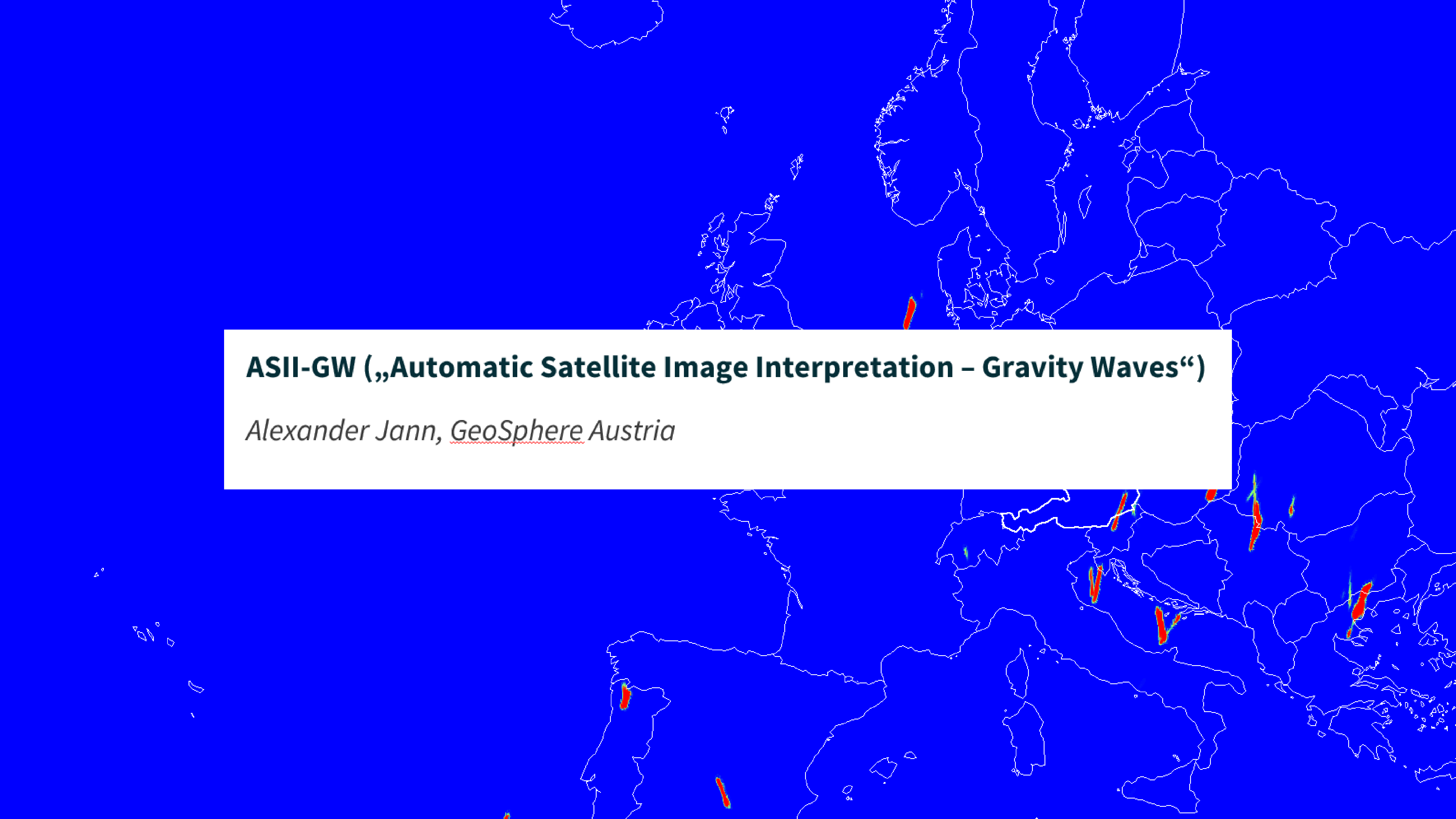
ASII-GW („Automatic Satellite Image Interpretation – Gravity Waves“)

Alexander Jann, GeoSphere Austria



Background

ASII-GW = Automatic Satellite Image Interpretation – Gravity Waves

ASII-GW detects horizontally propagating gravity waves (e.g., trapped lee waves), but cannot detect vertically propagating lee waves.

This satellite product is released in v2021 of the Nowcasting-SAF software package.

https://www.nwcsaf.org/Downloads/GEO/2021.3/Documents/Scientific_Docs/GEO_v2021.3_Release_Note_v1.2.pdf

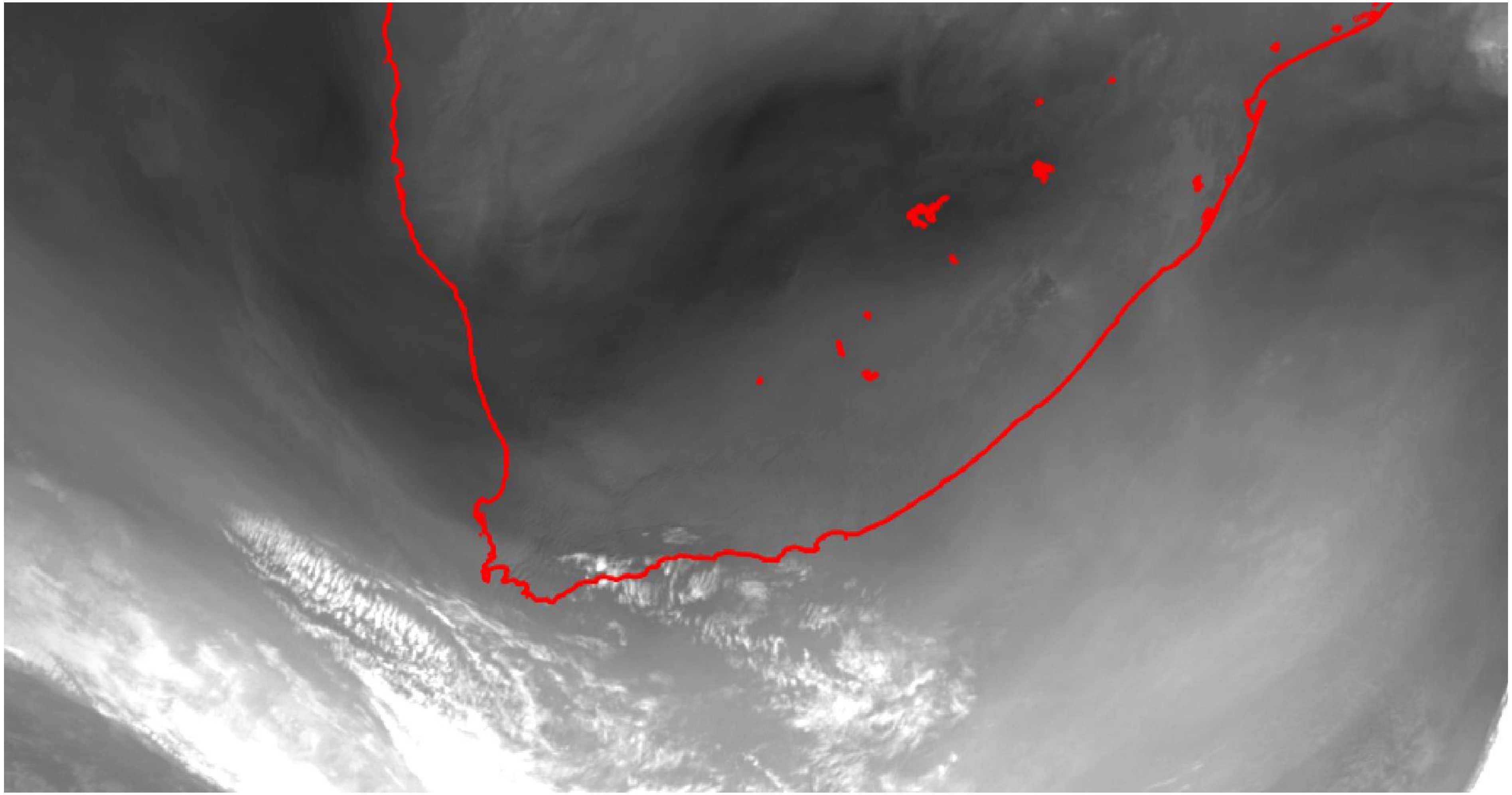
Motivation for gravity wave search

https://www.thisdayinaviation.com/5-march-1966/1-l2u9ukjt-xfry0xegxguag/

Flight BOAC 911

BOAC Flight 911 (call sign "Speedbird 911") was a round-the-world flight operated by the British Overseas Airways Corporation (BOAC) that crashed near Mount Fuji in Japan on 5 March 1966, with the loss of all 113 passengers and 11 crew members. The Boeing 707 jetliner involved disintegrated mid-air shortly after departing from Tokyo, as a result of severe clear-air turbulence.

The challenge - search for gravity wave ripples in WV7.3

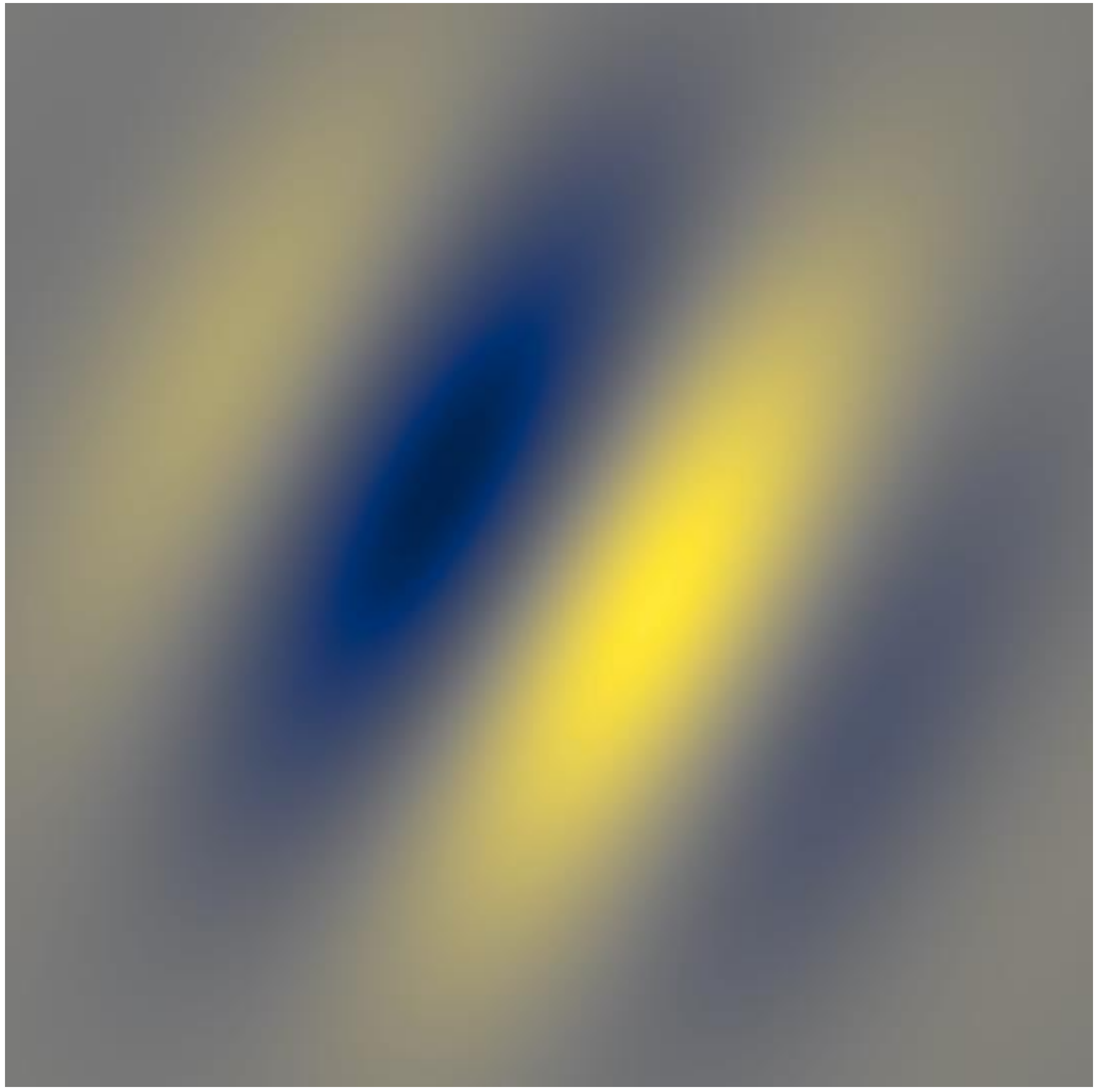


(Southernmost part of Africa, (29 June 2017, 1400 UTC)

ASII-GW: Motivation

- Gravity waves may become unstable, eventually resulting in the notorious “clear-air turbulence”
- GWs are often seen in the IR image as a grating pattern (alternating bright and dark stripes)
- However, in many cases they are only seen in WV channels (no condensation takes place)
- The fluctuations are fairly weak, however, so it is not easy to spot them in standard image visualizations
- Therefore: automatic pattern recognition, adapting models from the 1990’s

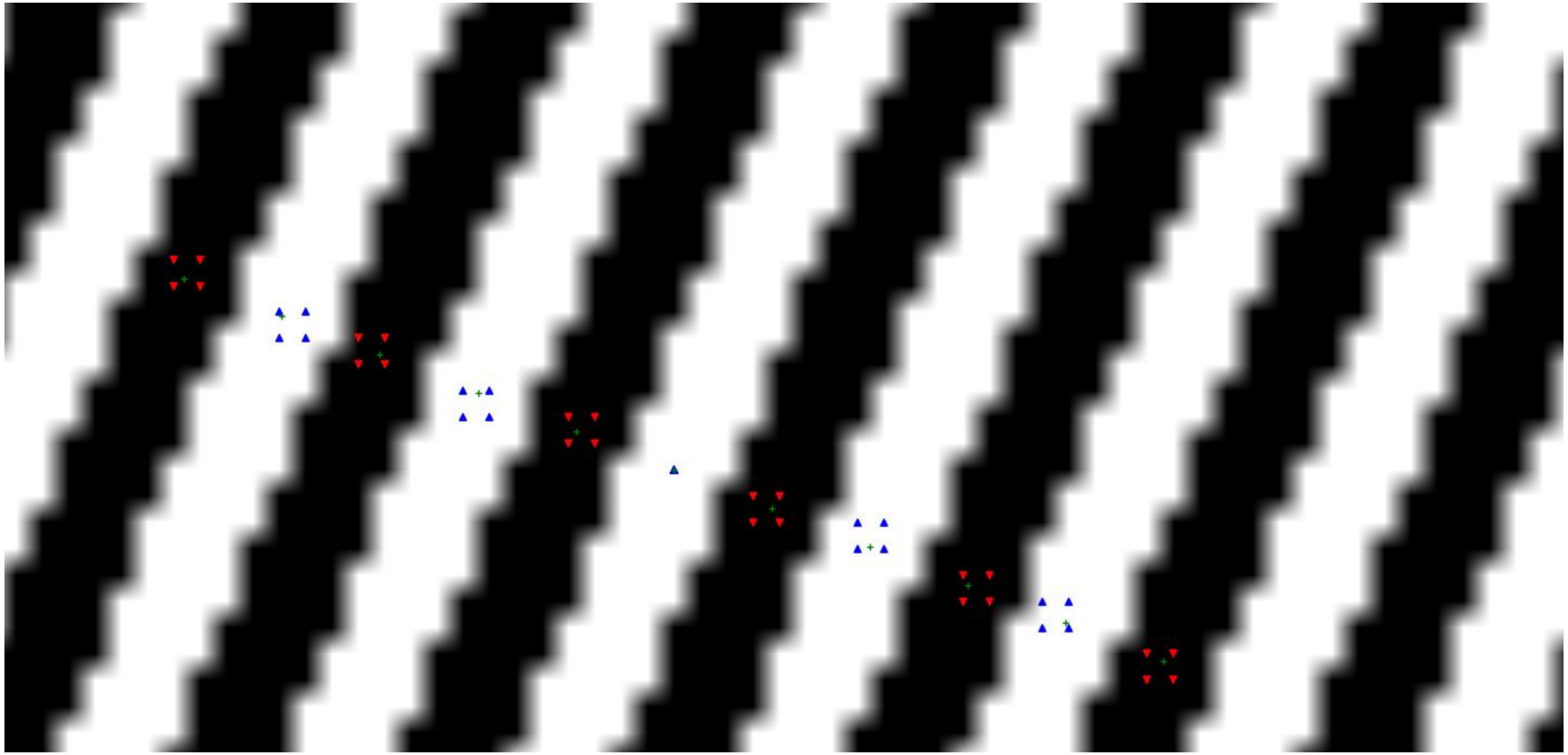
Algorithm step 1: Apply a Gabor filter onto the WV7.3 image



Filter size varies from 7x7 to 19x19 pixel

Algorithm step 2: Apply the grating cell operator

Verifying that we have alternating positive and negative Gabor filter responses of comparable magnitude

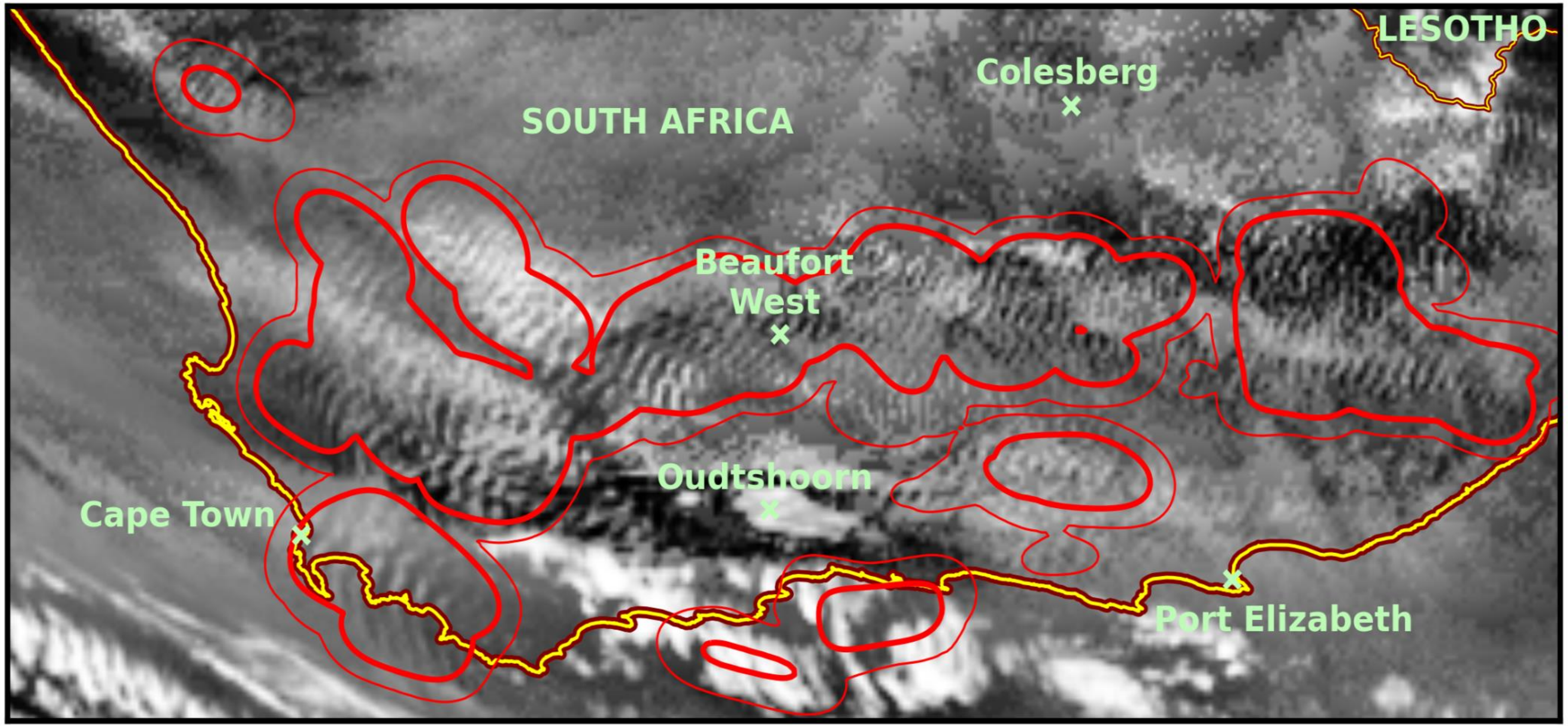


ASII-GW: Method

- The Gabor filter / grating cell operator is run for several orientations and wavelengths
- The signal density is translated into a probability-of-occurrence (0-100%, for every pixel)
- ASII-GW currently uses IR and WV satellite imagery for gravity wave detection.
- A version using VIS information is already implemented but not yet activated.
- More algorithmic details can be found in Jann, A. (2017)

Jann, A. (2017): Detection of gravity waves in Meteosat imagery by grating cell operators.
Eur. J. Remote Sens., **50,** 509-516.

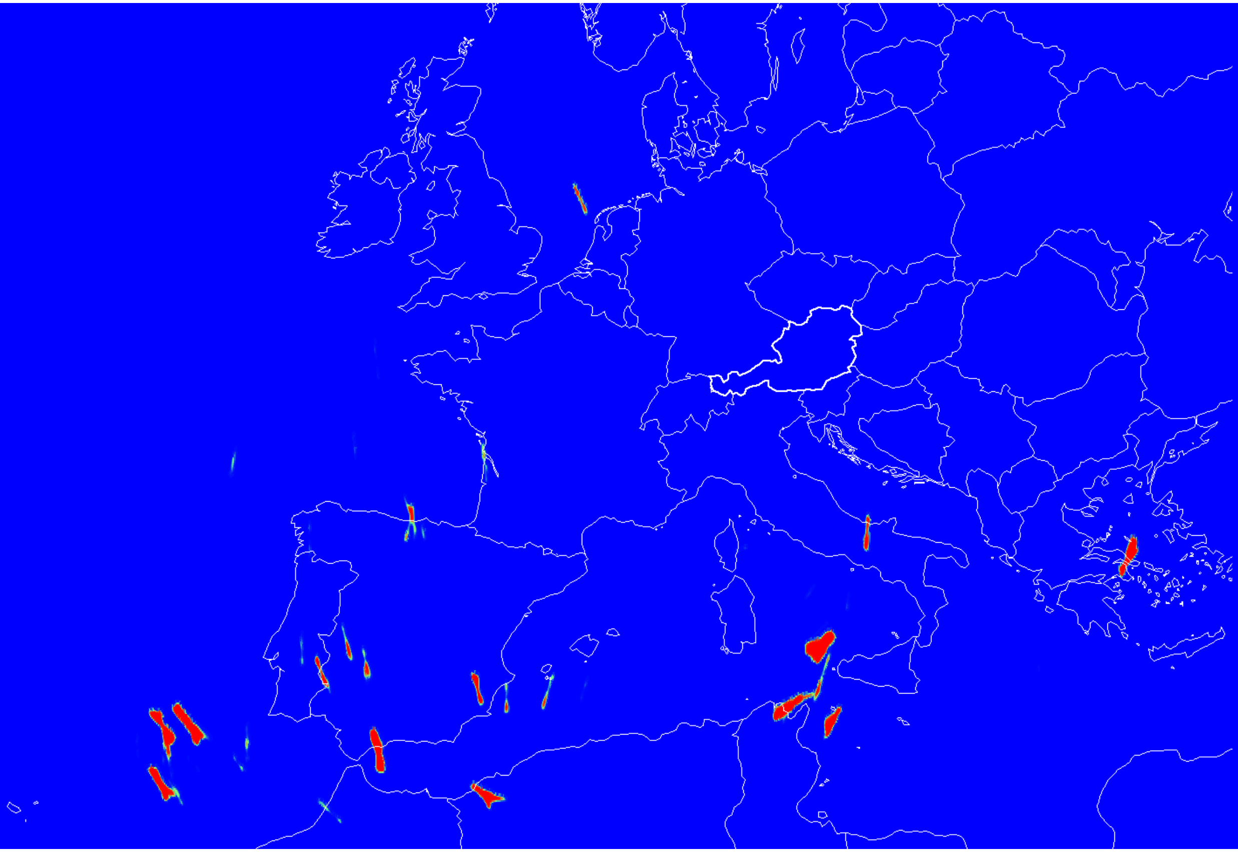
MSG-1/IODC analysis, 29 June 2017, 1400 UTC



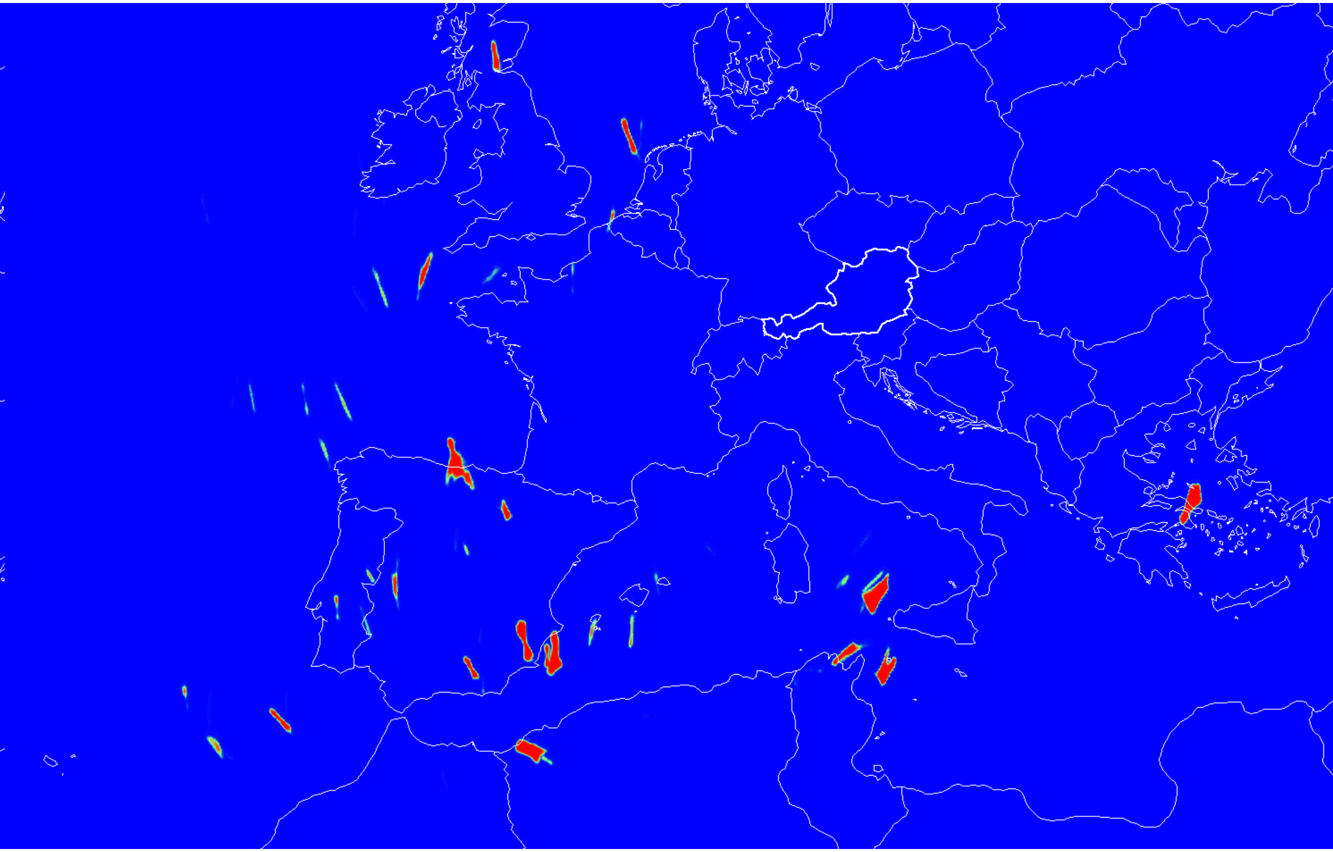
(Red isolines refer to the signal density of the ASII-GW pattern recognition algorithm)

Comparing ASII-GW (MSG, IR) with ASII-GW (MTG, IR)

MSG



MTG



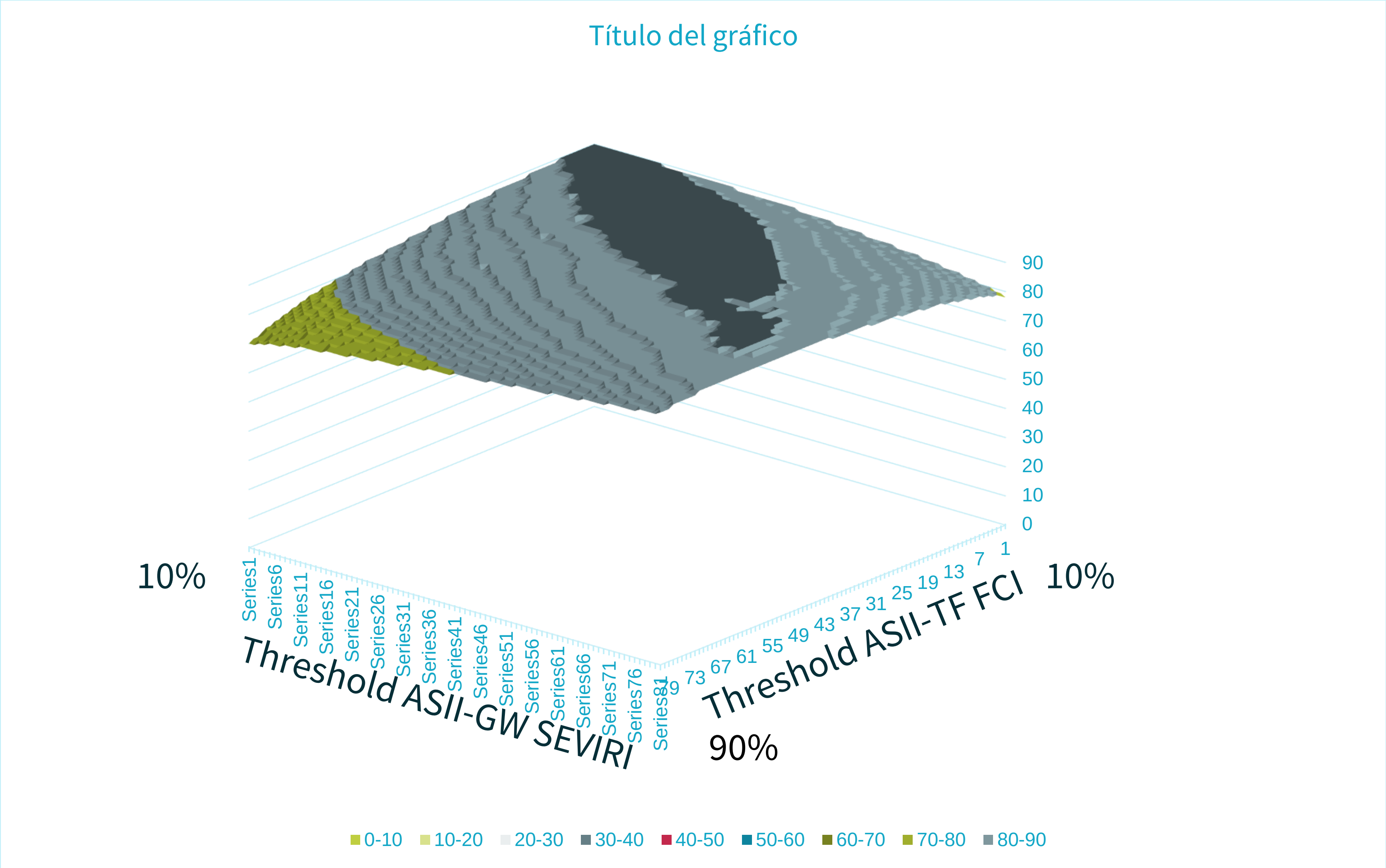
Comparing ASII-GW (SEVIRI) with ASII-GW (FCI)

Can we use the **fractions skill score** again to compare the outcome of ASII-GW using **MSG SEVIRI** on one hand and **MTG FCI** on the other?

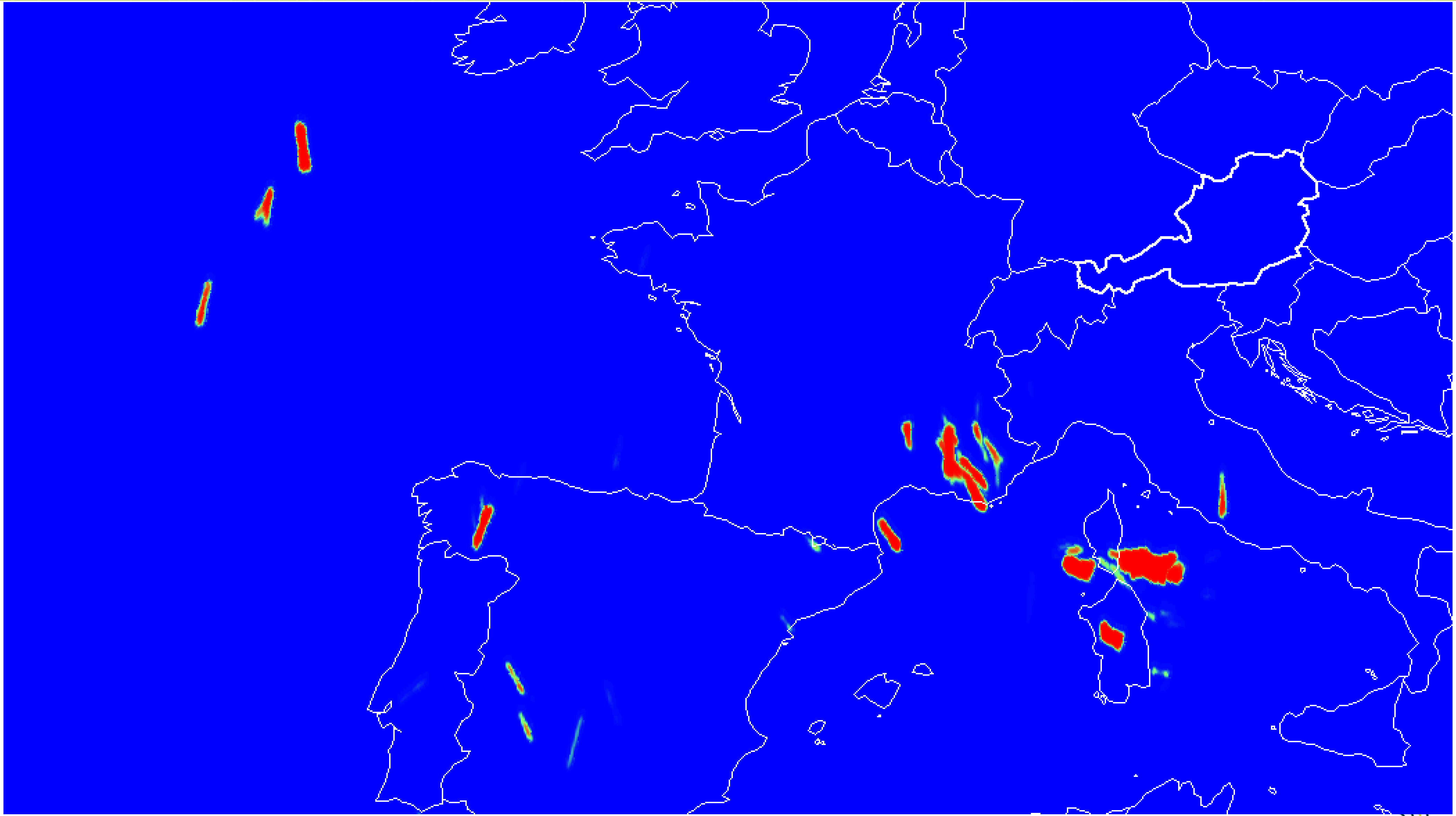
Pro: To a certain degree the outcome should be similar between SEVIRI and FCI

Con: With higher resolution of the FCI sensor, more gravitiy waves should be detected.

FSS with treshold from 10% – 90% for ASII-GW (SEVIRI) vs ASII-GW (FCI)



Example ASII-GW (14 February 2025 at 12:00 UTC)



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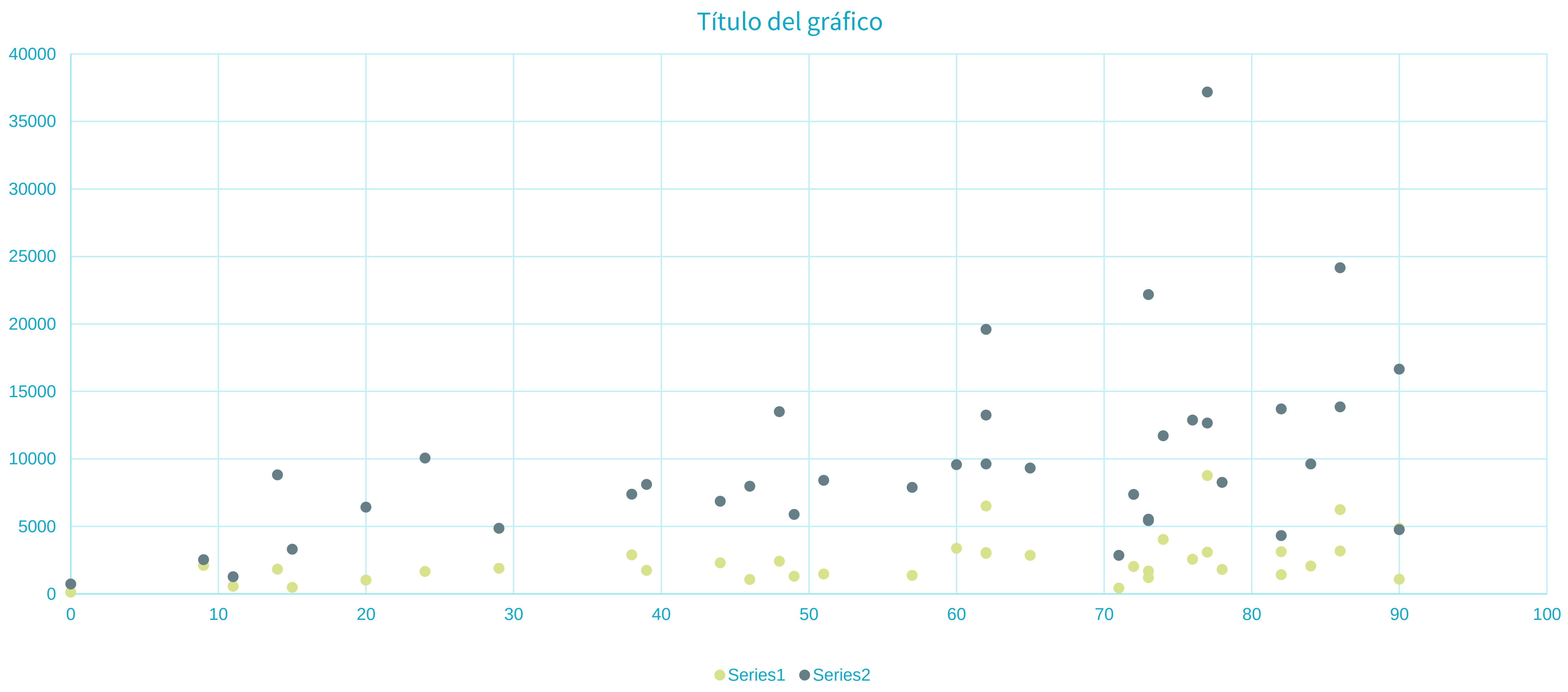
Comparing ASII-GW (SEVIRI, WV) with ASII-GW (FCI, WV)



Correlation of 0.62 between the number of detected wave grid points and the fss

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Comparing ASII-GW (SEVIRI) with ASII-GW (FCI)

The correlation of the number the grid points flagged as „gravity wave“ for both versions (SEVIRI and FCI) is very high for IR and WV results

→ **0.92** and **0.97** respectively

→ Obviously not so many “new” gravity waves detected with the higher resolution of FCI.

A detailed case by case evaluation is needed.