New COSMO Priority Project: Testing & Tuning of Revised Cloud Radiation Coupling $T^2(RC)^2$

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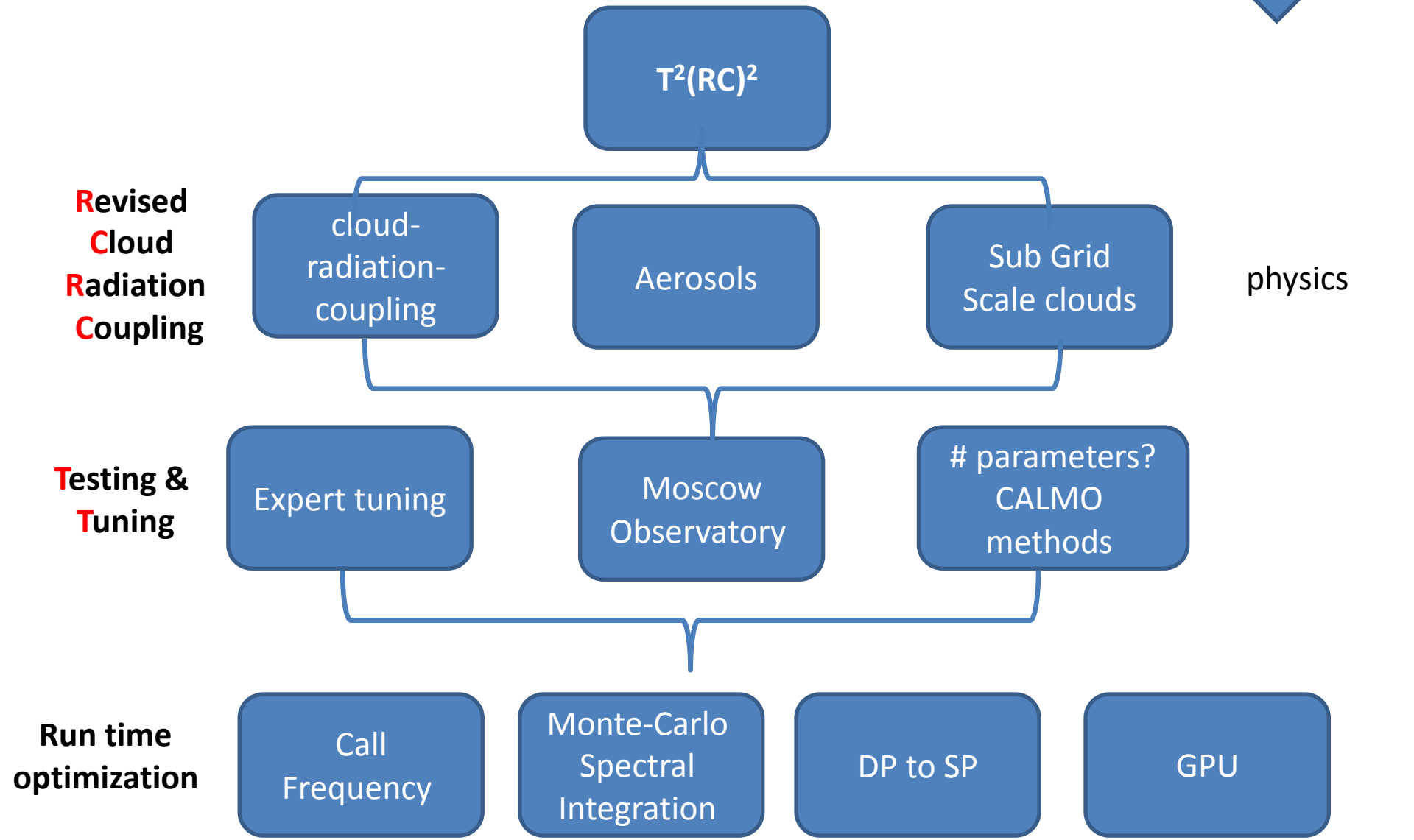
COSMO GM September 2015

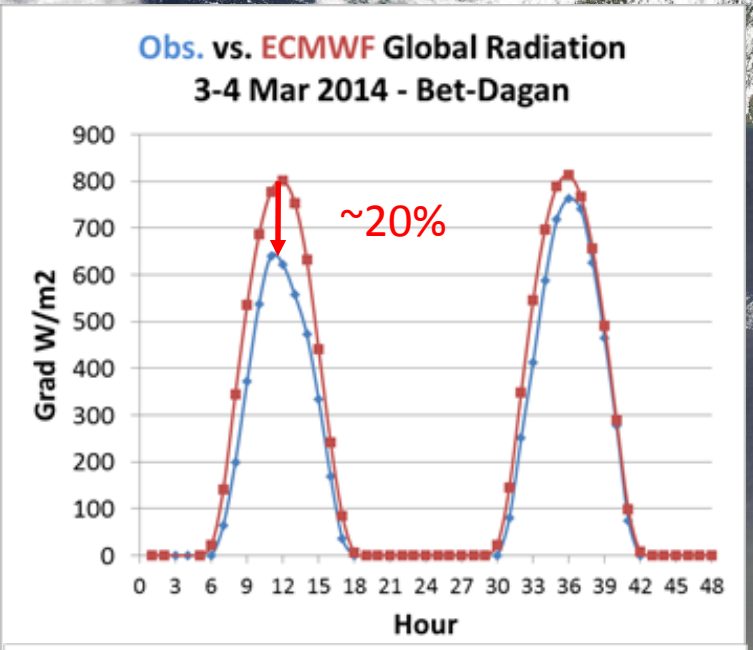
Outline

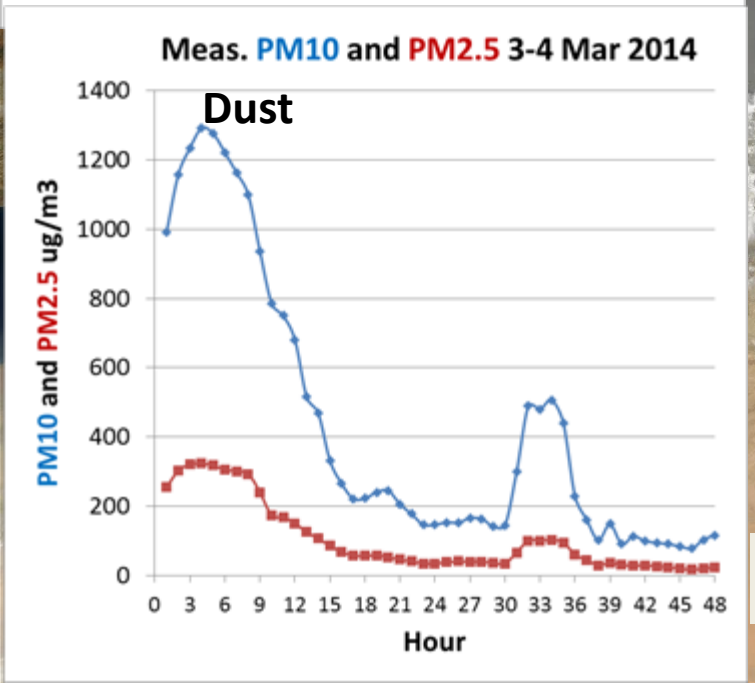

T²(RC)²
Revised Cloud Radiation Coupling
cloud-radiation-coupling
Aerosols
Sub Grid Scale clouds
physics
Testing & Tuning
Expert tuning
Moscow Observatory
parameters? CALMO methods
Run time optimization
Call Frequency
Monte-Carlo Spectral Integration
DP to SP
GPU

Revised **C**loud **R**adiation **C**oupling
$(RC)^2$

- Improve the current cloud-radiation-coupling before implementing Rapid Radiative Transfer Model (RRTM).
- New optical properties of hydrometeors with much larger size range, including snow, graupel and rain categories (UB, PH, HM).

The aerosol effect on global radiation



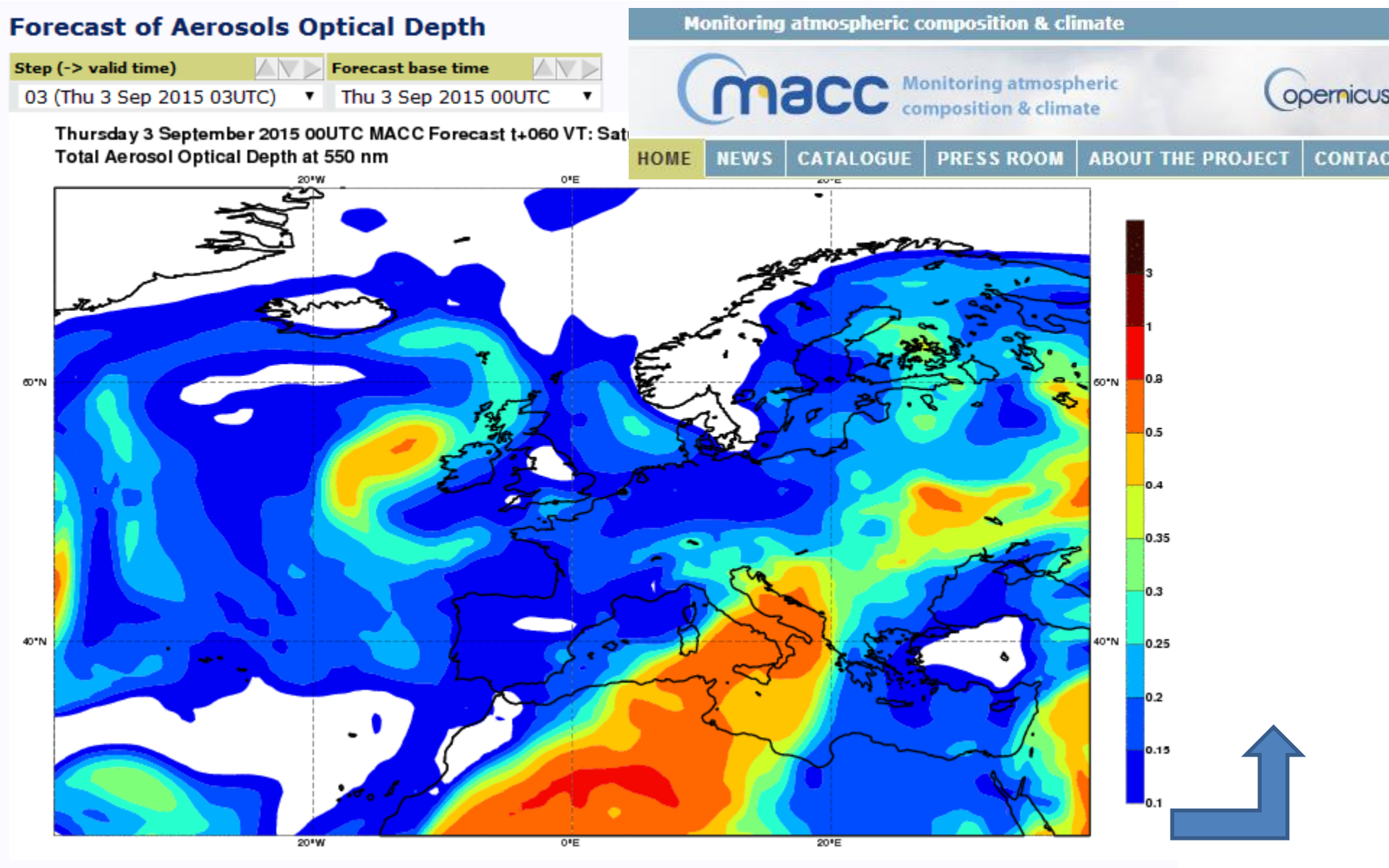


ECMWF uses Tagen et al. (1997) climatology

New Climatology

- The Max-Planck-Institute Aerosol Climatology (MAC-v1), Kinne (2013).
- Monthly aerosol radiative properties, with global coverage at a spatial resolution of 1°.

From climatology to forecast

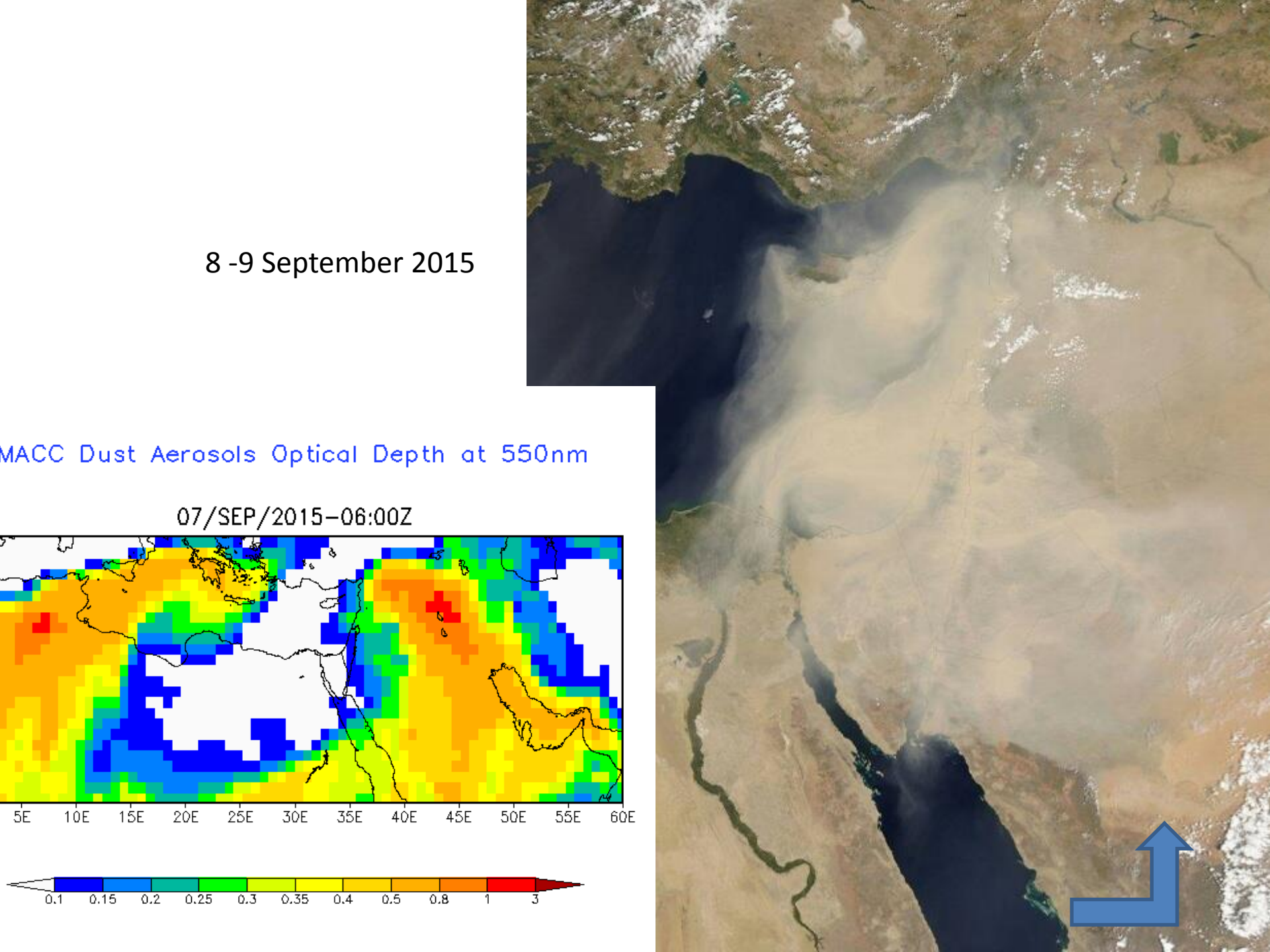


Jerusalem 8.9.2015
I hope it will not be our Climatology


69-396-54


Turkey
Syria
Cyprus
Mediterranean Sea
Iraq
Jordan
N
100 km

8 -9 September 2015

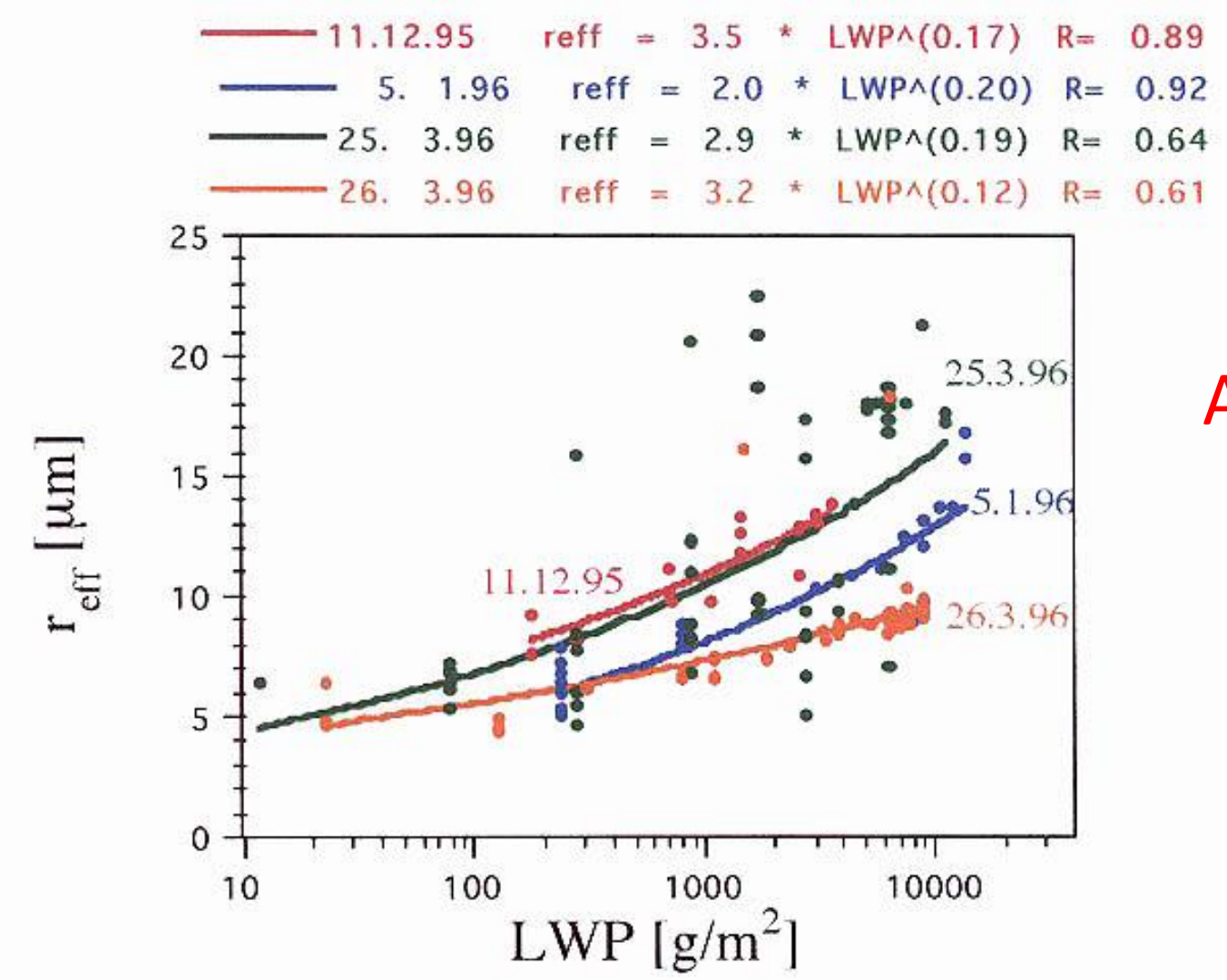


Sub-Grid Scale (SGS)

cloud-water and cloud-fraction

- Revision of overall estimation of cloudiness – combination by information from turbulence and convection schemes (MR, PK, HM)
- Re-introduce mixed phase extension into turbulence scheme so that TURBDIFF can be used also in radiation (MR, PH, HM)
- Currently diagnostic relative-humidity-closure **->** adapt the ice/water-ratio.
- Currently constant assumption for r_{eff} = 5 μm for water 10 μm for ice **->** derive a parameterization of the effective radius (r_{eff}).

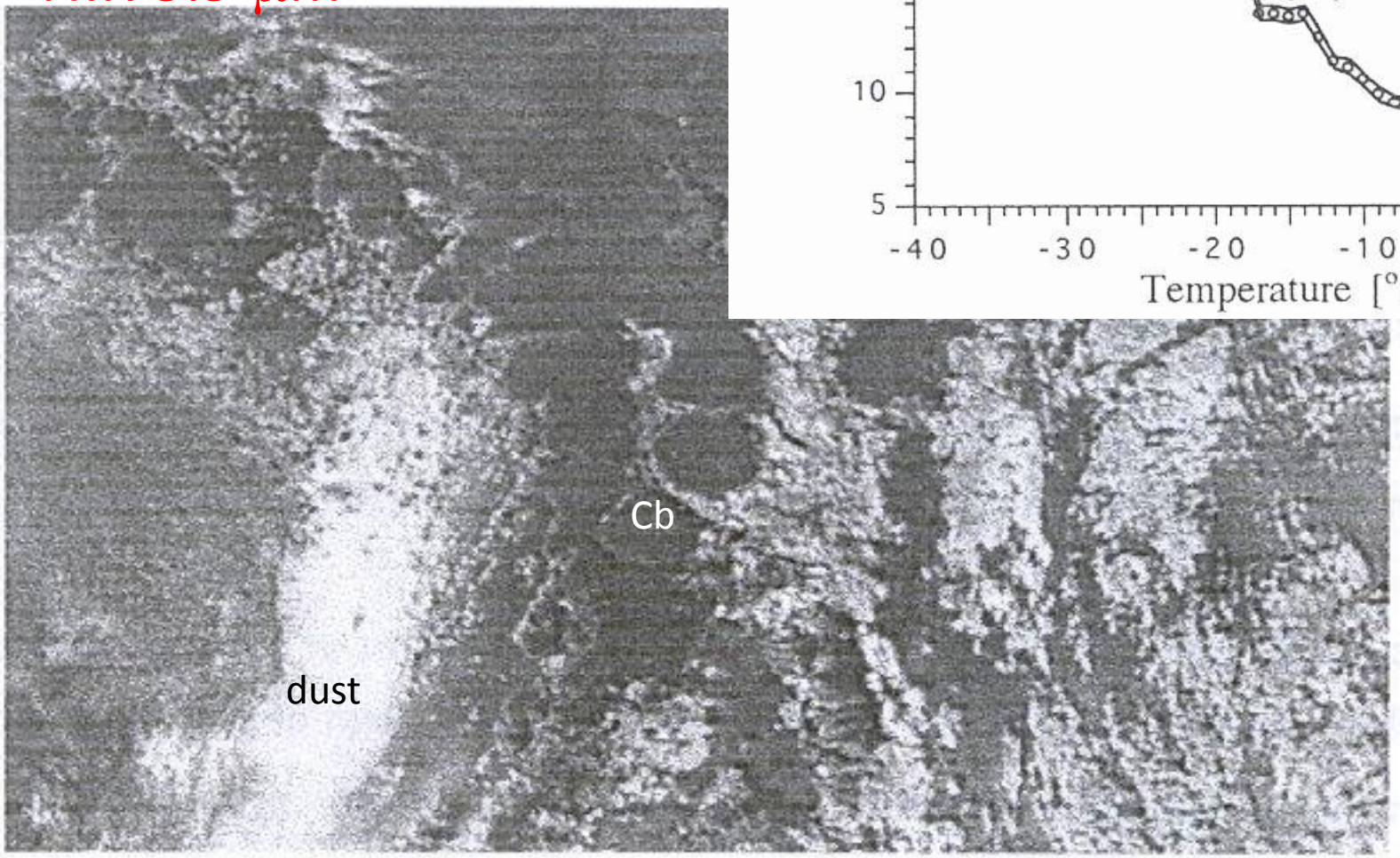
Parametrization of r_{eff} under different aerosol conditions

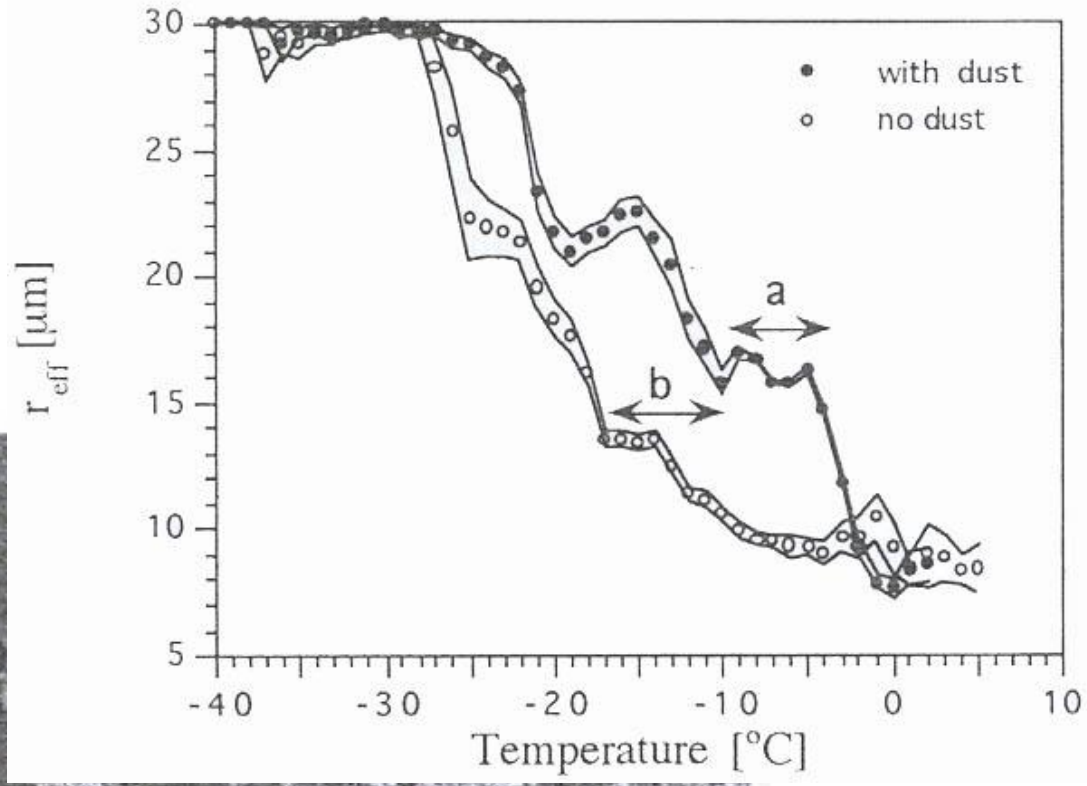


Aircraft Obs.

The effect of aerosols on r_{eff} Satellite image

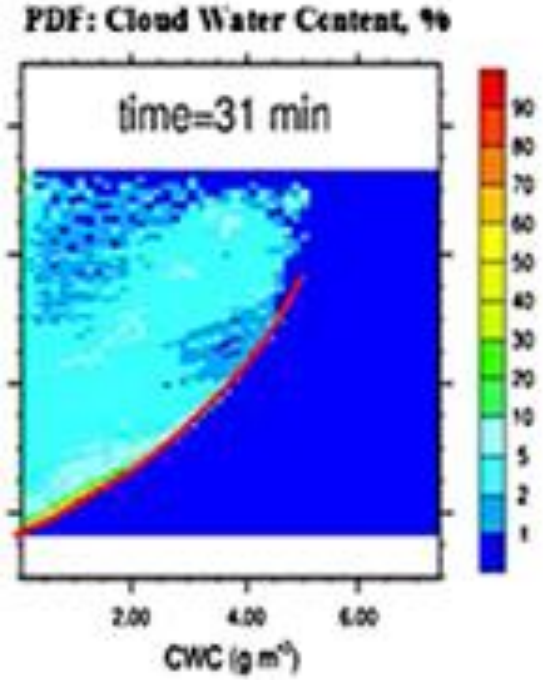
NIR 3.9 μm



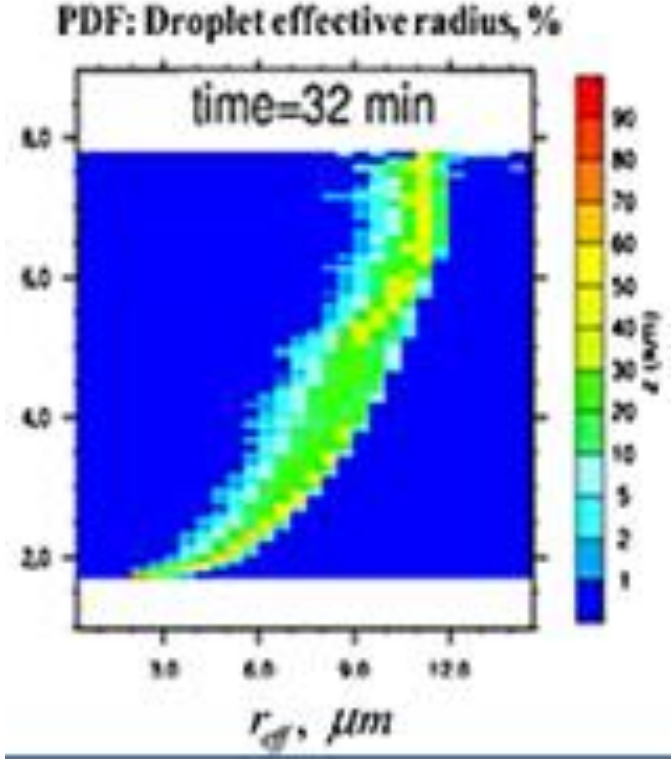


microphysical cloud models

- Hebrew University cloud model (HUCM).
- System Atmospheric Modeling with spectral bin microphysics (SAM-SBM).

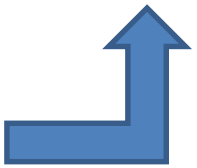


LWC/LWC_{ad}



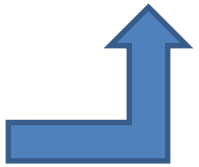
Testing & Tuning

- Case studies – “expert tuning” – defining sensitive parameters.
- CALMO methods - automatic parameters tuning by a “Meta-Model”.
- Verify against observations.



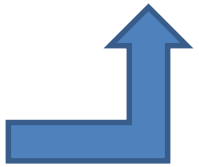
Expert tuning

- Idealized COSMO & full COSMO model.
- Case studies to defining sensitivities in order to reducing the 32 user-defined parameters (UB, PH, HM).



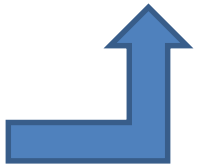
CALMO methodology

1. Ranking the sensitivity of 25 new continuous parameters.
2. Choosing the most sensitive and perform automatic tuning taking into account parameter interactions.



Testing the radiation code against experimental datasets

- Moscow State University Meteorological Observatory.
- clear sky conditions: 15 - 20 cases
- cloudy conditions: 30 - 50 cases
- evaluate the forecast sensitivity to aerosol/cloud characteristics applied in the radiative scheme.



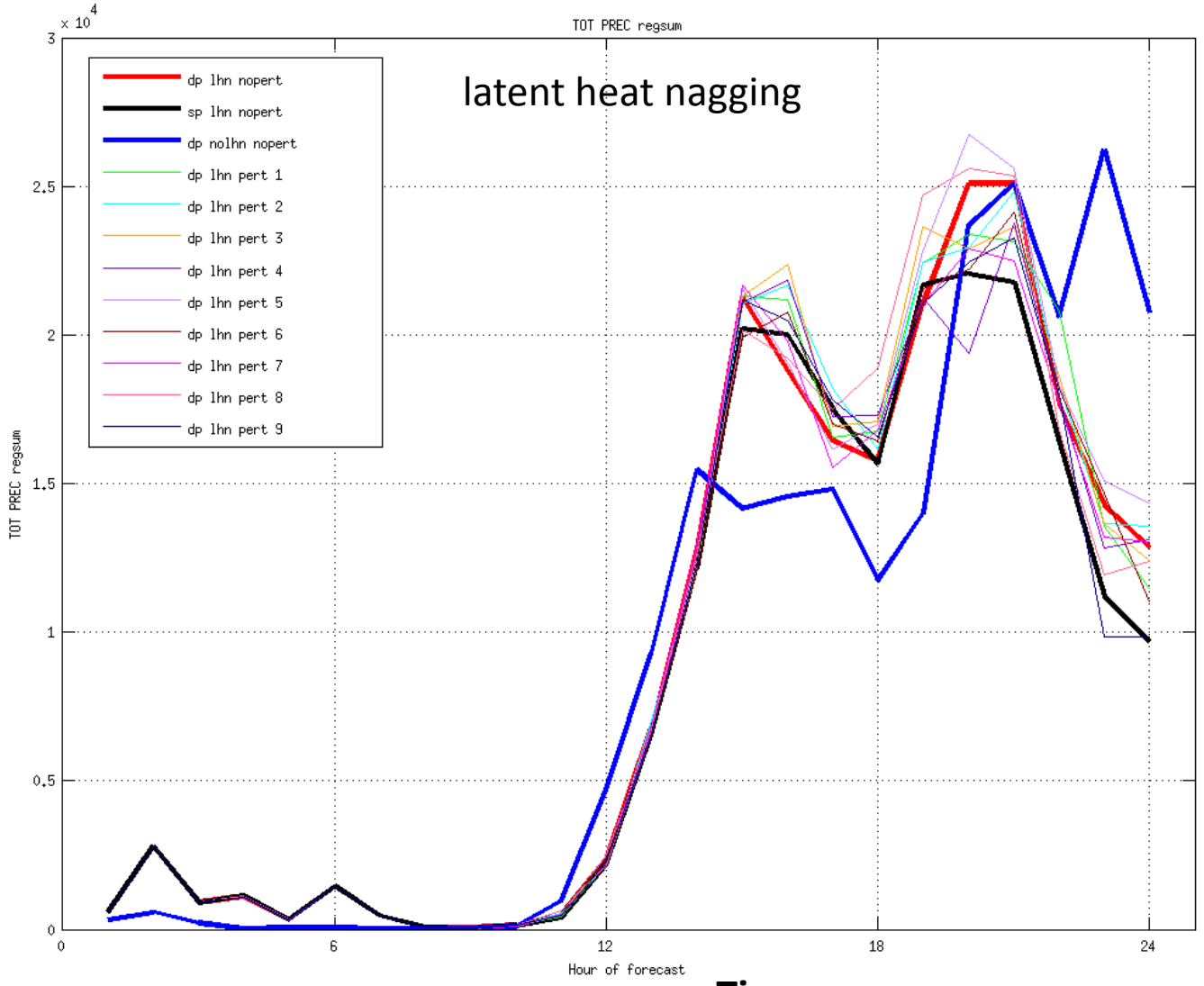
Optimizing expensive CPU time

- Radiation scheme current call time:

What is the optimal call to calculate the radiation fluxes?
What happens in fast changing thunderstorms?

switchable single/double precision to radiation scheme

Total Precip.



W/O latent heat

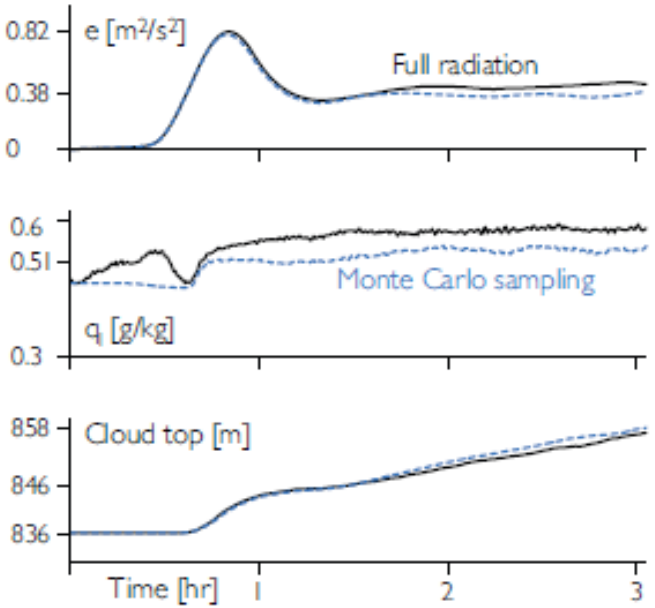
Double precision

Single precision

Time

Monte-Carlo Spectral Integration

- Bias free random sampling of the 8 spectral bands, instead of full spectral integration over every band in each radiation time step.
- The error introduced is substantial for individual samples but is uncorrelated in time and space.



Pincus and Stevens 2009

The FTE Price

Estimated resources (in FTE per year) needed for COSMO-year 2015-2016:

Ulrich Blahak	***0.25 FTEs***
Matthias Raschendorfer	***0.1 FTEs***
Pavel Khain	***0.4 FTEs***
HarelMuskatel	***0.7 FTEs***
Alon Shtivelman	***0.4 FTEs***
Oliver Fuhrer	***0.1 FTEs***
Xavier Lapillonne	***0.1 FTEs***
Alexey Poliukhov	***0.2 FTEs***
Nataliya Chubarova	***0.2 FTEs***
Marina Shatunova	***0.2 FTEs***
Gdaly Rivin	***0.1 FTEs***

Total:	***2.75FTEs***

2016-2017

Total: ***2.55 FTEs***

Happy new COSMO year