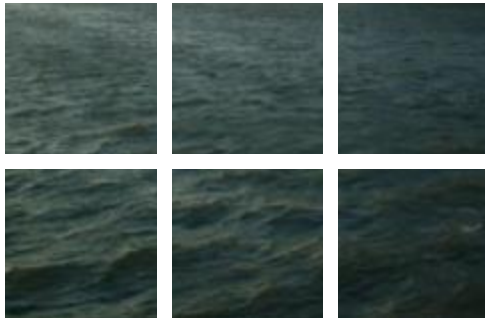


# R-Mode - Status -

R-Mode Intersessional Meeting Paris, 9-11 February 2016



**Michael Hoppe**  
German Federal Waterways and Shipping Administration  
Traffic Technologies Centre

# Overview

- The R-Mode Idea
- Results from R-Mode Feasibility Study
- R-Mode Test Beds
- Results from first on air tests
- Open tasks

# The R-Mode Idea

- R-Mode (Ranging Mode) is the transmission of accurate synchronized **timing** signals from **existing** terrestrial maritime radio infrastructure
- Use of terrestrial radio links which are standardized and already **globally distributed** for **maritime** usage
  - **MF: IALA Radiobeacon Service (DGNSS)**
  - **VHF: AIS-shore based service**

# Brief results of R-Mode within EU ACCSEAS Project in NSR

## Feasibility Study

- Part 1: Investigation of R-Mode based on existing **MF IALA radio beacons** infrastructure
- Part 2: Investigation of R-Mode based on existing **AIS shore** infrastructure (VHF)
- Part 3: **Combination** of R-Mode Signals from radio beacon, AIS and eLoran transmissions

## R-Mode Test Bed using MF transmissions

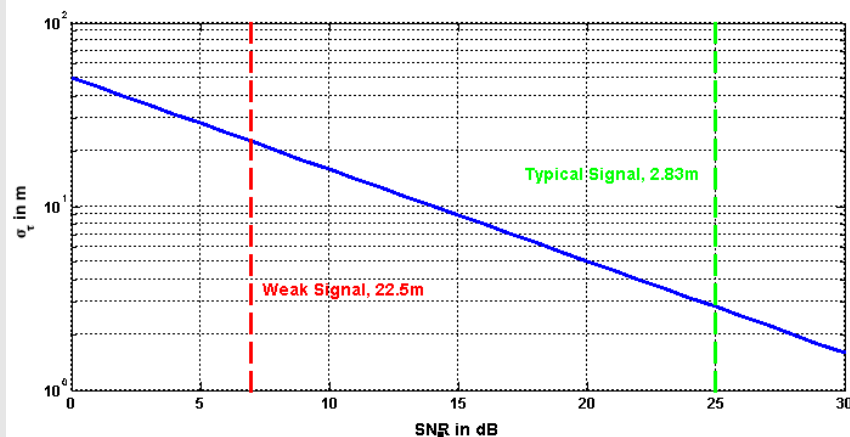
- R-Mode transmitting site in Ijmuiden
- R-Mode receiver site in Noordwijk/Zandmotor

# Brief results from feasibility study using MF transmissions from **DGNSS** radio beacons

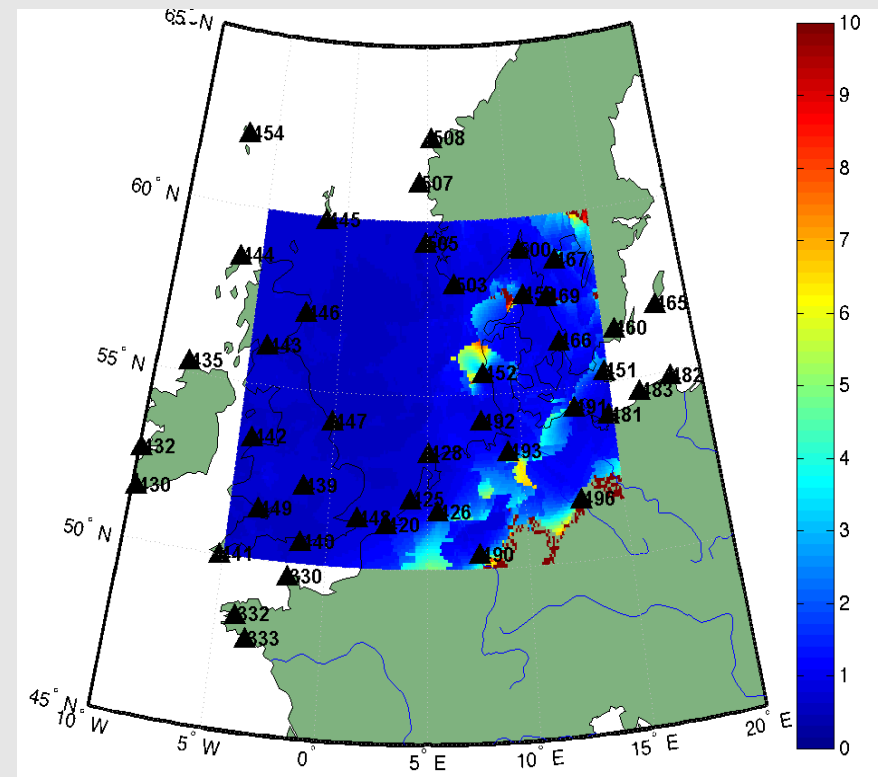
## Concept:

- Using CW's within the existing DGNSS Signal (MSK)
- Add accurate timing and synchronization

## Range estimation as function of SNR

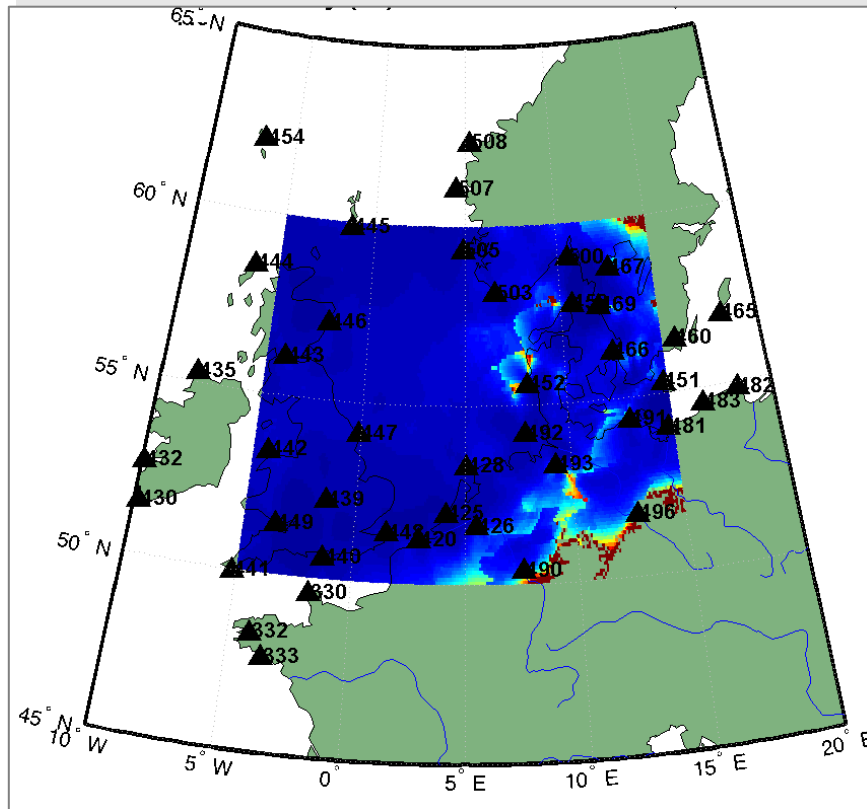


## Geometry (HDOP) based on existing MF-DGNSS network in North Sea area

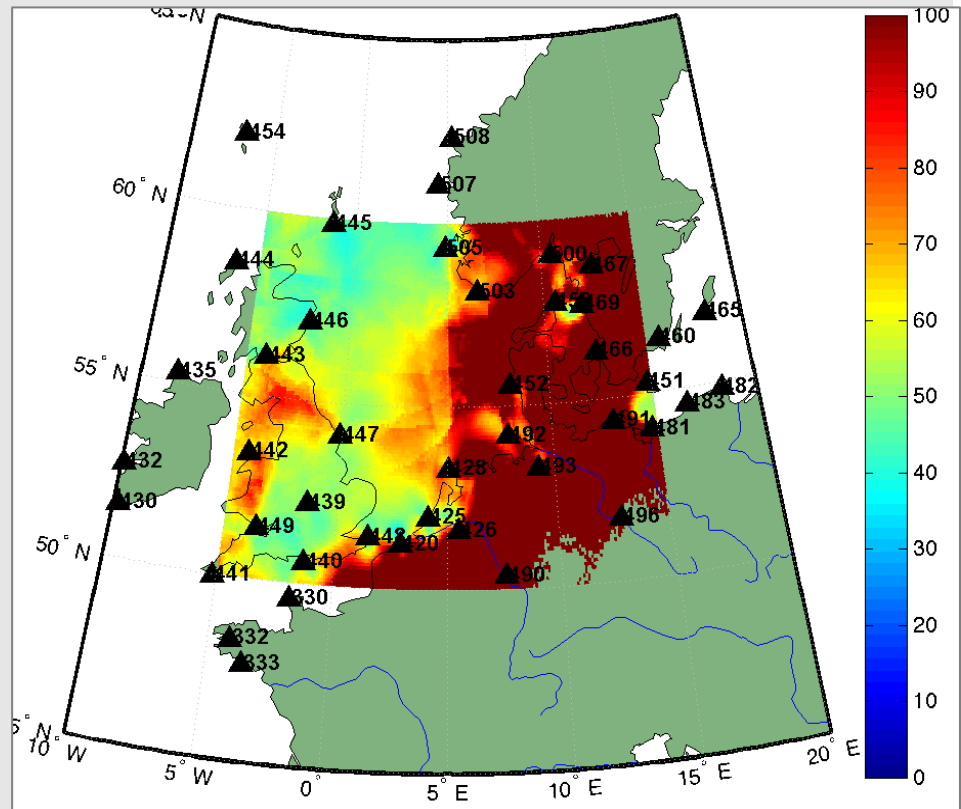


# Brief results from feasibility study using MF transmissions from **DGNSS** radio beacons

Day time (no sky wave)



Night time (sky wave)



Predicted daytime bound on R-Mode positioning accuracy is very good.  
Countermeasures are required to overcome the sky wave effect

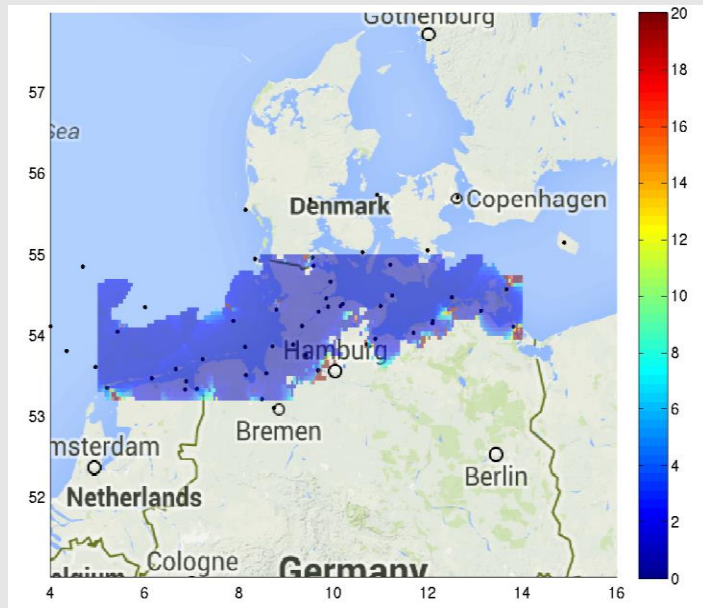


# Brief results from feasibility study using VHF transmissions from **AIS shore service**

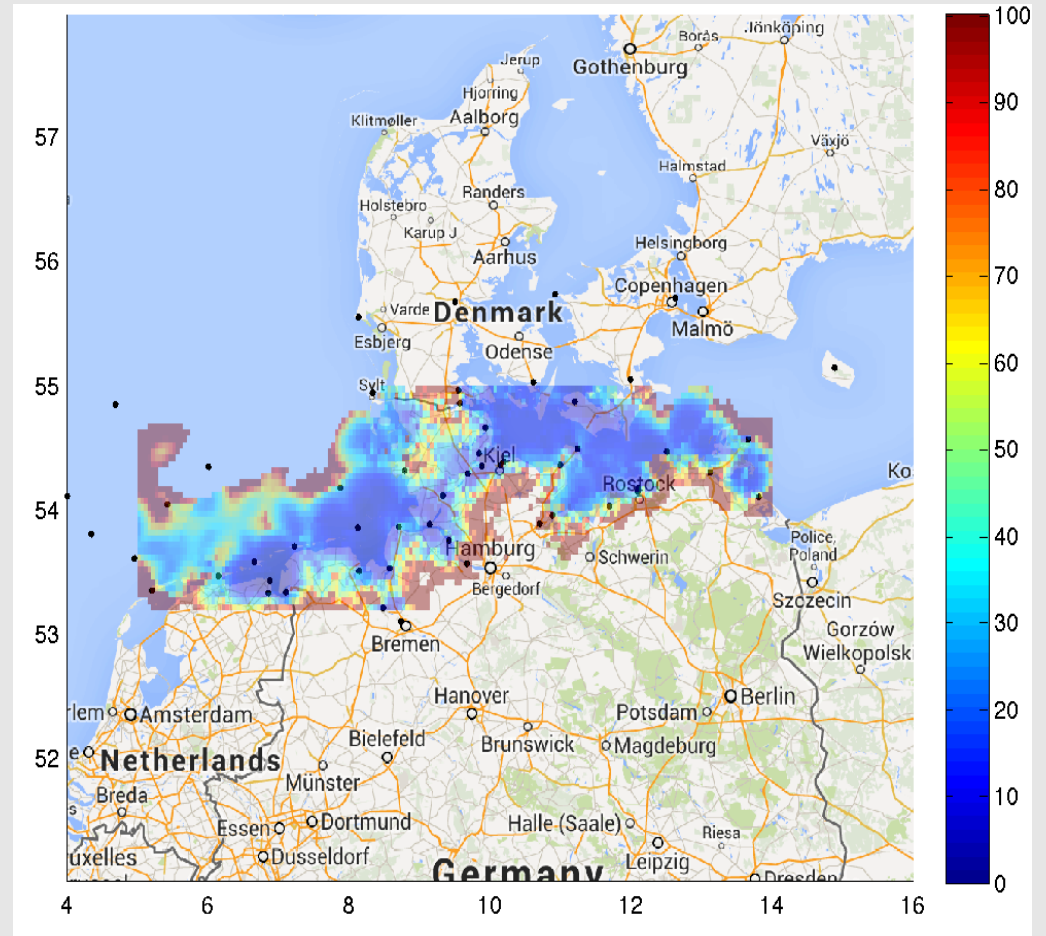
## Concept:

- Using standard transmissions without any modifications
- Add accurate timing and synchronization

## Geometry (HDOP)

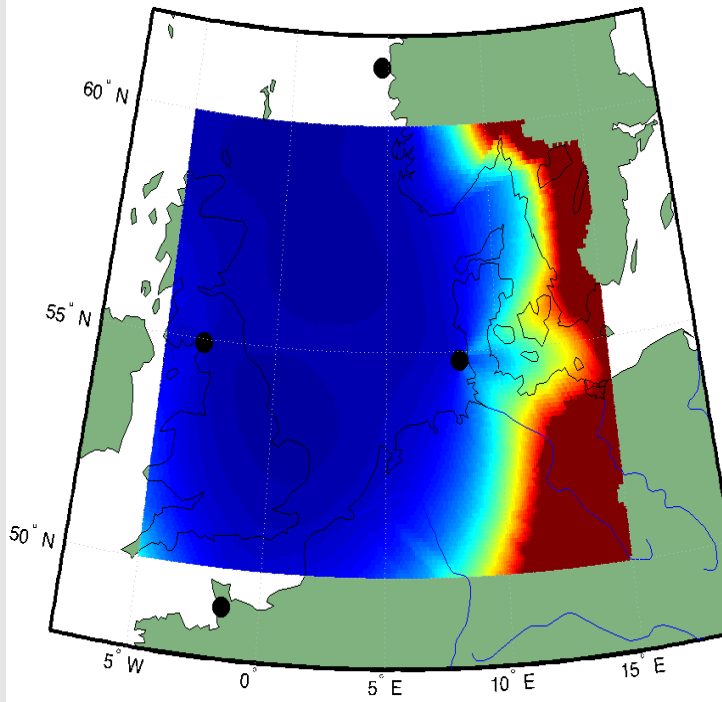


## Accuracy estimation

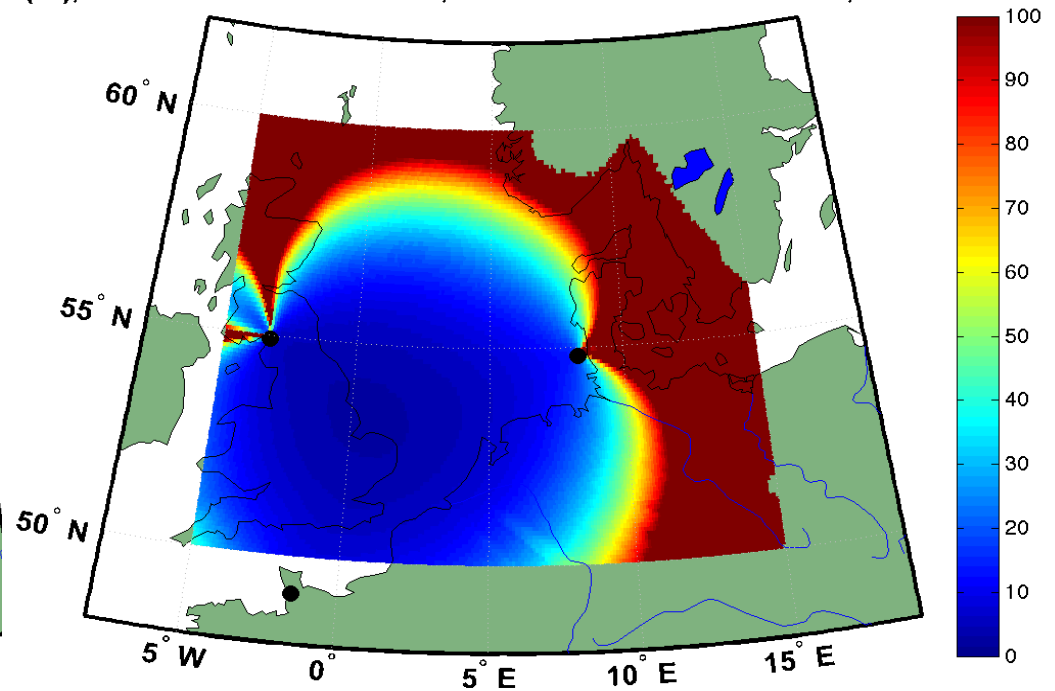


# Brief results from feasibility study using LF transmissions from **eLoran**

Lower bound to positioning accuracy  
of eLoran. Calculated for **5** eLoran  
sites

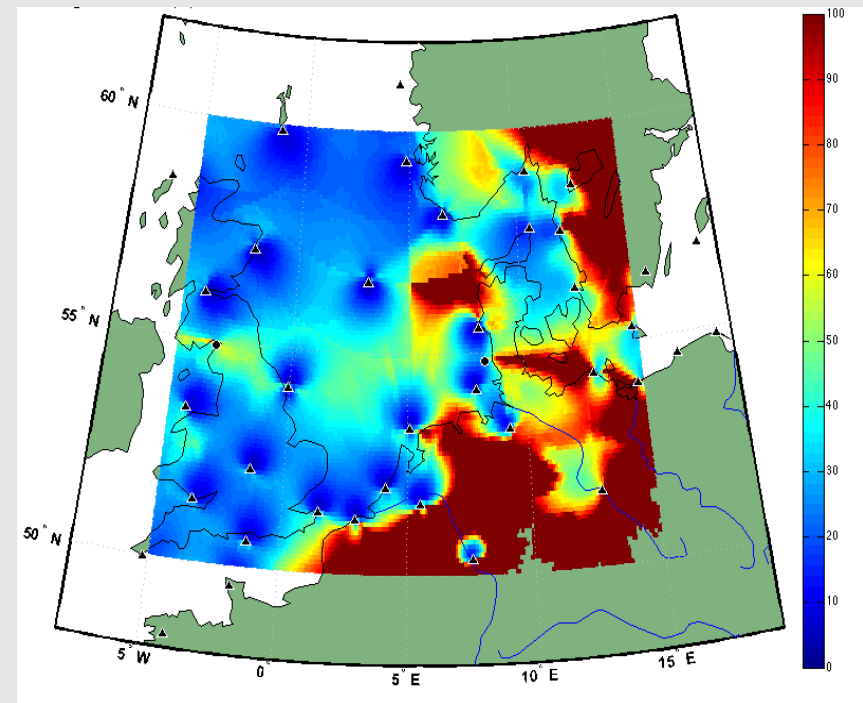
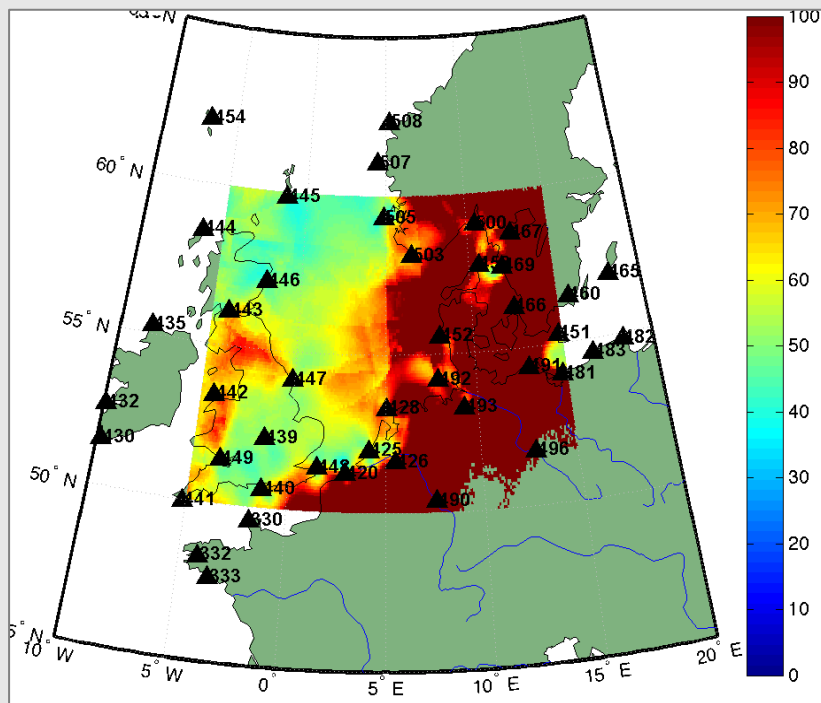


Lower bound to positioning accuracy  
of eLoran. Calculated for **3** eLoran  
sites

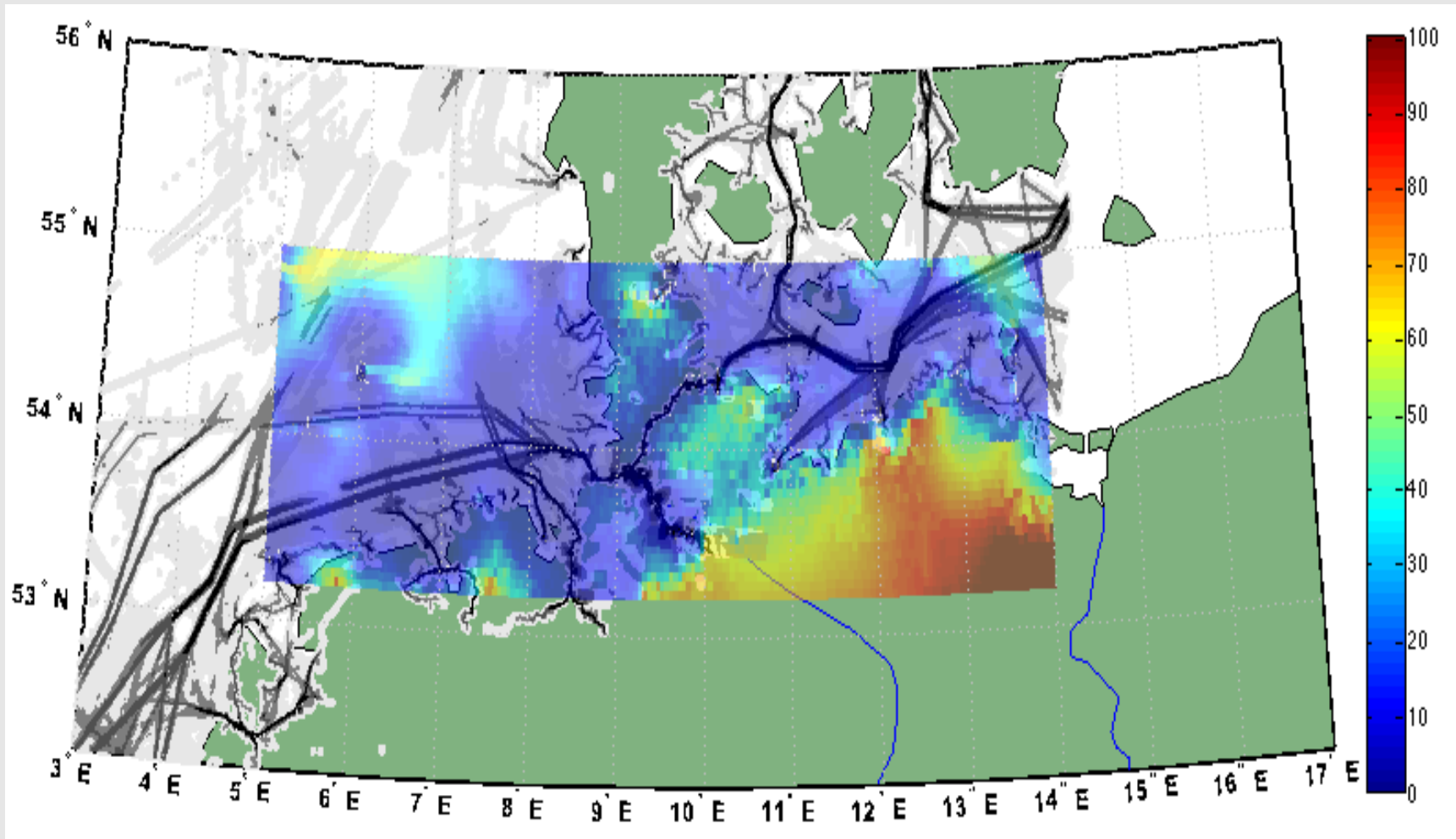




# Combined use of DGNSS and eLoran (Sylt and Anthorn) at night.



# Results from Feasibility study using a combination of MF, AIS and eLoran\*

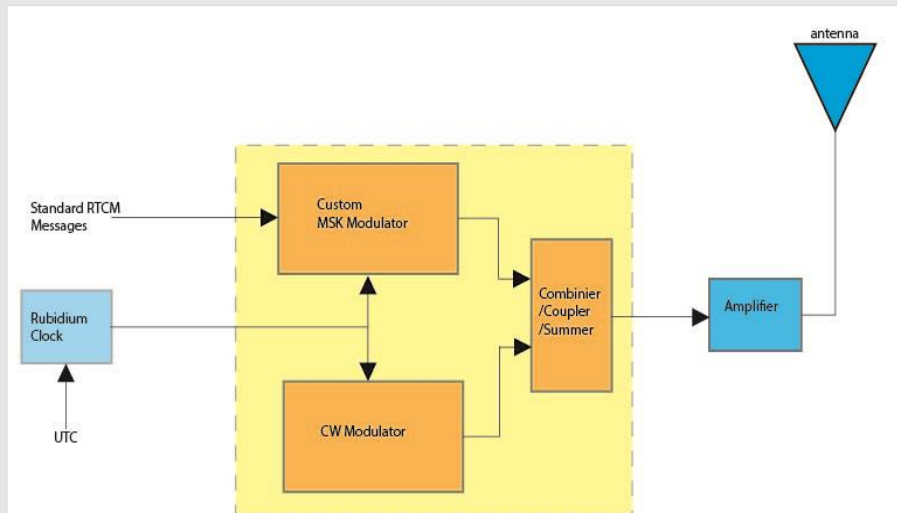


\*) 1 eLoran site in Sylt

# **Results from first on air tests**

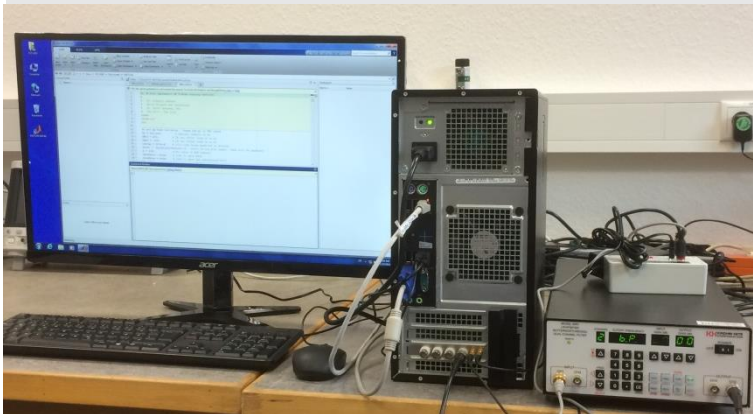
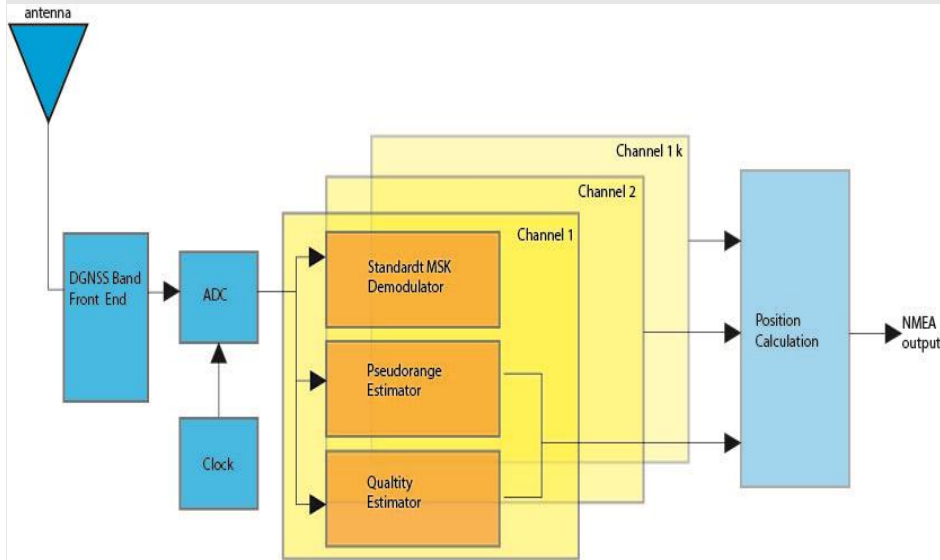
# R-Mode (MF) Test Bed

## - Transmitting site in Ijmuiden -



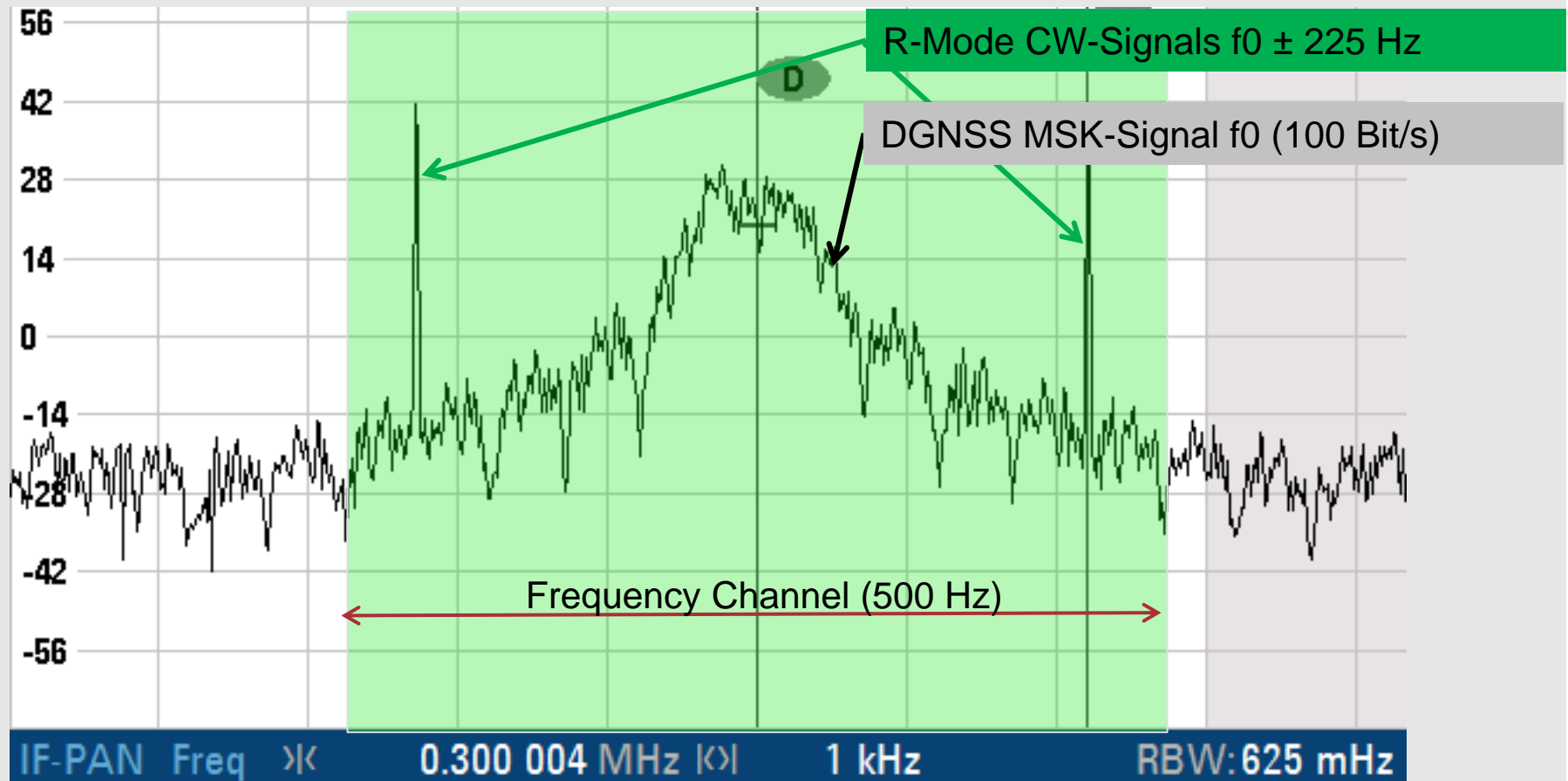
# R-Mode (MF) Test Bed

## - Receiver site in Noordwijk -



# R-Mode (MF) Test Bed

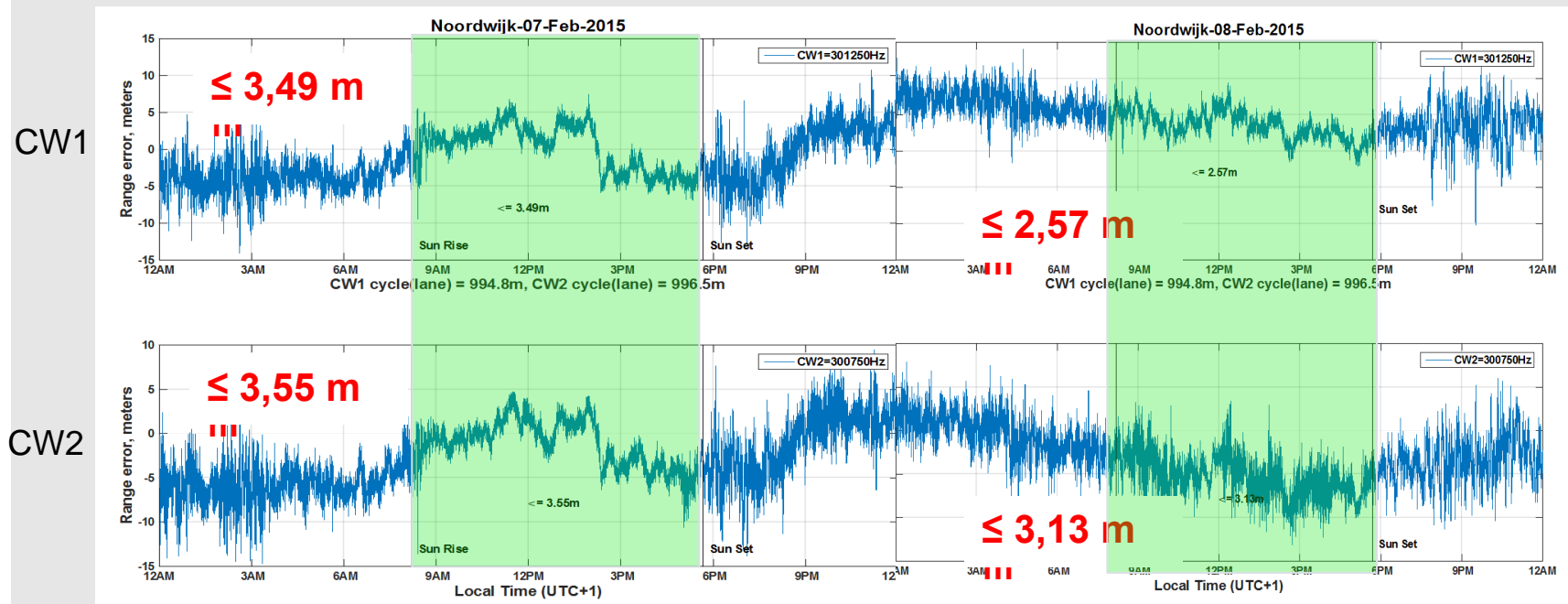
## - Test signal -





# R-Mode (MF) Test Bed

## - Results of measurement campaign -

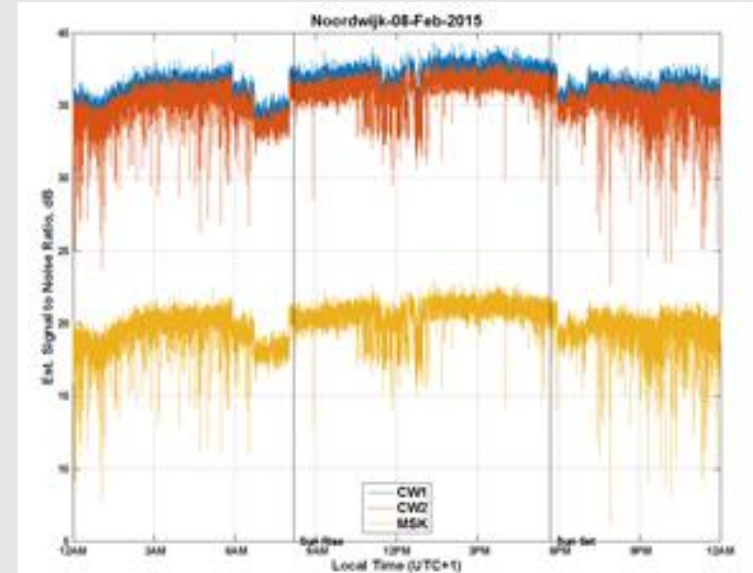
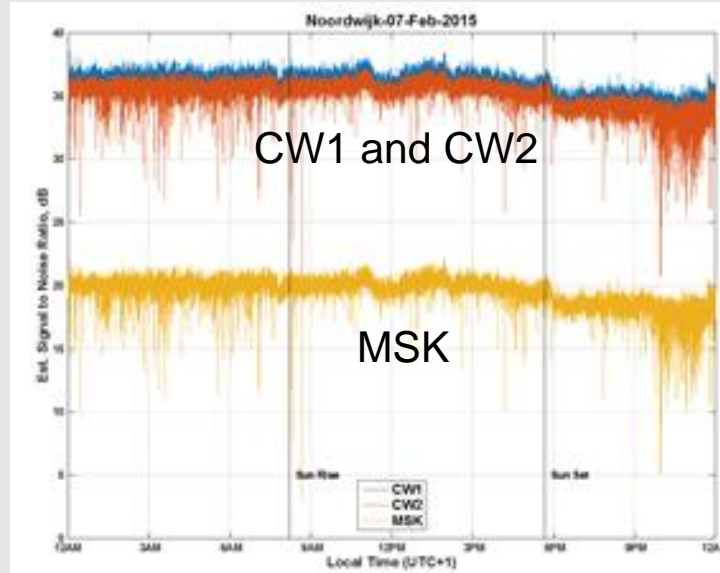


**Very encouraging results** which validate the theoretical findings of the feasibility study

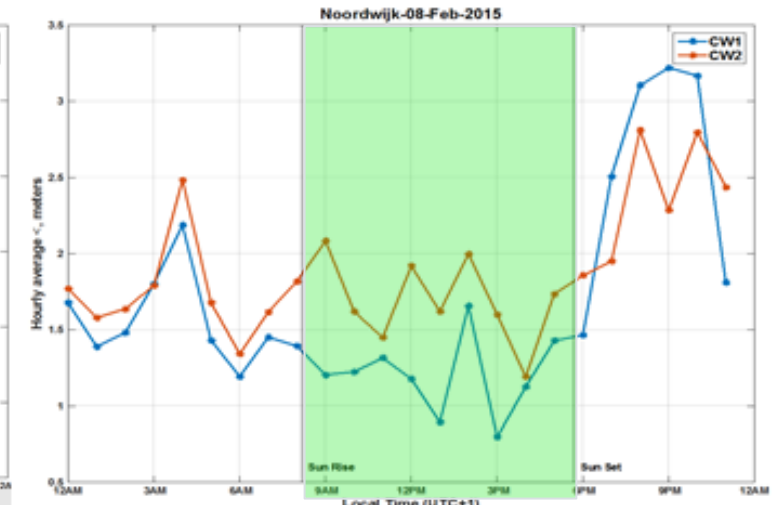
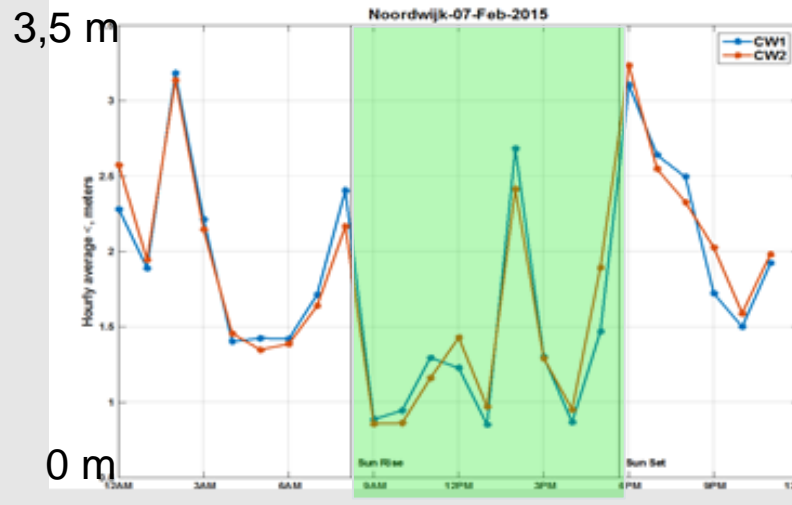
# R-Mode (MF) Test Bed

## - Results of measurement campaign

SNR over  
two days



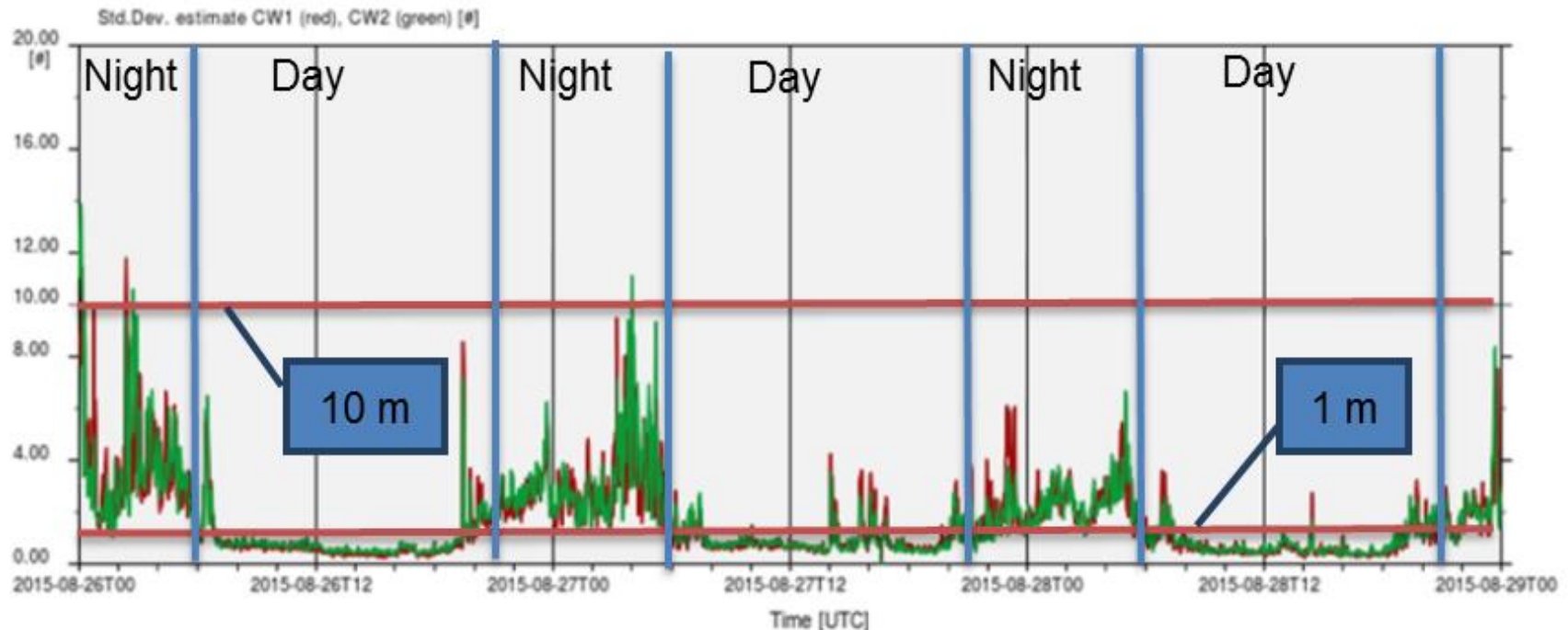
Range  
error  
(hourly  
average)



# R-Mode Tests in Germany from DGPS Site Heligoland

- Helgoland/Tönning, (70 km)
- Helgoland/List (Sylt), (100 km)
- Currently ongoing at Helgoland/Kiel-Canal, (130 km)
- Planned measurements up to 200-250 km

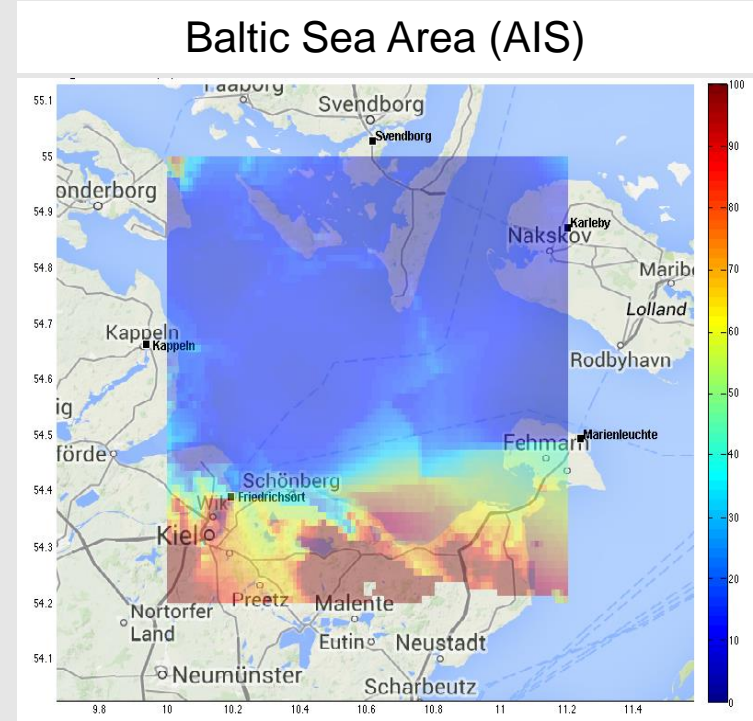
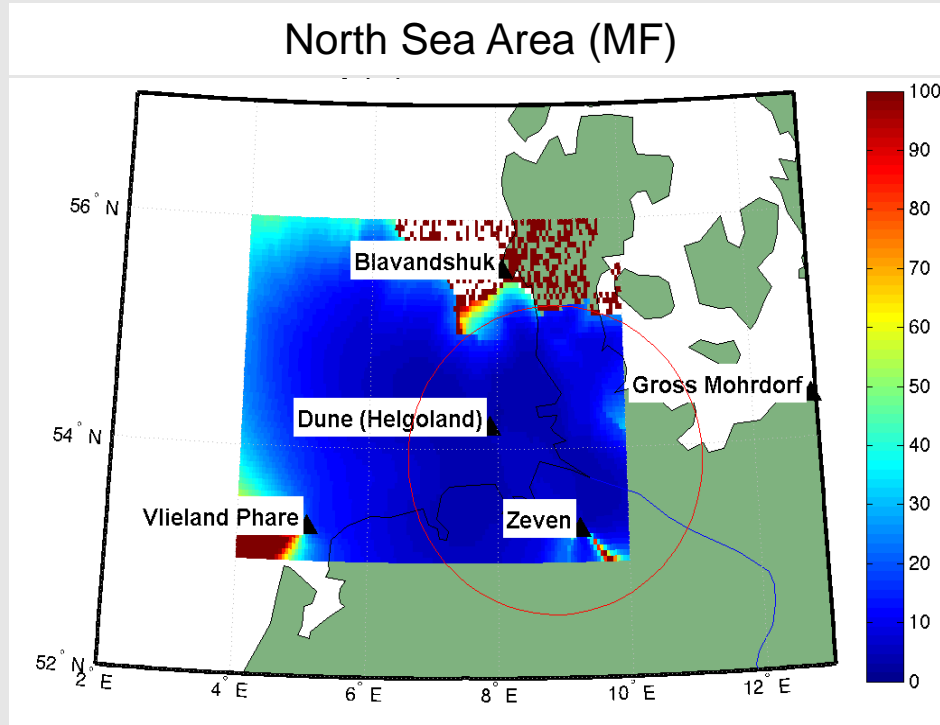
Std.Dev. estimate for CW1, CW2



# Results from R-Mode test bed

- ✓ Usability of standard installations (MF transmitter/antenna)
- ✓ Proof of R-Mode concept (validation of feasibility study)
- ✓ Achievable accuracy (range and timing)
- ✓ Mutual influence of (R-Mode and DGNSS signal)
- ✓ Test on longer distances to evaluate sky wave effects (ongoing)

## - Possible future test beds -



# Open Tasks

- Further investigations/measurements for MF-R-Mode are required concerning sky wave, propagation path, positioning, etc.
- Interference considerations (important for ITU-R Standardization)
  - Impact of R-mode CW's on MSK modulated DGNSS Signals
  - Impact on out band interference
- R-Mode on AIS:
  - No Tests performed until now
  - Analyzation of property rights (regarding Swedish patent)
- Timing and Synchronization
- Receiver developments (Positioning, Combined concepts, etc.)
- Future test beds and international projects
- ?



# Further information

All Details developed within the  
ACCSEAS project are still  
available at: <http://accseas.eu>

or contacting me:

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