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Limits and CO_2 equilibration of near-coast alkalinity enhancement

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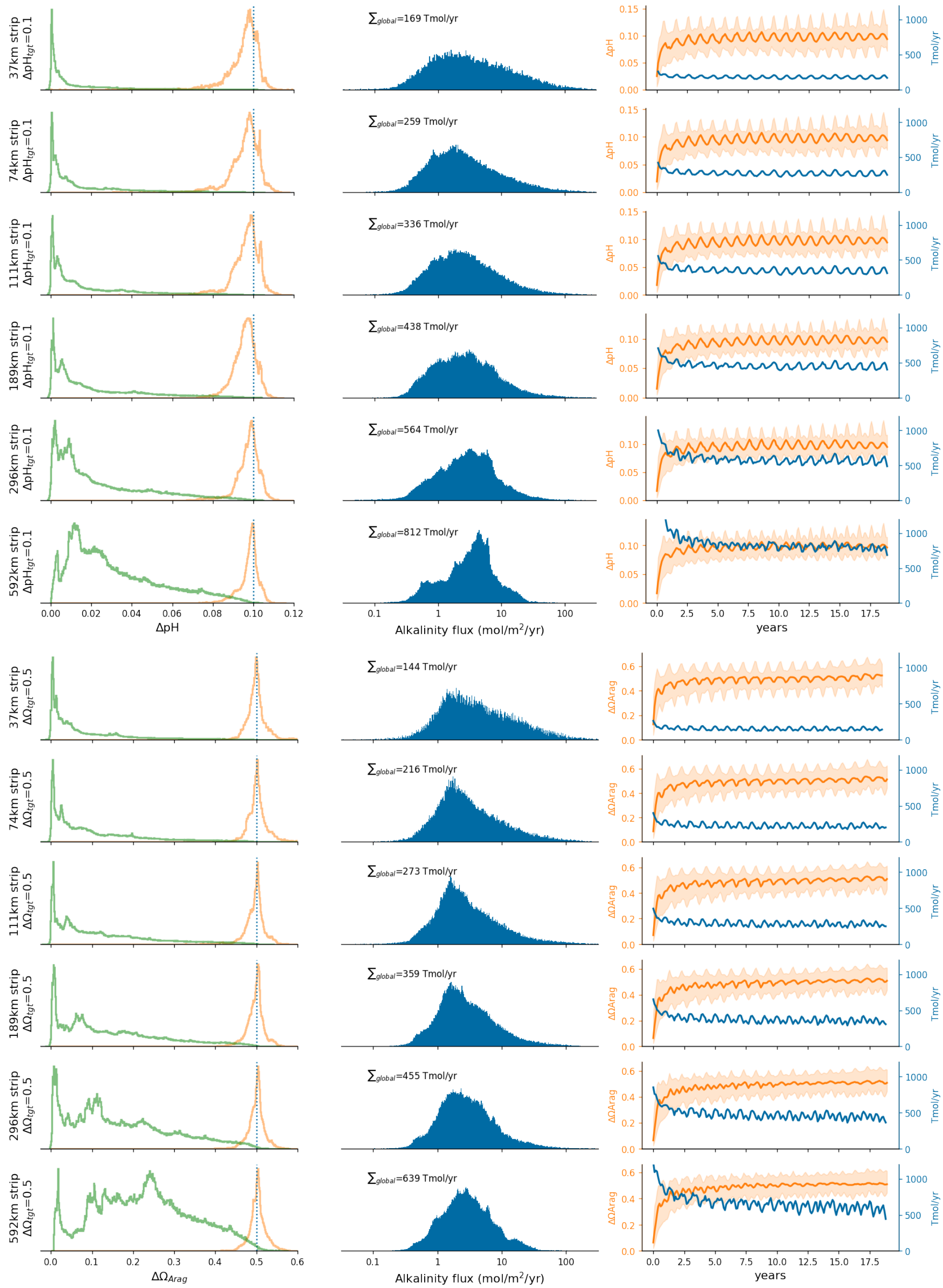


Figure S1. The left column shows normalized histograms of the annually averaged ΔpH or $\Delta\Omega_{Arag}$ over all grid points in the injection strip (orange) or outside the strip (green). The dotted vertical line indicates the respective target constraint. The middle column shows the distribution of the sustained alkalinity flux in the injection grid points. Note the x-axis is log-scaled, showing that injection flux spans >2 orders of magnitude. The total global injection rate is shown above the histogram. The right column shows the total global alkalinity addition rate (summed over all grid points in the coastal strip) in blue and median pH change from the reference simulation (exclusively over grid points in the strip) in orange. The shading shows the 10th and 90th percentile range. The addition rate and pH change stabilize after 5 years.

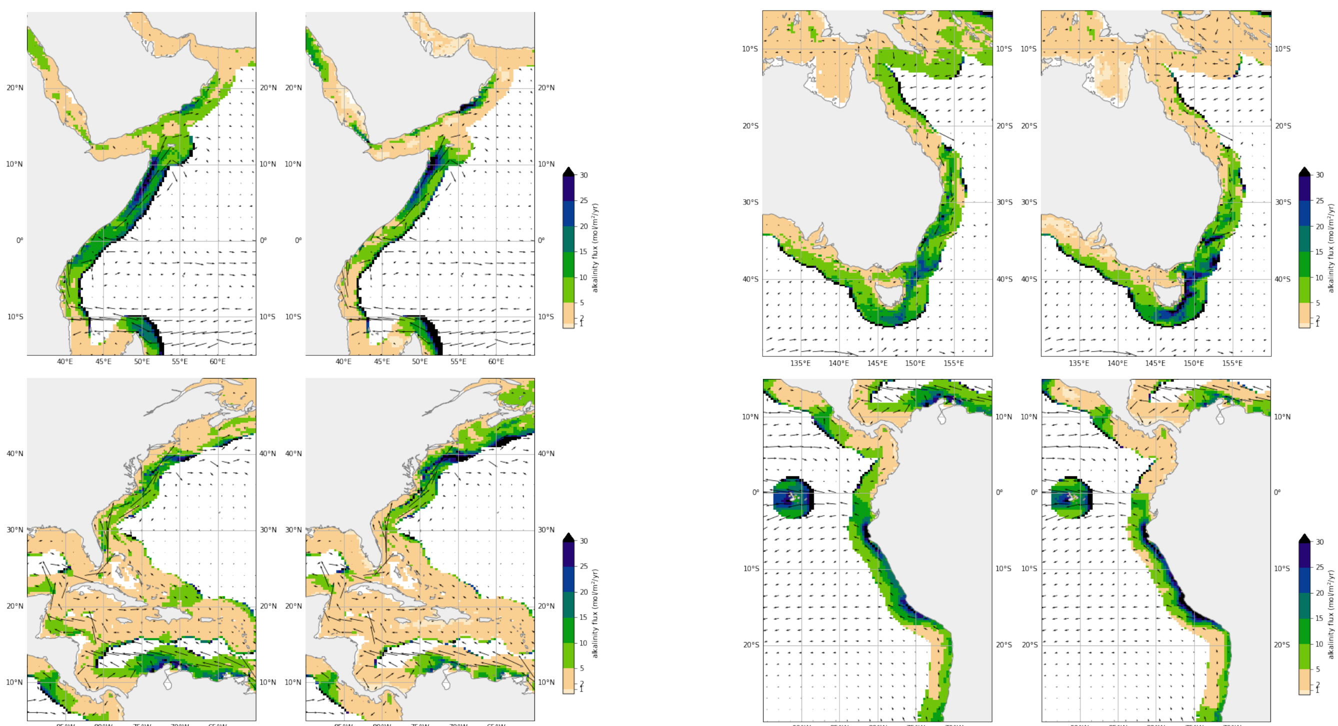


Figure S2. Comparison of injection patterns using a pH contraint ΔpH_{tgt}=0.1 (left) or a carbonate saturation constraint $\Delta\Omega_{tgt}$=0.5 (right) for four different regions.

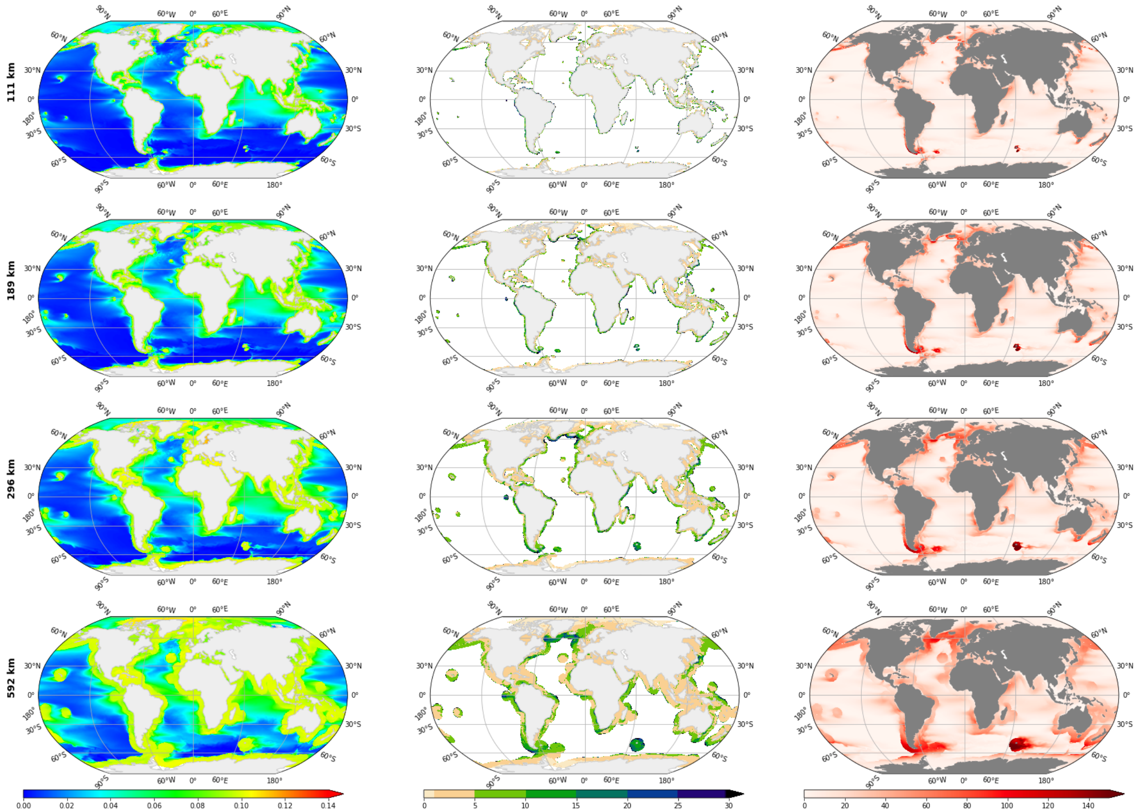
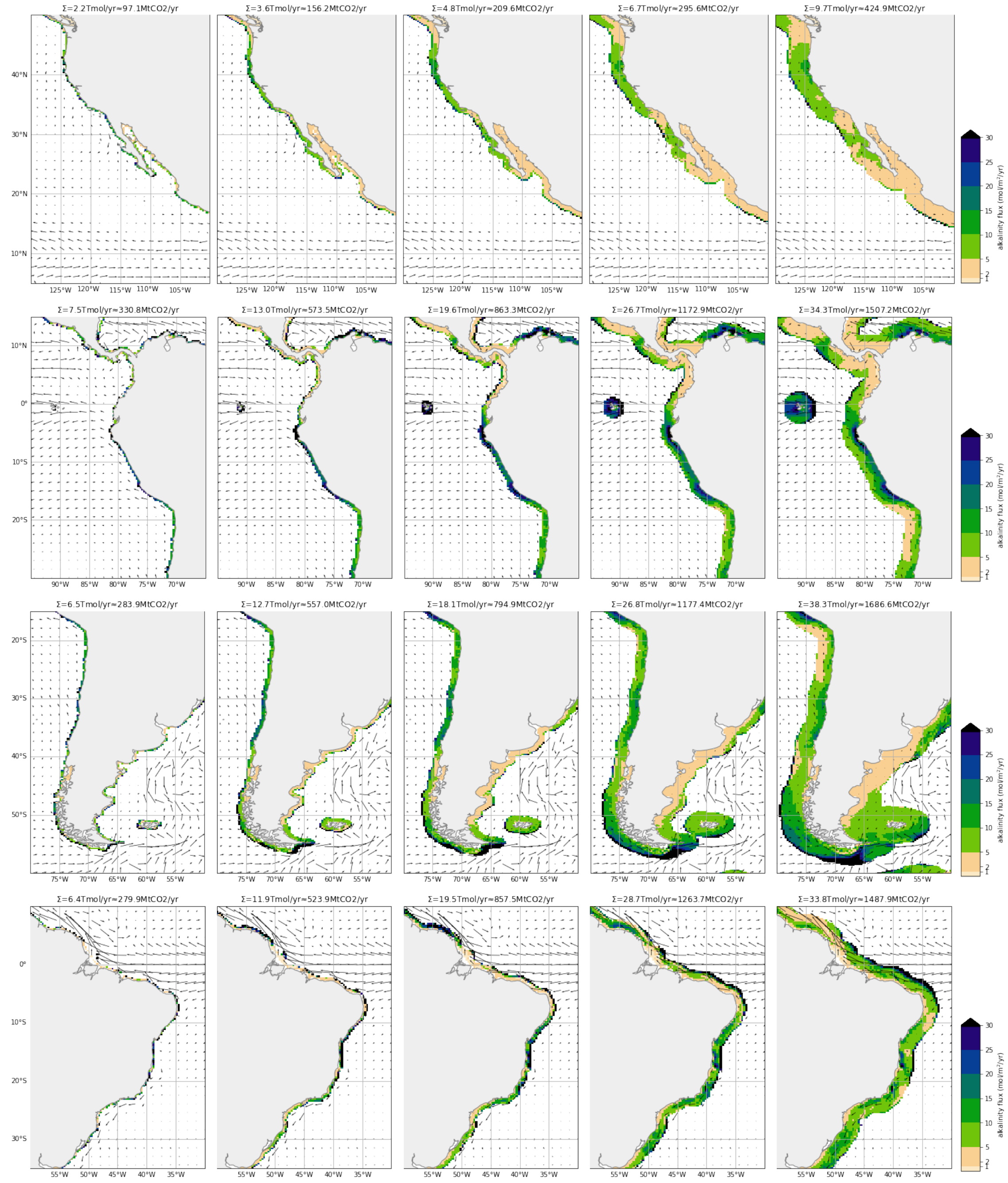
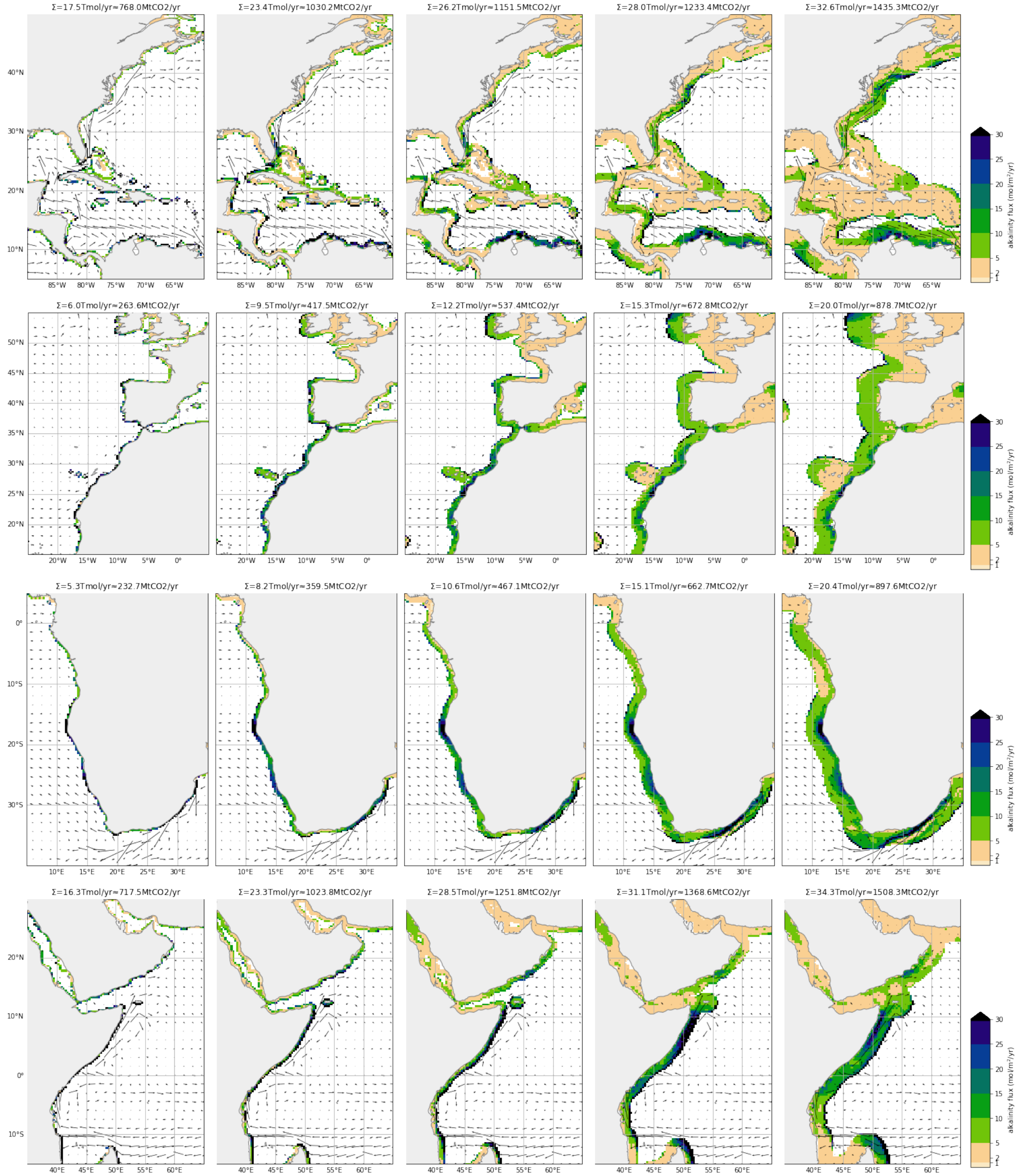


Figure S3. Mean pH change (left column) and alkalinity addition rate (middle column) for different strip widths. The pH change and alkalinity addition rate is averaged from years 5-20 in the simulation. Strip widths of 37 km and 74 km are not shown since they are too thin to see clearly in the global figures. Right columnn shows change in mean CO2 flux relative to the reference simulation.


Σ=2.2Tmol/yr≈97.1MtCO2/yr
Σ=3.6Tmol/yr≈156.2MtCO2/yr
Σ=4.8Tmol/yr≈209.6MtCO2/yr
Σ=6.7Tmol/yr≈295.6MtCO2/yr
Σ=9.7Tmol/yr≈424.9MtCO2/yr
Σ=7.5Tmol/yr≈330.8MtCO2/yr
Σ=13.0Tmol/yr≈573.5MtCO2/yr
Σ=19.6Tmol/yr≈863.3MtCO2/yr
Σ=26.7Tmol/yr≈1172.9MtCO2/yr
Σ=34.3Tmol/yr≈1507.2MtCO2/yr
Σ=6.5Tmol/yr≈283.9MtCO2/yr
Σ=12.7Tmol/yr≈557.0MtCO2/yr
Σ=18.1Tmol/yr≈794.9MtCO2/yr
Σ=26.8Tmol/yr≈1177.4MtCO2/yr
Σ=38.3Tmol/yr≈1686.6MtCO2/yr
Σ=6.4Tmol/yr≈279.9MtCO2/yr
Σ=11.9Tmol/yr≈523.9MtCO2/yr
Σ=19.5Tmol/yr≈857.5MtCO2/yr
Σ=28.7Tmol/yr≈1263.7MtCO2/yr
Σ=33.8Tmol/yr≈1487.9MtCO2/yr
alkalinity flux (mol/m²/yr)



Σ=17.5Tmol/yr≈768.0MtCO2/yr
Σ=23.4Tmol/yr≈1030.2MtCO2/yr
Σ=26.2Tmol/yr≈1151.5MtCO2/yr
Σ=28.0Tmol/yr≈1233.4MtCO2/yr
Σ=32.6Tmol/yr≈1435.3MtCO2/yr
Σ=6.0Tmol/yr≈263.6MtCO2/yr
Σ=9.5Tmol/yr≈417.5MtCO2/yr
Σ=12.2Tmol/yr≈537.4MtCO2/yr
Σ=15.3Tmol/yr≈672.8MtCO2/yr
Σ=20.0Tmol/yr≈878.7MtCO2/yr
Σ=5.3Tmol/yr≈232.7MtCO2/yr
Σ=8.2Tmol/yr≈359.5MtCO2/yr
Σ=10.6Tmol/yr≈467.1MtCO2/yr
Σ=15.1Tmol/yr≈662.7MtCO2/yr
Σ=20.4Tmol/yr≈897.6MtCO2/yr
Σ=16.3Tmol/yr≈717.5MtCO2/yr
Σ=23.3Tmol/yr≈1023.8MtCO2/yr
Σ=28.5Tmol/yr≈1251.8MtCO2/yr
Σ=31.1Tmol/yr≈1368.6MtCO2/yr
Σ=34.3Tmol/yr≈1508.3MtCO2/yr
alkalinity flux (mol/m²/yr)

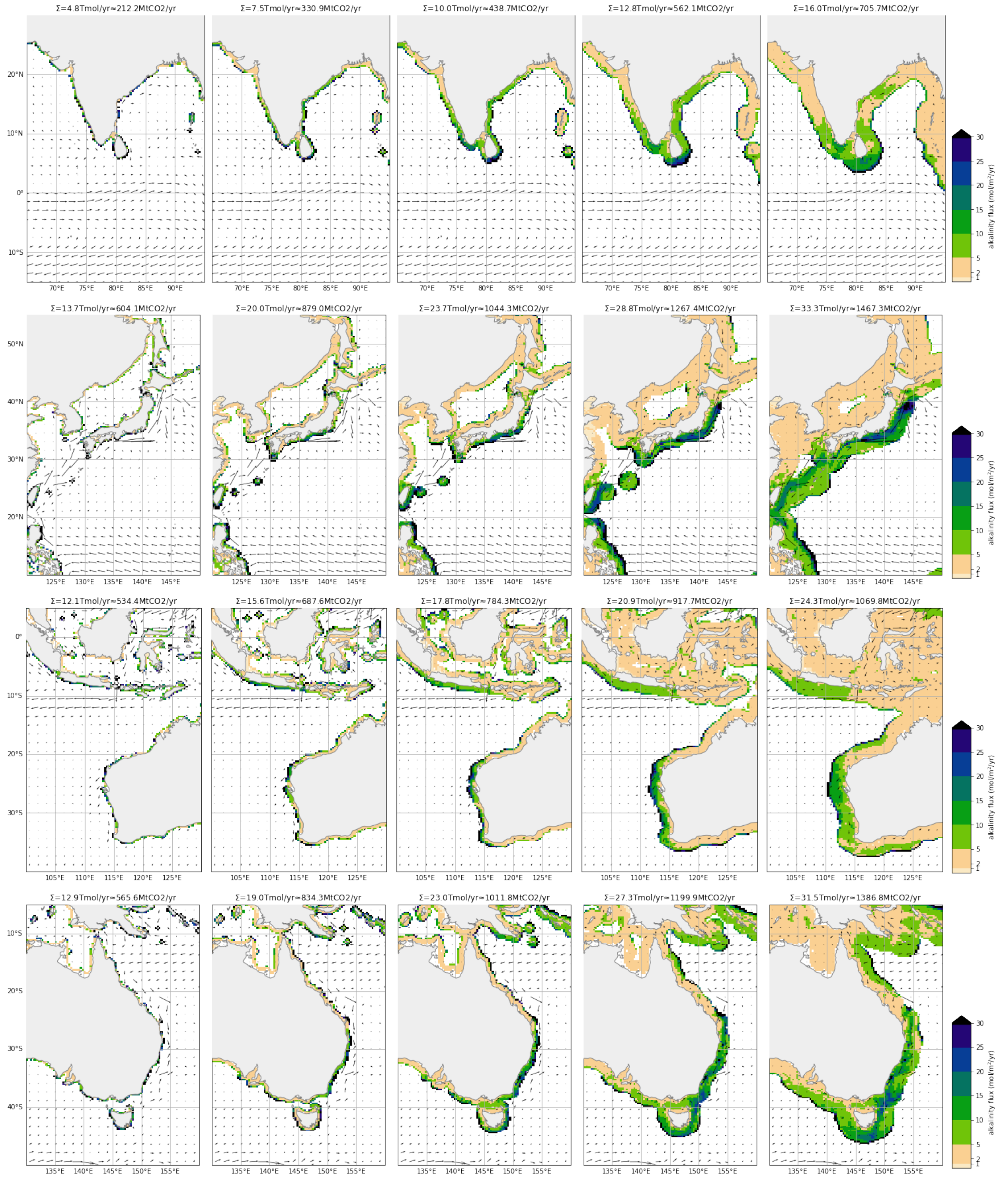
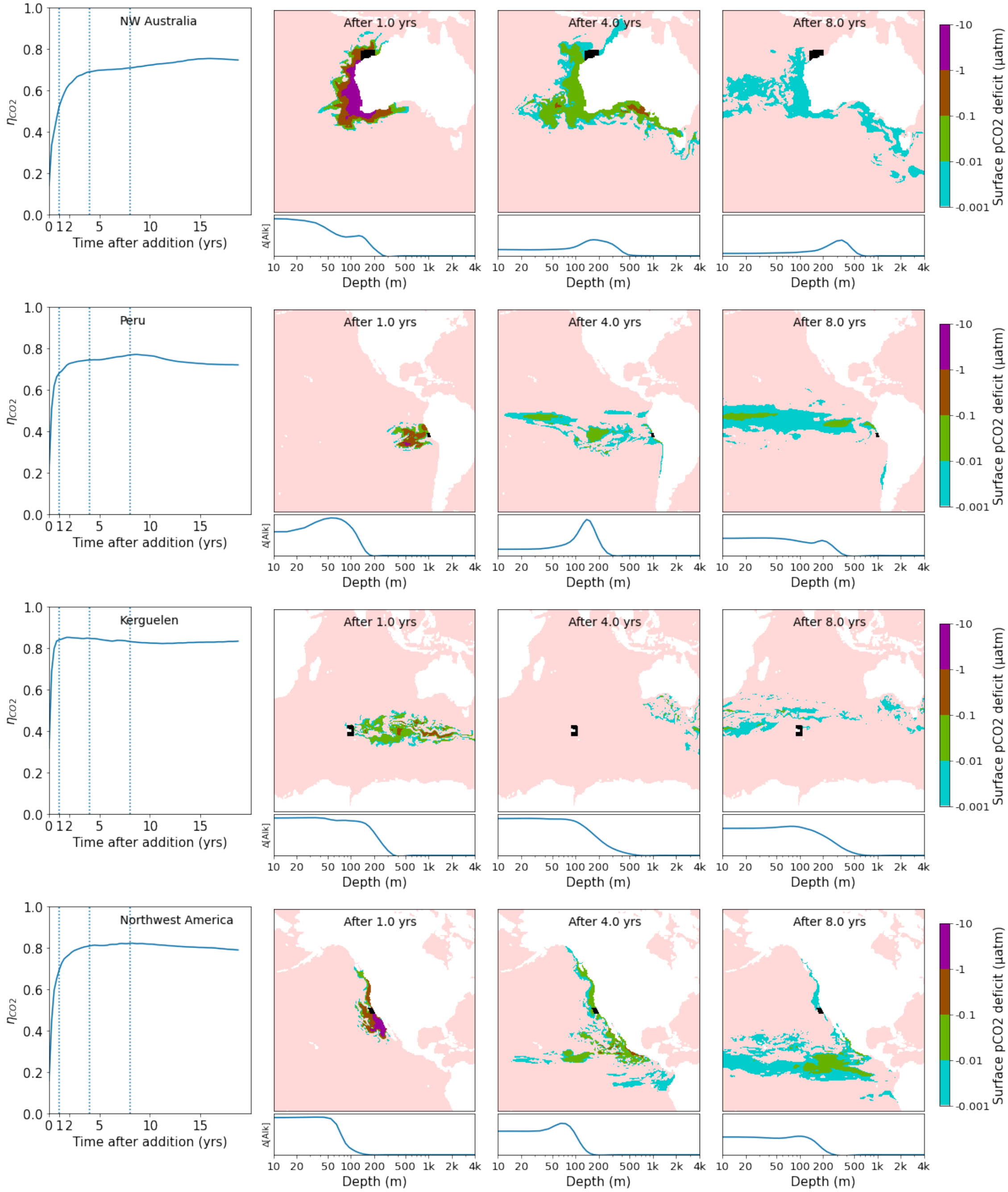
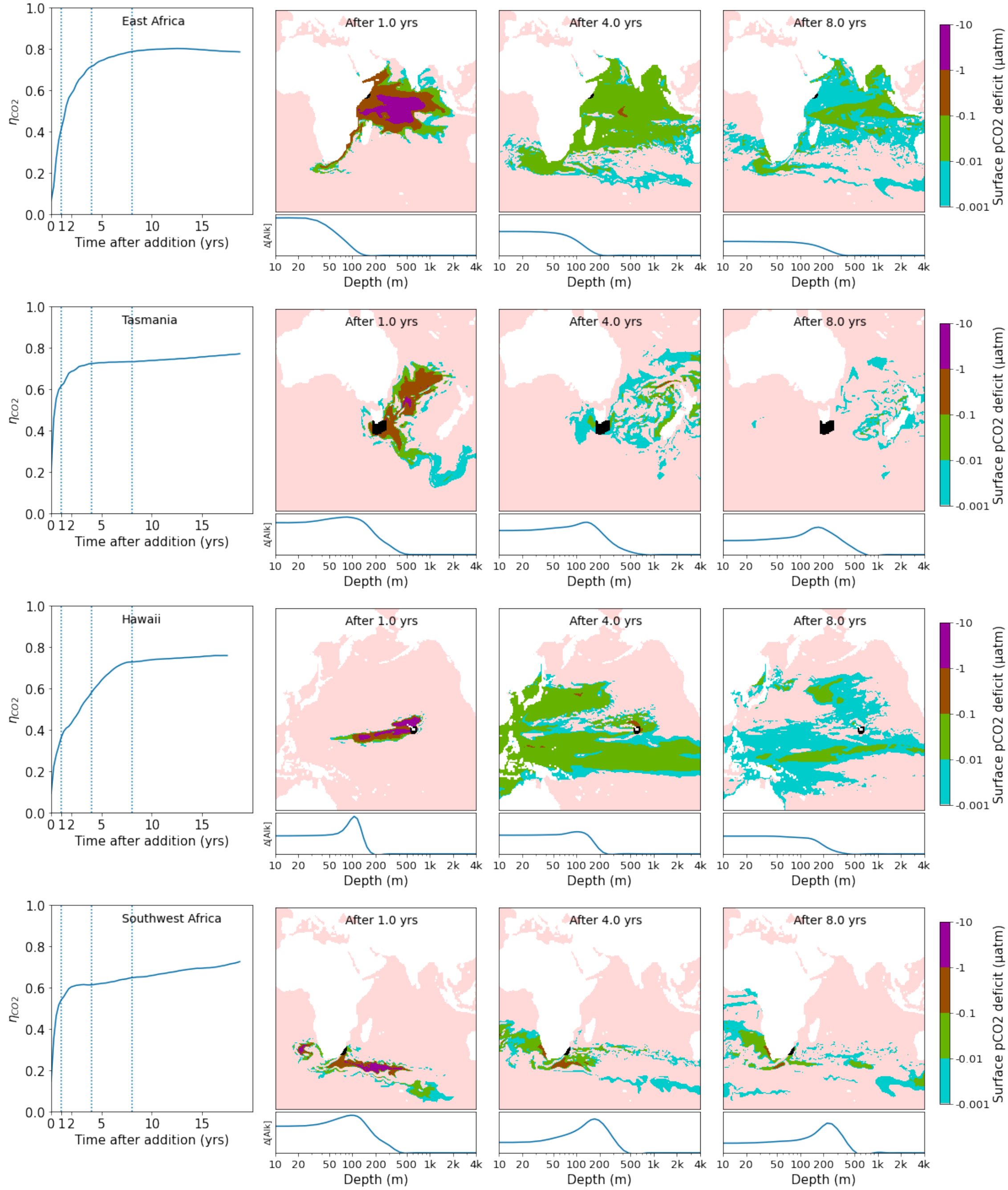


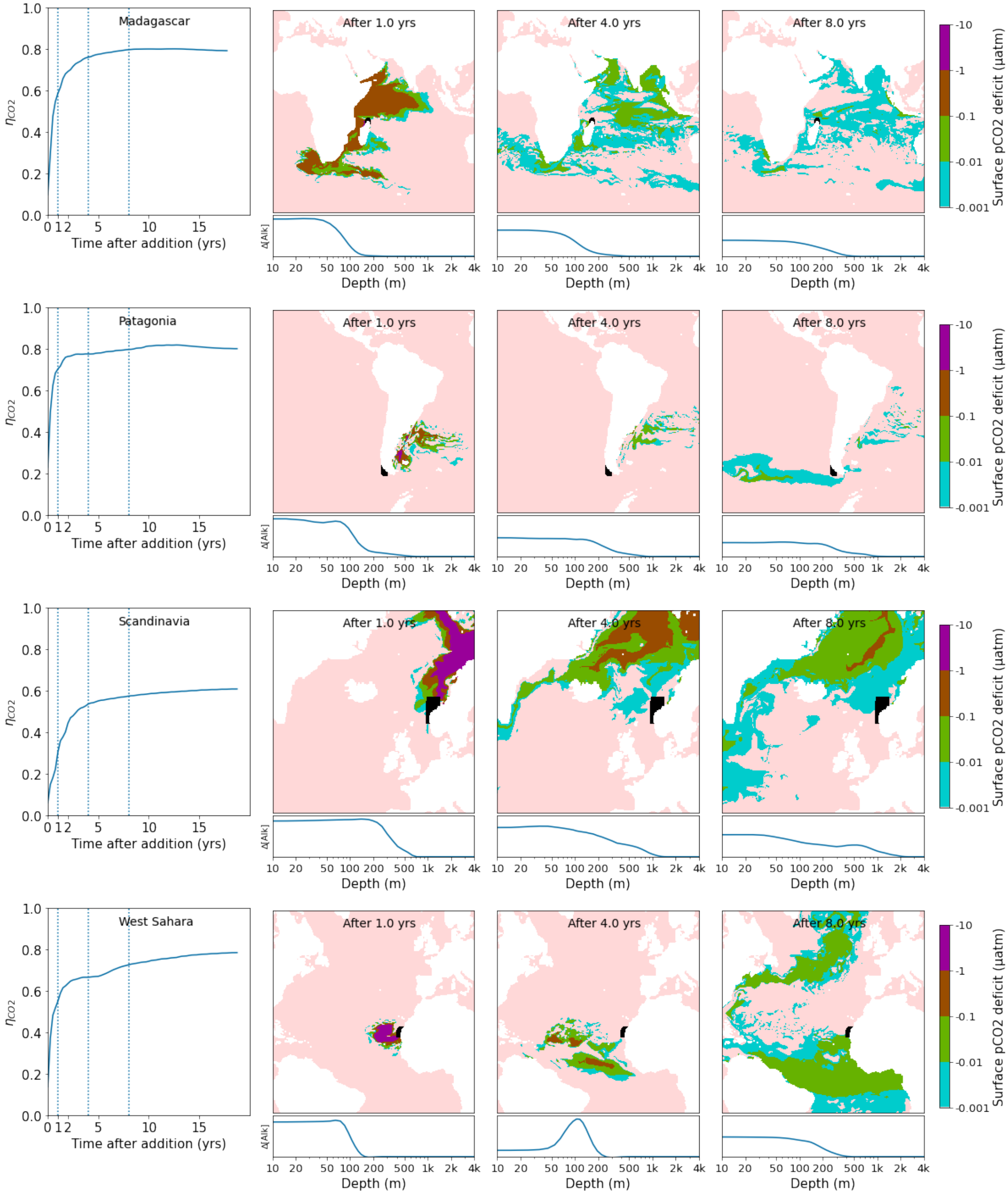
Figure S4. Detailed regional plots showing alkalinity fluxes, spanning the majority of coastlines. The total injection rate (in Tmol/yr) is indicated above each panel. The conversion into approximate negative emissions (in MtCO2/yr) assumes an uptake efficiency of 0.8. The panels cover most major coastlines running top to bottom from the Pacific Northwest down the west coast of the Americas, up the east coast of the Americas, Europe, West coast of africa, East Coast of Africa, India, and finally Japan and Australia.



NW Australia
Peru
Kerguelen
Northwest America
η_{CO2}
Time after addition (yrs)
After 1.0 yrs
After 4.0 yrs
After 8.0 yrs
Δ[Alk]
Depth (m)
Surface pCO2 deficit (µatm)
-10
-1
-0.1
-0.01
-0.001



East Africa
Tasmania
Hawaii
Southwest Africa
η_{CO2}
Time after addition (yrs)
After 1.0 yrs
After 4.0 yrs
After 8.0 yrs
Δ[Alk]
Depth (m)
Surface pCO2 deficit (µatm)
-10
-1
-0.1
-0.01
-0.001


Madagascar
Patagonia
Scandinavia
West Sahara
After 1.0 yrs
After 4.0 yrs
After 8.0 yrs
η_CO2
Time after addition (yrs)
Δ[Alk]
Depth (m)
10 20 50 100 200 500 1k 2k 4k
Surface pCO2 deficit (µatm)
-10
-1
-0.1
-0.01
-0.001

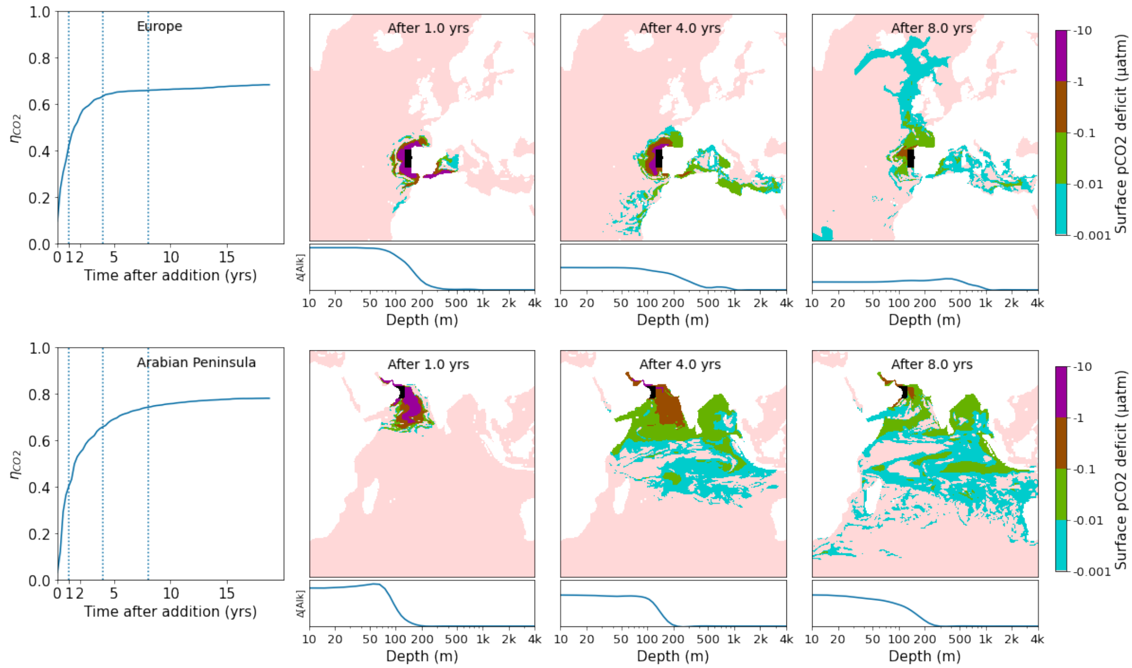


Figure S5. Pulse additions of alkalinity in additional locations. Due to computational contraints only a small number of pulse locations could be explored. The locations were chosen as examples, coarsely distributed along all major coastlines, in order to find and demonstrate the breadth of possible CO2 uptake kinetics.