Progress in integrated assessment modelling in the Russian Federation

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Recent IAM activities in Russia

Further investigation of the advantages of new regionalization in the GAINS Russia model.

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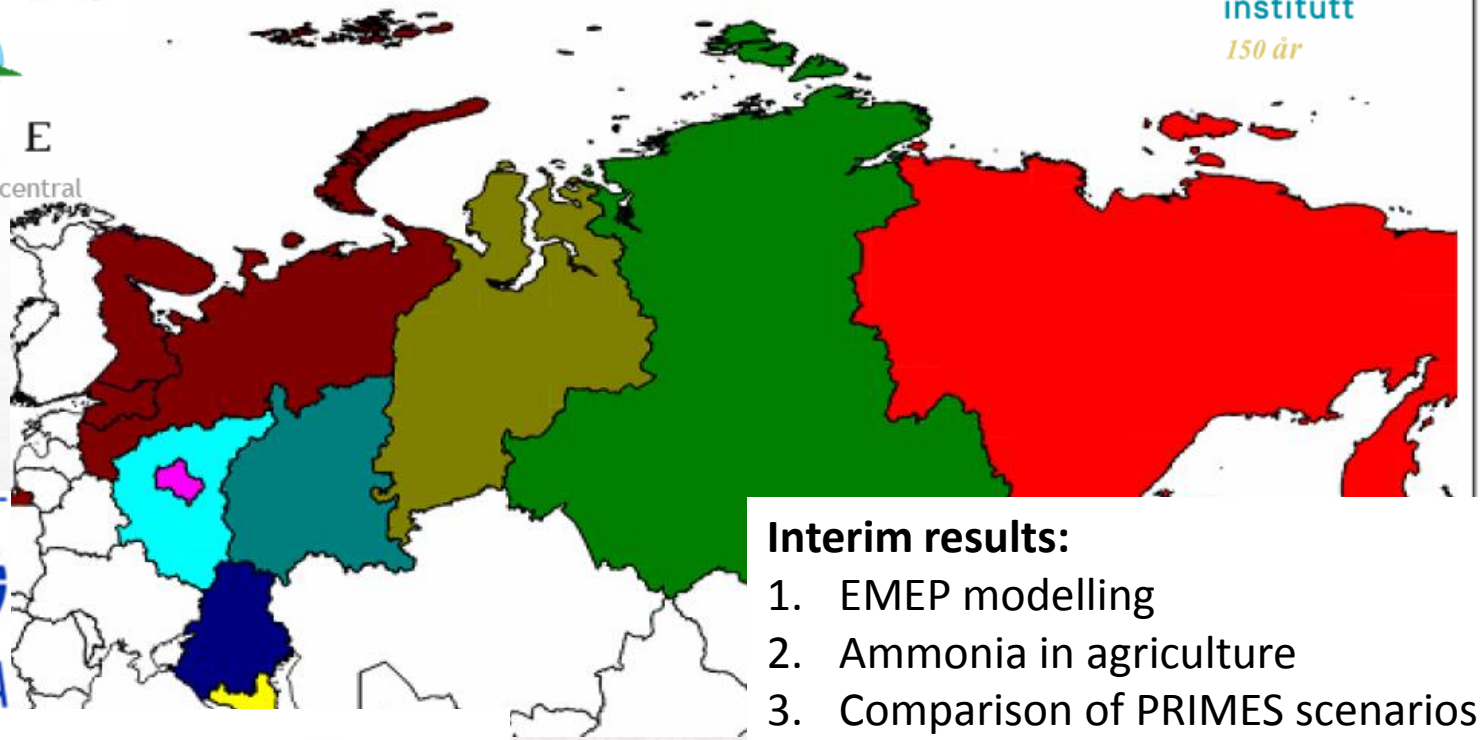
SYKE
Finlands miljöcentral

Meteorologisk institutt
150 år

SRI ATMOSPHERE

IIASA

norden



Interim results:

1. EMEP modelling
2. Ammonia in agriculture
3. Comparison of PRIMES scenarios
4. BC (gridded) EI comparison

1. EMEP modelling: recent developments

1. **Analysis of CEIP data**:

- European part of the Russian Federation, 2012
- Gridded emissions 50 km x 50 km
- Aggregated emissions by administrative units

The purpose – to identify discrepancies caused by suspected incorrect location of point sources assumed by CEIP and to suggest recommendations on data corrections.

2. Preparations for reporting in 0.1 x 0.1 ° resolution starting from 2017 – producing **gridded emissions for Murmansk oblast in 0.1 x 0.1°** (to implement in the TNO/INERIS data available in the same resolution and make test model runs with national data for the pilot region).

1. EMEP modelling: Murmansk oblast

North-Western Federal District

Located within the Arctic zone and close to Nordic countries (neighboring Finland and Norway)

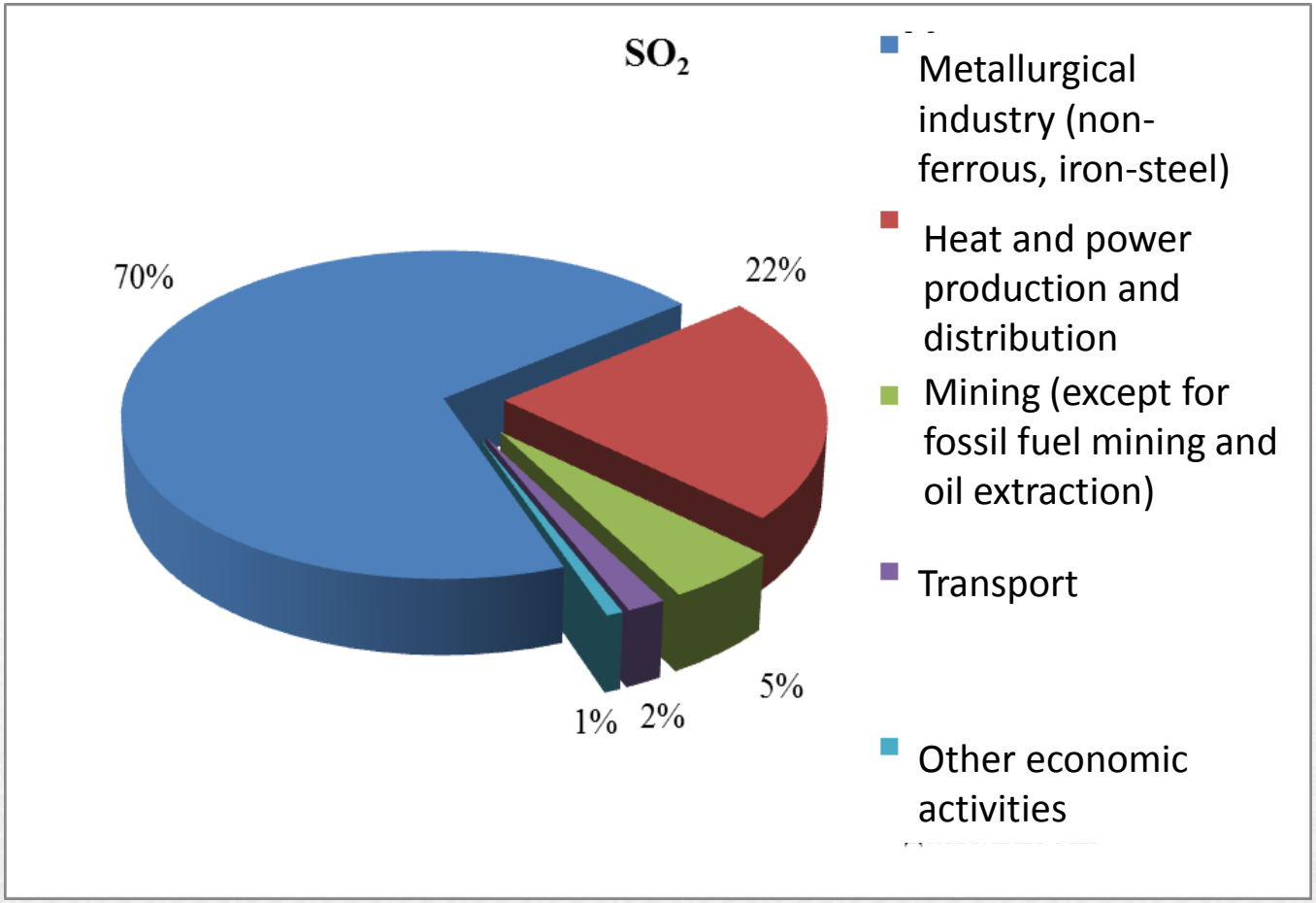
Population in 2016 – ~ 760 th people

Major emission sources:

- Production of nickel and aluminium
- Power plants (Murmansk, Apatity)
- Iron and steel industry

1. EMEP modelling: Murmansk oblast

Leader on SO2 emissions among the administrative subjects of the European part of the Russian Federation – 18% of total SO_2 emissions on ETR (2012)



1. EMEP modelling: CEIP vs. national data, SO_2 in 2012

Regions with major differences

diff = Rosstat (national) – CEIP data

N	Region	Diff, kt
1	Murmansk oblast	182
2	Komi Republic	94
3	Orenburg oblast	87
4	Moscow oblast	-69
5	Arkhangelsk oblast	58

Difference for ETR ≈ - 131 kt

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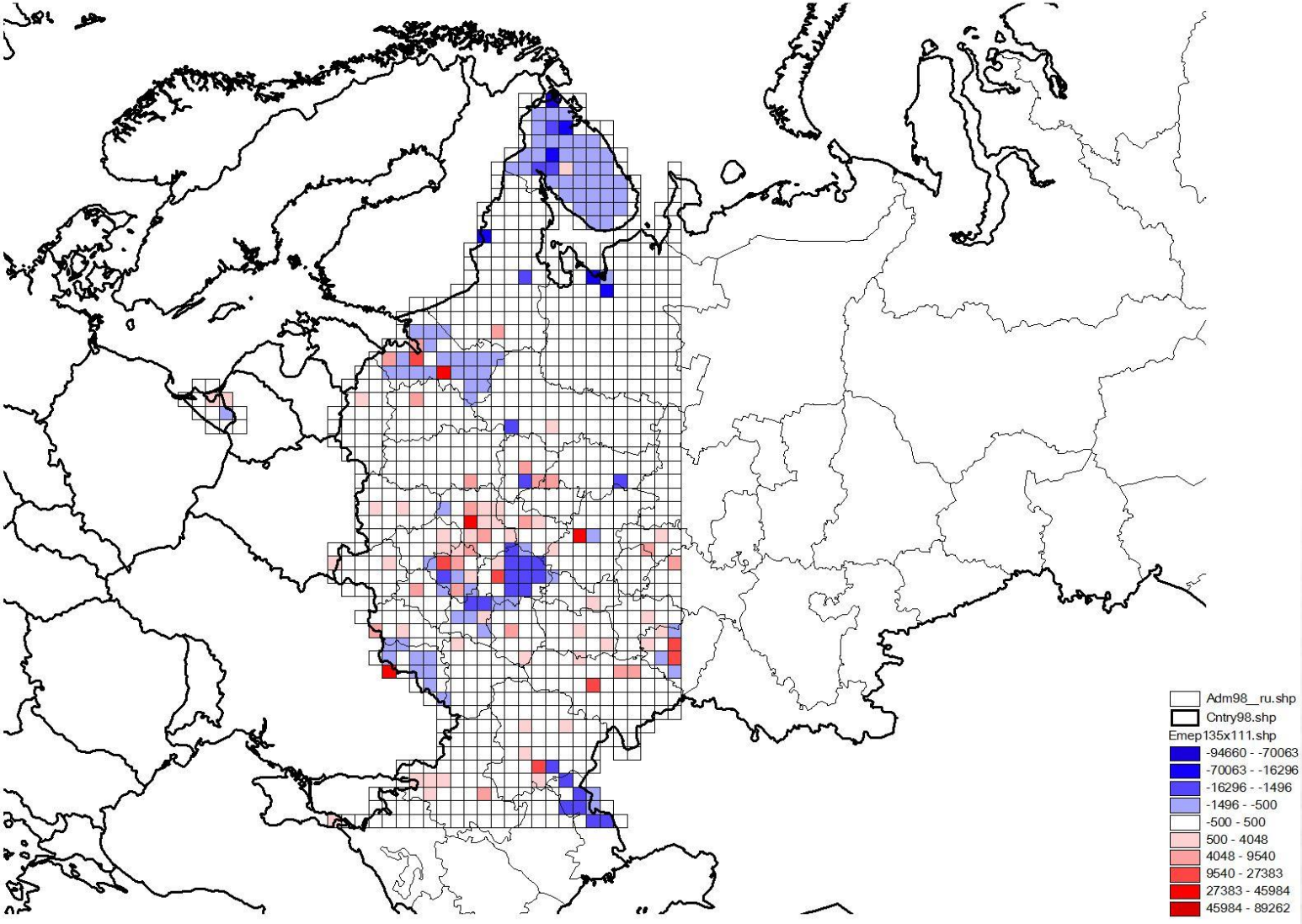
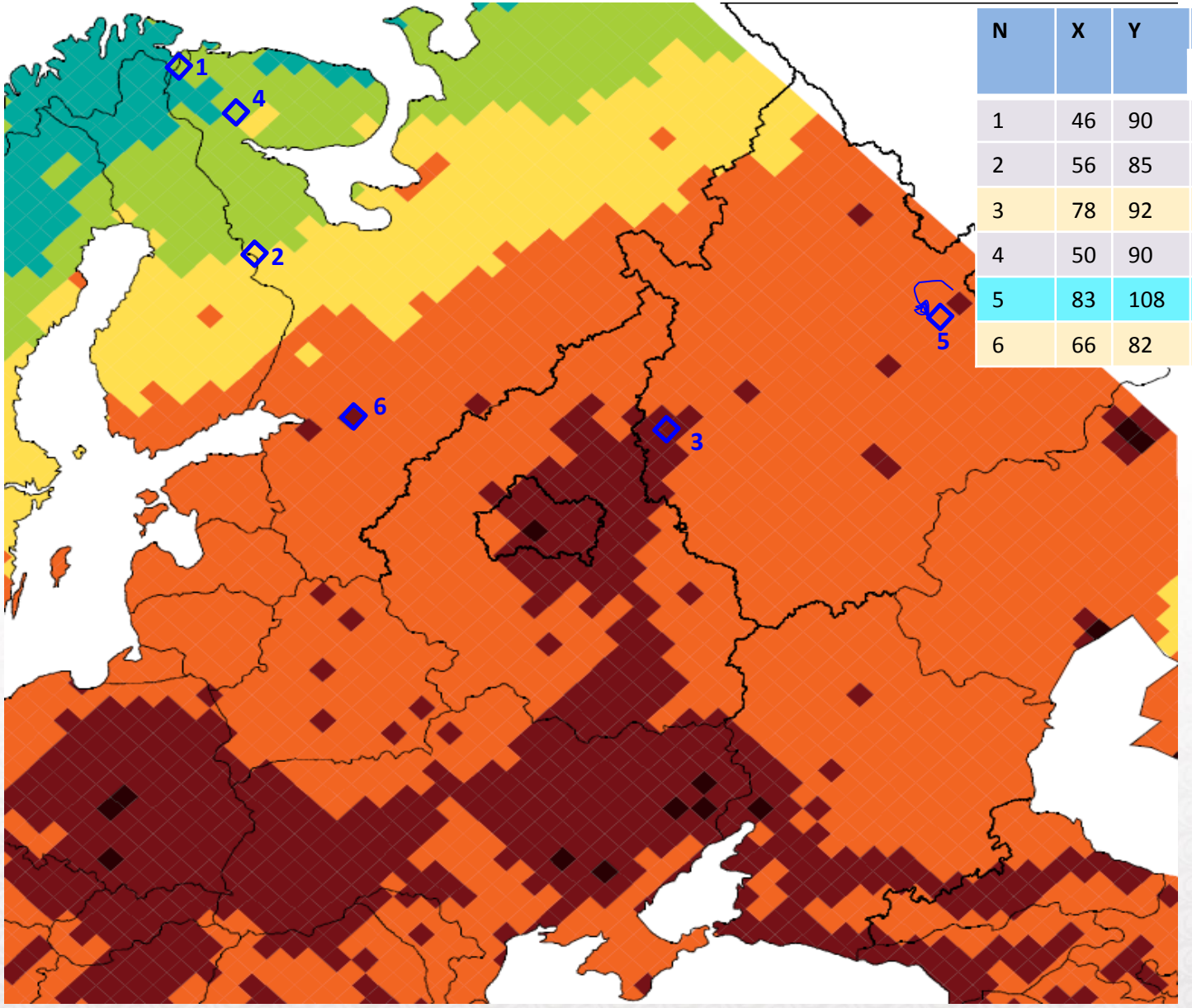
1. EMEP modelling: CEIP vs. national data, SO_2 in 2012



1. EMEP modelling: Suggested data corrections



N	X	Y	kt SO_2 in 2012		
			Nat.	CEIP	Diff
1	46	90	105	4	101
2	56	85	42	0.06	42
3	78	92	0.4	39	-39
4	50	90	34	0.2	34
5	83	108	0.2	31	-31
6	66	82	18	43	-26

SOx depositions, $mg/m^2/year$ 2010 (GAINS Russia)

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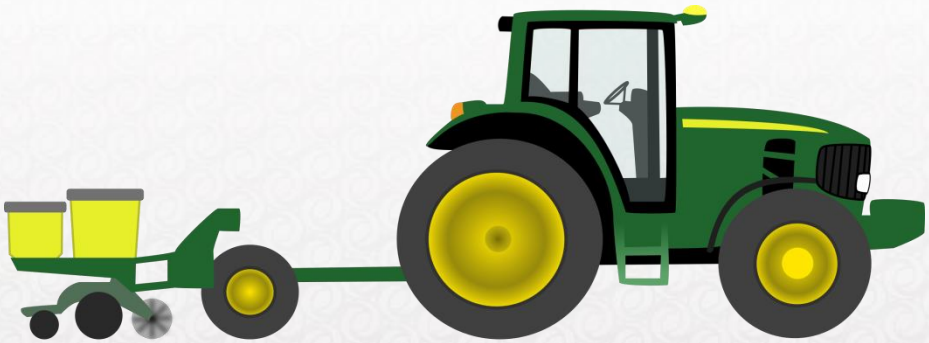
2. Ammonia: emissions and health impacts

”A leading cause of air pollution in… Russia…is agriculture. Ammonia is emitted into the atmosphere as a result of intensive livestock farming and use of fertilizers. It then reacts with other air pollutants…to form ammonium sulphate and ammonium nitrate, which are tiny airborne particles.”

Acid News 4 – 2015, *Air pollution takes 3.3 million lives per year* by Christer Ågren referring to the article:

The contribution of outdoor air pollution sources to premature mortality on a global scale by J. Lelieveld, J. S. Evans, D. Giannadaki, M. Fnais and A. Pozzer; published in Nature, 17 September 2015; doi: 10.1038/ nature15371



2. Ammonia: national data vs IIASA's for 2010

Parameter	Unit	National (Rosstat)		IIASA	diff	diff, %
		Used in EI	GAINS			
Dairy cattle	10^6 animals	6.3	6.3	7.1	-0.8	-11%
Other cattle	10^6 animals	7.9	7.9	9.6	-1.7	-18%
Pigs	10^6 animals	12.7	12.7	10.3	2.4	23%
Laying hens	10^6 animals	-	66	89	-23	-26%
Other poultry	10^6 animals	349	283	146	137	93%
Sheep	10^6 animals	16.6	17.9	12.8	5.1	40%
Goats	10^6 animals	1.3				
Horses	10^6 animals	0.53	0.53	0.47	0.06	12%
Fur animals	10^6 animals	-	2.04	0	2.04	100%
Camels	10^6 animals	-	0.006	0	0.006	100%
Milk yield	kg milk/animal	-	4100	3500	600	17%

3.4 kt NH_3 = 0.8 % of total animal stock NH_3

2. Ammonia: GAINS vs emission inventory (AGR)

Federal District	Emissions from animal stock, kt				
	2010, EI (subm. 2017*)	GAINS Russia, baseline, national data		GAINS Europe, baseline, IIASA (TSAP 16)	
		2010	**2030**	**2010**	**2030**
Central	193	104	110	-	-
North-Western	47	31	33	-	-
Volga	231	153	166	-	-
South	116	70	70	-	-
North Caucasian	79	50	50	-	-
Total ETR	**666**	**427**	**450**	**392**	**423**

* Preliminary data, please do not quote

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2. Ammonia: UEF for livestock, kg/head

Parameter	GAINS (NOV-14)	Used in the EI (averaged from the Guidebook, Tier 1)
Dairy cattle	15.7	34
Other cattle	11.1	11.3
Pigs	5.6	10.9
Laying hens	0.37	0.48
Other poultry	0.32	0.55
Sheep	1.2	1.4
Horses	8.1	14.8
Fur animals	1.69	0.02

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2. Ammonia: MFR scenario

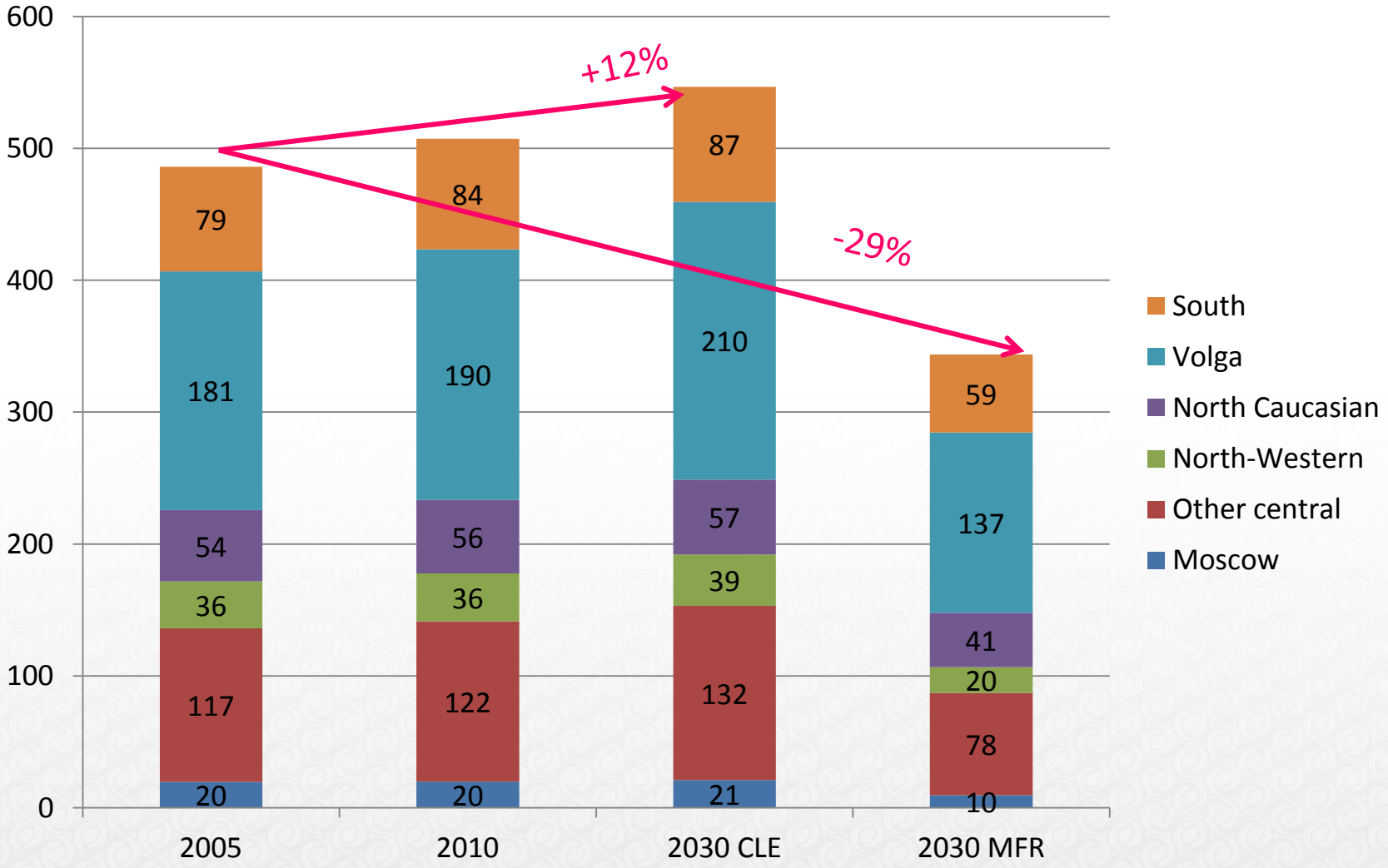
Target year – 2030

Same control strategy for all regions

Measures from MFR for EC4MACS (RUSS_EUROmfr_8437), e.g.:

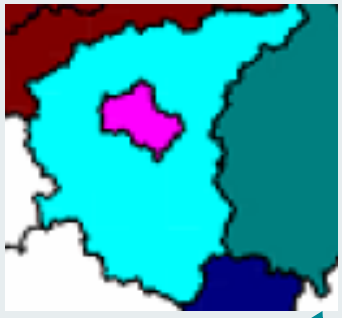
- *Cows* – low N feed + house adaptation + low ammonia application (44%)
- *Other cattle* – low ammonia application, high efficiency (84%)
- *Lying hens* – low N feed + house adaptation + low ammonia application (48%)
- *Other poultry* – low N feed + bio-filtration + covered outdoor storage + low ammonia application (39%)
- *Pigs* – low N feed + bio-filtration + covered outdoor storage + low ammonia application (70%)
- *Other animals* – low ammonia application, high efficiency (23%)
- *Urea application* – urea substitution (90%)
- *Mineral N fertilizer production* – combination of STRIP (100%)

2 Ammonia: Results MFR vs CLE: Emissions, kt (AGR)



Animal stock + fertilizer production and use

2. Ammonia: Results MFR vs CLE, 2030



	diff in emissions, kt	diff in PM2.5 concentration, µg/m3	diff in life expectancy loss, month	costs, MEuro
Moscow	11	0.22	0.16	36
Other central	55	0.19	0.14	179
North-Western	20	0.02	0.01	70
Northern Caucasus	16	0.07	0.05	61
Volga	74	0.20	0.15	264
South	28	0.17	0.12	105
TOTAL ETR	**204**	**0.12**	**0.09**	**715**

Indicative, preliminary results

Input from animal stock into totals:

- 78-93 % for emissions
- 66-96 % for costs

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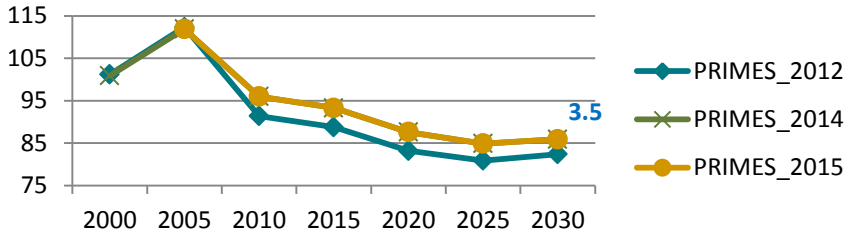
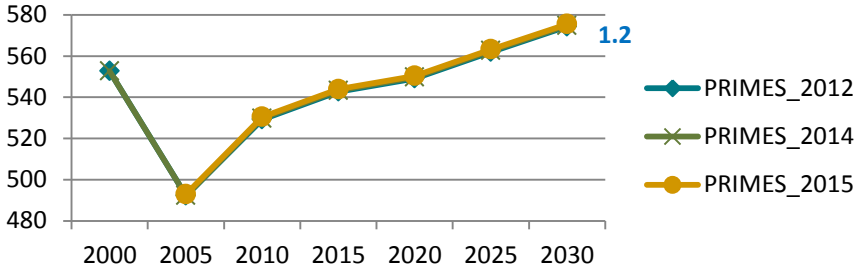
3. PRIMES: Emission differences

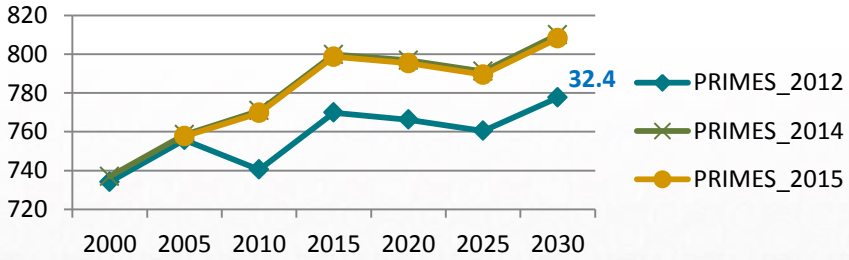
BC, kt



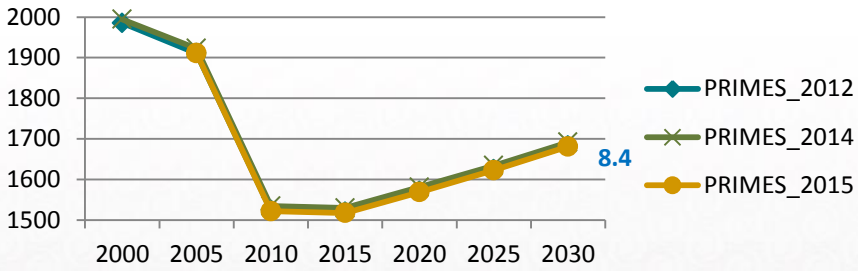
NH_3, kt



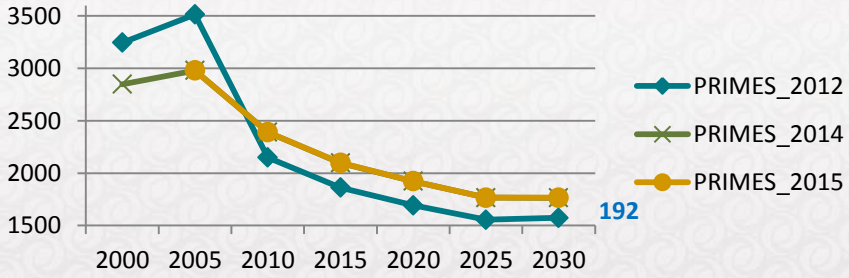
$PM_{2.5}$, kt



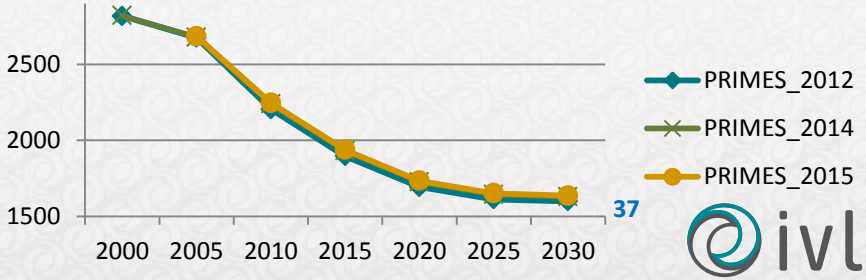
SO_2, kt



NO_x, kt



NMVOC, kt



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3. PRIMES: Main reasons for emission differences

Update in activity data – plus 300 PJ gas in pipeline compressors in 2030

Developments in the emission vector, in particular:

- New technologies and new emission factors for brick production
- Revision of emission factors for residential waste combustion
- Revision of emission factors for particles from road abrasion, tyre and break wear

Example – emissions of particles from road abrasion, tyre and brake wear (ETR)

BC, kt	PM2.5, kt	E-vector	Scenario
1.11	6.53	MAY12	PRIMES 2012
0.40	9.30	MARCH13	PRIMES 2014
0.40	7.37	NOV14	PRIMES 2015

4. Russian (gridded) BC emission inventories

Data taken mainly from the ECCAD-GEIA database
http://eccad.sedoo.fr/eccad_extract_interface/JSF/page_login.jsf

Compilation of 25 emission inventories and ancillary data

Global emissions with 0.5˚ spatial resolution and by source sector

SYKE collected BC emissions within the Russian borders from various inventories and compared the sums of the grid cells.

Newer inventories from IIASA and a recent paper by Huang et al. (2015)*

*Huang K., Fu J.S., Prikhodko V.Y., Storey J.M., Romanov A., Hodson E.L., Cresko J., Morozova I., Ignatieva Y. & Cabaniss J. 2015. Russian anthropogenic black carbon: Emission reconstruction and Arctic black carbon simulation. Journal of geophysical research, volume 120, issue 21: 11306-11333.

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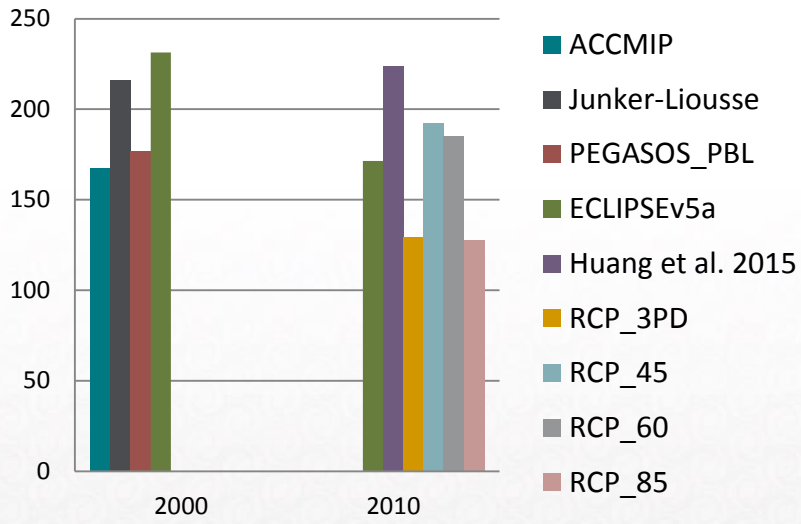
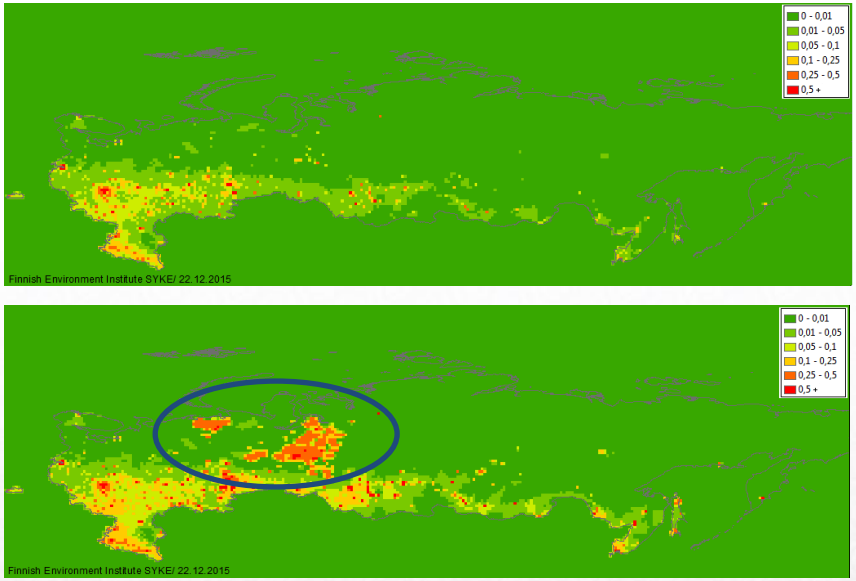
4. Russian (gridded) BC emission inventories

Total BC emissions by inventory, Russia [kt/year]



ACCMIP (above) and ECLIPSE (below) emissions in 2000



2000: ACCMIP and PEGASOS have the lowest total emissions, gas flaring being the most notable difference with ECLIPSE

2010: Huang et al. (2015) presents even bigger emissions from gas flaring, and suggests that other inventories may have underestimated these emissions

4. Russian (gridded) BC emission inventories

General observations

- About half of Russia's emissions comes from the European part
- The inventories give reasonably consistent total emissions for Russia, but have larger differences in emissions by sector
- Divergence in methods, initial assumptions and emission allocation
  - Gas flaring emissions appear to be very uncertain
- Local activity data and emission factors are rarely available

Highlights and conclusions

1	EMEP modelling	• Testing of fine resolution (0.1°) in EMEP is going on; • CEIP data might be improved by taking into consideration suggestions developed by national experts, in particular, concerning locations of large point sources.
2	Ammonia in agriculture (ETR)	• New activity data set based on national data; • In 2030, implementation of measures in MFR scenario on ETR may result in loss of life expectancy decrease by ~0.1 month (preliminary data).
3	Comparison of PRIMES scenarios	• In the latest PRIMES scenarios, emission changes were mostly affected by changes in the emission vector and concerned mainly NOx, VOC and particles.
4	Russian (gridded) BC EI comparison	• Difference in totals up to 100 kt an large variation in BC emissions by sectors; • Flaring is a large and uncertain emission source that deserves special consideration.

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