

Overview of the interpolation methods, analysis of the main error sources and outlook



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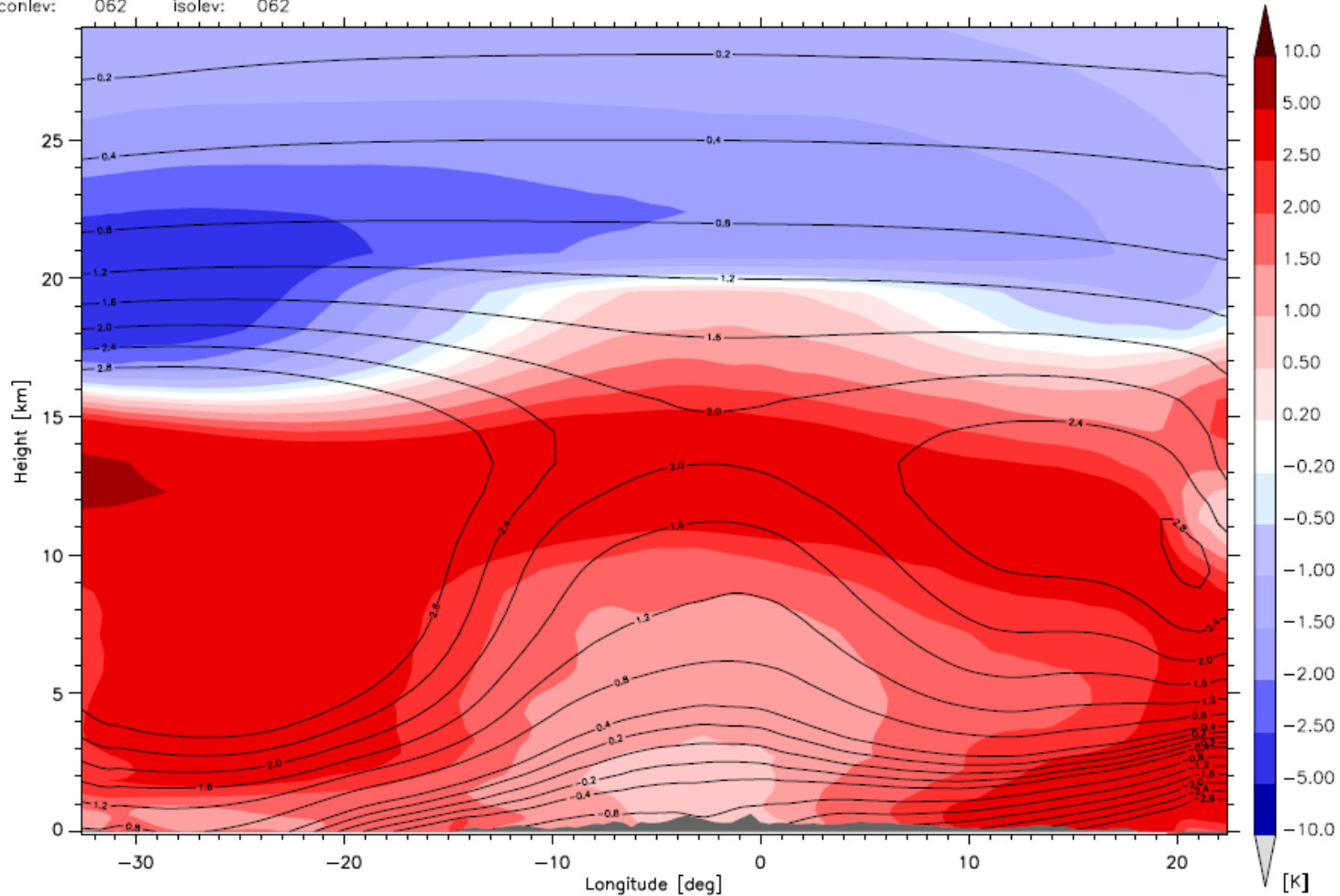


Overview

- 1. Motivation: Initial and boundary effects in NWP and RCM simulations**
- 2. Horizontal interpolation methods in int2lm**
- 3. Vertical interpolation method in int2lm**
 - 1. Interpolation and initial conditions**
 - 2. Interpolation and boundary conditions**

DIFF: Temperature TWN005–TWN006, 2009–200907
DIFF: PP, TWN005–TWN006, 2009–2009

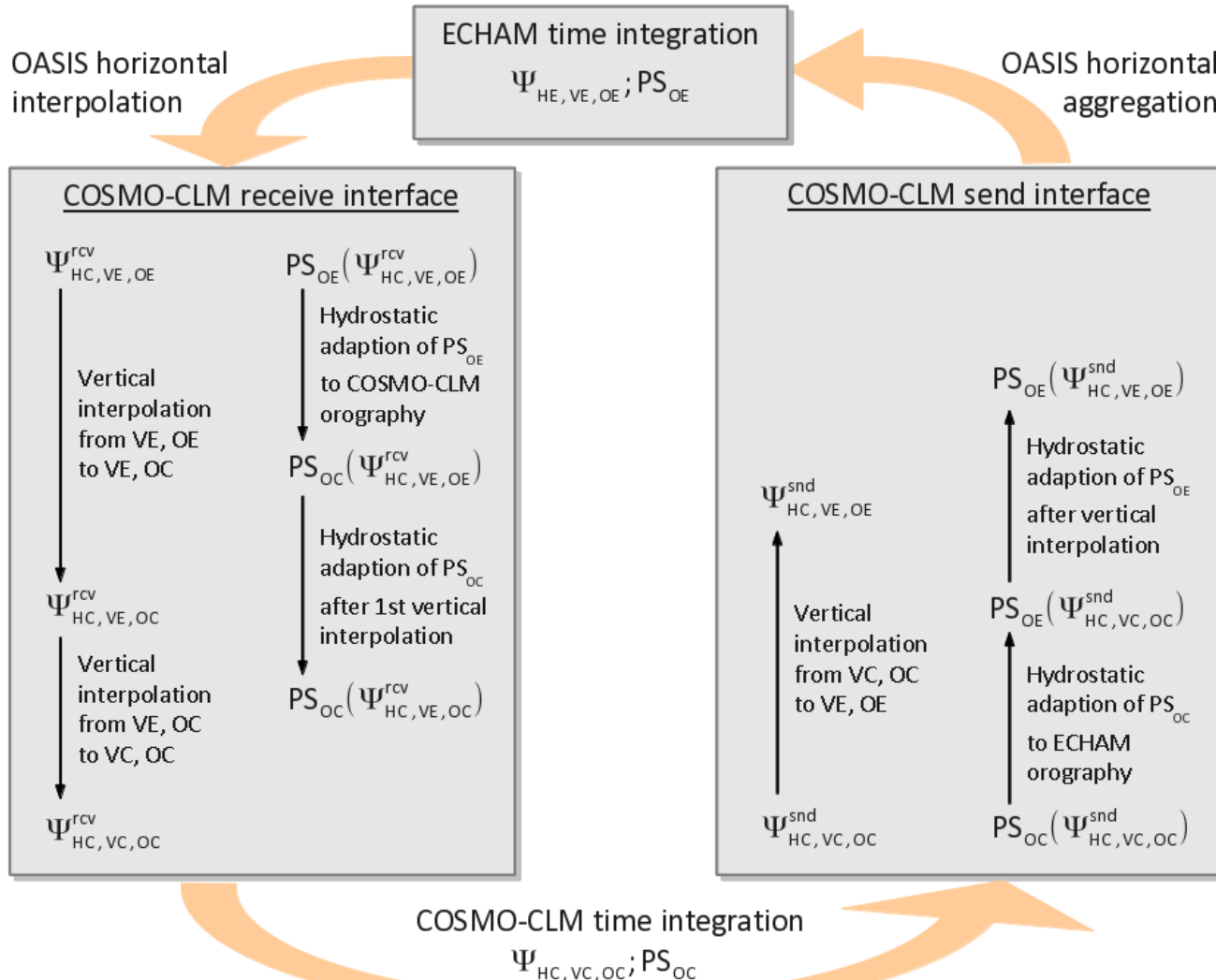
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2-way system

int2lm
p2z-levels

in COSMO via OASIS3-MCT
z2p-levels



1. Soil and Vegetation Variables

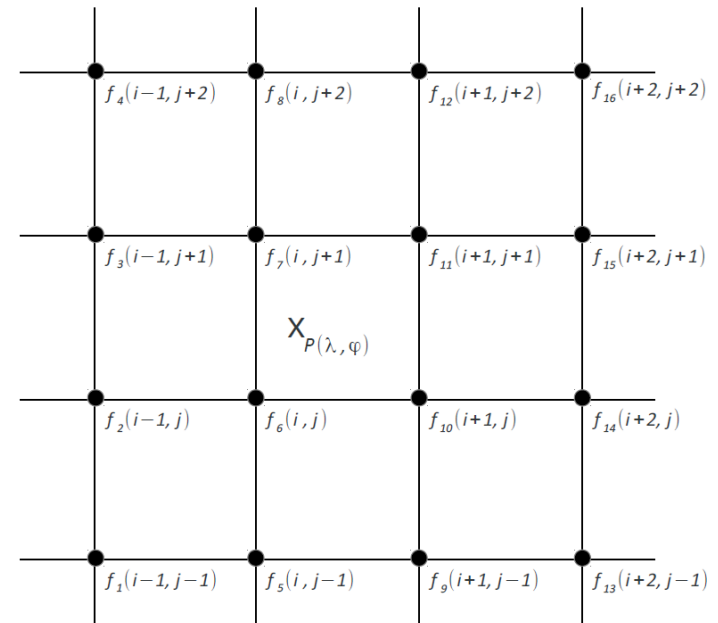
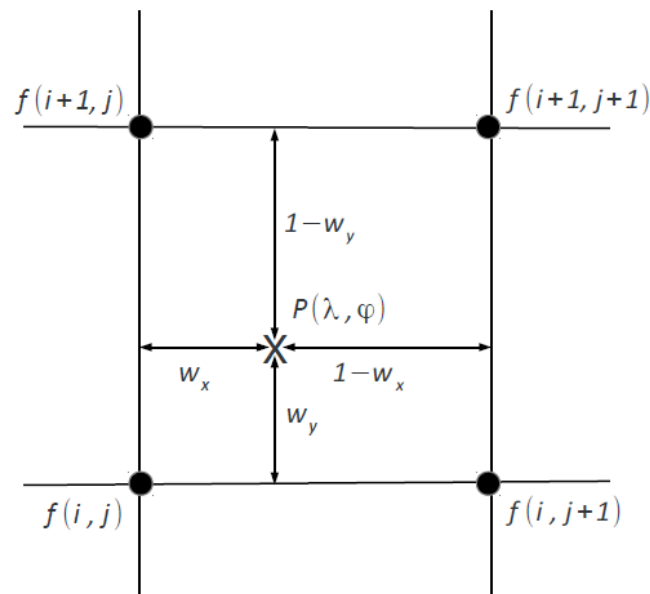
Nearest neighbour / bilinear / Cressmann (IDW-method) (removed)

2. Atmospheric Variables

quadratic (GME)

/

bicubic spline



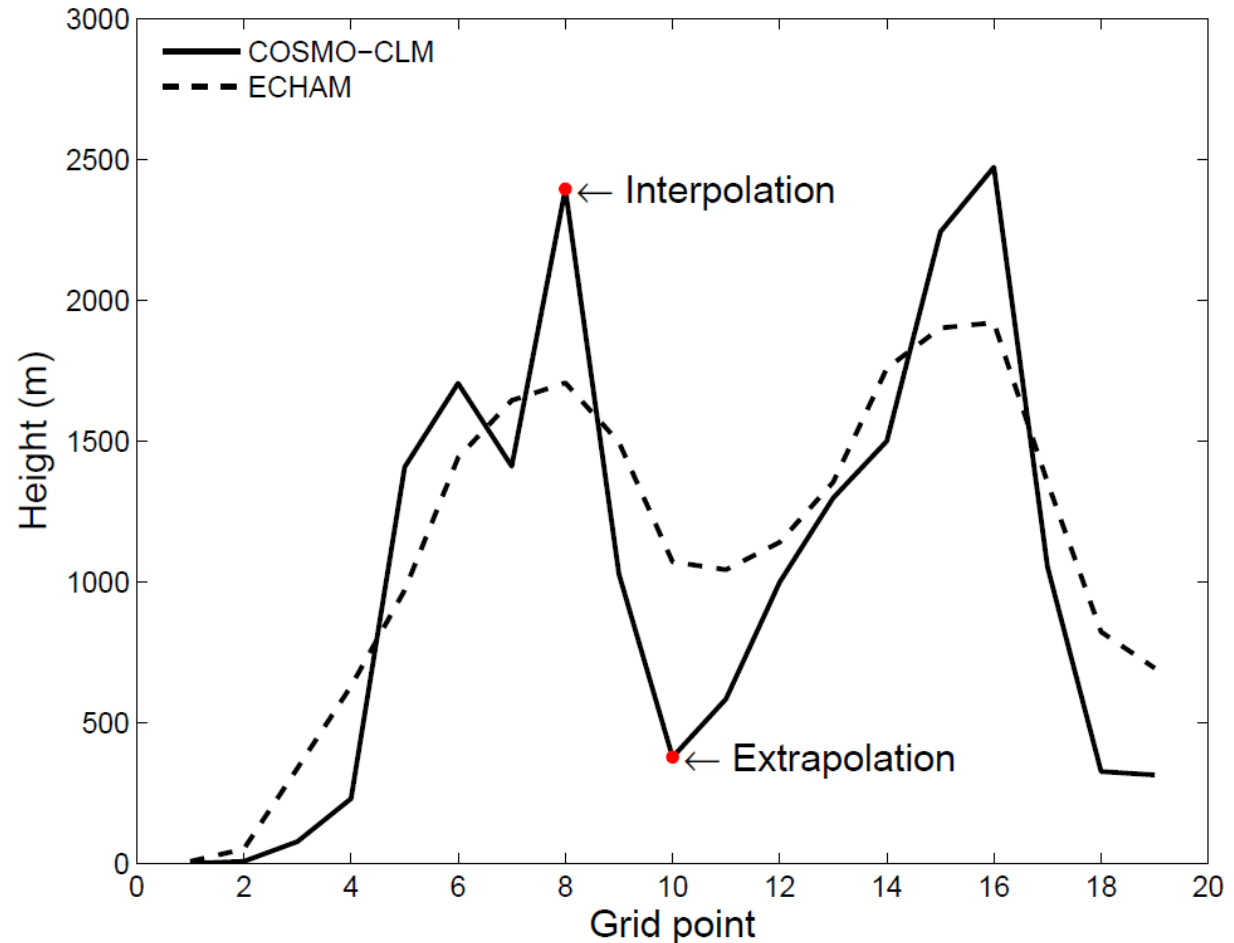
2. Atmospheric Variables

quadratic (GME) / bicubic spline

The accuracy of the horizontal interpolation of T and PP affects the total accuracy of the 3D interpolation. The numerical errors of the horizontal interpolation can be amplified by the vertical interpolation !!!

Inter- and extrapolation of the atmospheric variables PP, T, U,V, W, QX
From vertical grid of the driving model to those of the COSMO model

Example:
ECHAM L47 (80km) /
T63 (320km)
→
COSMO L45 (30km) /
0.44° (50km)



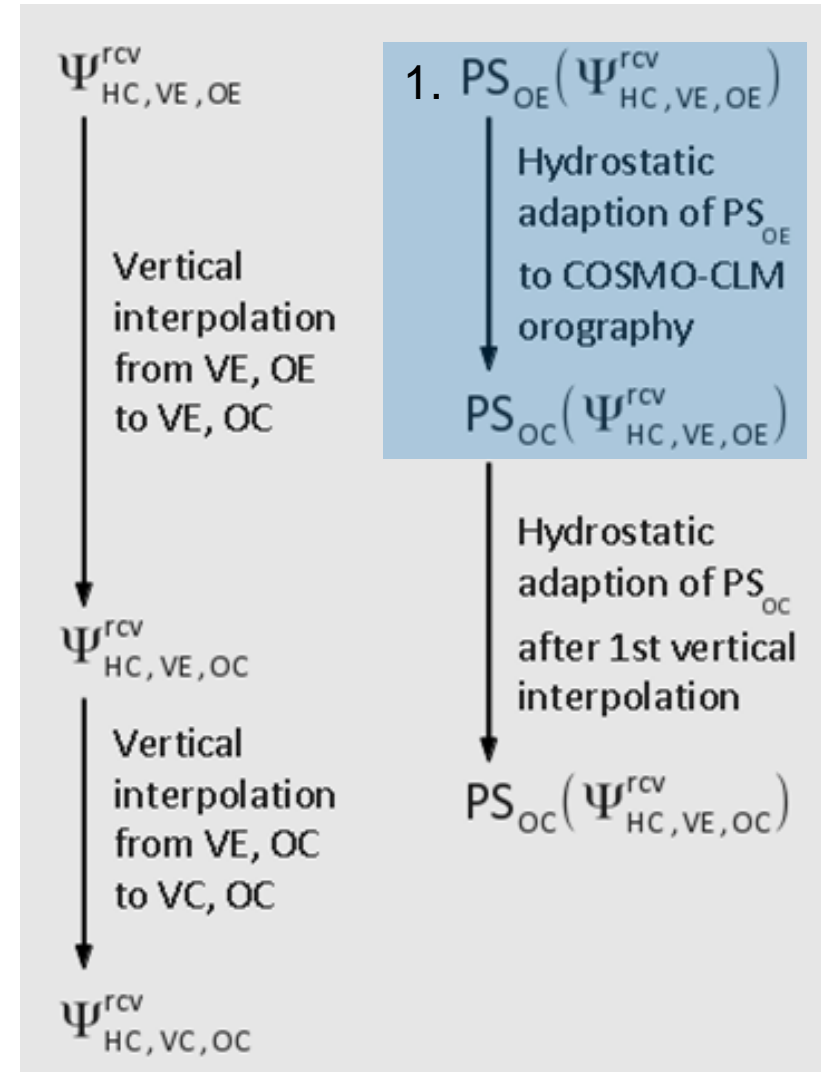
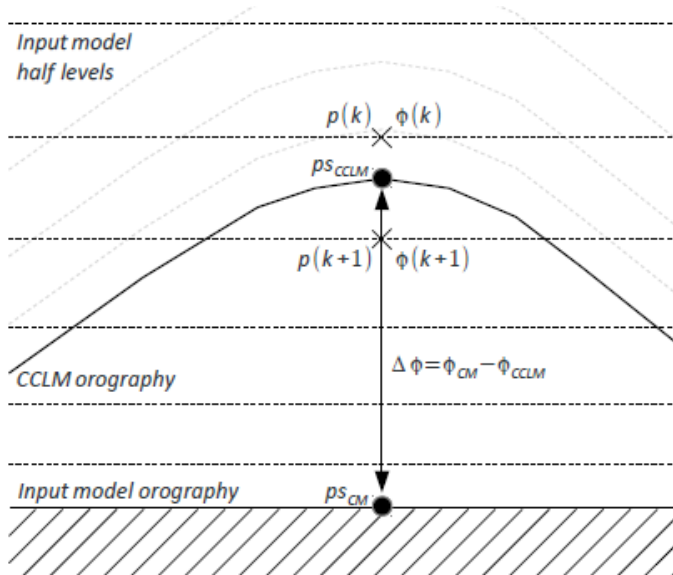
The vertical interpolation of field $\psi(p)$ requires ps on COSMO orography

1. PS

Orography ECHAM \rightarrow Orogr. COSMO

$PS_{OE} \rightarrow PS_{OC}$

- First guess using barometric height formula and mean virtual temperature



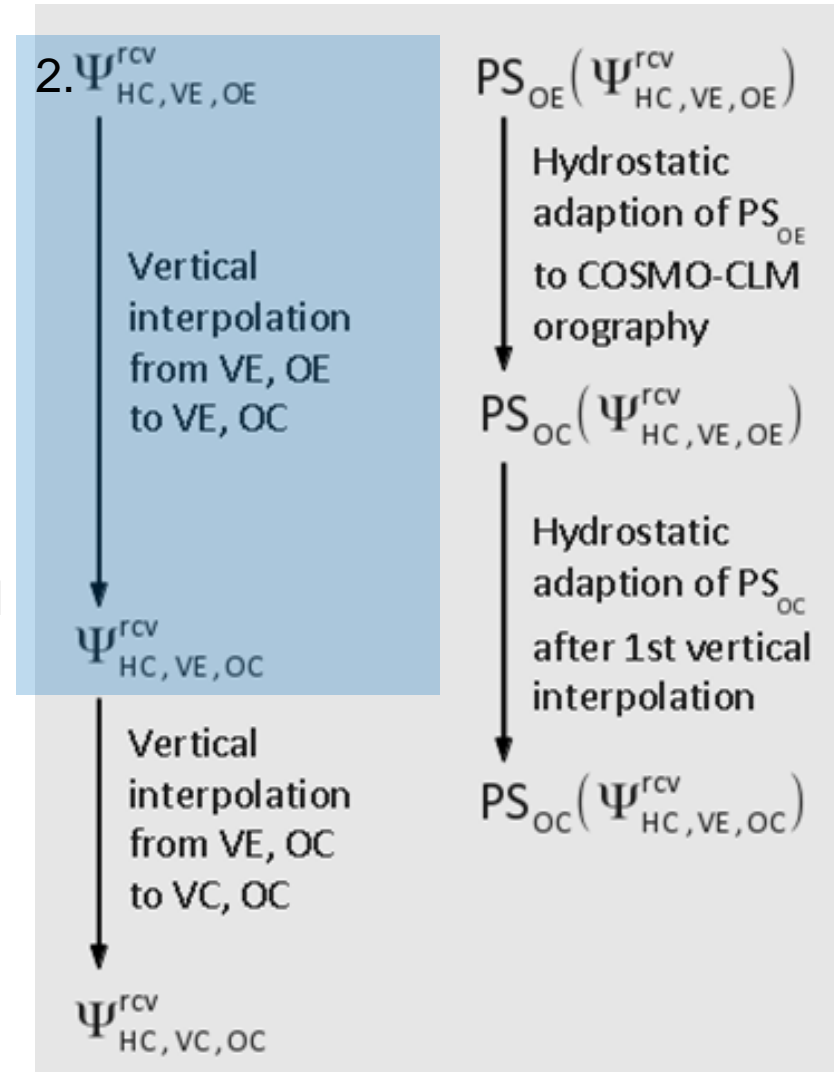
2. Ψ

Orography ECHAM \rightarrow Orogr. COSMO

$$\Psi_{OE}(k_E) \rightarrow \Psi_{OC}(k_E)$$

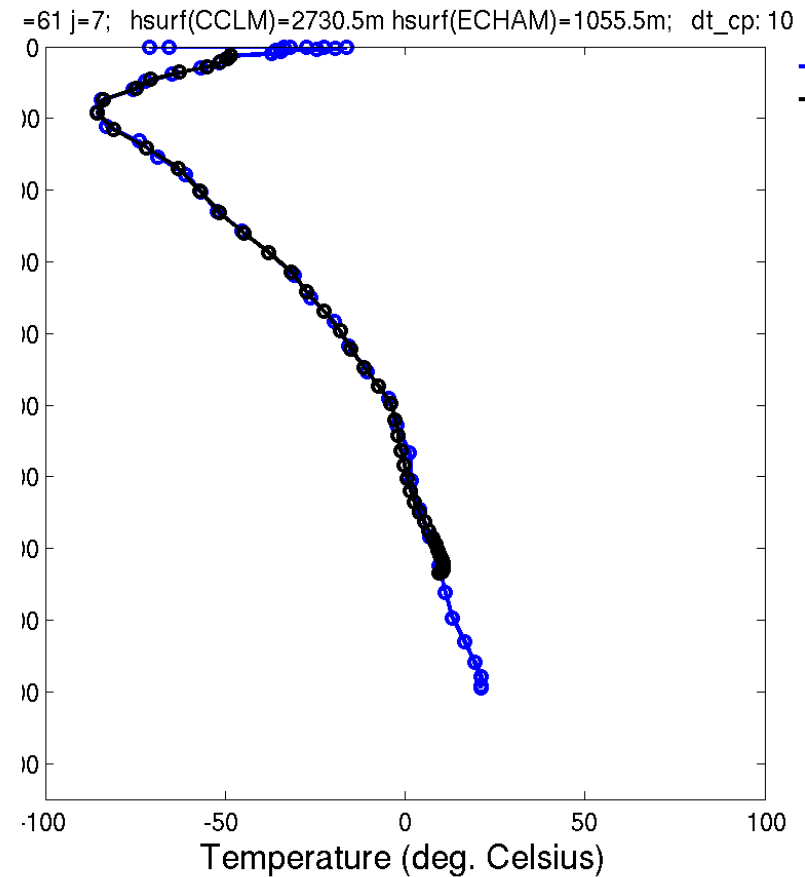
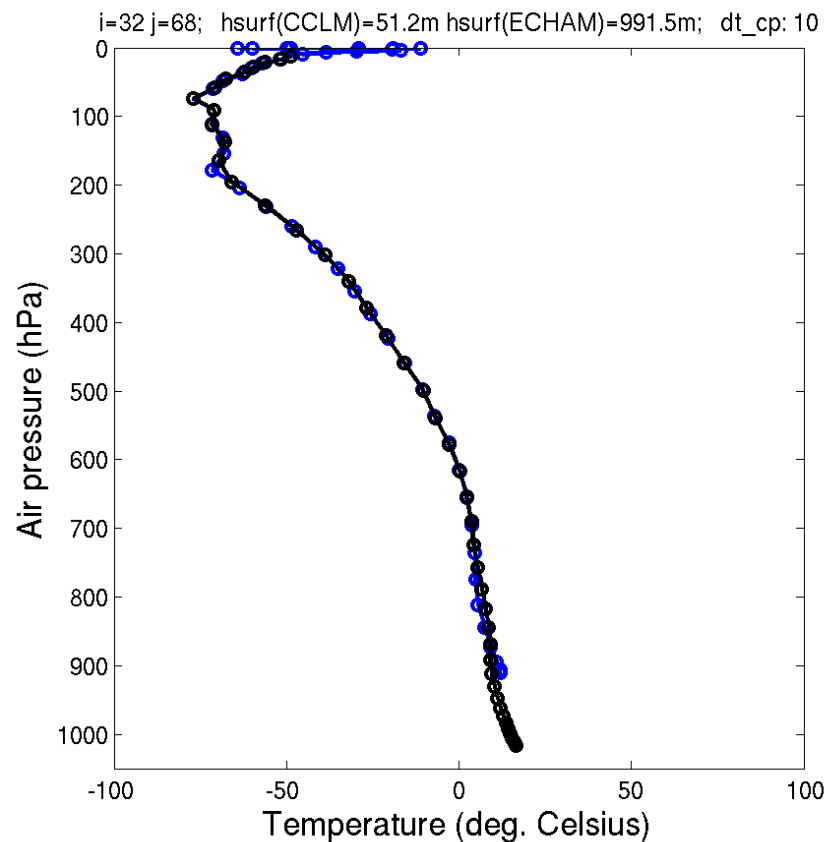
General procedure

- Select k_{ref} at 850hPa above sea points
- shift the profile between k_{ref} and k_{max} to COSMO orography
- remove / add gridpoints to shift the BL profil
- assumption of constant gradient or value of the field variable to shift the BL profile

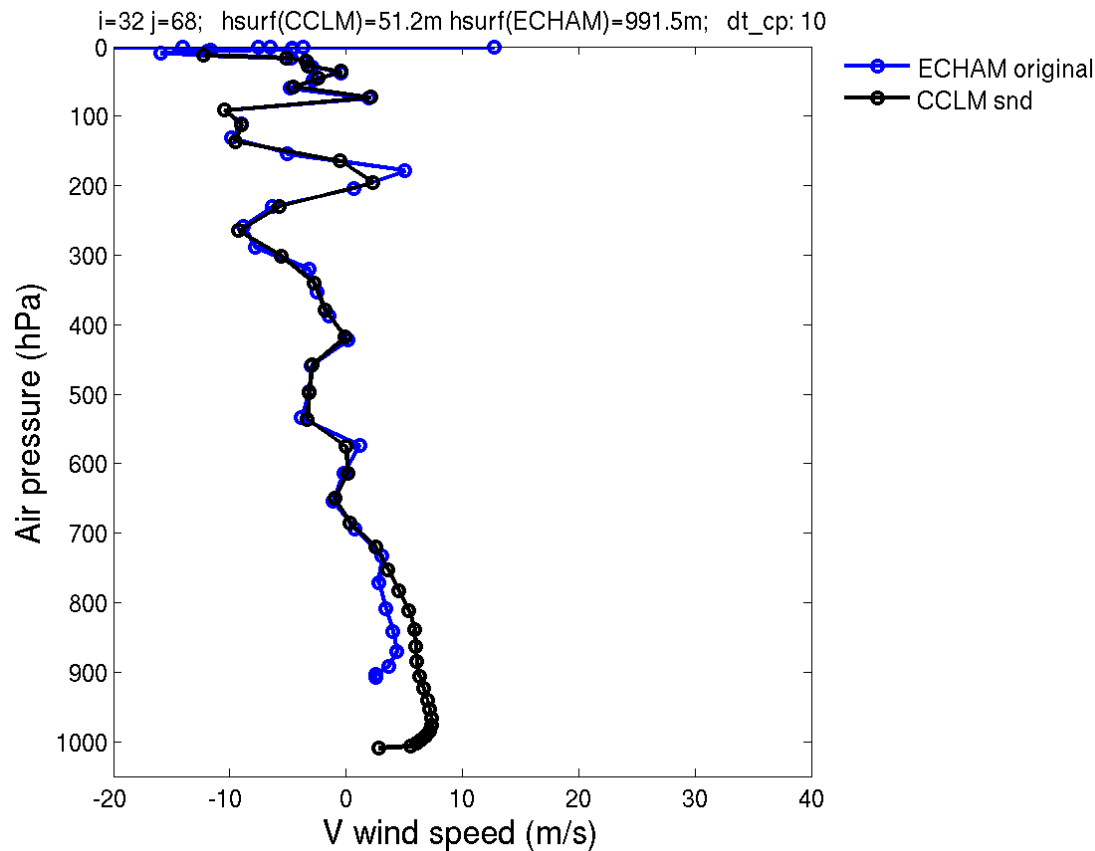


Interpolation

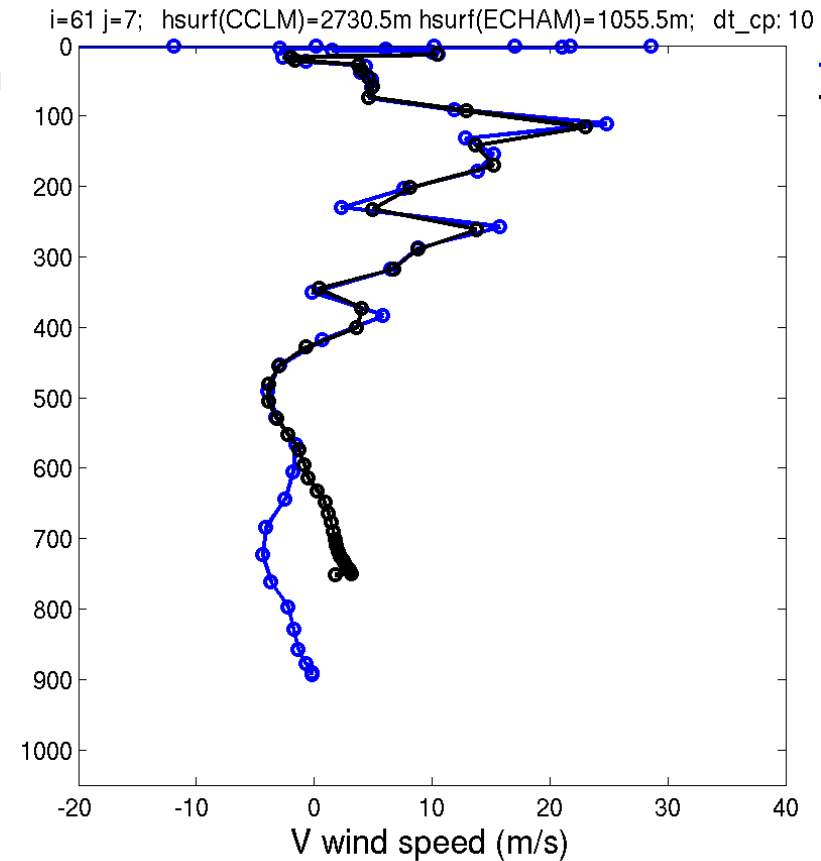
Extrapolation



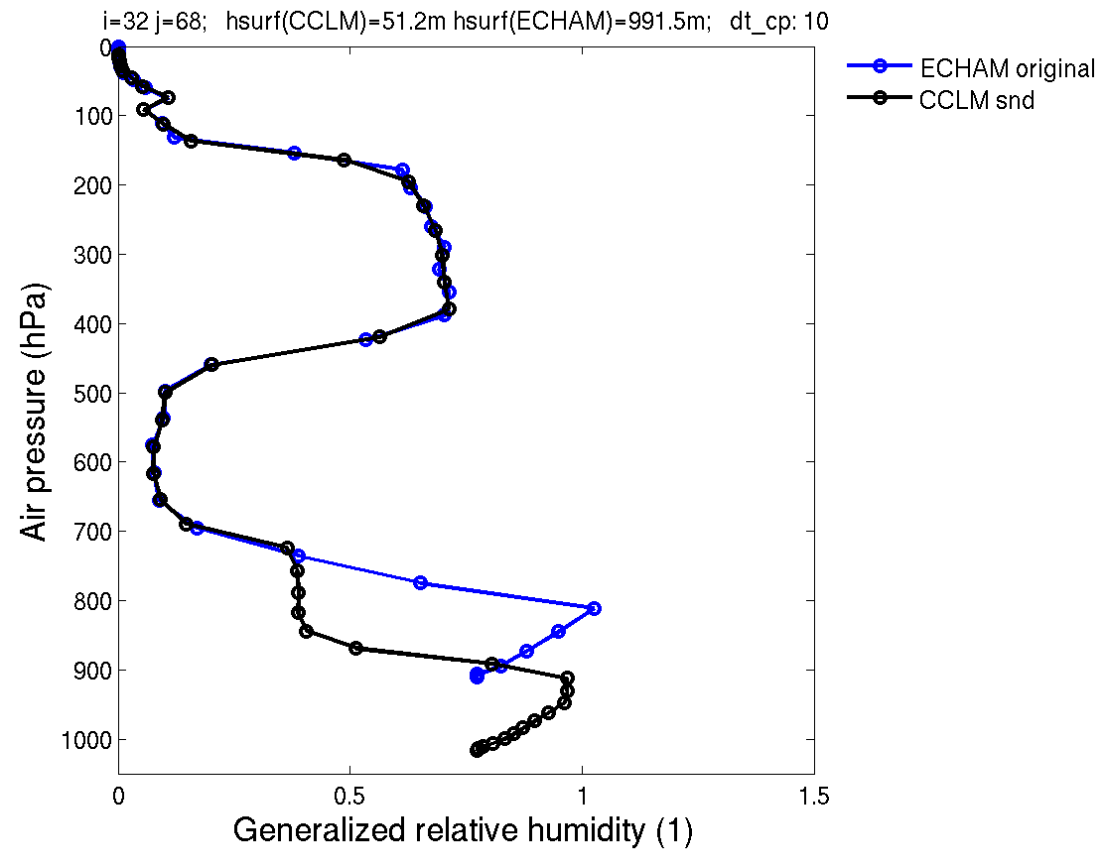
Interpolation



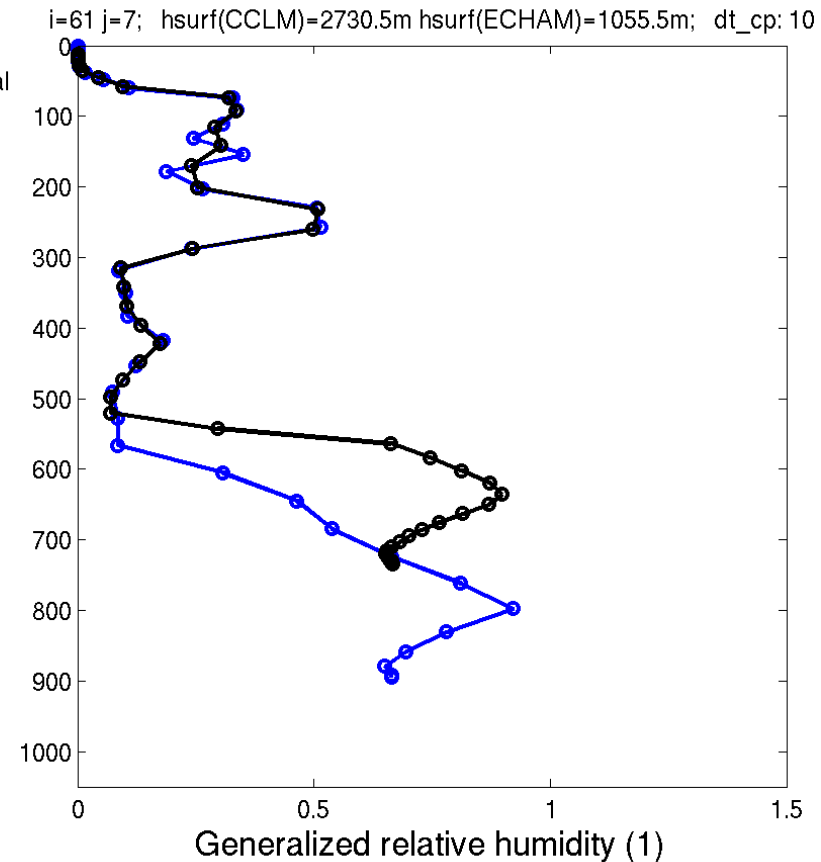
Extrapolation



Interpolation



Extrapolation



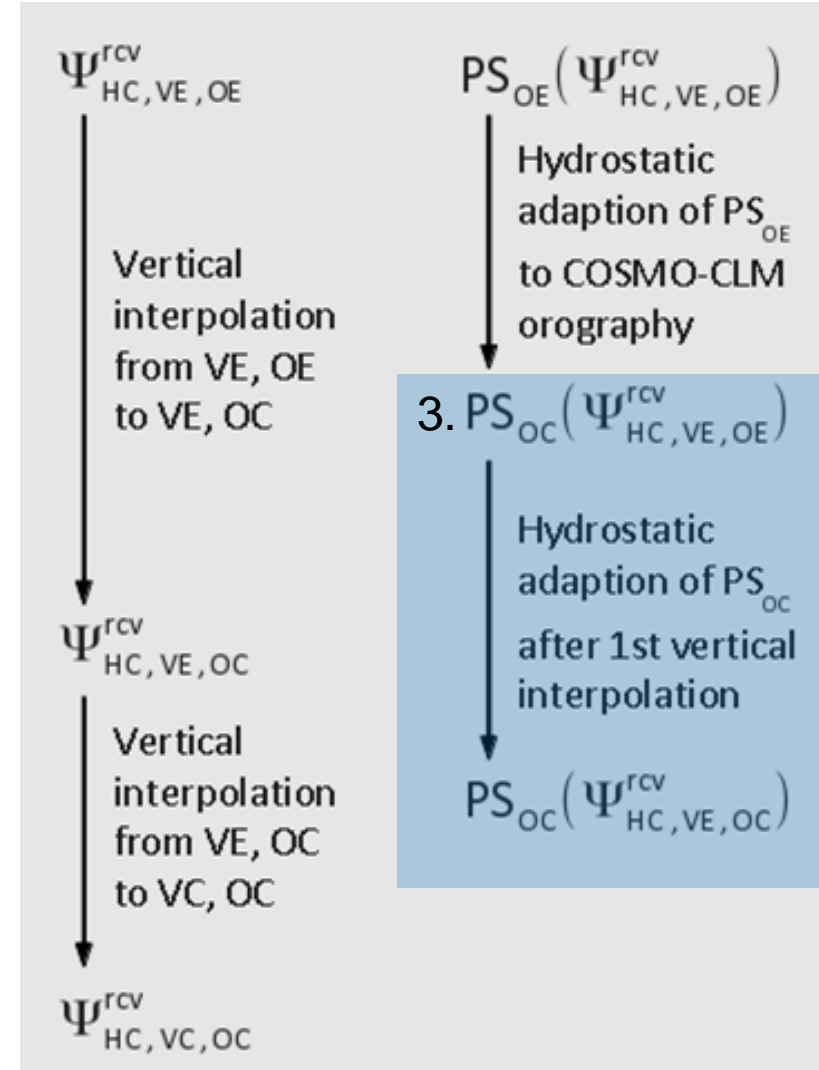
3. PS

Pressure adaption

$$\mathbf{PS}_{OC} \rightarrow \mathbf{PS}_{OC}(\Psi_{new})$$

General procedure

1. Calculate the geopotential height of the 300 hPa level and compare with ECHAMs 300 hPa level.
2. Correct PS accordingly and repeat step 1.



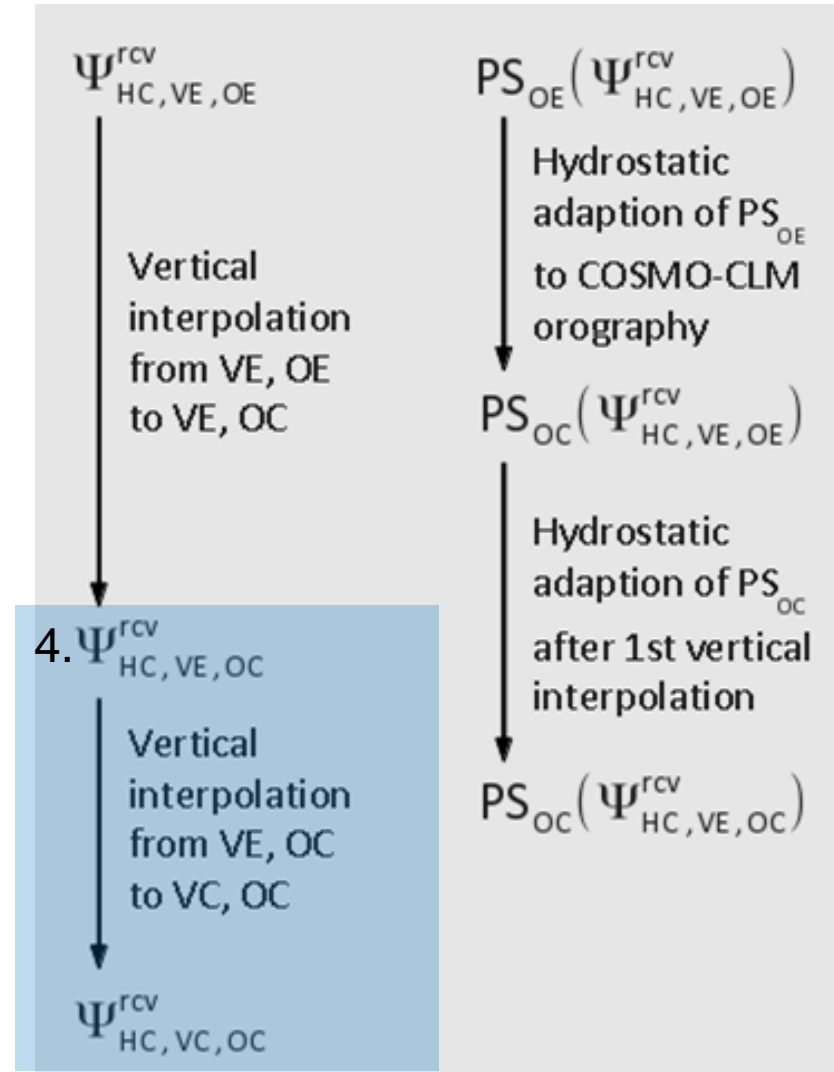
4. ψ

Final interpolation to COSMO levels

$$\Psi_{VE,OC} \rightarrow \Psi_{VC,OC}$$

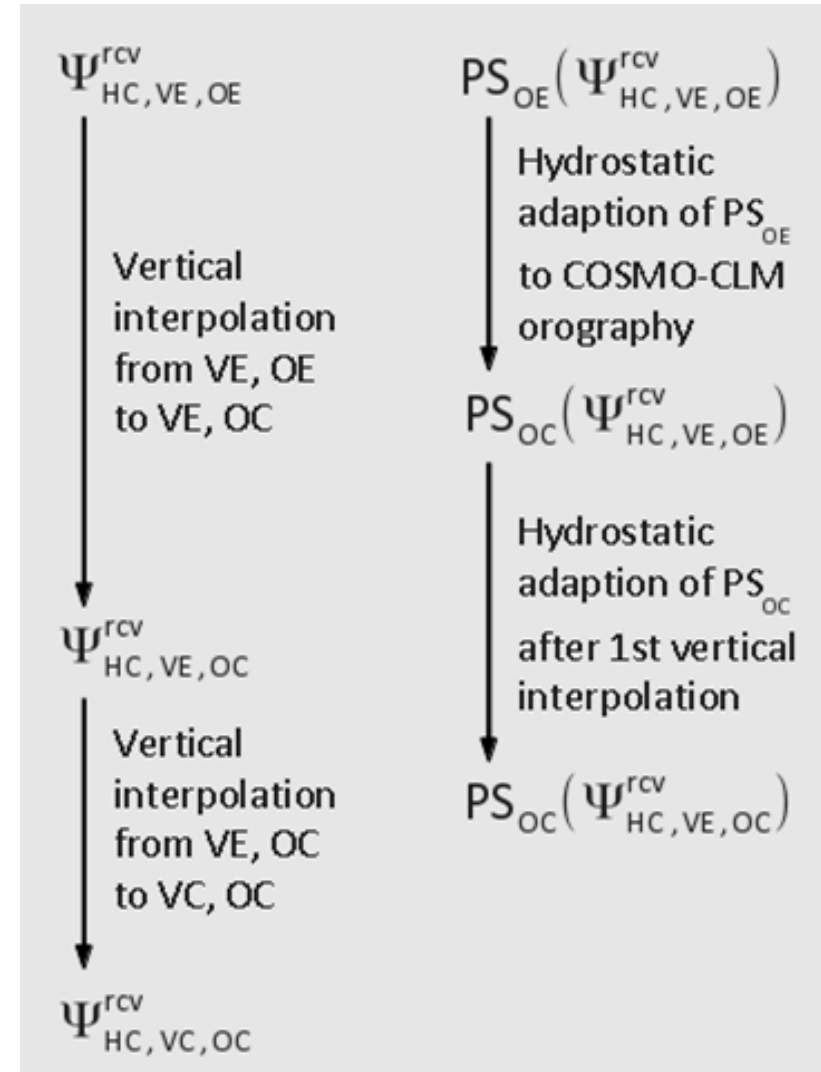
General procedure

1. Calculate the geopotential height of the COSMO levels using the final pressure
2. Interpolate ψ from ECHAM to COSMO levels



1. Initial conditions

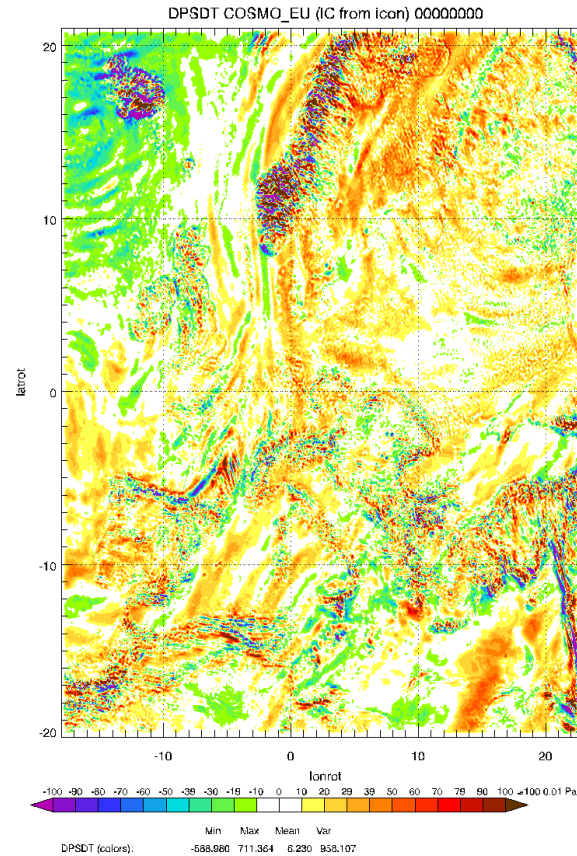
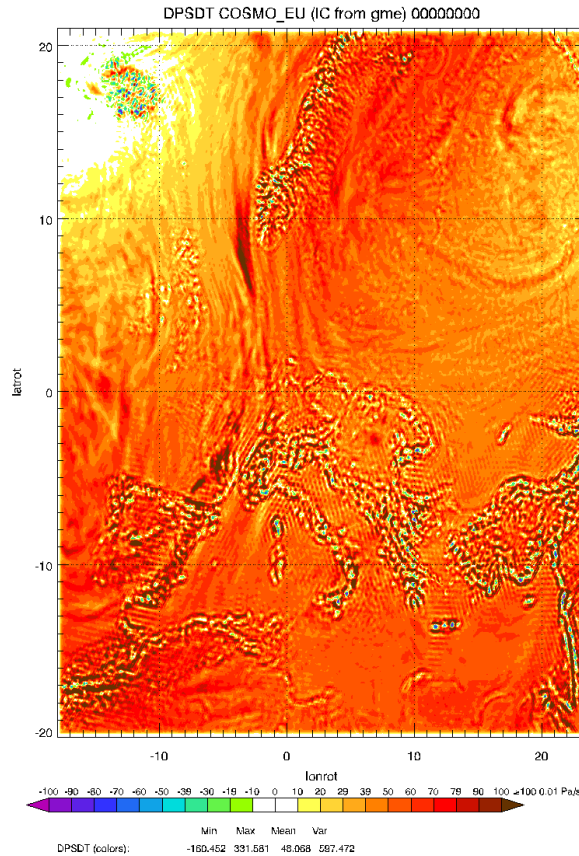
Analysis of pressure tendency as
measure of noise due to
initial and boundary conditions



GME → COSMO-CLM
20 km → 7km,

$\Delta t_{int}=1h$

ICON → COSMO-CLM
13 km → 7km



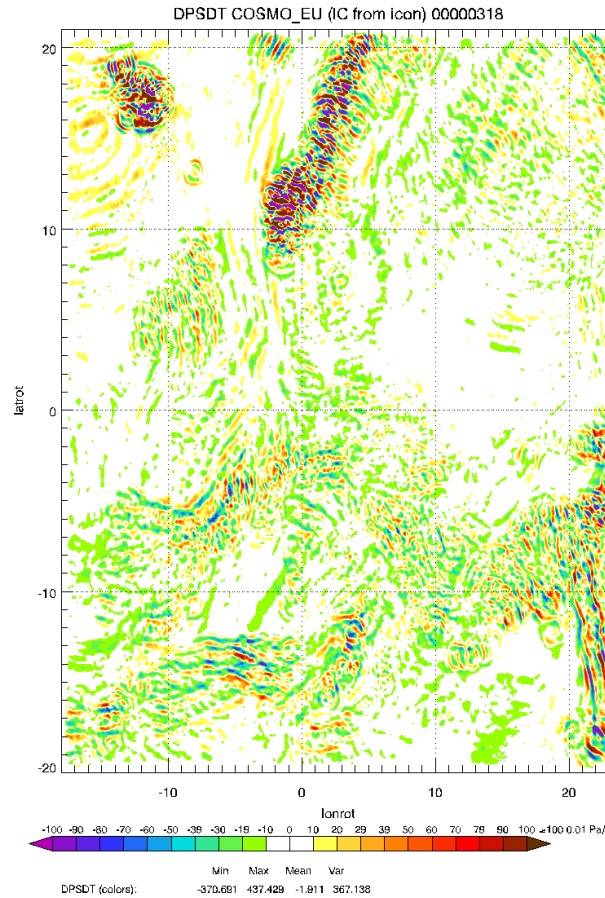
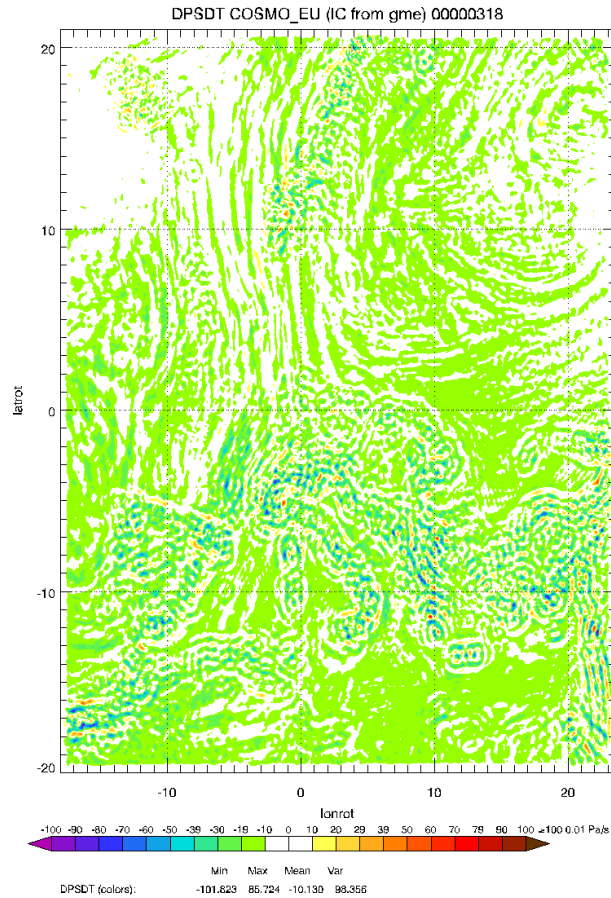
t=0,
nt=0
[Pa/s]

36 hPa/h = 1 Pa/s

GME → COSMO-CLM
20 km → 7km,

$\Delta t_{int}=1h$

ICON → COSMO-CLM
13 km → 7km



t=198s

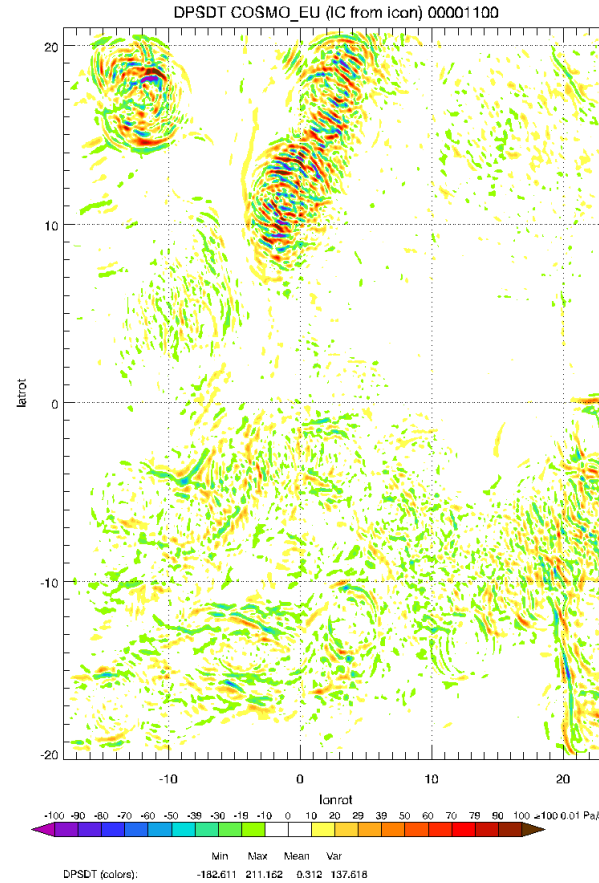
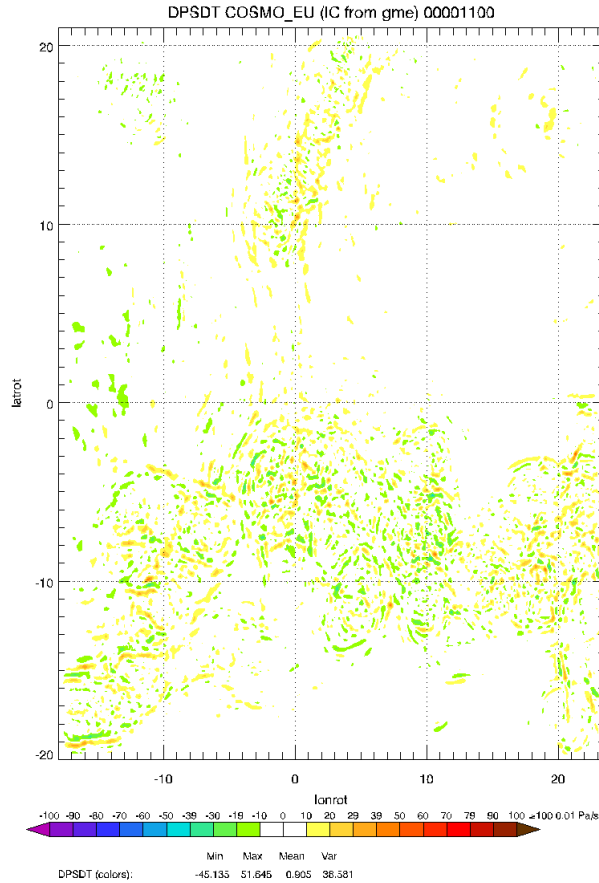
nt=4

[Pa/s]

GME → COSMO-CLM
20 km → 7km,

$\Delta t_{int}=1h$

ICON → COSMO-CLM
13 km → 7km

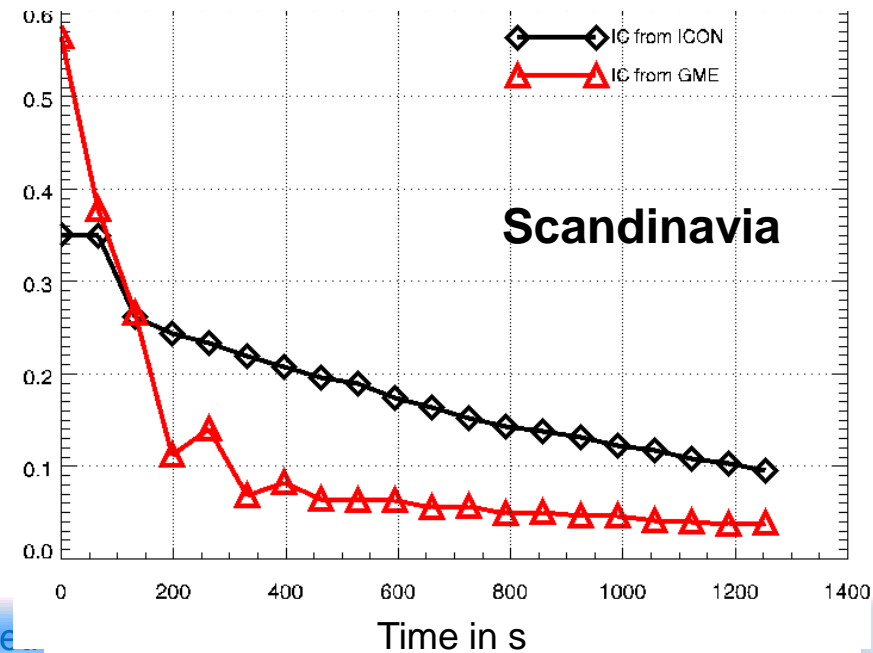
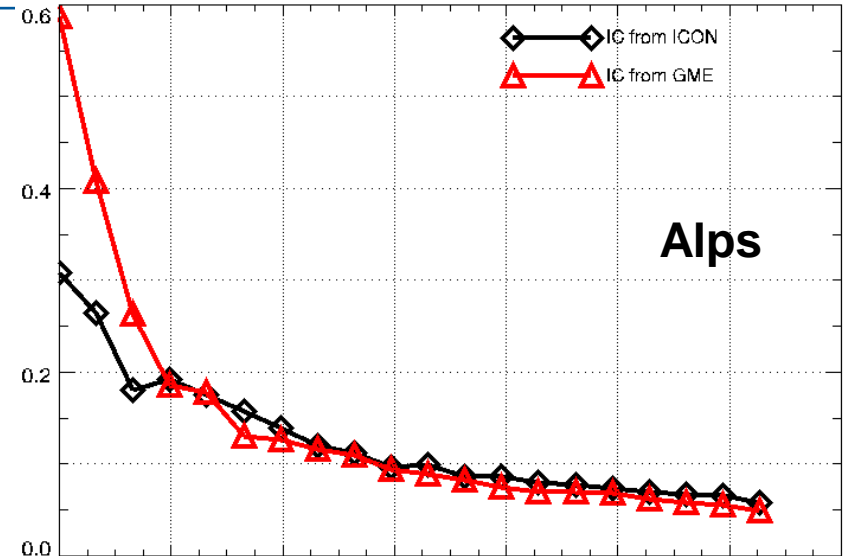
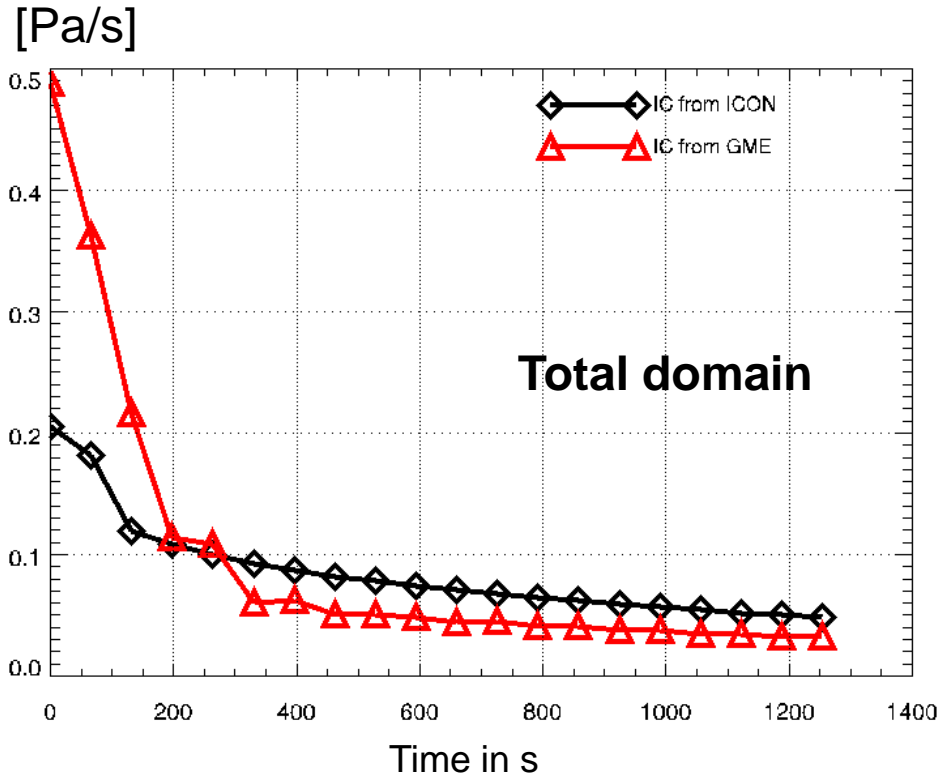


t=660s

nt=10

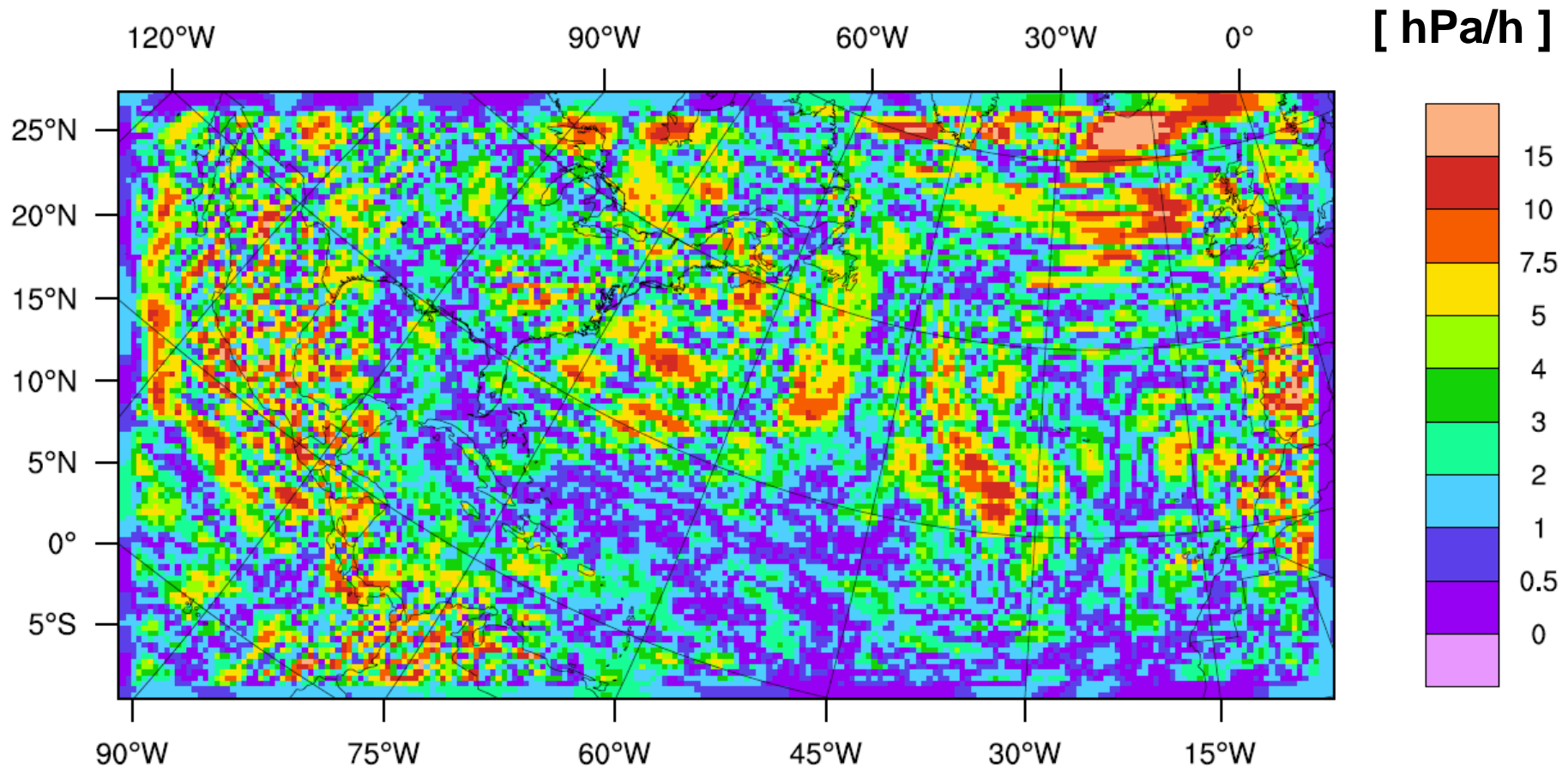
[Pa/s]

ICON/GME → COSMO-EU
20/13 km → 7km, $\Delta t_{int}=1h$



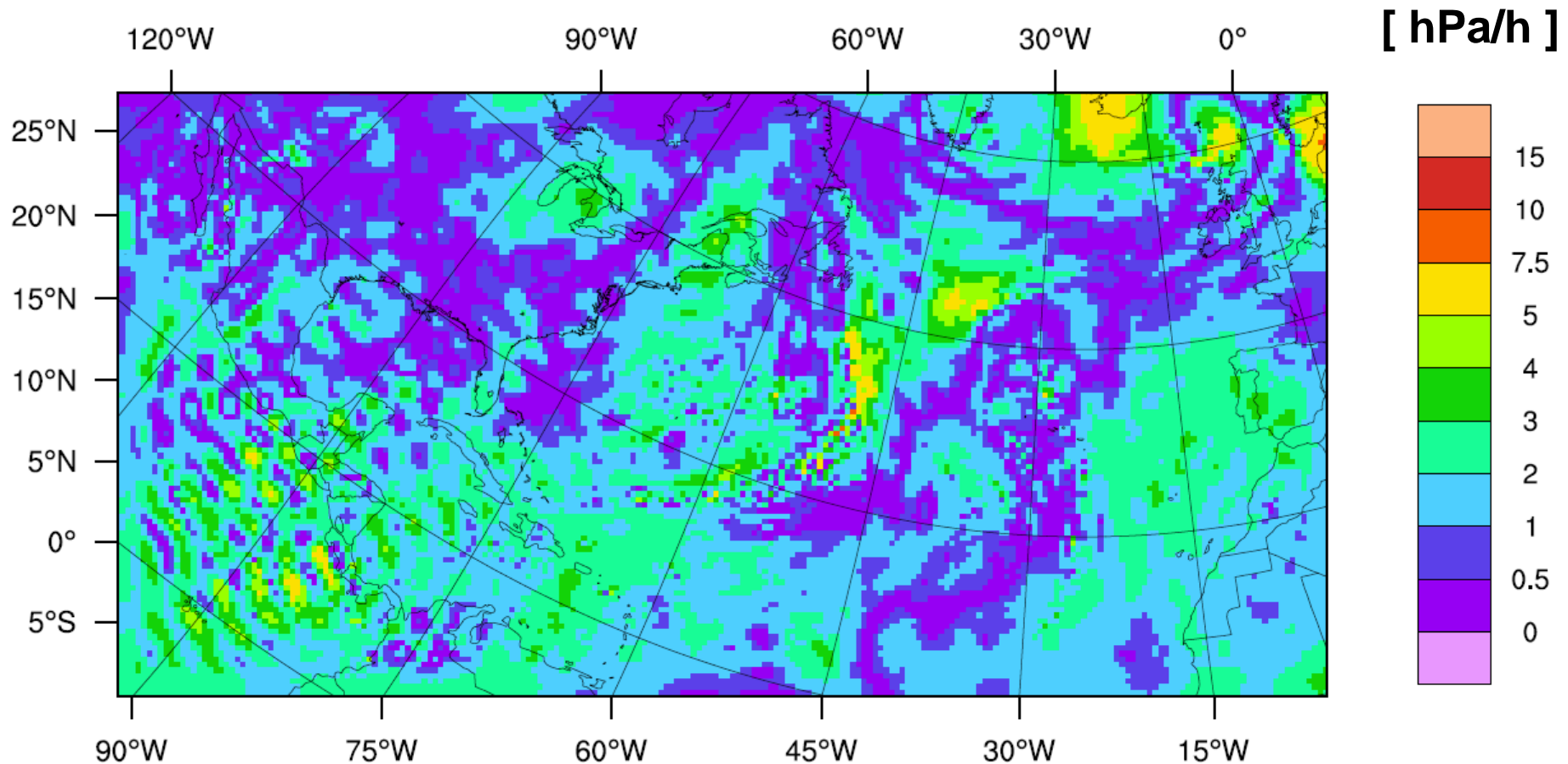
ECHAM6 → COSMO-CLM
300 km → 50km, $\Delta t_{int}=200s$

t=0, nt=0



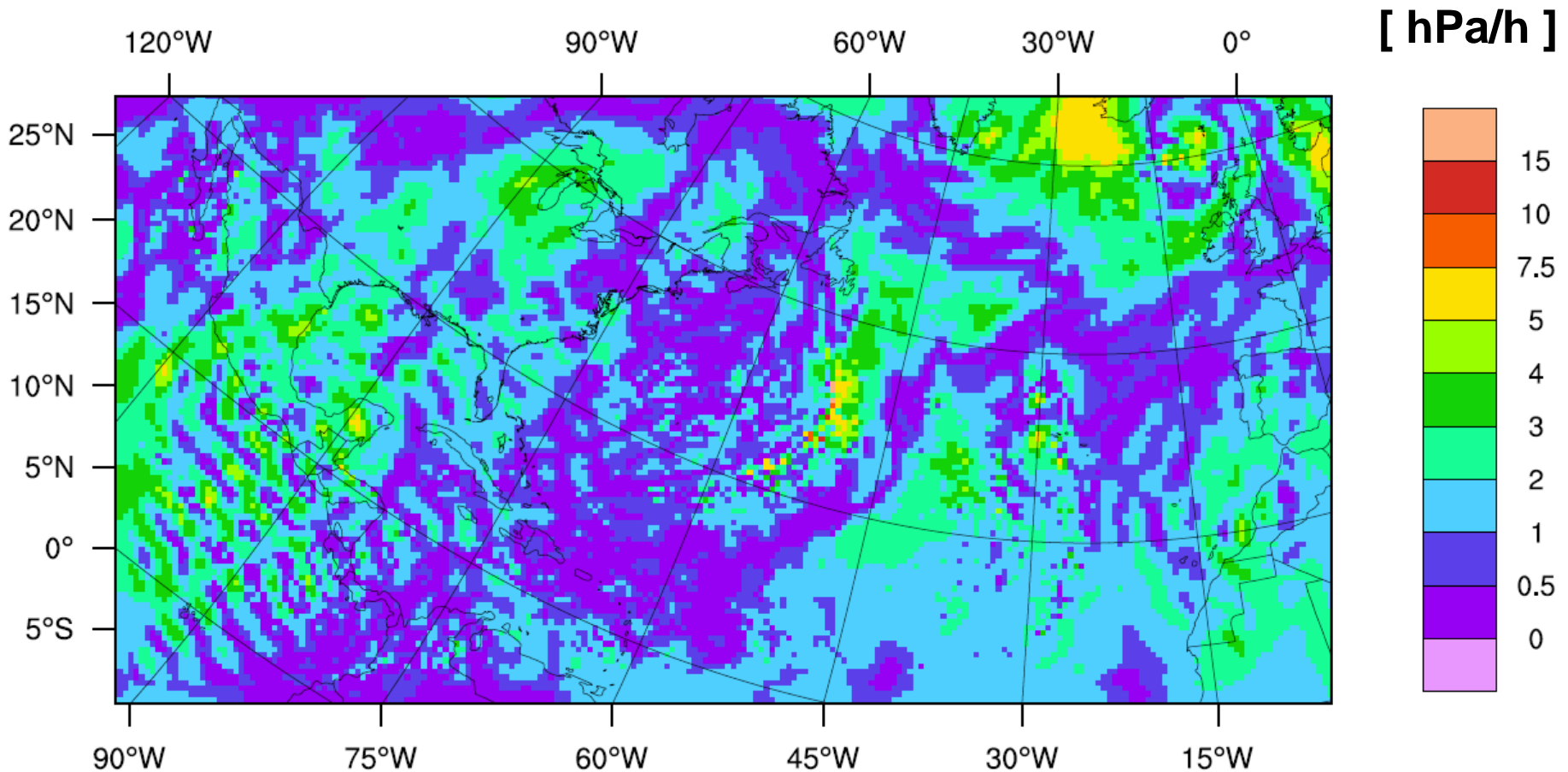
ECHAM6 → COSMO-CLM
300 km → 50km, $\Delta t_{int}=200s$

t=10 000s, nt=50



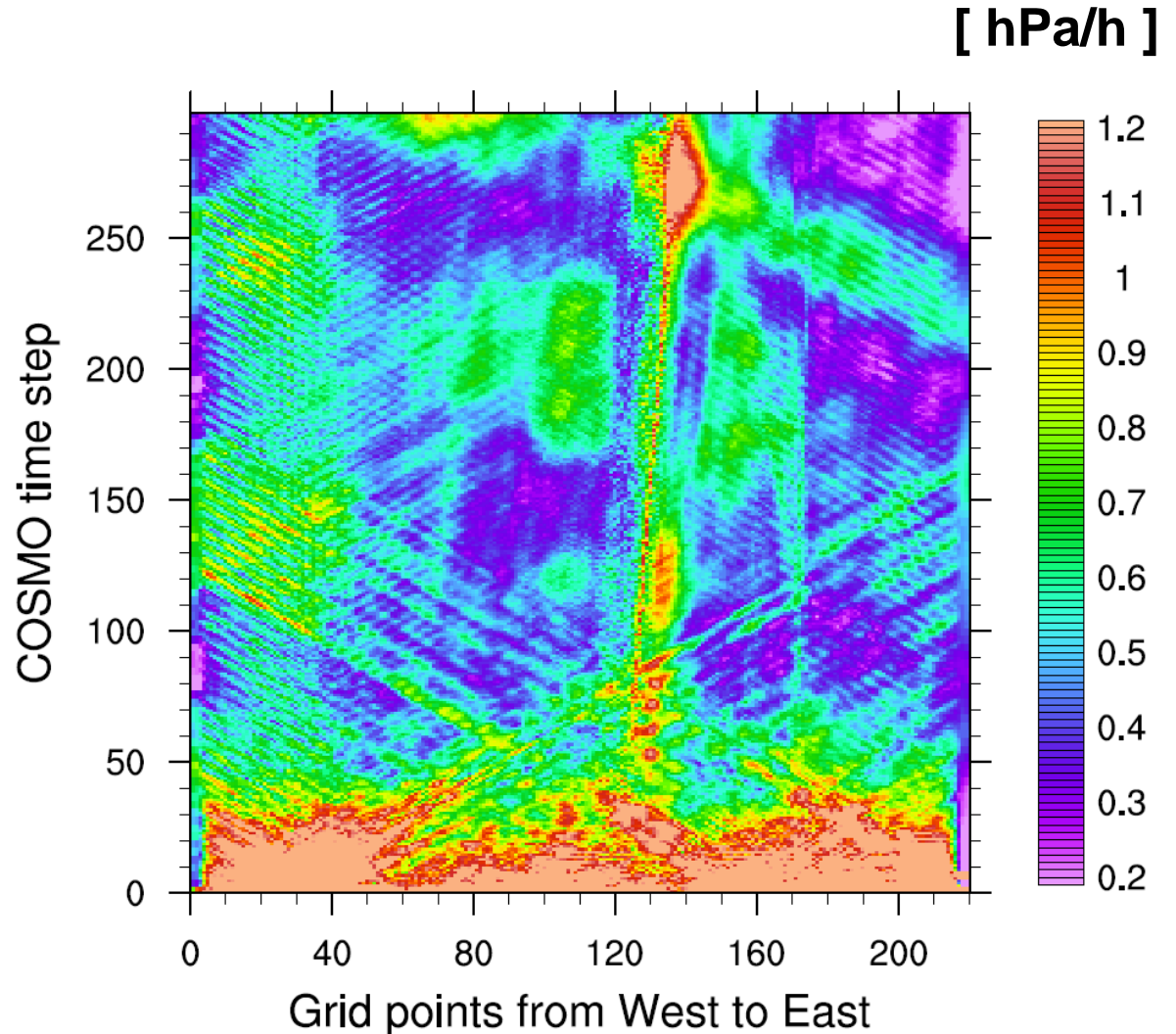
ECHAM6 → COSMO-CLM
300 km → 50km, $t_{int}=200s$

$t=15\ 000s$, $nt=75$



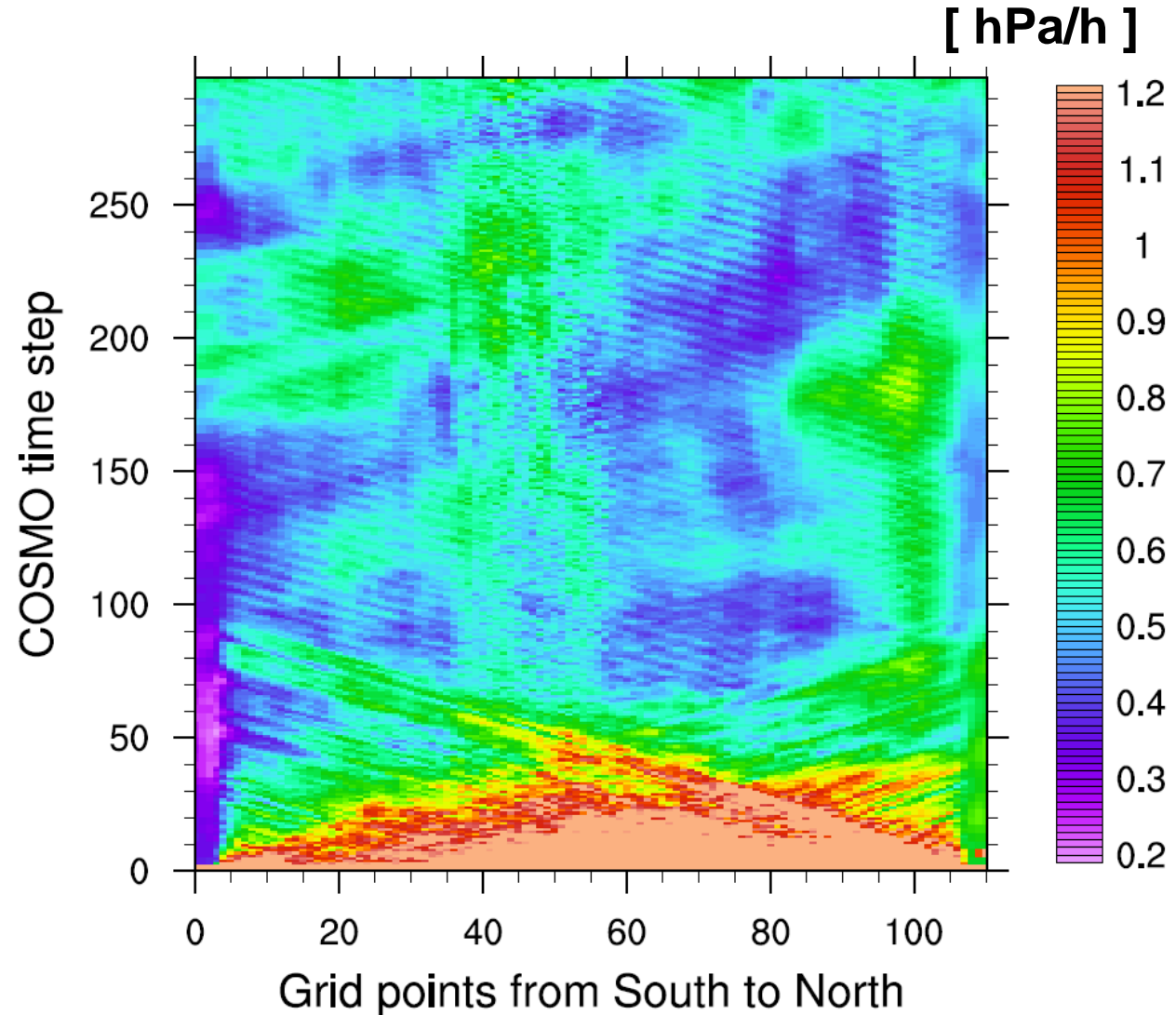
ECHAM6 → COSMO-CLM
300 km → 50km,
 $\Delta t_{int}=200s$

Meridional mean



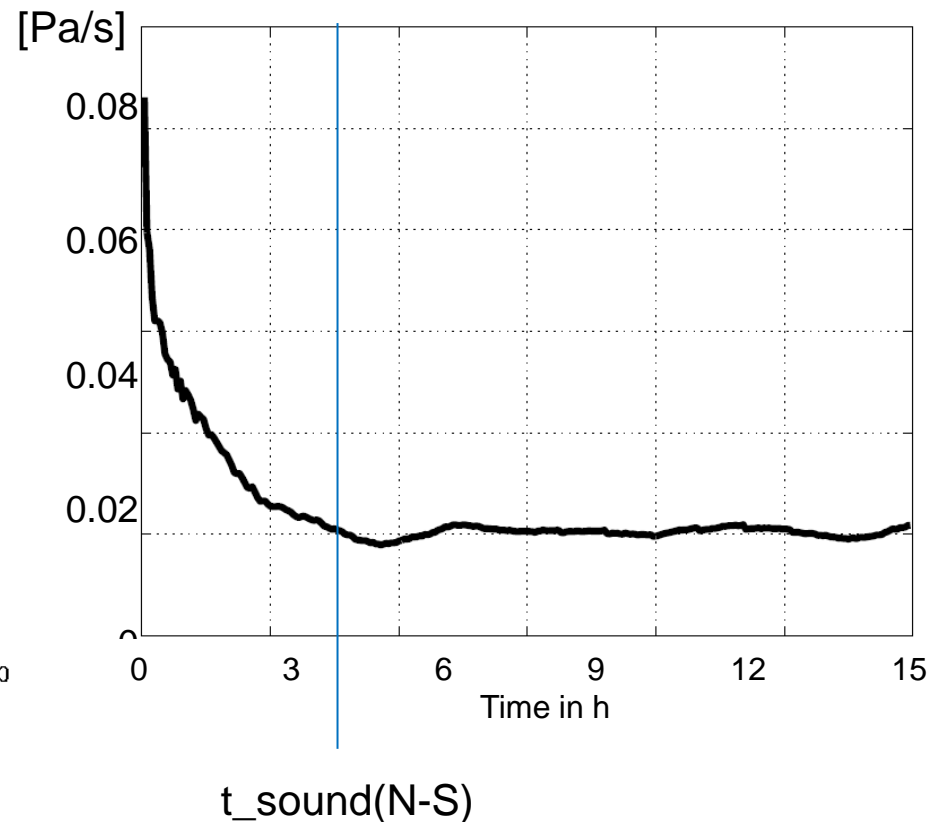
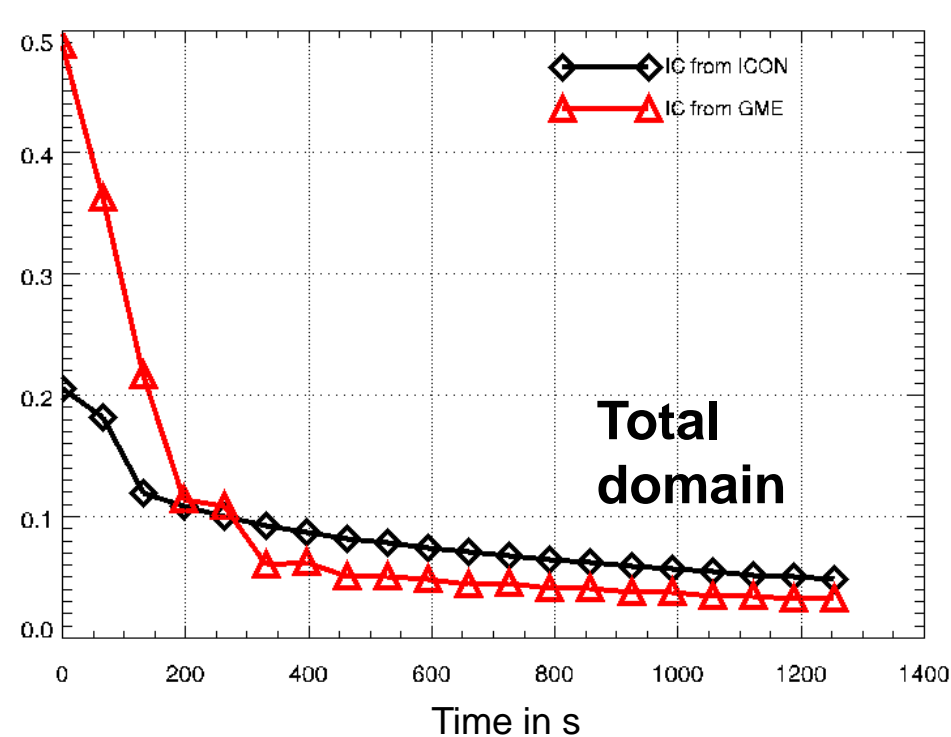
ECHAM6 → COSMO-CLM
300 km → 50km,
 $\Delta t_{int}=200s$

Zonal mean



ICON/GME → COSMO-EU
20/13 km → 7km, $\Delta t_{int}=1h$

ECHAM6 → COSMO-CLM
300 km → 50km, $\Delta t_{int}=200s$



36 hPa/h = 1 Pa/s

- $dT/dp=\text{const}$ \rightarrow $dT/dz=\text{const}$
- vertical shifting \rightarrow vertical stretching
- consolidation
 - main levels in the center of height (not pressure))
- update of the documentation
- Finalizing 2-way (and online 1-way) coupling