The EUMETSAT Satellite Application Facility on support to Operational Hydrology and Water Management (H-SAF)

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Thanks for contributions to all HSAF participats

Outline

- **Background, objectives, partnership**
- **The products (precipitation, soil moisture, snow parameters)**
- **The Hydrological validation programme**
- **The stepwise development approach**
- **Opportunities for cooperation with International ATOVS Group**

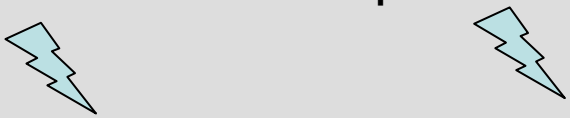
SATELLITE APPLICATION FACILITIES (SAF's):

decentralised elements of the EUMETSAT Application Ground Segment

Meteosat

MetOp-EPS

Other satellites (NOAA, TRMM, AQUA, ...)



Climate SAF

Ozone SAF

Nowcasting SAF

Land SAF

EUMETSAT Central Facility

Ocean & Ice SAF

GRAS Meteo SAF

New !

NWP SAF

Hydrology SAF

U S E R S

HSAF BACKGROUND

In recent years, the interest of the hydrological community for using satellite data has rapidly increased because of:

- improved satellite data quality;
- improved performance of hydrological models including their capability to assimilate observational data.

Steps towards the establishment of H-SAF:

- **2001-2002:** Working Group on a Potential SAF (established objectives).
- 2003-2004: SAF Hydrology Framework Working Group (defined scientific strategy and long term vision).
- 2005: Proposal for the H-SAF Development Phase (2005-2010) delivered.
- **HSAF Development Phase approved by Eumetsat Council on 3 July 2005.**

HSAF Development Phase Status as of today:

- **Kick-Off meeting held on 15 September 2005 in Rome**.
- Requirements Review meeting held on 26-27 April 2006.
- Primary Design Review (11-12 December 2006, being prepared)
- **First HSAF Workshop (October 2007 being prepared)**

The Operational Phase should follow in 2010-2015.

Objectives of H-SAF

The objectives of H-SAF are:

- **to provide operationally satellite-derived products:**
  - **precipitation (liquid, solid, rate, cumulate)**
  - **soil moisture (at surface, in the roots region)**
  - **snow parameters (cover, melting conditions, water equivalent)**

- **to perform independent validation with Hydrological models of the usefulness of the new products for hydrological applications**

- ***to carry on studies on new algorithms operational implementation*.**

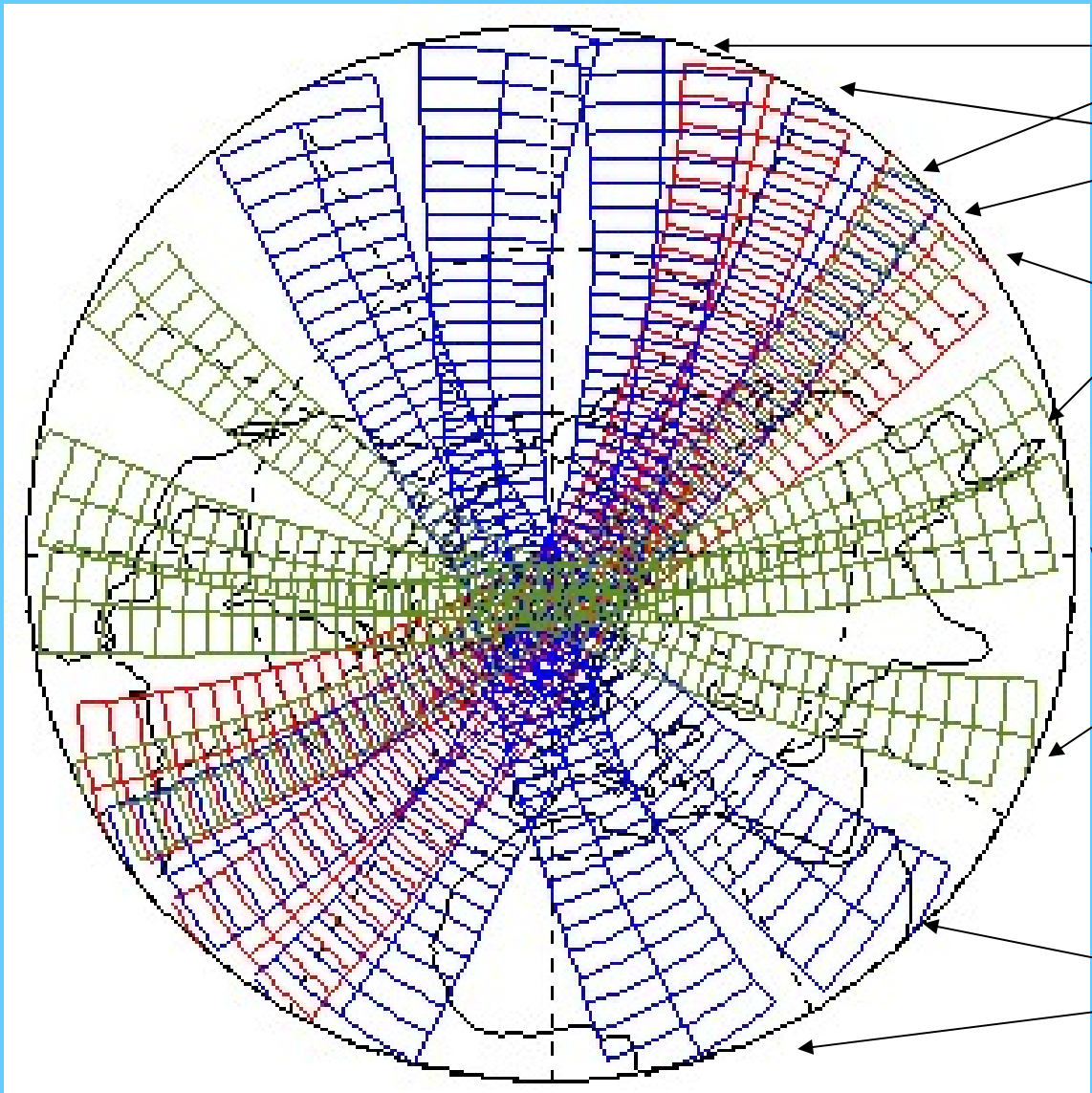
Composition of the H-SAF Consortium

No.	Country	Main Unit in the Country	Role
01	**Austria**	Zentral Anstalt für Meteorologie und Geodynamik	Leader for soil moisture
02	**Belgium**	Royal Meteorological Institute of Belgium	
03	**ECMWF**	N/A	Contributor for "core" soil moisture
04	**Finland**	Ilmatieteen Laitos	Leader for snow parameters
05	**France**	Météo-France	
06	**Germany**	Bundesanstalt für Gewässerkunde	
07	**Hungary**	Hungarian Meteorological Service	
08	**Italy**	Servizio Meteorologico dell'Aeronautica	Host + Leader for precipitation
09	**Poland**	Institute of Meteorology and Water Management	Leader for Hydrology
10	**Romania**	National Institute for Meteorology and Hydrology	
11	**Slovakia**	Slovakia Hydro-Meteorological Institute	
12	**Turkey**	Turkish State Meteorological Service	Contributor for "core" snow parameters

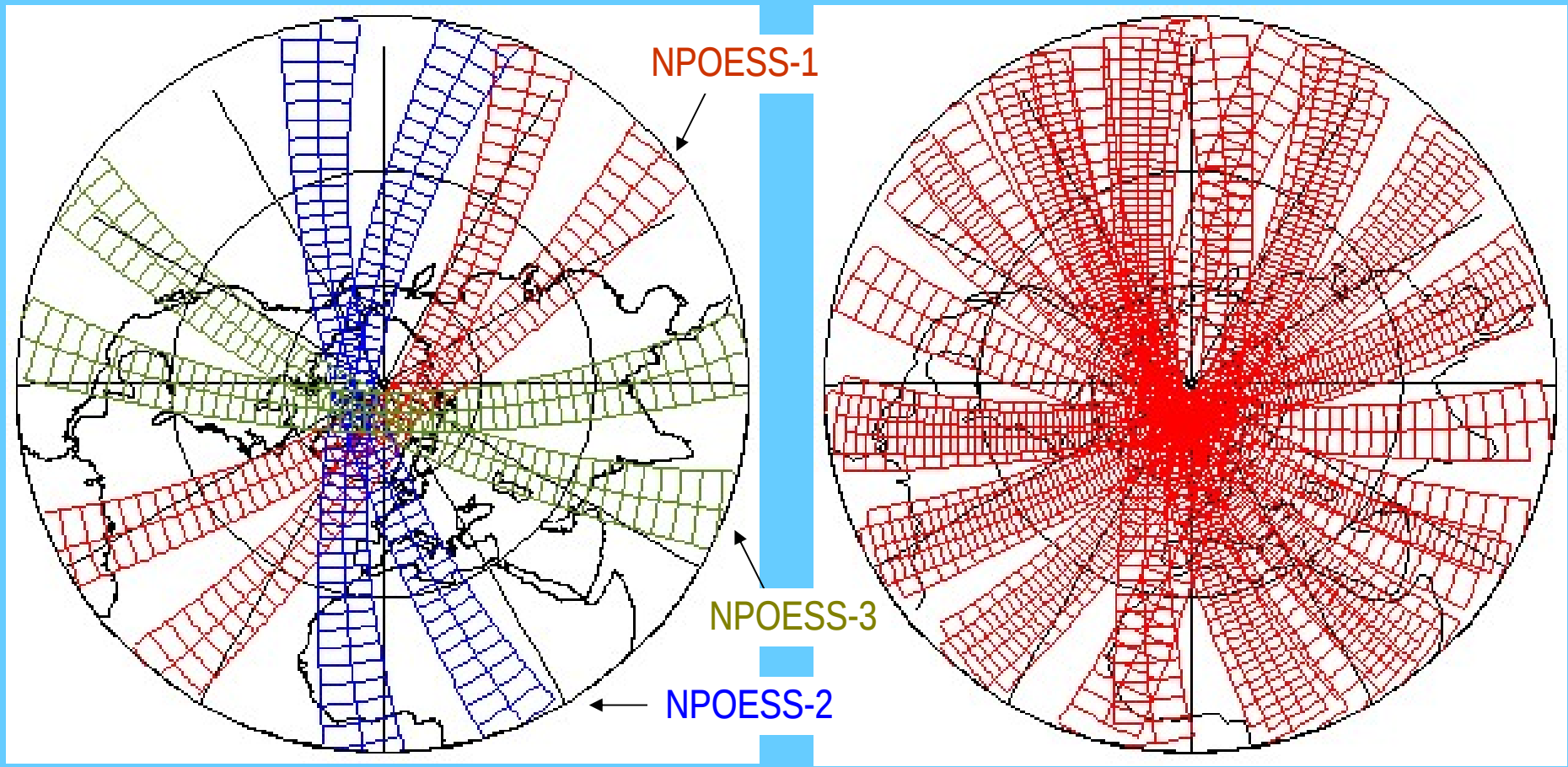
Satellite precipitation products and satellite data sources

Product	Anticipated product quality in the Operational Phase				Satellites / Sensors	
	Resolution	Accuracy	Cycle	Delay	Development	Operations
Precipitation rate (by MW only)	10 km (CMIS) 15 km (additional GPM satellites)	10-20 % (> 10 mm/h) 20-40 % (1-10 mm/h) 40-80 % (< 1 mm/h)	6 h (CMIS only) 3 h (full GPM)	15 min	Meteosat (MVIRI, SEVIRI) + DMSP (SSM/I, SSMIS) + NOAA + MetOp (AMSU-A, AMSU-B/MHS) + EOS/Aqua (AMSR-E, AMSU-A, HSB) + TRMM (TMI, PR, LIS)	Meteosat (SEVIRI) + NPOESS (CMIS, ATMS) + Further satellites of the GPM (all equipped at least with a MW radiometer, one also with radar)
Precipitation rate (by MW + IR)	10 km	Ranging from that of MW to one degraded by an extent TBD	15 min	5 min		
Precipitation phase (by MW only)	10 km (CMIS) 15 km (additional GPM satellites)	80 % probability of correct classification	6 h (CMIS only) 3 h (full GPM)	15 min		
Cumulate precipitation (by MW + IR)	10 km	Tentative: 10 % over 24 h 30 % over 3 h	3 h	15 min		

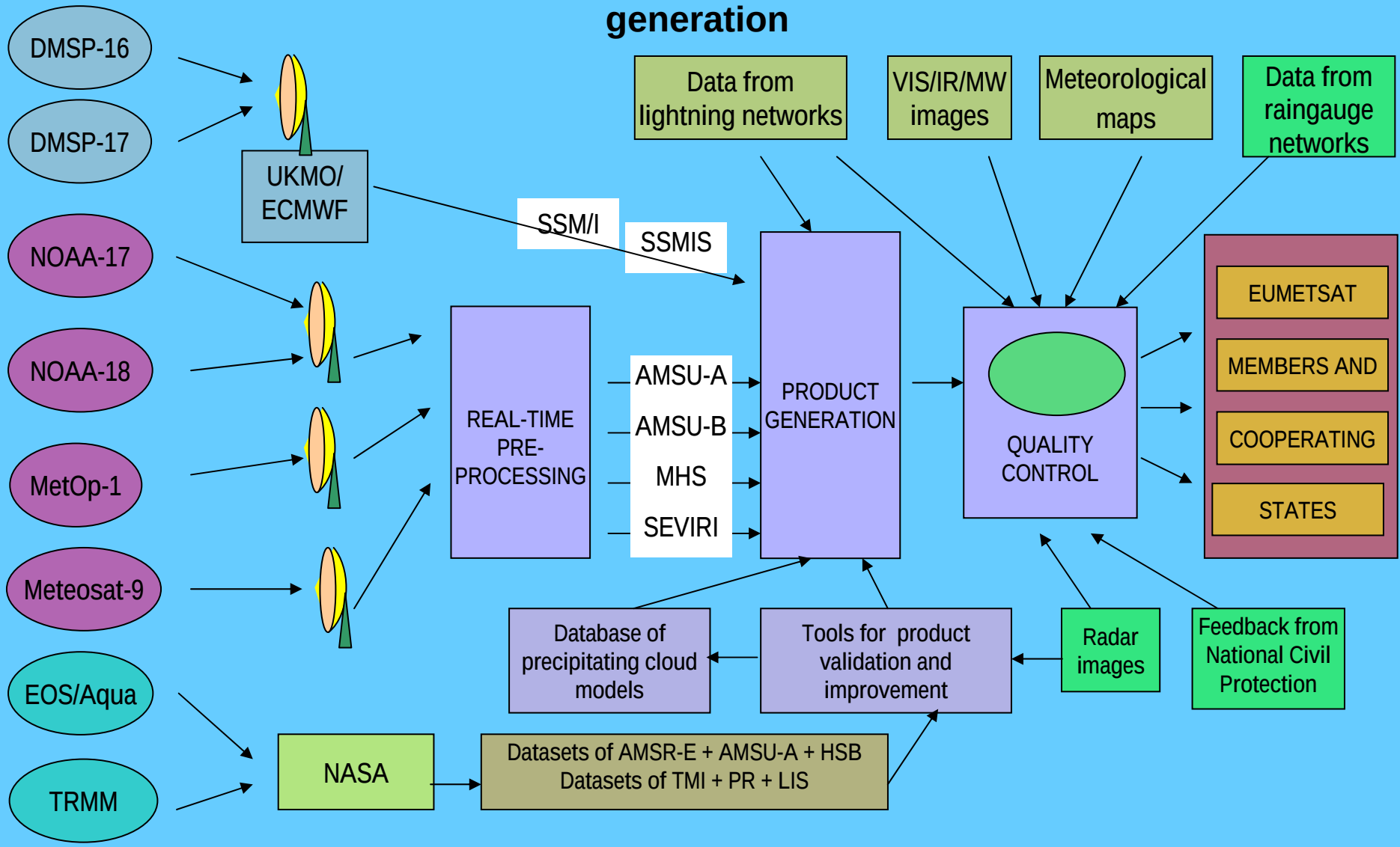
Coverage each three hours by polar satellites operational in 2006



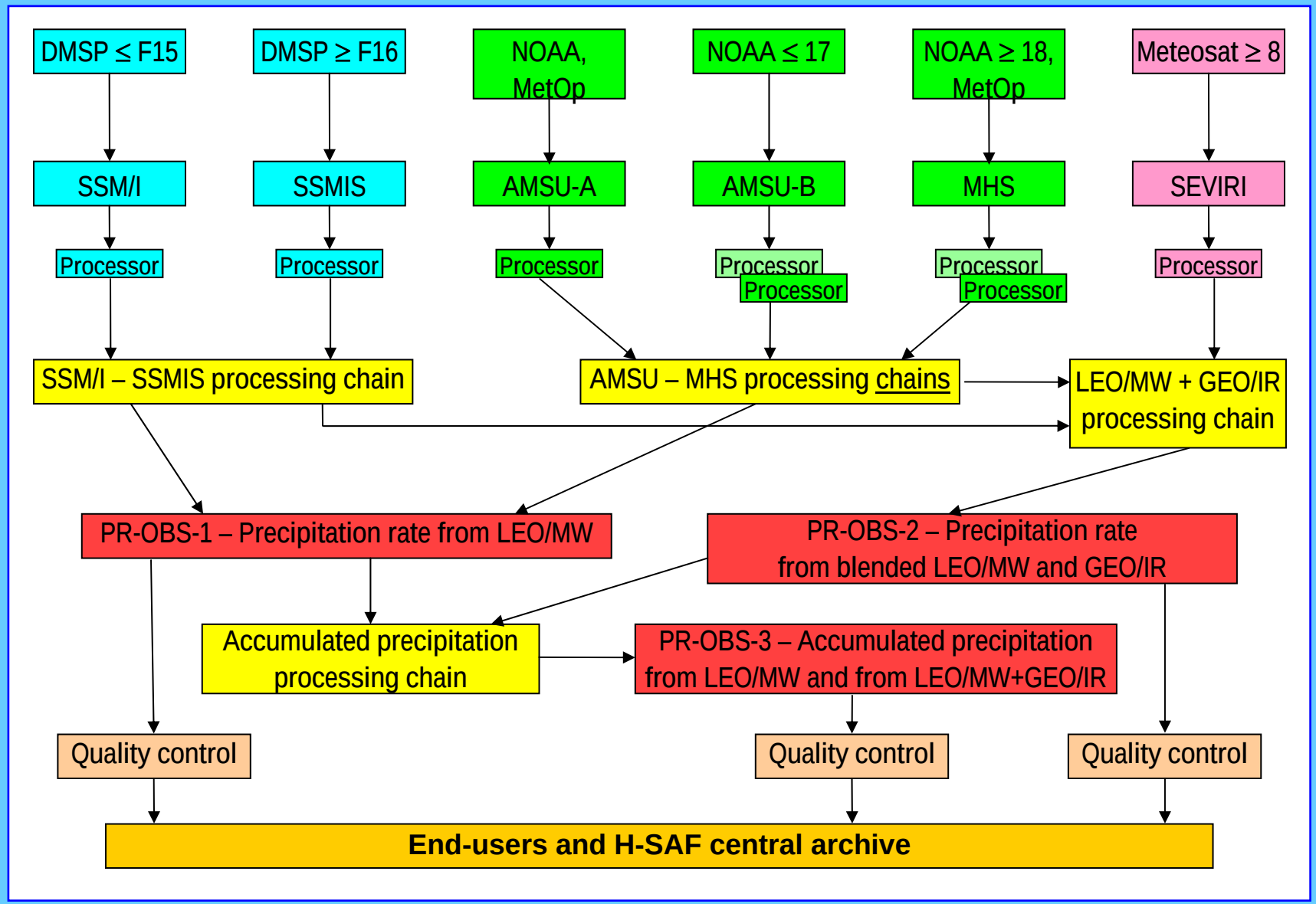
3-hourly coverage during the Operational Phase by 3 NPOESS with CMIS (left) or 8 GPM (right)



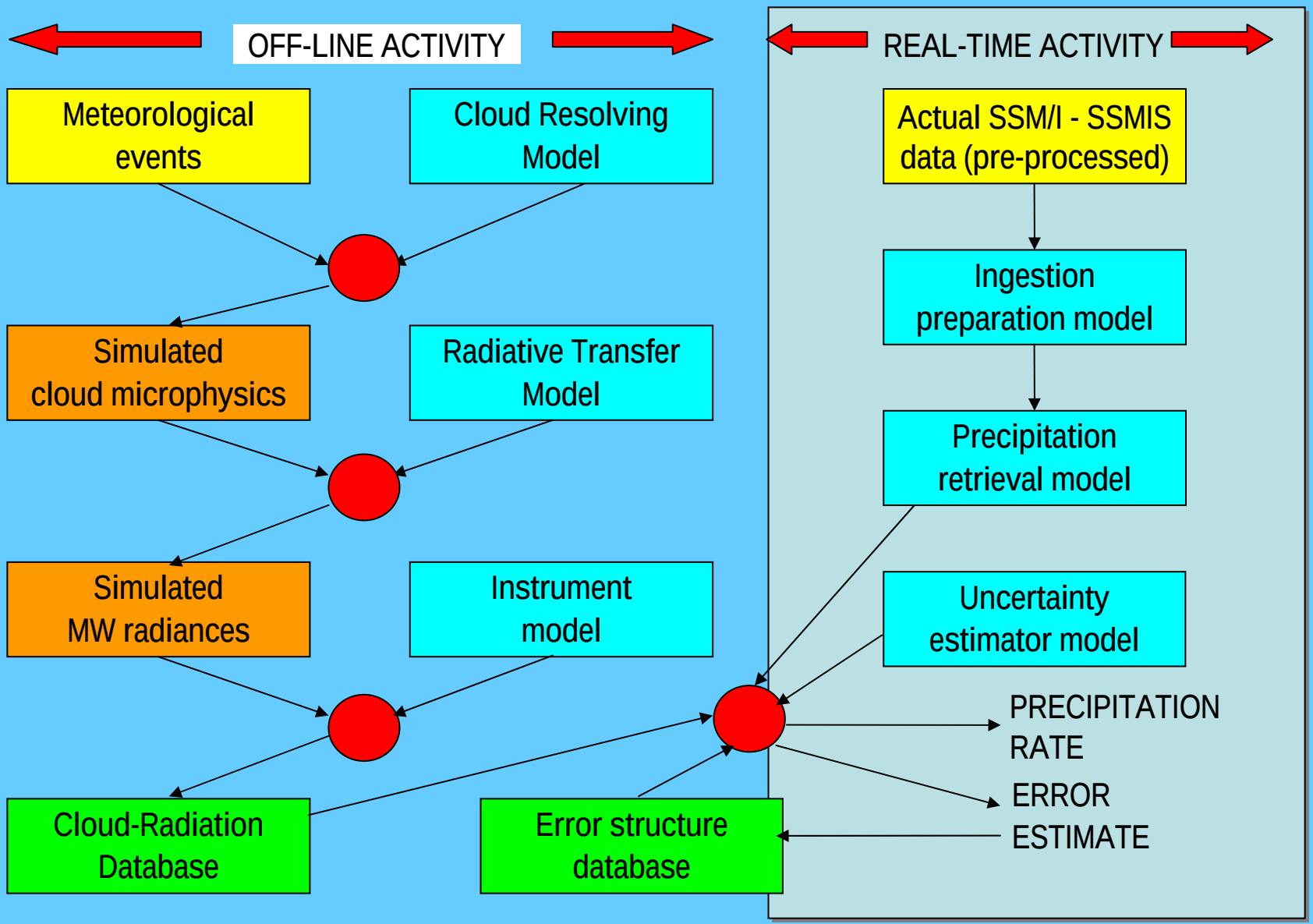
Functional concept of the processing chain for precipitation products generation



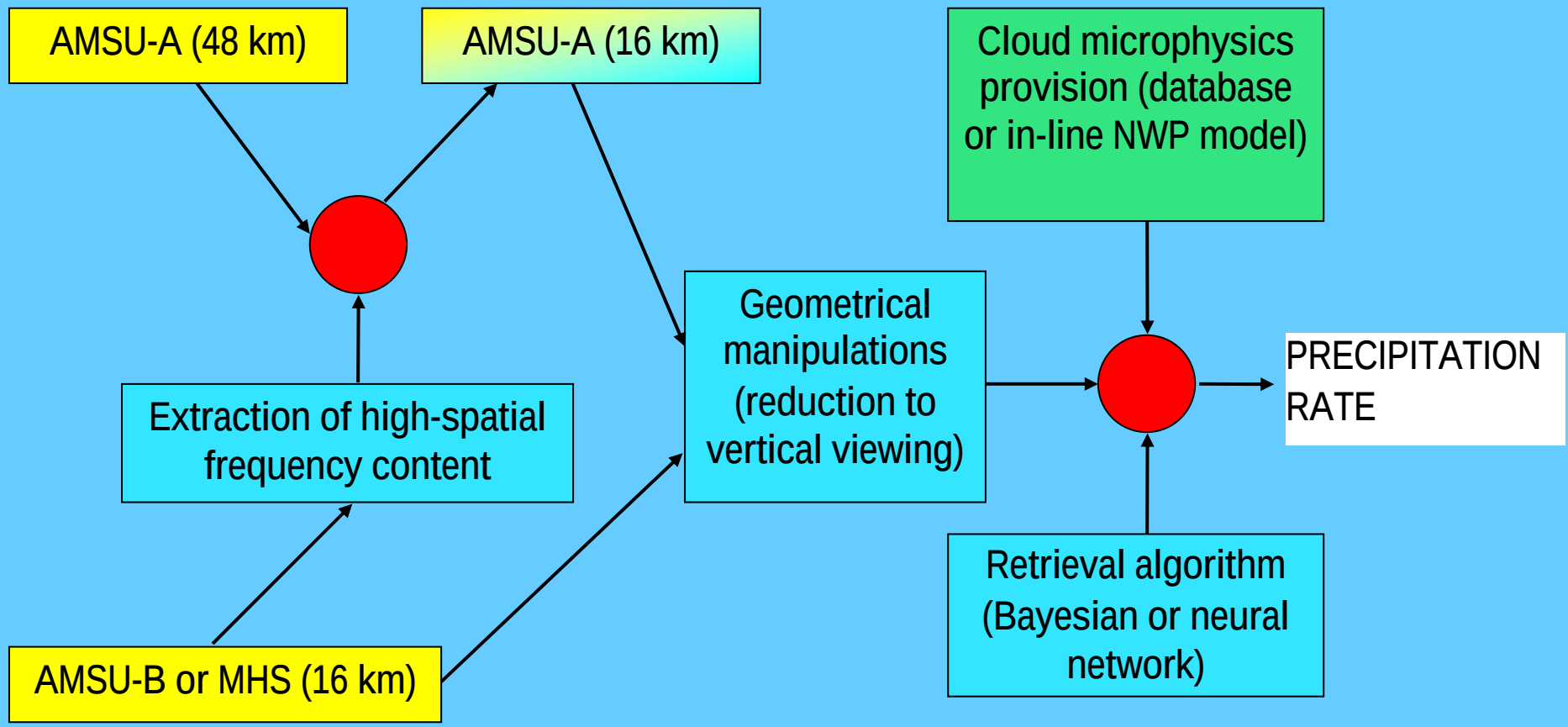
PROTOTYPE PRECIPITATION PRODUCTS GENERATION CHAIN



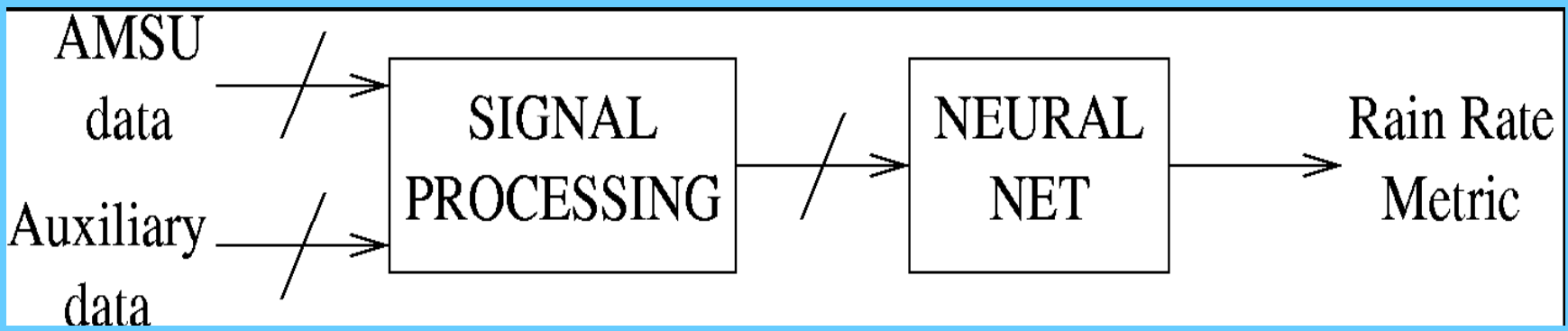
SSM/I – SSMIS PRECIPITATION RATE PROCESSING CHAIN



AMSU – MHS Precipitation Rate Processing Chain



AMSU – MHS PRECIPITATION RETRIEVAL ALGORITHM (Chen and Staelin, 2003)

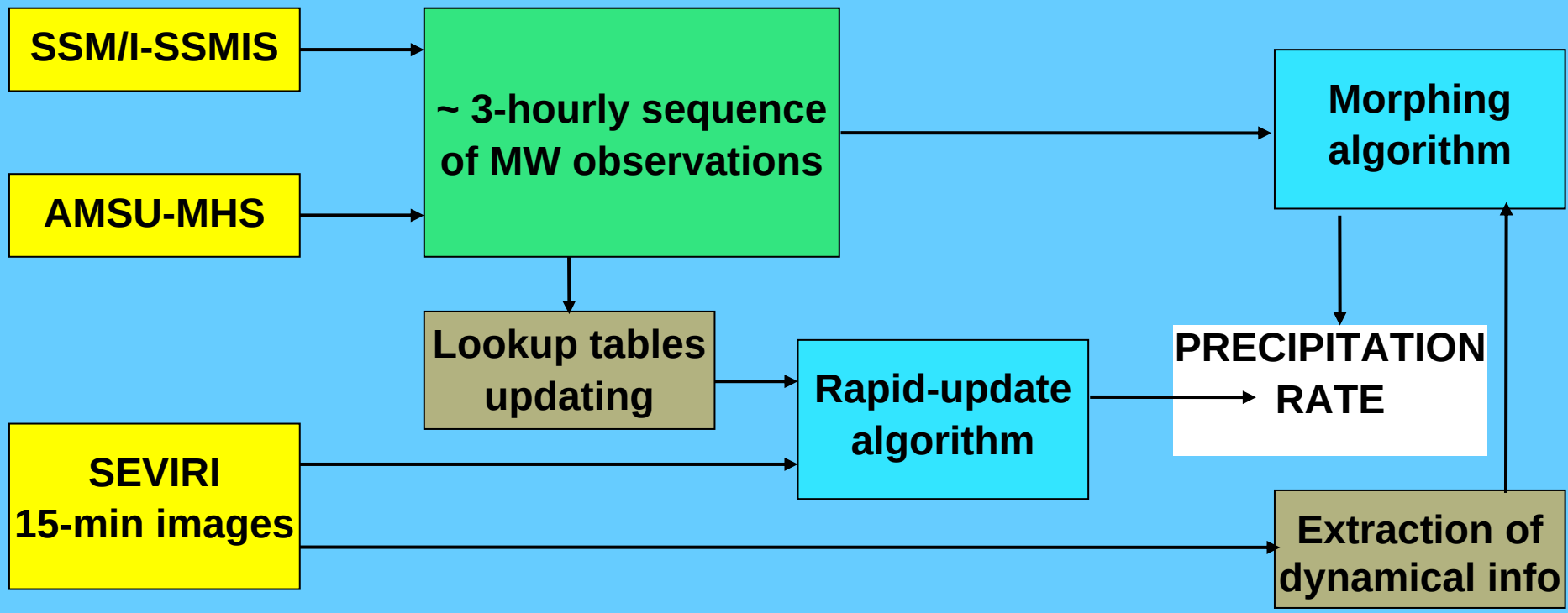


Statistics based algorithm was adopted to cope with the difficulty of the estimation of the highly complex and nonlinear dependence of radiometric observations on atmospheric parameters and properties of any existing hydrometeors.

Main task is to improve the algorithm performance over Europe making use of available ground based rainfall measurements in neural net

A study on the implementation of G. Petty algorithm improved by R. Bennard is ongoing as well, see presentation n. 11.7 by S. Puca et al.

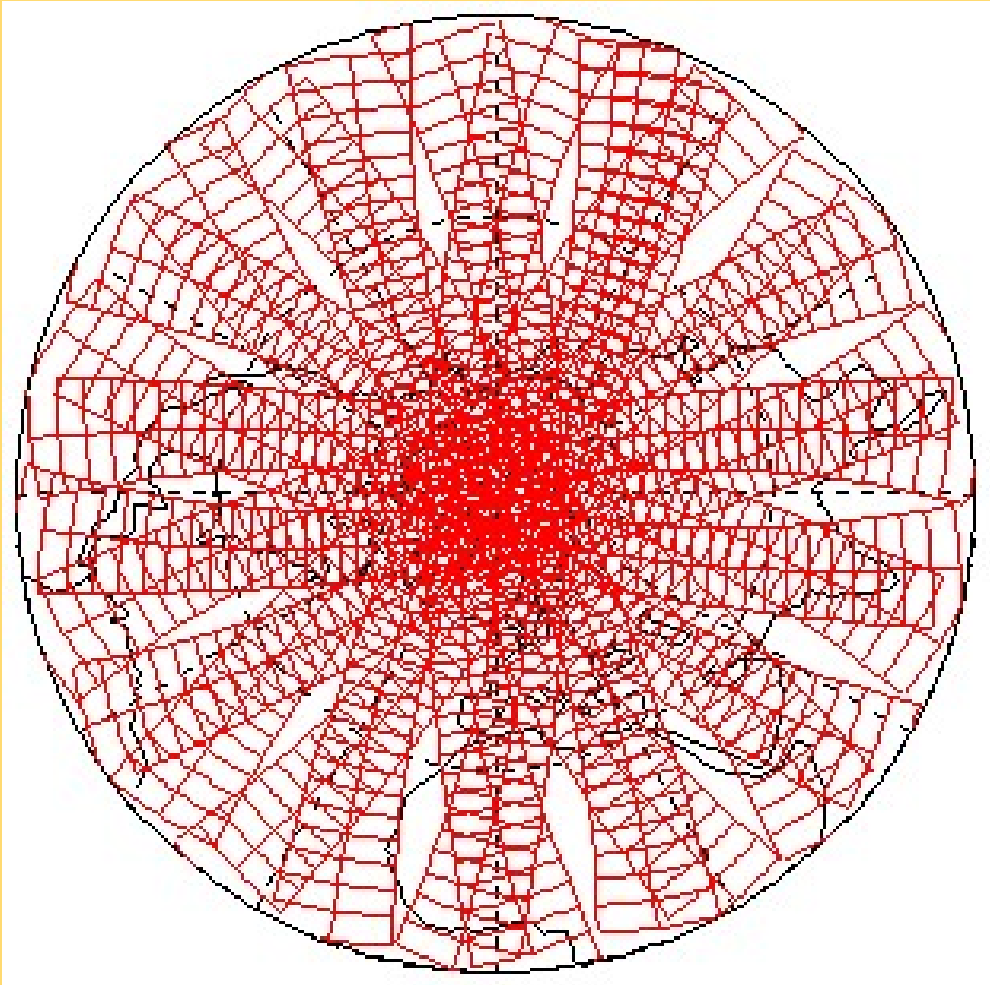
LEO/MW–GEO/IR-BLENDING
PRECIPITATION RATE PROCESSING CHAIN



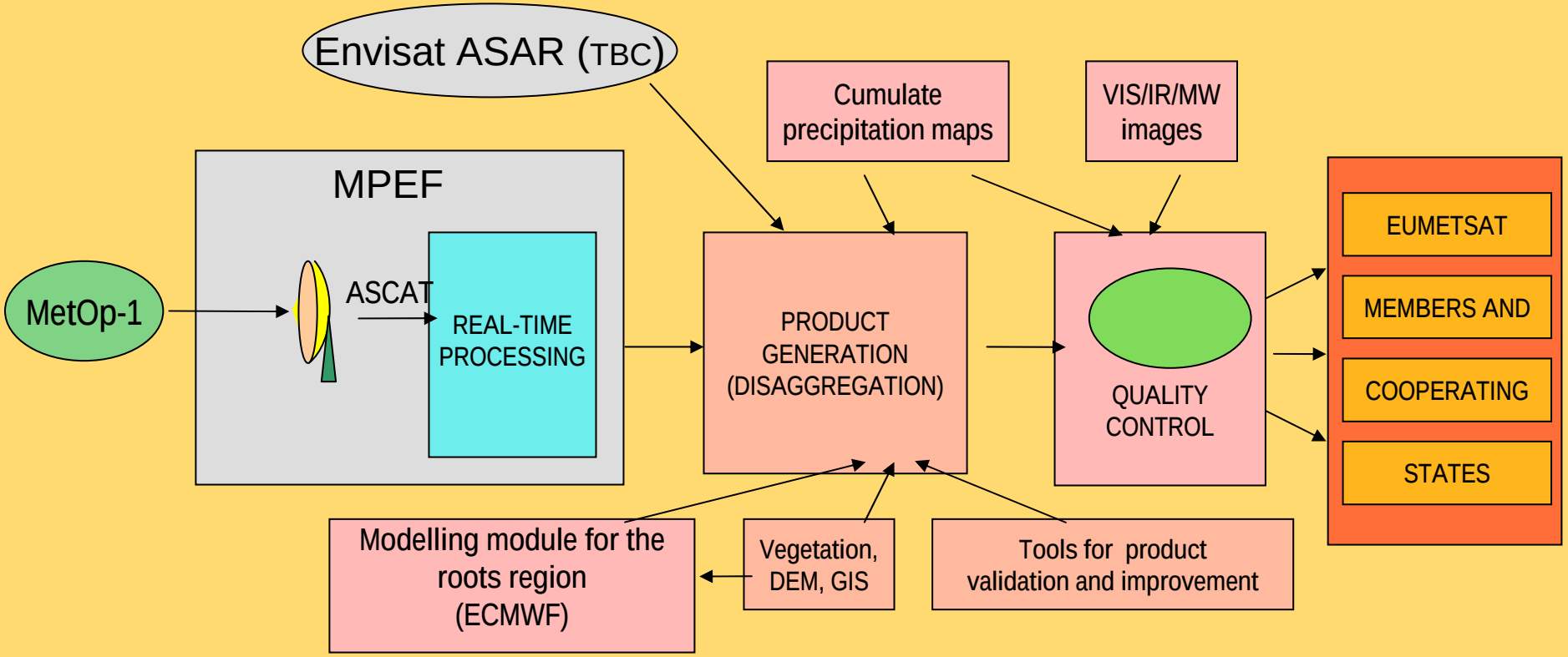
Satellite soil moisture products and satellite data sources

Product	Anticipated product quality in the Operational Phase				Satellites / Sensors	
	Resolution	Accuracy	Cycle	Delay	Development	Operations
Soil moisture in the surface layer	25 km (from ASCAT) *(1km disaggregated TBD)* 40 km (from CMIS)	0.05 $m^3 m^{-3}$ (depending on vegetation)	36 h (from ASCAT) 6 h (from CMIS)	2 h	ERS 1/2 (SCAT) + MetOp (ASCAT) + EOS/Aqua (AMSR-E)	MetOp (ASCAT) + NPOESS (CMIS)
Soil moisture in the roots region	25 km (from ASCAT) 40 km (from CMIS)	To be assessed (model-dependent). Tentative: 0.05 $m^3 m^{-3}$	36 h (from ASCAT) 6 h (from CMIS)	2 h		

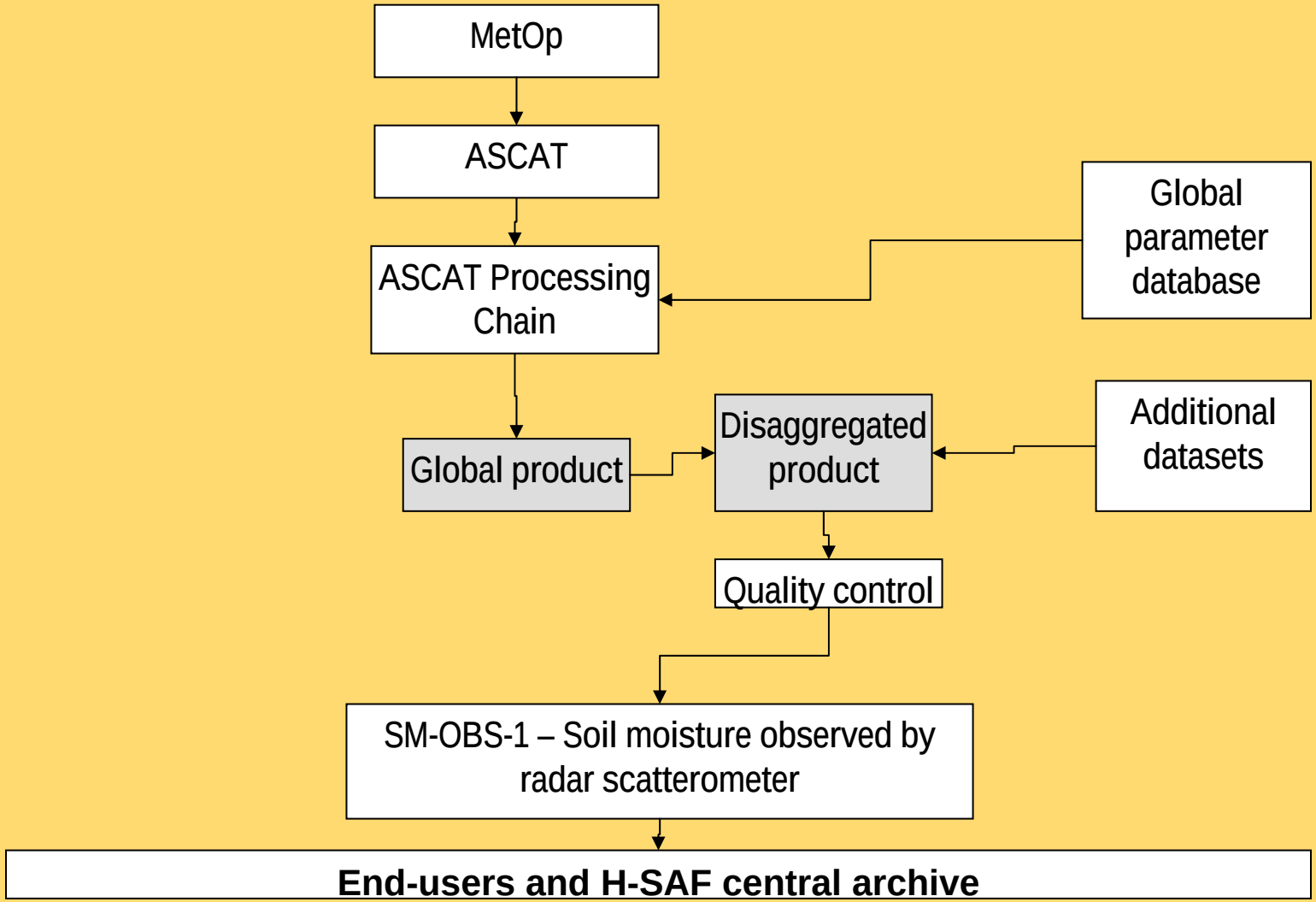
ASCAT coverage in 24 h. The close-to-nadir 700-km gap in between the two 500-km lateral swaths is not shown



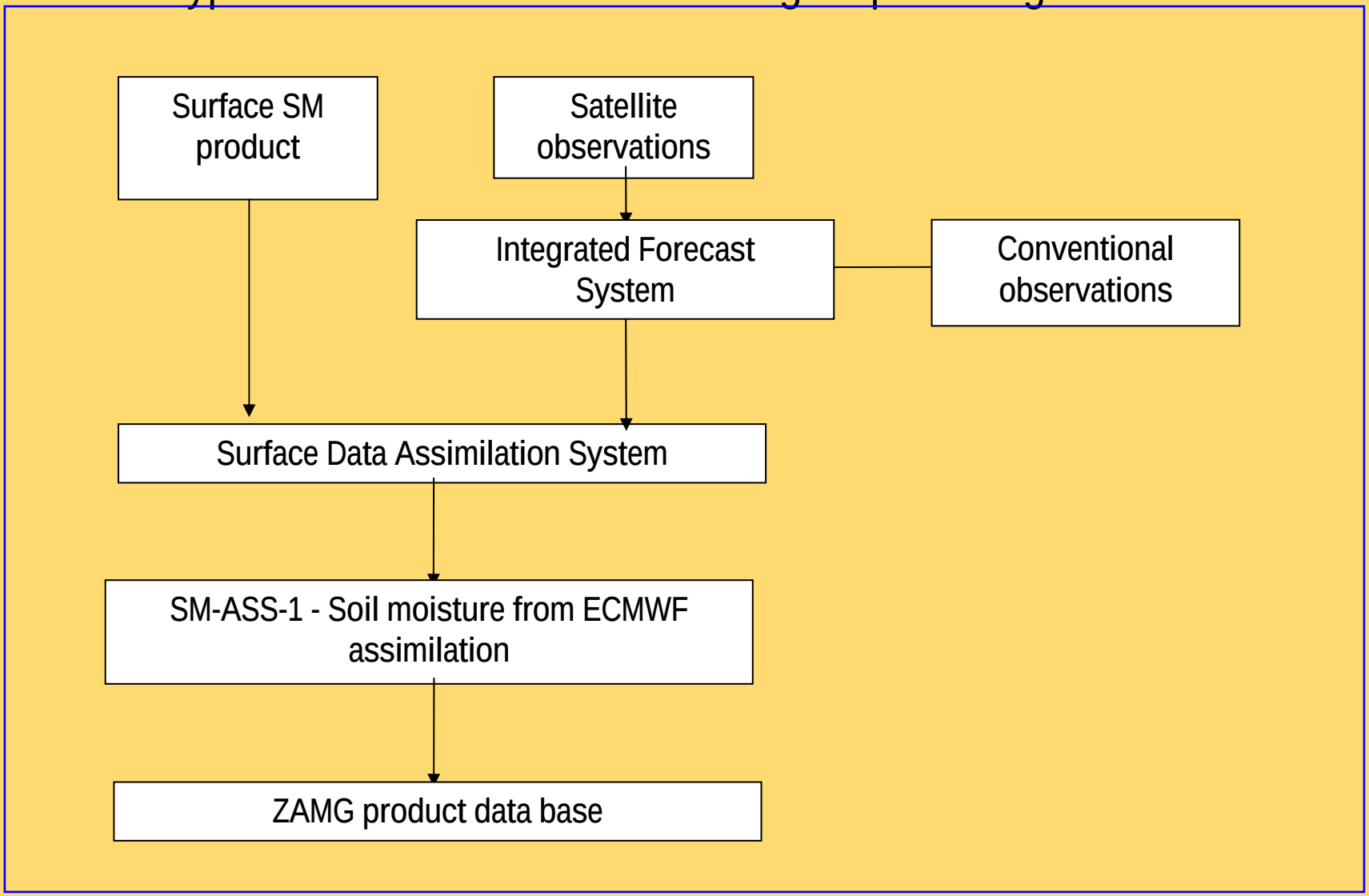
Functional concept of the processing chain for soil moisture processing (at the end of the Development Phase)



Prototype Surface soil moisture products generation chain.



Prototype Soil moisture in the roots region product generation chain.



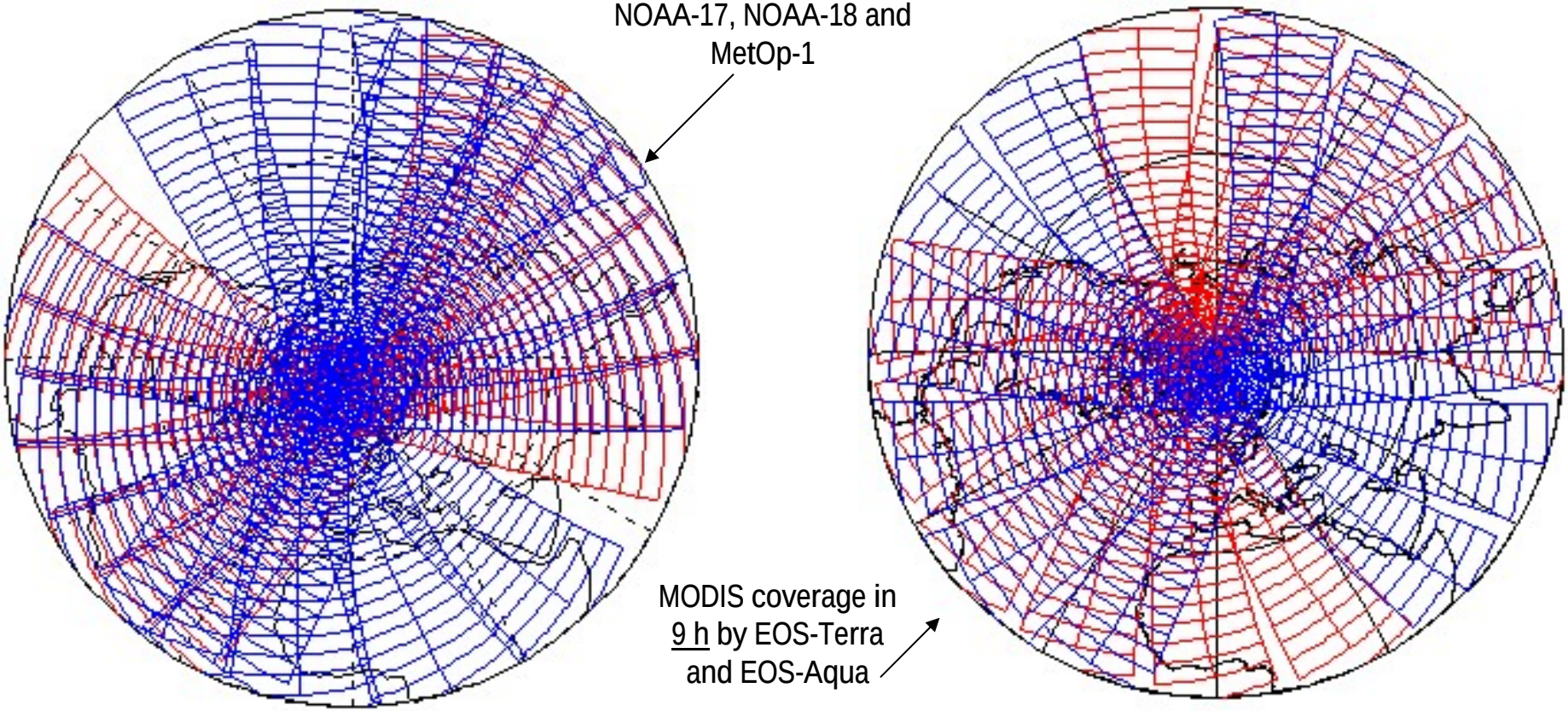
HSAF SM disaggregated product characteristics under study

- Disaggregated to 1km - where possible
- Additional quality information from various NRT datasets available for Europe
  - snow (from H-SAF)
  - freeze/thaw (ECMWF, or also from H-SAF)
- Land-cover specific quality flag
- European geographic projection tailored to European users,
- Data type format directly suitable for modellers
  - BUFR, HDF, or GRIB
- Could be available in NRT within 30 min when using EARS
  - EARS = EUMETCast Advanced Retransmission Service

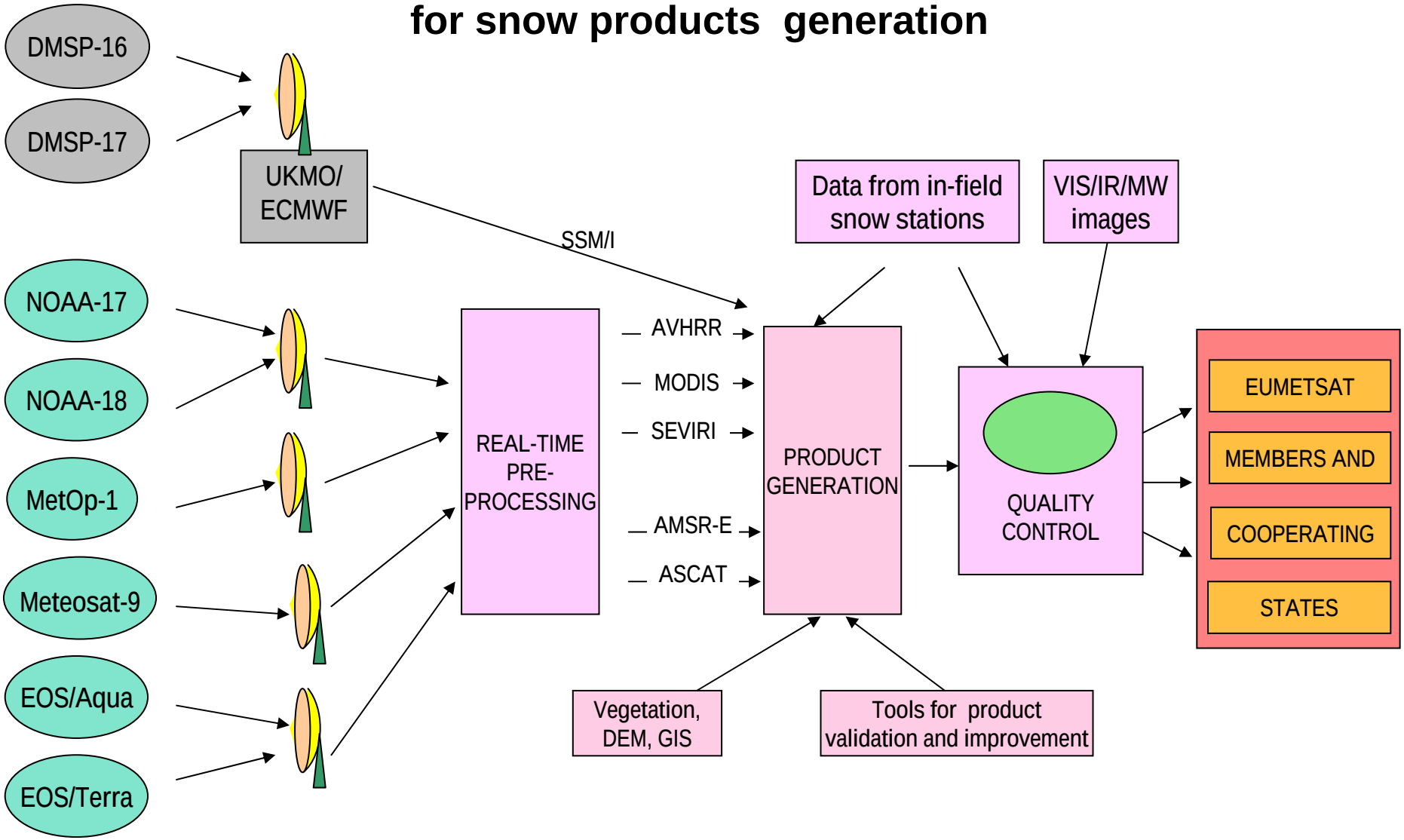
Satellite snow products and satellite data sources

Product	Anticipated product quality in the Operational Phase				Satellites / Sensors	
	Resolution	Accuracy	Cycle	Delay	Development	Operations
Snow recognition (SR)	5 km (in MW) 2 km (in VIS/SWIR/TIR)	95 % probability of correct classification	6 h (depending on latitude)	2 h	NOAA (AVHRR) + MetOp (AVHRR, ASCAT) + Meteosat (SEVIRI) + EOS-Terra/Aqua (MODIS) + DMSP (SSM/I, SSMIS) + EOS-Aqua (AMSR-E) + QuickSCAT (SeaWinds)	MetOp (AVHRR, ASCAT) + Meteosat (SEVIRI) + NPOESS (VIIRS, CMIS) + MW radiometers of the GPM constellation
Snow effective coverage (SCA)	10 km (in MW) 5 km (in VIS/SWIR/TIR)	15 % (depending on basin size and complexity)	6 h (depending on latitude)	2 h		
Snow status (wet or dry)	5 km	80 % probability of correct classification	6 h (depending on latitude)	2 h		
Snow Water Equivalent (SWE)	10 km	~ 20 mm	6 h (depending on latitude)	2h		

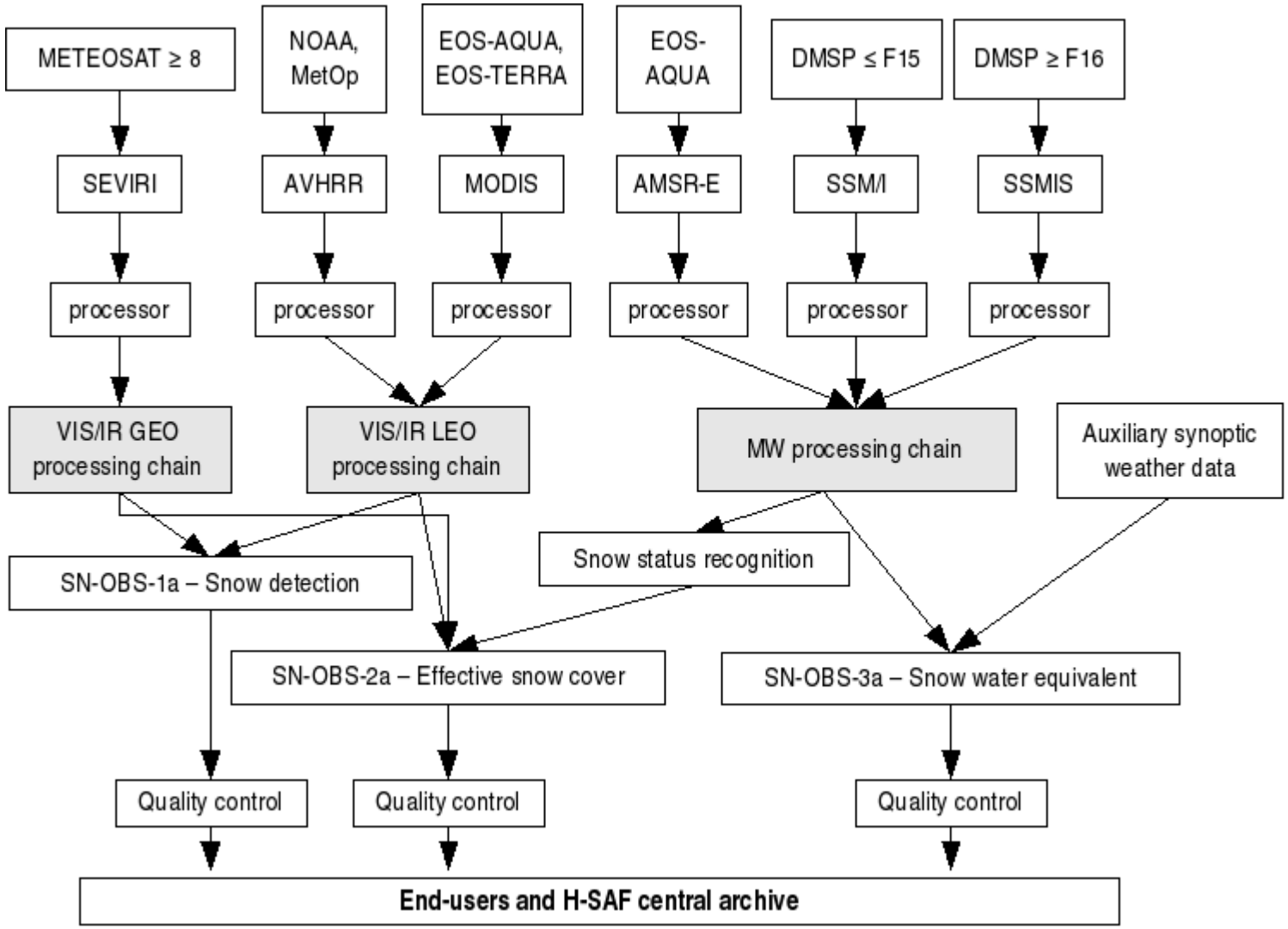
Coverage from AVHRR (in 6 hours) and MODIS (in 9 hours) during the Development Phase



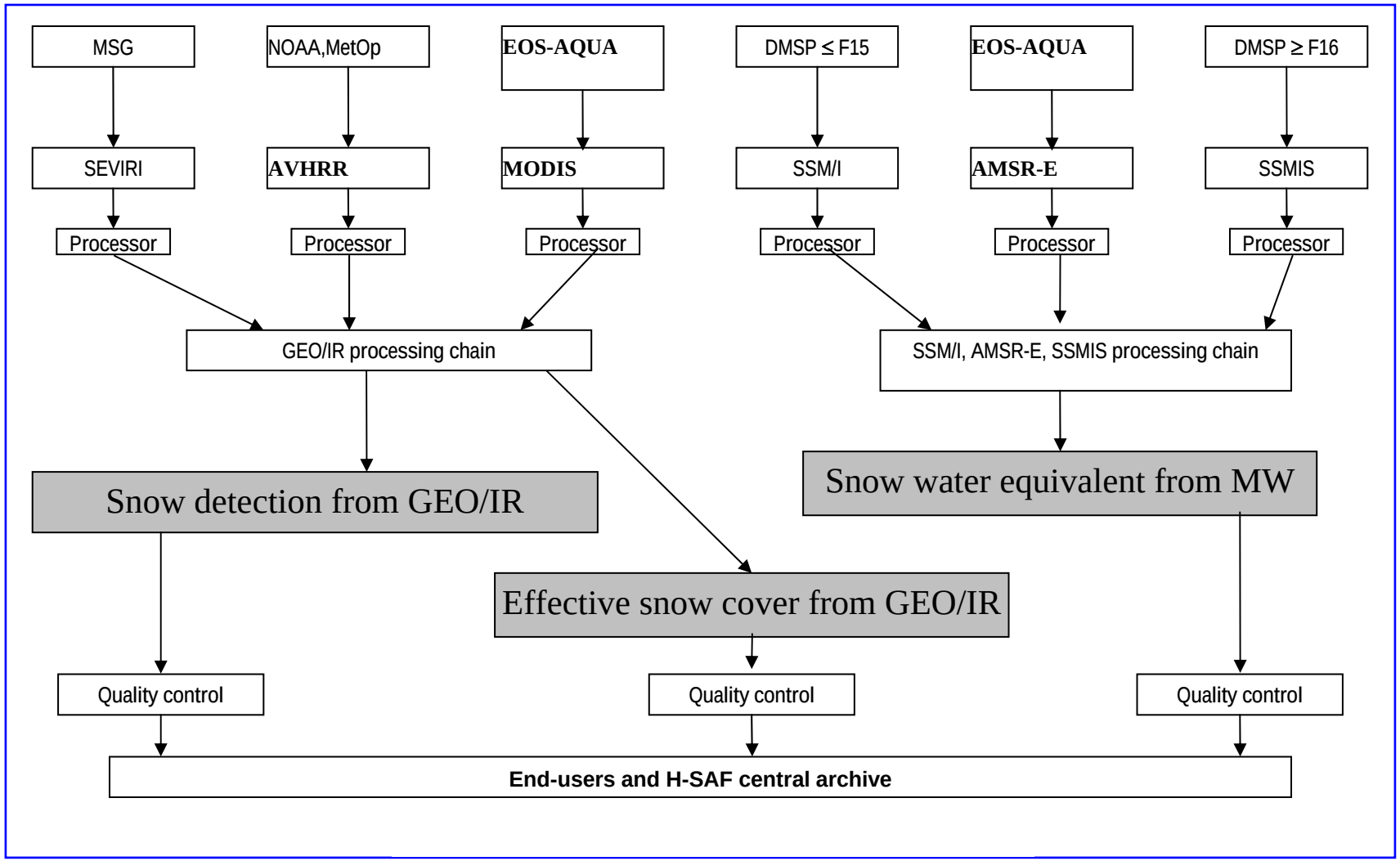
Functional concept of the processing chain for snow products generation



Prototype Snow parameters in flat areas and forests generation chain



Prototype Snow parameters in mountainous areas products generation chain



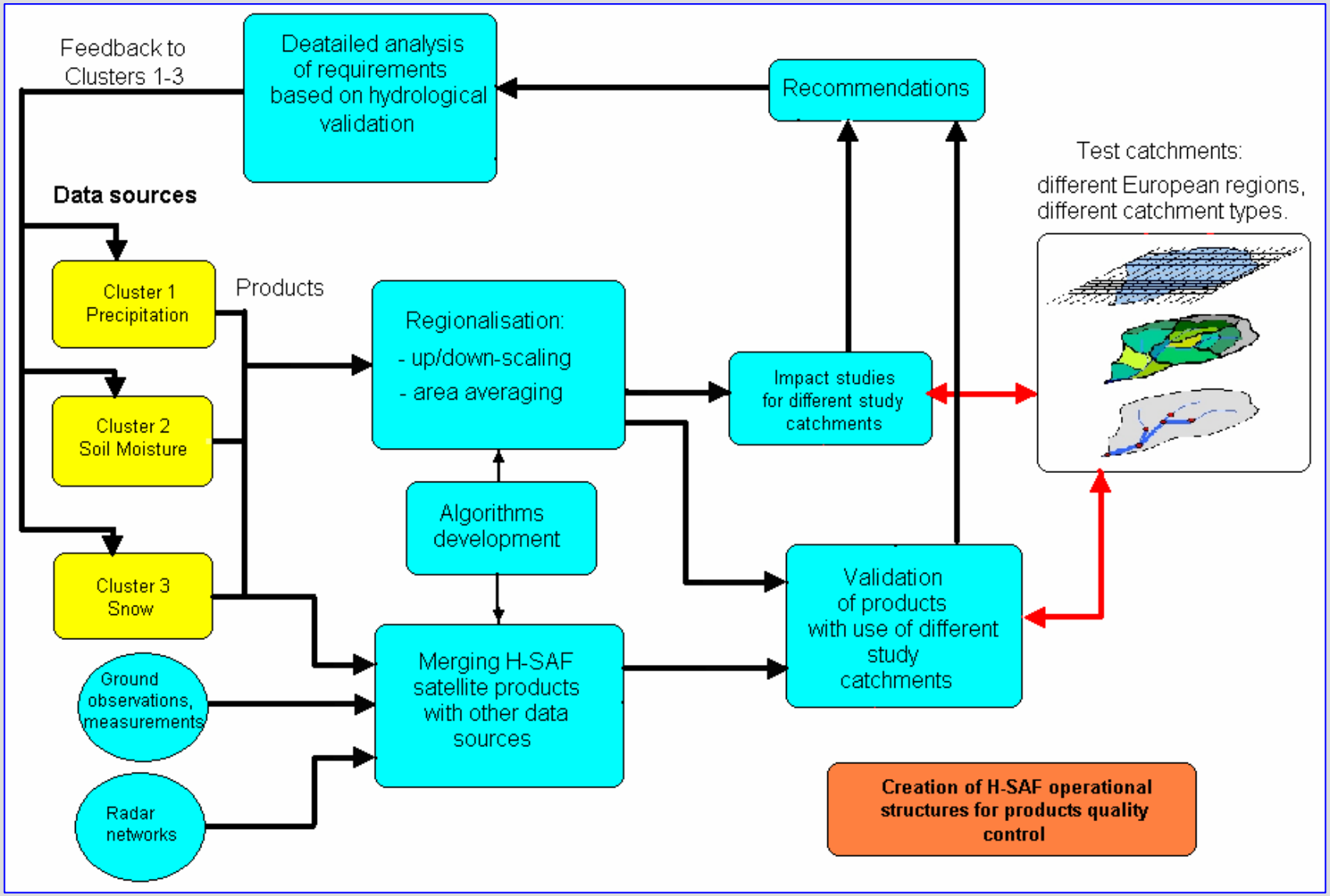
The hydrological validation programme

The hydrological validation programme must provide independent assessment of the impact of the new data on operational hydrology.

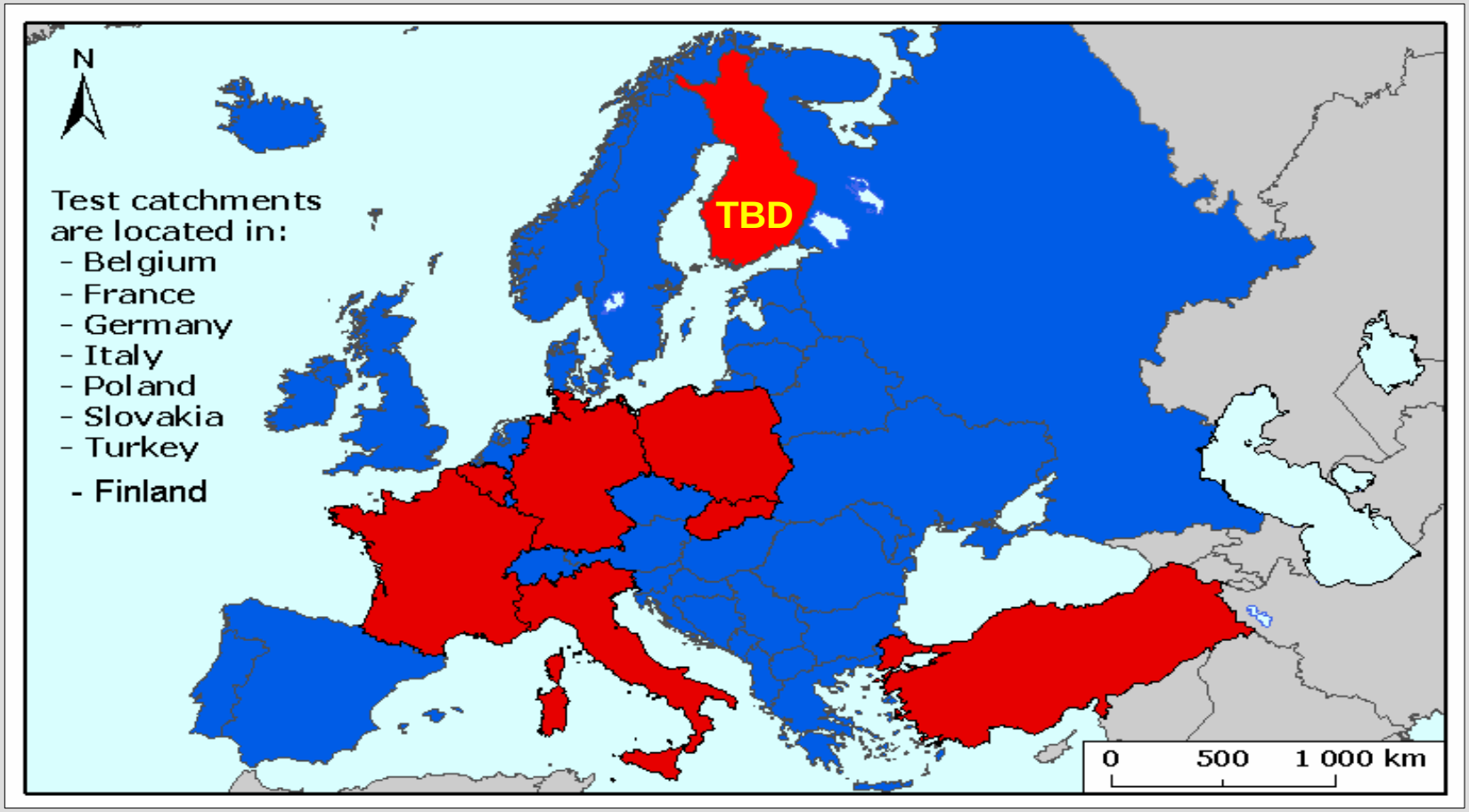
Activities:

- ***requirements analysis;***
- **development of methodology and algorithms for *products up-scaling, down-scaling, averaging over catchments* etc.;**
- **use of hydrological/hydrodynamic models for *impact studies*;**
- **determination of the *requirements for improvements of product algorithms;***
- ***validation of final products* with use of hydrological models;**
- **developments of methodology and algorithms for *merging satellite products with other data sources*;**
- **creation of structure for *on-going H-SAF products validation and quality assessment*.**

Concept of the hydrological validation and its relation to product clusters



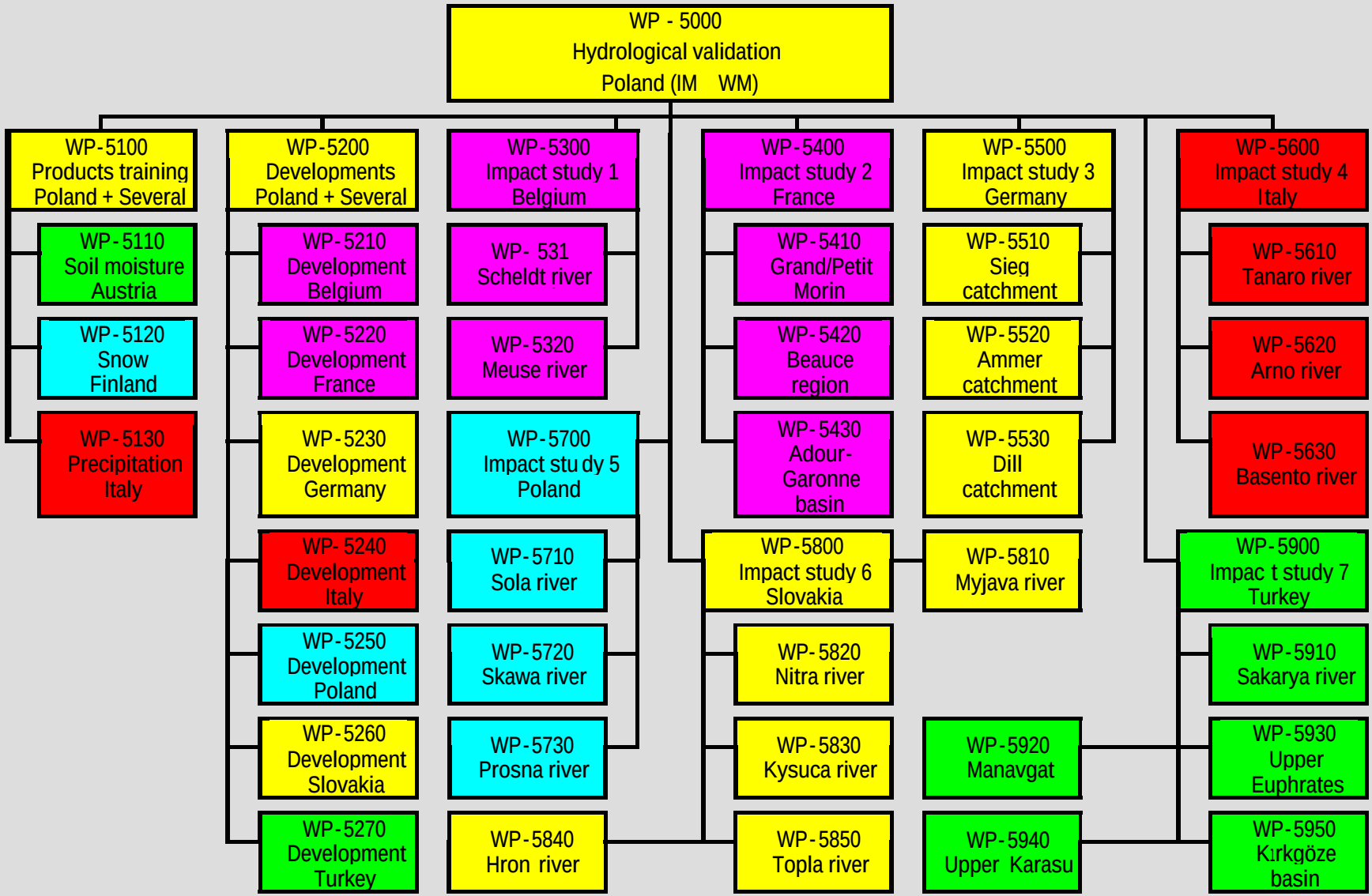
The hydrological validation programme will make use of test sites



- *7 countries*
- *24 test sites*

- *Variety of climatological conditions*
- *Variety of terrain conditions*
- *Variety of land cover*
- *Different hydrological regimes*

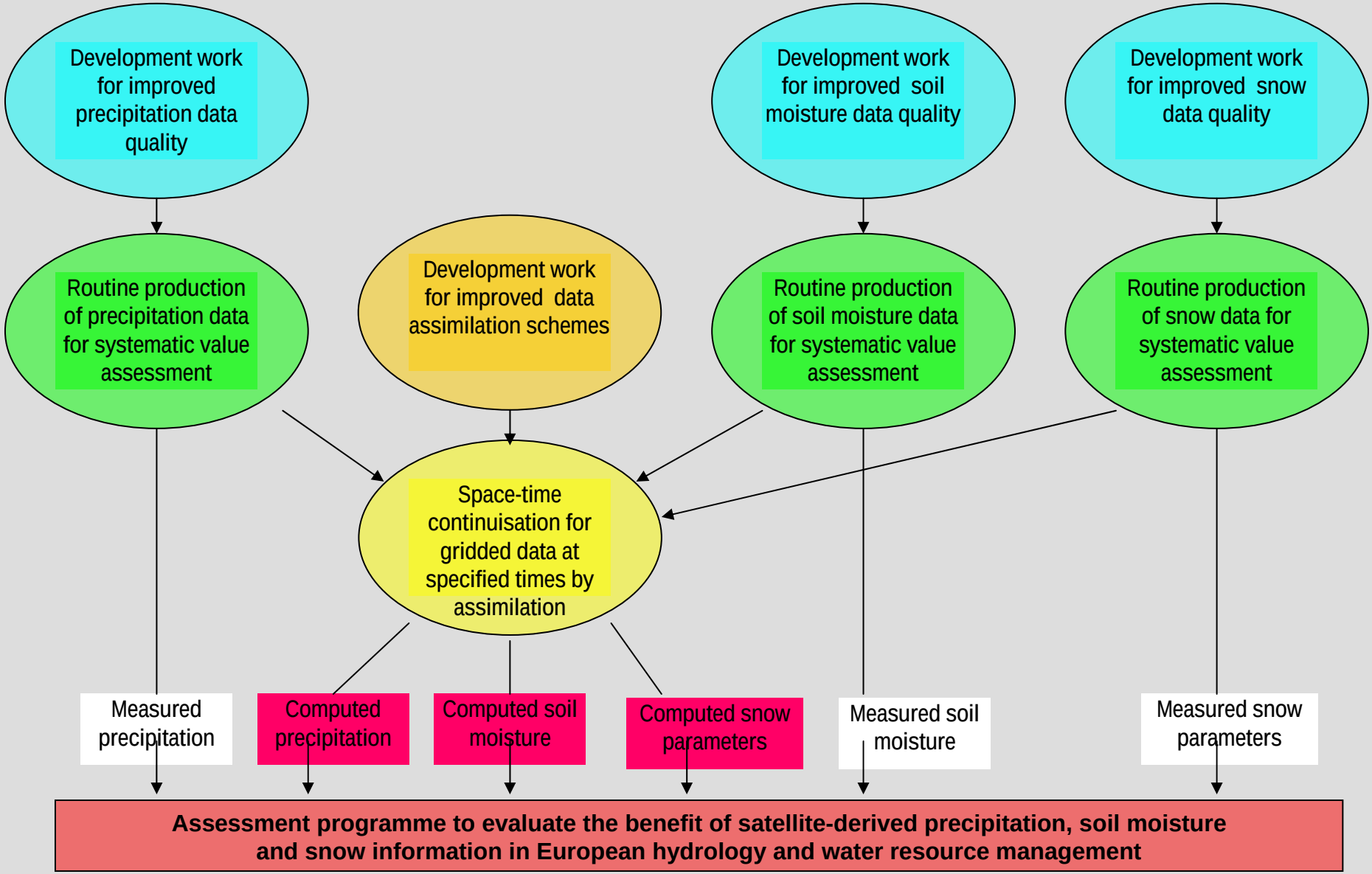
Structure of the Hydrovalidation Working Package



Input data for hydrological models

PARAMETER	REQUIRED SPATIAL RESOLUTION	REQUIRED TEMPORAL RESOLUTION
Precipitation	Regular grid 50m, 100m, 500 m, 1 km, 7 km, 8 km HRU, subcatchment	10 min, 15 min, 1h, 3h, 6h, daily
Snowfall	Regular grid 1 km, 8 km, HRU	6 h - daily
Air temperature	8 km, 25 km, point, HRU	10 min, 15 min, 1h, 2h, daily
Soil moisture	point, catchment	daily
Snow covered area	50m, catchment	daily
Solar radiation	8 km, 50 km, point	15 min,1h, 6h, daily
Snow water equivalent	50m, catchment	daily
Long wave radiation	8 km	1h
Sun duration	50 km	6h
Land use, vegetation type	30m, 250 m, 1km	10 days, season
Wind speed	7 km, 8 km, 25 km	10 min, 1h, 2h
Humidity	8 km, 50 km, point	1h, 2h, 6 h

Logic of the H-SAF Development Phase



Computed precipitation Work Package

This WP will make use of the the *EuroLM* (CNMCA operational set-up of the non-hydrostatic regional model named Lokal Modell (LM) developed by the Consortium for Small-Scale Modelling (COSMO)

A specific operational chain will produce QFP and dervied fields:

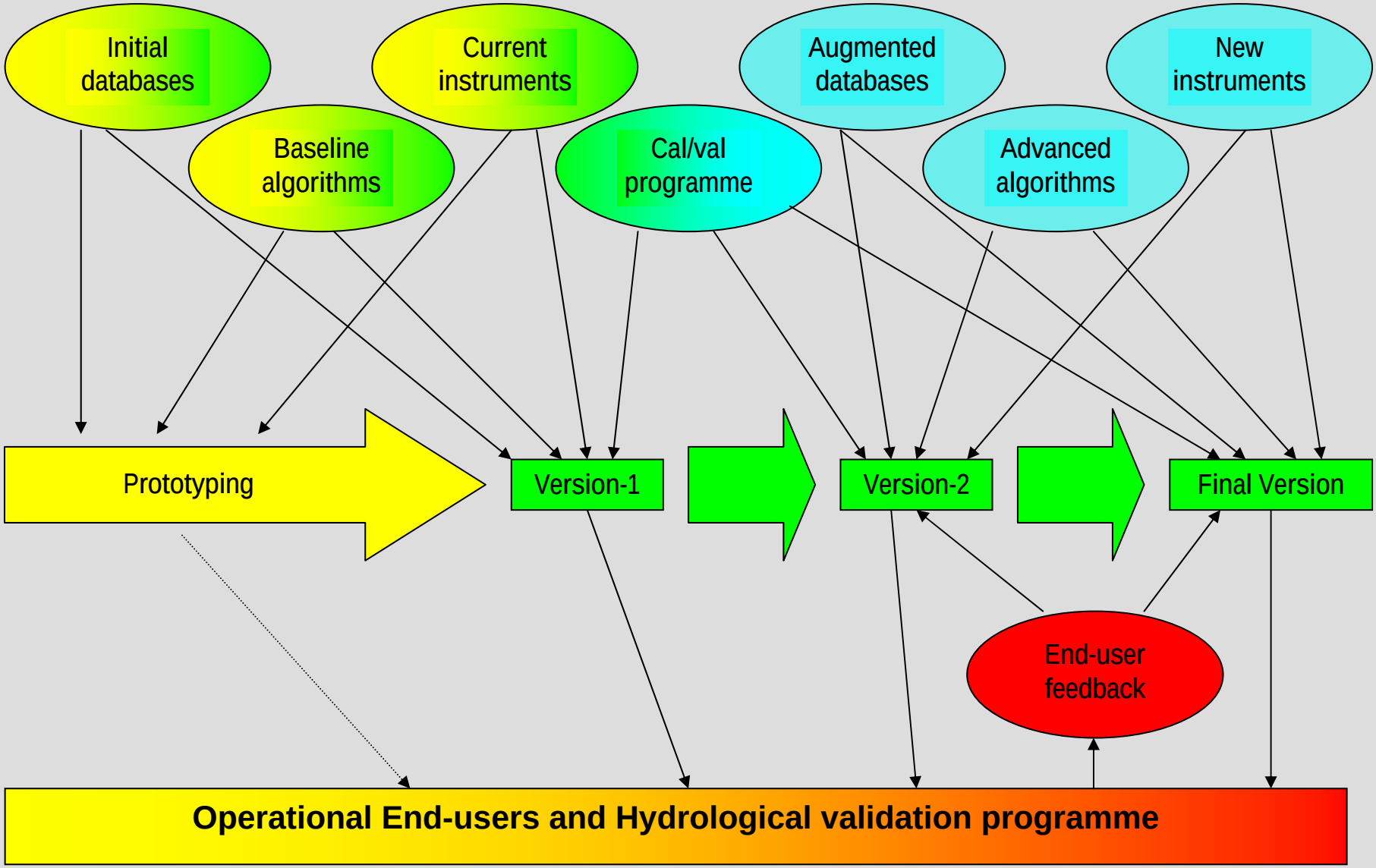
- accumulated precipitation
- large-scale soil moisture (experimental)
- snow water equivalent (experimental

The objective is the improvement of analysed and forecast precipitation fields through the use of microwave satellite observations in spectral ranges with proven sensitivity to precipitation and atmospheric humidity AMSUB, MHS and SSMI/S.

Main activities are:

- setting up of the RTTOV radiative transfer model and its interface with the EuroLM very high resolution NWP model;
- treatment of microwave window channels' radiances from available sensors, quality control and bias correction;
- setting up of a variational (1D-VAR) retrieval algorithm in order to optimally combine the EuroLM first-guess hydrometeors' profiles with the observed radiance information;
- ingestion of retrieved profiles in EuroLM model (presentation 7.5 by Vocino et al.).

Logic of the incremental development scheme



CONCLUSIONS

H-SAF could expand the use of satellites in Hydrology.

The Development Phase (2005-2010) will:

- **make available new products** (precipitation, soil moisture, snow parameters) in a pre-operational fashion;
- progressively improve products quality through a continuous development programme parallel to the pre-operational activity;
- **independently assess the benefit of the new products** through a hydrological validation programme.

Consequent to:

- demonstrated feasibility and affordability of generating the new products;
- demonstrated cost-effectiveness for application to Hydrology;

a possible Operational Phase (2010-2015) could follow.

HSAF can be considered end user of retrieval products and it is strongly interested into establishing tight relation with the International ATOVS Group with the aim of establishing a lasting and fruitful cooperation as well**.**

THANK YOU

AND

SEE YOU AT

HSAF 1ST WORKSHOP

ROME, OCTOBER 2007

(ATOVS WG members will be kept informed on the event)