



Satellite information downscaled to urban air quality in Bulgaria

Overview of SIDUAQ project

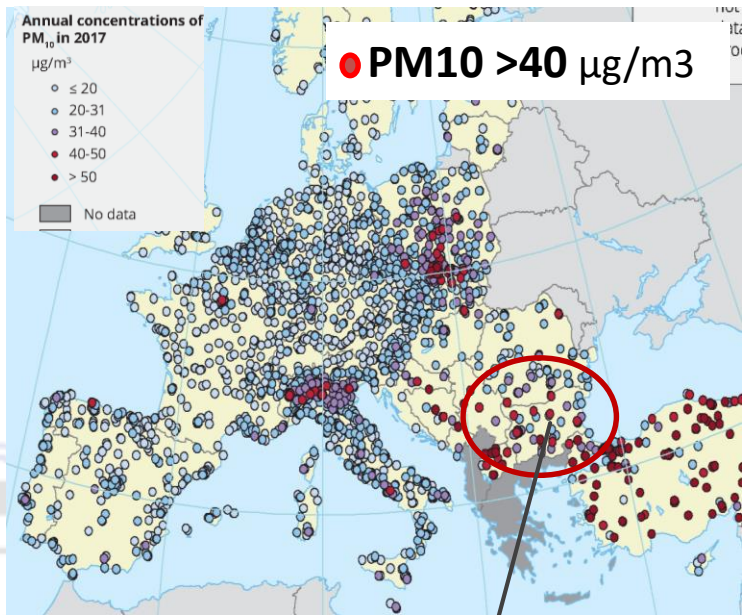
National Institute of Meteorology and Hydrology - NIMH
Space Research and Technology Institute, SRTI-BAS
Period: 2018 - 2020

Emilia Georgieva (NIMH) & SIDUAQ team

Motivation



1. EEA – OBS. PM₁₀ in 2017



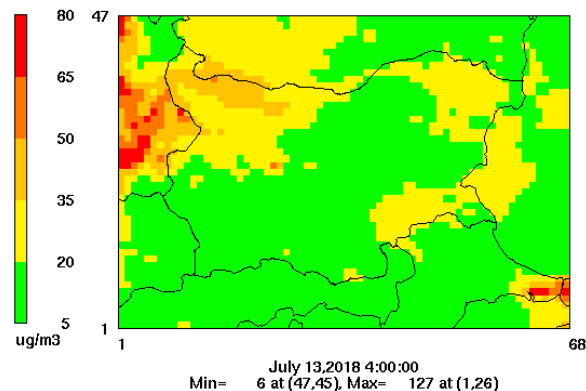
Plovdiv 2018



2. BgCWFS - operational chemical weather forecast system @ NIMH

Surface PM₁₀

dx = dy = 9 km.



<http://info.meteo.bg/cw2.1/>

PM₁₀ by BgCWFS are underestimated



Goal & Objectives

To use satellite data for atmospheric chemistry (**AOD, VCD NO₂, SO₂**) for improvement of air quality modeling & management at national (Bulgaria) and local level (city of Plovdiv)

How to achieve the goal :

synergetic use of data from:

- ESA satellites (MetOp, Sentinel 5P)
- in situ air quality monitoring
- air pollution dispersion models

Main activities

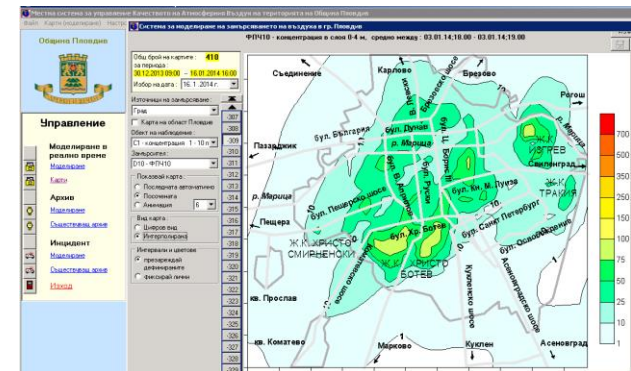
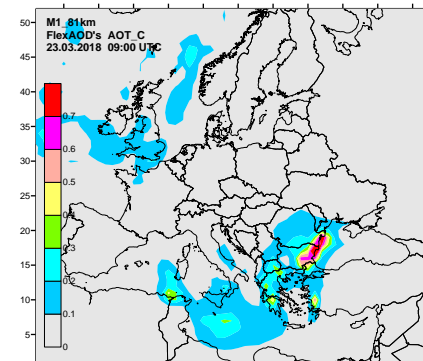
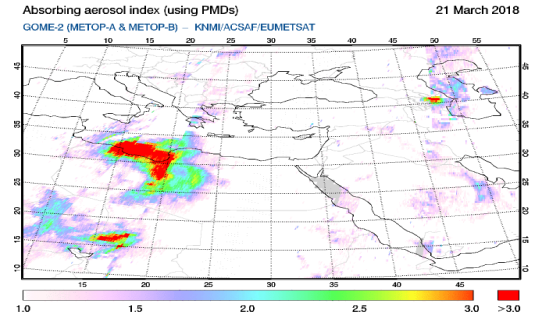
Identification of appropriate satellites

Assimilation of satellite retrieved data for AOD, NO₂, SO₂ in BgCWFS

Downscaling of BgCWFS outputs (9x9km) for the local AQ Management System (LAQMS) in Plovdiv (300x300m)

LAQM & Elaboration of expert analysis module suitable for the local AQ authority in Plovdiv

Evaluation of model performance based on ground based measurements data and inter-comparison to other models (e.g. EMEP/CAMS regional)



BgCWFS model

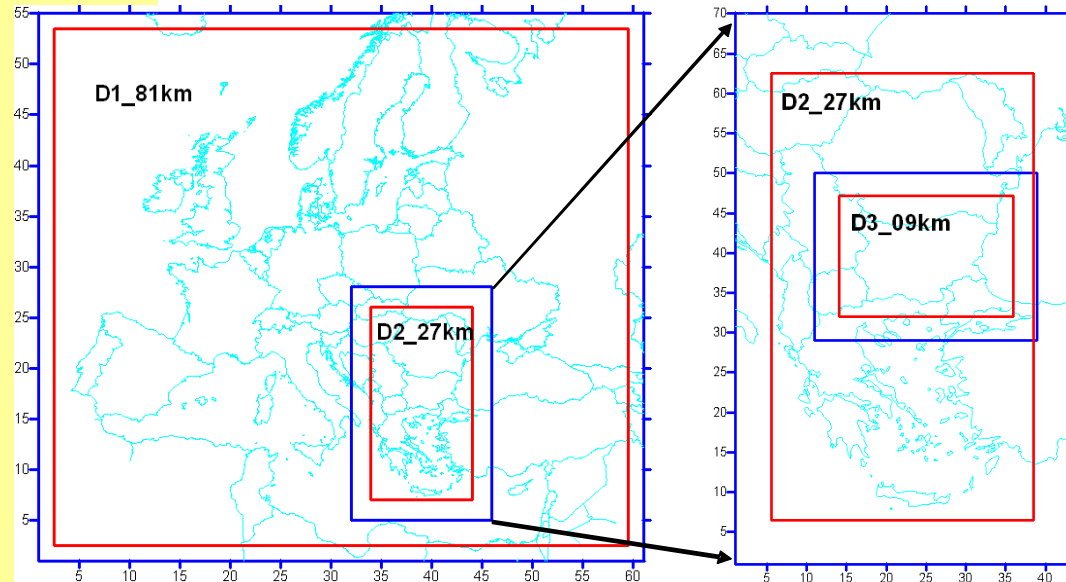


- Based on **WRF - CMAQ**

- 5 domains - 81km
27km, 9km,
- [3km, 1km x Sofia]

- Operational runs since 2012; 72h forecast

- NO DUST sources



- for satellite data assimilation the *off-line (non-operational)* version of BgCWFS as this is *the first attempt* to use data assimilation in BgCWFS



BgCWFS maps

<http://info.meteo.bg/cw2.2>
<http://info.meteo.bg/cw2.1>



National Institute of Meteorology and Hydrology

POLLUTANTS

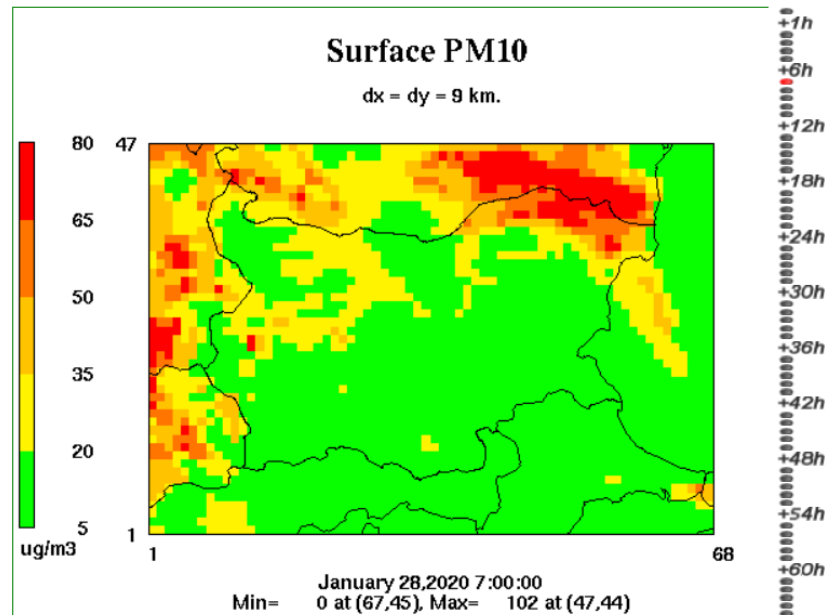
Nitrogen dioxide (NO₂)
72-hours forecast
Sulfur dioxide (SO₂)
72-hours forecast

OZONE
72-hours forecast

First day
Daily maxima
8-hour daily maxima
Second day
Daily maxima
8-hour daily maxima
Third day
Daily maxima
8-hour daily maxima

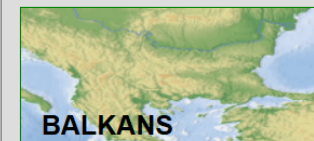
PM10
72-hours forecast

Description of Bulgarian
Chemical Weather Forecast
and Information System
(ver. 2.1)(PDF)



Bulgarian legislation for Fine Particulate Matter (PM10):
Daily threshold value (DT): 50 µg/m³
Permitted number of exceedings of DT in a year: 35
Yearly threshold value (YT): 40 µg/m³
Permitted number of exceedings of YT: impermissible

DOMAINS



Funded by the
National Science Fund of Bulgaria

Surface maps: hourly SO₂, NO₂, O₃, PM10

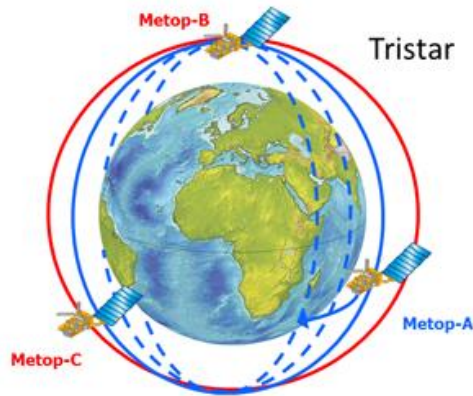


Challenges for BgCWFS

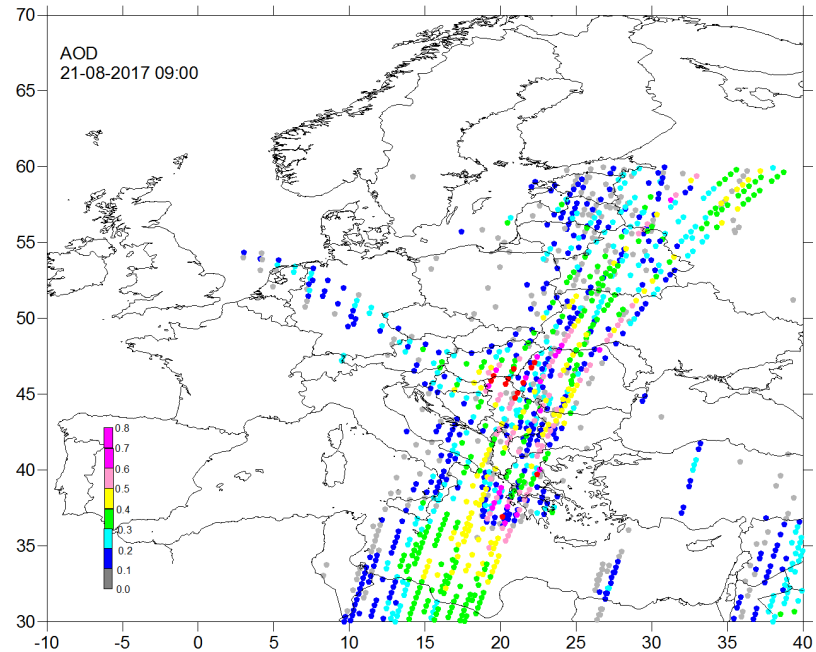
- * Which satellite data in which model region to assimilate
- * Assimilation procedure
- * How to treat nested domains
- * **How to estimate** AOD by the model -it is not a routine model parameter – 5 different algorithms have been tested, (CMAQ embedded + 1 external - *FlexAOD* software (Curci,2012)



Satellite data for atmospheric chemistry



- GOME 2 instruments on *MetopA*, *MetopB* & *MetopC* satellites:
- AAI aerosol absorbing index
- Vertical column densities of NO₂ and SO₂

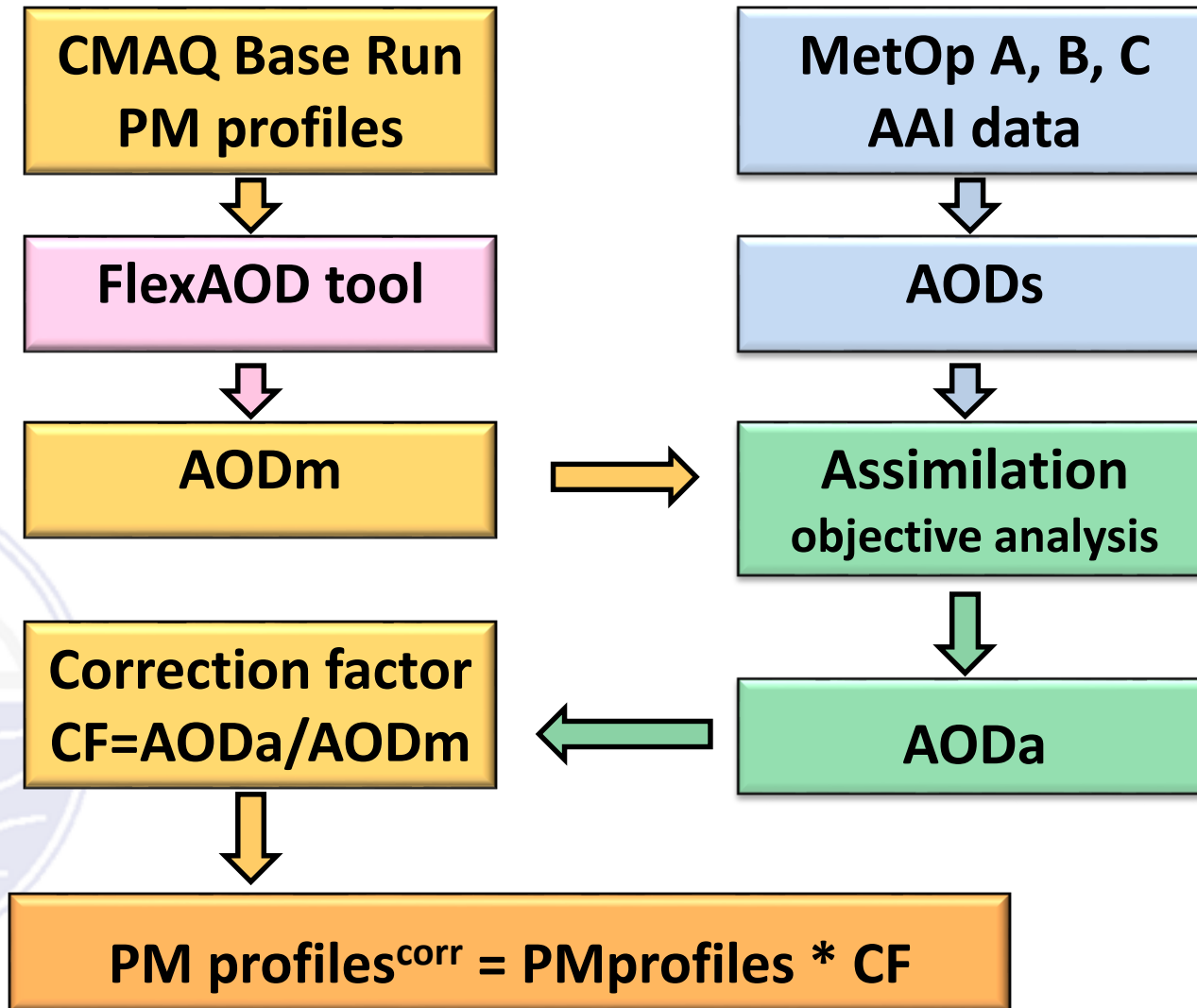


AOD from 3 satellites on 21-Aug-17
overpass time over BG~09:00 UTC

*AAI is converted into **AOD (aerosol optical depth)** ~ Aerosol mass concentration*



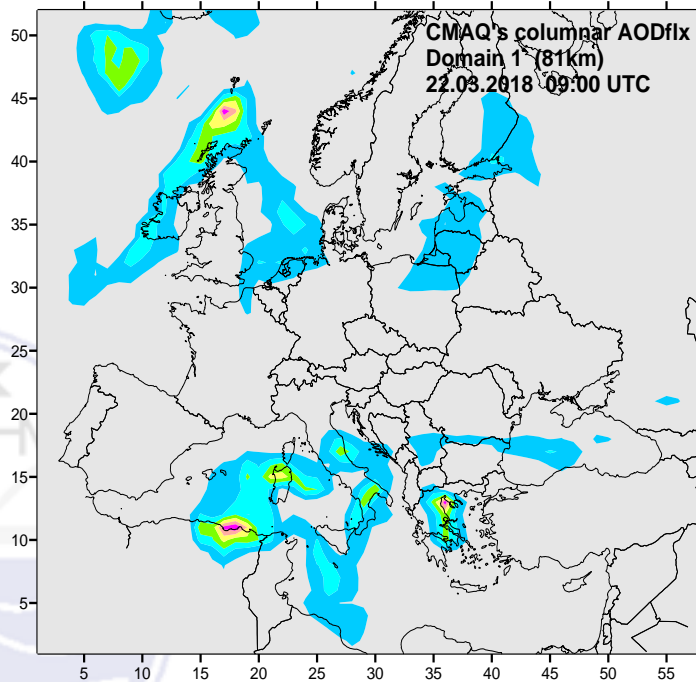
Modification of BgCWFS



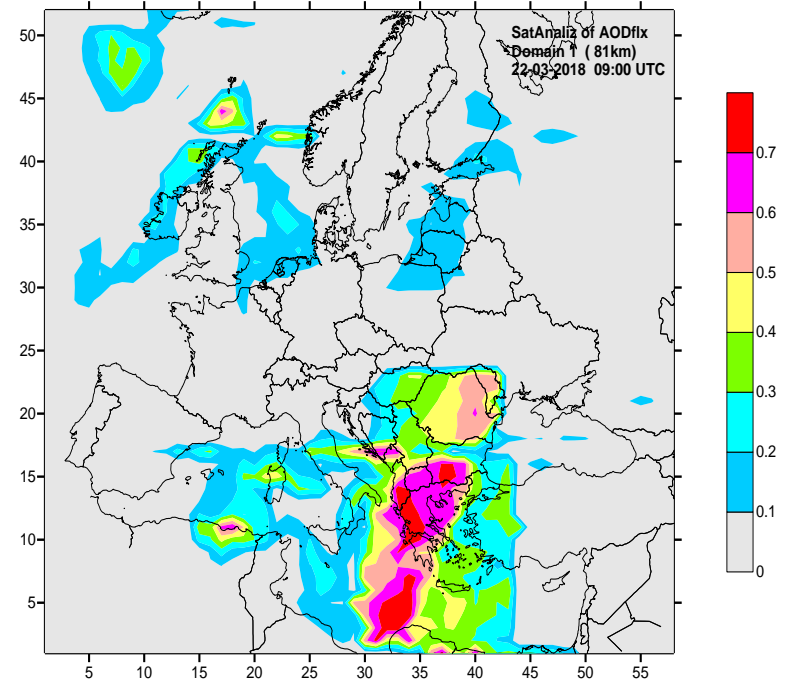


BgCWFS – AOD 22.03.2018

NO satellite data



WITH satellite data



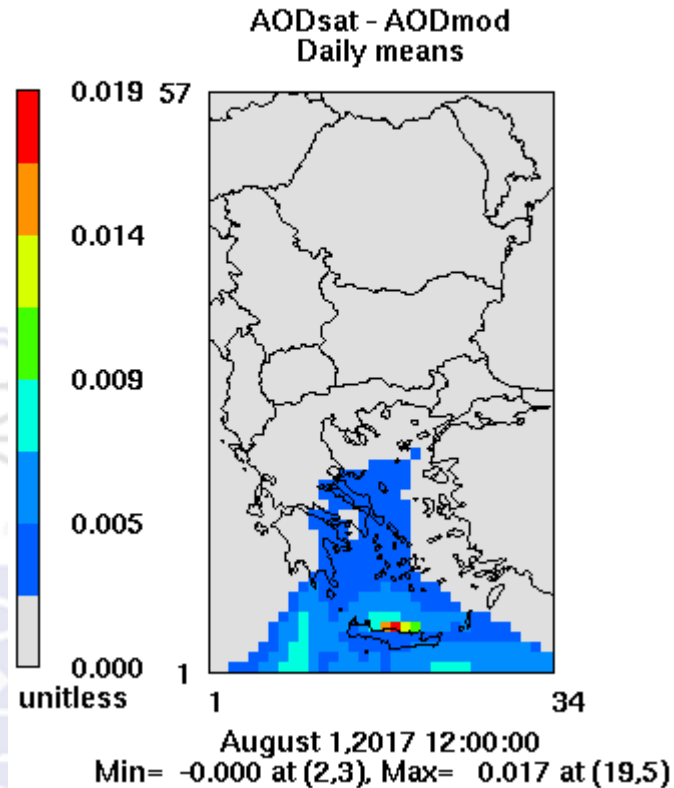
**Saharan Dust outbreak towards BG
captured with assimilation of satellite data**



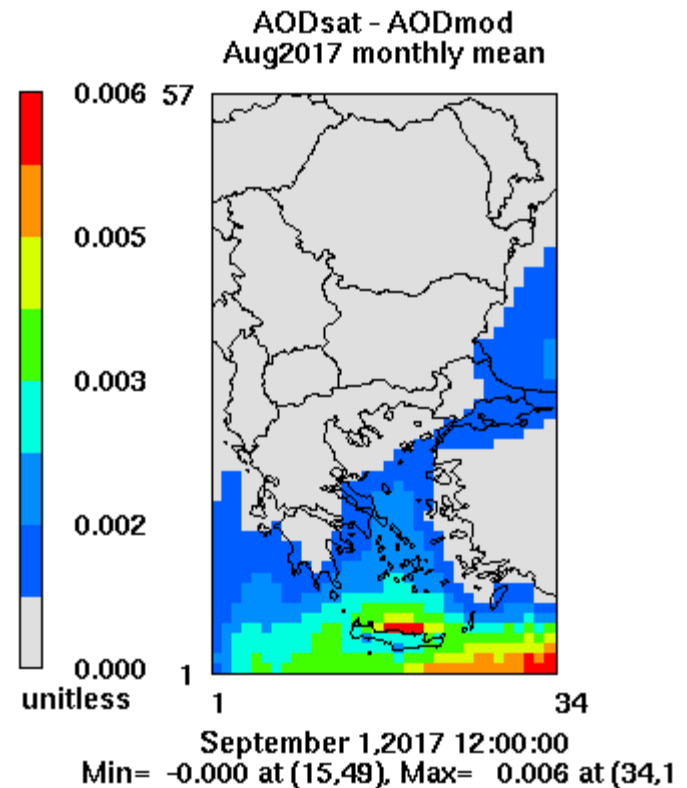
Simulations – August 2017

2 model runs: base case (m) & sat case (s)

$$\text{Diff AOD} = \text{AODs} - \text{AODm}$$



Diff AOD - daily

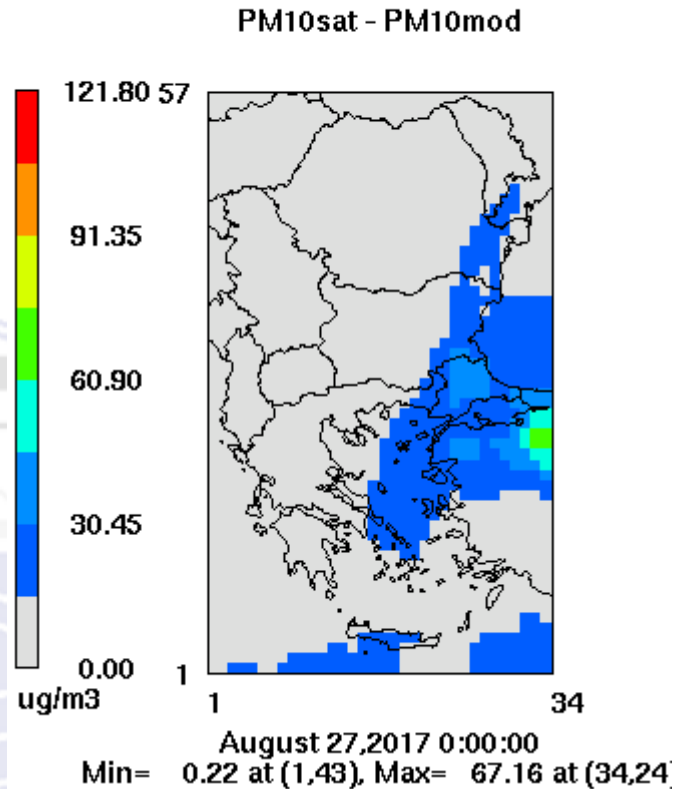


Diff AOD – mean monthly

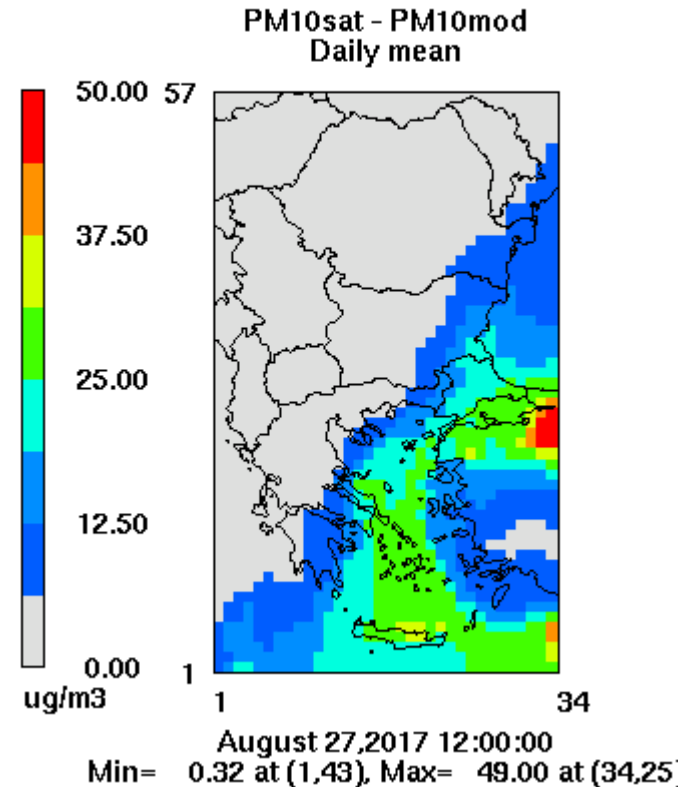


Simulations – August 2017

2 BgCWFS model runs: base case (m) & sat case (s)
Diff PM10 = PM10s-PM10m for 27.Aug 2017



Diff PM10s –PM10m



DIFF PM10 – daily mean



Work in progress

- **Simulations for another month (February 2019) by both BgCWFS (Bulgaria) and LAQMS (Plovdiv)**
- **Evaluation using in-situ measurements, AERONET data (1 station in BG), comparison to CAMS global model for AOD, VCD NO₂, VCD SO₂**



Acknowledgments

The **SIDUAQ project** "Satellite Information Downscaled to Urban Air Quality in Bulgaria" is funded by ESA and the Government of Bulgaria through the ESA Contract No.4000124150/18/NL/SC under the PECS (Plan for European Cooperating States).

***THANK YOU FOR
THE ATTENTION!***

БЛАГОДАРЯ за ВНИМАНИЕТО!

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