航海氣象講座之一 水蒸氣循環/大氣環流/季風
https://youtu.be/ZmLu57VqFn0
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概述

本次講座旨在增加大家對海洋氣象與貨櫃落海的基本知識與防範,以便在航行時能做出更準確的判斷。

水蒸氣循環

海水受到太陽照射產生熱量,導致水分蒸發到空氣中。這些水蒸氣比空氣輕,會往上升,在空中凝結成雲。冷空氣流動補充了這一過程中形成的真空,從而造成了雲、霧等自然現象。水蒸氣的水平流動則形成了風。大部分水蒸氣在高空凝結成降雨,最終又回到海洋,形成了水氣循環。

大氣環流

由於地球的自轉,赤道附近的熱空氣上升,而南北兩極的冷空氣下沉,形成了一個單胞的大氣環流模式。但實際上,由於科氏力的影響,這種環流模式變得更加複雜,形成了三胞模式。在 30 度緯度附近,下沉的氣流形成了無風帶,而補充的氣流則形成了貿易風。

季風

由於地球公轉時，地軸的傾斜,以及陸地和海洋對熱量吸收的差異,實際的大氣環流並非完全符合三胞模式,而是呈現出季風的特點。季風環流主要表現為赤道附近的低壓區和兩極的高壓區之間的溫度差異引起的氣流變化。

結論

通過本次講座,希望大家能夠對海洋氣象有更深入的瞭解,在航行時做出更準確的判斷,確保航行安全。

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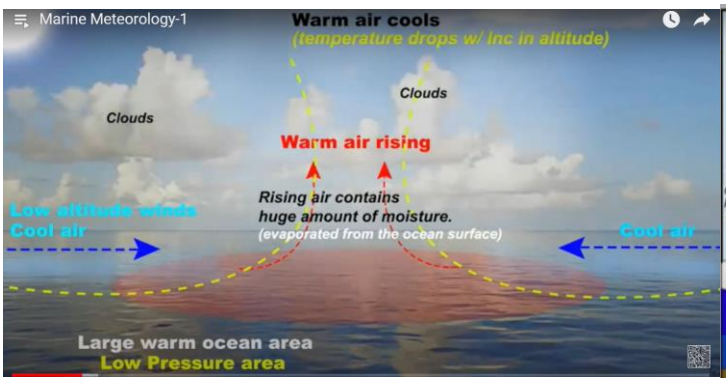
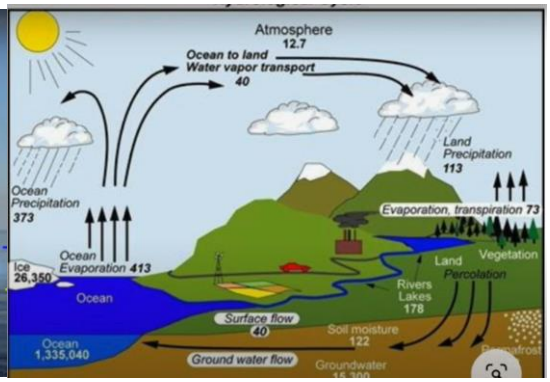
各位同仁大家好，我是李文愚，李船長有鑒於公司對氣象的重視，以對航行安全應用的資料參考，所以做這個氣象的講座，來增加大家的一些基本知識，方便以後在航行對海洋氣象做出更準確的判斷。任何的自然現象都是從最基本的物理開始，海洋氣象基本上就是跟燒開水是一樣的，物理最基本的原理就是冷縮熱脹，海水受到太陽的照射，產生的熱量沒有辦法消化，就直接蒸發到空氣裡面，蒸發的水蒸氣是比空氣輕，所以會往上升，這就是我們在圖片中間看到熱的空氣飽含著水氣往上升，升上去的水氣在空中就開始凝結，變成了天上的雲朵，旁邊的這個冷空氣就流過來(紫色的箭頭)來，補充因為熱蒸發的水蒸氣下面所留下來的真空，這種水蒸氣的上下運動，就造成了天空的雲與霧等等自然現象，這種水蒸氣的水平流動造成的是風。

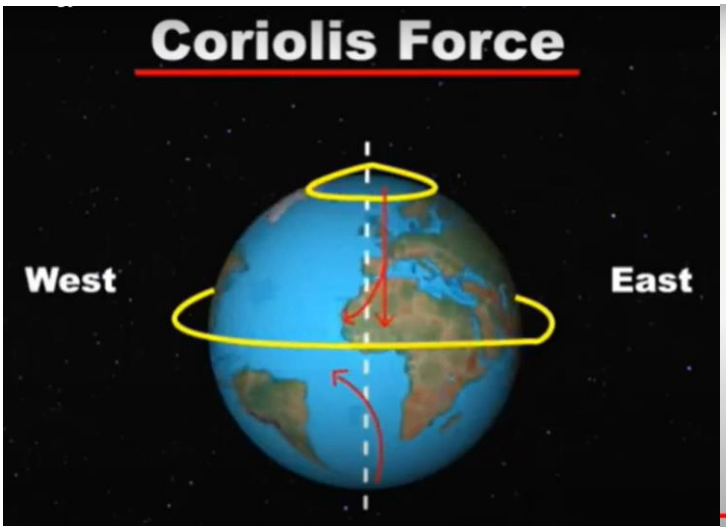
這些蒸發上來的水氣，百分之九十都在高空凝結，變成了海洋上的降雨，就是我們看到左邊373，這個不知道是什麼單位，其中的這個十分之一，就是隨著天上的氣流飄到陸地上，在陸地上形成了降雨，陸地上的雨連同陸地上最右邊中間陸地上蒸發的 73 的水蒸氣，又在陸地上下雨，變成了地上水的河流，跟地下水回到海洋裡面，這就是水氣的循環。

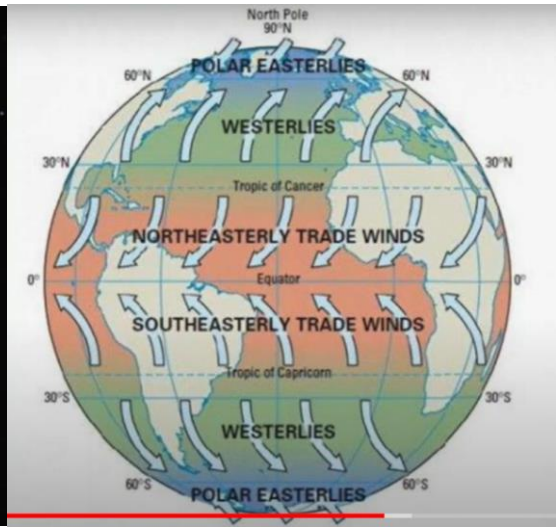




地球上的面積百分之七十是海水，百分之三十是陸地，太陽照到地球上的赤道部分是距離最短，所以赤道附近吸收到的熱量，就比南北兩極的熱量要多，照講這個熱空氣上升應該是從赤道上升，也就是緯度零度新加坡這一帶，然後到南北兩極再下降，這是就是造成一個循環也就是赤道上面的熱空氣上升到南北兩極下降，然後再從南北兩極把下降的冷空氣流到赤道上面補充。

這是單胞說，可是地球不是靜止不動的，所以地球還有一個力量，叫做地球自轉力。英文就叫做科氏力，科氏力就是我們上面看到的這個英文字，主要的意思是說，地球轉一圈在赤道上面因為直徑比較大，所以甩起來的力量就比較大，在南北兩極它的直徑比較小，甩起來的距離就比較小，這個甩就會產生偏向。



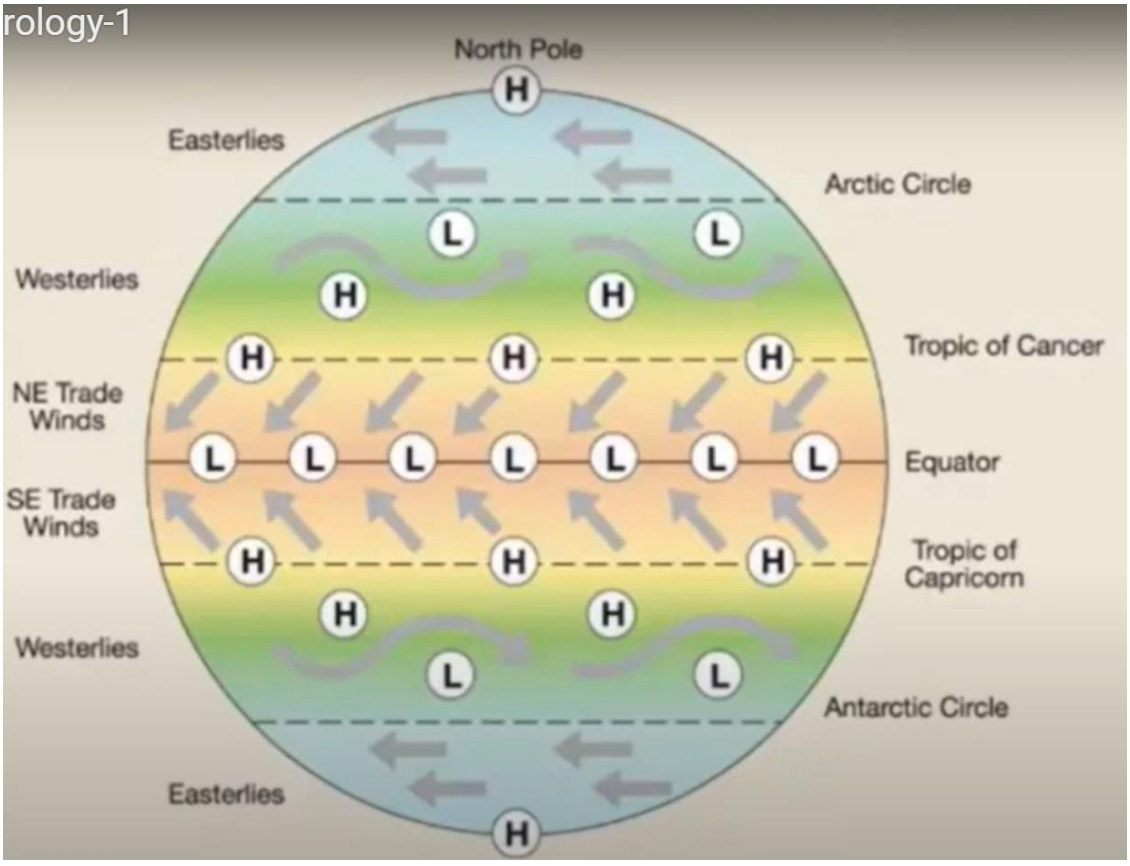


如果有一個人，從這個南北兩極向赤道出發，它看起來就會越來越偏，英文就叫做科氏力，這個科氏力就是我們上面看到英文寫的，地球的轉動是由西向東轉，遙遠的太陽看起來就像是從東邊升起，西方落下，這個是地球轉動的方向，除了地球的轉動，還有地球在南北極跟赤道的圓周是不一樣的，同樣是轉一圈在赤道的圓周要轉多少？360 度乘上 60 分= 21600 多

海浬的距離。

可是在南北兩極就沒有這麼多海浬，所以如果有一個人從北極出發要前往赤道，他感覺是在走直線，可是因為地球在轉動，走著走著從北邊下來的人，就會走到右邊去，從南極往赤道走的人，走著走著就會往左邊去，這個是視運動。因為這樣子的視運動，造成地球上的風都開始偏向，這個偏向就把單純的大氣的循環，變成複雜的三胞模式。請看下圖

因為這個旋轉的力量，也就是在北半球是向右轉，在南半球向左轉的力量，沒有辦法用這個單胞模式來消化，所以在赤道上升的氣流，會在北緯跟南緯 30 度的地方下降，下降了以後，氣流往北邊去就變成西南風，往南邊去就變成東北風，去補充赤道上升的氣流所留下來的這個真空，所以從 0 到 30 度之間是一個上下循環的大氣胞。



這個緯度 30 度，因為氣團的下降，就造成沒有地面水平流動的風，所以這個 30 度，又叫做無風帶，馬緯度無風帶。這個從 30 度移動到赤道的風，剛好彌補赤道因為受到太陽直射的熱量所上升氣流造成的真空，所以赤道也是一個無風帶，也就是沒有很強地面風的地方，現在我們看到的這個圖，是叫做行星風圖，也叫做貿易風信風圖，古時候的帆船都是靠這個風在航行，就是有的季節吹東北風，有的季節吹西南風。

其實地球除了會自轉以外，地球還會公轉，也就是繞著太陽轉一年轉一圈，因為地軸跟黃道面(公轉的平面)是傾斜 23.5 度的，所以赤道不是永遠都是最熱的地方，可以說地球的赤道，每年都要南北來回一次，也就是在南北回歸線 23.5 度間移動，這就是因為地球傾斜的角度，

加上有陸地，有海洋，他這個水汽蒸發的速度不一樣，空氣對流的速度也不一樣，所以實際上地球的行星風是不規則的。

下面我們看到的這張圖，就是實際上地球經常吹的季風，我們看這張圖實際上三胞模式根本就不存在，看起來就是只有兩胞一胞，就是在赤道附近黃色的部分，所有的氣流都在赤道輻合上升造成赤道的低壓，另外一胞就是南北極的冷空氣，因為冷空氣的質量大密度高，所以會下降，造成地面的高壓。在這兩極的高壓和赤道的低壓之間，實際上就是溫帶溫帶，這裡就是上下波動，可是在 30 度無風帶還是確立的，緯度 60 度的風向在北半球吹西風，在南半球也是吹西風，所以應該是叫做盛行西風帶才對。

Hello, everyone, I am Captain Lee Wen Uew. In view of the company's emphasis on meteorology, And reference materials on maritime safety practices on board, So, I am giving this lecture on meteorology, To increase everyone's basic knowledge, Making it easier to make more accurate judgments on marine meteorology during navigation, Any natural phenomenon, Always, Starts from the most basic physics, So, what is ocean meteorology, Basically, It is basically like boiling water, The most basic principle of physics is, Thermal contraction and expansion, When seawater is heated by the sun, The generated heat, Cannot be dissipated, So it directly evaporates into the air, The evaporated water vapor, Is lighter than the air, So, it rises up, This is what we see in the middle of the picture, The hot air, Full of water vapor rising up, As for, The rising water vapor in the air, Starts to condense Became the clouds in the sky that The one next to it. Where did this cold air go ? It flows over a purple arrow To supplement this part Because of the water vapored from evaporation, The up and down movement of water vapor Creates the clouds and fog in the sky, And other natural phenomena. The horizontal movement of this air flow Results in the Wind.

The water vapor that evaporates Ninety percent all
In the high altitude Condenses Turns into Rainfall over the ocean Is what we see To the left and center 373 This unknown unit Of which This one-tenth Is with the air flow in the sky floats down to the land on the land forms rainfall rain on the land together with the land the water vapor evaporated from the land on the far right middle of the land is 73 again raining on the land becomes rivers on the surface of the ground and groundwater back into the ocean this is the water cycle
on Earth area seventy percent is seawater thirty percent is land the sun shines on the earth the equatorial part of is distance shortest so near the equator absorbed heat than the heat near the two poles is more So as I was saying this

hot air rises it should be from the equator rising that is, latitude zero degrees Singapore this area then to the North and South Poles then descending so this is what creates a cycle that is, the hot air above the equator rises to the North and South Poles, descends then returns from the North and South Poles and what the descending cold air flows back to the equator completing so this is the single cycle but the Earth is not stationary so the Earth has another force called Earth's rotation in English, it's called Coriolis force Coriolis force is the English word we see above so the main idea is The Earth rotates once around. But at on the equator, because the diameter is larger, so the force when swung is greater. Then at the North and South poles, its diameter is smaller, so when swung, the distance is shorter. So this swinging, will then If there is a person starting from the poles towards the equator, it will appear more and more This in English is called Coriolis force. This Coriolis force is what we see written in English above, Then the Earth's rotation is from west to east, So that distant Sun appears to rise from the east and set in the west. So this is the direction in which the Earth rotates Besides that, the rotation of the Earth what else Earth The circumference at the North and South poles and the equator is different It's the same full rotation The circumference at the equator How much does it have to turn Multiply by 360 degrees times 60 minutes Over 21,000 nautical miles distance But at the equator There's not as much at the North and South poles So If there's a person Starting from the North Pole and heading to the equator They feel like they're walking in a straight line But because the Earth is rotating As they walk The person from the North Will end up on the right And from the South Pole towards the equator They will veer towards Go left So this is Four movements Because of these four movements Causing winds on Earth All start to lean This leaning Then Purely The circulation of the atmosphere Becomes a complex triad pattern Please refer to the diagram below Because The power of this rotation In the Northern Hemisphere Turns right While in the Southern Hemisphere it turns left It's not possible To use this Single-cell pattern to digest
So In The rising airstream at the equator Will in North latitude And in the South latitude Around 30 degrees Descend After descending They will each Move towards the north So it became Southwest wind Going towards the south it became Northeast wind to replenish equator rising airflow left by this whole void so from 0 to 30 degrees between is a upward and downward cycle air parcel so this at latitude 30 degrees because the descent of air masses so causes no surface winds so this 30 degrees is also called the doldrums horse latitudes doldrums so rising to the equator this from 30 degrees move to the equator wind rises at the equator that's just right compensate for the equator because of the direct sunlight heat so

upward airflow creating a vacuum so the equator is also a no wind belt that is without very strong winds place
Now, this picture we see is called planetary winds also known as trade winds the trades sailboats in ancient times depend on this wind in navigation that is sometimes blowing northeast winds sometimes blowing southwest winds actually the earth besides spinning rotation Earth will still revolve around the sun once a year Because the Earth's axis is tilted with respect to the ecliptic So the equator is not always the hottest place That is to say the equator of the Earth every year has to travel north and south which are the Tropics of Cancer and Capricorn at 23.5 degrees This is tilted at an angle Adding to this with both land and oceans the speed of water evaporation differs and so does the speed of air convection Therefore in reality the planetary winds are irregular Now let's look at this diagram
In the 30-degree windless zone still being established At 60 degrees The wind direction is blowing In the Northern Hemisphere, the west wind blows In the Southern Hemisphere, the west wind also blows So it should be called the westerlies