



# Use of microwave radiances for weather forecasting

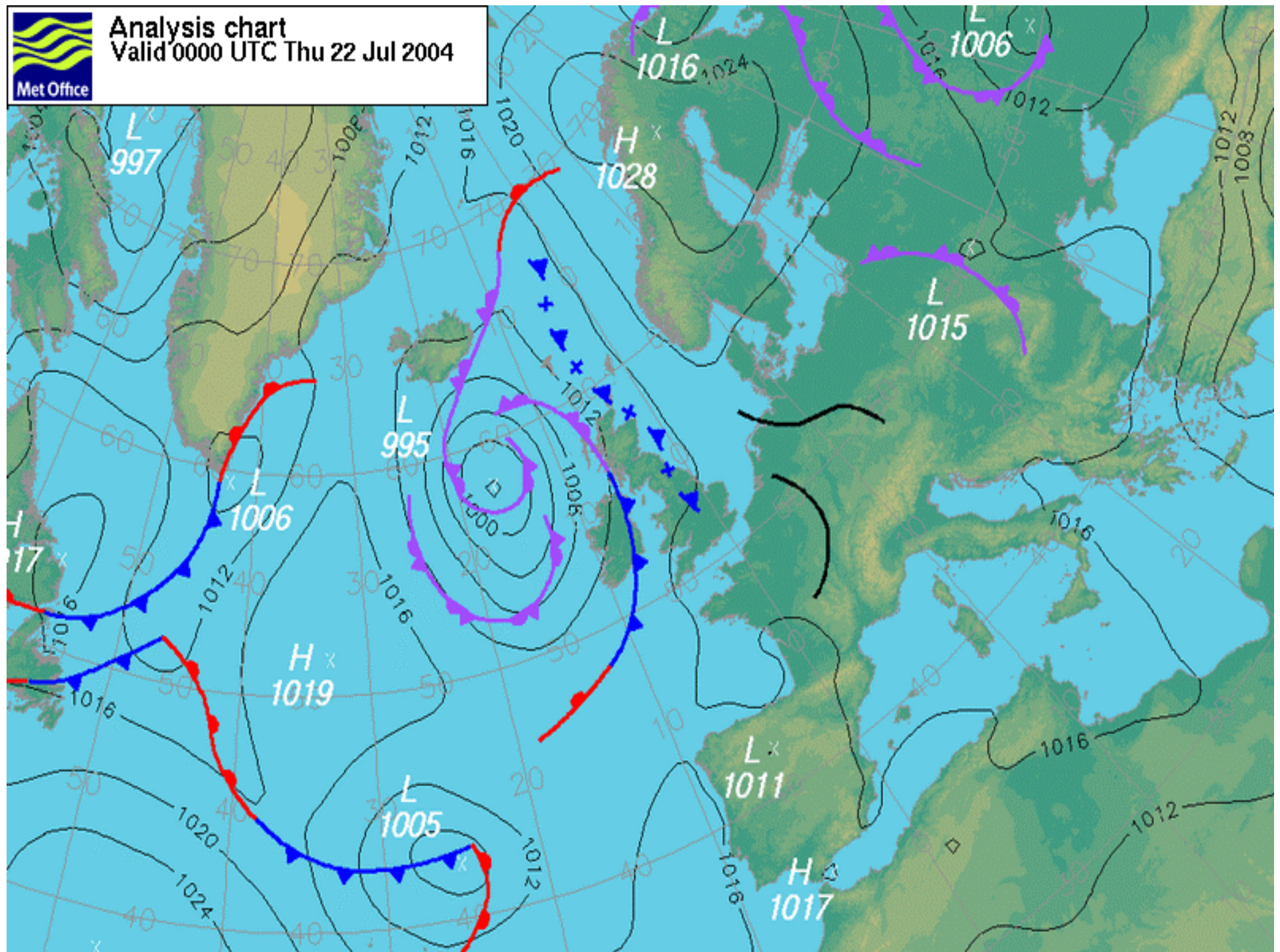


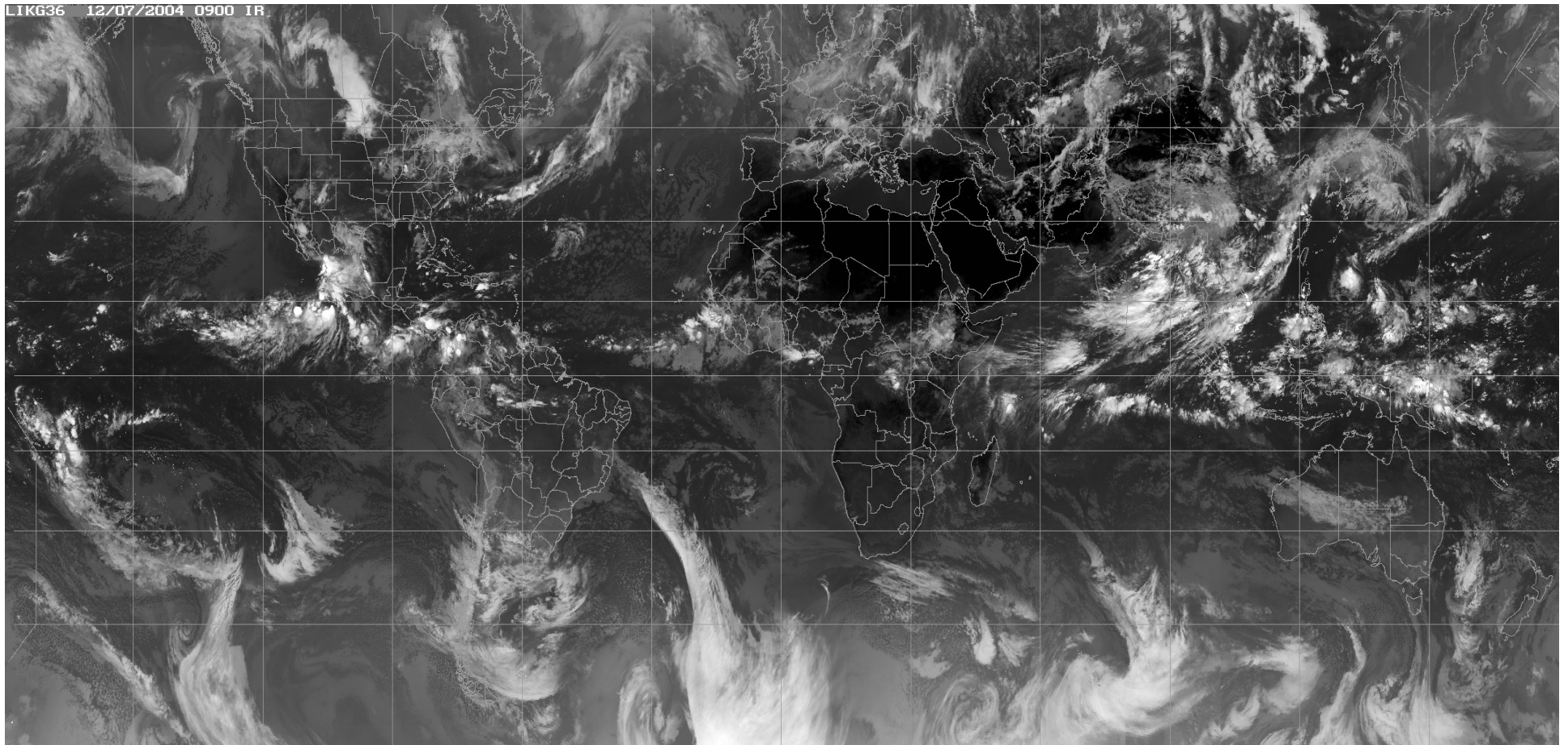
**Roger Saunders**

**SFCG-24 20 Sep 2004**





Analysis chart  
Valid 0000 UTC Thu 22 Jul 2004





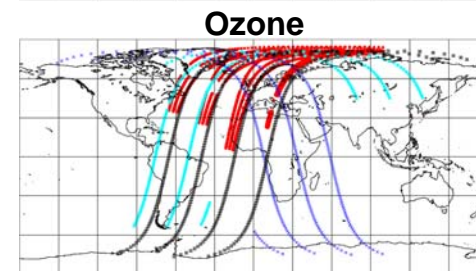
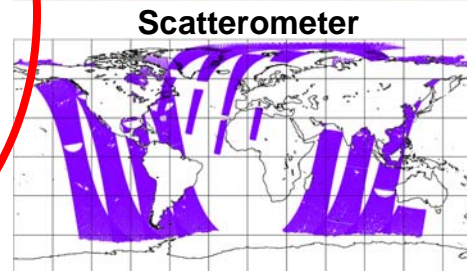
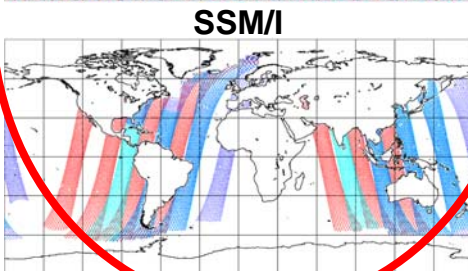
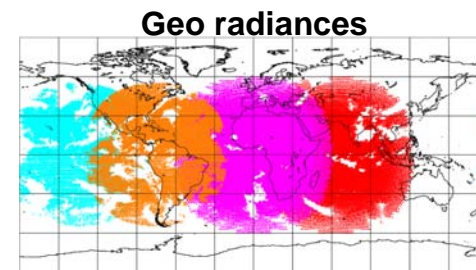
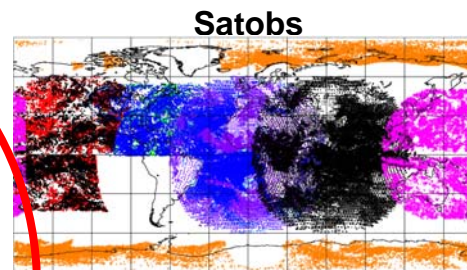
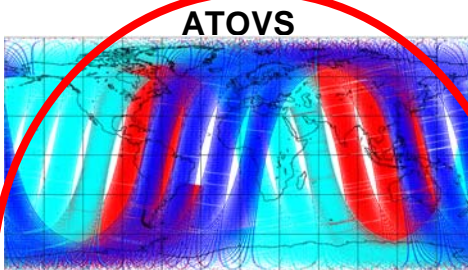
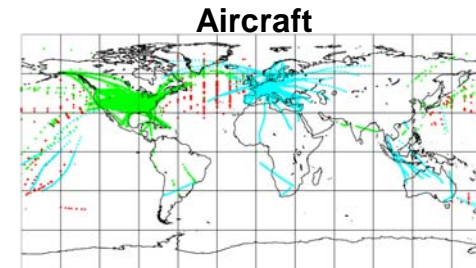
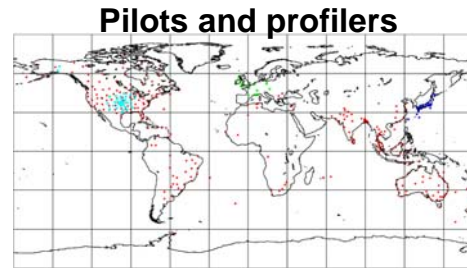
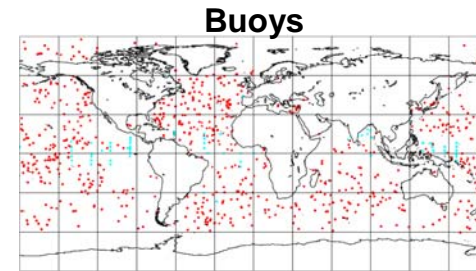
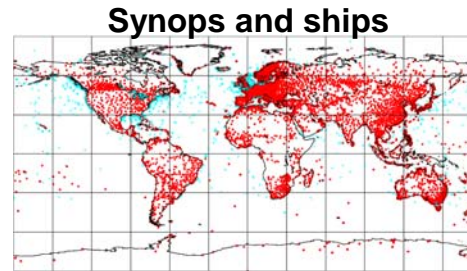
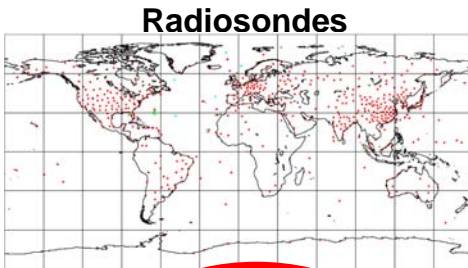
## Cloud is common

Band	Instrument	Cloud-free	Cloud-free upper-trop
<b>INFRARED</b>	AIRS (14 km)	5% 	30%
<b>MICROWAVE</b>	AMSU (50 km)	70% 	95%

# In situ vs satellite data coverage



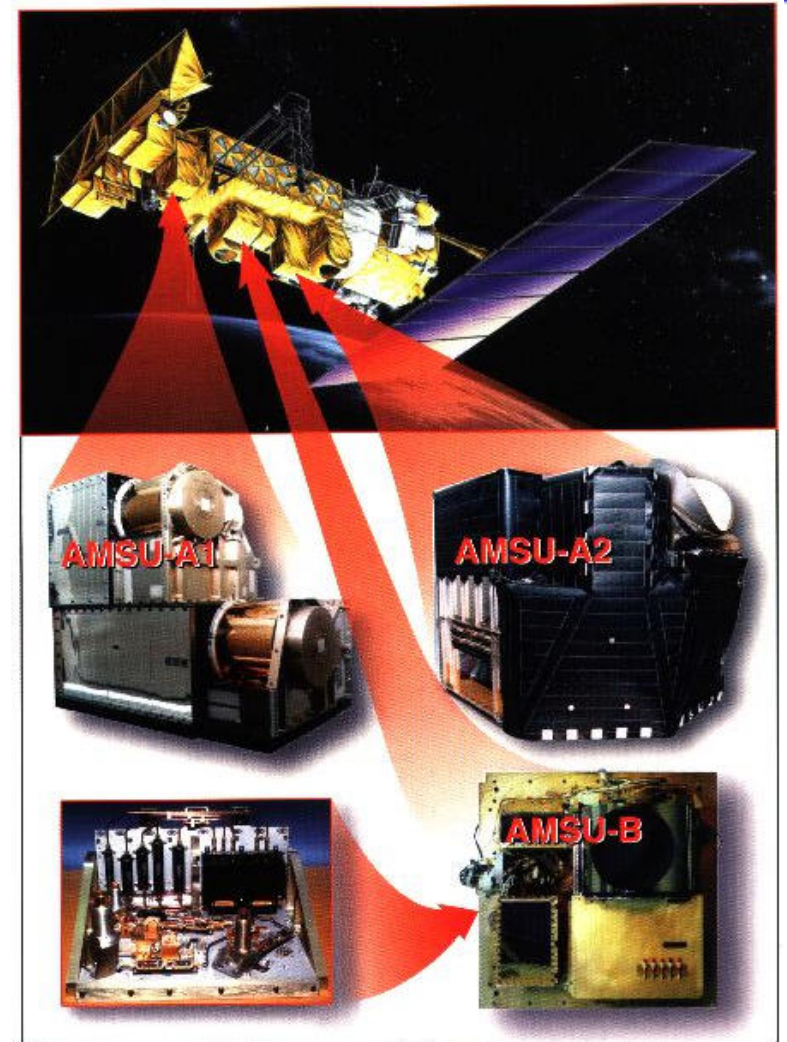
**Data coverage**  
**09 – 15 UTC5**  
**September 2003 +**  
**AQUA (Airs,AMSUA)**  
**and 5 geo rads.**

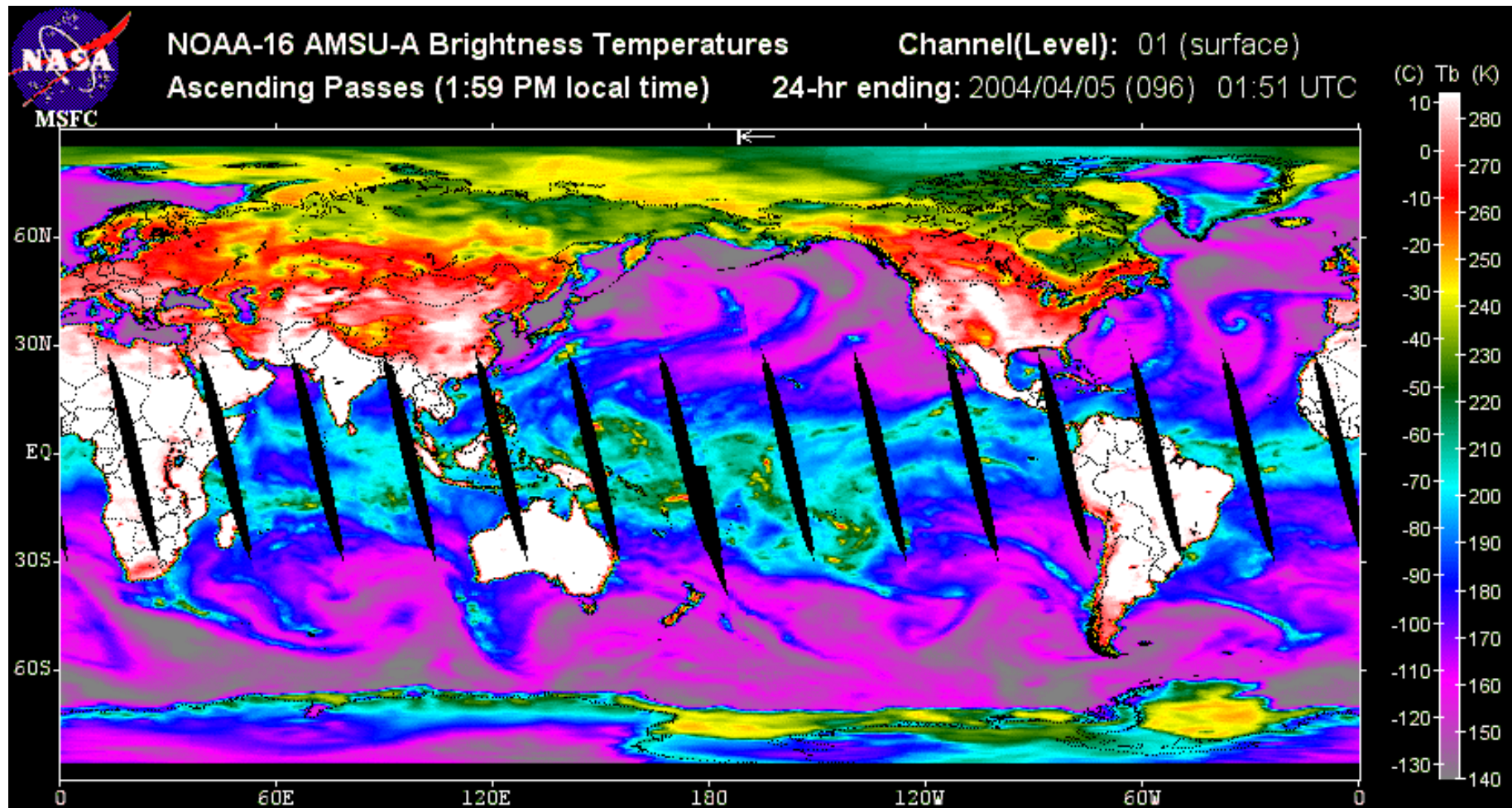


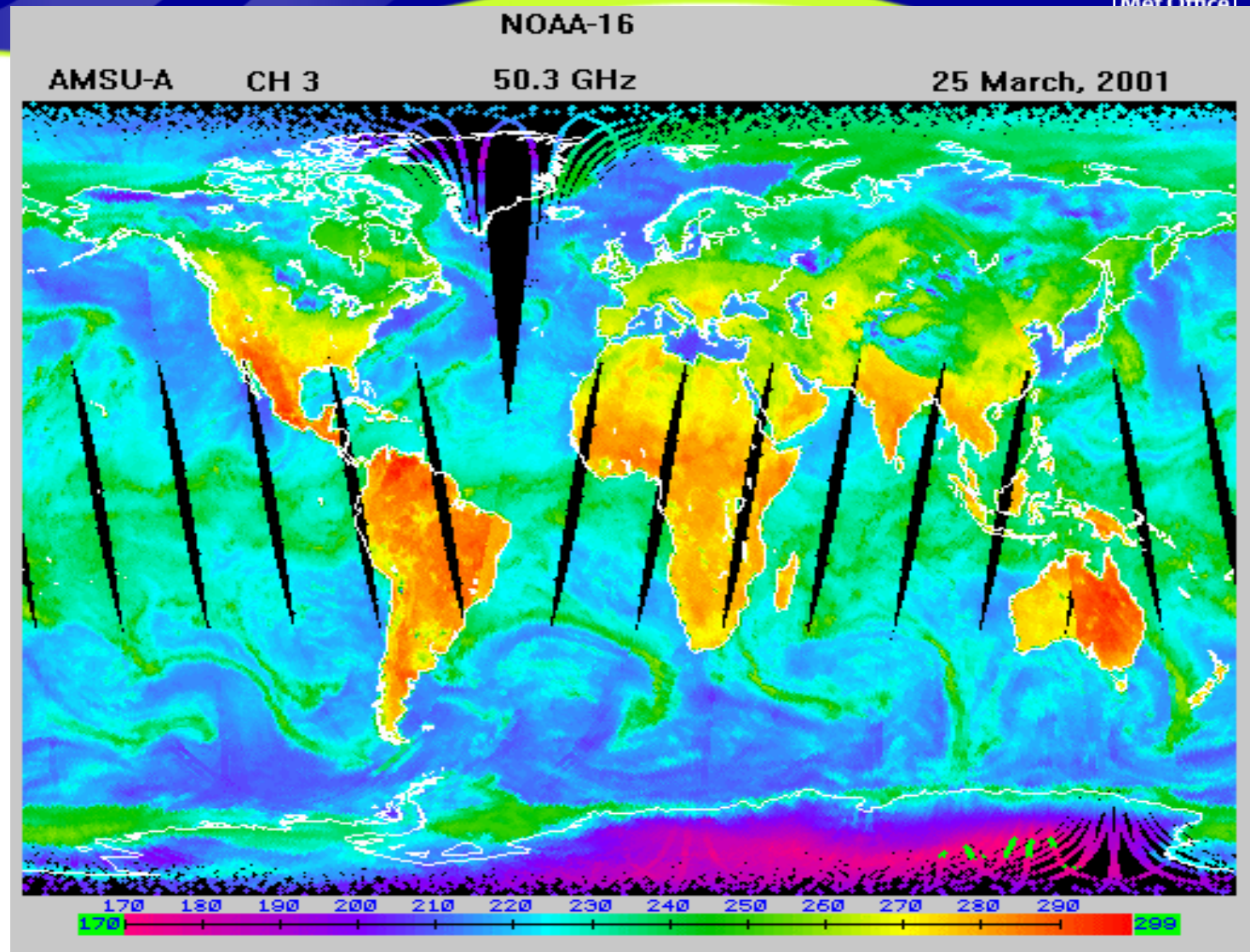
# The Advanced Microwave Sounding Unit



- Microwave sounders have become very important to the accuracy of NWP
- High information content in persistently cloudy data sparse areas.
- AMSU is the current operational generation







Global composite  
of brightness  
temperature (K)  
from  
AMSU-A  
Channel 3

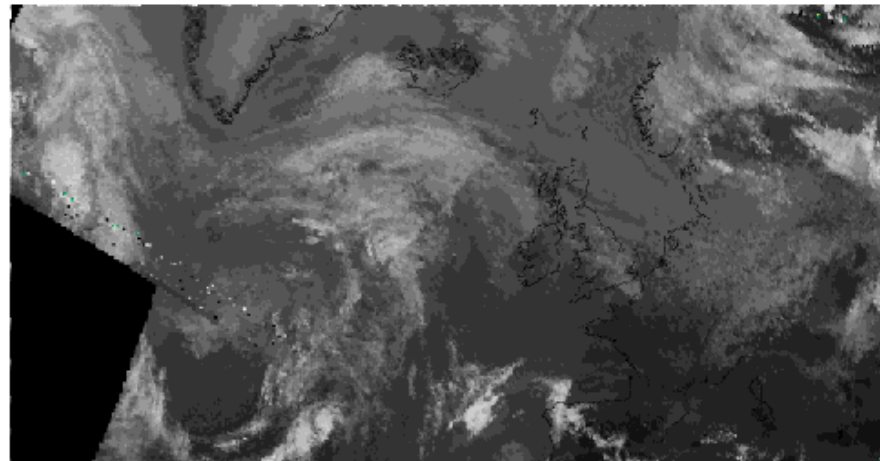
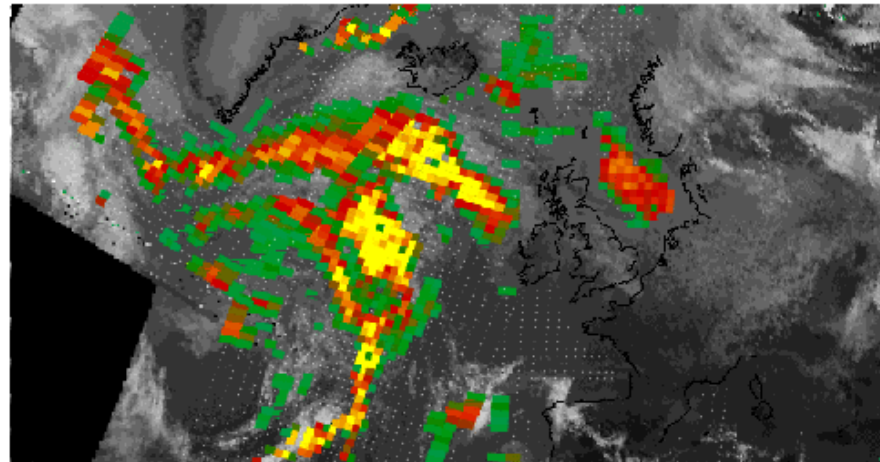
# AMSU cloud liquid water index



The AMSU window channels indicate the location of the highest liquid water contents. These occur near the storm head and also along the trailing cold front. The infra-red imagery gives an indication of this to the experienced eye but is not so quantitatively precise.

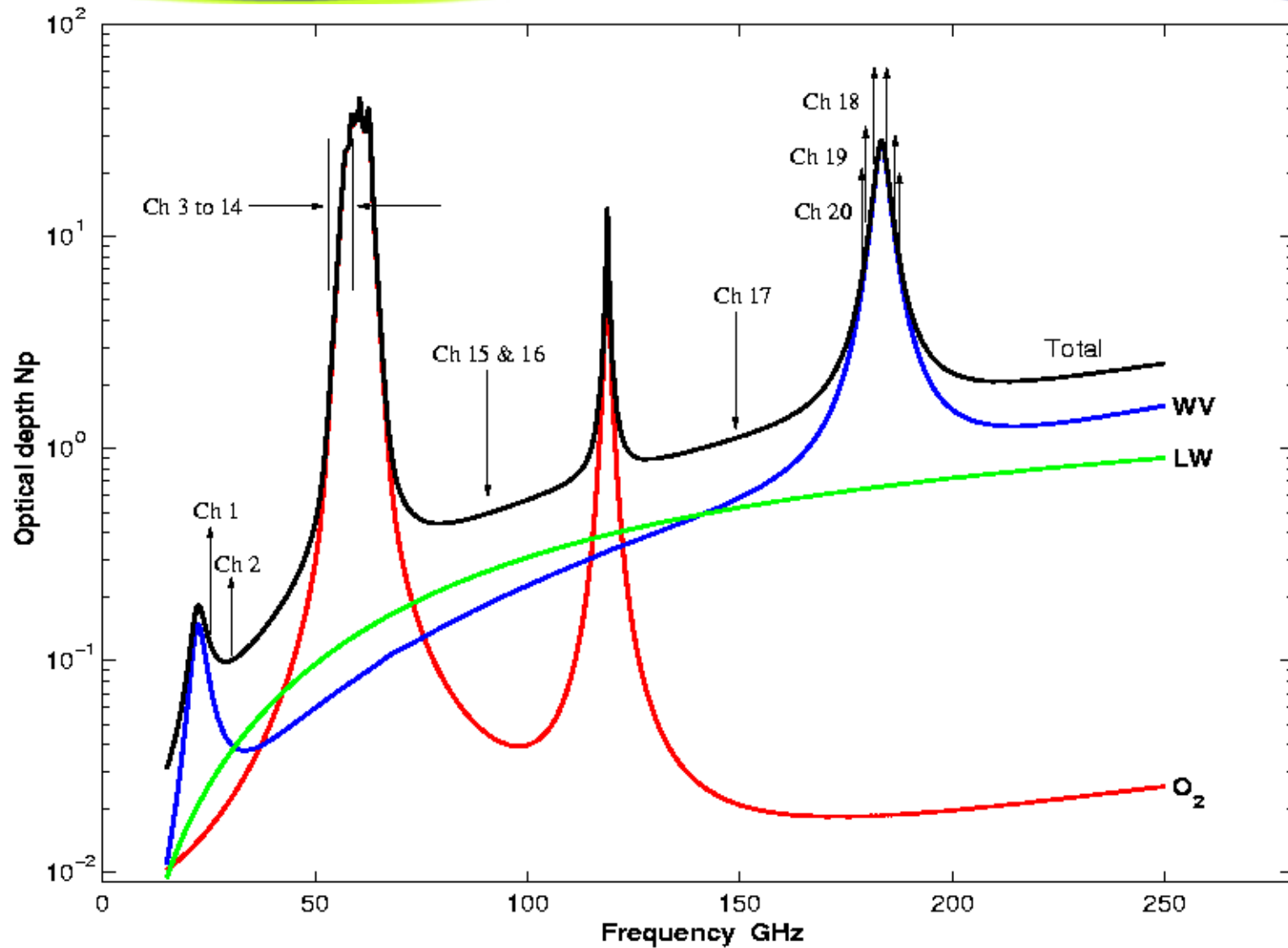
## NOAA15 AVHRR IR & AMSU cloud index composite imagery LOCAL DATA

Image generated: 06/26/2000 11:46:07 UTC Most recent overpass time: 1118 (Slot time: 1100)

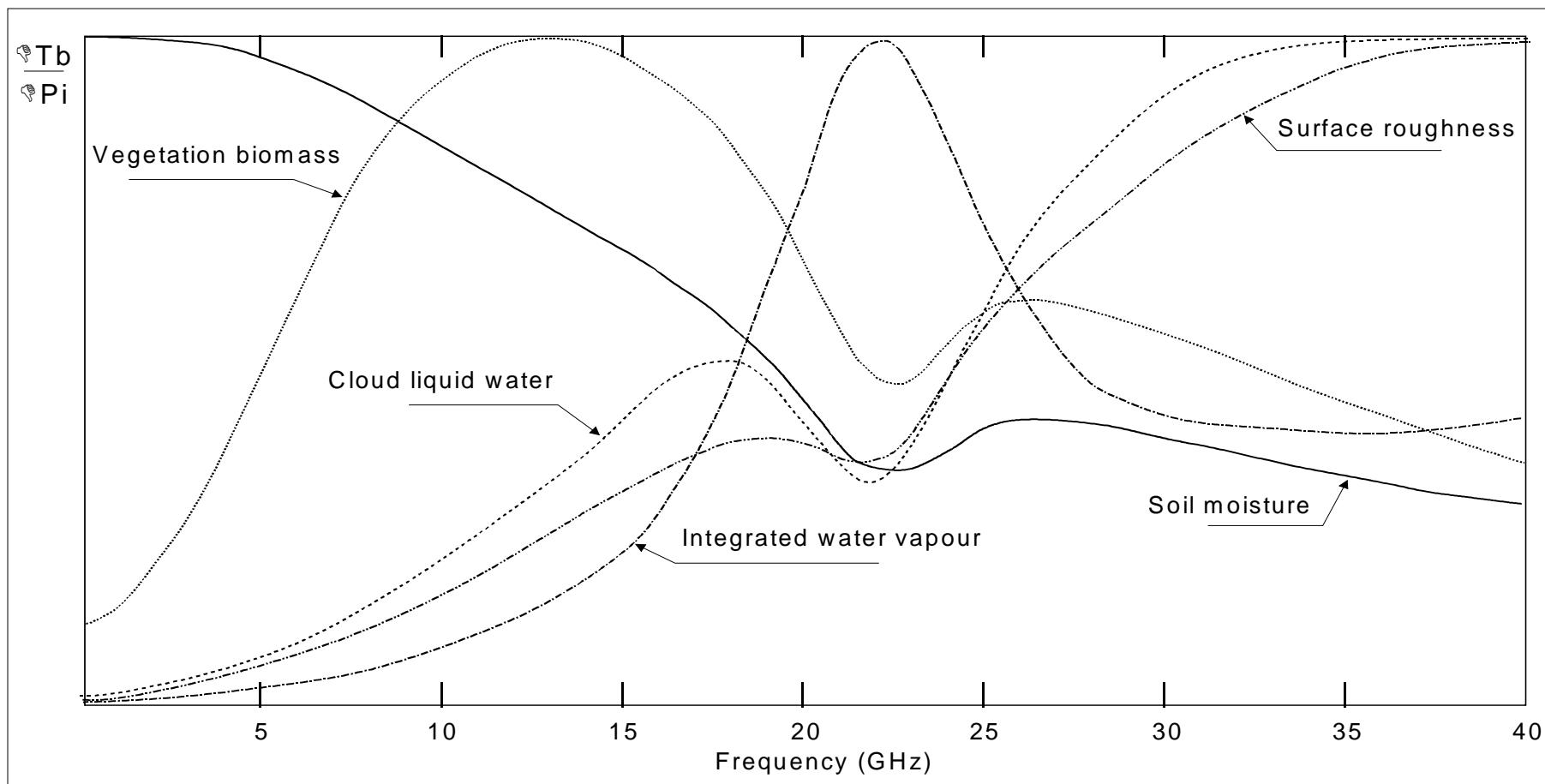




# Microwave spectrum used by Met Satellites



# Sensitivity of brightness temperature to geophysical parameters over land surfaces

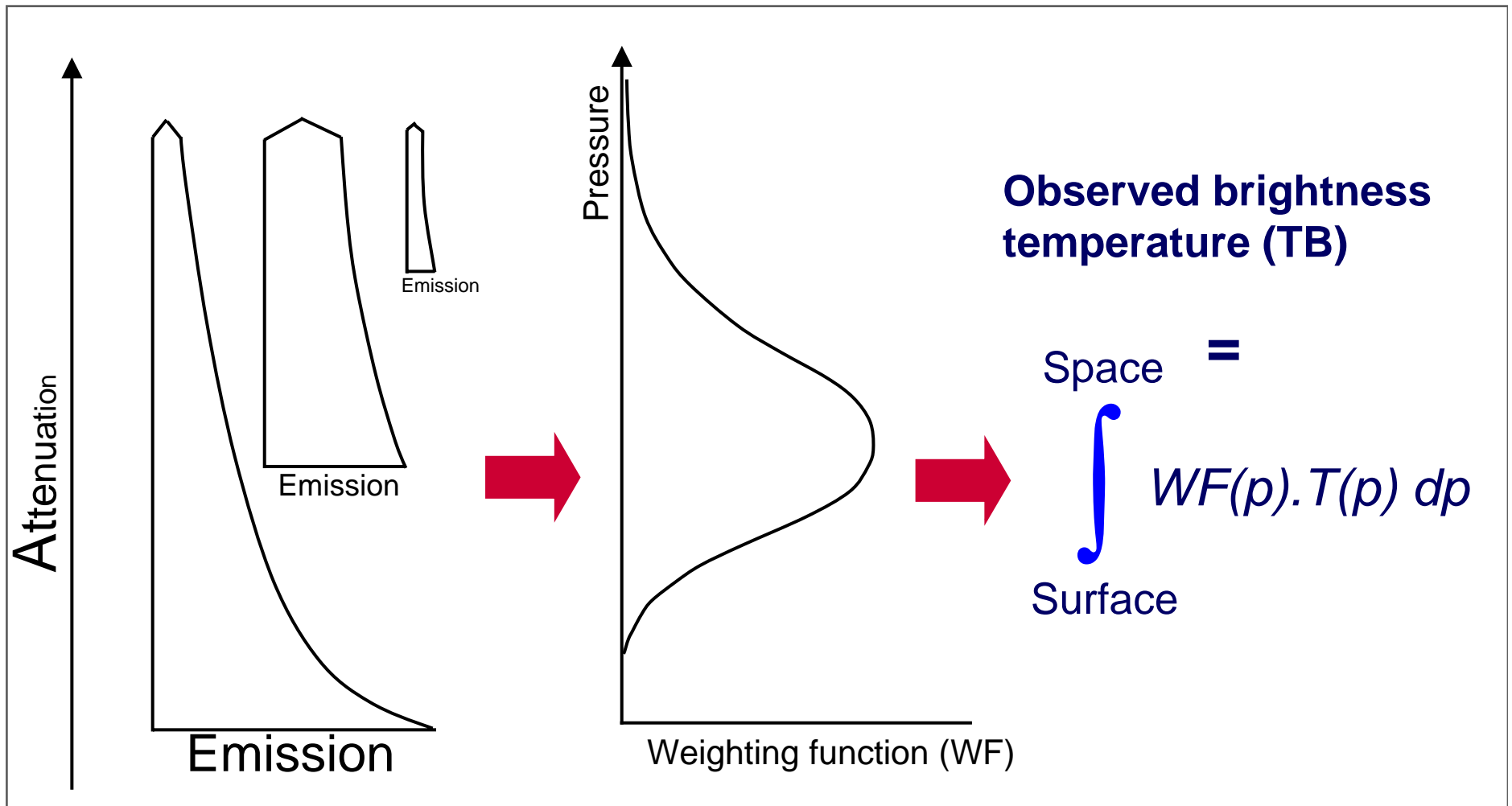


# Current use of microwave spectrum for meteorology



Frequency (GHz)	Bandwidth (MHz)	Measurement	Sensor
6.92	200	SST	AMSR
10.65	100	Rain rate, snow, ice, SST, ocean wind	AMSR, TMI
18.7	200	Rain rate, ice, water vapour, wind speed	AMSR, TMI, SSM/I
23.8	400	Water vapour, liquid water, atmos sounding	SSM/I, AMSU-A
31.4	500	Atmospheric temp, liquid water	AMSU-A
50-55	5000	Atmospheric temp	AMSU-A
89 + 150 + 157	3000	Atmospheric temp, water vapour + surface	AMSU-A/B
183+/-7	14000	Atmospheric temp, water vapour + surface	AMSU-B

# Weighting functions

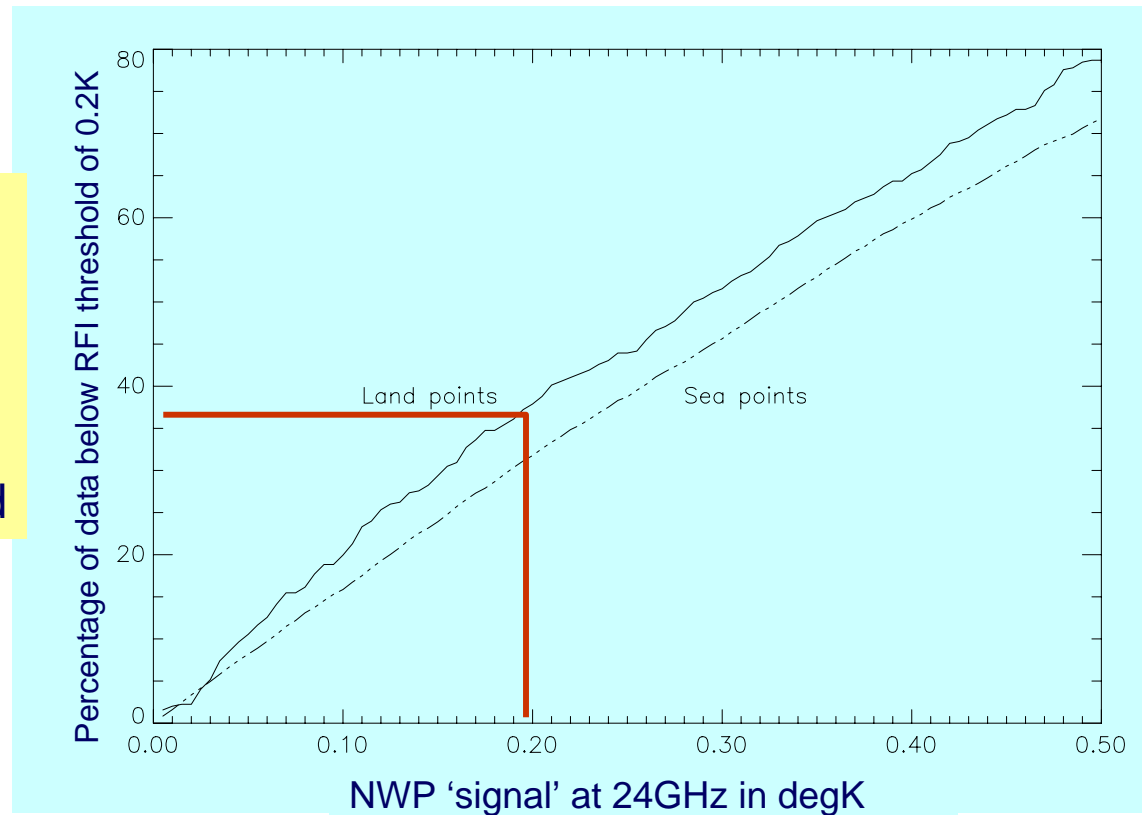


# Use of 24 GHz channel for weather forecasting

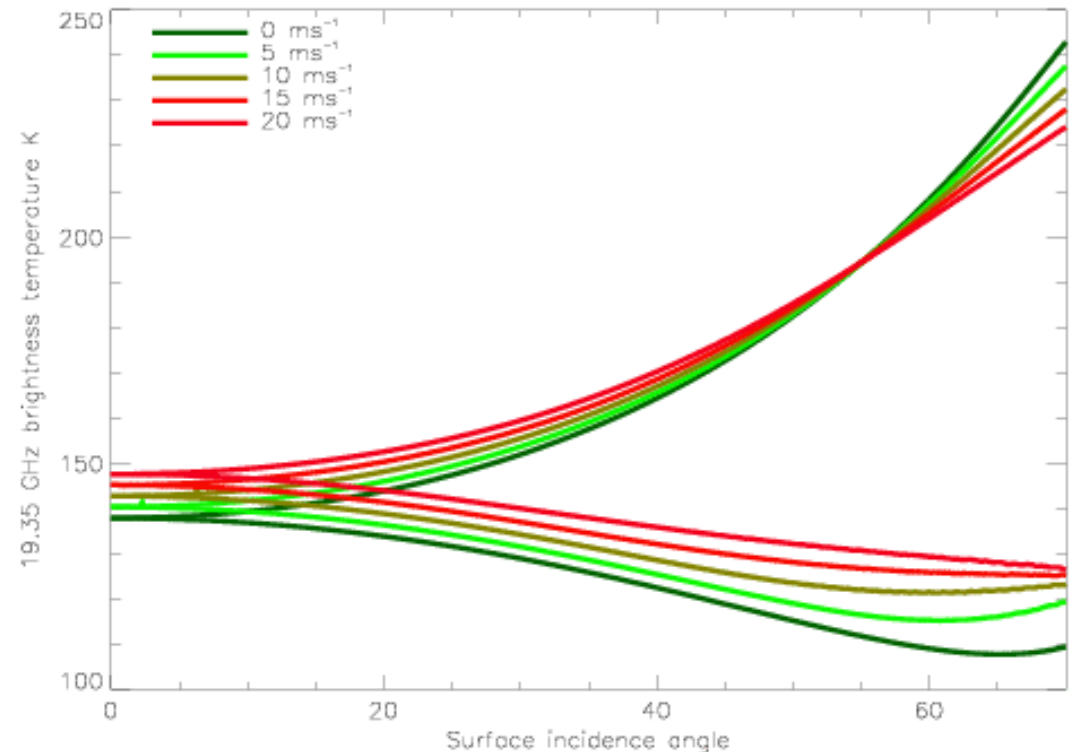
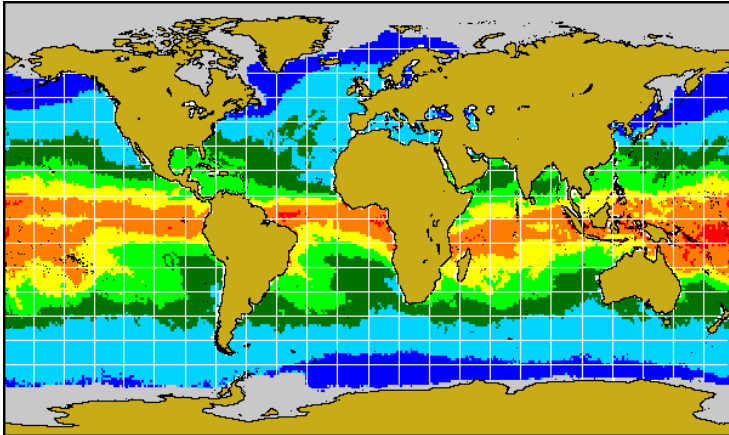


- 24 GHz channel is used for identifying best footprints for sounding channels
- Also used for inferring water vapour, cloud water and surface properties

- RFI would exceed 0.2K threshold 38% of the time over land.
- A threshold of 0.03K is required to reduce significant interference to < 5% over land



# Microwave imagers: SSM/I, AMSR, TMI...

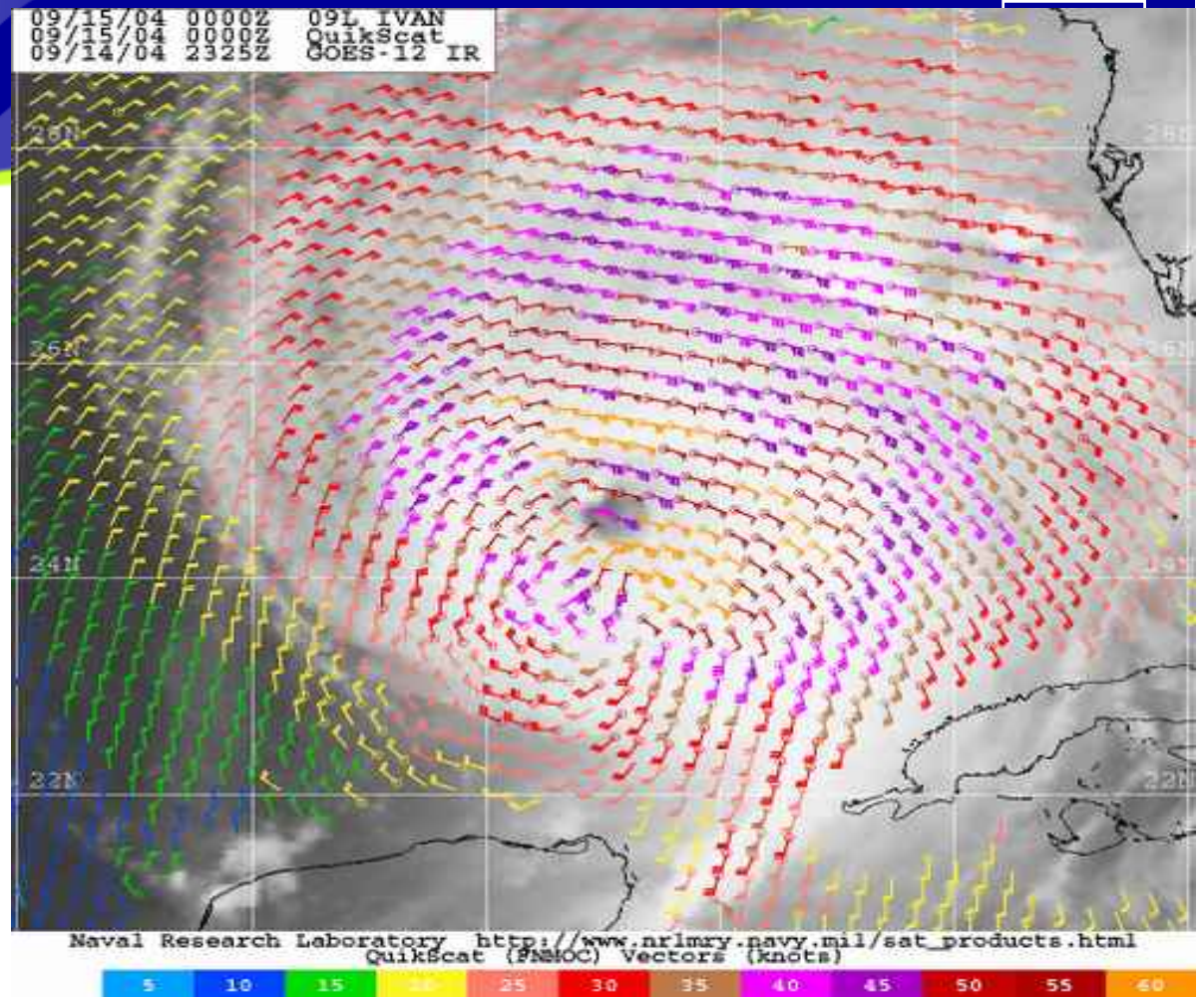
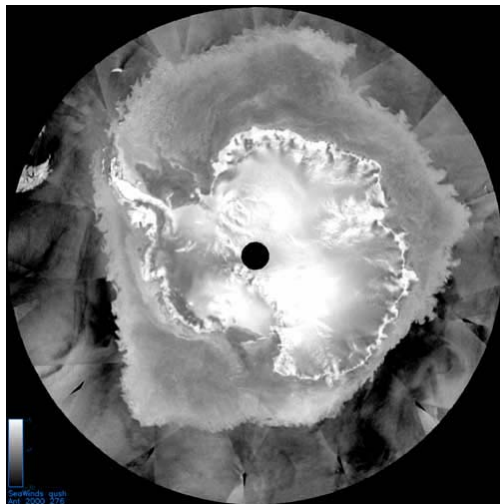


- Wind speed information from vertical and horizontal polarised microwave radiometer data is well established.

# Wind Scatterometers

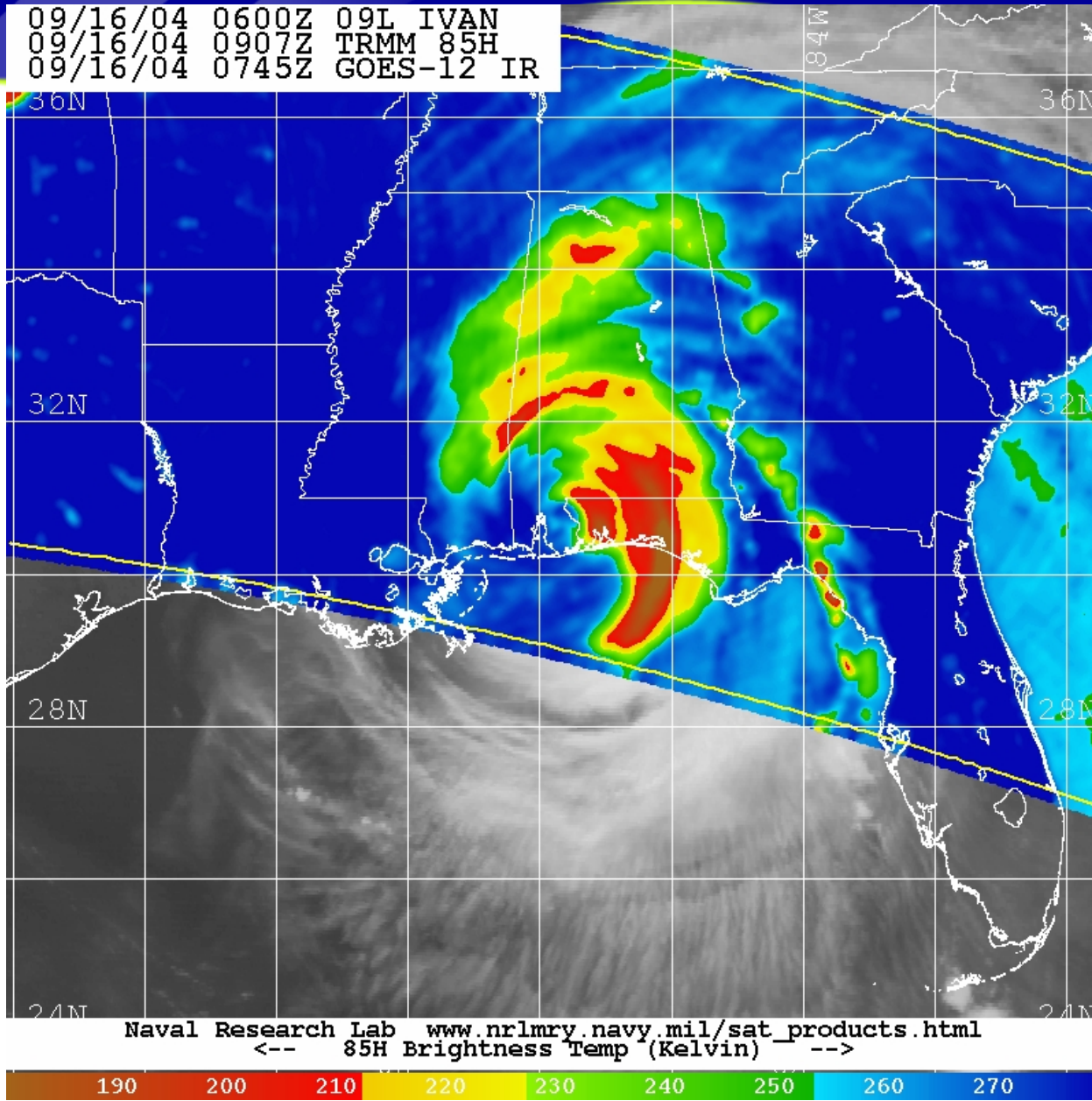


Sea-ice, Snow



- Calibrated radar operating at frequencies which are only weakly affected by atmosphere
- Measures surface backscatter at several azimuth angles

# Precipitation from microwave radiometers



Scattering by rain at 85 GHz shows rain bands clearly.

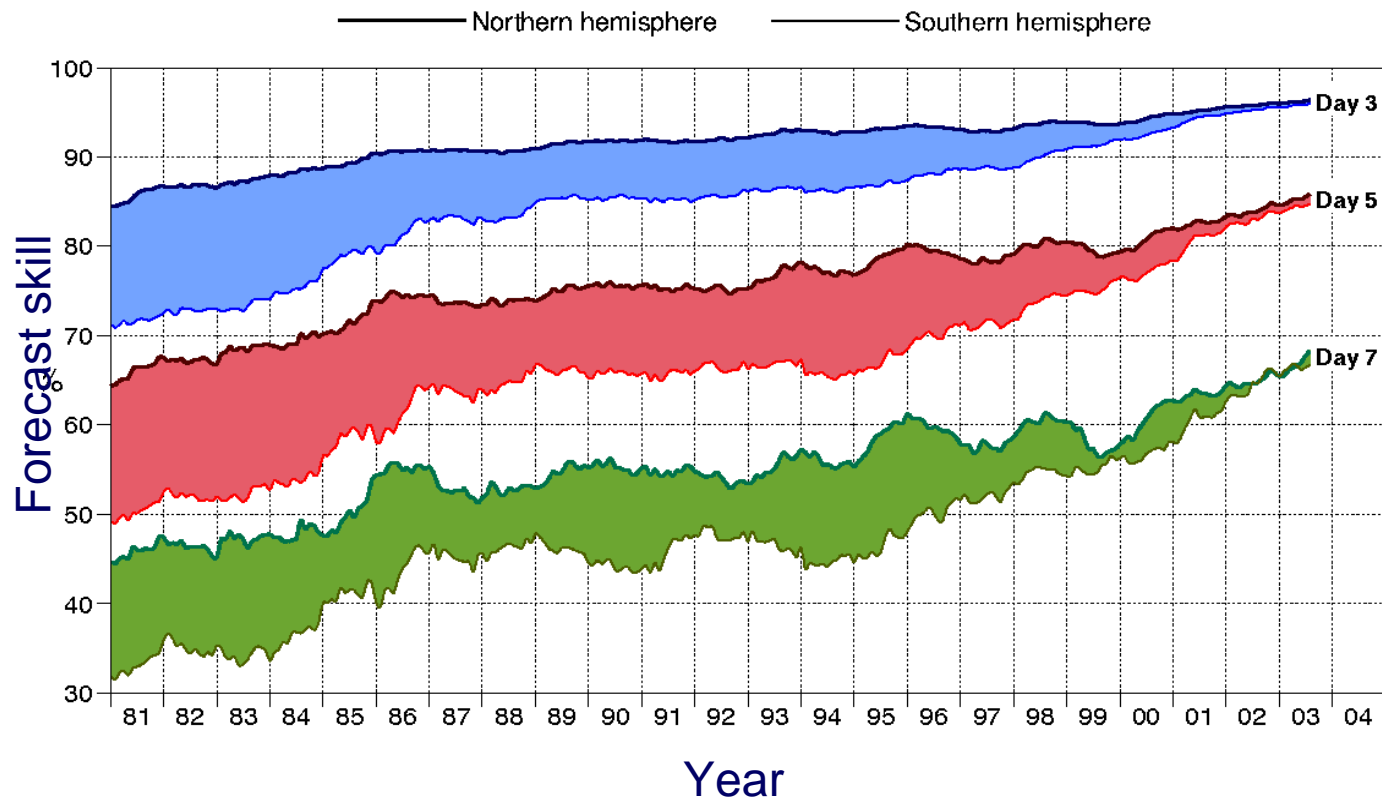


# Forecast improvements



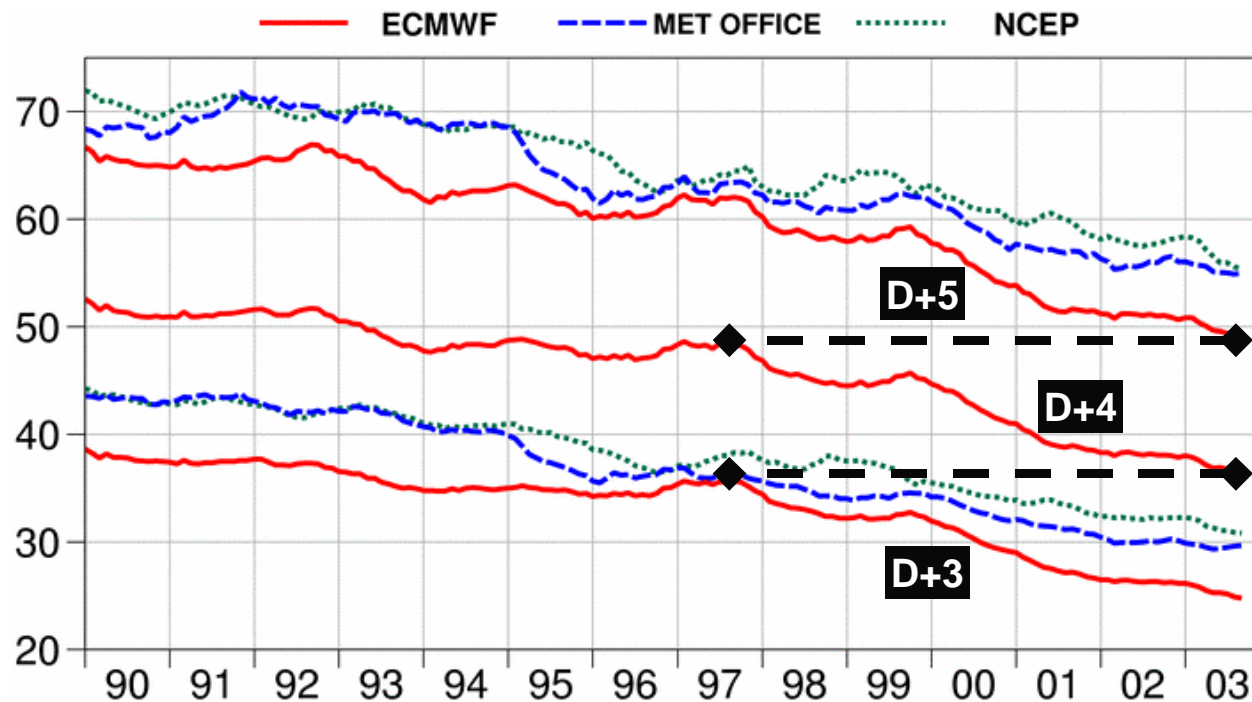
## ECMWF forecasts 1981-2003

### Anomaly correlation of 500hPa height forecasts

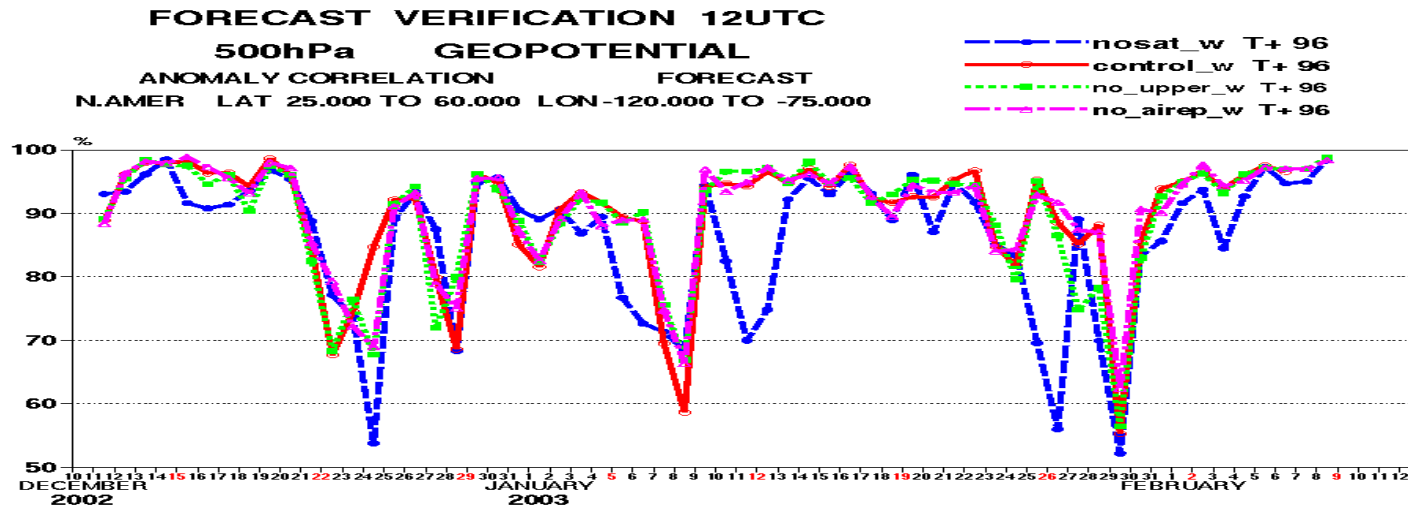
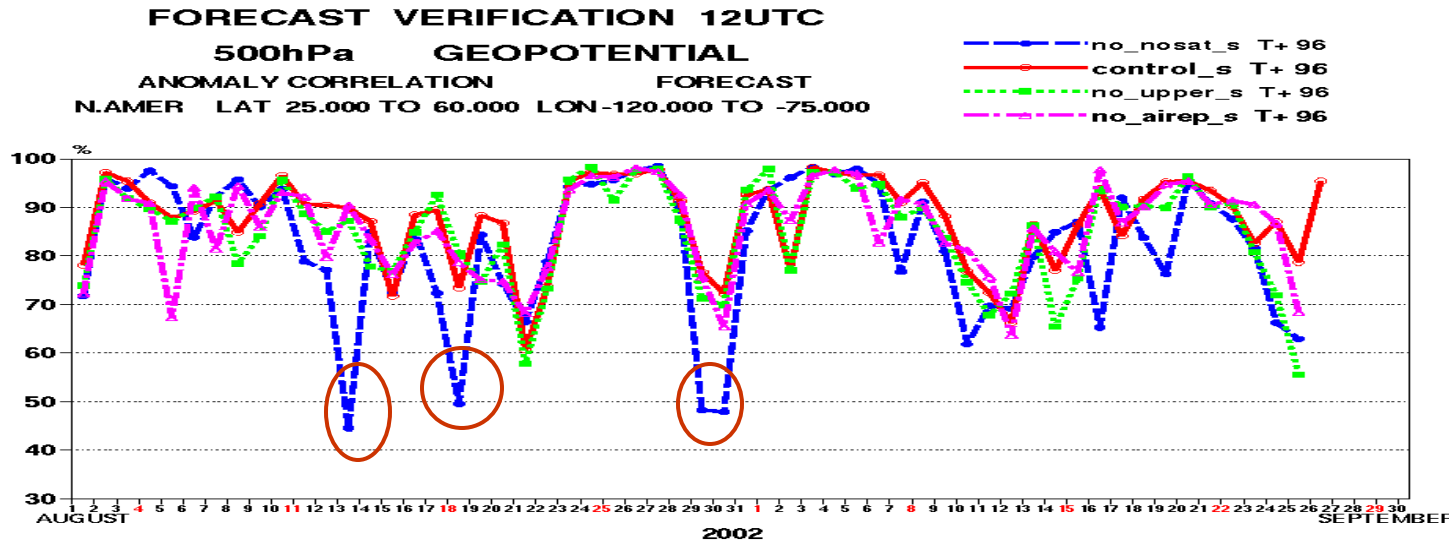


## Recent improvement in the accuracy of forecasts

Annual-mean r.m.s. errors against analyses from WMO scores  
500hPa height (m) Northern hemisphere



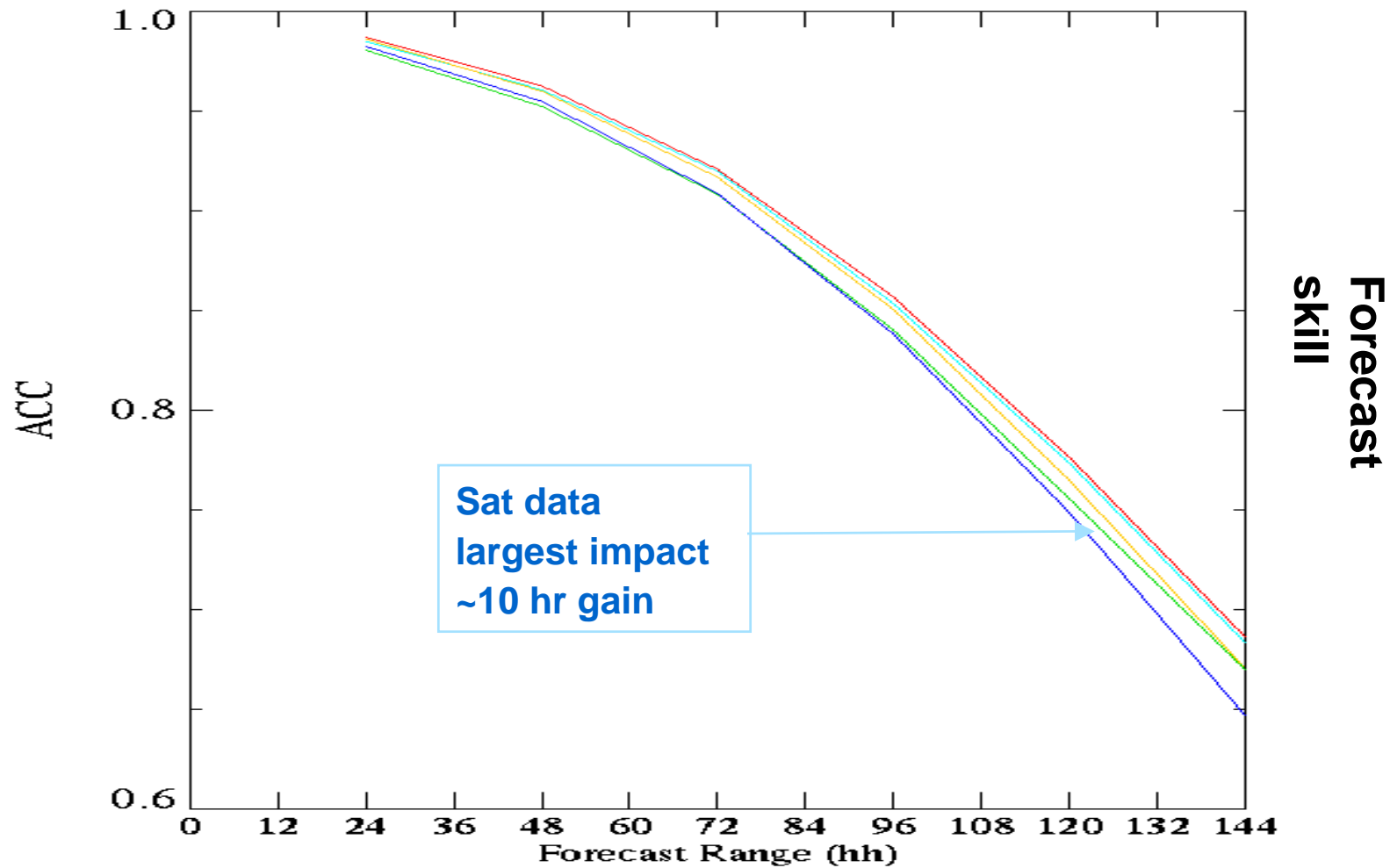
# Forecast skill vs time



# Satellite vs conventional: NH height



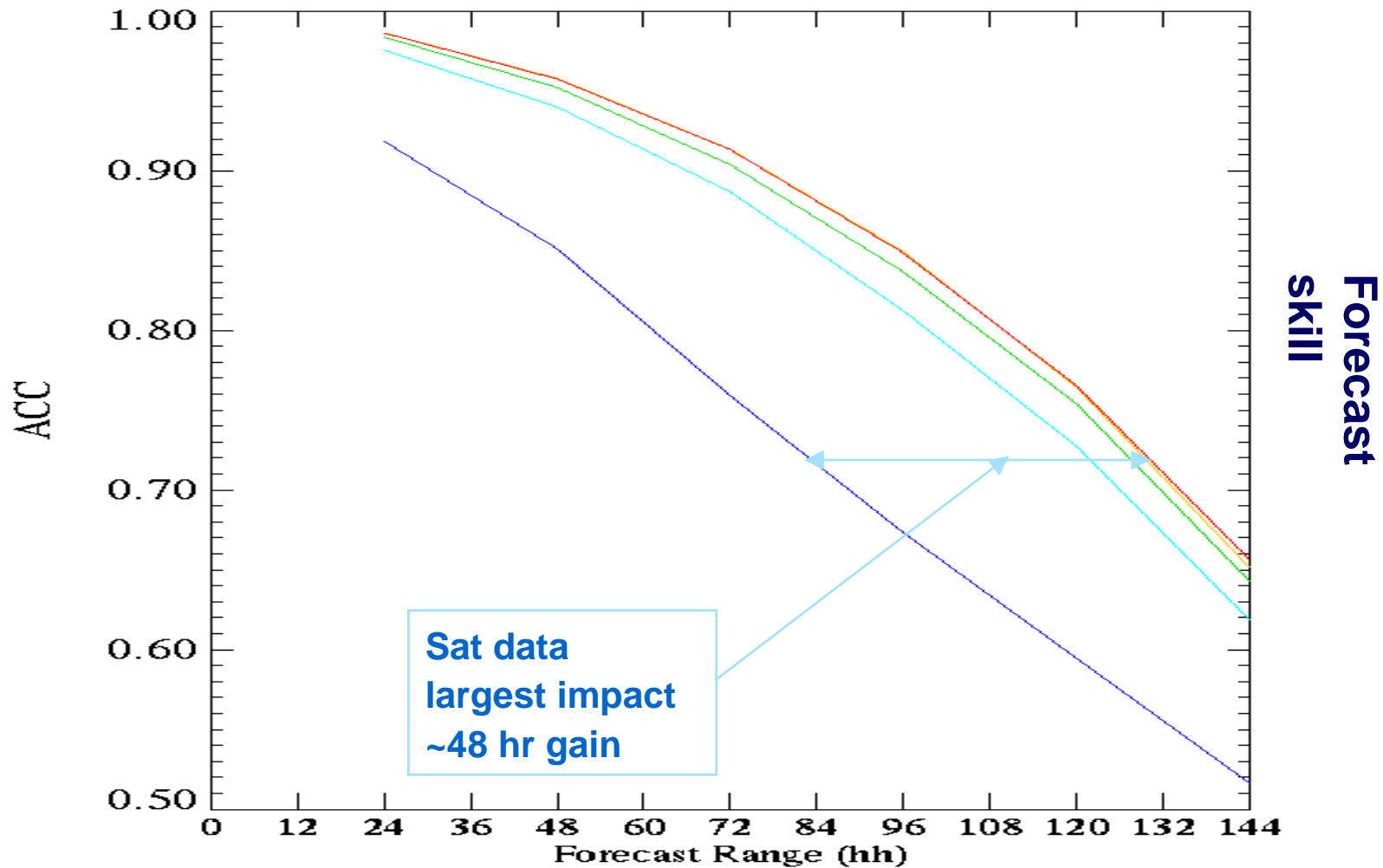
Height (metres) at 500.0 hPa: Analysis  
Northern Hemisphere (CBS area 90N-18.75N)  
Equalized and Meaned from 1/7/2001 12Z to 6/8/2001 12Z  
Cases: — ALL DATA — NO SAT — NO SONDE  
— NO AIRCRAFT — NO SURFACE



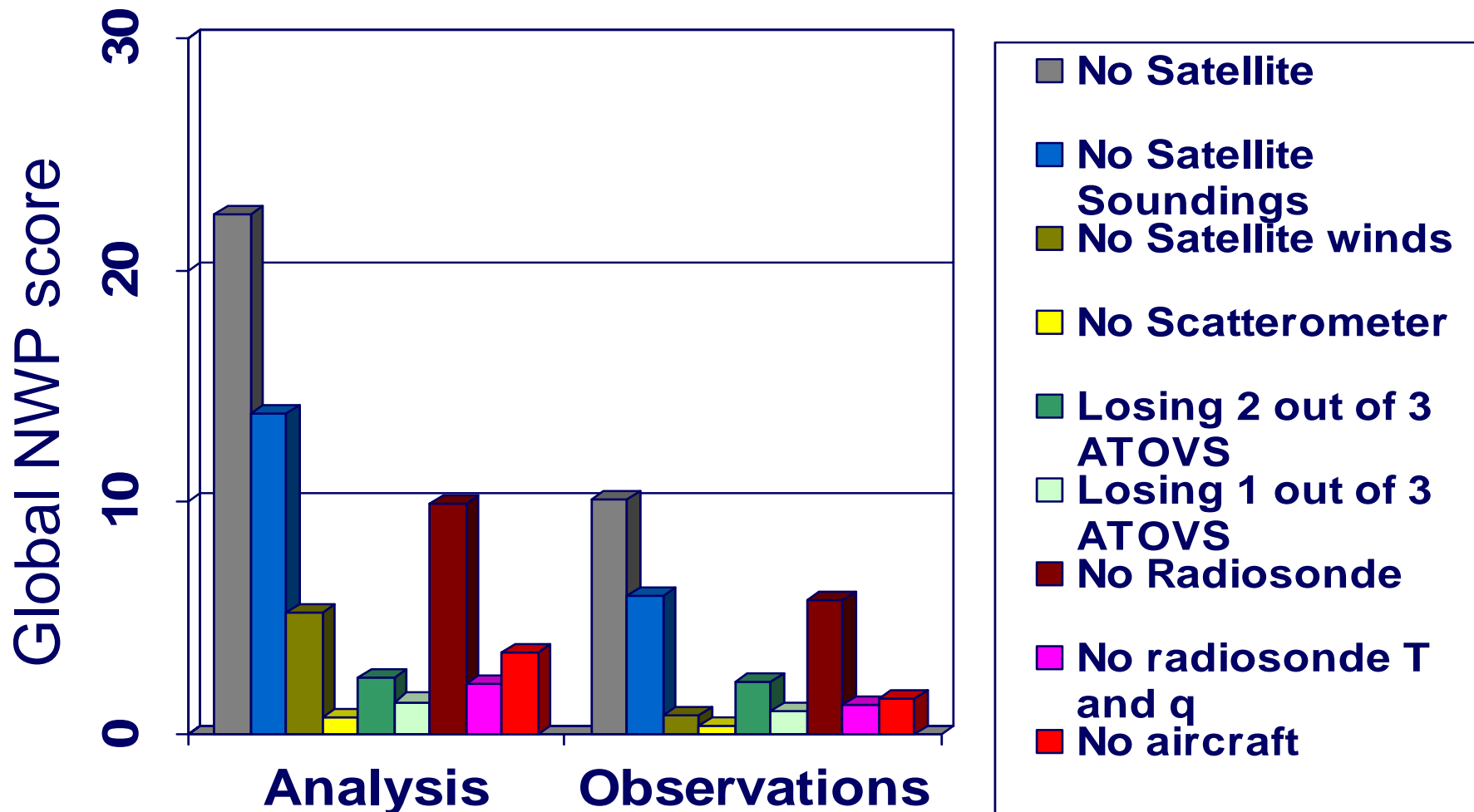
# Conventional vs satellite: SH height



Height (metres) at 500.0 hPa: Analysis  
Southern Hemisphere (CBS area 90S-18.75S)  
Equalized and Meaned from 1/7/2001 12Z to 6/8/2001 12Z  
Cases: — ALL DATA — NO SAT — NO SONDE  
— NO AIRCRAFT — NO SURFACE



# Comparison of overall impact of observing systems



...surface pressure obs also very important to prevent drift in mass of atmosphere

- The additional information provided by the observations is very small in any given assimilation cycle - does it actually have any impact?
  - 1-2 days forecast improvement in the SH
  - 1/3-1/2 days forecast improvement in the NH
  - Humidity information is most important in the tropics
  
- AMSU is the most important current source of satellite data, providing most of this impact.

The background of the slide features a light blue color with several overlapping, wavy, white and light blue patterns that create a sense of movement and depth.

# Thanks

and please keep the channels we use  
free of interference.



### Global NWP Index Analysis based – 12 Month Mean – Normalised to Mar 2000

