

Implementing TheoryWaves as a CESM Component

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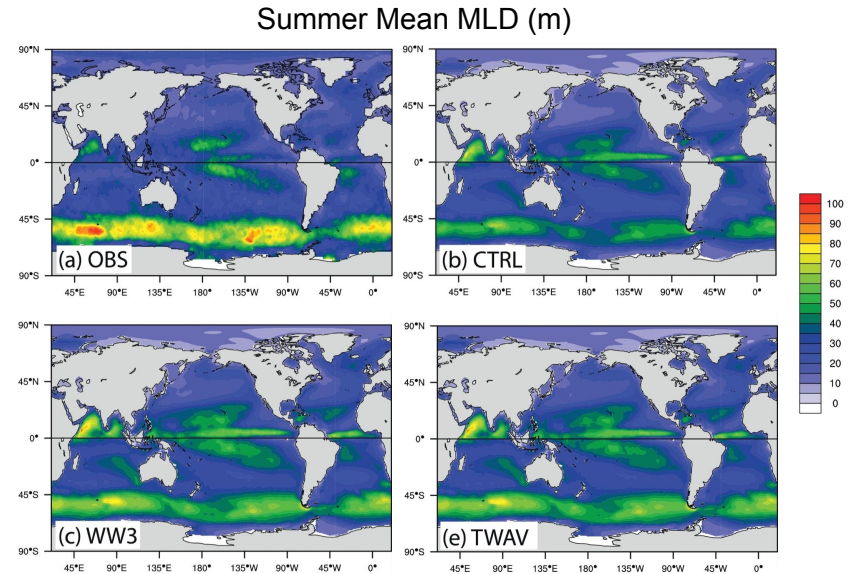
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Theory Waves

Theory Waves (Li et al, 2016, 2017)

- Approximation of Langmuir turbulence enhancement factor (ε) based on Stokes drift profile from an empirical wave spectrum
- Reproduces much of the effect of Langmuir mixing at a fraction of the computational cost of prognostic wave models
- Wind-sea only (no swell)
- Input: U_{10} , τ_a , and H_{BL}
- Output: ε , u_{SL}^s , La_{SL} , v^s , k_{Phill} , h_{mo} , f_p , f_m



Li et al. (2017)

Li, Q., Fox-Kemper, B., Breivik, Ø., Webb, A., 2017. Statistical models of global Langmuir mixing. Ocean Model. 113, 95-114.

Theory Waves

$$u_0^S \approx 0.016U_{10},$$

$$V^S \approx 2.67 \times 10^{-5} gU_{10}^3,$$

$$k_p \approx 0.176 \frac{u_0^S}{V^S},$$

$$k_p^* = 2.56k_p,$$

$$H_{SL} = H_{BL}/5,$$

$$T_1(k, z) = e^{2kz},$$

$$T_2(k, z) = \sqrt{2\pi k|z|} \operatorname{erfc}\left(\sqrt{2k|z|}\right),$$

$$u_{SL}^S \approx u_0^S \left\{ 0.715 + \left(\frac{0.151}{k_p H_{SL}} - 0.840 \right) [1 - T_1(k_p, H_{SL})] - \left(0.840 + \frac{0.0591}{k_p H_{SL}} \right) T_2(k_p, H_{SL}) + \left(\frac{0.0632}{k_p^* H_{SL}} + 0.125 \right) [1 - T_1(k_p^*, H_{SL})] + \left(0.125 + \frac{0.0946}{k_p^* H_{SL}} \right) T_2(k_p^*, H_{SL}) \right\},$$

$$La_{SL} = \sqrt{\frac{u^*}{u_{SL}^S}},$$

$$\mathcal{E} = \sqrt{1 + (1.5La_{SL})^{-2} + (5.4La_{SL})^{-4}}.$$

Li, Q., Fox-Kemper, B., Breivik, Ø., Webb, A., 2017. Statistical models of global Langmuir mixing. *Ocean Model.* 113, 95-114.

Theory Waves

Current status:

- Implemented locally as a drop-in replacement for WaveWatch III using cesm2_3_alpha17a
 - main_0.0.13 tag of WW3_interface
 - dev/unified_0.0.10 tag of WW3
- Works with with WD compsets (GMOM_JRA_WD)
- Works with TL319_t061_wt061 grid

Theory Waves

Goals:

Short-term:

Have TheoryWaves available for use with CMIP7 (CESM3.0? CESM3.1?)

Long-term:

Fully interchangeable wave model components (TheoryWaves, WW3, PiCLES)

- standardize output from wave models through NUOPC

Theory Waves

Questions:

Short-term:

- Which CESM release to target for TheoryWaves?
- What release tags should be targeted to insure compatibility?
- What are the requirements for addition to CESM?
 - compsets / grids
 - testing required?
 - test scenarios (1 JRA cycle? No waves vs. WW3 vs. TheoryWaves?)
 - what parameters should be used for evaluation?
- What should the process be (steps, timeline) for making TheoryWaves available?