NPP Advanced Technology Microwave Sounder (ATMS): Sensor Description and Preliminary Data Product Performance

William J. Blackwell[1], Christy F. Cull[1], R. Vincent Leslie[1], Otto Bruegman[2], Tammy Faulkner[2], and Edward J. Kim[2]
[1]Lincoln Laboratory, Massachusetts Institute of Technology
[2]NASA Goddard Space Flight Center

Abstract

A suite of sensors scheduled to fly onboard the NPOESS Preparatory Project (NPP) satellite in 2011 will continue the development of environmental data records provided by operational and research missions over the last 40 years. The Cross-track Infrared and Microwave Sounding Suite (CrIMSS), consisting of the Cross-track Infrared Sounder (CrIS) and the first space-based, Nyquist-sampled cross-track microwave sounder, the Advanced Technology Microwave Sounder (ATMS), will provide atmospheric vertical profile information needed to improve numerical weather and climate modeling. The ability of ATMS to sense temperature and moisture profile information in the presence of non-precipitating clouds complements the high vertical resolution of CrIS. Furthermore, the ability of ATMS to sense scattering of cold cosmic background radiance from the tops of precipitating clouds allows the retrieval of precipitation intensities with useful accuracies over most surface conditions.

This poster will present several assessments of the performance of ATMS and the geophysical quantities that are to be derived using ATMS measurements. Prelaunch testing of ATMS has characterized the principal calibration parameters and has enabled predictions of on-orbit performance with high levels of confidence. Planned on-orbit characterization of ATMS will further improve both the measurement quality and the understanding of various error contributions.

ATMS Continues Successful AMSU/MHS/HSB Heritage

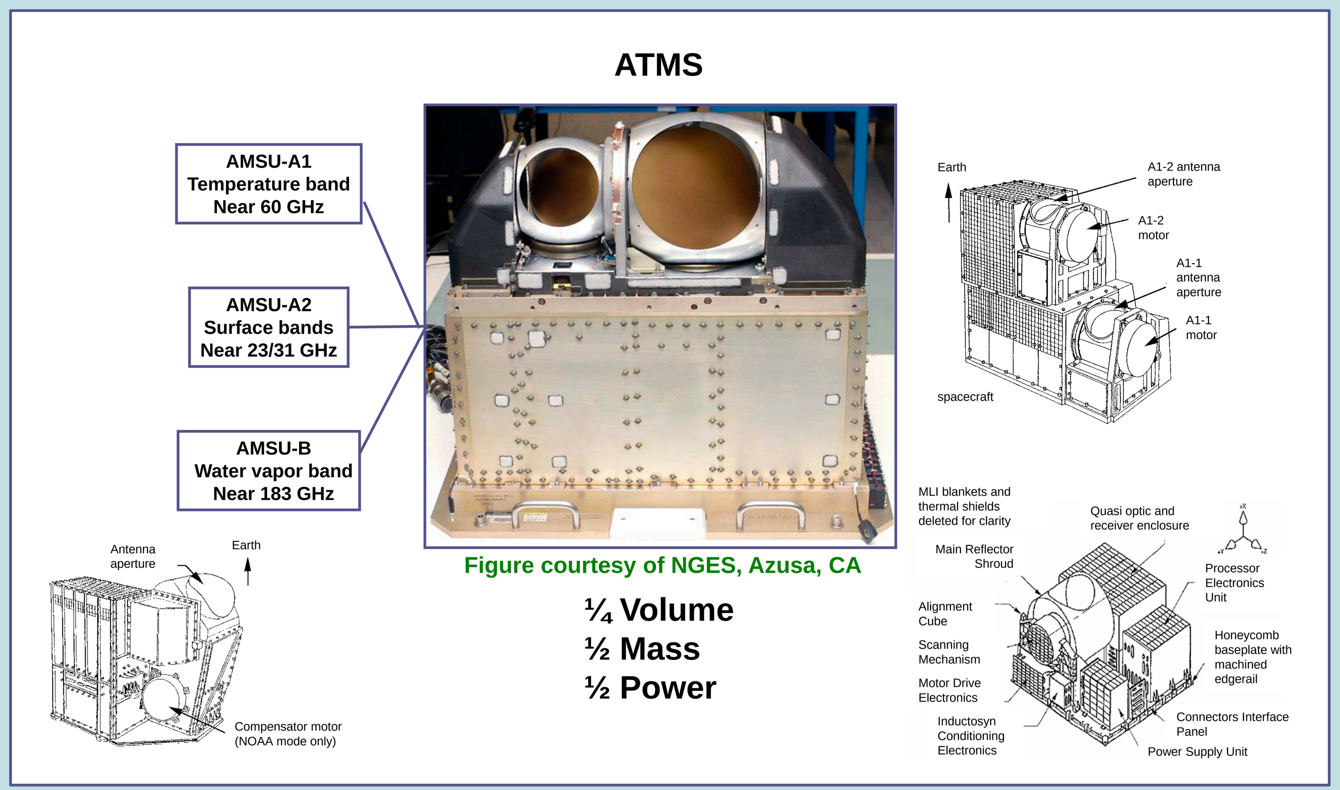


Figure courtesy of NGES, Azusa, CA

ATMS Overview

- Built by Northrop Grumman Electronic Systems under contract to NASA Goddard
- NPP unit delivered Nov. 2005 for 2011 launch; C1 unit on track for 2012 delivery
- Total-power radiometer with 22 channels; based on AMSU/MHS/HSB heritage

ATMS Radiometer Block Diagram

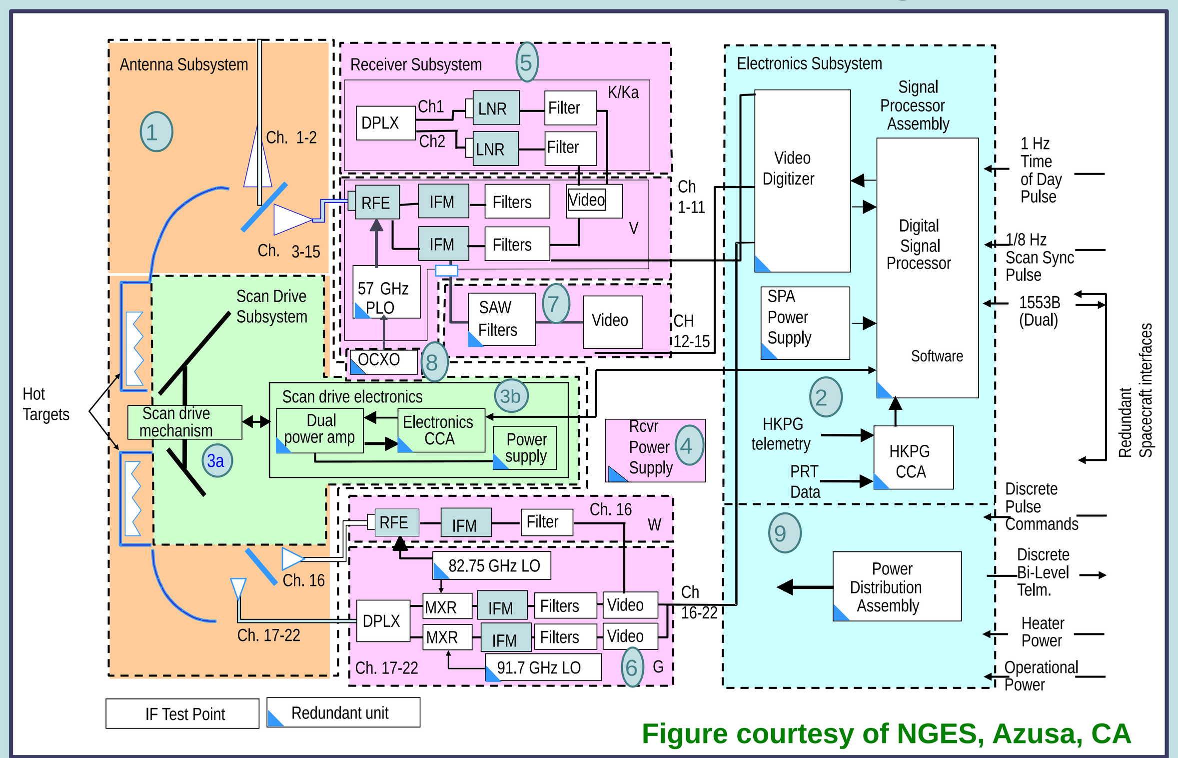


Figure courtesy of NGES, Azusa, CA

ATMS Design Features and Challenges

- Antenna quasi-optics yield a compact system through frequency diplexing
- Highly integrated scan drive and electronics subsystems
- High-performance MMIC receivers

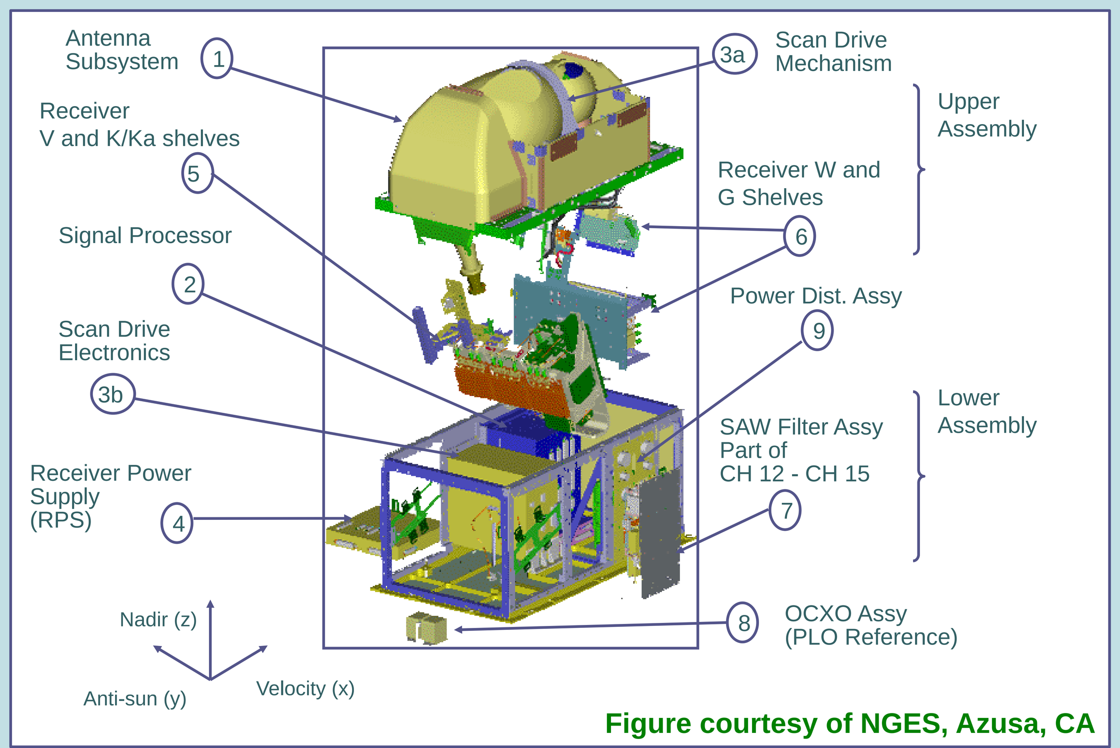


Figure courtesy of NGES, Azusa, CA

Summary of Key ATMS Attributes

Parameter	PFM Measurement
Envelope dimensions	70x60 X 40 cm
Mass	75 kg
Operational average power	119 W
Operational peak power	200 W
Data rate	30 kbps
Absolute calibration accuracy	0.6 K
Maximum nonlinearity	0.36 K
Frequency stability	0.5 MHz
Pointing knowledge	0.03 degrees
NEΔT	0.3/0.5/1.0/2.0 K
Orbit altitude	824 km (NPP)
Reliability	0.87

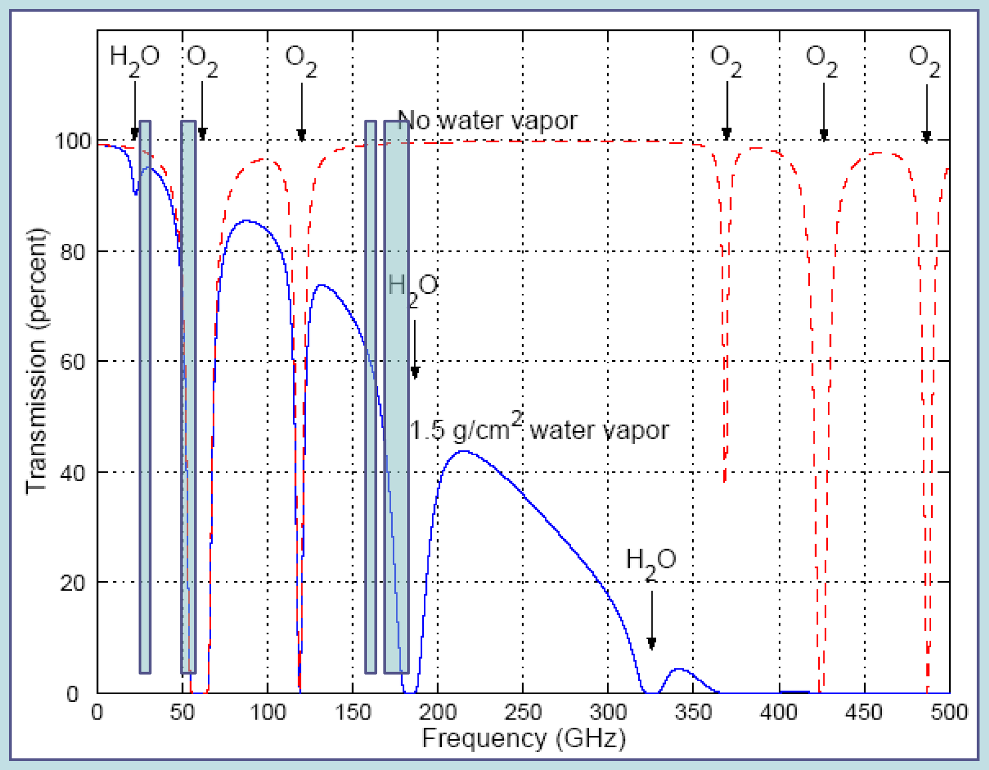
AMSU/MHS Ch	Frequency (GHz)	Pol	Antenna beamwidth	Footprint spacing	ATMS Ch	Frequency (GHz)	Pol	Antenna beamwidth	Footprint spacing
1	23.8	QV	3.3°	3.33°	1	23.8	QV	5.2°	1.11°
2	31.399	QV	3.3°	3.33°	2	31.4	QV	5.2°	1.11°
3	50.299	QV	3.3°	3.33°	3	50.3	QH	2.2°	1.11°
			3.3°	3.33°	4	51.76	QH	2.2°	1.11°
4	52.8	QV	3.3°	3.33°	5	52.8	QH	2.2°	1.11°
5	53.595 ± 0.115	QH	3.3°	3.33°	6	53.596 ± 0.115	QH	2.2°	1.11°
6	54.4	QH	3.3°	3.33°	7	54.4	QH	2.2°	1.11°
7	54.94	QV	3.3°	3.33°	8	54.94	QH	2.2°	1.11°
8	55.5	QH	3.3°	3.33°	9	55.5	QH	2.2°	1.11°
9	fo = 57.29	QH	3.3°	3.33°	10	fo = 57.29	QH	2.2°	1.11°
10	fo ± 0.217	QH	3.3°	3.33°	11	fo ± 0.3222±0.217	QH	2.2°	1.11°
11	fo ± 0.3222 ± 0.048	QH	3.3°	3.33°	12	fo ± 0.3222±0.048	QH	2.2°	1.11°
12	fo ± 0.3222 ± 0.022	QH	3.3°	3.33°	13	fo ± 0.3222±0.022	QH	2.2°	1.11°
13	fo ± 0.3222 ± 0.010	QH	3.3°	3.33°	14	fo ± 0.3222 ± 0.010	QH	2.2°	1.11°
14	fo ± 0.3222 ± 0.0045	QH	3.3°	3.33°	15	fo ± 0.3222±0.0045	QH	2.2°	1.11°
15	89.0	QV	3.3°	3.33°				2.2°	1.11°
16	89.0	QV	1.1°	1.11°	16	88.2	QV	2.2°	1.11°
17	157.0	QV	1.1°	1.11°	17	165.5	QH	1.1°	1.11°
18	183.31 ± 1	QH	1.1°	1.11°	18	183.31 ± 7	QH	1.1°	1.11°
19	183.31 ± 3	QH	1.1°	1.11°	19	183.31 ± 4.5	QH	1.1°	1.11°
20	191.31	QV	1.1°	1.11°	20	183.31 ± 3	QH	1.1°	1.11°
					21	183.31 ± 1.8	QH	1.1°	1.11°
					22	183.31 ± 1	QH	1.1°	1.11°

AMSU-A: channels 1–15; MHS: channels 16–20

Legend:
- Exact match to AMSU/MHS
- Only Polarization different
- Unique Passband
- Unique Passband, and Pol. different from closest AMSU/MHS channels

- The ATMS swath width is approximately 2600 km, compared with 2200 km for AMSU/MHS
- Two additional ATMS water vapor channels improve retrieval performance relative to AMSU/MHS
- The MIT LL ATMS Proxy Data Generator allows CrIMSS algorithms to be evaluated using AMSU/MHS observations

Primary ATMS Sounding Bands



Summary of ATMS Radiometric Performance

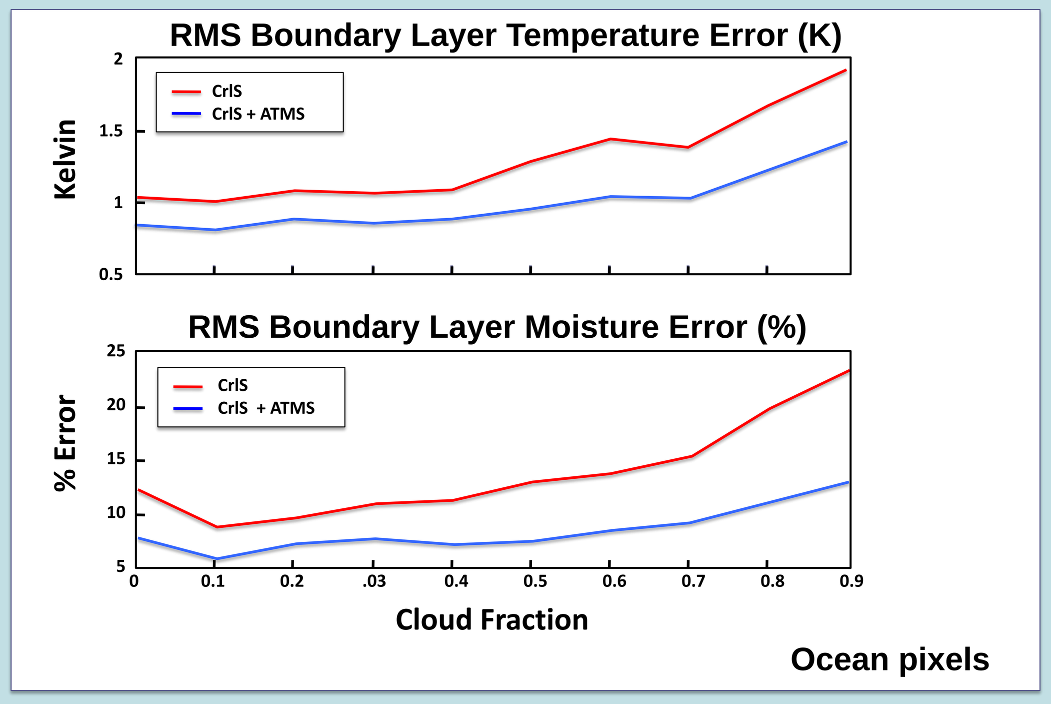
- The ATMS SDR products will meet or exceed the accuracy of the equivalent AMSU/MHS products
- Nyquist sampling of ATMS TDR products allows improved EDR products due to beam sharpening
- Prelaunch radiometric testing has indicated excellent ATMS performance
- Planned on-orbit cal/val activities will further refine calibration accuracy and ensure improved "climate quality"

ATMS Products (CDR and IP not archived by IDPS)

[1]FOV = "field of view", FOR = "field of regard"

Data Product	Description
RDR (Raw Data Record)	FOV[1] antenna temperature (counts)
TDR (Temperature Data Record)	FOV[1] antenna temperature (K)
SDR (Sensor Data Record)	FOR[1] brightness temperature (K)
EDR (Environmental Data Record)	P/T/WV profile
CDR (Climate Data Record)	"Climate-optimized" product
IP (Intermediate Product)	Used to generate EDR/CDR

ATMS Contribution to Temperature and Moisture EDRs



- ATMS improves upon CrIS-only retrievals, even in clear scenes
- ATMS information critical as cloudiness increases (impact doubles for temperature and triples for moisture)

Observation Impact: 3DVAR DAS & Forecasts

Accumulated forecast error reduction due to various observing instruments for the February 2007 forecasts – ½ degree system

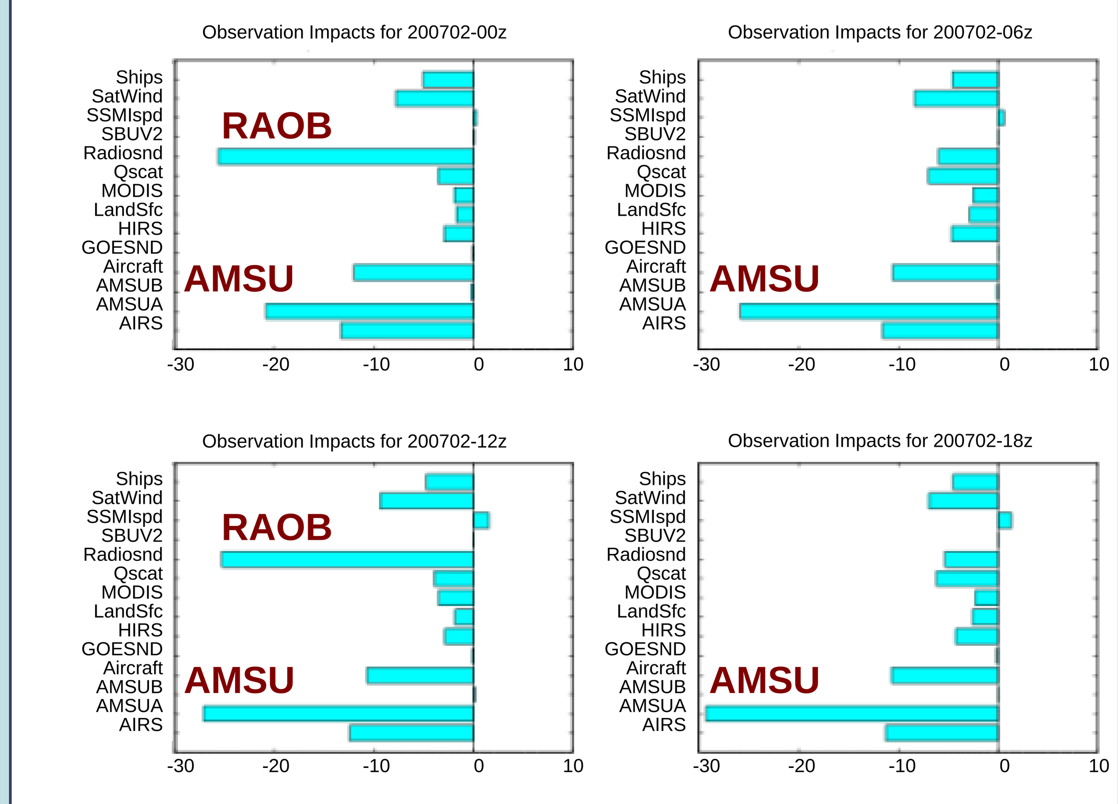


Figure courtesy of Gelaro and Rienecker, NASA GMAO

Retrieval of Precipitation Using Opaque Microwave Bands

Black and red circles highlight "before" and "after" differences between AMSU and ATMS, and between ATMS and ATMS-sharpened data products, for six simulated storms validated with AMSU. Note the better definition of strong convective cells with ATMS due to its 33-km resolution and Nyquist sampling, and the better recovery of the warm rain with sharpening

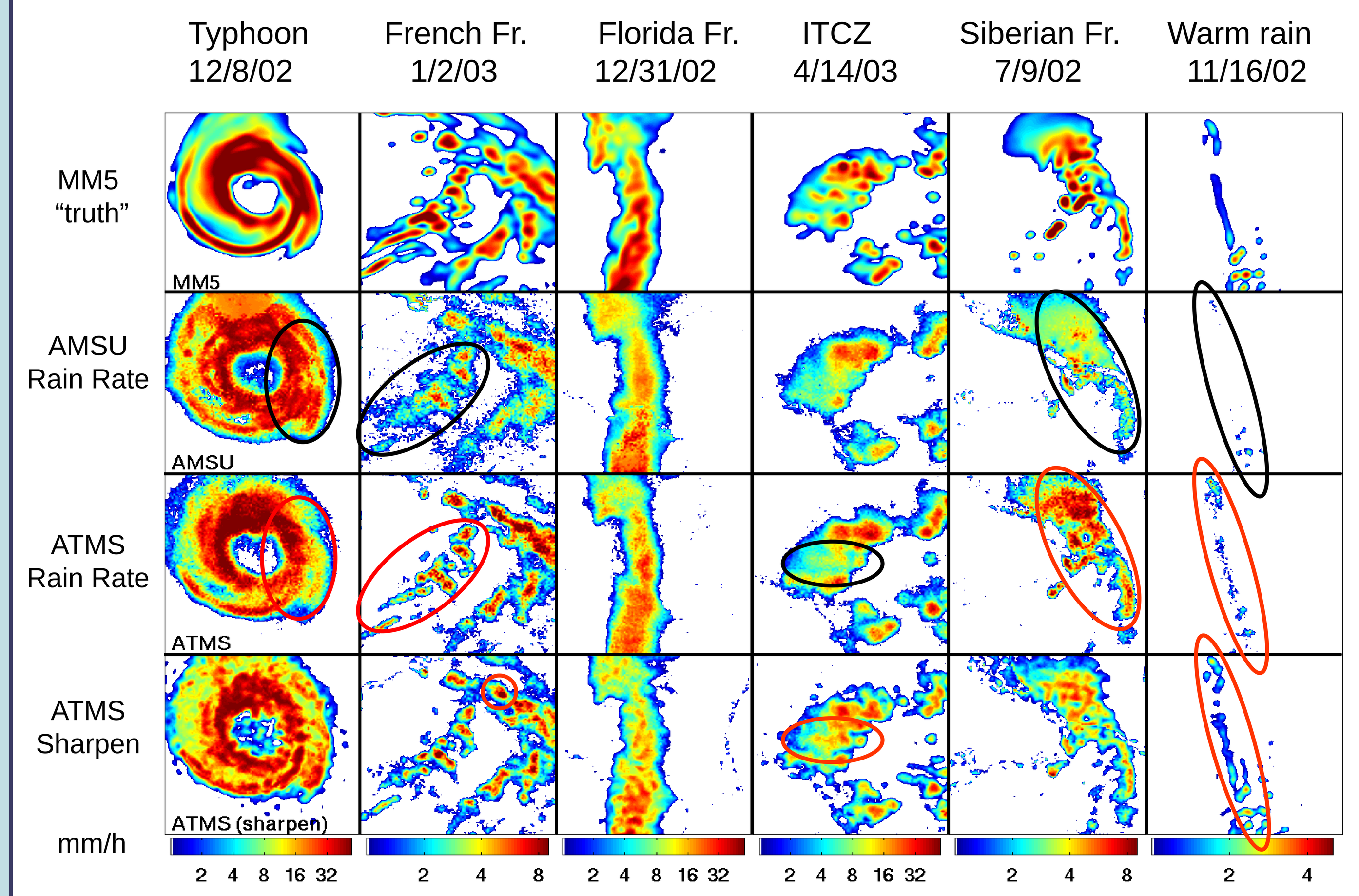


Figure courtesy of Staelin and Surussavadee, MIT

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