

Copertina

# Corso di Fisica dell'Atmosfera

## Approccio unitario alla descrizione dei cicloni atmosferici

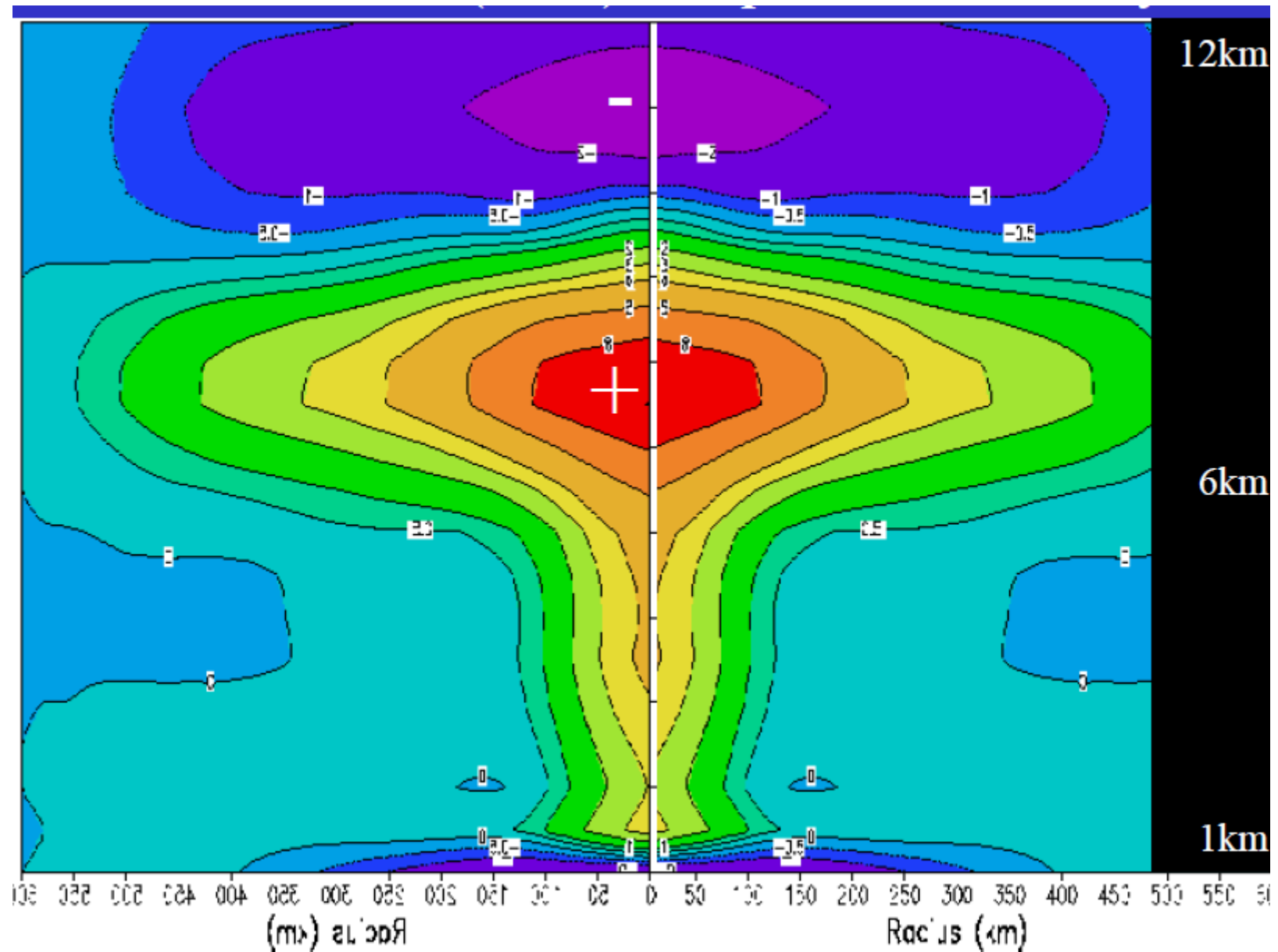
Giaiotti Dario

## Sommario della lezione

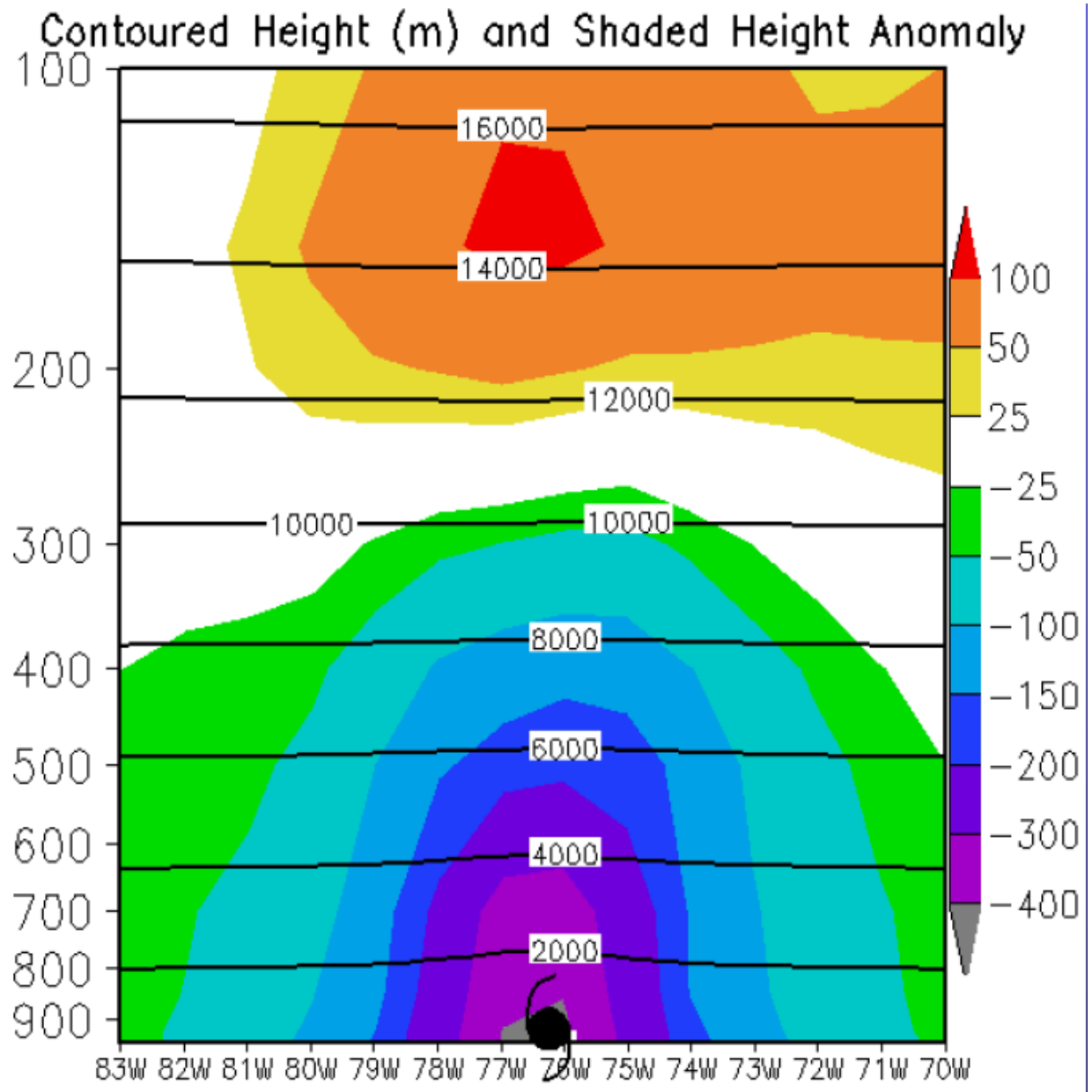
- Lo spazio delle fasi per una rappresentazione dell'evoluzione dei cicloni atmosferici
- Caratteristiche termiche e bariche dei cicloni tropicali
- Caratteristiche termiche e bariche dei cicloni extra tropicali
- Evoluzione di cicloni tropicali in extra tropicali



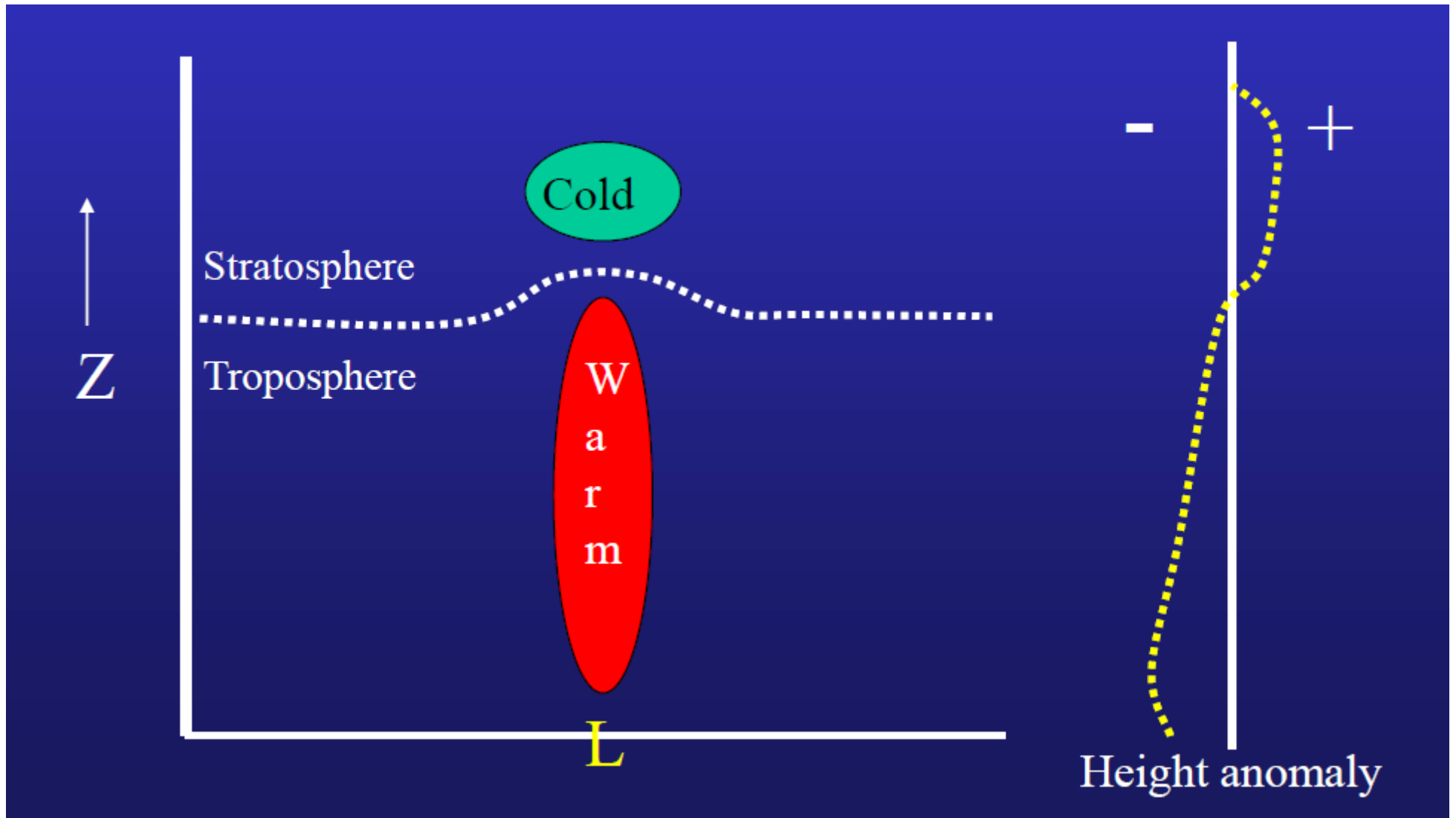
## Cicloni tropicali ed extra-tropicali a confronto: ciclone tropicale a cuore caldo



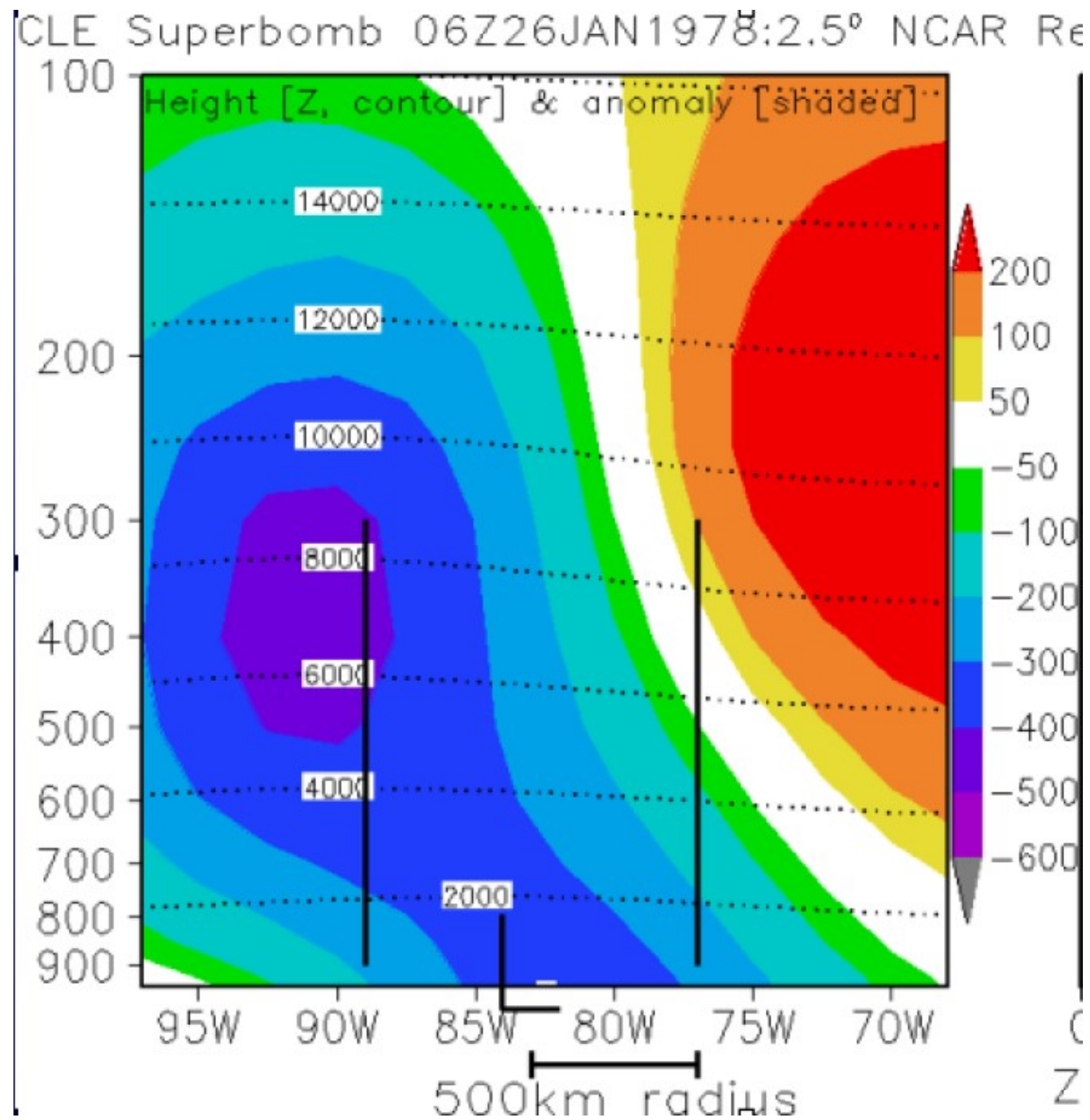
# Cicloni tropicali ed extra-tropicali a confronto: ciclone a cuore caldo



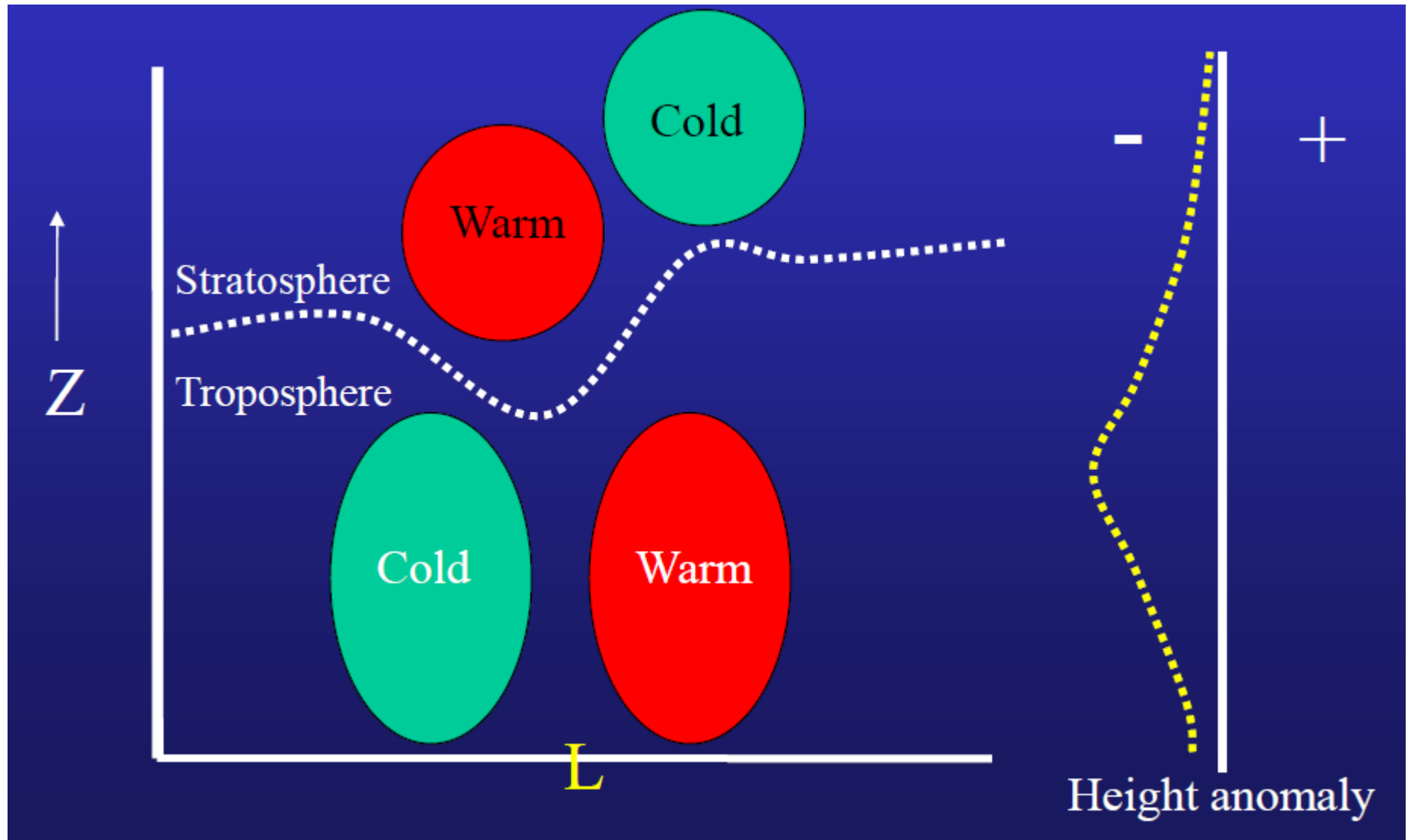
## Cicloni tropicali ed extra-tropicali a confronto



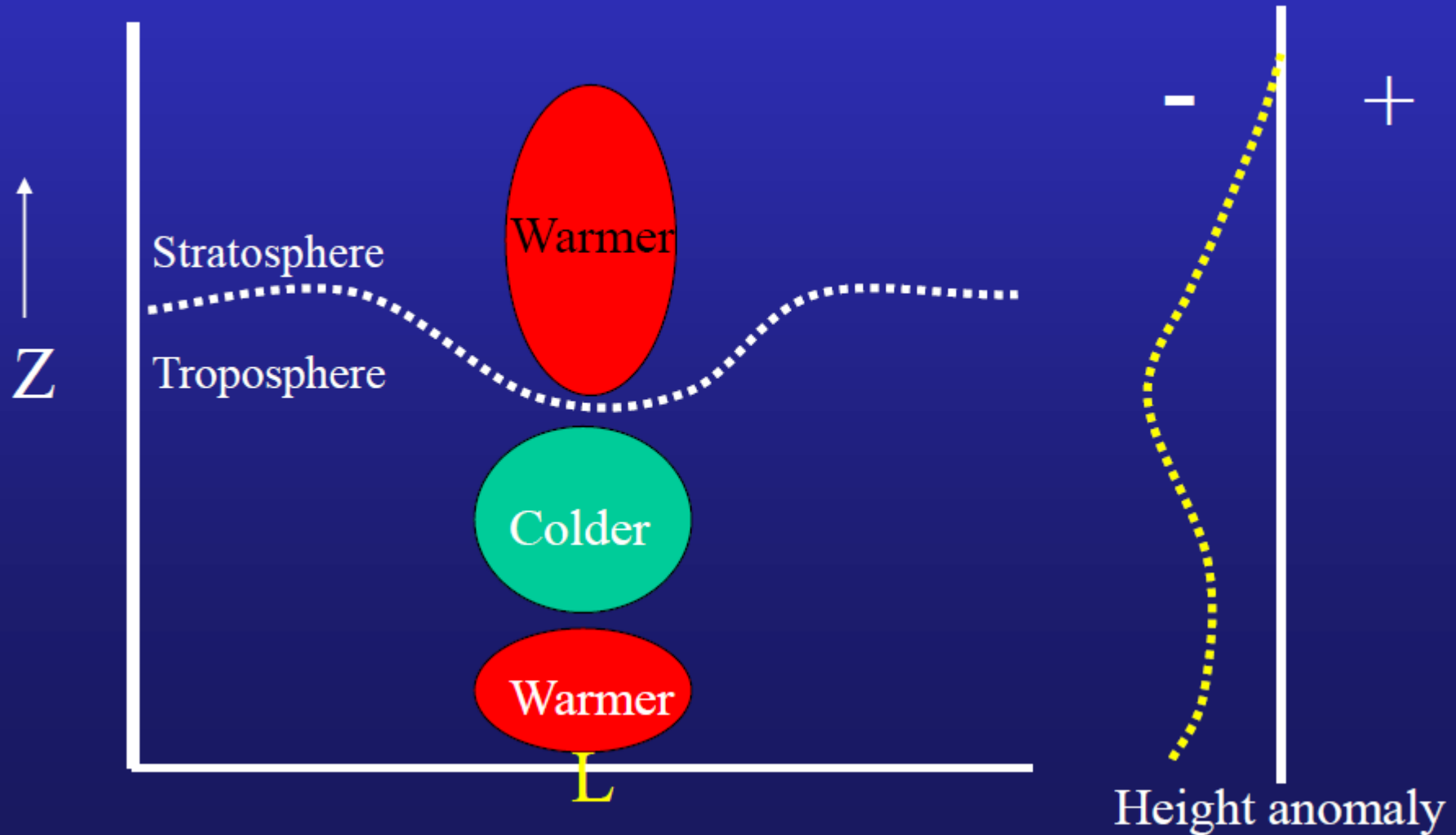
## Cicloni tropicali ed extra-tropicali a confronto: ciclone a cuore freddo



## Cicloni tropicali ed extra-tropicali a confronto: ciclone a cuore freddo

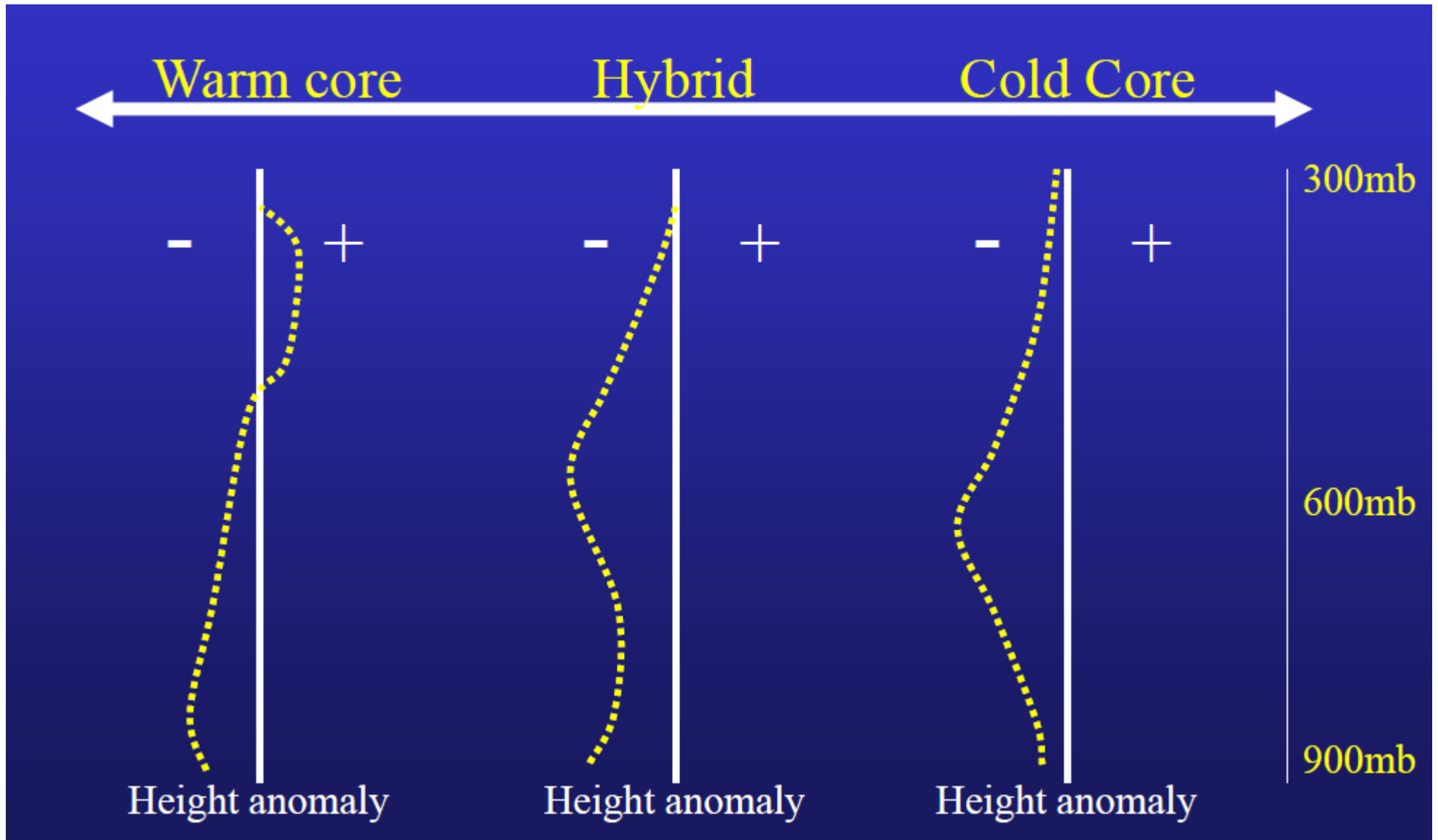


## Cicloni tropicali ed extra-tropicali a confronto: la transizione tra i due tipi



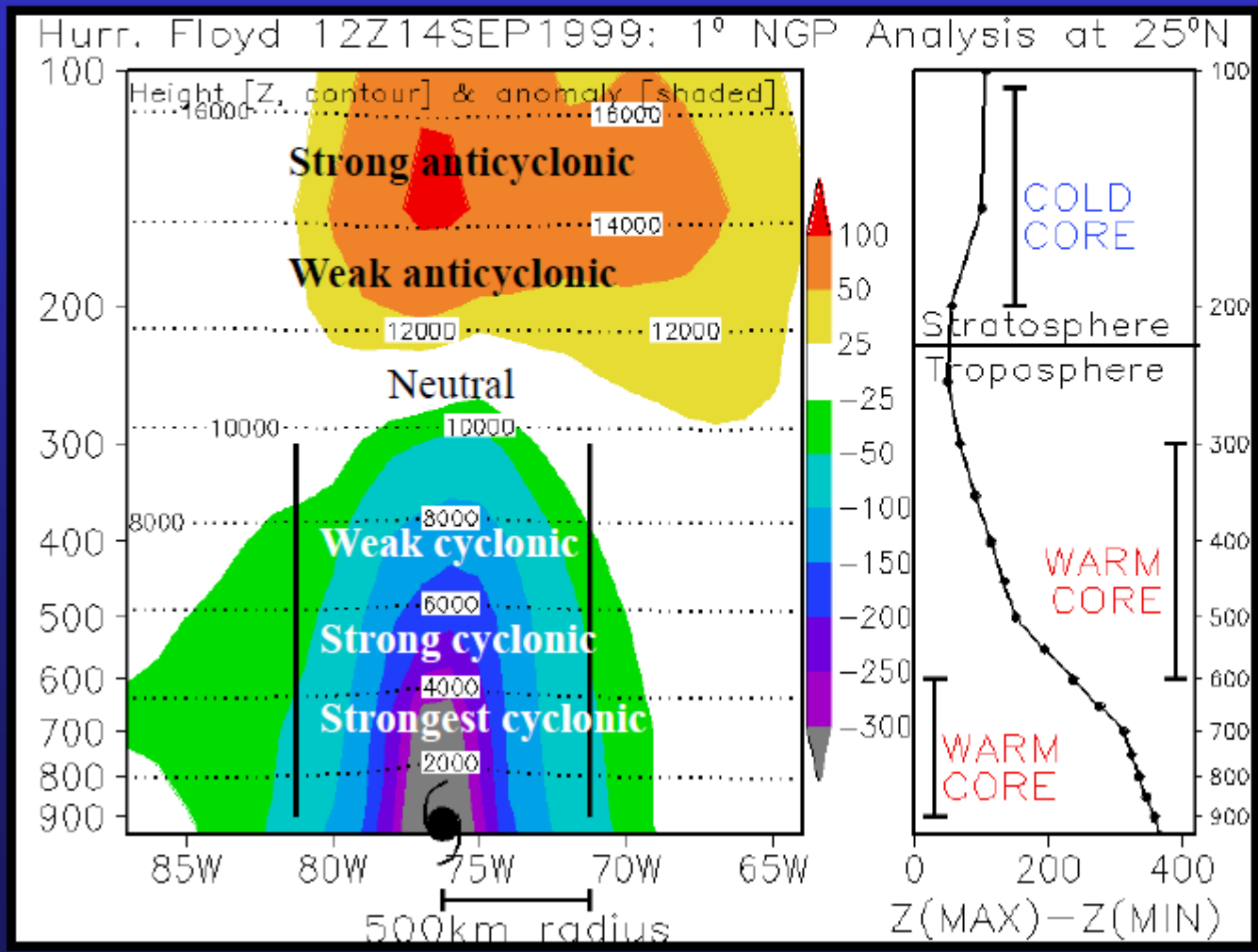


## Cicloni tropicali ed extra-tropicali a confronto: anomalia di altezza geopotenziale



# Cicloni tropicali ed extra-tropicali a confronto

## Warm-core example: Hurricane Floyd 14 Sep 1999



Vertical profile of  $Z_{MAX} - Z_{MIN}$  is proportional to thermal wind ( $V_T$ ).

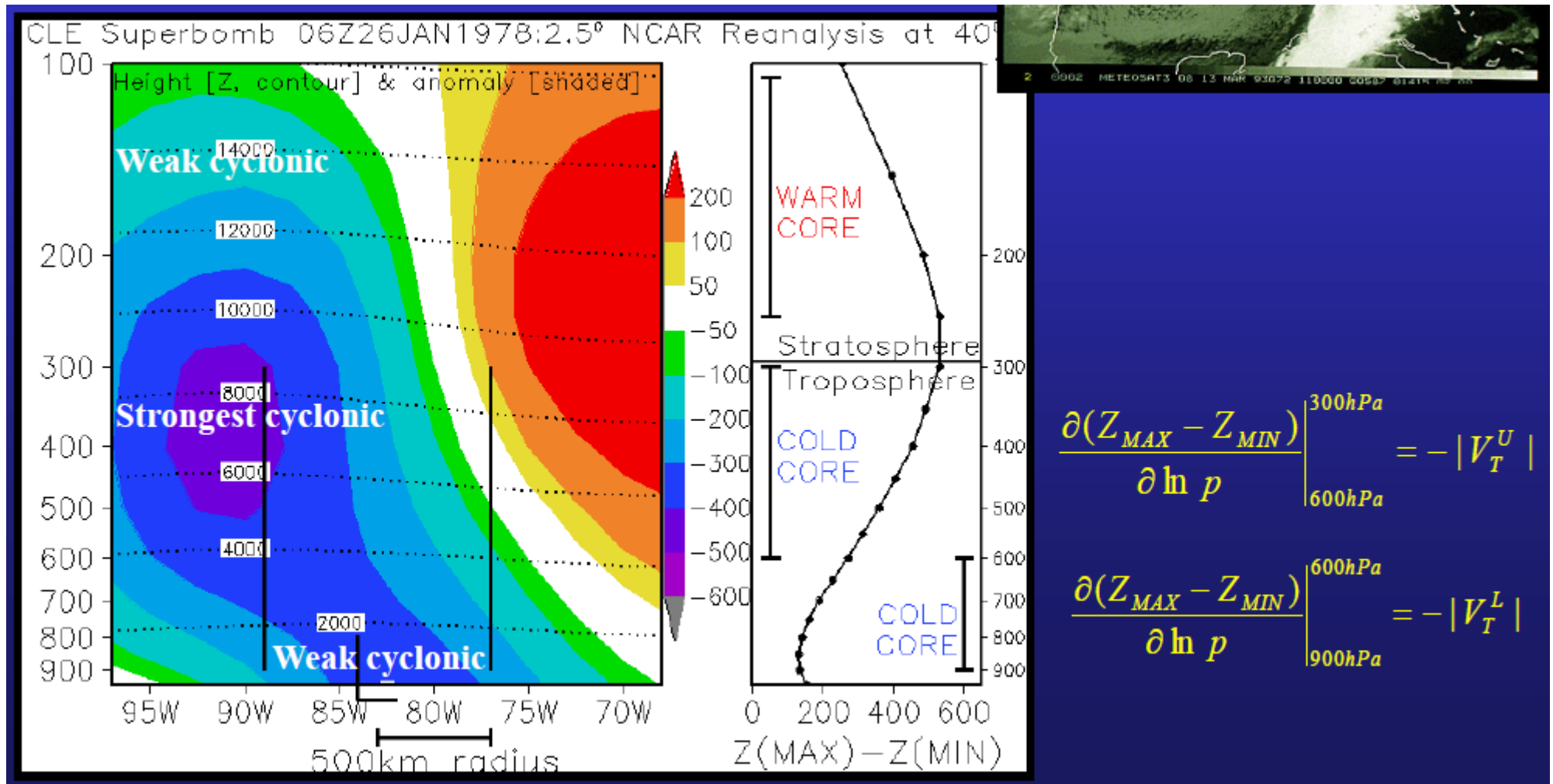
$$\frac{\partial(Z_{MAX} - Z_{MIN})}{\partial \ln p} = - |V_T|$$

Two layers of interest

$$\frac{\partial(Z_{MAX} - Z_{MIN})}{\partial \ln p} \Big|_{600hPa}^{300hPa} = - |V_T^U|$$

$$\frac{\partial(Z_{MAX} - Z_{MIN})}{\partial \ln p} \Big|_{900hPa}^{600hPa} = - |V_T^L|$$

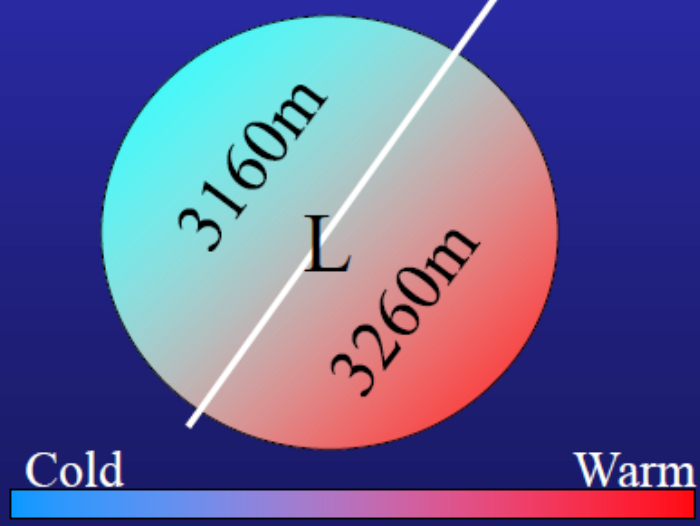
## Cicloni tropicali ed extra-tropicali a confronto



## Cicloni tropicali ed extra-tropicali a confronto

- Defined using storm-relative 900-600hPa mean thickness field (shaded) asymmetry within 500km radius:

$$B = \overline{Z_{600hPa} - Z_{900hPa}} \Big|_R - \overline{Z_{600hPa} - Z_{900hPa}} \Big|_L$$



$B \gg 0$ : Frontal

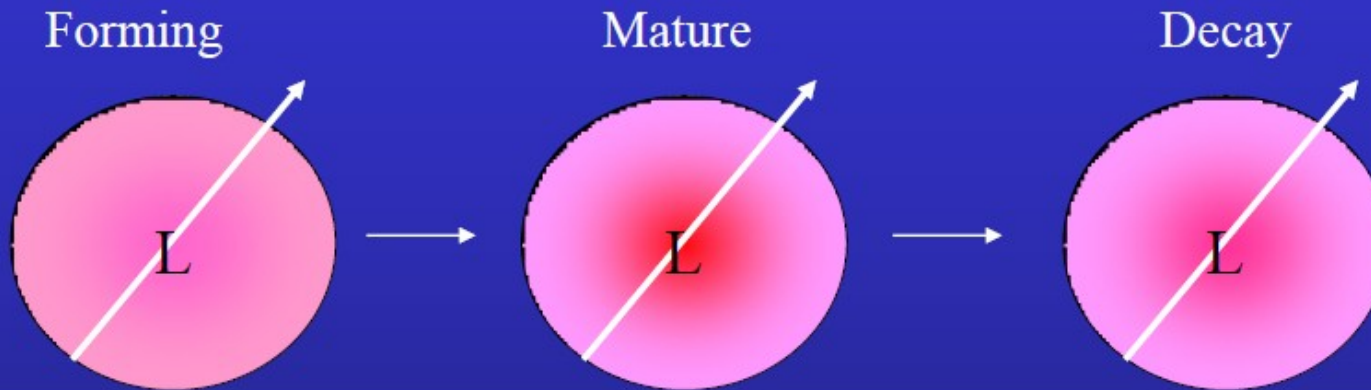
$B \approx 0$ : Nonfrontal

## Bibliografia

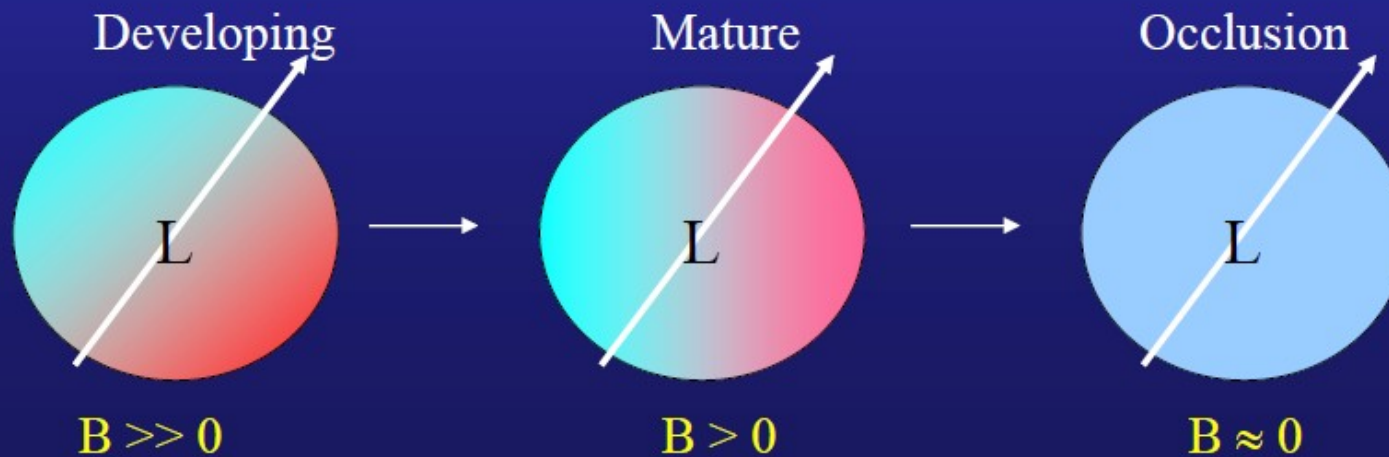
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- A Cyclone Phase Space Derived from Thermal Wind and Thermal Asymmetry (2002) R. E. Hart  
[https://journals.ametsoc.org/view/journals/mwre/131/4/1520-0493\\_2003\\_131\\_0585\\_acpsdf\\_2.0.co\\_2.xml](https://journals.ametsoc.org/view/journals/mwre/131/4/1520-0493_2003_131_0585_acpsdf_2.0.co_2.xml)
- The Extratropical Transition of Tropical Cyclones. Part I: Cyclone Evolution and Direct Impacts (2017)  
<https://journals.ametsoc.org/view/journals/mwre/145/11/mwr-d-17-0027.1.xml>
- The Extratropical Transition of Tropical Cyclones. Part II: Interaction with the Midlatitude Flow, Downstream Impacts, and Implications for Predictability (2019) <https://journals.ametsoc.org/view/journals/mwre/147/4/mwr-d-17-0329.1.xml>
- Evolution of the upper-level thermal structure in tropical cyclones (2016)  
<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL070622>
- Objective tropical cyclone extratropical transition detection in high-resolution reanalysis and climate model data (2017)  
<https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2016MS000775>

## Cicloni tropicali ed extra-tropicali a confronto

*Conventional Tropical cyclone:  $B \approx 0$*



*Conventional Extratropical cyclone:  $B$  varies*



## Cicloni tropicali ed extra-tropicali a confronto

### Symmetric warm core

- $B \leq 10$  and  $-V_T^L > 0$ 
  - Tropical cyclones, warm seclusions

### Asymmetric warm core

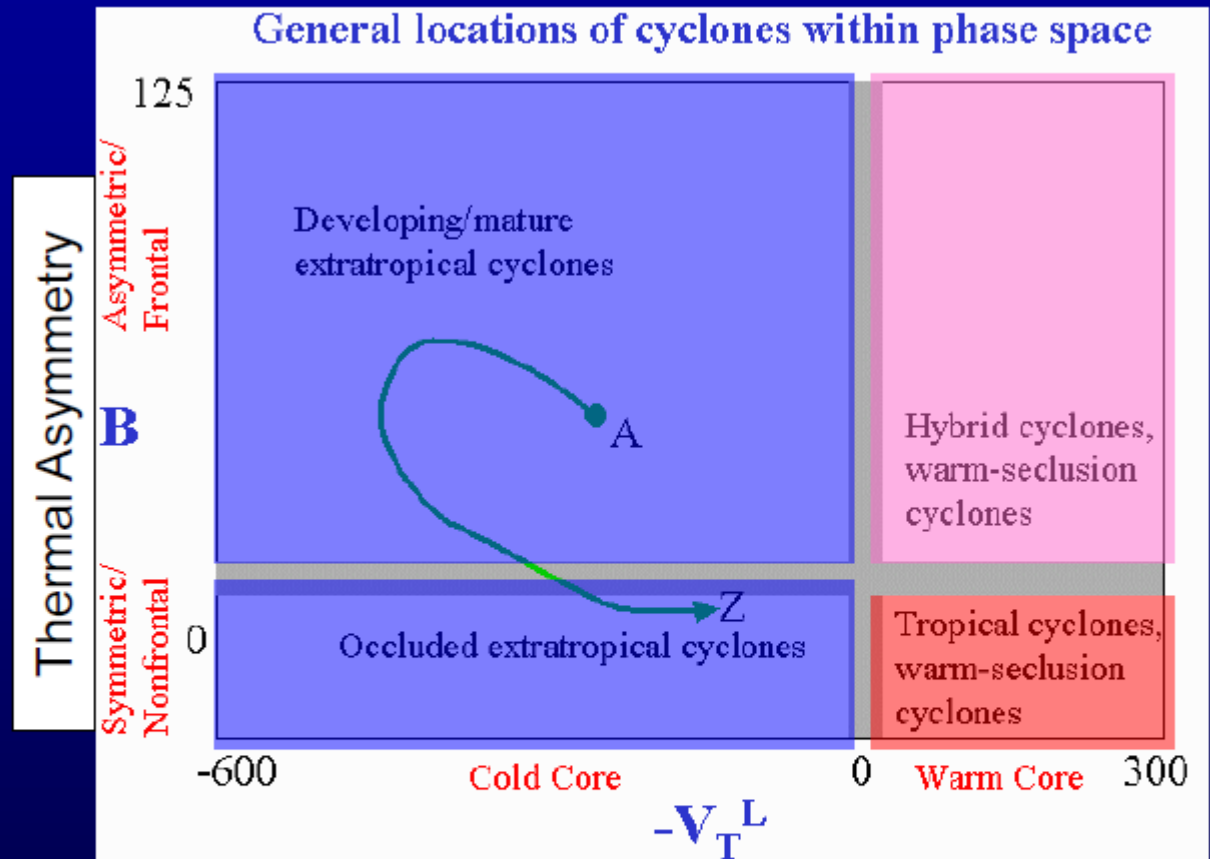
- $B > 10$  and  $-V_T^L > 0$ 
  - Hybrid cyclones, warm seclusions
  - Most cyclones undergoing ET found here

### Symmetric cold core

- $B \leq 10$  and  $-V_T^L < 0$ 
  - Occluded extratropical cyclones

### Asymmetric cold core

- $B > 10$  and  $-V_T^L < 0$ 
  - Developing or mature extratropical cyclones



Lower Troposphere

## Cicloni tropicali ed extra-tropicali a confronto

### Deep warm core

- $-V_T^L > 0, -V_T^U > 0$
- Tropical cyclones

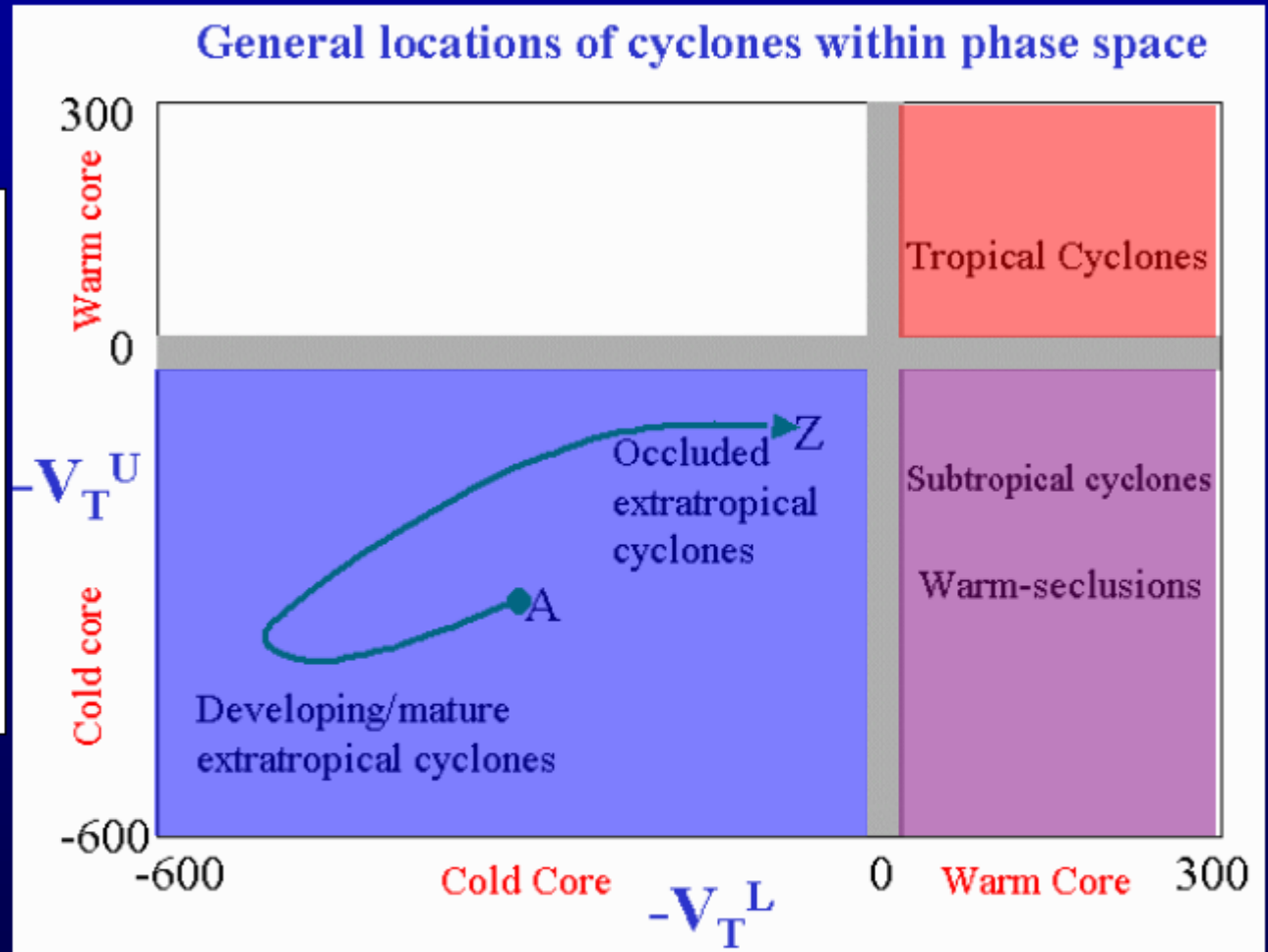
### Deep cold core

- $-V_T^L < 0, -V_T^U < 0$
- Extratropical cyclones

### Shallow warm core

- $-V_T^L > 0, -V_T^U < 0$
- Subtropical cyclones, warm seclusions

Upper Troposphere



Lower Troposphere



# Cicloni tropicali ed extra-tropicali a confronto



Hurricane Bonnie near peak intensity east of the Bahamas on August 23

<b>Formed</b>	August 19, 1998
<b>Dissipated</b>	August 30, 1998
<b>Highest winds</b>	1-minute sustained: 115 mph (185 km/h)
<b>Lowest pressure</b>	954 mbar (hPa); 28.17 inHg
<b>Fatalities</b>	5 overall
<b>Damage</b>	\$1 billion (1998 USD)
<b>Areas affected</b>	Leeward Islands, North Carolina, Mid-Atlantic States

Part of the [1998 Atlantic hurricane season](#)

