



# Modeling and Assessing Impact of Artificially Enhancing the Arctic Sea Ice Albedo

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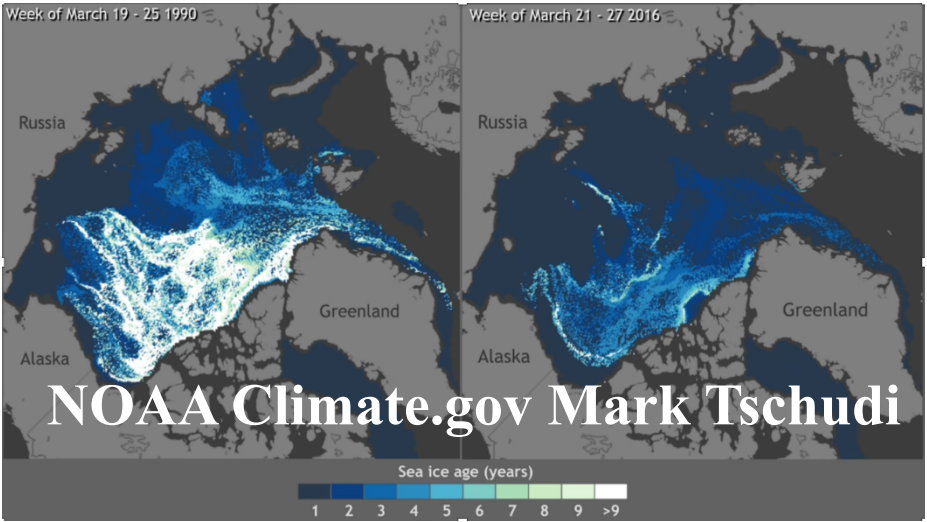
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## Why High-Albedo Arctic Ice Loss Matters

The highest rate of change in climate is observed in the Arctic where the summer ice is diminishing at an accelerated rate. The loss of Arctic sea ice increases radiative forcing and contributes to global warming.



## Ice911 Technology can Restore Arctic Ice

Restoring reflectivity of Arctic ice could be a powerful lever to help in the effort to limit global warming to 1.5°C or less. Ice911's novel method to locally increase ice albedo is to spread a thin layer of highly reflective materials like hollow glass spheres materials on top of the ice.

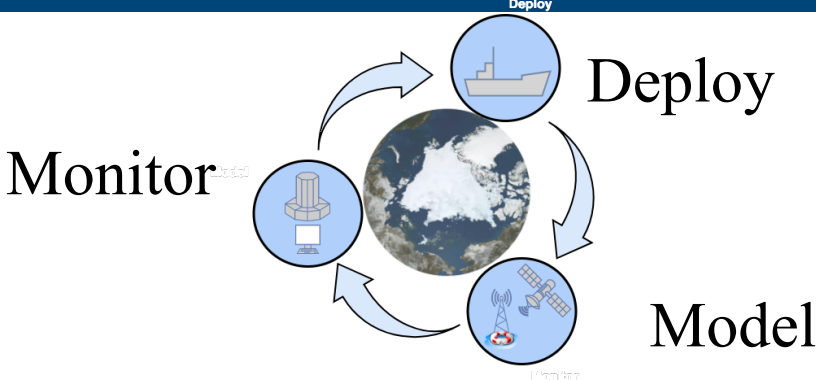
## Ice/Snow Preservation Field Work

Ice911's technology was tested using an array of monitoring instrumentation on sections of small ponds located in California's Sierra Nevada Range, Alberta, Canada, Minnesota, and the BEO area in Barrow, AK.



A delay in ice melt was observed beyond that seen in surrounding untreated control areas. For small areas of shallow ponds, influenced by untreated sections of the pond, surrounding shores and pond bottoms, this delay is a significant result. This merits detailed climate modeling and impact assessment of Ice911's technology, before large scale testing/deployment.

## Arctic Restoration Methodology



## Climate Modeling

**Objective:** To investigate the regional and large scale climate impact of local changes in the Arctic sea ice albedo.

We study how the changes in sea ice albedo impact:

- Sea ice concentration
- Sea ice area
- Sea ice volume
- Sea ice thickness
- Sea ice export
- Arctic temperature
- Global temperature

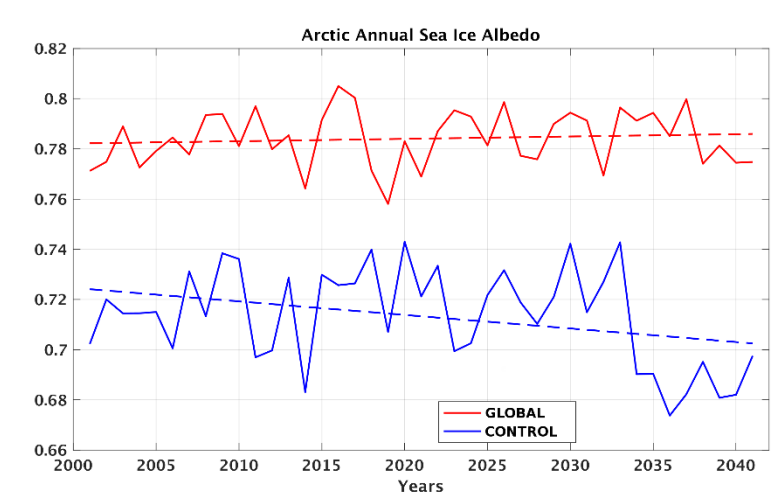
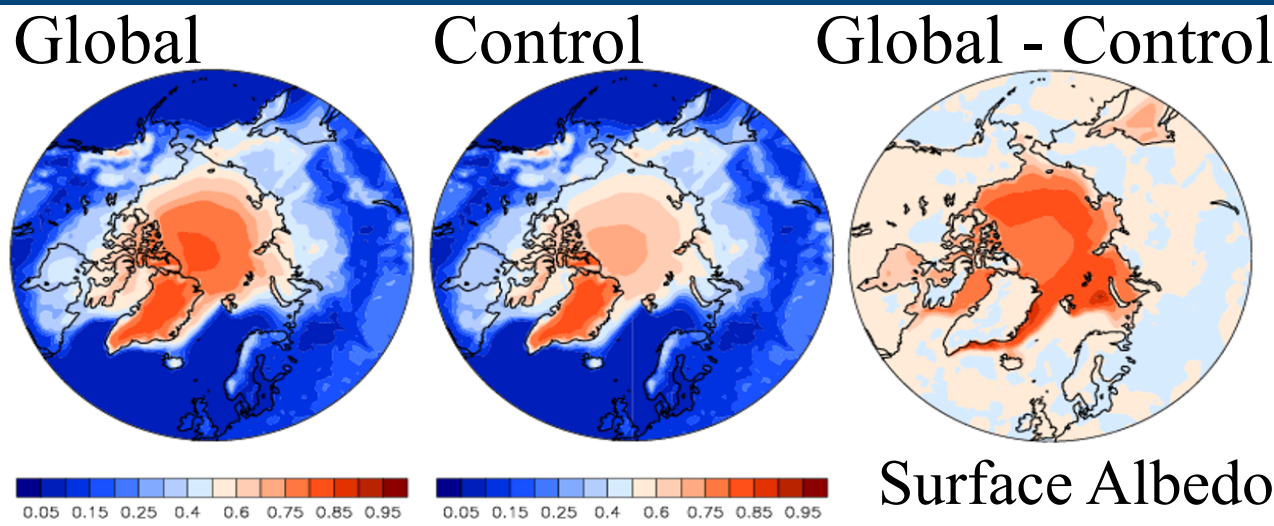
**Modeling & Simulation:** Simulate the effect of Ice911 material by perturbing the sea ice albedo in key Arctic regions using climate model.

We use the NCAR Community Earth System Model (CESM) - fully coupled climate model which consists of atmospheric, ocean, land and sea ice components interacting and exchanging water and energy fluxes via coupler.

## Numerical Experiments:

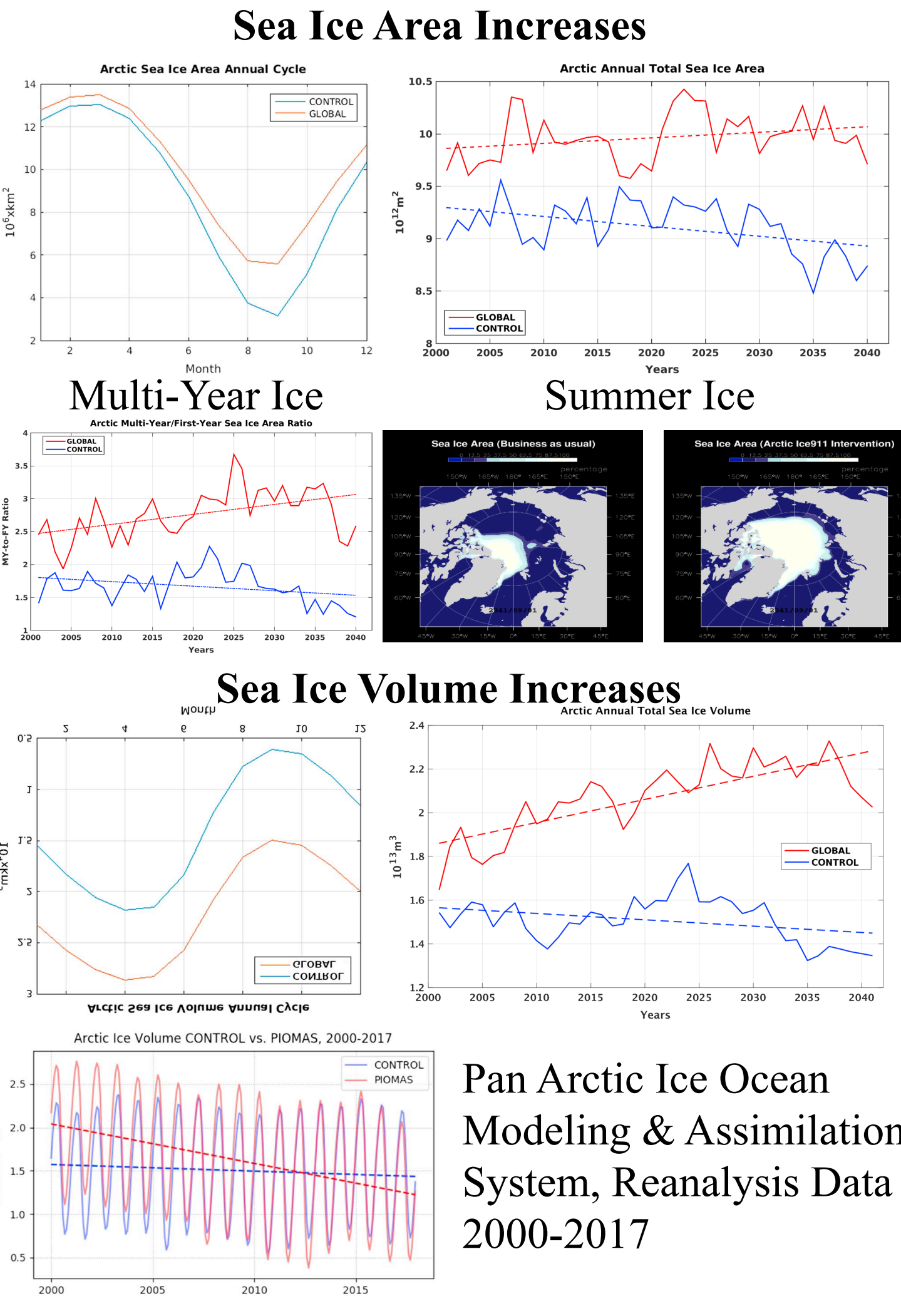
- Control – Current Day Climate
- Sensitivity Experiment 1 – Arctic-Wide Sea Ice Albedo Changes (Global)
- Sensitivity Experiment 2 – Fram Strait Sea Ice Albedo Changes (Fram)

## Results show increasing albedo

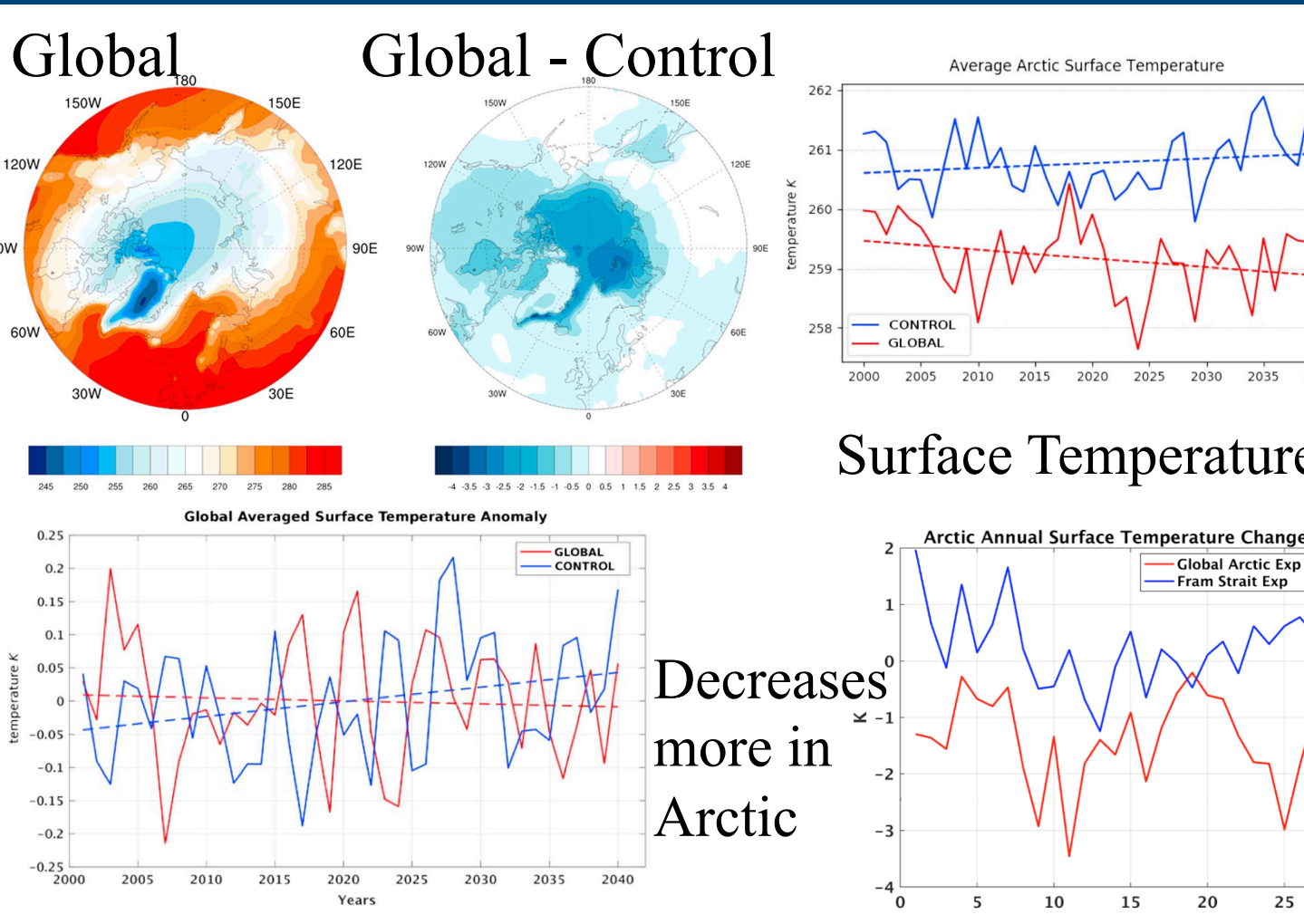


Increasing trend in annual sea ice albedo

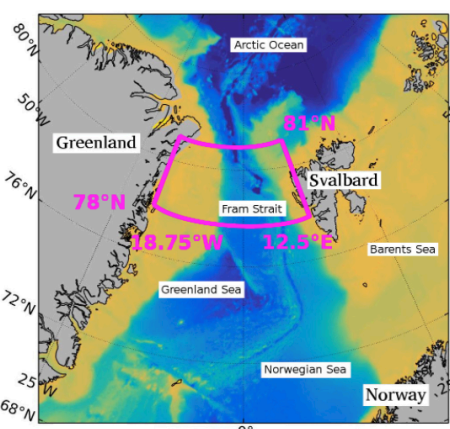
## Enhancing Albedo Increases Ice metrics



## Lowers Surface Temperatures



## Targeted Strategic Deployment

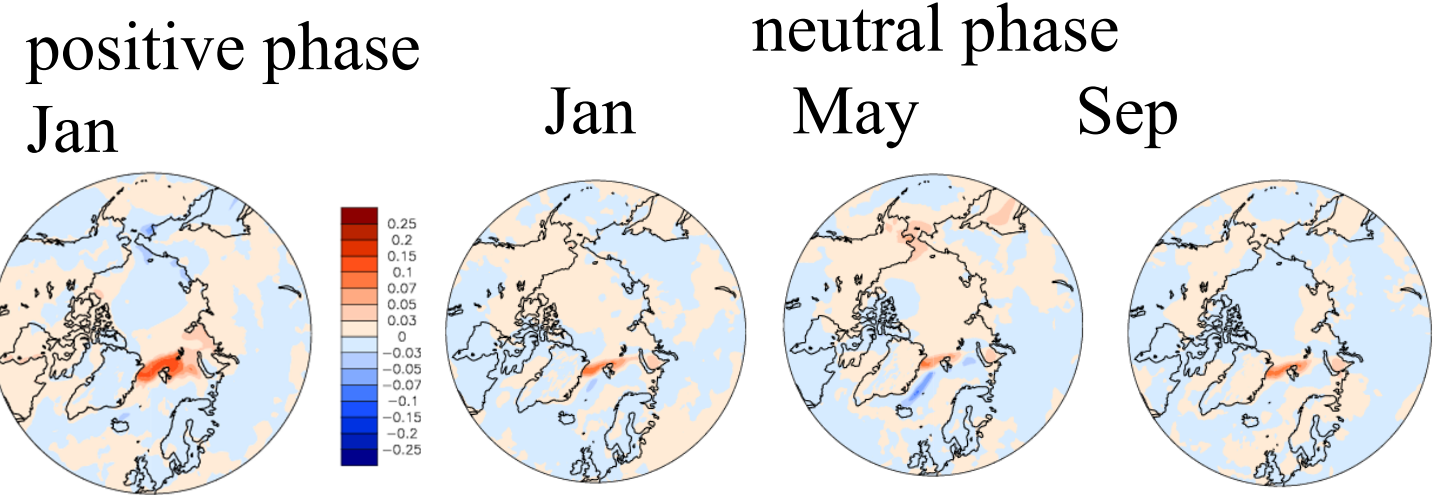


## Questions we seek to answer

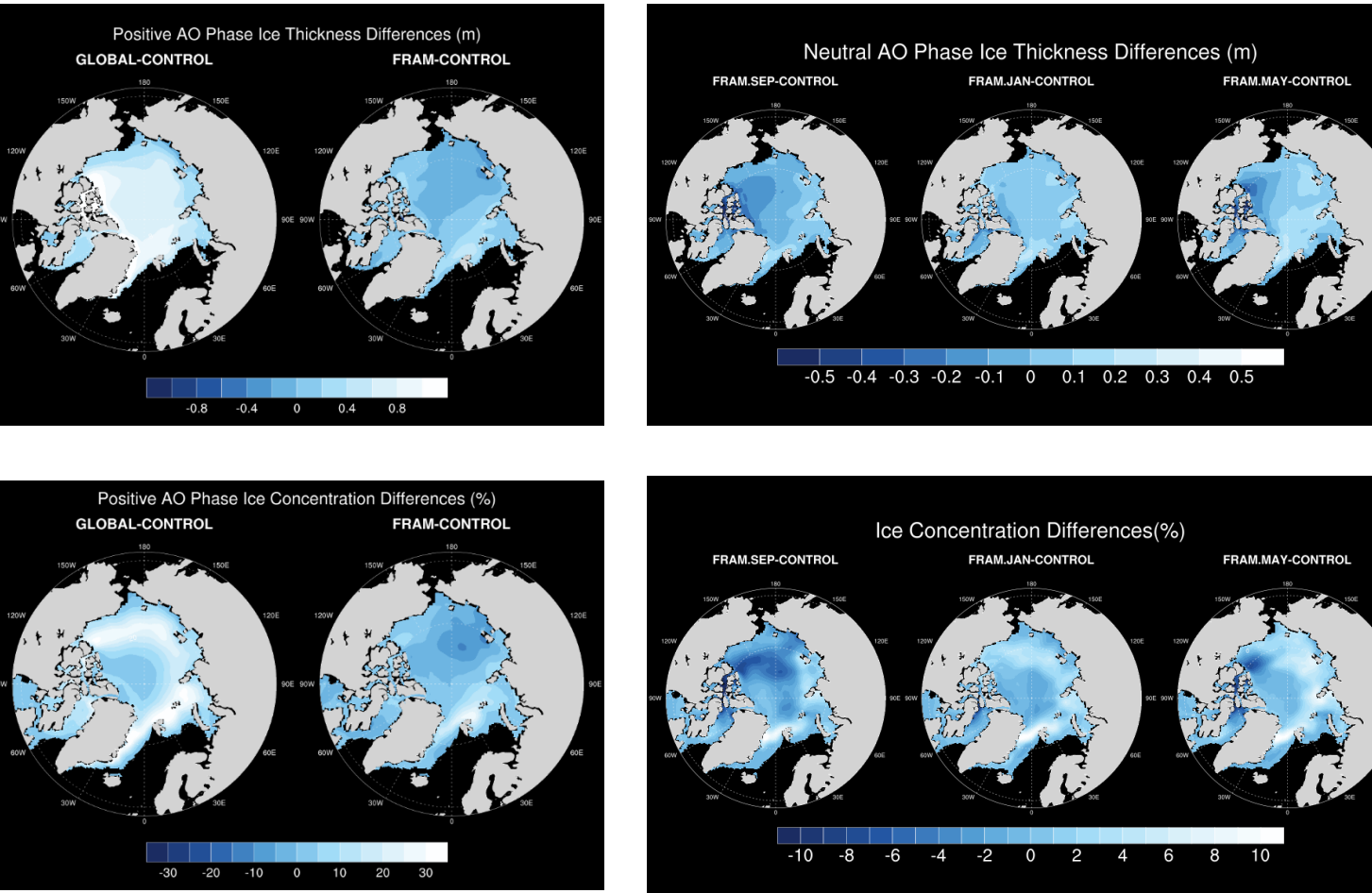
- Selecting a strategic location
- When to deploy? Seasonality
- Arctic Oscillation Phase
- Comparing Arctic-Wide vs strategic deployment
- Size to deploy

Strategic treatment area in Fram Strait

## Surface Albedo increase over Fram (Fram-Control)



## Increase in Ice Thickness & Ice Concentrations



## In Conclusion

- Arctic ice regrowth is an effective lever on global climate
  - Albedo modification of sea ice is an effective method of ice preservation
  - Albedo enhancements increase the sea ice area and volume and decrease the surface temperature
- Further studies underway to evaluate impacts of targeted deployment. Ref: Field et al. 2018, *Earth's Future*, 6, 10.1029/2018EF000820