ESA-MOST Dragon Cooperation

2015 DRAGON 3 SYMPOSIUM

Project title: Satellite based marine environmental safety and protection in the China and European Seas
Project ID: 10580

Chinese Side:
Prof. Ming-Xia HE
Ocean Remote Sensing Institute (ORSI), Ocean University of China (OUC)

European Side:
Dr. Susanne Lehner, Wolfgang Rosenthal
Remote Sensing Technology Institute (IMF), German Aerospace Center (DLR)

22-26 June 2015 | Interlaken | Switzerland
German Bight:
• high temporal and spatial variability of sea state, interaction waves/bathymetry/currents
• high activity: shipping and building offshore constructions

AIS messages mapped on TerraSAR-X image

condition: wave height < 1.3m – accurate forecast necessary
German Bight
AIS Data one week AIS
Über TerraSAR-X
Operational Algorithms to Derive Products on:

- Wind Field
- Sea State
- Oil Spills
- Ship, Wakes
- Bathymetry by Refraction
- Breaking Waves
- Land-Water-Line
- Currents
- Sea Ice, Icebergs
At DLR Bremen
Downloading and archiving
Oceanographic Sentinel Data
Wave Mode?
Echtzeit-Datenempfang der Sentinel-1 Mission am Deutschen Fernerkundungsdatenzentrum

Freitag, 8. Mai 2015

Nordostküste Südafrikas, aufgenommen von Sentinel-1A am 7. Mai 2015
Storm Niklas over German Bight

April 1st, 5:40 UTC
Einleitung


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Abb. 1: Satellitenbild vom 31. März 2015, 12 UTC. Der Kern des Orkantief NIKLAS befindet sich im Bereich Danemarks. [Quelle: DWD]
Sentinel-1 image in IW mode, descending
5:41 UTC
subscene of
1024×1024 pixels
(pixel size ~ 10 m)
Sentinel-1 SAR Image spectrum, derived by 2-dim FFT normalized to maximum 1

Peak Wave Length of ~120 m, IW

Peak Wave Direction of 95 deg. with respect to flight direction of satellite;

Wave Direction is 110.8 deg going to (satellite heading is 195.8 deg)

Wave Direction from Cross spectra in progress when Complex data are made available
oil, oil rigs, ships

North Sea

20km

S1A_S4_GRDH_1SSV_20141004T062011_20141004T062030_002676_002FBE_C0A3
wind, waves for bathymetry
Radar signal penetrates clouds. No sun light is necessary.
Wind and Waves from TerraSAR-X Products for NRT

**TerraSAR-X**
- **StripMap Image**
- **Bight of Kiel, Baltic Sea**

**WIND**
- New non linear Geophysical Model Function **XMOD-2**
- Streaks 2D-FFT, Interpolation
- SAR Image Calibration
- Direction
- NRCS
- Incidence angle
- Wind field

**WAVES**
- New empirical Algorithm **XWAVE-2**
- Sub-Szene
- Image spectra $S$
- Filtering, $L_{min}, L_{max}$
- $XWAVE$ function
- Parameters: $H_s, L_p, T_p$...
Windpark ALPHAVENTUS mit DWD

TS-X Stripmap Image (32km×41km) 07.09.2011 17:18 UTC

Wind Farm “Alpha Ventus”

ALPHA VENTUS mit DWD

TerraSAR-X Wind

DWD Wind

TS-X Sea surface wind speed (m/s)

15km ~20%
Remote sensing for validation of forecast model

**DWD-German Meteorological Service:**
Sea sate Forecast - improvement for coastal regions

**DLR:**
Remote Sensing - Sea State Data for Validations

Development of a new coastal wave model 900m resolution, interactively coupled with BSH circulation model
6 Buoys in German Bight comparison
SI=20%  RMSE=0.25

New data since Dec. 2014
- shown: wavelength range from 50-130 m
- analysed subscenes between 1024x1024 and 256x256 pixels
- sea state analysis at high spatial resolution
- Sentinel-1 IW Data analyzed for Wind Field and Wave Spectra

- In Storm situations up to 30 m/sec wind gusts observed

- Ocean Waves of 110 m peak wave length detected on IW

- Wave Mode still not available

- Useful for Waterline Detection and Bathymetry

- Applications are used in Offshore Windfarming at DWD and at EMSA for Oil Spill Detection in the frame of CleanSeaNet

- For TerraSAR by empirical DLR algorithm XWAVE: high Resolution Significant Wave Height down to 1.2 meters at SI 20% and Peak Wavelength lts SI 15 % validated against buoys

- Similar Results expected for Sentinel-1
Co-Investigators:

Dr. Wolfgang Rosenthal (DLR Guest scientist)
Dr. Xiao-Ming Li (DLR -> CEODE, CAS)
Dr. Sven Jacobsen (DLR)

Prof. YiJun HE (NUIST),
Prof. Qing Dong (CEODE, CAS),
Dr. YongZheng Ren (CEODE, CAS),
Prof. Biao Zhang (NUIST)
Sentinel-1 acquisition plan

SENTINEL-1A - OBSERVATION SCENARIO 22.03.2015 - 03.04.2015 (CYCLE 44)
Thank You!
empirical Algorithms XMOD (wind) und XWAVE (waves)

TerraSAR-X Radar Image
StripMap 30km×50km
3m Resolution

German Bight

Cuxhaven

NRT NZ

TerraSAR-X
TanDEM-X

NRT
wind and waves

\[ \bar{U}_{10} = 7.4 \text{ m/s} \]

\[ H_s = 0.6 \text{ m} \]
## Sentinel-1 SAR Products

### Full resolution Level-1 GRD

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<th>Resolution (\text{rg} \times \text{az})</th>
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### High resolution Level-1 GRD

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### Medium resolution Level-1 GRD

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