Enviro-HIRLAM black carbon modeling for Northern Europe and Arctic

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Outline

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  - Main Aim
  - Motivation
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- Methodology
  - Enviro-HIRLAM
  - Model setup
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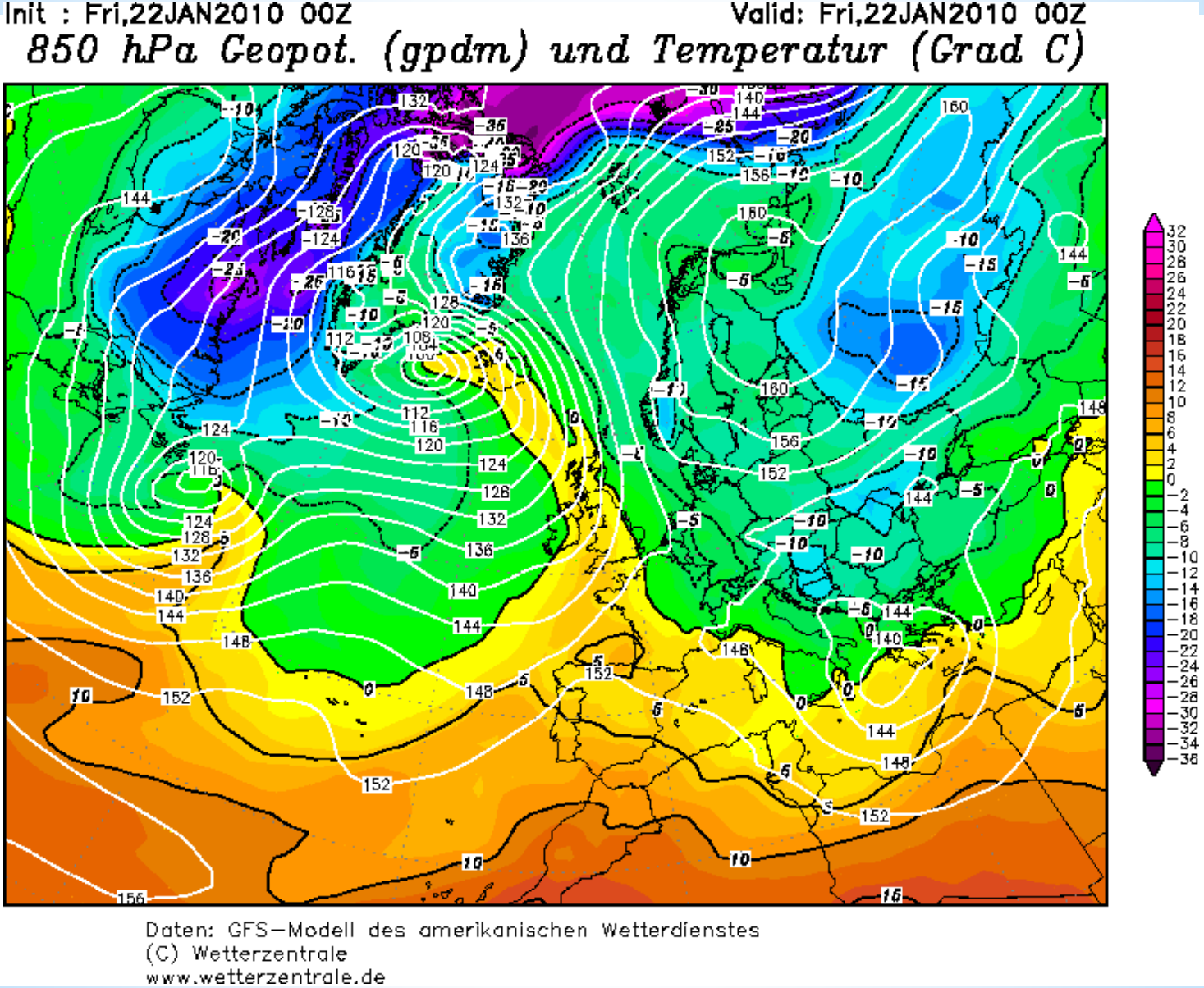
Main Aim

- To simulate Black Carbon (BC) concentrations using Enviro-HIRLAM with focus on Northern Europe and Arctic

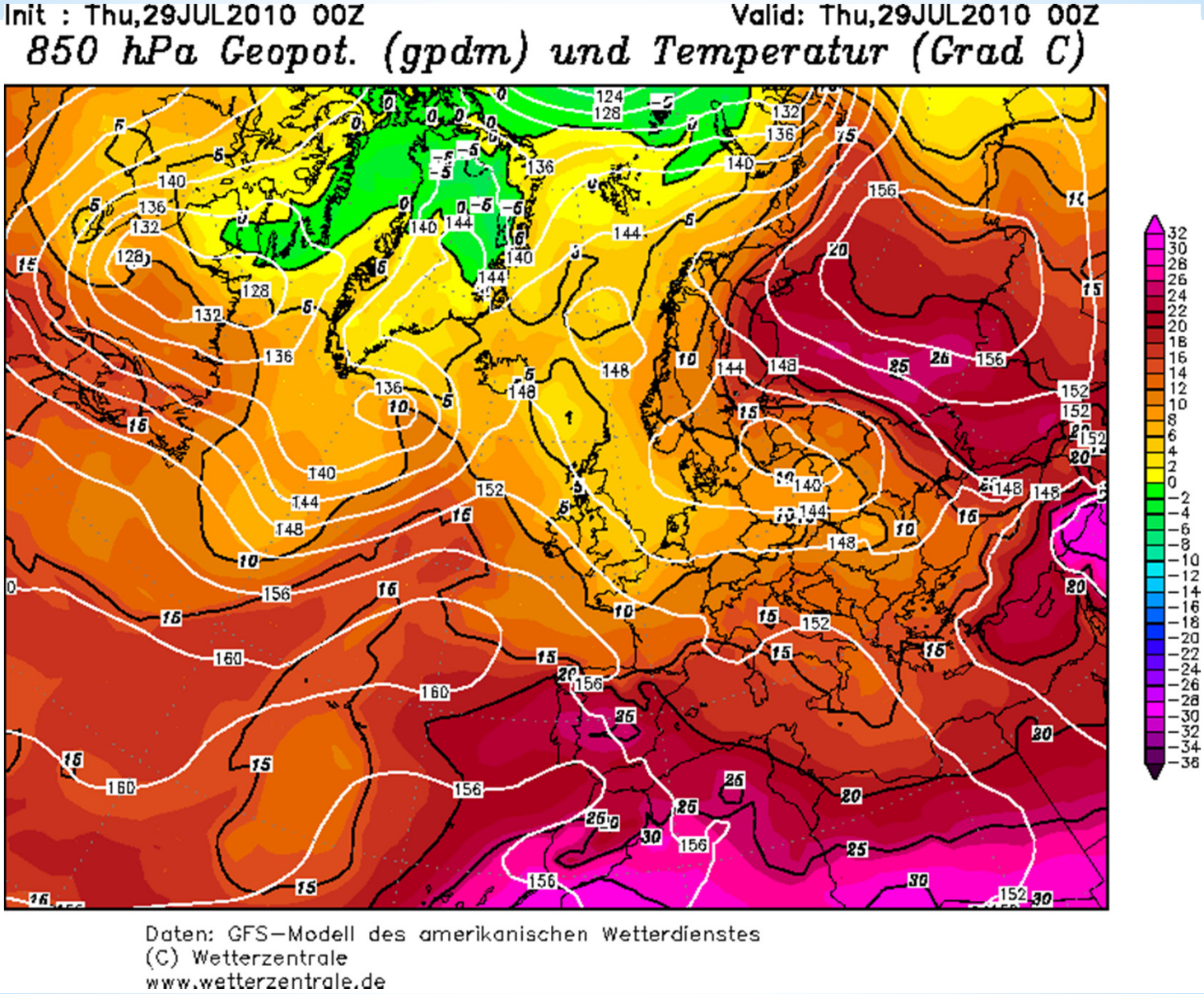
Motivation

- BC is the second climate stressor next to CO_2
- BC absorbs heat in the atmosphere => atmospheric warming + positive climate forcing
- BC particles deposited on snow decrease surface albedo => melting

Selected episode:
19 – 27 January



Selected episode:
29 July – 13 August, 2010



Enviro-HIRLAM: Aerosol Module

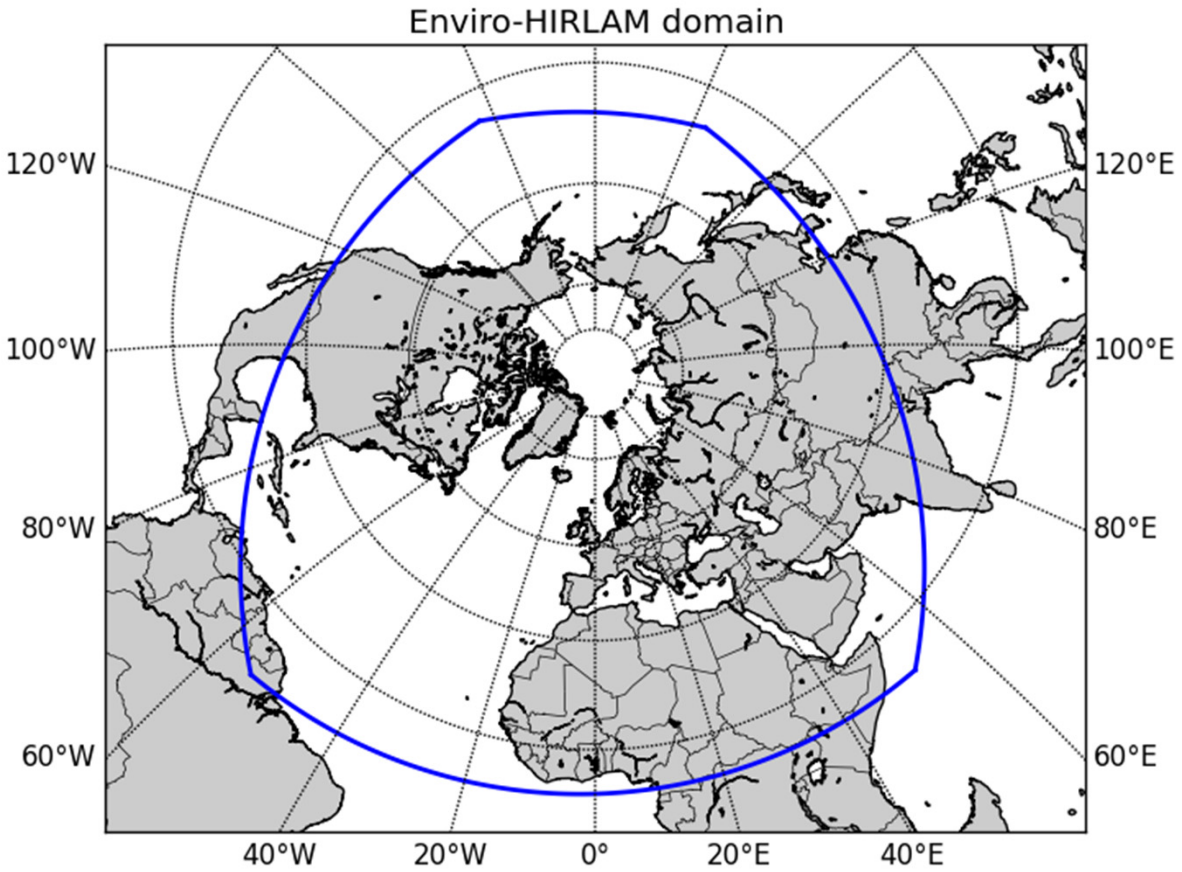
- Aerosol microphysics - M7 *(Vignatti et. al. 2005)*
  - Aerosols: BC, OC (+ Sea Salt, Mineral Dust, Sulfate)
  - Considered modes: ait. – soluble/insoluble, accu./coarse insoluble

- Emissions: Anthropogenic and Natural

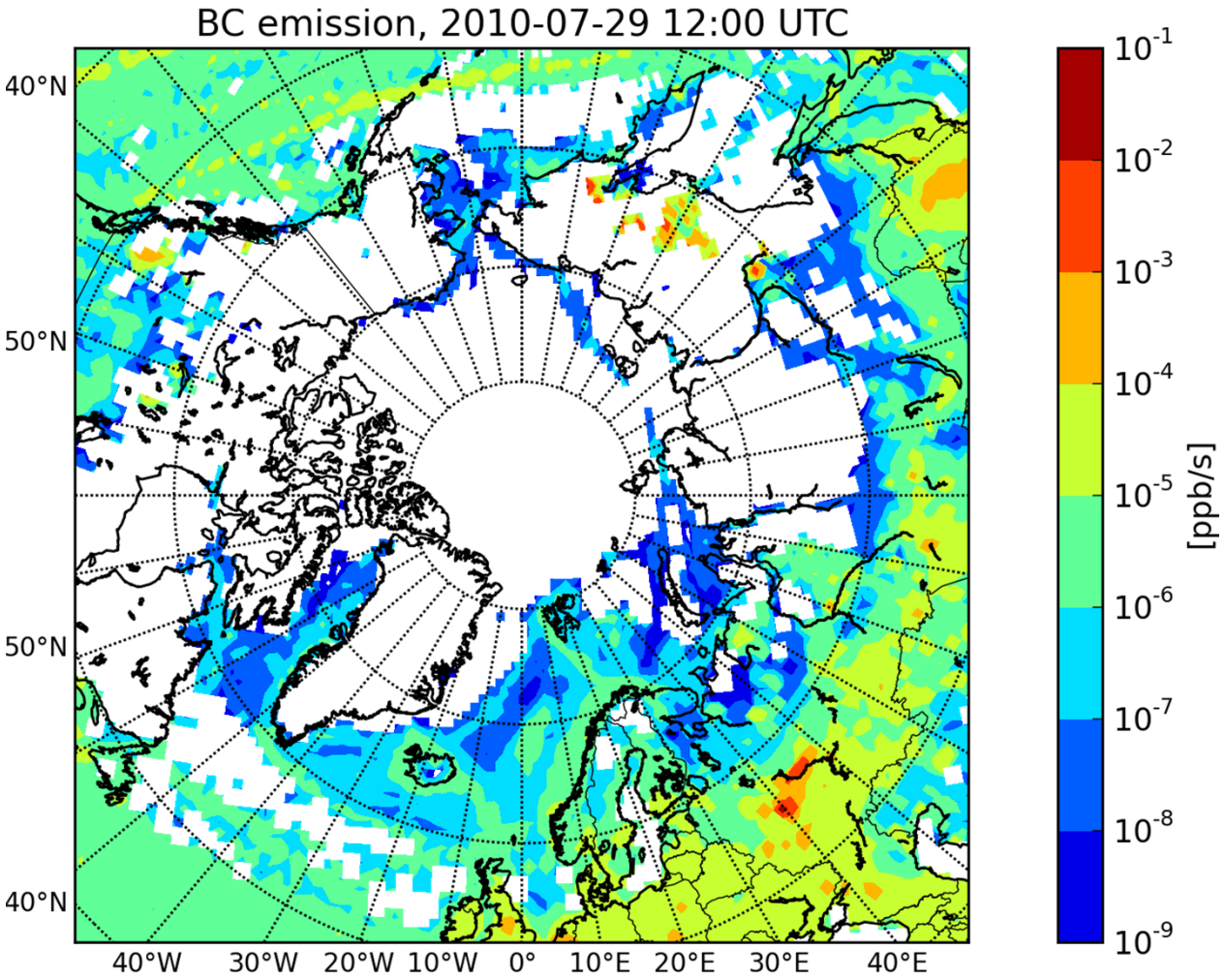
- Sedimentation, Wet & Dry Deposition
  - SED – *Seinfeld & Pandis, 1998*
  - WET – in-cloud/below cloud scavenging (*Croft et al., 2009*)
  - DRY – prescribed dep. velocities (*Roeckner et al., 1992*)

Enviro-HIRLAM model setup

Horizontal res.:	0.72^{o} x 0.72^{o}
Vertical res.:	40 hybrid levels
Time step:	450 s
Forecast length:	6 hrs (spin-up 7 days)
Data assimilation:	surface / every 6 hr
Feedbacks:	on/off
Emissions:	ECLIPSE / IS4FIRES/ AU_RCP + FMI SS / DUST/ DMS
Meteo ICs/BCs:	ECMWF-IFS (0.75^{o} x 0.75^{o})
Chem ICs/BCs:	MACC Reanalysis (1.125^{o} x 1.125^{o})



Emission module
Anthropogenic & Biomass Burning



Anthropogenic:

ECLIPSE v5a --- 0.5º x 0.5º, yearly
(http://eclipse.nilu.no)

Ship emissions:

AU_RCP --- 0.5º x 0.5º, monthly
(http://tntcat.iiasa.ac.at)

FMI --- 0.1º x 0.06º, hourly
(http://fmi.fi)

Wild fires:

IS4FIRES --- 0.5º x 0.5º, hourly
(http://is4fires.fmi.fi)

Specification of Enviro-HIRLAM runs

- Winter Episode:

  - Start : January 11th , 2010
  - End : January 27th , 2010

- Summer Episode:

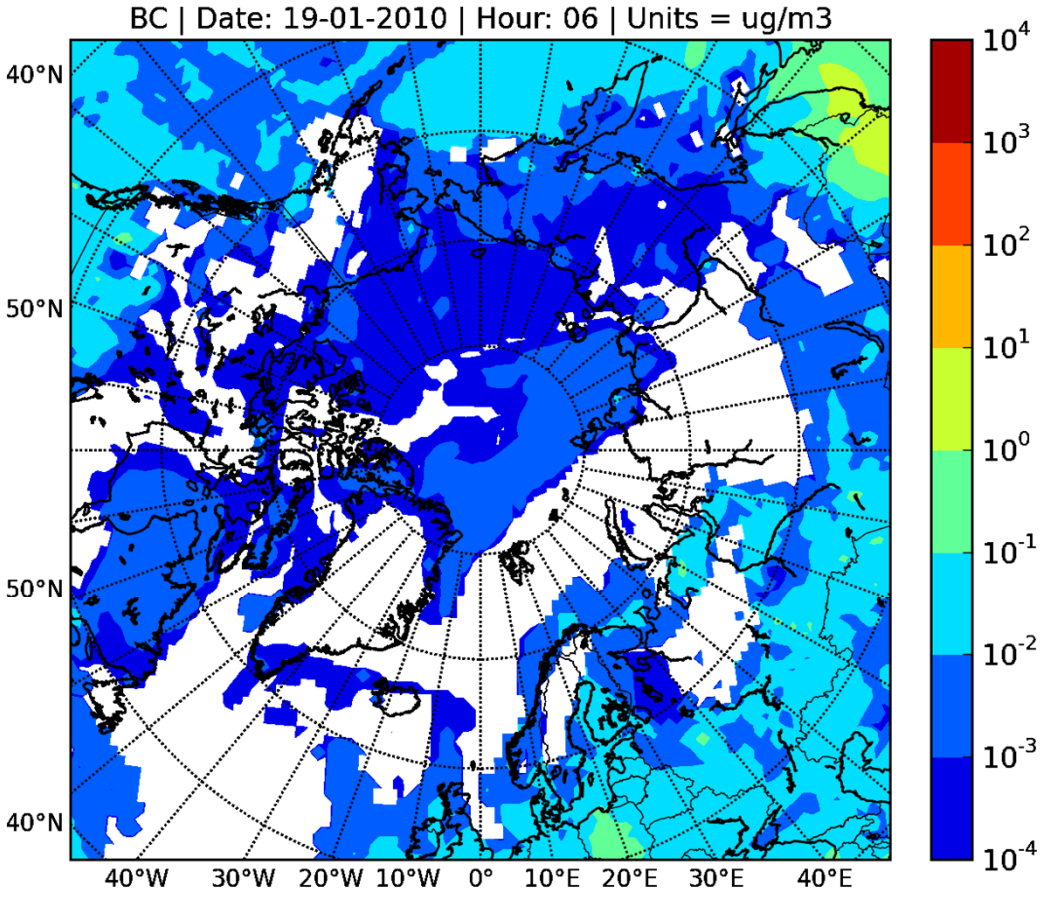
  - Start : July 22th , 2010
  - End : August 13th , 2010

- Both Episodes:

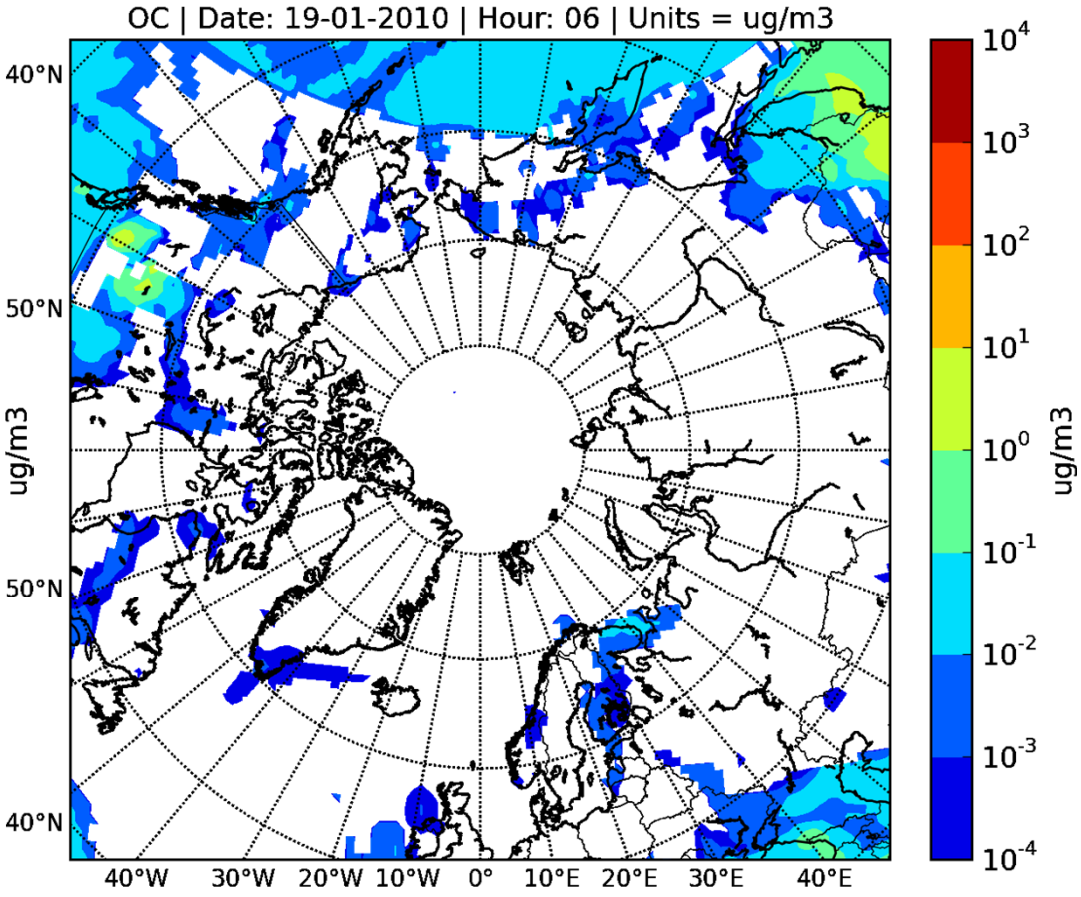
  - Spin-up length : 7 days
  - Forecast length : 6 hours
  - Data assimilation (surface, meteo) : 6 hours

Preliminary Results: Winter Episode

BC

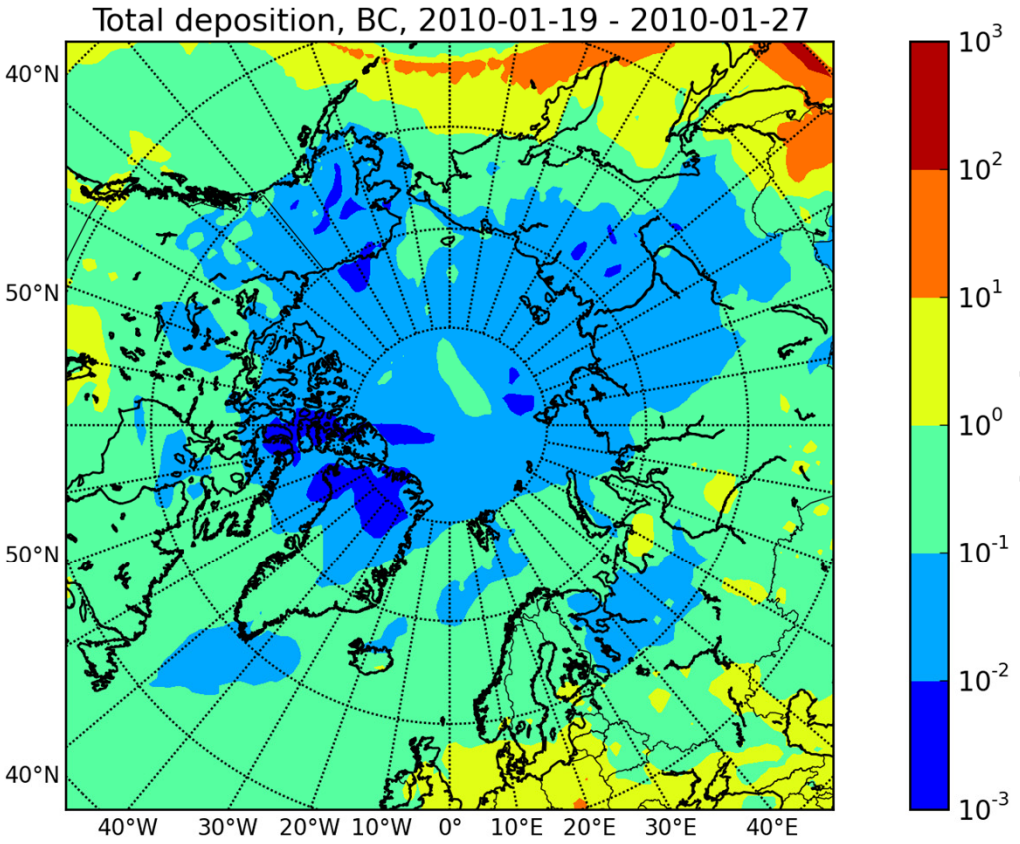


OC

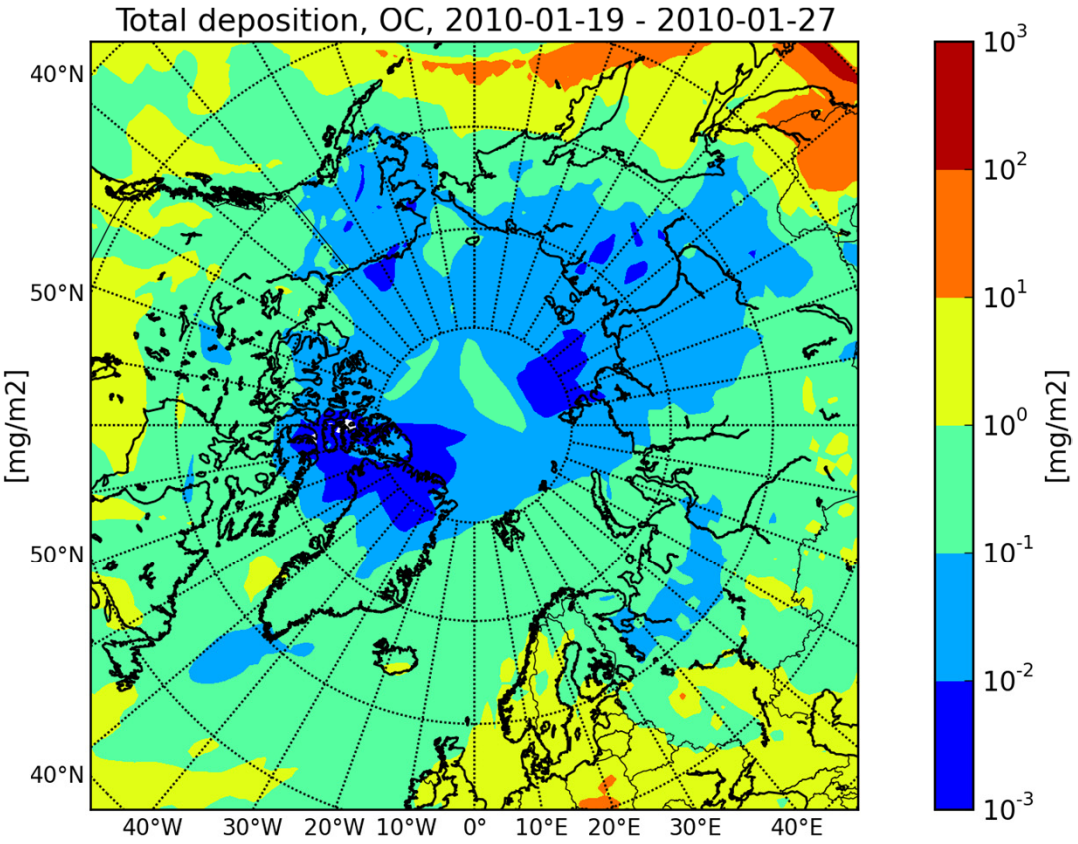


Preliminary Results: Winter Episode

BC



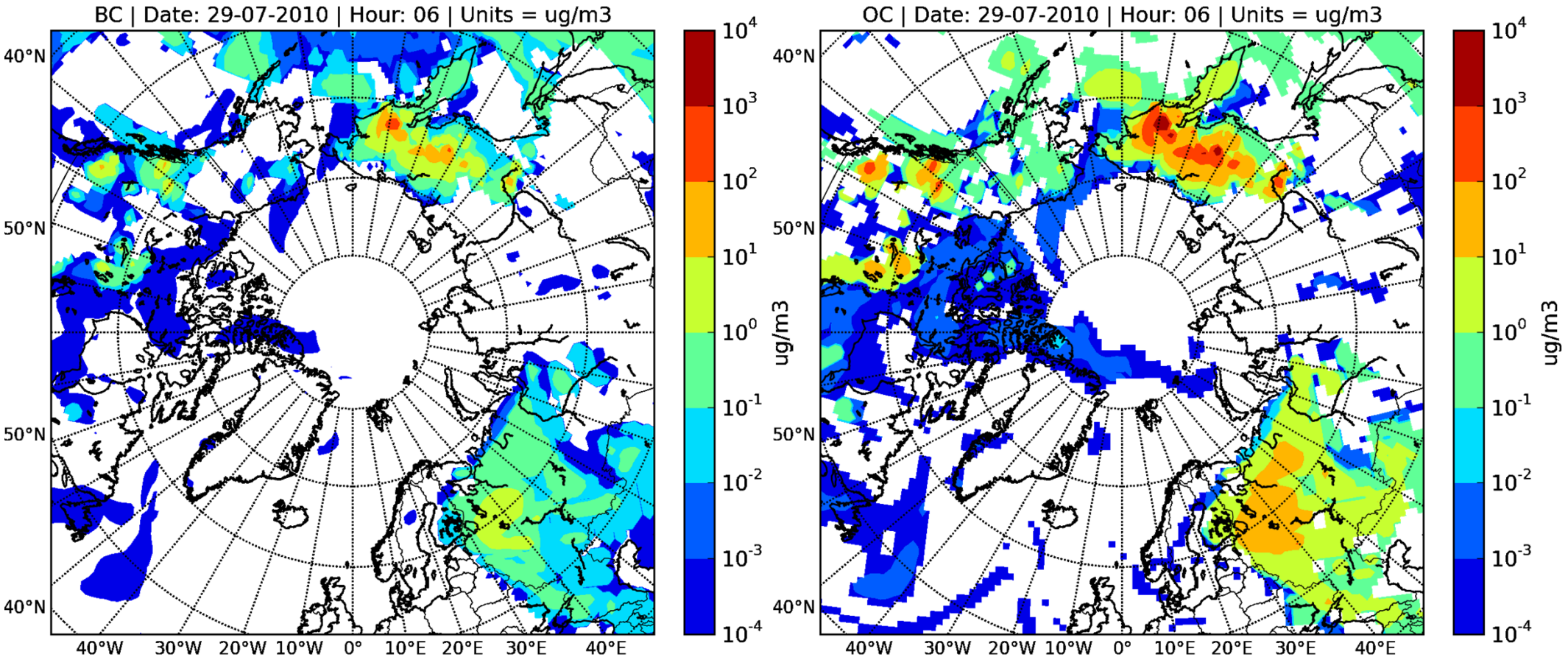
OC



Preliminary Results: Summer Episode

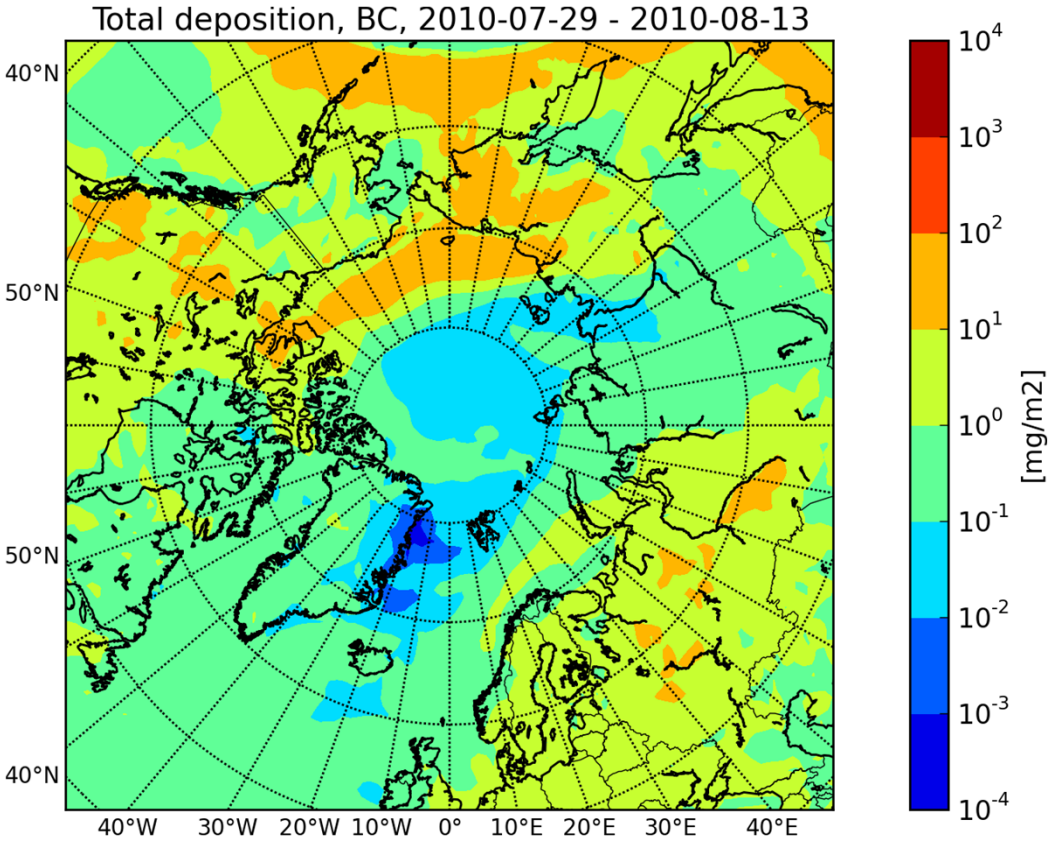
BC

OC



Preliminary Results: Summer Episode

BC



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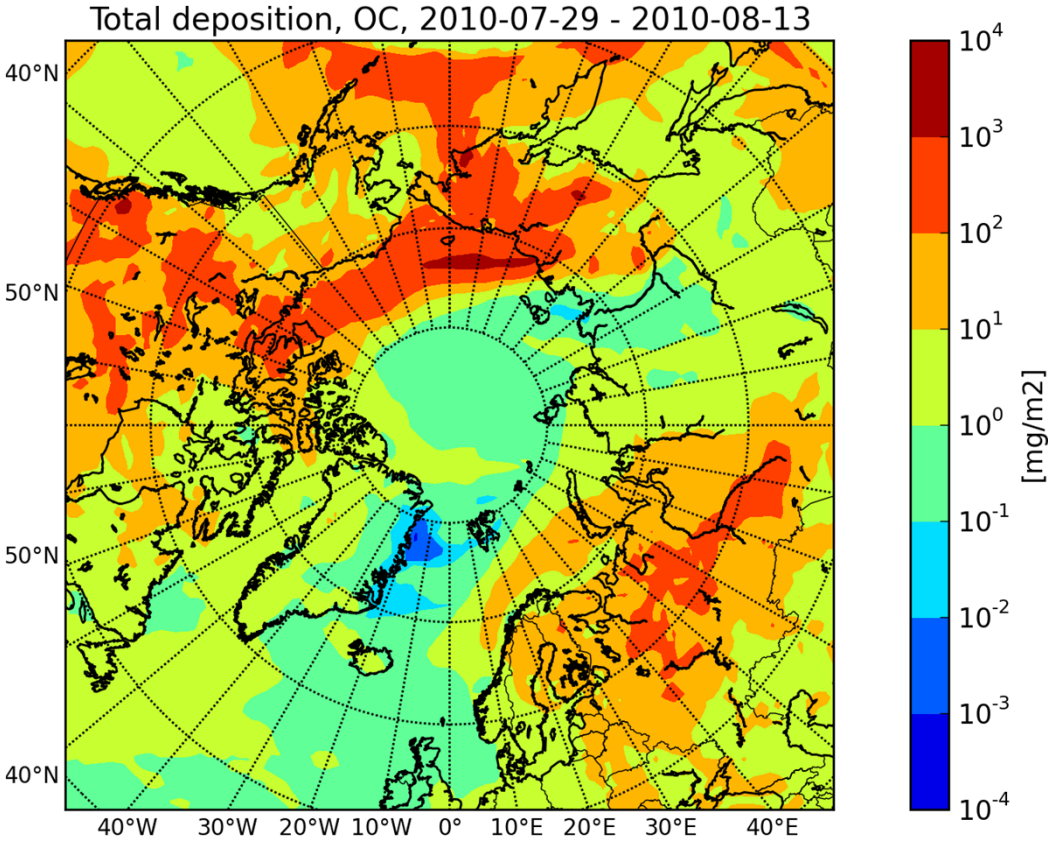
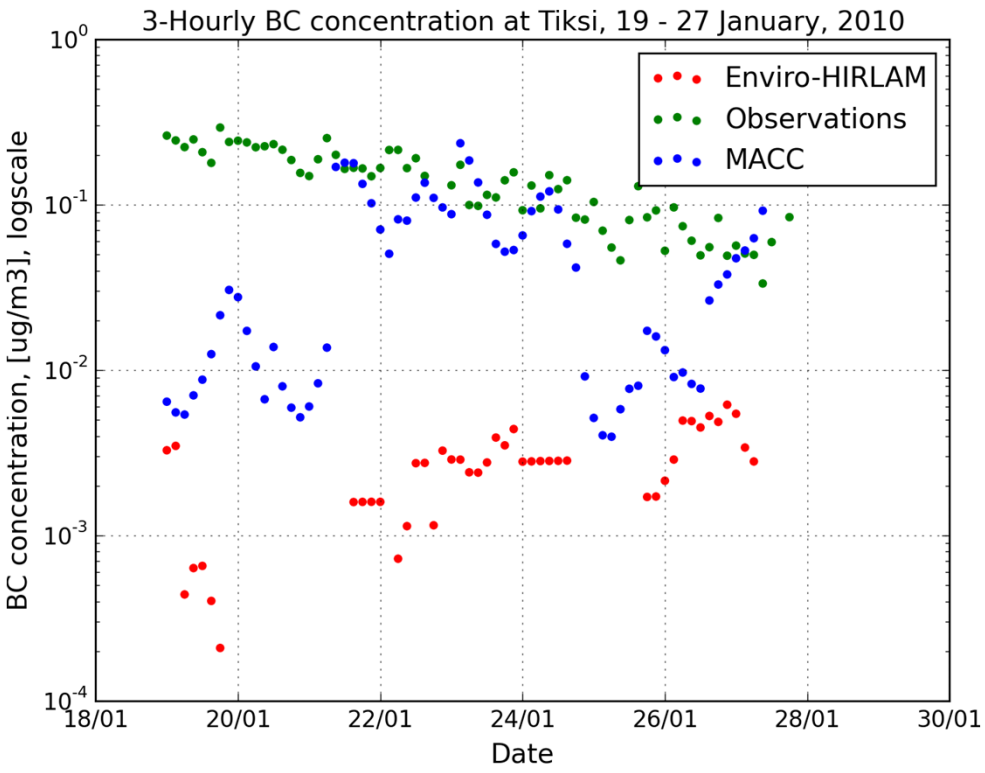
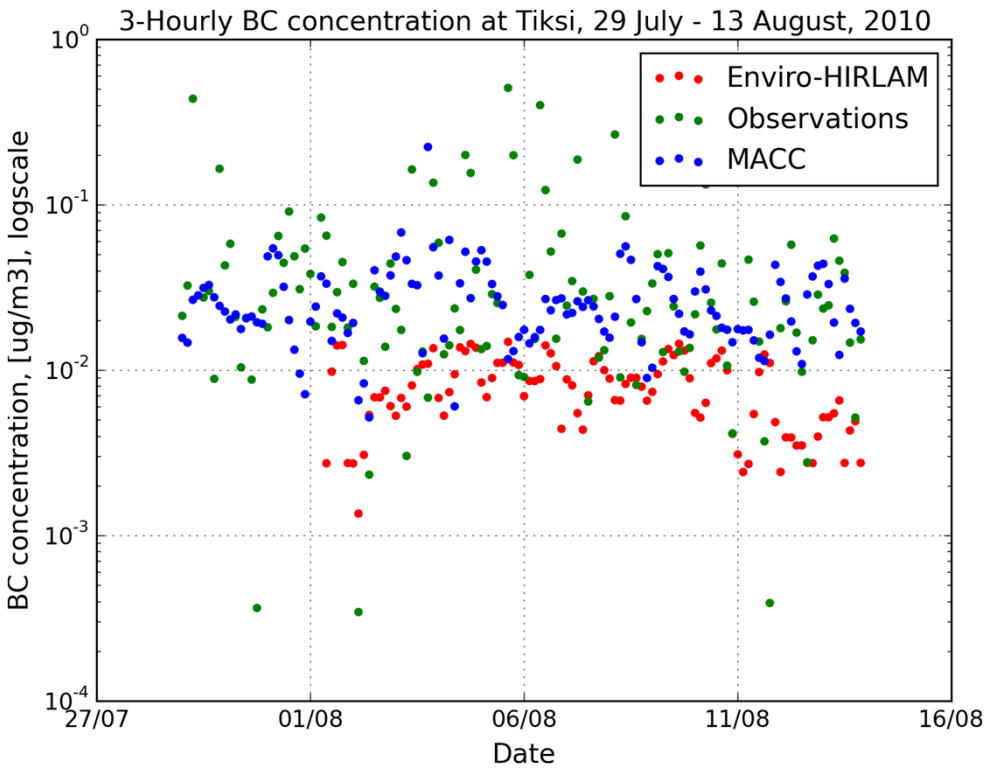


Model Vs. Observations: Tiksi

Winter

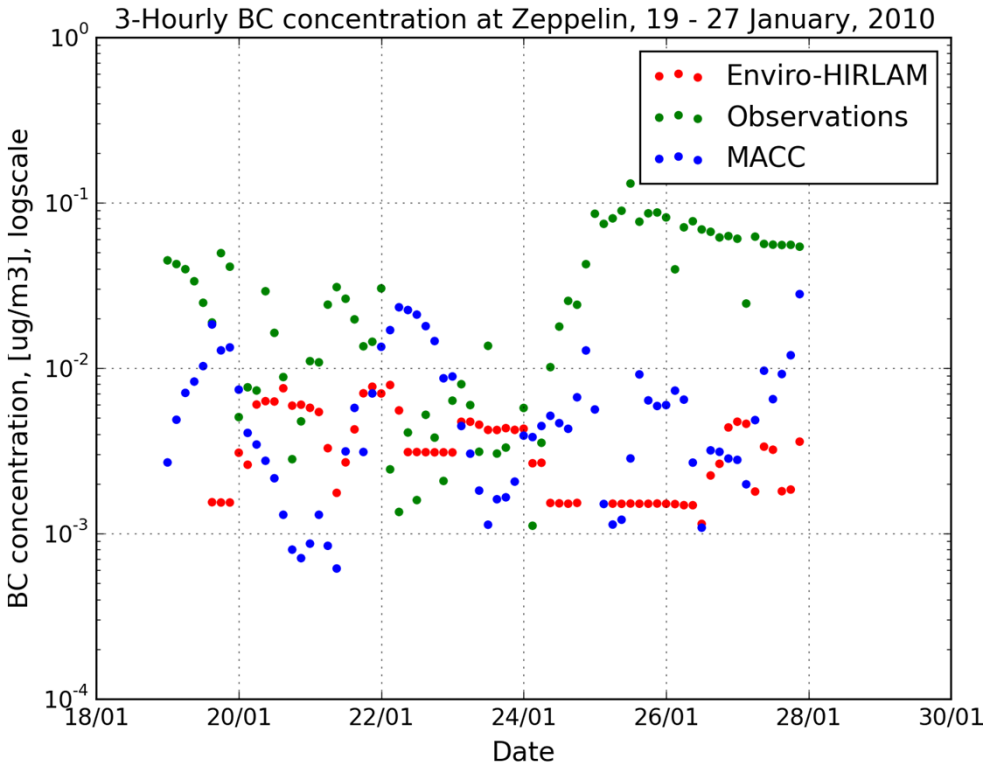


Summer

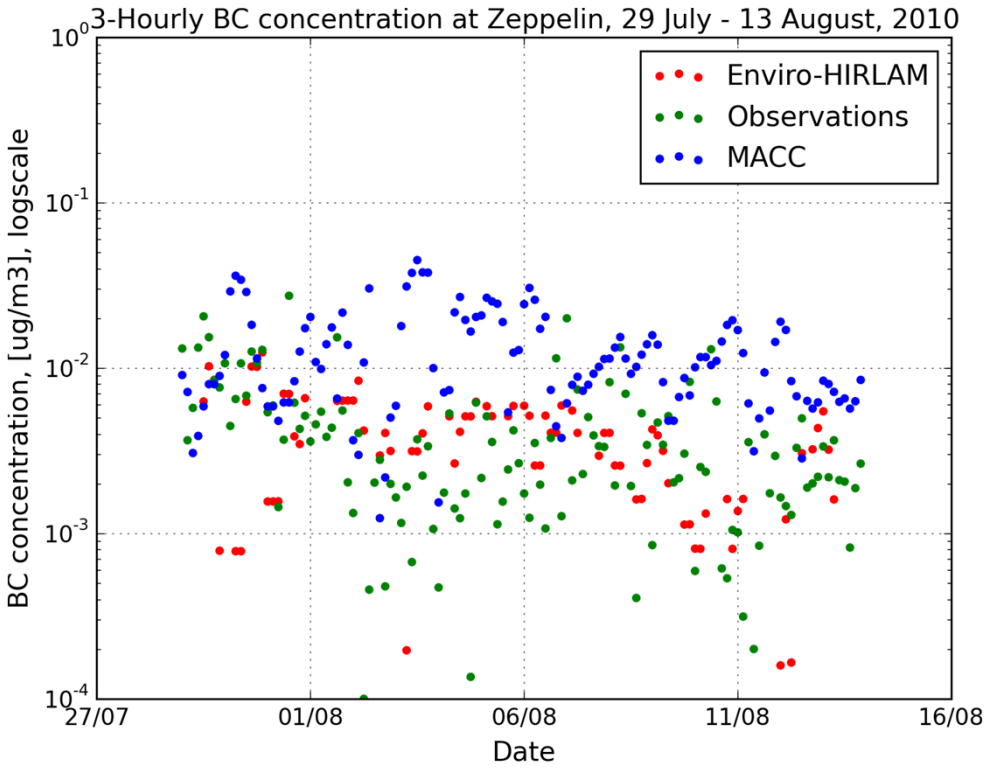


Model Vs. Observations: Zeppelin

Winter



Summer



Summary

- The modeled BC concentrations have been compared with ground-based observation and MACC reanalysis data: Tiksi and Zeppelin stations.

- Underestimation of modeled BC concentrations (esp. for Tiksi, winter)

- Underestimation might be caused by uncertainty of emission inventories, underestimated LRT

- An additional study is needed (aerosol feedbacks, etc.)

Thank you for your attention!