An Evaluation of Cloud Microphysics and Radiation Calculations at the NSA

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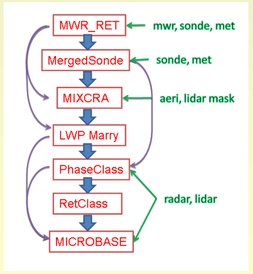
"ShupeTurner" Cloud Properties Dataset

[1-min, IWC/Rei, LWC/Rel @ NSA for 3/2004 – 2/2005]

Methods

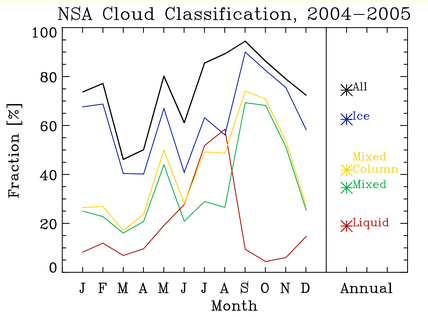
A Multi-Algorithm Collaboration

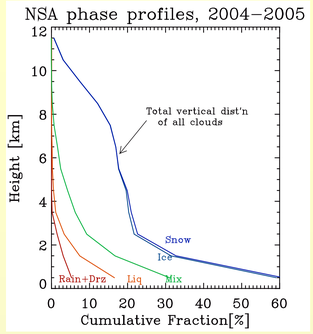
- ***Phase Classification*** – combines phase signatures from radar, lidar, radiosonde, and lwp
- ***Retrieval Classification*** – conditional based on phase type and measurement availability
- ***Liquid Retrievals*** – aeri+mwr or mwr+radar or adiabatic (radiosonde, radar, lidar) or climatology
- ***Ice Retrievals*** – radar+aeri or radar

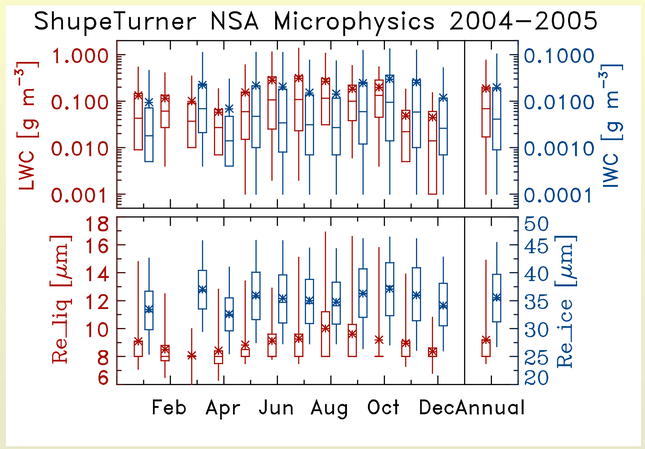


Cloud Phase Characteristics – Key Findings

1) Cloud ice occurs most of the time that clouds are present.
2) Liquid–containing clouds occur throughout the year with occurrence fractions greater than 20% in the winter.
3) Late summer cloud fractions are very high.
4) Low-level clouds of all types are most prevalent







Microphysical Properties – Key Findings

1) Highest LWC and largest liquid droplets in summer
2) IWC is approx. 1 order of magnitude less than LWC, on average
3) Re_ice shows little annual variation.

BBHRP Radiative Closure Analysis

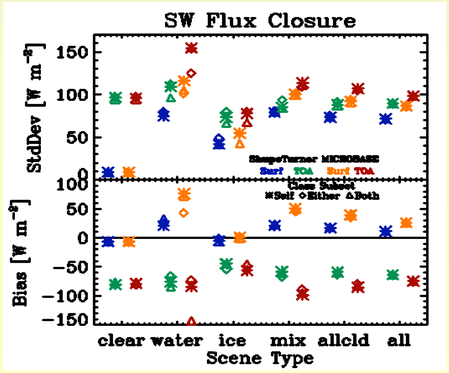
Cloud phase dependence and comparison with BNL Microbase

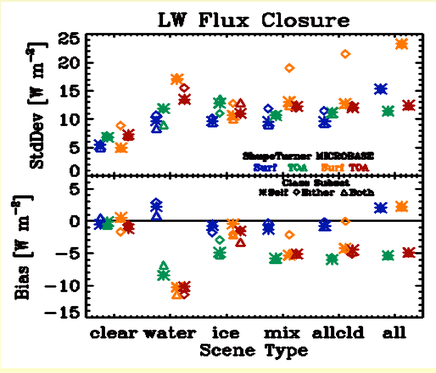
ShupeTurner and BNL microphysics products are incorporated into the Broadband Heating Rate Profiles algorithm to compute radiative fluxes at the surface and TOA. These are compared with similar flux measurements to evaluate the quality of the microphysics products.

Comparison of Scene Identification

	# of occurrences	ShupeTurner			
		clear	water	ice	mix
BNL	clear	1761	35	1	0
	water	31	347	0	21
	ice	515	20	1045	784
	mix	106	223	233	5359

* These statistics are at 20-min resolution. Phase class is for the full column.





Key Findings

1) ShupeTurner shows significant, all around improvements (both StdDev and Bias) for cloud scenes containing liquid water.
2) Ice clouds show similar results (both are based on radar reflectivity).
3) SW TOA closure is better when clouds are present than under clear skies!?
4) Surface closure is usually better than TOA closure
5) Key discrepancies in cloud classification. ST identifies many cases as "mixed" that BNL calls "ice." ST identifies more clear sky than BNL.

Reasons for Improvement

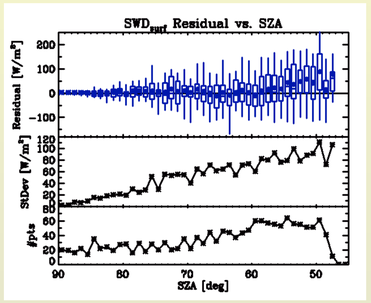
1) Cloud classification (improved location of liquid)
2) LWP retrieval

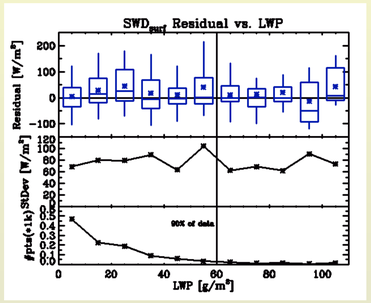
BBHRP Surface Radiative Closure Analysis

Dependence on Cloud and Environment Properties

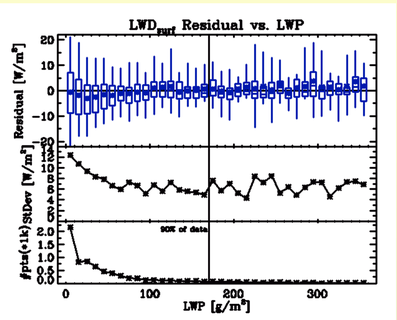
Surface SW– Key Findings

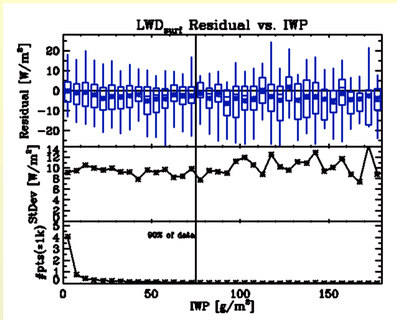
1) SW closure becomes worse as SZA decreases and insolation increases
2) SW closure appears to be insensitive to LWP and IWP
3) SW closure is better for ice clouds than for other cloud types

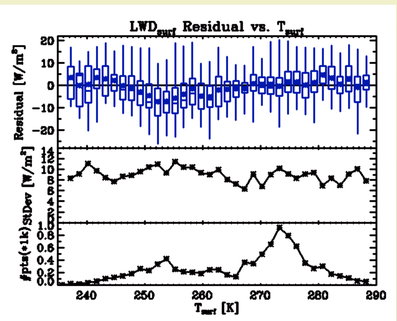




SW closure is great when there is no sun!







Surface LW – Key Findings

1) StDev and Bias decrease as LWP increases.
2) Quality of radiative closure is not dependent on IWP.
3) StDev slightly decreases as T_{surf} increases and as the total downwelling LW increases.
4) Quality of LW closure appears to be independent of cloud phase

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Summary

❖ A new "ShupeTurner" cloud microphysics product has been implemented for 1 year at the NSA site, and will soon be expanded to more years and sites

❖ ShupeTurner shows improvement over BNL Microbase in terms of radiative closure, especially in liquid-containing cases.

❖ Ice cloud cases are similar between ST and BNL products

❖ Some issue other than cloud microphysics adversely affects the SW closure analyses (clear sky closure is no better than cloudy sky).

❖ LW closure may be improved through further improvements to the characterization of low LWP clouds (StDev and Bias increase as LWP decreases).