MOXXI 2019 Topical Conference

New York, 11-13/03/2019

The H SAF products and services: new products for operational hydrology

Flavio Gattari

H-SAF Project Management

H SAF Objectives

Satellite Application Facility in Support to Operational Hydrology and Water Management

- to **provide satellite-derived products** from **existing** and **future satellites** with sufficient time and space resolution to satisfy the needs of operational hydrology. Identified products:
  - precipitation (liquid, solid, rate, accumulated);
  - soil moisture (at large-scale, at local-scale, at surface in the roots region);
  - snow parameters (detection, cover, melting conditions, water equivalent);
- to perform **continuous quality assessment** and **independent validation** of the usefulness of the products for facing floods, landslides, avalanches, and managing water resources

Civil Protection,

Risk Management,

Hydrological applications,

Nowcasting,

Hydrology and water management,

Climate,

NWP

EUMETSAT H SAF

The Consortium and Partners

ITALY
ITAF MET
DPC
CNR -ISAC
UNIBO
CNR-IRPI
CIMA
TELESPAZIO

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TU WIEN

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

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H SAF
Support to Operational Hydrology and Water Management

The Context: The SAF Concept

EUM Geostationary Systems

Data Acquisition and Control

Data Processing EUMETSAT HQ

EPS

Other Data Sources

Application Ground Segment

EUMETSAT Central Application Facility

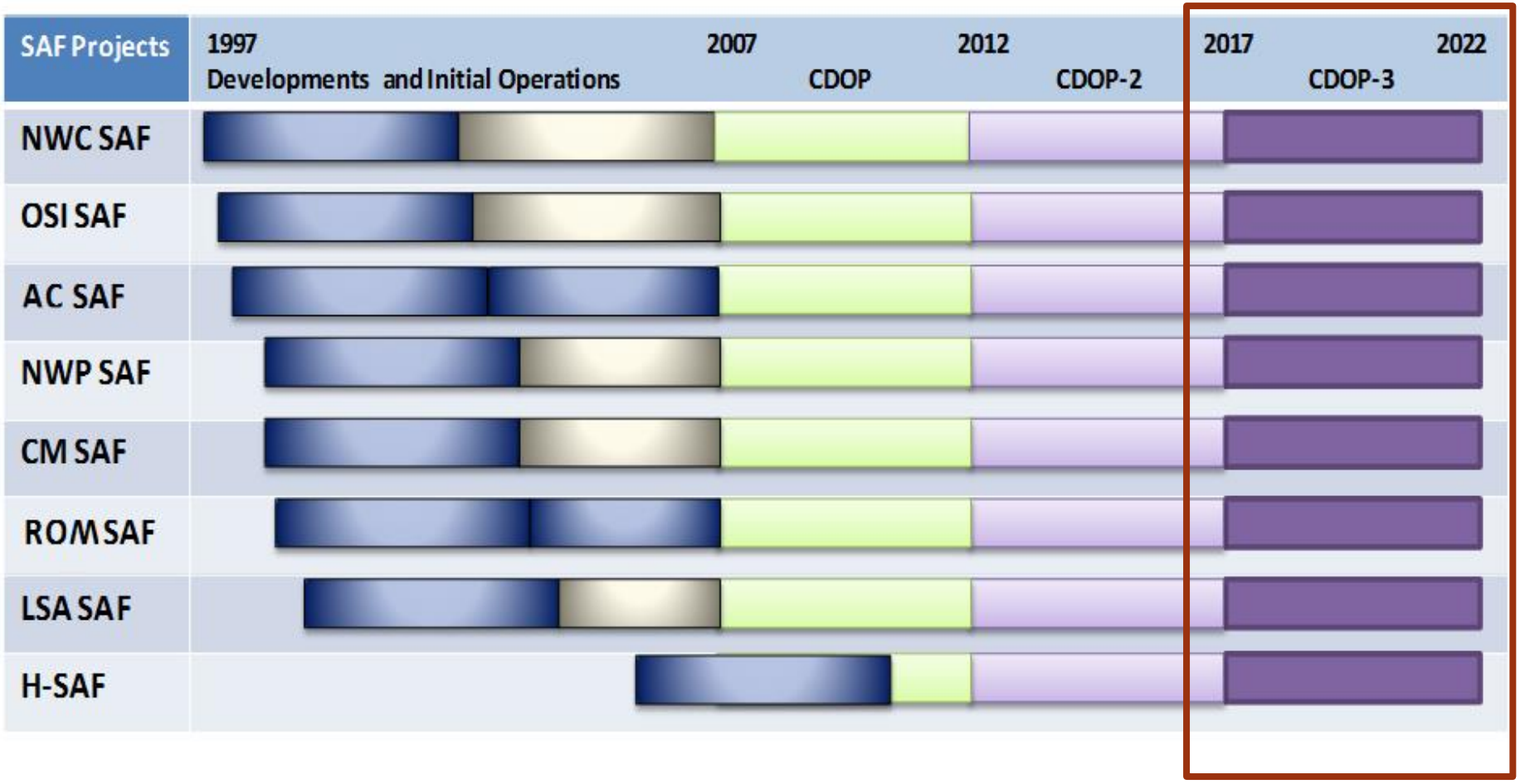
Satellite Application Facilities (SAFs)

Central Processing

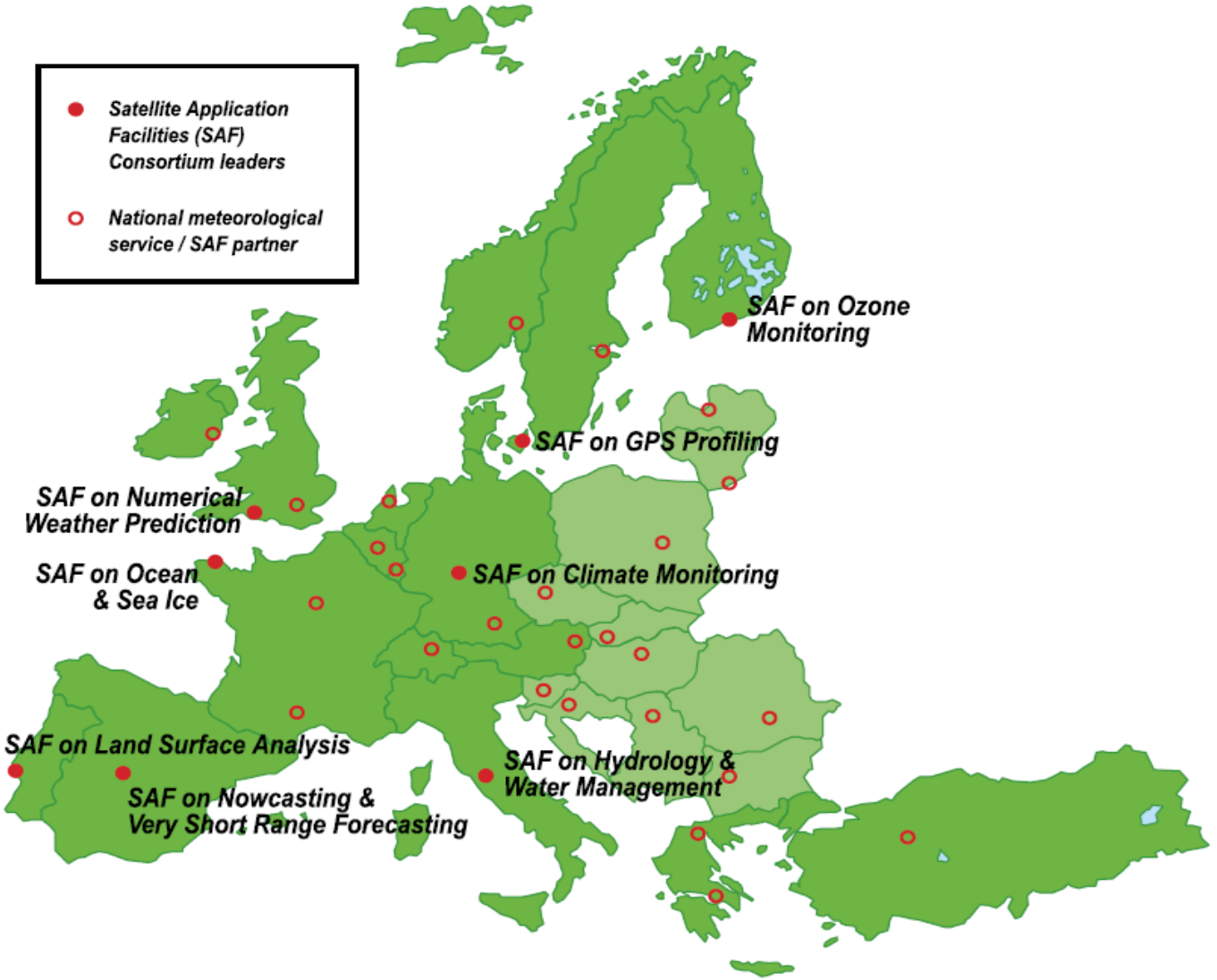
Distributed Processing and generation of specific products

USERS

The Context: The SAF Schedule

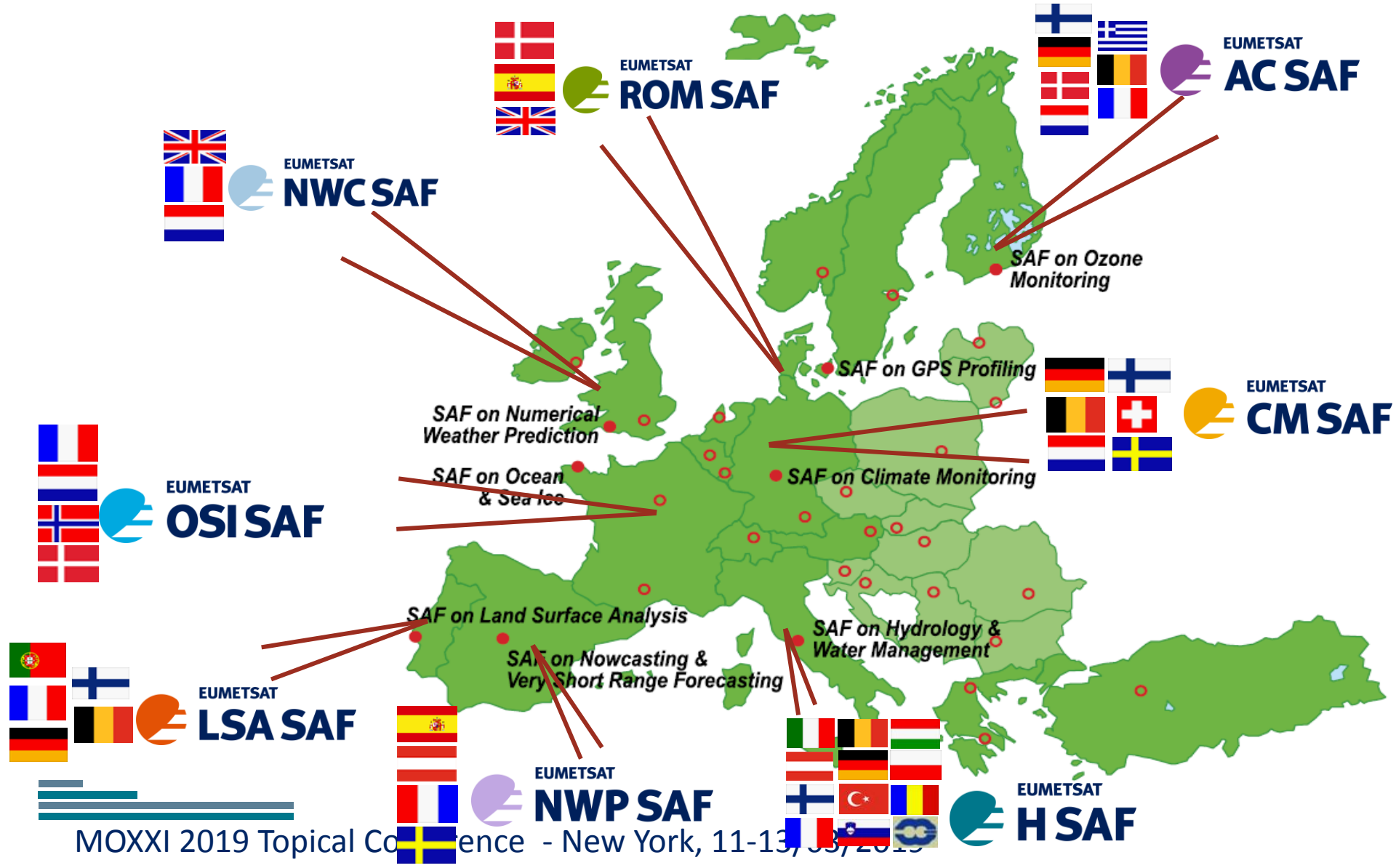


The Context: The SAF Network



SAF
The EUMETSAT Network of Satellite Application Facilities

The Context: The SAF Network



The H SAF Products

H-SAF Operational Products

Key Points

- Products are provided in **NRT**
- Their **timeliness** is compliant with the needs of operational users: some of the products are provided within 15 minutes from last received image
- **Operational provision**:
  - 24/7 service
  - Full operational support
- **Long term** perspective (up to 2032)
- High **accessibility**: EUMETCast dissemination, ftp direct download, orders

H-SAF Operational Products

Precipitation Products

H01 P-IN-SSMIS	Precipitation rate at ground by MW conical scanners	Operational
H02A/B P-IN-MHS	Precipitation rate at ground by MW cross-track scanners	Operational
H03B P-IN-SEVIRI	Precipitation rate at ground by GEO/IR supported by LEO/MW	Operational
H15A P-IN-SEVIRI-CO	Blended SEVIRI Convection area / LEO MW Convective Precipitation	Pre-operational
H05B P-AC-SEVIRI	Accumulated precipitation at ground by blended MW and IR	Operational

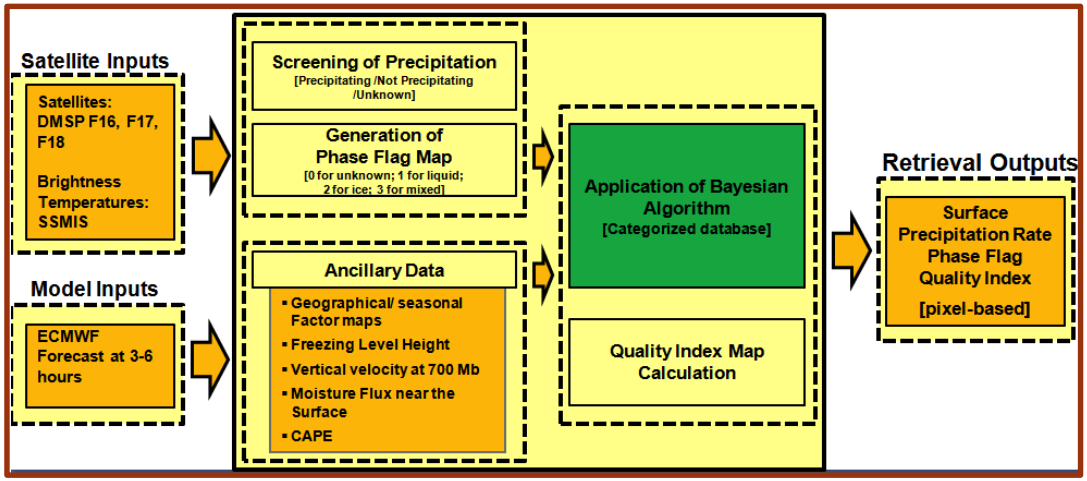
H-SAF Operational Products: precipitation

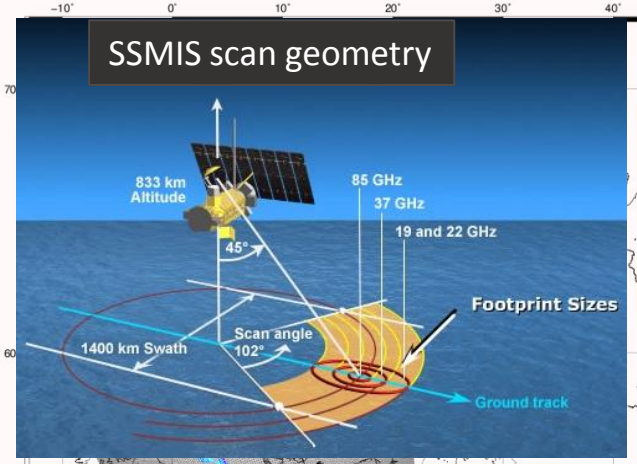
P-IN-SSMIS / H01 new. rel.

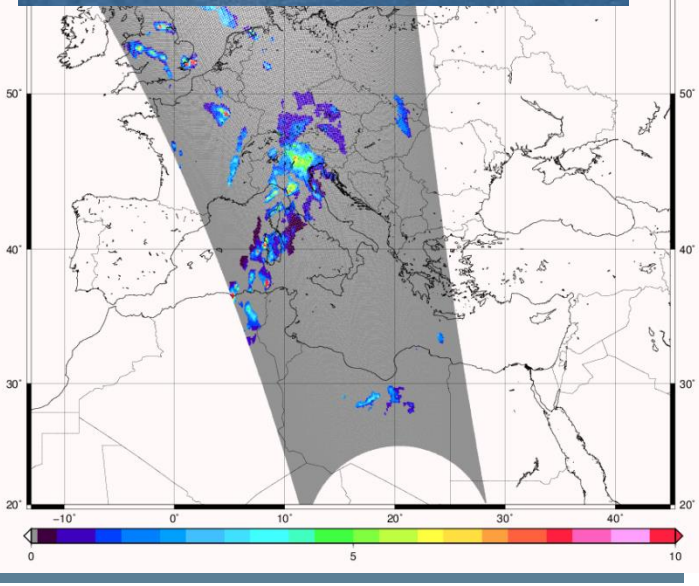
Cloud Dynamics and Radiation Database (CDRD)

Bayesian Algorithm for conical scanners

(Sanò et al., TGRS, 2013, Casella et al., TGRS, 2013; Smith et al., Mugnai et al., NHESS, 2013)







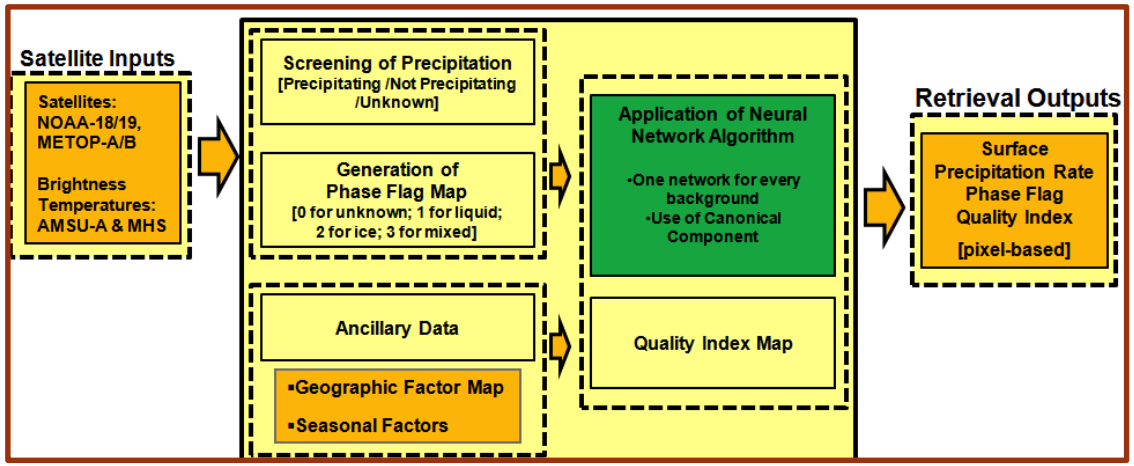
- Use of MW conical scanners (Tb) (DMSP-SSMIS);
- Physically-based Bayesian technique;
- *A synthetic a-priori* database built from cloud model generated microphysical profiles coupled to RTE model;
- Use of dynamical-thermodynamical-hydrological (DTH) model-derived variables to reduce *ambiguity* problem of retrieval solution; DTH variables from ECMWF forecast/analysis are used as additional input;
- Precipitation phase and Quality index evaluation.
- Proc. Time: < 2 min (H-SAF area), Hor. Res.: ≅15 km

H-SAF Operational Products: precipitation

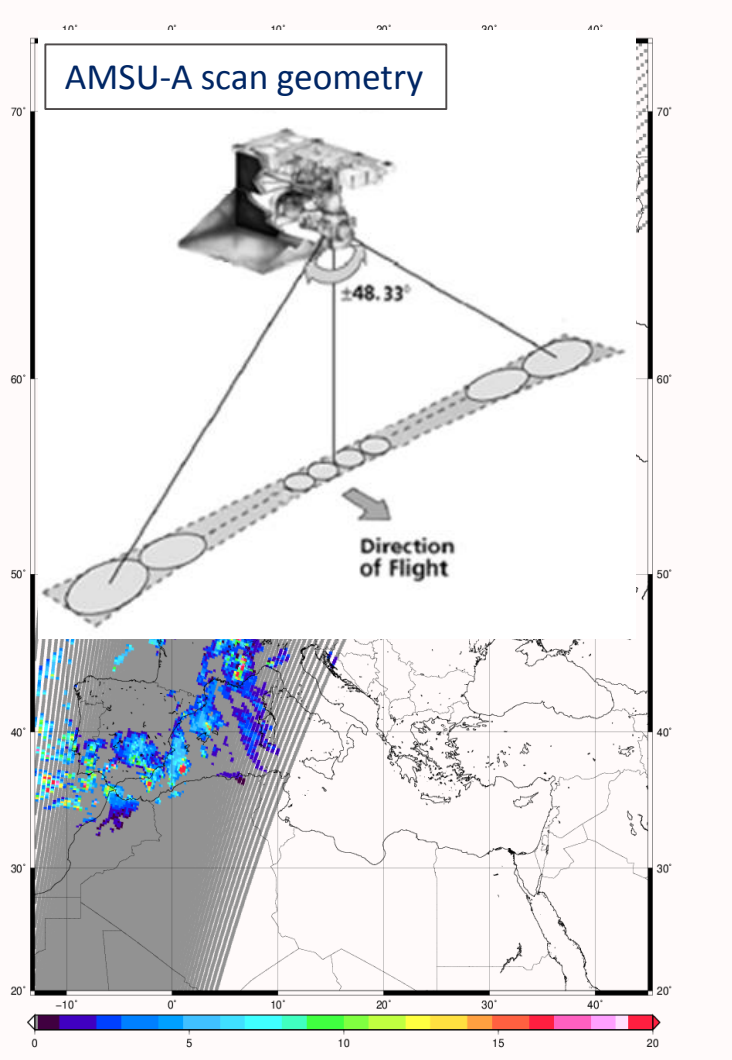
P-IN-MHS / H02 new. rel.

PMW Neural-net Precipitation Retrieval (PNPR) Algorithm for cross-track scanners

(Mugnai et al., NHESS, 2013b, Sanò et al., AMTD, 2014)

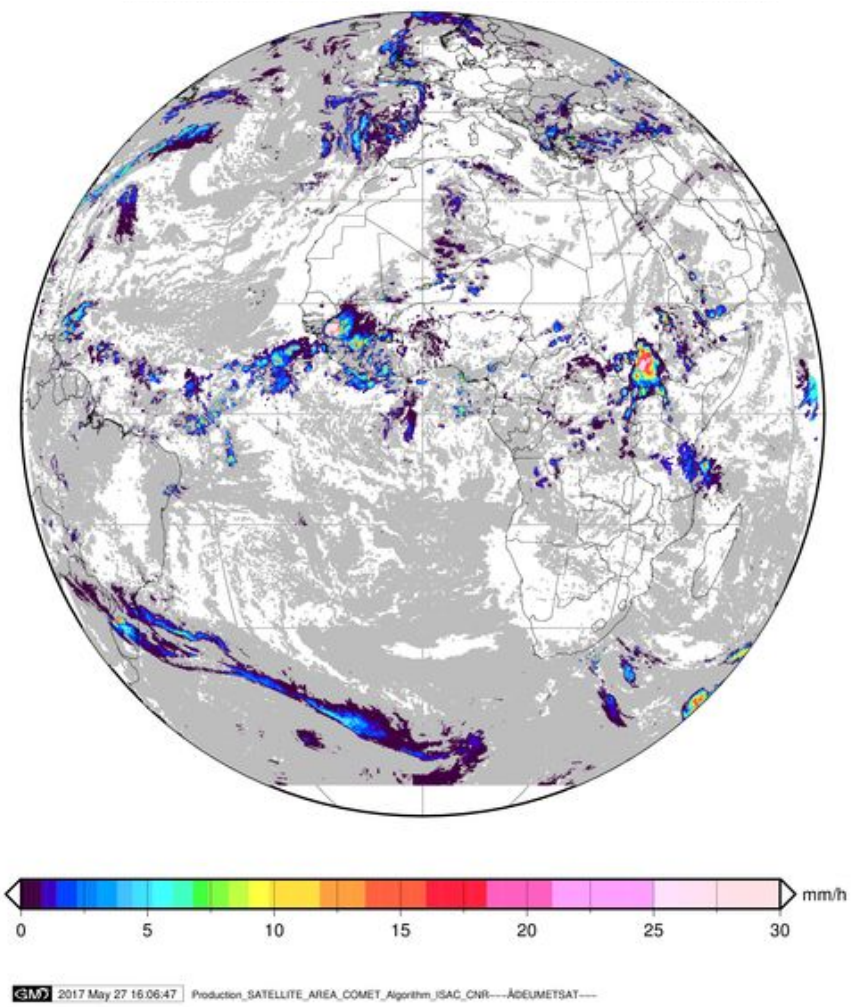


- Use of MW cross-track scanners (Tb) (NOAA and MetOp);
- Training database built from same cloud resolving simulations as CDRD;
- New optimal Artificial Neural Network (ANN) algorithm, one ANN for all surface backgrounds;
- The Full Disk Algorithm uses two ANNs (ANN-A for European Area, ANN-B for African Area) trained by the two Databases.
- Correction of MetOp-A channel [AMSU-A Channel 7 (54 GHz)] using a specific ANN.
- Input: AMSU-A/MHS channels, additional channel derived variables;
- Geographycal inputs (i.e., latitude, season, topography) used as additional input;
- Precipitation phase and Quality index evaluation
- Proc. Time: < 30 sec (H-SAF area), Hor. Res.: ≅16-50 km



H-SAF Operational Products: precipitation

P-IN-SEVIRI/H03: Multi-platform algorithm: BLENDING Technique



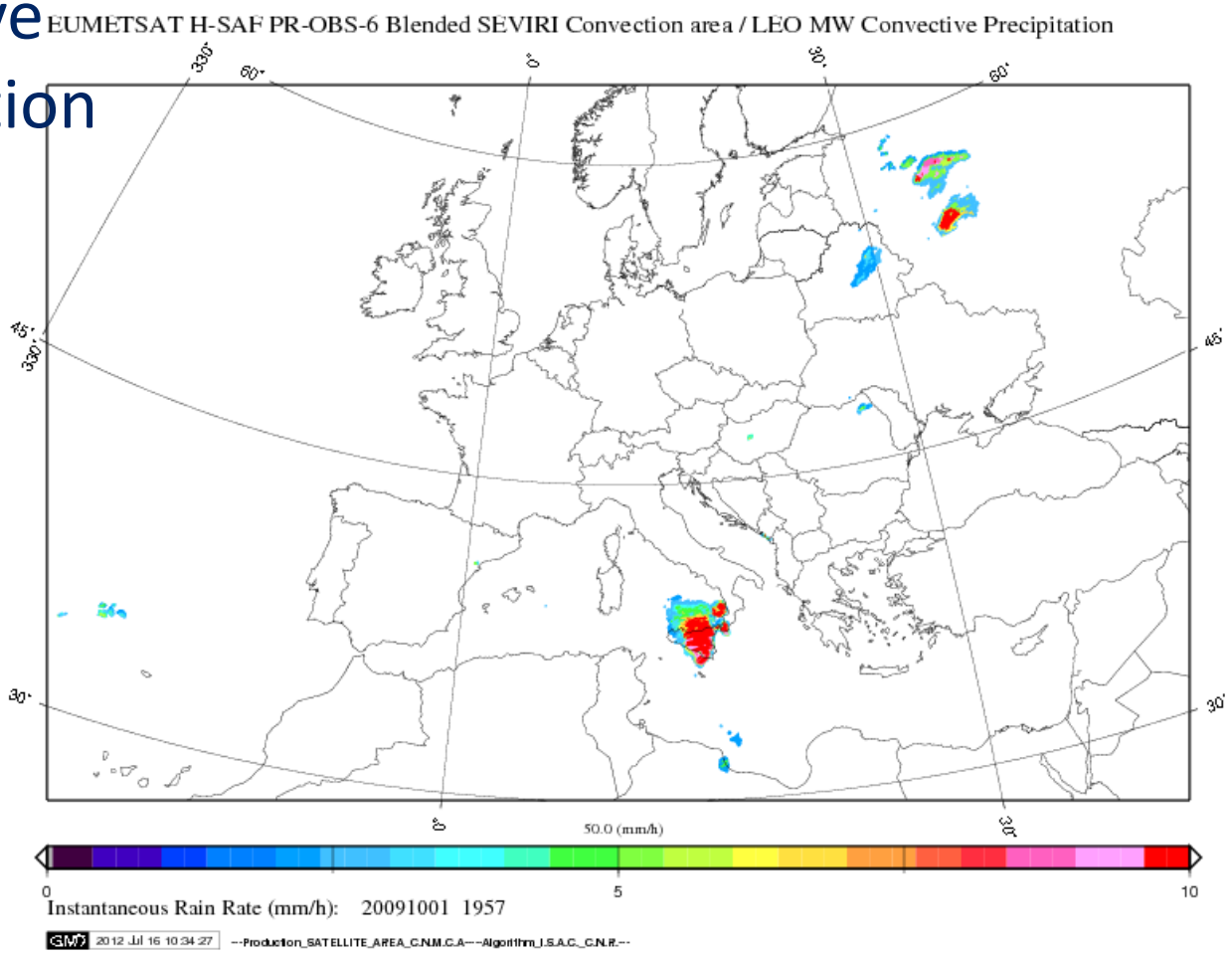
The "Rapid Update" tecnique allows to compute instantaneous rain intensities at the ground at the geostationary time-space scale (Turk et al. 2000, Torricella et al. 2007).

It is based on a blended MW-IR technique that correlates, by means of the statistical probability matching, brightness temperatures measured by the IR geostationary sensors and PMW-estimated precipitation rates at the ground.

H-SAF Operational Products: precipitation

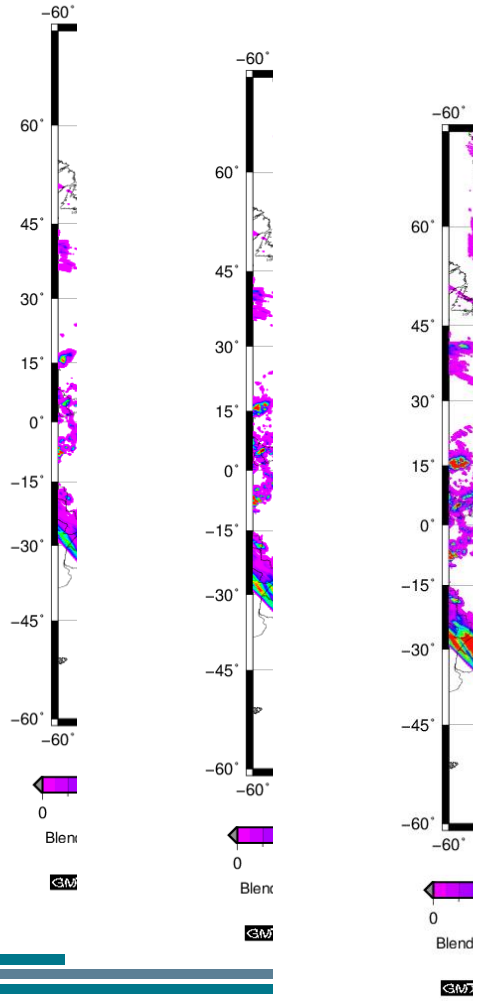
P-IN-SEVIRI-CO / H15A: **BLENDING** Technique + **NEFODINA**

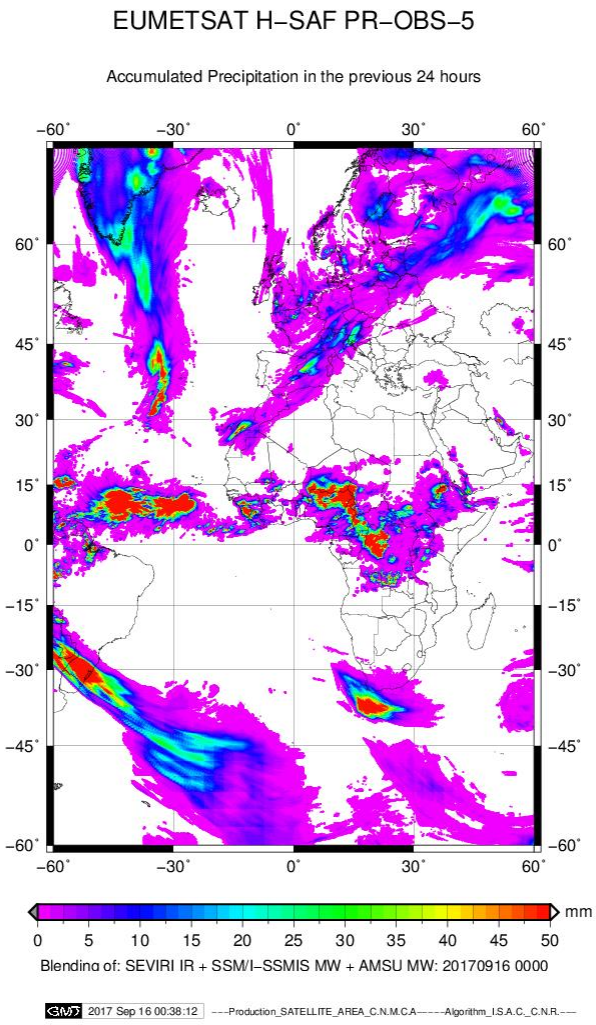
Convective Precipitation



H-SAF Operational Products: precipitation

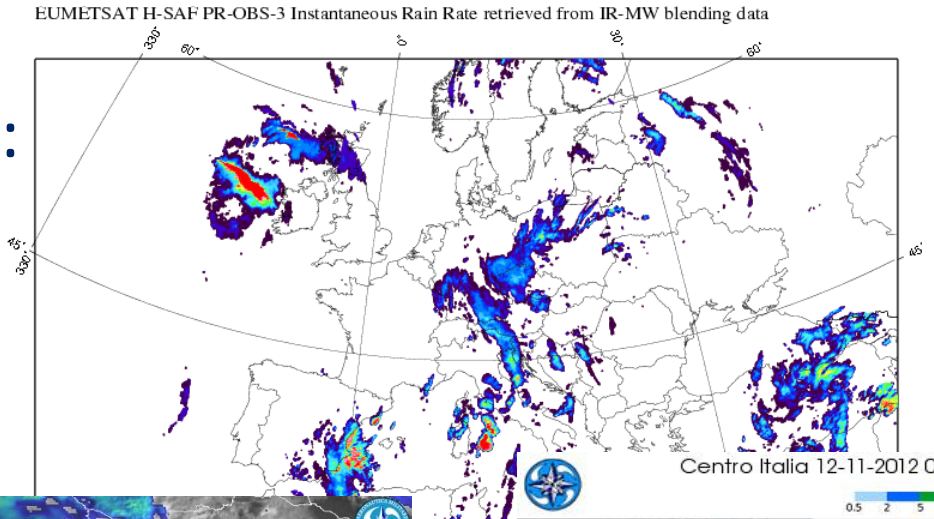
P-AC-G-SEVIRI / H05
Accumulated Precipitation

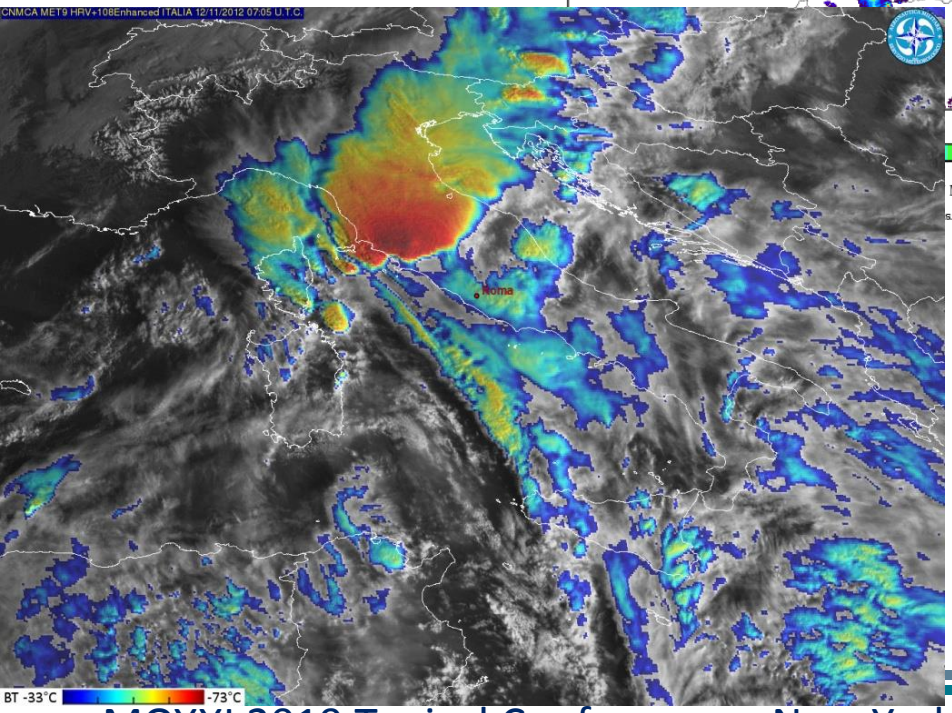


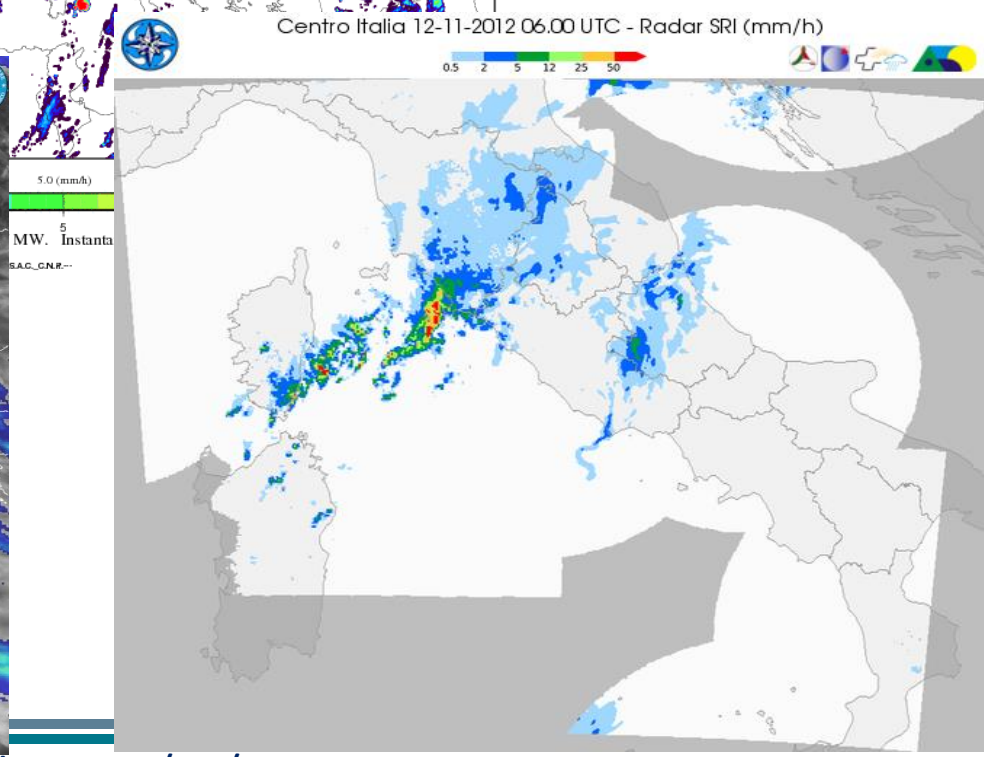


Precipitation: Case studies

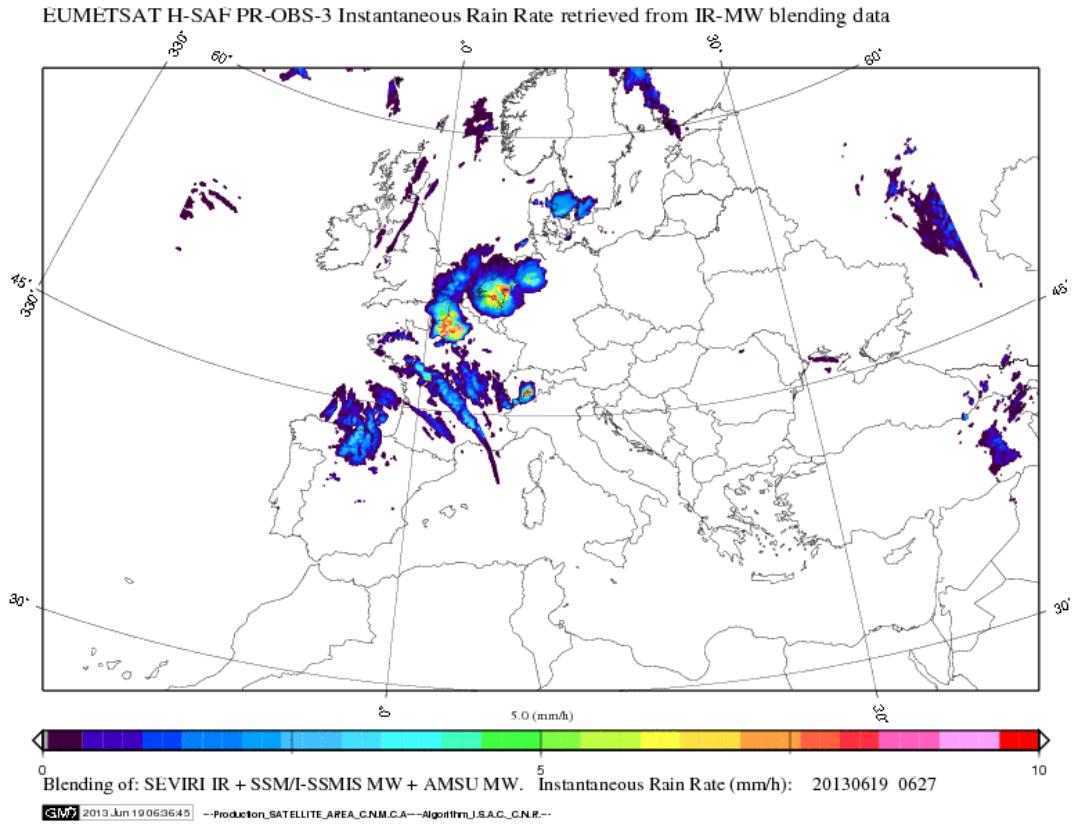
P-IN-SEVIRI (H03): Flood event in Grosseto (Italy)



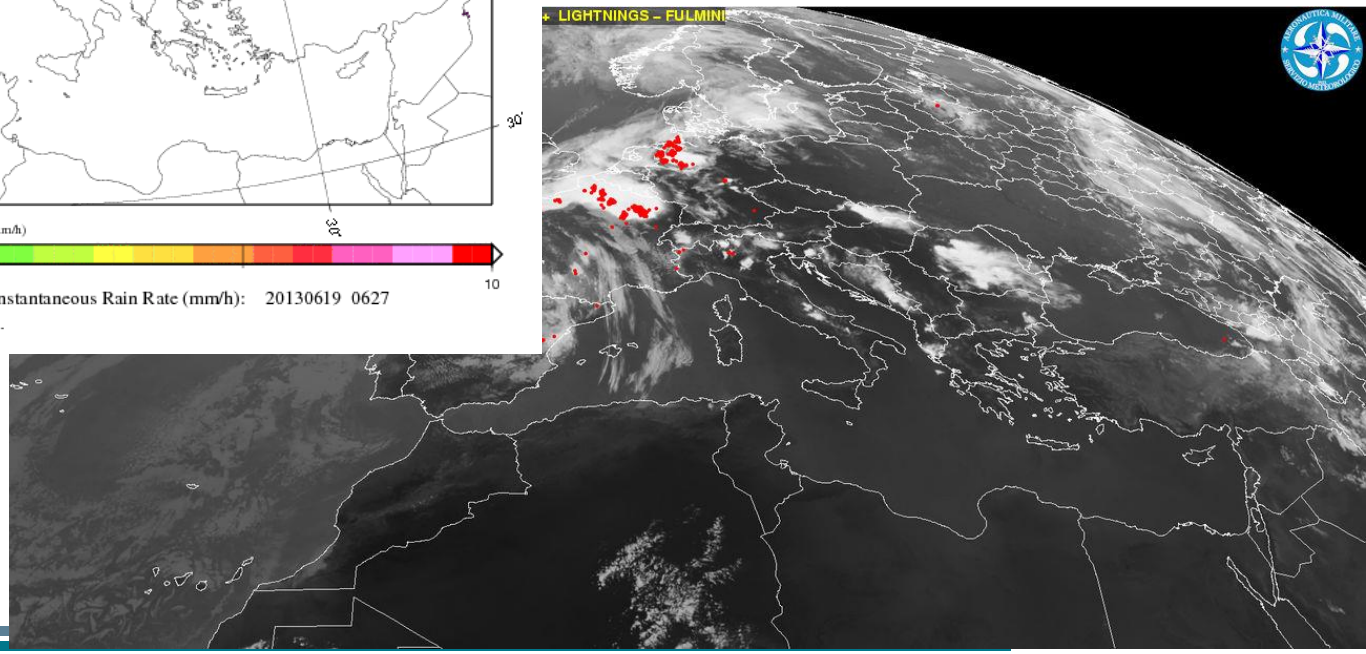




Precipitation: Case studies



P-IN-SEVIRI (H03): extreme precipitation event, Germany



In development Precipitation products

Strategy and foreseen improvements

New PMW based Products

Higher temporal sampling

- Full exploitation of all overpasses of present and future satellites, including GPM

Transition to MTG

- From FCI, LI

Transition to EPS-SG

- From MWS, MWI

CDOP3 **CDOP4**

In development Precipitation products

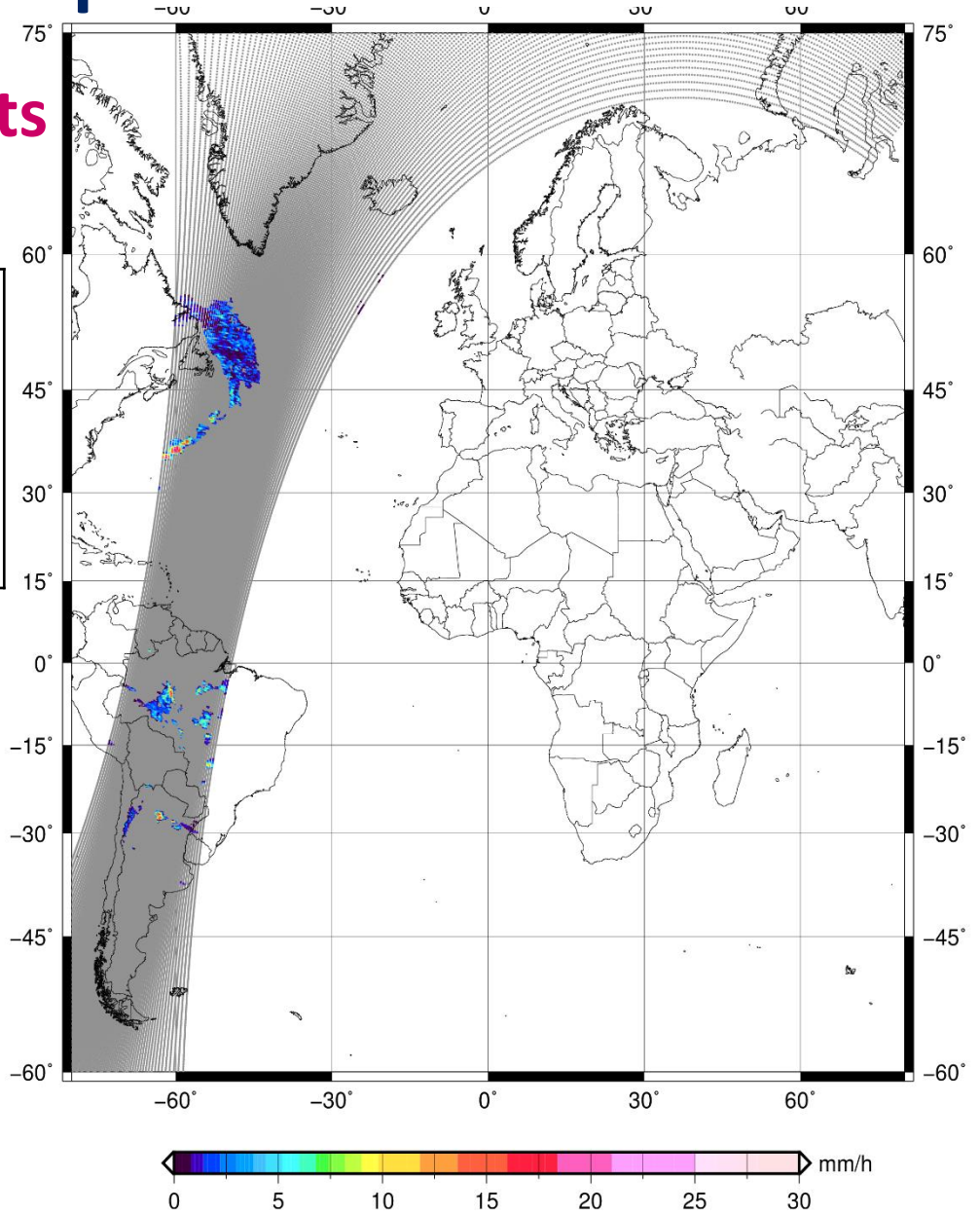
New MW based Products

H18 P-IN-ATMS	Precipitation rate at ground by MW cross-track scanners (Suomi NPP ATMS)	Algorithms assessed Expected Operations in 2019
H23 P-DM-PMW	High frequency MW delineation of cloud areas with new development of hydrometeors (MHS)	

In development Precipitation products

New MW based Products

H18 P-IN-ATMS	Precipitation rate at ground by MW cross-track scanners (Suomi NPP ATMS)



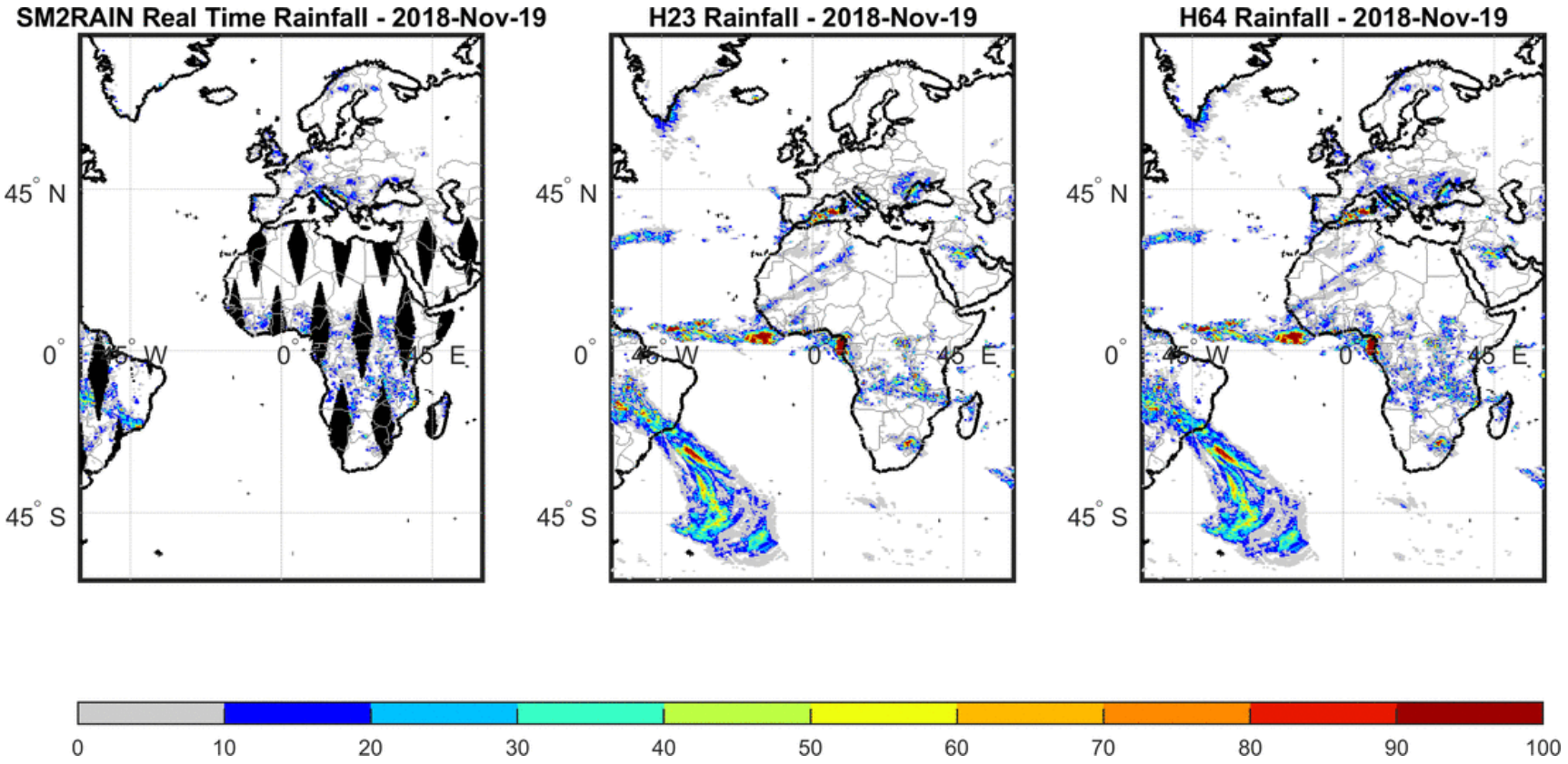
In development Precipitation products

Integration of Precipitation/Soil Moisture Products

H64 P-AC-SM2RAIN	Precipitation/Soil Moisture integrated product	Algorithm assessed Expected Operations in 2019

In development Precipitation products

Integration of Precipitation/Soil Moisture Products



In development Precipitation products

Indian Ocean Data Coverage (IODC) Products

H63 P-IN-SEVIRI_E	Precipitation rate at ground by GEO/IR supported by LEO/MW	Algorithm assessed Expected Operations in 2019
H90 P-AC-SEVIRI_E	Accumulated precipitation at ground by blended MW and IR	

In development precipitation products

MTG-based Products

H40 P-IN-FCI	Precipitation rate at ground by GEO/IR supported by LEO/MW and MTG FCI	Algorithms assessed Expected Operations in CDOP4
H42 P-AC-FCI	Accumulated precipitation at ground by blended MW and IR and MTG FCI	
H50 P-IN-LI	Rainfall intensity from MTG LI	

EPS-SG based products

H70 P-IN-MWS	Precipitation Rate at ground by EPS-SG MWS	Expected operations in CDOP-4
H71 P-IN-MWI	Precipitation Rate at ground by EPS-SG MWI	

H-SAF Operational Products: Soil Moisture

Soil Moisture NRT Products

H08 SSM ASCAT NRT DIS	Disaggregated Metop ASCAT NRT SSM at 1 km NRT	Pre-Operational
H101 SSM ASCAT-A NRT O12.5	Metop-A ASCAT NRT SSM orbit geometry 12.5 km sampling	Operational
H102 SSM ASCAT-A NRT O25	Metop-A ASCAT NRT SSM orbit geometry 25 km sampling	Operational
H16 SSM ASCAT-B NRT O12.5	Metop-B ASCAT NRT SSM orbit geometry 12.5 km sampling	Operational
H103 SSM ASCAT-B NRT O25	Metop-B ASCAT NRT SSM orbit geometry 25 km sampling	Operational
H14 SM-DAS-2	Soil Wetness Profile Index in the roots region retrieved by Metop ASCAT surface wetness scatterometer assimilation method	Operational

H-SAF Operational Products: Soil Moisture

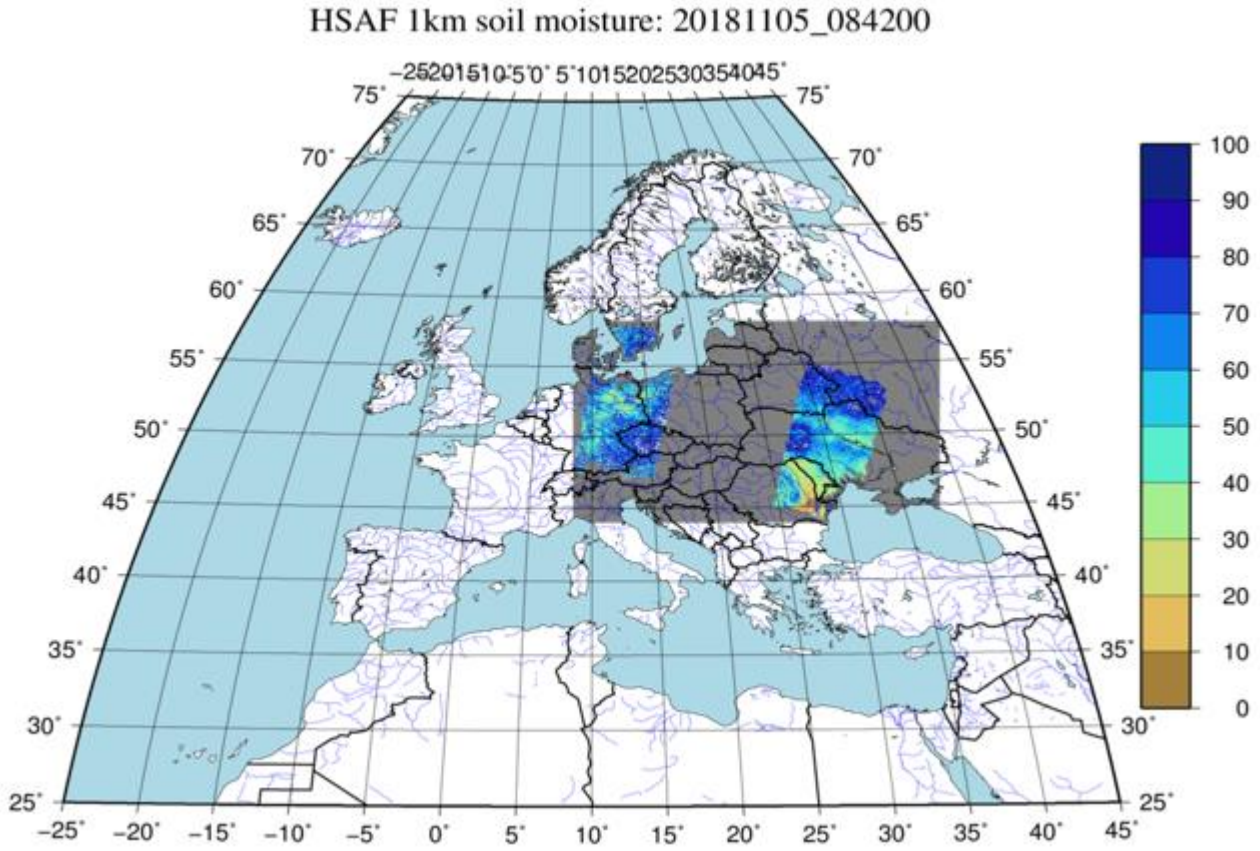
Soil Moisture Data Records

H25 - SSM ASCAT DR2015 TS12.5	Metop ASCAT DR2015 SSM time series 12.5 km sampling	Released
H109 - SSM ASCAT DR2016 TS12.5	Metop ASCAT DR2016 SSM time series 12.5 km sampling	Released
H111 - Metop ASCAT SSM CDR2016	Metop ASCAT DR2017 SSM time series 12.5 km sampling	Released
H113 - Metop ASCAT SSM CDR2017	Metop ASCAT DR2018 SSM time series 12.5 km sampling	Released
H27 SM-DAS-3	Scatterometer Root Zone Soil Moisture (RZSM) Data Record, based on ERS-SCAT and ASCAT-A assimilation, at 16km resolution	Released
H140 SM-DAS-DR2018-EXT-16km	Extension of H27 for 2015-2016	Released

H-SAF Operational Products: Soil Moisture

SSM ASCAT NRT DIS / H08

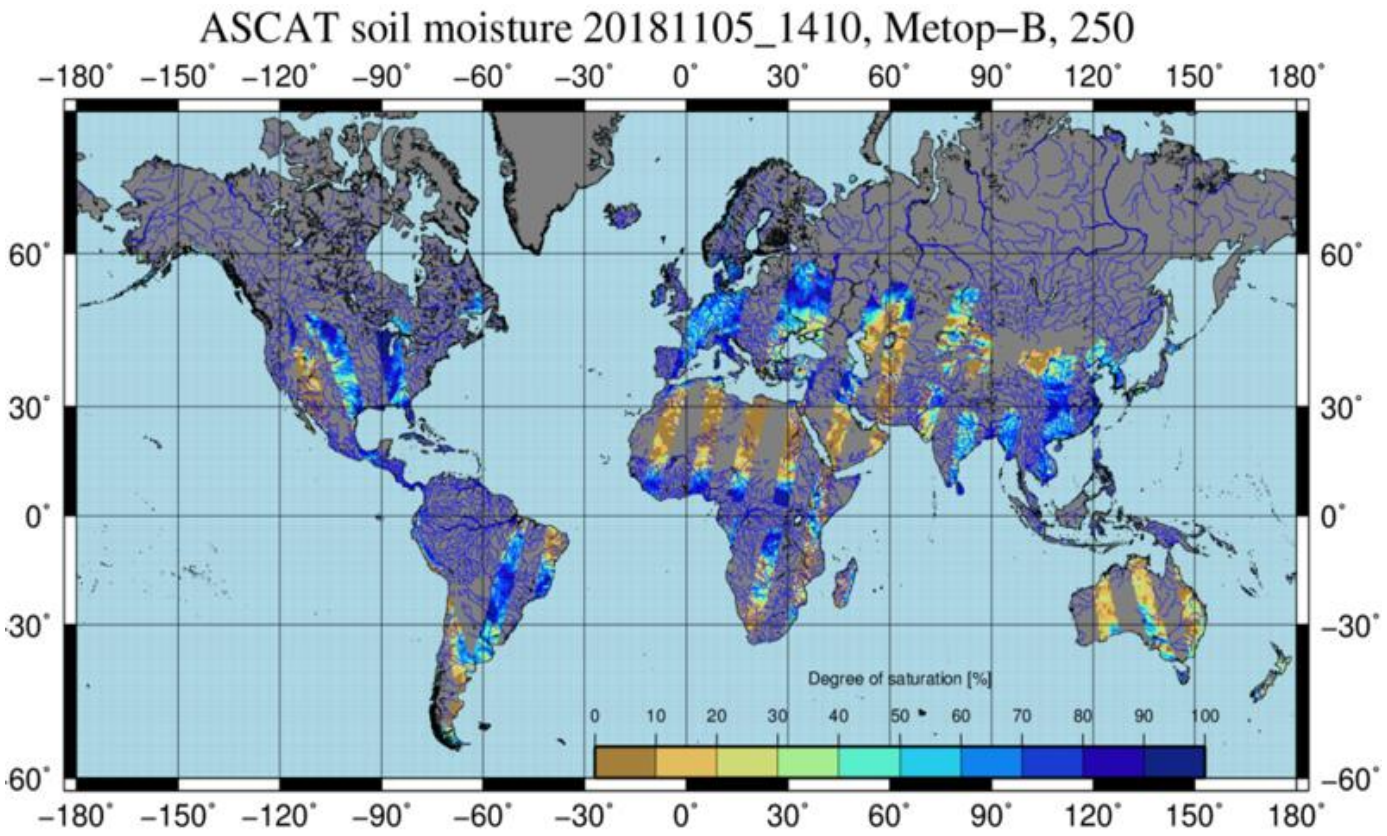
Small-scale surface soil moisture by radar scatterometer [1 km, ASCAT/SAR]



H-SAF Operational Products: Soil Moisture

SSM ASCAT-A NRT / H16, H101, H102, H103

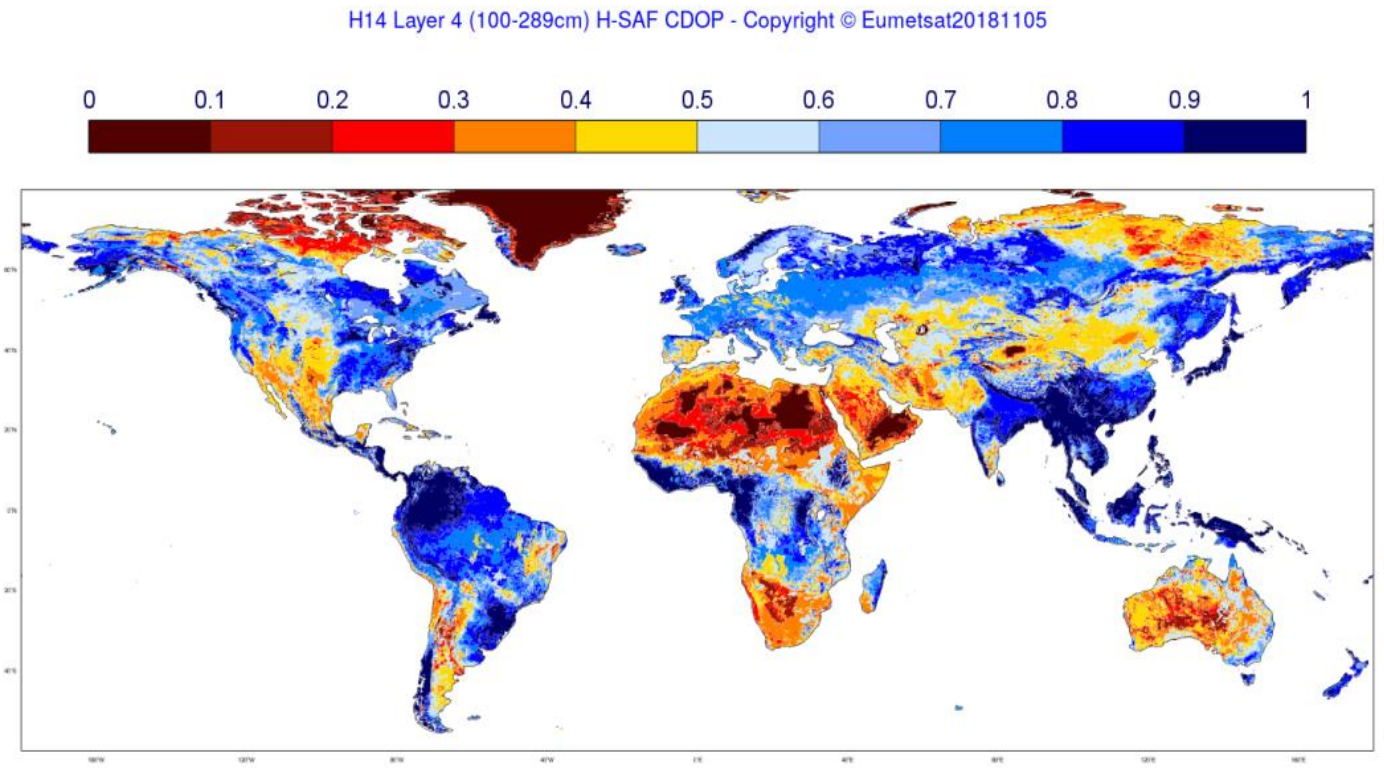
ASCAT NRT SSM orbit geometry (12,5 / 25 km sampling)



H-SAF Operational Products: Soil Moisture

SM-DAS-2 / H14

Soil Moisture Profile Index in the roots region retrieved by surface wetness scatterometer assimilation method



In development Soil Moisture products

Strategy and foreseen improvements

Higher resolution

- For Surface Soil Moisture

Higher resolution

- For Root Zone Soil Moisture

Transition to EPS-SG

- From ASCAT to SCA, both surface and Root Zone Soil Moisture

CDOP3 **CDOP4**

In development Soil Moisture products

H28 SSM ASCAT NRT DIS	Disaggregated Metop ASCAT NRT SSM at 1 km	Higher Resolution
H26 RZSM-ASCAT-NRT-10	Metop ASCAT NRT Root Zone Soil Moisture 10km resolution	Higher Resolution
H122→H124 SSM ASCAT-A/B/C NRT O6.25	ASCAT NRT SSM orbit geometry 6.25 km sampling	Higher Resolution
H73 SSM SCA NRT DIS	Disaggregated Metop-SG SCA NRT SSM at 1 km	Transition to EPS-SG SCA
H80→H83 SSM SCA-1/2B NRT O6.25/O12.5	**Metop-SG SCA-1B** – H80 NRT SSM orbit geometry 6.25 km sampling – H81 NRT SSM orbit geometry 12.5 km sampling **Metop-SG SCA-2B** – H82 NRT SSM orbit geometry 6.25 km sampling – H83 NRT SSM orbit geometry 12.5 km sampling	Transition to EPS-SG SCA
H76 RZSM-SCA-NRT-10	root zone soil moisture transition to SCA (res. 10 km, accuracy R > 0.65)	Transition to EPS-SG SCA
ASCAT SSM and RZSM Data Record release		Yearly release

H-SAF Operational Products: Snow

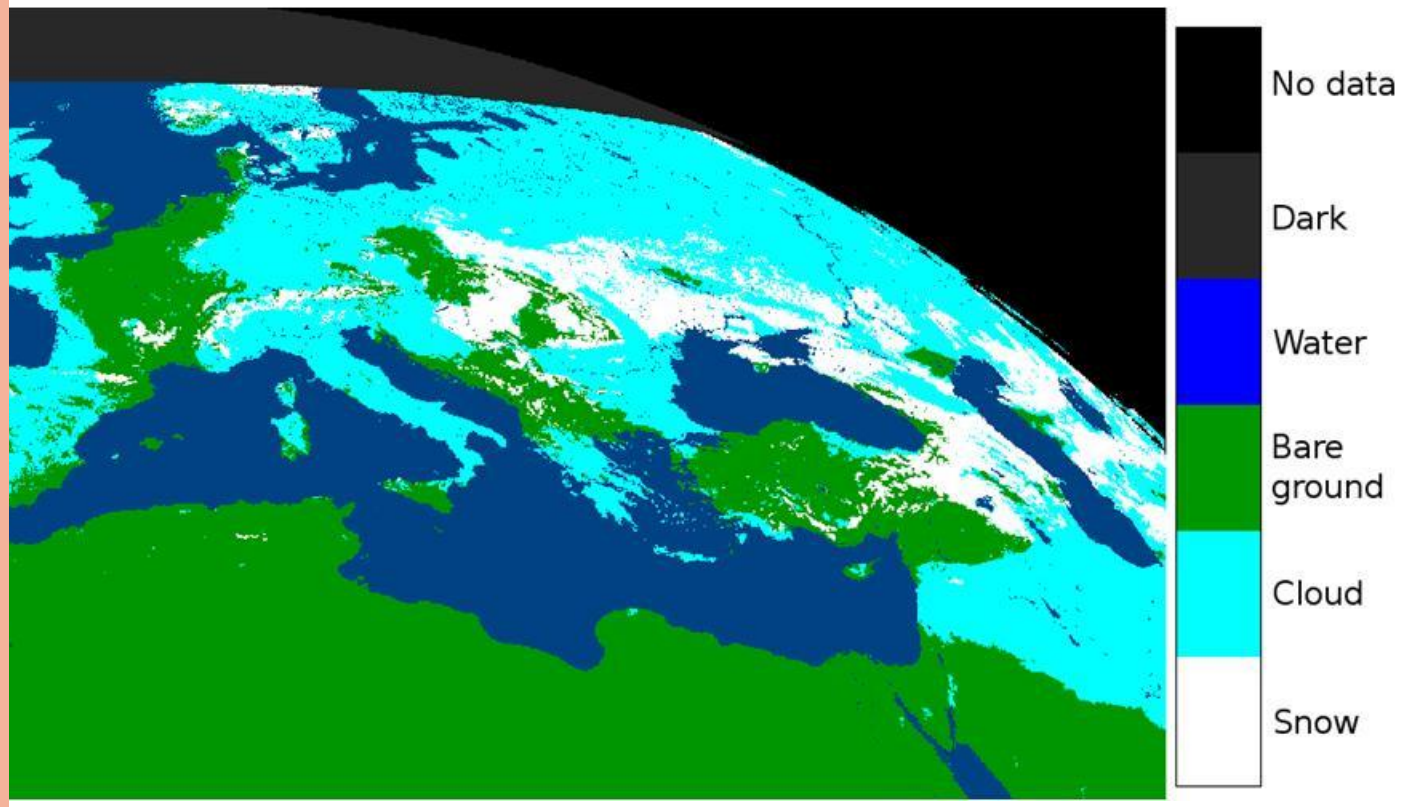
Snow Products

H10 SE-E-SEVIRI	Snow detection (snow mask) by VIS/IR radiometry	Operational
H11 WS-E	Snow status (dry/wet) by MW radiometry	Operational
H12 FSC-E	Effective snow cover by VIS/IR radiometry	Operational
H13 SWE-E	Snow water equivalent by MW radiometry	Operational

H-SAF Operational Products: Snow

SE-E-SEVIRI / H10 Snow detection (snow mask) by VIS/IR

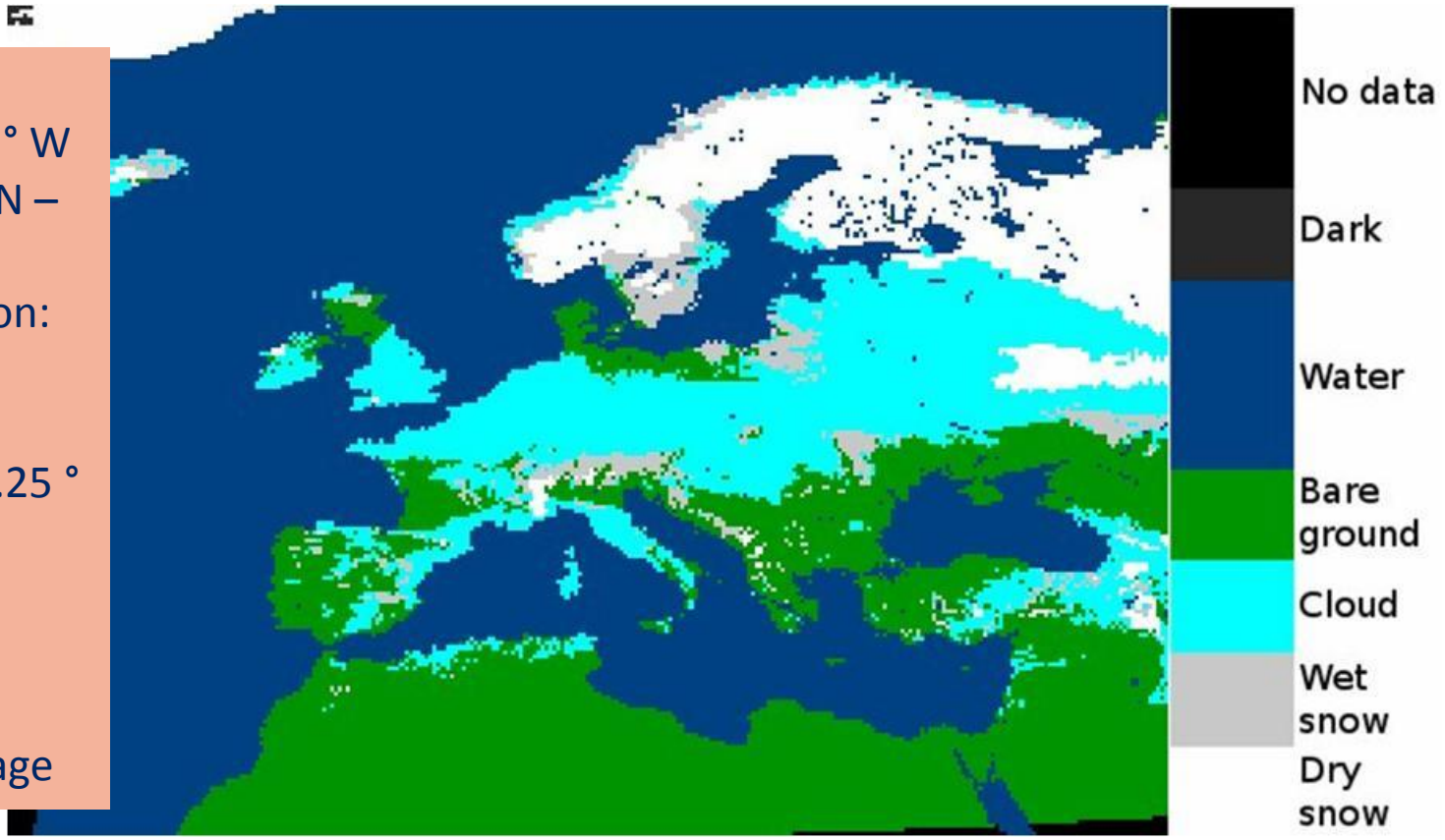
- Cycle: Daily
- Coverage: Europe, Northern Africa, Middle East
- Grid/Projection: Part of Meteosat/SEVIRI 0° fulldisk, GEOS projection
- Resolution: Variable from 3 km to 10 km, depending on distance from sub-satellite point
- Formats: HDF5, PNG quicklook



H-SAF Operational Products: Snow

WS-E / H11 Snow status (dry/wet) by MW

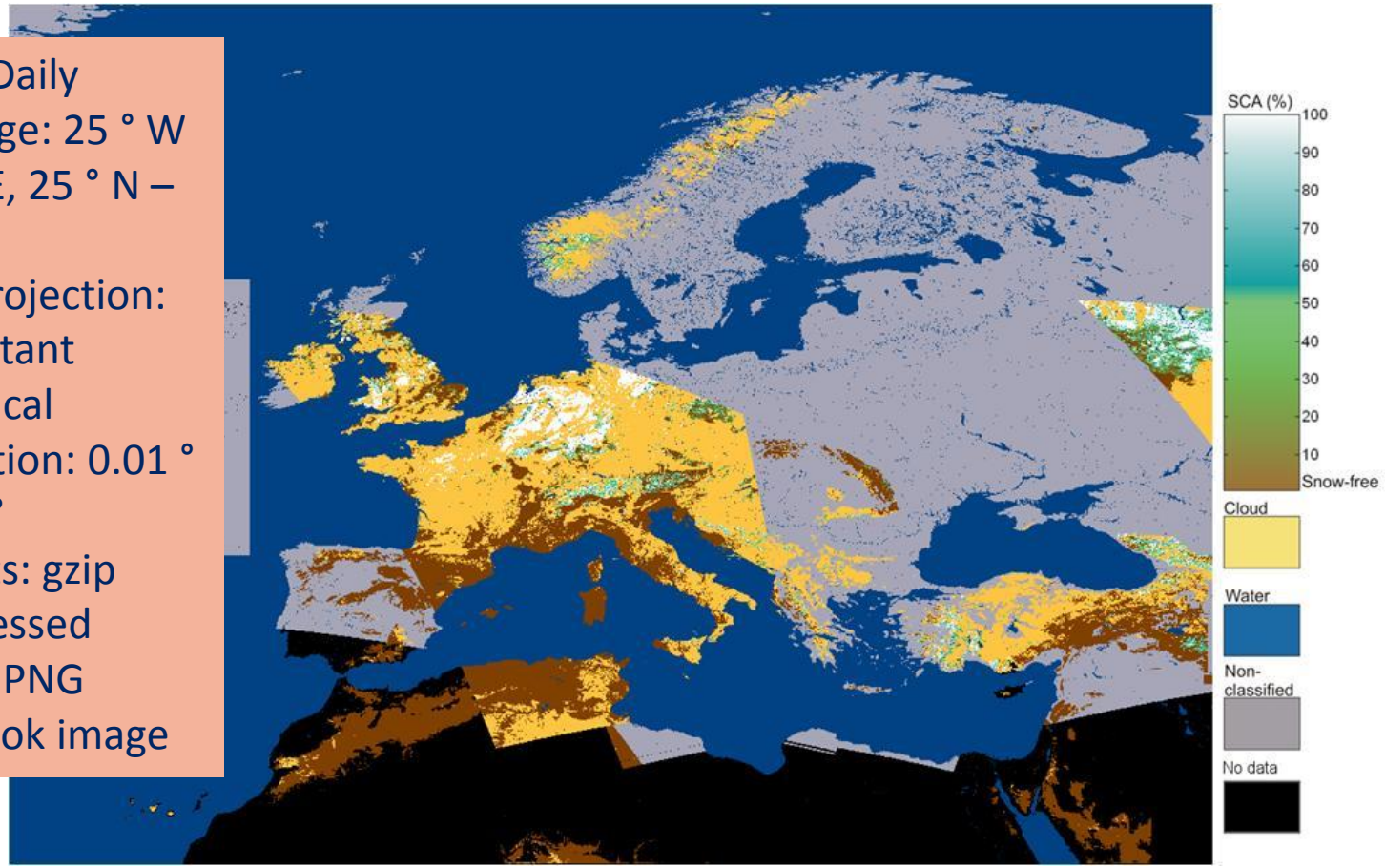
- Cycle: Daily
- Coverage: 25 ° W – 45 ° E, 25 ° N – 75 ° N
- Grid/Projection: Equidistant cylindrical
- Resolution: 0.25 ° x 0.25 °
- Formats: gzip compressed GRIB2, PNG quicklook image



H-SAF Operational Products: Snow

FSC-E / H12 Effective snow cover by VIS/IR

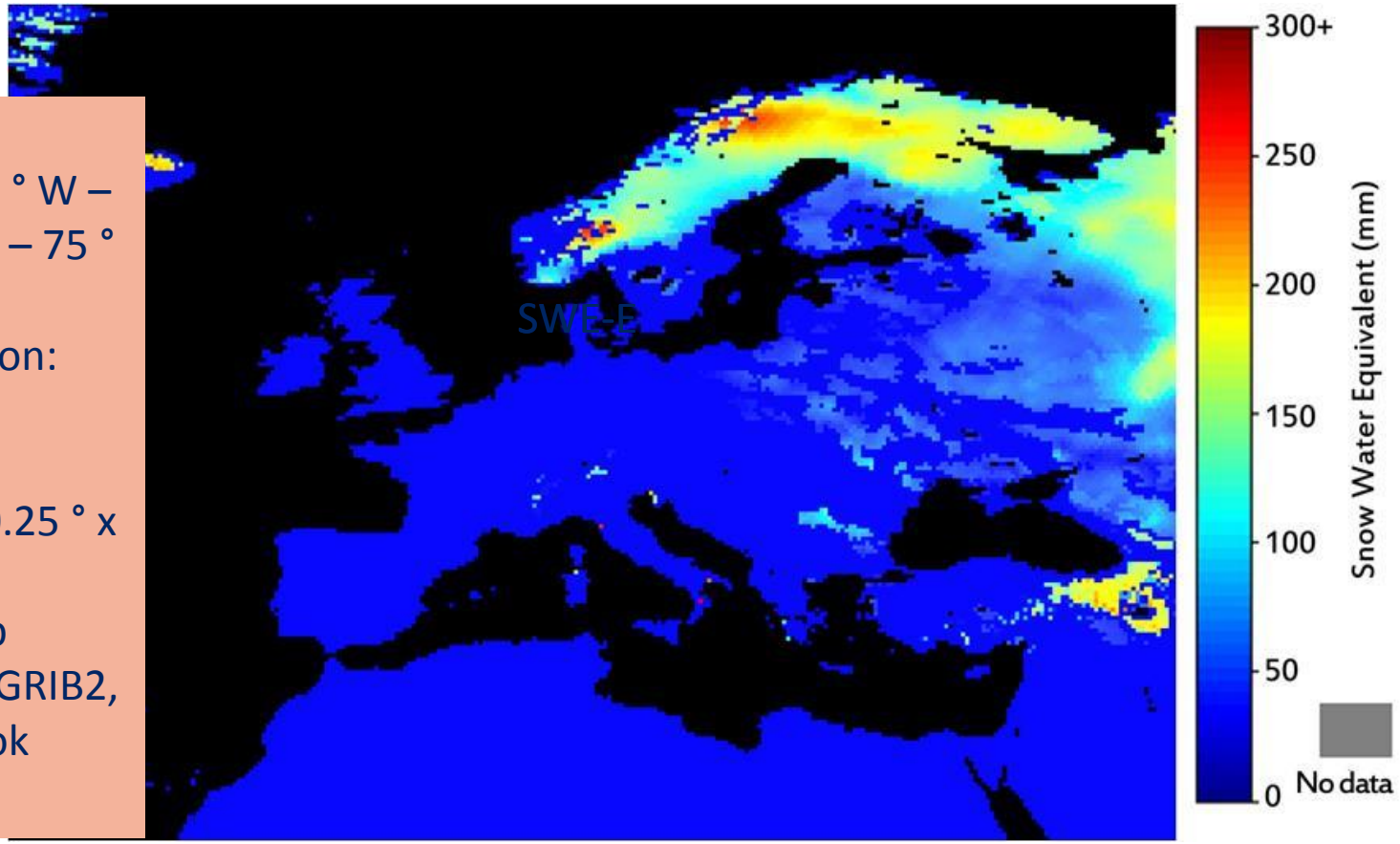
- Cycle: Daily
- Coverage: 25 ° W – 45 ° E, 25 ° N – 75 ° N
- Grid/Projection: Equidistant cylindrical
- Resolution: 0.01 ° x 0.01 °
- Formats: gzip compressed GRIB2, PNG quicklook image



H-SAF Operational Products: Snow

SWE-E / H13 Snow water equivalent by MW

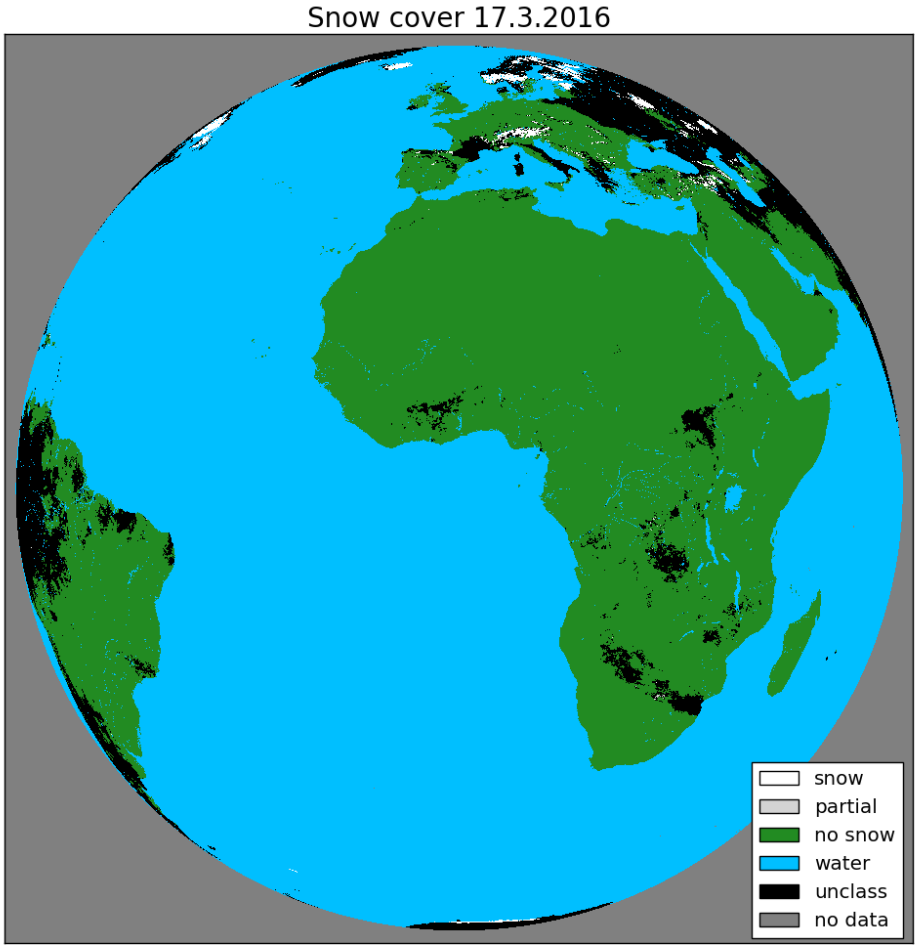
- Cycle: Daily
- Coverage: 25 ° W – 45 ° E, 25 ° N – 75 ° N
- Grid/Projection: Equidistant cylindrical
- Resolution: 0.25 ° x 0.25 °
- Formats: gzip compressed GRIB2, PNG quicklook image



H-SAF Operational Products: Snow

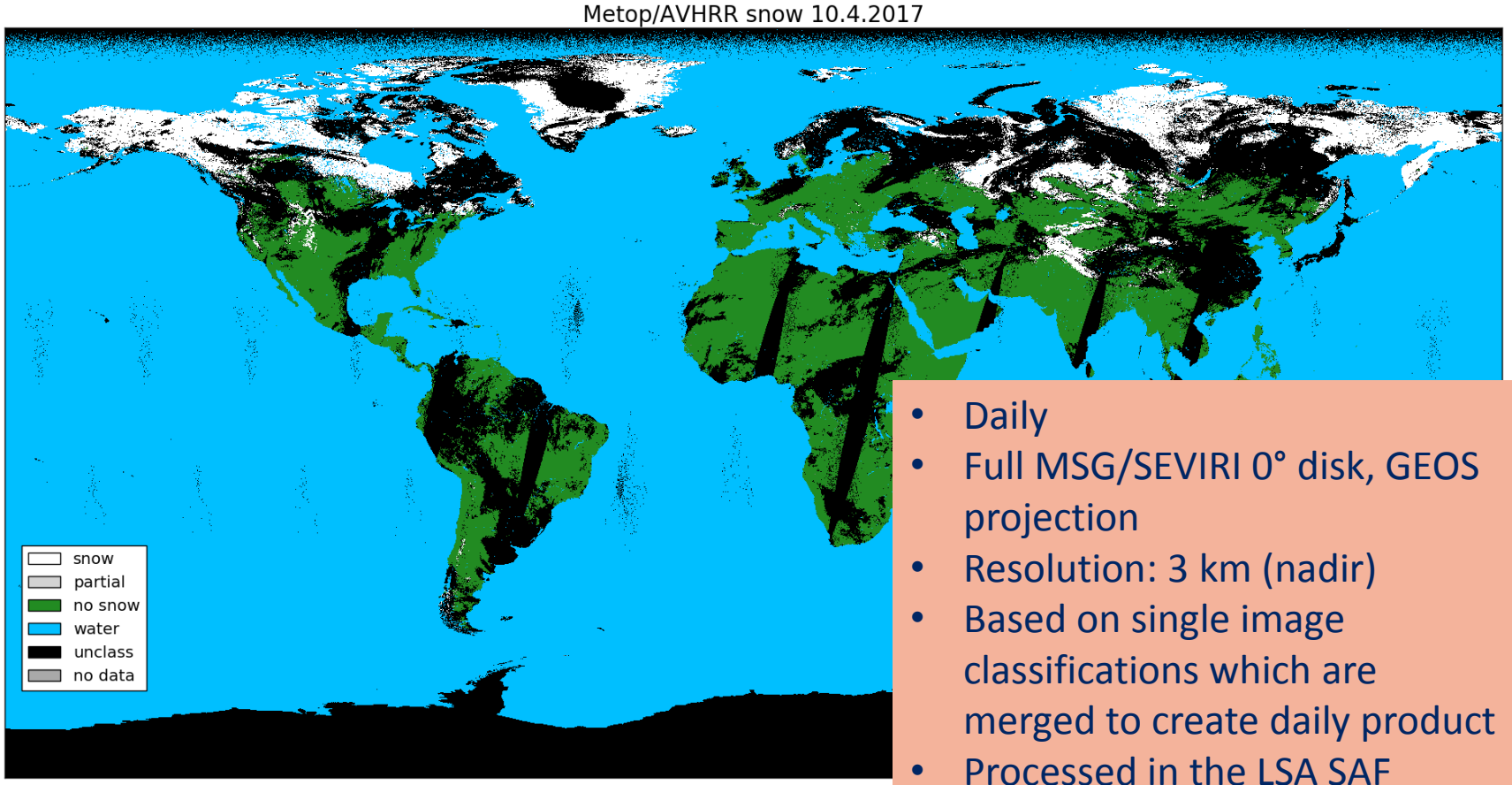
SE-DF-SEVIRI / H31 MSG/SEVIRI snow extent

- Daily
- Full MSG/SEVIRI 0° disk, GEOS projection
- Resolution: 3 km (nadir)
- Based on single image classifications which are merged to create daily product
- Processed in the LSA SAF



H-SAF Operational Products: Snow

SE-G-AVHRR / H32 Metop/AVHRR snow extent



- Daily
- Full MSG/SEVIRI 0° disk, GEOS projection
- Resolution: 3 km (nadir)
- Based on single image classifications which are merged to create daily product
- Processed in the LSA SAF

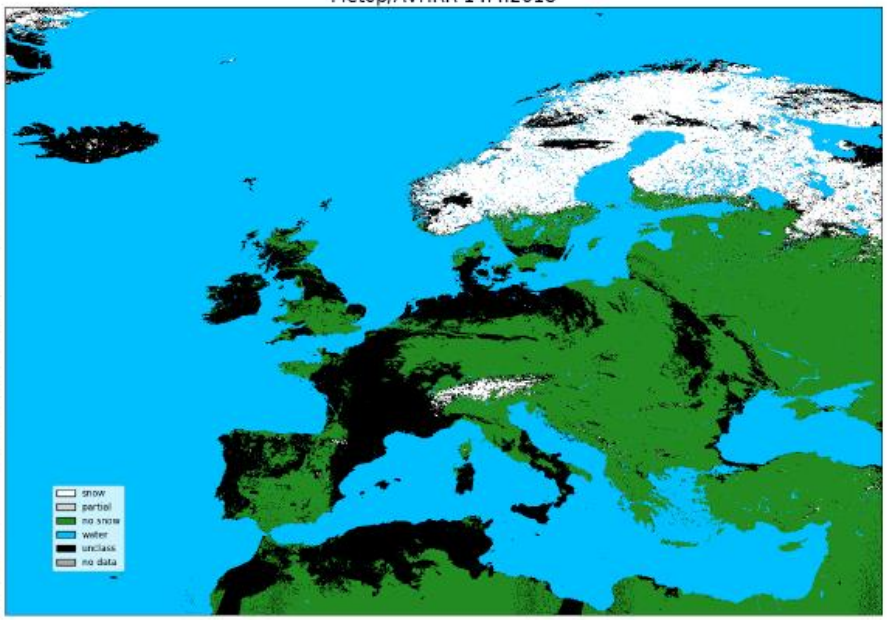
H-SAF Operational Products: Snow

- FINNISH METEOROLOGICAL INSTITUTE

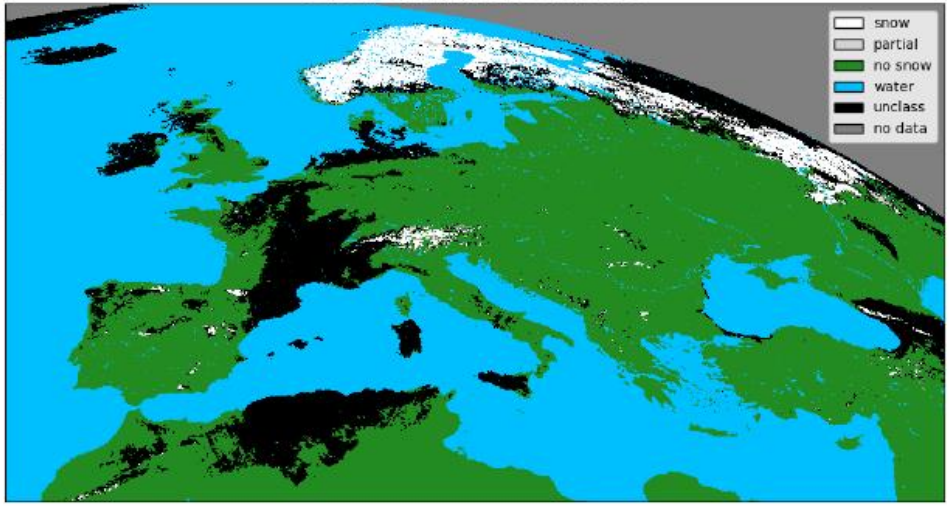
April 14, 2018

NASA Worldview (MODIS, Suomi NPP)

Metop/AVHRR 14.4.2018



MSG/SEVIRI 14.04.2018



The future: in development Snow products

Strategy and foreseen improvements – Snow Products

Enlargement to Northern Hemisphere

Transition to MSG

- From FCI

Transition to EPS-SG

- From MetImage

CDOP3

CDOP4

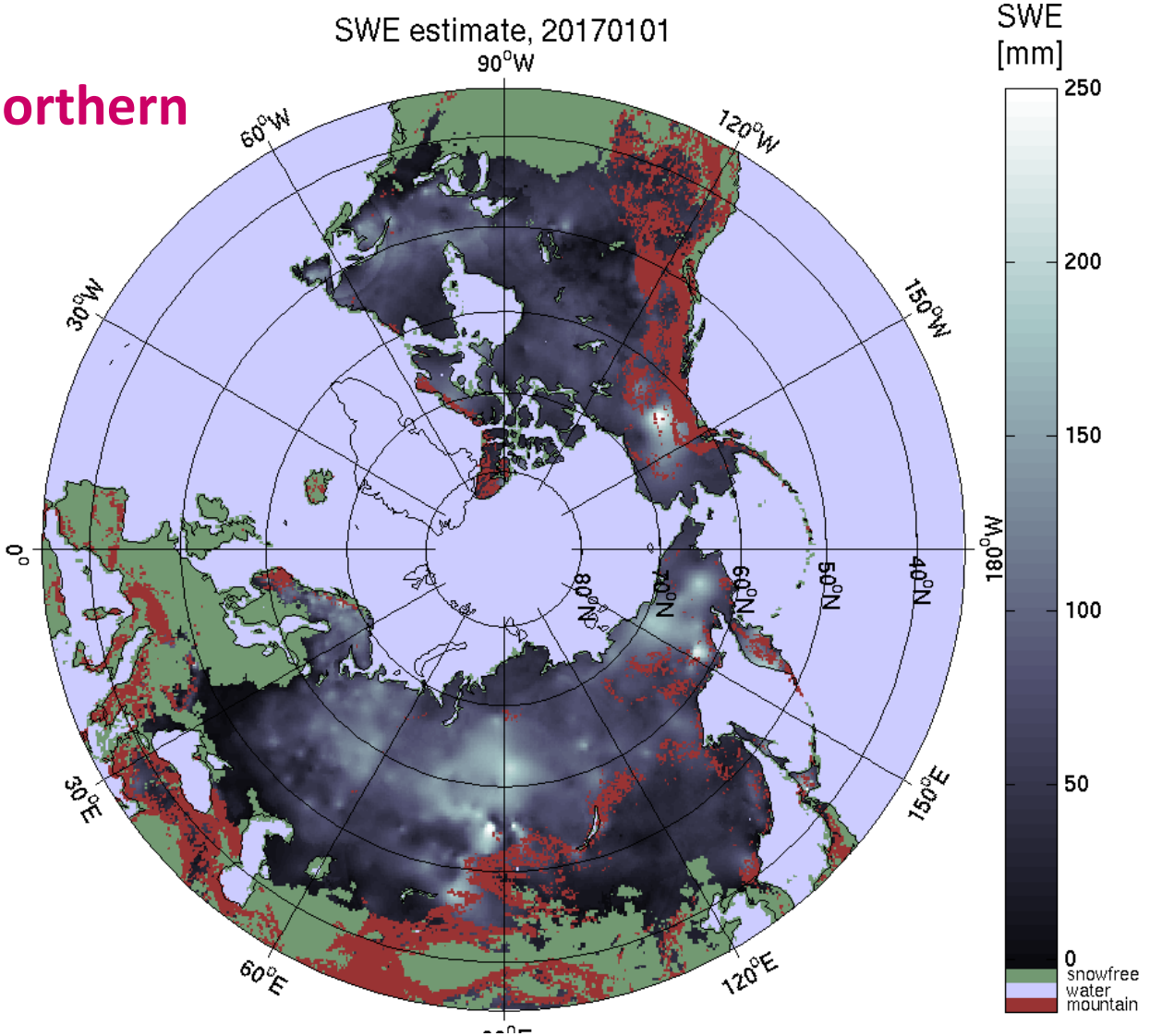
The future: in development Snow products

H34	Snow detection (snow mask) by VIS/IR radiometry	The H10 algorithm applied to full disk	Full MSG/SEVIRI 0° disk, GEOS projection
H35	Effective snow cover by VIS/IR	The H12 algorithm applied to Northern Hemisphere	Coverage: 180 ° W – 180 ° E, 0 ° N – 90 ° N Resolution: 0.01 ° x 0.01 °
H43 SE-D-FCI	Snow detection (snow mask) by VIS/NIR of MTG FCI	MTG-based Product Expected operations in CDOP-4	Daily Full MTG/FCI disk Satellite grid Resolution: about 1 km (nadir)
H65 SWE-H	New Global (hemispherical) SWE 25 km resolution	Expected operations in 2019	Cycle: Daily Coverage: Northern Hemispherical Grid/Projection: “EASE-Grid” - Lambert's equal-area Resolution: 25 km x 25 km Formats: HDF5
H85 SE-G-MI	Metop-SG/Metimage snow extent	Metop-SG/Metimage based product Expected operations in CDOP-4	Daily Global Grid/projection: TBD Resolution: about 1 km

The future: in development Snow products

H65: Enlargement to Northern Hemisphere

Cycle: Daily
Coverage: Northern Hemispherical
Grid/Projection: “EASE-Grid” - Lambert's equal-area
Resolution: 25 km x 25 km
Formats: HDF5, PNG quicklook
Operational status: **In development**



The H SAF Services

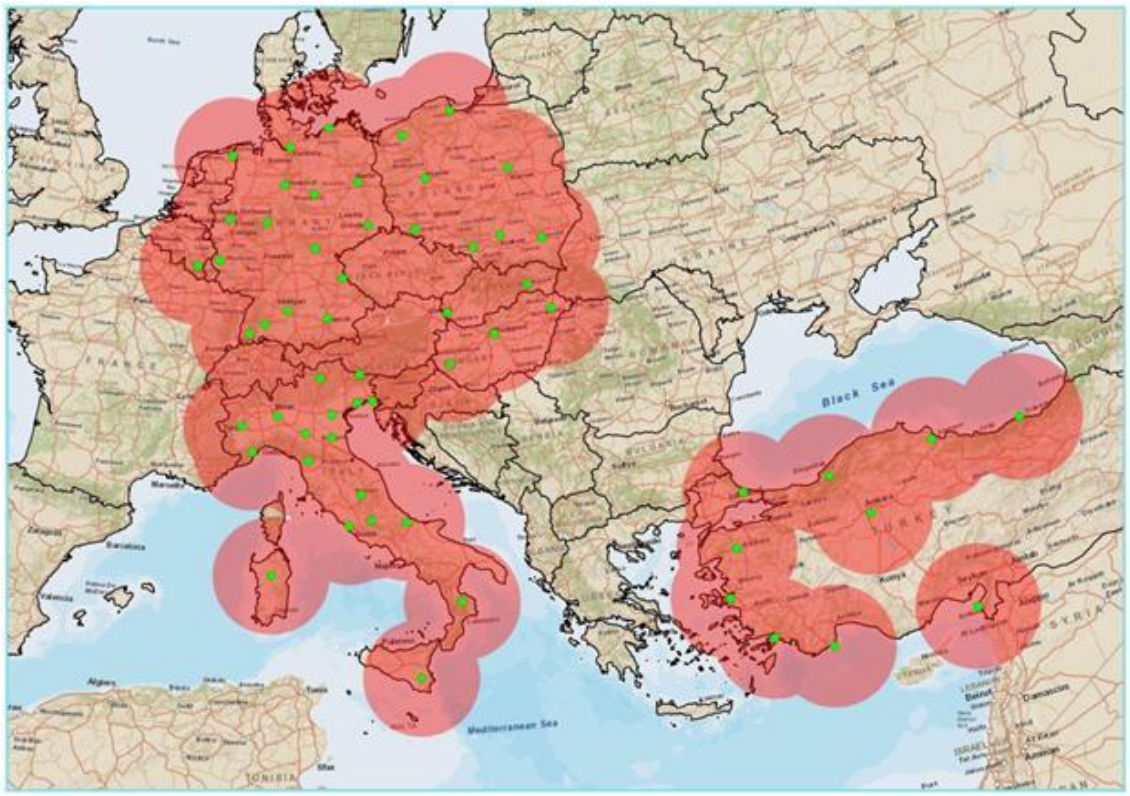
H SAF: Support to Operational Hydrology and Water Management

Quality Monitoring Programme

- Quality Monitoring Programme provides a continuous assessment of the products quality and performances by evaluating **statistical scores** and **case study analysis** on the base of **comparison between satellite products and ground data**

Quality Monitoring Programme

The Quality Monitoring Cluster is composed of experts from the National Meteorological and Hydrological Institutes of 8 European countries under the coordination of the Italian Civil Protection Department (DPC). The PPVG uses ground measurement for validation: for precipitation products, for example, **rain gauge** and **radar** data are used.



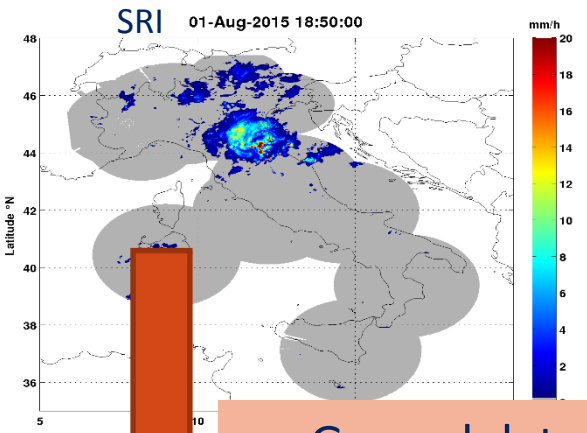
Country (Acronyms)	Institutes
Belgium (BE)	IRM
Bulgaria (BG)	NIMH
Germany (DE)	BfG
Hungary (HU)	OMSZ
Italy (IT-DPC, IT-UNIFE)	DPC, UniFe
Poland (PL)	IMWM
Slovakia (SK)	SHMU
Turkey (TU)	ITU, METU, TSMS

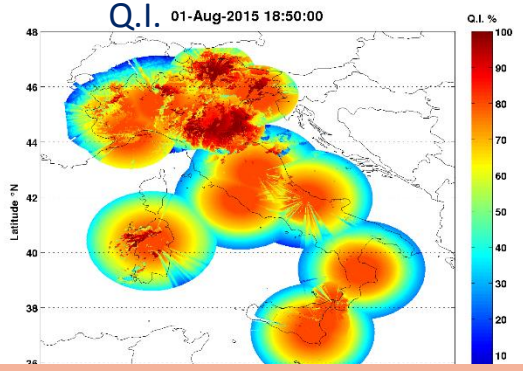
Country	Total number of gauges *	Average minimum distance (km)
Belgium	89**	11.2
Germany	1300	17
Italy	2600	9.5
Poland	330-475	13.3
Turkey	193***	27

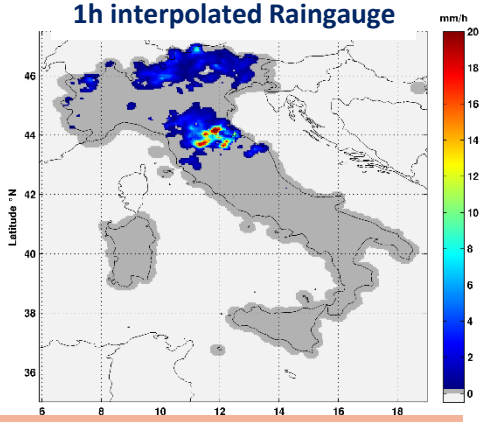
* the number of rain gauges could vary from day to day due to operational efficiency within a maximum range of 10-15%.
** only in the Wallonia Region
*** only covering the western part of Anatolia

Quality Monitoring Programme

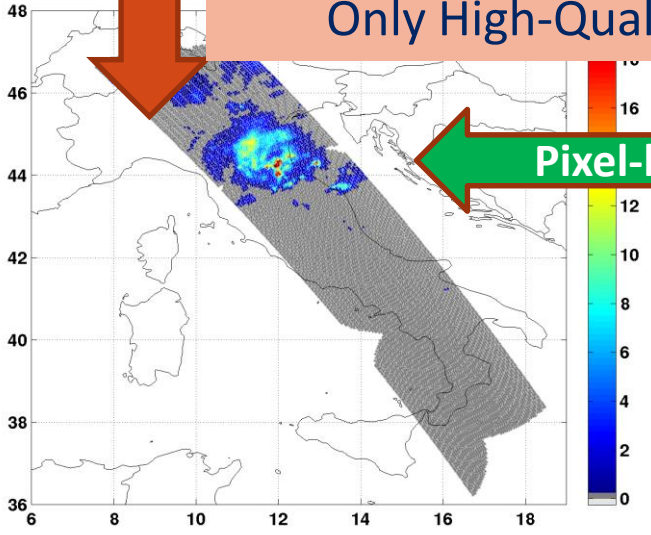
Validation Methodology



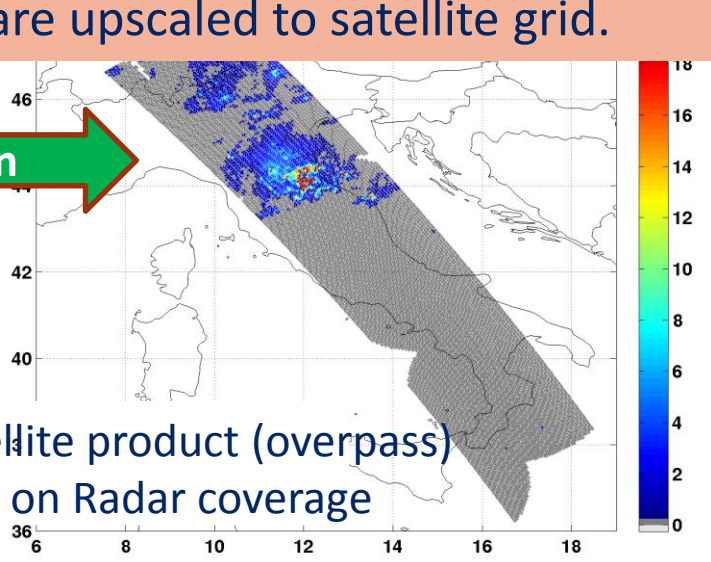




Ground data (Radar, Raingauge and relative quality index) are quality-checked and filtered.
Only High-Quality Radar Data are upscaled to satellite grid.



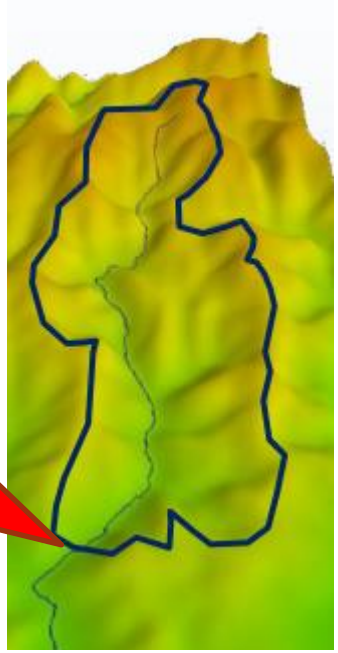
Pixel-based comparison

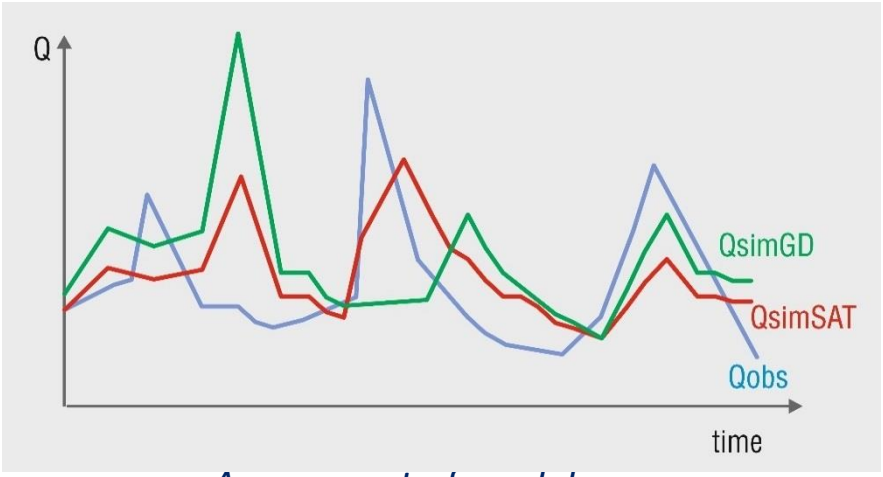


Satellite product (overpass) on Radar coverage

Hydrovalidation Programme

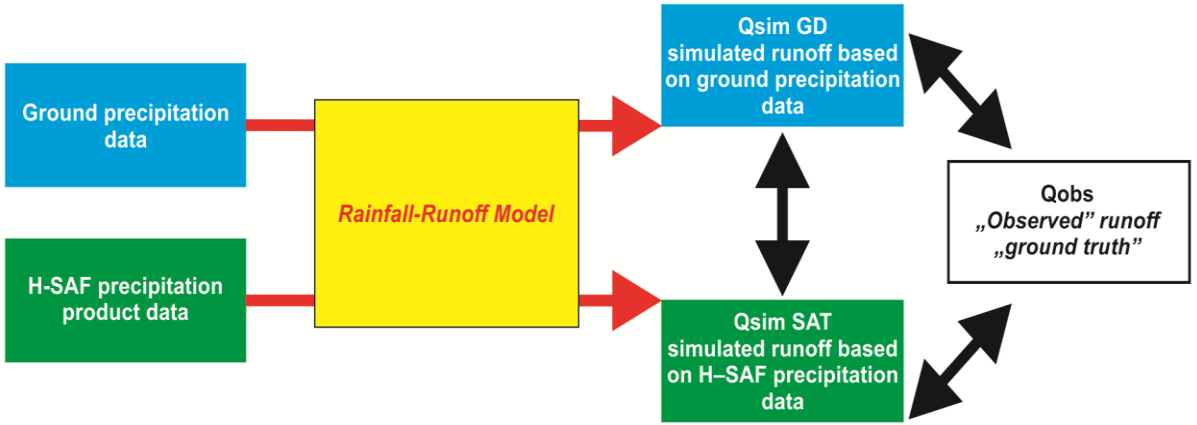
The Hydrological Validation





Assessment of model

Indirect comparison, end user point of view



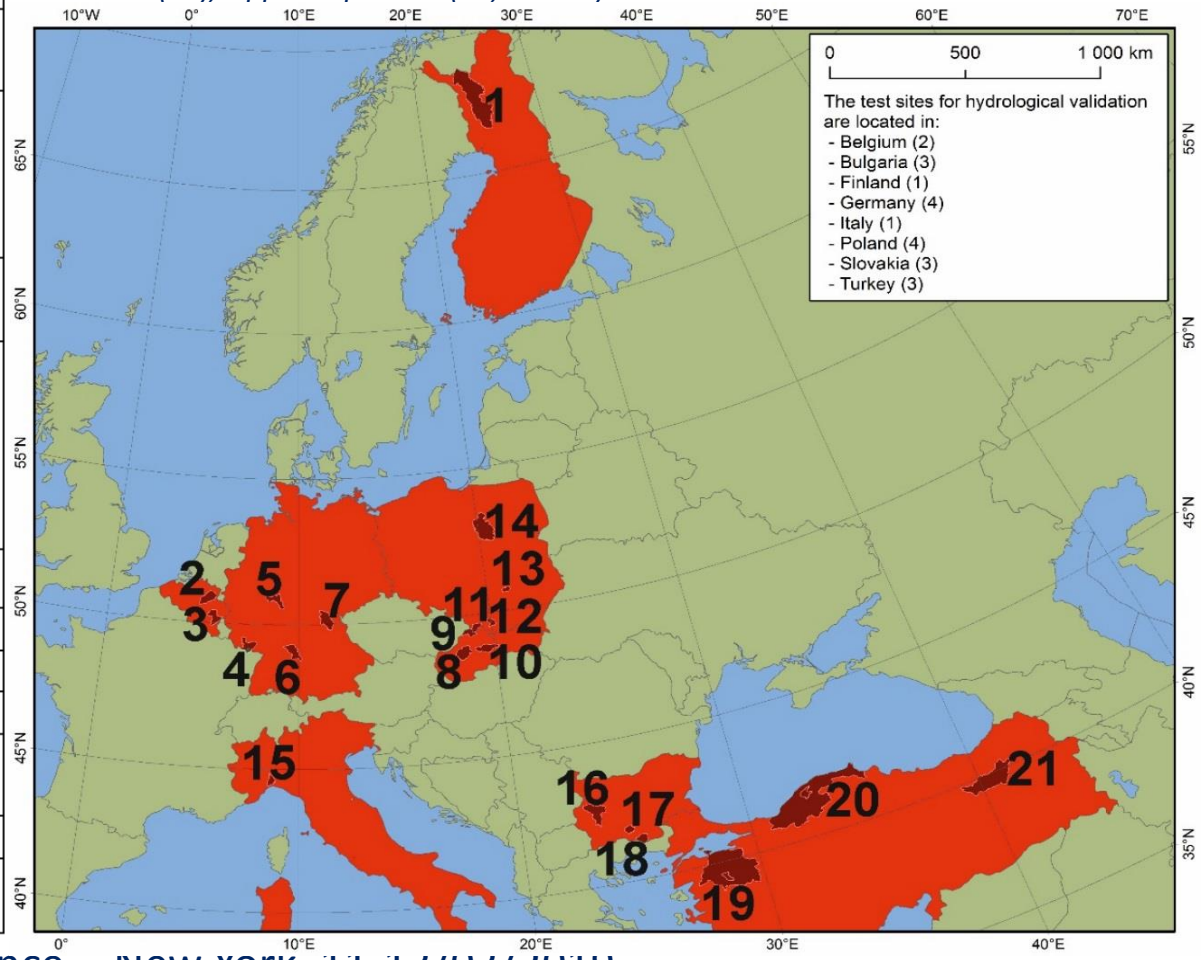
assessment of products

Hydrovalidation Programme

Test sites and models

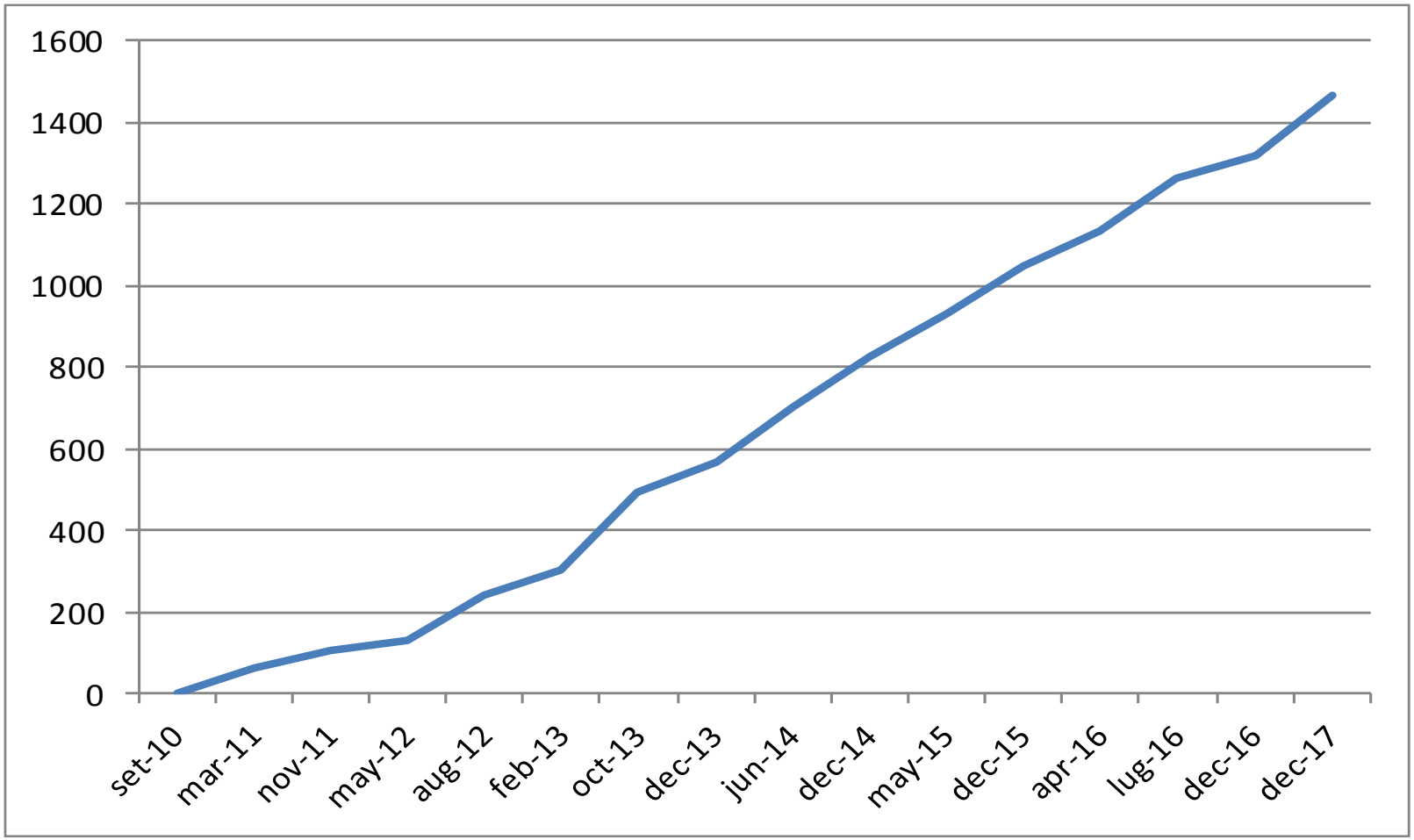
Country	Basin	Model
Finland	Ounasjoki	HOPS
	Simojoki	
	Kiiminkijoki	
Belgium	Demer-Scheldt	SCHEME
	Ourthe-Meuse	
Germany	Blies	HBV
	Lahn	
	Kocher	
	Main	
Slovakia	Nitra	Hron-NAM
	Kysuca	
	Hron	HBV
Poland	Soła	
	Raba	
	Wkra	
	Czarna	
Italy	Orba	Continum
Bulgaria	Iskar River	ANN
	Chepelarska	Isba-Modcou
	Varbica river	Mike-11/NAM
Turkey	Killi	ANN
	Ulus	
	Karasu (Upper Euphrates)	SRM
		HBV

Ounasjoki (no 1), Demer-Scheldt (no 2), Ourthe-Meuse (no 3), Blies (4), Lahn (5), Kocher (6), Main (7), Nitra (8), Kysuca (9), Hron (10), Soła (11), Raba (12), Czarna and Lagowianka (13), Wkra (14), Orba (no 15), Iskar River (no 16) , Chepelarska (no 17), Varbica river (no 18), Killi subbasin in Susurluk Basin (19), Ulus subbasin in Western Black Sea Basin (20), Upper Euphrates (21, Karasu)



User Services – user community

Trend in user registration



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Thank you for your attention

http://hsaf.meteoam.it/