Bringing Core Seamanship And Navigational Competencies to Your Organization

By Ronald Wisner

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NATIONAL SAILING PROGRAMS SYMPOSIUM 2019 US SAILING

Seamanship

How do we define it?
Why do we espouse it?

Seamanship

We can answer these questions with the simple statement:

Seamanship….

Is the set of skills and the character traits
which makes someone want to go on a boat with you.

Do I trust my life and limb with this person?

Do I trust my boat with this person?

What are Seamanship Skills?

1. Boat handling
2. Decision making
3. Technical skills
4. Navigation

As I break down each of these categories, think about how your organization furthers these skills within your membership…

1. Boat handling
2. Decision making
3. Technical skills
4. Navigation

1. Boat handling

- Sail setting
- Sail trim
- Steering (sailing to weather, steering by the compass)
- Docking
- Line handling

2. Decision making

- Judgement
- Situational awareness
- Experience

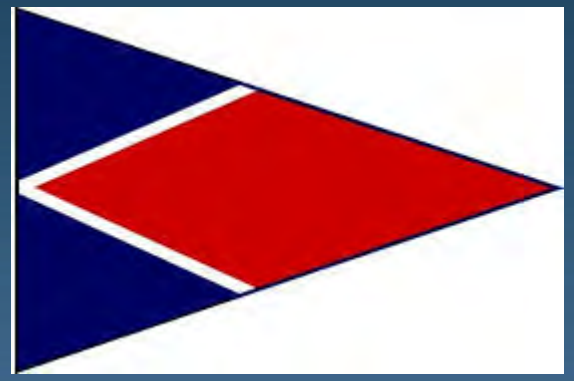
3. Technical skills

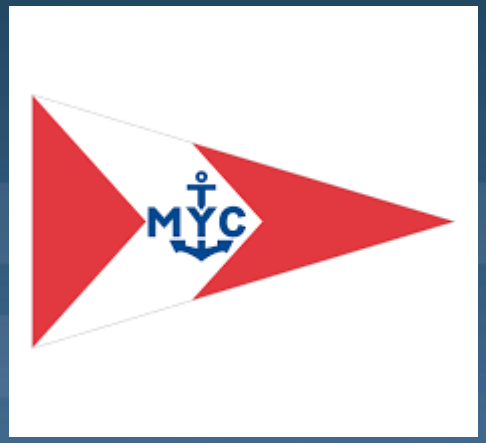
- Marlinspike seamanship:
  knot tying, splicing, line handling, rigging
- Familiarity with boat hardware:
  shackles, snatch-blocks, cars, winches
- Engines

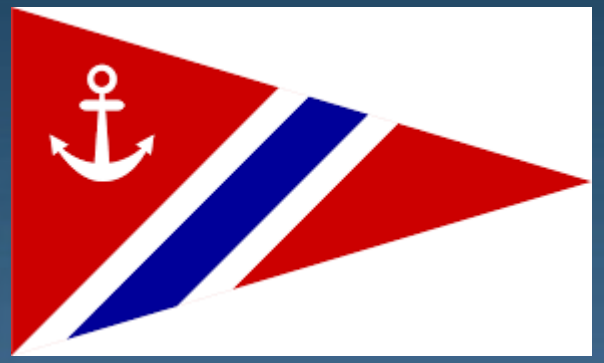
4. Navigation

- Chart literacy (reading scales, knowing symbols)
- Understanding the compass
- How to take bearings
- How to plot a position
- Navigational aids

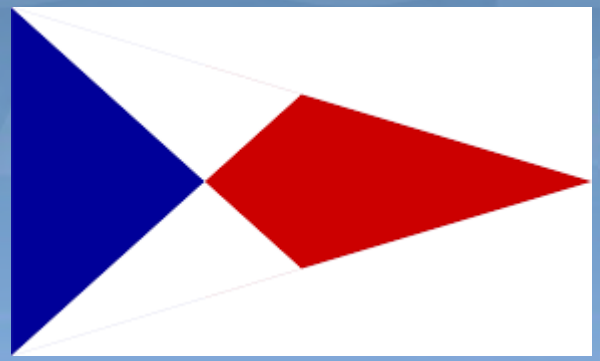
Can you improvise?







The club or organization generally has, as one of their missions, the promotion of seamanship skills



The Technology Trap

It coddles us, it takes care of us, it gives us easy answers and solutions, it makes us feel smart.

The Technology Trap

But

We Are Losing Basic Literacy

- Driving a car (standard shift anyone?)
- Reading an analog clock (ask your kid)
- Chart and map reading
- Using a library
- Basic Hand tools

Ultimately leading to a loss of self reliance

Many young sailors don't know how to read charts

Or even the difference between longitude and latitude

The lost art of map reading

- Four out of five 18 to 30-year-olds can’t navigate without GPS.
- 53 per cent of over-60s are still comfortable with conventional maps.

7:10 *P.M.* on November 29th 2014, shortly after sunset

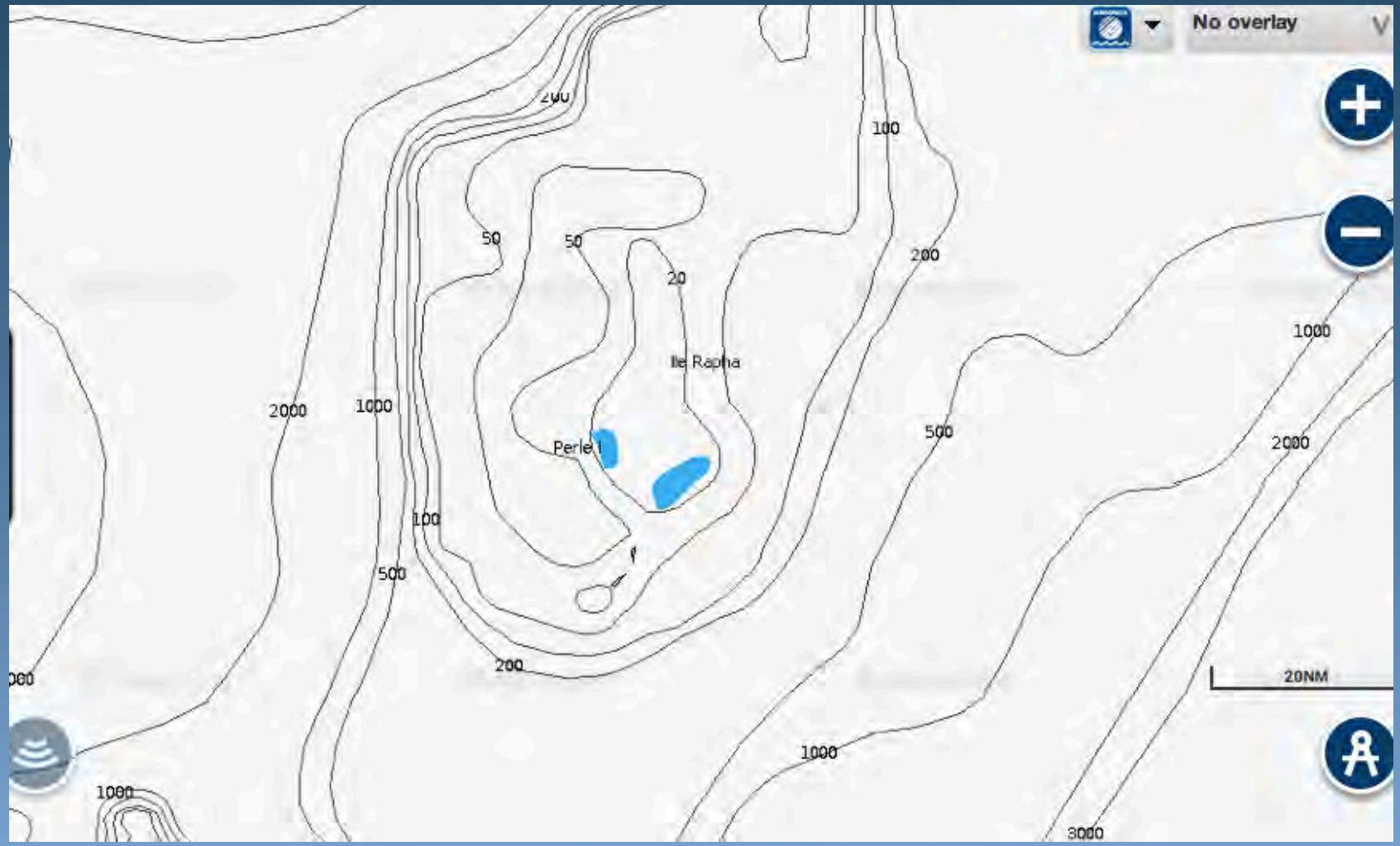
The Danish Volvo boat Vestas Wind slammed into a coral reef in the Indian Ocean.

It was going 19 knots.

Christopher Oxenbould, retired deputy chief of the Royal Australian Navy and chair of Yachting Australia:

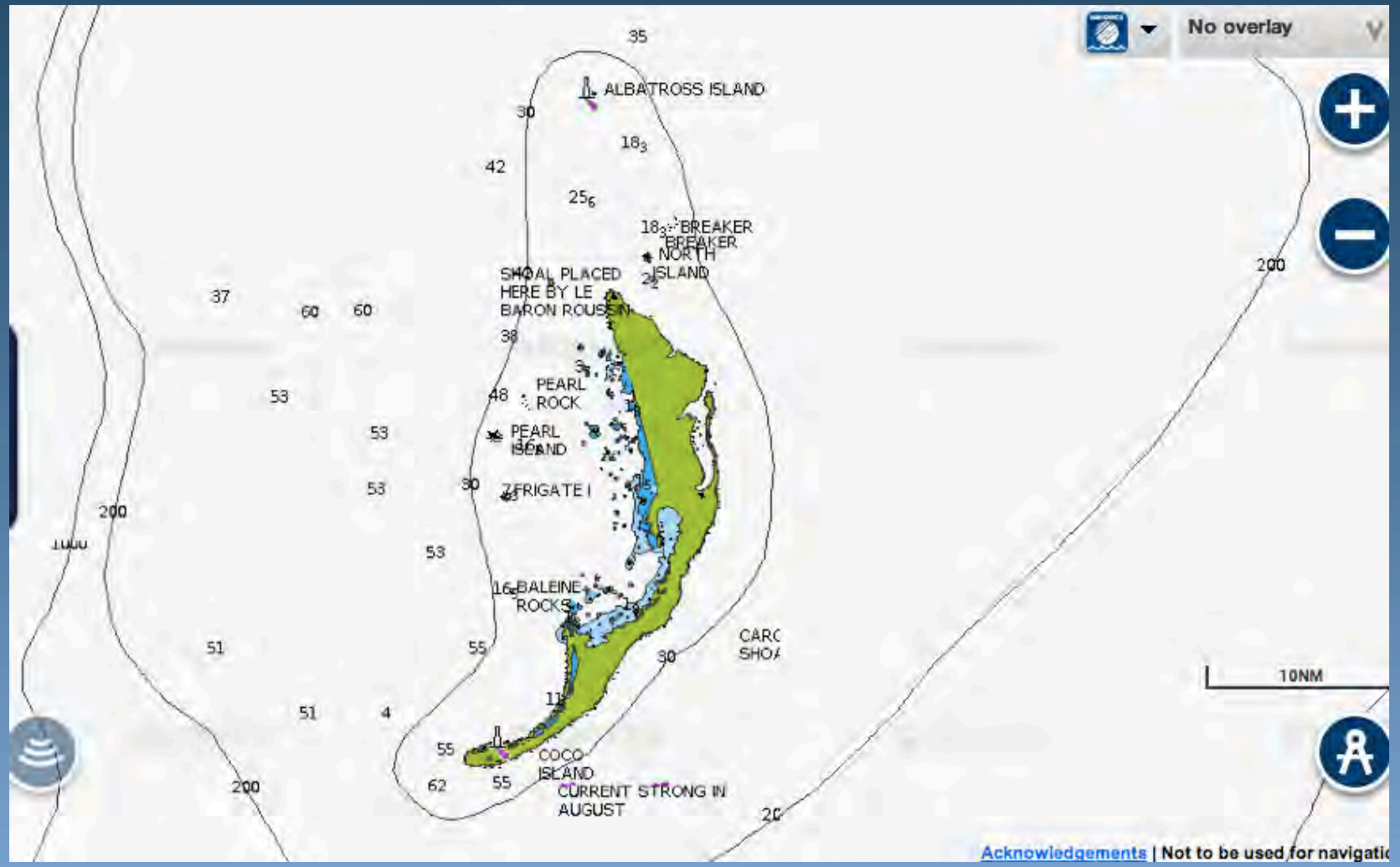
"On paper charts of every scale that cover the area, the hazard was clear."

Electronic chart



"On paper charts of every scale that cover the area the hazard was clear."

Zoomed in one layer



"On paper charts of every scale that cover the area the hazard was clear."

The Technology Trap…

What is the antidote?

Sailing

Especially traditional Seamanship skills

She’s 12

She is comfortable piloting a 50’ Sloop

“A Novice”

1917 Cosmopolitan Magazine

Not just for Kids

Sailing builds

- Situational awareness
- Decision making skills
- Analysis and Problem solving
- Self reliance

Sailing, Camping, Riding a horse, Scouting or similar programs:

All require decision making and self reliance outside the cocoon of modern life

Traditional Skills and Literacy:

How do you promote these in your club or organization?

Developing Programs

Who in your organization promotes education?

Developing Programs

Programs can be *ad hoc*

However, if programs are not structural they tend to die.

Does Your Organization Have

- Guest Speaker Series Coordinator?
- Youth (junior) Sailing Program?
- Race Committee Sponsored Education?
- Seamanship Committee?
- An Adult “Learn to Sail” Program
- Women's Sailing Program

Examples:

- New York Yacht Club has a Seamanship Committee
- US Sailing has education programs, including Safety At Sea

One Way to Start:
Surveys

Invite membership to give input

Surveys

- Surveys create interest, like a push-poll
- Surveys start a dialogue about the needs of the organization and the membership
- What Programs do they want?

Sample Survey

Are you...

- ○ female
- ○ male

How Old Are You?

- ○ Under 30
- ○ 30 to 40
- ○ 41 to 50
- ○ 51 to 60
- ○ 61 to 70
- ○ 71 or older

How you would describe your boating activity?

- ○ Sail: Racing
- ○ Sail: Both racing and cruising
- ○ Sail: Cruising
- ○ Powerboating

Do You Own a Vessel(s)?

- ☐ Sail
- ☐ Power

What best describes your role on board?

Are you acquiatined with celestial navigation

- ○ Not at all
- ○ Somewhat
- ○ Very

How interested would you be in taking a course on celestial navigation?

	1	2	3	4	5	6	7	8	9	10	
No Interest	○	○	○	○	○	○	○	○	○	○	Significant Interest

Please elaborate on your answer above.

If you're interested in learning celestial navigation, how much time would you be willing to spend?

- ○ One day learning basic celestial navigation theory
- ○ One weekend learning both basic concepts and more advanced skills

Would You Prefer to Attend the Seminar at...

- ○ 44th Street
- ○ Harbour Court

In the context of the GPS-era in which we live, for determining location and route, how do you view the use of celestial navigation as a tool regarding...

A. Your own pleasure at sea

B. Your own safety at sea

Look for volunteers who share your passion for education
Find a champion in a position of authority:

- Flag Officer In Your Club
- Board Member
- Committee Chair

Suggested Programs *And Target Group*

- Learn-to-sail Programs
  All ages and genders
- Coastal Navigation
  Cruisers and Daysailers
- Women and Sailing
  *Overcoming the male bias in sailing**
- Celestial Navigation
  Anyone going off shore
- Survival Navigation
  Cruisers and offshore sailors

*More later

After the Kids go through Opti and 420 programs, Where do they go from there?

- US Sailing has a big-boat program template
- Within your club PHRF racing, give a rating bonus to boats with kids on board

*Women in sailing:

- 20% of the Volvo race is women (an improvement)
- 10% of the Marion to Bermuda Race Is Women
- The Marion/Bermuda Race has a special trophy for fastest all-female boat

Establish a mentoring program to promote women In Sailing

Example:

- On *Hotspur II* half of my crew is female.
- We placed 6th of of 50 boats
- Won local club trophy for best corrected time.

We also had two new celestial navigators testing their skills

Sample Program

Excerpts

Women in Navigation

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Woman in Navigation

In the days before GPS, when couples went offshore on private yachts it was not unusual for the women to be the navigator.

In the 19th Century, captains of packets, clippers and coastal cargo vessels sometimes brought their families.

Barkentine AURORA, Homeport San Francisco

There are many examples of the captain's wives acting as one of the navigators and helping to run the ship

Mrs. Hansen taking the noon site
on board the barkentine AURORA, early 1900s

Eleanor Creesy navigated the Flying Cloud and set the world's sailing record for the fastest passage between New York and San Francisco in 1851. She and her husband beat their own record three years later. It remained the record until 1989.

The FLYING COUD, a Gold Rush era clipper-ship was commanded by Captain Josiah Creesy from 1851-1855. Eleanor Creesy sailed with her husband throughout his career and served as his navigator

Woman in Navigation: World War II

In World War II it was the *Women* who trained the *Men* In Pensicola and Lakehurst

Over 100,000 Army Aircorps men were trained in the CNT. The entire program was taken over by the WAVES in 1943

United States Naval Reserve (Women's Reserve)

The Celestial Navigation Trainer

Woman in Navigation

A WAVE instructor guides a navigational student on a simulated cross-country flight in the Link Celestial Navigation Trainer

Woman in Navigation

*Specialist Teacher, 2nd Class – Waneta Miller demonstrates the use of the **Link sextant** in this Navy photo*

Sample Program

Excerpts

Coastal navigation

Coastal Navigation

BY RON WISNER

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Compass

- Magnetic vs true
- Steering
- Variation (declination)
- Deviation
- Reciprocals
- Leeway

Chart reading

- Bathymetry soundings: fathoms (feet) vs meters
- Latitude, Longitude, scales
- Finding coordinates: seconds vs tenths of a minute

Aids to navigation: buoys, lighthouses, day marks and landmarks

Taking bearings

- Tools (bearing compass, plotting parallels)
- Range (transit) using two in-line objects
- Position lines from objects

Fixes

- By Position Lines
- Raising or dipping of lights or land
- Position by soundings

Electronic Instruments

- GPS and Chartplotters
- AIS

Distance and speed

Passage planning

- Waypoints
- Using Eldridge (pilot charts, Reeds)

Weather Basics

***Collision Avoidance*: Collregs**

- Lights and shapes of commercial vessels, towing in Buzzards Bay

Radio:

- Correct radio etiquette
- Hailing Commercial traffic, inshore vs offshore
- Bridges and canals

Passage to Padanarum

Coastal Navigation is principally achieved by the use of navigational aids

- Landmarks
- Buoys
- Lighthouses
- Day marks and
- GPS*

Compass

Lubber’s line

Compass Card

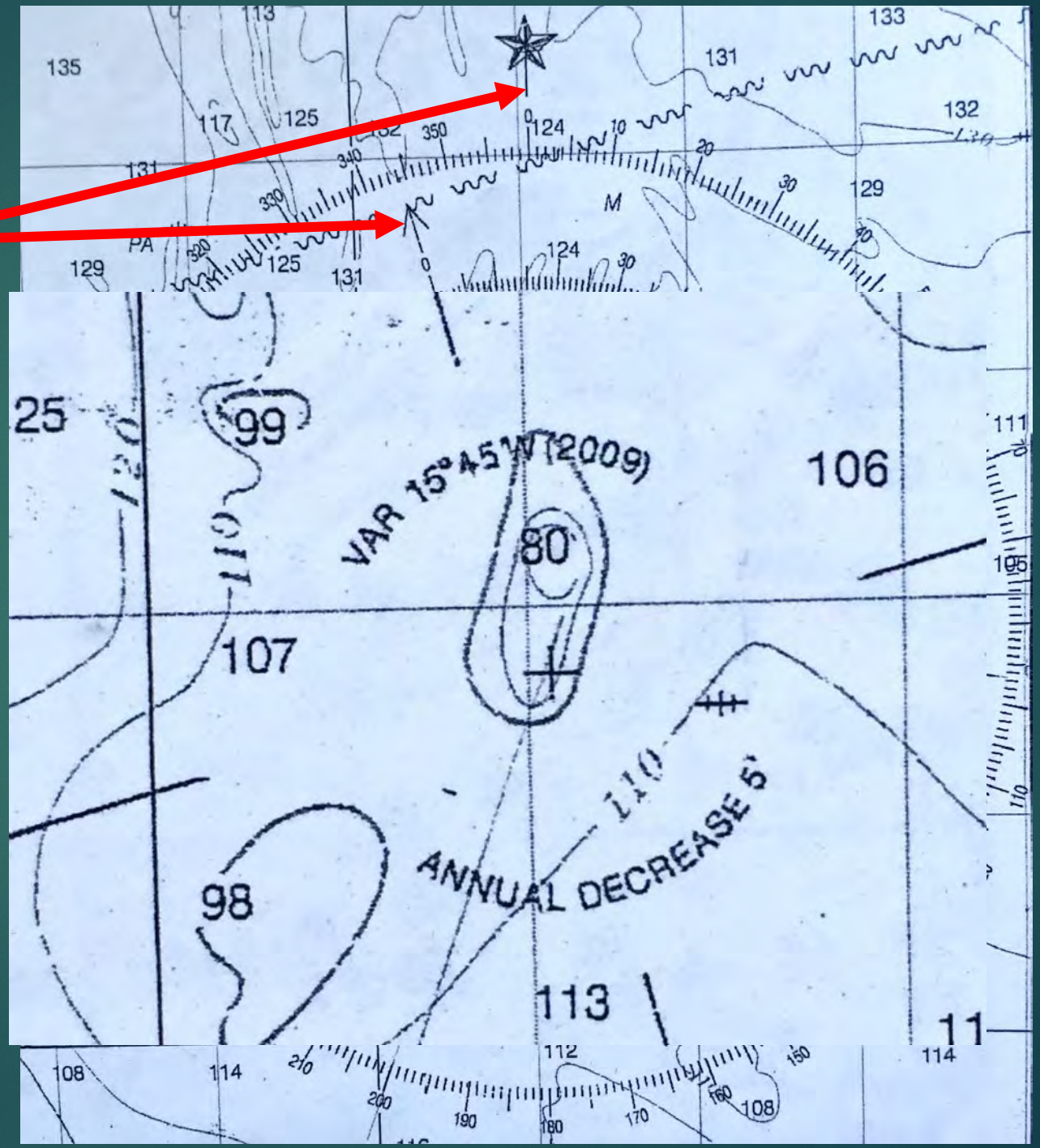
Gnomon

Reciprocal Lubber’s line

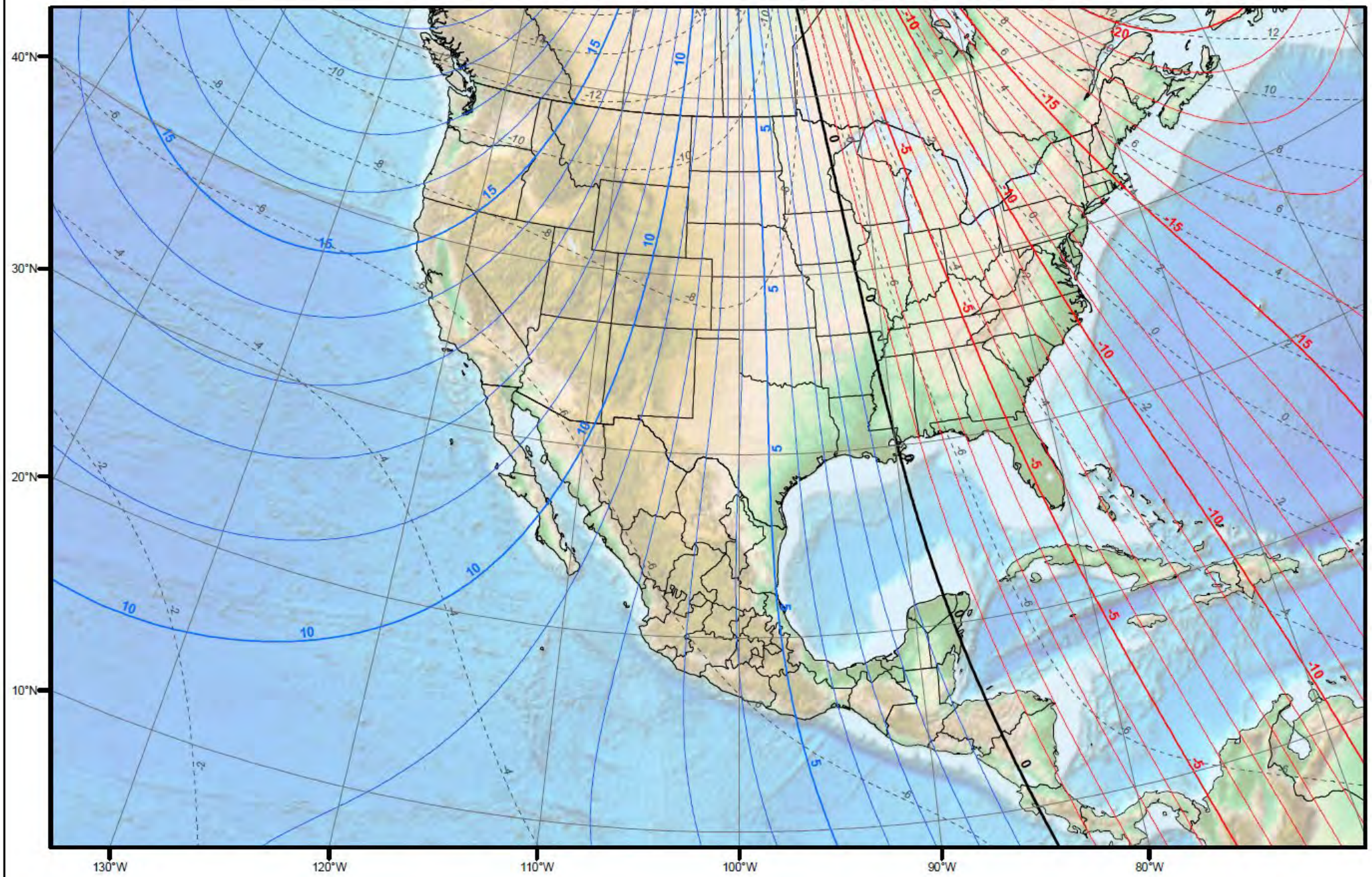
Compass

Magnetic vs. true

Variation (declination)



Magnetic Declination Map of North America for the year 2010



Compass

Deviation

Magnetic Heading	Deviation
000	3°E
045	1°E
090	1°W
135	0°
180	3°E
225	4°W
270	1°E
315	1°E

Compass

Check Deviation

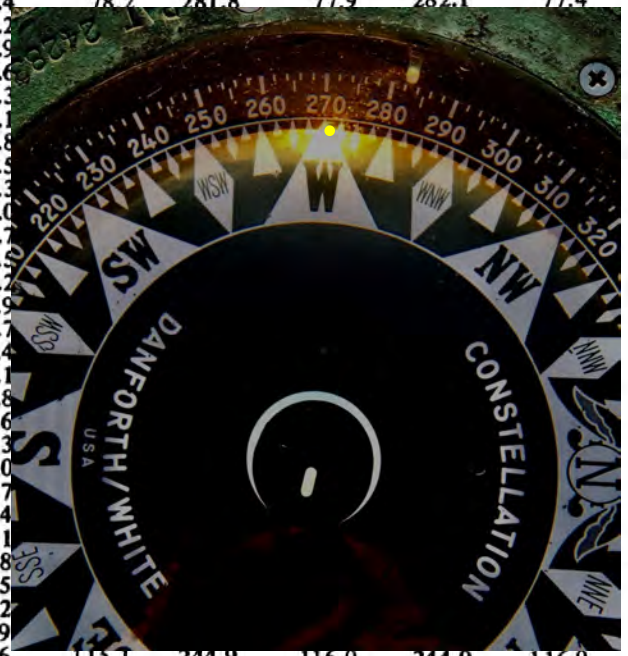
Using the true bearing of Sunrise or sunset in Eldridge

2018 pg. 232

Sun's True Bearing at Rising and Setting

To find compass deviation using the Sun.
Figures are correct for all Longitudes

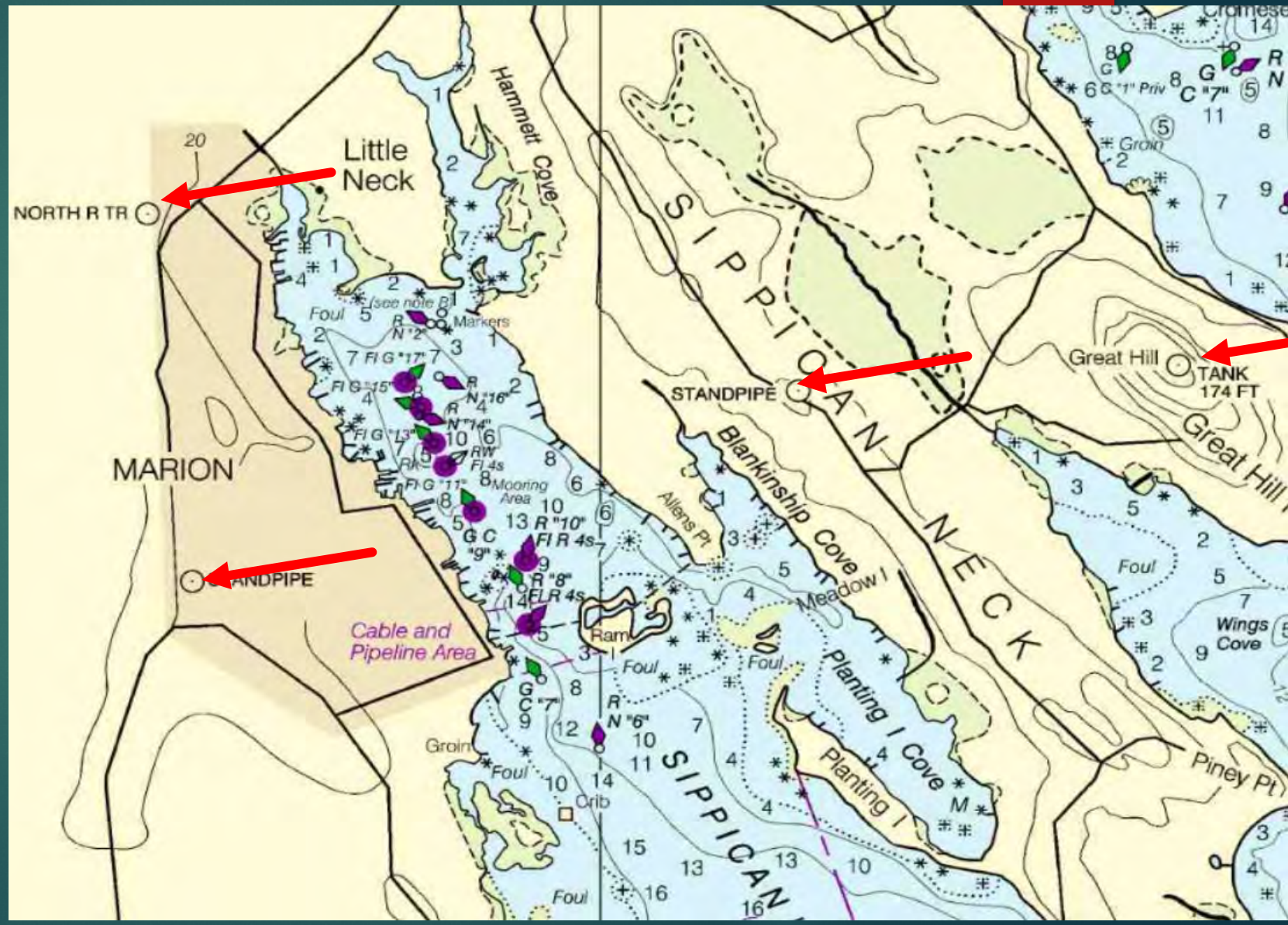
Sun's Decl.	38° N Rise	38° N Set	40° N Rise	40° N Set	42° N Rise	42° N Set	44° N Rise	44° N Set	Sun's Decl.
N 23°	60.3°	299.7°	59.3°	300.7°	58.3°	301.7°	57.1°	302.9°	N 23°
22	61.6	298.4	60.7	299.3	59.7	300.3	58.6	301.4	22
21	63.0	297.0	62.1	297.9	61.2	298.8	60.1	299.9	21
20	64.3	295.7	63.5	296.5	62.6	297.4	61.6	298.4	20
19	65.6	294.4	64.9	295.1	64.0	296.0	63.1	296.9	19
18	66.9	293.1	66.2	293.8	65.4	294.6	64.6	295.4	18
17	68.2	291.8	67.6	292.4	66.8	293.2	66.0	294.0	17
16	69.5	290.5	68.9	291.1	68.2	291.8	67.5	292.5	16
15	70.8	289.2	70.3	289.7	69.6	290.4	68.9	291.1	15
14	72.1	287.9	71.6	288.4	71.0	289.0	70.4	289.6	14
13	73.4	286.6	72.9	287.1	72.4	287.6	71.8	288.2	13
12	74.7	285.3	74.3	285.7	73.8	286.2	73.2	286.8	12
11	76.0	284.0	75.6	284.4	75.1	284.9	74.6	285.4	11
10	77.3	282.7	76.9	283.1	76.5	283.5	76.0	284.0	10
9	78.6	281.4	78.2	281.8	77.9	282.1	77.4	282.6	9
8	79.8	280.2						281.1	8
7	81.1	278.9						279.7	7
6	82.4	277.6						278.3	6
5	83.7	276.3						277.0	5
4	84.9	275.1						275.6	4
3	86.2	273.8						274.2	3
2	87.5	272.5						272.8	2
N 1°	88.7	271.3						271.4	N 1°
0	90.0	270.0						270.0	0
S 1°	91.3	268.7						268.6	S 1°
2	92.5	267.5						267.2	2
3	93.8	266.2						265.8	3
4	95.1	264.9						264.4	4
5	96.3	263.7						263.0	5
6	97.6	262.4						261.7	6
7	98.9	261.1						260.3	7
8	100.2	259.8						258.9	8
9	101.4	258.6						257.4	9
10	102.7	257.3						256.0	10
11	104.0	256.0						254.6	11
12	105.3	254.7						253.2	12
13	106.6	253.4						251.8	13
14	107.9	252.1						250.4	14
15	109.2	250.8						248.9	15
16	110.5	249.5						247.5	16
17	111.8	248.2						246.0	17
18	113.1	246.9						244.6	18
19	114.4	245.6	115.1	244.9	116.0	244.0	116.9	243.1	19
20	115.7	244.3	116.5	243.5	117.4	242.6	118.4	241.6	20
21	117.0	243.0	117.9	242.1	118.8	241.2	119.9	240.1	21
22	118.4	241.6	119.3	240.7	120.3	239.7	121.4	238.6	22
S 23°	119.7	240.3	120.7	239.3	121.7	238.3	122.9	237.1	S 23°



Compass

Check Deviation

Or use landmarks on the chart on a quiet morning



Compass

Reciprocals

90
+ 180
= 270

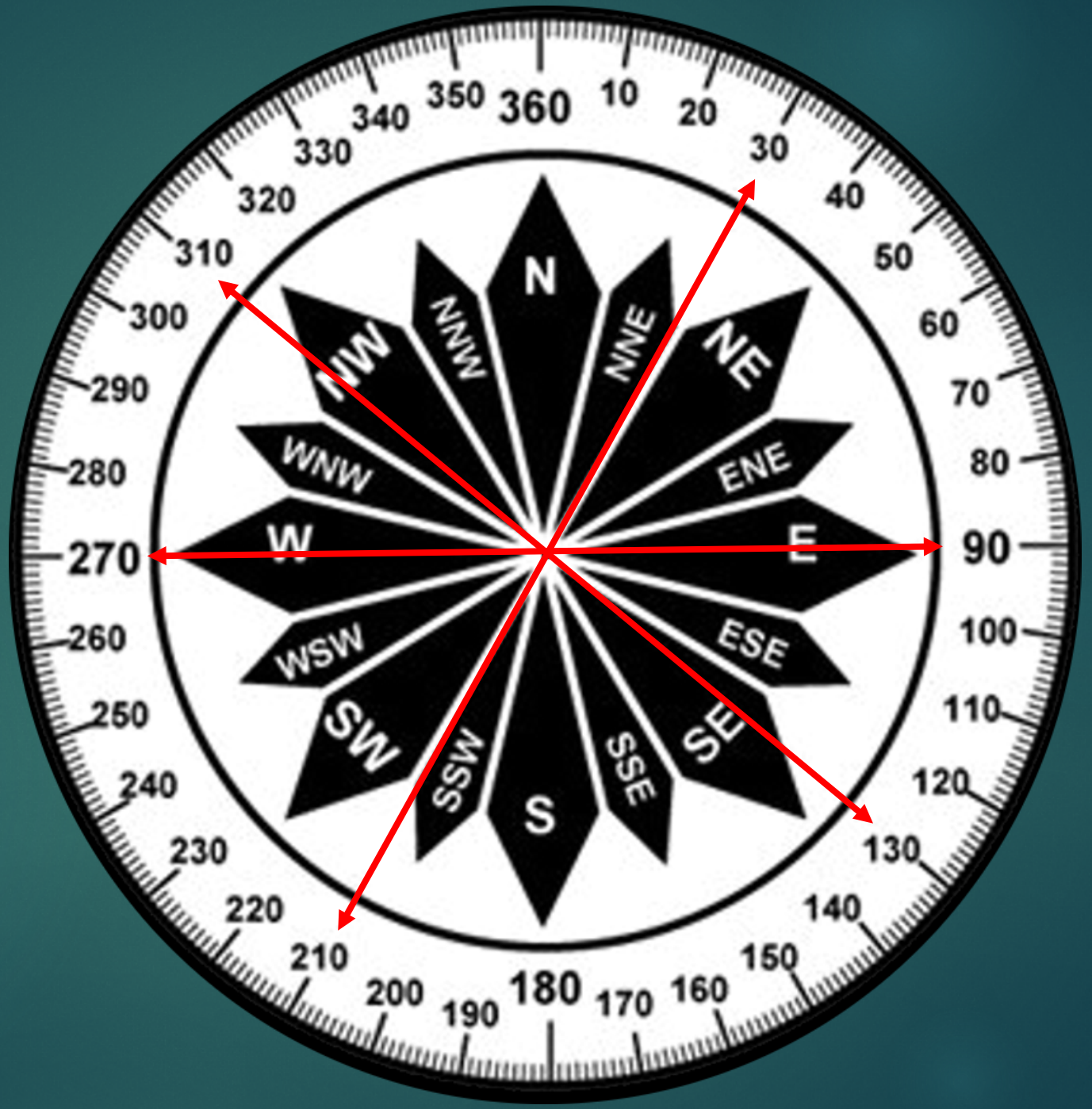
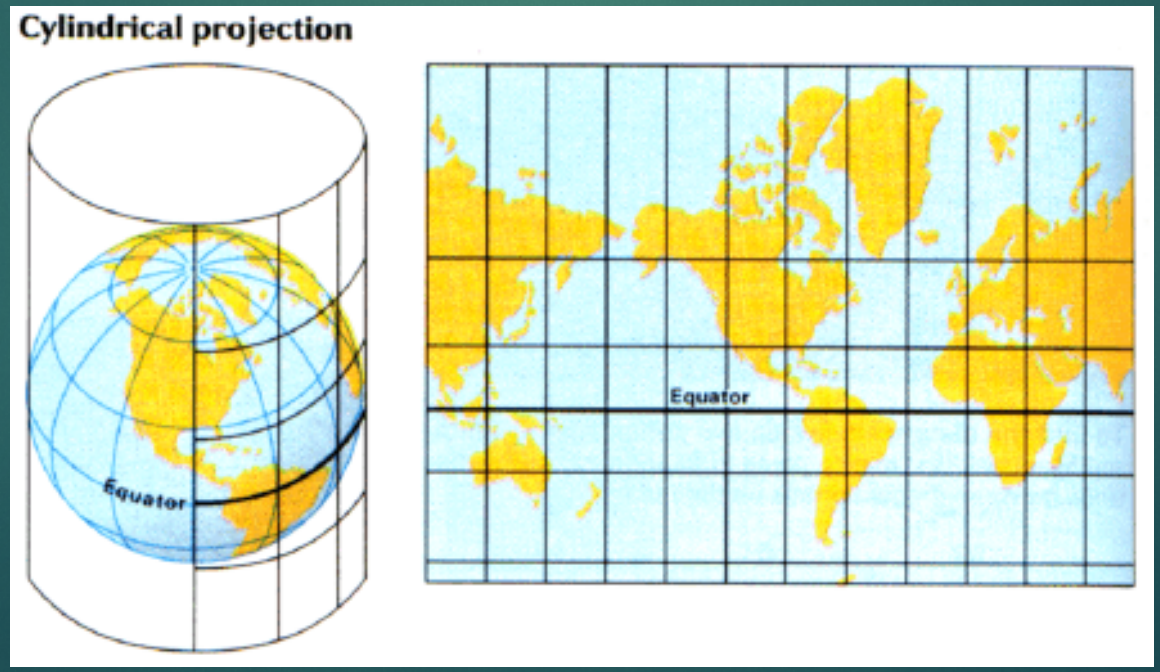


Chart Basics

Coastal Charts are always Mercator projections

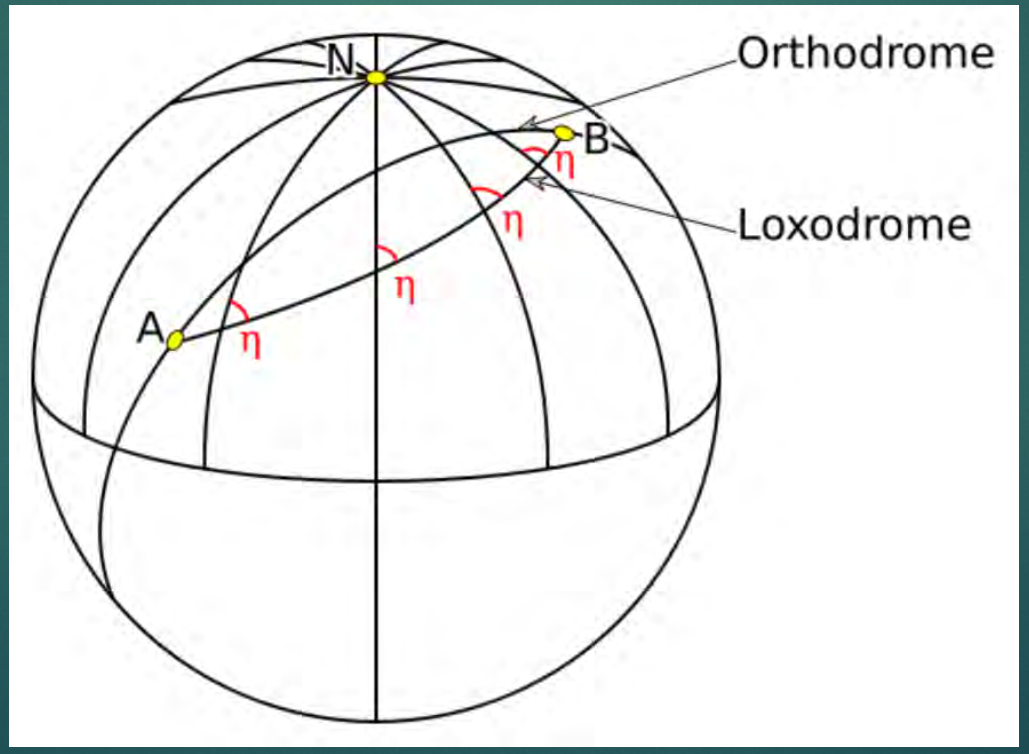
What does that mean?

The earth is projected onto a cylinder so that all latitude and longitude lines are straight and perpendicular



What are the advantages?

- *The chart is a flat plane*
- *A line between two waypoints is a straight line and crosses all meridians at the same angle*
- *This means a constant compass course between points*



Great Circle

Rhumb Line (straight line on a Mercater chart)

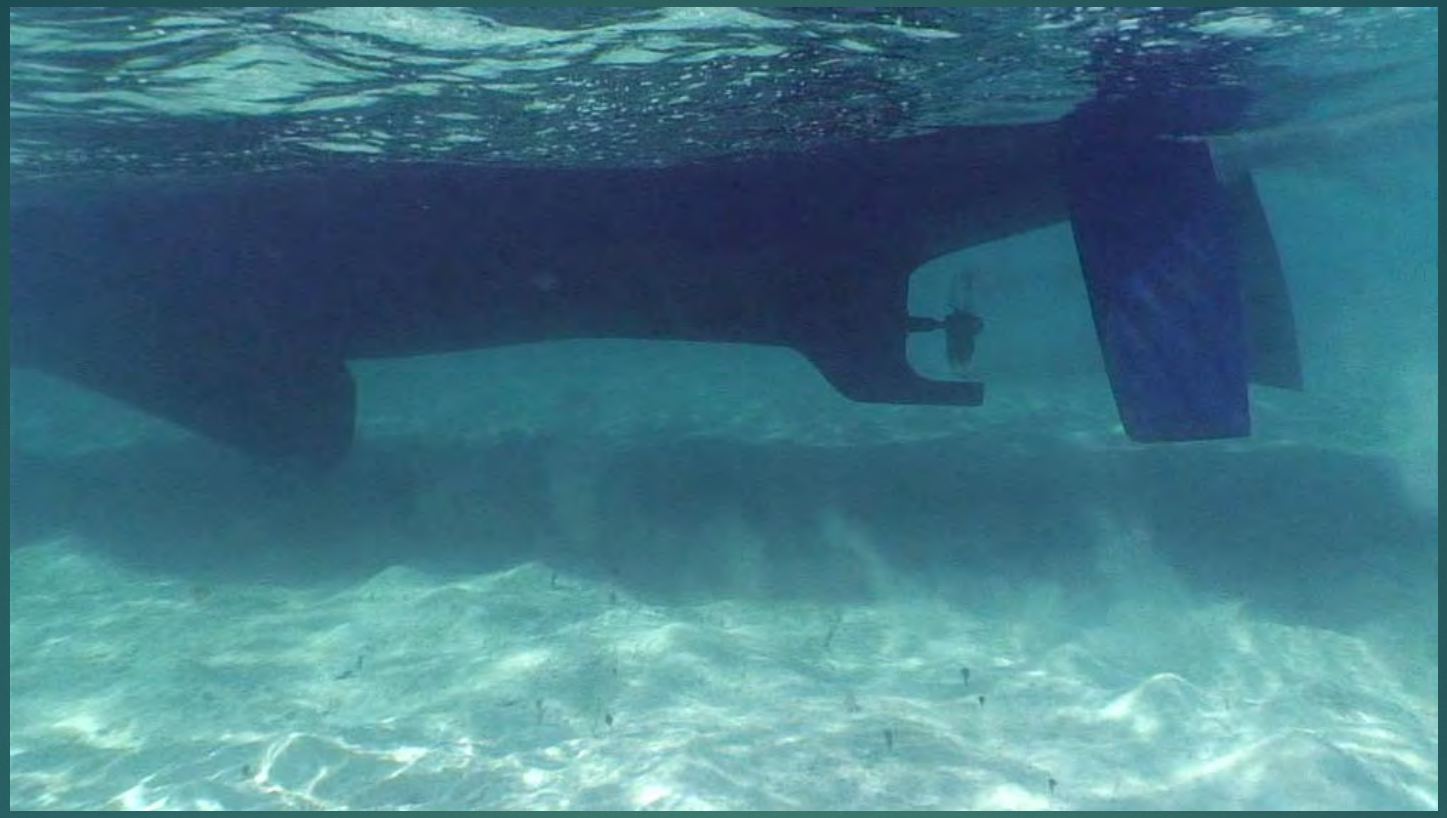
Chart Basics

Why paper charts?

- The navigator can plot bearings, lines of positon and rhumblines
- Much faster overview of region and details (Volvo boat Vesta)
- A critical backup to your electronic charts

The navigator can review planning, progress and strategy at nav-station without disturbing the helm

Chart Basics



- Soundings: fathoms, feet, or meters?
- Latitude, Longitude, scales
- Finding coordinates: seconds vs. tenths of a minute

Chart Basics

- Bathymetry soundings: fathoms (feet) vs meters?

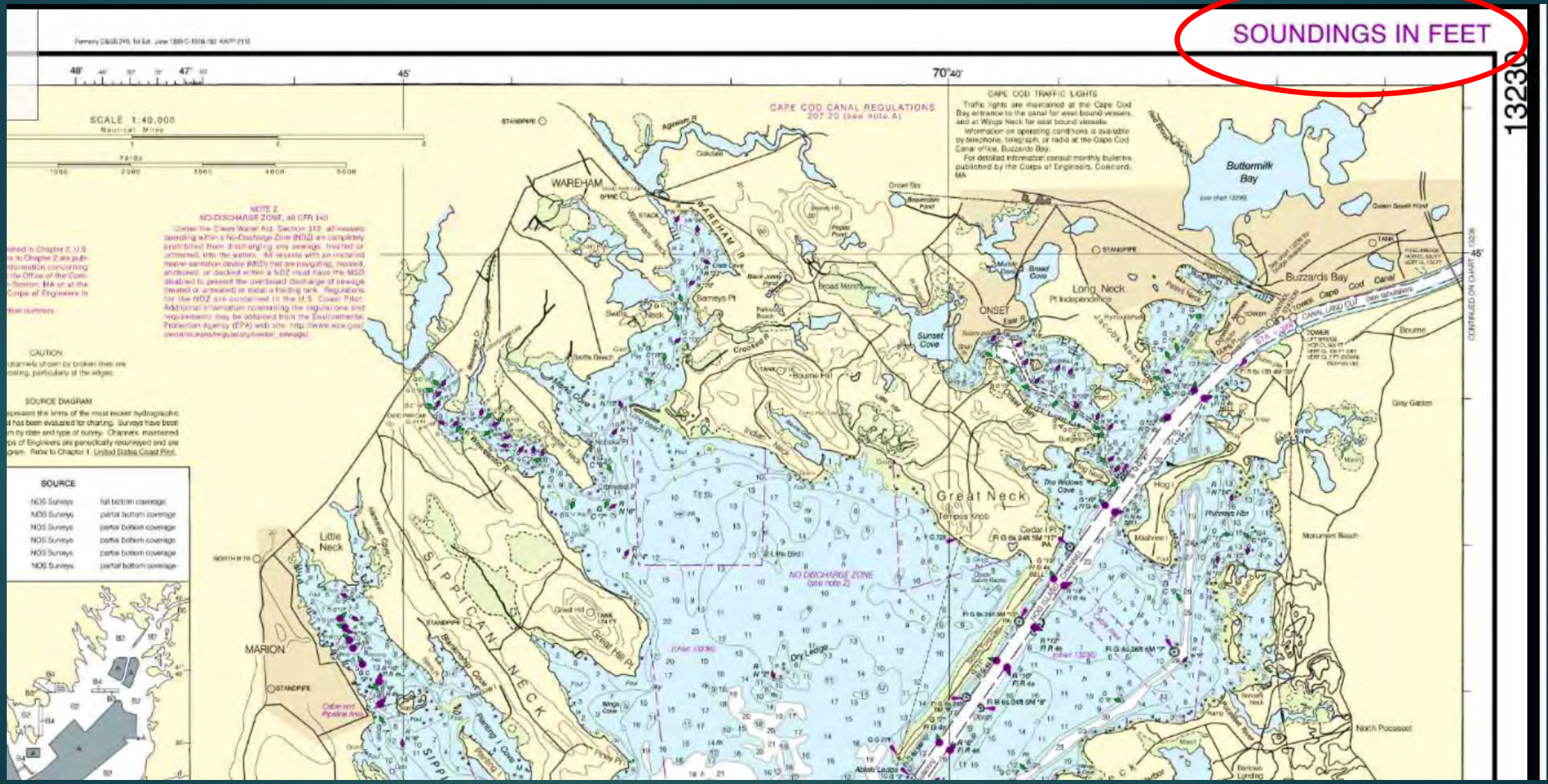


Chart Basics

Scale of measurement: Scale on Chart

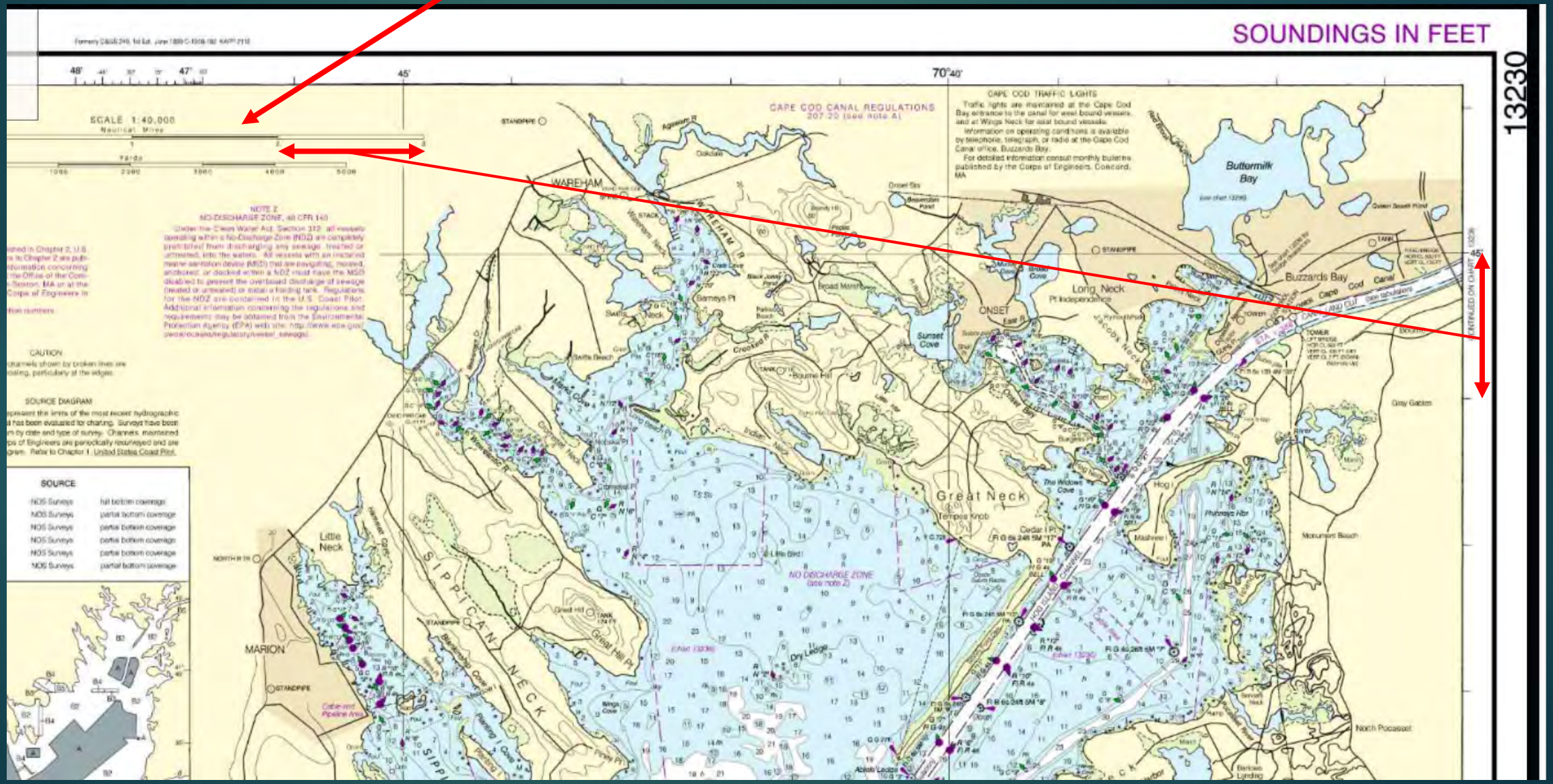


Chart Basics

Scale of measurement: Scale on Chart

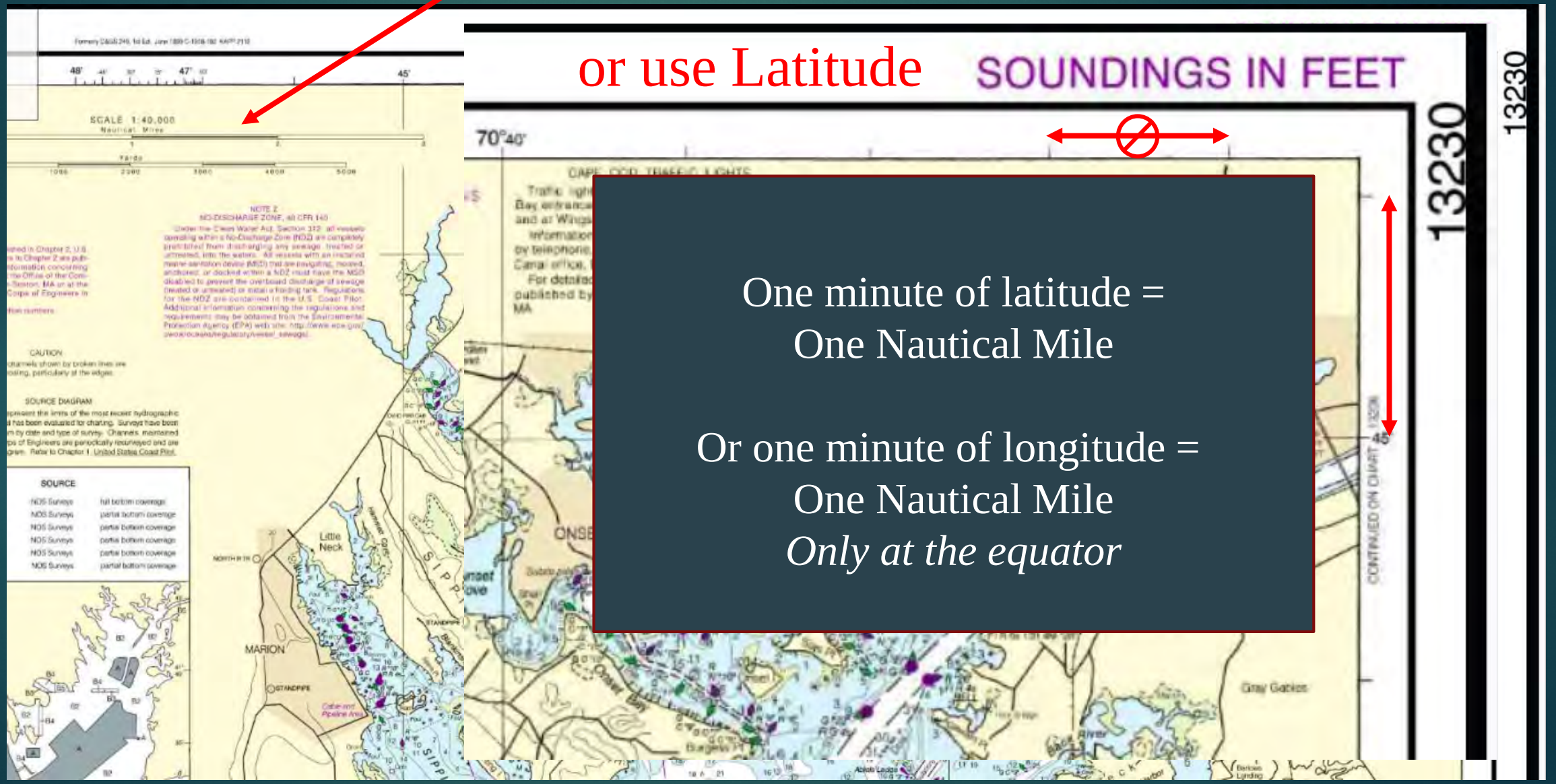
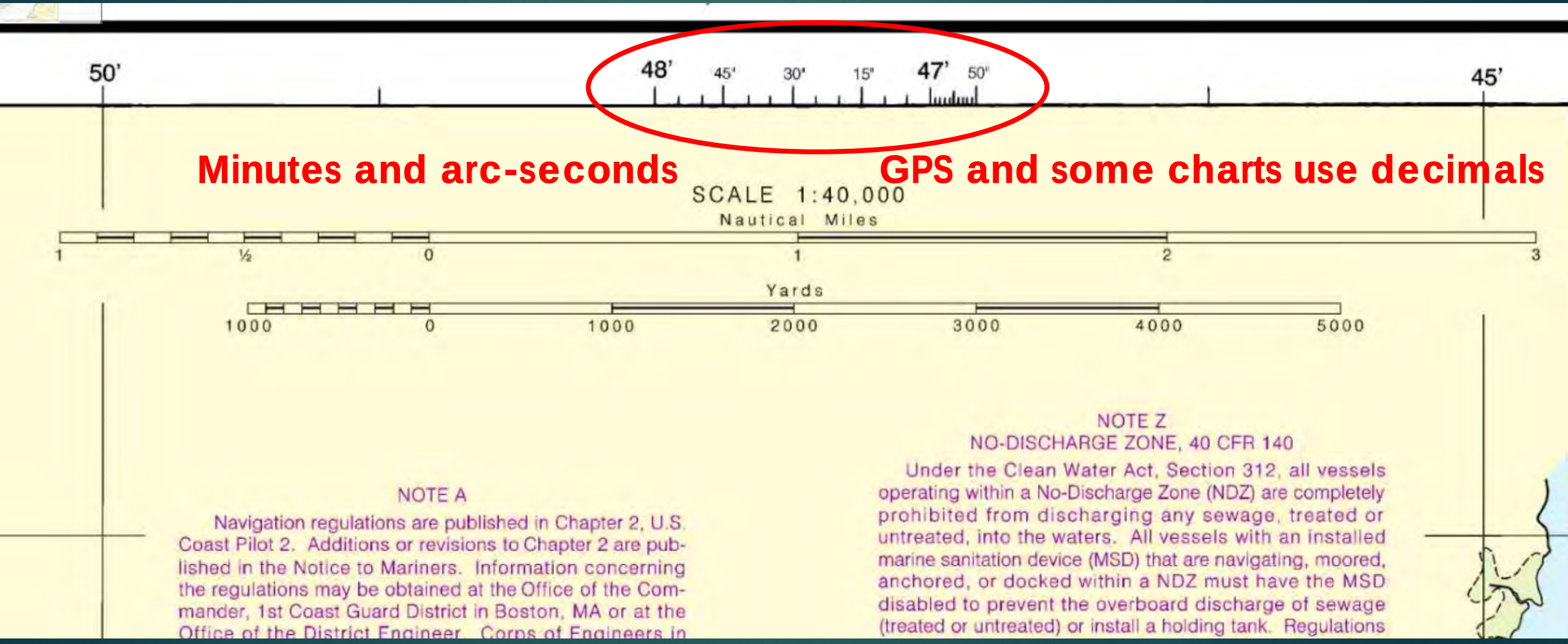


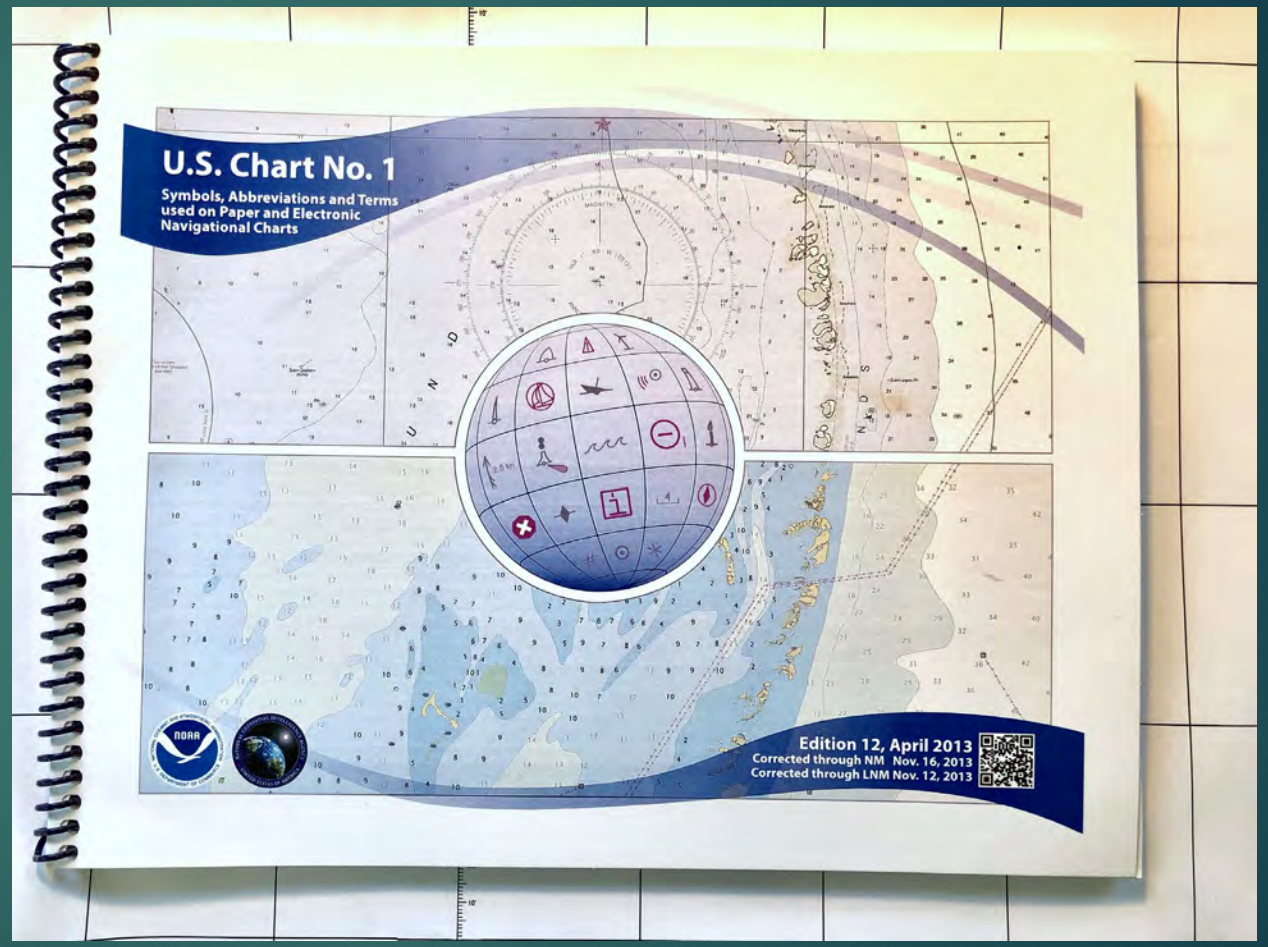
Chart Basics

Scale of measurement: Seconds or Decimal of arc-minutes?



Aids to navigation:

- Buoys
- Lighthouses
- Day marks
- Landmarks



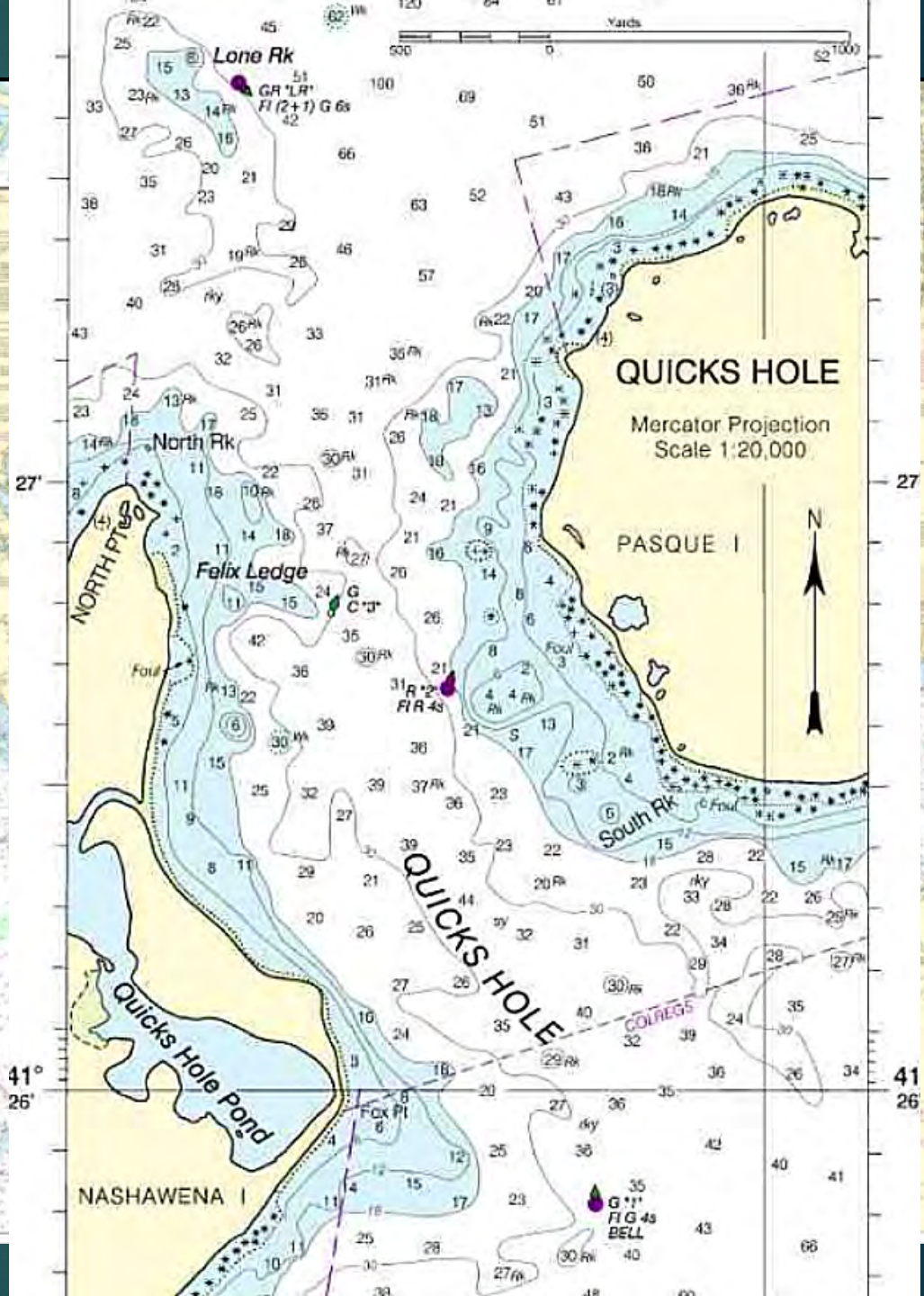
U.S. Chart No. 1
Contains Symbols,
Abbreviations
And Terms used on
Paper and Electronic
Charts

Aids to navigation:

“Red Right Returning”

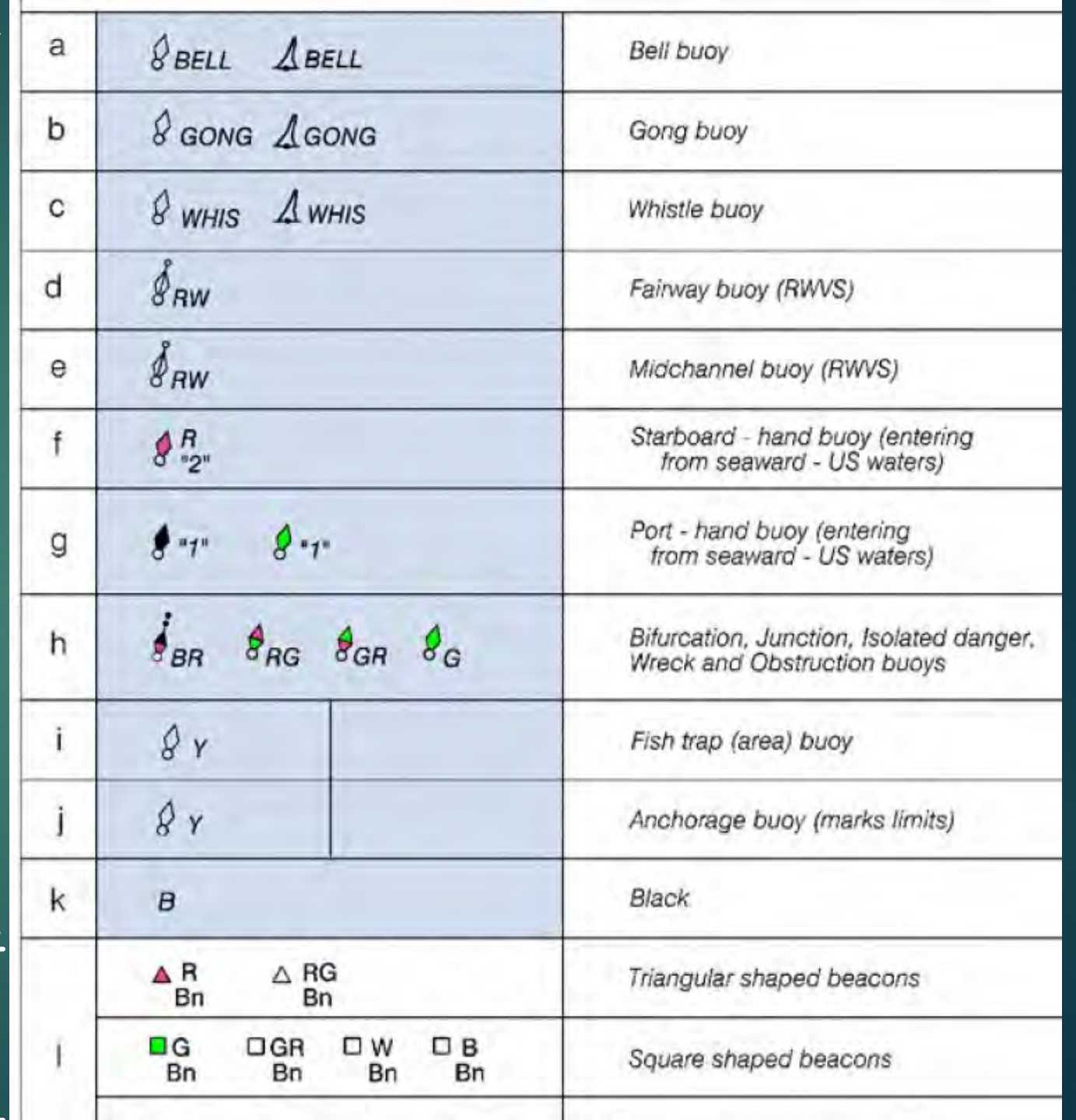
In All Cases Refers to *returning from Seaward*

Chart and other information give context
And may be necessary to understand buoy



Aids to navigation:

- Buoys
- Day marks



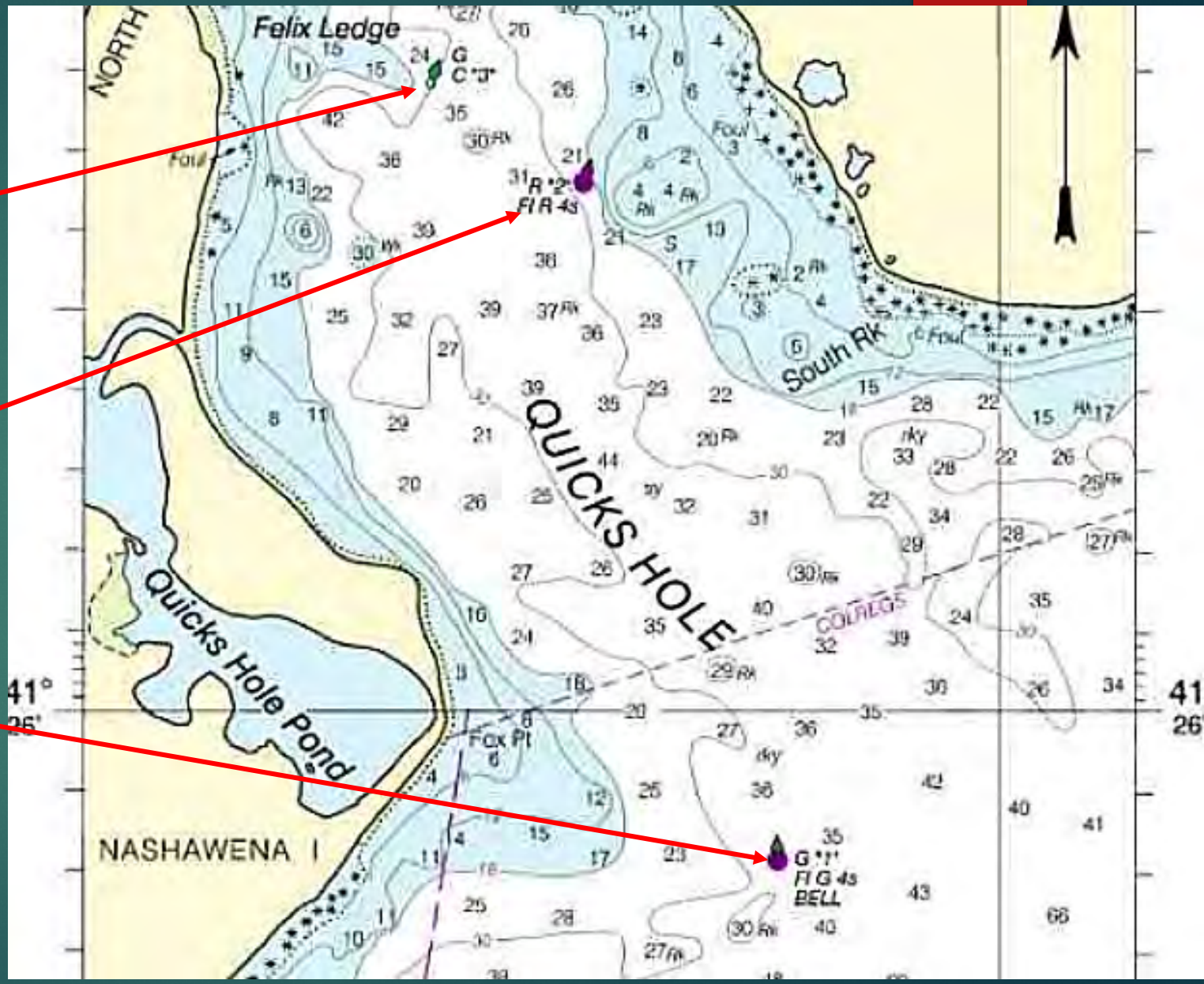
a	BELL BELL	Bell buoy
b	GONG GONG	Gong buoy
c	WHIS WHIS	Whistle buoy
d	RW	Fairway buoy (RWVS)
e	RW	Midchannel buoy (RWVS)
f	R "2"	Starboard - hand buoy (entering from seaward - US waters)
g	"1" "1"	Port - hand buoy (entering from seaward - US waters)
h	BR RG GR G	Bifurcation, Junction, Isolated danger, Wreck and Obstruction buoys
i	Y	Fish trap (area) buoy
j	Y	Anchorage buoy (marks limits)
k	B	Black
l	R Bn RG Bn	Triangular shaped beacons
	G Bn GR Bn W Bn B Bn	Square shaped beacons

Aids to navigation:

Un-lighted buoy

lighted buoy

lighted buoy

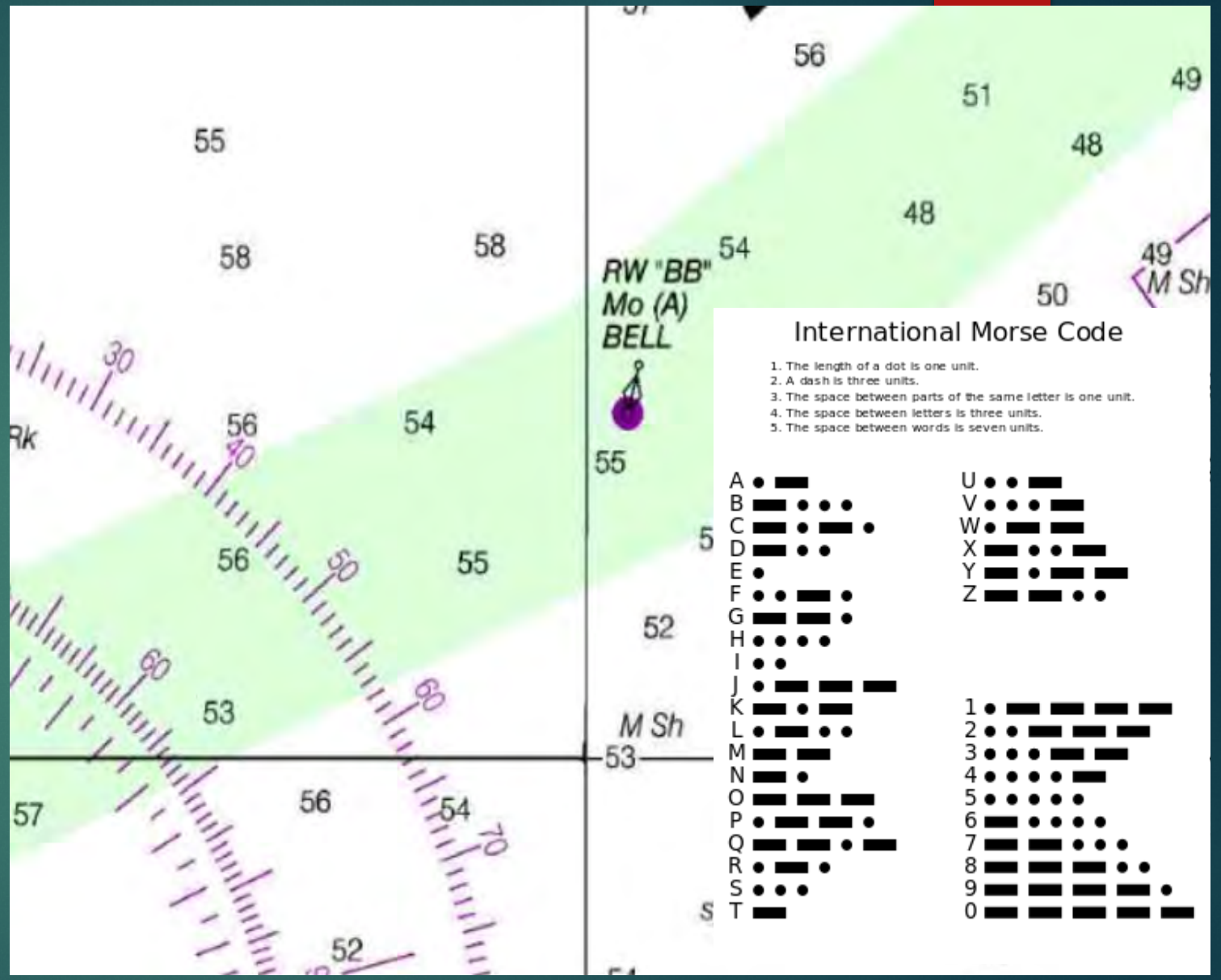


Naming Buoys

Color: RW (vert stripe)
Fairway/mid-channel

Name: ”BB”
Light pattern/Color:
Morse (A)

Sound: Bell



Sample Program

Excerpts

Passage Planning (Navigation)

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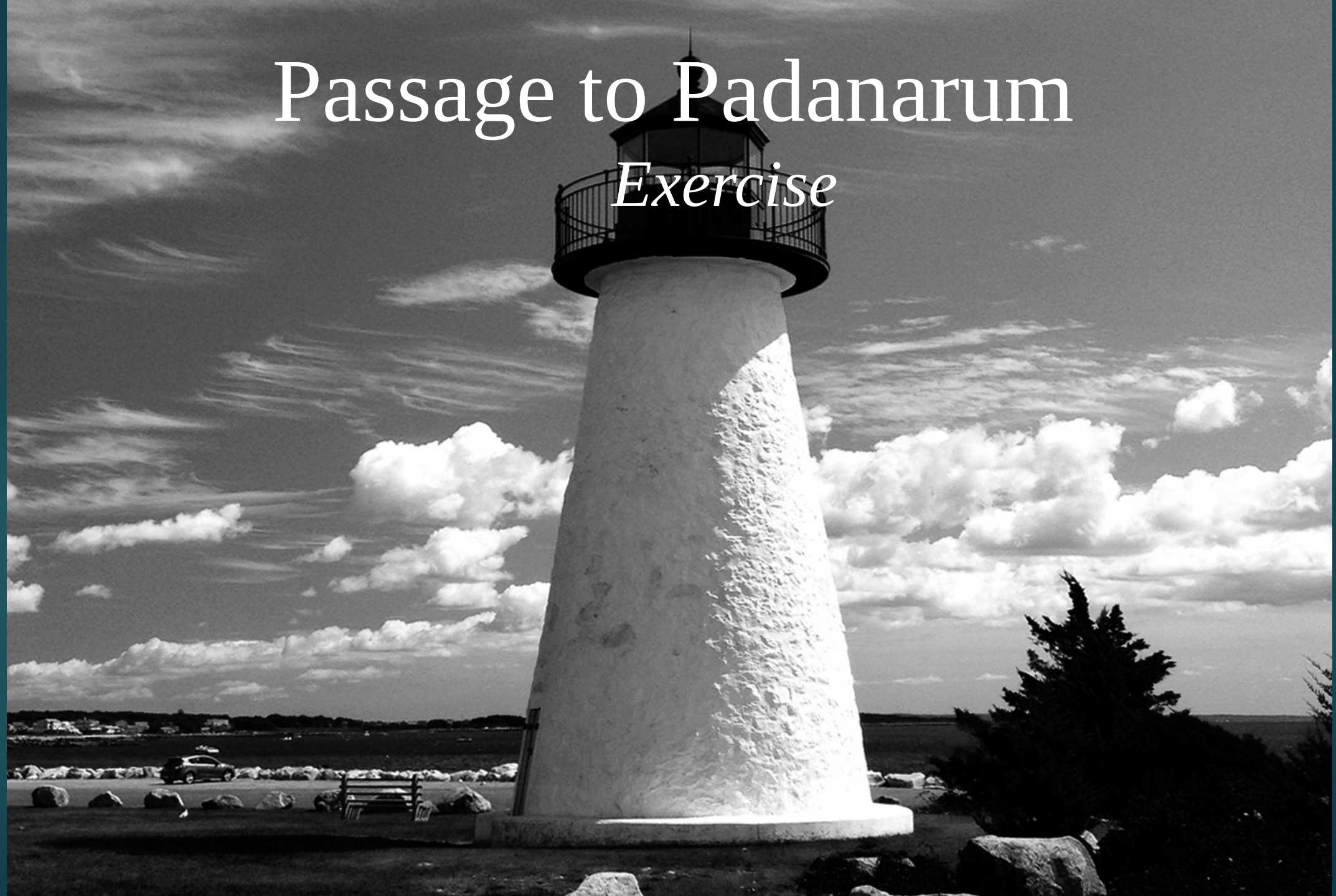
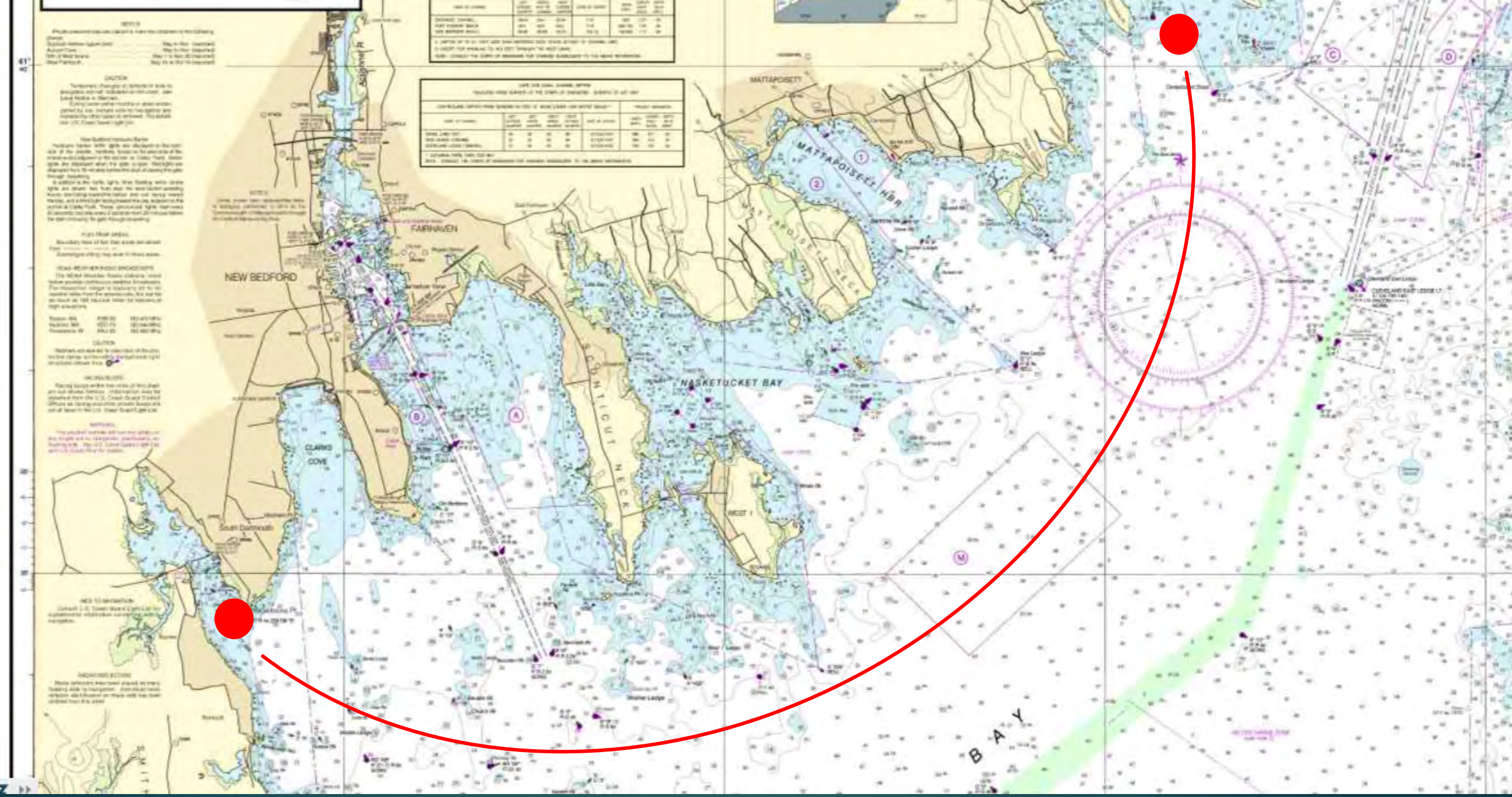
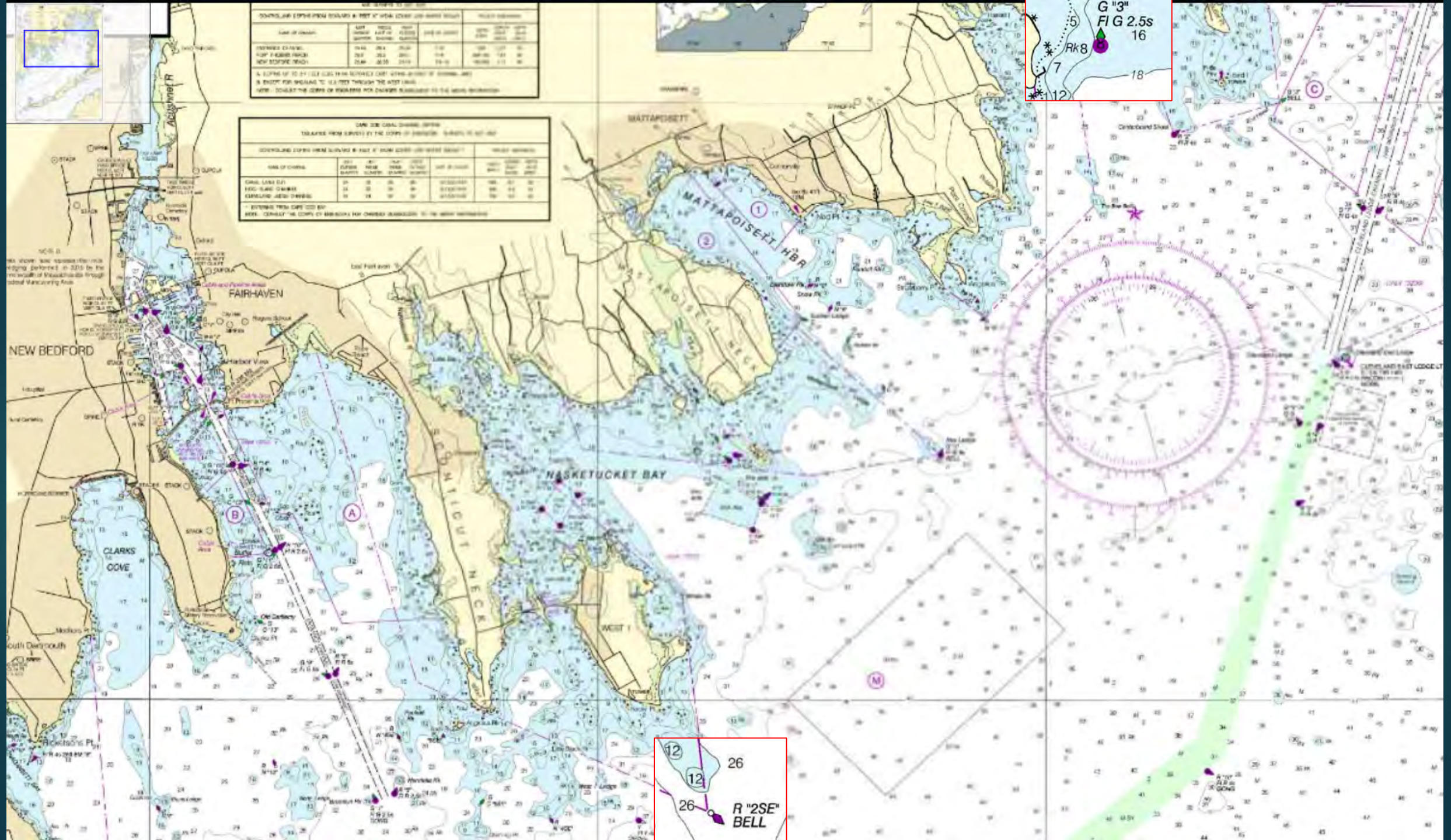
Passage to Padanarum

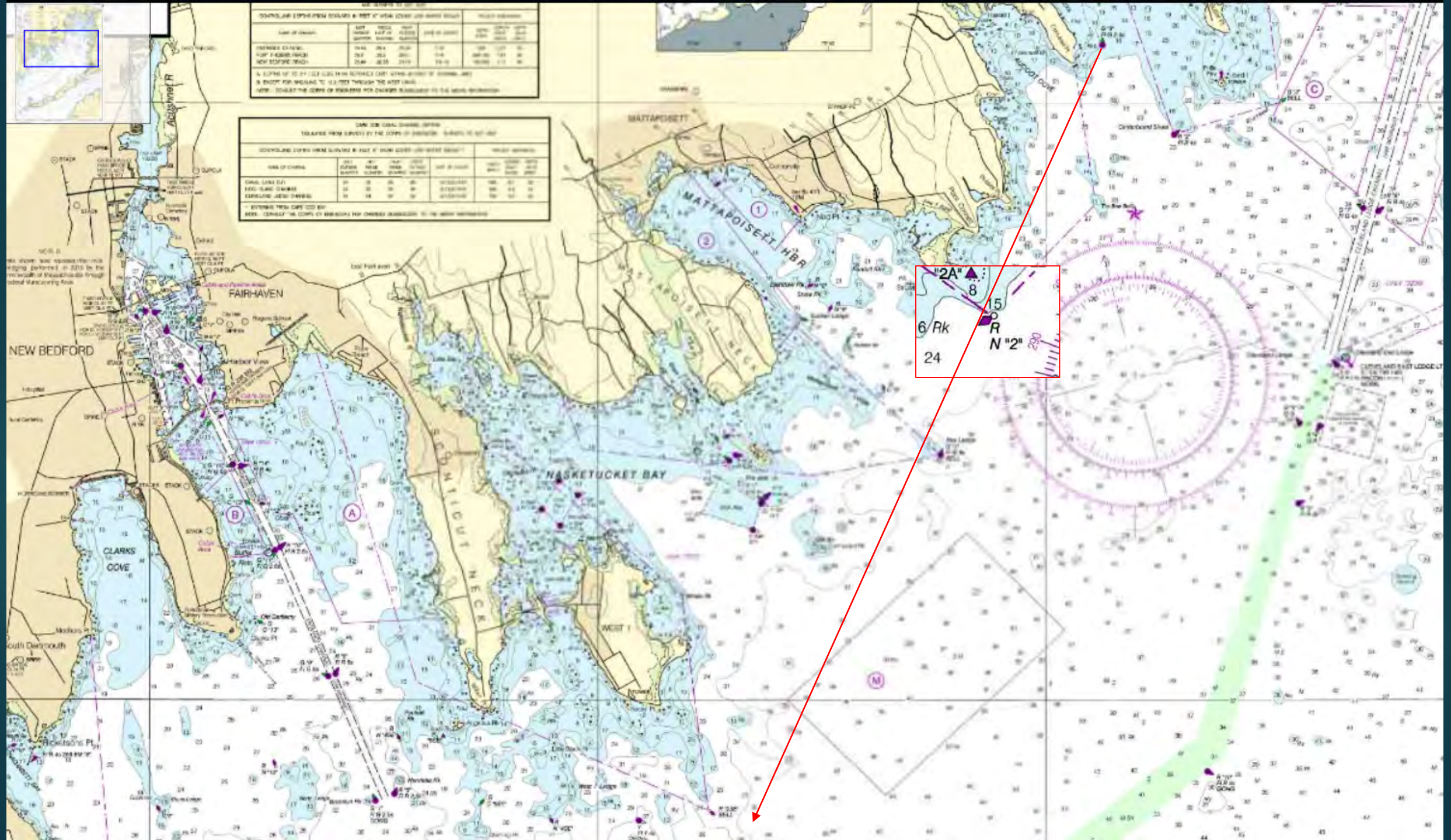
Exercise

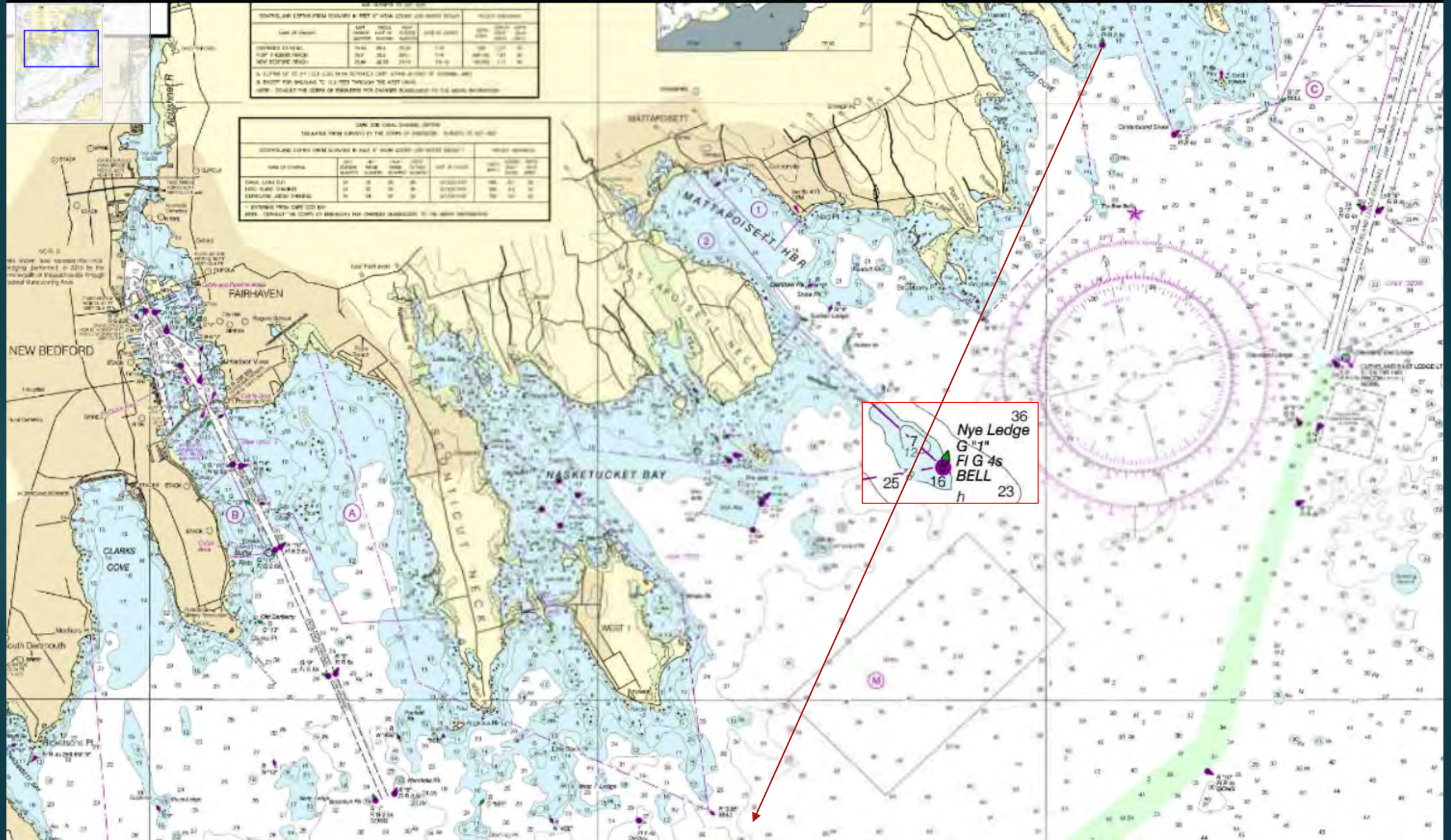



NEW BEDFORD
FAIRHAVEN
MATTAPOISETT
MATTAPOISETT HBR
MATTAPOISETT NECK
POINTICUT NECK
CLARKS COVE
South Dartmouth
NASKETUCKET BAY
BAY

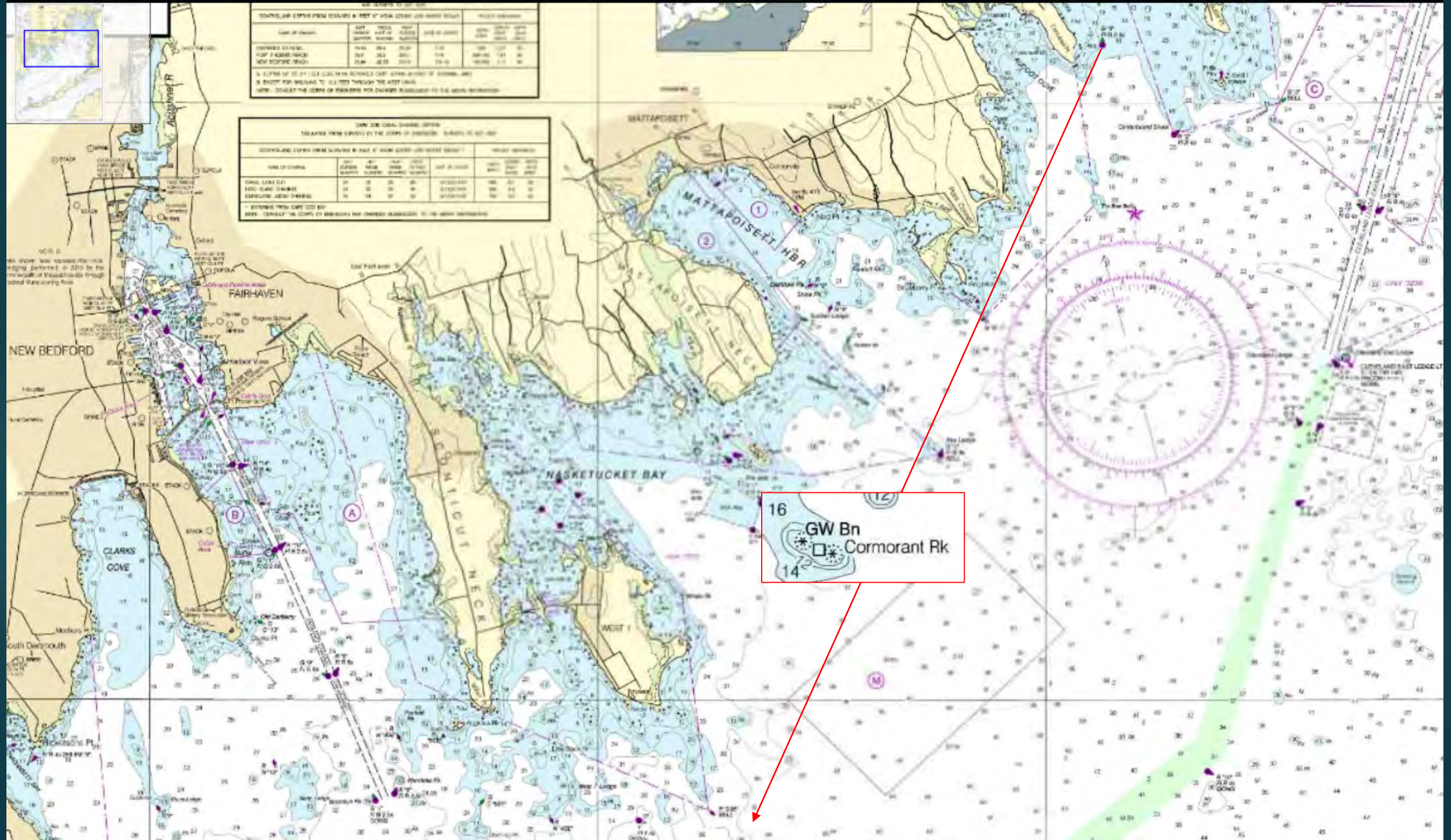


G "3"
Fl G 2.5s
16
Rk 8
7
5
12
18
MATTAPOISETT
MATTAPOISETT HBR
FAIRHAVEN
NEW BEDFORD
NASKETUCKET BAY
CLARKS COVE
WEST 1
12
26
12
26
R "2SE"
BELL

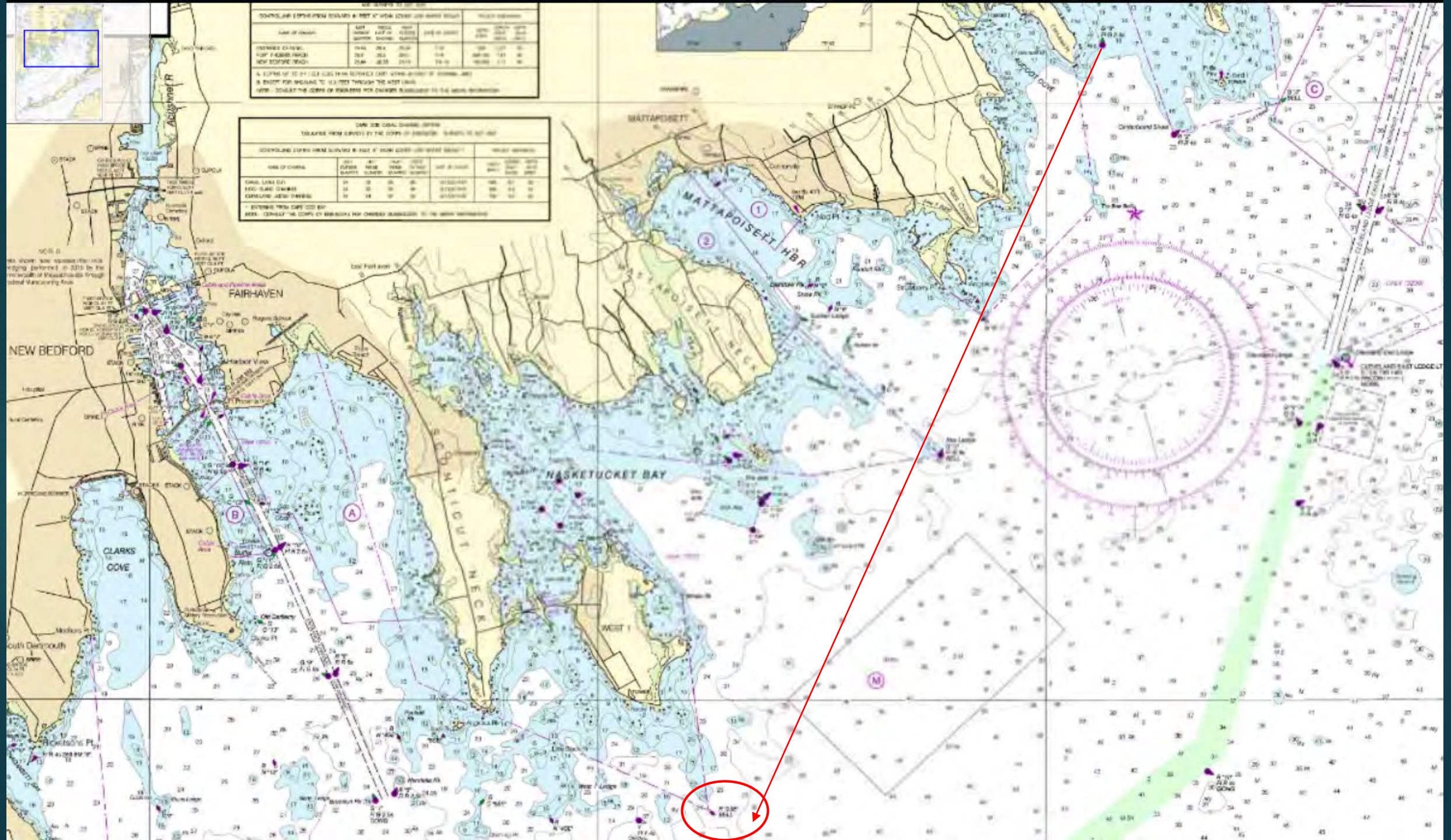

MATTAPOISETT
MATTAPOISETT HBR
MATTAPOISETT NECK
FAIRHAVEN
NEW BEDFORD
CLARKS COVE
APPONEGANSET NECK
BUZZARDS BAY
"2A"
8
15
6 Rk
24
R
N "2"
Acushnet R



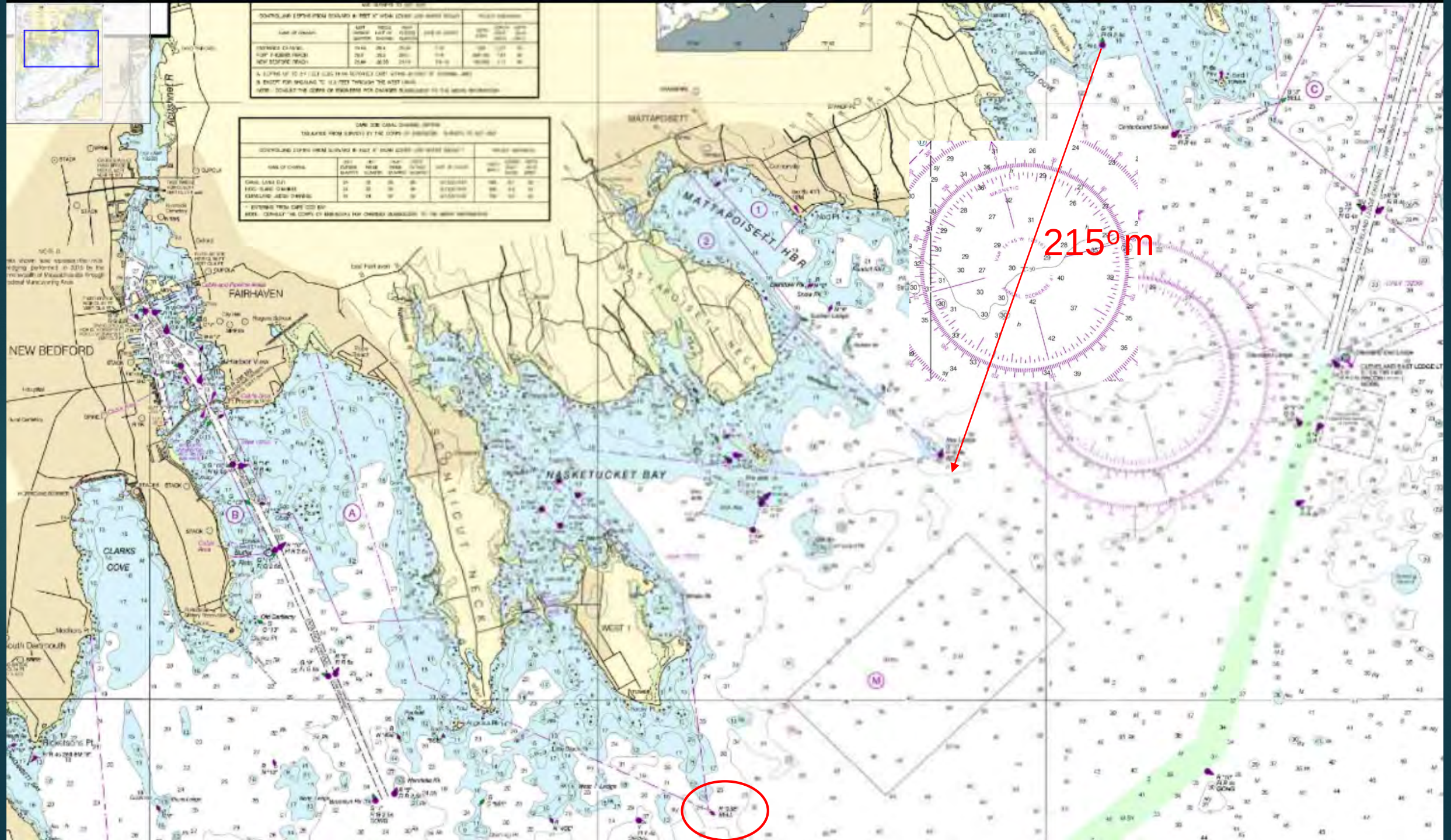
NEW BEDFORD
FAIRHAVEN
MATTAPOISETT
MATTAPOISETT HBR
NASKETUCKET BAY
CLARKS COVE
Acushnet R
Nye Ledge
G "1"
Fl G 4s
BELL
36
7
12
25
16
23
h

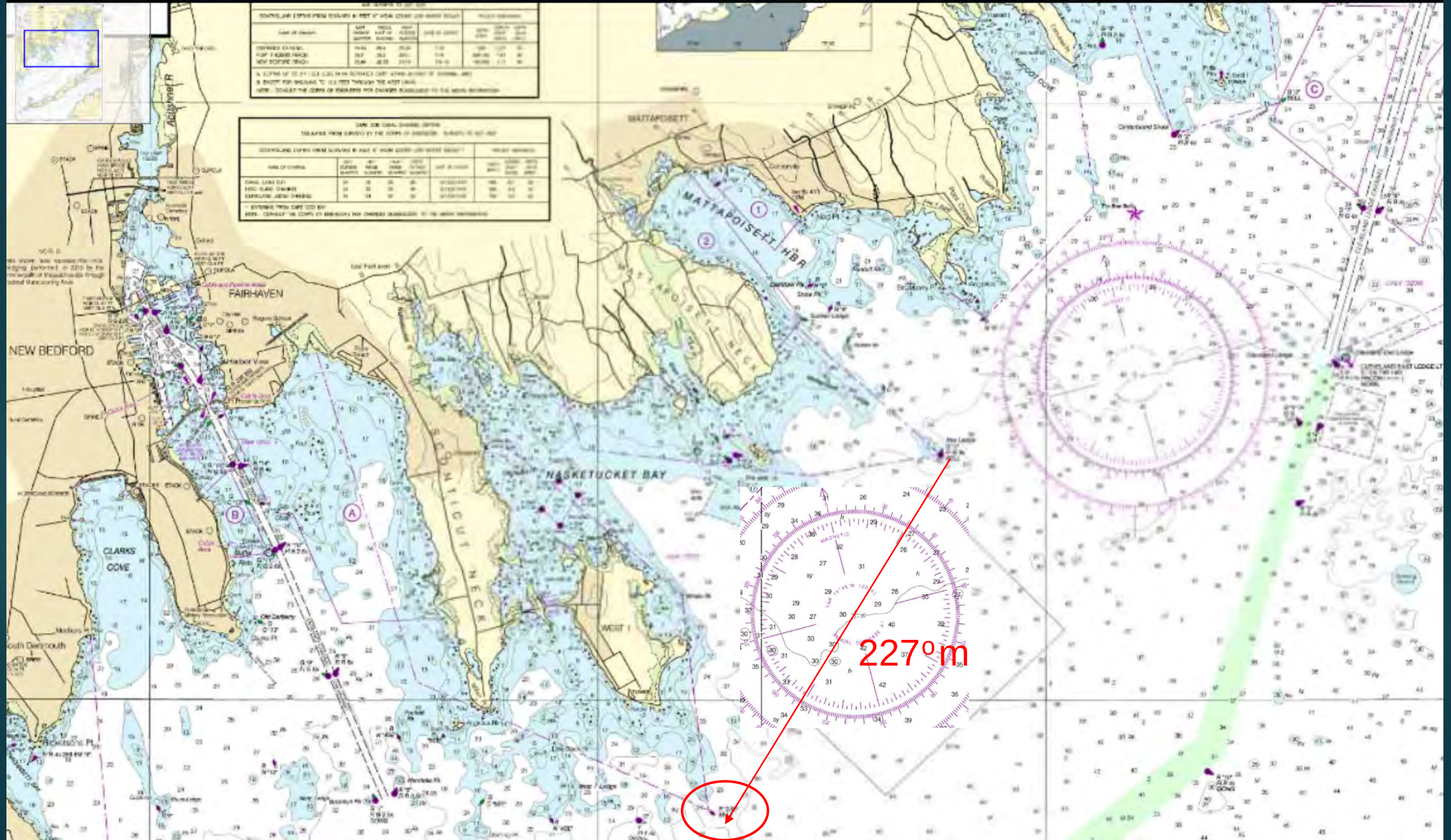


16
GW Bn
Cormorant Rk
14
NEW BEDFORD
FAIRHAVEN
MATTAPOISETT
MATTAPOISETT HBR
NASKETUCKET BAY
CLARKS COVE
Acushnet R

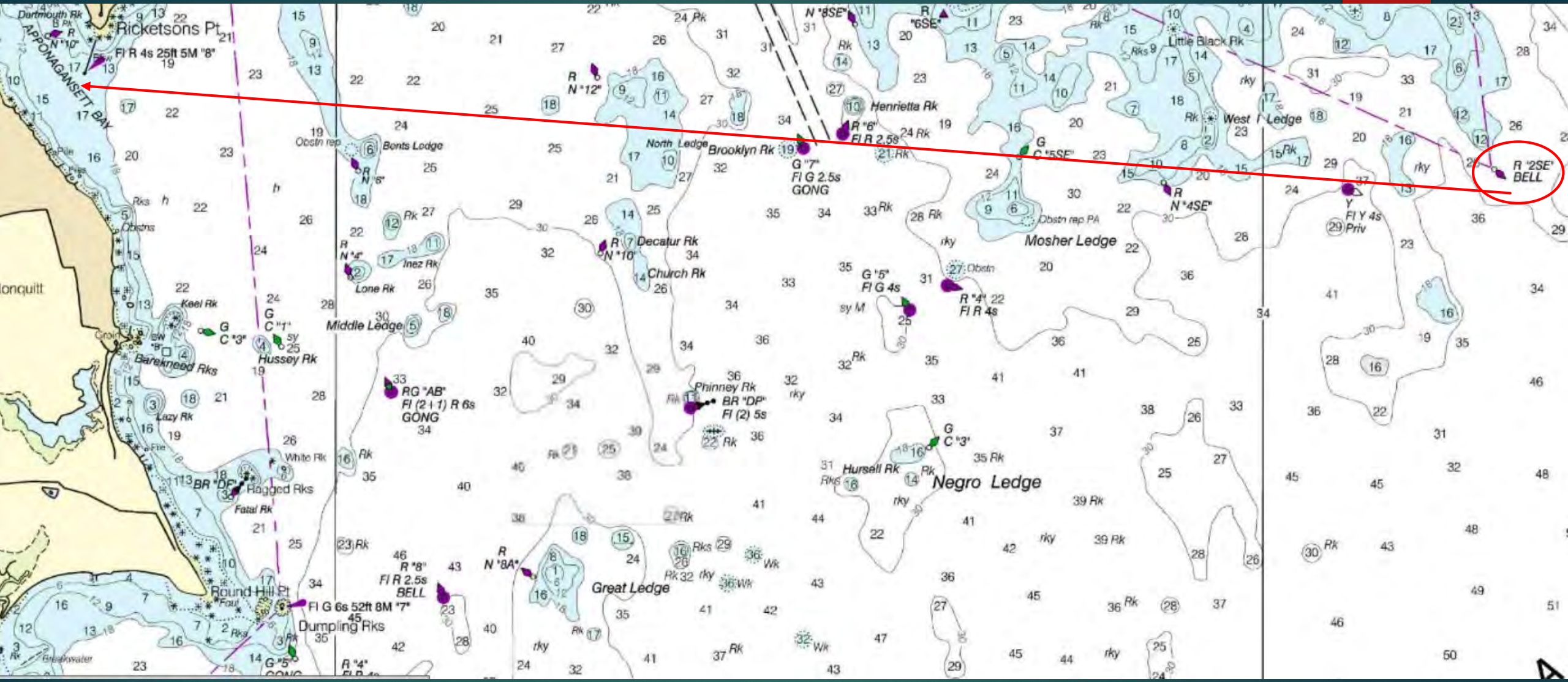


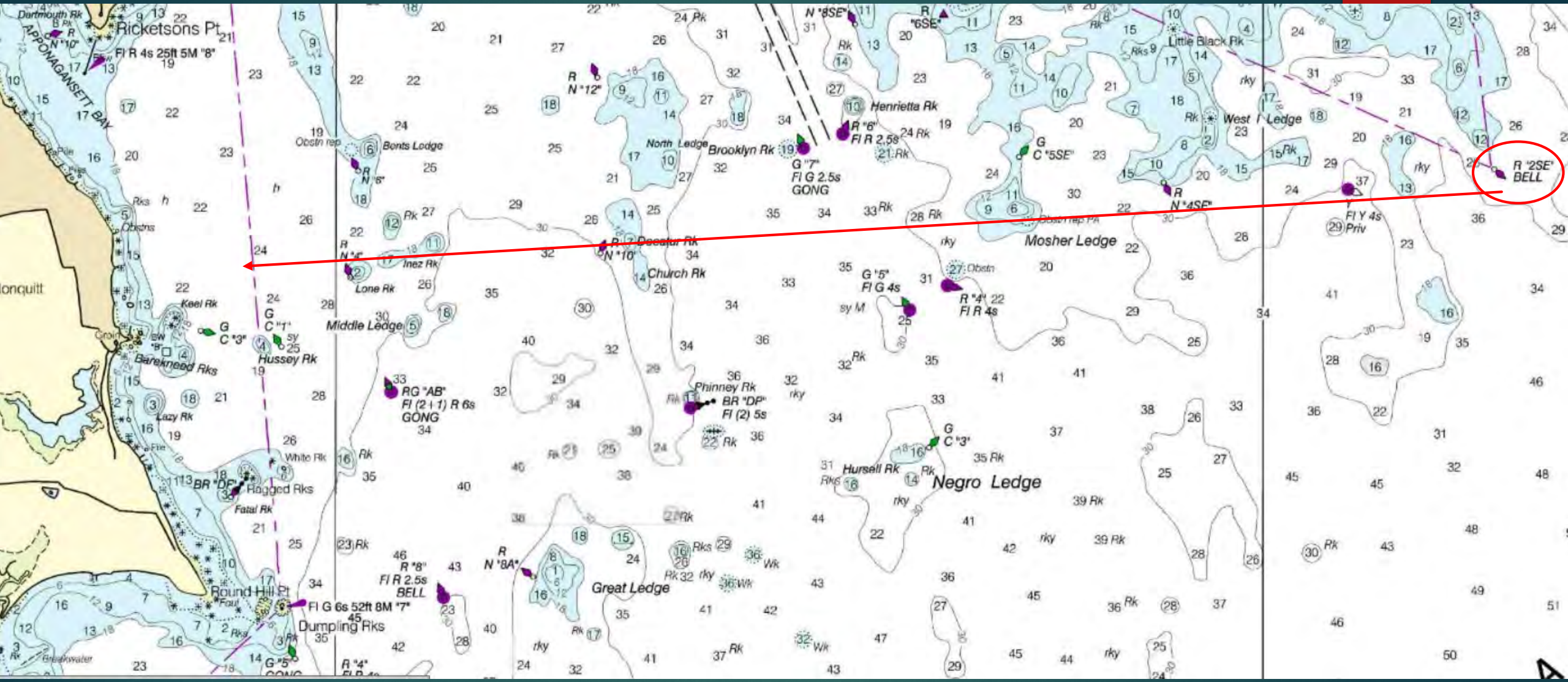
MATTAPOISETT
MATTAPOISETT HBR
FAIRHAVEN
NEW BEDFORD
NASKETUCKET BAY
CLARKS COVE
Acushnet R
Rickettsons Pt


215°m
NEW BEDFORD
FAIRHAVEN
MATTAPOISETT
MATTAPOISETT HBR
NASKETUCKET BAY
CLARKS COVE
Acushnet R
Rickettsons Pt
WEST 1

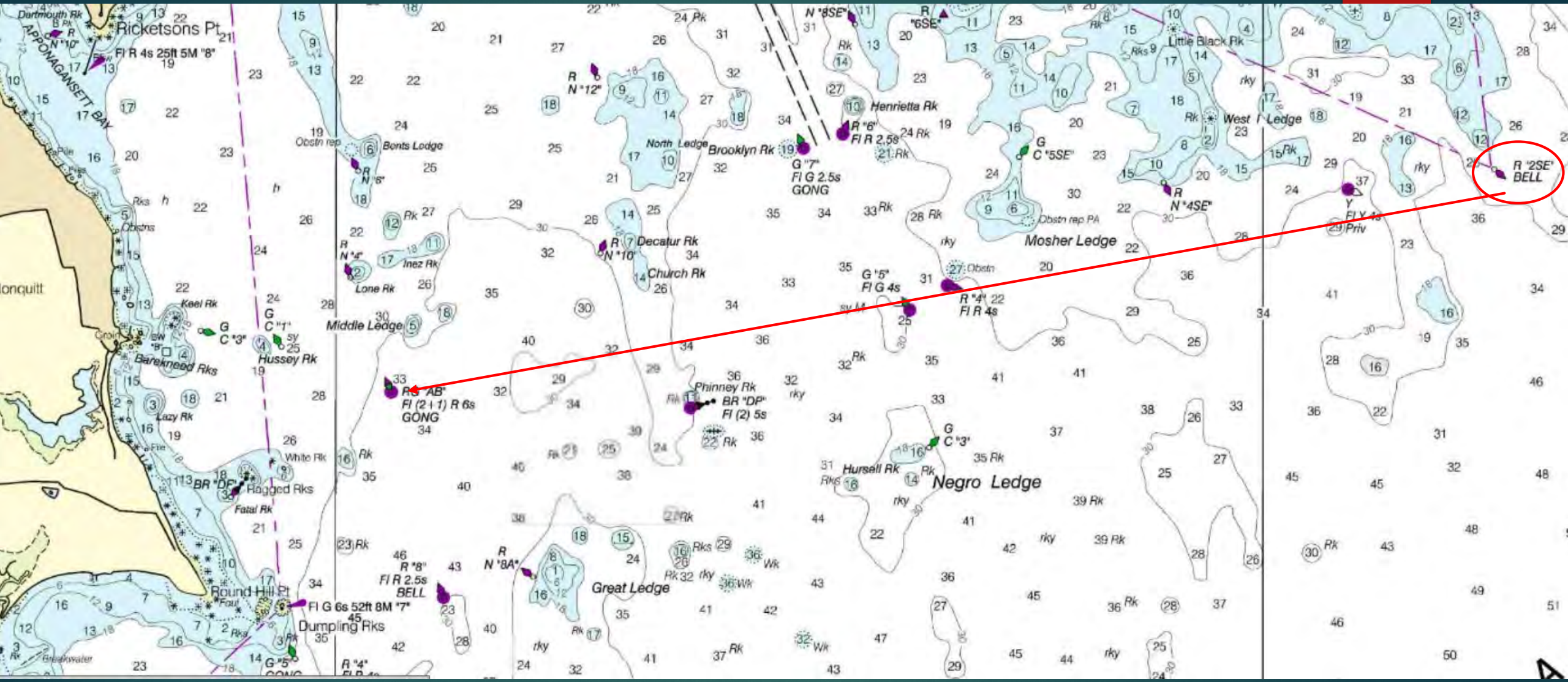


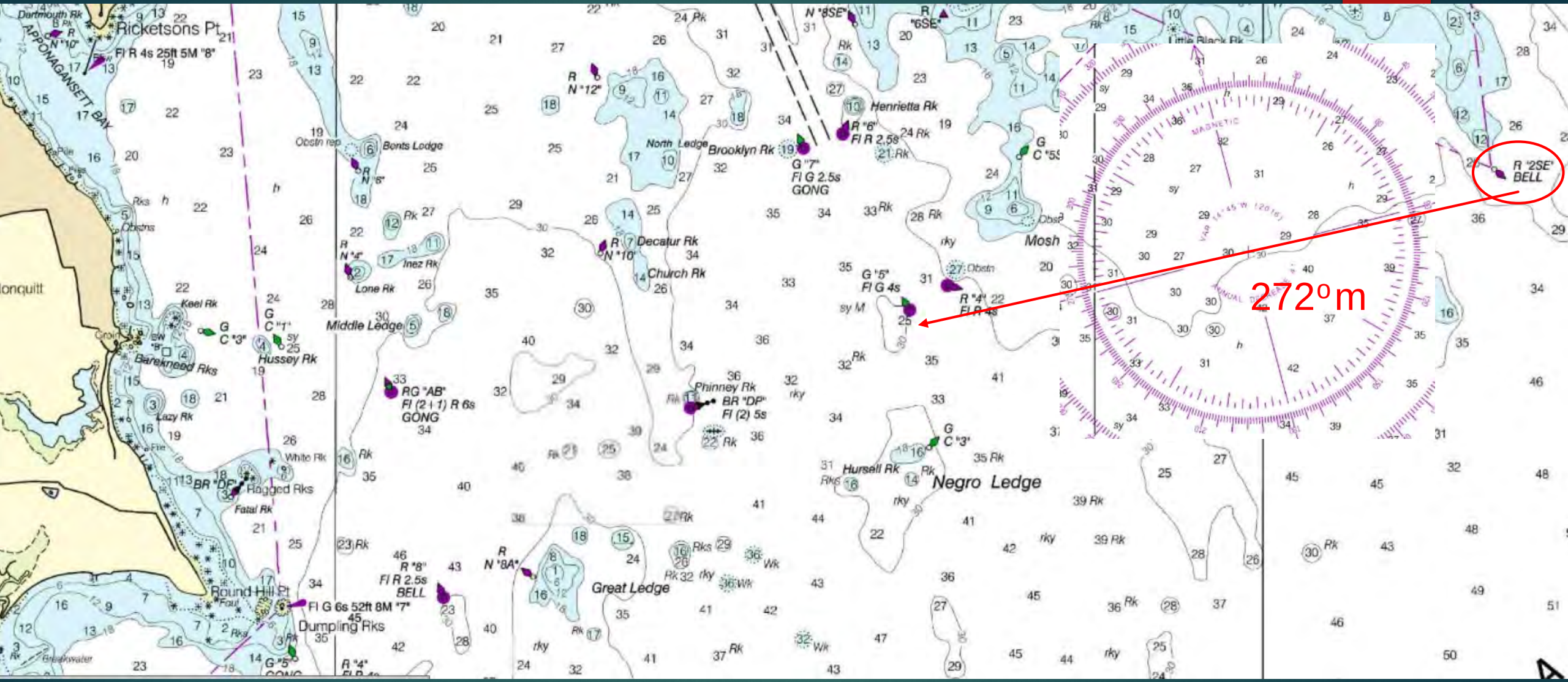
227°m
NEW BEDFORD
FAIRHAVEN
MATTAPOISETT
MATTAPOISETT HBR
NASKETUCKET BAY
CLARKS COVE
Acushnet R
Rickettsons Pt

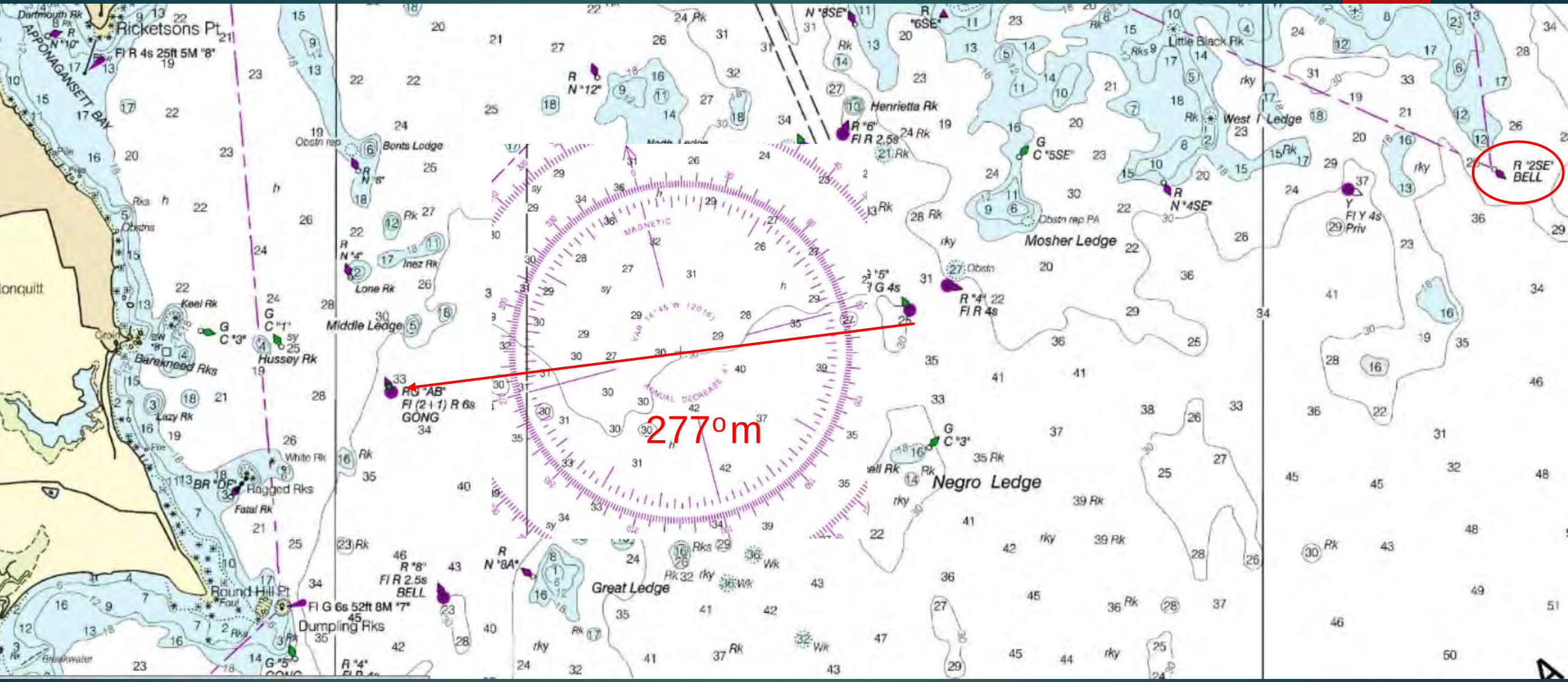

Ricketsons Pt
Fl R 4s 25ft 5M "8"
APPONAGANSETT BAY
Dartmouth Rk
Bonts Ledge
Obstn rep
North Ledge
Brooklyn Rk
G "7"
Fl G 2.5s
GONG
Henrietta Rk
R "6"
Fl R 2.5s
Little Black Rk
West I Ledge
G "5SE"
R "2SE"
BELL
R "4SE"
Y
Fl Y 4s
Priv
Mosher Ledge
Obstn rep PA
Decatur Rk
Church Rk
Inez Rk
Lone Rk
Middle Ledge
G "5"
Fl G 4s
R "4"
Fl R 4s
Keel Rk
G "3"
G "1"
Hussey Rk
Barekneed Rks
Lazy Rk
RG "AB"
Fl (2+1) R 6s
GONG
Phinney Rk
BR "DP"
Fl (2) 5s
White Rk
BR "DP"
Ragged Rks
Fatal Rk
Hursell Rk
Negro Ledge
G "3"
Round Hill Pt
Fl G 6s 52ft 8M "7"
Dumpling Rks
R "8"
Fl R 2.5s
BELL
R "8A"
Great Ledge
Breakwater

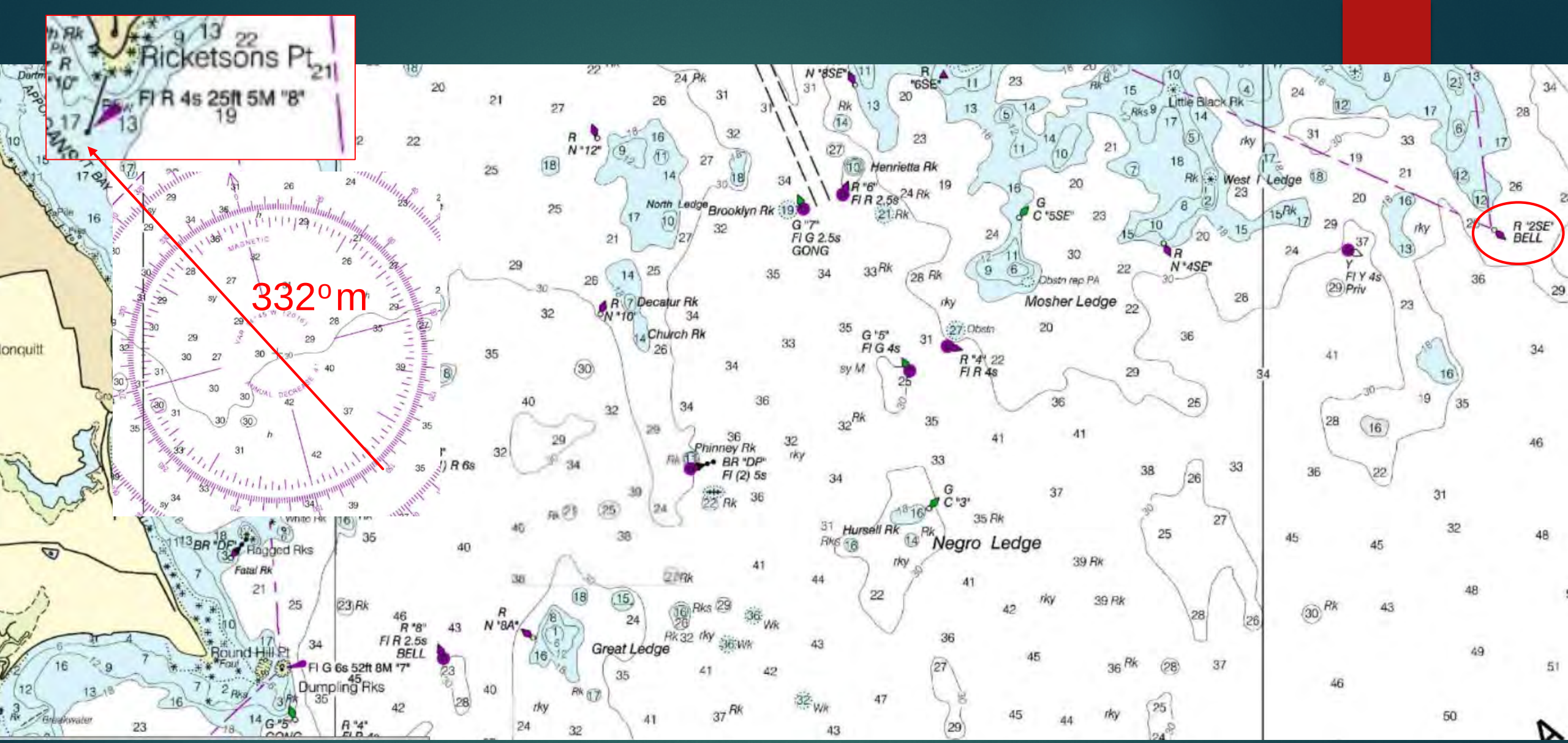


Ricketsons Pt
Fl R 4s 25ft 5M "8"
APPONAGANSETT BAY
Dartmouth Rk
Bonts Ledge
North Ledge
Brooklyn Rk
G "7"
Fl G 2.5s
GONG
Henrietta Rk
R "6"
Fl R 2.5s
Little Black Rk
West Ledge
R "2SE"
BELL
Mosher Ledge
Fl Y 4s
Priv
Decatur Rk
Church Rk
Inez Rk
Lone Rk
Middle Ledge
Keel Rk
Barekneed Rks
Hussey Rk
Lazy Rk
White Rk
Ragged Rks
Fatal Rk
RG "AB"
Fl (2+1) R 6s
GONG
Phinney Rk
BR "DP"
Fl (2) 5s
G "5"
Fl G 4s
R "4"
Fl R 4s
Hursell Rk
Negro Ledge
Round Hill Pt
Fl G 6s 52ft 8M "7"
Dumpling Rks
R "8"
Fl R 2.5s
BELL
Great Ledge


Ricketsons Pt
Fl R 4s 25ft 5M "8"
APPONAGANSETT BAY
Dartmouth Rk
Bonts Ledge
North Ledge
Brooklyn Rk
G "7"
Fl G 2.5s
GONG
Henrietta Rk
R "6"
Fl R 2.5s
G "5SE"
Little Black Rk
West I Ledge
R "2SE"
BELL
R "12"
R "8SE"
R "6SE"
R "4SE"
Mosher Ledge
Obstn rep PA
Decatur Rk
R "10"
Church Rk
Inez Rk
Lone Rk
Middle Ledge
G "5"
Fl G 4s
R "4"
Fl R 4s
Keel Rk
G "3"
G "1"
Hussey Rk
Barekneed Rks
Lazy Rk
White Rk
BR "DP"
Ragged Rks
Fatal Rk
RG "AB"
Fl (2+1) R 6s
GONG
Phinney Rk
BR "DP"
Fl (2) 5s
Hursell Rk
Negro Ledge
Great Ledge
R "8"
Fl R 2.5s
BELL
R "8A"
Round Hill Pt
Fl G 6s 52ft 8M "7"
Dumpling Rks
G "5"
Y
Fl Y 4s
Priv


Ricketsons Pt
Fl R 4s 25ft 5M "8"
APPONAGANSETT BAY
Bonts Ledge
North Ledge
Brooklyn Rk
G "7"
Fl G 2.5s
GONG
Henrietta Rk
R "6"
Fl R 2.5s
Decatur Rk
N "10"
Church Rk
Inez Rk
Lone Rk
Middle Ledge
Keel Rk
Barekneed Rks
Hussey Rk
Lazy Rk
White Rk
Ragged Rks
Fatal Rk
Round Hill Pt
Fl G 6s 52ft 8M "7"
Dumpling Rks
RG "AB"
Fl (2+1) R 6s
GONG
Phinney Rk
BR "DP"
Fl (2) 5s
Great Ledge
R "8"
Fl R 2.5s
BELL
Hursell Rk
Negro Ledge
G "5"
Fl G 4s
R "2SE"
BELL
272°m


Ricketsons Pt
Fl R 4s 25ft 5M "8"
APPONAGANSETT BAY
Dartmouth Rk
Bonts Ledge
Inez Rk
Lone Rk
Middle Ledge
Keel Rk
Barekneed Rks
Hussey Rk
Lazy Rk
White Rk
Ragged Rks
Fatal Rk
Round Hill Pt
Fl G 6s 52ft 8M "7"
Dumpling Rks
Great Ledge
Henrietta Rk
Little Black Rk
West Ledge
Mosher Ledge
Negro Ledge
R "2SE" BELL
277°m



Ricketsons Pt
Fl R 4s 25ft 5M "8"
332°m
Brooklyn Rk
North Ledge
Henrietta Rk
Decatur Rk
Church Rk
Phinney Rk
Mosher Ledge
Little Black Rk
West Ledge
Hursell Rk
Negro Ledge
Great Ledge
Ragged Rks
Fatal Rk
Round Hill Pt
Dumpling Rks
Fl G 6s 52ft 8M "7"
R "2SE" BELL

Sample Program

Excerpts

Introduction to Celestial Navigation

Introduction to Celestial Navigation

BY RON WISNER

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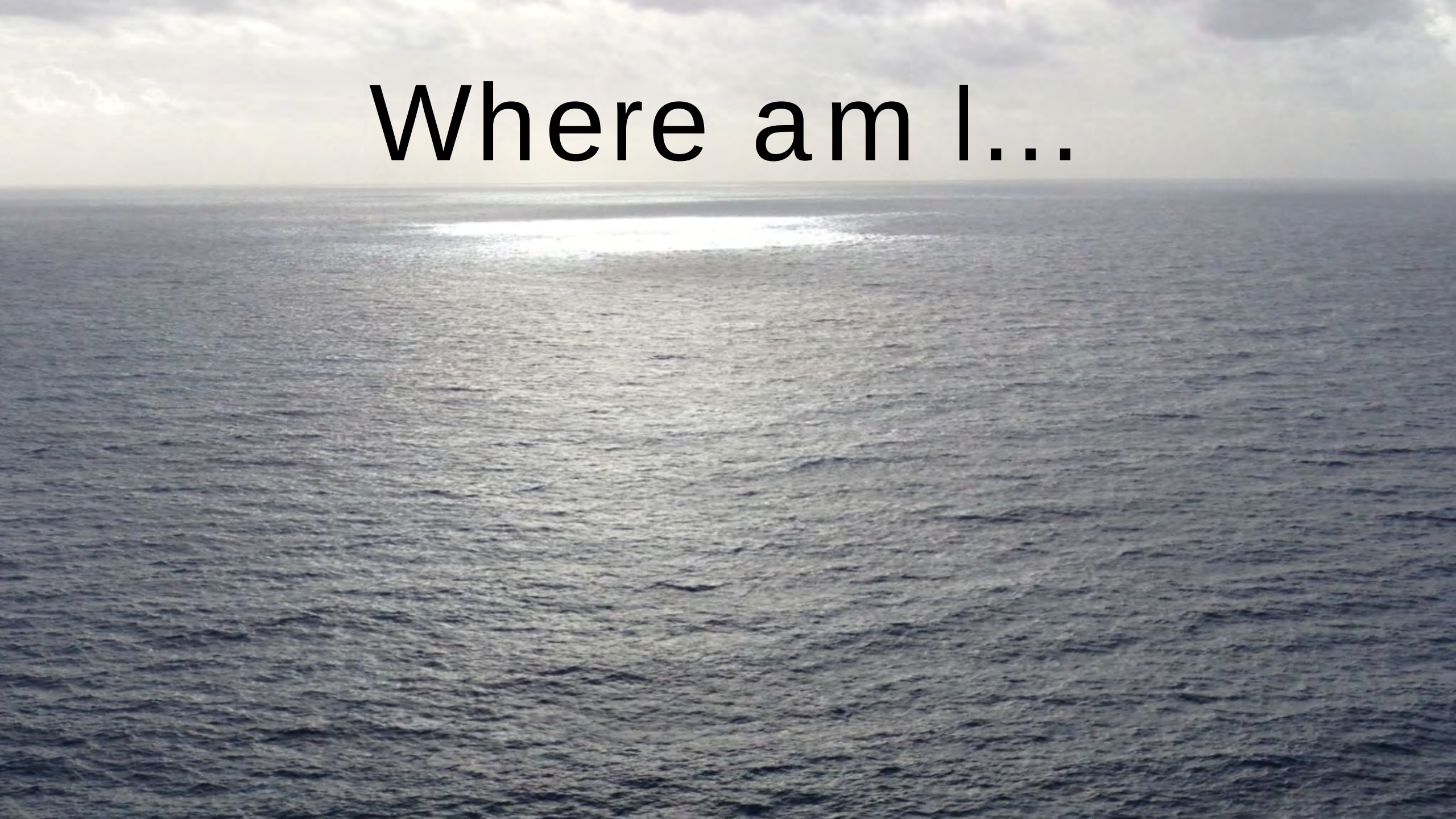
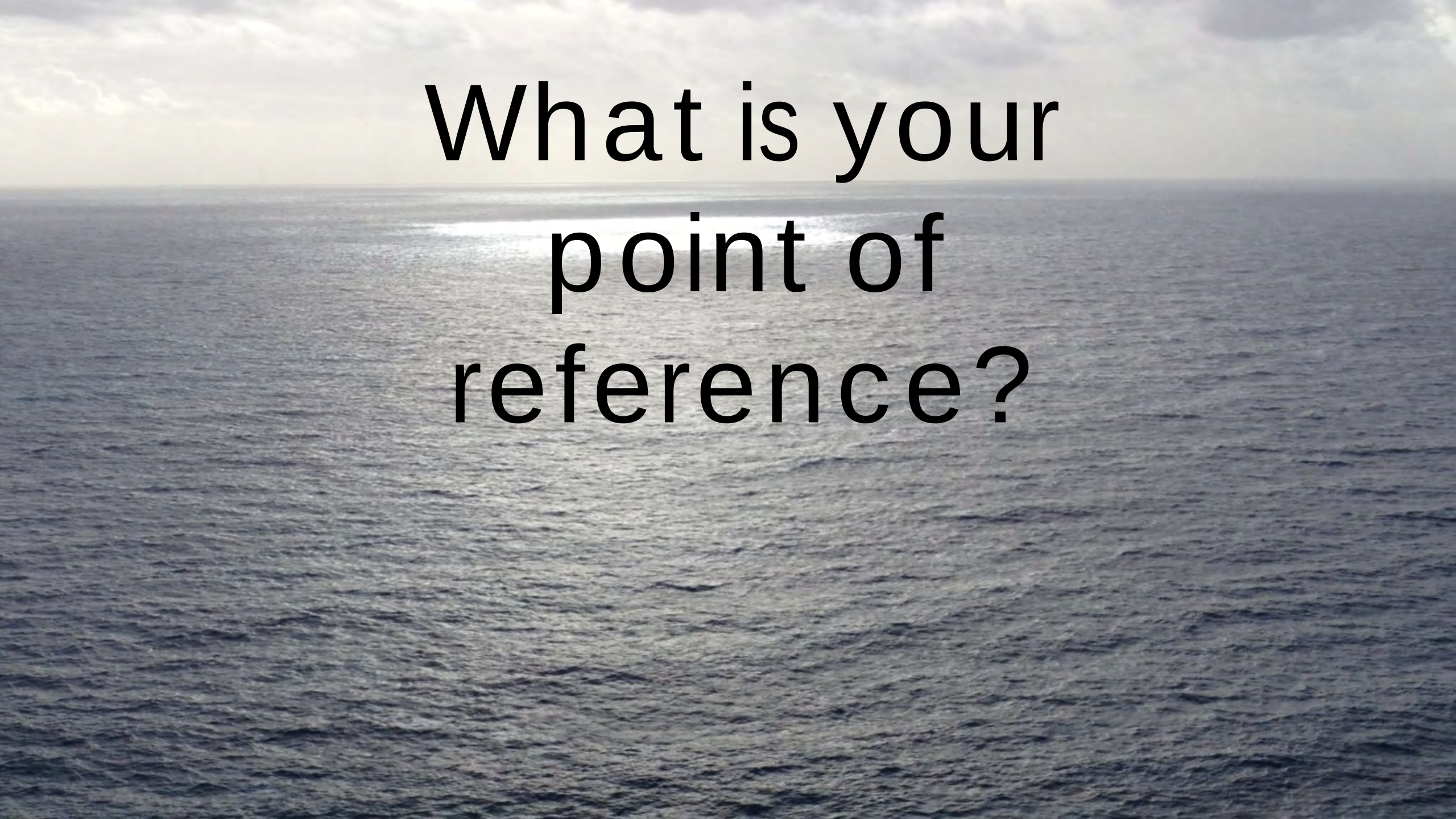

Where am I...

On A
Featureless
sea, with an
endless
horizon...


What is your point of reference?

Look to the Heavens

Celestial Bodies

If you know the position of a celestial body....

You can infer your own position

The moon

The planets

The stars

The sun

90% of celestial navigation is by the sun

- It’s the brightest object
- It’s easy to find
- There is no mistaking it

Why Learn Celestial Navigation?

- Because Things Go Wrong

Why Learn Celestial Navigation?

- Because Things Go Wrong
- Because Safety at Sea dictates redundant capabilities and systems

Things that go wrong

- Dismasting
- Lightening strike
- Engine failure/battery failure
- Knockdown/Swamping
- War/GPS system disabled
- Hacking
- Jamming

PETTY OFFICER 2ND CLASS JARED KING | U.S. NAVY

Seaman Pasquale Verrastro uses a sextant on the guided missile destroyer Ramage. The Navy is rebuilding its celestial navigation program for enlisted ranks.

In the face of online threats, the Navy once more **looks to the stars**

From wire reports

The techniques guided ancient Polynesians in the open Pacific, led Sir Ernest Shackleton to remote Antarctica and oriented astronauts when Apollo 12 was disabled by lightning.

Now celestial navigation has returned to the Naval Academy.

Officials reinstated lessons in the technique this year, nearly two decades from the curriculum.

That decision, in the late 1990s, caused a stir among the old guard of navigators.

But nostalgia isn't behind its return.

Rather, the escalating threat of cyberattacks has led the Navy to dust off its tools to measure the angles of stars.

After all, you can't hack a sextant.

"We went away from celestial

NAVIGATION | *Cyberattack threats make analog methods more valuable*

Continued from Page 1

navigation because com-

Navy spokeswoman. Officers' training returned in 2011 for ship navigators, she

A lightning strike to a ship's mast could disable GPS receivers, for example.

Celestial Navigation Overview

- Find your position relative to a celestial body
- Like lighthouses, if you know the position of a body, you can find your own
- First step, Noon Latitude, used for centuries
- Second step, simultaneous Noon Latitude and Longitude, late 18th century
- Line of position at any time of day using time and measured altitude, 19th Century forward

Sample Program

Excerpts

Basic Astronomy

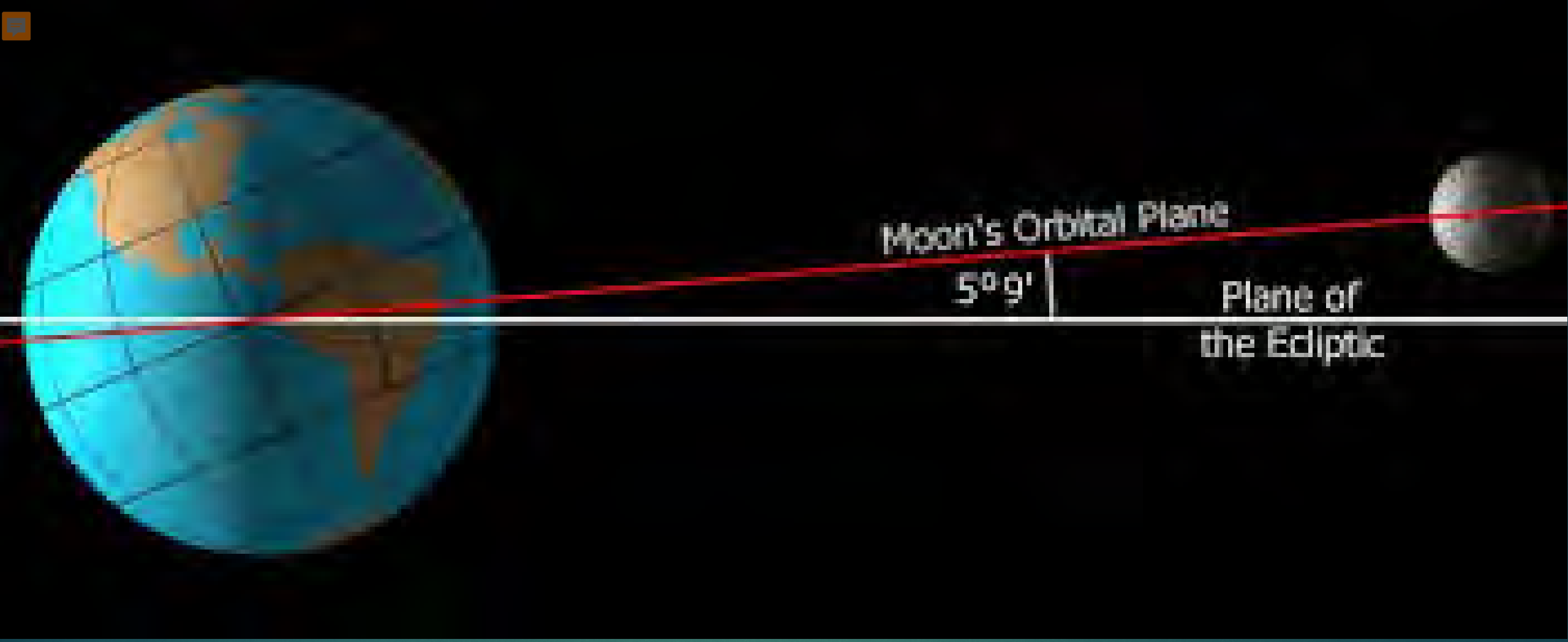
Basic Astronomy

UNDERSTANDING THE HEAVENS

The Ecliptic

Relative Paths of Celestial Bodies

All follow a path close to the same plane



Moon’s orbital deviation from ecliptic

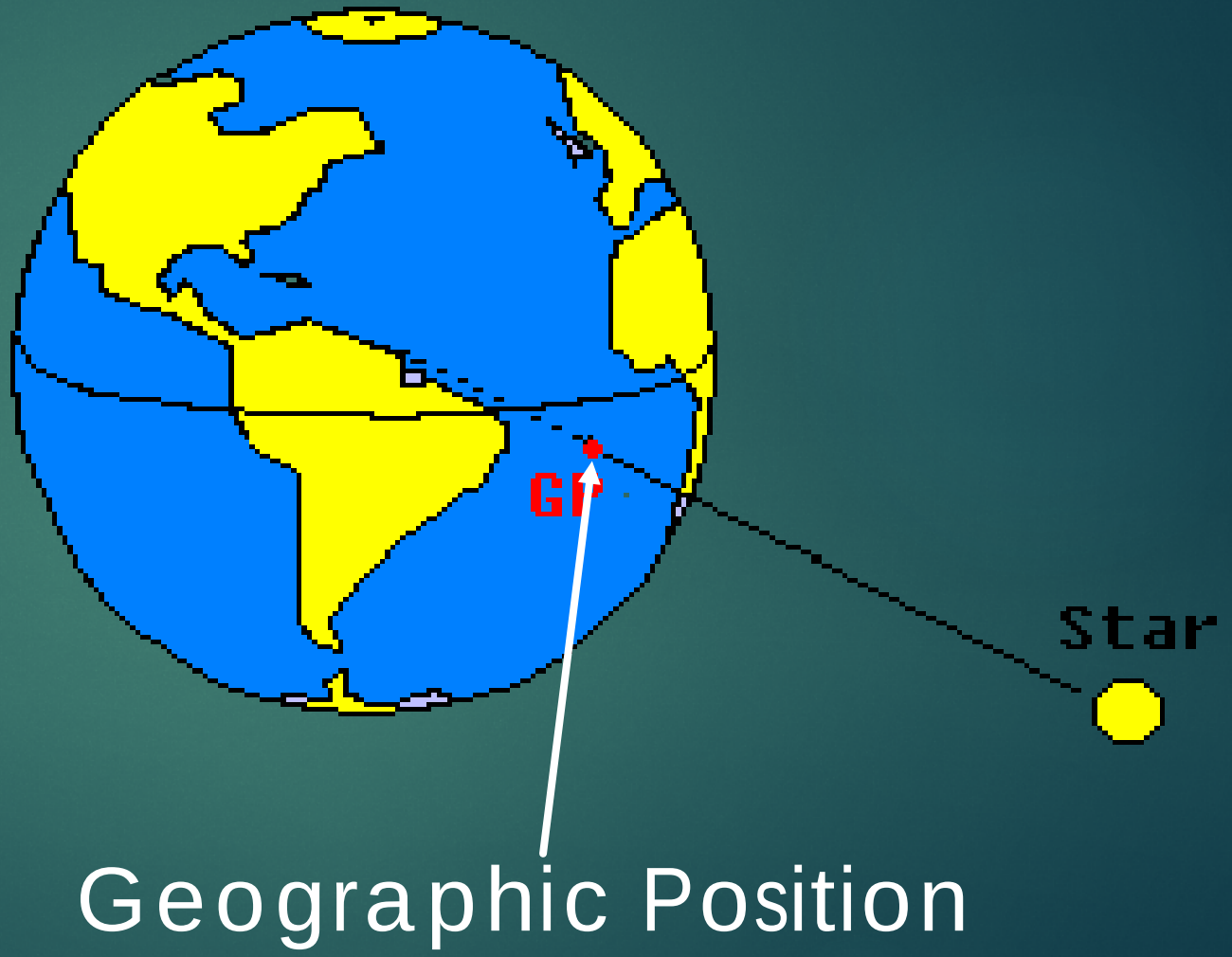
Why are the orbits of the celestial bodies important?

- *Declination (all solar system bodies)*
- *Retrograde/Prograde (planets)*

Declination:

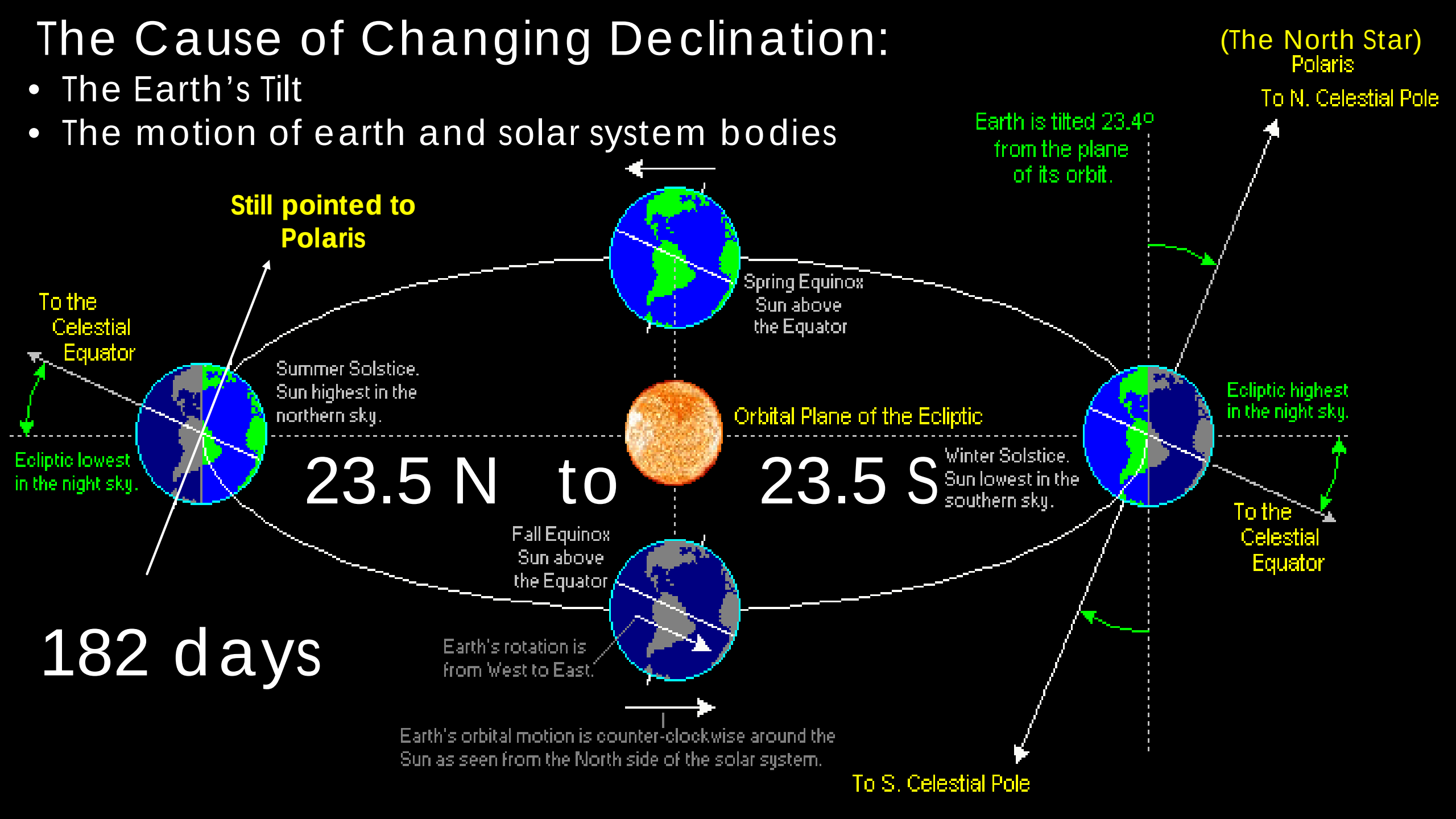
The geographical latitude of a celestial body

The geographical latitude of a line from the celestial body to the earth's center



The Cause of Changing Declination:

- The Earth's Tilt
- The motion of earth and solar system bodies



Sample Program

Excerpts

History

Use History as a Hook,
A Way to make subject matter
Accessible

Early Celestial Navigation

The Vikings

The World of the Northmen

NORTH ATLANTIC OCEAN
WITH
EASTERN NORTH AMERICA AND EUROPE
DOMINION OF CANADA
UNITED STATES
GREENLAND
ICELAND
Settlement
60 N
Oslo
Settlement

How Did They Do It?

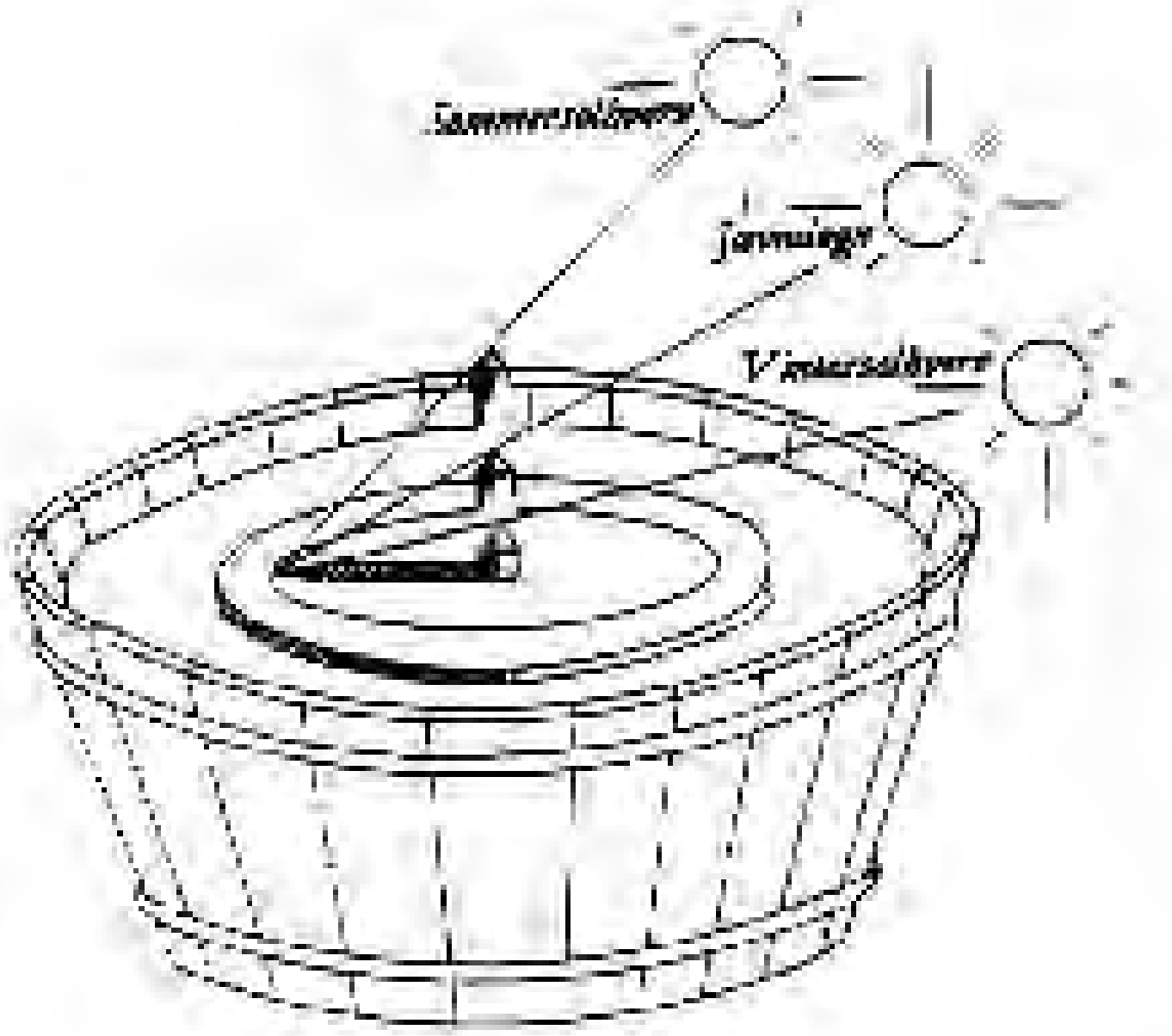
Greenland
982
Vinland
1000
Iceland
Faroer
Shetland
First Viking Raid
Scandinavia
793
Dublin
795
York
820
Atlantic
Ocean
Rhine
Normandy
911
860
844
820
Staraya
Ladoga
854
Novgorod
Volga
Kiev 882
Dnieper
Don
Dniester
Danube
880
Constantinople
941
839
Territories and voyages
of the Vikings

Contact with the Byzantine Empire is thought to have given the Vikings a new Technology and knowledge of astronomy

The Sun Board

Simple form, used at noon for latitude sailing

- **Each circle was for one latitude**
- **A different height gnomon was used for a specific time of year**



Line of Latitude Sailing

Latitude by noon sight has been used for centuries, well into the 19th century

In the autobiography “Two Years Before the Mast,” written in the 1830s, by Richard Henry Dana, the ship had no chronometer and used latitude sailing around the Horn to California.

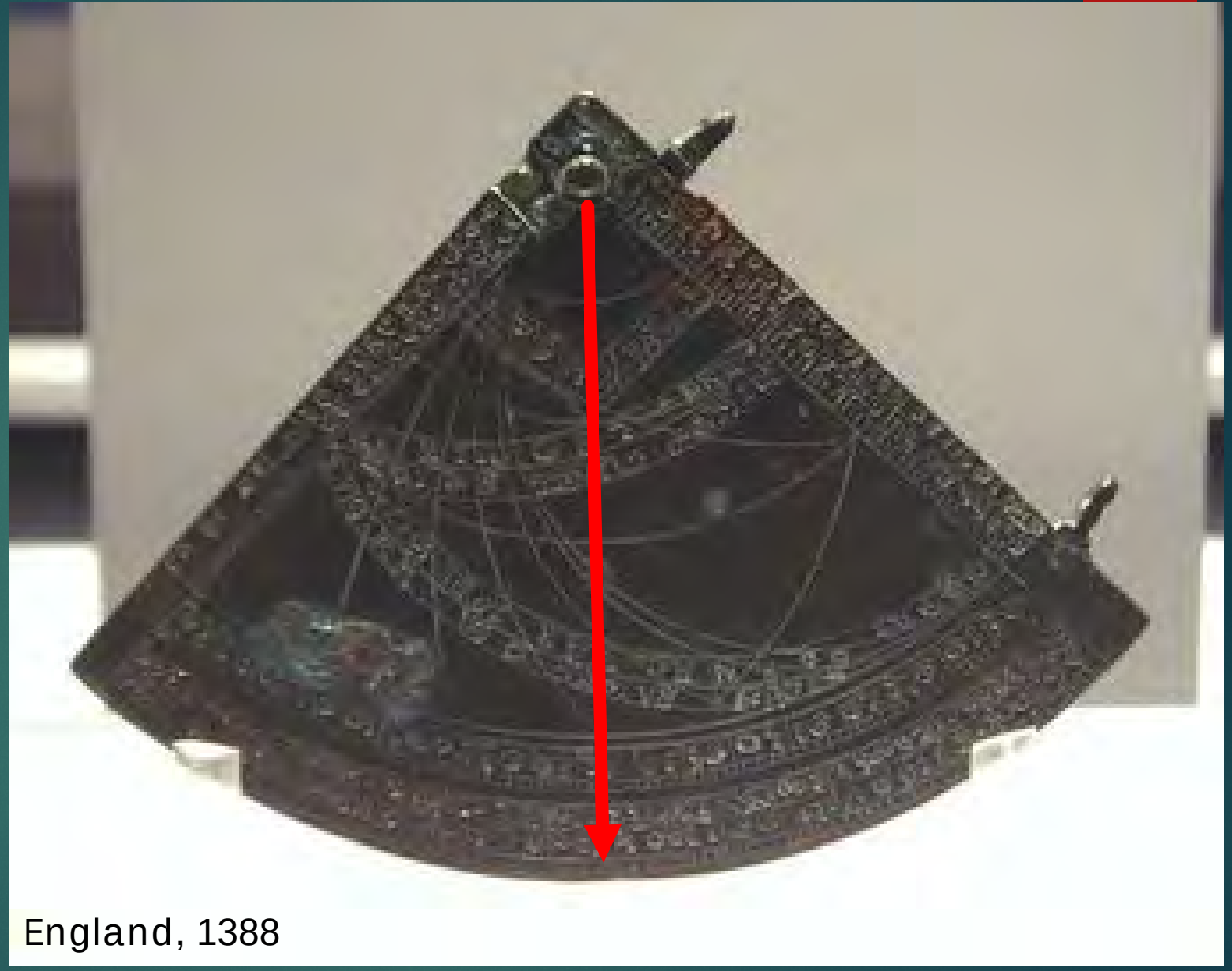
Longitude was by dead reckoning

The Quadrant and Astrolabe

Invented by the Greeks around 240 B.C., several different types of quadrants have been used over the past 2500 years.

The Quadrant

A plumb bob on the Quadrant



England, 1388

Or by hanging as a pendant

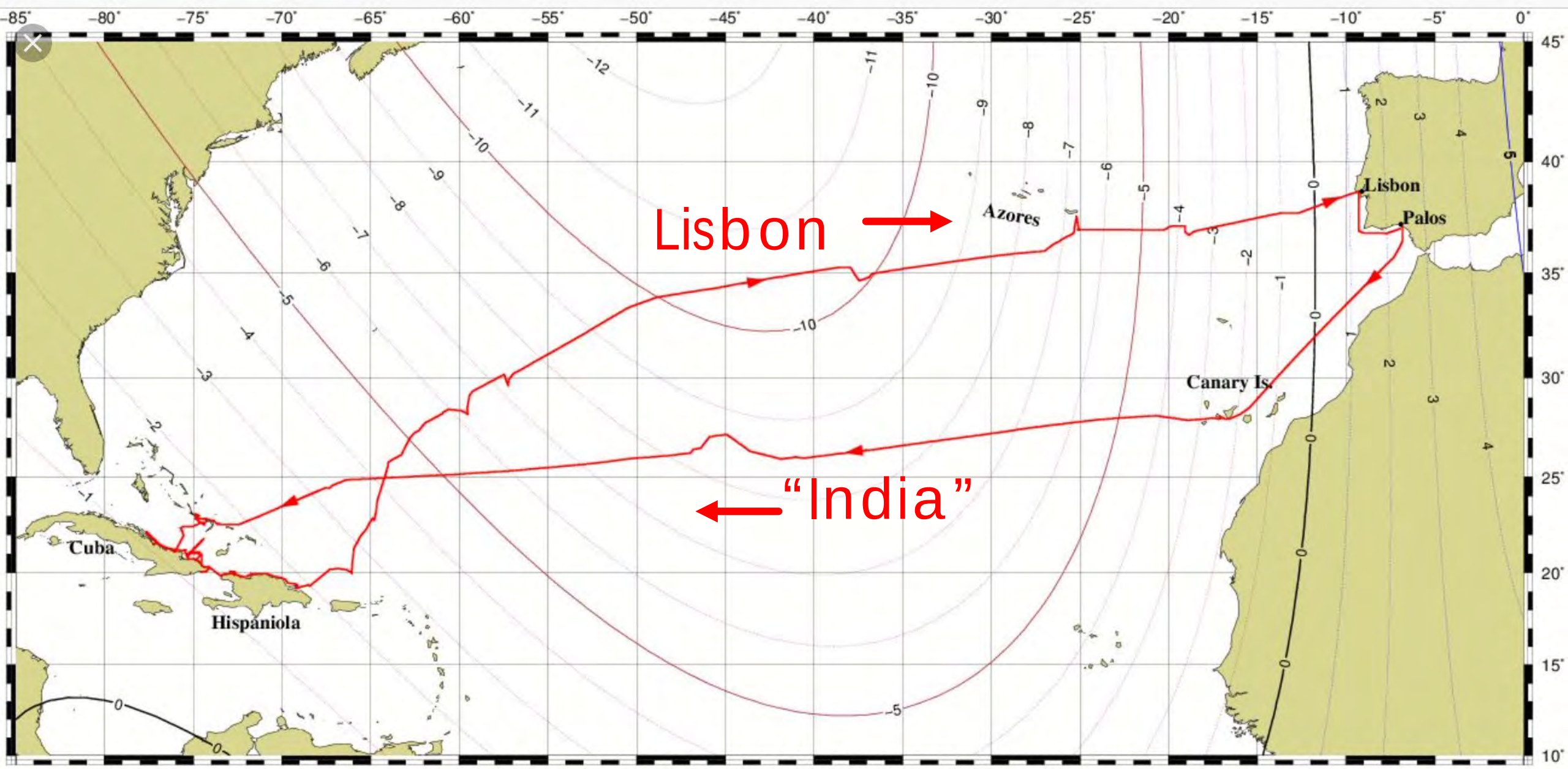
The Astrolabe

The Astrolabe

A treatise on the Astrolabe
Geoffrey Chaucer, 1391

“This treatis…, wol I shwew the…in Egnlissh, For Latyn ne canst thou yit but small”

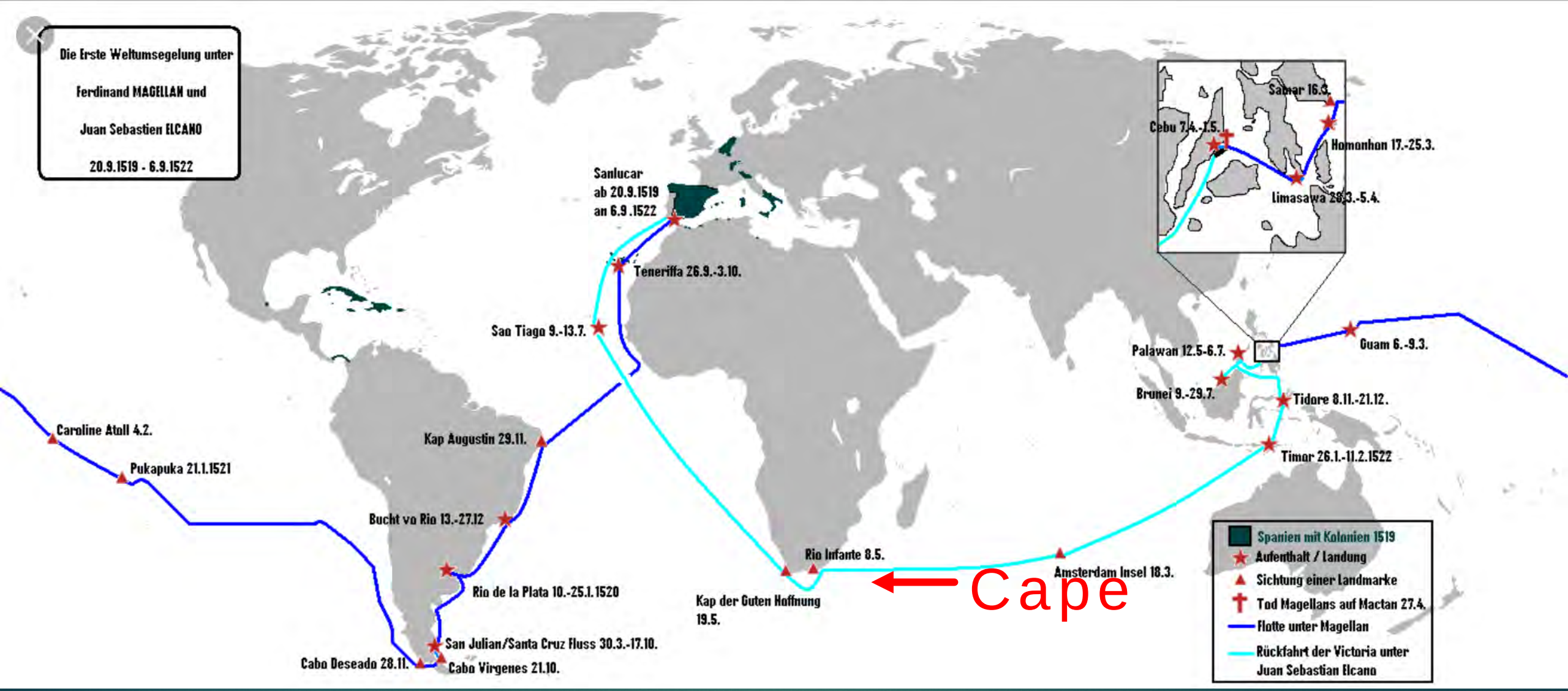
- Measurements may be taken at any latitude and
- Any time of year


Lisbon
Azores
Lisbon
Palos
Canary Is.
"India"
Cuba
Hispaniola

Columbus

The World According To Martin Behaim,

1492



Magellan
1519

After centuries of latitude sailing

Furthering navigation would require technology and astronomy to advance together

This creates a new requirement...

Better Data of the motions of celestial bodies

The 16th and 17th centuries marked the development of national observatories to develop this data

Such as the Greenwich Observatory Established in 1675

Sample Program

Excerpts

Time

A key advance in Science and Technology

Time

Time is based on the daily cycle of the rising and setting of the sun

Solar Noon occurs locally at the same time every day.

Like clockwork

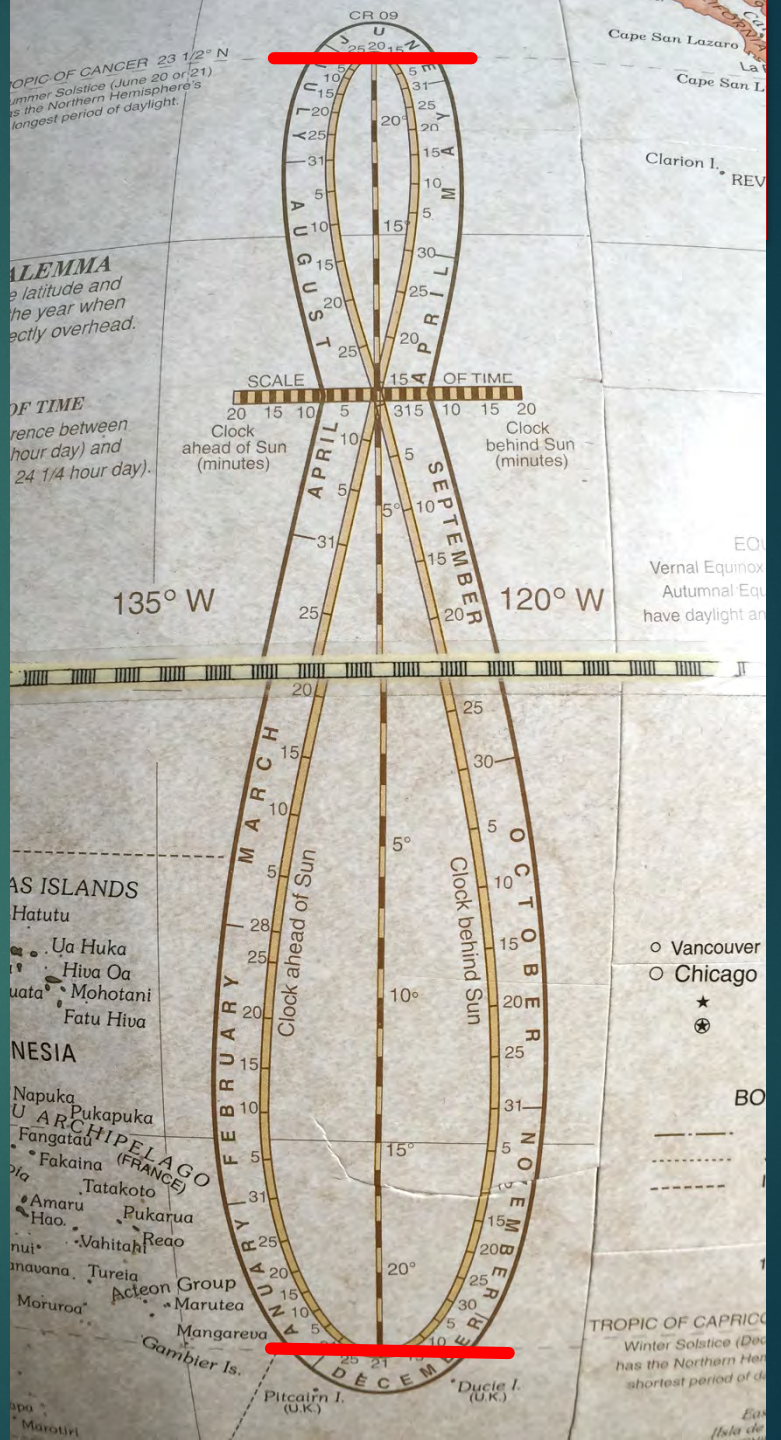
Right?

Known to Astronomers in antiquity
And described by Ptolemy in the 2nd Century,
Solar time varies

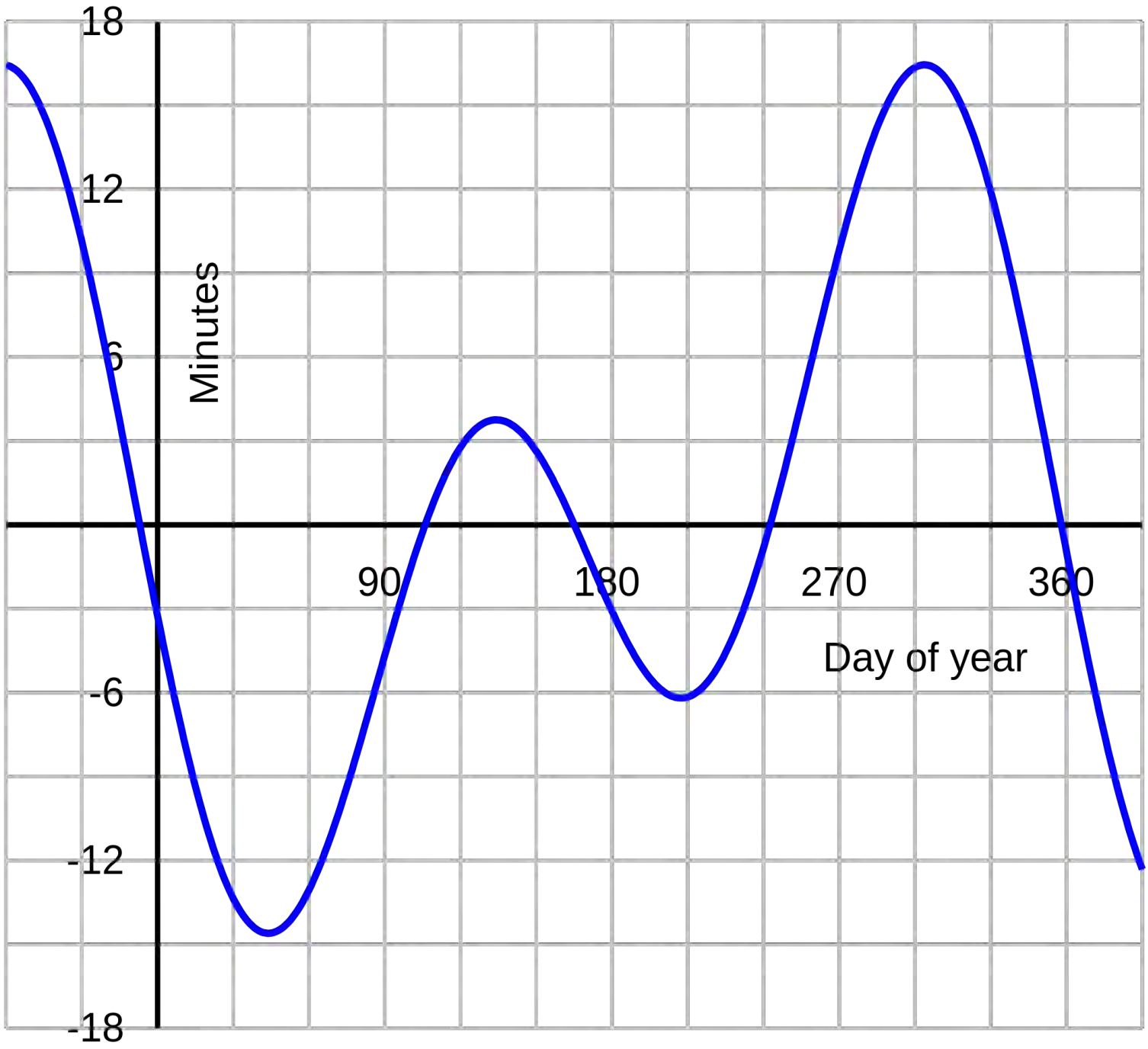
Scientists and astronomers discovered a predictable variation of the Sun’s path during the year.

The Equation of Time
Analemma can be found on most globes

Winter and summer solstices
At the North and South tropical lines

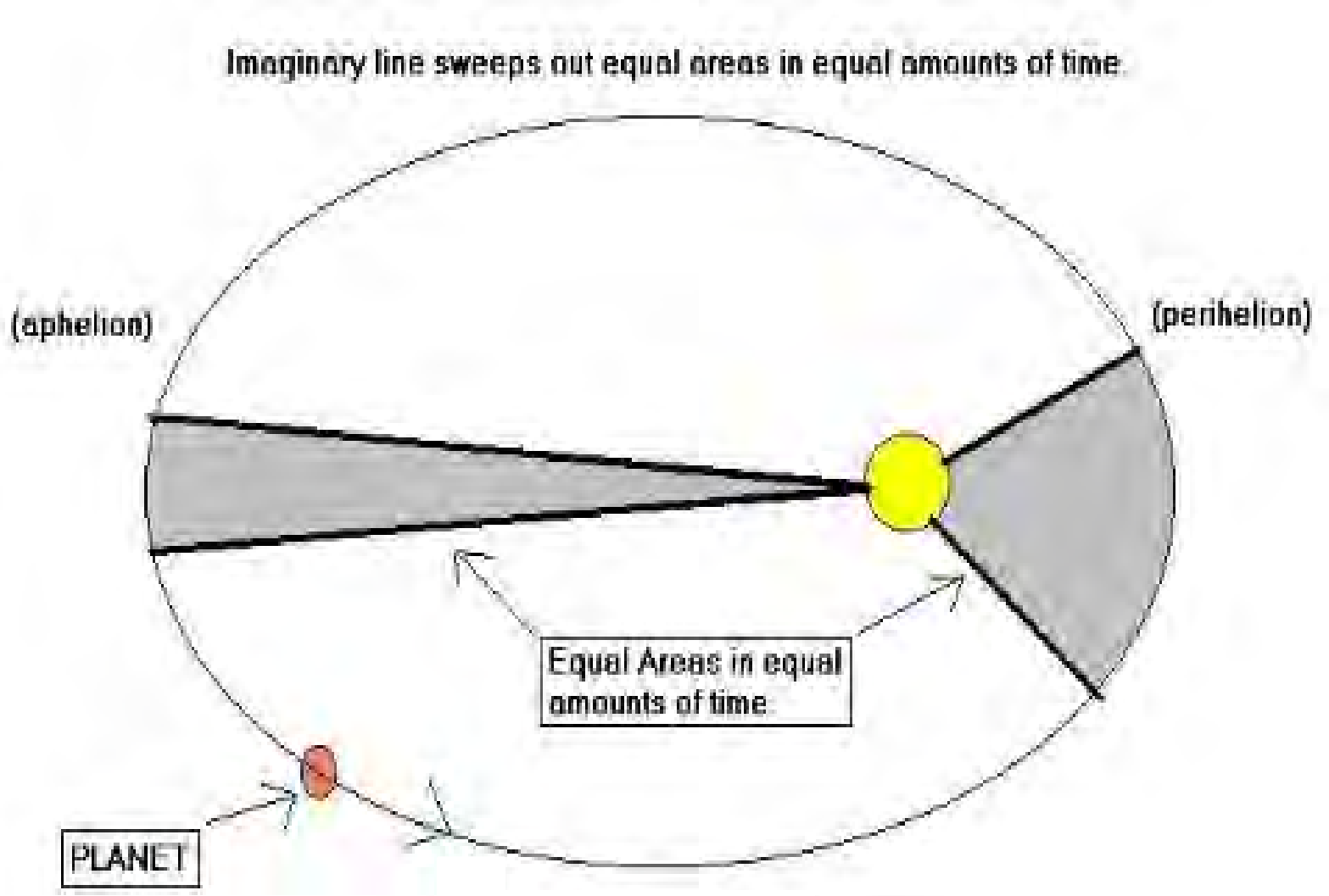


Called the "Equation of Time," *apparent* solar time will vary from "Mean Solar Time" by almost 17 minutes, depending on the time of year



Primary causes of variations in apparent solar time

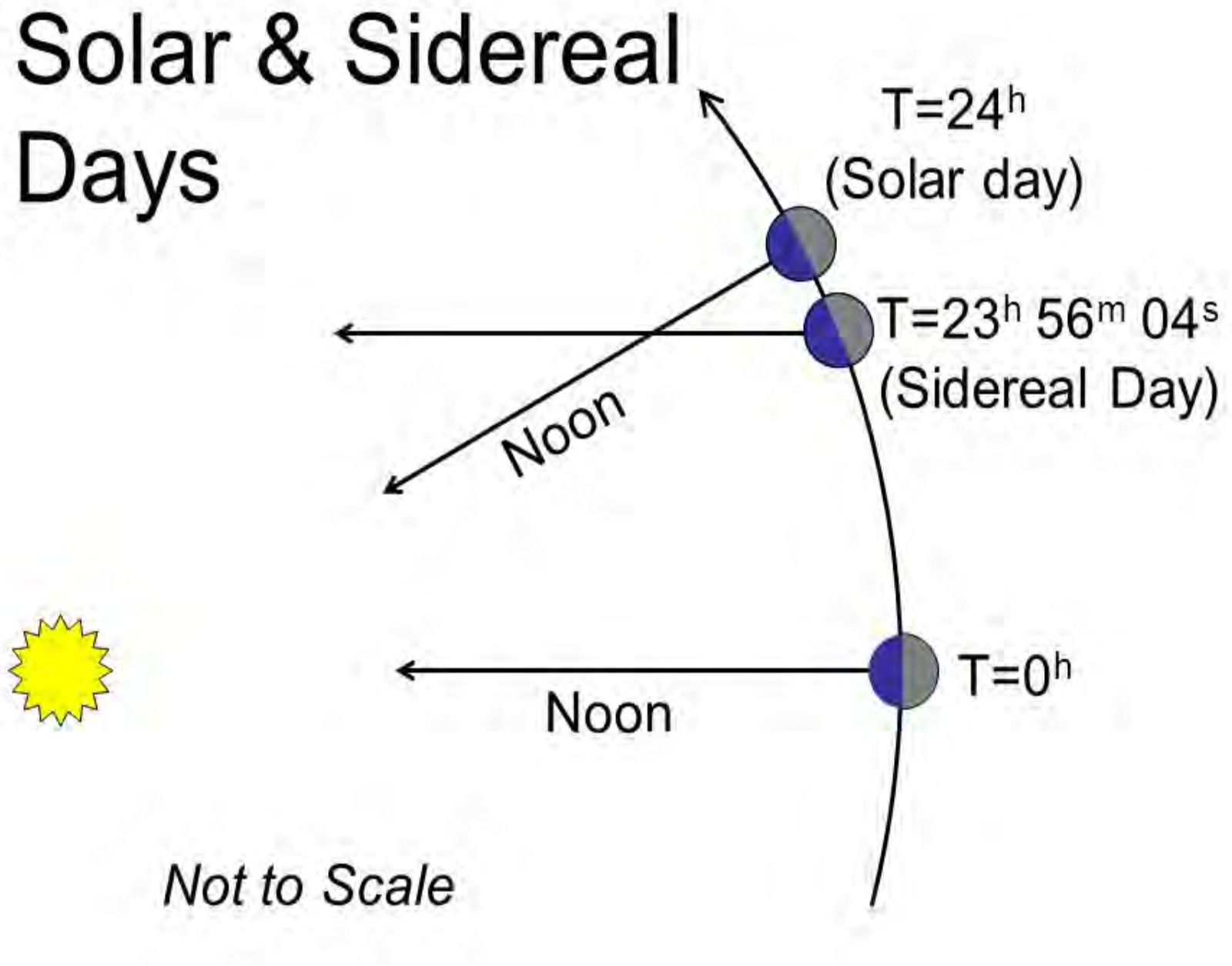
- Elliptical orbit
- Earth's tilted axis



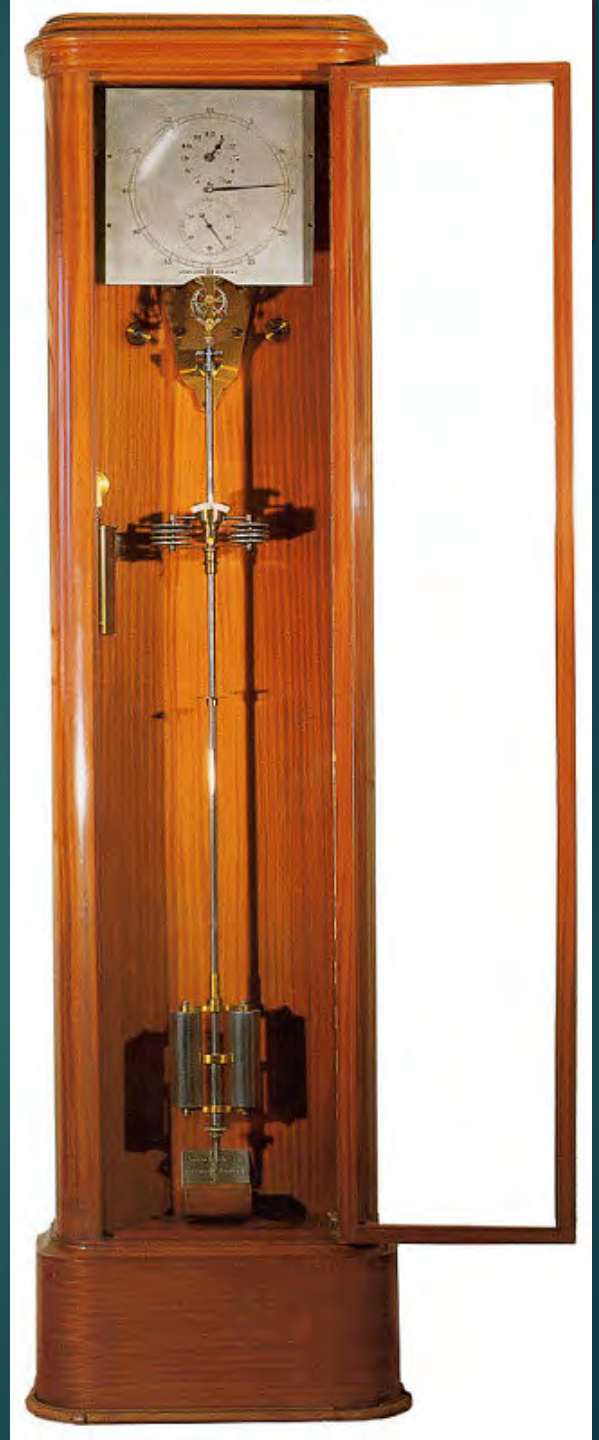
Kepler's laws, 1609

The Earth actually rotates more than 360 degrees every 24 hours

Per Kepler, the angular distance traveled around the sun varies depending on the part of the orbit



With the invention of accurate pendulum clocks, the disparities between solar time and clock time became quantifiable.



Clocks run at a constant rate, beginning and ending the year in agreement with the sun*, keeping an average, or “mean” of the sun’s motions throughout the year.

*ie, the winter solstice

The clock and the earth

Two measuring systems for a circle

360 degrees

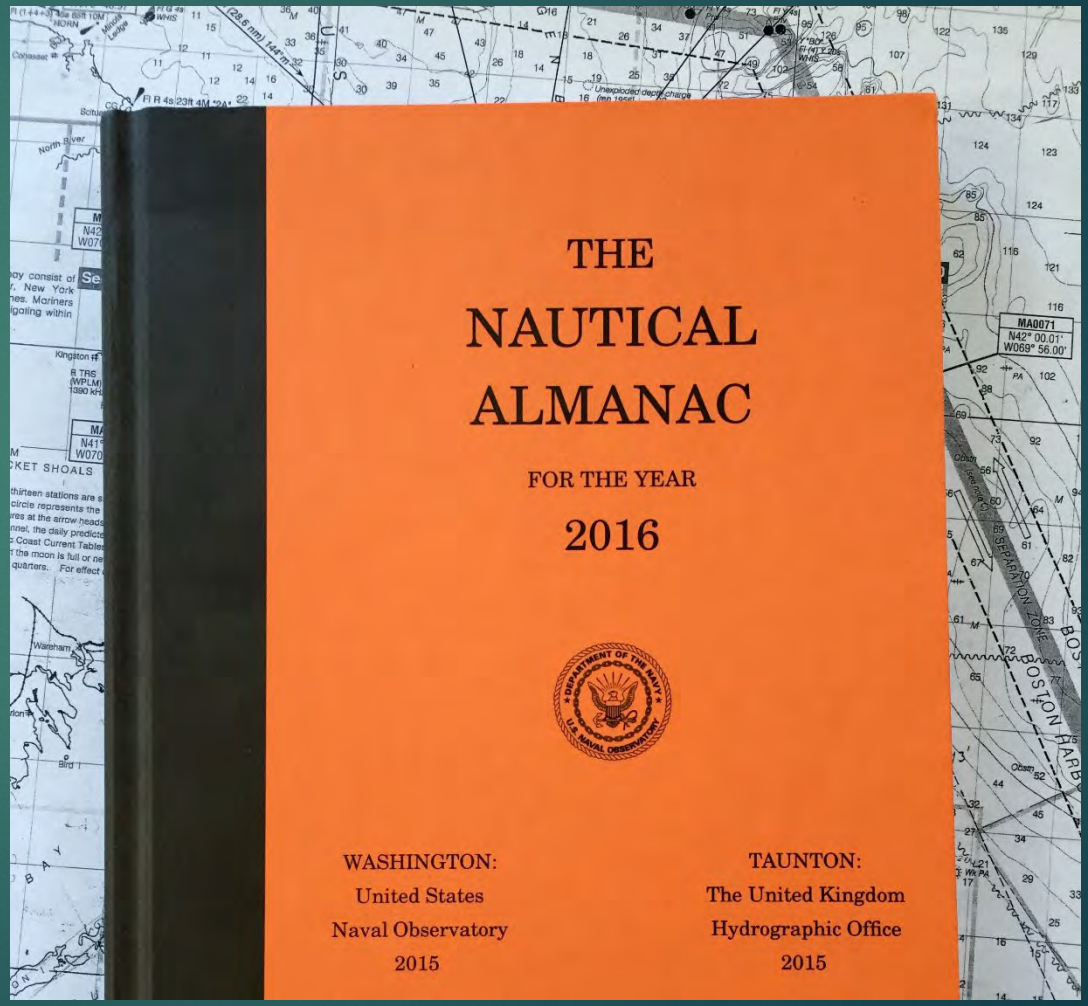
Navigators and Astronomers routinely convert between the two

24 hours (1440 minutes)

The Nautical Almanac

First published in 1767 to By the Greenwich Observatory

Jointly published by Her Majesty's Nautical Almanac Office and the United States Naval Observatory since 1858



“Mean Time”

- Originally called Greenwich Civil Time or Greenwich Mean Time
- Now called UTC, or Universal Coordinated Time

Universal time starts at the Greenwich (Prime) Meridian, 0 degrees longitude →

Sample Program

Excerpts

The Noon Sight

The Noon Sight

For latitude sailing

“I make it noon, Sir”

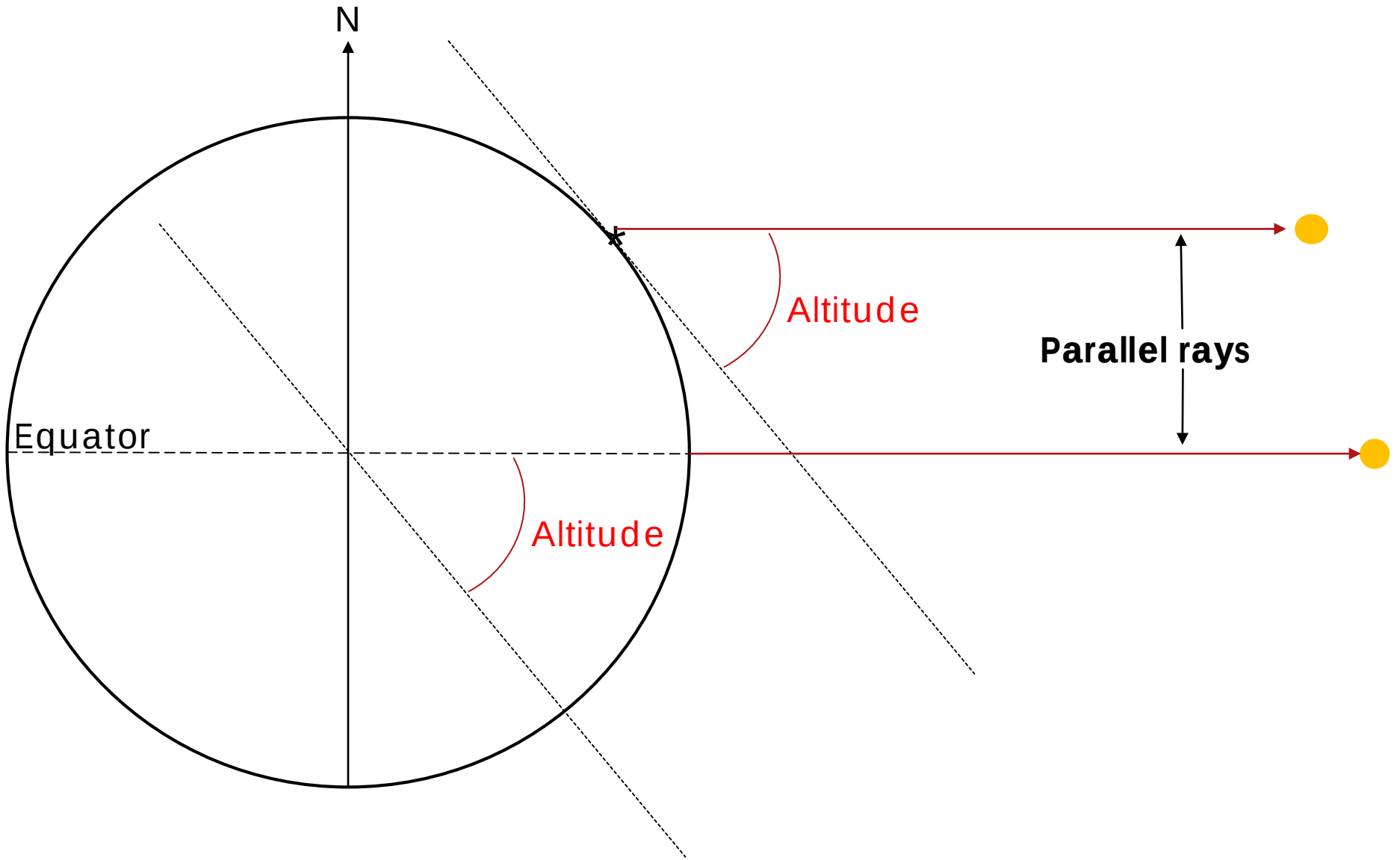
When the sun is on your meridian you can measure it’s altitude to find your latitude.

Local Meridian
Due South*

Arc of the sun

Noon sight At Equinox

"Zero Declination"

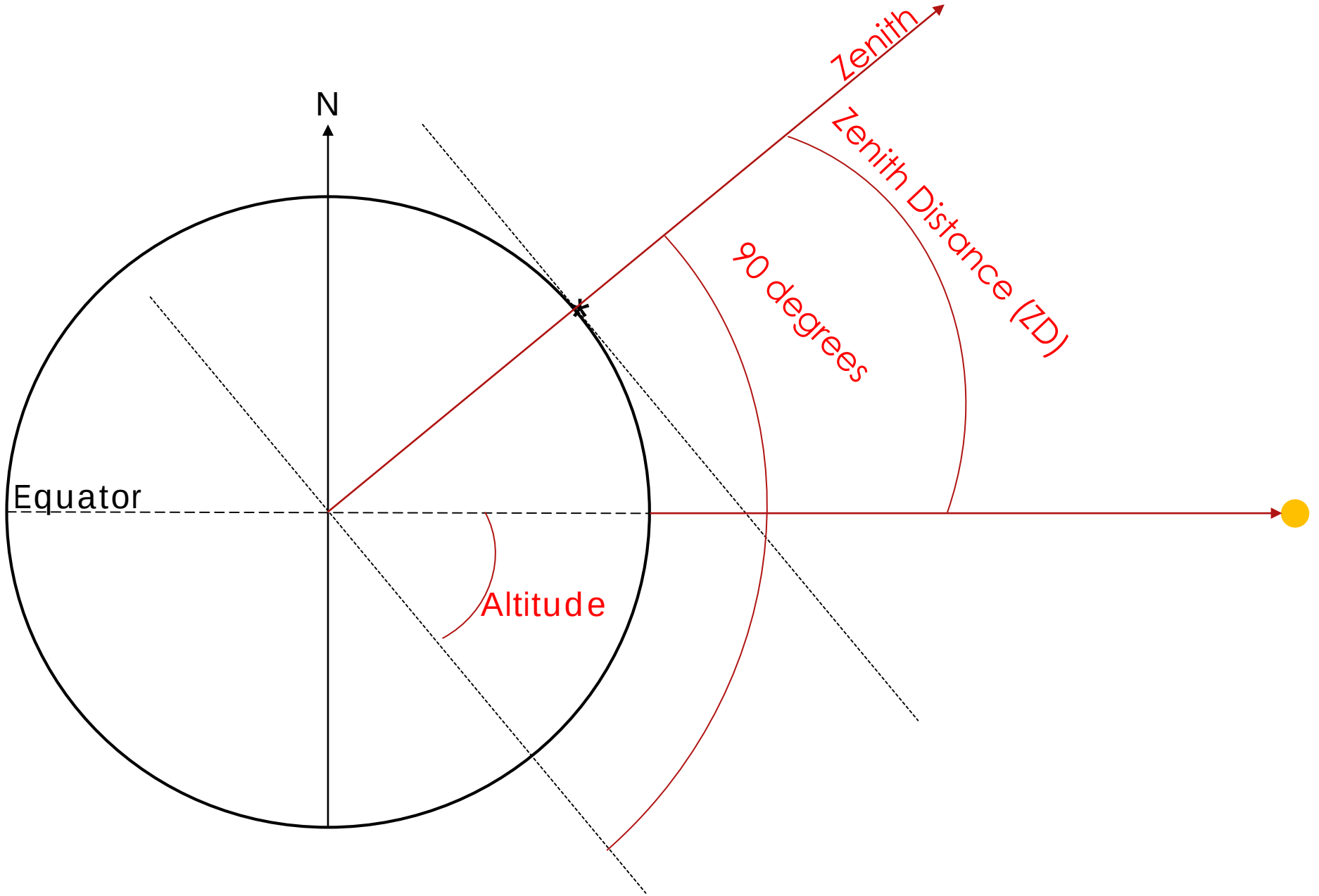


Noon sight
At Equinox

90 deg.
- Altitude

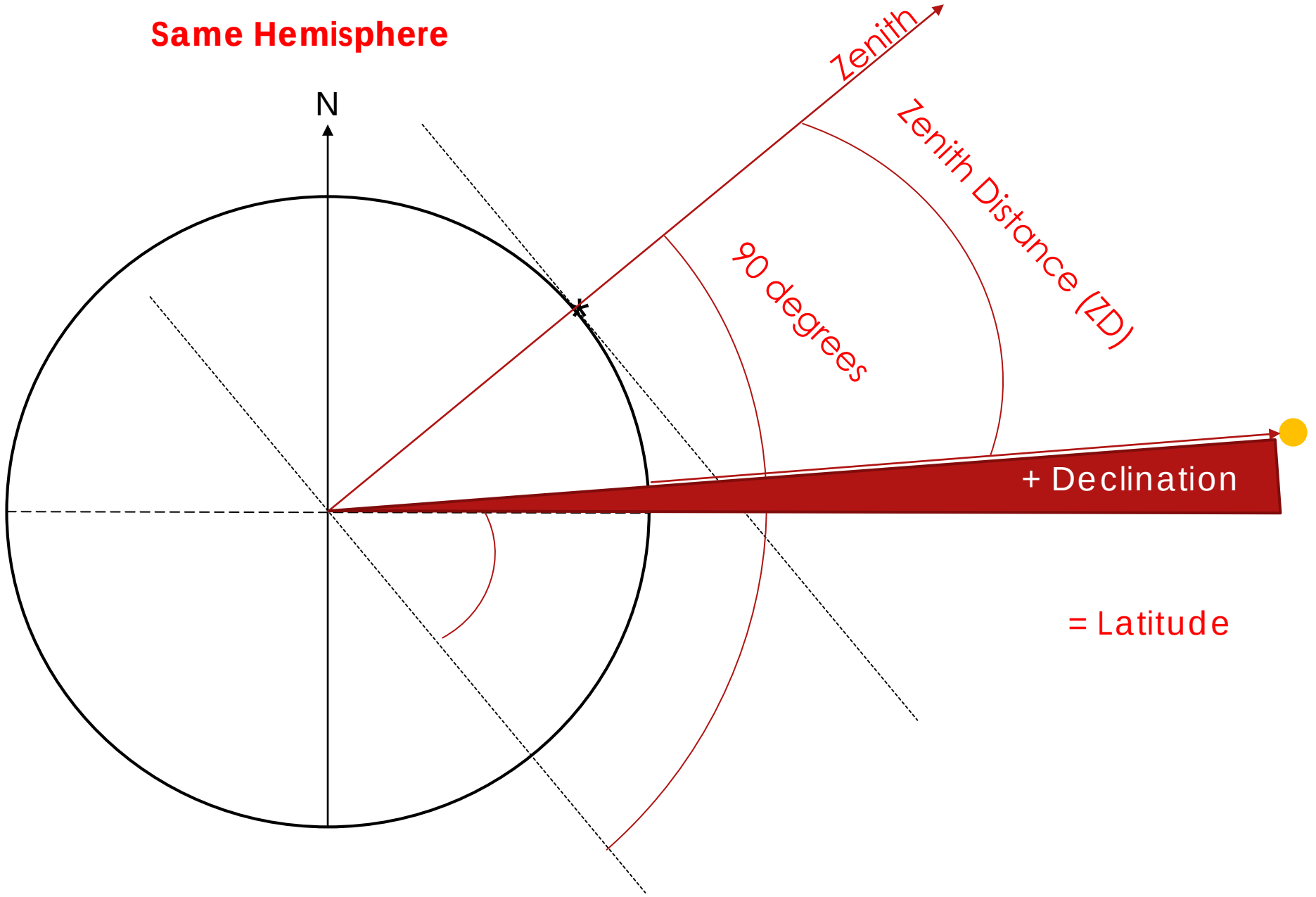
Zenith Distance

Zenith Distance
At Noon
Is your Latitude



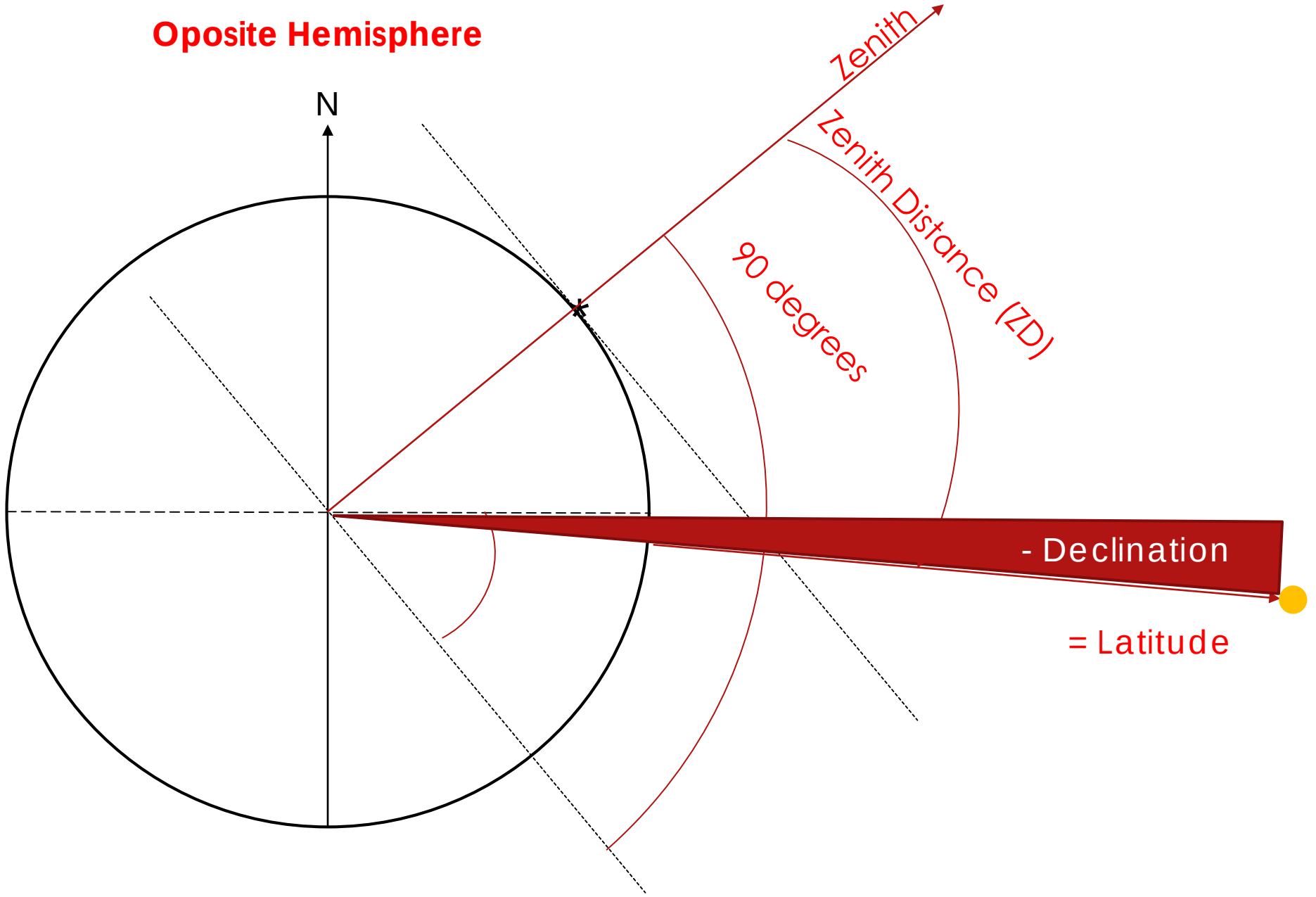
Noon sight Any other time of year

Add Declination If Sun in your Hemisphere To get Latitude



Noon sight Any other time of year

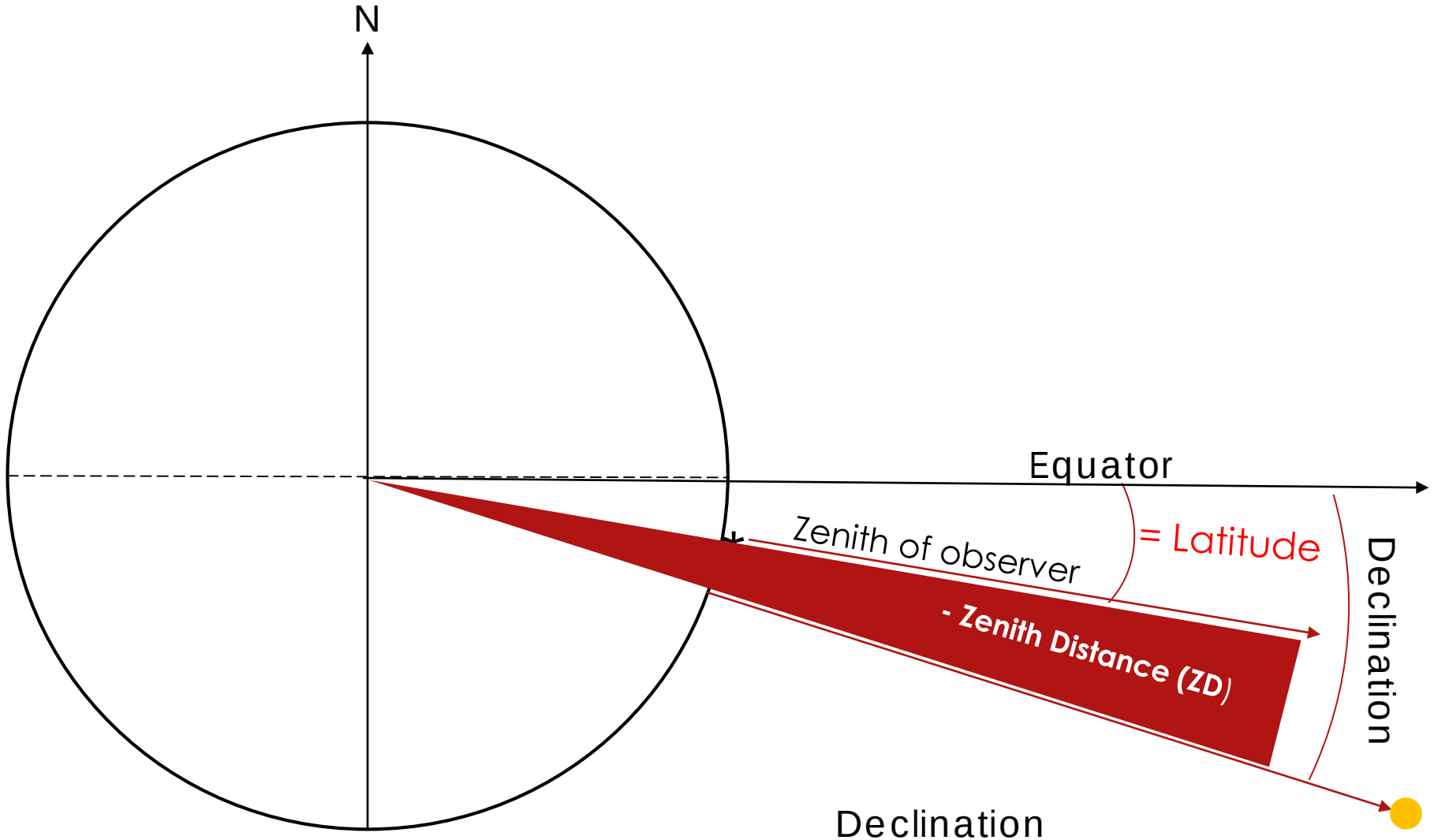
Subtract Declination If Sun Not in your Hemisphere To get Latitude



Latitude from noon sight close to the equator*

* Observer is closer to the equator than the sun

Noon latitude in the tropics



Declination
- ZD
= Latitude

Review

1. Subtract the sun's precise observed altitude in degrees, minutes, and seconds at local noon from 90 degrees to get Zenith Distance (ZD).

2. Find Declination in the Nautical Almanac for the date and hour of your sight.

3. Add or subtract the sun's declination to or from ZD depending on hemisphere. *

** (When sailing in the tropics, you may be closer to the equator than the sun.*

Simply subtract the smaller number from the larger)

You can find latitude at sea to within than a mile

Sample Program

Excerpts

Advanced Celestial Navigation

Advanced Celestial Navigation

BY RON WISNER

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Captain Thomas H. Sumner

December 17th, 1837

Approaching the St. George's Channel between Ireland and Wales with only a dead reckoning (DR) position.

Strong SSE winds setting his ship to the Irish lee coast. Heavy clouds had prevented taking any Altitudes for days.

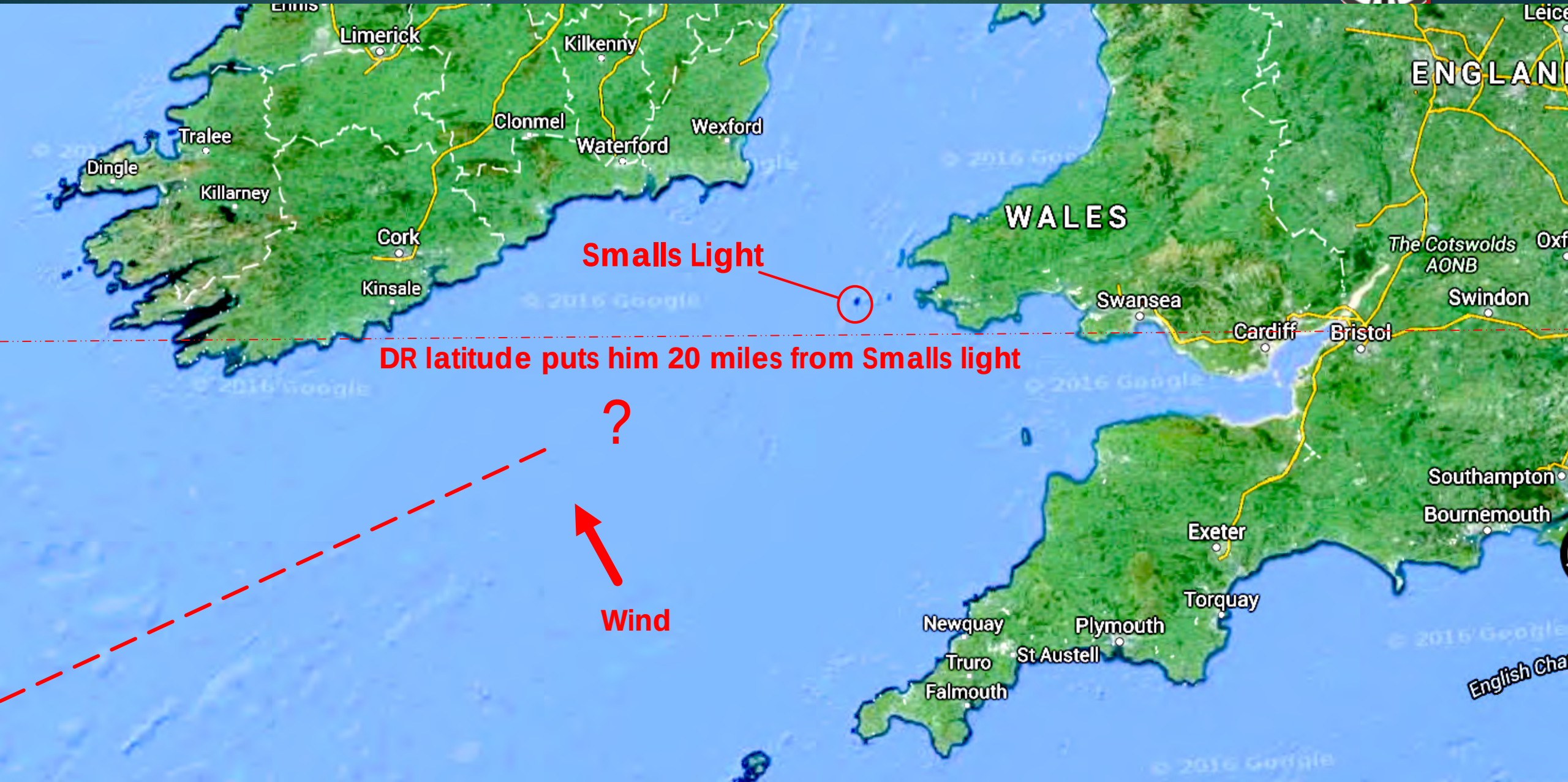
In the morning the clouds cleared for a short time and he was able to take the Altitude of the Sun.

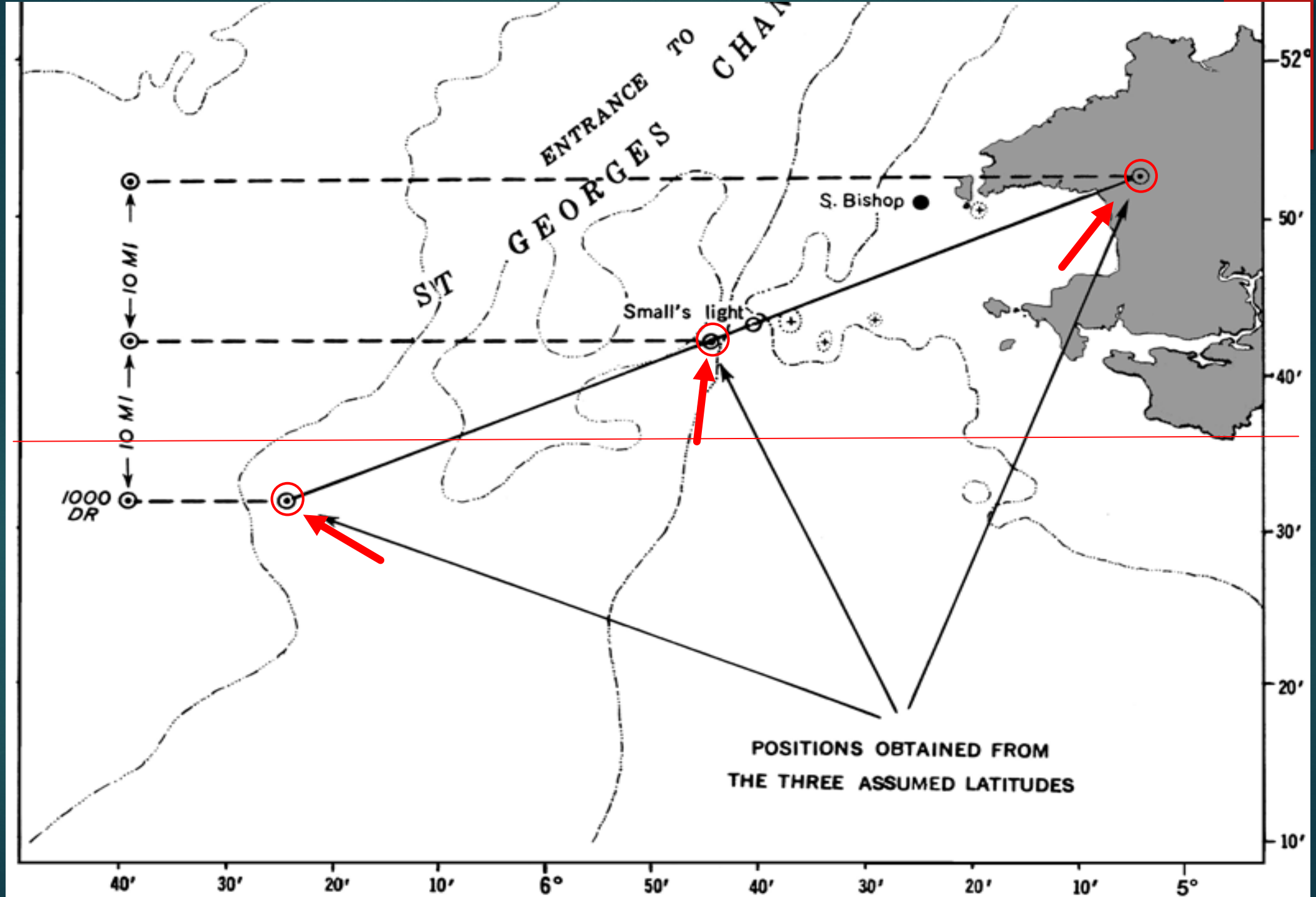
Captain Thomas H. Sumner

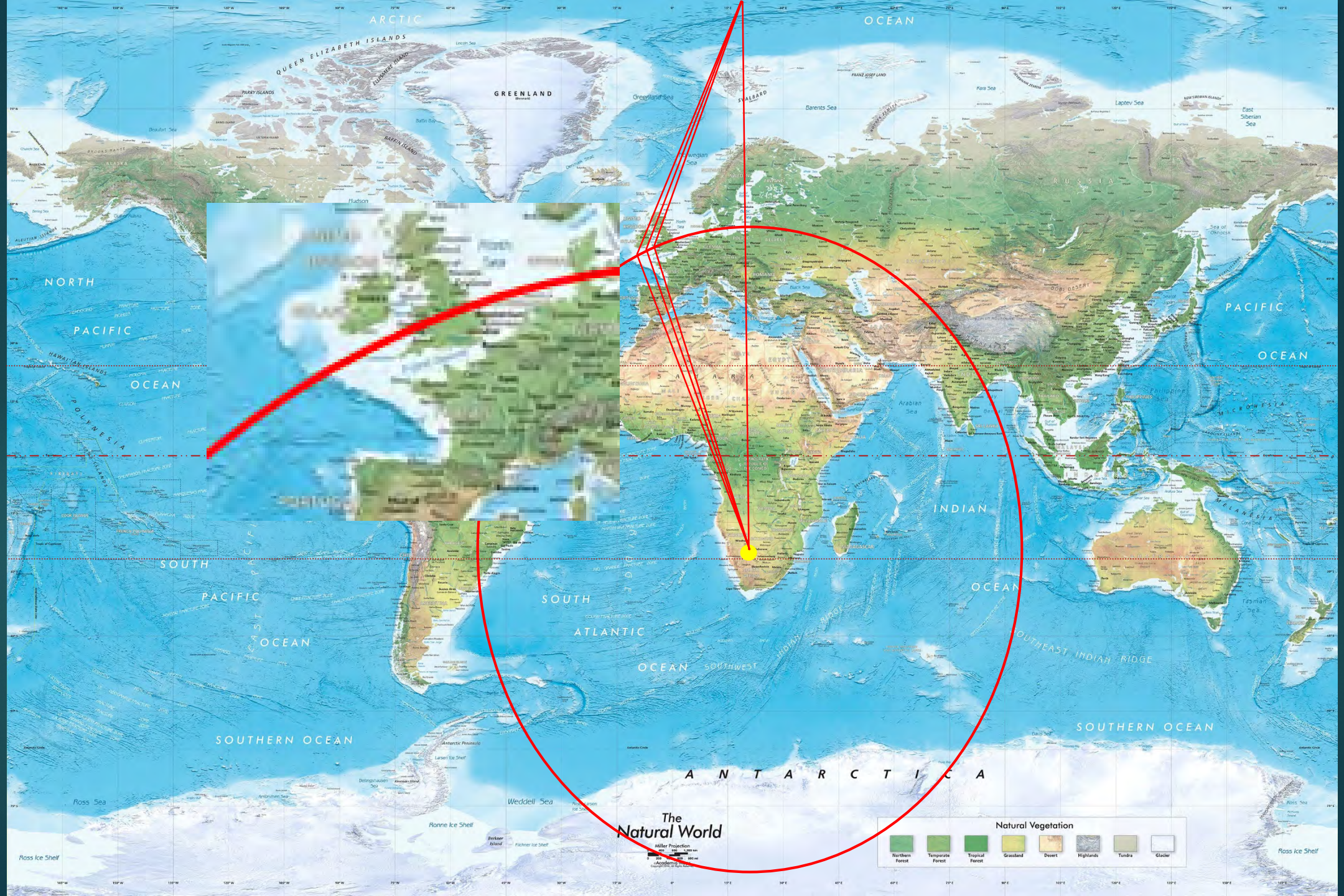
Ships log:

“On 17th December 1837, sea account, the Latitude by DR was 51° 37'N. The Altitude of the Sun's lower limb was 12° 02' at 10:47:13 Greenwich Mean Time by chronometer and the eye of the observer being 17 feet above the sea.”

Captain Thomas H. Sumner




ENTRANCE TO ST GEORGES CHA
S. Bishop
Small's light
10 MI
10 MI
1000 DR
POSITIONS OBTAINED FROM
THE THREE ASSUMED LATITUDES
52°
50′
40′
30′
20′
10′
40′
30′
20′
10′
6°
50′
40′
30′
20′
10′
5°


ARCTIC
OCEAN
QUEEN ELIZABETH ISLANDS
GREENLAND
Greenland Sea
Barents Sea
Laptev Sea
East Siberian Sea
RUSSIA
NORTH
PACIFIC
OCEAN
PACIFIC
OCEAN
Arabian Sea
INDIAN
OCEAN
SOUTH
PACIFIC
OCEAN
SOUTH
ATLANTIC
OCEAN
SOUTHEAST INDIAN RIDGE
SOUTHERN OCEAN
SOUTHERN OCEAN
ANTARCTICA
Ross Sea
Weddell Sea
Ronne Ice Shelf
Ross Ice Shelf
Ross Ice Shelf
The Natural World
Miller Projection
Natural Vegetation
Northern Forest
Temperate Forest
Tropical Forest
Grassland
Desert
Highlands
Tundra
Glacier

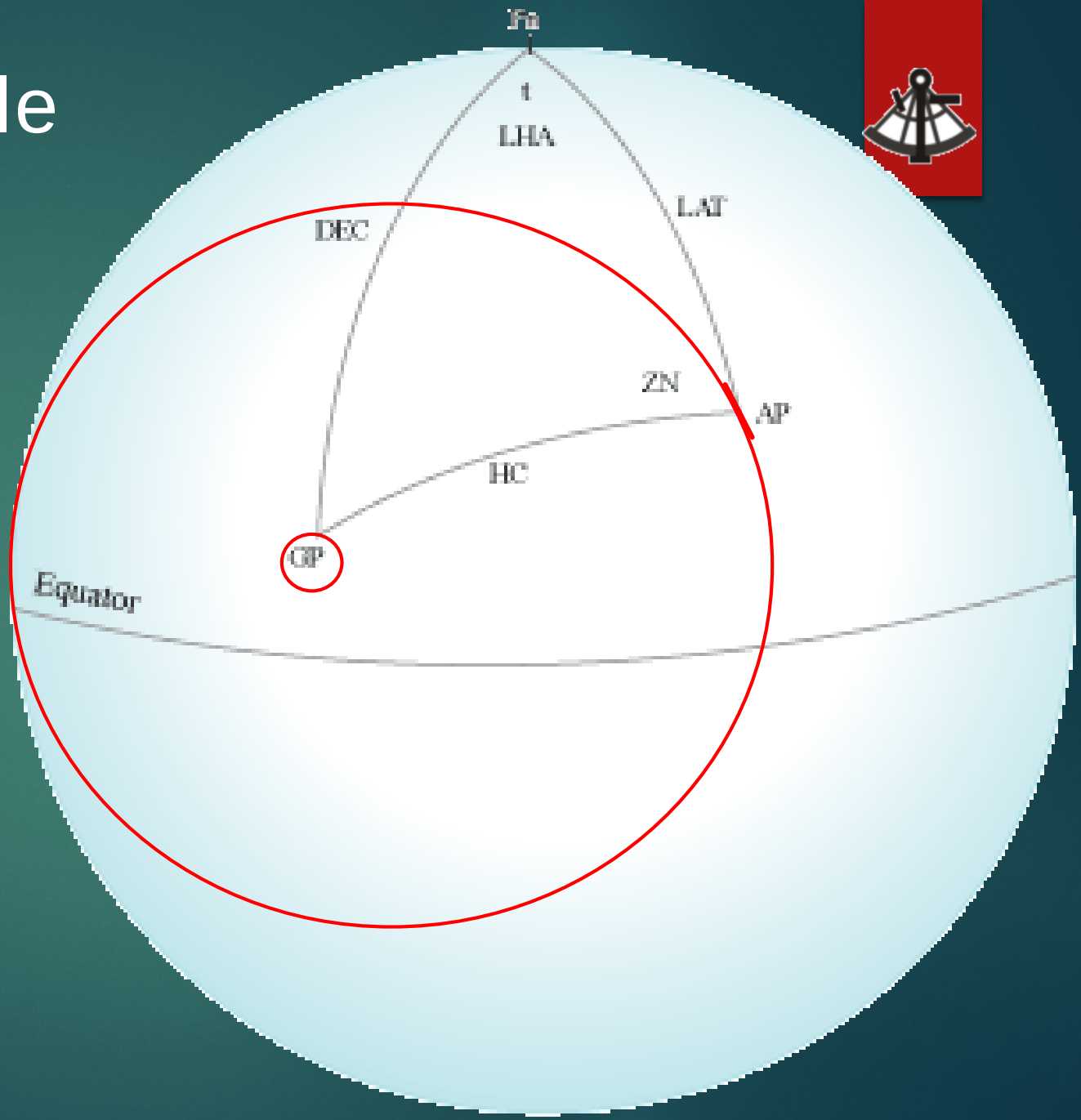
The Navigational Triangle

When we do a sight
To get a *line of position*,

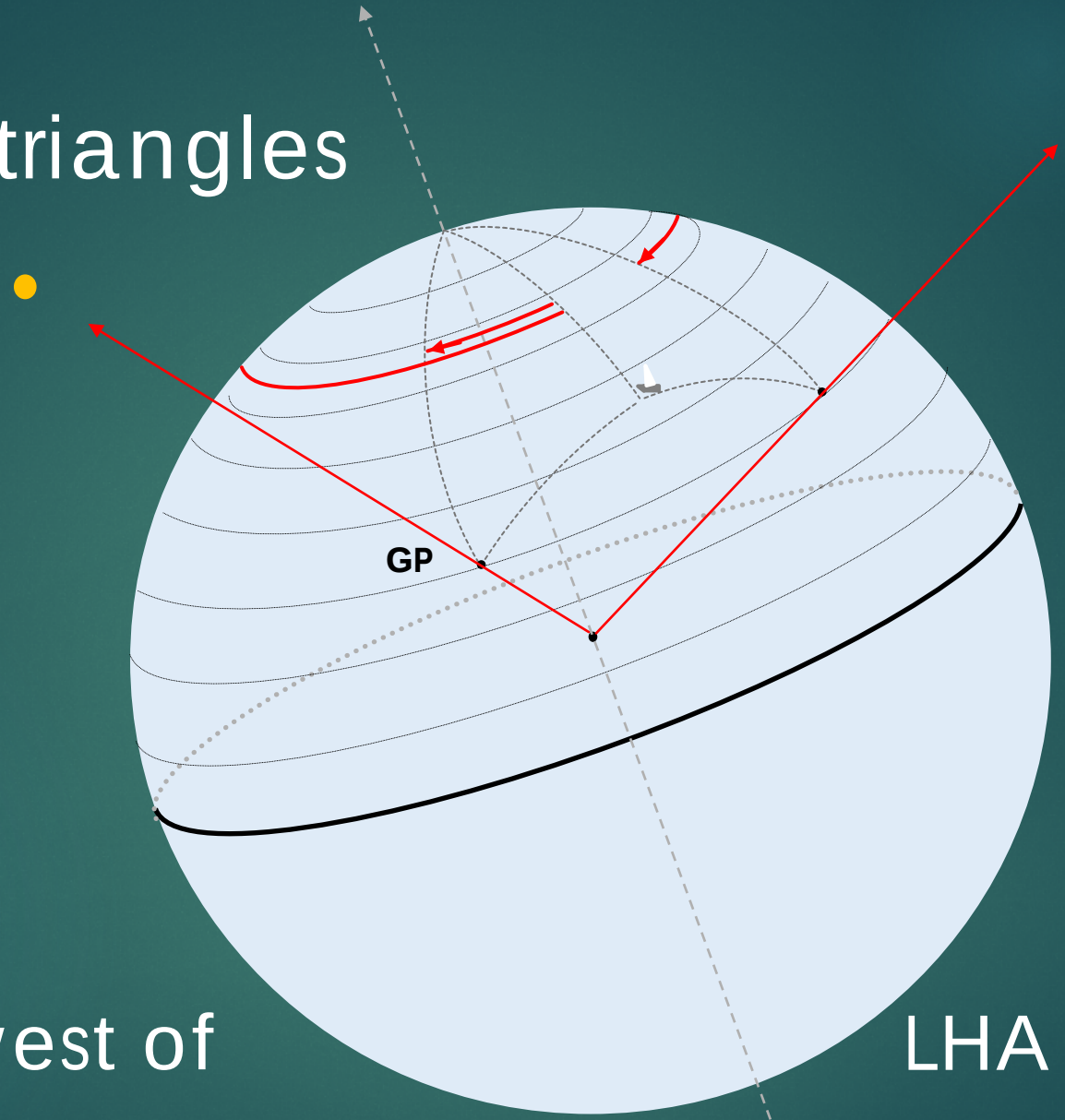
We are solving a triangle to place our position on a small segment

of a circle of equal altitude relative to the

GP of a body



Two Identical triangles



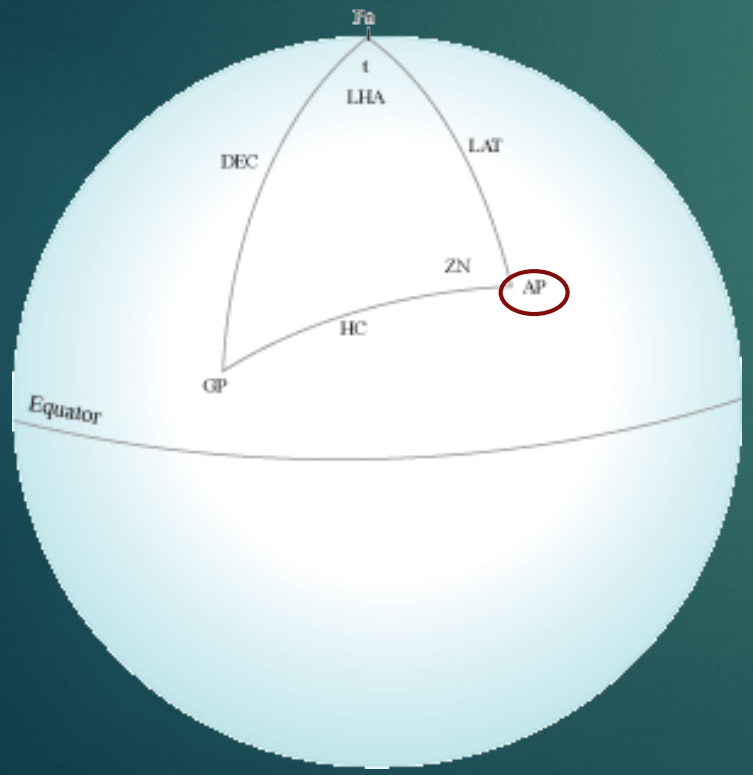
LHA of body west of observer

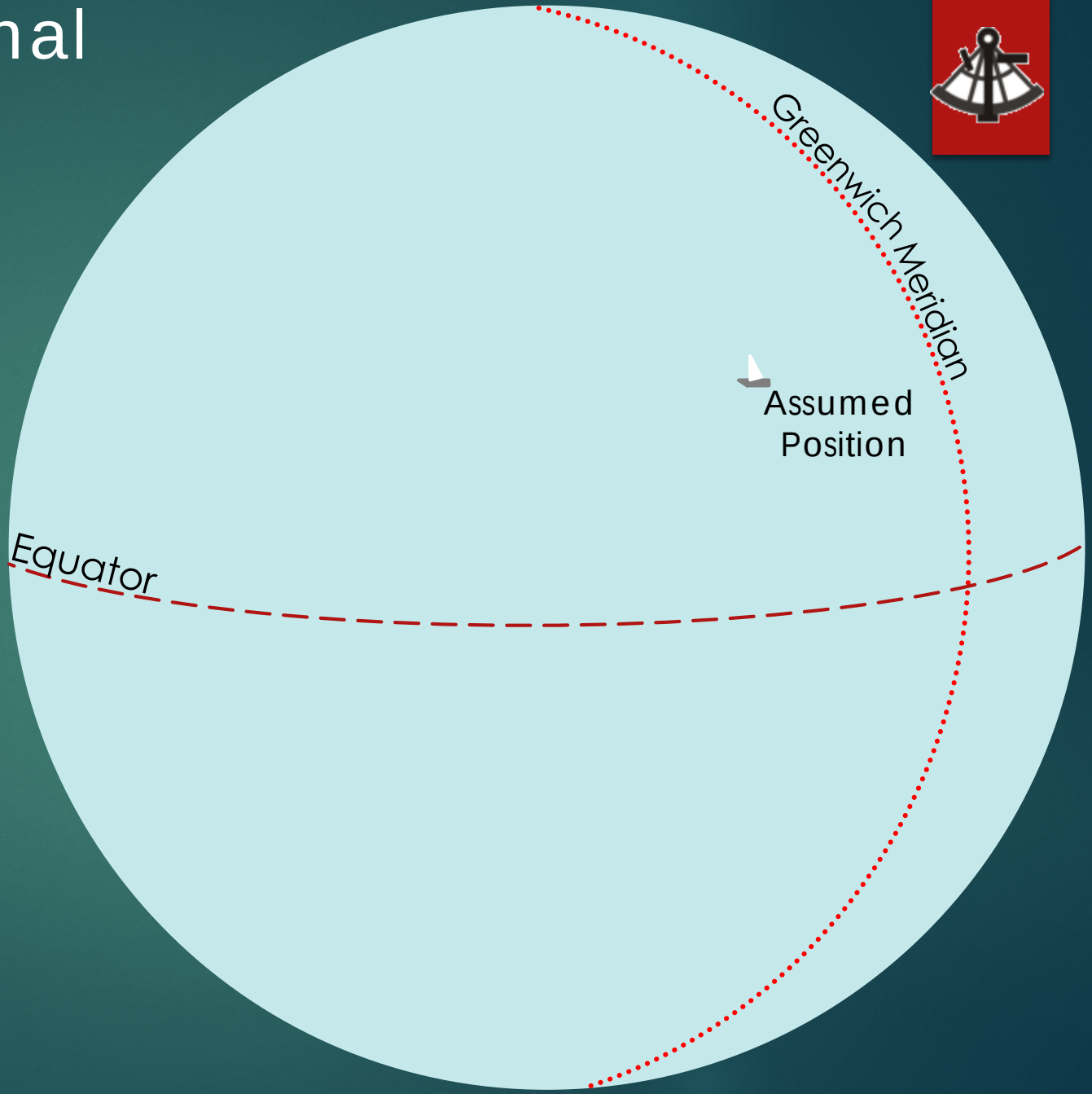
LHA of body east of observer

+

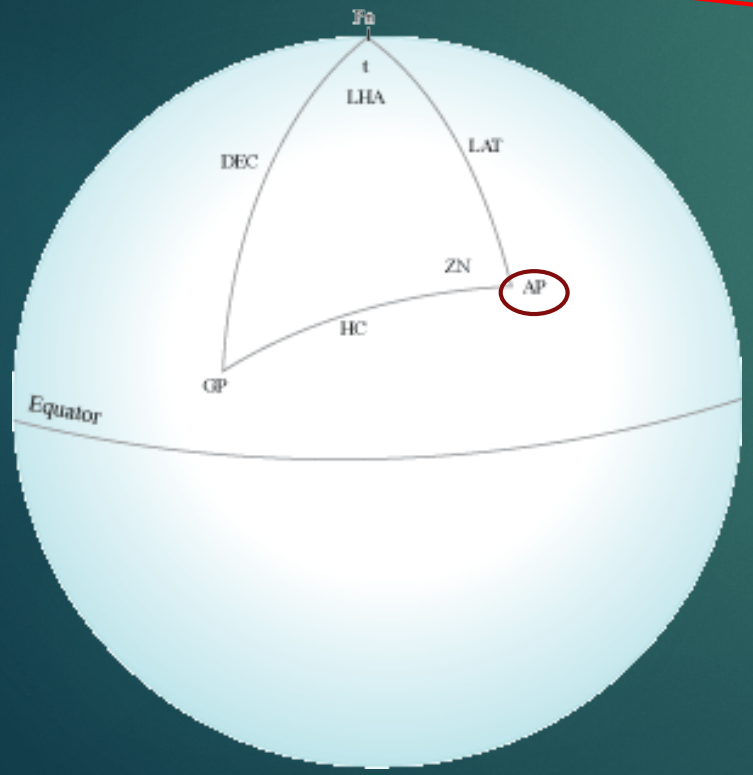
= 360 degrees

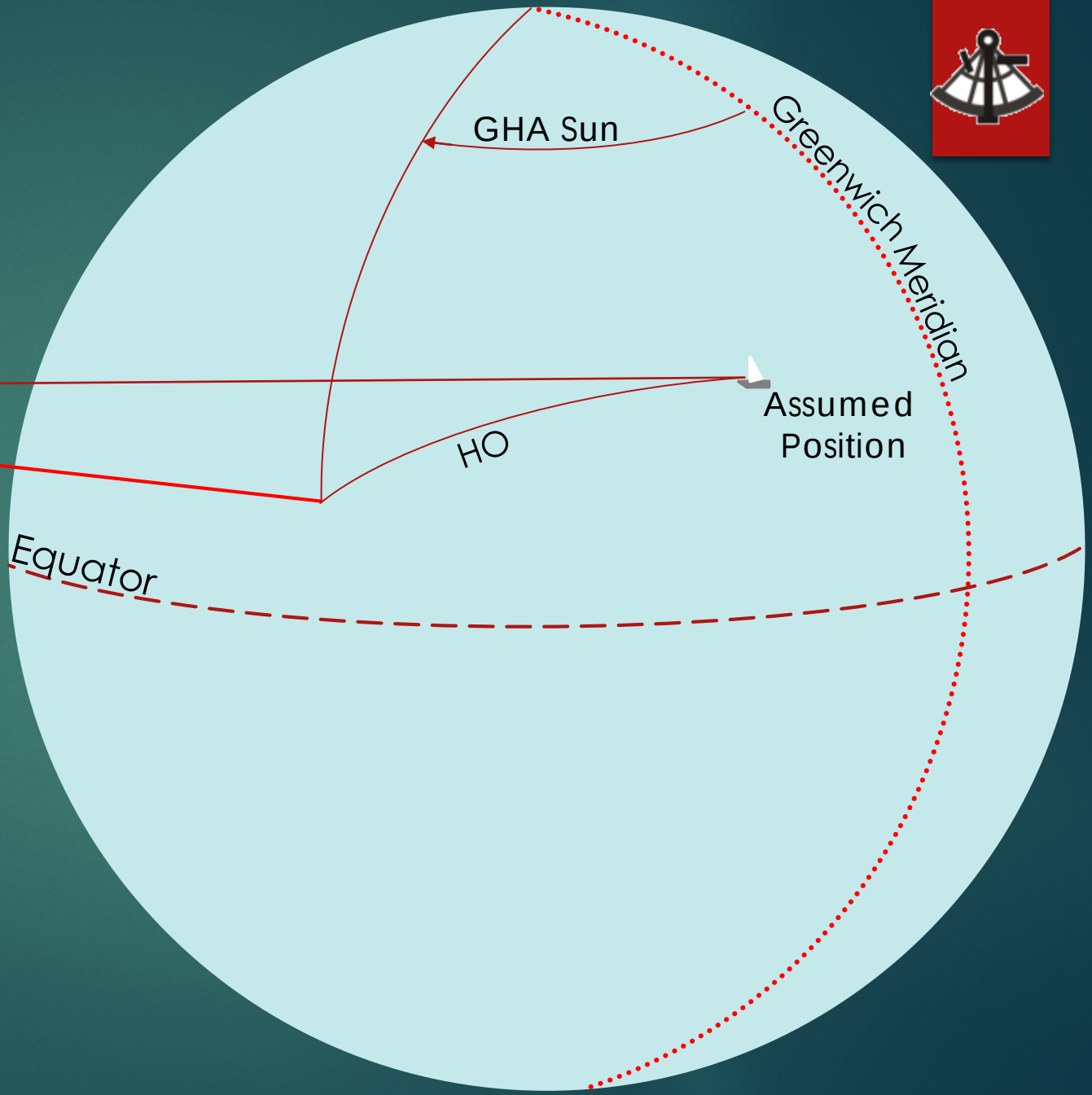
Let’s build the navigational triangle
Using the sun and our position





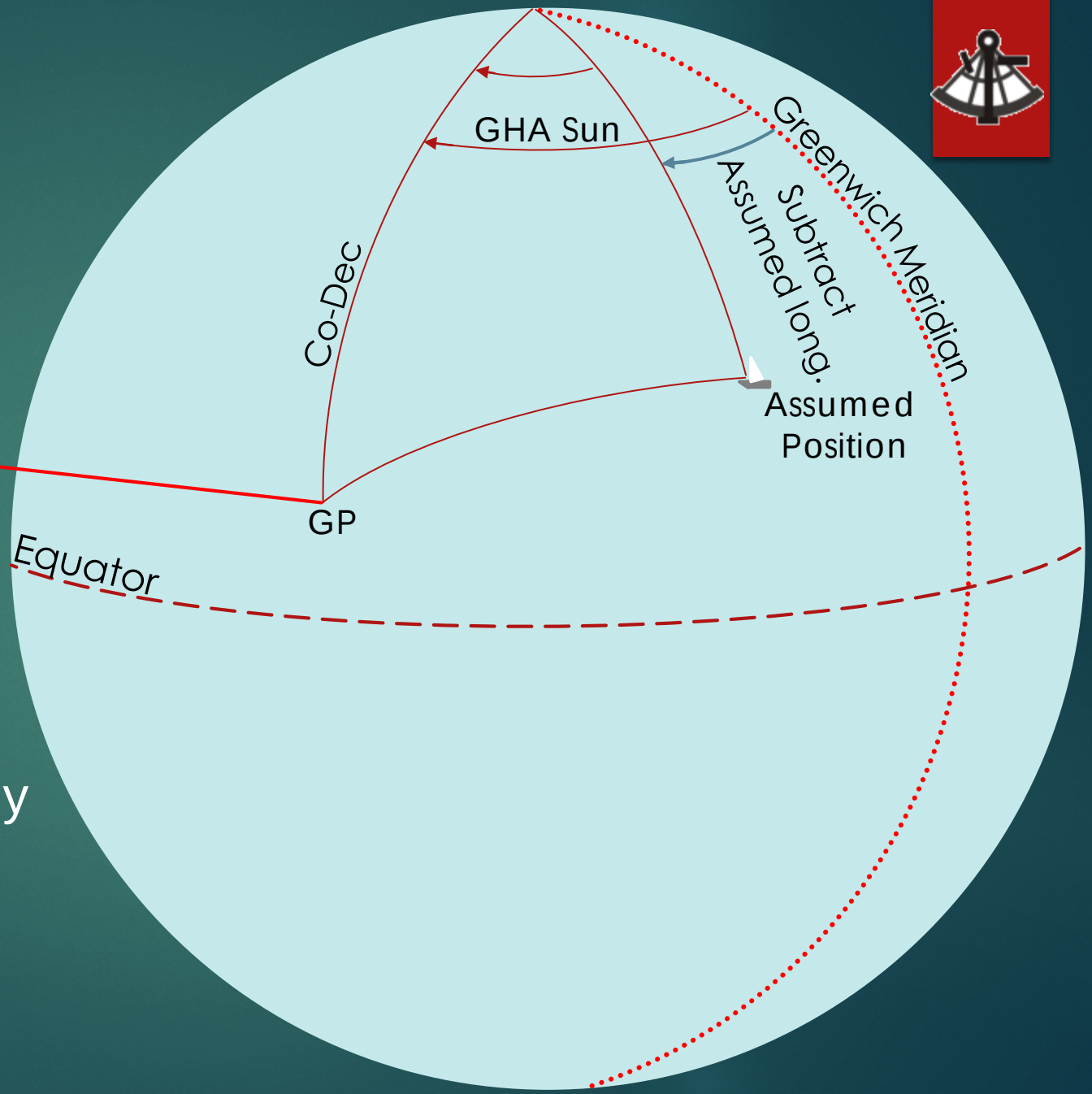
- Measure the HO
- Record the exact time
- Convert time to GHA





- Measure the HO
- At the exact time
- Convert time to GHA
- Subtract your longitude for LHA

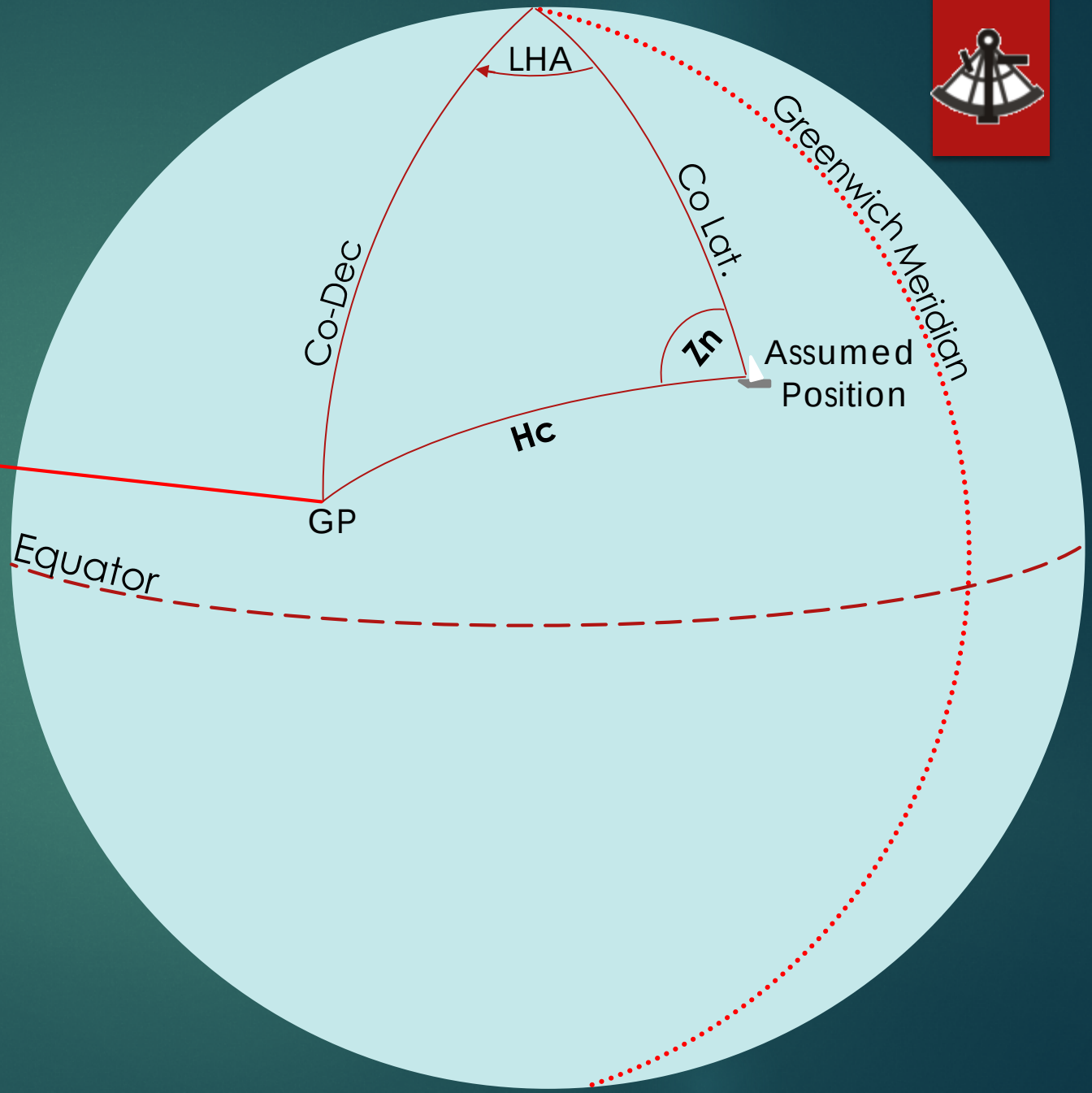
(*add* in East longitude)



We now have the GP of the body
And one side of the triangle

You now have:

- two sides
- and an angle

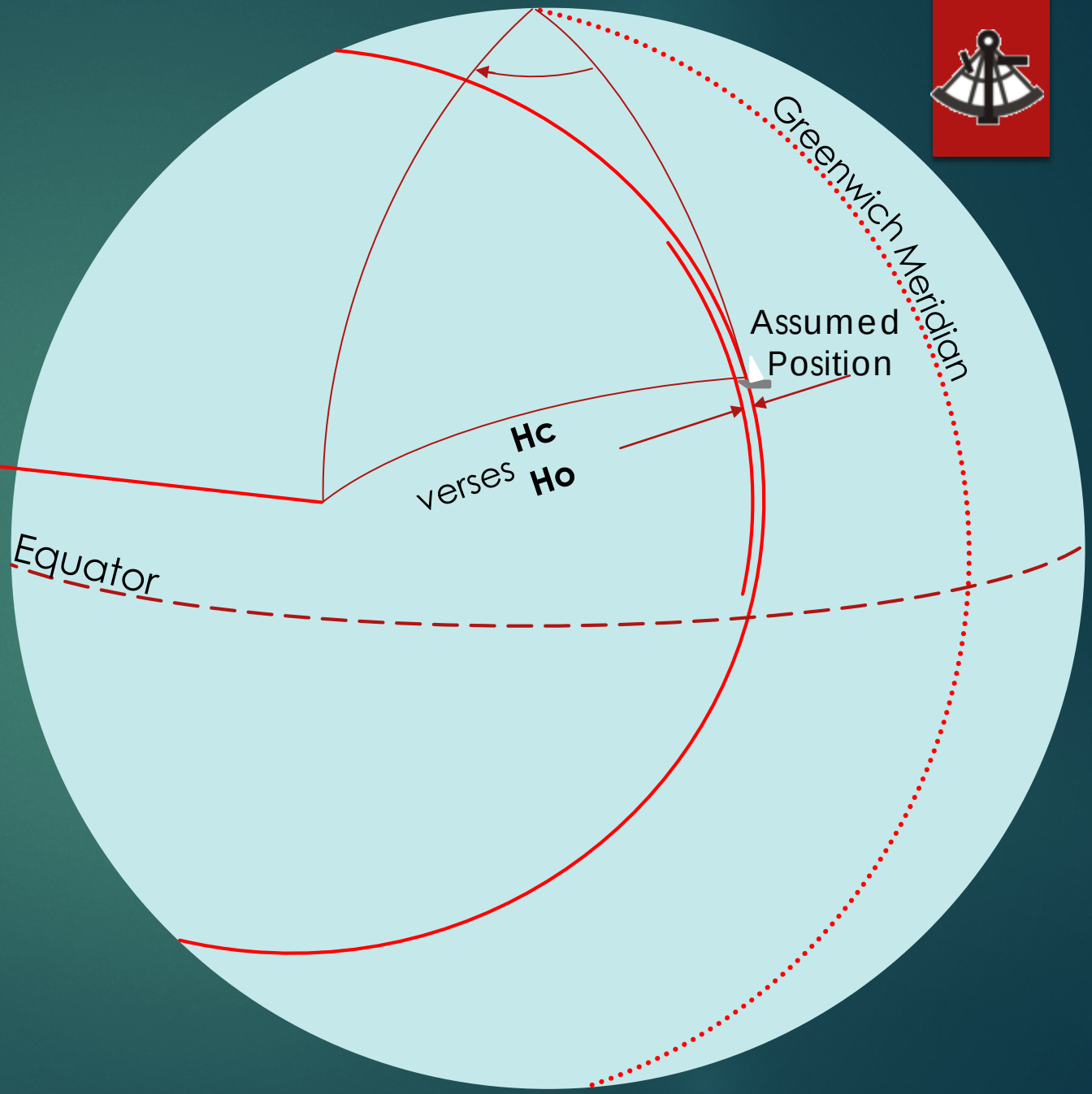


Solve for ZN and HC
(look them up in the tables)

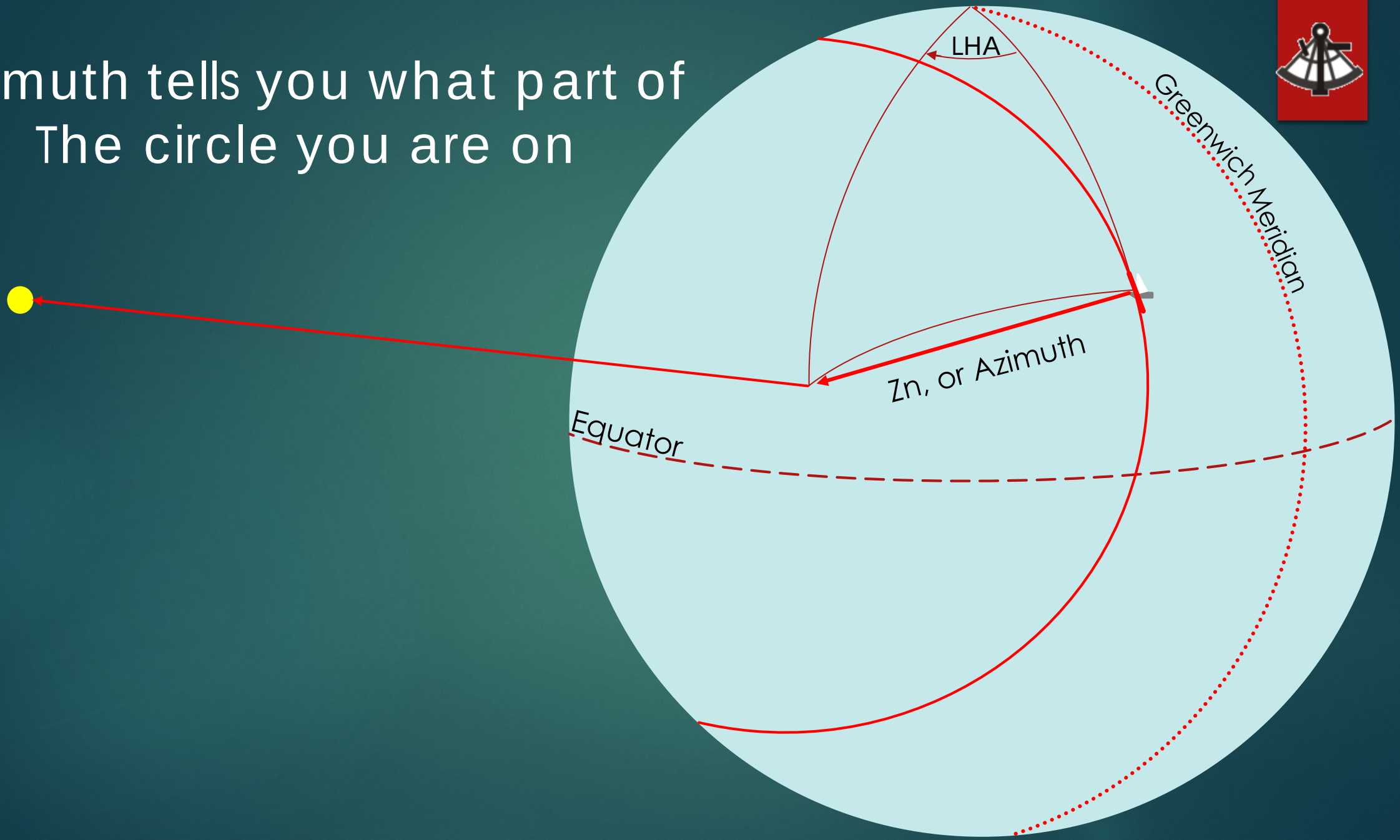
Called the ***Intercept,***

Take the difference between
The Computed, or HC altitude
And the HO,
or as-measured altitude

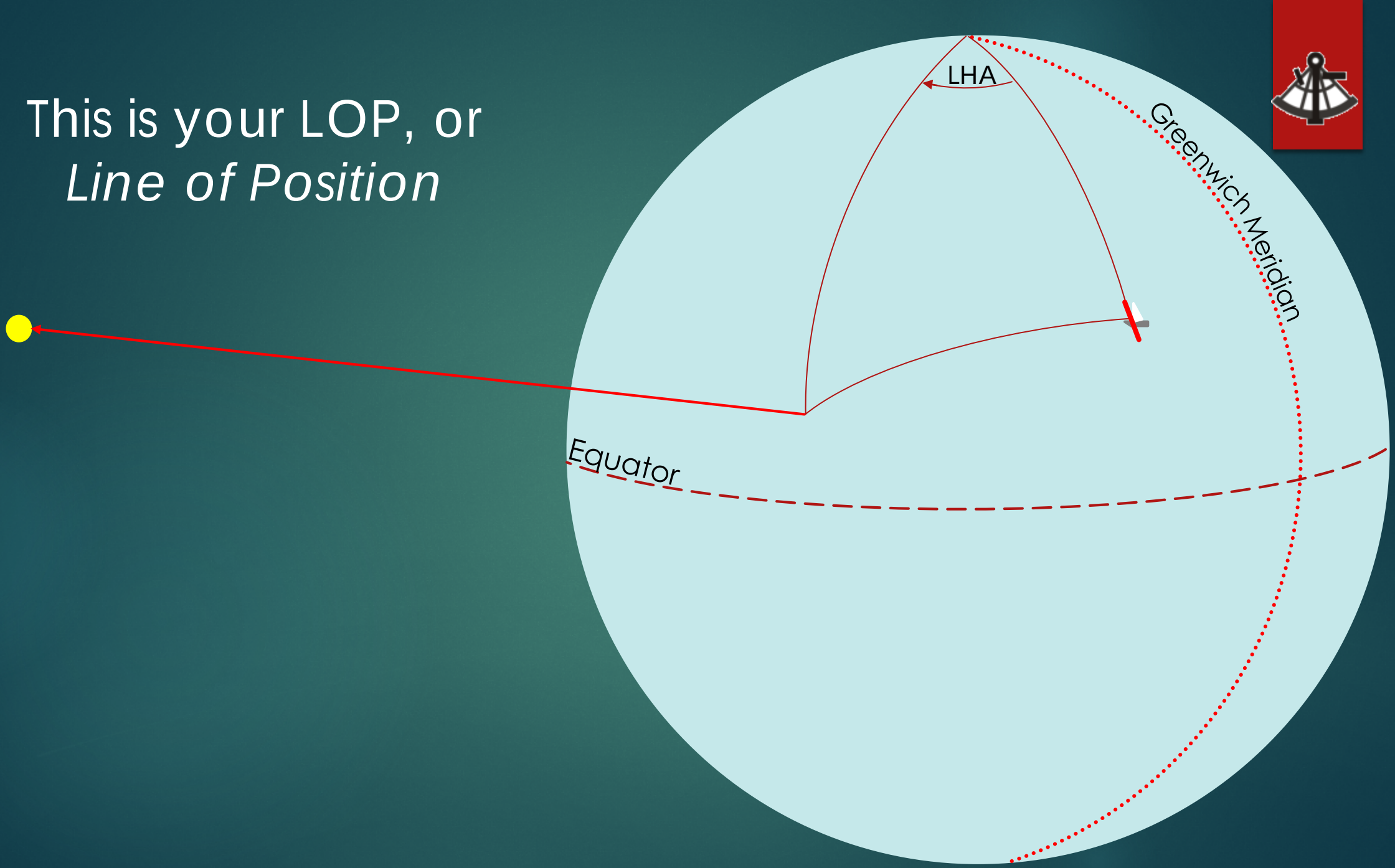
To plot *line of position*



Azimuth tells you what part of The circle you are on



This is your LOP, or
Line of Position



Sample Program

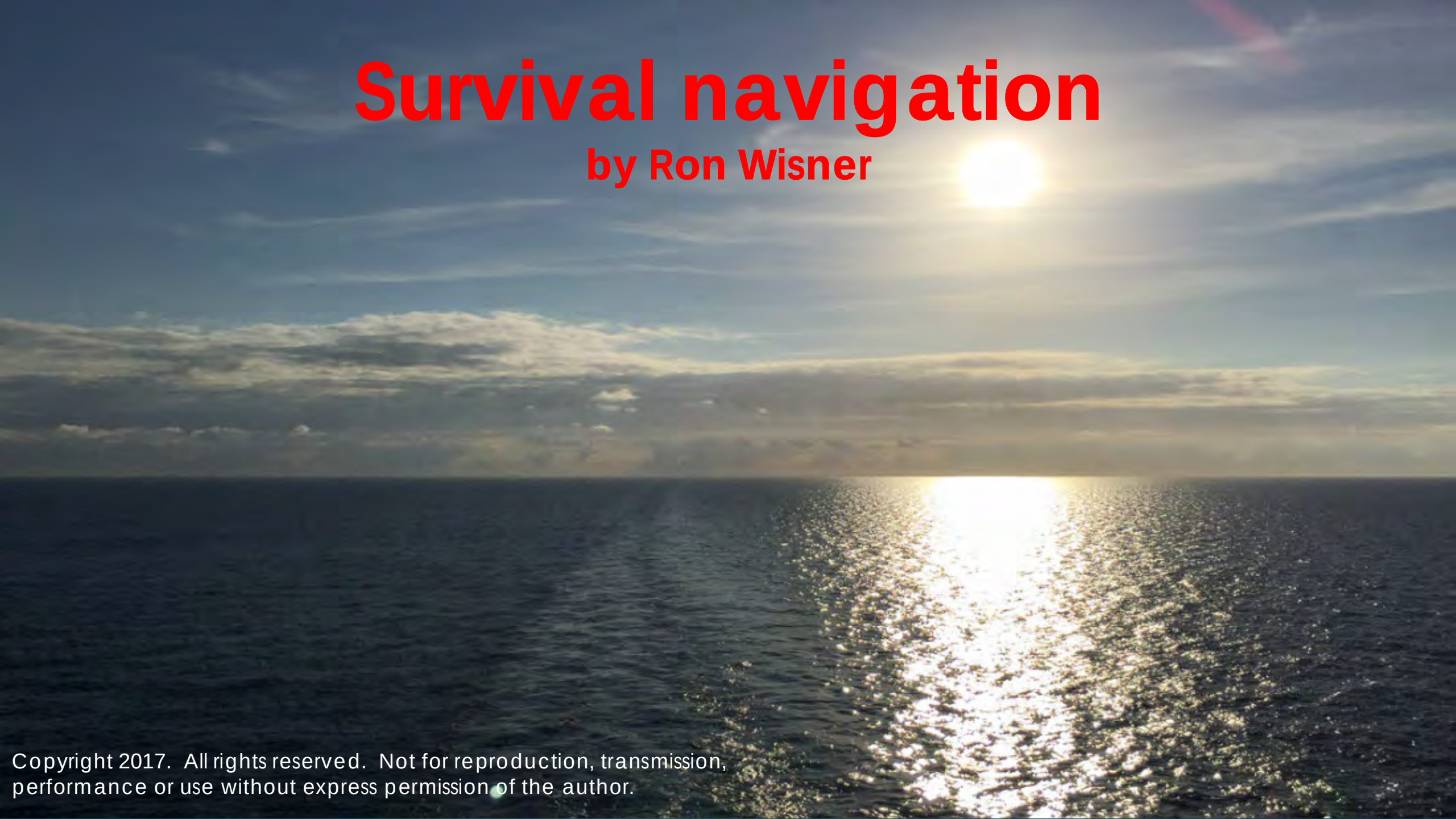
Excerpts

Survival Navigation

NATIONAL SAILING PROGRAMS SYMPOSIUM 2019

Survival navigation

by Ron Wisner



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100’ Ketch off Cape Hatteras

November 29
15:30

Getting my
deck gear on for my
16:00 watch

I hear the bilge alarm

We lost all electronics

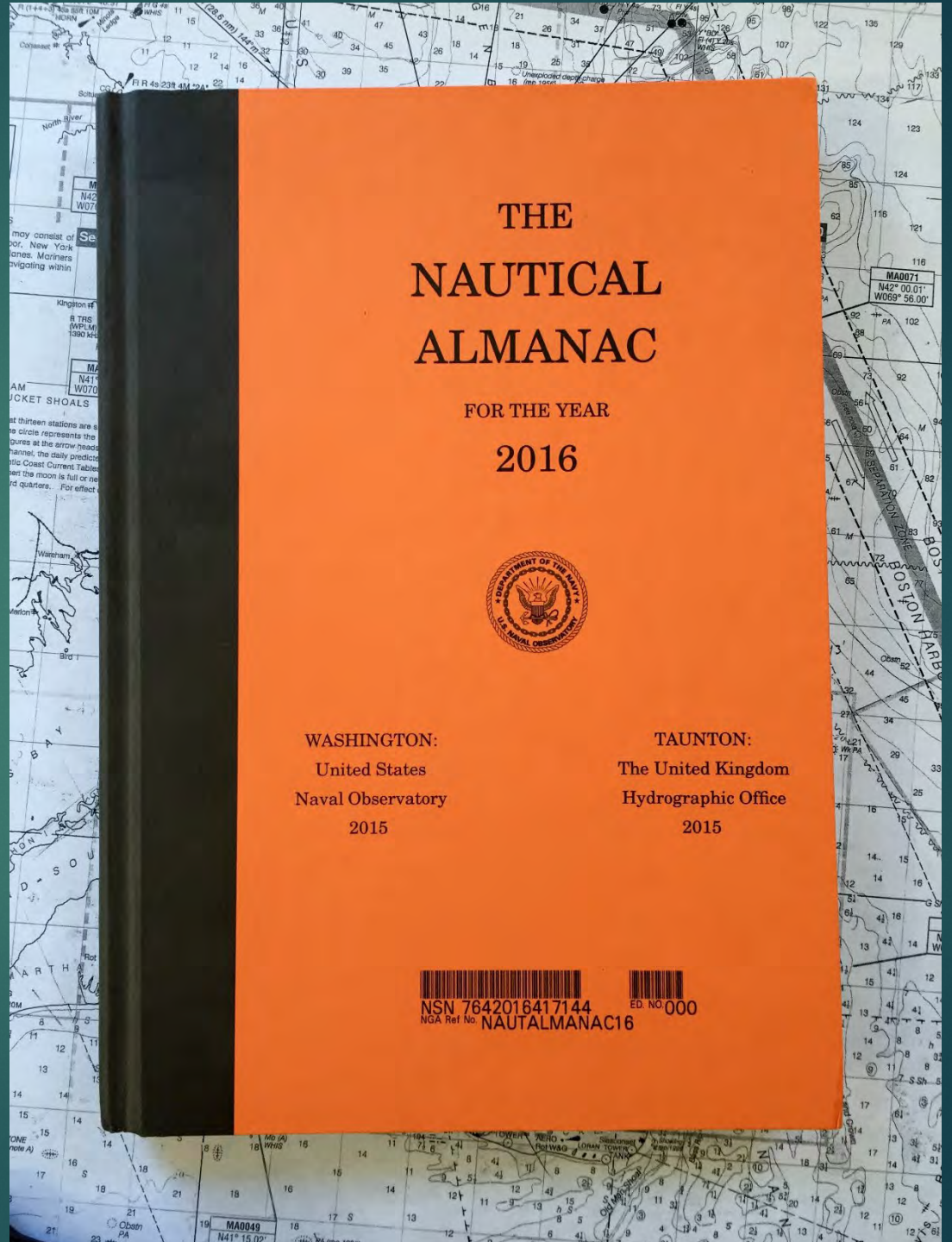
Survival navigation

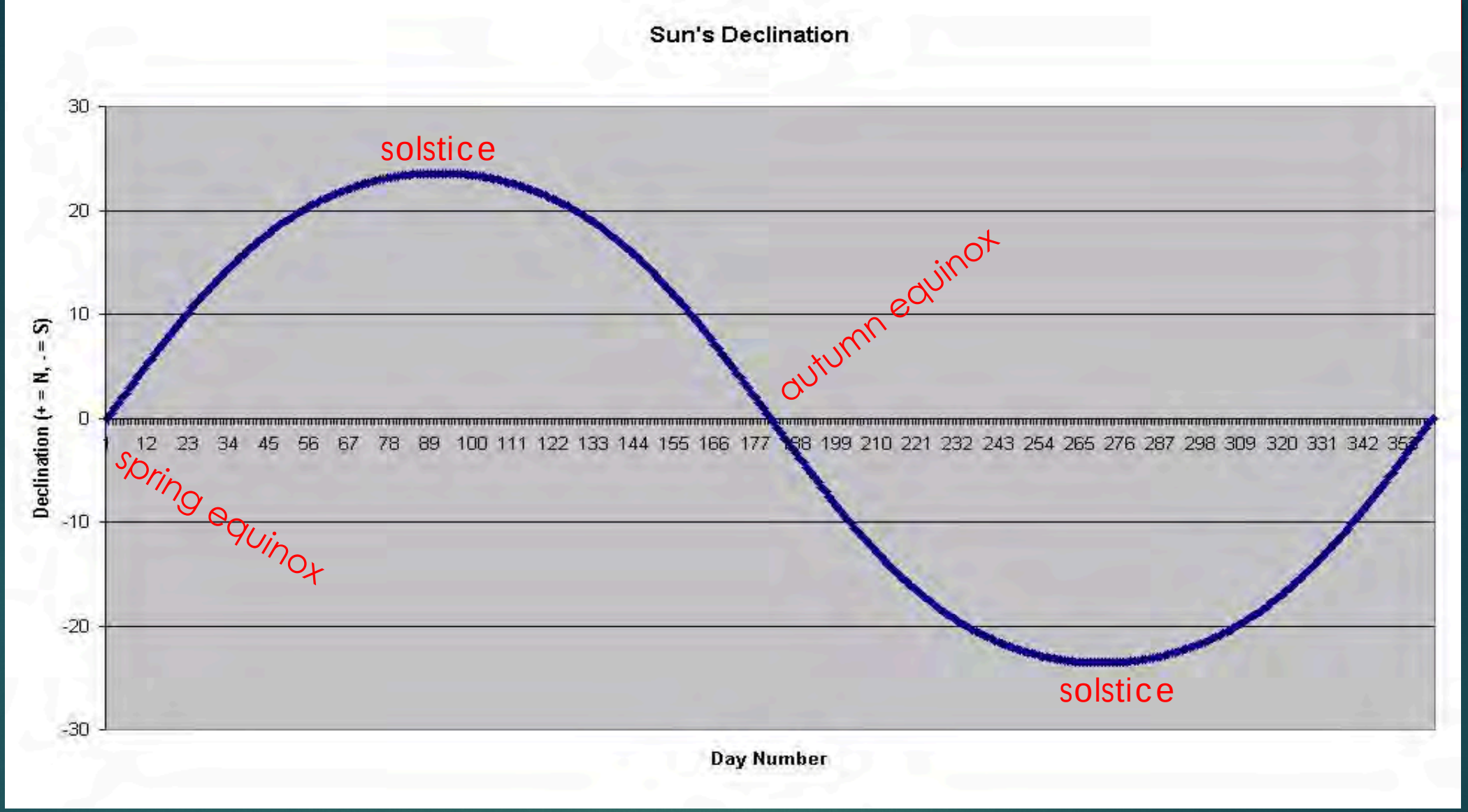
- No electronics
- No clock
- No almanac
- No sextant

When the sun is on your meridian you can measure it’s altitude to find your latitude.

Problem:

You don’t have an almanac



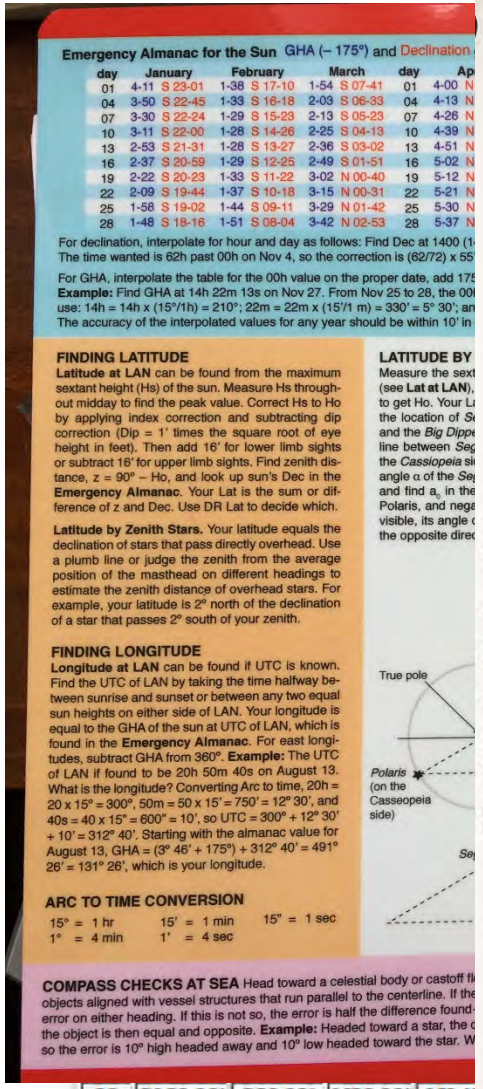


But you know this:

Every 182 days the Sun goes from 23.5 North to 23.5 South

Or Keep this on your boat:

Mean Declination For every day of the year



Emergency Almanac for the Sun GHA (– 175°) and Declination

day	January	February	March	day	Ap
01	4-11 S 23-01	1-38 S 17-10	1-54 S 07-41	01	4-00 N
04	3-50 S 22-45	1-33 S 16-18	2-03 S 06-33	04	4-13 N
07	3-30 S 22-24	1-29 S 15-23	2-13 S 05-23	07	4-26 N
10	3-11 S 22-00	1-28 S 14-26	2-25 S 04-13	10	4-39 N
13	2-53 S 21-31	1-28 S 13-27	2-36 S 03-02	13	4-51 N
16	2-37 S 20-59	1-29 S 12-25	2-49 S 01-51	16	5-02 N
19	2-22 S 20-23	1-33 S 11-22	3-02 N 00-40	19	5-12 N
22	2-09 S 19-44	1-37 S 10-18	3-15 N 00-31	22	5-21 N
25	1-58 S 19-02	1-44 S 09-11	3-29 N 01-42	25	5-30 N
28	1-48 S 18-16	1-51 S 08-04	3-42 N 02-53	28	5-37 N

For declination, interpolate for hour and day as follows: Find Dec at 1400 (1
The time wanted is 62h past 00h on Nov 4, so the correction is (62/72) x 55

For GHA, interpolate the table for the 00h value on the proper date, add 175
Example: Find GHA at 14h 22m 13s on Nov 27. From Nov 25 to 28, the 00
use: 14h = 14h x (15°/1h) = 210°; 22m = 22m x (15'/1 m) = 330' = 5° 30'; an
The accuracy of the interpolated values for any year should be within 10' in

FINDING LATITUDE

Latitude at LAN can be found from the maximum sextant height (Hs) of the sun. Measure Hs throughout midday to find the peak value. Correct Hs to Ho by applying index correction and subtracting dip correction (Dip = 1' times the square root of eye height in feet). Then add 16' for lower limb sights or subtract 16' for upper limb sights. Find zenith distance, z = 90° – Ho, and look up sun's Dec in the **Emergency Almanac**. Your Lat is the sum or difference of z and Dec. Use DR Lat to decide which.

Latitude by Zenith Stars. Your latitude equals the declination of stars that pass directly overhead. Use a plumb line or judge the zenith from the average position of the masthead on different headings to estimate the zenith distance of overhead stars. For example, your latitude is 2° north of the declination of a star that passes 2° south of your zenith.

FINDING LONGITUDE

Longitude at LAN can be found if UTC is known. Find the UTC of LAN by taking the time halfway between sunrise and sunset or between any two equal sun heights on either side of LAN. Your longitude is equal to the GHA of the sun at UTC of LAN, which is found in the **Emergency Almanac**. For east longitudes, subtract GHA from 360°. **Example:** The UTC of LAN if found to be 20h 50m 40s on August 13. What is the longitude? Converting Arc to time, 20h = 20 x 15° = 300°, 50m = 50 x 15' = 750' = 12° 30', and 40s = 40 x 15" = 600" = 10', so UTC = 300° + 12° 30' + 10' = 312° 40'. Starting with the almanac value for August 13, GHA = (3° 46' + 175°) + 312° 40' = 491° 26' = 131° 26', which is your longitude.

ARC TO TIME CONVERSION

15° = 1 hr 15' = 1 min 15" = 1 sec
1° = 4 min 1' = 4 sec

LATITUDE BY

Measure the sext
(see **Lat at LAN**),
to get Ho. Your L
the location of *S*
and the *Big Dippe*
line between *Seg*
the *Cassiopeia* si
angle α of the *Se*
and find a_o in the
Polaris, and nega
visible, its angle
the opposite direc

True pole

Polaris (on the Casseopeia side)

Se

COMPASS CHECKS AT SEA Head toward a celestial body or castoff fi
objects aligned with vessel structures that run parallel to the centerline. If the
error on either heading. If this is not so, the error is half the difference found
the object is then equal and opposite. **Example:** Headed toward a star, the c
so the error is 10° high headed away and 10° low headed toward the star. W

29	S18° 09'	S8° 03'	N3° 09'	N14
30	S17° 53'		N3° 32'	N14
31	S17° 37'		N3° 55'	

The Sun's Declination 2018

For celestial navigators, the "noon sight" reading of the Sun's height above the horizon, together with the Sun's Declination from this table, determines latitude.

The Sun's Declination 2018

MEAN NOON – 75° MERIDIAN (1700 G.M.T.)

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	
	South ° '	South ° '	South ° '	North ° '	North ° '	North ° '	North ° '	North ° '	North ° '	South ° '	South ° '	South ° '	
1	-22 58	-16 58	-7 25	+4 43	+15 12	+22 07	+23 04	+17 54	+8 07	-3 21	-14 34	-21 52	1
2	-22 52	-16 41	-7 02	+5 06	+15 30	+22 14	+22 60	+17 39	+7 45	-3 45	-14 53	-22 01	2
3	-22 46	-16 23	-6 39	+5 29	+15 48	+22 22	+22 55	+17 23	+7 23	-4 08	-15 12	-22 09	3
4	-22 40	-16 05	-6 16	+5 51	+16 05	+22 29	+22 50	+17 07	+7 01	-4 31	-15 30	-22 17	4
5	-22 33	-15 47	-5 53	+6 14	+16 23	+22 35	+22 44	+16 51	+6 39	-4 54	-15 48	-22 25	5
6	-22 26	-15 29	-5 30	+6 37	+16 39	+22 42	+22 38	+16 34	+6 16	-5 17	-16 06	-22 32	6
7	-22 19	-15 10	-5 06	+6 59	+16 56	+22 47	+22 32	+16 18	+5 54	-5 40	-16 24	-22 39	7
8	-22 11	-14 51	-4 43	+7 22	+17 12	+22 53	+22 25	+16 01	+5 31	-6 03	-16 41	-22 45	8
9	-22 02	-14 32	-4 20	+7 44	+17 28	+22 58	+22 18	+15 43	+5 09	-6 26	-16 59	-22 51	9
10	-21 53	-14 12	-3 56	+8 06	+17 44	+23 02	+22 10	+15 26	+4 46	-6 48	-17 16	-22 57	10
11	-21 44	-13 53	-3 33	+8 28	+17 59	+23 07	+22 02	+15 08	+4 23	-7 11	-17 32	-23 02	11
12	-21 34	-13 33	-3 09	+8 50	+18 15	+23 10	+21 54	+14 50	+4 00	-7 34	-17 48	-23 06	12
13	-21 24	-13 12	-2 45	+9 12	+18 29	+23 14	+21 45	+14 32	+3 37	-7 56	-18 04	-23 10	13
14	-21 13	-12 52	-2 22	+9 34	+18 44	+23 17	+21 36	+14 13	+3 14	-8 18	-18 20	-23 14	14
15	-21 02	-12 31	-1 58	+9 55	+18 58	+23 19	+21 27	+13 54	+2 51	-8 41	-18 35	-23 17	15
16	-20 51	-12 11	-1 34	+10 17	+19 12	+23 22	+21 17	+13 36	+2 28	-9 03	-18 50	-23 20	16
17	-20 39	-11 50	-1 10	+10 38	+19 25	+23 23	+21 07	+13 16	+2 05	-9 25	-19 05	-23 22	17
18	-20 27	-11 28	-0 47	+10 59	+19 39	+23 25	+20 56	+12 57	+1 42	-9 46	-19 19	-23 24	18
19	-20 14	-11 07	-0 23	+11 19	+19 52	+23 26	+20 46	+12 37	+1 19	-10 08	-19 33	-23 25	19
20	-20 01	-10 46	+0 01	+11 40	+20 04	+23 26	+20 34	+12 18	+0 55	-10 30	-19 47	-23 26	20
21	-19 48	-10 24	+0 24	+12 00	+20 16	+23 26	+20 23	+11 58	+0 32	-10 51	-20 00	-23 26	21
22	-19 34	-10 02	+0 48	+12 21	+20 28	+23 26	+20 11	+11 38	+0 09	-11 12	-20 13	-23 26	22
23	-19 20	-9 40	+1 12	+12 41	+20 40	+23 25	+19 59	+11 17	-0 15	-11 33	-20 26	-23 25	23
24	-19 06	-9 18	+1 35	+13 00	+20 51	+23 24	+19 46	+10 57	-0 38	-11 54	-20 38	-23 24	24
25	-18 51	-8 56	+1 59	+13 20	+21 02	+23 22	+19 33	+10 36	-1 01	-12 15	-20 50	-23 23	25
26	-18 36	-8 33	+2 23	+13 39	+21 12	+23 20	+19 20	+10 15	-1 25	-12 35	-21 01	-23 21	26
27	-18 20	-8 11	+2 46	+13 58	+21 22	+23 18	+19 06	+9 54	-1 48	-12 55	-21 12	-23 18	27
28	-18 05	-7 48	+3 09	+14 17	+21 32	+23 15	+18 52	+9 33	-2 11	-13 16	-21 22	-23 15	28
29	-17 48		+3 33	+14 36	+21 41	+23 12	+18 38	+9 12	-2 35	-13 35	-21 33	-23 12	29
30	-17 32		+3 56	+14 54	+21 50	+23 08	+18 24	+8 50	-2 58	-13 55	-21 42	-23 08	30
31	-17 15		+4 19		+21 58		+18 09	+8 29		-14 15		-23 04	31

Vernal Equinox: March 20th, 11:15 a.m. E.S.T.
Summer Solstice: June 21st, 5:07 a.m. E.S.T.
Autumnal Equinox: September 22nd, 8:54 p.m. E.S.T.
Winter Solstice: December 21st, 5:22 p.m. E.S.T.

To find Sun's Declination in the Atlantic Time Zone (1 hour earlier than E.S.T.), take 1/24 of the difference between Day 1 and Day 2. Add or subtract this figure from Day 2 to find the Declination for Day 2.

If Declination is increasing (N. or S.), *subtract*. If Declination is decreasing (N. or S.), *add*.

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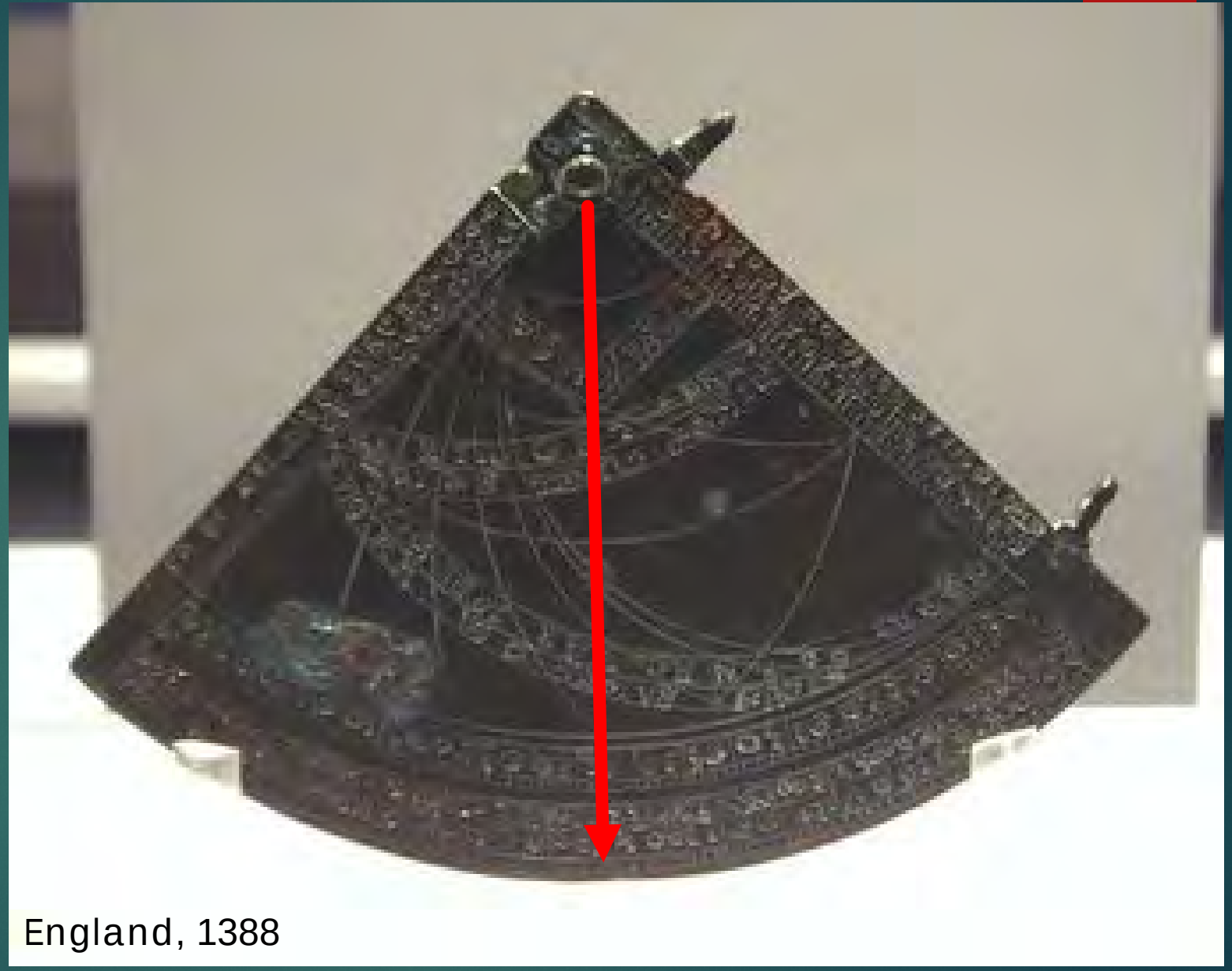
Eldridge

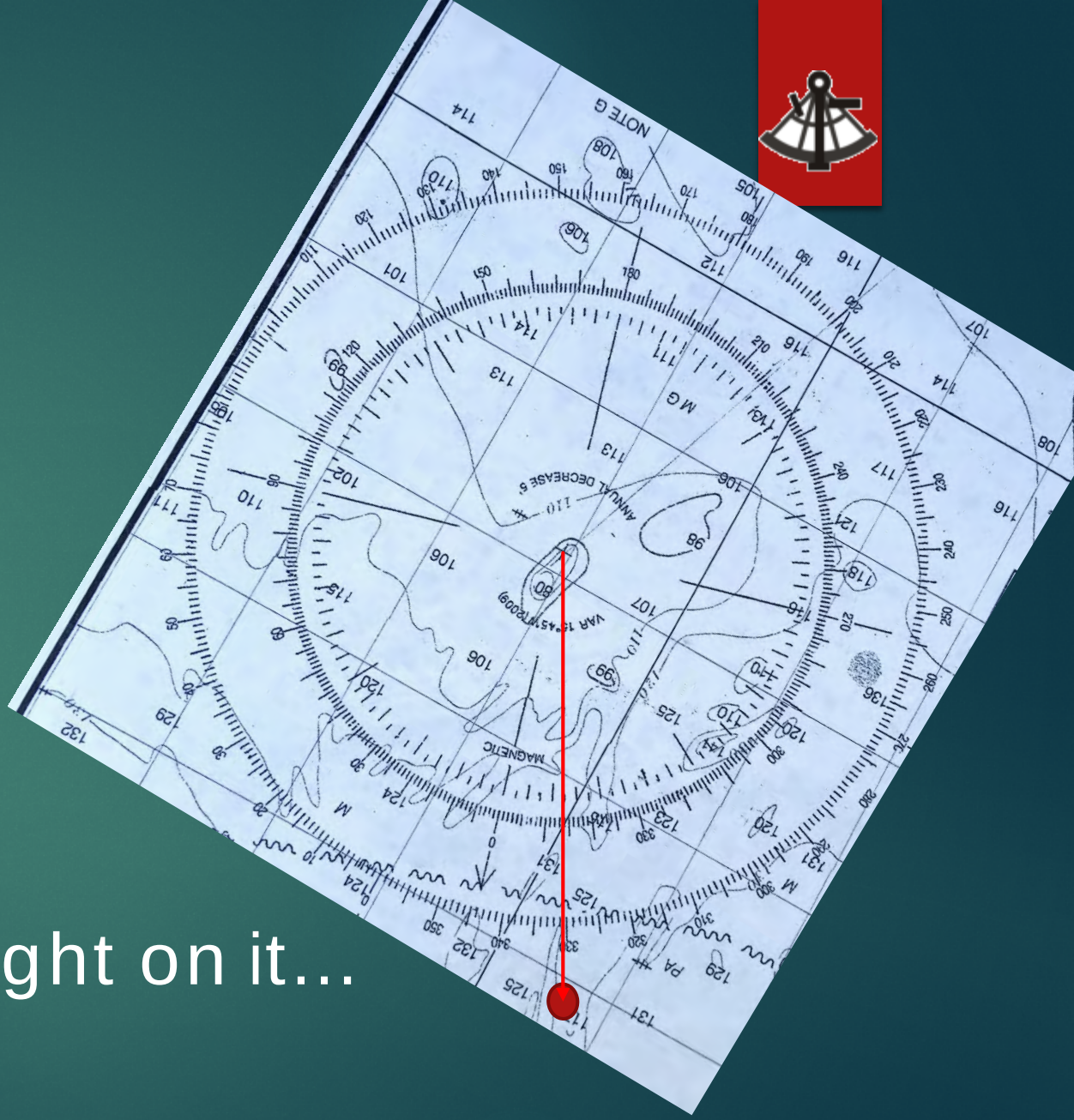
The Quadrant

A plumb bob on the Quadrant



England, 1388

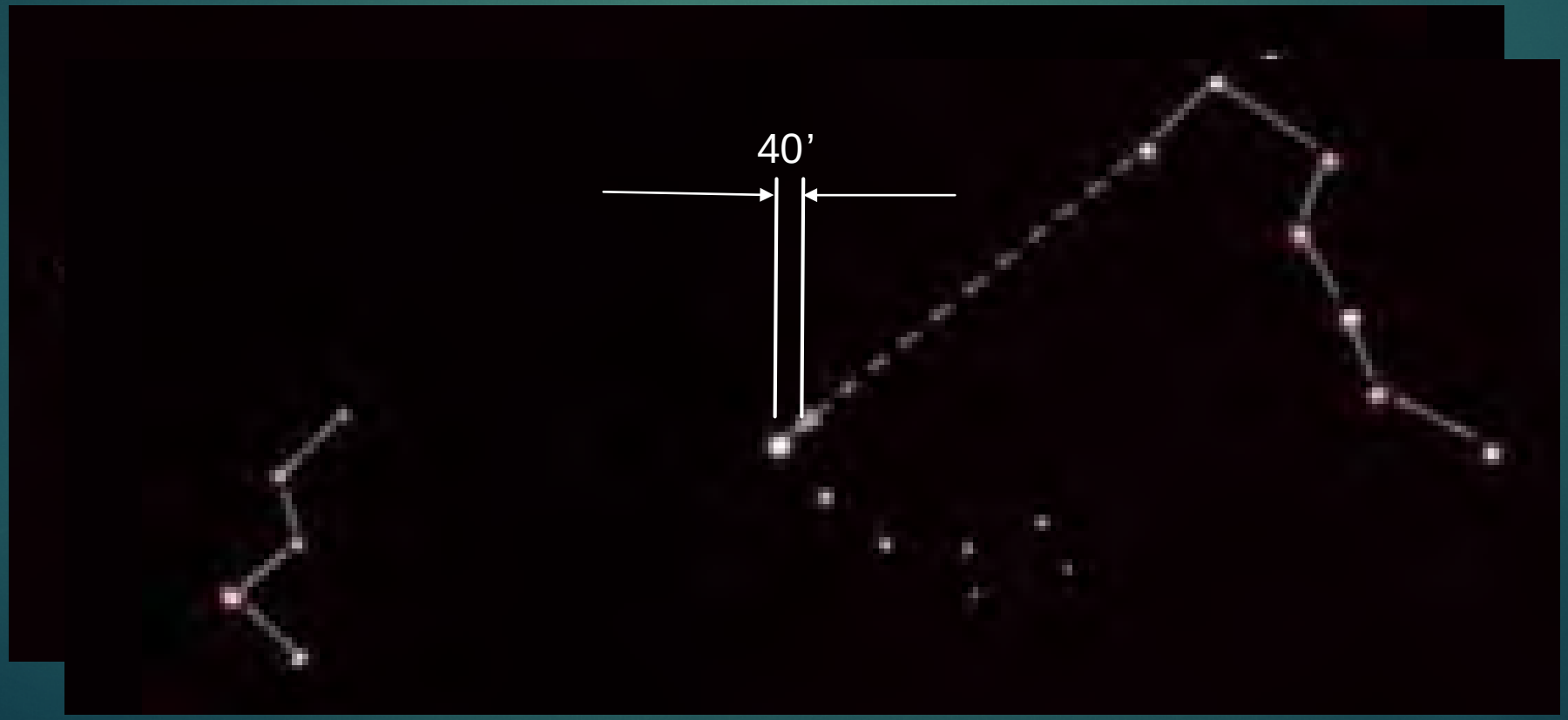
Every chart has
a compass rose

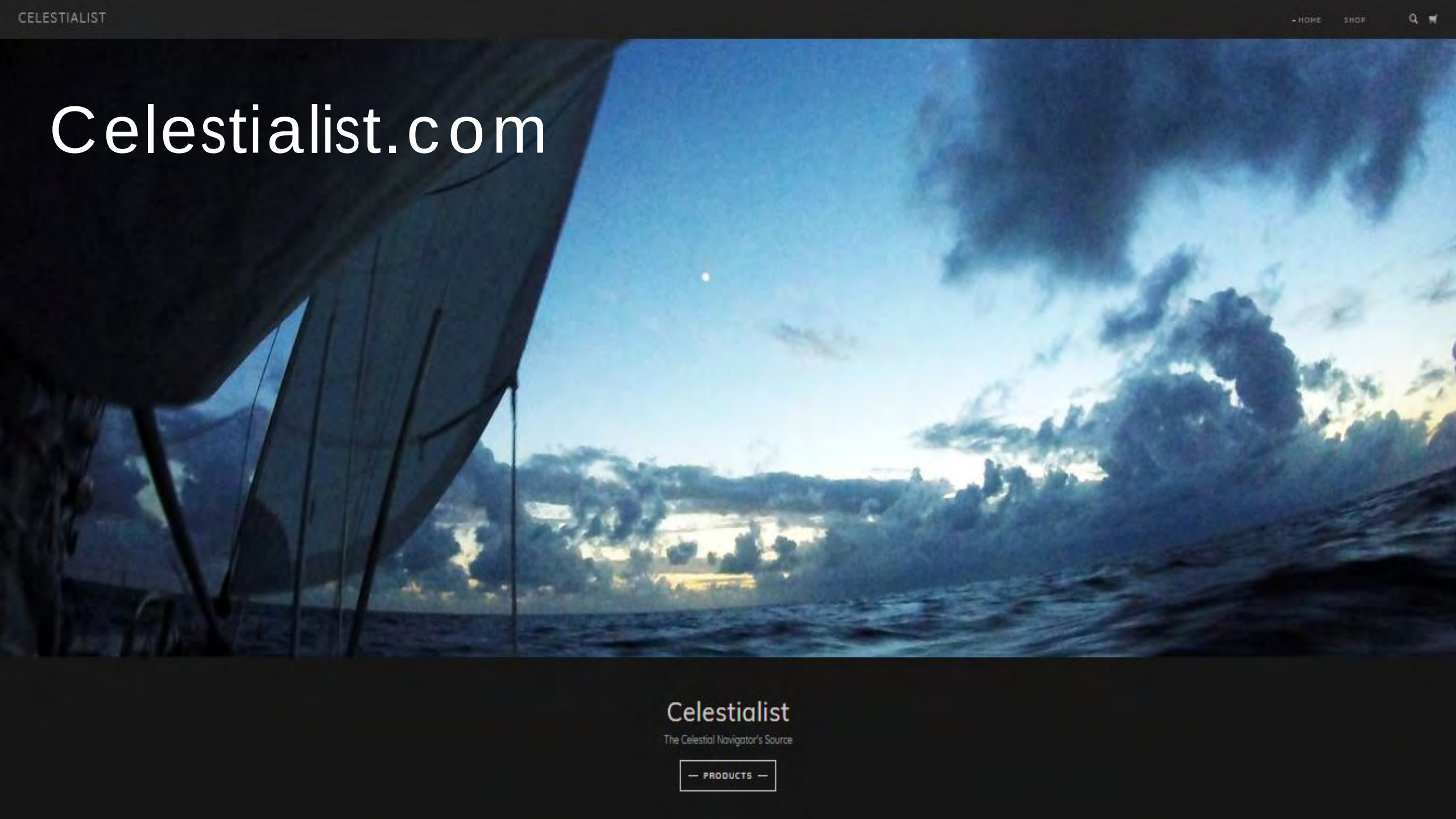


A piece of thread with a weight on it...
You’re in business

What about Polaris?

When Cassiopeia and Ursa Minor are horizontal = Zero correction

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