

Maxwave – Extreme Wave Analysis



© BBC November 2002
Horizon – Freak Wave

GKSS

DNMI

DLR

UK Met

Meteo F

*Norske
Veritas*

OSW

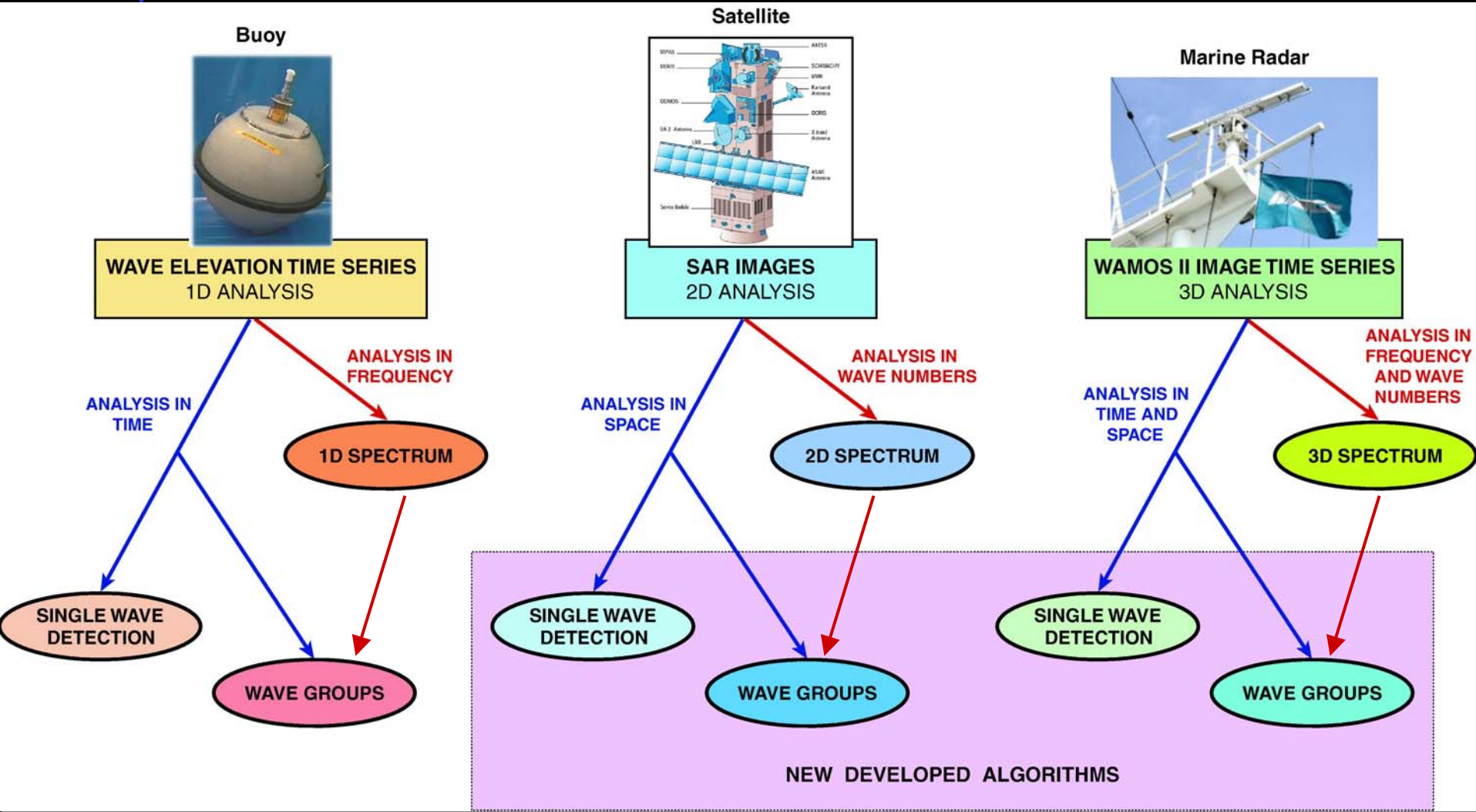
TUL

TUB

IST

Susanne Lehner

Temporal and spatial Wave Analysis



Wave Measurements on Ekofisk

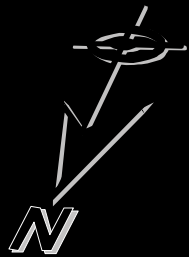
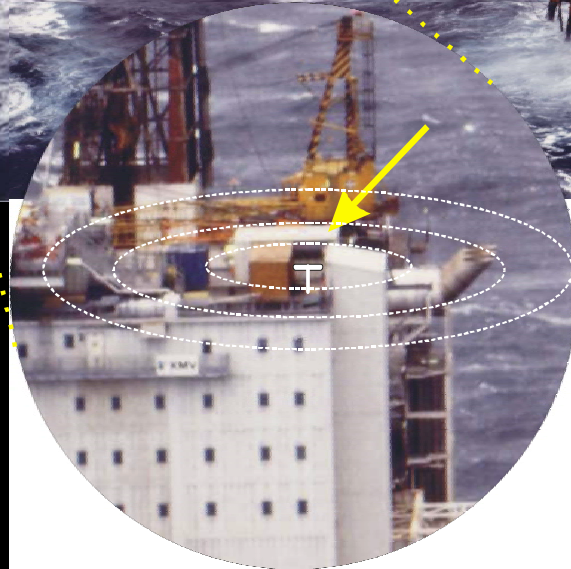
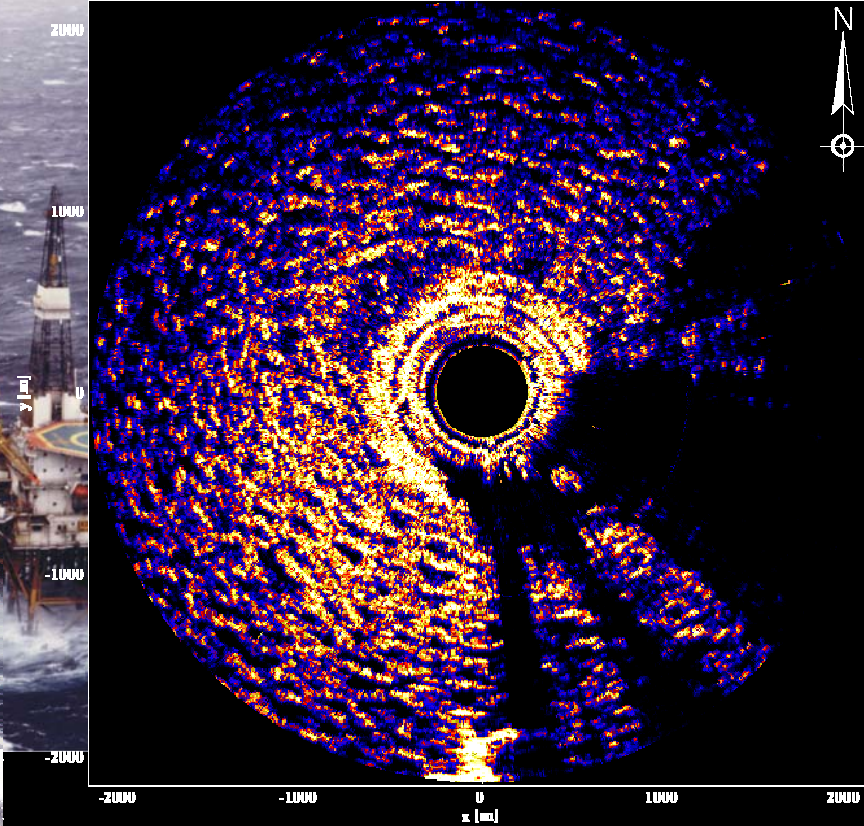


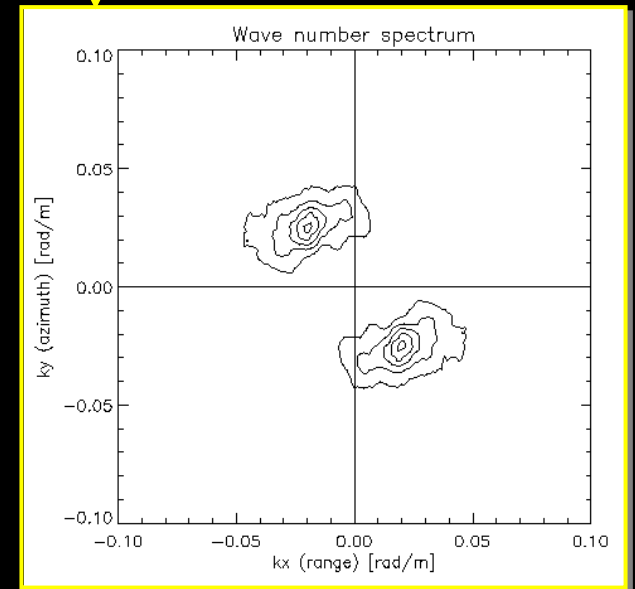
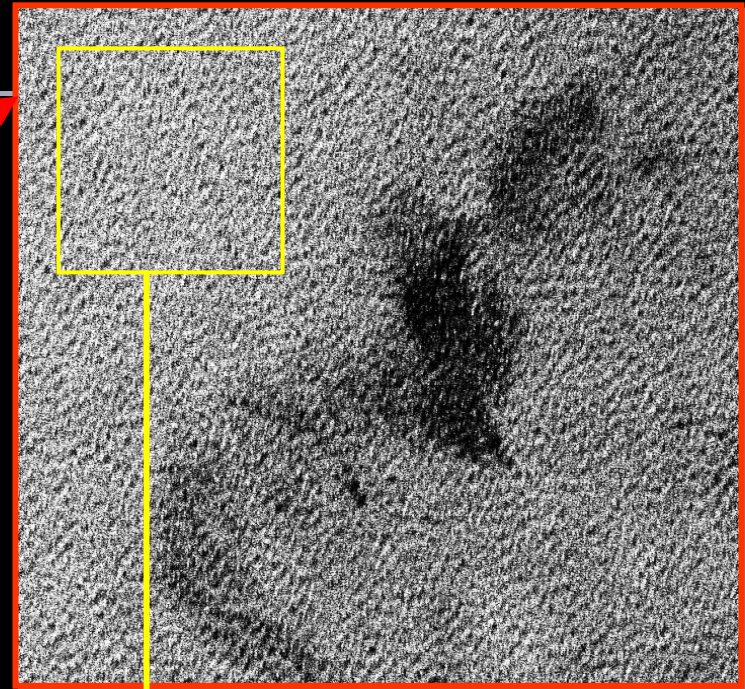
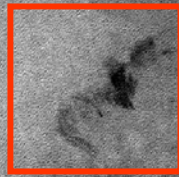
Image (1 of 32) TOWER Ekofisk 2/4k PFCoN, 02-10-2001





MS "Bremen" kann dank seiner Bauweise entlegene Regionen anlaufen.

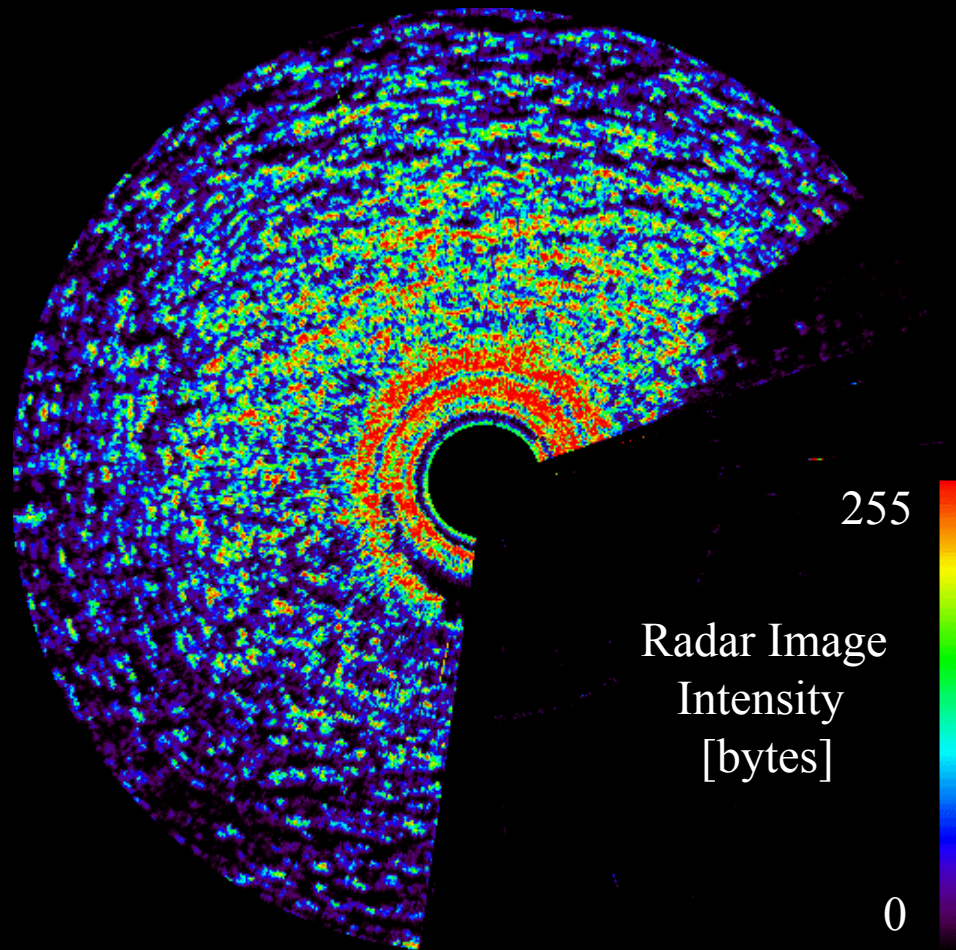
**ERS-2 SAR image (100 x 100 km²)
December 2, 2002 22:59 UTC**



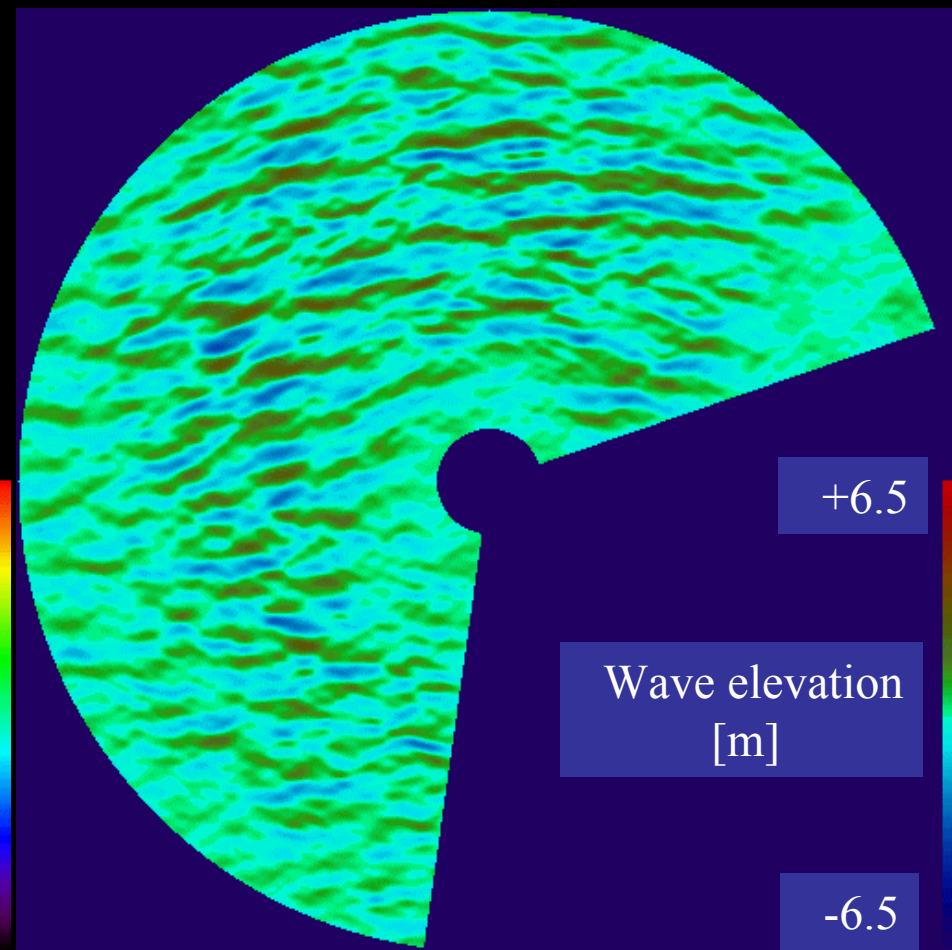
Prestige oil spill

Temporal Sequences of Wave Elevation SWIMSAT Principle

Radar image intensity time series

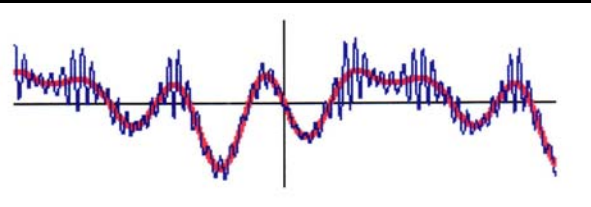
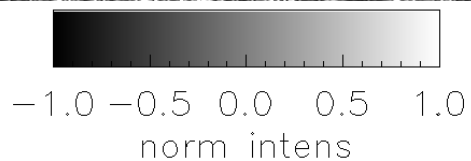
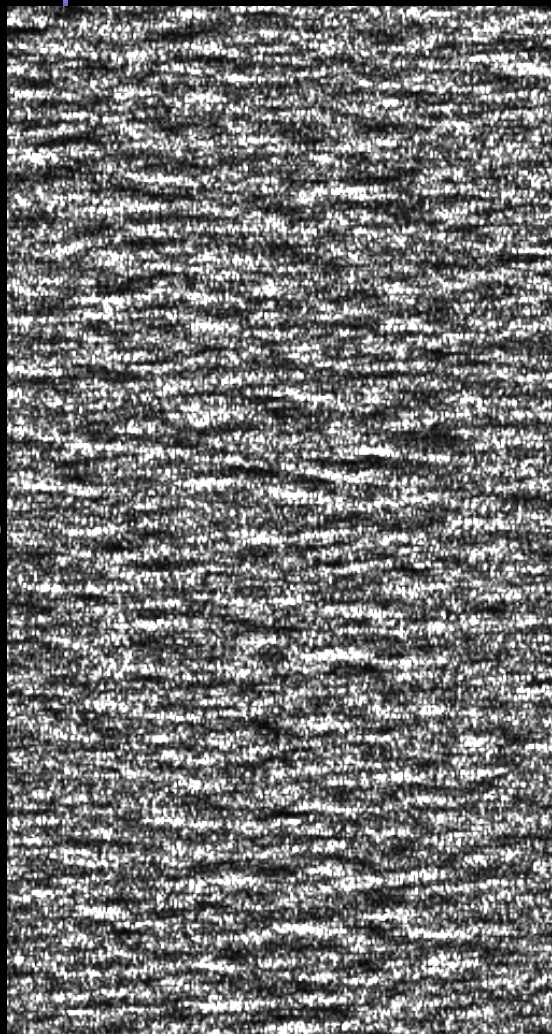


Wave elevation Map



Radar image

8 km



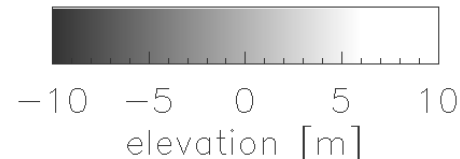
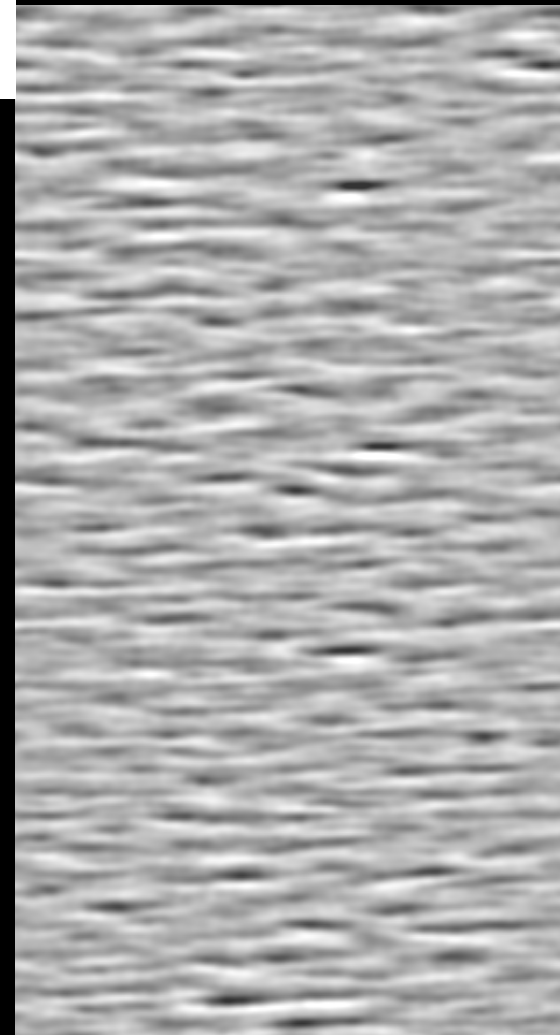
←
Radar Mapping
Tilt+Hydro+(Motion)
RAR+SAR

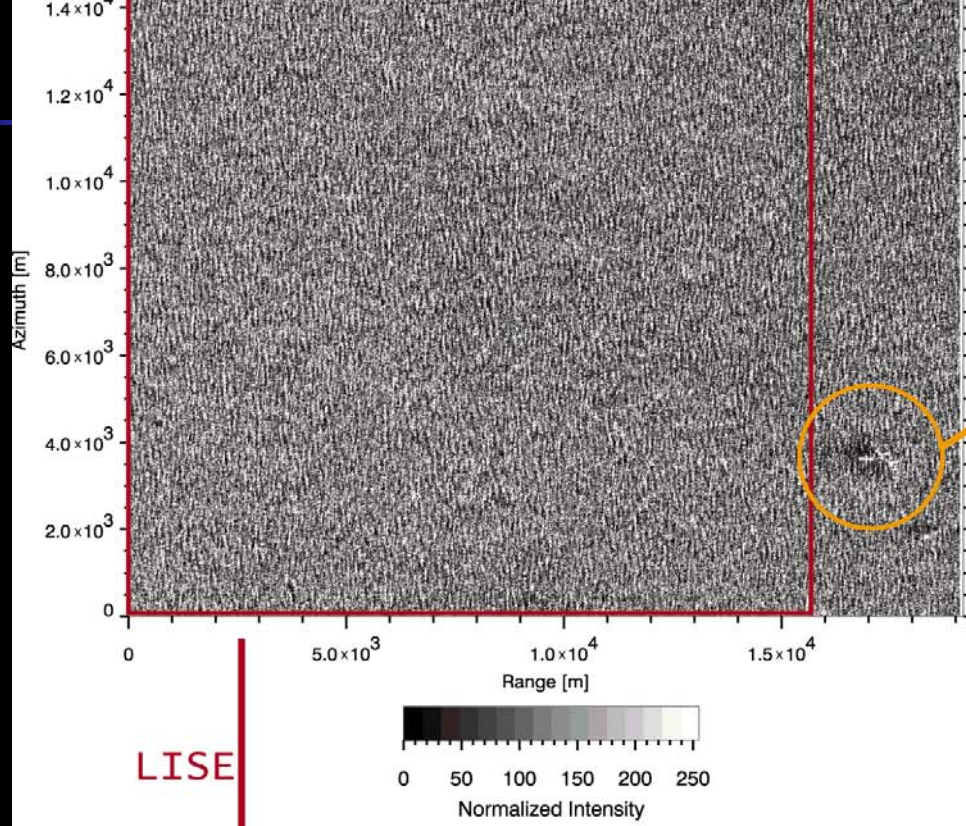


Inversion
LISE

forward
CMOD

Ocean waves

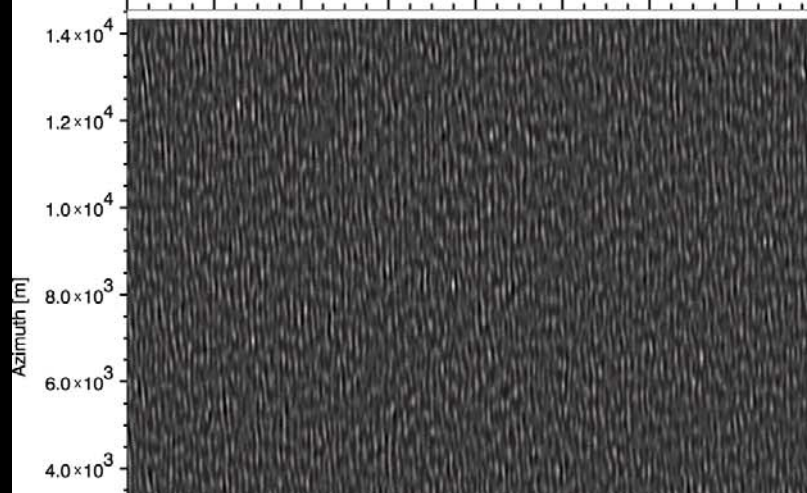




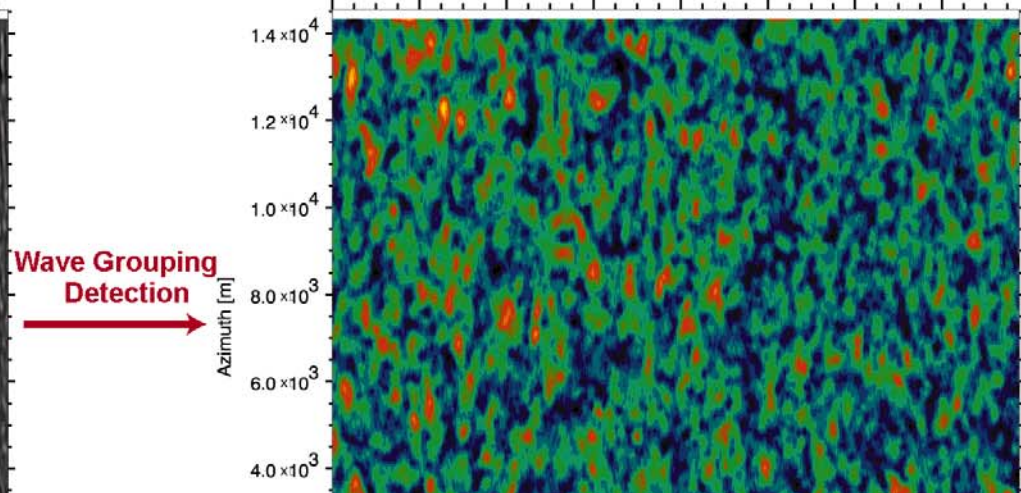
**EKOFISK Oil Platform
(North Sea)**



Wave elevation map (inverted SAR imagette)

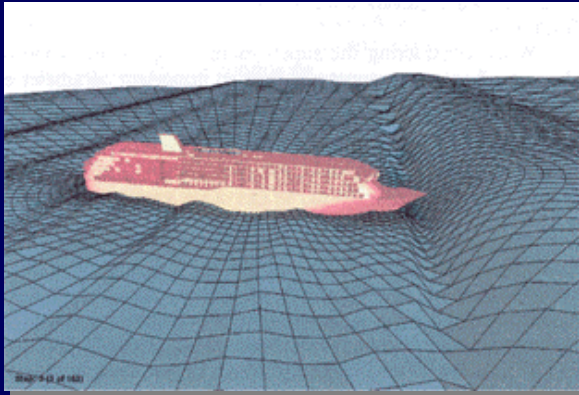


Smoothed local envelope (from total 2D H.T.)

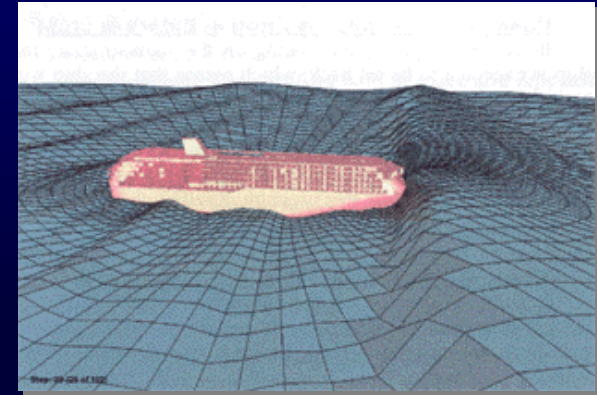


Application of the Wave Elevation Maps: Numerical Studies of Vessel Stability under heavy Sea States*

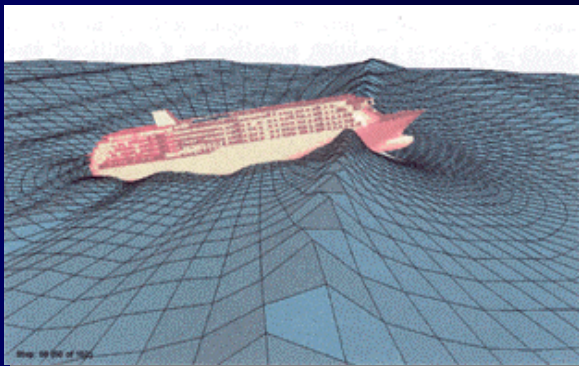
Phase 1



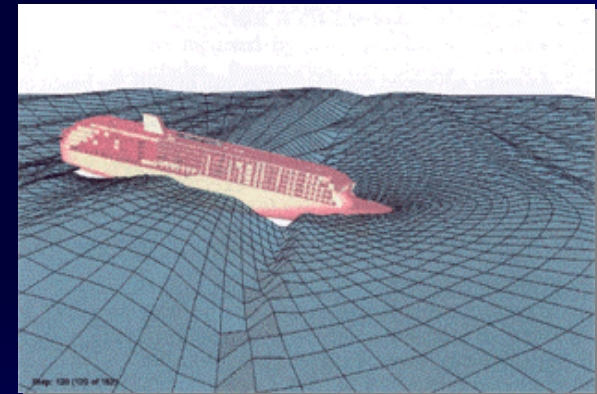
Phase 2



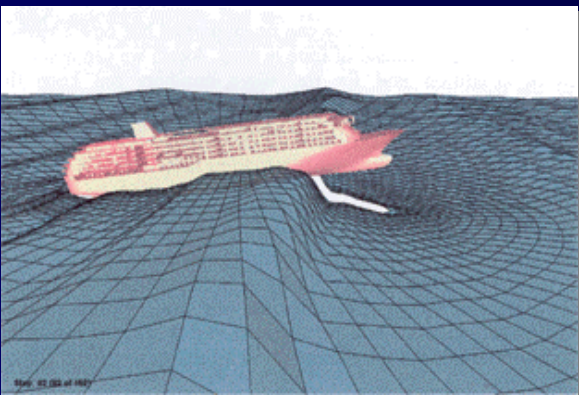
Phase 3



Phase 4



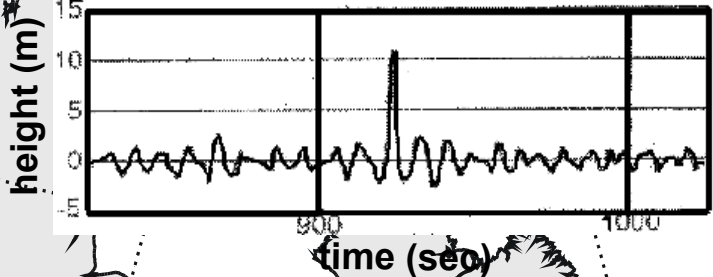
Phase 5



Courtesy Pastor Wouter DNV, Norway
OMAE 2003

Maxwave project

EU Projekt MaxWave

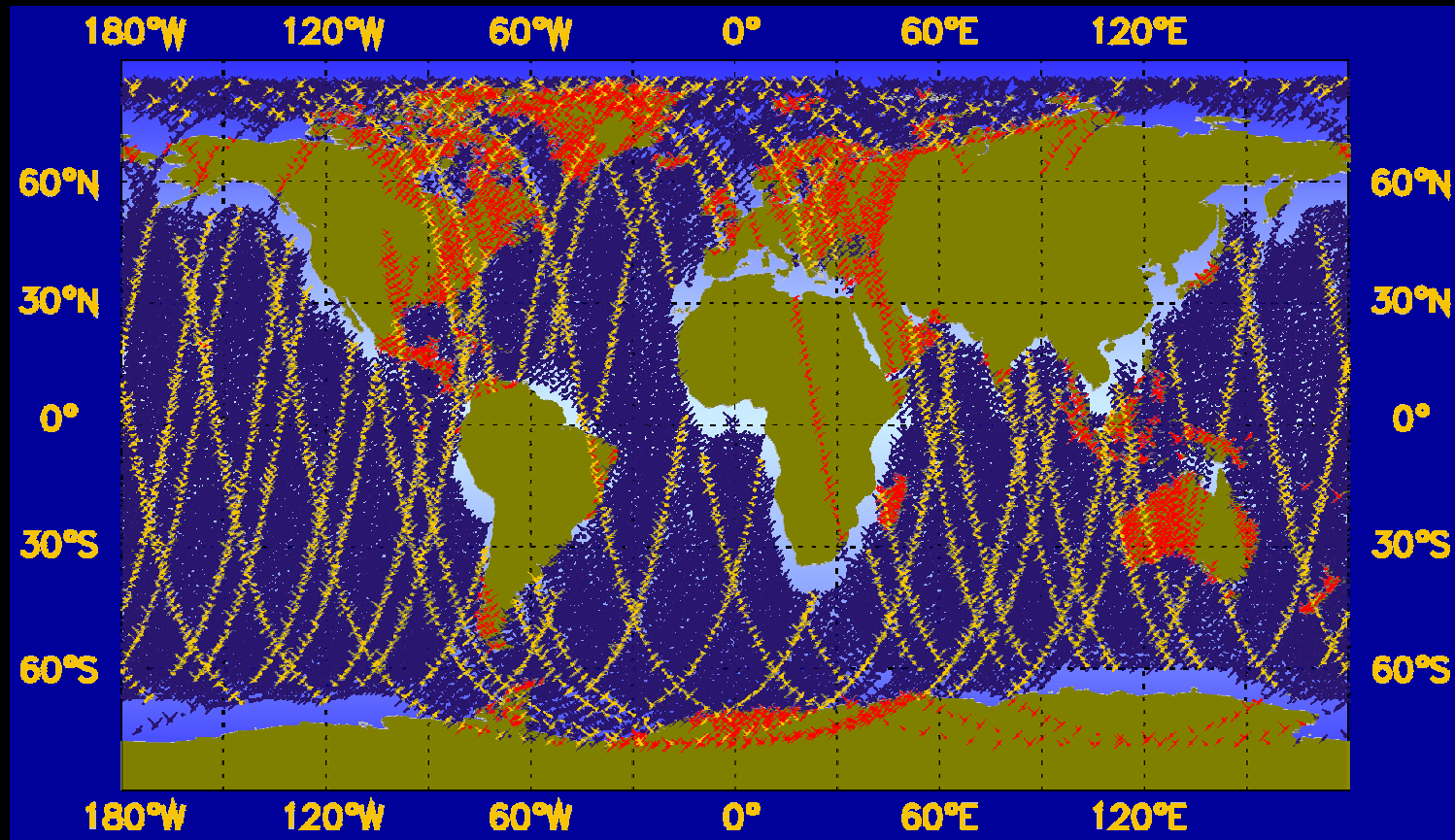


- ◆ Dec 21. – Mar 21.
- ◆ Mar 22. – Jun 21.
- ◆ Jun 22. – Sep 21.
- ◆ Sep 22 – Dec 21.

- ▲ foundered ships
- damaged ships

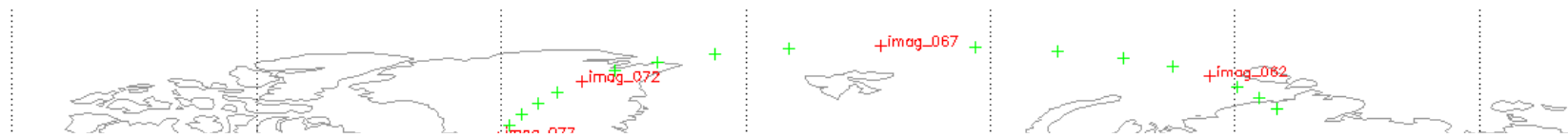
Ship accidents 1995-1999, Lloyds Ship Register (nach Norske Veritas)

ERS Wave Mode Data during southern winter 1996

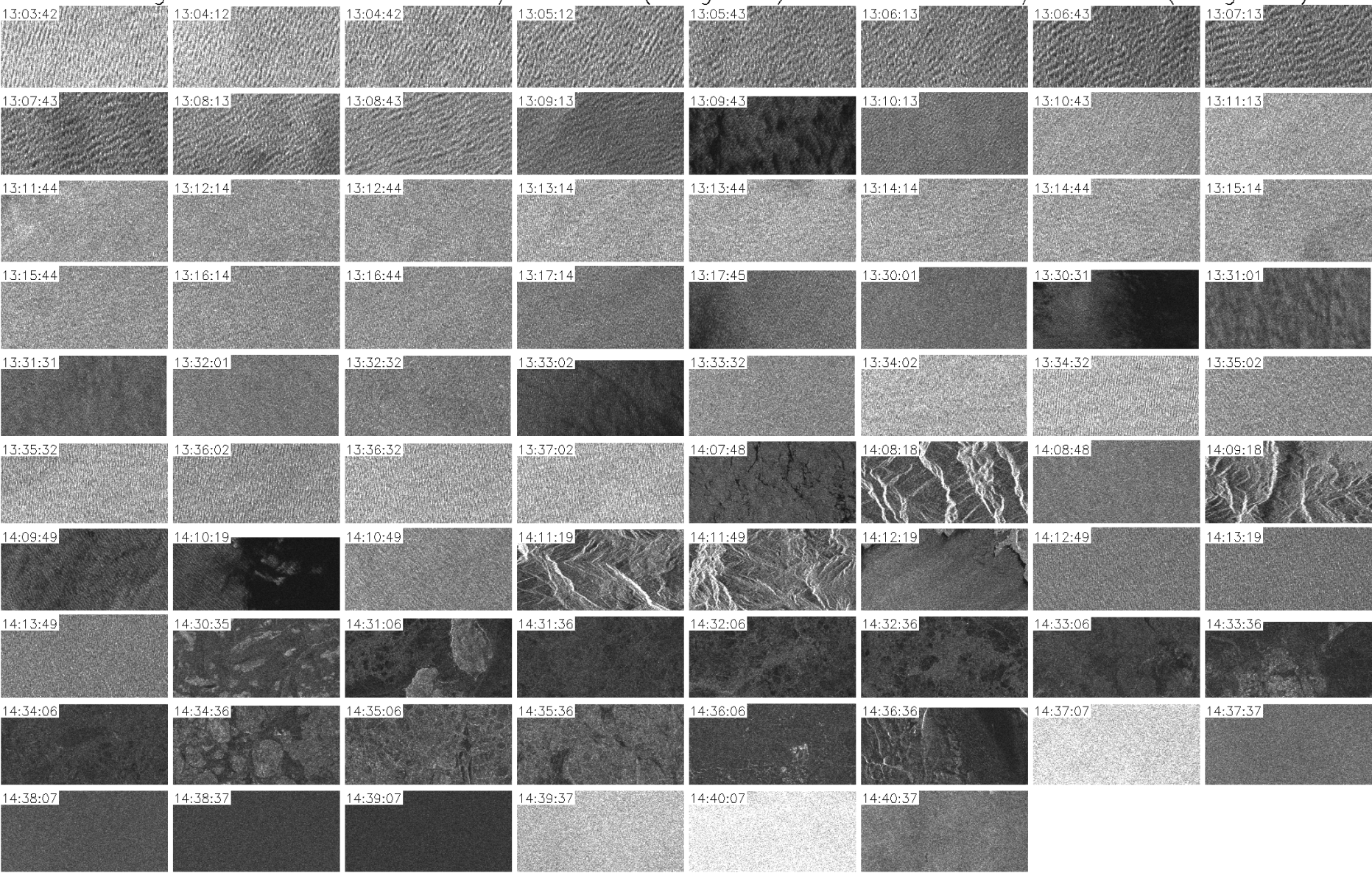


- 27 days ERS-2 SAR imageries (34 310)
- collocated ERS-2 SCAT Wind data
- collocated ERS-2 Altimeter data
- collocated ECMWF Wind fields, Ocean Wave Spectra

E2 Imagettes from 08-JAN-2000/13:03:42 to 08-JAN-2000/14:40:37 [KST29720]



E2 Imagettes from 08-JAN-2000/13:03:42 (imag_002) to 08-JAN-2000/14:40:37 (imag_079)



Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2003

Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2003

Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2000

Raw Data ID: KST29627
UTC Time: 03-JAN-2000
Coordinates: N 42.69°
Processing Date: 27-SEP-2000

Raw Data ID:
UTC Time:
Coordinates:
Processing Date:

Raw Data ID: KSS06003-21-10-4
UTC Time: 22-AUG-1996/21:01:44
Coordinates: N 80.83° / W 118.77°
Processing Date: 21-JUN-2000



Flight



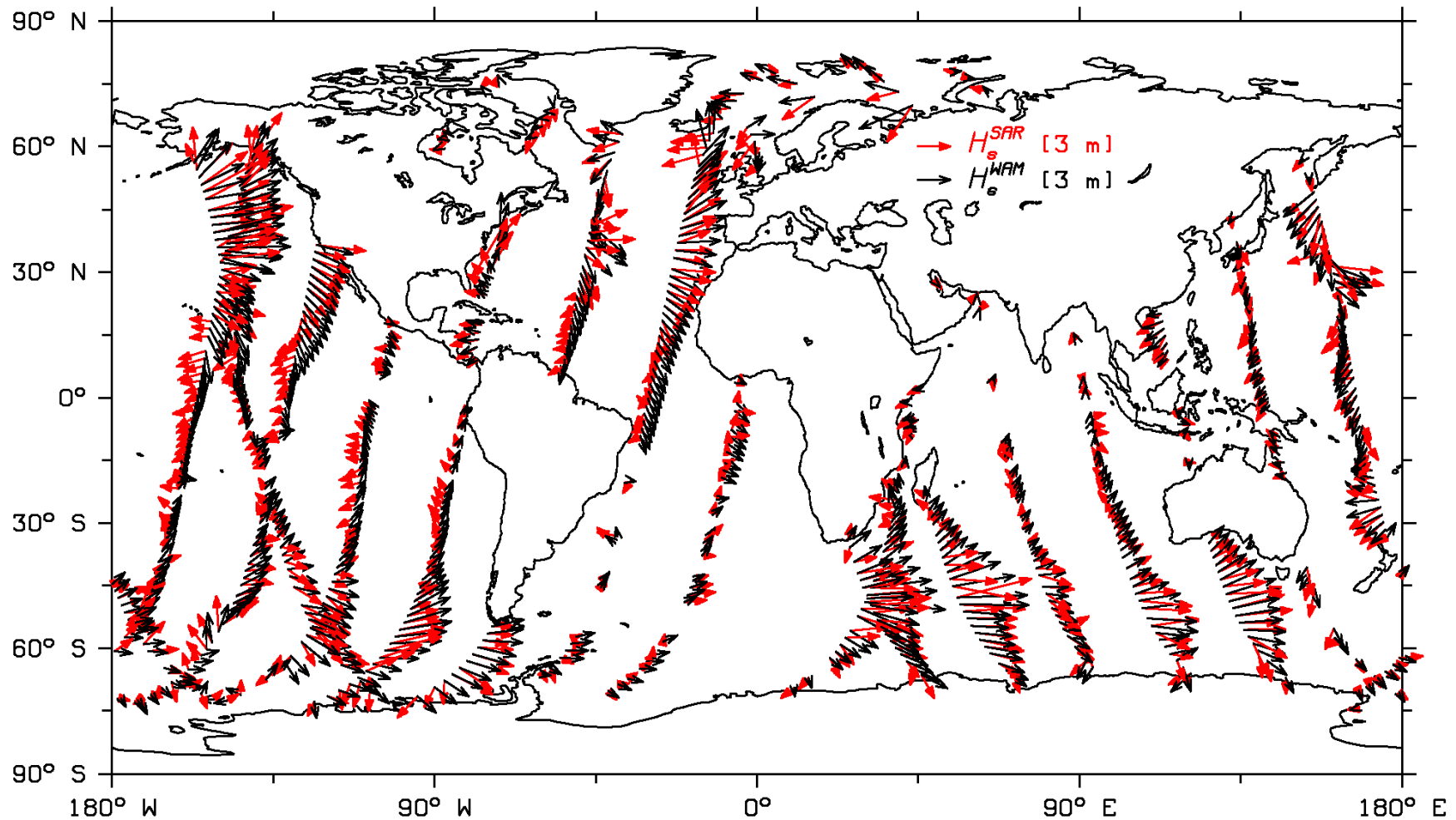
North



DLR

Significant wave height from ENVISAT SAR

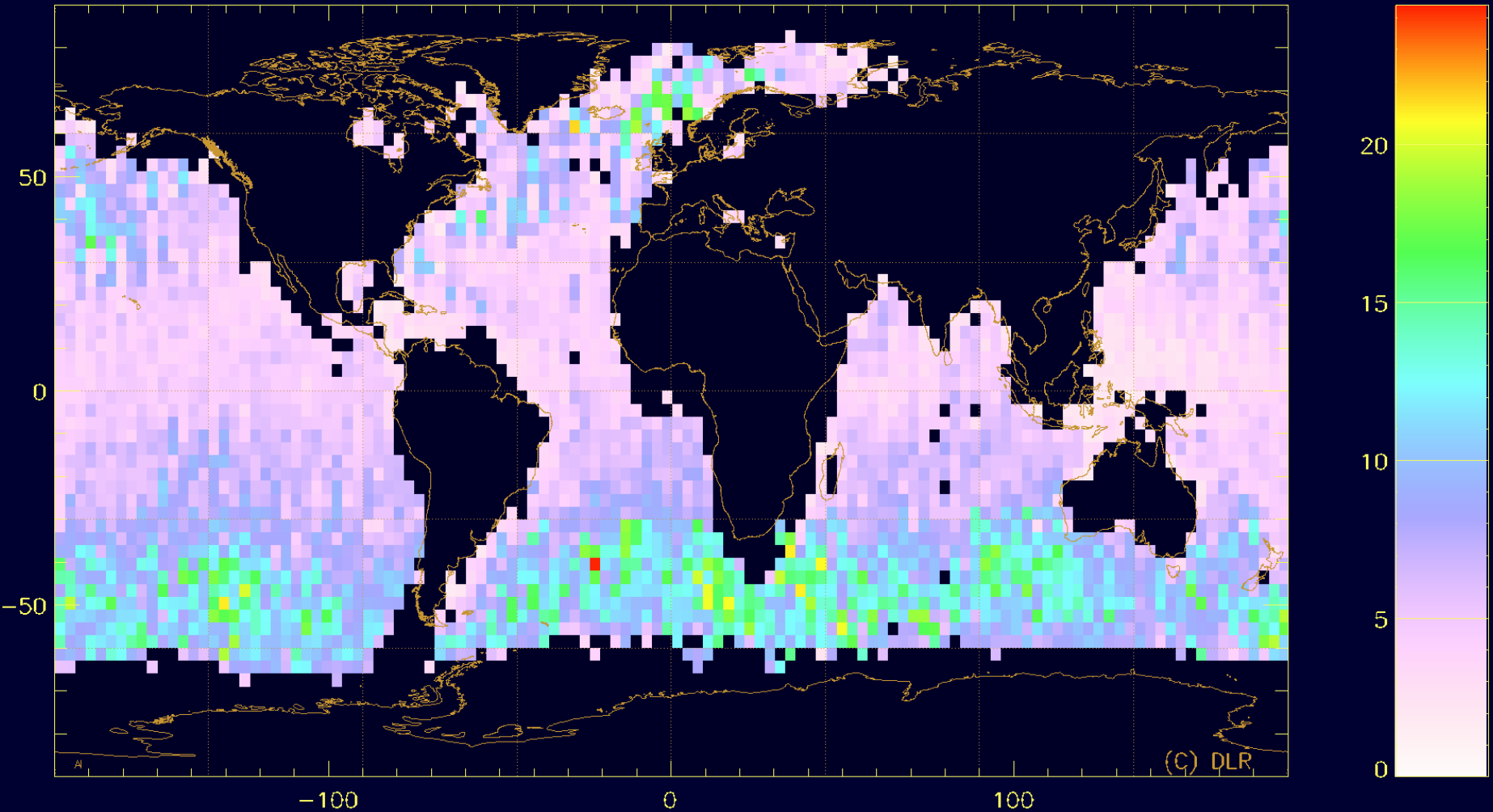
French Met office wave model hindcast - black
PARSA Inverted SAR red
2.1.2003



Maximum wave height

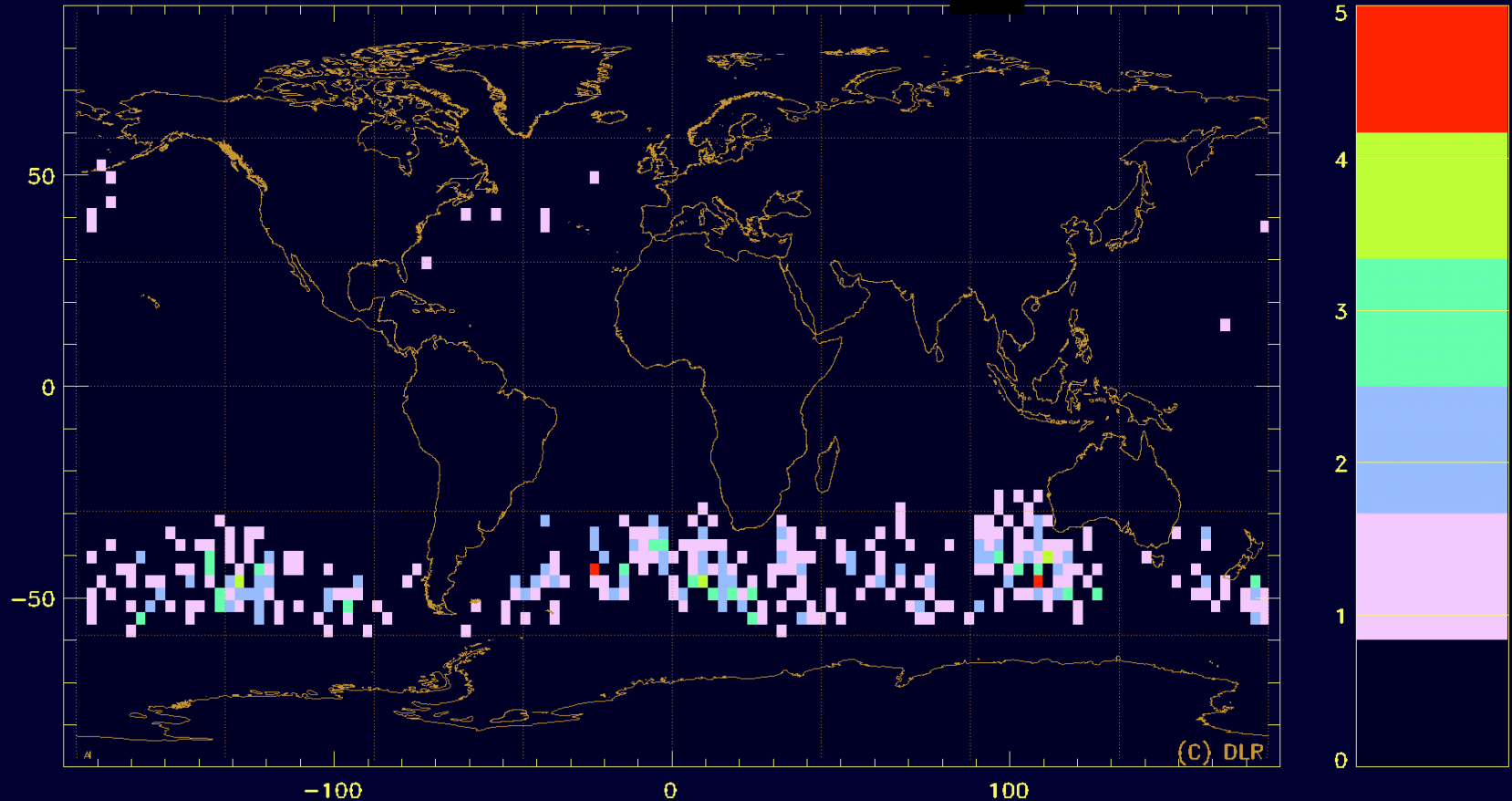
$H_{\max, \text{Lise2}}$ (highest wave in meters)

meters



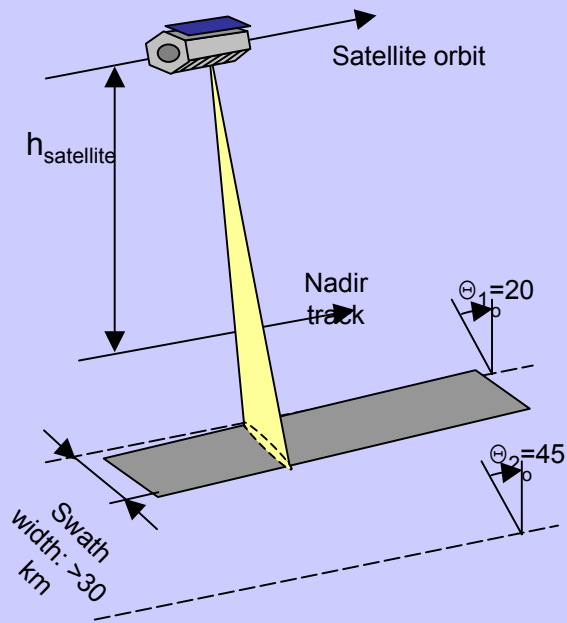
Frequency of extreme waves derived from SAR data

No. of extr. waves ($H_{\max}/H_s > 2$, $H_{\max} > 10\text{m}$) in region

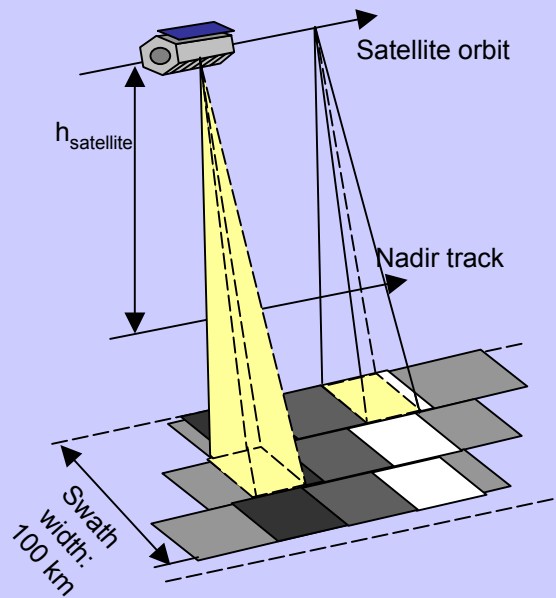


TerraSAR-X Imaging Modes

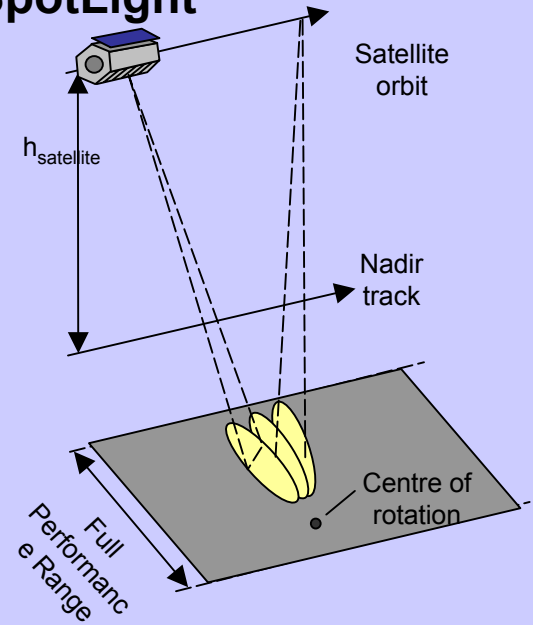
StripMap



ScanSAR



Sliding SpotLight



Summary, Conclusions and Outlook

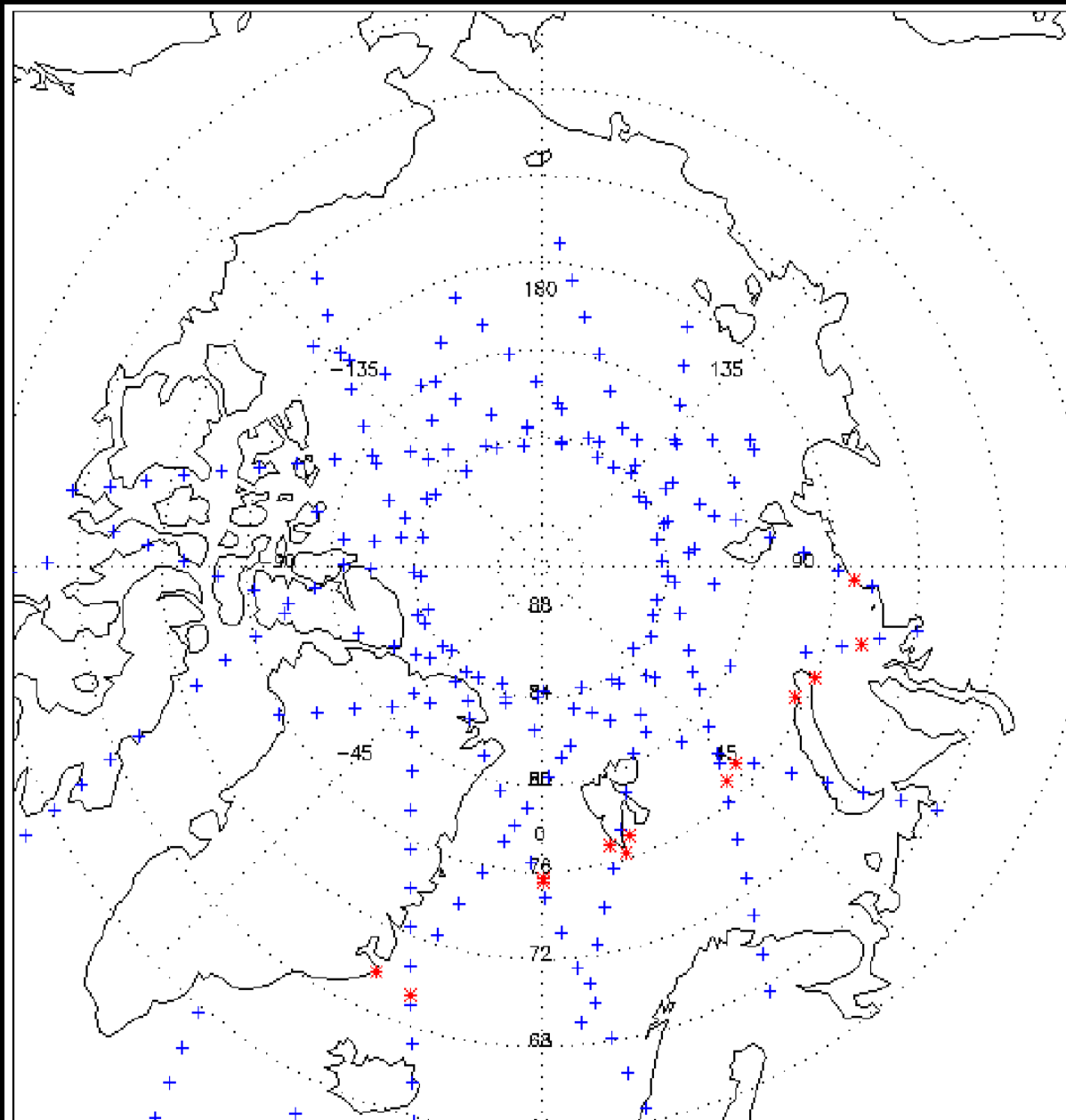
- New algorithms used: Sea Surface retrieved from marine and satellite radar-Images
- Extreme waves detected near Antarctica
- More extreme waves detected by SAR than predicted by theory for high H_s in the southern Hemisphere
- Statistics for Northern Hemisphere under investigation, 2 years of raw data are being made available by ESA
- 150 images available over Arctic daily
- Cryosat, TerraSAR, SWIMSAT



Objectives

- **Sea Surface from satellite SAR wave mode**
- **Extreme Statistics**
- **Radar Hogben Atlas**
- **Wind fields**
- **Sea ice parameters from SAR**
- **Decadal change**

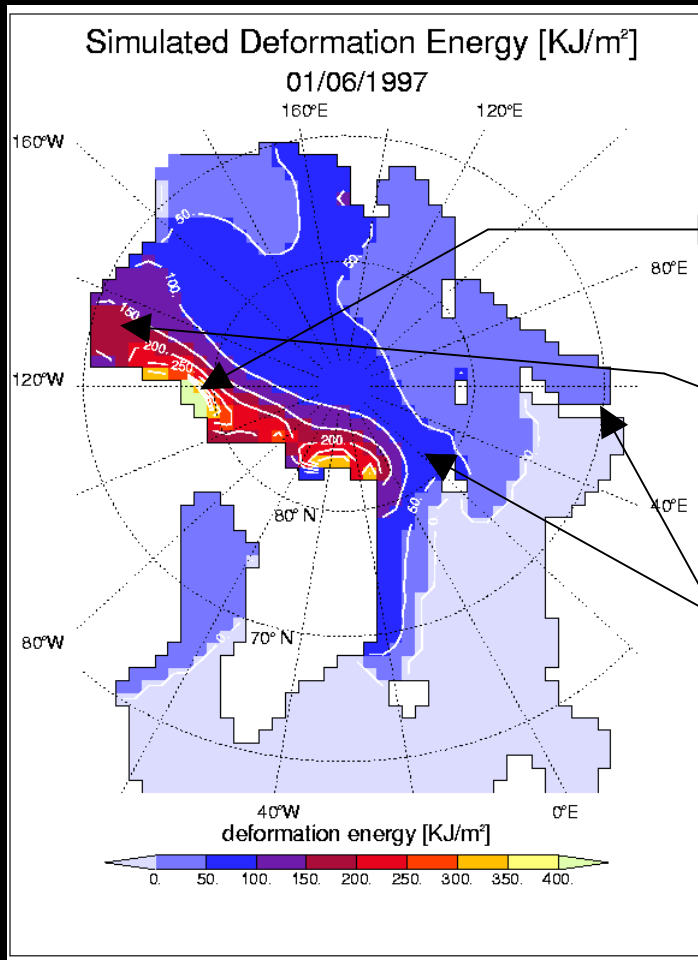
Imagette Coverage



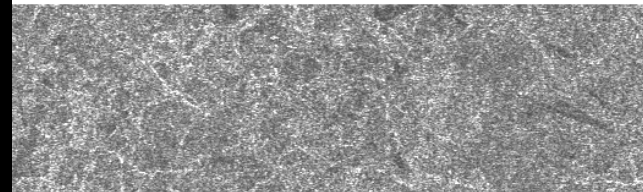
ERS-2 Imagette Coverage of Fram Strait, June 1, 1997



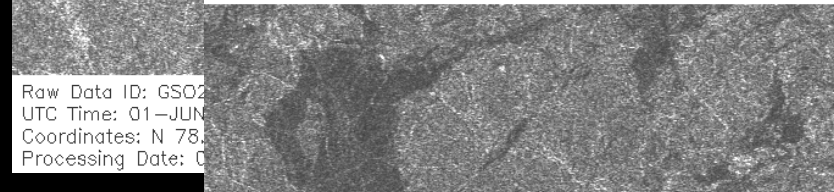
Imagette SAR <-> Model Deformation Energy



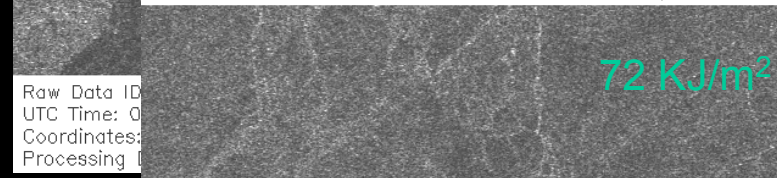
Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2000



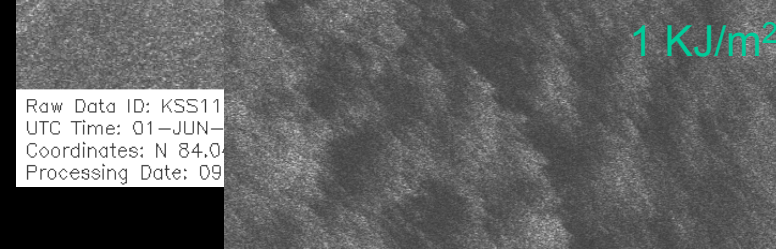
Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2000



Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2000



Sensor: ERS-2 Processor: BSAR@IMF © ESA/DLR 2000



Raw Data ID: KSS11491-15-7-100
UTC Time: 01-JUN-1997/17:38:47
Coordinates: N 69.68° / E 57.25°
Processing Date: 09-JUN-2000

↑ Flight ↑ North

Media Response

mareTV

Welle.

7. November 2002
20:15 Uhr, NDR

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15th
Text

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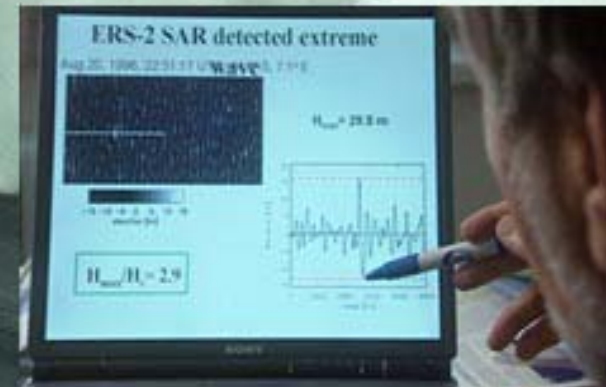
Like t

Send

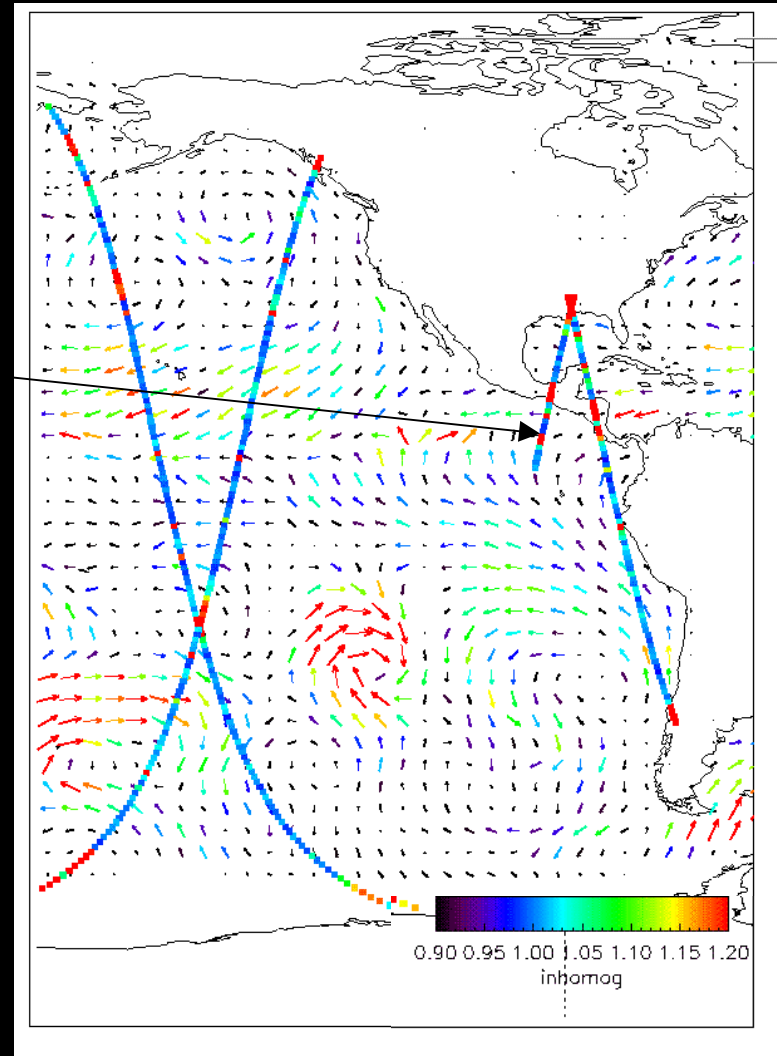
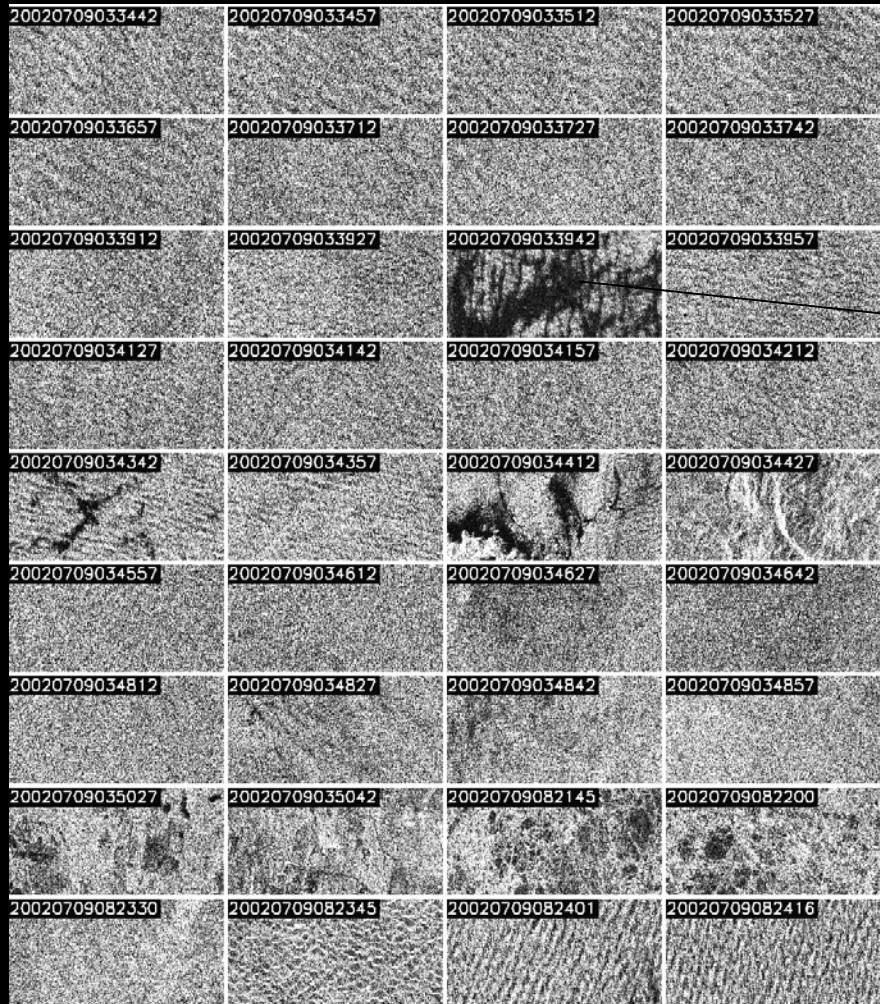


Kaventsmänner.

Von Freak Waves und
Monsterwellen.



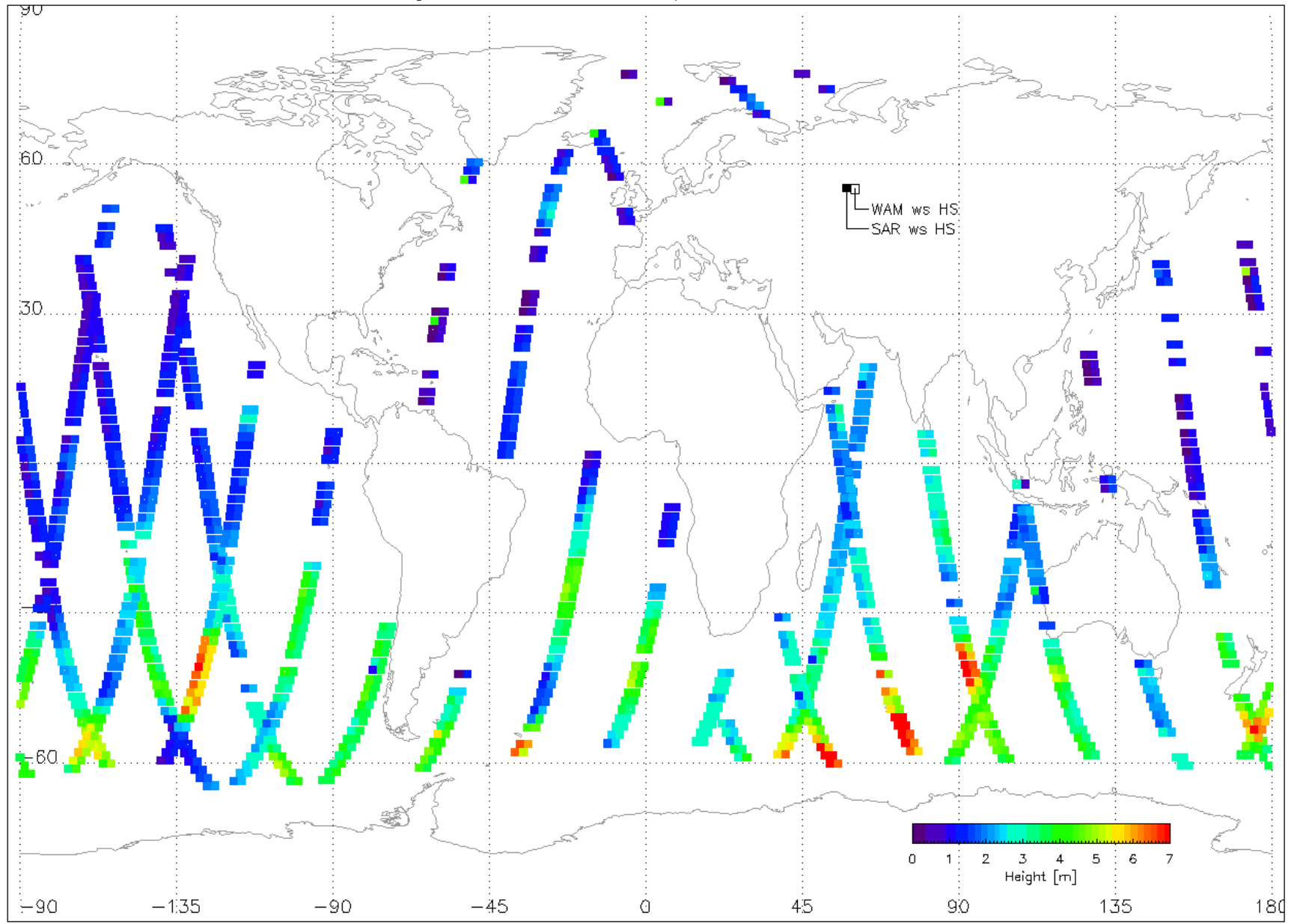
Wave Mode data from ENVISAT ASAR 2002



QuickSCAT wind field

From SAR: storm areas (defined by wave height) have larger size

August 22, 1996 – Comparison SAR to WAM



SAR - Image

