6D.4 HURRICANE'S EVOLUTION AND LATENT HEATING PROFILE STRUCTURE

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## 1. INTRODUCTION

The purpose of the present study is to retrieve latent heat profiles in hurricane from spaceborne passive microwave measurements. The connection between hurricane Bret's evolution and latent heat stucture is presented.

A bayesian algorithm (BRAIN) is used to retrieve hydrometeors profiles from TMI brightness temperature. To support the inversion, we use an original database built with co-located data from TRMM-Precipitation Radar (PR) and TRMM-Microwave radiometer (TMI).

The latent heat release is expressed as the vertical fluxes of the different water species which include not only the water content but also some other information not directly retrieved by the BRAIN algorithm. Among the variables we need is the vertical velocity. Thanks to the outputs of the meso-NH simulation model, we determined a simple relationship between the vertical velocity and hydrometeor profiles. The last terms required are the hydrometeors terminal fallspeed velocities for which we use parameterised relations from the litterature. The latent heating calculation is performed.

The studied case is the tropical hurricane Bret (21-23 august 1999). Results from three successive orbits are presented.

## 2. DATA

The TRMM satellite is the first mission to carry a passive (TMI) and an active (PR) microwave instruments together. The radar PR provides vertical profile of reflectivity at 14 GHz. The TMI measures brightness temperatures at different frequencies : 10.65, 19.35, 21.3, 37.0, 85.5 GHz, polarized both vertically and horizontally but for the 21 GHz channel which is only polarized vertically. TMI swatch is about 600 km large while the PR one is about 200 km. The PR swath is completely overlaid by the TMI measurements on both sides of nadir.

## 3. METHOD

### 3.1 *INVERSION METHOD*

The method used to retrieve water contents is derived from GPROF/2A12 extensively described in Kummerrow *et al* (2001). It's well documented and tested in Burlaud (2003). It is based on the Bayes's theorem applied on a database made of colocated PR and TMI data. The main advantage of such a database is its representativeness which is theoretically perfect.

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### 3.2 *LATENT HEATING CALCULATION*

The calculation of the latent heating profiles are conduced from water content profiles retrieved from the TMI brightness temperatures. The Roux and Sun (1997) formalism is used as follows:

$$Q_H(z) = \frac{L}{c_p}\left[\delta F(q_c) + (1-\delta)F(q_p)\right] - \frac{L_f}{c_p}FONT \qquad (1)$$

with $F(q_p)$, the production fonction of precipitation (Hauser and Amayenc, 1986), where $q_p$ and $q_c$ are respectively the total precipitation and total cloud water content.

$$F(q_p) = w\frac{\partial q_p}{\partial z} - \frac{1}{\rho}\frac{\partial(\rho V_p q_p)}{\partial z}, \qquad (2)$$

with w, the vertical velocity and $V_p$ the terminal fallspeed. Furthermore, $F(q_c)$ is the production fonction of cloud:

$$F(q_c) = w\frac{\partial q_c}{\partial z} \qquad (3)$$

and the latent heating du to melting process is parametrized in Leary and Houze (1979):

$$FONT = \frac{V_{pw}q_{pw}}{\Delta z} \qquad (4)$$

where $V_{pw}$ and $q_{pw}$ correspond to the first level above the melting region with $\Delta z$, the melting region depth.

$\delta$ in (1) is equal to 1 when the air is saturated while equal to 0 when the air is unsaturated (respectively $F(q_p) > 0$ and $F(q_p) \leq 0$).

## 4. RESULTS

On Fig. 1, 2 and 3 are represented horizontal cross-section of latent heating released in the case of hurricane Bret respectively for the 20th, 21st and 22nd of August 1999. On the 20th (Fig. 1) , the dynamic forcing is weak and even if the low levels are close to saturation, the the production of latent heating is low. Indeed, the system will remain at this level of intensity for the next 10 hours. On the 21st (Fig. 2.), the mature dynamic drags the surrounding water vapor producing a huge amount of latent heating released. The system is in the middle of its intensification stage and will reach its maximum intensity in the next 10 hours. The 22nd of August (Fig. 3), the dynamic is at its maximum but the presence of the land in the western part of the system prevents the water vapor to be advected from the left hand side of the picture leading to a moderated latent heat production.

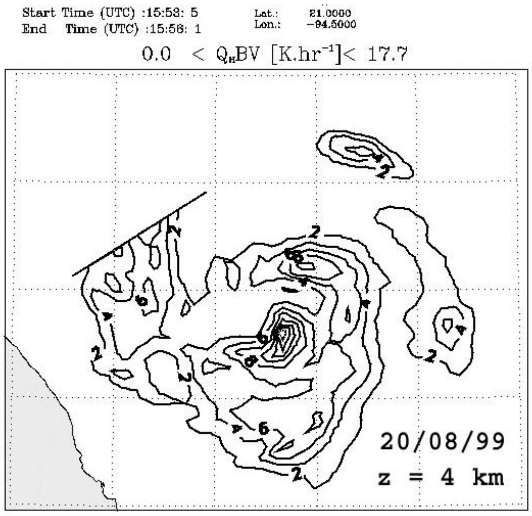


FIG. 1: Horizontal cross-section at 4 km altitude of latent heating released the 20th of August 1999.

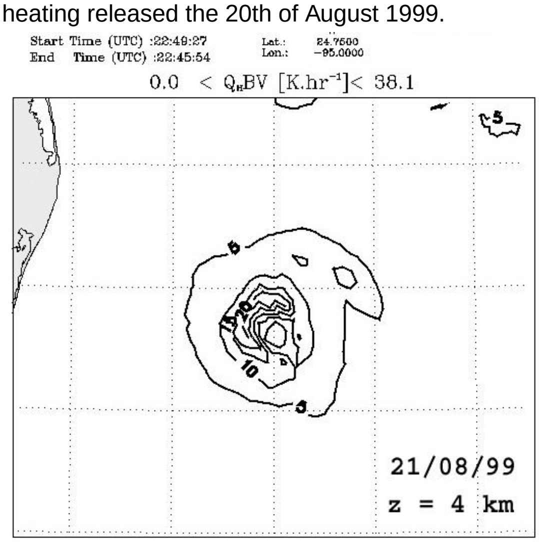


FIG. 2: Horizontal cross-section at 4 km altitude of latent heating released the 21st of August 1999.

## 5. CONCLUSION AND PERSPECTIVES

Bret was observed three times by TRMM in different phases of its evolution. A retrieval method was developped to provide water content profiles which are in turn used to calculate latent heating profiles. A posteriori, analysis of the results show good consistency between the system evolution and the respective order of magnitude of latent heating retrieved.

Nevertheless, these good results have to be tested in other situations. Hurricane cases are more difficult because of the strong horizontal advection due to strong wind which can't be directly retrieved from satellite measurements. In a futur version, a very simple dynamic model based on minimum central pressure and system size will hopefully be used to account for this effect.

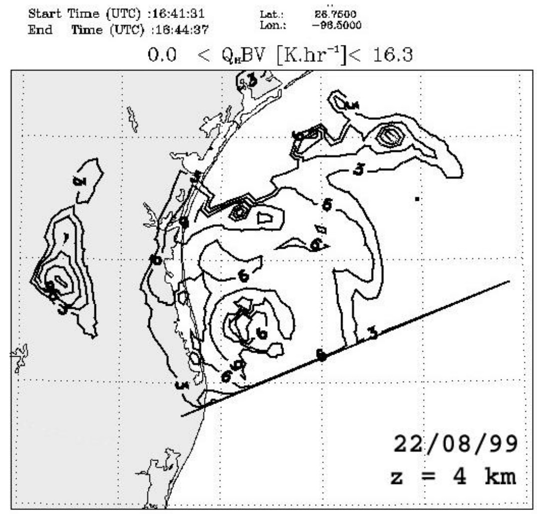


FIG. 3: Horizontal cross-section at 4 km altitude of latent heating released the 22nd of August 1999.

Furthermore, some improvements on vertical velocity estimate is also necessary to calculate latent heating profiles (Eq. 2 and 3).

## 6. ACKNOWLEDGEMENTS

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