Met Office RMetS RMetS Ryal Meteorological Society

Introduction to tropical cyclones

Presented by Jenny Rourke RMetS National Meeting, 16 January 2019

Met Office What are Tropical Cyclones?

Cyclones, **typhoons** and **hurricanes** are all names for severe tropical cyclones – some of the most destructive weather systems on the planet.



Hurricane Maria 2017 - Puerto Rico

Cyclone Gita – 2018 Credit: NOAA





Hurricane Maria 2017 Credit: BBC News

Hurricane Harvey 2017 – Texas Credit: NOAA



Hurricane Irma 2017 - Florida Credit: CNN



Typhoon Haiyan 2013 - Philippines Credit: International Business News

Met Office Hadley Centre Tropical Cyclone Formation

- Low level convergence (e.g. easterly wave) and pre-existing disturbance
- Warm ocean typically above 26°C





Met Office Hadley Centre Where do they occur?



Saffir-Simpson Hurricane Intensity Scale

Met Office Tropical Cyclone Impacts

Wind

Can reach winds of more than 150 mph with gusts as high as 200 mph.



Record: Hurricane Patricia (2015) sustained winds of **215 mph!**



Rain

Even once the winds die down, rain may continue for days just inland. They can produce 30" (75cm) rain - as much as some parts of the UK receive in a year!

Hurricane Harvey (2017) dropped 60 inches (~1.5m) of rain in 4 days over Texas.

Storm surge

Water piles up and is pushed towards the coast as the tropical cyclone approaches. Can reach several metres high.











Record: The highest storm surge occurred in 1899 in Australia at 42ft (13m).



The Weather Channel use of 'augmented reality' to illustrate storm surge impacts

Met Office Tropical Cyclone Impacts Hadley Centre

 Tropical cyclones have significant social and economic impacts around the world.

Costliest tropical cyclone Hurricane Harvey (2017) and Hurricane Katrina (2005) \$125 billion



Source: IT\





Costliest tropical cyclone season 2017 Atlantic hurricane season ≥\$280 billion

Irma





Harvey

Maria

Deadliest tropical cyclone Cyclone Bhola (1970)

North Indian ocean. Caused 500,000+ fatalities in Bangladesh.



Source: NBC New

Met Office Hadley Centre Tropical Cyclone Impacts

- Some of the worlds most deadly tropical cyclones occur around the Indian Ocean and Western Pacific.
- Over the last two centuries, tropical cyclones account for the deaths of ~1.9 million people worldwide (~10,000 people per year).

Deadliest Tropical Cyclones			
Rank	Name/Year	Region	Fatalities
1	Bhola 1970	Bangladesh	500,000
2	India 1839	India	300,000
	Haiphong 1881	Vietnam	300,000
4	Nina 1975	China	229,000
5	Bangladesh 1991	Bangladesh	138,866
6	Nargis 2008	Myanmar	138,373



Vulnerability of countries to tropical cyclones

Wikipedia

Met Office Saffir-Simpson Hurricane Wind Scale **Hadley Centre**

Tropical Storm Winds < 74 mph



Tropical storm Alberto (2018). Cuba. Source: Wikipedia



Tropical storm Gordon (2018), Florida, Source: ABC News



Tropical storm Emily (2017). Florida, Source: ABC News

Hurricane Category 1 Winds 74-95 mph Some damage to roofs. Power outages.

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Hurricane Matthew (2016) South Carolina. Source: Wikipedia



Hurricane Hermine (2016) Florida. Source: Wikipedia

Texas, Source: CNN









Hurricane Ike (2008)



3

Severe roof damage. trees uprooted, electricity and water unavailable for several days. E.g. Hurricane Katrina (2005)

Hurricane Category 4

Most intense

5

Winds 130-156 mph Catastrophic damage. Severe damage or loss of roof. Trees snapped or uprooted. Power lines down.





Cyclone Debbie (2017) Queensland Australia Source: ABC News



Hurricane Harvey (2017) Texas, USA



Cyclone Sidr (2007) Bangladesh, Source: Wikipedia

Hurricane Category 5 Winds ≥157 mph Catastrophic damage. Houses can be destroyed, power outages can last for weeks. Area uninhabitable. E.g. Hurricane Irma (2017),





Typhoon Haiyan (2013) Philippines, Source: BBC



Met Office Who Forecasts Tropical Cyclones?



Regional Specialised Meteorological Centres (RSMCs)

RSMCs are **special** forecast centres.

They are responsible for issuing tropical cyclone forecasts to the public and emergency authorities.

There are 6 RSMCs around the world.

Tropical Cyclone Warning Centres (TCWC) have regional responsibility e.g. Australia.

Met Office Tropical Cyclone Forecasting

North Atlantic

U.S. National Hurricane Center





Hurricane Irma (2017) Forecast 5 day track, intensity and warning areas

Location and timing of strong winds







Typhoon Mangkhut (2018)

Forecast centres issue warning charts

- Expected track
- Probability of strong winds

Met Office Hadley Centre Flying into a Hurricane

- In several parts of the world flights are made into tropical cyclones to collect data for real time forecasts and research
- NOAA Hurricane Hunters fly into hurricanes threatening the USA or Caribbean
- Short video of a flight into Hurricane Irma in 2017





Met Office Hadley Centre Tropical Cyclone Research

- Numerous institutions, universities and meteorological centres undertake
 research into tropical cyclones
 - From short period forecasting to climate timescales
 - Small scale processes to large scale motion
- Research underpins numerical models which underpin forecasts from regional tropical cyclone warning centres
- Julian Heming and Linus Magnusson describe numerical modelling of tropical cyclones at the Met Office and the European Centre for Medium-range Weather Forecasts
- Demo of high resolution modelling of tropical cyclones in the tea break





Met Office Hadley Centre Tropical Cyclone Research

 Andy Hartley and Sam Hardy will showcase how the Met Office, universities and the UK Government have partnered in tropical cyclone research and forecaster training



Met Office Global Hazard Map

- Tropical cyclone impacts dependent on more than track and intensity
- Global Hazard Map incorporates level of exposure
- Demo during tea break





Met Office Hadley Centre Tropical Cyclones and Climate Change

- · Difficult to establish if there has already been an impact
- · Large interannual variability in tropical cyclone activity
- Inhomogeneity of the historical record



Met Office Hadley Centre Tropical Cyclones and Climate Change

Total storm energy by year





2005 - the most

active Atlantic

Met Office Hadley Centre Tropical Cyclones and Climate Change

• Consensus projections from climate models indicate decreases in global numbers, but increases in the frequency of strong tropical cyclones and increases in rainfall.



Pier Luigi Vidale to discuss tropical cyclone variability on the climate timescale

Met Office Hadley Centre Tropical Cyclones and Insurance



Risk Management Solutions: Hurricane Harvey Flooding

- Harvey caused catastrophic and unprecedented inland flooding across southeast Texas
- Flood levels exceeded the 1000-year return period in many areas around Houston
- RMS leveraged its wind, surge, and inland flood catastrophe models to estimate insured losses of USD \$25 to \$35 billion





More details in poster on the balcony

Met Office Preparedness and Response

- Governments and NGOs work in partnership to prepare and respond to tropical cyclone related disasters
- Beth Simons will describe how ShelterBox responded to two of the major tropical cyclones of 2018
 - Hurricane Florence
 - Typhoon Mangkhut





Thank you

