• Distance

- Departure (NM) = Δlong (min) · cos (mean lat)
  = Δlong (deg) · 60 · cos (mean lat)

↕ 1° = 60 NM

↔ Δlong ↕ Δlat

- C D M V T D_R TT

arrow point toward biggest #

ex. 4L ← 4R → flow wind vect

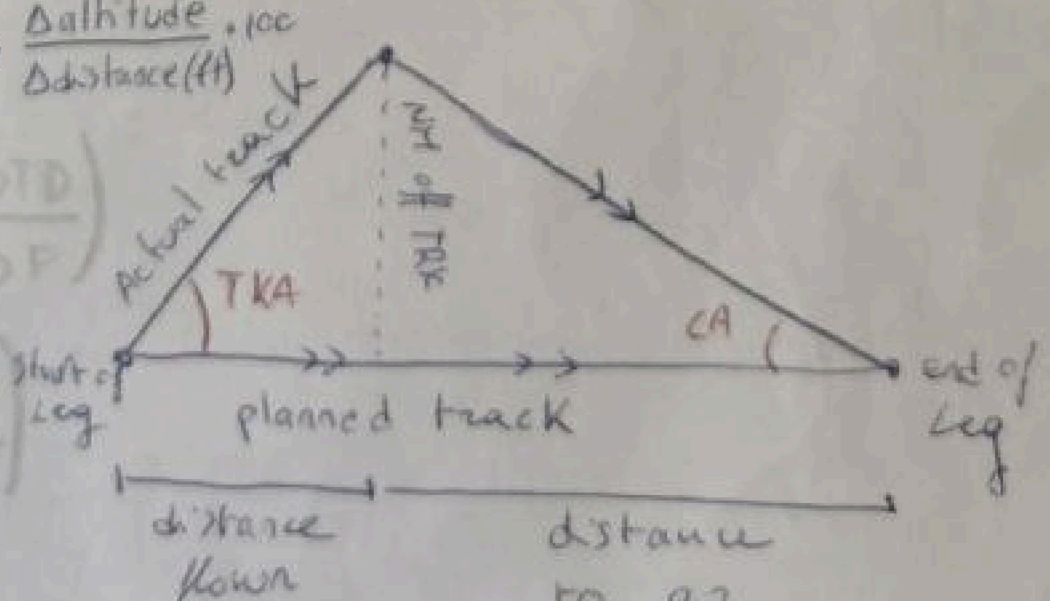
D_R = HDG → TRK (no correction)
TRK → HDG (correction) → follow opposite wind vector

steer = compass ; tr = magnetic

• Speed and wind

climb = $\frac{3}{3}$ Δalt
descend $\frac{1}{2}$ Δalt

- TAS increases 2% each 1000 ft increment
- TAS temperature correction 4% each 10°C of ISA deviation
  ISA − x = add ; ISA + x = subtract
- Compressibility factor (ISA > 300 Kt) : (TAS ÷ 100) − 3
- TAS (Kt) = $38,964 \sqrt{T(K)} \cdot M$
- ETAS = cos (drift angle) · TAS
- Wind correction angle = $\frac{XW \cdot 60}{TAS}$
- Gradient = $\frac{\Delta \text{height}}{\Delta \text{distance}} = \frac{ROC}{TAS} = \frac{ROD}{TAS} = \frac{\Delta \text{height (ft)}/100}{\Delta \text{distance (NM)}}$
- ROC (ROD) = angle (deg) · GS · $\frac{5}{3}$ = Δaltitude ÷ $\frac{\text{distance (NM)}}{GS}$ · 60
  = GP(%) · GS GP(%) = $\frac{\Delta \text{altitude}}{\Delta \text{distance (ft)}}$ · 100
- TKE = $\frac{\text{off track distance}}{\text{distance flown}} \cdot 60$ $\tan^{-1}\left(\frac{OTD}{DF}\right)$



$\tan^{-1}\left(\frac{OT}{DTG}\right)$

- closing angle (CA) = $\frac{\text{offtrack}}{\text{distance to gp}} \cdot 60$

Total correction = TKE + CA

- Drift = |HDG − TRK| TKE = from planned track to actual track

- Triangle of velocities

GS → Track

TAS → Heading

wind → wind speed + direction

wind$_x$; wind$_y$
w_x w_y

$$\vec{GS} = \vec{TAS} + \vec{wind}$$

$$GS\angle TRK - TAS\angle HDG = wind_x \angle wind_y$$

$$\text{wind speed} = \sqrt{w_x^2 + w_y^2} \qquad \alpha_{wind} = \tan^{-1}\left(\frac{w_y}{w_x}\right) + 180^\circ$$

- VFR Navigation

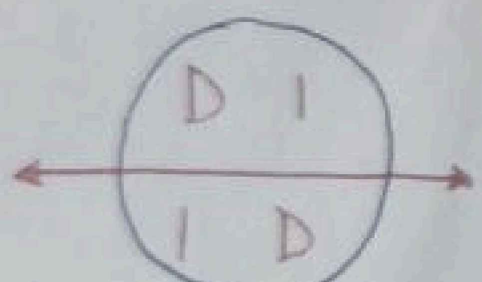
True Bearing = True heading + Relative bearing
(from a/c to feature)

$$\begin{cases} QDM \overset{(M)}{=} HDG + RB \\ QUJ \overset{(T)}{=} HDG + RB \end{cases}$$

- Great circles and rhumb lines

$$\text{Convergency} = \Delta long \cdot \sin(\overline{lat})$$

conversion angle = $\frac{1}{2}$ convergency
angle between gc and rl
(great circle in rhumb line)



Ⓝ W→E increasing
E→W decreasing

Ⓢ W→E decreasing
E→W increasing

to know if the great circle track increase or decrease depending on the travel direction.

I D

Initial Great circle

D I

Charts

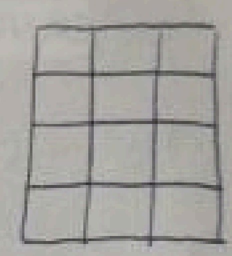
| meridian
| longitude

— parallel
latitude

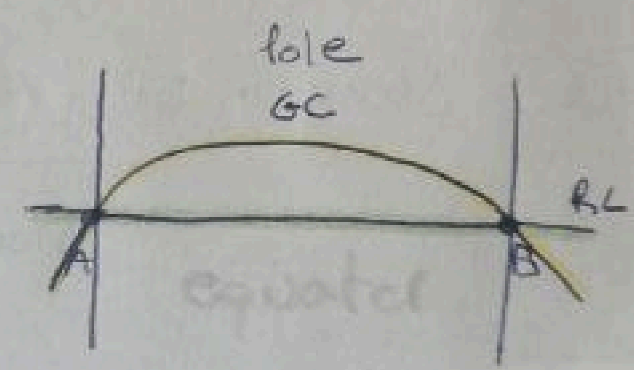
- Conformal (orthomorphic) : local preservation of angles, but not distance.
  track on chart ≡ track on earth
- Constant scale : $\text{scale} = \dfrac{\text{chart length}}{\text{Earth distance}}$
- Great circle and rhumb lines should be both straight lines
- Meridian and parallel should intersect at 90° everywhere

It is impossible to have all such features in 1 chart, so each chart is ≠

Mercator projection



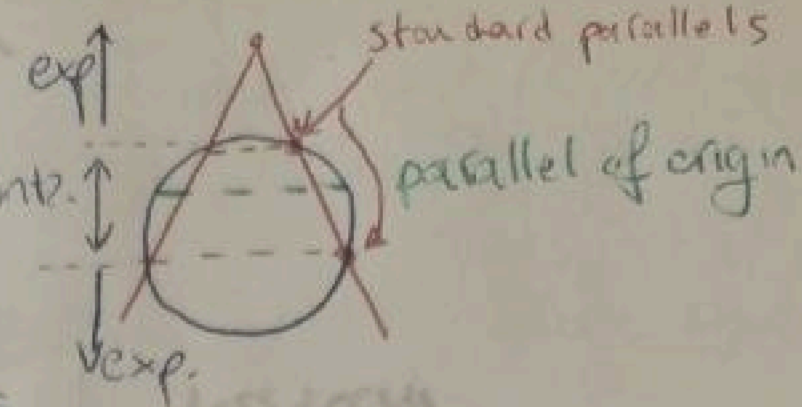
- cylindrical
- plane tangential to the equator of the RE → correct at the equator
- direction plotted as straight lines
- Rhumb lines are straight
- Great circles concave to the equator



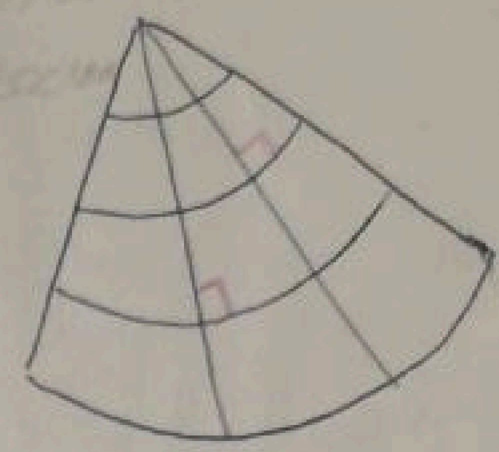
- Meridian are all parallel → no convergency
- Radio bearings have to be converted into rhumb lines before plotting as they are great circles
- $\dfrac{\text{New Distance}}{\text{Old Distance}} = \dfrac{\cos(\text{lat new})}{\cos(\text{lat old})} = \dfrac{\text{New scale}}{\text{Old scale}}$

1 : 100 is a bigger scale than 1 : 10000

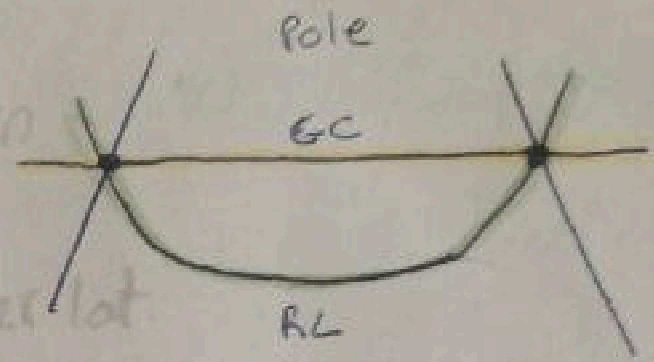
Lamberth projection



- conical
- parallel of origin: where the cone intersect the globe
- Scale correct on the standard parallel, contracts between them and the parallel of origin, expands away from them. Scale constant along a // of latitude



- Meridians are straight lines originating from the poles
  Parallels are arcs of circles centered at the pole.
- Convergence constant across the chart
- Rhumb lines are concave to the pole at // origin or concave to // origin any other lat
- Great circle lines are straight lines



- Radio bearings are GC, so are easy to plot being great circles.
- Chart convergence = $\Delta long \cdot \underbrace{\sin(\text{parallel of origin})}_{\text{constant of the cone "n"}}$ → halfway between the standard parallels

Same scale = standard parallel

Same convergency = parallel of origin

Produced mathematically to obtain conformality

Scale minimum value at // origin

Convergency = $\frac{\text{opening angle}}{360}$ → // origin = $\sin^{-1}\left(\frac{\text{opening angle}}{360}\right)$

constant of cone

Polar stereographic

- There's a true N/S and a grid north
- True N/S is in the center of the map, so true track changes depending on where it is on the chart
- Grid north definition and the grid on the chart allow for a constant grid track
- Rhumb lines are curves, concave to the nearest pole
- Great circles are considered straight lines (above 70°). Less curvature than RL
- Convergency is constant and correct only at the poles, expanding away from it
- Colatitude = 90 - latitude
- Convergence = $\sec^2\left(\frac{1}{2}\text{colatitude}\right) = \dfrac{1}{\cos^2\left(\frac{1}{2}\text{colatitude}\right)}$