RADIO PROPAGATION FROM NO DATA TO BIG DATA

Neville Palmer

100 YEARS AGO THIS DECEMBER!

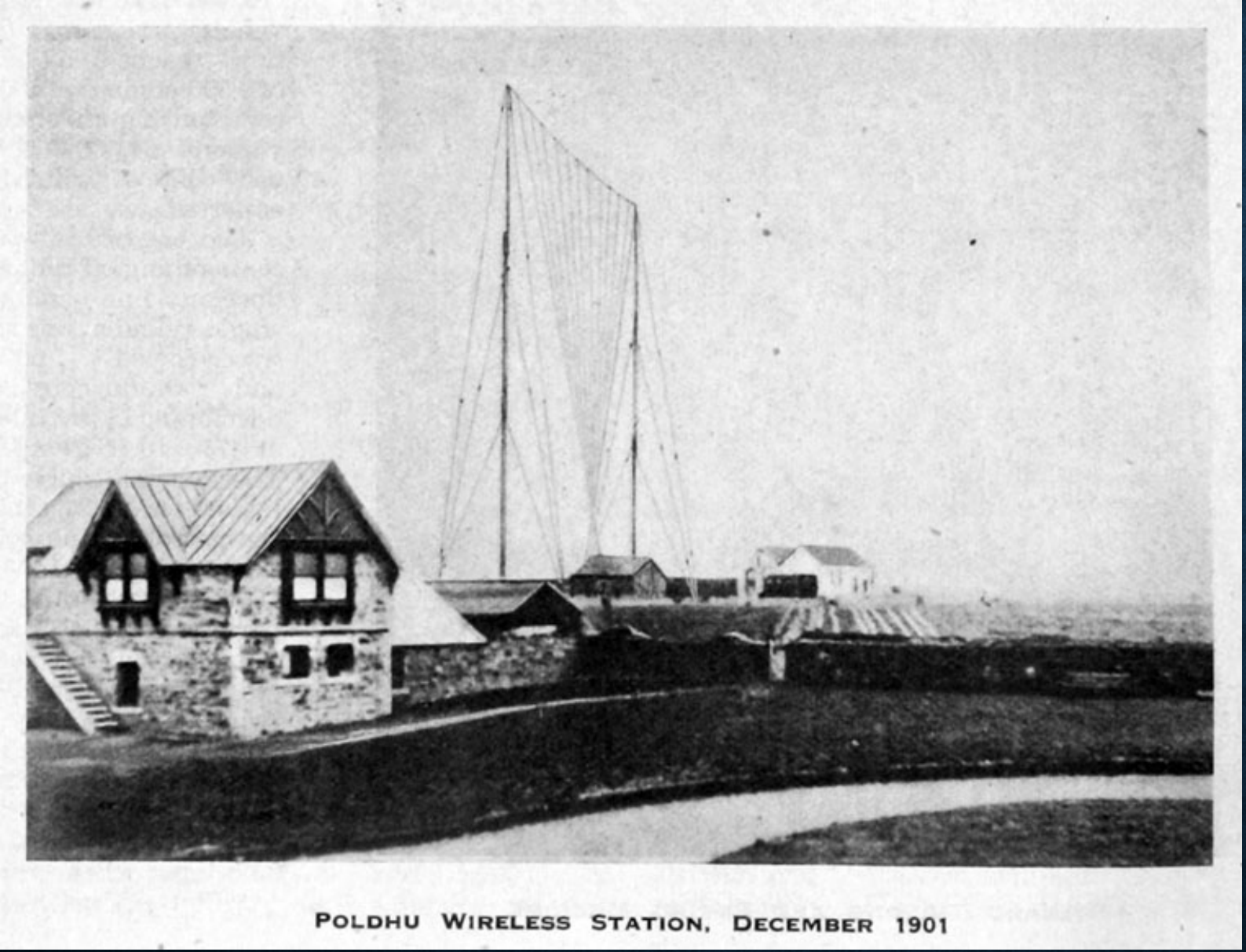
- Reception of High Frequency signals from across the Atlantic
- Started step change in understanding of radio propagation
- Today:
  - Prediction software
  - Digital techniques
  - Automated data gathering
  - Research
    - Propagation
    - Solar activity

1900

- Little data about radio propagation
- Transatlantic wireless believed impossible

Marconi disagreed!

POLDHU, CORNWALL, 1901



POLDHU WIRELESS STATION, DECEMBER 1901

Transmitter about
10 to 12 kW
On about 500kHz

Antenna:
50 wire fan between two
61m masts

- The original 20 mast array fell down in a storm!

ST. JOHN'S, NEWFOUNDLAND, 1901

Marconi's Atlantic leap!

Kite receiving antenna

Received three dots (letter S) on 12th December

(Bussey, 2001)

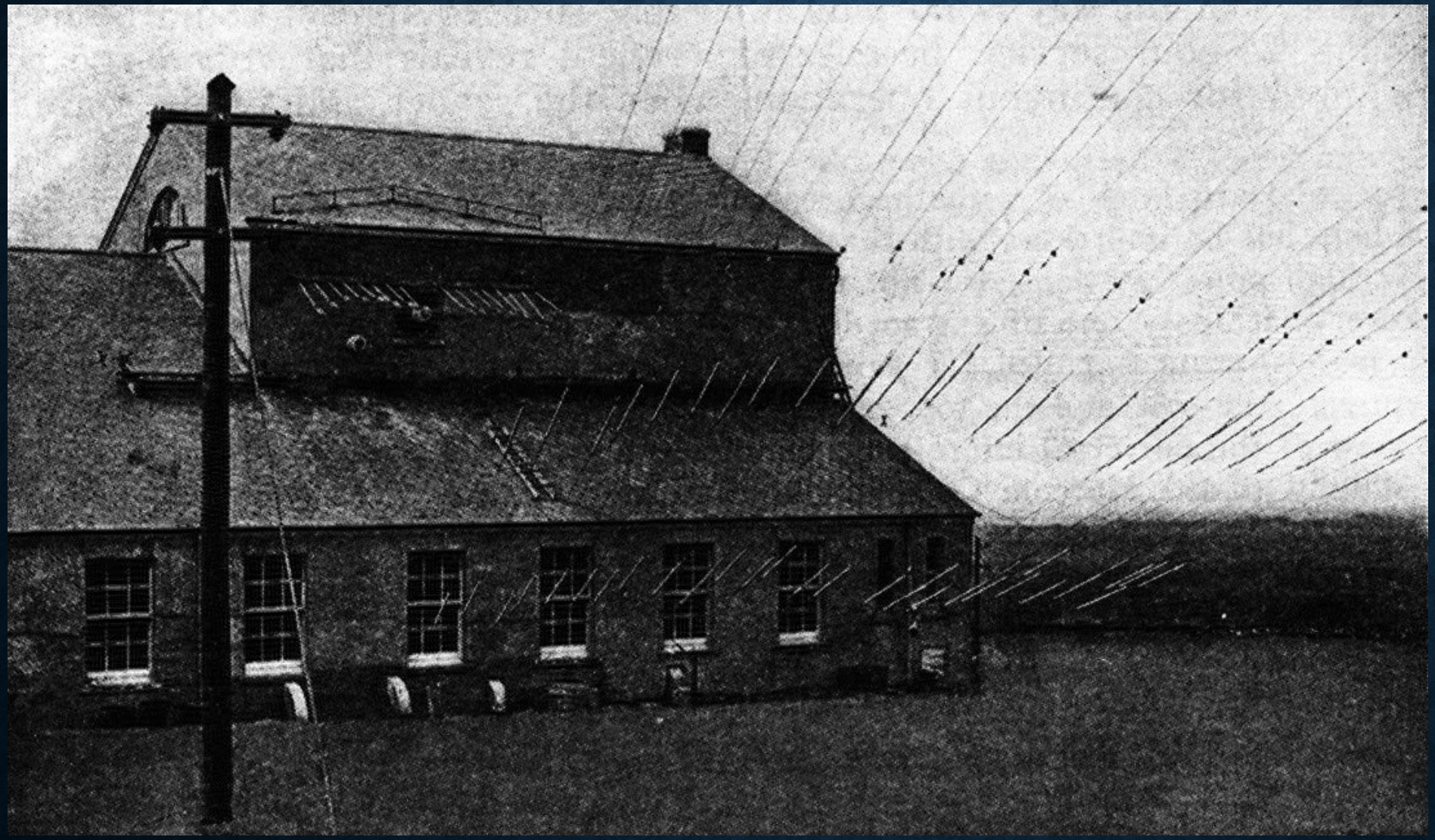
HEAVISIDE IN UK AND KENNELLY IN USA

- 1902
- Predict that Marconi's Atlantic signals must be due to unseen reflective layer in the upper atmosphere
- Named Kennelly-Heaviside layer

FURTHER TESTS

- December 1902 – first message from Glace Bay, Nova Scotia to Poldhu
- Commercial radio system
  - Clifden, Ireland to Glace Bay, Nova Scotia – 1907
- Jointly awarded Nobel Prize for Physics in 1909

CAERNARFON, WALES – TRANSATLANTIC STATION – 1916 – CALL "MUU"



1,200 metre antenna fed by 36 wires

Power: 200 kiloWatts (considered low power) On 21 kHz

Wavelength 14 km - Ideal antenna length 3.5 km!

For two way transmissions between UK – Canada/USA

(Wikepedia, 2021a)

(Bull, 2018)

CAERNARFON TO SYDNEY - 1918

- 22nd September 1918
- Edward Fisk
- receives first wireless messages direct from UK
- signals weak and only audible at certain times

Amalgamated Wireless Australasia (AWA) builds first direct two way low frequency wireless communications system to UK

Receiving antenna - Sydney

(Naval Historical Society of Australia, 2018)

POST WW1

- 1919 - amateur radio activity resumes
- Amateurs allocated commercially useless frequencies below 200 metres (1500 kHz)
  - in today's medium wave broadcast band
  - Maximum 1kW (in USA)
- Most operated close to 1500 kHz
  - Shorter range on higher frequencies (shorter ground wave)
  - Difficult to transmit on higher frequencies

Noticed: Longer range at night (and winter)

Q. Would it be possible to span the Atlantic even at these frequencies?

(RSGB, 2021)

VEALS FARM 1557 KHZ

- Local radio transmitter
- Near Hythe
- 500 Watts on 1557 kHz
- Serves Southampton and New Forest up to 15 miles

Heard From America?

FEBRUARY 1921

- UK amateurs listened for 25 active US transmitters
  - Nothing heard
  - Too much interference!

NOVEMBER 1921

- ARRL sends Paul Godley, 2ZE to UK
- Expert radio systems engineer
- On SS Aquitania
- Assistance of Marconi Company
- To Ardrossan, Scotland
  - Quiet location
- Latest superheterodyne receiver
- “Beverage antenna” – 1300 ft long wire

12TH DECEMBER 1921

- Success!
- USA received during the night
- Special codes confirm reception
- Sent via Marconi station at Caernarfon to USA

WHAT OF TWO WAY COMMUNICATION?

- 1923: In France Leon Deloy, 8AB, uses shorter wavelength 100m (3 MHz)
- Easily made two way contact with USA!

Finding:

- Shorter wavelengths and higher frequencies give greater range more reliably!
- With less power
- Smaller antennas (shorter wavelength)

Those useless short waves weren't so useless after all!

MARCONI 1923 -24

- Yacht Elettra
- Conducted short wave tests at sea
- Successful!
- Opened Beam Wireless Service for GPO:
  - Bodmin to Canada 1926
  - Bodmin to Australia 1927

All the low frequency high power stations – scrapped!

1924

- 1922 Medium wave broadcasting starts
- Edward Appleton at Rutherford lab notices that medium wave transmissions from Bournemouth are constant during the day, but fade up and down at night
- Must be two paths!
- Proves by measurement that there is a "sky wave" refracted from an unknown layer – E layer
- Higher layers are responsible for long range propagation – F layers
- Ionised layers – solar radiation

Awarded Nobel Prize

Heaviside and Kennelly were right!

Method of reflecting radio waves from ionosphere later used by Watson-Watt to invent Radar!

PROPAGATION PREDICTION

- Slowly data is gathered over many years
- Varies due to:
  - Time of day
  - Season
  - Distance
  - Frequency
  - Solar activity
    - Sunspots and cycle (11 years)
    - Solar wind
    - Solar flares (disruptive)