

High-resolution climate modeling in historical context:

Where are we now? How did we get here?

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Aspen Global Change Institute – August 2015

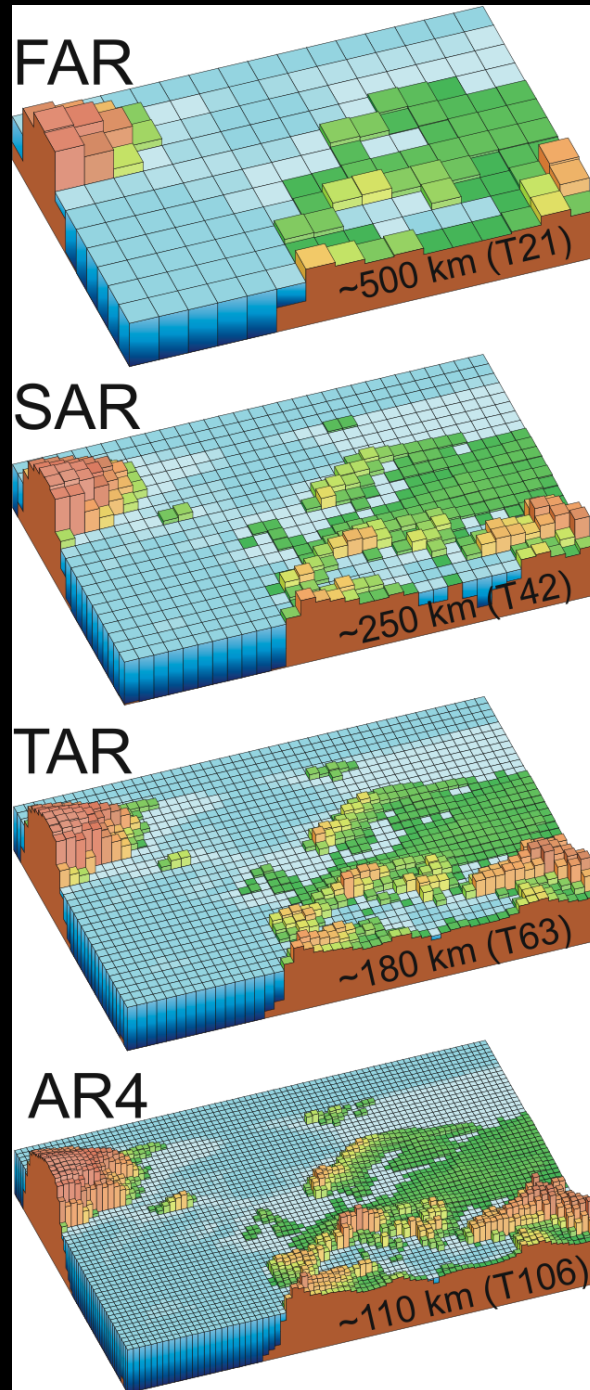
“Prepare a talk that provides an accessible introduction to the challenges and opportunities incumbent in executing climate models at increasingly high resolution. For example, it would be helpful if you could delve into issues such as...”

1. “How climate models to date have treated processes in models that occur at finer spatial scales than the nominal resolution of the model (e.g., cloud parameterization).”

2. “How these techniques impact the realistic representation of phenomena for different variables and regions.”

3. “What possible benefits and constraints exist from a model development perspective in moving to higher resolution.”

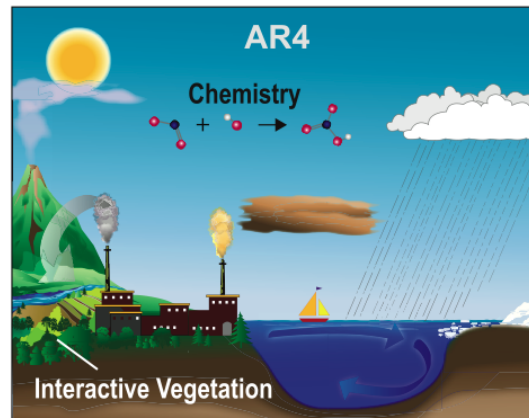
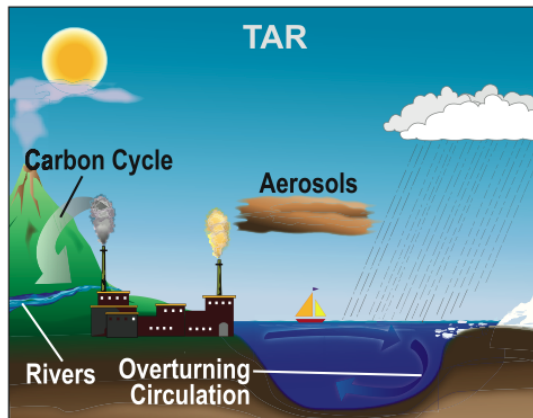
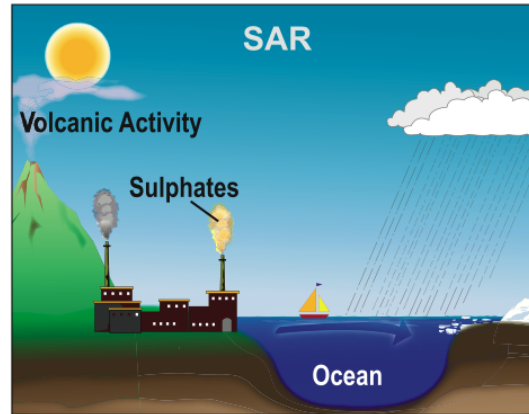
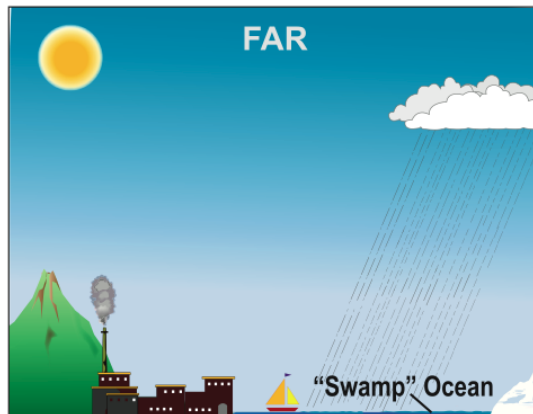
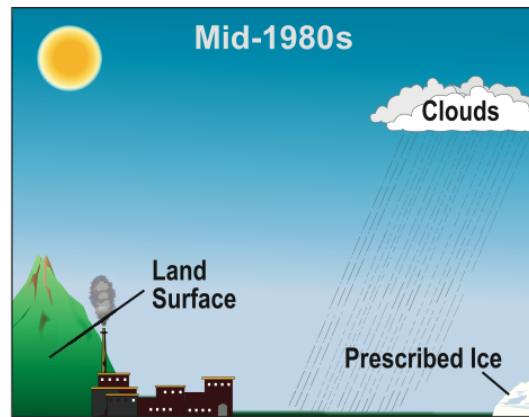
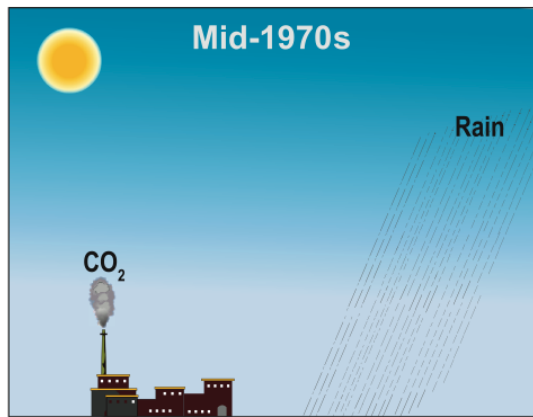
Climate models have evolved rapidly during recent decades.



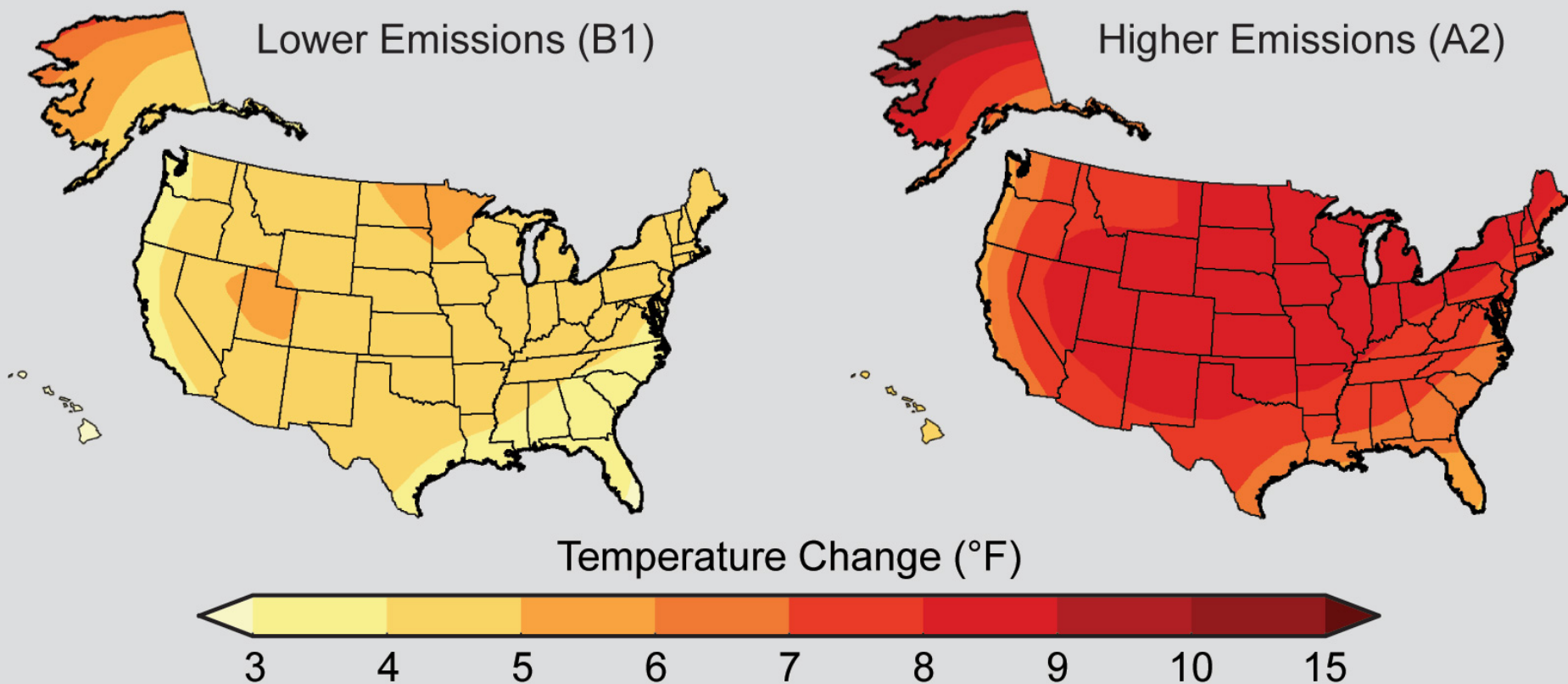
IPCC has issued five assessment reports:

FAR – 1990
SAR – 1995
TAR – 2001
AR4 – 2007
AR5 – 2013

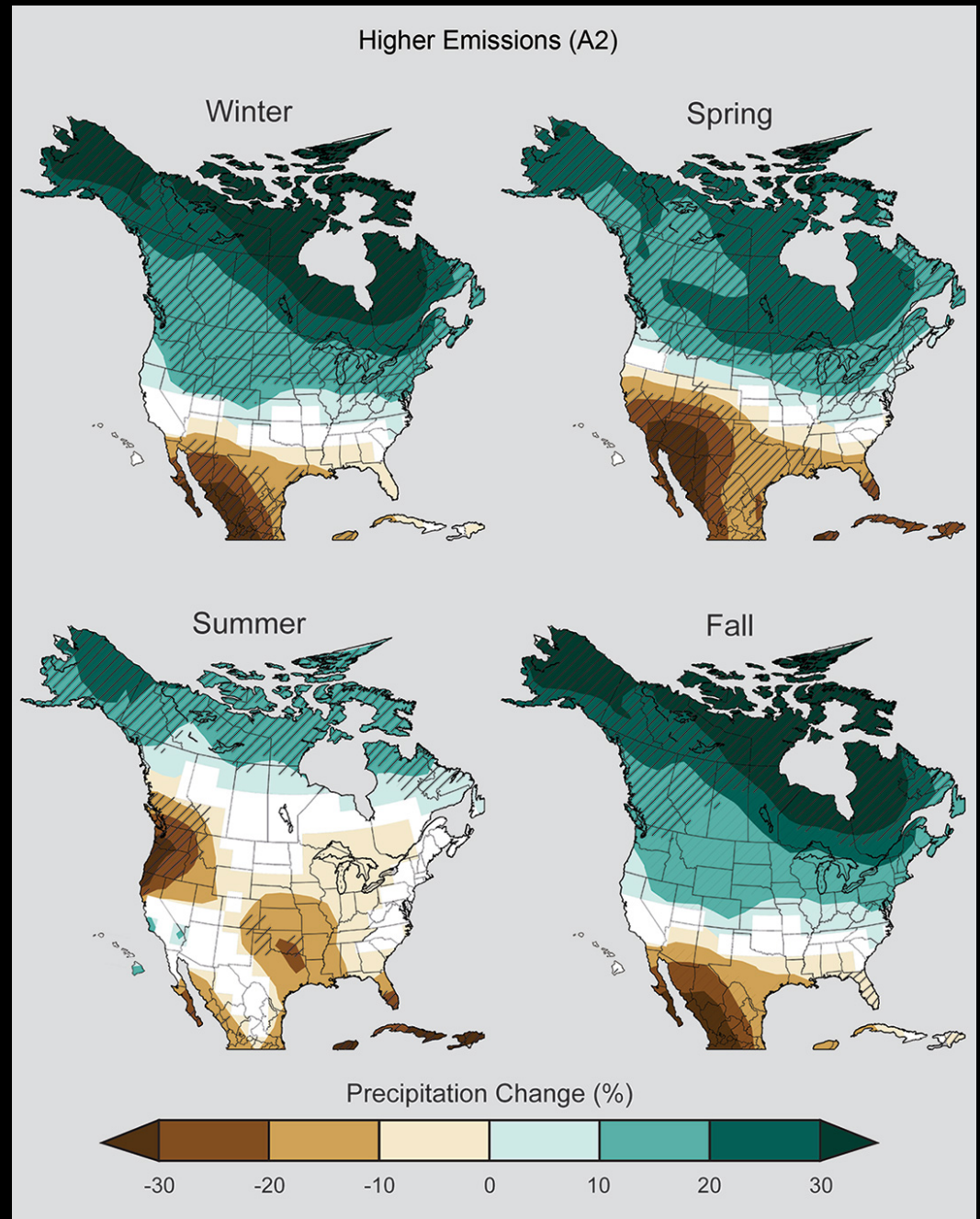
The World in Global Climate Models

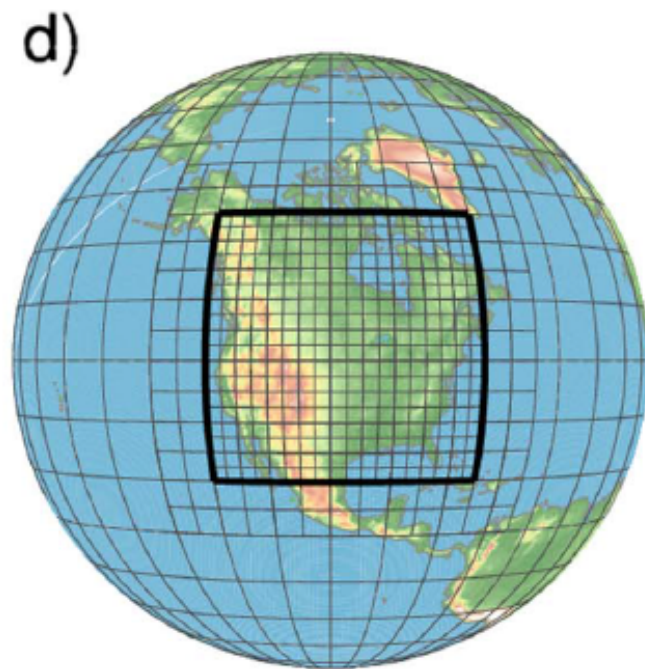
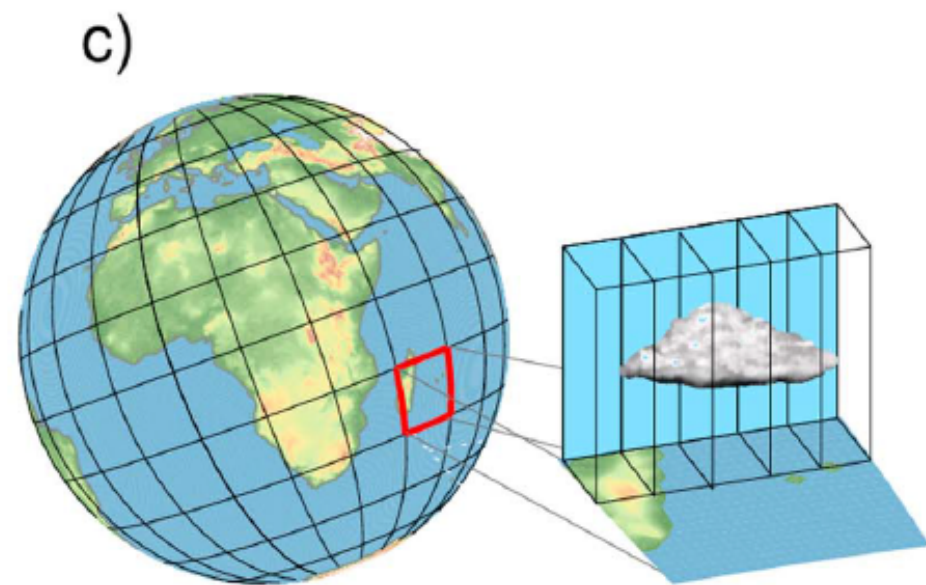
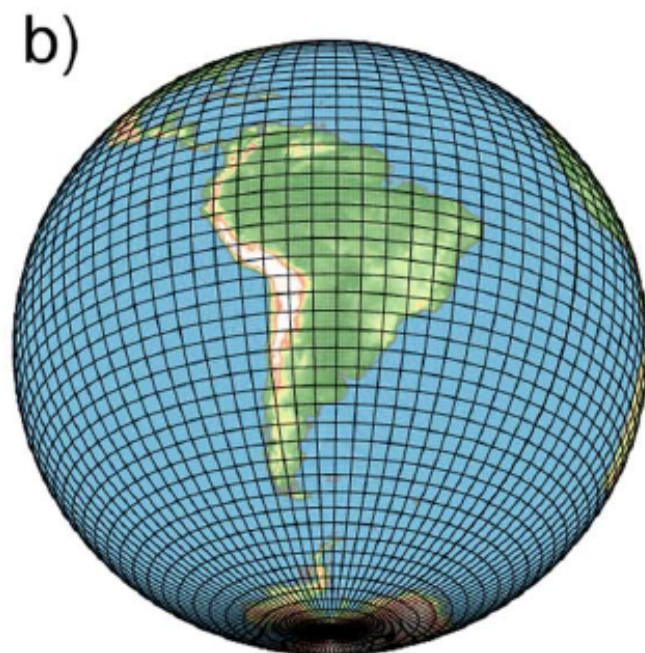
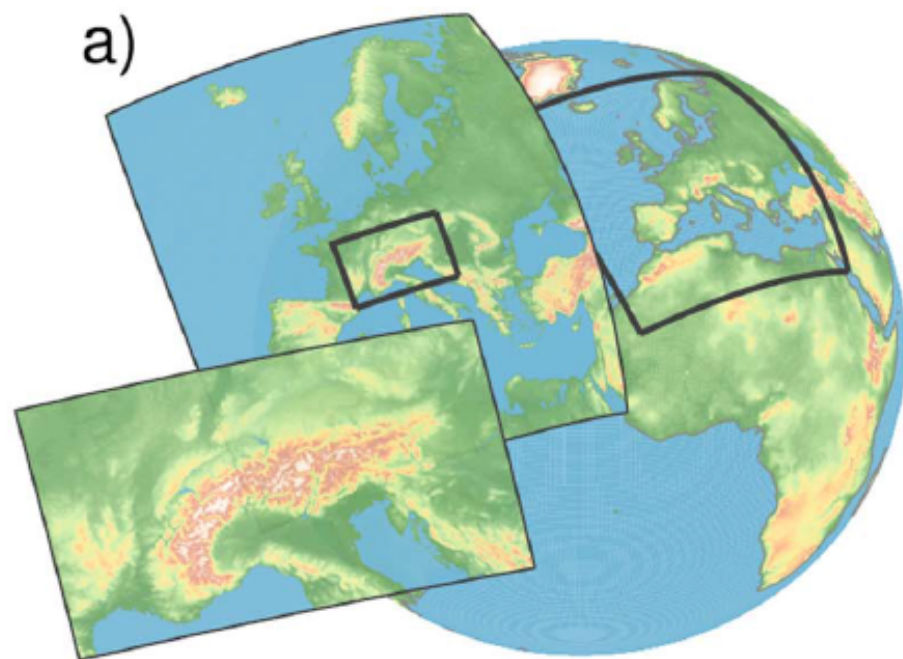


Projected Temperature Change

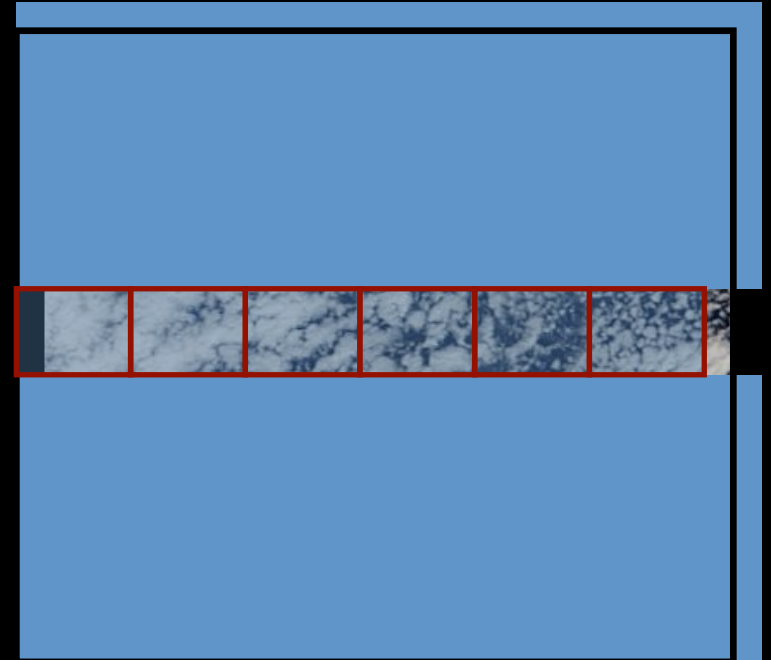
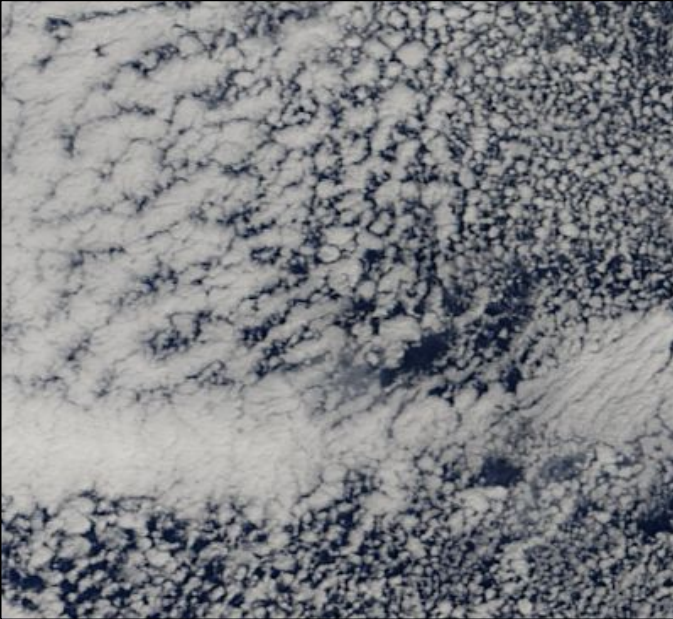


Projected Precipitation Change by Season



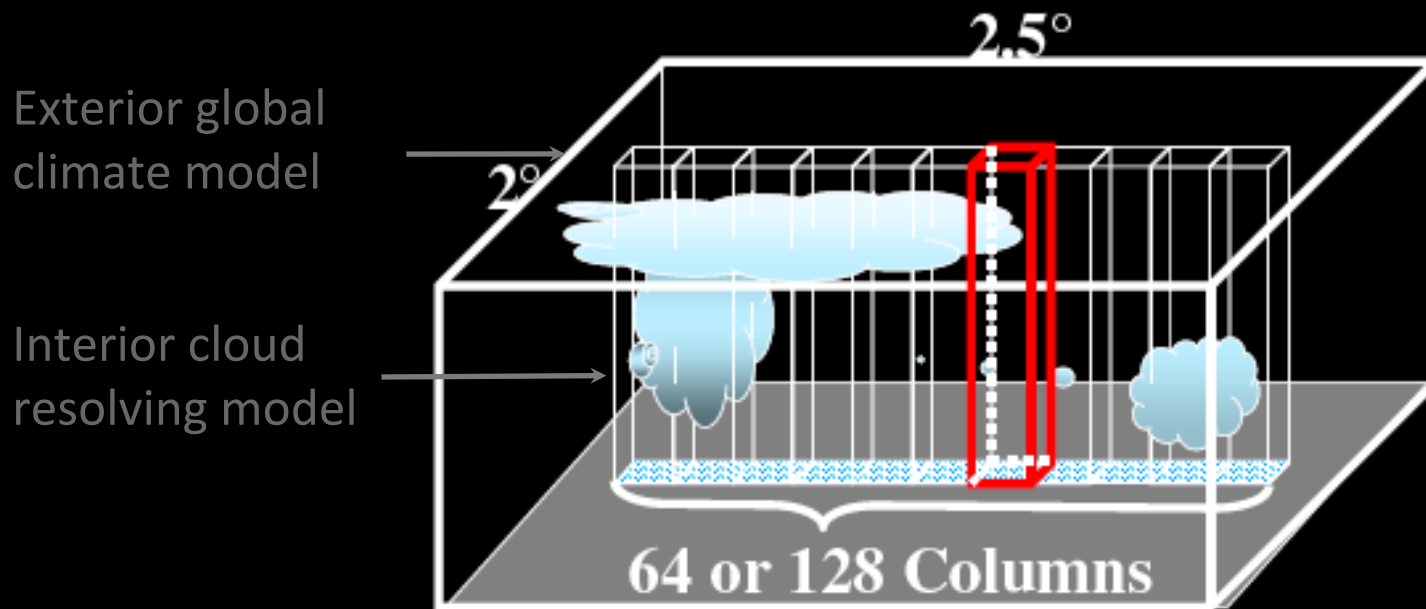


The MMF concept is a bit like an opinion poll. You cannot ask everybody for their opinion, but you can ask a *representative sample*.

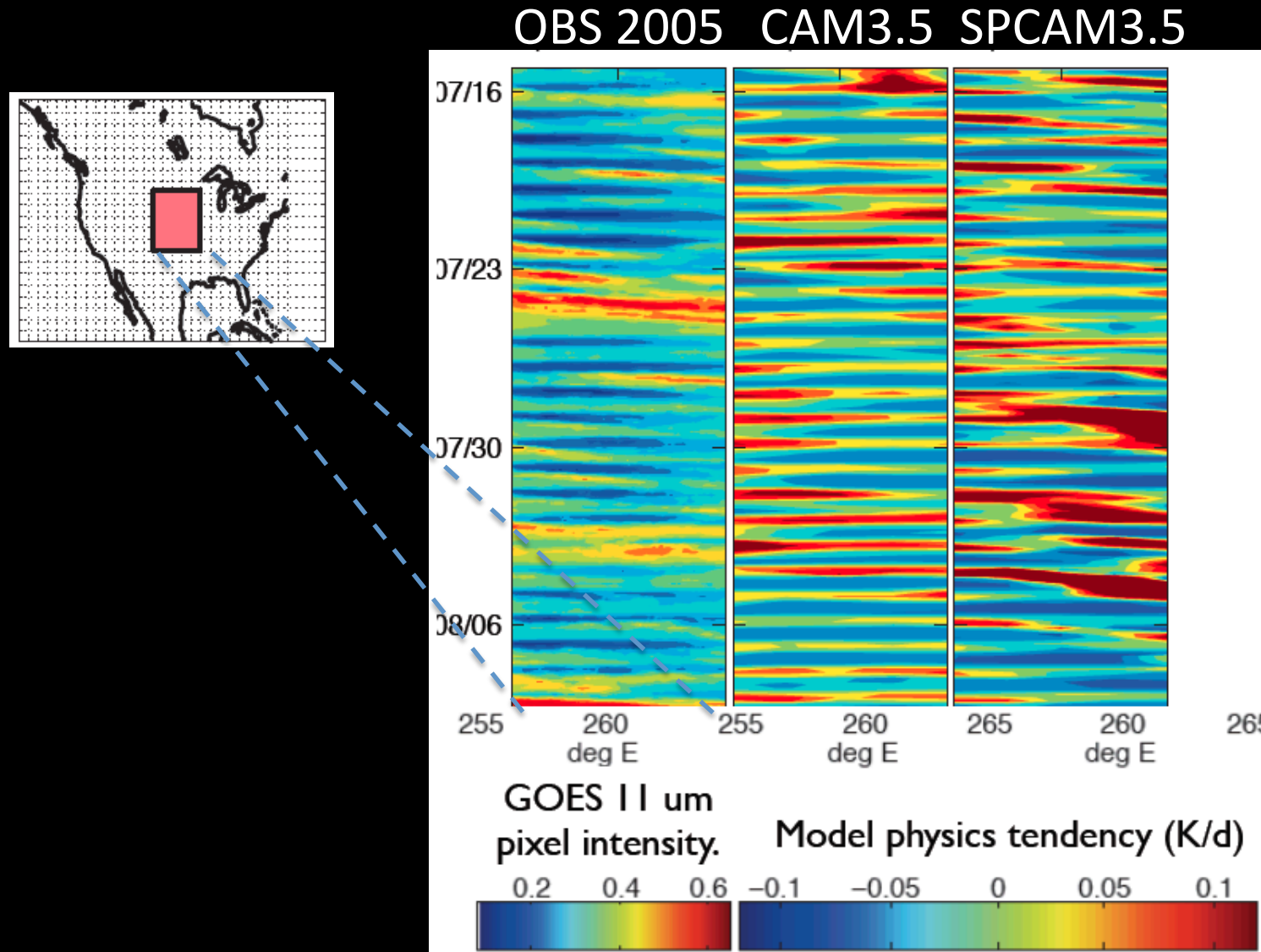


MMF: Multiscale Modeling Framework

The Multi-scale Modeling Framework (MMF) approach
(also known as “super-parameterization”)



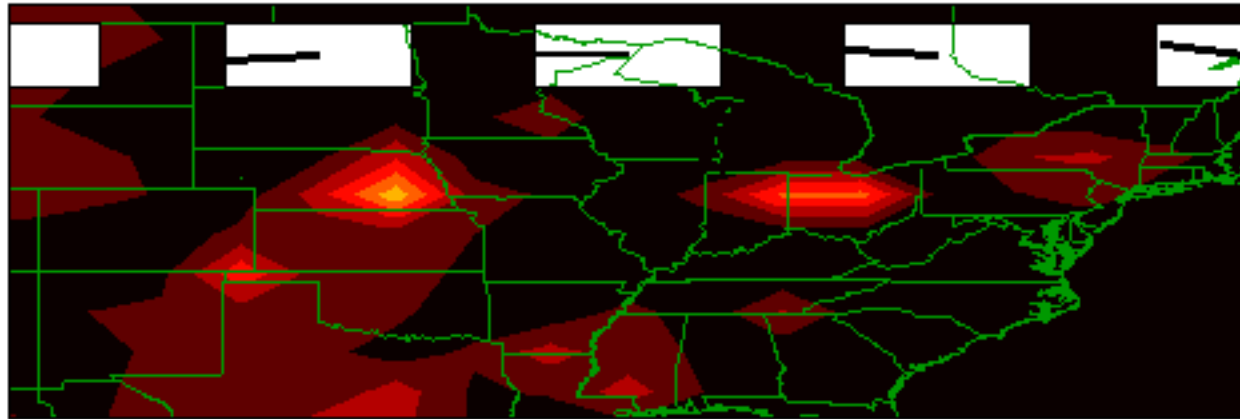
We found SP-CAM3.5 simulates orogenic Central US nocturnal convective systems in free-running mode...



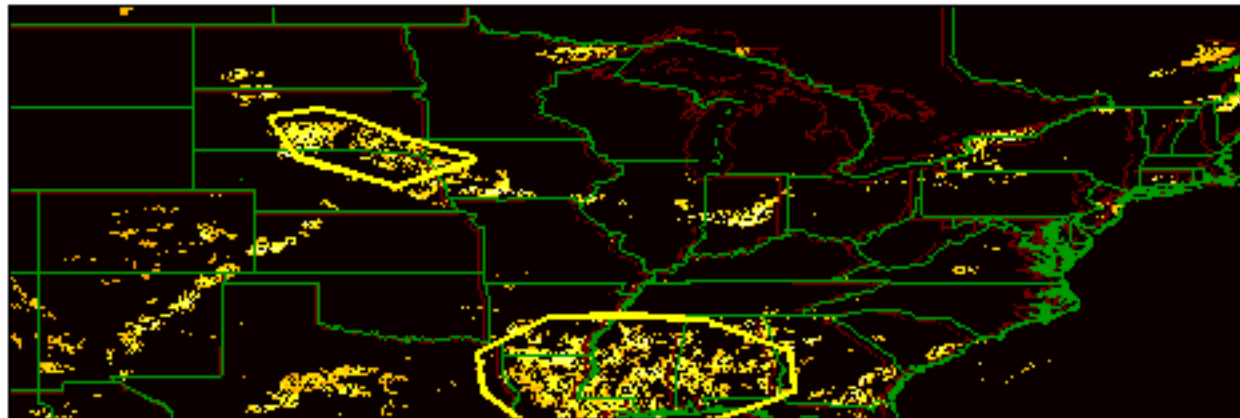
Pritchard, M.S., M.W. Moncrieff, R.C.J. Somerville, *J. Atmos. Sci.*, 2011

SPCAM can also forecast an actual nocturnal system.
We can run it in numerical weather prediction mode.

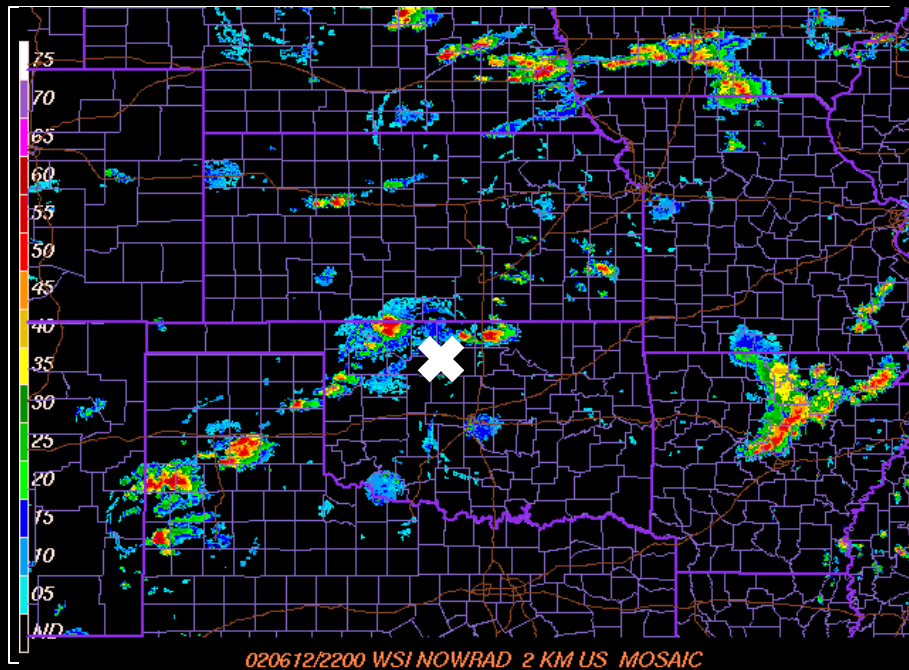
Forecast hour: 24.0



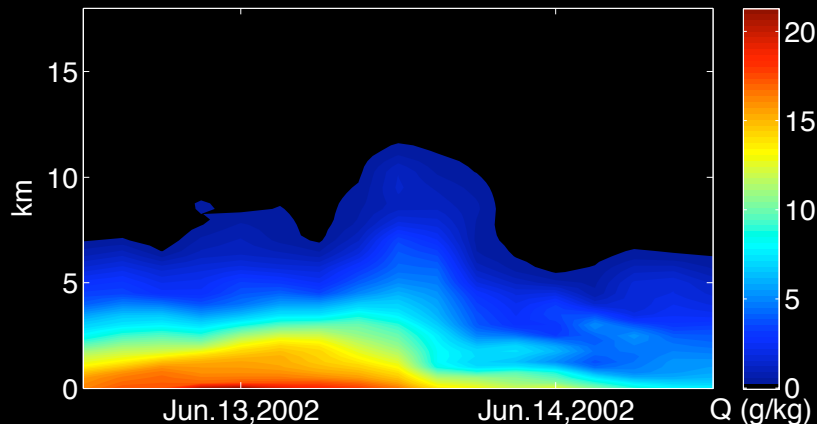
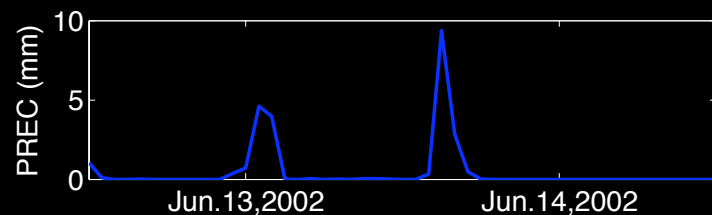
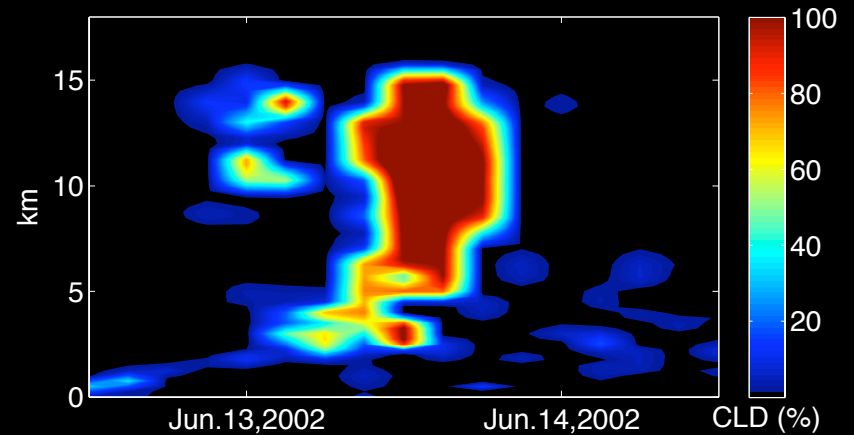
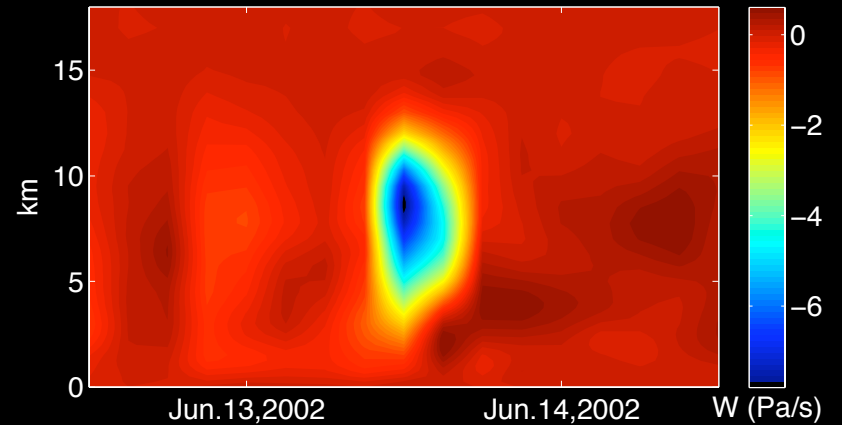
RADAR OBS: 06-Jul-2003



This may open new doors to scrutinize SPCAM cloud biases at the process-level against high quality data.



x = ARM SGP Site



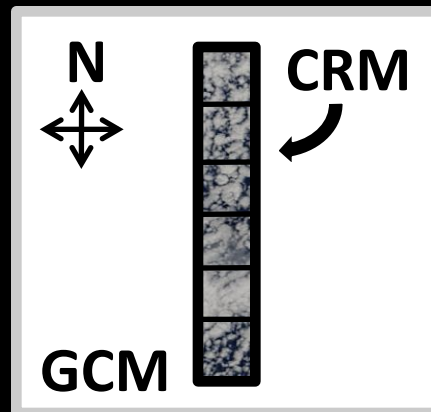
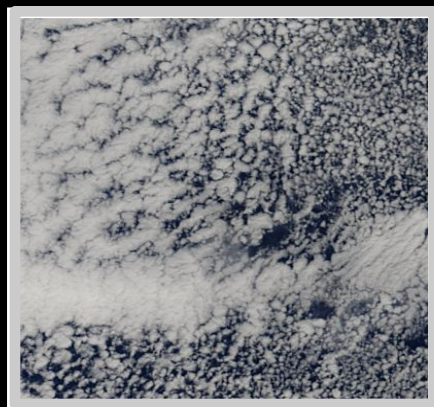
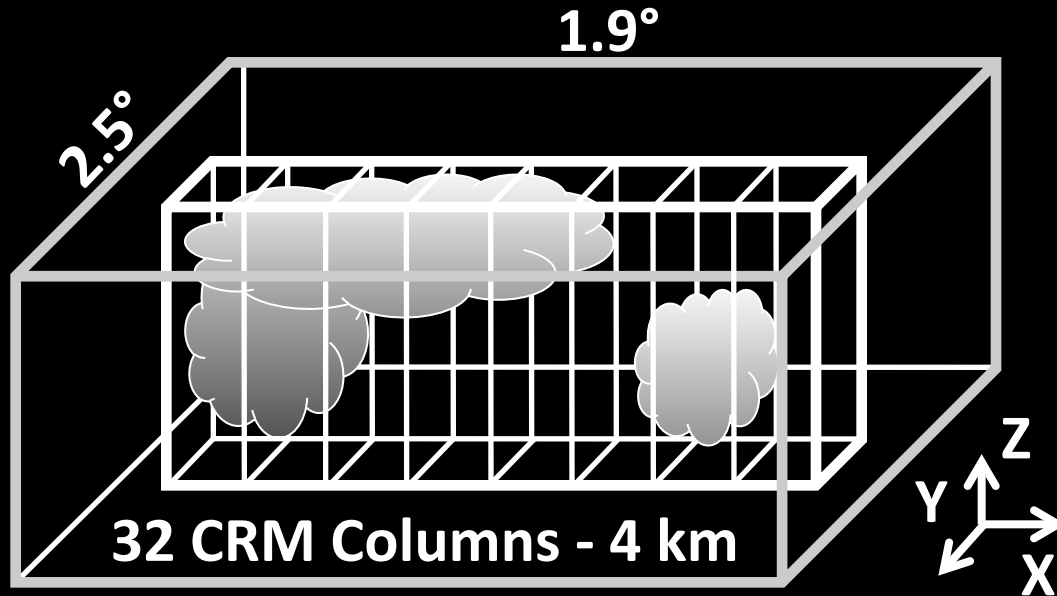
CONCLUSION: Multiscale modeling is a promising approach to high-resolution climate models.

a.k.a.

"super-parameterization"

Idealized 2D cloud resolving models (CRMs) are embedded in each grid column of a GCM to replace conventional cloud parameterizations and explicitly represent sub-grid convection.

MMFs are 200x more expensive computationally than GCMs, but scale efficiently with increasing number of processors, providing an interim strategy until global-climate CRMs are affordable.



Multiscale Modeling Framework

