

Quantifying water, ice and ash using ORAC

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Background

Utilising satellite imager measurements to retrieve cloud properties requires knowledge of the complex refractive index, size distribution, shape and habit of the water, ice and ash particles that potentially make up the cloud of interest. Here we use Himawari-8 to characterise the ash clouds produced during the June 2019 Raikoke eruption.

Results

- Combining water cloud and ash cloud retrievals allows more realistic estimation of height and total mass of ash
- We estimate a maximum total mass of fine ash from the Raikoke eruption of 0.73 ± 0.40 Tg
- OE-ash retrieval using 4 thermal channels shows improvement over standard 2 channel methods

Method

Optimal Estimation (OE)

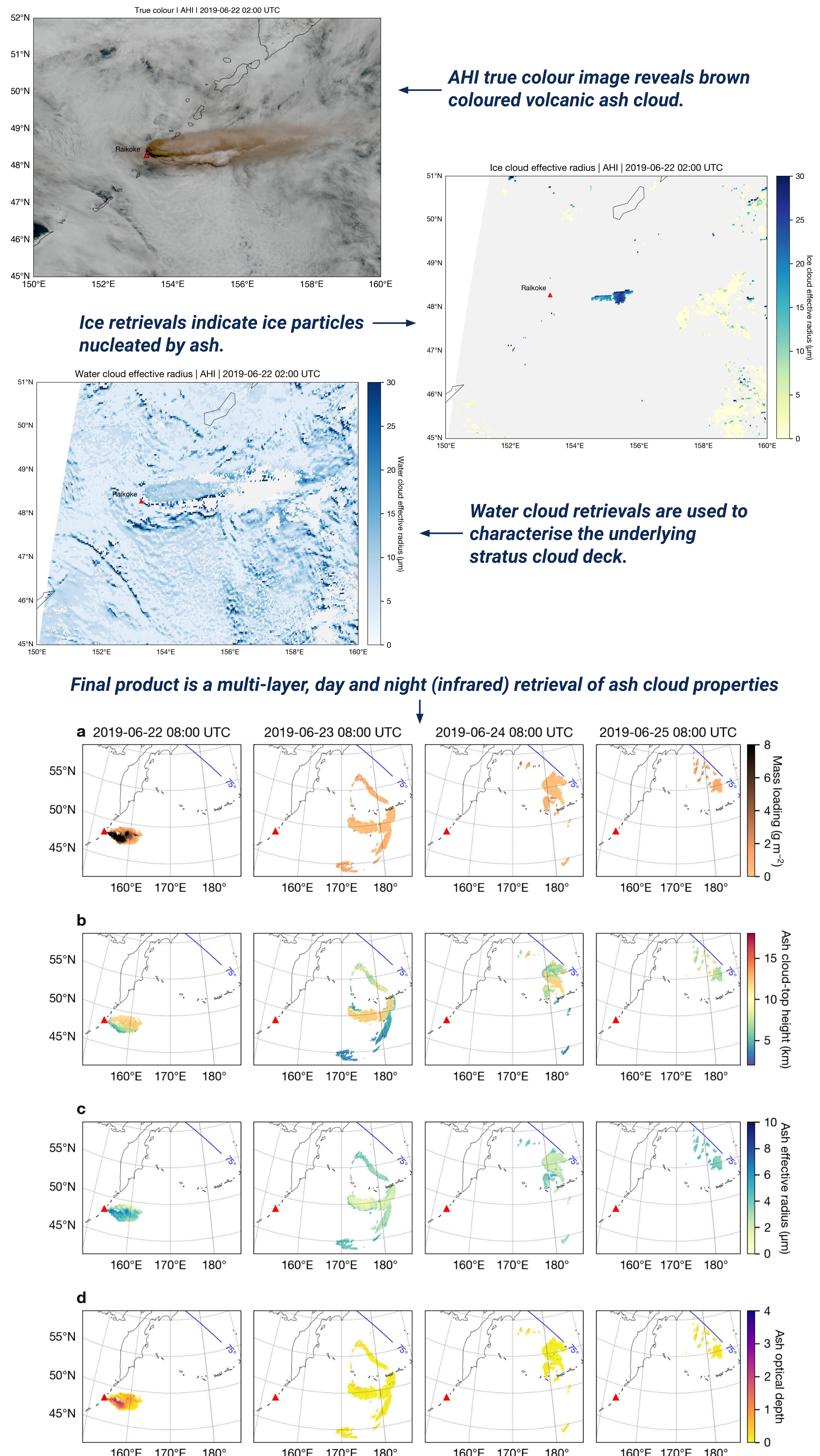
We use the Optimal Retrieval of Aerosol and Cloud (ORAC) code, which implements OE (Rodgers, 2000), to determine surface temperature, cloud-top pressure, effective radius and optical depth from a given set of measurements, *a priori* constraints and associated uncertainties.

Measurement vectors

For water and ice retrievals (developed during Cloud_cci+ project; McGarragh *et al.*, 2018), we use: 0.64, 0.86, 1.6, 11.2 and 12.4 μm channels. For ash retrievals, we use a new set of thermal channels (Prata *et al.*, 2022) available from the current generation of geostationary satellites (e.g. AHI, ABI): 10.4, 11.2, 12.4 and 13.3 μm .

Multi-layer retrievals

We performed multi-layer (ash over water cloud) retrievals to better characterise the ash clouds produced by the Raikoke eruption.



ORAC Github: <https://github.com/ORAC-CC/orac>

References

Rodgers, C. D., Inverse methods for atmospheric sounding : theory and practice, World Scientific, 2000.
 McGarragh, G. R. *et al.*: The Community Cloud retrieval for CLimate (CC4CL) - Part 2: The optimal estimation approach, Atmos. Meas. Tech., 11, 3397–3431, <https://doi.org/10.5194/amt-11-3397-2018>, 2018.
 Prata, A. T. *et al.*: Uncertainty-bounded estimates of ash cloud properties using the ORAC algorithm: Application to the 2019 Raikoke eruption, 2022, in prep.