Precipitation top heights estimation in convective systems

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Motivation

The absence of systematic estimates of vertical transport of water by convective systems is one of the main causes of uncertainties:

- Weather forecasting
- Climate-scale analysis
- Prediction of global circulation

Available orbital instruments

Radar

- \+ Water content vertical profile
- – Narrow swatch
- – Revisit time $>$ 3 days

Millimeter Wave radiometers

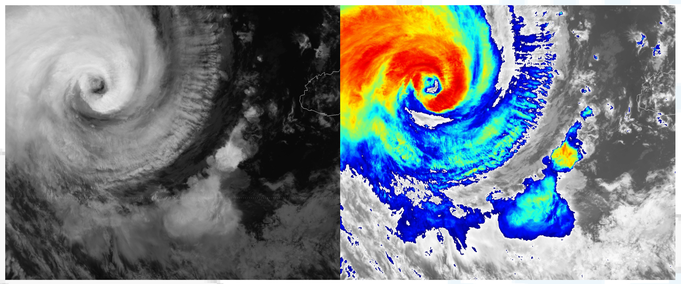
- \+ Wide swath
- \+ Revisit time $\approx$ 80 min
- – Absence of vertical profile (but features can be infered)

IR instruments

- \+ Extra wide swath
- \+ No Revisit time
- –– Non sensitive for precitation

Objective

Develop a **systematic** method for quantitatively estimating the maximum height of precipitation in convective systems using brightness temperatures b.



Source: *IR images of Tropical Cyclone Winston obtained from* `http://eumetsat.int`

Near-simultaneous coincidences

Radar-radiometer pair of coincidences searched in **millions of records**, between Dual-Frequency Precipitation Radar (**DPR**) and each of the following instruments:

- GPM Microwave Imager - **GMI**
- **SAPHIR** humidity sounder
- Advanced Technology Microwave sounder - **ATMS**
- Special Sensor Microwave Imager/Sounder - **SSMIS**

As a result, a training database and a testing database were built from the intersections obtained.

Precipitation detection

- Binary detection is performed using Linear Discriminant Analysis (LDA).
- This method classifies b between precipitation P and dry D.
- We used the training database to obtain a LDA discriminant x and its threshold v_{thr}.

$$\rho(b) = \begin{cases} P & \text{if } v(b) > v_{thr} \\ D & \text{otherwise} \end{cases} \qquad v(b) = x \cdot b$$

Precipitation estimation

- Water height is estimated from b measurements classified as P, or b_p.
- Lookup tables are indexed based on the Principal Components (PC) of b_p.
- We used the training database to build lookup tables for every radiometer where every cell is addressable by the PC of their b_p values, containing the estimated height:

$$L\left(PC_1(b_p), PC_2(b_p), ..., PC_i(b_p)\right) \leftarrow \mathbb{E}\left\{h_{max}\right\}$$

Estimation maps

We used the L tables to get estimation maps of the maximum height of precipitation of the Tropical Cyclone Winston, just from b measurements:

- Chosen case: 22 February 2016
- Tropical Cyclone Winston
- Minimum water content for detection $= 0.05 g/m^3$.