Algorithm Refinement and Validation of Cloud and Radiation Products Derived from MODIS and CERES Using Ground-Based and Aircraft Data

Jay Mace, University of Utah

- Development of relational database on the web for cloud property retrieval validation
- Use of MODIS Cloudmask in the cloudsat geometrical profile operational product
- Development of an algorithm suite for cirrus property retrieval with A-Train data

Cloud property retrieval algorithm enhancement activity:

Evaluation of Cirrus Cloud Properties Derived from MODIS Data Using Cloud Properties Derived from Ground-Based Observations Collected at the ARM SGP Site

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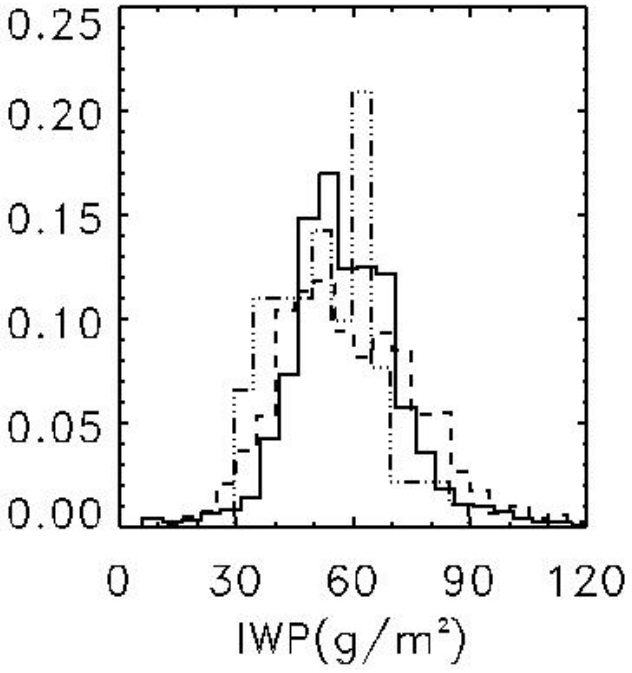
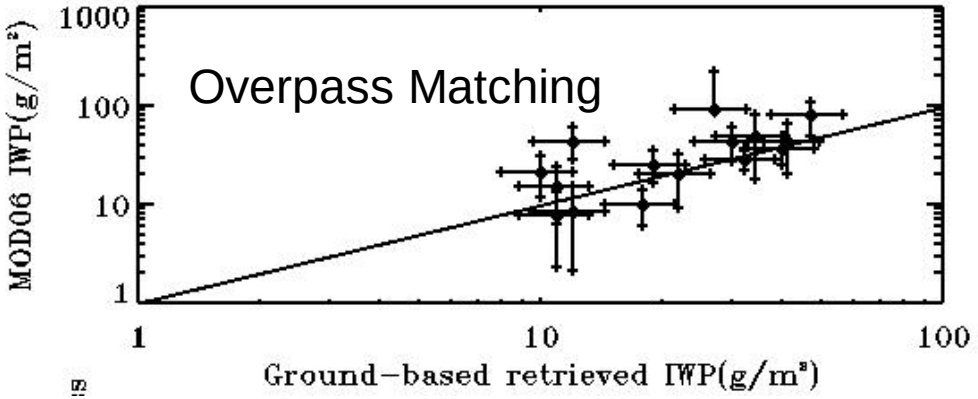
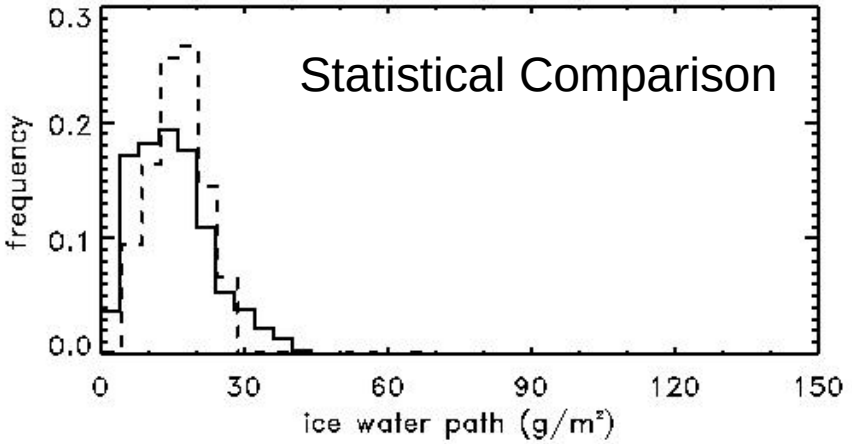
Case Study Evaluation



Overpass Matching



Statistical Comparison



Goal: Extend/expand this study:

1) From a dozen overpasses of ARM ground sites to thousands
2) From thin cirrus to all cloud types and situations
3) Make the validation/intercomparison process easy – foster science investigations

Approach: Construct a relational database that brings together MODIS cloud products and ground based cloud products with web acess

Prototype:

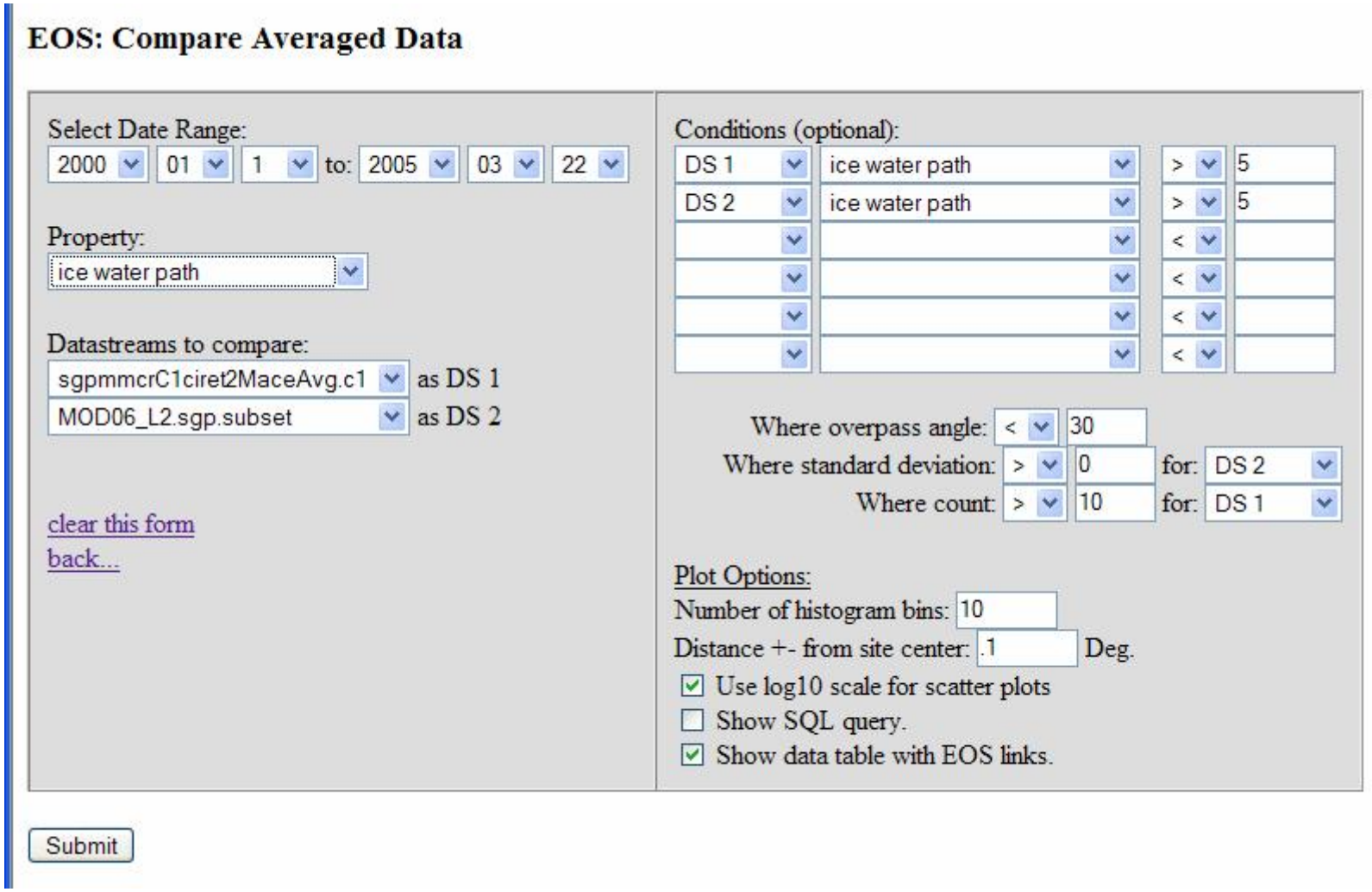
http://www.met.utah.edu/cgi-bin/mace/cgalli/mysql/eos_avg_query.pl

Current Prototype Status:

Includes Terra MOD06 IWP, effective radius, and optical depth retrievals of Cirrus events from 2001 and 2002 – 300 events

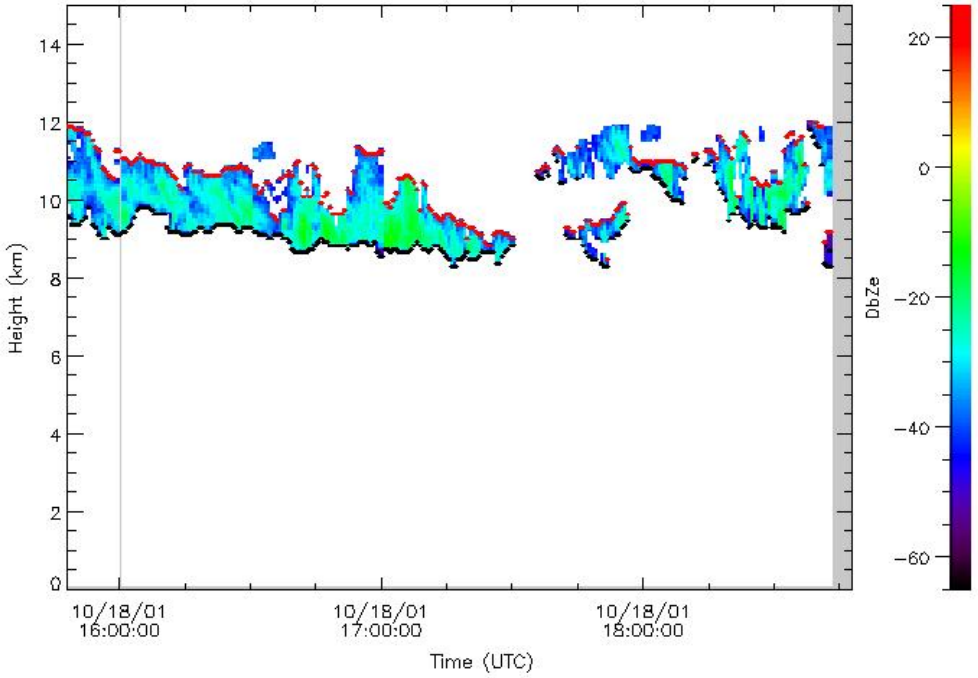
ZV cirrus algorithm results from ARM MMCR data.

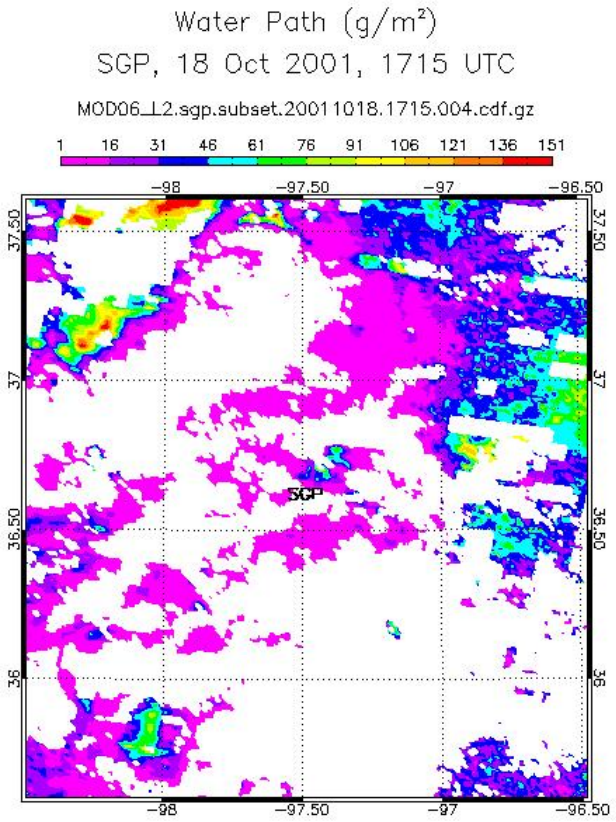
Prototype Interface:



A Case of Good Agreement – 10/18/2001

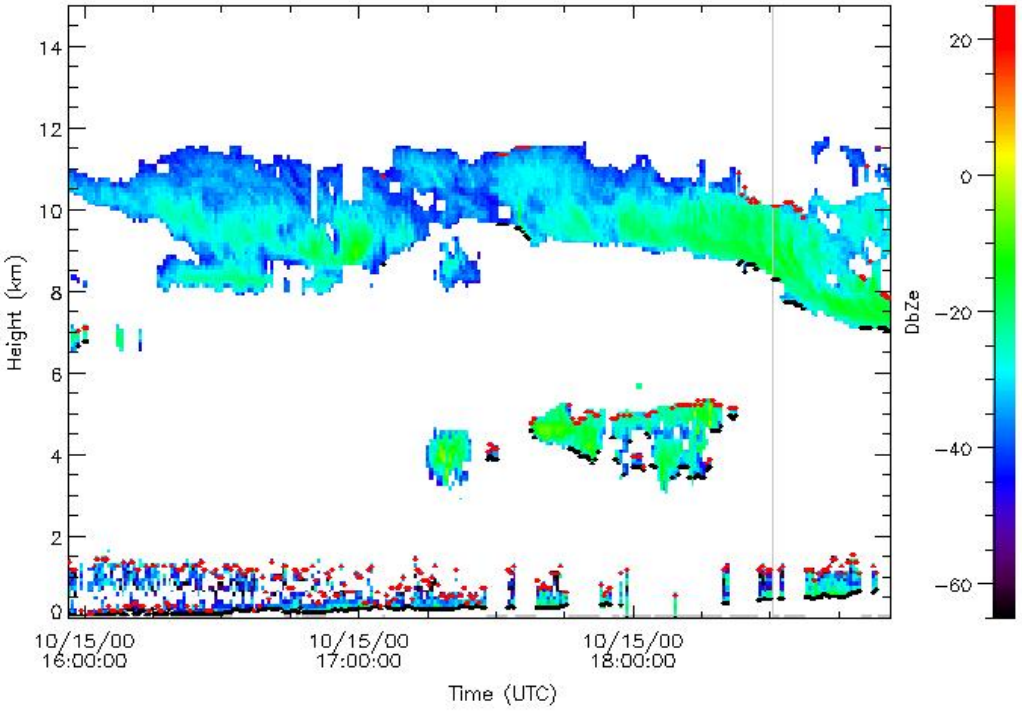
DS1	1003425490	Thu Oct 18 17:18:10 2001	1.54139	55.9947	14.0046322709984	9.03059644323872	134	36	
DS2	1003425490	Thu Oct 18 17:18:10 2001	3	109	15.3121951219512	17.2145740172702	135	205	EOS

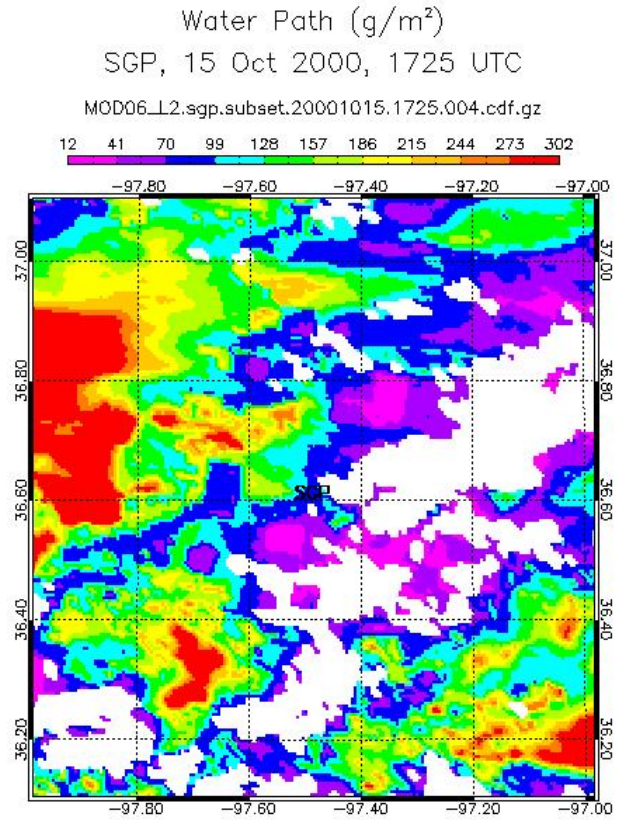




A case of not-so-good agreement – 10/15/2000

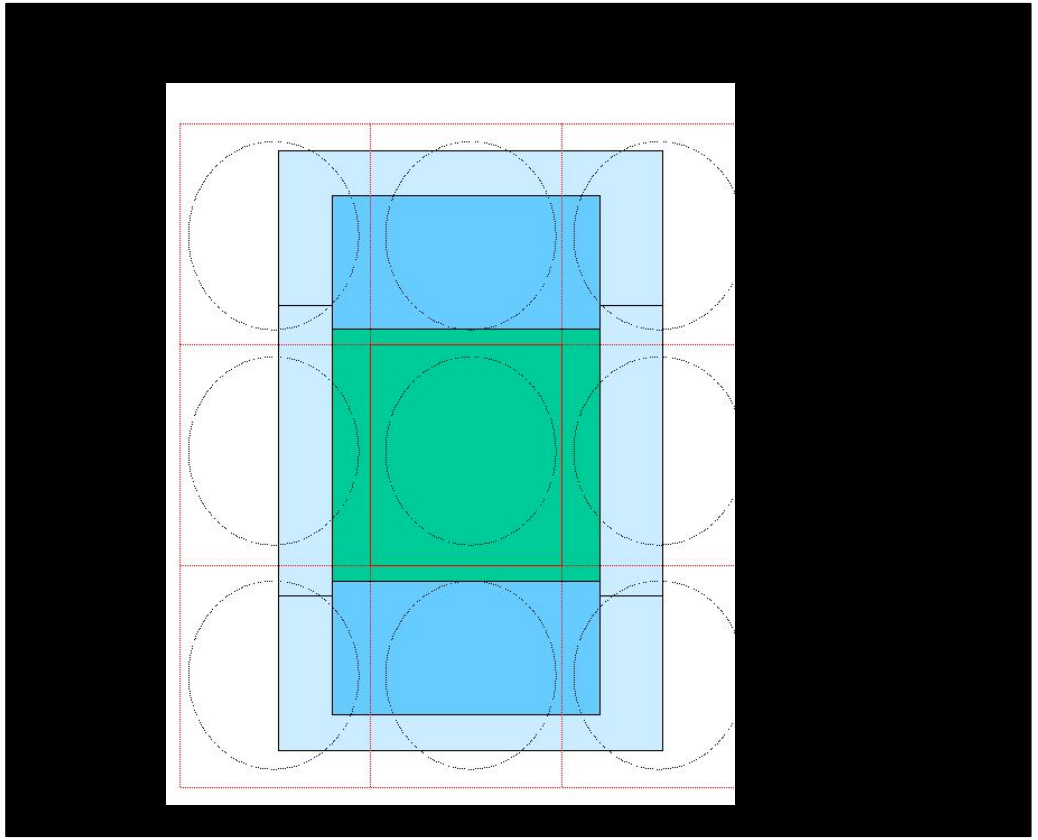
DS1	971630797	Sun Oct 15 17:26:37 2000	0.870128	29.9757	6.14484791911167	6.07025557119294	134	46	
DS2	971630797	Sun Oct 15 17:26:37 2000	20	195	84.2322580645161	39.1871966179275	135	310	EOS





CloudSat Geometrical Profile Product

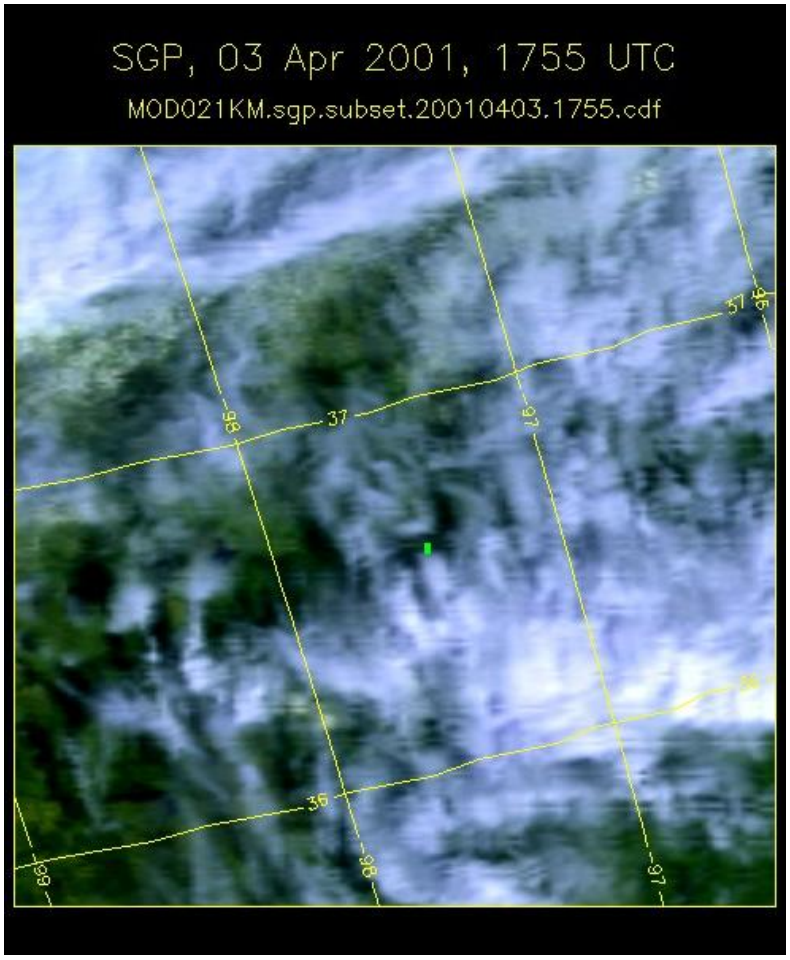
Goal: To combine the spatial information provided by the MODIS CloudMask with the vertical profile information provided by the active sensors

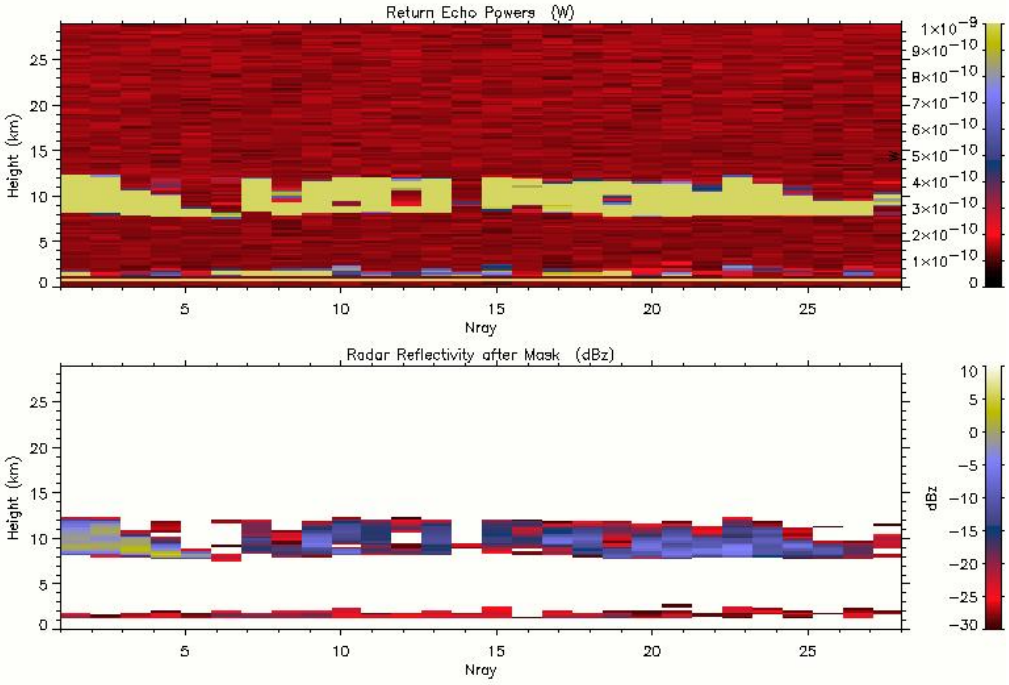


Issues: 1) CloudSat does not detect certain clouds that contribute to radiance field
2) MODIS radiance field suggests a highly variable local cloud field

Approach: Use the MOD35 Cloud Mask bit tests to identify (where possible) cloud type – goal is to identify spatial coherence consistent with cloudsat profile observations.

An Example: April 3, 2001 – SGP ARM Site





[redacted]

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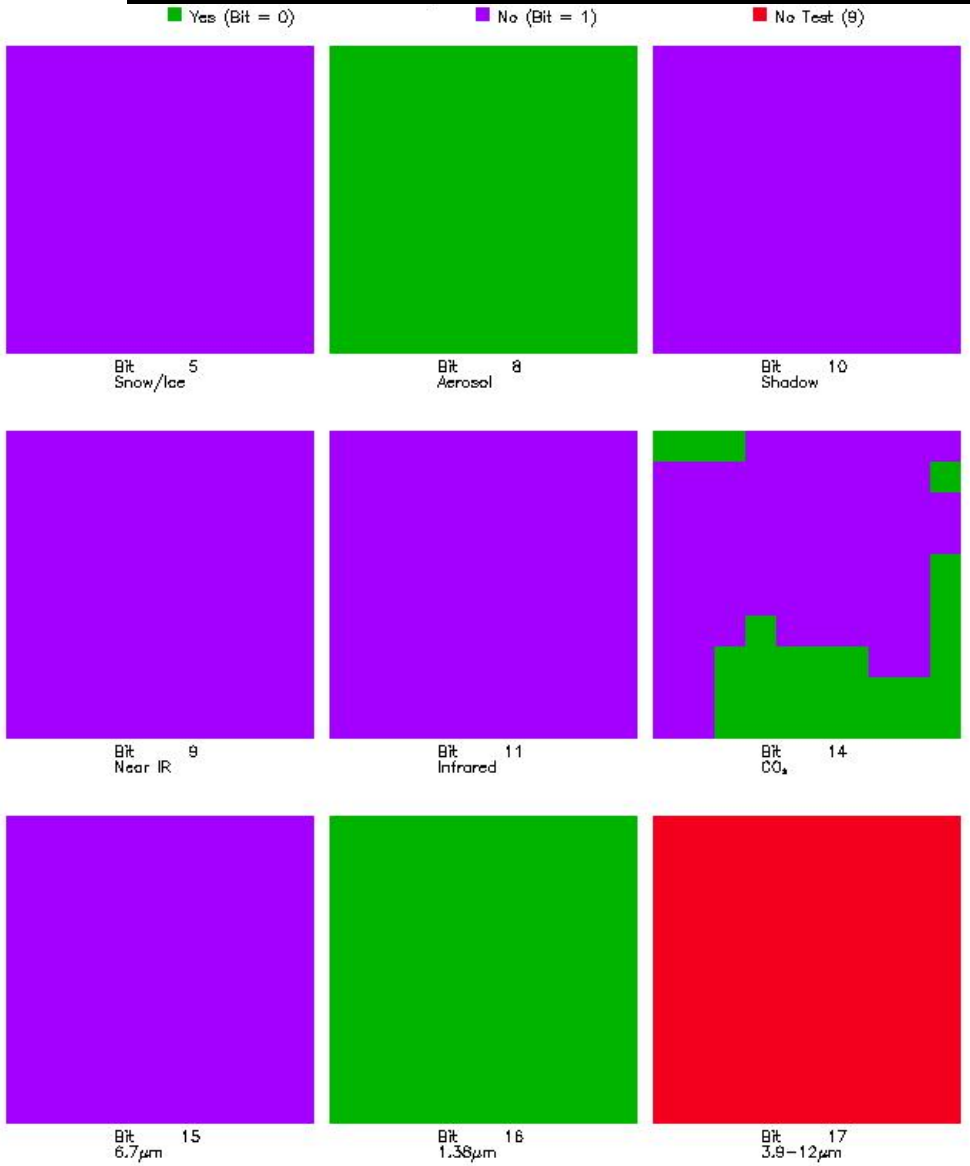
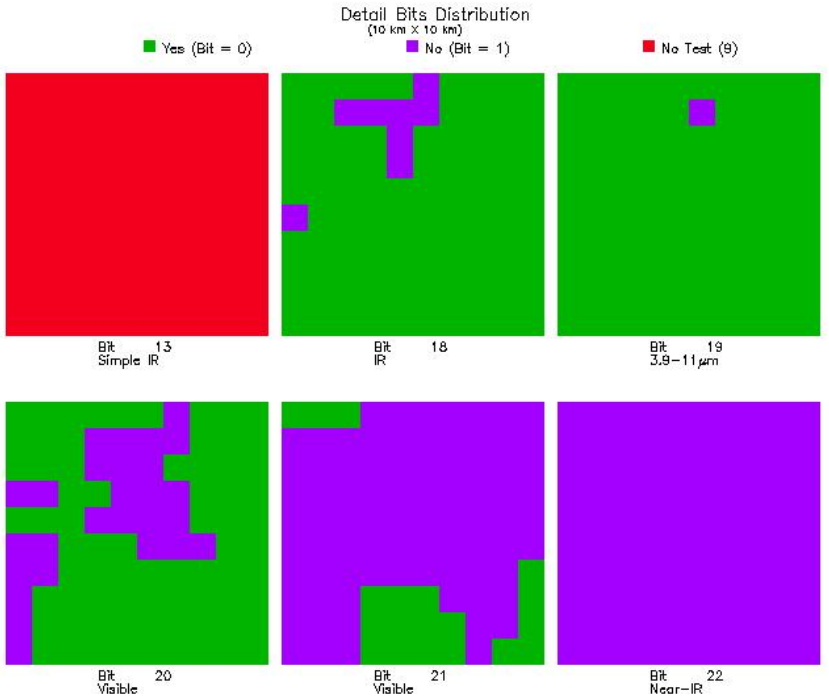
Purple: NO Green: yes RED: no test



CO2 and 1.38 test suggest cirrus. High cloud is detected over the entire box by 1.38 but it appears to be variably thick as indicated by the visible reflectance and CO2 test. Certain tests such as the 6.7 micron test curiously do not find cloud in this case



2B GeoProf Output

Data Granule	CloudSat Metadata			TBD	
	CPR Metadata			TBD	
	Swath Data	Time		Table: nray 10 bytes	
		Geolocation		2 × nray 4-byte float	
		SEM	Radar Reflectivity	125 × nray 2-byte integer	
			Quality assurance Q_A	125 × nray 1 byte integer	
			CPR Cloud Mask	125 × nray 1 byte integer	
		SEM-MODIS	MODIS scene characterizations (Table 3)	1 byte	nray
			CPR echo top characterizations (Table 4)	1 byte	
			MODIS scene variability (Table 5)	1 byte	
			MODIS 250m cloud fraction	1 byte	

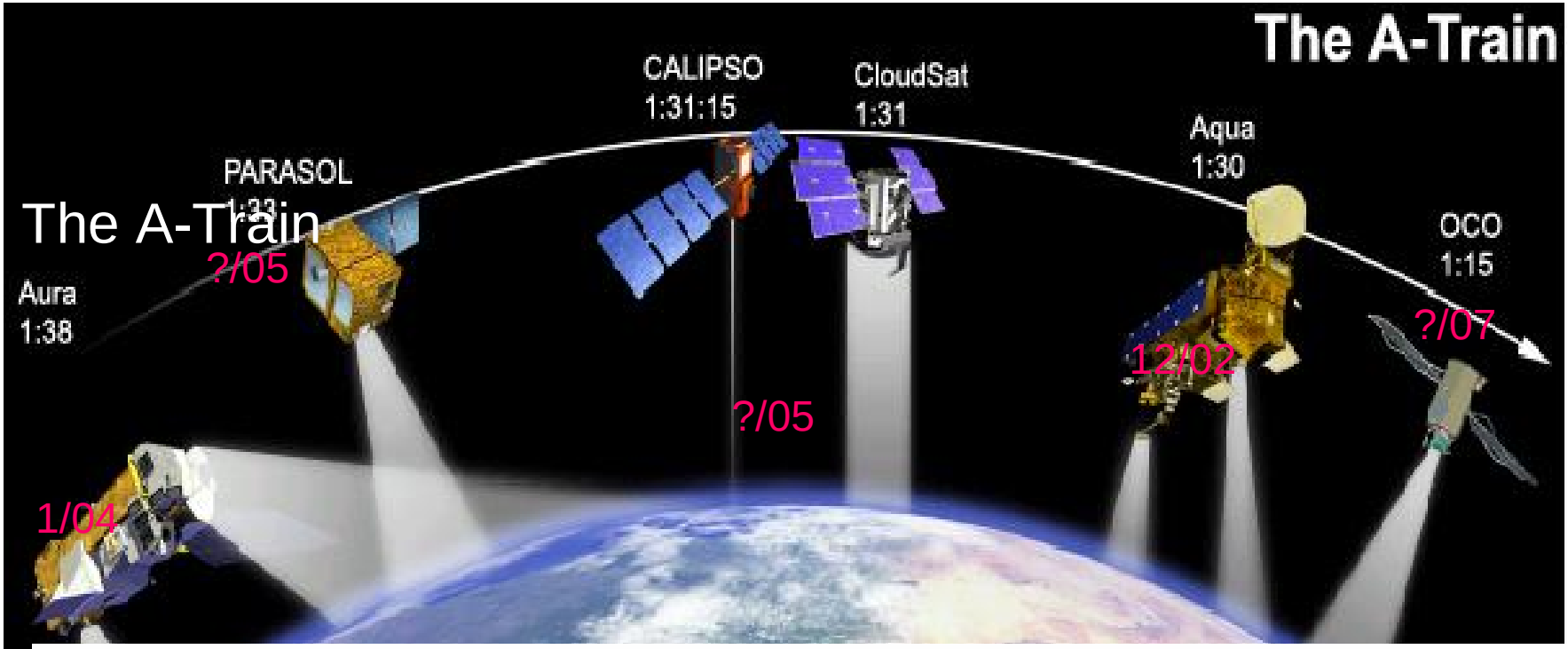
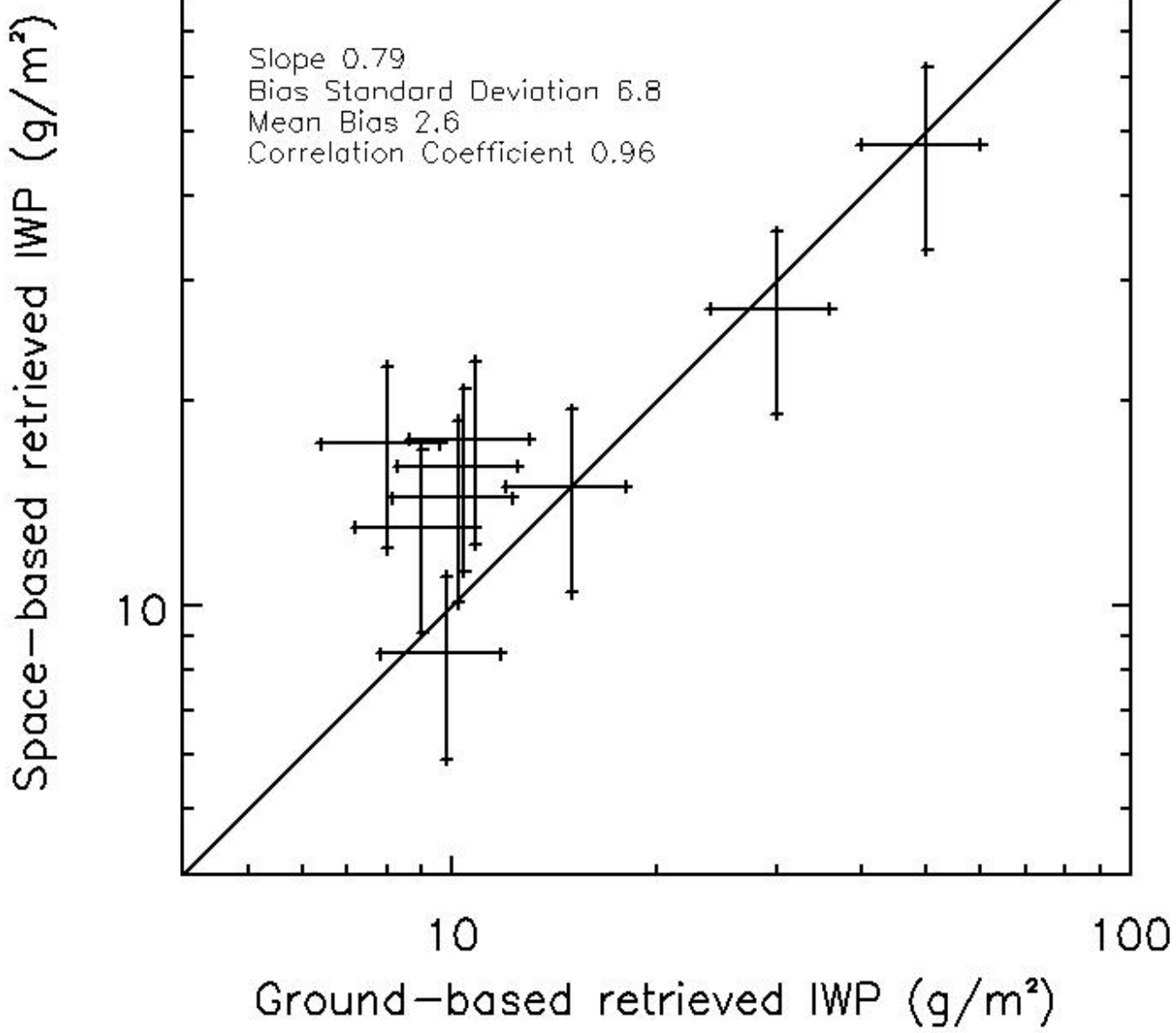


Table 1. a suite of algorithms developed based on different observations and assumption of the particle size distribution

Observations			assumption
Radar	Lidar	Radiometer	
Z	T (β_{ext})	ε (β_{abs})	
X	X		$n(L) = n_e \exp(-\lambda_e L)$
X		X	
	X	X	
X	X	X	$n(L) = n_m (\frac{L}{L_m})^{\alpha} e^{\alpha} \exp(-\frac{\alpha L}{L_m})$



Comparison between an algorithm using MODIS 13 Micron and MPL Tau and ground-based ZR

Summary:

Our use of MODIS data and products is very diverse and continuing to expand:

- Development of relational database on the web for cloud property retrieval validation and basic exploration of the data sets

- Use of MODIS Cloudmask in the cloudsat geometrical profile operational product

- Development of an algorithm suite for cirrus property retrieval with A-Train data