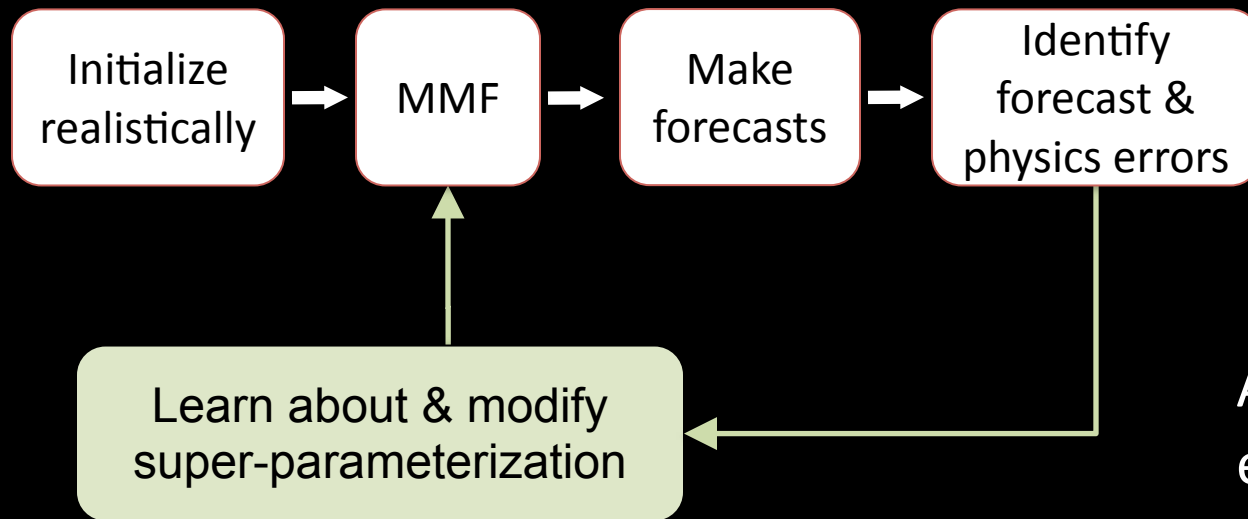


Forecast simulations with a multiscale modeling framework

Gabe Kooperman, Mike Pritchard,
Richard Somerville & Marat Khairoutdinov

Question: Can forecast simulations help identify critical aspects of MMF climate simulations?

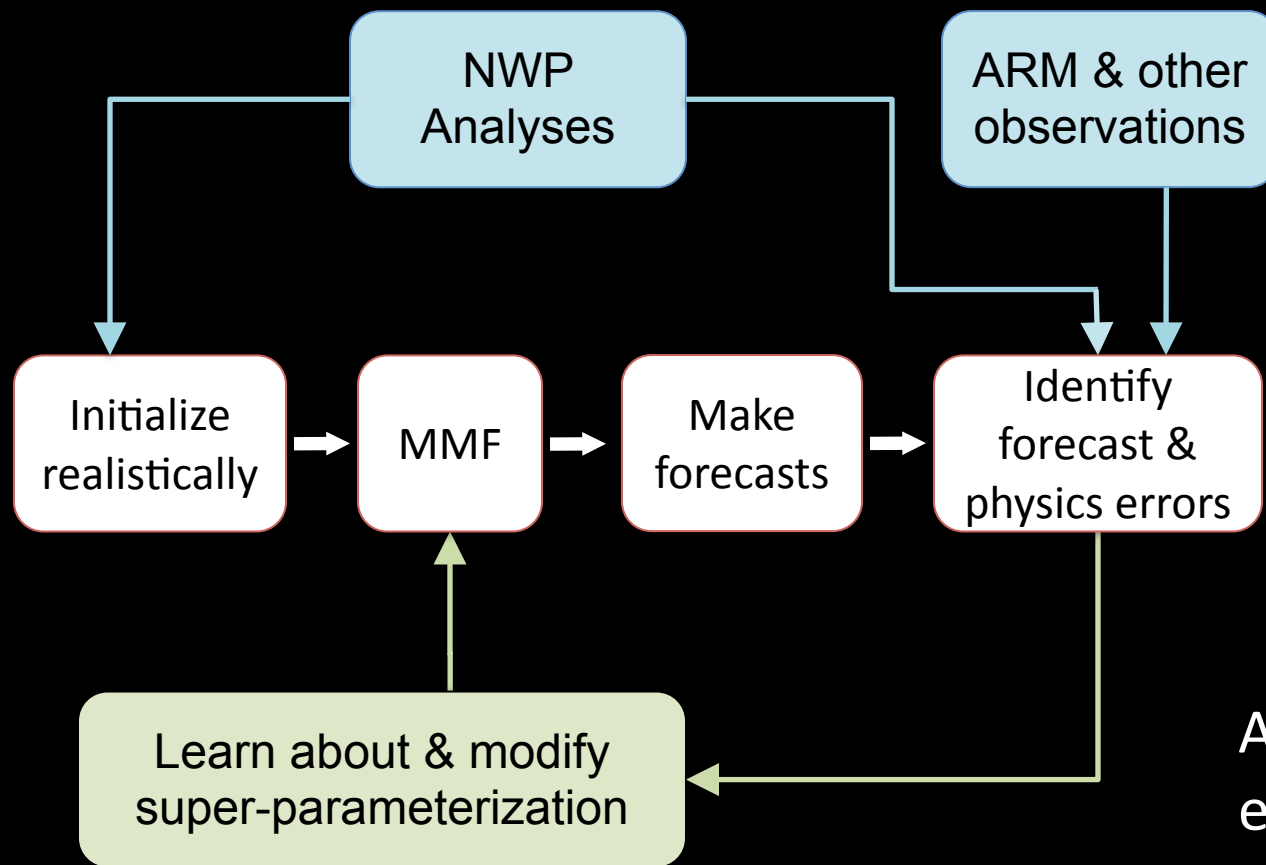
The “Cloud Associated Parameterization Testbed (CAPT) paradigm:



Adapted from Phillips et al., BAMS, 2004

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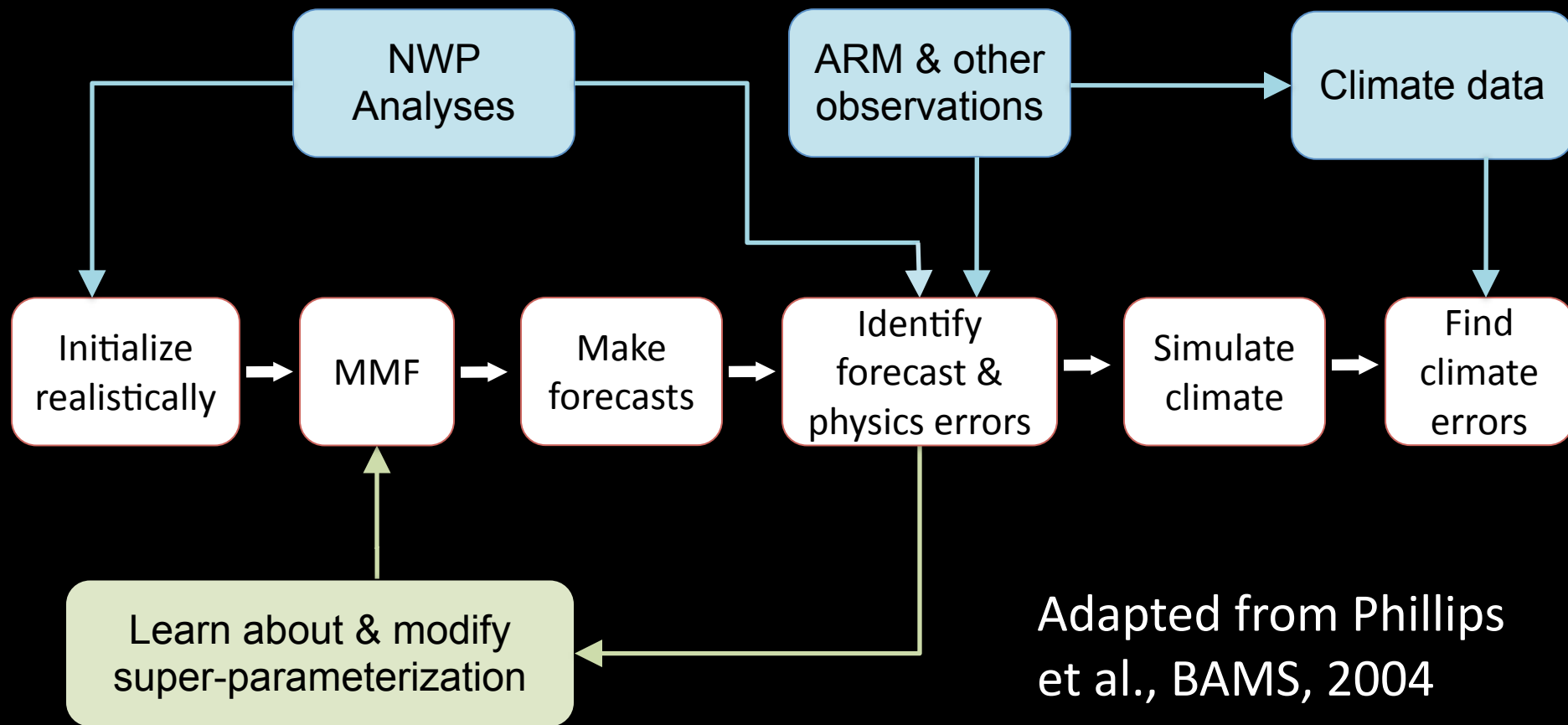
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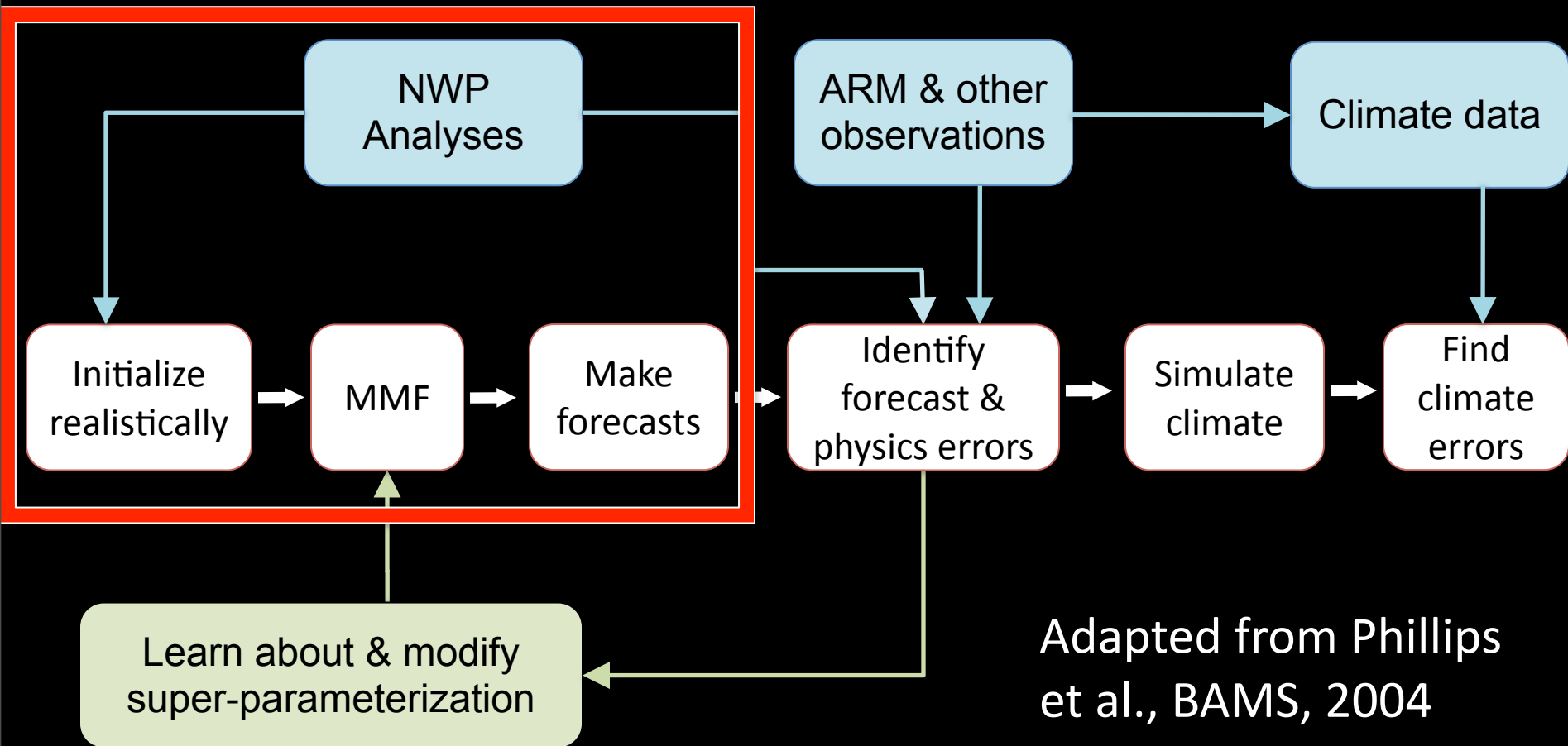
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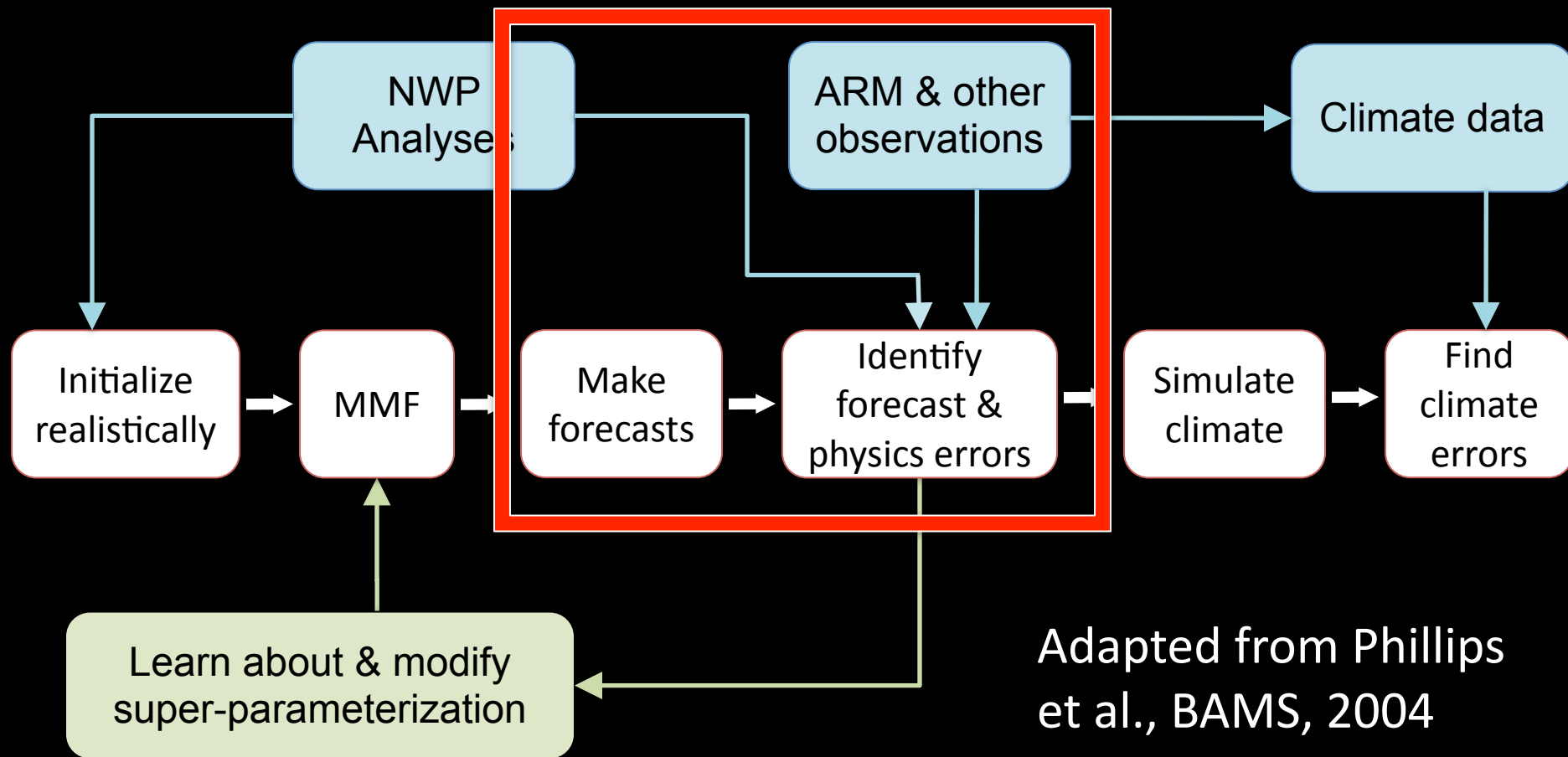
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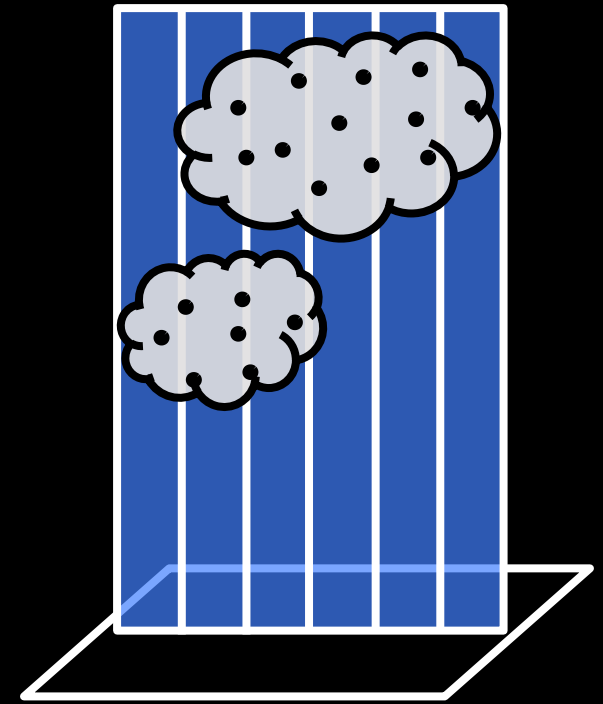
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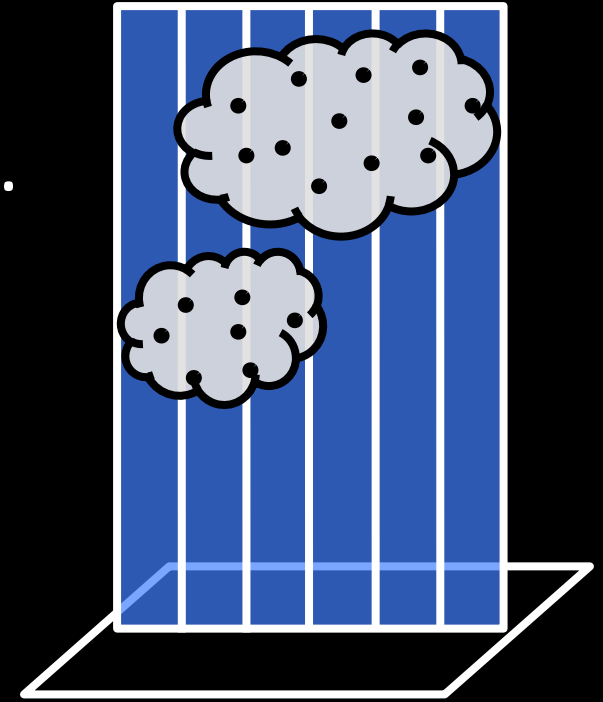
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Problem: How to initialize the interior idealized
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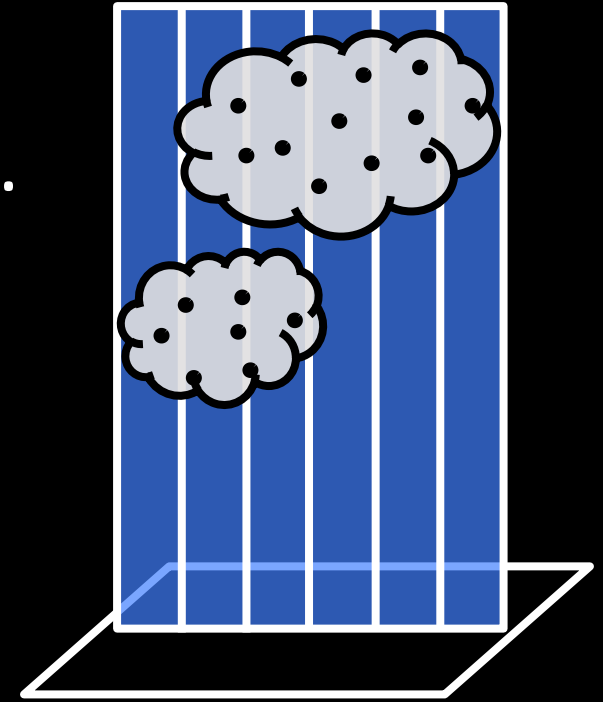
Globe analyses resolution ≈ 50 km.



Problem: How to initialize the interior idealized 2D CRM for MMF forecasts?

Globe analyses resolution ≈ 50 km.

GCM resolution ≈ 200 km. ✓

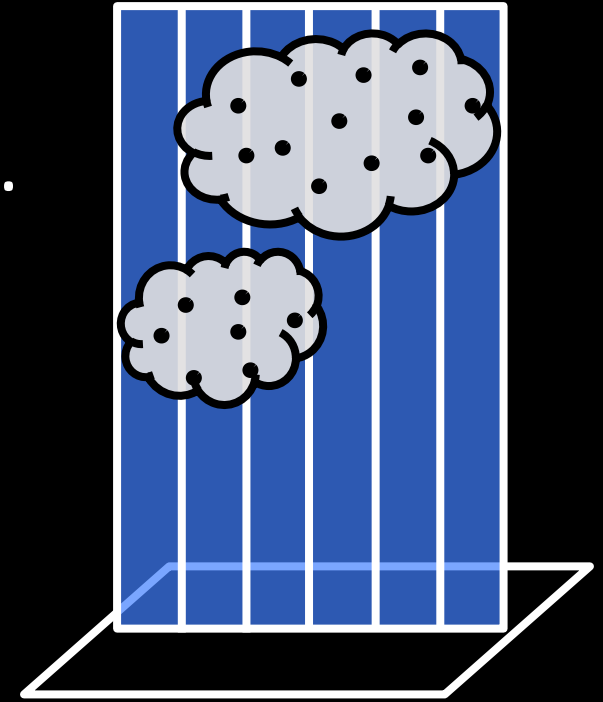


Problem: How to initialize the interior idealized 2D CRM for MMF forecasts?

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CRM resolution ≈ 4 km. ✗

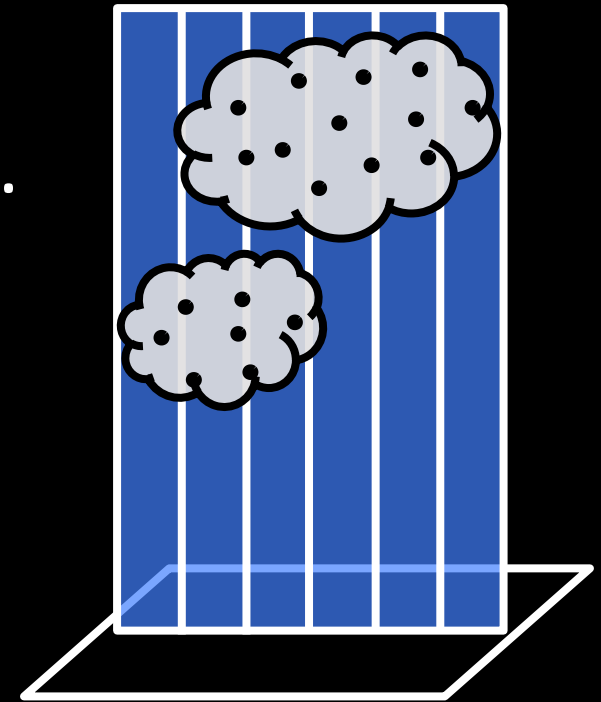


Problem: How to initialize the interior idealized 2D CRM for MMF forecasts?

Globe analyses resolution ≈ 50 km.

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CRM resolution ≈ 4 km. ✗



What would a 2D idealized representation of observations even look like for the MMF's CRM?

Solution: Spin up CRM by nudging exterior model to analyzed observations.

$$\frac{\partial \mathbf{X}_M}{\partial t} = \dots - \left(\frac{\mathbf{X}_M - \mathbf{X}_A}{\tau} \right)$$

Nudging

Resolved Dynamics

Sub-grid Physics/CRM

X = horizontal winds
temperature
specific humidity

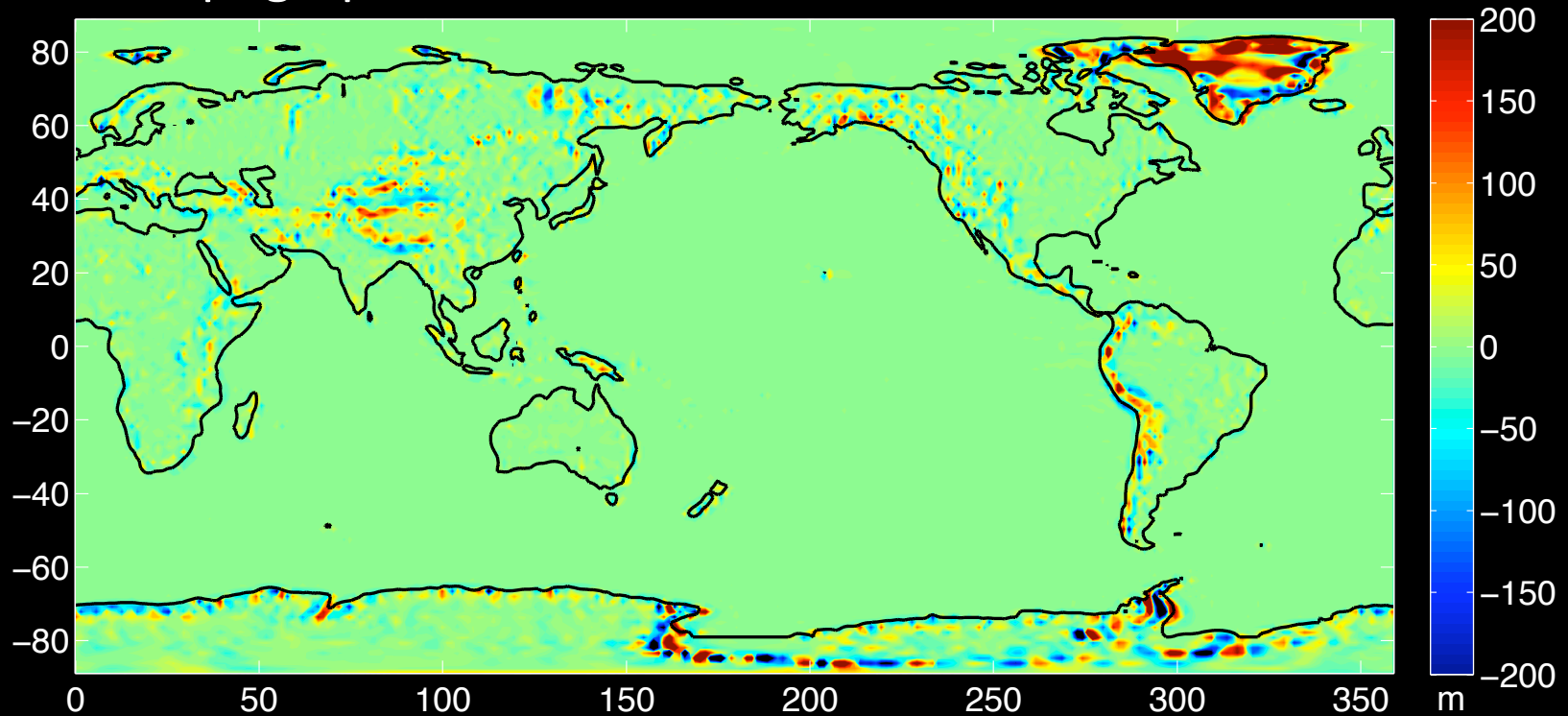
M = model

A = analysis

τ = relaxation time constant

Warning: Forecast quality depends critically on regridding analyses to outer climate model grid.

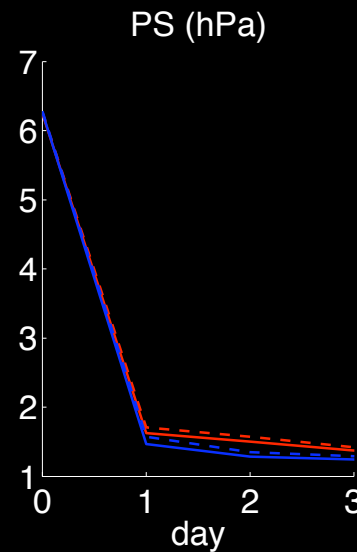
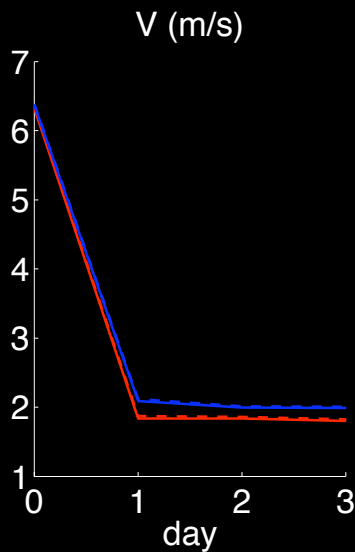
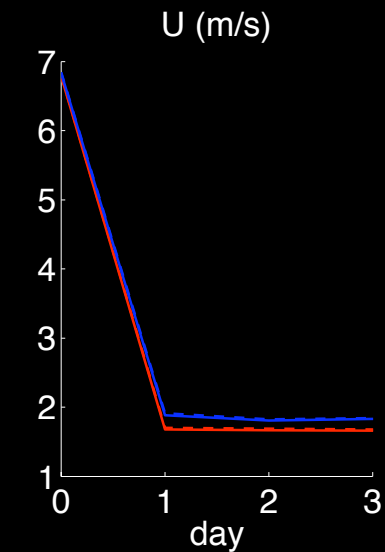
Topographic difference between ECMWF and CAM



Interpolation must account for:

- Orographic and surface pressure differences
- Field specific vertical interpolation
- Artificial supersaturated conditions
- Grid type differences (Gaussian vs finite volume)

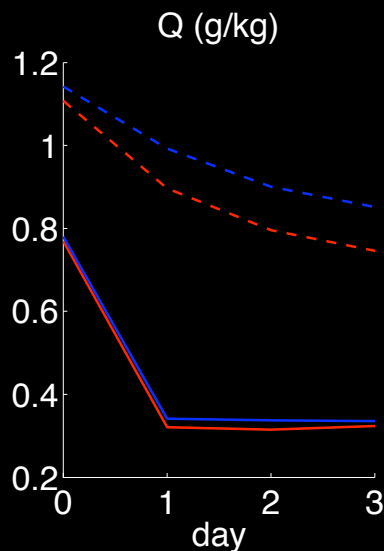
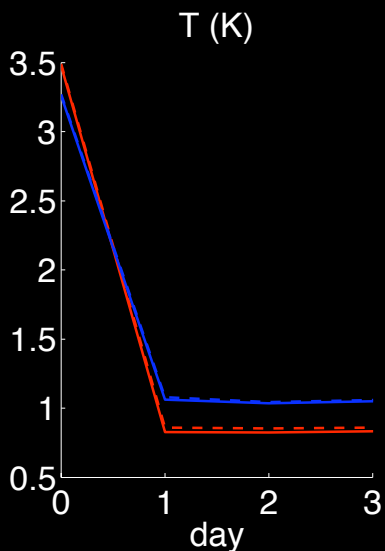
Check 1: With appropriate care, interpolation issues can be overcome...



Root mean square error from CAM experiments:

- Analysis Products:
 - CAM-DART Analysis
 - ECMWF Interim

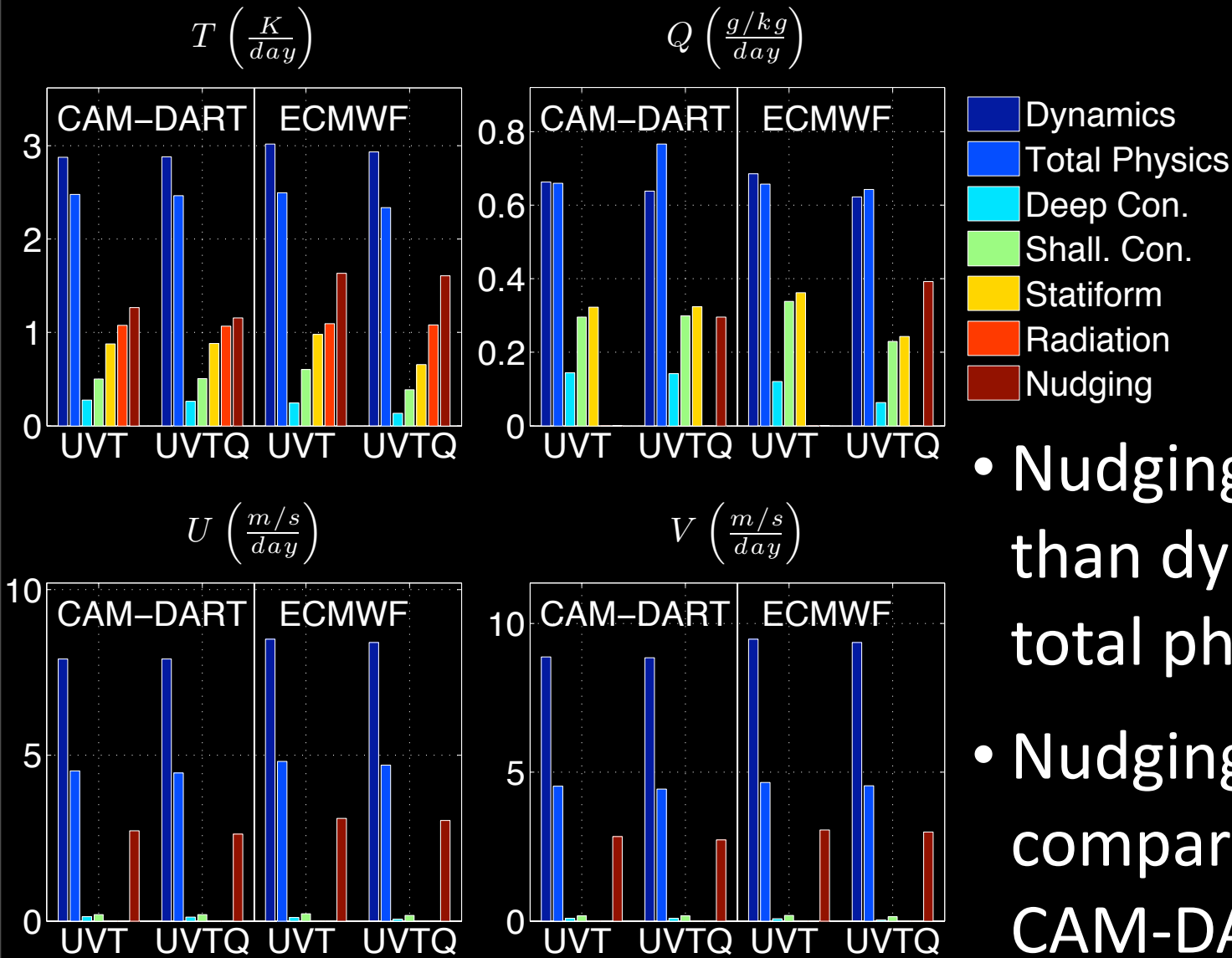
- Nudged Fields:
 - Horizontal Winds
 - Temperature
 - Humidity



- CAM-DART w Q
- - - CAM-DART w/o Q
- ECMWF w Q
- - - ECMWF w/o Q

- Surface pressure error is not effected by humidity nudging.
- ECMWF error is similar to CAM-DART.

Check 2: ...and nudged fields behave well with model - don't dominate other tendencies.

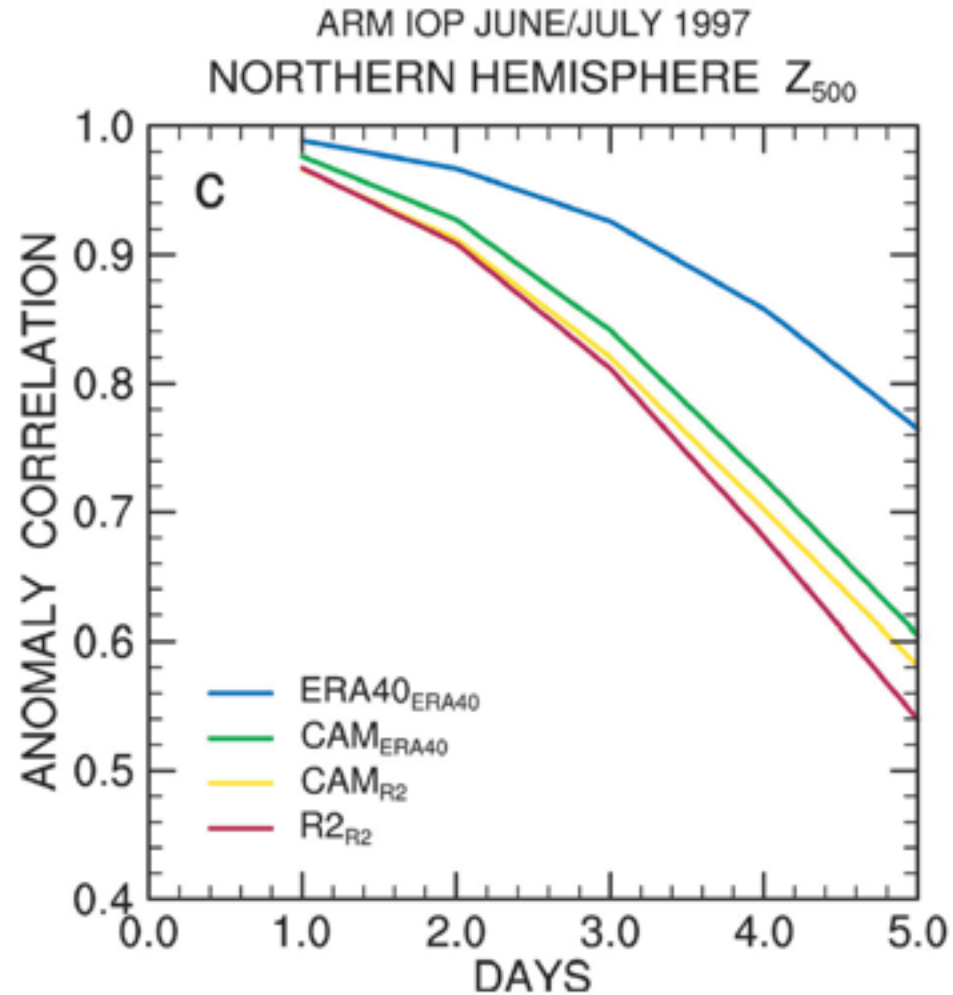
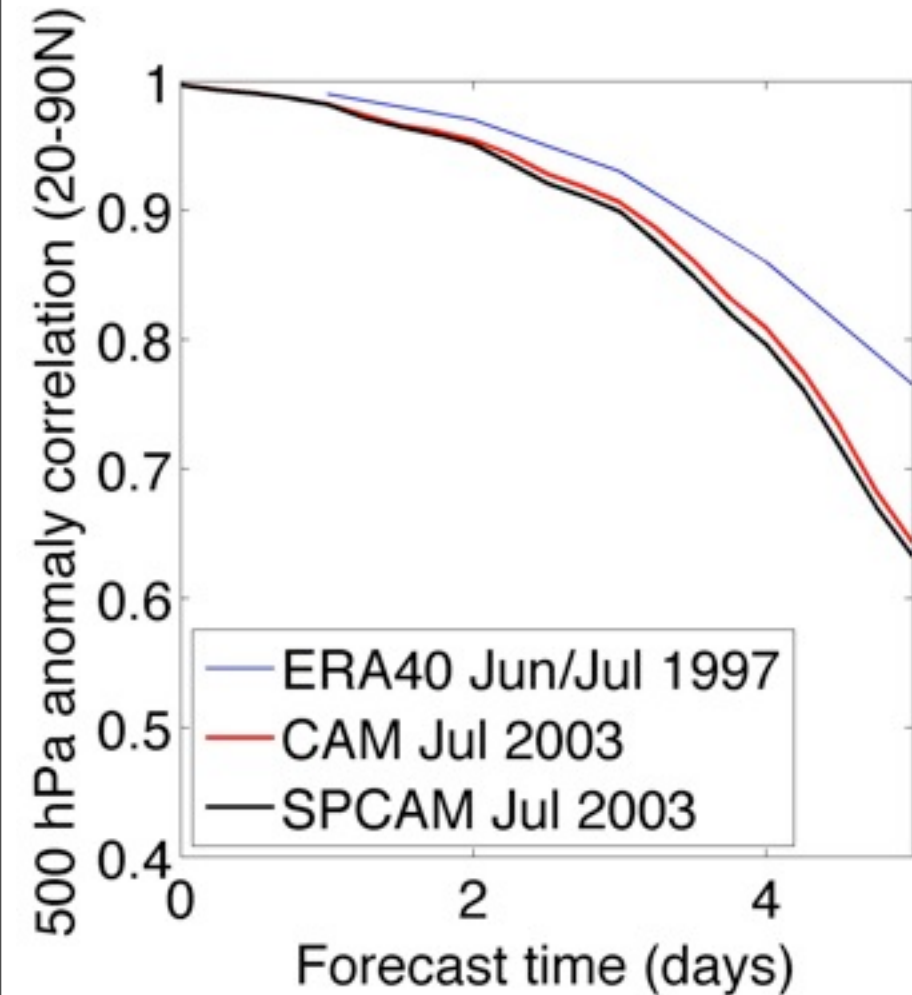


- Nudging is smaller than dynamics and total physics.
- Nudging is ECMWF comparable to CAM-DART.

Skill: SP-CAM can now be run in forecast mode!

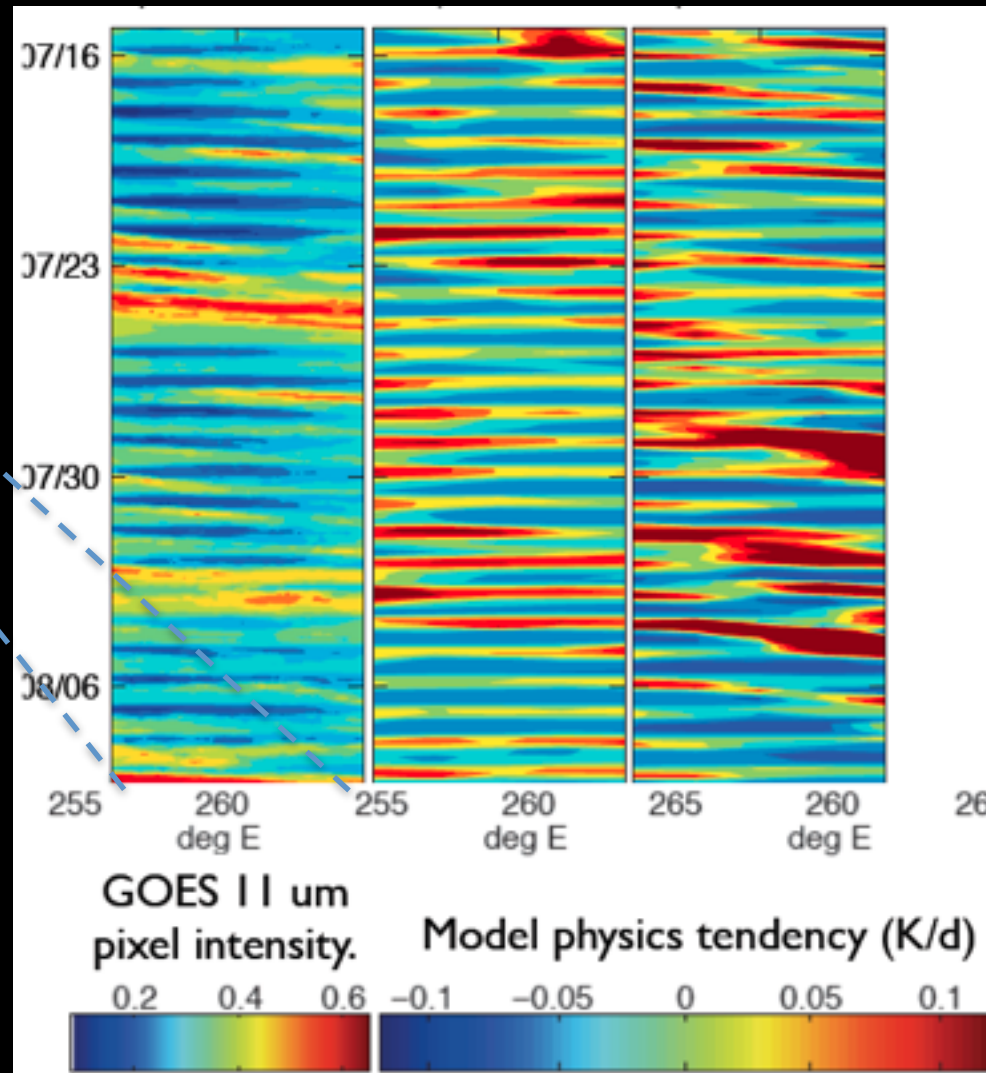
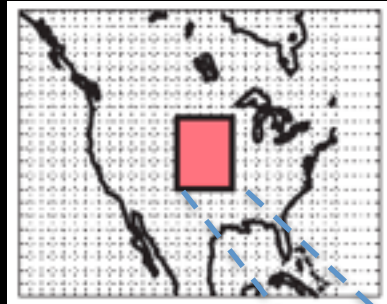
Our result

Phillips et al., BAMS, 2004



We knew SP-CAM3.5 admits orogenic Central US

OBS 2005 CAM3.5 SPCAM3.5

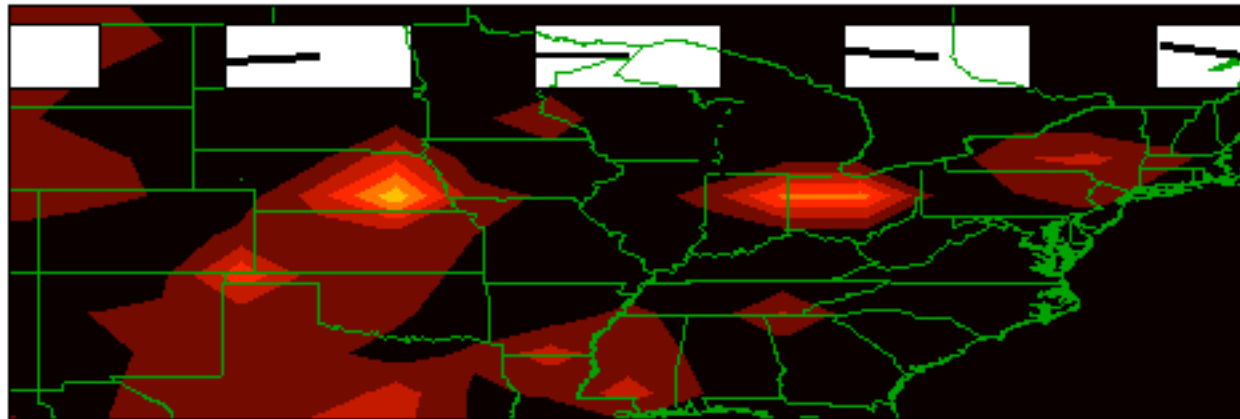


Pritchard et al., JAS, in revision.

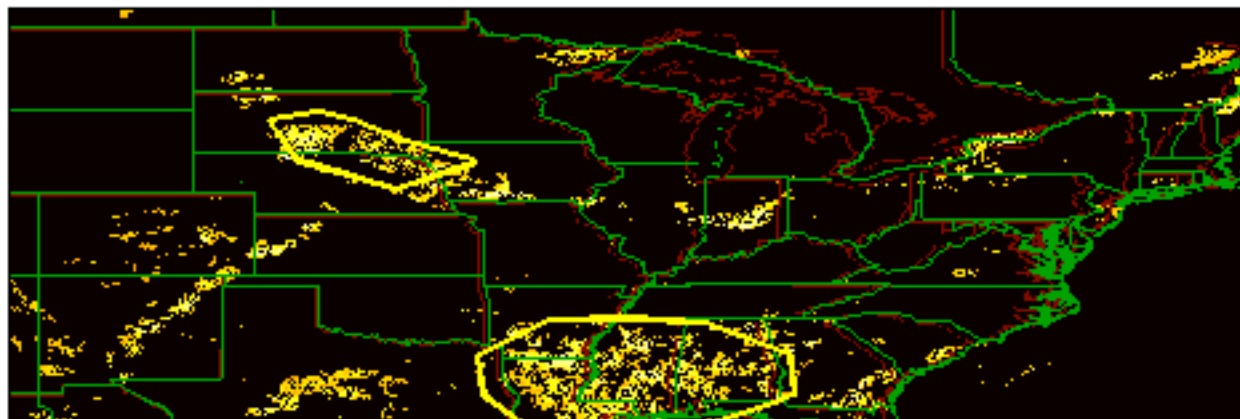
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Forecast hour: 24.0

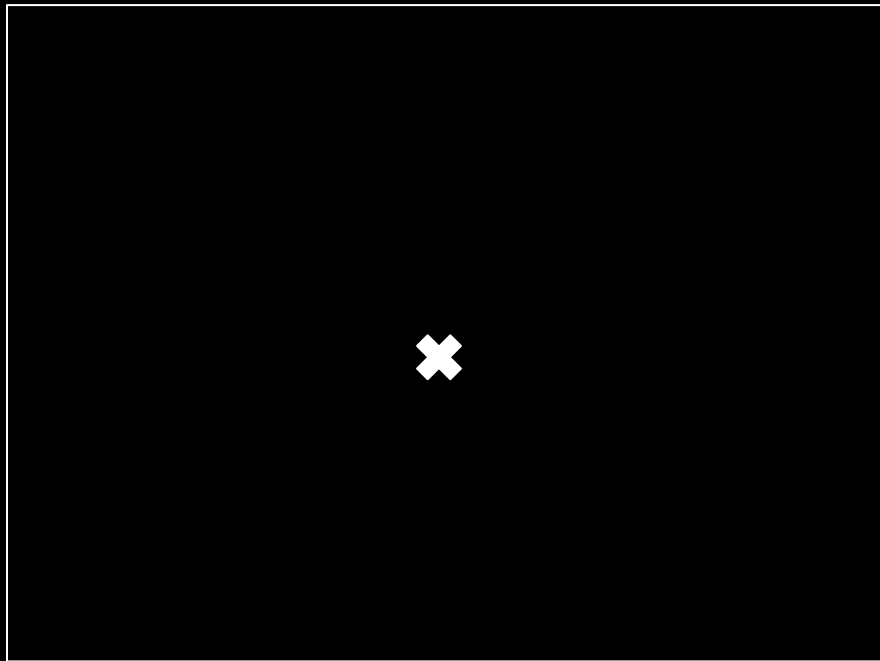


RADAR OBS: 06-Jul-2003

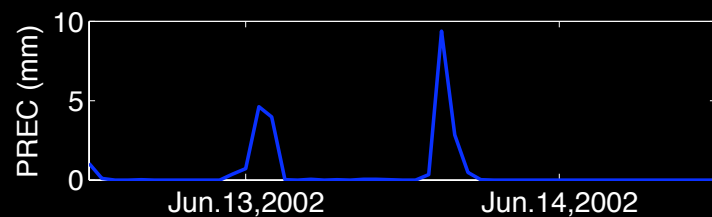
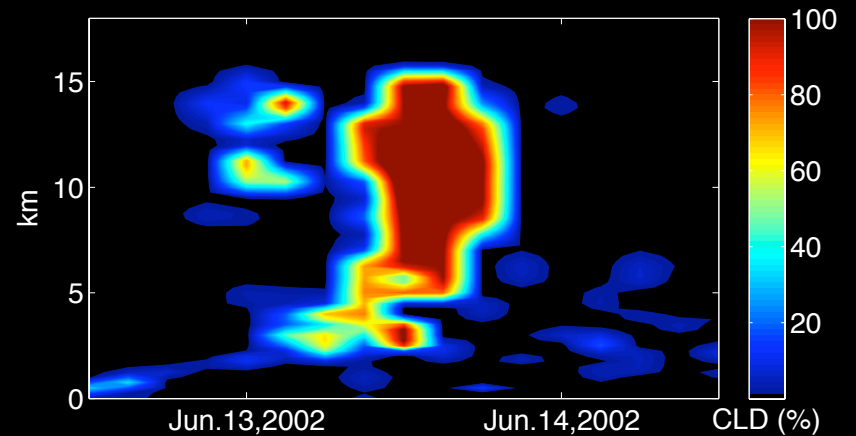
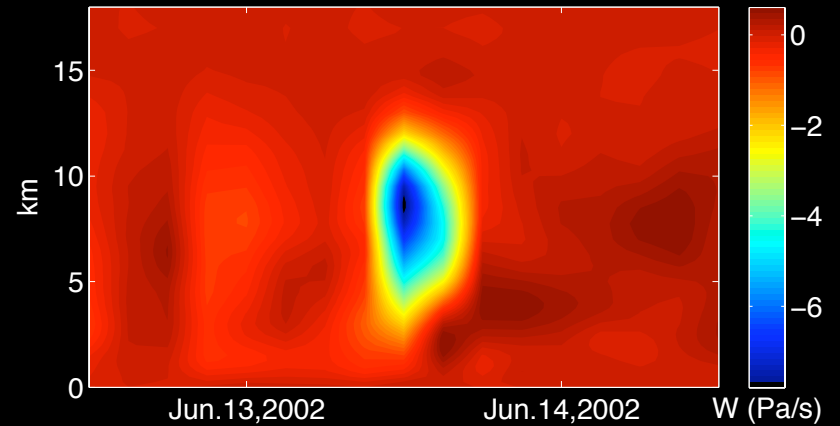
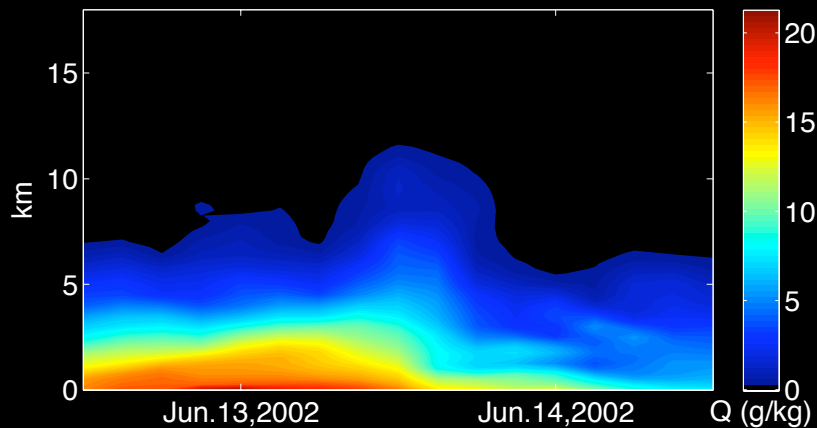


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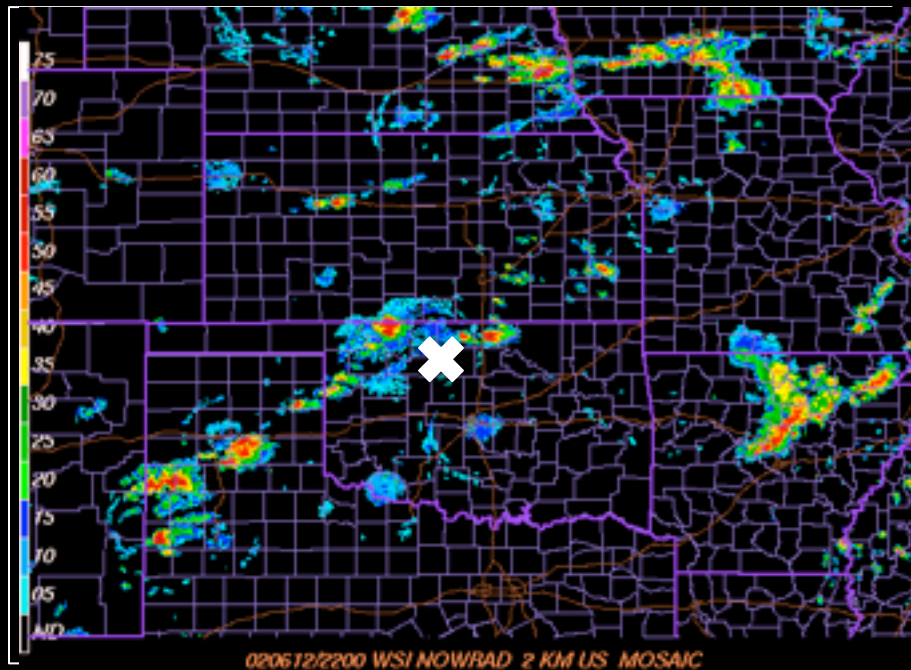
This may open new doors to scrutinize SPCAM cloud biases at the process-level against high quality data.



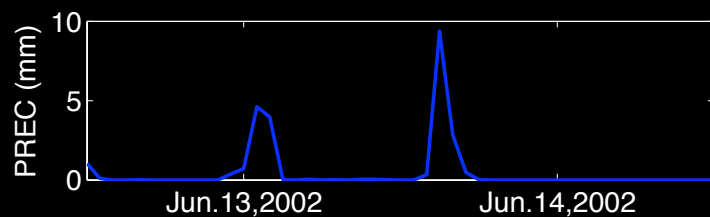
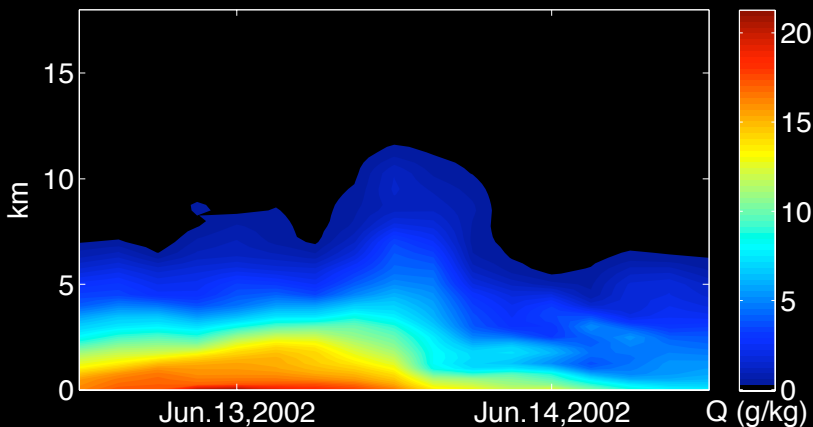
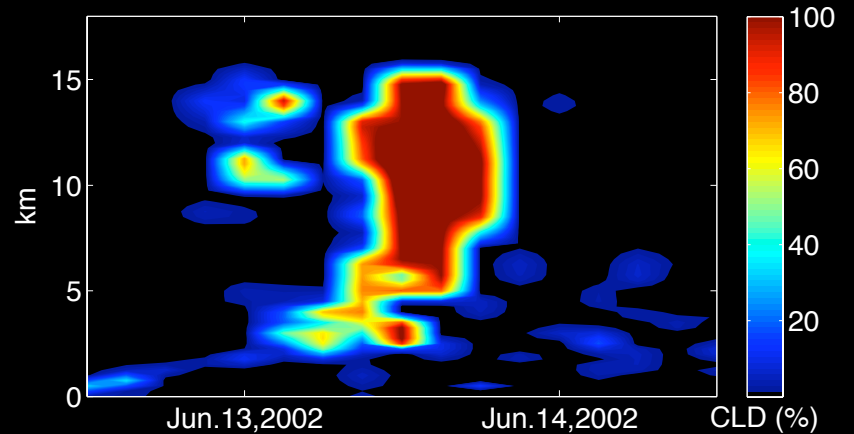
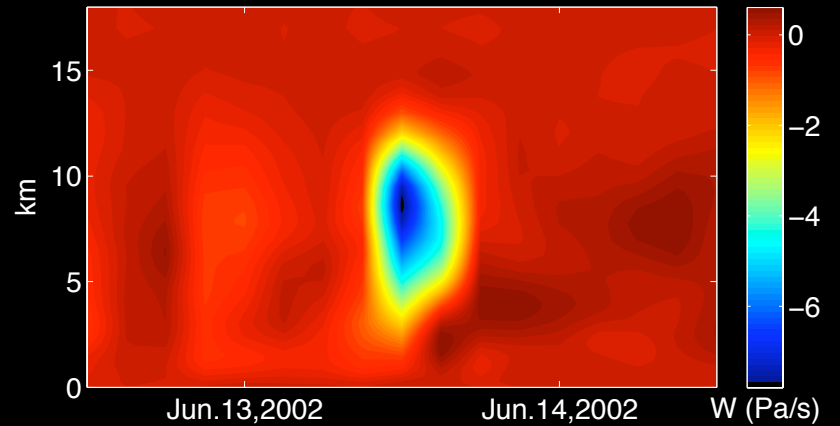
x = ARM SGP Site



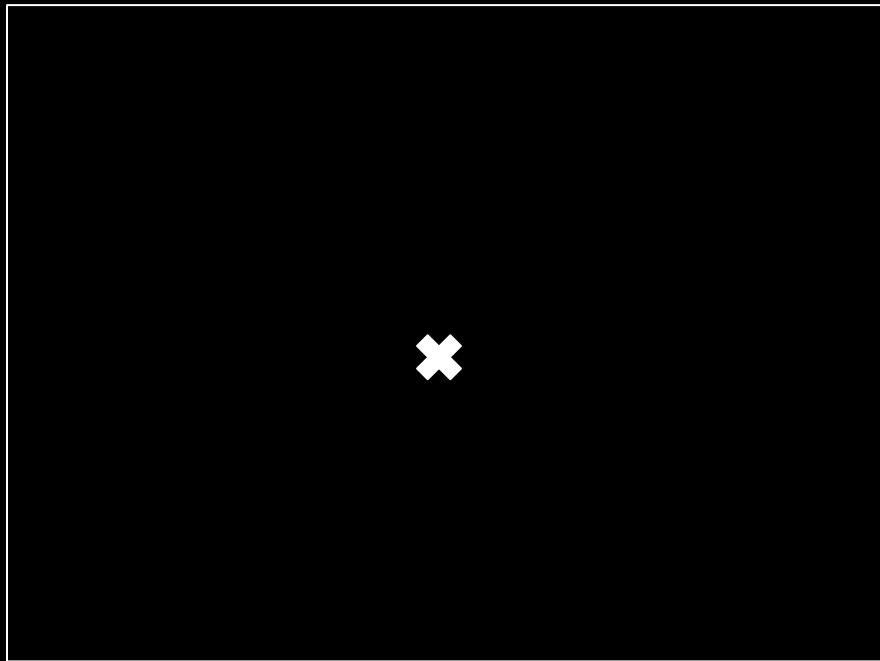
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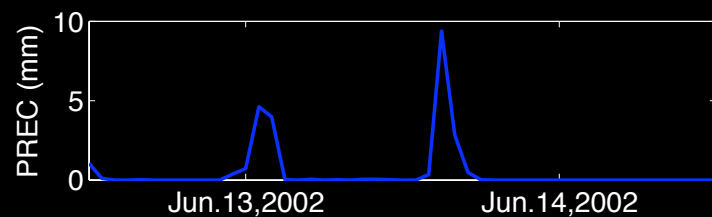
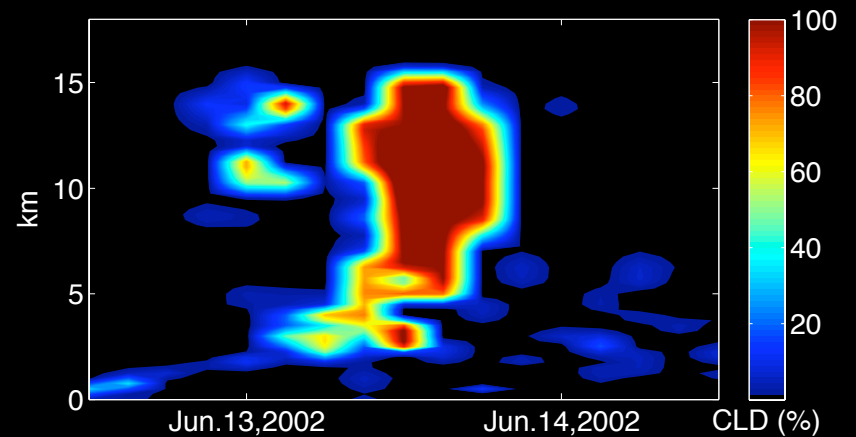
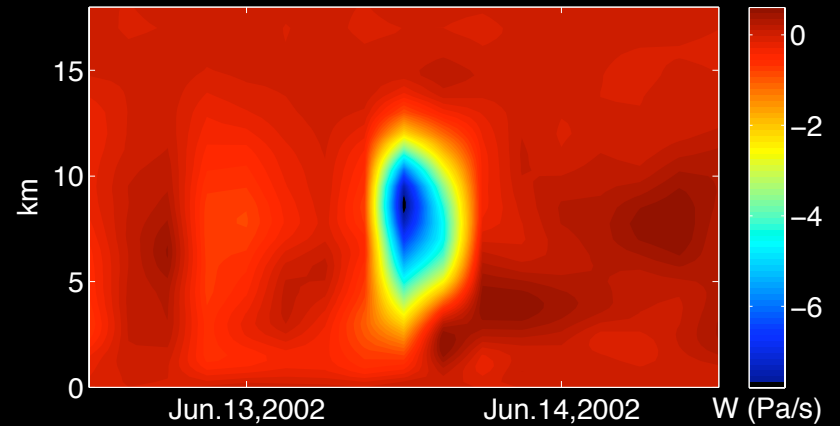
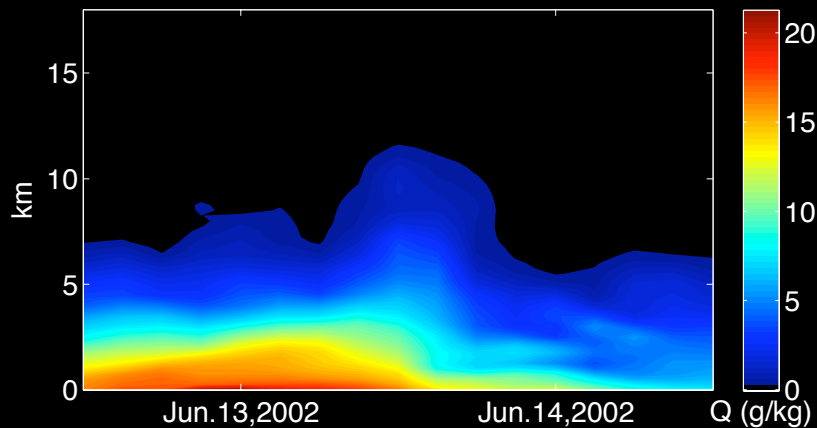
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This may open new doors to scrutinize SPCAM cloud biases at the process-level against high quality data.



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Forecast-SPCAM will be an efficient numerical test-bed, to explore and better understand:

- ❑ SP cloud structure biases
- ❑ Nature of MCS multi-grid propagation mechanism
- ❑ Fidelity of SP Latent heating during TOGA-COARE.
- ❑ Consequences of new SAM turbulence/microphysics once implemented in SPCAM.
- ❑ MJO predictability (YOTC hindcasts)
- ❑ **< your idea here >**