

Relationships of observed cloud fractions to ARM continuous forcing and NARR at the ARM SGP

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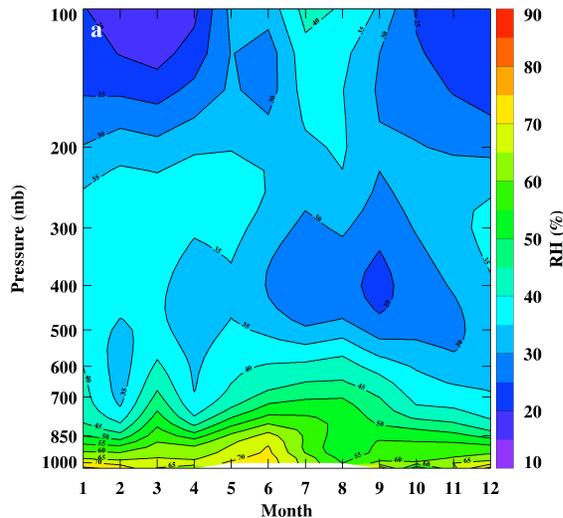


Motivation

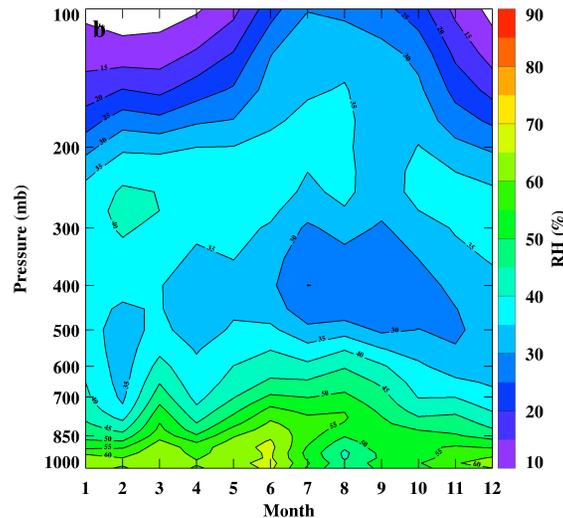
- **Investigation of NASA GISS SCM**
 - **Driven by ARM Cont. Forcing (1999-2001)**
 - **How do modeled and observed clouds relate to:**
 - Large-scale variables such as RH and omega
 - Synoptic pattern
 - NARR used to retrieve
 - 3h, 29 level, ~32km resolution, based off ETA/NAM
 - **Curiosity led to a comparison between NARR to ARM forcing**
 - NARR relatively new and is now commonly used
 - How do RH, omega, and precipitation compare?
 - NARR averages found for cont. forcing domain (~50pts)

Relative Humidity

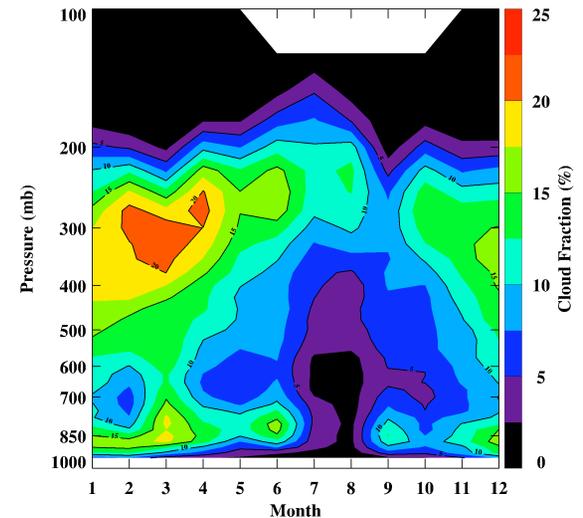
ARM Mean



NARR Mean



MMCR/MPL CF



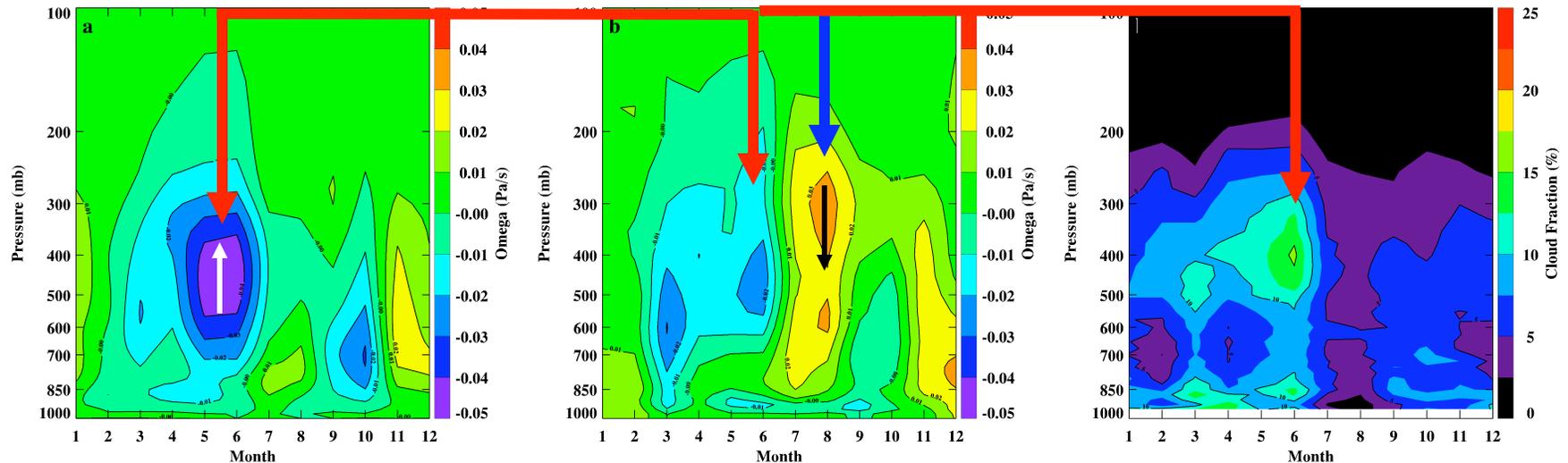
- Overall, ARM RH is similar to NARR
- ARM is moister in PBL, upper troposphere
 - RUC vs. ETA assimilation?
- Mid-troposphere within a few %
- **Appears to be a decent relationship between CF and RH**

Omega

ARM Mean

NARR Mean

SCM CF



- **Significant differences between ARM and NARR**
 - Difference in amplitudes of upwelling/downwelling
 - ARM has large peak in upward motion during May-June.
 - NARR has weaker upward motion and a larger downwelling branch during summer
- **Qualitatively, vertical motion looks important for this SCM cloud simulation**

Monthly Correlation between Observed CF with 300mb ARM and NARR (36mo)

Cloud Fraction	Relative Humidity		Omega	
	ARM	NARR	ARM	NARR
Total	<i>0.84</i>	0.89	-0.37	-0.69
Low <i><2km</i>	<i>0.66</i>	0.73	-0.30	-0.65
Mid	<i>0.64</i>	0.74	-0.30	-0.59
High <i>>6km</i>	<i>0.85</i>	0.85	-0.44	-0.62

- Both ARM and NARR RH have high correlations with CF.
- NARR omega has significantly higher correlations than ARM
- Not shown – SCM correlations even higher with omega (-0.63 to -0.75)

Discussion

- **Why are NARR correlations higher?**
 - Investigate full vertical resolution
 - All/precipitating periods
 - Compare time-series

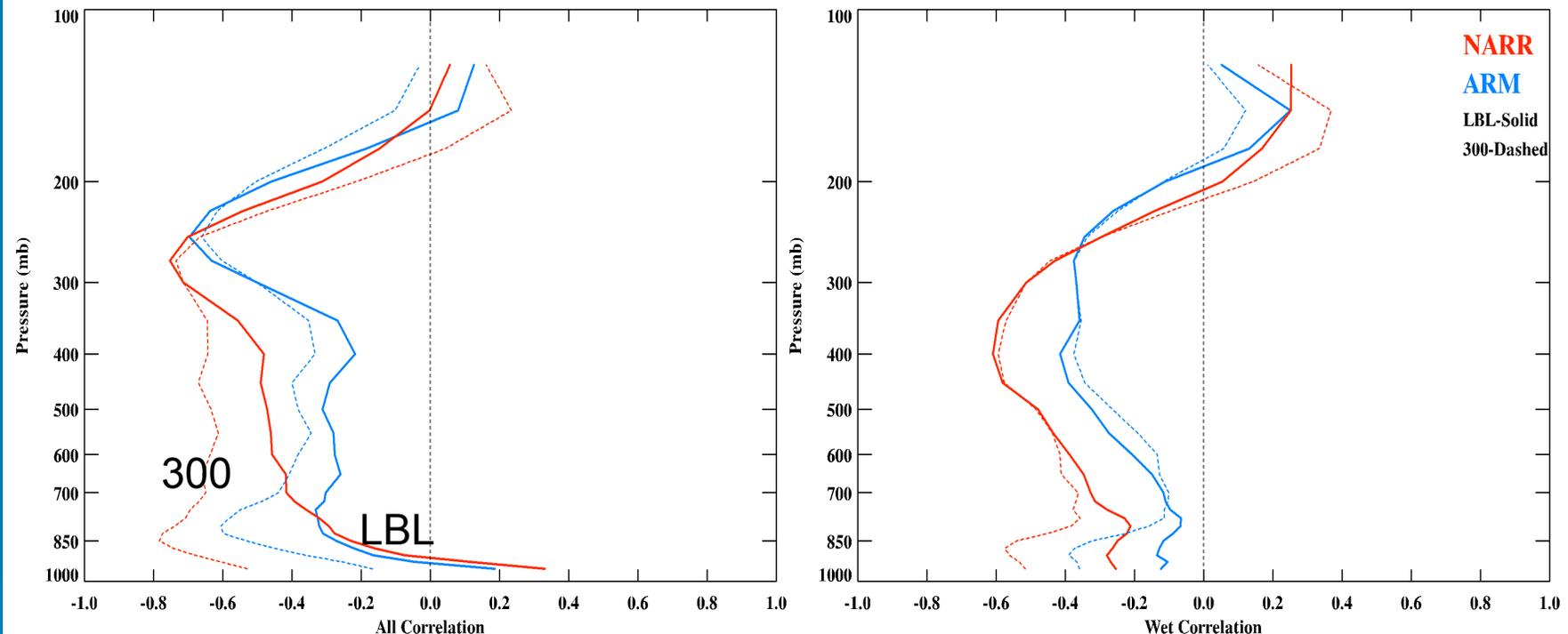
 - **What are correlations for shorter time periods?**
 - Is there any seasonal dependence?
- 

Monthly Omega Correlation

All Samples

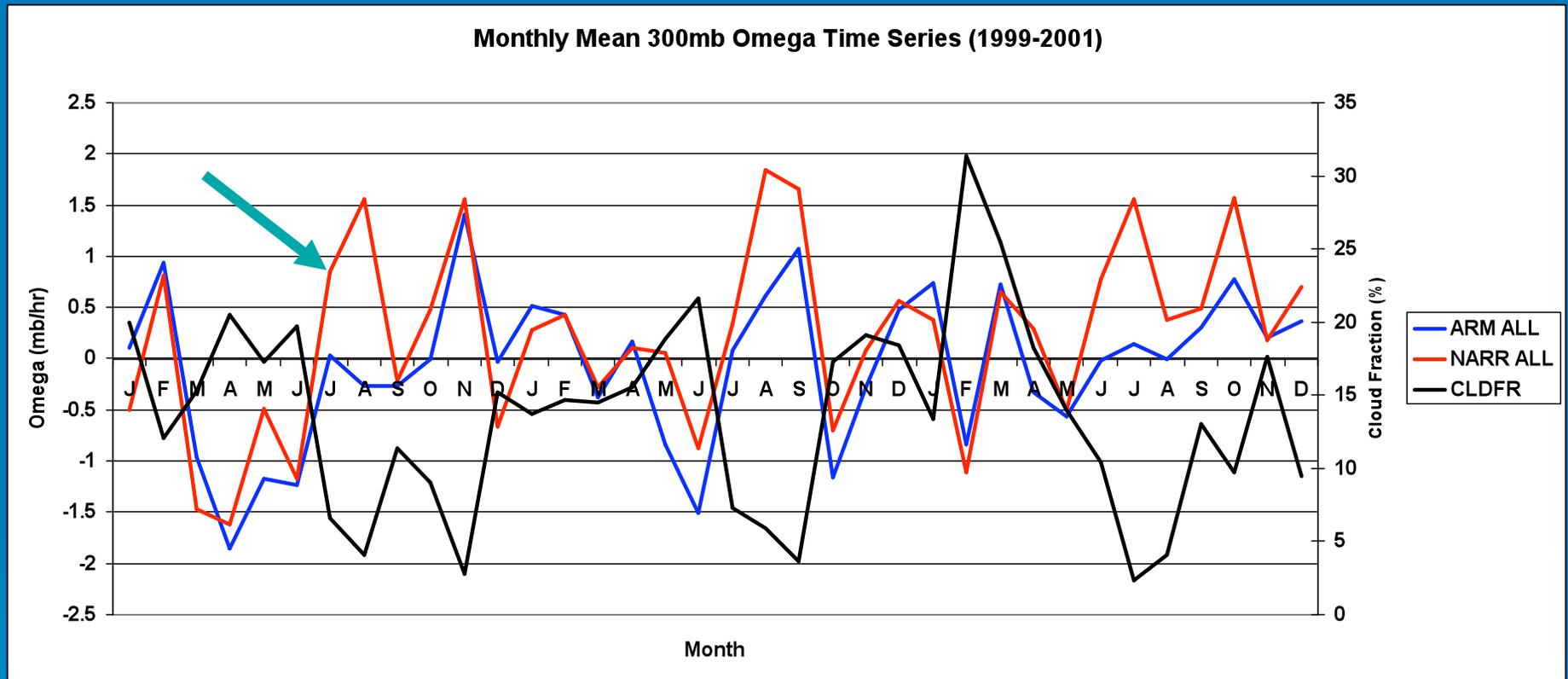
Monthly Correlations for NARR and ARM (All,Wet)

Wet Samples



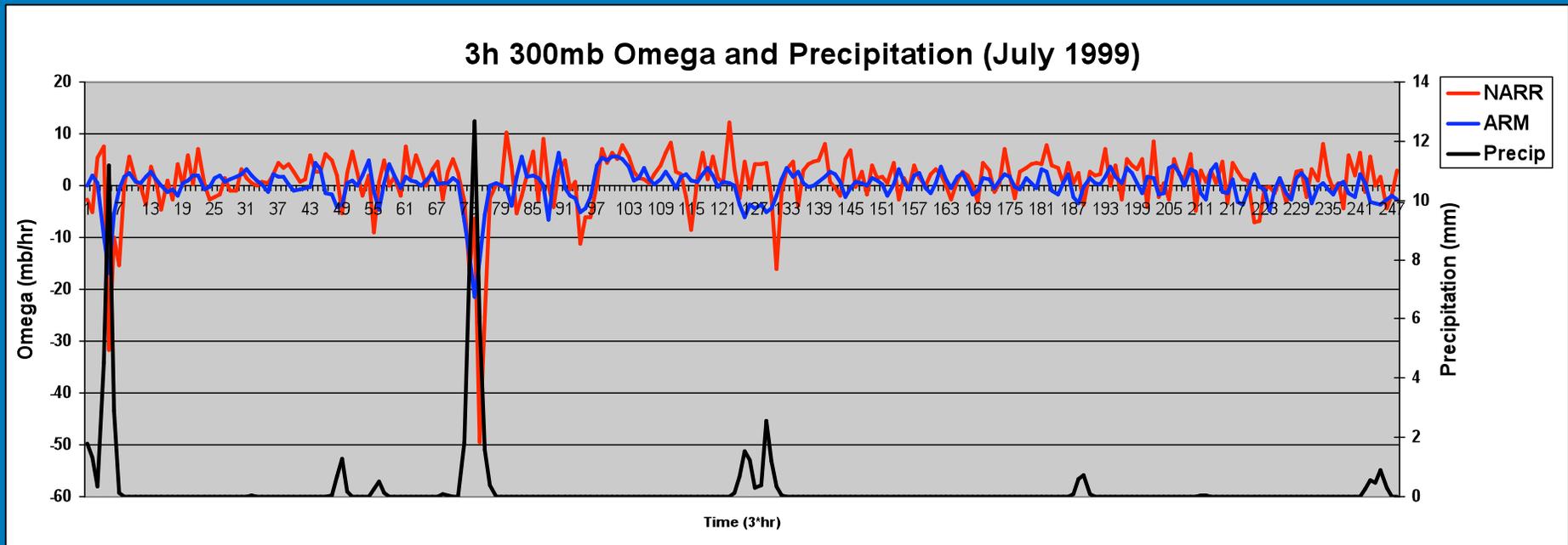
- Two correlations:
 - level-by-level (LBL)
 - CF by level vs. 300 mb omega
- Even by level, NARR is higher except near the top of the troposphere.
- Difference is larger when 300mb omega is used

Monthly Time Series



- Such as in the time/height plot, NARR has stronger downwelling, especially during the summer
- With the lowest CF during these months (typically) this may be the reason for the higher correlations

3h Time Series for July 1999

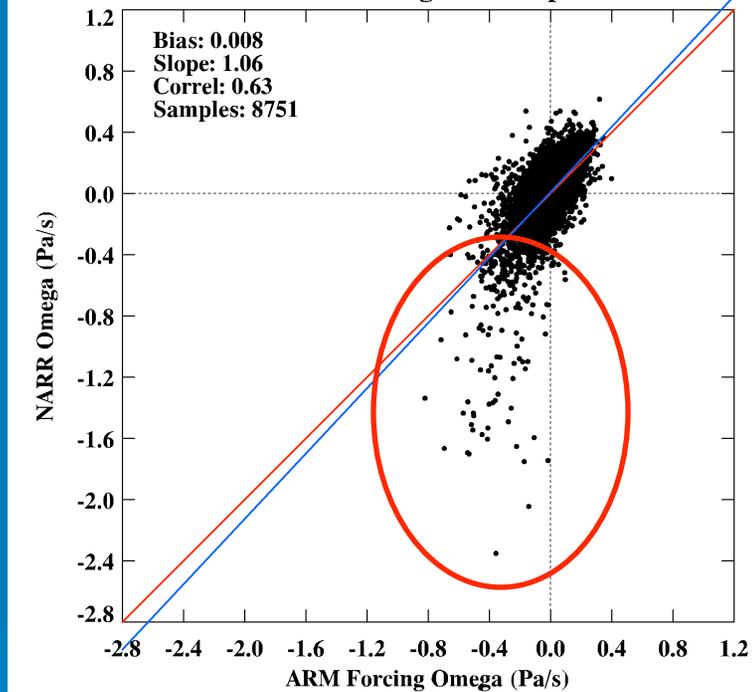


- July 1999 – ARM = 0.03 mb/hr NARR = 0.86 mb/hr
- During precipitation events, NARR actually has stronger upward velocities in many cases (see next slide)
- For the entire month, NARR has positive bias
 - Typical for summer months where NARR > ARM
 - **Contributes towards larger range of values and linear correlations**

ARM vs. NARR Omega

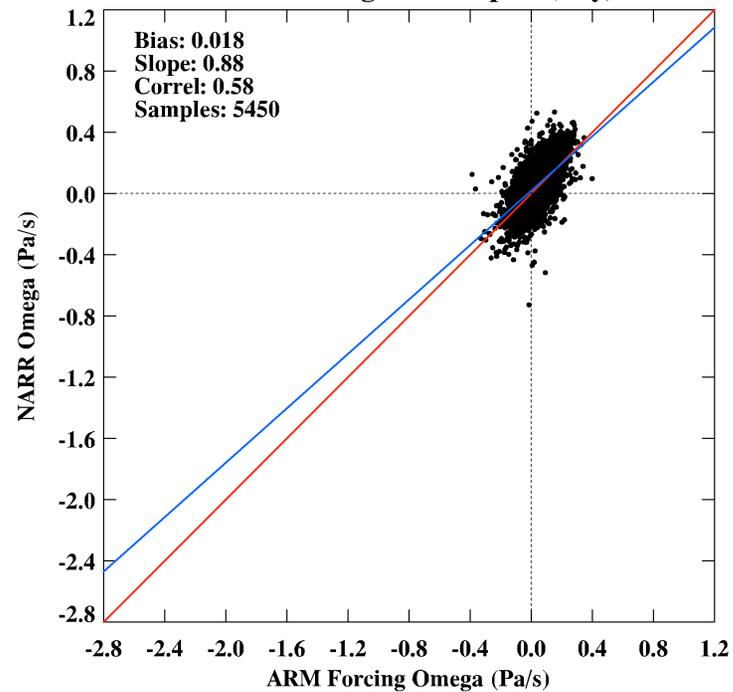
All Samples

300 mb Omega Scatterplot



Dry Samples

300 mb Omega Scatterplot (Dry)



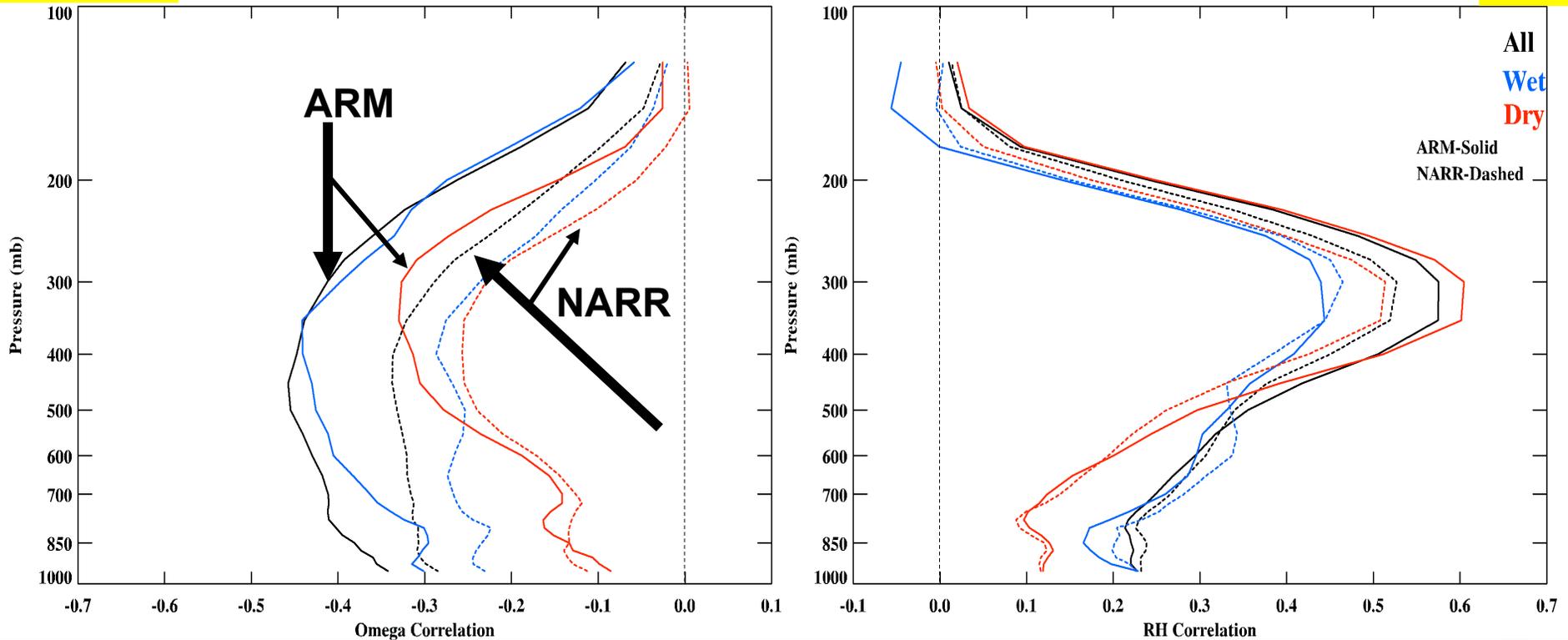
- 3h resolution (3h average from 1h ARM forcing)
- NARR does have some issues with vertical velocity
 - West et al. 2007 – Spurious grid-scale precipitation
 - Occurs when modeled precipitation is significantly mismatched with observed
 - Assimilated precipitation leads to anomalously large latent heating which causes large vertical velocities

3H Correlation

Omega

3H Omega (l) and RH (r) Correlations for NARR and ARM

RH



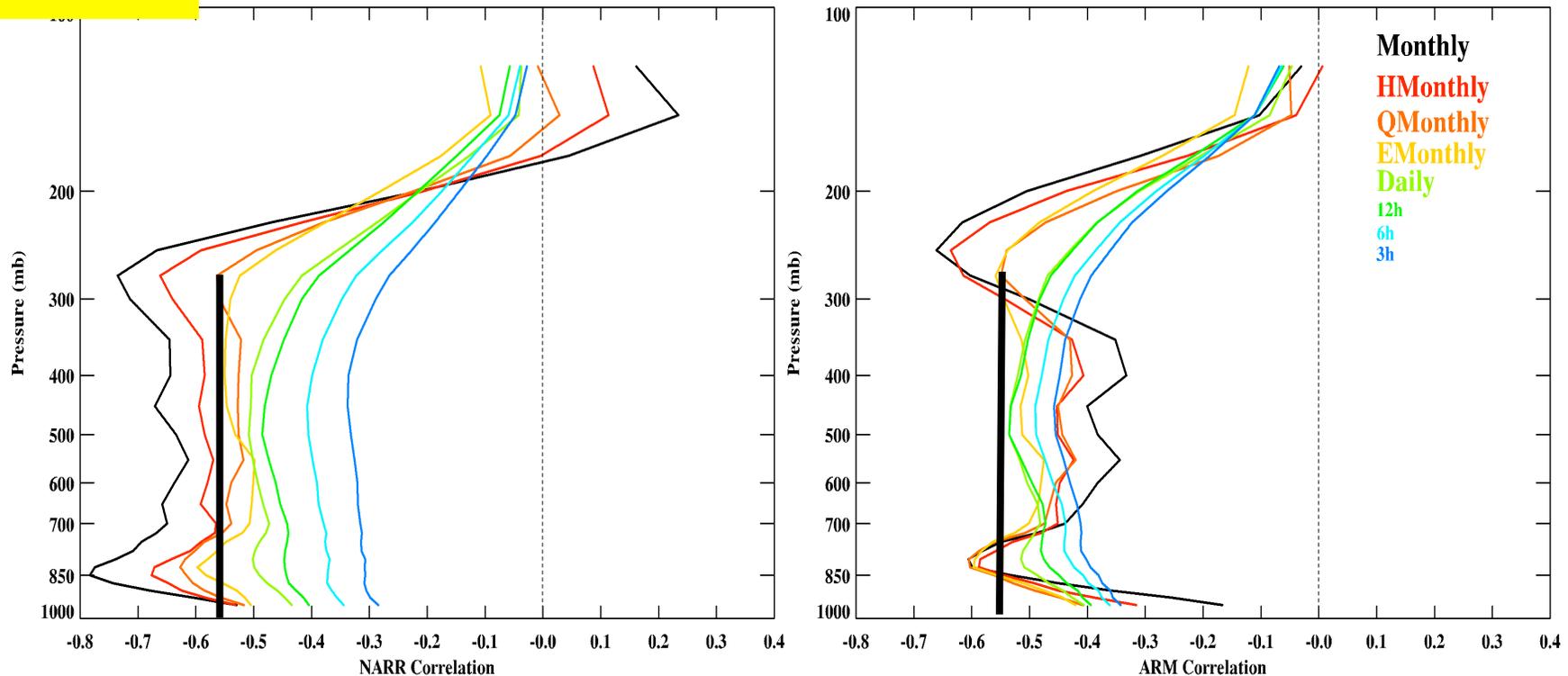
- At 3h resolution, ARM correlation is highest, especially for all and wet conditions
- Most noticeable for omega

Correlation by Time (Omega)

ARM

NARR

Omega Correlations by Time for NARR and ARM (300mb)



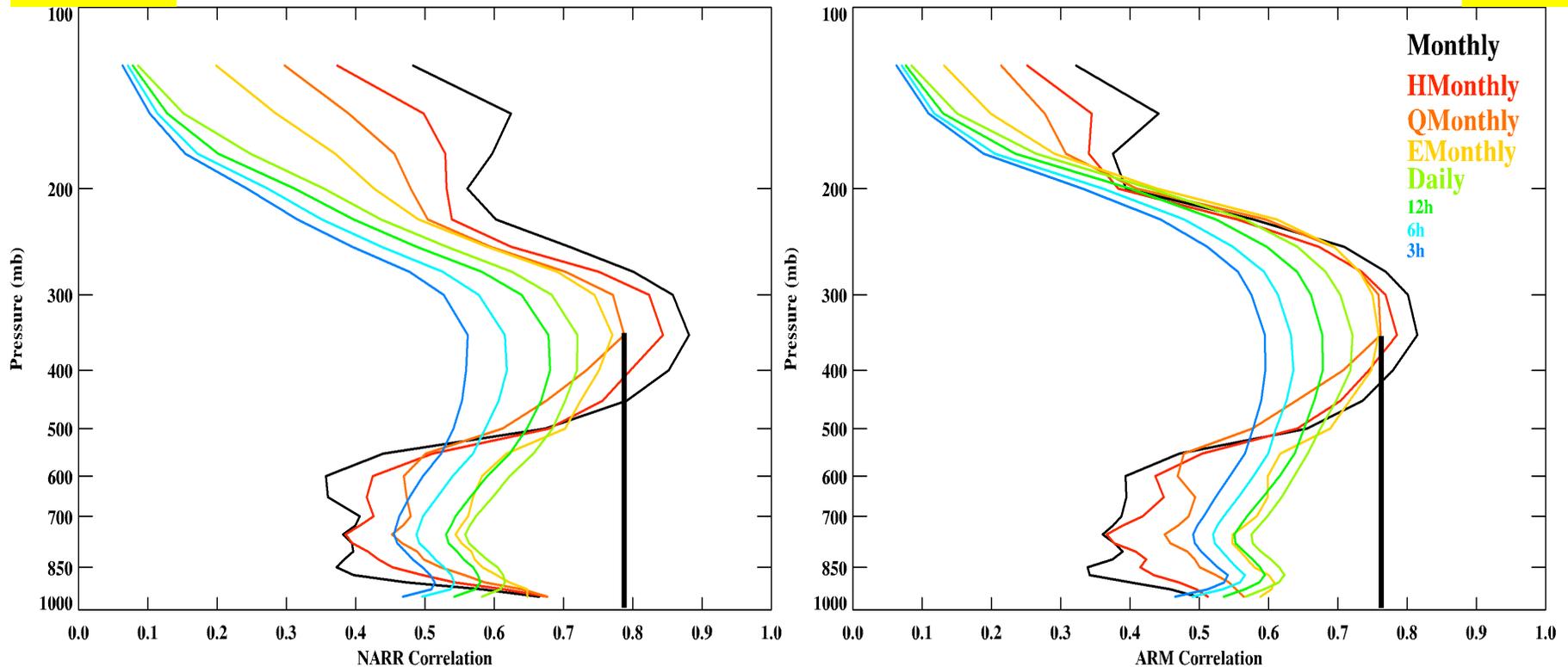
- Correlations calculated for various timescales
- NARR correlations increase with longer time scale
- For ARM, this increase is less, and actually decreases in the mid-troposphere
 - May be related to the bimodal distribution of CF at ARM SGP
- **Critical point at which NARR surpasses ARM is a quarter-month.**

Correlation by Time (RH)

NARR

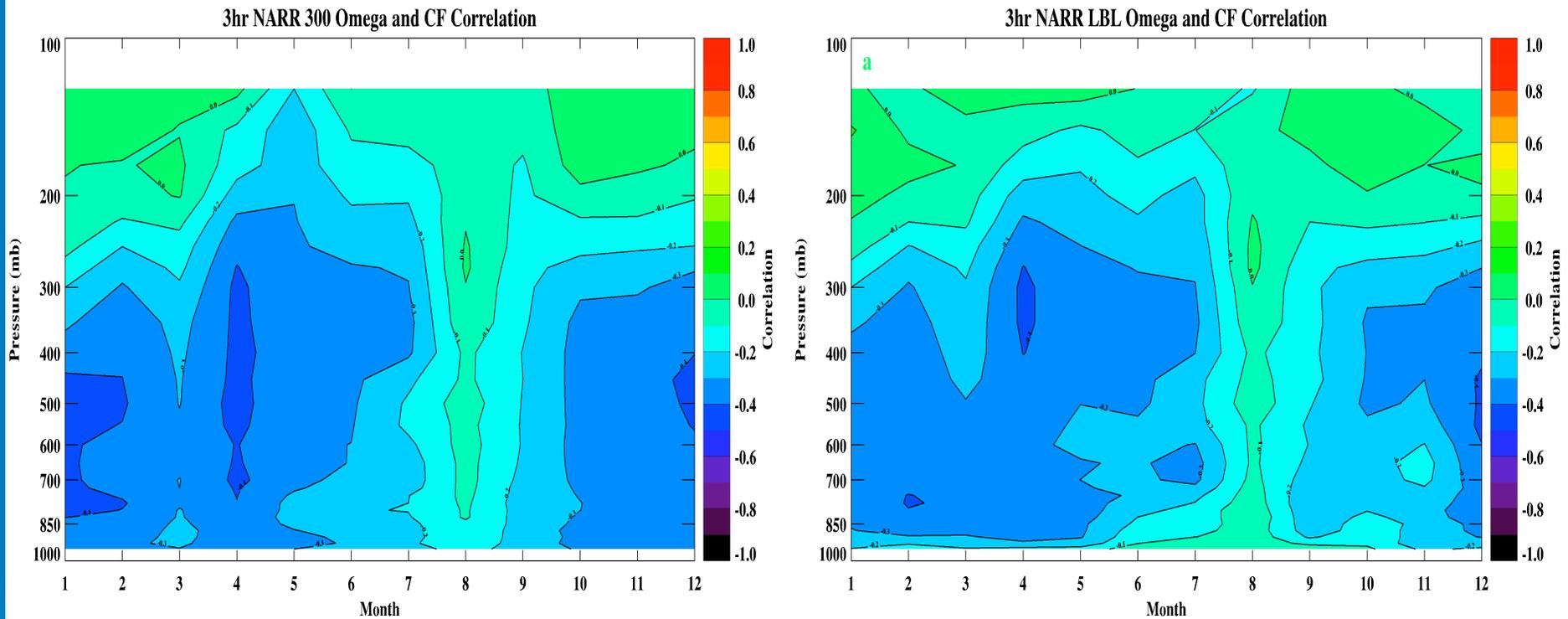
RH Correlations by Time for NARR and ARM (LBL)

ARM



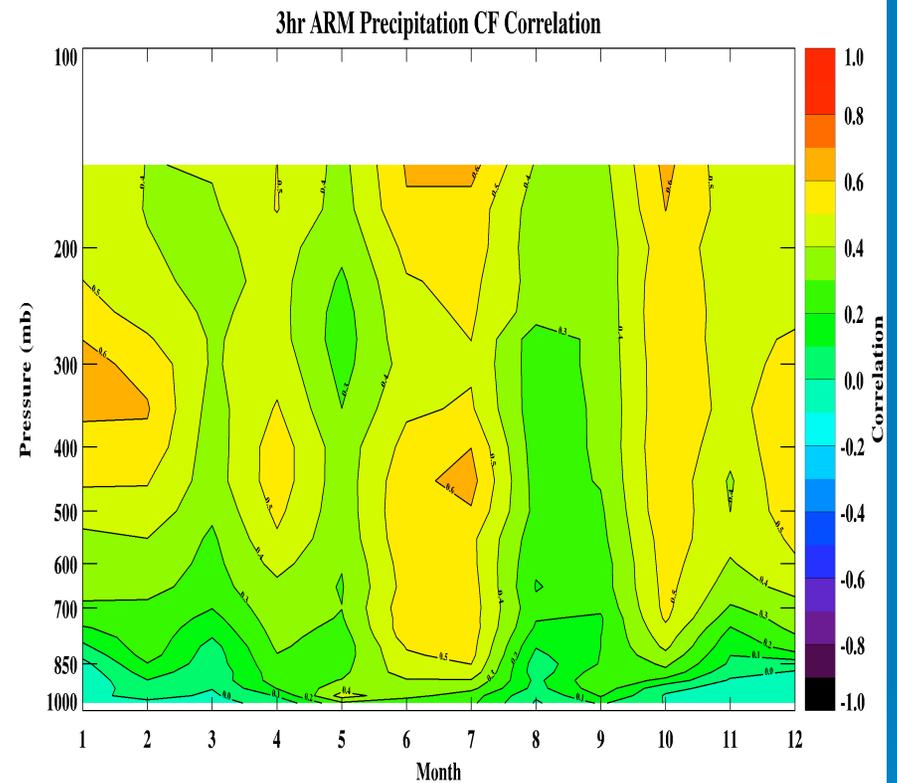
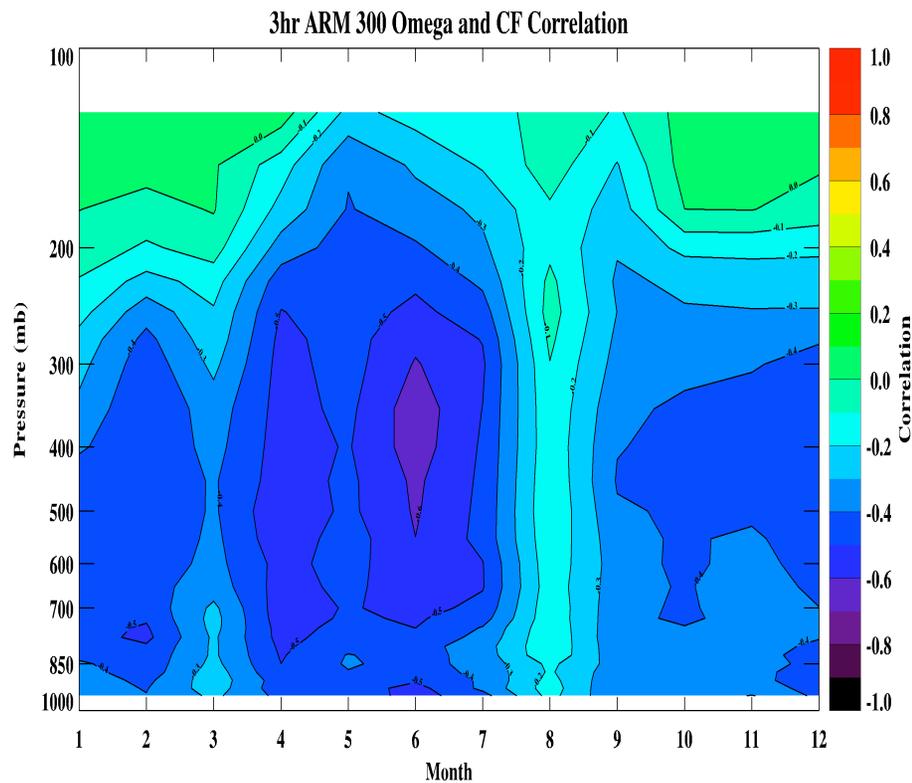
- Similar to omega, correlations crosses over at quarter month resolution
- Magnitude of difference is less than for omega

NARR Correlation by Season



- **Seasonal variation of correlation exists**
 - Highest during winter/spring
 - Minimum during summer
- **Slight increase in mid-tropospheric correlations when using 300mb omega instead of LBL**

ARM Correlation by Season



- Higher correlations than NARR
- Seasonal variation still exists
- Similar pattern for RH

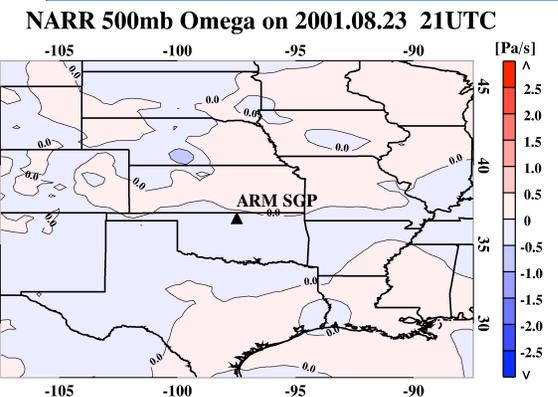
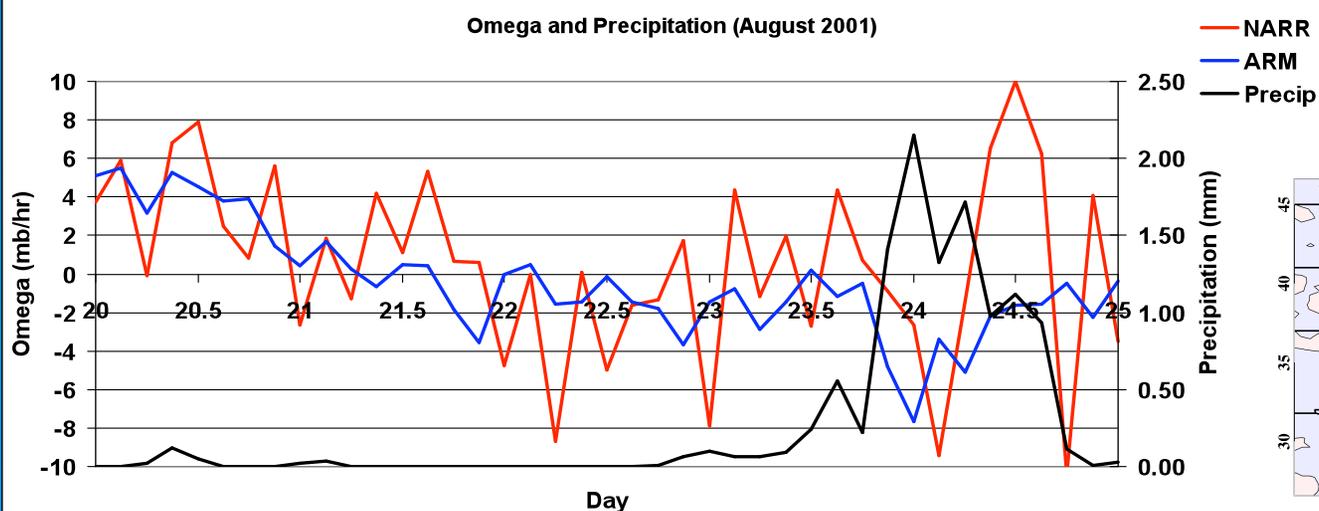
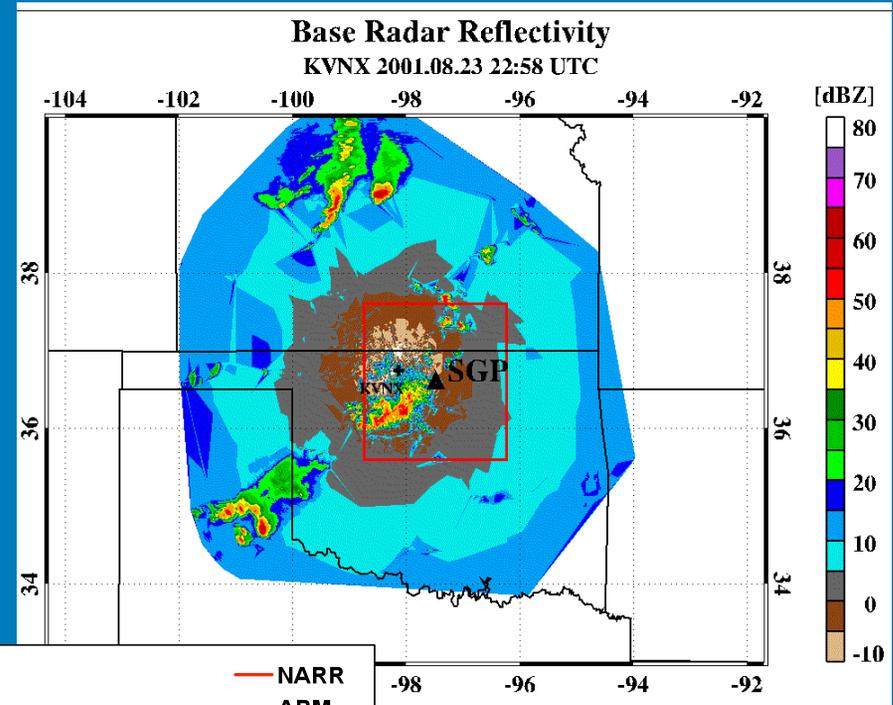
Summary

- **NARR and ARM were compared...**
 - NARR has higher correlations at timescales greater than a quarter month
 - This appears to be due to more downwelling during summer months
 - Jury still out
 - Correlations do show a seasonal cycle with lowest during the summer months (ARM SGP under ridging typically)
- **What's the importance of this?**
 - If ARM correlates better at short timescales, shouldn't it also at longer time periods?
 - Probably good for individual cases...
 - What are the ramifications when forcing is used for SCMs which are concerned more with long-term means?
 - Precipitation correlates well with omega (not shown)
 - CF will then be correlated to this precipitation
 - CF correlates better at longer time periods with synoptic scale vertical motion?

My question...

➤ Consider a case...

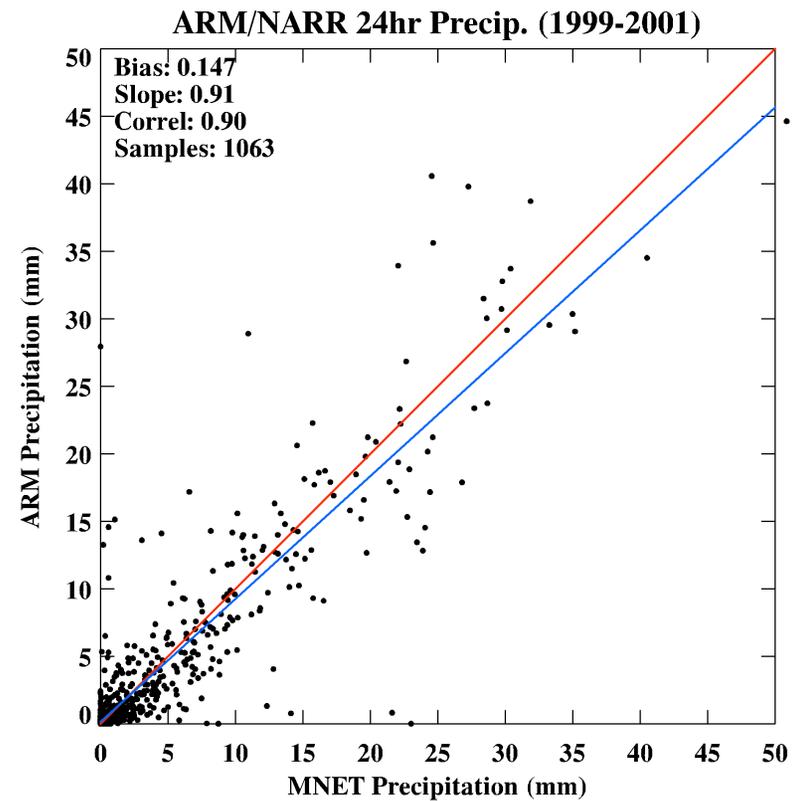
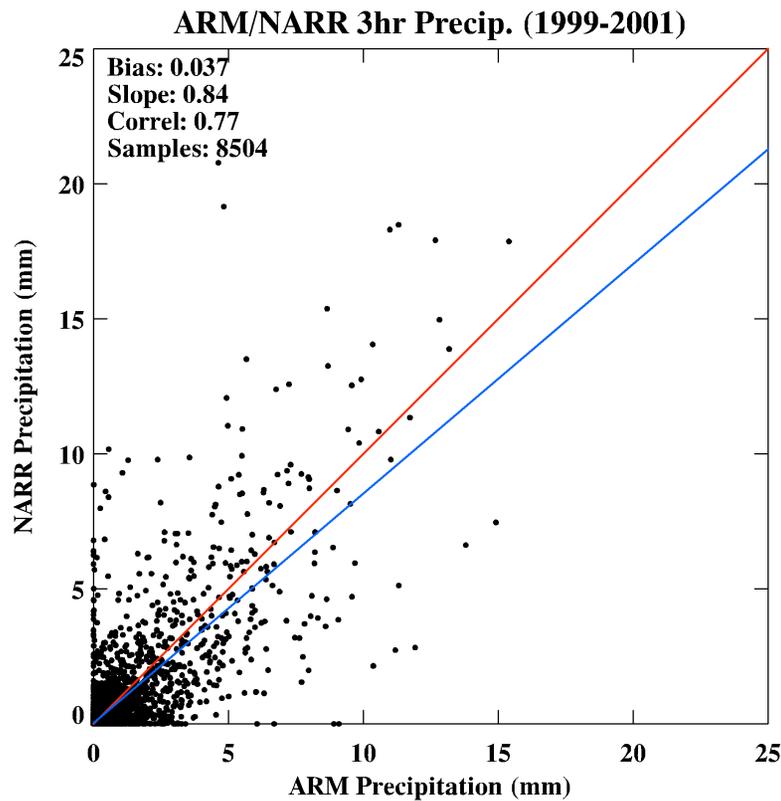
- Thunderstorms develop from mesoscale processes under weak synoptic forcing
- Thunderstorms then precipitate at ARM SGP
- **If vertical velocities are constrained by precipitation will this then lead towards upwelling which makes it easier than “reality” for models to simulate said thunderstorms?**



Questions?

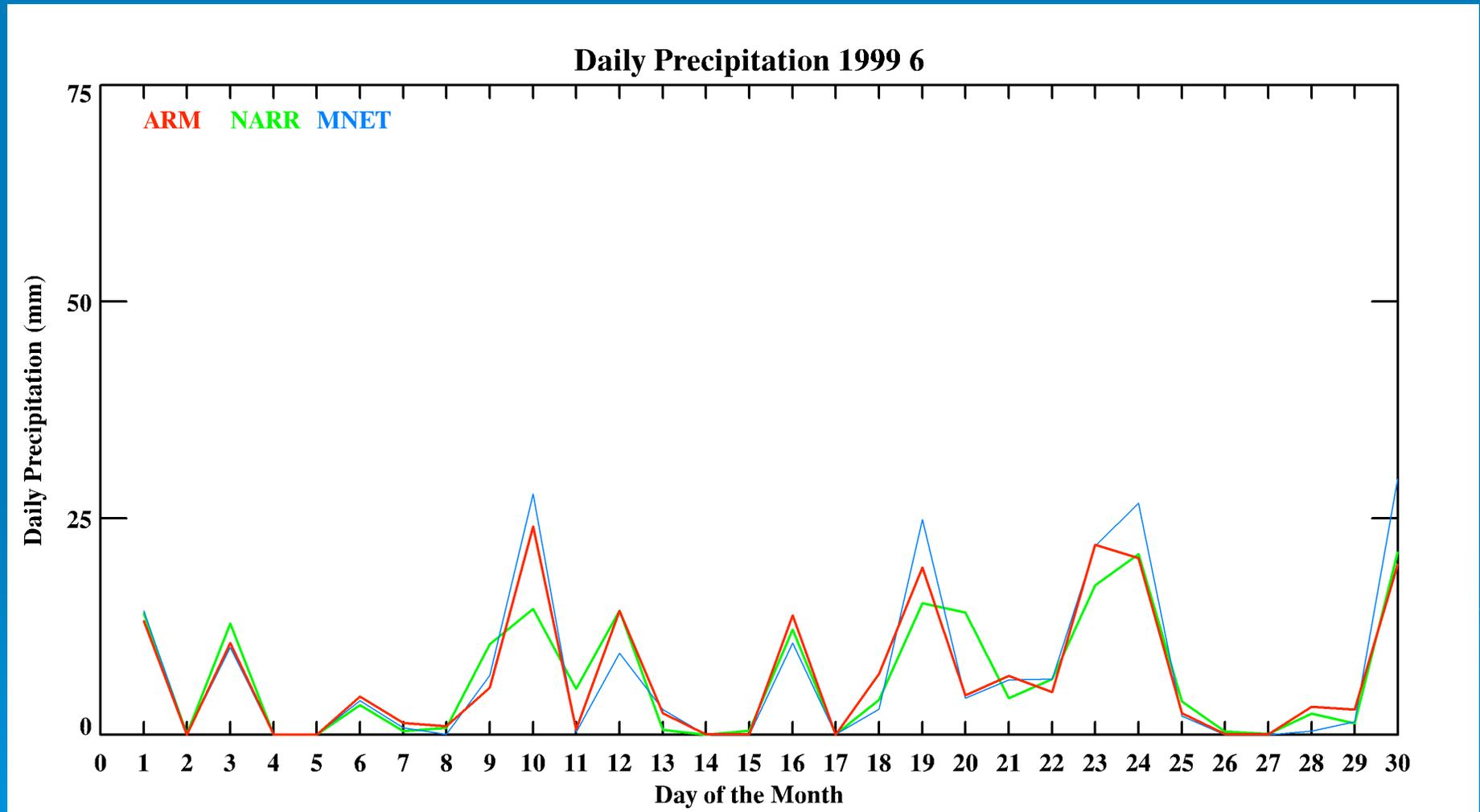


3h / Daily Precipitation

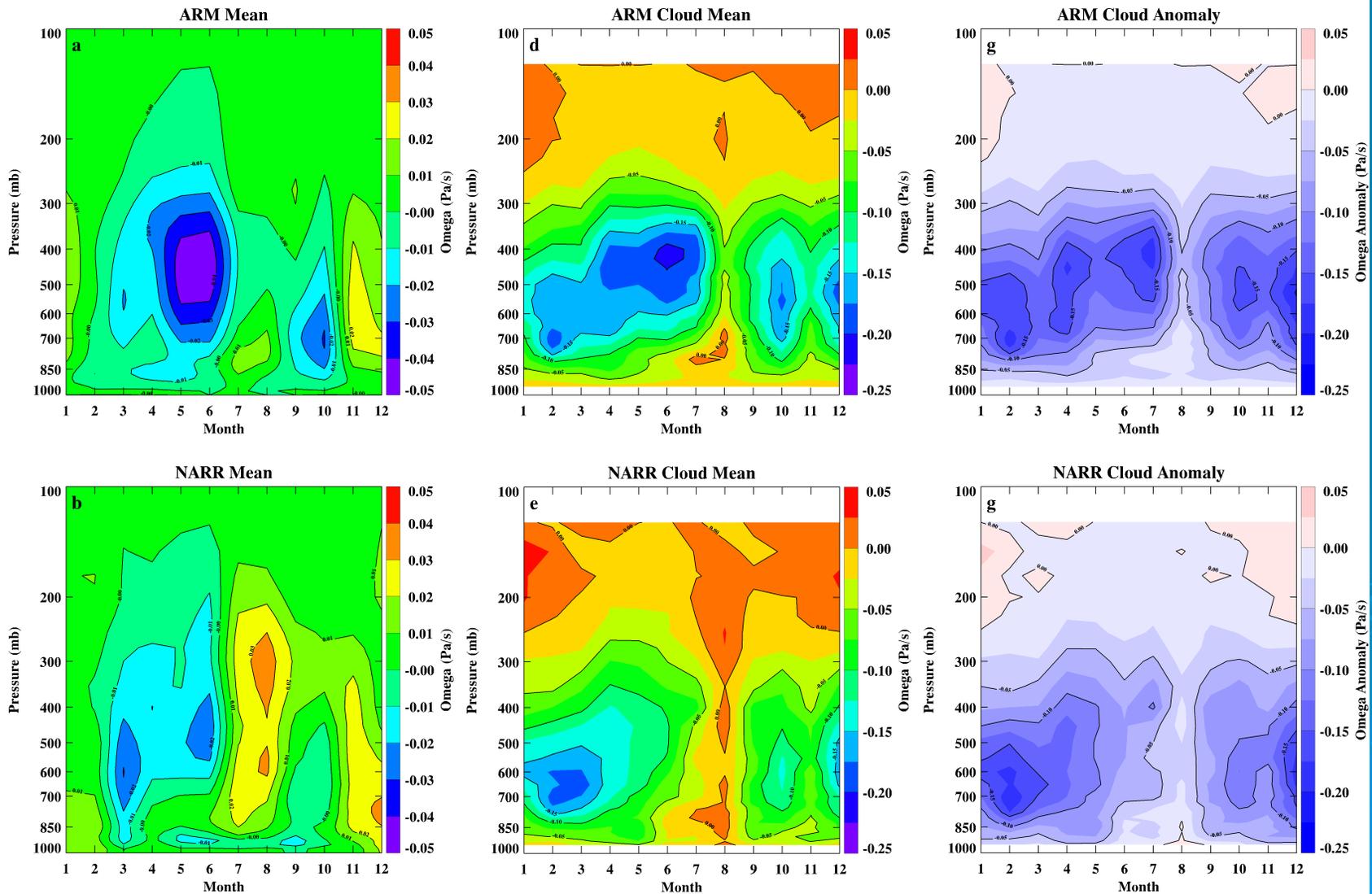


Monthly correlation: 0.99

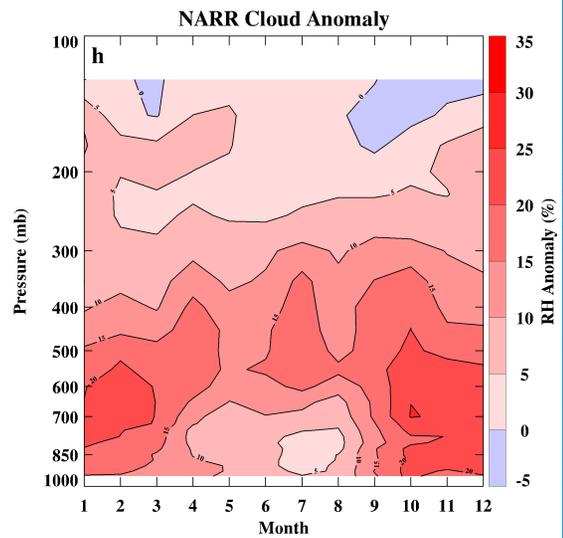
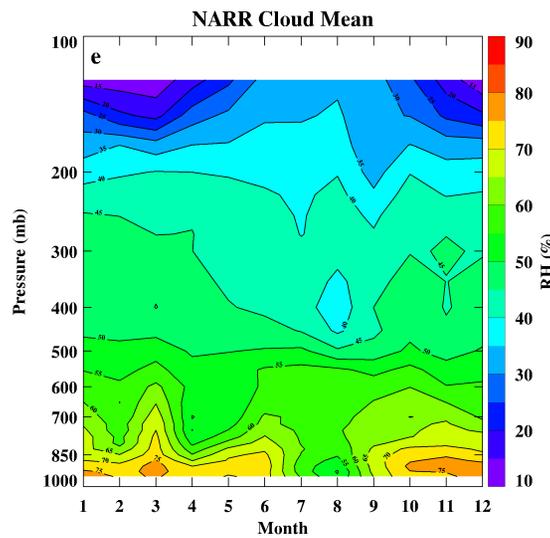
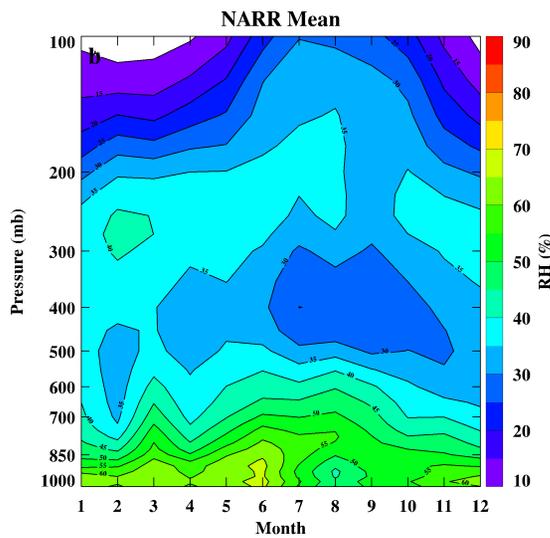
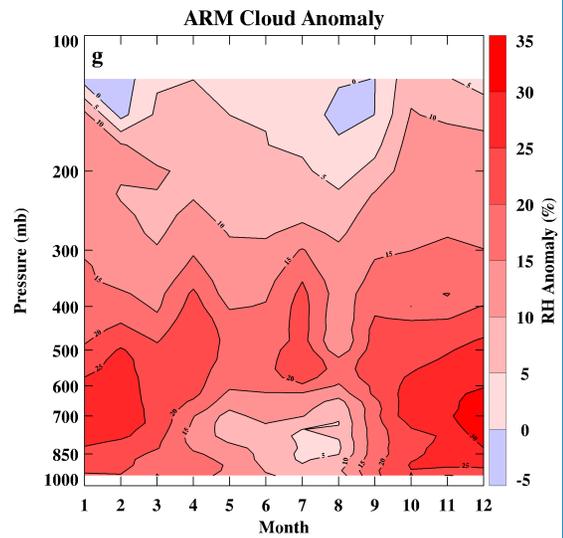
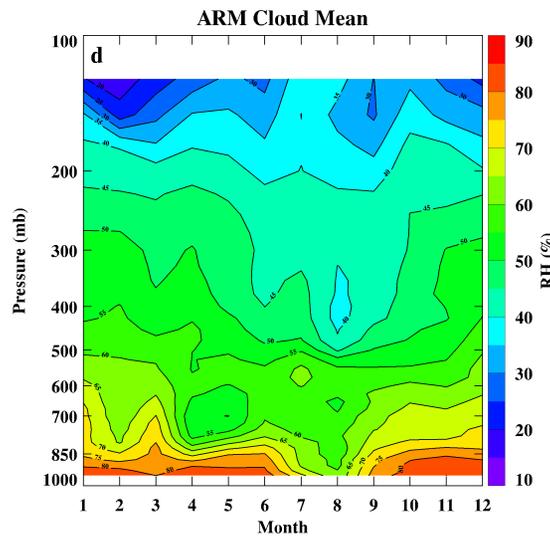
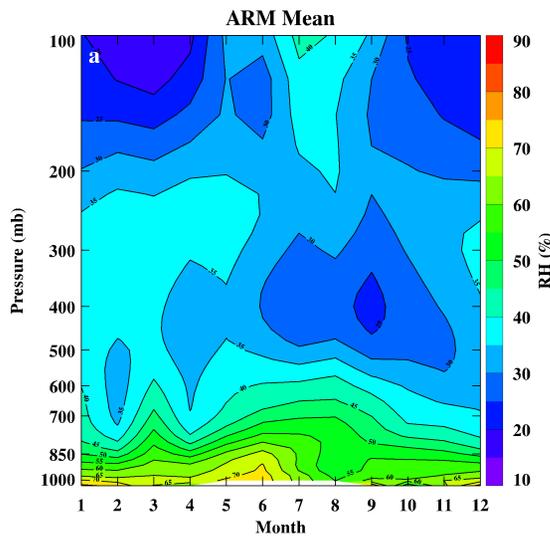
Daily Precipitation Time Series



ω Cloud Anomaly NARR/ARM



RH Cloud Anomaly NARR/ARM



CF

➤ ARM - RED

