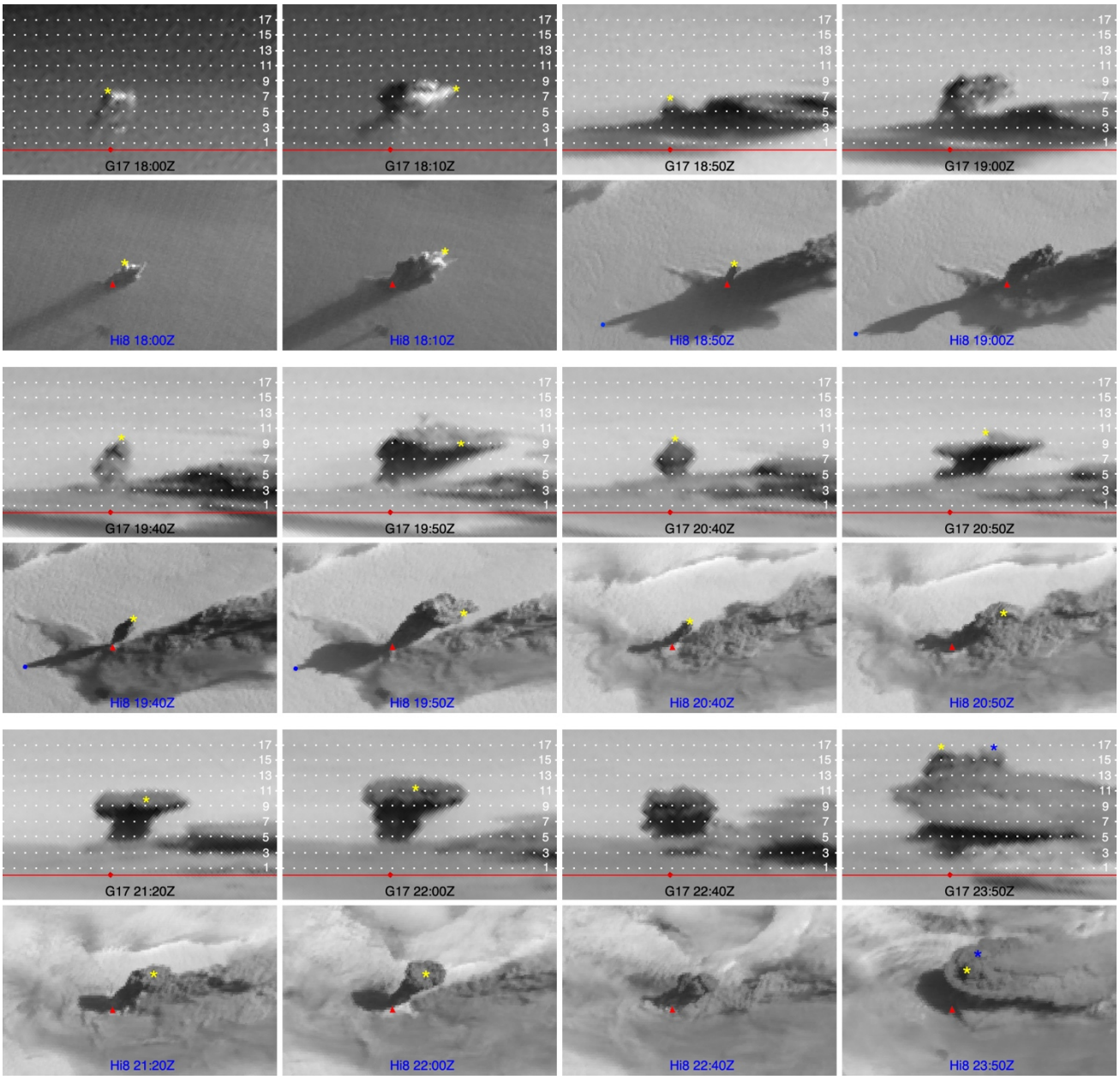

Figure S1. Snapshots of the 21 June 2019 eruption of Raikoke: GOES-17 (G17) band 2 fixed grid image (8x magnification) and Himawari-8 (Hi8) band 3 CEReS V20190123 image. The red diamond/triangle marks the volcano base. The baseline (solid red) and the odd number isoheights (in km, dotted white) are also drawn in the GOES-17 images. When present, the yellow/blue asterisks indicate the same plume top feature(s) in the corresponding satellite image pairs and the blue dot is the shadow terminus on the marine Sc layer.

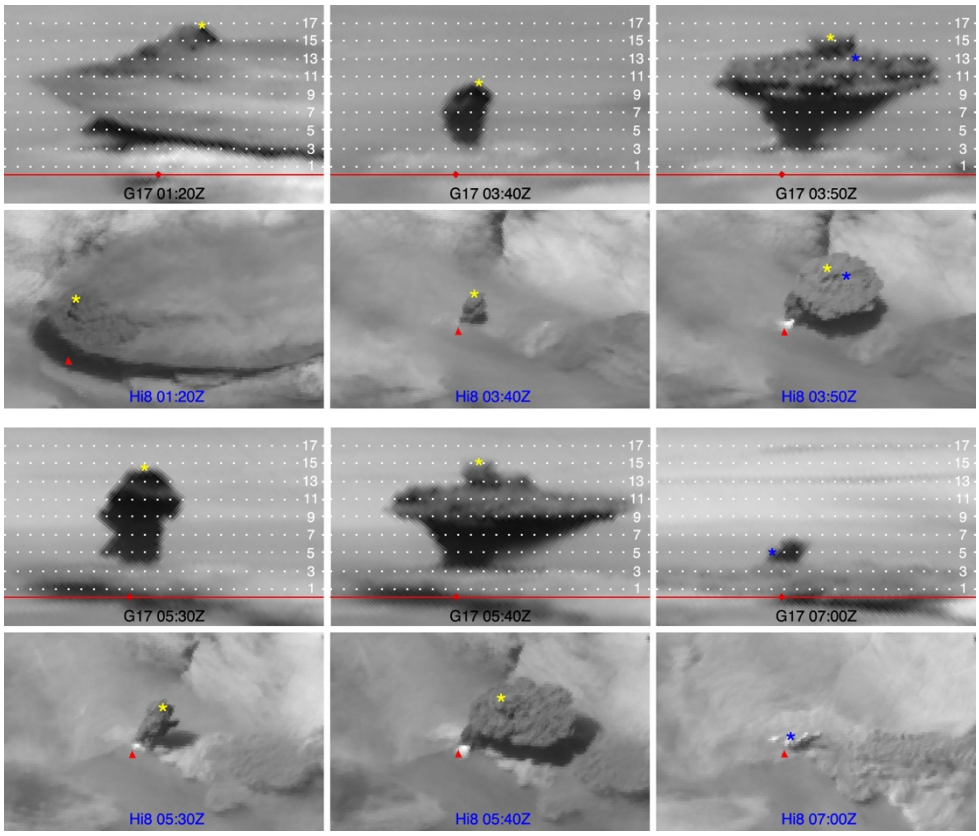

Figure S2. Same as Fig. S1, but for 22 June 2019.

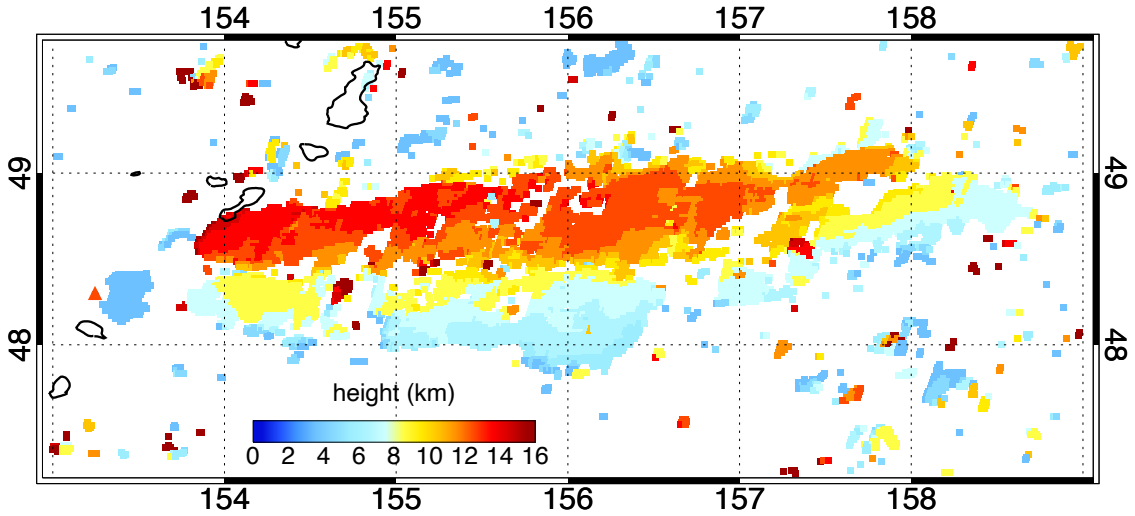

Figure S3. MODIS *Aqua*–Himawari-8 3D Winds stereo heights of the Raikoke plume on 22 June 2019 at 03:10 UTC. The red triangle marks the volcano.

Table S1. Plume height estimates, in kilometer and rounded to the nearest hectometer, derived from GOES-17 (G17) and Himawari-8 (Hi8) data for the 21-22 June 2019 eruption of Raikoke, corresponding to the snapshots shown in Figs. S1 and S2. The retrieval methods are described in Part 1. The three traditional geometric methods are as follows. Method 1 (M1): sensor-projected length, method 2 (M2): true (stick) shadow length, and method 3 (M3): edge shadow length; method 3 can also be applied in 'stereo mode' using the parallax between the GOES-17 and Himawari-8 image locations of a given plume feature. Height is also estimated by matching the minimum 11-μm brightness temperature (BT_{11}) to the ERA5 temperature profile; if the reanalysis profile yields no solution due to plume undercooling (X), the height derived from the U.S. Standard Atmosphere 1976 temperature profile is given instead in parenthesis. VolSatView is the temperature method used by KVERT. The last column is the new geometric side view estimate, obtained from GOES-17 fixed grid imagery.

	M1 G17	M1 Hi8	M2 G17	M2 Hi8	M3 G17	M3 Hi8	M3 stereo[a] G17–Hi8	BT_{11} G17	BT_{11} Hi8	VolSatView Hi8	Side view G17
Raikoke 2019-06-21, 18:00Z		7.4					7.7				7.7
Raikoke 2019-06-21, 18:10Z							9.0				9.0
Raikoke 2019-06-21, 18:50Z		6.9		7.2[b]			6.8				6.8
Raikoke 2019-06-21, 19:00Z				10.2[b]							10.1
Raikoke 2019-06-21, 19:40Z	9.7	10.0		9.6[b]		9.8[b]	10.0	6.1	6.5	8.8	9.9
Raikoke 2019-06-21, 19:50Z				11.5[b]			11.2				11.0
Raikoke 2019-06-21, 20:40Z		9.3					9.6				9.5
Raikoke 2019-06-21, 20:50Z							11.3				10.6
Raikoke 2019-06-21, 21:20Z							10.5				9.9
Raikoke 2019-06-21, 22:00Z							11.6	9.4	10.7, 12.2, 13.7, 23.7	10.0	11.3

Raikoke 2019-06-21, 22:40Z					11.0
Raikoke 2019-06-21, 23:50Z overshooting top (yellow asterisk)	16.4				16.6
Raikoke 2019-06-21, 23:50Z overshooting top (blue asterisk)	16.7				16.7
Raikoke 2019-06-22, 01:20Z	16.1	11.3, 14.7, 22.5	X / (X)	11.1	16.5
Raikoke 2019-06-22, 03:40Z	10.2				10.3
Raikoke 2019-06-22, 03:50Z overshooting top (yellow asterisk)	15.8	10.4, 12.2, 14.1, 23.1	10.4, 12.5, 13.8, 23.4	10.1	15.6
Raikoke 2019-06-22, 03:50Z umbrella cloud (blue asterisk)	13.7	10.4, 12.2, 14.1, 23.1	10.4, 12.5, 13.8, 23.4	10.1	13.0–14.0
Raikoke 2019-06-22, 05:30Z	14.6	9.7	10.4, 12.4 13.4, 22.8	10.2	14.5
Raikoke 2019-06-22, 05:40Z overshooting top (yellow asterisk)	15.4				15.1

Raikoke 2019-06-22, 07:00Z	4.8	4.9

[a]Calculated from the marked image locations (yellow or blue asterisks) of an identifiable plume feature
[b]Low-level CTH estimate of 0.7 km added