IONOSPHERIC AND ATMOSPHERIC
REMOTE SENSING GROUP

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Probing a hurricane's eye with the GPS radio occultation technique

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Overview

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Objectives

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1. Study Tropical Cyclone (TC) activity

2. Compare our results with ECMWF

3. Can GPS RO provide an insight in a hurricane's core?

Introduction (1)

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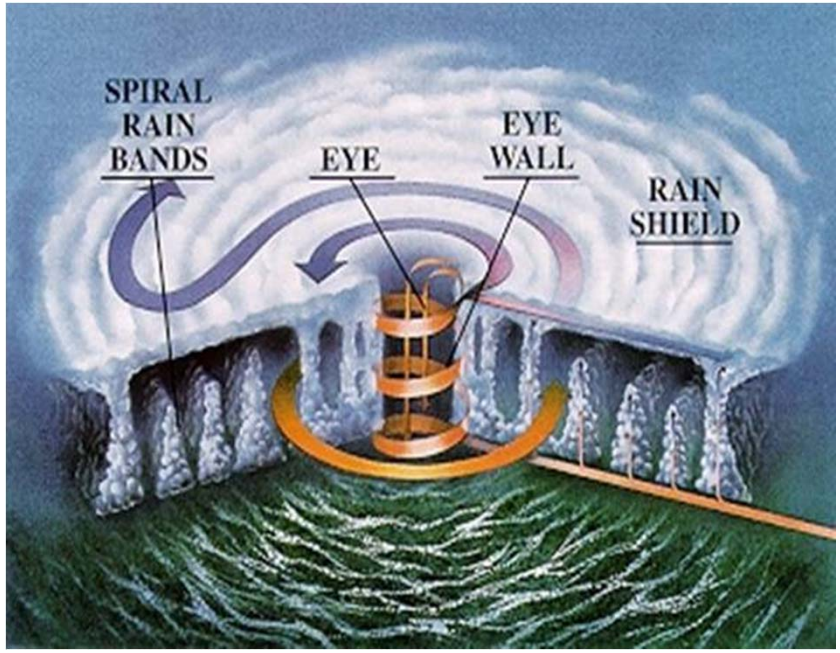
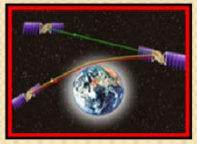
The recipe for Tropical Cyclone formation is:

- Late summer over the oceans
- Sea surface temperature > 26 ^{o}C
- Eye; eye-wall; spiral rain brands



The Global Positioning System radio occultation:



1. Insensitive to clouds and precipitation
2. High vertical resolution: 100 – 200 m (in troposphere)
3. Global coverage

Introduction (2)

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Mendelsohn et al., [2012] describes in great detail future projections of tropical cyclones in society

Economic impact:

Forecast of baseline damage

The present annual global damage from tropical cyclones is US$26 billion (which is equal to 0.04% of the gross world product (GWP)[13].

Example: New Orleans – Hurricane Katrina

Methodology

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COMPONENTS OF SOFTWARE (double collocations)

DATA	COMBINATIONS	RETRIEVALS
Data • JTWC • COSMIC • ECMWF	**Combine** • GPSRO+ECMWF	**Water vapor** $P_w = {}^{1}/_{b}\,(NT^2\text{-}aPT)$
Collocations • $< \pm$ 600 km • $< \pm$ 3 hr • Extract GPSRO to ECMWF pressure levels	**Use** • Forward refractivity operator • GPSRO: Refractivity • ECMWF Temperature	**Retrieve** • Derive water vapor profiles • Compare profiles with reference (ECMWF)

Results (1)

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GPS RO events: ~700

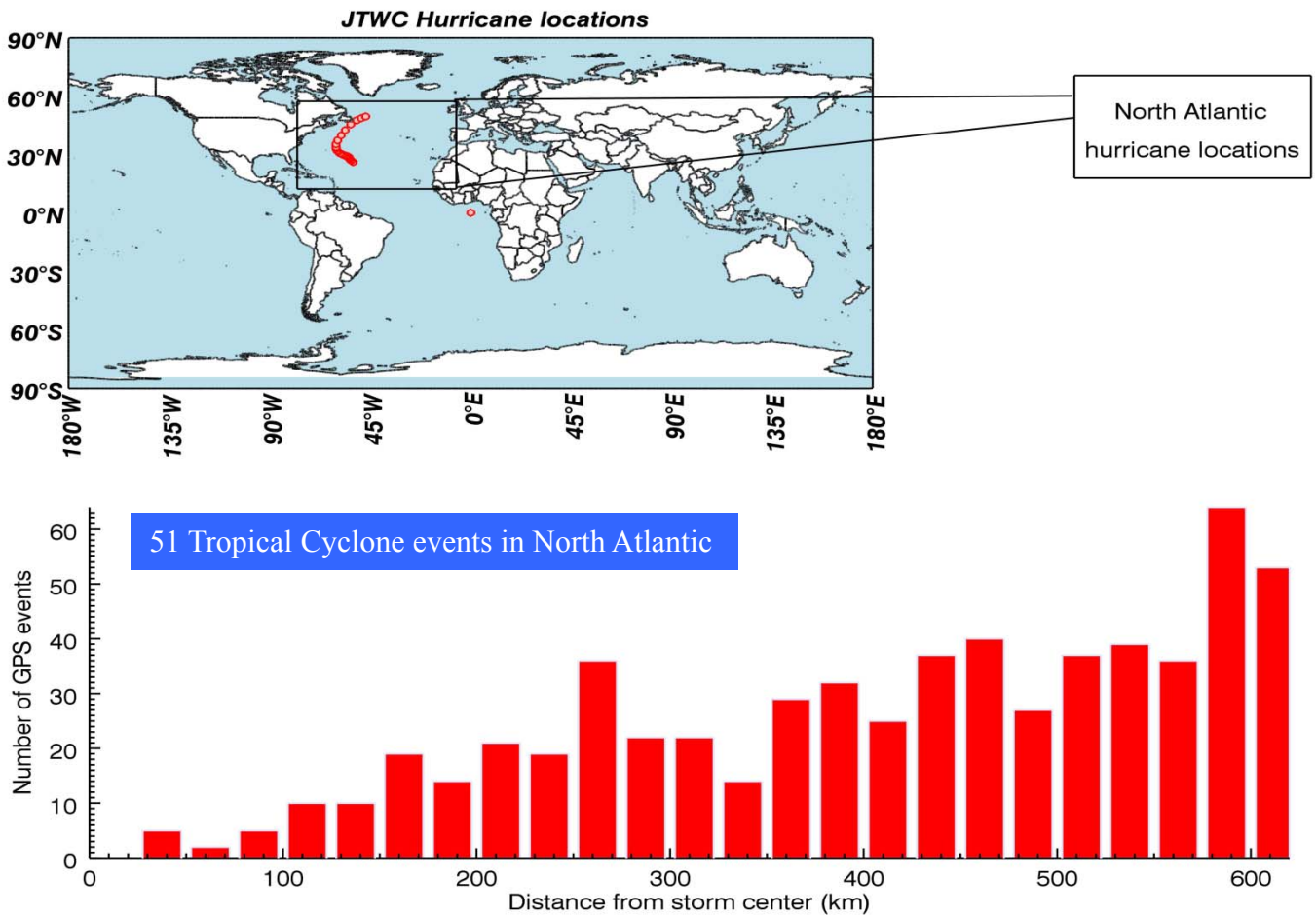

Figure 1: The tropical cyclone locations from the Joint Typhoon Warning Center (JTWC) between 2002 and 2010 **(top)** and the distribution of their collocated GPSRO events as function of distance from the storms' center up to 600 km **(bottom)**.

Results (2)

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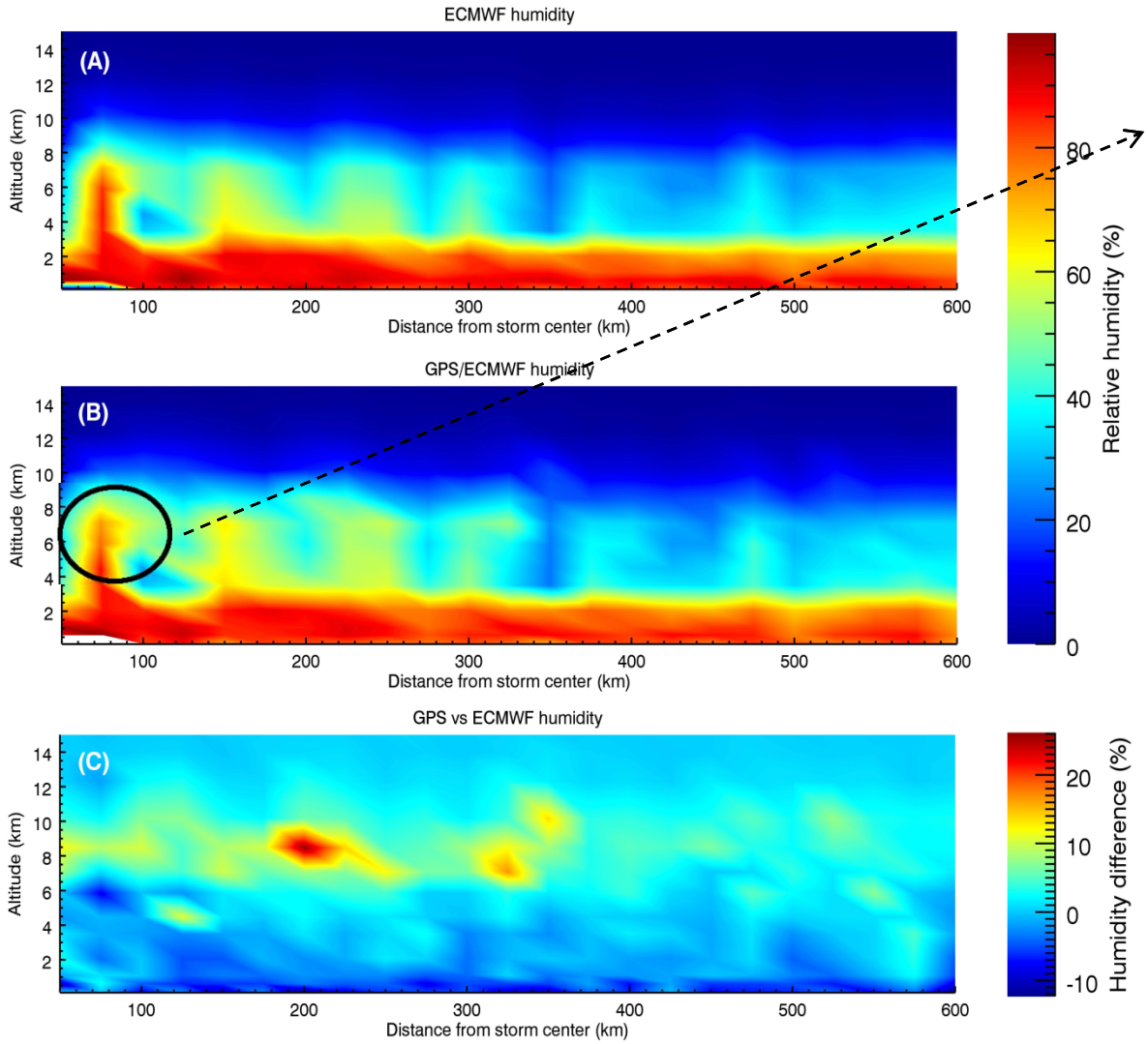
Analysis as function of distance



GPS data seem to capture the general characteristics of Tropical cyclones

ECMWF moister (drier) than GPS below (above) 4 km

Results (3)

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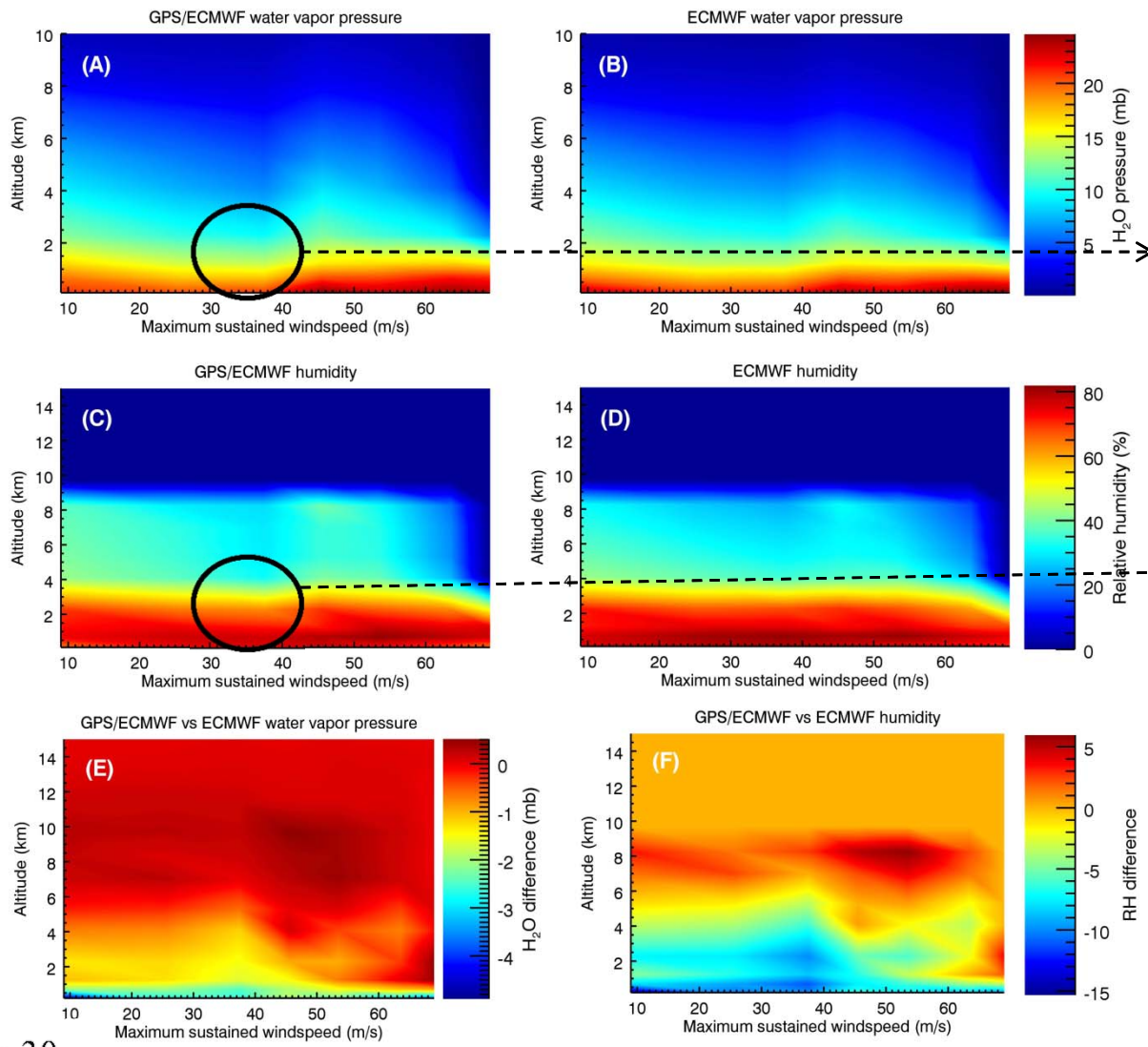
Analysis as function of category scale



1. Gradual decrease in RH from tropical depression to tropical storm to Category-I huricane
2. Increase in RH at transition from Cat.-I to Cat.-II hurricane
3. Almost steady state after that

Relative Humidity appears more homogeneous than water vapor pressure.

Conclusions

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1. GPSRO captures the morphology of Tropical Cyclones

2. GPSRO sees the same features as AIRS Tropical Cyclone studies ***

3. GPSRO can (potentially) be used to probe the inner core (eye) of Tropical Cyclones

*** Wu, L., H. Su, R. G. Fovell, B. Wang, J. T. Shen, B. H. Kahn, S, M. Hristova-Veleva, B. H. Lambrigtsen, E. J. Fetzer, and J. H. Jiang (2012), Relationship of environmental relative humidity with North Atlantic tropical cyclone intensity and intensification rate, *Geophys. Res. Lett.,* doi:10.1029/2012GL053546.

Future plans

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In progress research:

- Focusing in the inner core (0 – 100 km) and outer core (100 – 200 km)
- Comparisons between these two regions

Future research plans:

- **Focus on the eyewall and investigate the moistening of the upper troposphere through "water vapor injection"**

Thank you!