Ash Dispersal Forecast and civil aviation workshop, Geneva 18-20 October 2010

FLEXPART

Modeling of volcanic eruptions

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Outline

- The FLEXPART model; brief overview
- Simulating volcanic eruptions
- Inverse modeling with FLEXPART
- Case study: Kasatochi Volcano 2008 eruption
- Few results from Hekla 2000 eruption

FLEXPART model description

➢**Lagrangian Particle Dispersion Model** (LPDM)

➢Originally design around 1997 for calculating the long-range and mesoscale dispersion of **air pollutants** from point sources .

➢**Development** supervised by Andreas Stohl and mainly by people from

- Norwegian Institute of Air Research, Kjeller, Norway
- Institute of Meteorology, University of Natural Resources and Applied Life Sciences, Vienna, Austria
- Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organization, Vienna, Austria

➢Used by **35 groups** in 17 different countries; both operational and research applications.

➢**Applications**;

transport of radionuclides after nuclear accidents, pollution transport, greenhouse gas cycles, stratosphere-troposphere exchange, water cycle research, and others.

➢**More information**:
http://transport.nilu.no/flexpart

FLEXPART model description

Calculations take into account:

- Turbulence [*Stohl and Thompson, 1999]*
- Convection [Emanuel and Živković-Rothman ,1999]
- Wet and dry deposition
- Radioactive decay

- Off-line model, meteorological data in GRIB format from ECMWF, GFS ++

Modes:

- Forward to simulate dispersion of tracers.
- Backward to determine potential source contributions.

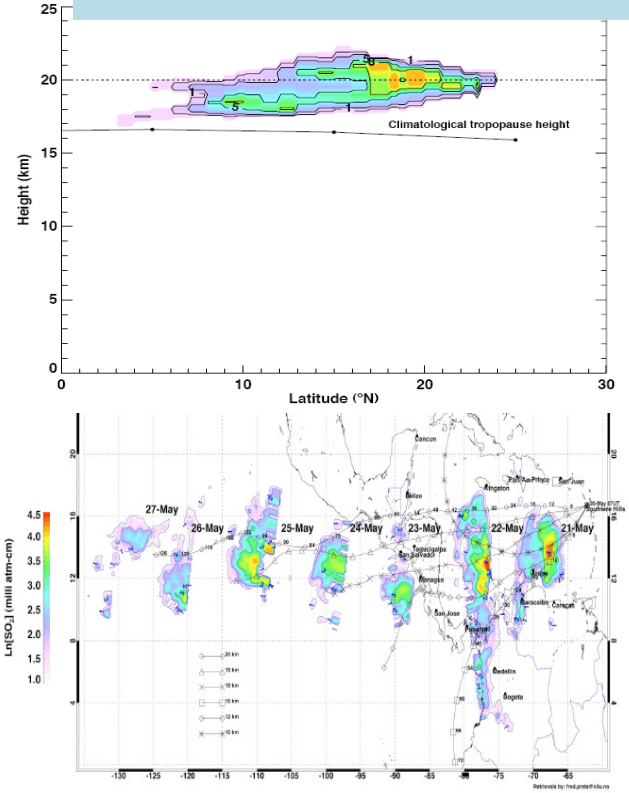
- No chemistry scheme

- No operational volcanic application

Volcanic applications

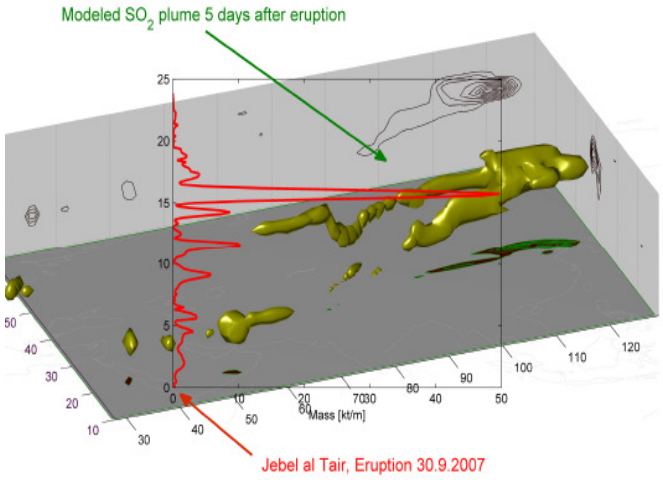
MONTSERRAT, May 2006

Prata et al (2007),*Long range transport and fate of a stratospheric volcanic cloud from Soufriere Hills volcano, Montserrat*, ACP



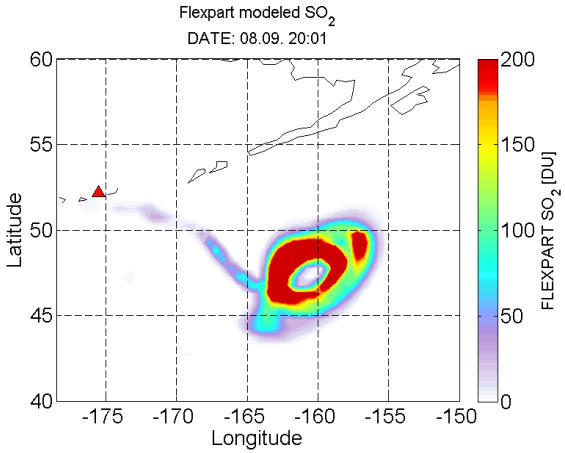
JEBEL AT TAIR, September 2007

Eckhardt et al (2008), *Estimation of the vertical profile of sulfur dioxide injection into the atmosphere by a volcanic eruption using satellite column measurements and inverse transport modeling*, ACP



KASATOCHI, August 2008

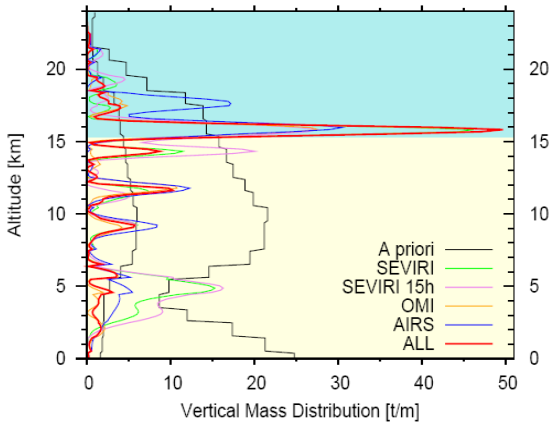
Kristiansen et al (2010), *Remote sensing and inverse transport modeling of the Kasatochi eruption sulfur dioxide cloud*, JGR Special Issue



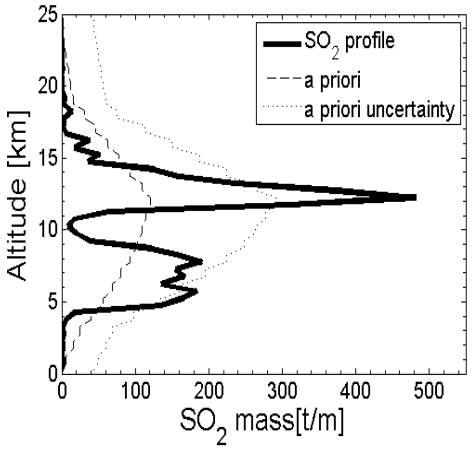
Source term estimations

- **Inverse modeling** framework with FLEXPART
- Retrieve mass flux of ash/SO_2 emitted from the volcano (function of height and time)
- Compare **model data** (FLEXPART) and **satellite data** (SEVIRI, AIRS, OMI, IASI..) to optimize the fit between the two data sets.
- More accurately simulate ash/SO_2 concentration fields.

JEBEL AT TAIR

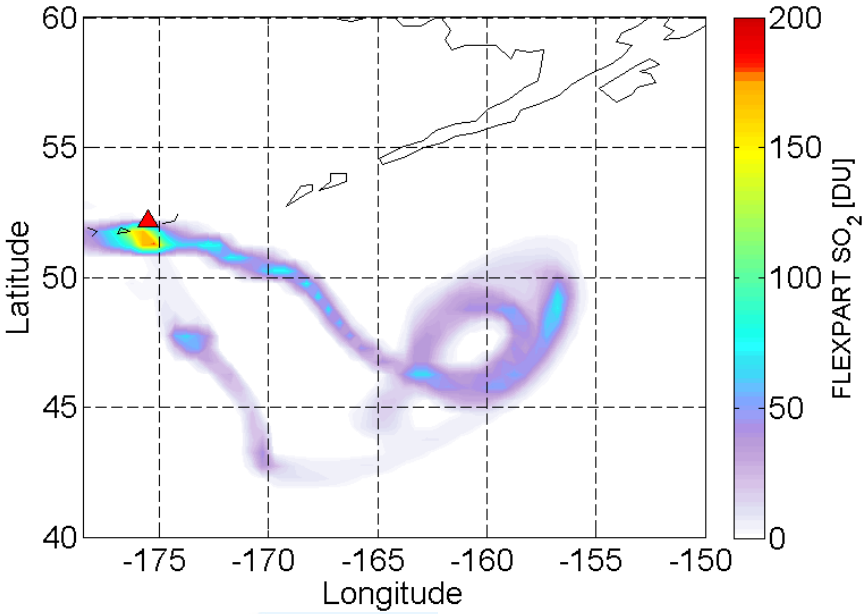


KASATOCH

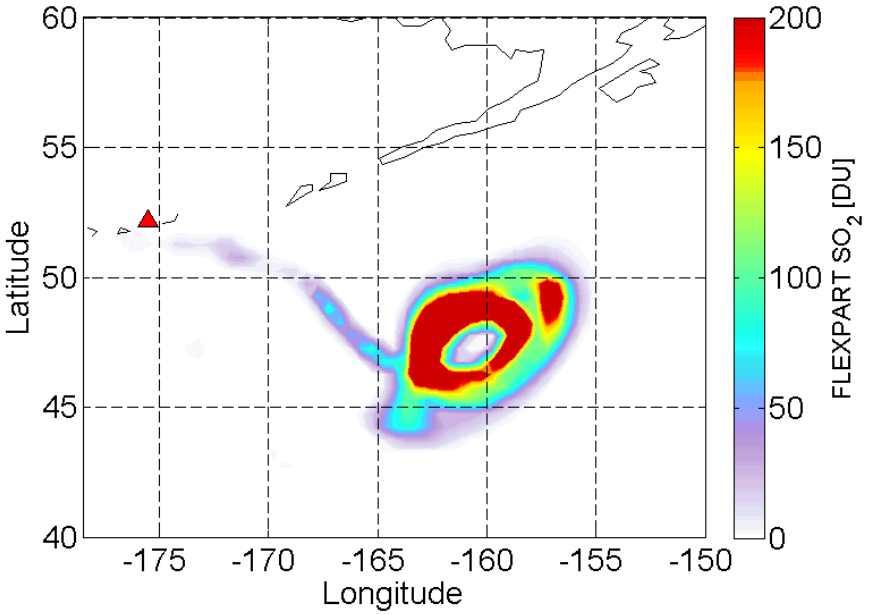


EYJAFJALLAJÖKULL 2010

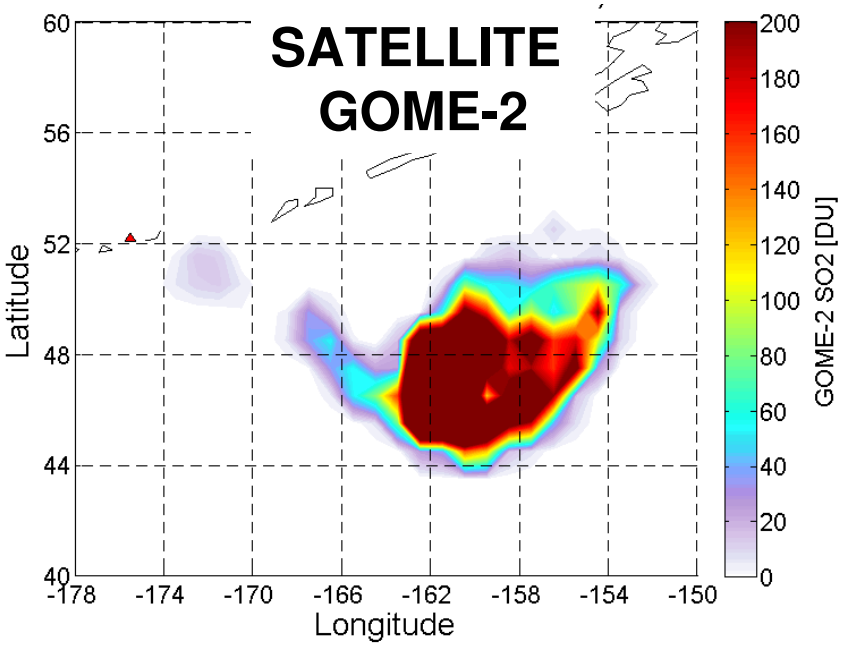
FLEXPART
a priori

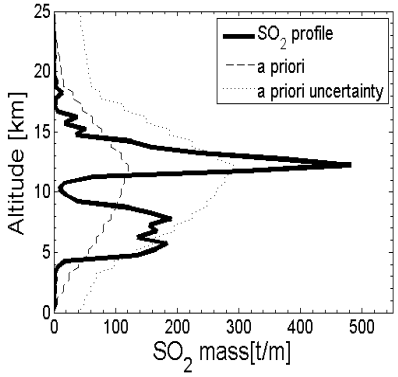


FLEXPART
a posteriori



SATELLITE
GOME-2





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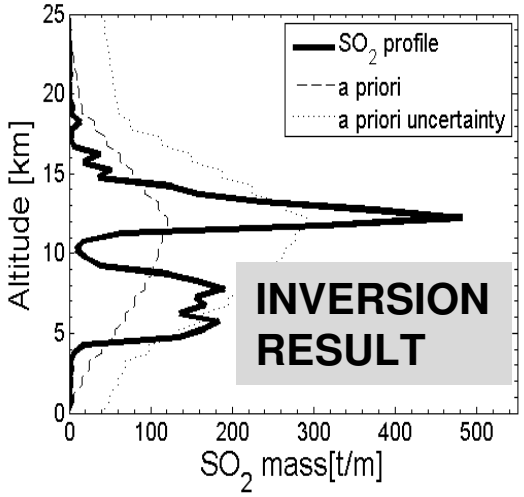
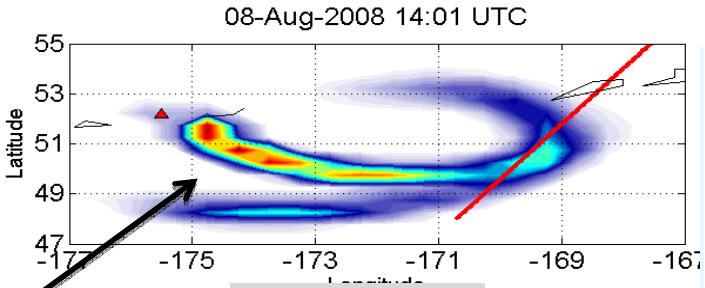
Kasatochi 2008



INVERSION RESULT

FLEXPART



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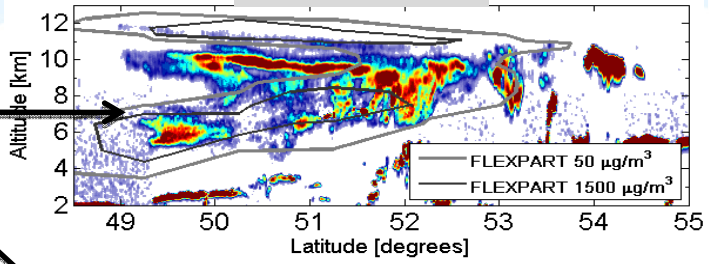
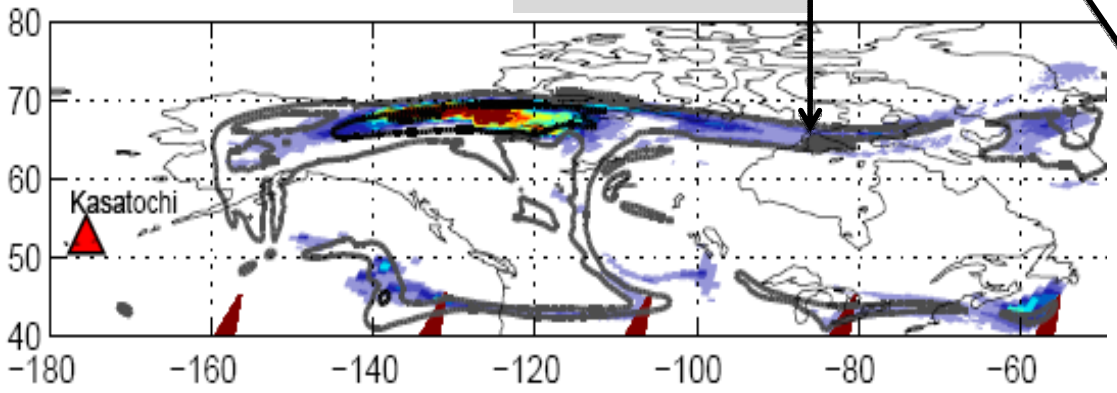
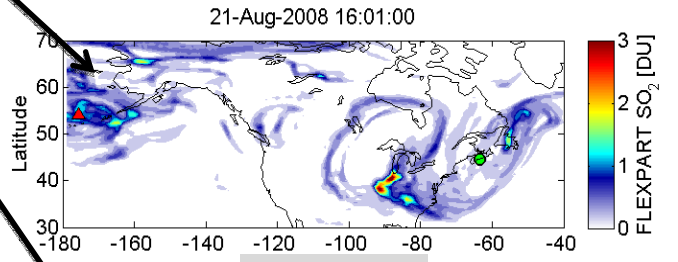
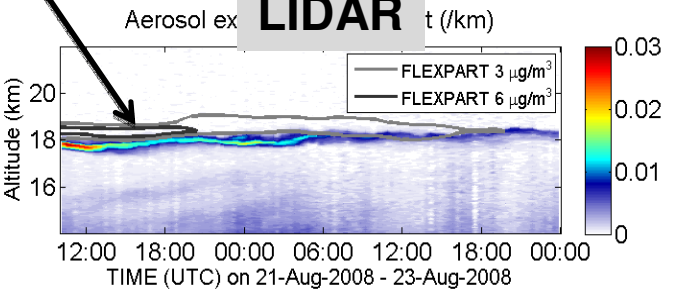


GOME-2





LIDAR



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HEKLA 2000

- ECMWF, ERA 40 data
- Dry + wet deposition
- No aggregation
- Release 1.5-12 km a.s.l
- 1 hourly time averages
- Flight levels (50FL deep)

HEKLA 2000
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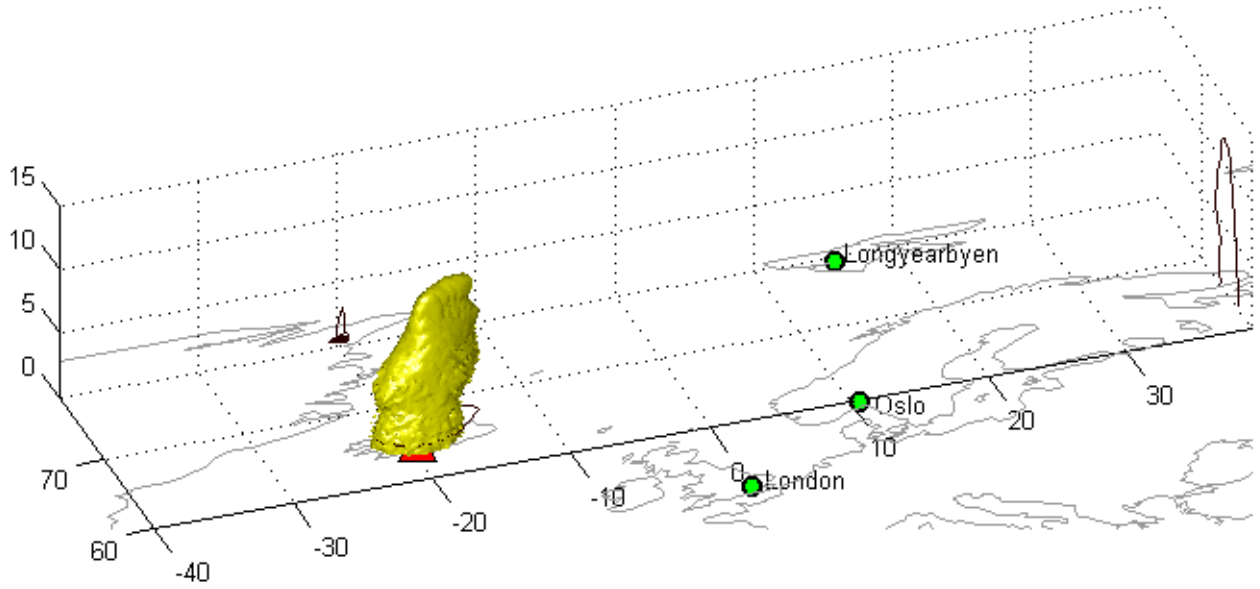
+3h



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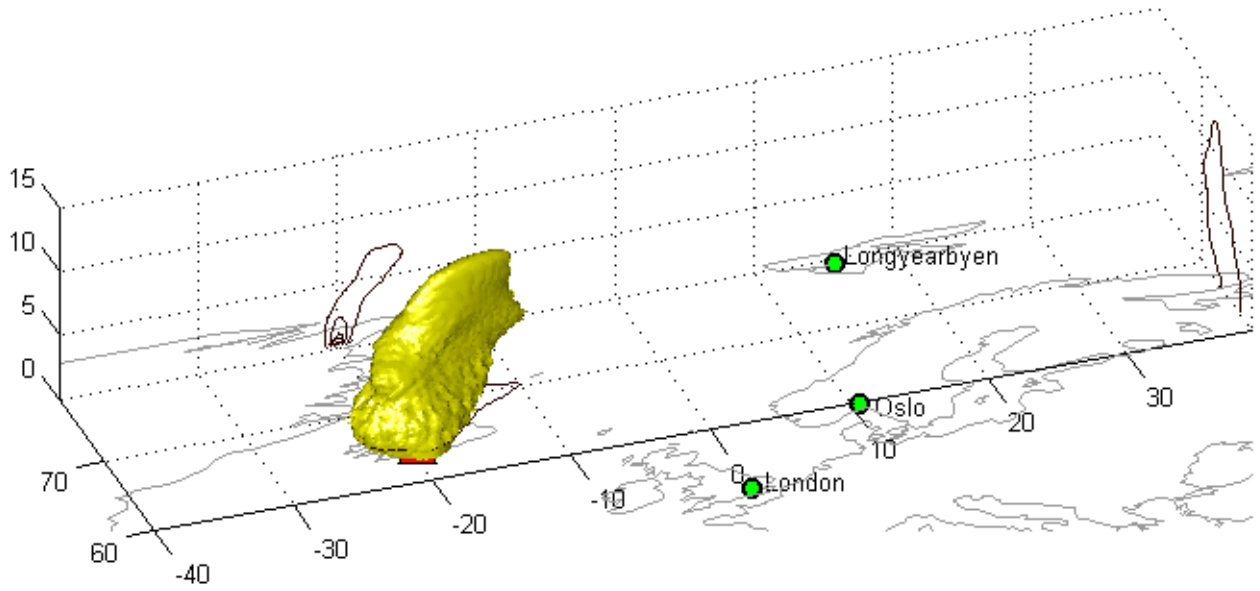

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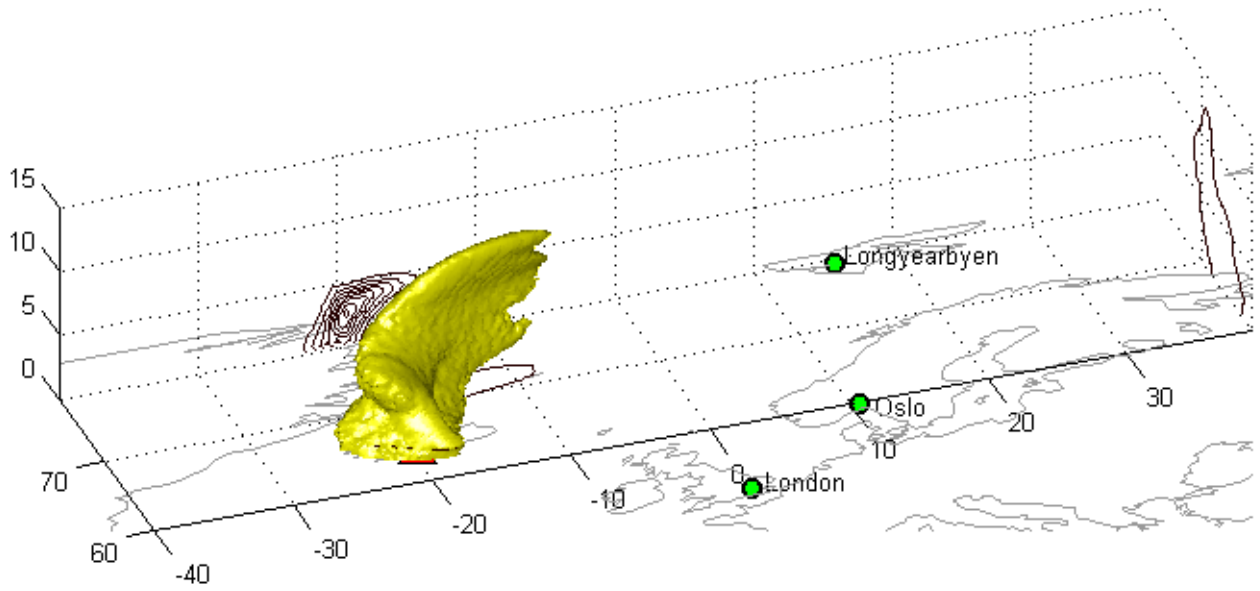

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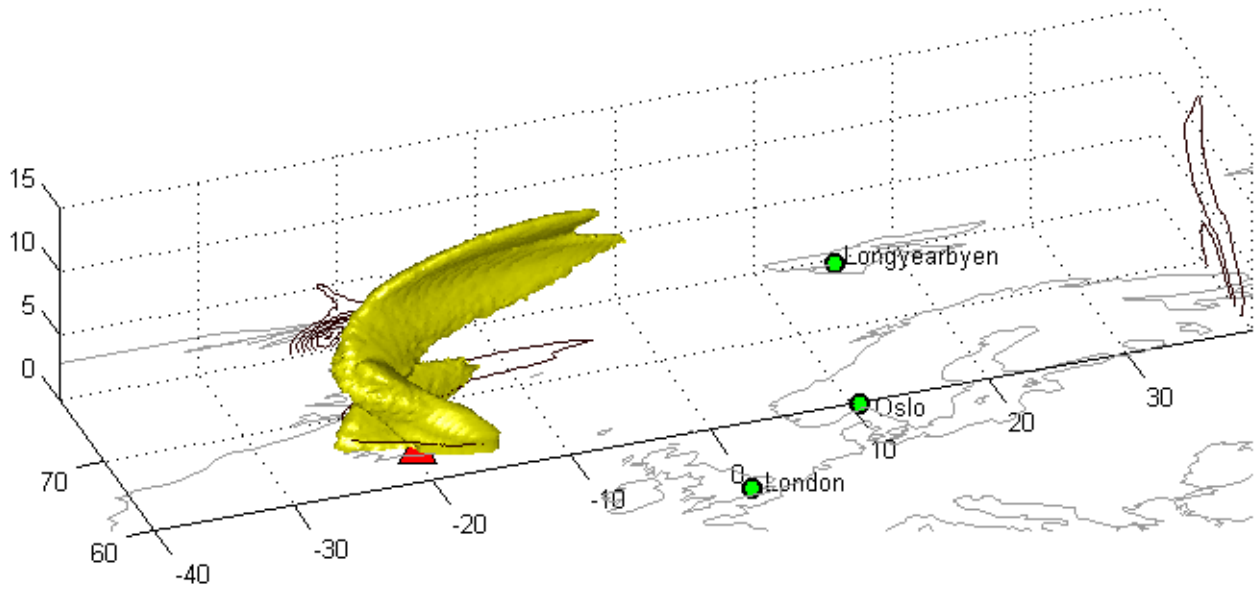

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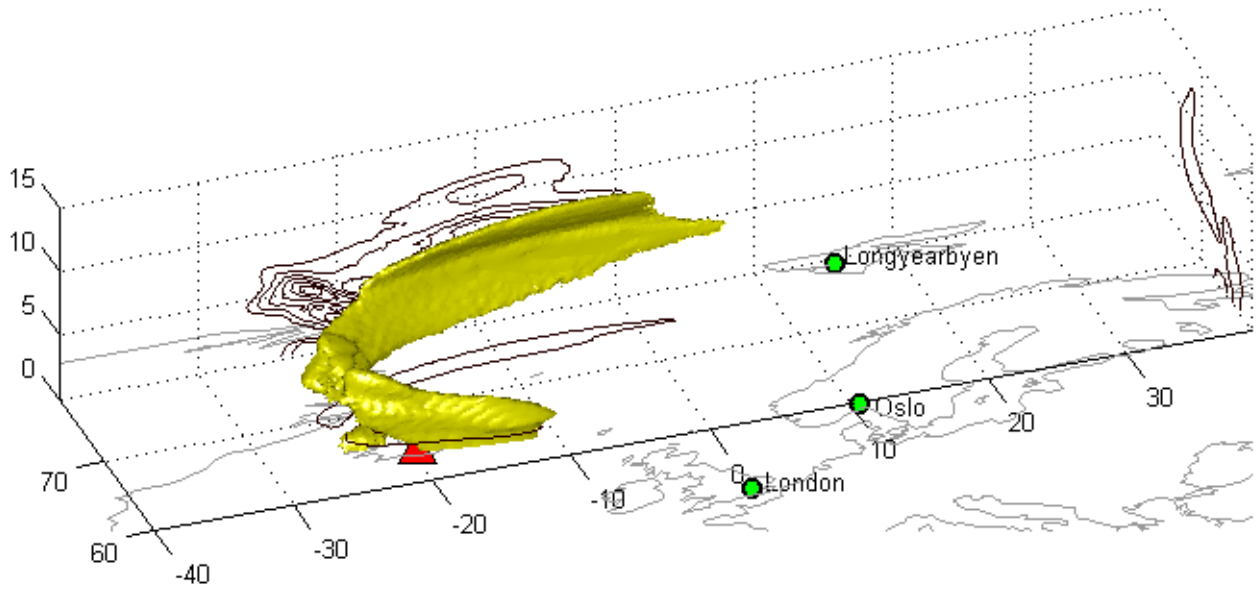

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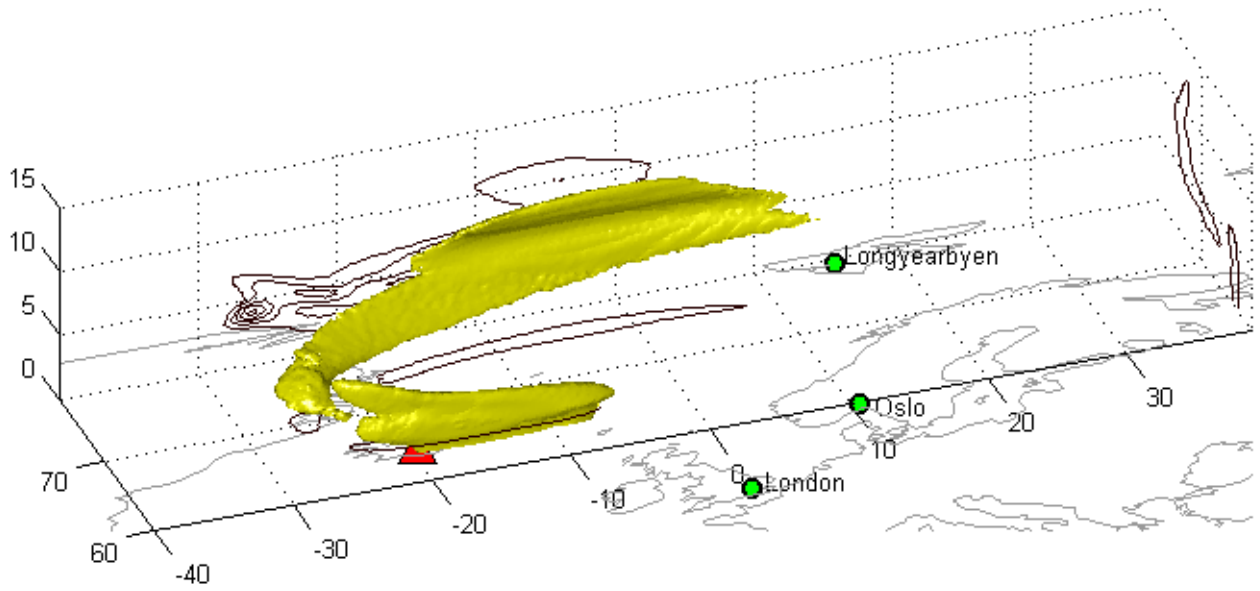

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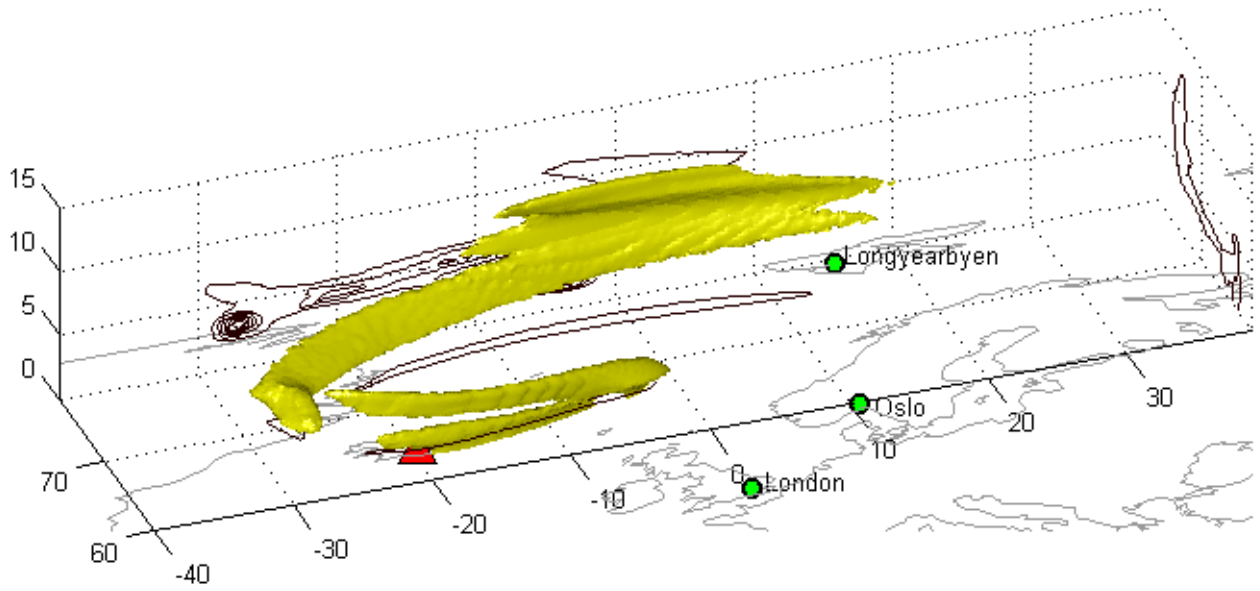

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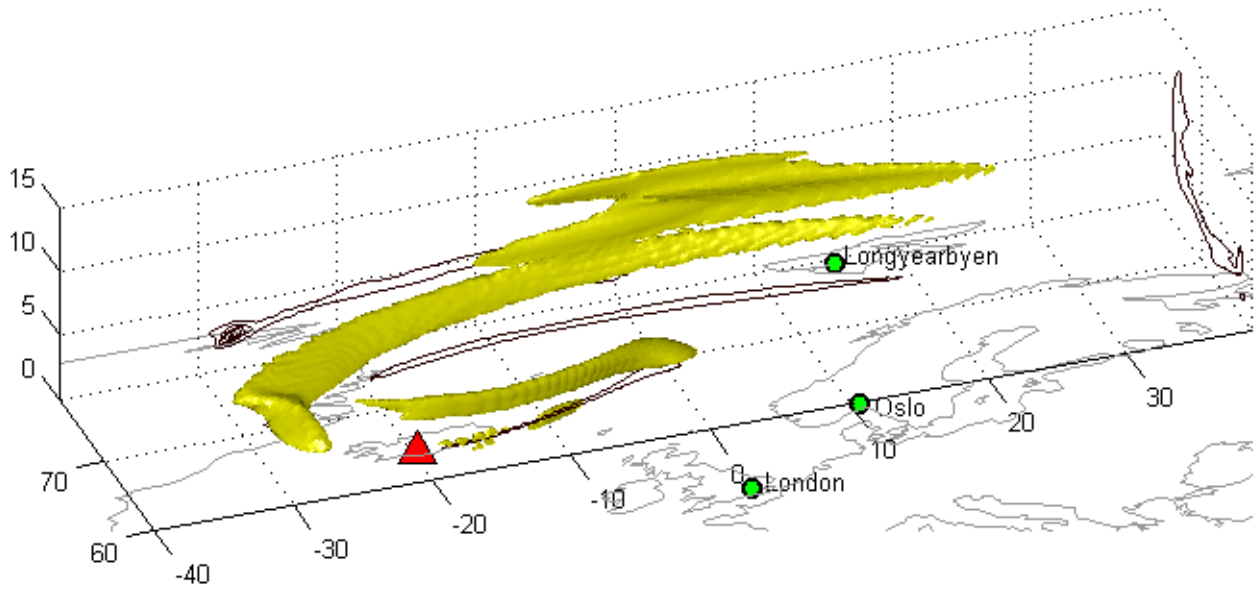

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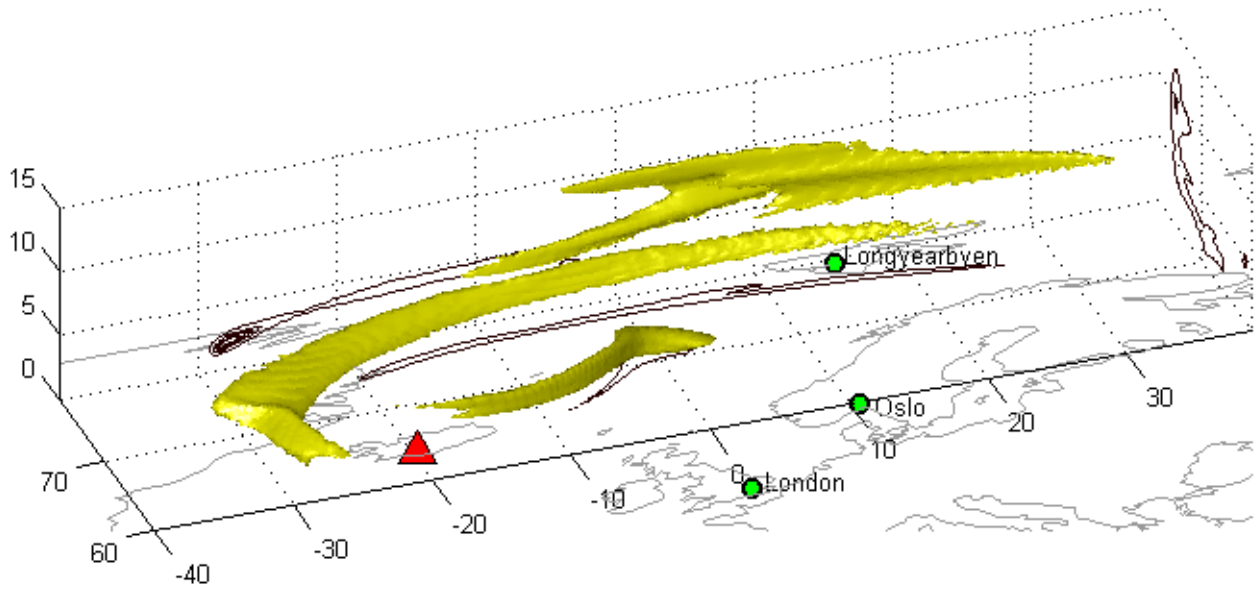

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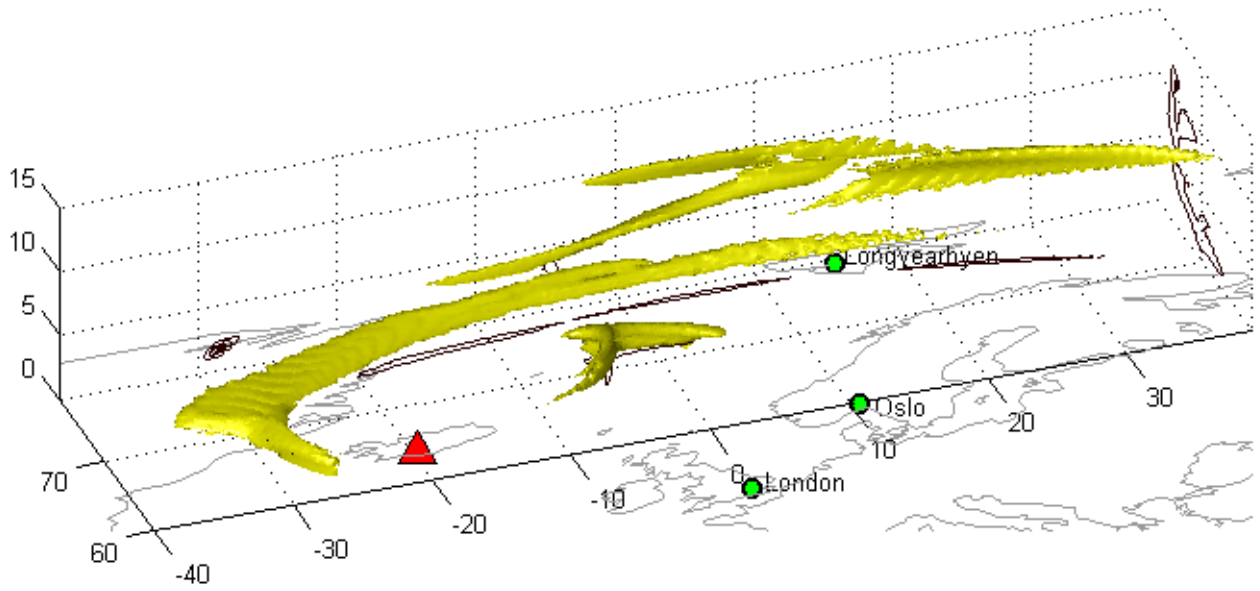

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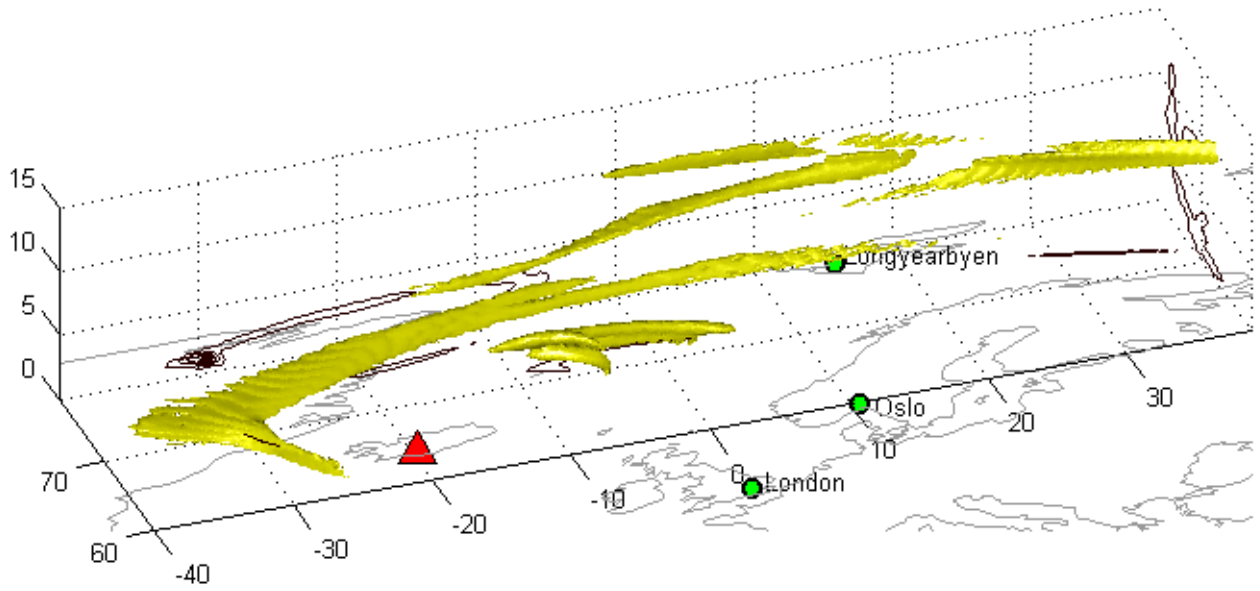

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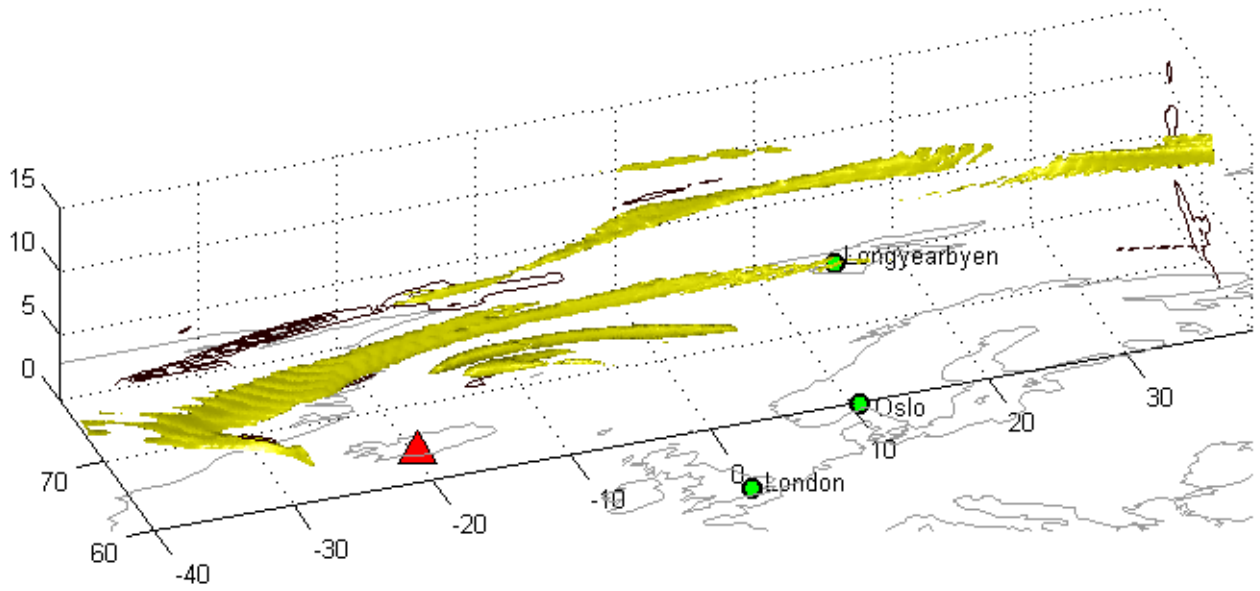

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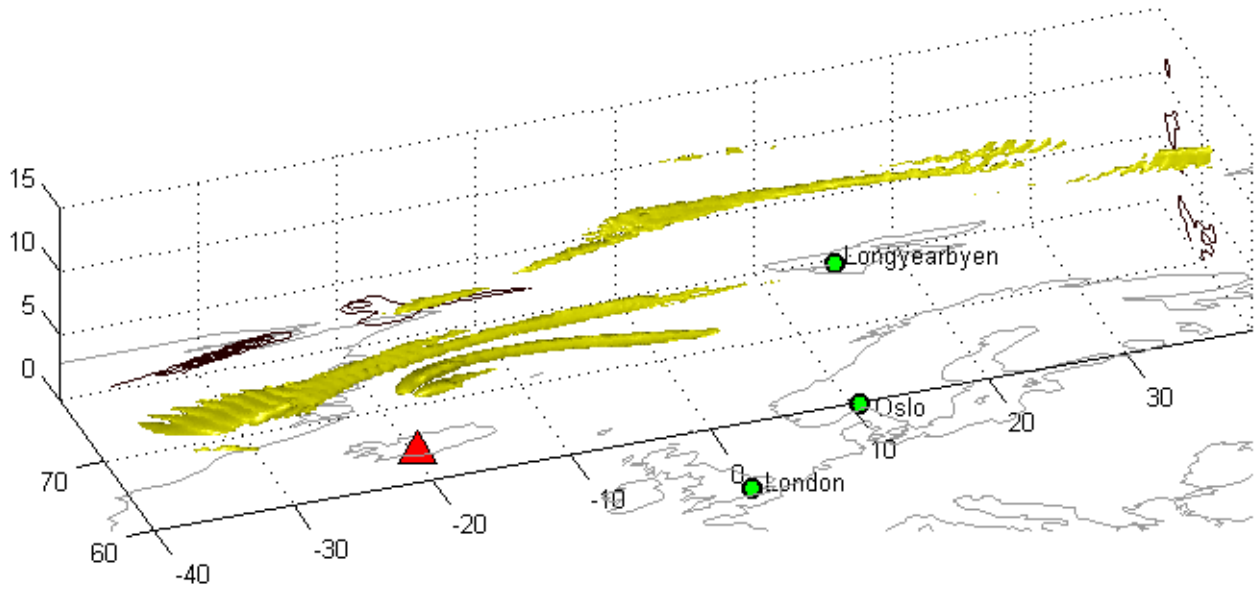

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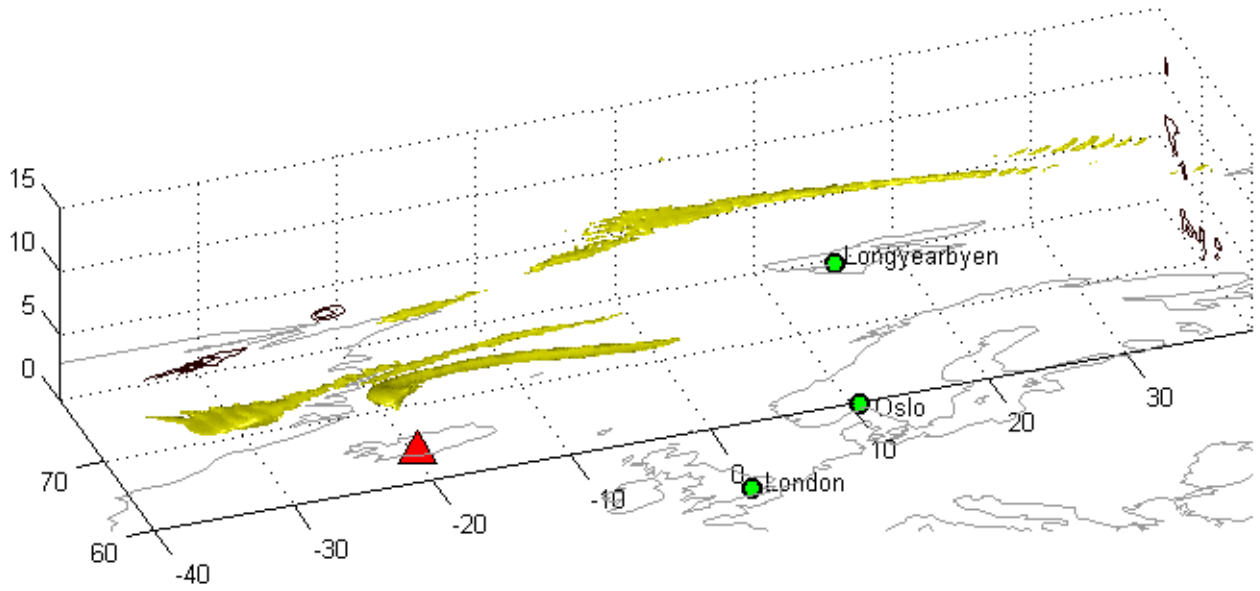

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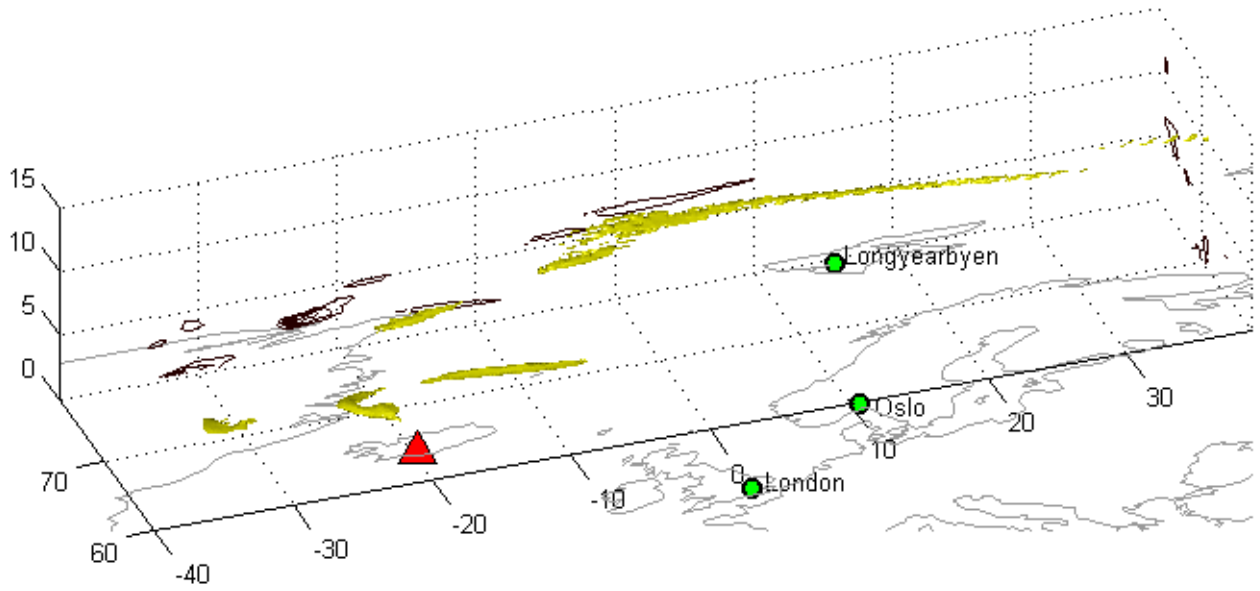

Conclusions

- The LPDM **FLEXPART** has been used to perform 3+1 detailed studies of previous volcanic eruptions
- Main work concerned with **source term** estimations using FLEXPART with an inversion algorithm
- Main topics for volcanic ash dispersion:
  - Mass eruption rate (function of height and time)
  - Ash size distribution

Acknowledgements

The project

Support to Aviation for Volcanic Ash Avoidance (SAVAA)

http://savaa.nilu.no

Financed in the European Space Agency's Earth Observation Envelope Programme (EOEP) – Data User Element.

Thank you for your attention!

Takk for oppmerksomheten!