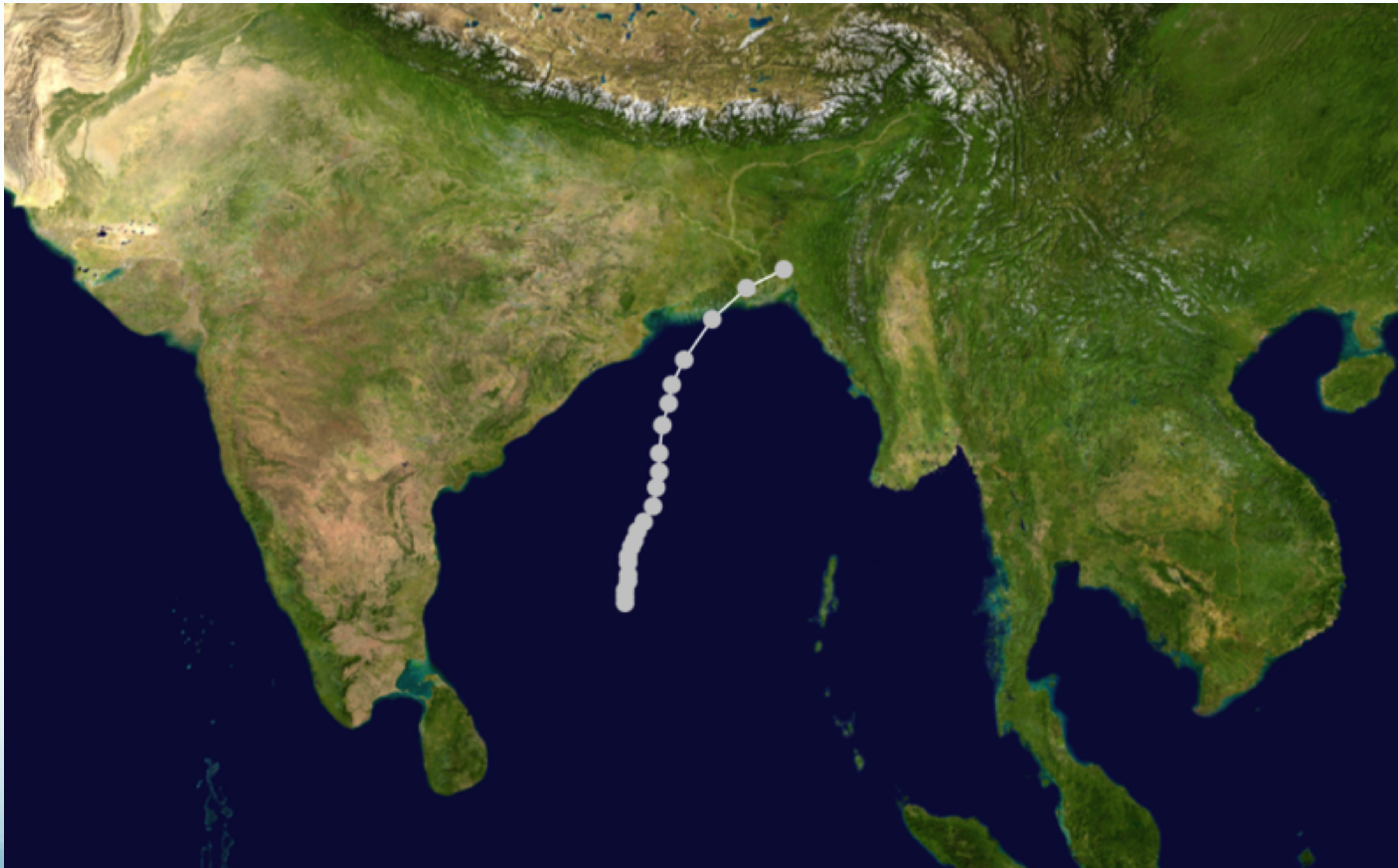
## USS Bunker Hill, 1945



2 kamikaze aircraft hit and killed 349 people on board



## Bhola, Pakistan: November 1970





## W Aftermath did NOT include

300,000 to 500,000  
deaths

25% of East  
Pakistan flooded

Efficient delivery of  
international aid

Civil war



## Answer: There was no efficient delivery of international aid

- West Pakistan's failure to help get international aid to the victims helped precipitate the civil war.
- Estimated 250,000 civilians killed in atrocities during the civil war.



# Societal Adaption

Bangladesh  
1991



140,000 killed. structures like these prevented 20% more deaths. many more built since then



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# Water in the Atmosphere



# Vapor (isolated water molecules)





# Liquid (tiny droplets)





# Ice (tiny crystals)





# Is the wispy stuff water vapor?





# W The wispy stuff is water vapor

Yes

No

Start the presentation to see live content. Still no live content? Install the app or get help at [PollEv.com/app](https://PollEv.com/app)

Total Results



# Answer: False

Water vapor is an invisible gas, what you see are water droplets.



# Water at the Molecular Level

- Two hydrogens bond with one oxygen
- Animation of bonds in liquids, solids and gases



# Water in the Atmosphere



**Vapor** (gas): all bonds between molecules are broken



**Liquid**: some broken bonds between molecules



**Ice** (solid): almost no bonds broken between molecules



# Cloud formation: phase change of water

