# Model calculation of aerosol radiative heating during POLARCAT

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# Context

- We develop a radiative transfer code, MOMO, FU Berlin (extension to LW).
- We compute radiative fluxes with RT code MOMO within the [0.2 – 20 μm] band.
- We want to qualify this code. POLARCAT data are interesting: validation of MOMO computations (done with some instruments measurements as inputs) with other instruments measurements.
- POLARCAT dataset combined to MOMO permits the “optics’ closure” and maybe the “radiative closure”.

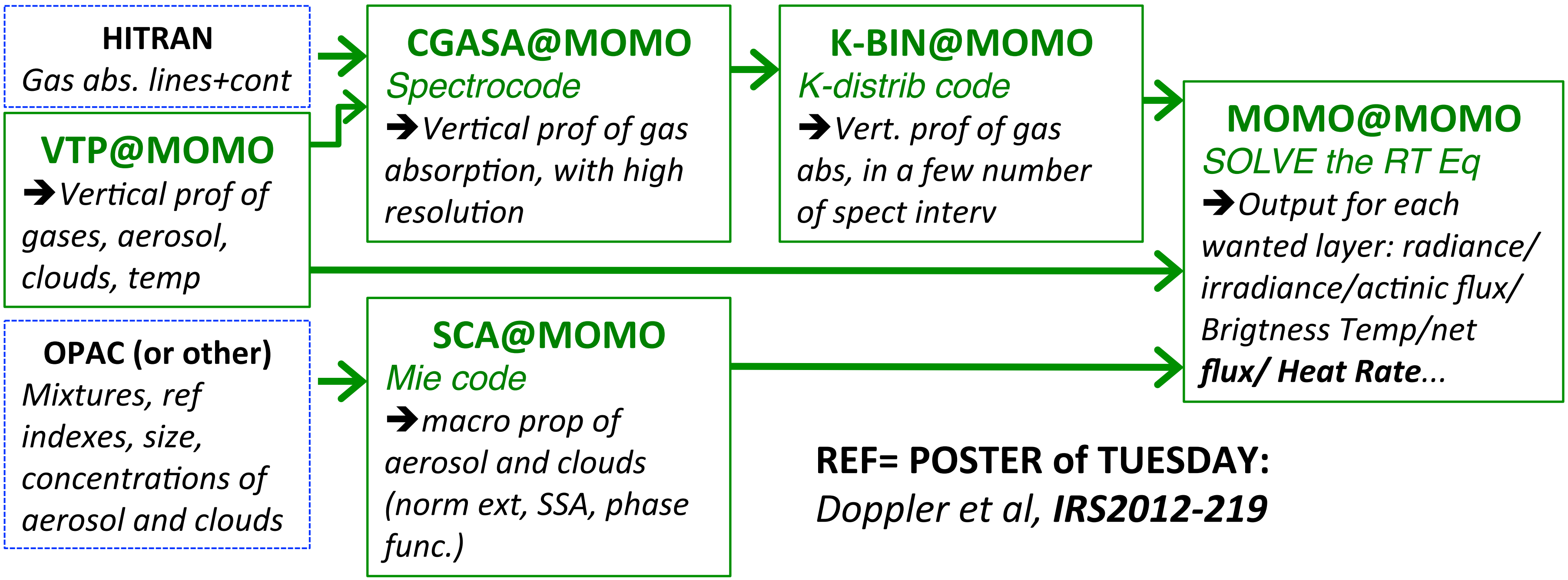
# Context

- With MOMO and POLARCAT observations we will estimate the heating rates and forcings due to aerosol for a given region (Arctic). We will do a sensitivity study about the important parameters (type of aerosol, cloud-aerosol structure, albedo…) for the radiative heating.

- In a second step, we will extend these case-study to the mean situation in the artic region. This will give the opportunity to compare MOMO and WRF radiation scheme.

- In this talk, we will present a case study: for the case of POLARCAT flight of 31 March 2008, we present the method to get the "optic closure" in input of MOMO and the values of the heating rates and forcing in SW and LW for these inputs.

# RT Code MOMO




**REF= POSTER of TUESDAY:**
*Doppler et al,* ***IRS2012-219***

- **Matrix Operator Model (MOMO)** Free University of Berlin radiative transfer code since **26/05/1991**

  *(Fell and Fischer JQSRT 2001, Fischer and Grassl AO 1984)*

- **Spectral range: [0.2 – 100 µm]**

  *(Doppler, Carbajal, Fischer, Pelon, Ravetta, Deleporte, in prep)*

- **NON CORRELATED k-distribution method**

  *(Bennartz and Fischer JQSRT 2000, Doppler, Bennartz, Preusker and Fischer, in prep)*

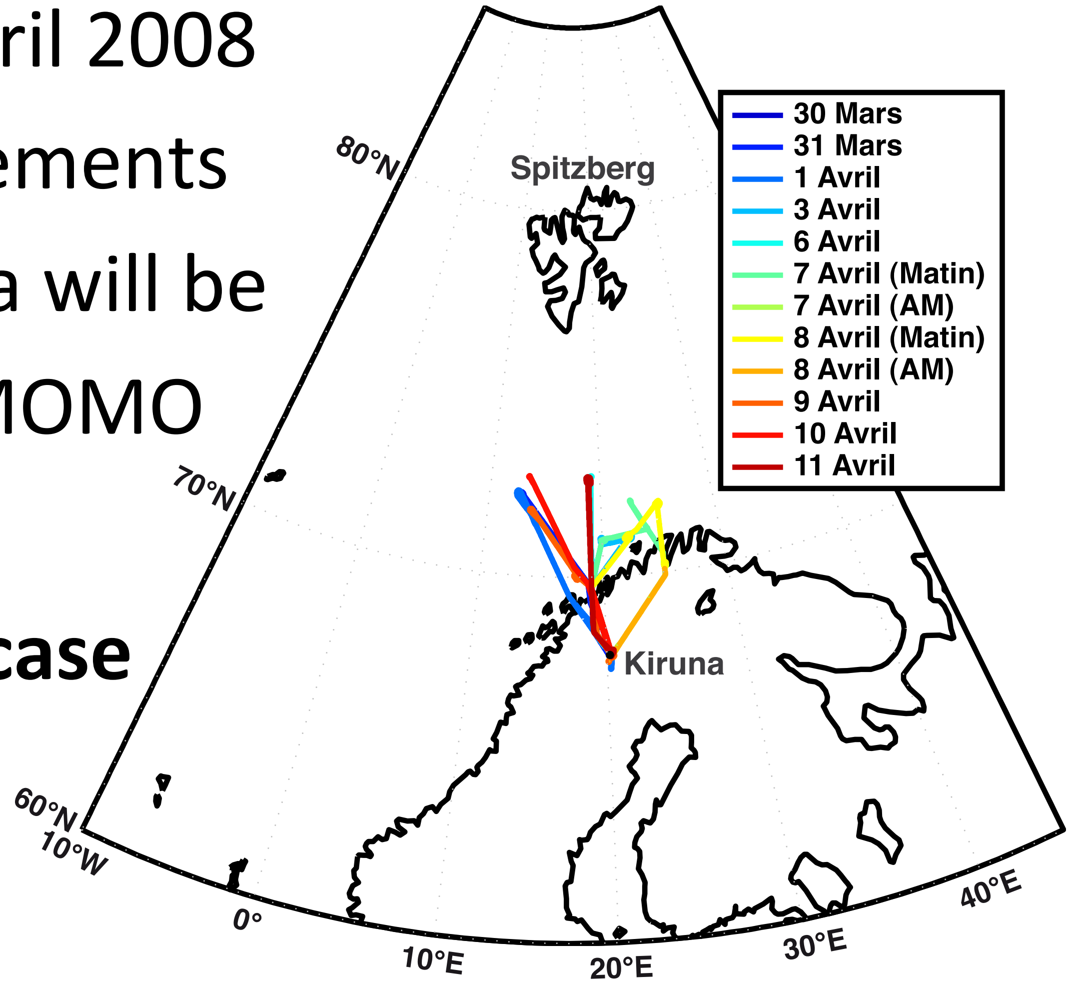
# POLARCAT-Kiruna Campaign

30 March – 11 April 2008

Airborne measurements

LIDAR, in-situ data will be used in input of MOMO

**Here presented: case of 31 March**



# Radiation impact of the aerosol with MOMO

-> We compute: HR vertical profile + forcings

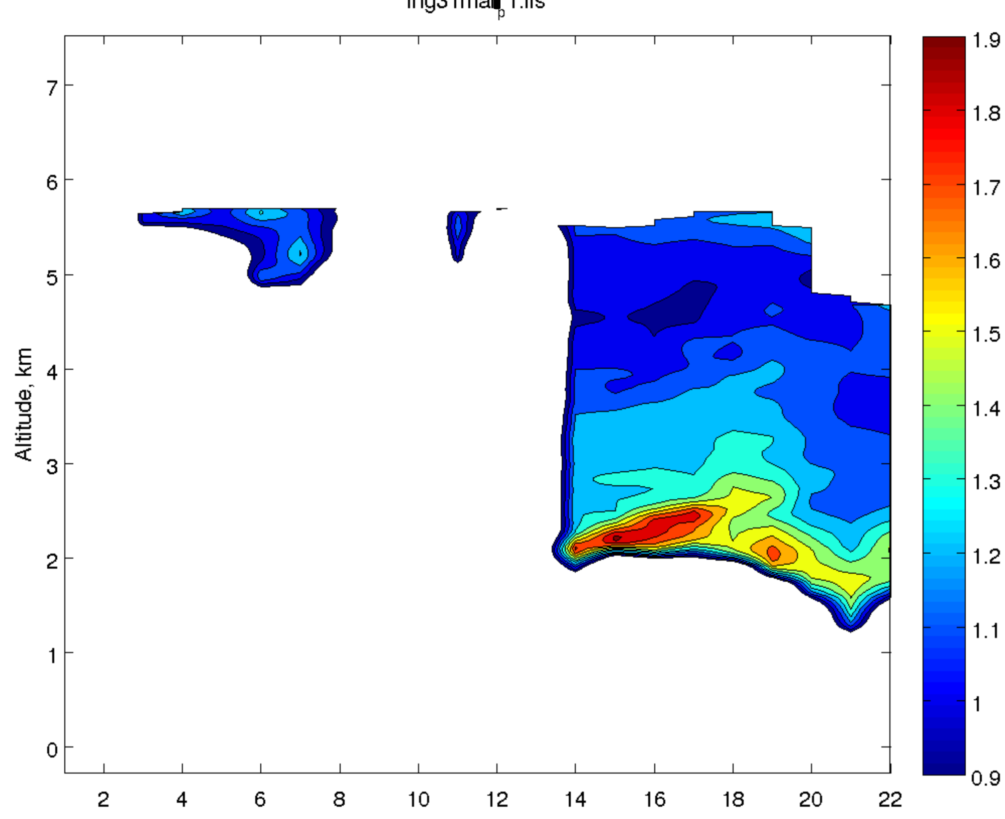
-> **We need** in input:

- **Vertical and horizontal distribution of aerosol**
- Optical properties : obtained with SCA-preprocessor from **ref indexes** and **size distribution**

We use LIDAR and in-situ measurements to get these information

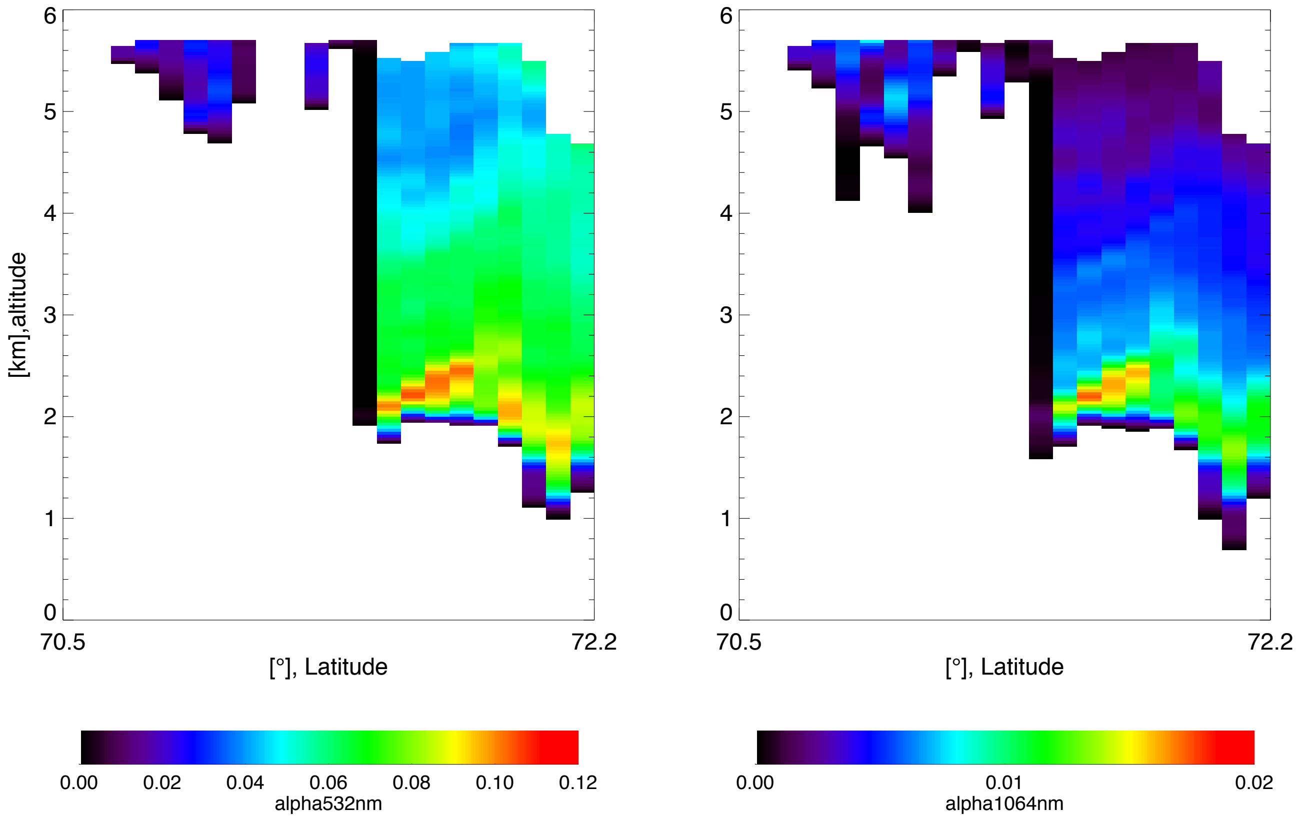
# LIDAR Profile

- G. Ancellet algorithn applied to 31/03/2008 flight: attenuated-beta profile of aerosol



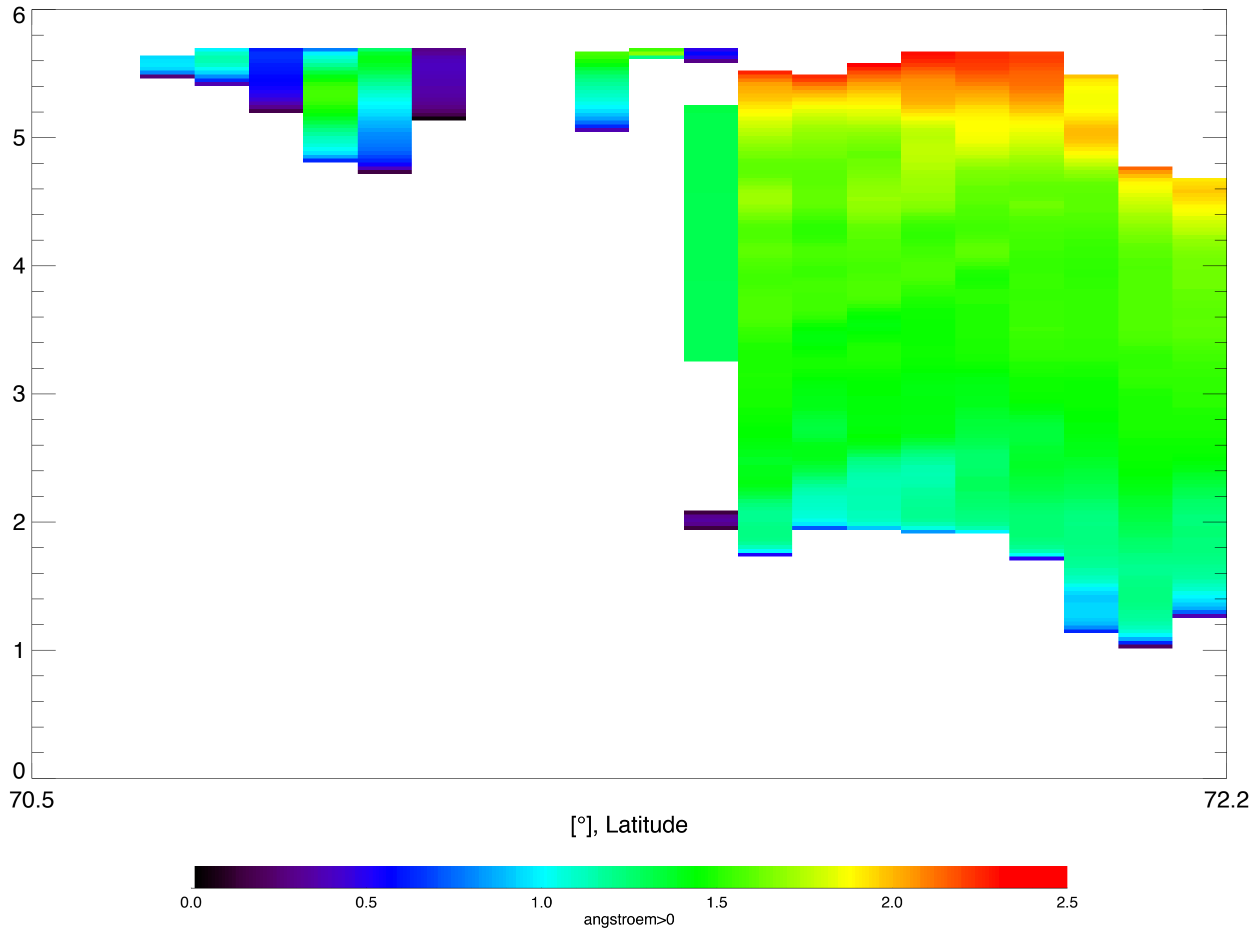
# LIDAR inversion

Iterative inversion algorithm gives the alpha profile for the 2 channels:



# LIDAR inversion

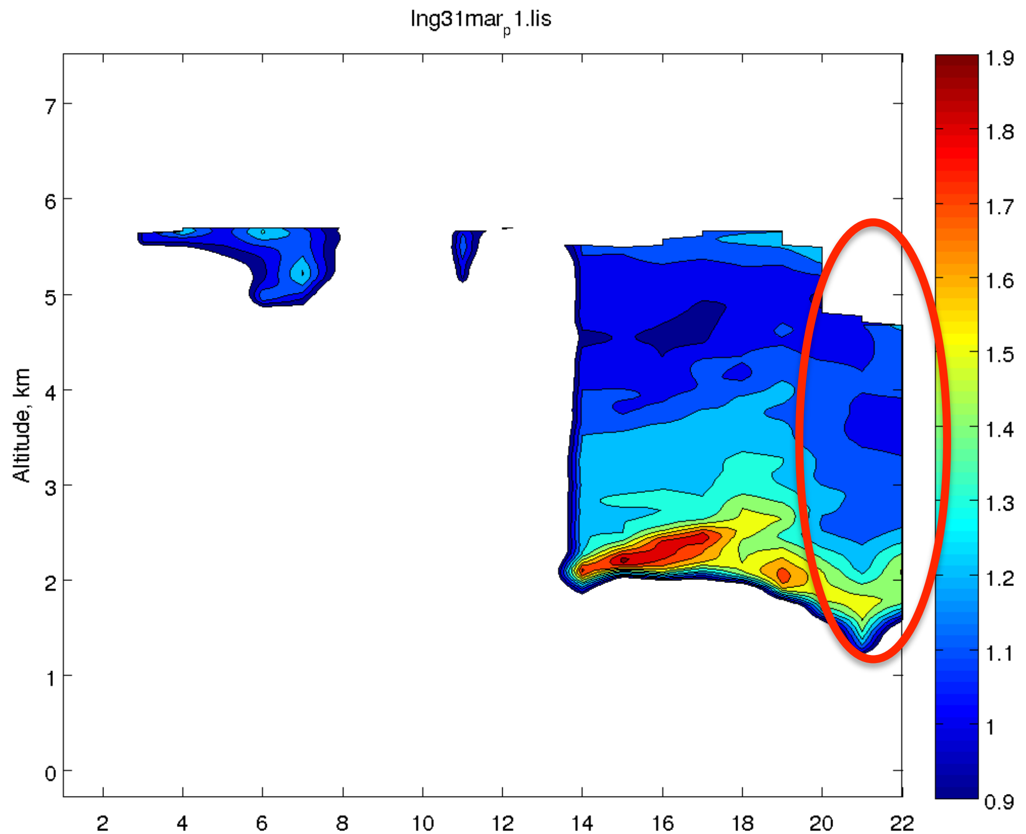
The Angström coefficient is also retrieved. The figure seems to announce some small particles in the upper layer:



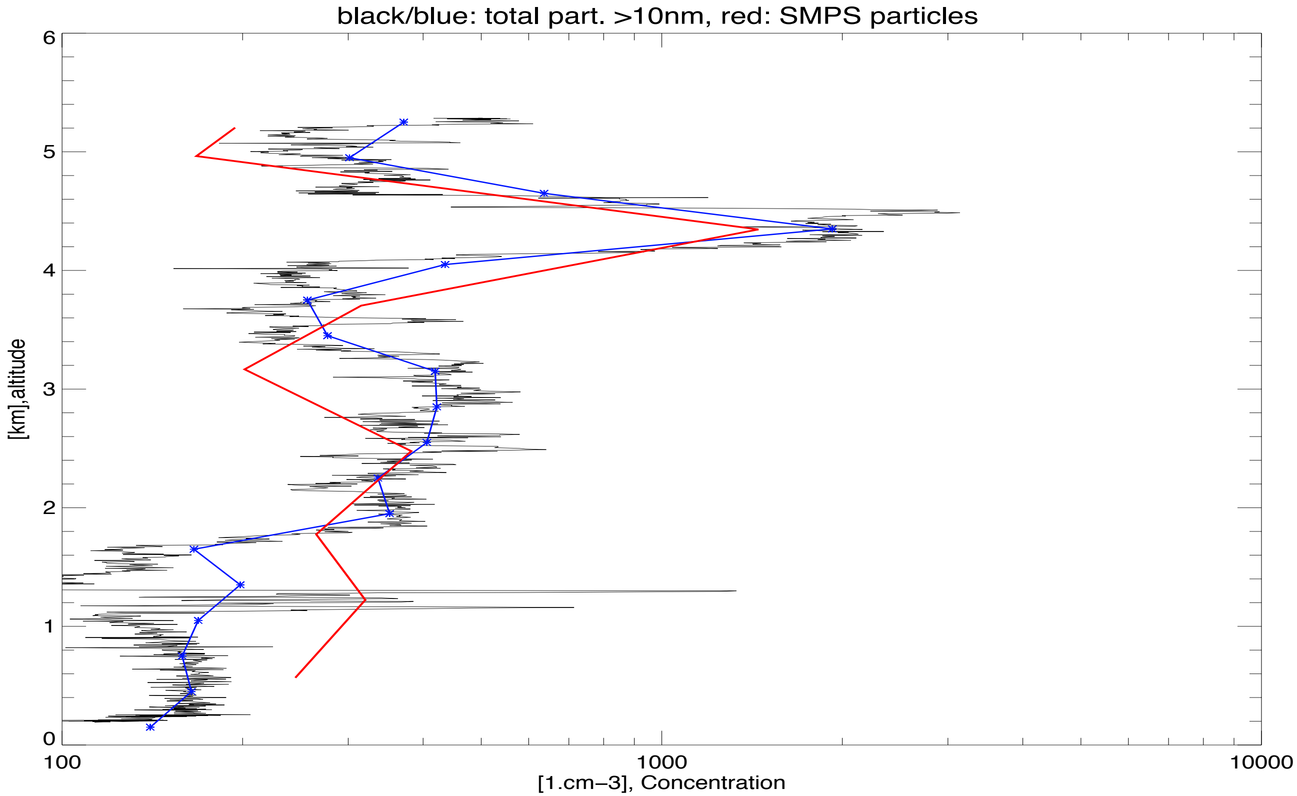
# In-situ DATA

Grimm: 0.2<diam<2µm // SMPS: 0.02<diam<0.4µm

At the end of the track: hippodrome decent. We analized in-situ data there.



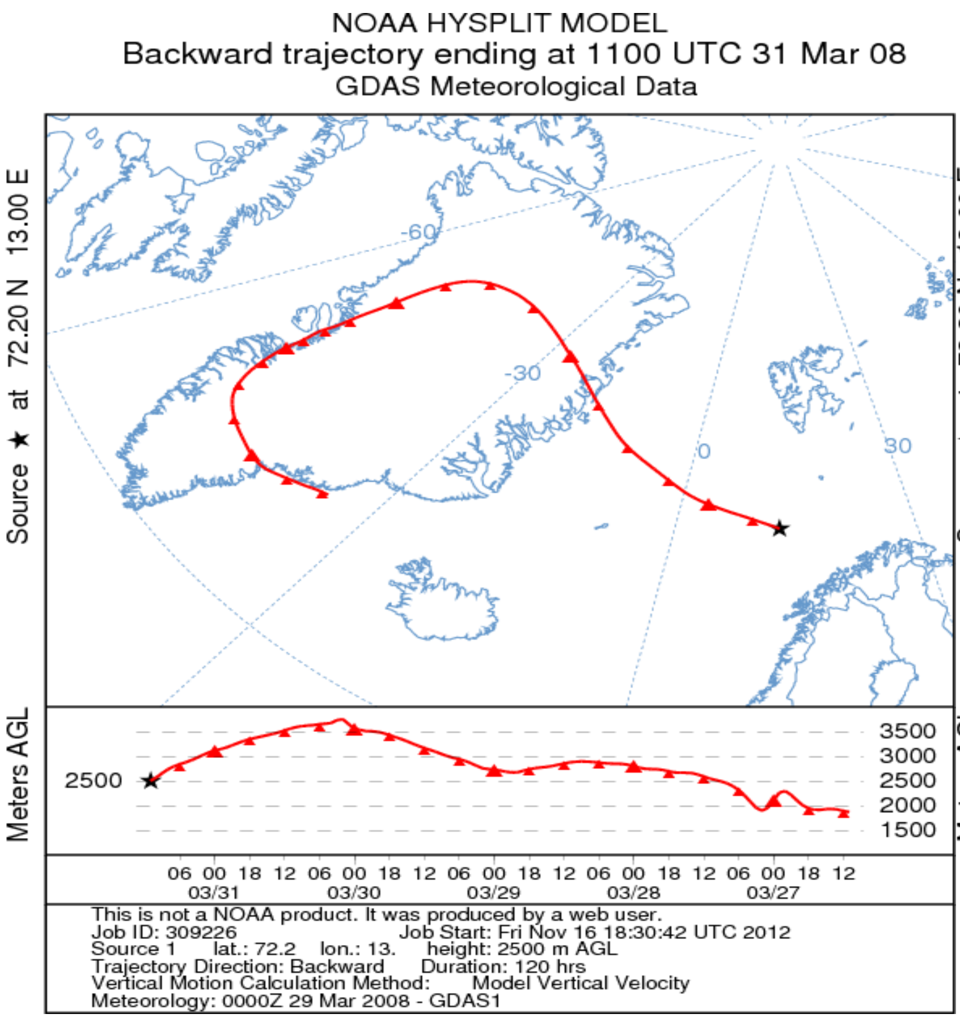
# Hippodrome descent with in-situ instruments

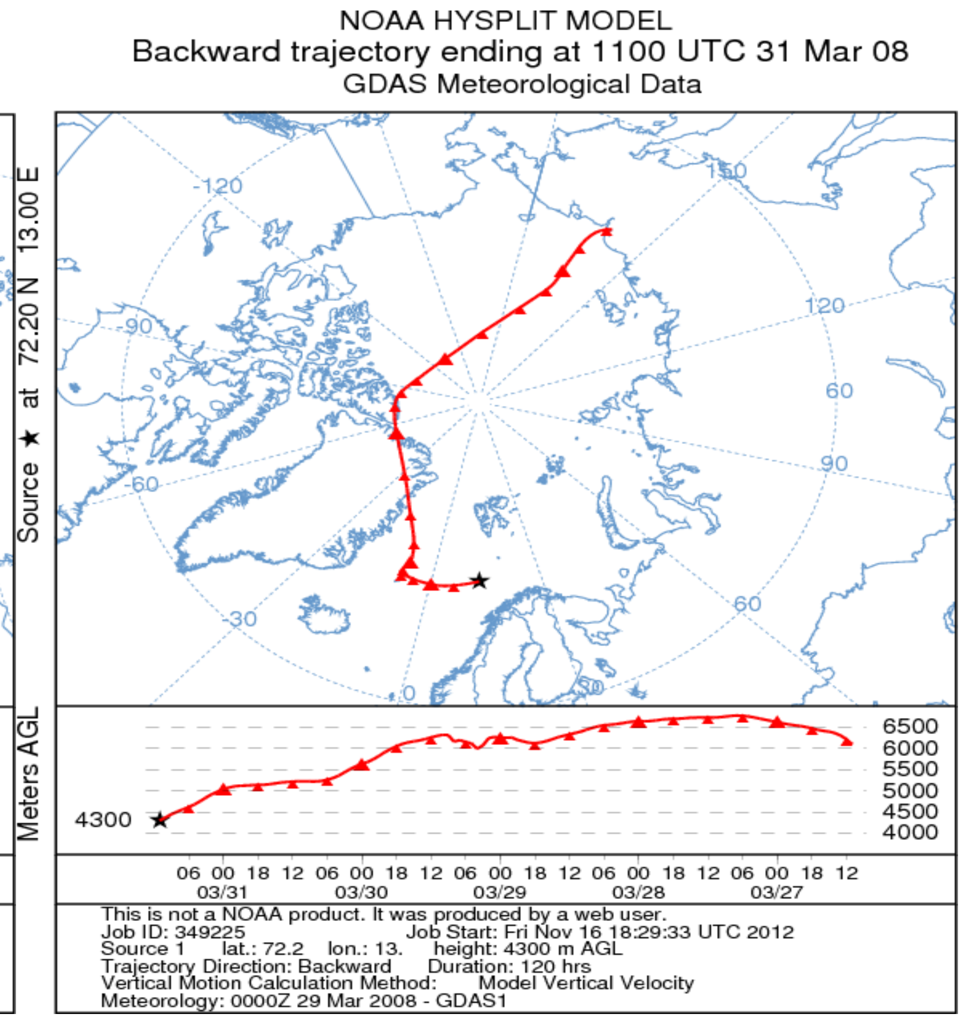



We select two layers: 4300m and 2500m

SMPS is the good instrument to use (fine particles: 0.02<diam<0.4µm)

# Origins: HYSPLIT




Origin of 2500m layer: Atlantic???

Origin of 4300m layer: Asia

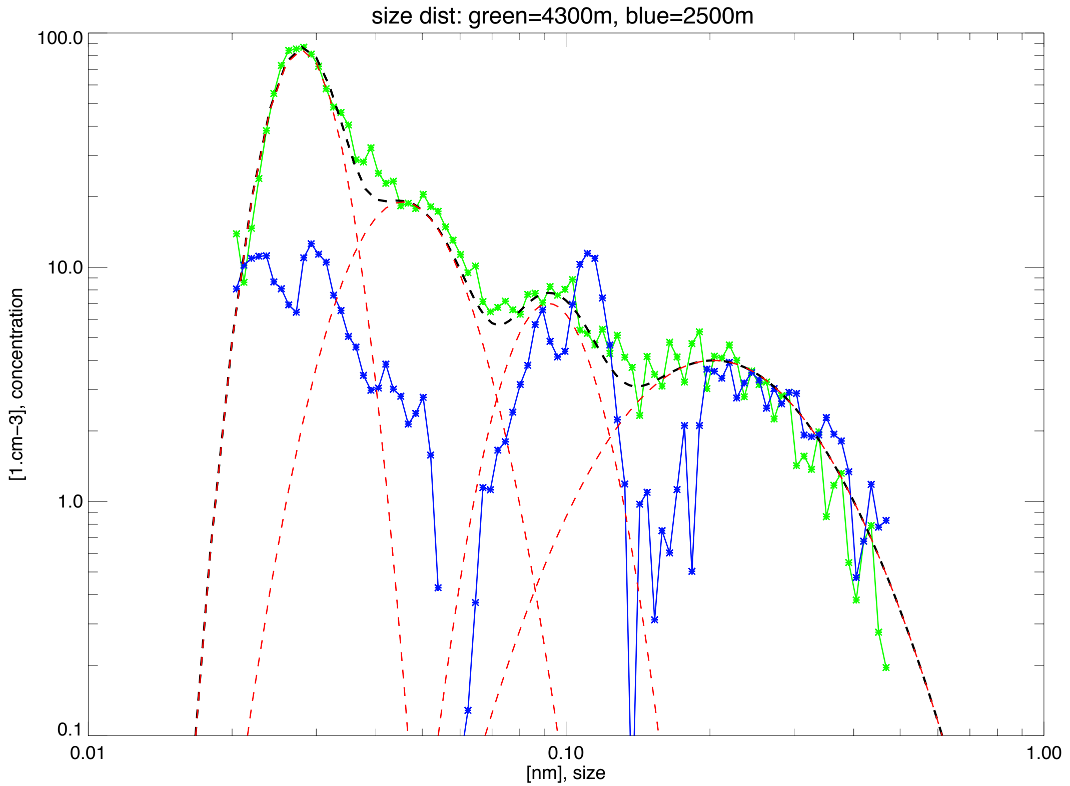
# Discussion

Top layer aerosol comes from Asia => we suppose anthropic urban aerosol, let see the size distribution (if small, the supposition is maybe correct) => model with OPAC soot ref index

The middle layer comes from the atlantic => Oceanic aerosol?

OUTLOOK: Do a better origin study with FLEXPART

# Size-distribution




-> **For the 4300m layer (green):** we model small particles arc with OPAC soot ref index, and "large" particle arc with OPAC "inso" ref indexes

**-> For the 2500m layer (blue):** No distribution can really be found. We take OPAC maritime standard aerosol

# Size-distribution

We put these size distributions and refractive indexes in input of MOMO SCA-preprocessor.

This preprocessor is a Mie-Code that computes the SSA, ext_norm coeff and phase functions.

Then MOMO MOMO-preprocessor can solve the RT equation

# Results for the flight of 31 March

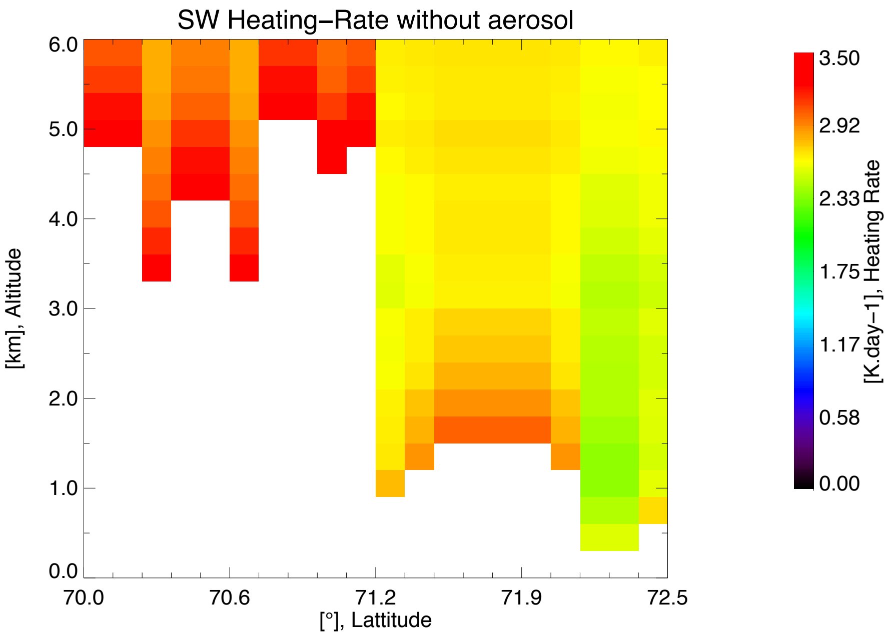
COMPUTATION with MOMO:

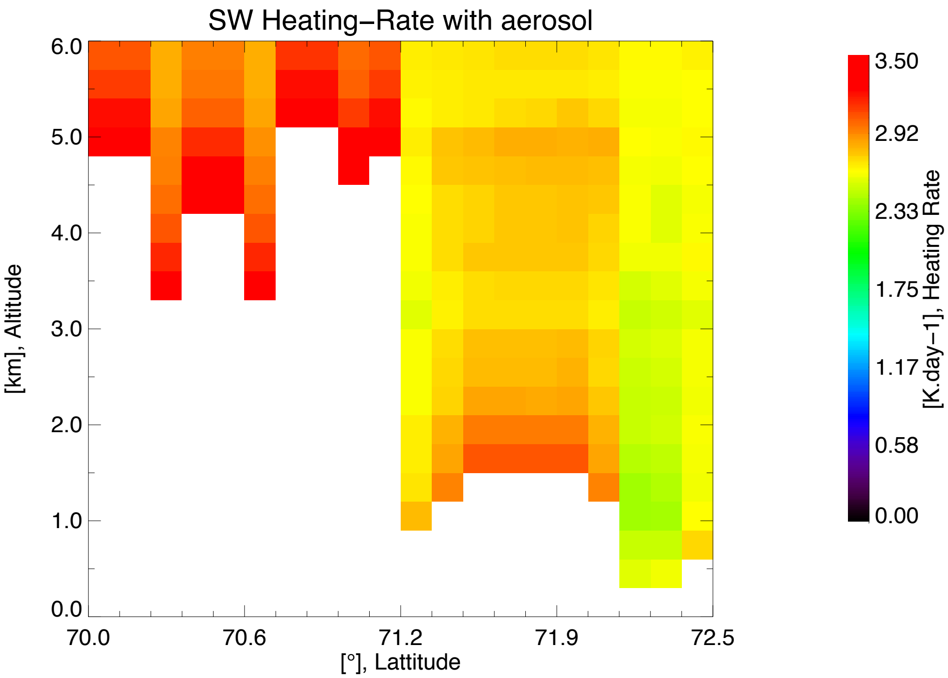
-> Heating rates

-> TOA forcing

-> AOD, COD

# Heating Rates in SW

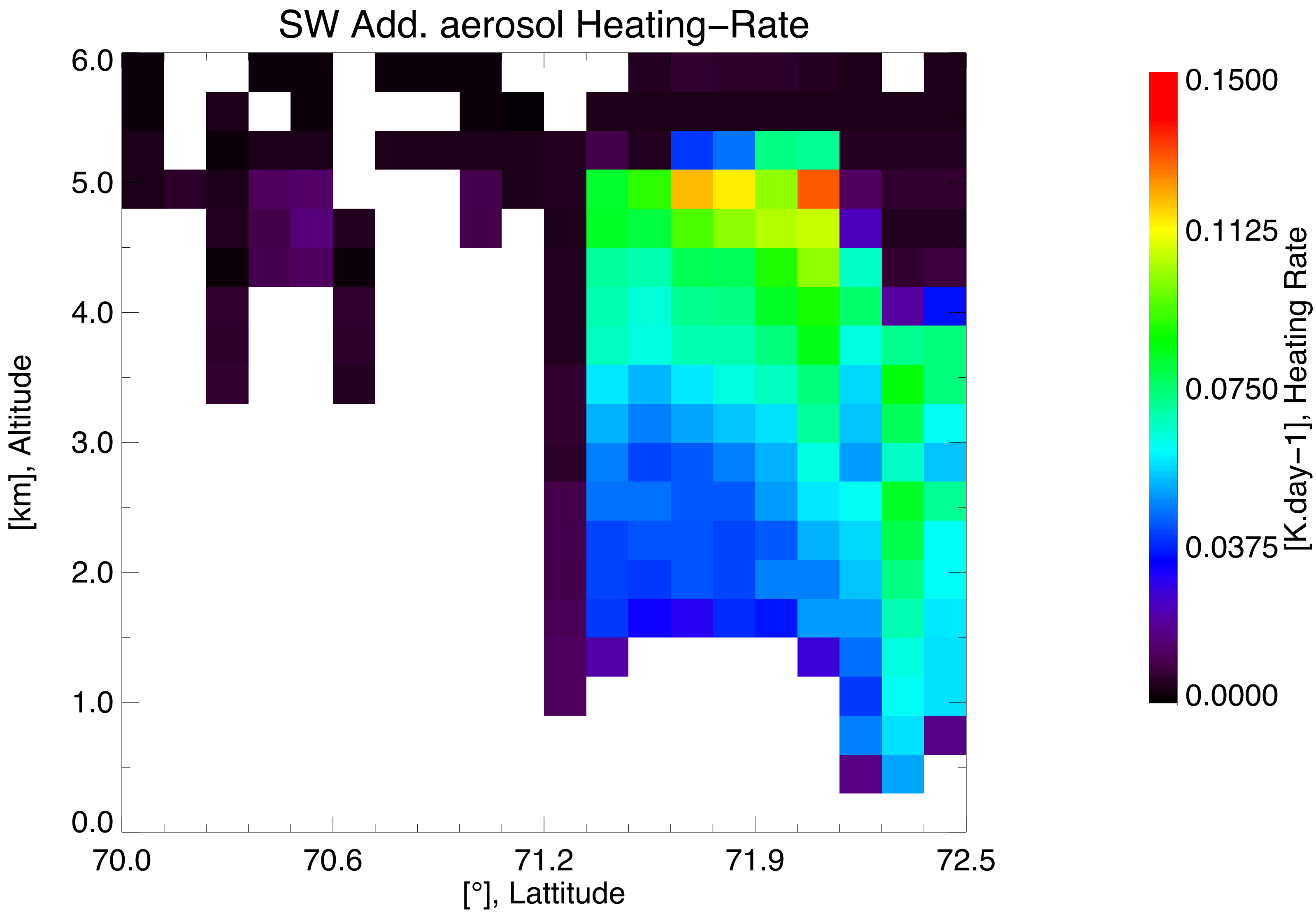


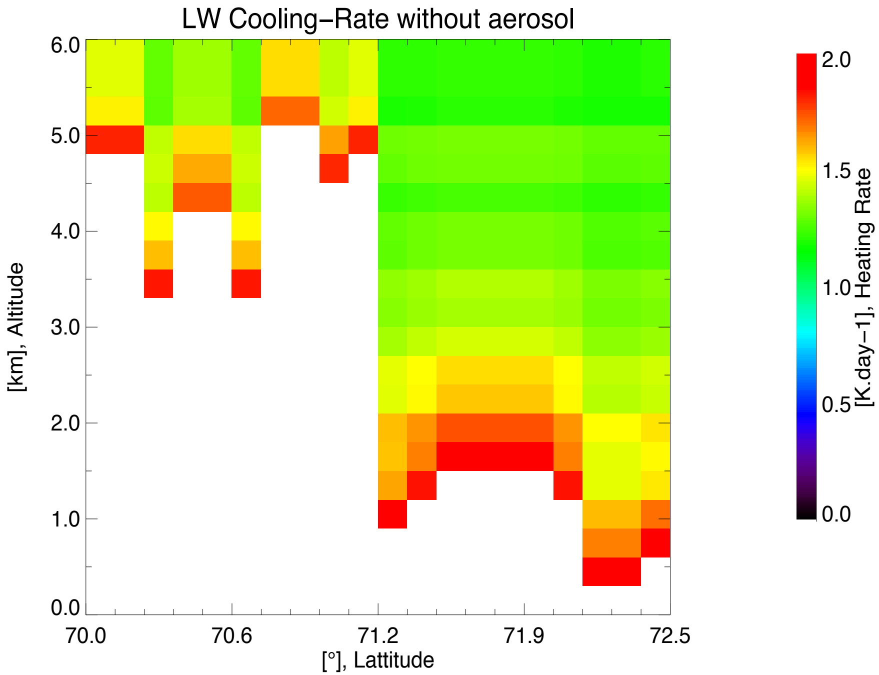

Without aer

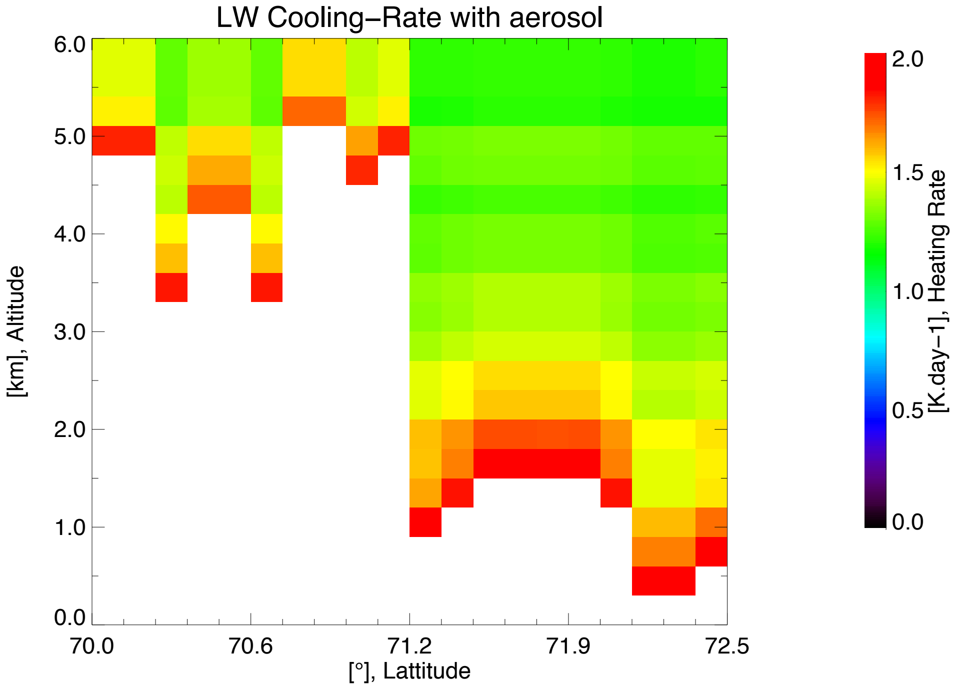
With aer

# Additional Heating Rates of aerosol (SW)



# Cooling Rates (LW)

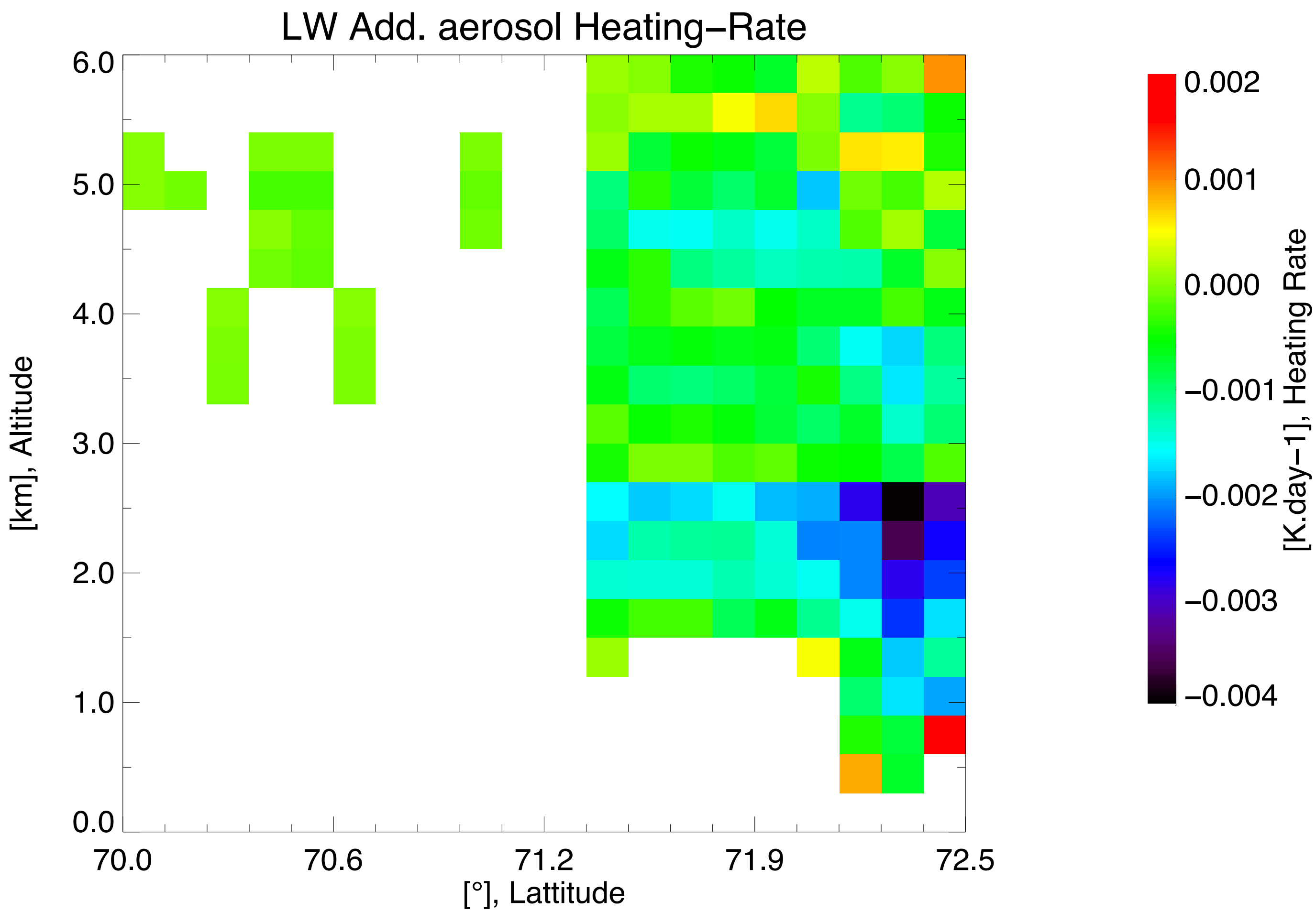


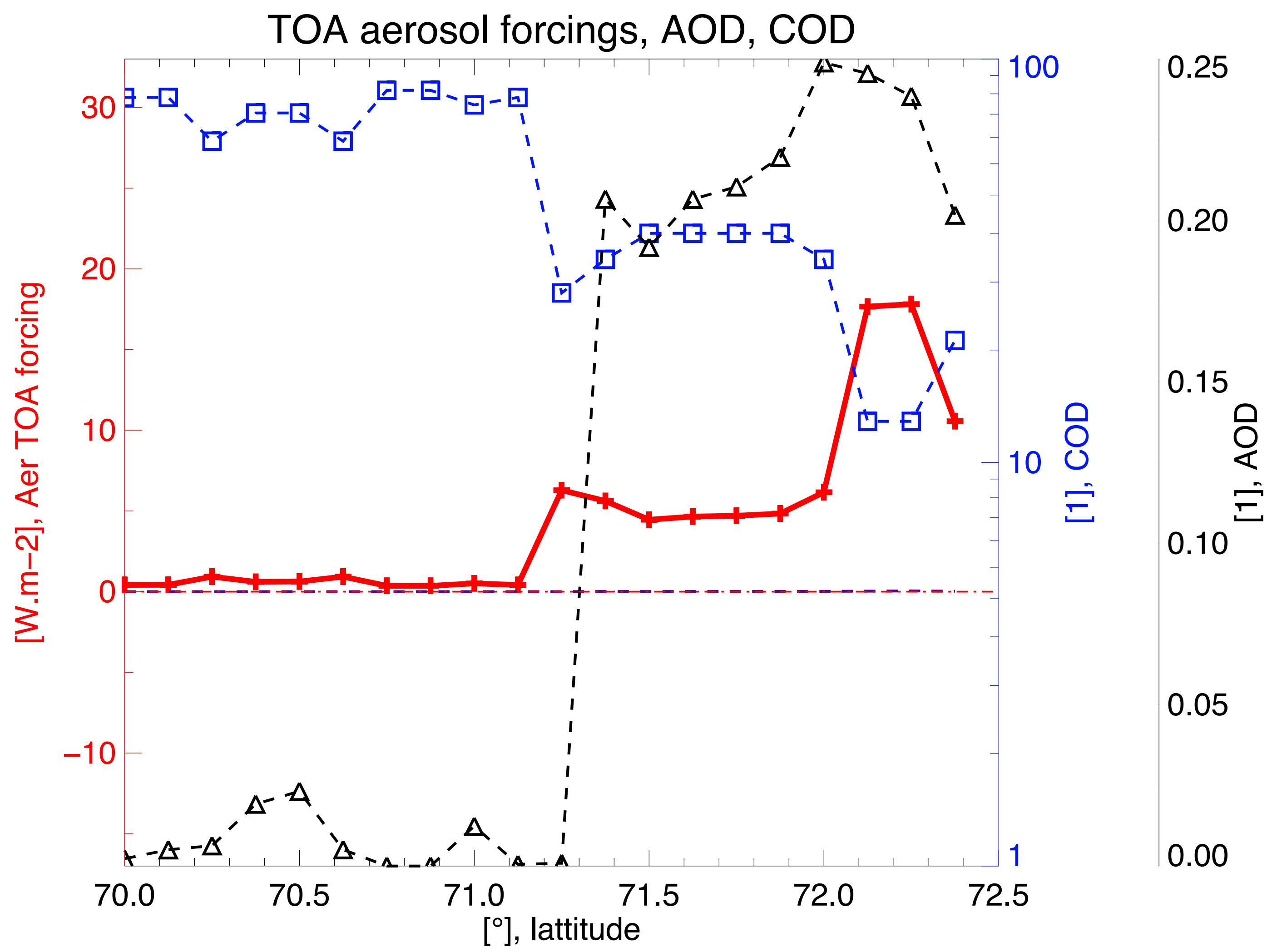

Without aer

With aer

# Additional Heating Rates of aerosol (LW)



# Aerosol Forcing LW=1%SW



# Comment about the results

-> AOD are low

-> LW radiative impact << SW radiative impact for the aerosol

-> in SW: absorption for the high small particules' layer = heating

-> in LW: small cooling for the lower layer

-> 9, 10, 11 april flights will be more relevant (bigger AOD, better characteization (origin)

-> The same method will be applied to these flights