

## Remote Sensing of Winds

These are primarily horizontal wind measurements. Vertical winds are in general very small except in localized convective downdrafts

### Direct measurement

Feature tracking

See [http://www.nrlmry.navy.mil/sat-bin/cloud\\_winds.cgi](http://www.nrlmry.navy.mil/sat-bin/cloud_winds.cgi)

Cloud tracking visible images

Passive imager with sufficiently short time between images to identify features  
 limitations with altitude determination

water vapor ...

Cross-correlation

GPS PW possibility

via Doppler shift

Doppler radars

Raindrops versus cloud drops

Tornadoes

Wind profilers

Tilted upward looking radar

low frequency

some dielectric change to reflect the transmitted signal

Doppler lidar

SWIRLS

Acoustic measurements

Doppler shift of Absorption Lines

Works better at low pressures where line widths are narrow

WINDI? University of Michigan

MLS type Dong Wu

Active probing MACO

### Indirect measurements

Near-surface winds over oceans via surface roughness

sun glint (Cox and Munk, 1954)

requires clear air

Scatterometers

Passive microwave

Importance of polarization

Horizontal pressure gradients and balanced wind

Need coriolis force (doesn't work at equator)

Indirect inference of subsidence rates

Radiative cooling

### References

Cox and W. Munk, "Measurement of the Roughness of the Sea Surface from Photographs of the Sun Glitter, J. Opt. Soc. Amer., Vol. 44, No. 11, pp.839-850, 1954.