

EUMETSAT – general overview

Zagreb, Croatia 13 February 2020



1 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

A MU

EUMETSAT: an intergovernmental Organisation with 30 Members





2 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

EUMETSAT

EUMETSAT: mandate and programmes

- Mandate
 - Establish, maintain and exploit European systems of operational meteorological satellites
 - Contribute to operational monitoring of climate
- Activity structured by programmes approved by Member States
 - Mandatory programmes
 - Optional programmes
 - Third-party programmes

Long term commitment and multi-satellite programmes...



... impose large investment cycles



EUMETSAT within Europe and WMO





Meteorology needs two types of satellites

Meteosat



EUMETSAT Polar System 🌽



CO column*1e18, molecules/cm2

1.5

2.0

2.5

Geostationary orbit

Nowcasting and forecasts up to a few hours

Polar orbit Global forecasts up to 10 day

1.0

0.5

7 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020



3.0

Meteosat for nowcasting of fast developing high impact weather



8 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

EUMETSAT

MSG Animation over Croatia



MSG Animation over Croatia

Flash floods in Zadar Region – 11 September 2017





Use of EUMETSAT data at the Croatia DHZ





Use of EUMETSAT data at the Croatia DHZ





Information to the general public





DHMZ @DHMZ_HR

Nastavlja se zimska #suša! Na Jadranu je osvanuo još jedan 🔅 dan, a unutrašnjost je prekrivena 🌅 i niskim oblacima. Prognozu za #vikend pratite na meteo.hr

#prognozaDHMZ



10:14 AM · Jan 11, 2020 · TweetDeck

High targets for absolute availability



Confirmation of forecast scenario



EUMETSAT

EUMETSAT Polar System: contribution to a Joint Polar System shared with the US



16 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

EUMETSAT

Europe world leader of medium range numerical weather prediction





The EUMETSAT Polar System satellites has the highest impact on Global Numerical Weather Prediction



18

Some forecasts matter more than others





EUMETSAT currently exploits 10 satellites



METEOSAT-9, -10, -11

GEOSTATIONARY ORBIT	TWO-SATELLITE SYSTEM
METEOSAT 2ND GENERATION	FULL DISC IMAGERY MISSION (15 MINS) (METEOSAT-11 @0°)
	RAPID SCAN SERVICE OVER EUROPE (5 MINS) (METEOSAT-10 @9.5° E) BACKUP SATELLITE AND GAP FILLER FOR RSS (METEOSAT-9 @3.5°E)

EUMETSAT ground systems across Europe...





Ground stations for controlling satellites and acquiring their data



Meteosat 2nd and Third Generation Fucino, Italy



Meteosat 3rd Generation Lario, Italy and Leuk, Switzerland



Metop and Metop-SG Spitzbergen, Norway



Jason Usingen, Germany



World class infrastructure



TIB PUE January 2013 - January 2018







Extracting products from observations



EUMETSAT Network of Satellite Application Facilities





SAF on Nowcasting and Very Short Range Forecasting





26 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

EUMETSAT

SAF on Land Surface Analysis





Sensible (MH) & Latent (MLE) Heat Fluxes – 2019



Daily Downward Surface Longwave Flux - 2017



MSG 10-days Gross Primary Production – 2018



SAF on Ocean and Sea Ice





Global Sea Ice Concentration (SSMIS) Artic, July to September 2019



Copyright (2019) EUMETSAT

Atlantic High Latitude Downward Longwave Irradiance July 2019



Metop Sea Surface Temperature over Europe, September 2019

OSI SAF Sea Ice Concentration: long-term data records



SAF on Operational Hydrology and Water management





Instantaneous Rain Rate retrieved from IR-MW blending data , 2019

H14 Layer 3 (28-100cm) H-SAF CDOP - Copyright © Eumetsat20190803



Profile Index in the roots region by scatterometer data assimilation H SAF, at different depths, July 2019







SAF on Atmospheric Composition Monitoring





EUMETSAT

AC SAF UV Index from EPS GOME-2 satellite data







32 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

SAF on Climate Monitoring





Surface solar radiation from SARAH 2 data record, 2015



Cloud fraction derived from SEVIRI data, 2018



Surface normalized direct shortwave flux from SEVIRI data, 2018



SAF on Numerical Weather Prediction





RTTOV (Radiative Transfer for TOVS) screenshot



Wind Speed ASCAT Metop-A 25km, 8 march 2019



Brightness temperature difference between RARS and global data for AMSU-A, September 2015.



SAF on Radio Occultation Meteorology







Radio occultation concept from Grass instruments



Specific Humidity example from southern Spain 2019

Dry temperature example from southern Spain 2019



Radio Occultation: Navigation satellites' signal for meteorology



36 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020
Leveraging additional benefits from cooperation Third party data services

INDIA (ISRO)







CHINA (CMA & CSOA)



RUSSIA (Roshydromet)

USA ((NASA)
-------	--------





Delivering time-critical data to the European and African continents



38 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

EUMETSAT in a multilateral world

- CGMS: coordination group on meteorological satellites (under WMO)
- **Second** World Meteorological Organization

- CEOS: coordination on Earth
 observation satellites
 CEOS-SIT meeting in Zagreb in September 2020
- GEO: Group on Earth observation





EUMETSAT user support, training and conference

- EUMETSAT training programme
 - <u>https://training.eumetsat.int/</u>
 - http://www.eumetrain.org
- EUMETSAT help desk
 - ops@eumetsat.int





- EUMETSAT Meteorological Satellite Conference
 - 28 September 2 October 2020 in Würzburg, Germany



Cooperation with Western Balkan

- Facilitate access and use of EUMETSAT data by Western Balkan NMHS
- DAWBEE project: supported by DHMZ expert



Biennial Information Day in western Balkan
Dedicated training programme (SEEMET)



Deployment of current generation satellites completed safe transition with next generation systems



MSG et EPS in retrospect

- MSG
 - Has been the best geostationary imagery mission for 12 years, is still the best over the Indian Ocean
 - End-to-end availability: 99%
 - Longevity: 4 satellites in orbite, Meteosat-8 over the Indian Ocean until mid-2022
- EPS
 - After 12 years in orbit, EPS has still the highest impact on NWP
 - IASI was the first operational hyperspectral infrared sounder
 - End-to-end availability: 98%
 - Longevity: 3 satellites in orbit, Metop-A until end of 2021
 - Socio-economic benefit in the EU:
 - At least 5.4 B€/year, 32 times the annualised operations cost



Benefits areas of weather forecasting



Safety of life, property and infrastructure...

Transport ...

....Energy, agriculture, tourism....

...Climate policy and environment protection

Socio economic benefits of weather forecasts (proportional to GDP in developed economies)

AREA FOR WHICH BENEFITS CAN BE QUANTIFIED	ESTIMATED BENEFIT IN EU 27
Protection of property and infrastructure	€5.4 billion/year
Added value to economy	€41.0 billion/year
Private use by citizens	€15.0 billion/year
TOTAL ESTIMATED BENEFIT FOR EU 27	€ 61.5 billion/year
TOTAL ESTIMATED BENEFIT FOR CROATIA (assuming GDP is 0.32% of EU 27 GDP)	€ 190 million/year

The EUMETSAT Polar System satellites has the highest impact on Global Numerical Weather Prediction



Socio-Economic benefits of EPS are estimated at 5.4 B€/year in the EU

This means 17 M€/year for Croatia

47 EUM/SCIR/VWG/20/1163786, v1 Draft,

EUMETSAT Next Generation Satellite Systems



Meteosat Third Generation (MTG) Approved in 2011 flies Sentinel-4 Copernicus instrument



Jason-Continuity of Service (Jason-CS)

Approved in 2015 Mission shared with EU, ESA and NASA

EUMETSAT Polar System of Second Generation (EPS-SG) Approved in 2015 Flies the Sentinel-5 Copernicus instruments

48 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020



The ESA-EUMETSAT Cooperation Model



EUMETSAT Procurement Policy

- Overarching principle: Best Value for Money
 - No georeturn
 - Open competition within Member States
- "EUMETSAT shall take maximum advantage of the technologies developed in Europe"
- Procurements of recurrent satellites delegated to ESA
 - Block procurement with development of first (prototype) satellites funded 70% by an ESA optional programme

Coordinated ESA and EUMETSAT programmes and decisions





Time

Meteosat Third Generation: two types of MTG satellites

- Full disc every 10 minutes in 16 spectral bands (MTG-I1)
- Imagery of Europe every 2.5 minutes (MTG-I2)
- Full disc Lightning Imager
- Sounding mission: MTG-S satellites
 - IRS hyperspectral infrared sounder
 - Temperature, moisture profiles every 30 minutes (Europe)
 - Atmospheric chemistry:
 - IRS/Copernicus Sentinel-4 synergy

Operational exploitation: 2022-2042



Meteosat Third Generation: full in-orbit configuration (2025)



MTG-S Sounding Service

MTG-I Full Scan Service

53 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020



MTG sounding mission covering Europe every 30 minutes



 Coverage LAC-4 (Europe) every 30 minutes

54 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020



MTG-I:

Fires in USA, GOES-16 ABI, Fire Temperature RGB 6 March 2017

...MTG higher resolution provides better pin-pointing of fires

=> better decision tools for emergency services

55 EUM/So

4D weather cube with MTG-I and MTG-S



56 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020





EPS Second Generation: a two-satellite system

Three successive pairs of satellites:

Metop-SG A for optical imagery and sounding
 6 instruments, including Sentinel-5 from Copernicus

Metop-SG B for microwave imaging
 5 instruments

Contribution to the Joint Polar System (JPS) shared with NOAA

Operational exploitation: 2023 – 2044

EPS-SG mission capabilities

- Major improvements to all EPS observation missions
 - Infrared and microwave sounding
 - Optical imagery
 - Scatterometer
 - Radio-occultation
- New imagery missions
 - 3MI: first operational imaging polarimeter (operational premiere)
 - Microwave imager (MWI): imagery of precipitation
 - Ice Cloud Imager (ICI): ice clouds (world premiere)

New measurements from EPS-SG







ICE CLOUDS

~

EPS-SG regional mission for Nowcasting





 Products disseminated within 15 to 30 minutes from sensing



One launch per year from 2021 to 2025





61 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020



Climate monitoring

62 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

A State

The challenge of climate monitoring from space



Cross-calibration : IASI as an infrared calibrator

64



Support to climate services New climate records

Records of Metop Atmospheric Motion Vector for C3S (2007-2017)



Comparison with MODIS/Terra record for low, medium and high winds in the Arctic (wind speed)

Support to climate services New climate records (2)

Meteosat 1st generation records of surface albedo & aerosol optical thickness (1991-2006 at 0°; 1998-2007) at 63°E



Comparison with AERONET data demonstrates value of reconstructed spectral response function

🗲 EUMETSAT

⁶⁶ EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

Climate Monitoring SAF





Contribution to Global Architecture for monitoring climate from space

Updated inventory: 1300 Climate Records of ECVs (821 existing & 479 planned)



CM SAF Solar radiation products and applications



Sunshine Duration, Germany 2018 vs. Climatology



This plot shows the anomaly of sunshine duration compared to the climatology (1983-2017) from the CM SAF Surface Radiation Data Set – Heliosat (SARAH) 2.1 data record and is the sunniest first half of the year since 1983 for the shown area (followed by 2007 and 2012). Credit: CM SAF

Interim Climate Data Records: Climate in "real time"





GRAPHIC: Software adapted from Zachary Labes' GitHub

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	_			_		_	_					
1979 -	21.35	19.71	20.8	23.44	25.24	27.43	27.74	26.62	26.15	27.23	27.01	23.13
1980 -	19.89	19.23	19.89	21.46	23.32	25.49	26.76		27.53	28.42	28.22	24.47
1981 -	19.85	18.9	19.53	21.36	23.76	26.27		26.7	26.82		27.68	24.99
1982 -	20.92			23.64	25.37	26.65	27.3	26.97	26.51	27.78	27.66	23.47
1983 -	20.21	19.52	20.53	22.14	23.59	25.57	26.95	26.31	26.93	27.73	27.95	24.33
1984 -	19.72	18.44	19.69	21.81	23.76	25.91	27.23		25.87	26.63	27.43	24.07
1985 -	19.58	18.58	20.01	22.2	24.7	26.3	26.49	25.99	26.39	27.33	27.54	25.0
1986 -	20.69	19.38	19.91	-			26.44	25.84	26.0	27.24	27.03	23.5
1987 -		19.69	20.26	22.42	23.92	25.8	27.03	26.07	26.54	27.38	27.39	
1988 -		18.88	20.41	21.87	23.76	25.67	26.5	26.21	26.6	28.22	28.06	25.55
1989 -	20.22	18.84	19.72	21.01	23.63	26.28	26.54	25.95	25.71	27.2	27.34	23.9
1990 -	20.02	18.9	20.11	21.99	23.41	25.21	25.8	25.02	25.14	26.83	27.16	23.94
1991 -	20.15	18.84	19.67	22.32	24.09	25.66	25.95	25.86	25.54	27.02	26.96	23.65
1992 -	19.8	18.63	19.54	21.86	23.52	25.47	26.96	26.37	26.29	27.79	27.73	24.44
1993 -	19.85	18.56	19.93	22.08	23.79	25.51	26.26	25.6	25.72	27.44	27.92	23.93
1994 -	20.11	19.08	20.49	22.34	24.42	26.07		26.24	26.53	27.44	27.52	23.98
1995 -	20.71	19.09	20.16	21.98	23.73	25.29	25.62	25.33	25.24	26.54	26.9	24.13
1996 -	20.58	18.58	19.76	21.82	24.34	26.33	27.0	26.56		27.49	26.66	23.14
1997 -	19.02	18.23	19.35	21.36	23.66	25.41	26.21	25.55	25.96	27.05	27.1	24.12
1998 -	19.6	19.13	20.13	22.09	24.35	25.6	26.14	26.05	26.22	27.74	27.36	24.06
1999 -	19.71	18.72	19.8	22.29	24.47	26.0	26.48	25.91	25.7	27.58	27.37	24.17
2000 -	19.54	18.44	19.67	22.06	24.52	26.06	26.52	26.2	26.06	27.15	26.68	23.05
2001 -	19.91	19.26	20.56	22.2	24.26	25.39	25.78	25.52	25.64	26.62	26.85	23.79
2002 -	19.61	18.77	19.47	20.99	22.87	24.53	25.54	24.5	24.51	26.69	26.41	24.07
2003 -	20.63	19.37	20.36	22.09	24.13	26.1	26.45	25.21	25.2	26.74	26.81	23.87
2004 -	20.01	18.81	19.86	21.65	23.43	25.71	26.55	25.54	25.53	26.98	27.05	23.43
2005 -	18.76	17.64	19.12	21.42	23.55	25.02	25.87	24.91	25.08	26.57	27.18	22.77
2006 -	18.18	17.31	18.04		22.5	24.93	25.58	25.62	25.9	27.14	26.65	22.74
2007 -	18.96	17.83	18.88	20.81	23.03	25.24	24.95	23.97	24.02	25.53	26.5	24.84
2008 -	21.08	19.47	20.98		24.58	26.02	25.81	24.74	23.94	26.36	27.34	24.77
2009 -	20.52	18.42	20.08	22.85	24.82	26.12	26.13	25.34	25.3	26.11	26.41	23.86
2010 -	19.35	18.16	19.47	21.94	24.13	25.8	26.23	25.56	24.84	26.57	27.21	24.12
2011 -	18.6		18.43	20.77	23.49	24.95	25.0	24.53	24.35	25.63	26.33	24.32
2012 -	20.13	18.72	20.37	22.49	24.12	25.13	25.2	23.94	23.8	25.4	26.29	23.32
2013 -	19.9	19.02	20.38	22.32	24.54	26.33	26.01	25.63	25.5	27.33	27.55	24.79
2014 -	20.65	18.77	20.15	22.9	24.87	26.55	26.33	25.93	26.07	27.07	27.25	24.99
2015 -		18.63	19.78	22.74	24.75	26.13	26.31	24.38	24.03	26.28	26.79	23.4
2016 -	18.73	17.42	18.95	21.4	22.64	24.54	25.17	24.45	23.59	24.44	23.86	20.65
2017 -	17.56	16.77	17.43	19.67	22.15	23.96	24.42	23.61		25.39	25.42	22.14
2018 -	17.98		18.28			24.44	25.17	23.96	23.61	24.72	25.76	
2019 -		17.4	18.11	19.61	21.6	23.67	24.34	23.58		24.53		
Highest												owest

SEA ICE EXTENT

[OSISAF, monthly mean sea ice extent values, Global (Mill.km²)]





ntributions to COPERNICUS

EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020

- Carlor

71

From weather to environmental forecasting















Meteosat 9 IR10.8 20080525 0 UTC

ECMWF Fc 20080525 00 UTC+0h:





esa
EUMETSAT activities in support of Copernicus

- Legal Framework:
 - EUMETSAT: Third Party Programme foreseen by the Convention approved on 15 October 2014
 - EU: Copernicus Agreement signed on 7 November 2014, amended in January 2019 (254 M€ over 7 years)
- Focus: ocean and atmospheric composition monitoring
- Cooperation with ESA on development and operations
- Vision: deliver integrated data streams (from Copernicus, EUMETSAT and third party missions)

EUMETSAT contributions to

- Ocean monitoring
 - Dual satellite Sentinel-3 Marine mission

- Jason-3 and Sentinel-6/Jason-CS cooperative missions
- Atmospheric Composition monitoring
 - Sentinel-4 as part of MTG(-S) system
 - Sentinel-5 as part of EPS-SG system
 - Preparation of CO2 monitoring mission
- Data access and support services







26 March: dual Sentinel-3 marine mission in routine operations



Copernicus Sentinel-3 SLSTR-A and SLSTR-B SST 18-19 Mar 2019







Monitoring Mean Sea Level and Ocean Circulation





WEkEO Copernicus DIAS Platform with ECMWF and Mercator-Ocean



77

Atmospheric chemistry: IASI-NG & Sentinel-5 on Metop-SG A





Monitoring CO2 emissions for the Paris Agreement Using observations and Earth system Modeling



R&D ROADMAP FOR AN OPERATIONAL CO₂ EMISSIONS MONITORING SERVICE



EUM/SCIR/VWG/19/1120769, 25 October 2019

Greenhouse gases - preparing for CO2M Sentinel



81

EUM/SC

EUMETSAT

CO peak observed by IASI in China



82

EUMETSAT





Hvala !!

+

83 EUM/SCIR/VWG/20/1163786, v1 Draft, 4 February 2020