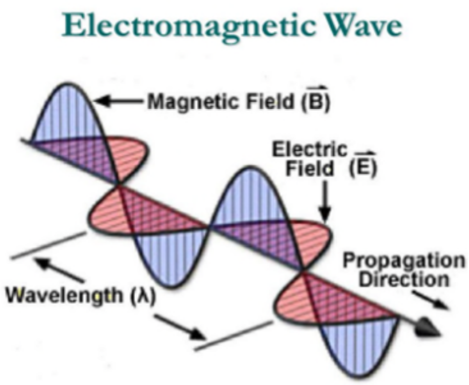
Chapter Eight
Weather Radar
(Part three)

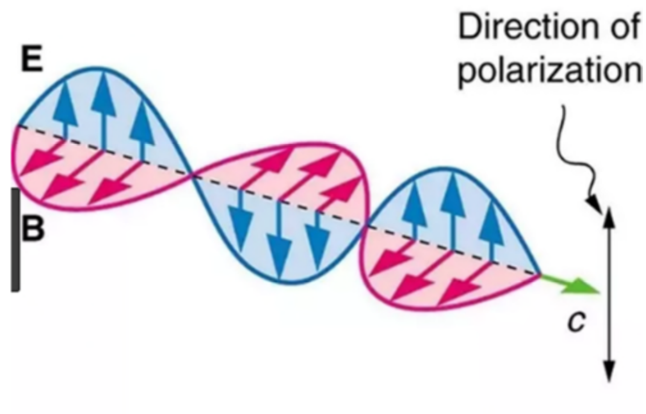
Dual Polarization Weather Radar

- **Polarization of EM waves**

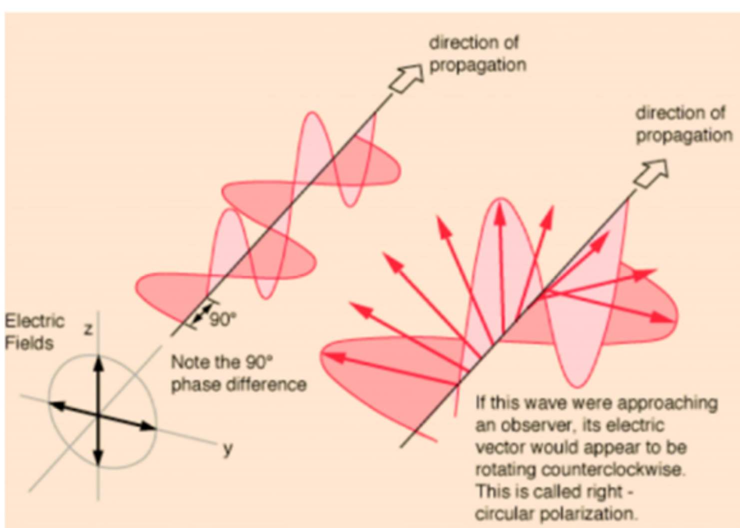
  - An electromagnetic wave such as light consists of a coupled oscillating electric field and magnetic field, which are always perpendicular to each other and to the direction of propagation.

- By convention, the "polarization" of electromagnetic waves refers to the direction of the *electric field* **E**.
- In *linear polarization*, the fields oscillate in a single direction (*horizontal or vertical*)



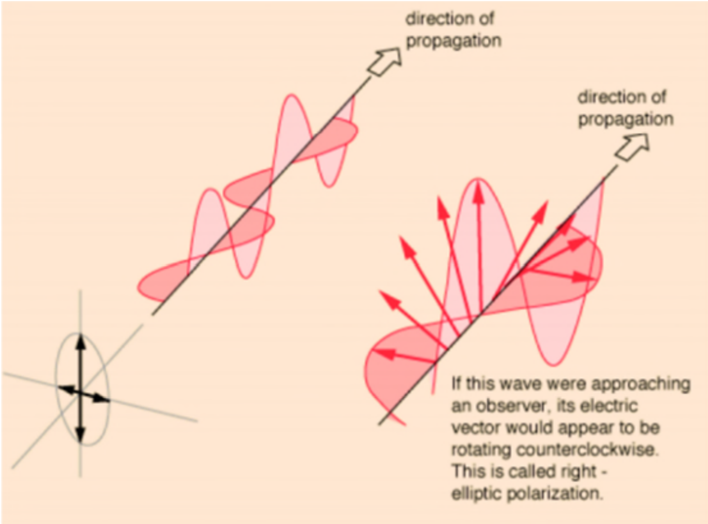


- *Circularly polarized* light consists of two perpendicular EM plane waves of equal amplitude and 90° difference in phase.
- (either right- or left-hand circular (clockwise/anti-clockwise respectively)
- The light illustrated is right-hand circularly polarized



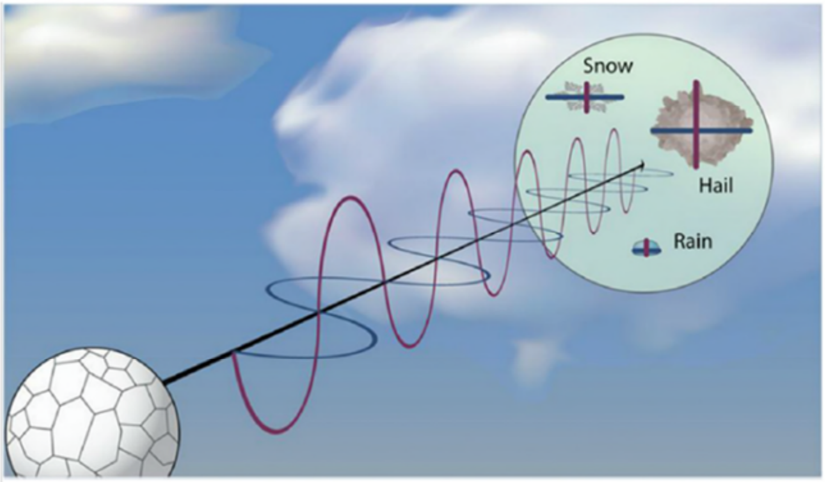
- *Elliptically polarized* light consists of two perpendicular waves of unequal amplitude which differ in phase by 90°.

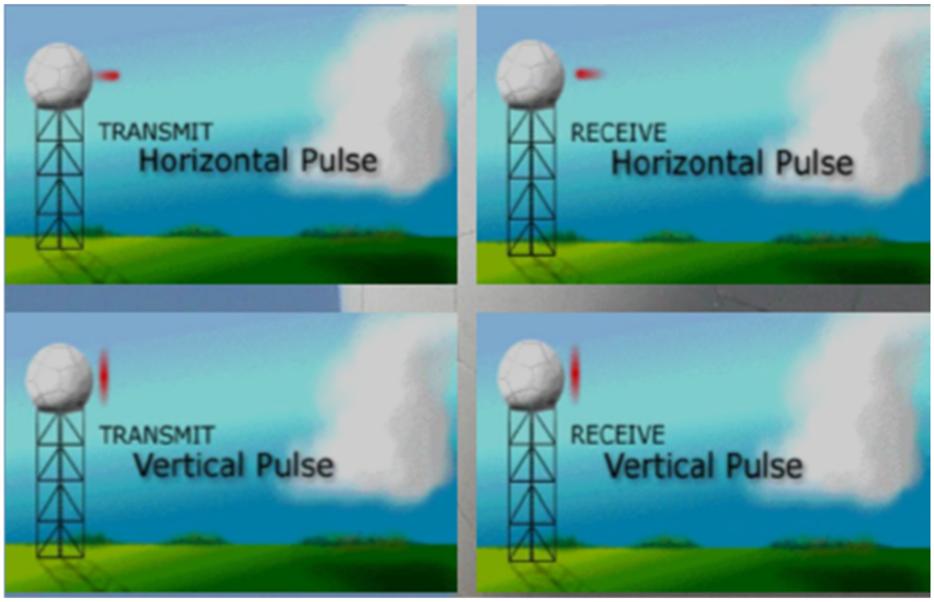
- The illustration shows right-hand elliptically polarized light.



What is Dual-Polarization & How Is It Different from conventional Radar?

- Many radars transmit and receive radio waves with a single horizontal polarization
- Polarimetric radars transmit and receive both horizontal and vertical polarizations
- Can determine:
  - SIZE
  - SHAPE
  - VARIETY



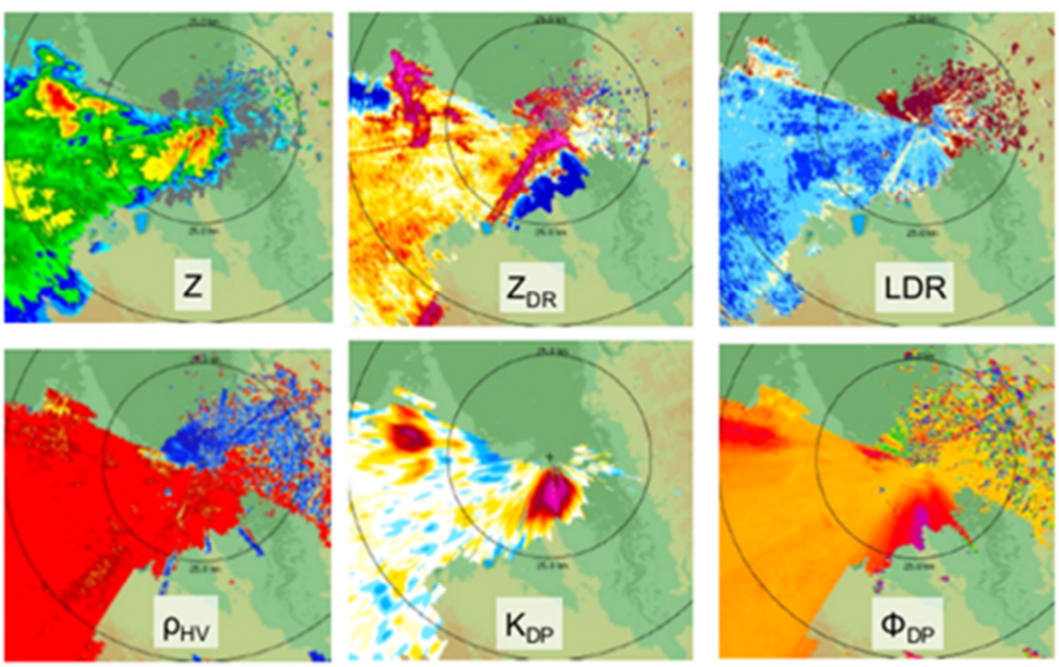


Still gets

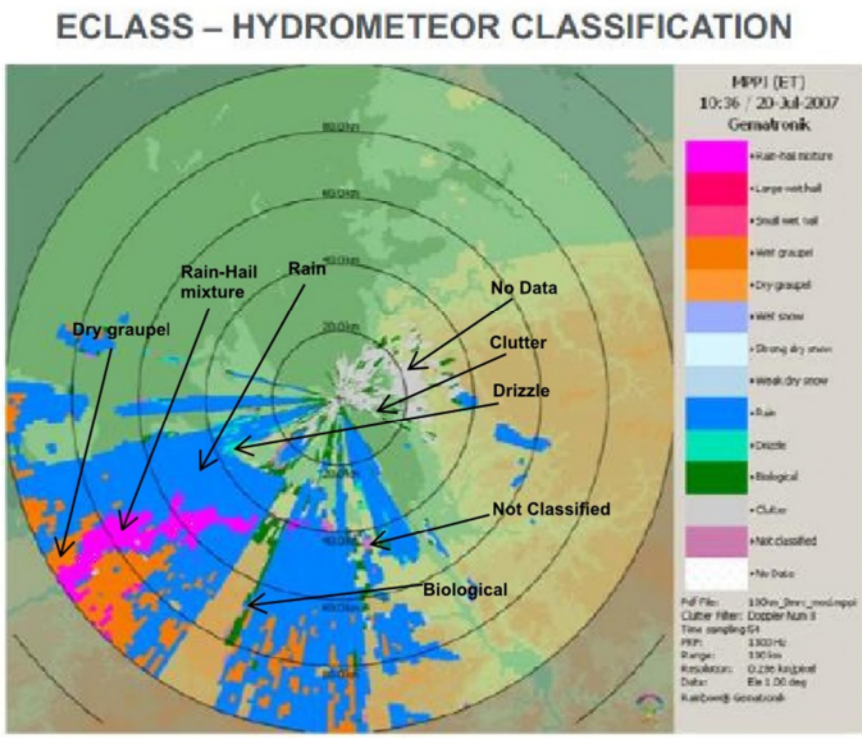
- Reflectivity (**Z**)
- Velocity (**V**)

+

- Differential Reflectivity ($\mathbf{Z_{DR}}$)
- Linear Depolarization Ratio (**LDR**)
- Correlation Coefficient ($\boldsymbol{\rho_{HV}}$)
- Specific Differential Phase ($\mathbf{K}_{DP}$)
- Differential Phase Shift ($\boldsymbol{\Phi_{DP}}$)



- Based on the values of the radar parameters a classification system is used to identified different types of hydrometeors

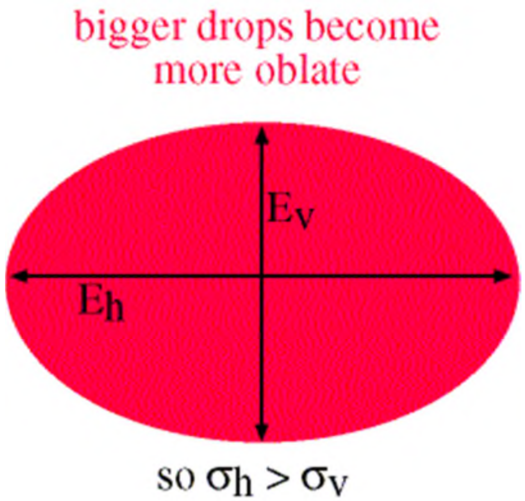


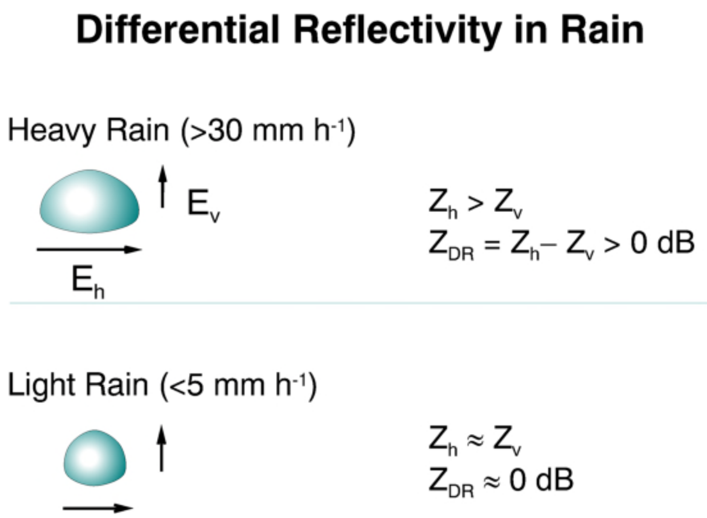
Differential Reflectivity

- Raindrops are not always spherical when they fall - especially the larger drops
- They tend to become more oblate
- So, the reflectivity would be larger if the wave were horizontally polarized, or $Z_h > Z_v$
- Define differential reflectivity (Z_{DR})

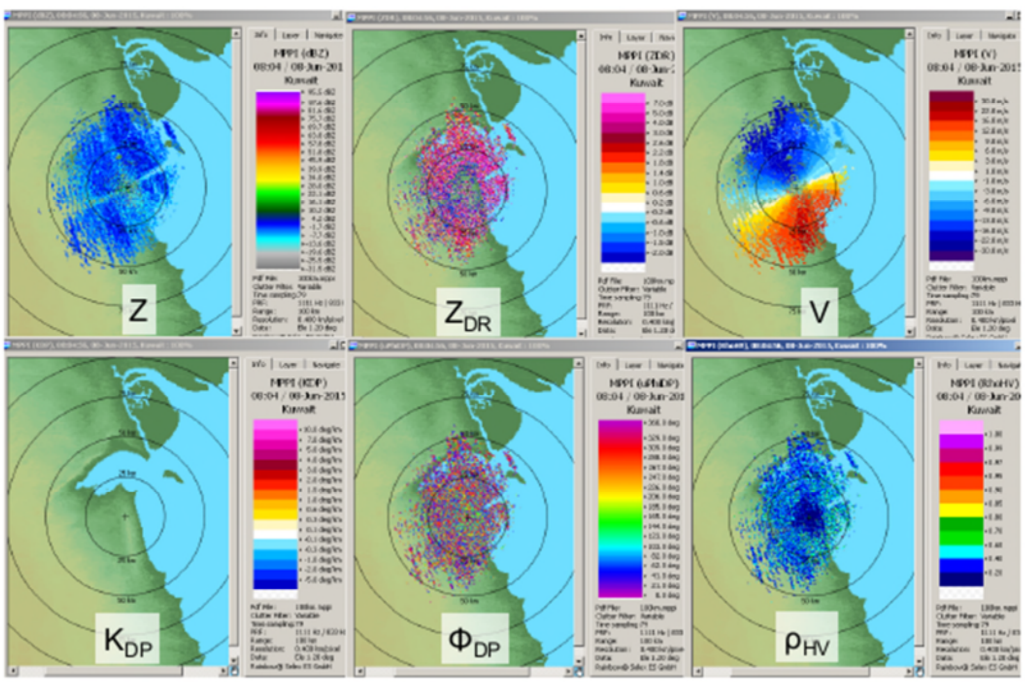
$$Z_{DR} = 10 \log (Z_h/Z_v)$$

- Z_{DR} is great for discriminating large drops from hail - hail tumbles randomly, looks like a spherical particle.
  - So, Z_{DR} for hail is about 0.
  - Z_{DR} for ice is about 0 as well



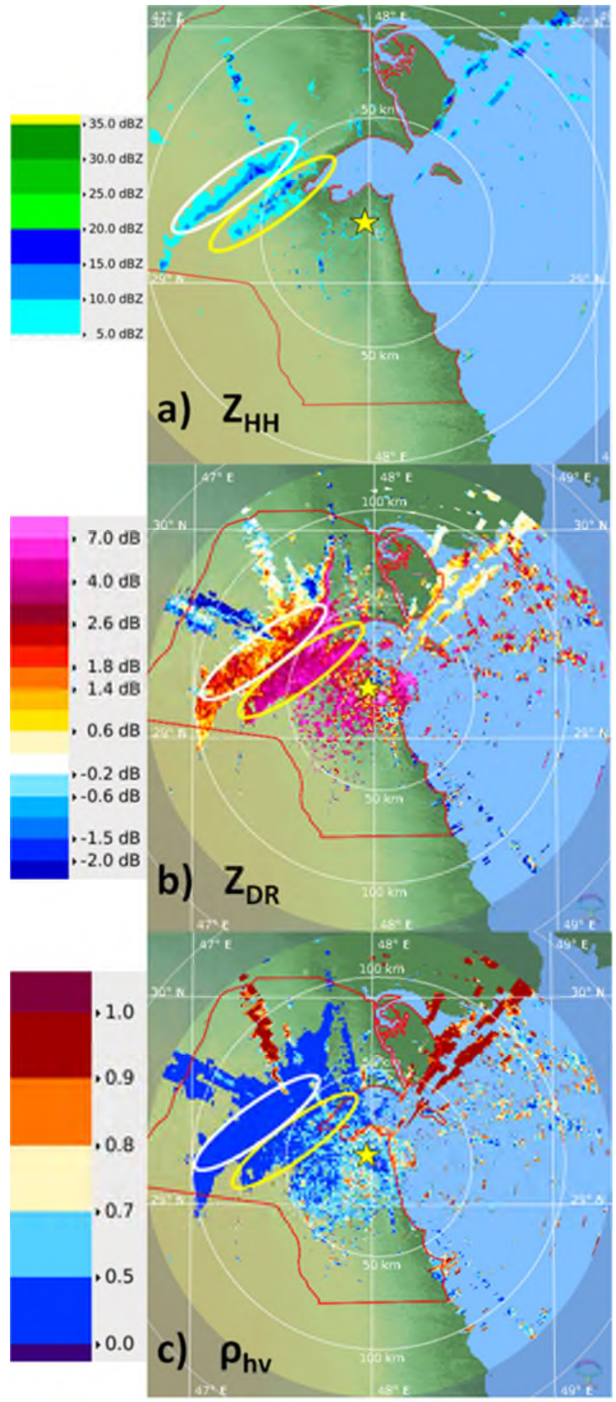


Kuwait Radar



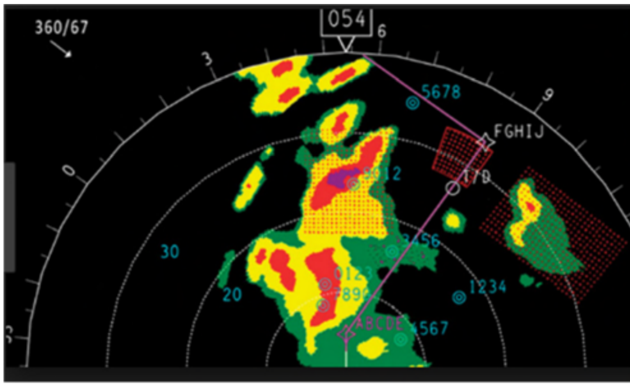
Dust Storm Detection

- Kuwait (C-band) example of dust storm observations at 1319 UTC 20 February 2015
- White ellipse indicates dust storm.
- Yellow ellipse indicates area of likely biological scatters
- Yellow star is location of Kuwait International Airport (radar site)
- Spikes extending down-radial to the northwest and northeast likely are clutter



Air Born Weather Radar

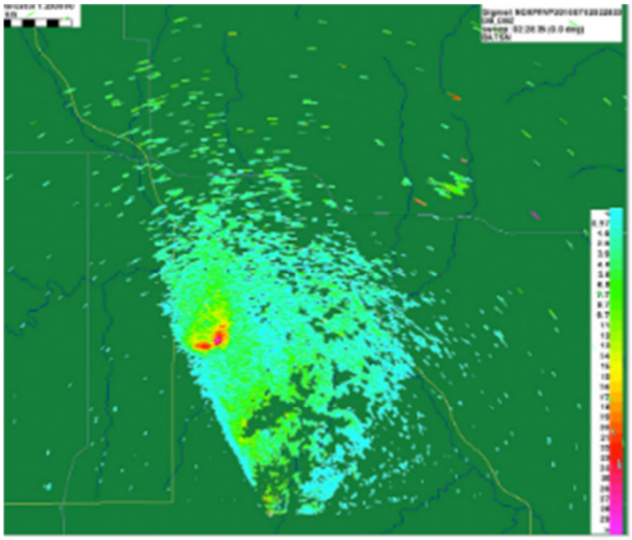
Air born weather radars are used for research missions and for detection of hazardous weather events ahead of flight route (military and commercial aviation)



Mobile Weather Radar

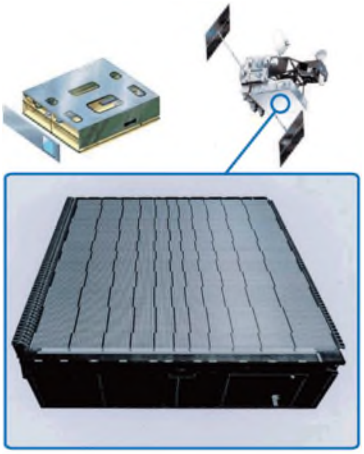
Mobile radars can be driven into position as a storm is developing to rapidly scan the atmosphere at low levels, below the beam of WSR-88D radars





Space Born Weather Radar

Used for detecting clouds and measuring precipitation like TRMM satellite born radar and GPM satellite born radar.

Some of the Uses of Radar in Meteorology

- Precipitation measurements
- Wind measurements
- Turbulence and wind shear detection
- Nowcasting
- Hail and aircraft icing detection
- Location of melting level in stratiform precipitation
- Mesocyclone and tornado vortex guide (TVS) detection
- Wind soundings in stratiform precipitation
- Hurricane structure
- Wind data assimilation in numerical weather prediction models
- Extrapolation forecasting of severe weather