# f011grshw[001-003]: Wave growth in shallow water

## Purpose

The purpose of this test is to verify depth-limited wave growth for 3 different wind speeds.

## Situation

Wave growth, caused by a constant uniform wind blowing perpendicularly off a long and straight coastline over constant limited depth is considered. Results are taken at infinite fetch. The wind velocities considered are $U_{10}$ = 10, 20 and 30 m/s for case f011grshw001, f011grshw002 and f011grshw003 respectively. Ambient currents are absent.

## Comparison

Model results are compared with expressions of Bretschneider (1973), Young and Verhagen (1996), Young and Babanin (2006) and the envelope of observations compiled by Holthuijsen (1980). Comparisons are made for the range of non-dimensional depth of 0.01 to 10. The depth and results are scaled with the wind speed $U_{10}$ (i.e. wind velocity at 10m above sea level). The non-dimensional depth is defined as:

$$\tilde{d} = \frac{gd}{\left(U_{10}\right)^2} \qquad \text{(F1.1)}$$

where g is gravity and d is depth.

The model results are non-dimensional total energy and non-dimensional peak-frequency as a function of non-dimensional fetch. Non-dimensional energy is defined here as:

$$\tilde{E} = \frac{g^2 m_0}{\left(U_{10}\right)^4} \qquad \text{(F1.2)}$$

where $m_0$ is the zero order moment over the spectral density ( $m_0 = \int E(f)df$ )

The non-dimensional peak frequency is defined as

$$\tilde{f}_p = \frac{f_p U_{10}}{g} \qquad \text{(F1.3)}$$

where $f_p$ is the peak frequency.

The non-dimensional wave number at the peak frequency is defined as

$$\tilde{k}_p = \frac{k_p U_{10}^2}{g} \qquad \text{(F1.4)}$$

where $k_p$ is the wave number that follows from the linear dispersion relation:

$$\omega_p^2 = g k_p \tanh\left(k_p d\right) \qquad \omega_p = 2\pi f_p \qquad \text{(F1.5)}$$

For reasons of completeness, we repeat the expressions in Young and Verhagen (1996):

$$\tilde{E} = 1.06 \cdot 10^{-3} \cdot \tilde{d}^{1.3} \qquad \tilde{f}_p = 0.20 \cdot \tilde{d}^{-0.375} \tag{F1.6}$$

For reasons of completeness, we repeat the expressions in Young and Babanin (2006):

$$\tilde{E} = 1.0 \cdot 10^{-3} \cdot \tilde{d}^{1.2} \qquad \tilde{k}_p = 1.80 \cdot \tilde{d}^{-0.73} \tag{F1.7}$$

## Default model commands

### Model commands for $U_{10}$ = 10 m/s (f011grshw001)

| | **COMPUTATIONAL GRID** | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1D/2D | XPC | YPC | ALPC | XLENC | YLENC | |
| 00 | ID | 0 | 0 | 0 | 4500 | 0 | |
| 01 | ID | 0 | 0 | 0 | 45 000 | 0 | |
| 02 | ID | 0 | 0 | 0 | 300 000 | 0 | |
| 03 | ID | 0 | 0 | 0 | 300 000 | 0 | |
| 04 | ID | 0 | 0 | 0 | 1 800 000 | 0 | |
| 05 | ID | 0 | 0 | 0 | 15 000 000 | 0 | |
| 06 | ID | 0 | 0 | 0 | 15 000 000 | 0 | |
| 07 | ID | 0 | 0 | 0 | 50 000 000 | 0 | |
| 08 | ID | 0 | 0 | 0 | 50 000 000 | 0 | |
| 09 | ID | 0 | 0 | 0 | 50 000 000 | 0 | |

| | ΔX | ΔY | DIR1 | DIR2 | Δθ | FLOW | FHIGH | MSC |
|---|---|---|---|---|---|---|---|---|
| 00 | 10 | 0 | 0° | 360° | 10° | 0.227 | 3.333 | 27 |
| 01 | 10 | 0 | 0° | 360° | 10° | 0.1538 | 2.0 | 27 |
| 02 | 100 | 0 | 0° | 360° | 10° | 0.1 | 1.0 | 24 |
| 03 | 100 | 0 | 0° | 360° | 10° | 0.1 | 1.0 | 24 |
| 04 | 600 | 0 | 0° | 360° | 10° | 0.065 | 1.0 | 29 |
| 05 | 3000 | 0 | 0° | 360° | 10° | 0.05 | 1.0 | 31 |
| 06 | 3000 | 0 | 0° | 360° | 10° | 0.05 | 1.0 | 31 |
| 07 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |
| 08 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |
| 09 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |

| | **PHYSICS** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | GEN | BREAK | FRIC | TRIADS | QUAD | WCAP | REFRAC | FSHIFT | SETUP |
| | 3 | on | on | on | on | on | on | off | off |

| | **BOUNDARY CONDITIONS** | | | | |
|---|---|---|---|---|---|
| | TYPE | BOU | C/V | P/R | NAME OF FILE |
| | _ | _ | _ | _ | _ |

| | **BOTTOM:** | **FAC** | **WIND:** | | **CURRENT:** | **WATER LEVEL:** |
|---|---|---|---|---|---|---|
| 00 | 'f011grshw001.bot' | 0.156 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 01 | 'f011grshw001.bot' | 0.313 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 02 | 'f011grshw001.bot' | 0.625 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 03 | 'f011grshw001.bot' | 1.25 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 04 | 'f011grshw001.bot' | 2.5 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 05 | 'f011grshw001.bot' | 5 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 06 | 'f011grshw001.bot' | 10 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 07 | 'f011grshw001.bot' | 20 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 08 | 'f011grshw001.bot' | 40 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |
| 09 | 'f011grshw001.bot' | 80 | $U_{10}$: 10 m/s | $\theta_w$: 0° | _ | _ |

## Model commands for $U_{10}$ = 20 m/s (f011grshw002)

| | **COMPUTATIONAL GRID** | | | | | |
|---|---|---|---|---|---|---|
| | 1D/2D | XPC | YPC | ALPC | XLENC | YLENC |
| 00 | ID | 0 | 0 | 0 | 4500 | 0 |
| 01 | ID | 0 | 0 | 0 | 45 000 | 0 |
| 02 | ID | 0 | 0 | 0 | 300 000 | 0 |
| 03 | ID | 0 | 0 | 0 | 300 000 | 0 |
| 04 | ID | 0 | 0 | 0 | 1 800 000 | 0 |
| 05 | ID | 0 | 0 | 0 | 15 000 000 | 0 |
| 06 | ID | 0 | 0 | 0 | 15 000 000 | 0 |
| 07 | ID | 0 | 0 | 0 | 50 000 000 | 0 |
| 08 | ID | 0 | 0 | 0 | 50 000 000 | 0 |
| 09 | ID | 0 | 0 | 0 | 50 000 000 | 0 |

| | ΔX | ΔY | DIR1 | DIR2 | Δθ | FLOW | FHIGH | MSC |
|---|---|---|---|---|---|---|---|---|
| 00 | 10 | 0 | 0° | 360° | 10° | 0.227 | 3.333 | 27 |
| 01 | 10 | 0 | 0° | 360° | 10° | 0.1538 | 2.0 | 27 |
| 02 | 100 | 0 | 0° | 360° | 10° | 0.1 | 1.0 | 24 |
| 03 | 100 | 0 | 0° | 360° | 10° | 0.1 | 1.0 | 24 |
| 04 | 600 | 0 | 0° | 360° | 10° | 0.065 | 1.0 | 29 |
| 05 | 3000 | 0 | 0° | 360° | 10° | 0.05 | 1.0 | 31 |
| 06 | 3000 | 0 | 0° | 360° | 10° | 0.05 | 1.0 | 31 |
| 07 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |
| 08 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |
| 09 | 10 000 | 0 | 0° | 360° | 10° | 0.03846 | 1.0 | 34 |

| | **PHYSICS** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | GEN | BREAK | FRIC | TRIADS | QUAD | WCAP | REFRAC | FSHIFT | SETUP |
| | 3 | on | on | on | on | on | on | off | off |

| | **BOUNDARY CONDITIONS** | | | |
|---|---|---|---|---|
| | TYPE | BOU | C/V | P/R | NAME OF FILE |
| | _ | _ | _ | _ | _ |

| | **BOTTOM:** | **FAC** | **WIND:** | | **CURRENT:** | **WATER LEVEL:** |
|---|---|---|---|---|---|---|
| 00 | 'f011grshw002.bot' | 0.625 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 01 | 'f011grshw002.bot' | 1.25 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 02 | 'f011grshw002.bot' | 2.5 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 03 | 'f011grshw002.bot' | 5 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 04 | 'f011grshw002.bot' | 10 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 05 | 'f011grshw002.bot' | 20 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 06 | 'f011grshw002.bot' | 40 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 07 | 'f011grshw002.bot' | 80 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 08 | 'f011grshw002.bot' | 160 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |
| 09 | 'f011grshw002.bot' | 320 | $U_{10}$: 20 m/s | $\theta_w$: 0° | _ | _ |

**Model commands for $U_{10}$ = 30 m/s (f011grshw003)**

| | COMPUTATIONAL GRID | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1D/2D | XPC | YPC | ALPC | XLENC | YLENC | | | |
| 00 | ID | 0 | 0 | 0 | 6 000 | 0 | | | |
| 01 | ID | 0 | 0 | 0 | 60 000 | 0 | | | |
| 02 | ID | 0 | 0 | 0 | 300 000 | 0 | | | |
| 03 | ID | 0 | 0 | 0 | 10 000 000 | 0 | | | |
| 04 | ID | 0 | 0 | 0 | 10 000 000 | 0 | | | |
| 05 | ID | 0 | 0 | 0 | 10 000 000 | 0 | | | |
| 06 | ID | 0 | 0 | 0 | 50 000 000 | 0 | | | |
| 07 | ID | 0 | 0 | 0 | 50 000 000 | 0 | | | |
| 08 | ID | 0 | 0 | 0 | 110 000 000 | 0 | | | |
| 09 | ID | 0 | 0 | 0 | 110 000 000 | 0 | | | |
| | ΔX | ΔY | DIR1 | DIR2 | Δθ | FLOW | FHIGH | MSC | |
| 00 | | 0 | 0° | 360° | 10° | 0.12 | 3.0 | 34 | |
| 01 | | 0 | 0° | 360° | 10° | 0.08 | 2.0 | 34 | |
| 02 | | 0 | 0° | 360° | 10° | 0.08 | 1.0 | 27 | |
| 03 | | 0 | 0° | 360° | 10° | 0.06 | 1.0 | 30 | |
| 04 | | 0 | 0° | 360° | 10° | 0.03 | 1.0 | 34 | |
| 05 | | 0 | 0° | 360° | 10° | 0.03 | 1.0 | 34 | |
| 06 | | 0 | 0° | 360° | 10° | 0.025 | 1.0 | 39 | |
| 07 | | 0 | 0° | 360° | 10° | 0.02 | 1.0 | 41 | |
| 08 | | 0 | 0° | 360° | 10° | 0.02 | 1.0 | 41 | |
| 09 | | 0 | 0° | 360° | 10° | 0.018 | 1.0 | 42 | |
| | PHYSICS | | | | | | | | |
| | GEN | BREAK | FRIC | TRIADS | QUAD | WCAP | REFRAC | FSHIFT | SETUP |
| | 3 | on | on | on | on | on | on | off | off |
| | BOUNDARY CONDITIONS | | | | | | | | |
| | TYPE | BOU | C/V | P/R | NAME OF FILE | | | | |
| | _ | _ | _ | _ | _ | | | | |
| | BOTTOM: | FAC | WIND: | | CURRENT: | WATER LEVEL: | | | |
| 00 | 'f011grshw003.bot' | 1.40 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 01 | 'f011grshw003.bot' | 2.81 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 02 | 'f011grshw003.bot' | 5.62 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 03 | 'f011grshw003.bot' | 11.2 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 04 | 'f011grshw003.bot' | 22.5 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 05 | 'f011grshw003.bot' | 45 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 06 | 'f011grshw003.bot' | 90 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 07 | 'f011grshw003.bot' | 180 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 08 | 'f011grshw003.bot' | 360 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |
| 09 | 'f011grshw003.bot' | 720 | $U_{10}$: 30 m/s | $\theta_w$: 0° | _ | _ | | | |

## References

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