

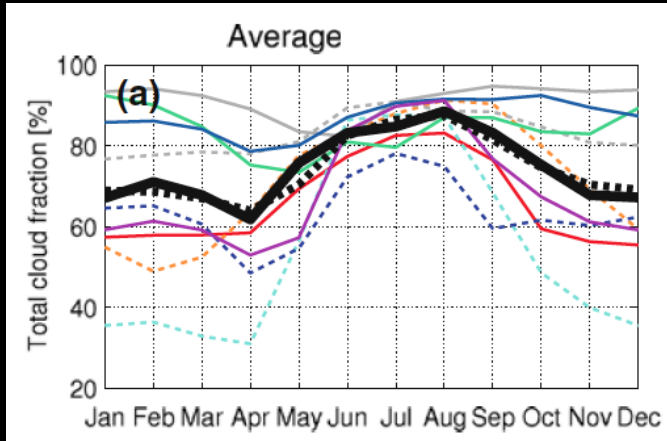
Arctic Synoptic Regimes: Comparing domain wide Arctic cloud observations with CAM4 and CAM5 during similar dynamics

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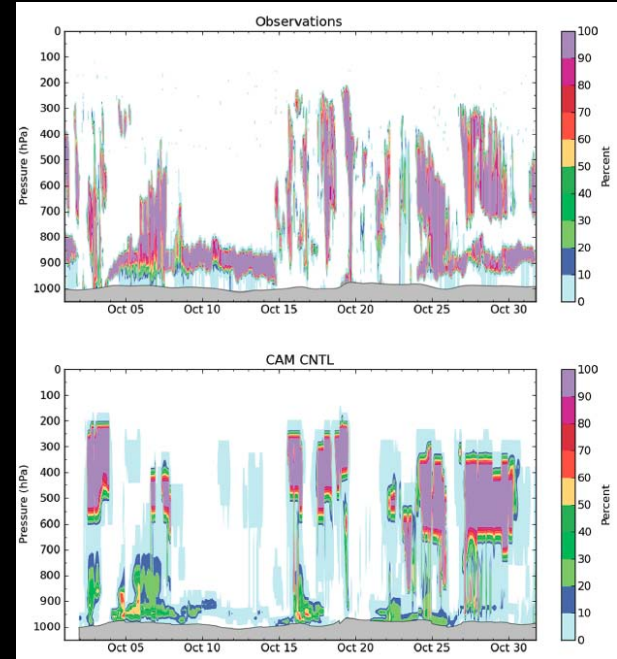
Motivation

Arctic Average Comparisons



Karlsson and Svensson (2011)

Case Study Comparisons



Gettelman et al. (2011)

**Bridging the gap: Analyze
GCM Arctic cloud production
over a large domain with a
knowledge of the dynamics.**

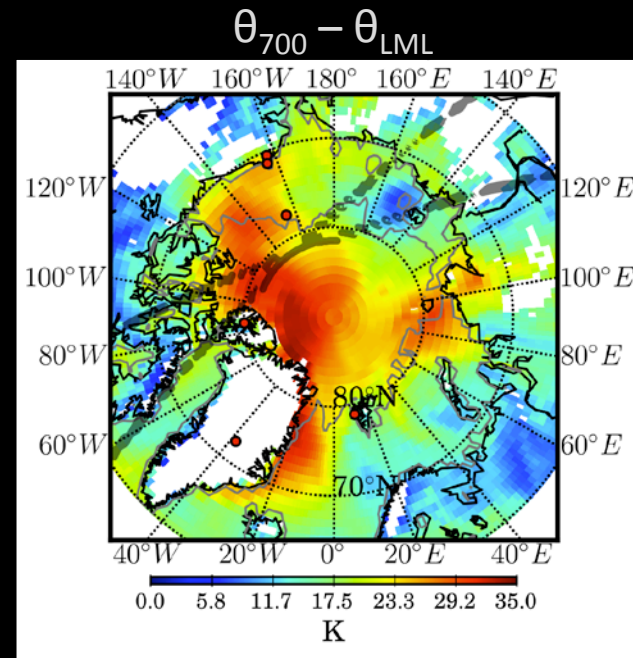
Data and Models

- Analysis and Model Initialization Data
 - ECMWF Year of Tropical Convection (YOTC) Analysis; ERA-YOTC
 - April 2008 to February 2010
 - Interpolated to 3 hour temporal resolution (original 6)
 - Interpolated to 1.25° Longitude by 0.94° Latitude
- Cloud Data
 - GCM Oriented CALIPSO Cloud Product
 - Cloud fractions calculated along-track at 3-hour temporal resolution
 - About 2 passes every 3 hours
- CAM4 and CAM5 run in *forecast* mode
 - Initialized from the ERA-YOTC analysis, Reynolds SSTs, and NCEP sea-ice
 - CALIPSO cloud simulator
 - Day 2 output analyzed

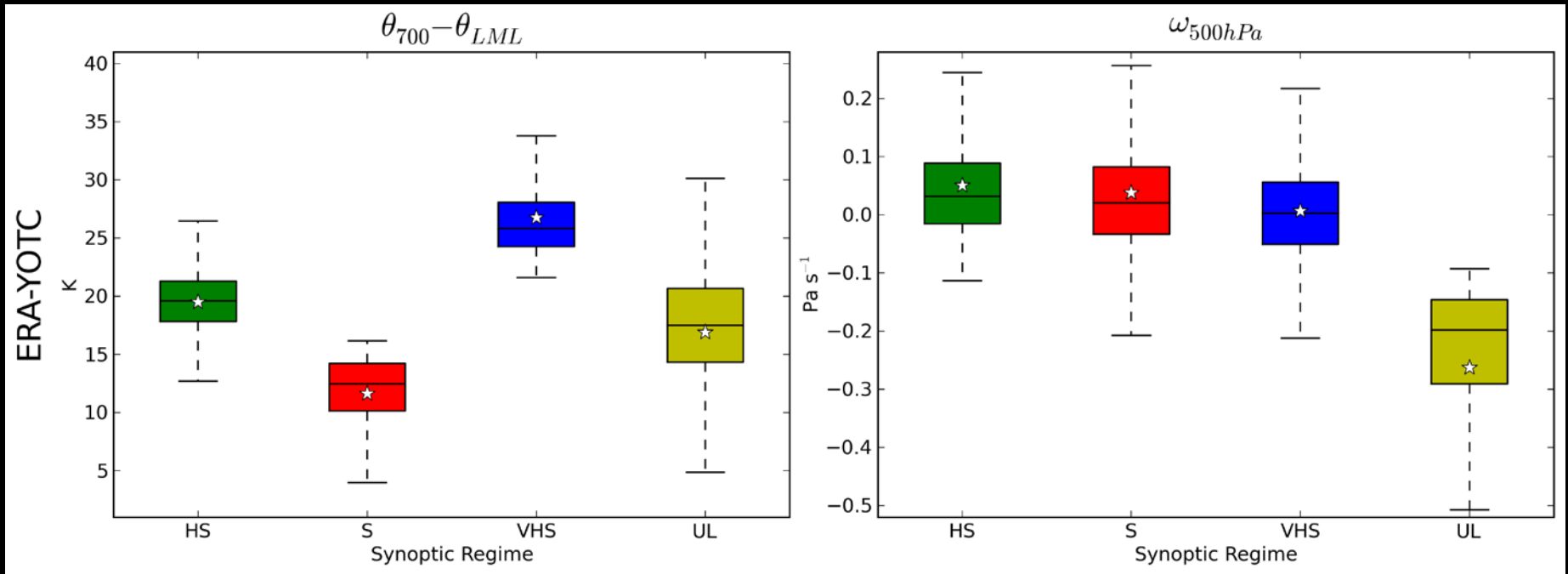
Synoptic Regimes: A K -means clustering approach

Input Variables:

$$\theta_{700} - \theta_{\text{LML}}$$
$$\omega_{500}$$



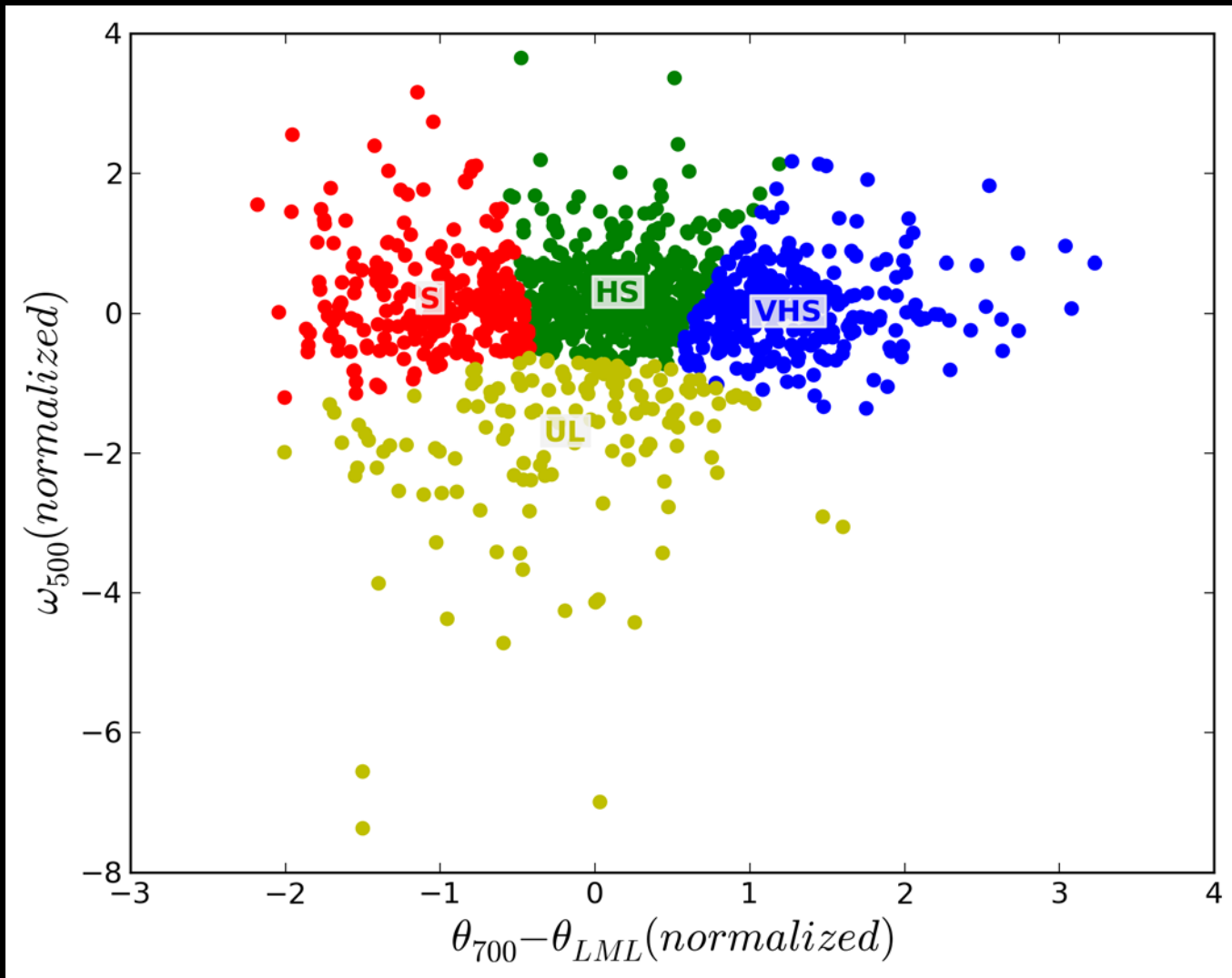
- Largely followed Rossow *et al.* 2005 to determine number of clusters



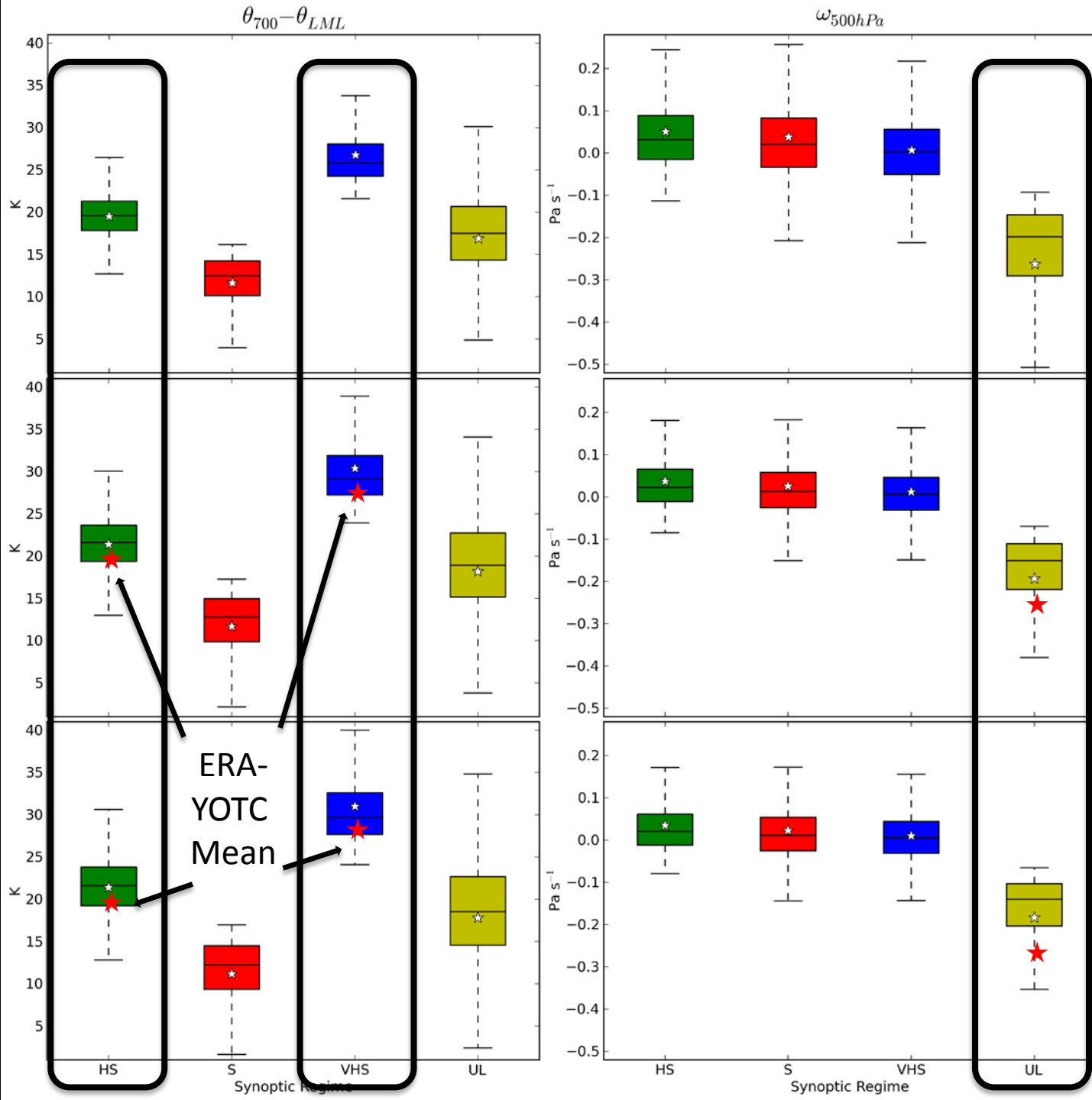
HS = High Stability Regime; S = Stable Regime; VHS = Very-High Stability Regime; UL = Uplift Regime

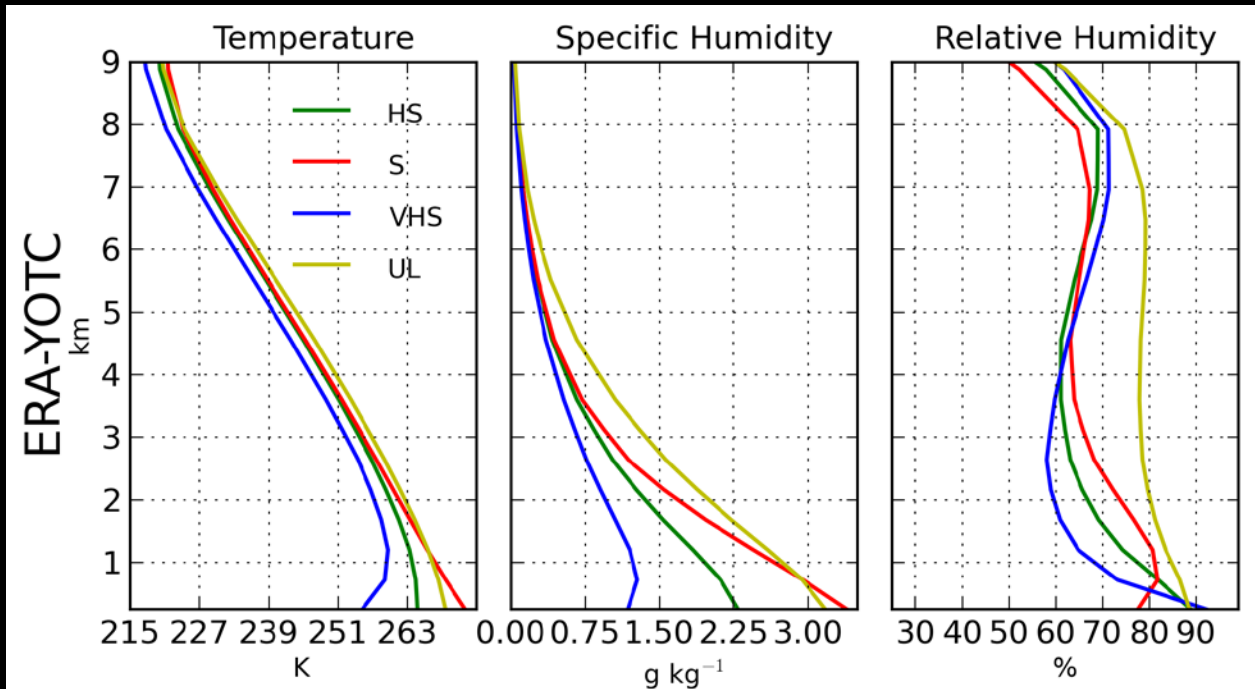
Frequency of Occurrence: HS = 36%, S = 29%, VHS = 24%, UL = 11%

- Assigned GCM clusters by determining the minimum Euclidean distance between the ERA-YOTC cluster centroids and the $\theta_{700} - \theta_{LML}$ and ω_{500} in the GCMs



CAM5 CAM4 ERA-YOTC





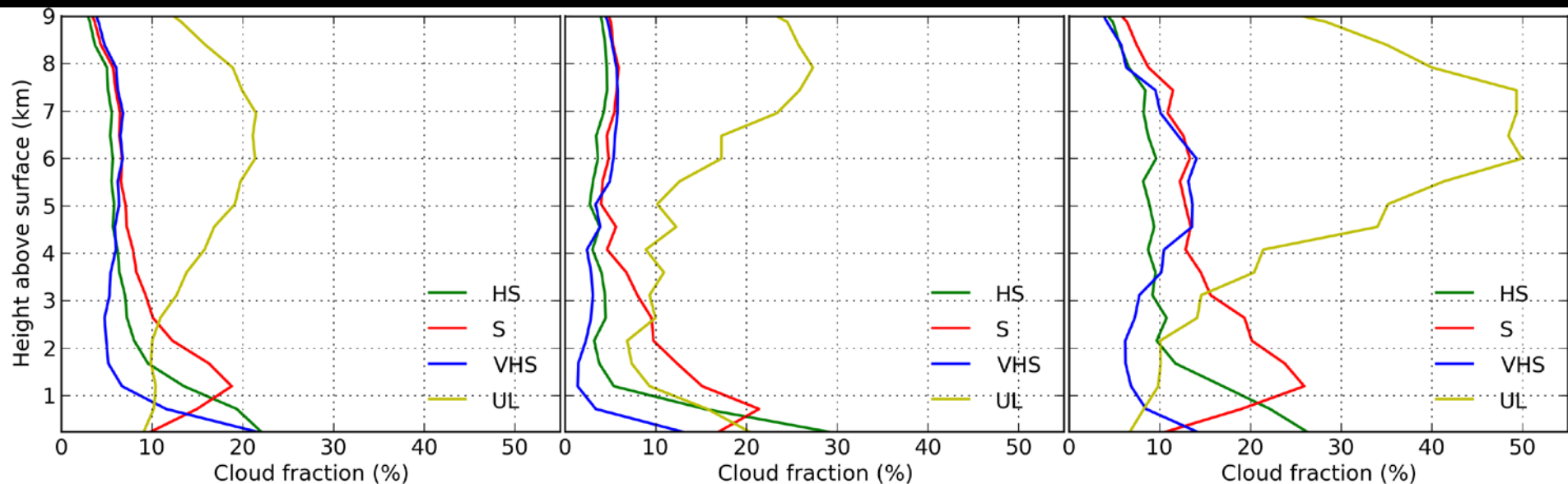
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CALIPSO simulator

CALIPSO

CAM4

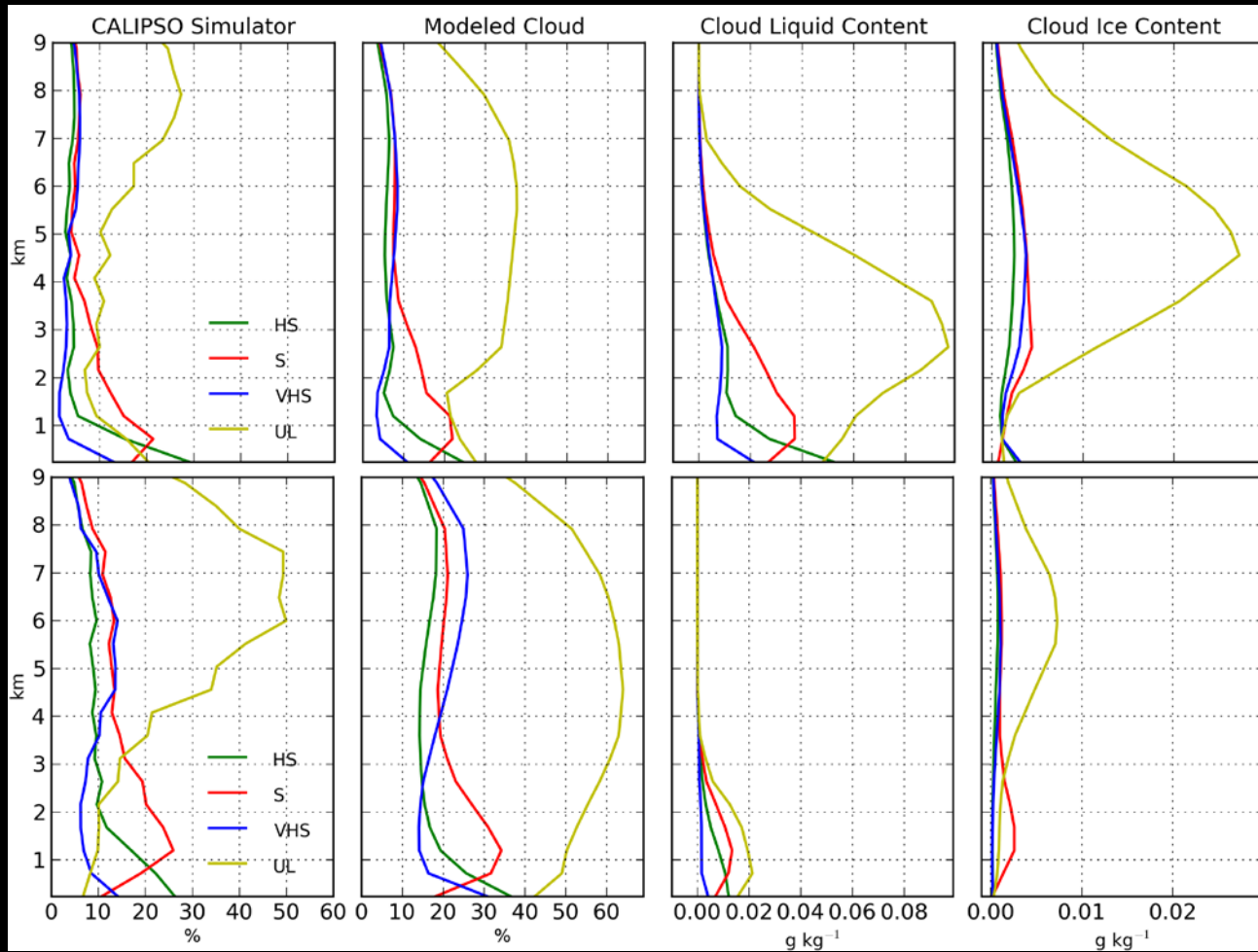
CAM5



HS = High Stability Regime; S = Stable Regime; VHS = Very-High Stability Regime; UL = Uplift Regime

CAM4

CAM5



HS = High Stability Regime; S = Stable Regime; VHS = Very-High Stability Regime; UL = Uplift Regime

LWPs

Eureka, Canada	Observations (g m⁻²)	CAM4 (g m⁻²)	CAM5 (g m⁻²)
HS	16.4	69.4	15.5
S	30.8	200.5	21.7
VHS	6.4	22.1	0.0
UL	64.9	220.2	6.1

HS = High Stability Regime; S = Stable Regime; VHS = Very-High Stability Regime; UL = Uplift Regime

Is the Cloud Response to Changes in Sea Ice dependent on the Thermodynamics and Dynamics?

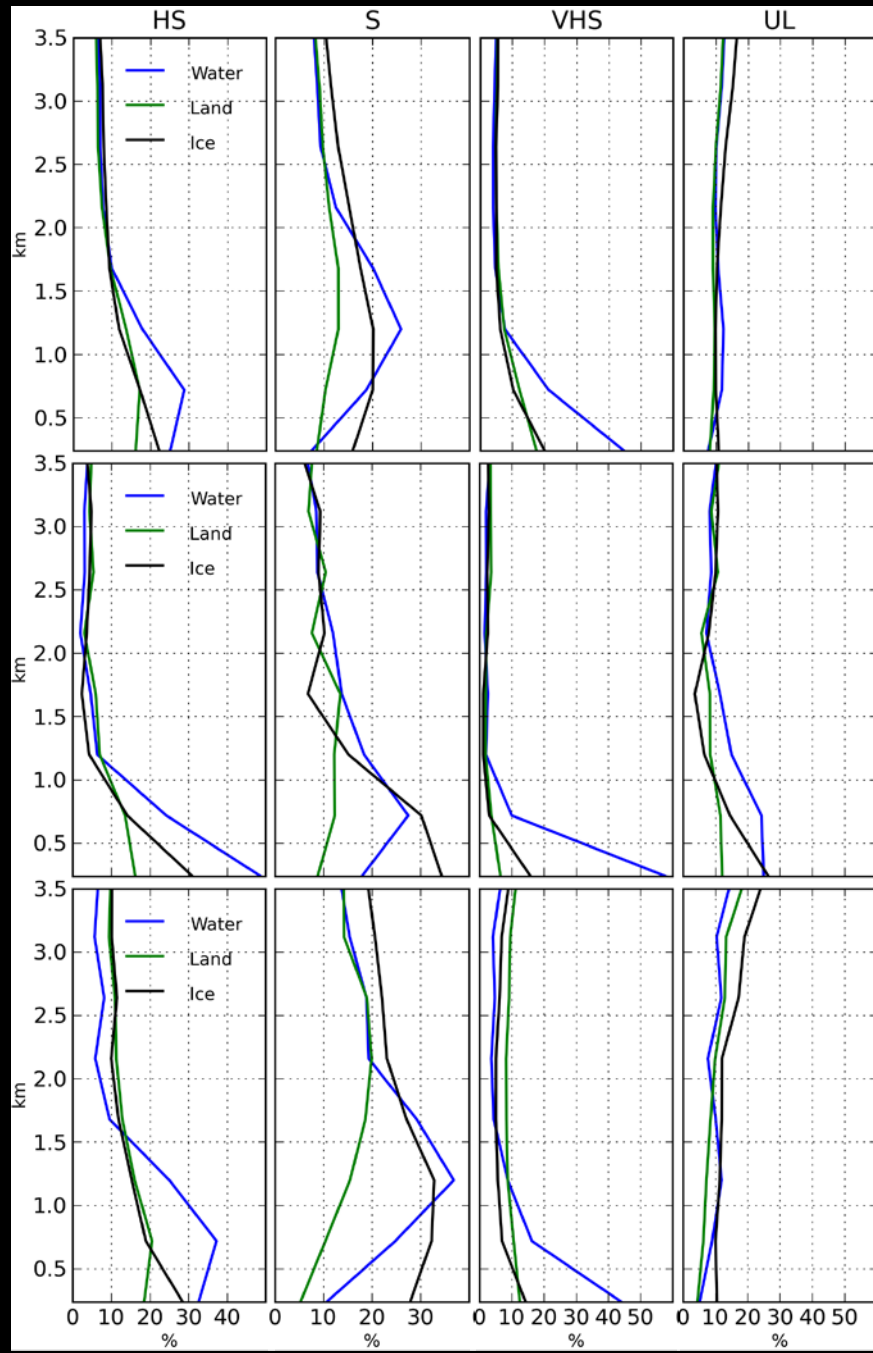
Cloud Fractions

CALIPSO simulator

CALIPSO

CAM4

CAM5



Conclusions

- *K-means clustering* technique successfully separated *distinct Arctic synoptic regimes*.
- *CAM4 and CAM5 lower tropospheric stabilities* were *larger* than ERA-YOTC in the day 2 forecast.
- *Cloud response* to the removal of *sea ice* is *dependent* on the overlying *thermodynamics*.
- The *improved* boundary layer turbulence and cloud microphysics scheme in *CAM5* resulted a better *boundary layer cloud* compared to CAM4.

Thank You/Questions?



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