F: #A05 High Resolution Modeling and Measurements in the Arctic

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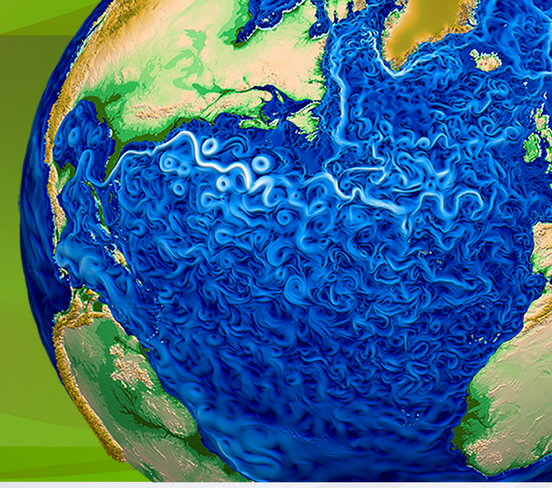
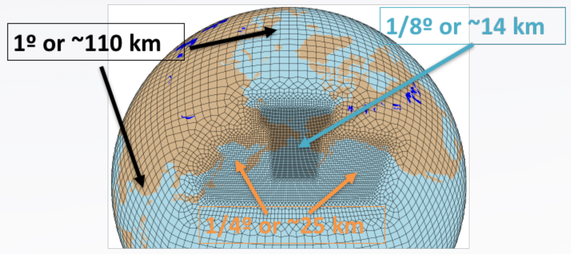


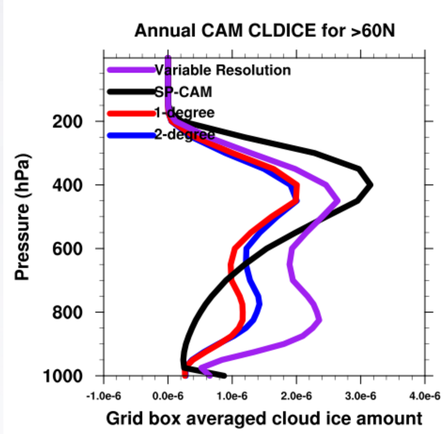
Hypothesis: Higher resolution will increase Arctic cloud amount

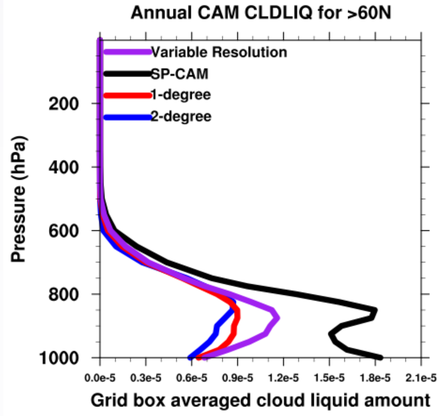
High Resolution Atmospheric General Circulation Models with Variable Resolution and Super-Parameterization

- Global earth system model development is trending toward higher resolutions.
- Certain aspects of the climate are improved with resolution and SP-CAM, but unique biases in cloud liquid and ice content arise when compared with observations.

Figures: (Bottom) Variable resolution grid for North Pacific. (Top Right) Profiles of annual means of cloud ice and cloud liquid for all Latitudes greater than 60N for simulations of uniform resolution, variable resolution, and SP-CAM.







Evaluating model simulations against satellite retrievals

Using a satellite simulator tool, we find that the Community Atmosphere Model (CAM) and SP-CAM have very different biases in liquid cloud amount relativeto CALIPSO retrievals (below).

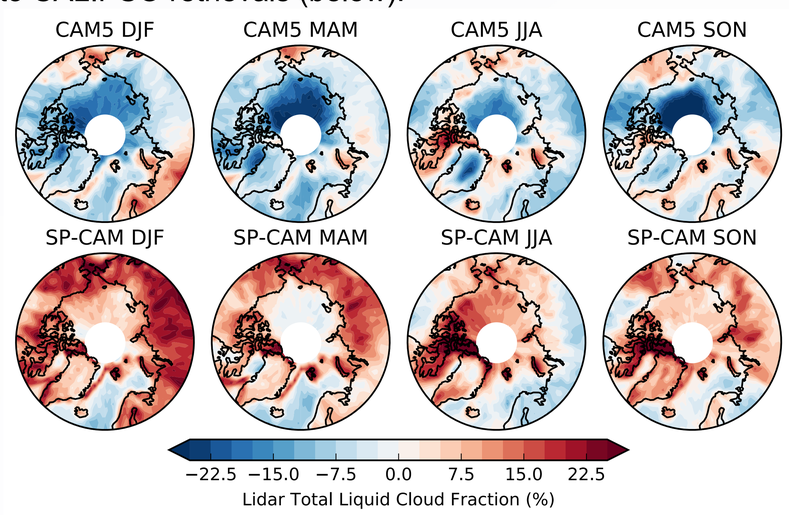


Figure: Seasonal cycle of biases in liquid cloud amount in CAM and SP-CAM relative to retrievals from CALIPSO.

Evaluating Large Eddy Simulations and in situ Tethered Balloon Measurements

Routine high-resolution large eddy simulations (LES) are developed for the ARM sites at the North Slope of Alaska to develop a statistical understanding of the phase of the clouds. We use the System for Atmospheric Modeling (SAM) to explore LES performance of cloud amount at Oliktok Point during field campaigns. A supercooled liquid water content sensor and fiber-optic distributed temperature sensor are flown on a tethered balloon to obtain observations of supercooled liquid for evaluation of LES performance. We found the magnitude of the supercooled liquid water content in the simulations is sensitive to tuning and forcing conditions.

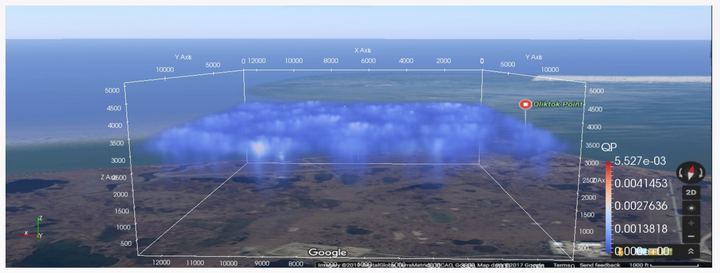


Figure: (Left) Snapshot of three-dimensional precipitation from a simulation of a cloud over Oliktok Point for day in October, 2016. (Right) The ascending aerostat balloon on the runway of the Long Range Radar Station in Oliktok Point, Alaska as viewed on the instrumentation deck at the ARM facility.

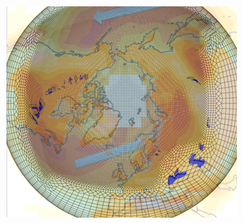
Developments Required

Comprehensive Arctic Grid

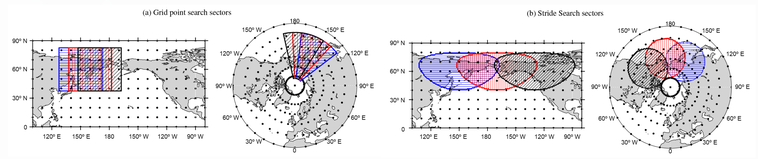
ACME v2/v3 development plans for comprehensive, coupled Arctic grid (See R. Leung's Talk)

Diagnostic Storm Tracking and Detection Algorithm for Unstructured Grids

Work has started for finding objects in unstructured grids (See CMDV breakouts)



Number of Elements in Atmosphere: 21,895



Search sectors along 60◦ N with s = 2500 km for grid point search and Stride Search

Expected Impact

Increase understanding of Arctic System

Reducing cloud bias will add confidence when evaluating more complex problems (e.g., aerosols)

Improve validation and diagnostics in data-poor region

Object-finders are missing from GCM diagnostic toolkits, which are needed as resolution increases

ACME Accelerated Climate Modeling for Energy

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