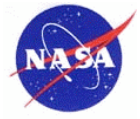


Hurricane Research with HAMSR

Early HAMSR Results from TCSP

Case Study: Hurricane Emily

Bjorn Lambrigtsen
JPL

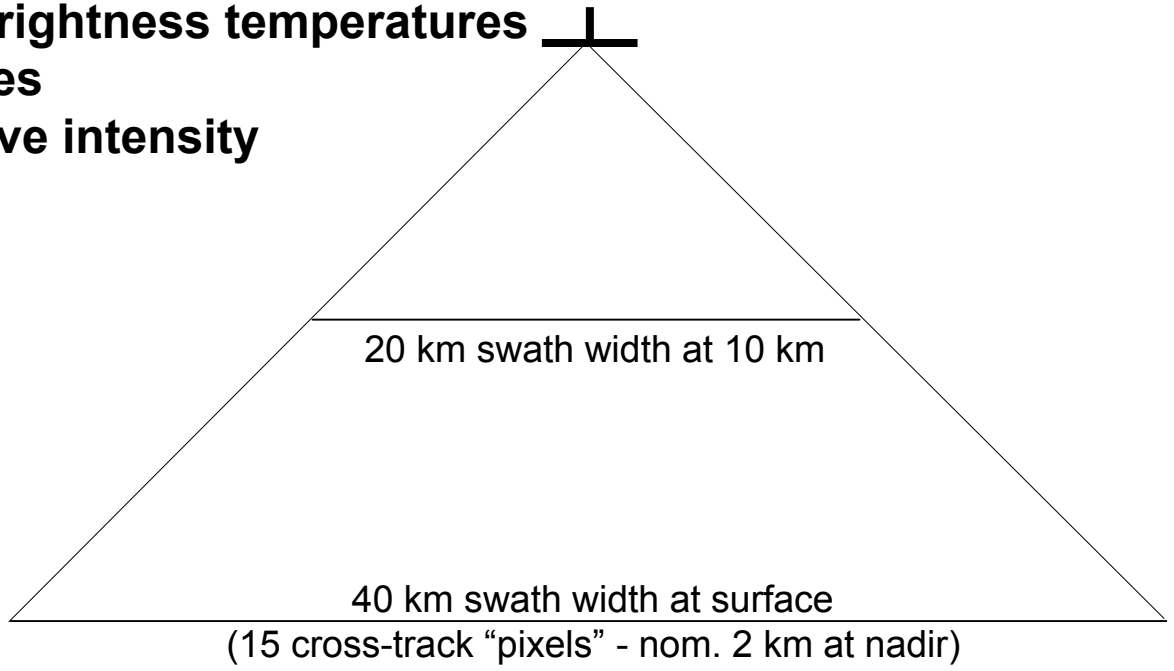
TCSP Science Team Workshop
Huntsville, AL; April 4-5, 2006

The research described in this presentation was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration

HAMSR Summary

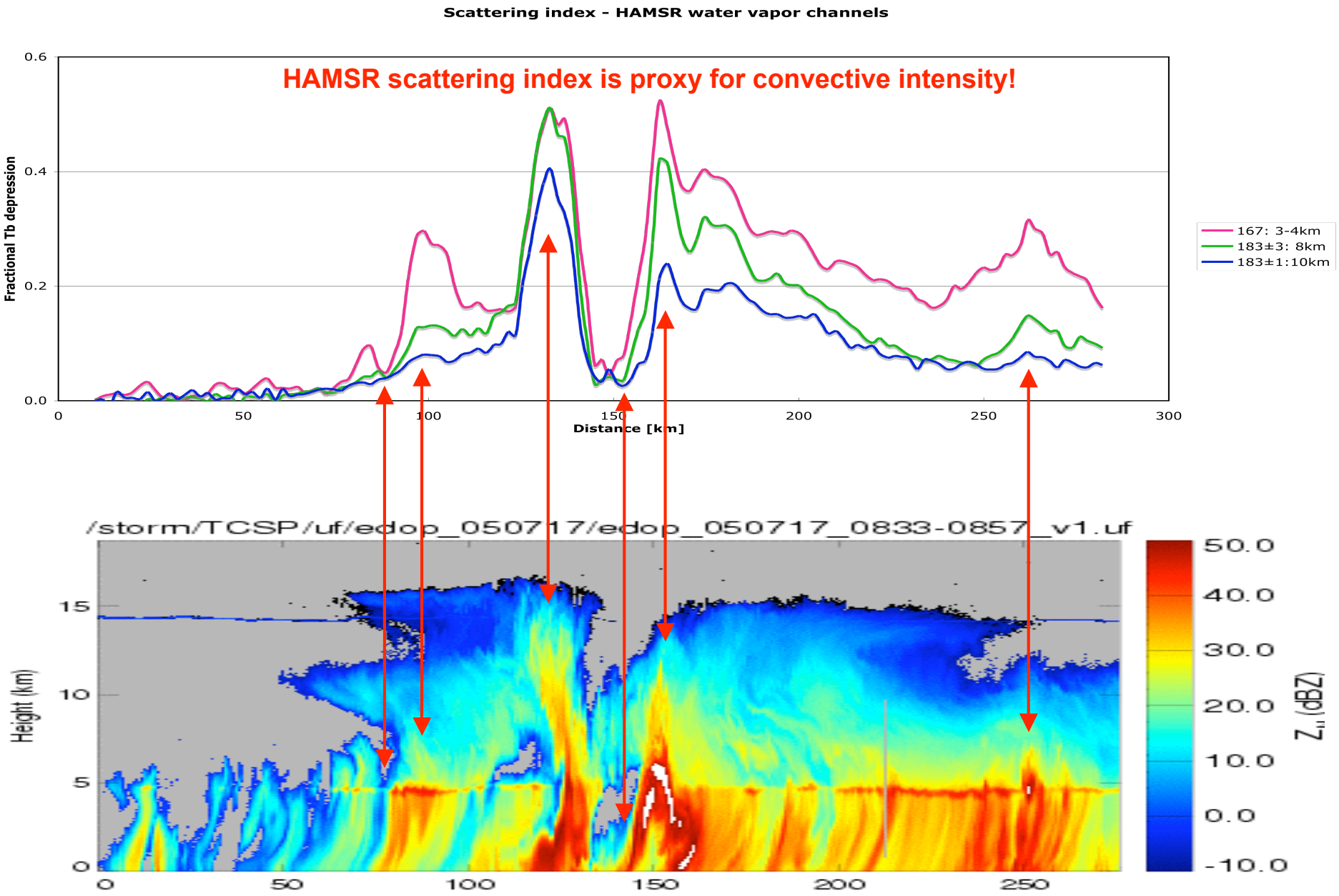
- **Microwave temperature & humidity sounder**
  - Coverage from surface to flight altitude (<100 mb)
  - ~ 2 km vertical resolution
  - ~ 2 km horizontal resolution (at nadir, at the surface)
  - ~ 40 km wide swath (at the surface)
- **8 channels in the 50-GHz band: primary T-sounding**
- **10 channels in 118-GHz band: secondary T-sounding**
- **7 channels in 183-GHz band: q- sounding**

- **Current products: Calibrated brightness temperatures**
- **Coming: Retrieved T & q profiles**
- **Research: Rain rates, convective intensity**

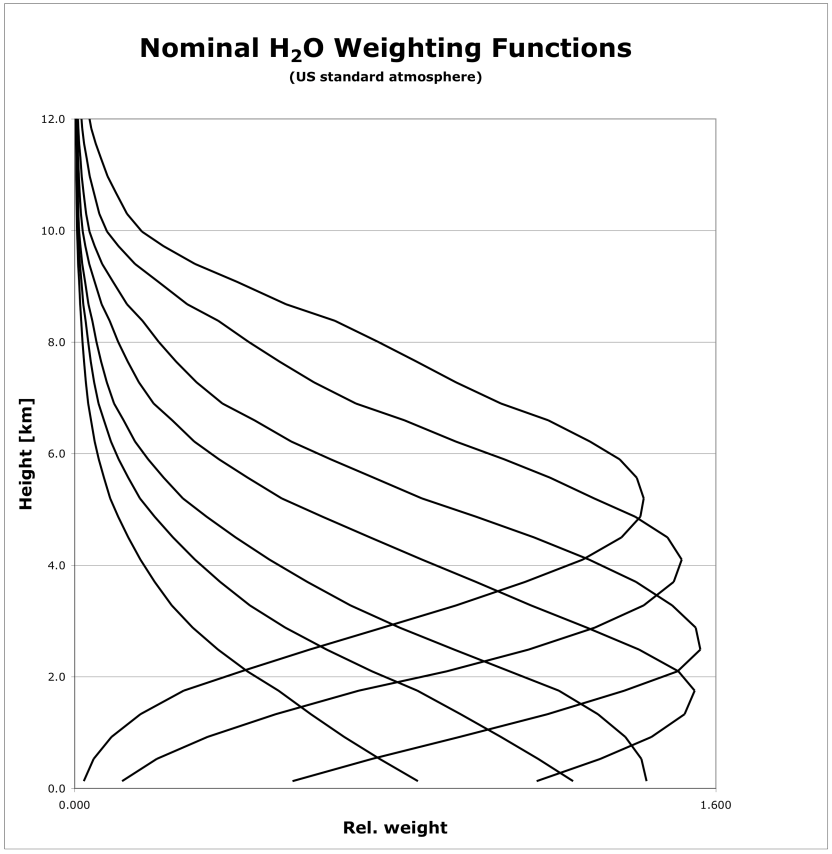


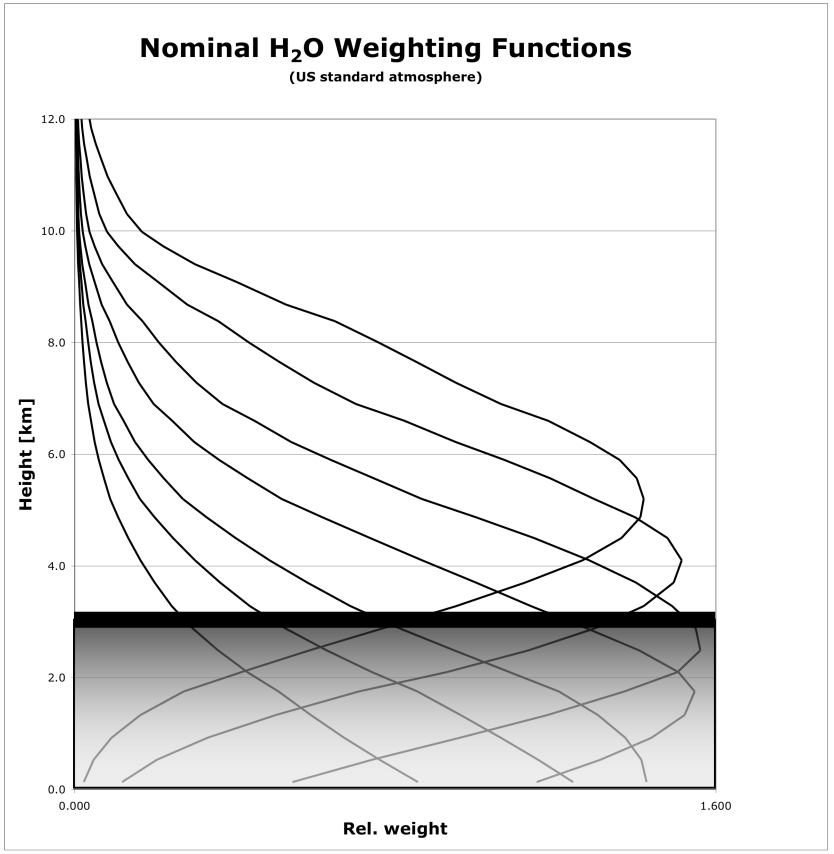
HAMSR vs. EDOP

Hurricane Emily: July 17, 2005, 08:33-08:57 UTC



Physical Basis for Scattering Profiling





RTE: $Tb = \varepsilon \bullet T_{sfc} \bullet \tau + \int T_{atm} d\tau$

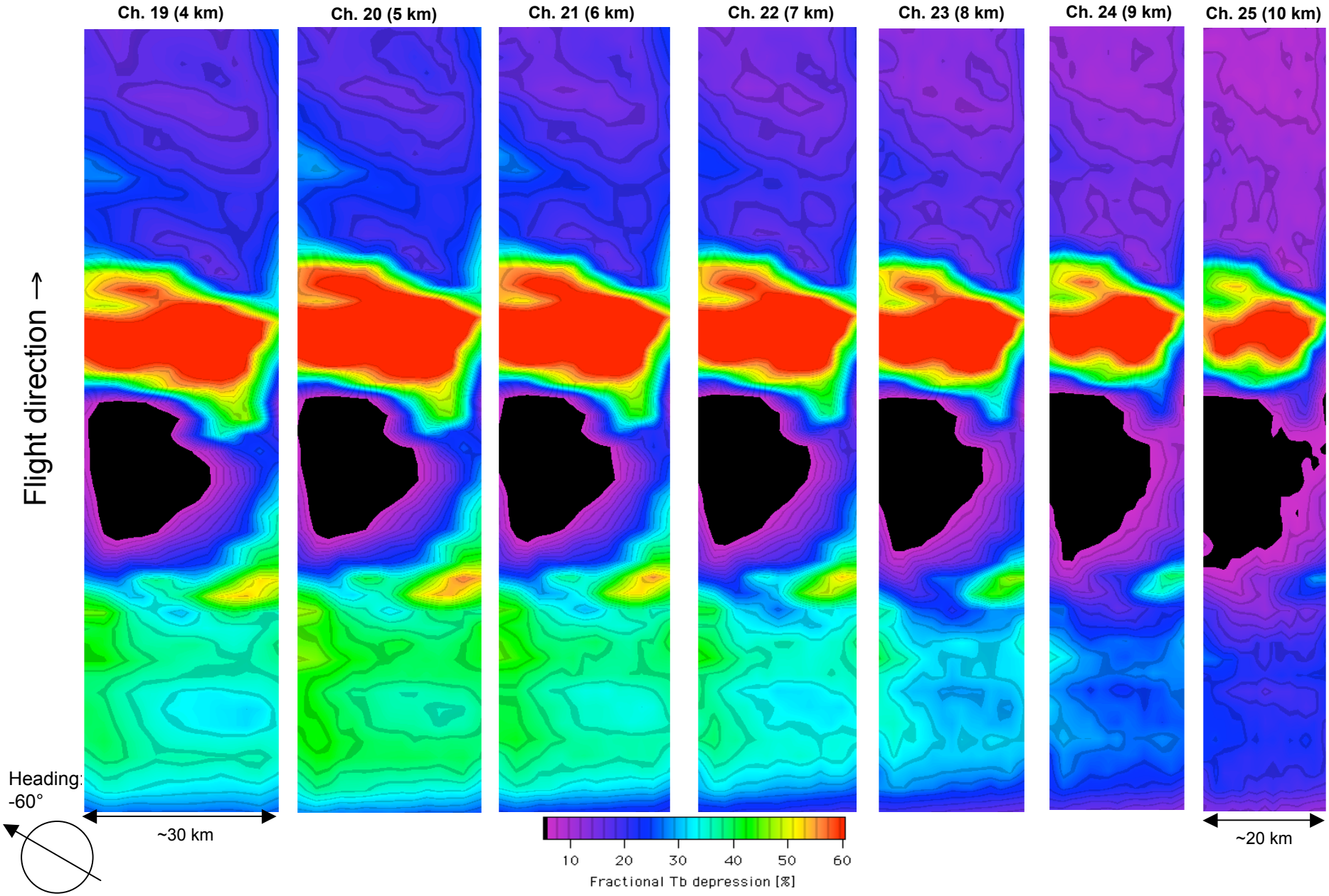
Opaque channels ($\tau \approx 0$):
$Tb \approx T_{atm}$ @ w.func peak
Transparent channels ($\tau \approx 1$) :
$Tb \in [T_{atm}, \varepsilon \bullet T_{sfc}]$
If ε is low, $Tb << T_{phys}$

Scattering layer acts like low-ε "surface"
Cold "Tb_{sfc}" replaces lower range of integral
Result is $Tb_{scatt} < Tb_{normal}$

ΔTb vs. channel => vertical distribution of scattering
ΔTb vs. band (wavelengths) => particle size info
for d < 1 mm (otherwise in Mie regime)

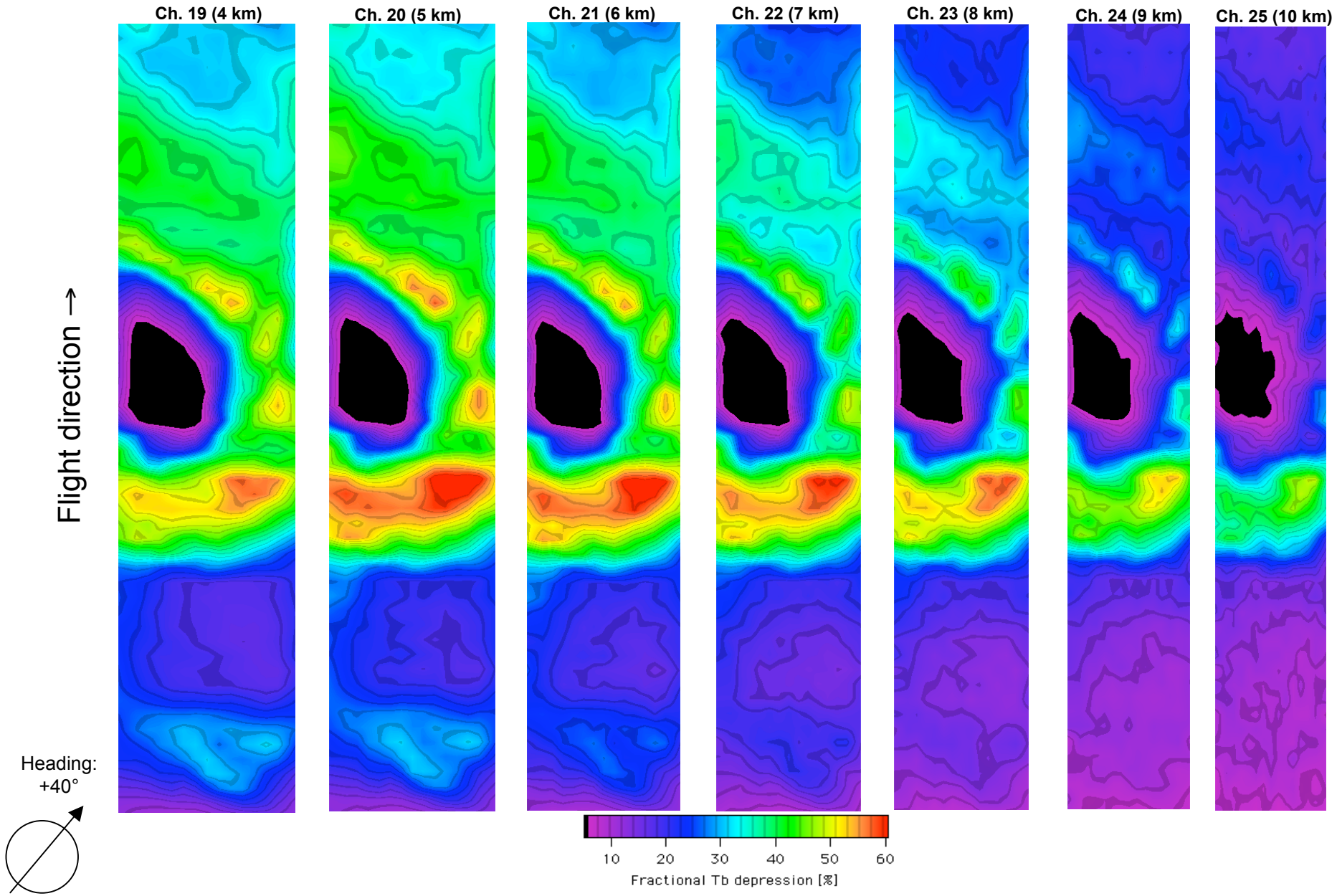
HAMSR-derived Convective Intensity

Hurricane Emily — July 17, 2005, 07:48-07:57 UTC



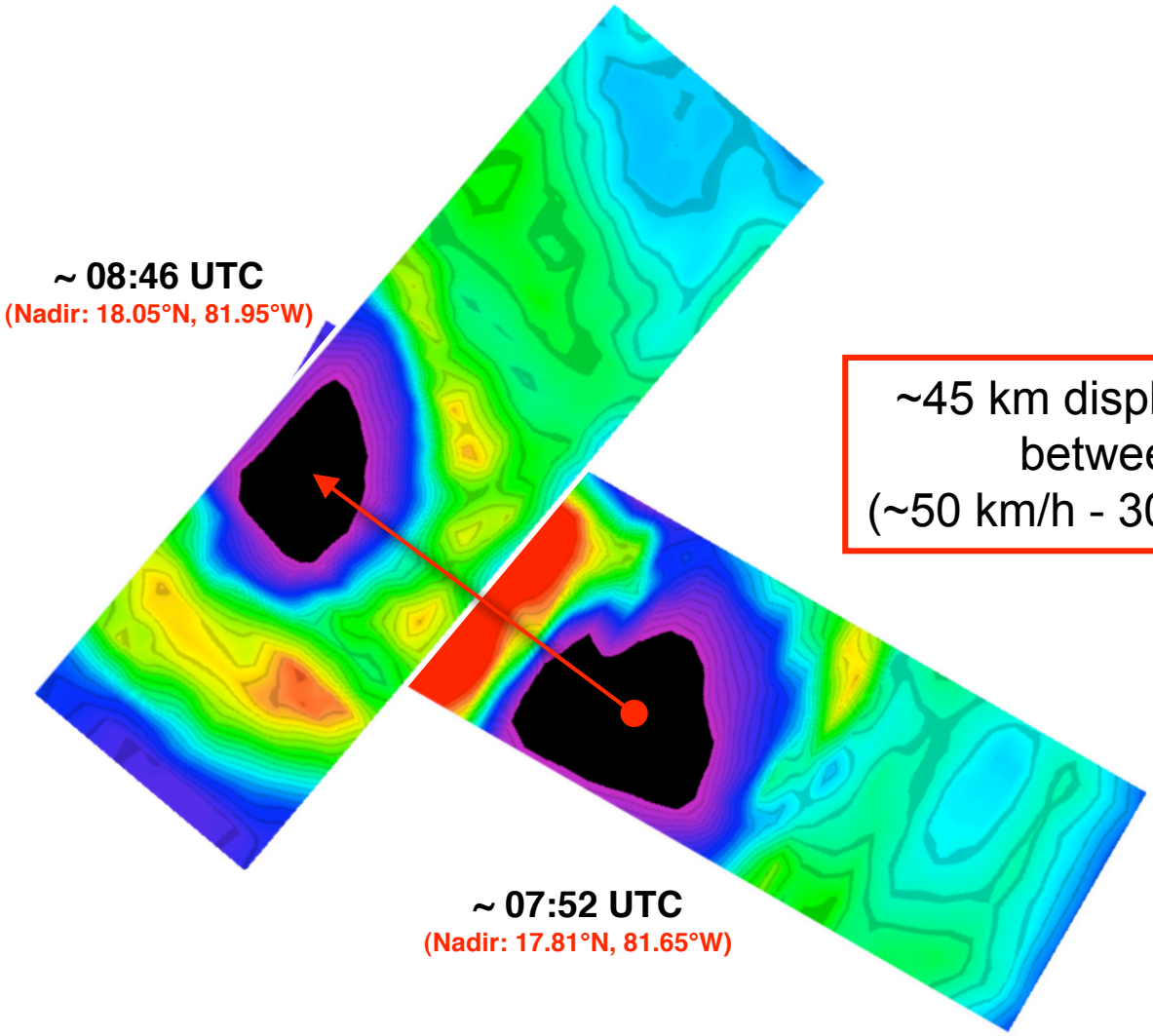
HAMSR-derived Convective Intensity

Hurricane Emily — July 17, 2005, 08:41-08:50 UTC



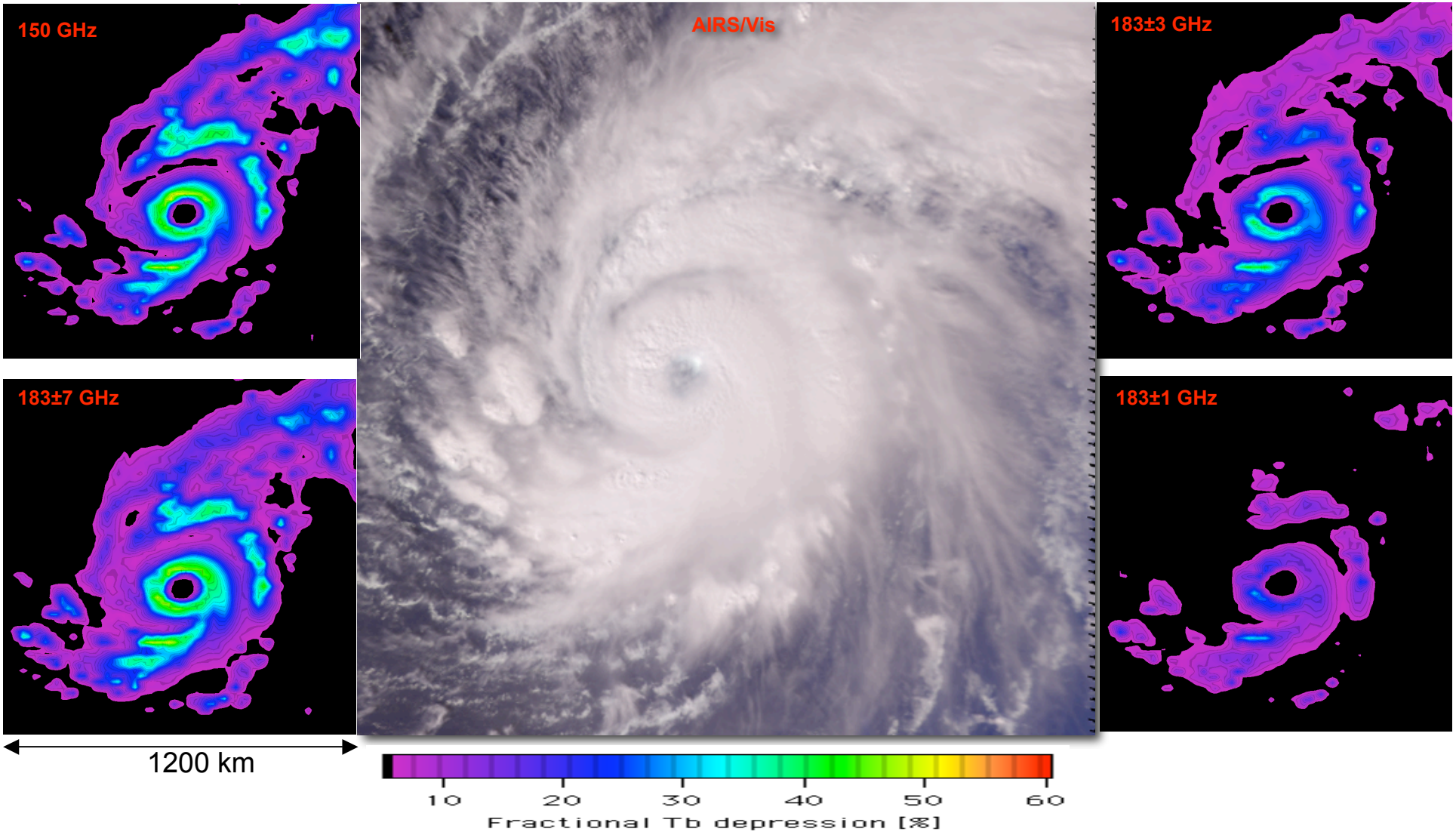
Repeat Views of Eye

Hurricane Emily — July 17, 2005, 07:52 & 08:46 UTC



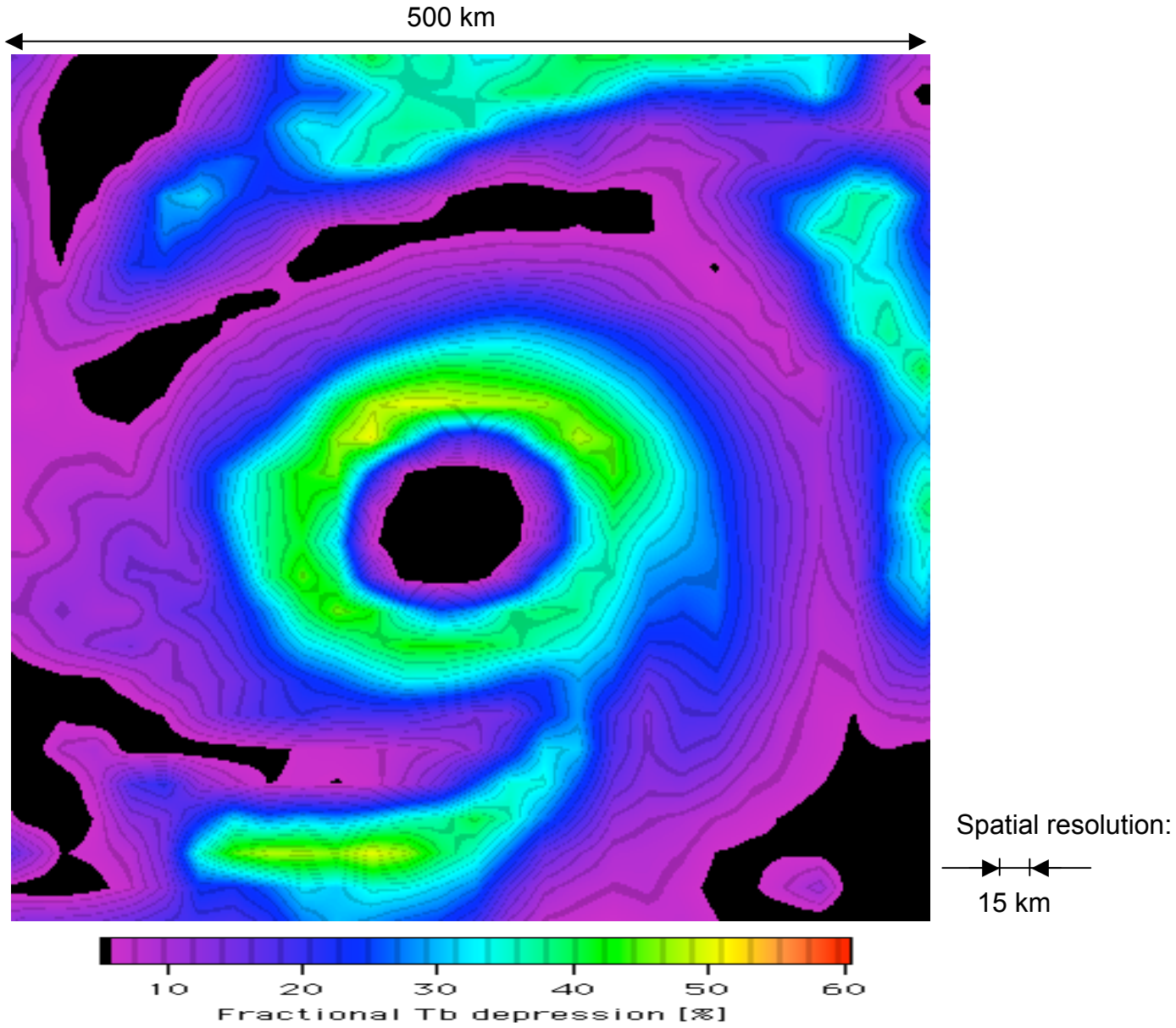
~45 km displacement to NW
between passes
(~50 km/h - 30 mph - 13.5 m/s)

The View From Space:
Super Typhoon Pongsona at Guam
Aqua/HSB — December 8, 2002, 03:50 UTC

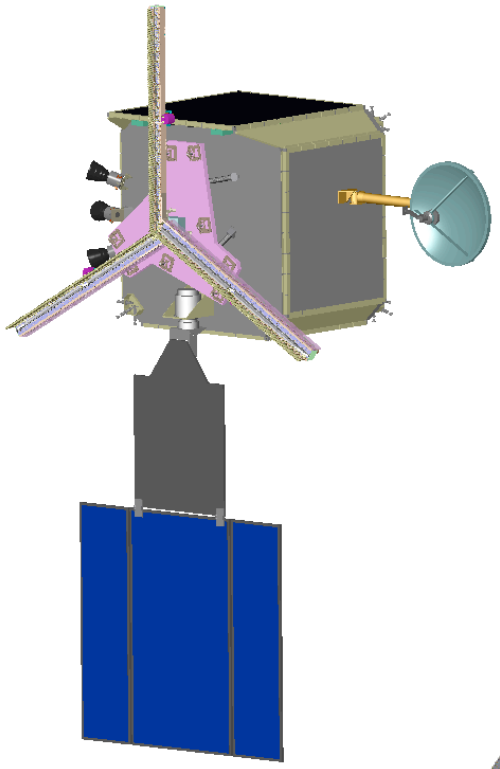


Closeup of Pongsona

Convective intensity per HSB 150-GHz channel

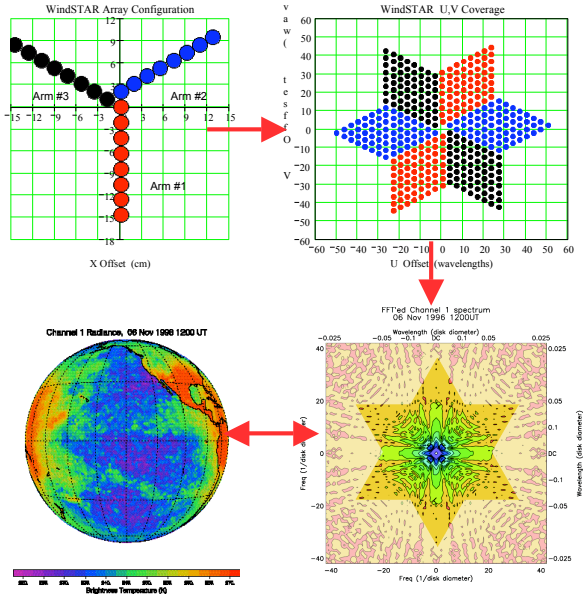


Future: GeoSTAR
HAMSR-functionality on GOES-R!

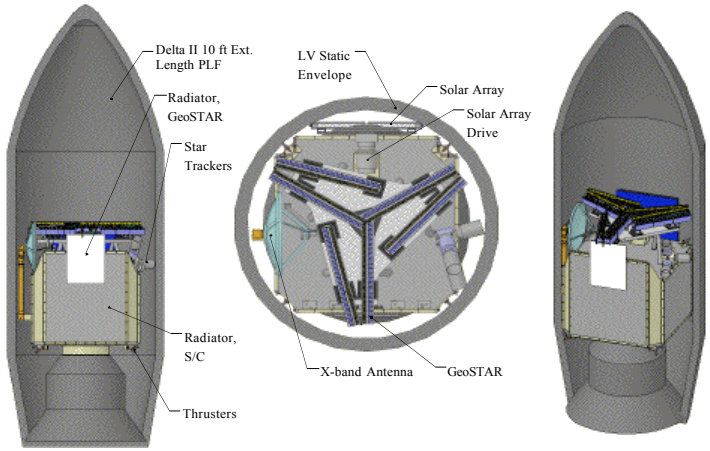


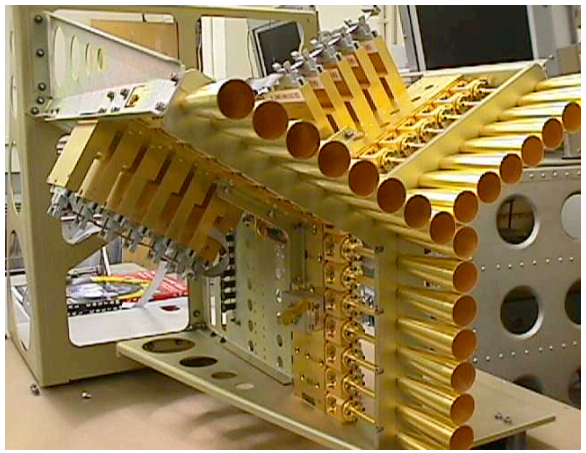
- Large aperture synthesized
- No mechanical scanning
- Continuous full-disk coverage
  - T(p) @ 50 GHz/50 km every 30 min
  - q(p) @ 183 GHz/25 km every 10 min
    precip, convective intensity
  - IDEALLY SUITED FOR 4DVAR
- Functionality similar to AMSU
- Low sidelobes; No scan bias
- Expandable to larger apertures

Works in spatial Fourier domain:



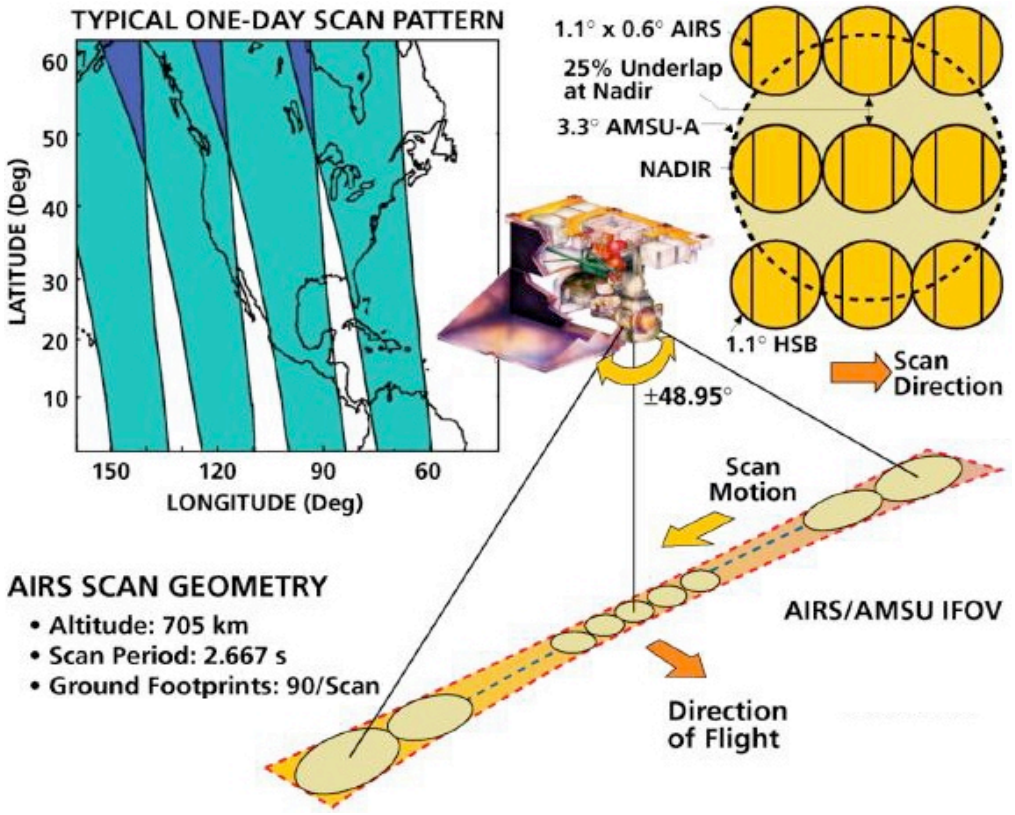
Example: 50-GHz array
Each arm 2 m/100 rec's
—> 50 km resolution
Arms folded for launch
Shown in Delta II fairing





Prototype being readied for testing at JPL

AIRS/AMSU/HSB System Overview



- Aqua is in a 1:30 pm (ascending) sun-synchronous orbit at a 705 km altitude
- Each AMSU footprint, 45 km across at nadir, contains 9 AIRS footprints
  - This is the retrieval granularity
  - 324,000 retrievals globally per day
  - Microwave retrieval success rate: ~90 %
  - Combined IR/MW success rate: 40-60 %
- Swath (30 AMSU/90 AIRS): 1650 km
- Covers ~95% of globe every day
  - Most areas covered twice per day
    - ***1:30 am local time (at equator)***

AIRS Vis/Nr IR	4 channels 0.40 - 0.95 μm Footprint 2 km
AIRS InfraRed	2378 channels 3.7 - 15.4 μm (650 - 2700 cm^{-1}) $\nu/\delta\nu$ ~ 1200 Footprint 15 km, IFOV 1.1°
AMSU	15 channels 23 - 90 GHz Footprint 45 km, IFOV 3.3°
HSB	4 channels 150 - 190 GHz Footprint 15 km, IFOV 1.1°

AIRS Data Products

	Accuracy	#	Spatial res.
Radiance products (Level 1B)			
AIRS IR radiance	3%	2378 ch.	15x15 km
AIRS Vis radiance	20%	4 ch.	2.3x2.3 km
AMSU radiance	0.3-1.2 K	15 ch.	45x45 km
HSB radiance	1.0-1.2 K	4 ch.	15x15 km
Standard products (Level 2)			
Cloud-cleared IR rad.	1.0 K	2378 ch.	45x45 km
Sea surface temperature	0.5 K	1	45x45 km
Land surface temperature	1.0 K	1	45x45 km
Temperature (0 – 45 km)	1.0 K	28 levels	45x45 km
Water vapor (0 – 45 km)	15%	28 levels	45x45 km
Total precipitable water	5%	1	45x45 km
Fractional cloud cover	5%	2 clouds	45x45 km
Cloud top height	0.5 km	2 clouds	45x45 km
Cloud top temperature	1.0 K	2 clouds	45x45 km

1 km below 700 mb
2 km above 700 mb
2 km in troposphere

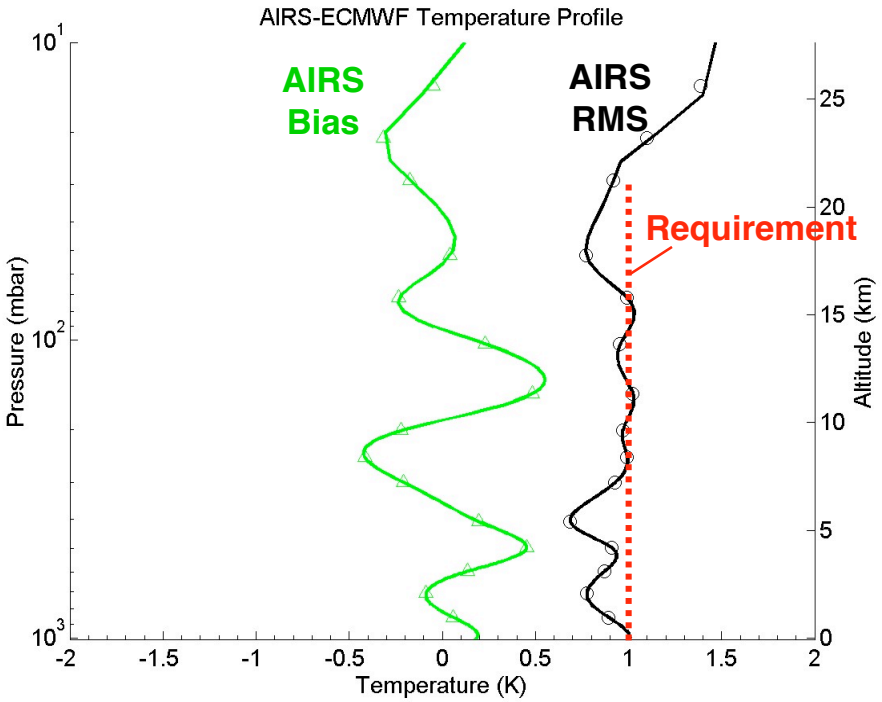
Additional experimental/non-standard products:

Microwave-derived T and q profiles
Total cloud liquid water
Cloudy-sky & clear-sky OLR
Trace gas profiles (O_3, CO)
Geopotential height
Intermediate products

Temperature & Water Vapor Profiles

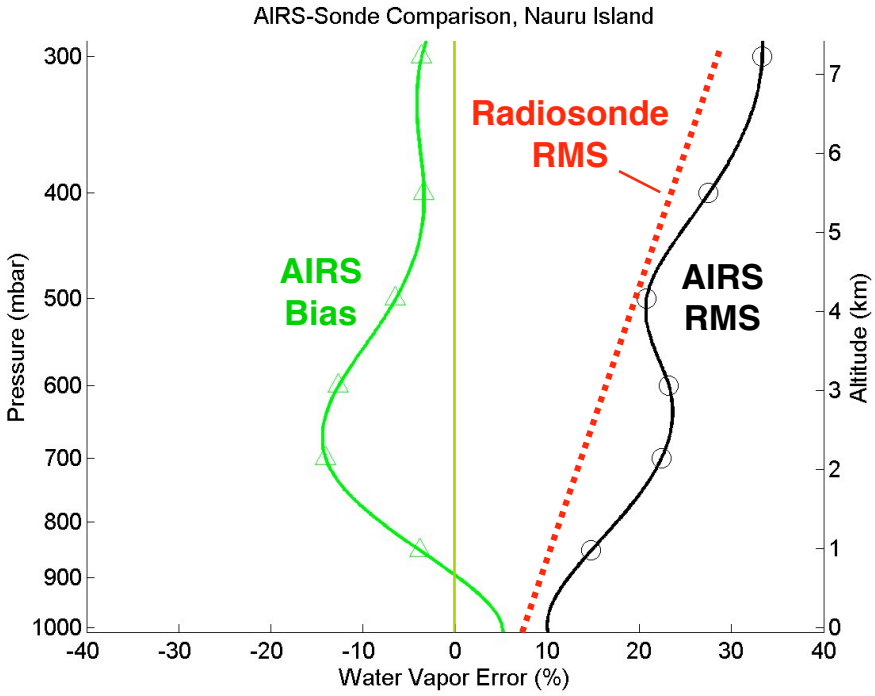
Temperature profiles accurate to 1K/km to 30 mb

Ocean, mid latitude vs ECMWF



Water vapor profiles match observations

Nauru Island radiosondes



Getting More Info and Data

There are three DAAC access routes for downloading

SYSTEM	DESCRIPTION from AIRS Data Support	URL
DATA POOL	A quick search for data products most frequently requested. User can access anonymous ftp area for retrieval of selected AIRS Level1B and soon Level2 products. Data retrieved in this manner can not be added to the shopping cart of the search and order function.	http://daac.gsfc.nasa.gov /data/datapool/AIRS_DP/
WHOM	WHOM (Web Hierarchical Ordering Mechanism) is the Goddard DAAC Search and Order system which is a simple point-and-click web interface used to search for and order nearline data products archived locally. Data is displayed in tables based on a hierarchical organization. Descriptive information of each data product is provided.	http://daac.gsfc.nasa.gov /data/dataset/AIRS/
EDG	A WWW interface to access all data available in NASA's Earth Observation System Data Information System and related data centers. With EDG, a user can search for and acquire a large variety of earth, ocean, and atmospheric science data obtained from EOS instruments.	http://eos.nasa.gov /imswelcome/

Additional information about AIRS Data may be found at the AIRS public web site:

<http://airs.jpl.nasa.gov>