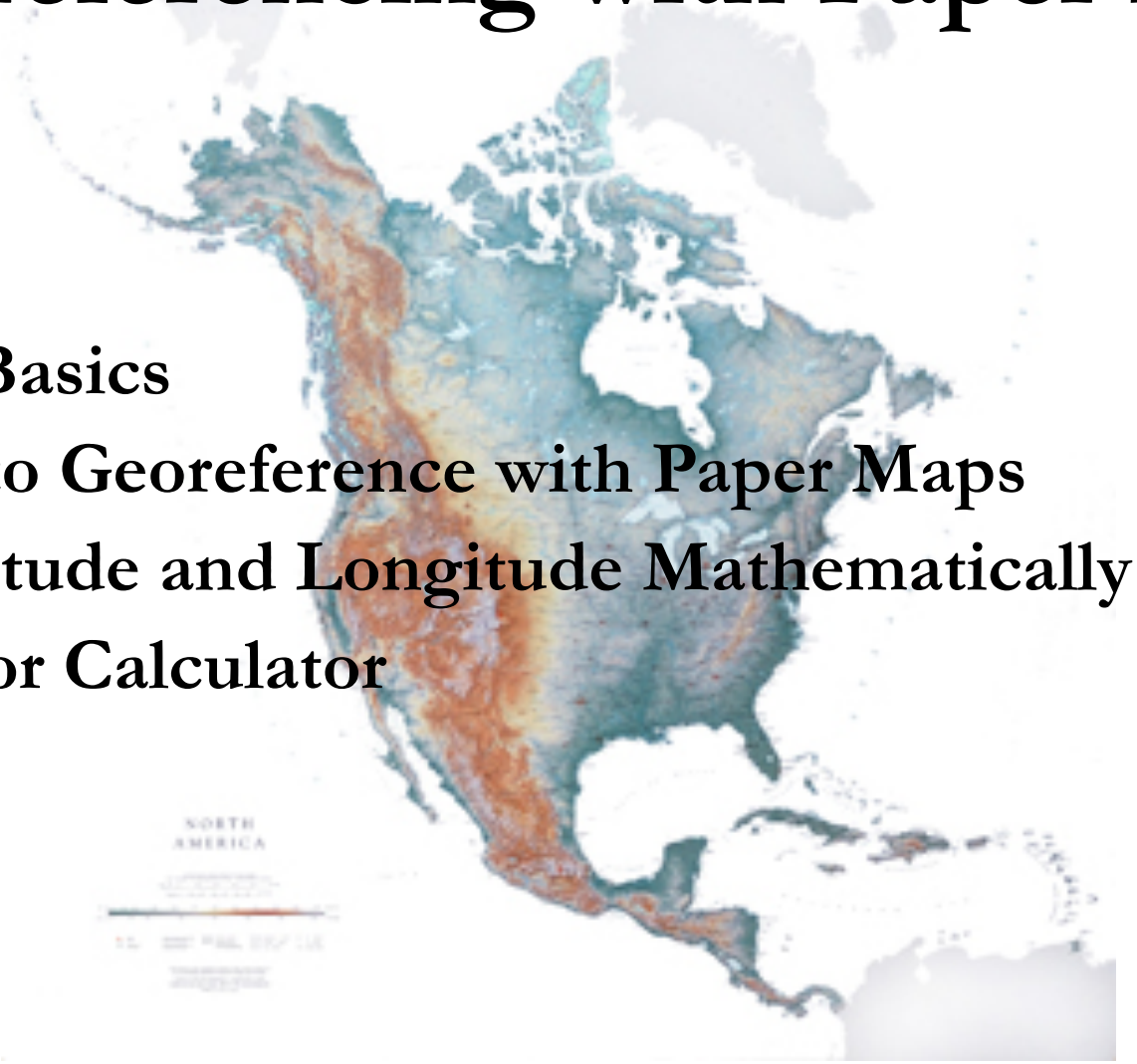
Georeferencing with Paper Maps



- Map Basics
- How to Georeference with Paper Maps
  - Latitude and Longitude Mathematically
  - Error Calculator

Pros and Cons of Paper Maps

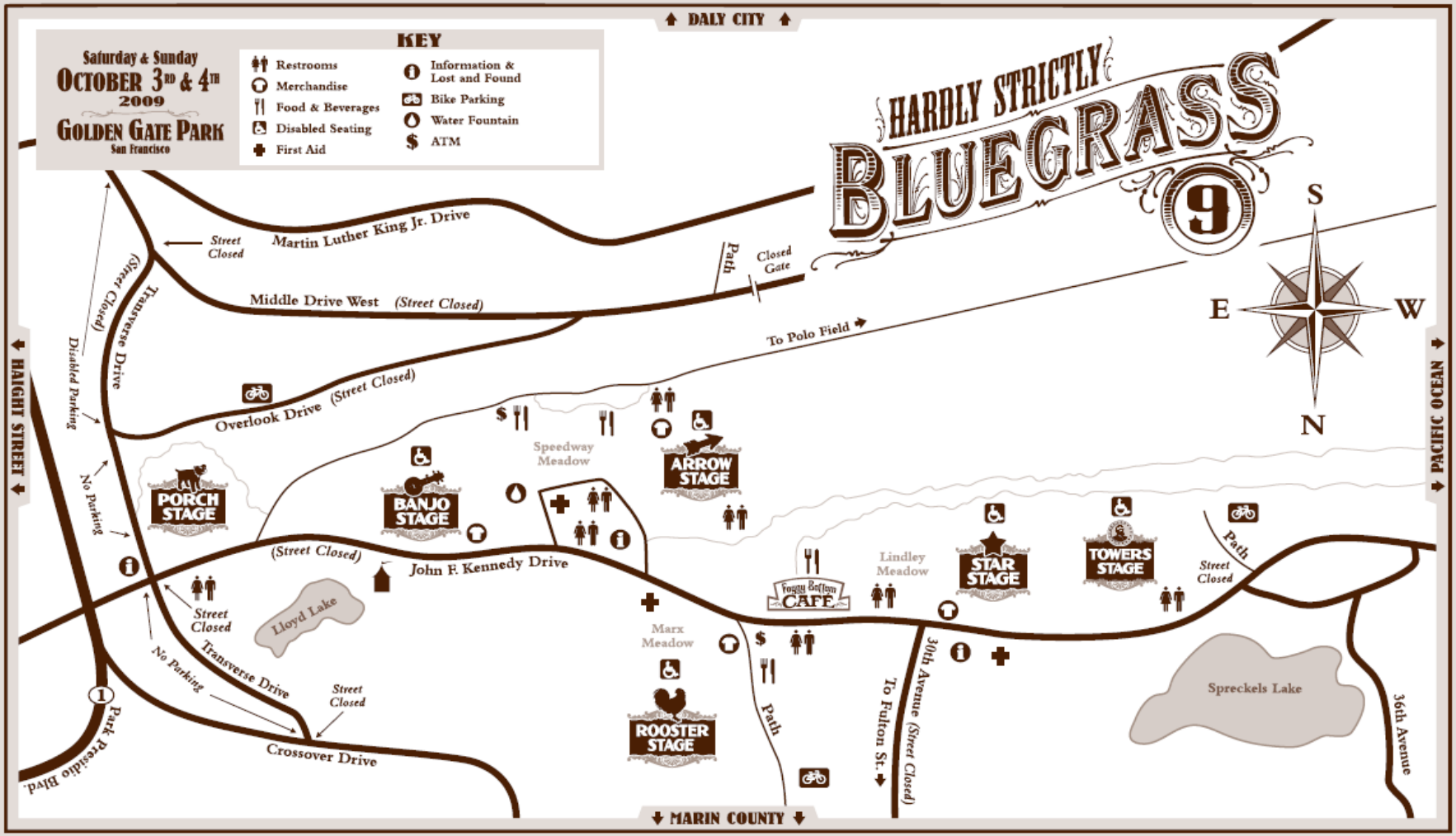
Pros

- Some features, such as topographic contours may only be found on printed maps.
- Old paper maps may be the only option for obtaining coordinates for historic localities
- Expedition maps may be annotated with exact locations of events.
- Some areas of the world may only be well-mapped on paper maps.

Cons

- Time-consuming
- Good quality paper maps may be hard to find
- Map printing errors (sometimes intentional)

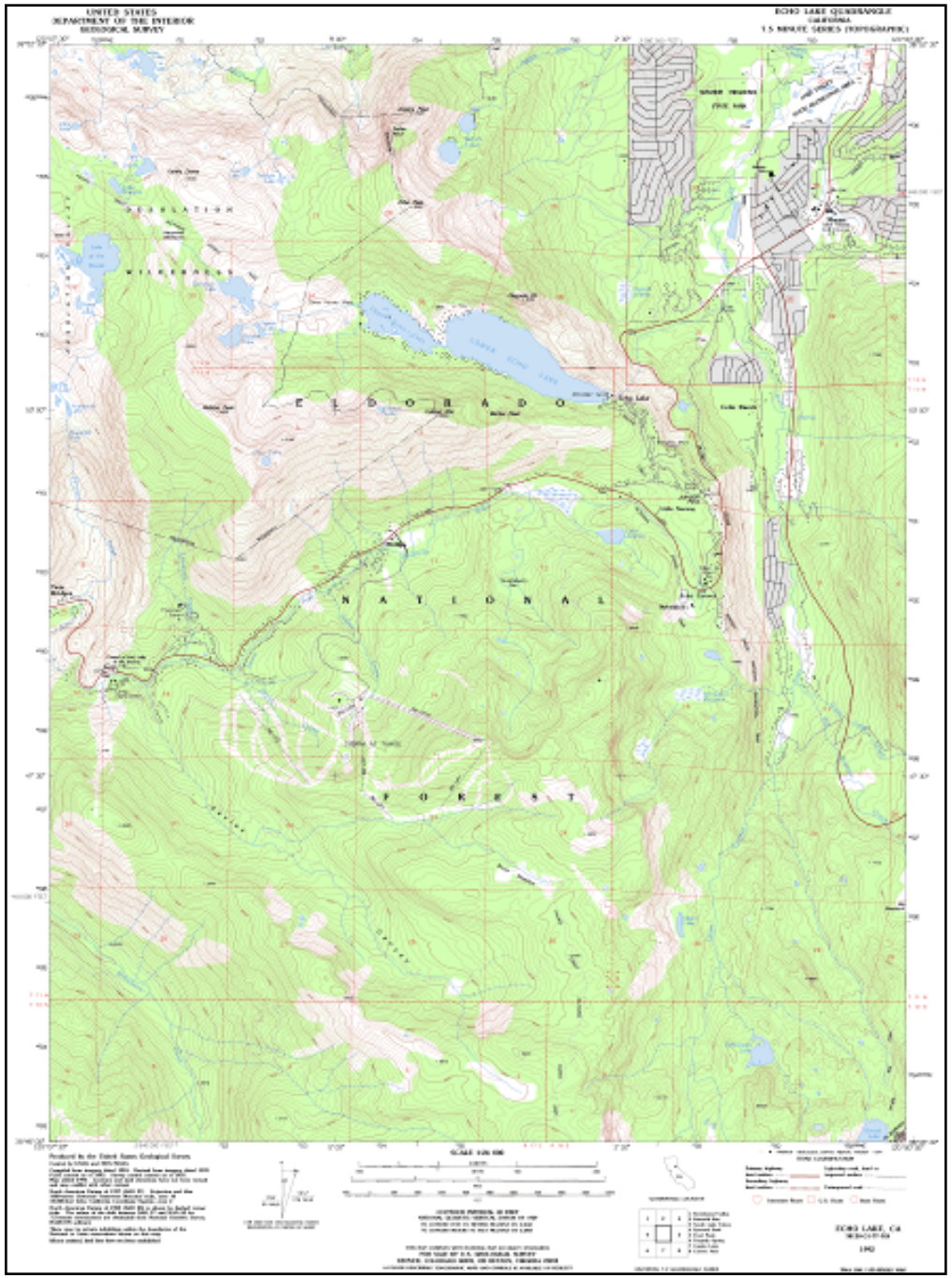

Canada's
Wonderland
KIDZVILLE
SPLASH WORKS
WHITE WATER CANYON
PLANET SNOOPY
INTERNATIONAL FESTIVAL
ACTION ZONE
INTERNATIONAL STREET
MEDIEVAL FAIRE
MAIN ENTRANCE AND EXIT


Saturday & Sunday
OCTOBER 3RD & 4TH
2009
GOLDEN GATE PARK
San Francisco
KEY
Restrooms
Merchandise
Food & Beverages
Disabled Seating
First Aid
Information & Lost and Found
Bike Parking
Water Fountain
$ ATM
HARDLY STRICTLY BLUEGRASS 9
DALY CITY
HAIGHT STREET
PACIFIC OCEAN
MARIN COUNTY
S
E
W
N
Martin Luther King Jr. Drive
Street Closed
Middle Drive West (Street Closed)
Path
Closed Gate
To Polo Field
Transverse Drive (Street Closed)
Disabled Parking
Overlook Drive (Street Closed)
No Parking
Speedway Meadow
PORCH STAGE
BANJO STAGE
ARROW STAGE
(Street Closed)
John F. Kennedy Drive
Lloyd Lake
Street Closed
Transverse Drive
No Parking
Street Closed
Crossover Drive
Park Presidio Blvd.
Marx Meadow
ROOSTER STAGE
Foggy Bottom CAFE
Lindley Meadow
STAR STAGE
TOWERS STAGE
Path
Street Closed
Path
30th Avenue (Street Closed)
To Fulton St.
Spreckels Lake
36th Avenue

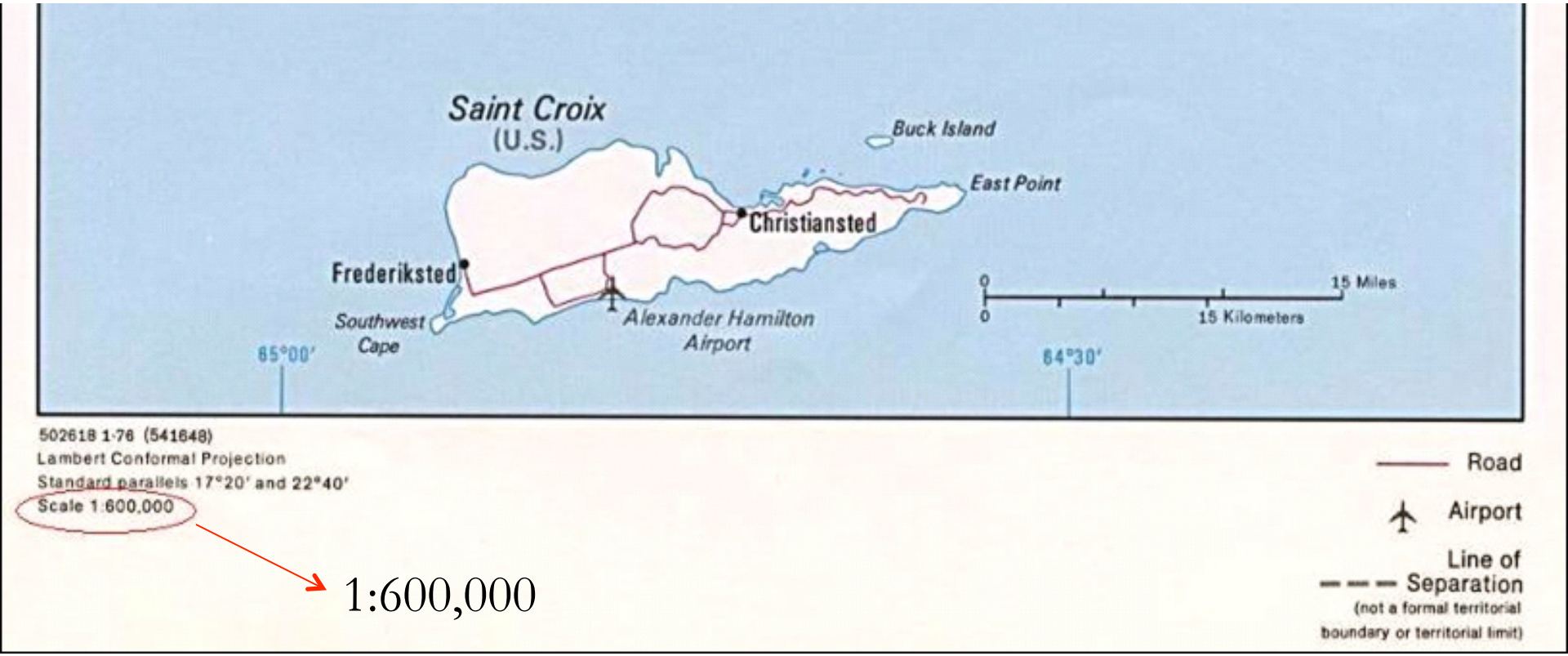
Map Basics

- Projection (See Geographic Concepts)
- Map Anatomy
  - Scale
  - Grid
  - Datum
- Citing Map as Georeferencing Source

The Paper Map



Map Anatomy: Map Scale

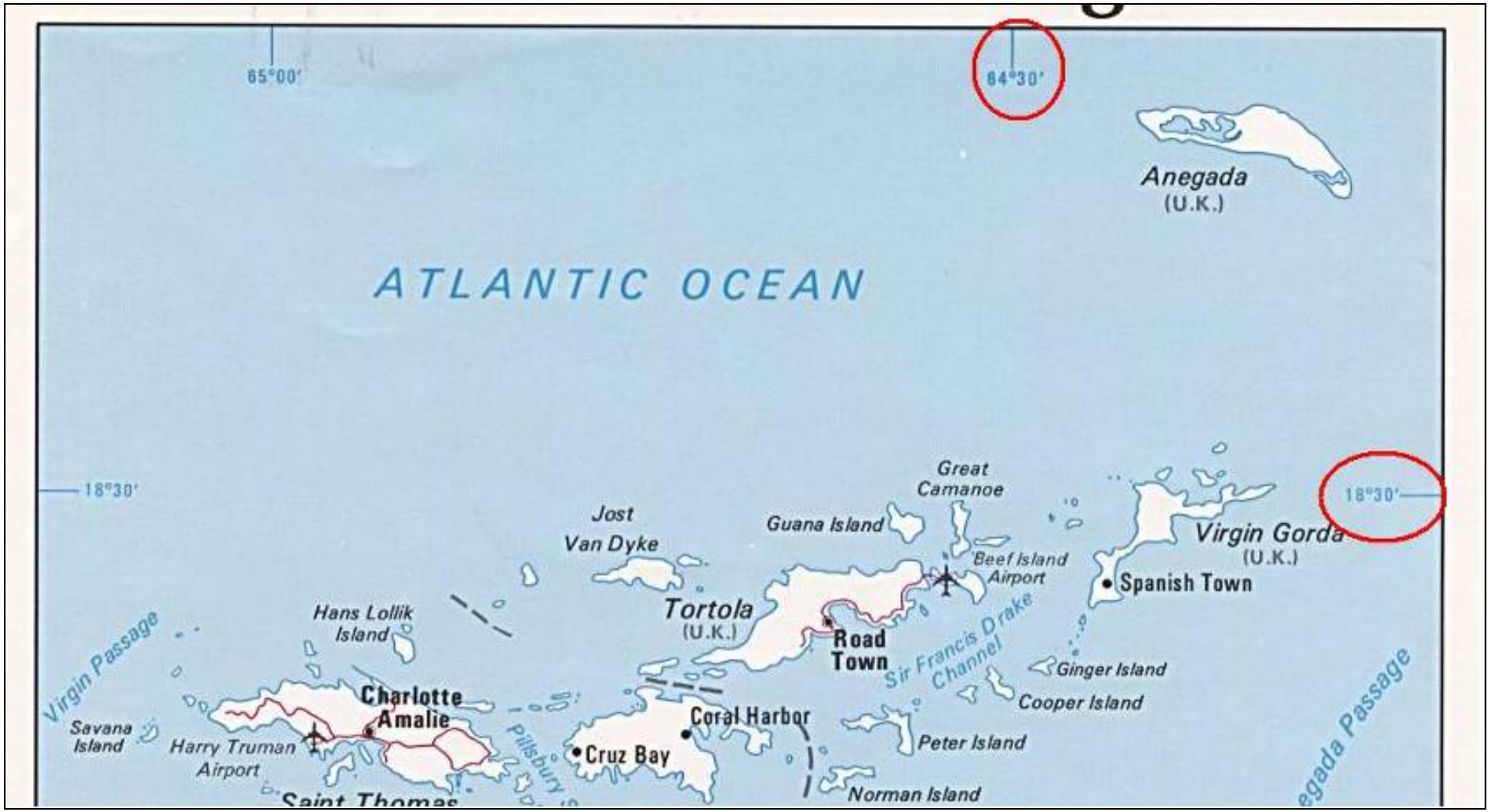


1:600,000

Map Anatomy: Map Scale

- Usually recorded as a ratio, such as 1:100,000, or a fraction, such as 1/100,000
- **Large scale** maps, such as 1/10,000, show finer detail, *less area*
- **Small scale** maps, such as 1/500,000, show less detail, *greater area*
- Think of large and small scale as how big the fraction is.
  - Example 1/10,000 > 1/500,000

Map Anatomy: Grid



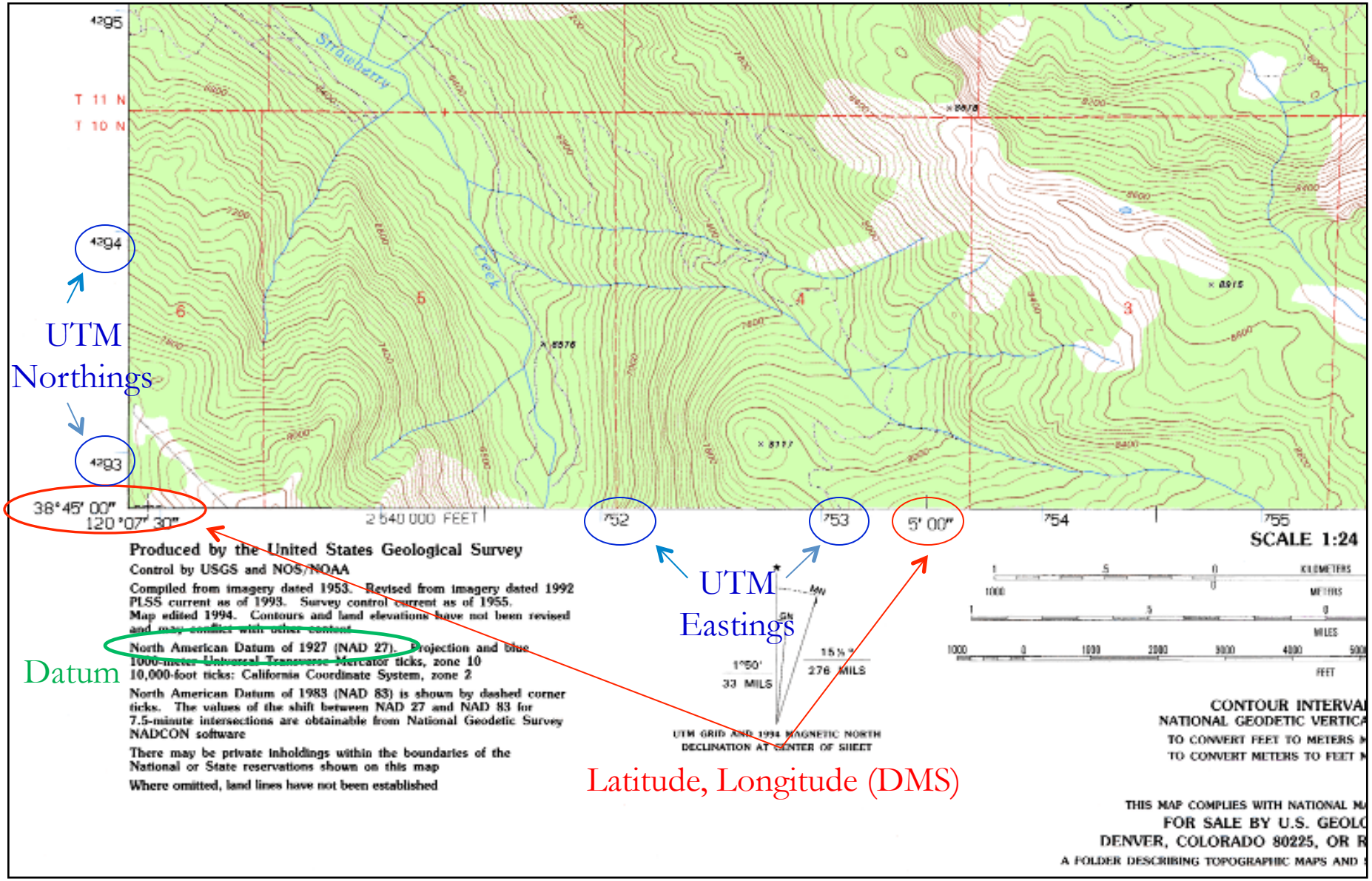
Map Anatomy: Grid

Map with no grid

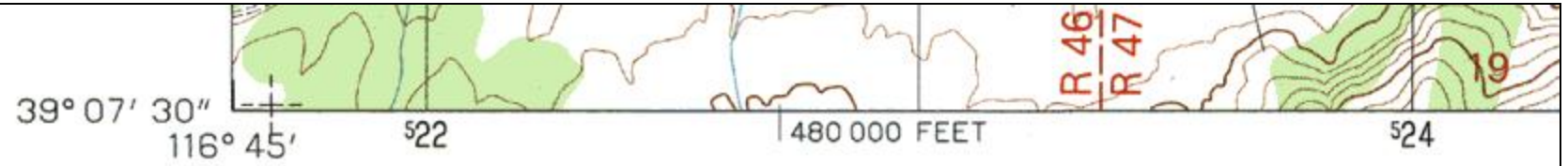
Map Anatomy: Grid

- Can have more than one grid system on a map (e.g., UTM, and latitude and longitude)
- Shows placement of parallels and meridians
- Maps without grids cannot be used to determine coordinates – only extents

Map Anatomy: Grid



Map Anatomy: Datum



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY . . . . . USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN. 1956
PLANETABLE SURVEYS 1960
LIMITED REVISION FROM AERIAL PHOTOGRAPHS TAKEN 1983
FIELD CHECKED . . . . . 1987 MAP EDITED 1989
PROJECTION . . . . . TRANSVERSE MERCATOR
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR . . . . . ZONE 11
10,000-FOOT STATE GRID TICKS . . . . . NEVADA, CENTRAL ZONE
UTM GRID DECLINATION . . . . . 0°12′ EAST
1989 MAGNETIC NORTH DECLINATION . . . . . 15° EAST
VERTICAL DATUM . . . . . NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM . . . . . 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (12 meters north and 79 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

Where omitted, land lines have not been established

Public Land Survey System is shown as published in 1960 and verified or supplemented in 1987

PROVI
Produced
manuscrip
mation sh
field check

Map Anatomy: Datum

- Usually found near the map scale or publisher's name
- Use Horizontal Datum, not Vertical Datum
- If ellipsoid is given instead of a datum, then one can choose a comparable datum using the pdf document found at http://earth-info.nga.mil/GandG/publications/tr8350.2/wgs84fin.pdf (Use Appendix B)

Georeferencing Source Data

- For georeferencing, sources should include:
  - Publisher
  - Map Date
  - Map Scale
  - Map Name

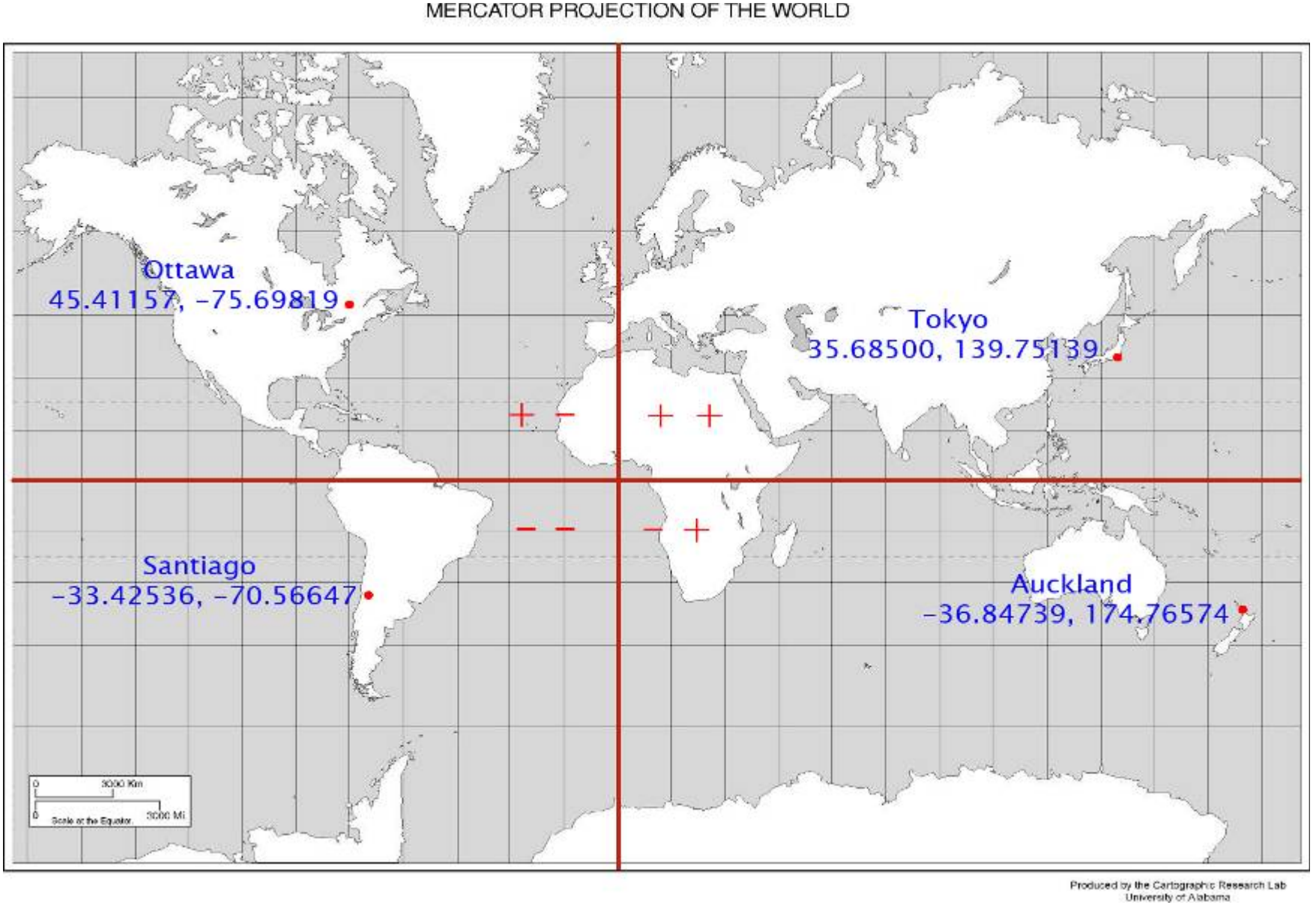
- Examples:
  - USGS 15’ Topographic Series Boone 1956
  - USGS Topo quad 1:24000 Key West 1962

Paper Maps

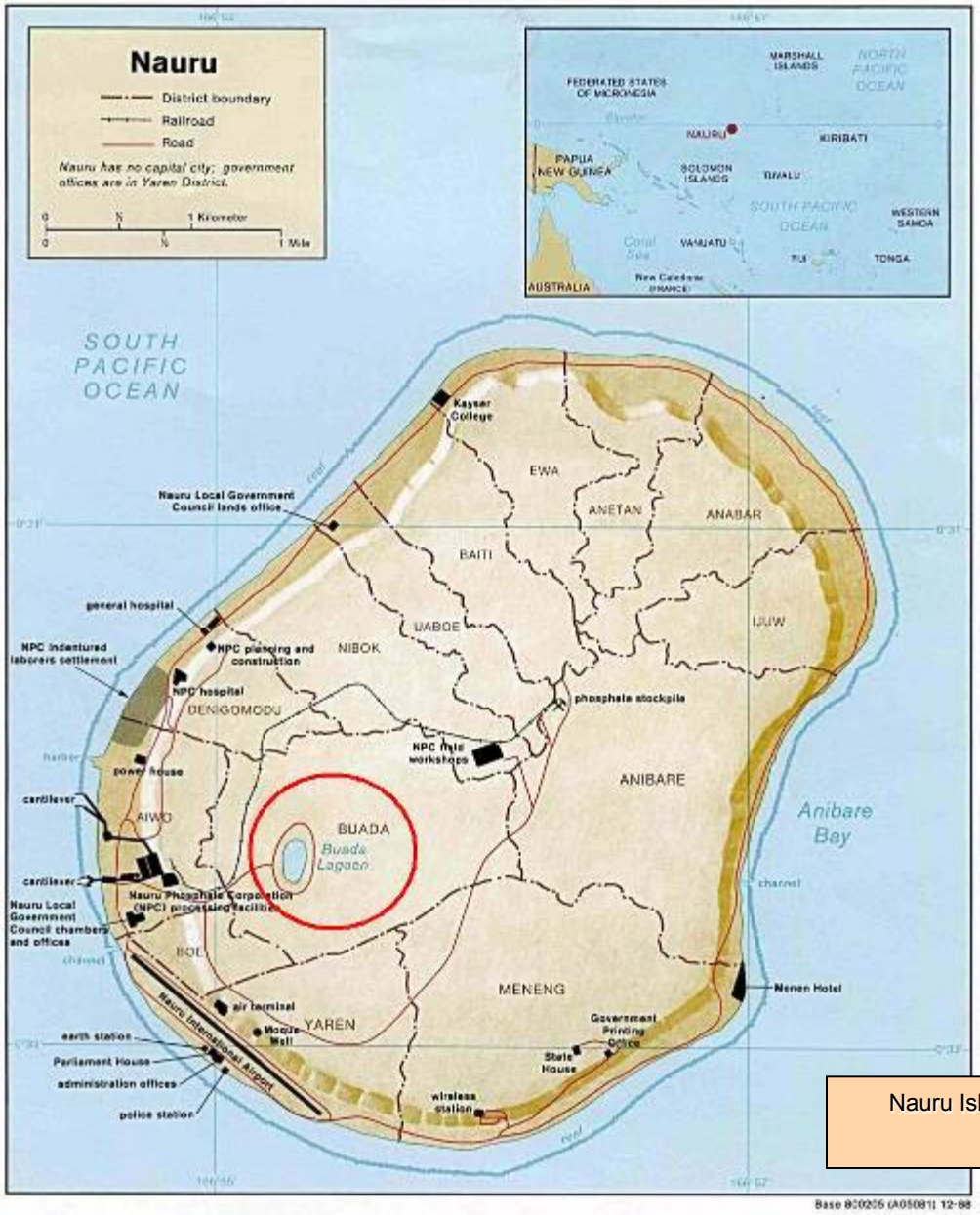
- Paper often have more detail than other sources
  - Especially useful for distances by roads and topographic features like rivers and mountain ranges

- Pay special attention to the grid lines and the hemisphere when reporting in decimal degrees

Coordinate Signs for Hemispheres



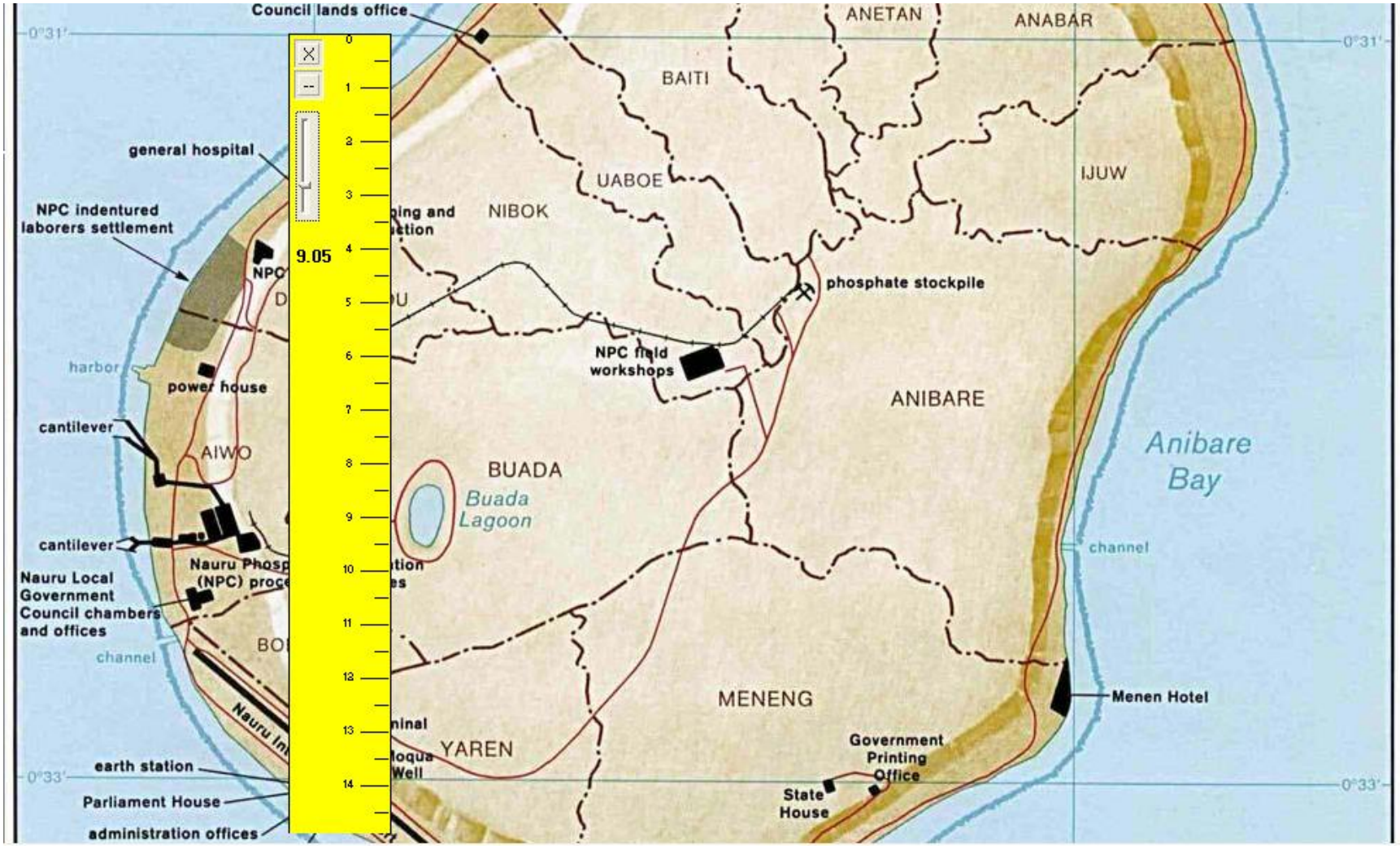
Determining Coordinates from Paper Maps: Ye Olde Method



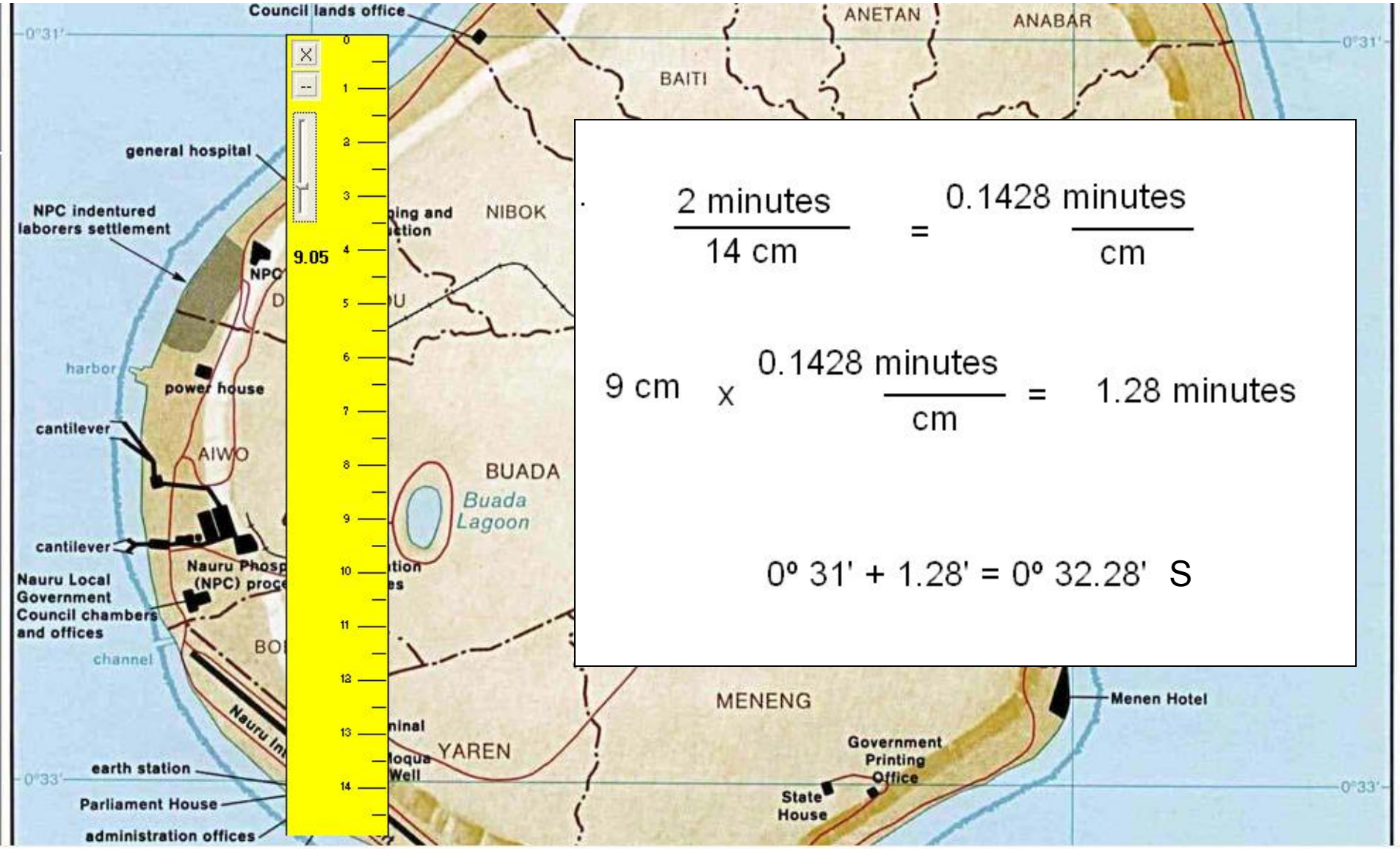
This is the point were you all thank John, Carol, David, and Nelson for developing the Georeferencing Calculator and GEOLocate.

Nauru Island, Pacific Islands Geographic Society, 1960 1:12,000

Determining Coordinates from Paper Maps: Latitude



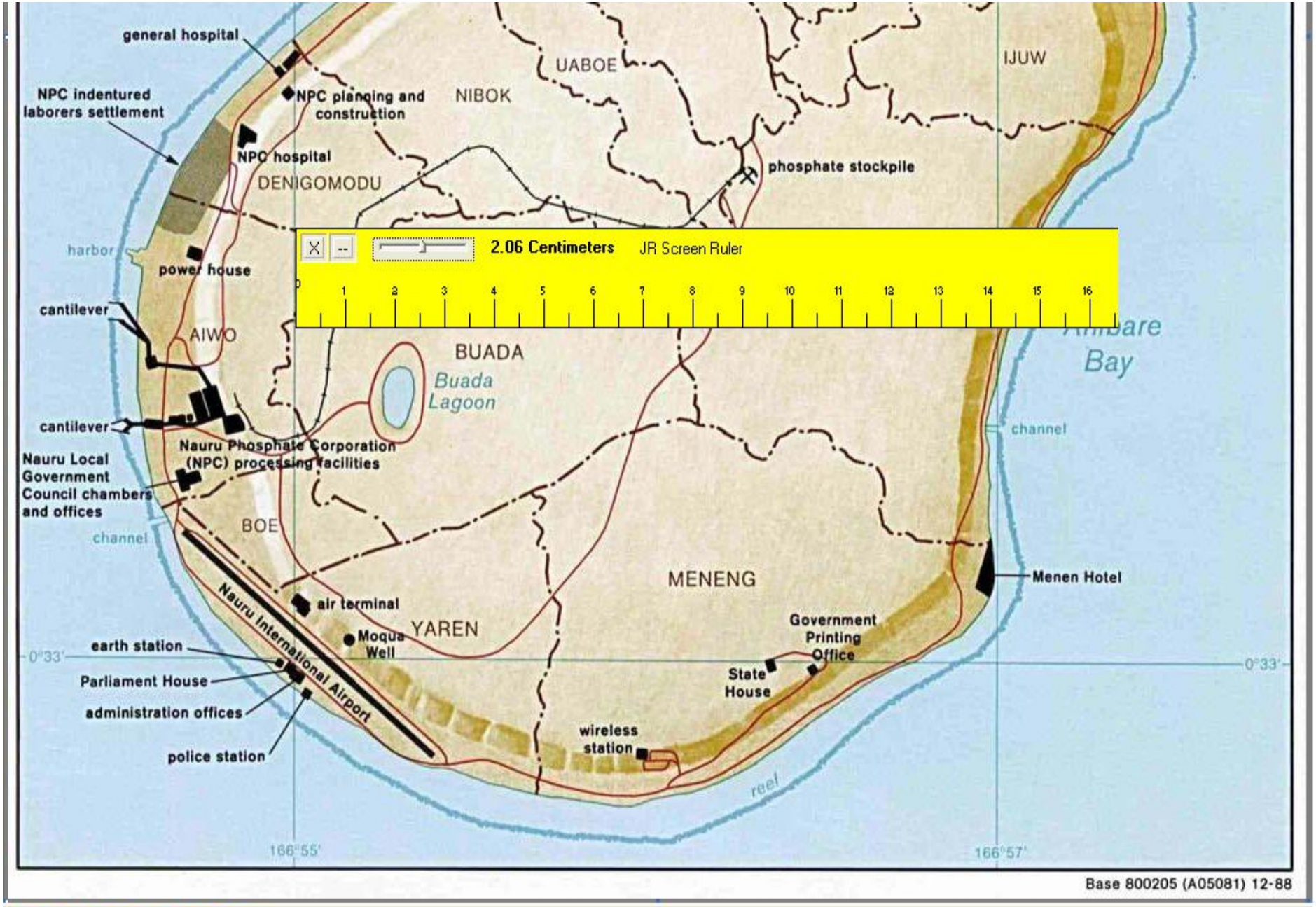
Determining Coordinates from Paper Maps: Latitude



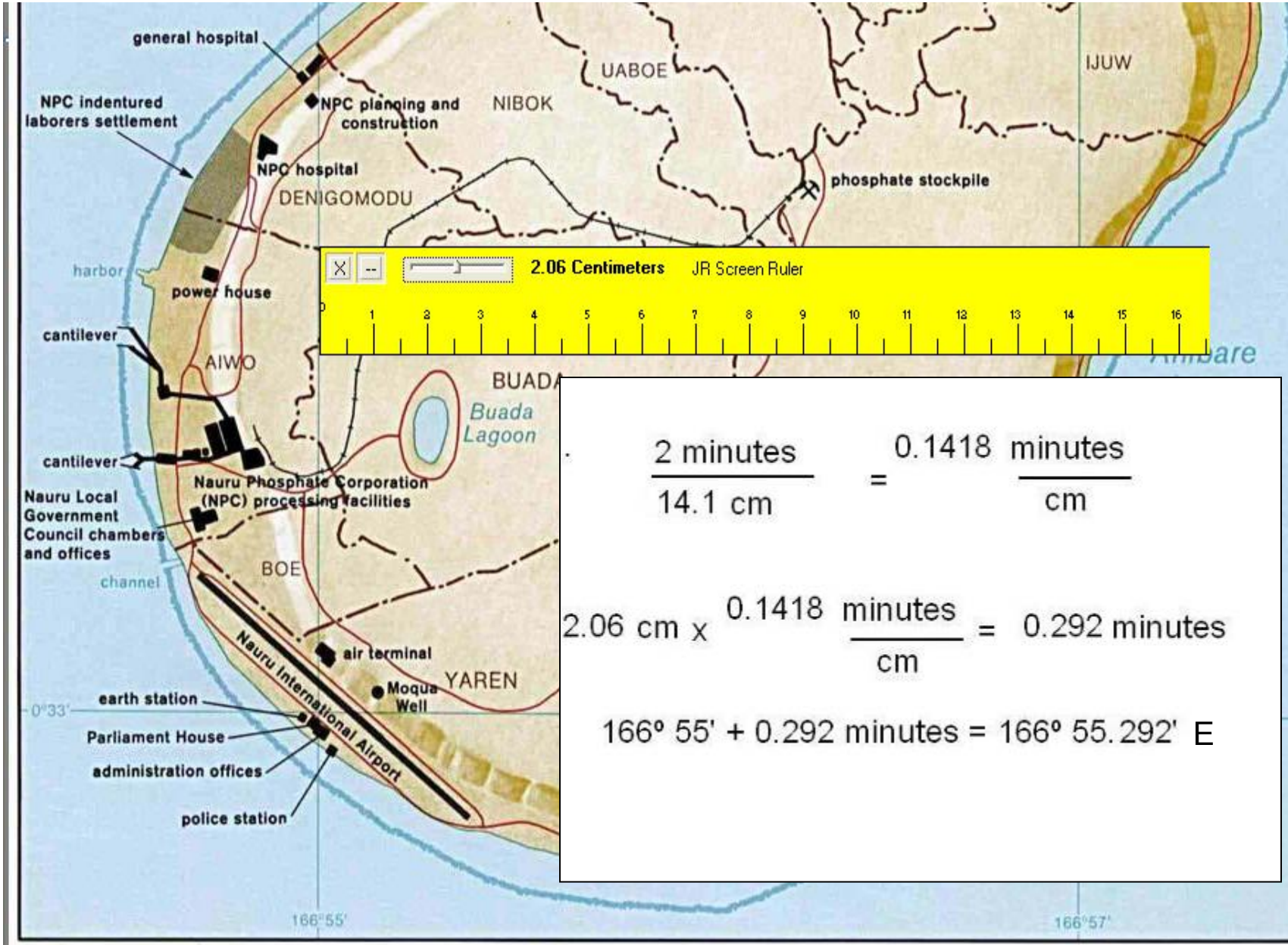
$$\frac{2 \text{ minutes}}{14 \text{ cm}} = \frac{0.1428 \text{ minutes}}{\text{cm}}$$

$$9 \text{ cm} \times \frac{0.1428 \text{ minutes}}{\text{cm}} = 1.28 \text{ minutes}$$

$$0^\circ\ 31' + 1.28' = 0^\circ\ 32.28'\ \text{S}$$



Base 800205 (A05081) 12-88

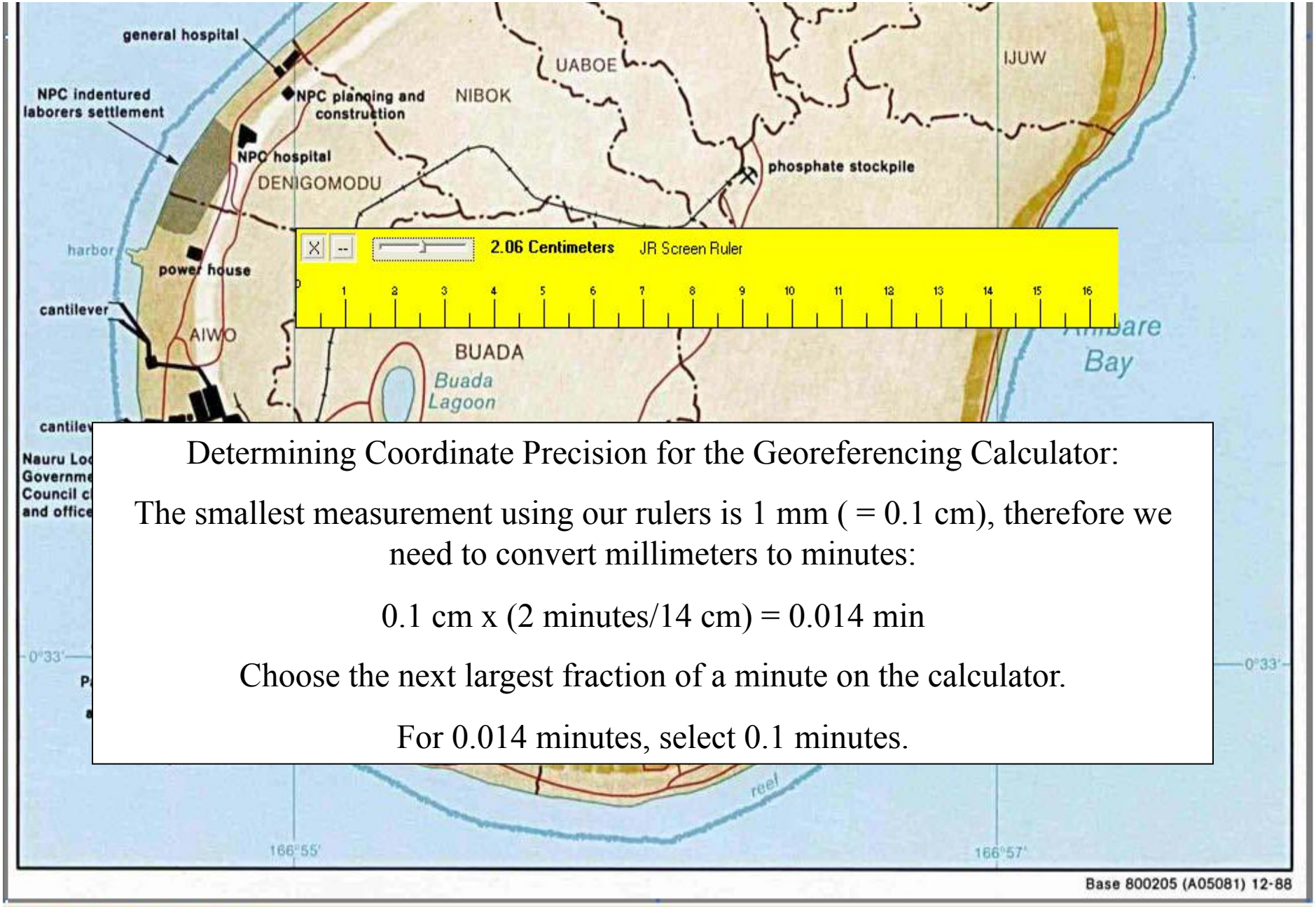


$$\frac{2 \text{ minutes}}{14.1 \text{ cm}} = \frac{0.1418 \text{ minutes}}{\text{cm}}$$

$$2.06 \text{ cm} \times \frac{0.1418 \text{ minutes}}{\text{cm}} = 0.292 \text{ minutes}$$

$$166^\circ\ 55' + 0.292 \text{ minutes} = 166^\circ\ 55.292'\ \text{E}$$

Base 800205 (A05081) 12-88



Determining Coordinate Precision for the Georeferencing Calculator:

The smallest measurement using our rulers is 1 mm (= 0.1 cm), therefore we need to convert millimeters to minutes:

0.1 cm x (2 minutes/14 cm) = 0.014 min

Choose the next largest fraction of a minute on the calculator.

For 0.014 minutes, select 0.1 minutes.

English (local)

Georeferencing Calculator

Calculation Type: Error only - enter Lat/Long for the actual locality

Locality Type: Named place only (e.g., Bakersfield)

Step 3) Enter all of the parameters for the locality.

Coordinate Source: other map: 1:20,000

Coordinate System: degrees decimal minutes

Latitude: 0 ° 32.28 ' S

Longitude: 166 ° 55.292 ' E

Datum: datum not recorded

Coordinate Precision: nearest 0.1 minutes

Extent of Named Place: 0.576

Distance Units: km

Decimal Latitude	Decimal Longitude	Maximum Error Distance			
-0.538	166.9215333	1.858	km	Calculate	Promote

degrees decimal minutes□nearest 0.1 minutes□□-0.538□166.9215333□datum not recorded□1.858□km□

Distance Converter: [ ] km = [ ] km

Scale Converter: 0.48 cm 1:120000 = 0.576 km

Version 20080313en

Determining Coordinates from Paper Maps: The Georeferencing Calculator Method

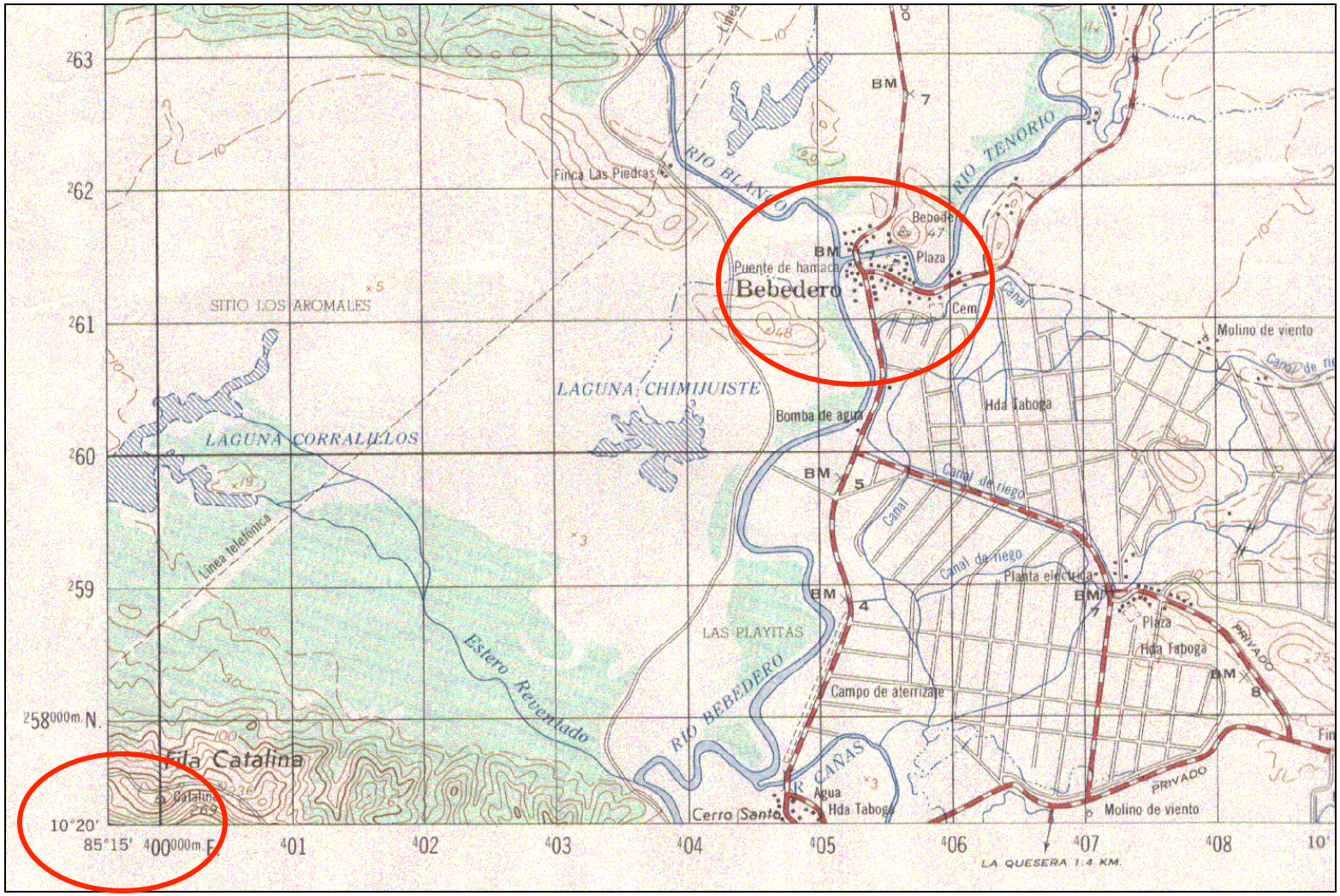
Locality Description: Bebedero

We need:

- One set of known coordinates (can be found in the corner of the map)
- Measuring tool (such as a ruler)

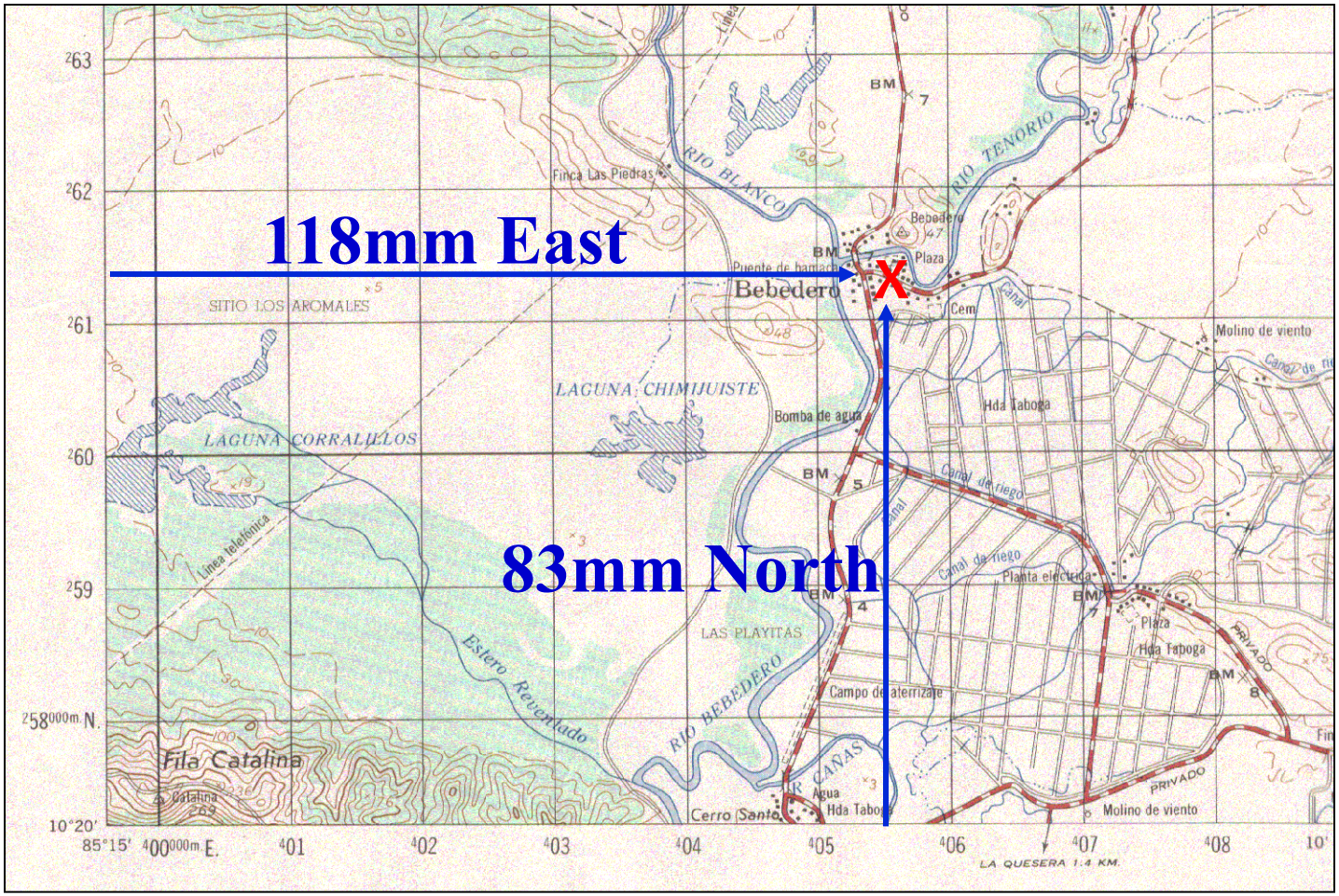
Determining Coordinates from Paper Maps

1. Find locality and known coordinates.

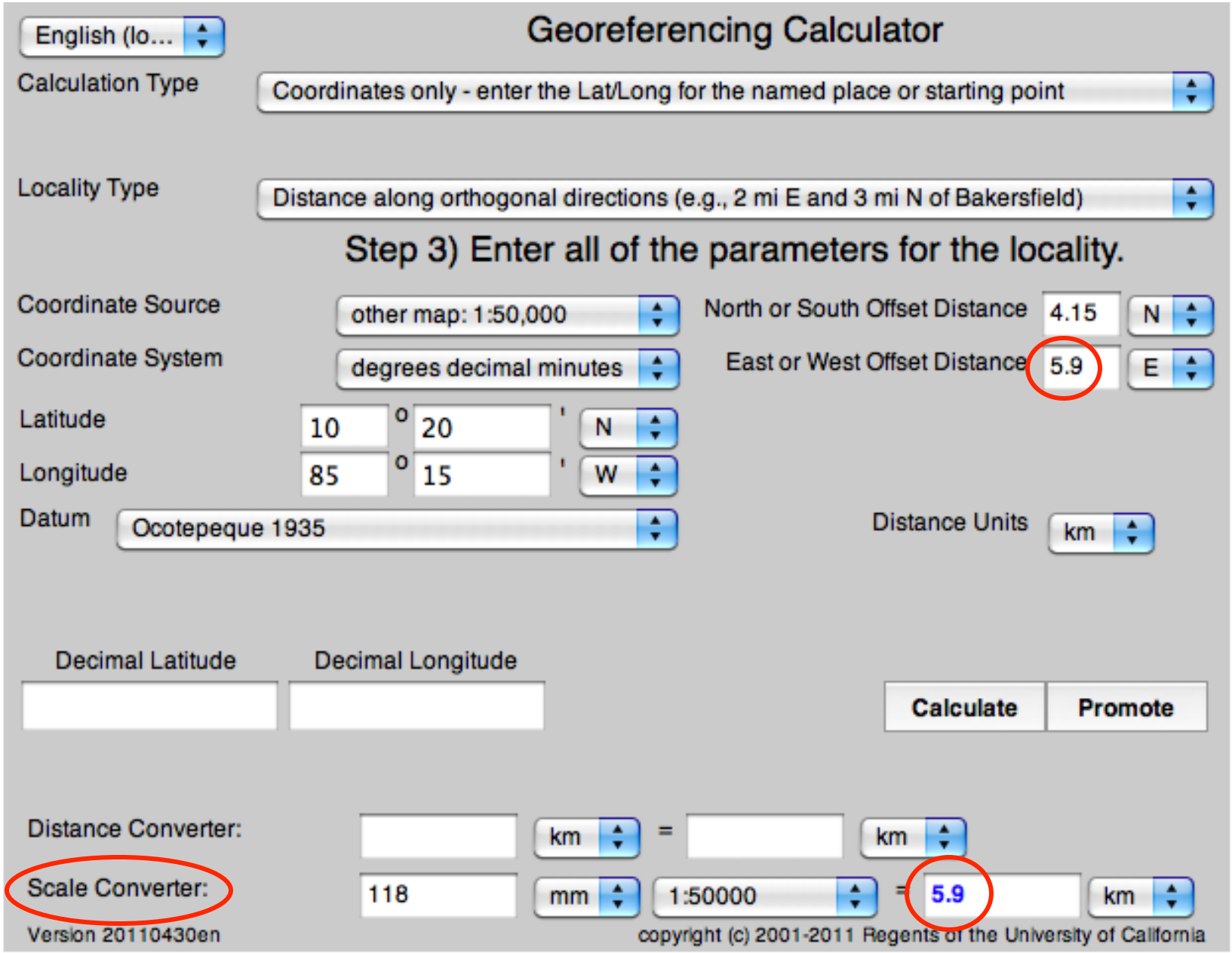


Determining Coordinates from Paper Maps

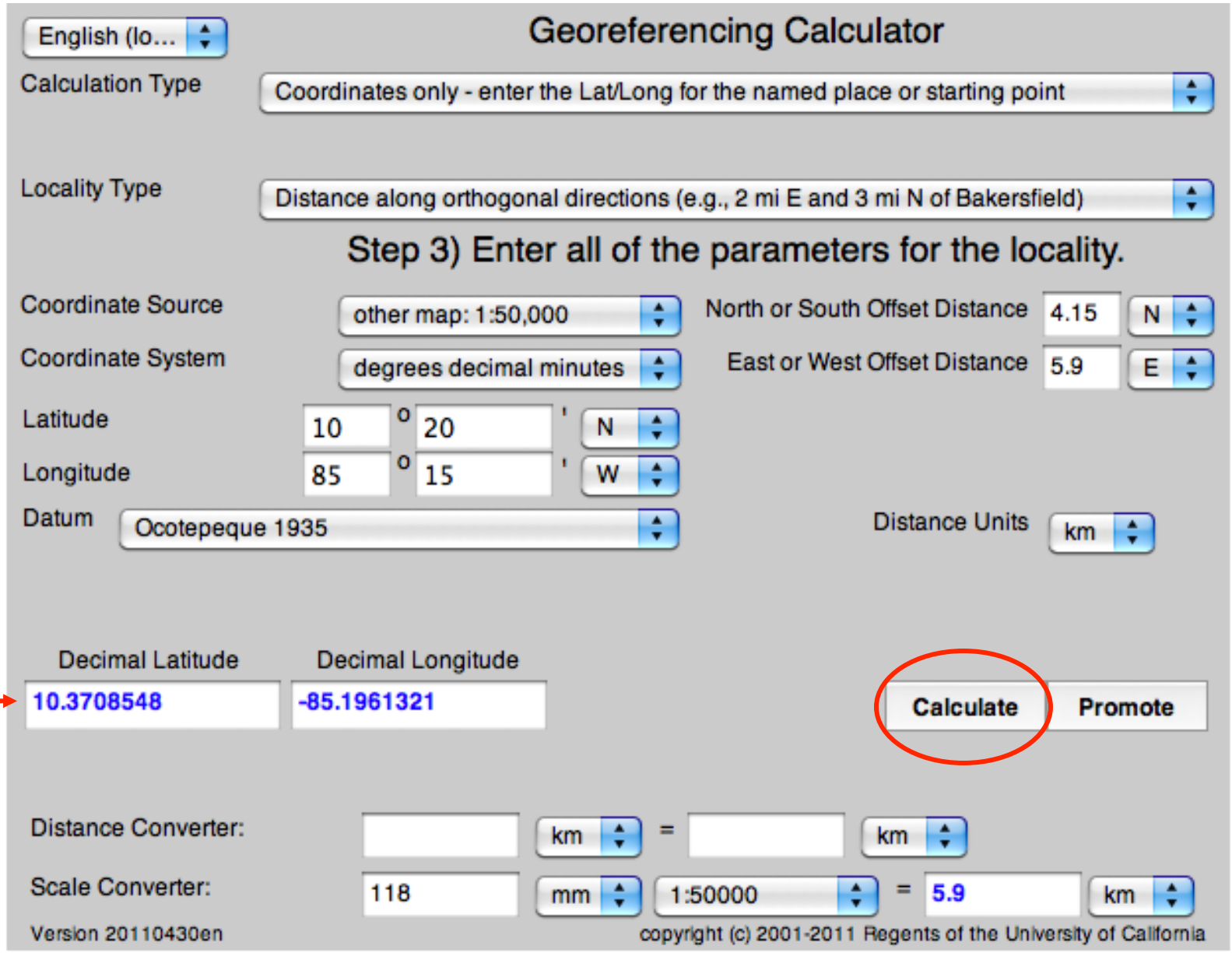
2. Measure distance in both directions from the known location to the center of the named place.



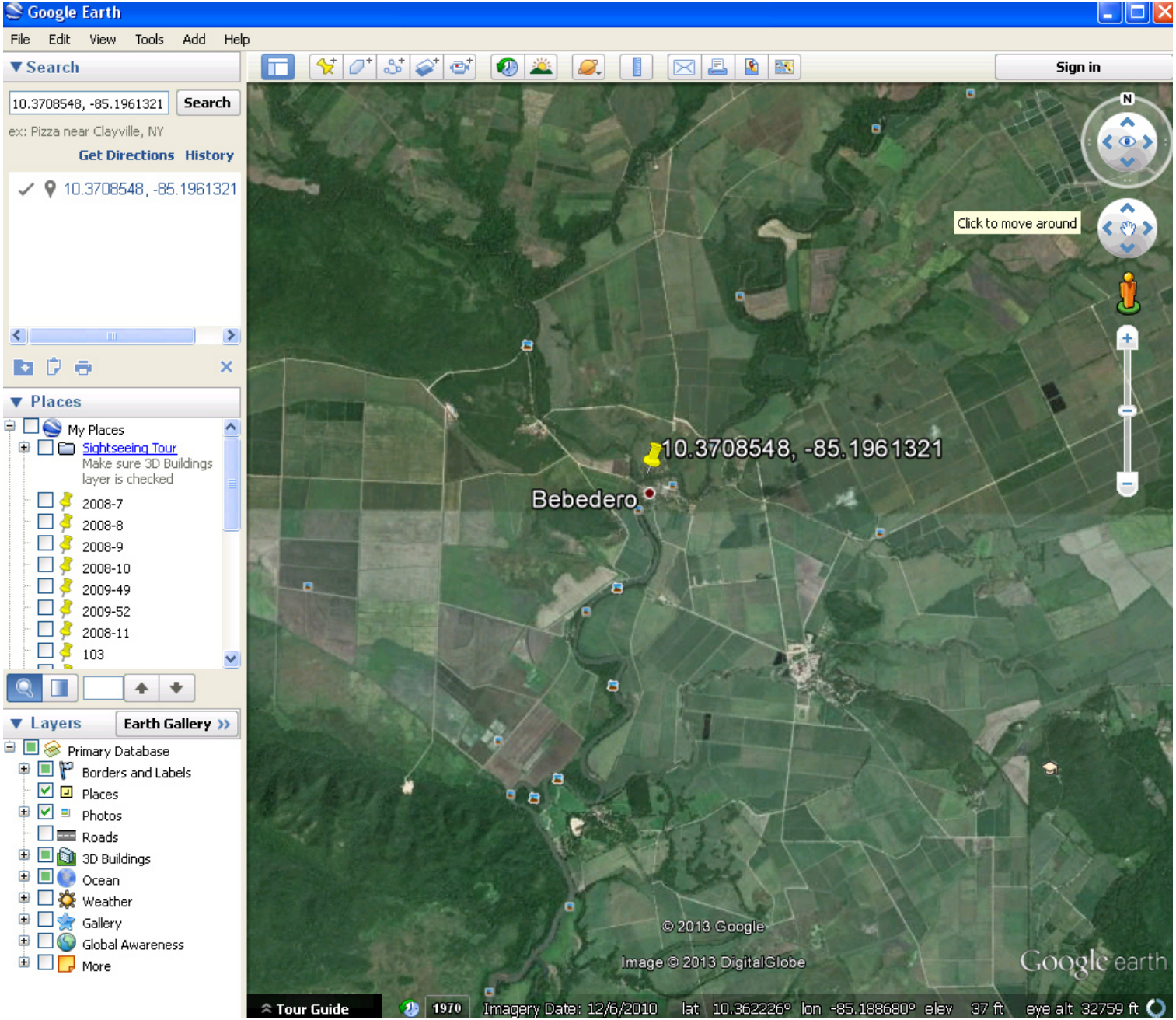
3. Use calculator to convert map measurements to real-world distances.



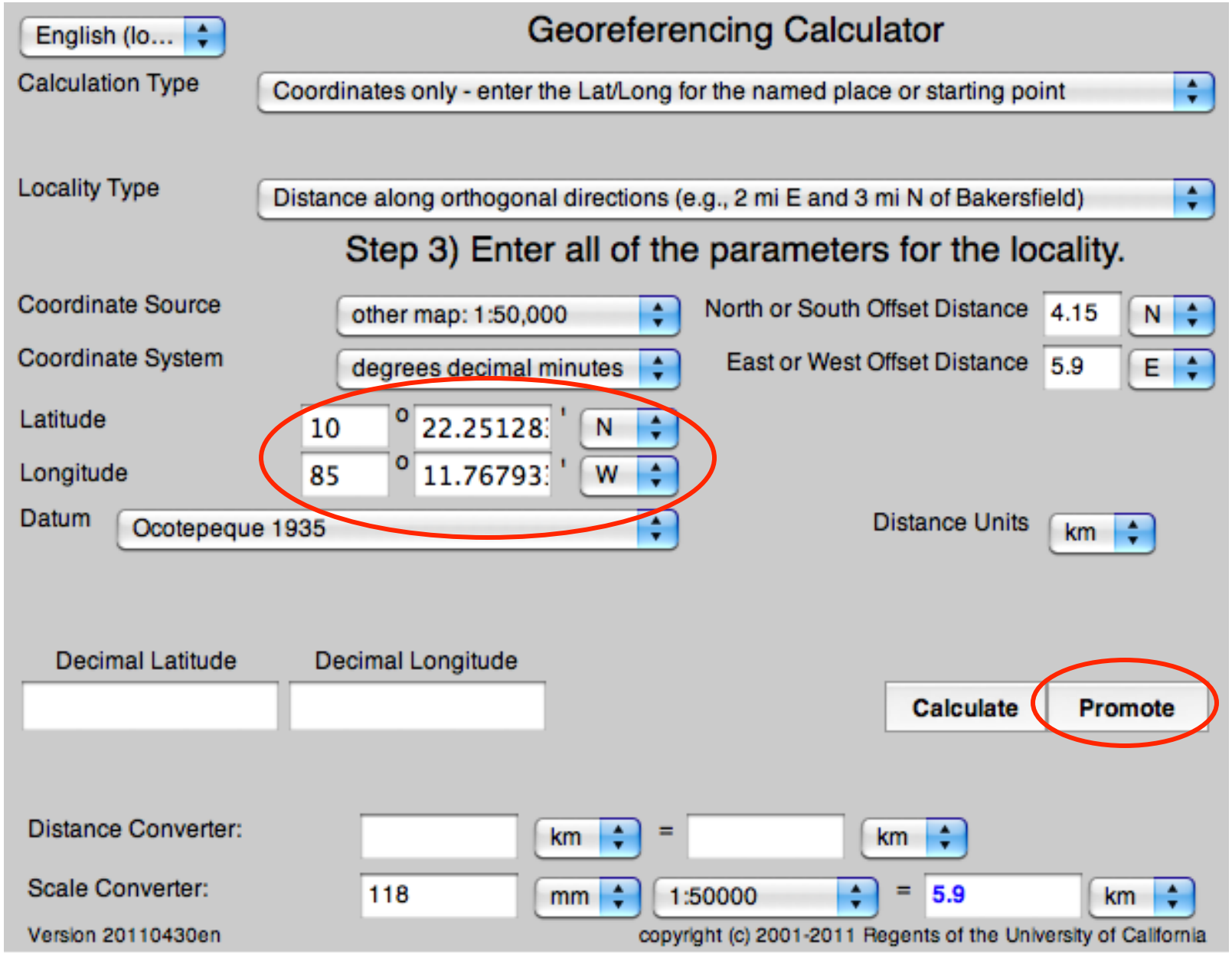
4. Calculate to determine new coordinates.



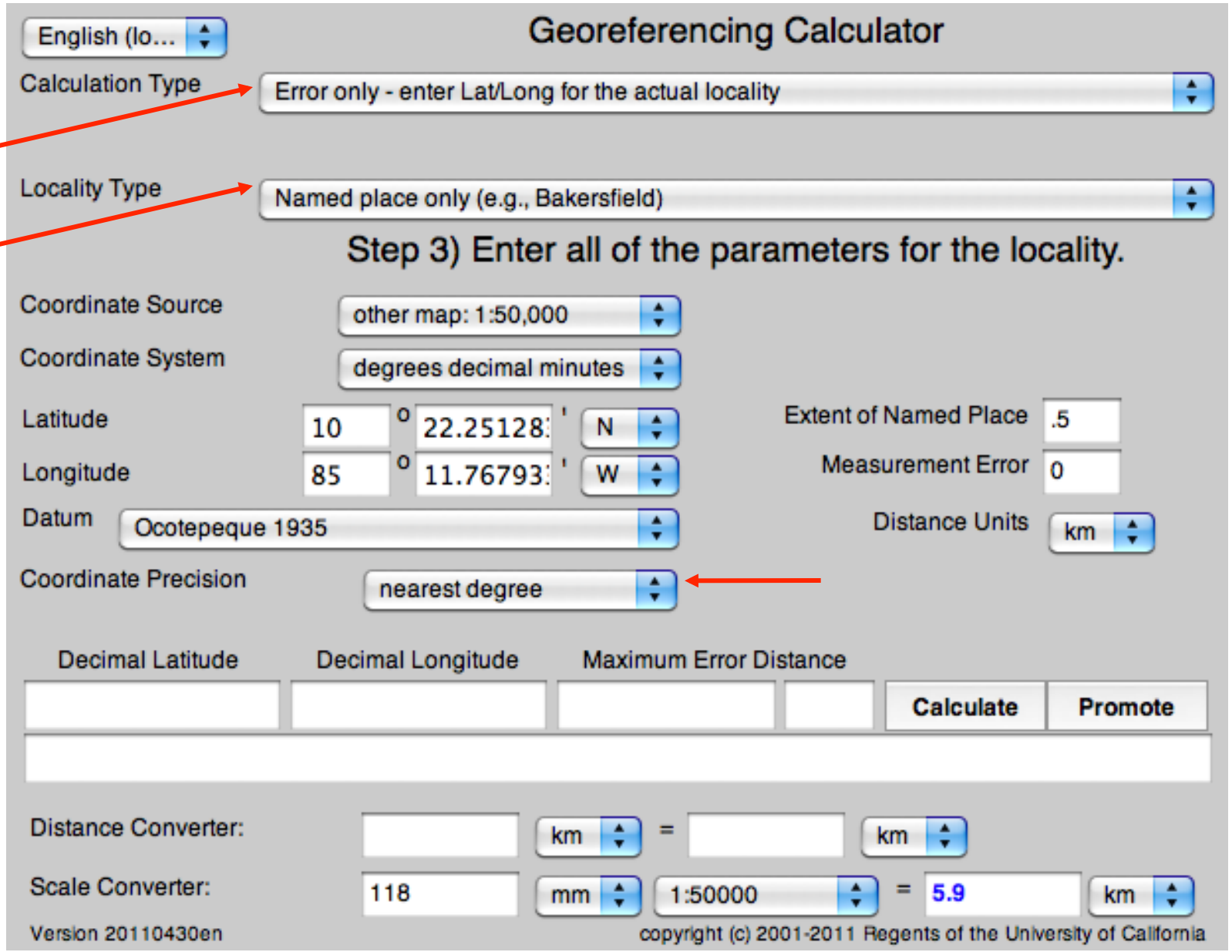
5. Verify new coordinates.



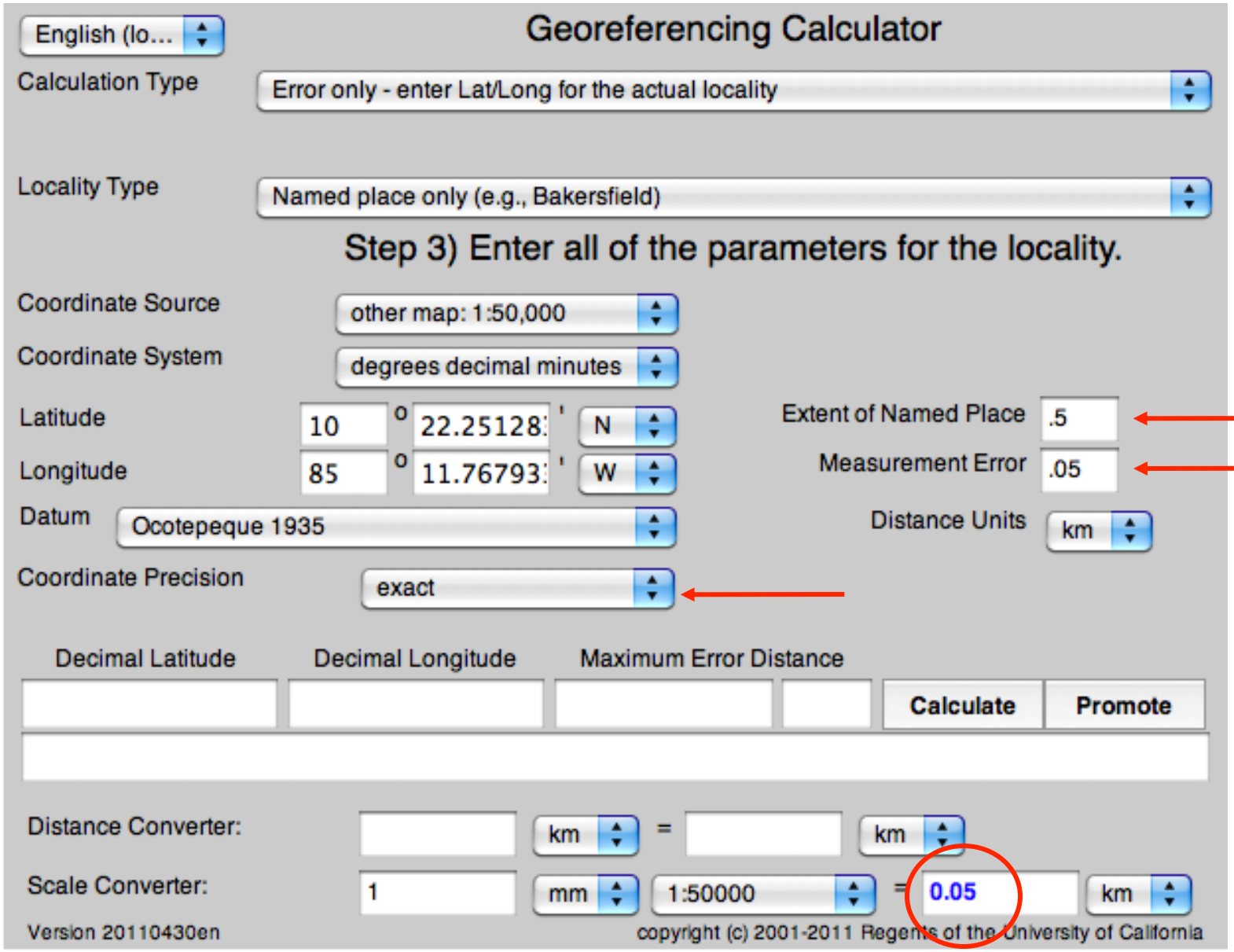
6. Promote coordinates to make the named place a new starting point.



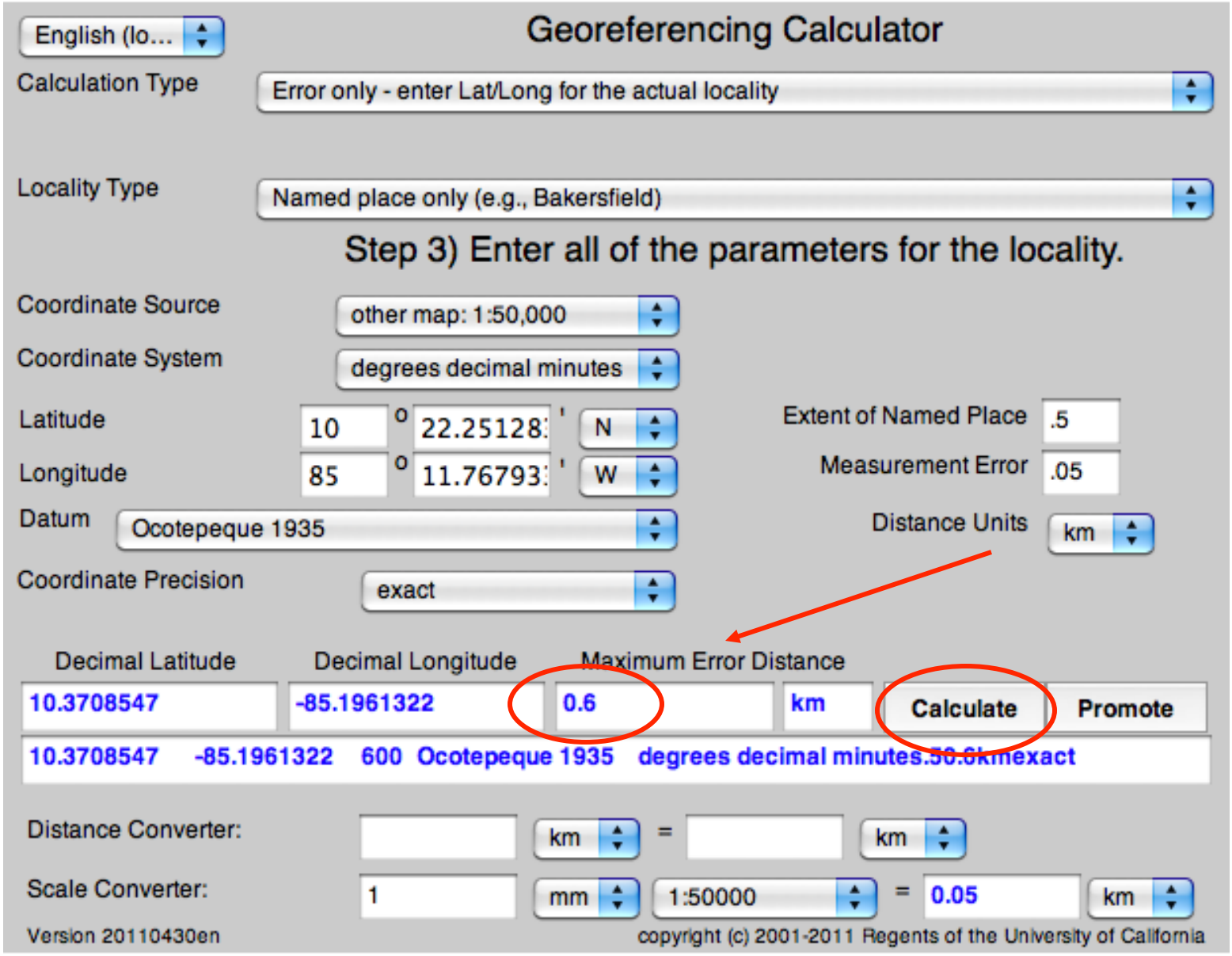
7. Use calculator to determine error only.



8. Account for measurement error.



9. Calculate for coordinate uncertainty (maximum error).



In Conclusion

- Pay attention to cardinal directions and hemispheres.
- Measure from the center to the edge of the feature to get the extent of the feature.
- Plot your coordinates to double-check your work.
- Explain any decisions you had to make in the **georeferenceRemarks** field.
- Explain any errors in the locality description in the **locality errors** field.

- For Georeferencing Source be sure to include the following:
  - Publisher name
  - Map date
  - Map scale
  - Map name
    - Example: United States Geological Society (USGS) Topographic Map California, 1956, map scale 1:24,000, map name “Boone”
- Leave bread crumbs!
  - No one can recreate what you did without knowing what you did.
  - It’s like showing your work in math class. If your final answer is wrong, knowing how you got that answer can help you fix the problem.
  - Record what tools you used, when you used them, and any assumptions you made.

Map Activity

- Use Georeferencing Calculator to calculate the coordinates and error of the desired points
- Provide:
  - Decimal latitude
  - Decimal longitude
  - Uncertainty (meters)
  - Datum
  - Coordinate system
  - Georeferencing Source (notes, comments, methods, etc)