

Aerosol Measurements at Urdukas (Pakistan) during Summer 2011

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PAPRIKA meeting – 8 November 2011, Bergamo

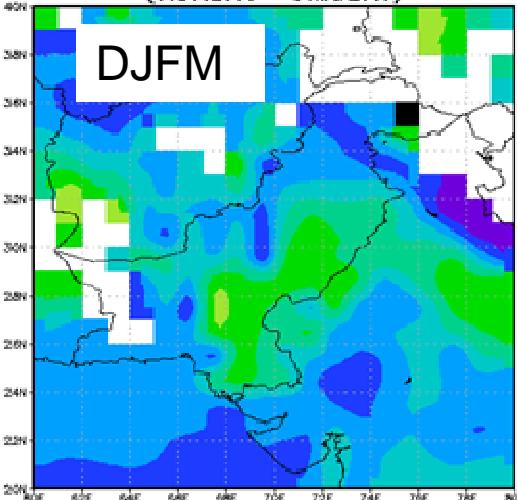
Outline:

- Background
- Measurement site
- Experimental set-up
- PM10 measurements
 - General behaviour
 - Comparison with other sites
 - Special events
- Conclusions/next activities

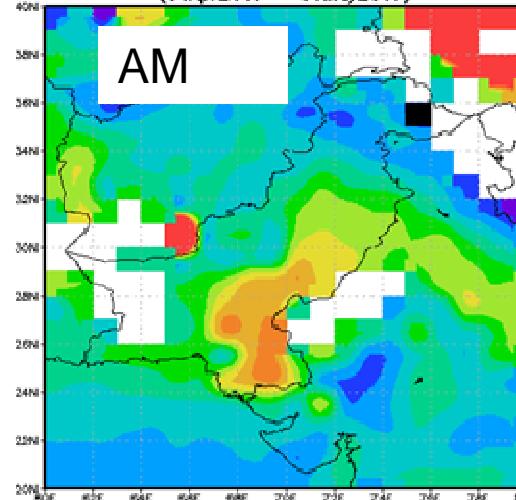
Background

- Satellite observations showed high aerosol amount

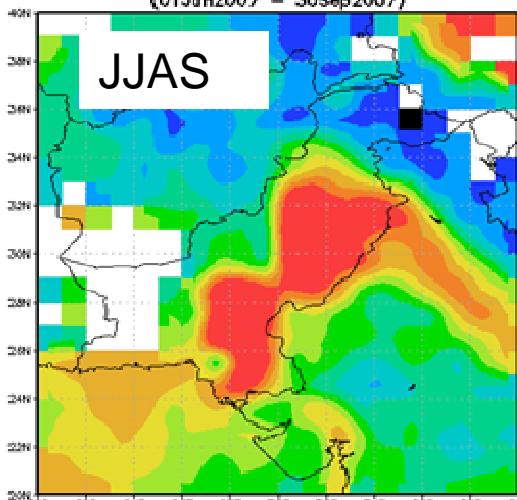
MOD08_D3.005 Aerosol Optical Depth at 550 nm [unitsless] (01Dec2008 – 31Mar2009)



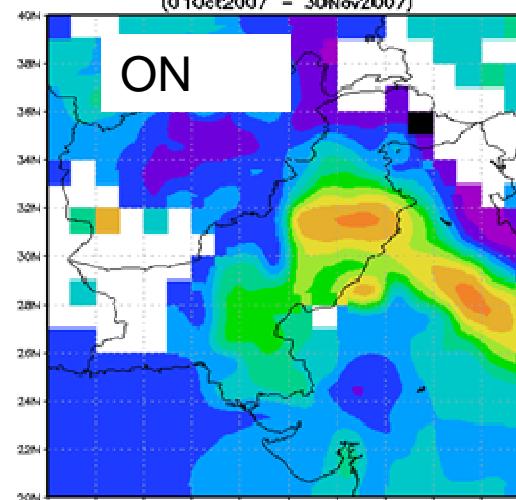
MOD08_D3.005 Aerosol Optical Depth at 550 nm [unitsless] (01Apr2007 – 31May2007)



MOD08_D3.005 Aerosol Optical Depth at 550 nm [unitsless] (01Jun2007 – 30Sep2007)



MOD08_D3.005 Aerosol Optical Depth at 550 nm [unitsless] (01Oct2007 – 30Nov2007)



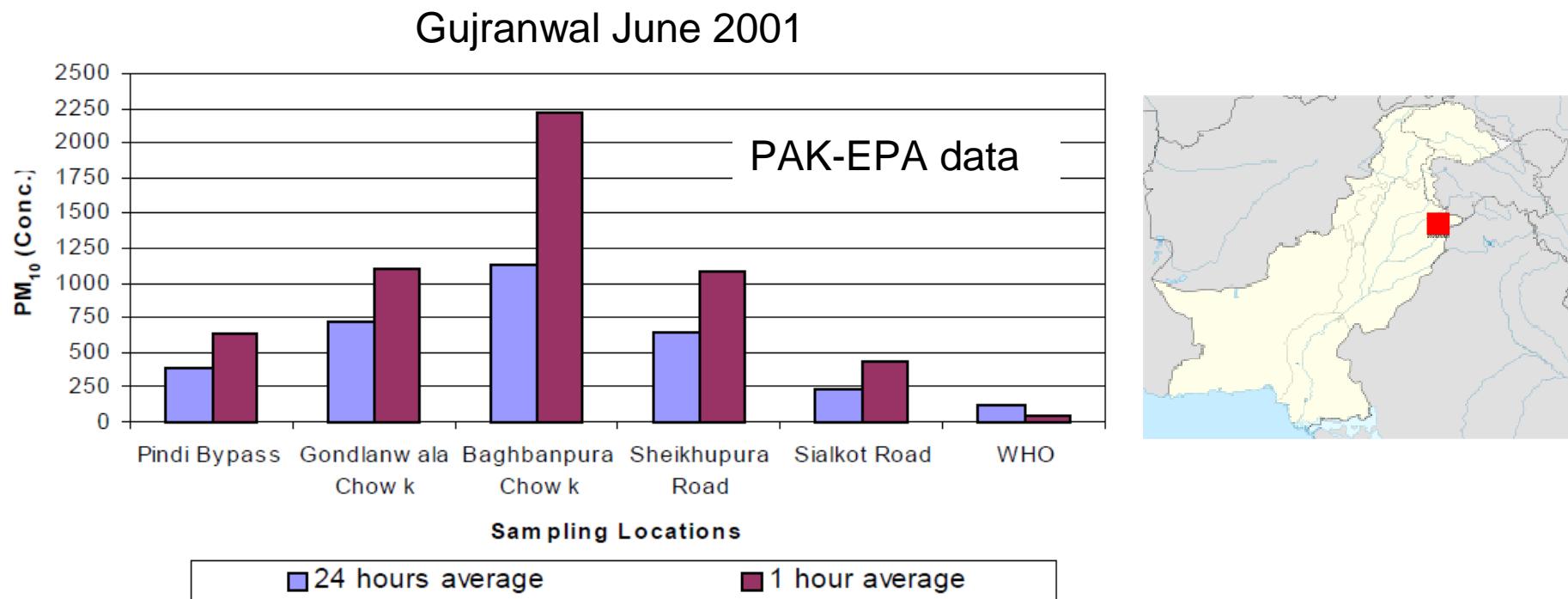
Seasonal averaged MODIS (Terra, Collection 5) AOD₅₅₀ over Pakistan for 2007.

The surveys conducted by Pakistan Environmental Protection Agency revealed presence of very high levels of total suspended particulate matter and PM2.5 about 2-3 times higher than the US-EPA guidelines.

Great contributions to the aerosol mass from deserts (Taklimaklan, Cholistan and Thar) and soli resuspension (especially in summer).

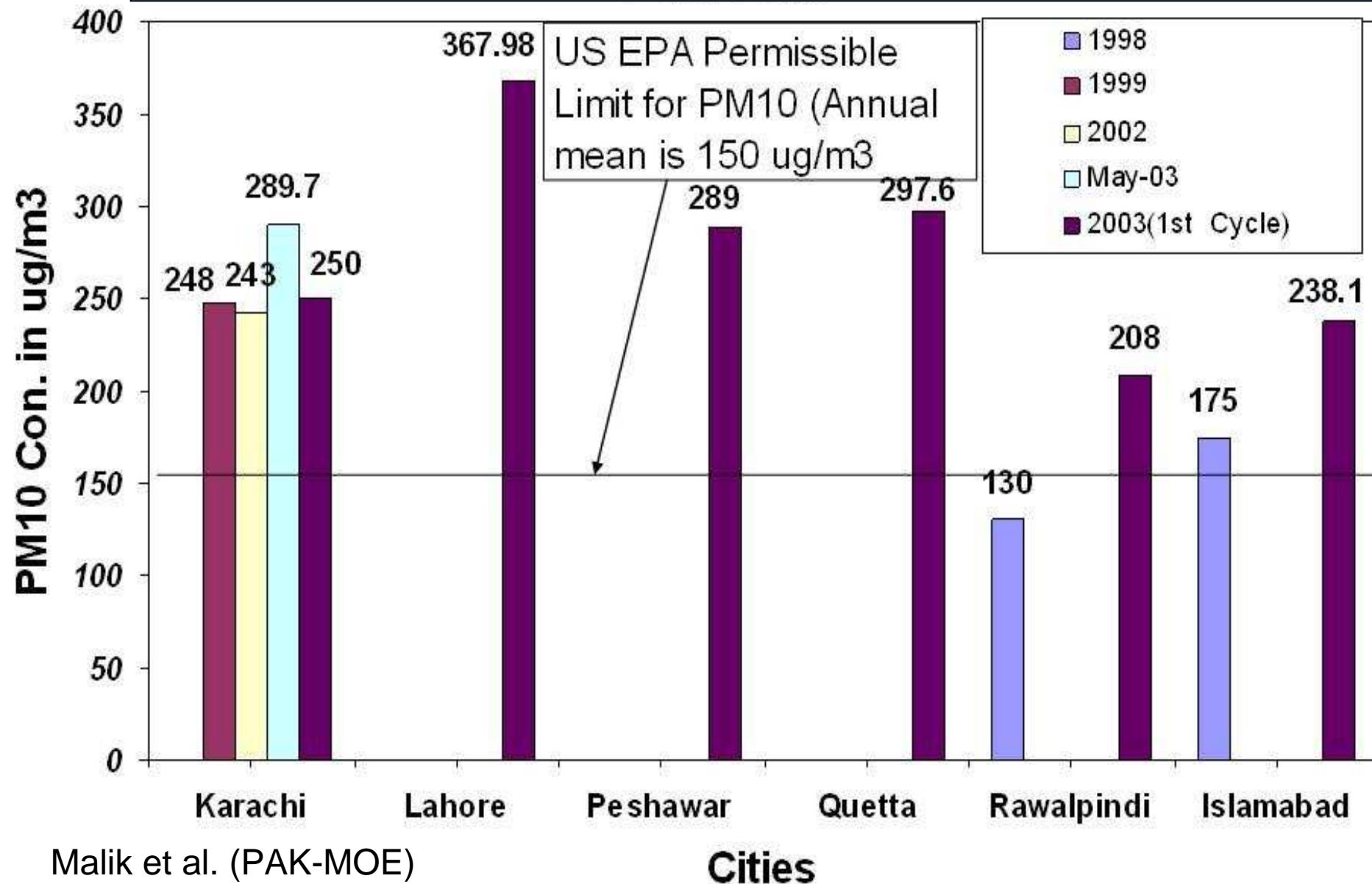
Background

- Pakistan air-quality measurements showed some of the highest PM10 values in the world

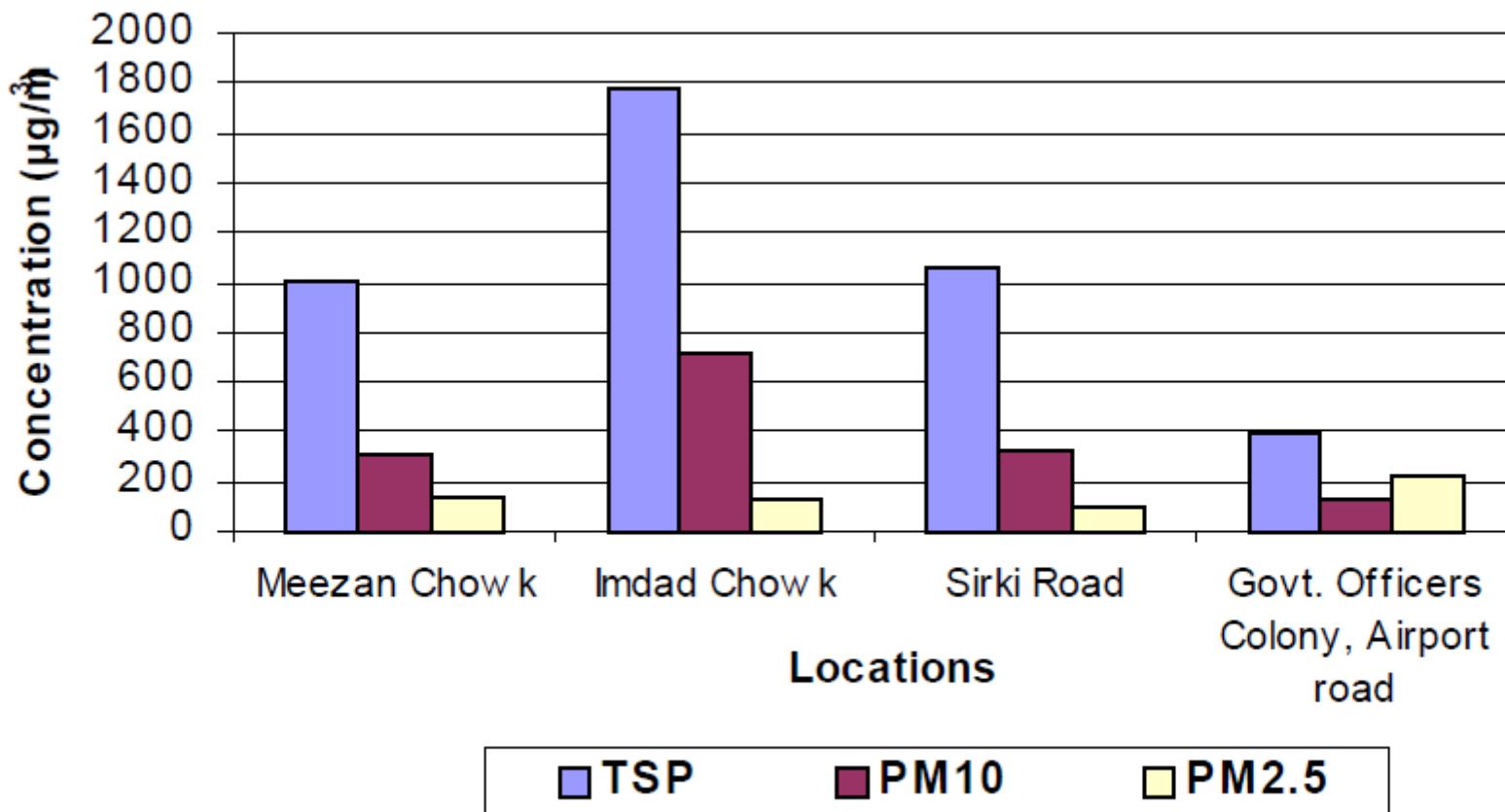


- Limited air quality data available only for a few Pakistani cities (PM_{2.5} daily values up to 200 µg/m³ in May 2007, PAK-EPA)

Max Concentration of PM 10 in Six Big Cities of Pakistan (SUPARCO)



TSP, PM10, PM2.5 at Quetta (May 2006)



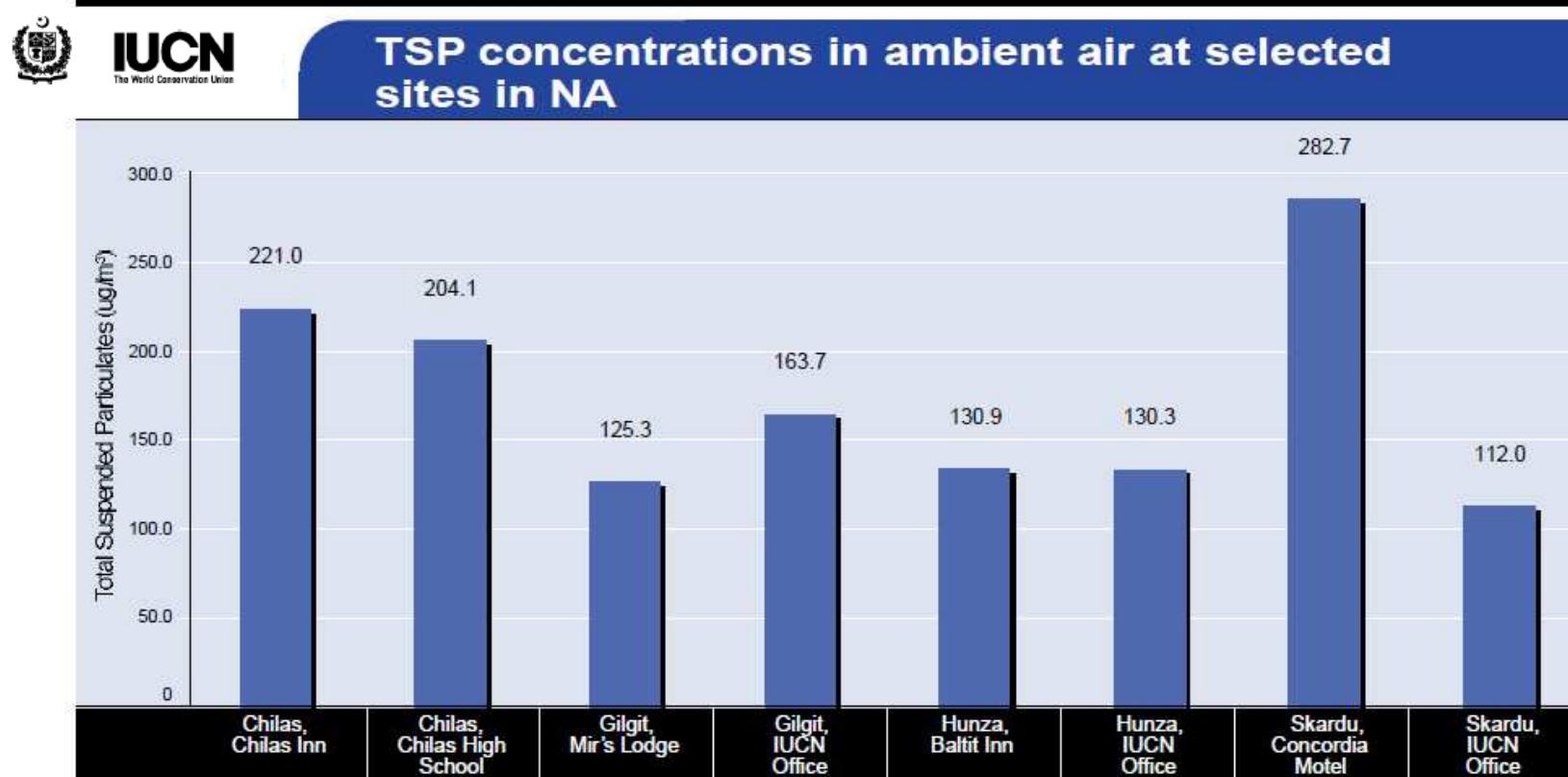
"Ambient Air Particulate Matter and water Quality Investigation in Quetta", May 2006, Pak-EP

The huge amount of TSP and PM10 (coarse fraction) suggest significant contribution by soil or mineral dust!

Background

- No systematic data for the «northern Areas» and mountain region

Short campaigns (2-3 days) on April – May 2001 showed high TSP values on urban areas

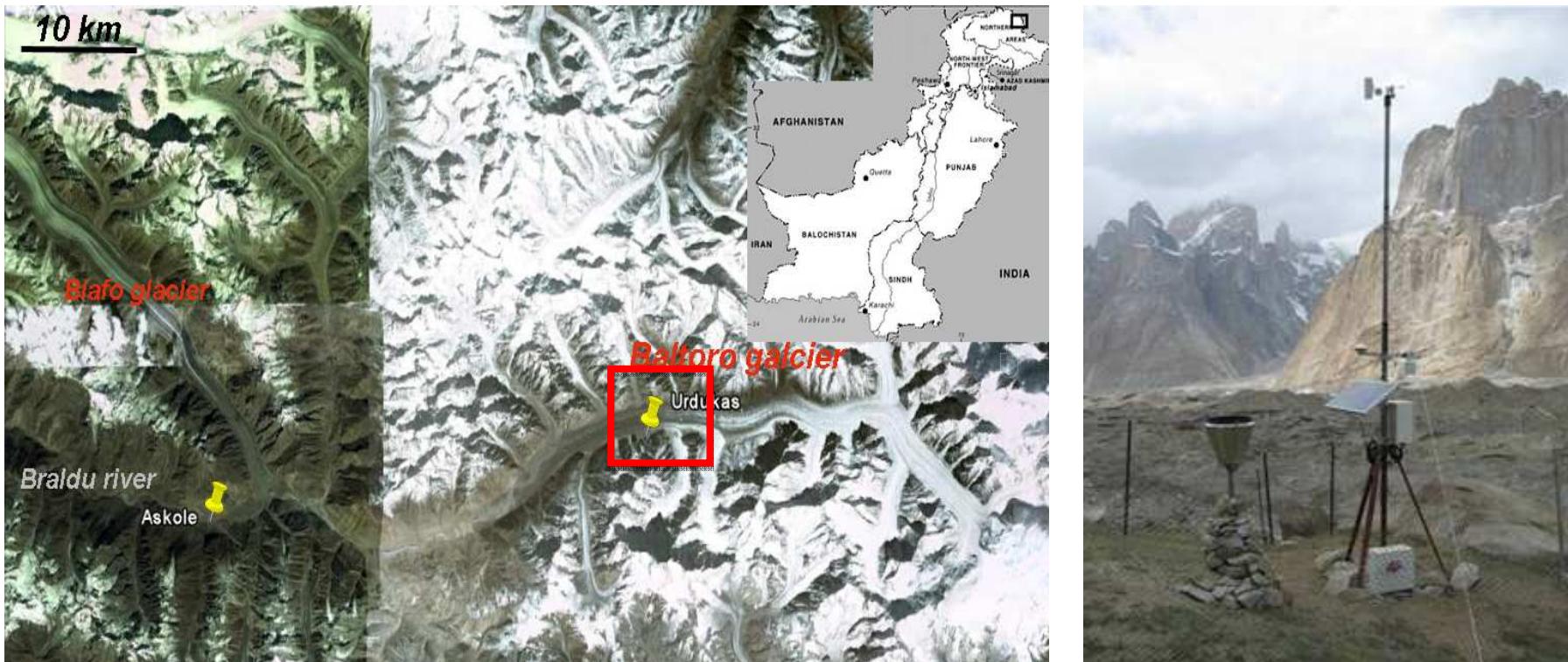


Source: Saeed et al., 2001.

Measurement site

- Urdukas (3,926 m asl; $35^{\circ} 43' 41''$ N, $76^{\circ} 17' 10''$ E)

Located along the Baltoro Glacier, on a moraine ridge close to the left glacier margin.

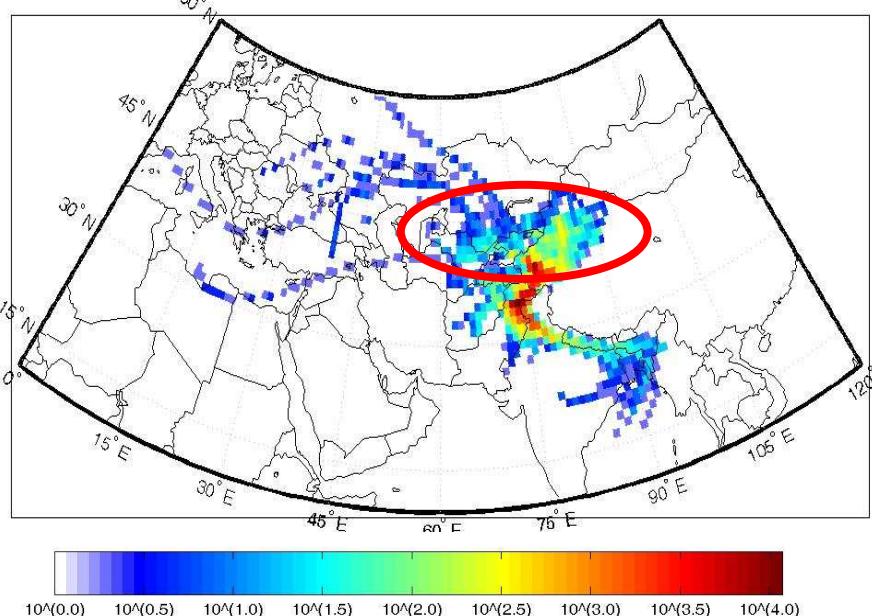


- Meteorological station (*Lastem LSI*)
- Aeroqual AQM60 (PM10 by OPC) 21 July – 28 August 2011

Measurement site (circulation and meteo)

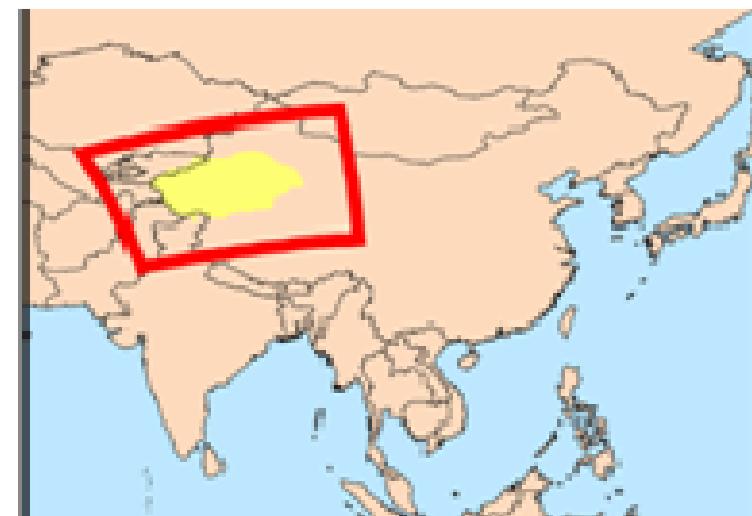
In contrast to central and southern Pakistan, northern areas appeared to be only partially influenced by South Asia southerly monsoon.

Trajectory counts: 21 July – 28 August 2011



For the campaign periods, 3D air-mass back-trajectories (144 h long) calculated by HYSPLIT model basing on GDAS meteorological data ($1^{\circ} \times 1^{\circ}$). Every 6 hours (00, 06, 12, 18 UTC), 10 trajectories located at Urdukas $\pm 1.0^{\circ}$ at 100 m agl and 500 m agl. .

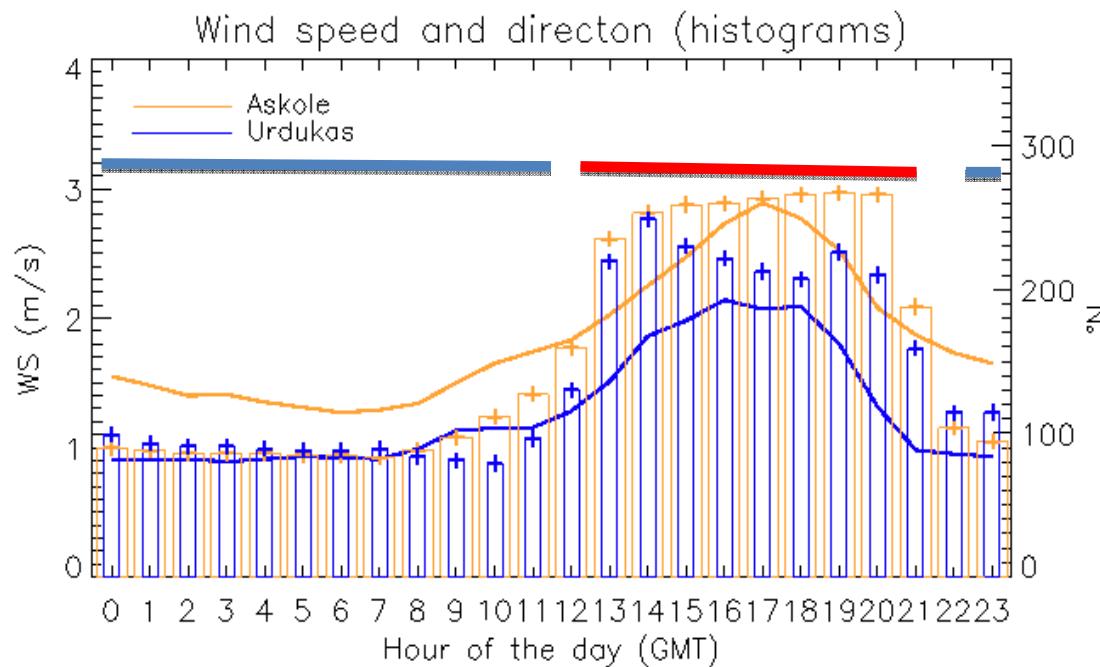
Not negligible number of trajectory originated from the Taklimakan desert, suggesting that transport of mineral dust could influence PM10 at Urdukas during the measurement periods



Measurement site (circulation and meteo)

As shown by observations carried out from 2006 to 2009, the local wind is strongly affected by the topography of Baltoro valley (prevalence of Easterly and Southwesterly flows).

A “thermal” mountain wind system is characterized by daytime (SW) up-valley and nighttime (E) down-valley flows.



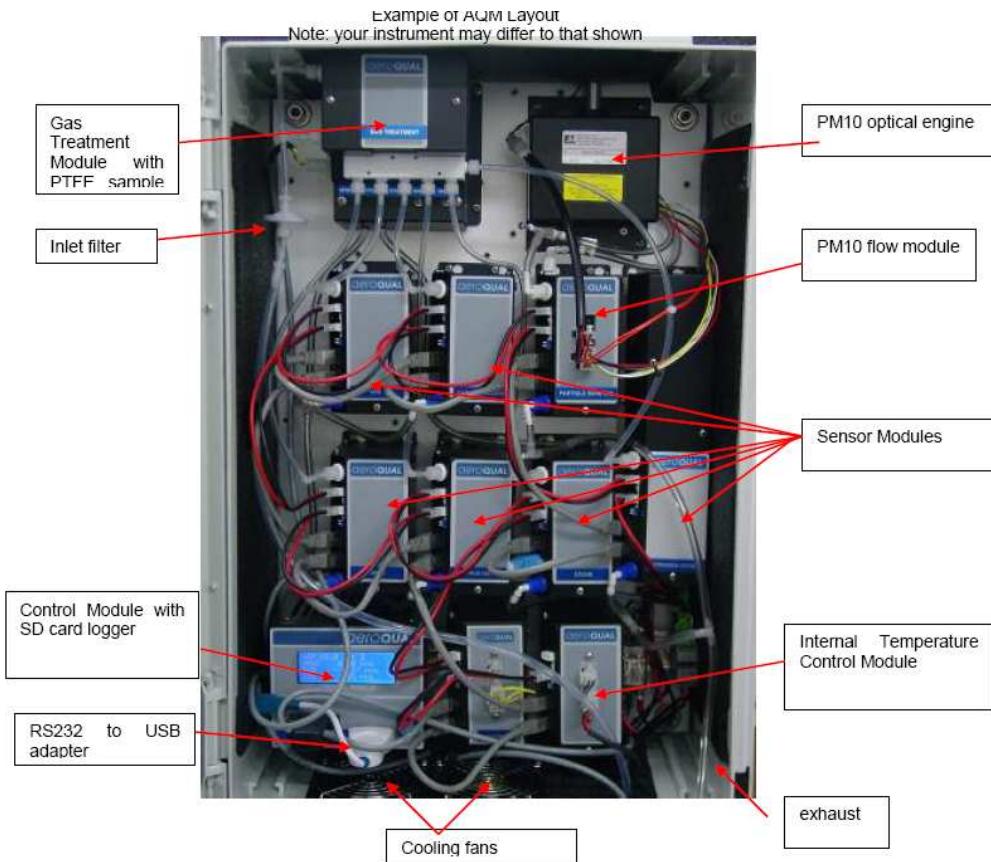
Is the atmospheric composition (PM10) affected by this mountain wind system?

Still waiting for summer 2011 data from Urdukas AWS!

Experimental set-up: Aeroqual AQM60

Execution of a summer field campaign at Urdukas (Baltoro glacier) for the characterization of aerosol particulate mass (PM10) and atmospheric composition (VOC, NOx) variability.

Instrument: AQM60 by Aeroqual



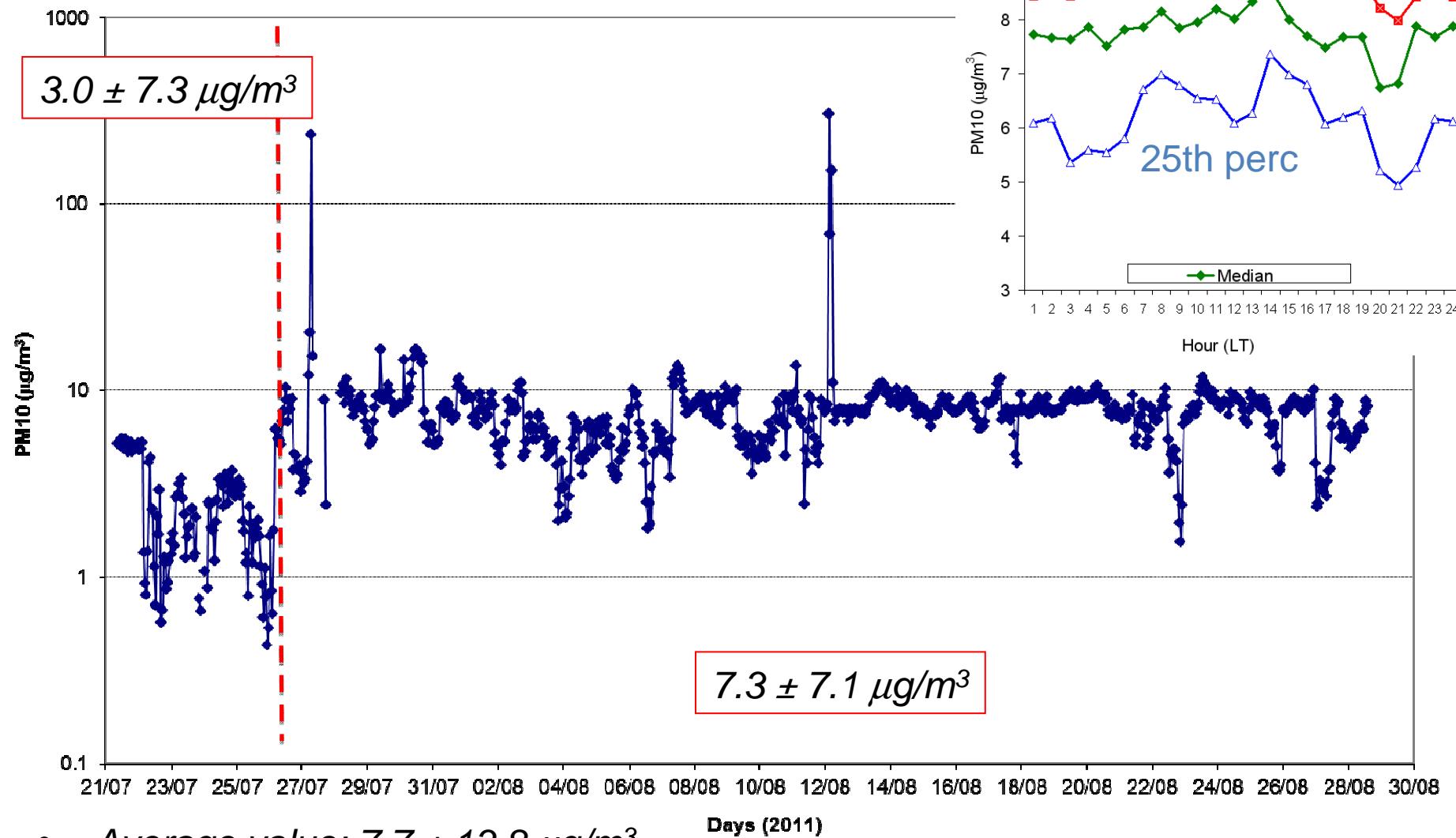
Particle module
Met One 80180

The image shows a close-up view of the Particle module (Met One 80180). Components labeled include:

- TSP Assembly
- Sharp Cut Cyclone
- Inlet Tube/Heater Assembly
- Pump Assembly
- MD Engine
- Electronics

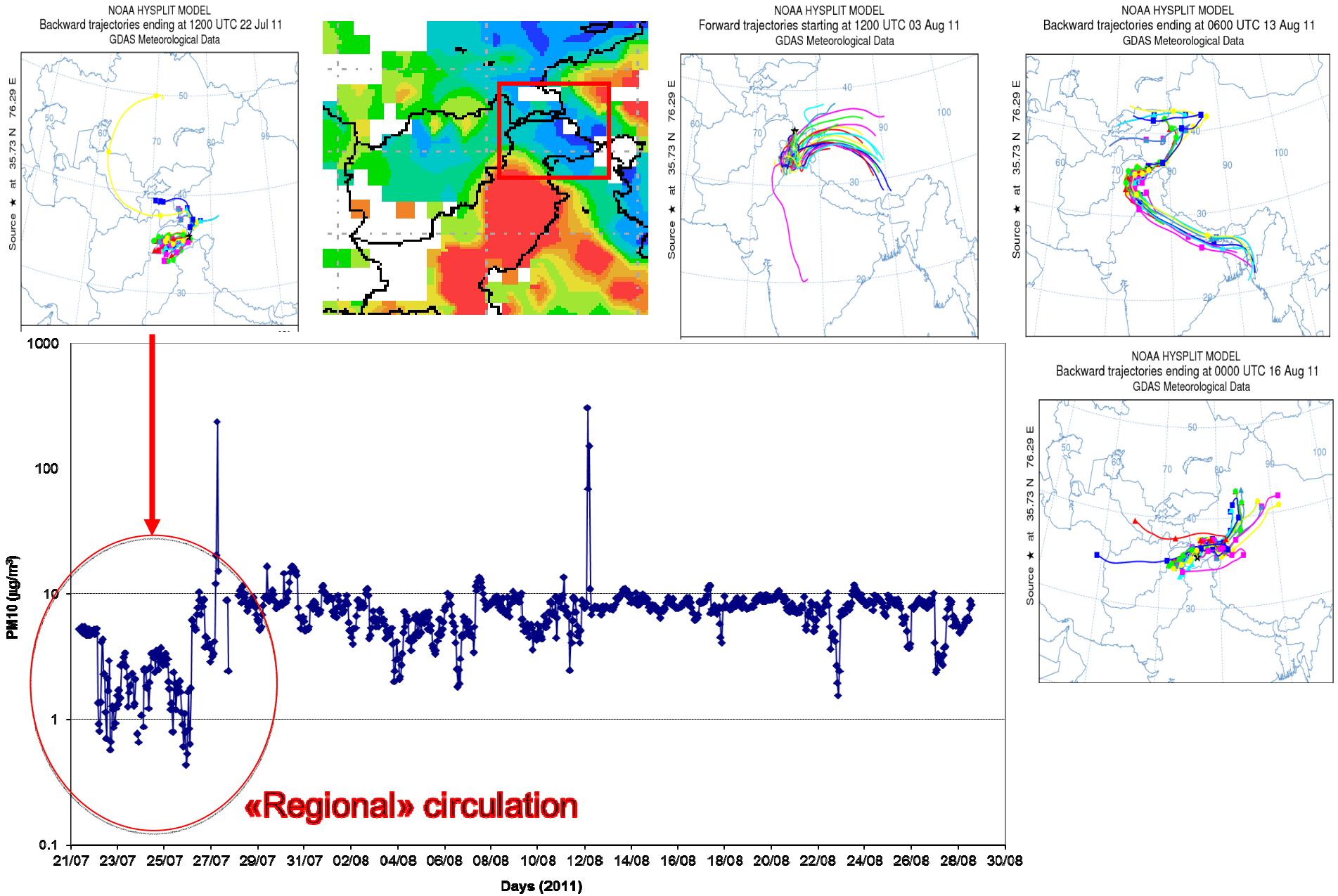
Parameter	Specification
Concentration	0 to 2000 $\mu\text{g}/\text{m}^3$
Sensitivity	1 $\mu\text{g}/\text{m}^3$
Sample Period	1 sec
Accuracy	+/- 8%
Precision	3 $\mu\text{g}/\text{m}^3$ (or 2% reading)
Zero calibration	Auto zeroing built in
Span check	Manual span check switch

Data overview

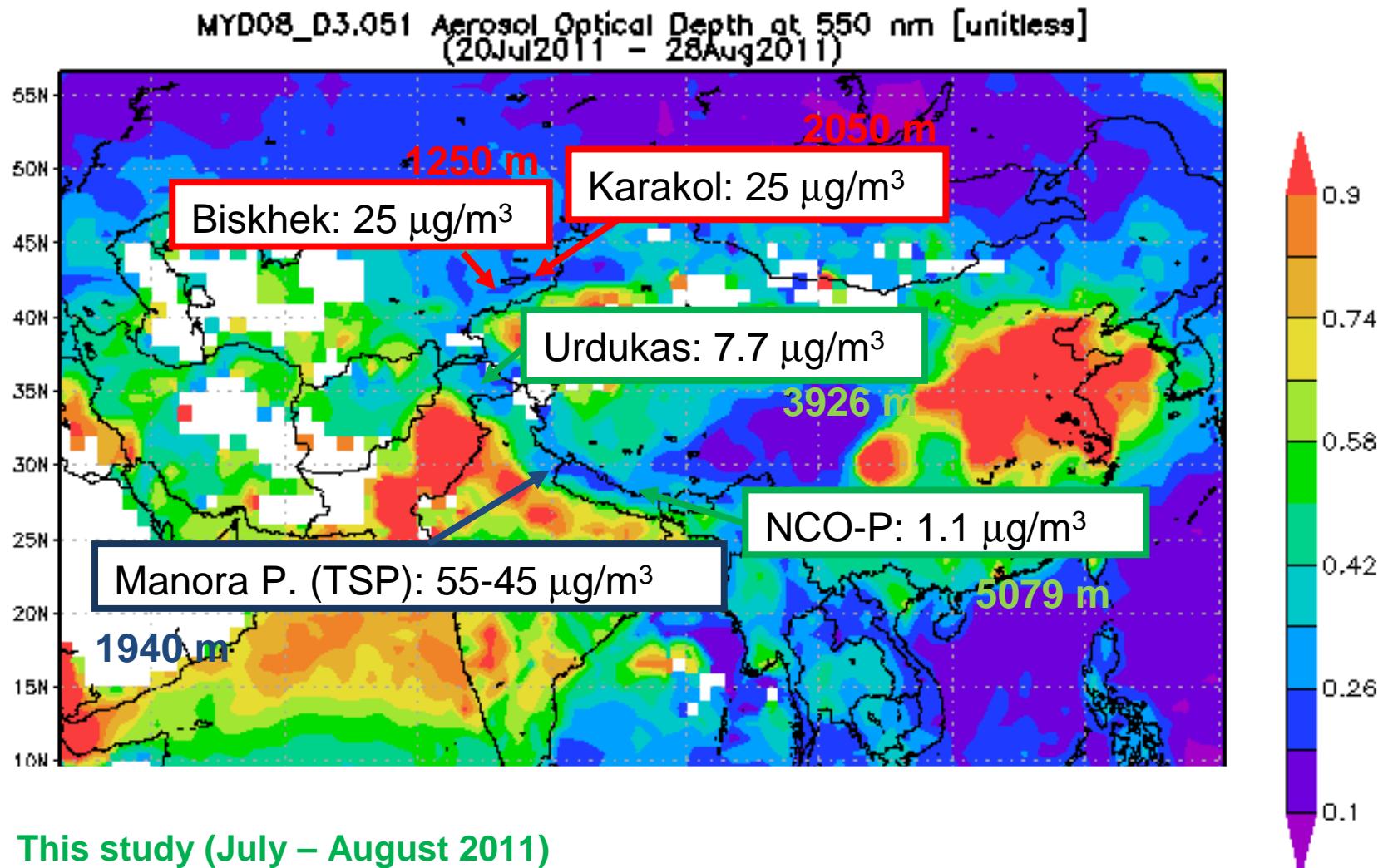


- Average value: $7.7 \pm 13.8 \mu\text{g}/\text{m}^3$
- No evident diurnal variability on PM10
- Two different «regimes» (21-27 July; 28 July – 28 August)
- High PM10 “Special events” (27 July and 11 August)

Data overview



Comparison with other sites

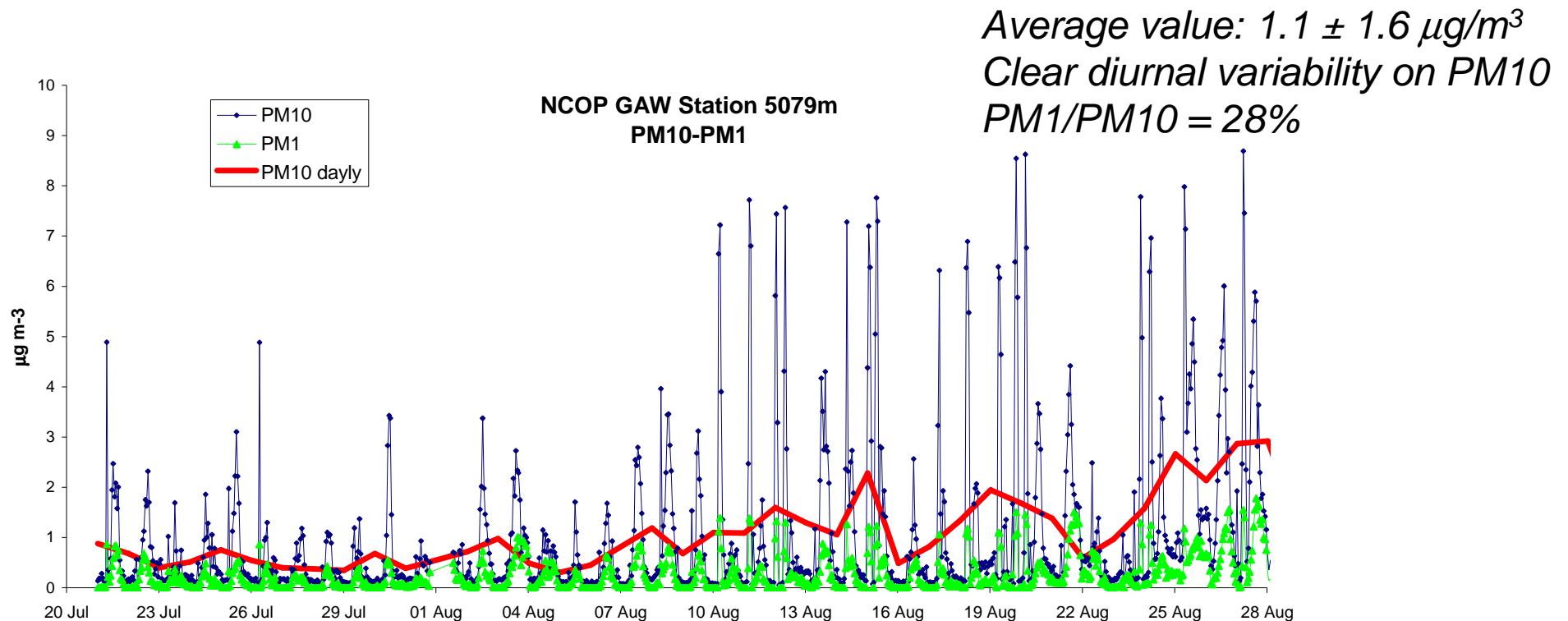


This study (July – August 2011)

Shafer et al. 2010 (July – August 2009)

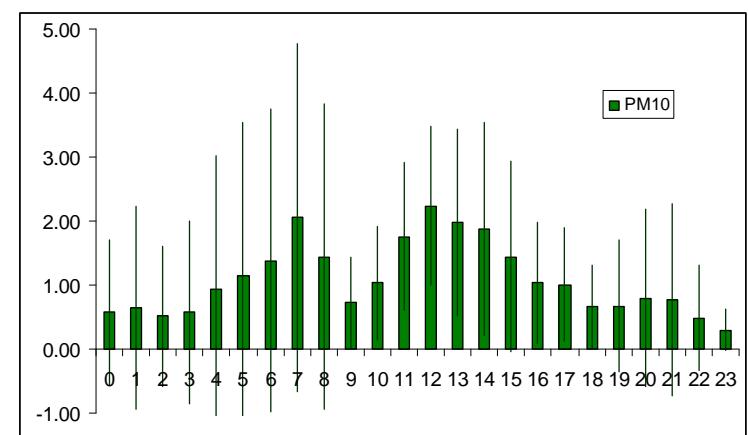
Ram et al. 2011, (July – August 2005-08)

Comparison with Himalayan site

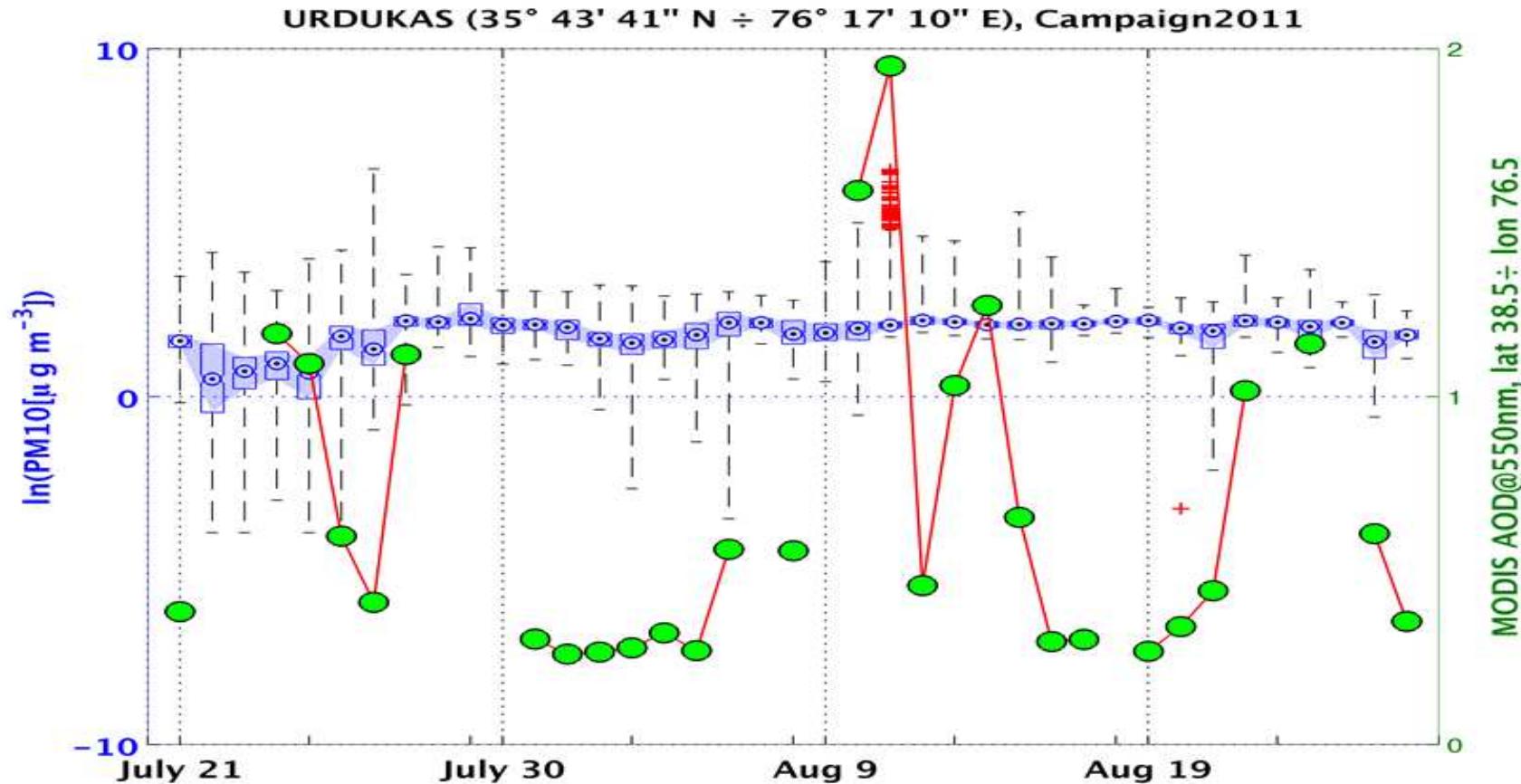


With respect to Urdukas (Karakorum) in the Himalayas were observed:

- Lower levels of PM10
- Larger variability both at diurnal basis and over the entire period



Special event: 12 August 2011



On each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers. Red cross represents “outliers”, thus anomalous PM10 values.

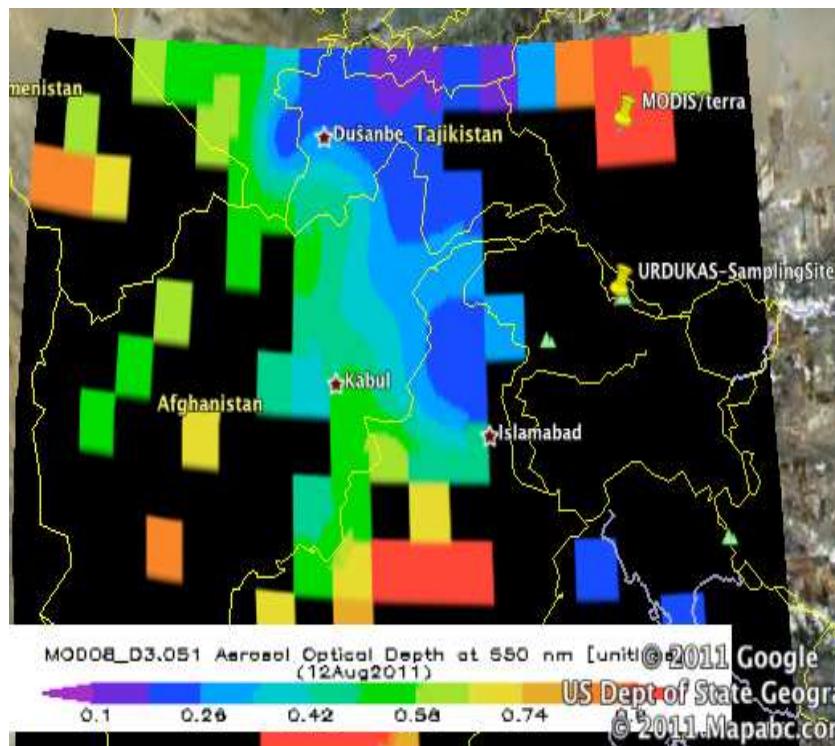
We analysed MODIS AOD within a $3^{\circ} \times 3^{\circ}$ domain around Urdukas location.
Green dots represent MODIS AOD@550nm over the Taklimaklan desert

Special event: 12 August 2011

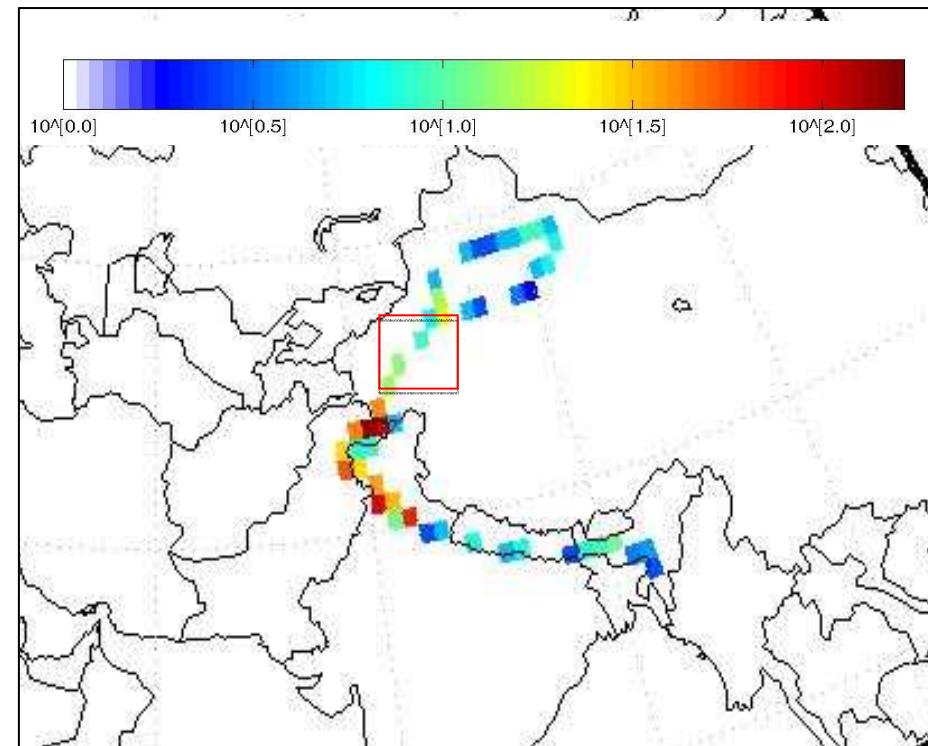
Satellite observations (MODIS AOD) and HYSPLIT back-trajectories suggested that the observed PM10 increase could be related with a mineral dust transport (1-2 days old) from the Taklimaklan deserts.

HYSPLIT simulated air-masses travelling over the desert from 10 to 11 August 2011 at pressure levels greater than 800 hPa.

MODIS AOD@550 nm



HYSPLIT – 3DBT ensemble

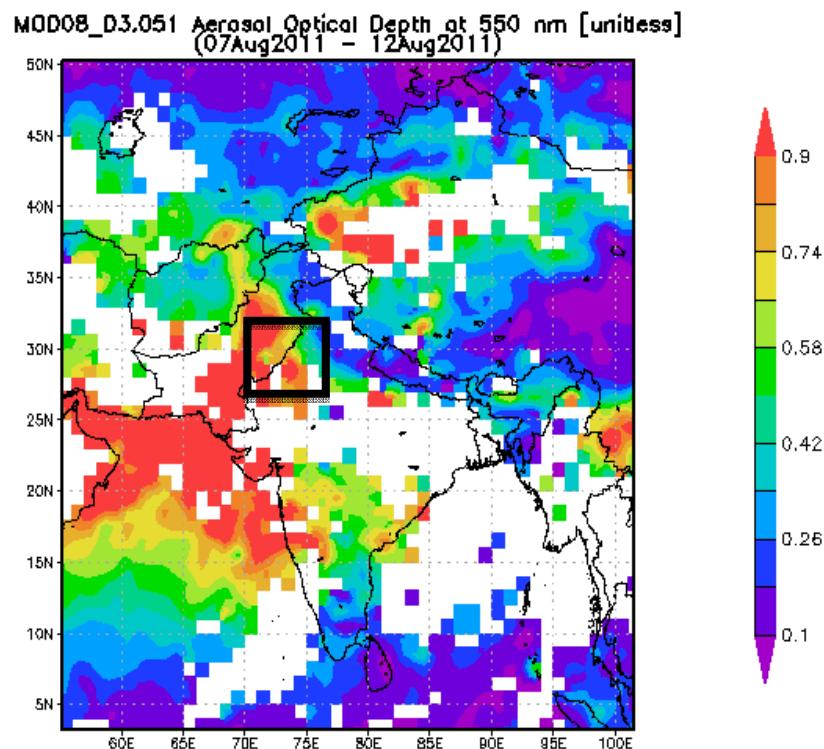


Special event: 12 August 2011

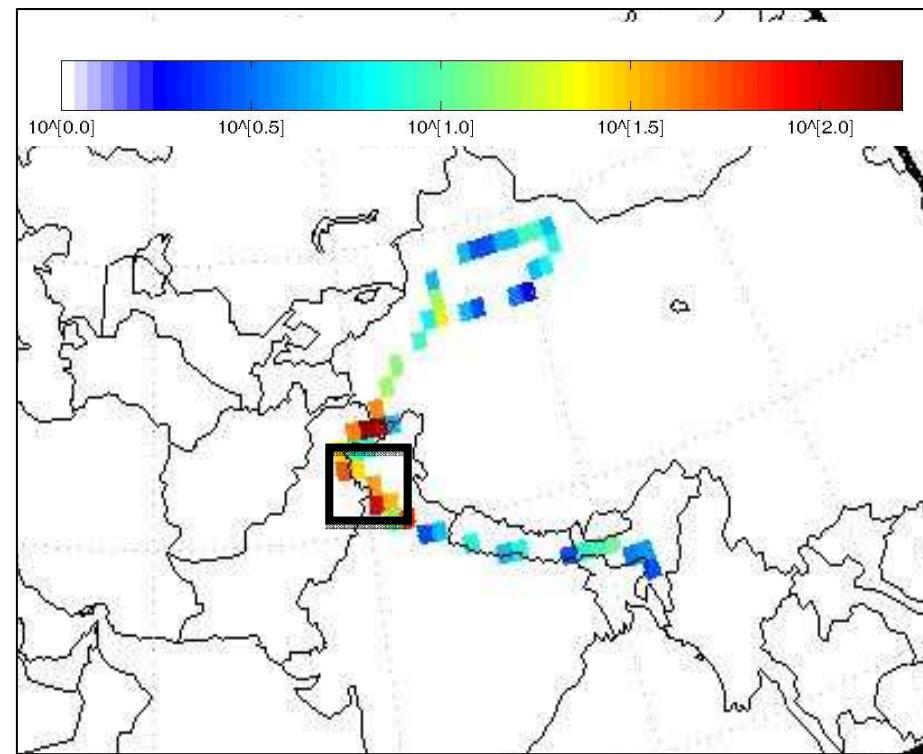
Satellite observations (MODIS AOD) and HYSPLIT back-trajectories suggested ALSO that the observed PM10 increase could be related with transport from along the south Karakoram-Himalayas foothills and urban areas (Islamabad, Rawalpindi, Lahore...).

Further analyses are needed for evaluation!

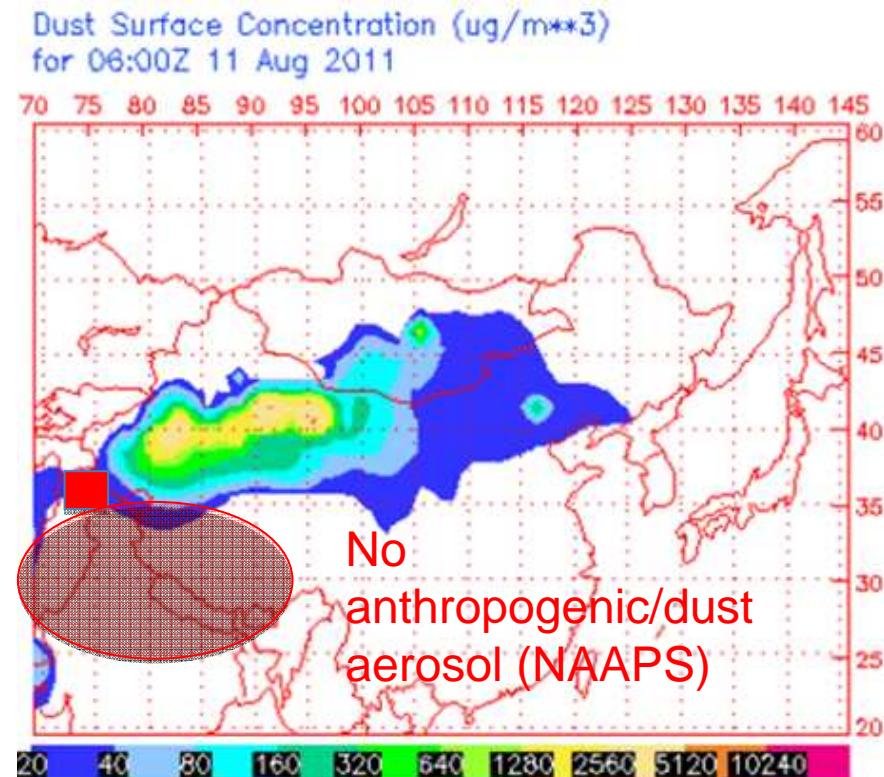
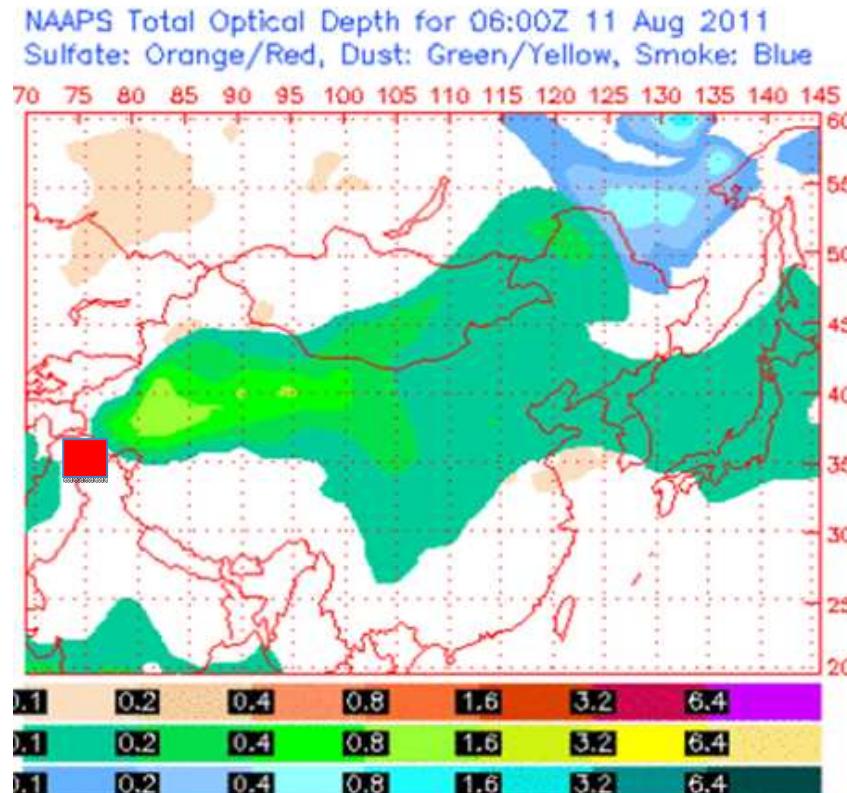
MODIS AOD@550 nm



HYSPLIT – 3DBT ensemble



Special event: 12 August 2011



Simulation carried out by NAAPS system (NRL Monterey) further corroborated the transport of mineral dust from Taklimaklan.

As indicated by these simulations (available at <http://www.nrlmry.navy.mil>), North Pakistan was only partially affected by the transport events: this can explain the low time length as seen at Urduqas.

These evidences indicated that mineral dust transport from central Asia can strongly influence PM10 over Baltoro region.

Conclusions

- During summer 2011(21 July – 28 August) an average PM10 concentrations of $7.7 \pm 13.8 \mu\text{g}/\text{m}^3$ was observed at Urdukas (Baltoro glacier)
- These values appeared to be lower than PM10 (or TSP) values observed at lower altitude measurement sites located both in the central and southern Asia, but higher than those observed in the same period at the NCO-P (Nepal).
- Despite NCO-P no evident diurnal variations was observed at Urdukas (more “uniform” background? Constant inputs from near desert areas? Which the role of the mountain winds?).
- Special episodes were detected (PM10 hourly value up to $300 \mu\text{g}/\text{m}^3!$) possibly associated with direct inputs from near desert regions (Taklimaklan).

Next activities

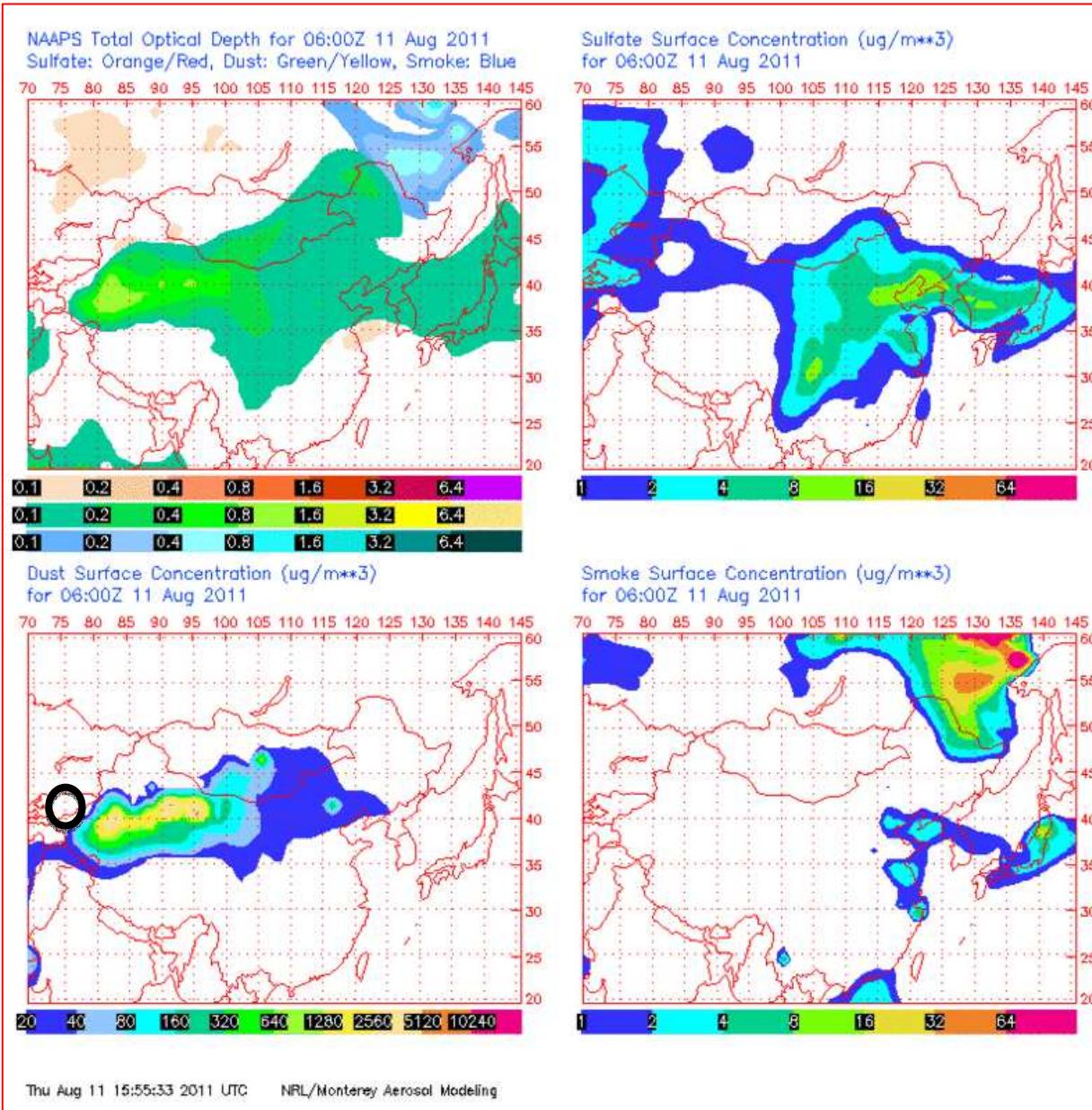
- Analysis of the Urdukas AWS summer 2011 data as soon the data will be delivered.
- In the summer 2012, displacement of the NANO-SHARE device (tested this year on the Forni glacier) on the Baltoro glacier (O3, BC, size distribution, total particle number).
- Use of satellite data (MODIS, OMI, AIRS...) to gain more information about the atmospheric variability over North Pakistan



THANK YOU!

PAPRIKA meeting – 8 November 2011, Bergamo

ACTIVITY 1: atmospheric observations and variability of atmospheric circulation in the Karakorum and integrated climate modelling.



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