



# IMPACT OF ASHES ON OPTICAL SIGNATURES FROM THE 2022 TONGA VOLCANIC ERUPTION AS DETECTED BY SATELLITE OCEAN COLOR OBSERVATIONS

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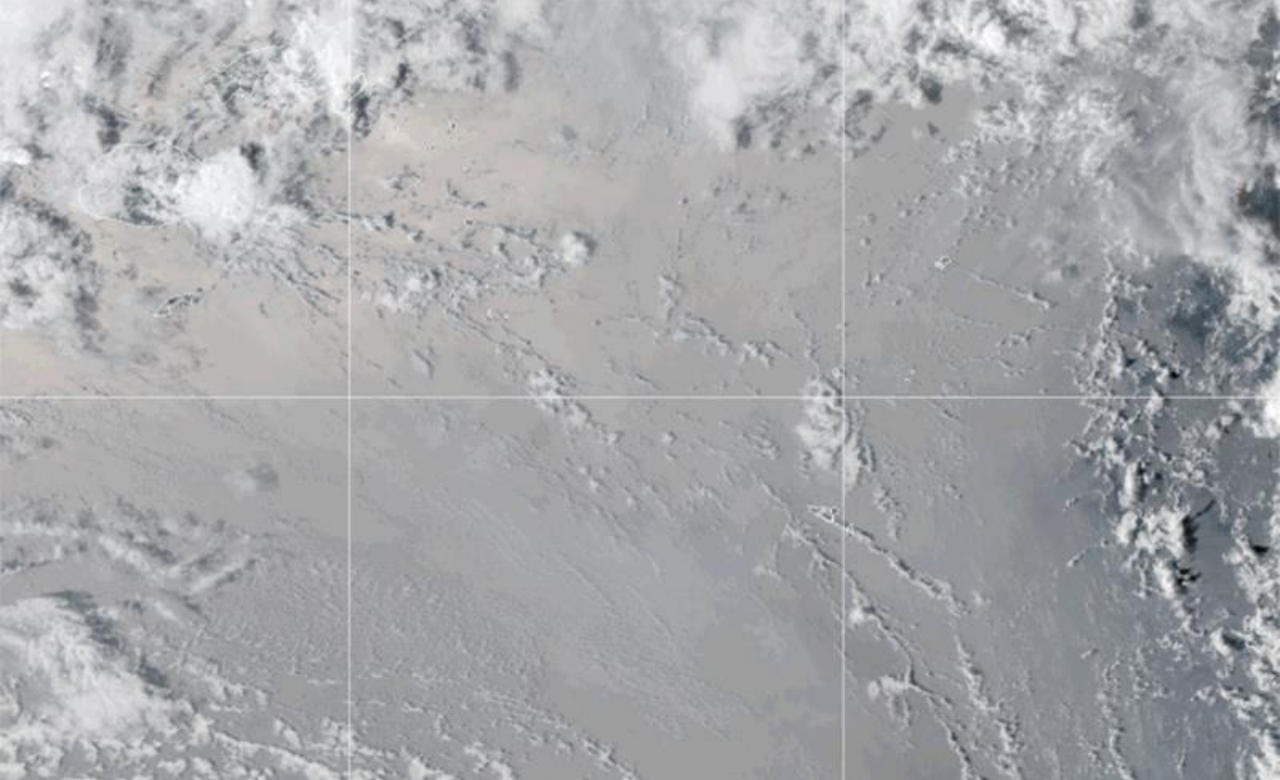
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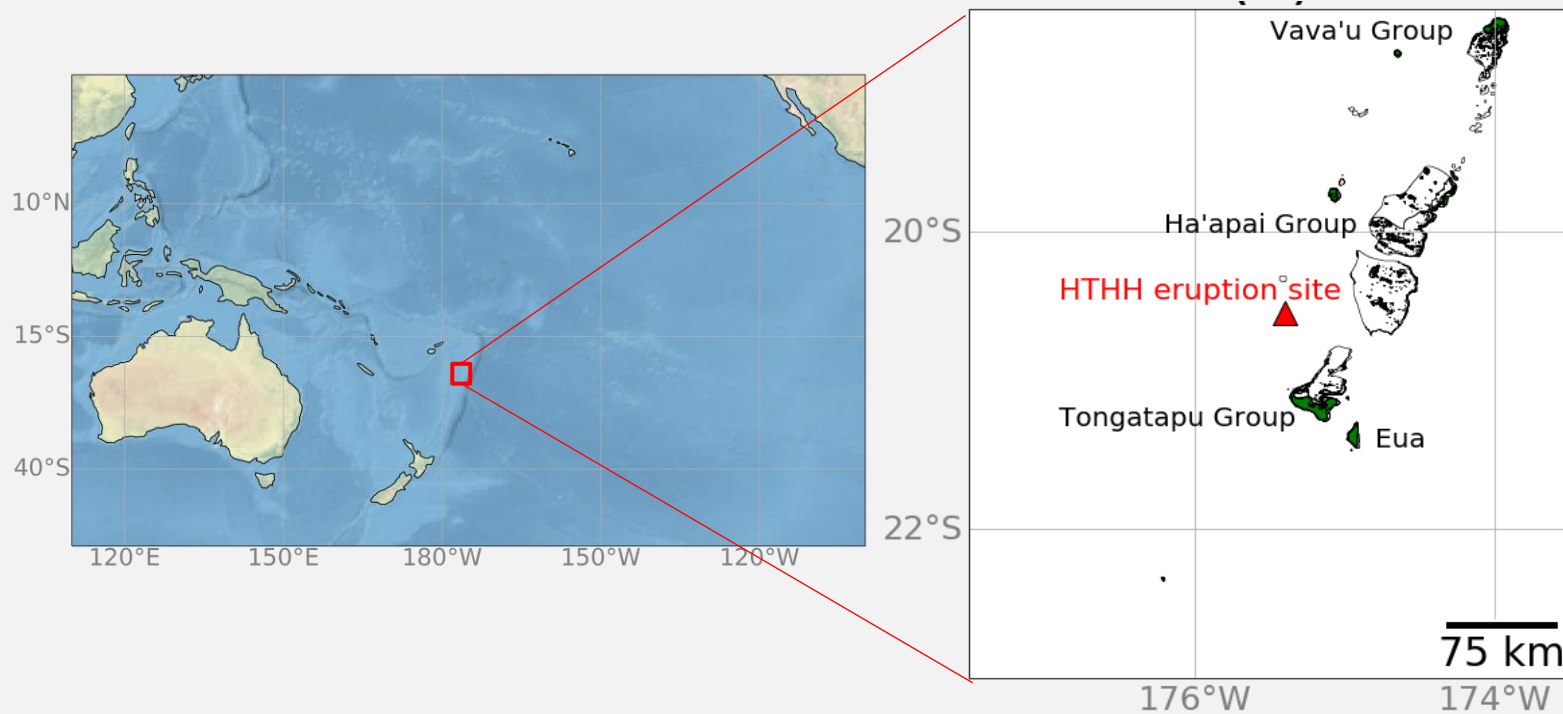


## THE HUNGA TONGA-HUNGA HA'APAI VOLCANIC ERUPTION

- An extraordinary eruption within the Hunga Tonga-Hunga Ha'apai (HT-HH)
- Thick layer of volcanic ash into the lower stratosphere, subsequently covering islands across the Tongan group



**Credit: (top)** Visible Earth/NASA **(bottom)** Tonga Geological Services



- Mostly submerged volcano in the Kingdom of Tonga
- Shockwaves across the globe which were heard across the Pacific
- Eruptions at smaller scales between 20 December 2021 and 5 January 2022 prior to the main event (Cronin, 2022).



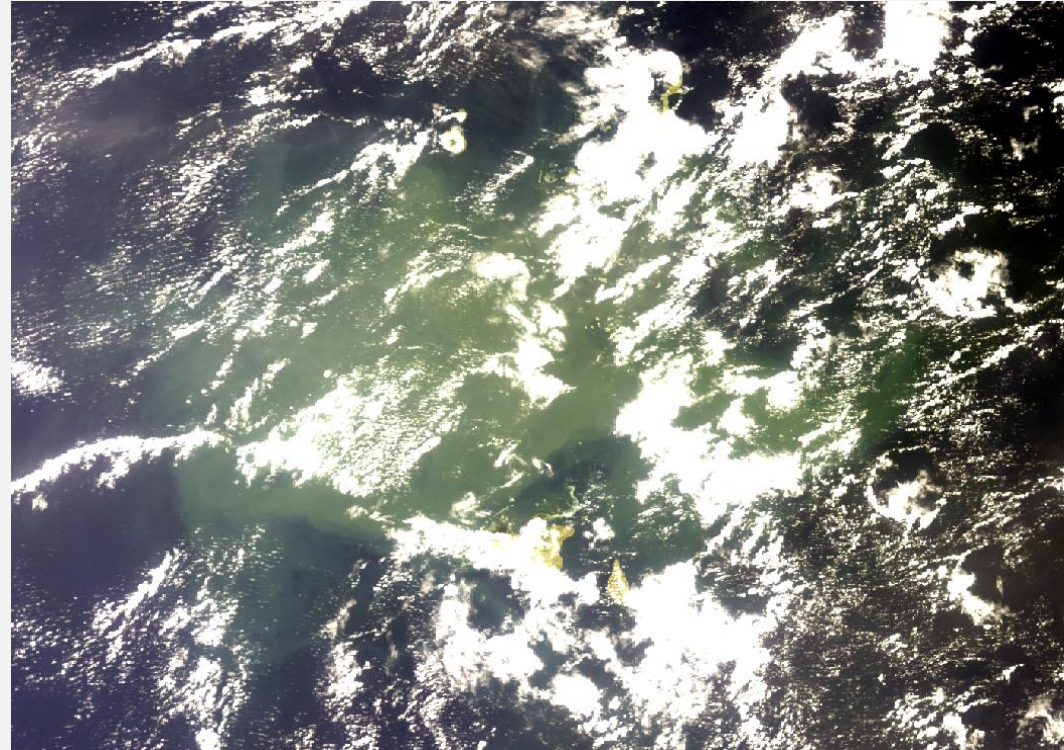
# IMPACT OF ASH ON LAND



Source: Maxar Technologies



# APPEARANCE OF DISCOLORED WATERS



Credit: (left)  
Copernicus/ESA/  
Sentinel  
Hub/PlanetLabs

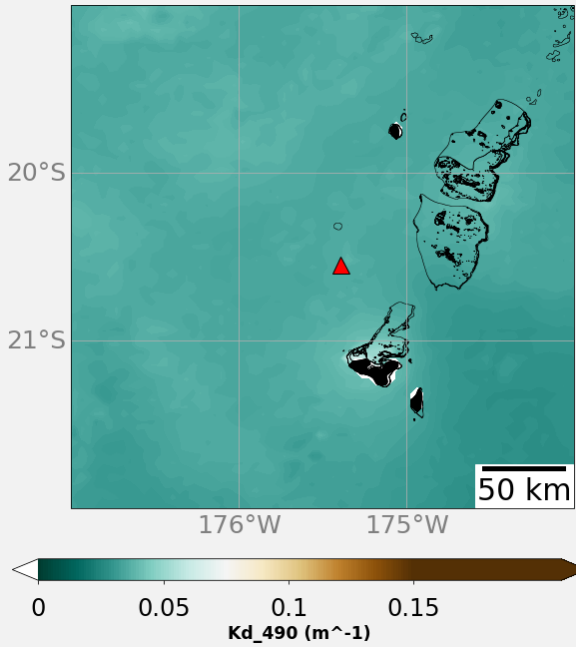
Large patch of  
discolored waters with  
estimated size 32,250  
km<sup>2</sup>.

Satellite observations to  
investigate major  
features after eruptions  
around site

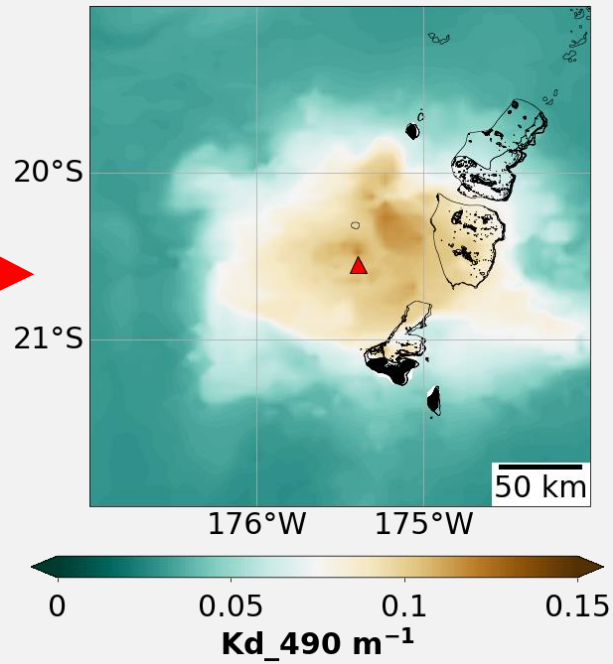
Chl-a vs volcanic ash?

# LIGHT ATTENUATION / PENETRATION (KD(490))

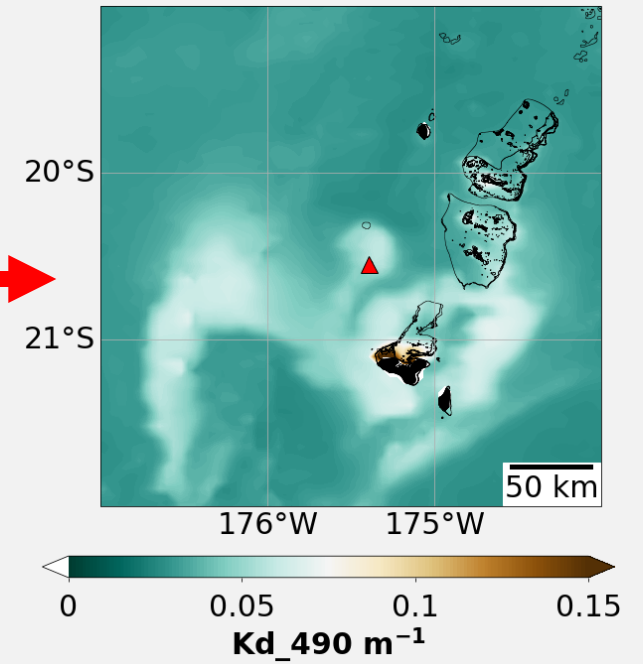
4 days pre-eruption



2 days post eruption

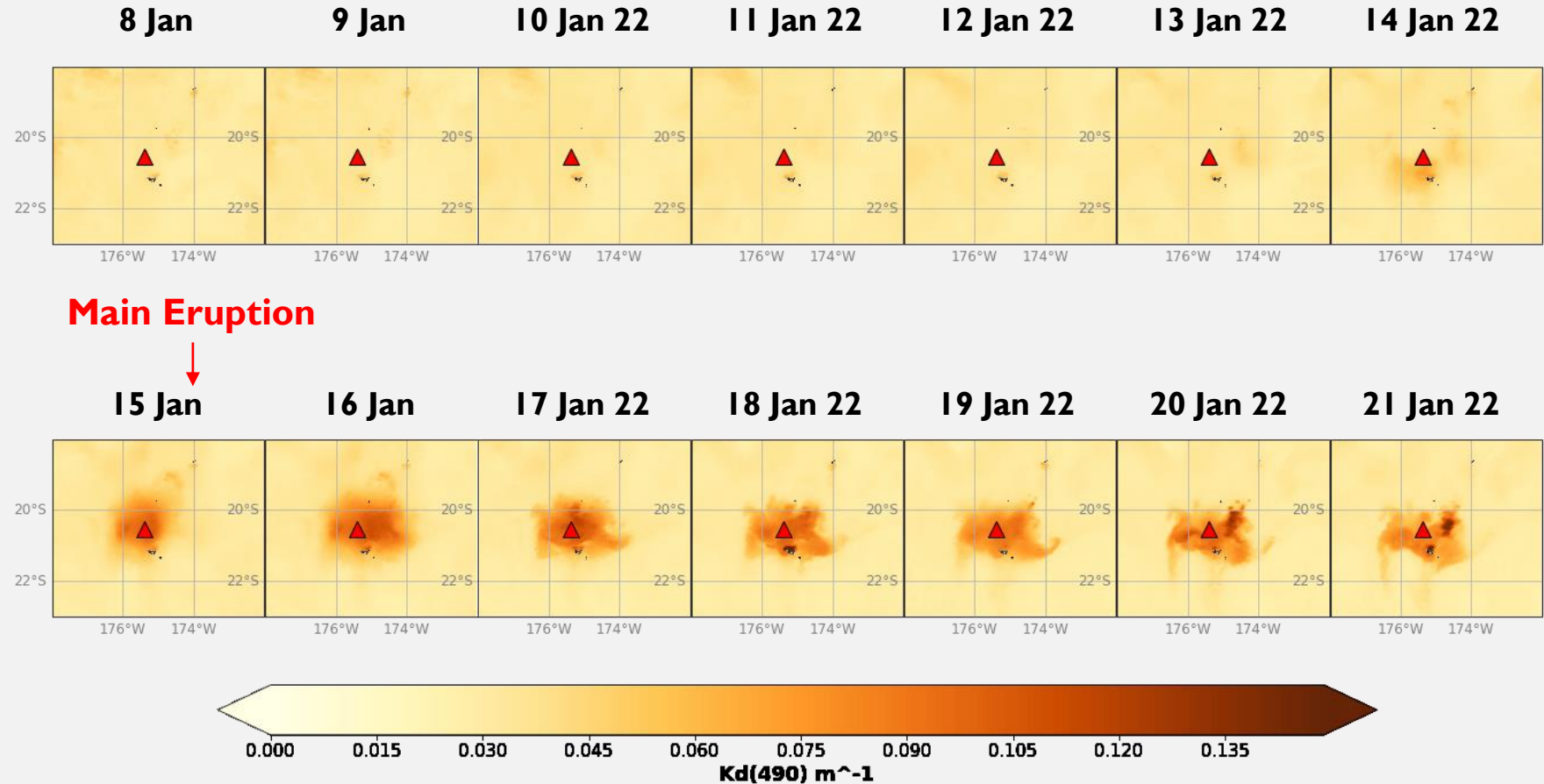


10 days post eruption



# TIME-SERIES PRE- AND POST ERUPTION

- Evolution of material released from the eruption that has been ejected and deposited to the ocean.
- Probable false Chl-a values, and that other material is influencing ocean color signature.

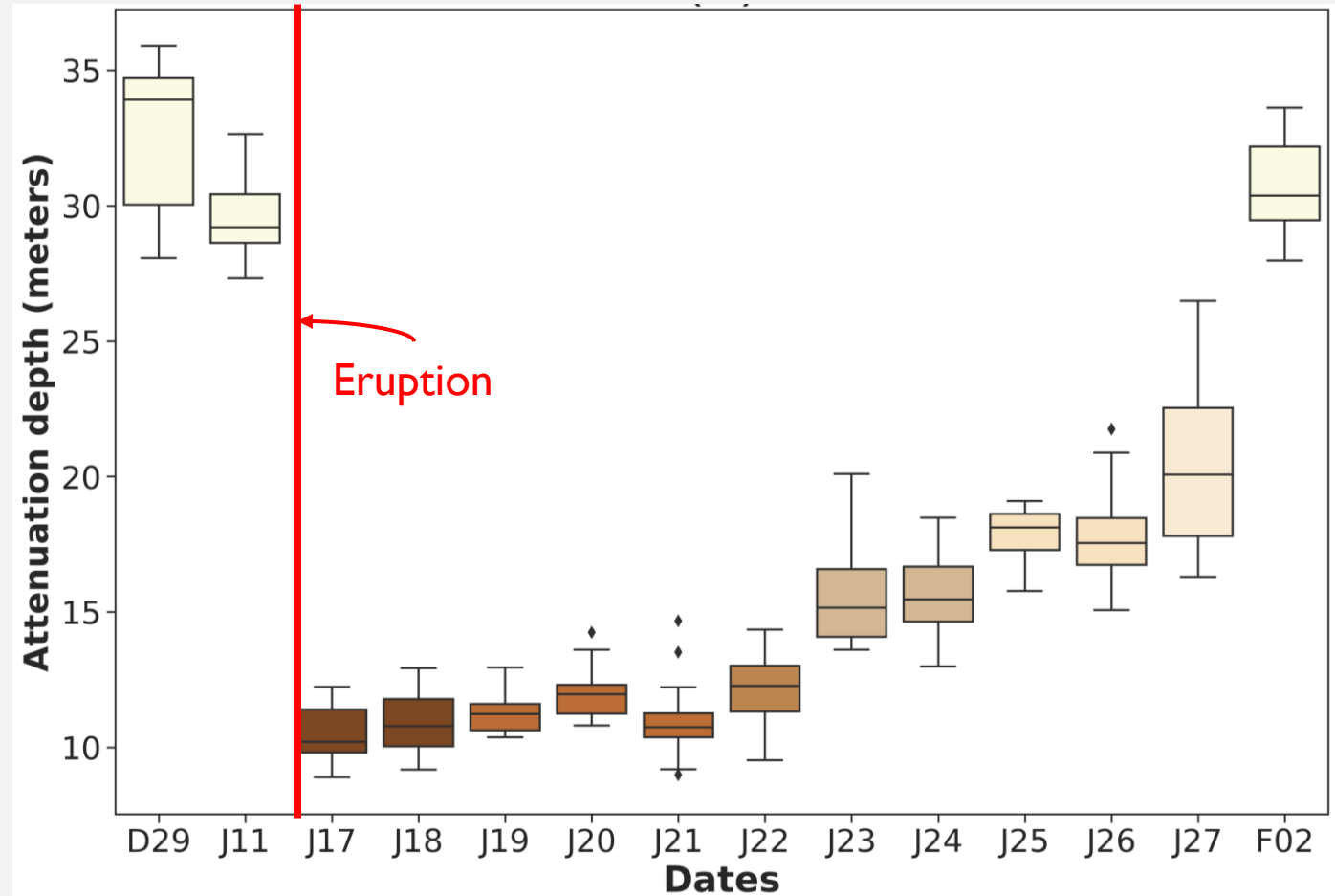




# LIGHT ATTENUATION / PENETRATION (KD(490))

High attenuation of light due to ash, reducing the penetration depth to  $< 10$  meters during the first period after the eruption.

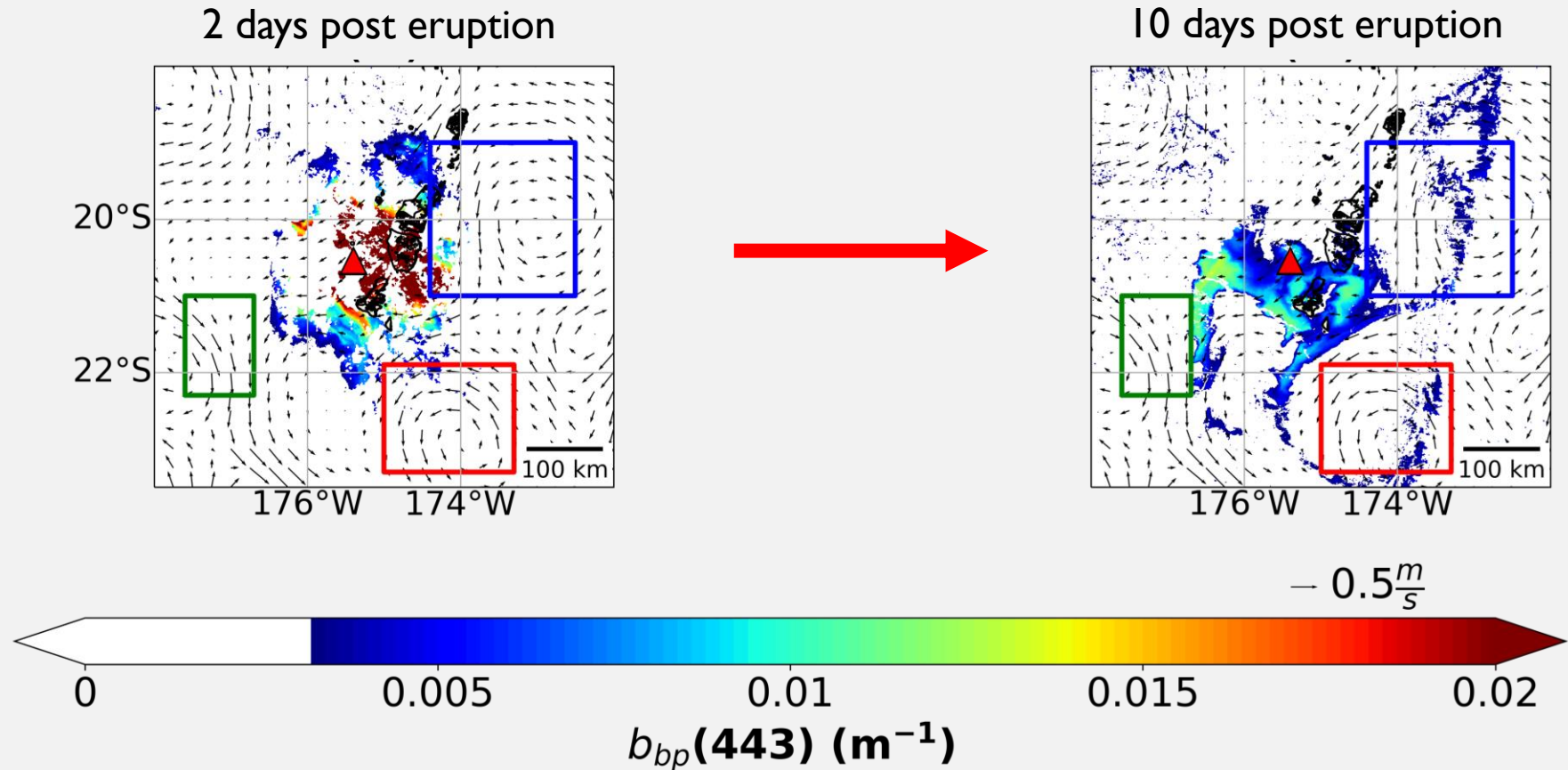
Reduction of light from the ashes raised immediate concerns over the health of the coral reef ecosystems after the eruption, notably the smothering of ash particles in waters over corals (Franklin and Storel, 2022).





# PLUME DISPERSAL OVER TIME

- Discolored waters patch decreases in size and intensity over time.
- Currents influence the dispersal of the patch.
- Edges of the plume traveled further south faster than its center, eventuating in an inverted crown-like shape, attributed to small-scale eddies south of the region.



## SIMILAR STUDY CARRIED OUT IN 2019

An underwater volcanic eruption off the Vava'u island group in Tonga on 7 August 2019 resulted in the creation of floating pumice over an area of 150 km<sup>2</sup>.

Methods of automatic detection using satellite imagery are described, making it possible to track the westward drift of the pumice raft over 43 days.

Source: <https://fijisun.com.fj/2019/09/12/pumice-menace-hits-parts-of-lau-group/>



Source: Erika Fish/QUT/AAP

NATION

### Pumice Menace Hits Parts Of Lau Group

*In some islands in Lau the pumice raft is so thick that people are standing on it. Director Marine Resources Apete Soro said the pumice raft could affect marine life as well as shipping.*

By **Shalveen Chand**

12 Sep 2019 11:30



Children play on pumice at the Tubou Jetty, Lakeba.

## Pumice raft drifts

By **ANA MADIGIBULI**

THE Pumice raft which was reported to have been moving to the southern Lau Group in September this year has found its way to the western parts of Fiji.

The pumice raft has been found to have drifted to the West with people reporting of such volcanic sediments drifting from Lomaiviti waters down to the Navitilevu Bay.

Since last week, fishers have reported to have noticed the pumice after several outings, but hasn't affected fishers or boat operators move-

ments in that part of the country.

"We try to steer clear of the pumice now when going out to sea because the first time we had encountered it, it sounded and felt like we were running on dry ground and it could easily damage our engines," Naiserealagi villager and fisherman Delai Luvenitoga said.

"It's good to have people who know how to navigate the waters when going out at sea to avoid floating sediments like that," he said. "A lot of us rely on fishing and we hope this will not affect us in any way."

There are huge sediments at Navuira waters

and close to Vatu.

"We haven't heard about the pumice drifting to this part of the province but I hope people get informed especially those who operate boats in this part because their boats can get damaged."

According to a report published in this newspaper on October 12, the pumice was also visible along a 3km stretch of foreshore at Volivoli Point in Rakiraki.

Damage that can arise from the pumice raft are clogged pumices in rudder, blocked harbours, inaccessible jetties and abrasion of the boat hull.















Fishing boats sit on a bed of pumice at low tide at Volivoli Point. Picture: ANISH CHAND

Source: <https://www.pressreader.com/fiji/the-fiji-times/20191016/282226602489283>

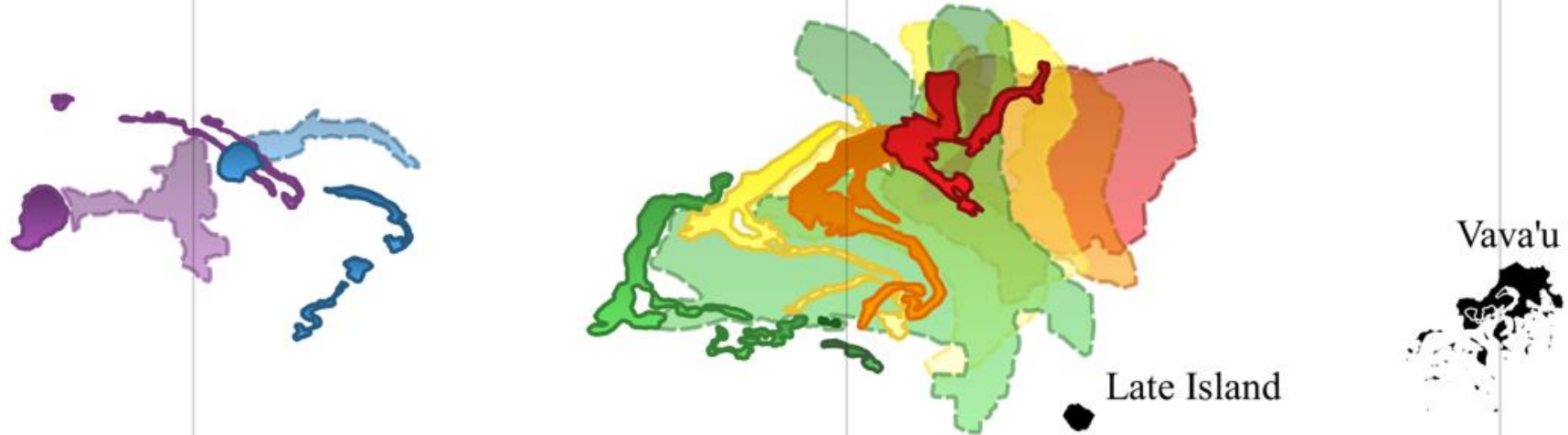




### Legend

- |   |  |
|---|--|
|  Pumice Raft 08 Aug 19 |  Discolored Water 08 Aug 19 |
|  Pumice Raft 10 Aug 19 |  Discolored Water 10 Aug 19 |
|  Pumice Raft 11 Aug 19 |  Discolored Water 11 Aug 19 |
|  Pumice Raft 12 Aug 19 |  Discolored Water 12 Aug 19 |
|  Pumice Raft 21 Aug 19 |  Discolored Water 21 Aug 19 |
|  Pumice Raft 23 Aug 19 |  Discolored Water 23 Aug 19 |

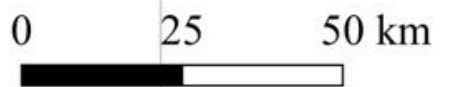
18.0°S



Vava'u

Late Island

19.0°S



176.0°W

175.0°W

174.0°W

# CONCLUSION

- Ocean color products tracked the expanse of floating and suspended material post 2019 and 2022 eruption.
- Both eruptions were very different
- High penetration of light due to ash, reducing the penetration depth to  $< 10$  meters during the first period after the eruption may have had strong implications on ecological processes and biogeochemical cycles in the Tongan waters.
- The study also showed the difficulty of interpreting ocean color signals in this area.



VINAKA!

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Whiteside, A., Dupouy, C., Singh, A., Bani, P., Tan, J., and Frouin, R. (2022) *Impact of Ashes from the 2022 Tonga Volcanic Eruption on Satellite Ocean Color Signatures*. Accepted in *Frontiers in Marine Science*.

# ASH PRODUCE HIGH REFLECTANCE SPECTRUM

