

UPDATE 5 Saba - January 2021

This update reports on the activities of KNMI in 2020 with respect to the volcanic/seismic monitoring network at Saba. The COVID-19 pandemic provides certain challenges considering our work, mainly related to travel restrictions and delayed delivery of new equipment. Regular observations of the data continued regardless throughout the year. The current monitoring network, and its extension planned for April 2021, is displayed in Fig. 1.

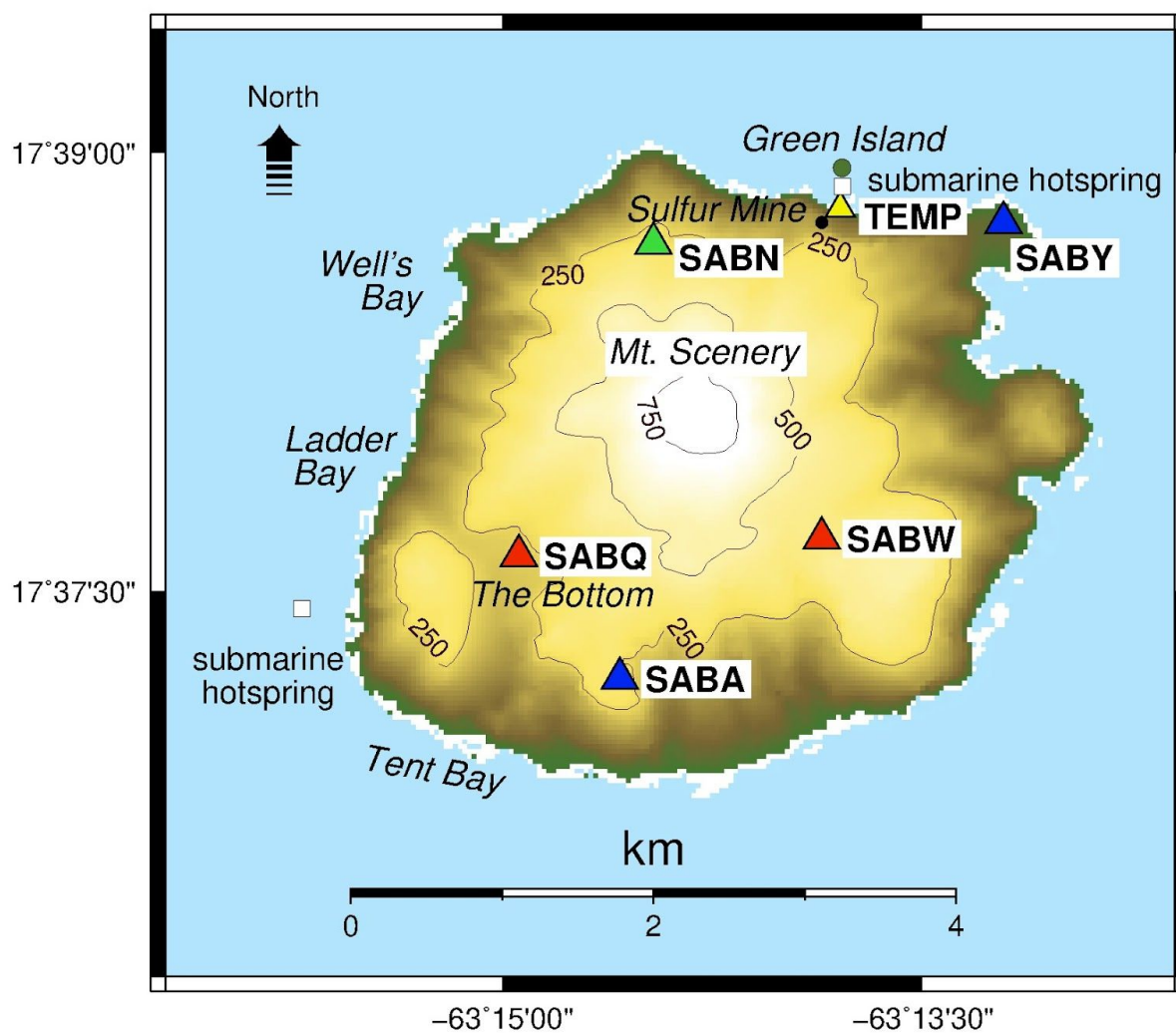


Fig. 1: Map showing the locations of current measurement sites on Saba with blue (GNSS/seismic stations) and red (seismic stations) triangles. In green the location of the proposed station at Grey Hill (planned installation April 2021).

Seismic data

Seismometers “SABY”, “SABW” and “SABA” are functioning well and produce data of good quality for the purpose of detecting earthquakes. Seismometer “SABQ” is currently out-of-order due to technical issues. Part of the equipment needs to be repaired by the manufacturer. Lightning protection is one of the most challenging issues in continuous data collection.

As an example of earthquake detection, on Dec 27, 2020, at 23:56:18 UTC (19:56:18 local time), a magnitude 4 earthquake took place at a depth of 6 km, about 27 km south-east of Saba. Our automatic monitoring system detected this event using the recordings from 3 seismometers at Saba, 3 seismometers on St. Eustatius and 1 on St. Maarten. The figures 2 and 3 show screenshots of the automatically determined earthquake parameters, as well as the recordings of the ground movement.

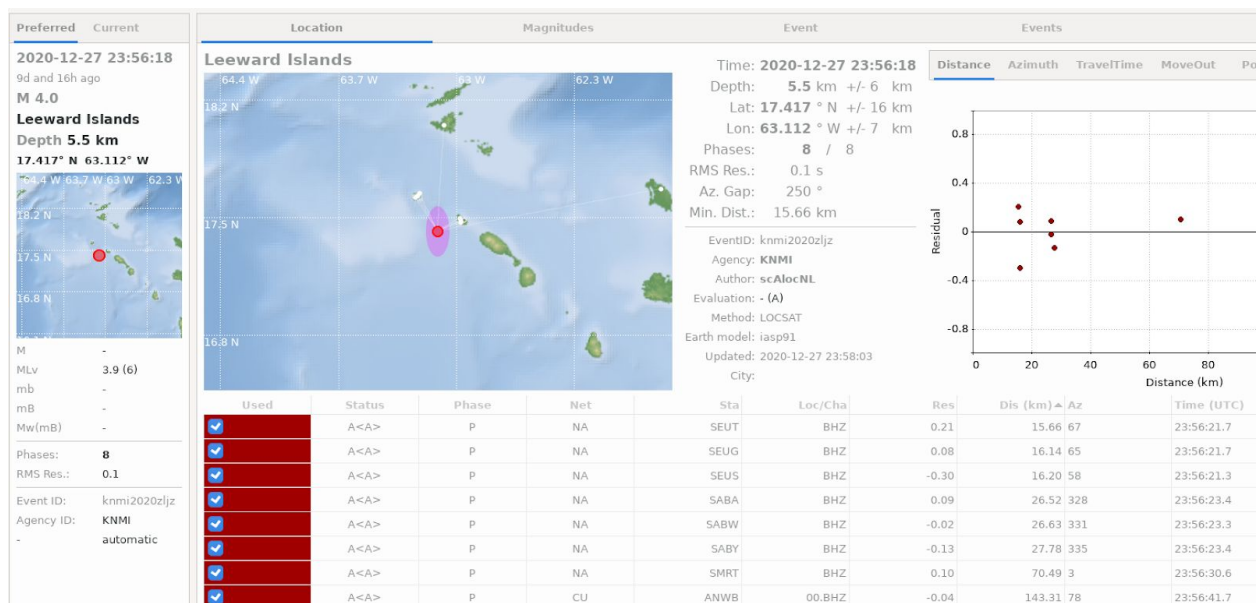


Fig. 2: Screenshot of the location of the earthquake at 27-12-2020 as derived by our automatic system from the seismometers at Saba , St. Eustatius and St. Maarten.

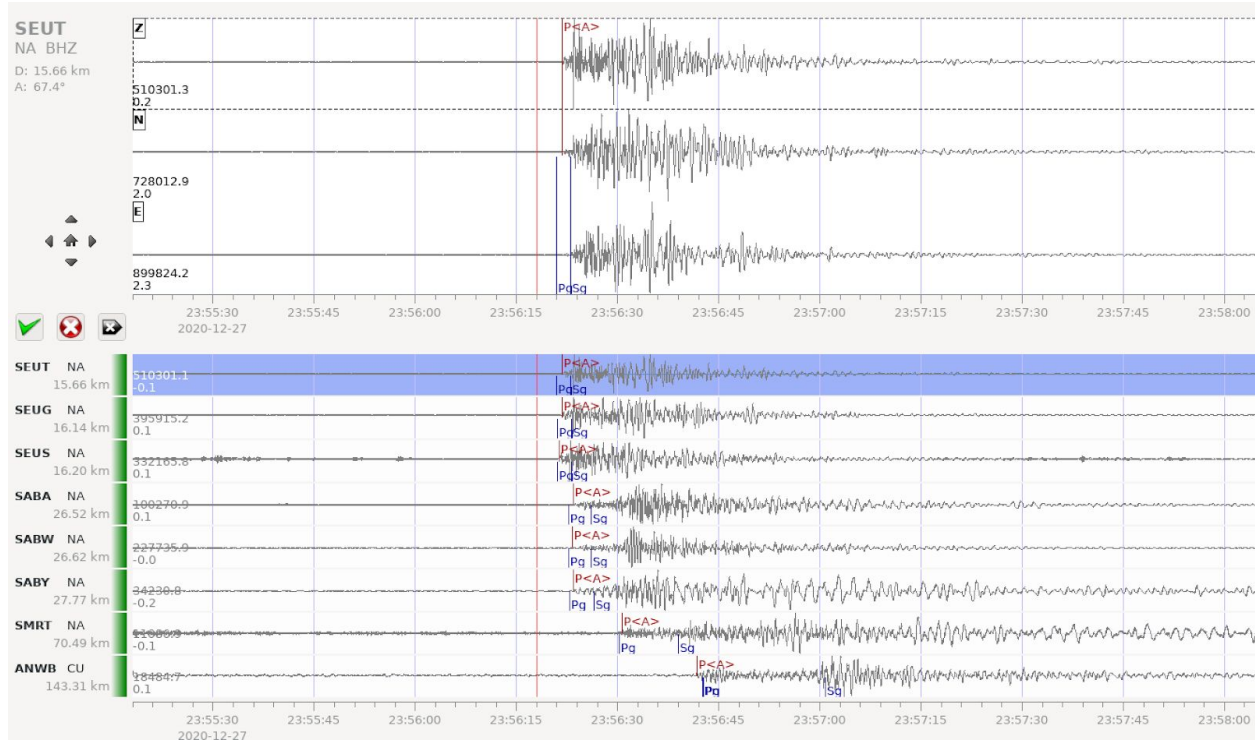


Fig. 3: Screenshot of the recorded seismic waveforms after the earthquake at 27-12-2020.

Don't forget that if you feel an earthquake it helps us if you fill out this form: <https://www.knmi.nl/nederland-nu/seismologie/aardbevingen/melden>

GNSS data

The two GNSS stations, at the SATEL facility at St. Johns (called "SABA") and at the airport (called "SABY") worked well most of 2020.

For each instrument we calculate the daily position very precisely. The result is plotted in a graph as a point, and by adding a new data point to the graph each day a time series is formed (Fig. 4). Station SABA has been operational since January 2018 and hence has a longer time series than station SABY, which became operational in February 2019.

Changes through time can be viewed in the time series for three components:

1) horizontal North-South, 2) horizontal East-West and 3) vertical Up-Down. Uncertainties for each point are, as expected, a few mm for the East and North component and up to a few cm for the Up component. The data show a horizontal movement towards the NE for both stations. This movement is due to well-known plate tectonics whereby the North and South American plates subduct underneath the Caribbean Plate. We can evaluate local deformation better by removing the plate tectonic signal from the data. Data corrected for the plate spreading signal are constant through time indicating no local deformation occurred. In most cases deformation of the flank of the volcano in the order of multiple centimeters to decimeters precedes a volcanic eruption. This will be best visible in the horizontal components of the data (North and East) as these have the highest accuracy.

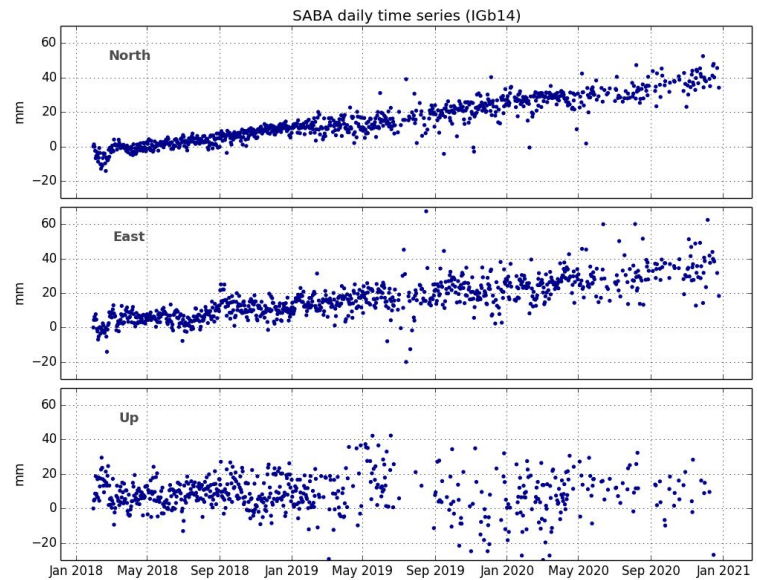
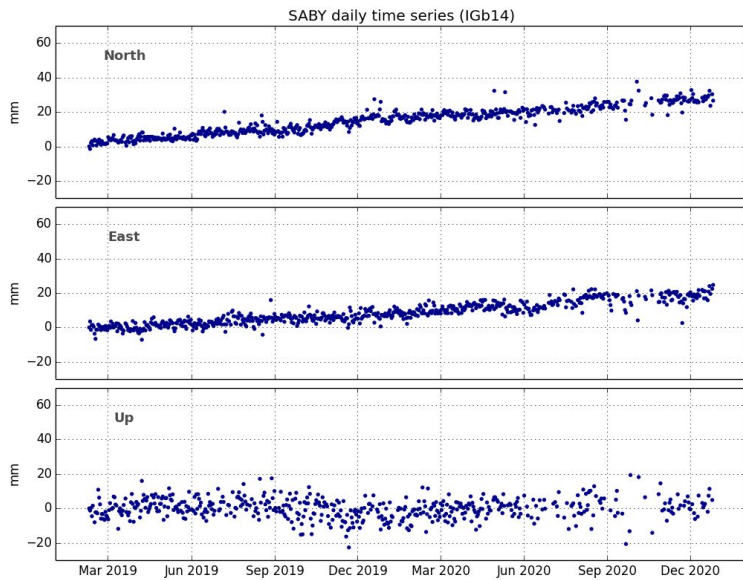
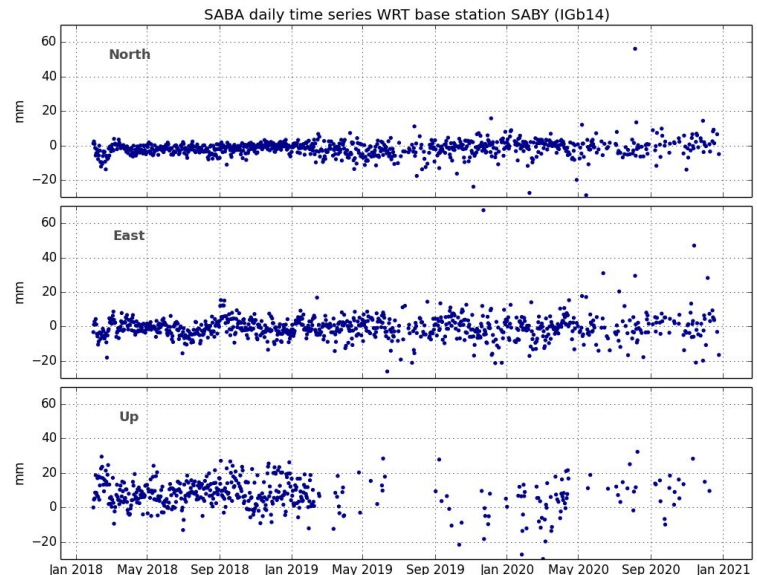


Fig. 4: GNSS data from stations SABY (upper left) and SABA (upper right). When the plate spreading signal is removed data show very little deviation from a horizontal line (bottom right).



Installation new site at Grey Hill

A new GNSS/seismic installation is planned for April 2021 at the Grey Hill. All materials for this installation will be shipped to Saba in February 2021. This installation is innovative as it will be completely stand-alone. Satellite communication will be used to send the data to KNMI and solar panels/batteries will be used to power the site.

In October/November 2020 we tested the set-up at KNMI (Fig. 5). The GNSS/seismic station will consist of 1) a GNSS antenna mounted on a monument, 2) a concrete box housing the seismometer, 3) a VSAT dish needed to transmit the data, 4) two solar panels to power the equipment and 5) a cabinet housing all electronics.



Fig.5: GNSS antenna mounted on a concrete monument (left). Concrete box for the seismometer not displayed. Test set-up at KNMI (right) showing VSAT dish, solar panels with cabinet underneath (5).

Temperature data hot spring

Continuous temperature data were collected from the hot spring opposite Green Island in January 2020 (Fig. 6). Measurements are taken every 20 minutes and stored locally. During summer the temperature variations are smaller than in winter which can be explained by the calmer sea conditions in summer. Analysis of the temperature data show a strong correlation between the temperature variations and the tides. The maximum spring temperature remains constant at ~82 degrees Celsius. During our next visit we will collect temperature data for 2020.

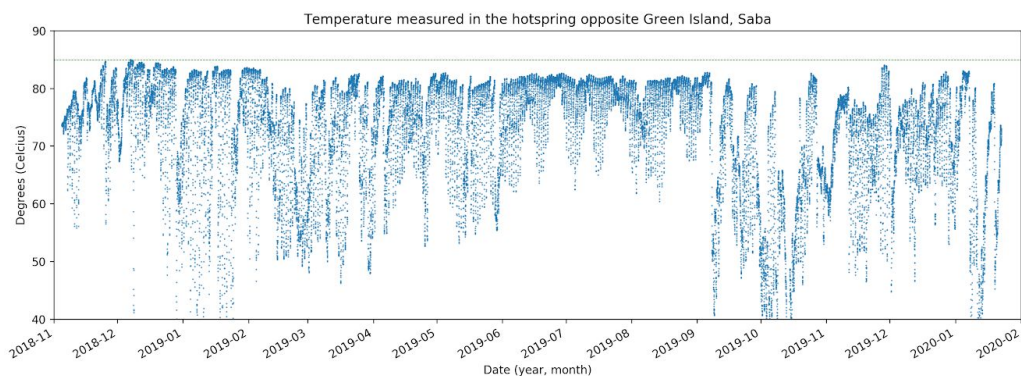


Fig. 6: Recorded temperature (in degrees Celsius) at the hot spring opposite Green Island.

Cracks Green Gut



In March 2020 a member of the public reported multiple cracks in the area of the Green Gut (Fig. 7). The crack along the wall was 60 cm deep and had warm moist air venting from it ($T \sim 50^{\circ}\text{C}$). The Green Gut is an unstable area, however the warm air is unusual. It may be that compaction and rotting of waste causes heath to form. There is always the possibility that the volcano forms a vent, or already had it there in the past. If this would be the case the temperatures are still relatively low and there is no other evidence of volcanic origin yet (like sulfur or other mineral deposits). KNMI will bring a thermal camera to closely inspect the area during the next visit.

Fig. 7: Cracks at Green Gut March 2020

Dead vegetation on top of Mnt. Scenery

In March 2020 rangers of the SCF reported dead mountain mahogany trees in an area of ~10x10 m² close to the top of Mnt. Scenery (17.634617° -63.239450°). The area was investigated by a SCF team under guidance of KNMI for other signs of volcanic activity such as volcanic deposits (ash, sulphur), fumes and heath release. No such evidence was found, suggesting volcanic activity did not cause the trees to die. Photos and videos were captured for future reference by SCF. In January 2021 another photo and video survey was done (Fig. 7). The new images show clear regrowth of vegetation confirming that there is no volcanic activity in the area.



Fig. 7: Drone imagery captured by SCF showing the dead vegetation in March 2020 (left) and regrowth covering most of the patch in January 2021 (right).

Volcanic activity in the region

Currently several volcanoes in the Caribbean show increased levels of activity (see Fig. 8). This is not uncommon, for example in 1902 both Mt. Pelée, Martinique and La Soufrière, St. Vincent erupted. The Caribbean volcanoes are all formed by the same process: subduction at the plate boundary, but they do not share the same magma chamber, nor are they connected by long magma conduits. A volcanic eruption on one island can therefore not trigger an eruption on another island. For more information on the activity of other Caribbean volcanoes see:

- <http://uwiseismic.com> and <http://nemo.gov.vc/nemo/index.php/home/welcome> for Grenada, Grenadines, St. Vincent, St. Lucia, Dominica, St. Kitts and Nevis
- <https://www.ipgp.fr/fr/ovsm/observatoire-volcanologique-sismologique-de-martinique-ovsm-ipgp> for Martinique
- <https://www.ipgp.fr/fr/ovsg/actualites-ovsg> for Guadeloupe
- <http://www.mvo.ms/> for Montserrat.

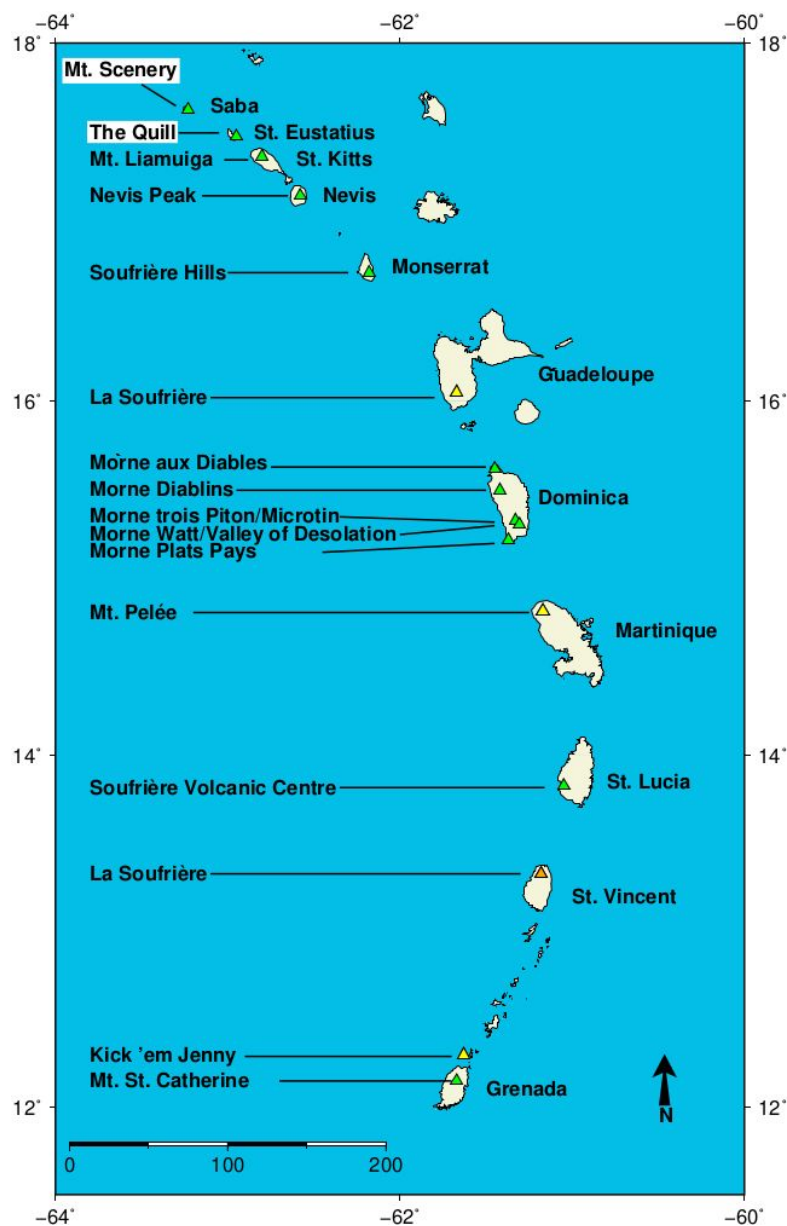


Fig. 8: The active arc of the Lesser Antilles showing the islands of Saba and St. Eustatius in the far north, as well as the other islands of the chain. The triangles depict the location of an active volcano, and their names are shown on the left. Mnt. Scenery and The Quill are highlighted. The color of the triangle depicts the state of the volcano as of 5 Jan 2021 whereby green=normal, yellow=advisory and orange=watch.