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Source terms in volcanic eruptions and nuclear emergencies

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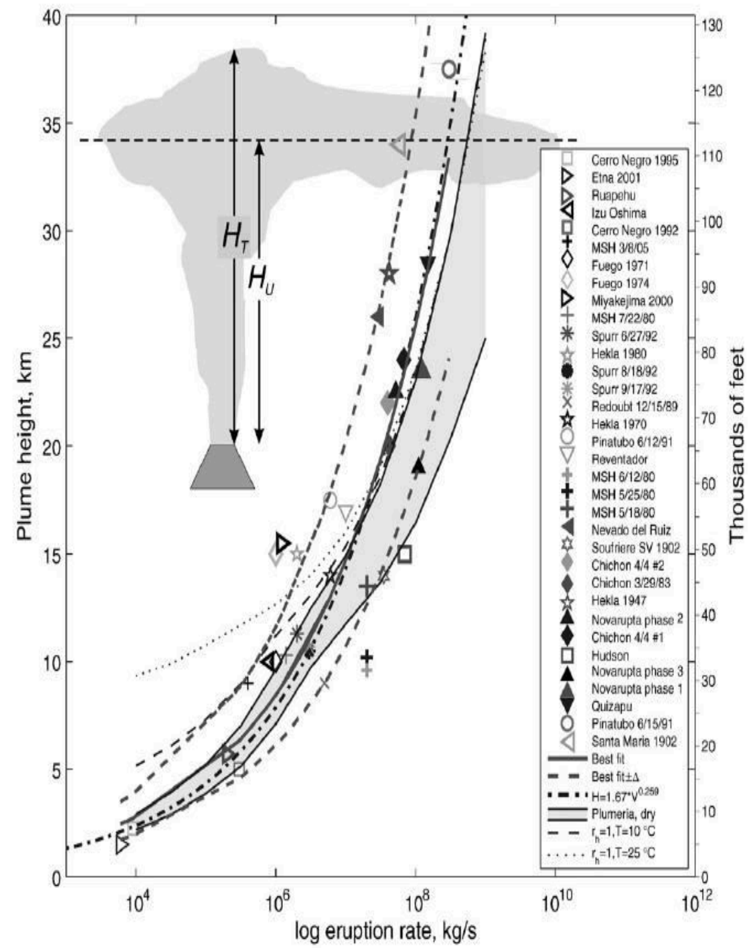
Source terms for volcanic eruptions

- **Experience from the Eyjafjallajökull (2010) and Grimsvötn (2011)**
- **Emission mass flux not measured**
- **Plume top measured with radars, cameras, etc.**
- **How to obtain quantitative predictions?**
  - try to estimate mass flux from plume top
  - try to calibrate using satellite observations

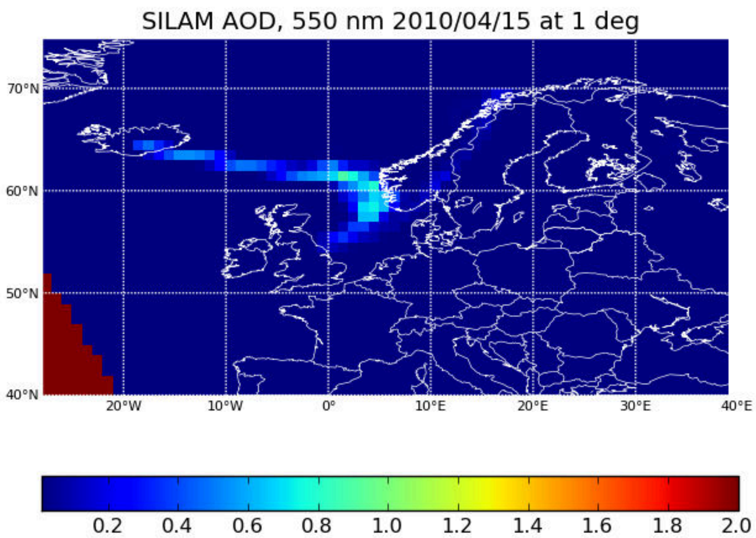
Plume top as a proxy for eruption mass flux

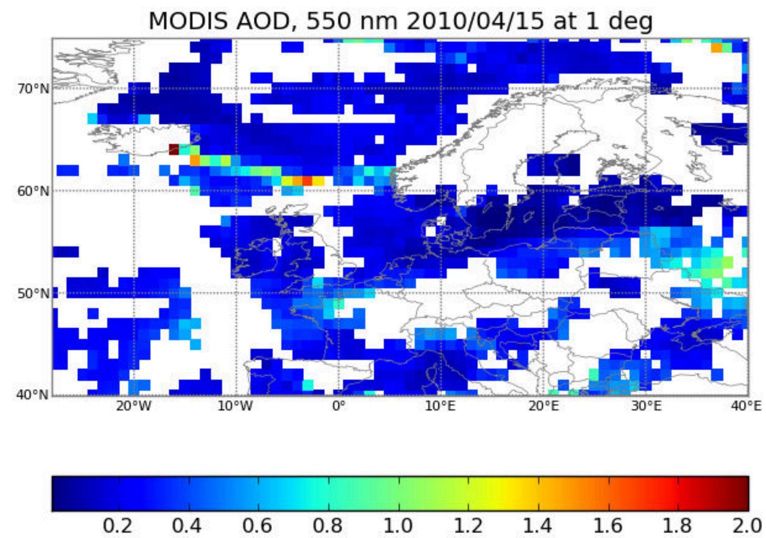
- **Common approach: empirical fits like Mastin et al. (2009)**
- **Problems:**
  - big uncertainty in the fit
  - size spectrum not known: is there 1%, 2% or 5% of mas in PM10?
  - plume top not always well defined



Calibration efforts using satellites

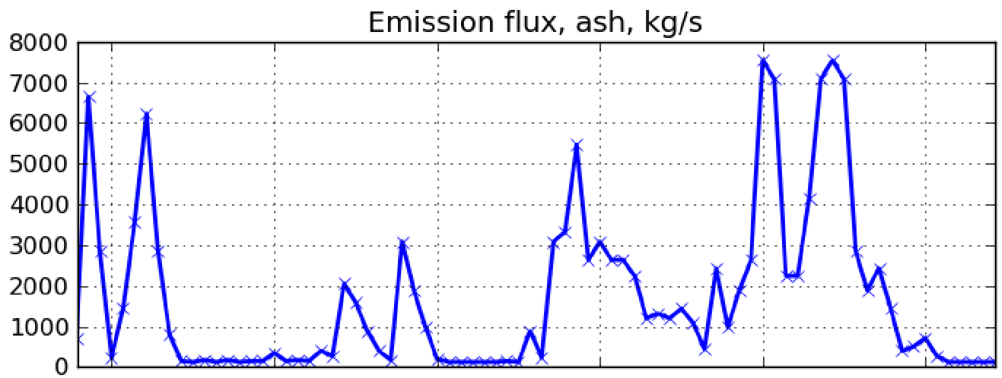
Ash AOD, April 14 – SILAM vs MODIS





MODIS data obtained via the GIOVANNI website

Source terms: Eyjafjallajökull



~ 5.9 Tg total

- **Plume height from 12 h averaged radar observations**
- **Ash emission computed using the Mastin et al. (2009) fit, assuming 2% LRT fraction**

Source terms in nuclear emergencies

- **Released amounts often estimates as fractions of the core inventory – the cocktail of nuclides present in the reactor**
- **The most volatile components are of primary interest**
  - Noble gases (Xe, Kr, …)
  - Halogens (I, …)
  - Alkaline metals (Cs,…)

Table 3.12 BWR Releases Into Containment*

	Gap Release***	Early In-Vessel	Ex-Vessel	Late In-Vessel
Duration (Hours)	0.5	1.5	3.0	10.0
Noble Gases**	0.05	0.95	0	0
Halogens	0.05	0.25	0.30	0.01
Alkali Metals	0.05	0.20	0.35	0.01
Tellurium group	0	0.05	0.25	0.005
Barium, Strontium	0	0.02	0.1	0
Noble Metals	0	0.0025	0.0025	0
Cerium group	0	0.0005	0.005	0
Lanthanides	0	0.0002	0.005	0

* Values shown are fractions of core inventory.
** See Table 3.8 for a listing of the elements in each group
*** Gap release is 3 percent if long-term fuel cooling is maintained.

Examples of releases in severe nuclear accidents(1 PBq = 10^{15} Bq)

- **Chernobyl (NEA/OECD, http://www.oecd-nea.org/rp/chernobyl/c02.html)**
  - ~6500 PBq Xe-133 (100%)
  - ~760 PBq I-131 (50-60%)
  - ~85 PBq Cs-137 (20-40%)
  - Additionally long-lived Sr and Pu isotopes, etc.
- **Fukushima (Stohl et al., 2012 ACP, inventory estimate + inverse computations, includes all units and spent fuel storage pools)**
  - 15.3 EBq Xe-133 (100%)
  - 36.6 PBq Cs-137 (2 %)