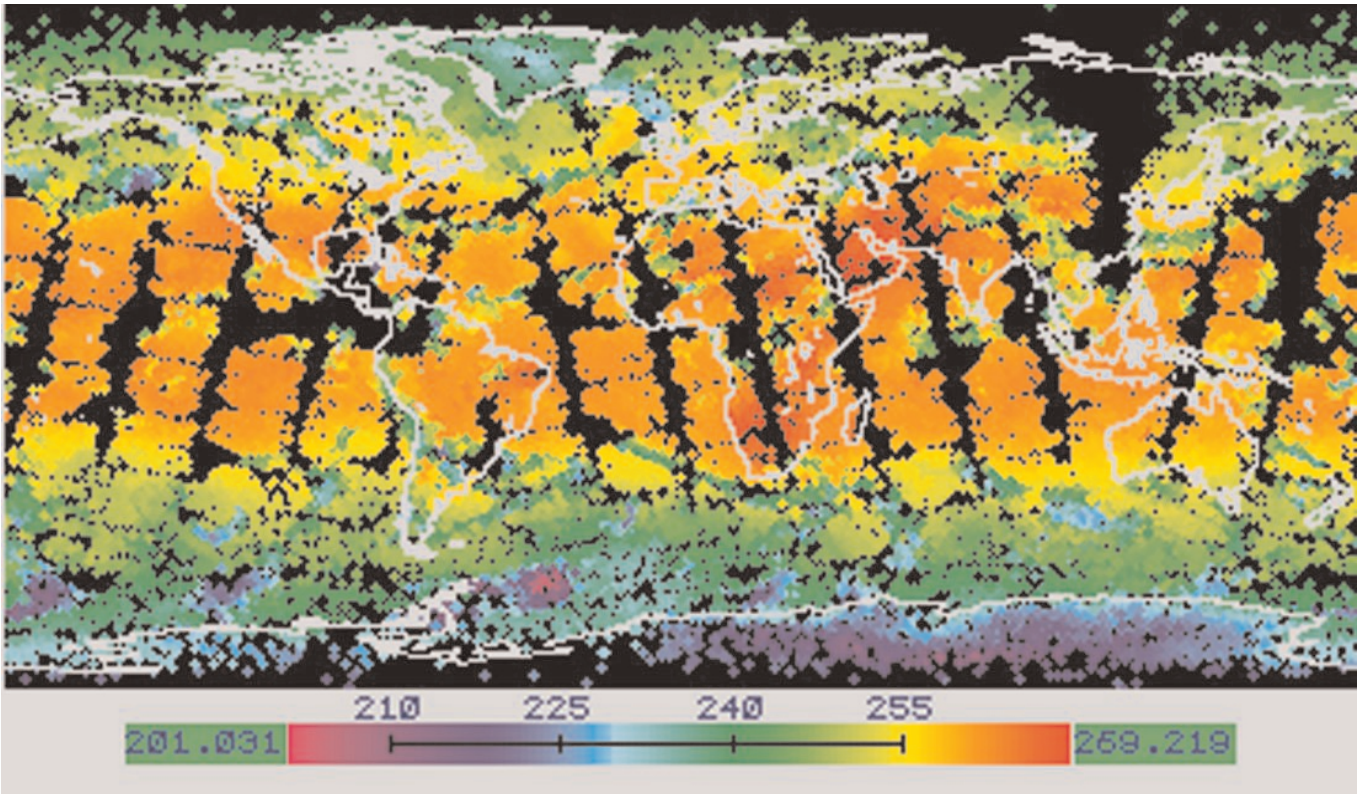
Centre de
Météorologie
Spatiale

METEO FRANCE

Satellite atmospheric sounding instruments (1)



Atmospheric temperatures of the globe extracted from the HIRS 13.6 µm channel on the NOAA-14 satellite

Since the 1970s, it has been possible to obtain information on the vertical temperature profile of the entire atmosphere using weather satellites. The improvement in the systems and processing algorithms has enabled the retrieval of temperatures to an accuracy of one Kelvin or better, which is a remarkable feat for satellites flying over the atmosphere at an altitude of over 800 km. With the new generation of microware instruments equipped from 1998, the accuracy has improved still further, especially in the estimation of atmospheric humidity.

ICI (Inversion Coupled with Imager) is a programme developed at the CMS to retrieve the temperature and humidity profiles from sounder measurements.

DP/CMS May 2004

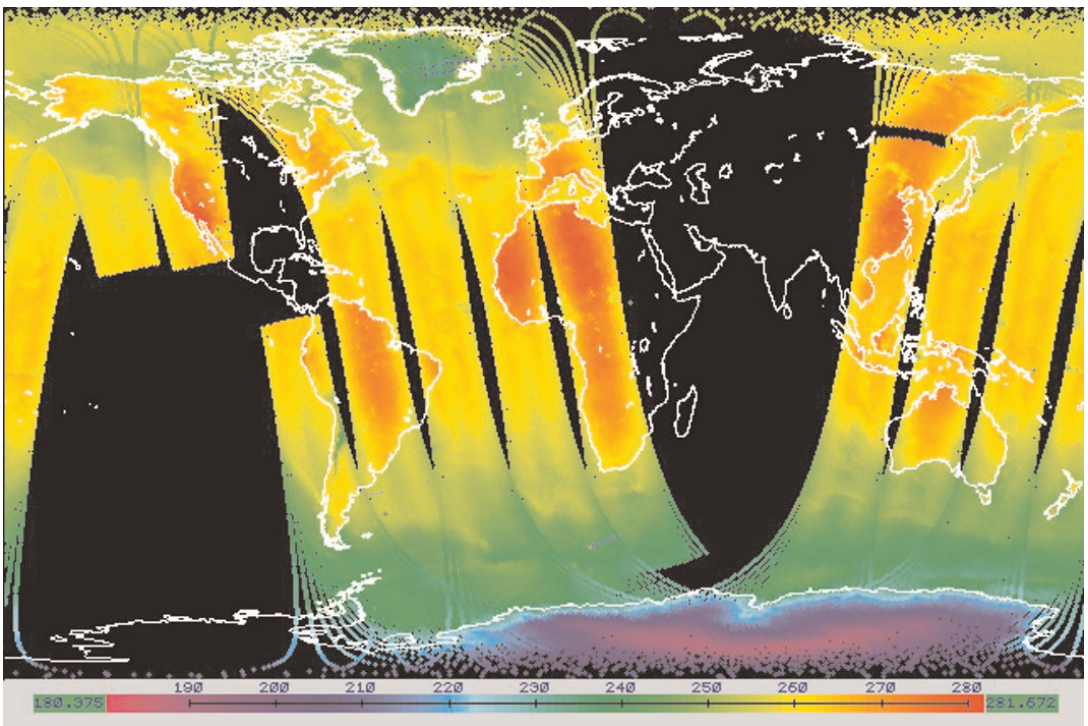
The ATOVS sounders of the NOAA polar orbiting satellites are composed of a high resolution infrared radiation sounder (HIRS) and an advanced microwave sounder unit (AMSU). Since the NOAA-15 became operational in 1998, a new generation of sounders has been implemented and is aboard the current NOAA 16 & 17 satellites.

HIRS

The High Resolution Infrared Radiation Sounder (HIRS/3) is the current version of an instrument that was the first source of atmospheric sounding from the NOAA satellites from their first flight on TIROS-N (Television InfraRed Operational Satellite - Next-generation) in 1978. The first example of this new version was run on NOAA-15 in May 1998. Other copies were equipped on subsequent NOAA satellites. Three copies of an improved version HIRS/4 will be provided by the NOAA for the EUMETSAT METOP satellites. This function will be provided chiefly on METOP by the Infrared Atmospheric Sounding Interferometer (IASI).
The HIRS measures the radiance in 20 spectral bands to enable the vertical temperature profile in clear conditions to be computed from the surface to around an altitude of 40 km. HIRS/3 and HIRS/4 are similar in their performances and spectral responses, but the most noticeable difference lies in the effective Field Of View (FOV). It is approximately 20 km on HIRS/3 and 10 km on its successor, giving an increased capacity for observing regions free of all cloud.
Multispectral data of a visible channel (0.69 µm), seven short wave channels (3.7 to 4.6 µm) and twelve long wave channels (6.7 to 15 µm) are obtained from a simple telescope and rotating filter with 20 separate filters. The resolution is 17.4 km at the nadir.

AMSU-A and AMSU-B

The Advanced Microwave Sounder Unit-A (AMSU-A) is a microwave radiometer designed to measure radiances in 15 channels, which enables vertical temperature profiles to be calculated from the surface of the Earth to a pressure of approximately 3 hPa (45 km). It is used in combination with HIRS for the priority objective of measuring atmospheric temperature profiles. It is complementary to HIRS, which has better resolution but is more sensitive to clouds than the microwaves of the AMSU-A. The AMSU-A resolution is 45 km at the nadir. It was installed for the first time on NOAA-15, launched in May 1998. The NOAA will supply copies of the instrument for the METOP satellites so as to ensure compatibility between the NOAA and EUMETSAT satellites.
The Advanced Microwave Sounder Unit-B (AMSU-B) is a microwave sounder developed by the Met Office (Great Britain) for the satellites NOAA-15, 16 and 17. The first model was run on NOAA-15 in May 1998. An instrument with similar specifications, the Microwave Humidity Sounder (MHS) was developed by EUMETSAT for the future NOAA satellites and for the series of EUMETSAT METOP satellites. The aim of the AMSU-B instrument is to measure the radiation at different layers of the atmosphere to obtain humidity profiles on a global scale. Combined use with the AMSU-A instruments makes a total of 20 microwave channels available for atmospheric sounding. At the microwave frequencies used, the clouds are almost transparent, whereas precipitations emit strongly: the instrument will also be used to map the precipitations. The channels cover the water vapour line that is highly opaque at 183 GHz and supplies atmospheric humidity measurements. The 89 GHz and 150 GHz channels enable deeper penetration through the atmosphere to the earth's surface. AMSU-B has a greater resolution than that of the AMSU-A, with a circular field of view of approximately 16 km diameter at the nadir.



The first data, available in June 1998, from the 53 GHz channel of AMSU-A, unit installed on NOAA-15 in May 1998