Cloud-Climate Breakout Summary

Peter Blossey (UW)

The role of organization in tropical large-scale, convective interactions

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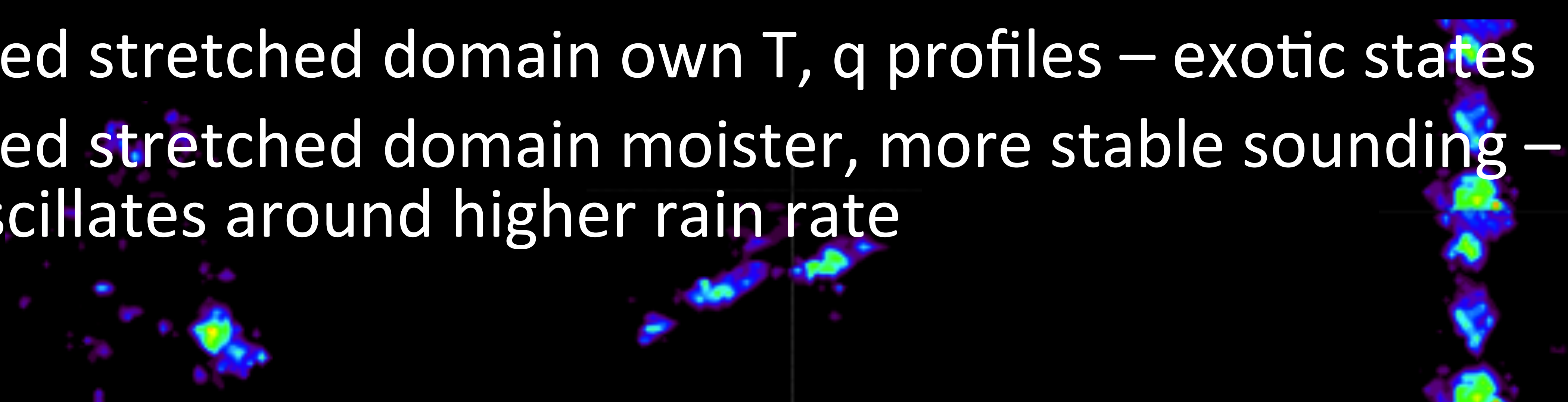
Summary, Conclusion

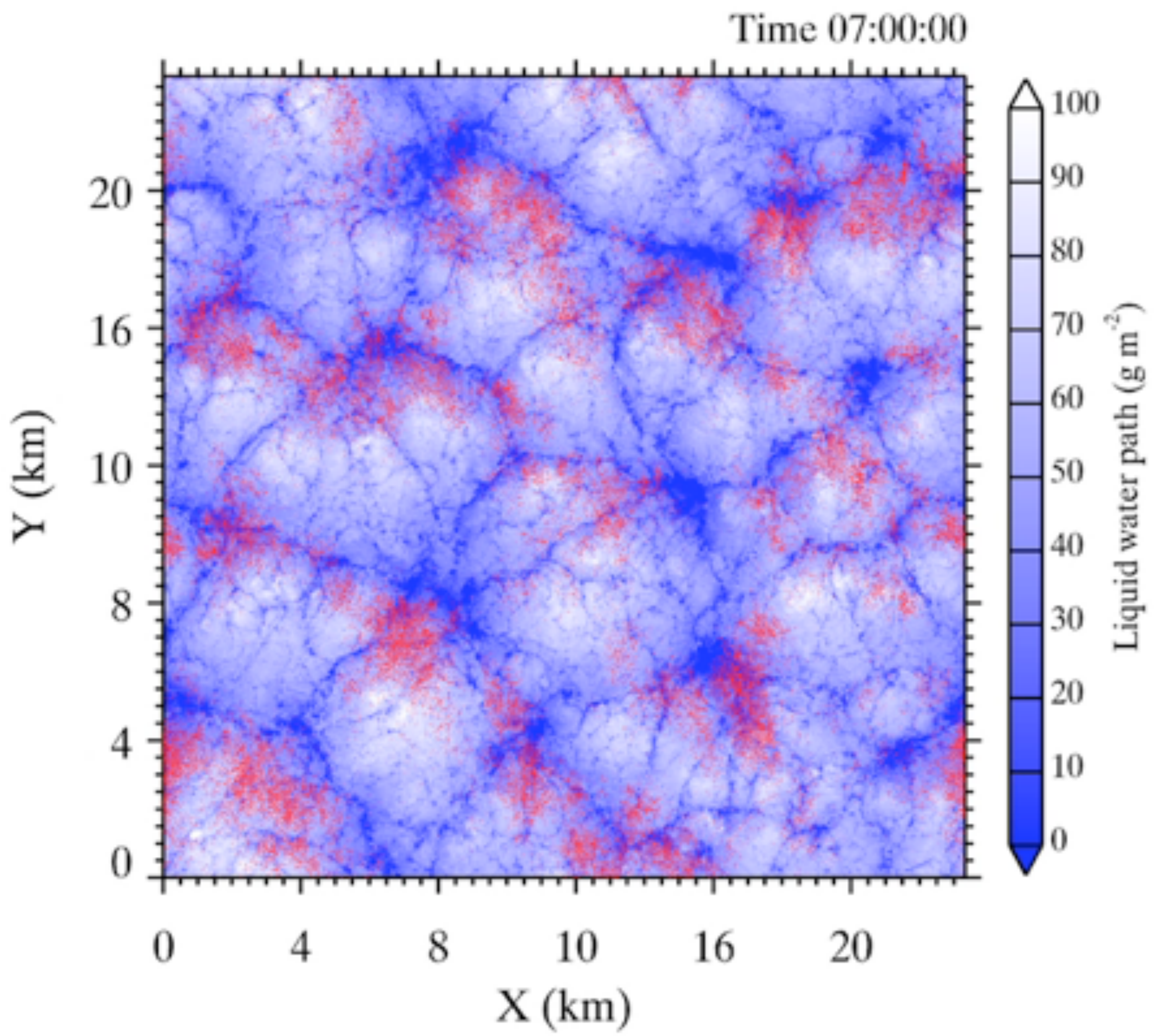
- Goal: Understand organization in coupled convective, LS system
- Approach:
  - Used CSRM with parameterized large-scale dynamics
  - Controlled organization via shear and altering domain shape and size.
- Coupled convective parameterized LS system:
  - more responsive with shear
  - has exotic states in long, narrow domains
- Stretched domains have drier, more unstable mean state
  - feed stretched domain own T, q profiles – exotic states
  - feed stretched domain moister, more stable sounding – precip oscillates around higher rain rate



Relationship between stratocumulus cloud hole size and entrainment

Takanobu Yamaguchi[1,2] and Graham Feingold[2]

Cooperative Institute for Research in Environmental Sciences, University of Colorado
NOAA Earth System Research Laboratory, Boulder CO



Horizontal position tracking for the parcel entrained at 7:40

- Cloud *hole* sizes follow a negative power-law much like trade cumulus cloud sizes.
- Small cloud holes are very numerous while large cloud holes are very small in number. ($y \propto x^{-1.8}$)
- Larger cloud holes entrain more efficiently than smaller cloud holes. ($y \propto x^{1.0}$)

➡ On balance, **entrainment occurs preferentially in smaller cloud holes**. ($y \propto x^{-0.8}$)

- The same conclusion is also obtained with cloud hole perimeter.

Intrinsic predictability insensitivities of the super-parameterized MJO

Mike Pritchard (UW), In collaboration with C. Bretherton, T. Ackerman, R. Marchand

Take-home points

- Mesoscale organization may not be a critical link in how SPCAM couples large scale intreasonal convection and tropical circulation.
  - Intrinsic predictability insensitive to CRM initialization, domain size, dimensionality & CMT.
- Intrinsic predictability of the SPMJO is disrupted by weak white noise.
- 4x MMF speedup seems possible using tiny CRMs.
- SPCAM does not have much useful forecast skill if initialized with ERA-I reanalyses. Drift is an issue.

Motivates a closer look at SPCAM's MJO in new free-running tiny-CRM configurations...

So what hurt the SPMJO in SPCAM versions since 3.0?

Is the ***FV dycore*** *the culprit?...* **No.**

*Were updates to the CRM in 3.5 the culprit**? Marat:*** **No.**

Inference: *Changes in the exterior host model are responsible.*

Logical path to understanding:
Sysematically search CAM version repo to find breaking point.

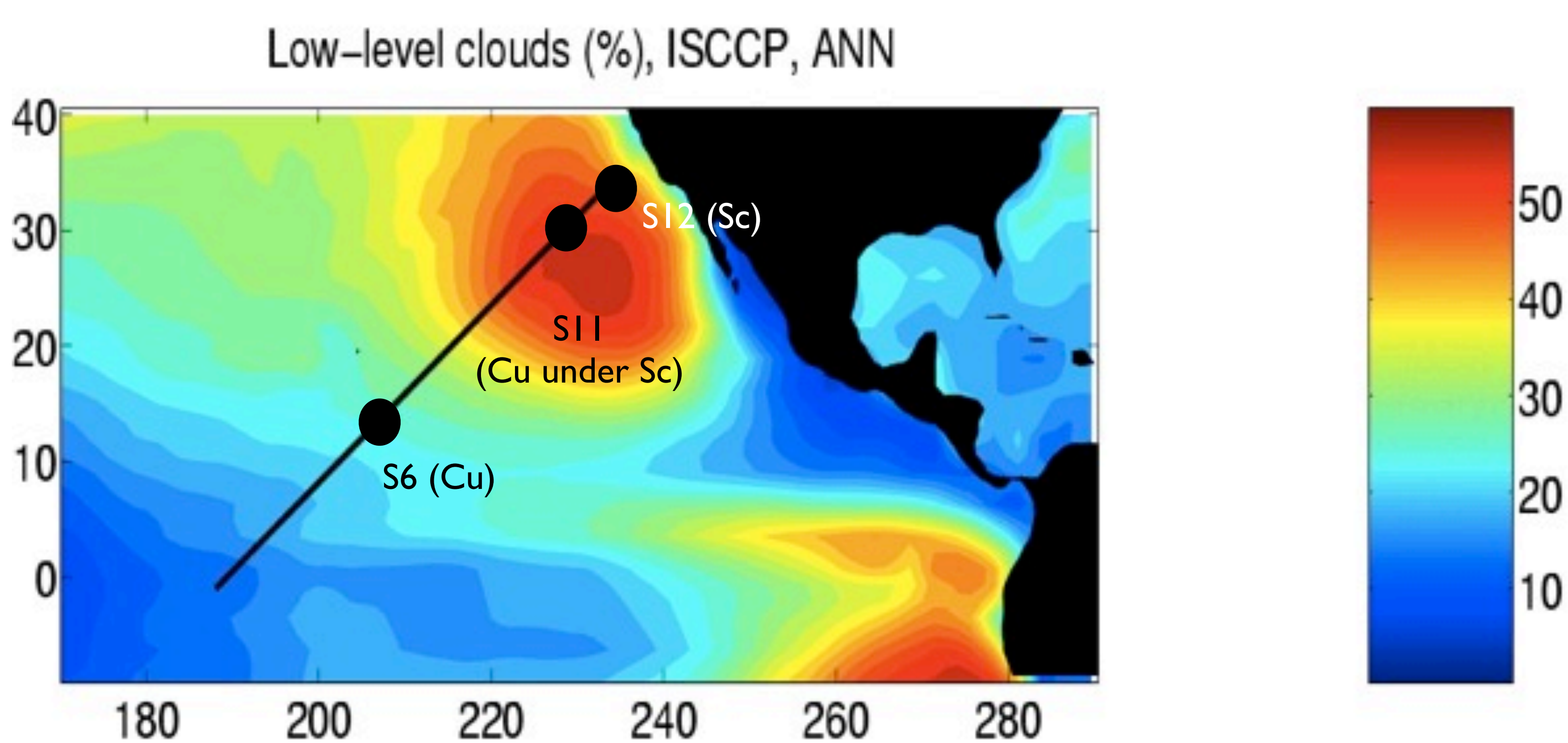
CAM tag circa. "SPCAM3.0" ⟷ CAM tag circa. "SPCAM3.5"

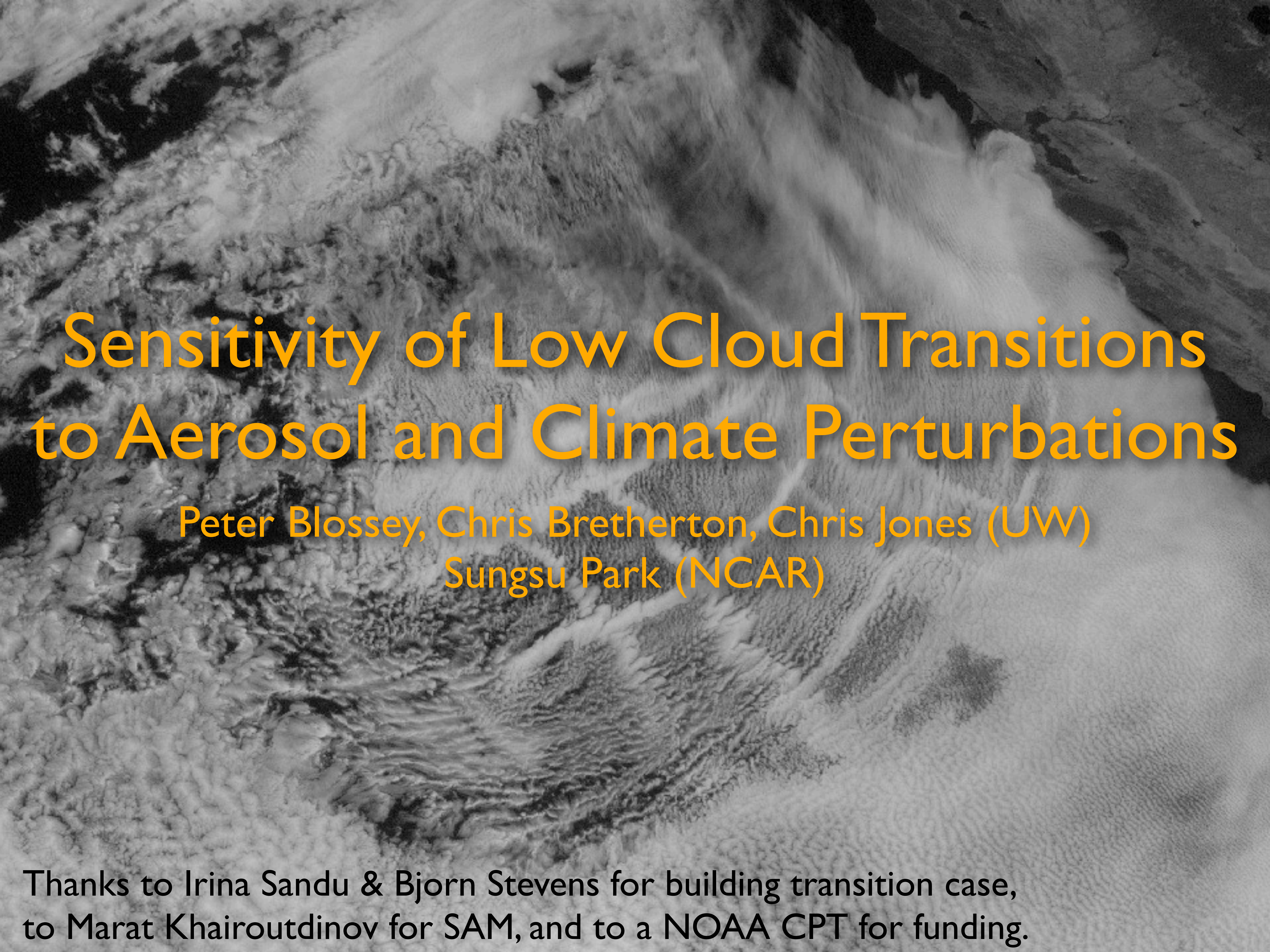
↓

binary revision search
re-test SP

CGILS Update/Plans (Peter Blossey, UW)

1. Have LES models all run cases (S12, S11, S6) with 4xCO2 and with composite changes based on the CMIP3 multi-model mean.
   - Steady forcings w/diurnally-averaged insolation.
2. Have a few LES models and the SCMs run longer (multi-month) simulations at trade cumulus location (S6) using transient forcings (ECMWF July).
   - SCM simulations with steady forcings suffered from grid-locking, making interpretation of climate sensitivity quite difficult.
   - Transient forcing (e.g., Brient & Bony, 2012) can produce a cloud climatology similar to model and may make comparison between LES and SCM easier.
   - May also facilitate comparison to observations.





Sensitivity of Low Cloud Transitions to Aerosol and Climate Perturbations

Peter Blossey, Chris Bretherton, Chris Jones (UW)
Sungsu Park (NCAR)

Thanks to Irina Sandu & Bjorn Stevens for building transition case, to Marat Khairoutdinov for SAM, and to a NOAA CPT for funding.

Conclusions of Nd Sensitivity Study

- LES of marine low cloud transition show interesting sensitivity to cloud droplet number concentration (Nd), with thicker cloud for smaller Nd.
- This seems to be related to the effects of both sedimentation and drizzle on entrainment.
- SCAM5 shows the opposite sensitivity to Nd, with thicker cloud at higher Nd.
- Another LES model (Sandu & Stevens, 2011) shows a similar sensitivity to SCAM5, but that model dries the boundary layer through surface precipitation, while SCAM5 doesn't precipitate at the surface.
- We're still working to understand this sensitivity.
- Note that AM3-CLUBB (Guo et al, 2011) does a good job of reproducing Nd sensitivity of Sc clouds from Ackerman et al (2004).

Conclusions

- Preliminary exploration of climate sensitivity of marine low cloud transitions indicates positive low cloud feedbacks for the conditions studied here.
- Warming and direct effect of CO_2 act to thin cloud, consistent with results seen in CGILS.
- Stability increases offset cloud thinning, though expected EIS changes in subtropics are smaller than simulated here (0.5-1 K).

Future Plans

- These transition simulations don't actually simulate the full breakup of inversion cloud.
- We are constructing a six-day Lagrangian transition case based on the median trajectory of Sandu, Stevens & Pincus (2010).
- We will explore effects of warming, CO2, stability and subsidence changes both separately and together, as in Bretherton et al (2012).
- Simulate case in both LES and single-column models. Will they agree better for perturbations to climate than they do for aerosols?