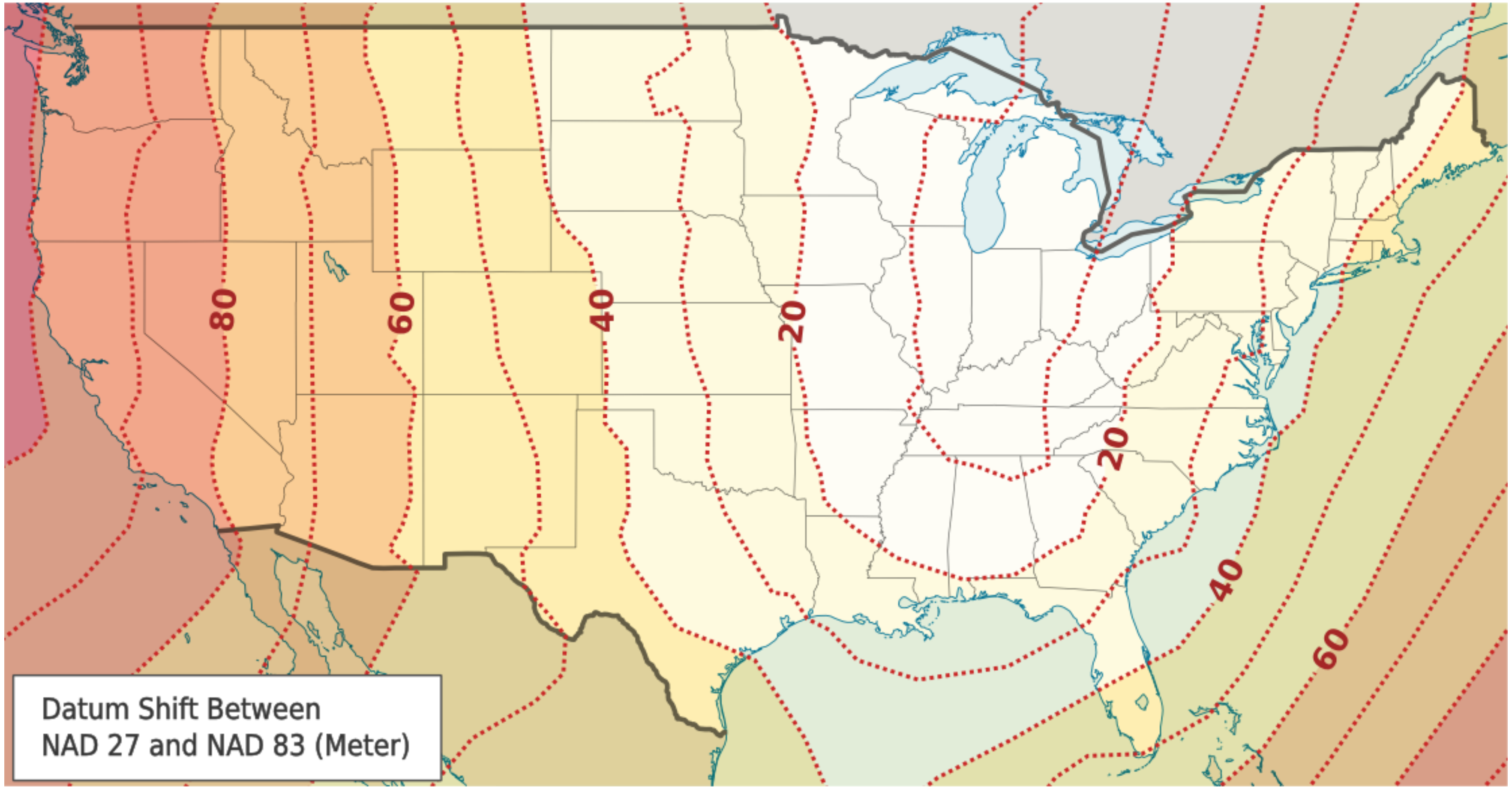
Positioning

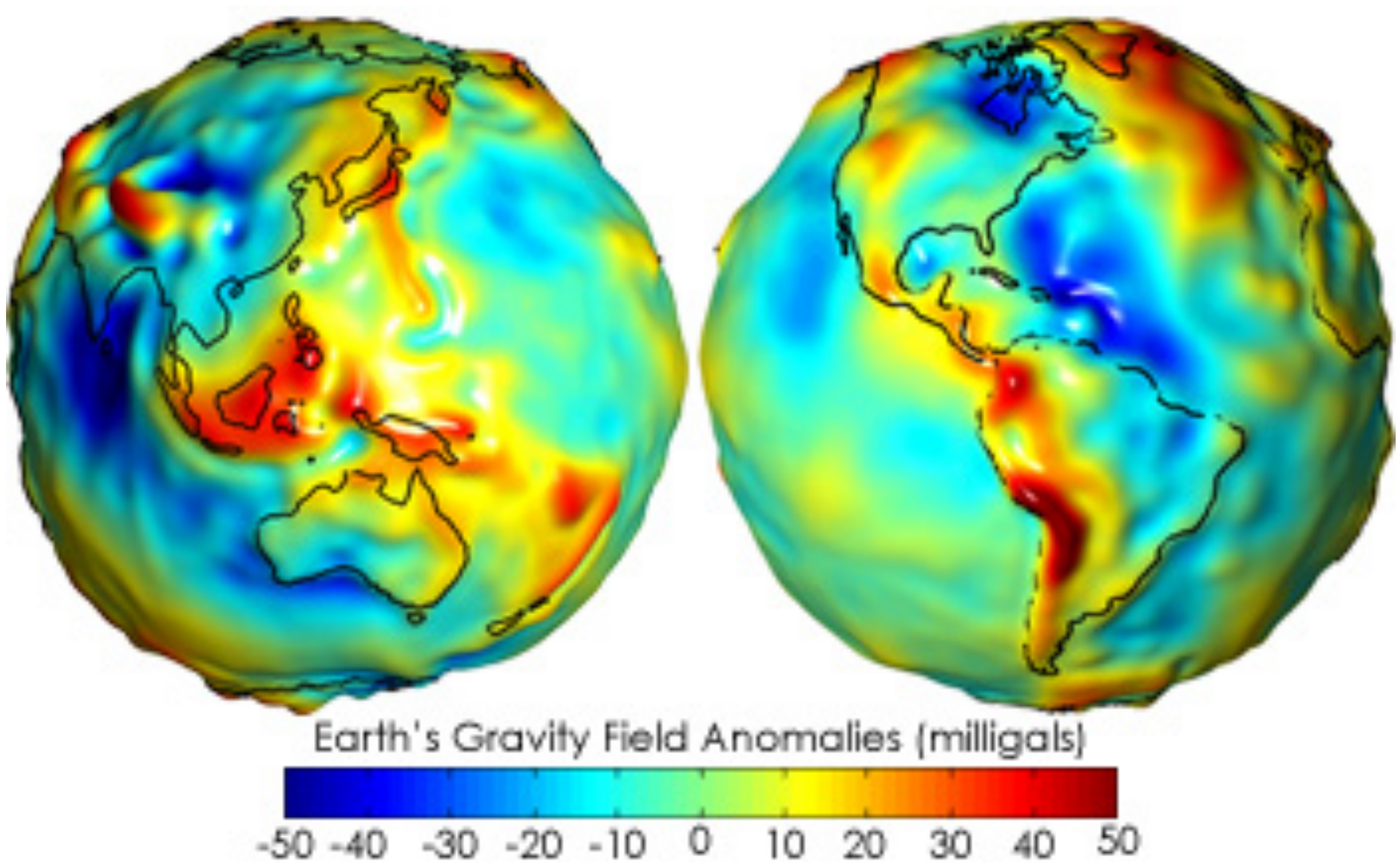
6.S062 Class 2 – 2/15/2017

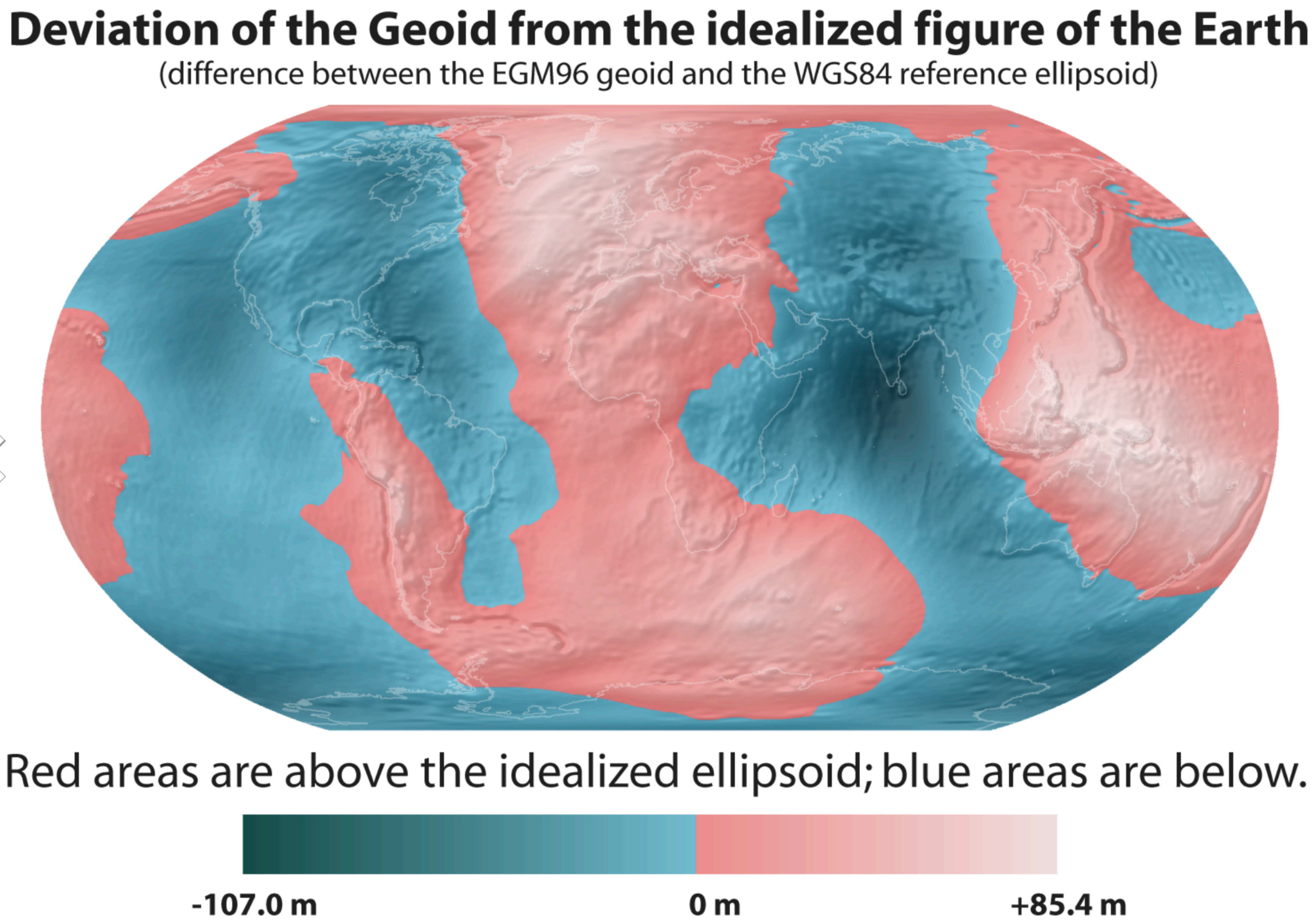
Sam Madden

NAD27 vs NAD83 (WGS84)



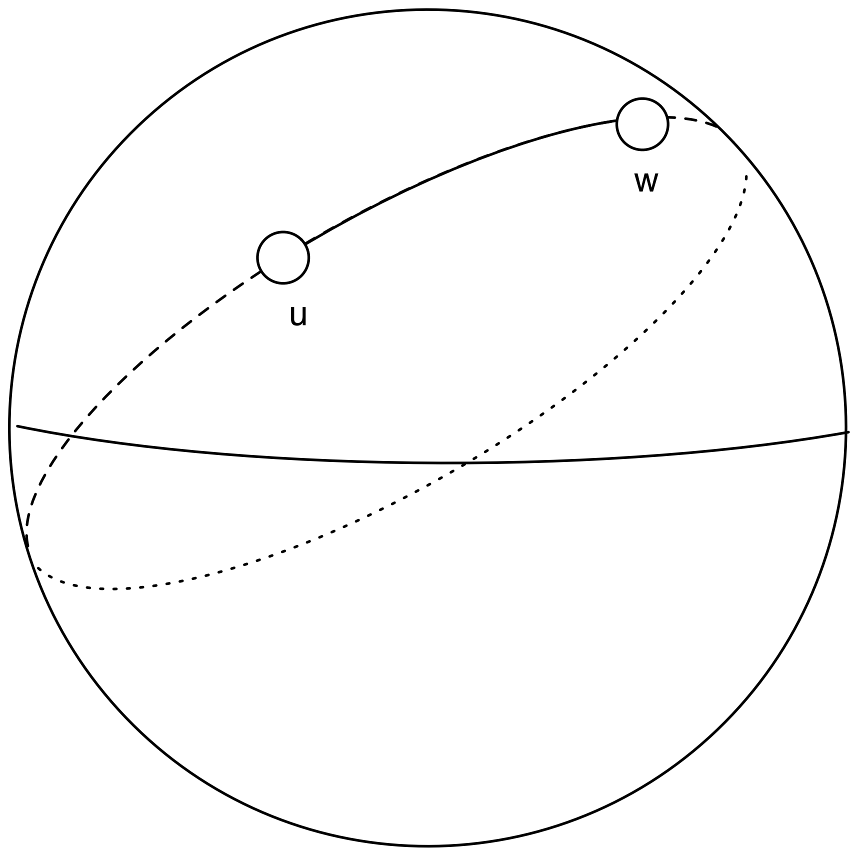
Geoid Undulations – 360 degree spherical harmonic





https://en.wikipedia.org/wiki/Geoid#/media/File:Geoid_height_red_blue_averagebw.png

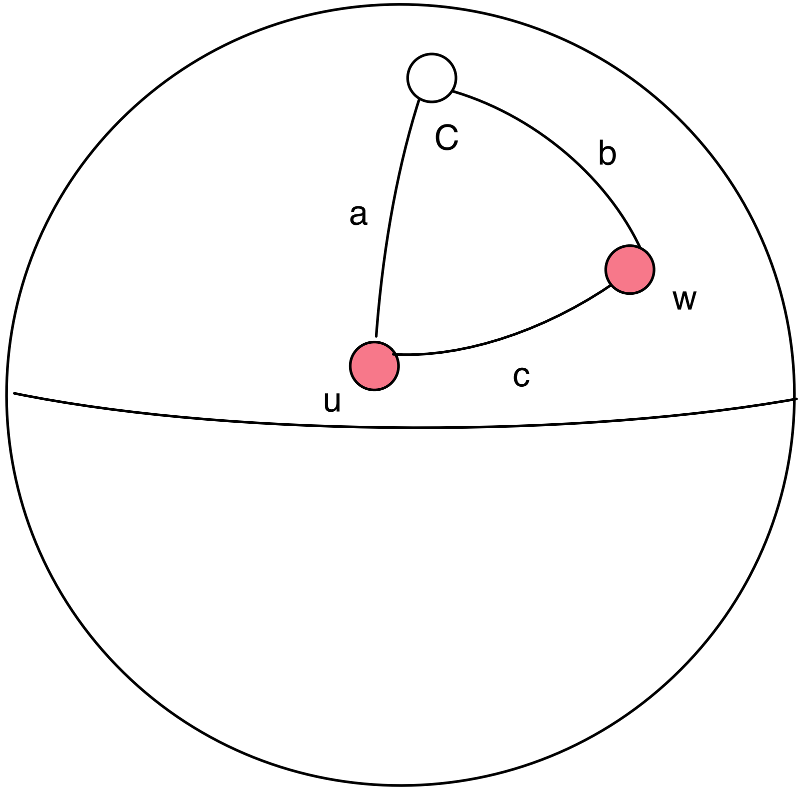
Finding the Distance Between Two Points



Law of haversines (hav)

$$\mathrm{hav}(\theta) = \sin^2\left(\frac{\theta}{2}\right) = \frac{1-\cos(\theta)}{2}$$

$$\mathrm{hav}(c) = \mathrm{hav}(a-b) + \sin(a)\sin(b)\ \mathrm{hav}(C).$$



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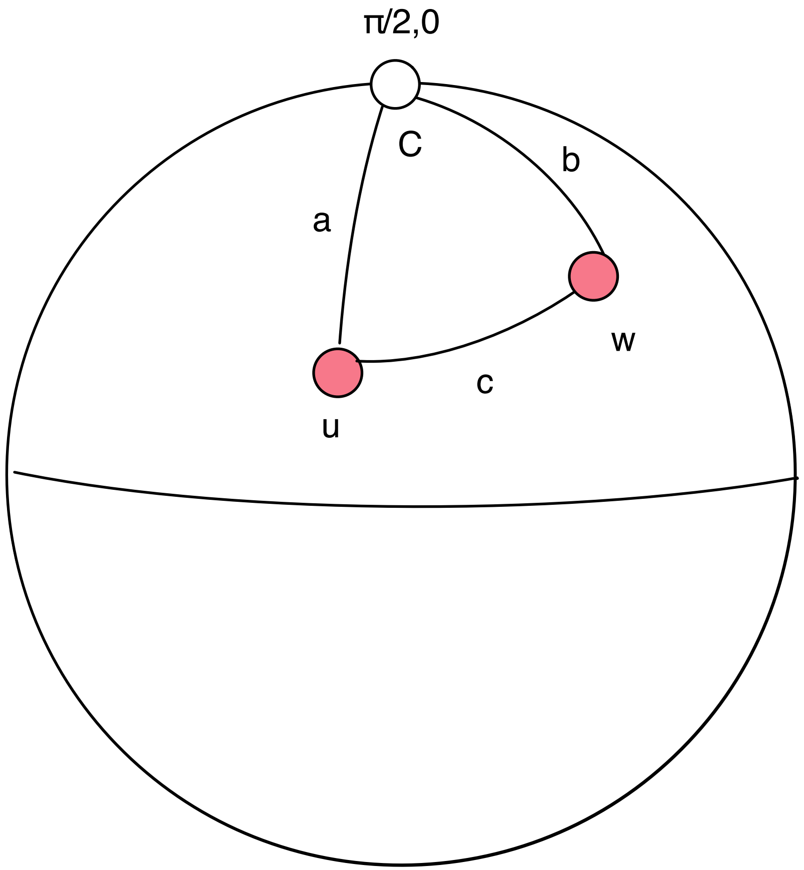

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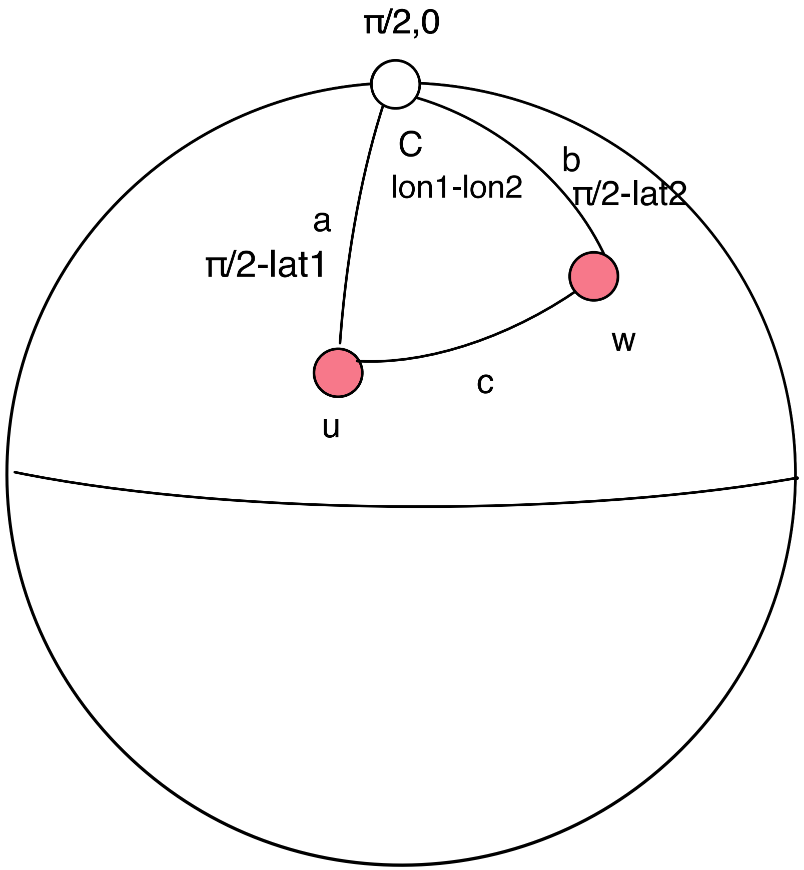

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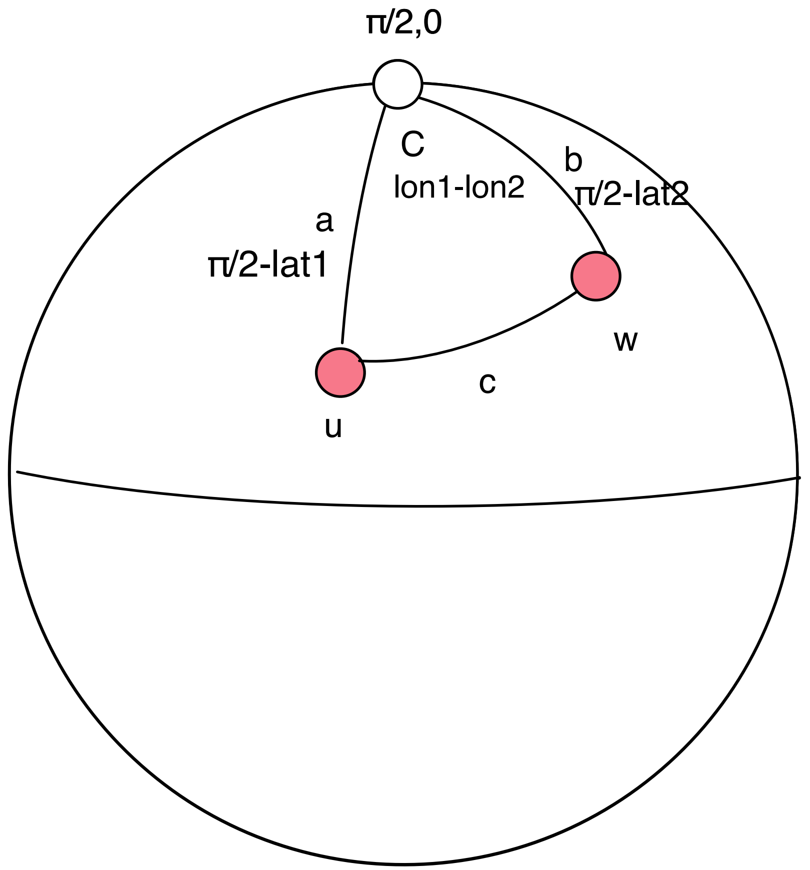
$$\sin(\pi/2-\theta) = \cos(\theta)$$



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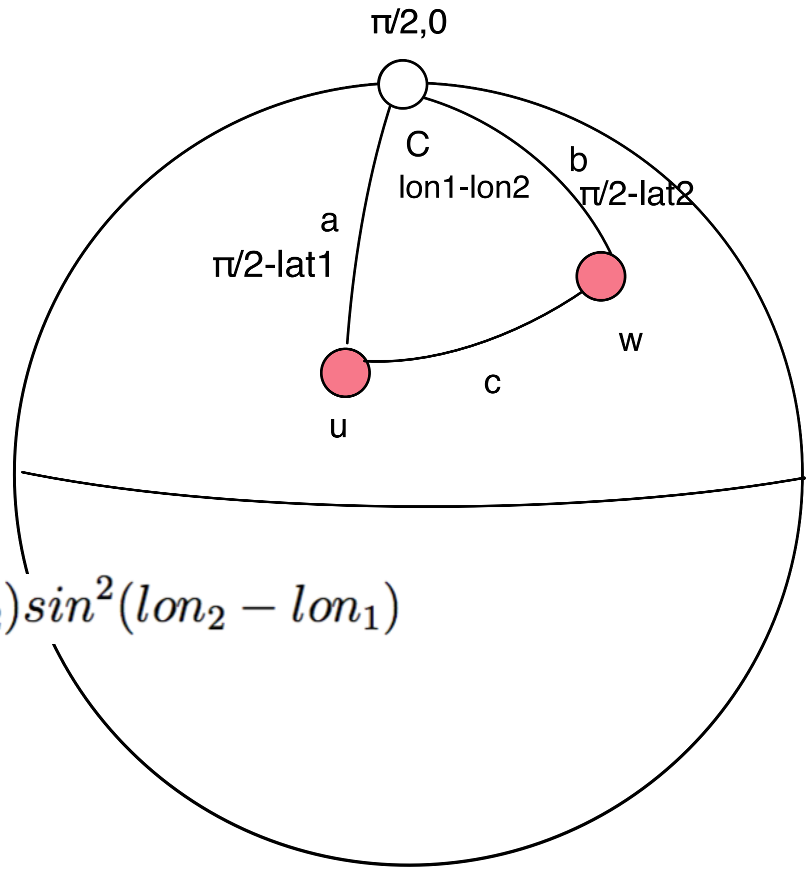

$$\sin^2(c/2) = \sin^2((lat_2-lat_1)/2) + \cos(lat_1)\cos(lat_2)sin^2(lon_2-lon_1)$$

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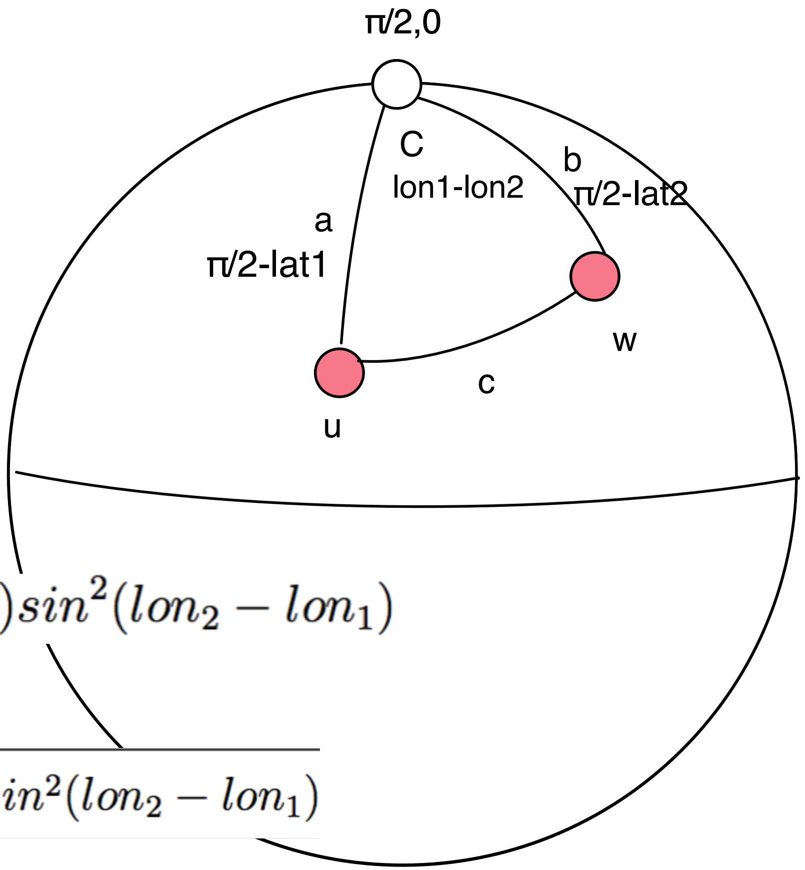
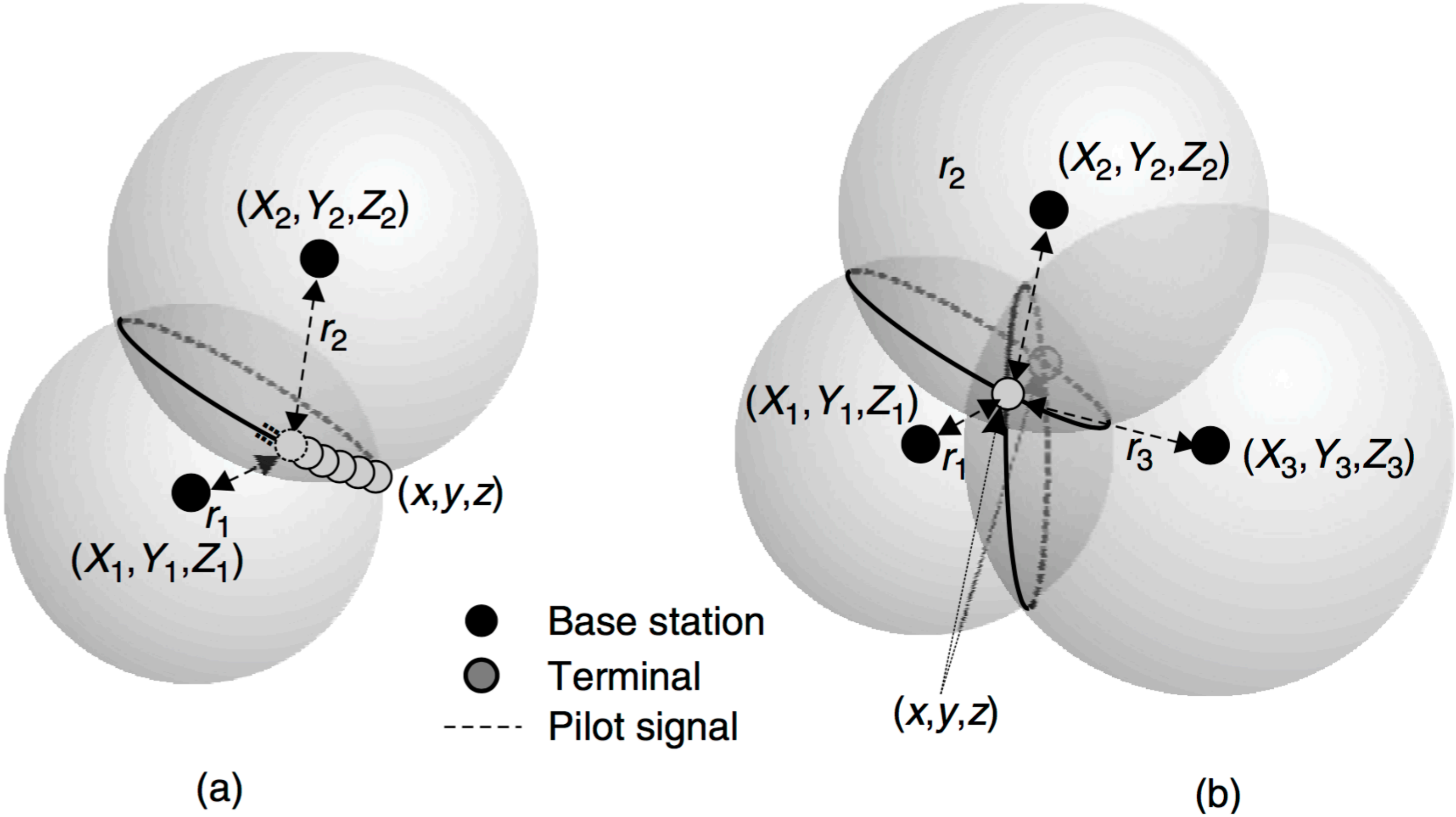


$$\sin^2(c/2) = \sin^2((lat_2-lat_1)/2) + \cos(lat_1)\cos(lat_2) sin^2(lon_2-lon_1)$$

$$c = d/R$$

$$d = 2R\arcsin\sqrt{\sin^2((lat_2-lat_1)/2) + \cos(lat_1)\cos(lat_2) sin^2(lon_2-lon_1)}$$

Trilateration in 3D



Positioning APIs

```
locmgr = [[CLLocationManager alloc] init];
locmgr.desiredAccuracy = kCLLocationAccuracyThreeKilometers; //cellular?
locmgr.desiredAccuracy = kCLLocationAccuracyHundredMeters; //wifi?
locmgr.desiredAccuracy = kCLLocationAccuracyBest; //gps?

[locmgr startUpdatingLocation];

(void)locationManager:(CLLocationManager *)manager
didUpdateLocations:(NSArray<CLLocation *> *)locations {
        ....
}
```

Ranging APIs

```
-(void) init {
   locMgr = [[CLLocationManager alloc] init];
   static NSString * const activeUUID= @"B8FED863-9F1C-447C-8F82-DF0C2E067DEA";
   CBUUID *uuid = [[NSUUID alloc] initWithUUIDString:activeUUID] ;
   region= [[CLBeaconRegion alloc] initWithProximityUUID:uuid
   identifier:@”region”];
   [locMgr startRangingBeaconsInRegion:region];
}

-(void)locationManager:(CLLocationManager *)manager
      didRangeBeacons:(nonnull NSArray<CLBeacon *> *)beacons
      inRegion:(nonnull CLBeaconRegion *)region
{
   …
}
```

Indoor Ranging Performance

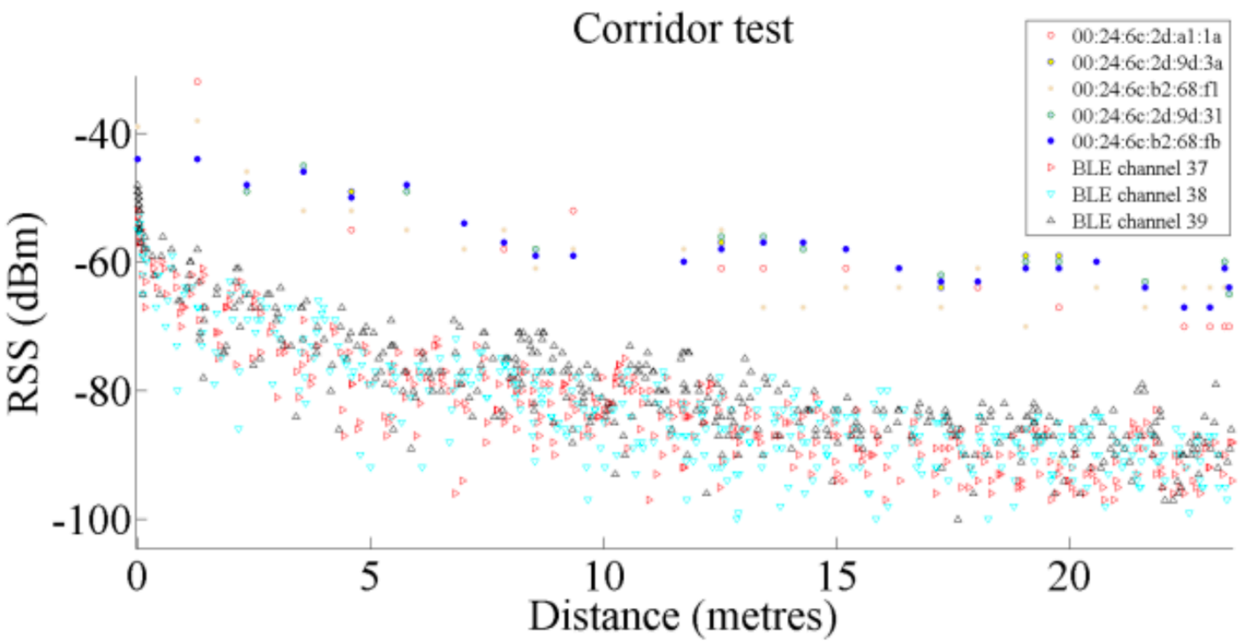


Figure 6 shows the WiFi RSS data (circles) and the iPhone BLE data separated out by channel number (triangles) as the user moved away from the transmitters.

Faragher et al. An Analysis of the Accuracy of Bluetooth Low Energy for Indoor Positioning.

Geocoding APIs

```
CLGeocoder *geocoder = [[CLGeocoder alloc] init];
…
[geocoder reverseGeocodeLocation:location  //location is a CLLocation
completionHandler:
  ^(NSArray< CLPlacemark *>* placemarks, NSError* error){
        if ([placemarks count] > 0) {
               NSLog(@"%@\n%@\n%@",
                  placemarks[0].name,
                  placemarks[0].thoroughfare,
                  placemarks[0].locality]];
            }
         }];
```