

A Data Assimilation-Based 20th Century Climate Reconstruction Framework for Identifying Antarctic Ice Core Sites

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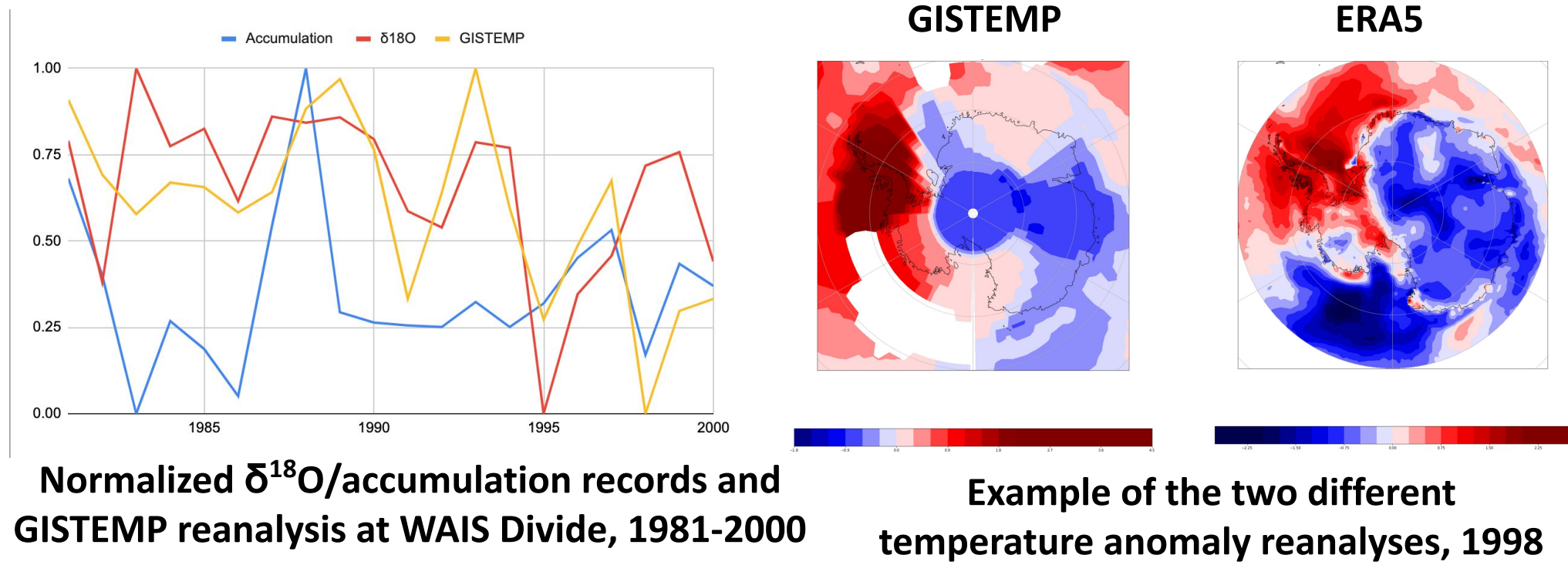


Motivation

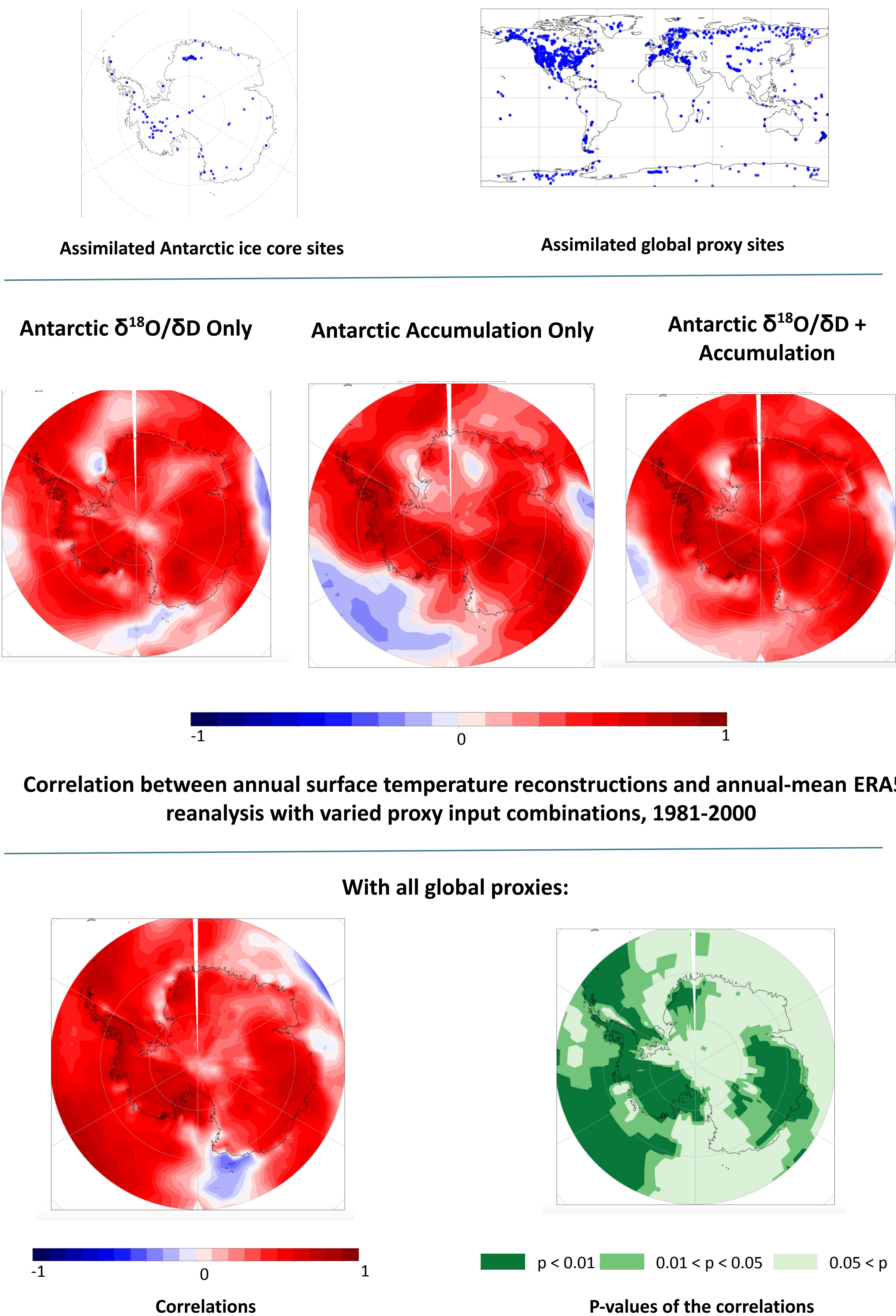
- Ice cores record information about past temperature and precipitation with $\delta^{18}\text{O}$ and accumulation proxies
- A new ice core site ideally improves climatic reconstruction skill as much as possible, with skill being a defined metric that gauges a reconstruction's performance
- This study develops an Antarctic climate reconstruction method that defines a baseline skill
- This would allow for future efforts to test how well potential ice core sites improve that skill

Methods

- Last Millennium Reanalysis (LMR) - reconstructs temperature through data assimilation of varied climate proxies
- Proxy data calibrated to GISTEMP temperature reanalysis with a linear fit, reconstructing site-specific temperature.
- Temperatures assimilated into 100 ensembles of a climate model prior in order to reconstruct spatial variability
- We adapt the LMR framework to incorporate ice core accumulation and $\delta^{18}\text{O}/\delta\text{D}$ data not present in LMR's default database



- Reconstructing annually resolved surface temperature anomalies from 1981-2000, with varied proxy data subsets
- Quantifying the skill by taking the correlation over the time series between LMR reconstructions and ERA5 reanalysis.



Results

- All reconstructions demonstrate a high degree of skill
- Best performance in West Antarctica
- Water isotope + accumulation outperforms just one or the other, greatest improvement in Southern Ocean
- Reconstructing with Antarctic data not significantly different from full global data

Conclusions

- Annually resolved 20th century Antarctic temperature can be reconstructed with a high degree of skill
- Some regions (South Pole, Southern Ocean, Eastern DML) have room for improvement
- These are generally where proxies are spatially sparse

Future Work

- Future research can build on these results by incorporating synthetic proxy records (psuedoproxies) into reconstructions
- Pseudoproxies are created by adding artificial noise to reanalysis
- This allows for a quantitative analysis regarding which ice core sites best improve upon the baseline skill
- Also, certain ice core records missing from current databases but known to exist can be tracked down and used

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