# Design of the 3rd ATM-Challenge 2019: Scenario and practical guidelines

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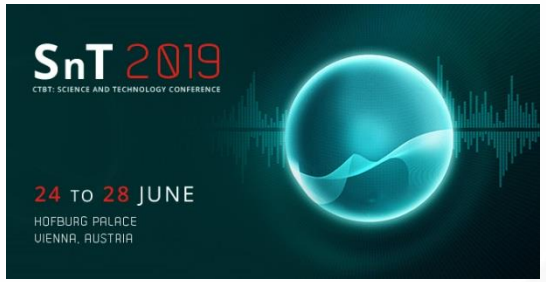
ZAMG: Zentralanstalt fuer Meteorologie und Geodynamik, Vienna, Austria
CTBTO/IDC: Comprehensive Nuclear Test-Ban Treaty Organization/International Data Center, Vienna, Austria

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# 1. History of ATM-Challenges (1st and 2nd ATM-Challenge)

**Purpose:** „*To ascertain the level of agreement one can achieve between real IMS measurements and those simulated using only the stack release data and ATM*“

| | Challenge 2015[1] | Challenge 2016[2] |
|---|---|---|
| Nummer of participants | 13 | 17 |
| Emission source & time resolution | IRE (Belgium); Nov., 10th - Dec., 8th, 2013, 15min | ANSTO (Australia); May, 11th - Jun., 11th, 2016, hourly |
| IMS stations involved & distance | SEX33, 380 km | AUX04, AUX09, BRX11, FRX27, NZX46, GBX68; 680 - 17000 km |
| Method: | Time series for collection times with actual emissions given | Time series of dilution factors for individual unit emission releases, *actual emissions not given -> „Blind test“* |
| Isotope: | Xe-133 | Xe-133 (Xe-135 investigated, but no measurements above MDC) |

[1] Publication from P. W. Eslinger et al.: http://dx.doi.org/10.2016/j.jenvrad.2016.03.001

[2] Publication from C. Maurer et al.: https://doi.org/10.1016/j.jenvrad.2018.01.030

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# 2. Set-up of 3rd ATM Challenge

*The scenario:*

- **6 months of** atmospheric dispersion **simulations** (June to November 2014) to cover seasonal variations and yield robust statistics
- **Four target stations** frequently hit by known emitters in the Northern Hemisphere within this time frame: **USX75** (Charlottesville), **DEX33** (Schauinsland), **SEX63** (Stockholm) and **CAX17** (St. John's)
- **Sources:**
  1. **Main sources: Daily releases** from MIPFs **Chalk River Laboratories (CRL)** and **L'Institut National des Radioéléments (IRE)**
  2. **Minor sources: Daily NPP** and **reserach reactor releases in the Northern Hemisphere. Annual releases** from **Mallinckrodt**, **NIIAR** and **Karpov** facilities.
- **Coordination Team: ZAMG, CTBTO/IDC, CMC & NOAA-ARL**

*Aim:* First step in the transition from merely scientific case studies to the practical use of forecasting radioxenon background at selected IMS stations. Thus, we include as many emitters as possible and target at statistically robust results.

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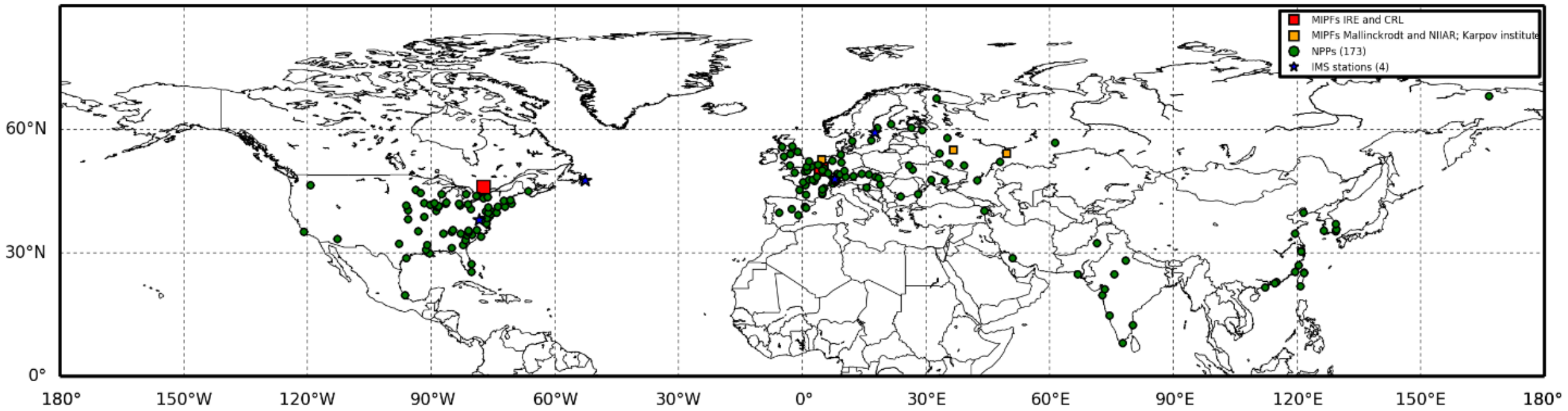
# 3. Locations of emitters and receptors for the 3rd ATM Challenge

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# 4. A pending need: Prescribing more model set-up parameters for enhancing comparability and diversity

- Four possible emission resolutions (daily, half-daily, 3-hourly and hourly) were prescribed to participants of the 2nd ATM Challenge in order to perform the „*Blind Test*“ approach. However, there was **critics of comparing non-uniform spatial resolutions concerning the model output.**

- Thus, **set-up parameters should be harmonized and controlled as much as possible** in a next challenge.

- For this purpose a **questionnaire was sent out** to participants in October 2017 to check what could be achieved.

- **Answers from 11 respondents** received by the end of October 2017.

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# 5. Parameters in question and feedback received I

1. Dispersion model
   - Type: *Cannot be pre-scribed.* Each organization uses its specific dispersion model or a specific version of it.

2. Meteorological input data
   - Type: May be pre-scribed for some participants if input data pools for FLEXPART and HYSPLIT are established by the scenario team. Not all FLEXPART users should use ECMWF input and not all HYSPLIT users NCEP input.
   - Spatial (horiz. & vert.) resolution: Consequently may be pre-scribed too.
   - Temporal resolution: Maximum possible for everybody is 3-hourly resolution.

3. Model output
   - Spatial resolution: Maximum possible for everybody is 0.5°.

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# 5. Parameters in question and feedback received II

- **Temporal resolution:** Maximum possible for everybody is one hour. However, this is not a critical parameter, since concentrations will be anyway averaged over the IMS station sampling interval.
- **Vertical resolution:** Surface output layer could be pre-scribed.

4. Simulation direction
   - **Forward or Backward:** Participants can choose as they like.

5. Emission resolution
   - **Temporal resolution:** Maximum of one hour (for MIPFs) possible for everyone. Results for lower resolutions can be produced in a post-processing step simply by averaging if they are integer multiples of the original one. However, primary focus will be on daily emission resolution (see „*Quantifying uncertainties in the Atmospheric Modelling (ATM) simulations resulting from different emission time resolution*"/T4.4-P10). All the sources proposed can be handled.

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# 5.Parameters in question and feedback received III

## 6. Number of particles released and internal model time step

- May be pre-scribed. Largely depends on organizations‘ hardware and how well the dispersion modell is coded (static versus dynamical allocation).

## 7. Parameterizations

- May be pre-scribed. **Diversity is needed!** All the more as the ensemble of model runs will likely not be optimally diverse due to two dominating meteorology-model combinations (NCEP-HYSPLIT and ECMWF-FLEXPART).

## 8. Simulation length

- 6 months feasible for nearly all of the participants. But not a must. 3 months (July till September) would be fine as well. However, full 3 months are mandatory.

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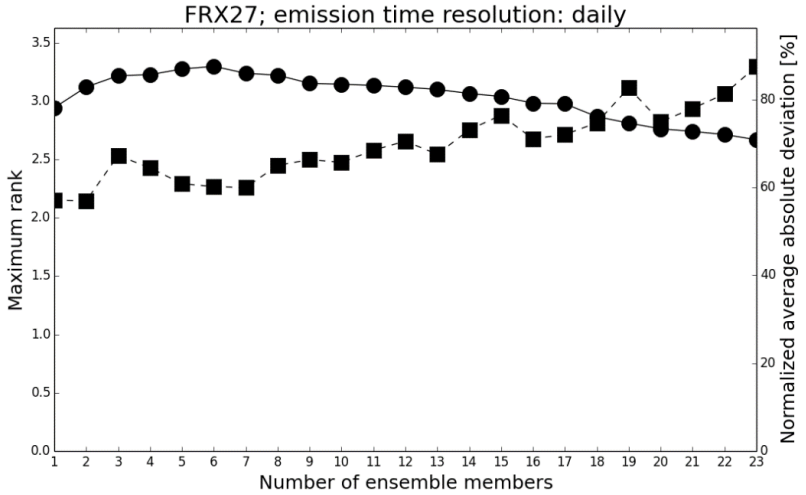
# 6. Ensemble approach: Cooperation with the Joint Research Center (JRC)/ISPRA/Italy

- Averaging all model runs together in a multi-model exercise where similar model errors may be encountered is not appropriate and therefore we need to select an optimum ensemble combination!
- An optimum ensemble combination per station (and per season) can be trained with **sufficient data.** Therefore 6 months of simulation are planned. 2/3 of the time span will be used for training, 1/3 for evaluation purposes.
- An **optimum ensemble outperforms the best individual member and keeps a good balance between accuracy and diversity**!

Example from the 2nd ATM Challenge

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# 7. Hints and things to bear in mind for the computationally intensive simulations

- **Use „particle aging“**, e.g., 14 days from the time of release. There is no need to track all emissions until the simulation end (Xe-133 has half-life of ~5 days ).
- **Split the simulation period in two chunks of equal length. Define an overlap period according to particle aging.** During the overlapping period contributions from the two runs have to be summed up.


- **Perform two separate runs** (per simulation sub-period) **for main and minor emitters.**
    1. Main emitters need to be included based on a unit-emission approach according to a release date-time template provided. **Emissions need to be tracked individually**!
    2. Minor emitters can be lumped together. **There is no need to track emissions individually!**
- **Inclusion of minor sources is optional!**

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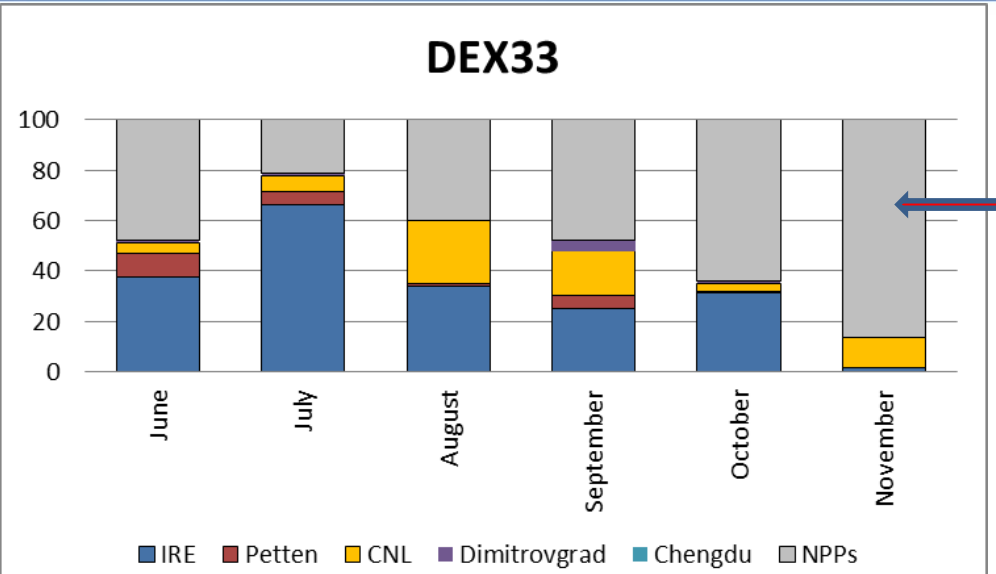
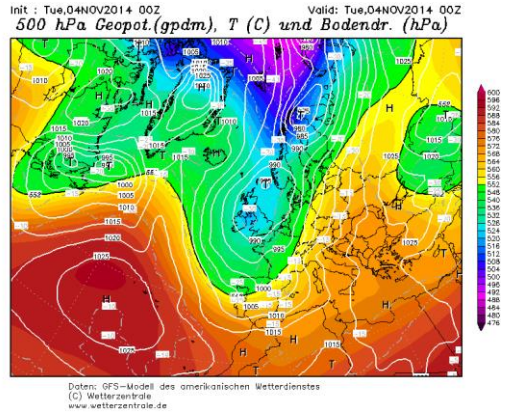
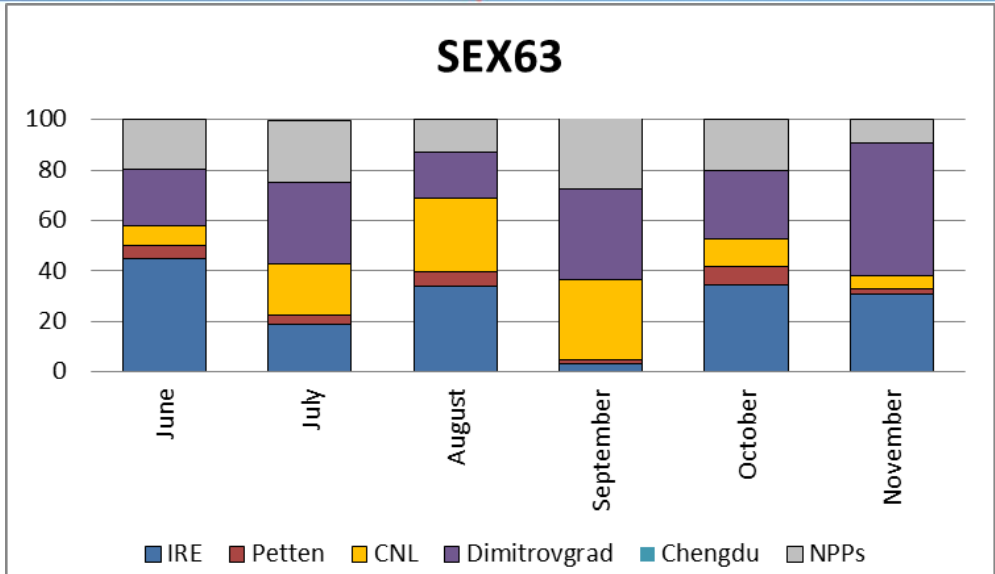
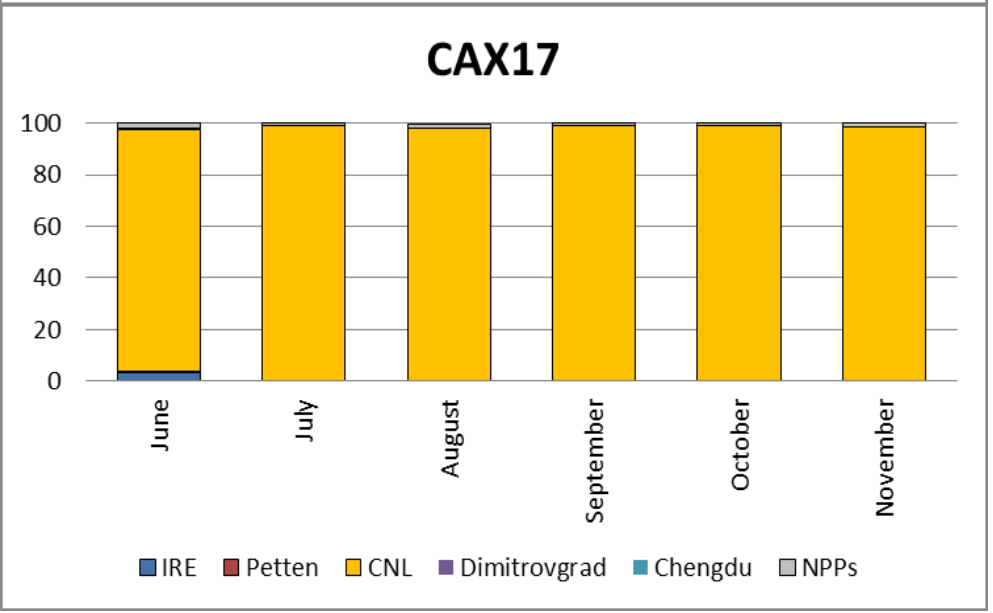
# 8. Monthly Xe-background in 2014



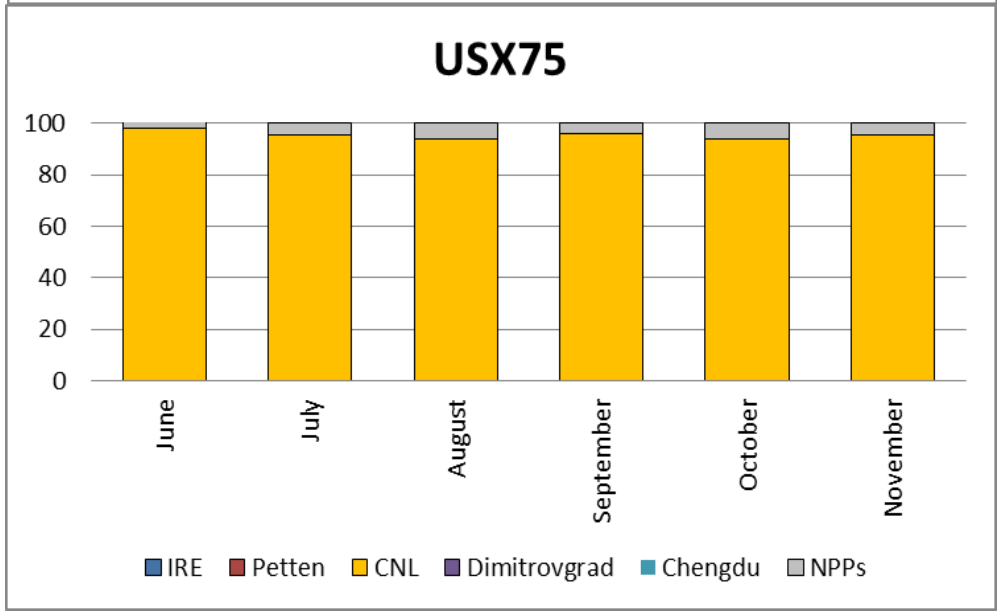




Gueibe et al. (2017):
IRE: 2E15 Bq/y
CRL: 1.5E16 Bq/y

CRL has highest annual values!
Percentage values are based on actual concentrations in Bq/m3



# 9. Persued timeline for the 3rd ATM Challenge

- **Start of the 3rd ATM Challenge in 2019**
- Participants (if they want) start the procedures necessary for a vDEC agreement.
- **Participants inform the scenario team about their planned model set-up within two weeks. Discussing with participants which elements of the set-up can be pre-scribed.**
- **Participants get 12 weeks** – as requested in some of the filled-in questionnaires – to complete the runs.
- IRE & CRL emissions as well as IMS measurement data are supplied to participants (provided they signed the vDEC agreement).
- Results to be shown at the next WOSMIP workshop.

If you have any suggestions related to the design of the 3rd ATM Challenge please state them right now!

THANK YOU FOR YOUR ATTENTION!

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