

Supplementary Material

Table S1. Scales, air-sea heat flux amplitude, and target 10–20% uncertainty for each air-sea interaction phenomena shown in Figure 2. Citations for each are listed.

Air-Sea Interaction Phenomena	Horizontal scale (km)	Temporal scale	Amplitude of heat flux in W m^{-2}	10–20% target heat flux error in W m^{-2}	Citations
Cumulus	1-10	0.5–2 hr	$Q_{sen}+Q_{lat}$: 50–90	10	Yokoi et al. (2014)
Atmospheric mesoscale convective system	$1-10^3$	1 hr–1 day	$Q_{sen}+Q_{lat}$: 200	30	Chuda et al. (2008)
Diurnal cycle	.01 - 10^3	24 hr	600	100	Cronin and McPhaden (1999)
Tropical cyclones & hurricanes	$10 - 10^3$	1 hr–5 days	1200		Jacob et al. (2000) Potter et al. (2014)
Extratropical cyclones & storms	$10 - 10^4$	1 hr–7 days	~1000	100	Tilinina et al. (2018)
Mesoscale & shorter scale physical-biological interaction	$10 - 50$	1–5 days	30 ~200	5–30	Villas Bôas et al. (2015)
Shelf air-sea interaction processes, cold air outbreaks	$10-50$	6 hr–3 days	300–1000	30	Grossman and Betts (1990) Morey et al. (2009)
Ice margin	1-10	1 hr–1 day	100–500	50–100	Yu et al. (2017) Renfrew and Moore (1999)
Marine heat waves	$100 - 5000$	5 days–2 yr	20	4	Hobday et al. (2018) Bond et al. (2015)
Boundary currents, ocean fronts & eddies		daily–6 monthly	cross-front: 200 cross-eddy: 120	30	Tomita et al. (2018) Bishop et al. (2017) Shi (2017)
Intraseasonal oscillation (e.g. Madden-Julian Oscillation)	$10^3 - 10^4$	10–100 days	70–150	10	Shinoda et al. (1998) Fu and Wang (2004)
Monsoon	$10^3 - 10^4$	5 days–1 yr	150	20	Kawamura et al. (2002)
El Niño–Southern Oscillation	$500 - 4 \times 10^4$ (all basins)	0.5–6 yr	50	10	Wang and McPhaden (2000)
Anthropogenic global warming	$10^4 - 14 \times 10^4$	10–100 yr	0.4	0.1	Levitus et al. (2012)