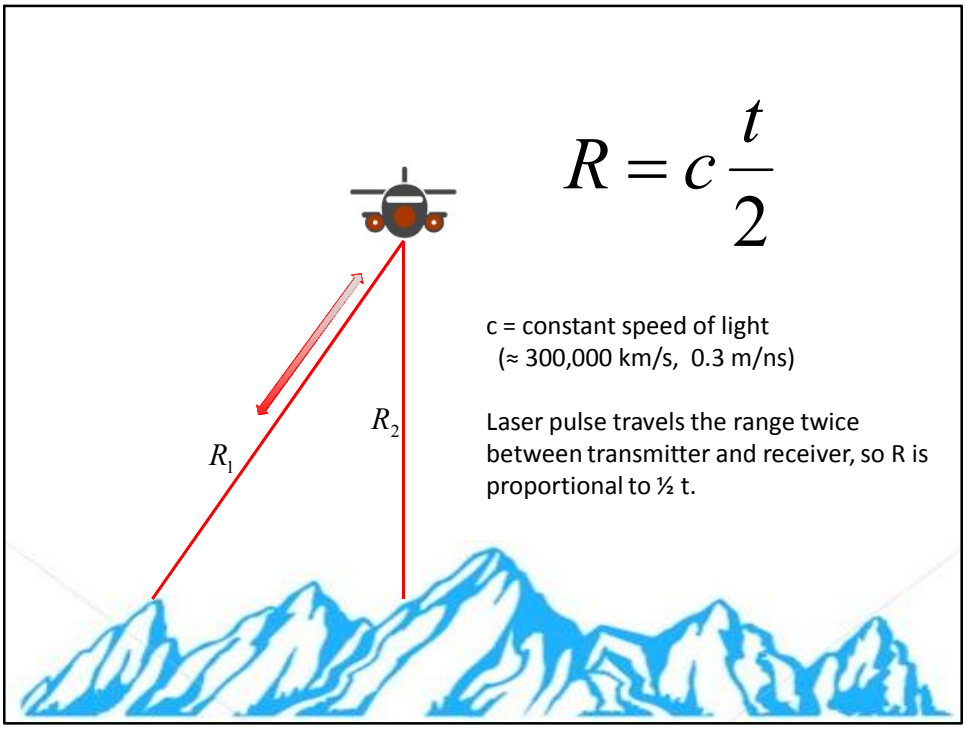
Range Distance of Airborne Laser Scanning (ALS)

Jacob Macdonald
GEOG 593, Fall 2009



Examples

- At a typical flight altitude of 400m above the ground, accurate pulse return time measurements of about t = 2R/c = 2*400m/0.3m ns^{-1} = 2700ns are needed; that's $2.7*10^{-6}$ seconds (2.7 millionths of a second).
- A pulse cannot be sent until the returns from the previous pulse are received. The maximum allowable pulse rate varies with range. The greater the range, the lower number of pulses per second can be sent. A typical LiDAR system is capable of 100 kHz pulse rate, resulting in a maximum return time of $1*10^{-5}$seconds (range = 1500m).
- Range is related linearly to pulse return time, so a % change in either one will result in an identical % change in the other. If time measurements are accurate to +/- 1%, range measurements will also be accurate to +/- 1%.

Questions

1. What fundamental physical constant is used in ALS range finding?
   (a) speed of light
   (b) Avogadro constant
   (c) Stefan-Boltzmann constant
   (d) elementary charge constant
2. A nadir (straight down) pulse transmitted from an ALS takes 8,000 nanoseconds to make it back to the sensor. What is the height in meters of the sensor above the reflecting surface?
3. For the ALS system in question 2, if the system advertises a timing accuracy of +/- 0.1%, what is the accuracy of the nadir range measurement (+/- how many meters)?
4. What is the maximum range an ALS system with a timing accuracy of +/- 0.1% can measure to a range accuracy of +/- 0.25 meters?

Answers

1. What fundamental physical constant is used in ALS range finding?

   (a) speed of light

   ~~(b) Avogadro constant~~

   ~~(c) Stefan-Boltzmann constant~~

   ~~(d) elementary charge constant~~

2. A nadir (straight down) pulse transmitted from an ALS takes 8,000 nanoseconds to make it back to the sensor. What is the height in meters of the sensor above the reflecting surface?

$$R = c * \frac{t}{2} = 0.3 m/ns * \frac{8000 ns}{2} = 1200 m$$

3. For the ALS system in question 2, if the system advertises a timing accuracy of +/- 0.1%, what is the accuracy of the nadir range measurement (+/- how many meters)?

$$\Delta R = c * \frac{\Delta t}{2} = 0.3 m/ns * \frac{0.001 * 8000 ns}{2} = 1.2 m$$

Or, since R and t are linearly related:

$$\Lambda R = 0.001 * R = 0.001 * 1200 m = 1.2 m$$

4. What is the maximum range an ALS system with a timing accuracy of +/- 0.1% can measure to a range accuracy of +/- 0.25 meters?

$$R = \frac{0.25 m}{0.001} = 250 m$$

That's It.