Использование данных регулярной сети мониторинга и информации о зондировании атмосферы для оценки регионального загрязнения приземной атмосферы

Трифонова-Яковлева А.М.
ИГ РАН, ЛАИКС

Сеть мониторинга EANET

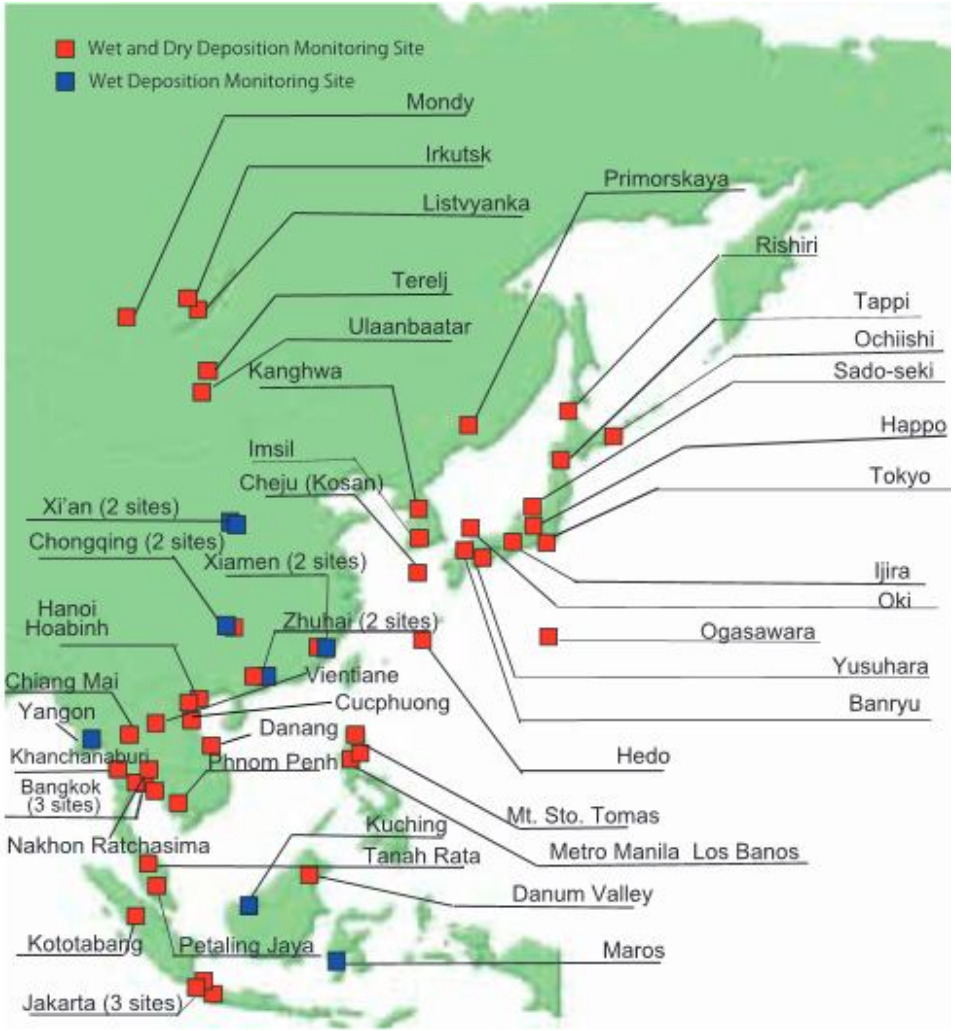
EANET (Acid Deposition Monitoring Network in East Asia) - сеть мониторинга кислотных выпадений в восточной Азии.

Функционирует с 2000 года.

13 стран

54 станции мониторинга по выпадениям с осадками
(pH, EC, SO_4^{2-}, NO_3^-, NH_4^+, etc.)

46 станций мониторинга концентраций газов и аэрозолей в воздухе
(SO_2, NO_2, O_3, SO_4^{2-}, NO_3^-, NH_4^+ etc.)



Данные EANET 2000-2014

- Фильтрпак

SO2, NH3, HNO3, HCl, SO42-, NO3-, Cl-, NH4+, Na+, K+, Mg2+, Ca2+ (26 станций)

Разрешение 2 недели

- Автоматический монитор

O3, SO2, NO, NOx, PM10, PM2.5 (13 станций)

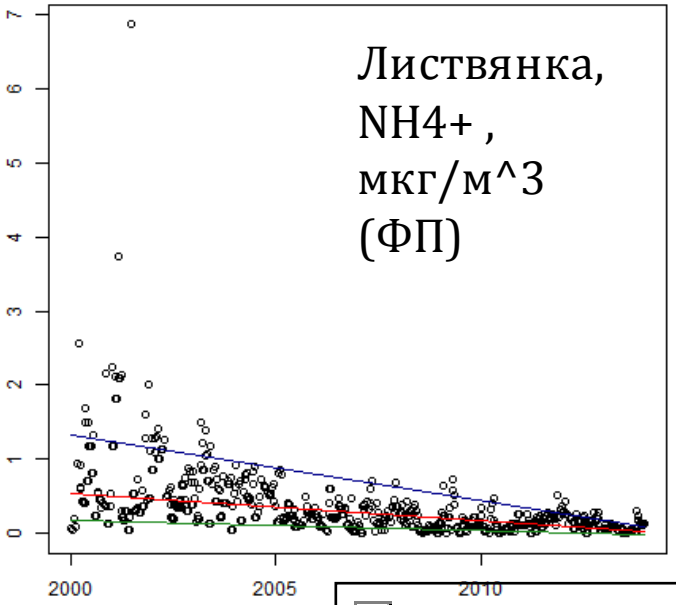
Часовое или суточное разрешение

- Осадки

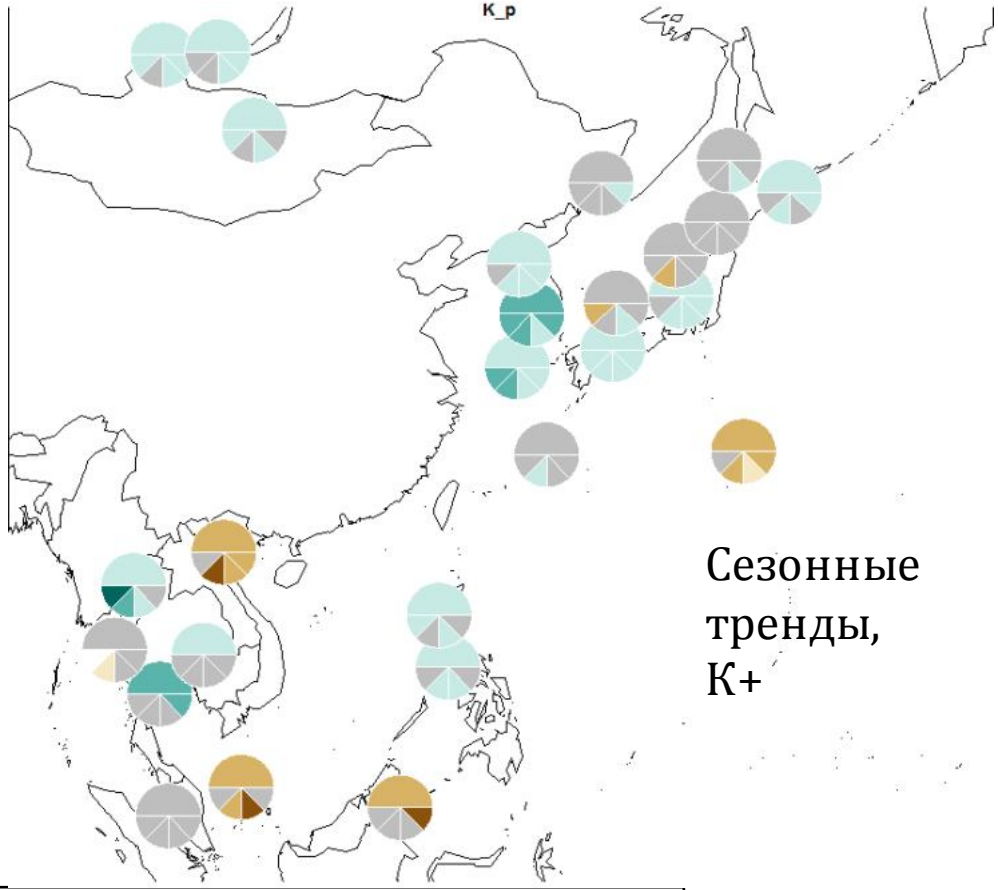
Разрешение 1-2 недели

Удаленные и негородские станции – в данной работе

Примеры данных EANET



Лиственка, NH4+ , мкг/м^3 (ФП)



Сезонные тренды, K+

D:\EANET DATA\AM_results\Russia_Mondy_O3.png

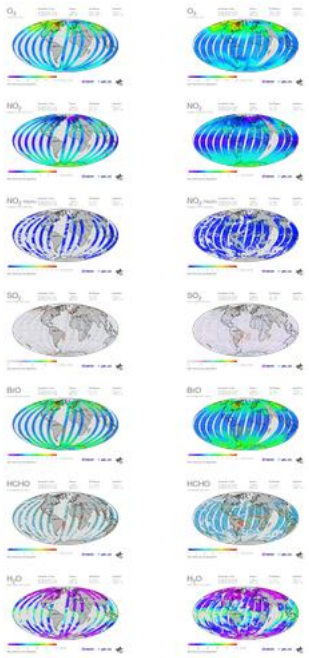
Монды, O3, ppb (AM)

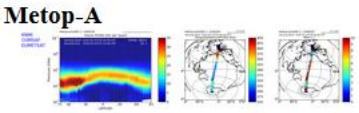
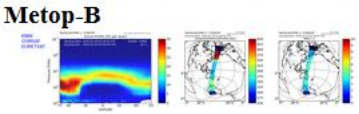
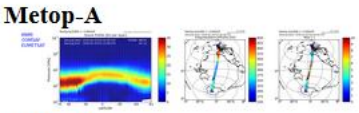
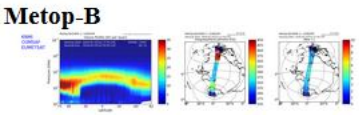
Задачи

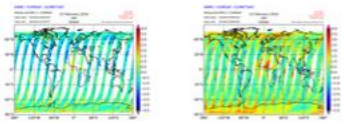
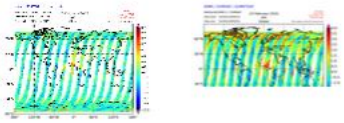
- Пространственная интерполяция концентраций ЗВ между станциями, выделение пространственных областей схожих концентраций
- Выявление долговременных трендов концентраций ЗВ на станциях
- Сравнение с трендами эмиссий
- Построение моделей для оценки концентраций ЗВ на территории восточной Азии
- Оценка трансграничного переноса ЗВ

Привлечение спутниковой информации к решению задач!

O3M SAF (EUMETSAT)

Composite images	Product name
Metop-A / Metop-B  *Images not yet available*	Total ozone column
	Total and tropospheric NO2 columns
	SO2 column
	Total BrO column
	Tropospheric HCHO column
	Total H2O column
	Tropical tropospheric O3 column [2]

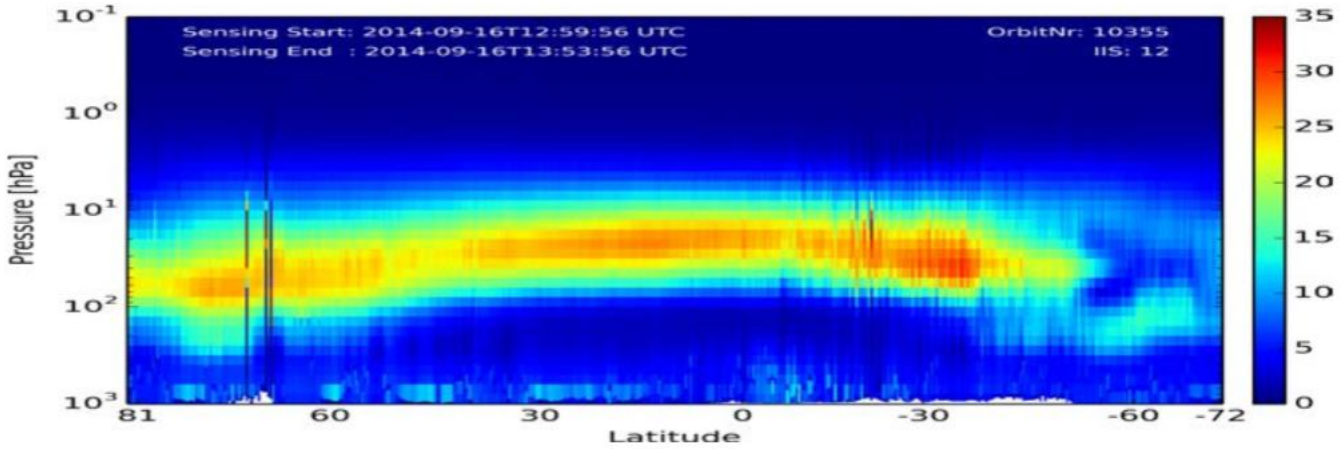
Composite images	Product name
Metop-A  Metop-B  Metop-A  Metop-B 	Coarse resolution ozone profile
	High-resolution ozone profile

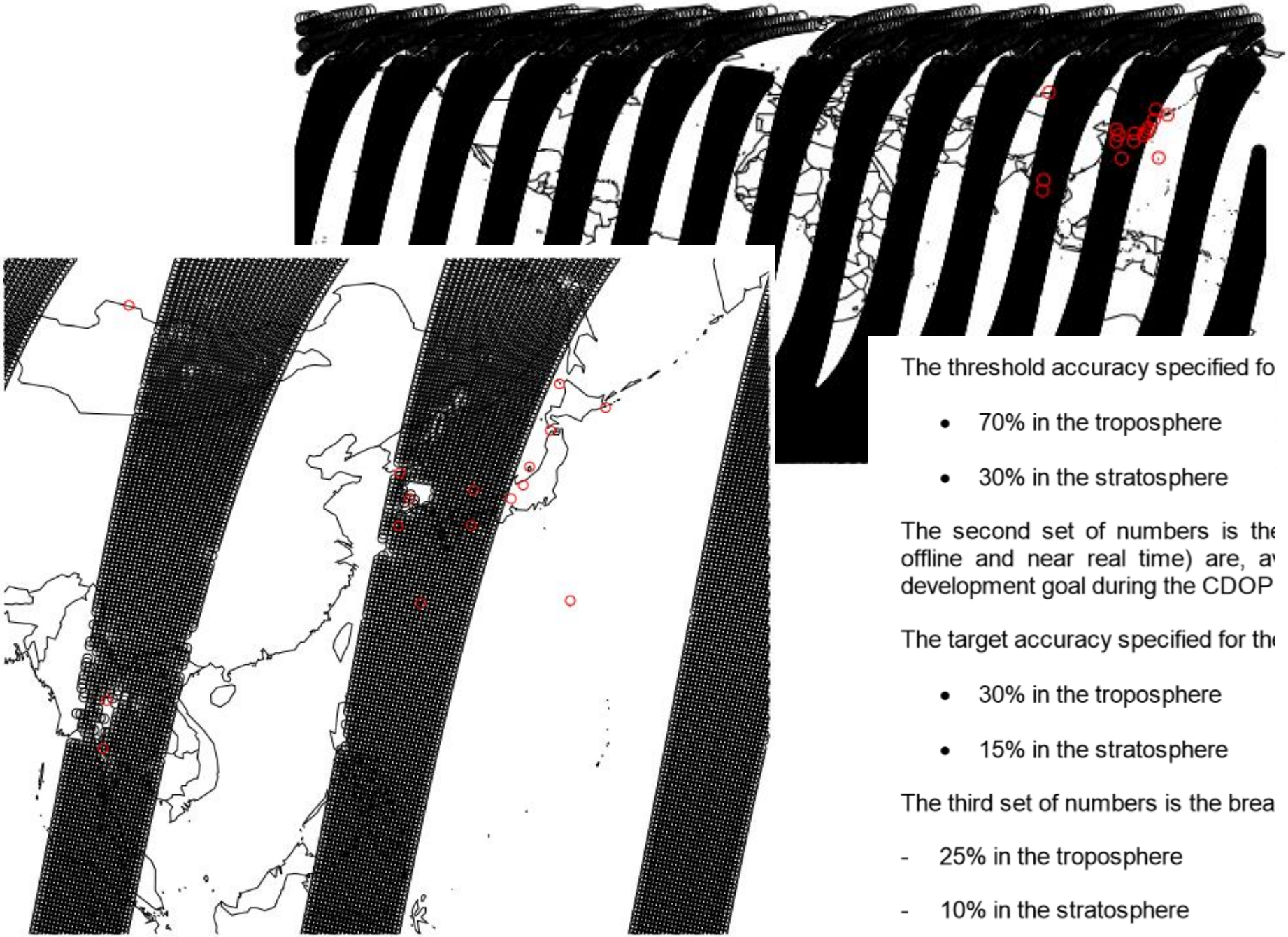
Composite images	Product name
Metop-A / Metop-B 	Absorbing aerosol index
	Absorbing aerosol index from PMDs

Сравнение данных по концентрациям озона у поверхности земли

- EANET – данные автоматического монитора (часовые или суточные)
- MetopA, MetopB: GOME2
  High-resolution ozone profile

(O3M SAF http://o3msaf.fmi.fi)





The threshold accuracy specified fo

- 70% in the troposphere
- 30% in the stratosphere

The second set of numbers is the offline and near real time) are, a development goal during the CDOP

The target accuracy specified for th

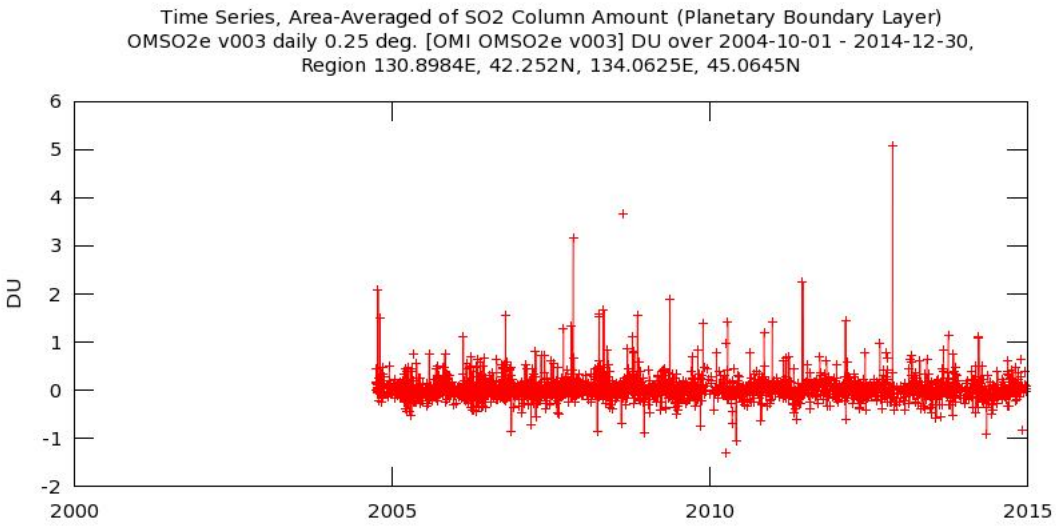
- 30% in the troposphere
- 15% in the stratosphere

The third set of numbers is the brea

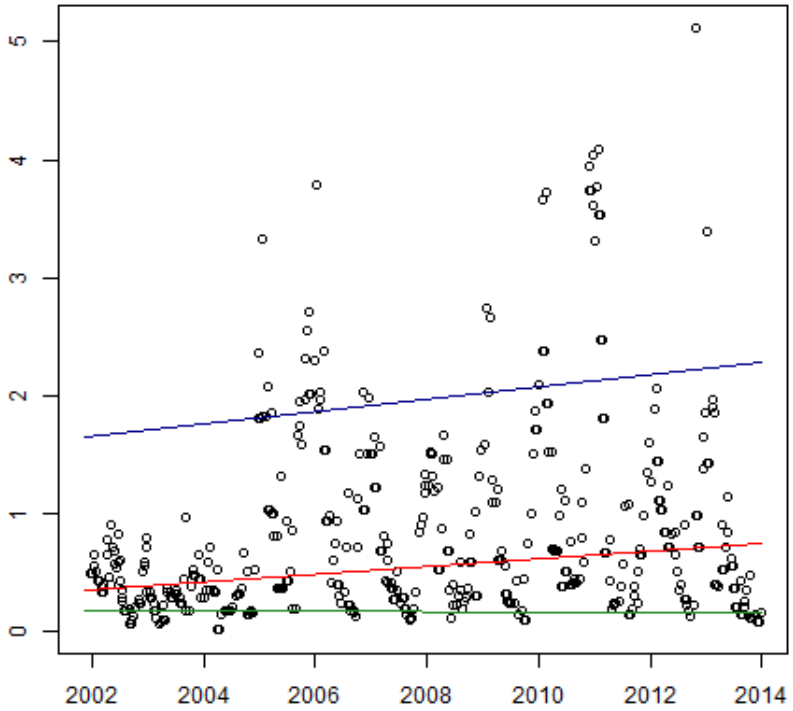
- 25% in the troposphere
- 10% in the stratosphere

The breakthrough accuracy is the e

Сравнение данных по содержанию SO2



Giovanni (http://giovanni.sci.gsfc.nasa.gov)



EANET (filterpack data)

Станция мониторинга Приморская
(Уссурийский край, Каменюшка)

Примеры использования спутниковых данных в оценке трендов эмиссий в Восточной Азии

- **Sulfur dioxide emissions in China and sulfur trends in East Asia since 2000** Z. Lu, D. G. Streets, Q. Zhang, S. Wang, G. R. Carmichael …Atmos. Chem. Phys., 10, 6311–6331, 2010 www.atmos-chem-phys.net/10/6311/2010/ doi:10.5194/acp-10-6311-2010

"The aerosol optical depth (AOD) products of Moderate Resolution Imaging Spectroradiometer (MODIS) are found to be highly correlated with the surface solar radiation (SSR) measurements in East Asia. Using MODIS AOD data as a surrogate of SSR, we found that China and East Asia excludingJapan underwent a continuous dimming after 2000, which is in line with the dramatic increase in SO2 emission in East Asia. The trends of AOD from both satellite retrievals and model over East Asia are also consistent with the trend of SO2 emission in China"

- **Aura OMI observations of regional SO_2 and NO_2 pollution changes from 2005 to 2014** N. A. Krotkov et.al. Atmos. Chem. Phys. Discuss., 15, 26555–26607, 2015 www.atmos-chem-phys-discuss.net/15/26555/2015 doi:10.5194/acpd-15-26555-2015

Создание статистической модели для распределения PM2.5

NASA training **Satellite Remote Sensing of Particulate Matter Air Quality: Data, Tools, Methods and Applications (Aka AOD-PM)** 10/01/2015 to 10/29/2015

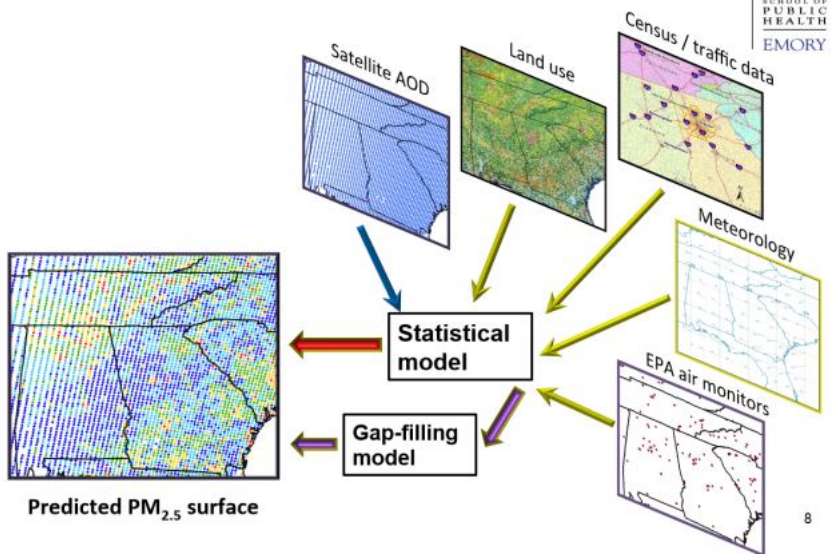
"Particulate Matter Air Quality from Space – Advanced Statistical Modelling",
Yang Liu

Examples of Advanced Statistical Models

- Multiple linear regression with effect modifiers (e.g., Liu et al. 2005)
- Linear mixed effects (LME) models (e.g., Lee et al. 2011)
- Geographically weighted (GWR) regression (e.g., Hu et al. 2013)
- Generalized additive models (GAM) (e.g., Liu et al. 2009, Strawa et al. 2014)
- Hierarchical models (e.g., Kloog et al. 2012, Hu et al. 2014, Ma et al. 2015)
- Bayesian models (e.g., Chang et al. 2013)
- Artificial neural network (e.g., Gupta et al. 2009)

9

Basic Ideas of Model Development



8

High-resolution ozone profile

O3M SAF (EUMETSAT Network of Satellite Application Facilities)
http://o3msaf.fmi.fi

Resolution: High resolution
Metop-A: 40 x 80 km^2 (2010 – 16/07/2013) and 40 x 40 km^2 (16/07/2013 – present).
Metop-B: 40 x 80 km^2 (12/12/2012 – present)

- **Theoretical basis:** Global Ozone Monitoring Experiment-2 (GOME-2) measures the radiance spectrum of sunlight scattered from the atmosphere in the (UV) wavelength region 260-330 nm.
- **Processing algorithm:** At KNMI, Ozone ProfilE Retrieval Algorithm (OPERA) iteratively finds the vertical ozone profile best matching the GOME-2 reflectance using optimal estimation. The forward model is based on LidortA and uses an externally prescribed instrument response slit function. The a-priori ozone climatology is (currently) based on McPeters/Labow/Logan. The surface pressure and the vertical temperature profile come from operational ECMWF forecasts. Special adaptations have been made to handle spikes in the measured radiance spectrum in the South Atlantic Anomaly.
- **Units and spatial resolution:** The vertical ozone profiles are given as partial ozone columns in Dobson Units (DU) in 40 layers from the surface up to 0.001 hPa. The ground pixel size corresponds to the footprint of the Band-1b integration time, which usually means 40 x 80 km^2 (along-track x cross-track, see also resolution above).
- **Validation:** This product is validated by DWD (Germany) and RMI (Belgium). The validations are based on detailed comparisons of the operational retrieved profiles from GOME-2 satellite data with ground-based measurements (balloon soundings, lidar and microwave radiometer measurements). Visit O3M SAF ozone profiles validation website for further information.