## A new 3D fully wave-current model MARS-WWATCH III: Application to the Biscarosse beach

A-C. Bennis<sup>3,2</sup>, F. Ardhuin<sup>1,2</sup>, F. Dumas<sup>2</sup>

IFREMER, L.O.S, 29280 Plouzané, France
 IFREMER, DYNECO/PHYSED, 29280 Plouzané, France
 LPO, 6 avenue Le Gorgeu, 29200 Brest, France

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#### MARS-WW3

Anne-Claire BENNIS (bennis@univbrest.fr)

NSTS experiment

BISCAROSSE experiment

### Outline

NSTS experiment

BISCAROSSE experiment

Summary

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# $\mathsf{NSTS} \to \mathsf{Configuration}$ and goal



Bathymetry - Leadbetter Beach, CA (4/02/1980)

- NSTS Experiment, 4/02/1980 (cf. Thornton et Guza,1986 et Wu et al, 1985)
- Simulation of the longshore current.
- dx=4m, dy=20m, 100 sigma levels (mesh refinement near bottom and surface), dt=1s.
- One-way coupling.

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### Goal

- Validation of the 3D version of the coupled model based on the theoretical model of Ardhuin et al (2008) in surf zone.
  - Breaking waves: addition of the  $F_{d,x}$  and  $F_{d,y}$  terms.
  - Bottom stress+resolution of the WBBL: addition of the  $F_{b,x}$  et  $F_{b,y}$  terms.
  - Turbulent mixing: addition of the  $F_{m,x}$  et  $F_{m,y}$  terms.

### $\mathsf{NSTS} \to \mathsf{The}$ equations: part 1

$$\begin{aligned} (1): \frac{\partial \widehat{u}}{\partial t} &+ \widehat{u} \frac{\partial \widehat{u}}{\partial x} + \widehat{v} \frac{\partial \widehat{u}}{\partial y} + \widehat{w} \frac{\partial \widehat{u}}{\partial z} - f \widehat{v} + \frac{1}{\rho} \frac{\partial \rho^{H}}{\partial x} \\ &= \left[ f + \left( \frac{\partial \widehat{v}}{\partial x} - \frac{\partial \widehat{u}}{\partial y} \right) \right] V_{s} - W_{s} \frac{\partial \widehat{u}}{\partial z} - \frac{\partial J}{\partial x} + \widehat{F}_{d,x} + \widehat{F}_{m,x} + \widehat{F}_{b,x} \end{aligned}$$

$$\begin{aligned} (2): \frac{\partial \widehat{v}}{\partial t} &+ \widehat{u} \frac{\partial \widehat{v}}{\partial x} + \widehat{v} \frac{\partial \widehat{v}}{\partial y} + \widehat{w} \frac{\partial \widehat{v}}{\partial z} + f \widehat{u} + \frac{1}{\rho} \frac{\partial \rho^{H}}{\partial y} \\ &= -\left[f + \left(\frac{\partial \widehat{v}}{\partial x} - \frac{\partial \widehat{u}}{\partial y}\right)\right] U_{s} - W_{s} \frac{\partial \widehat{v}}{\partial z} - \frac{\partial J}{\partial y} + \widehat{F}_{d,y} + \widehat{F}_{m,y} + \widehat{F}_{b,y}. \end{aligned}$$

$$(3): \frac{\partial e}{\partial t^{\star}} = \frac{1}{D^2} \cdot \frac{\partial}{\partial \varsigma} \left( \frac{\nu_V}{s_e} \cdot \frac{\partial e}{\partial \varsigma} \right) - \frac{\partial e}{\partial \varsigma} \cdot \frac{\partial \varsigma}{\partial t} + \operatorname{Prod} + \operatorname{Buoy} - \epsilon + P_e,$$

$$(1)$$

$$(4): \frac{\partial \epsilon}{\partial t^{\star}} = \frac{1}{D^2} \cdot \frac{\partial}{\partial \varsigma} \left( \frac{\nu_V}{s_{\epsilon}} \cdot \frac{\partial \epsilon}{\partial \varsigma} \right) - \frac{\partial \epsilon}{\partial \varsigma} \cdot \frac{\partial \varsigma}{\partial t} \\ + \frac{\epsilon}{e} \left( c_1 \operatorname{Prod} + c_3 \operatorname{Buoy} - c_2 \epsilon F_{wall} \right) + P_{\epsilon}.$$

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 $\mathsf{NSTS}\ \mathsf{experiment}$ 

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### NSTS $\rightarrow$ The equations: part 2

 $P_e$  and  $P_\epsilon$  are respectively the TKE and dissipation source terms due to breaking waves and bottom stress.

Their expressions are given by : (cf. Walstra et al 2000)

$$P_{e} = \frac{4D_{w}}{H_{rms}} \left(1 - \frac{2z'}{H_{rms}}\right)_{z' \le H_{rms}/2} + \frac{2D_{f}}{\delta} \left(1 - \frac{D - z'}{\delta}\right)_{D - \delta \le z' \le D},$$
(2)
$$P_{\epsilon} = c_{1\epsilon} \frac{\epsilon}{e} P_{e}(z') \text{ avec } c_{1\epsilon} = 1.44,$$
(3)

where  $D_w$  and  $D_f$  are respectively the energy dissipation generated by the breaking wave and bottom stress and  $\delta$  is the WBBL thickness.



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## $\mathsf{NSTS} \to \mathsf{Sensitivity\ tests}$



### Sensitivity to the rugosity length







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Anne-Claire BENNIS (bennis@univbrest.fr)

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### $\mathsf{NSTS} \to \mathsf{Vertical} \ \mathsf{profiles}$



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## $\mathsf{BISCA} \to \mathsf{Configuration}$ and <code>Goals</code>



### Goals

- Validation of the 3D version of the coupled model based on the theoretical model of Ardhuin et al (2008) in surf zone.
- Impact of the feedback on the rip current.
- Vertical structure of the rip current.

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### $\mathsf{BISCA} \to \mathsf{The}$ field experiment description

#### (bennis@univ-Directional wave spectra (mm<sup>2</sup>/Hz/Cycle) brest.fr) $x 10^{6}$ Shoreline orientation NSTS experiment BISCAROSSE experiment 0.1 Hz 1 Hz 0.2 Hz Summary 0.2 Hz 0.3 Hz 0.3 Hz Dide Level (m) -3 -2 -1 245050 North Longshore North May Marine Marine 245000 ŝ Y (m, Lambert 3 Projection) Cross-shore H°. 244950 246000 (s) d 244900 24575 245500 245250 244850 245000 ADC minimper trans manipatry 0 d -50 244750 244800 244500 -10 13/06/2007 14/06/2007 14/06/2007 15/06/2007 15/06/2007 16/06/2007 16/06/2007 17/06/2007 17/06/2007 244750 313850 313950 314050 12:00 00:00 12:00 00:00 12.00 00:00 12:00 00:00 12:00 (cf. Bruneau 2009) X (m, Lambert 3 Projection) (cf. Bruneau 2009) Time (UT+2)

#### 10/19

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## $\mathsf{BISCA} \to \mathsf{Map} \text{ of current}$

- Comparison between the coupled (left panel) and forced (right panel) modes.
- Vector velocity is drawn over the mean depth and the norm of the barotropic velocities (the reference vector is equal to 0.5 m.s<sup>-1</sup>).

Anne-Claire BENNIS (bennis@univbrest.fr)

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NSTS experiment

BISCAROSSE experiment



## $\mathsf{BISCA} \to \mathsf{Map}$ of barotropic cross-shore velocity

- Comparison between the coupled (left panel) and forced (right panel) modes.
- The barotropic cross-shore velocity is drawn over the mean depth.
- The barotropic cross-shore velocity is higher with the coupled mode and the rip current is spatially shifted.



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## $BISCA \rightarrow Cross-shore profiles$

LATITUDE : 44.4N TIME : 15-JUN-2007 11:22

1 30000

<del>× ∗ ×</del>Couplé

1.290\*#

1.282\*#

LONGITUDE

Barotropic cross-shore velocity (m/s)

1.260°W

1.250%





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#### MARS-WW3

Anne-Claire BENNIS (bennis@univbrest.fr)

JSTS experiment

BISCAROSSE experiment

Summary

### Summary

### ► IN THE FUTURE

- Improve the vertical and horizontal resolutions.
- Investigate the vertical structure of the rip current.
- Comparison with MARS-SWAN results and observations.

#### MARS-WW3

Anne-Claire BENNIS (bennis@univbrest.fr)

NSTS experiment

BISCAROSSE experiment

#### MARS-WW3

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VSTS experiment

BISCAROSSE experiment

Summary

The End. Thank you.

Questions?