ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 2, Issue 10 , October 2015

The Role of Vorticity Advection on the Weather

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ABSTRACT: Vorticity is a curl of fluid velocity and the absolute $\xi_0 = \xi + f$
Where ξ is the relative vorlicity while f is the carioles parameter. North word moving air acquires and increasing value for f and hence decreasing value for f .The concept of circulation is related that of vorticity , and it has big role on the weather changes . Horizontal. Closed curves in either hemisphere will have positive circulation, vorlicity is negative. While the curvature is negative, the vorticity is positive.

KEYWORDS: - Vorticity – Carioles parameter Convergence – Divergence, Weather.

I. Introduction

Several types of wave travel westwards in the equatorial and tropical troposphere easterlies, the differences between them probably result from regional and seasonal variations in the structure of the tropical atmosphere. Their wavelength is about 2,000 – 4,000 km, and they have a lifespan of one to two weeks, travelling some 6-7˚ longitude per day.The first wave type to be described in the tropics was the easterly wave of the Caribbean area. This system is quite unlike a mid-latitude depression. There is a weak pressure trough, which usually slopes eastwards with height and typically the main development of cumulonimbus cloud and thundery showers is behind the trough line. This pattern is associated with horizontal and vertical motion in the easterlies. Behind the trough, low-level air undergoes convergence, while ahead of it there is divergence. This follows form the equation for the conservation of potential vorticicty which assumes that the air travelling at a given level does not change its potential temperature (i.e. adiabatic motion):

$$\frac{f + \zeta}{\Delta P} = k$$

Where f the Coriolis parameter, ξ = relative vorticite (cyclonic positive) and Δp = the depth of the troposphere air column. Air overtaking the trough line is moving both pole wards (f increasing)

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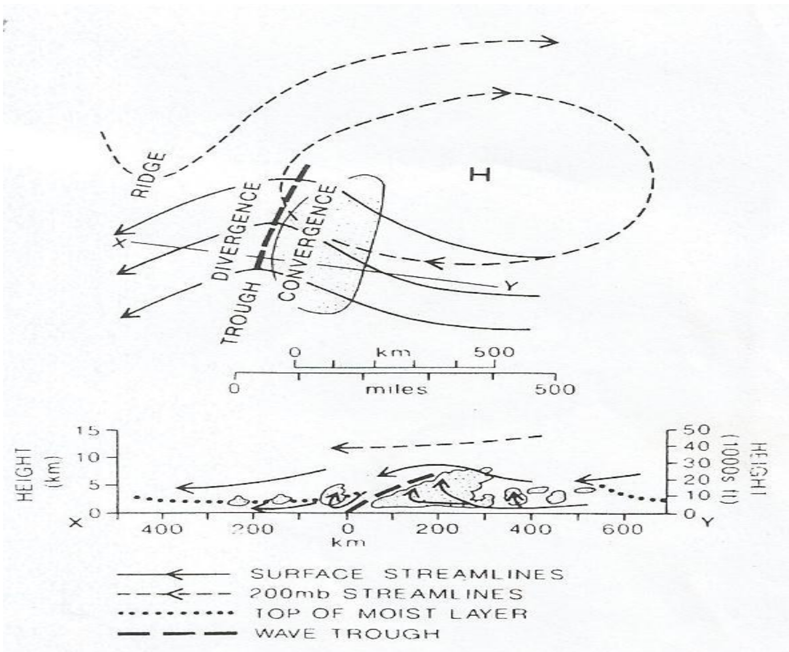

Source: Partly after Riehl and Malkus

II. Related Work

A model of the areal (above) and vertical (below) structure of an easterly wave. Cloud is stippled section. The streamline symbols refer to the areal structure, and the arrows on the vertical section indicate the horizontal and vertical motion. And towards a zone of cyclonic (ξ curvature increasing). So that if the left – hand side of the equation is to remain constant Δp must increase.

In the usual ease where $f >> \xi$

$$\frac{d}{dt}(\xi + f) = -f \, div_p \, V$$

By using this equation near the surface – say at 1000 mb – and at some upper level and subtracting them to obtain the relative divergence it can be shown that:

$$f(f \, div_p \, V - div_p \, V_0) = - \acute{V} \frac{\partial}{\partial s} (\acute{\xi} + 2\xi_0)$$

Where $\acute{V}$ is the thermal wind , V_0 is the surface wind , $\acute{\xi}$ the vorticity of the thickness pattern and ξ_0 the vorticity of the surface pattern and $\frac{\partial}{\partial s}$ denotes differentiation along a thickness line .

If $(div_p \, V = 0)$ i.e. the upper leve is a level non-divergence – say at 500 mb – then:

$$div_p \, V_0 = \frac{\acute{V}}{f} \frac{\partial}{\partial s} (\acute{\xi} + 2\xi_0)$$

Relating the surface divergence to thickness pattern. This vertical expansion of the air column necessitates horizontal contraction (convergence). Conversely, there is divergence in the moving southwards ahead of the trough and curing ant cyclonically. The true divergent zone is characterized by descending, drying air with only a shallow moist layer near the surface, while in the vicinity of the trough and behind it the moist layer may be 4,500 m or more deep. When the easterly airflow is slower than the speed of the wave, the reverse pattern of low-level convergence ahead of the

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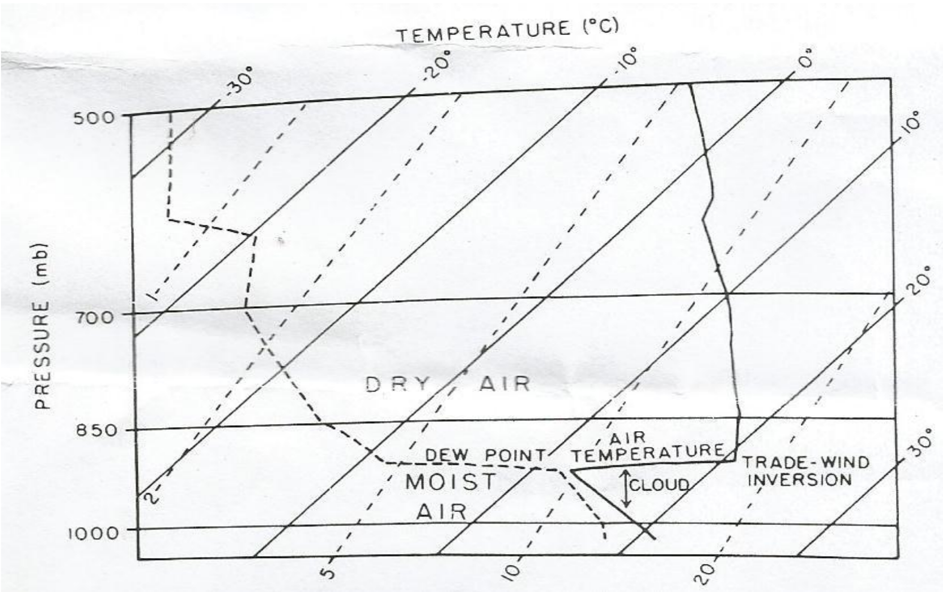
trough and divergence behind it is observed as a consequence of the potential vorticity equation. Often this is the case in the middle troposphere, so that the pattern of vertical motion is augmented.



The vertical structure of trade wind air at 30˚N, 140˚W at 0300GMT on 10 July 2009The mixing ratio is the saturation valuesource Based on Riehl

III. Conclusion

The passage of such a transverse wave in the trades commonly produces following weather sequence:
1- In the ridge ahead of the trough: fine weather, scattered cumulus cloud, some haze.
2- Close to the trough line: well-developed cumulus, occasional showers, improving visibility.
3- Behind the trough: veer of wind direction, heavy cumulus and cumulonimbus, moderate or heavy thundery showers and a decrease of temperature. Satellite photography indicates that the simple easterly wave is rather less common than has been supposed. Many Atlantic disturbances show an (inverted V) waveform in the low-level wind field and associated cloud, or a comma cloud related to a vortex. They are often apparently linked with a wave pattern on the ITC further south. West African disturbances that move out over the eastern tropical Atlantic usually exhibit low-level confluence and upper-level influence ahead of the trough, giving maximum precipitation rates In this same sector.
Many disturbances in the easterlies have a closed cyclonic wind circulation at about the 600 mb level.
It is obviously over the oceans and in continental areas with sparse data coverage. However, some generalizations can be made. At least eight out of ten disturbances develop some 2-4˚latitude. Ward of the Equatorial Trough convection is probably set off by convergence of moisture in the airflow, accentuated by fiction, and then maintained by entrainment into the thermal convective disturbances develop during the Jun-November hurricane season in the tropical Atlantic, apparently one system every three to five days. More than half of those disturbances originate over Africa.
According to N. Frank, a high ratio of African of depressions in the storm total in a given season indicates tropical characteristics , where as a low ratio suggests storms originating from cold lows and the bar clinic zone between Saharan air and cooler, moist monsoon air Many of them can be tracked westwards into the eastern North Pacific. A quarter of the disturbances intensify into tropical depression and 10 per cent become named storms.
Developments in the Atlantic air closely related to the structure of the trades. In the eastern sectors of subtropical anticyclones, active subsidence maintains a pronounced inversion at 450 to 600 m. Thus, the cool eastern tropical oceans are characterized by extensive, but shallow, marine stratocumulus, which gives little rainfall. Downstream the height of the inversion base rises because the subsidence decreases away from the eastern part of the anticyclone and cumulus towers penetrate through the inversion from time to time.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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