

Volcanic Hazards in Guatemala

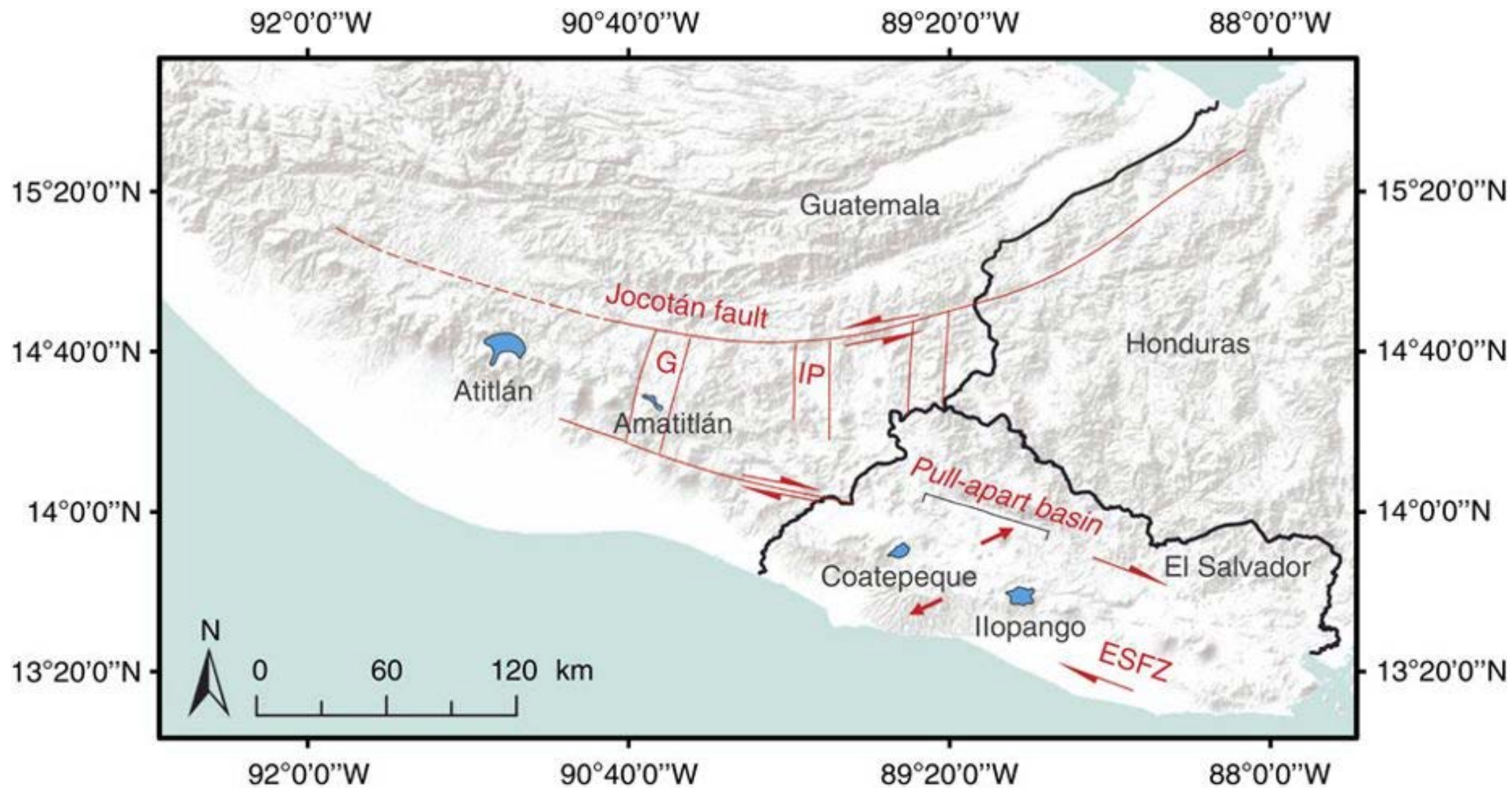
Dr. Matt Watson

School of Earth Sciences

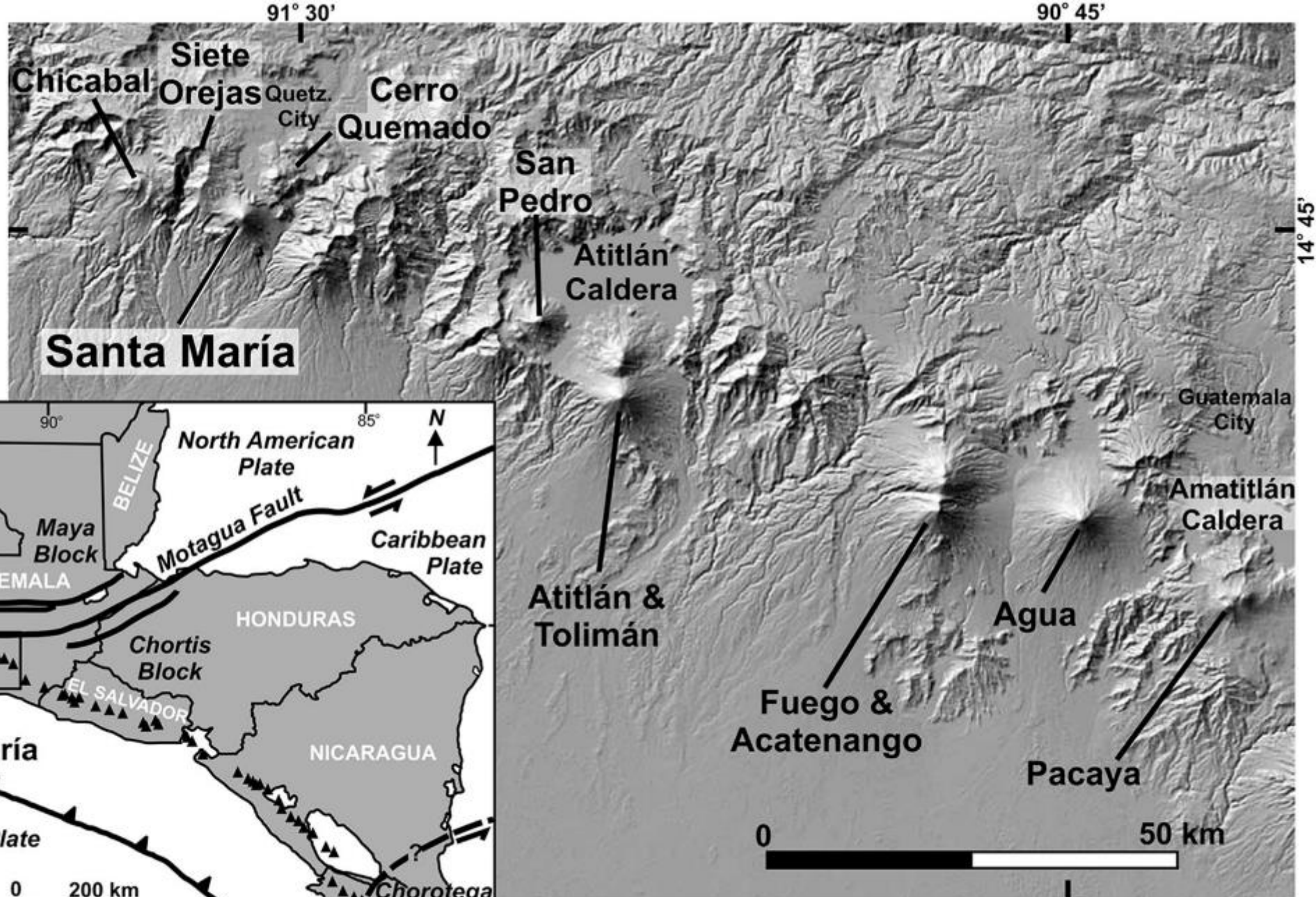
Presentation to the *Bristol Branch of the Geographical Association* in September 2018



Image credit: Albert Dros. www.albertdros.com



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Volcán de Fuego (& emissions)



Why quantify volcanic emissions?

- Indicators of volcanic activity
- Aircraft hazard mitigation
- Hazardous to population, wildlife, environment and infrastructure (including aircraft)
- Long-lived and climatologically active



Image credit: (left to right): Ecuador Ciencia; Getty images; MODIS Science team; NASA-SOLVE

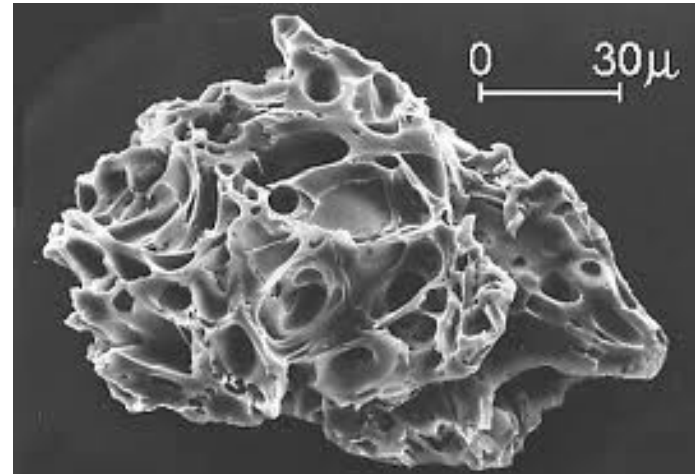
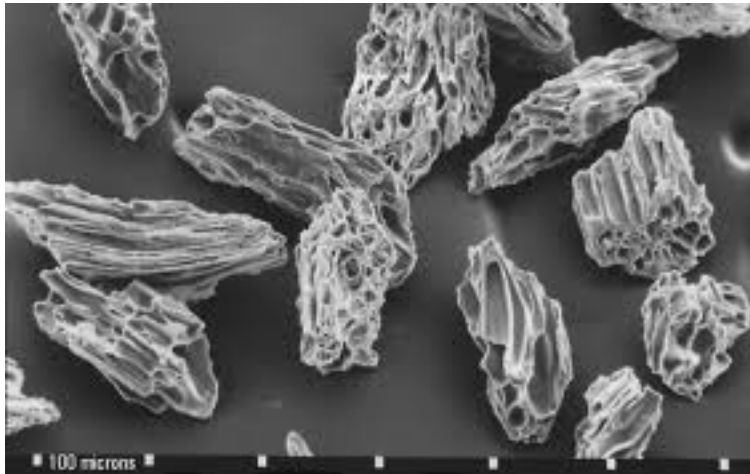


Image credit: USGS

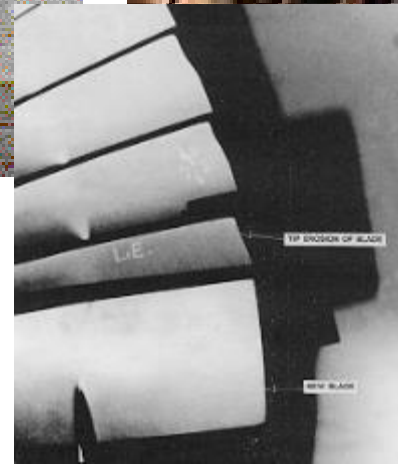
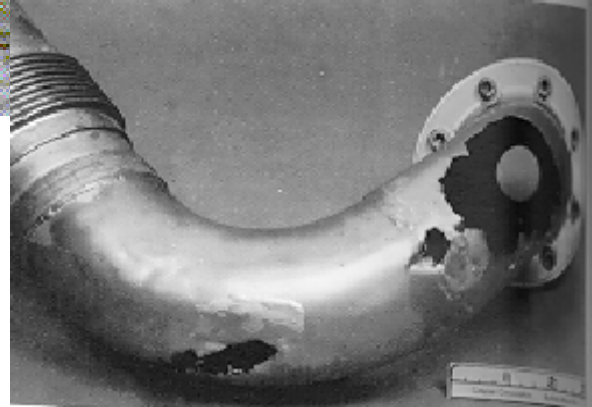


Image credit: R.L. Rieger. U.S. Navy (top left) and Boeing

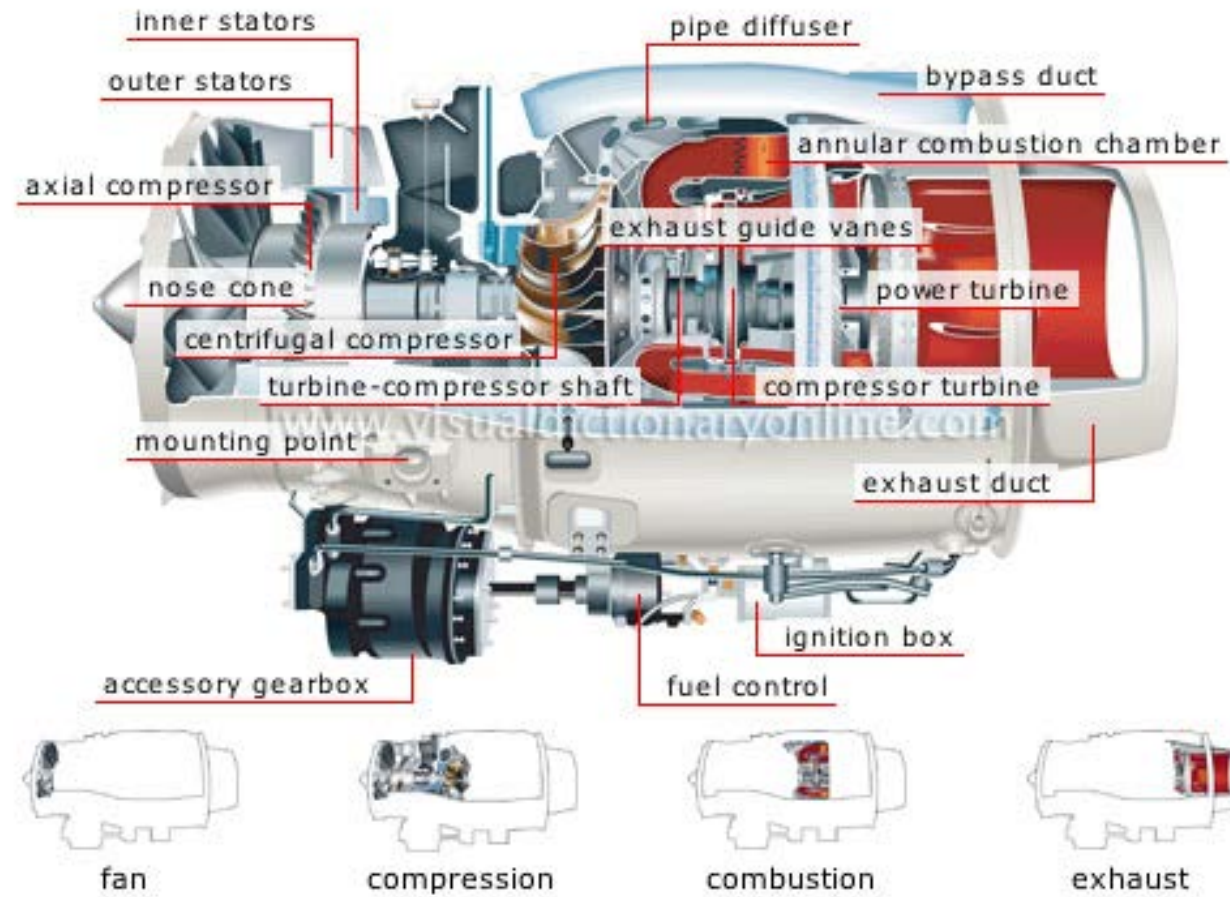


Image credit: Rolls Royce

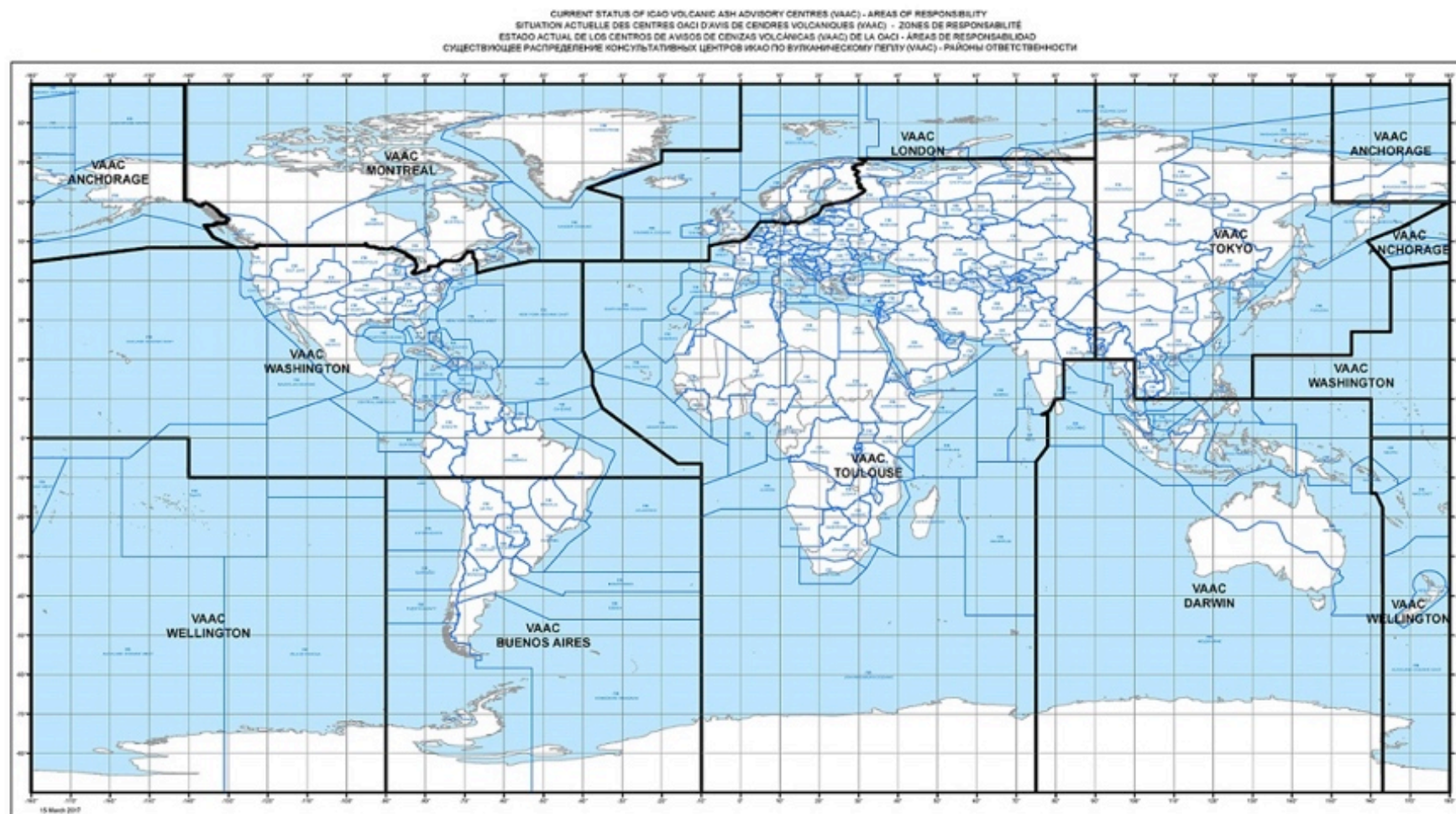
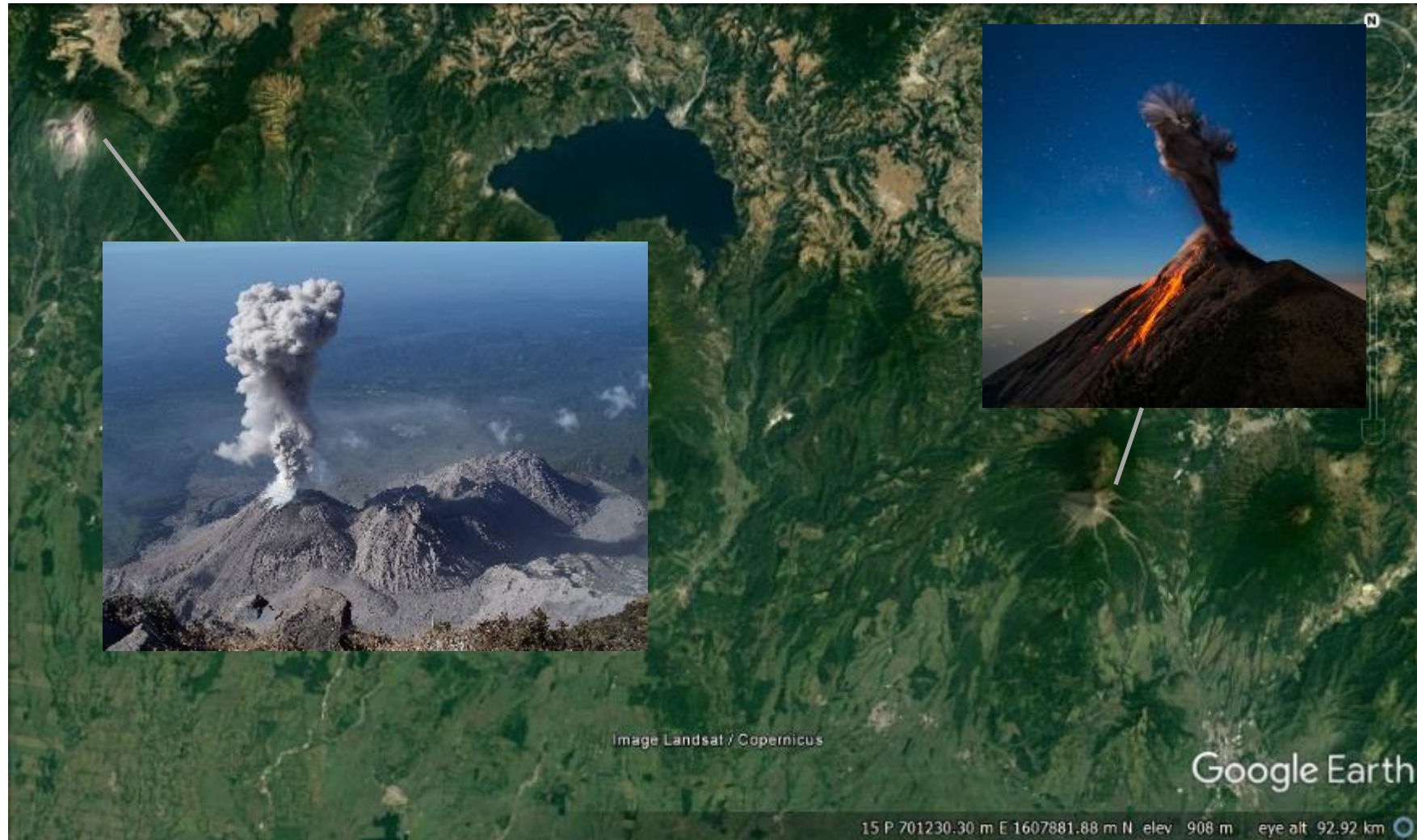
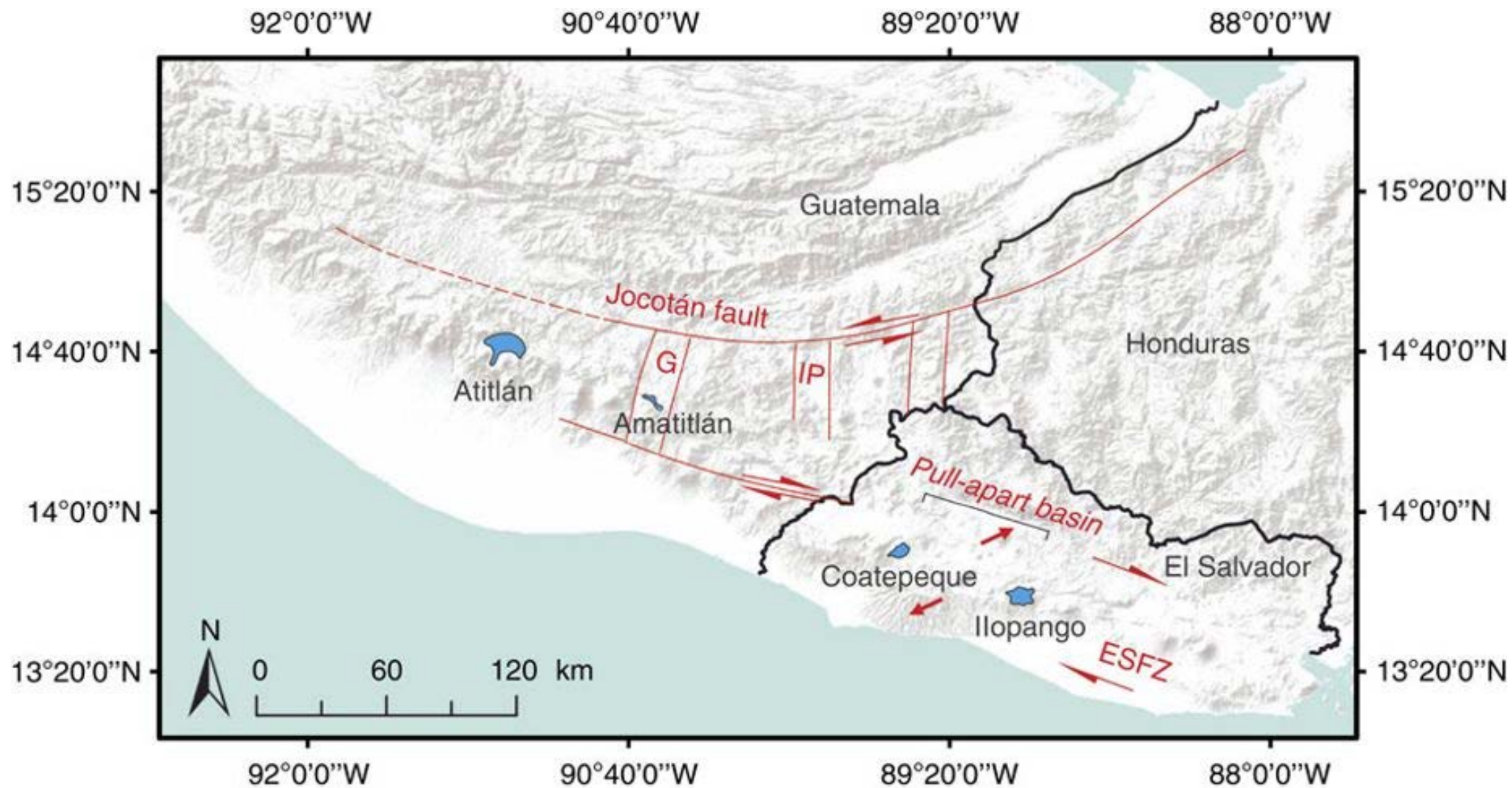


Image credit: ICAO

Central American Volcanism





Volcán de Fuego, Guatemala



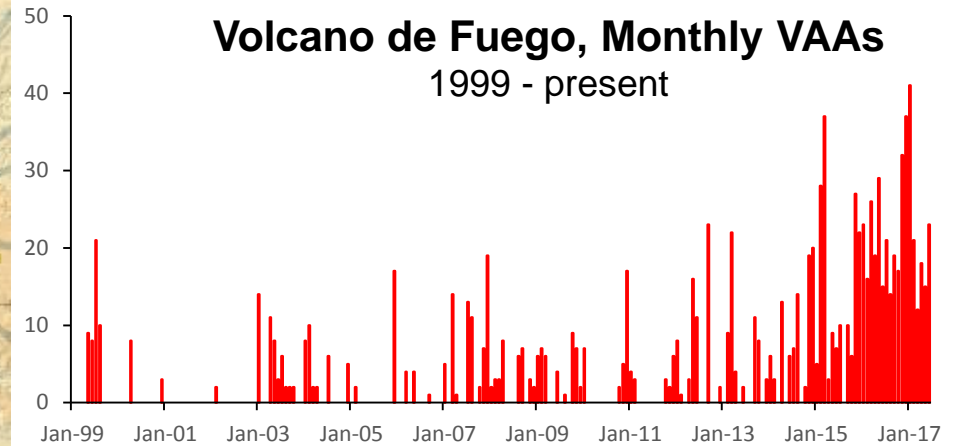
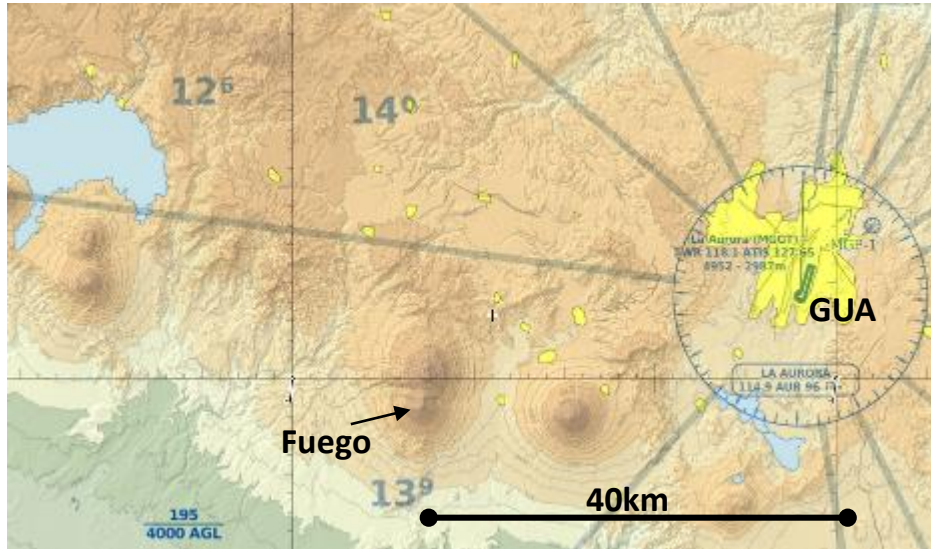
With paroxysms every 3-5 weeks



Regular
Strombolian activity

Image credits (left to right): IM Watson, Andy Shepherd/National Geographic

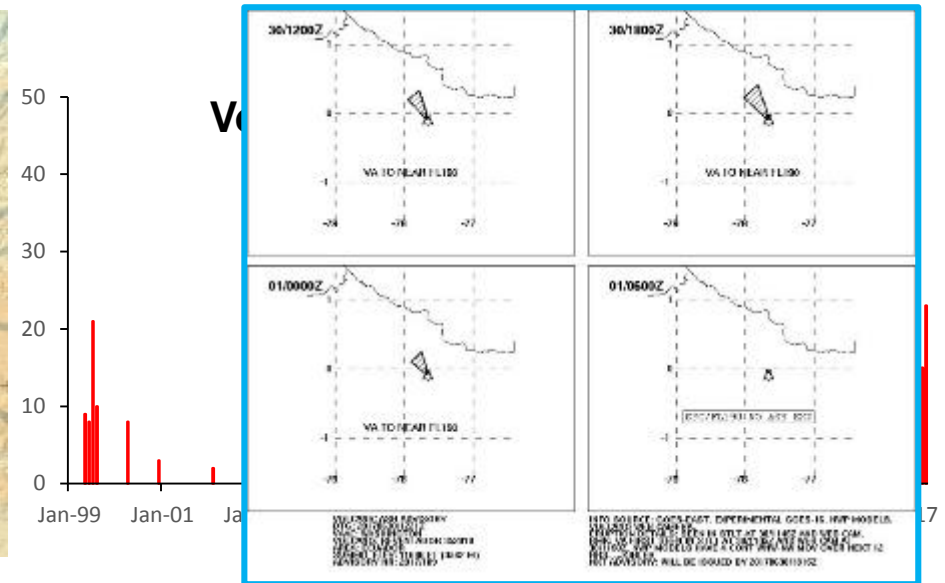
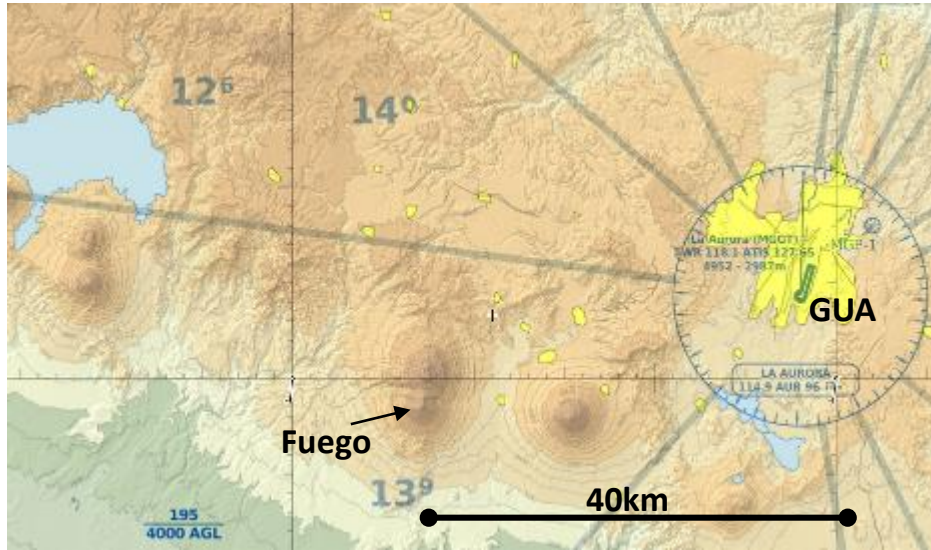
Aviation Hazards



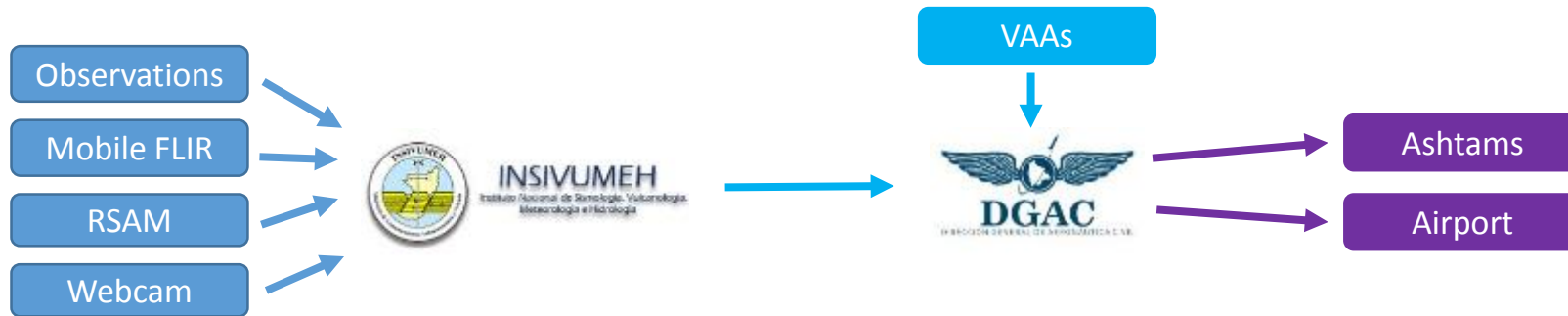
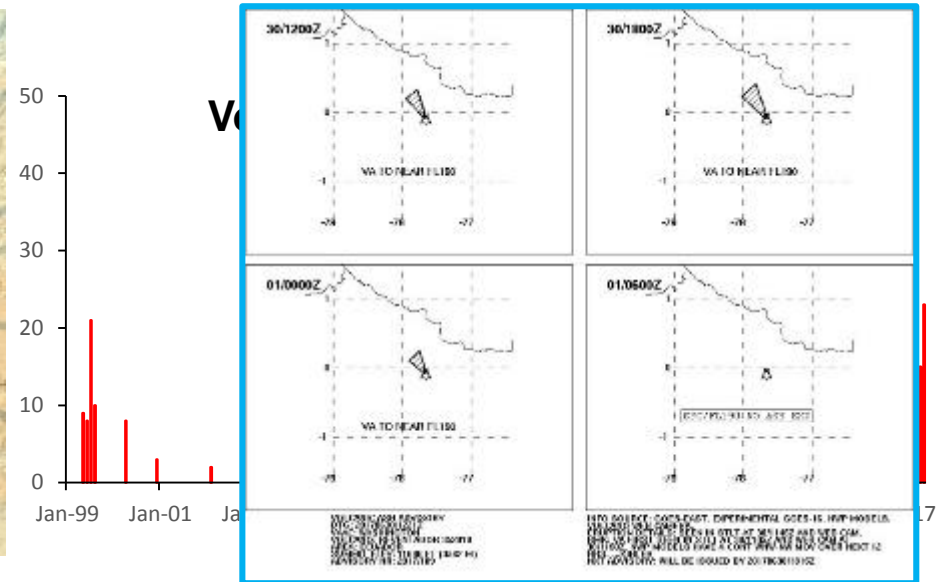
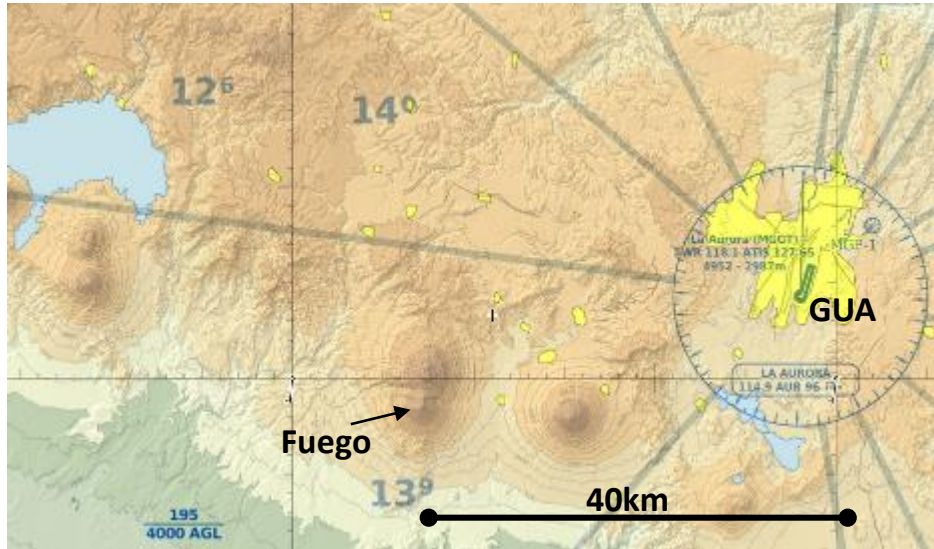
Source: Washington VAAC



Aviation Hazards



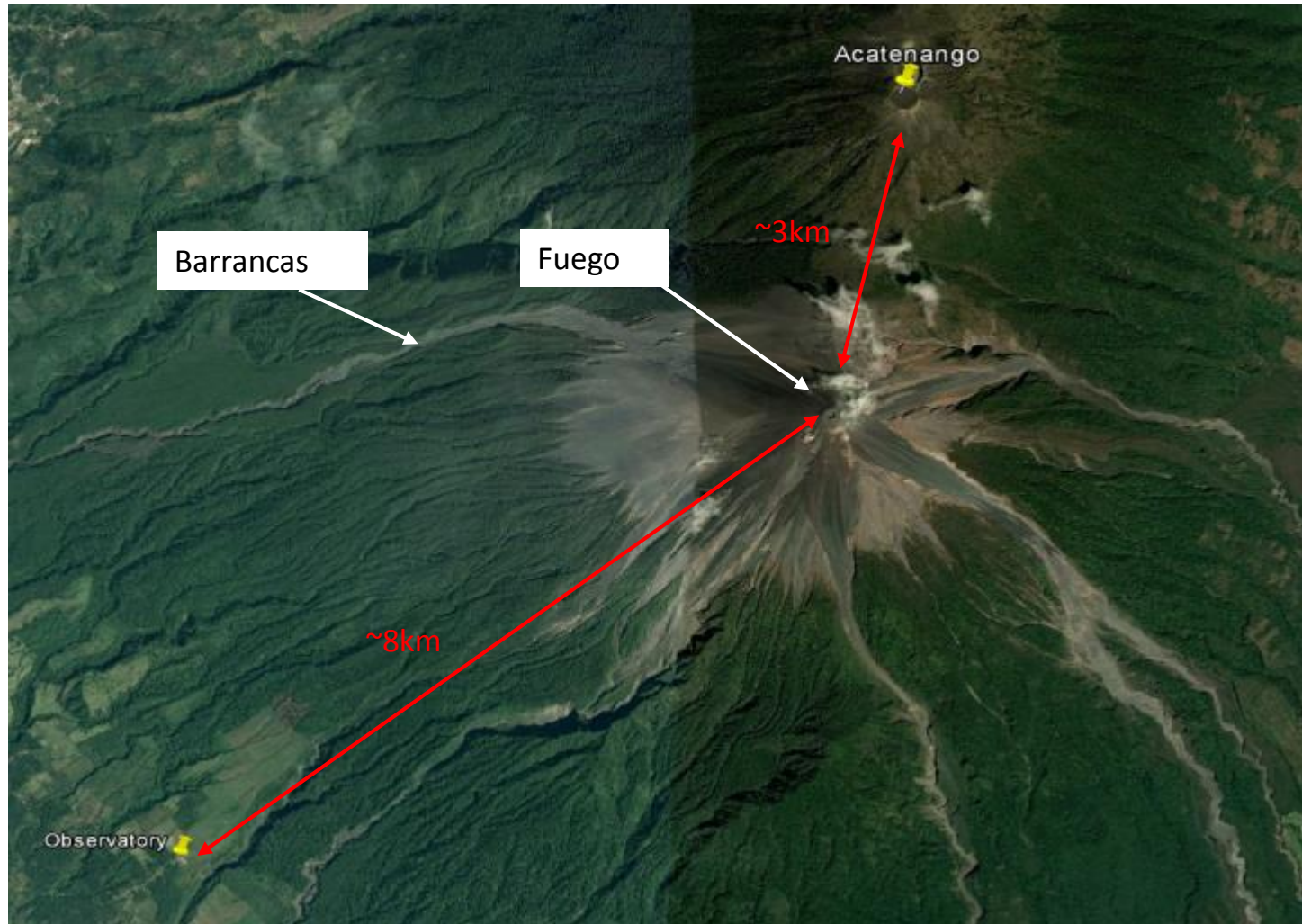
Aviation Hazards



UoB Drones/Platforms taken to Guatemala



Volcán de Fuego, Guatemala



Observatory Fixed Wing - Challenges & Operations



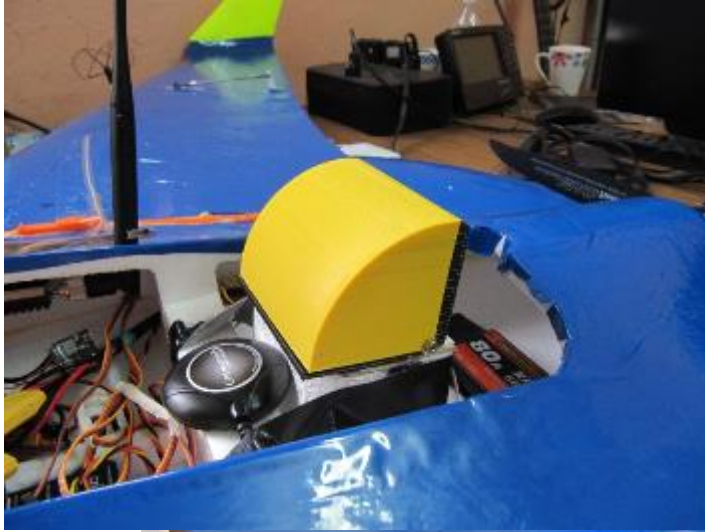
Observatory Fixed Wing - Challenges & Operations



Challenges - Operations



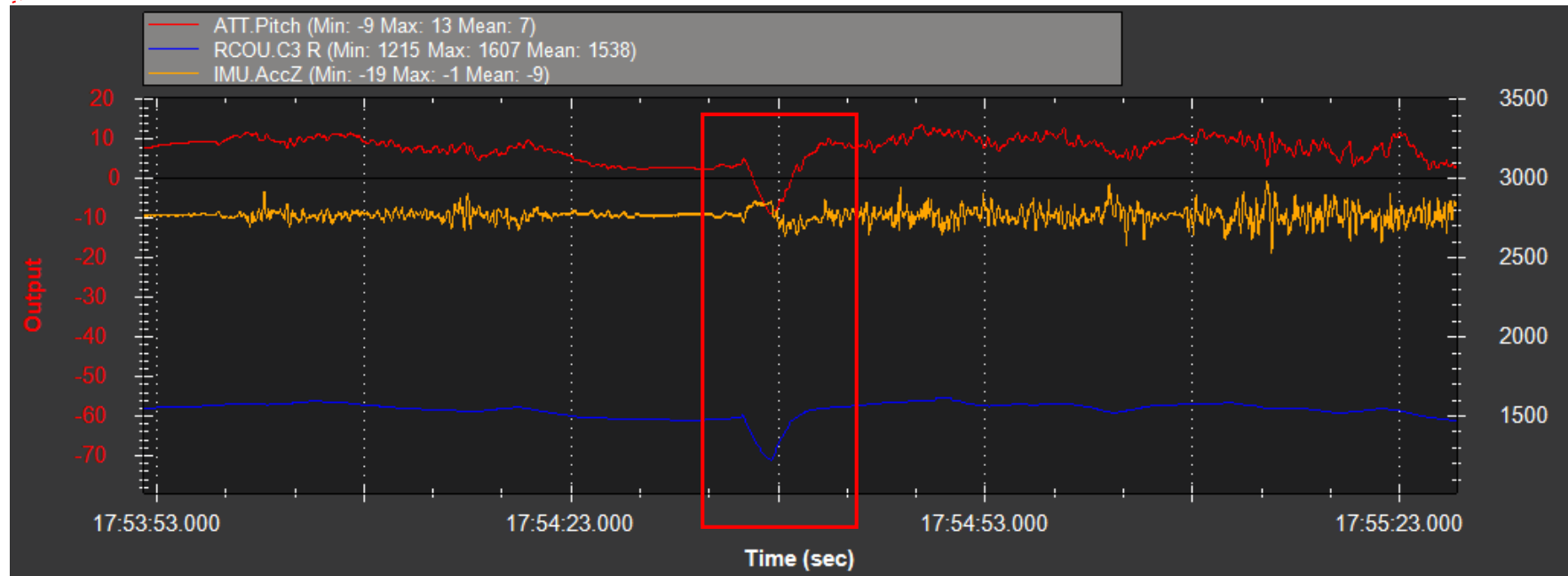
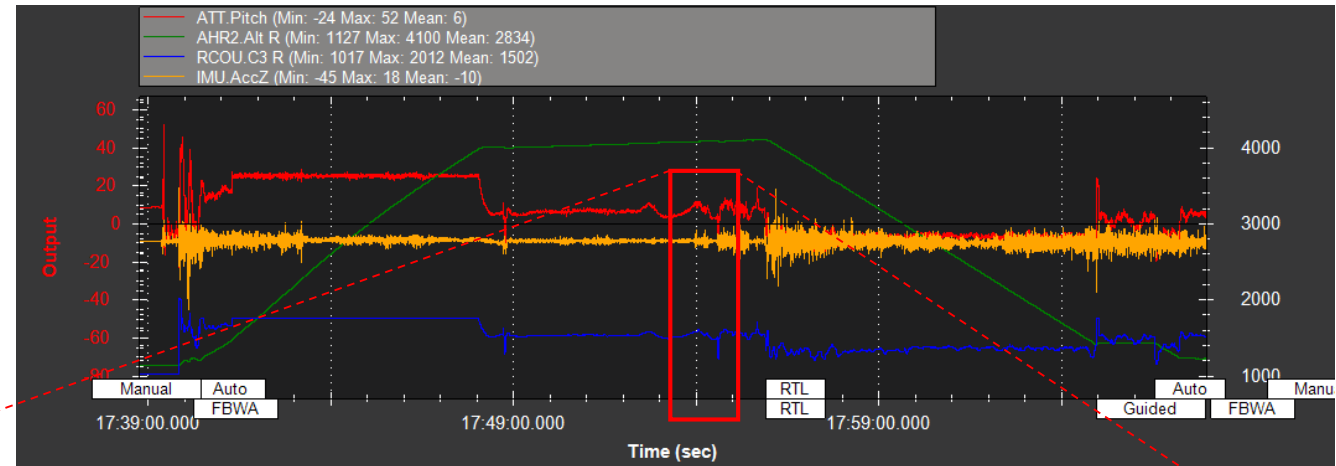
Onboard Sensors and Sampling



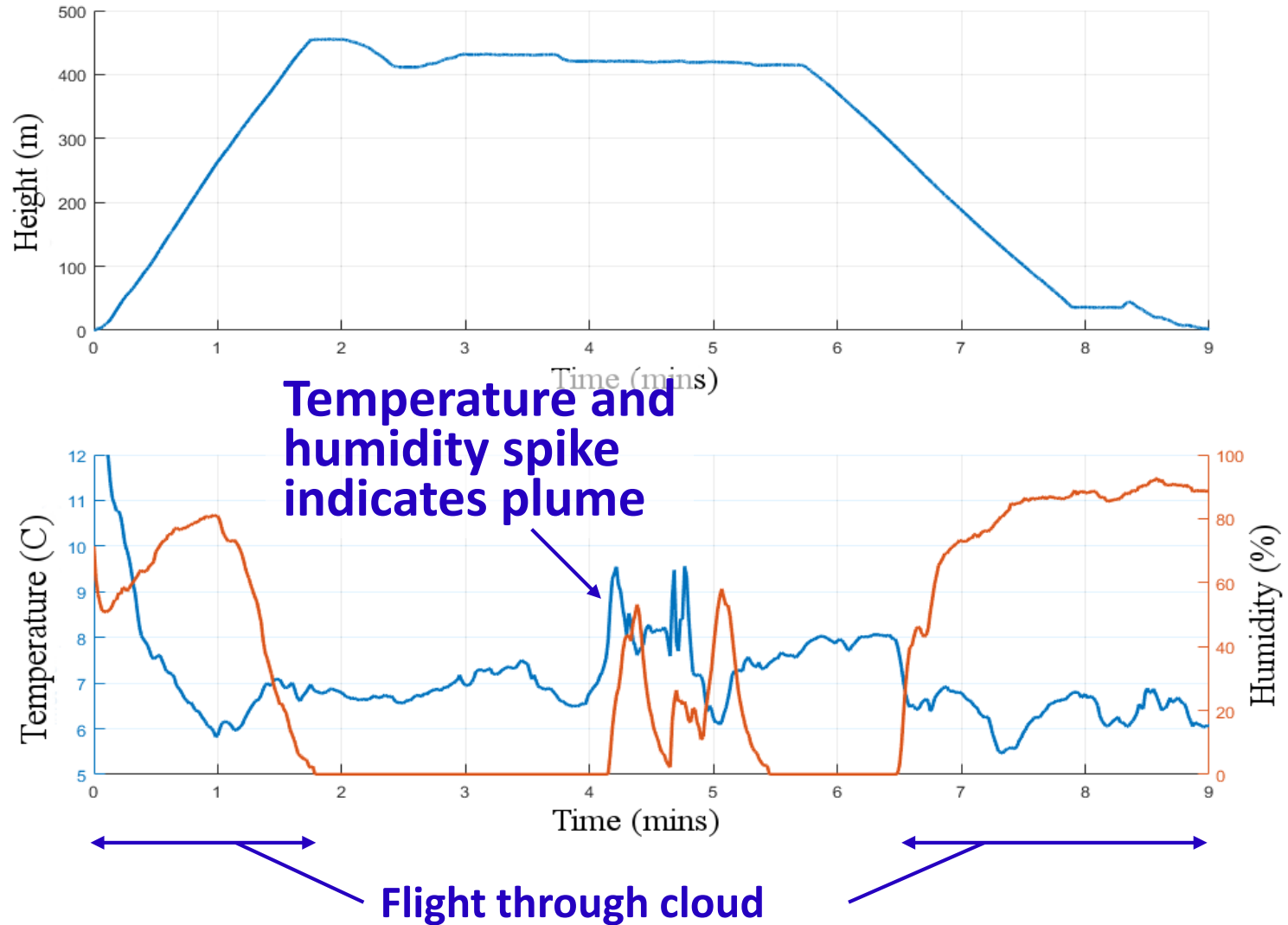
- In-plume sampling of fine ash
- Direct capture on to sticky carbon SEM stubs, for rapid analysis

Plume Detection

- Drop in throttle
- Upwards vertical acceleration
- Nose down correction



Plume Detection



Photogrammetry

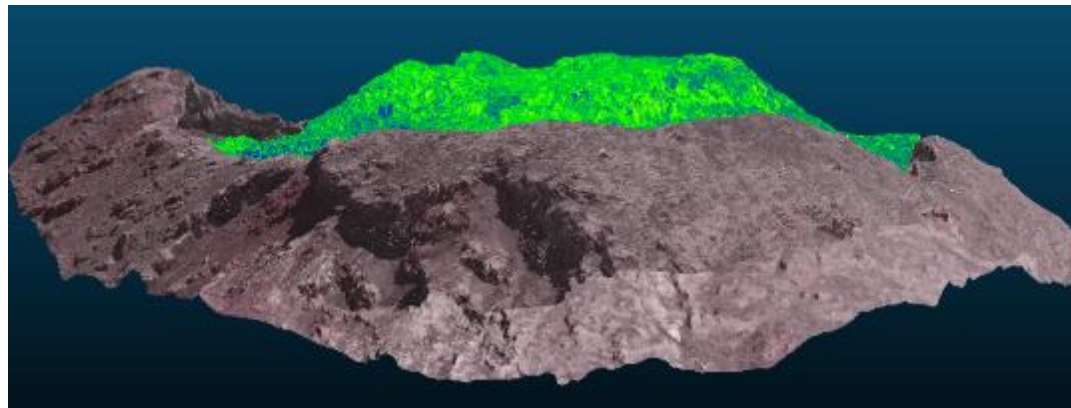
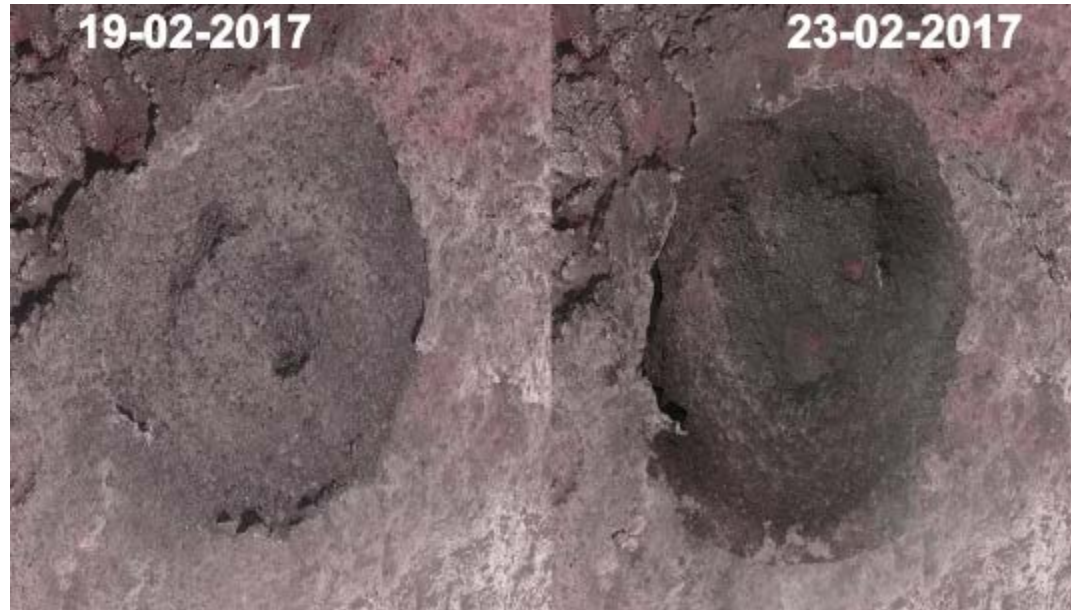
Feb 2016

- Volume added:
+44,850 m³ over 4 days
- Extrusion rate:
~0.13 m³/s
(~0.08 m³/s DRE)

Average point density:

19 Feb: 635 m⁻² (0.04 m)

23 Feb: 814 m⁻² (0.035 m)



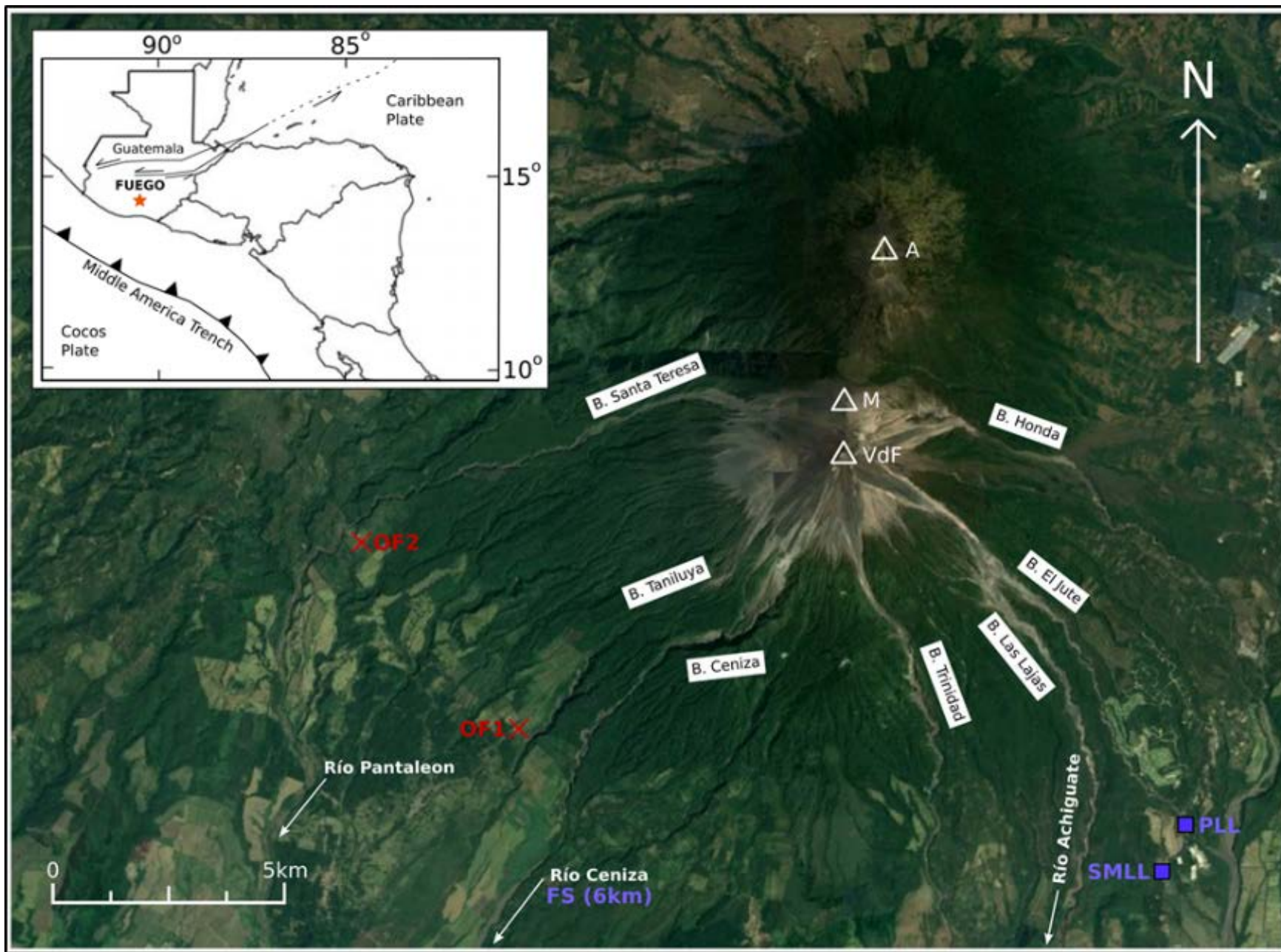
Outreach – UAV/Drone training



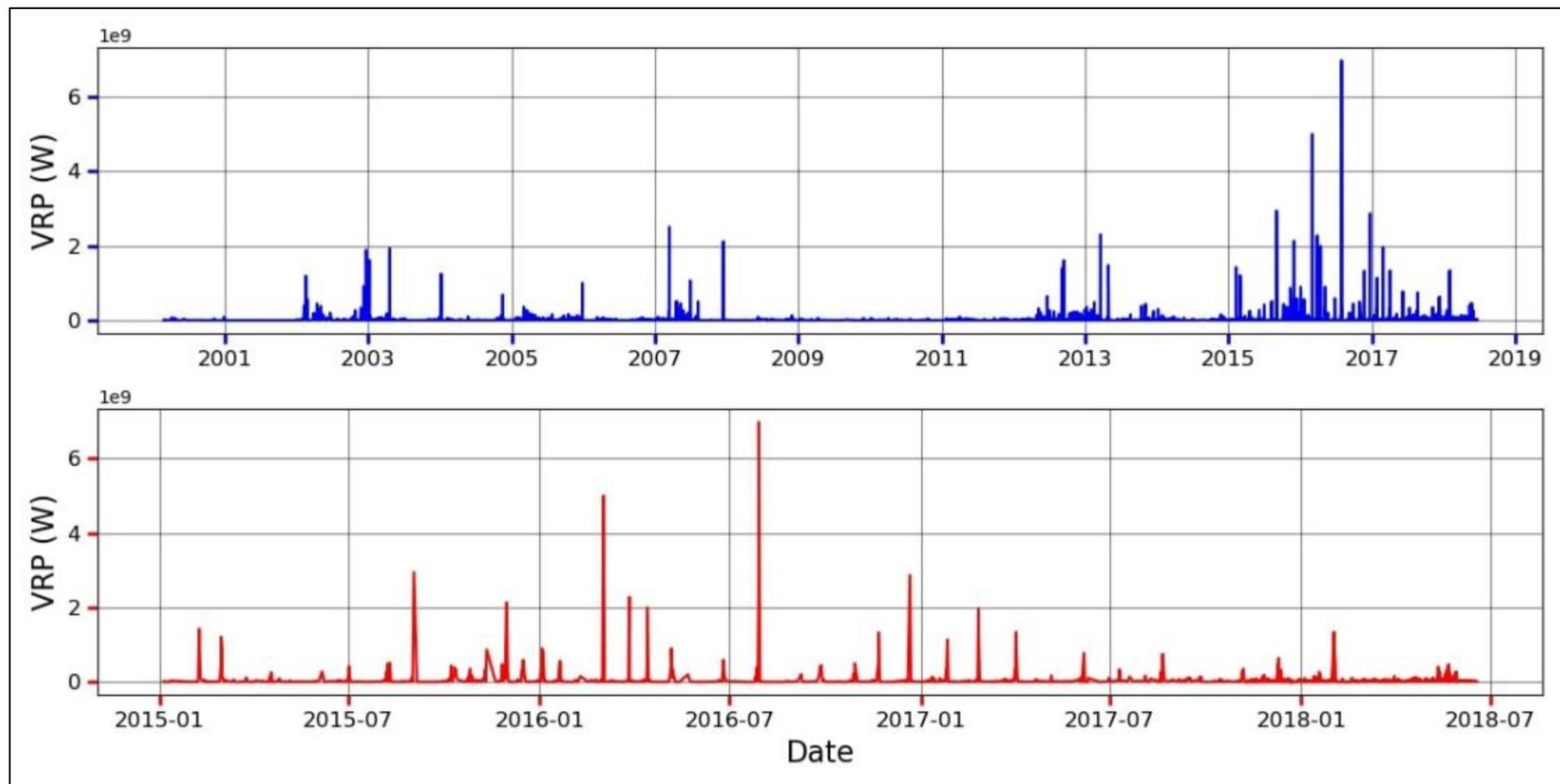
The 3rd June eruption of Volcán de Fuego, Guatemala



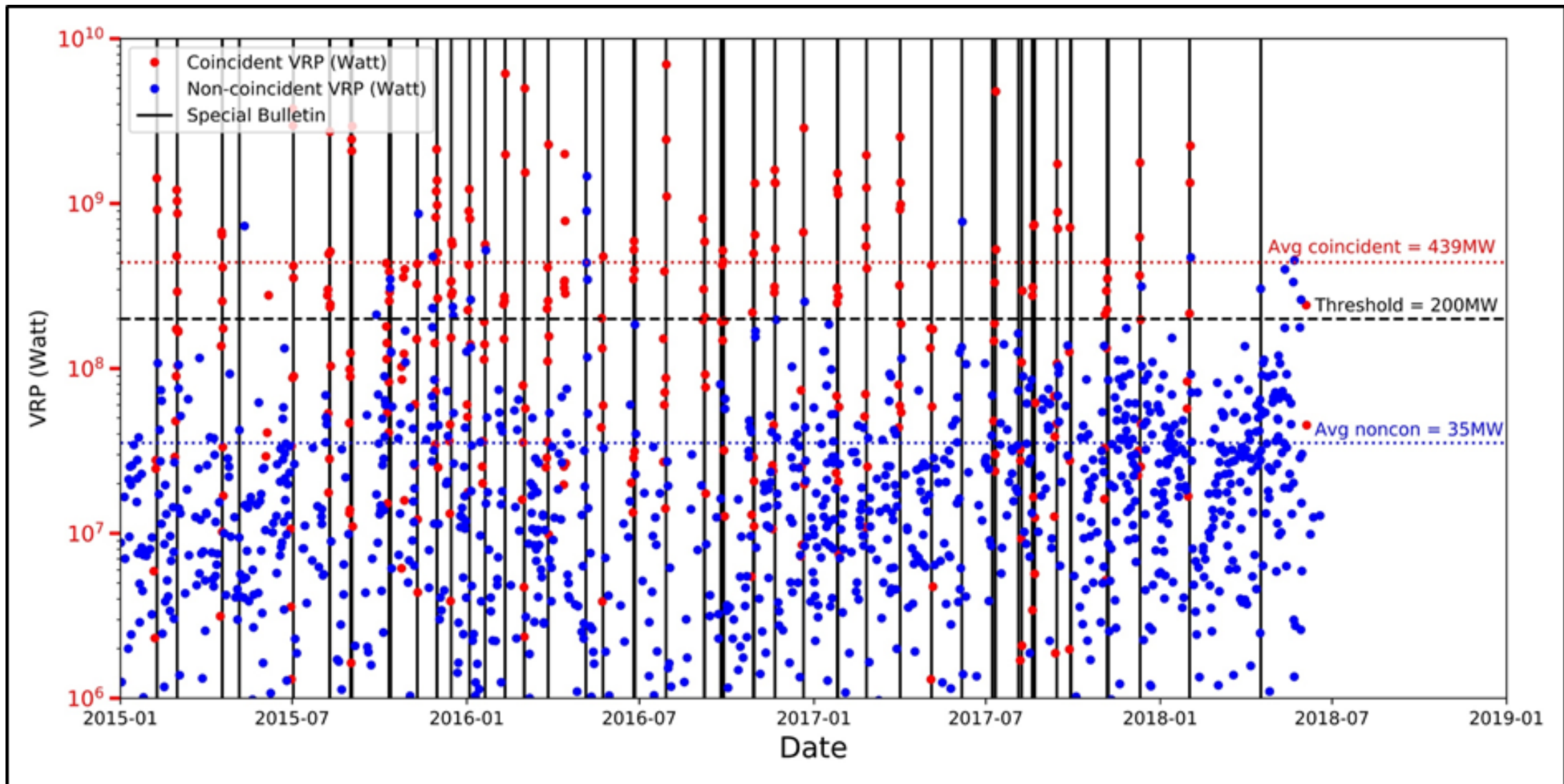




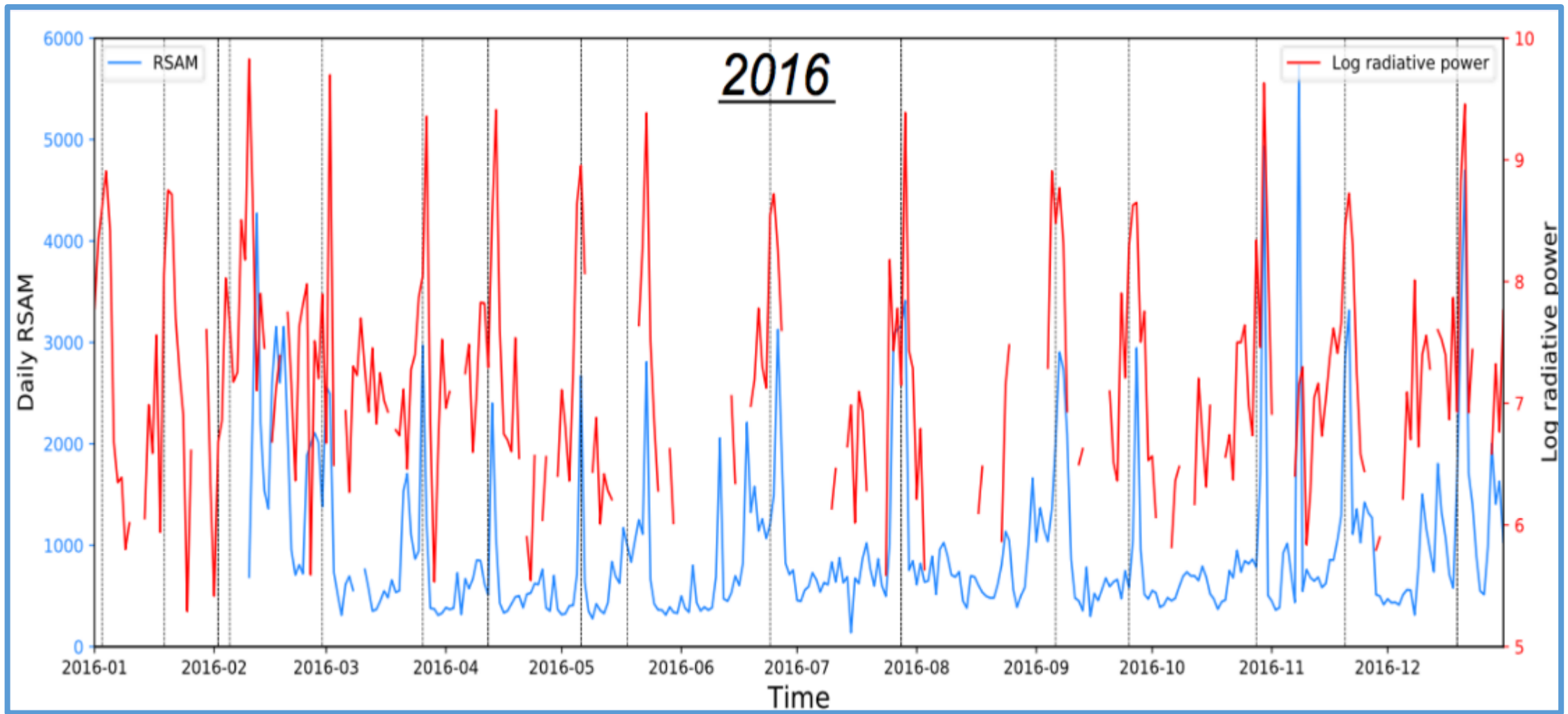
Naismith et al., in review



Naismith et al., in review



Naismith et al., in review



Naismith et al., in review

Summary of pre-3rd June activity

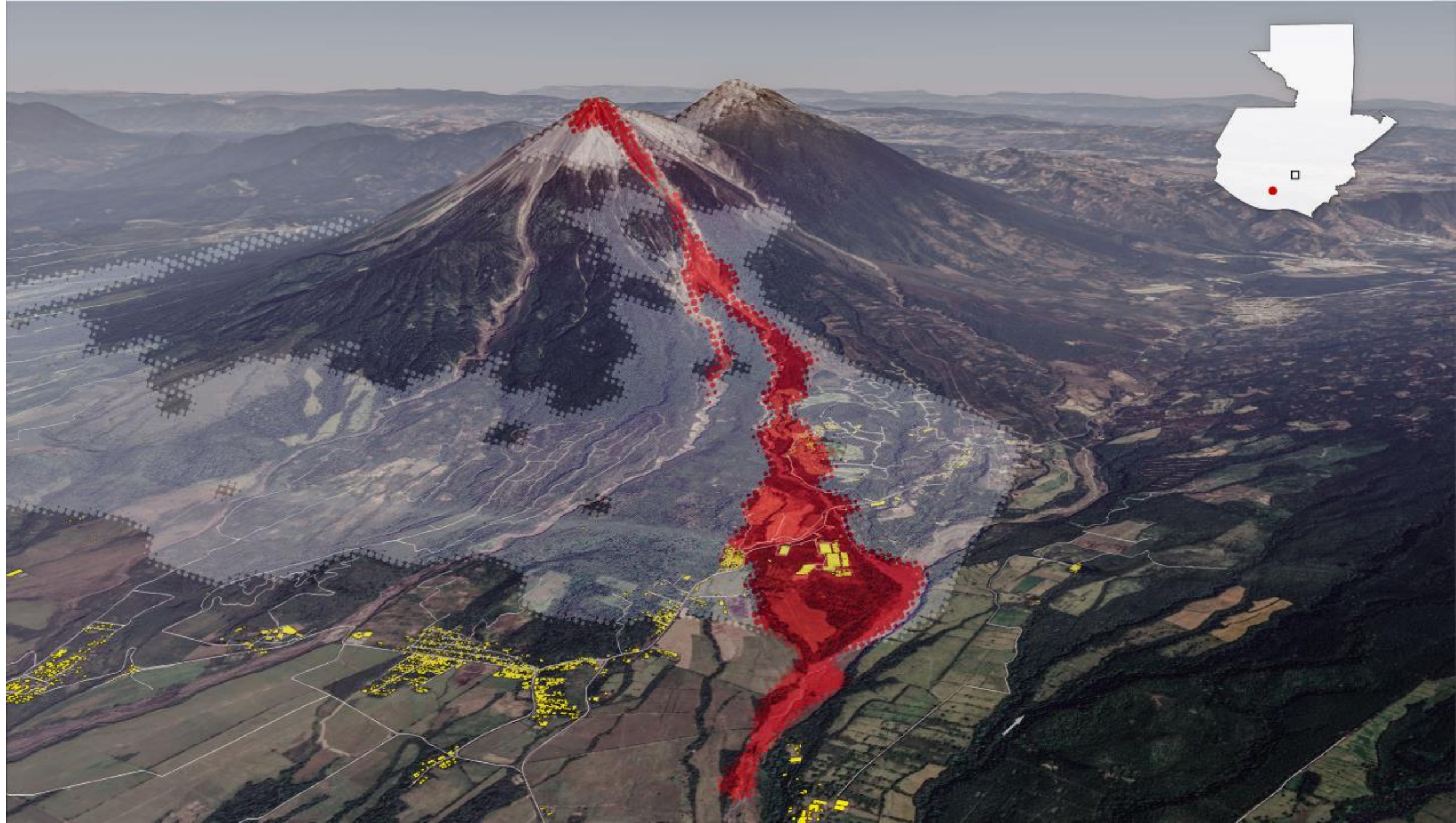
- Strongly cyclical
- Repeated sequence – cone building > lava flow > paroxysm > PDCs
- Average repose period of about a month (until 2018)
- Failed (or at least less intense) paroxysm in Nov 2017
- Longest repose was Feb – June 2018

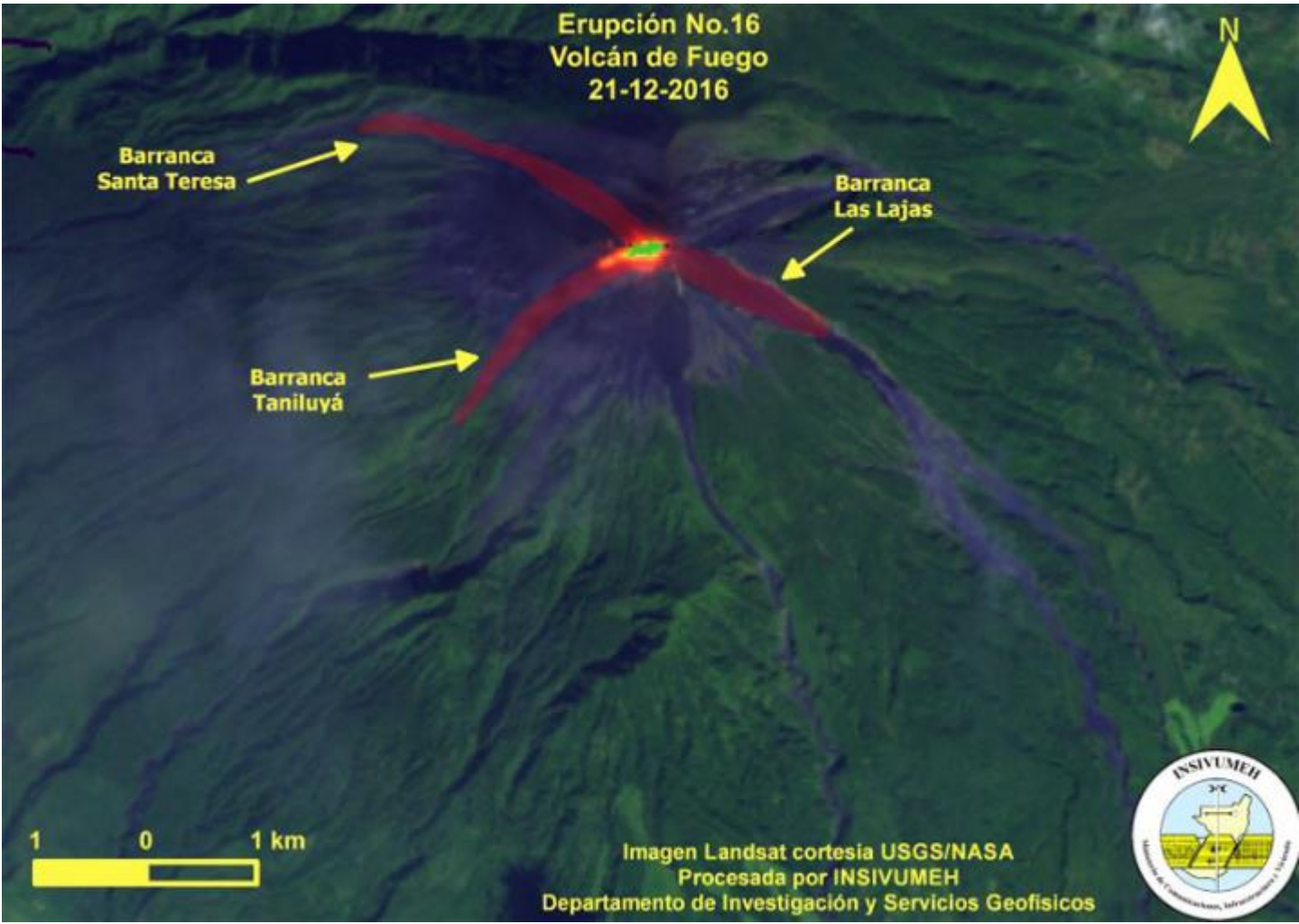
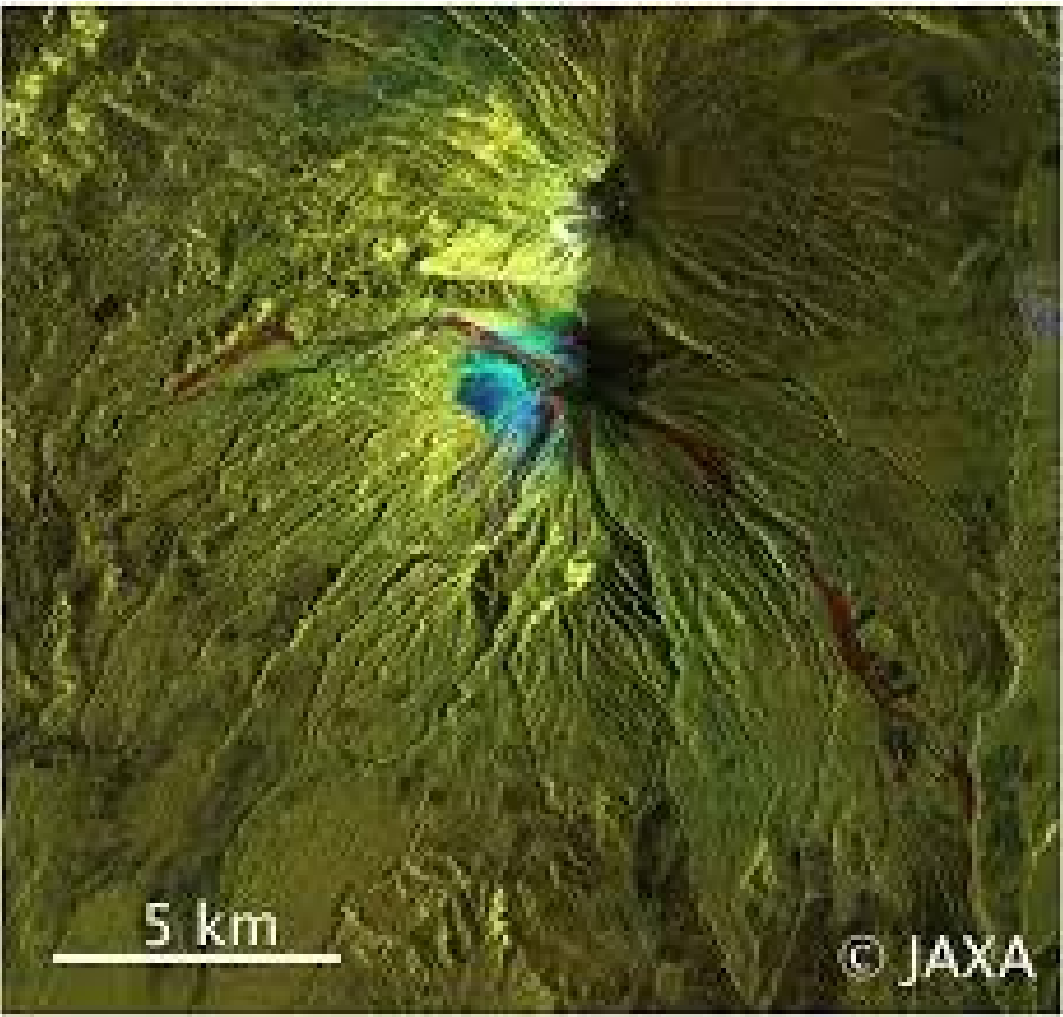
3rd June eruption (AN and RE)

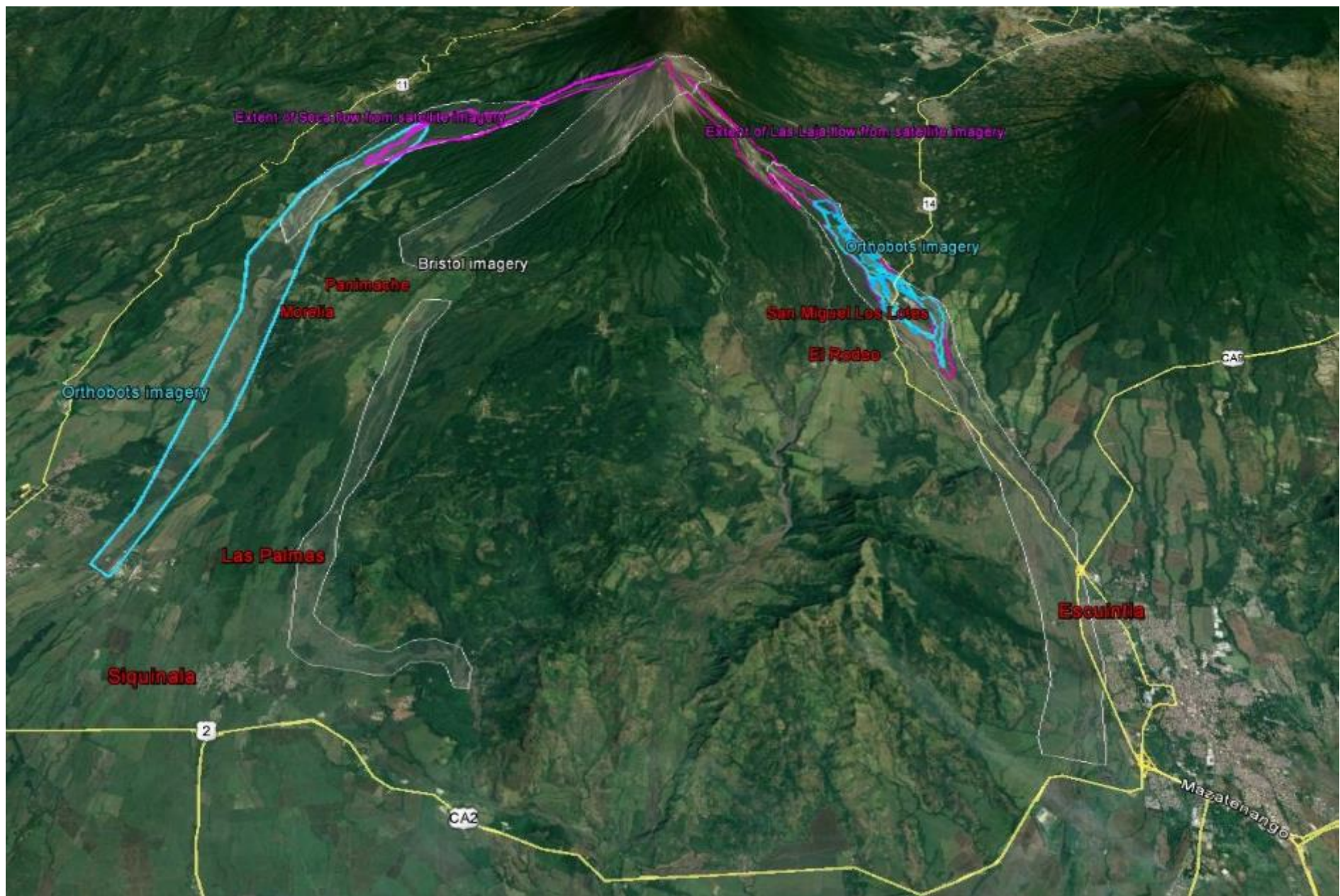
- **3rd June eruption timeline**
- This timeline has been assembled from INSIVUMEH (National Institute for Seismology, Volcanology, Hydrology and Meteorology) bulletins, CONRED (National Coordination for Disaster Reduction) reports, discussion with local actors and social media postings.
- Before **06:00** Sunday 3rd June: eruption of Fuego begins, with strong vertical incandescent fountaining ejecting ballistic material. PDCs descending towards Barranca Santa Teresa (Seca, Figure 2.). Some early photos of the eruption by INSIVUMEH suggest it is a typical paroxysm.
- **07:30**: small PDCs descend W flanks of volcano towards Panimache Uno, Sangre de Cristo.
- **09:00 – 09:30**: eruption continues with explosive activity. Recorded as another paroxysmal eruption but no recorded activity that affects E flanks of volcano.
- **10:05**: Eruption continues, generating PDCs down Barrancas Seca and Cenizas. Eruptive column moving towards W, N of volcano.
- **11:00 – 11:30**: PDCs reported by CONRED; say evacuation still unnecessary. PDCs continue to travel down W flanks.
- **11:30 – 12:00**: First descent of PDCs down Barranca Las Lajas. Evacuation of La Reunion golf resort begins.
- **12:00**: heavy ashfall on roofs. Evacuation still not recommended by authorities.
- **12:55**: Further PDCs descending Las Lajas. PDCs have already begun to burn upper slopes of La Reunion. All guests and 95% of personnel have been evacuated from La Reunion.

Timeline (cont.)

- Before **13:00**: Vigorously convecting eruptive column visible from (NE)? of volcano.
- **13:45**: Eruption column has increased in height to >10,000m asl and PDCs generated down all principal barrancas. INSIVUMEH issue report recommending evacuation of Sangre de Cristo inhabitants, and encourage careful monitoring of SE, S, SW flanks.
- Before **14:00**: Descent of PFs down Barranca Las Lajas, visible from RN-14 E of volcano near Alotenango.
- Between **14:30 – 16:00**: San Miguel Los Lotes completely destroyed by PDCs.
- **15:00 – 15:30**: Reports of evacuations already underway.
- **15:15 – 16:15**: Heavy ashfall in Antigua
- **15:25 – 15:35**: Descent of series of powerful PDCs down Barranca Las Lajas. Twitter videos from La Prensa and NotiSeis show pedestrians and CONRED personnel on Las Lajas bridge immediately prior to, and during, descent of PDCs. Likely destruction of Las Lajas bridge and death of Juan Fernando Galindo (CONRED staff) between 15:30 and 15:35.
- **16:30**: Report of PDCs reaching >8km from Fuego's summit down Barranca Las Lajas. Bridge still intact in a Tweet posted at 16:27, although photo does not have timestamp. Other Tweets suggest Las Lajas bridge may have already been destroyed by this time – see 15:25 – 15:35.
- **16:30**: Alert level for Fuego is currently orange [Alert level for Fuego is set by CONRED].
- Before **16:40**: Las Lajas bridge is obstructed due to volcanic material, communities trapped. RN-14 blocked by volcanic material at km95.
- **16:55**: INSIVUMEH issue report that PDCs are underway down Barrancas Seca and Cenizas. Reports that Panimache, Palo Verde, and Sangre de Cristo have already been evacuated by CONRED. Ash fall reported to W, NW, N of volcano.
- Before **17:30**: Rescue efforts underway of families in San Miguel Los Lotes devastated by PDC descent.
- **17:30 – 18:00**: Further PDCs descending Las Lajas?







Conclusions

- Geography and Earth Sciences degrees enable you to work at the interface between science and people
- A PhD in Geography has allowed me to travel the world, and to do fun stuff like flying drones over (and occasionally into) volcanoes
- I enjoy my work because it is both fascinating scientifically and makes a difference to peoples' lives on the ground
- Bristol University is world class in a number of fields of which volcanology is one example