GEM-AQ / GEM-AC applications in Poland

Joanna Strużewska (1,3), Jacek W. Kamiński (2,3),

1) Warsaw University of Technology
2) Institute of Geophysics , Polish Academy of Sciences
3) Department of Atmospheric and Climate Modelling, IOŚ-PIB

Warsaw University of Technology

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INSTYTUT OCHRONY ŚRODOWISKA – PAŃSTWOWY INSTYTUT BADAWCZY
INSTITUTE OF ENVIRONMENTAL PROTECTION – NATIONAL RESEARCH INSTITUTE

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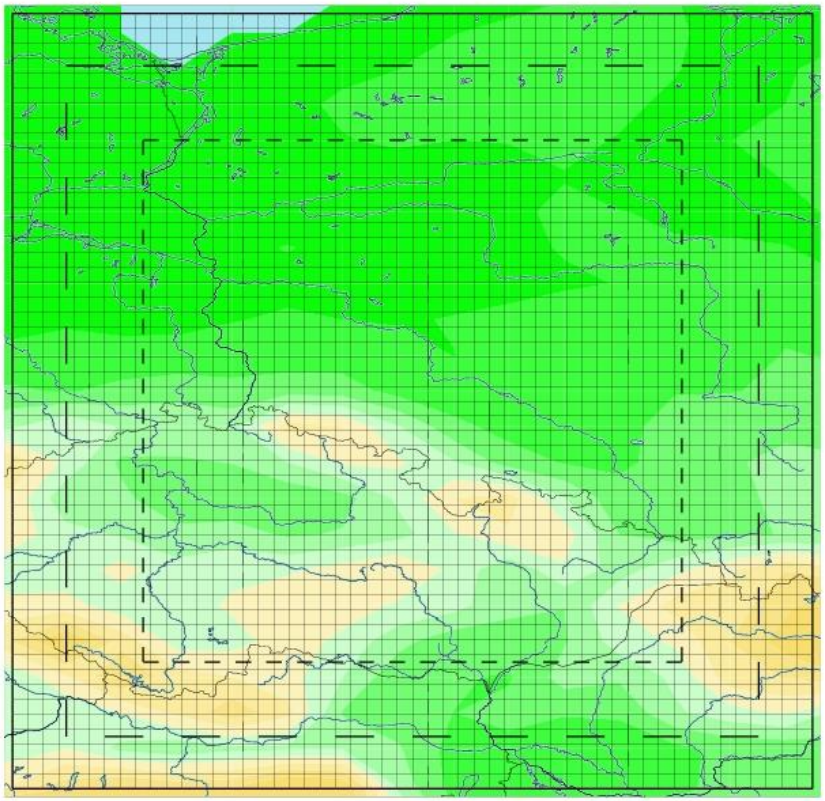
Outline

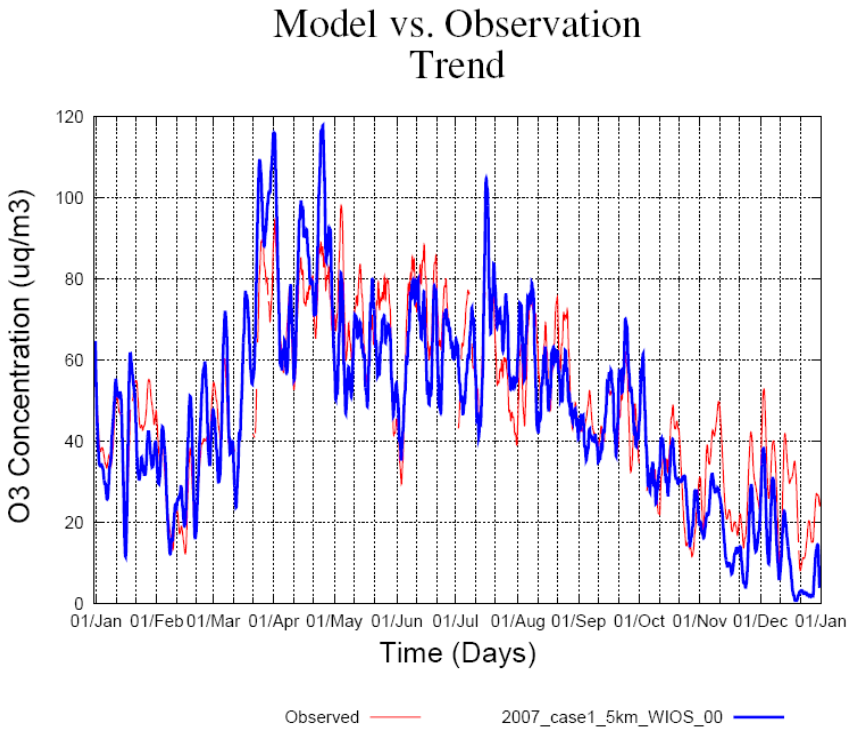
- GEM-AQ
  - AQ assessment
  - AQ forecast
  - CAMS_50
  - Vertical structure (ozone + NO_2 column)
  - Aerosols – composition, optical properties, direct effect
- GEM-AC
  - Climate
  - Stratosphere
  - Interactive O_3 and H_2O

GEM-AQ - ASSESSMENT

- Strategies of emission reduction for Katowice and Silesia regions (2002)
- AQIP for Dolnoslaskie Voivodship (2007)
- Meteorological data for AQIP for Silesia Voivodship
- Pilot ozone assessment for 2006 (2009)
- Support of ozone assessment 2010-2011 (modelling for 2008-2011)
- Support of ozone assessment 2012-2013
- Ukraine – transboundary impact in 2012
- Pilot primary pollutants assessment (country scale) for 2012 (2014)

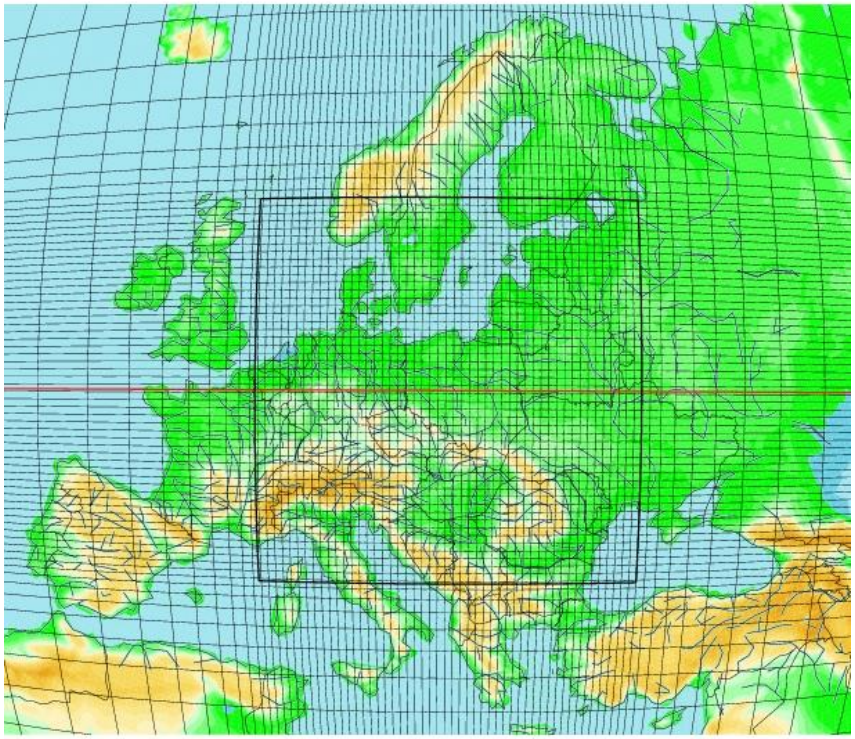
AQIP – Dolnoslaskie (2007)

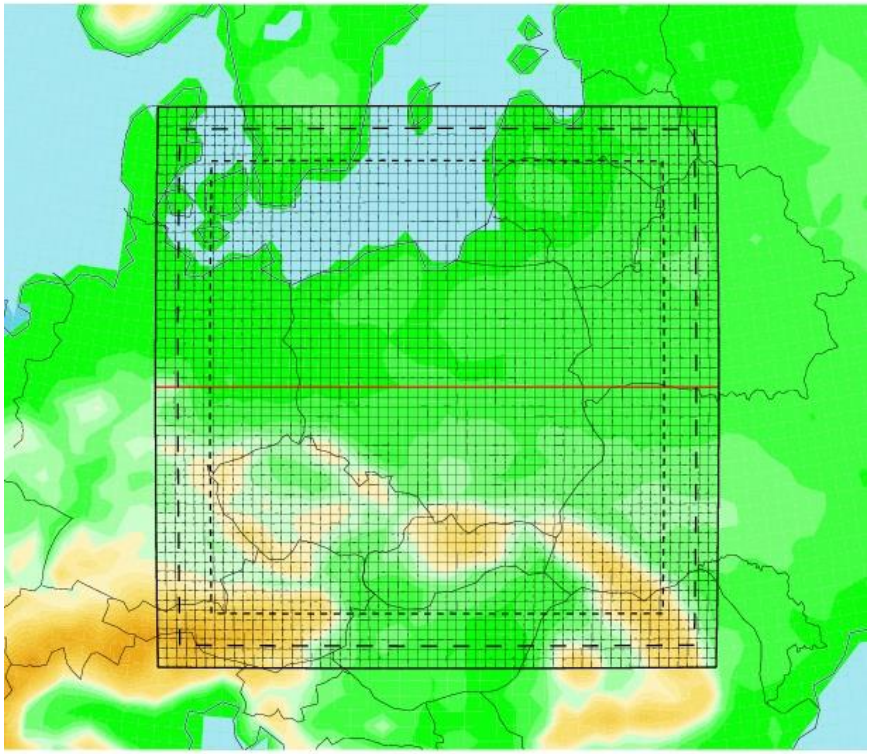




Wrocław-Bartnicza – 2007

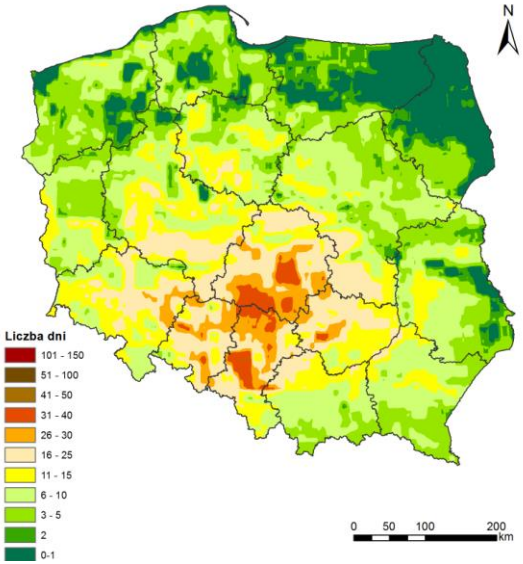
Ozone assessment 2012-2013

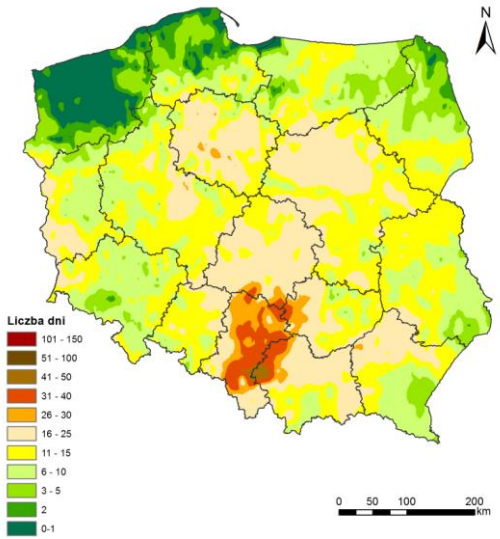




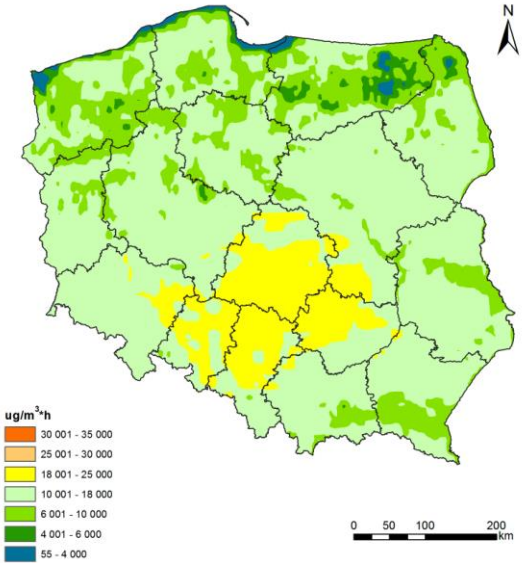
Exposure to high O3 concentrations (2012-2013)

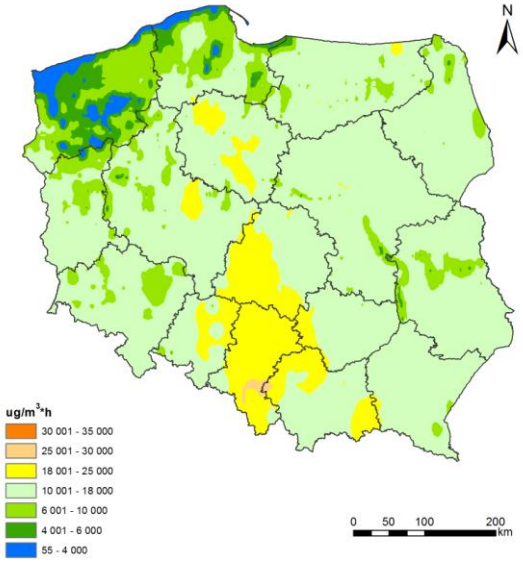
Number of days with 8h>120ug/m3

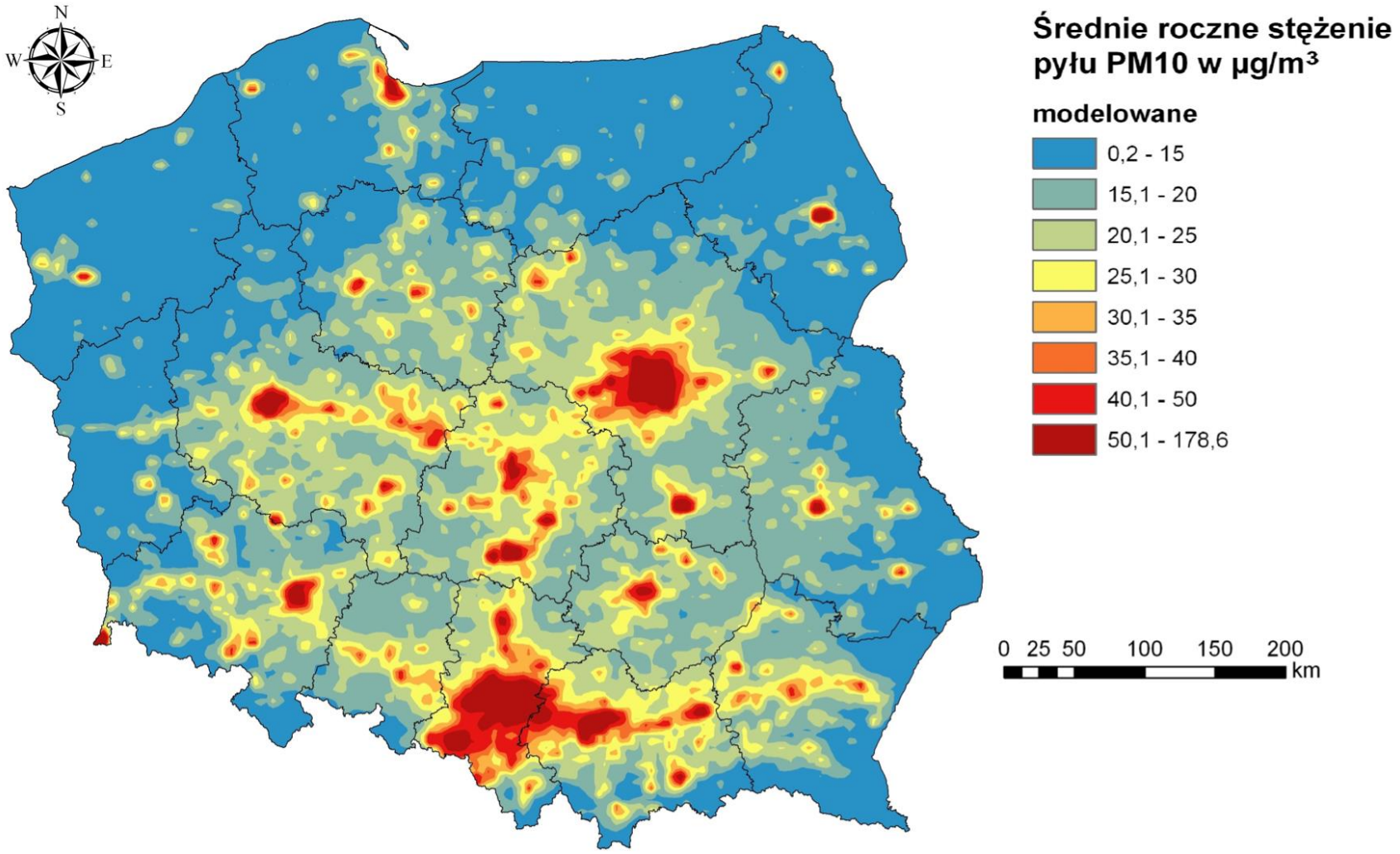




AOT40

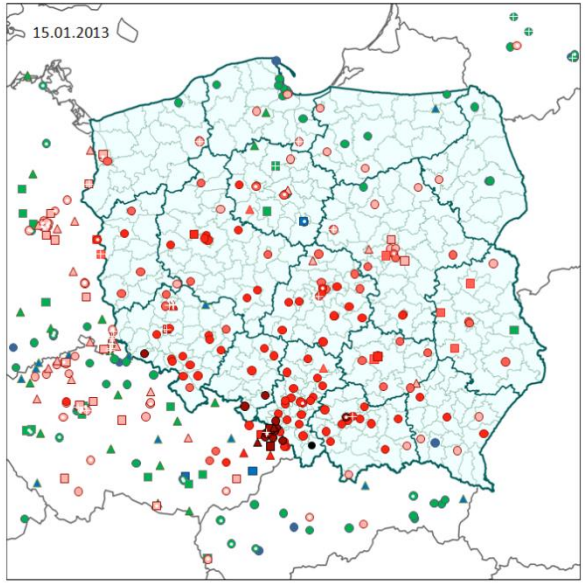


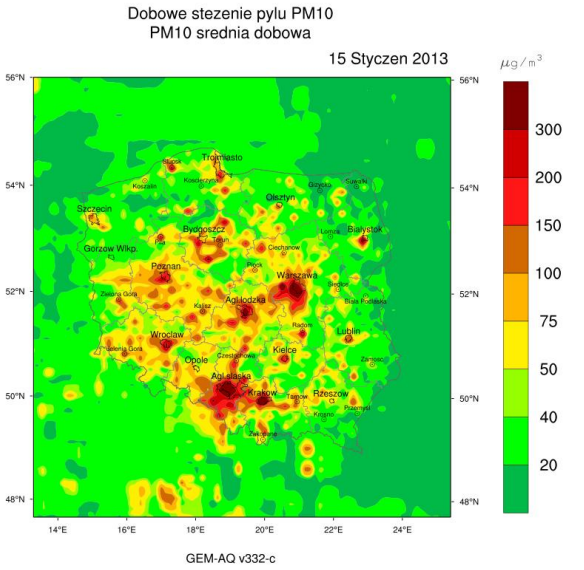


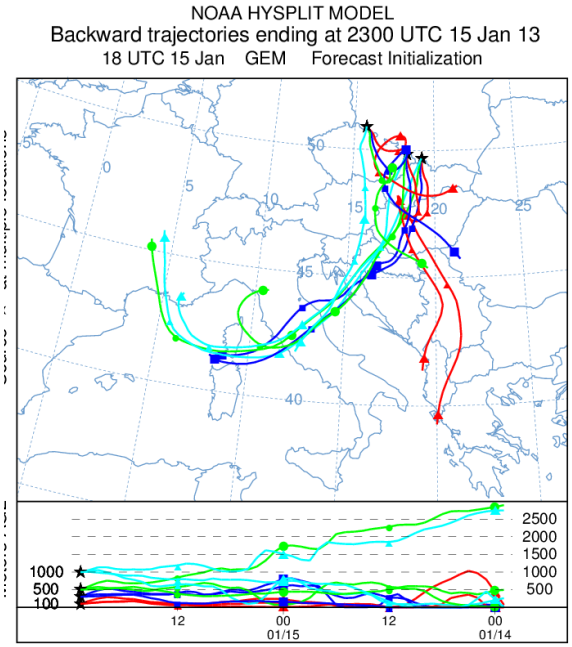


Rysunek 1 *Rozkład stężeń średniorocznych pyłu zawieszonego PM10 na obszarze kraju – wynik modelowania GEM-AQ dla roku 2012.*

GEM-AQ trajectories – PM episodes



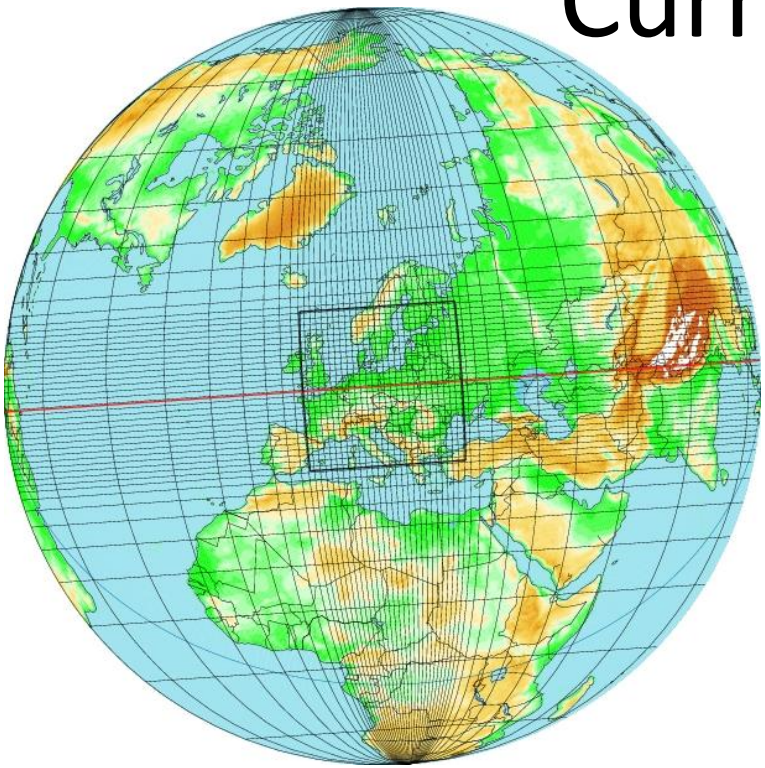


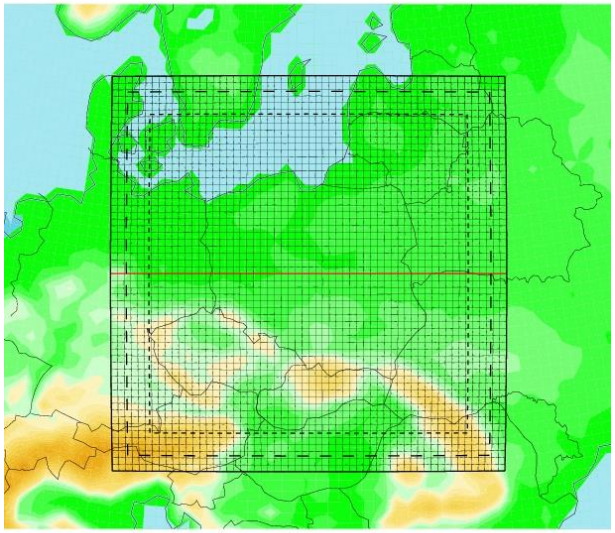


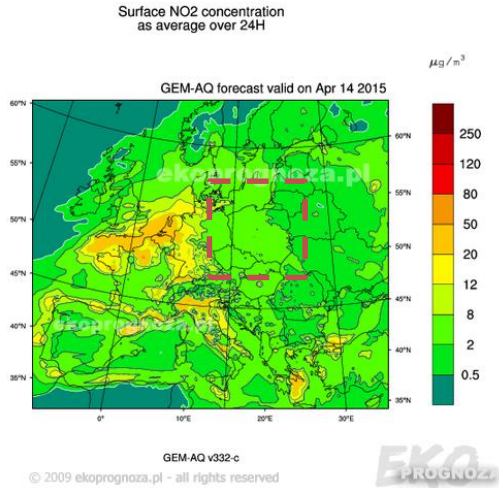
GEM-AQ - AQ Forecast

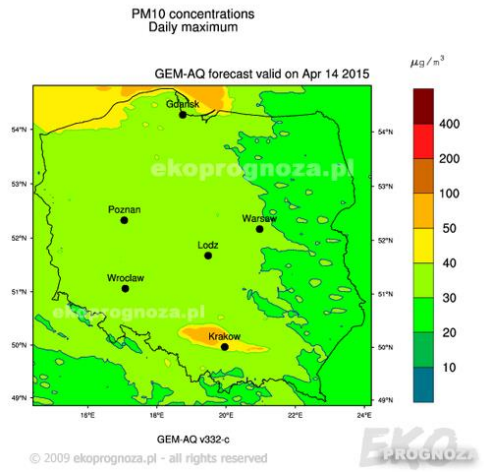
- COST ES0602
- EcoForecast Foundation – AQ forecast for Europe and Poland (ecoforecast.eu)
- Ozone forecast 2013-2015 + 2016-2018 (country scale)
- AQ 5km forecast for Malopolskie (2010-2015) and Podkarpackie voivodships (2011-2014)
- PM_{10} – 1km for Krakow, Lodz, Sieradz

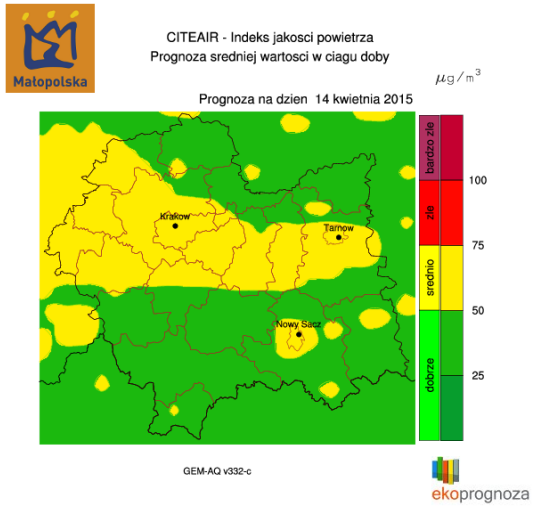
Current setup



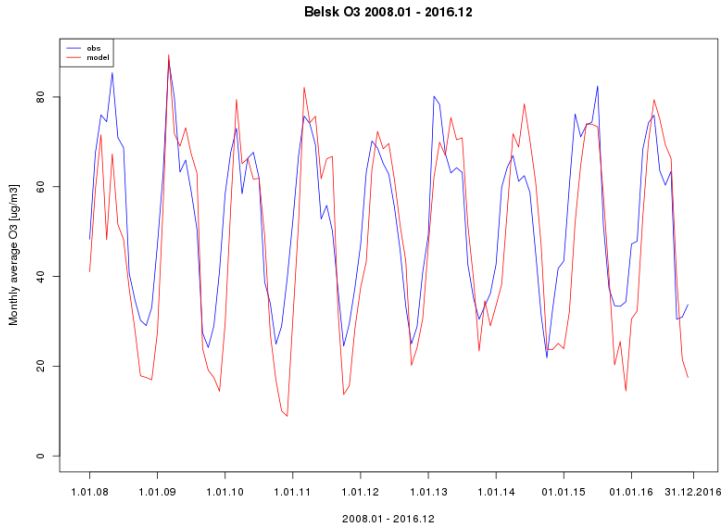


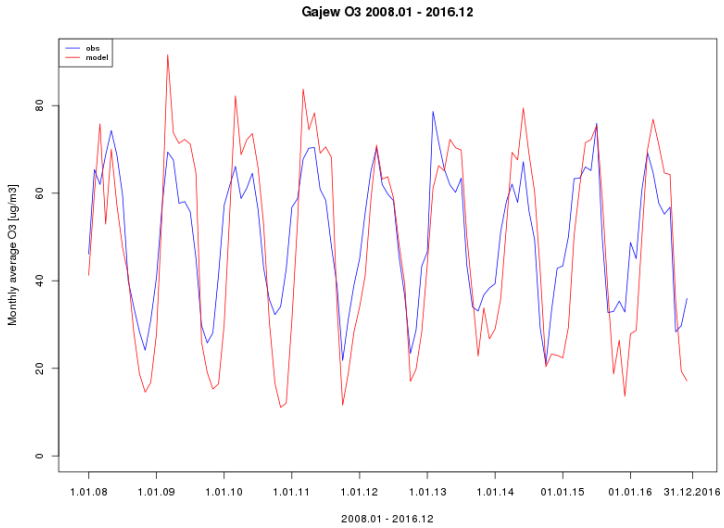


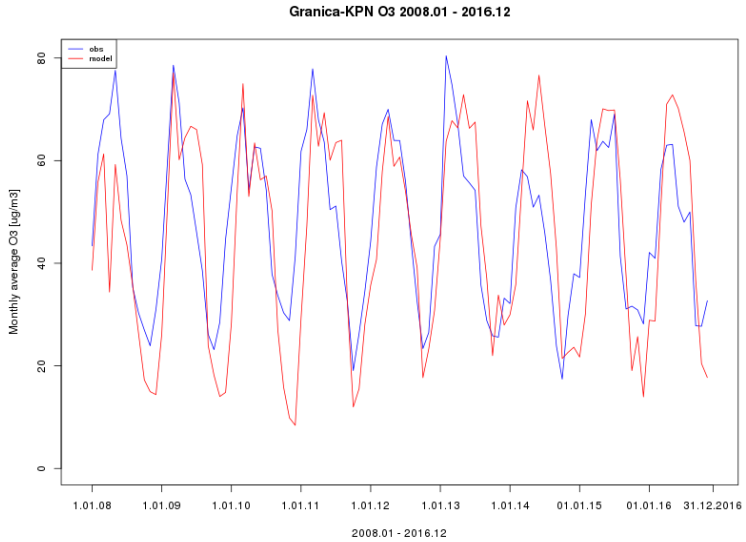


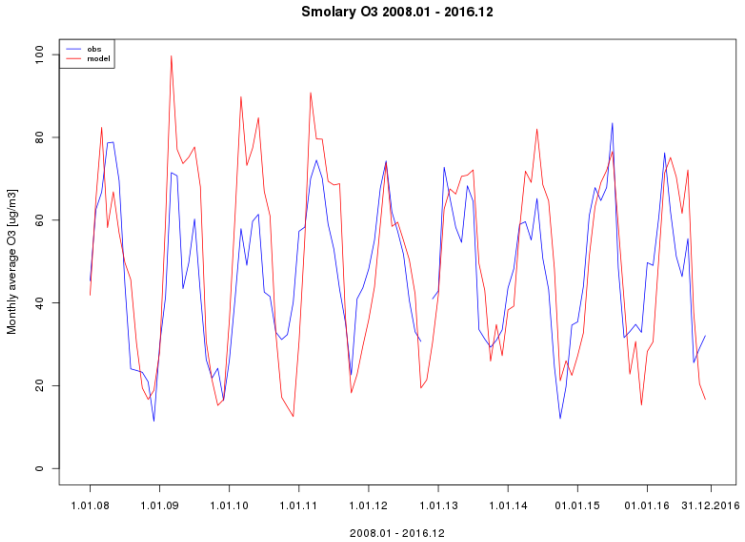


Observed and forecasted ozone variability (selected stations, monthly average 2008-2016)

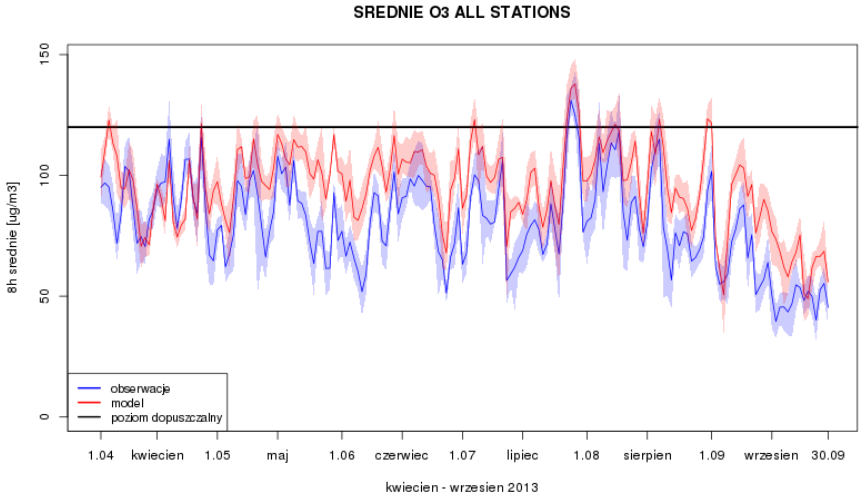


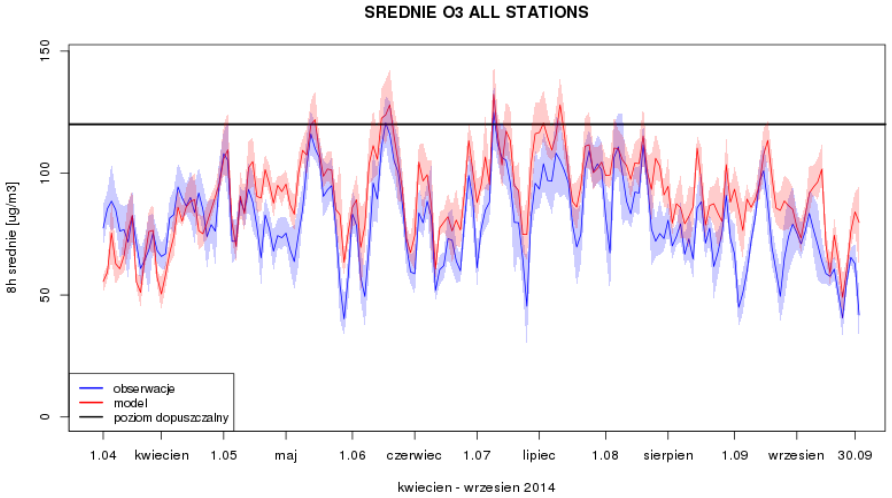


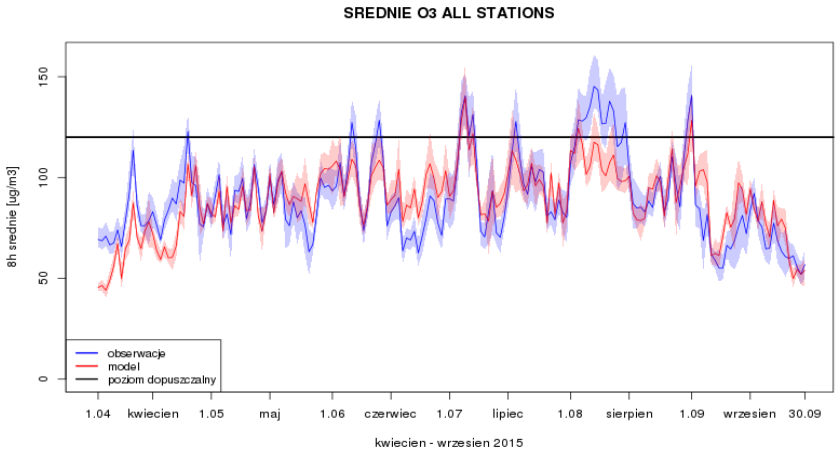


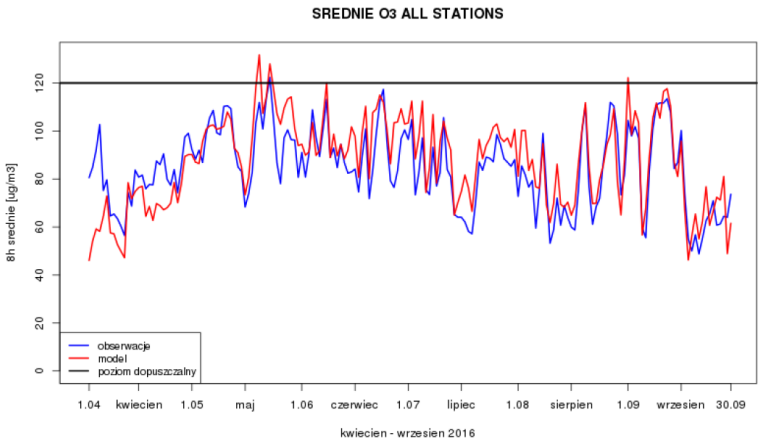


Observed and forecasted ozone variability (all stations, 8h-aver, Apr-Sept 2013-2016)



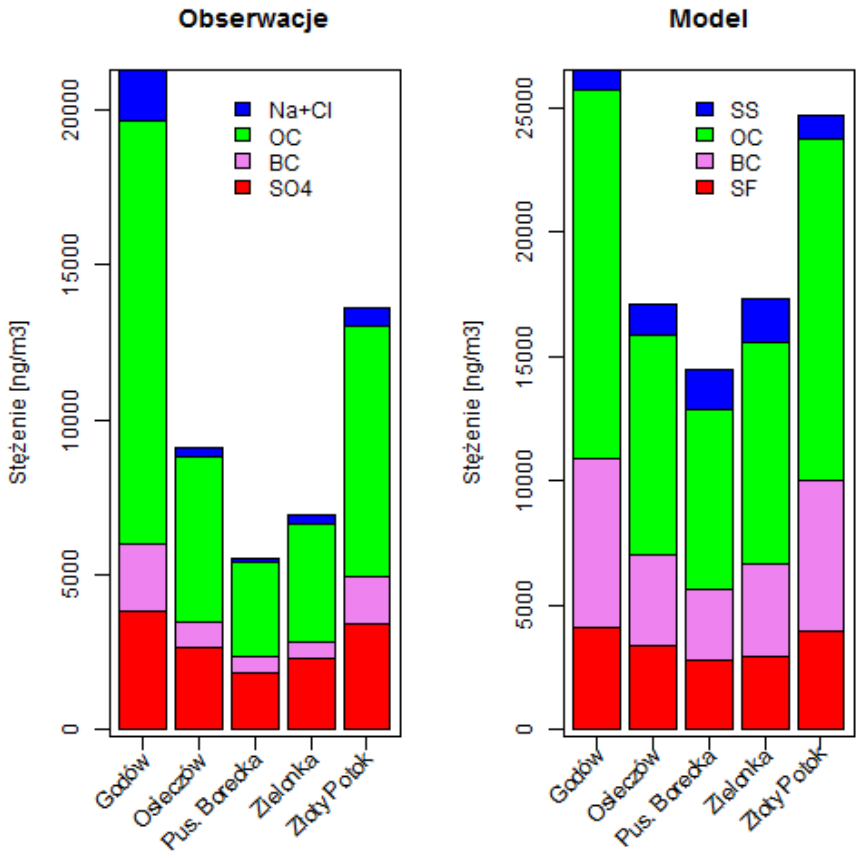






Aerosol chemical composition

PM2.5
2013 (based on report)



Total aerosol
2014

EkoPrognoza.pl

PL EN

ekoprognoza

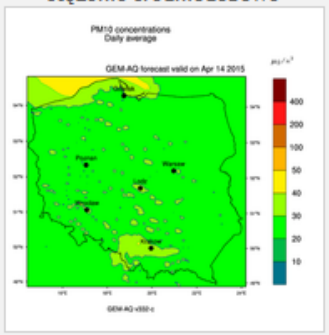
pogoda | indeks jakości powietrza | stężenia zanieczyszczeń

Europa | Polska | *** wybierz region ***

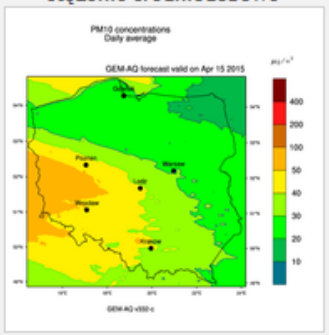
- Strona główna
- Ozon
- Dwutlenek azotu
- Dwutlenek siarki
- Tlenek węgla
- Pył PM10
- Pył PM2.5

Pył PM10 Polska

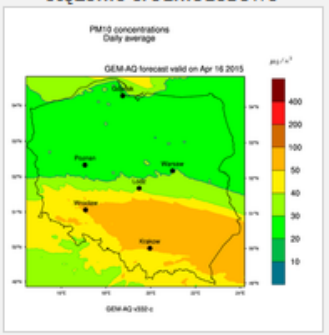
14.04.2015
stężenie średniodobowe



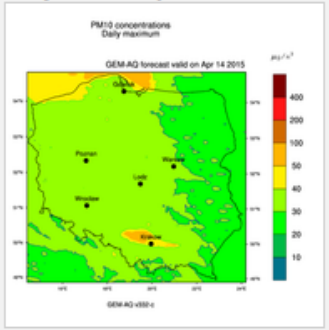
15.04.2015
stężenie średniodobowe



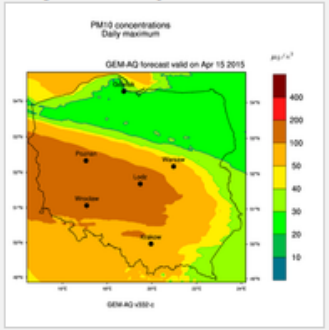
16.04.2015
stężenie średniodobowe



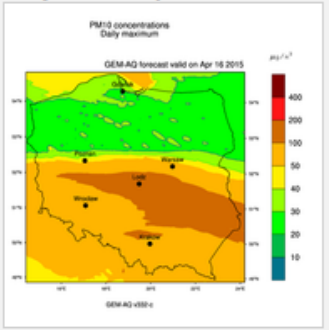
14.04.2015
stężenie maksymalne dobowe



15.04.2015
stężenie maksymalne dobowe



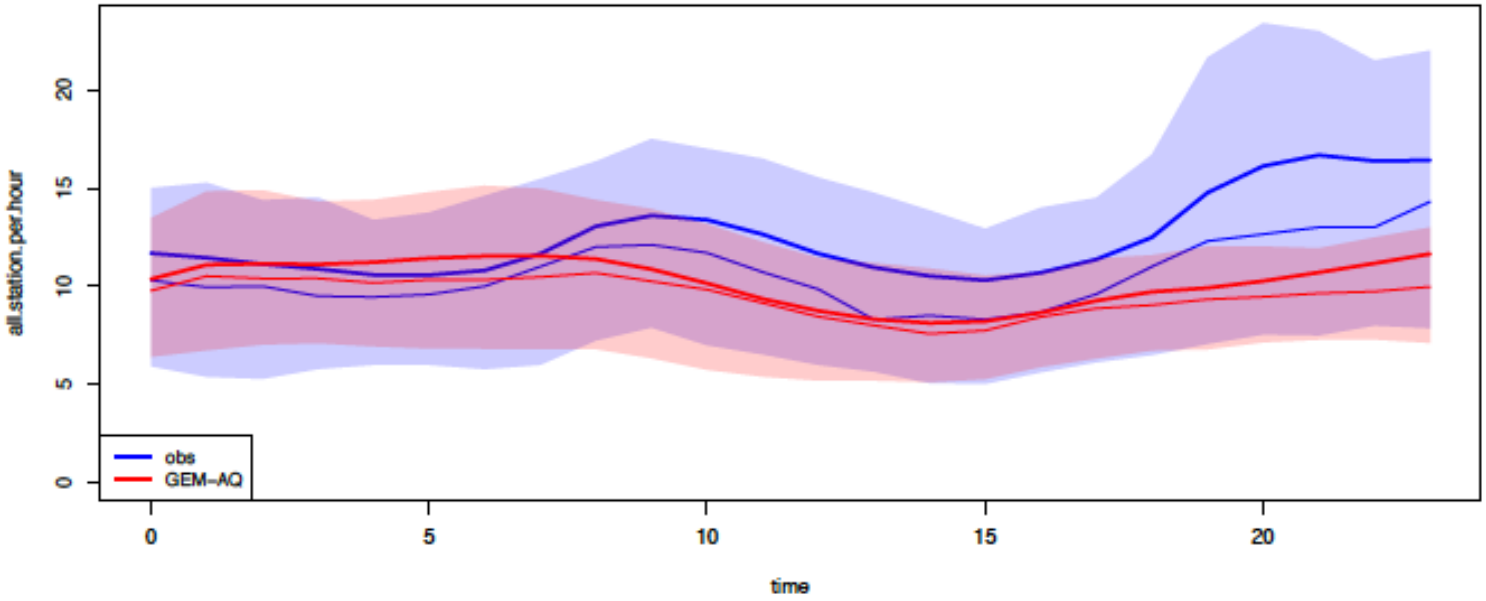
16.04.2015
stężenie maksymalne dobowe



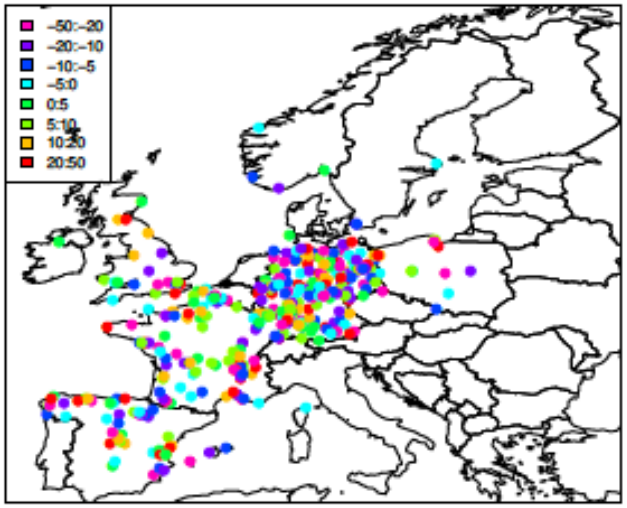
GEM-AQ - CAMS_50

- Part of Copernicus Service (ECMWF)
  - ❑ CAMS Target grid
    - Global variable grid with 0.20 x 0.20 deg over Europe
    - 28 vertical levels up to 10 mb, 10 layers below 2km
    - Timestep 600 s
- In 2015-2018 three hindcast experiments forced with CAMS_50 data
- Data Assimilation system: OI method with error statistics based on the Hollingsworth-Lonnberg (1986)
- Birch and olive pollen module: source functions based on Sofiev et al. (2012, 2017)

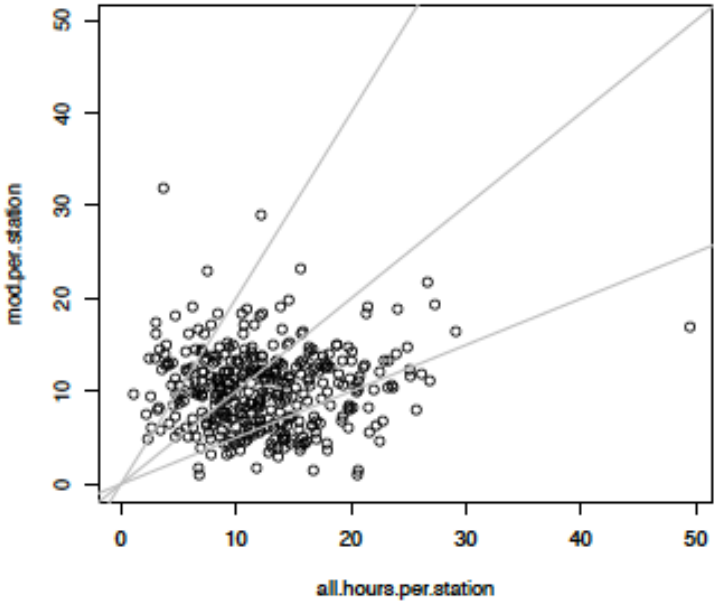
Hourly concentrations – PM10 – 20160205



Hourly based MBE ug/m3 – PM10 – 20160205



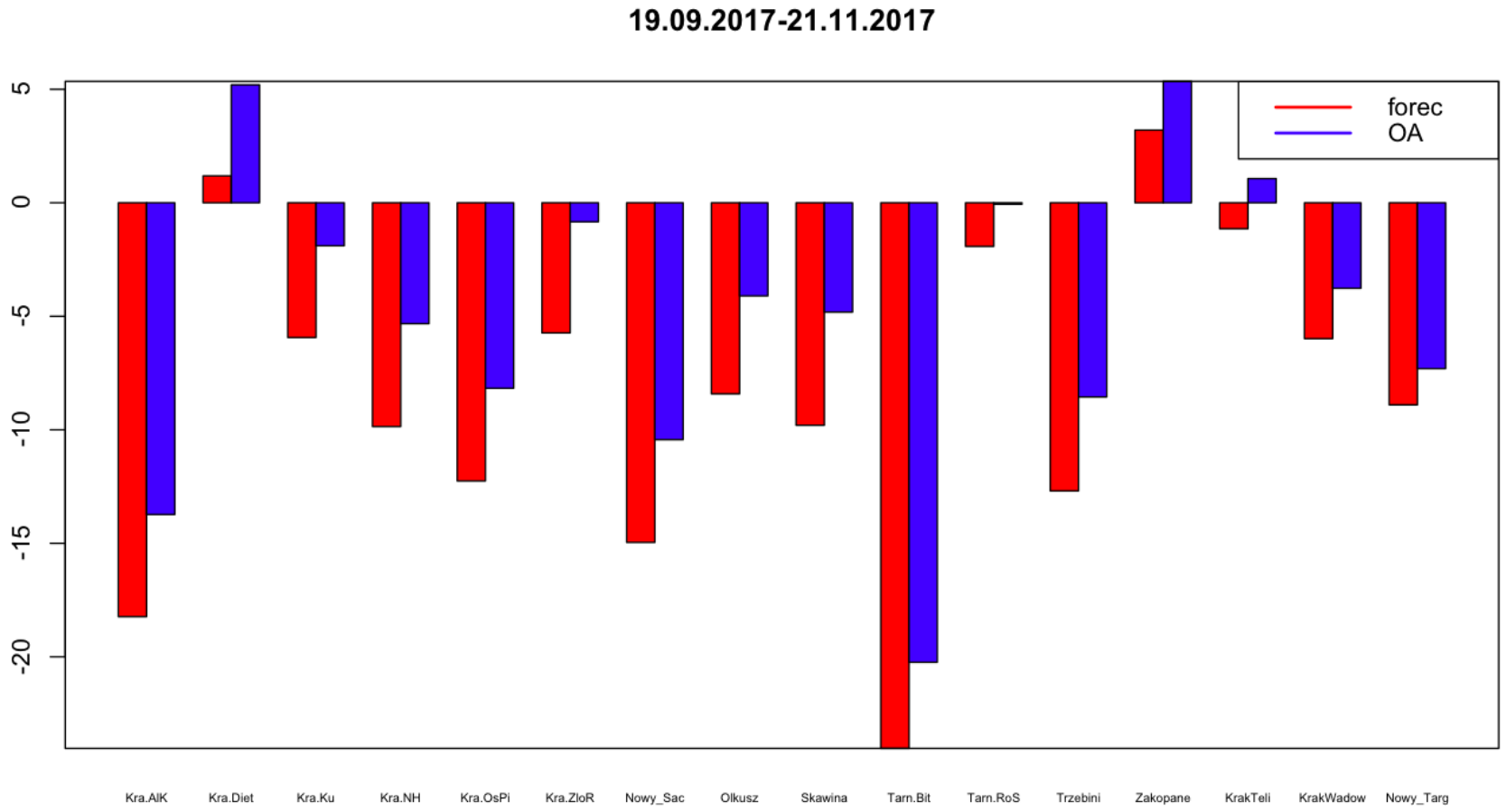
24h–average – PM10 – 20160205



Data Assimilation

- Optimal interpolation
  - CAMS50 - reanalysis
  - AQ forecast for Malopolska – Chem-IC
  - Ozone forecast (country scale) – Chem-IC

Impact of Chem-OA on forecast accuracy in Malopolska



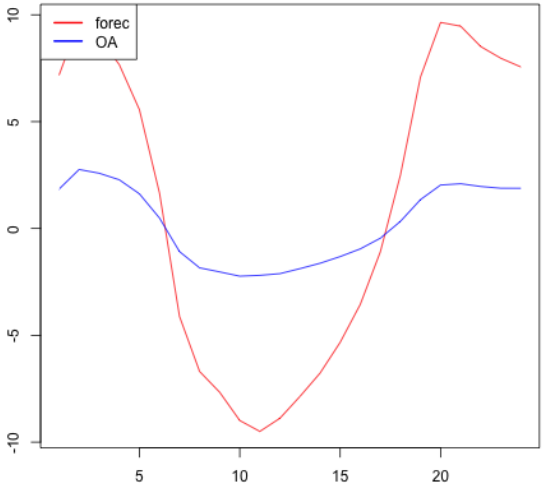
BIAS raw-Forecast = -8.52 µg/m3

BIAS oi-Forecast = -4.96 µg/m3

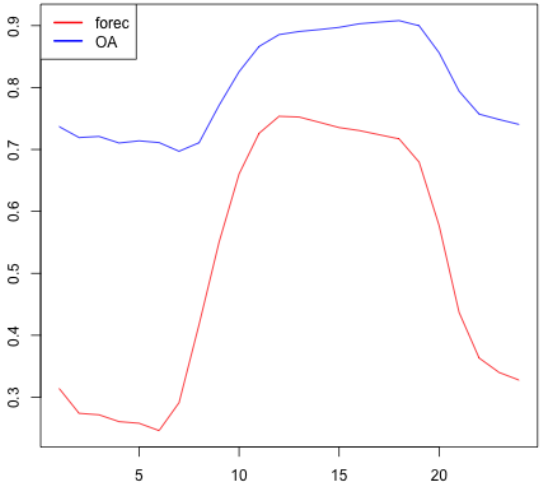
CAMS50 – O_3 reanalysis

GEM-AQ performance – O3 reanalysis
June-July-August 2015

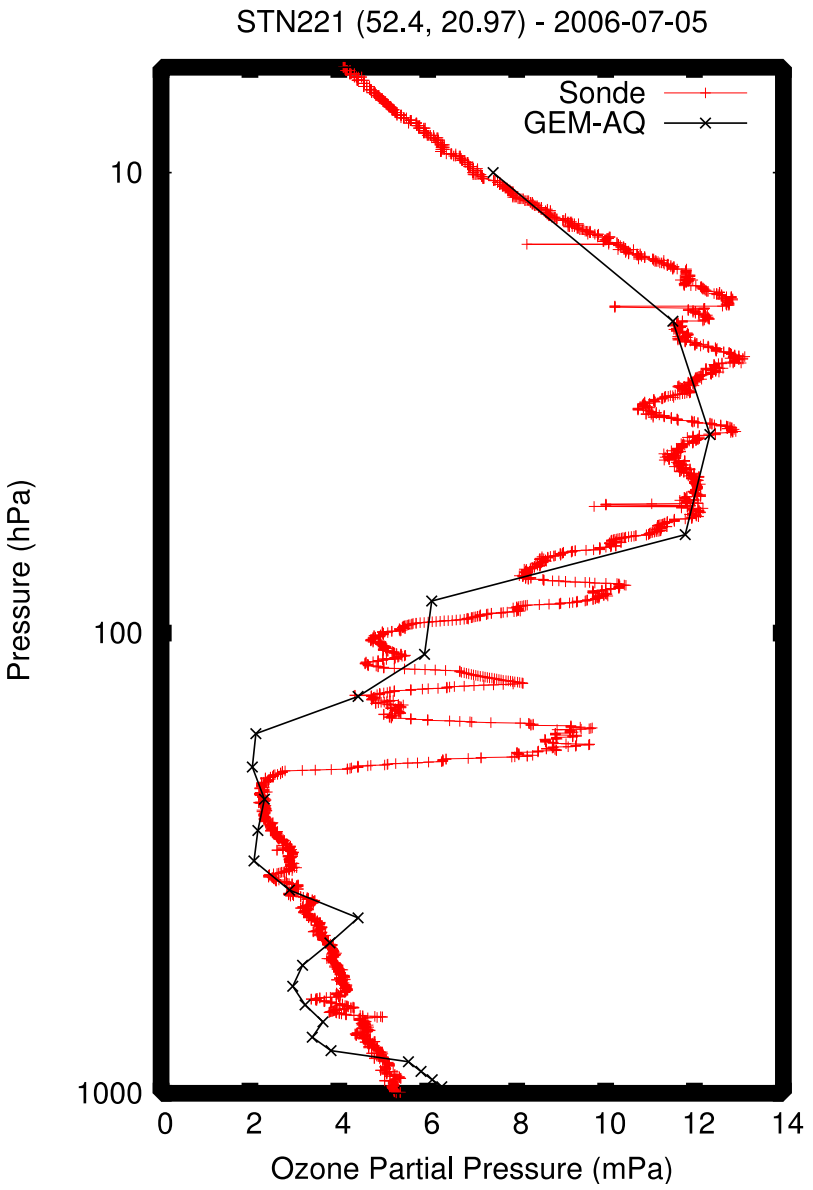
Mean bias error averaged over stations and over JJA 2015

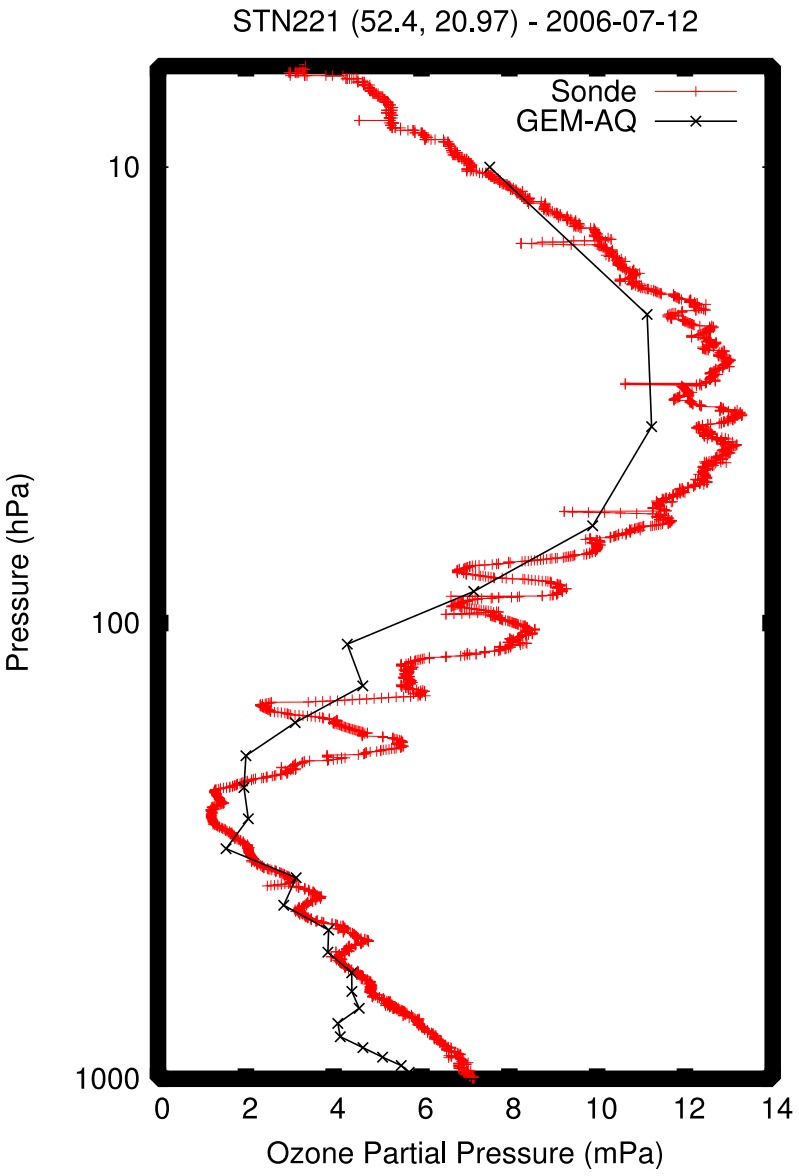


Spatial correlation coefficient averaged over JJA 2015



GEM-AQ - Ozone profiles

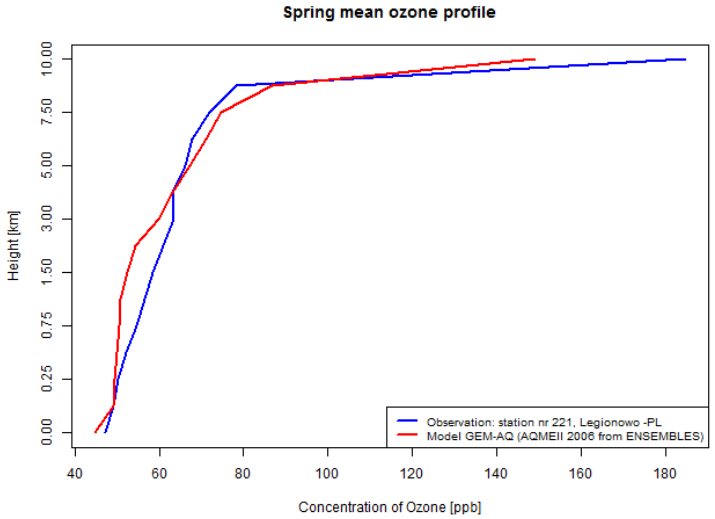


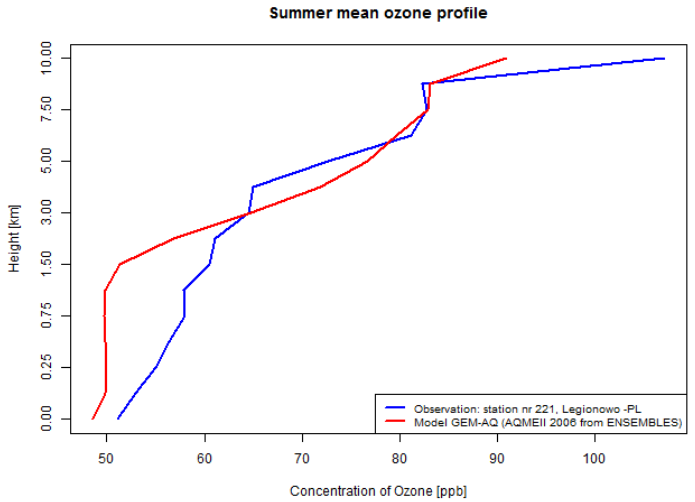


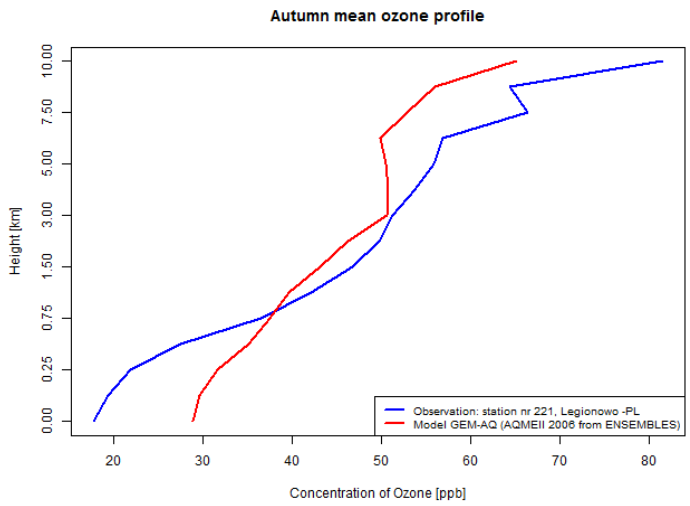
Seasonal ozone profiles (AQMEII modelling study)

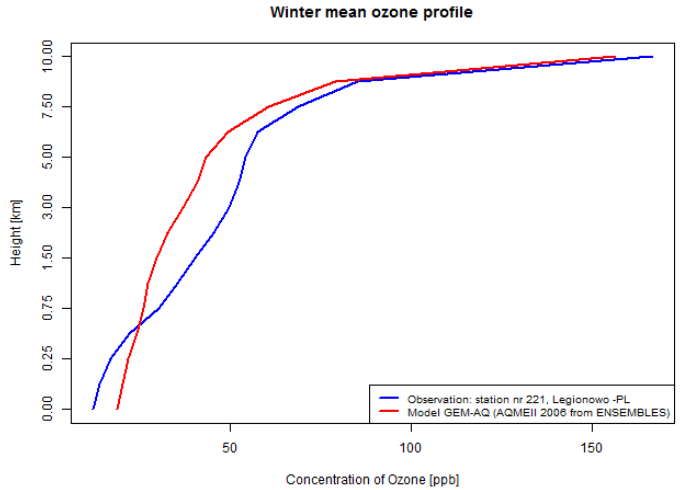
model

obserwacja

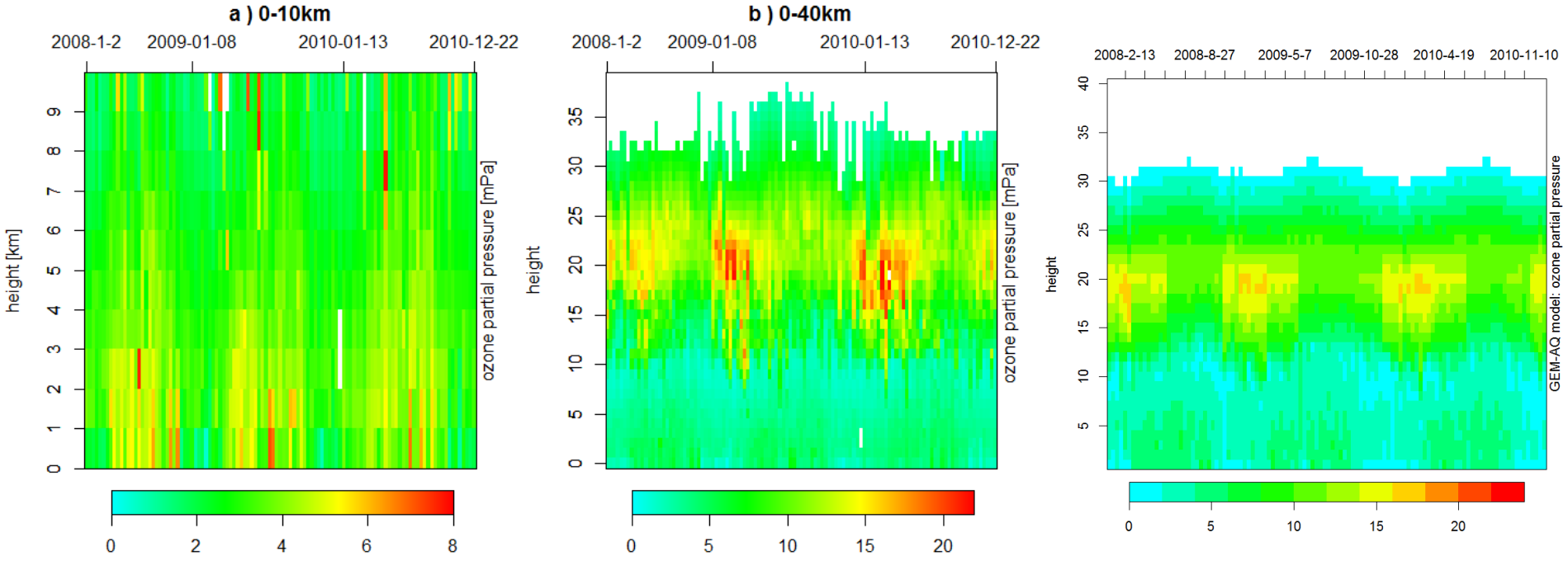




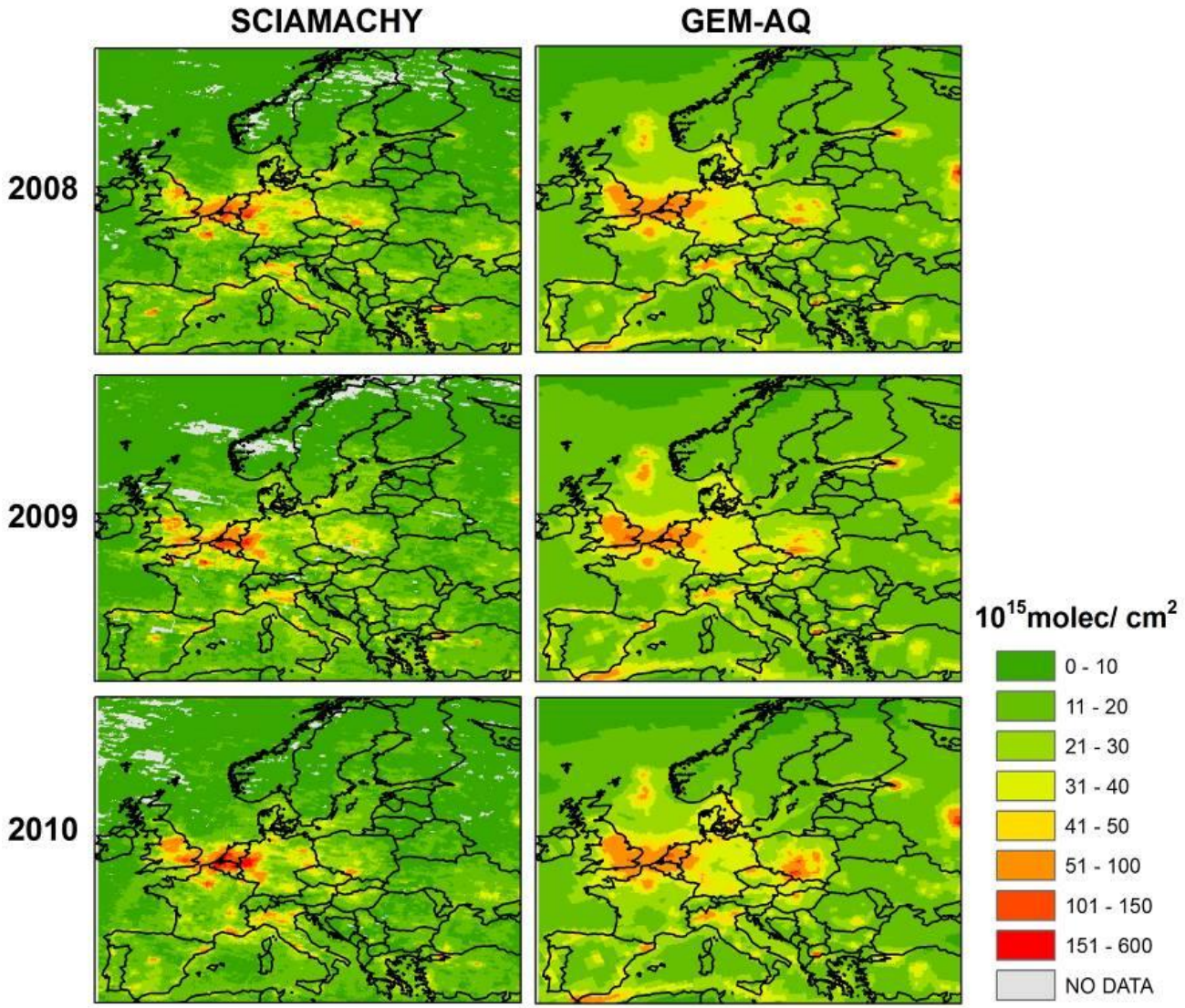




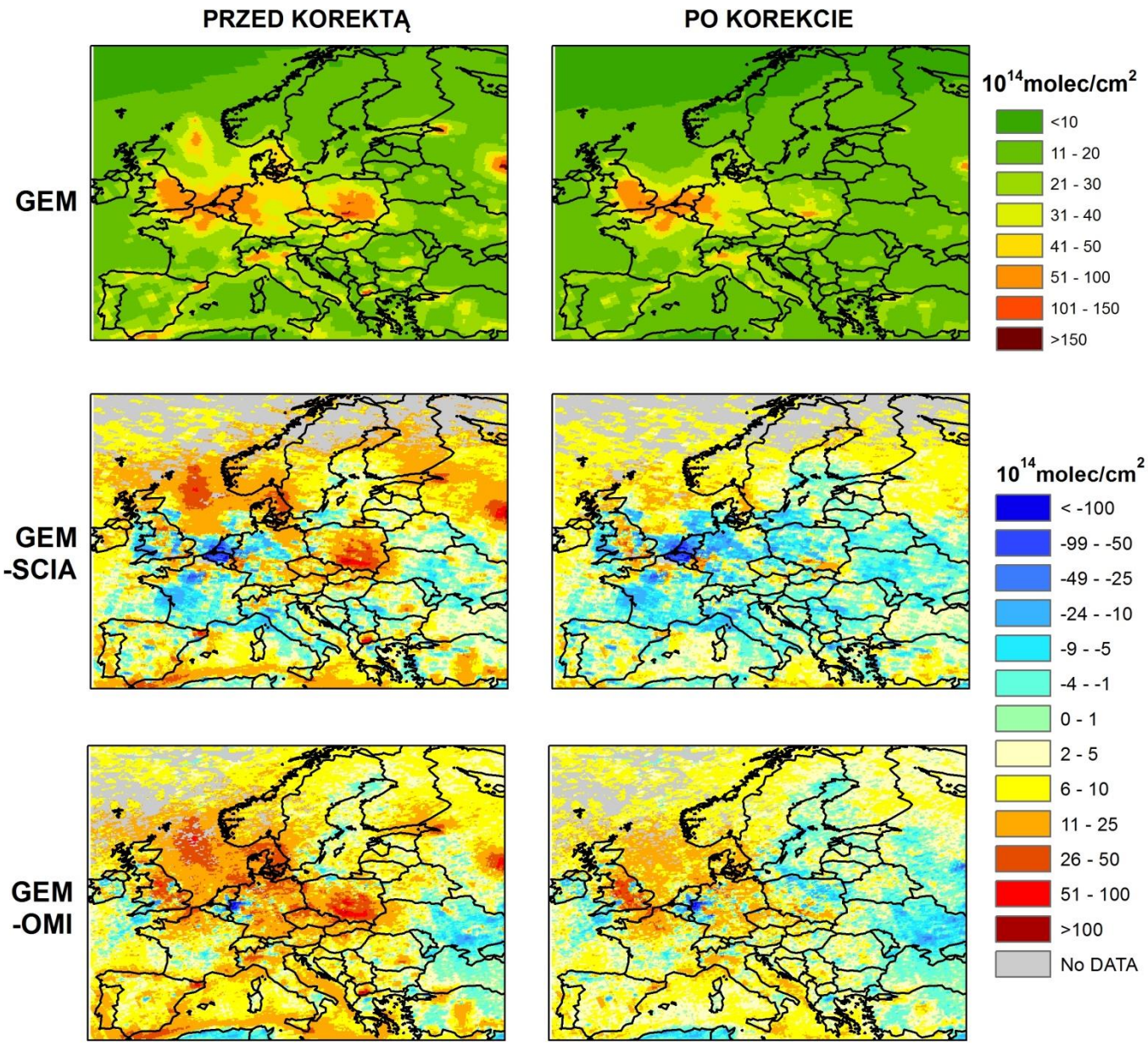
Observed ozone partial pressure from January 2008 to December 2010 at Legionowo



GEM-AQ – NO2 column (SCIA/OMI)

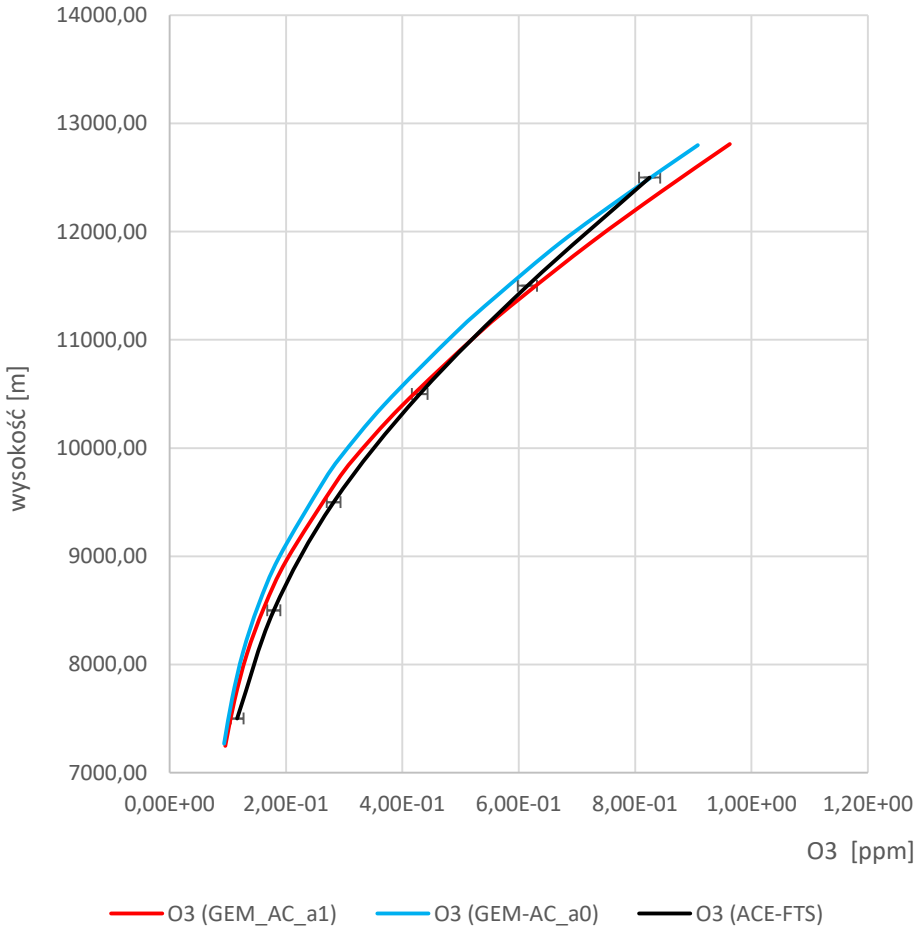


Emission correction based on satellite observations – July 2011



- Systematic differences over North Sea, Medit. Sea and Mocow reduced

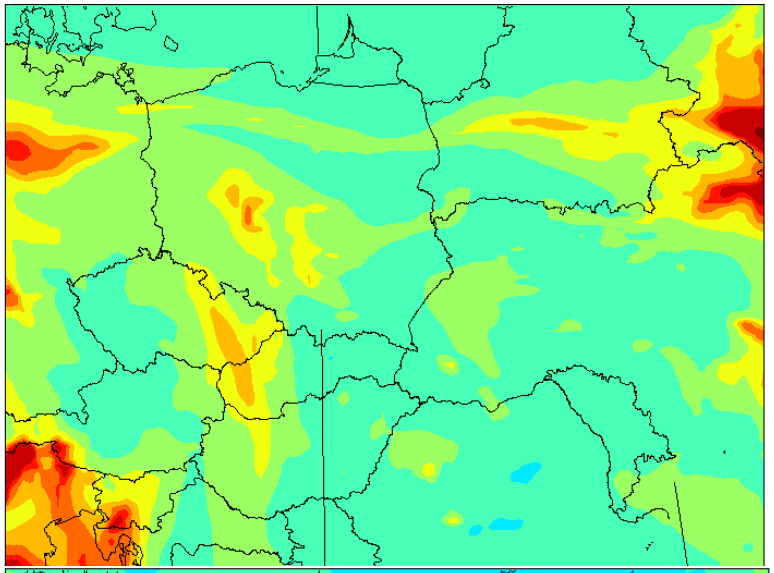
GEM-AC vs satellite observations

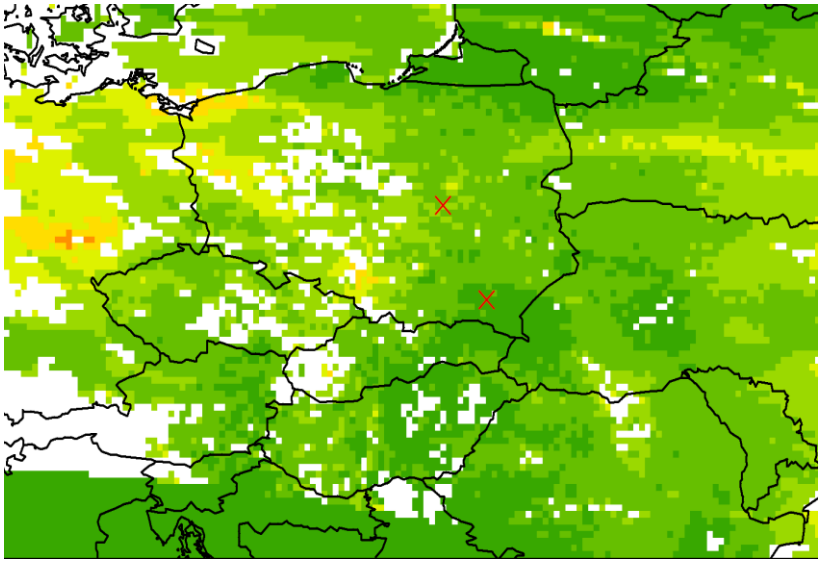


Ozone mixing ratio in UTLS during winter season (60ºN-90ºN)

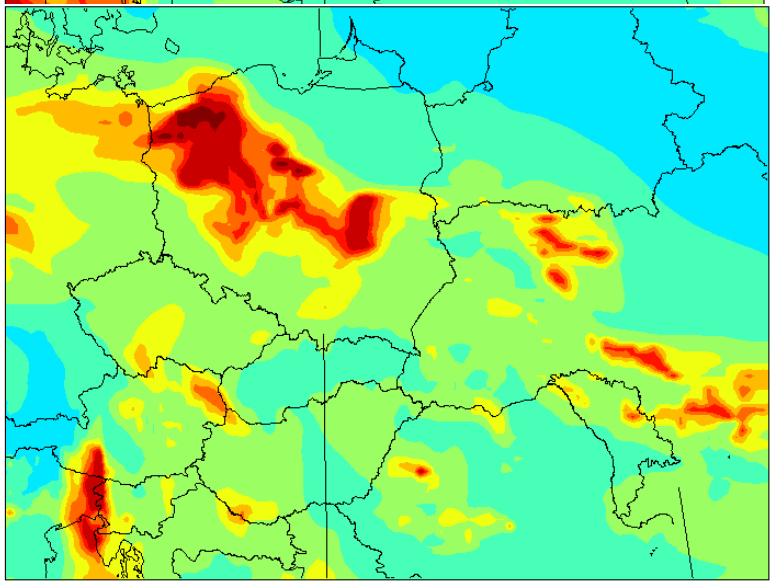
AOD 550nm – GEM-AQ vs. MODIS

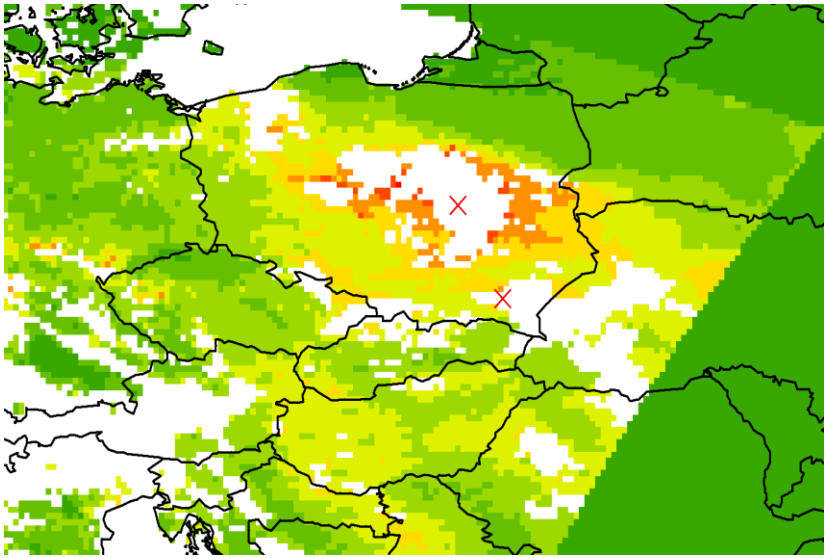
1 May 2012



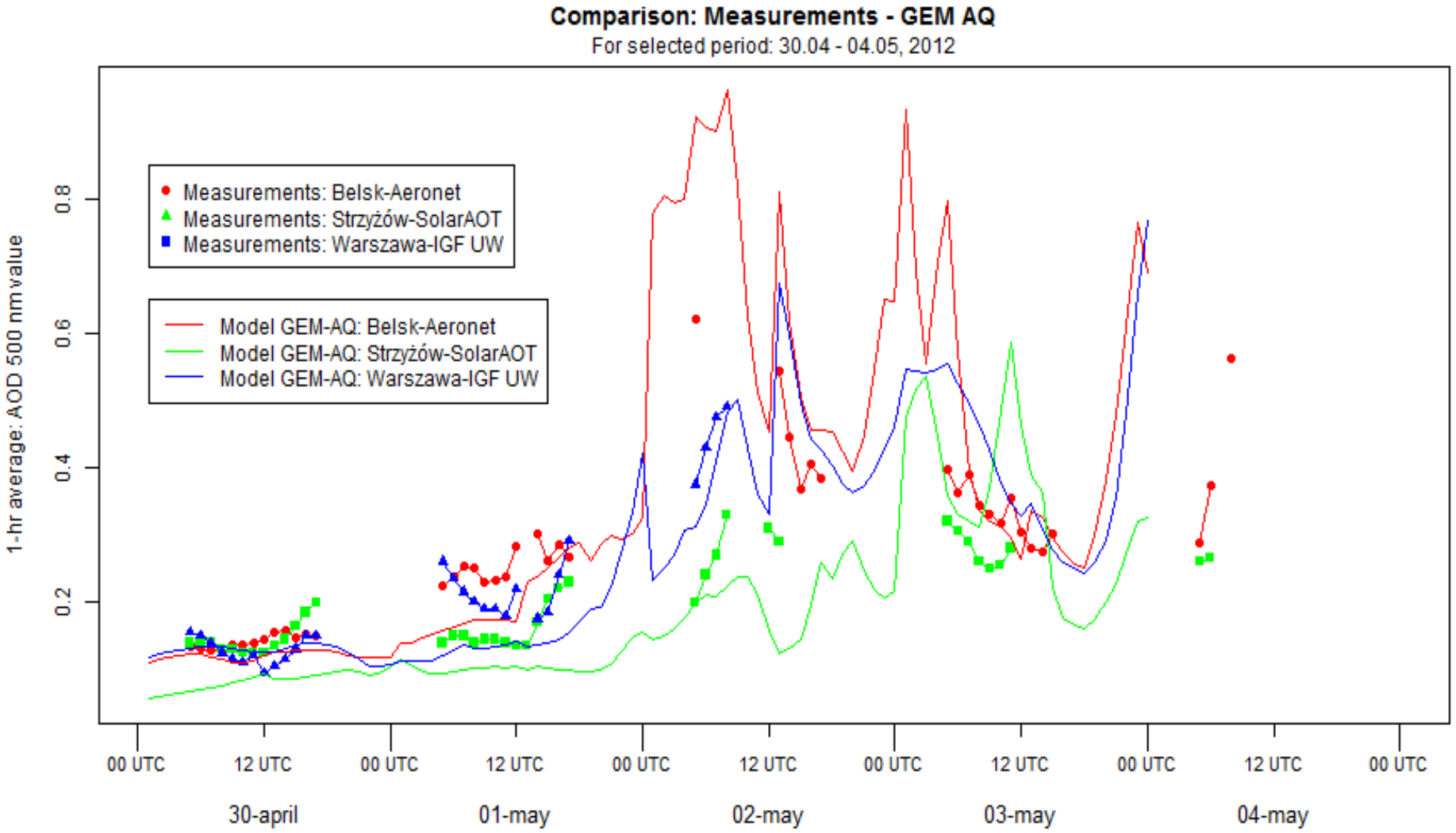


2 May 2012

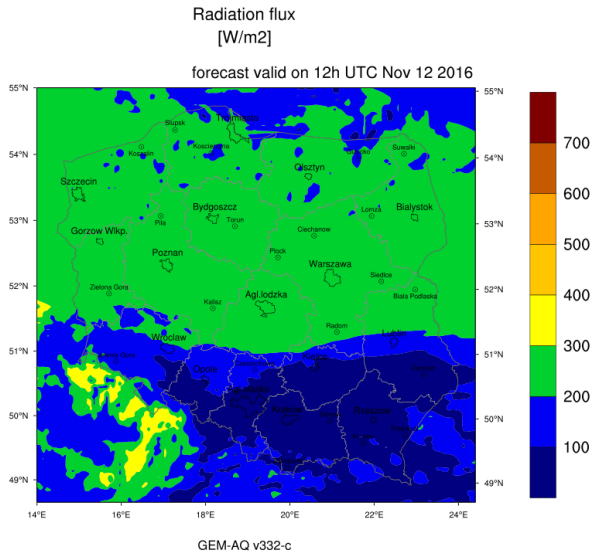


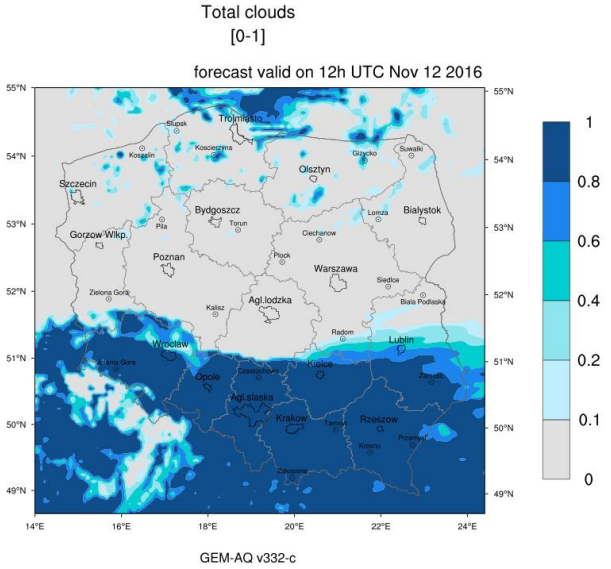


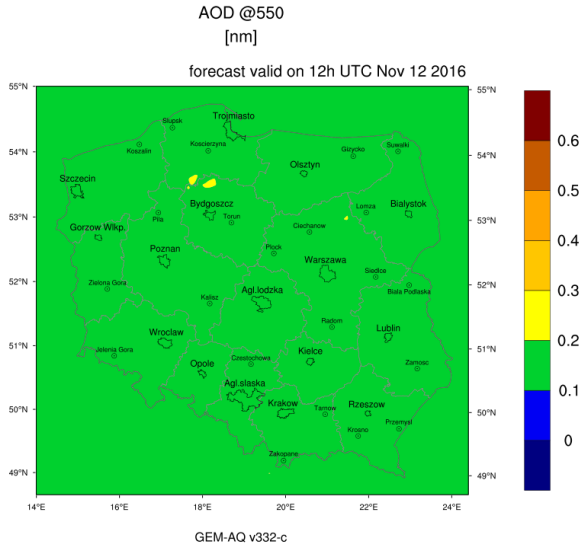
AOD – obs. vs. GEM-AQ

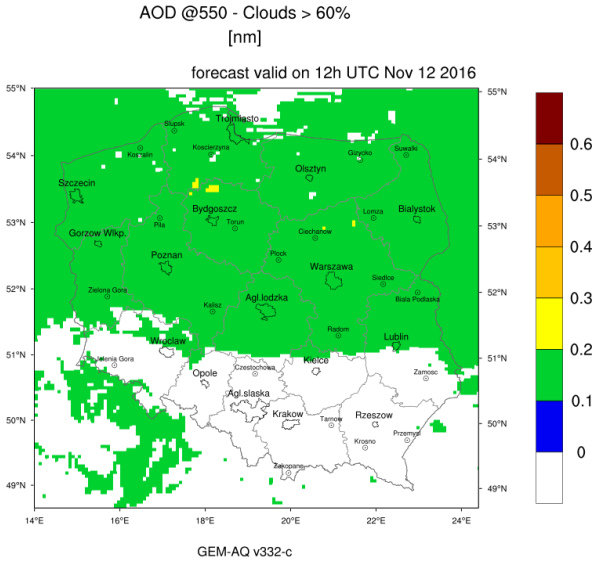


GEM-AQ - AOD

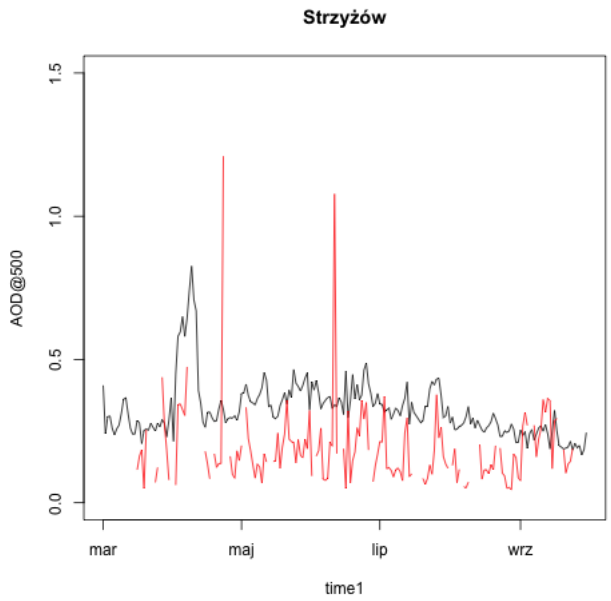

Radiation flux
[W/m2]
forecast valid on 12h UTC Nov 12 2016
700
600
500
400
300
200
100
GEM-AQ v332-c

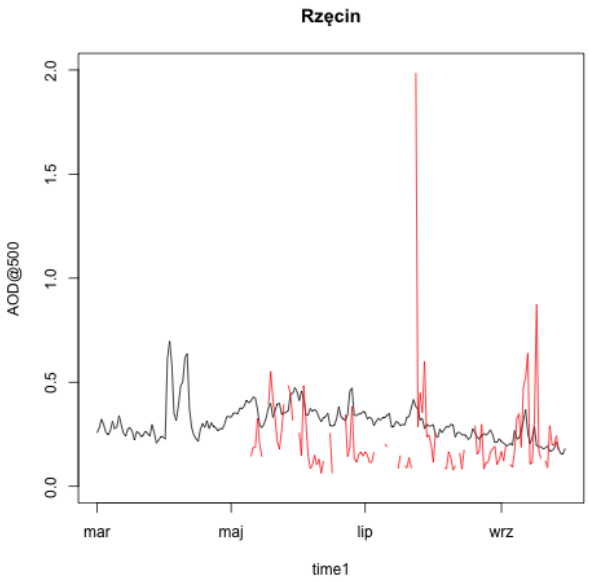

Total clouds
[0-1]
forecast valid on 12h UTC Nov 12 2016
1
0.8
0.6
0.4
0.2
0.1
0
GEM-AQ v332-c

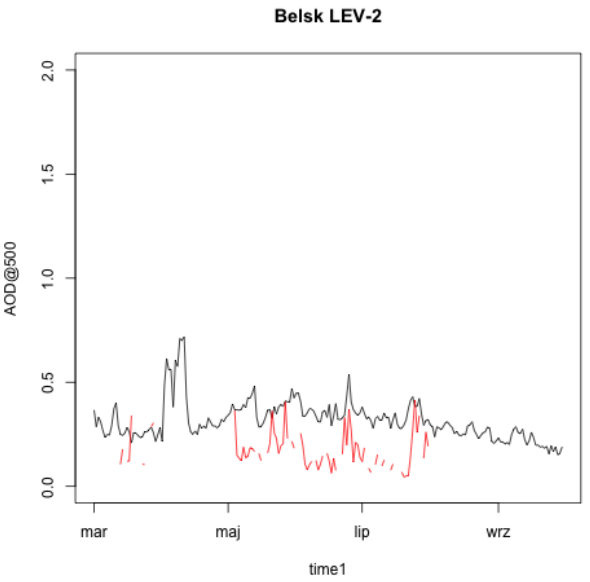

AOD @550
[nm]
forecast valid on 12h UTC Nov 12 2016
0.6
0.5
0.4
0.3
0.2
0.1
0
GEM-AQ v332-c


AOD @550 - Clouds > 60%
[nm]
forecast valid on 12h UTC Nov 12 2016
0.6
0.5
0.4
0.3
0.2
0.1
0
GEM-AQ v332-c

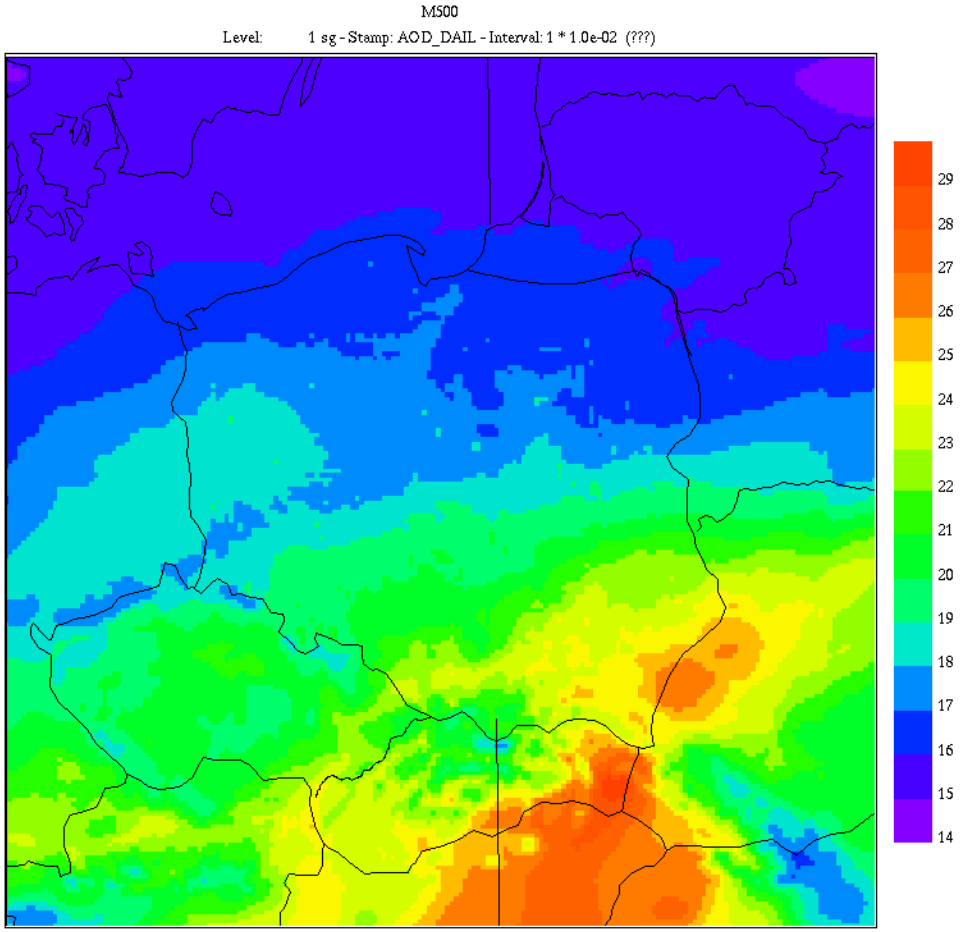
Comparison with observations







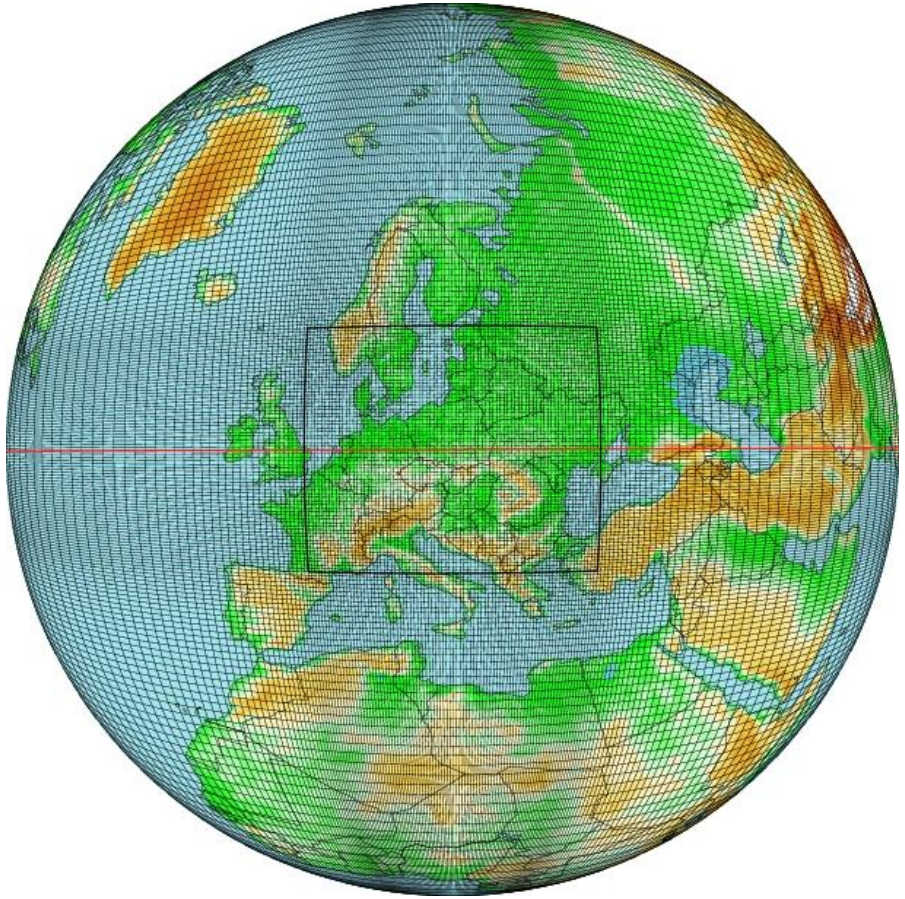
AOD for March-September 2016



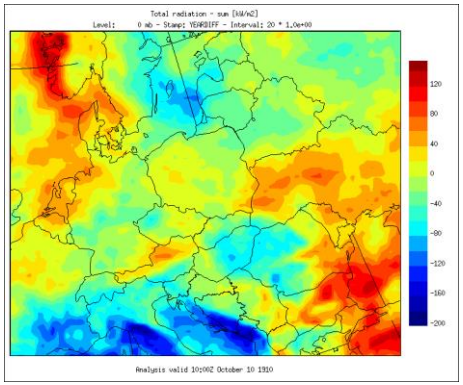
Air Quality in Future Climate
Model setup

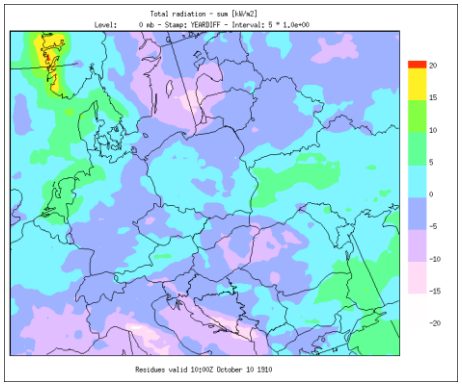
- Global variable approach with rotated equator focused over the Central Europe
- Resolution ~30 km in the core
- 70 vertical layers up to 0.1 hPa
- Timestep – 30 min

- Emissions from the Atmospheric Chemistry and Climate Model Intercomparison Project for 2000 with the resolution – 0.5 x 0.5 global



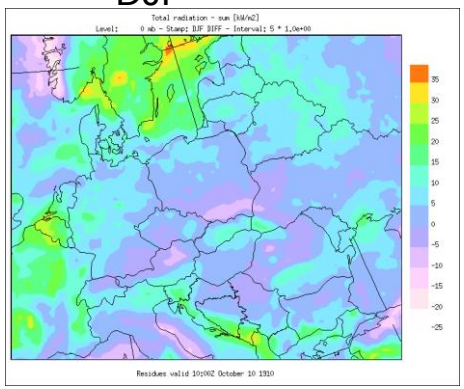
Interactive vs non-interactive O_3 and H_2O



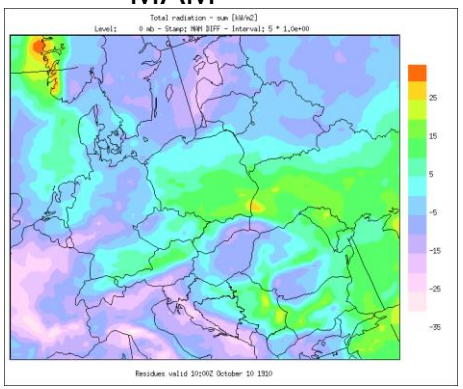


Absolute and relative difference of solar flux at the surface

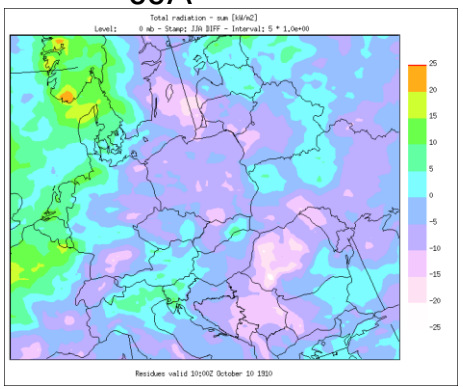
DJF



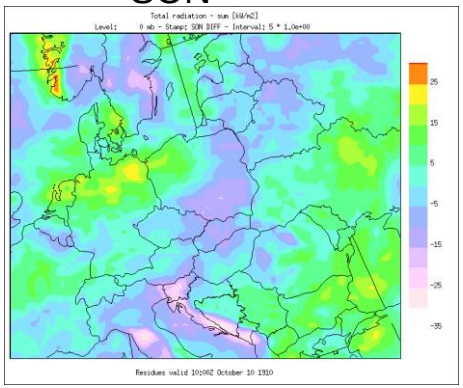
MAM

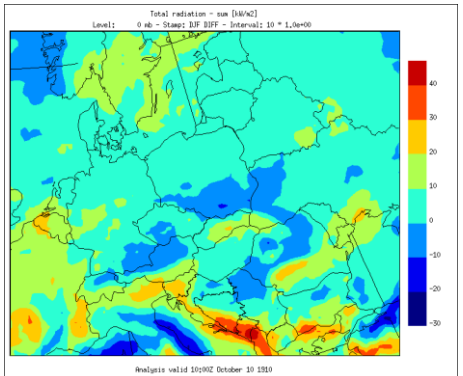


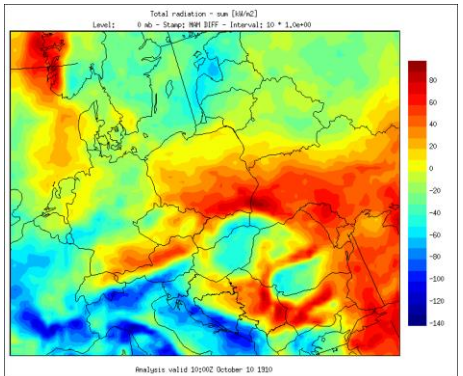
JJA

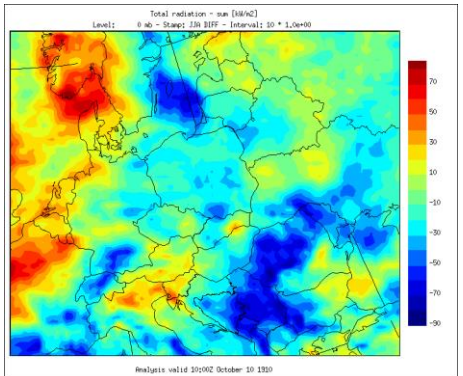


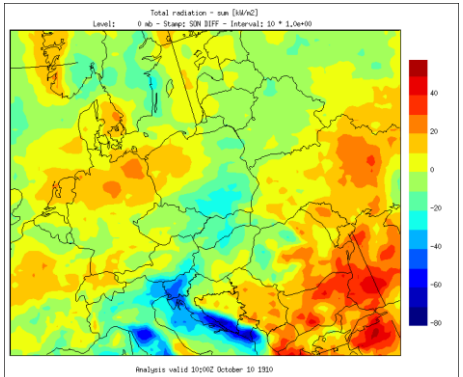
SON





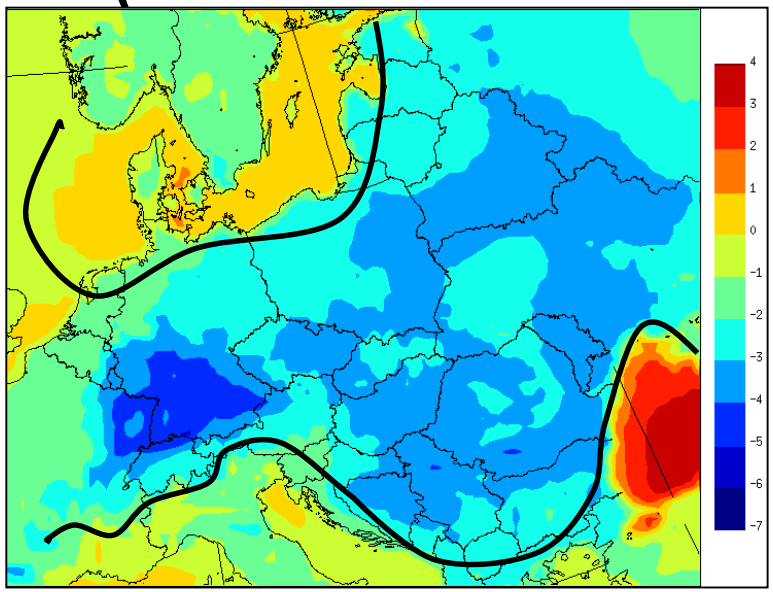




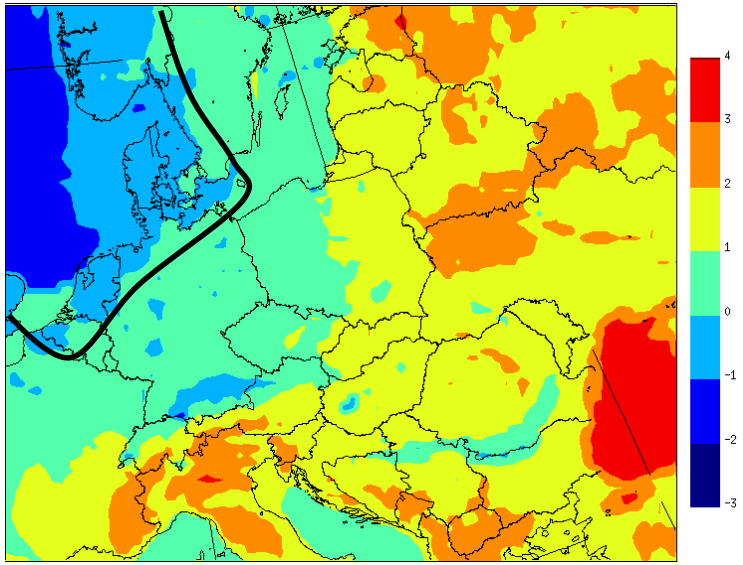


Temperature [°C]
(seasonal aver – 2050-2000 difference)

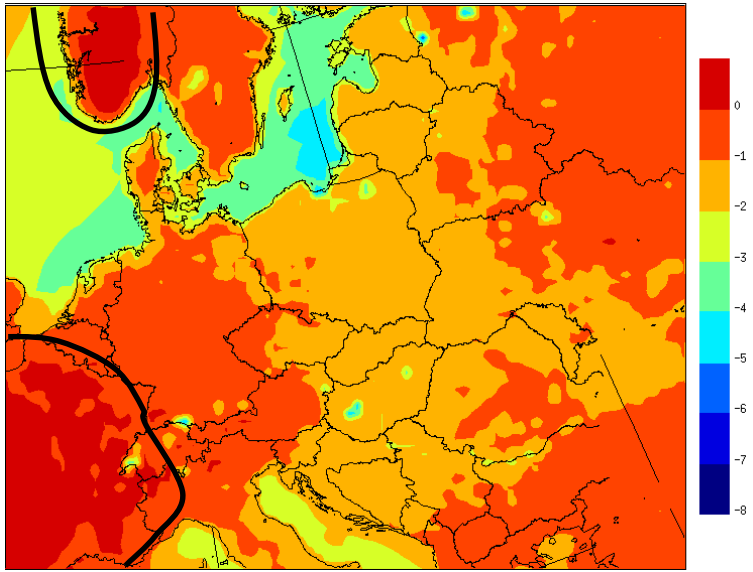
DJF



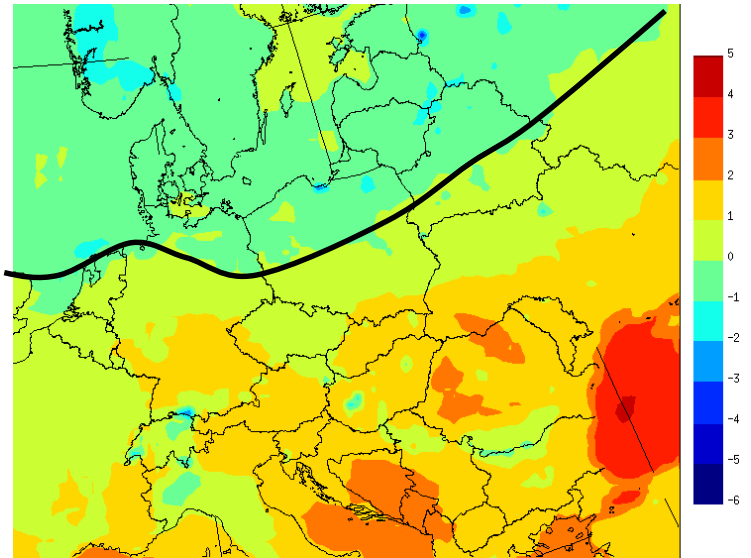
MAM



JJA

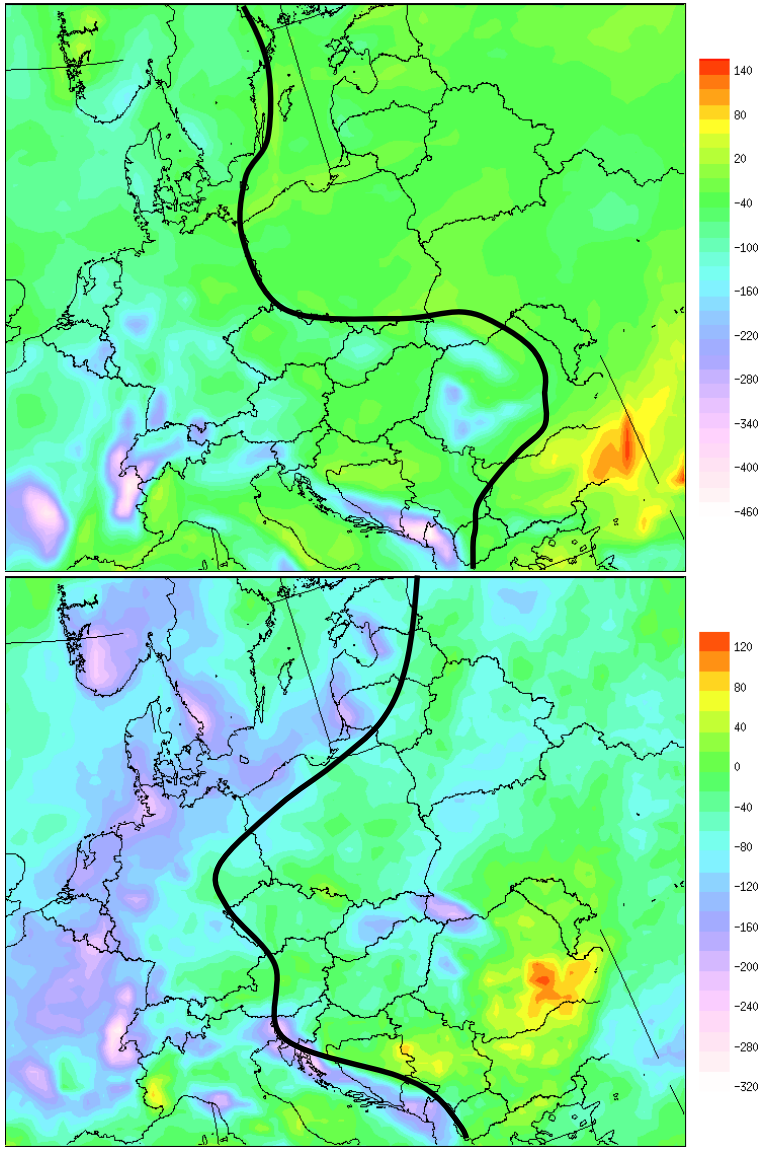


SON

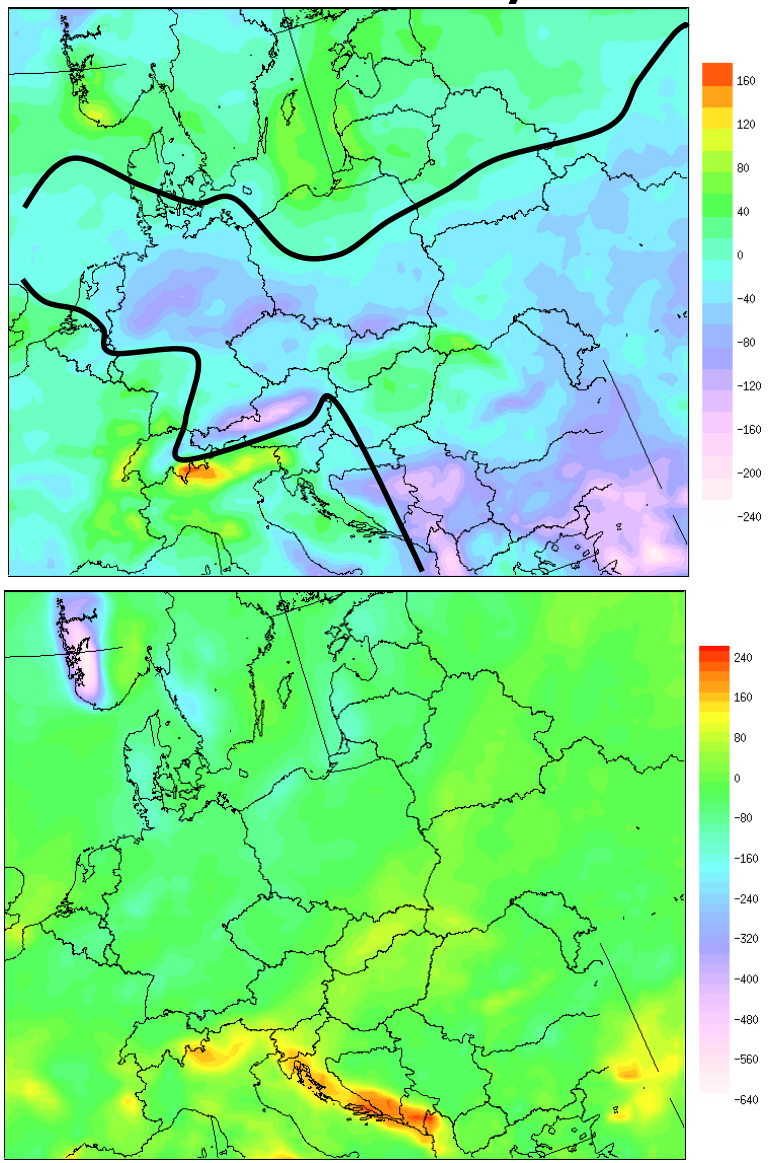


Precipitation [mm]
(seasonal sum – 2050-2000 difference)

DJF



MAM



JJA

SON

Wybór daty

May 2018

S	M	T	W	T	F	S
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

Today

Wybór mapy - Polska

- Zachm., opady, ciśnienie
- Mapa dolna: U, T
- Energia chwiejności (CAPE)

Krok: < > |<

Odtwórz 4x >>>>

+1h	+37h
+2h	+38h
+3h	+39h
+4h	+40h
+5h	+41h
+6h	+42h
+7h	+43h
+8h	+44h
+9h	+45h
+10h	+46h
+11h	+47h
+12h	+48h
+13h	+49h
+14h	+50h
+15h	+51h
+16h	+52h
+17h	+53h
+18h	+54h
+19h	+55h
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+21h	+57h
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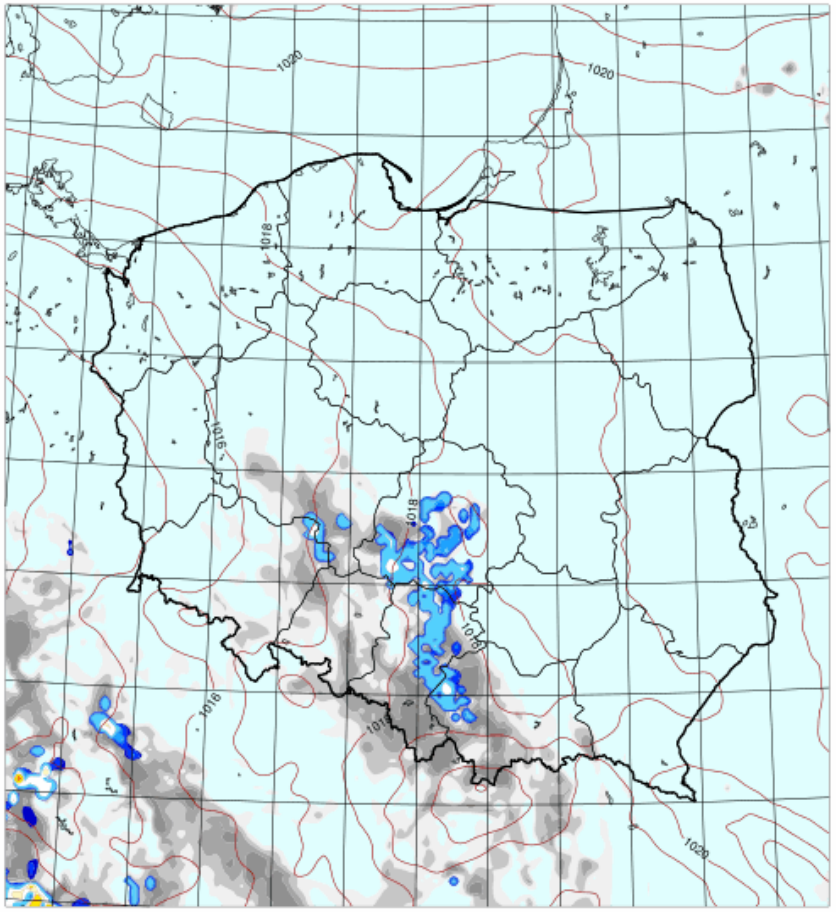
+23h	+59h
+24h	+60h
+25h	+61h
+26h	+62h
+27h	+63h
+28h	+64h
+29h	+65h
+30h	+66h
+31h	+67h
+32h	+68h
+33h	+69h
+34h	+70h
+35h	+71h
+36h	+72h

meteo.pw

Precipitation rate [mm/h]
Cloudiness / Sea-level pressure [hPa]

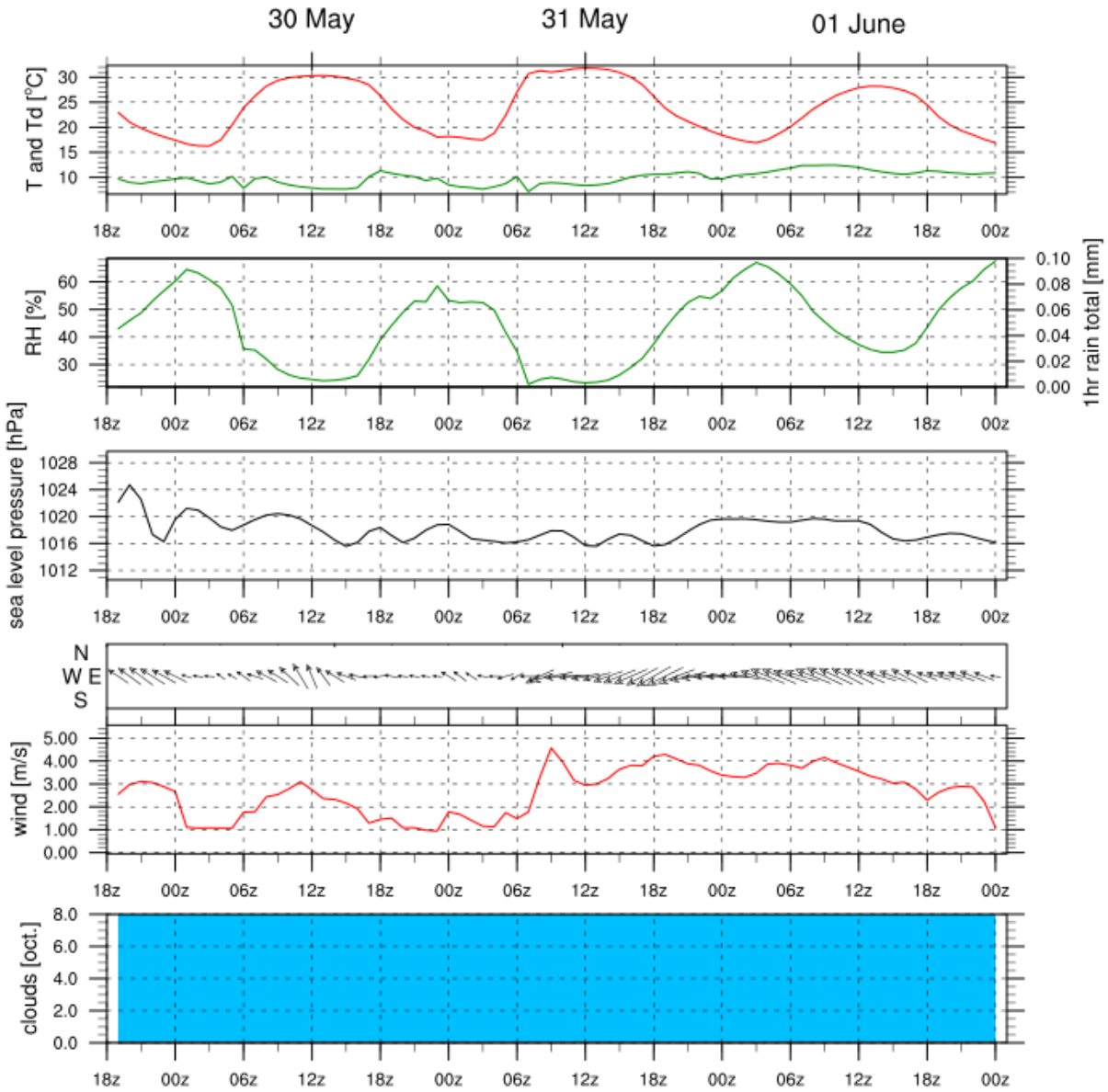
ekoprognoza

ISSUED: 29/05/2018 18Z VT: 30/05/2018 04:00Z



Warszawa

based on GEM-LAM forecast started at: 2018-05-29 18UTC



Thank you