Summary of Papers presented by

Prashant Kumar (02-18-2007) and Wei-Chun-Hsieh (02-25-2007)

Paper 1: Xue, H., and G. Feingold, Large eddy simulations of tradewind cumuli: Investigation of aerosol indirect effects. J. Atmos. Sci., 63, 1605-1622, 2006.

Paper 2: Guo, H., Penner, J. E., Herzog, M., and Pawlowska, H., Examination of the aerosol indirect effect under contrasting environments during the ACE-2 experiment, Atmos. Chem. Phys., 7, 535-548, 2007.

Paper 3: Tao et al., Role of atmospheric aerosol concentration on deep convective precipitation: Cloud-resolving model simulations, J. Geophys. Res., 112, D24S18, doi:10,1029/2007JD008728, 2007.

Comparison of three papers:

	Xeu/Feingold	Guo	Tao		
Type of Clouds	Warm Cumulus clouds	Marine Stratocumulus Clouds	Deep Convective Clouds		
Models	LES (Large-Eddy Simulation)	ATHAM (Active Tracer High-resolution Atmospheric Model)	2D-CRM (Cloud Resolving Model)		
MODEL SETUP					
Domain - Range	Horizontal: 6.4km*6.4km and Vertical:3km	Horizontal: 6.4km* 6.4km	80 m in boundary layer 1000 m in the upper levels		
Time Step	0.5 sec	0.5 * 4 = 2sec	5 s		
Spin-Up Time	2 hours	6 hours	Not mentioned		
Analysis Time	4 hours	24 hours	8 hours		
Campaign	BOMEX	ACE-2	TOGA	PRE-STORM	CRY-STAL
Aerosol Distribution	1 mode Log normal	3 mode Log normal	$N= N_{0}*S_{w}^{k}$ (unit cm^{-3})		
Aerosol Type	Marine	Marine	Marine	Cont.	Cont.
CCN	Sulphate	Sulphate	Not mentioned		

Number concentration					
Clean	25 per mg	218 per cm3	N_0=100 k=0.42	N_0=600 k=0.3	N_0=600 k=0.3
Polluted	2000 per mg	636 per cm3	N_0=2500, k=0.3		
Mixing Ratio units of per mg is roughly equal to per cm3					
Bin number	33		33		
Comparison with Observations	Yes	Yes	Yes (benchmark study)		
Changes with Meteorological Condition	No	Yes	MCS	MCS	Sea breeze convec-tion
CLOUD PROPERTIES CHANGES WITH INCREASING AERSOSOL CONCENTRATION					
Cloud Fraction	Decrease	Decrease	**NA**		
LWP_Cloud	Increase	Decrease	↑	↓	No obv. change
Cloud Top Height	Decrease	No Effect	Not mentioned		
Effective Drop Radius	Decrease	Decrease	Not mentioned		
COD	Increase	Increase	Not mentioned		
COD is directly proportional to LWP and inversely proportional to Effective Drop Radius					
Precipitation Rate	Decrease	Not Mentioned	↑	↓	No obv. change
Parcel Updrafts	Increase		Max w.		
			↑	Fluctuati ons	No obv. change

Important Overall Conclusions:

1. CCN spatial and temporal distribution play an extremely important role to simulate clouds; quantification of aerosol indirect effects need to be constrained because of its substantial uncertainty based on the correct estimate of CCN available for cloud droplets formation.
2. Entrainment and Evaporation are important factors in determining cloud physics.

   Time Scale of droplet evaporation in clean and polluted clouds differs by a factor of 10.

   Large Evaporation cooling → Stronger Downdraft Stronger Cool Pool (More Precipitation
3. Polluted Clouds have higher horizontal buoyancy gradients than the Clean clouds.

   This results in higher entrainment rates and causes decrease in cloud fraction and cloud heights. This is a direct consequence of suppression of precipitation. [Paper 1]
4. Entrainment effect depends on the relative condition of air being entrained into the parcel from the top relative to parcel initial conditions, which can result in a decrease or an increase in water vapor available for condensation on the surface of aerosols. Decrease in cloud drops would cause suppression of precipitation; this characteristic is most significant during the early stage of cloud formation.
5. Updraft Velocities of the air parcel play a significant contribution in overall cloud properties.

   Higher Updrafts are generally found in deep convective clouds in comparison with low-level stratus clouds. This results in significant turbulence within the parcel and directly affects the growth of the particle, which dictates precipitation rate of the cloud. Turbulence in both low-level stratus clouds can enhance droplet growth by collision-coalescence process, or ice formation due to rimming process in deep convective mixed phase clouds thus increasing the uncertainty that is already existing in studies of clouds.
6. The chemistry of aerosol also adds another dimension to the complexities associated with different clouds that has not been explored in any of these three papers dealing with stratus or deep convective clouds.
7. Hence, it can be concluded through these studies that there is a direct linkage of different aerosol concentration with clouds and precipitation, however a well-defined trend has not been observed for precipitation. It can hence be concluded that changes in precipitation due to second AIE can either result in an increase or decrease or no change depending on the individual cloud system and cloud microphysics interactions.
8. Total Aerosol Indirect Effect Forcing is negative BUT Forcing due to Second Aerosol Indirect Effect can be either Positive or Negative depending on the cloud microphysical properties. This is a contradiction to the Albrecht effect of 1989.