



*Institute for Advanced Studies
in Basic Sciences, Zanjan, Iran*



In the name of God

***Monitoring Dust Storms Over the Persian Gulf and
the Oman Sea Using CALIPSO Recordings***

Farizeh Bayat

Farize.bayat @ iasbs.ac.ir

2016.11.09

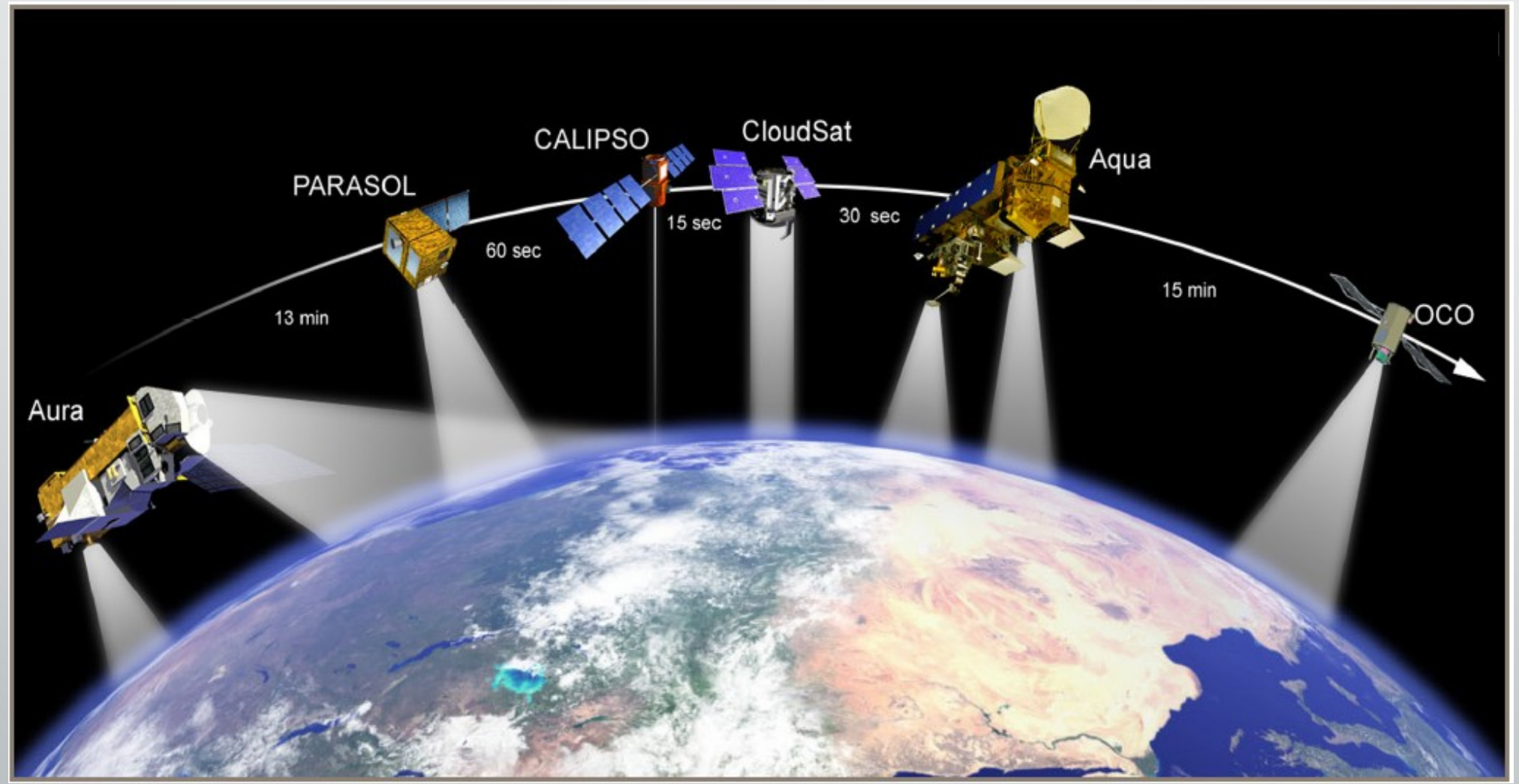
Overview



- CALIPSO
- Studied region and calculated parameters
- Discussion
- Results



A-Train



CALIPSO



Cloud – Aerosol Lidar Infrared Pathfinder Satellite Observations

- CALIOP lidar
- IIR imaging infrared radiometer
- Wide Field Camera (WFC)



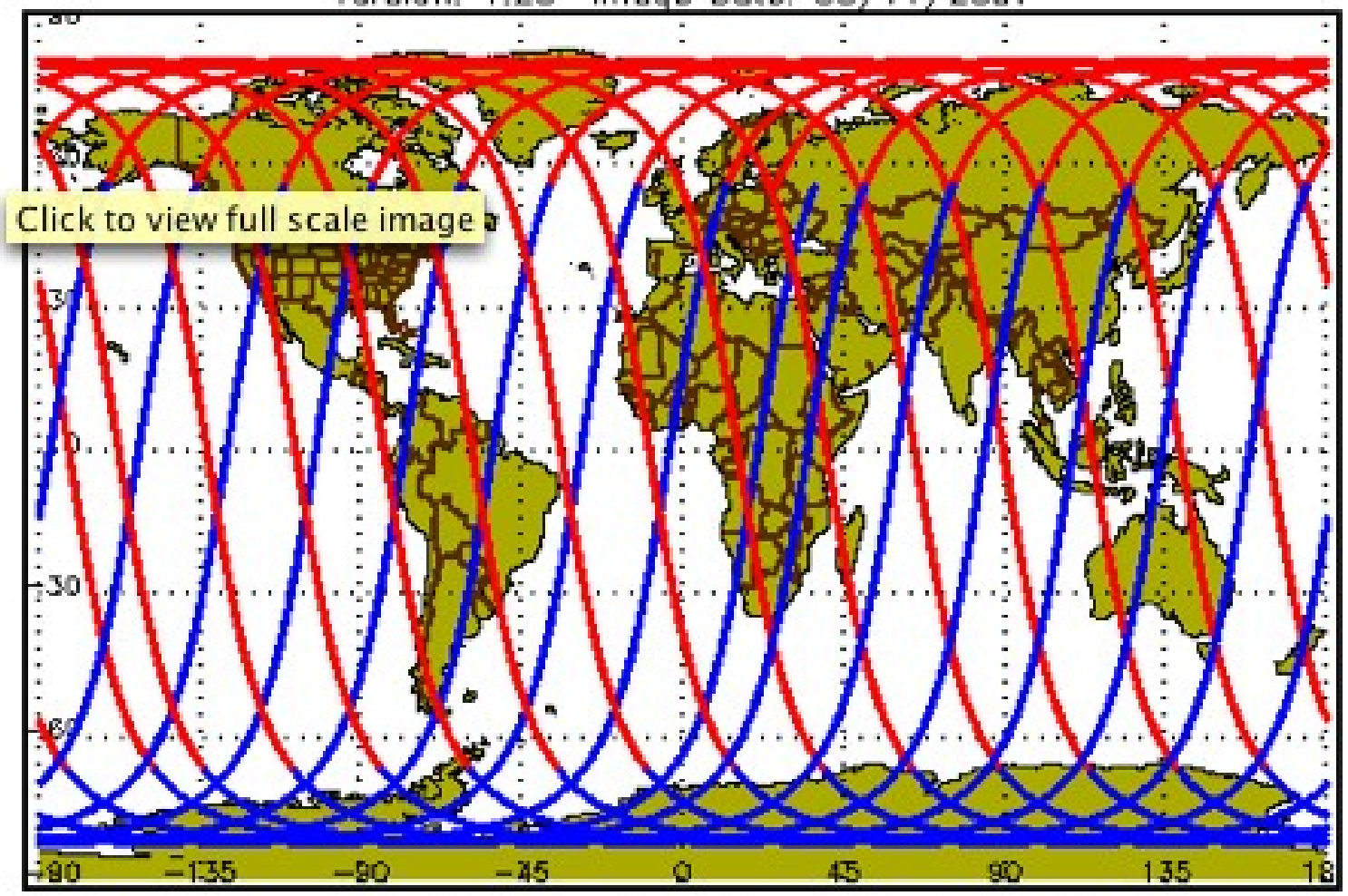


CALIPSO Tracks



2007-06-07 Red is Daytime, Blue is Nighttime

Version: 1.20 Image Date: 06/11/2007

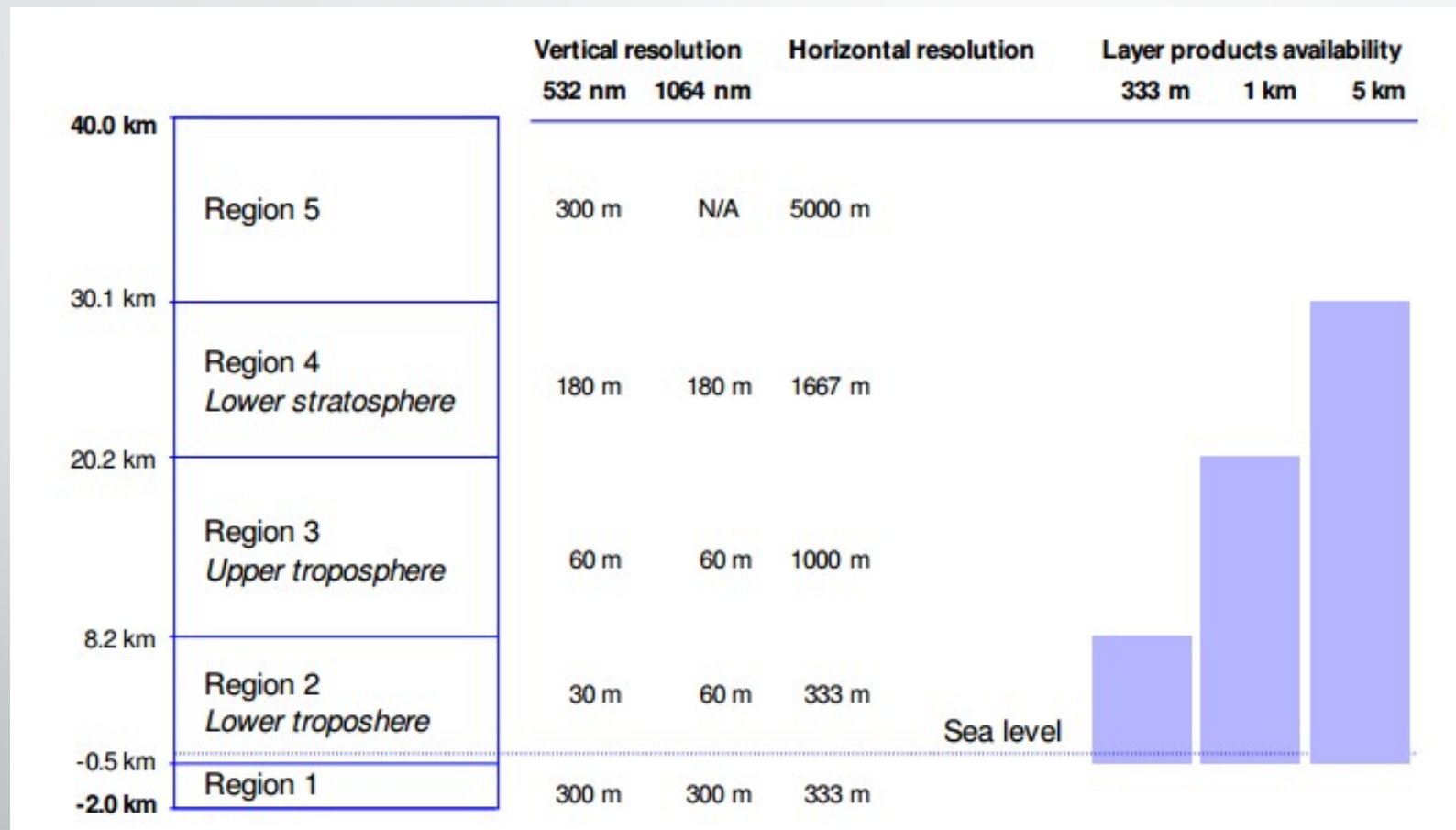




CALIOP



Cloud – Aerosol Lidar with Orthogonal Polarization



CALIOP regions

Available Data Products

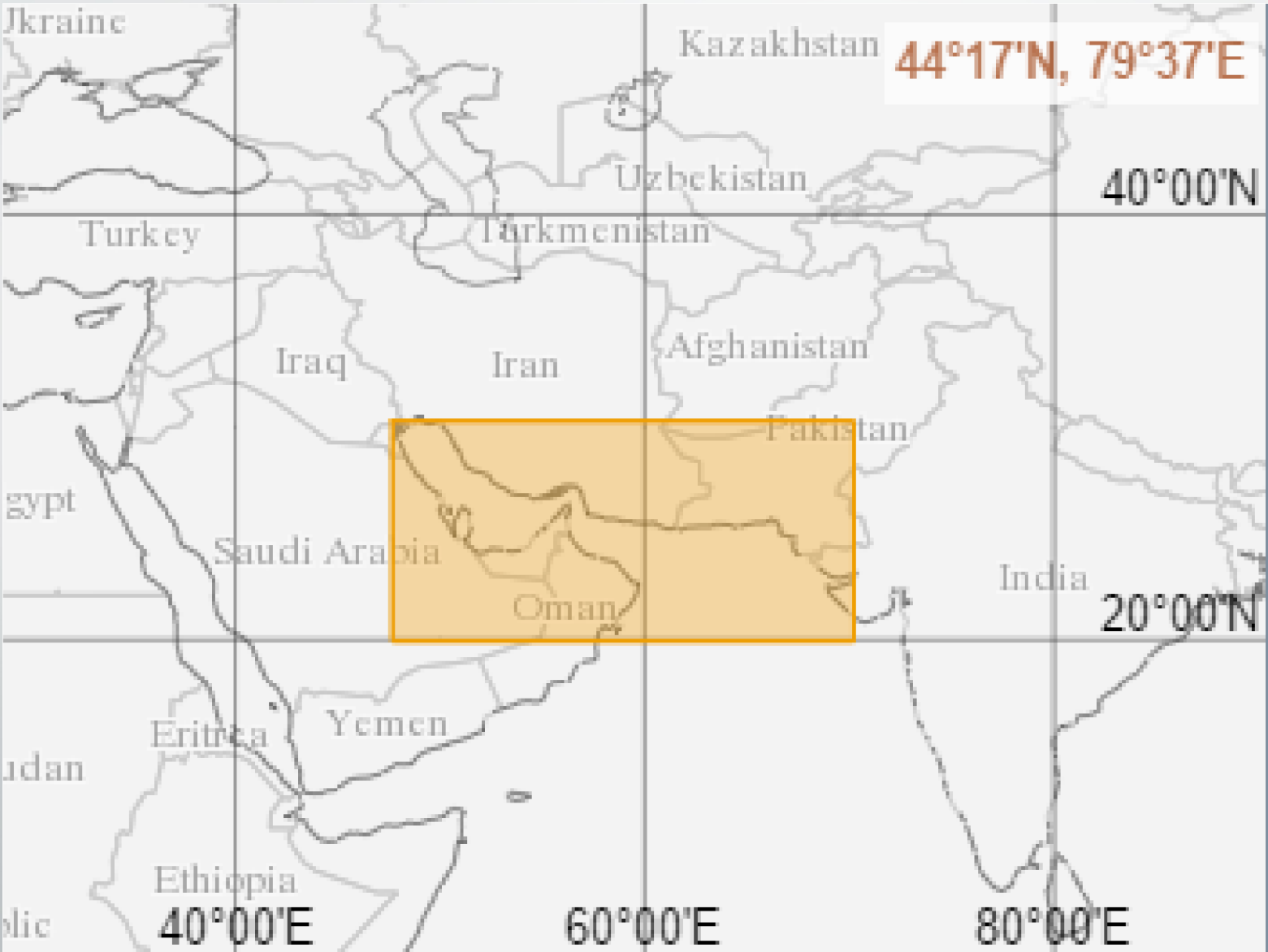


- **Lidar level 1** : The lidar backscatter data are geolocated and calibrated

- **Lidar level 2** : Three primary modules
 - ✓ Layer detection algorithm known as the selective, iterated boundary locator (SIBYL)
 - ✓ Scene classification algorithms (SCA)
 - ✓ hybrid extinction retrieval algorithm (HERA)

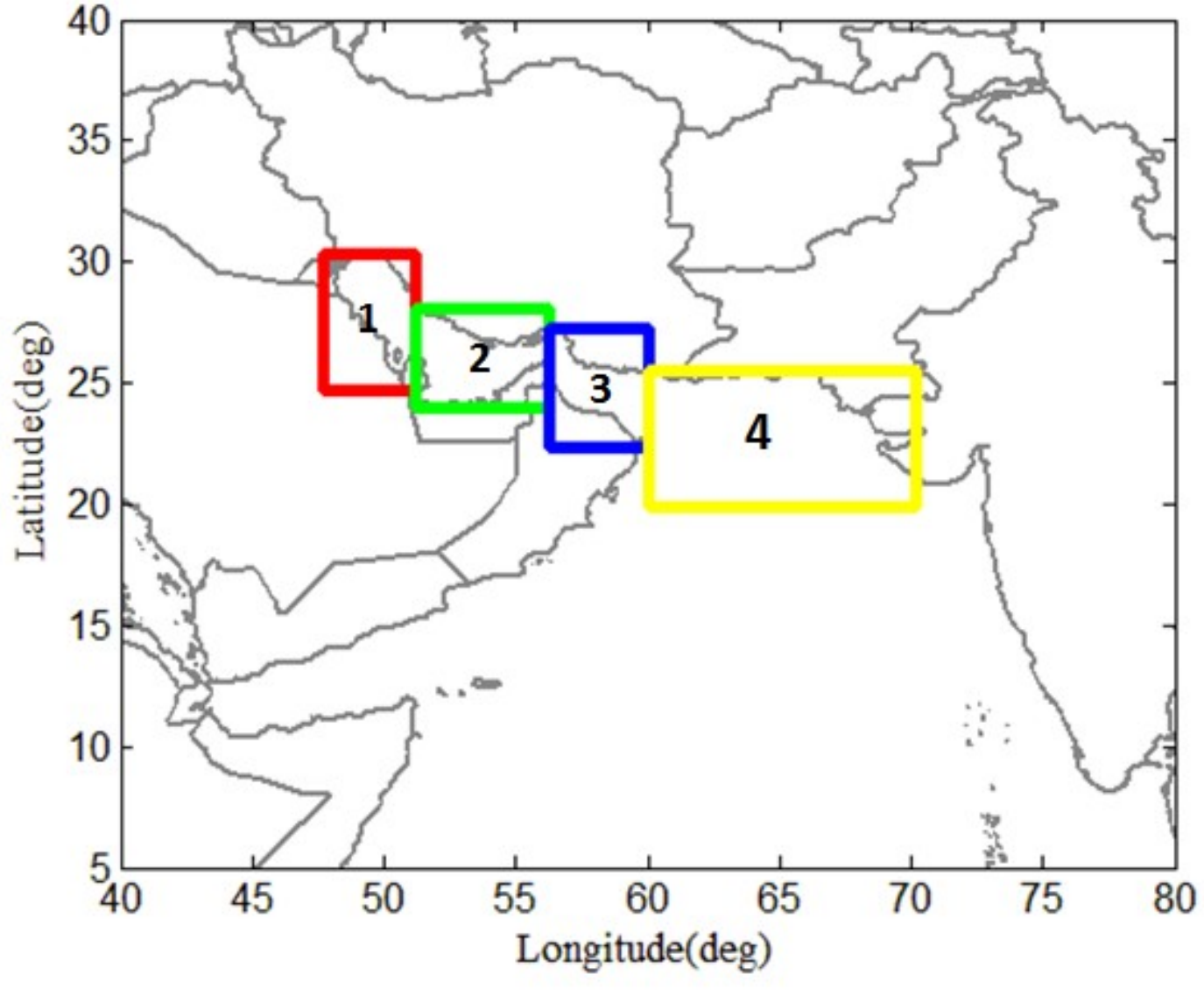


Region Introduction



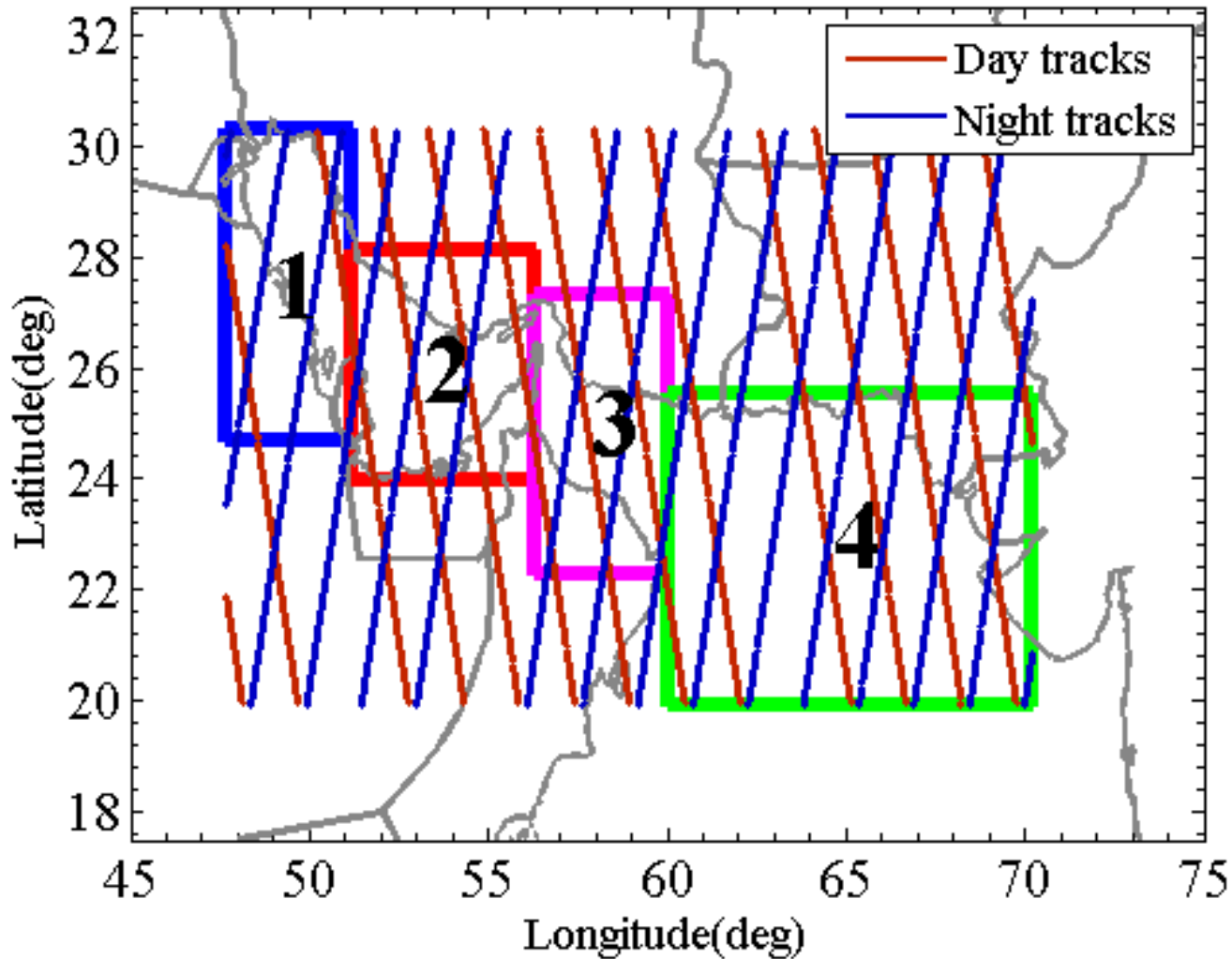


Region Introduction





16-day CALIPSO ground tracks over regions 1 to 4





Data set :

- ❑ CALIPSO level 2 / 5km aerosol profile , Version 3
- ❑ CALIPSO level 2 / 5km aerosol layer profile , Version 3

During June 2006 to December 2015

Studied parameters :

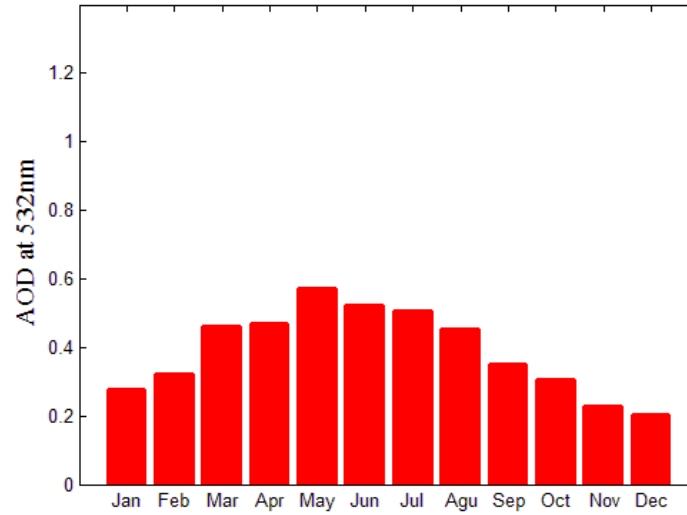
- Column Aerosol Optical Depth (AOD) at 532 and 1064nm
- Column Integrated Attenuated Backscatter (IAB) at 532nm
- Angstrom Exponent (AE)



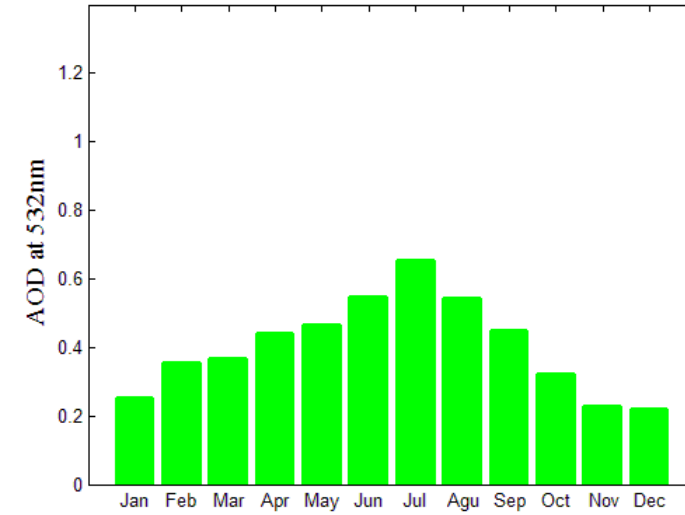
Monthly AOD 532nm at four regions :



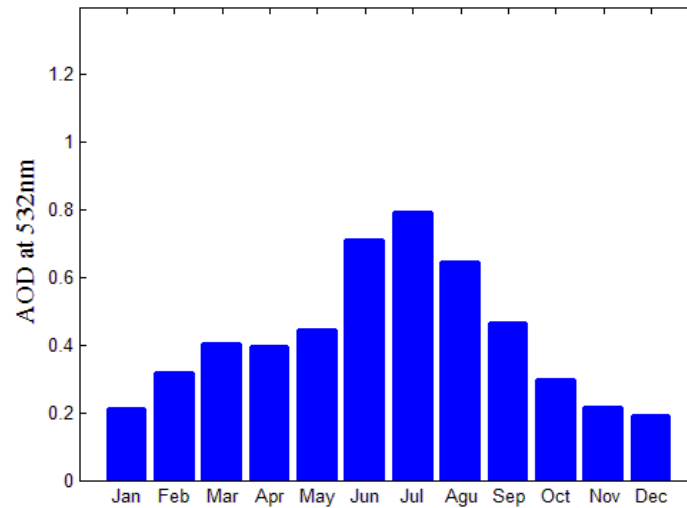
Region1-Mean AOD 532 of 2006-2015



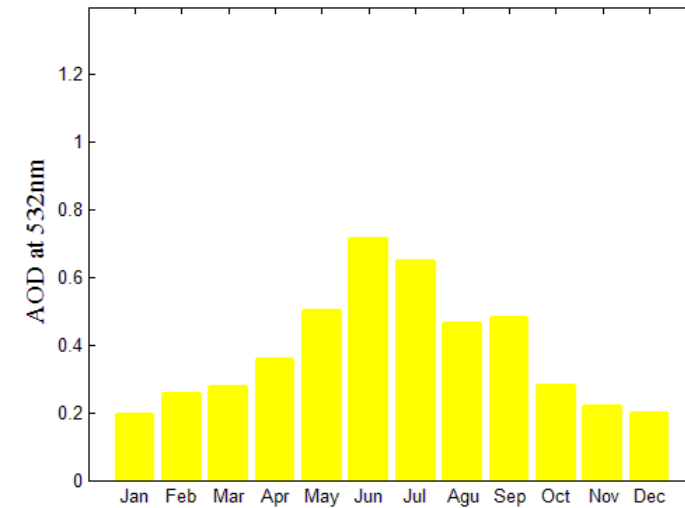
Region2-Mean AOD 532 of 2006-2015



Region3-Mean AOD 532 of 2006-2015



Region4-Mean AOD 532 of 2006-2015

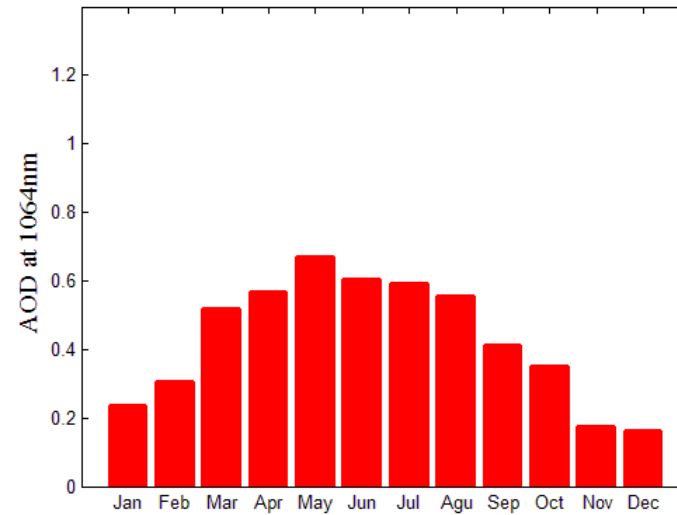




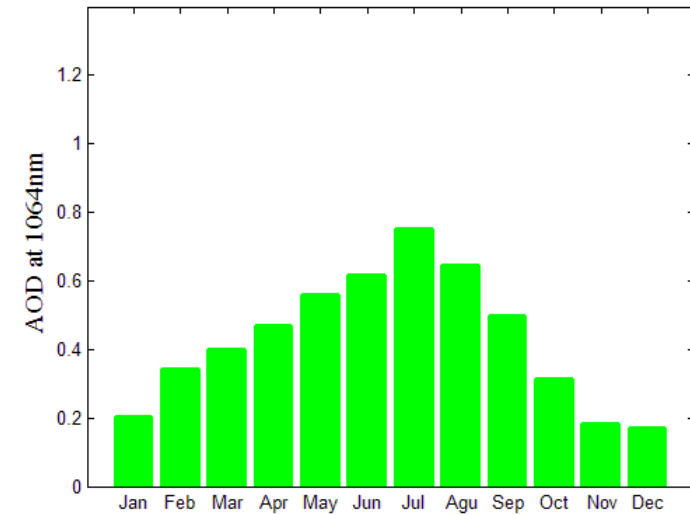
Monthly AOD 1064nm at four regions :



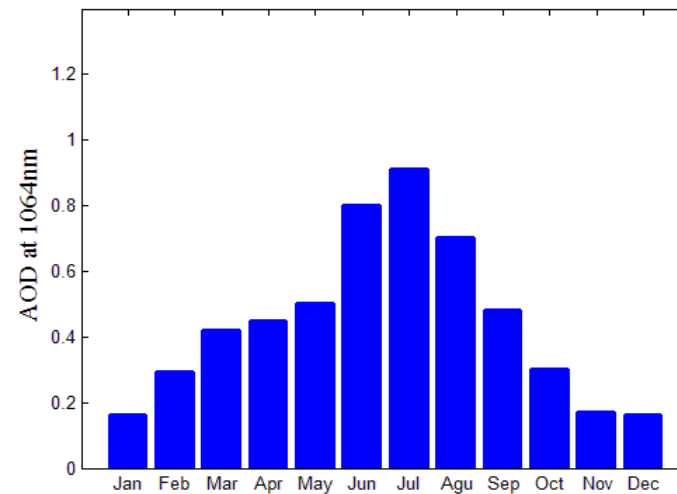
Region1-Mean AOD 1064 of 2006-2015



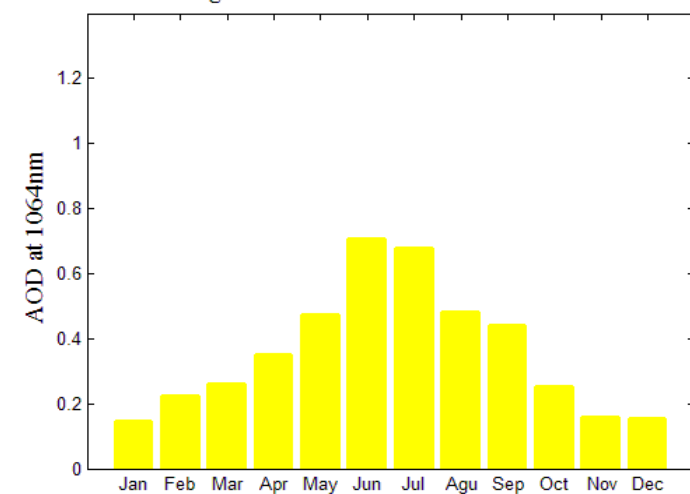
Region2-Mean AOD 1064 of 2006-2015



Region3-Mean AOD 1064 of 2006-2015



Region4-Mean AOD 1064 of 2006-2015

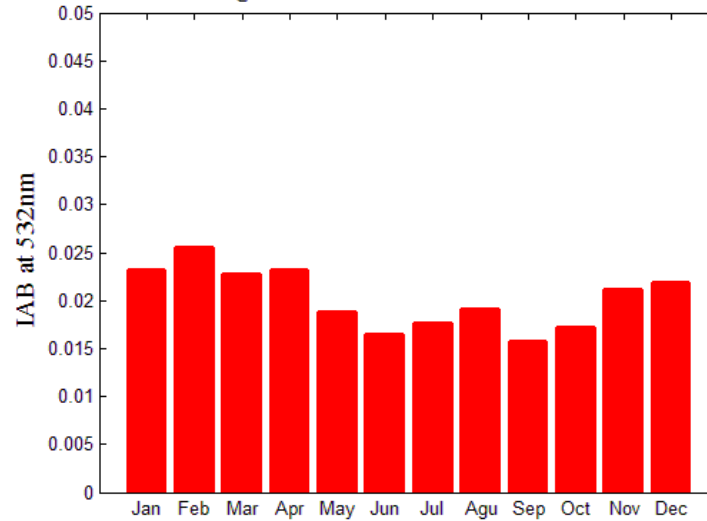




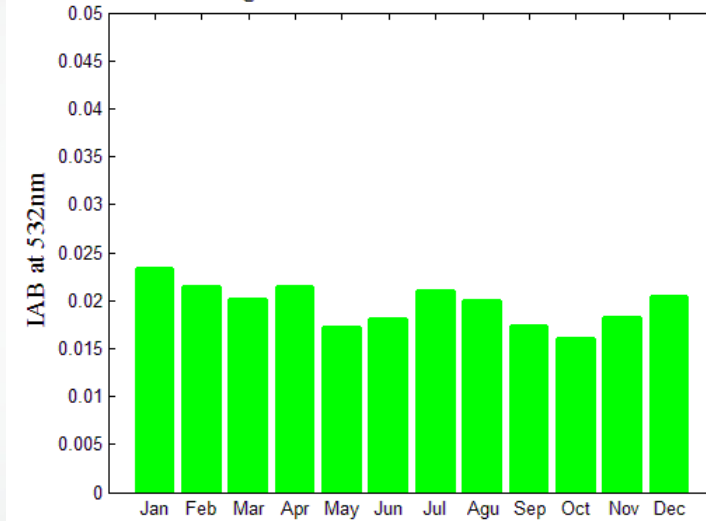
Monthly IAB 532nm at four regions :



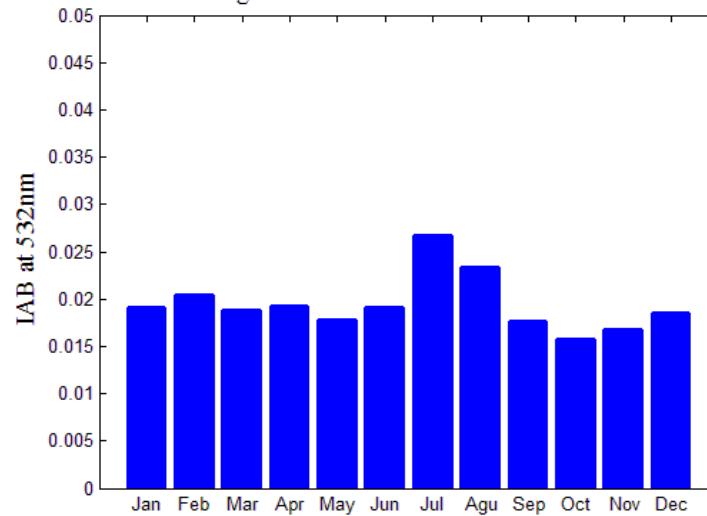
Region1-Mean IAB 532 of 2006-2015



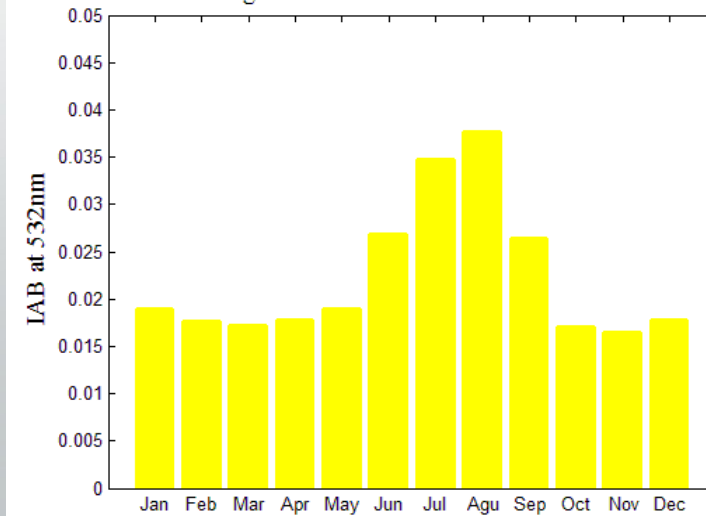
Region2-Mean IAB 532 of 2006-2015



Region3-Mean IAB 532 of 2006-2015



Region4-Mean IAB 532 of 2006-2015

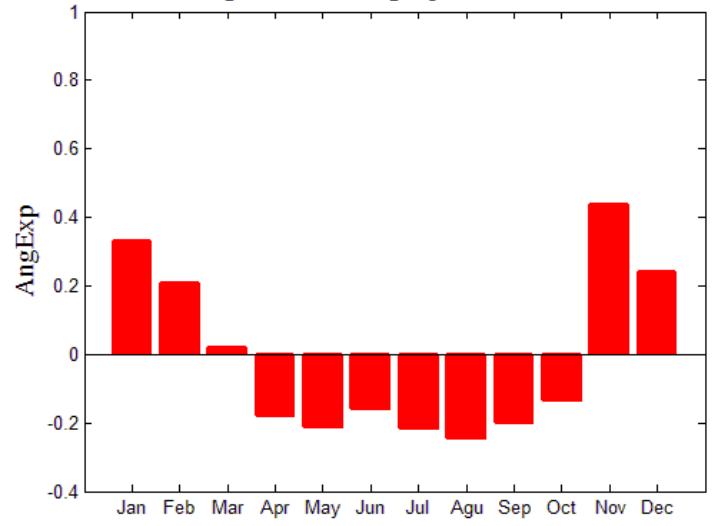




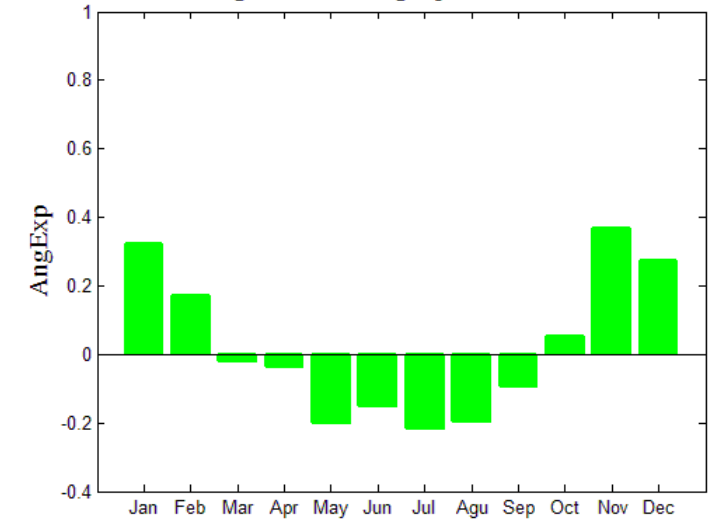
Monthly AE at four regions :



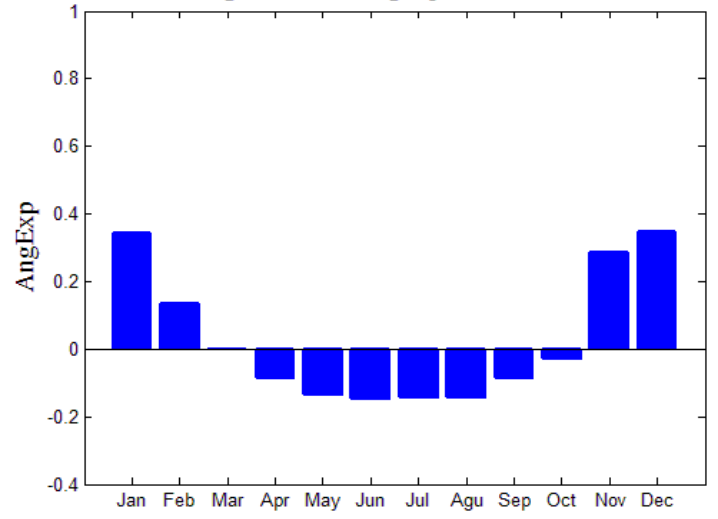
Region1-Mean AngExp of 2006-2015



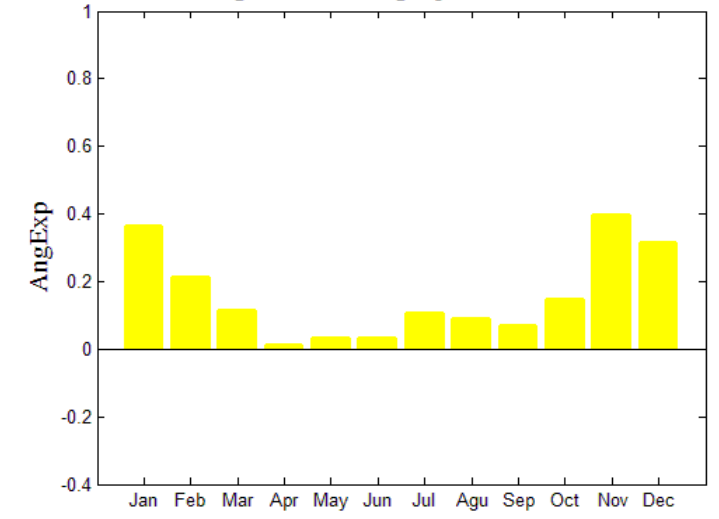
Region2-Mean AngExp of 2006-2015



Region3-Mean AngExp of 2006-2015



Region4-Mean AngExp of 2006-2015

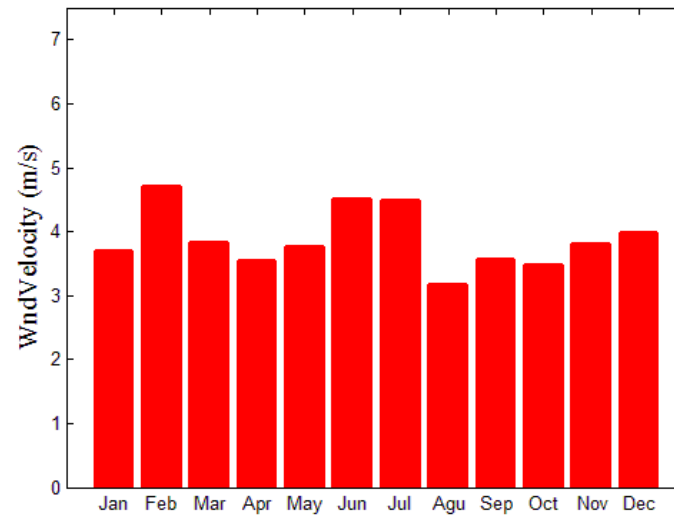




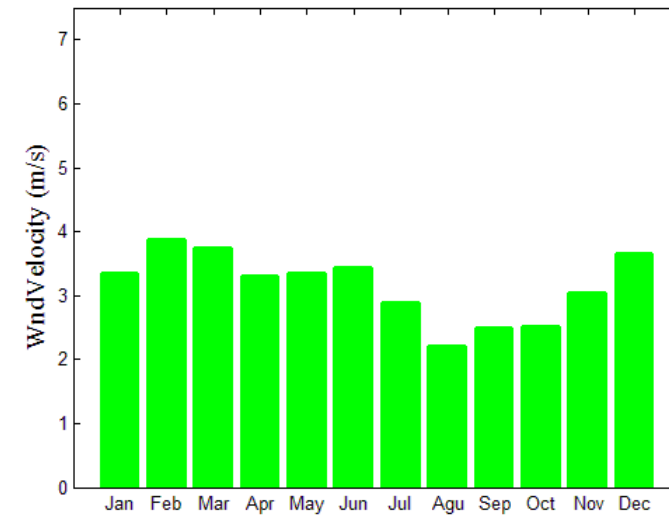
Monthly surface wind speed at four regions :



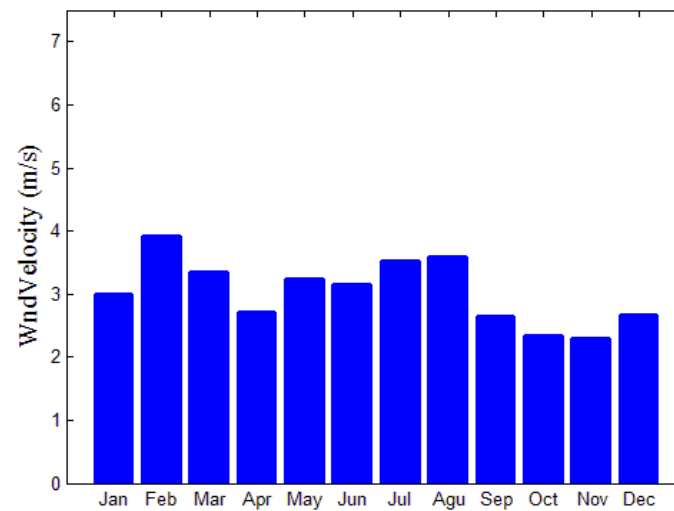
Region1-Mean WndVelocity of 2006-2015



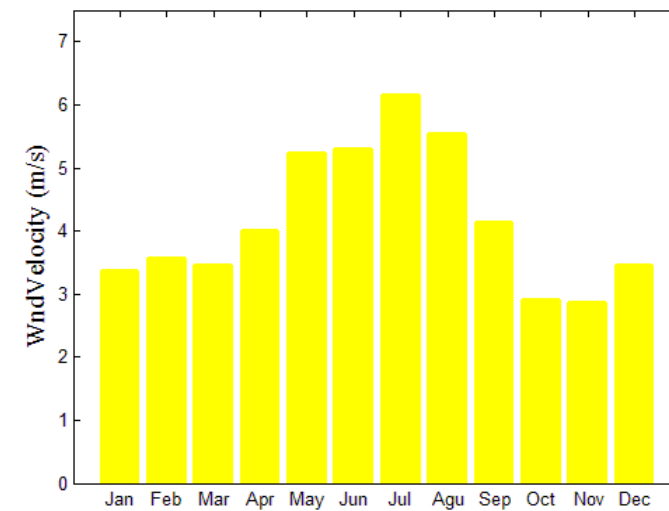
Region2-Mean WndVelocity of 2006-2015



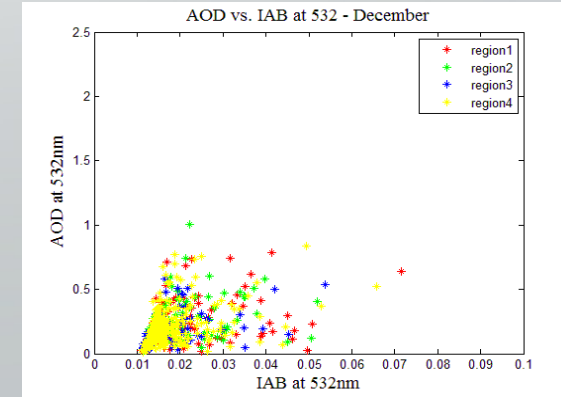
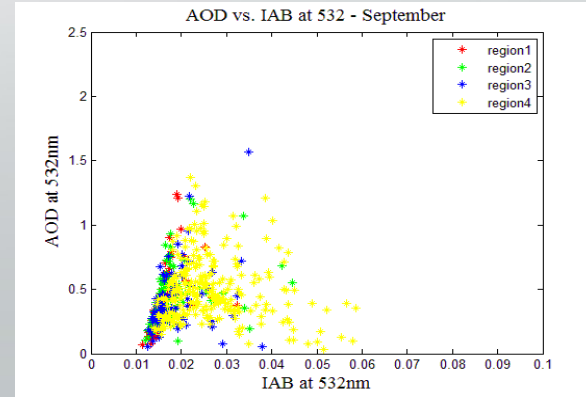
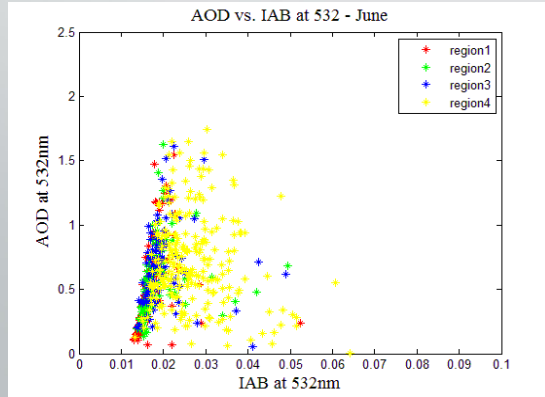
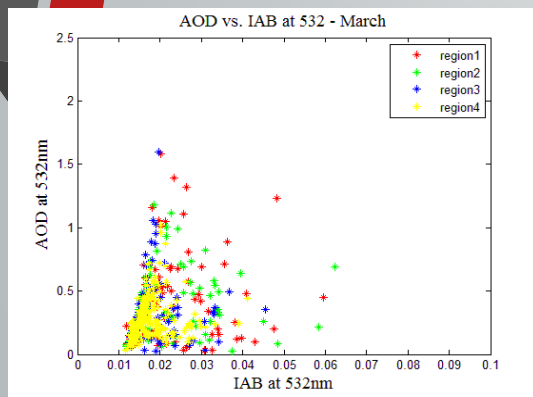
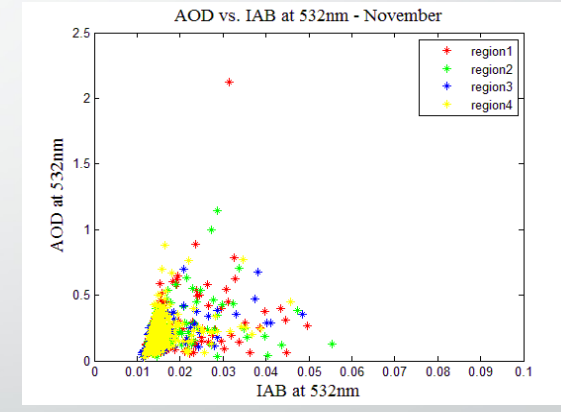
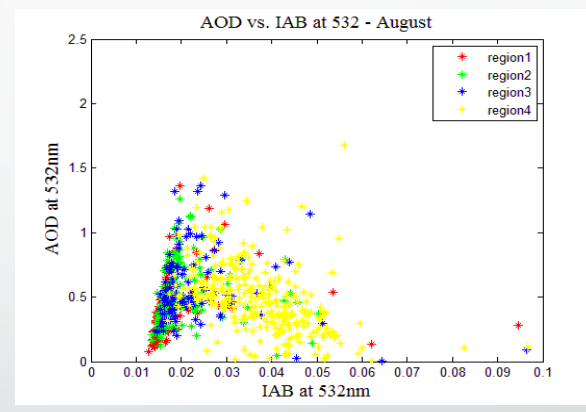
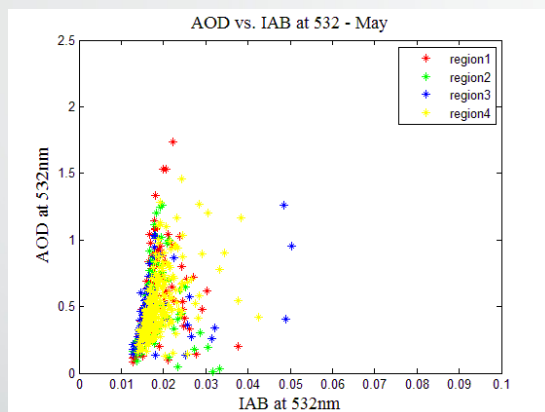
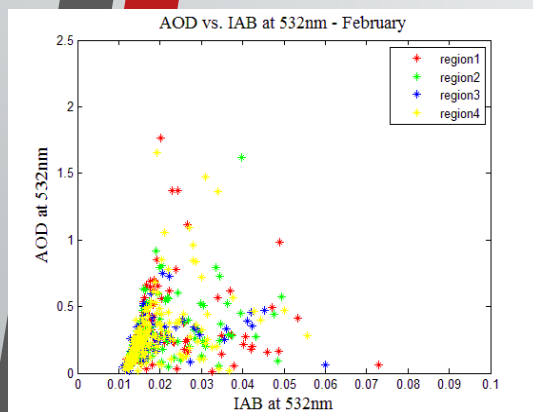
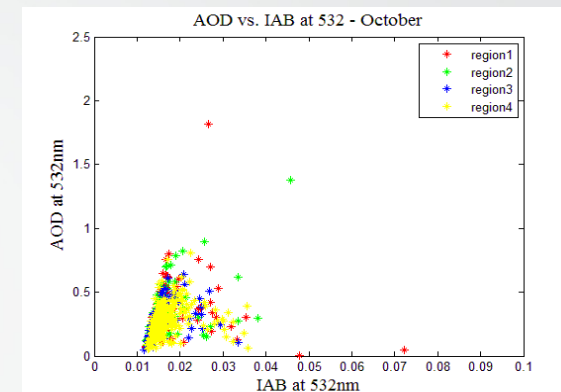
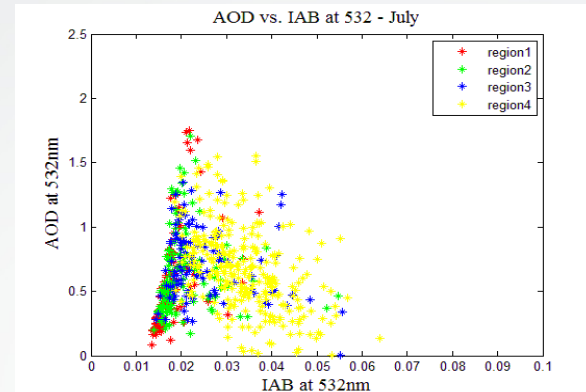
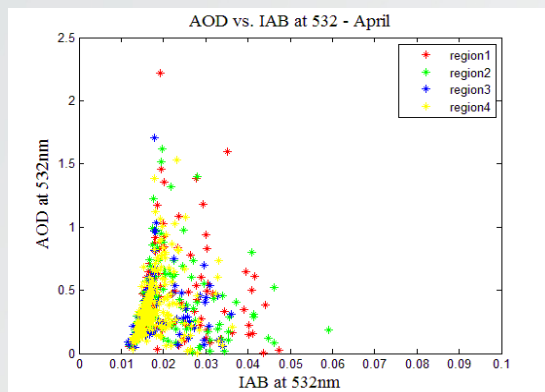
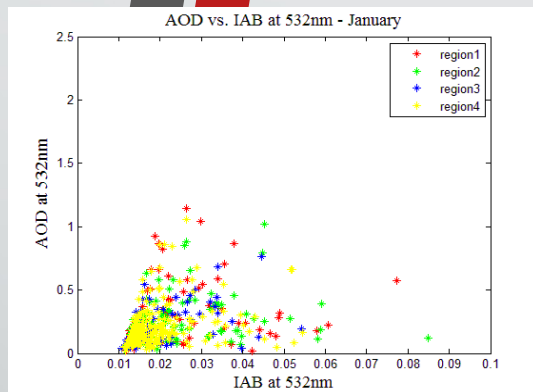
Region3-Mean WndVelocity of 2006-2015



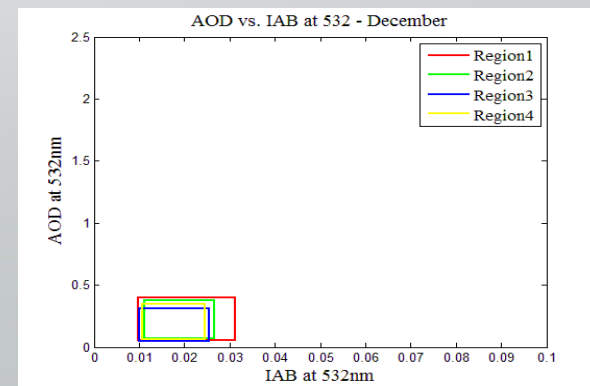
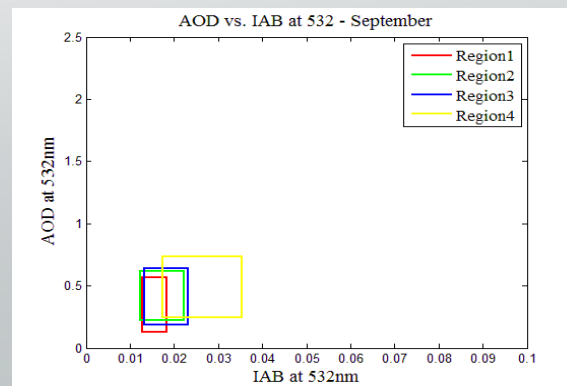
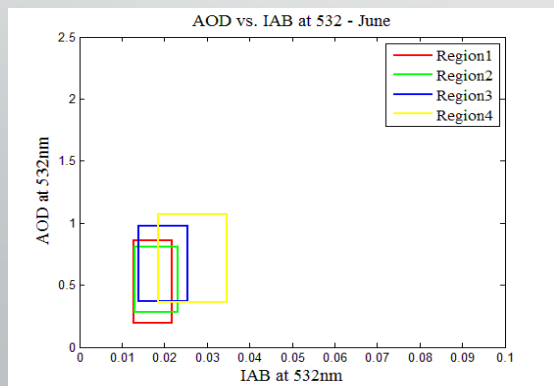
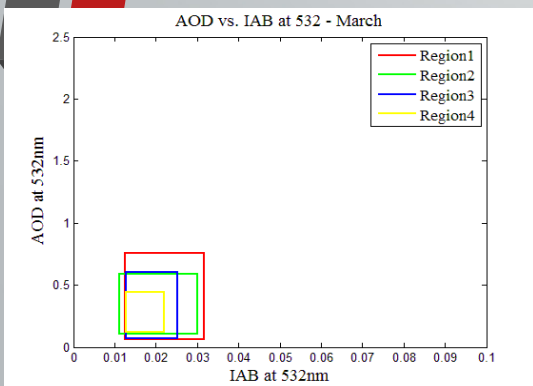
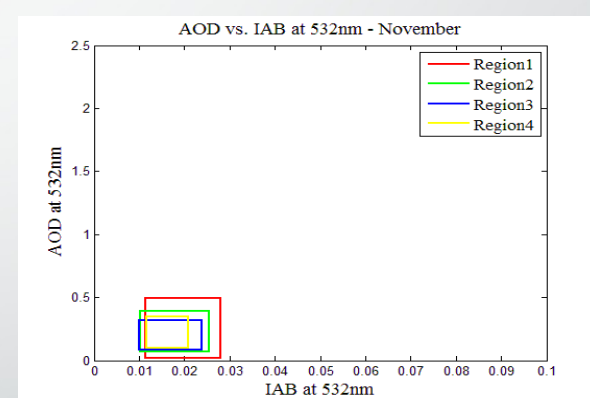
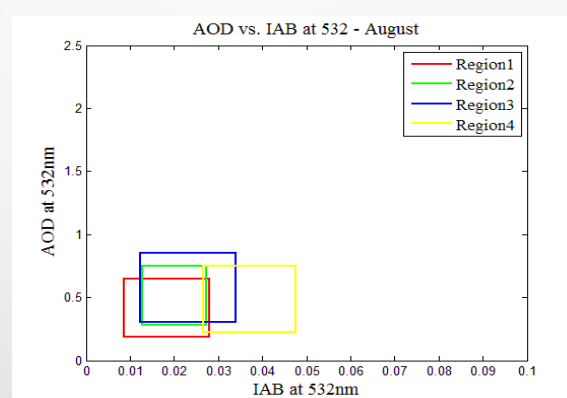
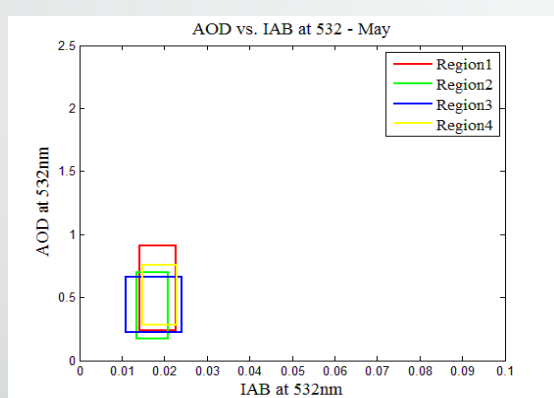
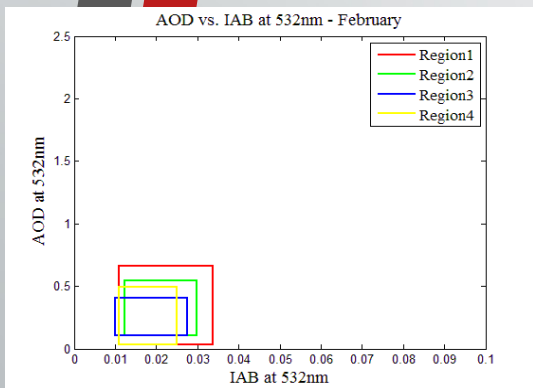
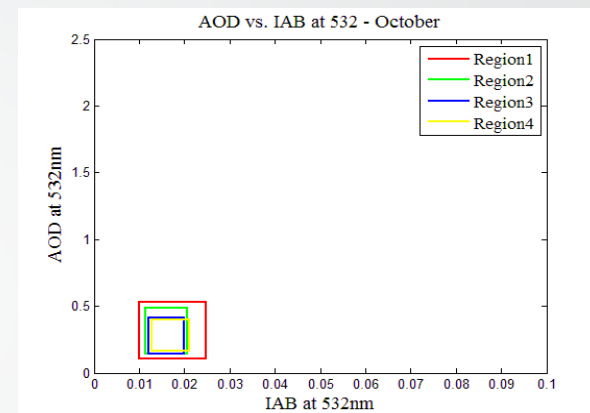
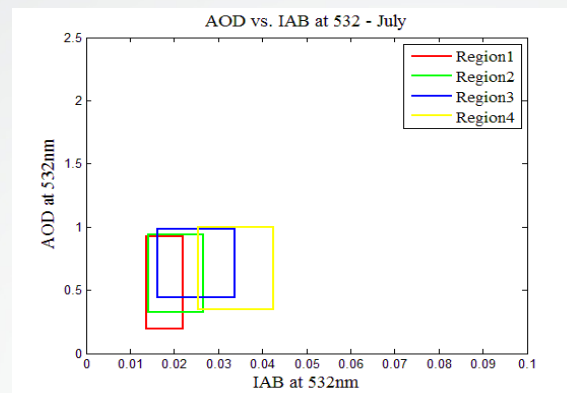
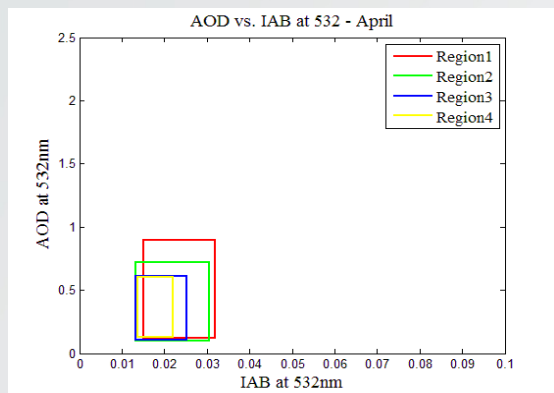
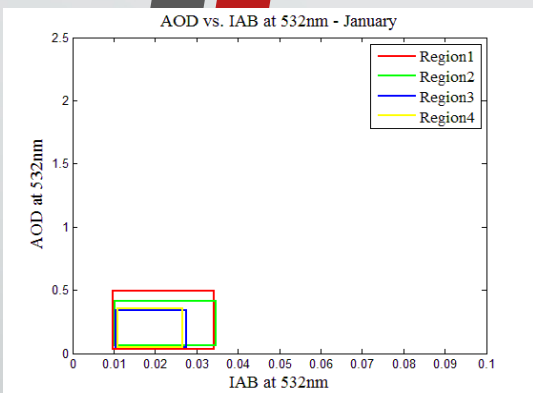
Region4-Mean WndVelocity of 2006-2015



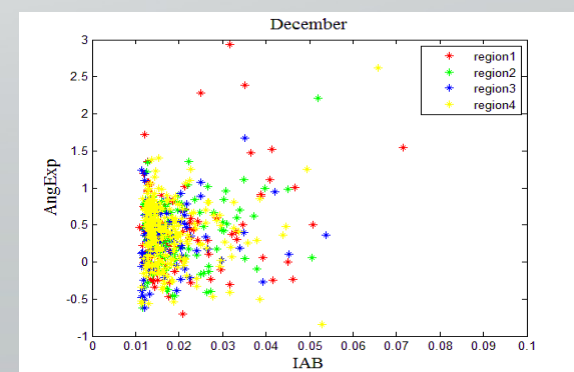
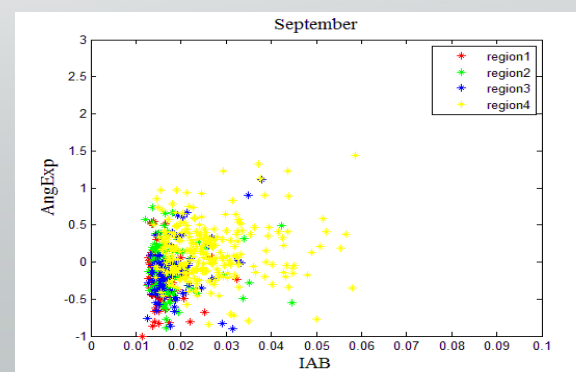
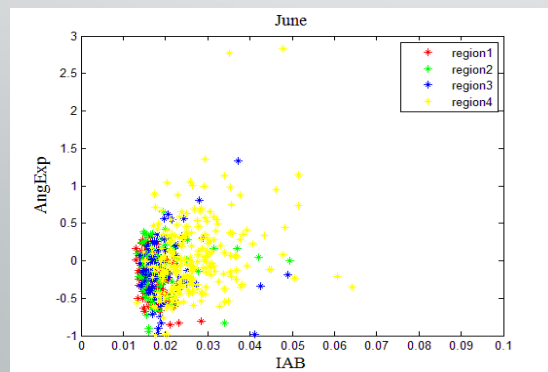
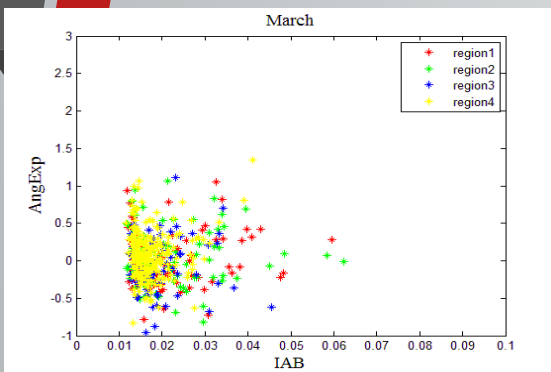
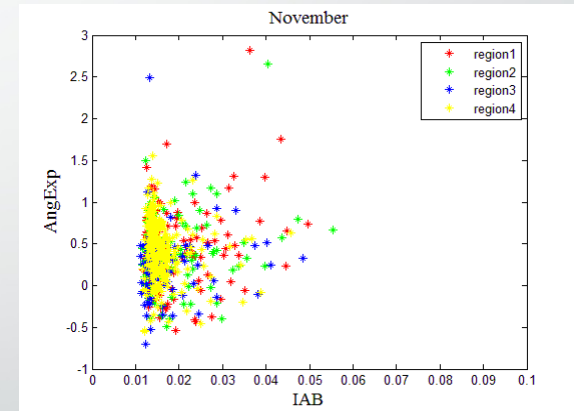
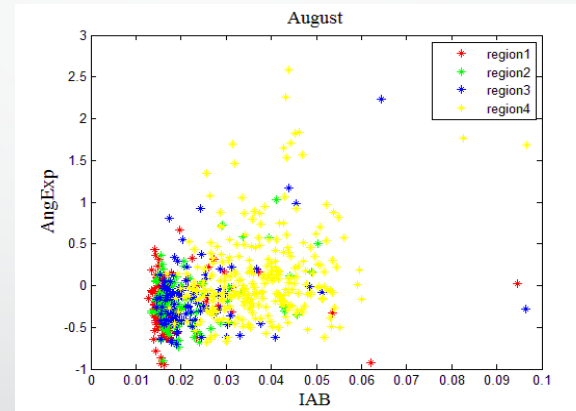
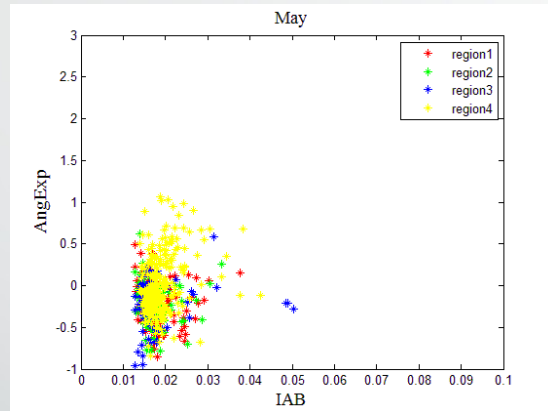
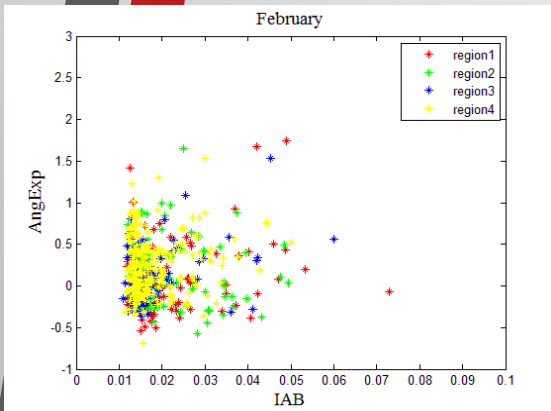
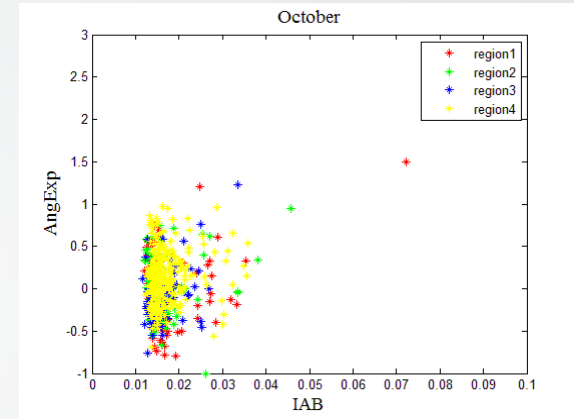
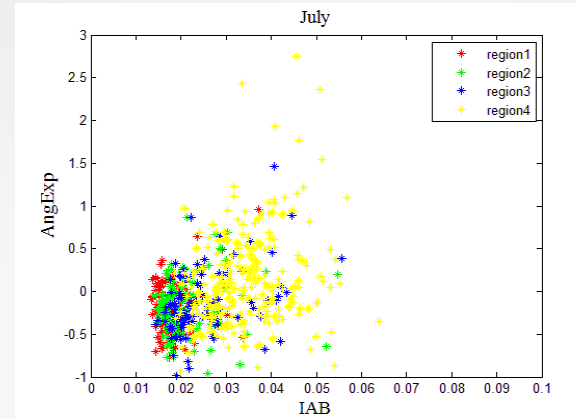
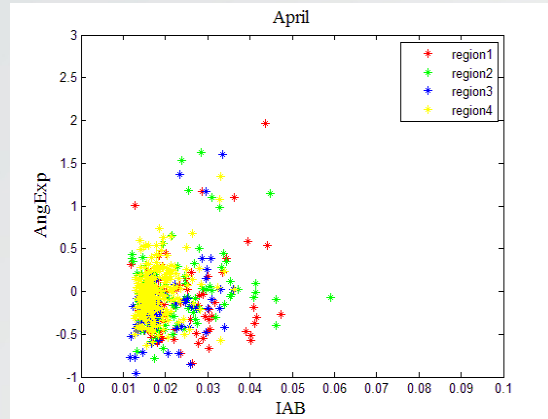
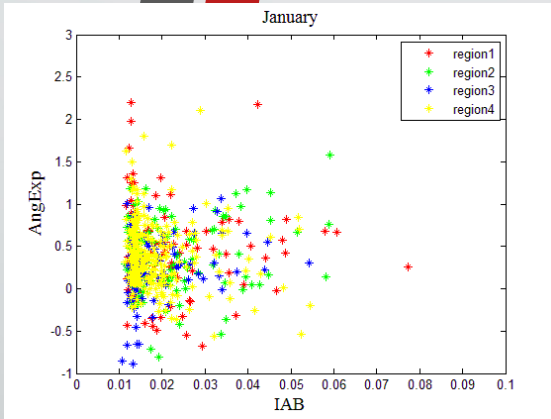
Data plot of AOD vs. IAB :



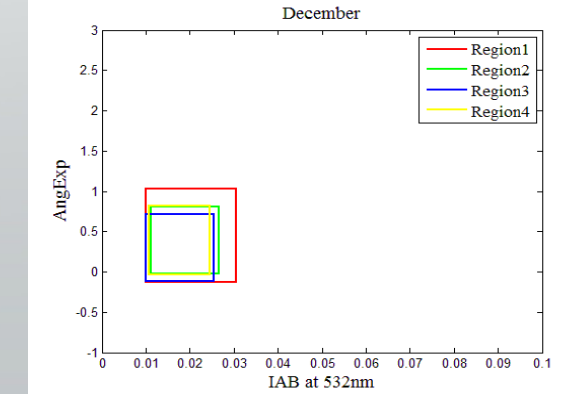
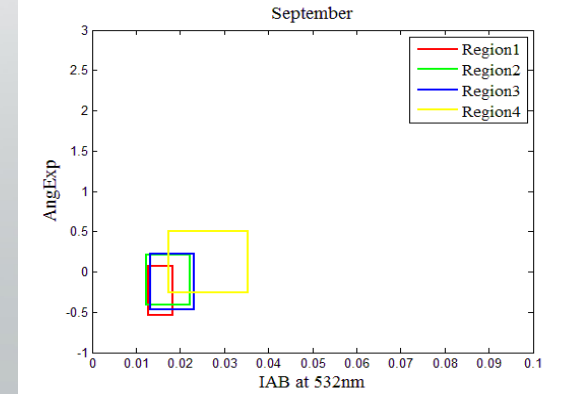
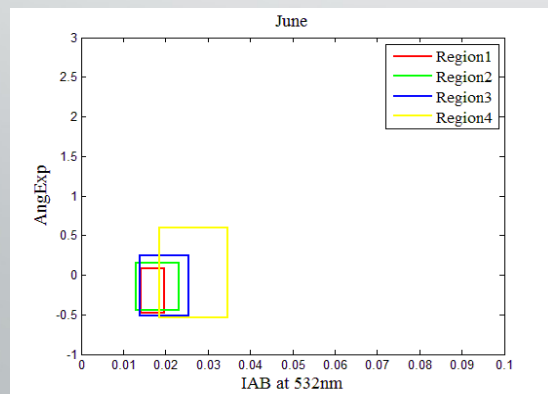
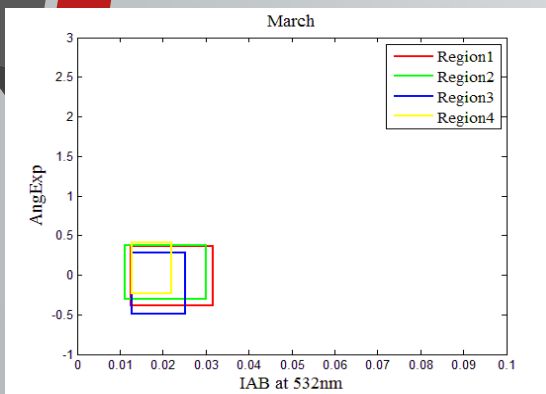
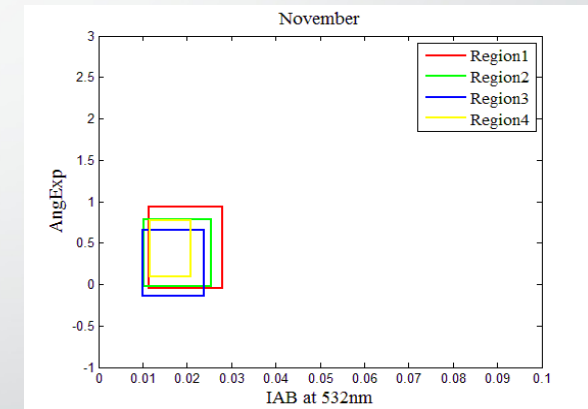
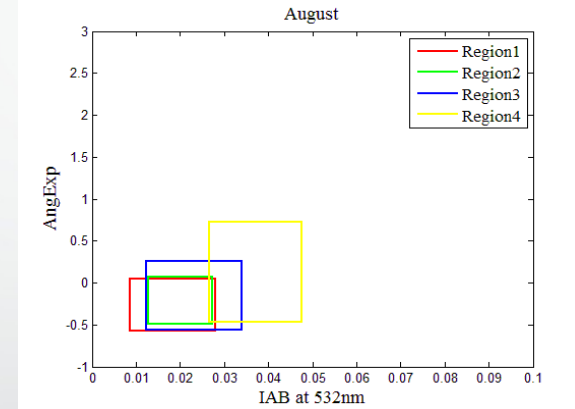
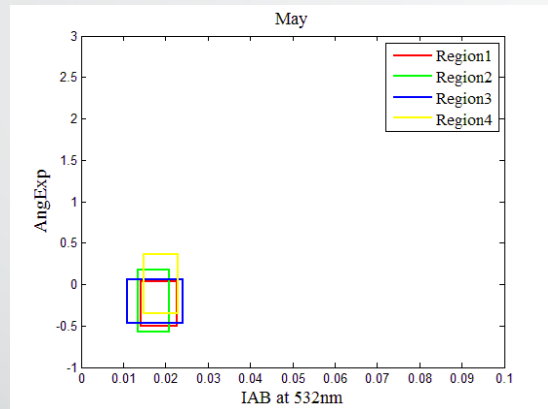
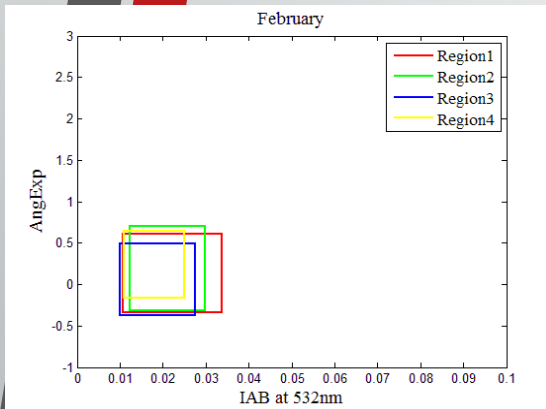
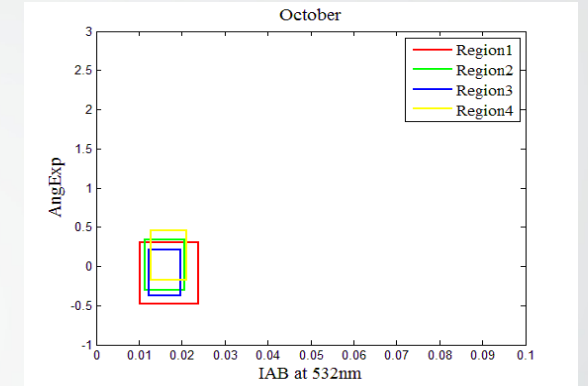
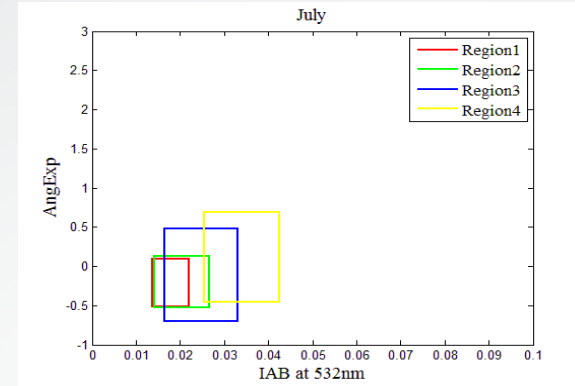
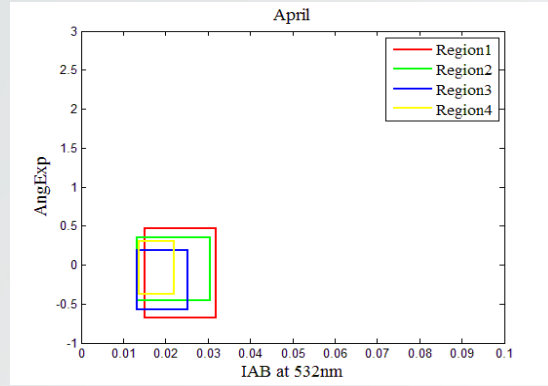
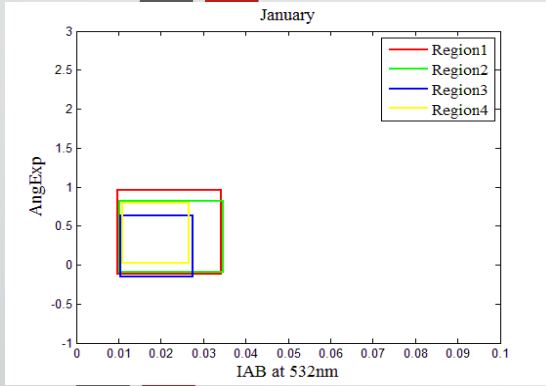
Avg plot of AOD vs. IAB :



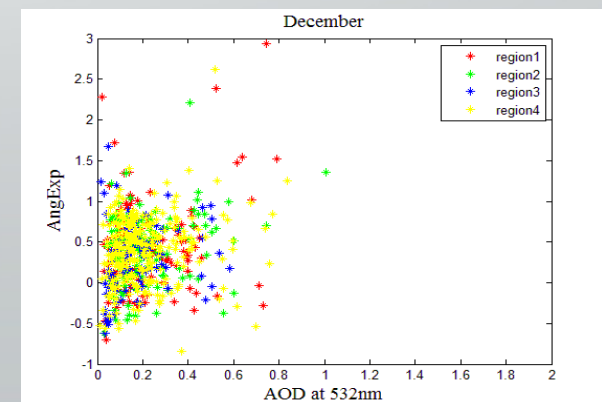
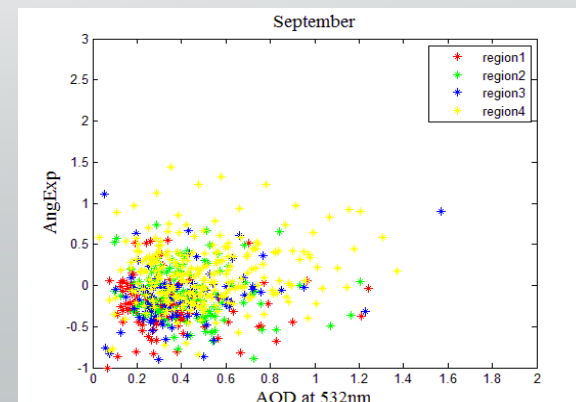
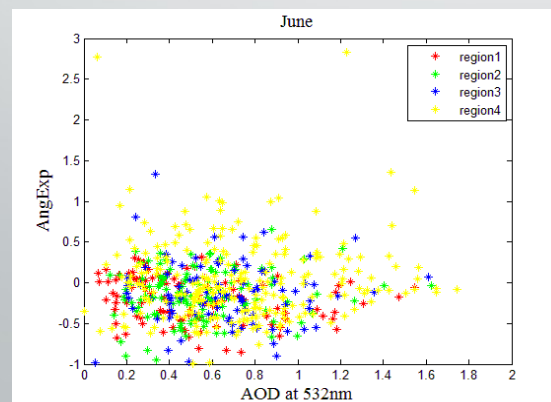
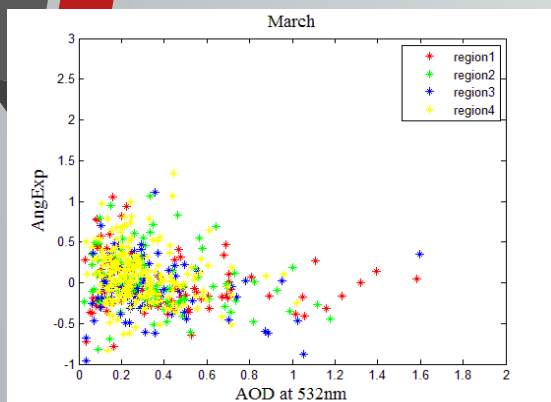
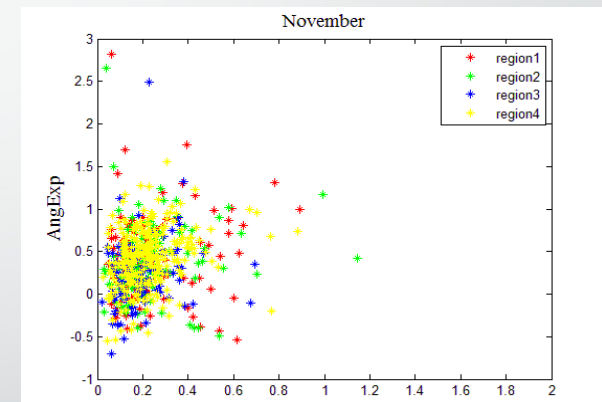
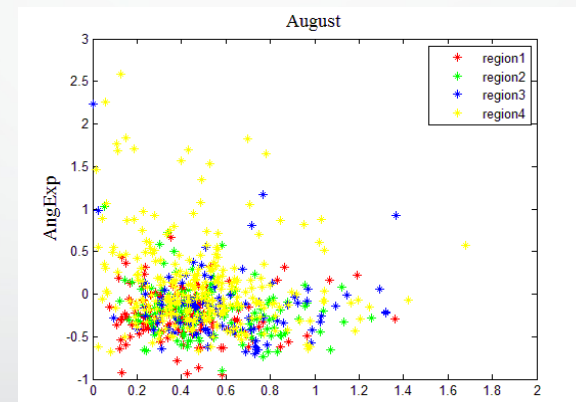
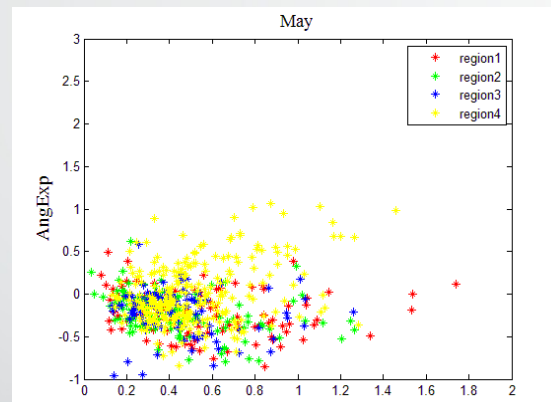
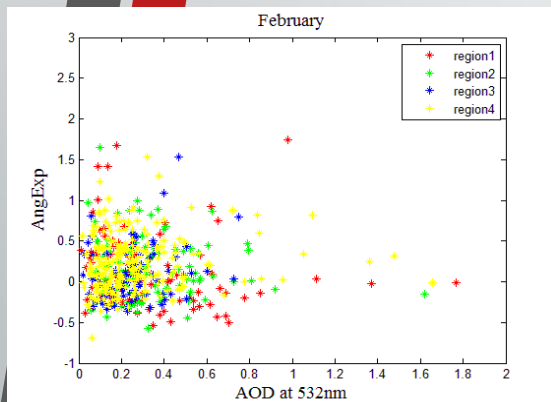
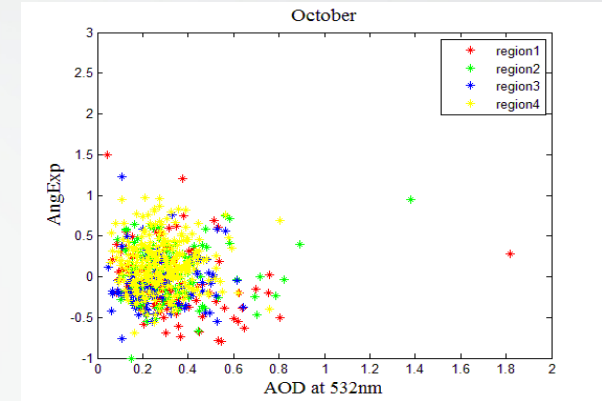
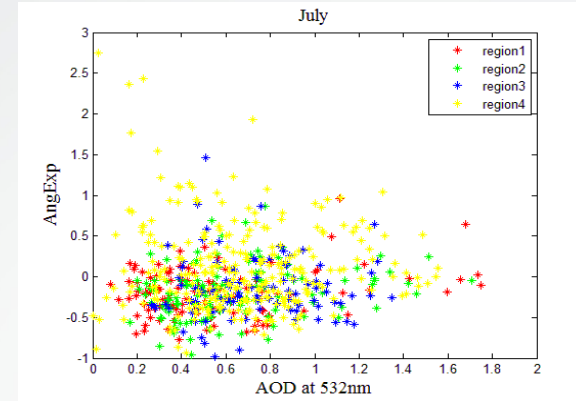
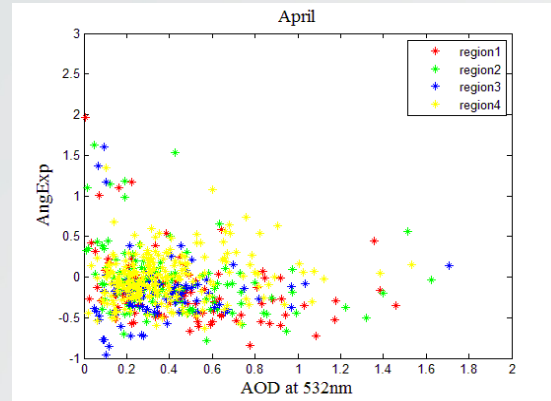
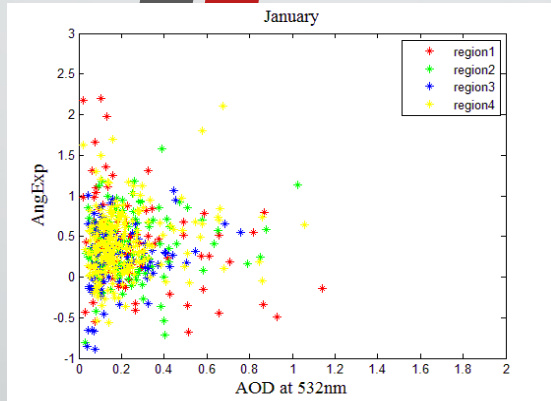
Data plot of AE vs. IAB 532nm :



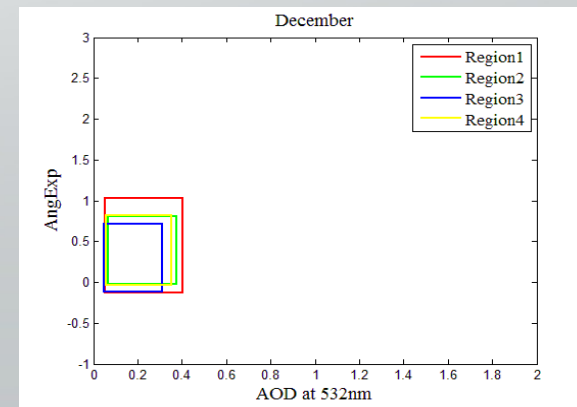
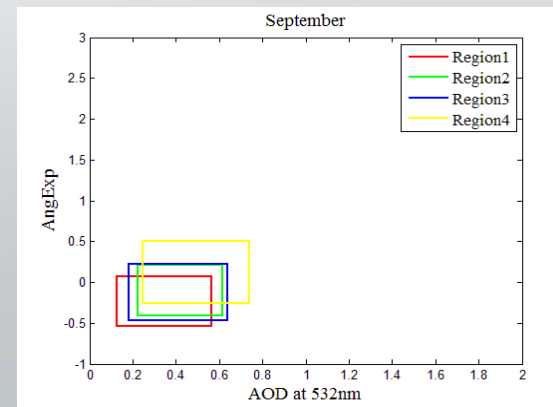
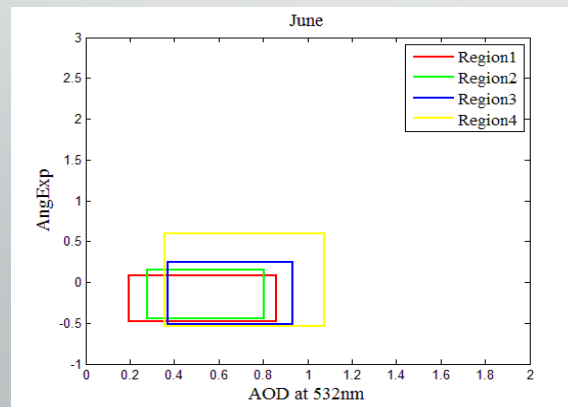
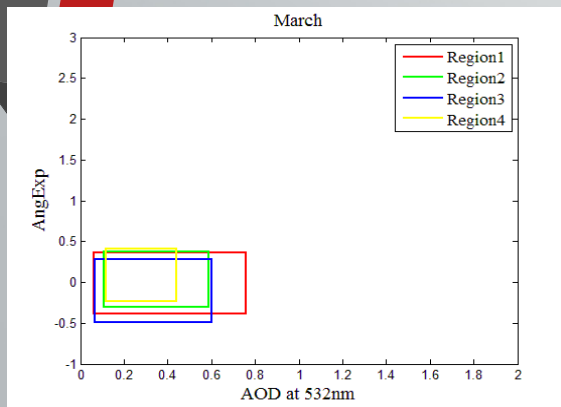
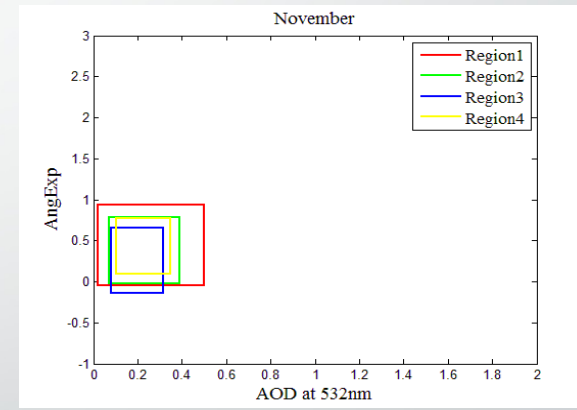
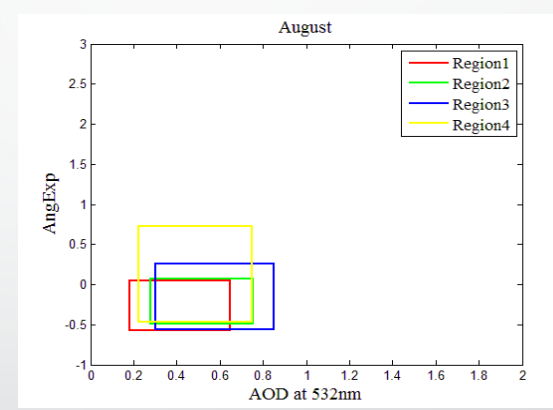
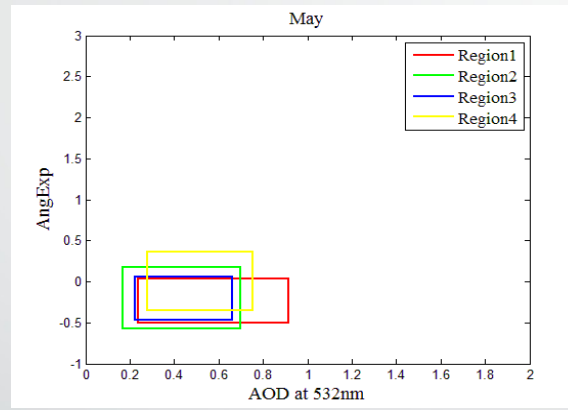
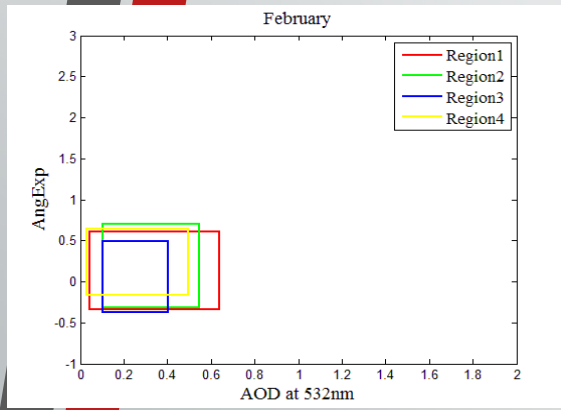
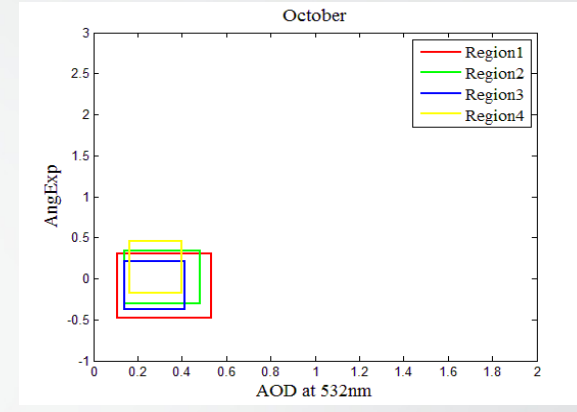
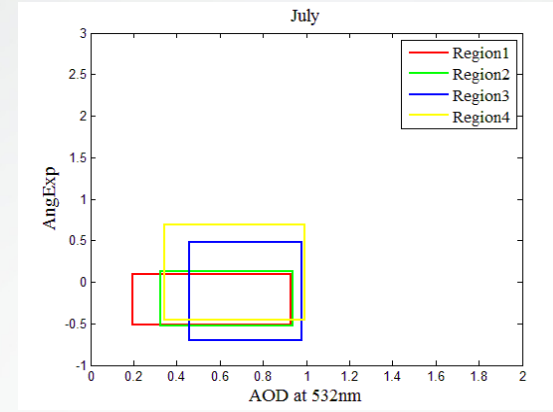
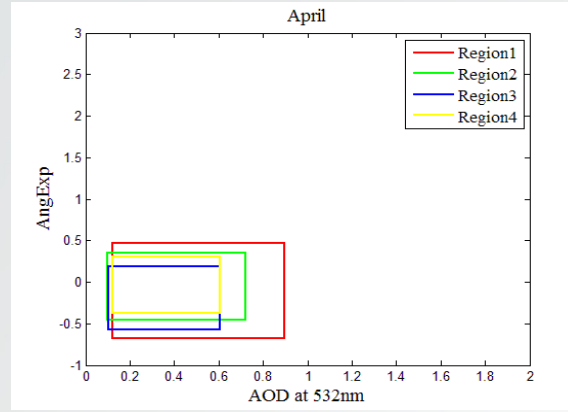
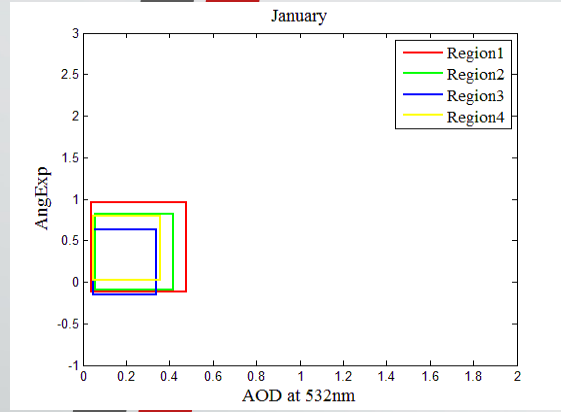
Avg plot of AE vs. IAB 532nm :



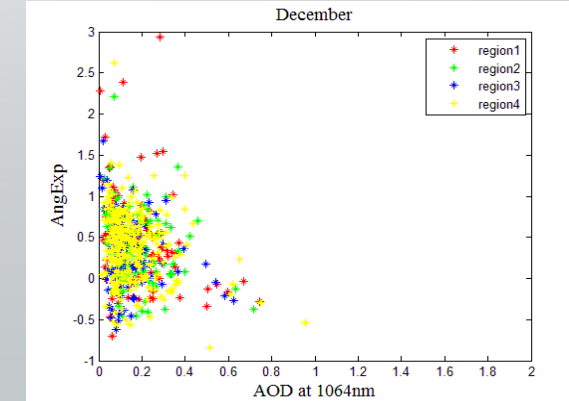
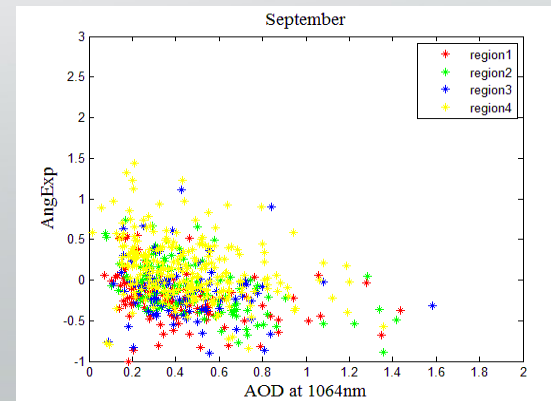
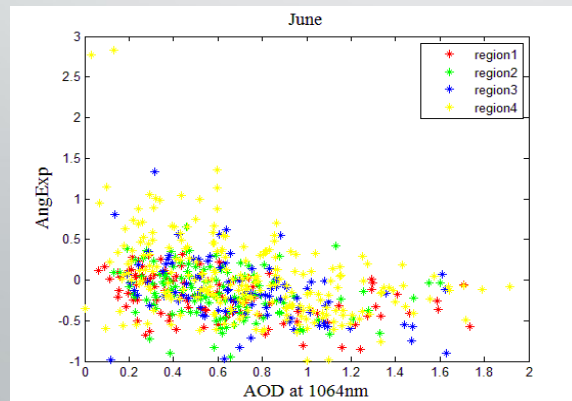
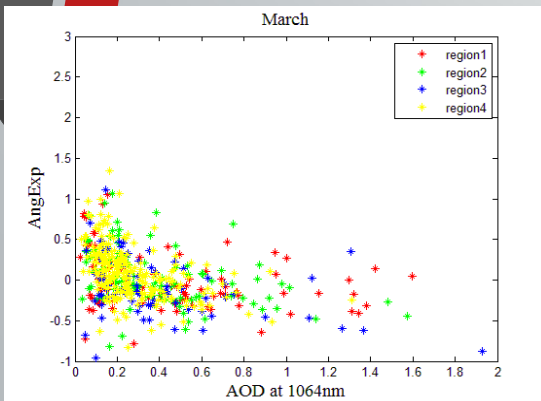
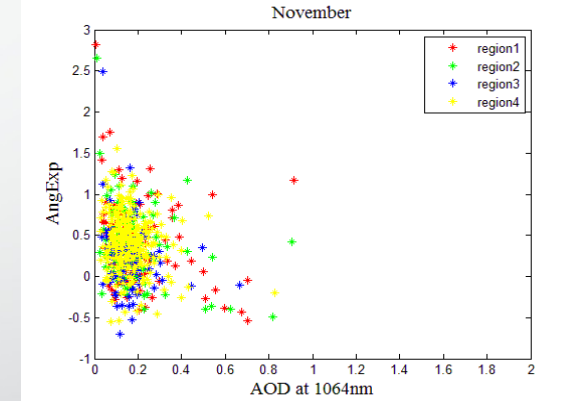
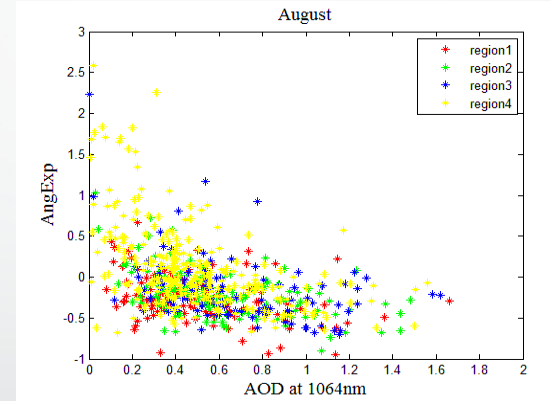
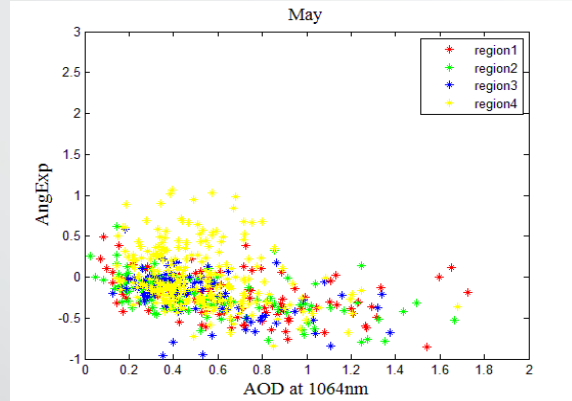
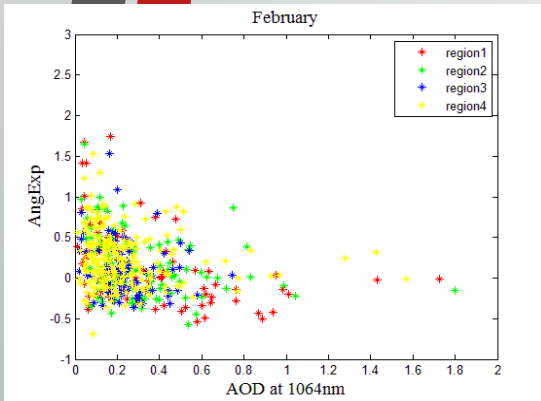
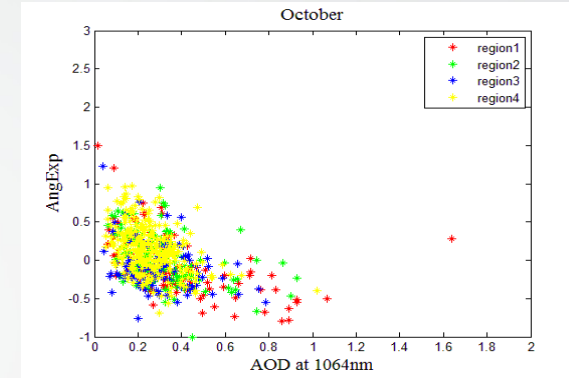
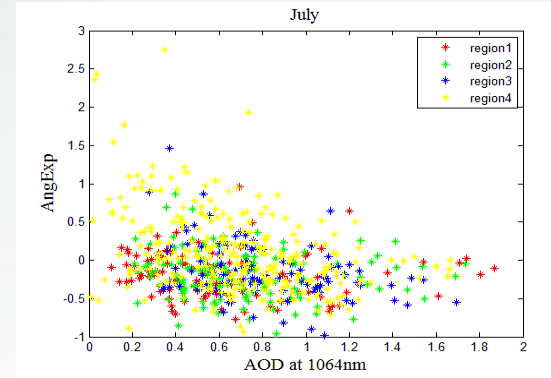
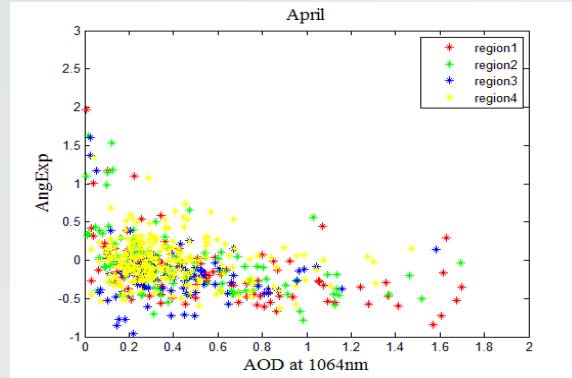
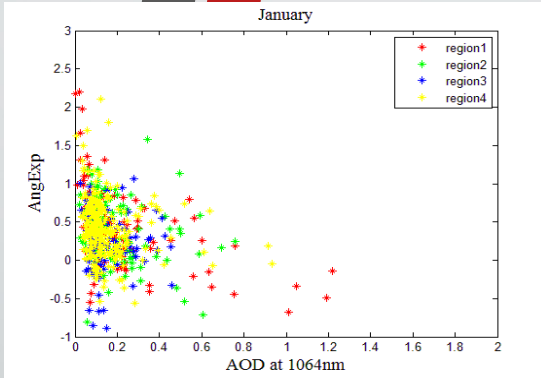
Data plot of AE vs. AOD 532nm :



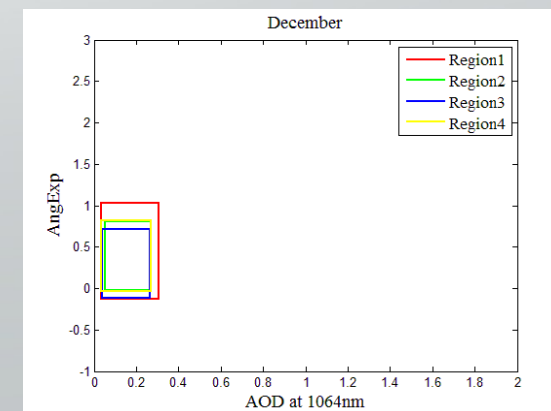
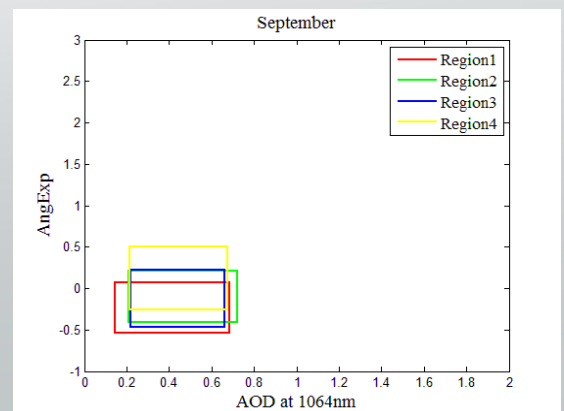
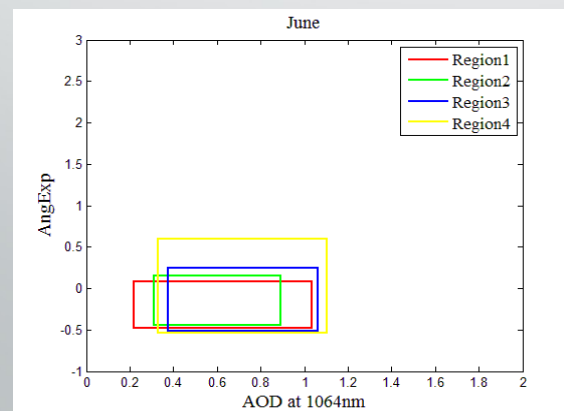
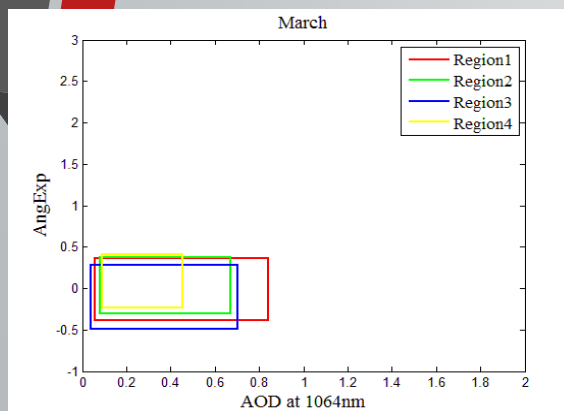
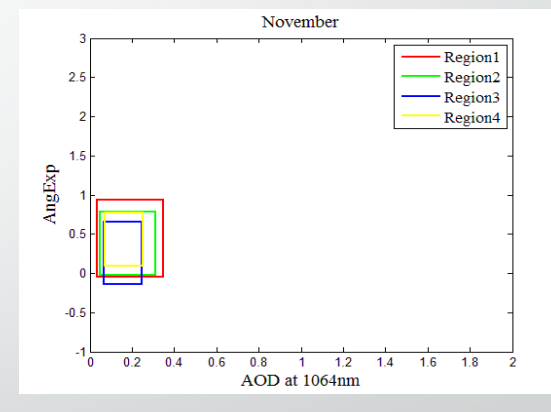
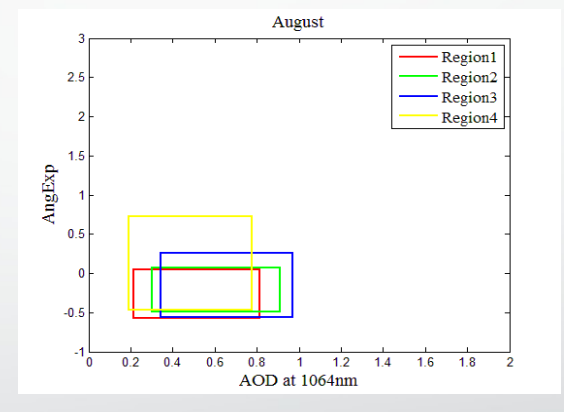
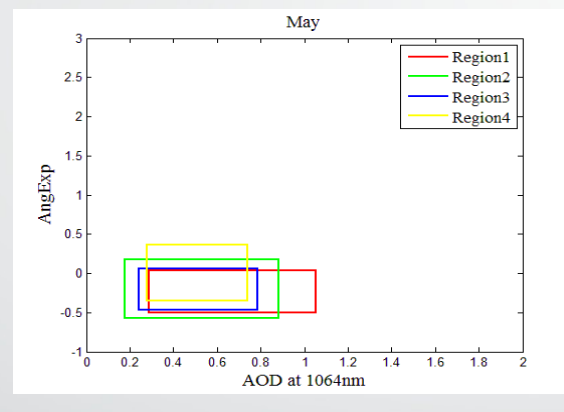
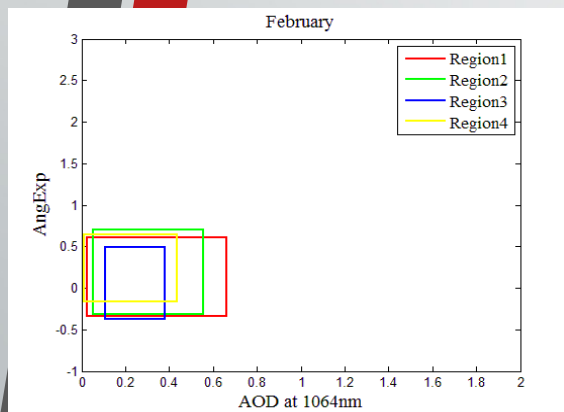
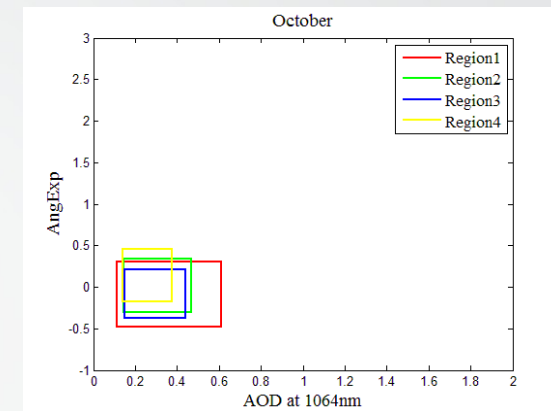
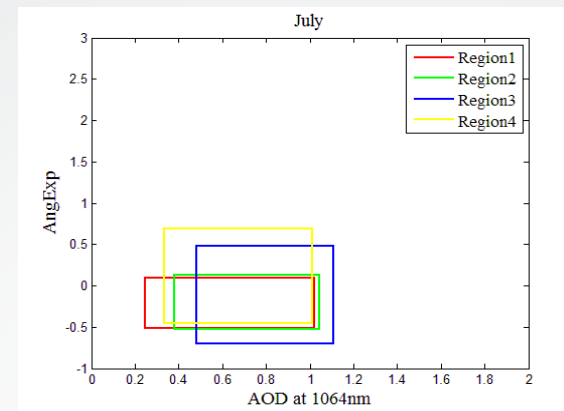
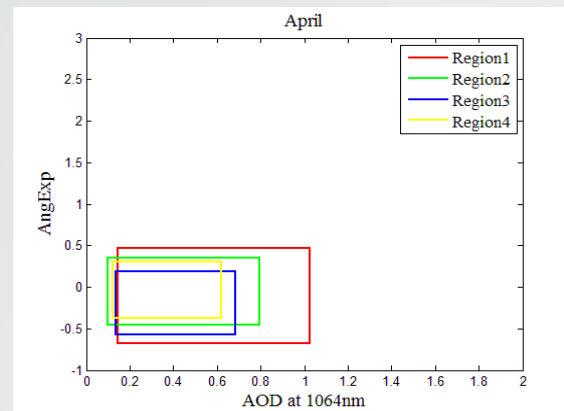
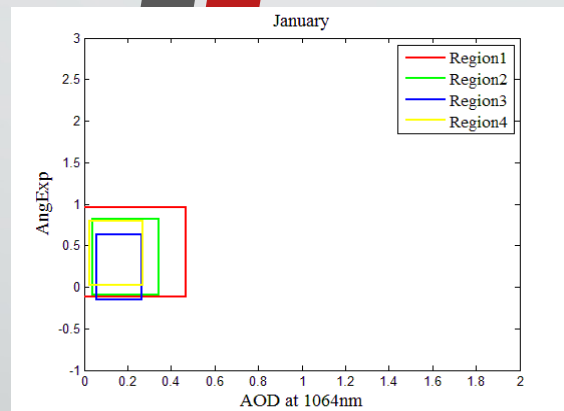
Avg plot of AE vs. AOD 532nm :



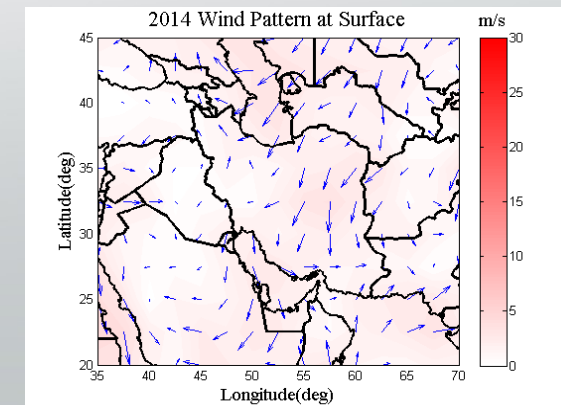
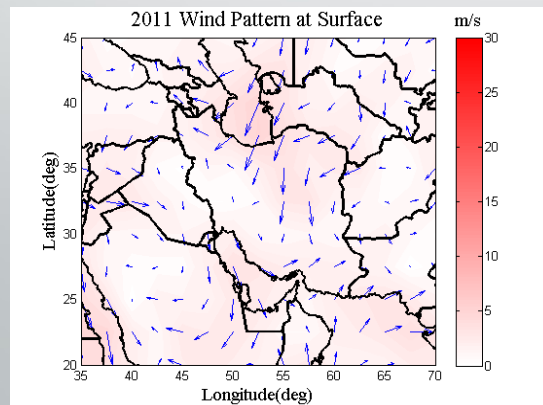
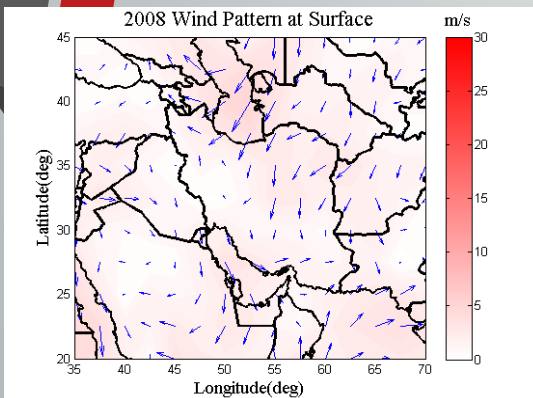
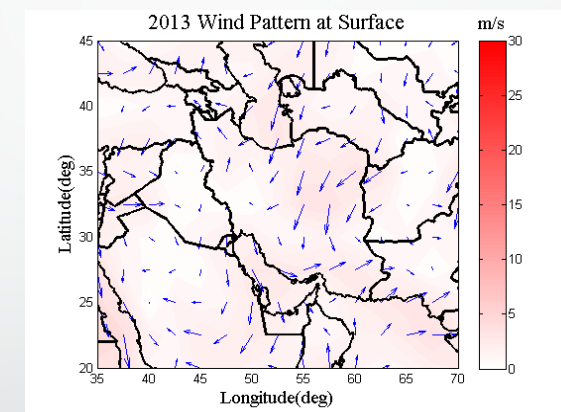
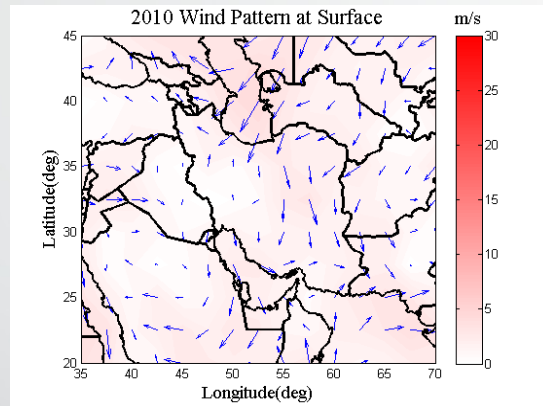
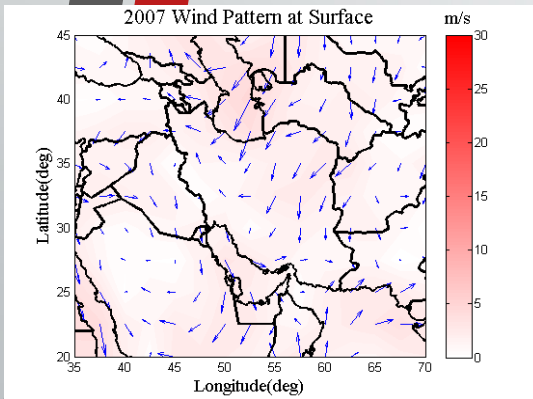
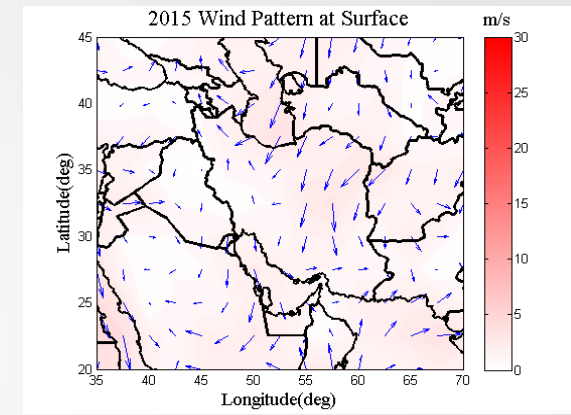
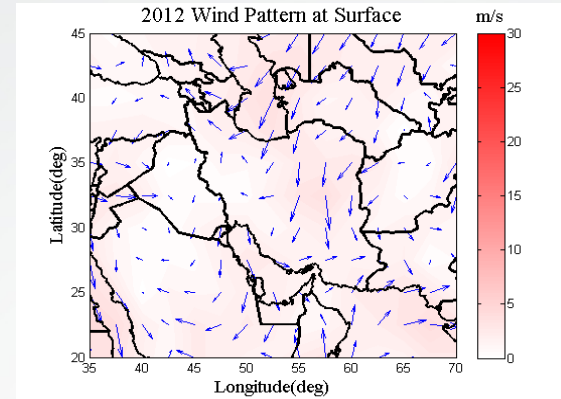
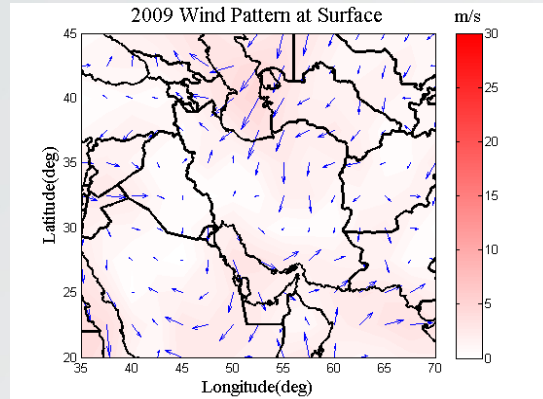
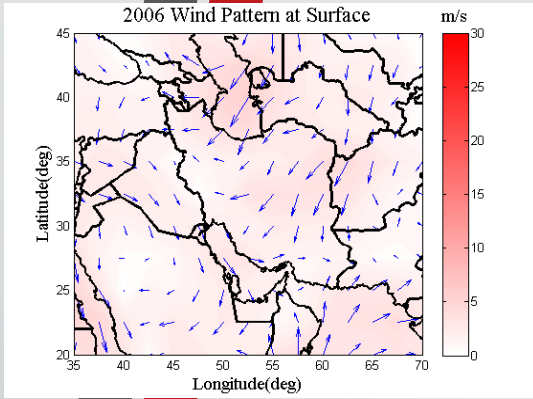
Data plot of AE vs. AOD 1064nm :



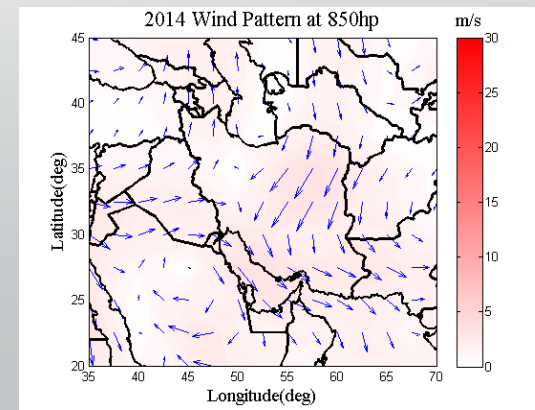
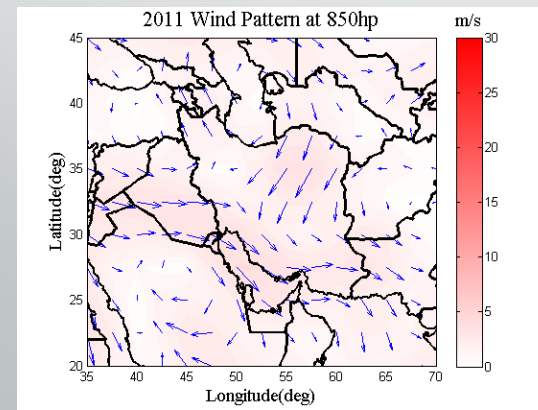
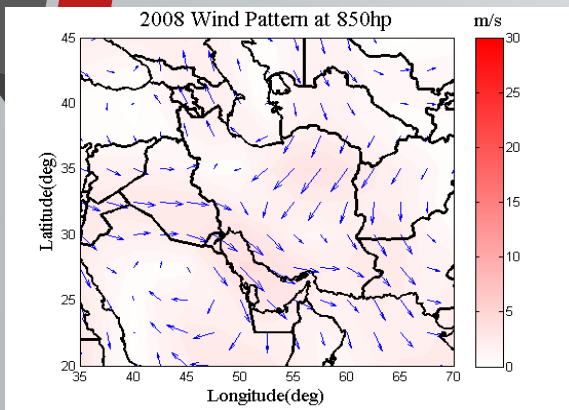
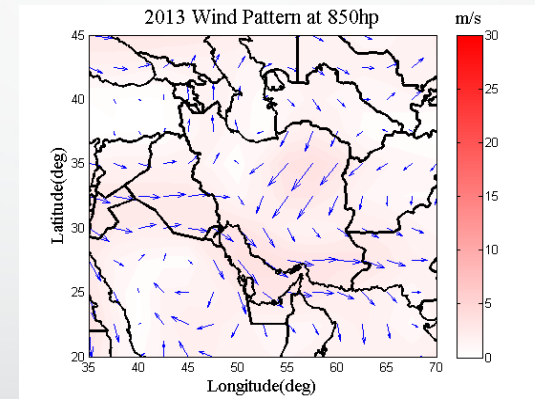
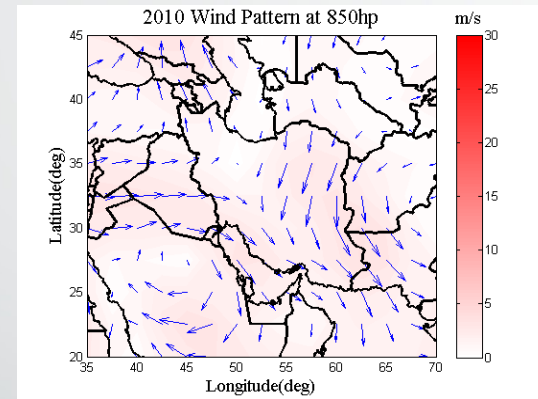
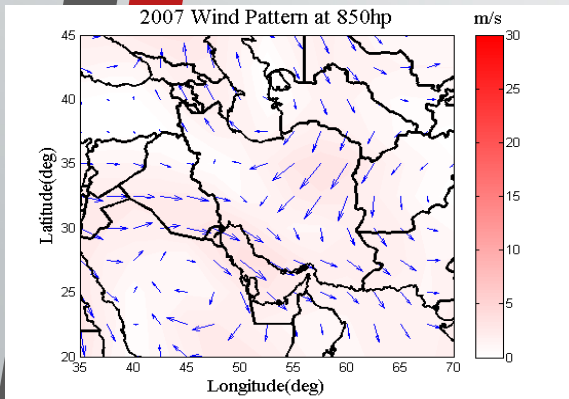
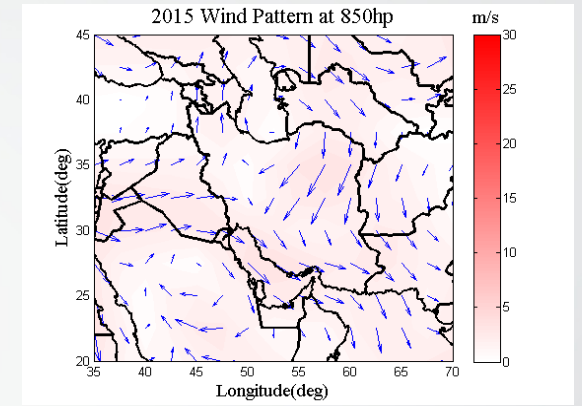
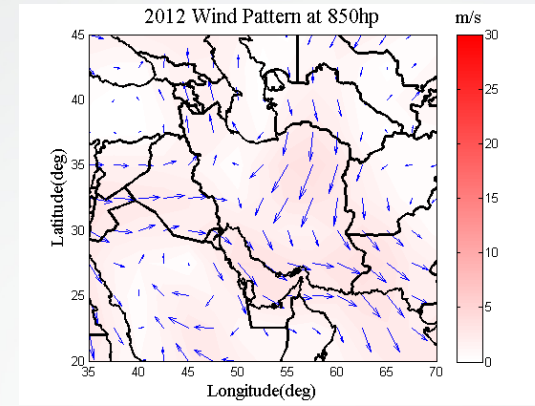
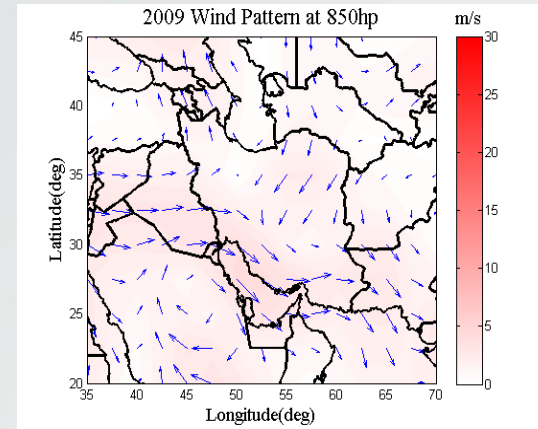
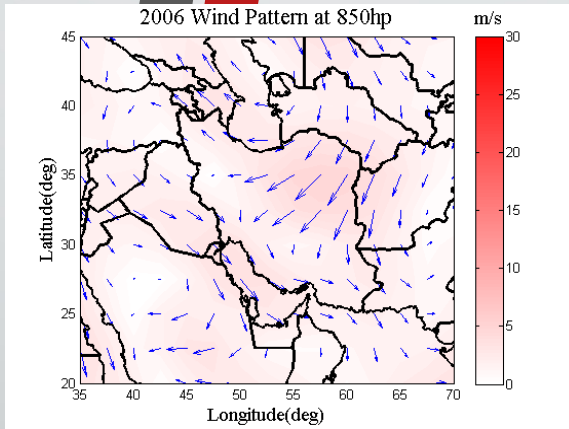
Avg plot of AE vs. AOD 1064nm :



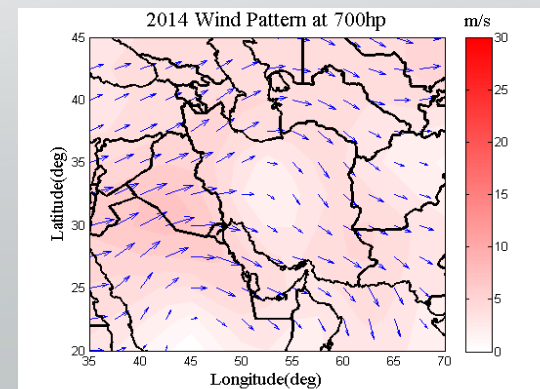
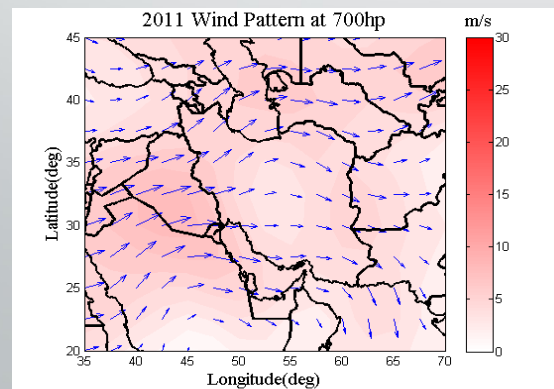
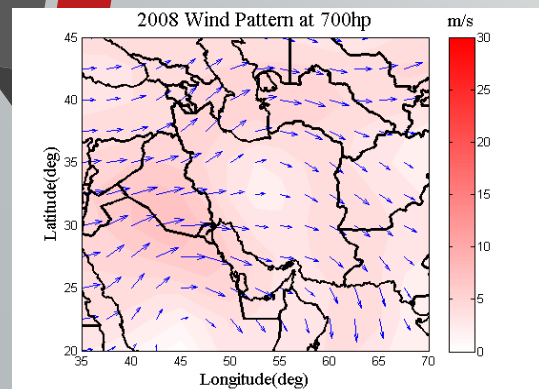
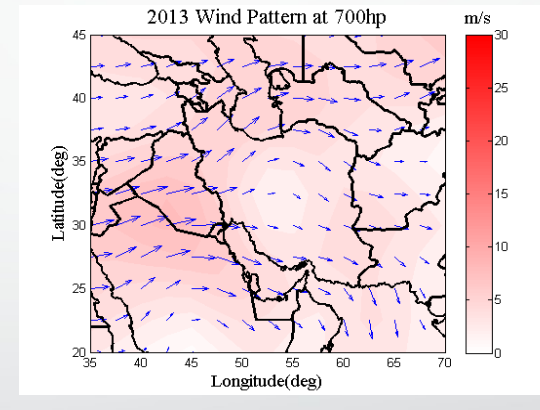
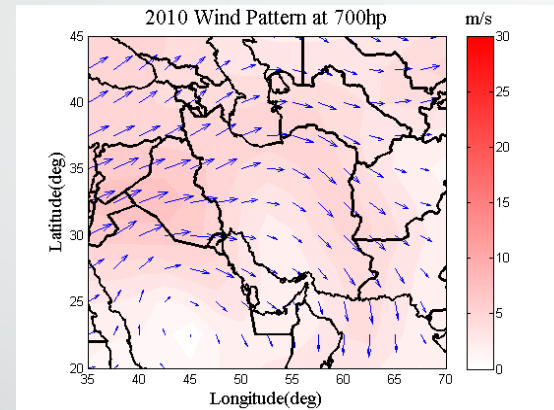
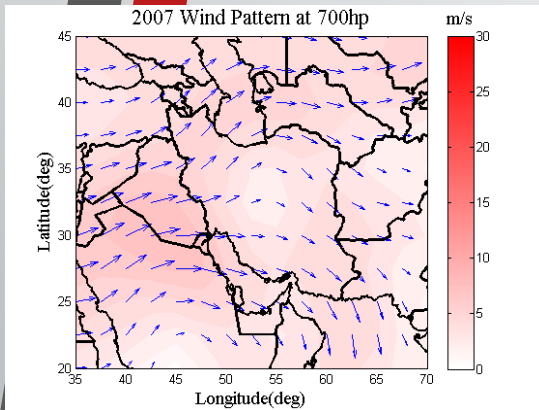
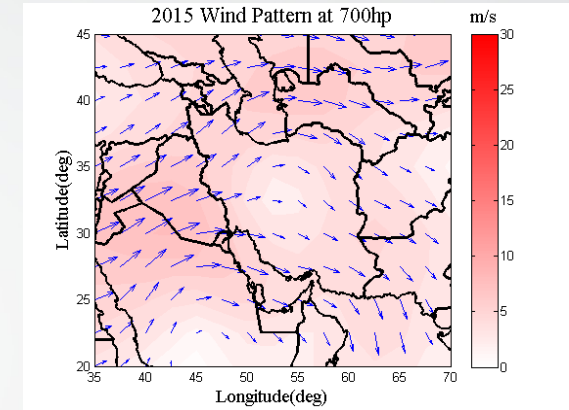
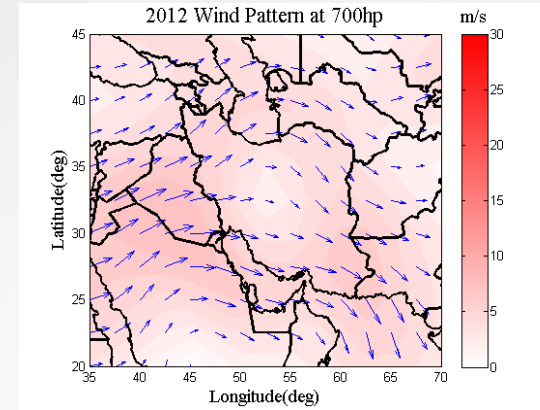
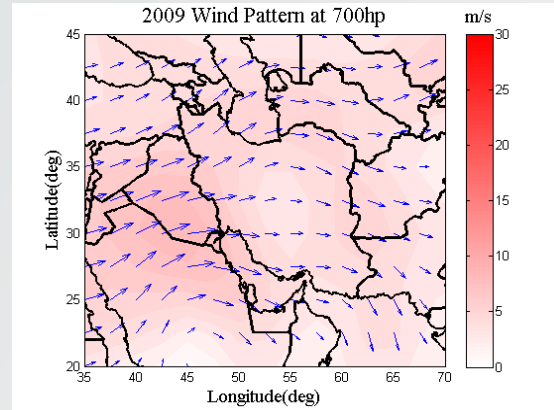
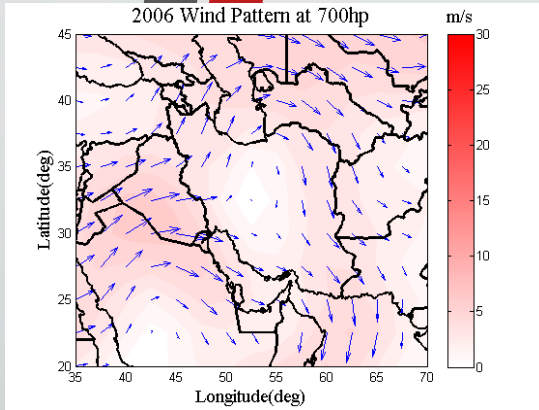
Annual Wind Pattern at Surface :



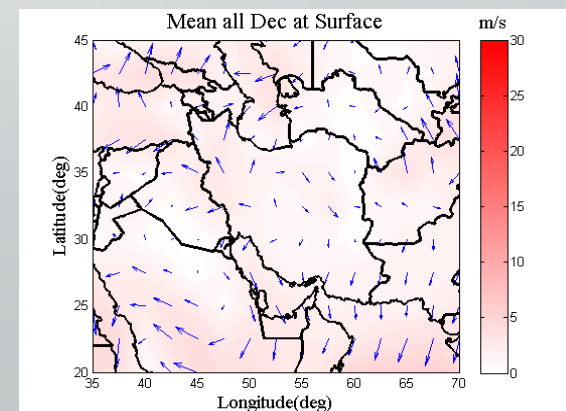
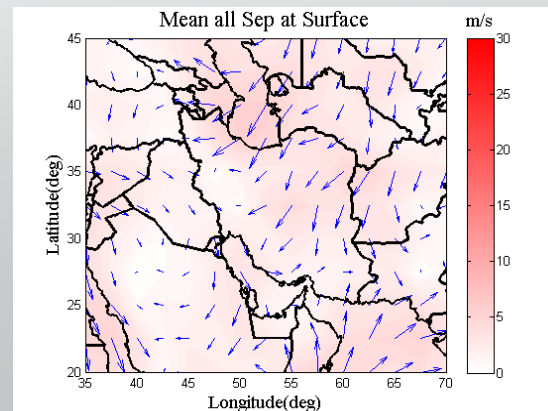
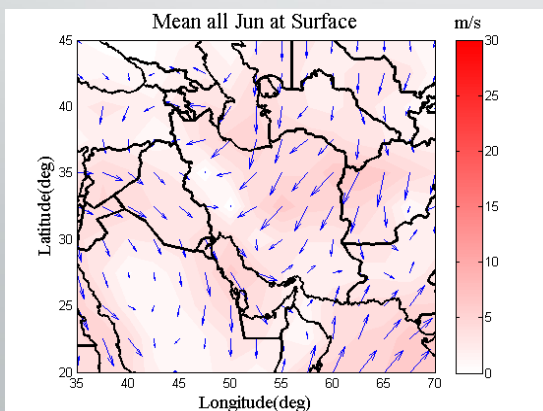
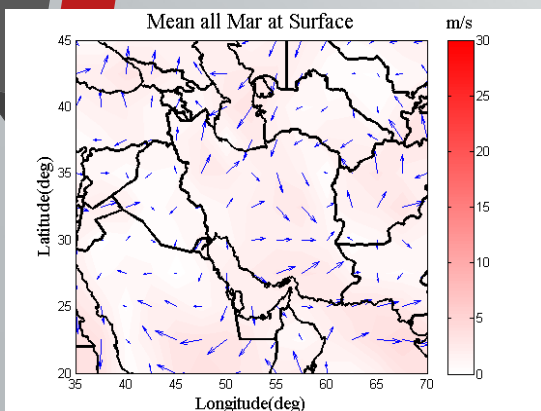
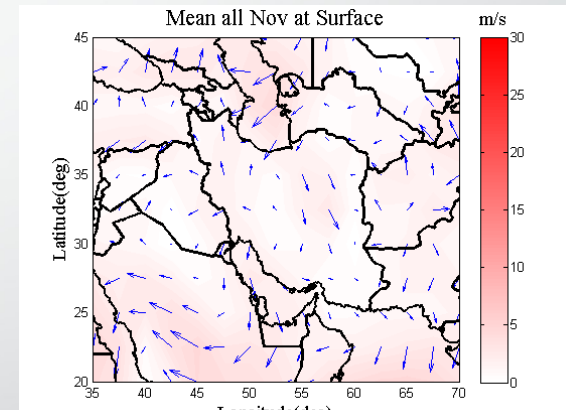
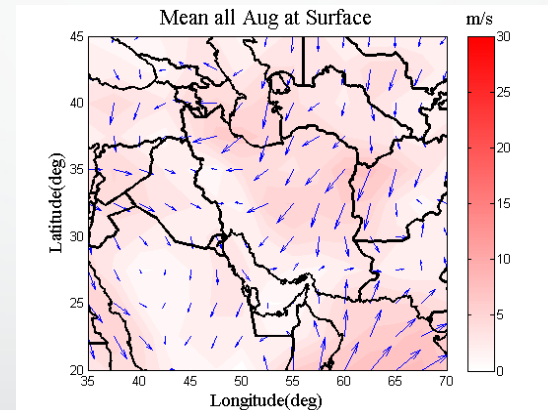
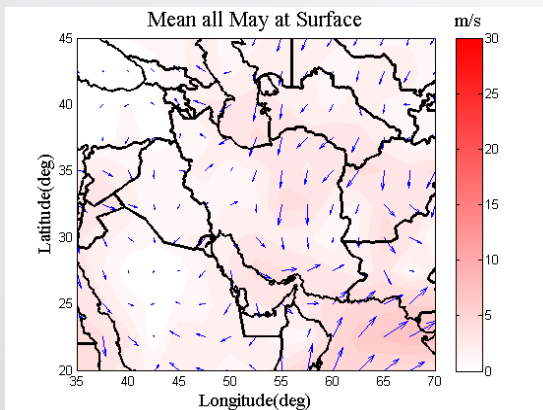
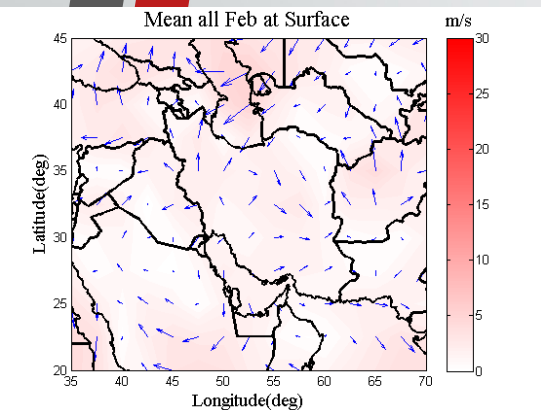
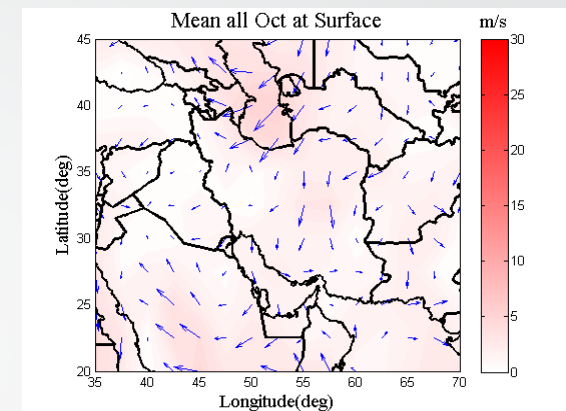
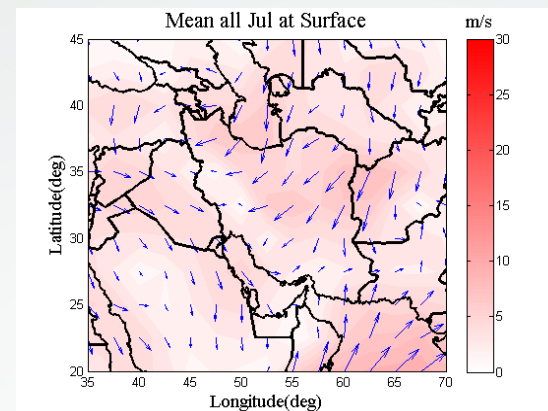
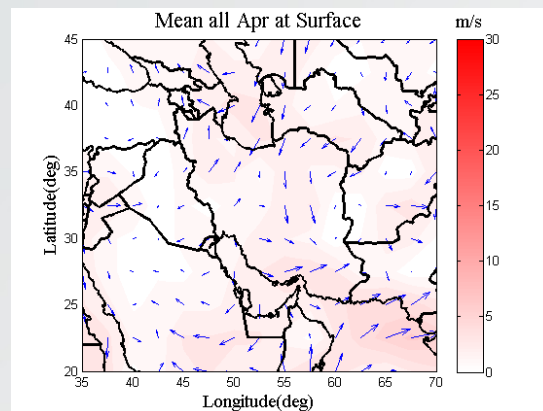
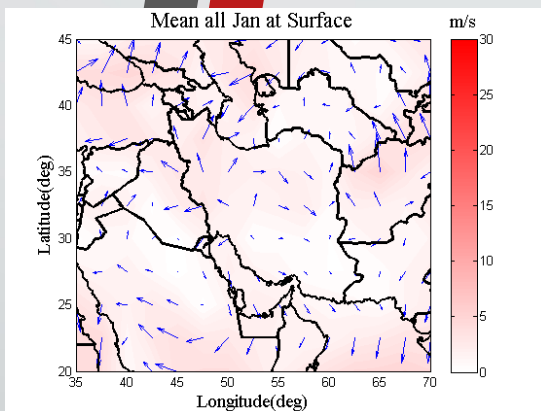
Annual Wind Pattern at 850hp :



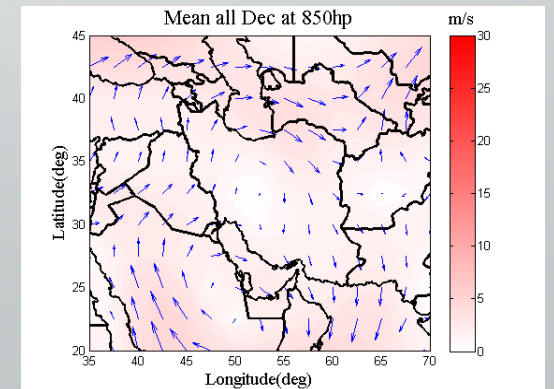
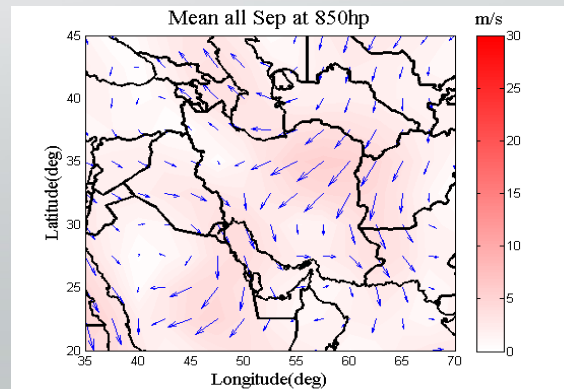
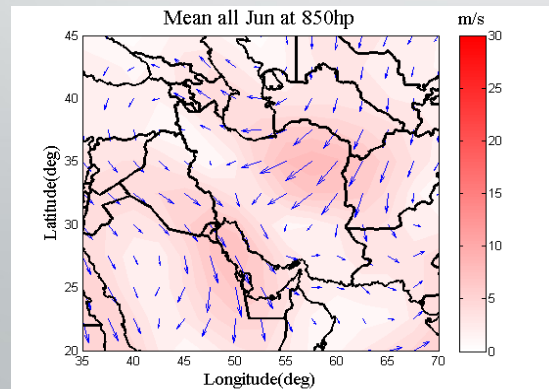
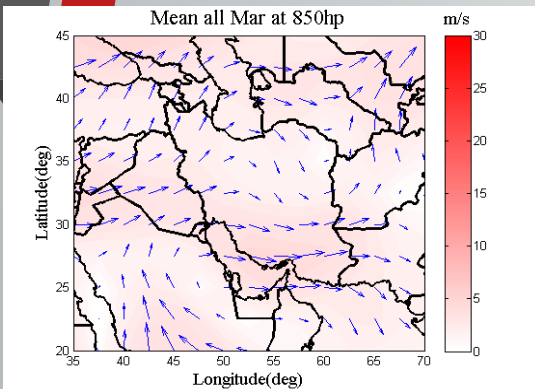
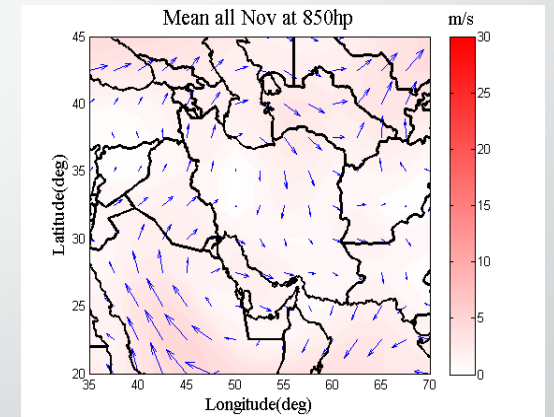
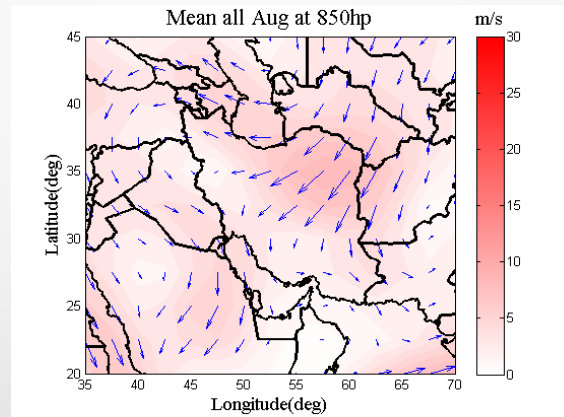
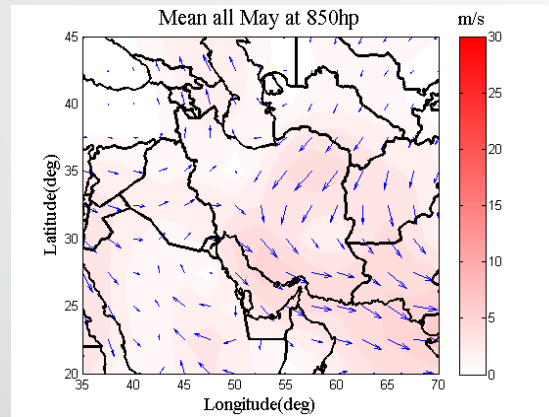
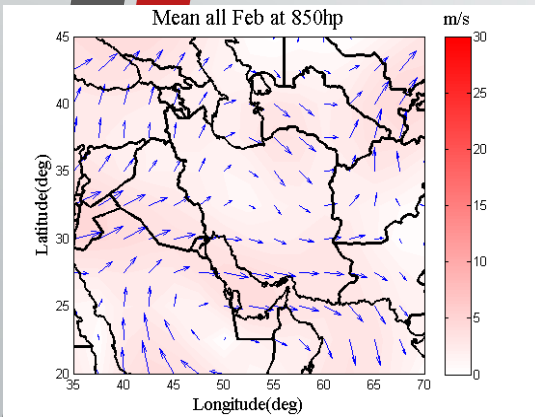
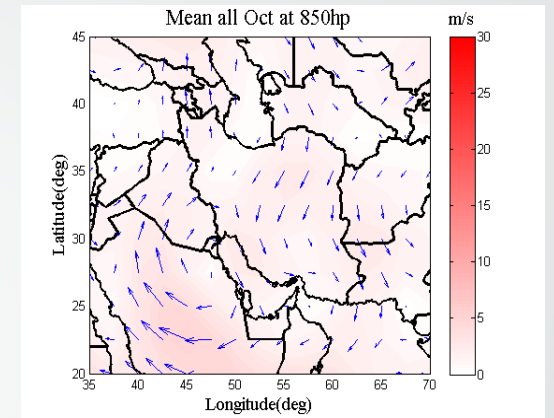
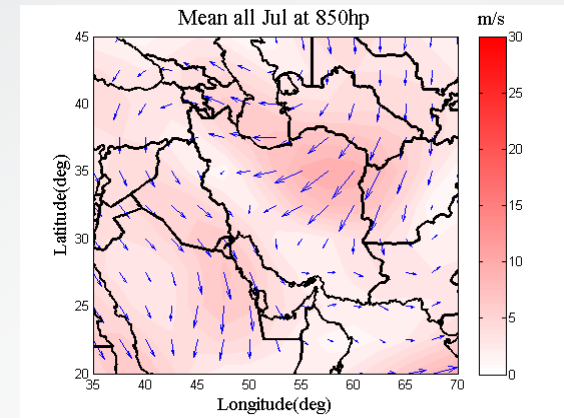
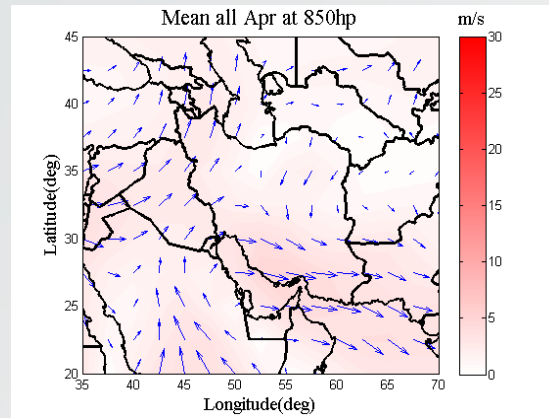
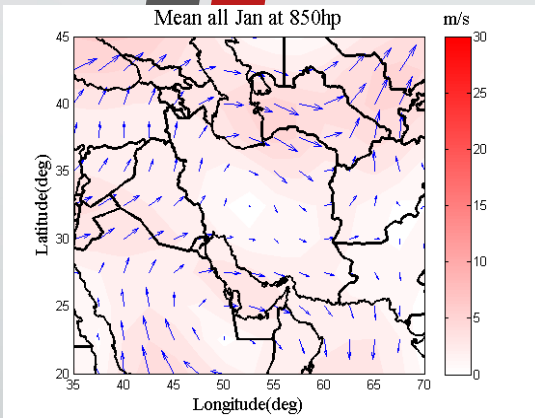
Annual Wind Pattern at 700hp :



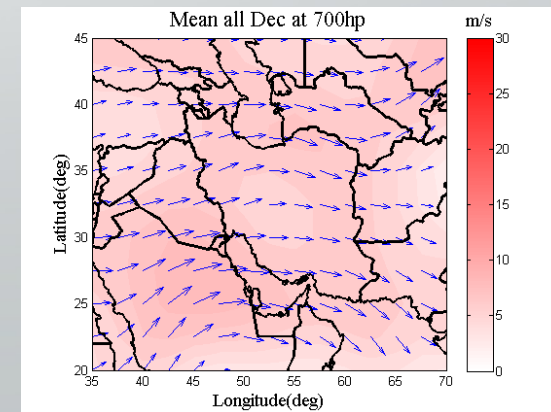
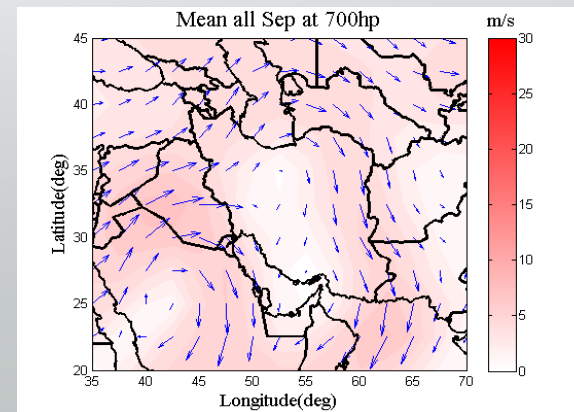
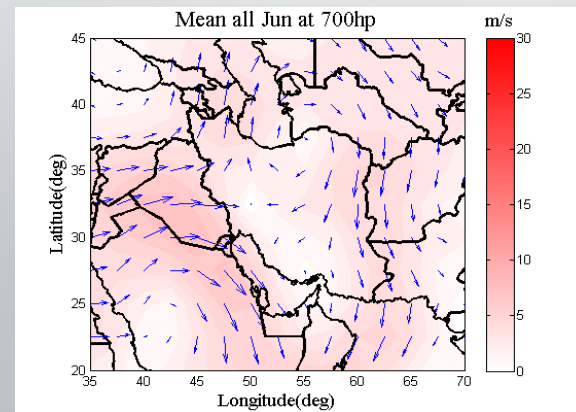
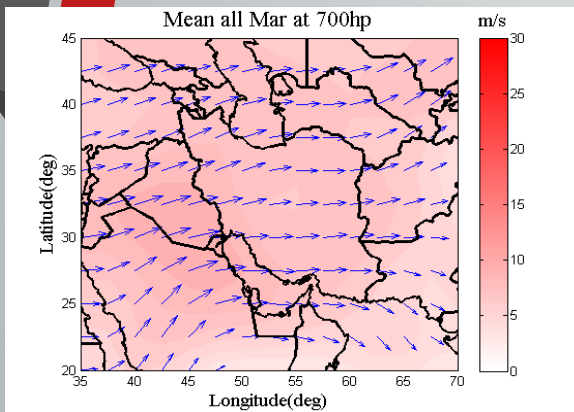
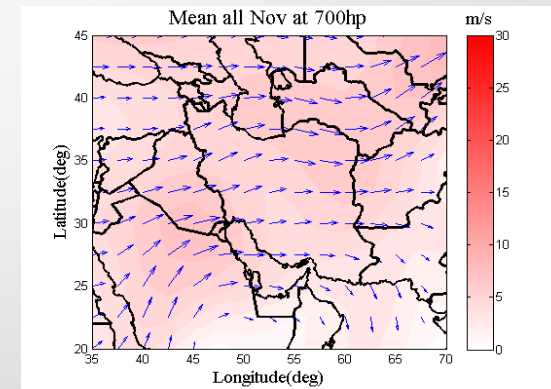
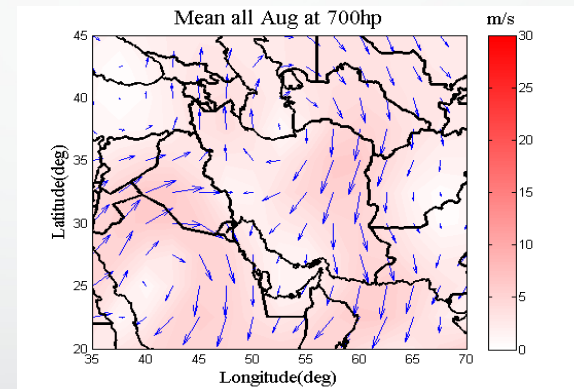
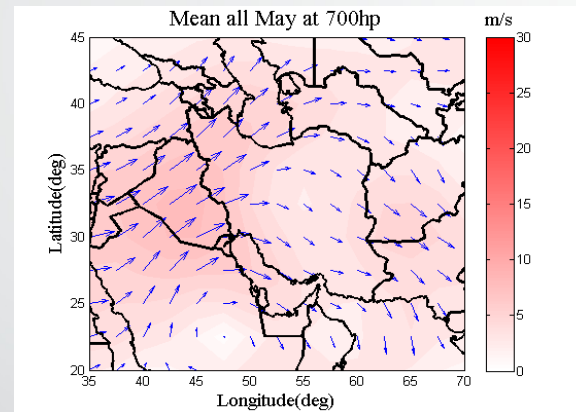
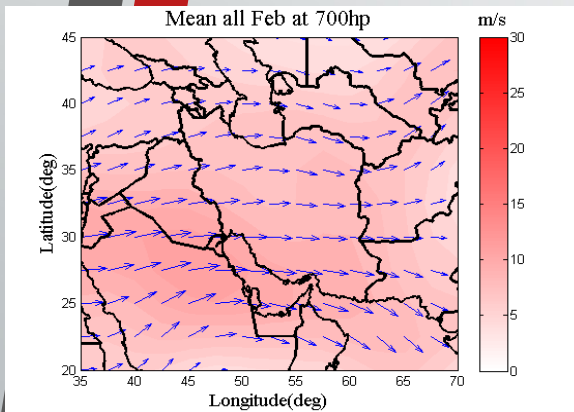
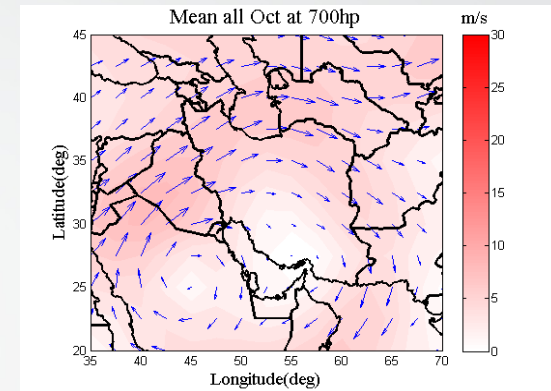
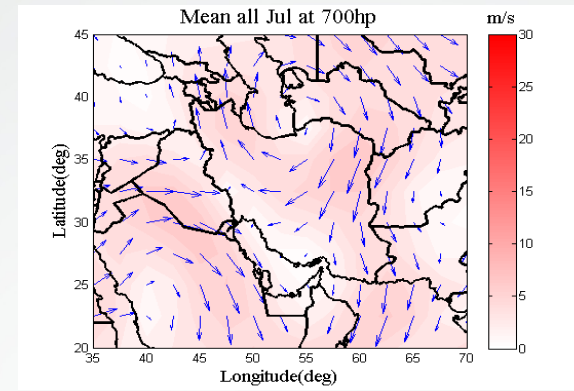
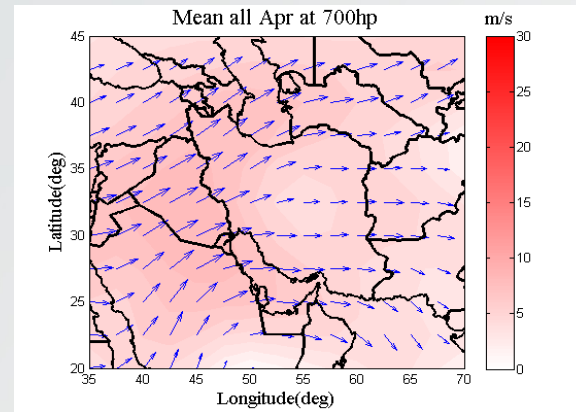
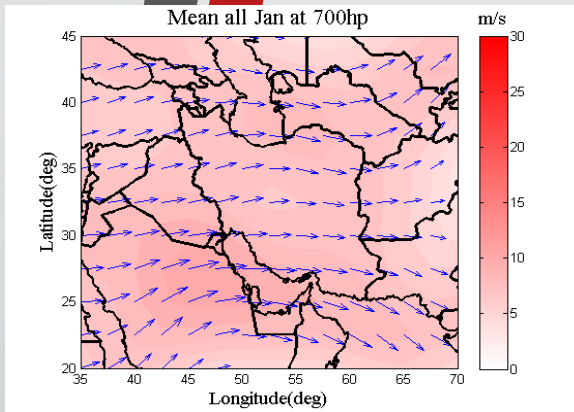
Monthly Wind Pattern at Surface :



Monthly Wind Pattern at 850hp :



Monthly Wind Pattern at 700hp :



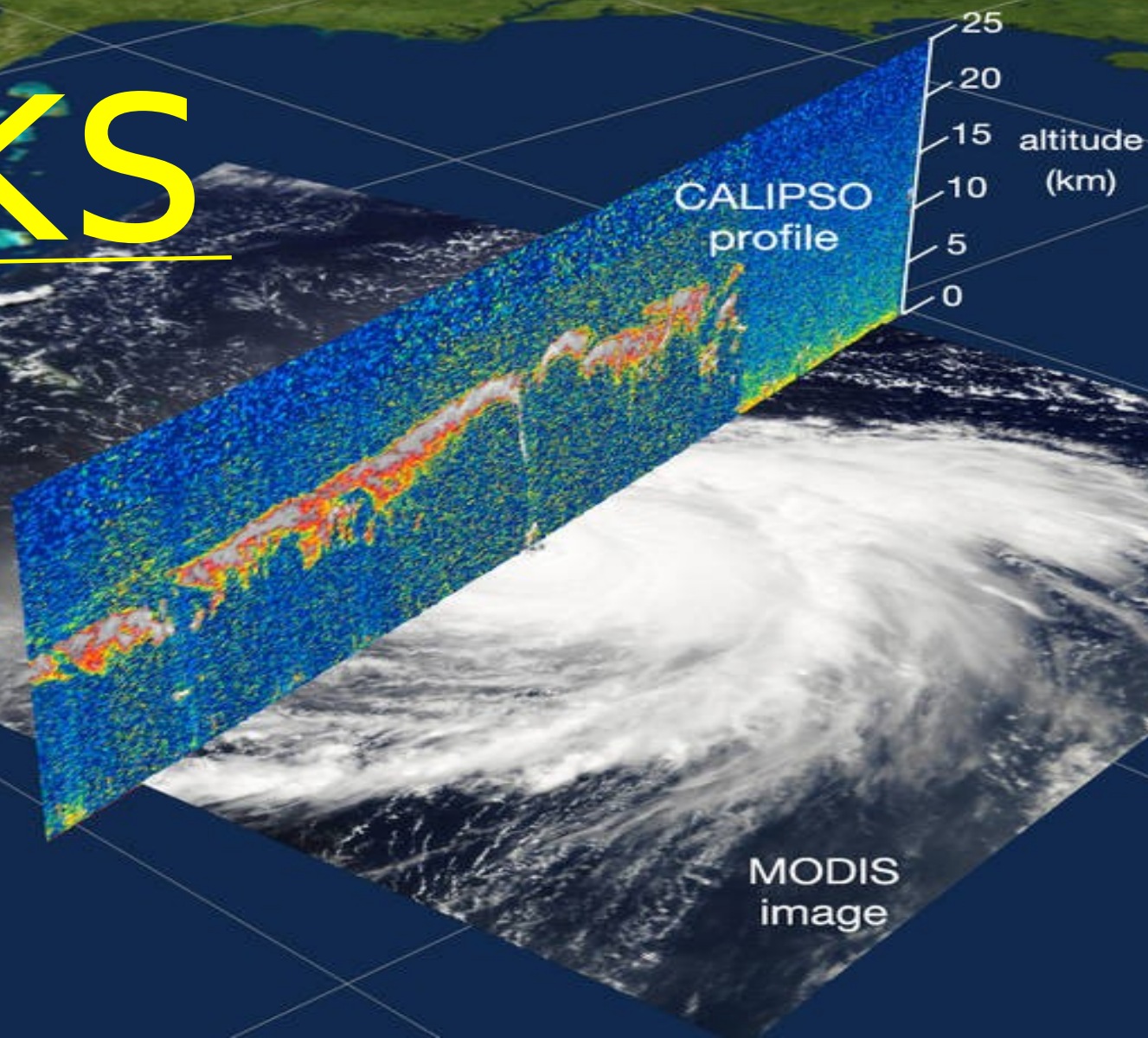


Results :



- ☐ Histograms of all annual studied parameter except AE have the same pattern at four regions.
- ☐ Histogram of annual AE at region 4 has different pattern from other regions.
- ☐ Histograms of monthly IAB, AOD 532 and 1064nm and AE have different patterns from other regions. These difference are at May to September.
- ☐ All data plot which versus IAB clearly indicate that data of region 4 at May to September are completely different from other regions data.
- ☐ Annual wind patterns at surface, 850hp, 700hp and 500hp approximately have the same pattern at 10 years.
- ☐ Monthly wind patterns at surface, 850hp, 700hp and 500hp have different patterns at May to September and are northerly wind.
- ☐ 120 wind days are exactly from mid May to mid September. This wind occurs at studied region 4.

Thanks





- **Extinction** : refers to several different measures of the absorption of light in a medium
 - In meteorology, or climatology, **extinction coefficient** is the name for the attenuation coefficient.

- **Backscattering** : or backward scattering, coefficient, in units of m^{-1} . It indicates the attenuation caused by scattering at angles from 90° to 180°



➤ AOD :

$$\tau_{\alpha} = \int_0^r \alpha(r) dr$$

➤ IAB :

$$\Gamma = \int_0^r \beta'(r) dr = \int_0^r \beta(r) e^{-2\tau_{\alpha}} dr$$

➤ AE :

$$\alpha = -\frac{\ln\left(\frac{\tau_{1064}}{\tau_{532}}\right)}{\ln\left(\frac{1064}{532}\right)}$$