Governing Emerging Marine Climate Techniques

**Common Governance Challenges include:**
1. Responsibility for implementation, financing and compensation
2. Public interests including concern and informed consent
3. Commercialisation and patenting issues
4. Monitoring and addressing climate impacts
5. Aligning governance frameworks
6. Impact on Sustainable Development Goals

**Specific Governance Challenges include:**
1. Material production is likely to have a very large carbon/energy footprint
2. Effects on coastal communities and fisheries
3. Global constraints to phosphorus supply
4. Uncertainty about environmental impacts
5. Scaling up from laboratory to oceans
6. Resolving sequestration of captured carbon
7. Regional variation in impacts

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**1. Enhanced weathering and ocean alkalisation**
- Adding alkalinity to increase CO₂ uptake, and reduce acidification
- Large-scale farming of macroalgae in near and/or offshore waters, to capture carbon through photosynthesis
- Injecting CO₂ into appropriate host rocks beneath the seabed to react with the minerals there to form stable minerals/rock
- Introducing nutrients (e.g., iron, nitrogen, phosphorus) to surface waters to promote CO₂ uptake through photosynthesis

**2. Macroalgal cultivation for sequestration**
- placing liquid CO₂ in the mid/deep oceans, on the seabed and in sediments
- Seeding and whitening clouds above ocean surfaces, most likely using sea salt spray, to reflect solar radiation back into space.
- Making surfaces brighter to reflect solar radiation. Potential techniques include reflective floating silica spheres; micro bubbles; reflective foam; creating Arctic sea ice; and creating bright calcifying phytoplankton blooms.

**3. Ocean fertilisation**
- Storing carbon by dumping crop residue and other organic material in the deep ocean
- Removing dissolved inorganic carbon from the water to be taken to long term storage sites

**4. Crop residue oceanic carbon sequestration**
- Injecting liquid CO₂ at depth, placing it on the seabed, or sequestrating it in sediments
- Mineralisation of injected CO₂ within geologic structures
- Seeding and whitening clouds above ocean surfaces, most likely using sea salt spray, to reflect solar radiation back into space.

**5. Ocean carbon capture and storage**
- Storing carbon by dumping crop residue and other organic material in the deep ocean
- Injecting liquid CO₂ at depth, placing it on the seabed, or sequestrating it in sediments
- Mineralisation of injected CO₂ within geologic structures

**6. Marine cloud brightening**
- Making surfaces brighter to reflect solar radiation. Potential techniques include reflective floating silica spheres; micro bubbles; reflective foam; creating Arctic sea ice; and creating bright calcifying phytoplankton blooms.

**7. Surface albedo modification**
- Injecting CO₂ into appropriate host rocks beneath the seabed to react with the minerals there to form stable minerals/rock
- Introducing nutrients (e.g., iron, nitrogen, phosphorus) to surface waters to promote CO₂ uptake through photosynthesis
- Injecting liquid CO₂ at depth, placing it on the seabed, or sequestrating it in sediments

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