The Art of Wayfinding 2: Wave Piloting and Stick Charts of the Marshall Islands
John Huth
Water wave
Full eqn: \[ c = \sqrt{\frac{g\lambda}{2\pi}} \tanh \left( \frac{2\pi d}{\lambda} \right) \]

- \( \lambda \) wavelength
- \( d \) depth
- \( g \) gravity

Deep: \[ c = \frac{g\lambda}{\sqrt{2\pi}} \]

Shallow: \[ c = \sqrt{gd} \]
Wave height map

Waveheight measured by the ERS-2 Radar Altimeter, Summer 1995
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)
Rebbelib chart
Wave refraction around atoll

Eastern swell
Reflections, interference and shadowing
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

\[ R^2 \approx 1 \quad \text{(reflected energy)} \]

when

\[ M = \frac{16g^2}{(2\pi)^5} \frac{\tan^5 \beta}{H_\infty f^4} \geq 1 \]
“Reflection of Ocean Surface Gravity Waves From a Natural Beach” Elgar, Herbers, Guza (1993)
“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
Wapppepe stick chart
Teaching chart: Wappepe

- Island
  - Bunto swell from east
  - Jukai - 1st zone of current
  - Rubukae - 2nd zone of current
  - Jeljeltae - 3rd zone of current
  - Buntak swell from west
  - Buntokrok swell from south

Wappepe
The Mystery of Dilep

Island 1

Island 2

dilep

dilep

Island 3

booj

Dilep
Wind

Tacking

Shunting
Outgoing trip to Aur
Isao and Alson
21:40 wind picks up a little

From Nada, 4 w. 8th
toward course to SSE

22:08
7° 38.7
17.0° 58.6

Saw previously
SSW using
Nada, a center
parts of

23:08
7° 56.0
17.0° 58.9

00:03
7° 53.6
17.0° 58.6

22nd
5:44

30° 37.2
170° 56.3

heading SE or SEBE
speed 3.1 mph
probably have
a westerly current
~ 1 kts

seem to have corrected heading

swell 5 sec
NEBE
at this rate
1 and fall ~ noon?

trach more like SSE

wind ENE
5 kts
strengthening
E(f,θ) represents wave field
Propagation
Propagation

random-phase/amplitude model
Reflections are in

Reflected

Incident

Frequency and Direction at probe location (x=1300m, y=500m)
Return trip to Majuro
Island 1

Wave field
And extinction

Wave field

Island 2
Closing Thoughts