Volcanic Ash Forecasts for Aviation

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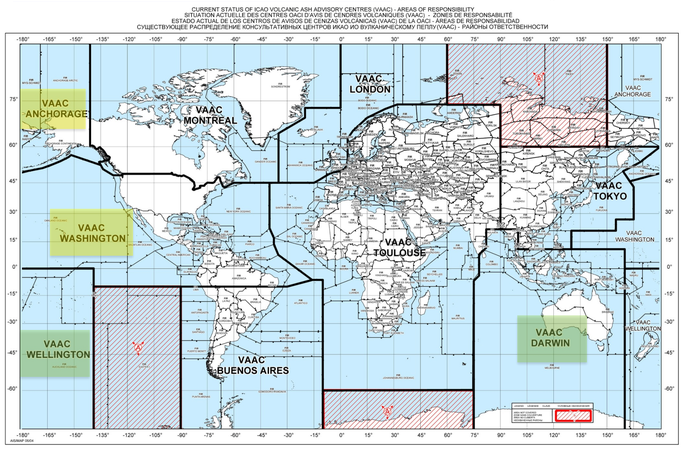
INTRODUCTION

Supporting the Volcanic Ash Advisory Centers (VAACs)



HYSPLIT is run operationally at the Washington, Anchorage, Darwin and Wellington VAACs to help produce forecasts of volcanic ash for use by the aviation industry.

HYSPLIT Transport and Dispersion model.
http://www.arl.noaa.gov/HYSPLIT_info.php

Lagrangian model designed for simple air parcel trajectory AND complex dispersion/deposition simulations.

INITIALIZATION
Forecaster observes eruption and decides on initialization (height of plume and duration)
HYSPLIT picks a default concentration threshold based on the plume height.
(large uncertainty in empirical relationship between plume height and mass eruption rate)

↓ HYSPLIT

OUTPUT

↓

EVALUTATION
Forecaster visually compares output to observations and decides if default concentration threshold needs to be adjusted.
Comparison is qualitative.
No automatic feedback to model developers

Challenges:

- Utilize new sources of information.
- How well are we doing? Produce quantitative verification metrics
- Reduce uncertainty in initialization (source term).

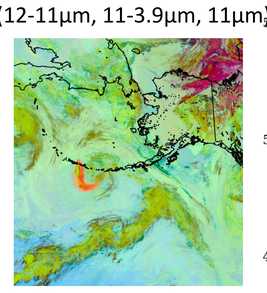
METHODOLOGY

Utilizing the Latest Satellite technology

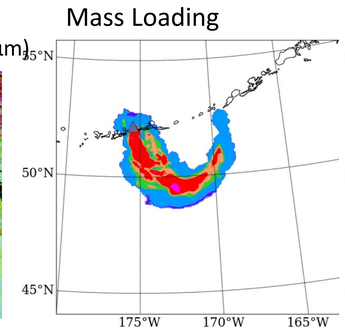
Passive IR sensors aboard geo-stationary and polar orbiting satellites.
Ash products from NOAA/NESDIS/CIMMS

Pavolonis, Hiedinger, Sieglaff, "Automated Retrievals of Volcanic Ash and Dust Cloud Properties From Upwelling Infrared Measurements.", *J. of Geophysical Research: Atmospheres,* VOL. 118, 1436-1458, doi:10.1002/jgrd.50173, 2103.v

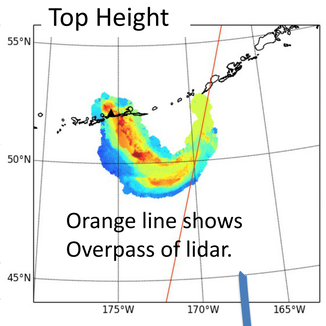
False Color Imagery (12-11μm, 11-3.9μm, 11μm)



Mass Loading



Top Height

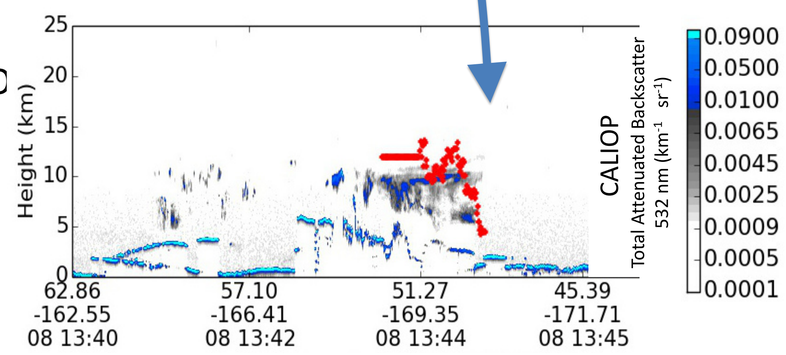


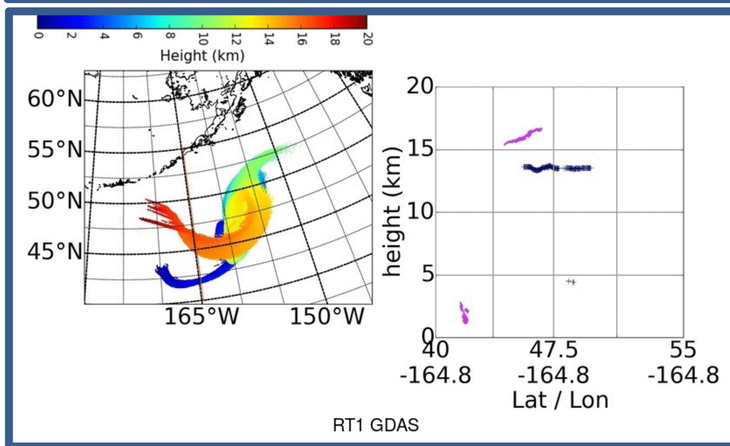
Ash Cloud produced by Kasatochi. 2008 AUG 08 14:00 UTC

MODIS DATA
Similar channels available on next generation of geostationary satellites (GOES-R)

CALIOP LIDAR on polar orbiting satellite CALIPSO

Verification of vertical structure of ash cloud.





Compare Passive IR retrieved top heights with model output

INITIALIZATION
An initialization is constructed from quantitative satellite data.

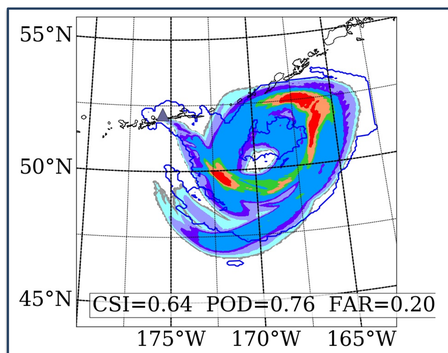
↓ HYSPLIT

OUTPUT → **Satellite Data**

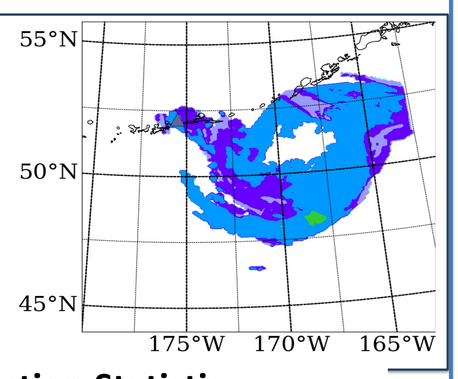
Quantitative verification metrics produced for forecaster and automatically communicated to model developers.
Revised initialization fed back to HYSPLIT.

2008 AUG 09 01:00 UTC

Model Output

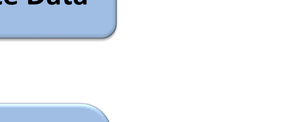


Satellite Mass Loading



Verification Statistics produced by comparison

$$CSI = \frac{A}{A+B+C}$$



OUTCOMES

- Measurements of mass loading improve forecasts.
- Initializing at downwind location can produce better forecasts.
- Use cylindrical source instead of line source for large eruptions

Crawford, Stunder, Ngan, Pavolonis, (2016) "Initializing HYSPLIT with satellite observations of volcanic ash: A case study of the 2008 Kasatochi eruption", *J. of Geophysical Research: Atmospheres,* 121, 10,786-10,803, doi:10.1002/2016D024779

ONGOING WORK

- More Case Studies
- Comparison of verification metrics
- Output which contains information about uncertainty.
- Resuspension Algorithms for Volcanic Ash

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