Cloud and convection in Alaro-1

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In essence CSD has MANY differences with 3MT

- $+$ Triggering
- $\neq$ Plume model:
  - perturbation approach
  - organized entrainment
  - mesh fraction treatment and vertical variation
  - cond-evaporation treatment
- Closure: mixed.
- External adaptations: Nc protection, Neq, revision of shallow cloud mass-flux-like scheme in TOUCANS, switch off cloud sedimentation and diffusion.
- Complete behaviour (see next slides)

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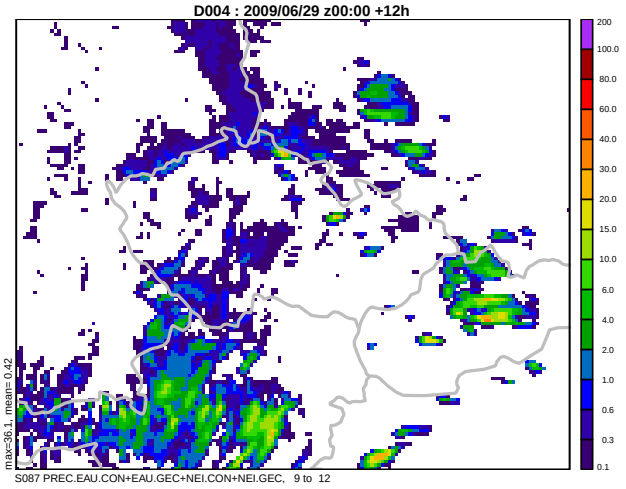
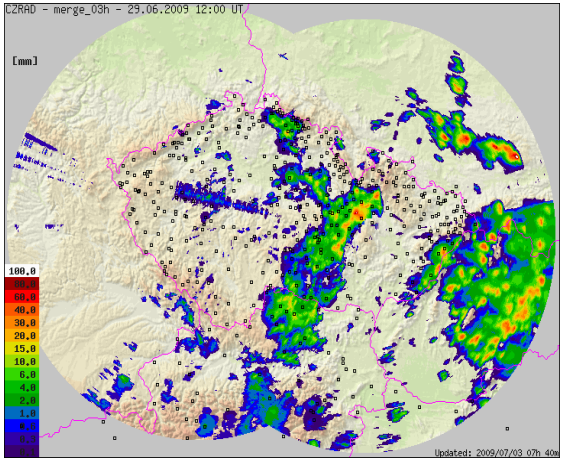
$\Longrightarrow$ *This required retuning the cloud scheme...*

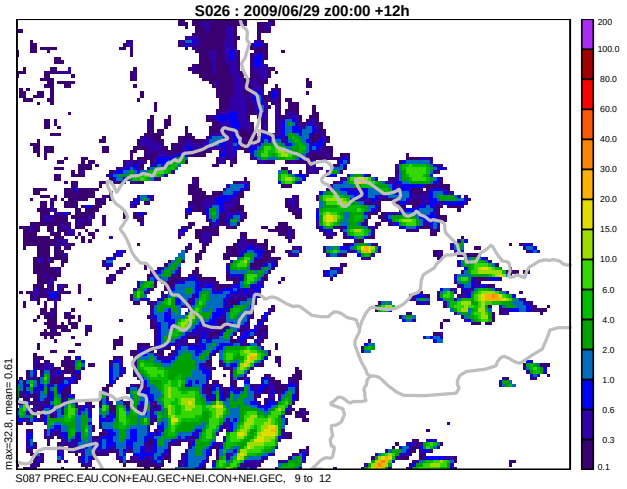
... and going across much trouble.

In essence CSD behaves differently than 3MT

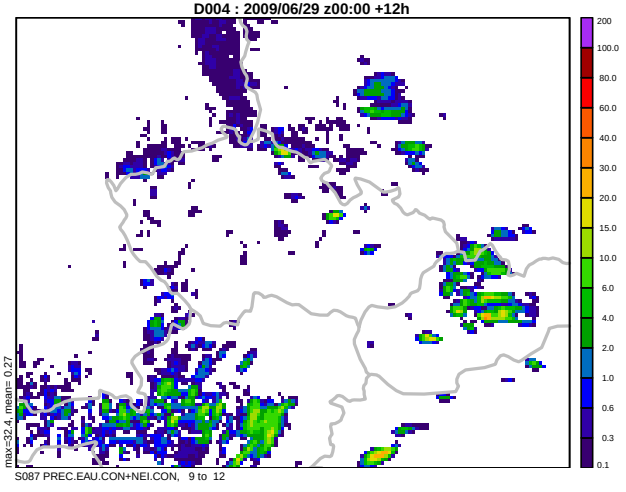
3-hour accumulated total and subgrid precipitation



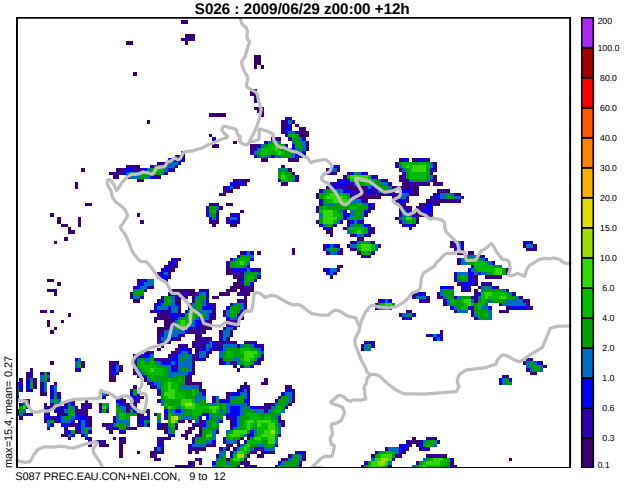




3MT RADAR CSD



subgrid part



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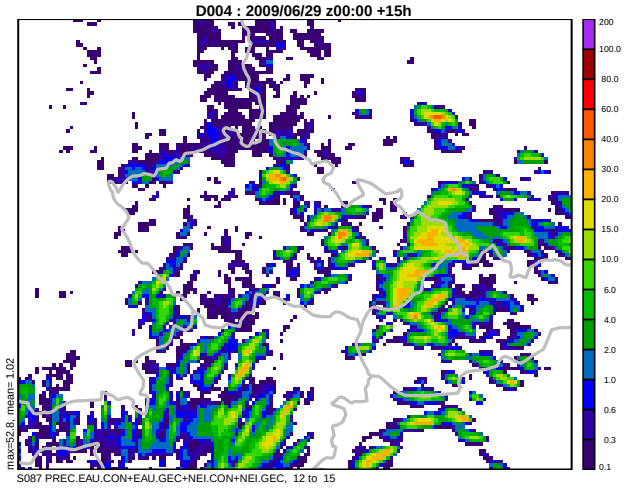
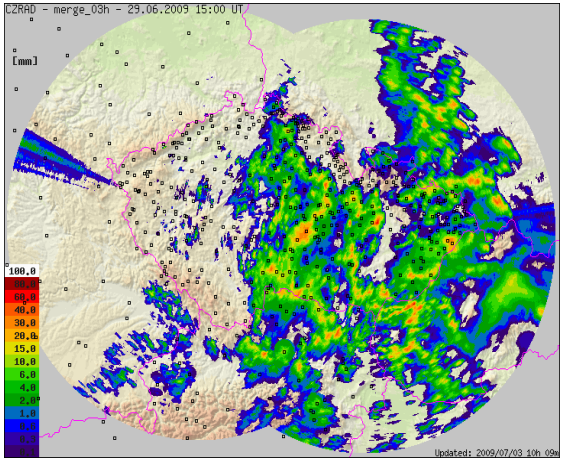
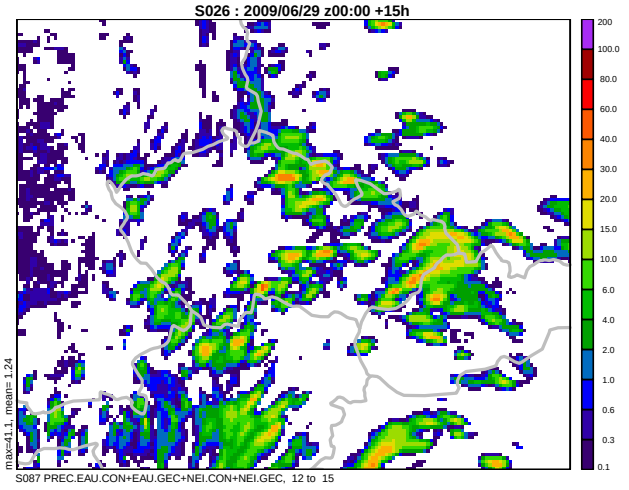


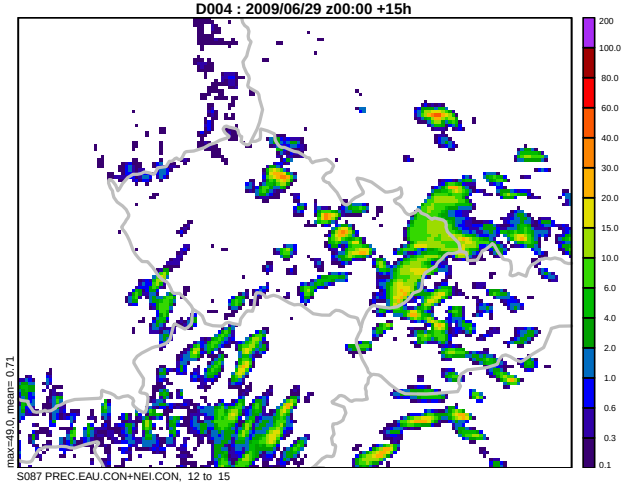
3MT



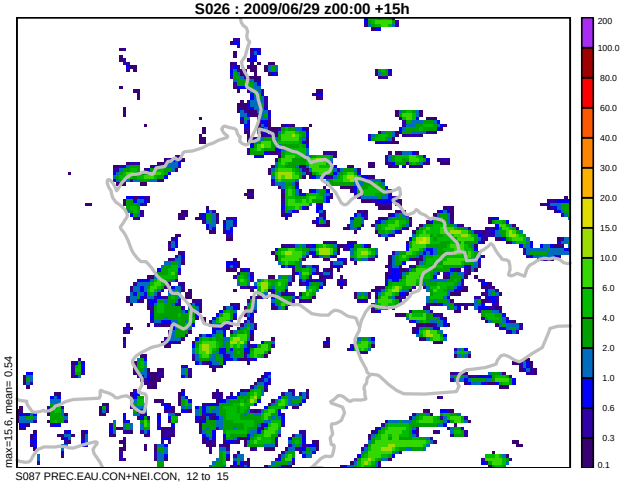
RADAR



CSD



subgrid part



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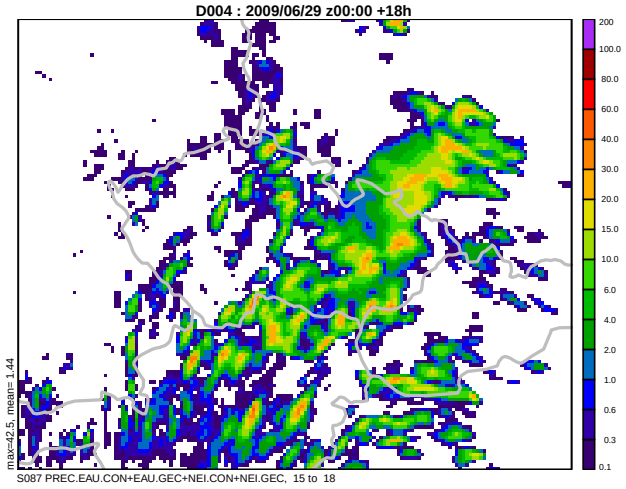
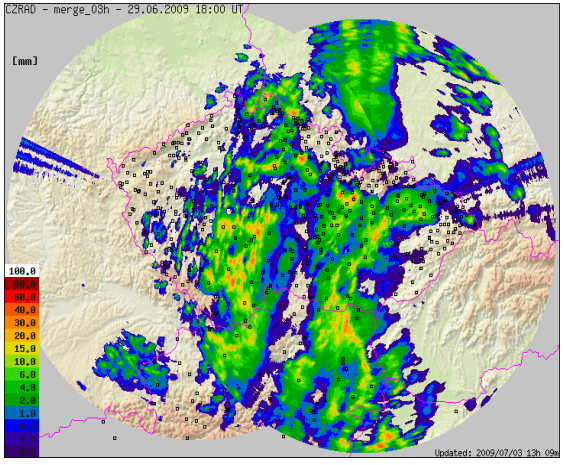
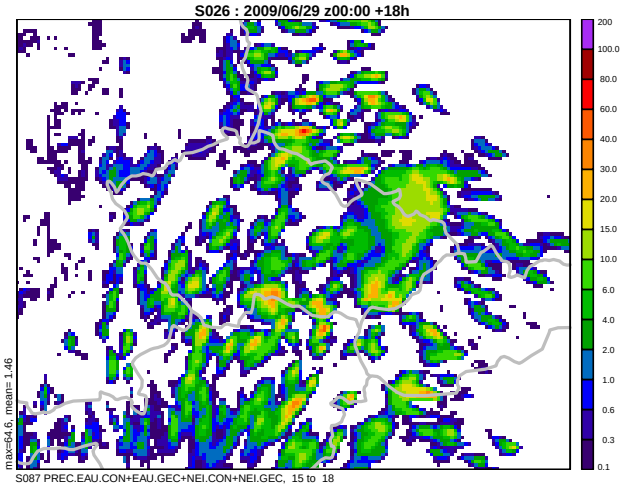
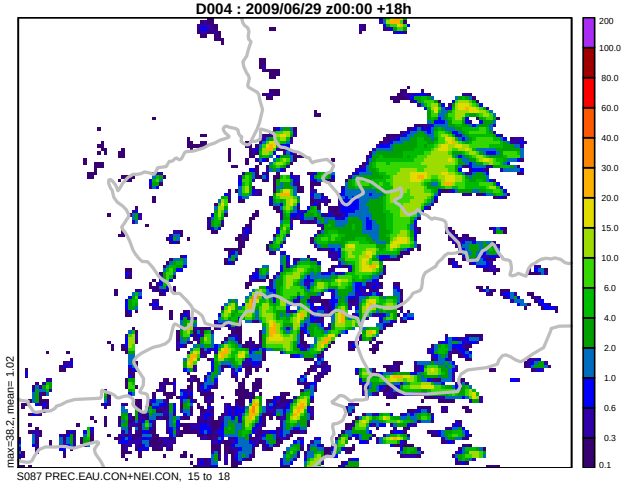
3-hour accumulated total and subgrid precipitation



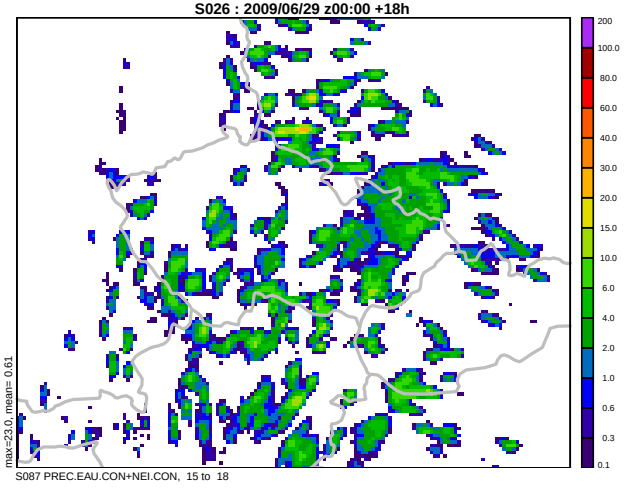




3MT RADAR CSD



subgrid part



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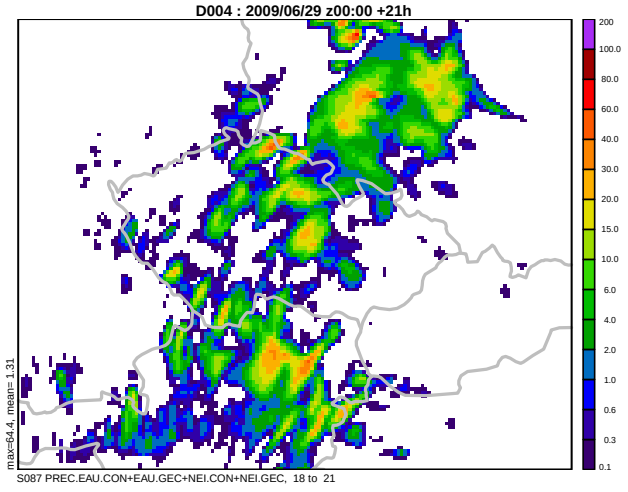
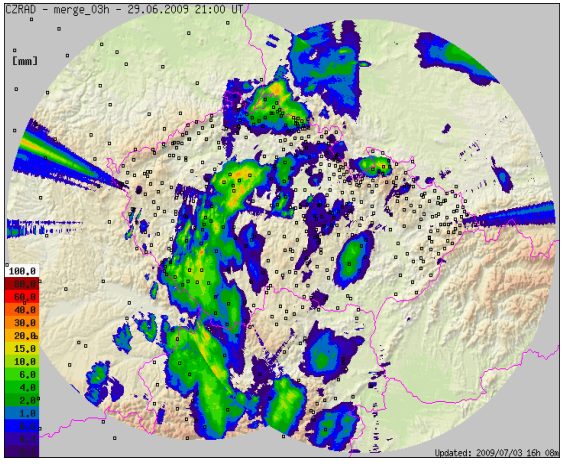
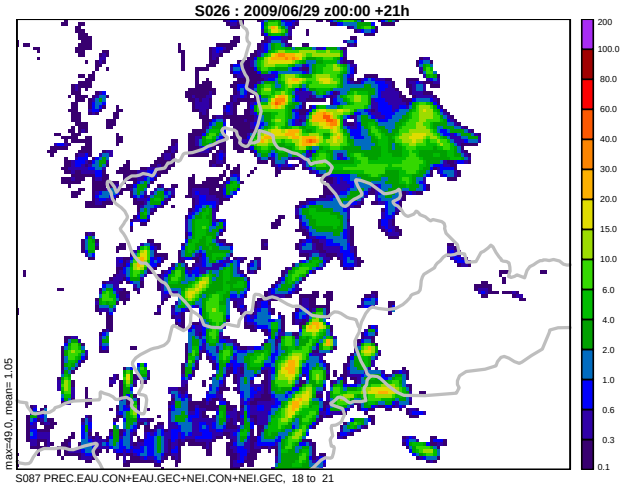
3-hour accumulated total and subgrid precipitation







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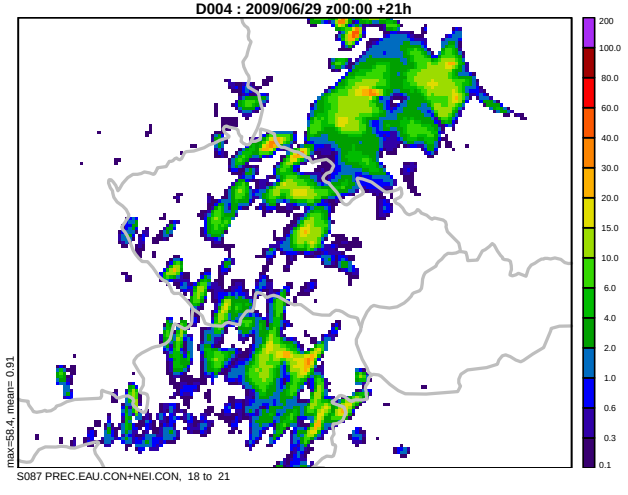
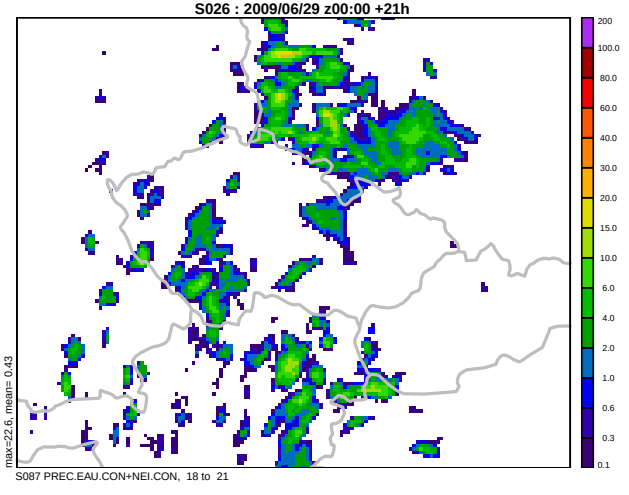


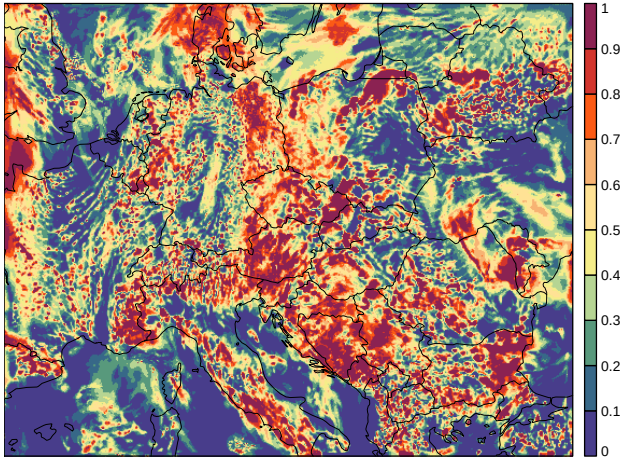
subgrid part



In essence CSD behaves differently than 3MT

Classified cloudiness

D004 Ntot



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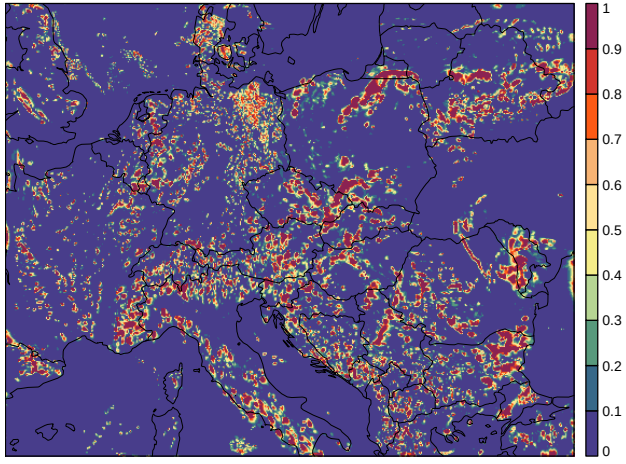
D004 Nconvec



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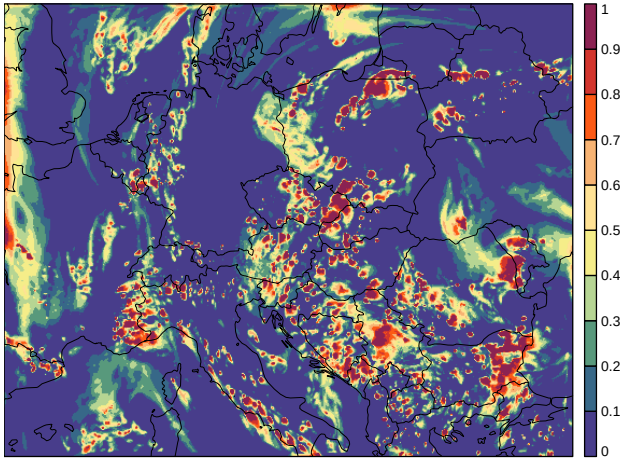
3MT

D004 Nhigh



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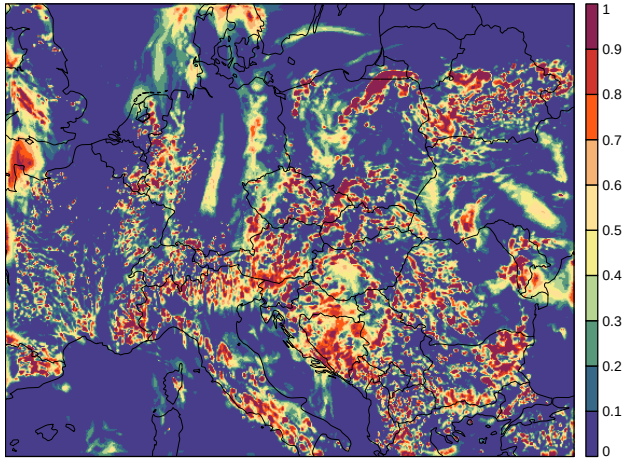
D004 Nmedium



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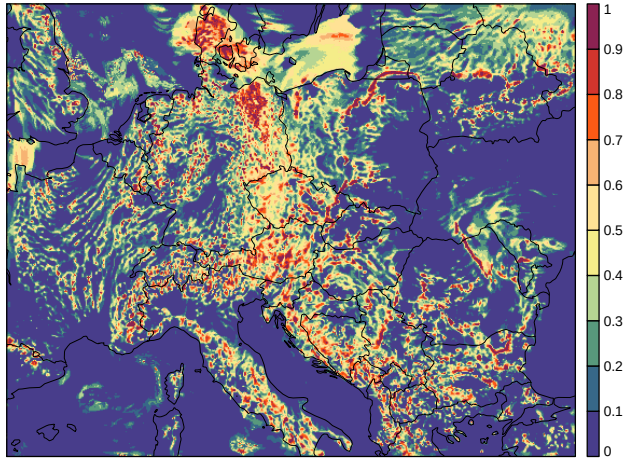
D004 Nlow



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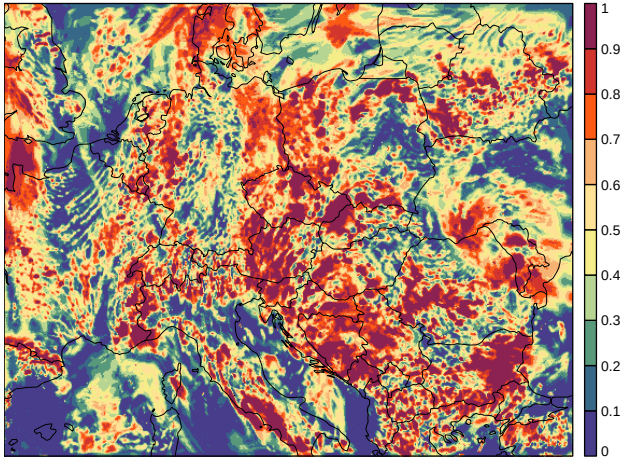
In essence CSD behaves differently than 3MT

Classified cloudiness

S026 Ntot



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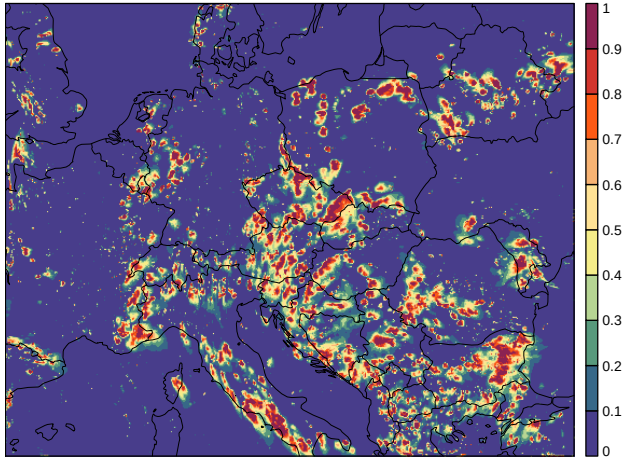
S026 Nconvec



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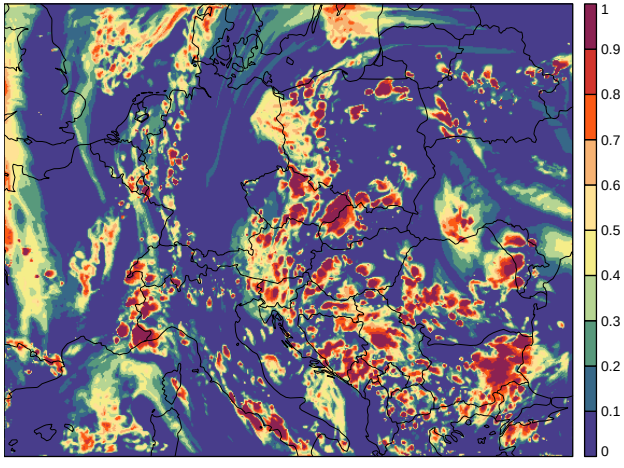
CSD

sg part mode organized

$\neq$ cond profile + $\neq$ in shallow mass flux scheme affects radiative cloudiness

S026 Nhigh



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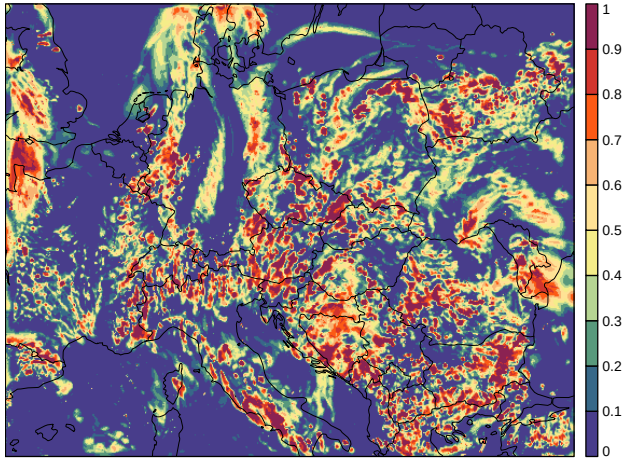
S026 Nmedium



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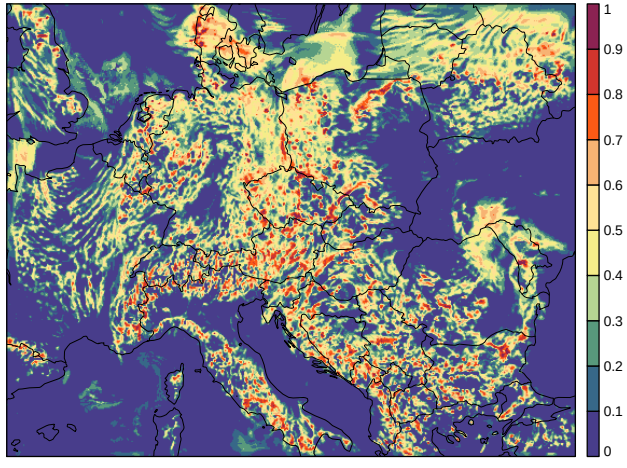
S026 Nlow



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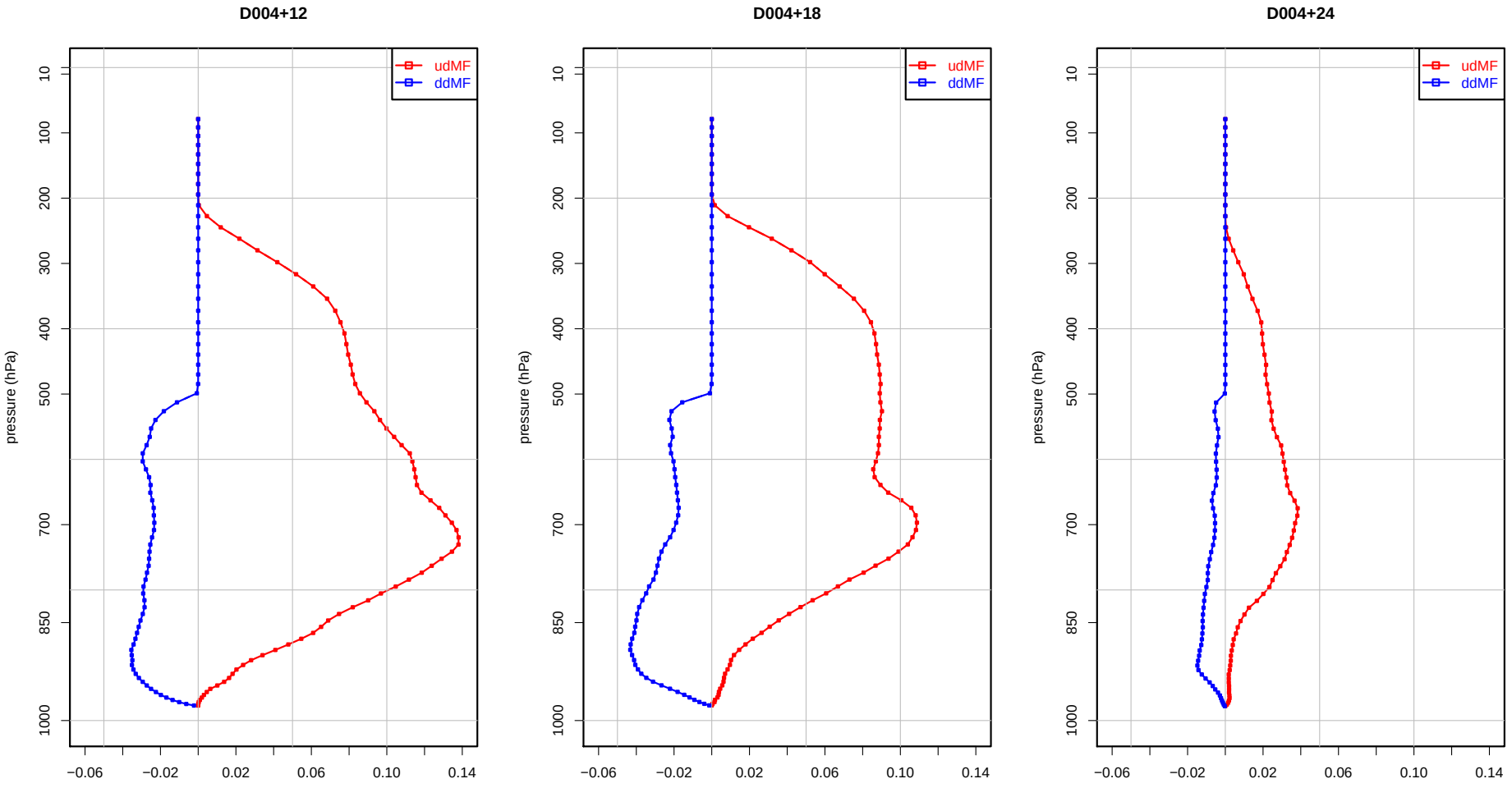
In essence CSD behaves differently than 3MT

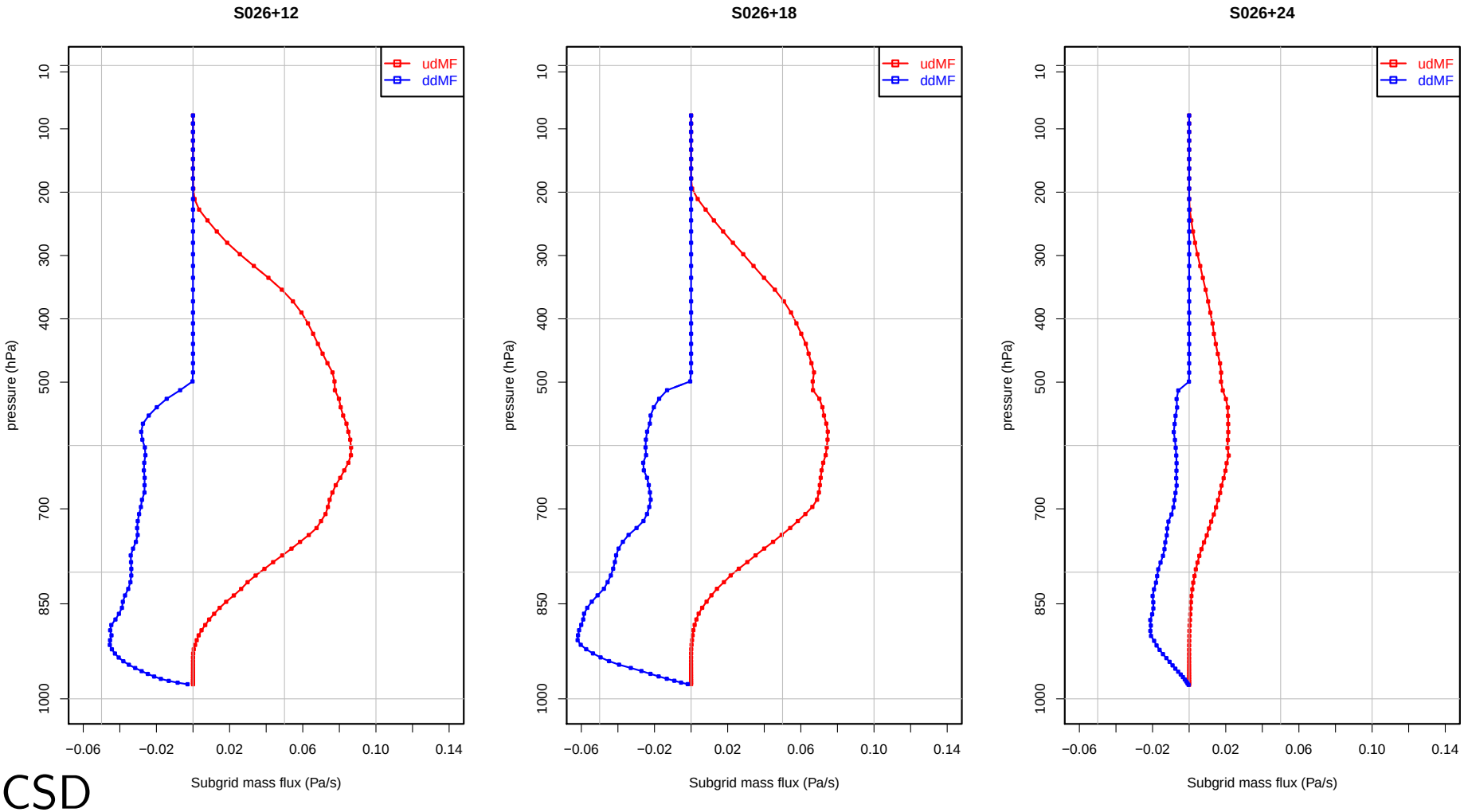
Domain-averaged updraught and (unsaturated) downdraught mass flux



3MT

In essence CSD behaves differently than 3MT

Domain-averaged updraught and (unsaturated) downdraught mass flux

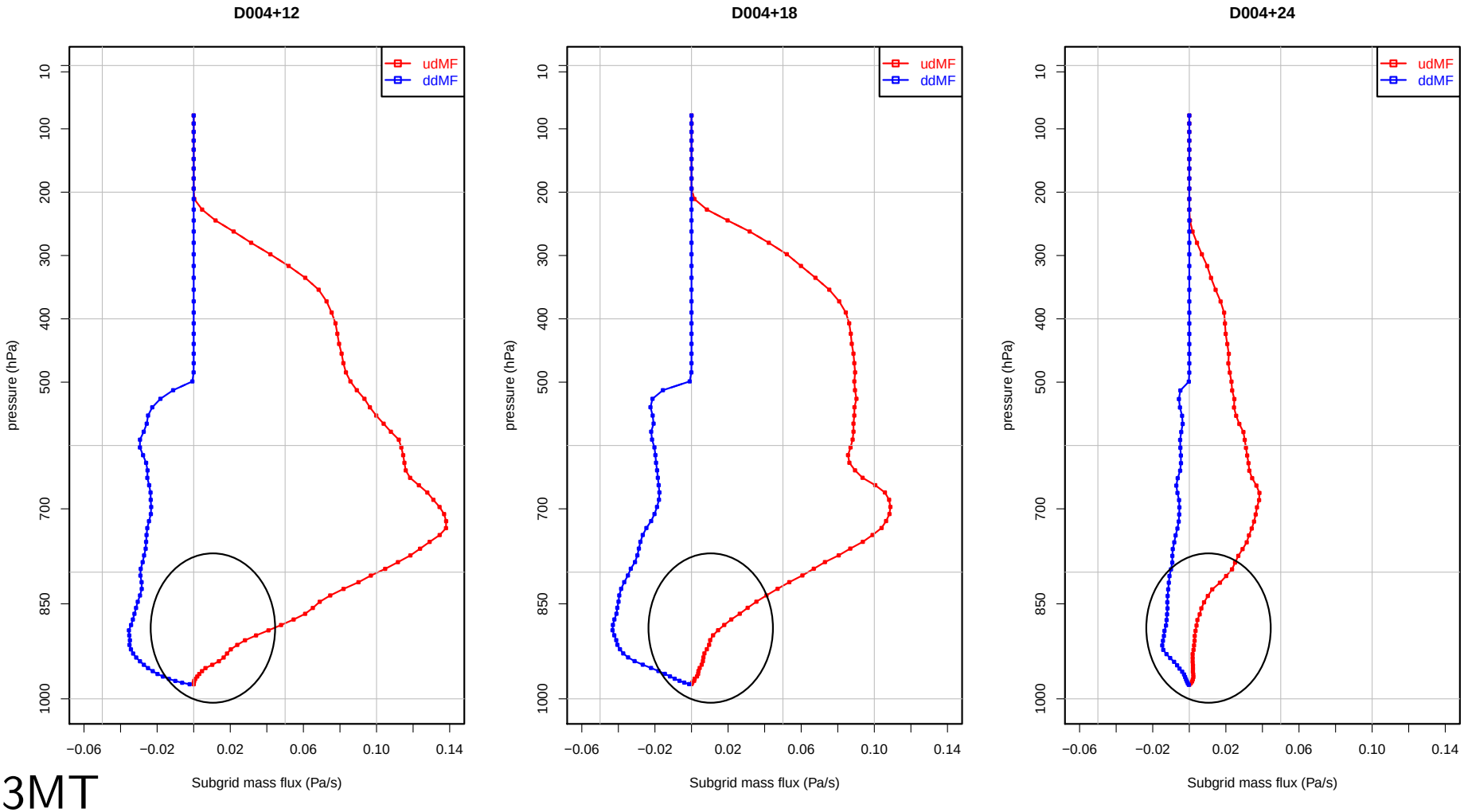


CSD

Sugrid scheme less active (complementarity)

In essence CSD behaves differently than 3MT

Domain-averaged updraught and (unsaturated) downdraught mass flux

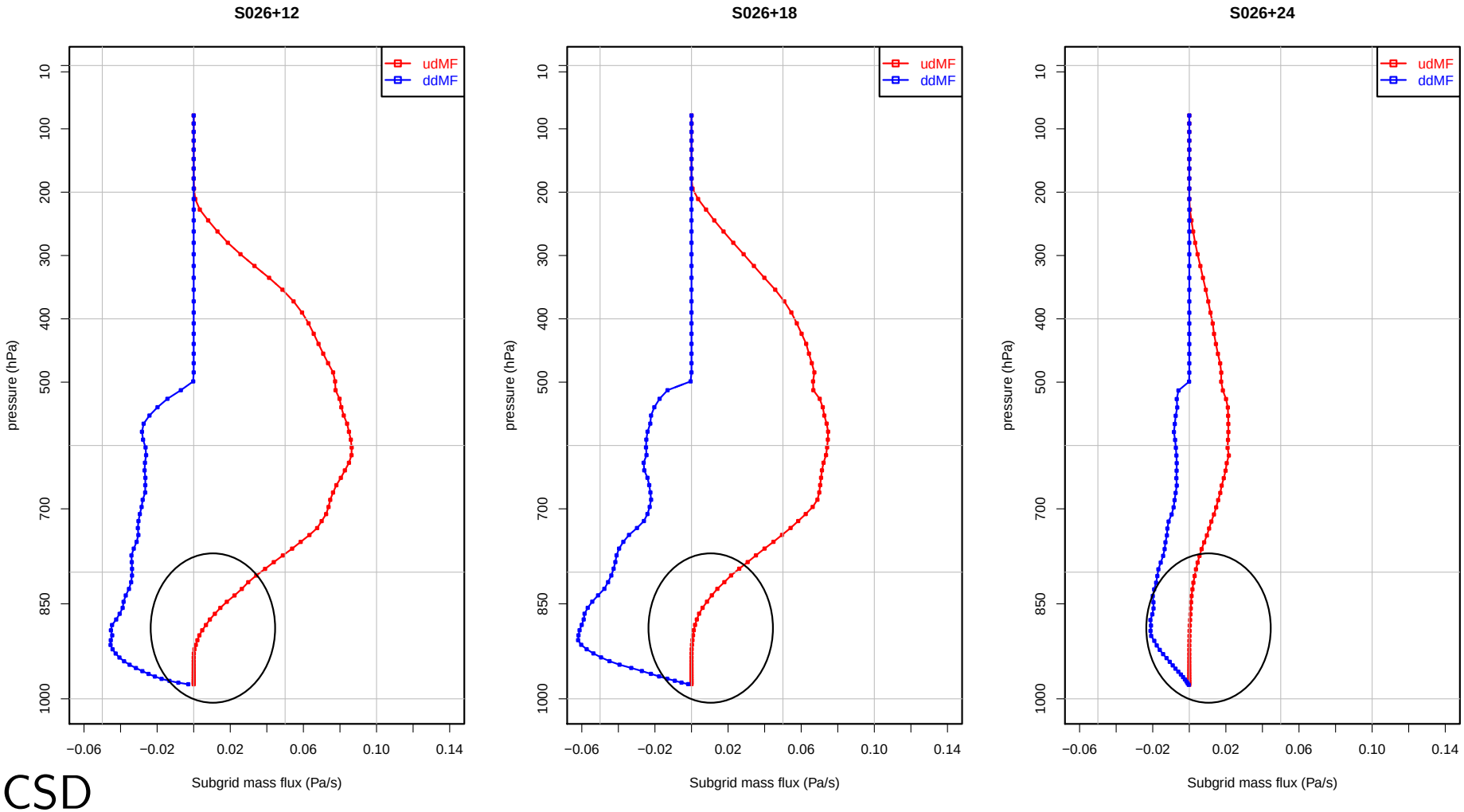


3MT

no triggering, cloud can start as low as the surface

In essence CSD behaves differently than 3MT

Domain-averaged updraught and (unsaturated) downdraught mass flux



CSD

USL triggering ⇒ changed subgrid transport in lower layers

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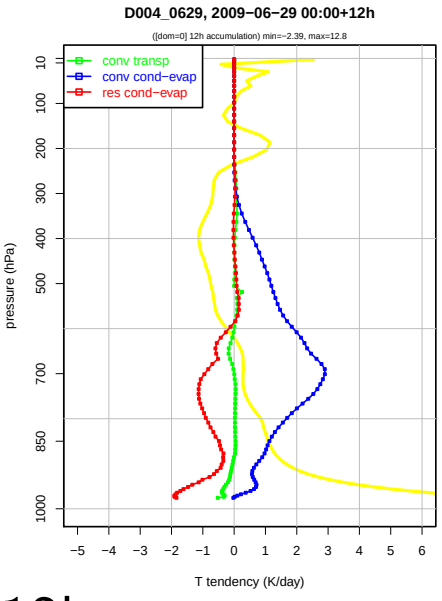
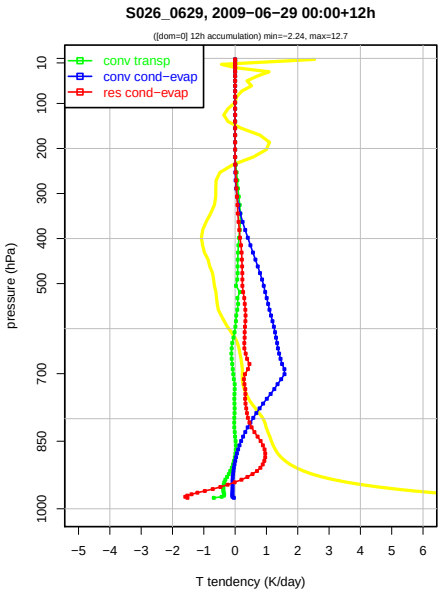
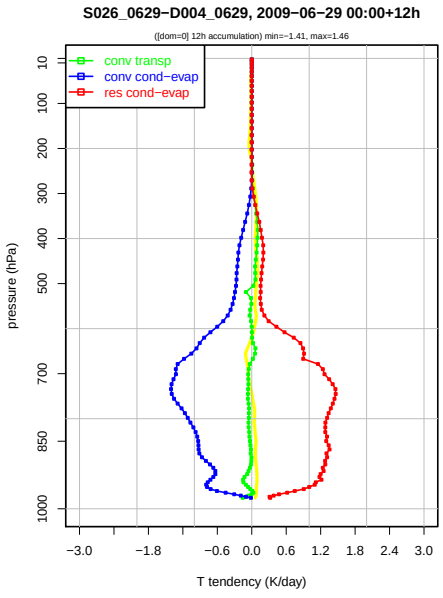




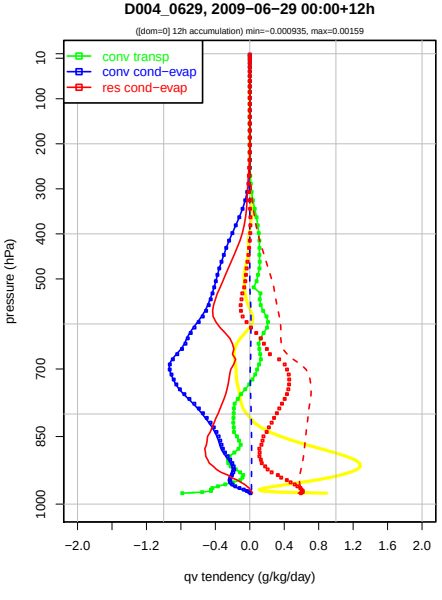


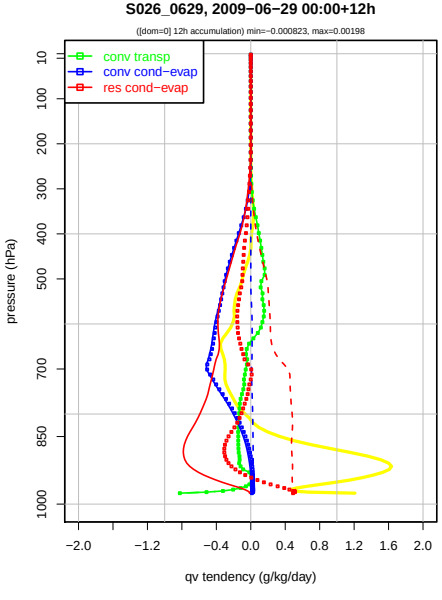
12h

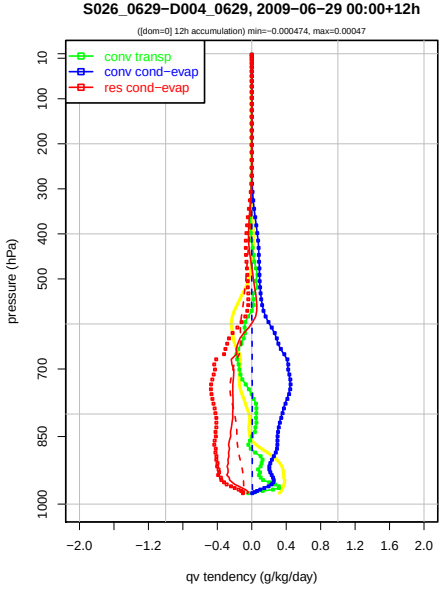
3MT

CSD

CSD-3MT







CT tendency

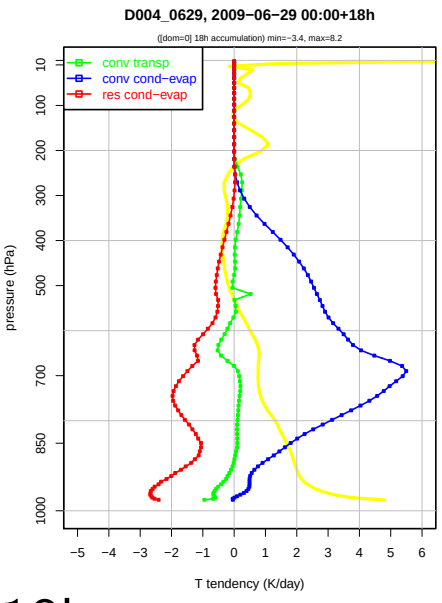
SG transport

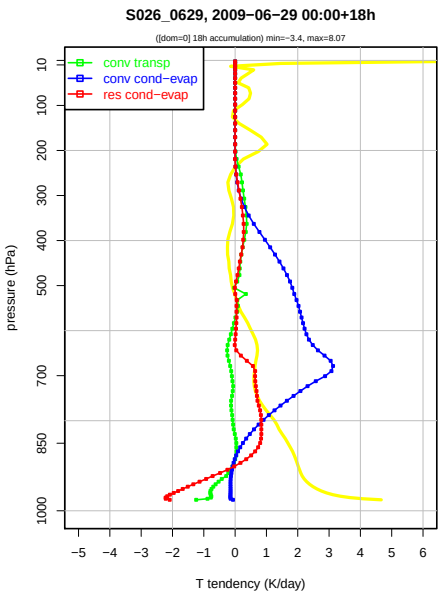
SG cond-evap tendency

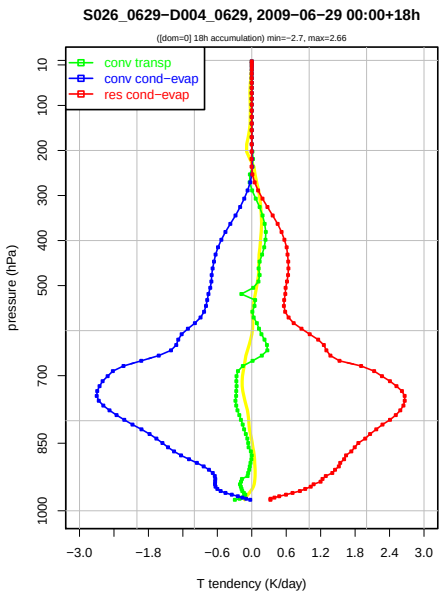
Cloud-scheme cond-evap tendency

QV tendency

In essence CSD behaves differently than 3MT





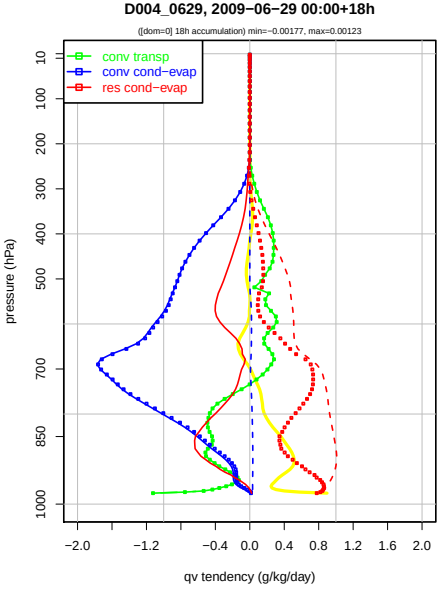


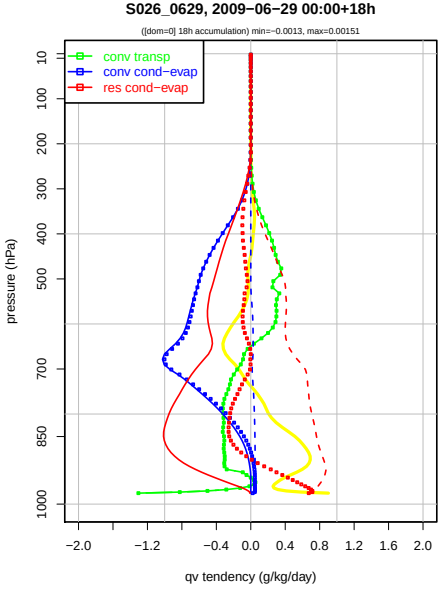
18h

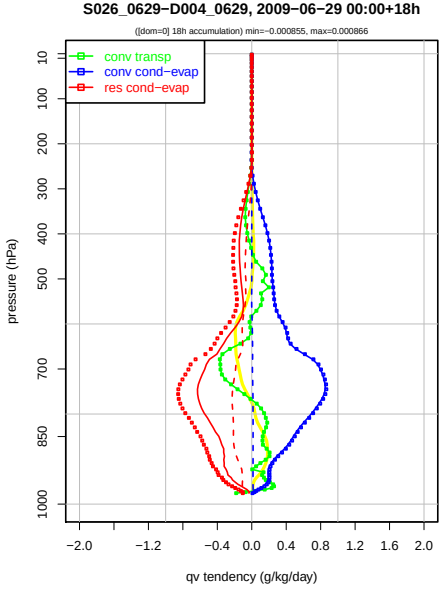
3MT

CSD

CSD-3MT







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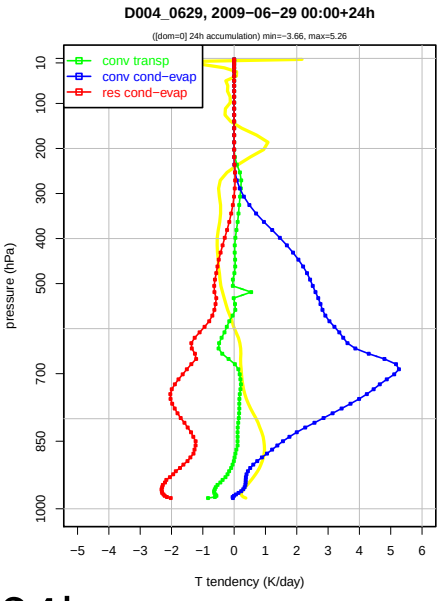
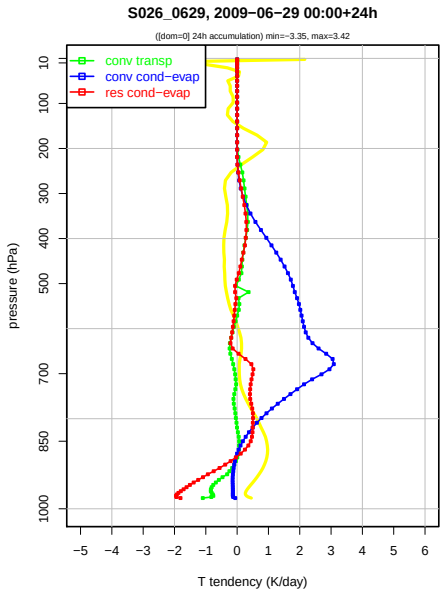
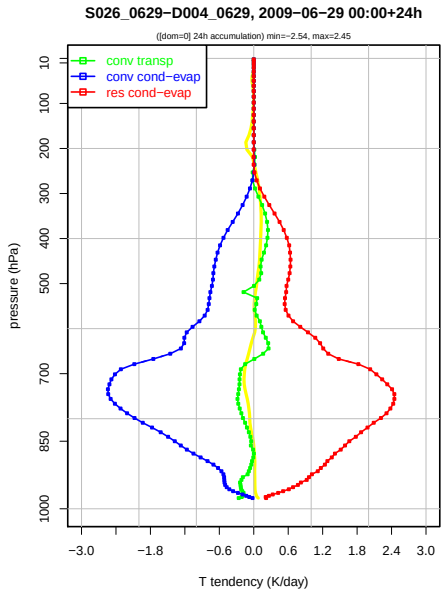




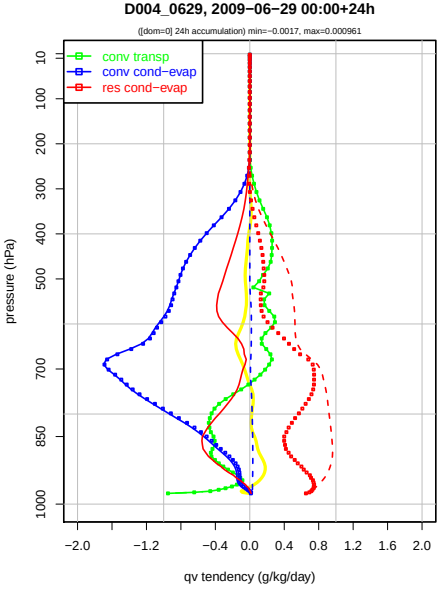


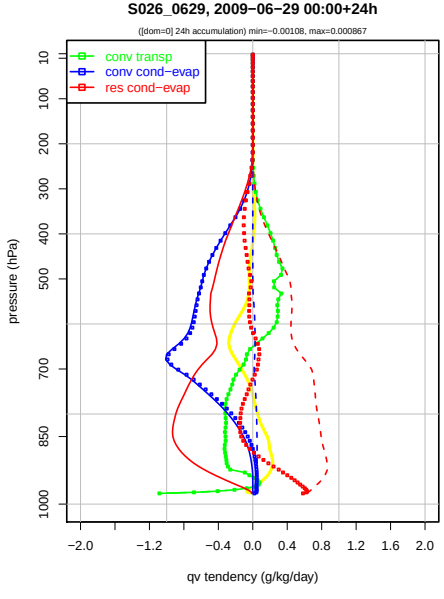
24h

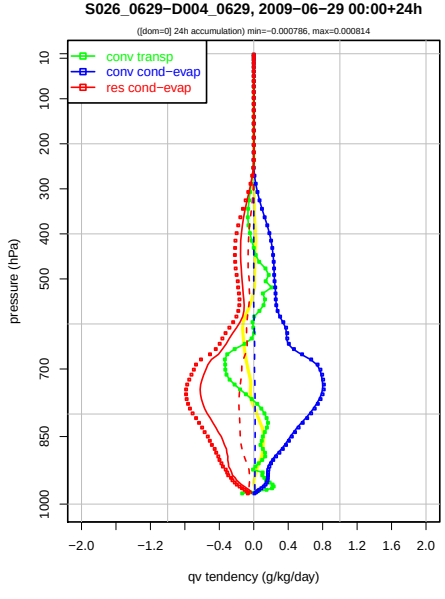
3MT

CSD

CSD-3MT







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Cloud-scheme cond-evap tendency

QV tendency

Cloud and condensates in Alaro: a historical split with a joyful entanglement

- Prognostic cloud condensates (q_i, q_l):
  - cloud scheme combining Xu & Randall (1996) formula

    $$N = XR[\overline{q_c}, \overline{q_t}, \overline{q_w}]$$

    + a geometrical hypothesis implying a critical RH profile:

    $$\overline{q_v} = \overline{q_w} \cdot N + H[z, \text{phase}, \triangle x] \cdot \overline{q_w} \cdot (1 - N)$$
  - completed by protection of convective area

Cloud and condensates in Alaro: a historical split with a joyful entanglement

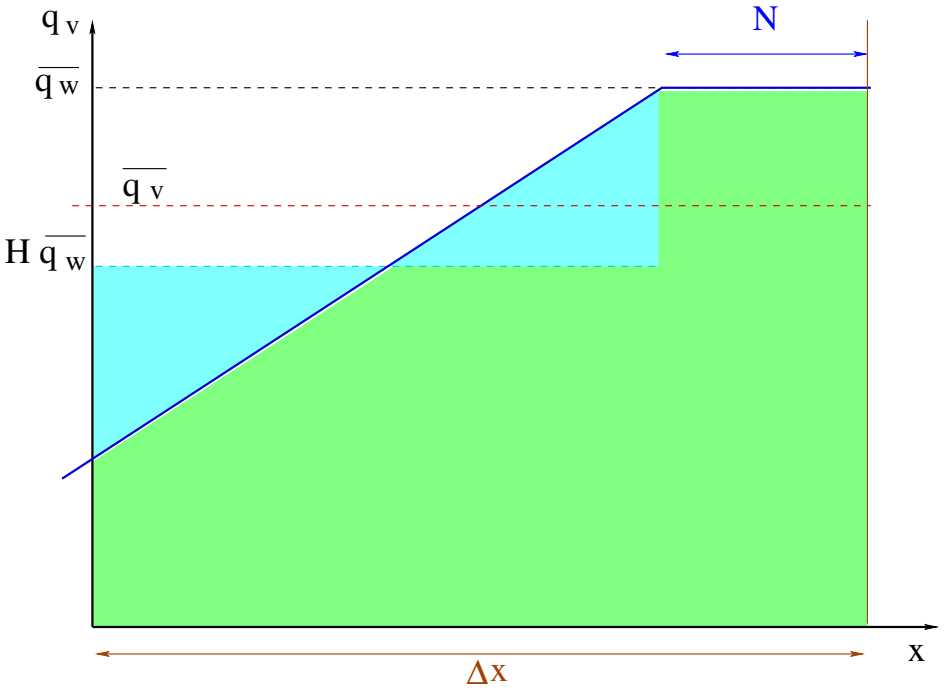
- Prognostic cloud condensates (q_i, q_l):
  - cloud scheme combining Xu & Randall (1996) formula

    $N = XR[\overline{q_c}, \overline{q_t}, \overline{q_w}]$

    + a geometrical hypothesis implying a critical RH profile:

    $\overline{q_v} = \overline{q_w} \cdot N + H[z, \text{phase}, \triangle x] \cdot \overline{q_w} \cdot (1 - N)$

  - completed by protection of convective area



imposed mean $\overline{q_v}$ *in clear part ?*

H *is* **not** *a threshold of* $\overline{q_t}/\overline{q_w}$

Cloud and condensates in Alaro: a historical split with a joyful entanglement

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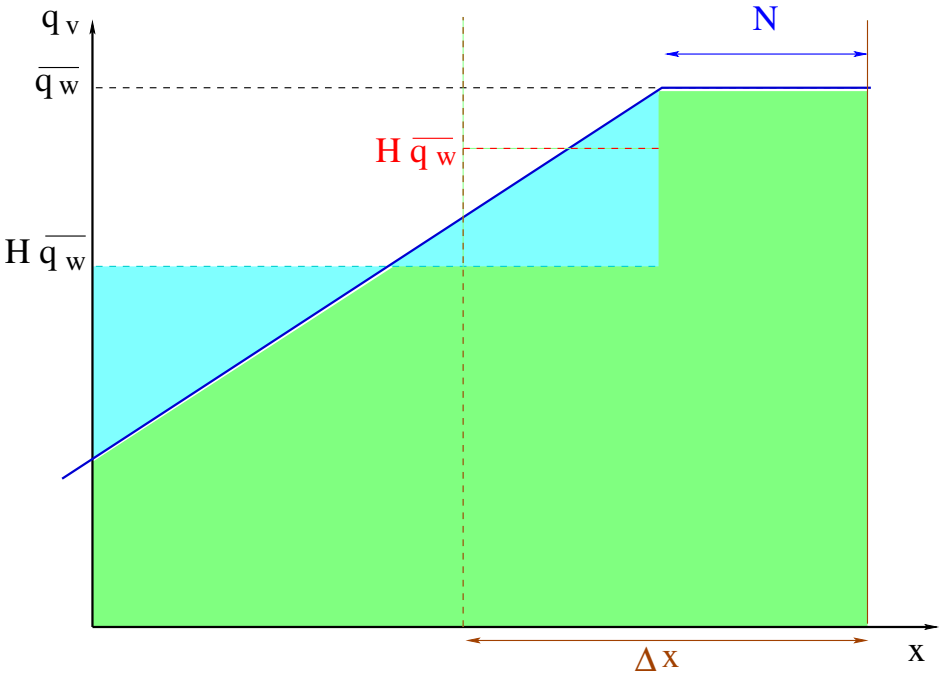

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$\triangle x$ *dependency (?)*

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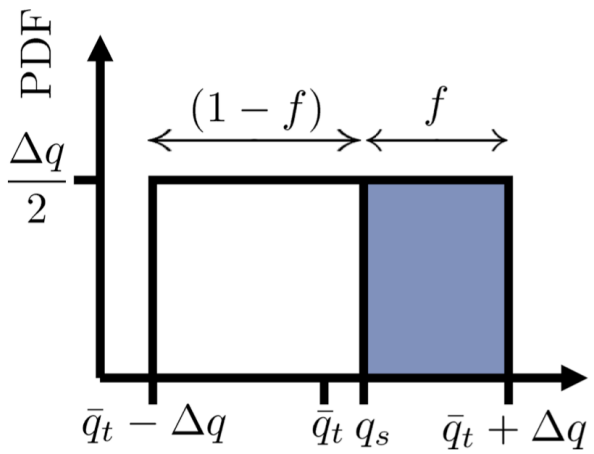
  $\Rightarrow$ water phase contents, latent heat conversion;

(Quaas, 2012)



$H \neq$ Sundqvist et al. 1989: homogeneous pdf of q_t

$$\triangle q = (1 - H)\overline{q_{\text{sat}}}$$

$$\Rightarrow (1 - N)^2 = \frac{1 - RH}{1 - H}$$

here $\triangle q = \overline{q_t} + (1 - 2H)\overline{q_w}$

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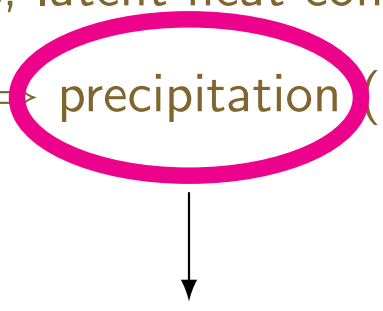

final suspended $q_c <$,

XR adjustment is broken !

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  - (stratiform) diagnosed from oversaturation wrt RH profile
    $$q_{cs} = \overline{q_t}' - H'(z)\overline{q_{\text{sat}}}$$
  - (convective) q_{cc} diagnosed from N_c^-, $\quad q_{cc} = XR'^{-1}[N_c^-, \overline{q_t}, \overline{q_w}]$
  - cloud fraction $\quad N = XR'[q_{cs} + q_{cc}, \overline{q_t}, \overline{q_w}]$

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H' **is** *a threshold of* $\overline{q_t}/\overline{q_{\text{sat}}}$
$\iff \overline{q_v} = H'\overline{q_{\text{sat}}}$

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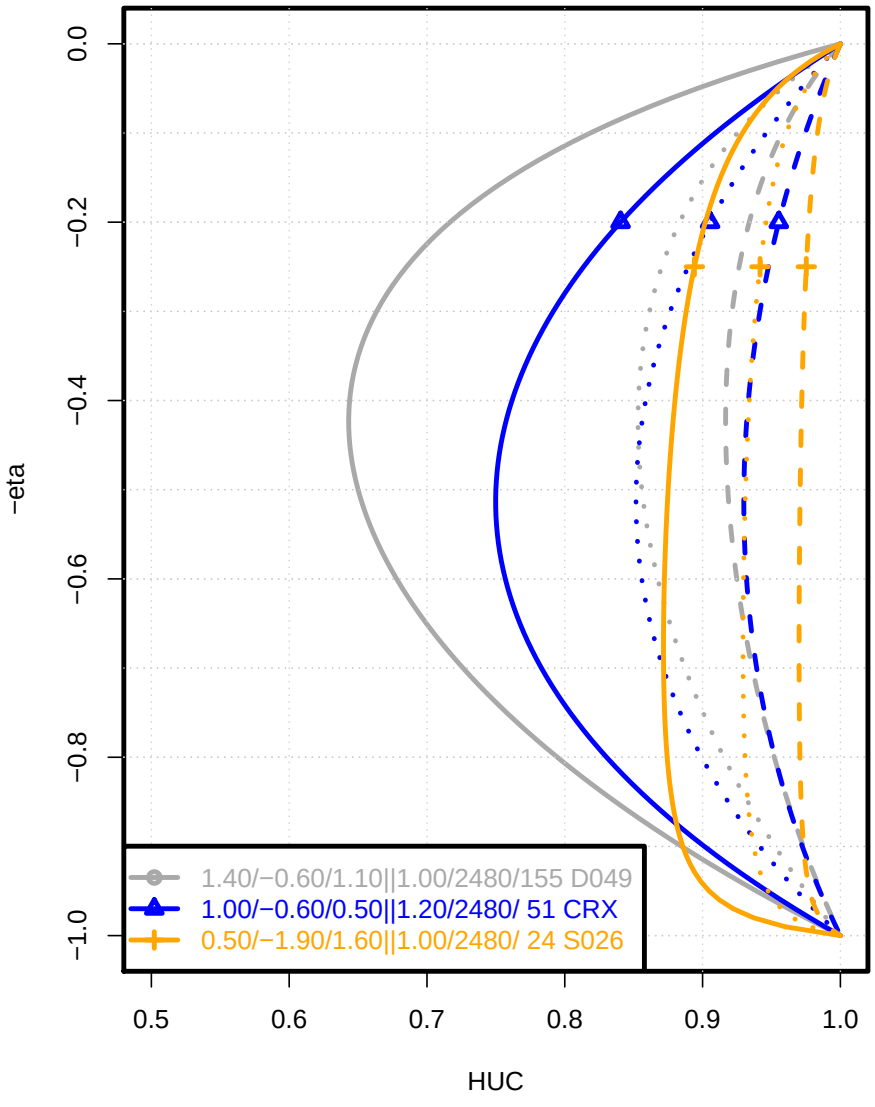
- To spice up:
  - $H'(z)$ tuning entangled with $H(z, ...)$ while they represent $\neq$ things and should not have same values nor variations
  - substantial impact of N_c^- in radiative cloud diagnostic
  - limits of realism + wish to reconcile the things...

Separate HUC profile



Alaro-1 3MT Tuning

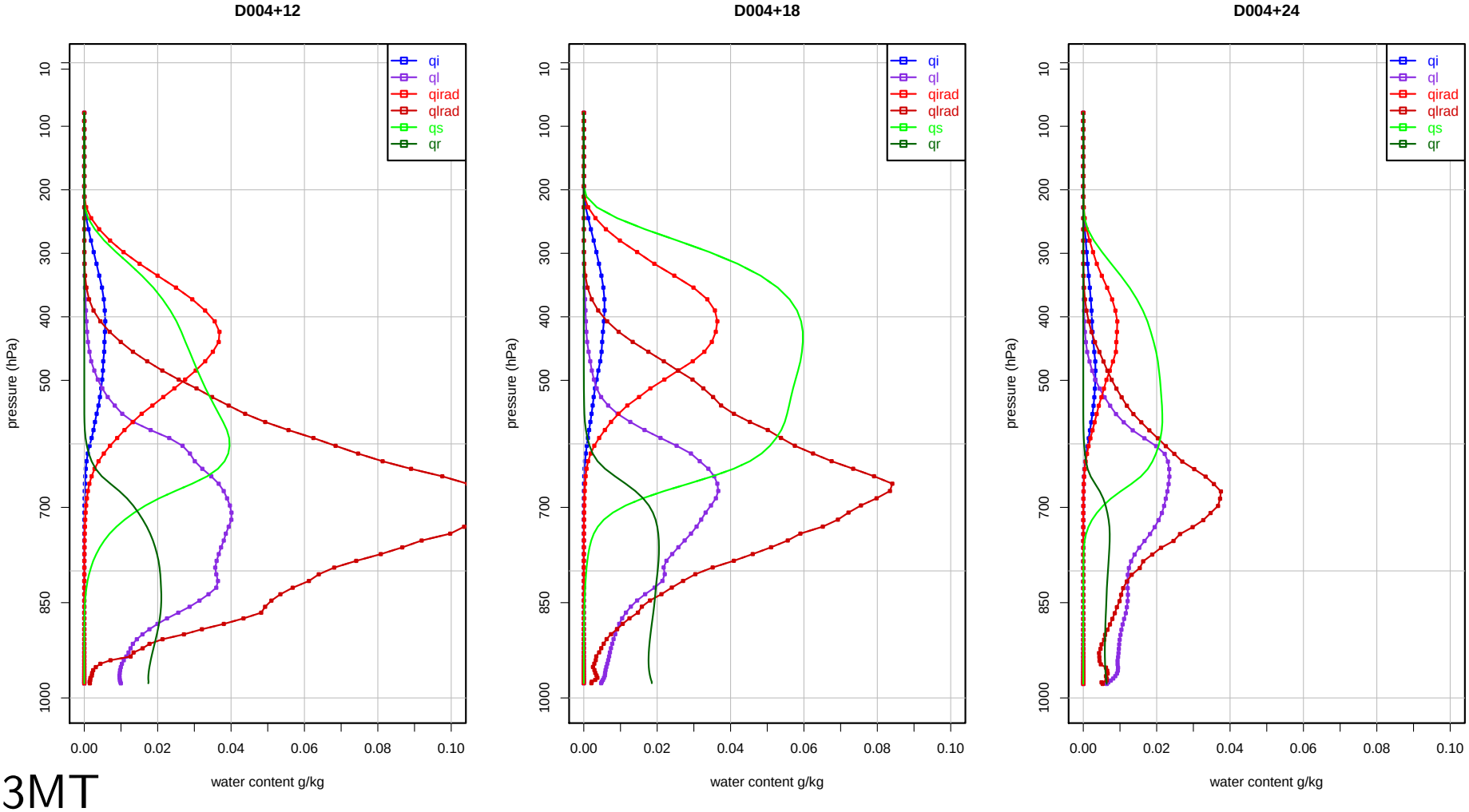
solid: $H'(z)$, dash: $H(q_l)$, dot: $H(q_i)$

CSD tentative Tuning

$H(q_l)$ and $H(q_i)$ (adj)

but same $H'[z]$ (rad)

Domain mean profiles: condensates



3MT

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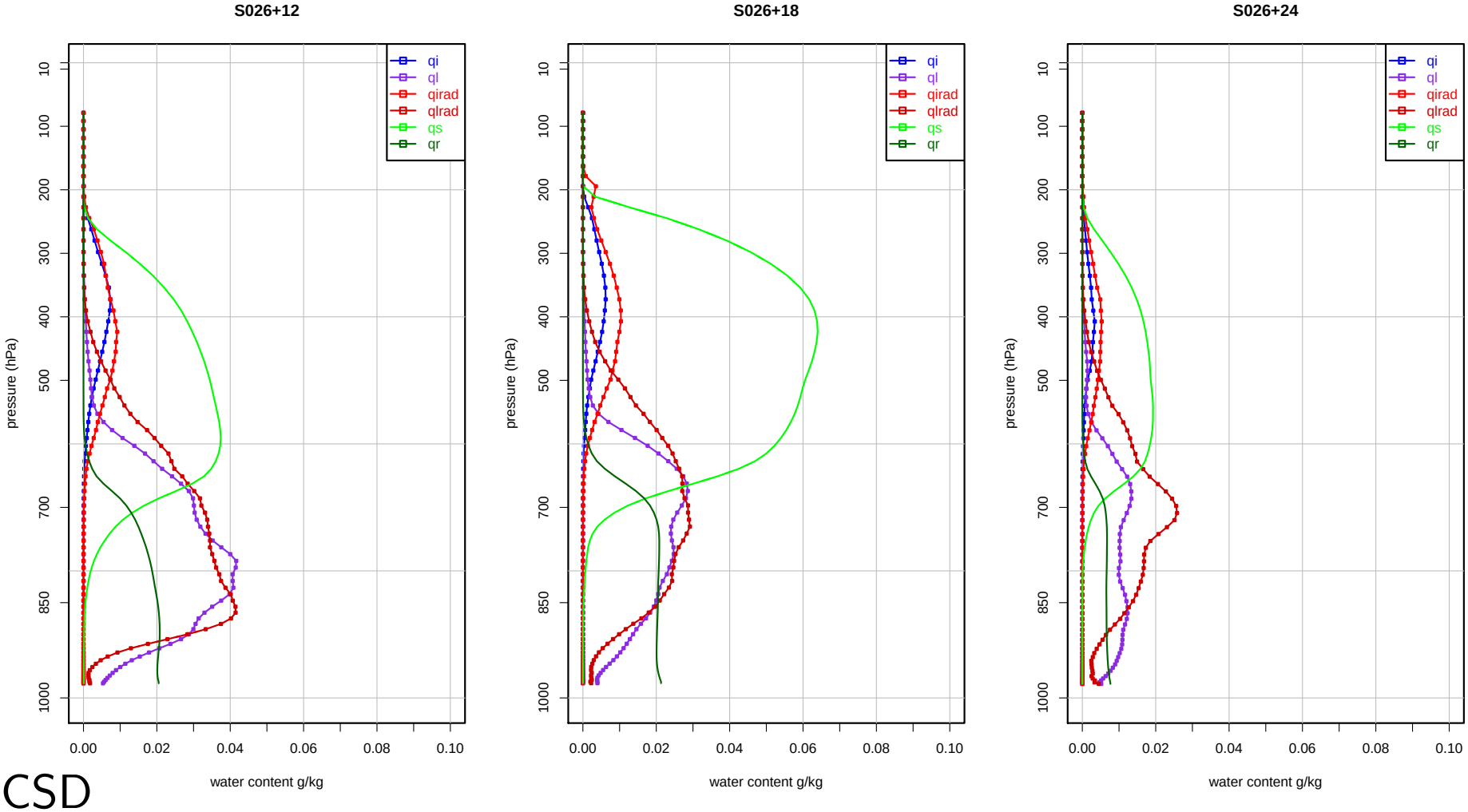

CSD

$\Rightarrow$ *suspended* (q_i, q_ℓ) *may approach values of* $(q_{i,rad}, q_{\ell,rad})$

A long long way to scores

- Finally could escape from the desperating entanglement (radiative vs adjustment tuning)
- Dangerous trap: focusing on a single 1-fortnight period.
- Presented tuning can give some good scores at the surface,
- and also upper air...
- ..except mainly a large positive bias of Relative humidity above 500hPa.
- Further tuning can now be done more peacefully
- Relativity of scores:
  - Local versions use different resolutions, domains, some specific tunings
  - Multi-resolution behaviour tuned by intercomparison, not with full verification package.

Model physics

is not an outdated topic

should not be left to a few old-timer

All good will welcome.