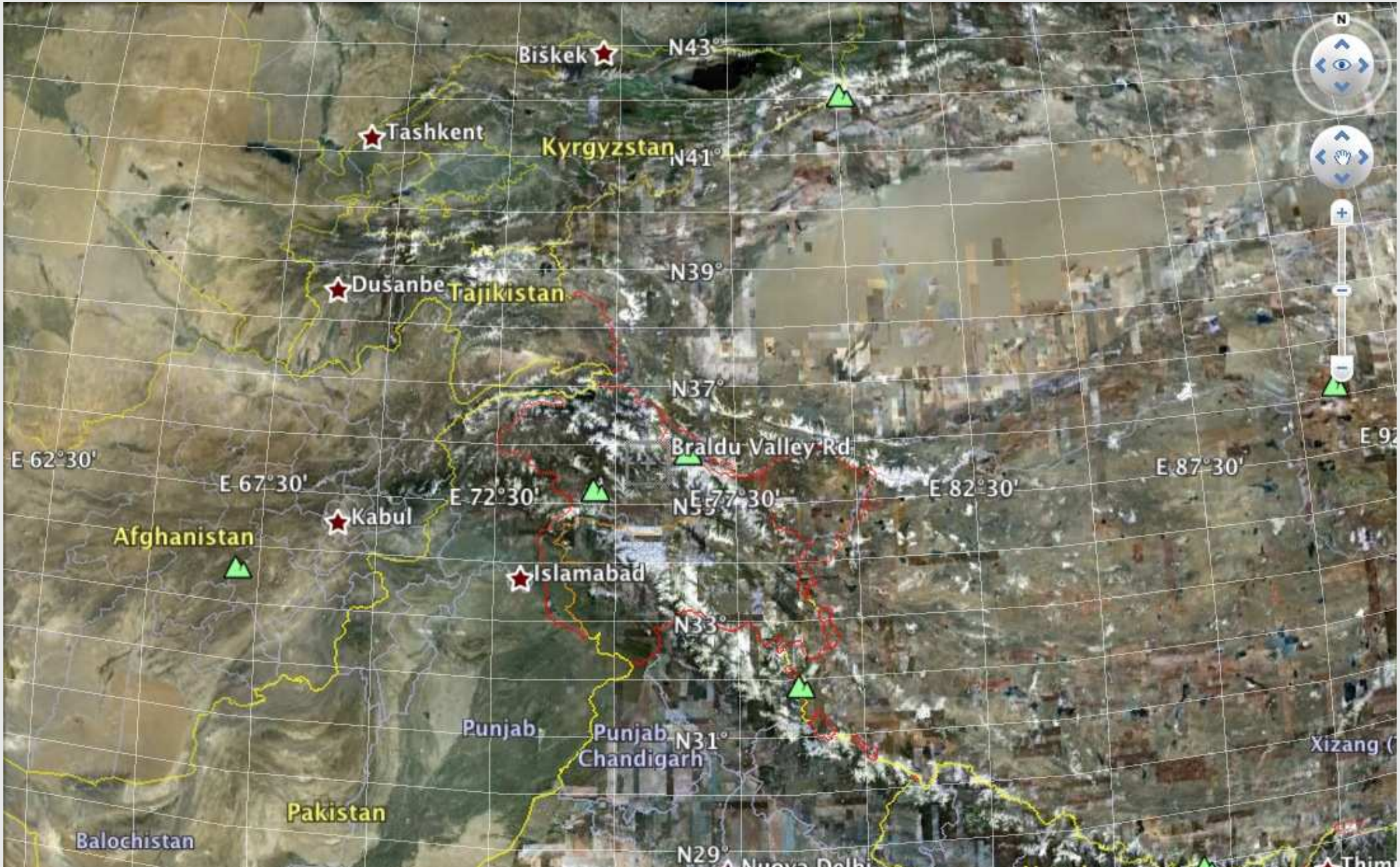
High-resolution non-hydrostatic simulations in HKKH

A. Parodi (1), J. von Hardenberg (2), and A. Provenzale (2)

(1) CIMA Research Foundation, Savona, Italy,
Istituto di Scienze dell'Atmosfera e del Clima (ISAC), Consiglio Nazion
delle Ricerche, Torino, Italy

The case study:

ere Rains in Central Karakoram, 9-10 September 1



Impacts

TABLE 1

September 9/10th, 1992 precipitation for two transhimalayan stations compared to their monthly and annual means (c.f. Whiteman, 1985)

Elevation (m)	Sept. 9/10 1992 (mm)	Sept. Mean (mm)	Mean Annual (mm)	Highest Month (mm)
1260	94	2.6 (25 yr)	165.0	40.2 (Apr)
1450	53	6.8 (30 yr)	131.7	28.3 (Apr)

-triggered active de-
eposit, partly blocking
er below Hoto. 13
9.

FIGURE 3. Boulder-strewn section of the Braldu River

al Rains in Central Karakoram, 9-10 September 1992.

NUMERICAL MODEL SETTING

model 3.3.1 which is a fully compressible, drostatic, scalar variable-conservings, mesoscale .

omains, two-way nesting (IC and BC from ERA-m, 08-12 september 1992):

d01: $\Delta x = \Delta y = 15$ km

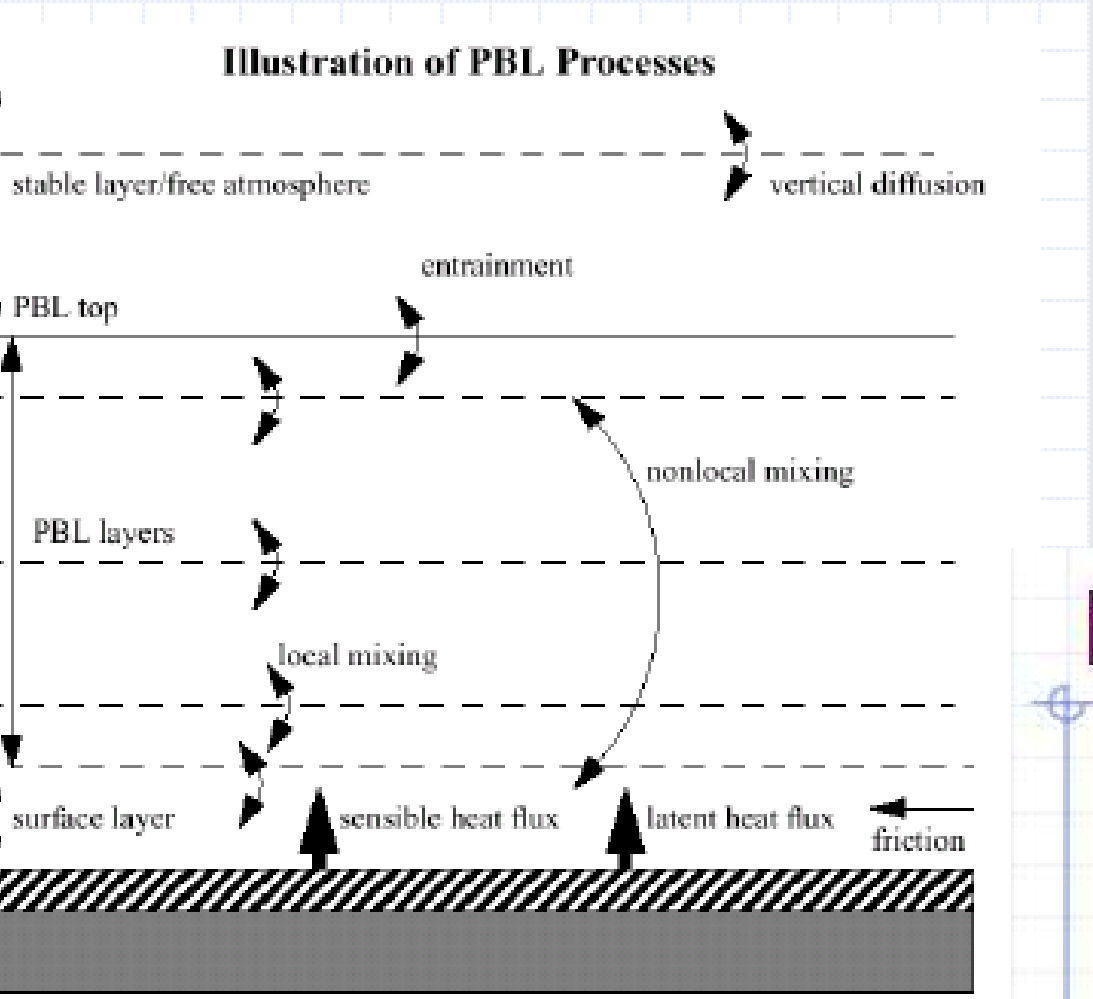
d02: $\Delta x = \Delta y = 5$ km

cal domain size: until to 20 km [~ 60 m near the boundary, ~ 600m near the top one]

ulent parameterization: Mesoscale 1D, Yonsei University (Y tary boundary layer scheme

ection parameterization: Kain-Fritsch scheme

PBL Processes parameterization



bl_pbl_physics=1

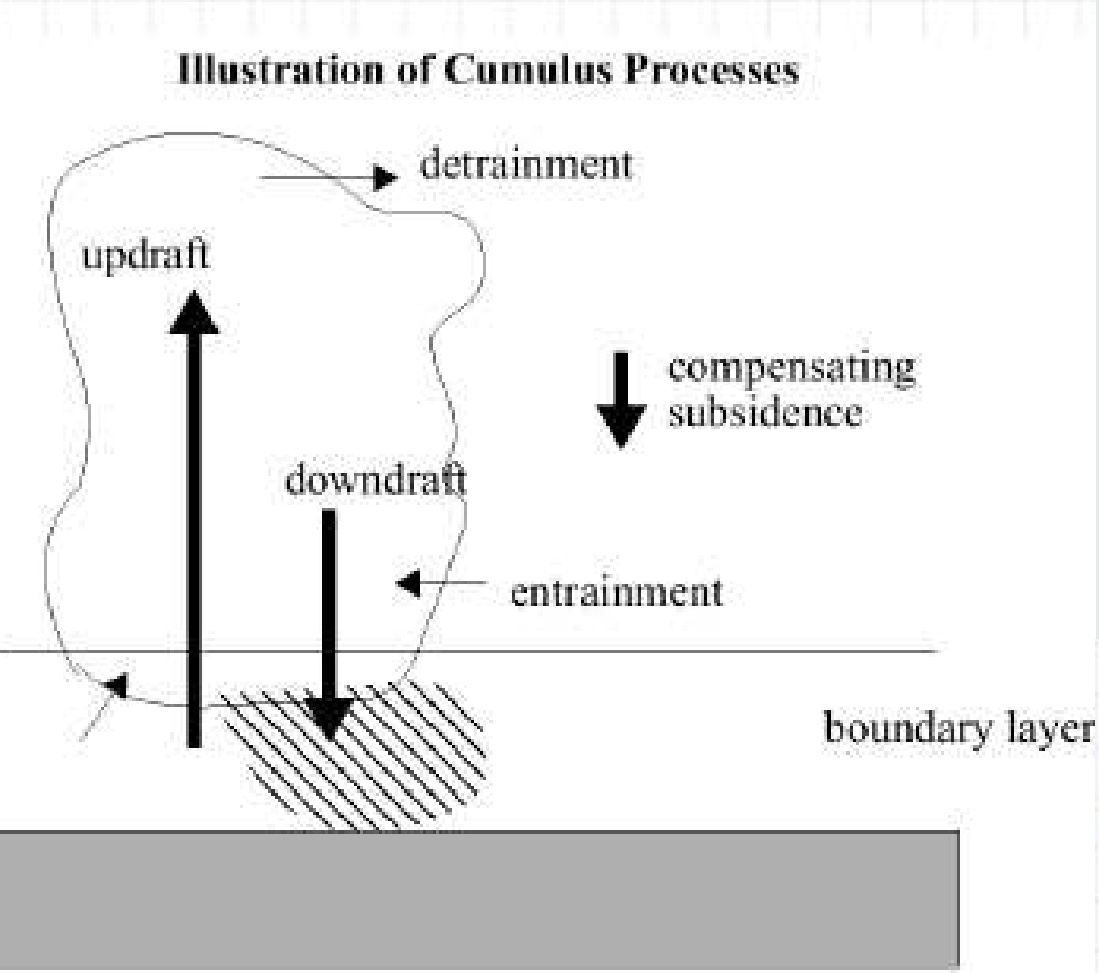
YSU PBL scheme (Hong, Noh and Dudhia

- Parabolic K profile mixing in dry convec boundary layer
- Troen-Mahrt countergradient flux (non-

$$\frac{\partial}{\partial z}(K_v \frac{\partial}{\partial z}\theta + \Gamma)$$

- Depth of PBL determined from thermal
- Explicit treatment of entrainment
- Vertical diffusion depends on Ri in free

Cumulus parameterization



cu_physics=1

New Kain-Fritsch

- As in MM5 and Eta/NMM ensemble ve
- Includes shallow convection (no down
- Low-level vertical motion in trigger fu
- CAPE removal time scale closure
- Mass flux type with updrafts and dow entrainment and detrainment
- Includes cloud, rain, ice, snow detrain

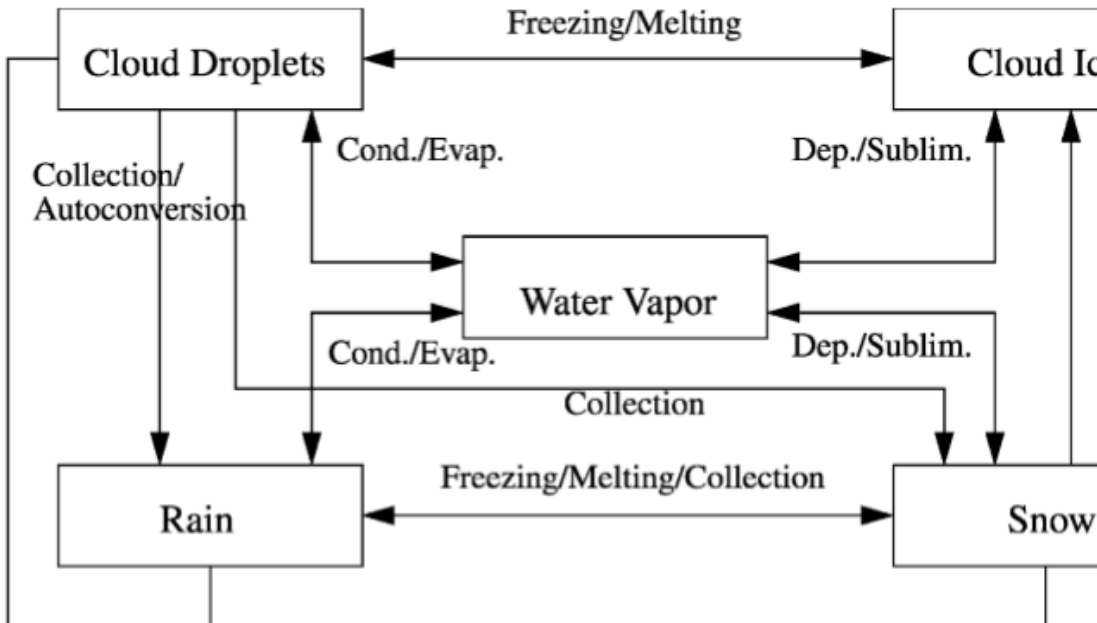
Microphysics parameterization: single-moment and double-moment schemes

ngle-moment schemes have one prediction
uation for mass (kg/kg) per species (Qr,
, etc.) with particle size distribution being
agnostic

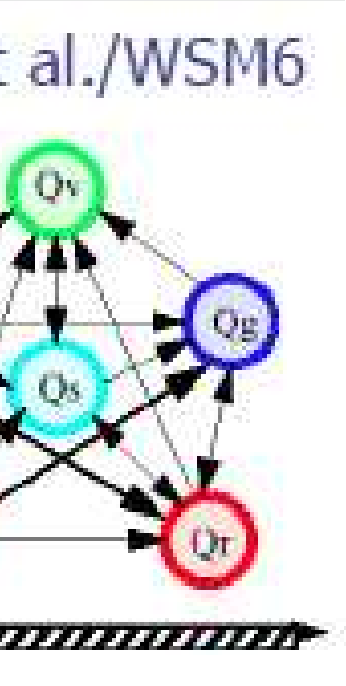
ouble-moment schemes add a prediction
uation for number concentration (#/kg)
r double-moment species (Nr, Ns, etc.)

ouble-moment schemes may only be
uble-moment for a few species

ouble-moment schemes allow for additional
ocesses such as size-sorting during fall-out
d sometimes aerosol effects on clouds



mp_physics=6



WSM 6-class scheme

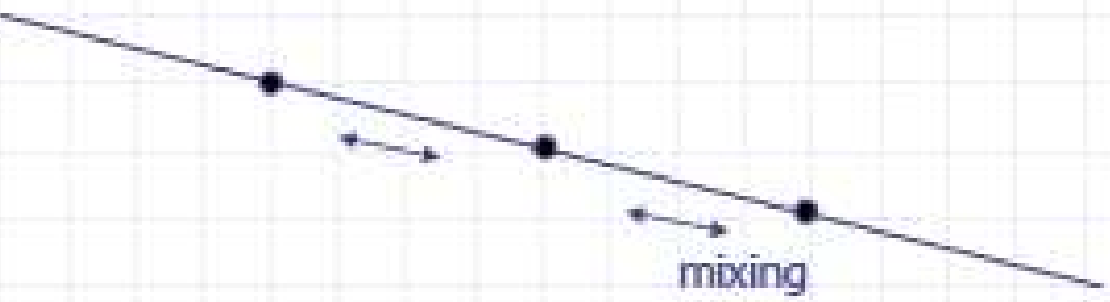
- From Hong and Lim (2006, JKMS)
- 6-class microphysics with graupel
- Ice number concentration as in WSI and WSM5
- New combined snow/graupel fall sp
- Semi-lagrangian fall terms

mp_physics=8

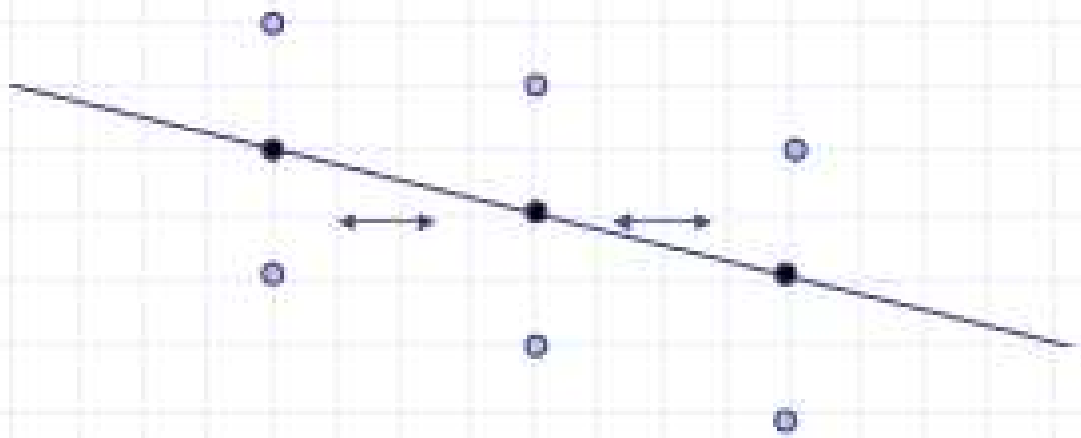
New Thompson et al. scheme in V3.1

- Replacement of Thompson et al. (2007) scheme that was option 8 in V3.0
- 6-class microphysics with graupel
- Ice and rain number concentrations also predicted (double-moment ice)
- Time-split fall terms

izontal diffusion computation (over steep orograp



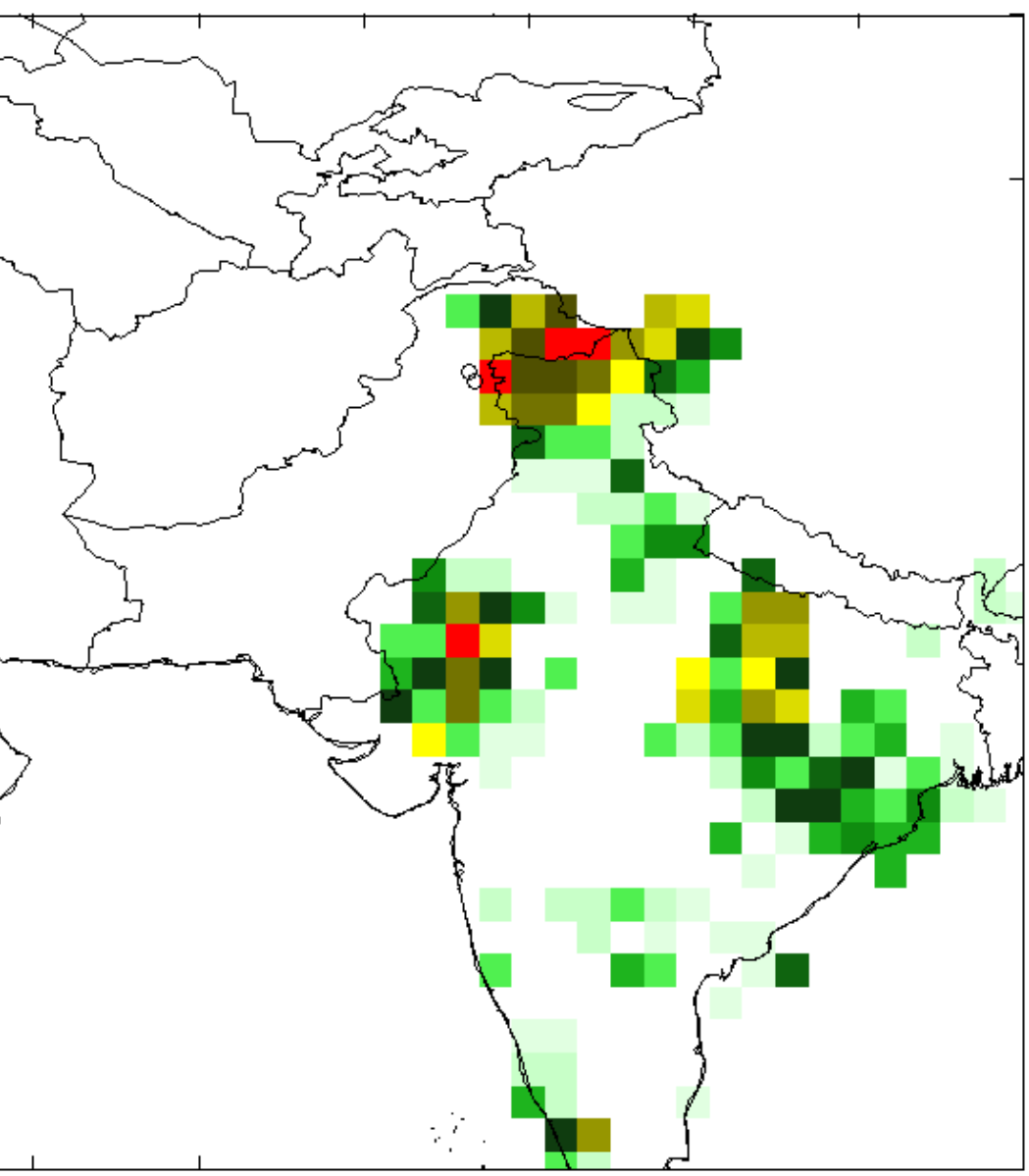
pt=1
ontal diffusion acts along model levels
er numerical method with only neighboring points on
e same model level

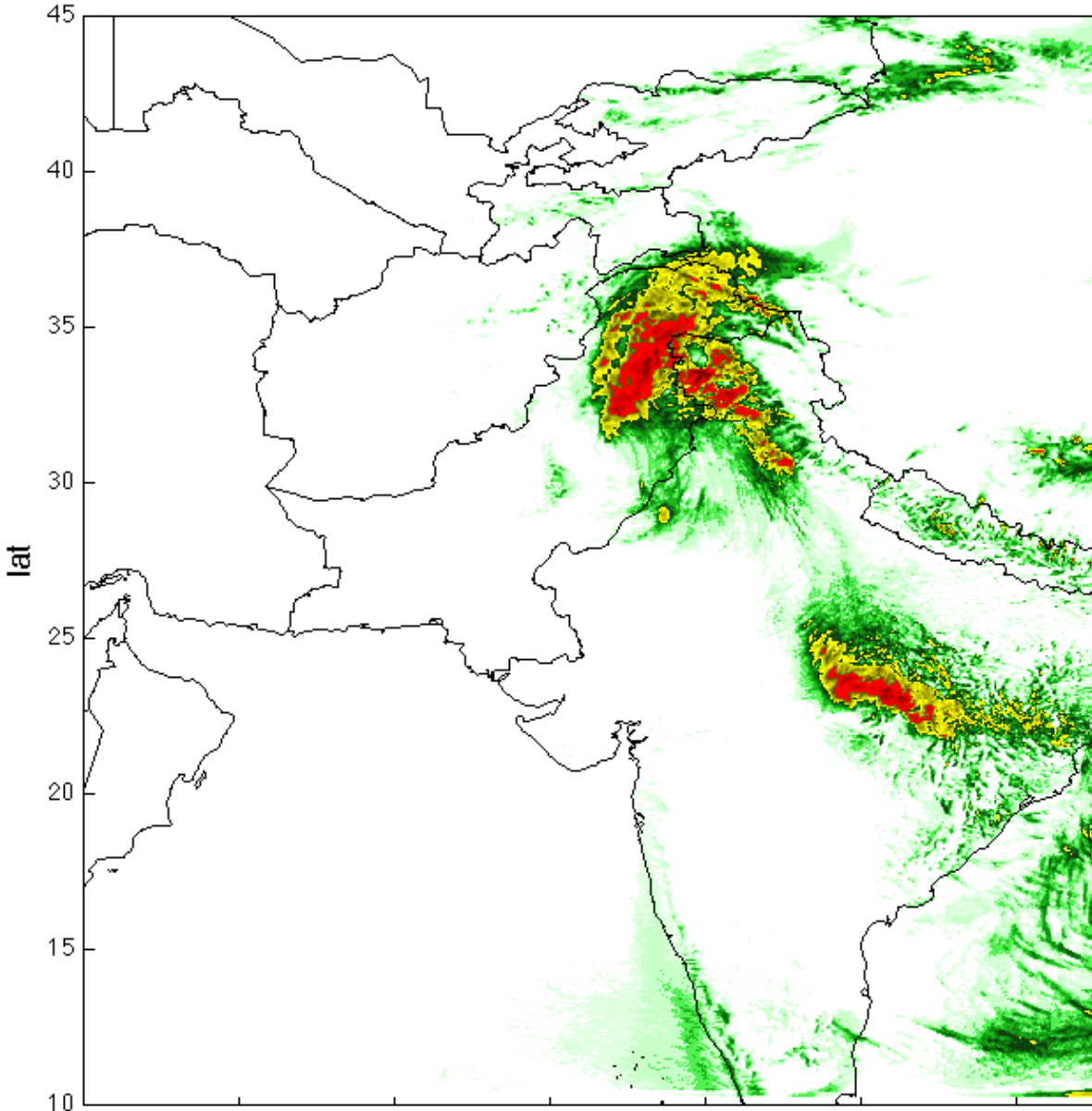


diff_opt=2
Horizontal diffusion acts on horizontal gradien

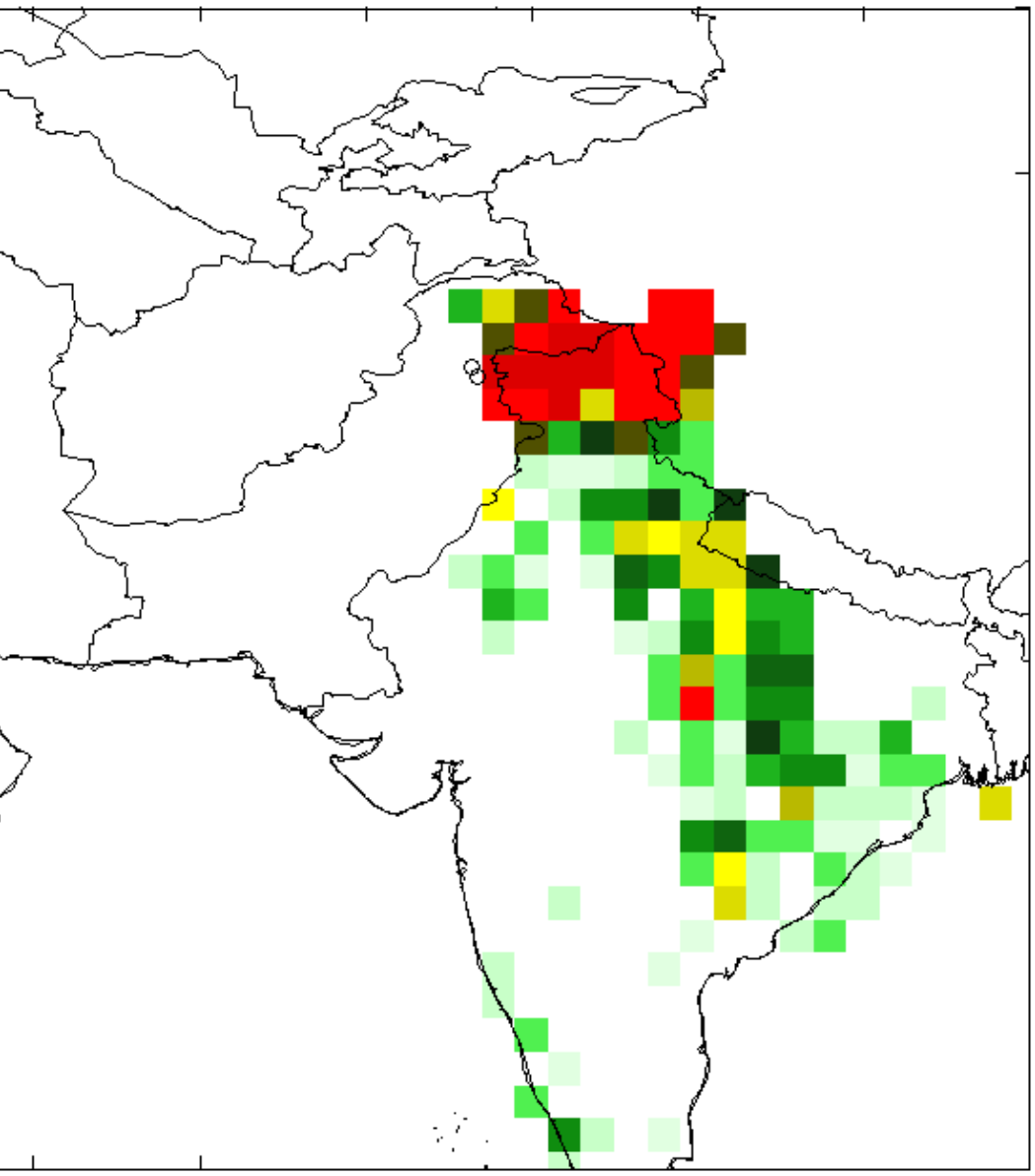
9 September 1992:

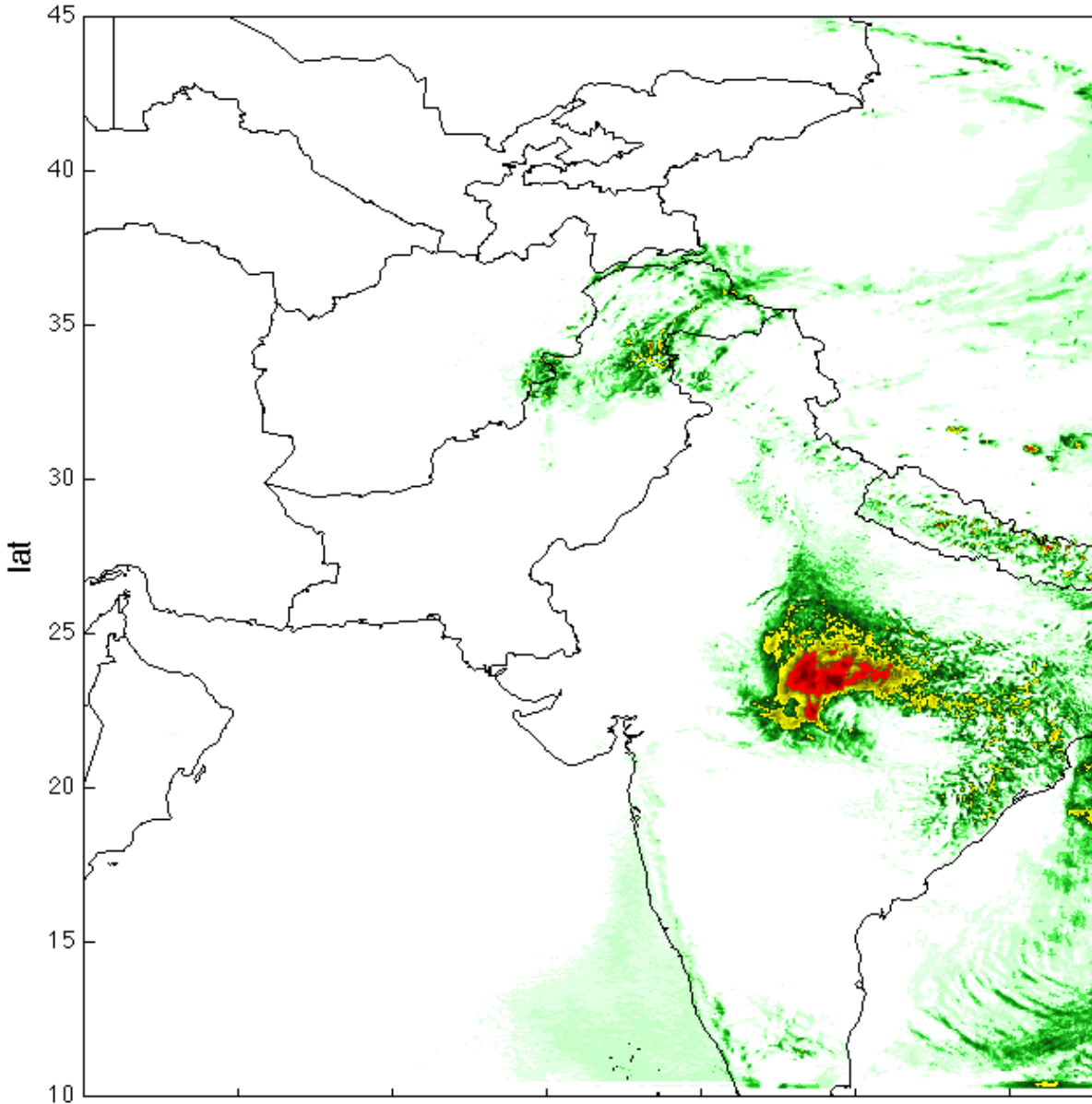
bserved vs predicted (d02, mp6) daily rainfall dept





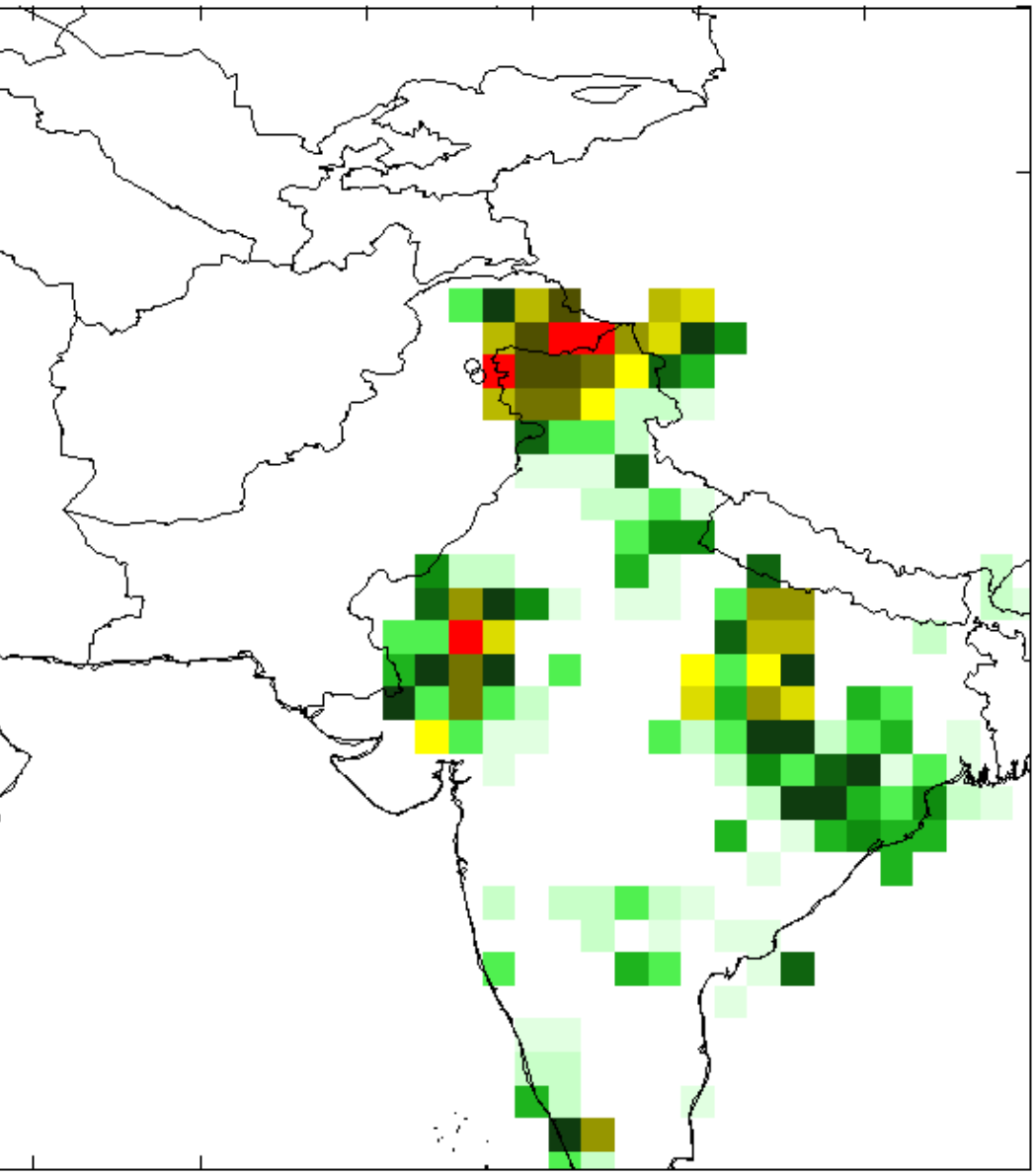
10 September 1992:
bserved vs predicted (d02, mp6) daily rainfall dept

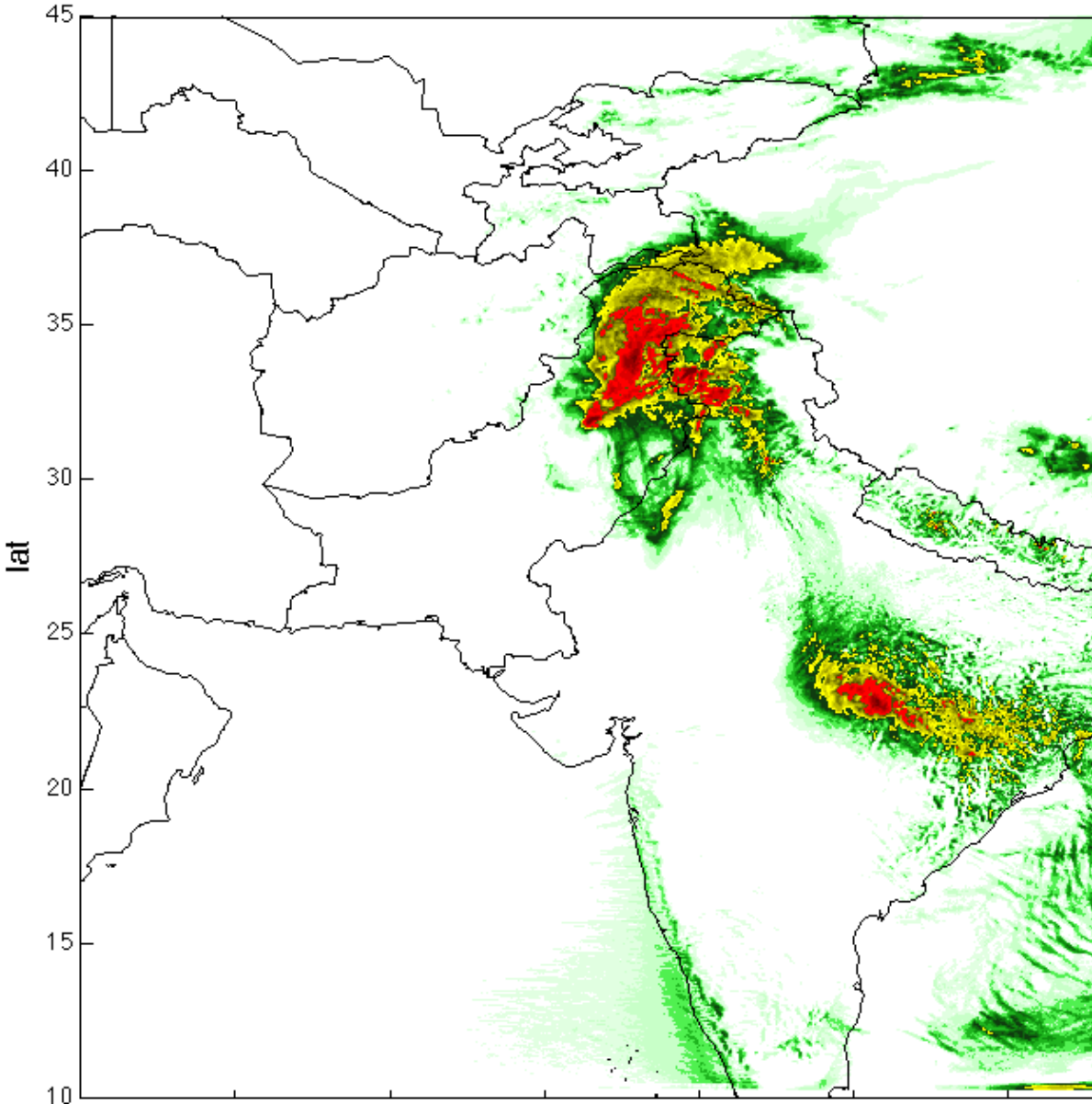




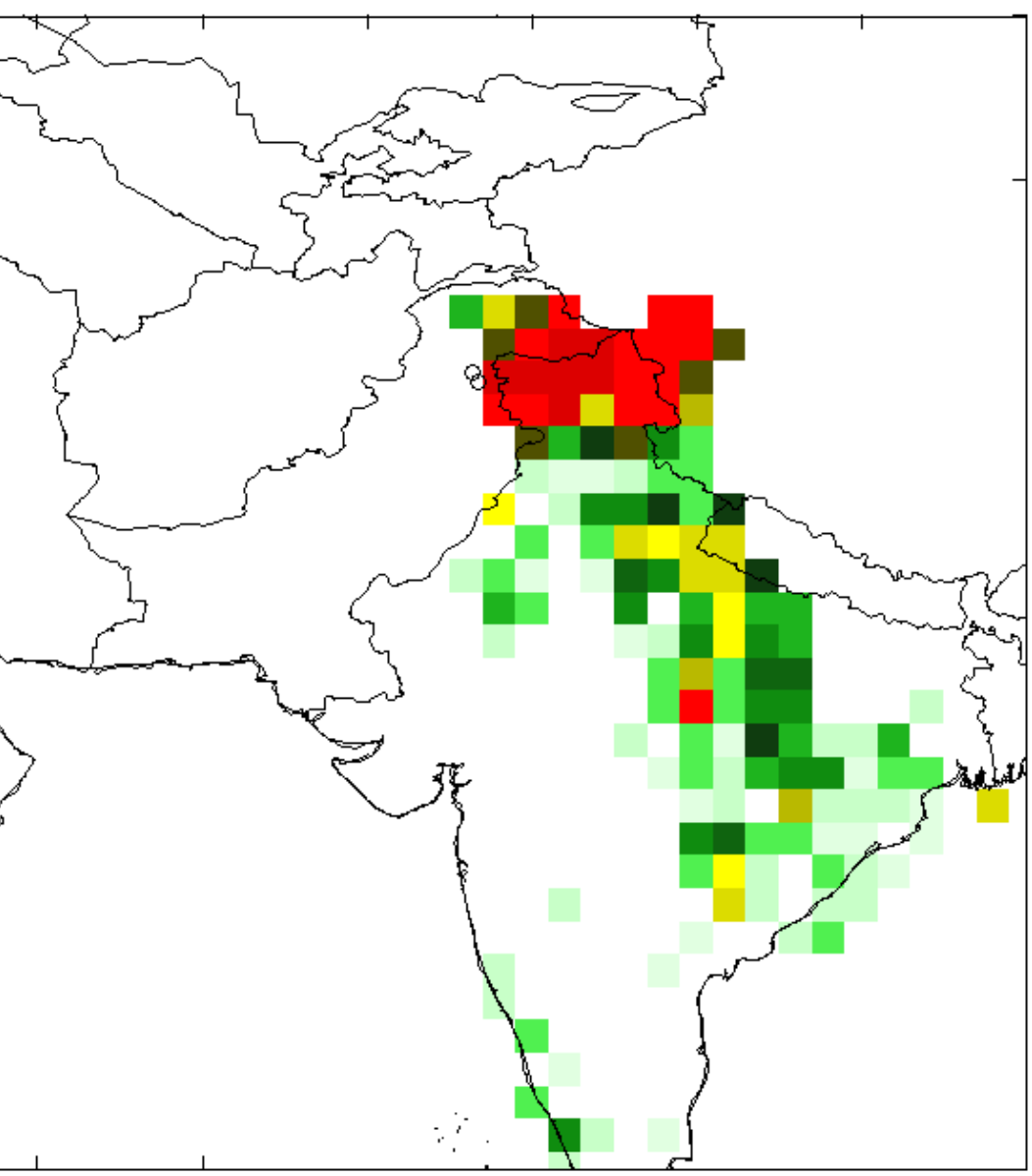
9 September 1992:

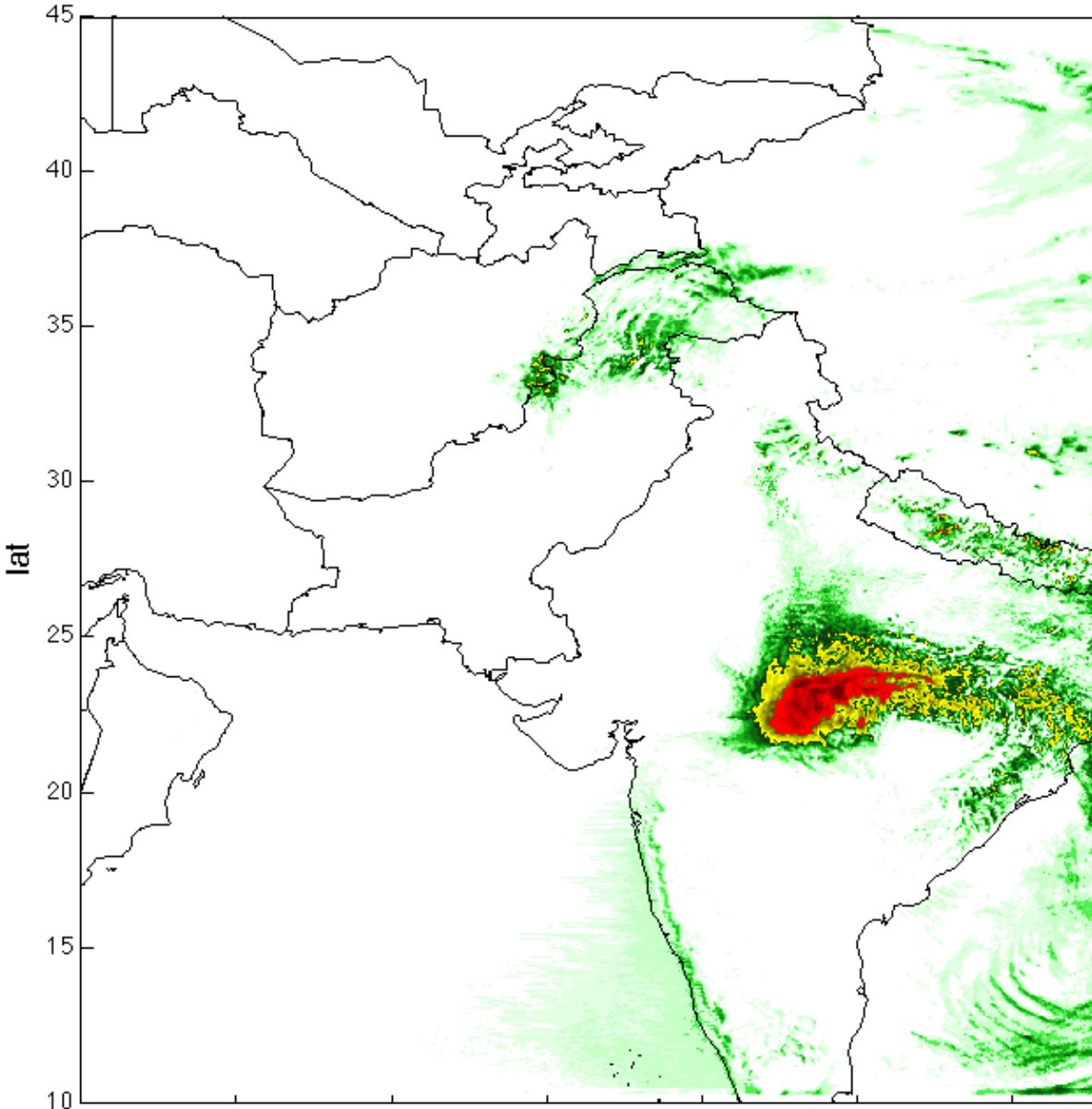
bserved vs predicted (d02, mp8) daily rainfall dept



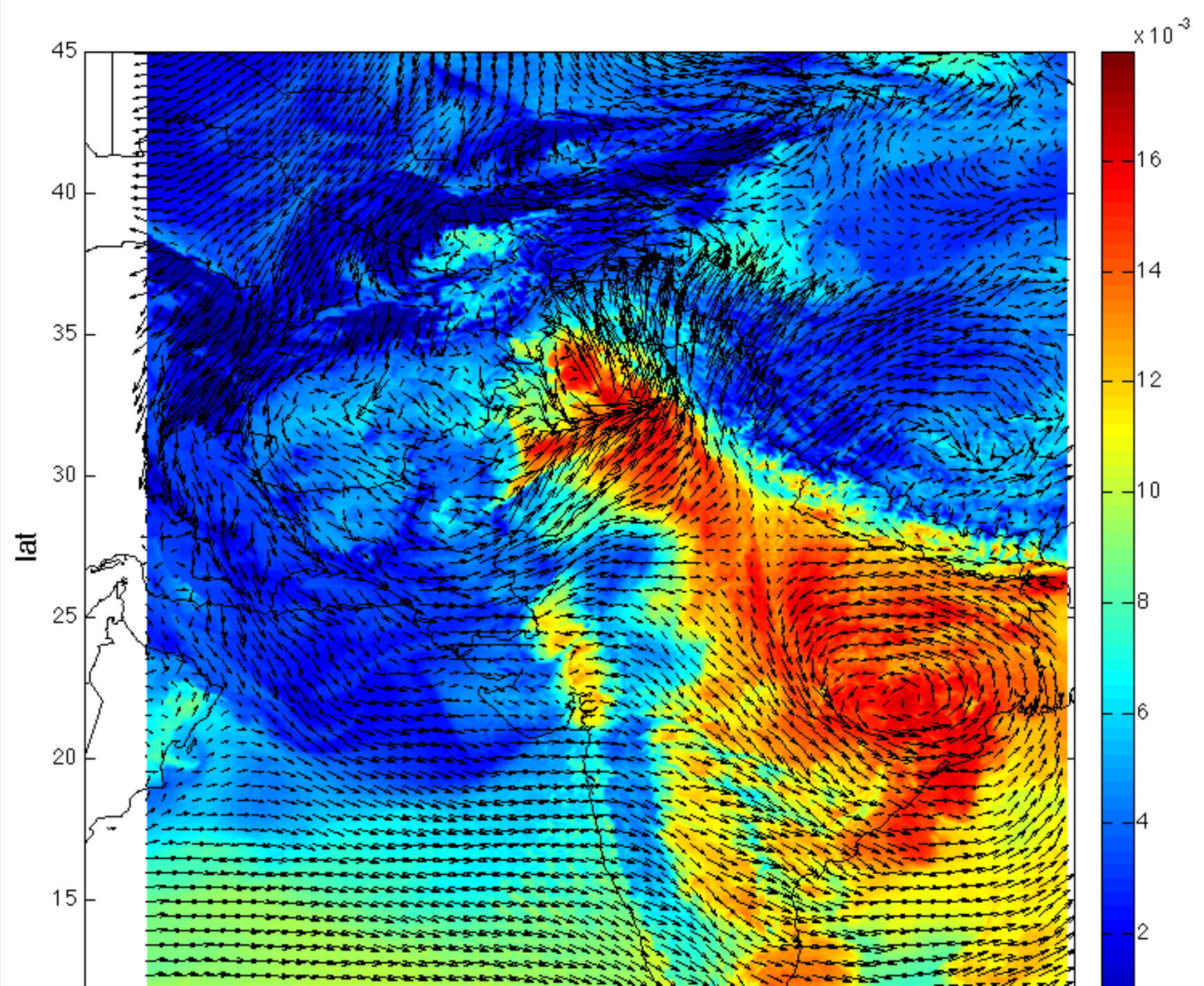


10 September 1992:
bserved vs predicted (d02, mp8) daily rainfall dept

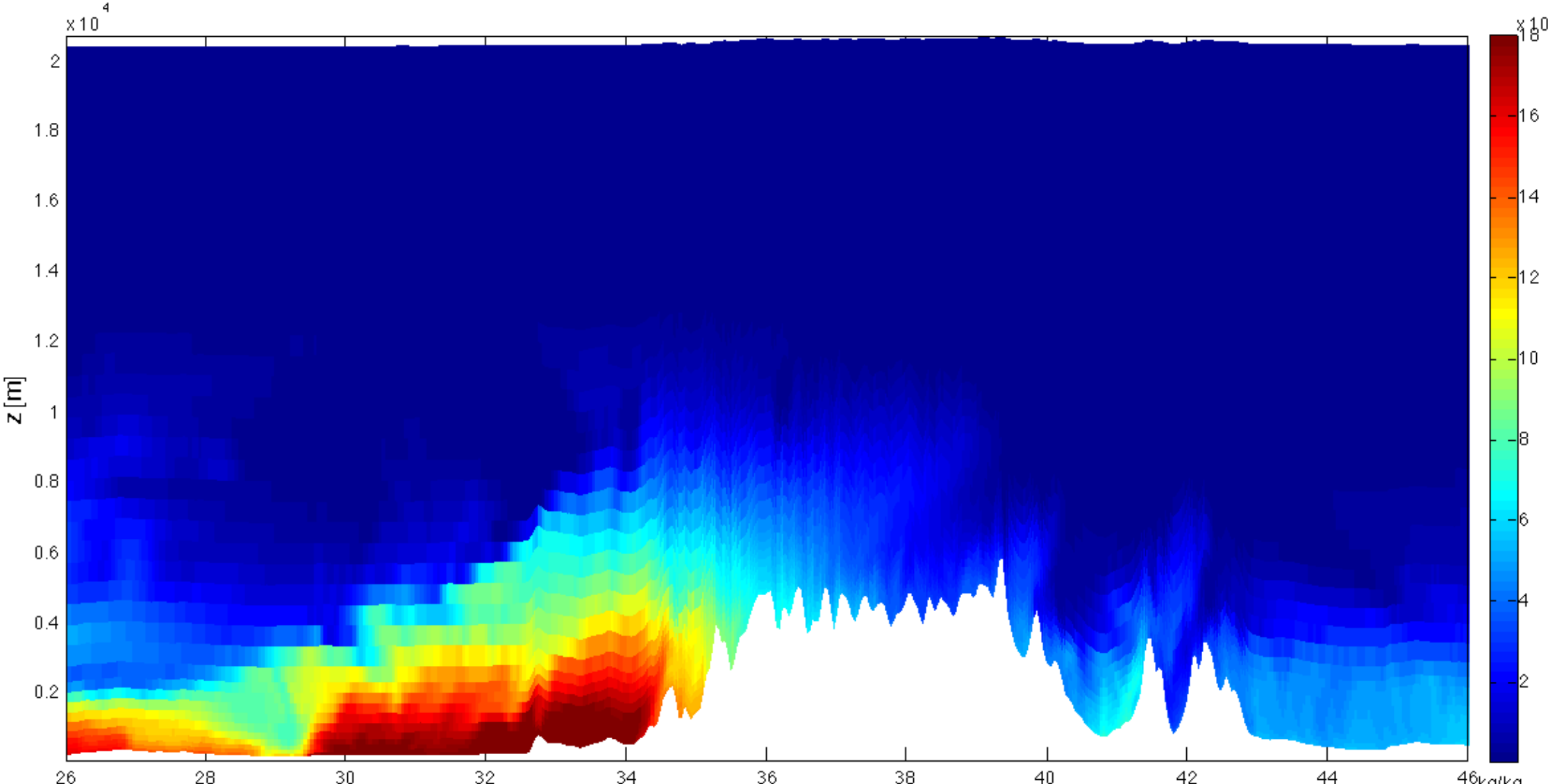




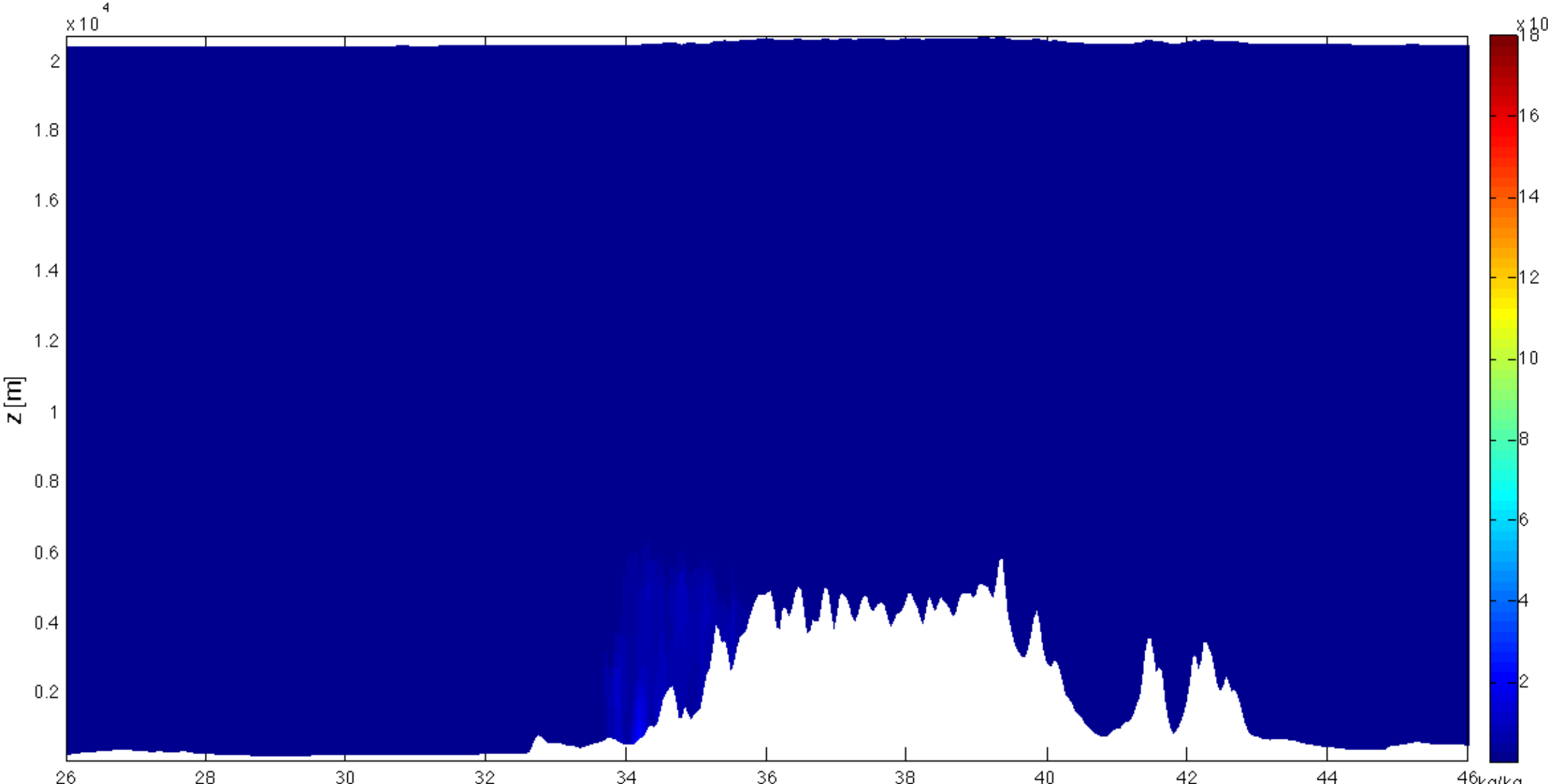
QV + wind field (lev=10): 9 september 1992, 15 UTC



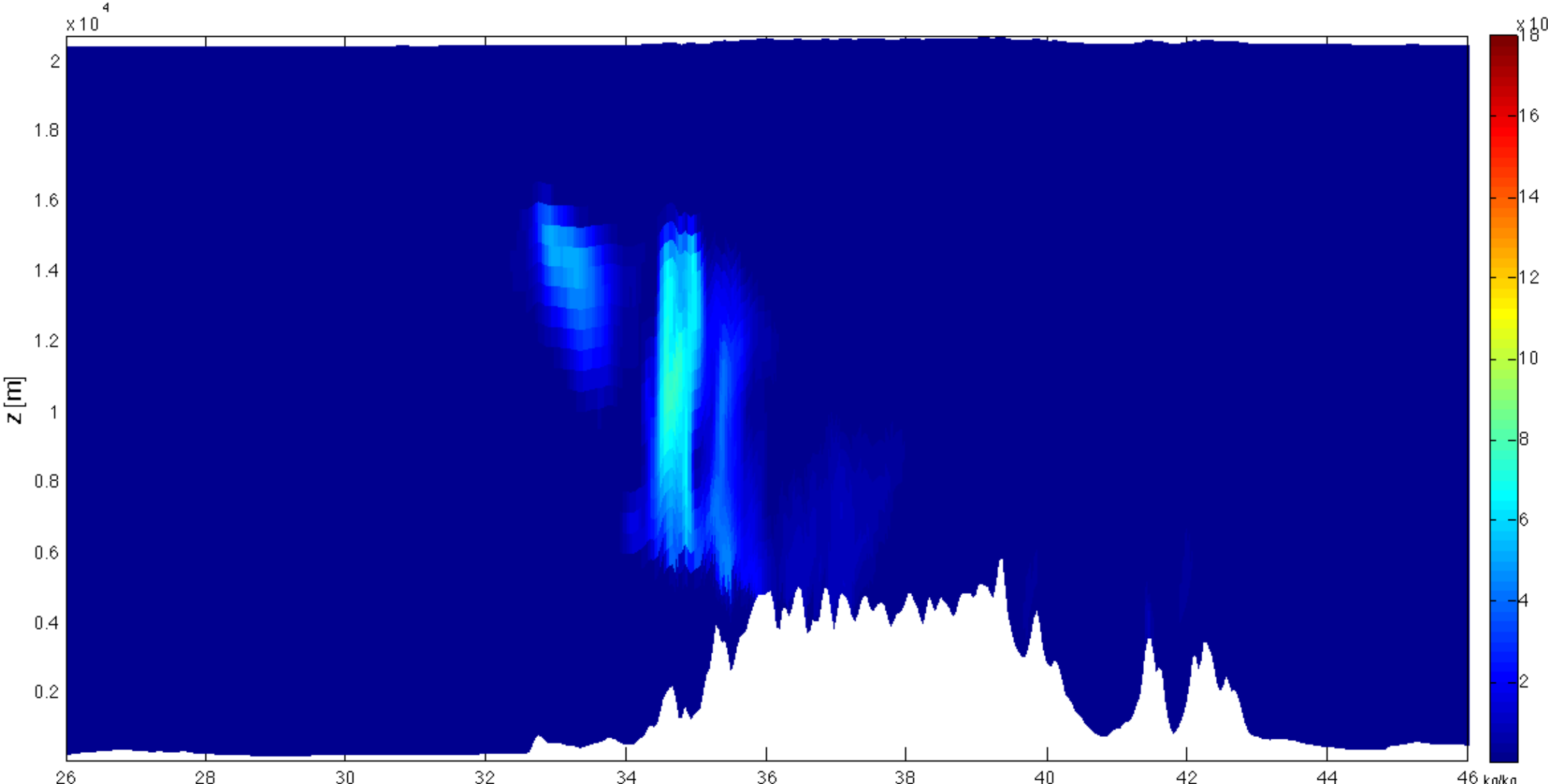
QV cross section (lon=72.9, d02, mp8): 9 september 1992, 15 UTC



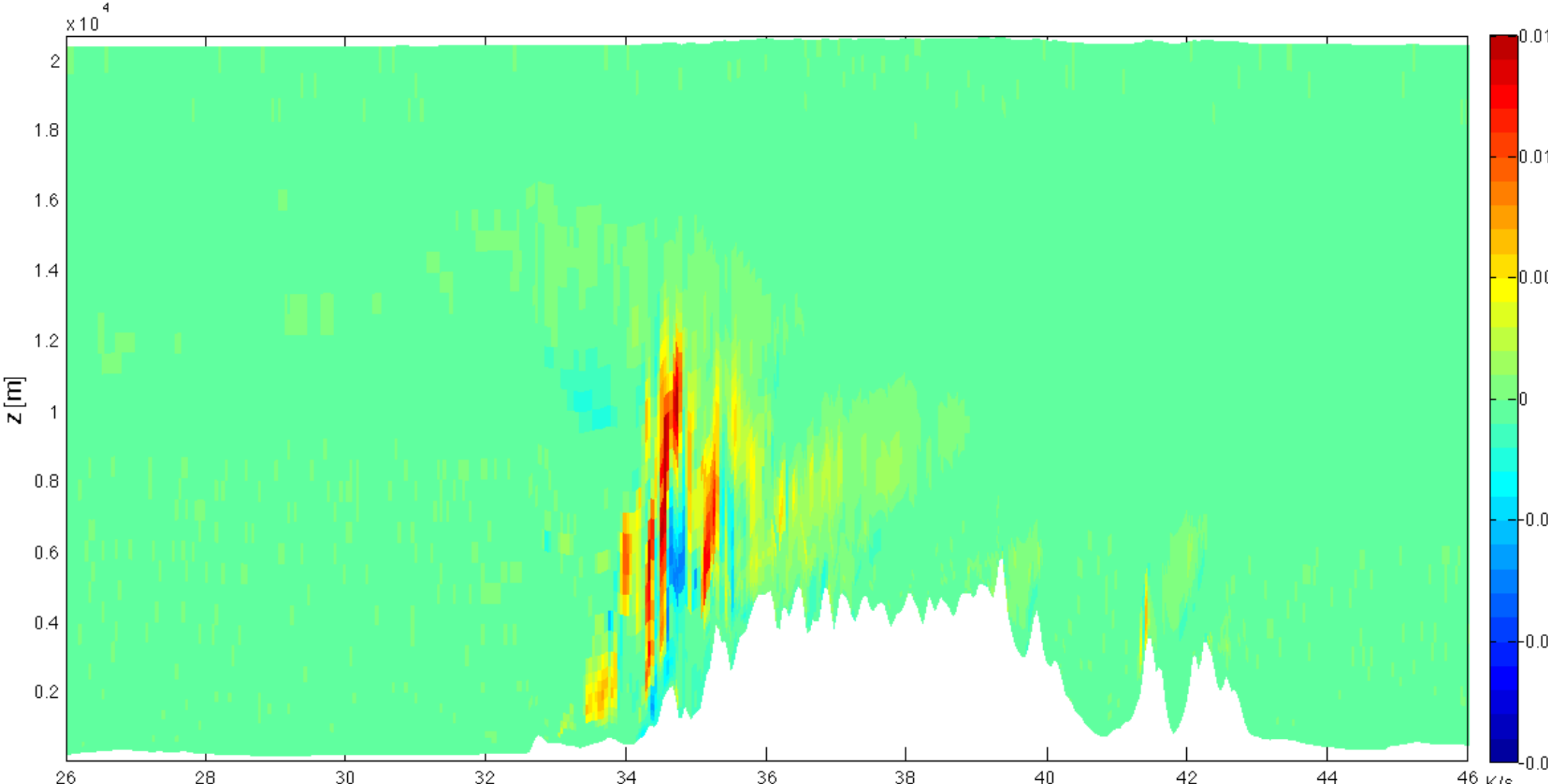
QR cross section (lon=72.9, d02, mp8): 9 september 1992, 15 UTC



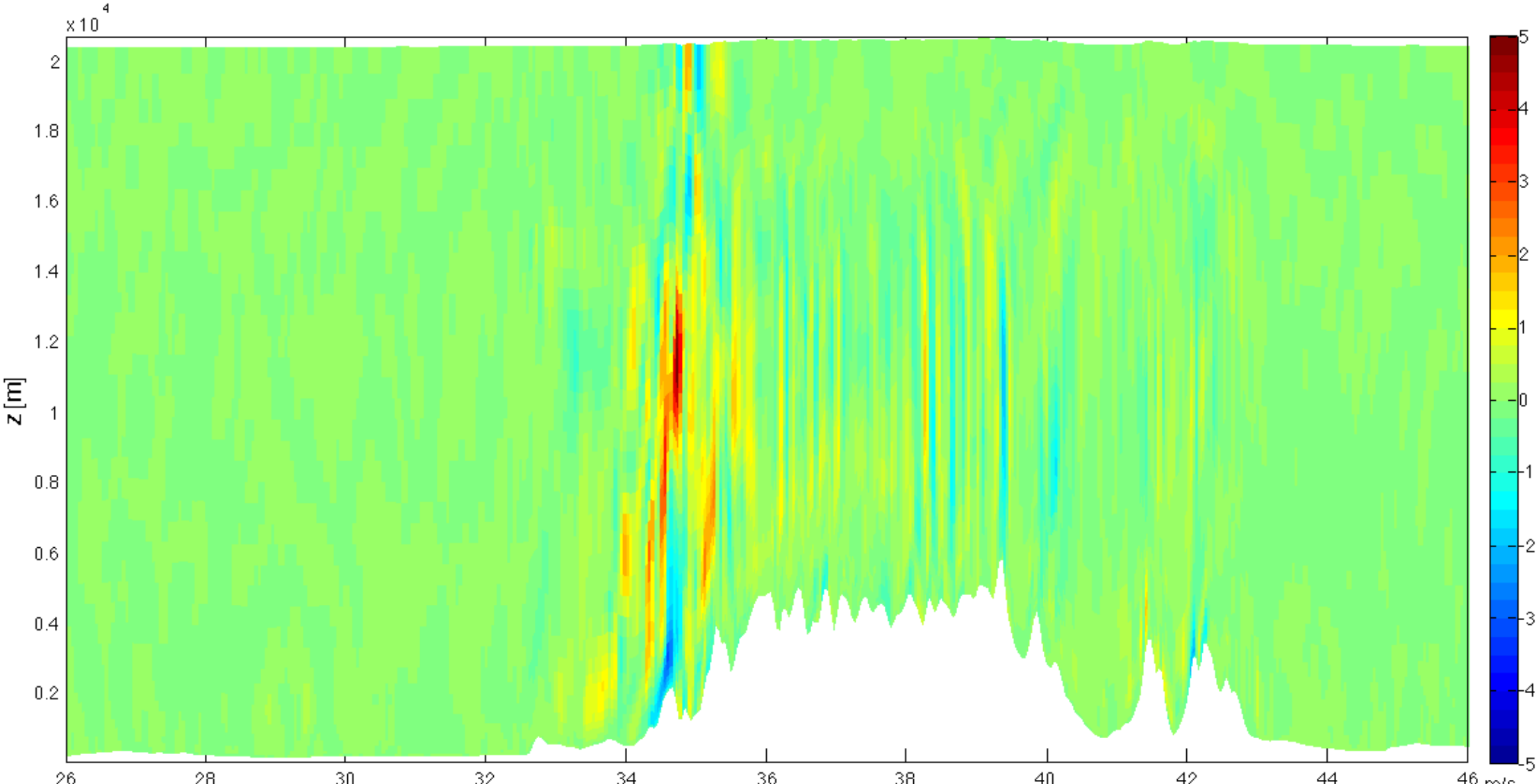
QS cross section (lon=72.9, d02, mp8): 9 september 1992, 15 UTC

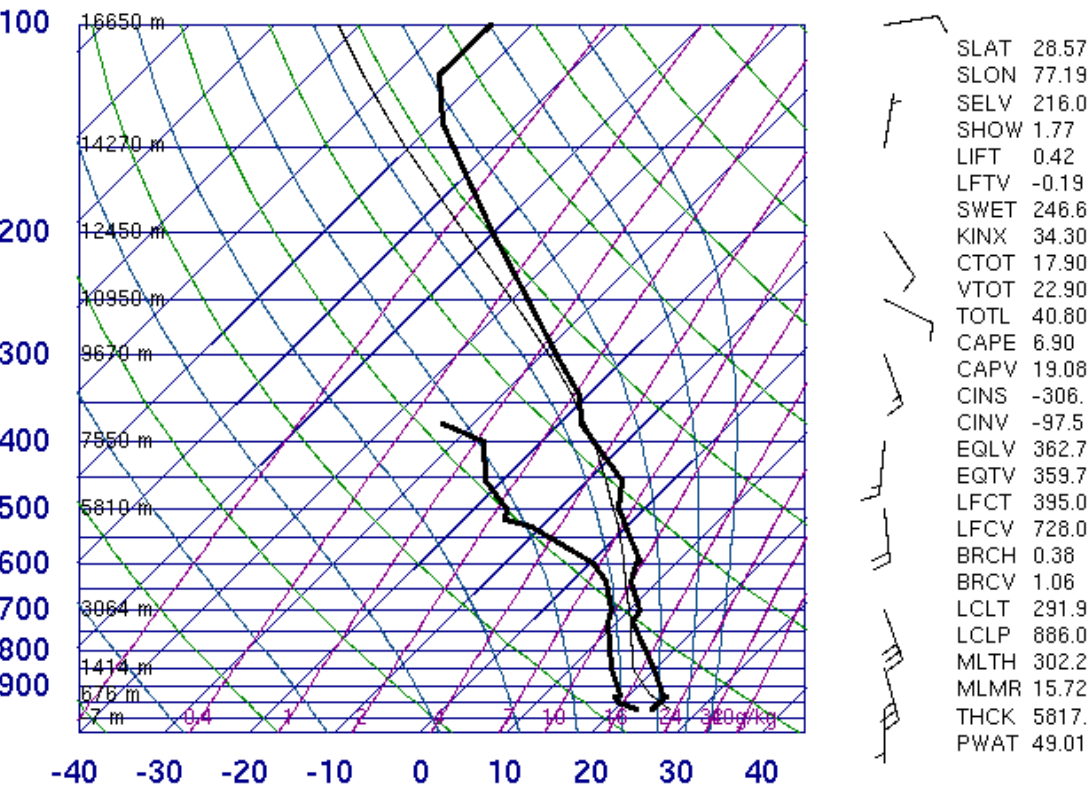


H_DIABATIC cross section (lon=72.9, d02, mp8): 9 september 1992, 15 UTC

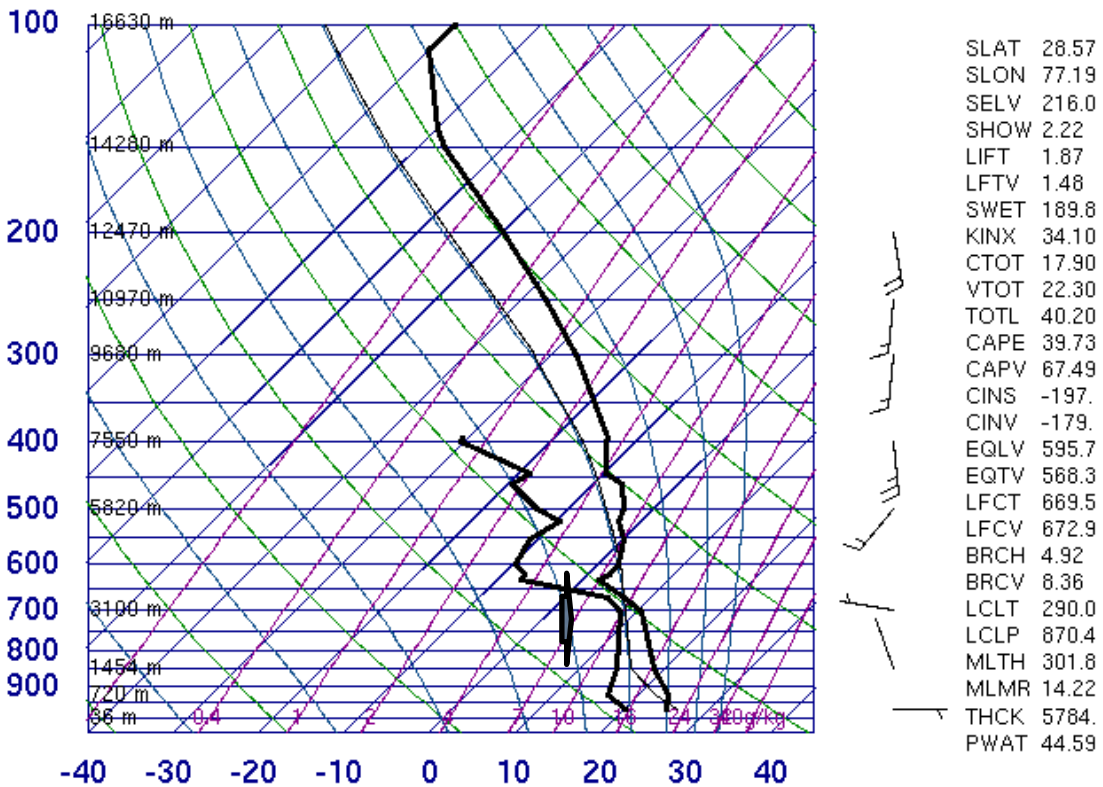


W cross section (lon=72.9, d02, mp8): 9 september 1992, 15 UTC

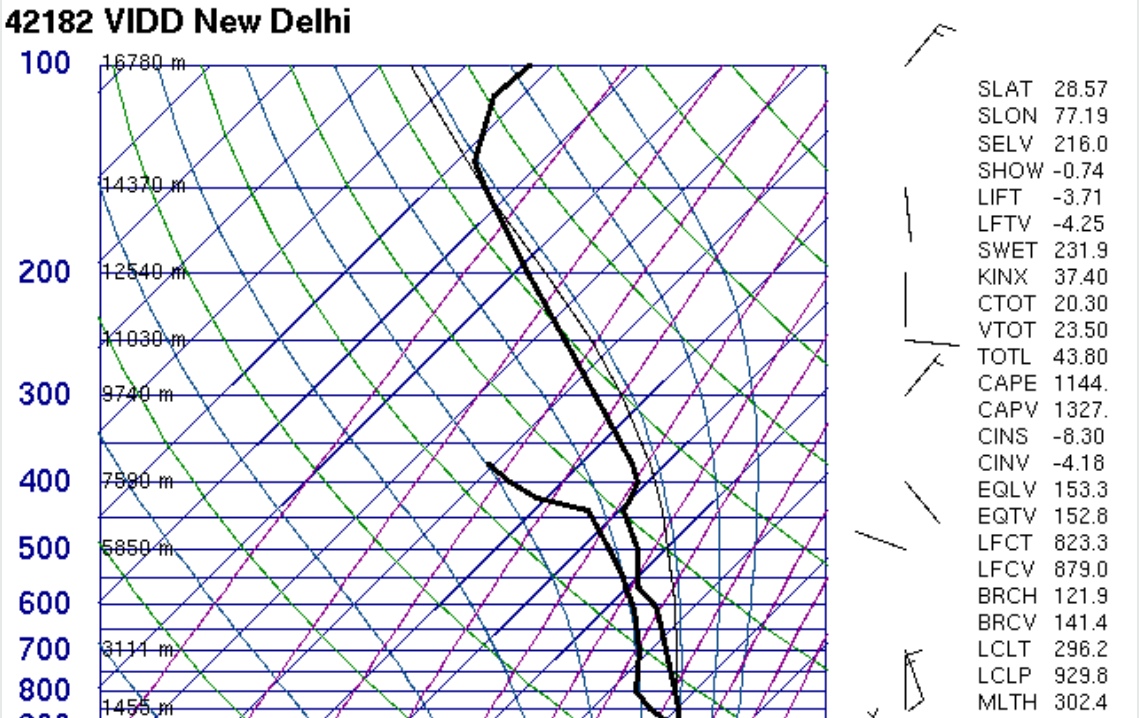




00Z 09 Sep 1992 University of Wyoming



00Z 10 Sep 1992 University of Wyoming



Conclusions

Preliminary runs of WRF model in cloud-permitting mode over the Karakoram area

The overall structure of the observed torrential eve s captured even if there is a temporal phase-error and overestimation in central India

Low sensitivity to microphysics

Further steps: additional comparisons with availabl observations + finer resolution runs (1 km or less)