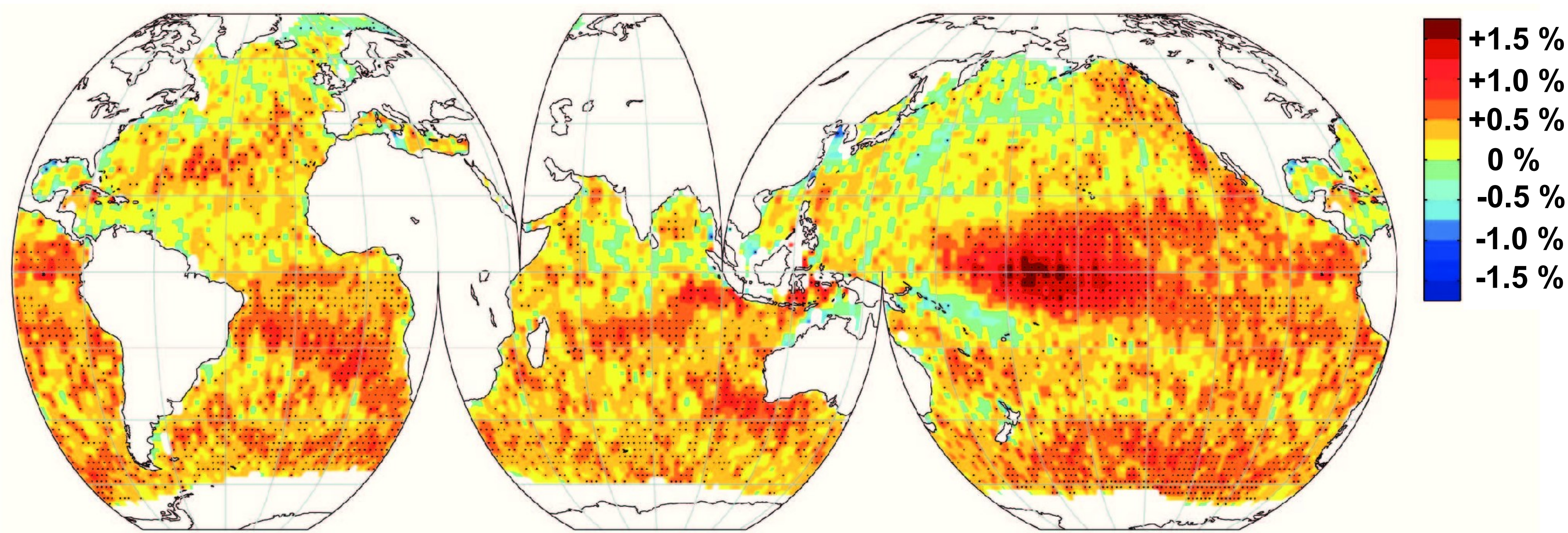
Observed and Projected Ocean Wind Speed Trends and Marine Boundary Layer Clouds

Jan Kazil and Graham Feingold

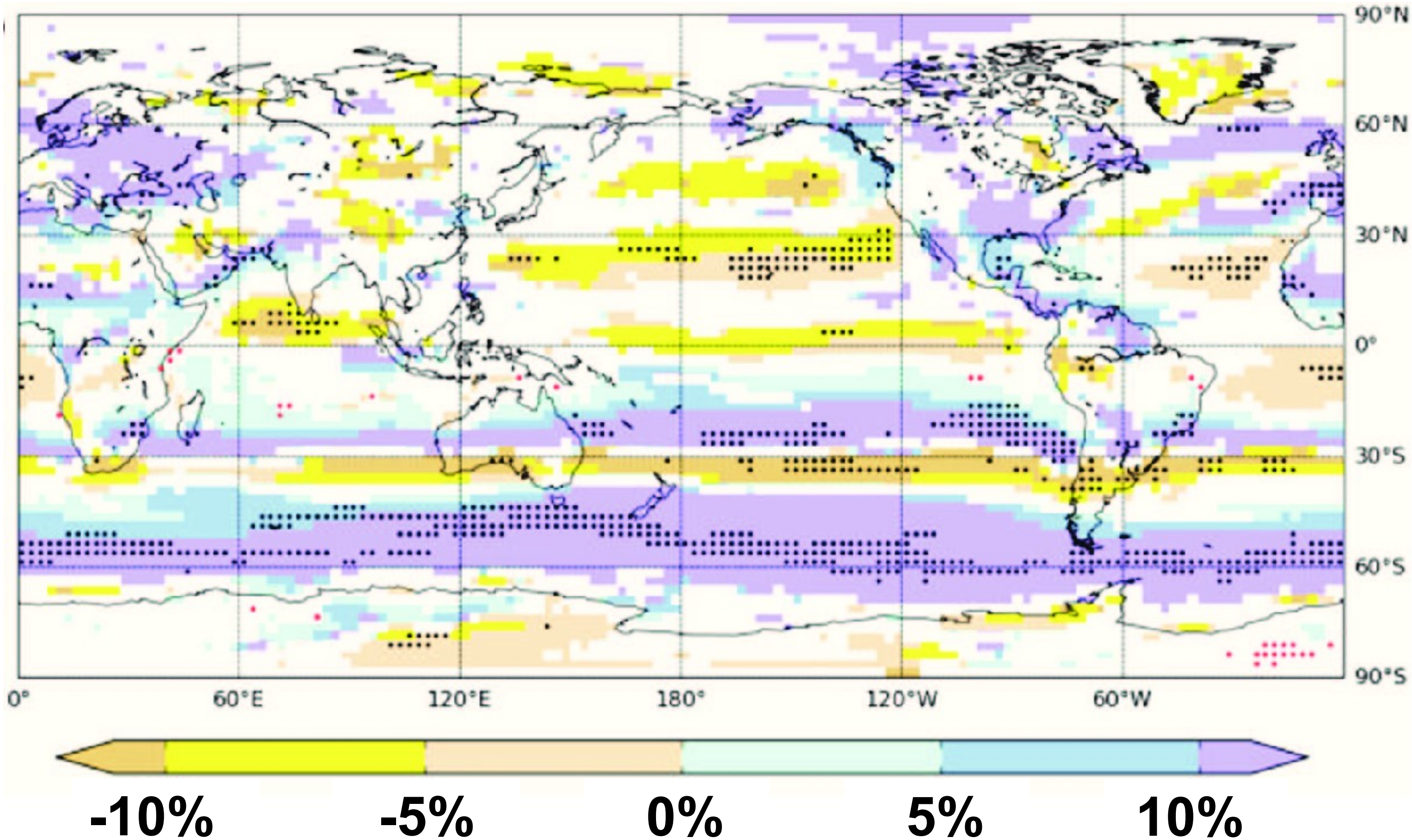
Annual mean 10 m wind speed trend 1991 - 2008



Young et al. (Nature, 2011)

- **Satellite radar altimeter**
- **Wave height**
- **10 m wind speed**

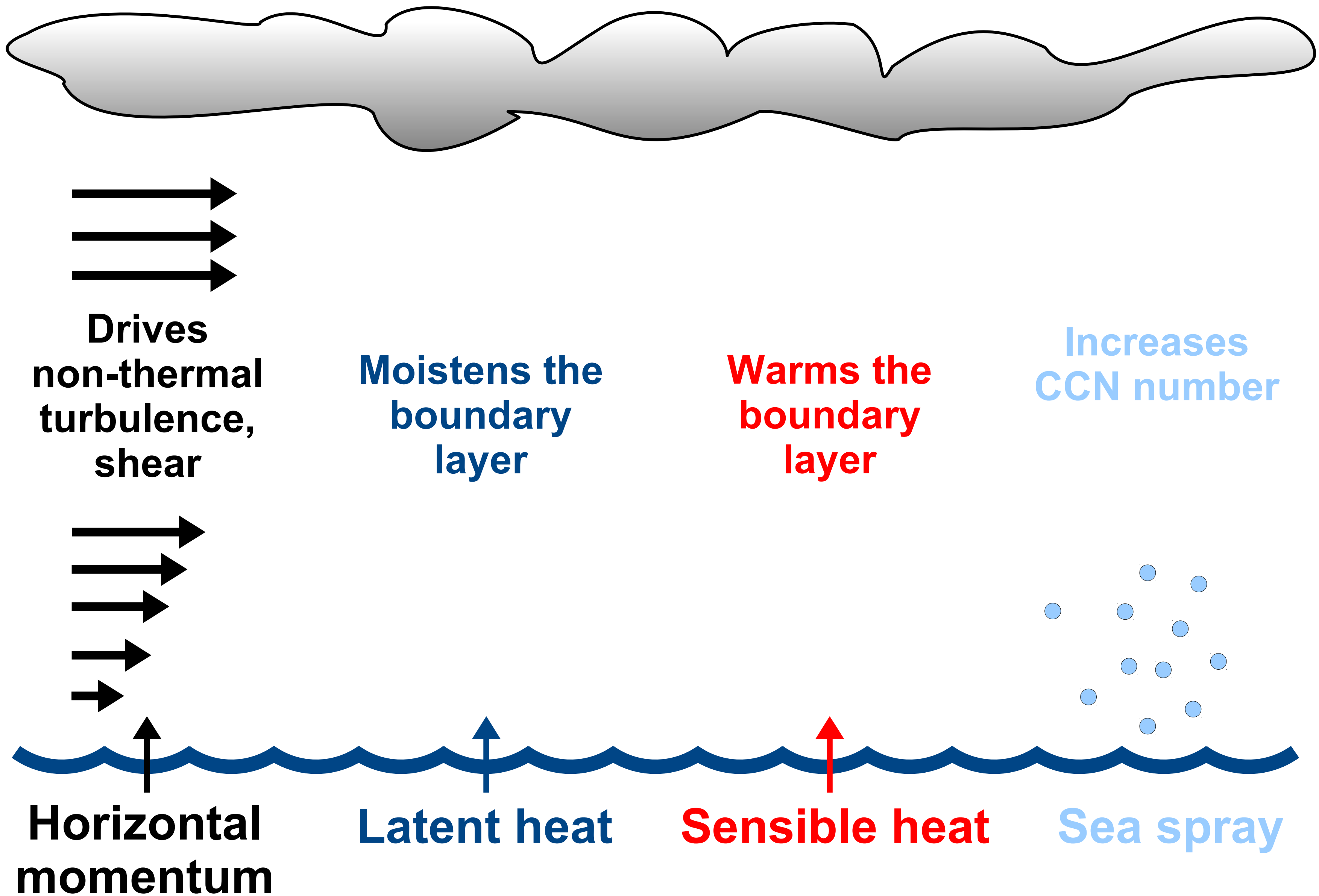
JJA 10 m wind speed in 2081–2100 relative to 1981–2000



McInnes et al. (Atm. Sci. Lett., 2011)

- WCRP CMIP3 model mean
- 19 coupled climate models
- A1B emission scenario

Wind speed


Drives non-thermal turbulence, shear
Moistens the boundary layer
Warms the boundary layer
Increases CCN number
Horizontal momentum
Latent heat
Sensible heat
Sea spray

Simulations – WRF

North-east Pacific

- DYCOMS II RF02
- Different domain sizes and resolutions

South-east Pacific

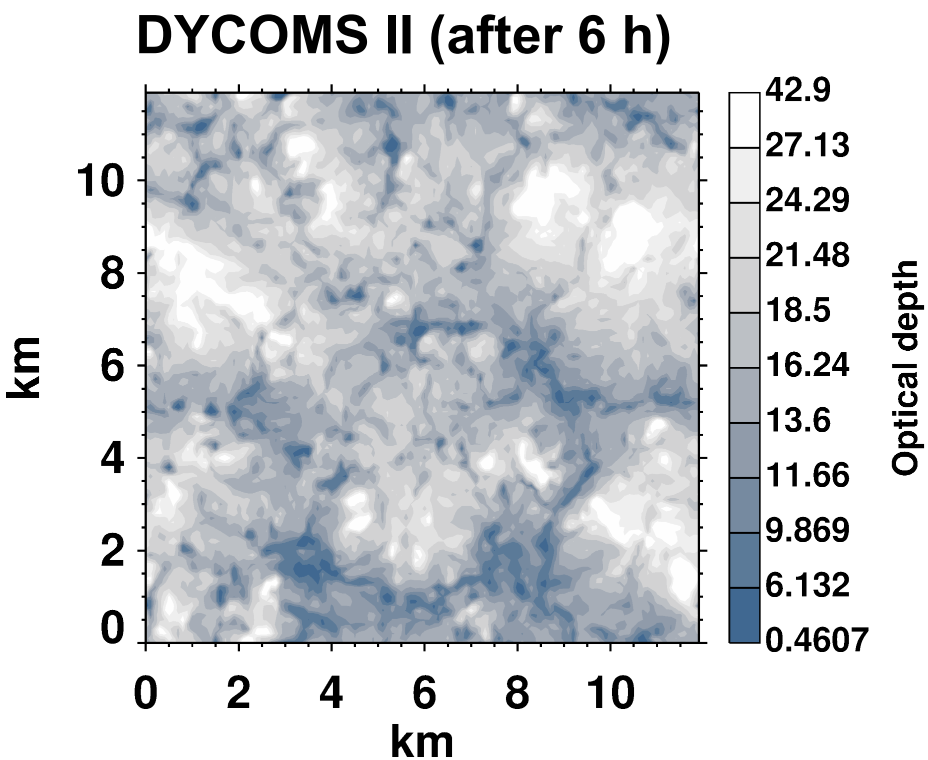
- VOCALS RF14
- Different domain sizes and resolutions

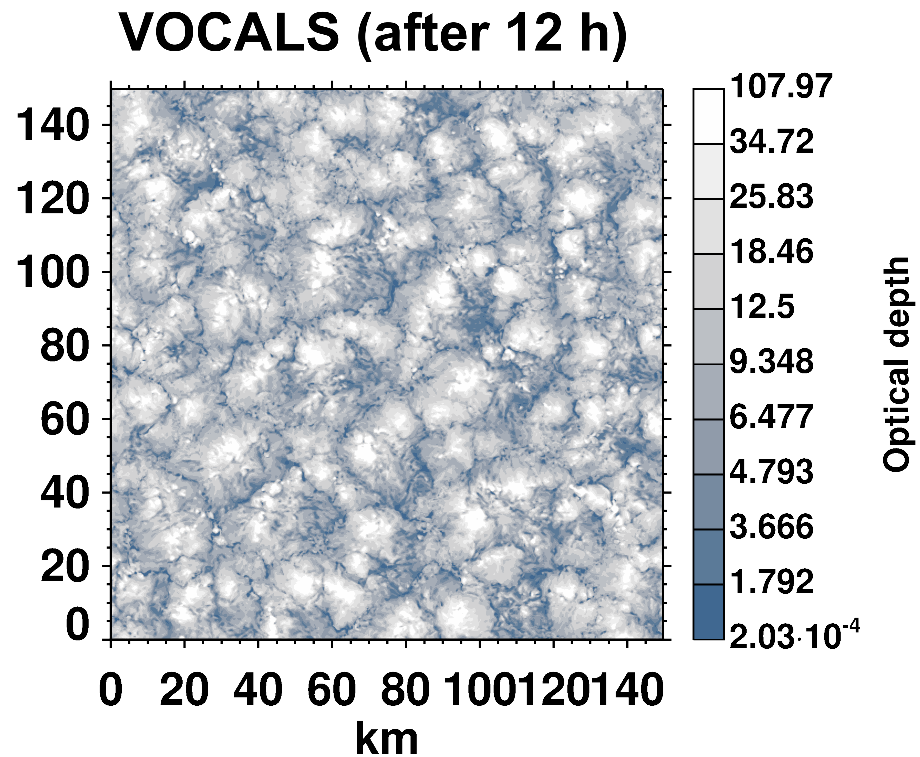
Geostrophic wind speed:

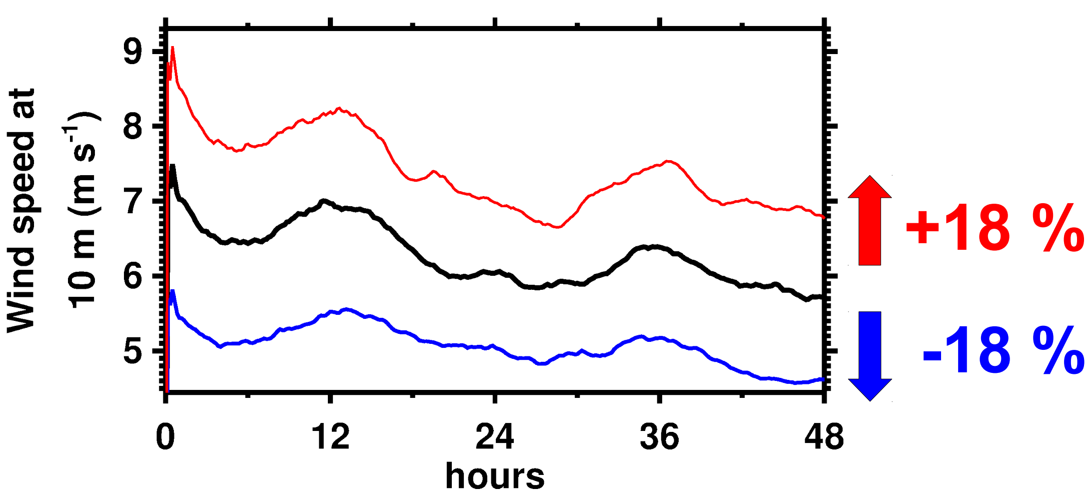
- Fast (average + 25 %)
- Average (observations)
- Slow (average – 25 %)

All else equal

Cloud field

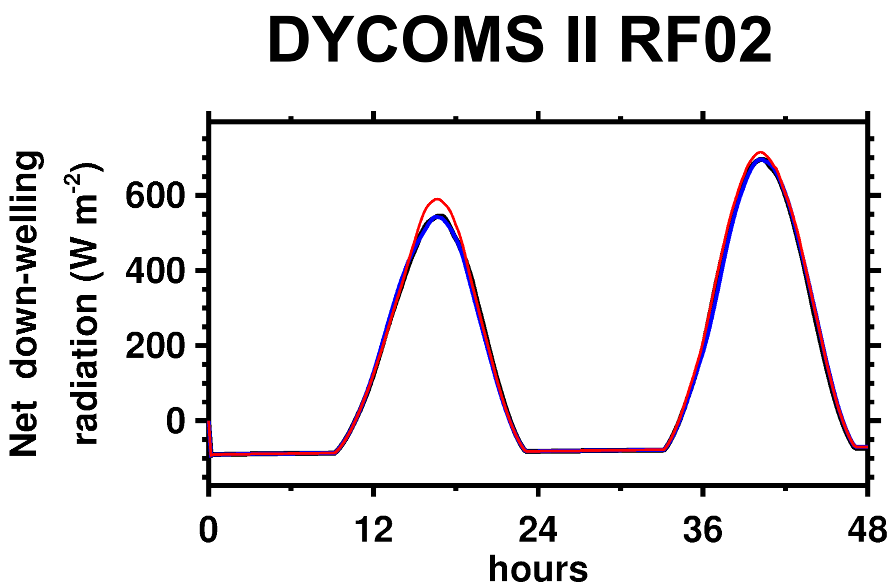


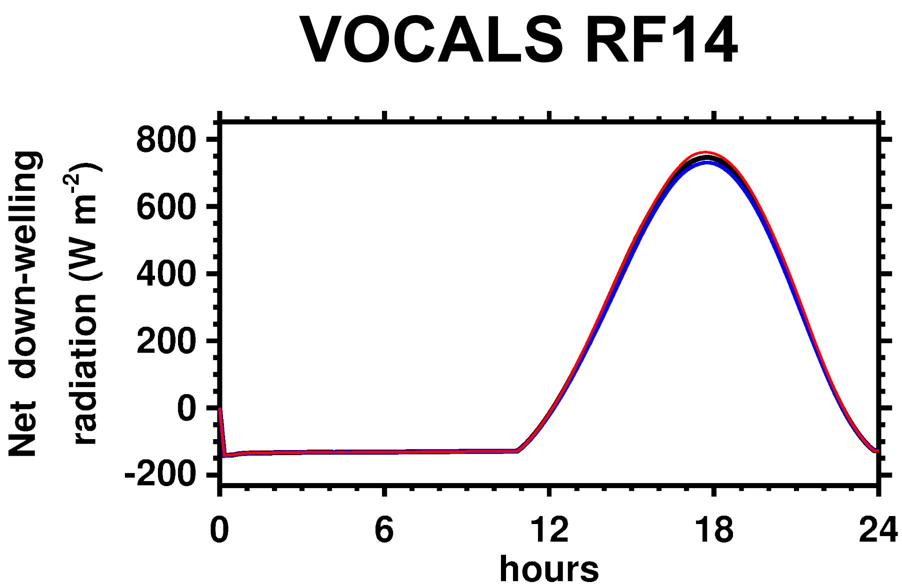




Response?

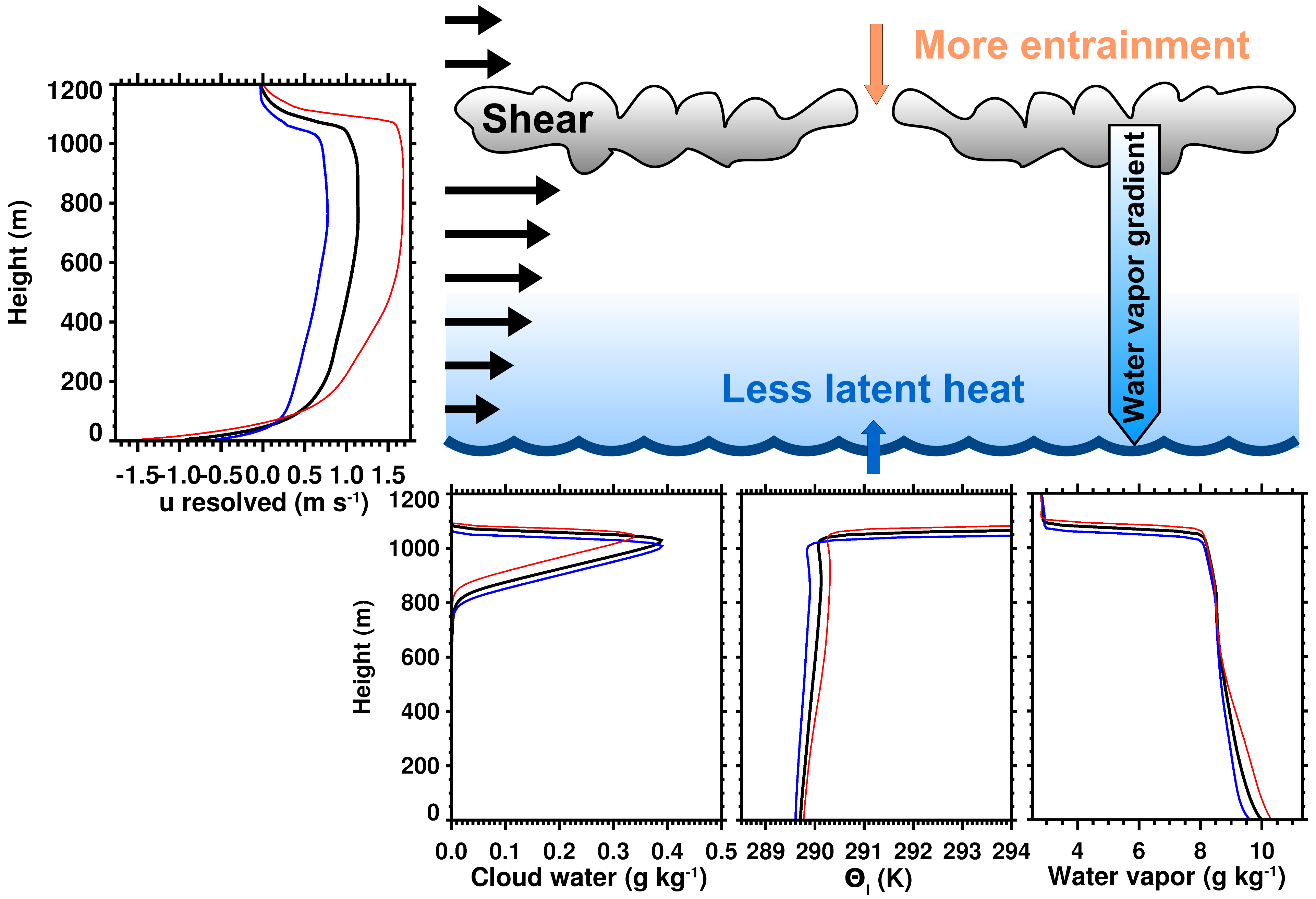
Net down-welling radiation





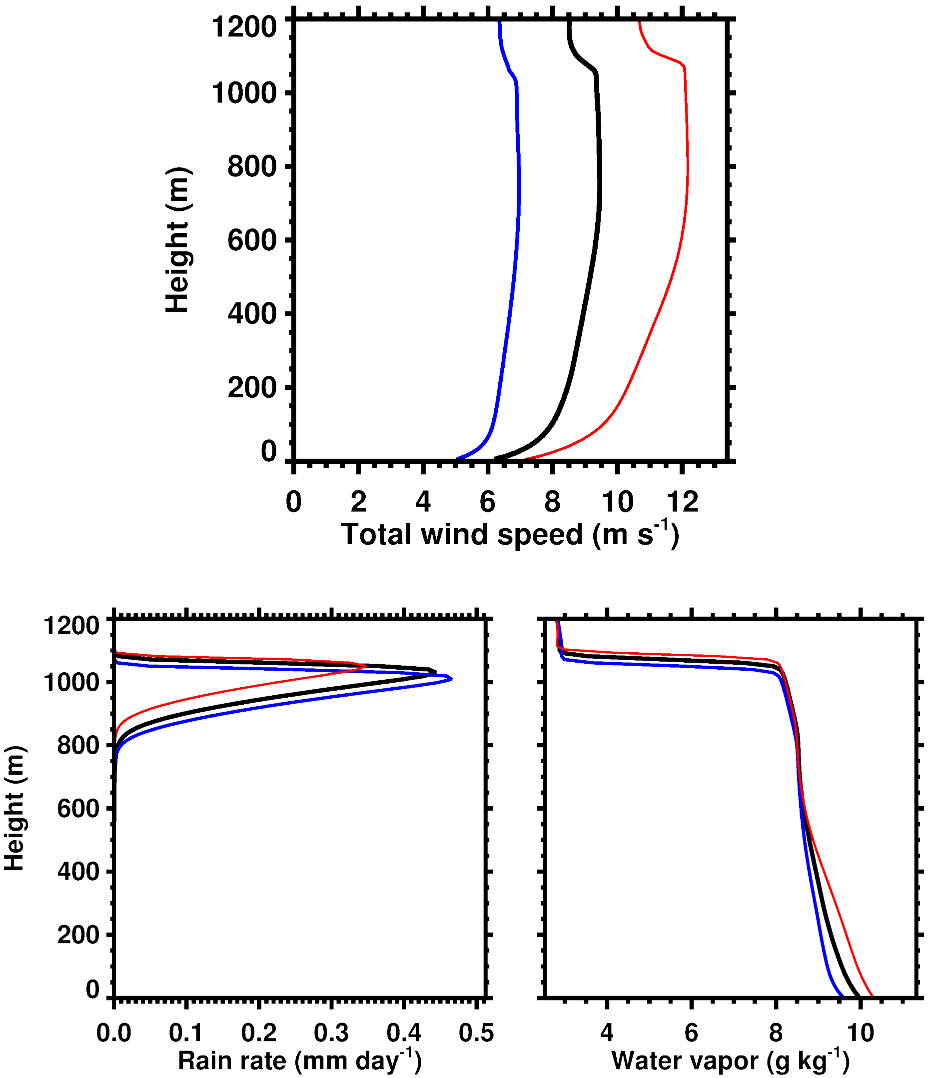
+6.3 W m^{-2}	Faster wind	+4.83 W m^{-2}
-0.99 W m^{-2}	Slower wind	-5.83 W m^{-2}

Decoupling due to wind shear?

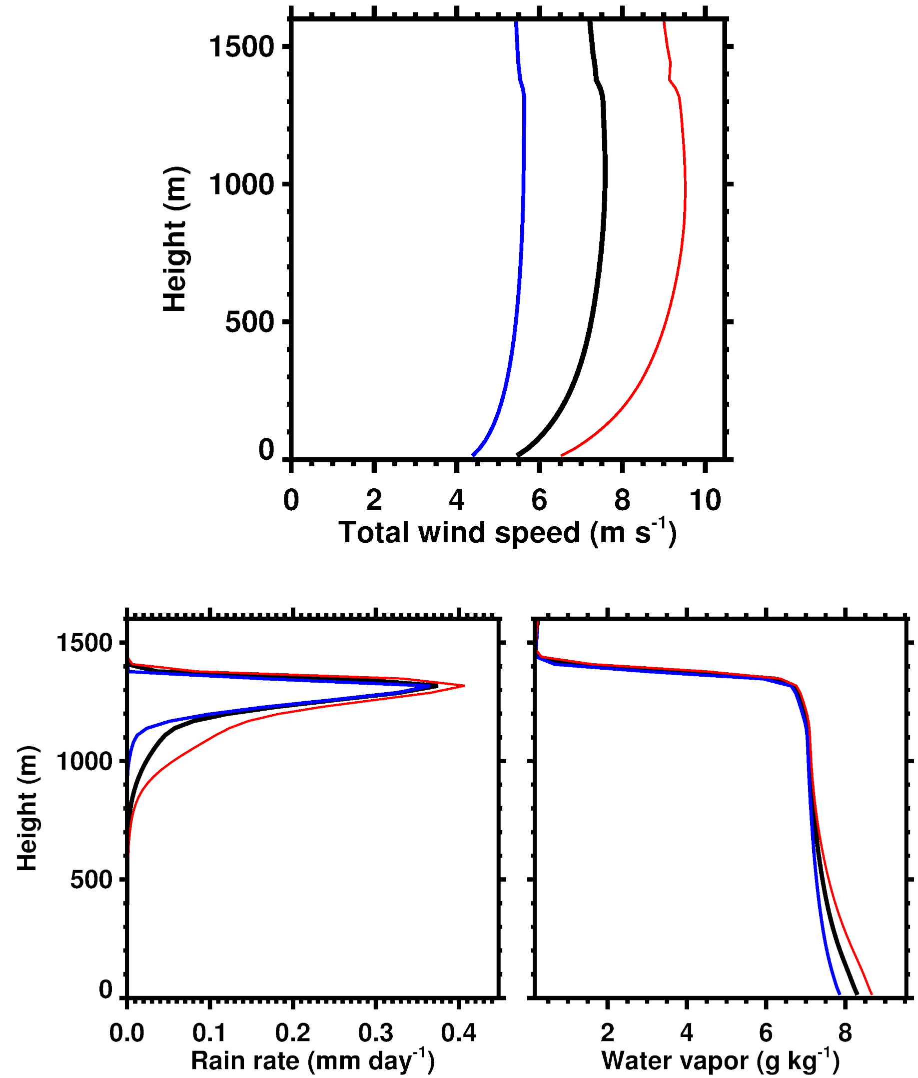


Two different decoupling mechanisms at play?

DYCOMS II RF02



VOCALS RF14



Wind speed effects on non-precipitating Sc

- Faster wind speed → higher radiative forcing
- Slower wind speed → reduced radiative forcing

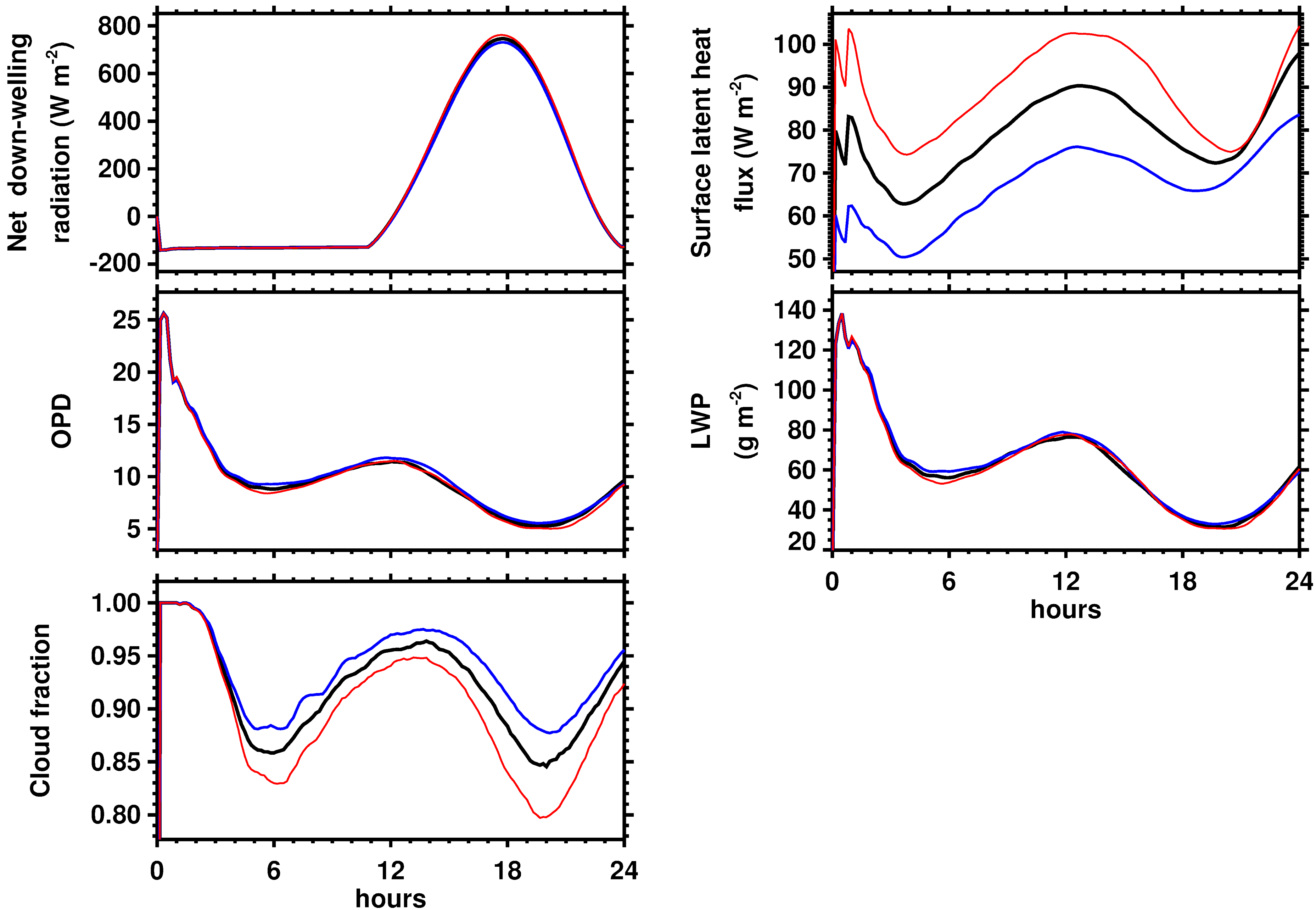
Different decoupling mechanisms depending on boundary layer depth?

- Faster wind speed → Stronger wind shear at inversion → more entrainment → decoupling
- Faster wind speed → Stronger latent heat flux → stronger drizzle → humidification of sub-cloud layer → decoupling

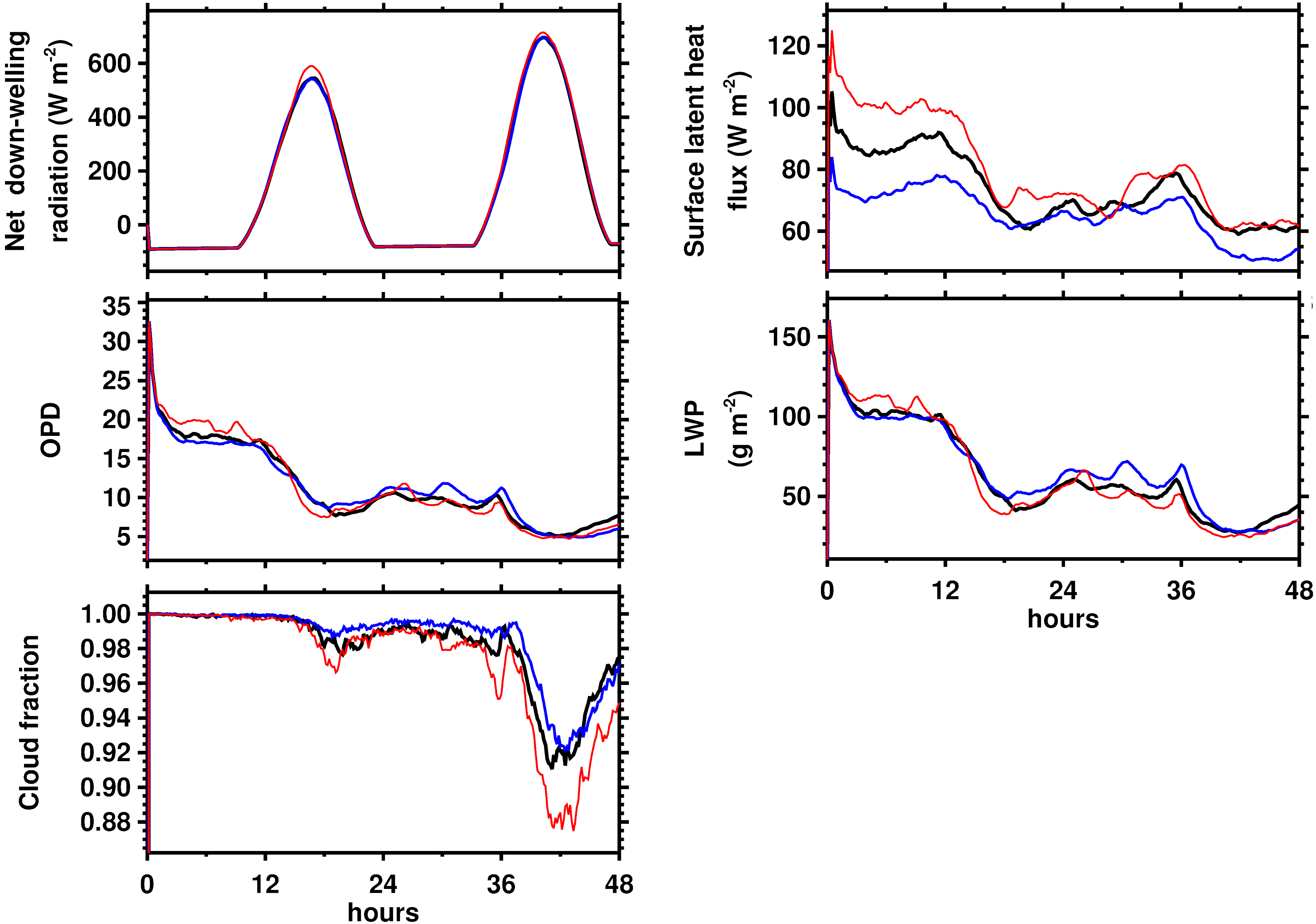
Path forward

- Simulations with higher resolution
- Isolate effect of different mechanisms
- Analyze observations for wind speed effects: MAGIC!

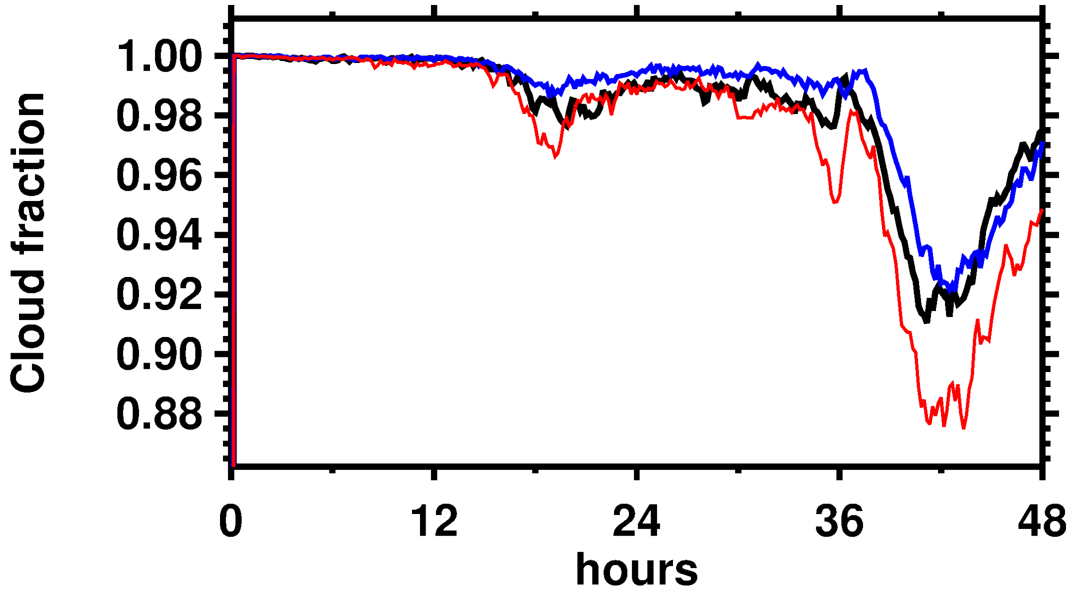
Response to wind speed (VOCALS RF14)



Response to wind speed (DYCOMS II RF02)



Asymmetric response due to solar heating



- **Faster wind speed → more decoupling**
- **Slower wind speed → less decoupling**

- **Solar heating adds to decoupling in both cases**