

Loran Trials in the United Kingdom

ILA 34, Santa Barbara,
October 2005

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UK & Ireland

General Lighthouse Authorities



General Lighthouse Authorities

- Responsible for Aids to Navigation
- 3 separate bodies
 - ◆ Trinity House
 - ★ England, Wales, Channel Islands & Gibraltar
 - ◆ Northern Lighthouse Board
 - ★ Scotland & The Isle of Man
 - ◆ Commissioners of Irish Lights
 - ★ Irish Republic & Northern Ireland
- Shared Research and Development

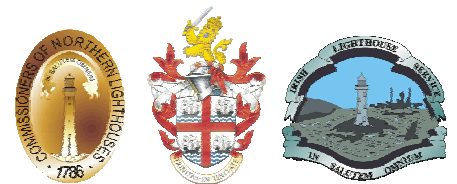
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UK's Interest in Loran

- UK has always been interested in Loran
 - ◆ Observer status in NELS
 - ◆ GLA director of the ILA
- A complement and backup to GNSS
 - ◆ Volpe report
 - ◆ Royal Institute of Navigation
 - ◆ 2020 – The Vision (GLA strategy)

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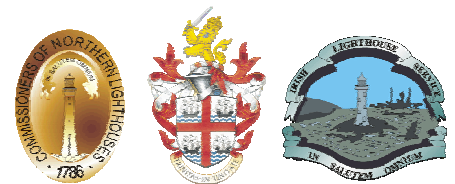
2020 – The Vision

“There are concerns about the vulnerability of GNSS in view of the total reliance on the system.

The provision of a terrestrial radionavigation backup... [is] ...essential.

Loran-C is the only terrestrial radionavigation backup currently operational that has the potential to fulfill these requirements.”

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Timescales

- Funding granted by the UK Department for Transport (DfT)
- Transmitter available until April 2007
- Trials to run to this date

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Location

- Rugby Radio Station
 - ◆ Central England
 - ◆ No sea path



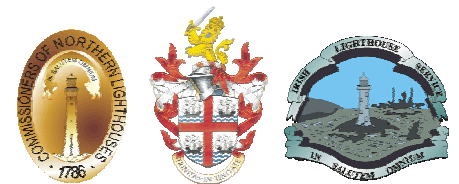
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History

- Built in the 1920s
- Originally LF comms
 - ◆ 1926 – First transatlantic radio telephone call
 - ◆ Category A target during cold war
- Hosts 60kHz time signal (MSF) run by NPL
 - ◆ Speaking clock
 - ◆ BBC Time Pips
- Run by British Telecom
- And now hosts a Loran transmitter!

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Transmitter

- Loop Head transmitter
 - ◆ Originally destined for Ireland
 - ◆ Loaned by France
 - ◆ 12 HCG
 - ◆ GRI 6731, ED 27300, Y



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The Rugby Masts and Antenna

- Originally twelve 250m masts – 10 were scheduled for demolition on 19 June 2004
 - ◆ 2 retained for timing
 - ◆ 2 retained for the Loran trial
- T-Antenna
 - ◆ Unique for Loran, designed by Telefunken
 - ◆ $52^{\circ} 22' 0.562''\text{N}$, $01^{\circ} 11' 17.636''\text{W}$



Photographs courtesy of BT, video © Steve Pell

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Diary of a Transmitter

April 2005

Transmitter building ready

15th: Megapulse's Factory Acceptance Test ends

May 2005

4th: Transmitter arrives at Rugby

June 2005

8th: First transmissions on GRIs 8940 and 9980

17th: Site Acceptance Test completed and transmitting on GRI 6731 for first time

20th: DCN perform remote control tests

23rd: Transmitter hall internal temperature reaches 86°F!

24th: Lightning damage to Loran simulators

July 2005

7th : 24 hour service begins

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Diary of a Transmitter

- Transmissions synchronised with Lessay under an **interim** Time Difference (TD) control, while full ToE control integration was being organised
- Occasional Local Phase Adjustments (LPAs) made by Control Center Brest (CCB)
- LPAs not made significantly more often than for the other stations in NELS.

Apart from scheduled maintenance, the station has been on air 24 hours a day since 7th July with only one incident requiring significant off air time...

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Diary of a Transmitter

August 2005

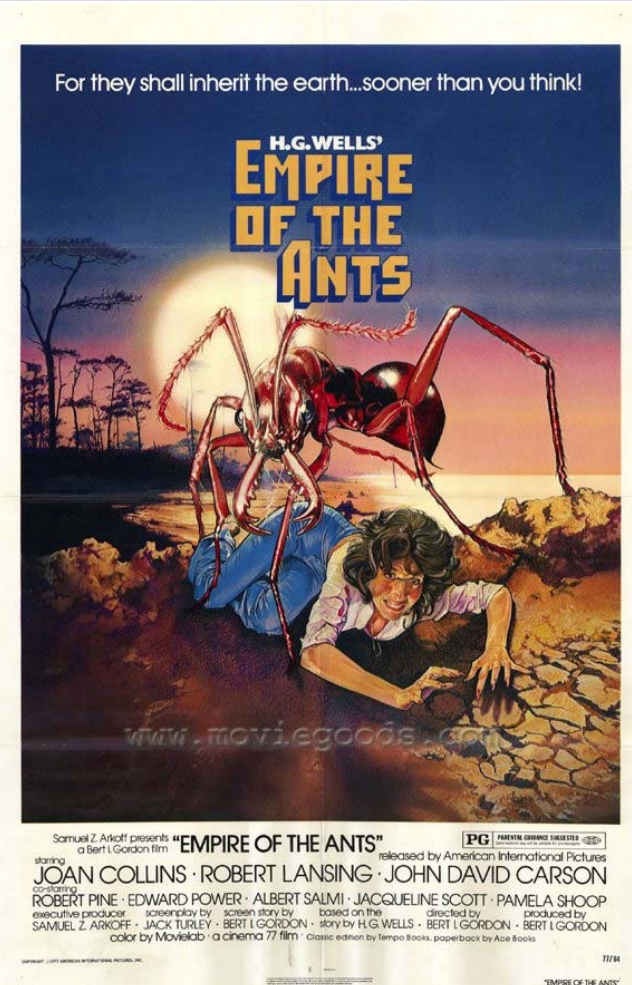
16th : The Attack of the Flying Ants!



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26th to 30th: Calibration of transmitter and integration into NELS Time of Emission (ToE) control system.

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Scope of Trials

- Assess Loran as a complement and backup – determine the degree to which this can be provided
- Main maritime application:
 - ◆ Port Approach -> **accuracy** and **continuity**
 - ◆ LORAPP shows 8-20m accuracy possible with a modernised Loran
- Timing community:
 - ◆ NPL – MSF replacement -> **stability** and **availability**
- Land application:
 - ◆ Road user charging -> **accuracy** and **continuity**



Measurements

Static

- Long term measurement – period of 1 year.
- Signal Stability
 - Signal strength and ToA
 - Seasonal variations
 - Weather effects
- Availability
- Early Skywave perhaps -> **integrity**

Kinematic

- Short term measurements – quick results
- Accuracy and continuity in UK and Irish waters

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Static Measurements



Commitment to measure for one year

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Kinematic – Two Phase Approach

- **Phase 1 – “Vessel of convenience”**
 - Get kinematic results quickly
 - Vessel goes about its normal, everyday business
 - Measurement system being constructed

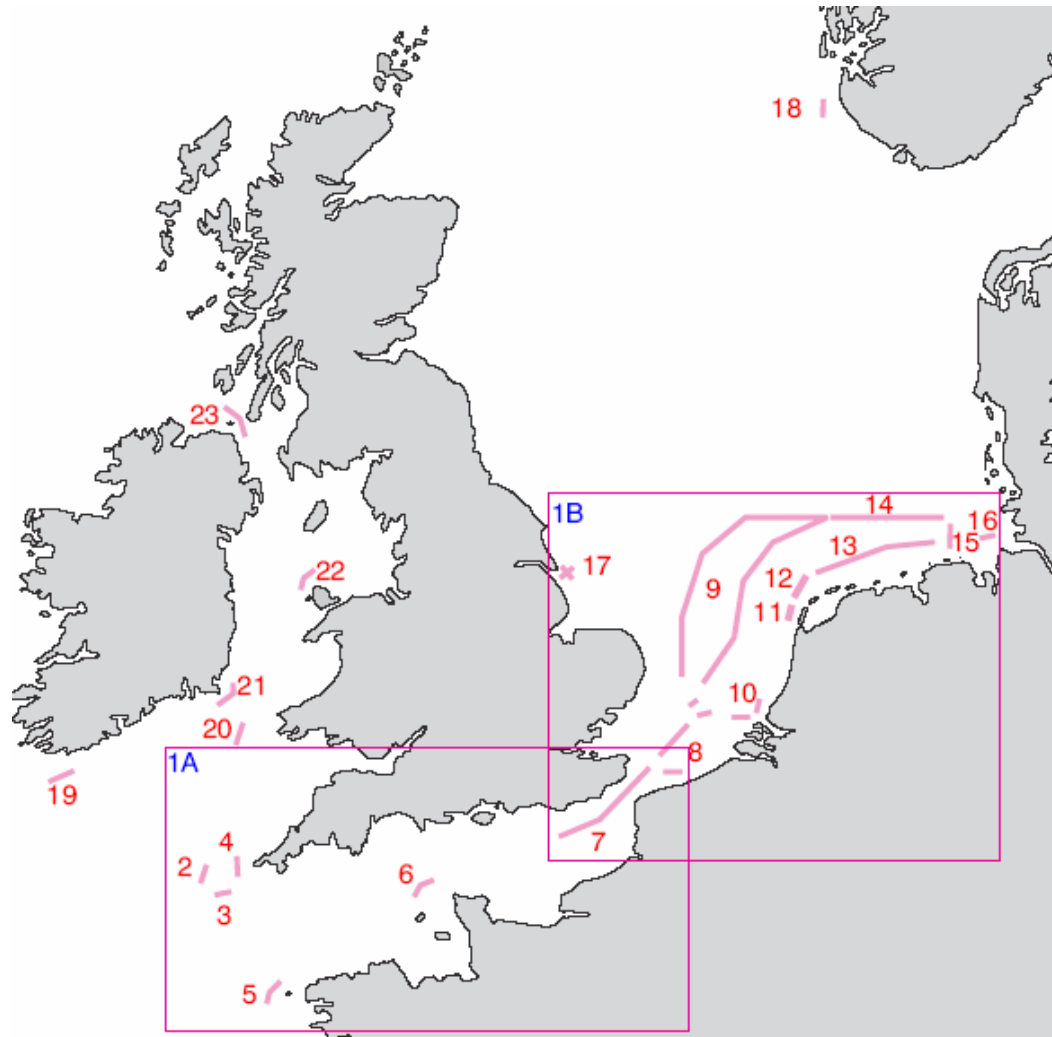


- **Phase 2 – Specific routes**
 - Traffic analysis – Traffic Sep. Schemes

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Traffic Analysis



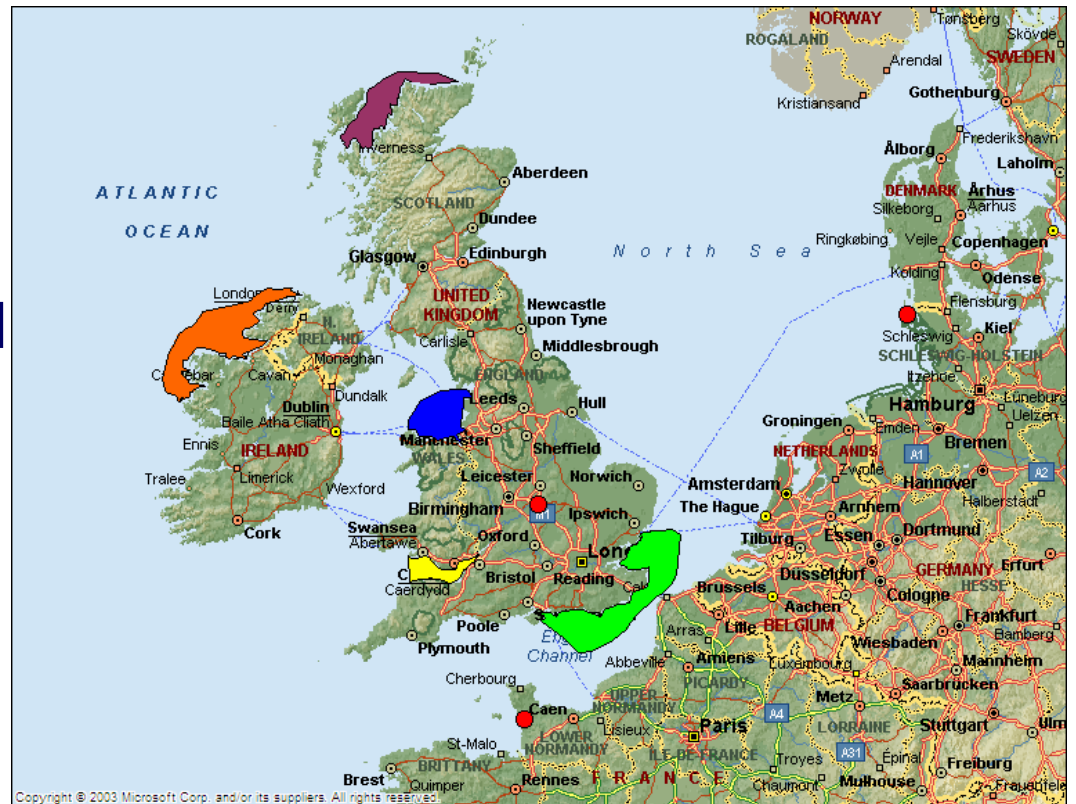
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Kinematic – Specific Routes

Identify most important areas for which good coverage is desirable:

- Dover Strait
- Liverpool Bay
- Severn Estuary
- North of Scotland
- West of Ireland



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Trials Aim

- Trials aim to assess the benefit to the mariner of a Loran transmitter in the UK, and Loran in general
- But Rugby is not necessarily the best location. At first sight:

1. Too close to Lessay
2. Too far from Ejde
3. Almost same longitude as Lessay, Soustons and Ejde
4. Non-optimal for Loran – site chosen due to infrastructure availability



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Assessing Loran in the UK

- We need to check that Rugby is doing what it is meant to do – give us good coverage with the other stations
- Loran stations have a **LO**ng **RAN**ge, but there are only enough resources to make a limited number of measurements.
- Rugby may move, so alternative sites need to be explored
- We can do this with **coverage prediction software** and the measurement data will help us validate that software.

Coverage prediction software tells us “what if?”

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What is coverage prediction?

Loran coverage prediction tells us:

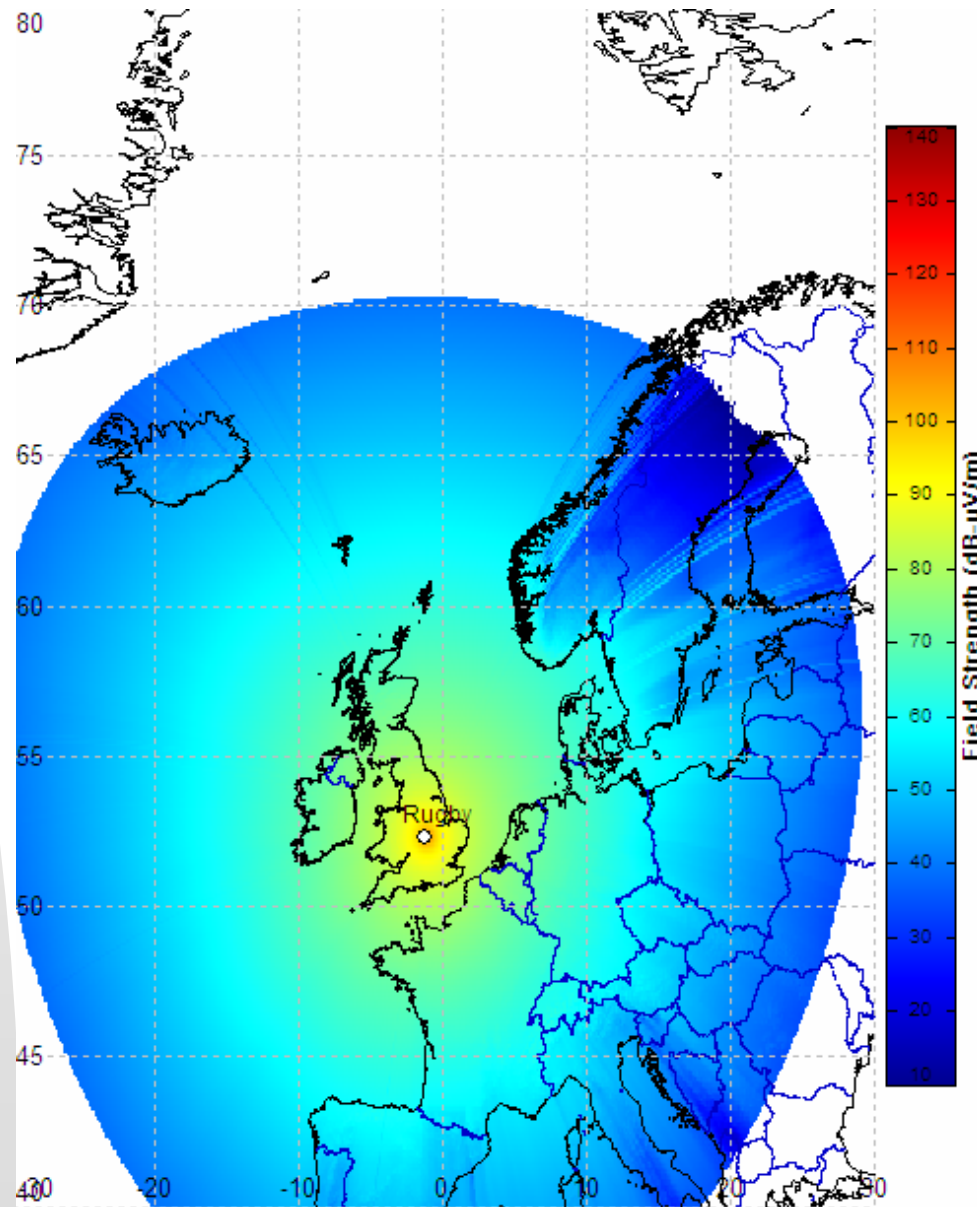
Over what geographical region we can use the Loran service and to what level of quality.

Coverage criteria might nowadays include:

- Station geometry – position of stations wrt user – for repeatable position accuracy
- Loran SNR and delay – groundwave and skywave
- Interference – continuous wave and cross rate
- Signal shape and stability
- Inclusion/exclusion of transmitters taking part in the position fix
- Receiver characteristics



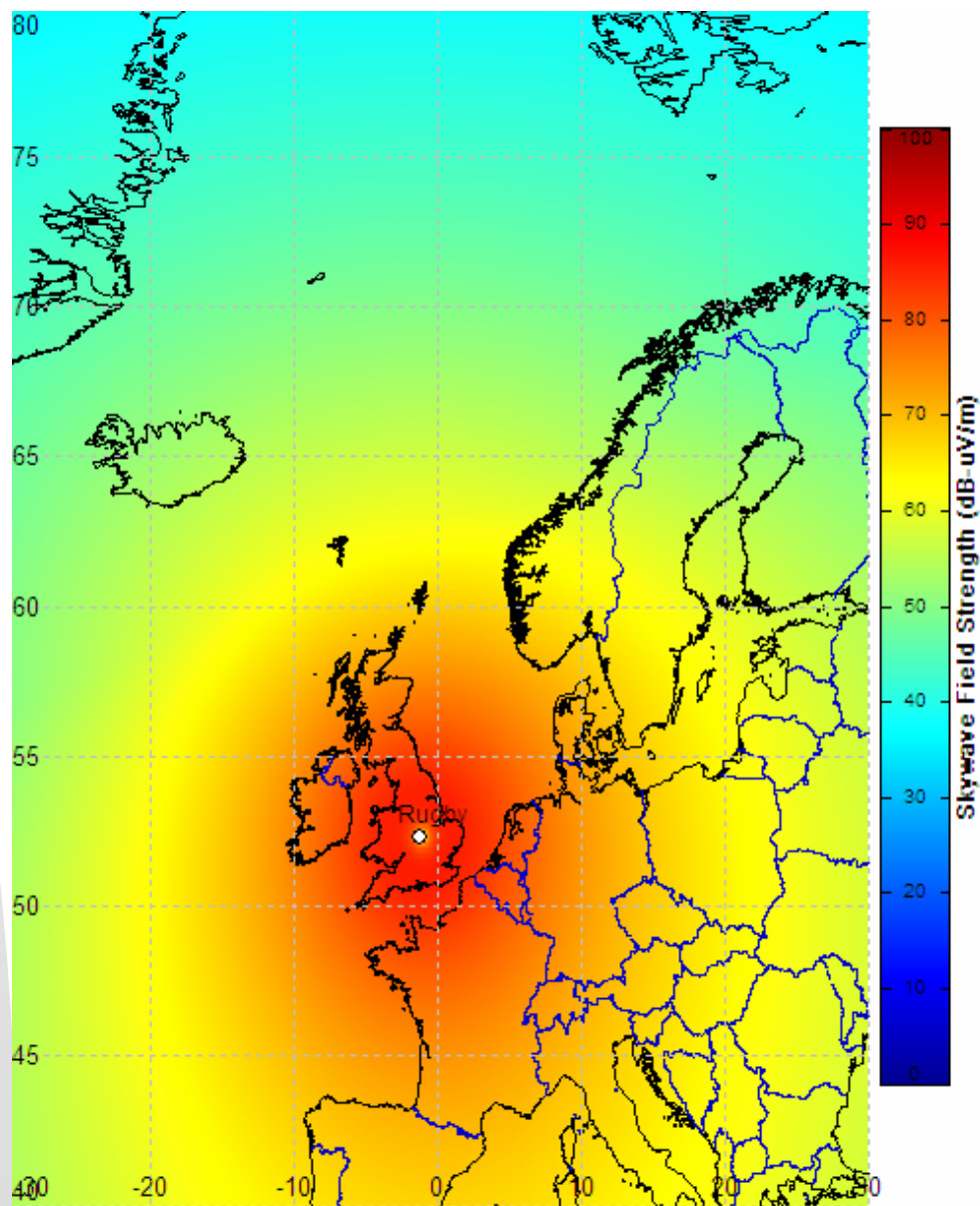
Groundwave Fieldstrength



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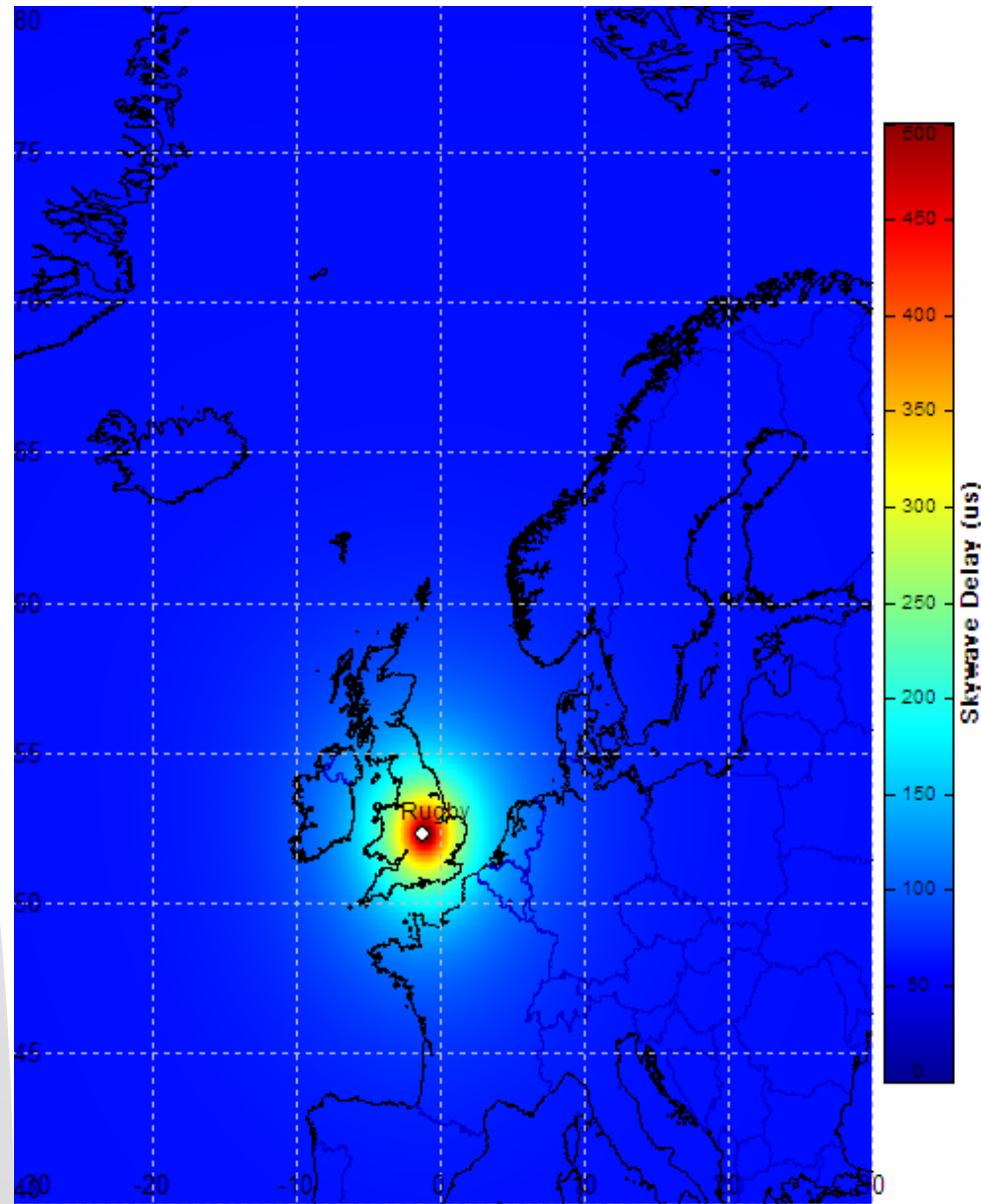
Skywave Fieldstrength



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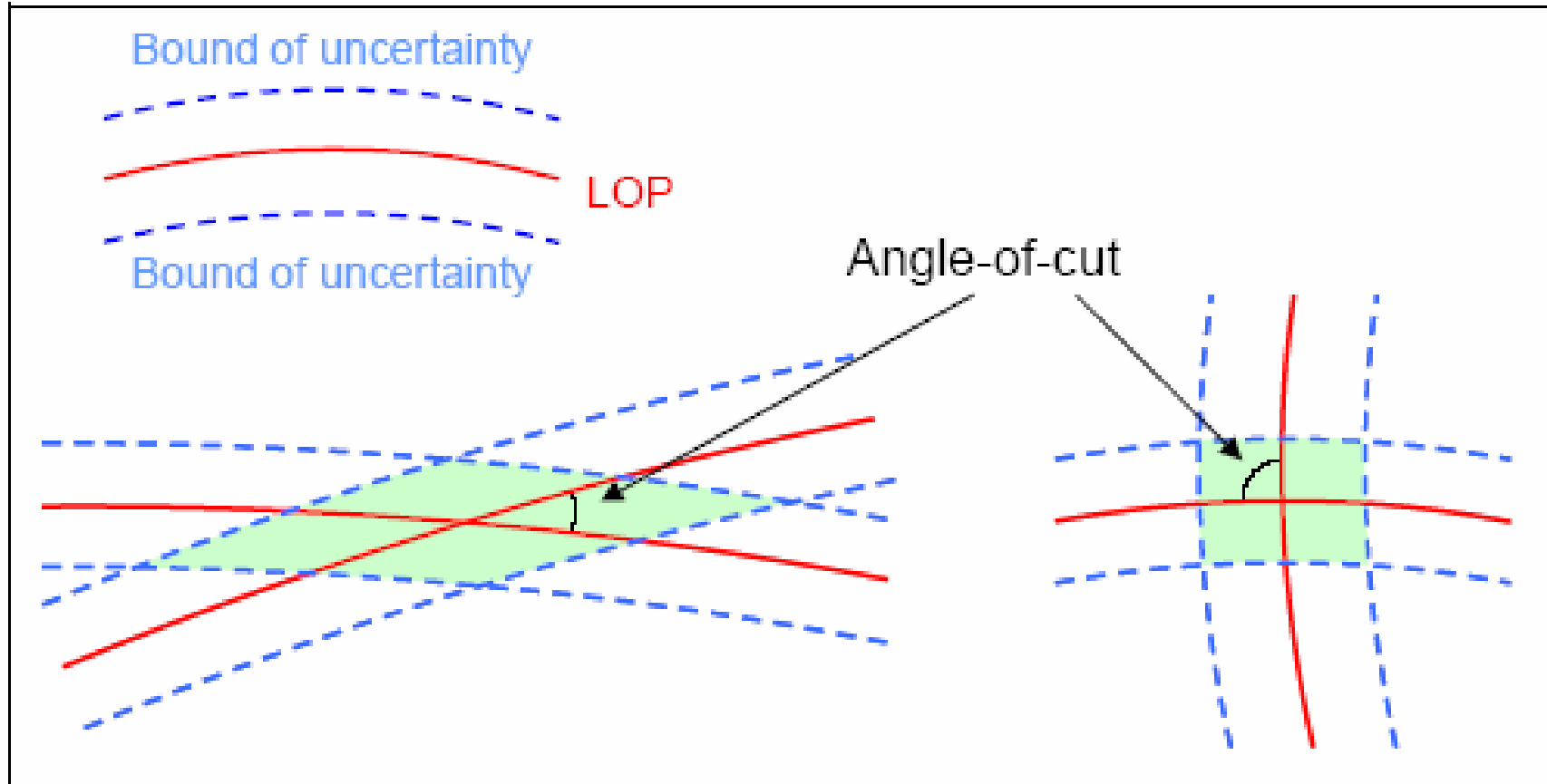
Skywave Delay



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Horizontal Dilution of Precision - HDOP



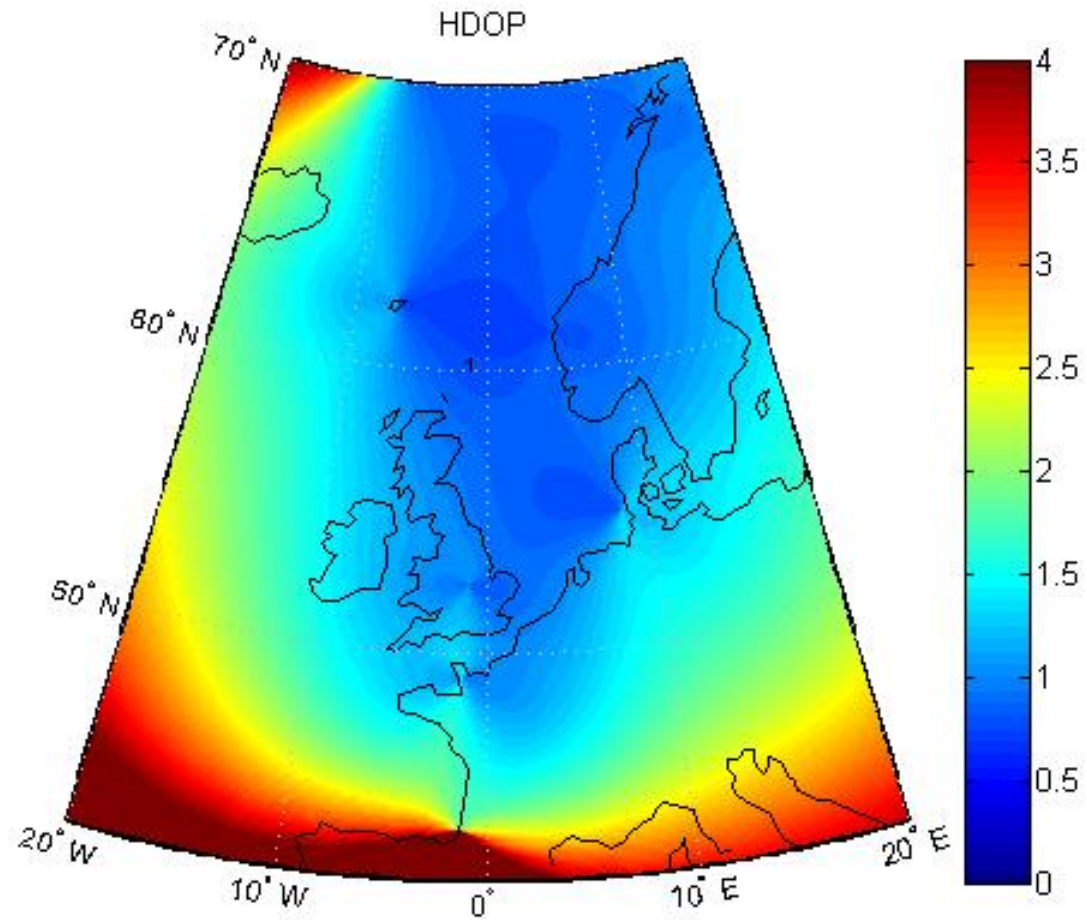
$$HDOP = \frac{DRMS_{2D}}{\sigma_0} = \frac{\sqrt{\sigma_E^2 + \sigma_N^2}}{\sigma_0}$$

Picture © Alwyn Williams

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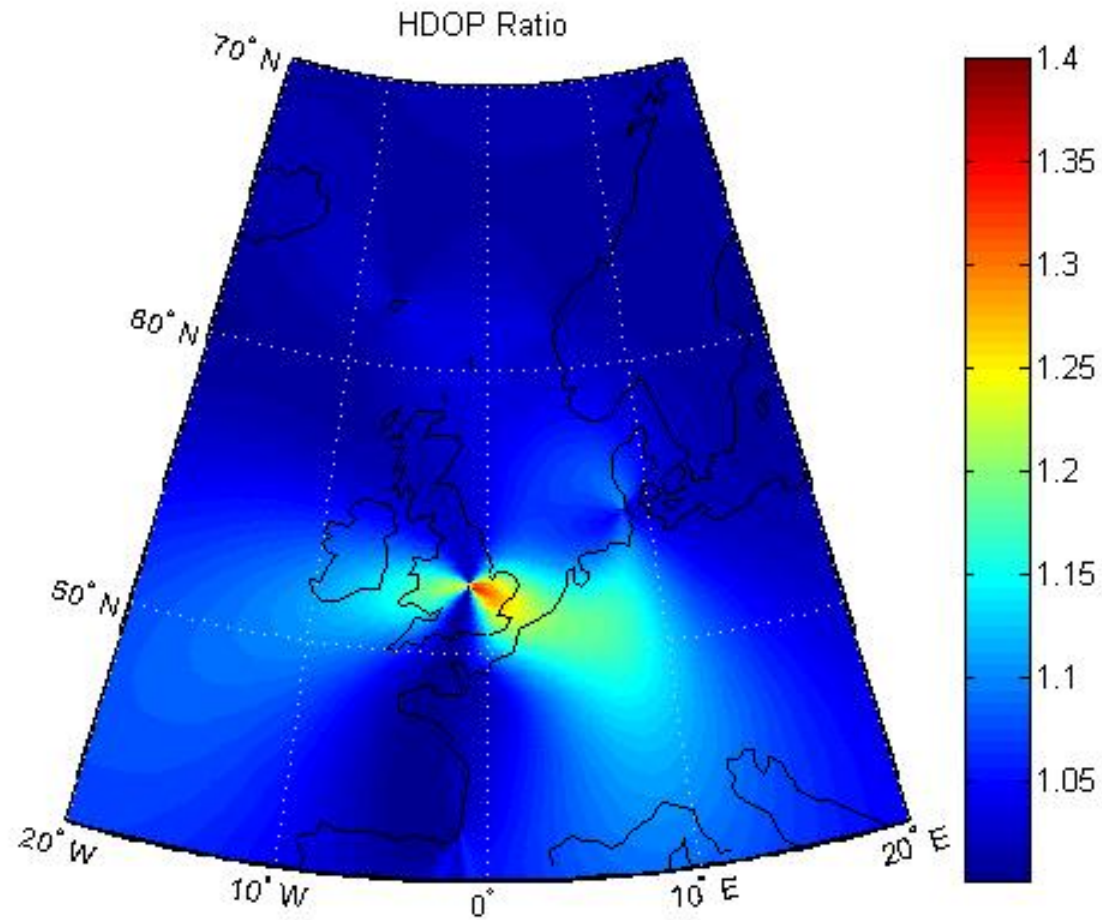
HDOP – All NELs and Rugby



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HDOP Ratio – All NELS/Without Rugby



$$HDOP_{RATIO} = \frac{HDOP_{WITHOUT_RUGBY}}{HDOP_{WITH_RUGBY}}$$



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We have work to do!

- Complete the trials planning
- Perform the measurement trials
- Write Loran post-processing software:
 - Position solution software – removing stations from solution
 - Position comparison – Loran vs. Ground Truth
- Complete the coverage prediction software
- Perform comparisons and validations
- Alternative location assessment
- Draw conclusions and report

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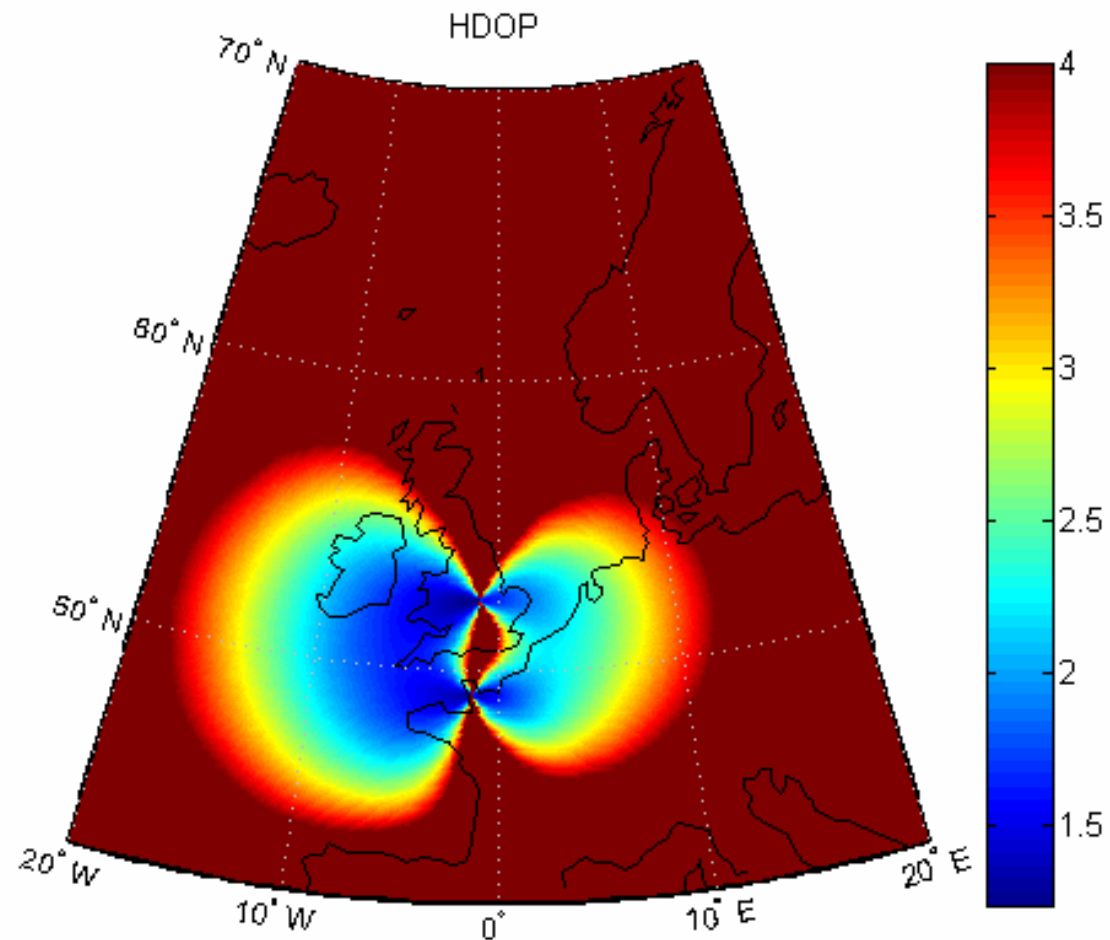


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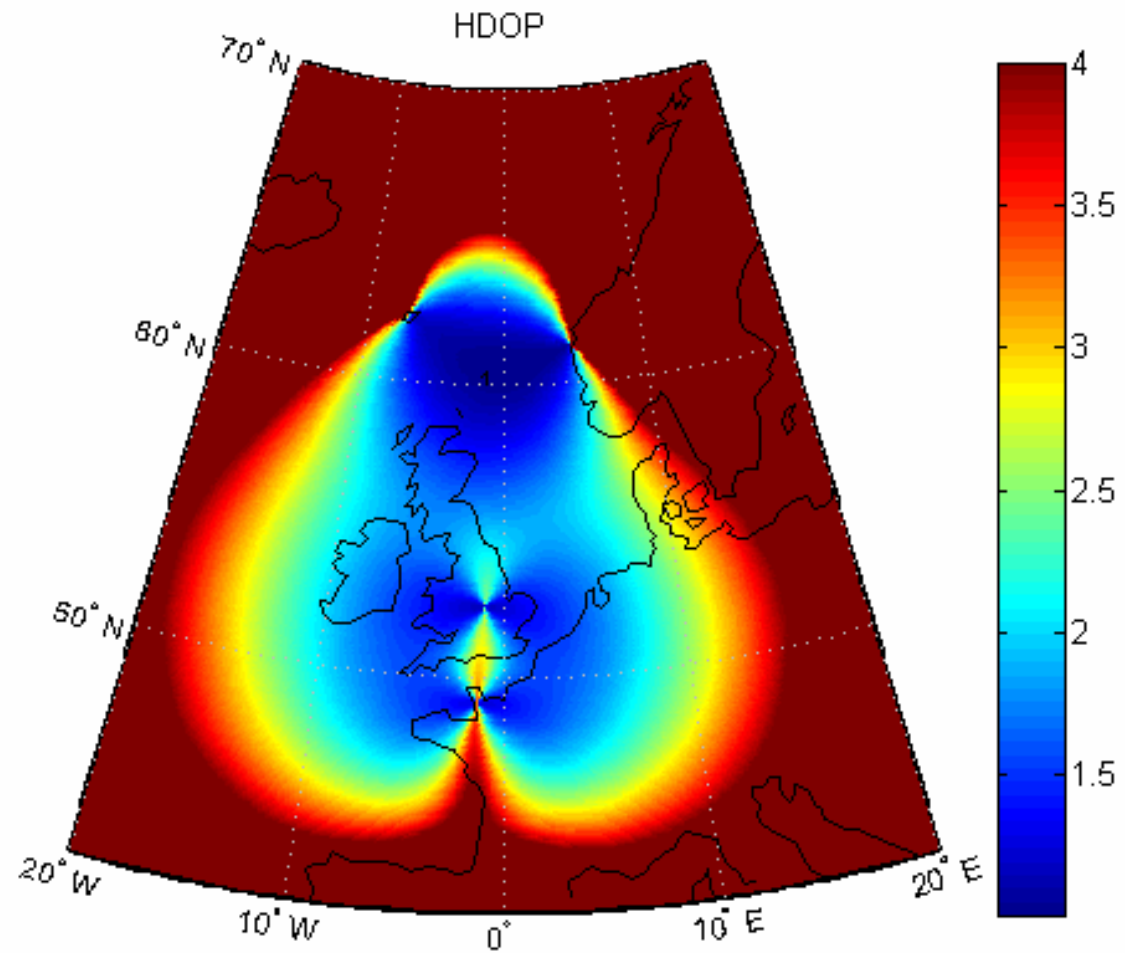
HDOP – Norwegian and Sylt Stations Closed



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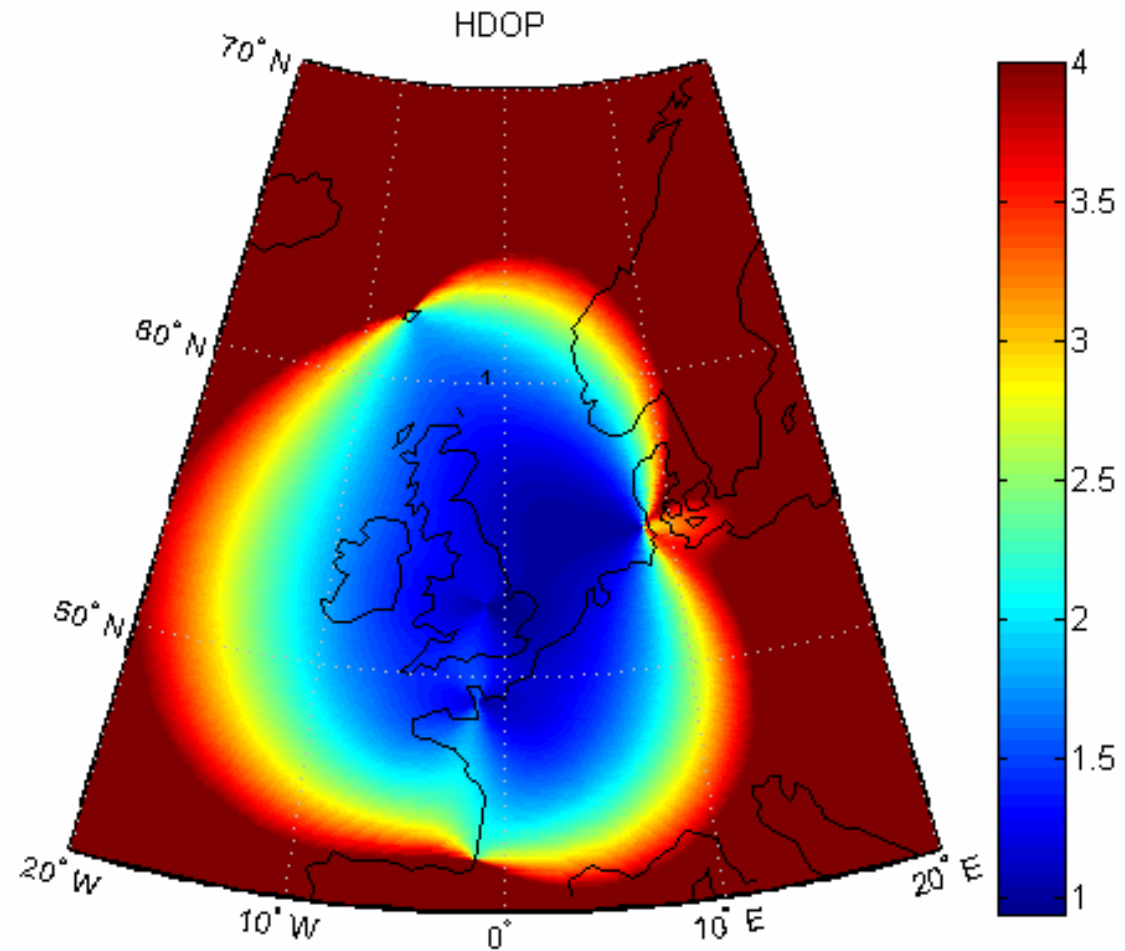
HDOP – With Just Vaerlandet



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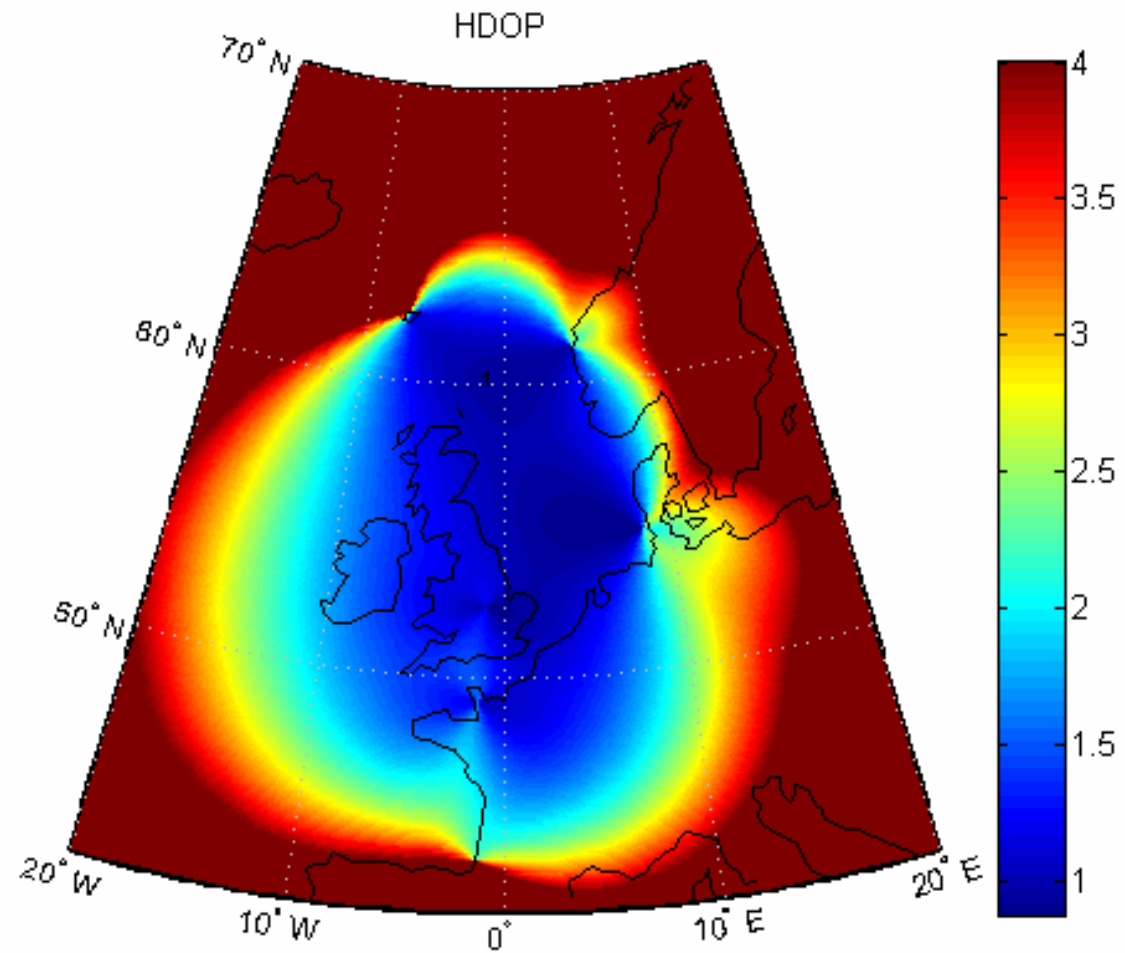
HDOP – With Just Sylt



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HDOP – With Vaerlandet AND Sylt



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