TC rainfall forecasting

Global TC Rainfall
Global TC Rainfall
% of yearly total
**Global TC Rainfall**

- TC rainfall peaks when global rainfall is low
- Asymmetric—generally more rain in the Northern Hemisphere
- Global rainfall is decreasing with increasing latitude while TC rainfall is increasing
- TC contributes 10-17% of global rain 15-30° poleward from Equator (subtropics)

*Frank Marks (HRD)*
Percent of maximum storm total rainfall (h)

81 cases – 1991-2005

50% of total rain falls in 12h; 90% falls in 72h

Average (mm) 23 35 44 51 75 90 125 168 244 287 309 334
Maximum 48 76 114 152 251 337 557 708 813 882 908 1017
Factors affecting rainfall?

- Storm track (location and translation speed)
- Storm size (positive) – the bigger the storm, the more it rains at any given spot
- Wind shear (negative) – leads to a quicker dropoff in rainfall for inland TCs
- Topography – Positive in the upslope areas, but negative past the spine of the mountains
- Nearby synoptic-scale features/Extratropical Transition
- Time of day – core rainfall overnight/outer band rainfall during day
Rainfall – does intensity matter?

CYCLONE BOBBY
Category 4
(measured on 24/02/1995)

CYCLONE STEVE
Cyclone Category 2 (27/02/2000)
Rain (24h) in 291mm (29/02/2000)
Flood Average Recurrence Interval in about 80 years
Vertical Wind Shear

High wind shear – shear dominates over motion asymmetry

If the shear is strong enough all rainfall may move away from the centre
Low wind shear – motion dominates over shear asymmetry in outer bands
Rainfall: forecasting tools

- Climatology: general 100-200mm/day + topography

- Kraft rule of thumb:
  - Rainfall accumulation (mm) = \( \frac{2500}{\text{translation speed in knots}} \)

- TPC
  - Rain Accumulation = \( \frac{\text{Diameter} \times \text{Rain Rate}}{\text{translation speed}} \)

- eTrap: [http://www.ssd.noaa.gov/PS/TROP/etrap.html](http://www.ssd.noaa.gov/PS/TROP/etrap.html)

- NWP and ensembles of NWP
Convective Rainfall Rates

Average Climatological Rain Rate = 2 mm / hour

Core Rain Rate = 5 times this Average

or

Core Rain Rate = 10 mm / hour

RAINFALL CALCULATION USING UNENHANCED INFRARED IMAGERY

Storm Name: **FREDERIC**
Date: **12 SEPT 1979**

<table>
<thead>
<tr>
<th>Image Date/Time</th>
<th>Diameter of Storm in Direction of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 / 0630 UTC</td>
<td>5.5 deg * 110 km/deg = 605 km</td>
</tr>
<tr>
<td>12 / 1200 UTC</td>
<td>5.5 deg * 110 km/deg = 605 km</td>
</tr>
<tr>
<td>12 / 1800 UTC</td>
<td>4.0 deg * 110 km/deg = 440 km</td>
</tr>
<tr>
<td>12 / 0000 UTC</td>
<td>4.5 deg * 110 km/deg = 495 km</td>
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</tbody>
</table>

Mean Diameter: \( D = 540 \) km
TROPICAL CYCLONE RAINFALL ESTIMATION

HURRICANE FREDERIC, SEPTEMBER 1979

6-HOUR CONTINUITY, INFRARED

Frederic
Forecast translation speed: \( V = \frac{4.0 \text{ deg} \times 110 \text{ km/deg}}{18 \text{ hrs}} = 24 \text{ km/hr} \)

Mean rainfall rate: \( R = 0.2 \text{ cm/hr} \)

\[
P = \frac{D \times R}{V} = \frac{540 \text{ km} \times 0.2 \text{ cm/hr}}{24 \text{ km/hr}} = 4.5 \text{ cm}
\]

Core Rainfall: \( C = 5 \times P = 22.5 \text{ cm} \) \((8.9'')\)

Rule of Thumb: \( T = \frac{450 \text{ cm}}{V \text{ km/hr}} = \frac{450 \text{ cm}}{24 \text{ km/hr}} = 18.8 \text{ cm} \) \((7.4'')\)
Mean diameter in direction of motion $D = 540 \text{ km}$

Forecast translation speed $V = 24 \text{ km/h}$

Mean rainfall rate $R = 2 \text{ mm/h}$

Rainfall potential $P = \frac{D \times R}{V}$

$$= \frac{540 \times 2}{24} = 45 \text{ mm}$$

Core rainfall $C = 5 \times P = 225 \text{ mm}$

Kraft “rule of thumb” $K = \frac{2500}{13.5} = 185 \text{ mm}$
1" = 25 mm
10" = 250 mm
11" = 225 mm

Hurricane Frederic
September 9-14, 1979
2516 sites

Maximum: 11.00"
Pascagoula, MS
Picking an analog for a TC event

- Size is important…look at the current rain shield and compare it to storm totals/storms from the past
- Is/was there vertical wind shear in current and past events?
- Look for storms with similar/parallel tracks
- Is topography/prism data a consideration?
- Look for nearby fronts/depth of nearby upper troughs for current and possible analogs
- Not all TC events will have a useful analog
Ensemble Tropical Rainfall Potential (eTRaP)

The eTRaP is a simple ensemble whose members are the 6-hourly totals from the single-orbit TRaPs. More information may be found at these links: eTRaP product information and Digital eTRaP Formats.

(Last Run for active storms: 2013-07-12-04Z)
Tropical Cyclone:
Rusty eTRaP rainfall +24h total
Production of TC Rainfall Forecasts

- Start with model closest to consensus forecast
- Locate relevant synoptic scale boundaries/coastal front
- Use conceptual models/current structure to modify/shift QPF (quantitative precipitation forecasts) (TRaP and recent satellite/radar imagery for current structure)
- Look at storm-relative shear/H2 winds to further shift/limit QPF
- Use climatology (r-CLIPER, TC Rainfall Climatology) to:
  - Temper down forecast bias/act as a reality check
  - Depict areas of terrain that could be significantly affected
TC rainfall forecasting - exercise

- Choose real-time case:
- Determine motion and size
- eTRaP
- NWP
- Topography/modifications (shear?)