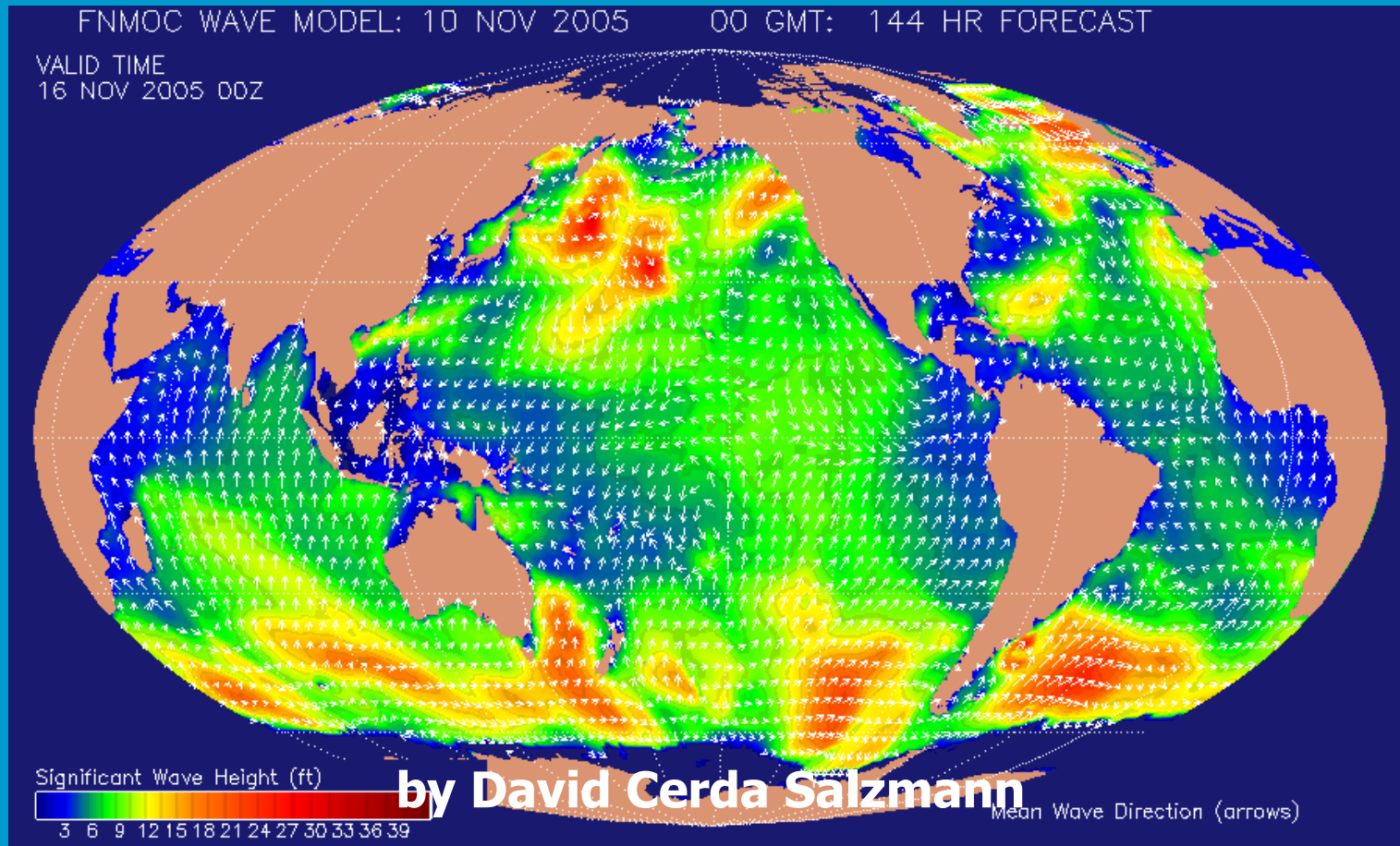


Databases



In the previous lecture...

- What data you need
- What you use it for
- This hour: **where to get data from**

Introduction



OWT Design Procedure

- ✓ Fatigue Loads
- ✓ Extreme Loads



Site-specific
environmental data

Introduction



OWT Design Procedure

- ✓ Installation
- ✓ Maintenance



Site-specific
environmental data

Introduction

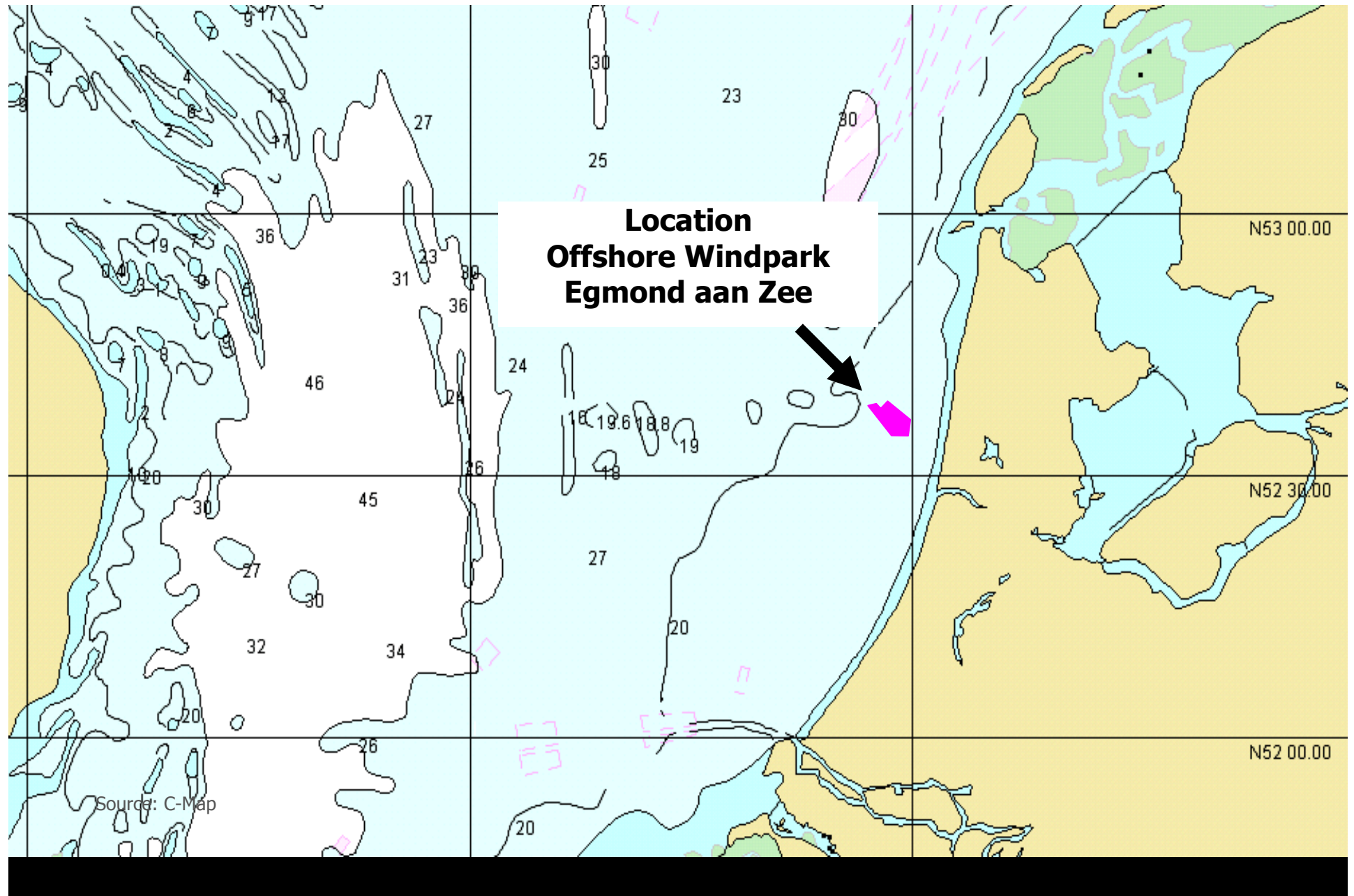
- Instantly available environmental conditions
 - Not on Site Location
 - Different Sources to choose from

"What to do?"



Case Study





Look for Data Sources

- Which data sources are available?
 - Measurements
 - Satellite observations
 - Hind-cast data

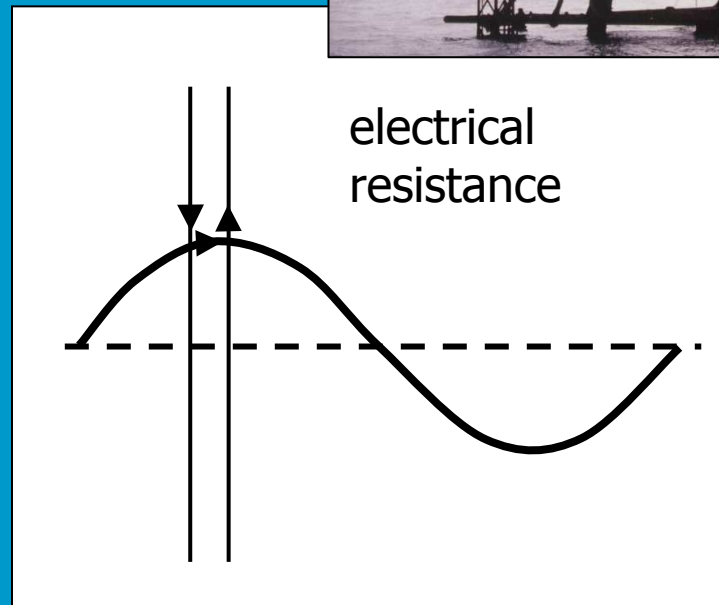
Measurements

- Wave buoy



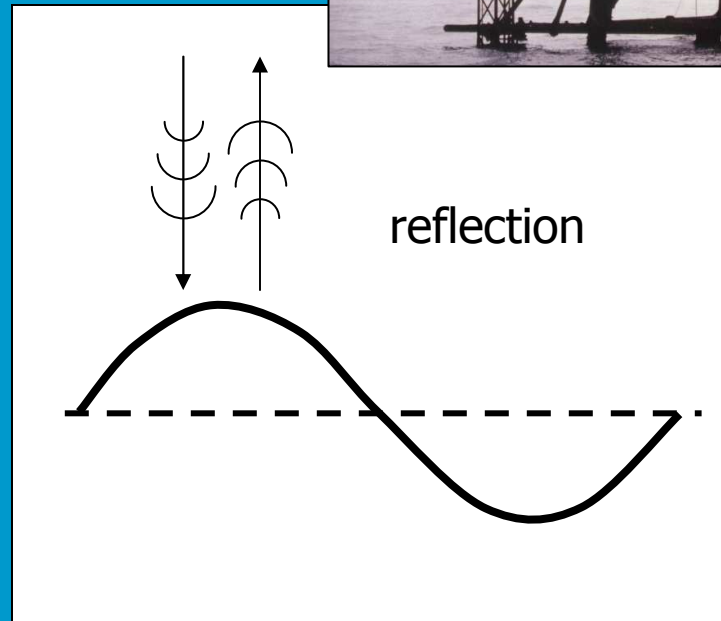
Measurements

- Step gauge



Measurements

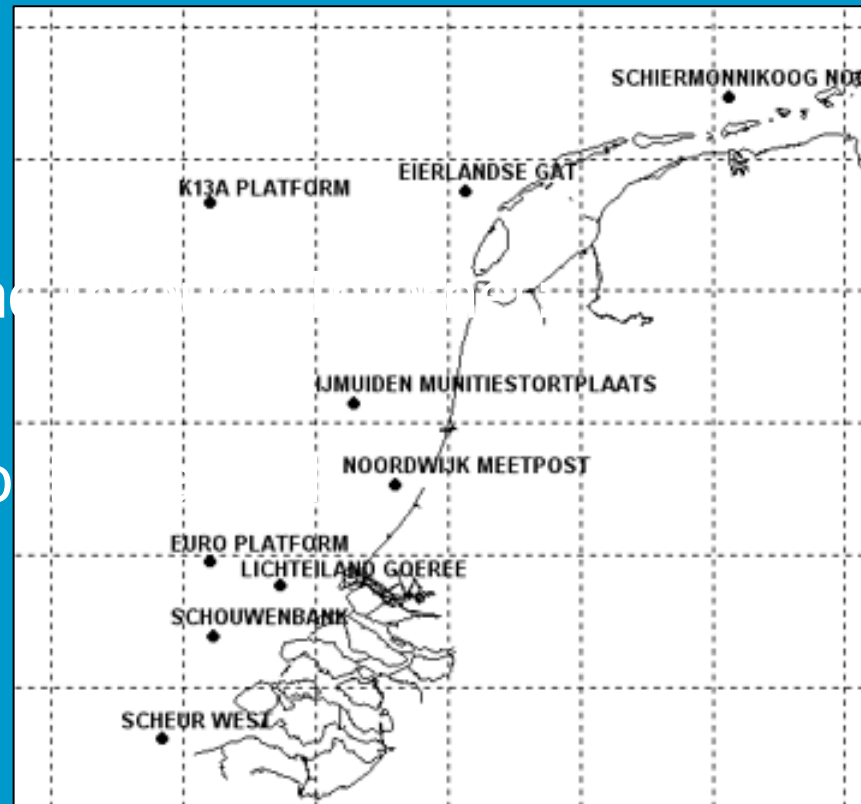
- Laser or radar altimetry



Measurements

- Dutch National Institute for Coastal and Marine Management
 - Since 1979
 - 9 locations
 - Free to download

www.go.nl



Favorites Tools Help

www.golfklimaat.nl/index.cfm?page=genereren.simultaan&load=mls/distributions_sim_NL.html

Ministerie van Verkeer en Waterstaat

GOLFklimaatmarkt

Golfklimaat > Genereren golfklimaat > Simultane kansverdeling

Extreme waarden voor golfperioden

De extremen waarden van de golfperiode zijn bepaald voor 9 locaties in het relatief diepe water voor het Nederlandse kustgebied. De berekeningen zijn gebaseerd op golfmetingen in de periode 1979-2002. Er worden maxima bepaald (hoogste waarden tijdens stormen) voor drie verschillende golfperiode parameters, namelijk de de spectrale golfperiode $T_{m-1,0}$, gemiddelde spectrale golfperiode T_{m02} en de spectrale piekperiode T_p . Zie uitleg.

Deze reeks maxima zijn uitgezet als overschrijdingskromme en vervolgens is daardoor een lijn gefit die voldoet aan de (conditionele) Weibull-verdeling. Met behulp van deze verdeling kan voor elke waarde van de golfperiode T_{m02} resp. T_p (boven de gekozen drempelwaarde) worden bepaald hoe frequent deze golfperiode naar verwachting zal worden overschreden.

Onderstaande tabel geeft enkele karakteristieke waarden van deze verdeling, namelijk de golfperiode $T_{m-1,0}$, T_{m02} resp. T_p , die gemiddeld eens per 10 jaar, eens per 100 jaar, eens per 1000 jaar en eens per 10.000 jaar wordt overschreden. Aan de berekeningen is veel aandacht besteed. Toch zijn de uitkomsten slechts schattingen, alleen al vanwege de beperkte periode van de beschikbare data.

Meetlocatie	10^{-1}	10^{-2}	10^{-3}	10^{-4}
Schiermonnikoog noord	12,38	13,92	15,23	16,39
Eierlandse Gat	11,25	12,47	13,53	14,46
K13a platform	11,34	12,59	13,66	14,62
IJmuiden munitiestortplaats	11,13	12,24	13,16	13,96
Meetpost Noordwijk	10,35	11,30	12,08	12,74
Euro platform	9,39	10,13	10,76	11,30
Lichteiland Goeree	9,31	10,03	10,63	11,16
Schouwenbank	9,11	9,77	10,33	10,81
Scheur West	8,91	9,59	10,14	10,60

Meetlocatie	10^{-1}	10^{-2}	10^{-3}	10^{-4}
Schiermonnikoog noord	9,46	10,38	11,14	11,79
Eierlandse Gat	8,98	9,77	10,42	10,97

- Monitoring
- Uitleg
- Genereren golfklimaat
 - Bestanden
 - Kengetallen
 - Kans- en overschrijdingsverdeling
 - Simultane kansverdeling**
 - Richtingsafhankelijke kansverdeling
 - Persistentie
- Extreme waarden
- Real Time golfgegevens
- Links
- Literatuur

Measurements

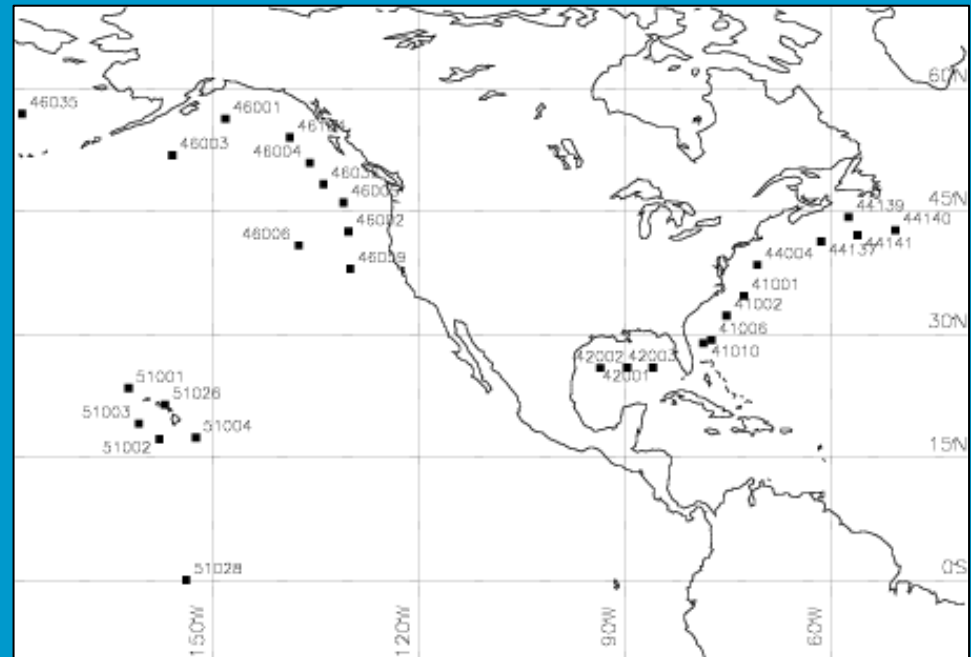
- Real data
- Freely available
- Long periods of measurements
- Wind data not always included
- Only few locations

Measurements

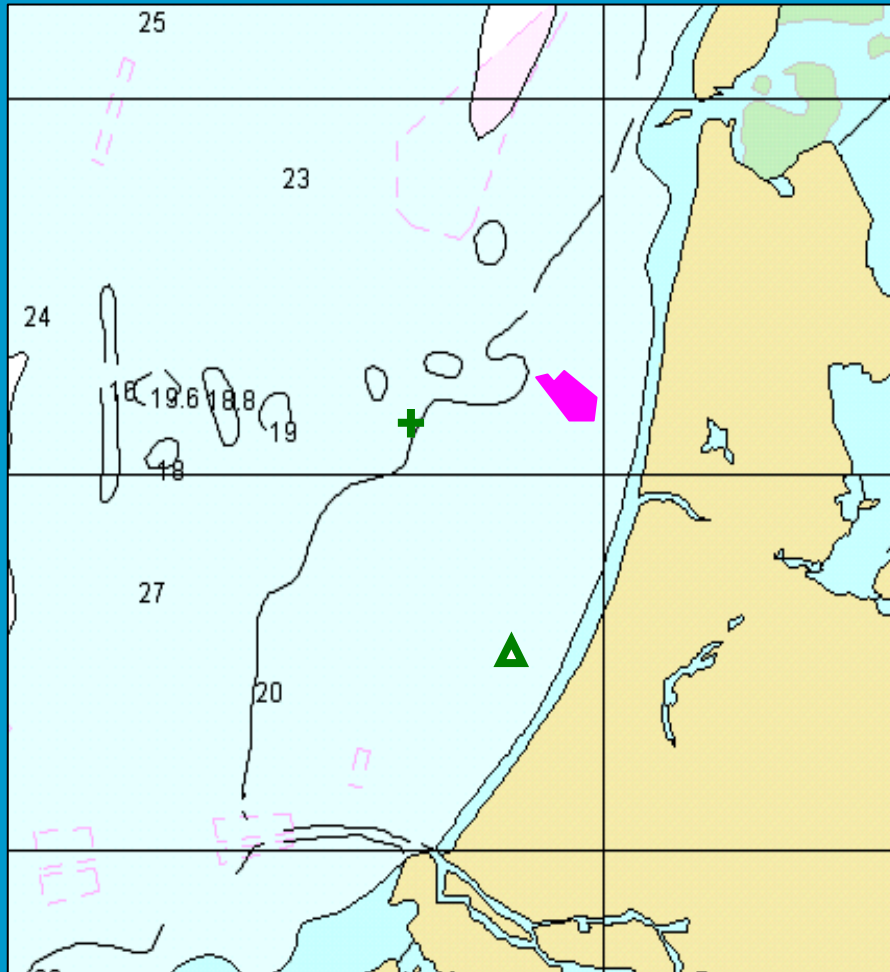
- Similar monitoring projects in other countries

www.noaa.gov

National Oceanographic and Atmospheric Agency



Data Sources



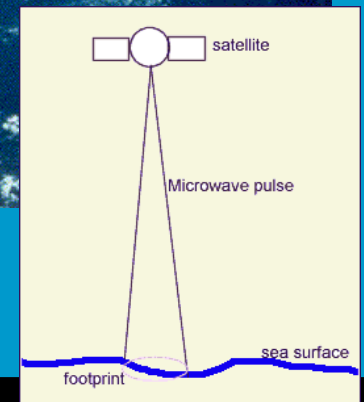
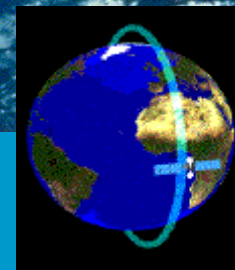
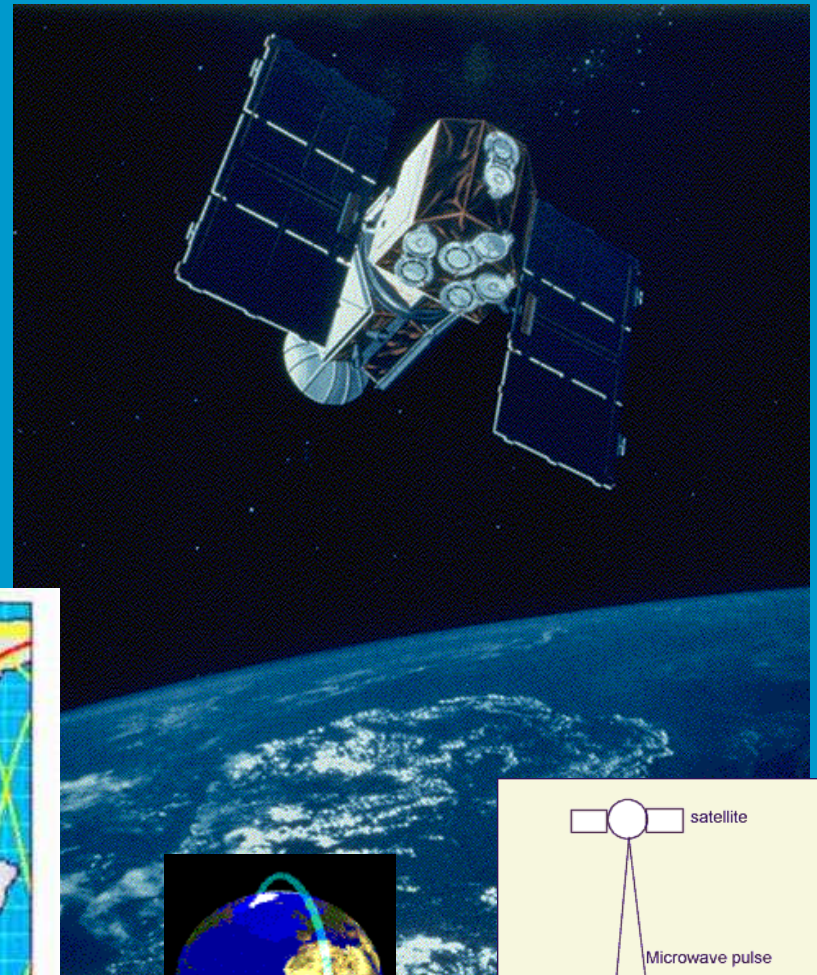
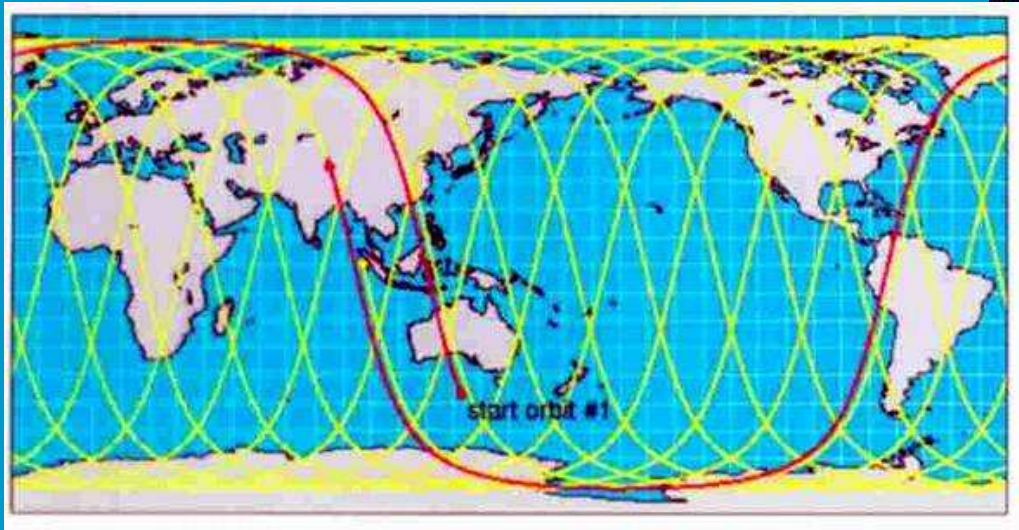
- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk

Data Sources

- There are more data sources available!
 - Satellite observations
 - Hind-cast data

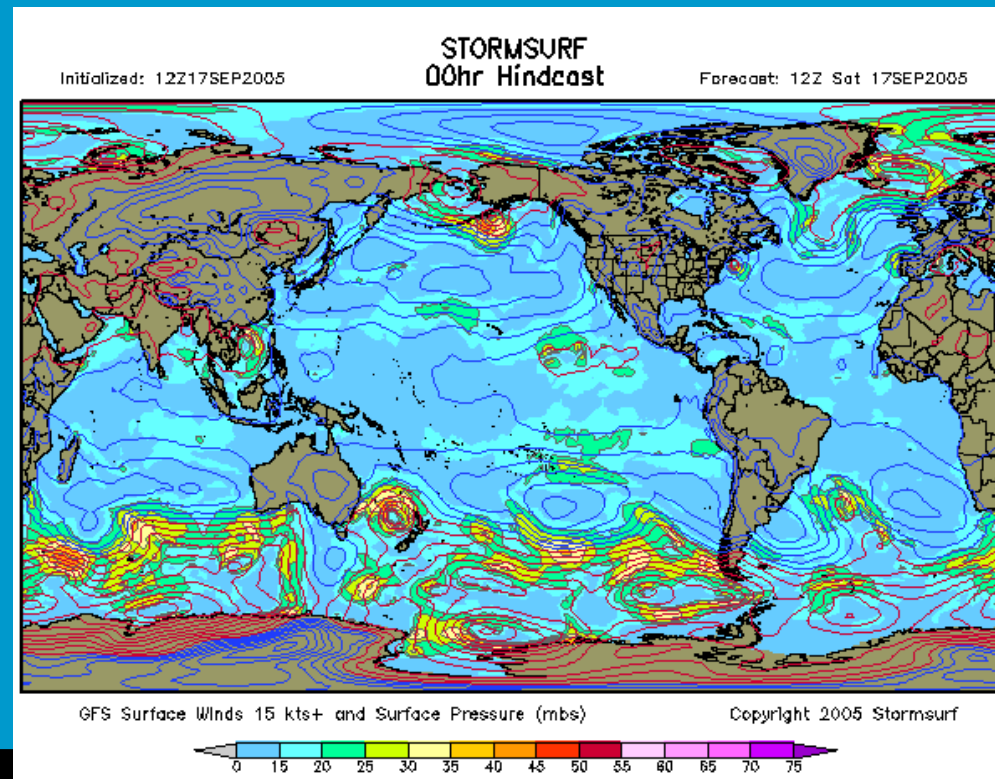
Satellite

- World-wide measurements
- Less accuracy
- Not continuous



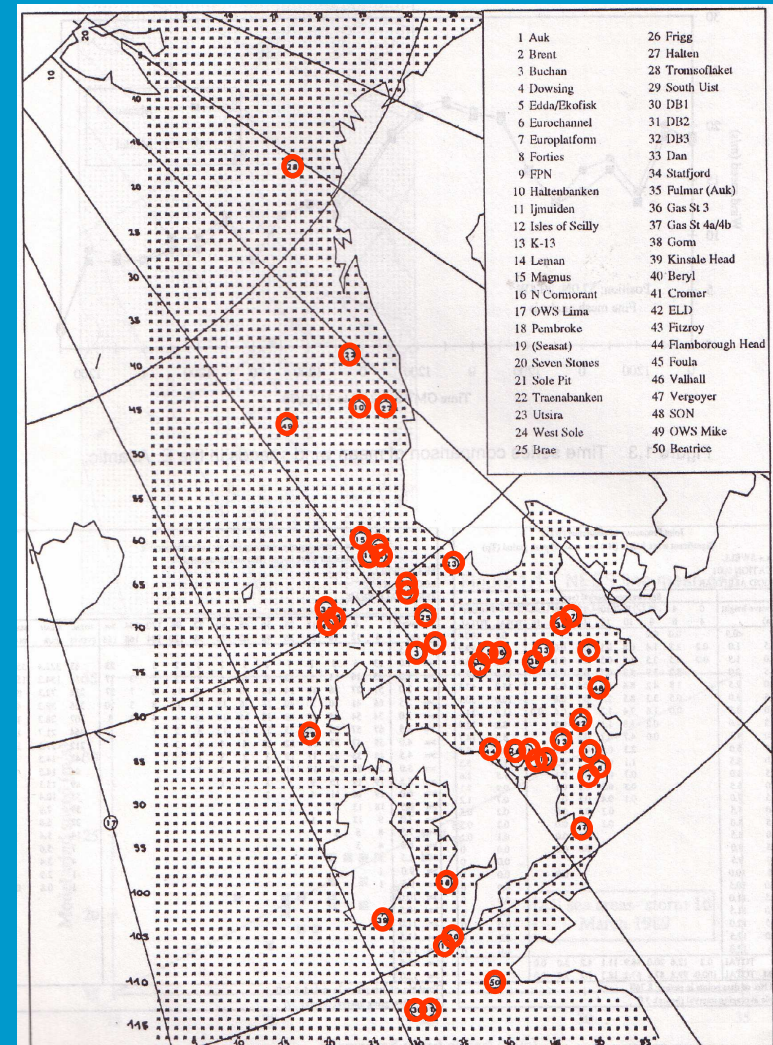
Hind-cast

- Prediction model
- Uses many different measurements



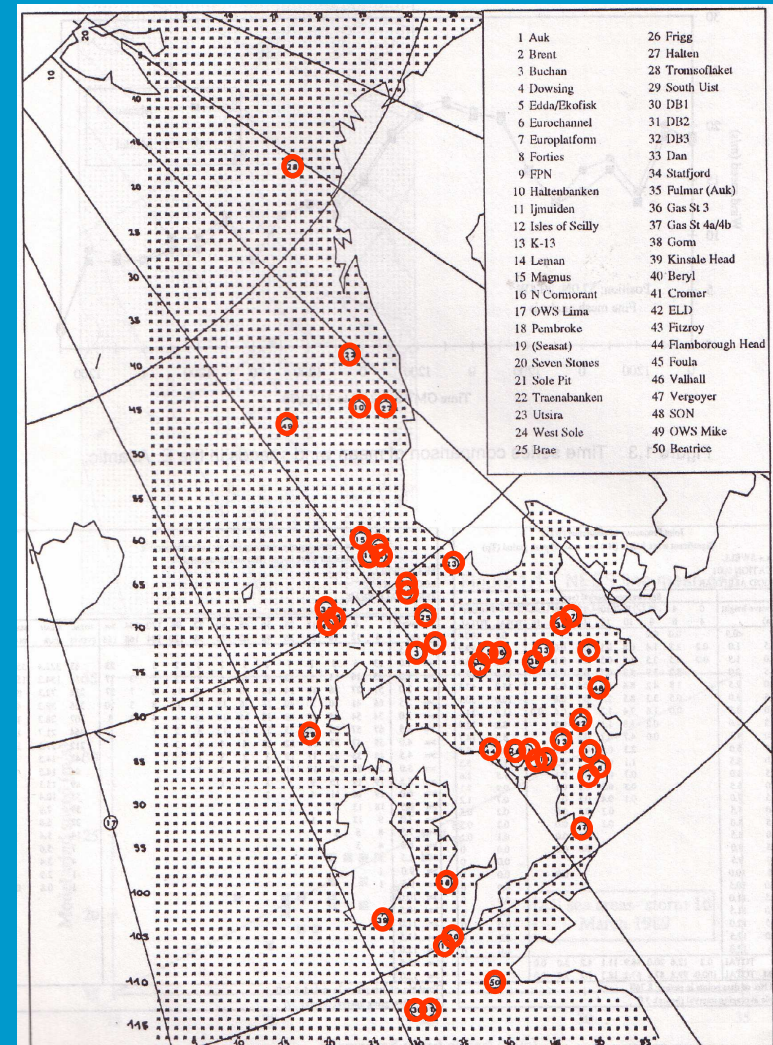
Hind-cast

- NESS-NEXT:
North European Storm Study
- 25 winters
- 7 full years

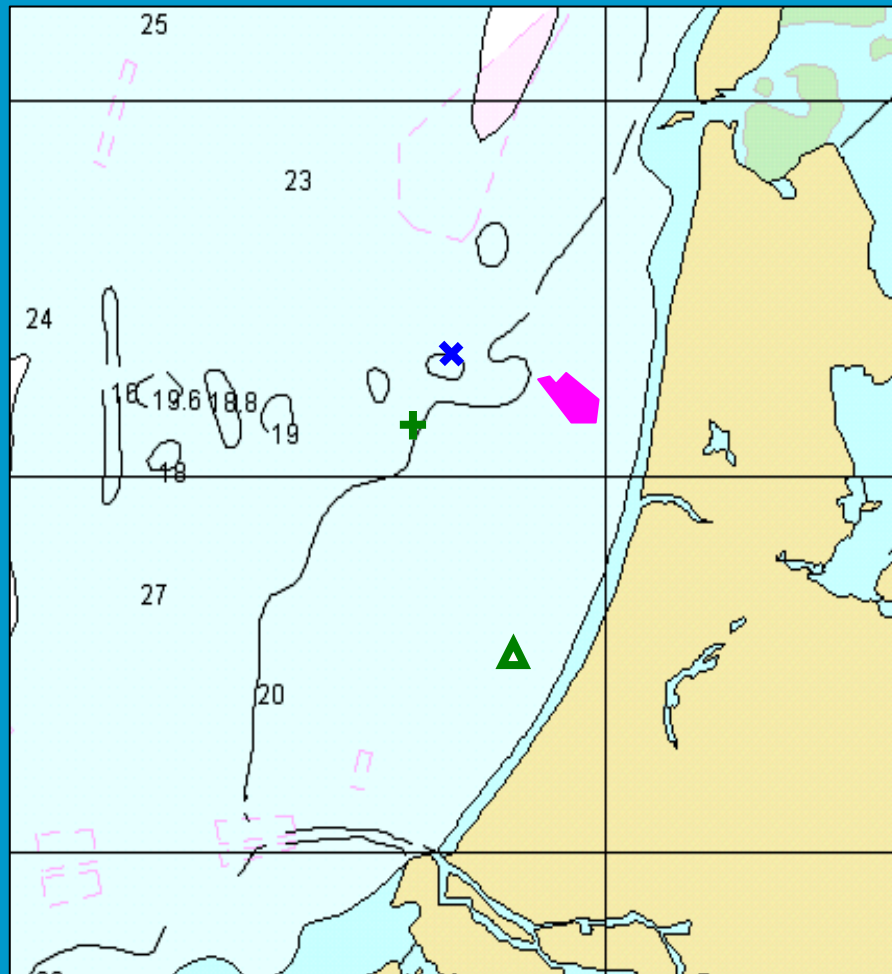


Hind-cast

- **NESS-NEXT:**
North European Storm Study
- 30 x 30 km grid: high density
- Includes wind data
- Only available for NESS partners

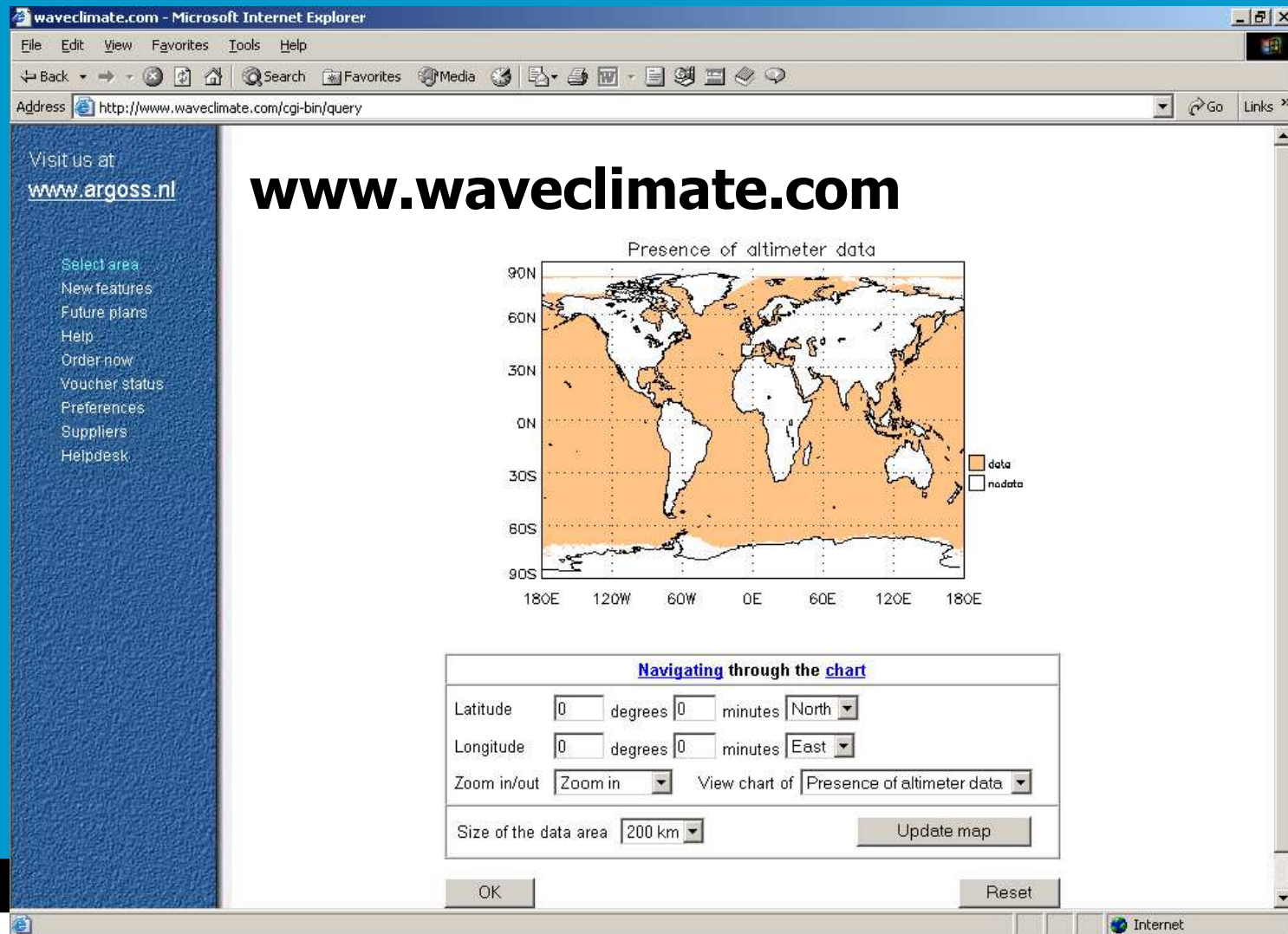


Data Sources



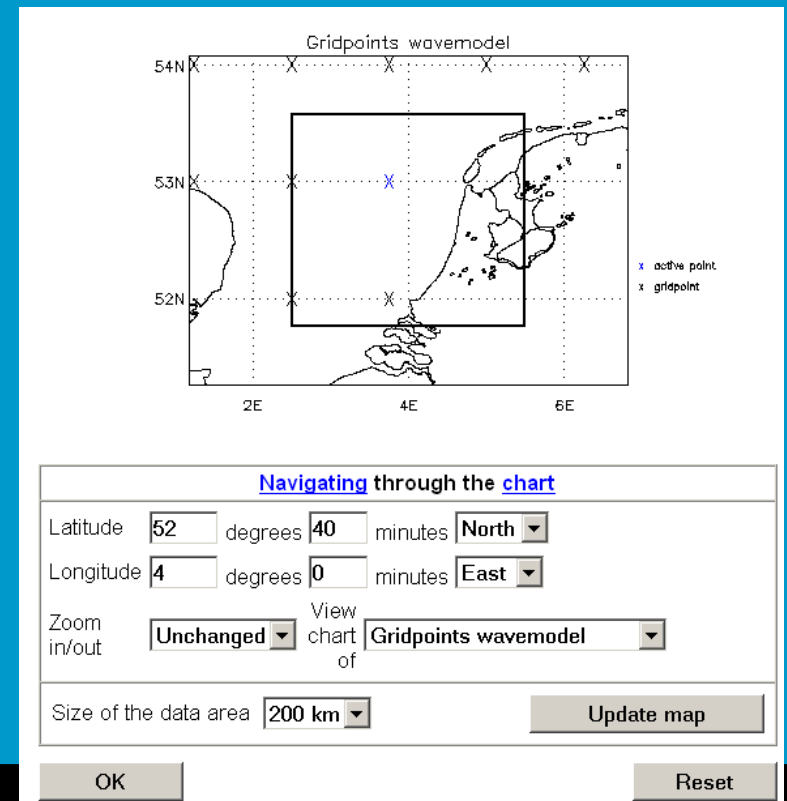
- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk
- × NESS/NEXT

Satellite data: ARGOSS



Satellite data: ARGOSS

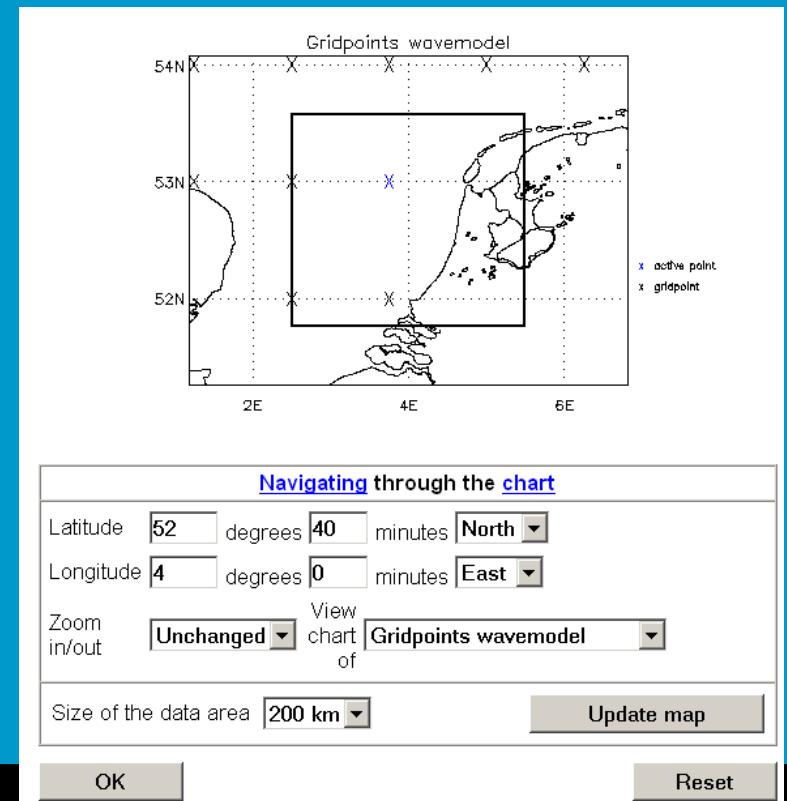
- Easy access
- Satellite observations from 1985
- Global
- Pre-processed
- Not continuous
- Includes wind data
- Also includes hind-cast data
- Still improving



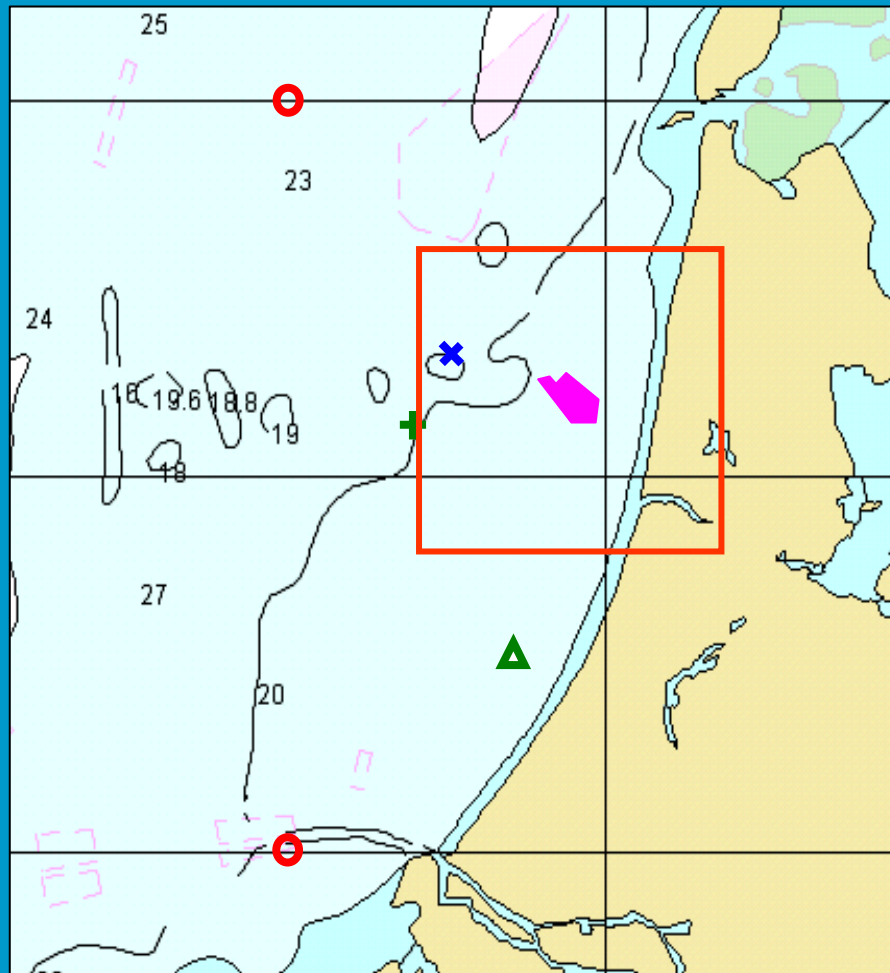
Satellite data: ARGOSS

2 Options for data:

- Data from Area
- Data from gridpoint model

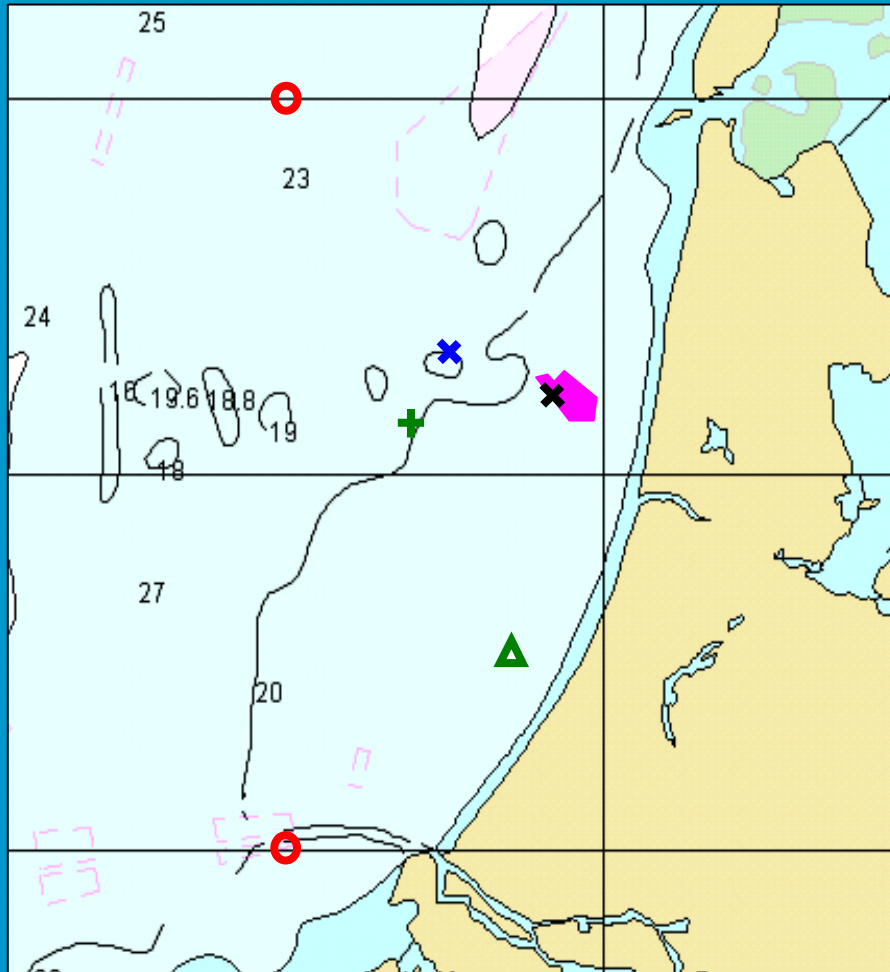


Data Sources



- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk
- x NESS/NEXT
- ⊙ ARGOS

Data Sources



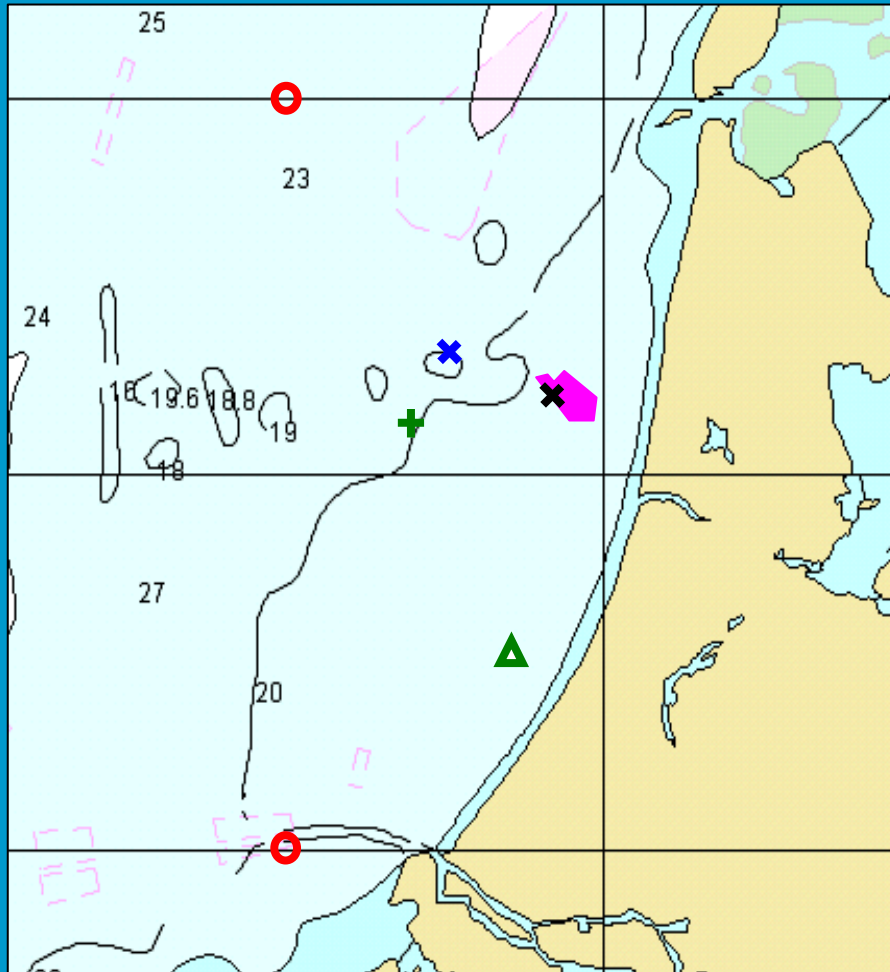
- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk
- × NESS/NEXT
- ARGOSS
- × Met Mast

Data Sources

- NSW Met Mast
 - Data since May 2004
 - Wind farm designed earlier



Data Sources



- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk
- x NESS/NEXT
- ARGOSS
- ~~x Met Mast~~

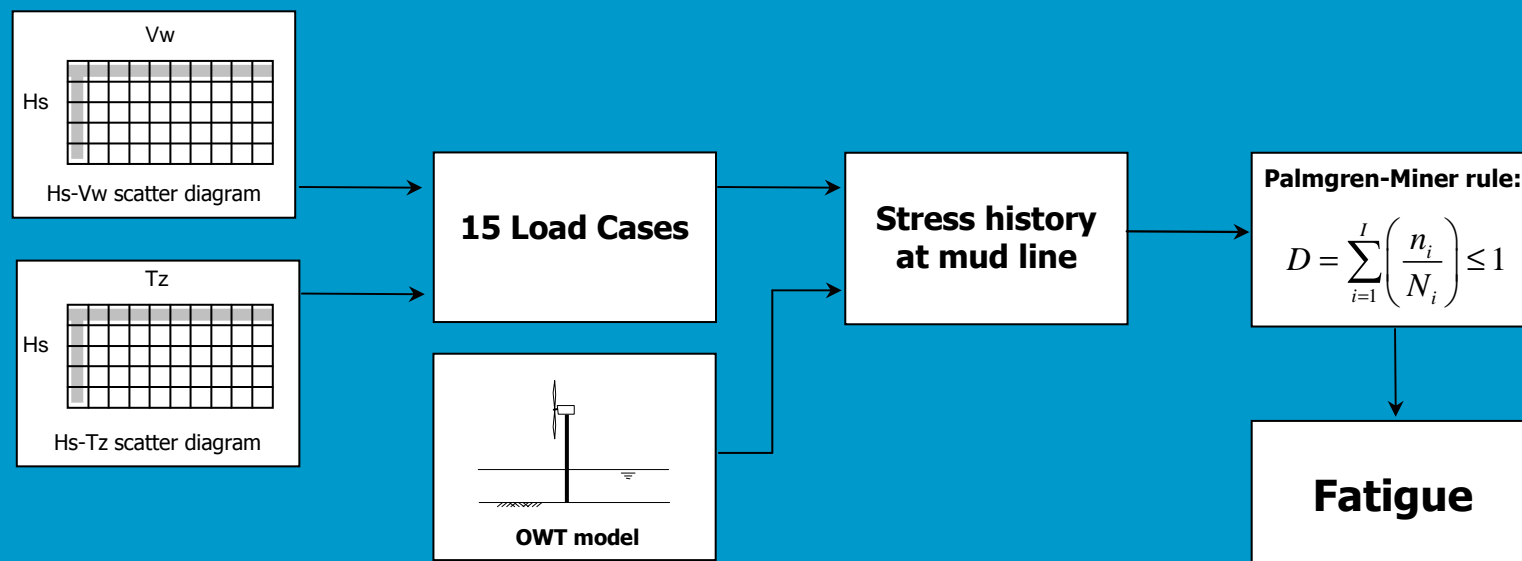
Lifetime Fatigue Analysis

Comparison between different data sources

- IJmuiden Munitie Stortplaats
- Meetpost Noordwijk
- NESS/NEXT
- ARGOSS: 2 gridpoints

Lifetime Fatigue Analysis

- Calculation Procedure



- Combined scatter diagrams



DUWIND
DELFT UNIVERSITY WIND ENERGY RESEARCH INSTITUTE

Lifetime Fatigue Analysis

- Reduced Load Cases

IJmuiden Munitie Stortplaats				
state	Vhub (m/s)	Hs (m)	Tz (s)	occ (%)
1	3,30	0,25	3,37	9,15
2	3,54	0,75	3,48	10,45
3	3,57	1,38	3,68	4,02
4	6,69	0,25	4,35	5,35
5	6,98	0,75	4,21	16,19
6	8,15	1,25	4,46	15,76
7	10,36	0,75	5,63	3,65
8	10,87	1,75	4,92	13,70
9	12,02	1,25	5,67	4,37
10	12,98	2,25	5,36	8,03
11	14,80	2,75	5,68	4,47
12	16,29	3,25	6,09	2,36
13	18,07	3,91	6,64	1,94
14	19,70	4,89	7,43	0,43
15	22,00	6,12	8,30	0,12
				100,00

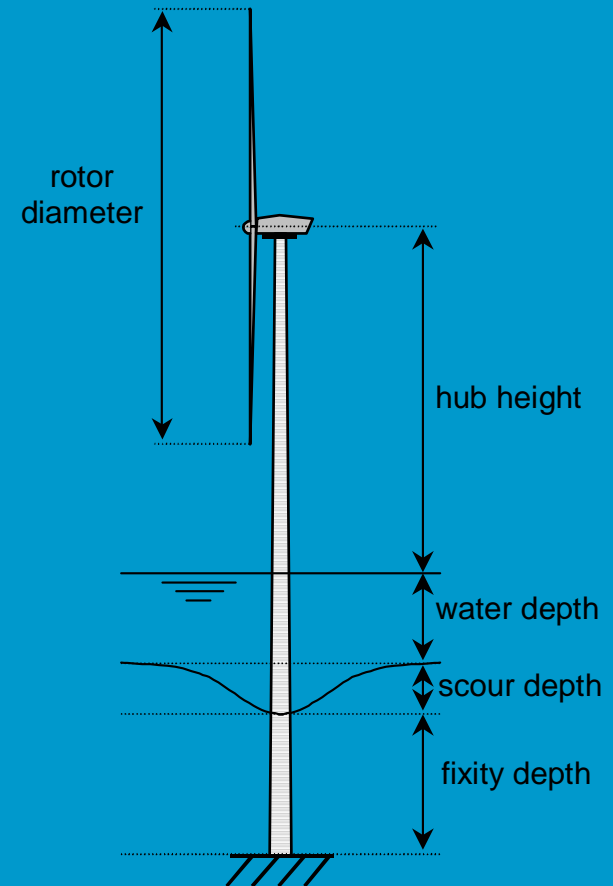
Lifetime Fatigue Analysis

- Wind and Wave Simulation
 - Wind Shear: Power Law
 - Turbulence Intensity 12%
 - Pierson-Moskowitz Wave Spectrum

Lifetime Fatigue Analysis

- Offshore Wind Turbine Model

Rated power	2.75 MW
Rotor diameter	92 m
Number of blades	3
Hub height	70 m
Water depth	20 m
Scour depth (? $1.8 \cdot D$)	8.5 m
Fixity depth (? $6 \cdot D$)	28.5 m
Tower base diameter	4.75 m
Tower top diameter	2.5 m
First natural frequency	0.29 Hz
Second natural frequency	1.28 Hz

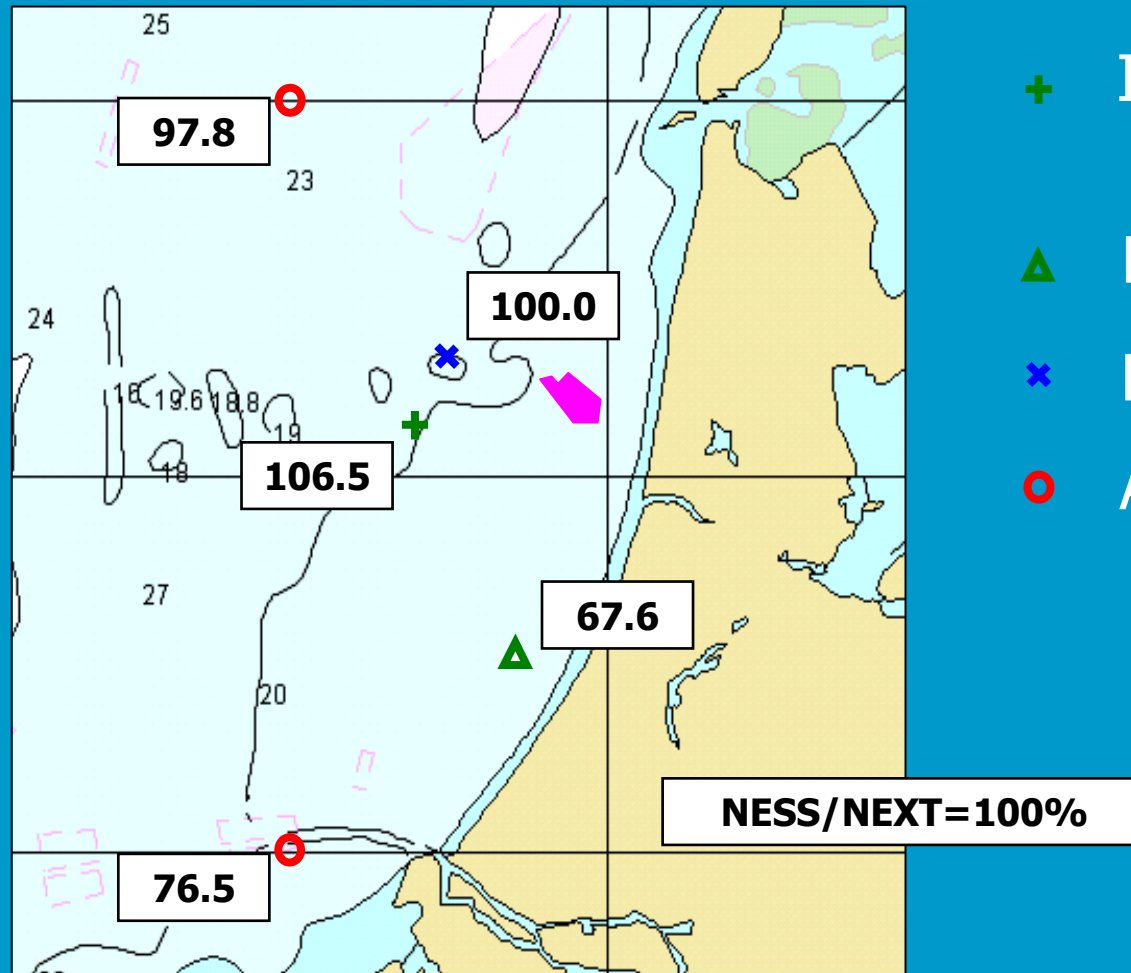


Lifetime Fatigue Analysis

- Simulation Results

Source	20-year cumulative damage ratio D [-]	Relative damage ratio [%] (NESS/NEXT = 100)
ARGOSS N53°	1.58	97.8
ARGOSS N52°	1.24	76.5
IJmuiden Munitie Stortplaats	1.72	106.5
Meetpost Noordwijk	1.09	67.6
NESS/NEXT	1.61	100.0

Lifetime Fatigue Analysis



- + IJmuiden Munitie Stortplaats
- ▲ Meetpost Noordwijk
- × NESS/NEXT
- ARGOS

Lessons learned

- Examine different data sources if available
- Be critical, be realistic
- Know what you're doing