EUMETSAT

NWC SAF

SUPPORT TO NOWCASTING AND
VERY SHORT RANGE FORECASTING

User Manual for the "Automatic Satellite Image Interpretation – Next Generation" Processors of the NWC/GEO: Science Part

NWC/CDOP3/GEO/ZAMG/SCI/UM/ASII-NG, Issue 2.0

10 January 2022

Applicable to

GEO-ASII-NG NWC-088

which is comprised of

GEO-ASII-TF-v2.1

GEO-ASII-GW-v1.1

Prepared by ZAMG

REPORT SIGNATURE TABLE

Function	Name	Signature	Date
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DOCUMENT CHANGE RECORD

Version	Date	Pages	CHANGE(S)
1.0	21 January 2019	18	Initial version (derived from NWC/CDOP2/GEO/ZAMG/SCI/UM/ASII, v1.0 by removing the ASII parts.) Gravity wave detection as a new sub-product.
1.0.1	1 October 2019	18	Version for SAFNWC/GEO v2018.1 (GOES-R patch).
2.0	*10 January 2022*	21	Version for SAFNWC/GEO v2021: Text reflects changes in output file content (IR analysis enabled for ASII-GW, more comprehensive quality indicators introduced); Table with possible error messages included

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List of Tables and Figures

1. INTRODUCTION

The EUMETSAT "Satellite Application Facilities" (SAF) are dedicated centres of excellence for processing satellite data, and form an integral part of the distributed EUMETSAT Application Ground Segment (http://www.eumetsat.int). This documentation is provided by the SAF on Support to Nowcasting and Very Short Range Forecasting, NWCSAF. The main objective of NWCSAF is to provide, further develop and maintain software packages to be used for Nowcasting applications of operational meteorological satellite data by National Meteorological Services. More information can be found at the NWCSAF webpage, http://nwc-saf.eumetsat.int. This document is applicable to the NWCSAF processing package for geostationary satellites, NWC/GEO.

1.1 SCOPE OF THE DOCUMENT

This document is the User Manual for the "Automatic Satellite Image Interpretation – Next Generation" Product (PGE17 of the NWC/GEO software).

This document contains practical information for the daily use of the products. This document is intended for the meteorologist giving some principal information on the abilities and limitation of the product output.

1.2 SCOPE OF OTHER DOCUMENTS

The algorithms used in this software are described in the Algorithm Theoretical Basis Document [AD.11].

Details of input and output data format of the products are also described in the Interface Control Documents [AD.5] for the External and Internal Interfaces of the NWC/GEO and in the NWC/GEO Output Product Format Definition [AD.7].

The general architecture of the software (interface with the NWCSAF software, architecture of the PGE) is described in the Architectural Design Document [AD.8].

The product generator elements are described in the corresponding Software Component and Version Description.

Instructions how to install, configure and execute the NWC/GEO software in order to extract the Automatic Satellite Image Interpretation – Next Generation Products (PGE17) are detailed in the NWC/GEO Software User Manual.

The latest validation of the algorithms used to extract the Automatic Satellite Image Interpretation – Next Generation (PGE17) is reported in a validation report [RD.2].

1.3 SOFTWARE VERSION IDENTIFICATION

This document is compliant with the ASII-NG/PGE17 version of the 2021 NWC/GEO software package delivery. It was decided that the individual products assembled under the ASII-NG label should be as separated as possible in order to facilitate version control and other programme-managerial tasks. In version 2021, there are two sub-modules which could indeed be totally separated, as there are only negligible synergies between them:
- the ASII-GW (gravity wave detection) module, v1.1, and
- the ASII-TF (tropopause folding detection) module, v2.1.

1.4 IMPROVEMENTS FROM PREVIOUS VERSION

ASII-TF tuned for GOES-R and Himawari; enhanced gravity wave detection algorithm, IR analysis enabled for ASII-GW, and more comprehensive quality indicators introduced.

1.5 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

See [RD.1] for a complete list of standard acronyms for the SAF project. Some specific abbreviations used herein include:

AD	Applicable Document
ASII	Automatic Satellite Image Interpretation
ASII-GW	Gravity wave detection sub-product of ASII-NG
ASII-NG	ASII next generation
ASII-TF	Tropopause folding detection sub-product of ASII-NG
ECMWF	European Centre for Medium-range Weather Forecast
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
IR	Infrared
MSG	Meteosat Second Generation
NWP	Numerical Weather Prediction
PGE	Product Generation Element
SAF	Satellite Application Facility
SEVIRI	Spinning Enhanced Visible and Infrared Imager
UTC	Universal Time Coordinated
WV	Water Vapour
ZAMG	Zentralanstalt für Meteorologie und Geodynamik (Vienna)

1.6 REFERENCES

1.6.1 Applicable documents

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.X].

For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the current edition of the document referred applies.

Current documentation can be found at the NWC SAF Helpdesk web: http://nwc-saf.eumetsat.int.

Ref	Title	Code	Vers	Date
[AD.1]	Project Plan for the NWCSAF CDOP3 phase	NWC/CDOP3/SAF/AEMET/MGT/PP	1.6	01/12/21
[AD.2]	NWCSAF CDOP3 Project Plan Master Schedule	NWC/CDOP3/SAF/AEMET/MGT/PP/MasterSchedule	1.6	01/12/21
[AD.3]	Configuration Management Plan for the NWC SAF	NWC/CDOP3/SAF/AEMET/MGT/CMP	1.1	15/04/20
[AD.4]	System and Components Requirements Document for the NWC/GEO	NWC/CDOP3/GEO/AEMET/SW/SCRD	1.0	01/09/21
[AD.5]	Interface Control Document for Internal and External Interfaces of the NWC/GEO	NWC/CDOP3/GEO/AEMET/SW/ICD/1	2.0	01/09/21
[AD.6]	Interface Control Document for the NWCLIB of the NWC/GEO	NWC/CDOP3/GEO/AEMET/SW/ICD/2	2.0	01/09/21
[AD.7]	Data Output Format for the NWC/GEO	NWC/CDOP3/GEO/AEMET/SW/DOF	2.0	10/01/22
[AD.8]	Component Design Document for the NWCLIB of the NWC/GEO	NWC/CDOP2/GEO/AEMET/SW/ACDD/NWCLIB	2.0.1	31/07/18
[AD.9]	NWC SAF Product Requirements Document	NWC/CDOP3/GEO/AEMET/MGT/PRD	1.5	01/12/21
[AD.10]	User Manual for the Tools of the NWC/GEO	NWC/CDOP3/GEO/AEMET/SCI/UM/Tools	2.0	10/01/22
[AD.11]	Algorithm Theoretical Basis Document for the "Automatic Satellite Image Interpretation – Next Generation" Processor of the NWC/GEO	NWC/CDOP3/GEO/ZAMG/SCI/ATBD/ASII-NG	1.0	01/09/21

Table 1: List of Applicable Documents

1.6.2 Reference documents

The reference documents contain useful information related to the subject of the project. These reference documents complement the applicable ones, and can be looked up to enhance the information included in this document if it is desired. They are referenced in this document in the form [RD.X].

For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the current edition of the document referred applies.

Current documentation can be found at the NWC SAF Helpdesk web: http://nwc-saf.eumetsat.int

Ref	Title	Code	Vers	Date
[RD.1]	The Nowcasting SAF Glossary	NWC/CDOP3/SAF/AEMET/MGT/GLO	1.0	20/10/20
[RD.2]	Scientific and Validation Report for the "Automatic Satellite Image Interpretation – Next Generation" Processors of the NWC/GEO	NWC/CDOP3/GEO/ZAMG/SCI/VR/ASII-NG	1.0	21/01/19
[RD.3]	Scientific and Validation Report for the "Automatic Satellite Image Interpretation – Next Generation" Processors of the NWC/GEO	NWC/CDOP3/GEO/ZAMG/SCI/VR/ASII-NG	2.0	10/01/22

Table 2: List of Referenced Documents

2. DESCRIPTION OF THE NWC/GEO-ASII-NG PRODUCTS

2.1 GOAL OF THE ASII-NG PRODUCTS

ASII-NG/PGE17 utilizes concepts established during the development of ASII in CDOP, but based on new algorithmic components developed during CDOP-2 and CDOP-3, especially the probabilistic method of logistic regression. The new product differs also in its focus on only a few selected phenomena of particularly high user interest and in its output of probability-of-occurrence on a pixel-by-pixel basis.

In its first development stage, ASII-NG focuses on the detection of turbulence from characteristic patterns (i.e. lee waves, jet-induced turbulence and tropopause folding). Algorithms based on pattern recognition methods are exploiting the image data provided by the MSG (or Himawari or GOES-R) satellite and are complemented by NWP data, where suitable, to give an objective analysis of regions with increased likelihood of turbulence.

Later, ASII-NG shall be extended by additional products, such as the detection of in-flight icing potential. Both phenomena, i.e. turbulence and icing, represent threats for civil aviation. The intention is to develop more accurate and timely diagnoses of conditions leading to ice accretion on aircraft during flight.

2.2 DESCRIPTION OF AUTOMATIC SATELLITE INTERPRETATION – NEXT GENERATION PRODUCTS

The ASII-NG products are encoded in standard NWCSAF netCDF output files. As such, they feature many standard entries/matrices common to all NWC/GEO netCDF products; such contents are described in the NWCSAF Data Output Format Document [AD.7]. There is one file per slot per sub-product, and the output files are located by default in $SAFNWC/export/ASII; the naming follows the schematic S_NWC_ASII-*<sub-product>_<satellite>_<region>*-VISIR_*YYYYMMDD*T*hhmmss*Z.nc (examples: S_NWC_ASII-GW_MSG3_global-VISIR_20150626T120000Z.nc and S_NWC_ASII-TF_MSG3_global-VISIR_20150626T120000Z.nc).

Apart from the standard fields, the netCDF file holds the following ASII-NG-specific fields:

- (ASII-TF) "asiitf_prob": derived probability for occurrence of tropopause folding; for each pixel a value between 0 and 100%, with failure to derive it at a certain pixel indicated by code 255.

- (ASII-TF) "asiitf_status_flag": giving more details on reasons why "asii_turb_trop_prob" could not be derived at a certain pixel. 0=everything OK, probability computed; otherwise:

    o bit 1 set: problem in "stripe in WV6.2"

    o bit 2 set: problem in "(gradient in) WV6.2"

    o bit 3 set: problem in "gradient of the difference image IR9.7-IR10.8"

    o bit 4 set: problem in "shear vorticity" (NWP parameter)

    o bit 5 set: problem in "wind speed" (NWP parameter)

    o bit 6 set: problem in "tropopause from specific humidity" (NWP parameter that may require model levels in great height)

- (ASII-GW) asiigw_ir_prob_pal, asiigw_wv_prob_pal; (ASII-TF) asiitf_prob_pal: turquoise (0)-to-red (100%) palettes

		Code: NWC/CDOP3/GEO/ZAMG/SCI/UM/ASII-NG
NWC SAF	ZAMG	**Issue:** 2.0 **Date**: *10 January 2022* **File:** NWC-CDOP3-GEO-ZAMG-SCI-UM-ASII-NG_v2.0.docx **Page:** *10*/21

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- (ASII-GW) "asiigw_wv_prob", "asiigw_ir_prob": derived probability for presence of gravity wave in the WV and IR channel, respectively; for each pixel a value between 0 and 100%, with failure to derive it at a certain pixel indicated by code 255.

- (ASII-GW) "asiigw_status_flag": giving more details on reasons why "asii_turb_wave_prob" could not be derived at a certain pixel. 0=everything OK, probability computed; otherwise:

    o bit 1 set: not a valid WV7.3 pixel

    o bit 2 set: pixel filtered by temperature threshold in WV7.3

    o bit 3 set: not a valid IR10.8/10.5/11.2 pixel

    o bit 4 set: pixel filtered by temperature threshold in IR10.8/10.5/11.2

- (ASII-GW) "asiigw_wv_continuity", "asiigw_ir_continuity": indicating the number of slots a gravity wave probability > 0% has been obtained at the pixel in the WV and IR channel, respectively, without interruption (currently testing up to 7 preceding analyses in $SAFNWC/export/ASII; i.e. 8 being the maximum number, 1 meaning that it appeared for the first time in the current analysis).

- the common processing conditions and quality flags (described in [AD.7]) for these products bear the names asiigw_conditions/asiitf_conditions and asiigw_quality/asiitf_quality.

The "product completeness" field in the netCDF file derives from the number of processed pixels divided by the total number of pixels (a baseline effect is to be expected if the processing region has space pixels in it). For the "product quality" of ASII-GW, a value of 1 is assigned to all pixels where all tests could be carried out. If this is not possible (typically at the edge of the domain), the quality should be lower – as the computational effort to determine the degree of incompleteness should be saved, the "average reduced quality" of 0.5 is assigned to such pixels; the netCDF variable then is computed as the average over all non-space pixels. Under normal circumstances, this is merely a function of region geometry and should therefore be a constant for a given region. For ASII-TF, no viable strategy has been devised so far to derive a global product quality figure which would provide additional value over the information contained in "asiitf_status_flag" (the major conceptual difference to ASII-GW being that the product is completely suspended at any pixel where one ingredient is missing; nevertheless, as the NWCSAF netCDF model requires the figure, it is currently arbitrarily set to 100%).

Some technical considerations in the period between the two releases v2018.1 and v2021 suggested name changes in netCDF fields. In order to facilitate the transition between the two ASII-NG releases, the changes are summarized hereafter in tabular form:

Variable name in v2021	Variable name in v2018.1
ASII-TF	
asiitf_prob	asii_turb_trop_prob
asiitf_status_flag	asii_turb_trop_prob_status_flag
asiitf_pal	asii_turb_prob_pal
ASII-GW	
asiigw_wv_prob	asii_turb_wave_prob
asiigw_status_flag	asii_turb_wave_prob_status_flag
asiigw_wv_prob_pal	asii_turb_prob_pal

asiigw_ir_prob	(new in v2021)
asiigw_ir_prob_pal	(new in v2021)
asiigw_wv_continuity	(new in v2021)
asiigw_ir_continuity	(new in v2021)

3. IMPLEMENTATION OF THE ASII-NG PGES

3.1 NWC/GEO SOFTWARE PACKAGE INSTALLATION AND PREPARATION

ASII-NG is extracted by PGE17 of the NWC/GEO software package. Detailed information on how to run this software package is available in the "Software User Manual for the NWC/GEO application".

The implementation of the ASII-NG software follows the general implementation of components of the NWC/GEO software (see the software part of the Users Manual of the NWC/GEO software for more details).

Basically, the following steps are needed to run the ASII-NG software:

1. Create or update configuration files (system, region, model and run configuration files) according to their format (see the Interface Control Document ICD/1 [AD.5]). Files are situated in $SAFNWC/config.

2. Algorithm configuration files are situated in the directories $SAFNWC/import/Aux_data/ASII-GW and $SAFNWC/import/Aux_data/ASII-TF. These PGE17 input files are provided with the software package, installed together with it, and are not foreseen for modification by users.

3. Ensure that the remapped NWP data has been made available in the DATABUF directory "$SAFNWC/tmp" (only needed by ASII-TF at the time being).

4. Ensure that the SEVIRI image file in HRIT format (mandatory input) (or the Himawari input) is available in the directory $SAFNWC/import/Sat_data/.

Then, the processing of ASII-NG is automatically monitored by the task manager (see the Software Users Manual for the Task Manager of the NWC/GEO software).

Submitting GEO-ASII-NG,v2021 in stand-alone mode, not using the task manager:

Ensure that all required input data are available in their respective directories, and that pre-requirements listed under items 1-4 are fulfilled.

The ASII-GW executable GEO-ASII-GW-v11 can be called as follows (from the directory where it is situated, which normally should be $SAFNWC/bin):

GEO-ASII-GW-v11 YYYY-MM-DDThh:mm:ssZ <region_conf_file> <model_conf_file>

Example:

GEO-ASII-GW-v11 2015-06-26T12:00:00Z test_asii.cfg safnwc_ASII-GW.cfm

The ASII-TF production follows an analogous scheme:

GEO-ASII-TF-v21 YYYY-MM-DDThh:mm:ssZ <region_conf_file> <model_conf_file>

Example:

GEO-ASII-TF-v21 2015-06-26T12:00:00Z test_asii.cfg safnwc_ASII-TF.cfm

3.2 NWC/GEO-ASII-NG DIAGNOSTIC ERRORS

The following table shows the whole list of errors and warnings that can appear during the execution of the NWC/GEO-ASII-NG PGEs, the reasons causing these errors and warnings, and

the way the NWC SAF user can try to solve them. In any case, if the errors or warnings persist, the NWC SAF Helpdesk should be contacted.

Code (E/W)	Message	Comment	Recovery action
E	"Usage: %s YYYY-MM-DDThh:mm:ssZ <region_conf_file> <model_conf_file>"	Error when launching an ASII-NG PGE	Check instruction for launching the concerned PGEs
E	All messages related to NWCLIB time handling functions: NwcTimeSetStr, NwcTimeSetT	Time input when launching PGE may be wrong.	Check the slot time input when launching PGE.
E	All messages including the following strings: "memory allocation" "allocation error" "Unable to allocate" "Error allocating" "not allocated" "cannot be allocated"	Problem of memory allocation	Check memory
E	All messages containing the following string: "ERROR when opening"	Problem to open an existing file or to create a new file.	Check permission and disk space on the directory. Check presence of the requested file. The recovery actions depends on the type of file: - for missing configuration files, copy them from delivered SW; - for missing file to be input by user: check why they are missing; for new file, check permission/disk space on the directory.
E	All messages containing the strings: "mod(el)_conf(iguration)_file" "PRODIO_CONF_FILE" "CONF_FILE_ERROR" "couldn't find all parameters for…"	Problem when looking for configuration file or reading a key from it.	Check corresponding configuration file for presence and content. If needed, copy them from delivered SW.
E	All messages containing the strings: "OUTPUT_PRODUCT…ERROR" "Error initiating/writing/finalizing…" "Error in module Write…" "coding failed"	Problem to send output to file.	Check permission and disk space on the output directories.
E	All messages (and knock-on messages) related to • NWCLIB initialization functions: NwcRegionSet, NwcCFRead, NwcSatInit • NWCLIB Reading function NwcSatReadBand • NWCLIB numerical function NwcNavGetLatLon		Consult NWCLIB-specific documentation
E	"Error in reading the supplementary input"	Refers to land-sea mask	Check correct installation of NWCSAF land-sea auxiliary data
E	"Error in reading the Gabor filter aux file"	Refers to auxiliary ASII-GW input	Check correct installation of NWCSAF auxiliary data
E	Messages containing the term "NWP"	Problem with NWP configuration file or remapped NWP data	Depending on the exact message, check NWP configuration file or completeness of remapped NWP data (ASII-TF) or NWP GRIB file (ASII).

Code (E/W)	Message	Comment	Recovery action
E	Messages stating in which part / which subroutine the problem occurred	Introduced mainly to facilitate debugging activities by the developers	Such messages should have been preceded by another error message (in most cases on memory allocation) → see the recovery actions under these categories

Table 3: *List of possible errors reported by the ASII-NG PGEs of v2021.*

4. INPUTS AND CONFIGURABLE PARAMETERS FOR THE ASII PRODUCT GENERATION ELEMENTS

4.1 ASII-TF

4.1.1 List of inputs

- IR imagery, channel 9.7, current slot
- IR imagery, channel 10.8, current slot.
- WV image, channel 6.2, current slot
- NWP data (temperature, relative humidity, wind)

4.1.2 Configurable parameters

N/A in NWC/GEOv2021.

4.2 ASII-GW

4.2.1 List of inputs

- WV image, channel 7.3, current slot
- IR image, channel 10.8, current slot

4.2.2 Configurable parameters

The configurable parameters can be found at the end of the model configuration file for ASII-GW:

Keyword(s)	Description	Type	Possible Value(s)
IR WV	Decide whether the IR10.8 and/or WV7.3 analysis are computed. The final product comprises the maximum signal found in either channel.	chain of characters	YES or NO (the software interprets any expression with a "Y" or "y" in it as a "Yes".)

5. SUMMARY OF AUTOMATIC SATELLITE IMAGE INTERPRETATION – NEXT GENERATION (ASII-NG) VALIDATION RESULTS

5.1 ASII-GW

The ASII-NG gravity wave detection sub-product ASII-GW directs the meteorologist in a time-saving manner to those areas where gravity waves can be seen. Recent advances that help eliminating cases of incorrectly flagged areas of marine stratocumulus (especially disturbing during the cold season) and allow to offer an IR10.8 analysis in ASII-GW v1.1 (v1.0 was based on WV7.3 only) are documented in Jann (2019). Applicability of the detection algorithm to higher-resolution imagery of the most recent sensors was verified in He et al. (2020).

5.2 ASII-TF

The ASII-NG tropopause fold detection sub-product is tuned to detect stronger variations of the tropopause height. Validation of the indicated tropopause fold positions by the ASII-TF product has been done against pilot reports (PIREP) and IASI derived tropopause heights.

Visual inspection of the ASII-TF output with IASI-derived tropopause gradients shows a fairly good consistency regarding the position of the tropopause folds; the ASII-TF product showing even more details than the sounding data, and it also seems to be more sensitive to smaller height variations.

When comparing the ASII-TF output against PIREPs, only turbulence reports from higher atmospheric levels have been considered. Here, turbulence experienced by aircrafts is mainly caused by wind shear at jet level. Strong wind bands at around 300 hPa are often found near tropopause folds. This geographical connection has been used to examine the relation between the position of the observed turbulence and the location of the tropopause fold. The obtained results show that most turbulence reports (87%) are issued within or close to tropopause folds identified by the ASII-TF product, when turbulence originates from wind shear.

Although tropopause folds are good indicators for the position of jet streaks, tropopause folds are not the root cause of turbulence. Hence, in case the ASII-TF product is intended to be used as turbulence warning tool, factors like vertical and/or horizontal wind shear should also be considered by the forecaster.

# 6. WELL-KNOWN PROBLEMS AND RECOMMENDATION FOR USE

These products are aimed to be part of the inputs for decision making by meteorologists, yet cannot be used as a stand-alone automatic warning tool. The products are satellite products searching for features favourable for turbulence but NOT the turbulence itself. As CAT by definition is a clear-air phenomenon there may be areas of turbulence which cannot be detected by any remote sensing tool. Therefore, the absence of signals in satellite imagery does not preclude the presence of CAT. In other words, even assuming the detection algorithms are working perfectly, the detection rate of CAT will never reach 1.

As computation of tropopause heights is one ingredient of ASII-TF, it is recommended that NWP data are provided up to the 50 hPa level to ensure that the tropopause is captured (on the other hand, it was found for the GFS model that the humidity fields in layers above 30 hPa are not dependable. Random fluctuations with often unrealistic increases at high levels accidentally satisfy the tropopause criteria. In order to avoid such erroneous signals, the ASII-TF software simply omits NWP input from layers with <30hPa pressure, as the tropopause should be located in lower layers anyway).

Although the NWCSAF software package can be processed at any region of the disc, the focus of tuning and validation was on Europe and the neighbouring sea areas (although the validation exercise for ASII-GW v1.1 included visits to areas on the whole disc including the southern hemisphere [RD.2]; Jann(2019)). The higher resolution of Himawari/GOES-R/MTG-FCI means that gravity waves with smaller wavelengths can be inspected. Given the typical scale of tropospheric gravity waves, this should have a positive impact on detectability. Still, for geometrical reasons, one must accept that gravity waves near the edge of the disc are not resolved or, in general terms, that the detection rate has an irremediable dependence on the satellite zenith angle.

7. EXAMPLES OF PRODUCT VISUALISATIONS

The ASII-NG output files are in netCDF format, a widespread standard for which several handy visualization and data extraction tools exist. As an example, **Figure 1** features a tool called "HDF Explorer" (which, despite of its name, can also be used to quickly look into NWCSAF netCDF files).
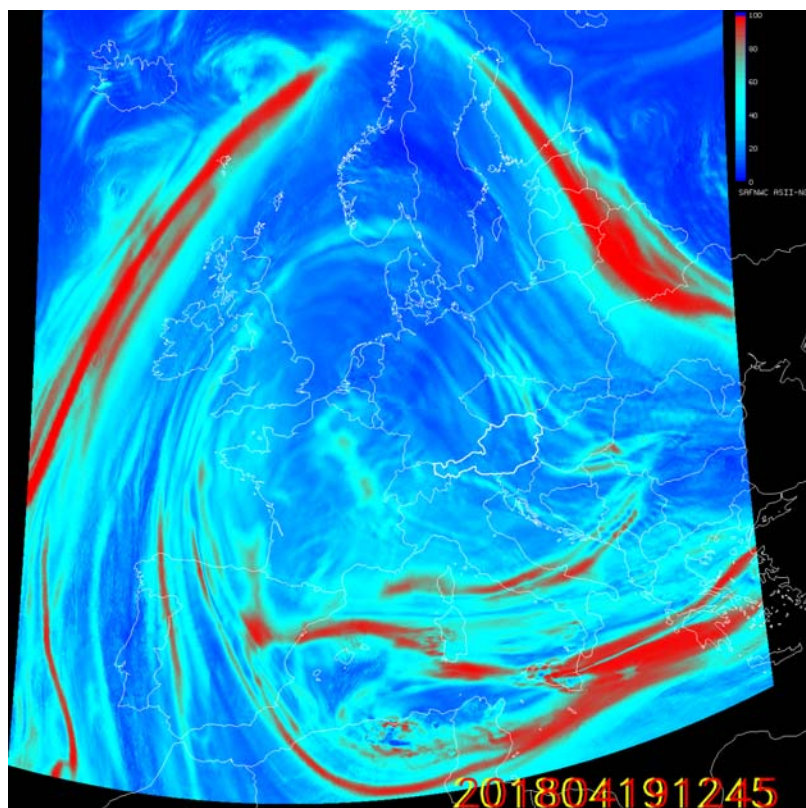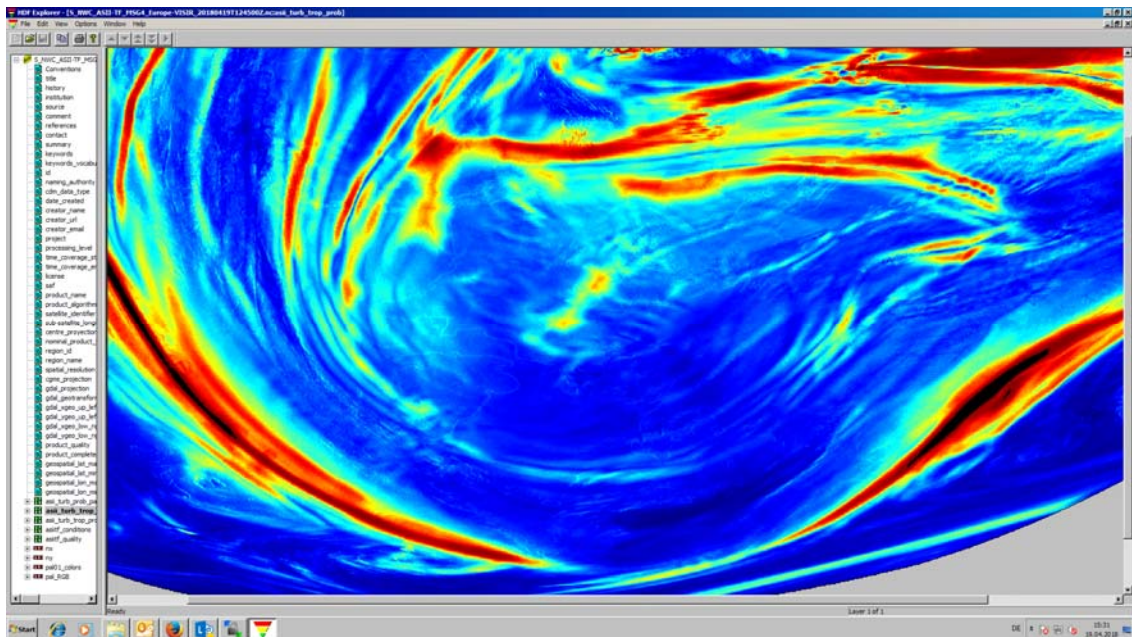

Figure 1: *Example quicklook displays of ASII-TF's "probability of occurrence of tropopause folding" for 19 April 2018, 1245 UTC. Upper panel: as shown in the "HDF Explorer" (a simple viewer that does not interpret/add geographical information); lower panel: as shown on the ZAMG monitoring website using the colour palette included in the output file.*
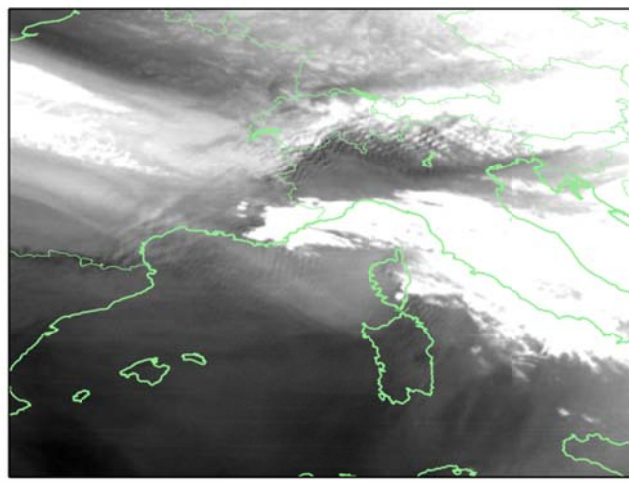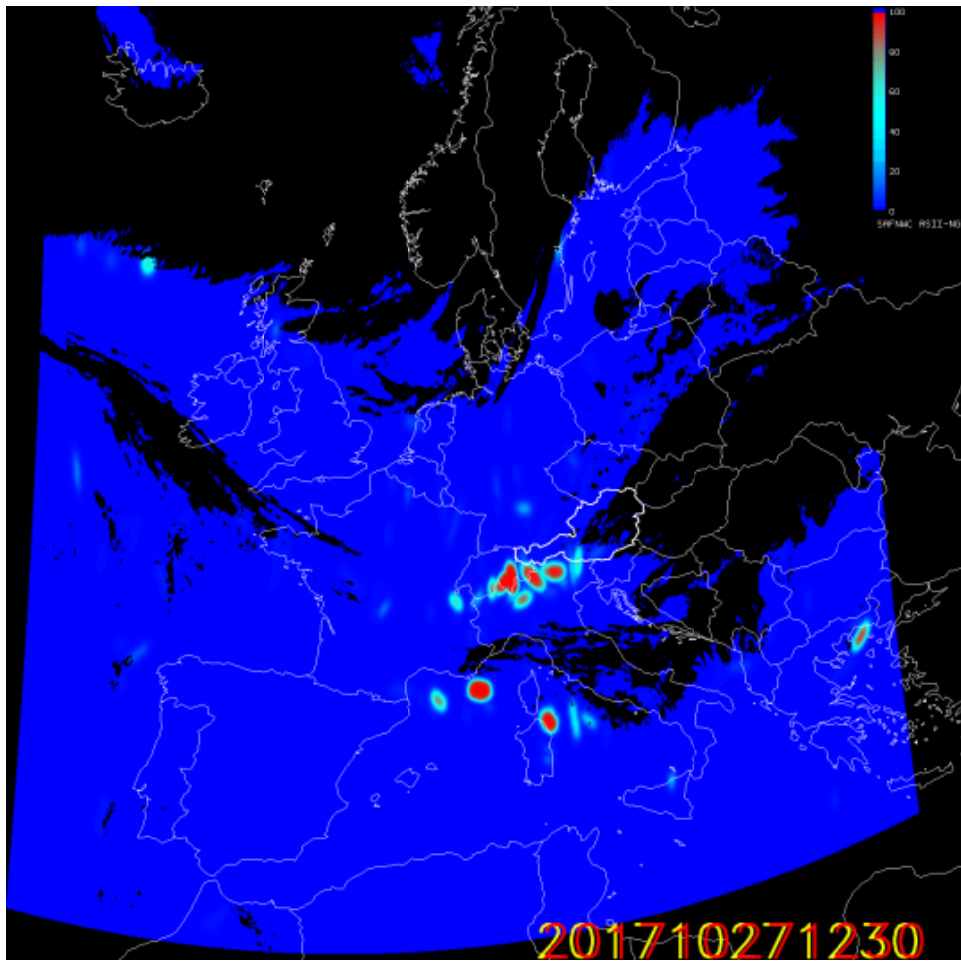
Figure 2: *Case of 27 October 2017, 1230 UTC. Uppermost panel: The probability-of-occurrence of gravity waves, as analysed by the ASII-GW module on the basis of the WV7.3 image (the colour table runs from dark blue = 0% to red=100%; the black areas are those masked by a temperature threshold used to avoid random signals in thick clouds; this is the colour palette included in the output file) Lower panel: Excerpt of the used WV7.3 image.*

Both ASII-NG products contain a turquoise (0)-to-red (100%) palette in the field asiigw_pal/asiitf_pal of their respective netCDF output files. **Figure 1** shows the selected case also in this colouring scheme, **Figure 2** features an example ASII-GW display produced with this suggested colour table. In this figure, the WV7.3 image is added on a separate display so the product can be verified against the patterns subjectively detected in the image. As the ASII-GW product is very amenable to isoline representation, such a verification can be conveniently accomplished also within a single image, as in **Figure 3**.
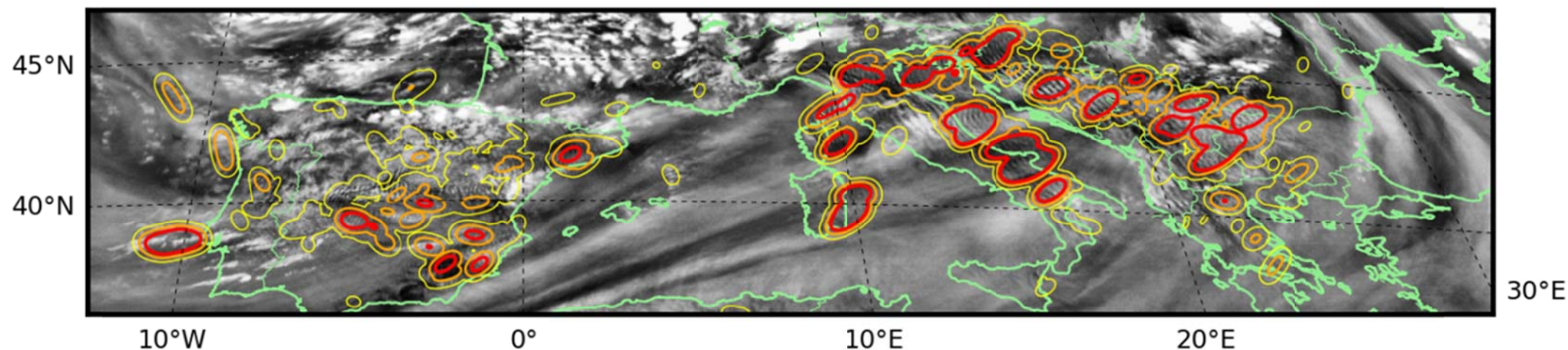
Figure 3: *The WV7.3 image of 29 June 2017, 1400 UTC, over Mediterranean Europe, superimposed by the 1, 50 and 99% isolines of probability of gravity-wave occurrence, as indicated by the ASII-GW product, v2018.*

8. REFERENCES

He, N., A. Jann and Y. Wang (2020): Objective detection of gravity waves in Himawari-8 imagery in support of aviation forecasting. *Meteorol. Z. (Contrib. Atm. Sci.)*, **29**, 323–332.

Jann, A. (2019): Objective detection of stripe patterns in satellite imagery caused by gravity waves: Lessons learnt from the southern hemisphere. *Trans. R. Soc. S. Afr.,* **74,** 163-172, https://doi.org/10.1080/0035919X.2019.1596176.