COSMIC Radio Occultation technique for measurement of the tropopause during tropical cyclones

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Publication date:
2009

COSMIC Radio Occultation technique for measurement of the tropopause during Tropical cyclones

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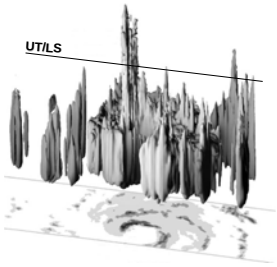
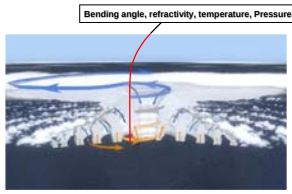
Goal & Methods

Water vapour transport to the upper troposphere (UT) and lower stratosphere (LS) by deep convective storms affects the radiation balance of the atmosphere and has been proposed as an important component of climate change. The aim of the work presented here is to understand if the GPS Radio Occultation (RO) technique will be useful for characterisation of this process.





GPS phase & amplitude -> Bending angle

Abel inversion -> Refractivity

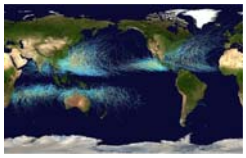
$N=77.6*P/T+3.73*10^{5}*p_w/T^2$

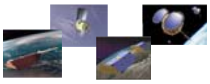
N refractivity, T temperature, P pressure, p_w water vapour pressure

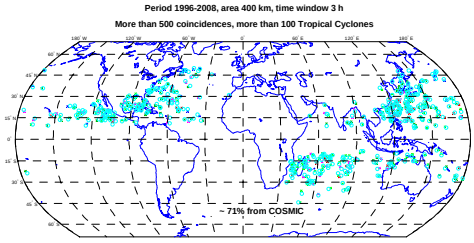
ECMWF model -> Temperature, Pressure, Water Vapour

Case selection

All the TC tracks were compared with GPS/MET, CHAMP, SAC-C and COSMIC ROs. More than 70% of coincidences are coming from COSMIC project. We finally selected two different TCs, Bertha 2008 and Hondo 2008, with completely different characteristics.



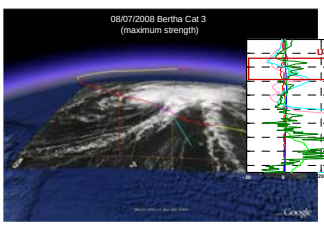




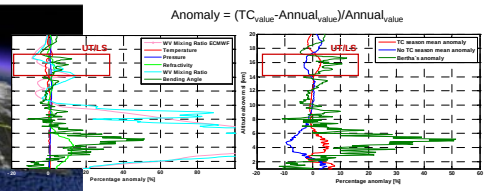
Tropical Depression
Tropical Storm
Tropical Cyclone
Maximum category
Extra-Tropical Cyclone
GPS Radio Occultation

Bertha 2008

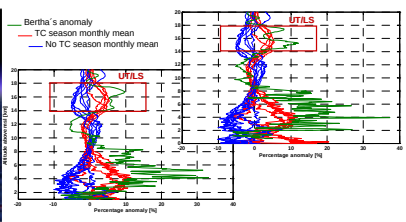
The bending angle of a GPS radio occultation signal contains interesting information on the atmosphere around the tropopause above the tropical cyclone. Temperature and refractivity profiles often show a variation at the same altitudes as the bending angle, but the signature is less pronounced and sometimes not evident. The water vapour anomalies from COSMIC agree largely with those of ECMWF, which can be explained by the fact that the ECMWF model is used in the derivation of the water vapour profiles.

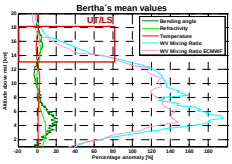


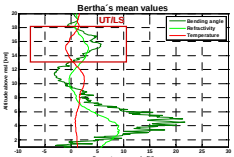
Anomaly = $(TC_{value}\text{-}Annual_{value})/Annual_{value}$

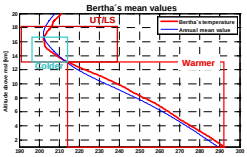


Bertha´s anomaly
TC season monthly mean
No TC season monthly mean



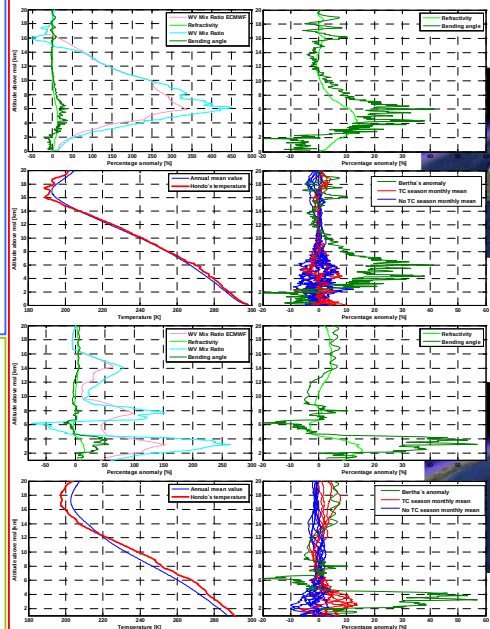


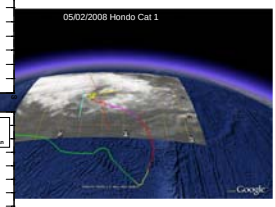


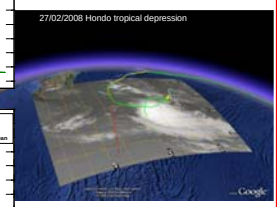


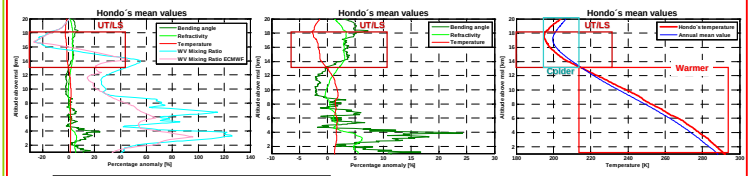
Hondo 2008

Analysis of Hondo profiles, confirms the same trends that we have found in Bertha. During Bertha all the ROs analysed were in TC status, during Hondo they are mostly during tropical depression status. The bending angle anomaly during tropical depression status is usually smaller in amplitude in the UT/LS and the peak is extended up to 25 km of altitude.









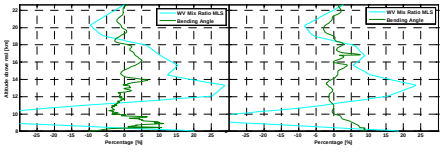
Comparisons

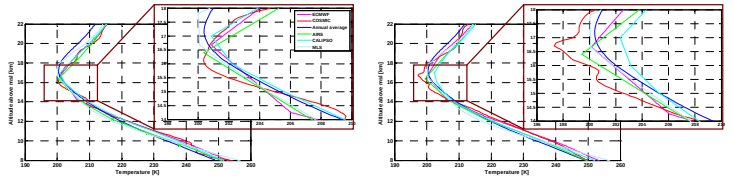
The temperature profiles show the TCs warm core and the cold peak reached in the UT/LS. This behaviour is confirmed from ECMWF, AIRS and MLS temperature profile.

In the UT/LS the water vapour comparisons with ECMWF show that the model largely influences the mixing ratio profile but the MLS mixing ratio anomaly has a behaviour in agreement with the bending angle anomaly.

Bertha´s track correspondences

TC	COSMIC	CALIPSO	MLS	AIRS
08/07 00.00	08/07 02.01			
08/07 12.00	08/07 14.19	08/07 16.50	08/07 13.30	08/07 17.05
10/07 06.00	10/07 05.34	10/07 05.58	10/07 02.00	10/07 06.11
10/07 06.00	10/07 04.36	10/07 05.58	10/07 02.00	10/07 06.11
11/07 18.00		11/07 17.21	11/07 13.30	11/07 17.47
12/07 12.00	12/07 12.37			12/07 16.53
12/07 12.00	12/07 12.47			12/07 16.53
13/07 12.00		13/07 17.09	13/07 13.30	13/07 17.35
18/07 00.00	18/07 02.44			18/07 05.17
19/07 00.00	19/07 02.07			19/07 05.59





Conclusions

- Bending angle profile shows a clear TC signature in the UT/LS
- Temperature and refractivity profiles from the COSMIC mission often show a variation at the same altitudes as the bending angle, but the signature is less pronounced and sometimes not evident
- The water vapour anomalies from COSMIC agree largely with those of ECMWF, which can be explained by the fact that the ECMWF model is used in the derivation of the water vapour profiles

Contacts

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