

# EPS-SG: Overview of Mission and Products



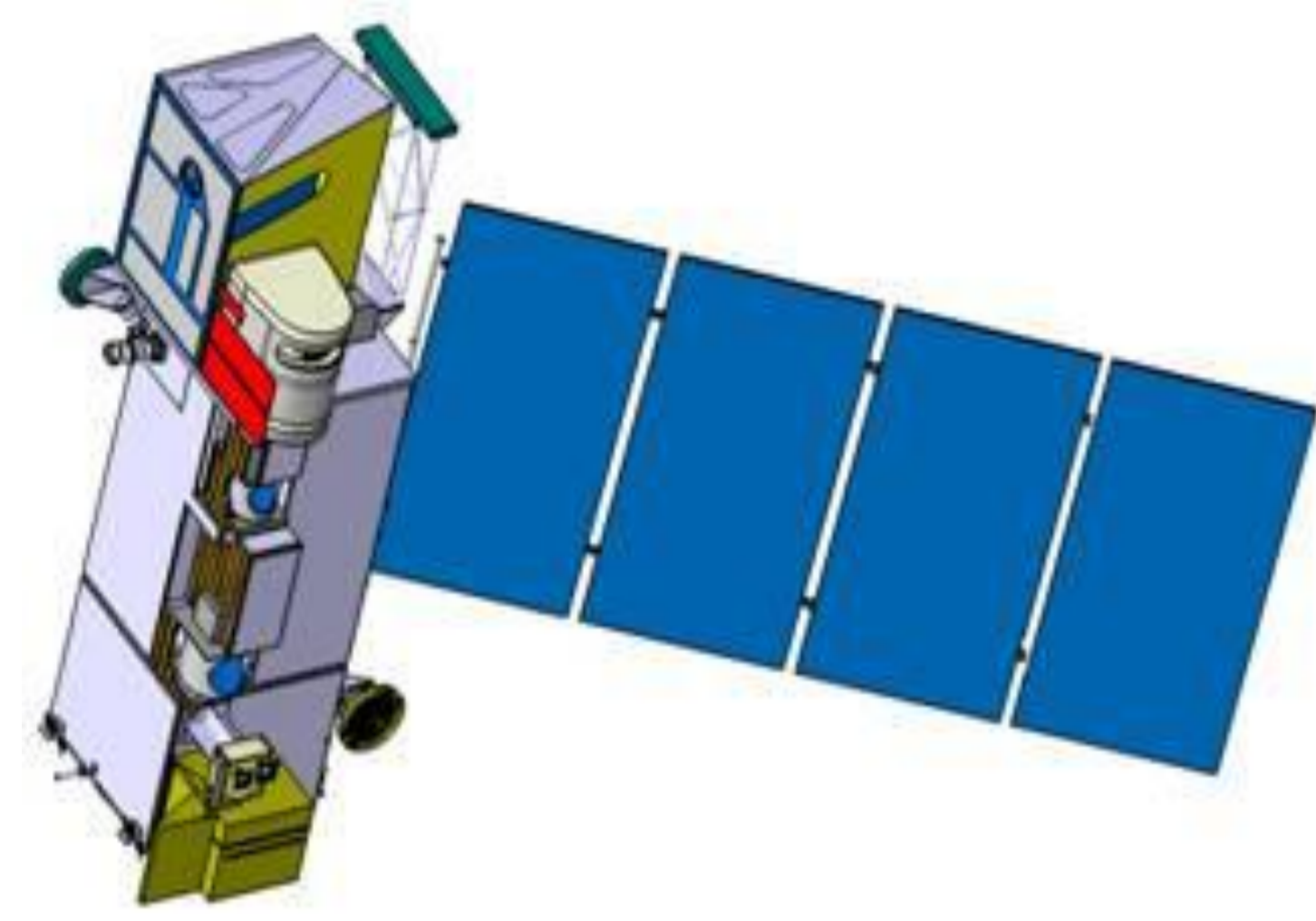
Jörg Ackermann, Peter Schlüssel, Dieter Klaes  
EUMETSAT, Eumetsat-Allee 1, D-64295 Darmstadt, Germany

**EUMETSAT**  
Monitoring weather and climate from space  
Surveiller le temps et le climat depuis l'espace

The EUMETSAT Polar System – Second Generation (EPS-SG) is the follow-up system of the EPS programme. It aims to ensure continuity of the European contribution to operational weather satellite services in the mid-morning polar orbit in the timeframe of 2020 to 2040. The European Space Agency ESA develops and procures the EPS-SG Space Segment, which consists of the Metop-SG Satellites A and B series, and EUMETSAT has the overall system responsibility. In the frame of the EPS-SG development, the mission requirements for the individual observations were defined in close cooperation with a Post-EPS Mission Experts Team (PMET) and compiled in the EPS-SG End User Requirements Document.

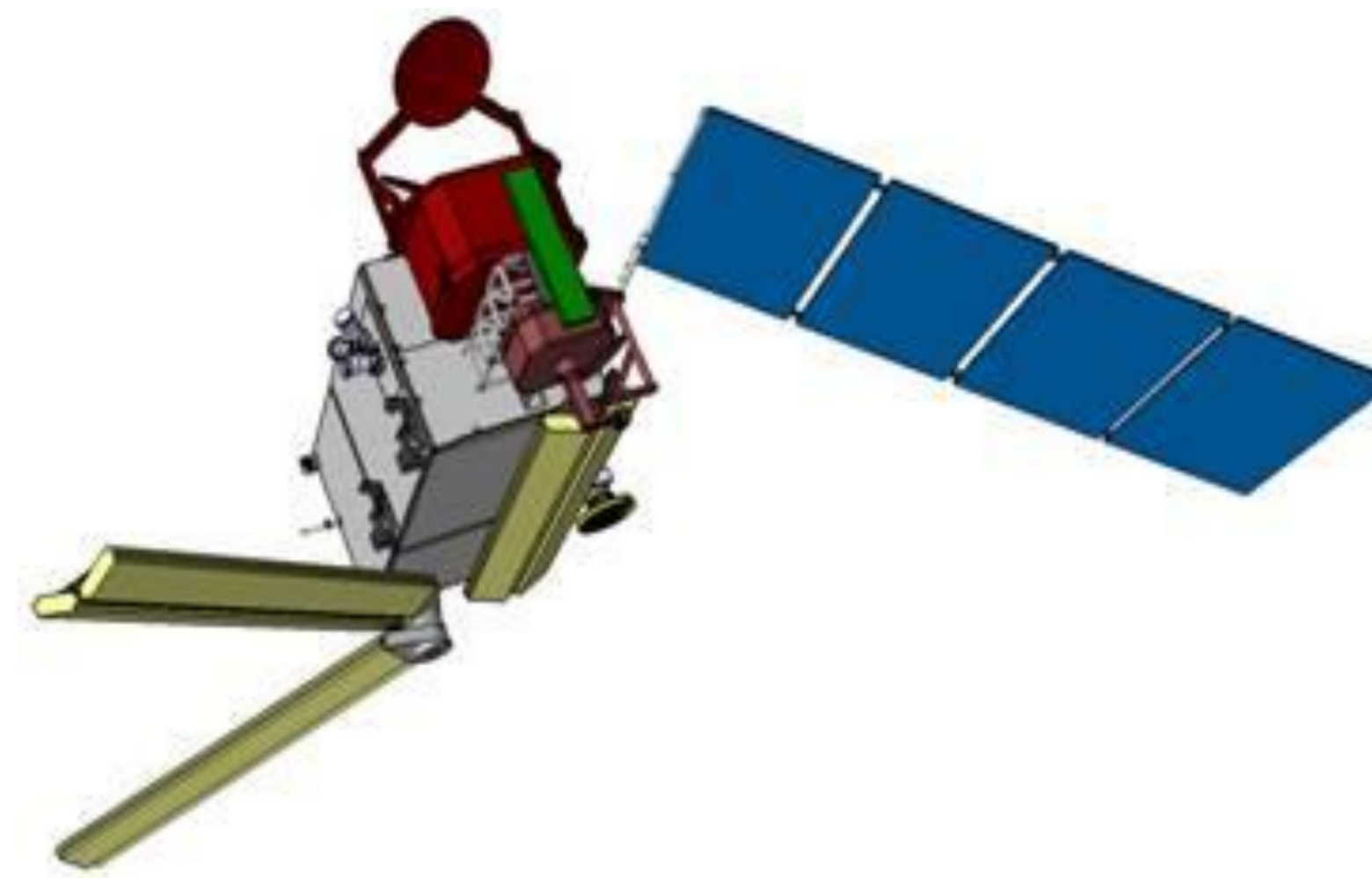
For the observation missions related to atmospheric sounding, the main requirements with respect to radiometric, spectral, and geometric performances are summarized. This gives a preliminary assessment of the performance of the EPS-SG Level 1 and Level 2 products that users can expect to receive for use in operational meteorology and climate monitoring.

## Metop-SG Satellite A



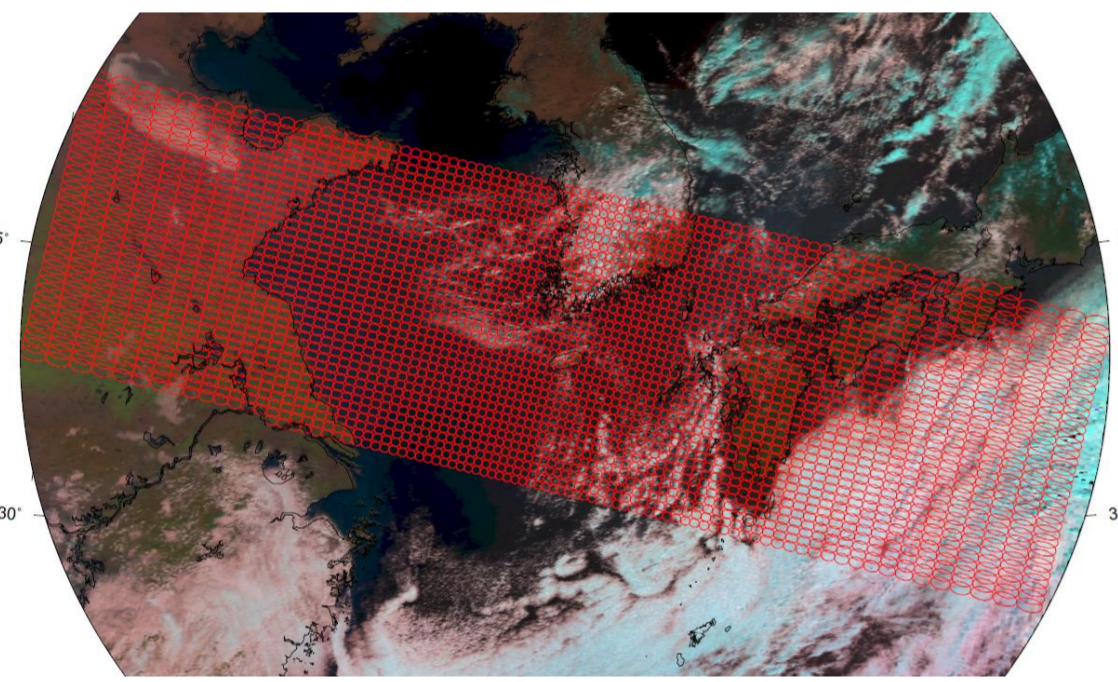
Satellite-A Payload	
<b>Meteorological Imager METImage</b>	
<b>Infrared Atmospheric Sounding Interferometer-Next Generation IASI-NG</b>	
<b>Microwave Sounder MWS</b>	
<b>Multi-view Multi-channel Multi-polarization Imager 3MI</b>	
<b>Ultra-Violet/Visible/Near Infrared/Short Wave Infrared Spectrometer UVNS (Copernicus Sentinel-5)</b>	
<b>Radio Occultation Sounder RO</b>	

## Metop-SG Satellite B



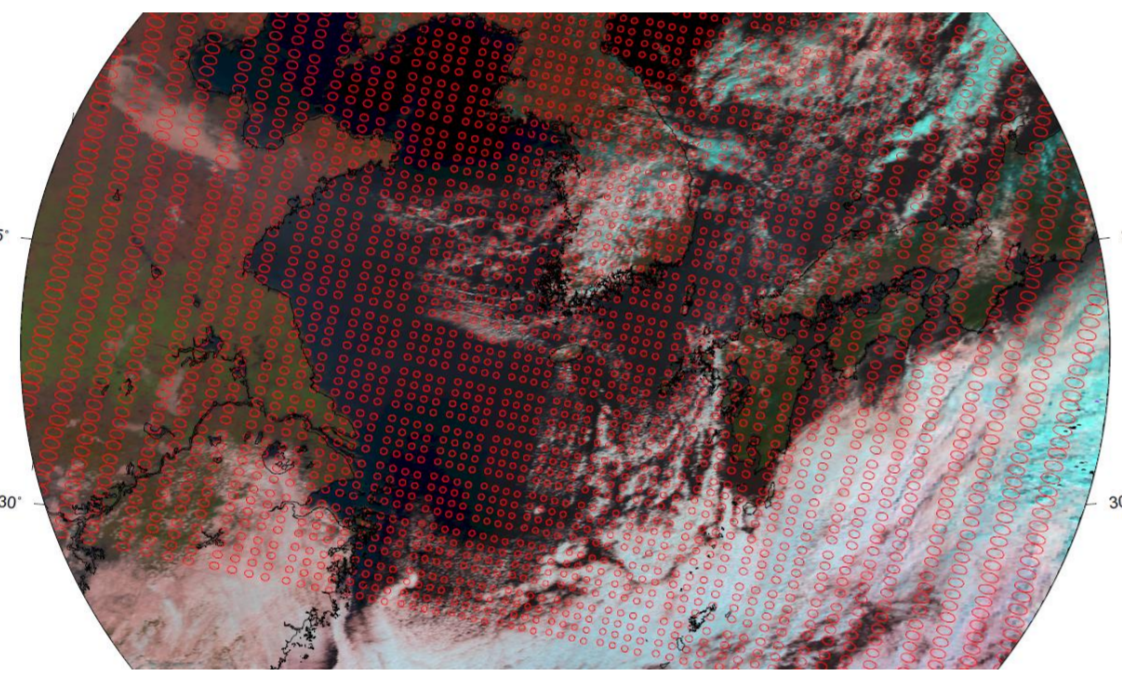
Satellite-B Payload	
<b>Scatterometer SCA</b>	
<b>Microwave Imager MWI</b>	
<b>Ice Cloud Imager ICI</b>	
<b>Radio Occultation Sounder RO</b>	
<b>Data Collection System DCS (Argos-4)</b>	

## MWS



MWS Swath

## IASI-NG



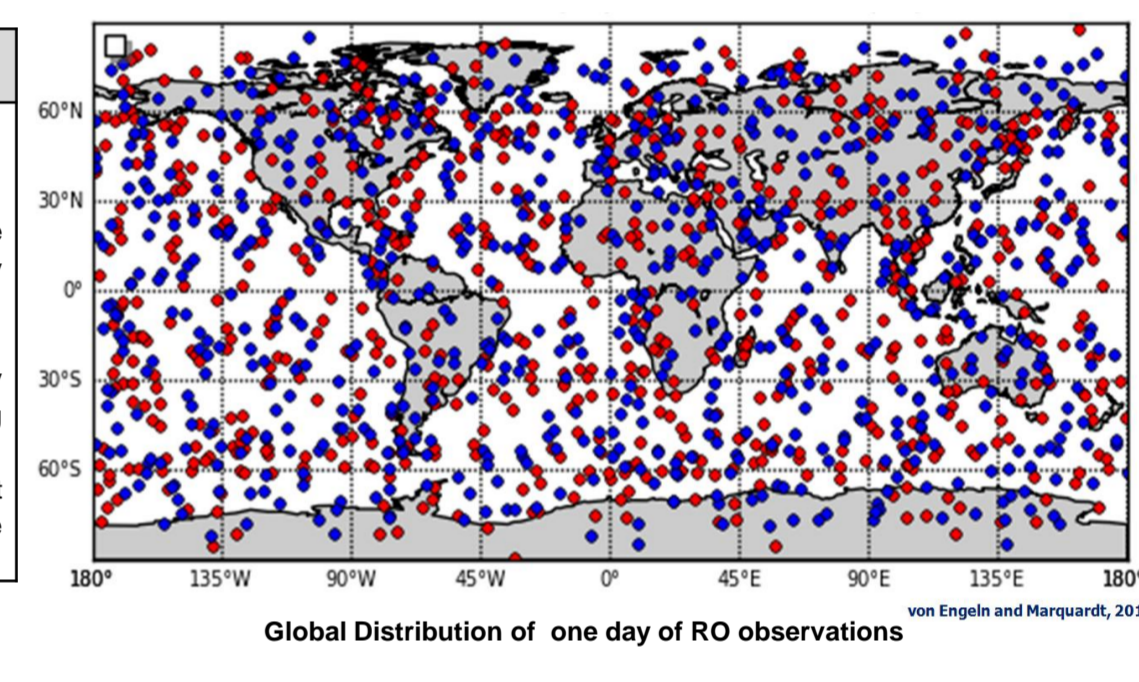
IASI-NG Swath

## MetImage

Channel	Central Wavelength (µm)	FWHM (µm)	Utilisation	SNR at L <sub>toplayer</sub> (#4 to #25) NEAT at T <sub>toplayer</sub> (K) (#26 to #40)
VII-4	0.443	0.03	Aerosol, true colour imagery (blue channel), vegetation	221
VII-8	0.555	0.02	Clouds, vegetation, true colour imagery (green channel)	215
VII-12	0.67	0.02	Clouds, vegetation, true colour imagery (red channel)	66
VII-15	0.752	0.01	Atmospheric corrections (aerosol), optical cloud top height assignment, vegetation	400
VII-16	0.763	0.01	Vegetation, aerosol, clouds, surface features	400
VII-17	0.865	0.02	Vegetation, aerosol, clouds, surface features	60
VII-20	0.914	0.02	Water vapour imagery	250
VII-22	1.24	0.02	Vegetation, aerosol	75
VII-23	1.375	0.04	High level aerosol, cirrus clouds, water vapour imagery	300
VII-24	1.63	0.02	Cloud phase, snow and ice, vegetation, aerosol, fire	300
VII-25	2.25	0.05	Cloud microphysics at cloud top, vegetation, aerosol over land, fire (effects)	110
VII-26	3.74	0.18	Cloud variables, cloud microphysics at cloud top, absorbing aerosol, SST, LST, fire, sea and land ice, snow	0.050
VII-28	3.959	0.04	SST, LST, fire	0.074
VII-30	4.04	0.06	SST, LST, fire	0.074
VII-33	6.725	0.37	Water vapour imagery (including wind in polar regions), water vapour profile (coarse vertical resolution)	0.215
VII-34	7.325	0.29	Water vapour profile (coarse vertical resolution)	0.200
VII-35	8.54	0.29	Cirrus clouds, cloud emissivity	0.050
VII-37	10.69	0.5	CO <sub>2</sub> slicing for accurate cloud detection, surface temperatures and other radiative variables, surface imagery (snow, ice etc)	0.050
VII-39	12.02	0.5	CO <sub>2</sub> slicing for accurate cloud top height, temperature profile (coarse vertical resolution)	0.2
VII-40	13.345	0.31	CO <sub>2</sub> slicing for accurate cloud top height, temperature profile (coarse vertical resolution)	0.2

## RO

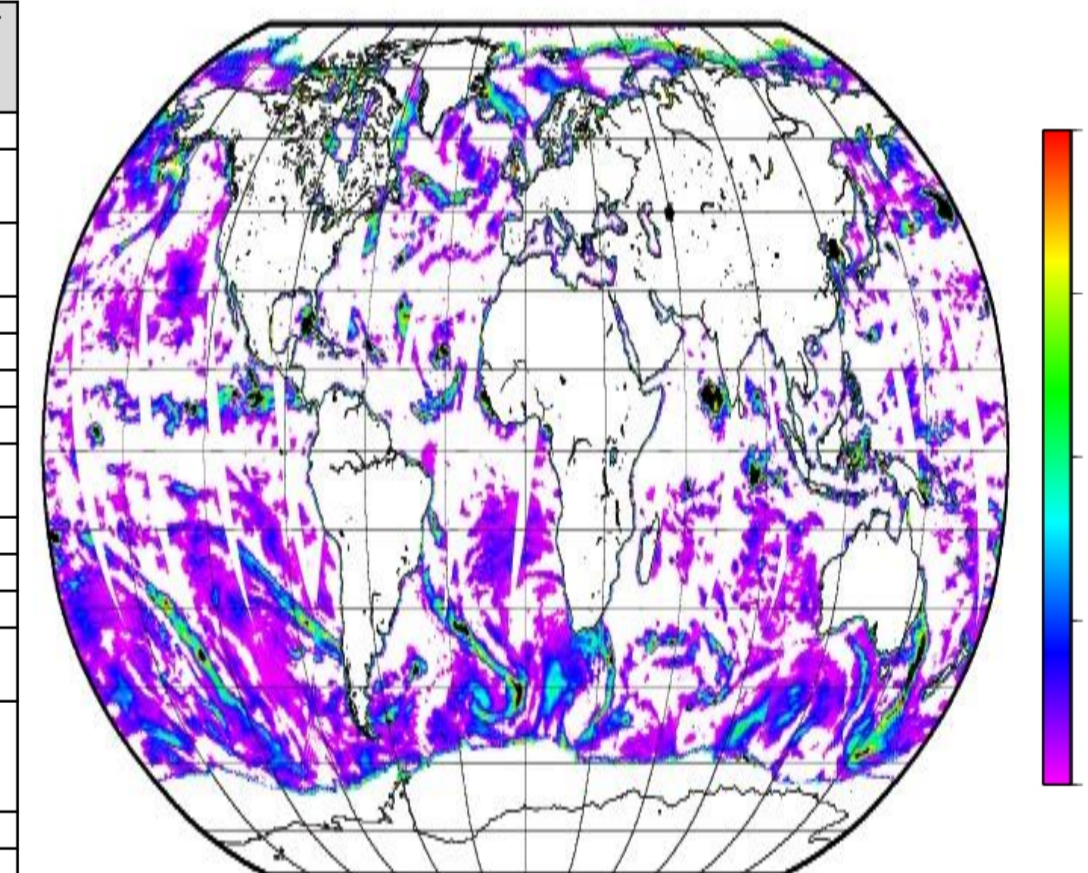
Mission Band	Sub-Band Frequency (MHz)	System	Utilisation
L1	1575.42	GPS	1. Temperature profile
L5	1176.45	GPS	2. Water vapour profile
Esa	1176.45	Galileo	3. Tropopause height
E1+BC	1575.42	Galileo	4. Height of the planetary boundary layer
L1	1575.42	GLONASS	
L5	1176.45	GLONASS	
B1	1575.42	COMPASS	5. Surface pressure
B3	1176.45	COMPASS	6. Electron density profile (supporting space weather)
			7. Total electron content (supporting space weather)



Global Distribution of one day of RO observations

## MWI

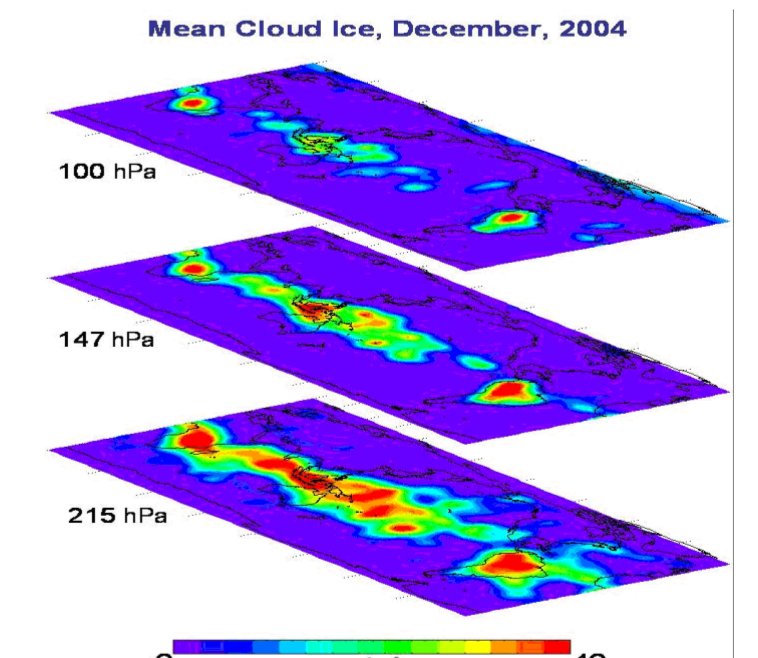
Channel	Frequency (GHz)	Bandwidth (MHz)	Utilisation	NEAT (K)	Footprint Size at 3dB (km)
MWI-1	18.7	200	Precipitation over sea	0.7	50
MWI-2	23.8	400	Total column water vapour over sea	0.6	50
MWI-3	31.4	200/1000	Precipitation over sea and (marginally) land	0.8	30
MWI-4	50.3	400	Precipitation over sea and land including drizzle, snowfall	1.0	30
MWI-5	52.810	400	height and depth of the melting layer	1.0	30
MWI-6	53.24	400	height and depth of the melting layer	1.0	30
MWI-7	53.750	400	Precipitation (sea & land) & snowfall	1.0	10
MWI-8	89.0	4000	Precipitation over sea and land including light precipitation and snowfall	1.2	10
MWI-9	118.7503:3.20	2x500	Precipitation over sea and land including light precipitation and snowfall	1.2	10
MWI-10	118.7503:2.10	2x400	height and depth of the melting layer	1.2	10
MWI-11	118.7503:1.4	2x400	height and depth of the melting layer	1.2	10
MWI-12	118.7503:1.2	2x400	Quasi-window, water-vapour profile, precipitation over land, snowfall	1.1	10
MWI-13	165.5:0.75	2x1350	Quasi-window, water-vapour profile, precipitation over land, snowfall	1.2	10
MWI-14	183.31:7.0	2x2000	Water vapour profile and snowfall	1.1	10
MWI-15	183.31:6.1	2x1500	Water vapour profile and snowfall	1.1	10
MWI-16	183.31:4.9	2x1500	Water vapour profile and snowfall	1.1	10
MWI-17	183.31:3.4	2x1500	Water vapour profile and snowfall	1.1	10
MWI-18	183.31:2.0	2x1500	Water vapour profile and snowfall	1.2	10



Cloud Liquid Water Content in mm

## ICI

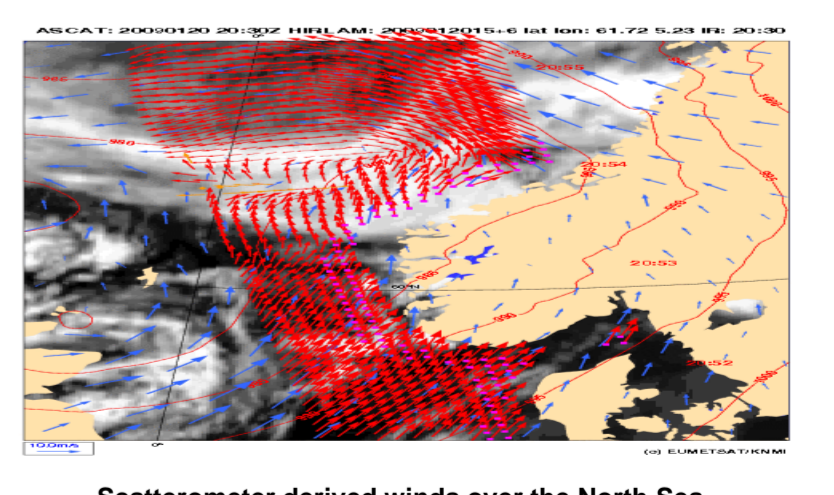
Channel	Frequency (GHz)	Bandwidth (MHz)	Utilisation	NEAT (K)	Footprint Size at 3dB (km)
ICI-1	183.31:7.0	2x2000	Water vapour profile, cloud ice water path	0.7	15
ICI-2	183.31:3.4	2x1500	Water vapour profile, cloud ice water path	0.7	15
ICI-3	183.31:2.0	2x1500	Water vapour profile, cloud ice water path	0.7	15
ICI-4	243.2:2.5	2x3000	Quasi-window, cloud ice water path, cirrus clouds	0.6	15
ICI-5	325.15:9.5	2x3000	Cloud ice effective radius	1.1	15
ICI-6	325.15:3.5	2x2400	Cloud ice effective radius	1.2	15
ICI-7	325.15:1.5	2x1600	Cloud ice effective radius	1.4	15
ICI-8	448:7.2	2x2000	Cloud ice water path and cirrus	1.3	15
ICI-9	448:3.0	2x2000	Cloud ice water path and cirrus	1.5	15
ICI-10	448:1.4	2x1200	Cloud ice water path and cirrus	1.9	15
ICI-11	664:4.2	2x5000	Cirrus clouds, cloud ice water path	1.5	15



Mean Cloud Ice, December, 2004

## SCA

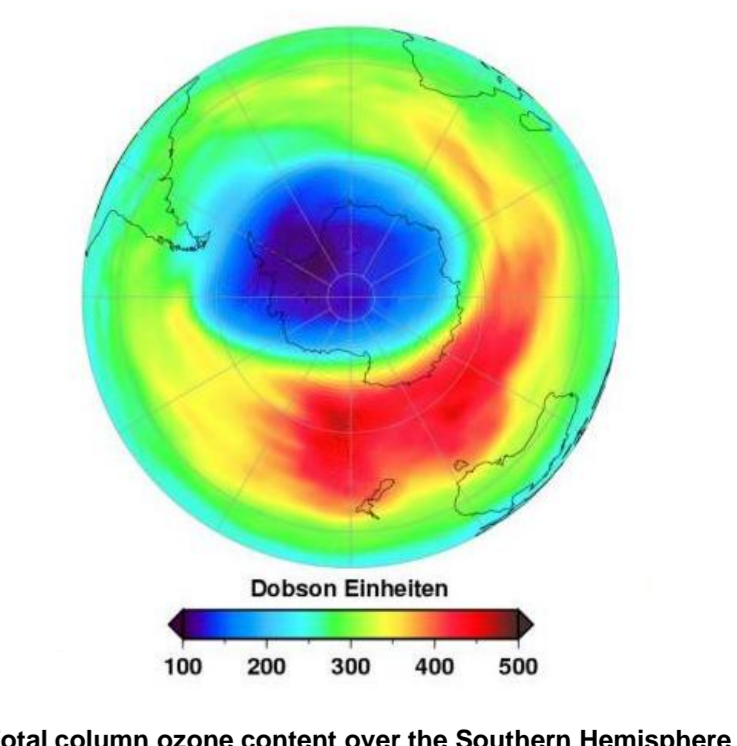
Carrier Frequency	Wind	Radiometric Resolution	Horizontal Resolution	Utilisation
5.3 GHz (C-Band Radar)	4 m/s cross-wind	(0.175 (θ) - 1.375%) for θ > 25°	≤ 25 km	1. Ocean surface wind vector
		3% for θ ≤ 25°		2. Land surface soil moisture
		θ is the incidence angle in degrees at the measurement node		3. Sea-ice type
				4. Sea-ice extent
				5. Snow water equivalent
	25 m/s up-wind	3%	≤ 25 km	6. Snow cover



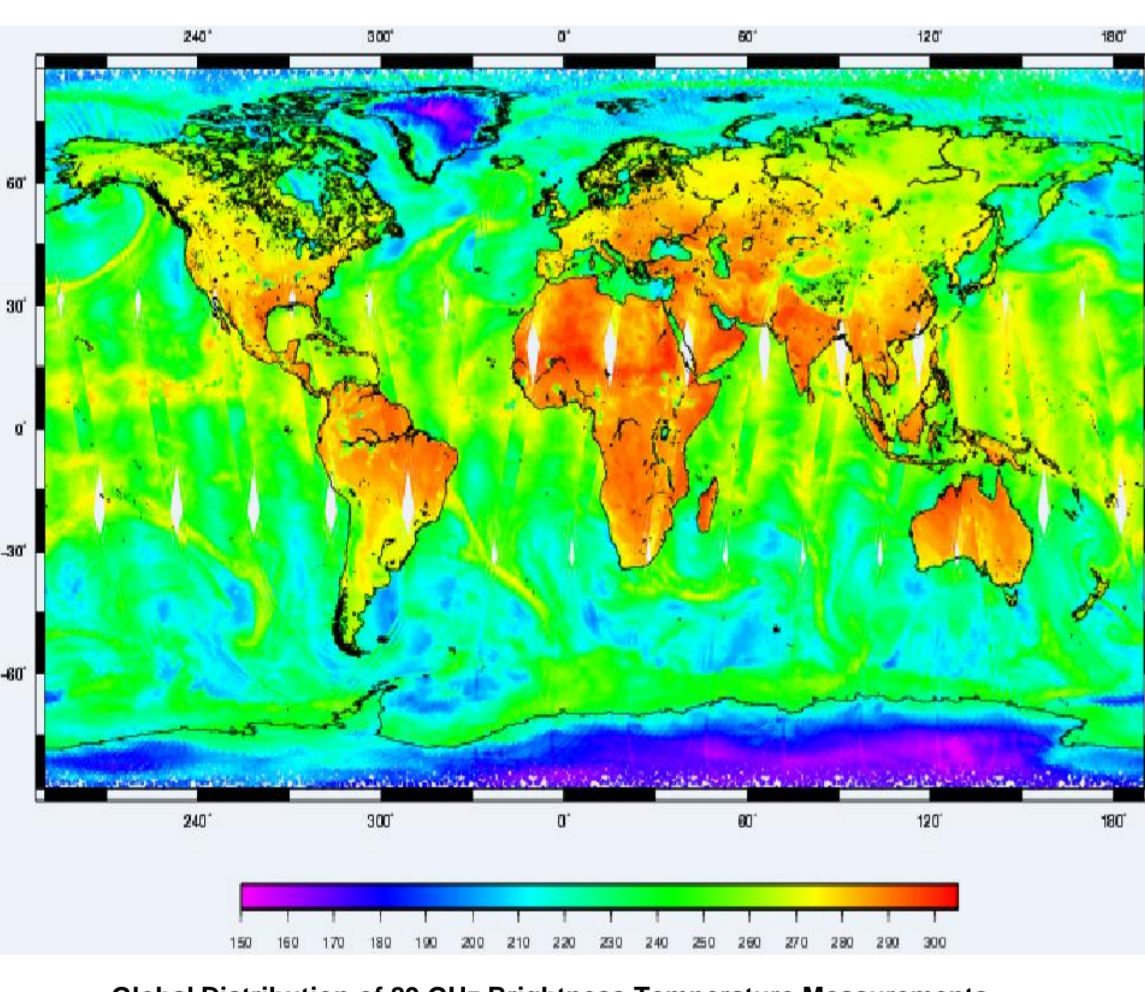
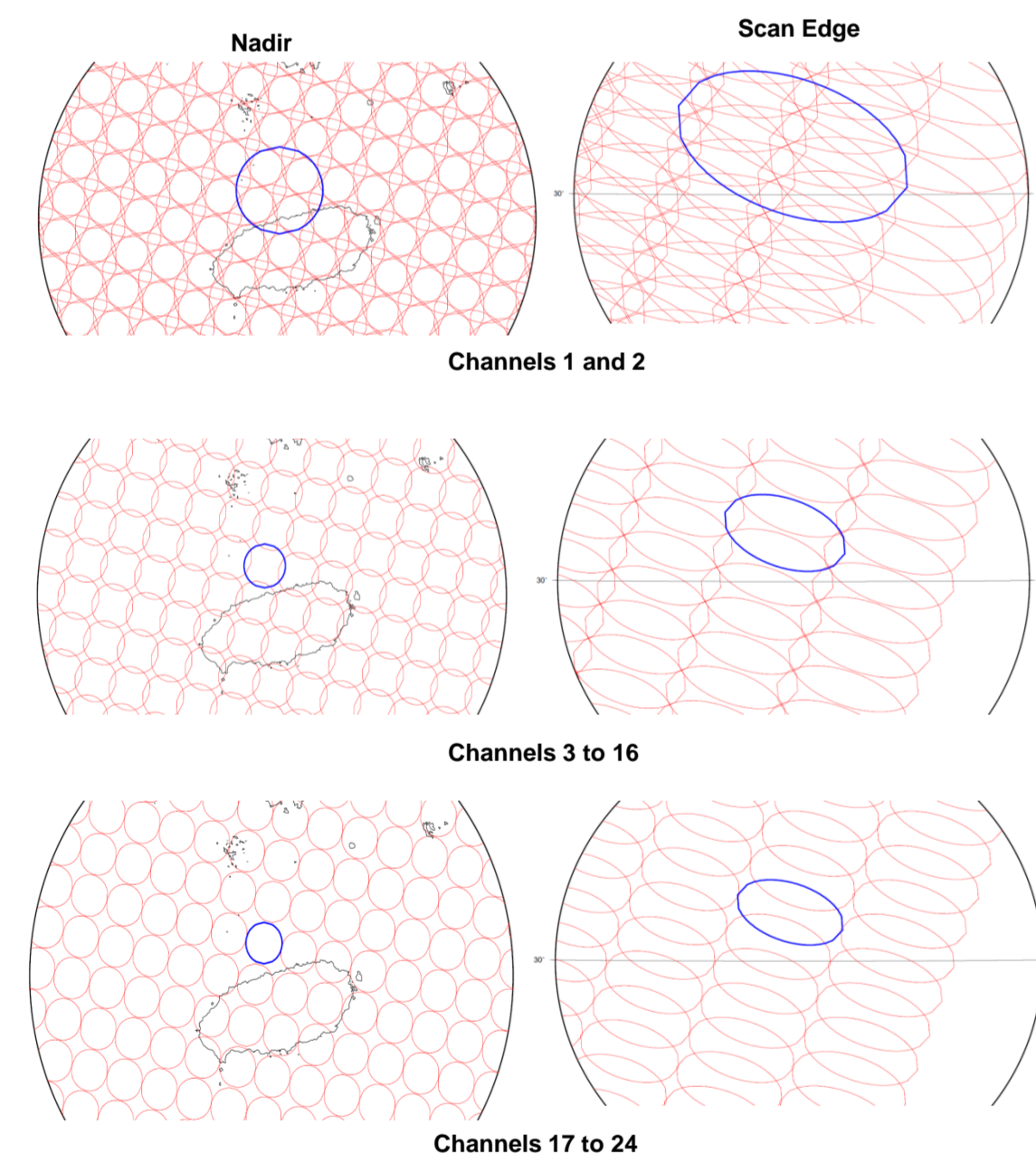
Scatterometer derived winds over the North Sea

## UVNS

Band ID	Full Performance Spectral Range (nm)	SNR Threshold	Utilisation
UV-1	270-300	10000	Priority 1 Products
UV-2	310-370	10000	
VIS	370-500	15000	Ozone profile and total column
NIR-1	710-750	5000	Total columns of sulphur dioxide, nitrogen dioxide, and water vapour
NIR-2	750-775	5000	Aerosol optical depth, potentially height-resolved information
SWIR-1	1590-1675	5000 @ λ <sub>max</sub> T <sub>0.4</sub>	Total column of CO <sub>2</sub>
SWIR-3	2305-2385	5000 @ λ <sub>max</sub> T <sub>0.4</sub>	Total column of CH <sub>4</sub> In combination with the IASI-NG CH <sub>4</sub> and CO in the PBL.
			Priority 2 Products
			Total column of bromine monoxide
			Total column of formaldehyde
			Total column of CO <sub>2</sub> (with column N <sub>2</sub> O as an auxiliary product used for normalisation)



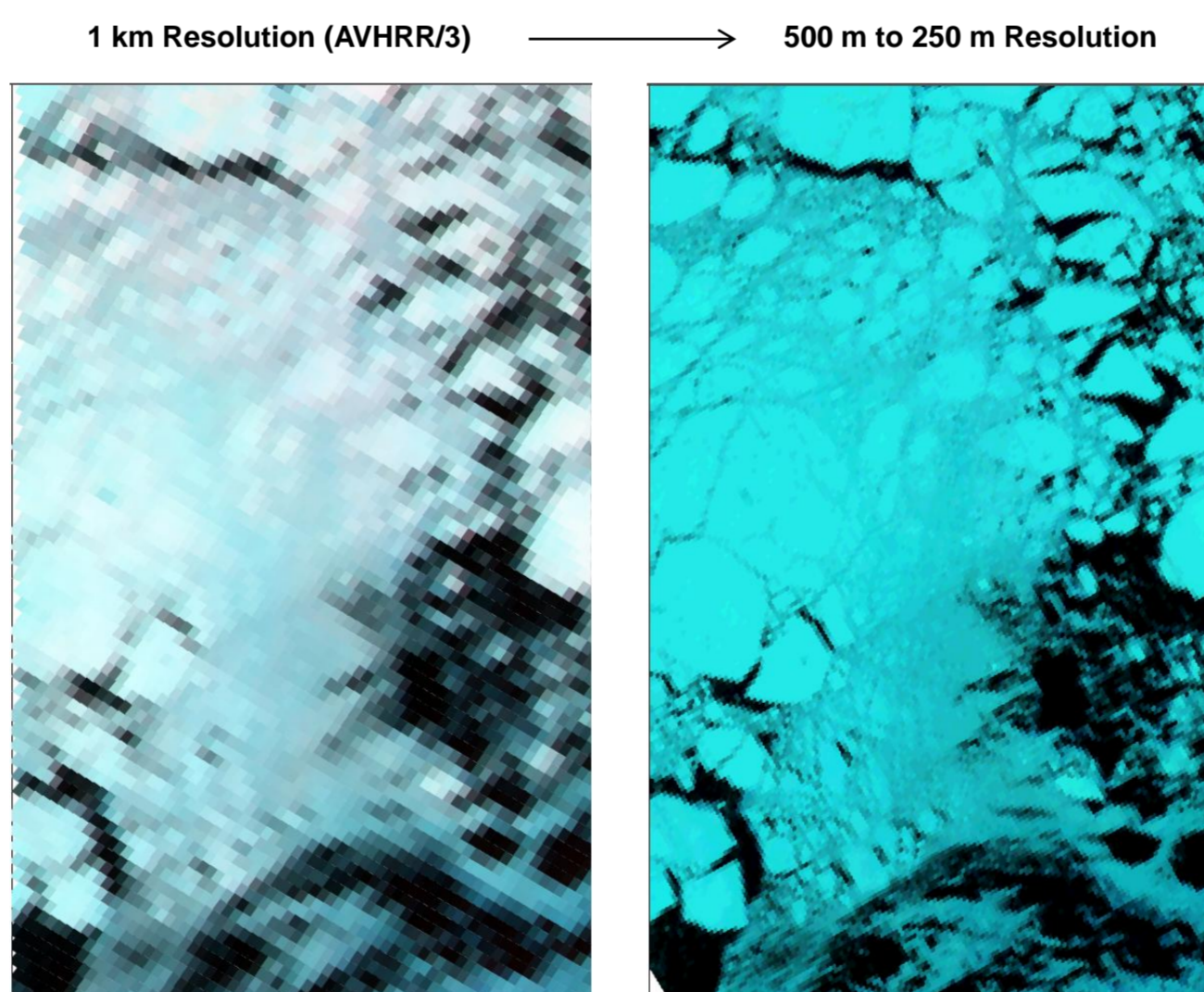
Global Distribution of Cloud Droplet Radius in relation to aerosol properties Kaufman et al. (2002)



Channel	Frequency (GHz)	Bandwidth per Passband (MHz)	Utilisation	NEAT Thres hold (K)	Foot print Size at 3dB (km)
MWS-1	23.8	270	Water-vapour column	0.25	40
MWS-2	31.4	180	Window, water-vapour column	0.35	40
MWS-3	50.3	180	Quasi-window, surface emissivity	0.5	20
MWS-4	52.8	400	Temperature profile	0.35	20
MWS-5	53.246 ± 0.08	2x140	Temperature profile	0.4	20
MWS-6	53.596 ± 0.115	2x170	Temperature profile	0.4	20
MWS-7	53.948 ± 0.081	2x142	Temperature profile	0.4	20
MWS-8	54.40	400	Temperature profile	0.35	20
MWS-9	54.94	400	Temperature profile	0.35	20
MWS-10	55.50	330	Temperature profile	0.4	20
MWS-11	57.290344	330	Temperature profile	0.4	20
MWS-12	57.290344 ± 0.217	2x78	Temperature profile	0.55	20
MWS-13	57.290344 ± 0.3222 ± 0.048	4x36	Temperature profile	0.6	20
MWS-14	57.290344 ± 0.3222 ± 0.022	4x16	Temperature profile	0.9	20
MWS-15	57.290344 ± 0.3222 ± 0.010	4x3	Temperature profile	1.2	20
MWS-16	57.290344 ± 0.3222 ± 0.0045	4x3	Temperature profile	2.0	20
MWS-17	89.0	400	Window	0.25	17
MWS-18	164-167	3000	Quasi-window, water-vapour profile	0.5	17
MWS-19	183.31:7.0	2x2000	Water-vapour profile, precipitation	0.4	17
MWS-20	183.31:4.5	2x2000	Water-vapour profile	0.4	17
MWS-21	183.31:3.0	2x1000	Water-vapour profile	0.6	17
MWS-22	183.31:1.8	2x1000	Water-vapour profile	0.6	17
MWS-23	183.31:1.0	2x500	Water-vapour profile	0.75	17
MWS-24	229	2000	Quasi-window, water-vapour profile	0.70	17

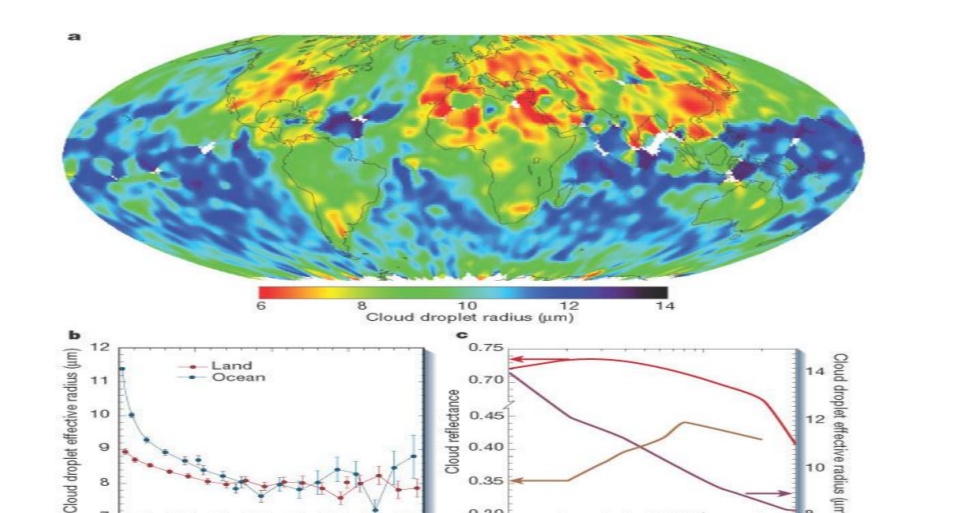
Spectral Band	Wavenumber Range (cm <sup>-1</sup> )	Utilisation	Spectral Resolution Threshold (cm <sup>-1</sup> )	NE.T@280 K Threshold
IAS-1	645 - 770	Temperature profile	0.25	0.3
IAS-2	770 - 1000	Temperature and water-vapour profiles, SST, surfaces and cloud properties	0.25	0.15
IAS-3	1000 - 1070	O <sub>2</sub> column	0.25	0.3
IAS-4	1070 - 1150	Surfaces and cloud properties	0.25	0.35
IAS-5	1150 - 1650	Water vapour profile	0.25	0.15
IAS-6	1650 - 2100	Water vapour profile	0.25	0.6
IAS-8	2160 - 2250	Temperature profile	0.25	0.3
IAS-9	2250 - 2420	Temperature profile	0.25	0.3
IAS-10	2420 - 2700	SST, surfaces and cloud properties	0.25	0.3

Spectral Band	Wavenumber Range (cm <sup>-1</sup> )	Utilisation	Spectral Resolution Threshold (cm <sup>-1</sup> )	NE.T@280K Threshold
IAS-2a	650 - 750	C <sub>2</sub> H <sub>2</sub> , HCN	0.25	0.25
IAS-2b	750 - 850	PHAN	0.25	0.25
IAS-2c	850 - 920	HNO <sub>2</sub>	0.25	0.25
IAS-2d	920 - 980	NH <sub>3</sub> , C <sub>2</sub> H <sub>6</sub>	0.25	0.25
IAS-3a	1030 - 1080	O <sub>2</sub> profile	0.25	0.25
IAS-3b	980 - 1080	CH <sub>3</sub> OH	0.25	0.25
IAS-4a	1080 - 1130	HCOOH	0.25	0.25
IAS-4b	1120 - 1160	Volcanic SO <sub>2</sub>	0.25	0.25
IAS-4c	1130 - 1200	PHAN, NH <sub>3</sub>	0.25	0.25
IAS-5a	1200 - 1360	Temperature profile, and N <sub>2</sub> O, CH <sub>4</sub> columns	0.25	0.25
IAS-5b	1340 - 1400	Volcanic SO <sub>2</sub>	0.25	0.25
IAS-7a	2140 - 2180	CO profile	0.25	0.25
IAS-11	2700 - 2760	CH <sub>4</sub> column	0.25	0.3



## 3MI

Channel	Central Wavelength (µm)	FWHM (µm)	Utilisation	SNR
3MI-2b	0.410 (T)	0.02	Absorbing aerosol	200
3MI-3	0.443	0.02	Aerosol absorption and height indicators	200
3MI-4	0.490	0.02	Aerosol, surface albedo, cloud reflectance, cloud optical depth	200
3MI-5	0.555	0.02	Surface albedo	200
3MI-6	0.670	0.02	Aerosol properties	200
3MI-7	0.763	0.01	Cloud and aerosol height	200
3MI-8	0.765 (T) / 0.754 (B)	0.04 (T) / 0.0075 (B)	Cloud and aerosol height	200
3MI-9	0.865	0.04	Vegetation, aerosol, clouds, surface features	200
3MI-9a	0.910	0.02	Water vapour, atmospheric correction	200
3MI-10	1.370	0.04	Cirrus clouds, water vapour imagery	200
3MI-11	1.650	0.04	Ground characterization for aerosol inversion	200
3MI-12	2.130	0.04	Cloud microphysics at cloud top, Vegetation, fire (effects) Ground characterization for aerosol inversion	200



Global Distribution of Cloud Droplet Radius in relation to aerosol properties Kaufman et al. (2002)