Institute of Remote Sensing and Digital Earth
Chinese Academy of Sciences

The Current Status of Aerosol Remote Sensing in China

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Outline

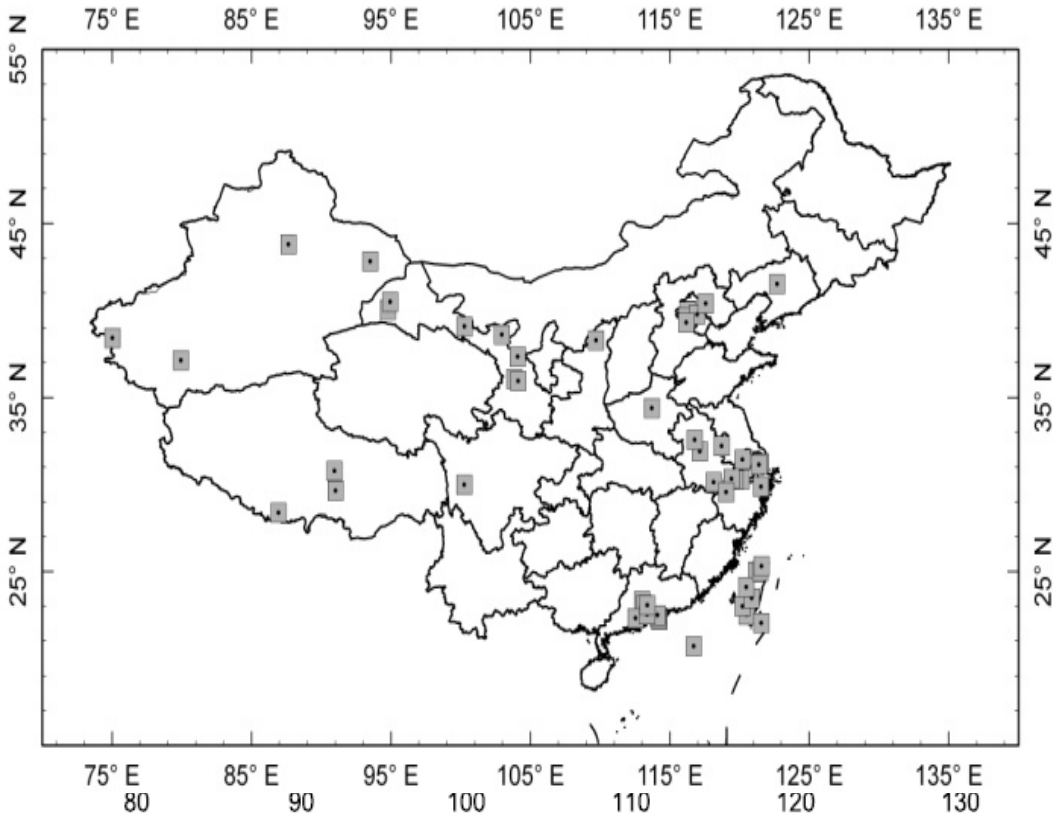
- Introduction
- Ground-Based Aerosol Remote Sensing
- Aerosol Remote Sensing from Satellite Data

Ground-based Network

- AERONET
- CARSNET
- CSHNET

- spectral AOD
- Ångström exponent (α)
- single scattering albedo (SSA, ω_a)
- phase function (p(Θ))
- asymmetry factor (g_a)
- refractive index(RI, n and k)
- size distribution (n(r))

$$\frac{dV}{d\ln r} = \frac{C_f}{\sqrt{2\pi}\cdot\sigma_f}\exp[-\frac{(\ln r - \ln r_f)^2}{2\sigma_f^2}] + \frac{C_c}{\sqrt{2\pi}\cdot\sigma_c}\exp[-\frac{(\ln r - \ln r_c)^2}{2\sigma_c^2}]$$



➢ CIMEL: sun/sky radiometers spectral measurements of direct sun radiation and scanned sky radiance

Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP-CAS)

Key Laboratory of Middle Atmosphere and Global Environment Observation (LAGEO) (http://lageo.iap.ac.cn/index.php/index)

➢Main research contents:

- *Surface-Atmosphere Coupled Radiative Transfer*
- *Ground-based airborne and spaceborne remote sensing of atmospheric compositions*
- *Sensor technique*
- *Remote sensing data analysis, multi-source data assimilation and numeric weather prediction*

Ground-based and airborne platform, and satellite data receiving station at LAGEO

Integrated observation site of atmosphere and radiation at Xianghe

- *Total/direct/difusse solar radiation measurement at UV/VIS/IR spectrum*
- *Aerosol properties from radiometers*
- *Atmospheric sounding from balloons*
- *Radar observation of wind, cloud and rain*
- *Lidar profiling of atmospheric composition*
- *Dobson ozone spectrophotometer, aerosol and gas sampling meters, meteorological tower etc.*

http://lageo.iap.ac.cn/index.php/article/173/172

See more super sites: e.g. Xinglong Atmospheric Background Observation Station

http://lageo.iap.ac.cn/index.php/article/173/261

Atmospheric Environment Monitoring Station

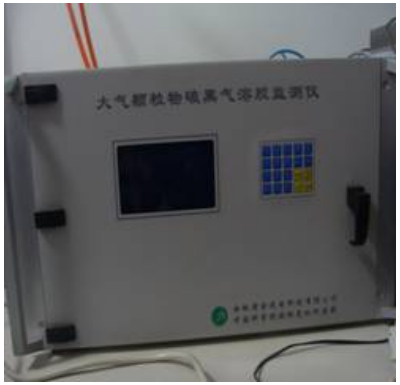
RADI: (http://www.rschina.org/menuPage/map.html?lg=0)

TEOM (PM_{10}, $PM_{2.5}$)

CE318 (size distribution, AOD, Lidar ratio)

Lidar (vertical profile)

- Other instruments for visibility, BC, trace gas profile etc.



Field Campaigns

Name	Peroid		Remote Sensing Instruments	reference
ACE-ASIA	March - May 2001	Yulin, Zhenbeitai	nephelometer, Particle Soot Absorption Photometer (PSAP)	Xu et al. (2004)
		AD-Net (Beijing, Hefei, Lanzhou)	Mie Lidar	Shimizu et al. (2004)
ADEC	April 2002 - April 2004	Aksu, Shapotou	Lidar, Sky-radiometer	Mikami et al. (2006)
EAST-AIRE	2004 - 2005	Xianghe, Taihu	broadband and narrowband radiometers, pyrheliometer, CE-318, MFRSR, Total Sky Imager(TSI)	Li et al. (2007a)
		Liaoning	sunphotometer, MPL Lidar, microwave radiometer, PSAP, nephelometer	
AMF-China	May 2008 - November 2008	Shouxian, SACOL, Zhangye	TSI, MFRSR, CE-318 and other radiometers, MPL lidar, ceilometer	Li et al. (2011b)

Satellites and Sensors

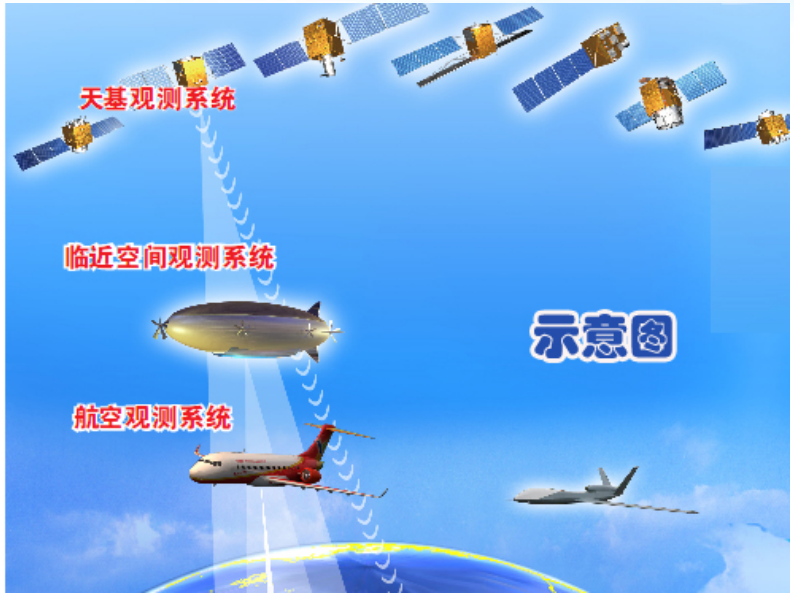
Satellite	Instrument	channels (μm)	spatial resolution
FY-3	MERSI	1 (0.47), 2 (0.55), 3(0.65), 4 (0.865)	250 m
		6 (0.412) - 14(0.865), 20 (2.13)	1 km
FY-2	VISSR	1 (0.55–0.90)	1.25 km
		2 (3.50–4.00), 3 (3.50–4.00), 4(10.30–11.30), 5 (11.50–12.50)	4 km
HJ-1A/1B	CCD	B (0.43-0.52), G (0.52-0.60), R (0.63-0.69), NIR (0.76-0.90)	30 m
CBERS	CCD	B (0.45-0.52), G (0.52-0.59), R (0.63-0.69), VIS (0.51-0.73), NIR (0.77-0.89)	19.5 km

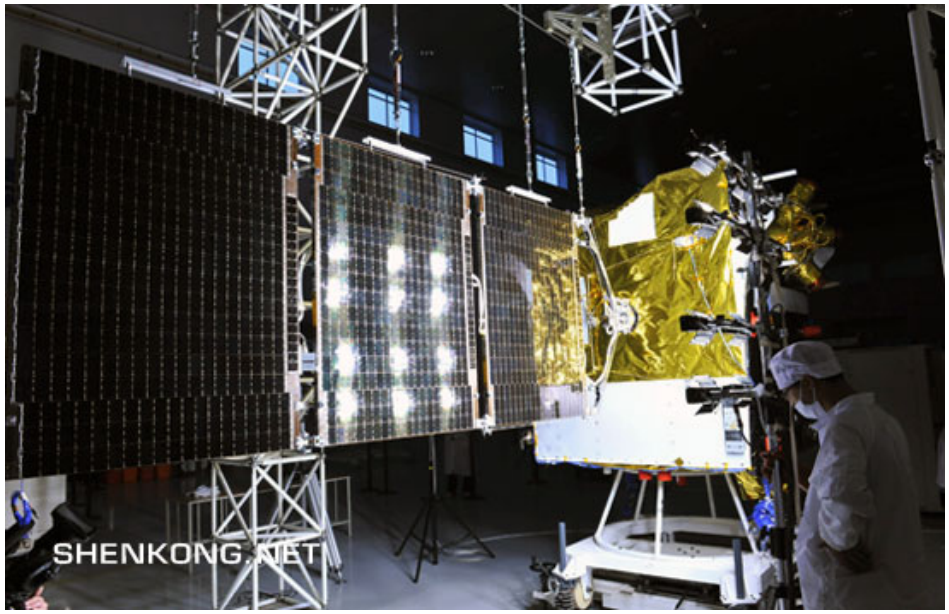
Satellite Environment Center, Ministry of Environmental Protection
http://www.secmep.cn/

National Satellite Meteorological Center
China Meteorological Administration (NSMC/CMA)

High-resolution Earth Observation System Plan (‘Gaofen’)

- *Constructing advanced and high-resolution earth observation system including satellites, tropospheric aircrafts and aeroplanes*
- *Establishing all-weather, round-the-clock operational and global coverage observation capability*
- *Developing compatible data receiving, processing and application technique*





‘Gaofen-1’ to be launched in April, 2013

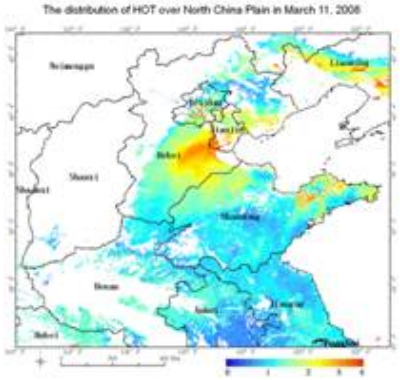
- Applications: modern agriculture, hazard prevention, land use, surveying and mapping, ocean and climate observations, urban traffic managements etc.

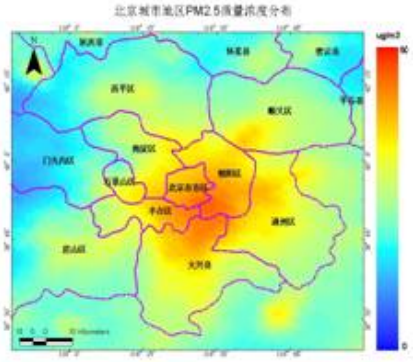
Aerosol Projects in China

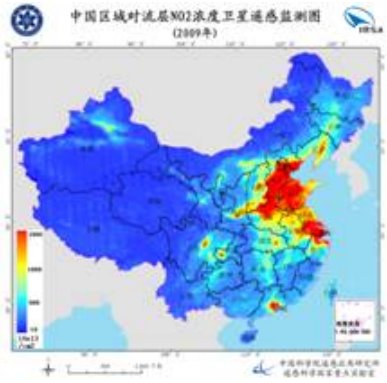
- Multi-source satellite remote sensing and monitoring of air pollution technology

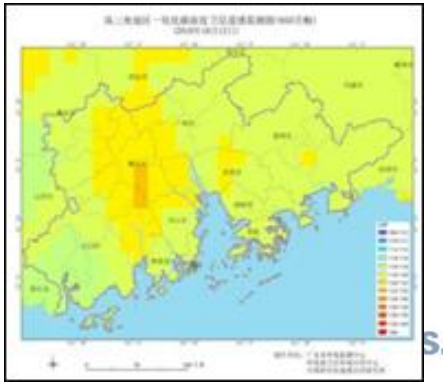
➢863 (State Plan for High-Tech Research and Development) Program
➢Principle Investigator: Liangfu Chen (RADI-CAS)
➢Period: 2007-2011
➢Main research contents:

- *Haze AOD retrieval and analysis*
- *PM retrieval and remote sensing monitoring*
- *High resolution AOD retrieval based on HJ-1 CCD*
- *Retrieval of tropospheric NO_2 and SO_2.*
- *Infrared remote sensing of CH_4, CO and O_3 profiles.*
- *Establishing "the integrated air pollution monitoring system based on multi-source satellite sensors"* (http://www.rschina.org/amers/nodecorators/result_intro_index.jsp)









Aerosol Projects in China

- Atmospheric Aerosols of China and their Climate Effects

➢973 (National Key Science Program) project

➢Principle Investigator: Xiaoye Zhang (Chinese Academy of Meteorological Sciences, CAMS)

➢Period: 2006-2010

➢Main research contents:

- *Observing aerosol physical and chemical properties*
- *Aerosol formation, evolution and sink mechanisms (especially haze and dust)*
- *Ground-based remote sensing network construction*
- *Aerosol direct and indirect radiative effects*
- *Modeling and coupling of GCM (general circulation Model) and CTM (chemical transport model) for climate study and numeric prediction*

(http://www.cams.cma.gov.cn/cgi/973-qrj2006.htm)

Aerosol Projects in China

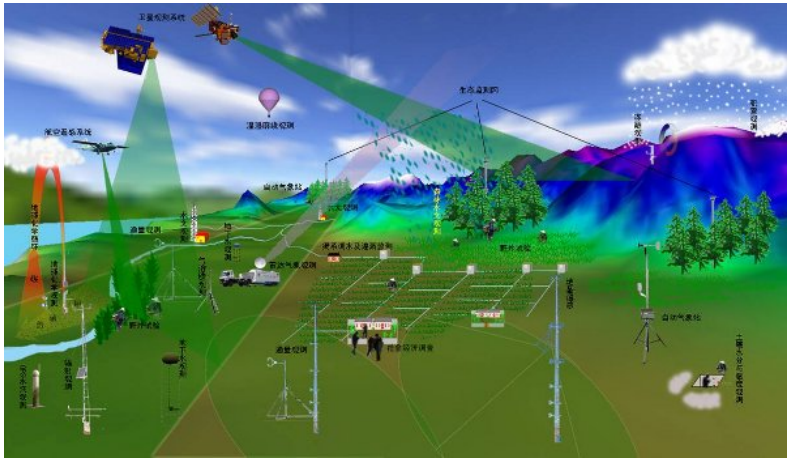
- Inversion Theories and Methods by Initiative and Passive Remote Sensing for the Elements of Ecological Environment

➢973 project (http://www.apsirs-973.cn)

➢Principle Investigator: Xiaowen Li
(Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences)

➢Period: 2007-2011

➢Main research contents:



- *Standard techniques and optimization methods for satellite data products of ecological environment*
- *Achieving quantitative inversion of ecological elements including aerosol.*
- *Authenticity testing theories and methods to validate the quality of remote sensing products*
- *A meta-data and data dissemination system of "collaborative experiment for integrated remote sensing of Heihe"*
(http://rsdc.bnu.edu.cn:8080/)

Aerosol Projects in China

- Typical climate change patterns over global arid and semi-arid regions and its impacts
  - 973 project (2012-2016)
  - Principle Investigator: Jianping Huang (http://hjp.lzu.edu.cn)
  - Semi-arid Atmospheric Climate Observation Laboratory (SACOL)
    Lanzhou University (LZU)

➢Research Interests:

- *Ground-based and satellite remote sensing of aerosol and cloud*
- *Establishing and maintaining the SACOL integrated observation site*
- *Dust and black carbon properties, evolution and radiative effects*
- *Climate analysis, modeling and prediction*

Aerosol Projects in China

- Observation and Modeling Studies of Cloud, Aerosol and Climate Effects

➢973 project
➢Principle Investigator: Zhanqing Li (Beijing Normal University, BNU)
➢Period: 2013-2017
➢Main research contents:
●*Observation of aerosol and CCN*
●*Remote sensing of aerosol and cloud parameters*
●*Modeling of aerosol-cloud-precipitation interaction*
●*Observation-based analysis of aerosol indirect effects and the implications on climate change*

Aerosol Projects in China

- Multi-scale comprehensive Observation and Study of Temporal-spatial properties of Aerosols Project (MOSTap)

➢973 project (http://english.irsa.cas.cn/ns/Researchnews/201206/t20120604_86713.html)

➢Principle Investigator: Xingfa Gu (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, RADI-CAS)

➢Period: 2010-2014

➢Main research contents:

- *Ground-based retrieval of aerosol microphysical and chemical properties*
- *New satellite AOD retrieval technique*
- *Characterizing aerosol optical properties from micro to macroscopic scale*
- *Studying aerosol temporal and spatial distribution over China*
- *Assessing aerosols' interactions with human activities and climate change*

Multi-scale, multi-platform and integrated field campaign of aerosol observations and experiments across the Beijing-Tianjin-Hebei region during summer 2011

Aerosol Projects in China

- High-throughput AOD retrieval over land based on remote sensing mechanism

➢863 subject (http://www.tgp.ac.cn)

➢Principle Investigator: Yong Xue (RADI-CAS)

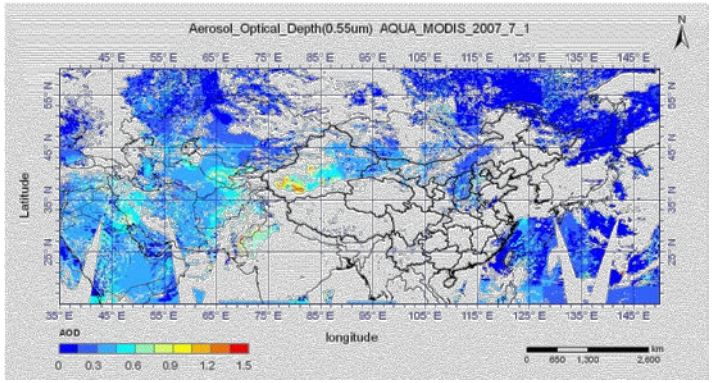
➢Period: 2007-2011

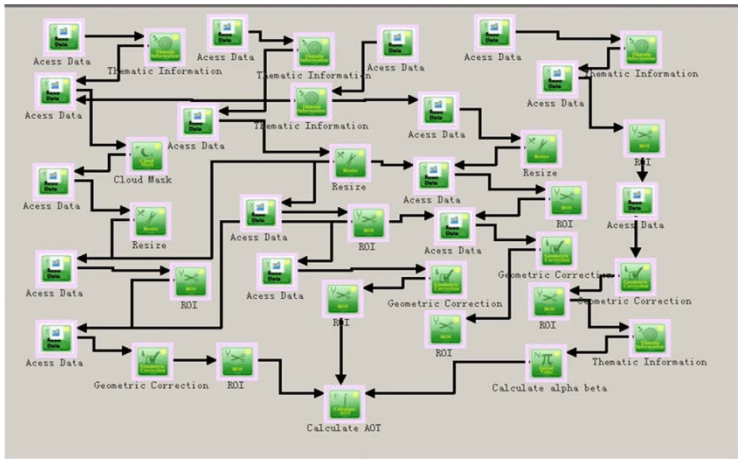
➢Main research contents:

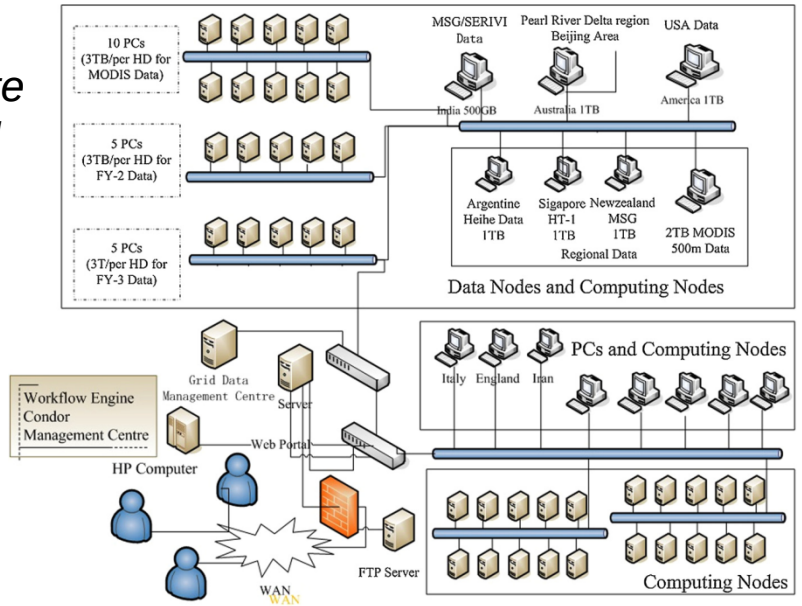
●*Synergic Retrieval of Aerosol Properties (SRAP) AOD retrieval algorithm and 10-year AOD dataset (China Collection 1.0 and 1.1)*

●*High throughput geoscience computing and remote sensing application platform based on condor pool*

●Grid Workflow composer GUI tool







Aerosol Projects in China

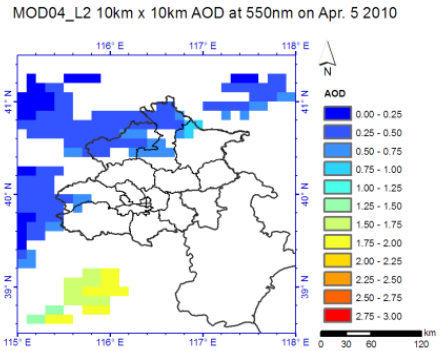
National Natural Science Foundation of China (http://www.nsfc.gov.cn/Portal0/default166.htm)

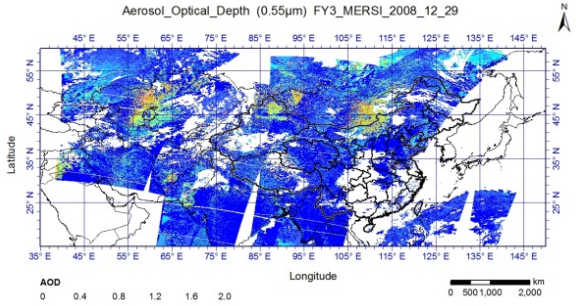
Project Title	PI (Affiliation)	Period
Study on the Radiative Effects of Atmospheric aerosols over China	Jietai Mao (Peking University, PKU)	1997-2000
Modeling the relationship between aerosol and cloud droplet size and aerosols' influence on precipitation based on multi-source remote sensing datasets	Jianping Guo (CAMS)	2012-2015
Study on Remote Sensing Technique of Aerosol Optical Properties based on New Polar-orbit and Geostationary Satellites	Chengcai Li (PKU)	2012-2015
Groud-based and Satellite Remote Sensing Study of the 3-dimentional Distribution and Regional Radiative Effects of Asian Aerosols	Xiangao Xia (Institute of Atmospheric Physics, IAP-CAS)	2012-2015
Study on Aerosol Remote Sensing over Land from NOAA/AVHRR Data Based on Time Series Technique	Yong Xue	2013-2016
Remote Sensing of aerosol chemical components	Zhengqiang Li (RADI)	2013-2016

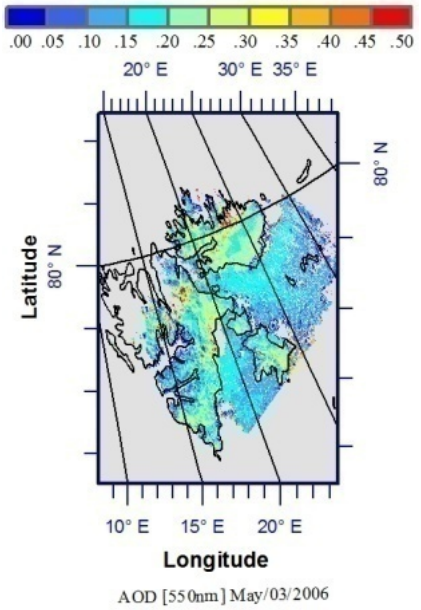
- Others…

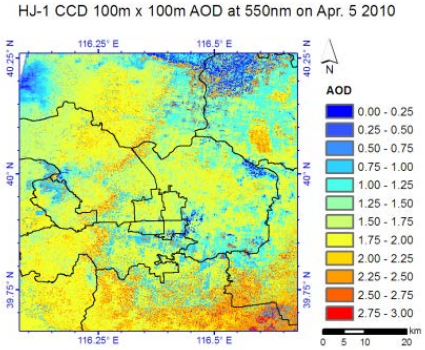
Multi-scale quantitative retrieval of Aerosol optical depth (AOD) over mainland China

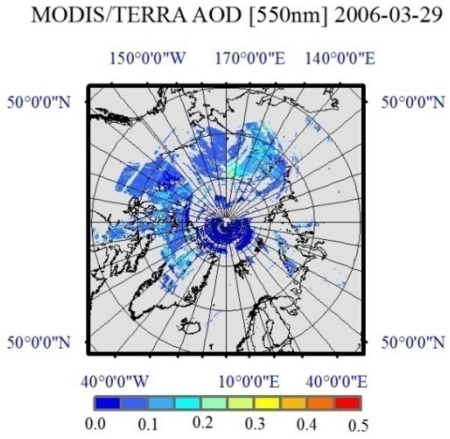
- Spatial resolution: 10km, 1km, 100m:
  - for researches of global AOD variation, especially the spatial and temporal AOD evolution and air pollution researches in urban regions over China
- Temporal resolution：polar-orbit satellites V.S. geostationary satellites:
  - for studies of extreme weather cases e.g. dust storms.





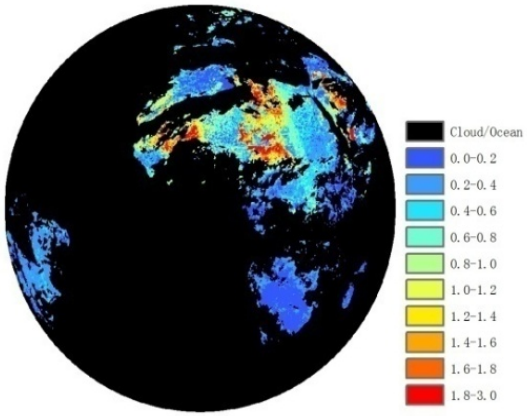




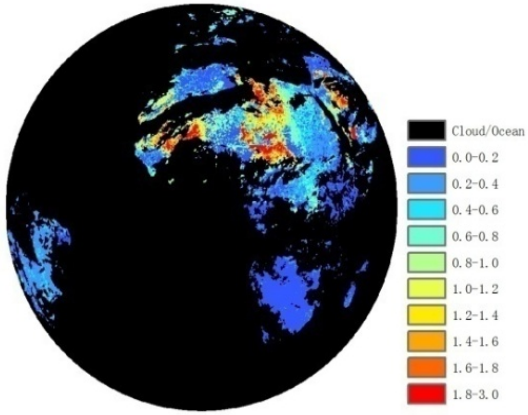


Hourly AOD from Geostationary Satellite Data

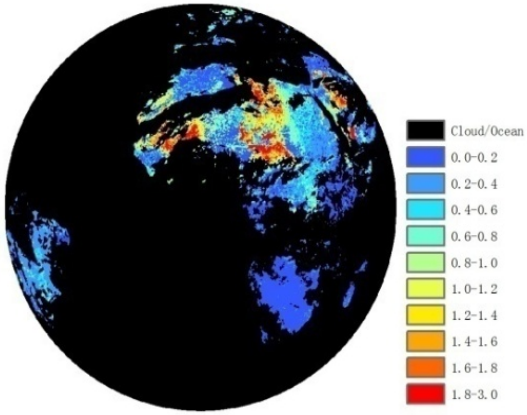
MSG/SEVIRI_AOD_12KM(0.6μm)
2010_04_14_10:30



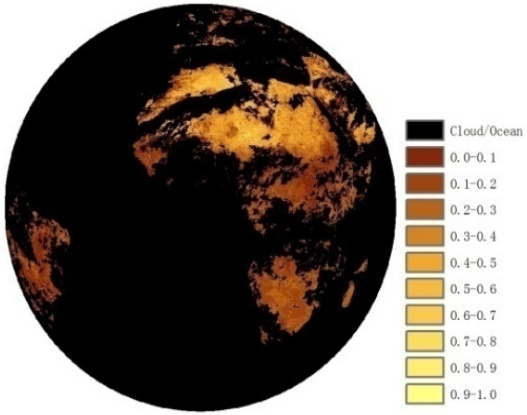
MSG/SEVIRI_AOD_12KM(0.6μm)
2010_04_14_10:45



MSG/SEVIRI_AOD_12KM(0.6μm)
2010_04_14_11:00



MSG/SEVIRI_REF_12KM(0.6μm)
2010_04_14_10:30



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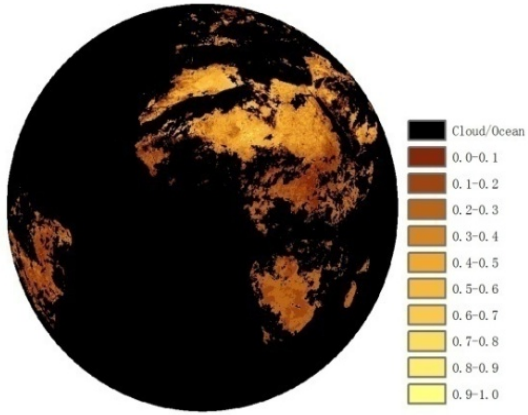
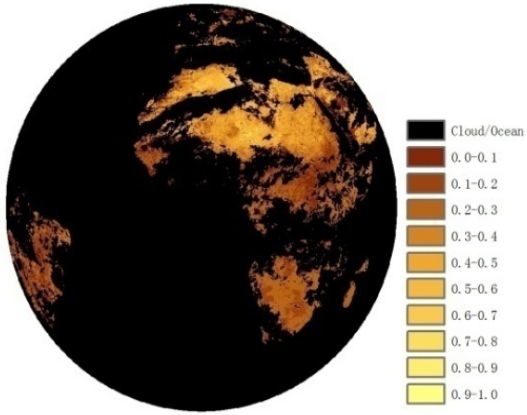
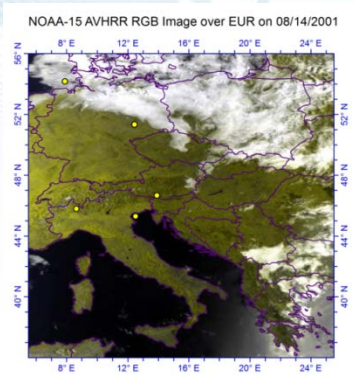
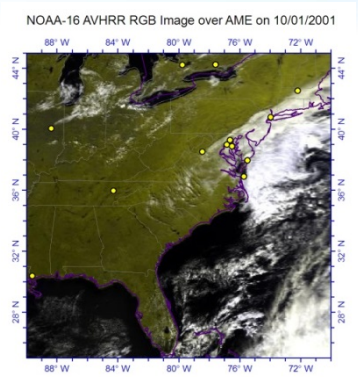


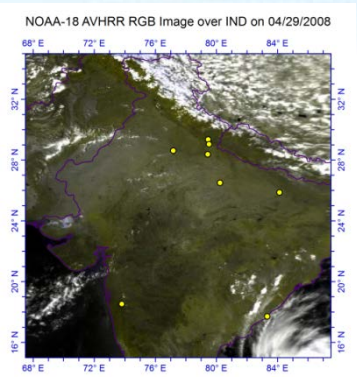
MSG/SEVIRI_REF_12KM(0.6μm)
2010_04_14_11:00

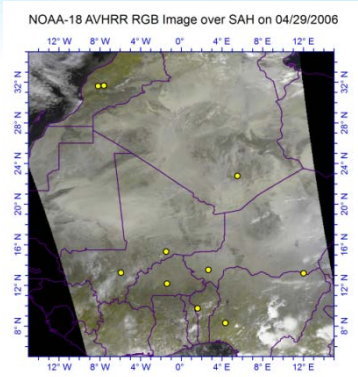


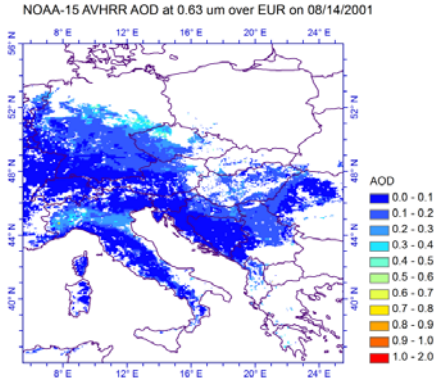
Long-term (30 yrs) AOD data from AVHRR Data

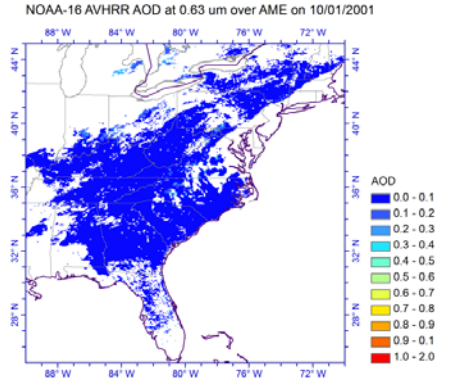


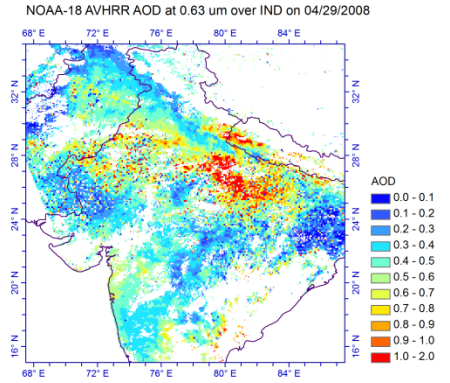


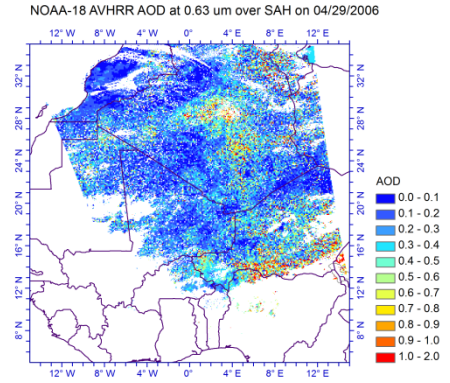


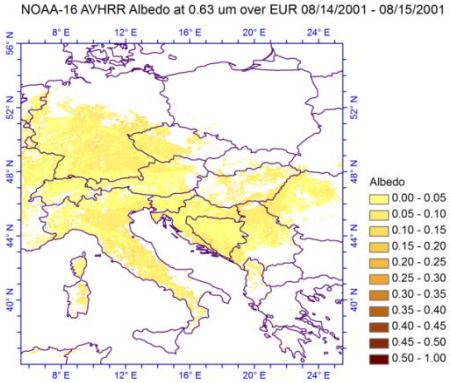


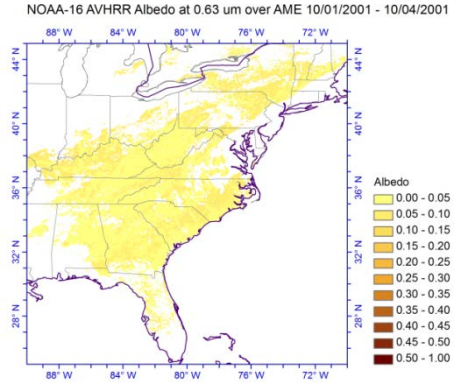


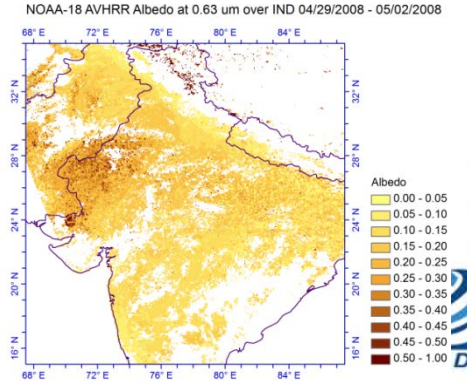


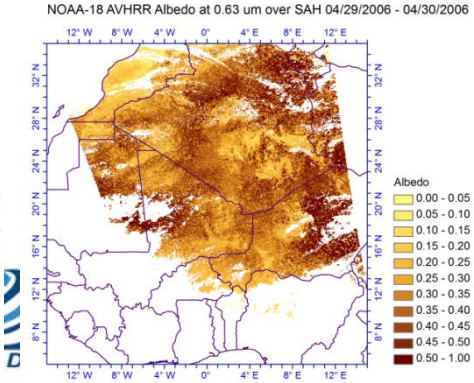








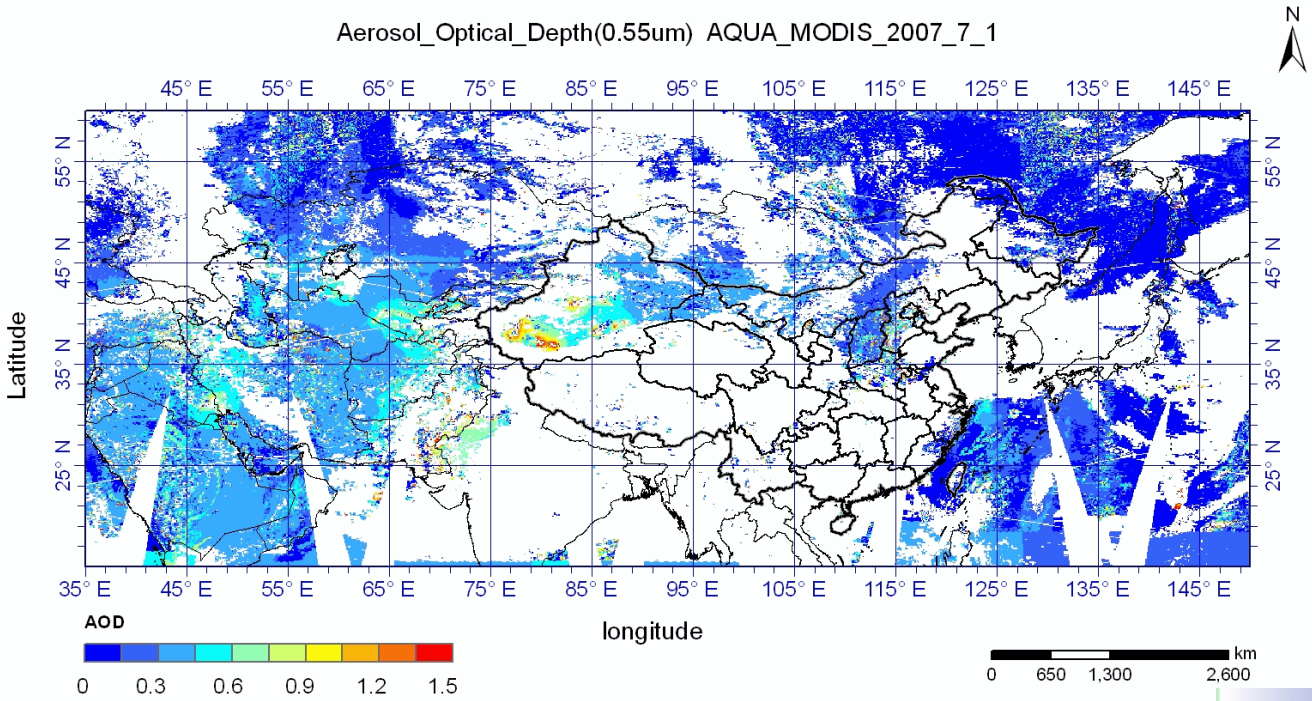




AOD data collection over Mainland China

China Collection 2.0 & 2.1

Spatial Resolution: 10km, 1km
Temporal Scale: from August 2002



(AOD at 1 km resolution)

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