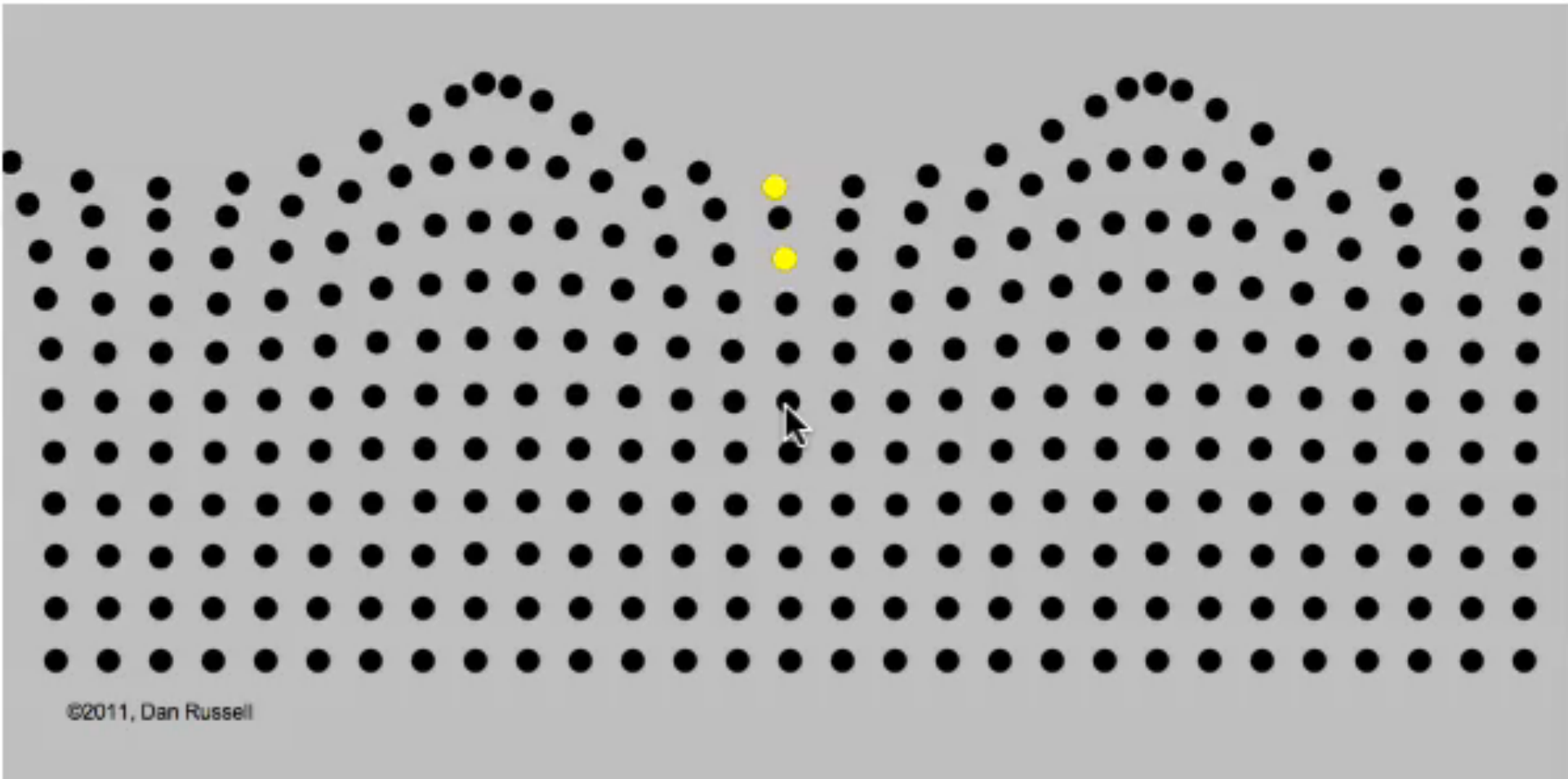


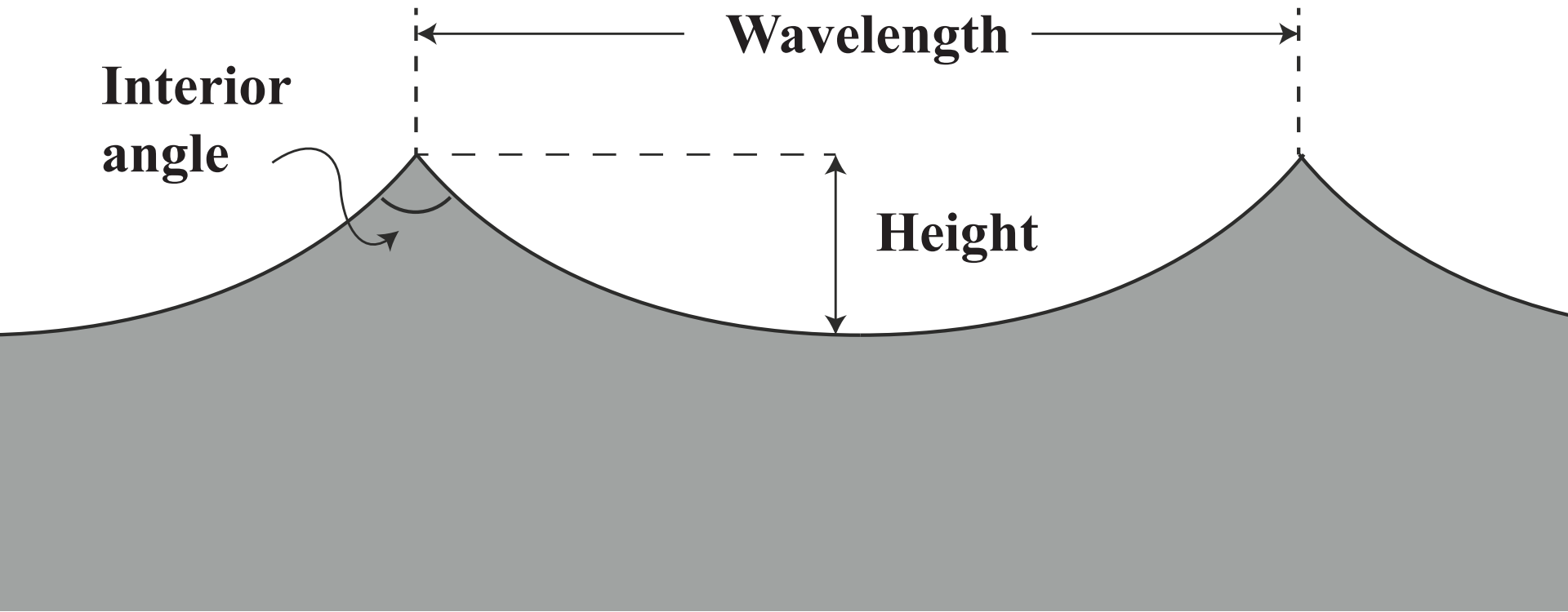
The Art of Wayfinding 2: Wave Piloting and Stick Charts of the Marshall Islands

John Huth



Water wave





Full eqn:

$$c = \sqrt{\frac{g\lambda}{2\pi} \tanh\left(2\pi \frac{d}{\lambda}\right)}$$

λ wavelength
 d depth
 g gravity

Deep

$$c = \sqrt{\frac{g\lambda}{2\pi}}$$

$$c = \sqrt{gd}$$

Shallow

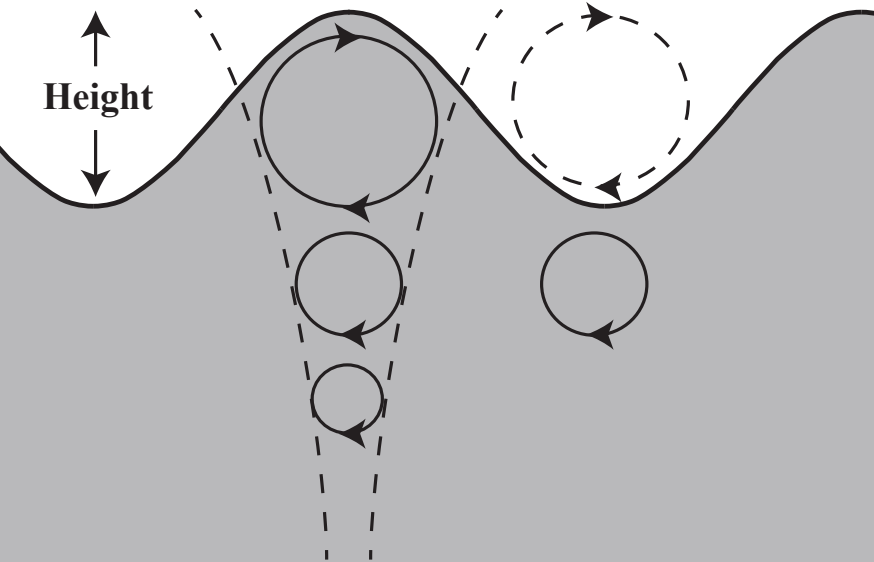
Direction of motion



Wavelength



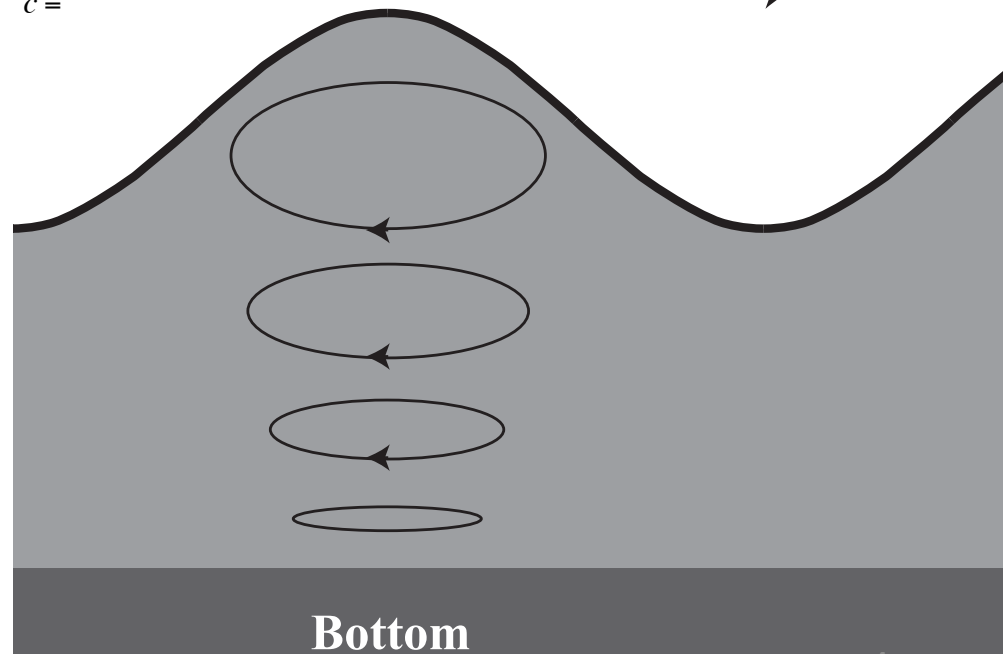
Height

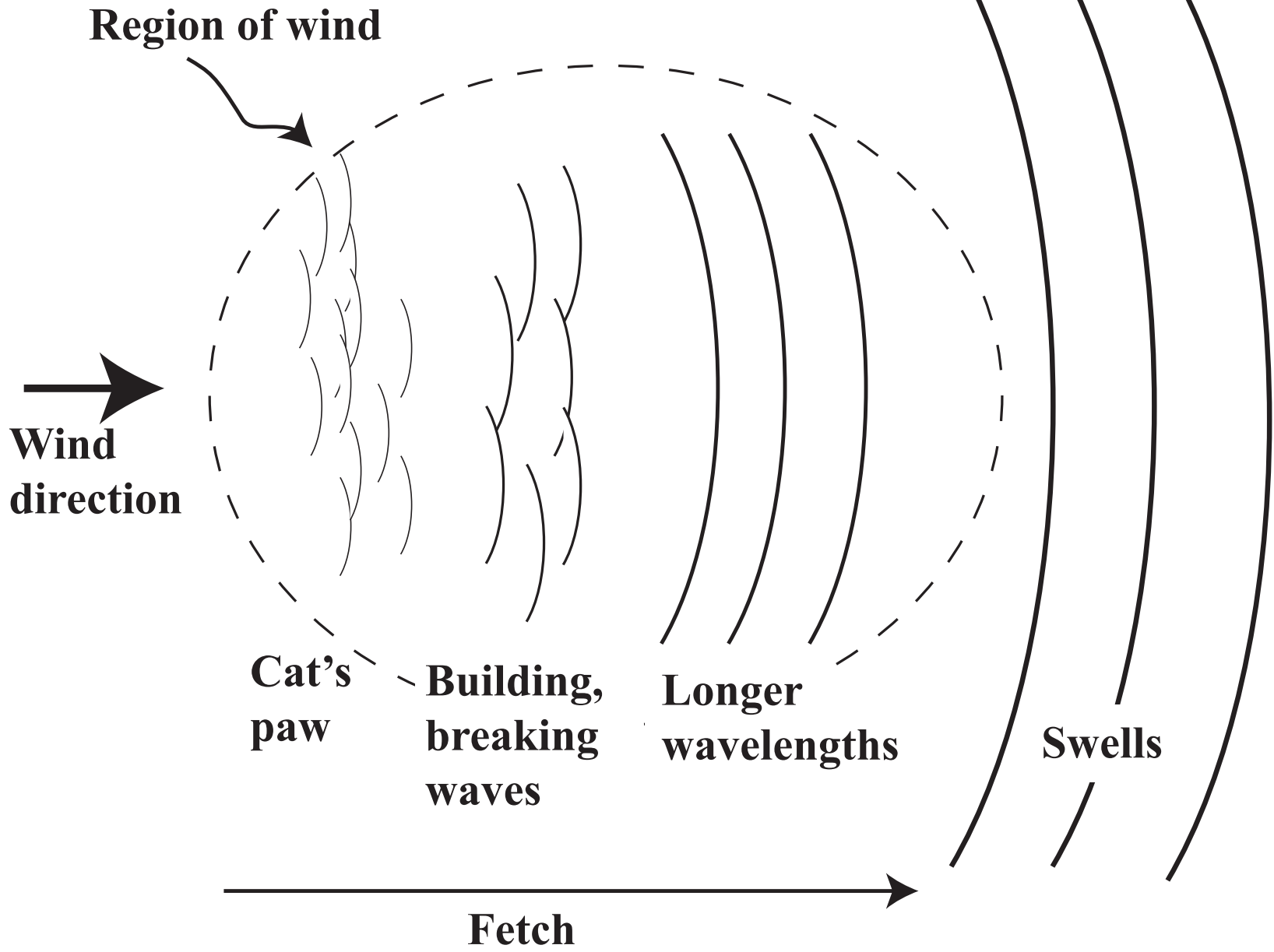


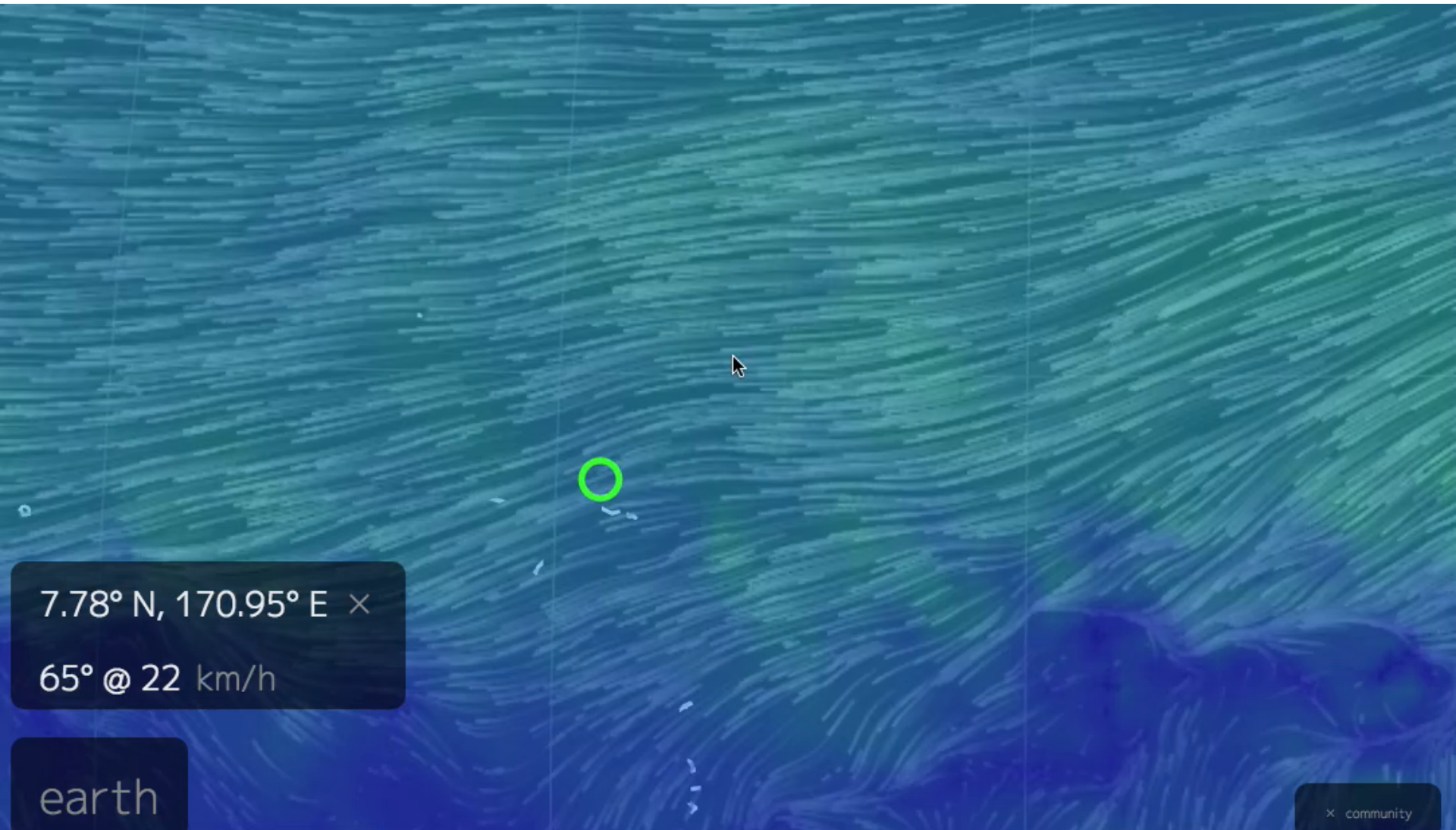
Direction of motion



$c =$









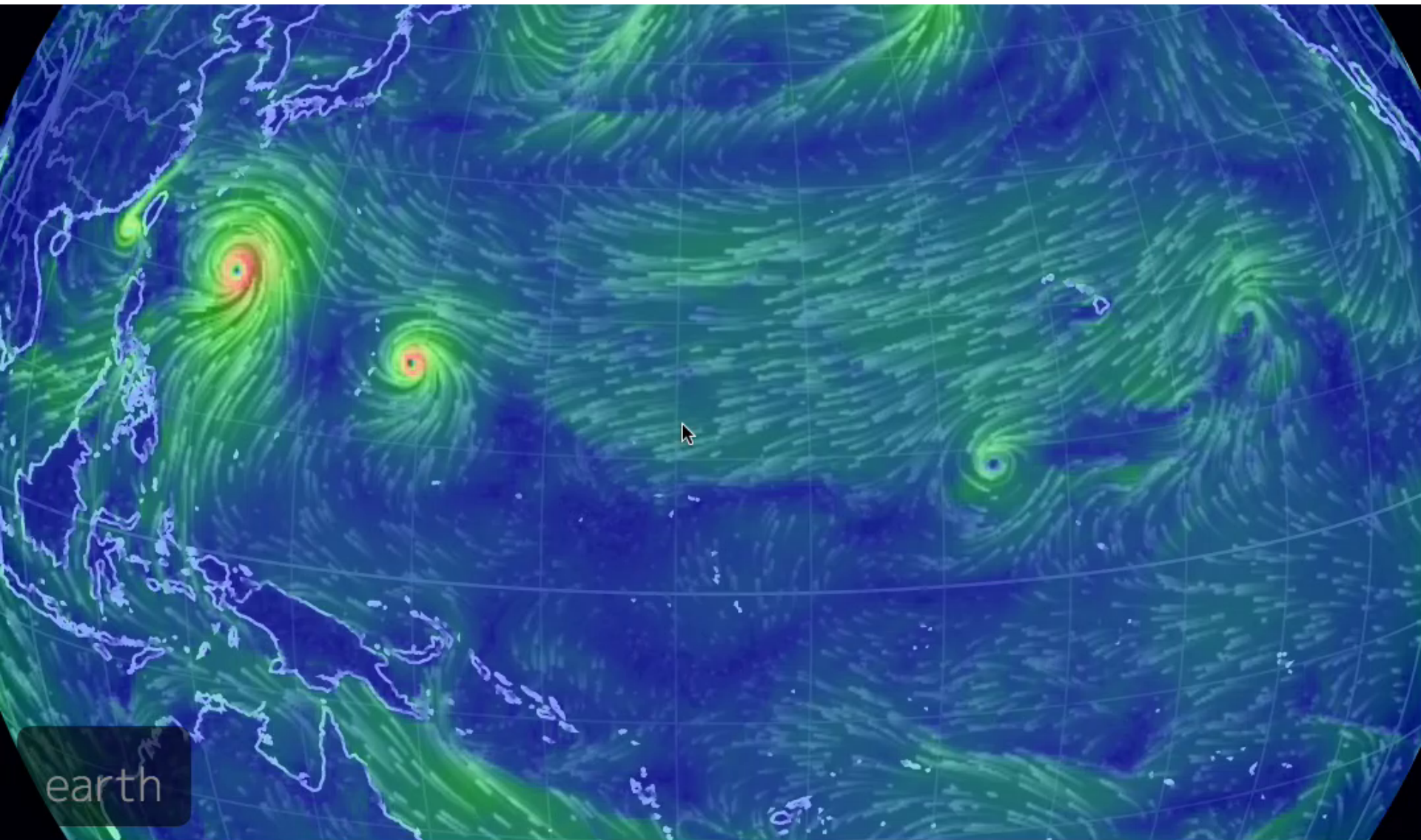
7.78° N, 170.95° E ×

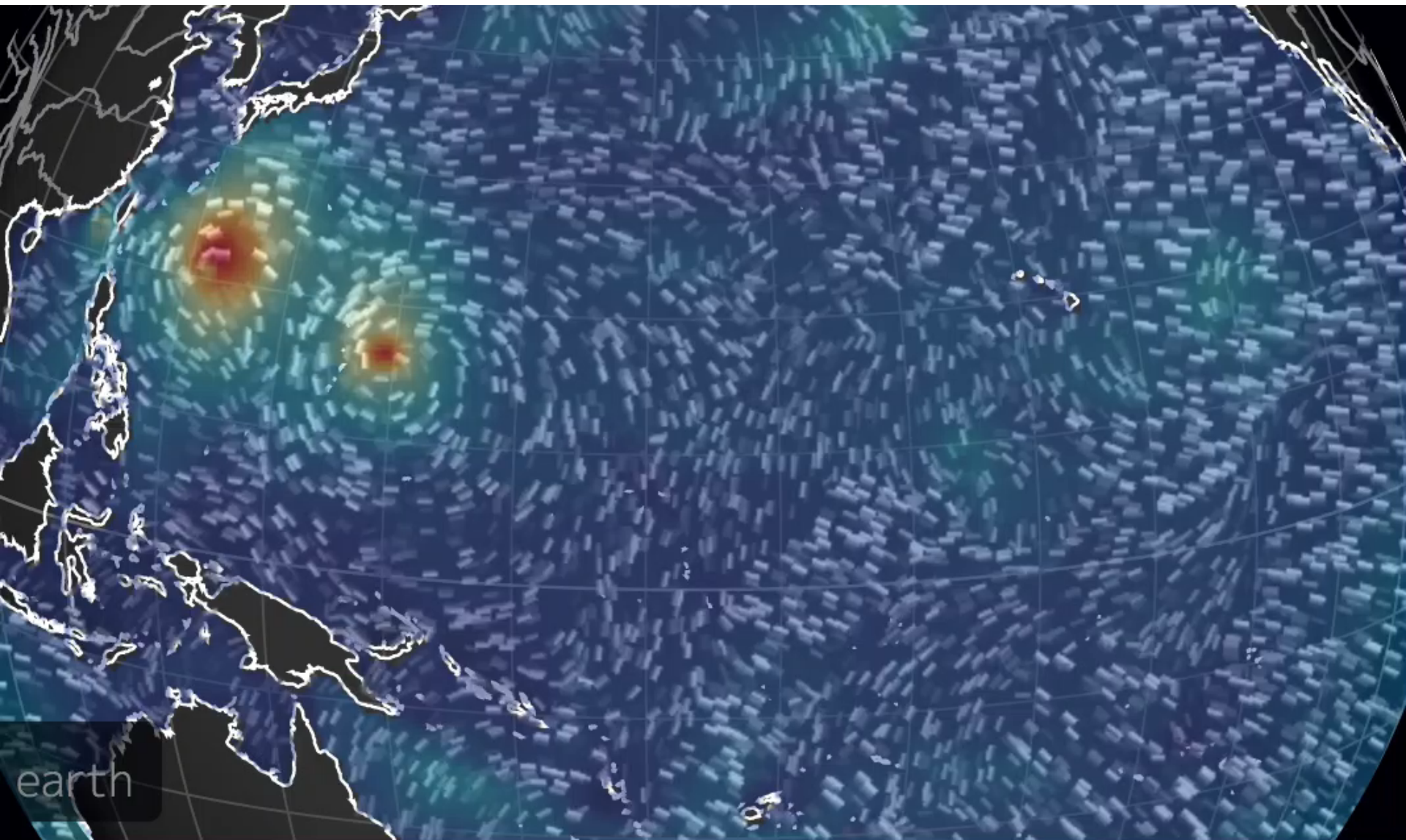
90° @ 9.5 sèc

1.44 m

earth

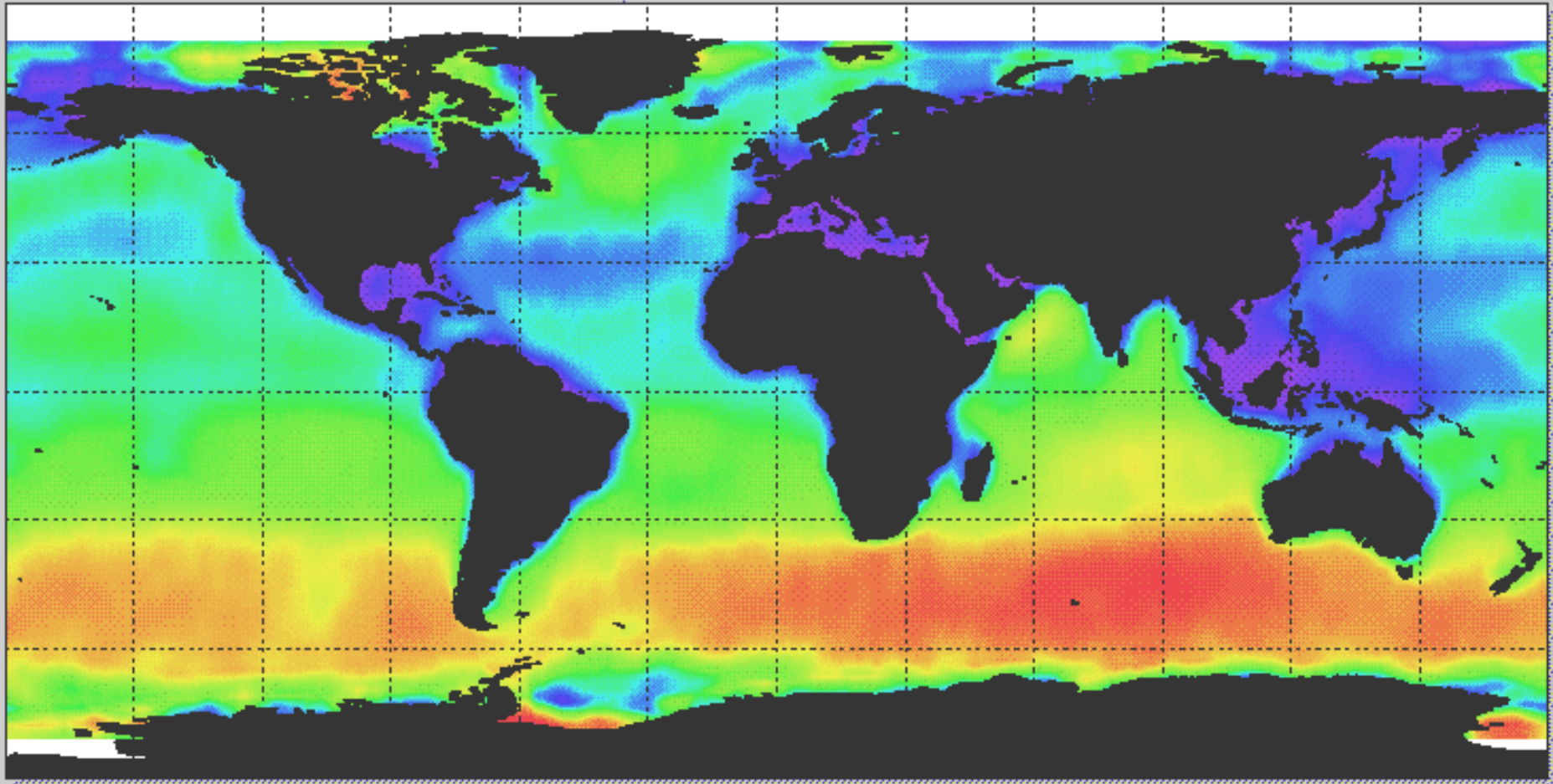
× community



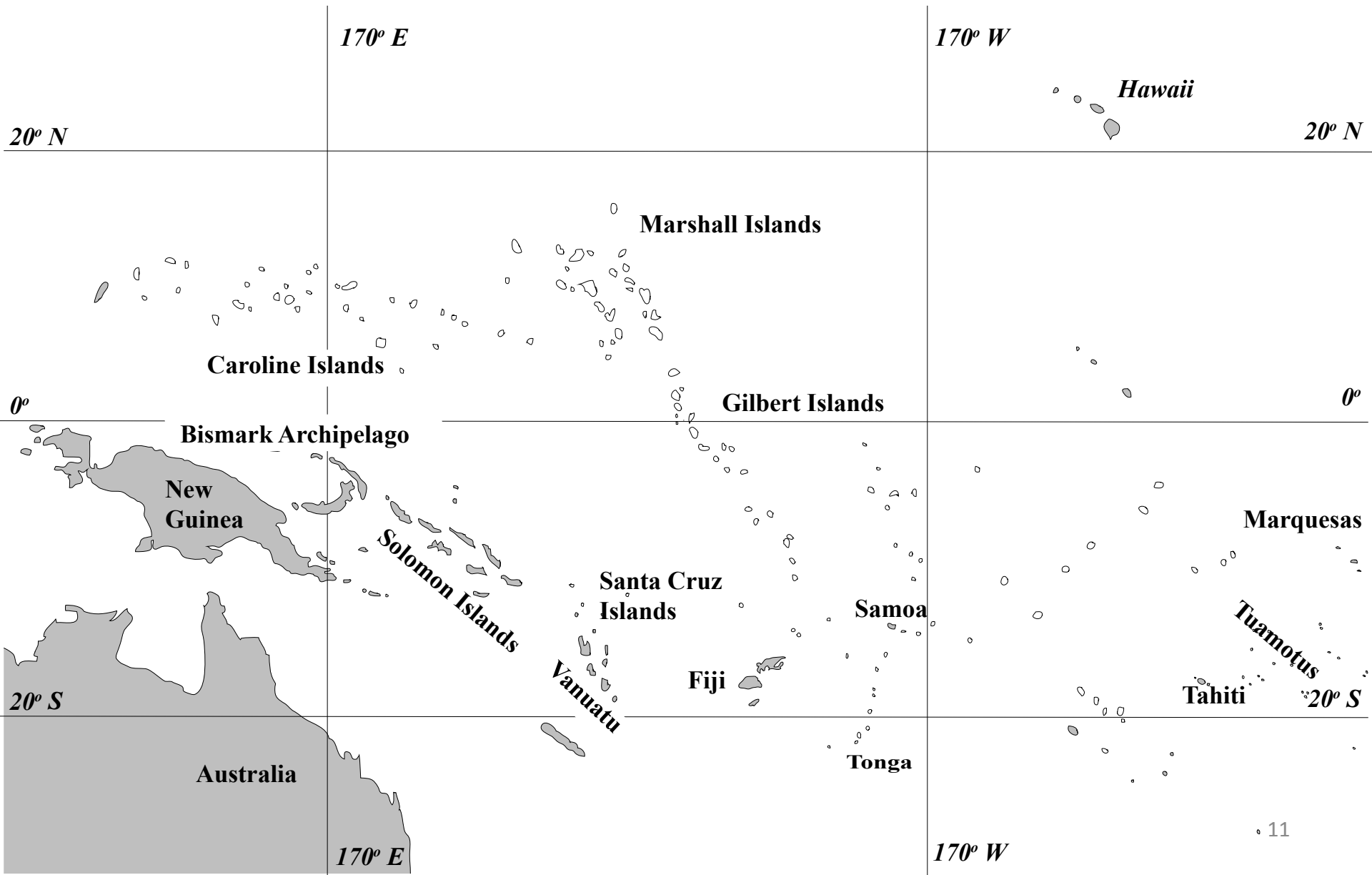


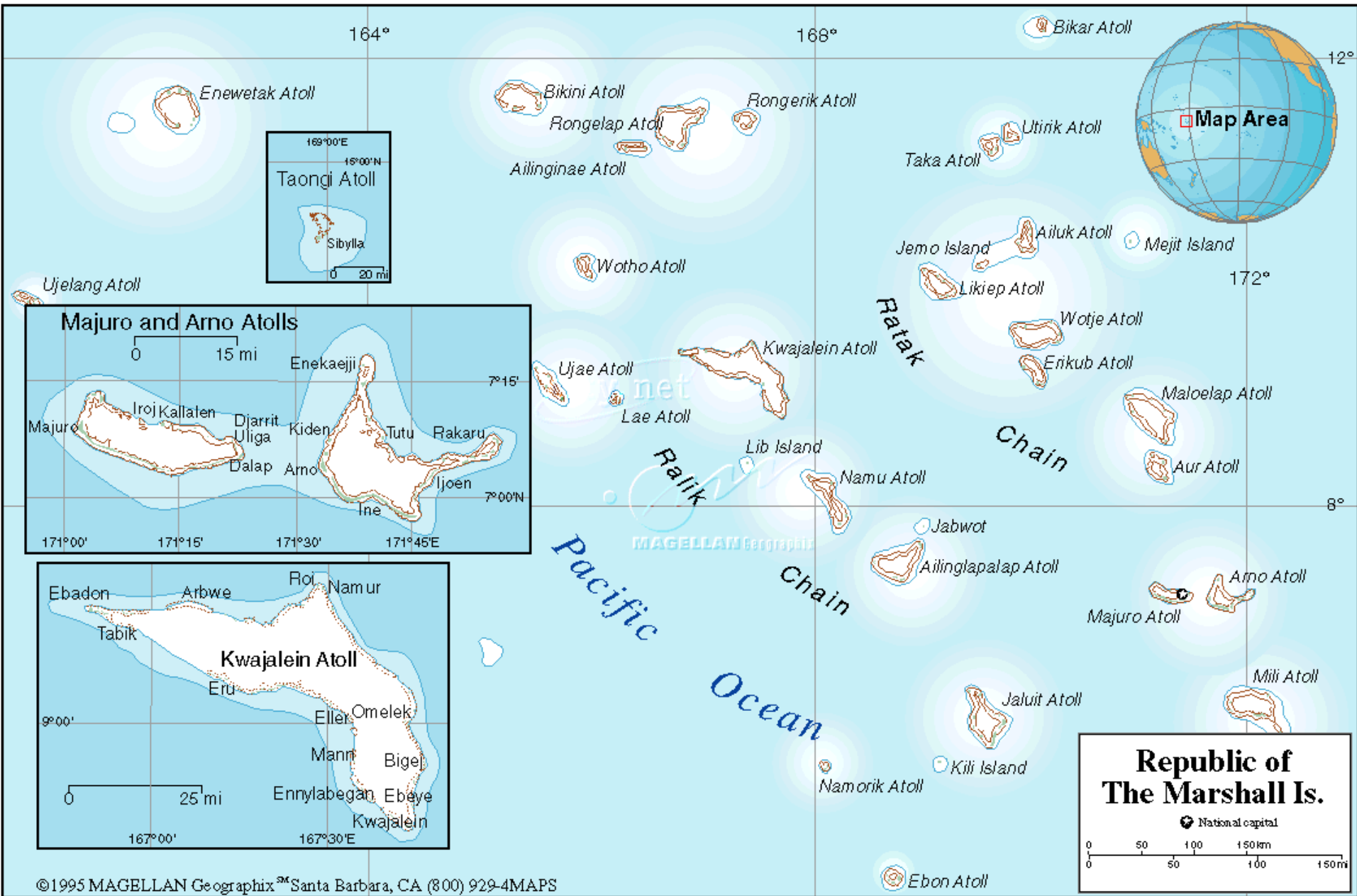
Wave height map

Waveheight measured by the ERS-2 Radar Altimeter, Summer 1995



Equatorial Pacific





Nuclear weapons testing in the Marshall Islands

Castle Bravo test – Bikini Atoll

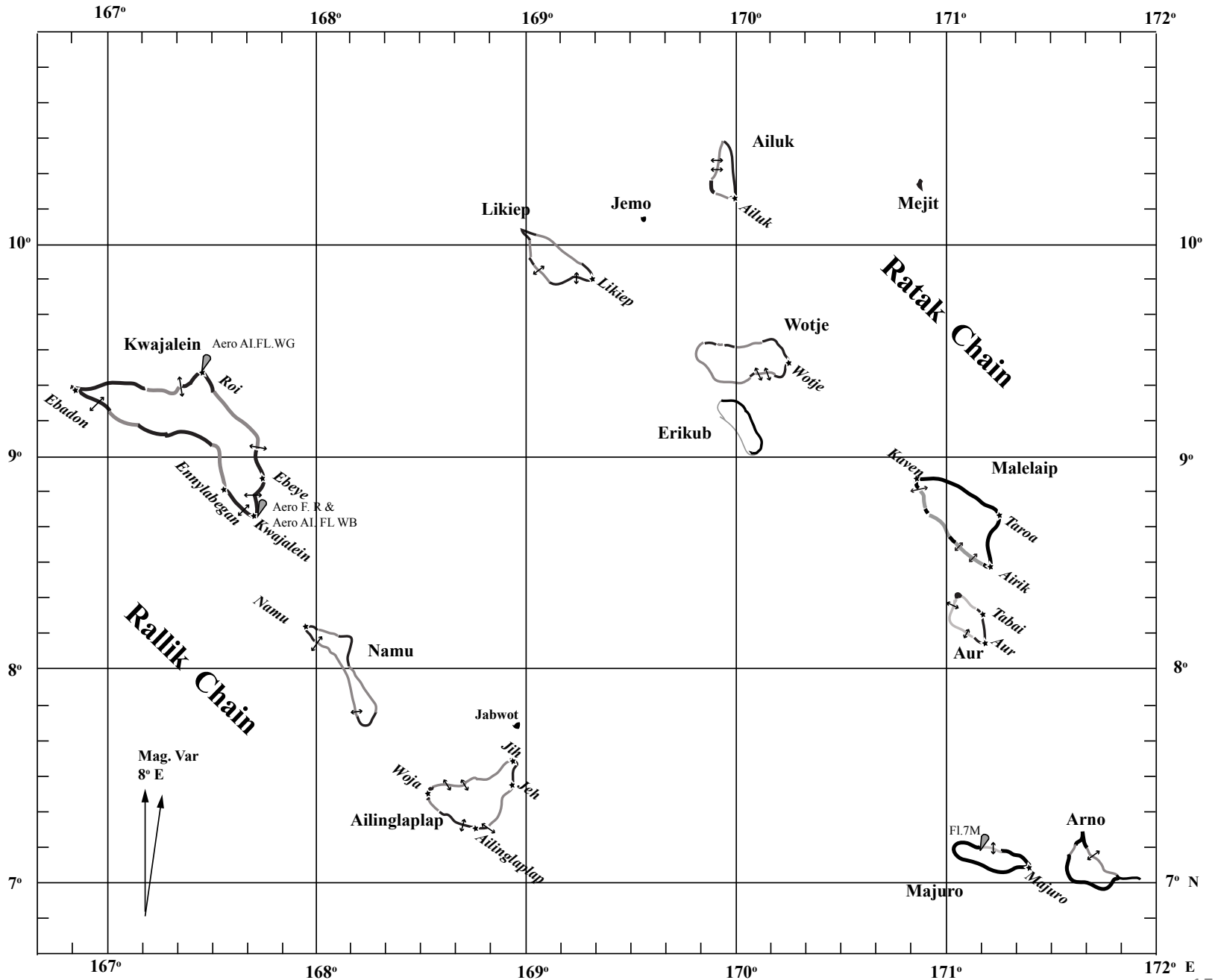


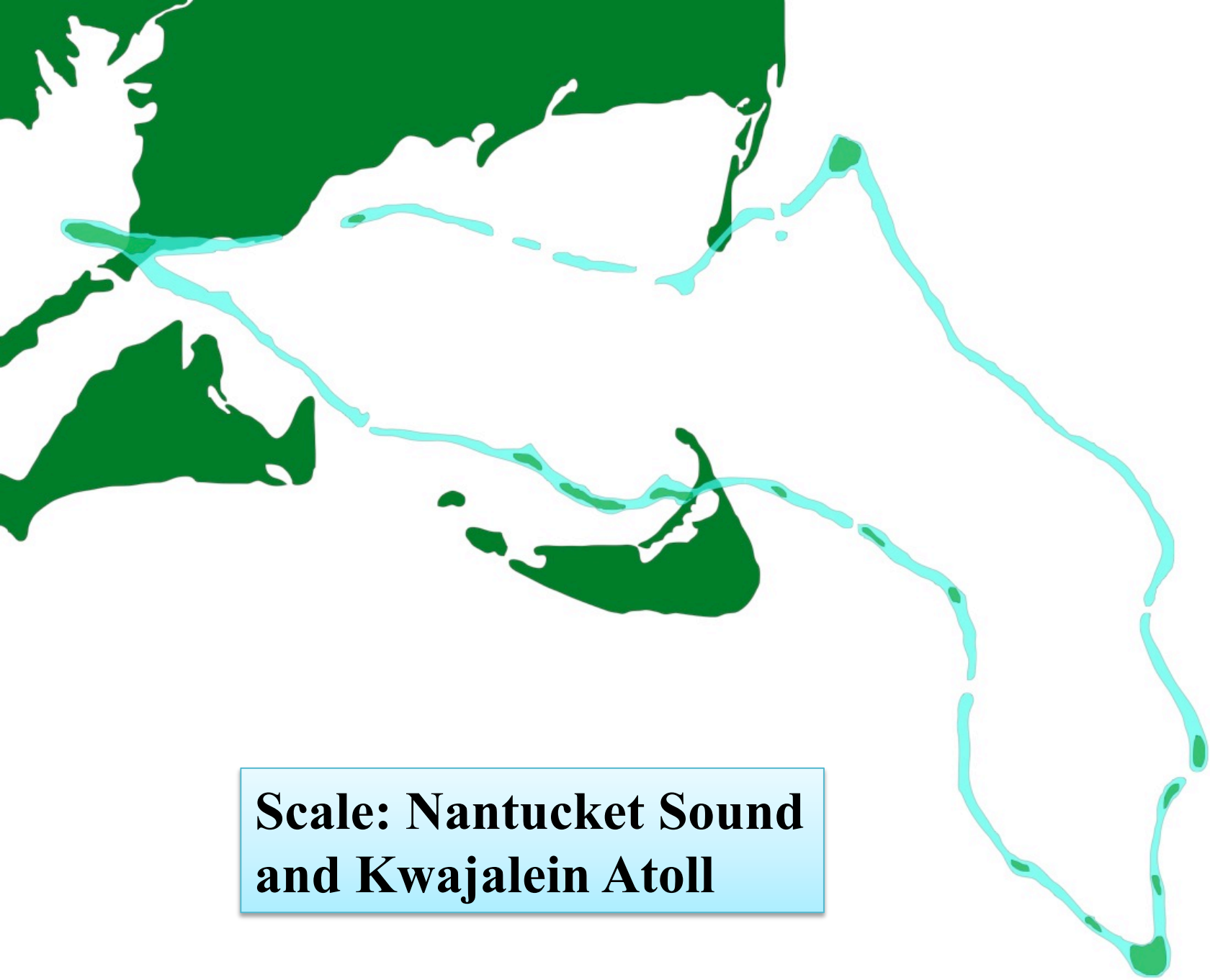
**Reviving the tradition of
wave piloting in the
Marshall Islands:**

Captain Korent Joel



*Study of Marshall Island
wave piloting by Joe Genz
(U. of Hawai'i)*





**Scale: Nantucket Sound
and Kwajalein Atoll**

ON SEA CHARTS FORMERLY USED IN THE MARSHALL ISLANDS, WITH NOTICES ON THE NAVIGATION OF THESE ISLANDERS IN GENERAL (Captain Winkler)

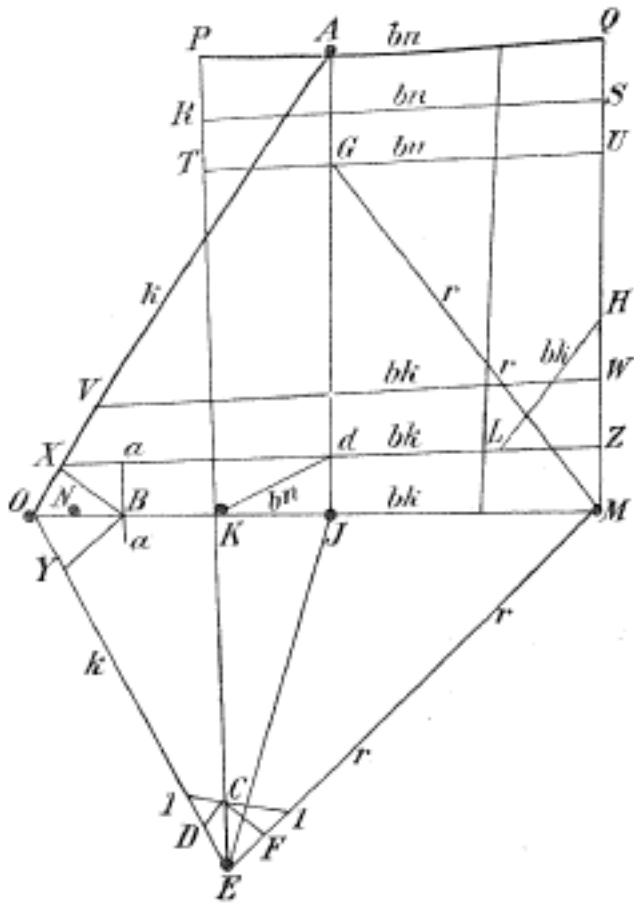
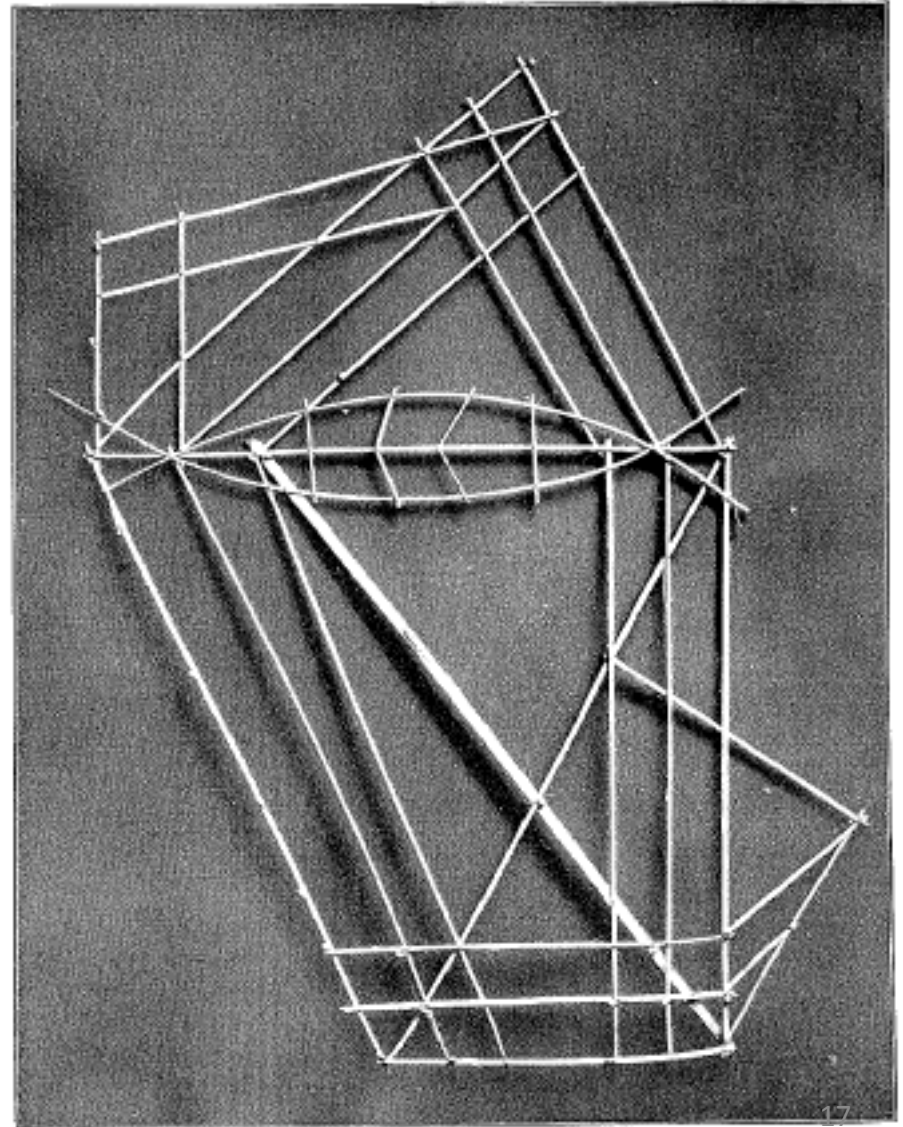
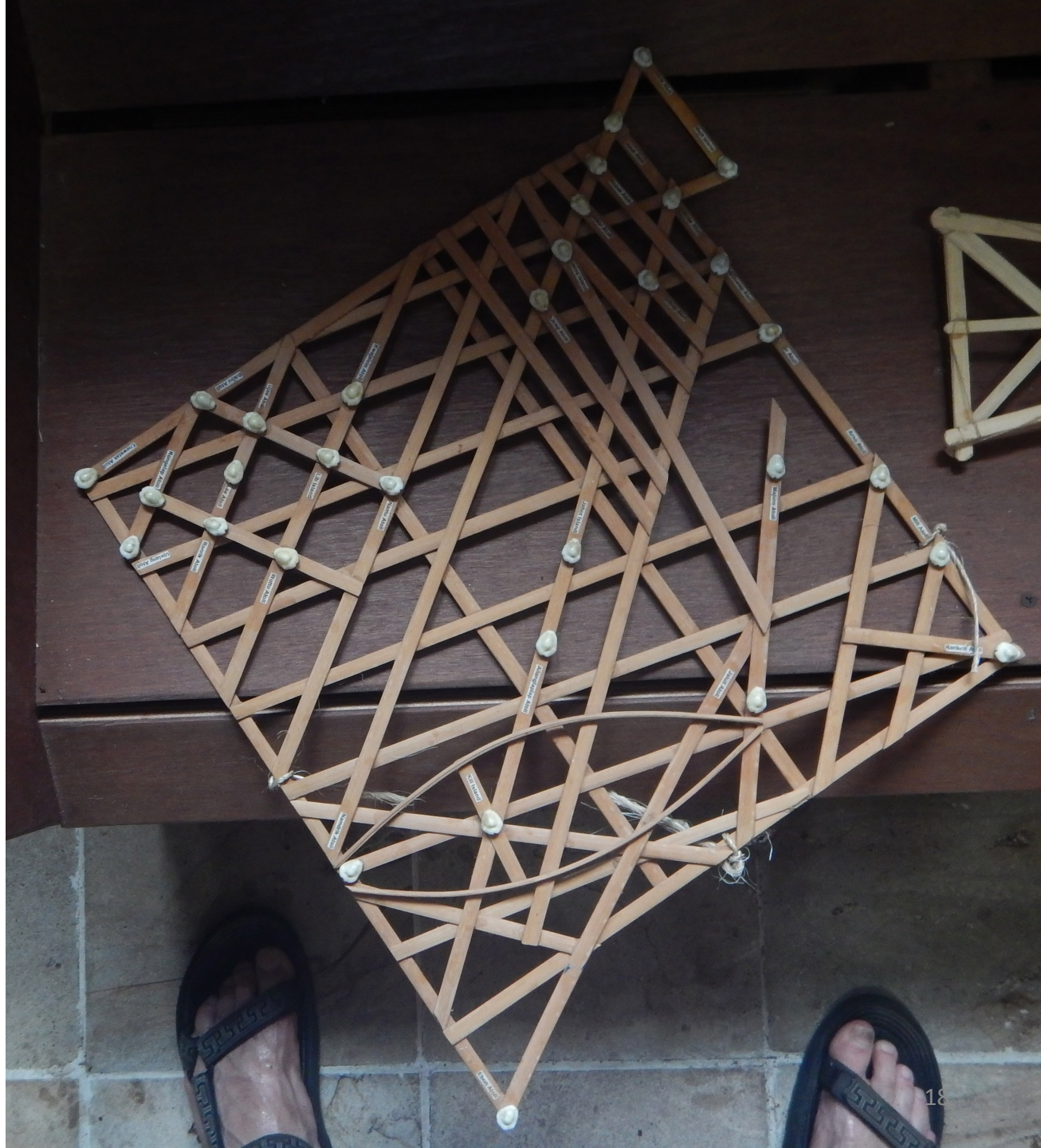
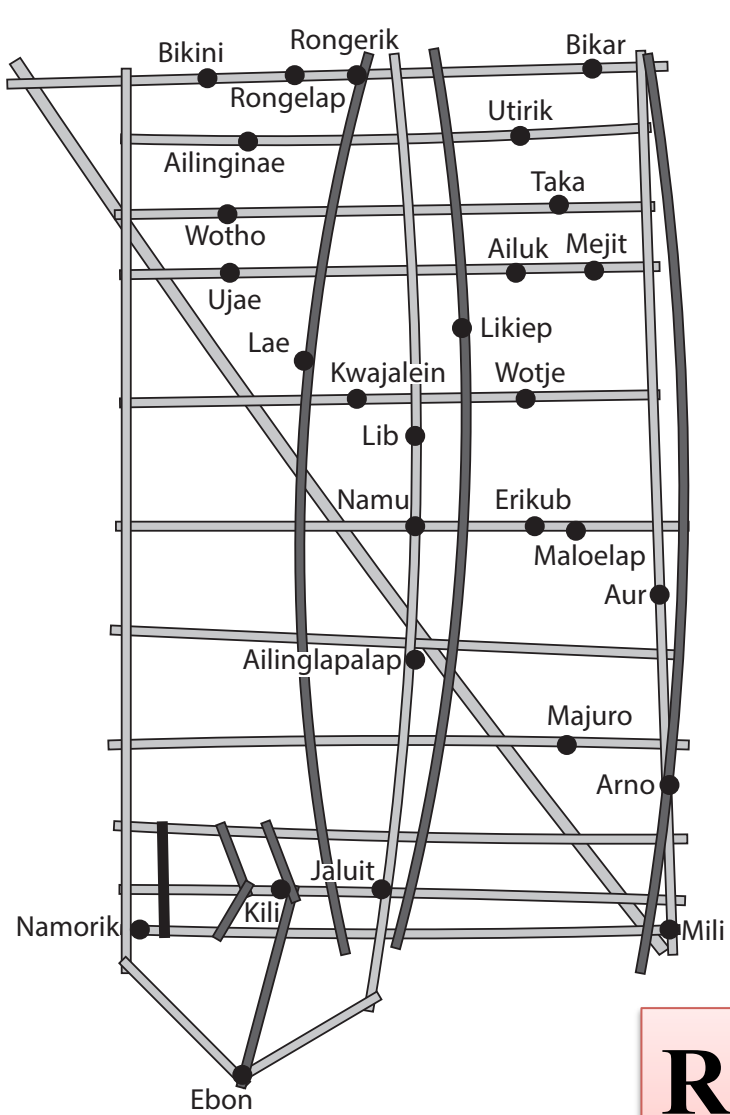


CHART III.—Meddo, covering part of a group.



Rebbelib chart





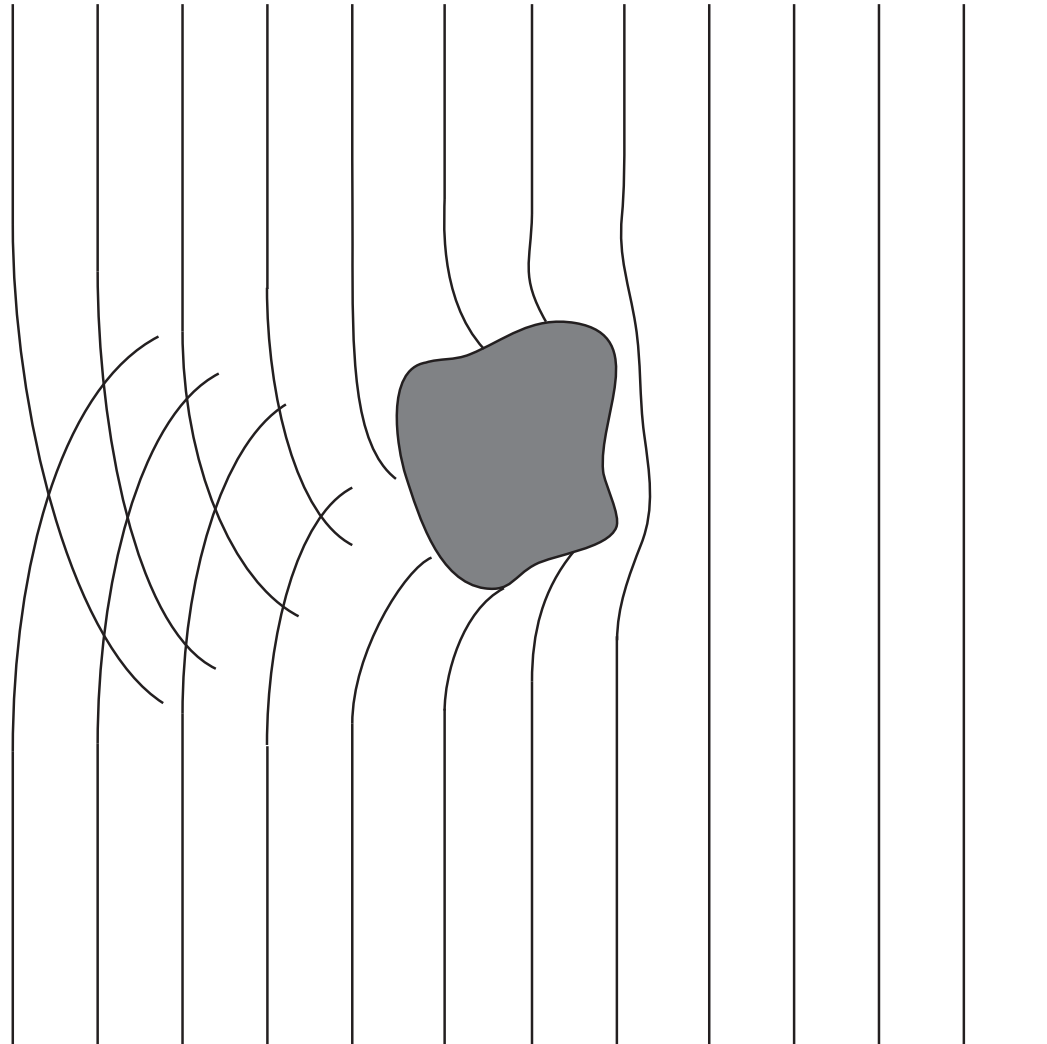
**Rebbelib
chart**

Wave refraction around atoll

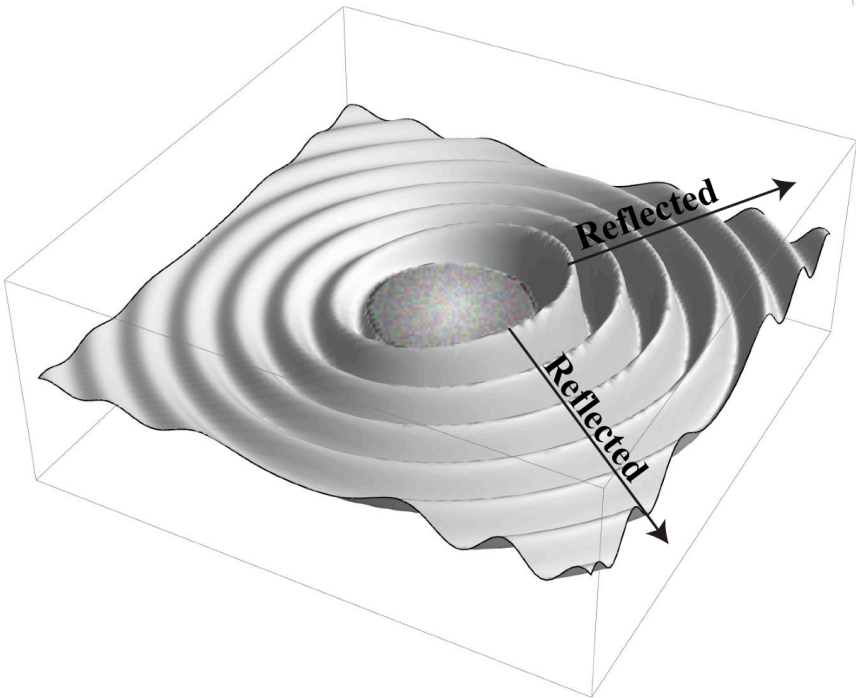
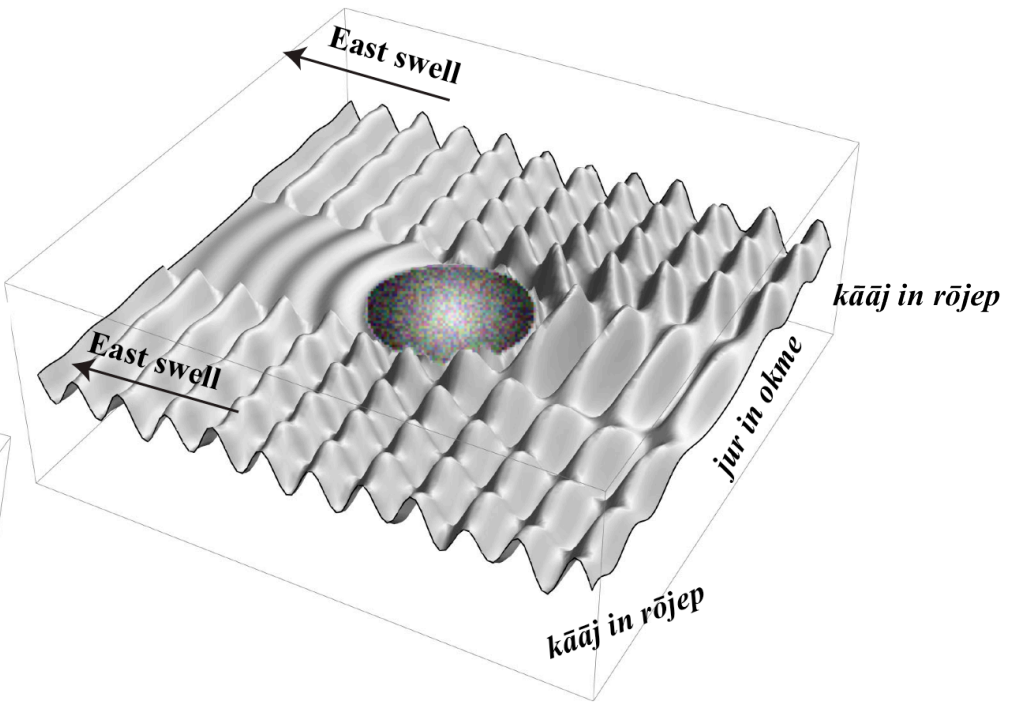
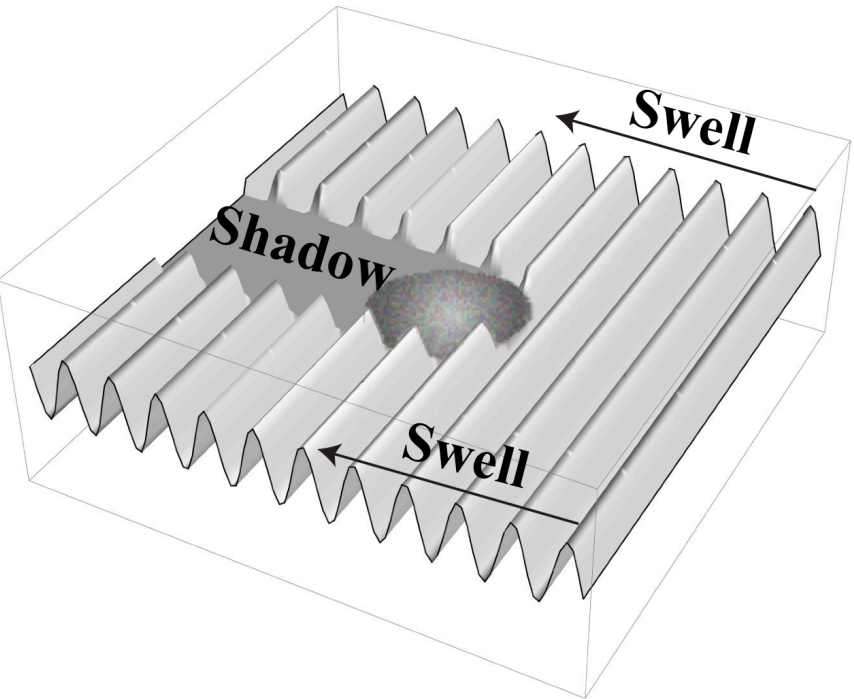


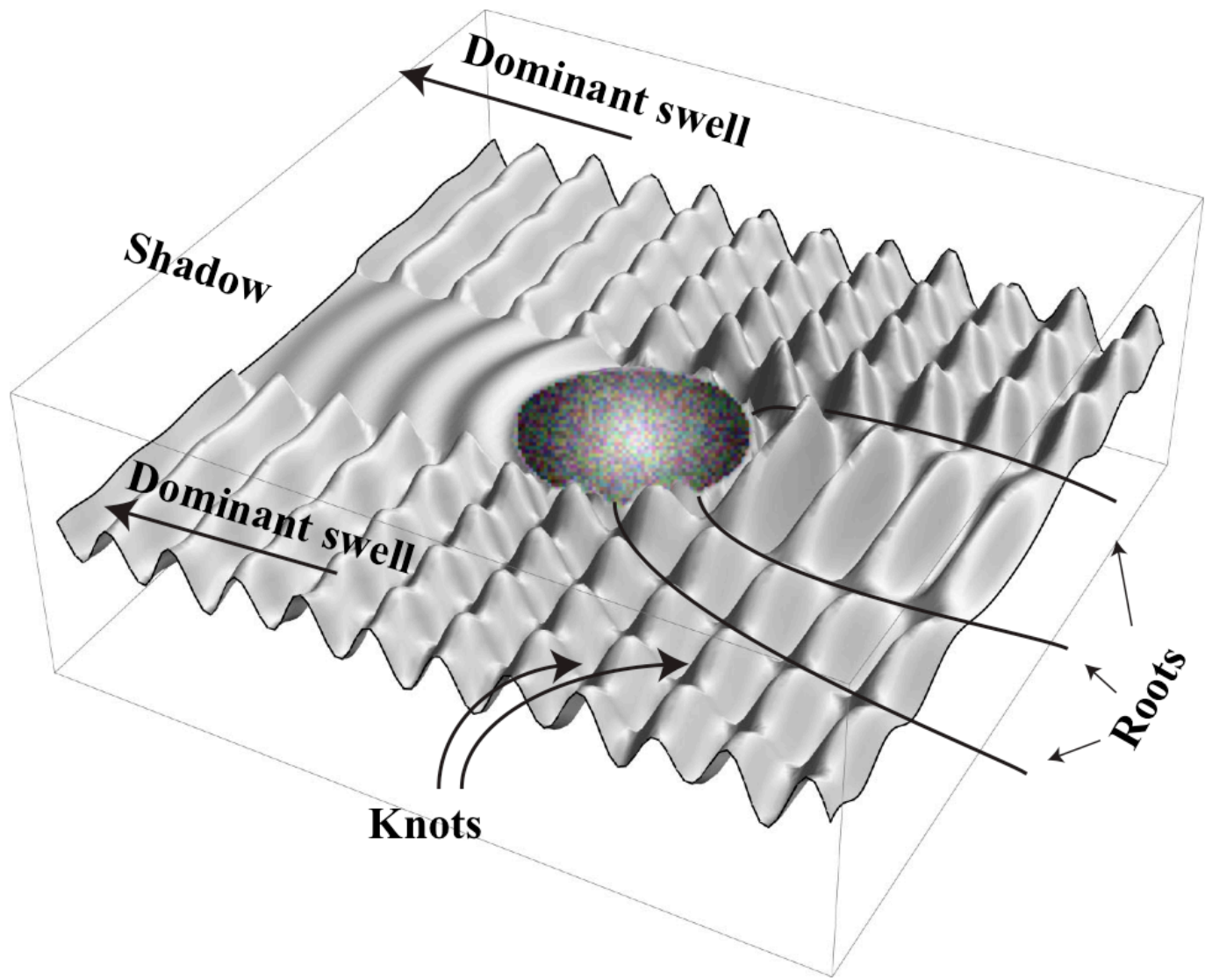
Eastern swell

mit in kōt



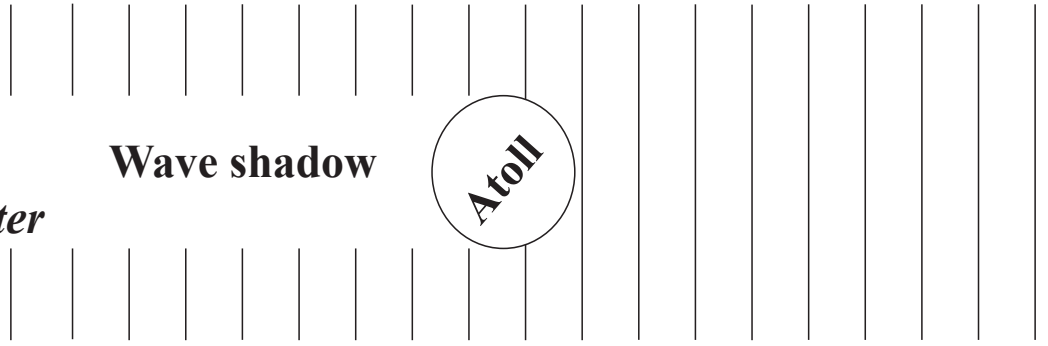
Reflections, interference and shadowing



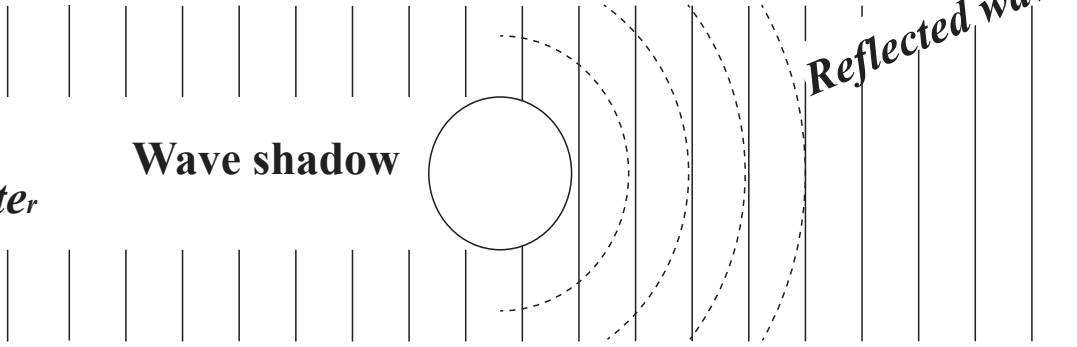


Swell direction
←

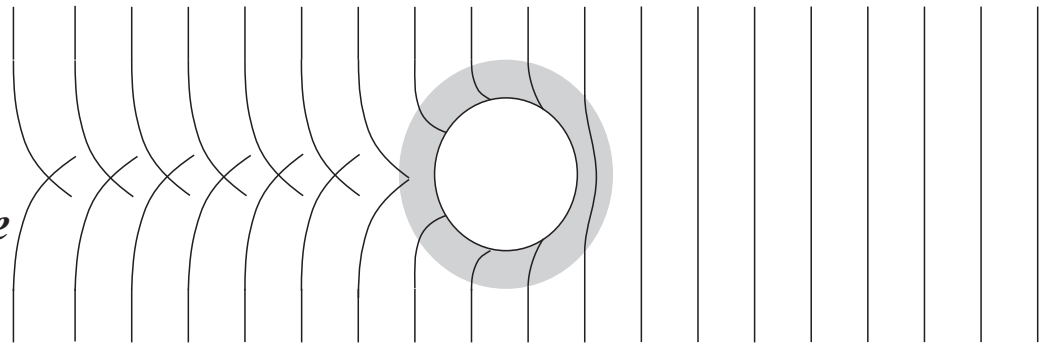
Case 1:
Shallow atoll shore
Steep drop-off underwater



Case 2:
Steep island cliff
Steep drop-off underwater



Case 3:
Shallow atoll
Gentle underwater slope

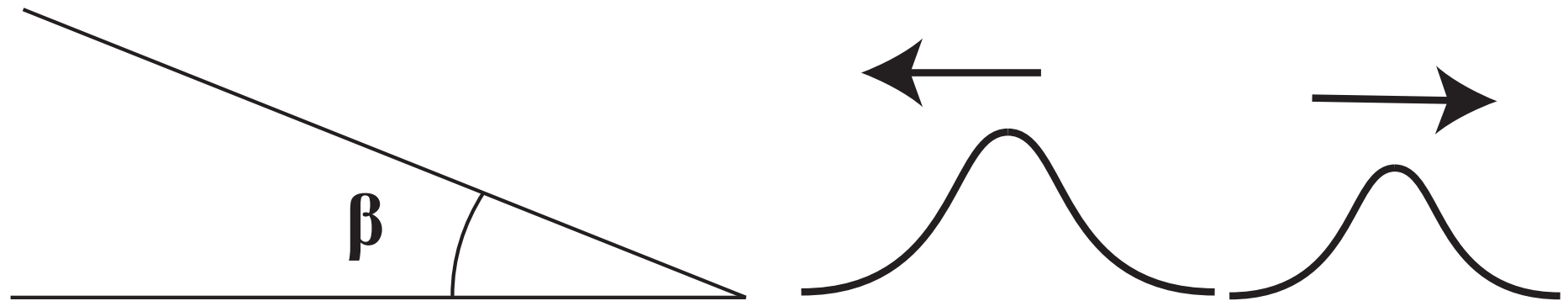


Miche parameterization for reflected energy

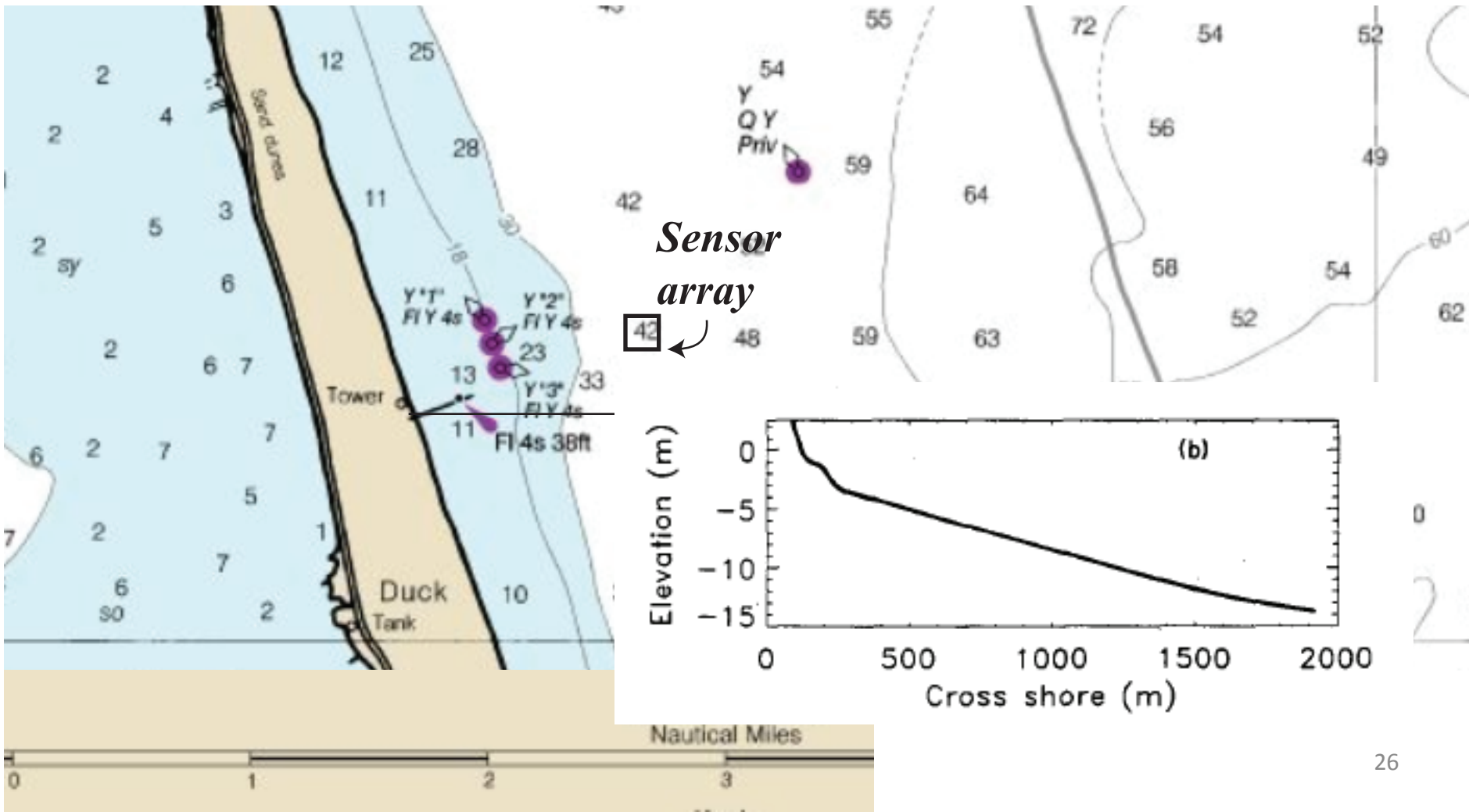
$R^2 \approx 1$ (reflected energy)

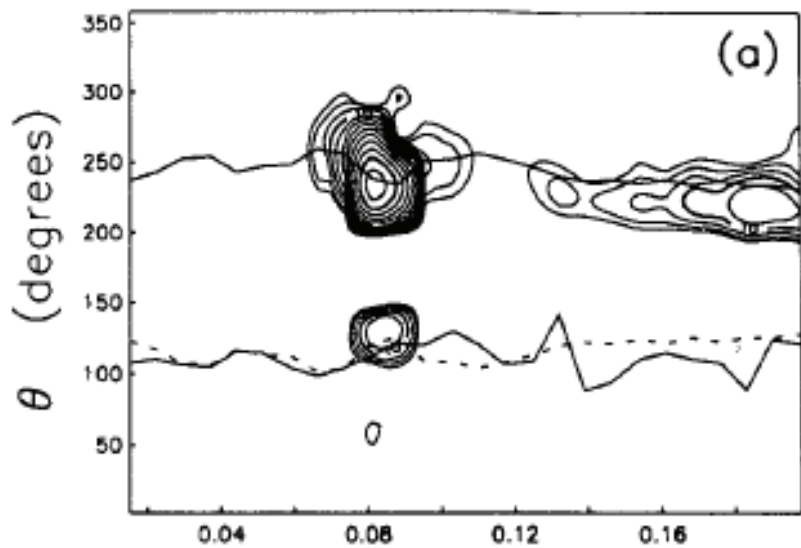
when

$$M = \frac{16g^2 \tan^5 \beta}{(2\pi)^5 H_\infty^2 f^4} \geq 1$$

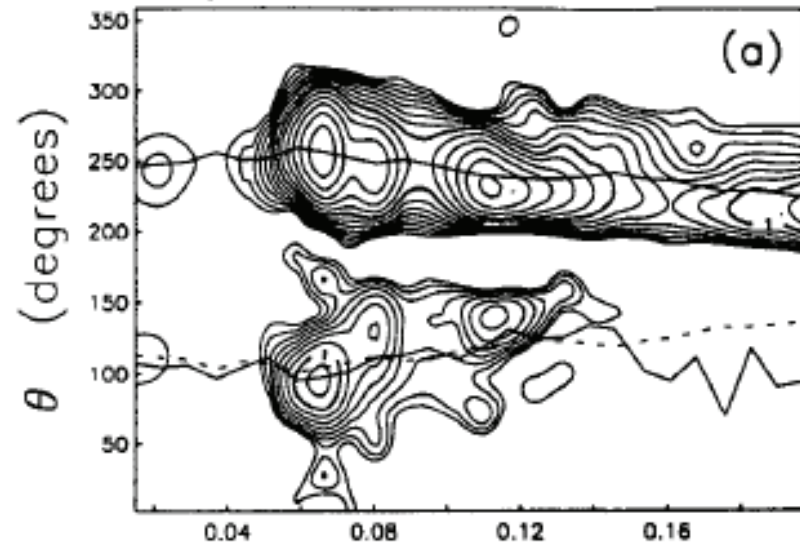


“Reflection of Ocean Surface Gravity Waves From a Natural Beach” Elgar, Herbers, Guza (1993)

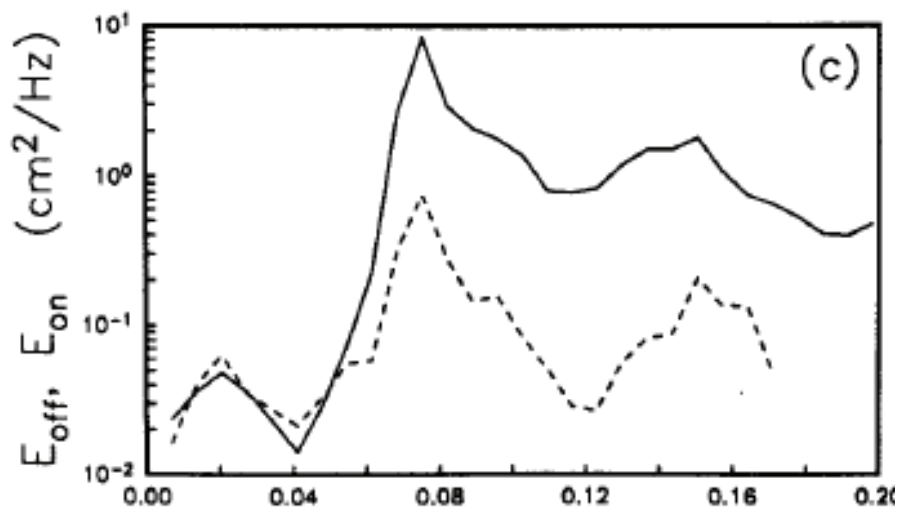




Frequency (Hz)

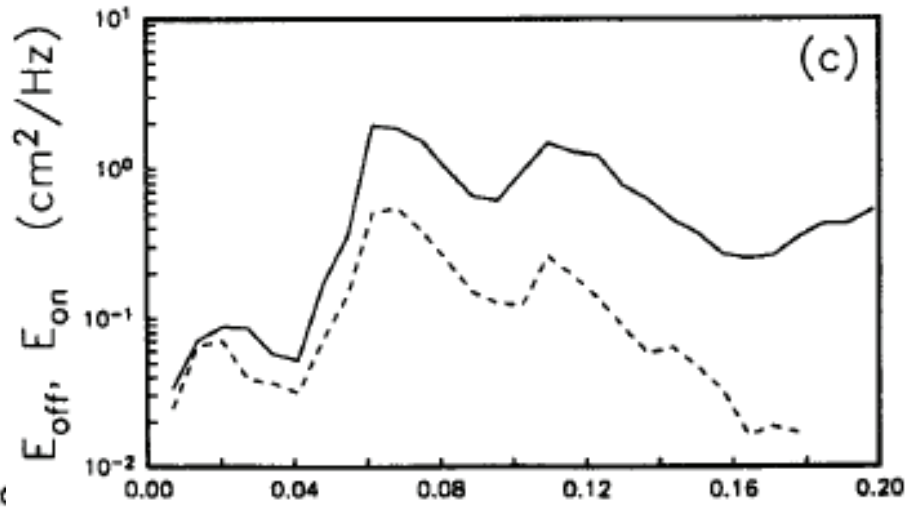


Frequency (Hz)



Frequency (Hz)

6 Oct 1990



Frequency (Hz)

17 Nov 1990

“Rules” for observing reflections

Know bathymetry of island

Know orientation of coastline

Look for low frequency returns on top of incoming swells

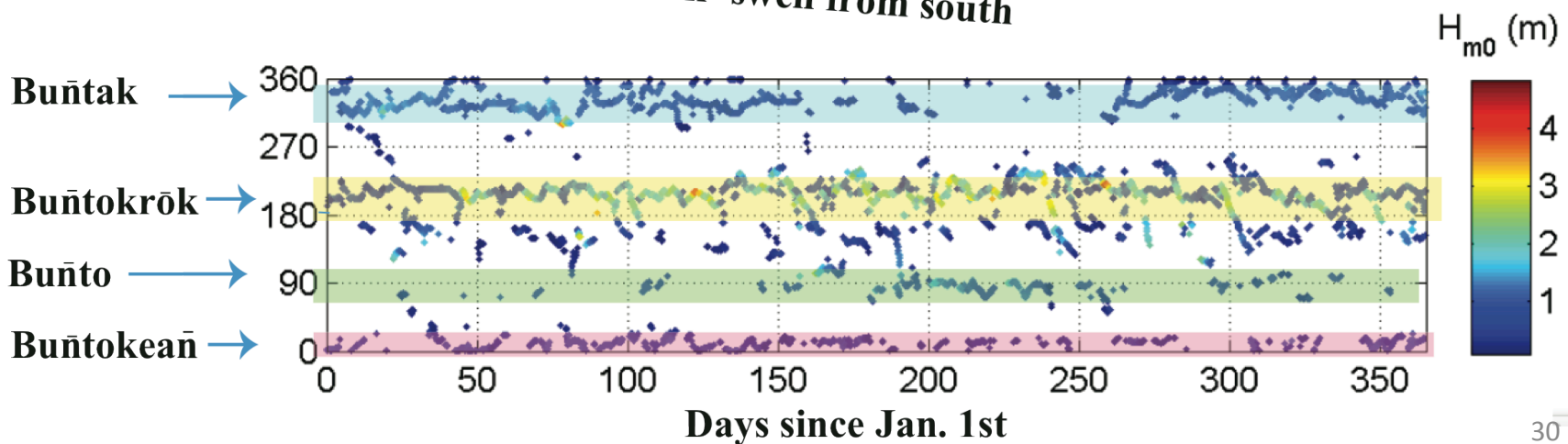
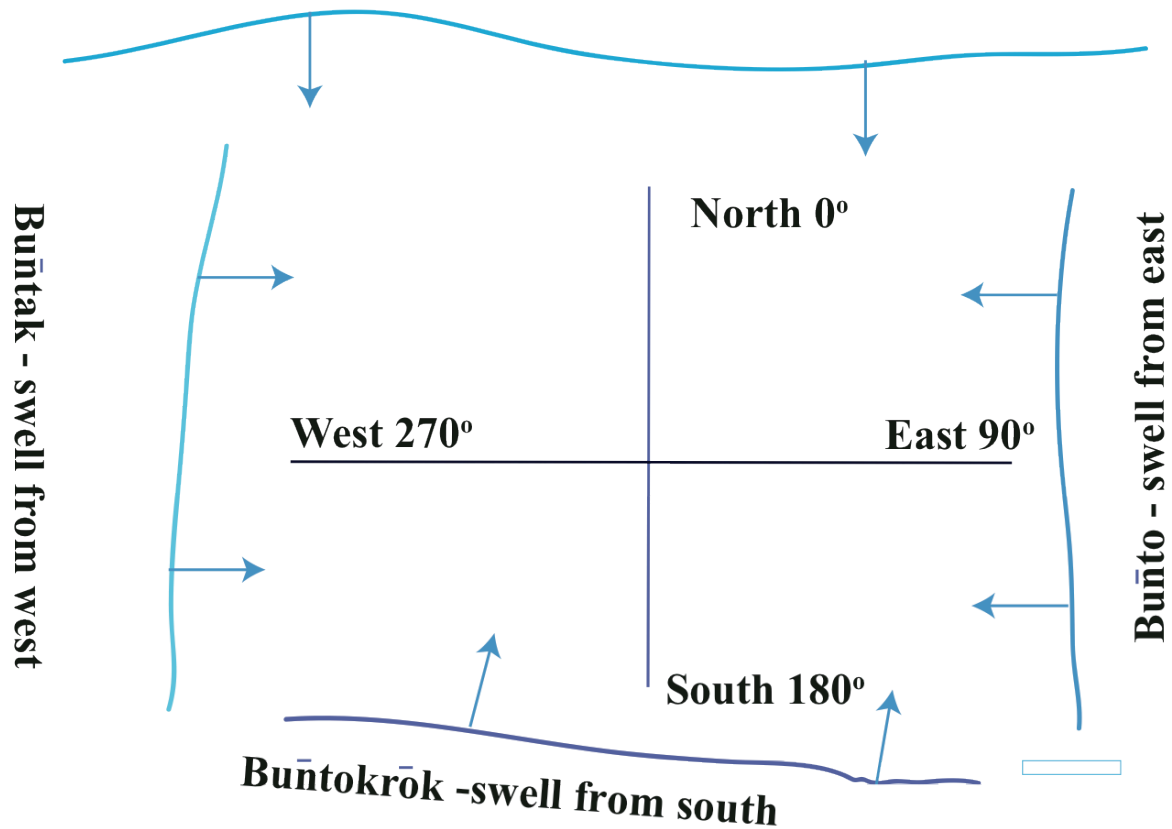
Reflections are small perturbations on incoming swell

Rocking motion of vessel

**Wappepe
stick
chart**

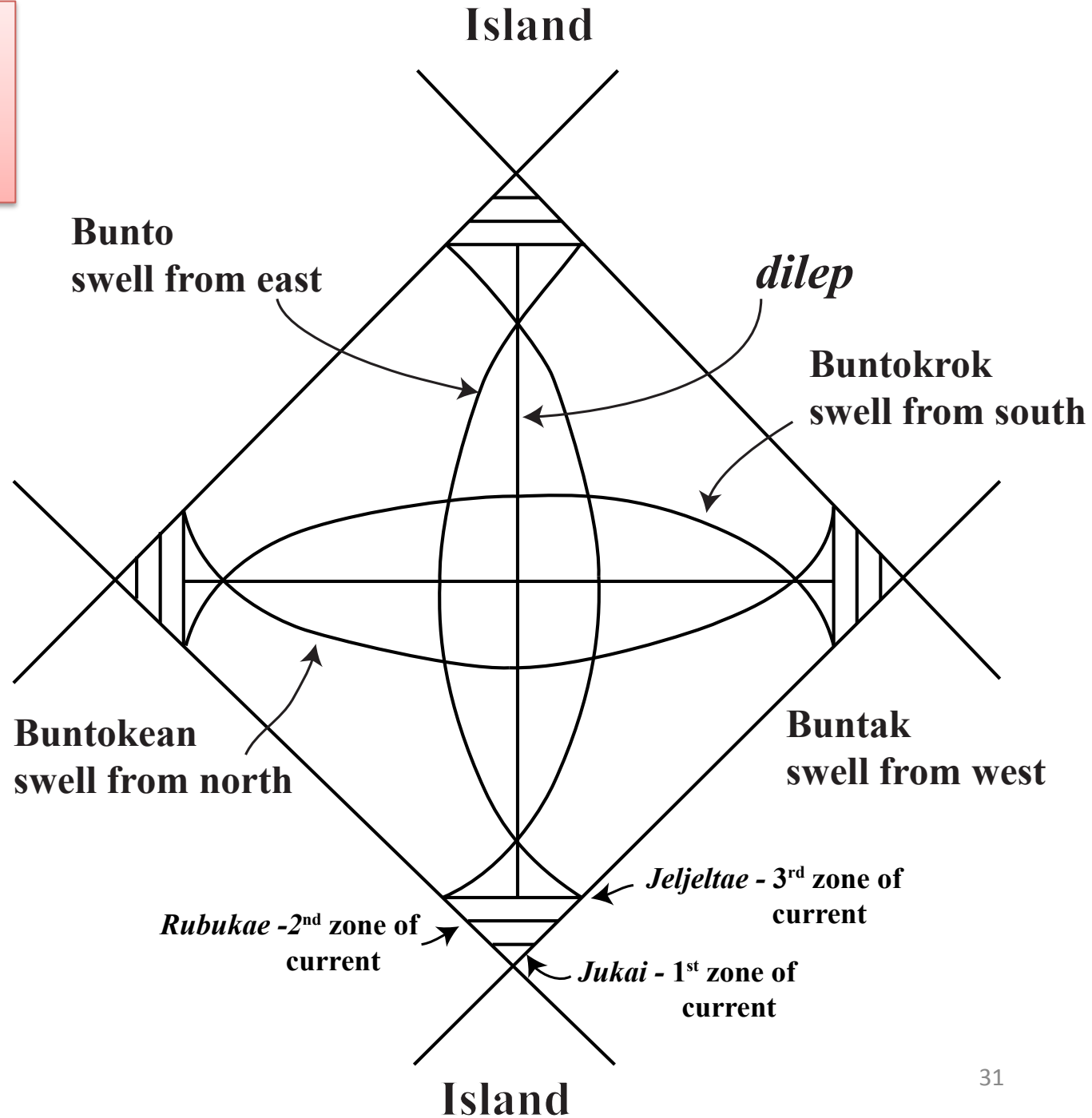


Buñtokeañ-swell from north

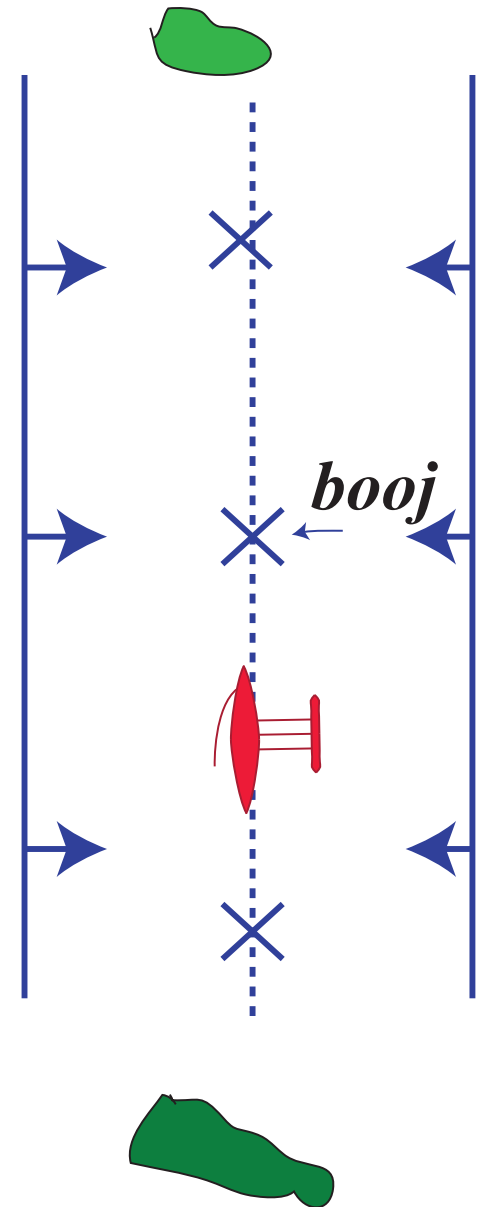
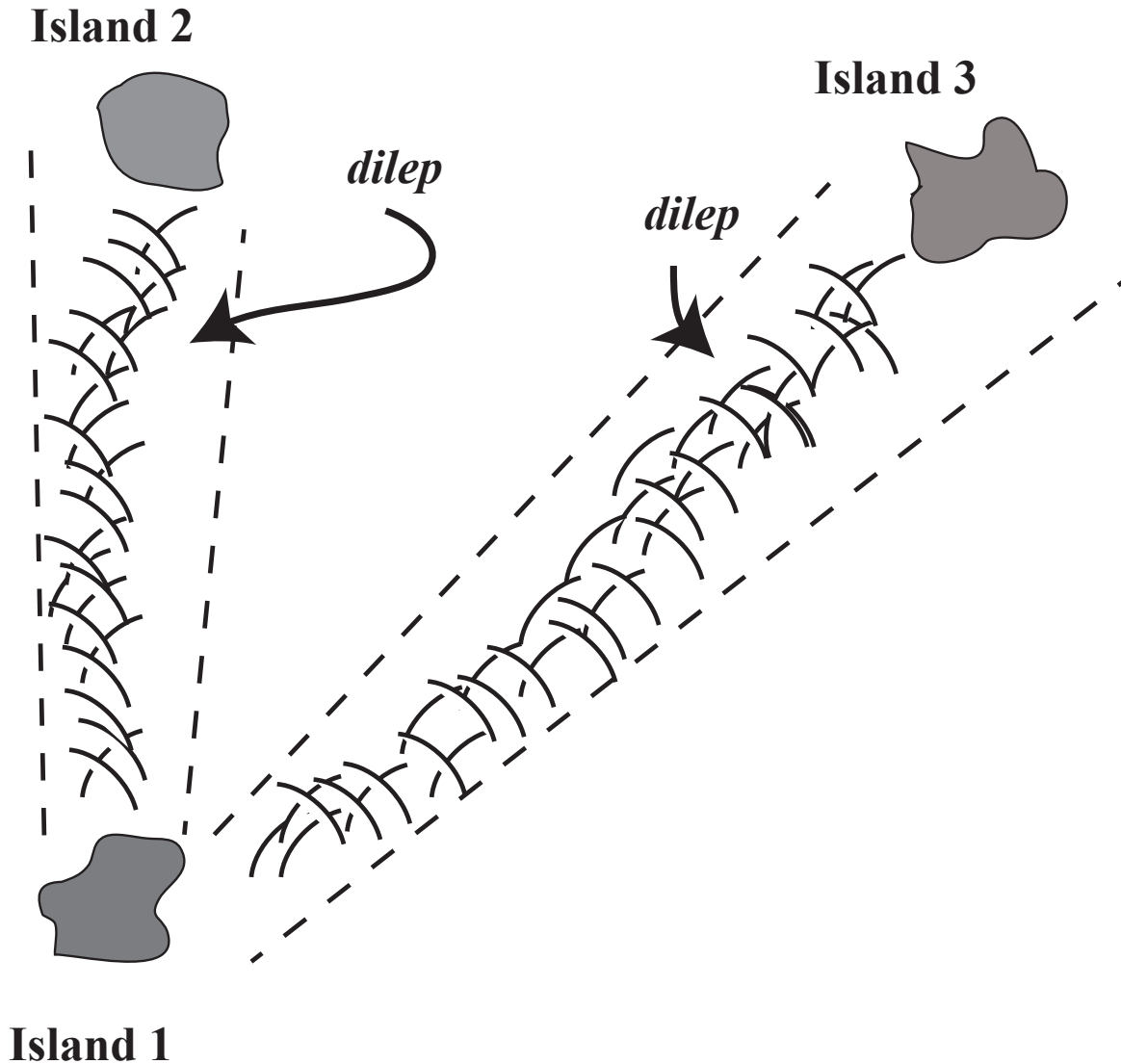


Teaching chart:

Wappepe



The Mystery of Dilep



Dilep

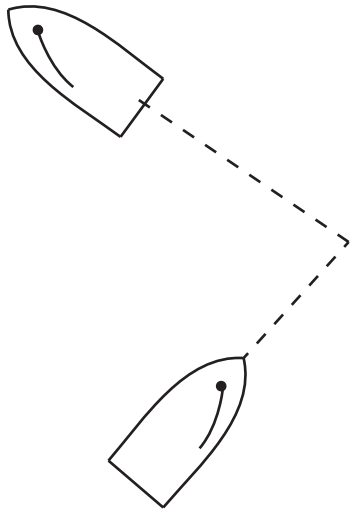


JITDAH KAPEEL

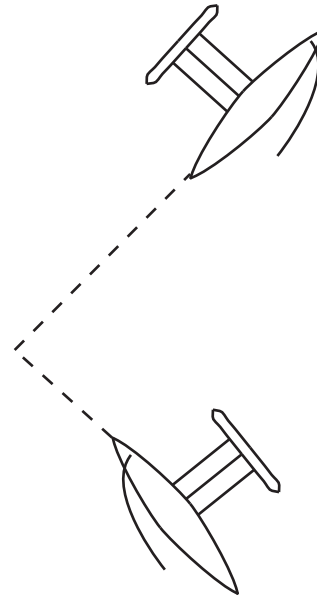




Wind

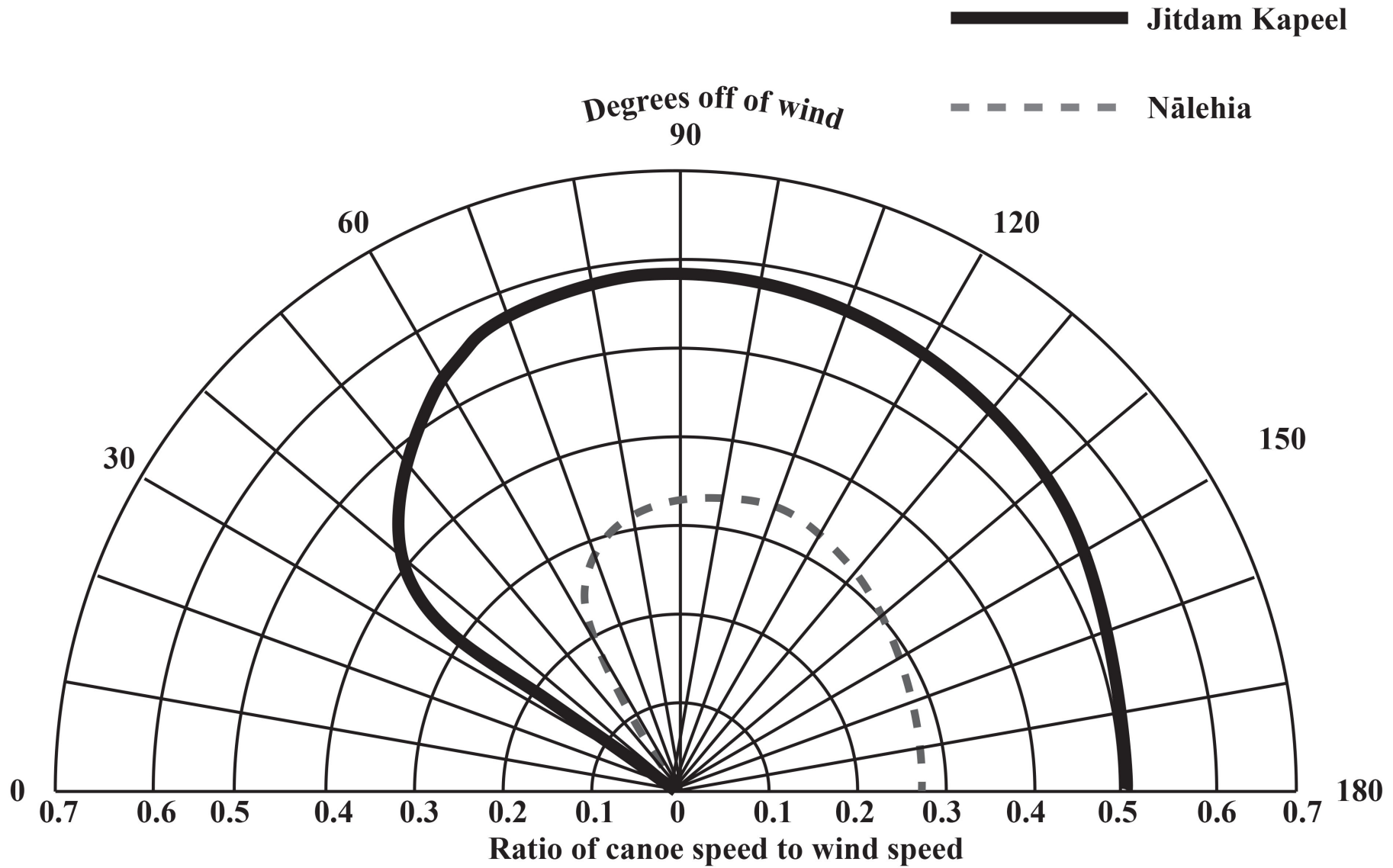


Tacking



Shunting





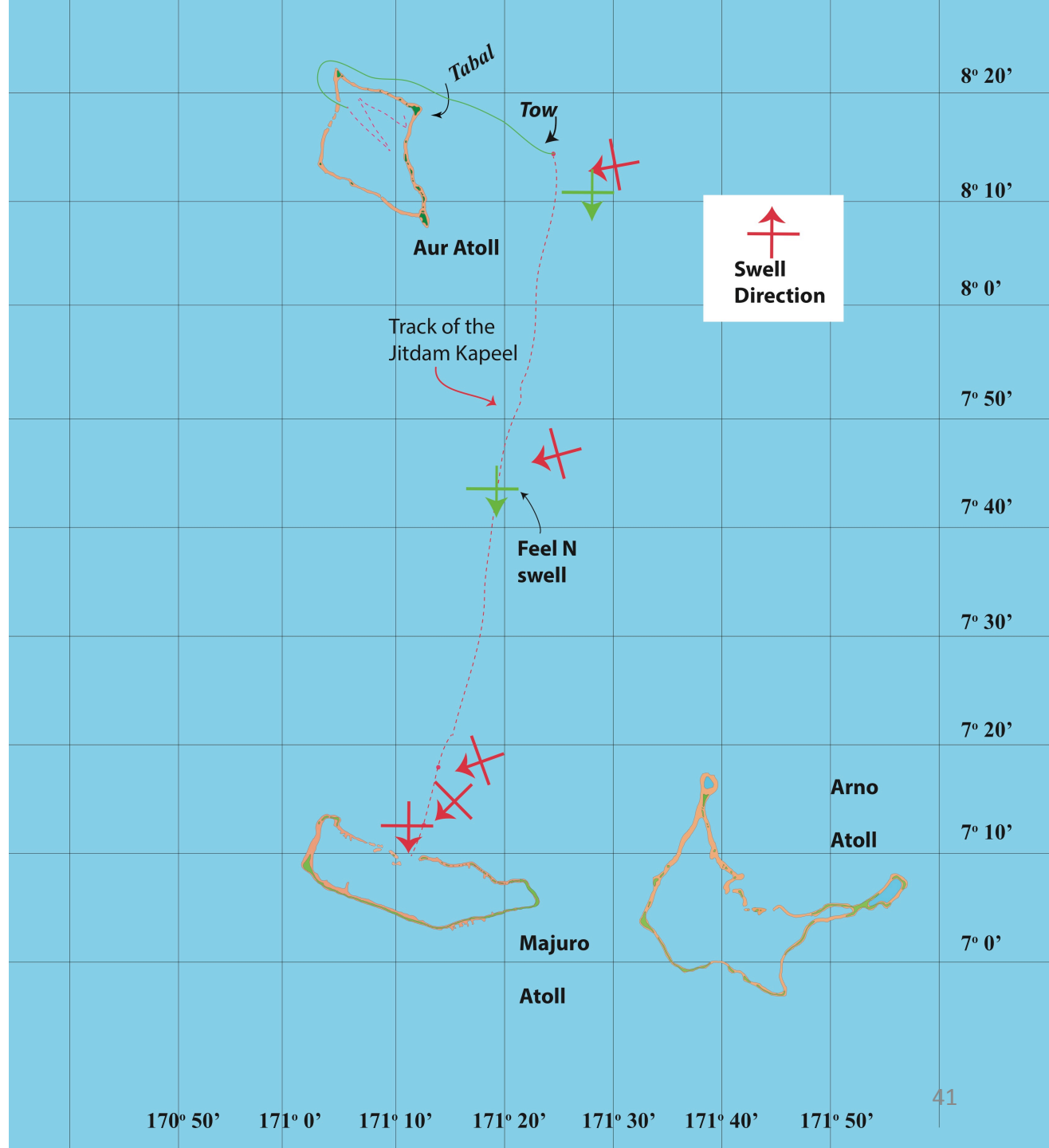


uno
ej
uno

PEPSI-COLA
MAJURO



Outgoing trip to Aur













Isao and
Alson



"Raw" data

21:40 wind picks up
a little

from Hadar + Centauri
seem to have altered
course to SSE ↓

22:08

7° 58.7

170° 59.8

Saw previously
SSW using
Hadar, & Centauri
parts of
(V25)

23:08

7° 56.0

170° 58.9

00:08

7° 53.6

172° 58.6

22nd

5:44

7° 37.2

170° 56.3

heading SE or SEBE

speed 3.1 mph

probably have

a westerly current
~ 1 kt

seem to have
corrected heading

(6)

swell 5 sec

NEBE

@ this rate

landfall ~ noon?

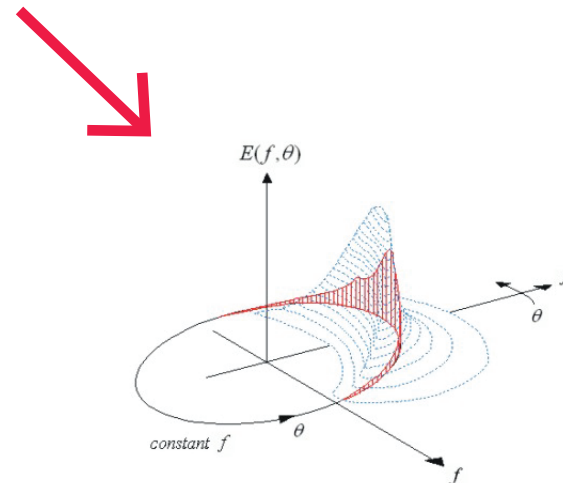
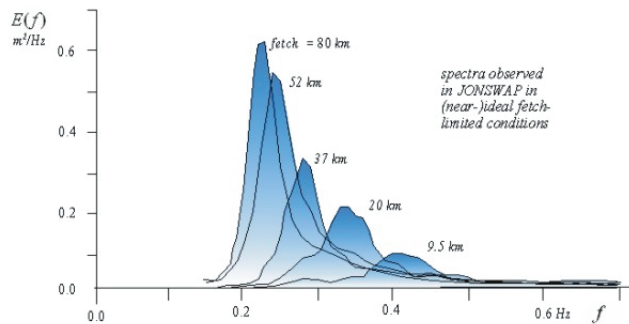
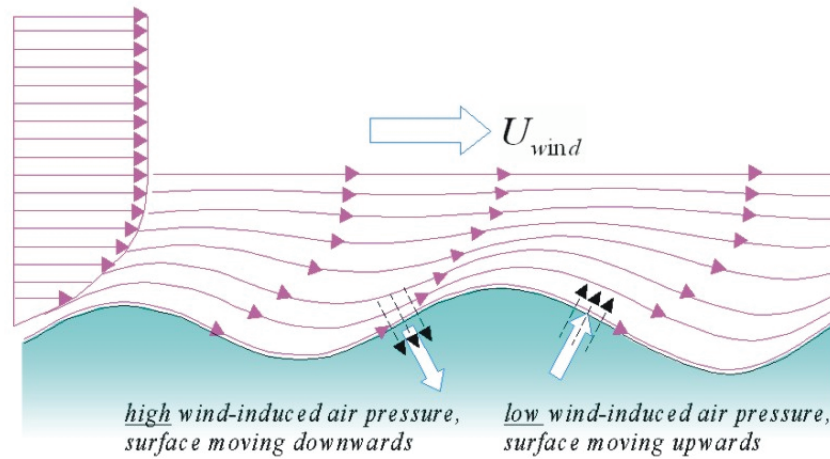
track more like SSE

wind ENE

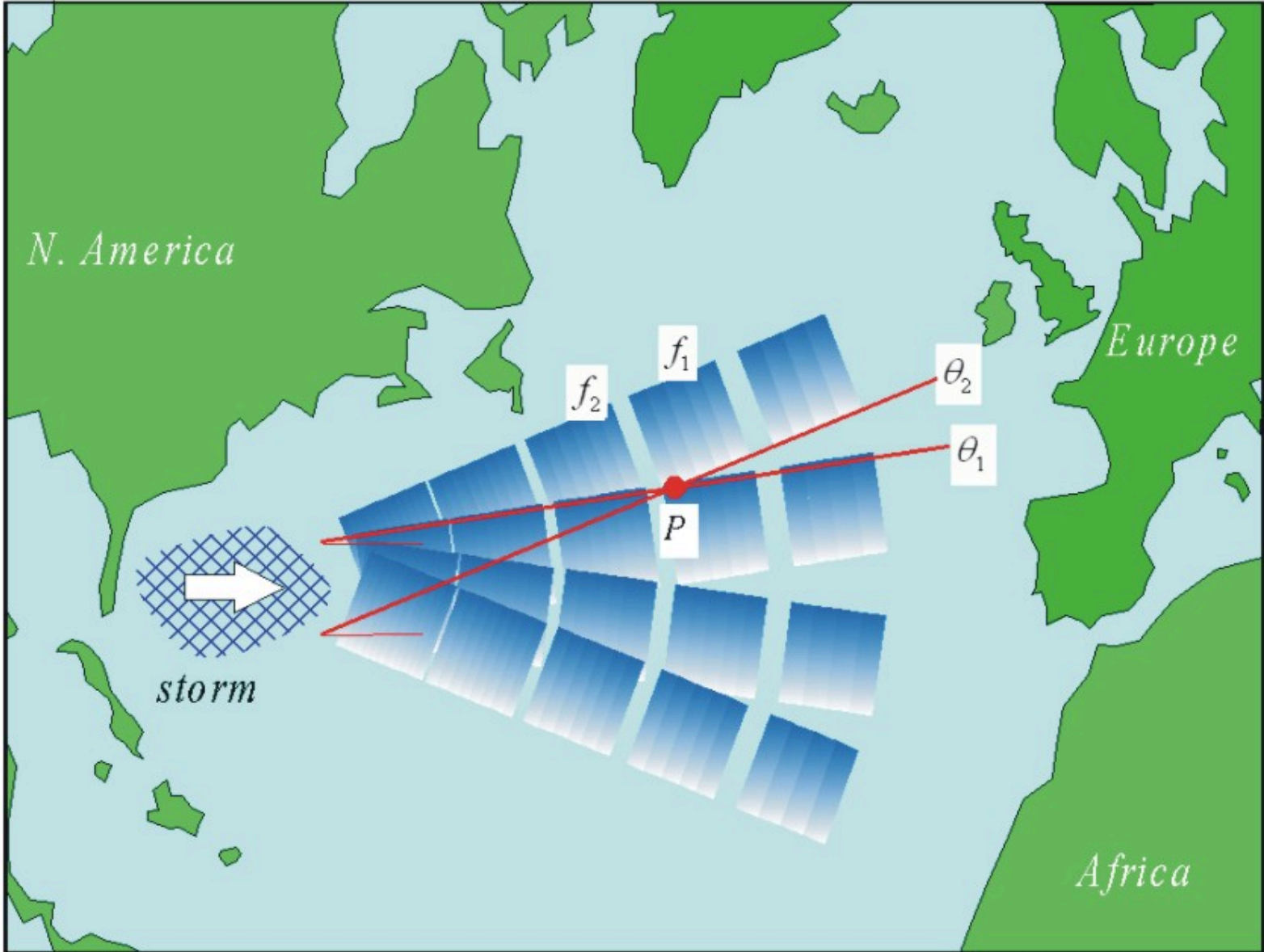
5 kts
3 reg heaving

Modeling/hind casting

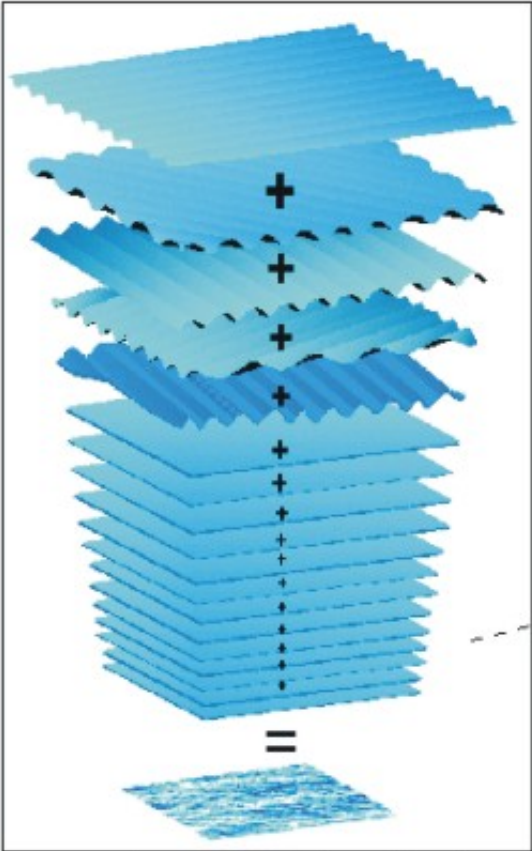
$E(f, \theta)$ represents wave field



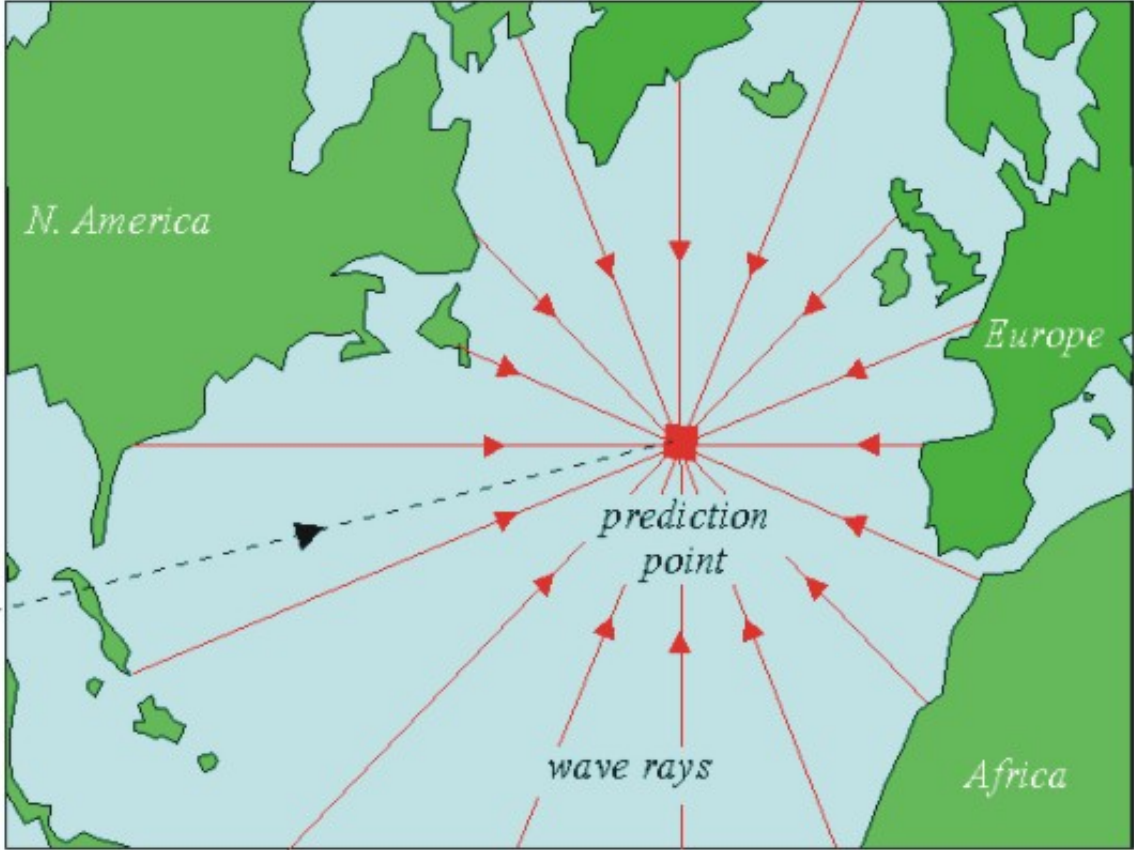
Propagation



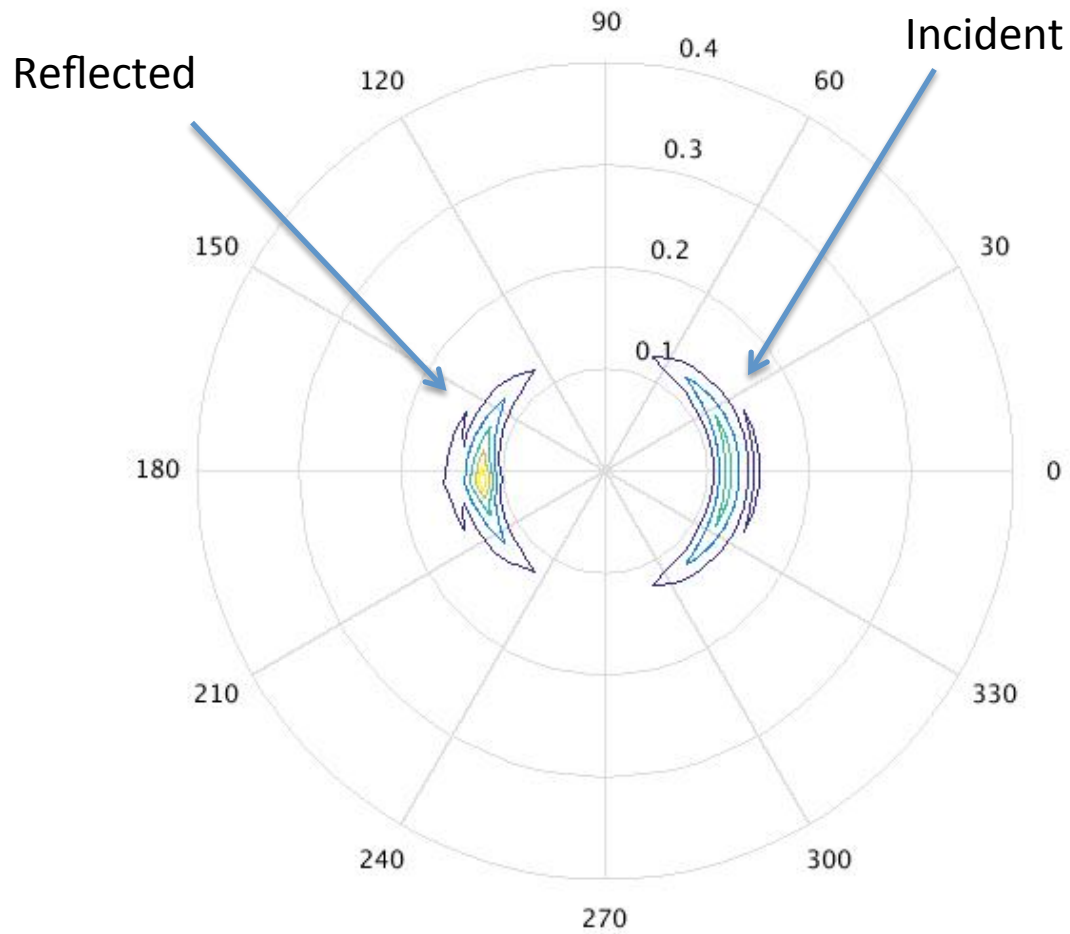
Propagation



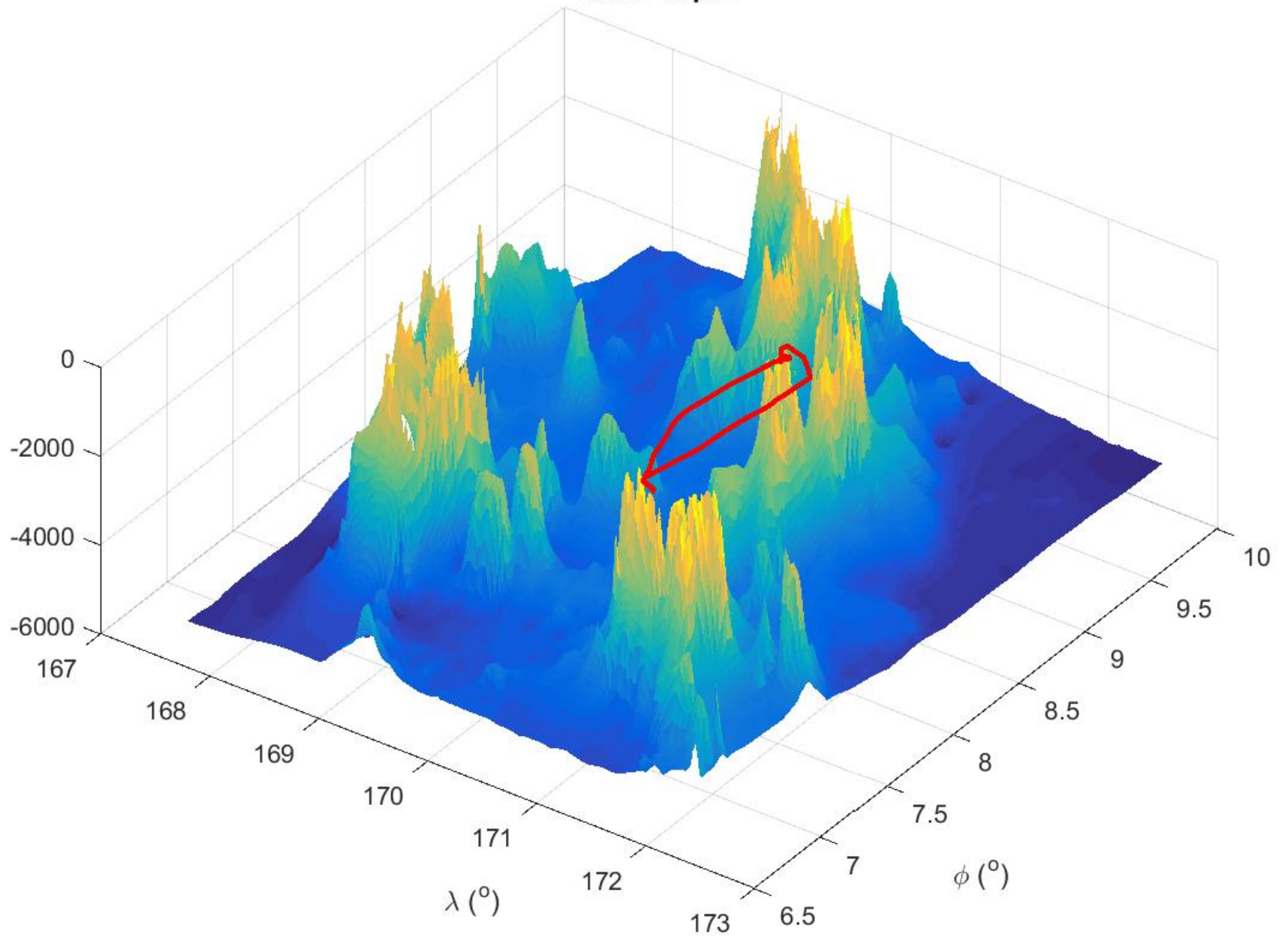
random- phase/amplitude model



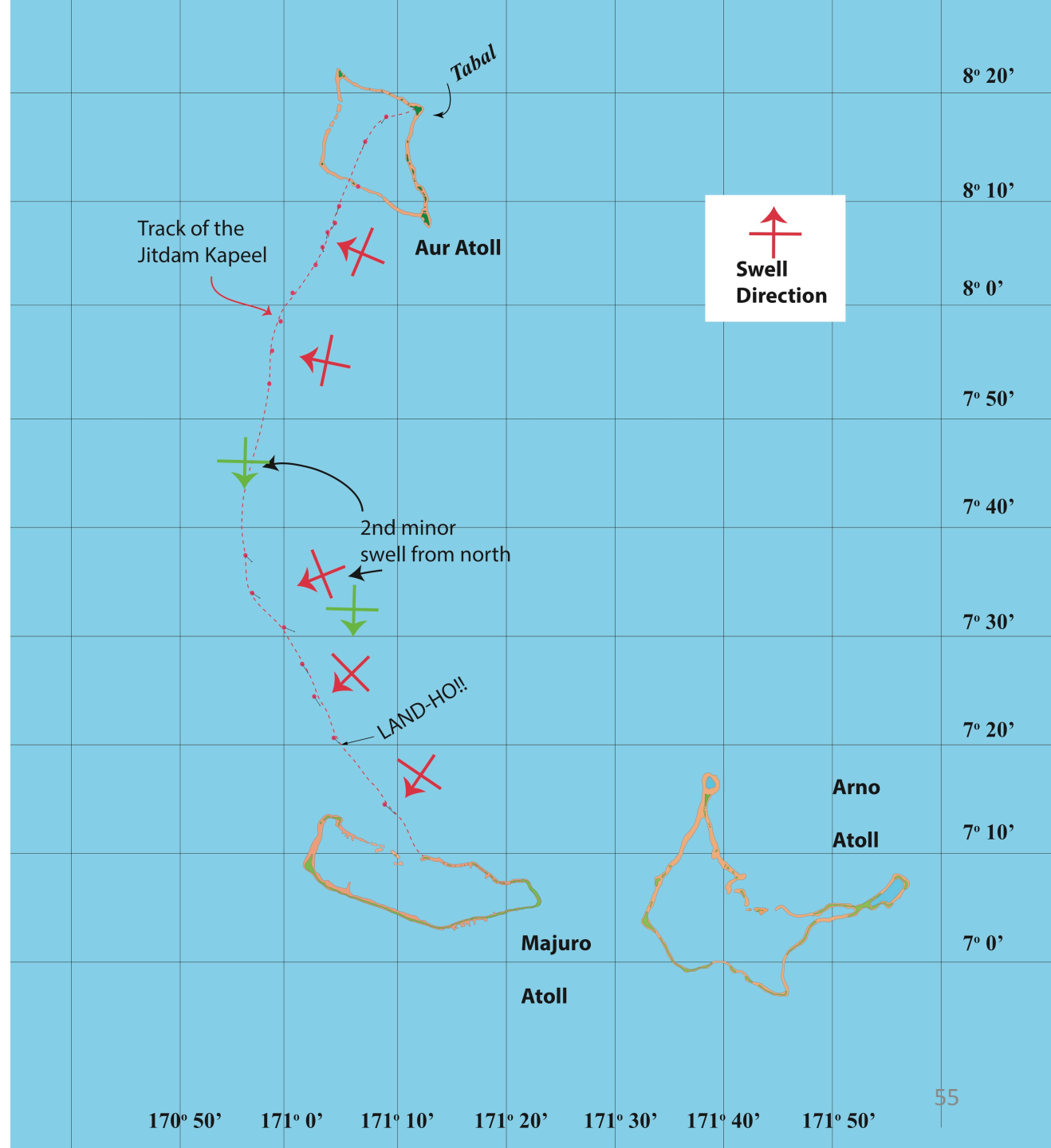
Reflections are in

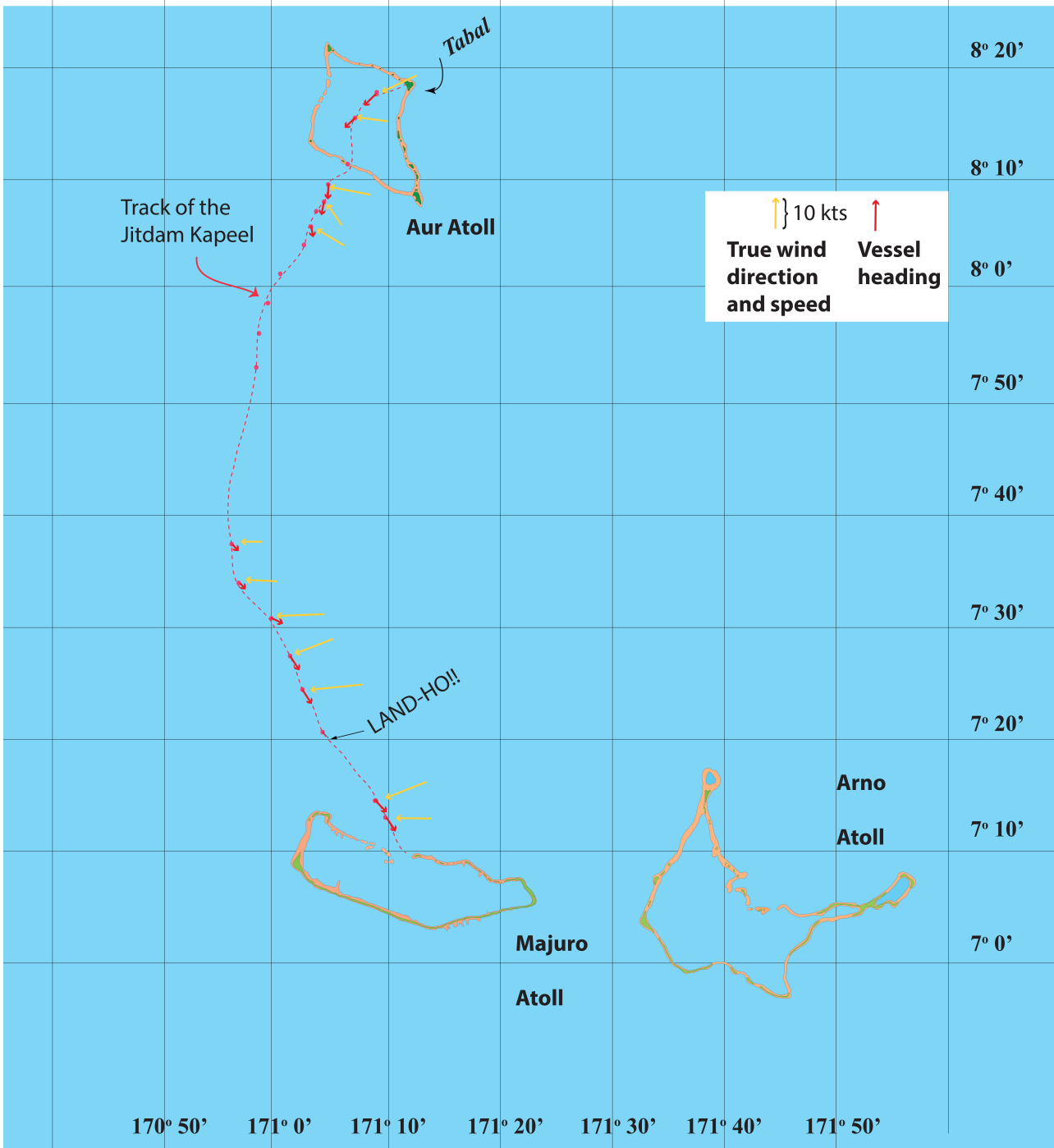


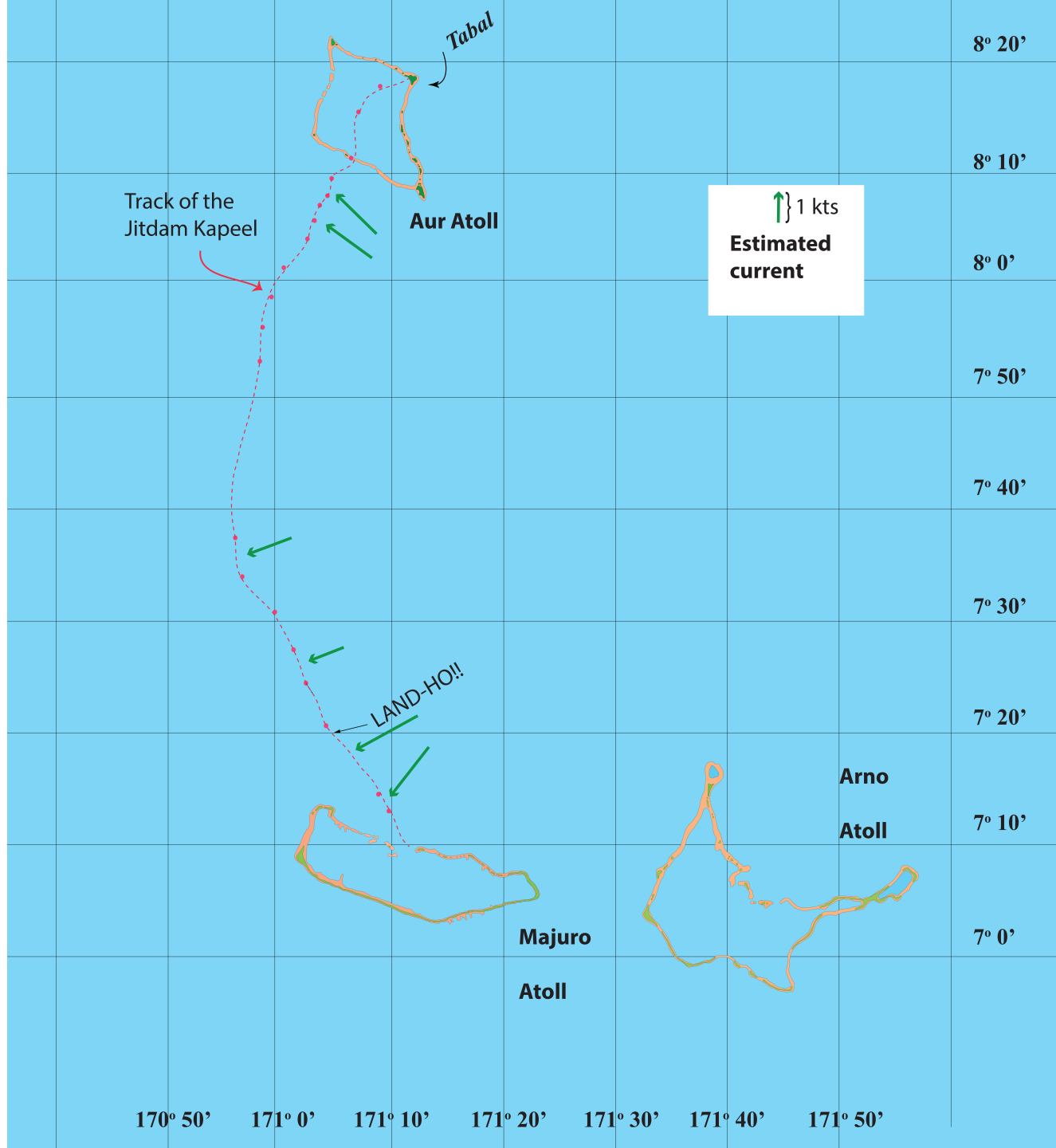
water depth



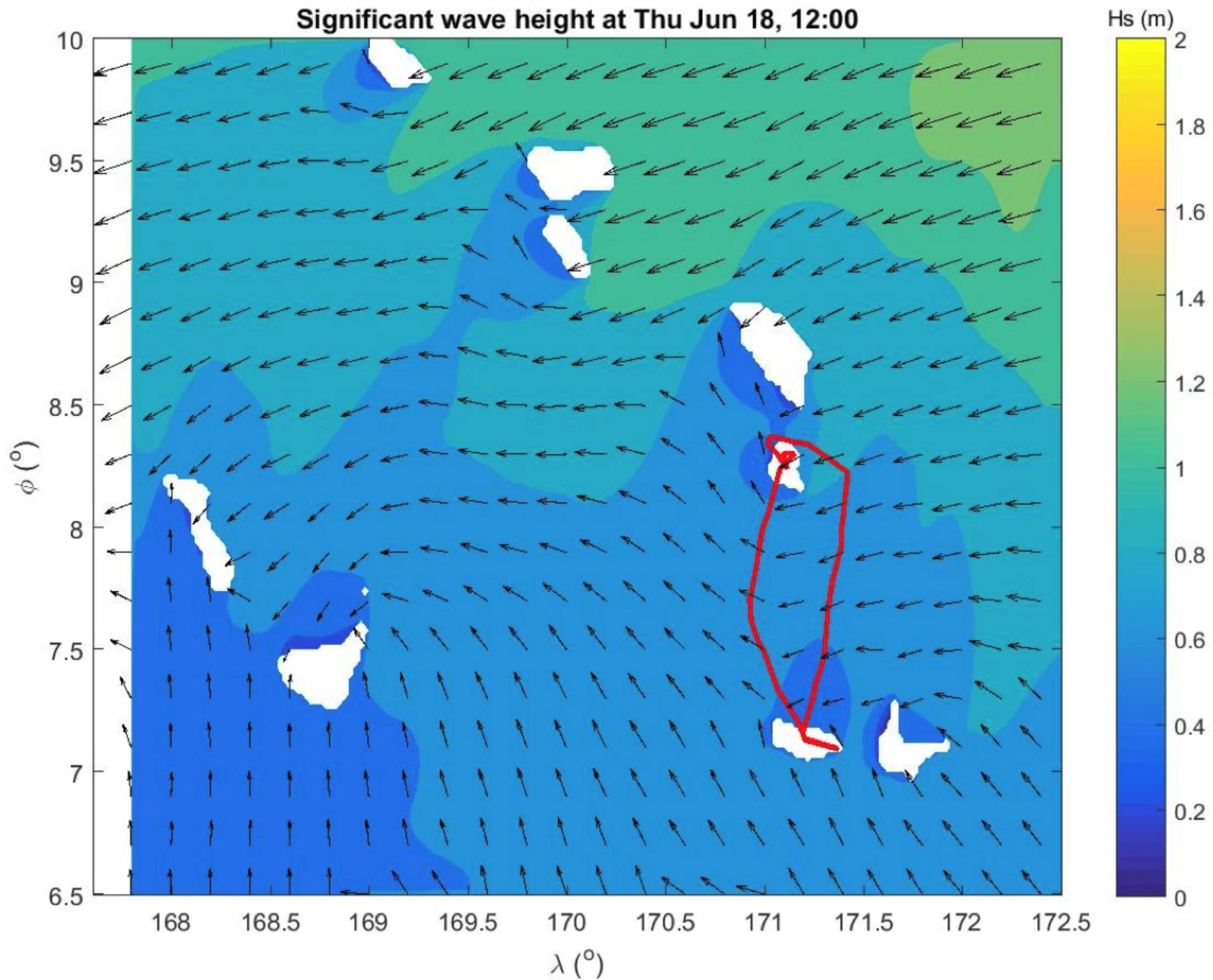
Return trip to Majuro



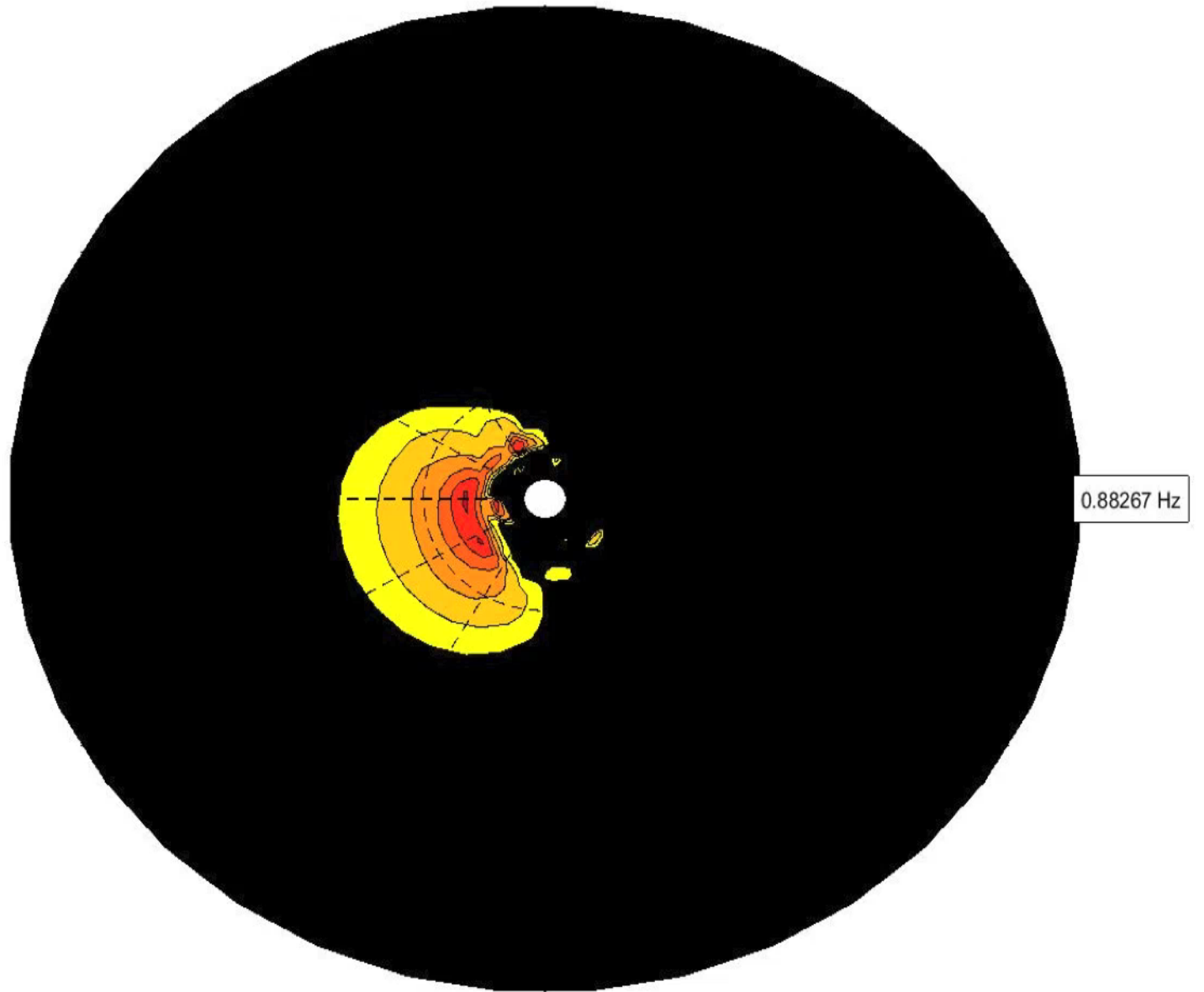




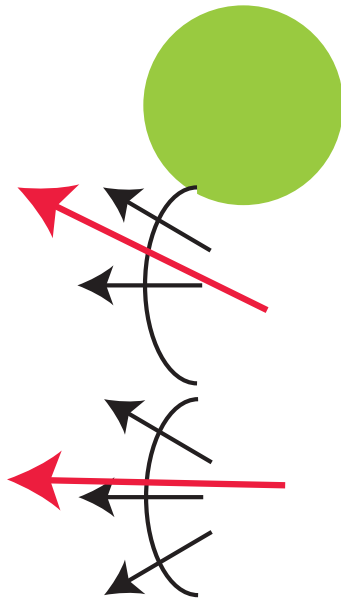
Significant wave height at Thu Jun 18, 12:00



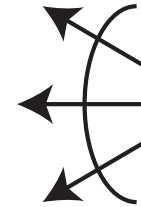
Tue 06 16, 00:00



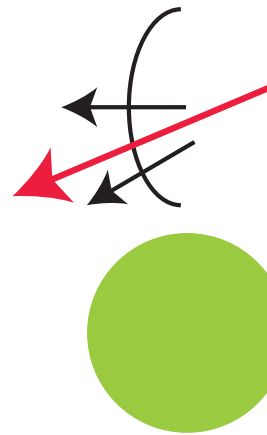
Island 1



Wave field And extinction



Wave field



Island 2

Closing Thoughts

