

# Measurements of black and brown carbon in the urban aerosol

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# Background

- Light absorbing carbonaceous material (Black carbon, BC) causes most of light absorption by atmospheric aerosols in visible range of spectrum
- Influence on global radiative balance
- Enhanced positive radiative forcing
- Health effects
- No standard measurement method available
- Thermally refractory organic carbon

# Operational definitions

- **Black carbon (BC)** → optical methods  
measured parameter: absorption coefficient  $\sigma_a$ ; conversion to BC mass
- **Elemental carbon (EC)** → thermal methods  
measured parameter:  $\text{CO}_2$  or  $\text{CH}_4$   
separation of EC and organic carbon (OC)
- Graphitic carbon
- Thermally refractory carbon
- „**Brown carbon**“

# HULIS / Brown carbon

- Weakly light absorbing
- Strong spectral dependence of absorption
  - Interference with optical methods
- Thermally refractory
- Chars easily
  - Na, K (in biomass smoke)
  - Interference with thermal methods

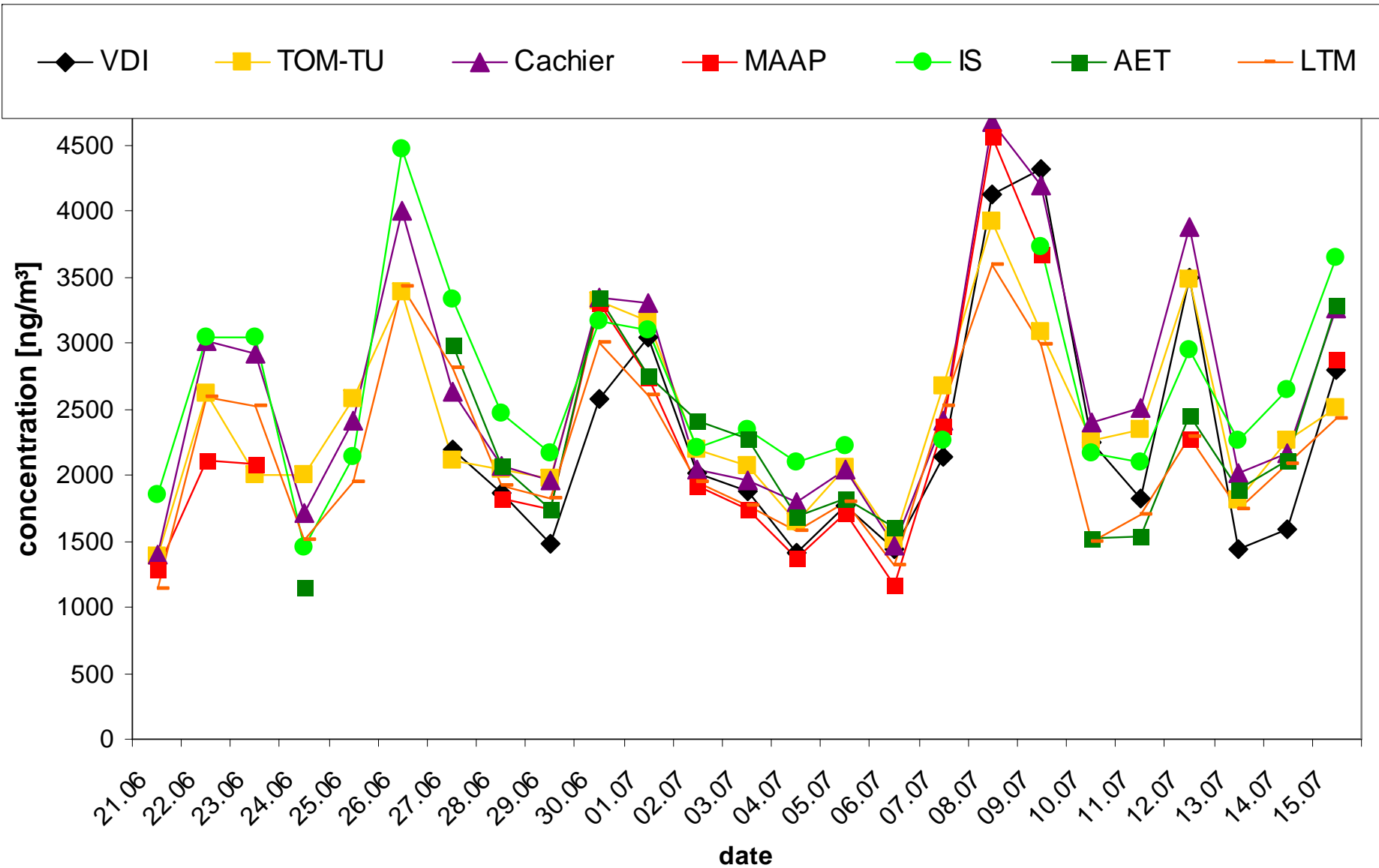
# Objectives:

- Correction of optical Integrating Sphere (IS) technique for the influence of brown carbon
- Estimation of influence of „brown“ carbon
- Test under conditions of known large contribution of biomass smoke
- Application in method intercomparison study

# Aerosol situation in Vienna

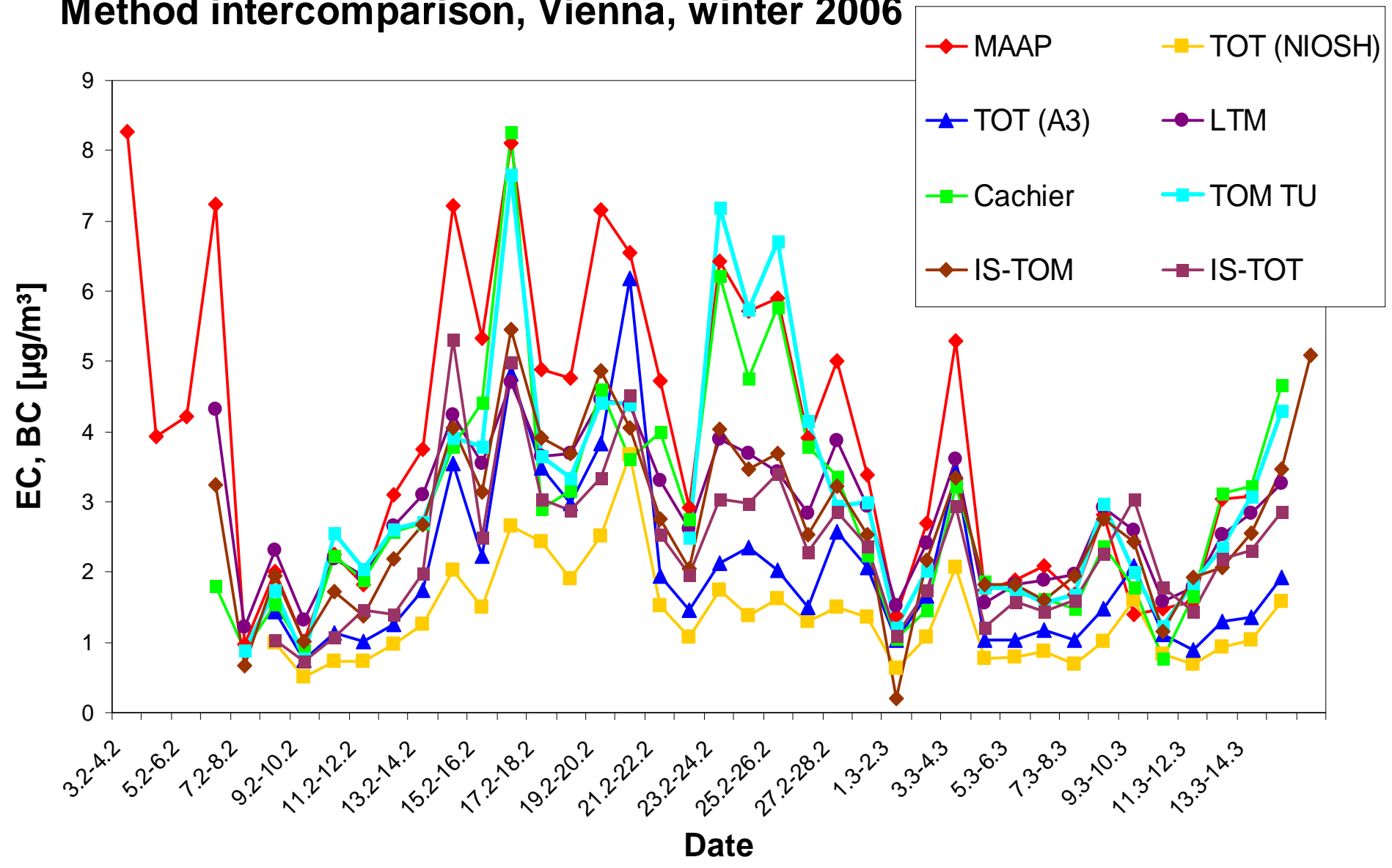
- Urban area of Vienna
- Prevailing winds: West – Northeast sector
- High source strength of Diesel traffic  
(70% of fuel sales in Austria)
- 1985/86: 63% of summer BC heavy duty diesel (32 % of fuel sales)
- Heating with wood: 2 – 30 % of households (Vienna → Burgenland)
- Winter: 20 – 40% of rural PM (AQUELLA)

# Method intercomparison, Vienna, summer 2004

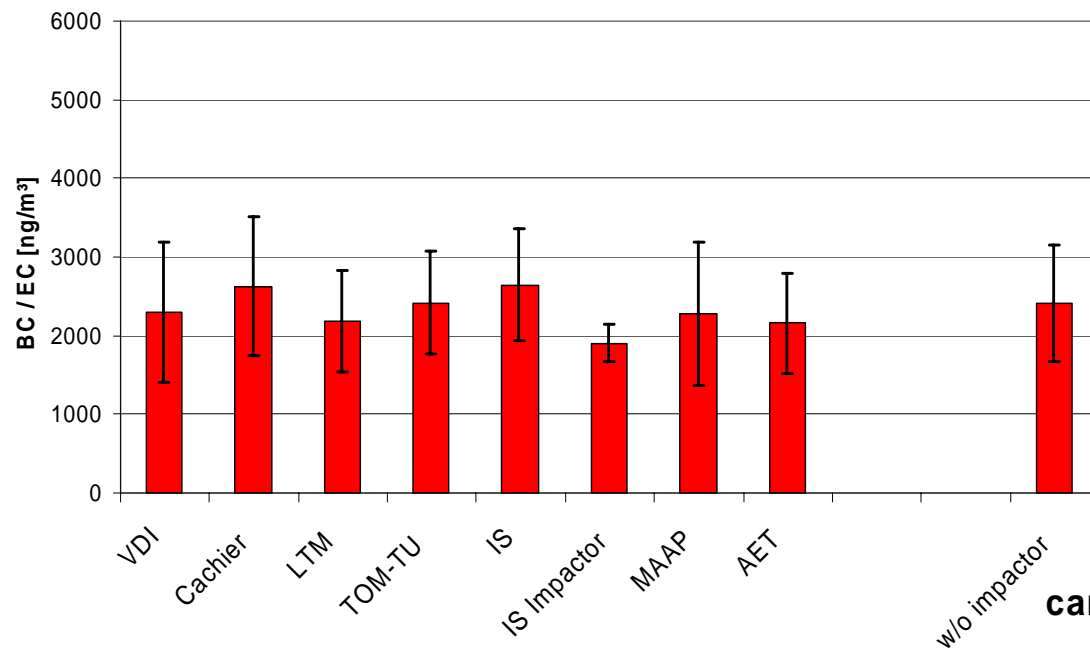


Hitzenberger et al. (2006) ES&T 40, 6377-6383

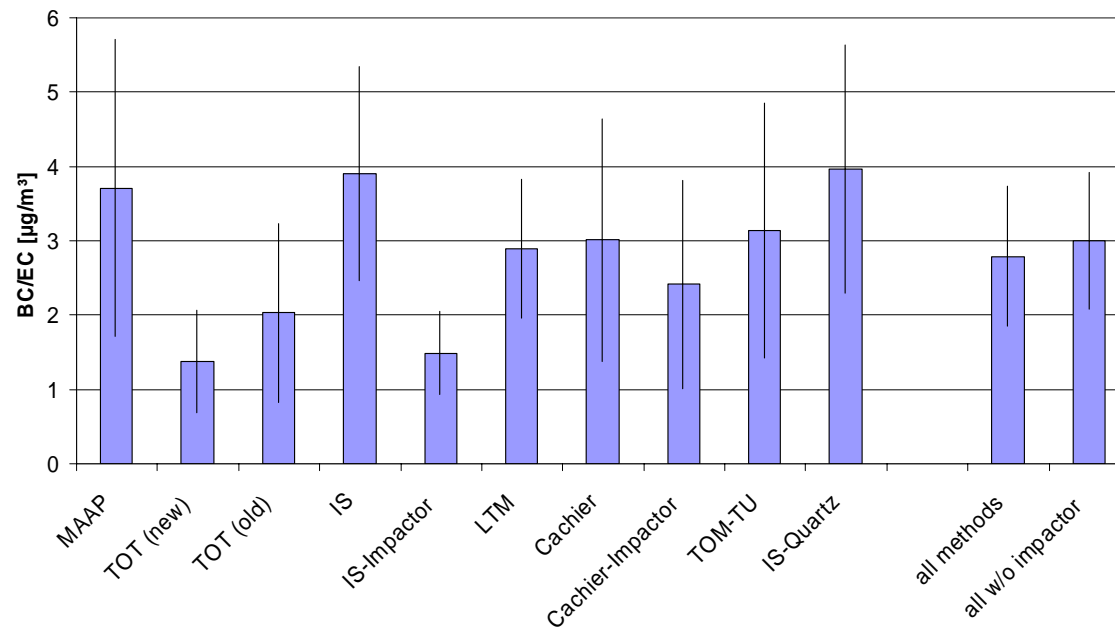
# Method intercomparison, Vienna, winter 2006



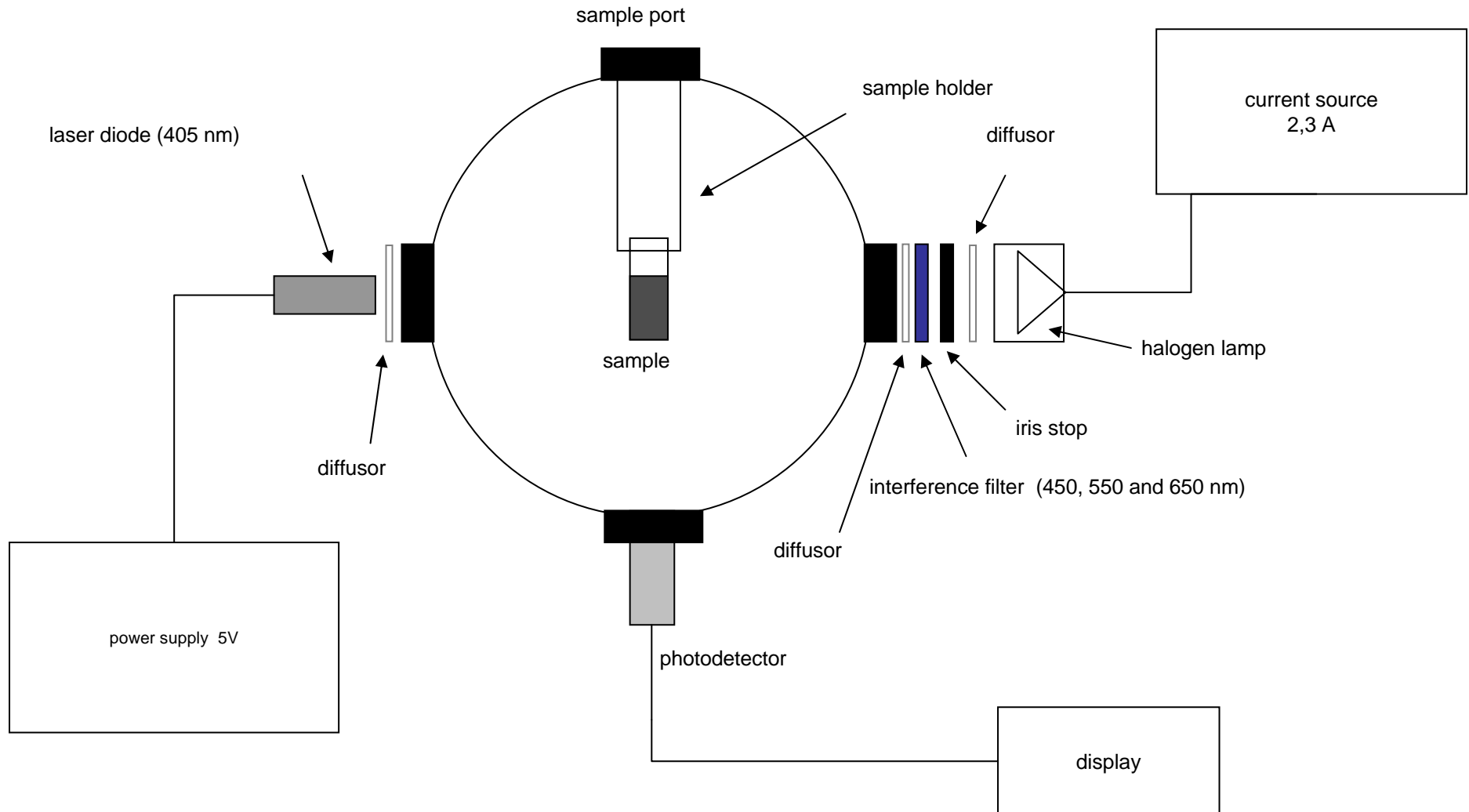
## campaign averages, summer 2002



## campaign averages, winter 2006



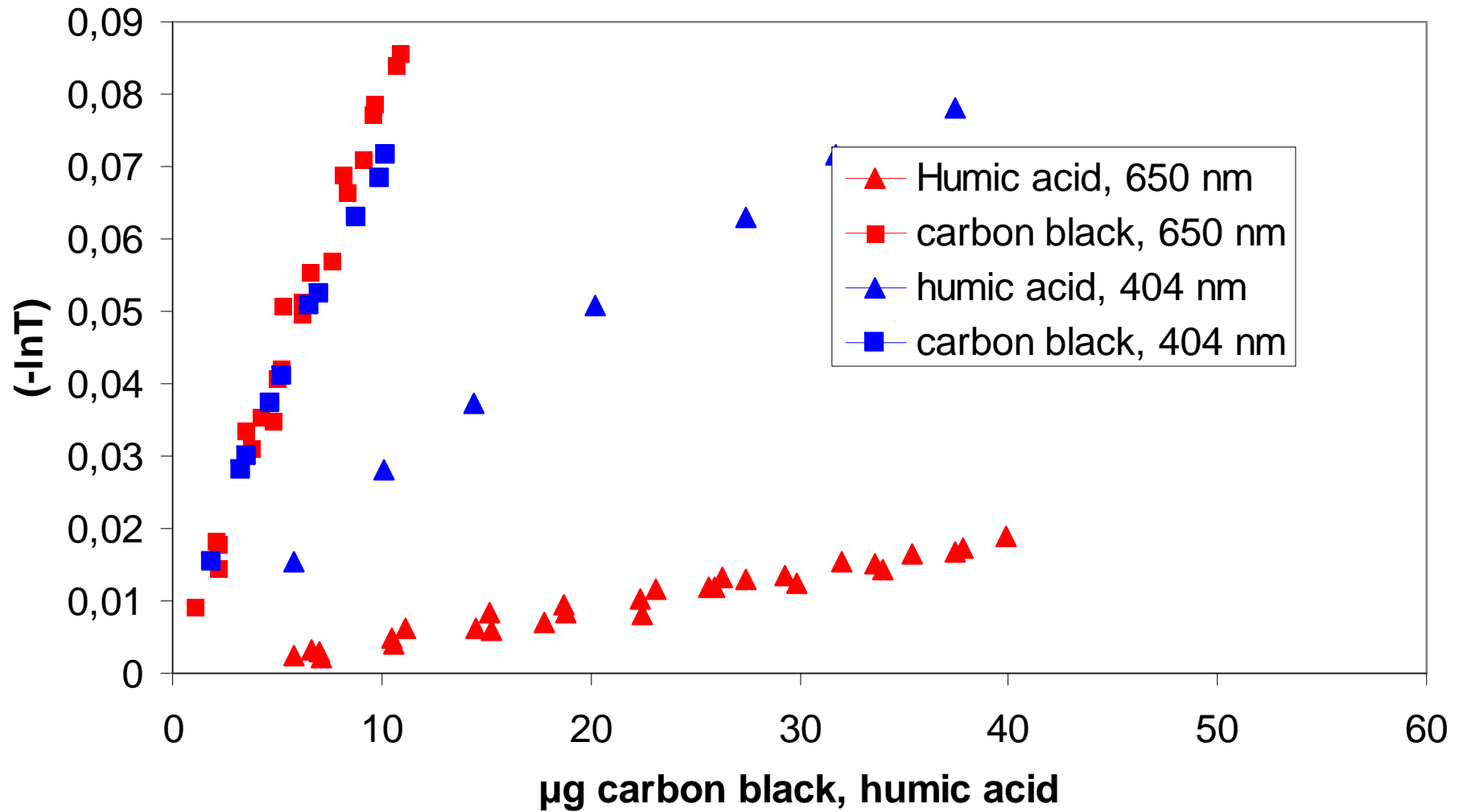
# Integrating Sphere Technique

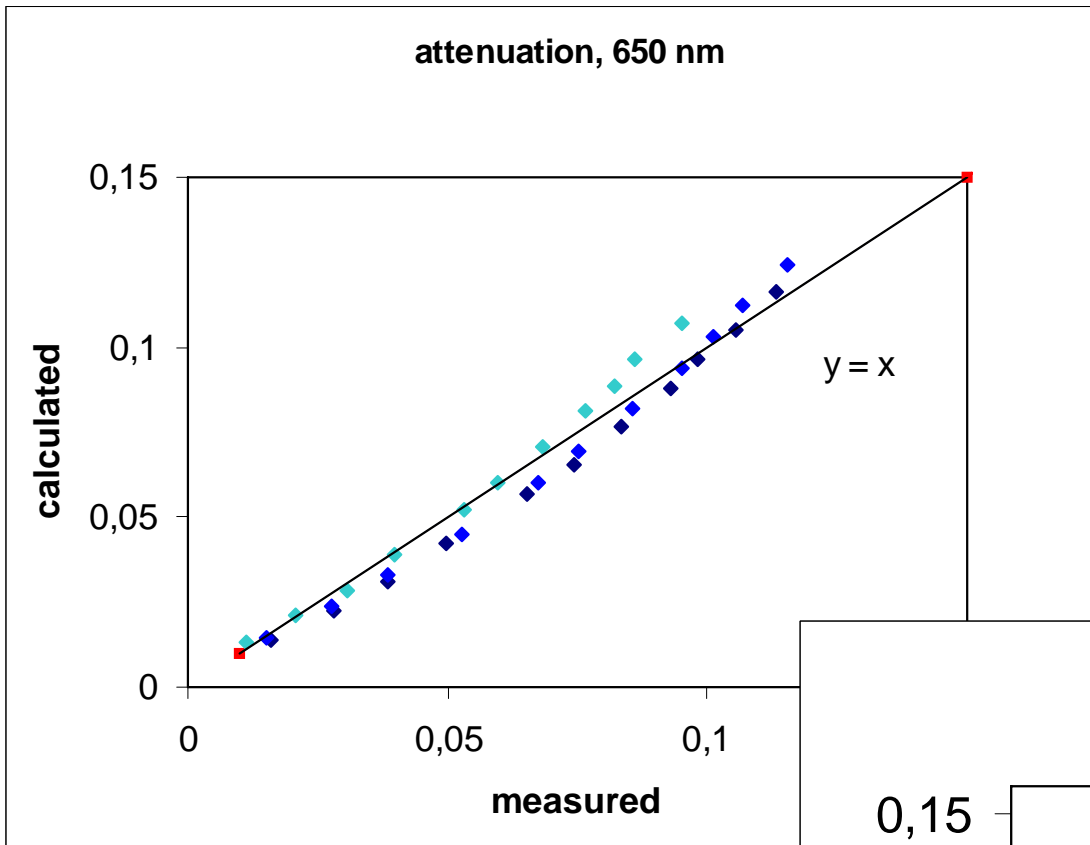


# Calibration / Assumptions

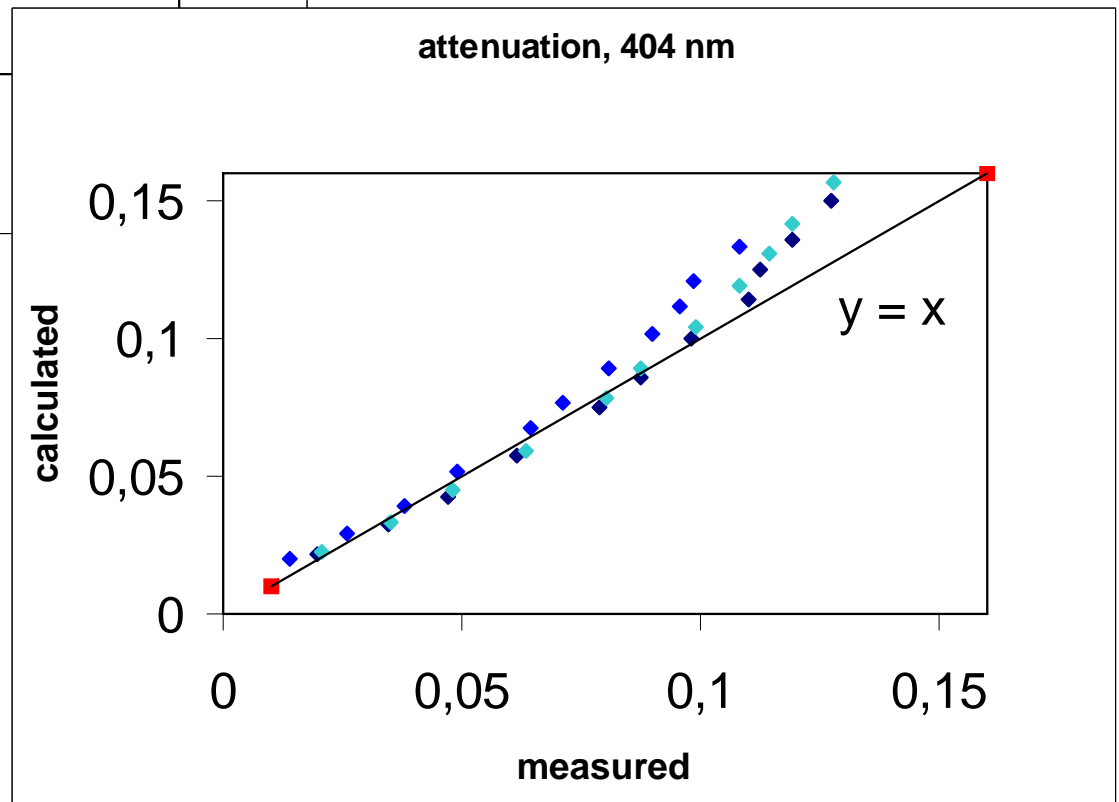
- Proxy substances
  - Elftex 124 (Cabot Corp.)
  - Humic Acid Sodium Salt (Acros Organics)
- BC behaves like Elftex 124
- BrC behaves like Humic Acid Sodium salt
  
- → BC concentration
- → BrC concentration

# Calibration curves, Carbon black (squares) and Humic Acid (triangles)





Mixtures of test substances



# Biomass smoke episodes

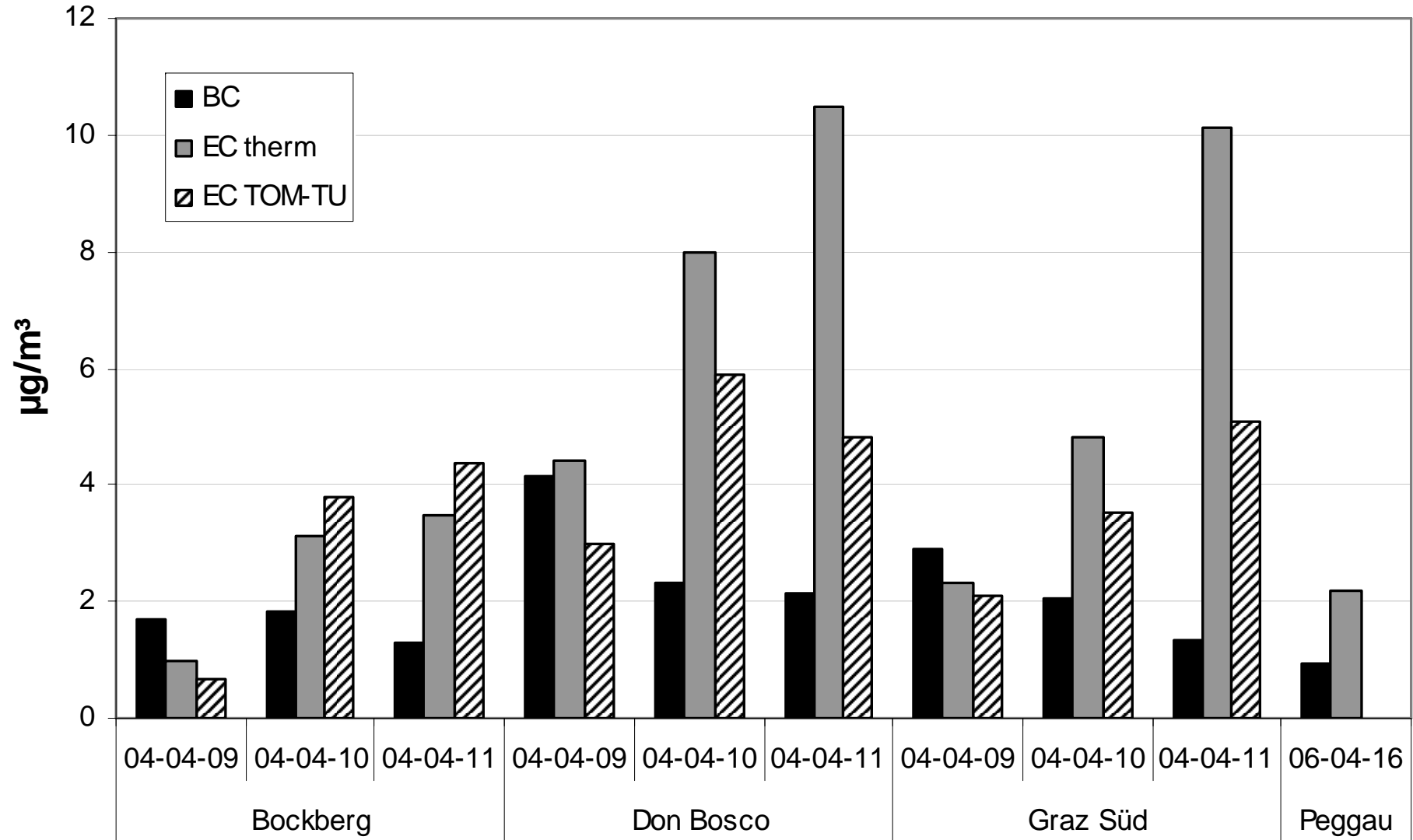
- AQUELLA samples April 2004
  - 24 hr PM10 filters
  - Kerbside → Don Bosco, PM10 mo. av. 38  $\mu\text{g}/\text{m}^3$
  - Urban background → Graz Süd
  - Rural → Bockberg, PM10 mo. av. 20  $\mu\text{g}/\text{m}^3$
- Easter bonfires
  - PM10 > 100  $\mu\text{g}/\text{m}^3$

All bonfire data from: Wonaschütz et al. 2008, EST submitted

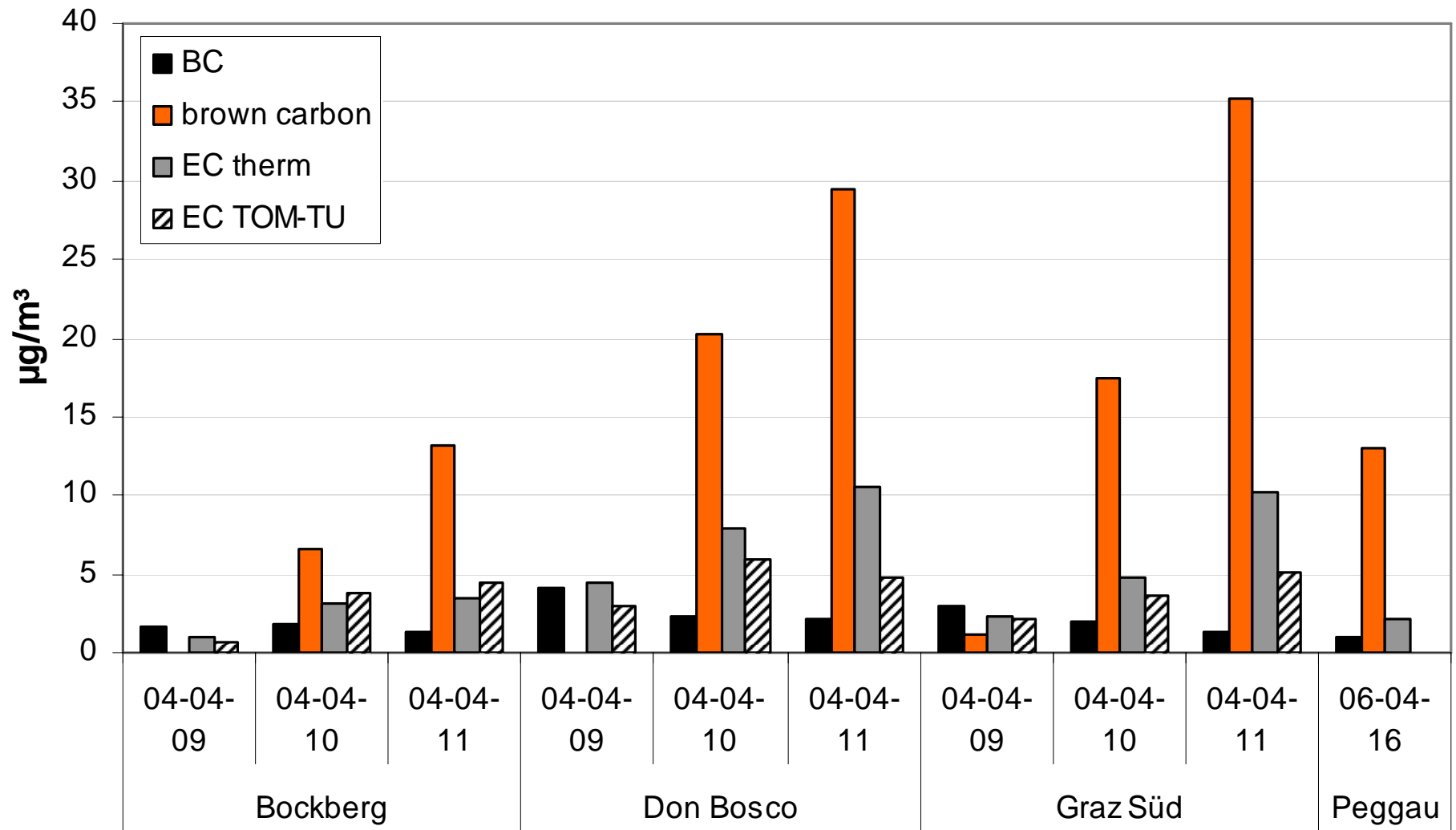
# EC methods used in AQUELLA

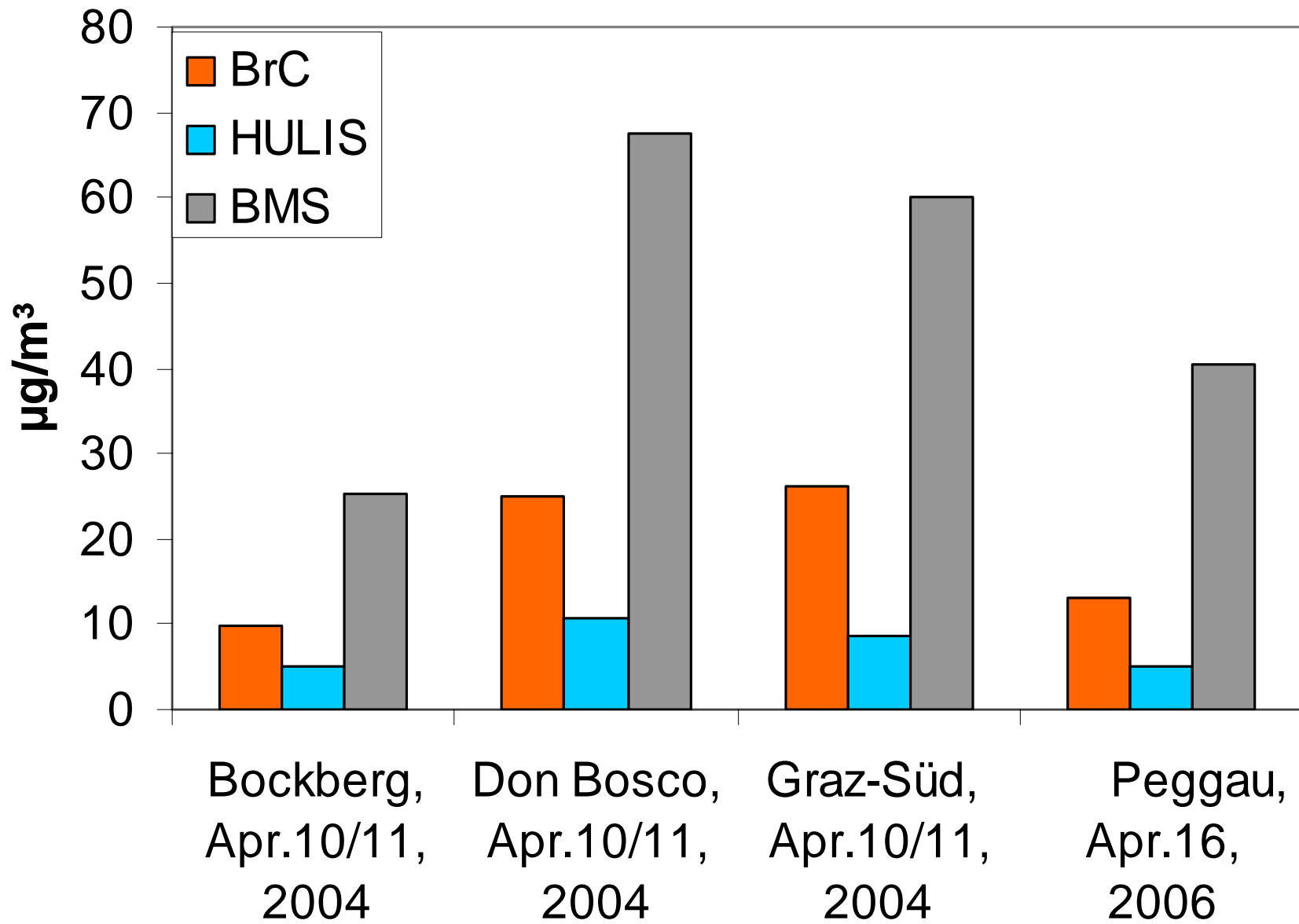
- Cachier method „EC therm“
  - Cachier et al., 1989, Tellus 41B, 379-390
    - Two-step, 2 hrs. 340°C, then 1000°C, O<sub>2</sub>
    - Here: no treatment with HCl, CC from soluble Ca
- Thermal-optical method „TOM-TU“
  - 20°C /min, T<sub>max</sub> = 800°C, O<sub>2</sub>
  - Laser transmission for charring correction
  - Jankowski et al., 2008, AE in press

## Concentrations Easter 2004 and 2006



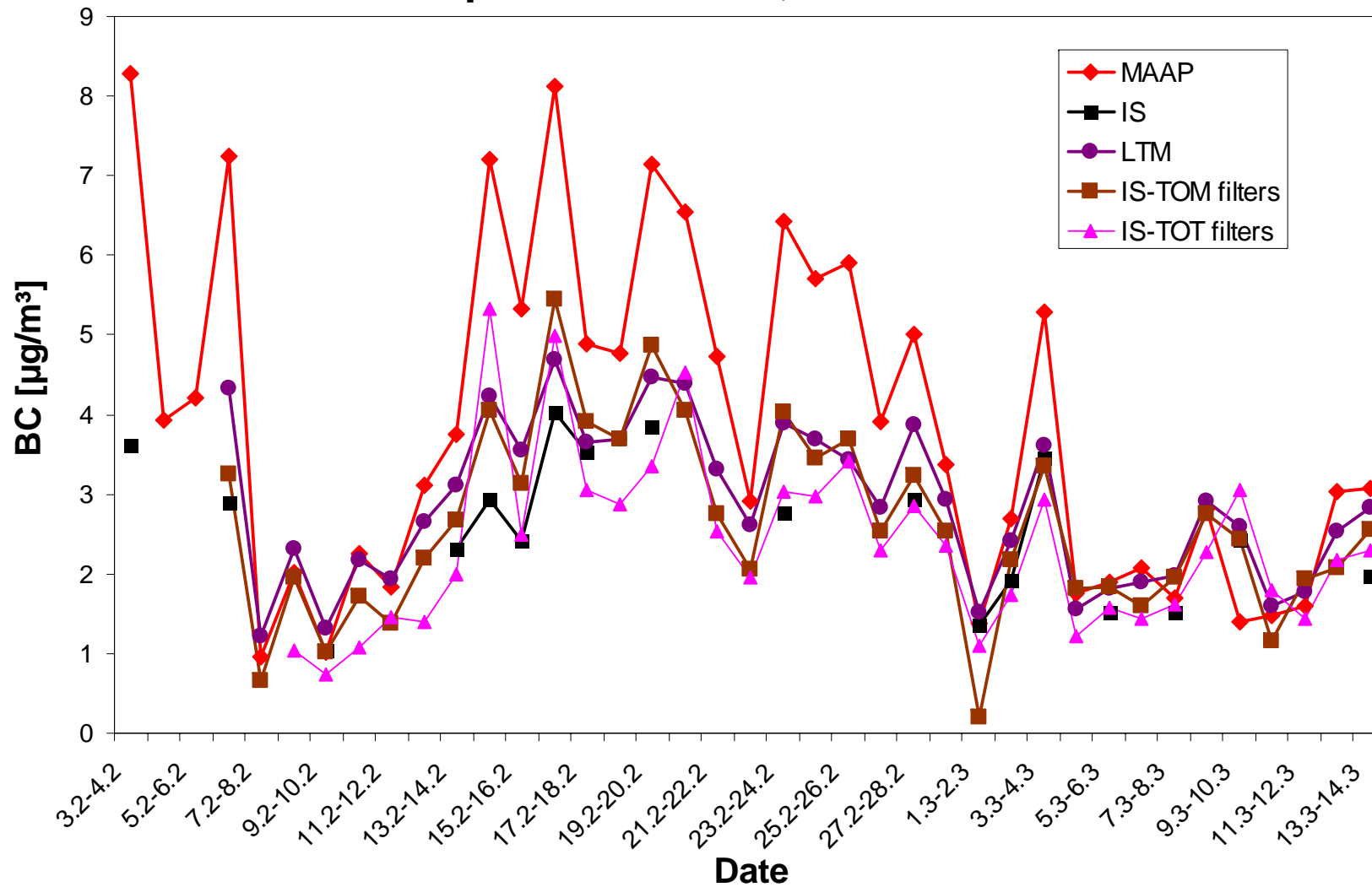
## Concentrations Easter 2004 and 2006





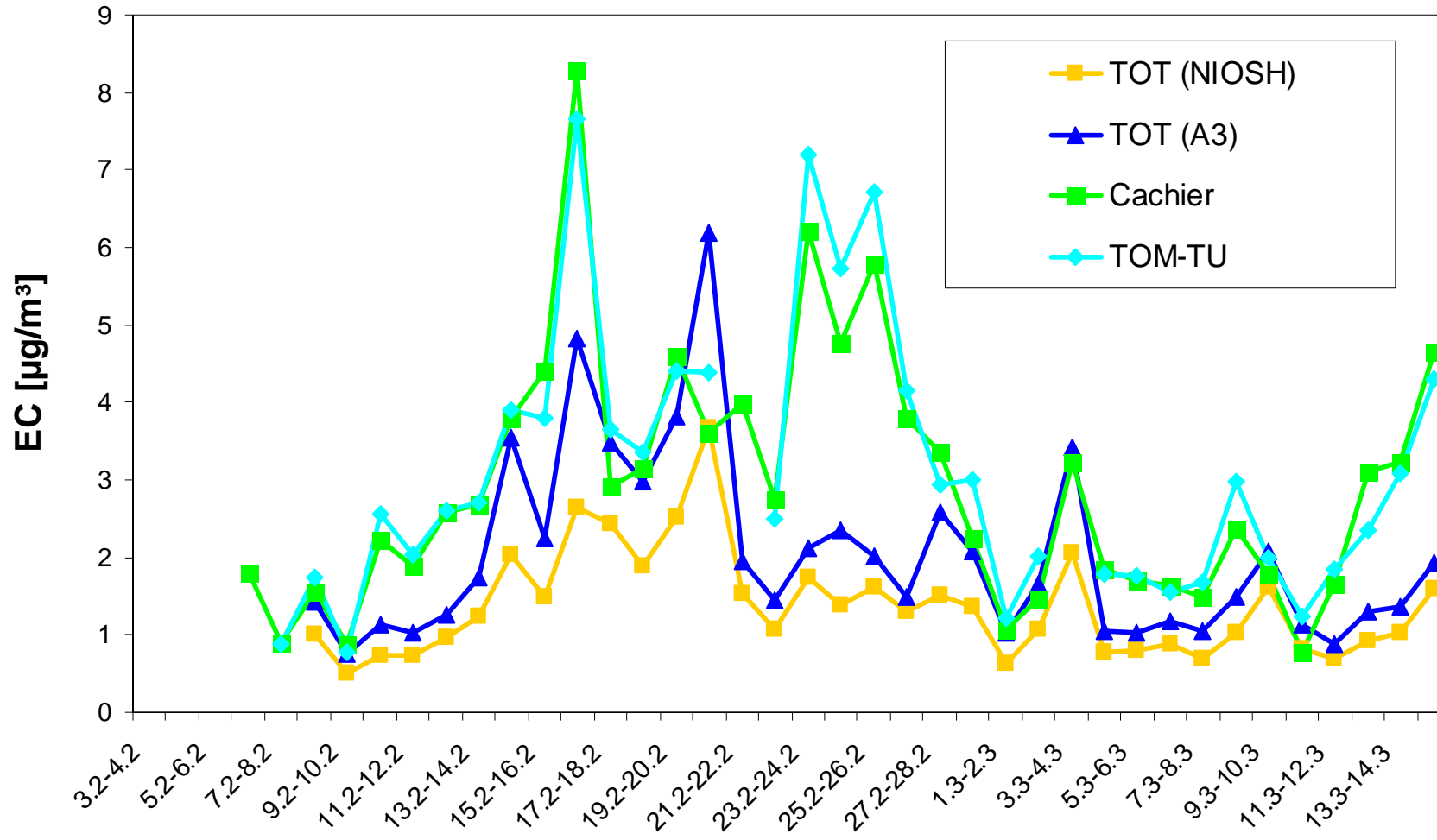
All data from winter 2006: Reisinger et al.(2008) ES&T 42, 884–889

### Optical Methods, winter 2006

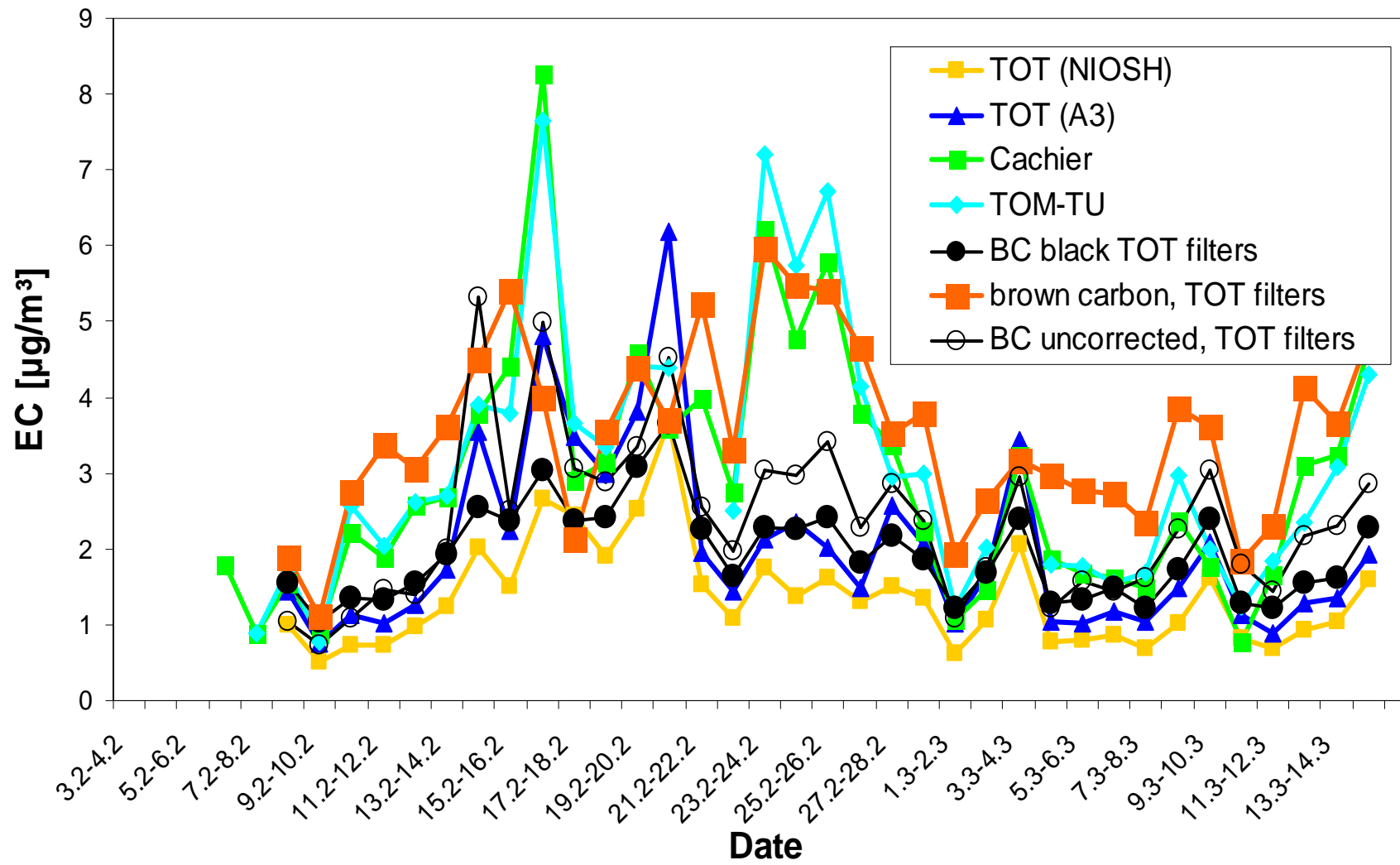


IS data uncorrected for BrC

# Thermal methods, winter campaign



## Thermal methods and brown carbon



# Conclusions

- BC from IS method corrected for influence of BrC
- Estimation of BrC concentration
- Effect of biomass smoke on EC or BC methods
- But: depends on proxy substances

# Acknowledgements

- AQUELLA - Steiermark
- Hochschuljubiläumstiftung der Stadt Wien



# Comparison with other parameters

- HULIS
  - Limbeck et al. 2005, Anal. Chem. 77, 7288-7293
  - HULIS mass = HULIS C \* 2
- Biomass smoke mass
  - OC = TC – BC (corrected for BrC)
  - Traffic OC = OC \* 0.5
  - Secondary OC: 10 - 20% of OC
  - BSM = (OC – traffic OC) \* 1.6 (Schmidl et al., 2008, AE, in press)