

Supplementary material for

## **A revised ocean mixed layer model for better simulating the diurnal variation of ocean skin temperature**

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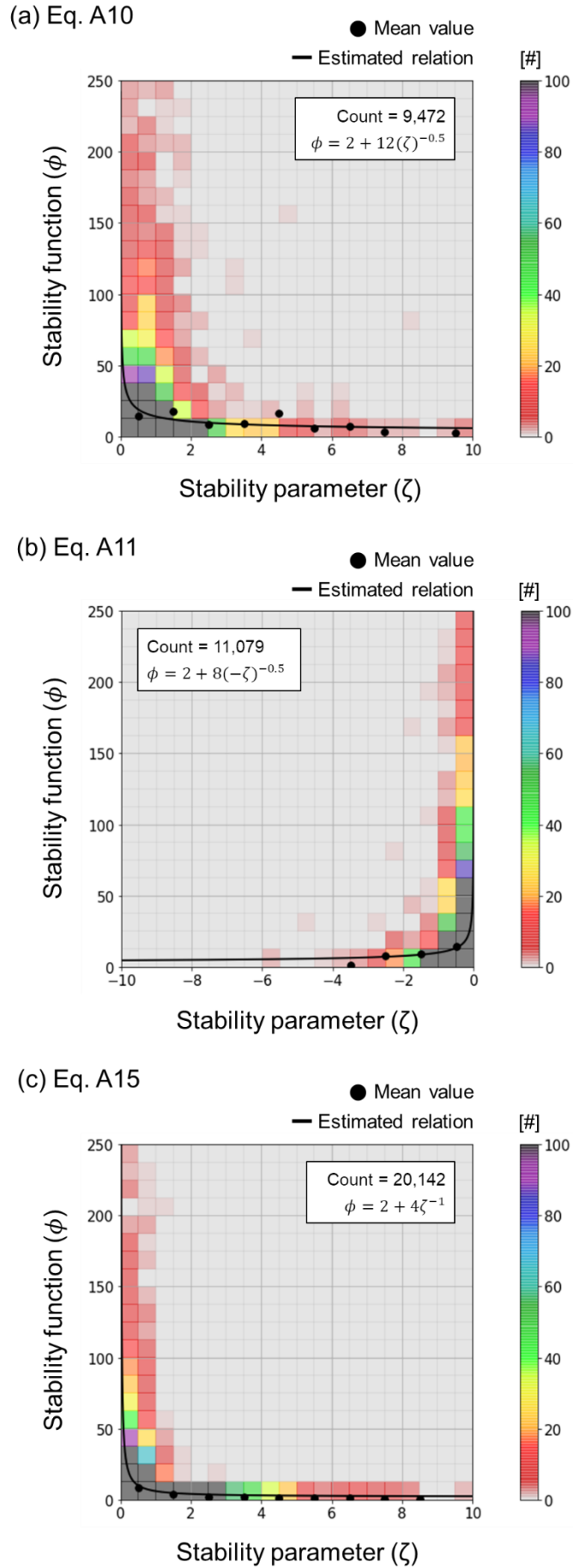
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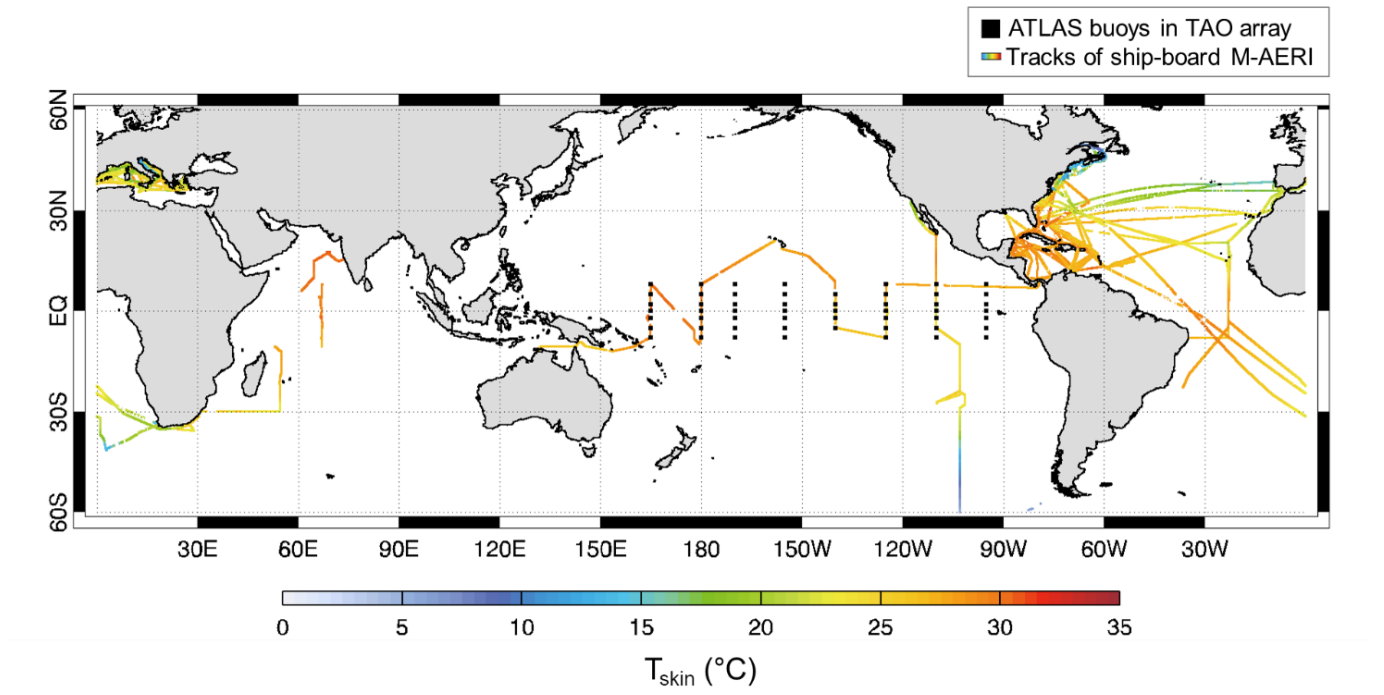
Tables S1 to S3

### **Additional supplementary material (Files uploaded separately)**

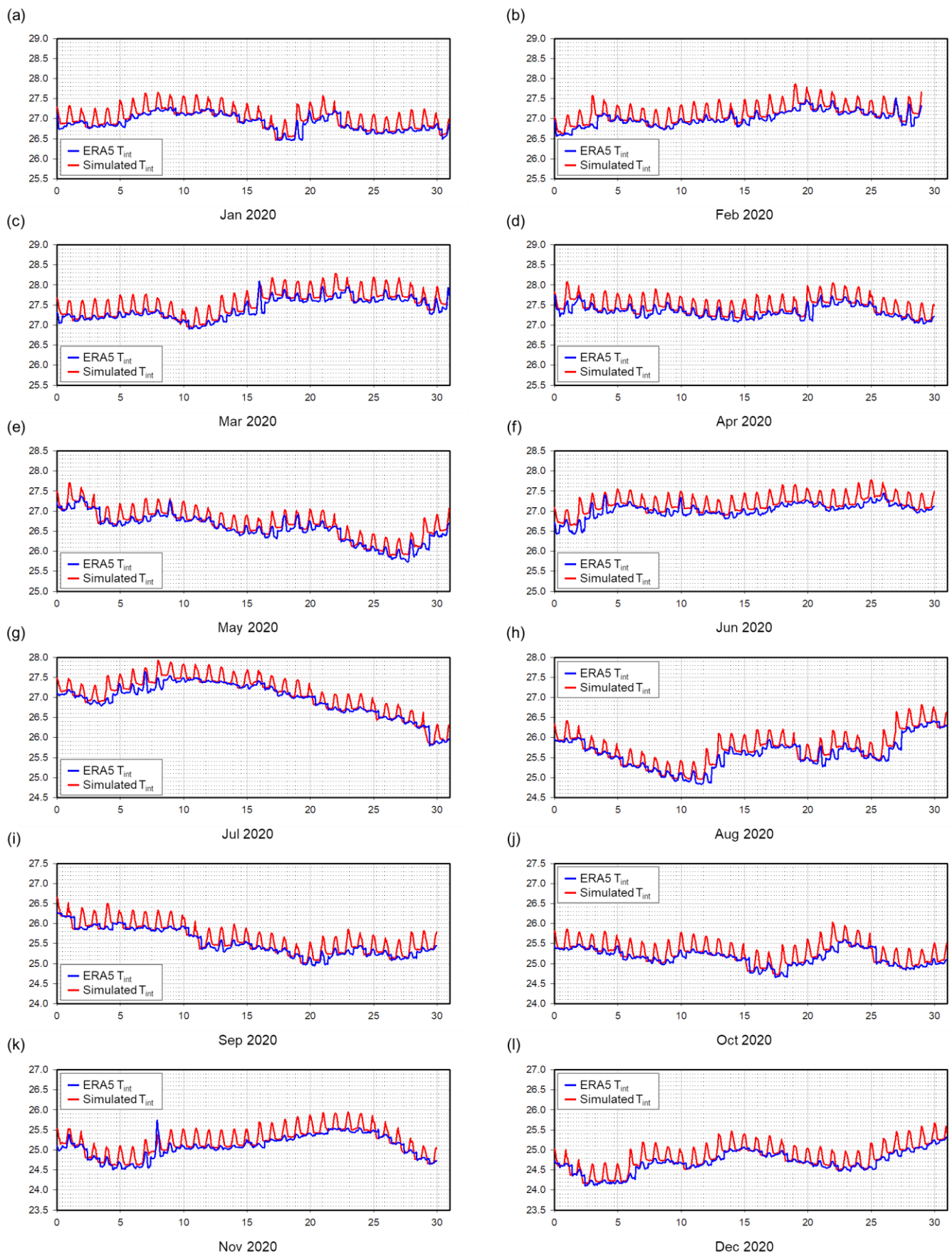
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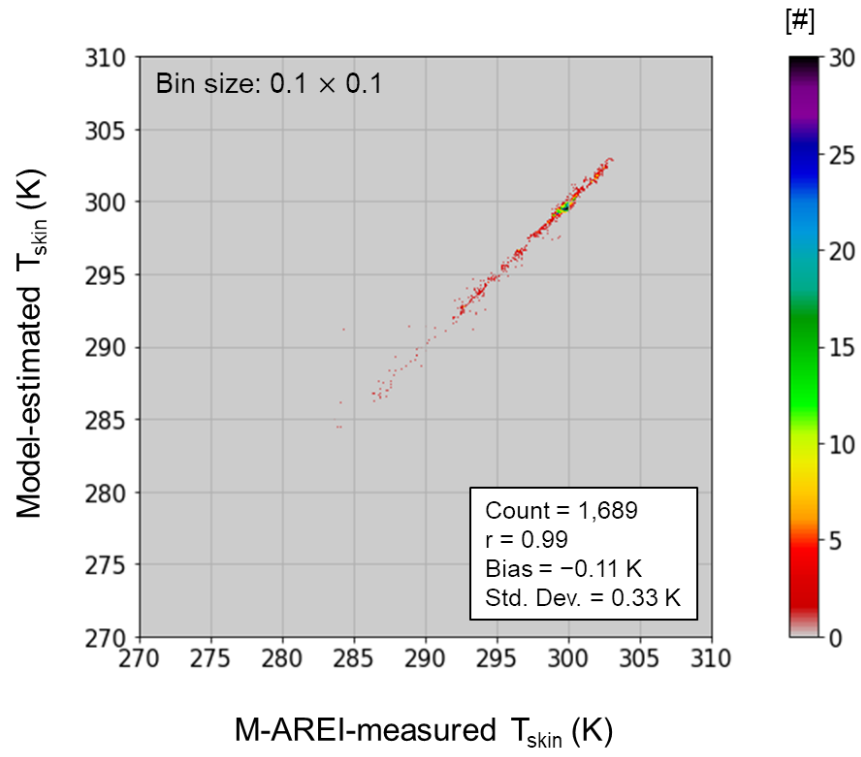
**Figure S1.** Scatterplots of stability functions ( $\Phi$ ) vs stability parameters ( $\zeta$ ), derived from ATLAS buoy measurements at  $0^\circ$  and  $140^\circ\text{W}$  in the period from 2001 to 2020. The color scale represents the data frequency. Mean values of stability function are given with black dots, and obtained  $\Phi$ - $\zeta$  relations are given with black solid lines. Panels (a), (b), and (c) correspond to Equations A10, A11, and A15, respectively.



**Figure S2.** ATLAS mooring buoy locations given with black squares in the tropical Pacific and ship tracks equipped with M-AERI instrument depicted with solid color lines.



**Figure S3.** Time series of  $T_{int}$  obtained from the revised OBL model (red) and from ERA5 (blue) at ( $0^\circ$ ,  $155^\circ\text{W}$ ) for January to December of 2020.



**Figure S4.** Model-estimated  $T_{\text{int}}$  with a scaling factor of 0.2 applied to the Saunders constant, based on the use of total 1,689 M-AREI measurements in the year 2020. The color scale is the data frequency. The ‘ $r$ ’, Bias, Std. Dev. denote correlation coefficient, mean deviation, and one standard deviation, respectively.

**Table S1.** Detailed information about the cruises/vessels equipped with the M-AREI.

#	Year	Ship	Region	Start date	End date
1	2013	Knorr (RV)	Atlantic Ocean	Feb 13	Feb 28
2	2013	Ronald H. Brown (RV)	North Atlantic Ocean	Nov 11	Dec 8
3	2014	Celebrity Equinox	Caribbean Sea	May 9	Jun 20
4	2014	Allure of the Seas.	Caribbean Sea	Aug 24	Dec 31
5	2014	Celebrity Equinox	Caribbean Sea	Nov 16	Dec 31
6	2015	Allure of the Seas.	Caribbean Sea North Atlantic Ocean Mediterranean Sea	Jan 1	Nov 29
7	2015	Celebrity Equinox	Caribbean Sea	Jan 1	Dec 26
8	2015	Minerva Uno (RV)	Regional	Mar 27	Apr 13
9	2015	Alliance (RV)	North Atlantic Ocean	Nov 17	Dec 14
10	2016	Celebrity Equinox	Caribbean Sea North Atlantic Ocean Mediterranean Sea	Jan 2	Dec 31
11	2016	Ronald H. Brown (R/V)	Pacific	Nov 7	Mar 19
12	2017	Celebrity Equinox	Caribbean Sea	Jan 1	Dec 31
13	2017	Allure of the Seas	Caribbean Sea	Oct 2	Nov 26
14	2017	Minerva Uno (R/V)	Regional	May 25	Jun 11
15	2018	Celebrity Equinox	Caribbean Sea	Jan 11	Sep 23
16	2018	Adventure of the Seas	Caribbean Sea US East Coast	Feb 12	Dec 31
17	2018	Allure of the Seas	Caribbean Sea	Feb 18	Oct 14
18	2018	Ronald H. Brown (R/V)	Global	Mar 7	Oct 23
19	2019	Adventure of the Seas	Caribbean Sea US East Coast	Jan 1	Oct 30
20	2019	Ronald H. Brown (R/V)	North Atlantic Ocean	Feb 24	Mar 29
21	2019	Ronald H. Brown (R/V)	US East Coast	May 7	May 31
22	2019	Ronald H. Brown (R/V)	US East Coast	Apr 8	Apr 30
23	2020	Ronald H. Brown (R/V)	Caribbean Sea	Jan 6	Feb 13
24	2020	Ronald H. Brown (R/V)	Caribbean Sea Atlantic Ocean	Feb 21	Apr 17

Knorr: Woods Hole Oceanographic Institution (WHOI) research vessel (RV)

Ronald H. Brown: National Oceanic and Atmospheric Administration (NOAA) research vessel (RV)

Minerva Uno: Italy Alpine Ocean Seismic Survey Inc. research vessel (RV)

Alliance: North Atlantic Treaty Organization (NATO) research vessel (RV)

Celebrity Equinox: Royal Caribbean International (RCI) cruise ship

Allure of the Seas: Royal Caribbean International (RCI) cruise ship

Adventure of the Seas: Royal Caribbean International (RCI) cruise ship

**Table S2.** Locations of used buoys in the TAO array

#	Location	#	Location	#	Location
1	0° 110°W	19	2°S 140°W	37	5°S 165°E
2	0° 125°W	20	2°S 155°W	38	5°S 170°W
3	0° 140°W	21	2°S 165°E	39	5°S 180°
4	0° 155°W	22	2°S 170°W	40	5°S 95°W
5	0° 165°E	23	2°S 180°	41	8°N 110°W
6	0° 170°W	24	2°S 95°W	42	8°N 125°W
7	0° 180°	25	5°N 110°W	43	8°N 155°W
8	0° 95°W	26	5°N 125°W	44	8°N 165°E
9	2°N 110°W	27	5°N 140°W	45	8°N 170°W
10	2°N 125°W	28	5°N 155°W	46	8°N 180°
11	2°N 140°W	29	5°N 165°E	47	8°N 95°W
12	2°N 155°W	30	5°N 170°W	48	8°S 110°W
13	2°N 165°E	31	5°N 180°	49	8°S 125°W
14	2°N 170°W	32	5°N 95°W	50	8°S 155°W
15	2°N 180°	33	5°S 110°W	51	8°S 165°E
16	2°N 95°W	34	5°S 125°W	52	8°S 170°W
17	2°S 110°W	35	5°S 140°W	53	8°S 180°
18	2°S 125°W	36	5°S 155°W	54	8°S 95°W

**Table S3.** Symbols, descriptions, values, and units of prescribed parameters used in the revised OBL model

Symbol	Description	Value	Unit
$g$	acceleration of gravity	9.8	$\text{m s}^{-2}$
$\rho_w$	density of ocean water	1025.0	$\text{kg m}^{-3}$
$\rho_a$	density of air	1.2	$\text{kg m}^{-3}$
$c_w$	specific heat capacity of water	4190.0	$\text{J kg}^{-1} \text{K}^{-1}$
$k_w$	thermal conductivity of water	0.6	$\text{W m}^{-1} \text{K}^{-1}$
$\nu_w$	kinematic viscosity of water	$1 \times 10^{-6}$	$\text{m}^2 \text{s}^{-1}$
$k$	Von Karman's constant	0.4	-
$v$	shape parameter of warm layer temperature profile	0.3	-
$d$	depth of warm layer	5	m
$\Delta t$	integration time	3600	sec