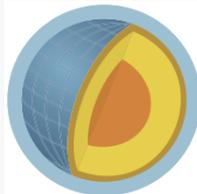


AN EXTENDED PERSPECTIVE FOR DMC - INITIATION IN THE ALPINE REGION?

Thomas Krennert¹, Astrid Kainz^{1,2}, Stefano Serafin²

- (1) ZAMG, Central Institute for Meteorology and Geodynamics, Vienna, Austria
t.krennert@zamg.ac.at
- (2) University Vienna, Department for u. Geophysics, Universität Wien,
astrid.kainz@gmail.com, stefano.serafin@univie.ac.at



imgw

Institut für Meteorologie
und Geophysik



ZAMG

Zentralanstalt für
Meteorologie und
Geodynamik

DEEP MOIST CONVECTION @ WV DARK FEATURES



Former publications about DMC and WV dark features (PV-anomalies) show

- favourable conditions for DMC – advection of dry and cold air within the PV Anomaly (Antonescu et al. 2013, Morcrette et al. 2007, Russel et al. 2009, 2012, ...)
- Inhibiting conditions – sinking dry lid (Russel et al., 2008)
- Most of the recent papers were derived from COPS and CSIP campaigns

- Known concepts for cyclonic environment:
Dry Slot Convection, Upper level fronts, PV – Anomaly, PV- Banner, Tropopause Fold, Dry Intrusion ... and some more...

- Do dark stripes in anticyclonic environment differ?
- Origins, development, modification, advection around the trough (Shapiro and Keyser, 1990, Appenzeller and Davies 1992, ...)

DEEP MOIST CONVECTION @ EASTERN ALPINE AREA

Majority: COLD FRONT:

- Pre-frontal / frontal, CAA above, organized (MCS, Squall Line), shear...

Without Fronts – 30 bis 40% (Krennert et al., 2003):

- Air-mass TS („Single Cell-“, Pulse Convection),
weak Pressure gradient, early Initiation at elevated surfaces, ...

Known Ingredients – Moisture/ Instability / Lift – pre existing conditions:

- Unstable air mass (hydrostatically, conditionally, $300 < \text{CAPE} < 2500 \text{ J/kg}$)
- Sufficient moisture supply @ ground levels
- Initiating shallow convection over mountains

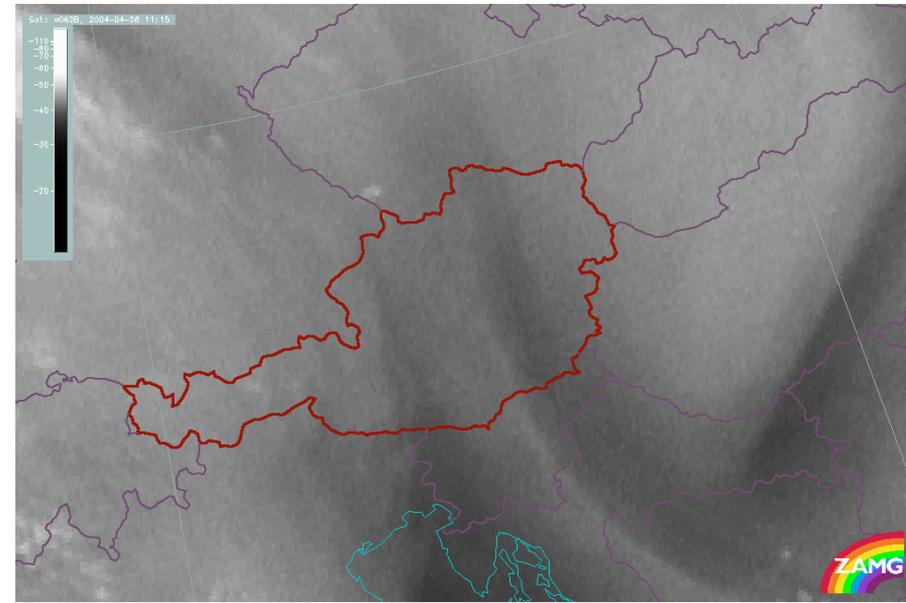
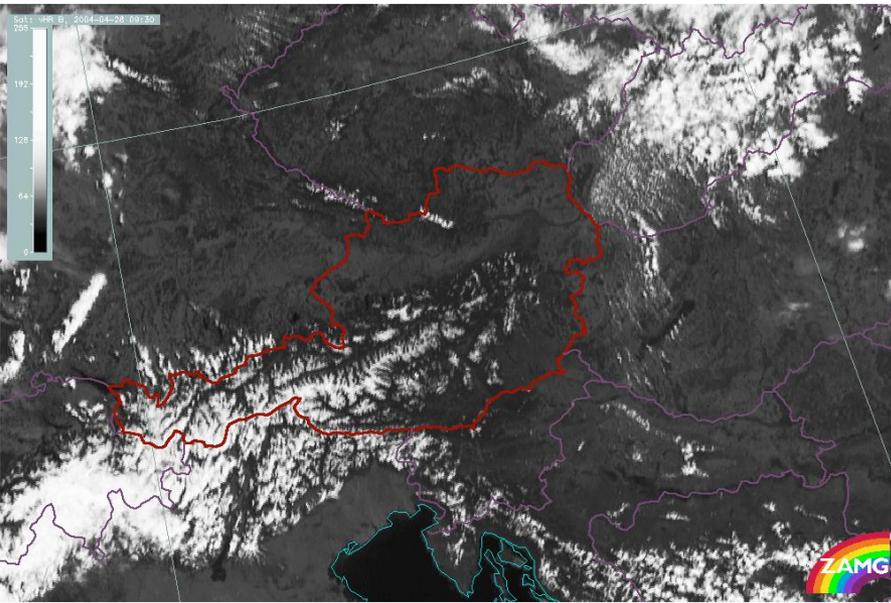
Contra: Entrainment, CIN, weak ingredients – suppressing DMC evolution

- **Basic Problem: Evolution from shallow to deep?**
- **Additional forcing to lift parcel towards its LFC?**

FORECASTING OF SINGLE CELL / PULSE CONVECTION DMC

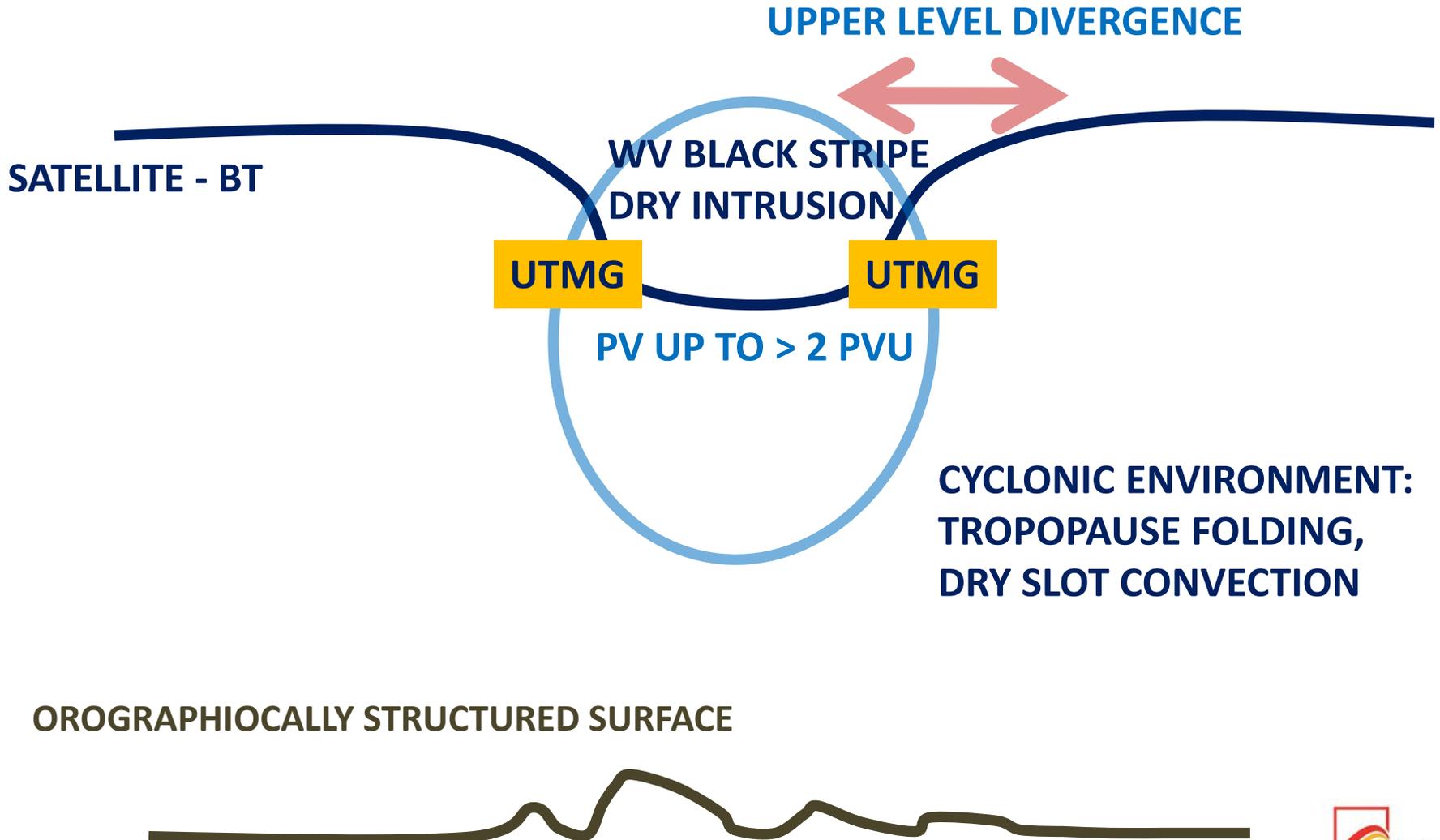
Operational challenge, Nowcasting > 60 min:

- Accuracy of Air mass TS forecast
- Intensity, propagation, orographic influence
- Connection?: SAT WV – Channel 7.3 μ and 6.2 μ
Upper Tropospheric Moisture Gradients UTMG
- **UTMG is not the dark stripe but its boundaries! Physical processes @ UTMG?**

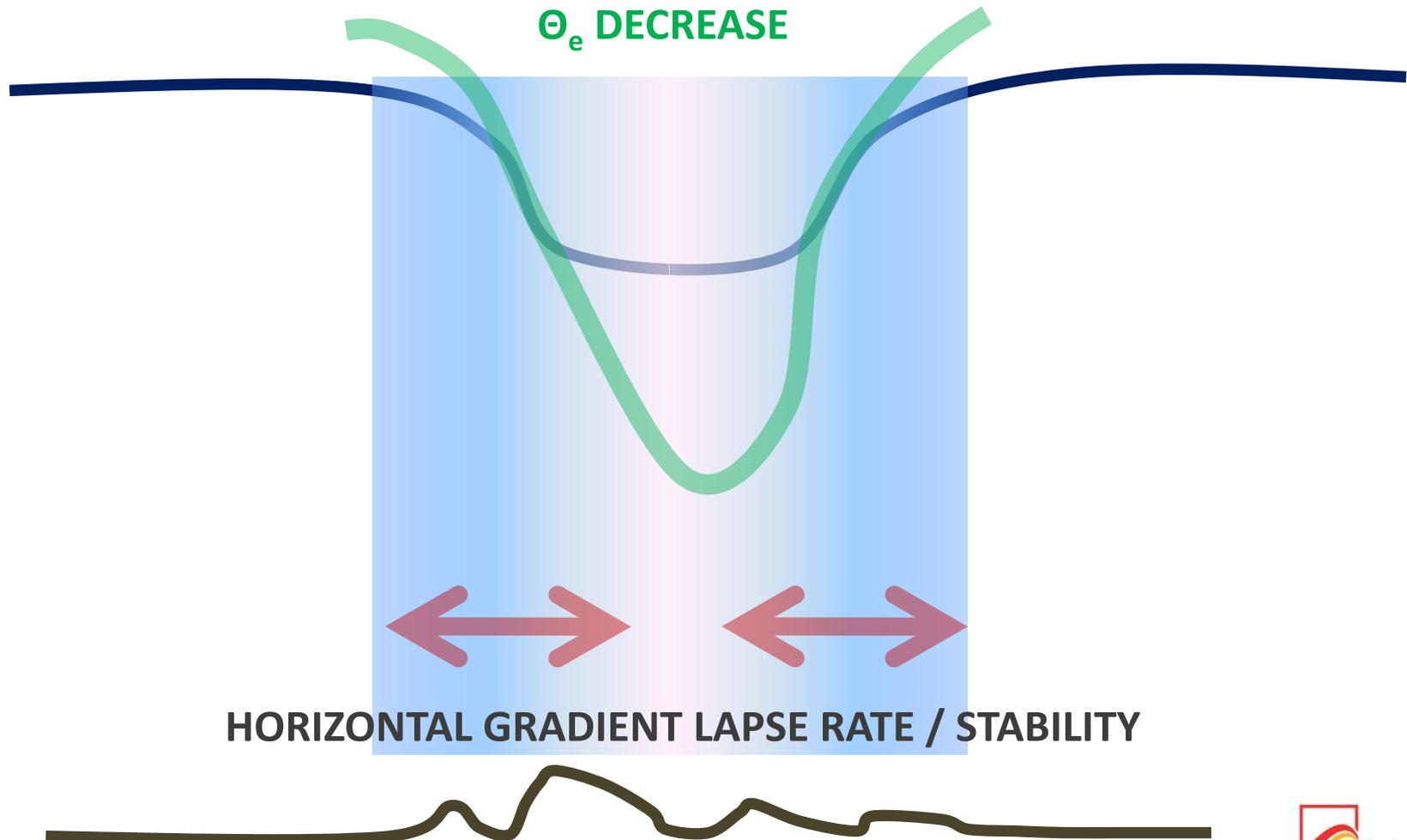




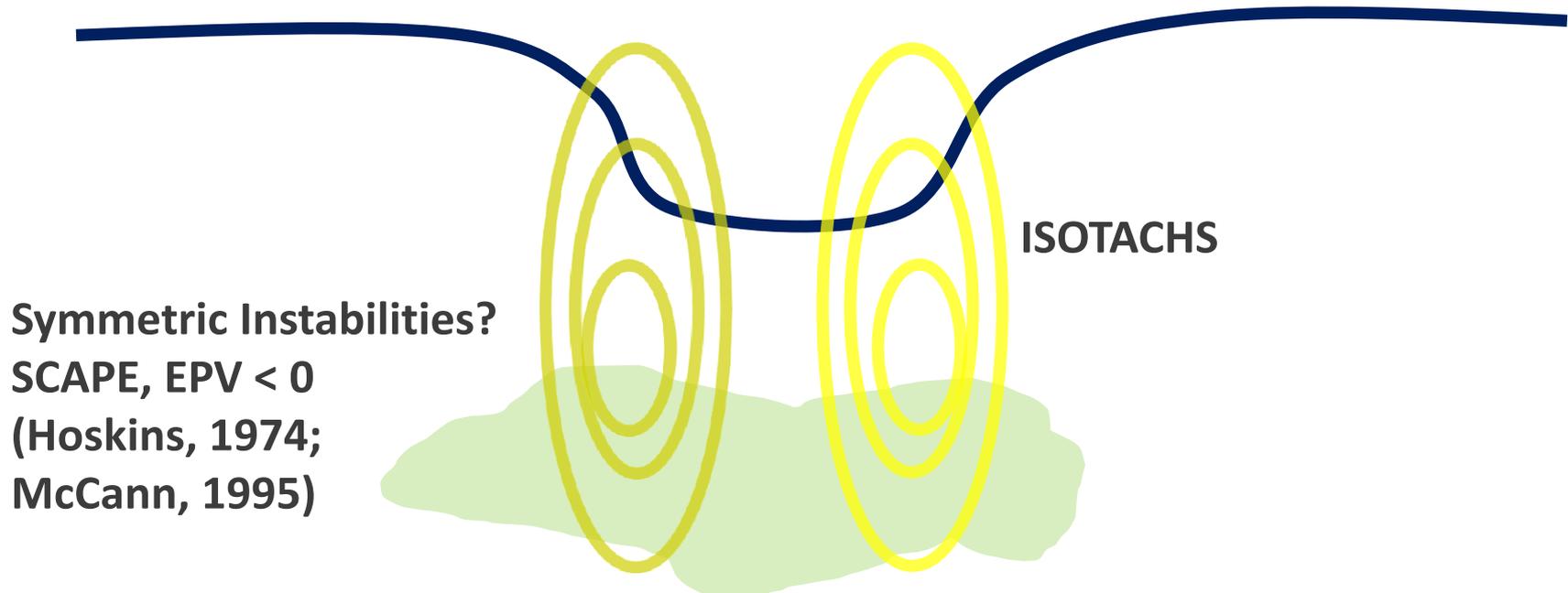
PHYSICS @ UTMG: POTENTIAL VORTICITY, CONCEPT 1



PHYSICS @ UTMG: Θ_e , CONCEPT 2



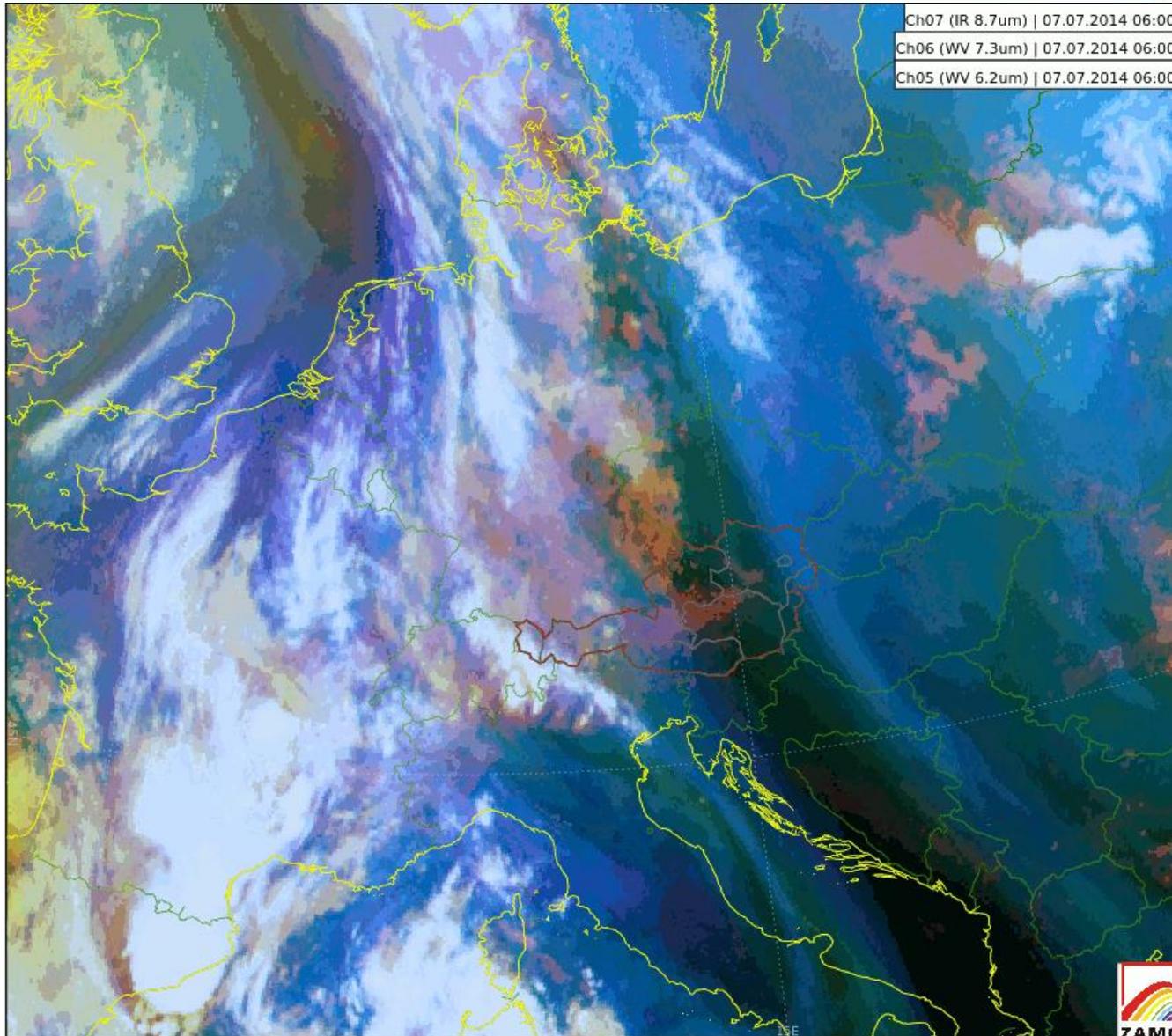
PHYSICS @ UTMG: WIND SHEAR, CSI, CONCEPT 3



INCREASED VERTICAL SHEAR (UNIDIRECTIONAL) @ UTMG



CASE STUDY 140707, MSG, RGB LOOP, 0600 – 1200 UTC

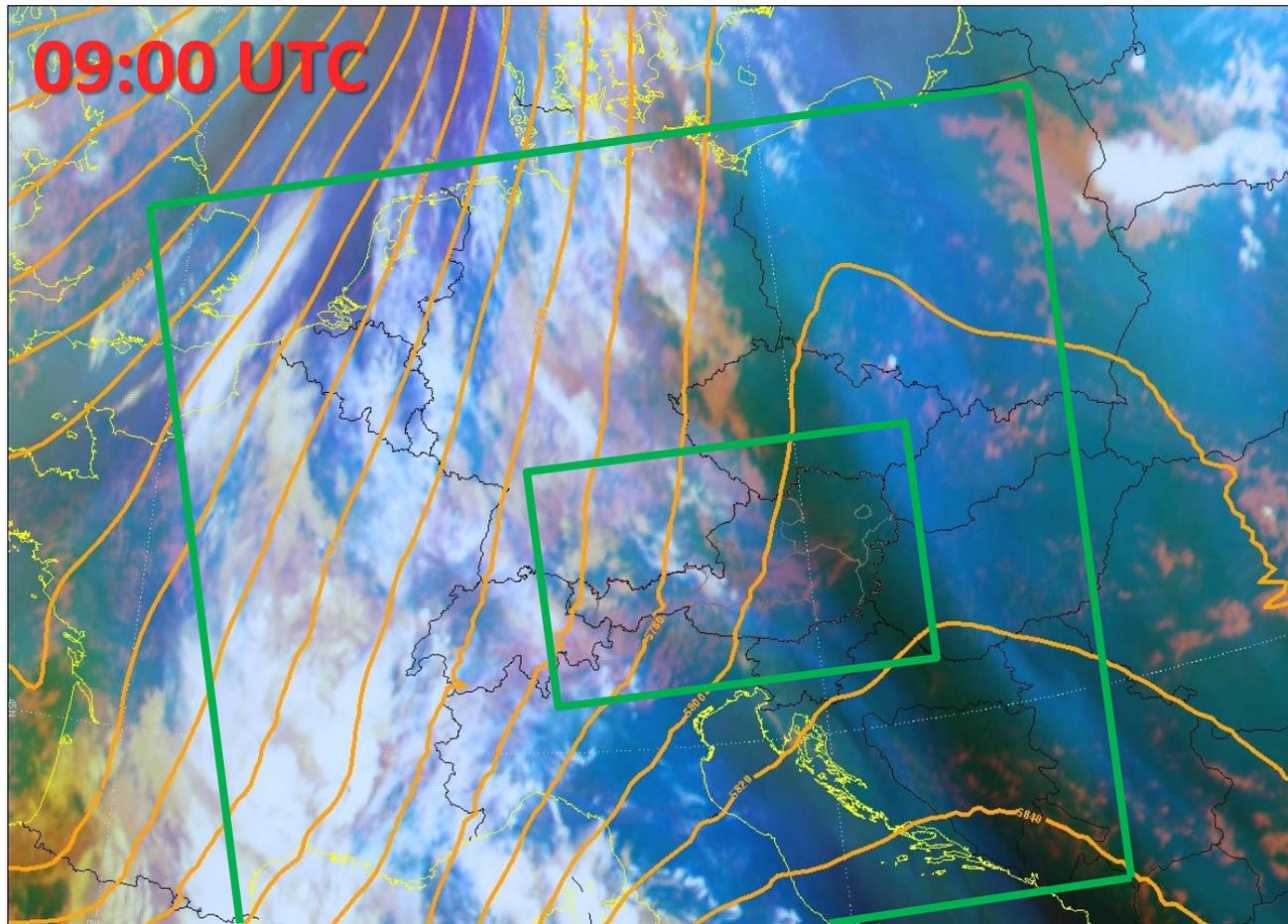


R 8.7 μ
G 7.3 μ
B 6.2 μ



CASE STUDY 140707, WRF MODEL SIMULATION

- 3 domains, ECMWF - nested, resolution 20 / 4 / 0,8 km (D1 / D2 / D3),
- PBL: MYJ; MP: WSM6; LS: RUC-3; ω :Grell3D (only in D1)



ECMWF, 500 hPa
Pressure Ridge

D1 exceeding image

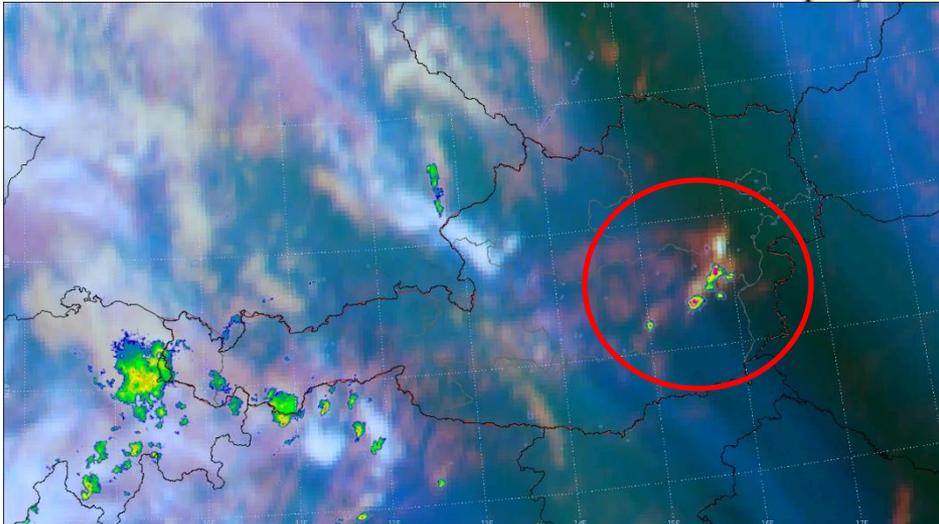
D1, D2 parameterized
D3 convection resolving



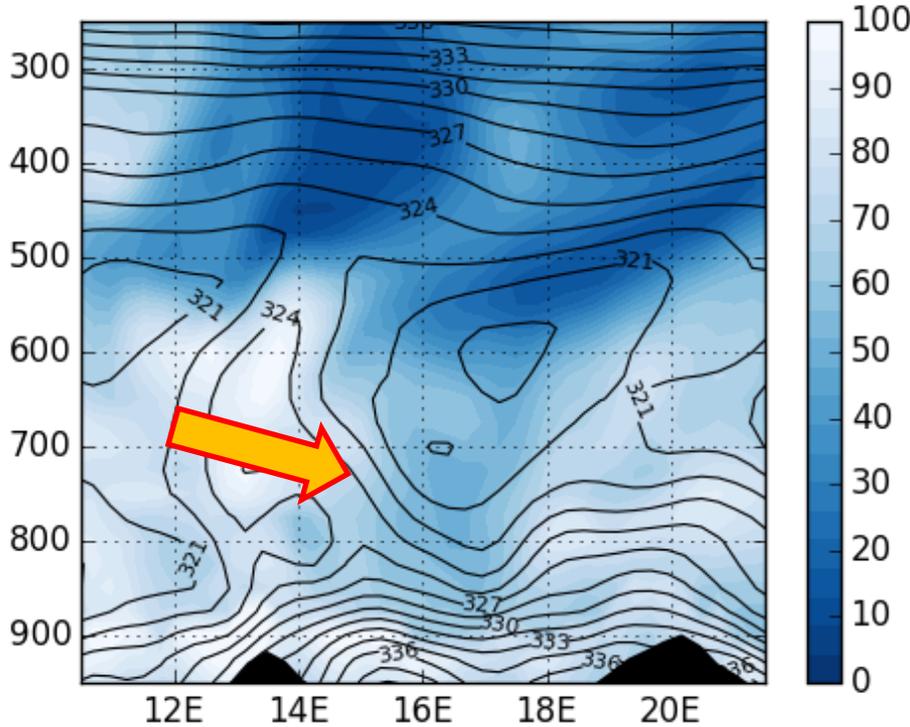
CASE STUDIE 140707, 1010 UTC, MODEL PERFORMANCE

Sum of all vertically integrated hydrometeors

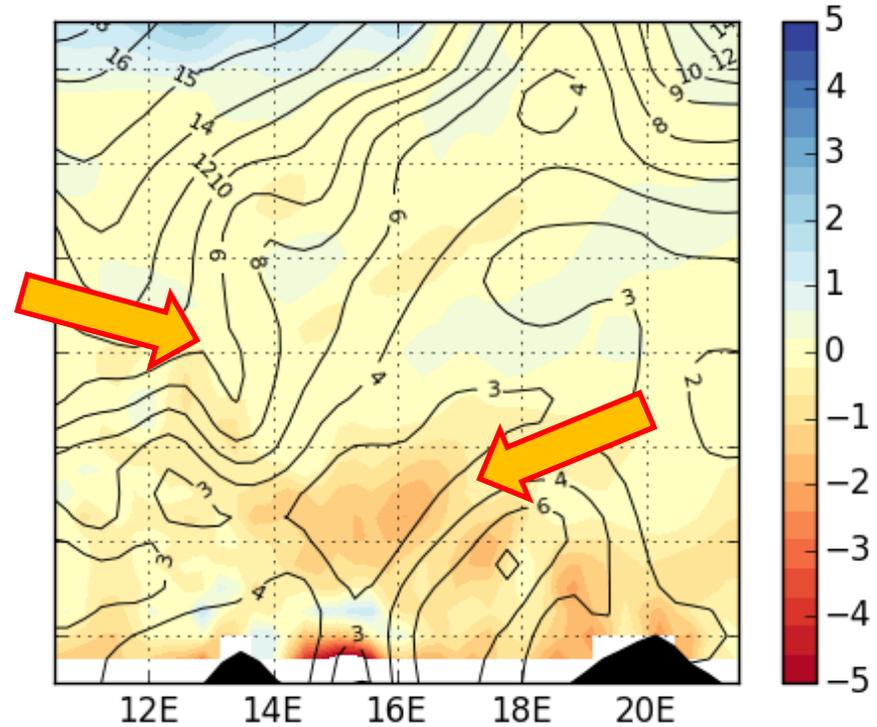
10:10UTC



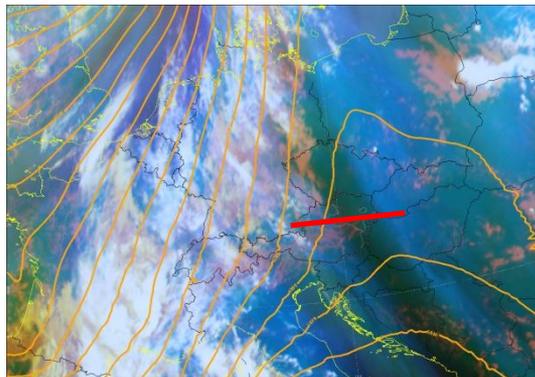
CASE STUDY 140707 0900 UTC, WRF VCS, D1, 20 KM



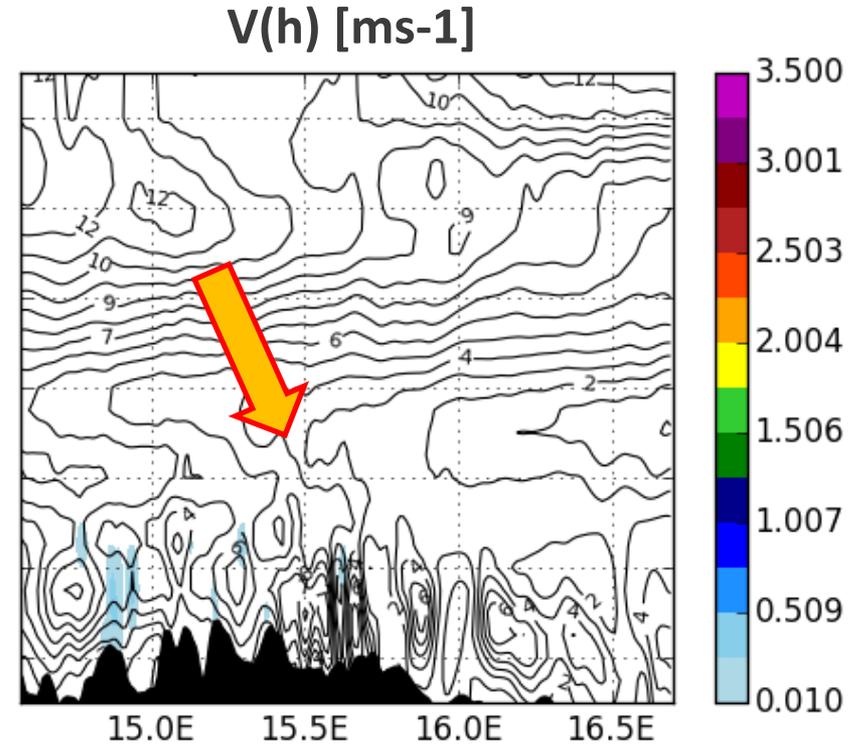
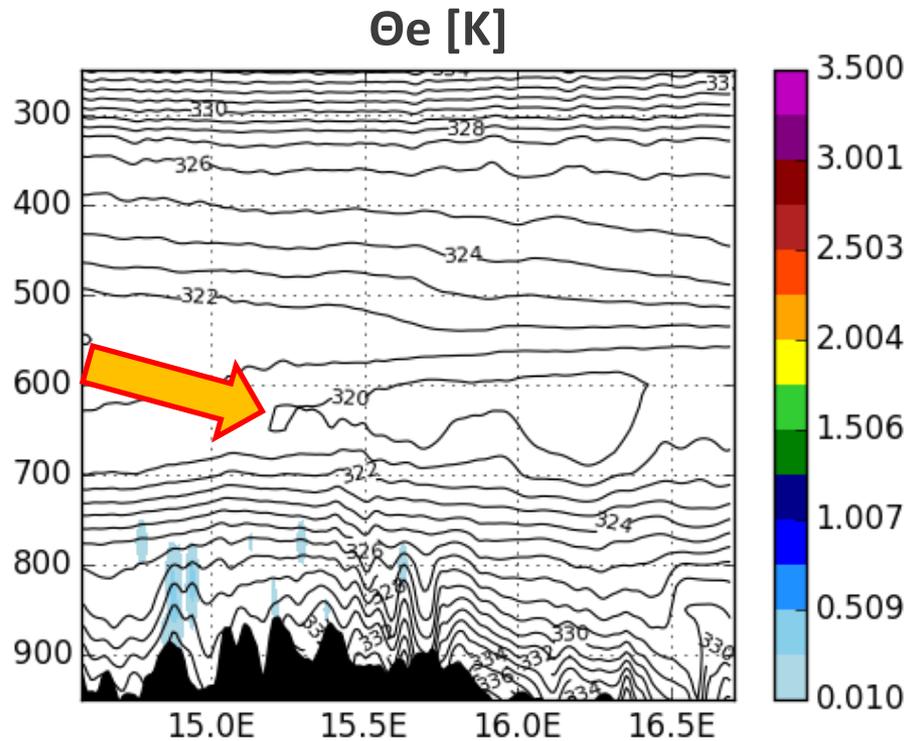
Relative Humidity [%]
(shaded),
 Θ_e [K] (lines)



EPV [PVU]
(shaded),
Horizontal wind component
[m/s] (lines)



CASE STUDY 140707 0800 UTC, WRF VCS, D3, 0,8 KM

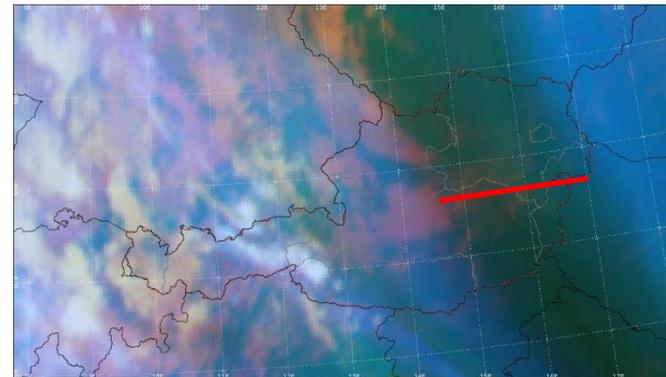


Total sum of Hydrometeors:

qh [g/kg] (shaded)

water, rain, ice, graupel, snow;

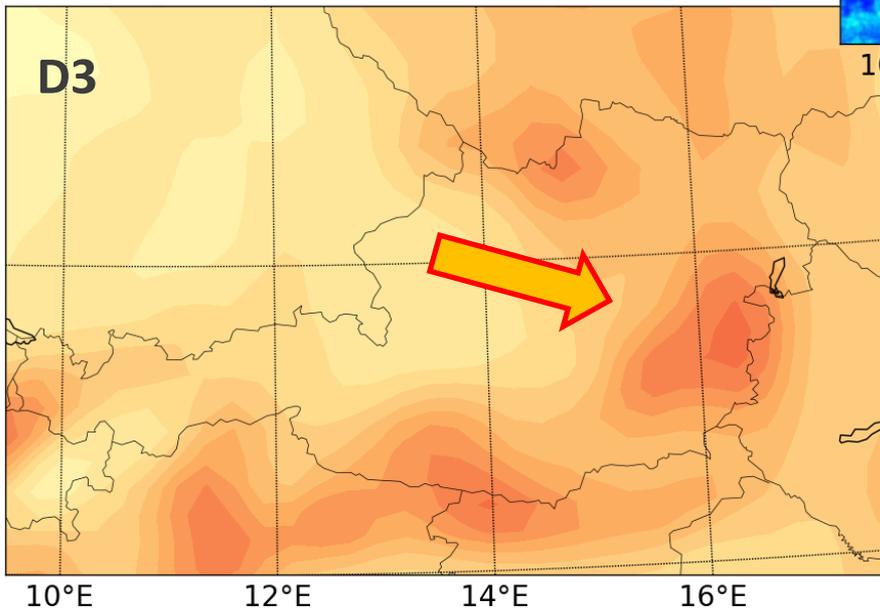
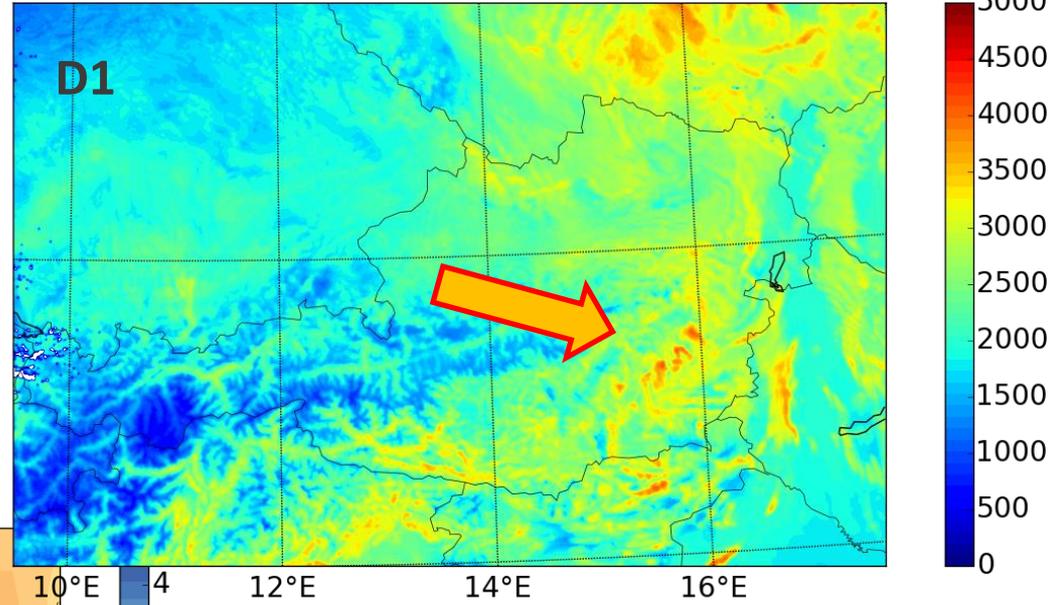
Kirshbaum (2011)





CASE STUDY 140707 0800 UTC, WRF, EPV (D3), SCAPE (D1)

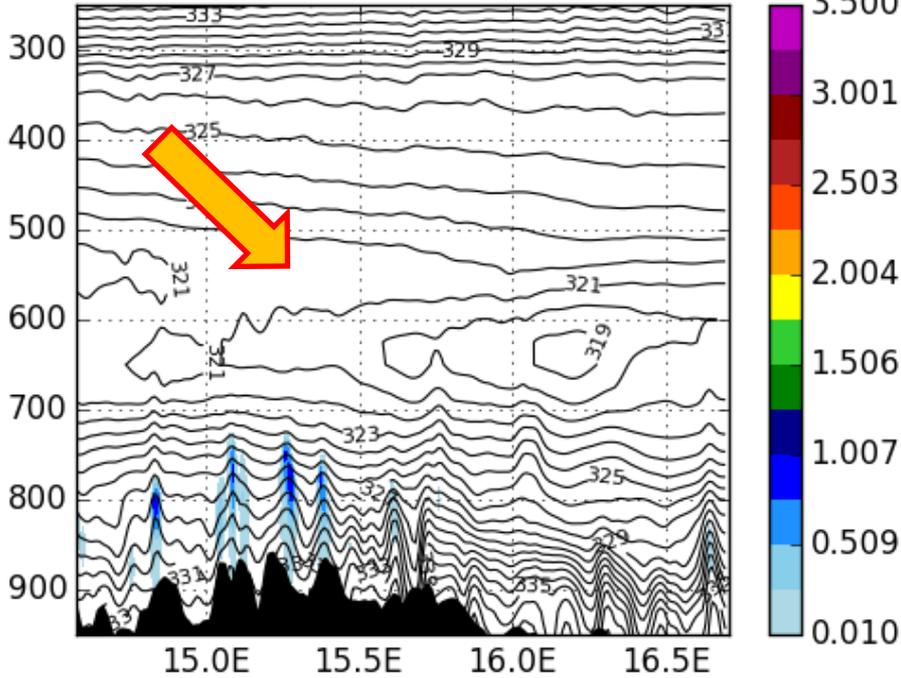
**Symmetric Available Potential Energy
SCAPE [J/kg],
integrated from 950 hPa,
after Dixon (2000)**



**Negative EPV
[PVU = $10^{-6} \cdot K \cdot m^2 / kg \cdot s$],
horizontal minimum projection,
layer 900 - 700 hPa**

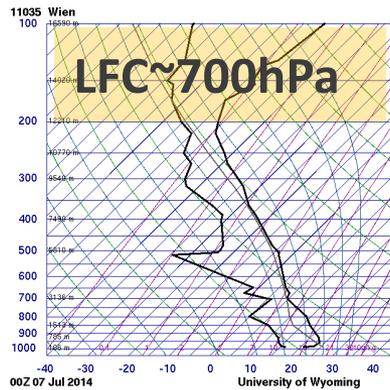
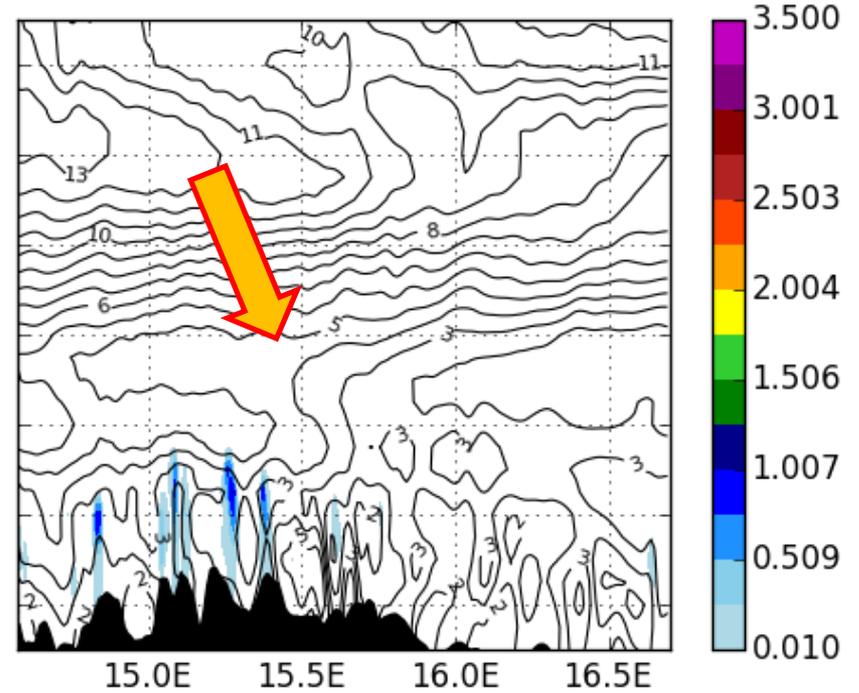
CASE STUDY 140707 0900 UTC, WRF VCS, D3, 0,8 KM

Θ_e [K], lines

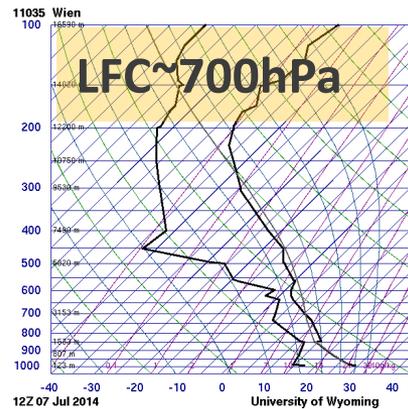


qh[g/kg] (shaded)

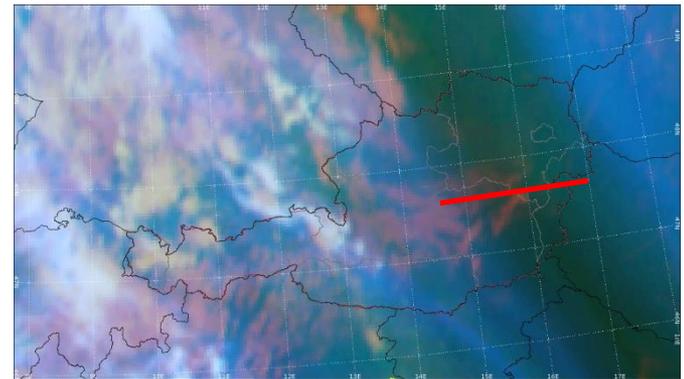
V(h) [ms-1], lines



SLAT 48.25
SLON 16.36
SELV 200.0
SHOW 3.31
LFT 1.28
LFTV 0.93
SWET 129.6
BRVC 29.70
CTOT 16.70
VTOT 43.40
CAPE 0.00
CAPV 0.82
CINS 0.00
CINV -0.02
EOLV -5899
EOTV 636.6
LFCT -9899
LFCV 706.2
BRCV 0.15
LCLV 289.0
LCLP 639.0
MLTR 289.6
MLMR 13.53
THCK 5704
PWAT 39.35

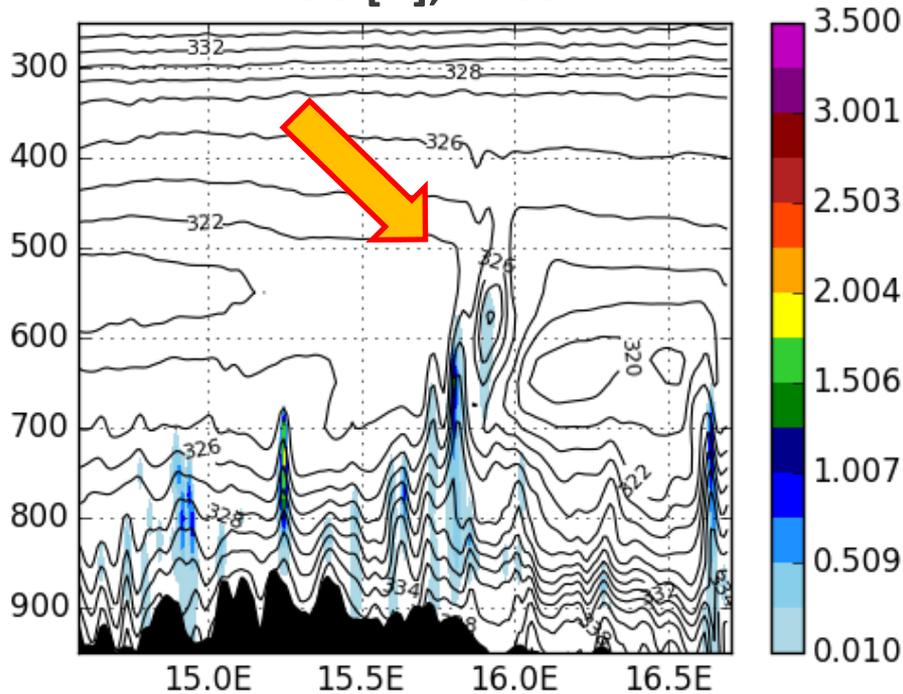


SLAT 48.25
SLON 16.36
SELV 200.0
SHOW -1.16
LFT -1.72
LFTV -2.15
SWET 170.9
BRVC 30.90
CTOT 23.30
VTOT 28.10
TOTL 49.40
CAPE 305.9
CAPV 479.5
CINS -181.1
CINV -53.4
EOLV 273.5
EOTV 273.9
LFCT 703.9
LFCV 719.1
BRCV 190.9
BRCV 219.5
LCLV 284.8
LCLP 619.9
MLTR 301.5
MLMR 19.69
THCK 5697
PWAT 32.35

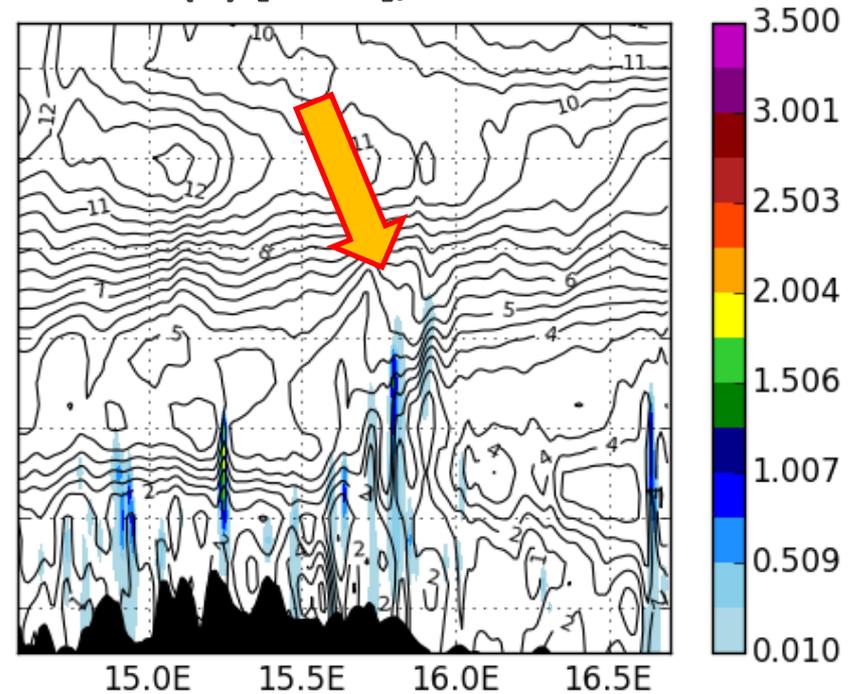


CASE STUDY 140707 1000 UTC, WRF VCS, D3, 0,8 KM

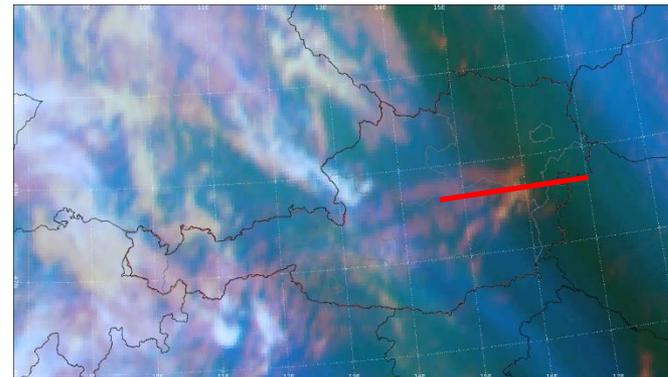
Θ_e [K], lines



V(h) [ms⁻¹], lines



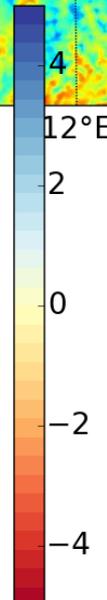
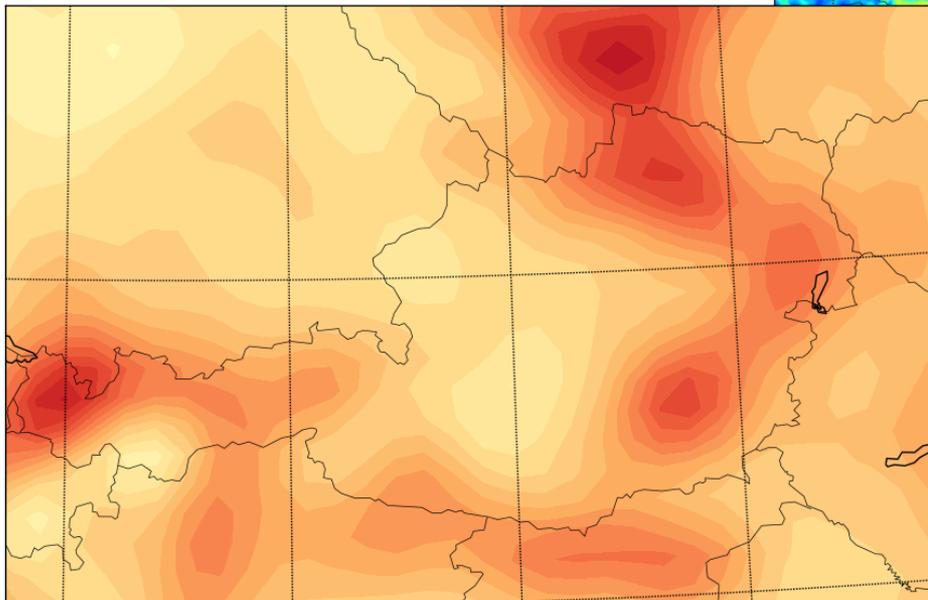
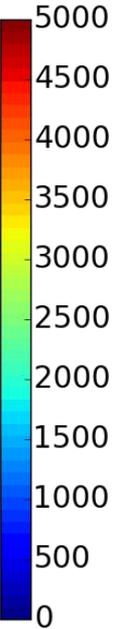
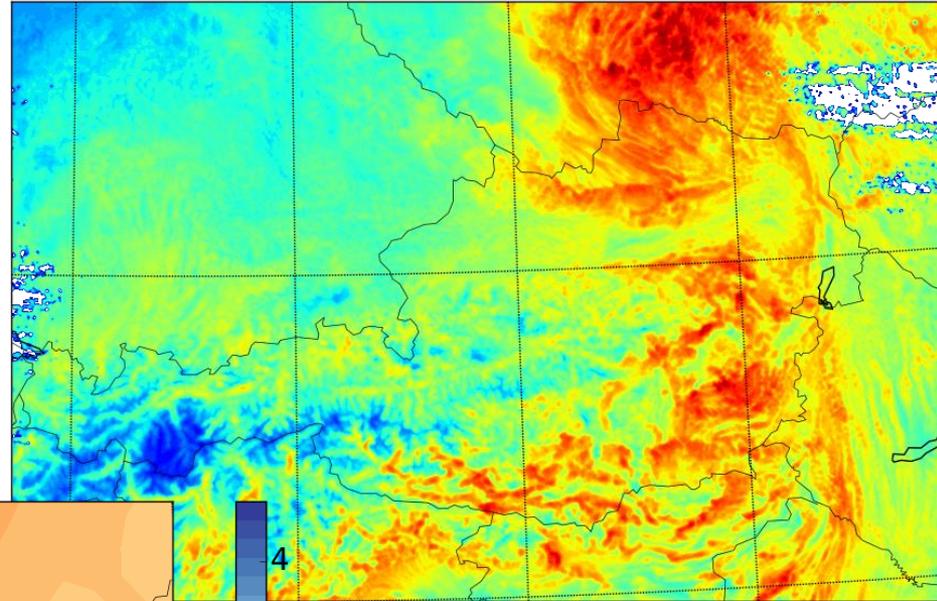
qh[g/kg] (shaded)





CASE STUDY 140707 1000 UTC, WRF, EPV (D3), SCAPE (D1)

SCAPE [J/kg]



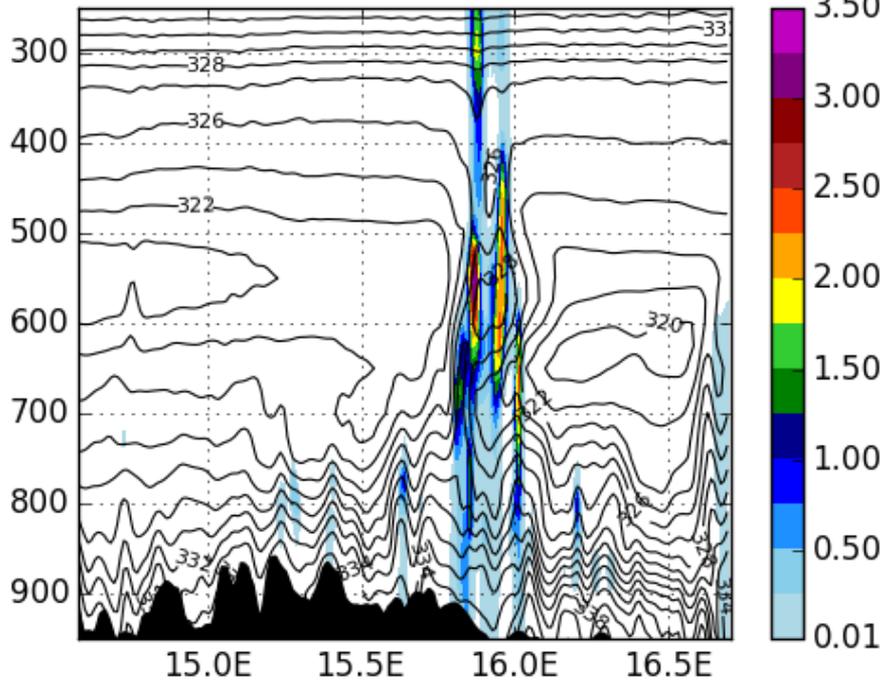
EPV [PVU = $10^{-6} \cdot K \cdot m^2 / kg \cdot s$]

10°E 12°E 14°E 16°E

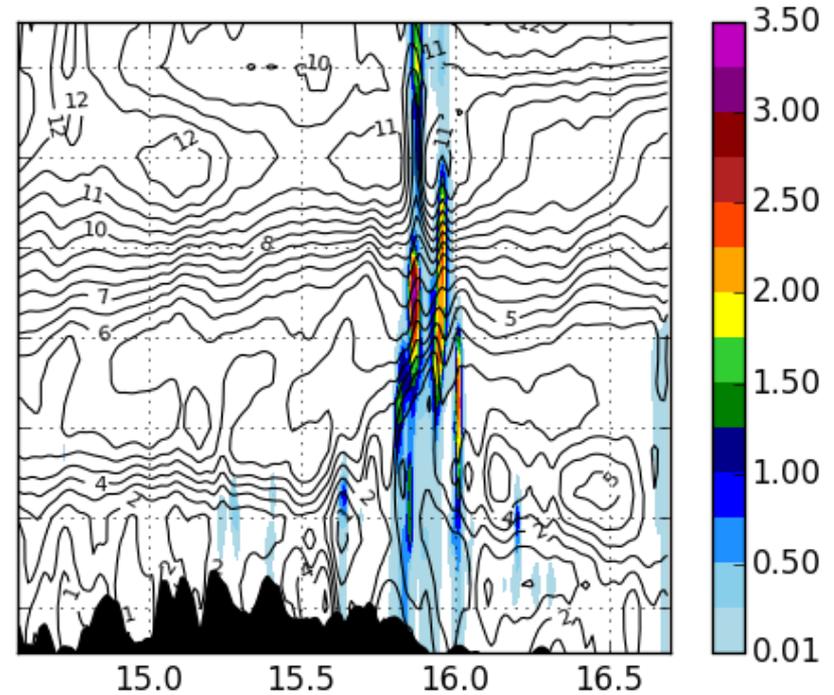
12°E 14°E 16°E

CASE STUDY 140707 1030 UTC, WRF VCS, D3, 0,8 KM

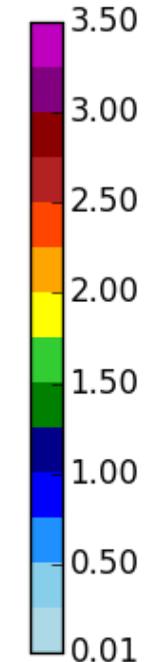
Θ_e [K], lines



qh[g/kg] (shaded)



V(h) [ms⁻¹], lines





SUMMARY

Case Study 140707:

- DMC initiation in the vicinity of horizontal and vertical gradients of Θ_e and significant wind shear (lower mid troposphere)
- SCAPE and negative EPV (Mc Cann, 1995) between 900 - 700h Pa, initially shallow convection reaches these layers before DMC evolution
- Co- existence of conditional (CI) - , inertial (II) - and conditional symmetric (CSI) instability along UTMG seems plausible
- Release of SCAPE possibly leads to portion of „Slantwise Convection“, predictors / indicators between 900 - 700 hPa
- „Slantwise Convection“ – concept similar to “Downscale Development” after Xu (1986)?

“...where bands generated during ascent in a moist symmetrically unstable environment lead to latent-heat release, effectively destabilizing the mid-troposphere to gravitational convection.”