

→ 3rd ESA ADVANCED TRAINING ON OCEAN REMOTE SENSING

# SAR Detection Capabilities, Interpretation and Application

J.A. Johannessen and F. Collard

23-27 September 2013 | | NMCI | Cork, Ireland





# The **SAR** images manifest expression of









# SAR CONTRIBUTION TO MARINE MONITORING

Operational	Emerging	<b>Routine Product</b>	Research
Surveillance	New	and partly used	Dominated
Survenunce	Application	in NWD	
	Application		
Ship detection	Wind field	Ocean Waves	Surface current
-	retrievals	and	fronts and
Oil spill		Ocean Spectra	eddies
detection			
			Internal Wayos
~ ~			unter har waves
Sea Ice			
			Atmospheric
Shallow water			boundary layor
Shallow water			boundary layer
Bathymetry			Processes
			Film domning
			r nn damping



# **Conventional SAR Signature Interpretation**







Dipubly gradientic biographic and the segment of th





## Surface Current Fronts



(a) Hydrodynamic modulation





# Converging-diverging surface currents



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# (b) Divergence





## Surface Current Fronts



#### (b) Surface film modulation









#### (c) Atmospheric boundary layer (ABL) stability





# Mesoscale variability and eddies





16 November 2009 19:58:15 UTC off the coast Of northern Norway and Lofoten

#### Mesoscale anticylonic eddy







### Sensor synergy to advance mesoscale studies





Kudryavtsev, A. Myasoedov, B. Chapron, J.A. Johannessen, F. Collard, JGR; 2012



## Importance of Sensor Synergy





SST AND SUNGLINT

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# **Doppler Centroid Analysis**



Chapron et al. [JGR-Oceans 2005]



- Doppler anomaly is correlated with line-of-sight wind
- Corrections for wind / wave contributions can be derived



# **Doppler Centroid Analysis**





Chapron et al. [JGR-Oceans 2005]

Image intensity (gray) and Doppler anomaly (color) of an ENVISAT ASAR ScanSAR image

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#### LINKS BETWEEN GOCE MSGC and ASAR Doppler







# Gulf Stream Separation in Envisat ASAR RD, GHRSST and SMOS SSS field



ASAR RD

GHRSST

**SMOS SSS** 



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## Satellite sensor synergy









# TanDEM-X





- Second satellite in close formation flight with TerraSAR-X
- Main purpose: High-resolution land topography mapping
- Ideal along-track baselines within narrow latitude regions, usually close to north and south pole



# 2D Vector Currents: Dual-Beam Interferometry







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# **TanDEM-X Example**

Orkney (Scotland), 2012-02-26 6:41 UTC, shown area = 30 km × 30 km



 Also performed Doppler centroid analysis; results found to be of quality similar to split-antenna ATI results

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# Bathymetry detection by imaging radar





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# Bathymetric features along the Chinese coast





ERS-1 SAR image of the Xinchuan Gang Shoals at the east coast of China north of Shanghai. Part of the area falls dry during ebb tide (dark areas off the coast).



## Bathymetric features along the Dutch coast









# **Conventional SAR Signature Interpretation (2)**





Cees de Valk [SeaSAR 2008]

Sandwave topography from 6 ERS SAR images

Reference topography from echosoundings

- Shallow water bathymetry retrieval from SAR signatures
- Main achievement: Reduction of required echosoundings



#### **Internal Waves**



IWs in the Straight of Gibraltar



http://earth.esa.int/ers/instruments/sar/applications/ERS-SARtropical/



# Roughness change by Internal Waves







# **Roughness change by Internal Waves**





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### Internal solitons from China Sea 27 March 2005









#### Internal waves in the South China Sea from SAR images





#### After Xilin Gan



# Internal soliton from China Sea







### Simulation of backscatter anomaly due to presence of IW





### Internal Waves and Oil Spill



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#### Atmospheric gravity waves and Oceanic IW





#### TYPICAL SAR SIGNATURE OF ATMOSPHERIC GRAVITY WAVES

TYPICAL SAR SIGNATURE OF OCEANIC INTERNAL WAVES

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