Distribution of data from meteorological satellites (MetSat)

Jose Arimatea de Sousa Brito
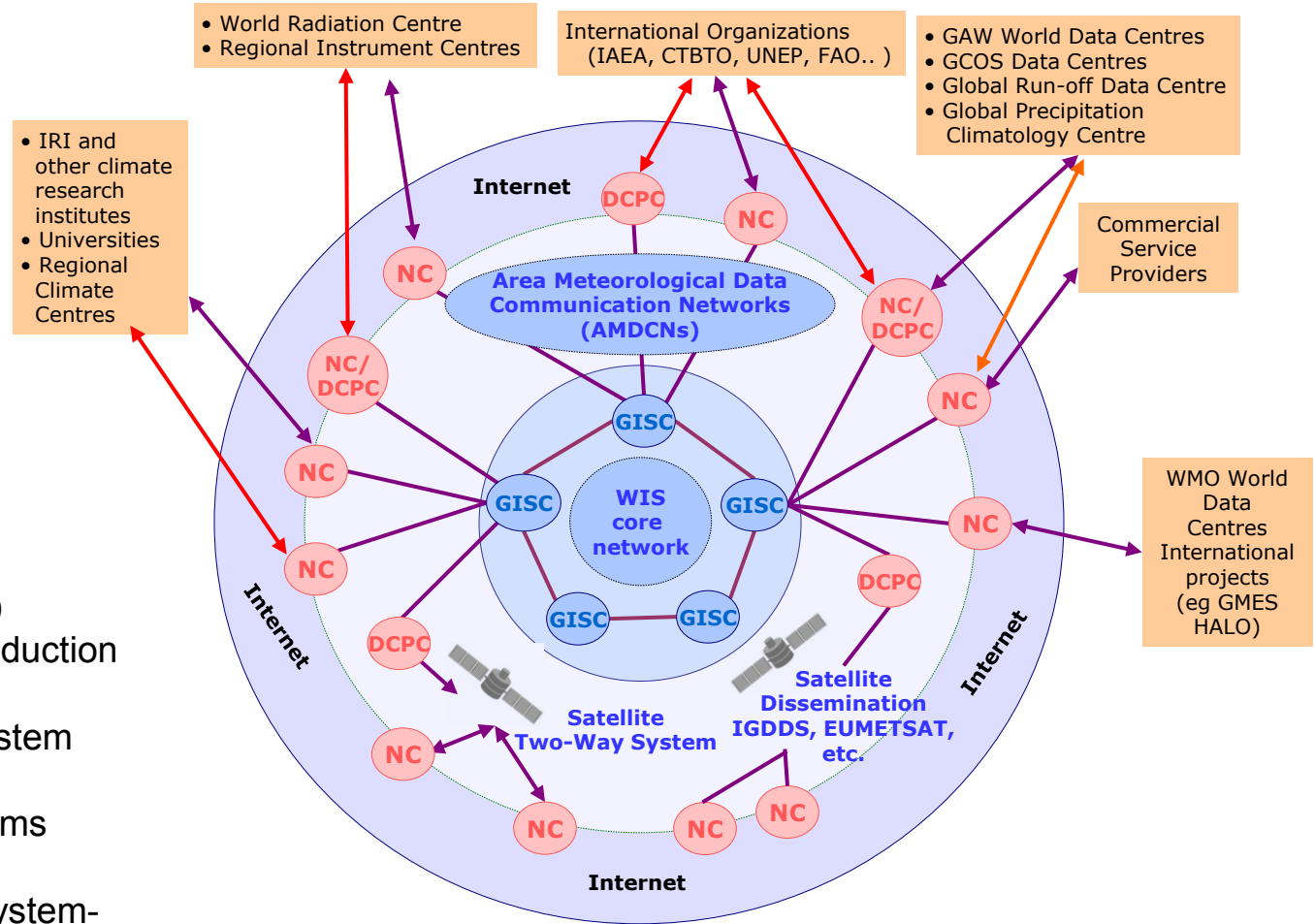**Chair - WMO Steering Group on Radio-frequency Coordination**

Overview

- WMO Information System (WIS)
  - Integrated Global Data Distribution System (IGDDS)
  - Regional ATOVS Retransmission Services (RARS)
- GSO MetSat data dissemination
- NGSO MetSat data dissemination
- Summary of frequencies used

WMO Information System (WIS)

- World Radiation Centre
- Regional Instrument Centres

International Organizations (IAEA, CTBTO, UNEP, FAO..)

- GAW World Data Centres
- GCOS Data Centres
- Global Run-off Data Centre
- Global Precipitation Climatology Centre

- IRI and other climate research institutes
- Universities
- Regional Climate Centres

Commercial Service Providers

WMO World Data Centres International projects (eg GMES HALO)

Internet

Area Meteorological Data Communication Networks (AMDCNs)

WIS core network

DCPC · NC · NC/DCPC · NC · NC · NC · DCPC · GISC · GISC · GISC · GISC · GISC · NC · NC · NC · NC · DCPC · NC/DCPC · NC

Satellite Two-Way System

Satellite Dissemination IGDDS, EUMETSAT, etc.

Internet

WIS Components
- National Centres (NC)
- Data Collection or Production Centres (DCPC)
- Global Information System Centres (GISC)
- Communication Systems (Including Global Telecommunication System-GTS)

WMO Integrated Global Data Distribution System (IGDDS)

Integrated Global Data Distribution System (IGDDS)

- IGDDS addresses different functions of the data circulation scheme:
  - User requirements review mechanism in every region
  - Data concentration (e.g. RARS project for timely availability of sounder data from polar-orbiting satellites) and inter-regional data exchange
  - Data dissemination (via telecom satellite broadcast, via Direct Broadcast, via Internet or via the GTS point-to-point network)
  - Data access on request, allowing data discovery and delivery to authorized users
  - Data and user management including interoperable catalogue, quality of service monitoring and user support.
- Includes: EUMETCAST, CMACast, MITRA, NOAAPORT…

RARS – Supporting Weather Forecast and Warning Services

Regional **A**TOVS **R**etransmission **S**ervices (RARS) are operational arrangements for the real-time acquisition of polar-orbiting satellite data over a wide region containing a network of direct readout stations and their rapid delivery to the global user community through regional Processing Centres.

Top level objective of the RARS project:

To deliver ATOVS (Advanced TIROS Operational Vertical Sounder) data (Level 1c) from at least 90% of the globe within no more than 30 minutes from acquisition.
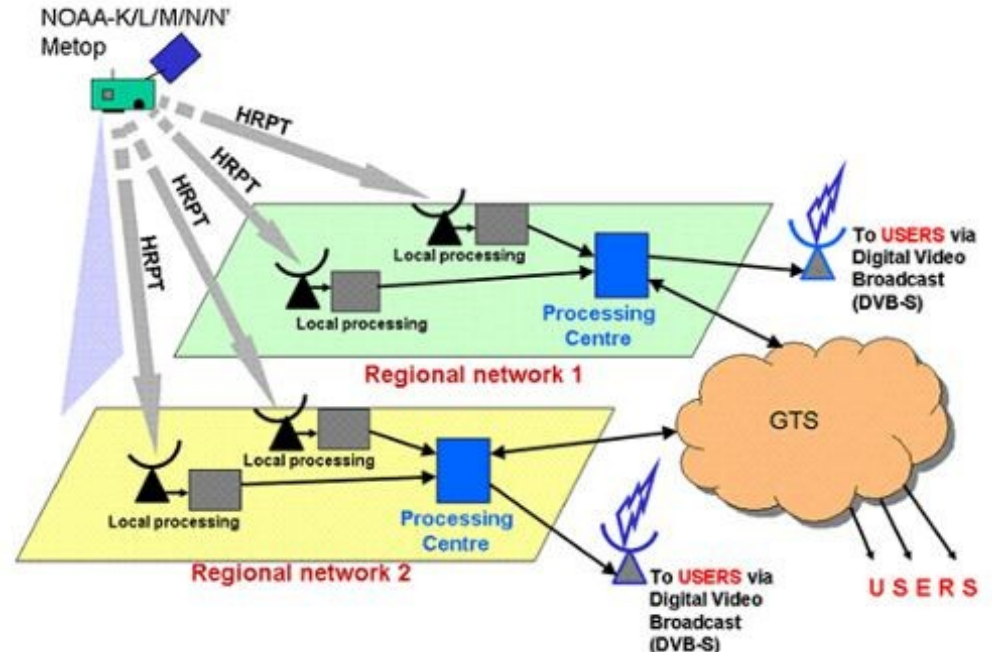
GSO MetSat Dissemination (1)

- **Dissemination of processed observation data to meteorological users:**

- HRI (High Resolution Image) on the remaining first generation Meteosat satellites (Meteosat-7),

- S-VISSR (GSO Stretched Visible Infrared Spin Scan Radiometer) on the current series of Feng-Yun-2 (FY-2) satellites,

- GVAR (Geostationary Operational Environmental Satellites (GOES) Variable) on current series of GOES satellites,

- WEFAX (Weather Facsimile) on first generation Meteosat and FY-2 satellites,

- LRIT (Low Rate Information Transmission) on current GOES, Meteosat Second Generation (MSG), MTSAT, GOMS-M, FY-2 and COMS satellites,

- HRIT (High Rate Information Transmission) on MTSAT, GOMS-M and COMS,

- GEONETCast (EUMETCast, FengYunCast and GEONETCast Americas).

GSO MetSat Dissemination (2)

- **High Resolution Image (HRI)**

- Operates on the first generation Meteosat spacecraft

- Data rate of 166.7 kbit/s using PCM/PM/SPL modulation

- Unique to Meteosat with coverage zone identical to the Meteosat telecommunications area (GSO positioned at 57.5E)

- High-resolution images including calibration and navigation information

- Primary users are national meteorological centres, universities, private forecasters, and television

GSO MetSat Dissemination (3)

- **GSO Stretched Visible Infrared Spin Scan Radiometer (S-VISSR)**

- Operated by the satellites FY-2 satellite series of the Chinese GSO MetSat system Feng-Yun-2

- Data are pre-processed in near real-time and retransmitted via the same satellite at 1687.5 MHz with 6.0 MHz bandwidth

- Data received by S-VISSR Earth stations also called medium-scale data utilization stations (MDUSs)

- Main users are meteorological services and universities

GSO MetSat Dissemination (4)

WMO OMM

- **Geostationary Operational Environmental Satellites (GOES) Variable (GVAR)**

- NOAA GOES satellites transmit processed measurement data known as GVAR to several hundred receiving stations within the combined GOES footprint from spacecraft located at 75° W and 135° W

- Images and sounder data with added calibration and navigation information as well as telemetry, text messages, and various auxiliary products

- Universities and government agencies involved with meteorological research or forecasting; value-added providers for weather forecasts to commercial interests

- Data stream transmitted at 1 685.7 MHz with a bandwidth near 5 MHz

GSO MetSat Dissemination (5)

- **Weather Facsimile (WEFAX)**

- Service consists of analogue transmissions to low-cost meteorological user stations within the reception area of meteorological satellites

- Service parameters were defined and agreed to by the Co-ordination Group for Meteorological Satellites (CGMS)

- Services are operated by Meteosat-7 and the FY-2 satellite series

GSO MetSat Dissemination (6)

- ## **Weather Facsimile (WEFAX), cont'd.**

  - WEFAX reception stations are still essential equipment for the operation of some smaller and mid-sized meteorological services and are also used by universities, environmental agencies, press agencies and schools.

  - Reception stations are also known as secondary data user stations (SDUS) (Meteosat) or LR-FAX Stations (FY-2)

  - Transmitted in the sub-band 1 690-1 698 MHz, with most using centre frequency of 1 691 MHz and a bandwidth between 0.03 MHz and 0.26 MHz

  - Is being replaced by digital low rate information transmission (LRIT)

GSO MetSat Dissemination (7)

WMO OMM

- **Low Rate Information Transmission (LRIT)**

- LRIT service began in 2003 on GOES MetSats and in 2004 on Meteosat Second Generation (MSG) for transmission to low-cost user stations, replacing WEFAX service

- LRIT data usually transmitted with centre frequencies around 1 691 MHz, using up to 600 kHz bandwidth

- User station antennas have diameters between 1.0 m and 1.8 m, with a minimum elevation angle of 3°.

- LRIT is also operated on MTSAT, FY-2 satellites and the Korean multi-purpose geostationary satellite system called Communication, Ocean and Meteorological Satellite (COMS).

GSO MetSat Dissemination (8)

- **High Rate Information Transmission (HRIT)**

- HRIT was first introduced in January 2004 with the operation of the first MSG satellite (Meteosat-8), but later replaced by EUMETCast.

- HRIT service is operated in the sub-bands 1 684-1 690 MHz or 1 690-1 698 MHz.

- High Antenna size for high rate user station (HRUS), MDUS is 4 m and the minimum elevation angle is 3°.

- HRIT is also operated on the Korean multi-purpose geostationary satellite system called Communication, Ocean and Meteorological Satellite (COMS).

GSO MetSat Dissemination (9)

WMO OMM

- ## **GEONETCast**

- Group on Earth Observations (GEO) initiative

- GEONETCast is a global network of satellite-based data dissemination systems providing environmental data to a world-wide user community,

- Based on standard Digital Video Broadcast (DVB) technology, using commercial telecommunication GSO satellites and MetSat satellites.

- GSO MetSat imagery data of Meteosat first and second generation, GOES, FY-2 and MTSAT and many other forecast data and meteorological products (including data from NGSO satellites) are already distributed via GEONETCast to several thousand users.

GSO MetSat Dissemination (10)

- ## **Future GSO Data Dissemination:**

  - Next-generation NOAA GSO MetSat GOES-R (circa 2015) will provide a new data stream to replace the current generation GVAR called GRB (GOES ReBroadcast).

  - Next Generation EUMETSAT GSO MetSat Meteosat Third Generation (MTG) (circa 2016/17) data dissemination will be performed through EUMETCast/GEONETCast.

  - China will maintain broadcast dissemination services (HRIT & LRIT) and Data Collection Systems. Feng-Yun-4 is scheduled for 2015

NGSO MetSat Dissemination (1)

- **Direct dissemination of observation data to meteorological user stations:**

- APT (Automatic Picture Transmission) on current series of Polar Orbiting Environmental Satellites (POES) satellites,

- LRPT (Low Resolution Picture Transmission) on future Meteor M satellites,

- HRPT (High Resolution Picture Transmission) on current POES and FY1-D satellites and future Meteor M satellites,

- AHRPT (Advanced High Resolution Picture Transmission) on series of FY-3 and Metop satellites,

- MPT (Medium-resolution Picture Transmission) on series of FY-3 satellites,

- DPT (Delayed Picture Transmission) on FY-1D and series of FY-3 satellites,

- HRD (High Rate Data) on Suomi-NPP and later on JPSS and EPS-SG,

- GEONETCast with its components EUMETCast, FengYunCast and GEONETCast Americas.
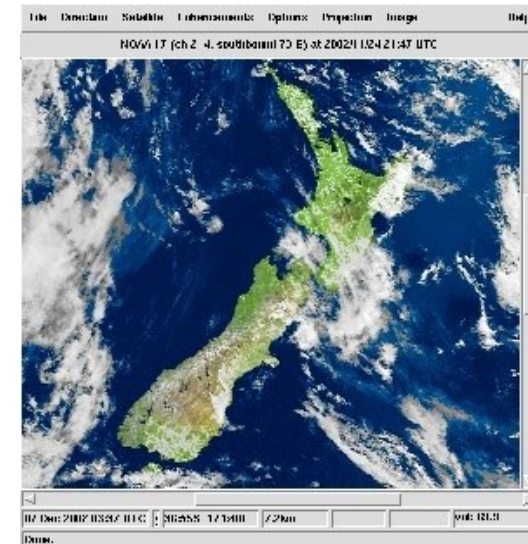
NGSO MetSat Dissemination (2)

- **Automatic Picture Transmission (APT)**

- APT service was introduced on some spacecraft in the 1960s becoming the most successful direct data dissemination system in the meteorological community.

- Thousands of very low cost APT receiving stations are still in operation worldwide.

- User stations are operated not only by meteorological services and universities but also by a large community of non-meteorological users.

- APT transmissions from POES satellites are based on an analogue modulation scheme.

NGSO MetSat Dissemination (3)

- **Automatic Picture Transmission (APT), cont'd.**

- Transmissions occur in four sub-bands of the 137-138 MHz band, with typical bandwidths of 30-50 kHz, but may be up to 175 kHz.

- Since 2005 APT transmissions are restricted to two sub-bands: 137.025-137.175 and 137.825-138 MHz.

- APT stations typically consist of omnidirectional antennas and commercial-off-the-shelf (COTS) VHF receivers.

- Low-cost image processing systems are attached to this front-end, with low-priced software running on commonly available desktop computers.

NGSO MetSat Dissemination (4)

- **Low Resolution Picture Transmission (LRPT)**

- The LRPT service is replacing the APT application on most non-GSO MetSat systems, using the same frequencies as APT (137.025-137.175 and 137.825-138 MHz).

- LRPT is based on digital transmission schemes and makes use of the same frequency bands as those currently used for APT.

- The bandwidth is up to 175 kHz.

NGSO MetSat Dissemination (5)

- **High Resolution Picture Transmission (HRPT)**

- HRPT service operated on POES and and FY-1 satellites provides high-resolution imagery to the meteorological community

- HRPT transmitters are turned on continuously and can be received by any user station

- Hundreds of HRPT receiving stations worldwide are registered with the WMO

- HRPT data are essential to operations of meteorological services and are widely useful in other endeavors as well

- HRPT transmissions use 1 698-1 710 MHz with bandwidths between 2.7 MHz and 4.5 MHz

NGSO MetSat Dissemination (5)

- **High Resolution Picture Transmission (HRPT)**

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- **Advanced High Resolution Picture Transmission (AHRPT)**

- AHRPT application is an enhancement of the HRPT service intended to replace HRPT on future meteorological satellites

- AHRPT transmissions are introduced in the same band as used by HRPT systems,

- AHRPT on the series of FY-3 satellites is disseminated at 1704.5 MHz with a bandwidth of 6.8 MHz at a data rate of 4.2 Mbps or on Metop at 1701 MHz with a bandwidth of 4.5 MHz at a data rate of 4.66 Mbps .

- **Medium-resolution Transmission (MPT):**

- MPT in the framework of the series of FY-3 satellites is disseminated at 7775 MHz with 45 MHz bandwidth at a data rate of 18.7 Mbps.

- **Delayed Picture Transmission (DPT):**

- MVISR imagery data from FY-1D are disseminated at 1708.5 MHz with 3 MHz bandwidth at a data rate of 1.33Mbps.

- DPT in the framework of the series of FY-3 satellites is disseminated at 8146 MHz with 149 MHz bandwidth at a data rate of 93 Mbps.

NGSO MetSat Dissemination (9)

WMO OMM

- **High Rate Data (HRD) Transmission:**
  - Since 2011 the Suomi NPP satellite (Suomi National Polar-orbiting Partnership) satellite provides a High Rate Data (HRD) service operated 7812 MHz using a bandwidth of 30 MHz.
  - In 2017 JPSS (Joint Polar Satellite System) will also implement a High Rate Data (HRD) service operated 7812 MHz using a bandwidth of 32 MHz.
  - The second generation of the European Polar System (EPS-SG) (circa 2018) will also provide a high rate data transmission service.

Summary

- WMO encourages integrated data dissemination DVB-S standard or DVD-S2.

- Operate in Ku-Band (around 12-15 GHz), X-Band (7-8GHz), C-Band (around 4 GHz), or L-Band (1.6-1.7GHz)
  - the C-Band being preferred at low latitudes because it is less disturbed than the Ku-Band by atmospheric liquid water
  - Increasingly higher resolution data favour Ku or X band, but L band used extensively for higher reliability and broader coverage, albeit at lower resolutions.

- Data volumes and demand for current data favour direct readout data systems, supported by terrestrial or other networks (eg: IGDDS & RARS)

- MetSat and Commercial telcon sats are used to rebroadcast processed data

- Forecast and warning systems rely on access to real-time satellite data

MetSat Frequencies Regions I, II & III

Click on the band range in the left column of the table to call up the allocation table for that band. Primary allocations are in UPPER CASE, secondary allocations are in Sentence case.

Frequency Band	Allocation (PRIMARY or Secondary)
137 - 137.025 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
137.025 - 137.175 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
137.175 - 137.825 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
137.825 - 138 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
400.15 - 401 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
401 - 402 MHz	METEOROLOGICAL-SATELLITE (Earth-to-space)
402 - 403 MHz	METEOROLOGICAL-SATELLITE (Earth-to-space)
460 - 470 MHz	Meteorological-satellite (space-to-Earth)
1670 - 1675 MHz	METEOROLOGICAL-SATELLITE (Earth-to-space)
1675 - 1690 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
1690 - 1700 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
1700 - 1710 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
7450 - 7550 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
7750 - 7850 MHz	METEOROLOGICAL-SATELLITE (space-to-Earth)
8175 - 8215 MHz	METEOROLOGICAL-SATELLITE (Earth-to-space)

Total number of bands: 15   Total Bandwidth: 293.85 MHz