Guidelines on user readiness for new satellite systems, adopted by CBS in Sept 2012 (Summary)

NEW

- Information/training of prospective users
  - User conferences and workshops on new capabilities
  - Portals providing instrument specifications, data formats
  - Proxy data sets, tools and demonstration products
  - Guidance on receiving hardware/software
  - Training material and training events
- System operation
  - Some overlap period of old/new satellites
  - Some overlap of old/new dissemination systems
  - Satellite-independent dissemination system *(e.g. GEONETCast)*
- User organizations
  - Set up a user readiness project (e.g.~5 years) prior to launch
  - Networking through online collaboration

http://www.wmo.int/pages/prog/sat/documents/SAT-GEN_CBS-15-GuidelineUserReadiness.pdf

Observing System Capabilities Analysis and Review Tool (OSCAR)

Jérôme Lafeuille and Nils Hettich
WMO Space Programme, Geneva

Acknowledgements

- *Nils Hettich, developer of OSCAR*
- *All satellite operators who provided updates entered in OSCAR*

- *Dr B. Bizzarri for compiling this information*
- *Members of ET-EGOS, ET-SAT, ICTSW, IPWG, IROWG, Met Office… for their review and feedback*

Outline

- **Purpose and overall concept**
- **OSCAR as directory of satellite capabilities**
- **OSCAR as analysis and review tool**
- **Benefits and limitations**

Evolution of WMO observing systems
Rolling Review of Requirements (RRR)

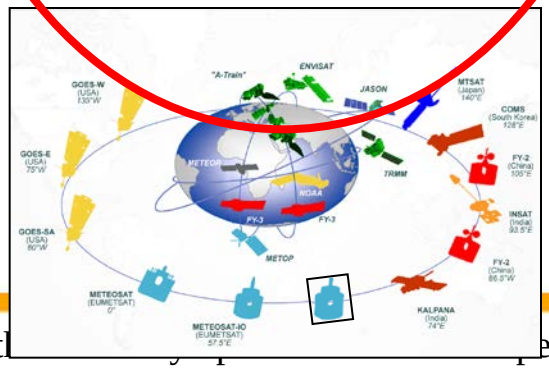
Requirements
Requirements
Requirements

Long-term vision

Gap Analysis

Recommendations
Implementation Plan

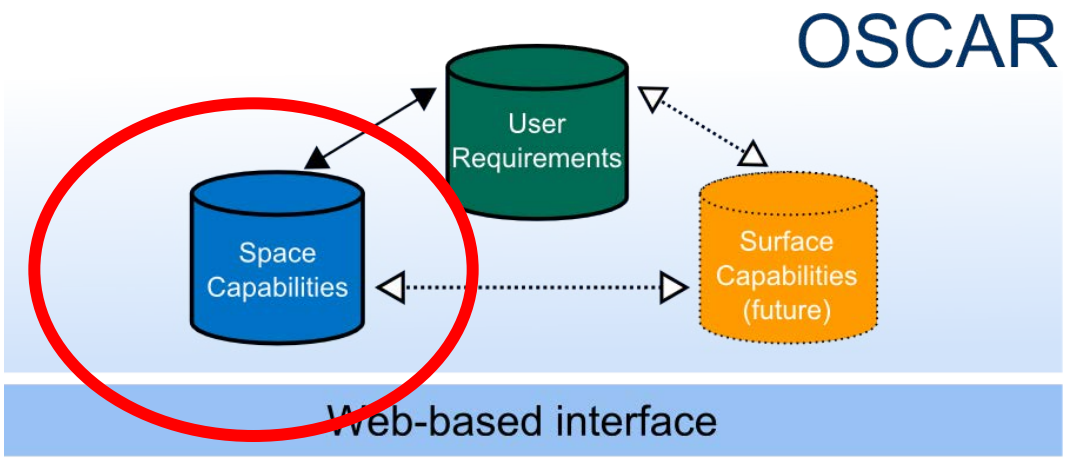
Observing capabilities
(space & surface)



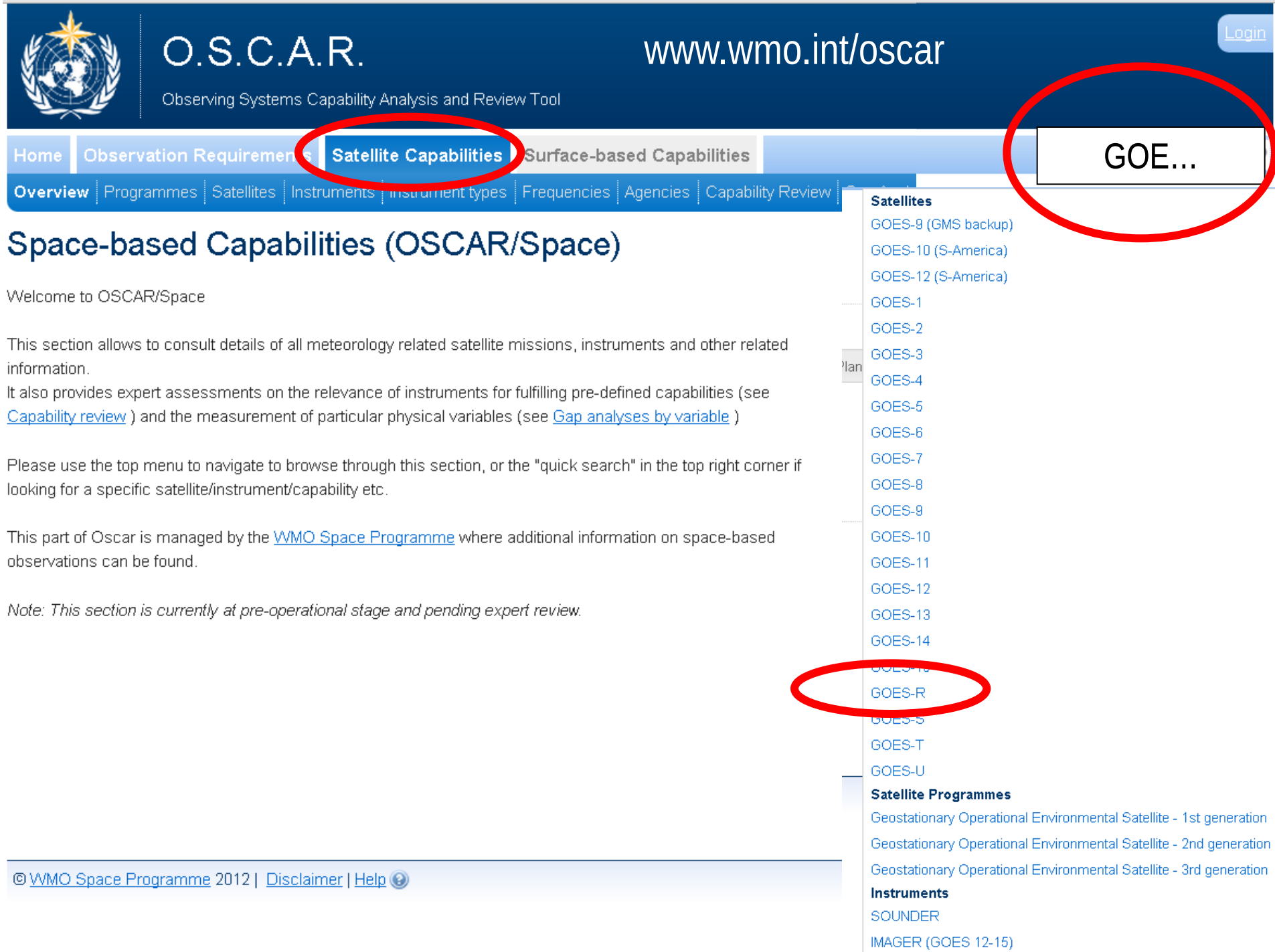
Members' programmes
(including space agencies)

OSCAR concept

www.wmo.int/oscar



- Technical details on 500+ EO satellites, 700+ instruments, programmes and space agencies
- Expert assessments
  - Comparison of planned capabilities with WMO plans
  - Relevance of instruments for measuring particular variables


O.S.C.A.R.
Observing Systems Capability Analysis and Review Tool
www.wmo.int/oscar
Login
Home
Observation Requirements
Satellite Capabilities
Surface-based Capabilities
GOE...
Overview
Programmes
Satellites
Instruments
Instrument types
Frequencies
Agencies
Capability Review
Space-based Capabilities (OSCAR/Space)
Welcome to OSCAR/Space
This section allows to consult details of all meteorology related satellite missions, instruments and other related information.
It also provides expert assessments on the relevance of instruments for fulfilling pre-defined capabilities (see Capability review) and the measurement of particular physical variables (see Gap analyses by variable)
Please use the top menu to navigate to browse through this section, or the "quick search" in the top right corner if looking for a specific satellite/instrument/capability etc.
This part of Oscar is managed by the WMO Space Programme where additional information on space-based observations can be found.
Note: This section is currently at pre-operational stage and pending expert review.
Satellites
GOES-9 (GMS backup)
GOES-10 (S-America)
GOES-12 (S-America)
GOES-1
GOES-2
GOES-3
GOES-4
GOES-5
GOES-6
GOES-7
GOES-8
GOES-9
GOES-10
GOES-11
GOES-12
GOES-13
GOES-14
GOES-R
GOES-T
GOES-U
Satellite Programmes
Geostationary Operational Environmental Satellite - 1st generation
Geostationary Operational Environmental Satellite - 2nd generation
Geostationary Operational Environmental Satellite - 3rd generation
Instruments
SOUNDER
IMAGER (GOES 12-15)
© WMO Space Programme 2012 | Disclaimer | Help

Satellite view

Satellite: GOES-R

Satellite details

Acronym	GOES-R		
Full name	Geostationary Operational Environmental Satellite - R		
Satellite Description	• 1st flight unit of the GOES 3rd generation programme. • Mission: operational meteorology. • Substantial contribution to space weather.		
Mass at launch	5500 kg	**Dry mass**	2800 kg
Power	4000 W		
Orbit	Geostationary orbit	**Altitude**	35786 km
Longitude	137° W		

Space agency	NOAA , NASA		
Status	Planned		
Details on Status (as available)	Longitude (137 W or 75 W) to be confirmed in due time		
Launch	≥2015	**EOL**	≥2026
Last update:	2013-01-02		

Associated satellite programme and related satellites

Note: red tag => no longer operational , green tag => operational , blue tag => future

- Geostationary Operational Environmental Satellite - 3rd generation
  - **GOES-R** (2015 - 2026)
  - GOES-S (2017 - 2028)
  - GOES-T (2019 - 2030)
  - GOES-U (2024 - 2035)

Satellite Payload

All known Instruments flying on GOES-R

Acronym	Full name
ABI	Advanced Baseline Imager
EXIS	Extreme Ultraviolet Sensor / X-Ray Sensor Irradiance Sensors
GEOS&R	Geostationary Search and Rescue
GLM	Geostationary Lightning Mapper
MAG	Magnetometer
SEISS	Space Environment In-Situ Suite
SUVI	Solar Ultraviolet Imager
DCIS	Data Collection and Interrogation Service
MPS	Magnetospheric Particle Sensor
EHIS	Energetic Heavy Ion Sensor
SGPS	Solar and Galactic Proton Sensor

Satellite Field of View

Estimate of the satellite's footprint, assuming a zenith angle of 75 °
You can drag the image around and zoom using the mousewheel

Instrument view (1)

Instrument: ABI

Instrument details

Acronym	ABI				
Full name	Advanced Baseline Imager				
Type of Instrument	01. Moderate-resolution optical imager				
Purpose	Multi-purpose VIS/IR imagery and wind derivation by tracking clouds and water vapour features				
Short description	16 channels, balanced VIS, NIR, SWIR, MWIR and TIR [see detailed characteristics below]				
Background	Replacing IMAGER flown on GOES 8 to 15				
Scanning Technique	Mechanical, 3-axis stabilised satellite, E-W continuous, S-N stepping				
Resolution	Changing with channel (see table)				
Coverage / Cycle	Full disk every 15 min, 3000 x 5000 km2 ("CONUS", Continental U.S.) in 5 min, 1000 x 1000 km2 in 30 s				
Mass	338 kg	**Power**	450 W	**Data Rate**	66 Mbps

Providing Agency	NOAA
Utilization Period:	2015-2035
Last update:	2012-09-05

Detailed characteristics

Central wavelength	Bandwidth	SNR or NEΔT @ specified inpu
470 nm	40 nm	300 @ 100 % albedo
640 nm	100 nm	300 @ 100 % albedo
860 nm	40 nm	300 @ 100 % albedo
1380 nm	30 nm	300 @ 100 % albedo
1610 nm	60 nm	300 @ 100 % albedo
2260 nm	50 nm	300 @ 100 % albedo
3.90 µm	0.20 µm	0.1 K @ 300 K
6.15 µm	0.90 µm	0.1 K @ 300 K
7.00 µm	0.40 µm	0.1 K @ 300 K
7.40 µm	0.20 µm	0.1 K @ 300 K
8.50 µm	0.40 µm	0.1 K @ 300 K
9.70 µm	0.20 µm	0.1 K @ 300 K
10.3 µm	0.50 µm	0.1 K @ 300 K
11.2 µm	0.80 µm	0.1 K @ 300 K
12.3 µm	1.00 µm	0.1 K @ 300 K
13.3 µm	0.60 µm	0.3 K @ 300 K

From instruments to variables

- **Which variables can be derived from a given instrument ?**

- **Which instruments can measure a given variable ?**

➢ OSCAR provides first-level, expert-reviewed assessments based on instrument design features

Instrument view (2)

Instrument: GrIS

Instrumen

Acronym
Full name
Type of Instrument
Purpose
Short description
Background
Scanning Technique
Resolution
Coverage / (
Mass
Providing Ag
Utilization P
Last update

Detailed (

Spectral range (µm)
9.13 - 5.40 µm
5.71 - 8.26 µm
3.92 - 4.6 µm

Tentative Evaluation of Measurements

The following list indicates which measurements can **typically** be retrieved from this category of instrument. To see a full Gap Analysis by Variable, click on the respective variable.

Note: table can be sorted by clicking on the column headers.

Variable	Relevance for measuring this Variable	Operational Limitations	Processing maturity
Specific humidity	1-Primary	Clouds	Consolidated methodology
Atmospheric temperature	1-Primary	Clouds	Consolidated methodology
Temperature of the tropopause	2-High	Coarse accuracy. Clouds	Consolidated methodology
Upward spectral radiance at TOA	2-High	Spectral range limited on FIR side	Consolidated methodology
Long-wave Earth surface emissivity	2-High	Coarse resolution. Clouds	Consolidated methodology
Upward long-wave irradiance at TOA	3-Medium	Highly indirect. Clouds	Consolidated methodology
Sea surface	3-Medium	Coarse resolution.	Consolidated

Variable view

Measurement Timeline for *Atmospheric temperature*

Definition: 3D field of the atmospheric temperature

Filter by Satellite or Instrument

Instrument	Relevance	Satellite	Orbit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
MWTS-2	1-Primary	FY-3RM-1							X	X	X	X	X											
MWTS-2	1-Primary	FY-3RM-2											X	X	X	X								
Radiomet	3-Medium	Meteor-M N3							X	X	X	X	X	X										
SOUNDER	3-Medium	GOES-15	135°W	X	X	X	X	X	X	X	X	X	X	X										
SOUNDER	3-Medium	GOES-14	75°W	X	X	X	X	X	X	X														
SOUNDER	3-Medium	GOES-12 (S-America)	60°W	X	X	X																		
HIS	1-Primary	Electro-M N2	14.5°W								X	X	X	X	X	X	X	X						
IRS	1-Primary	MTG-S1	0°											X	X	X	X	X	X	X	X	X		
IRS	1-Primary	MTG-S2	0°																			X	X	X
SOUNDER (INSAT-3D)	3-Medium	INSAT-3D-prime	74°E					X	X	X	X	X	X	X	X									
HIS	1-Primary	Electro-M N1	76°E							X	X	X	X	X	X	X	X							
SOUNDER (INSAT-3D)	3-Medium	INSAT-3D	82°E				X	X	X	X	X	X	X											
GIIRS	1-Primary	FY-4A	86.5°E						X	X	X	X	X	X										
GIIRS	1-Primary	FY-4C	86.5°E										X	X	X	X	X	X	X					
GIIRS	1-Primary	FY-4E	86.5°E																X	X	X	X	X	X
GIIRS	1-Primary	FY-4B	105°E								X	X	X	X	X	X	X							
GIIRS	1-Primary	FY-4D	105°E												X	X	X	X	X	X				
GIIRS	1-Primary	FY-4F	105°E																			X	X	X
ROSA	3-Medium	Megha-Tropiques	20 °		X	X	X	X	X	X														
Tri-G (COSMIC-2)	2-High	Cosmic-2 (1-6)	24 °							X	X	X	X	X	X									
SAGE-III	5-Marginal	ISS	51.6 °					X	X	X	X	X	X											
IGOR (COSMIC)	2-High	COSMIC (6 sats)	71 °	X	X	X																		
Tri-G (COSMIC-2)	2-High	Cosmic-2 (7-12)	72 °									X	X	X	X	X	X							
MAESTRO	5-Marginal	SCISAT-1	73.9 °	X	X	X																		
ACE-FTS	4-Useful	SCISAT-1	73.9 °	X	X	X																		
TIDI	5-Marginal	TIMED	74 °	X	X	X	X	X																

List of target « capabilities » in OSCAR

Multi-purpose VIS/IR imagery from LEO	Lightning imagery from LEO
Multi-purpose VIS/IR imagery from GEO	Lightning imagery from GEO
IR temperature/humidity sounding from LEO	Cloud and precipitation profiling by radar
IR temperature/humidity sounding from GEO	Lidar observation (for wind, cloud/aerosol, trace gases, altimetry)
MW temperature/humidity sounding from LEO	Cross-nadir SW spectrometry (for chemistry) from LEO
MW temperature/humidity sounding from GEO	Cross-nadir SW spectrometry (for chemistry) from GEO
Multi-purpose MW imagery	Cross-nadir IR spectrometry (for chemistry) from LEO
Low-frequency MW imagery	Cross-nadir IR spectrometry (for chemistry) from GEO
Radio occultation sounding	Limb-sounding spectrometry
Earth radiation budget from LEO	High-resolution imagery for land observation
Earth radiation budget from GEO	Synthetic Aperture Radar
Sea-surface wind by active and passive MW	Gravity field measuring systems
Radar altimetry	Space Weather: solar activity, solar wind, deep space monitoring
Ocean colour imagery from LEO	Space Weather: ionosphere and magnetosphere monitoring
Ocean colour imagery from GEO	Precise positioning
Imagery with special viewing geometry	Data Collection Systems and Search-and-Rescue

Monitoring the implementation of WMO plans

O.S.C.A.R.

Observing Systems Capability Analysis and Review Tool

Home | Observation Requirements | Satellite Capabilities | Surface-based Capabilities | Quick Search...

Overview | Programmes | Satellites | Instruments | Instrument types | Space Agencies | Capability Review | Gaps | Analyses by Variable

IR temperature/humidity sounding from LEO

Details on this configuration

Full name	IR temperature/humidity sounding from LEO
Definition	This capability consists of medium spectral resolution spectrometers or radiometers operating in the IR part of the spectrum, in Low Earth Orbit.
Reference Observing Strategy	The reference observing strategy is: • three orbital planes (early morning: 5:30 ± 2 h; mid-morning: 9:30 ± 2 h; early afternoon: 13:30 ± 2 h); • one fully compliant instrument in each plane, and one backup, as similar as possible.

Evaluation of "IR temperature/humidity sounding from LEO" after 2020	
05:30 ± 2 h	No IR sounding planned in the early morning orbit. An option to fly FY-3 is being investigated by China.
09:30 ± 2 h	Adequate data are expected to be provided by the MetOp-SG IAS and the likely follow-on of the FY-3 ASI and the Meteor-MP IKFS-2.
13:30 ± 2 h	Adequate data are expected to be provided by the JPSS CrIS and the likely follow-on of the FY-3 ASI and the Meteor-MP IKFS-2.
Overall	Full gap of IR sounding in the early morning orbit. Only MW, with non-optimal scanning (conical)

The « Capability Review » compares the available/planned capabilities with those required by the WMO Vision of global observing systems

CH4
CO2
HNO3
C2H6
N2O5
C2H2
N2O
ClONO2
SF6
H2O
PAN
CFC-12

IR SOUNDING from LEO

Instrument	Rating	Satellite	Orbit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TANSO-FTS	1	GOSAT	13:00 asc	X	X	X	X	X																
CrIS	1	Suomi-NPP	13:25 asc		X	X	X	X	X	X														
AIRS	1	EOS-Aqua	13:30 asc	X	X	X																		
CrIS	1	JPSS-1	13:30 asc							X	X	X	X	X	X	X	X							
CrIS	1	JPSS-2	13:30 asc												X	X	X	X	X	X	X	X		
HIRS/4	3	NOAA-19	13:34 asc	X	X	X	X	X																
IRAS	3	FY-3B	13:40 asc	X	X	X	X																	
HIRAS	1	FY-3D	14:00 asc						X	X	X	X												
HIRAS	1	FY-3F	14:00 asc										X	X	X	X								
HIRS/4	3	NOAA-18	14:58 asc	X	X	X																		
IKFS	1	Meteor-M N2-1	15:30 asc					X	X	X	X	X	X											
IKFS-2	1	Meteor-MP N1	15:30 asc								X	X	X	X	X	X								
HIRS/3	3	NOAA-15	04:44 desc	X	X	X																		
HIRS/3	3	NOAA-17	07:50 desc	X	X	X																		
HIRS/3	3	NOAA-16	08:37 desc	X	X	X																		
IASI	1	MetOp-A	09:30 desc	X	X	X																		
IASI	1	MetOp-B	09:30 desc			X	X	X	X	X	X													
IASI	1	MetOp-C	09:30 desc							X	X	X	X	X	X									
IKFS	1	Meteor-M N2	09:30 desc			X	X	X	X	X	X													
IKFS	1	Meteor-M N2-2	09:30 desc						X	X	X	X	X	X										
IASI-NG	1	MetOp-SG-A1	09:30 desc											X	X	X	X	X	X	X	X	X		
IASI-NG	1	MetOp-SG-A2	09:30 desc																		X			
IKFS-2	1	Meteor-MP N2	09:30 desc									X	X	X	X	X	X							
HIRS/4	3	MetOp-A	09:30 desc	X	X	X																		
HIRS/4	3	MetOp-B	09:30 desc			X	X	X	X	X	X													
HIRAS	1	FY-3E	10:00 desc								X	X	X	X										

PM

Gap in early morning

AM

Benefits and limitations

- Directory of satellites and instruments:
  - Useful reference for reports, applications, training
- First level gap analysis :
  - Based on sensor **classes**, not individual sensors
  - Based on sensor **design,** regardless of status or data availability
  - Based on **single** sensors, regardless of possible combinations
  - ➢ **Cannot replace detailed gap analysis but starting point for such analysis**
- Support for high-level global coordination of satellite plans within CGMS and WMO
  - Contingency planning, frequency spectrum management
  - Architecture for climate monitoring from space

- Please visit www.wmo.int/oscar
- Your feedback is welcome to help improving this resource

Thank you for your attention !

Back-up slides

Satellite frequency information
(Example: NOAA-19)

Space agency	NOAA		
Status	Operational		
Details on Status (as available)	• MHS channel 183.311 ± 1.0 GHz noisy since December 2009. • AMSU-A channel 55.5 GHz noisy since December 2009 • The ECT, initially 14:00 asc, is drifting at a rate of 0.35 min/month.		
Launch	2009-02-06	**EOL**	≥2014
Last update:	2012-11-02		

S&RSAT	Search & Rescue Satellite-Aided Tracking System
SBUV/2	Solar Backscatter Ultraviolet / 2
SEM/2	Space Environment Monitor – 2
MEPED	Medium energy proton detector
TED	Total Energy Detector

Frequency information Show expert details

Service	Dir	Frequency	Bandwidth	Polarisation	D/A	Data rate or Baseband	Comme
HRPT	S-E	1698 MHz	2660 kHz	RHCP	D	665.4 kbps	Full res. d
APT	S-E	137.1 MHz	38 kHz	RHCP	A	1.7 kHz	Low res.
DSB	S-E	137.35 MHz	48 kHz	RHCP	D	8.32 kbps	TIP data
DSB	S-E	137.77 MHz	48 kHz	RHCP	D	8.32 kbps	TIP data

Satellite missions in the Vision for the GOS in 2025

- GEO: imager, HS IR sounder, lightning
- Sun-synchronous: imager, IR/MW sounders
- Ocean surface topography constellation
- Radio-Occultation Sounding constellation
- Ocean Surface Wind constellation
- Global Precipitation constellation
- Earth Radiation Budget (GEO/LEO)
- Atmospheric Composition (GEO/LEO)
- Ocean colour and vegetation imaging
- Dual-angle view IR imaging
- Land Surface Imaging
- Synthetic Aperture Radar
- Solar and space environment monitoring

Operational pathfinders and demonstrators

- VIS/IR imagers in HEO
- Doppler wind lidar, Low-frequency MW
- GEO MW
- GEO High-resolution narrow-band imagers
- Gravimetric sensors

Reviewing the implementation of the WMO Vision of the GOS

- The WMO Vision of GOS for 2025 defines target space-based observing capabilities

- For each capability:
  - OSCAR records the reference configuration
  - Relevant instrument categories are identified
  - Actual/planned availability is displayed
  - Expert Team assessment is recorded

Example: ERB from LEO

Instrument	Rating	Satellite	Orbit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ScaRaB	2	Megha-Tropiques	20 °		X	X	X	X	X	X														
CERES	1	TRMM	35 °	X	X	X	X																	
SIM	4	SORCE	40 °	X	X	X																		
TIM	4	SORCE	40 °	X	X	X																		
CERES	1	Suomi-NPP	13:25 asc		X	X	X	X	X	X														
CERES	1	EOS-Aqua	13:30 asc	X	X	X																		
CERES	1	JPSS-1	13:30 asc							X	X	X	X	X	X	X	X							
CERES-FO	1	JPSS-2	13:30 asc												X	X	X	X	X	X	X	X		
TSIS	4	JPSS-FF-1	13:30 asc							X	X	X	X	X	X									
TSIS	4	JPSS-FF-2	13:30 asc												X	X	X	X	X	X				
ERM-1	3	FY-3B	13:40 asc	X	X	X	X																	
SIM-1	4	FY-3B	13:40 asc	X	X	X	X																	
ERM-2	1	FY-3E	10:00 desc								X	X	X	X										
ERM-2	1	FY-3G	10:00 desc												X	X	X	X						
ERM-1	3	FY-3C	10:00 desc				X	X	X	X														
SIM-1	4	FY-3C	10:00 desc				X	X	X	X														
SIM-2	4	FY-3E	10:00 desc								X	X	X	X										
SIM-2	4	FY-3G	10:00 desc												X	X	X	X						
ERM-1	3	FY-3A	10:15 desc	X	X	X																		
SIM-1	4	FY-3A	10:15 desc	X	X	X																		
CERES	1	EOS-Terra	10:30 desc	X	X	X																		
ACRIM-III	4	ACRIMSat	10:50 desc	X	X	X																		
BBR	5	Earth-CARE	13:30 desc						X	X	X	X												

Example: Limb sounding spectrometry

Instrument	Rating	Satellite	Orbit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SAGE-III	5	ISS	51.6 °					X	X	X	X	X	X											
MAESTRO	5	SCISAT-1	73.9 °	X	X	X																		
ACE-FTS	5	SCISAT-1	73.9 °	X	X	X																		
TIDI	1	TIMED	74 °	X	X	X	X	X																
SABER	4	TIMED	74 °	X	X	X	X	X																
OMPS-limb	1	Suomi-NPP	13:25 asc		X	X	X	X	X	X														
OMPS-limb	1	JPSS-2	13:30 asc												X	X	X	X	X	X	X	X		
TES-limb	2	EOS-Aura	13:30 asc	X	X	X																		
MLS (EOS-Aura)	3	EOS-Aura	13:30 asc	X	X	X																		
HIRDLS	4	EOS-Aura	13:30 asc	X	X	X																		
OSIRIS	1	Odin	06:00 desc	X	X	X																		
SMR	3	Odin	06:00 desc	X	X	X																		
OMS-limb	1	FY-3E	10:00 desc								X	X	X	X										
OMS-limb	1	FY-3G	10:00 desc												X	X	X	X						
POAM	5	SPOT-4	10:30 desc	X	X	X																		