SI Appendix. Supporting Information.

Table S1. Candidates for high-probability high-impact tipping points and tipping elements.

Area/tipping element	**Driver**	**Physical-biogeochemical variables affected**	**Hazards concerning:**	**Referen-ces and examples**
Coastal acidification	C_{anthro}, $\mathbf{v_{ocean}}$	DIC, pH, $\Omega_{calcite}$, $\Omega_{aragonite}$	Coastal ecosystem functioning, key species, marine living resources	(1, 2)
Coastal deoxygenation	ΔT, $\mathbf{v_{ocean}}$	O_2	Coastal ecosystem functioning, key species, marine living resources, further eutrophication, harmful algae blooms	(3, 4)
Open ocean deoxygenation	ΔT, $\mathbf{v_{ocean}}$	O_2	Marine living resources	(5-7)
Arctic sea ice reduction	ΔT, $\mathbf{v_{ocean}}$	Light availability, biological primary production, T	Shift in ecosystem intensification away from coast, warming, invasive species, species loss, marine living resources	(8, 9)
Marine permafrost thaw	ΔT, $\mathbf{v_{ocean}}$	DIC, pH, $\Omega_{calcite}$, $\Omega_{aragonite,}$	CH_4 outgassing, increase in ocean dissolved carbon, less ocean CO_2 uptake, atmospheric CO_2	(10)
Polar acidification	C_{anthro}	DIC, pH, $\Omega_{calcite}$, $\Omega_{aragonite}$	Ecosystem functioning, key species, marine living resources	(11, 12)
Warm water coral reef degradation	ΔT, C_{anthro}	pH, T	Coral bleaching, ecosystem functioning, species loss, coastal erosion, key species, marine living resources	(13, 14)
Large-scale ocean circulation changes (deep convection, upwelling, overturning)	ΔT, ΔS	DIC, Alk, pH, $\Omega_{calcite}$, $\Omega_{aragonite}$, O_2, T, S, nutrients, biological primary production	Ecosystem functioning, ocean CO_2 uptake, heat accumulation, pH change accumulation	(15-17)
El Niño and Monsoon alterations	ΔT, ΔS, $\mathbf{v_{ocean}}$	DIC, Alk, pH, $\Omega_{calcite}$, $\Omega_{aragonite}$, O_2, T, S, nutrients, biological primary production	Ecosystem functioning, marine living resources, ocean CO_2 uptake, heat accumulation, accumulation of pH changes	(18-20)
Open ocean warming and marine heat waves	ΔT	T, biological primary production	Ecosystem functioning, marine living resources, ocean CO_2 uptake, heat accumulation	(21-23)
Open Ocean acidification	C_{anthro}, $\mathbf{v_{ocean}}$	DIC, pH, $\Omega_{calcite}$, $\Omega_{aragonite}$	Ecosystem functioning, key species, marine living resources, deep-sea ecosystems	(24-26)

See following pages for explanation of symbols and references.

Explanation of symbols:
$\mathbf{v_{ocean}}$: ocean velocity field
C_{anthro}: additional ocean carbon from uptake of atmospheric excess CO_2
T: seawater temperature
ΔT: temperature change
S: salinity
ΔS: salinity change due to change in fresh water fluxes including ice melt
DIC: total dissolved inorganic carbon
Alk: alkalinity (ability of sea water to dissociate CO_2)
pH: ph-value, $pH=-\log_{10}([H^+])$.
$\Omega_{calcite}$: saturation state for calcite ($CaCO_3$), the boundary between over- and undersaturation is at $\Omega_{calcite}=1$
$\Omega_{aragonite}$: saturation state for aragonite ($CaCO_3$), the boundary between over- and undersaturation is at $\Omega_{aragonite}=1$
O_2: dissolved oxygen

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