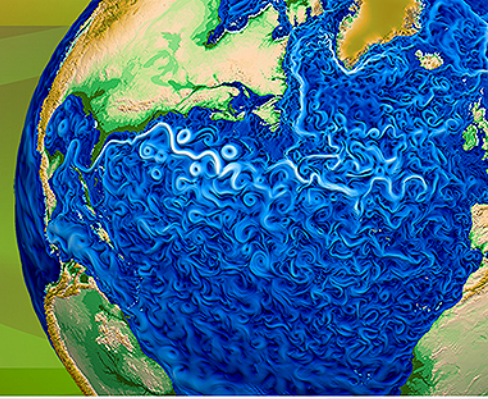




Accelerated Climate Modeling
for Energy



Representation of clouds and convection across scales in ACME

Chris Golaz

on behalf of the entire CMDV-RRM team

Team

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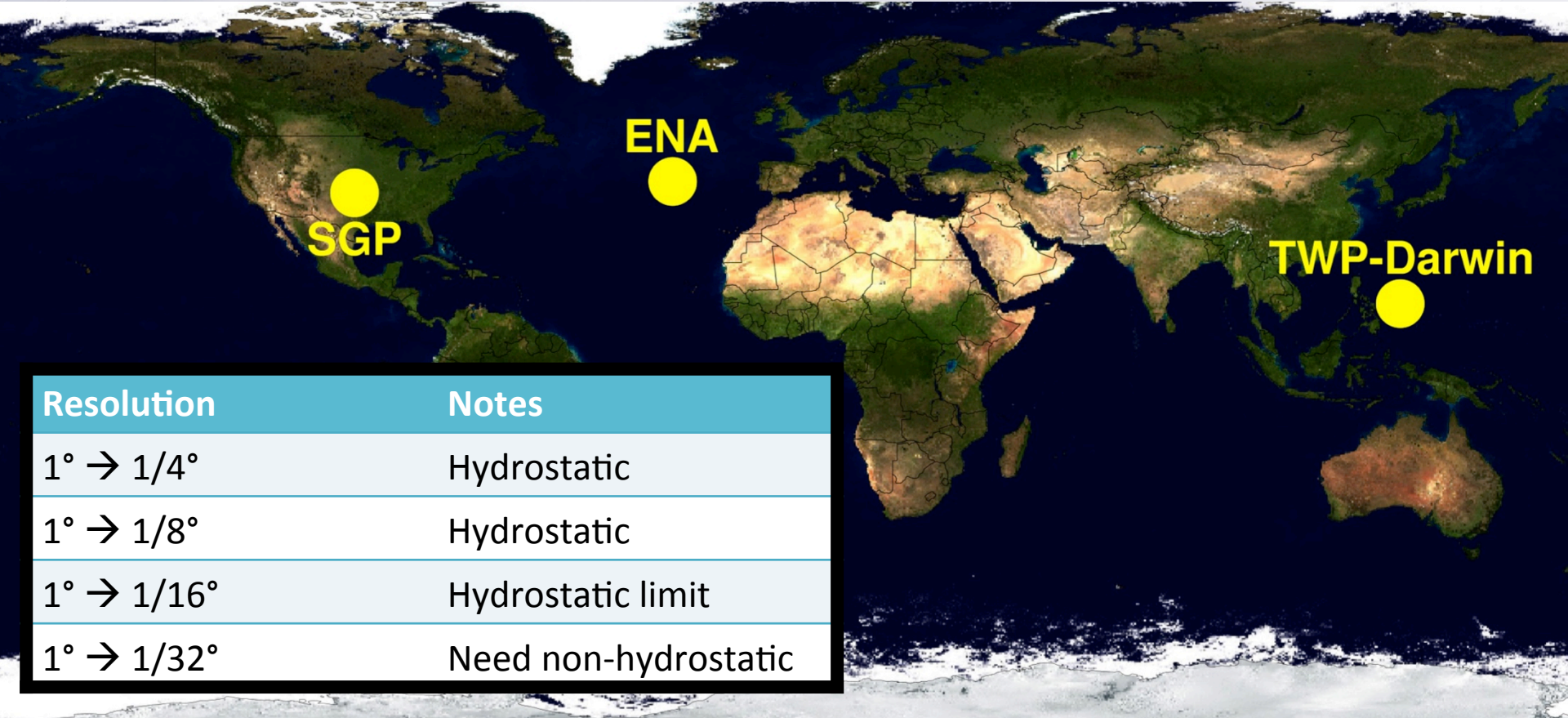
Focus Area

Variable Resolution Modeling

- Develop regionally refined mesh (RRM) framework for ACME
- Validate ACME with RRM
 - SGP
 - ENA
 - TWP-Darwin
- Evaluate cloud parameterizations in ACME and their (in)sensitivity to resolution (scale-aware)

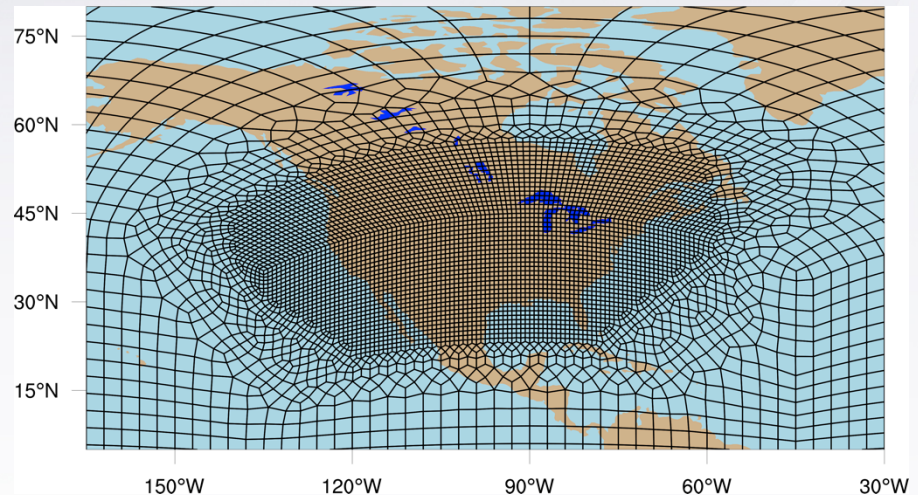
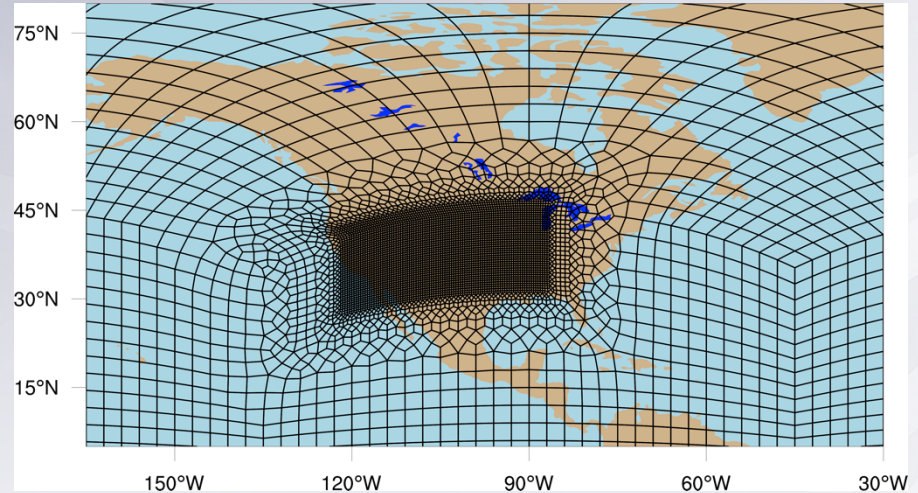
Variable Resolution Modeling

- Locations selected to
- (1) sample wide range of cloud regimes,
 - (2) maximize use of ARM observations.



Example of Regional Refinement in ACME

- SGP
 - “ARM” grid $1^\circ \rightarrow 1/8^\circ$
 - From CSSEF project
 - 10,284 elements
 - Works with ACME v0.1
 - CAPT, nudged, or free-running options
 - “CONUS” grid $1^\circ \rightarrow 1/4^\circ$
 - 9905 elements
 - On ACME master
 - CAPT, nudged, or free-running options



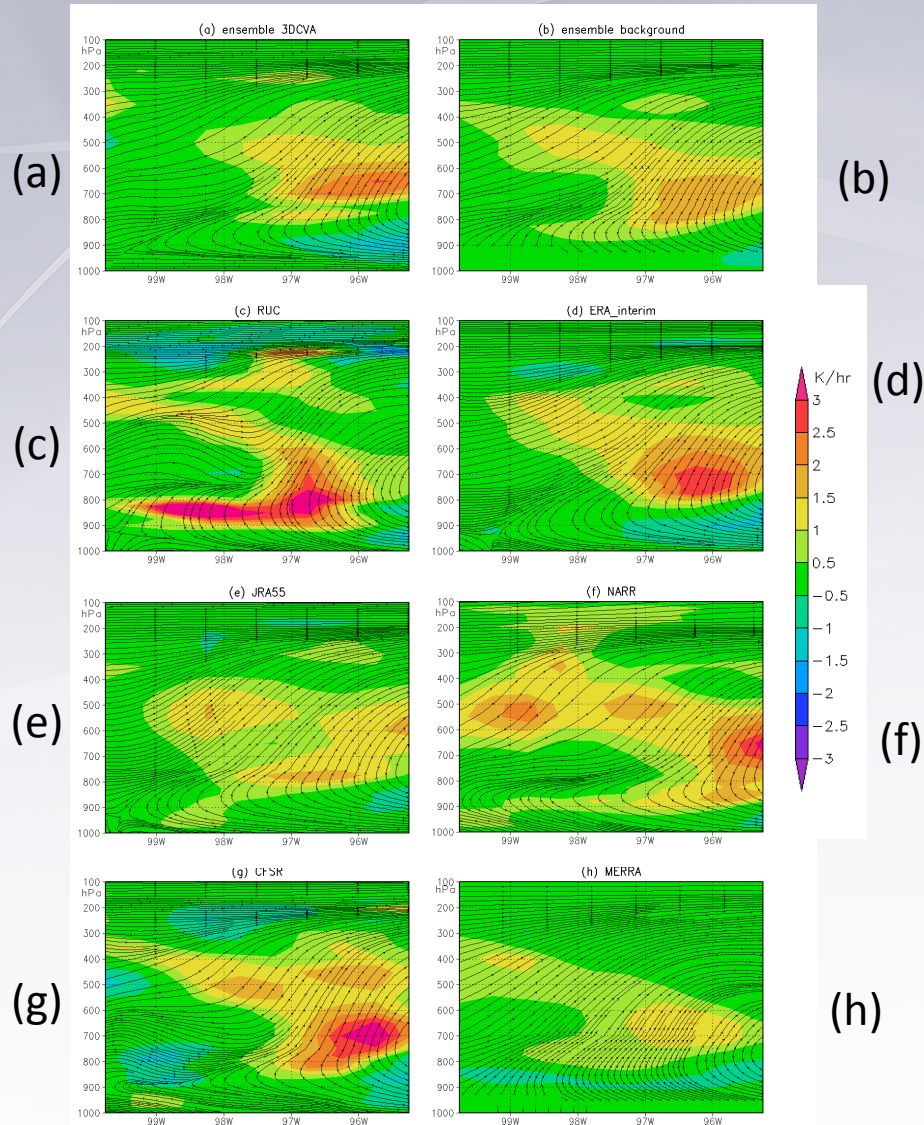
Compare to 1° with 5400 elements,
 $1/4^\circ$ with 86,400 elements, $1/8^\circ$ with 345,600 elements

Focus Area

New ARM/ASR validation tools and datasets

- 3-D ARM constrained variational analysis as forcing/evaluation/validation data for ACME.
- Radar retrieved cloud and precipitation statistics of convection for model testing.
- Use observationally-based LES and CRM to support analysis of RRM simulations.
- Expand ARM data-oriented diagnostics package to evaluate climate model simulations.

3-D variational analysis

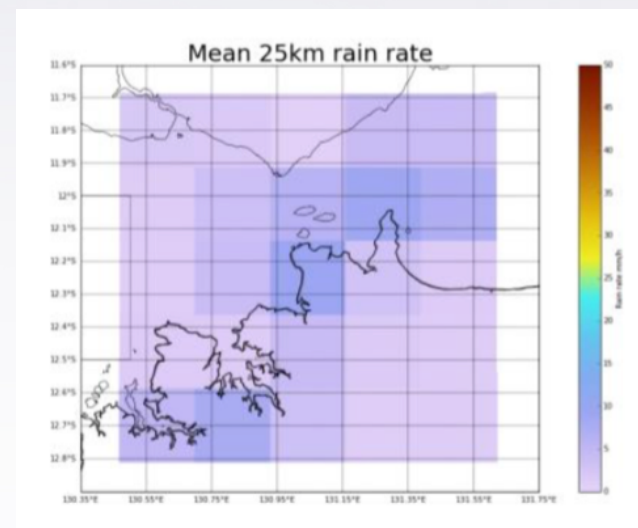
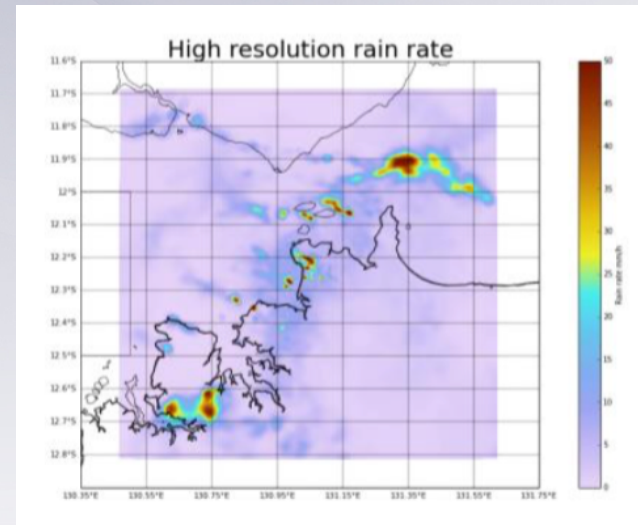


- (a) Example of a pressure-longitude cross section of **3-D variational analysis of apparent diabatic heating $Q1$** (color, K/hour) and velocity streamlines over the SGP during a frontal passage
 - (b) Ensemble average of six operational analysis and reanalysis products
 - (c) RUC
 - (d) ERA-Interim
 - (e) JRA
 - (f) NARR
 - (g) CFSR
 - (h) MERRA
- The time is 00Z Mar 3rd 2000. X axis shows the longitude along the cross section.

Only the 3-D variational analysis of $Q1$ is consistent spatially and temporally with the observed precipitation and TOA radiation.

Radar derived cloud and precipitation datasets

- Primary focus on the decadal record collected at the ARM TWP site in Darwin with possible expansion to other sites.
- Use large-scale data (sounding, VARANAL) to stratify into forcing regimes.
- For each regime we will compare high resolution data to high resolution models and “de-resolved” 13km data to ACME.
- This will give a **regime dependent** view of ACME performance.



LES/CRM to support evaluation with RRM

Process-level LES simulations based on **LASSO** and other LES and CRM simulations in the spirit of LASSO framework but extending to multiple cloud regimes.

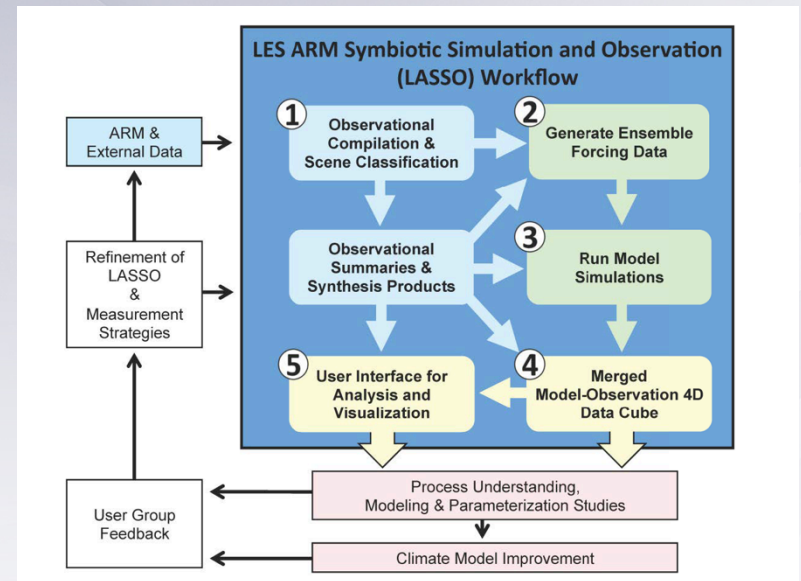


Figure: LASSO implementation strategy, DOE, 2015

- Provide **observationally constrained and dynamically consistent process-level data** to evaluate the ACME parameterizations, in particular various aspects of the CLUBB parameterization, including explicit calculation of CLUBB parameters and moments.
- **Bridge the scale gap between ARM observations and ACME model resolutions and enable explicit investigation of scale dependency** (via flexible domain size).

Expanded ARM diagnostics package

- Diagnostics package under development by the ARM Infrastructure Team (PI Xie).
- Use ARM measurements to evaluate regional climate simulations of clouds, radiation and precipitation.
- Plan to expand package as part of this project.
- Conduit to share new datasets and analysis tools to wider audience (ACME and beyond).

Diurnal cycle of precipitation at ARM SGP

