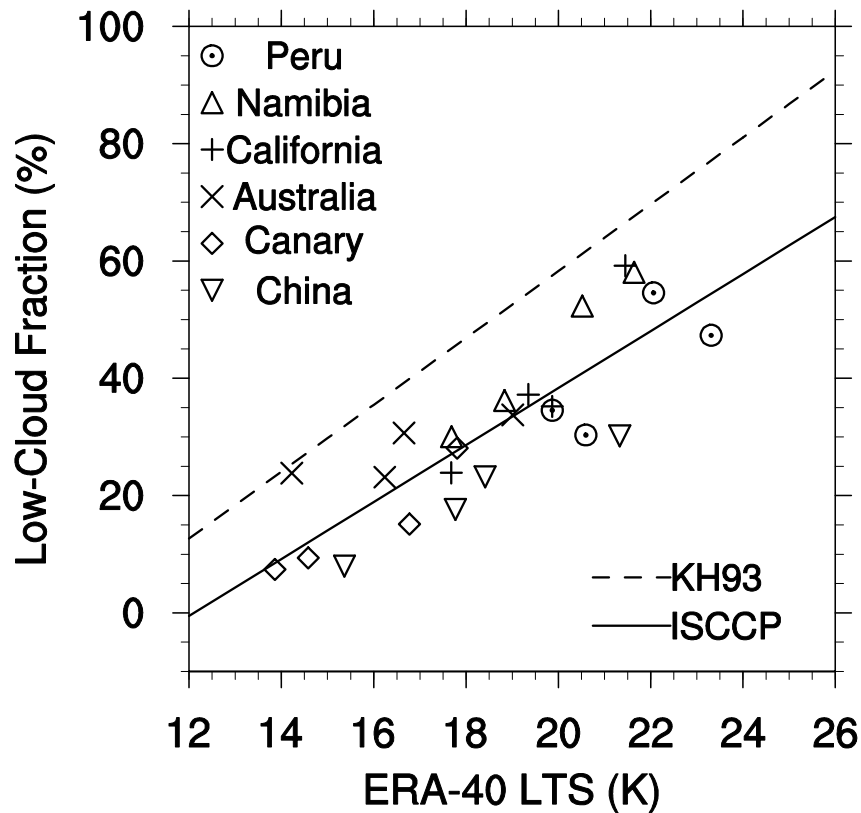


# Interpreting low-cloud climatology using a mixed-layer model

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@CMMAP 2008

# Low Cloud Fraction and Lower Tropospheric Stability (LTS)



- Strong correlation at seasonal mean
  - K-Line (Klein-Line)
- Empirically based parameterization
  - Potential inappropriateness
- Physically based parameterization
  - Representation?
  - What underlies?

# Mixed-layer model (Lilly 1968)

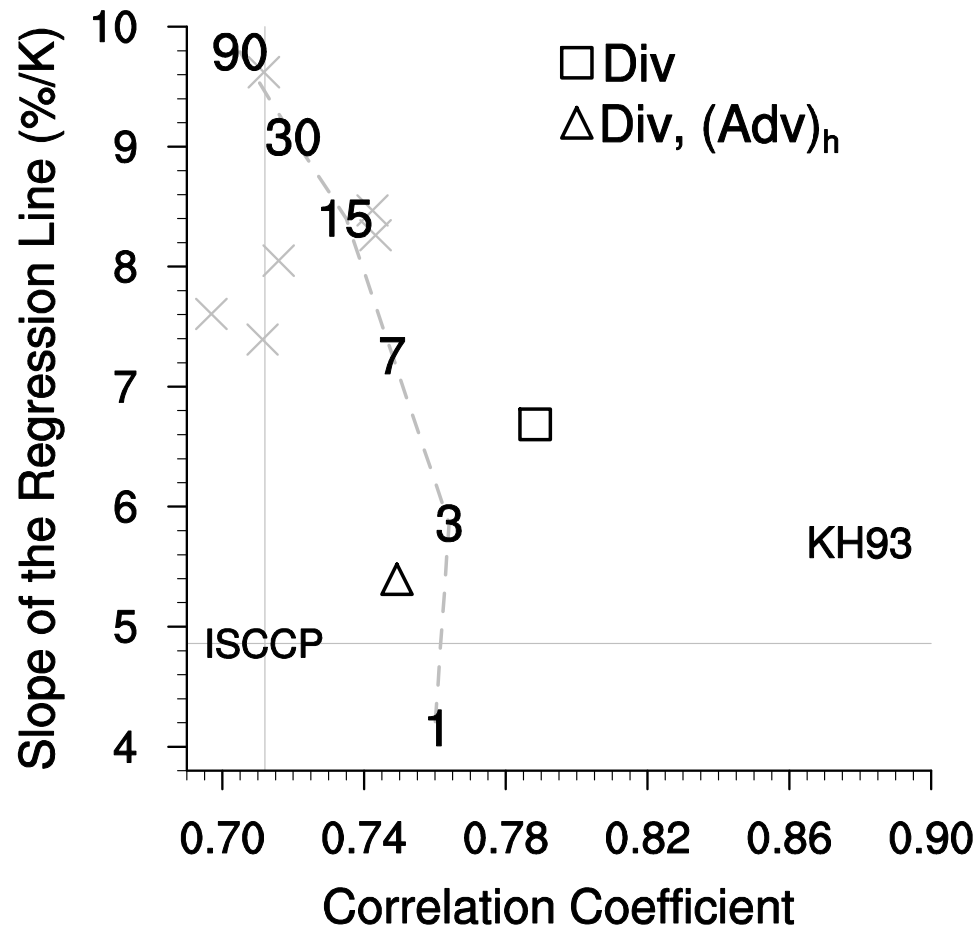
$$\begin{aligned}\frac{d}{dt} \langle s \rangle &= \frac{E (s_+ - \langle s \rangle) + V (s_- - \langle s \rangle) - F_+ + F_0}{h} && \text{-Adv}_s \\ \frac{d}{dt} \langle q \rangle &= \frac{E (q_+ - \langle q \rangle) + V (q_- - \langle q \rangle)}{h} && \text{-Adv}_q \\ \frac{dh}{dt} &= E + \bar{w}. && \text{-Adv}_h\end{aligned}$$

$$W = D \cdot h$$

Entrainment using LL98 + windsheer

- Pursue equilibrium solutions at domains  $D > 0.5 \cdot 10^{-6} / \text{s}$  and  $h_e < 2000 \text{m}$
- boundary condition from ERA-40 (at each T85 grid point) averaged at various time scales: 90 days (seasonal mean) to 1 day (daily mean)

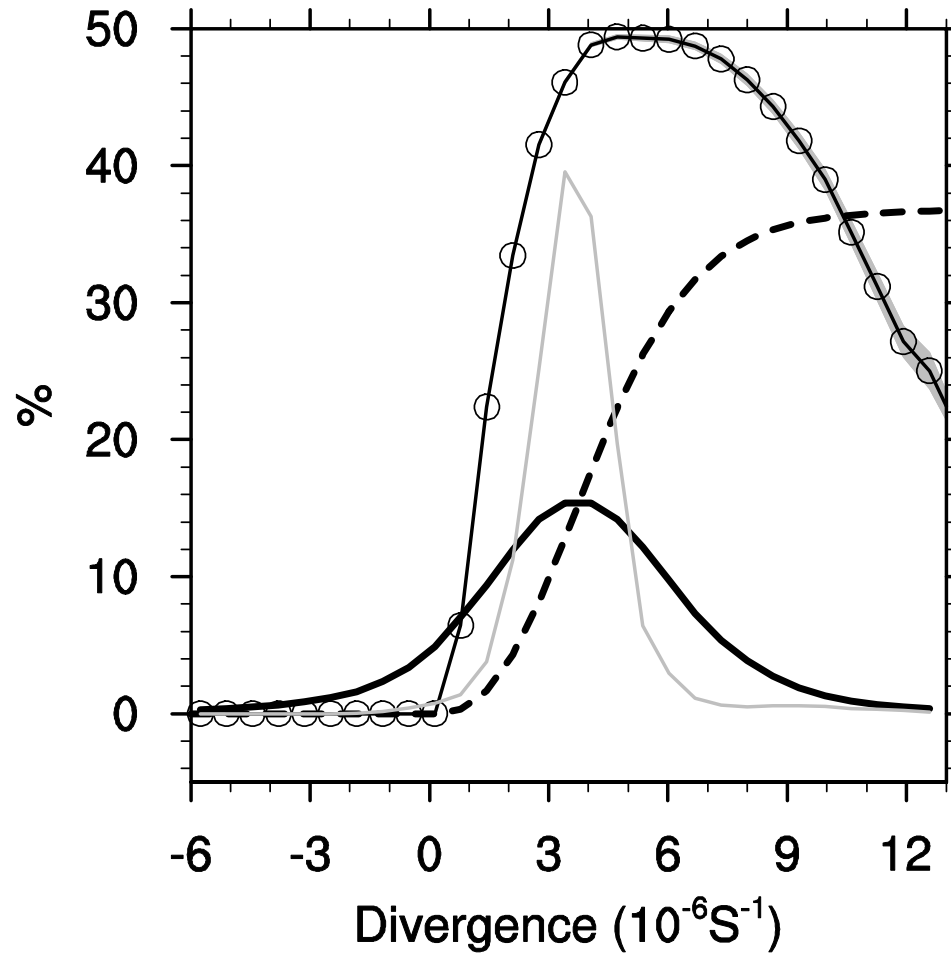
# Low Cloud Fraction and Lower Tropospheric Stability (LTS)



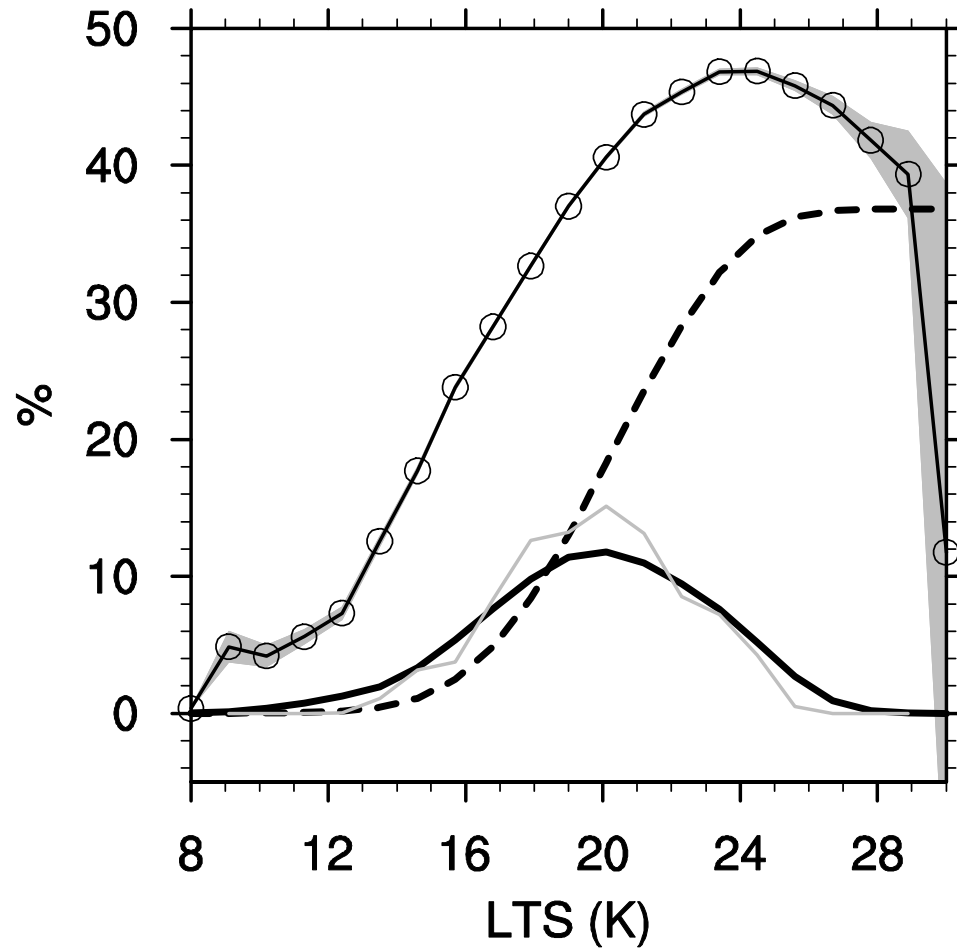
# remarks

- Mixed layer model is able to represent low cloud fraction climatology when incorporating synoptic variability of divergence

# Divergence vs. Low cloud fraction



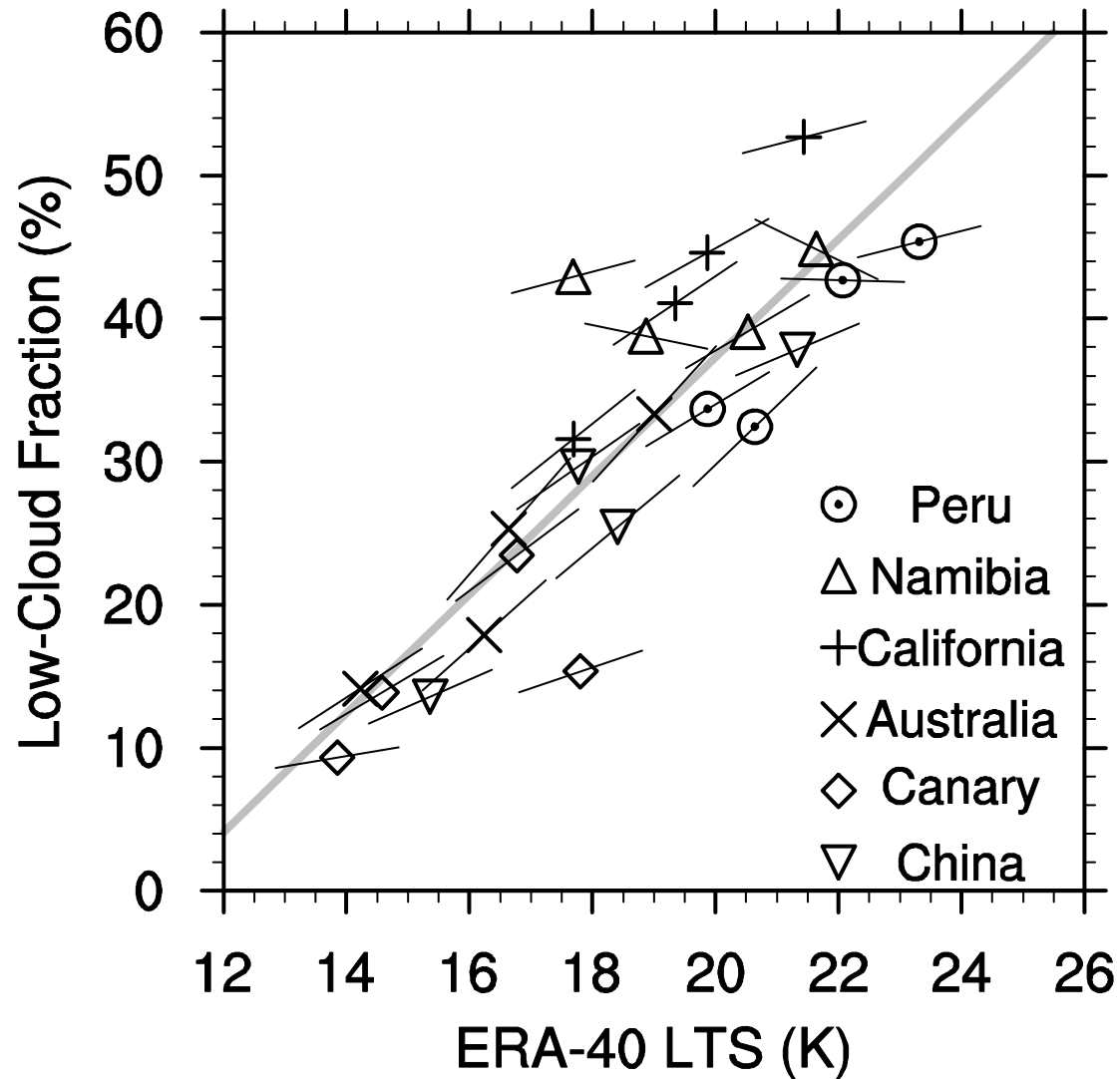
# LTS vs. Low cloud fraction



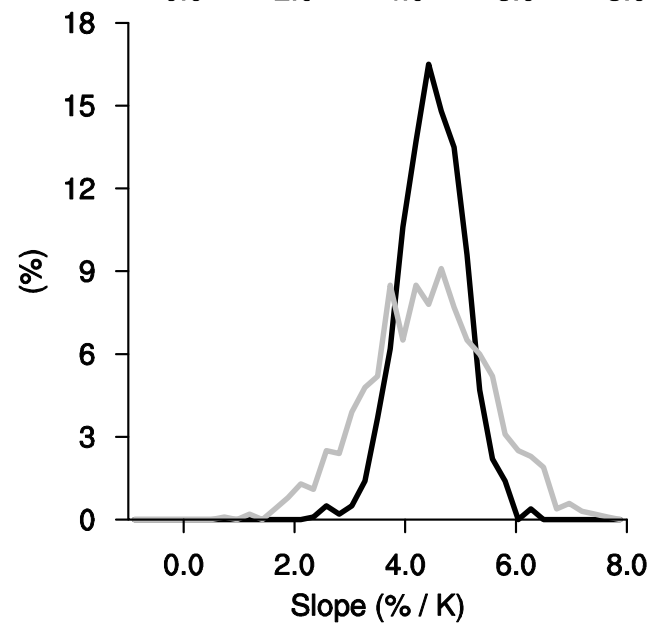
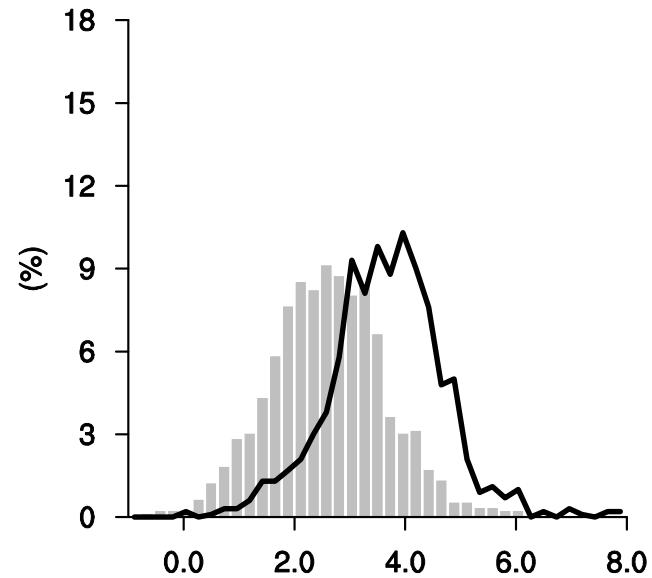
# remarks

- Low cloud fraction responds to divergence nonlinearly, sampling the full distribution of divergence is important
- This also makes simulations least susceptible to model bias
- Low cloud fraction responds to LTS almost linearly, and most of its variability at daily time scale has been represented at seasonal time scale

# Low Cloud Fraction and Lower Tropospheric Stability



# Low Cloud Fraction and Lower Tropospheric Stability



## remarks

- The relationship holds well in certain regimes but might be inappropriate outside.

The end