

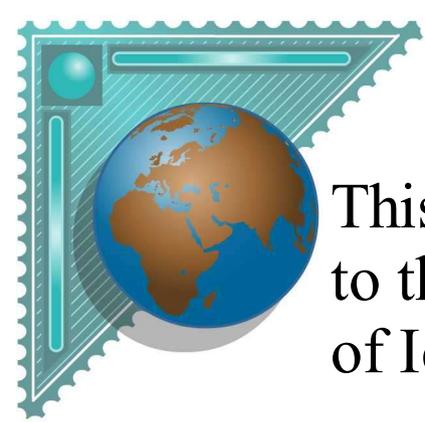


Flight north of Icelandnear Eyjafjallajökull

Presented by Cpt. Heinz Frühwirth, IFALPA
Prepared by Cpt. Klaus Sievers, German ALPA

27 June 2011





This presentation concerns a flight from Europe to the USA, with special focus on the region north of Iceland. Date: 14 May, 2010.

Highlights:

- ▶ information from "official" sources before flight, flightplanning
- ▶ information from internet-sources before flight
- ▶ what occurred during the flight
- ▶ observations available after the flight

Some questions most relevant to safe flight above/around/under volcanic ash clouds are posed, and a VA cloud detection method is introduced.





Met Office

Modelled Ash Concentration from FL200 to FL350 at 1200 UTC 14/05/2010

Issue time: 201005140000

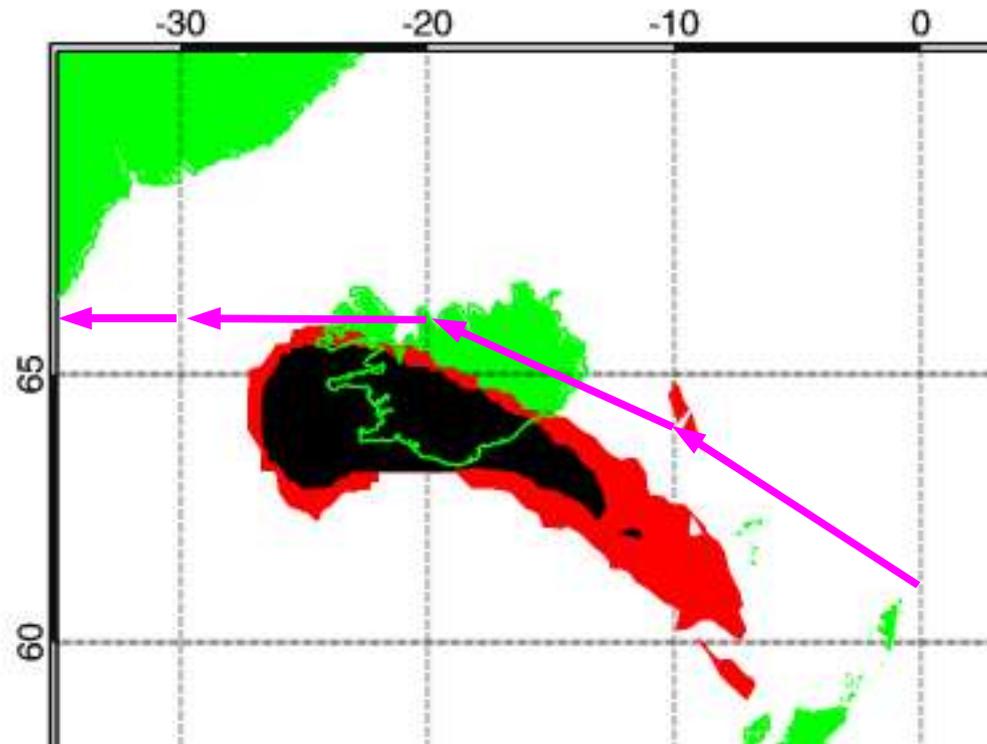
This is a guidance product generated from model data and is supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.



Predicted area where volcanic ash may be encountered



Predicted area of ash concentrations that exceed acceptable engine manufacturer tolerance levels



Precise planning for the flight done approx. 05:45...06:15 z. It stayed just clear of the edge of the ash-cloud, as forecast 00z.

Airplane performance information near Iceland: optimum FL 320, maximum FL 350





Modelled Ash Concentration from FL200 to FL350 at 1200 UTC 14/05/2010

This is a guidance product, supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.

Issue time: 201005140600



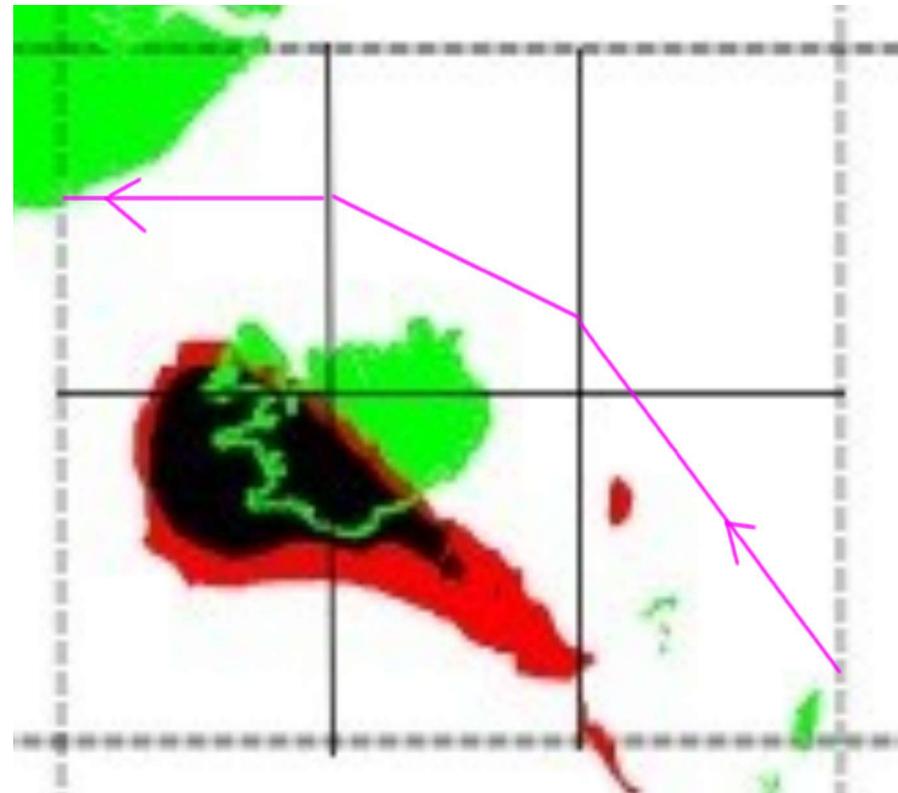
Predicted area where volcanic ash may be encountered



Predicted area of ash concentrations that exceed acceptable engine manufacturer tolerance levels

70N

60N



30W

0W

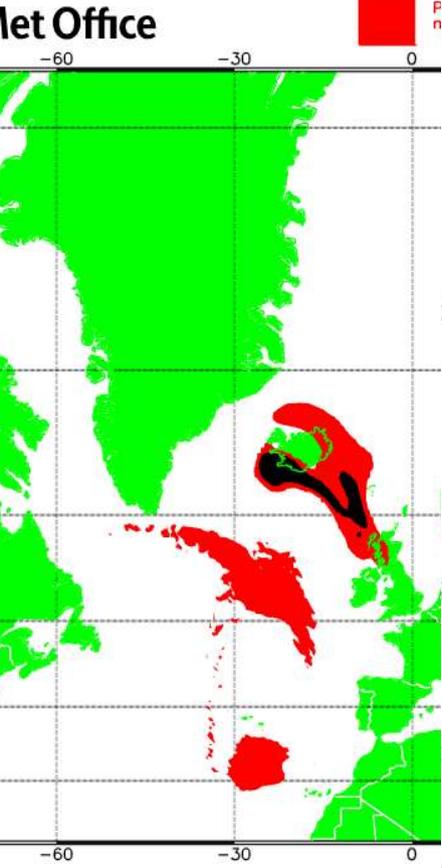
Right after completion of flight planning, a new Ash Concentration Chart became available. As the previously planned track would lead through the newly forecasted area, the flight was planned 2 deg. more northerly to avoid the area with some margin.





Modelled Ash Concentration from FL000 to FL200 at 1200 UTC 14/05/2010

This is a guidance product, supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.
Issue time: 201005140600



Modelled Ash Concentration from FL200 to FL350 at 1200 UTC 14/05/2010

This is a guidance product, supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.
Issue time: 201005140600

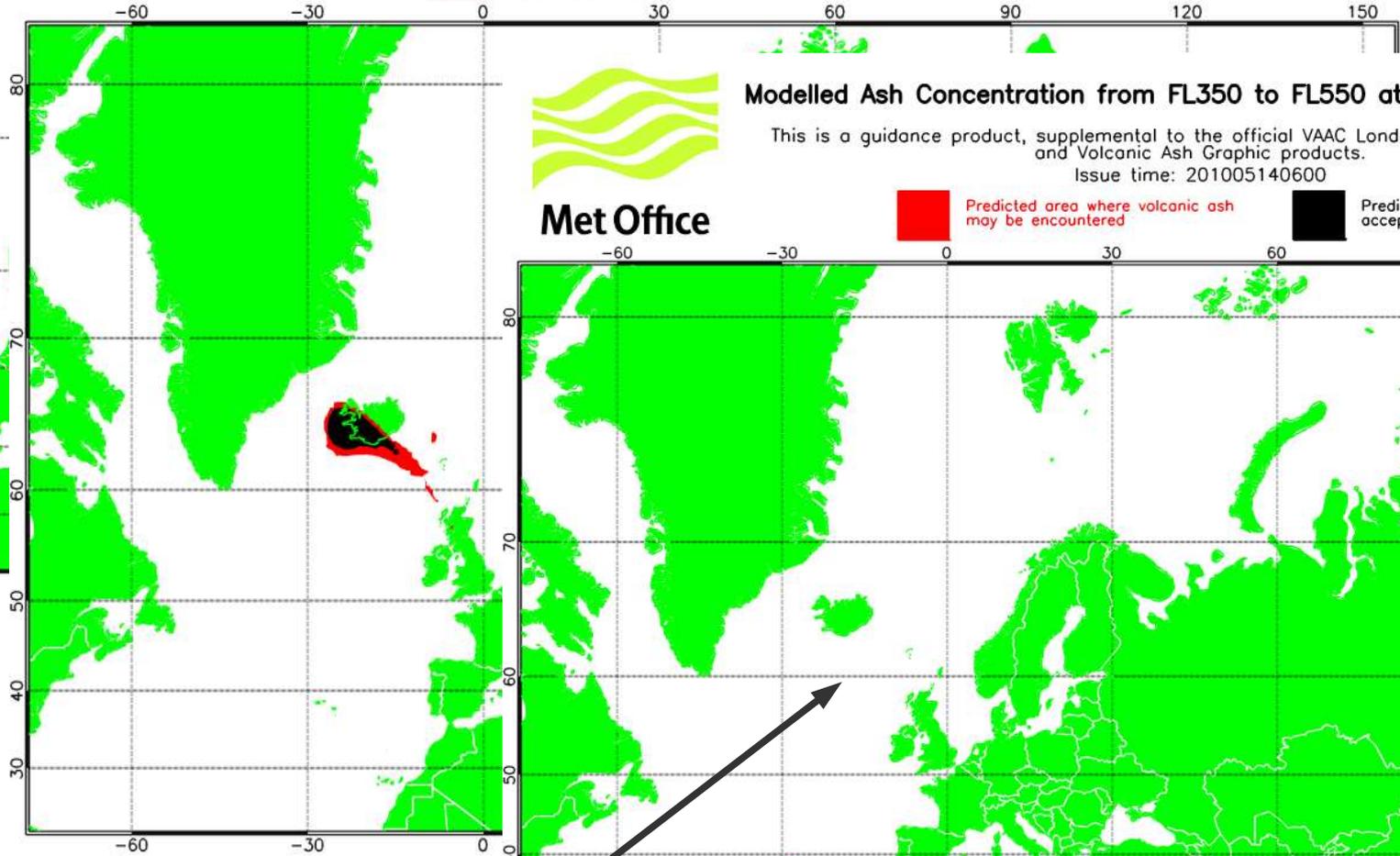
Met Office



Predicted area where volcanic ash may be encountered



Predicted area of ash concentrations that exceed acceptable engine manufacturer tolerance levels



Modelled Ash Concentration from FL350 to FL550 at 1200 UTC 14/05/2010

This is a guidance product, supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.
Issue time: 201005140600

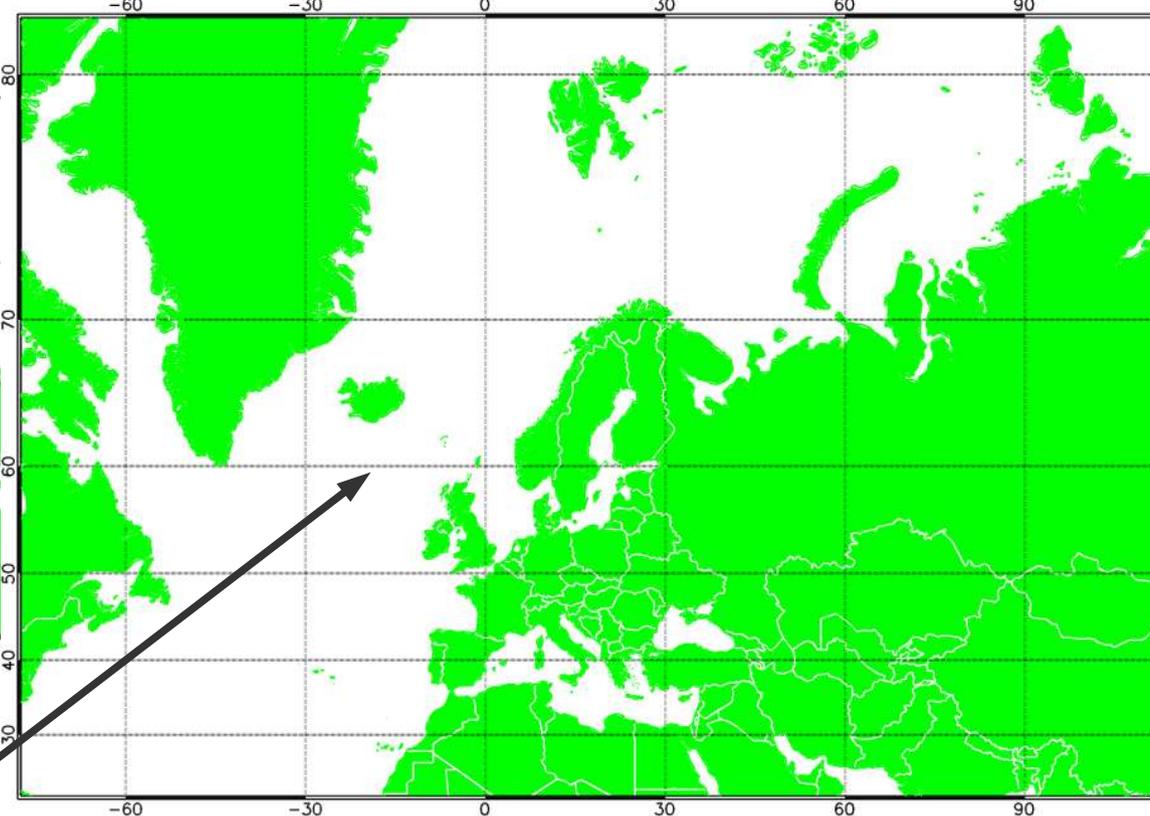
Met Office



Predicted area where volcanic ash may be encountered

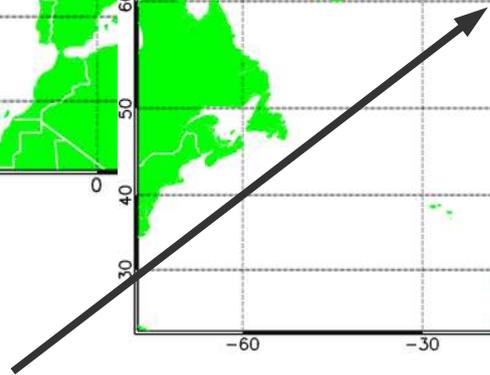


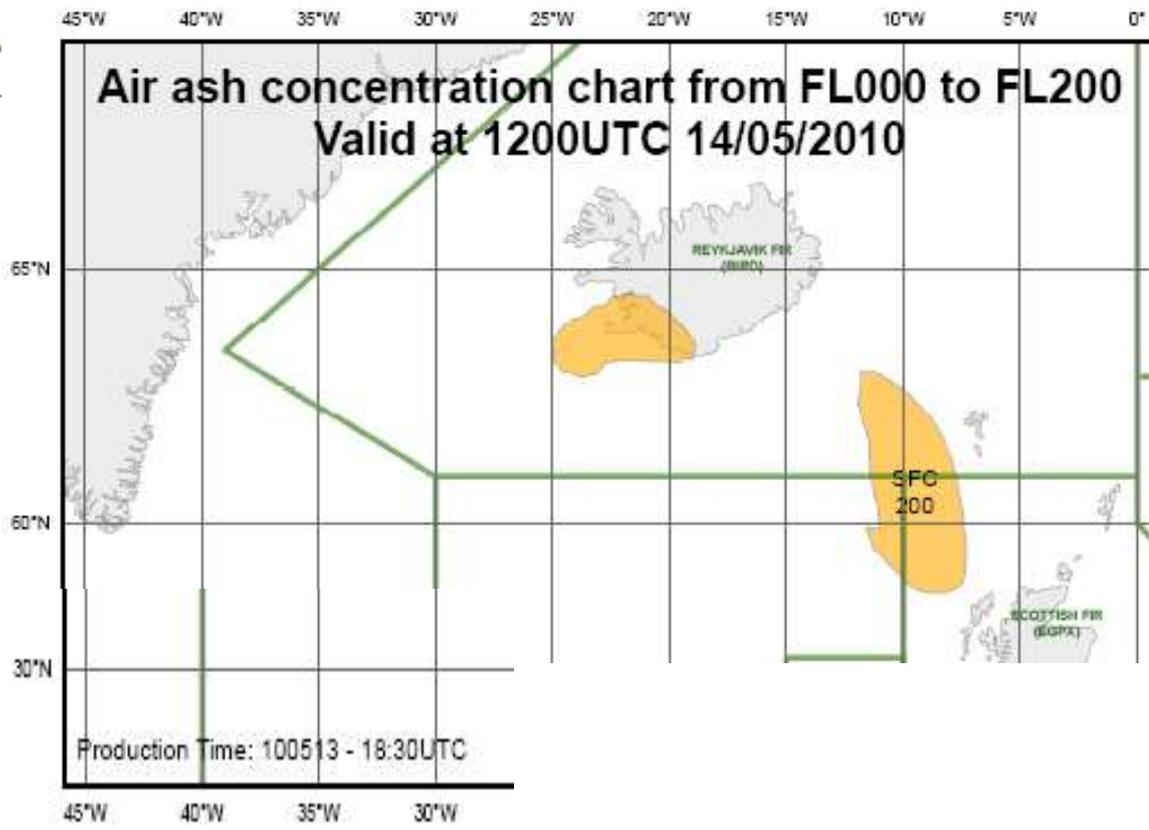
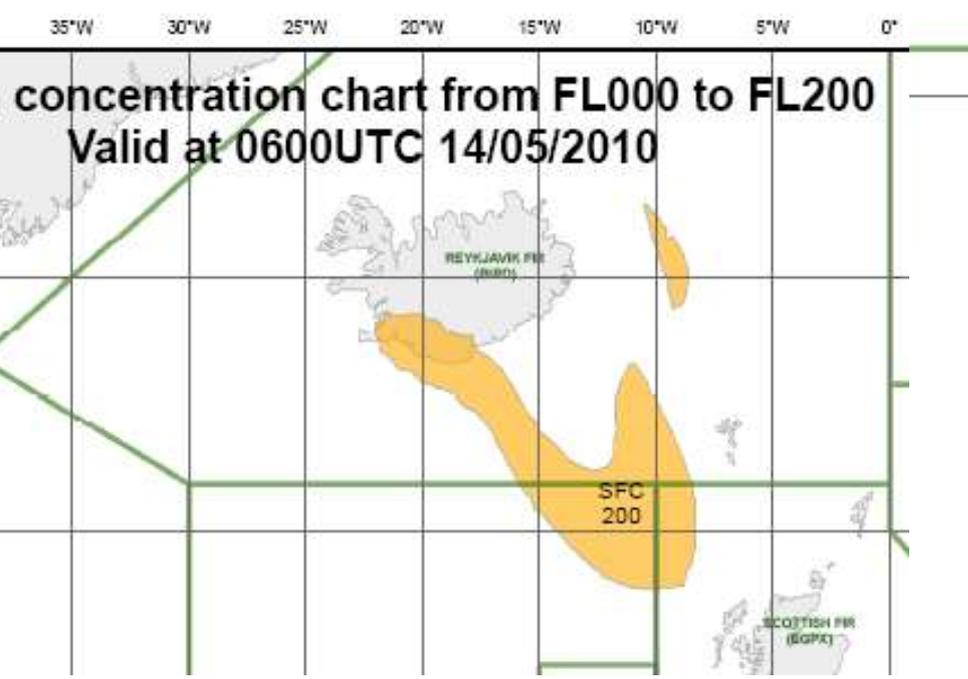
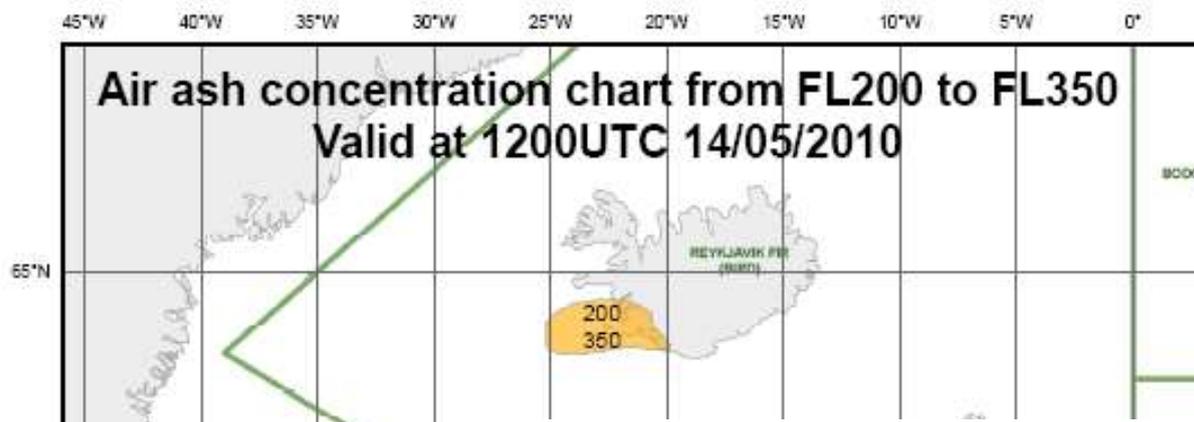
Predicted area of ash concentrations that exceed acceptable engine manufacturer tolerance levels



Complete low and high level prognostic (!) charts.....

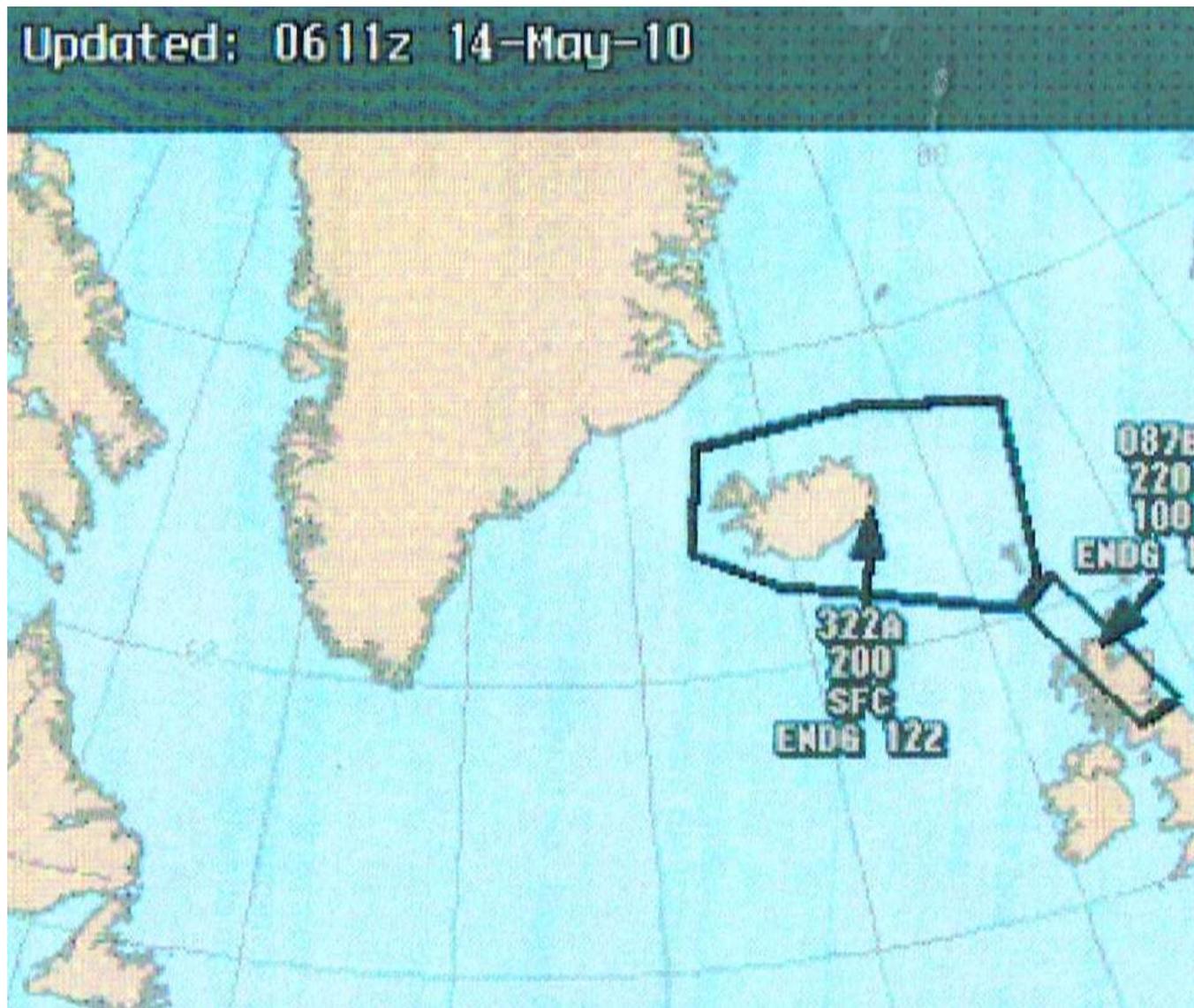
Note: **No Ash above FL 350 !!**





Air ash concentration charts, too, indicated a clear flight path north of Iceland.





Another source, WSI, had a different view of the ash cloud area. Note that no ash was shown above FL 200 !

**END OF OFFICIAL INFO AVAILABLE BEFORE FLIGHT.
INFO FROM INTERNET - SOURCES FOLLOWS.**

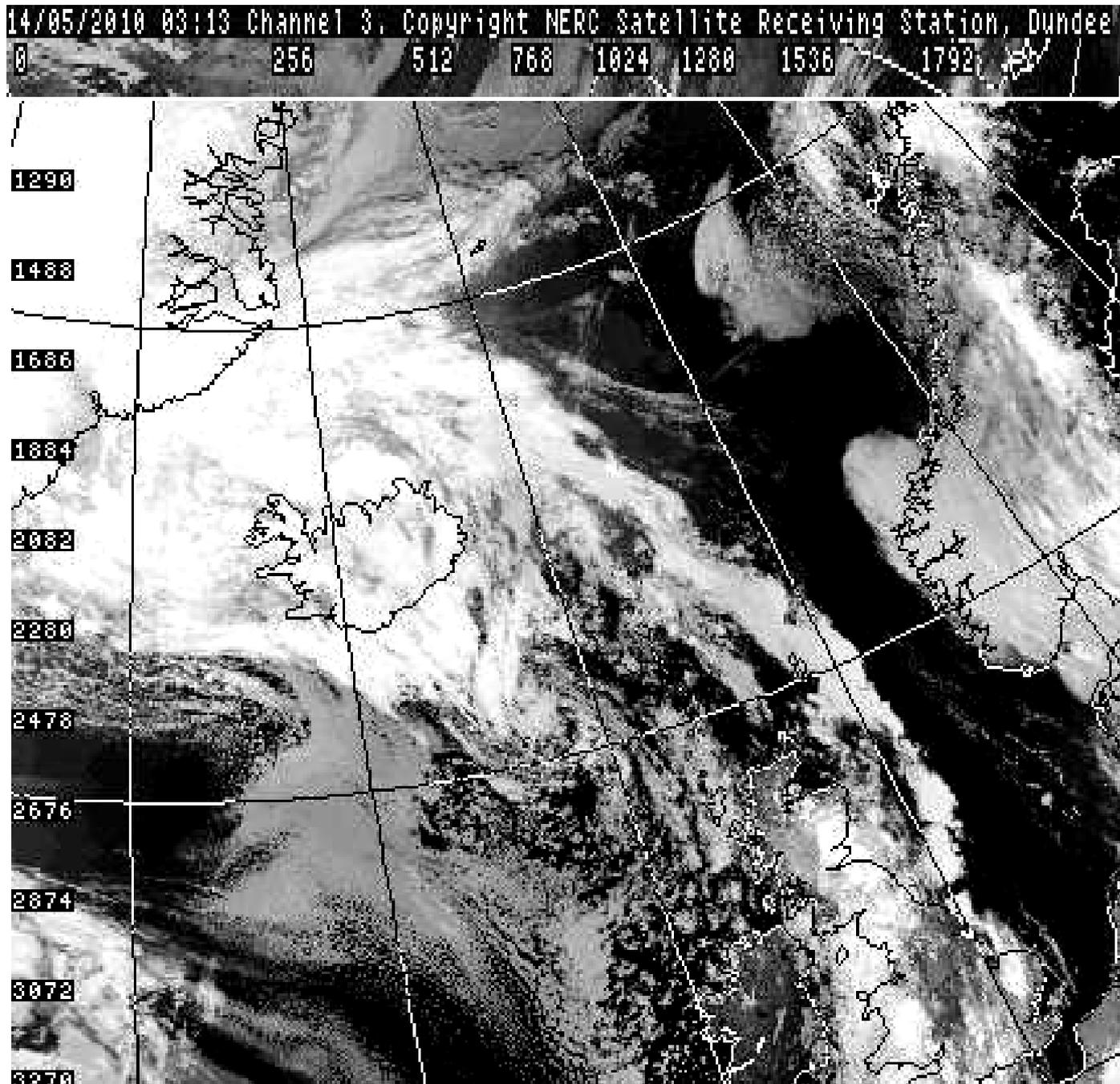




Eumetsat / Univ. Dundee picture, 00z, 14 May

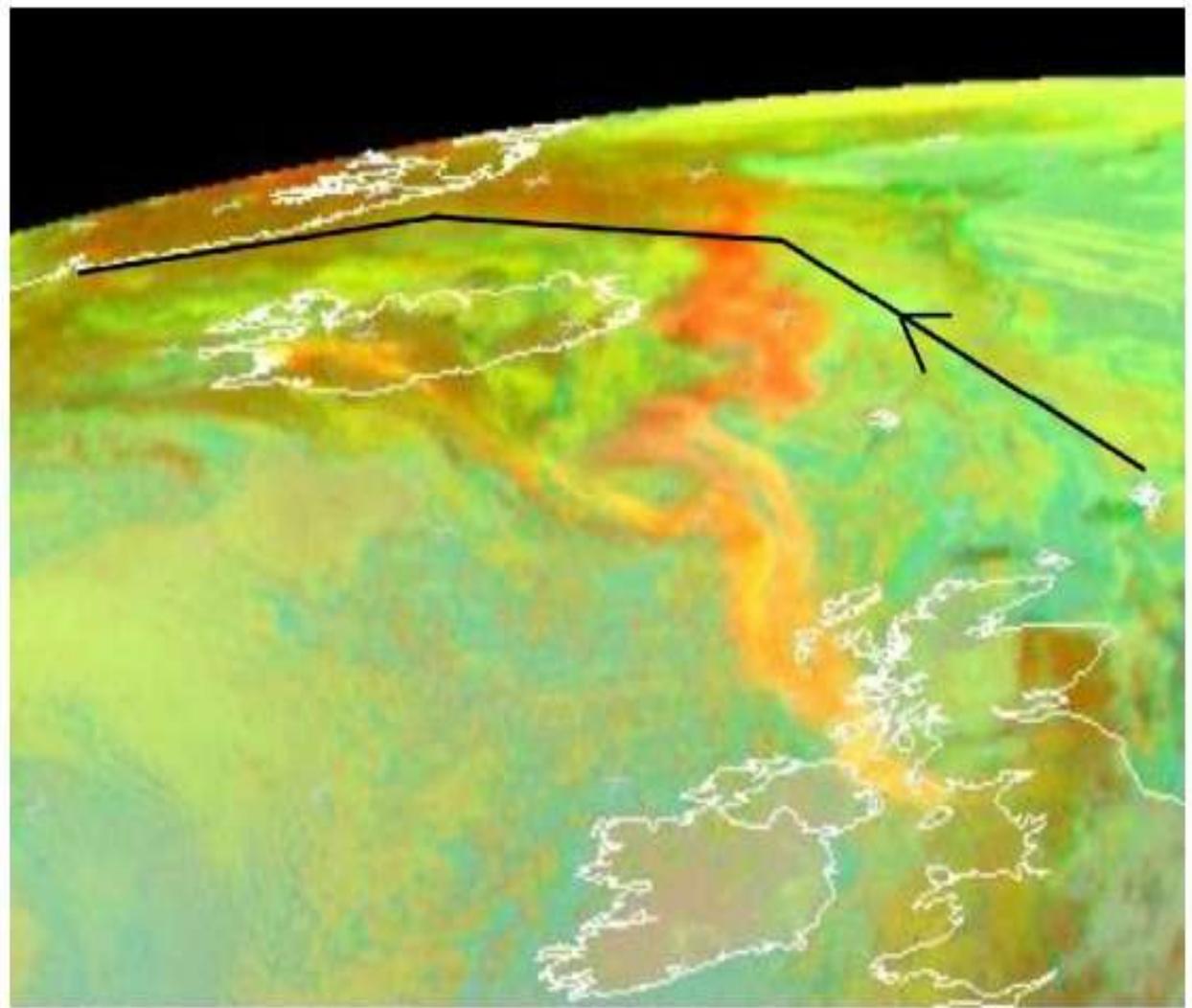
Nothing special to be seen, normal WX.





IR sat-picture, taken 14/5/10, 03 z, shows general cloud situation.
Nothing special to be seen, no CB, for instance.





ET9 RGB-Ash 2010-05-14 05:00 UTC



RGB 24-hours Ash Microphysics Interpretation of Colours



Cold, thick, high-level
clouds



Thin Cirrus clouds
Contrails



Volcanic SO₂ clouds



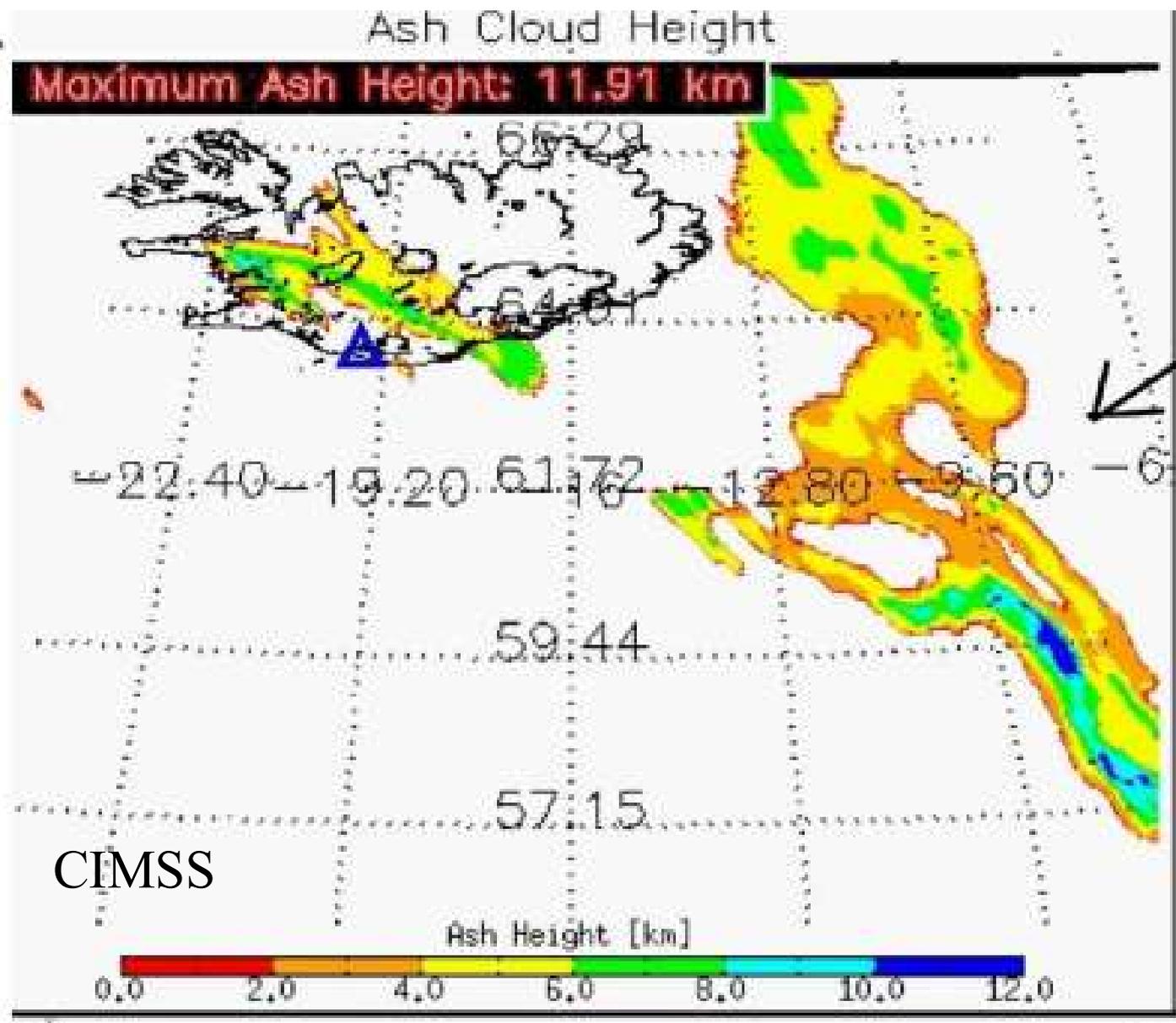
Volcanic Ash clouds

Source / details:

http://oiswww.eumetsat.org/IPPS/html/bin/guides/msg_rgb_ash.ppt

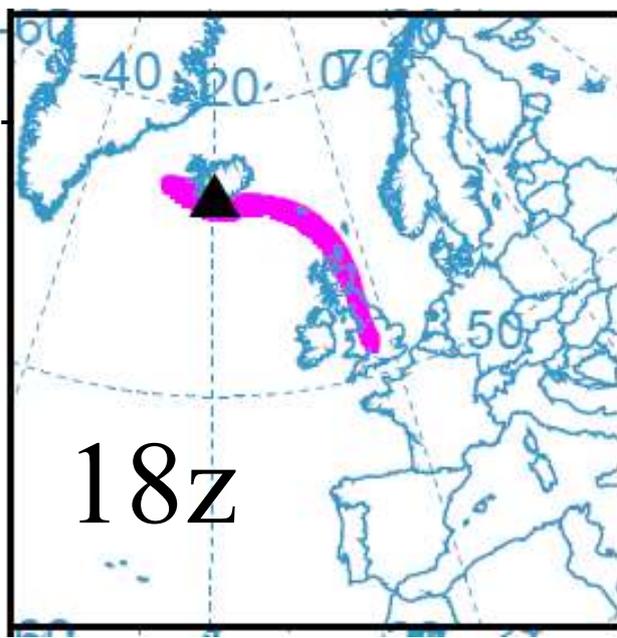
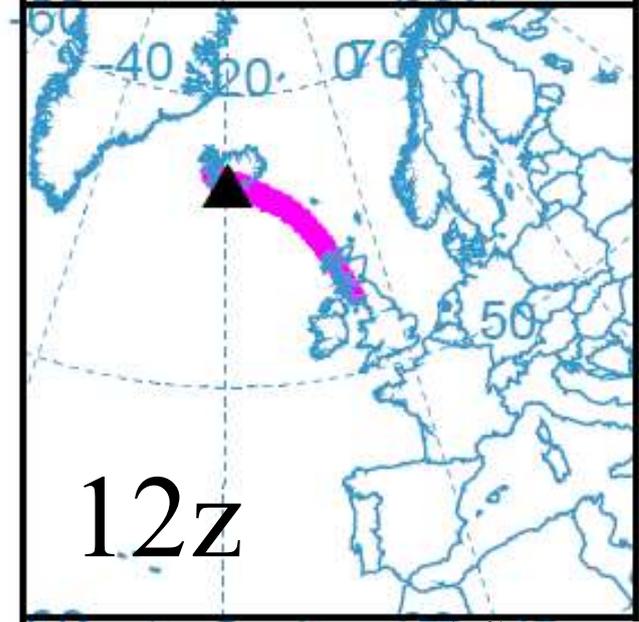
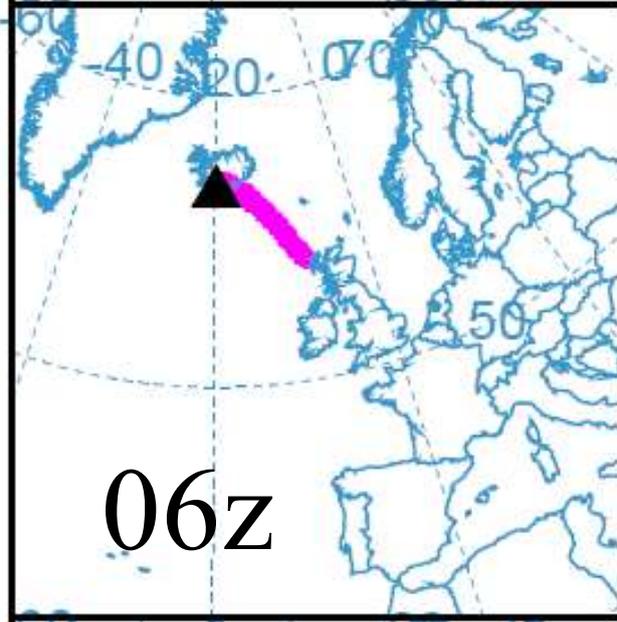
Satellite pictures freely available on the internet on the morning of the flight indicated ash clouds...but well away from the planned flight track. The situation north of Iceland was less clear, no timely satinfo was available. Routing was accepted, as the cloud was presumed to be older and therefore low.....and was up to fl 200 only - in the official documentation.





Another near real-time internet-source indicated the presence of ash at up to 11,91 km high, at 05z. Note that 11,91 km equals approximately FL 390 !



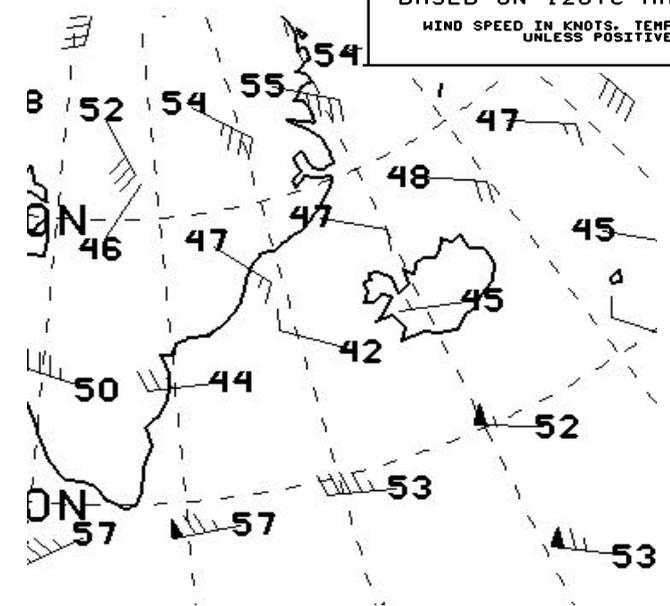


FL350
FL200

12z

WORLD AREA FORECAST CENTER
WASHINGTON
FL 340 WINDS/TEMPERATURES
VALID 06UTC MAY 14 2010
BASED ON 12UTC MAY 13 2010
WIND SPEED IN KNOTS. TEMPS UNSIGNED
UNLESS POSITIVE

FL350
FL200



FL
340
prog

A run of the NOAA Hysplit model as well as the wind-prog chart advised **caution**, as a counter-clockwise wind-circulation was present over Iceland.

NOAA HYSPLIT
 ▲ EYJAFJOLL N6338W01937
 SUMMIT 5466 FT
 ERUPTION 1200Z 13 MAY 10
 DURATION 48 HR
 ASH COLUMN FL300

Created: 0536 GMT 20100514
 GFSG CYCLE
 00Z 14 MAY 10

***** VISUAL ASH CLOUD *****

Job ID: 43056

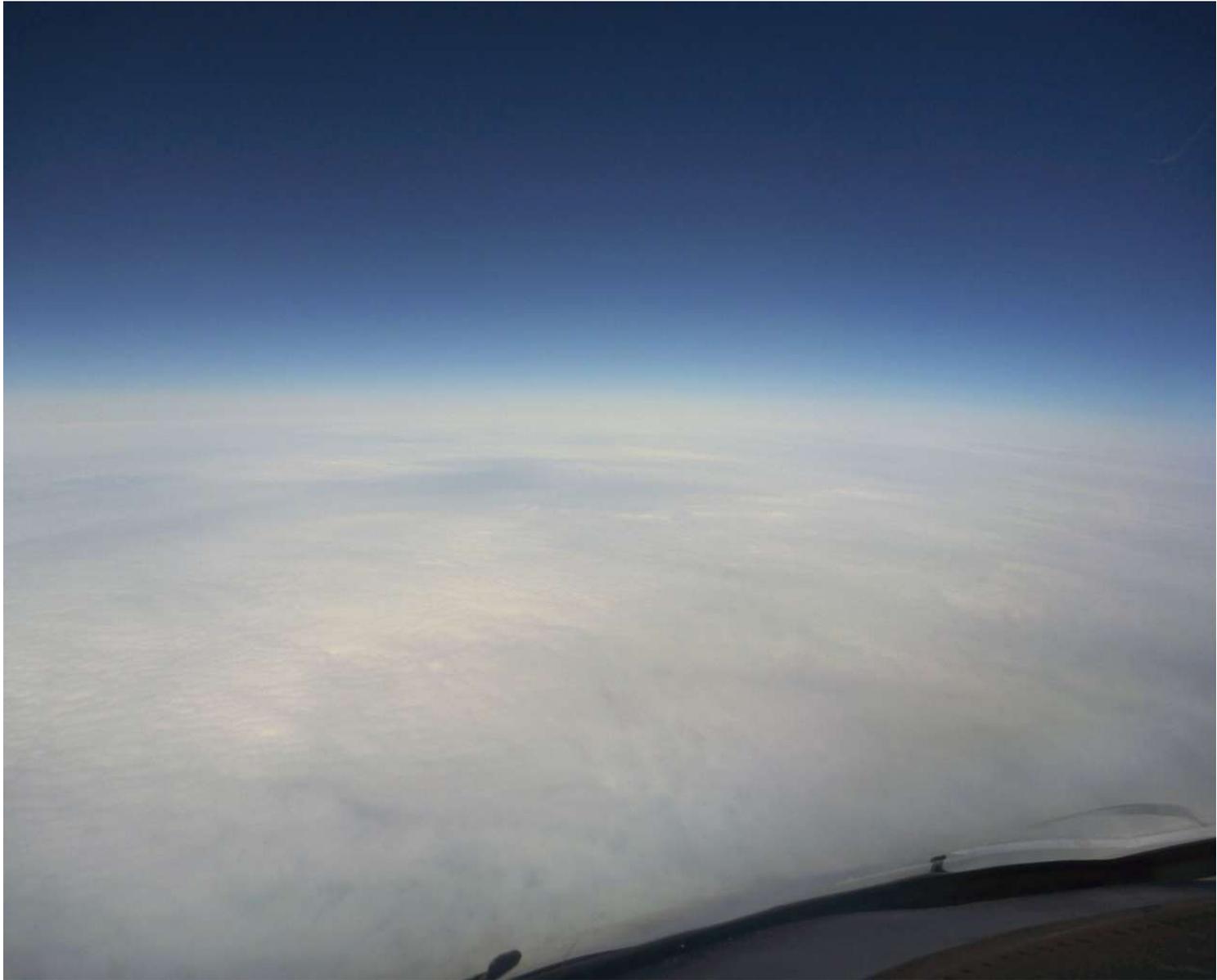
Produced from the NOAA ARL Website <http://www.ready.noaa.gov/>

END OF INFO-COLLECTION
 AVAILABLE BEFORE FLIGHT



Somewhere north of Iceland, the horizon became fuzzy. Ash ? Unknown. Safety first: climb from optimum FL to max FL to get a clear horizon.





The horizon seemed to be clear again, but the clouds below looked a bit different. Ash ? Unknown. No training in VA cloud recognition, no instruments for discrimination or detection. 



Modelled Ash Concentration from FL200 to FL350 at 1200 UTC 14/05/2010

This is a guidance product, supplemental to the official VAAC London Volcanic Ash Advisory and Volcanic Ash Graphic products.

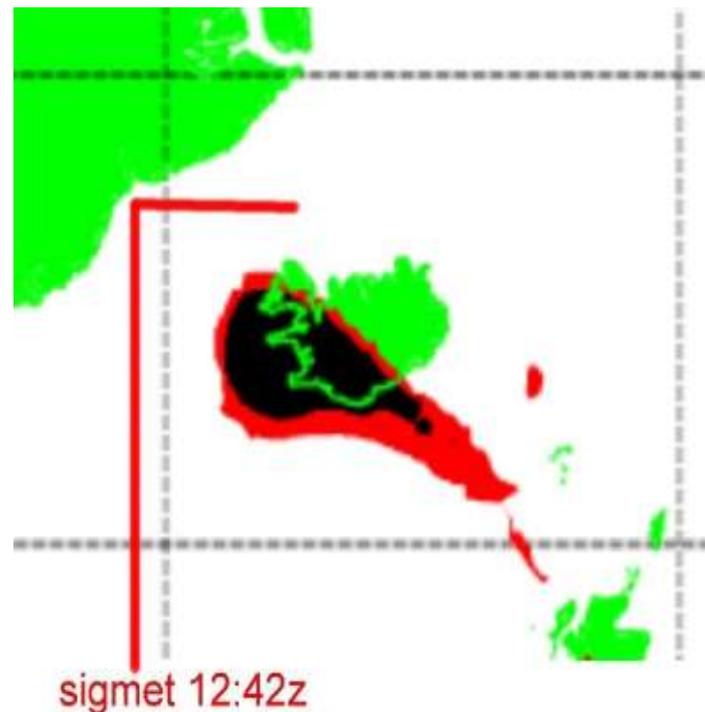
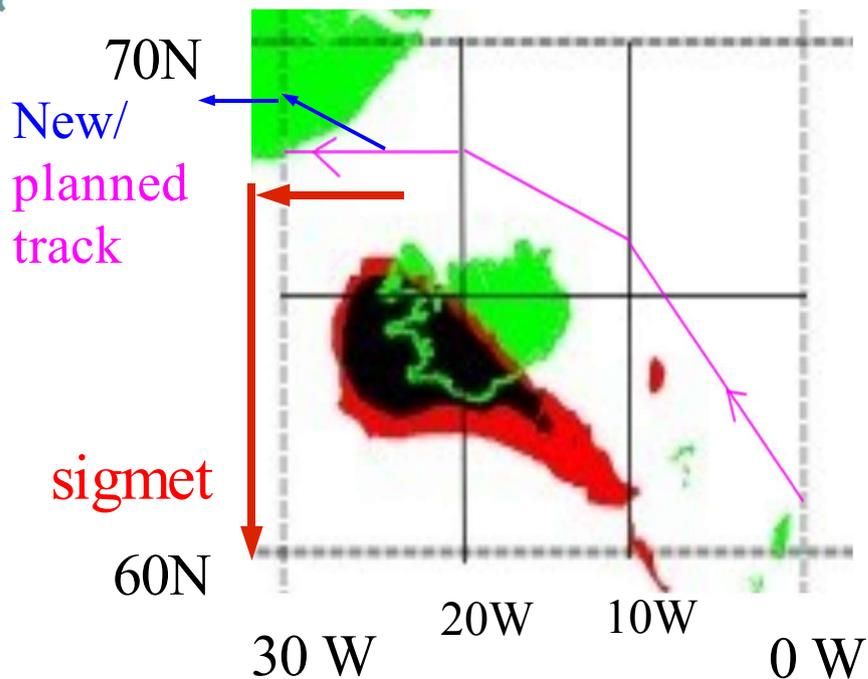
Issue time: 201005140600



Predicted area where volcanic ash may be encountered



Predicted area of ash concentrations that exceed acceptable engine manufacturer tolerance levels

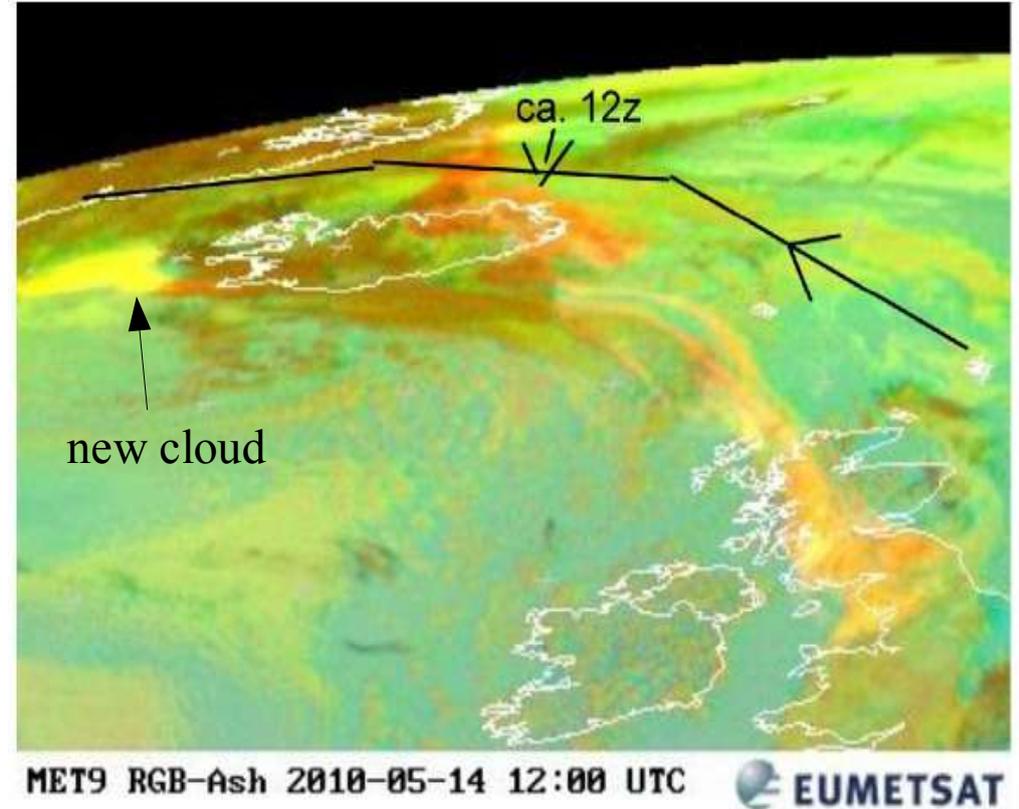
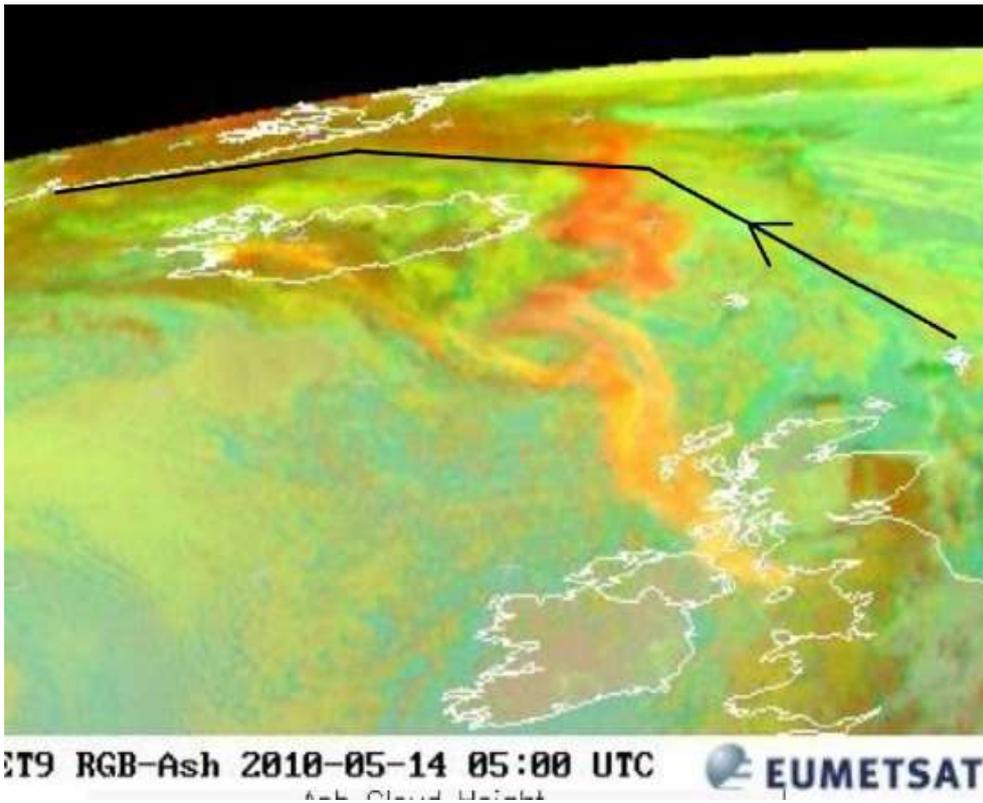


Shortly after passing 20W, a VA sigmet was transmitted via VHF radio. It indicated the presence of a VA-Cloud south and east of the red line shown. From memory: height up to FL 200 - 300.

Evaluation: modelled ash concentration chart no longer valid. All forecasts are unreliable / overtaken by events. Extra distance / trackchange away from volcano required. **Safety first. trackchange performed.** Normal flight to destination.



BEGIN OF INFORMATION AVAILABLE AFTER THE FLIGHT

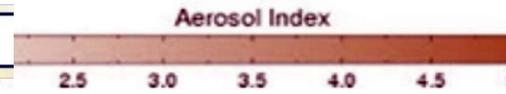


Comparison of the before flight and during-flight picture confirms counterclockwise rotation of clouds. It also shows the new VA-cloud that probably led to the sigmet.





<http://sites.google.com/site/iafceirscweb/eruptions/eyja>

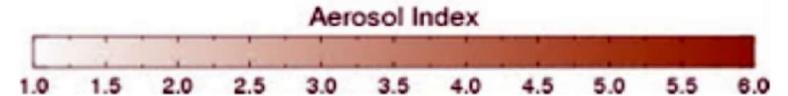
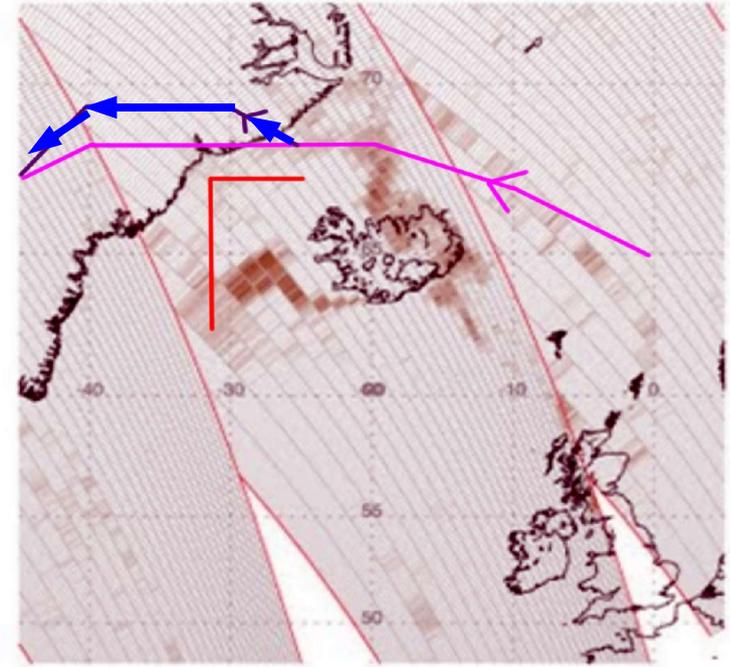
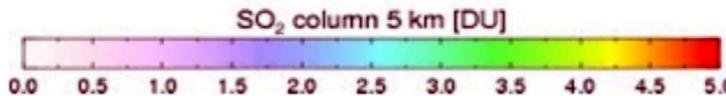
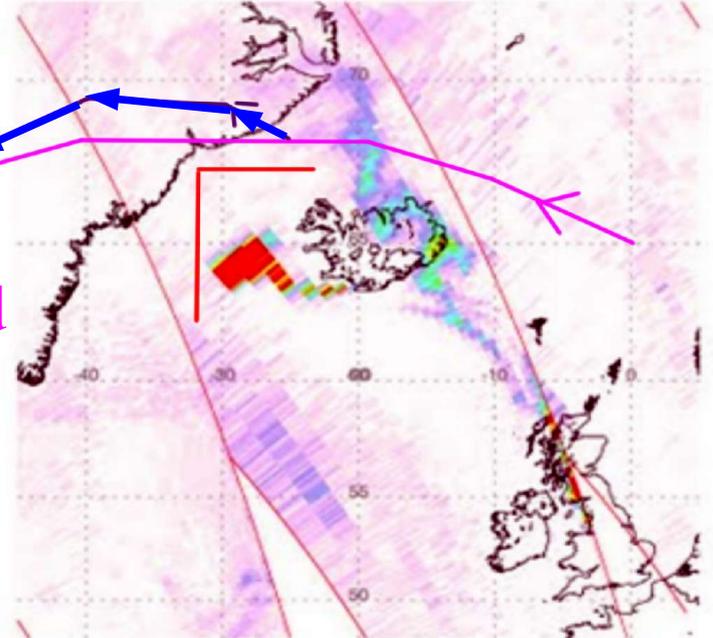


May 14

Aura/OMI - 05/14/2010 08:18-16:29 UT

SO₂ mass: 8.155 kt; Area: 421394 km²; SO₂ max: 42.32 DU at lon: -4.02 lat: 55.28 ; 13.06UTC

Aura/OMI - 05/14/2010 08:18-16:29 UT



NEW / planned
flight track
(approx.).

A fresh pulse of SO₂ and ash drifts west of Iceland.

SO₂ concentration approx. 3 ½ hrs after aircraft passed Iceland.

Note the **not forecast (!!)** SO₂ (= volc. gas / ash) cloud to the north. This was probably the strange looking cloud we flew over. West of Iceland, the cloud that made the sigmet necessary can be seen.

The 5 km value under the graph is NOT a height measurement of the cloud but an indication of the measuring range of the instrument.



subject: FVXX01 EGRR 141151

FVXX01 EGRR 141151

2010134 1153

VA ADVISORY

DTG: 20100514/1200Z

VAAC: LONDON

VOLCANO: EYJAFJALLAJOKULL 1702-02

PSN: N6338 W01937

AREA: ICELAND

SUMMIT ELEV: 1666M

ADVISORY NR: 2010/116

INFO SOURCE: ICELAND MET OFFICE

AVIATION COLOUR CODE: RED

ERUPTION DETAILS: ERUPTION CONTINUES, WITH ESTIMATED TOP OF THE PLUME
NOW AROUND FL240 TO FL260

OBS VA DTG: 14/1200Z

OBS VA CLD: SFC/FL200 N6800 W02202 - N6800 W01528 - N6351 W00546 -

N6110 W00808 - N5745 W00432 - N5359 W00126 - N5332 W00340 - N5447

W00447 - N5550 W01037 - N6004 W01450 - N6134 W01826 - N6124 W02623 -

N6308 W02807 - N6539 W02553 - N6338 W01734 - N6417 W01612 - N6502

W01627 - N6643 W02631 - N6800 W02202 FL200/FL350 N6559 W02548 - N6558

W02304 - N6330 W01510 - N6256 W01241 - N6019 W00848 - N5833 W00800 -

N5833 W00920 - N6027 W01101 - N6221 W01923 - N6221 W02644 - N6254

W02737 - N6520 W02720 - N6559 W02548 SFC/FL200 N5910 W04803 - N5859

W03524 - N5619 W02032 - N5004 W01543 - N4431 W01605 - N4356 W01840 -

N4851 W02158 - N4954 W02806 - N4747 W03228 - N3520 W03255 - N3734

W02854 - N3441 W01949 - N2913 W02032 - N2720 W02921 - N3222 W03716 -

N4001 W03514 - N5032 W03535 - N5451 W03300 - N5804 W05027 - N5910

W04803

This advisory came out during the flight & was probably
not intended for transmission via voice to aircraft in flight.....





VA-advisory continued.....

FCST VA CLD +6HR: 14/1800Z SFC/FL200 N6703 W02308 - N6707 W01742 -
N6616 W01310 - N6610 W00805 - N6513 W00810 - N6438 W01002 - N6247
W00941 - N5811 W00151 - N5410 W00140 - N5319 W00359 - N5450 W00447 -
N5508 W00826 - N5743 W00920 - N6051 W01331 - N6109 W01705 - N5917
W01945 - N6038 W02511 - N6323 W02938 - N6537 W03005 - N6539 W02511 -
N6340 W01857 - N6443 W01654 - N6629 W02356 - N6703 W02308 FL200/FL350
N6643 W02944 - N6643 W02529 - N6448 W02125 - N6344 W01619 - N6234
W01005 - N6138 W00713 - N6004 W00734 - N6132 W01330 - N6114 W02420 -
N6220 W02853 - **N6408 W03125 - N6614 W03121** - N6643 W02944 SFC/FL200
N5923 W05010 - N5926 W04017 - N5809 W03403 - N5752 W02847 - N5614
W02410 - N5236 W02116 - N5559 W01847 - N5526 W01522 - N5204 W01456 -
N4747 W01743 - N5007 W02449 - N5002 W03324 - N4402 W03429 - N3705
W03337 - N3649 W02743 - N3328 W02246 - N2755 W02312 - N2714 W03004 -
N2948 W03239 - N3459 W03201 - N3623 W03501 - N4538 W03540 - N5116
W03429 - N5141 W02632 - N5610 W03011 - N5711 W03232 - N5823 W05114 -
N5923 W05010

FCST VA CLD +12 HR....

FCST VA CLD +18 HR....

RMK: ASH WAS REPORTED TO FL300 OVERNIGHT.

NXT ADVISORY: 20100514/1800Z=

Note the fcst points **West** of 30 W ! Similar info
was received via voice during the flight, but for
a lower FL, if memory is correct.





BIRD SIGMET 07 VALID 141200/141300 BIRK-
BIRD REYKJAVIK CTA VA ERUPTION MT EYJAFJALLAJOKULL LOC N6337 W01937
VA CLD FCST BLW FL200 N65 W025 - N6430 W016 - N66 W018 - N67 W025 -
N68 W022 - N68 W016 - N64 W007 - N61 W007 - N61 W025 - N62 W027 -
N64 W027- N65 W025

BIRD SIGMET 08 VALID 141200/141300 BIRK-
BIRD REYKJAVIK CTA VA ERUPTION MT EYJAFJALLAJOKULL LOC N6337 W01937
VA CLD FCST BLW FL200 N65 W025 - N6430 W016 - N66 W018 - N67 W025 -
N68 W022 - N68 W016 - N64 W007 - N61 W007 - N61 W025 - N62 W027 -
N64 W027- N65 W025

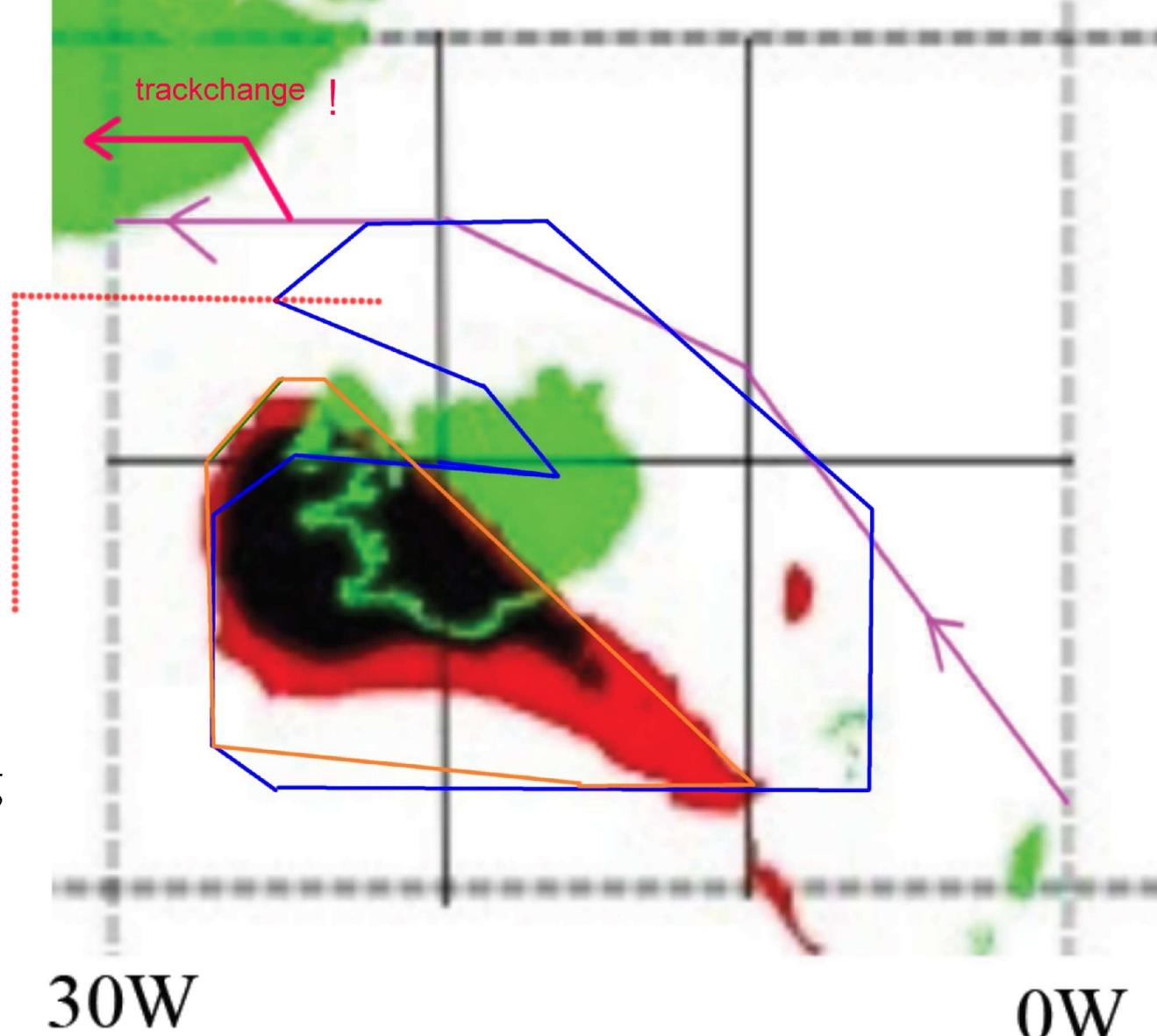
BIRD SIGMET 09 VALID 141215/141300 BIRK-
BIRD REYKJAVIK CTA VA ERUPTION MT EYJAFJALLAJOKULL LOC N6337 W01937
VA CLD FCST FL200/FL350 N65 W027 - N66 W025 - N66 W023 - N61 W010
-N61 W015 - N62 W027 - N65 W027 CNL SIGMET 07 141200/141300

Sigmets valid during the time-period 14/12z – 14/13z,
courtesy of Met Office Iceland.





70N



Red dotted line shows boundary of a sigmet received via voice, VHF. (from memory). Tops up to FL 200-250.

Trackchange was done for safety reasons, considering things seen previously.....

60N

30W

0W

Overlay of sigmets from previous page on modelled ash concentration chart valid 12z , issued 14/06z. FL 0-200 is blue, FL 200-350 is orange.

As they say: A picture is worth a thousand words.



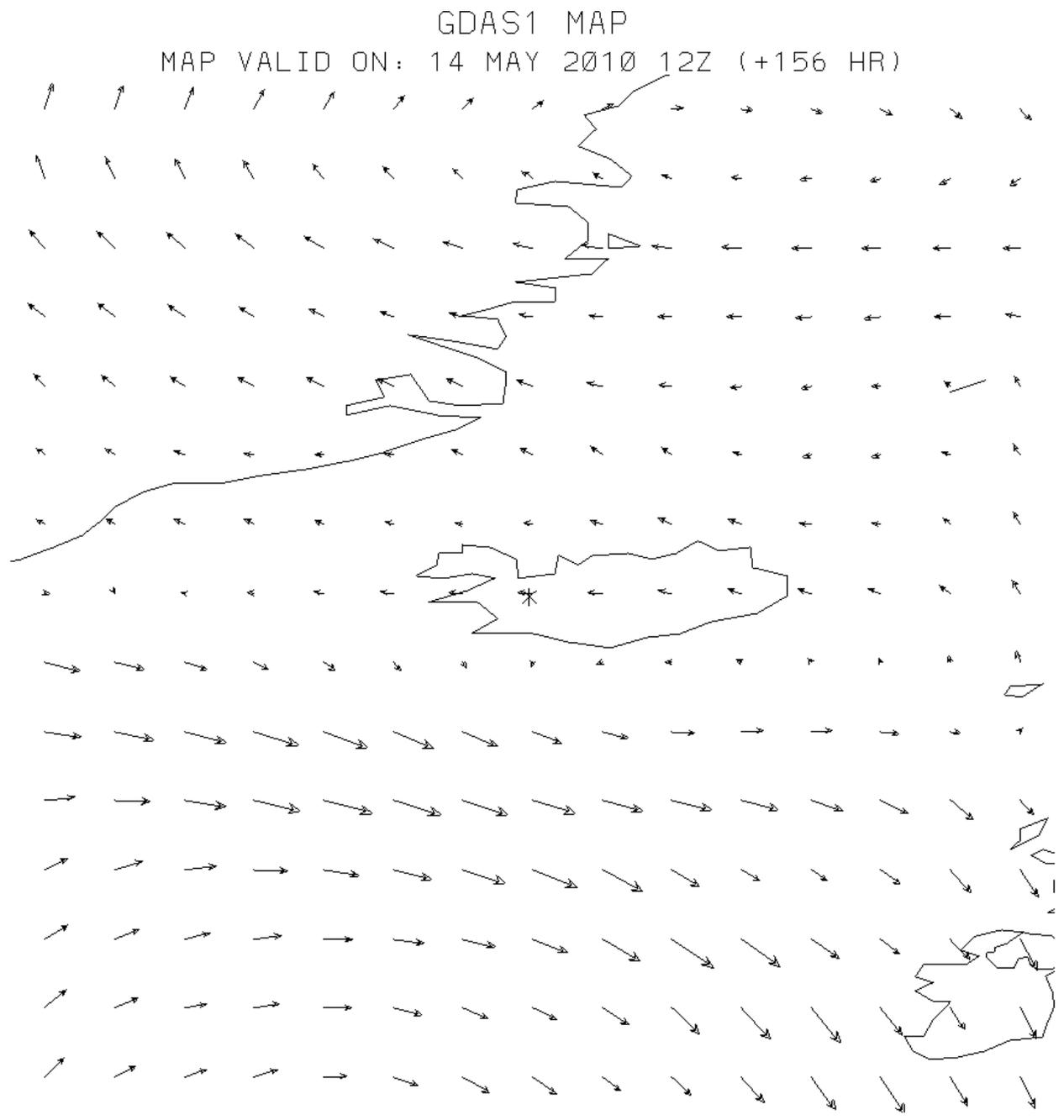


Further
Met
information..

windfield analysis
@ 300 mb
14 may, 12z

METEOROLOGICAL DATASET INFORMATION

Initialization time: 00 UTC 08 MAY 2010



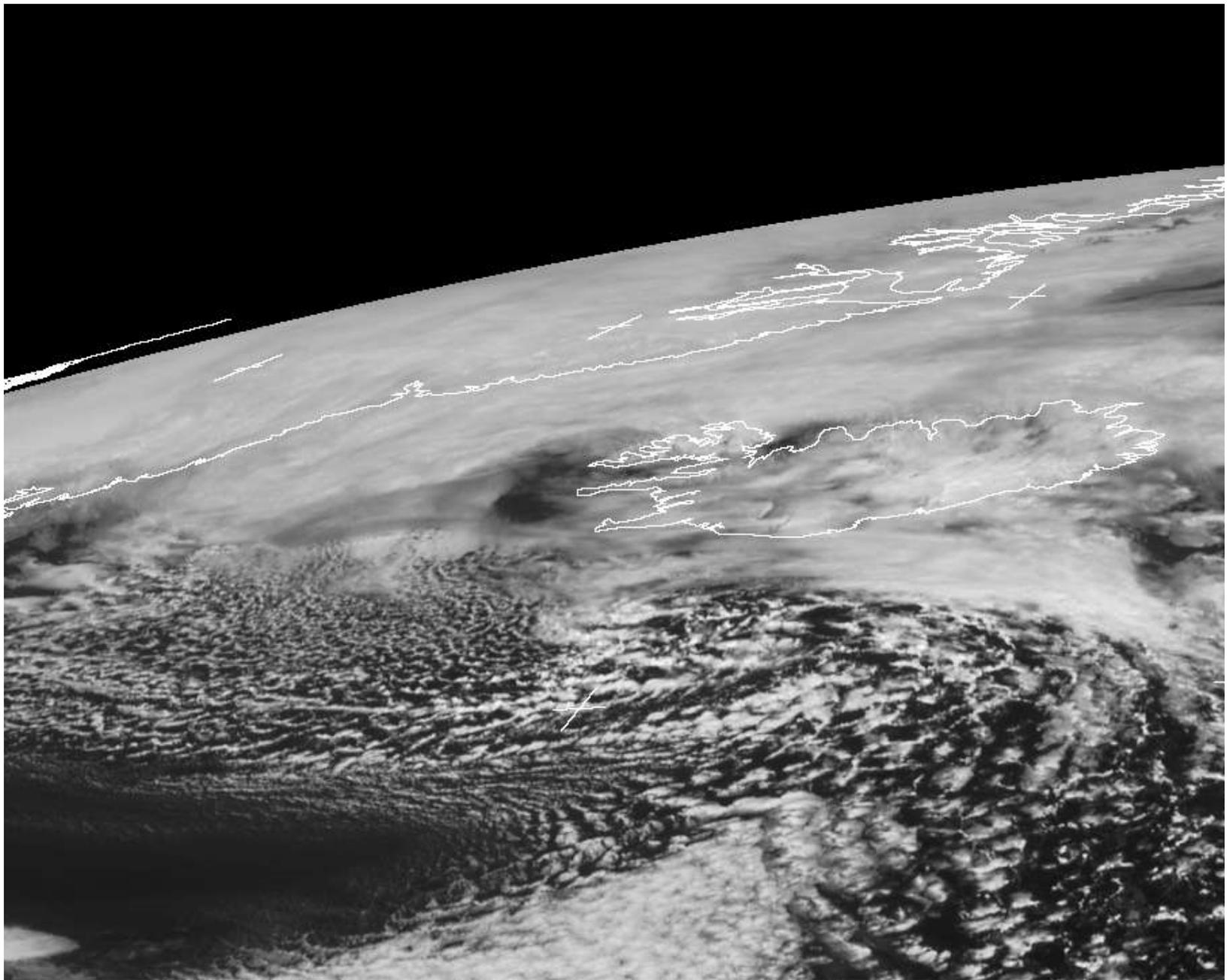
WIND VECTORS (KNTS) AT HEIGHT: 300. HPA

0.481E+02

 MAXIMUM VECTOR

NOAA - AIR RESOURCES LABORATORY
READY Web Server

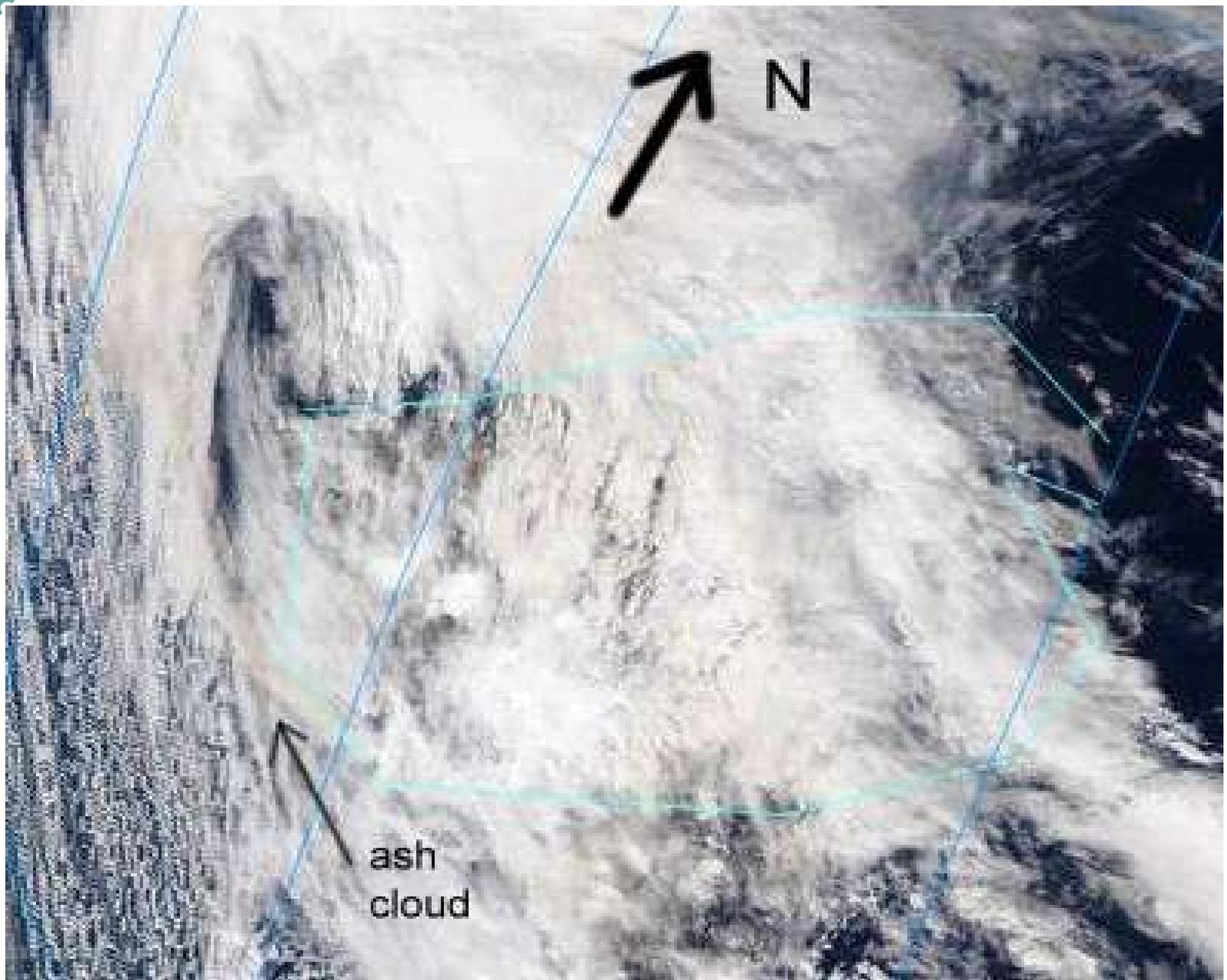




Meteosat 14.5.010, 12z

Note the dark cloud W / NW of Iceland.





MODIS, 14.5. ca. 13:00z

Note: outline-sketch of Iceland and N-arrow added





Question 1: How is it possible, what is the justification for issuing volcanic ash concentration charts with an upper limit of FL 350 on days where ash heights of 11.91 km / FL 390 are measured, which is much higher than the max published FL 350 ?

Question 2: how is the possible existence of ash clouds above or below the forecast top / bottom layer of an ash cloud accounted for in safety risk assessments ?

Question 3: given the uncertainties with ash cloud prognosis , what is the required safety-distance from the forecast top or bottom layer of an ash cloud ?

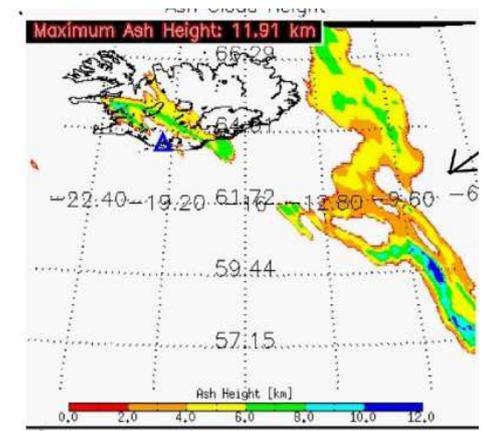
3000 ft above or below ?

5000 ft above or below ?

10.000 ft. above or below ?

Question 4: What is the required lateral safety distance from forecast VA areas , considering time from flight preparation to time of closest approach to VA area ?

60 NM ? 120 NM ? 180 NM ?



Copyright notice: Copyright remains with the sources mentioned in / near the pictures.





NAT - return - flight, 2 days later





The following is an introduction to a very interesting real-time VA detection/discrimination method found on the internet.





Monitoring of Volc. Ash from Space

Cpt. Klaus Sievers
VC, Germany

A compilation with comments.





Marco Fulle - www.stromboli.net

Automated Monitoring of Volcanic Ash Micro and Macro-Physical Properties: A comparison of Future and Current Satellite Instrument Capabilities

Michael Pavolonis
(NOAA/NESDIS/STAR)

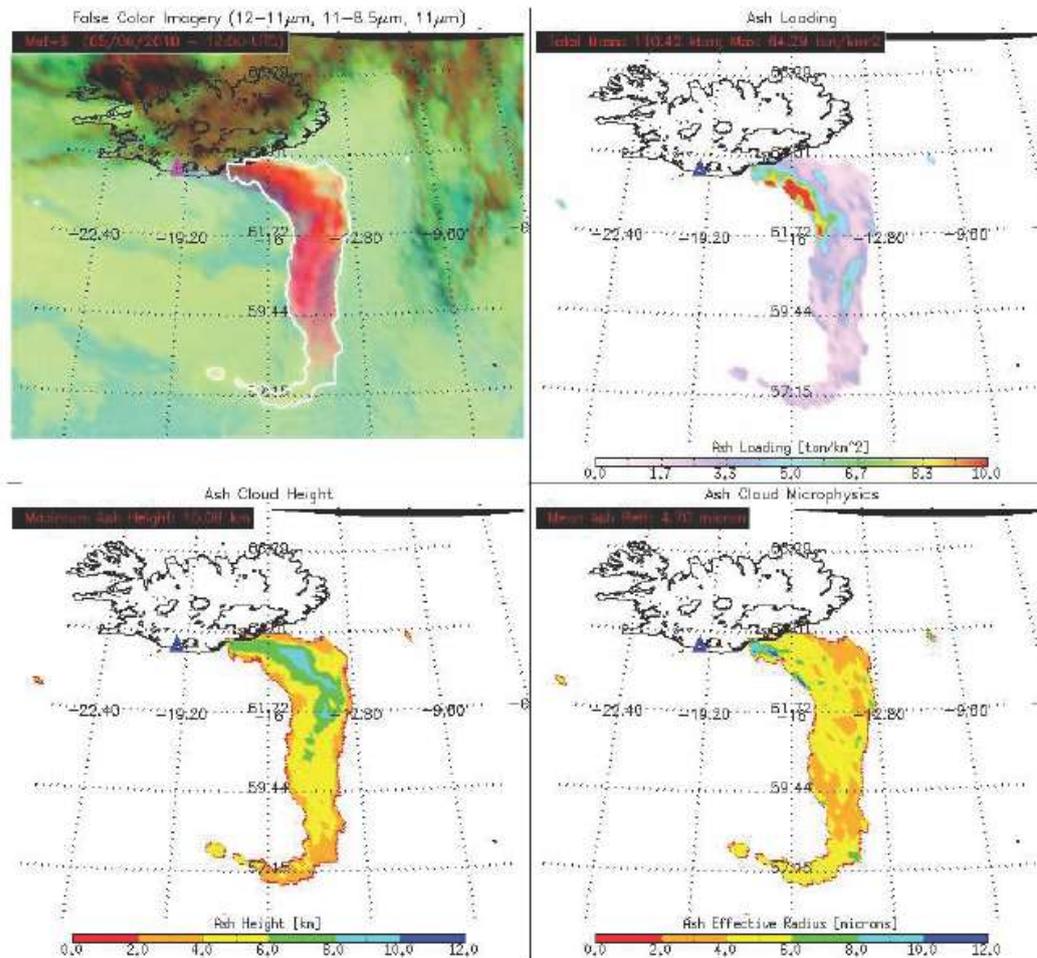


The following pages are excerpts from a presentation
(<http://www.slideshare.net/grssieee/igarss2010-volash-pavolonis>)
as well as pictures from the Eya- volcanic episode 2010





Volcanic Ash Properties



• **Retrievable ash cloud properties:** effective temperature, emissivity, and a microphysical parameter (mainly related to particle size)

• From these retrieved parameters, the effective ash cloud height, mass loading, and effective particle radius can be calculated.

• The retrieval is performed using optimal estimation (e.g. Heidinger and Pavolonis, 2009).

• **Possible channel combinations:**

- 1). 11/12 μm
- 2). 11/13.3 μm
- 3). 11/12/13.3 μm

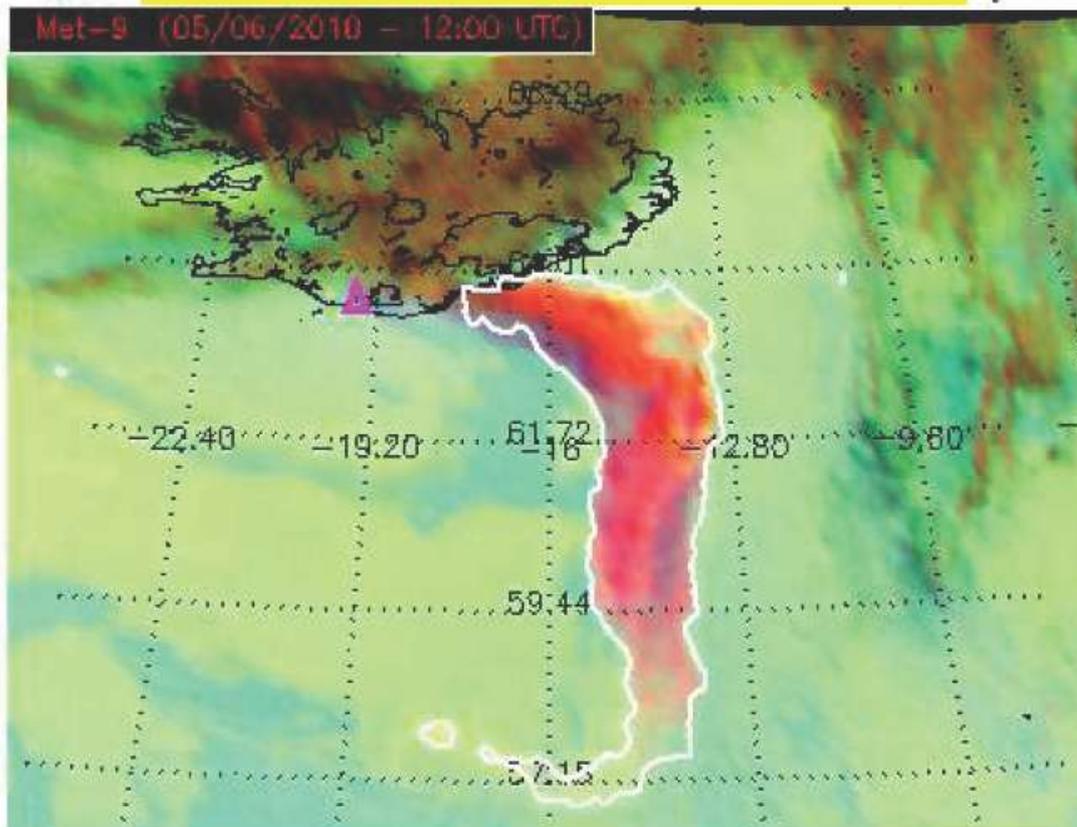
Science, not sorcery: satellites measure and classify ash clouds.





Volcanic Ash Properties

Quantitative Ash Detection



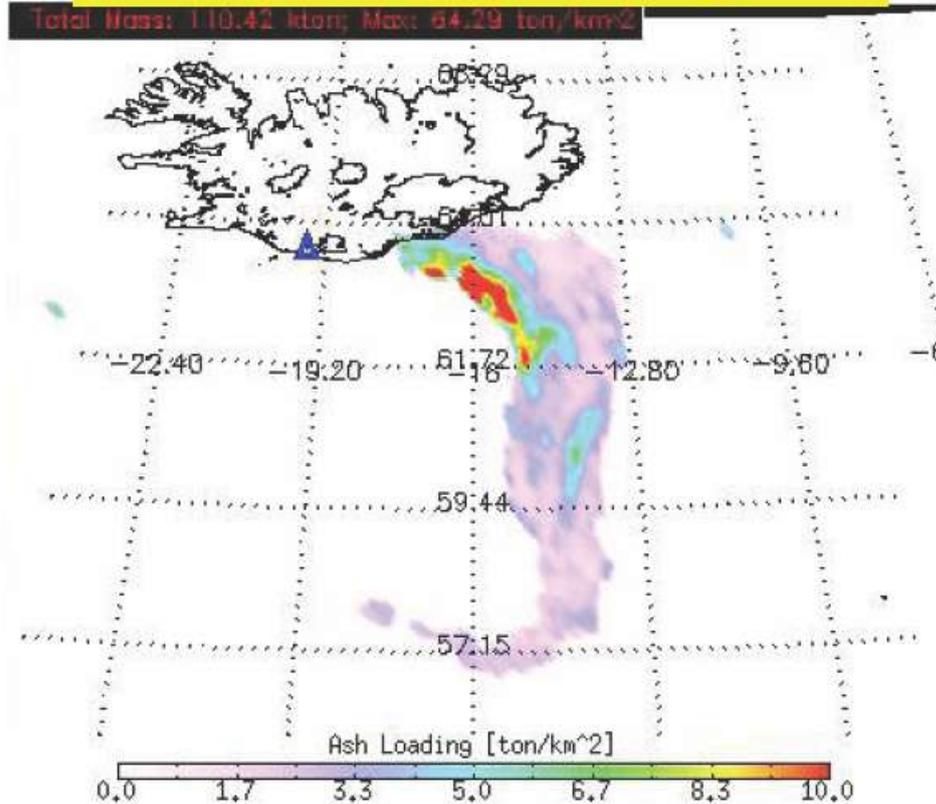
- Quantitative ash detection (Pavolonis 2010) is expressed as an ash confidence.
- Ash detection results can be overlaid on false color imagery to give the user perspective.
- The ash detection can be used to provide automated

Ash detection / discrimination from clouds....



Volcanic Ash Properties

Ash Mass Loading



- Ash mass loading (ton/km²) is needed to determine if jet engine tolerances are exceeded and to initialize models.

- If a 1 km cloud thickness is assumed, the mass loading is numerically equivalent to ash concentration in mg/m³.

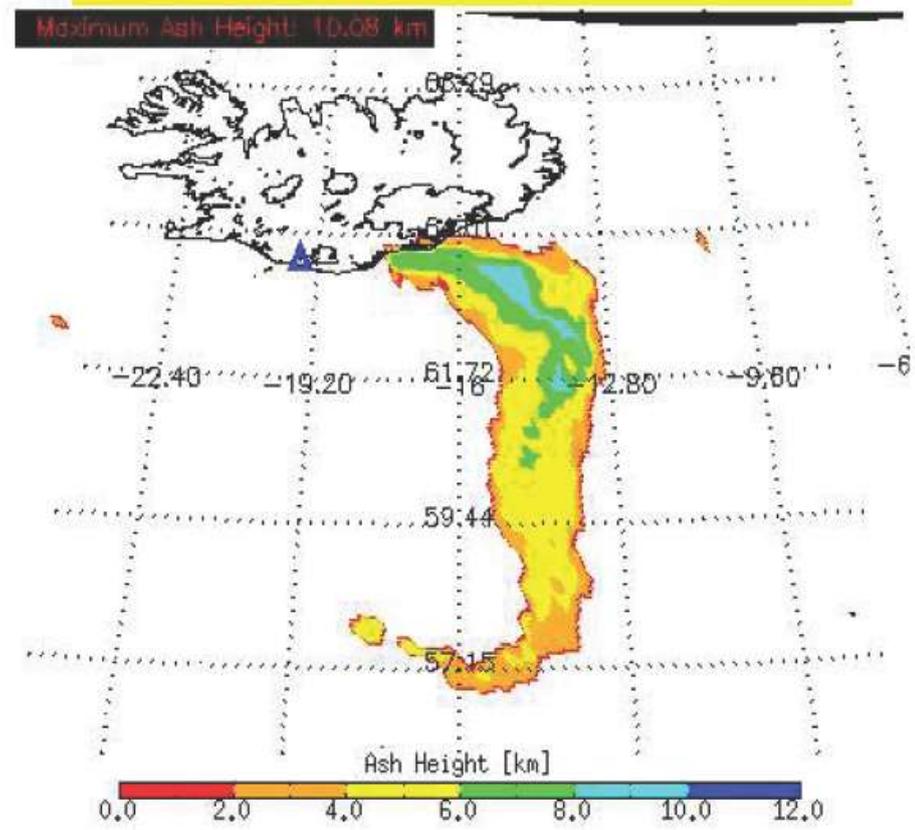
Ash concentration can be directly estimated.





Volcanic Ash Properties

Ash Cloud Height



- The ash cloud top height is critically important for determining if ash is at jetliner cruising altitudes (nowcasting component).
- In addition, the ash cloud height is a very important parameter for initializing dispersion models (forecasting component).

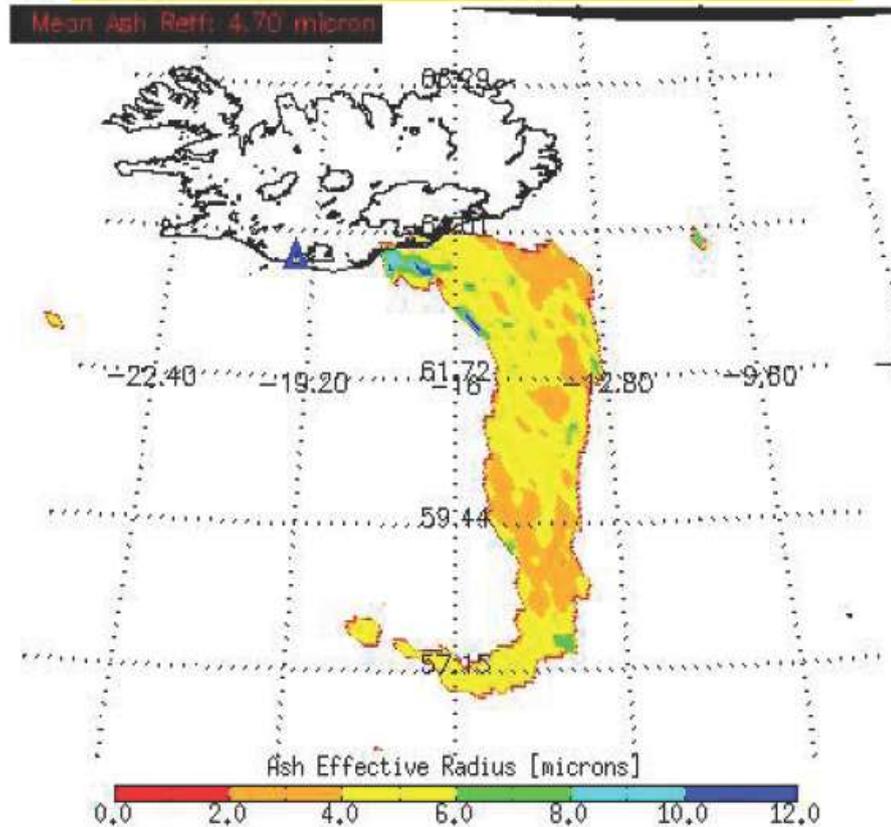
Here, the hight of the ash cloud is shown.





Volcanic Ash Properties

Ash Effective Radius

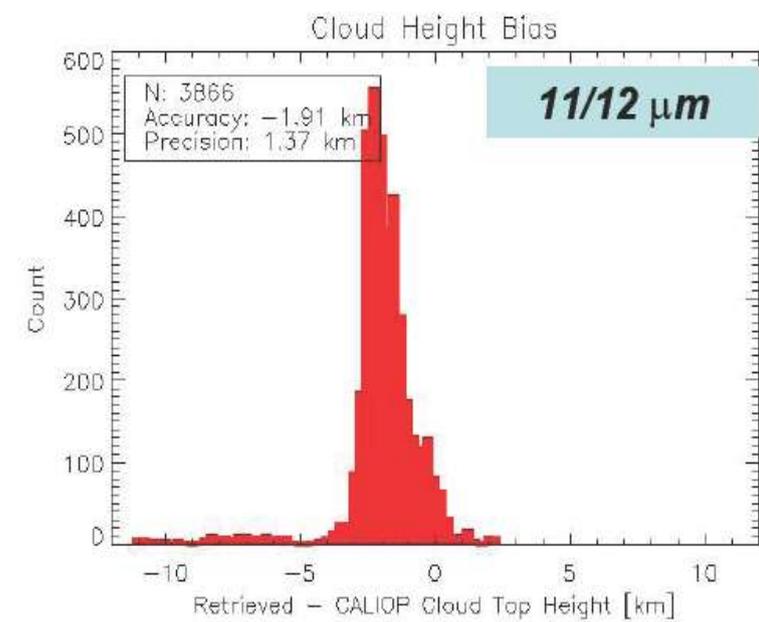
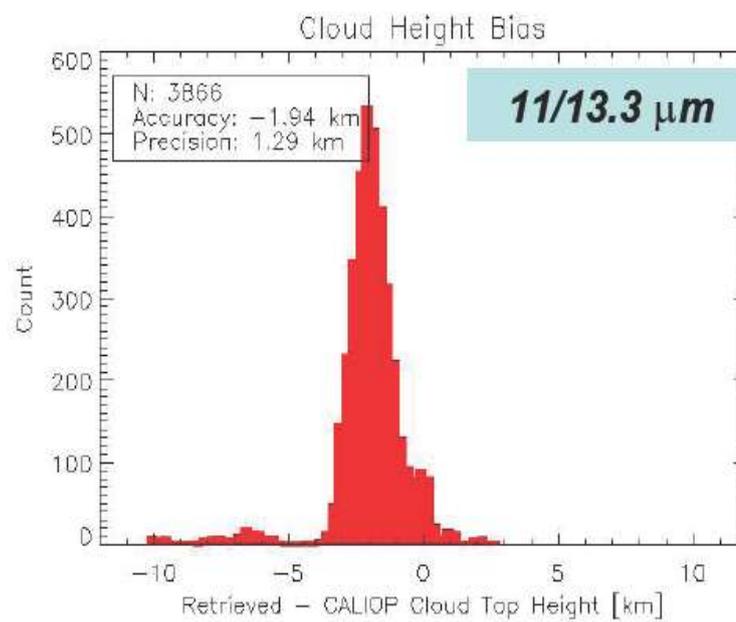


- The ash cloud effective particle radius is not a required GOES-R product, but it is automatically generated as part of the ash retrieval.
- The effective particle radius is well correlated with ash residence time.

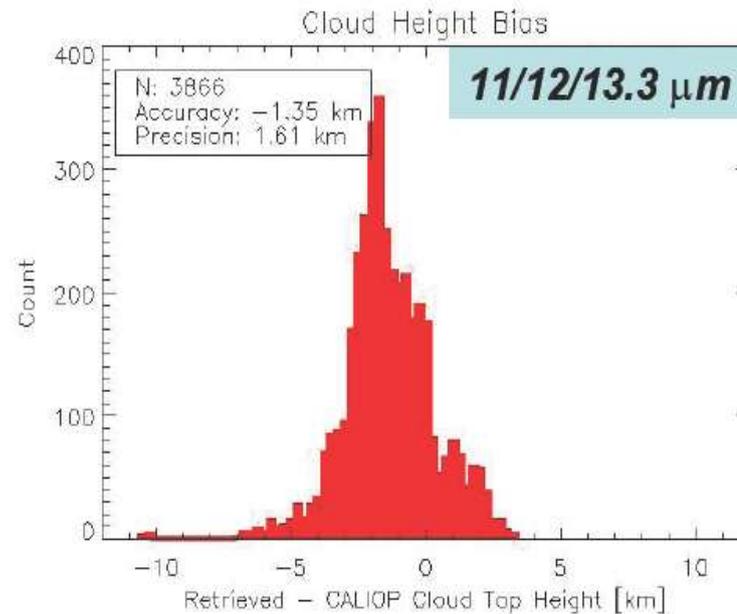
Statement: Ash particle size is discriminated.

Allows better estimation of how long ash will stay in the air.





**Ash Cloud
Height
Validation**

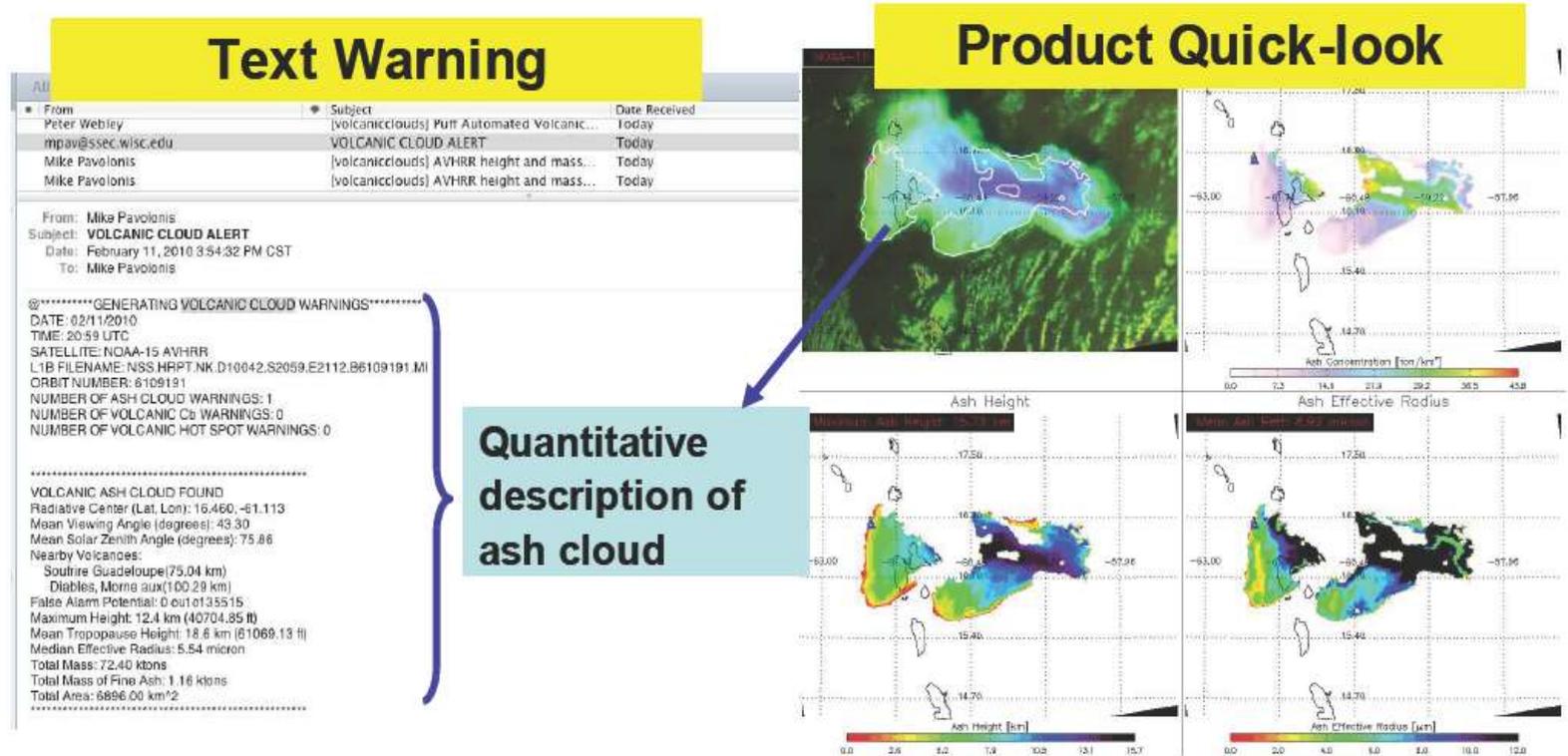


All measurements shown before are validated, a kind of quality indicator..... great improvement over met phenomena.





- The ash cloud property products can be used to issue automated ash cloud alerts to VAAC's.
- Decision support systems like this are needed because it is impossible to manually analyze every satellite image in real-time. In addition, the high temporal resolution of future geostationary measurements (like from GOES-R) will not be fully utilized for volcanic cloud monitoring without an automated alert system.



Shown here: this is, how ash detection and evaluation could work almost automatically.





Meteosat-9 SEVIRI volcanic ash retrieval products
The Icelandic volcano **Eyjafjallajökull** (which started to become active again **in late March 2010**) continued to remain active into early May, with another significant plume being observed on **06 May 2010**. EUMETSAT Meteosat-9 SEVIRI **volcanic ash retrieval products** (*above*) showed a plume streaming southeastward from Iceland, with the maximum ash cloud height reaching 17.27 km. These volcanic ash retrieval products provide a demonstration of the type of products that will be available with the ABI instrument on the GOES-R satellite — they are available in near-realtime on the **CIMSS GOES-R Proving Ground** site.

Quelle:

<http://cimss.ssec.wisc.edu/goes/blog/archives/category/volcanic-activity>





Summary

- In order to provide global information on ash cloud properties in a timely manner, a flexible retrieval algorithm is needed to accommodate three different infrared channel combinations (11/12, 11/13.3, and 11/12/13.3 μm).
- Comparisons to spaceborne lidar indicate that the 11/12/13.3 μm channel combination, which was developed for GOES-R, is significantly more accurate than the 2-channel combinations, especially for optically thin high ash clouds.
- Using SEVIRI, the GOES-R products were provided to the London VAAC during the eruption of Eyjafjallajökull.
- The 2-channel combinations still offer valuable information on ash cloud properties, especially if bias corrected.
- Current efforts are focused on developing a global, multi-sensor automated ash alert system and model initialization and assimilation studies.

All of these informations were available to the VAAC London. They were also freely available on the internet - many thanks to the researchers. A kind of openness almost unheard of in Europe.

