THE NWC SAF PRODUCTS

EUMETSAT – AUTH TRAINING WORKSHOP ON THE “USE OF SATELLITE INFORMATION IN NOWCASTING”

11 – 15 September 2017, Thessaloniki, Greece

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CONTENTS

➢ Introduction
➢ NWC SAF Overview
  • Services to Users
➢ NWC SAF Products
  • Cloud Products
  • Precipitation Products
  • Convection Products
  • Clear Air Products
  • Wind Products
  • Conceptual Model Products
➢ Plans for the future
➢ How to get and install the SW
**INTRODUCTION**

- EUMETSAT European Organization for the Exploitation of Meteorological Satellites
- **Purpose:** to supply weather and climate-related satellite data, images and products to the National Meteorological Services
- **SAFs (Satellite Application Facilities):**
  - located at Weather Services in EUMETSAT Member and Co-operating States
  - complement production of standard meteorological products at EUMETSAT central facility
INTRODUCTION
EUMETSAT SAF (SATELLITE APPLICATION FACILITY) PROJECTS

**OSI SAF**
Ocean and Sea Ice
The OSI SAF provides comprehensive information on the ocean-atmosphere interface — requirements of both meteorology and oceanography.

**H SAF**
Support to Operational Hydrology and Water Management
The H SAF generates and archives high-quality datasets and products for operational hydrological applications.

**AC SAF**
Atmospheric Composition Monitoring
The AC SAF processes data on ozone, other trace gases, aerosols and ultraviolet data, obtained from satellite instrumentation.

**NWP SAF**
Numerical Weather Prediction
The NWP SAF aims to improve and support the interface between satellite data/products and European activities in NWP.

**CM SAF**
Climate Monitoring
The CM SAF generates and archives high-quality climate datasets on a continuous basis.

**ROM SAF**
Radio Occultation Meteorology
The ROM SAF generates and archives high-quality GPS Radio Occultation (RO) datasets for Numerical Weather Prediction (NWP) applications and specific climate application areas.

**NWC SAF**
Support to Nowcasting and Very Short Range Forecasting
Nowcasting is a weather forecast for the next few hours, based on current information.

**LSA SAF**
Land Surface Analysis
The LSA SAF develops techniques to retrieve products related with land, land-atmosphere interactions, and biospheric applications.
NWC SAF GENERAL OBJECTIVES

- Development of Nowcasting products derived from both GEO and PPS satellite systems
- To be delivered to users as SW Packages

Responsible for
- Development and maintenance of the NWC products
- Development and maintenance of the SW Packages
- Users’ support and training tasks
The software is distributed freely to registered users of the meteorological community and is used for Nowcasting and as a development and research tool.

- The user runs the SW package and generate the products.
- Advantage: users can configure the SW to fit their needs (e.g. the user define the area where the products are generated).
- Potential problem: users need access to EUMETSAT satellite images and a NWP model output.
NWC SAF PHASES

**DOP** -> Development Operations Phase

1997-2002

**IOP** -> Initial Operations Phase (IOP)

2002-2007

**CDOP** -> Continuous Development and Operations Phase

2007-2012

**CDOP-2** -> 2\textsuperscript{nd} Continuous Development and Operations Phase

2012-2017

**CDOP-3** -> 3\textsuperscript{rd} Continuous Development and Operations Phase

2017-2022
NWC SAF CONSORTIUM — CDOP2
NWC SAF CONSORTIUM — CDOP3
SERVICES TO USERS

- SW Distribution
- Tickets (Mail Box)
- NWC Products
- Information
- Training
- User Requirements & Product Applicability
- General Information
  - Scientific Development
  - Documentation
- Workshops EUMeTrain
- Surveys
- Docs
- Users’ Workshops
- Helpdesk
- SAFNWC Users’ Group

145 Users June 2017
http://www.nwcsaf.org
PRODUCTS RESPONSIBILITY

Clear Air, Precipitation and Wind GEO products

Cloud and Thunderstorm GEO products

Cloud and Precipitation PPS products

Conceptual Model GEO products

Quality assessment and prototype products for MTG-LI *
CURRENT SOFTWARE PACKAGES

**GEO:**

v2016 released November 2016

**MSG:**

v2013 released August 2013

**PPS:**

v2014 released October 2014
v2017 available in 2018
NEW SW PACKAGE: GEO V2016

- Available since November 2016
- Previous operational version is MSG v2013
- GEO v2016 vs. MSG v2013: main improvements/changes:
  - Scientific Improvement in some products
  - New products: (CMIC, CI, ASII-NG, EXIM)
  - Adaptation of some products to GOES-N satellites
  - New output format: NetCDF
CLOUD PRODUCTS MSG

**Cloud Mask (CMa)**
Cloud-free pixels delineation in a satellite scene with a high confidence. Also: snow/sea ice, dust clouds and volcanic plumes.

**Cloud Type (CT)**
Detailed cloud analysis with information on the major cloud classes for all the pixels identified as cloudy. Also: Cloud Phase and Fractional Cloud. Future version: distinction between convective and stratiform clouds.
**CLOUD PRODUCTS MSG**

*Cloud Top Temperature & Height (CTTH)*
Information on the cloud top temperature, pressure and height for all pixels identified as cloudy. It contributes to the analysis and early warning of thunderstorm development.

*Cloud Microphysics (CMIC)*
Information on the cloud microphysics. Useful for the identification of precipitation clouds and characterization of rapidly developing thunderstorm
CLOUD MASK (CMA) INPUT/OUTPUT SCHEME

SEVIRI
- HRVIS
- VIS0.6
- VIS0.8
- IR01.6
- IR03.9
- WV7.3
- IR08.7
- IR10.8
- IR12.0
- IR13.4

GEO-CMA-v40
- YYYY-MM-DDThh:mm:00Z
- region
- config_file

NWP
- Tsfc
- Tair (925hPa)
- TPW
- Z (P levels)

Bilinear interpolation

Threshold Tests

AUXILIARY DATA
- Sun Zenith Angle
- Satellite Zenith Angle
- Land/sea atlas
- Land/sea/coast atlas
- Elevation atlas
- Monthly Climatology (SST, land reflectances, TPW, T_{1000})

netCDF
- Cloud Mask
- Dust clouds
- Ash

AUXILIARY DATA
- Non-prec.
- Snow/Ice
- Thin Ice Clouds over Snow/Ice
- Cloud
- Cloud Free
- SAFNWC CMA2
CLOUD TYPE (CT)
INPUT/OUTPUT SCHEME

NWP

Bilinear interpolation

GEO-CT-v30
YYYY-MM-DDThh:mm:00Z region config_file

AUXILIARY DATA

- Sun Zenith Angle
- Satellite Zenith Angle
- Land/sea atlas
- Elevation atlas
- Monthly Climatology (SST, 0.6μm and 1.6μm reflectances, TPW, T_{1000}, T_{850}, T_{700}, T_{500})

netCDF

- Tsfc
- T (950hPa)
- T (850hPa)
- T (700hPa)
- T (500hPa)
- T (tropopause)
- TPW
- Z (P levels)

SEVIRI

VIS0.6
IR01.6
IR03.9
WV7.3
IR08.7
IR10.8
IR12.0

CMa

NWP

Threshold Tests

CLOUD PHASE
- Ice
- Water
- Undefined
- No clouds

CLOUD TYPE
- Undefined
- Fractional
- Semitransp. above
- Semitransp. thick
- Sem. meanly thick
- Semitransp. thin
- Very high opaque
- High opaque
- Medium
- Low
- Very low
- Sea Ice
- Land Snow
- Cloud free sea
- Cloud free land
- Non-processed

AUXILIARY DATA

- Sun Zenith Angle
- Satellite Zenith Angle
- Land/sea atlas
- Elevation atlas
- Monthly Climatology (SST, 0.6μm and 1.6μm reflectances, TPW, T_{1000}, T_{850}, T_{700}, T_{500})

NWC SAF

AUXILIARY DATA

- Sun Zenith Angle
- Satellite Zenith Angle
- Land/sea atlas
- Elevation atlas
- Monthly Climatology (SST, 0.6μm and 1.6μm reflectances, TPW, T_{1000}, T_{850}, T_{700}, T_{500})
CLOUD TOP TEMPERATURE & HEIGHT (CTTH)
INPUT/OUTPUT SCHEME

SEVIRI

NWP
Bilinear interpolation

Threshold Tests

GEO-CTTH-v30
YYYY-MM-DDThh:mm:00Z region config_file

netCDF

Pressure
Temperature
Height

AUXILIARY DATA

Sun Zenith Angle
Satellite Zenith Angle
Land/sea atlas
Elevation atlas
Monthly Climatology (SST, 0.6μm reflectances)
CLOUD MICROPHYSICS (CMIC) INPUT/OUTPUT SCHEME

AUXILIARY DATA
- Land/sea atlas
- Elevation atlas
- Monthly 0.6µm and 1.6µm white-sky surface albedo climatology
- Monthly integrated atmospheric water vapor content climatology
- Monthly ozone content climatology

SEVIRI
- VIS 0.6
- NIR 1.6
- IR 8.7
- IR 10.8

CT
- CTTH

NWP
- Total O₃ content
- Water vapor content

Bilinear interpolation

GEO-CMIC-v10
YYYY-MM-DDThh:mm:00Z region config_file

Threshold Tests

netCDF
- Cloud Phase
- Cloud Effective Radii
- Cloud Optical Thickness
- Cloud Liquid Water Path
- Cloud Ice Water Path

NWC SAF
New GEO v2016 product CMIC (Cloud Microphysics):
- Cloud Phase
- Day time only: Effective Radius, COT, LWP, IWP

5 July 2016 15:00 UTC
CLOUD PRODUCTS MSG
APPLICATIONS

- Low cloud/fog identification
- Small clouds identification (HRV)
- Support to convection analysis
- Snow cover (day time)
- Precipitation clouds identification
- Desert dust identification
- Volcanic ash identification
- Artefact removal in radar images
- Automatic stations quality control
- Support to surface remote sensing: LSA SAF and OSI SAF
Cloud Mask (CMa) & Cloud Type (CT)

- Large areas of low clouds may not be detected in night-time conditions over land ("warm sectors", high satellite zenith angles).
- Snow ground not detected at night time.
- Very thin cirrus are often classified as fractional clouds. (v2016).
- Very low clouds may be classified as medium clouds in case strong thermal inversion.
- Low clouds under thin cirrus may be classified as medium clouds. (v2016).

Cloud Top Temperature & Height (CTTH)

- Semi-transparent clouds have problems for height/pressure estimation
- No CTTH is available for clouds classified as fractional.
- CTTH may not be computed for thin cirrus clouds.
- Overshooting tops are not well represented. (v2016)
Cloud Microphysics (CMIC)

The following problems may be encountered:

- No CMIC is available for cloud classified as fractional.
- No optical thickness, drop effective radius and liquid/ice water path are retrieved at nighttime or twilight, or at daytime for “mixed phase” or “undefined phase”.

NWC SAF
NWC SAF CLOUD PRODUCTS

GEO v2016: Validation of the SEVIRI cloud products over the full disk

Cloud Mask: Comparison with Surface observations (SYNOP, SHIP)

Cloud Top Height: Comparison with space born radar (CPR on cloudsat)

Cloud Microphysics: Cloud phase: comparison with space born lidar (caliop) and LWP: comparison with microwave imagery (AMSR-E)

Cloud phase: 28 June 2010 12:00 UTZ
CLOUD PRODUCTS PPS
CLOUD MASK (CMα)

- Two different products (extended and binary)
- Thresholding using luts with cloudfree simulations, nwp data

v2014 improvements:
- new tests
- update of surface reflectivity treatment
- updated emissivity maps
- roughness used instead of high terrain

Plans for v2017:
- refactoring for easier maintainance
CLOUD PRODUCTS PPS
CLOUD TYPE (CT)

- Thresholding using cloudfree simulations and nwp data

Not much changes in last years

Plans for v2017:
Fractional water clouds
Multilevel clouds
Cloud height estimates

Colors:
- Cloud free
- Cloud free
- Snow
- Snow/ice
- Very low
- Low
- Medium level
- High
- Very high
- Very thin cirrus
- Thin cirrus
- Thick cirrus
- Cirrus above
- Fractional
- Unclassified
- Unclassified
- Unprocessed
CLOUD PRODUCTS PPS

CLOUD TOP, TEMPERATURE AND HEIGHT (CTTH)

Two methods:
- For opaque clouds:
  11 micron brightness temperature (bt11) vs. nwp temperature profile.
- For fractional and semi transparent clouds:
  Curve fitting of bt11-bt12 vs. bt11

v2014 Improvements:
- Faster
- Higher retrieval rate 75% -> 98%
- Better accuracy

Future improvements:
- Possibly new algorithm, if:
  - Fast enough for nowcasting
  - Better accuracy
CLOUD PRODUCTS PPS
CLOUD PHYSICAL PROPERTIES (CPP)

Main features:
- Cloud Phase (CPh)
- Liquid Water Path (LWP)

Extra features:
- Ice Water Path (IWP)
- Effective Radius (r_{eff})
- Cloud Optical Thickness (COT)

v2014 Improvements:
- New independent cloud phase algorithm
- Phase product during night time
- New look up tables

To be renamed as CMIC for coherence with GEO software
NEW PRODUCT V2017: CLOUD MASK (PROB)

- Cloud probabilities, not mask
- Trained with calipso-data
- Developed by CM SAF
- Currently only for AVHRR instruments

Standard cloudmask

Probabilistic cloudmask
**PRECIPITATION PRODUCTS**

**Precipitating Clouds (PC)**

Probability of precipitation (percentage).

**Convective Rainfall Rate (CRR)**

Precipitation estimated rate associated to convective clouds. Instantaneous rain rate and hourly accumulations.

**Cloud Top Physical Properties**

**Precipitation (PPh)**

Based on Cloud Top Physical Properties, two outputs: Precipitation Probability and Precipitation Rate (+ hourly accumulations)
PRECIPITATING CLOUDS (PC) MSG
INPUT/OUTPUT SCHEME

SEVIRI

VIS0.6
IR01.6
IR03.9
WV06.2
WV07.3
IR10.8
IR12.0

CT

NWC SAF

GEO-PC-v153
YYYY-MM-DDThh:mm:00Z region config_file

Precipitation Index

Bilinear Interpolation

NWP

Tsfc

netCDF

MODERATE PREC. PROBABILITY

65-100%
55-65%
45-55%
35-45%
25-35%
15-25%
5-15%
0-5%

AUXILIARY DATA

Sun Zenit Angle
Satellite Zenith Angle
**PRECIPITATING CLOUDS (PC) PPS**

**ALGORITHM OUTLINE**

- AMSU-B/MHS estimate of precipitation likelihood based on scattering signature
  \[ SI = \text{Tb}_{89} - \text{Tb}_{150} - \text{corrections}(\theta) \]
  MHS (NOAA18... and METOP) 157GHz ch is corrected to simulate 150GHz behaviour
- The precipitation likelihood is estimated from the AVHRR and merged with the MW estimate (previously reprojected to AVHRR).
  - Only potentially precipitating pixels according to CT will be considered.
  - Precipitation Index from AVHRR is calculated and precipitation likelihood assigned.
  - If the precipitation likelihood exceeds a threshold (10% recommended), it is checked if a valid MW precipitation index is available.
  - If MW index is available, AVHRR estimate is replaced by MW estimate.
- Separate estimates over land and sea, in coastal areas blended estimate according to land/sea fraction

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**Likelihood supplied for classes**
- No precip (< 0.1mm/h)
- Light/chance of precip (0.1mm/h - 0.5mm/h)
- Moderate precip (>0.5mm/h – 5mm/h)
- Heavy precip (>5mm/h)

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**v2014 Improvements:**
- Updated flags and output format
CONVECTIVE RAINFALL RATE (CRR)
INPUT/OUTPUT SCHEME

AUXILIARY DATA

Satellite Zenith Angle
Saturated Vapour lookup table
Digital terrain elevation (USGS)
Climatological Profiles (NWP unavailable)

SEVIRI

VIS0.6
WV06.2
IR10.8

DAY

NIGHT

NWP

Bilinear Interpolation

Psfc
T y Td (2m)
T y HR (P levels)
Z (P levels)
U, V (850 hPa)

CONVECTIVE RAINFALL RATE (mm/h)

GEO-CRR-v401
YYYY-MM-DDThh:mm:00Z region config_file

Analytical Functions

Lightning Information

Instantaneous Rain Rates

Hourly Accumulations

Corrections:
Humidity
Evolution/Gradient
Orography
Parallax

AUXILIARY DATA

Satellite Zenith Angle
Saturated Vapour lookup table
Digital terrain elevation (USGS)
Climatological Profiles (NWP unavailable)
CLOUD PHYSICAL PROPERTIES PRECIPITATION (PPH)
INPUT/OUTPUT SCHEME

INPUT:
- Climatological Profiles (NWP unavailable)
- Parallax Correction
- Lightning Information
- SEVIRI
- NWP

OUTPUT:
- PoP = f (CWP)
- RR = f (R_{eff}, CWP)
- Illumination Flag

GEO-PPh-v101
YYYY-MM-DDThh:mm:00Z region config_file

Bilinear Interpolation

AUXILIARY DATA
- Sun Zenith Angle
- Satellite Zenith Angle

PCPh
CRPh (Instantaneous)
CRPh (Accumulated)
Illumination Flag
PREcipitation Products
Precipitation Rate

12th July 2008 - 13:30 UTC
8th September 2012 - 15:30 UTC
PRECIPITATION PRODUCTS

APPLICATIONS

- Estimation of rain rates
- Estimation of precipitation likelihood
- Areas out of the radar coverage
- Radar complement

Madeira 20th February 2010

Hourly Accumulations AREEIRO
Precipitating Clouds (PC)

- Sun Zenith Angle dependency: step day/night
- Bad behaviour for LAT > 60°
- No precipitation detected for Low clouds

Convective Rainfall Rate (CRR)

- CRR fits the cloud tops:
  - larger dimensions than radar data,
  - overshooting tops not well represented
- Warm top rainy clouds are hardly detected
- Very small convective cells are not detected

Cloud Physical Properties Precipitation (PPh)

- Product only available in day time
- High dependence on illumination conditions for Precipitation Rate
- Better Overshooting tops performance
- Detection of warm top rainy clouds
ILLUSTRATION OF THE ILLUMINATION CONDITIONS IMPACT CLOUD PHYSICAL PROPERTIES PRECIPITATION RATE

RADAR

CRPh

Illumination Quality Flag

9th September 2012 13:00 UTC

9th September 2012 16:00 UTC
CONVECTION PRODUCT

*Rapid Development Thunderstorm (RDT)*

Identification, monitoring and tracking of intense convective systems, and detection of rapidly developing convective cells
RAPID DEVELOPMENT THUNDERSTORMS (RDT) INPUT/OUTPUT SCHEME

**NWP**

Bilinear Interpolation

**Lightning**

GEO-RDT-CW-v40

YYYY-MM-DDThh:mm:00Z region config_file

**AUXILIARY DATA**

Discrimination files

**Z tropopause**

T y Td (2m)

T y HR (P levels)

Z (P levels)

**Contours:**

- - - Initiating cells Tmin > -25°C
- - - Growing cells Tmin > -40°C
- - - Mature cells Tmin ≤ -40°C
- - - Cells split

**Lines:**

- - - Cell trajectory
- - - Expected gravity centre motion

**netCDF**

Detection, discrimination and tracking methods
RAPID DEVELOPMENT THUNDERSTORMS (RDT) APPLICATIONS

- Detection and tracking of convective systems
- Early diagnosis of convective events

25th May 2009
RAPID DEVELOPMENT THUNDERSTORMS (RDT)
ASSUMPTIONS & LIMITATIONS

- Tuning carried out on summer period.
- Discrimination score during winter period could be weak
- Use of NWP data avoid false alarms
Convection Initiation (CI)

It provides the probability for a cloudy pixel to become a thunderstorm in a given following period range.
CONVECTION INITIATION (CI)
INPUT/OUTPUT SCHEME

**NWP**

GEO-CI-v10
YYYY-MM-DDThh:mm:00Z region config_file

**Bilinear Interpolation**

**GEO-CI-v10**

Psfc
T, Td and RH (2m)
Zsup
Z (P levels)
T, RH and Z (P levels)
U and V (P levels)
LI, KI and SHW index

**SEVIRI**

WV06.2
WV07.3
IR08.7
IR10.8
IR12.0
IR13.4

**CT**

**CMA**

**HRW**

**netCDF**

Detection, discrimination, tracking and advection methods

**AUXILIARY DATA**
Delivered as a demonstrational product in GEO v2016.

A major improvement is expected in GEO v2018, due to new tuning, use of microphysics, improvement of tracking.
CONVECTIVE INITIATION (CI) APPLICATIONS

➢ To catch the first steps of initiation of convection

ASSUMPTIONS & LIMITATIONS

➢ Is unfortunately too scarce for a full object-approach that allows a good following of meteorological systems
➢ Is a pixel product
CLEAR AIR STABILITY PRODUCTS

Satellite Humidity and Instability (iSHAI)

Two steps: Non-linear regression and optimal estimation algorithm to obtain Stability Parameters: Total and Layered Precipitable Water and Instability Indexes
SATELLITE HUMIDITY AND INSTABILITY (ISHAI)
INPUT/OUTPUT SCHEME (PRESSURE LEVELS)

SEVIRI

IR13.4
IR12.0
IR10.8
WV7.3
WV6.2

CMa

GEO-iSHAI-v30
YYYY-MM-DDThh:mm:00Z region config_file

NWP
T and RH (P levels)

• Horizontal: Bilinear Interpolation
• Vertical: 54 RTTOV pressure levels
• Temporal

Ancillary:
lon, lat, Satellite Zenith Angle
BIAS BT correction coefficients
Emissivity maps
Coefficients

AUXILIARY DATA

+ differences (iSHAI–NWP)

netCDF
TPW
BL (sfc-850)
ML (850-500)
HL (500-top)
LI
SHOWALTER
K-INDEX

NWP

CMa

NWC SAF
SATELLITE HUMIDITY AND INSTABILITY (ISHAI) INPUT/OUTPUT SCHEME (HYBRID LEVELS)

NWP: ECMWF Hybrid Levels from v2013

Vertical, temporal and spatial interpolation inside PGE13Hyb

GEO-iSHAI-v30 YYYY-MM-DDThh:mm:00Z region config_file

Ancillary: lon, lat, Satellite Zenith Angle
BIAS BT correction coefficients
Emissivity maps
Coefficients

AUXILIARY DATA

NWP: ECMWF Hybrid Levels from v2013

TPW
BL (sfc-850)
ML (850-500)
HL (500-top)
LI
SHOWALTER
K-INDEX

+ differences (iSHAI–NWP)
The VIS channels have been normalized in order to enhance the contrast at twilights.
Medium layers are very important (at least in Spain) to determine the region where convection could be triggered.

This is the layer with highest value add from satellite.

Precipitable Water in Middle Layer ML(850-500 hPa)
Medium layers are very important (at least in Spain) to determine the region where convection could be triggered.

This is the layer with highest value add from satellite

Differences on Precipitable Water in Middle Layer ML(850-500 hPa)
SAT\textsc{ellite} H\textsc{umidity} and Instability (ISHAI)
As\textsc{sumptions} & \textsc{limits}\textsc{ations}

- Only available in \textit{clear air}
- \textit{Long computation time}: small regions and/or lower resolution should be selected
- Errors over \textit{mountain regions and desert pixels} due to large differences between actual topography/skin temperature and the NWP ones.
WIND PRODUCT

HIGH RESOLUTION WINDS (HRW)

Detailed and frequently updated sets of Atmospheric Motion Winds including wind pressure level information and quality control flags.

FROM V2012 up to 7 channels are used:

HRVIS, VIS0.6, VIS0.8, WV06.2, WV07.3, IR10.8, IR12.0
HIGH RESOLUTION WINDS (HRW)
INPUT/OUTPUT SCHEME

**Input:**
- **HRVIS**, **VIS0.6**, **VIS0.8**, **WV06.2**, **WV07.3**, **IR10.8**, **IR12.0** (SEVIRI)
- **CT**, **CTTH** (NWC SAF)

**Maximum Interpolation:**
- NWP
- **GEO-HRW-v50**
  - YYYY-MM-DDThh:mm:00Z
  - `region config_file`

**Output for each wind:**
- Initial Tracer Latitude and longitude
- LAT/LON increment
- Direction and velocity
- Temperature, pressure and estimated error
- Wind Vector Quality Index (QI)
- Orographic Flag
- Cloud Type
- MSG channel used

**AUXILIARY DATA:**
- Climatological Profiles (NWP not available)
- Digital terrain elevation (USGS)

**Process:**
- Tracer calculation
- Tracer tracking in a later image
- Height assignment
- Quality Control

**Output Format:**
- Tsfc
  - T, U, V (P levels)
  - Z (P levels)

**netCDF**

**Digitization Details:**
- 57
Calculation of trajectories through the successive tracking of the same tracer in consecutive slots (can be calculated from 30 min to 5 hours)
HIGH RESOLUTION WINDS (HRW)

APPLICATIONS

- Watch and warning of dangerous wind situations
- Low level convergence (when and where cumulus start to develop)
- Divergence at the top of developed systems
- Small scale circulation monitoring
- NWP assimilation
- Air mass displacement (trajectories)
HIGH RESOLUTION WINDS (HRW)
ASSUMPTIONS & LIMITATIONS

- Variability with time of the amount of available AMV data.

- Variability with time of the persistence of trajectories:
  - Only 30-50% of tracers persist 1 hour
  - 5-15% of tracers persist 3 hours

- Errors caused by the dependence on a wrong NWP model forecast
  - Reduced since v2012 with tracking without wind guess
  - (although with a slower algorithm)
Automatic interpretation of features on satellite images: fronts, wave structures, areas of intensification at fronts by jet streak crossing, position of the jet axis, comma clouds, enhanced convection areas, etc.
AUTOMATIC SATELLITE INTERPRETATION (ASII)
INPUT/OUTPUT SCHEME

<table>
<thead>
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<th>Conceptual Model:</th>
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<tr>
<td>w</td>
<td>red</td>
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<td>c</td>
<td>blue</td>
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<tr>
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<td>(yellow)</td>
</tr>
</tbody>
</table>

SEVIRI

NWP

Bilinear Interpolation

T y HR (850 hPa)

GEO-ASII-v241

YYYY-MM-DDThh:mm:00Z region config_file

Patron Recognition

AUXILIARY DATA

netCDF

With NWP

Without NWP
AUTOMATIC SATELLITE INTERPRETATION (ASII) ASSUMPTIONS & LIMITATIONS

It cannot be expected that ASII will catch every instance to yield the right yes/no-decisions.

Inferior performance has to be expected:
* at the boundaries of the covered domain
* in far-northern regions with reduced spatial resolution.
Automatic identification of Clear Air Turbulence (CAT). As CAT involves physical processes with scales usually smaller than the resolution of numerical weather prediction (NWP) models, forecasts of CAT with NWP are difficult to perform. Therefore, it is of interest to identify areas with risk of CAT from satellite observations. ASII-NG plans comprise two products:

- A turbulence detection module
  - Tropopause folds
  - Gravity waves (e.g. lee waves)
  - Air mass boundaries (e.g. fronts)
  - Wind shear (e.g. jets)
AUTOMATIC SATELLITE INTERPRETATION NEW GENERATION (ASII-NG) *
INPUT/OUTPUT SCHEME

NWP
U, V (300 hPa)
RH and PV (P levels)

Bilinear Interpolation

GEO-ASII-NG-v10
YYYY-MM-DDThh:mm:00Z region config_file

AUXILIARY DATA

SEVIRI
WV06.2
IR09.7
IR10.8

netCDF
AUTOMATIC SATELLITE INTERPRETATION NEW GENERATION (ASII-NG) ASSUMPTIONS & LIMITATIONS

It cannot be used as a stand-alone automatic warning tool.

In case of lee wave turbulence or transverse banding, the absence of signal in satellite imagery does not preclude the existence of CAT.
NEW EXTRAPOLATED IMAGERY (EXIM)

EXTRAPOLATION OF MSG IMAGES AND NWC SAF PRODUCTS USING THE NWC SAF HRW WINDS

Extrapolated product
08:15 → 09:15

CMa 08:15

CMa 09:15
NWC SAF PRACTICAL GUIDE

-6 h  -3 h  -1 h  -30 min  0

Lead Time
NWC SAF PRACTICAL GUIDE

sSHAI, iSHAI: Humidity and Instability

Cl: Convective Initiation

RDT: Cell Tracking

EXIM: Extrapolate Images

Radar, CRR: Rain Rate

Lightning, MTG-LI

Time:
-6 h  -3 h  -1 h  -30 min  0
NWC SAF PRACTICAL GUIDE

- ASII: Automatic Interpretation
- EXIM: Image extrapolation
- HRW: Winds
- CMA, CT, CTTH: Clouds

Time:
- -6 h
- -3 h
- -1 h
- -30 min
- 0

NWC SAF or Other Product
NWC SAF PRACTICAL GUIDE
PRODUCT CLASSIFICATION

Under Development
Use with great care

Use with care

Use with confidence
**PRACTICAL GUIDE: ISHAI (1/2)**

- **SHAI**: imager Satellite Humidity And Instability
- Useful to track humidity and instability in clear air scenes
- Normally useful in clear air a few hours (-6 to -1 hr) before convection starts

Use with Confidence in Clear Sky Scenes

Use with Care Close to Clouds: Look for Persistence

Precipitable Water in Middle Layer (850-500 hPa)
PRACTICAL GUIDE: ISHAI (2/2)

- SHAI: imager Satellite Humidity And Instability
- Useful to track humidity differences with respect to the NWP model at any time there is a clear sky scene
- Regions drier than the model are shown in blue. Regions more humid than the model are shown in red

Precipitable Water Differences in Middle Layer (850-500 hPa) with respect to ECMWF

Use with Confidence in Clear Sky Scenes

Use with Care Close to Clouds: Look for Persistence
EXAMPLE ISHAI → LEAD TIME: -5 H DATE: 19.08.2015

- iSHAI: imager Satellite Humidity And Instability
- iSHAI showing big difference with ECMWF
- Obtained with MSG
- Data obtained at 2:00 am
- It is persistent in time at the same location until ~5:00 am
- RDT shows cell at 5:15 am
- Intense precipitation at around 07:00 am

2:00 am iSHAI Boundary Layer Humidity Difference with respect to ECMWF

Use with Confidence in Clear Sky Scenes

Use with Care Close to Clouds: Look for Persistence
PRACTICAL GUIDE: HRW

- HRW: High Resolution Winds
- Convergence regions and strong winds at lower levels are sometimes visible
- Very useful products of general purpose (any time)
- Easy to interpret

Use with Confidence
Well Tested Product
EXAMPLE HRW → LEAD TIME: -3 H DATE 19.08.2015

- HRW: High Resolution Winds
- HRW showing convergence in the region of interest
- Very useful products of general purpose (any time)
- Easy to interpret
- Obtained with MSG
- Data obtained at 4:00 am
- RDT shows cell at 5:15 am
- Intense precipitation at around 07:00 am

4:00 am HRW Winds at different levels (low levels in blue)

Use with Confidence
Well Tested Product
EXAMPLE ISHAI + HRW → LEAD TIME: -3 H DATE: 23.10.2016

- iSHAI: imager Satellite Humidity And Instability
- HRW: High Resolution Winds
- Obtained with MSG
- Data obtained at 3:00 am
- Moisture river confirmed with NWC SAF

3:00 am iSHAI Boundary Layer Humidity + HRW

Use with Confidence
Well Tested Products
PRODUCT GUIDE: RDT

- RDT: Rapid Developing Thunderstorm
- Very useful product for Cell Tracking, Detection and Evolution
- Cells are shown as polygons
- Color indicate cell evolution stage (red: growing, purple: mature, blue: decaying)
- Thickness of line indicate severity
- Overshooting tops are shown as green circles
- Yellow line: past 1 hour track
- Black line: future 1 hour track

Use with Confidence
Well Tested Product
EXAMPLE RDT → LEAD TIME: -2 H DATE: 19.08.2015

- RDT: Rapid Developing Thunderstorm
- Cell Tracking, Detection and Evolution product
- Fast Developing Cell shown
- Cell is shown 15 min before it appears on the Radar
- Obtained with MSG
- Data obtained at 5:15 am
- Intense precipitation at around 07:00 am

Use with Confidence
Well Tested Product
PRACTICAL GUIDE: CI

- CI: Convective Initiation
- Detects Growing Cells which will become Storms
- Detects Cells before Radar
- Still under development

Demonstrational
Under Development, but Promising
Current version with many False Alarms
EXAMPLE CI ➔ LEAD TIME: -1 H DATE: 19.08.2015

- CI: Convective Initiation
- Detects Growing Cells which will become Storms
- Detects Cells before Radar
- Fast Developing Cell shown
- Cell is shown 45 min before it appears in RDT
- Obtained with MSG
- Data obtained at 3:45 am (CI) and 4:30 am (RDT)

Demonstrational
Under Development, but Promising
Current version with many False Alarms
PRACTICAL GUIDE: CRR

- PC, PCPh, CRPh, CRR: Precipitation Products
- Detects Rain indirectly from Cloud Tops
- Useful when Radar is Off
- Radar is better when available
- Radar and CRR usually do not overlap exactly
- Differences between day and night products

Use with Confidence
Well Tested Product
Know its limitations
EXAMPLE CRR → LEAD TIME: 0 H DATE: 12.10.2016

- PC, PCPh, CRPh, CRR: Precipitation Products
- Detects Rain indirectly from Cloud Tops
- Useful when Radar is Off
- Radar is better when available
- Radar and CRR usually do not overlap exactly
- Differences between day and night products
- Obtained with MSG
- Data obtained at 13:15

Use with Confidence
Well Tested Product
Know its limitations
PRACTICAL GUIDE: CLOUD PRODUCTS

- CMa, CT, CTTH, CMIC: Cloud Mask, Cloud Type, Cloud Top, Cloud Microphysics, etc.
- Very useful products of general purpose (any time)
- Easy to interpret

Use with Confidence
Well Tested Product
EXAMPLE CLOUD PRODUCTS → LEAD TIME: 0 H

DATE: 19.02.2017

- Obtained with MSG
- Data obtained at 3:00 am
- Torrential rain at 3:00 am
- Radar had Echotops of 8.5 km giving a wrong cloud top height impression
- CTTH was giving up to 12 km cloud tops

Use with Confidence
Well Tested Product
PRACTICAL GUIDE: ASII-NG

- ASSI-NG: Currently detects tropopause folding
- These are areas where turbulence close at tropopause altitudes is likely to occur
- High turbulence probability regions are shown in red

Date 26.02.2017 Time: 00Z

Use with care
Product not fully Validated
User Feedback is welcome
EXAMPLE ASII-NG → TROPAUSE TURBULENCE DETECTION

- Turbulence Reported over Area of Black Sea and Caspian Sea

Date 26.02.2017 Time: 00Z

Use with care
Product not fully Validated
User Feedback is welcome
EXAMPLE SSHAI ➔ LEAD TIME: -9 H DATE: 15.07.2015

- sSHAI: sounder Satellite Humidity And Instability
- Obtained with IASI as proxy for MTG-IRS
- Data obtained at 9:49 am
- Useful for days when synoptic conditions do not change significantly
- Typically on solar triggered convection (summer)
EXAMPLE SSHAI → METEOSAT RGB IMAGES

9:45 Z

17:15 Z

2015/07/15
**EXAMPLE SSHAI ➔ LEAD TIME: -9 H**

- SSHAI: sounder Satellite Humidity And Instability
- Obtained with IASI as proxy for MTG-IRS
- Data obtained at 9:49 am
- Useful for days when synoptic conditions do not change significantly
- Typically on solar triggered convection (summer)

9:49 am SSHAI Instability over 17:15 MSG

Under Development
Use with great care
Product NOT Operationally Available
GEO EXTENSION

NWC/GEO software to process the observations from a generic geostationary satellite

Product scientifically tuned

HRW → GOES-N
HOW TO GET THE NWC SAF SW

1. Write an email expressing your interest to:
safnwchd@aemet.es (cc pripodasa@aemet.es)

2. You will be sent:
The Application Form, that should be fulfilled and sent by email
The License Agreement, that should be signed and sent by ordinary mail

3. You will be provided the credentials to access the Help Desk restricted area:
You can download the SW (GEO & PPS)
1. Download, decompress and install the package (Linux or Unix machine): A directory tree is created

2. Put the SEVIRI, NWP and LIGHTNING (optional) data in the corresponding folders ($SAFNWC/import/…)

3. Modify some configuration files ($SAFNWC/config/) to fix: Region, Output size, Products of interest, Satellite (Nominal, RSS)…

4. Start the Task Manager with the updated configuration files

5. $SAFNWC/export/… HDF5 conversion to your operational format
   A tool for BUFR conversion to HDF5 is available

HOW TO DEAL WITH NWC SAF PPS SW

User Manual available

Two different ways to install PPS package:

  From source code

  From binary files (if a distribution for your OS is available)

Process explained on an online workshop.

It can also be found on Eumetrain website:

http://www.eumetrain.org/resources/NWCSAF_tutorial_2015.html
THANKS TO Ana Sánchez Piqué, Pilar Rípodas y Xavier Calbet
Thanks for your attention

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THANKS FOR YOUR ATTENTION