Zentralanstalt für Meteorologie und Geodynamik

Modelling the regional and long-range dispersion of radioactivity from the Fukushima nuclear disaster at the Austrian Weather Service: estimate of release rates and first model validation based on CTBTO measurement data

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- Overview of the Fukushima accident and ZAMG response
- Atmospheric transport modelling
- Source-term estimation
- First results on model validation
- Transport of radioactivity towards Europe
- Conclusions and Outlook

The course of the accident

- Earthquake: 11th March 2011 05:56z (Magnitude 9.0, 24 km Depth); automatic shut-down block 1-3
- Tsunami-Wave: 11th March 2011 at approx. 07:00z, loss of emergency power system and cooling system
- Explosion in unit 1: 12th March 2011 06:36z
- ZAMG started first model simulation on 12th March 09:00z
- Explosion in unit 3: 14th March 2011 02:01z
- Explosion in unit 2: 14th March 2011 21:14z
- Fire in unit 4: 14th March 2011 23:54z

The role of ZAMG

- **National**: Providing data, information and assessments to national authorities, ATM calculations
- **National**: NDC Austria, access to CTBTO data and products
- **International**: Representing WMO at the IAEA Incident and Emergency Centre (IEC), ATM calculations on request
- **International**: Representing WMO at CTBTO briefings in Vienna

ZAMG model simulation of the Fukushima accident

- Transport model: FLEXPART Version 8
- Meteorological input: European Centre for Medium-Range Weather Forecasts (ECMWF), global 1.0º, 3 hours (analyses and forecasts)
- Species simulated: ^{137}Cs (dry deposition, wet deposition, decay), ^{131}I (dry deposition, wet deposition, decay), ^{133}Xe (decay)
- Output grid: 0.5º, global, 10 vertical levels (0-500 m lowest level)
- Assumed start of release: 12th March 2011 08:30z

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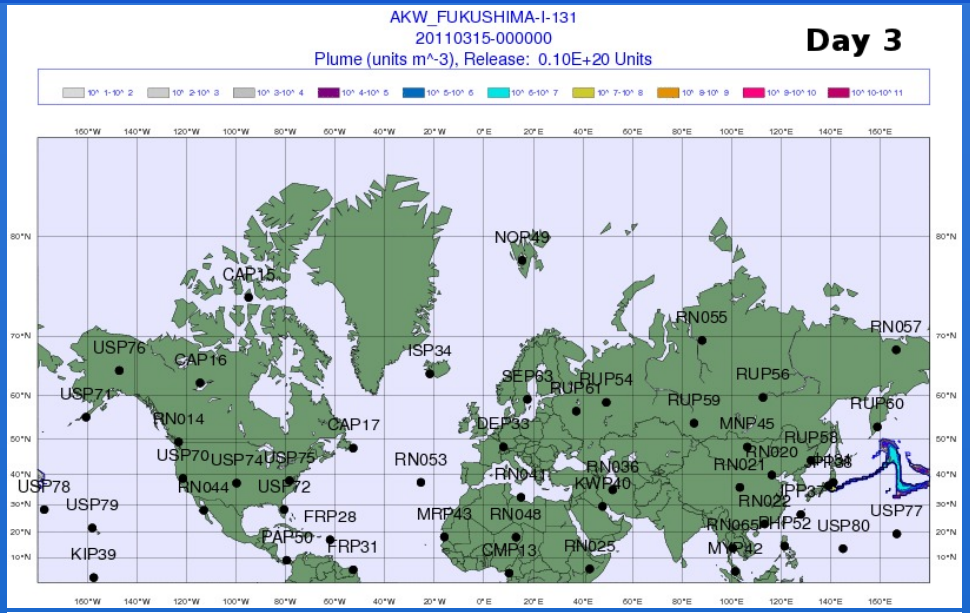
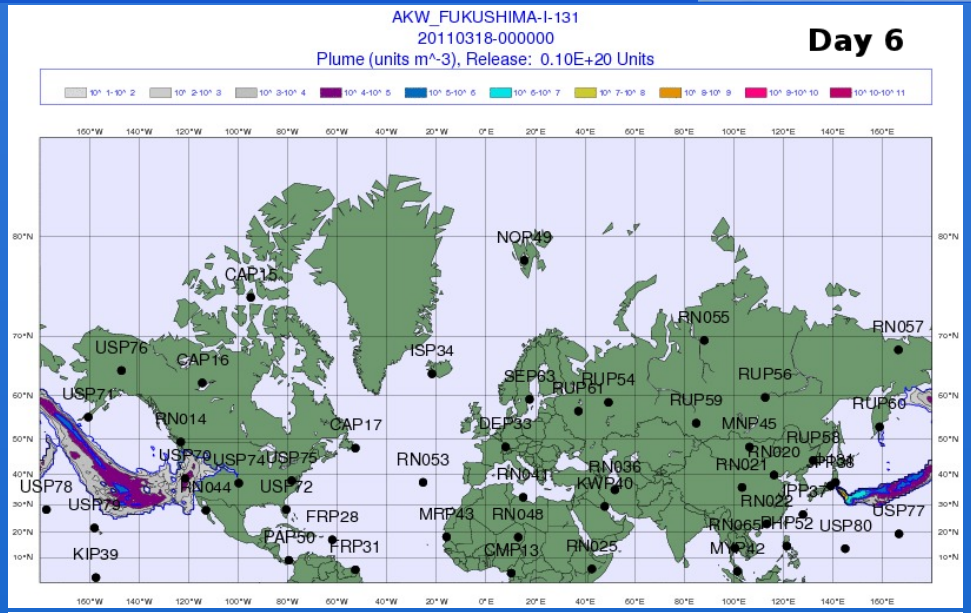
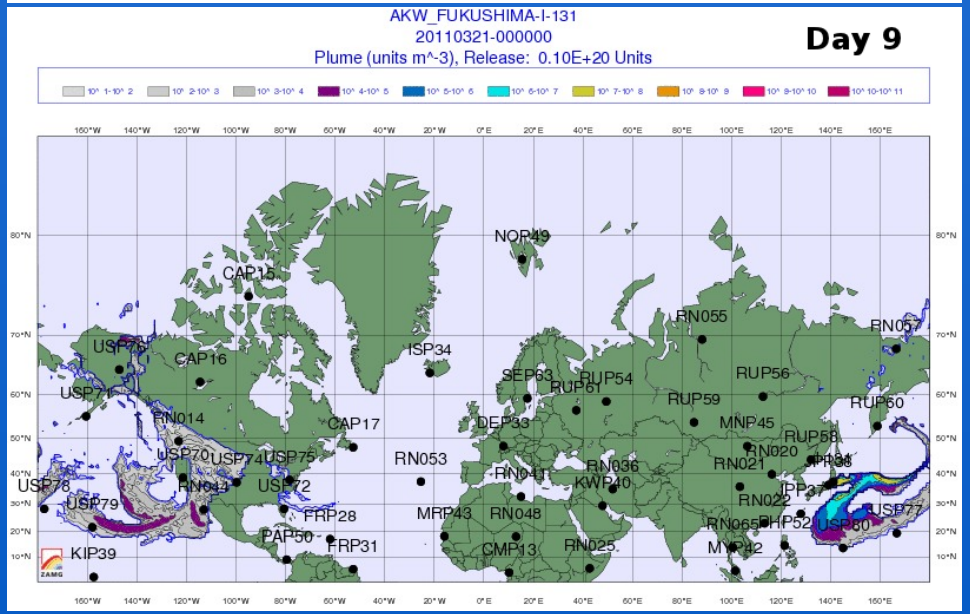
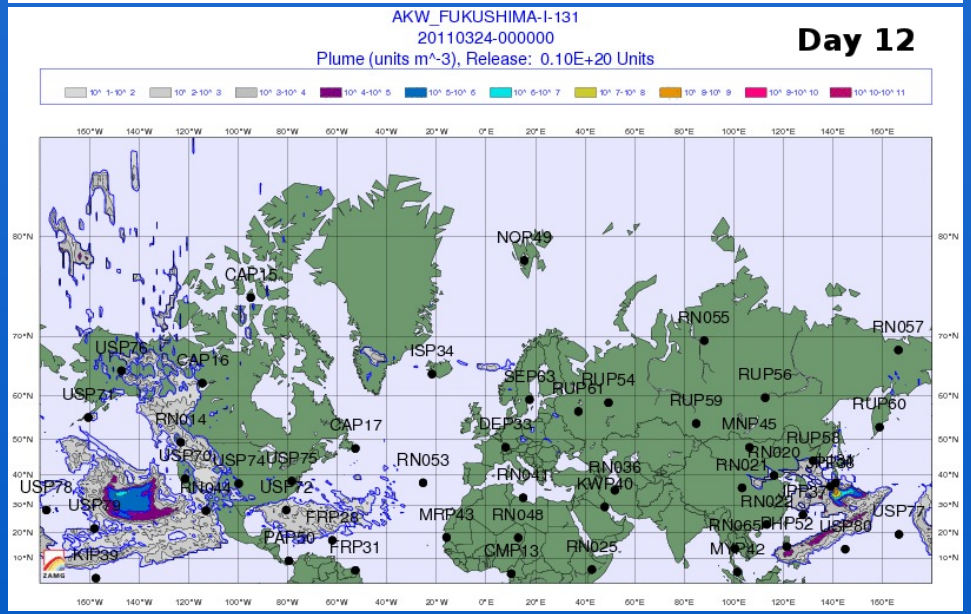
Simulation results









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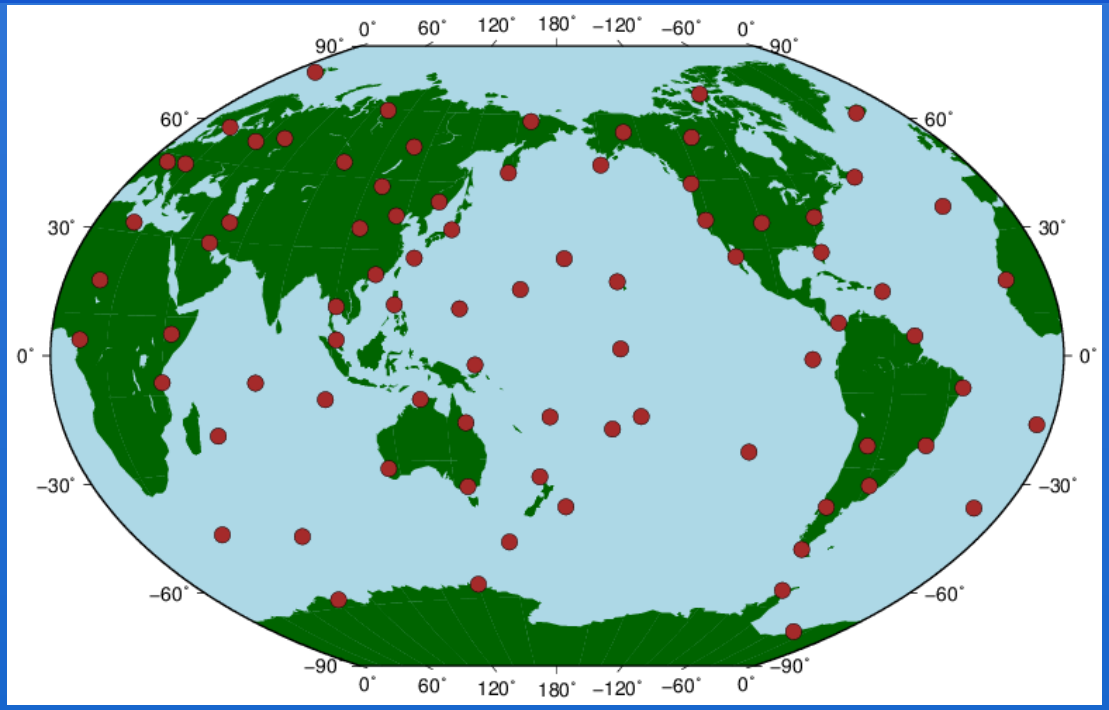
CTBTO-Measurements



- CTBTO RN measurements are well suited to
  - Validate the ATM simulations
  - Estimate the source terms of key nuclide
- Particulate network: Detection of ^{131}I and ^{137}Cs (MDC: 1 μBqm^{-3})
- Noble gas network: Detection of ^{133}Xe (MDC: $\approx$ 0.1 mBqm^{-3})

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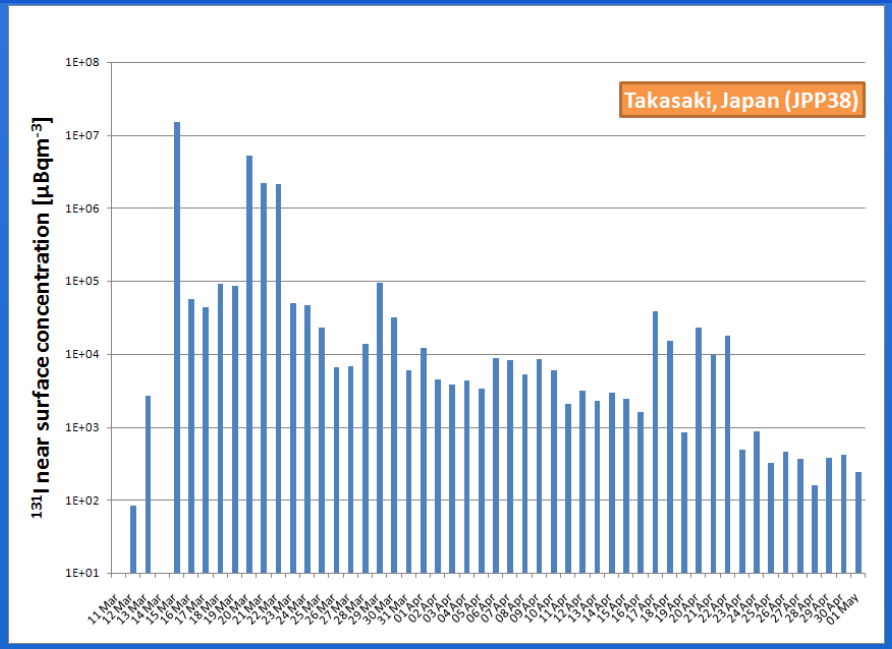
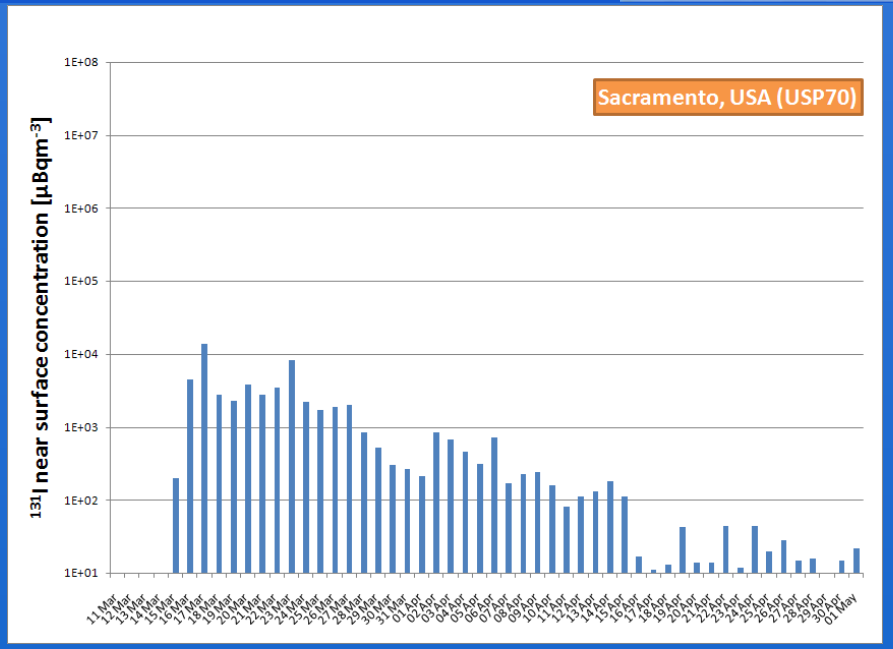
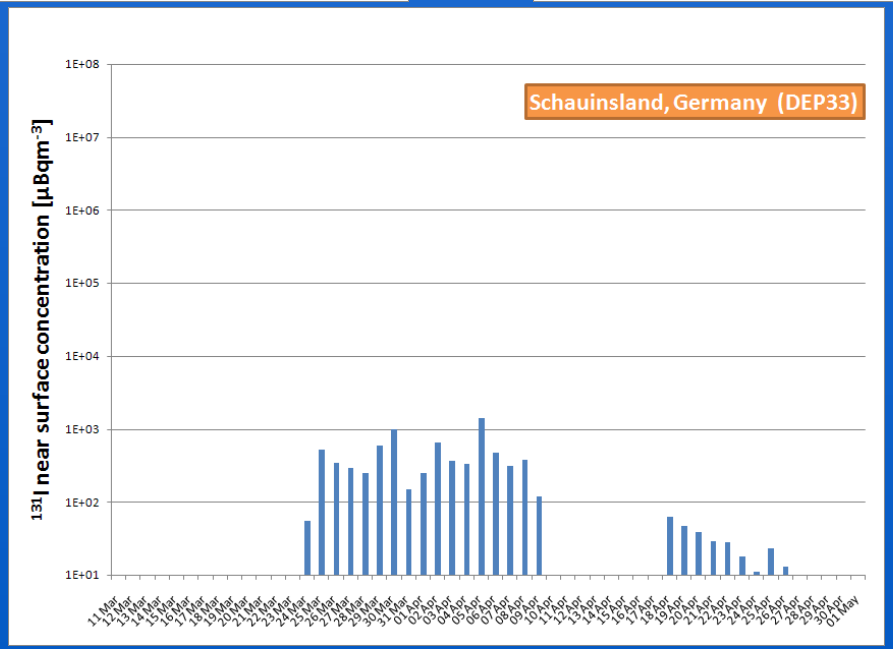
CTBTO Measurements: Plume arrival







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- First estimation of the source terms from Fukushima was given by ZAMG on 22th March 2011
- First estimates based on CTBTO radioactivity measurements showed:
  - High emissions of ^{131}I und ^{137}Cs during the first accident days: 10^{17}Bq/day ^{131}I, 10^{16} Bq/day ^{137}Cs
  - Emissions occurred already on the 12th/ 13th March

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- 24th March 2011: IRSN, France; emissions 12th – 22th March; $^{131}I \approx 2 \times 10^{17}$Bq, $^{137}Cs \approx 3 \times 10^{16}$ Bq
- 12th April 2011: Japan Nuclear Safety Commission and Japan Atomic Energy Agency: $^{131}I \approx 1.5 \times 10^{17}$ Bq, $^{137}Cs \approx 1.2 \times 10^{16}$ Bq
- Unofficial IAEA and CTBTO emission estimates were initially orders of magnitude too low

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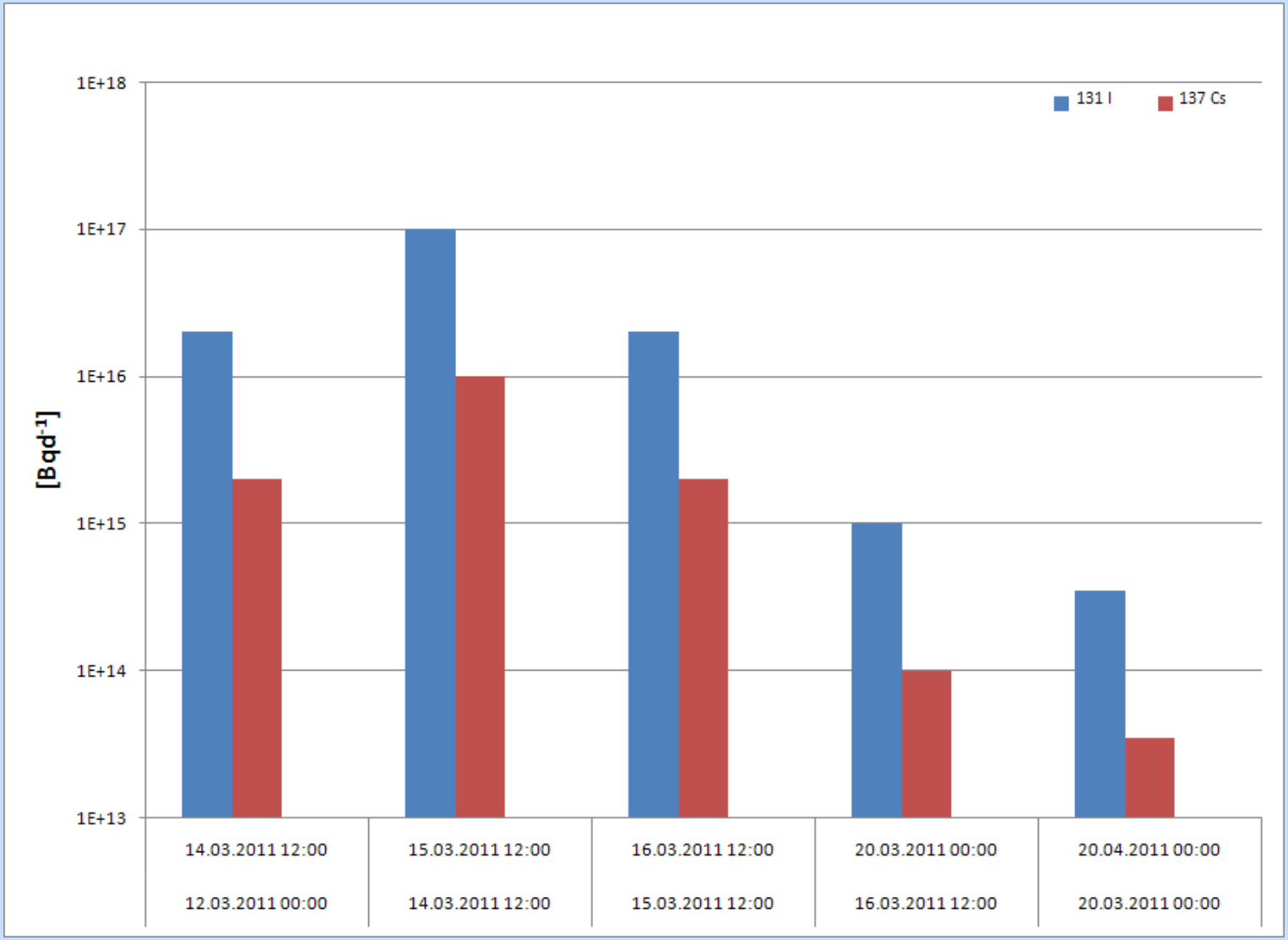
„Real“ Fukushima Source term was relatively complex



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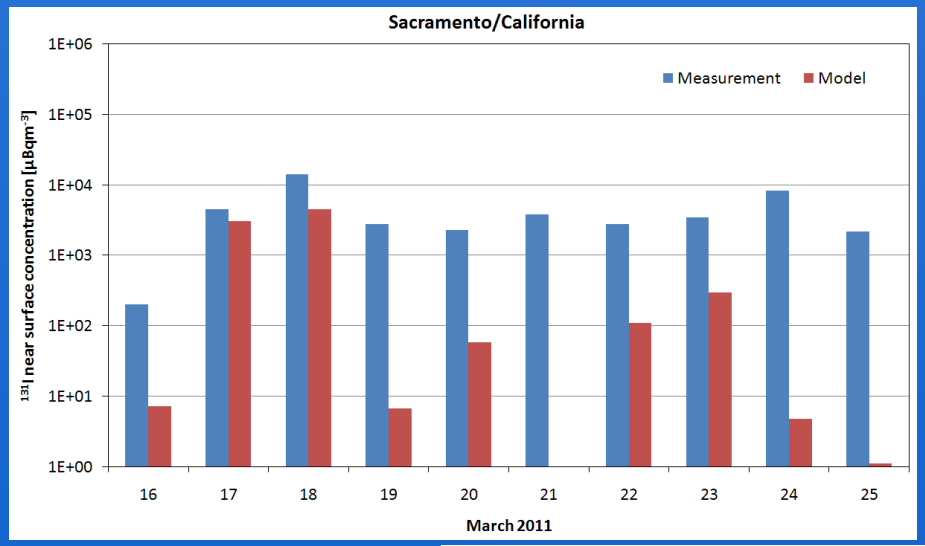
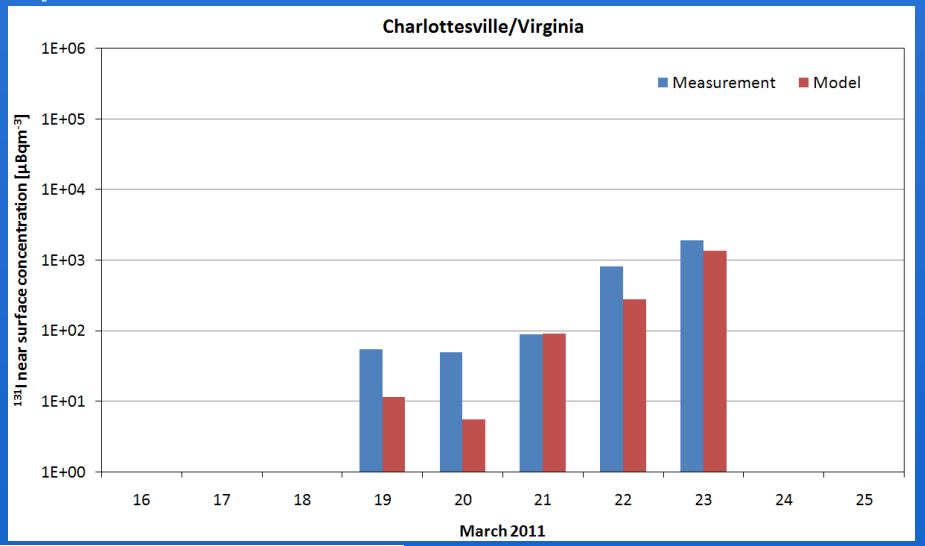
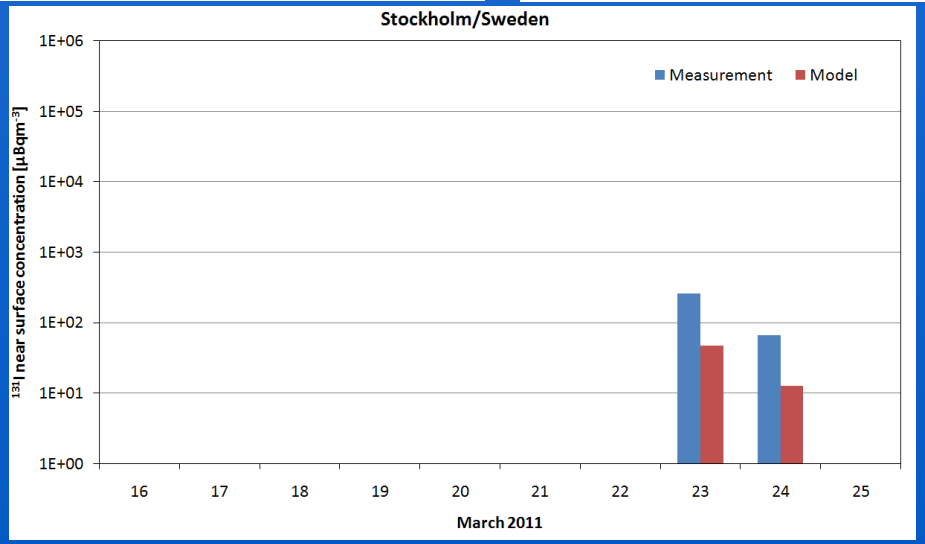
First results on model validation

The ZAMG Emergency Response System performed very well in simulating the arrival of the radioactivity plume from Fukushima at the U.S. West and East Coast and to Europe.







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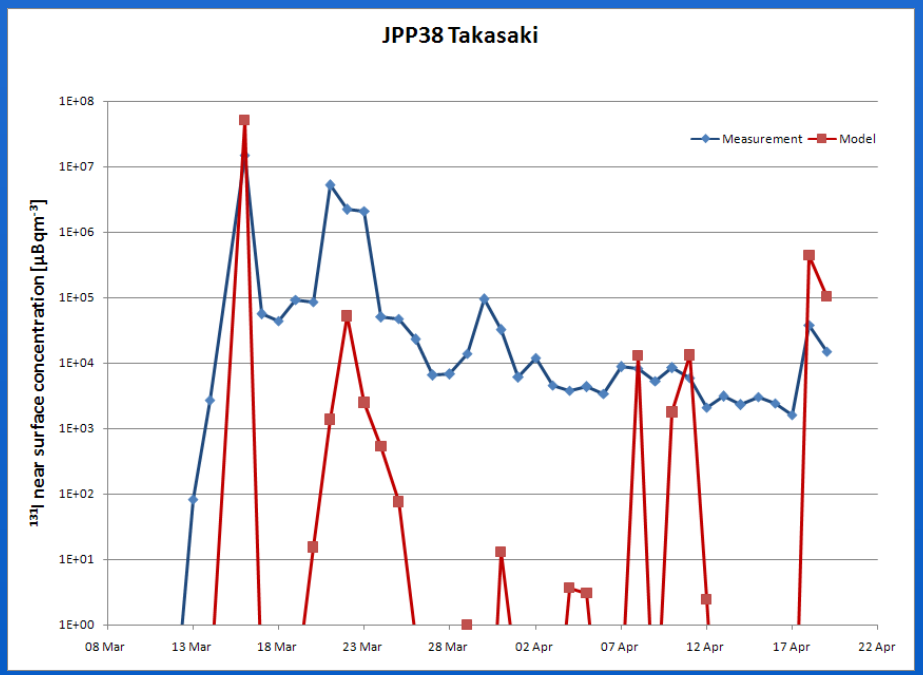
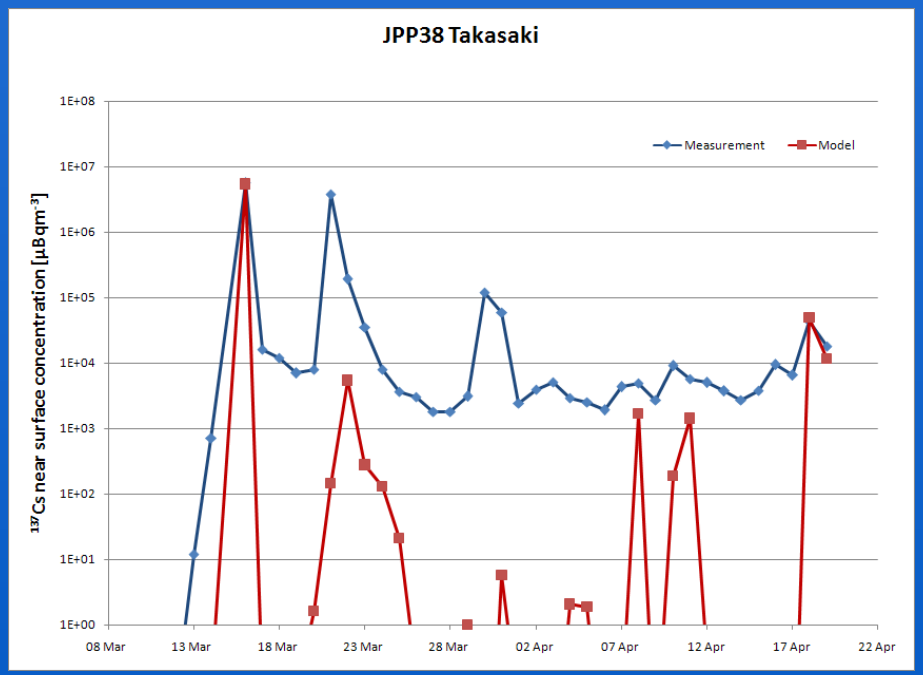
Comparison with CTBTO measurements in Takasaki, Japan (JPP38)

- Initial Releases of ^{131}I and ^{137}Cs well constrained by CTBTO measurements in Takasaki
- Subsequent comparison is difficult – detector was contaminated by high radiation levels





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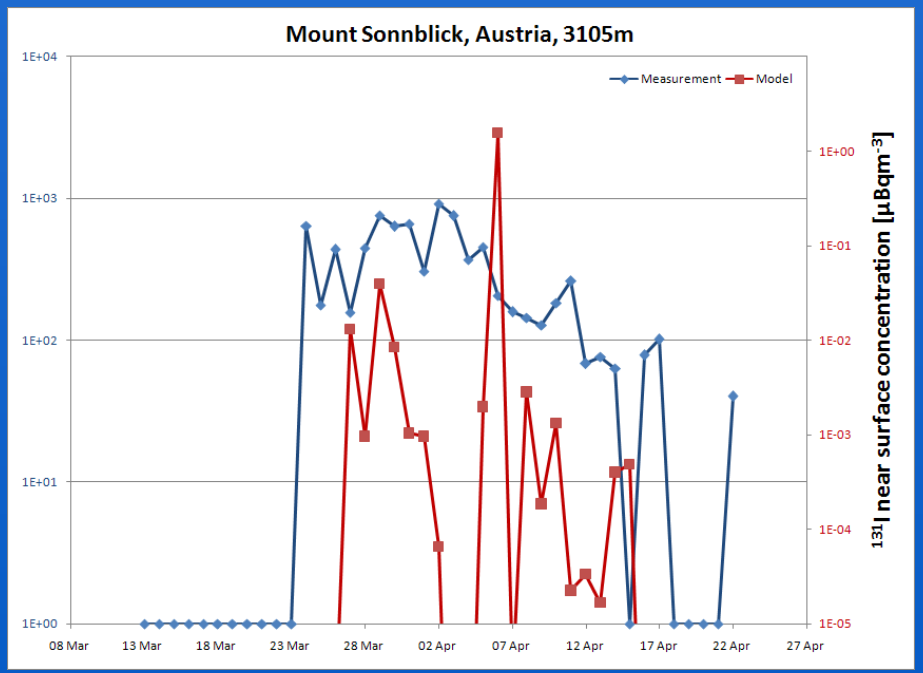
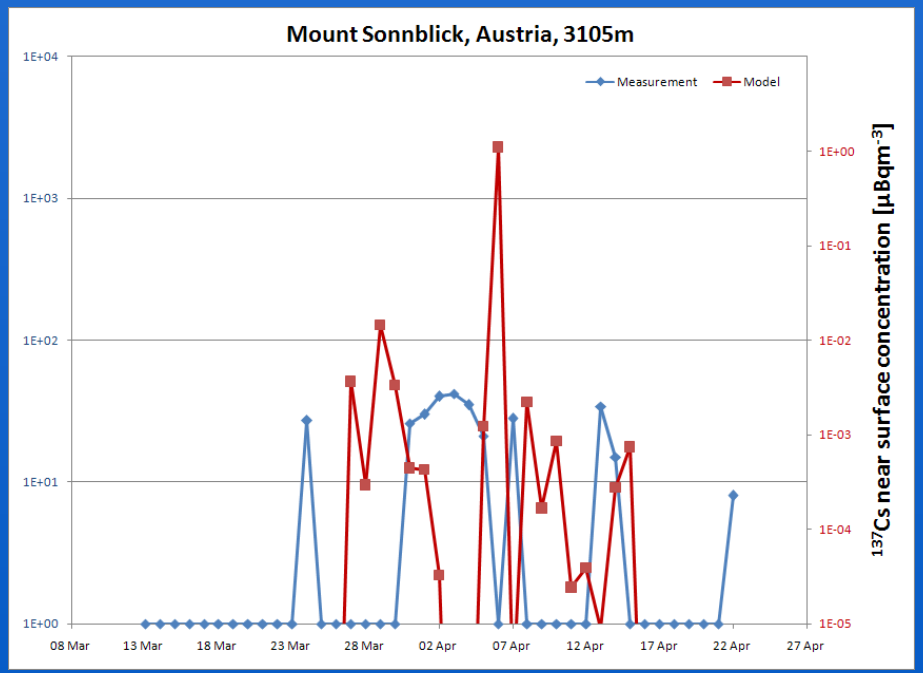
Models underestimated transport to Europe

- Period of elevated ^{131}I and ^{137}Cs levels was well predicted and reproduced by models
- ^{131}I levels under-predicted by factor 1000
- ^{137}Cs levels under-predicted by factor 100





- High initial emission estimates from Fukushima are confirmed by later studies
- Work is still needed to establish the exact emission sequence from the NPP
- CTBTO RN data proved to be extremely important to assess the situation after the accident
- Transport of radioactivity across northern hemisphere was well reproduced by models
- Level of contamination was highly underestimated by models
- Need for controlled experiments with substances subject to deposition

Thank you for your attention !

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