Low tropospheric wind profile diurnal regimes during winter and spring according to ICON-IL and Doppler wind profiler at a desert site

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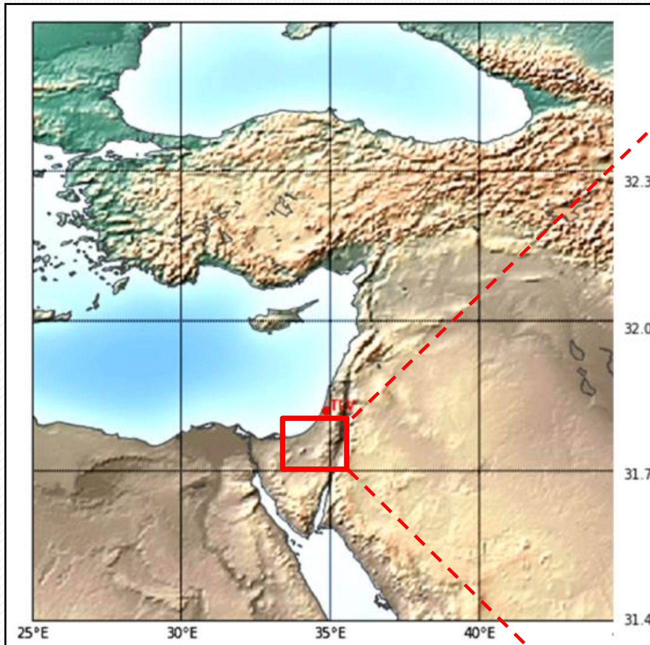
Low tropospheric wind profile JAN-APR 2022

- Motivation : Pollution / wind energy
- Streamline XR Doppler lidar VAD60 (u, v, w)
- Maximal resolution of 1.5 meters along LOS. The range is limited to ~1-3 Km (or the mixing layer height) due to insufficient aerosol concentration aloft, needed for backscatter of the signal.
- Data filtration: SNR limited to 0.0095 ->
- average radial velocity precision 1 m/s
- u, v 10 minute averages
- Tzadok et al 2022 Atmos. Meas. Tech. Discuss. https://doi.org/10.5194/amt-2022-5.

Israel, Eastern Mediterranean



Sde Boker, Negev desert
470 m a.s.l

ICON-IL

- **ICON** (ICOsahedral Nonhydrostatic) model, developed in DWD (Offenbach), MPI (Hamburg), DKRZ (Hamburg), KIT (Karlsruhe), and the COSMO consortium, including the Israeli Met. Service (IMS)
- **Platform**: ICON-IL is running operationally on the ECMWF HPC (Bologna, Italy)
- **Model setup:**
- Domain: **4-45.5E/25.5-53N**, Resolution: **~2.5km** horizontal, 65 levels vertical,
- Forecast range: **90h**,
- Initial and Boundary conditions:

IFS model 9km res, **2 runs/day (00, 12 UTC)**

- **Physics:**
- Main features: Turbulence: prognostic turbulent kinetic energy equation,
- Soil processes: TERRA scheme,
- Radiation transfer: ecRad scheme,
- Convection: permitted for deep clouds, parametrized for shallow
- Specific for ICON-IL:
- Aerosols: CAMS forecasted aerosols in dusty days, otherwise: CAMS climatology
- Data assimilation: Latent Heat Nudging (IMS radar + OPERA network)
- Additions: SST updated during IFS forecast
- Tuning: Specific for the Eastern Mediterranean, related to precipitation, wind, temperature, relative humidity and cloudiness

Research questions:

- The main features of the low tropospheric wind profile – relation to synoptic pressure gradients
- Monthly verification of model predictions
- Short term (24 h) and Long term (3 days) prediction
- Surface wind prediction

- Two main regimes of daily wind profile :

1. “Regular days”

- no sharp wind directions changes.

Mostly westerly component flow in the boundary layer (BL) up to 500 - 1000 m a.g.l, typical daily variability of the boundary layer height (BLH) according to the solar heating with or without wind direction shear above the BL. Such events are mostly under high pressure from the West .

Winter lows present strong (> 5 m/s) westerly flow with constant BLH.

2. “Transitional days”

- Sharp wind direction change in the BL (at least 90° within an hour). Their frequency is ~ 30% during February-April, while during January single event occurred. The synoptic conditions present pronounced change in the synoptic gradients or mild synoptic gradients allowing the development of local mountain breeze.

- Easterly winds events – low predictability

Transitional days

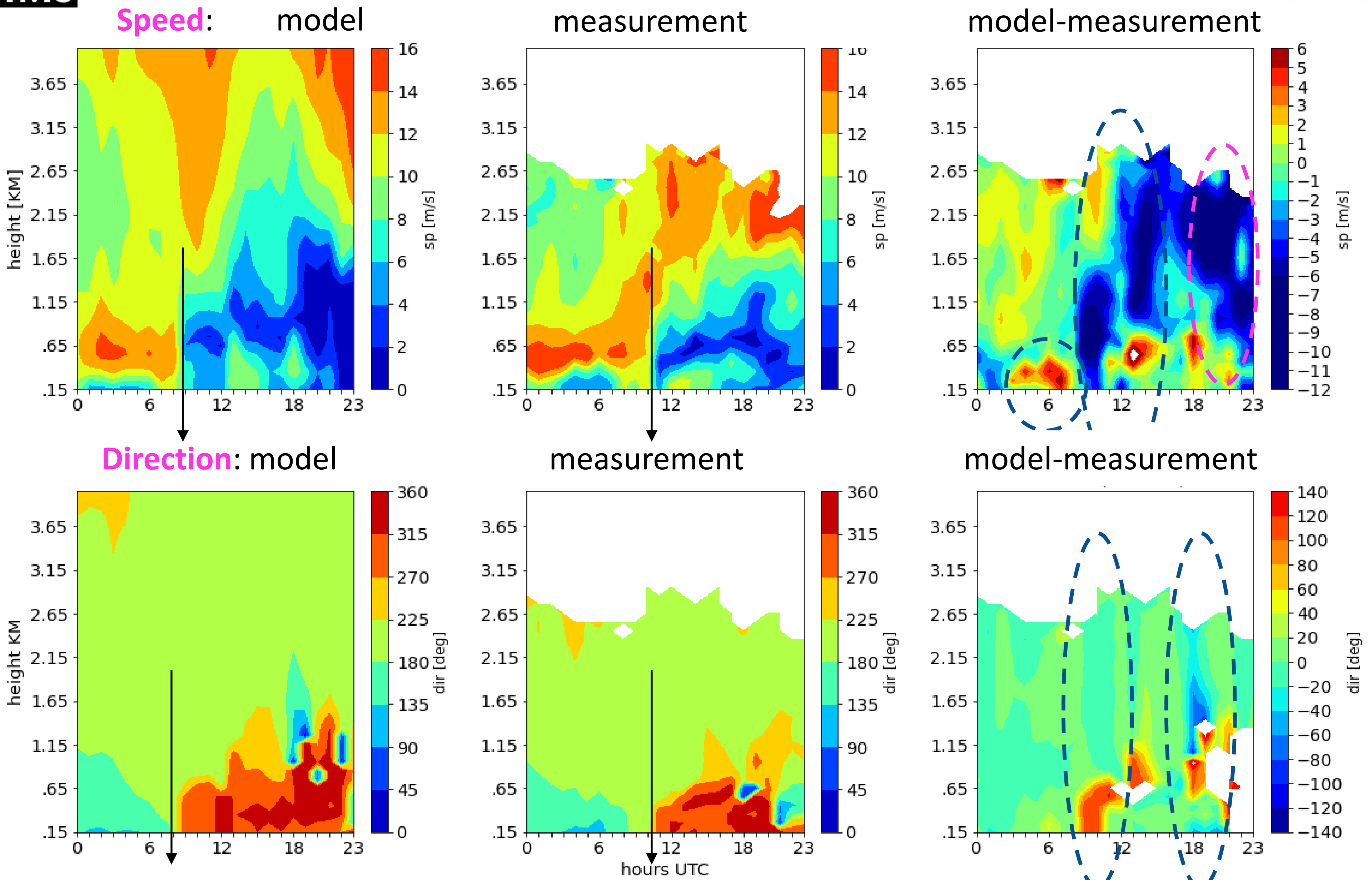
Synoptic gradients create fast direction change

Case studies:

18.4.2022

1.4.2022

Model measurements comparison 18/04/2022



Timing mismatch : 2h
Large differences 11 m/s speed, 100 deg direction

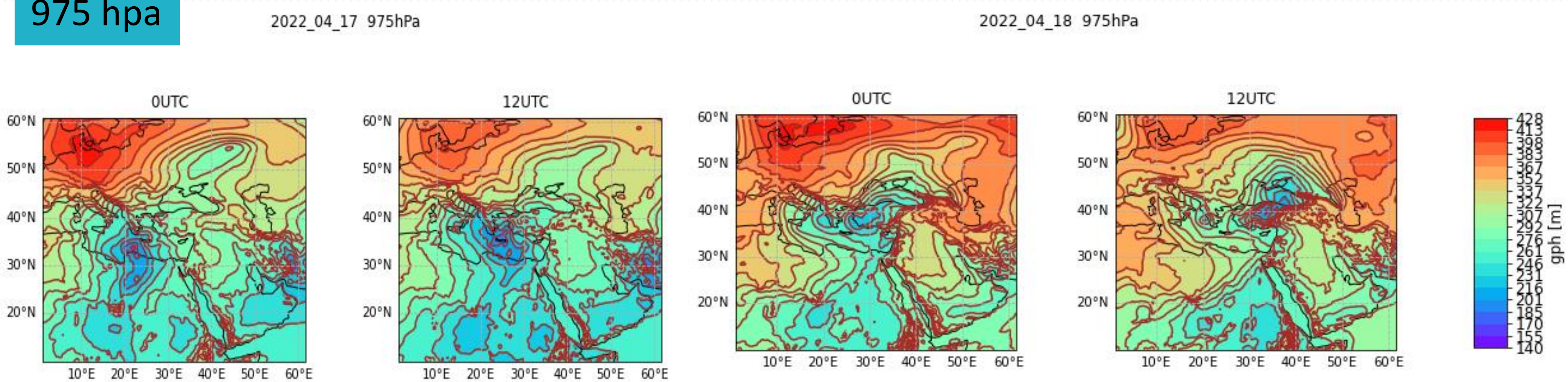
17-18/4/2022 E->W flow next to the surface (20-700 m a.g.l)

975 hPa: High to the East (HE) - Sharav,

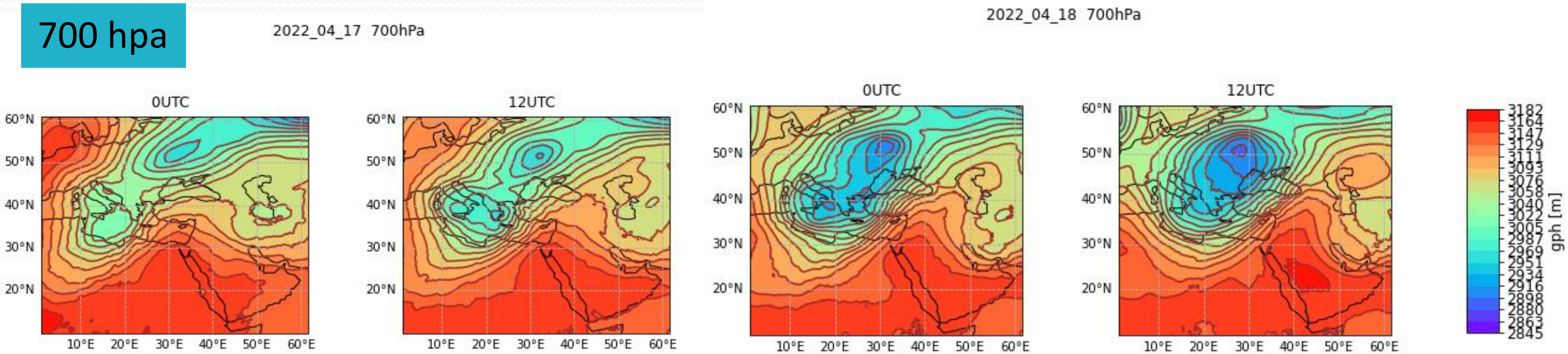
Cyclone propagating to the north, withdrawal of HE – High to the W strengthen

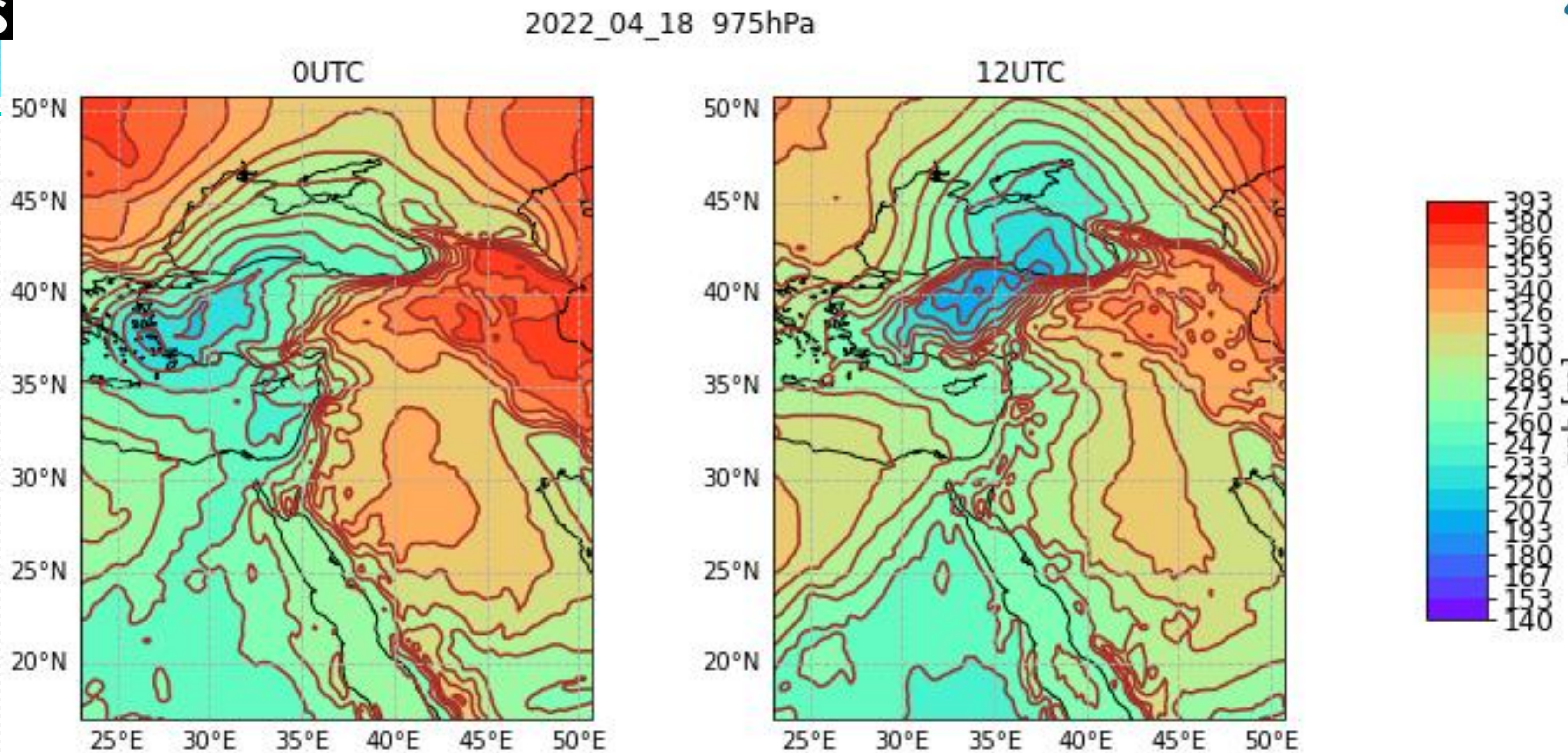
700 hPa: Ridge over the EM, low over the black sea

975 hpa



700 hpa





High to the East + Shallow low -> High to the West

17-18/4/2022 E->W flow next to the surface (20-700 m a.g.l)
975 hPa: High to the East - Sharav,
Cyclone propagating to the north, withdrawal of High to the East –
High to the West strengthen
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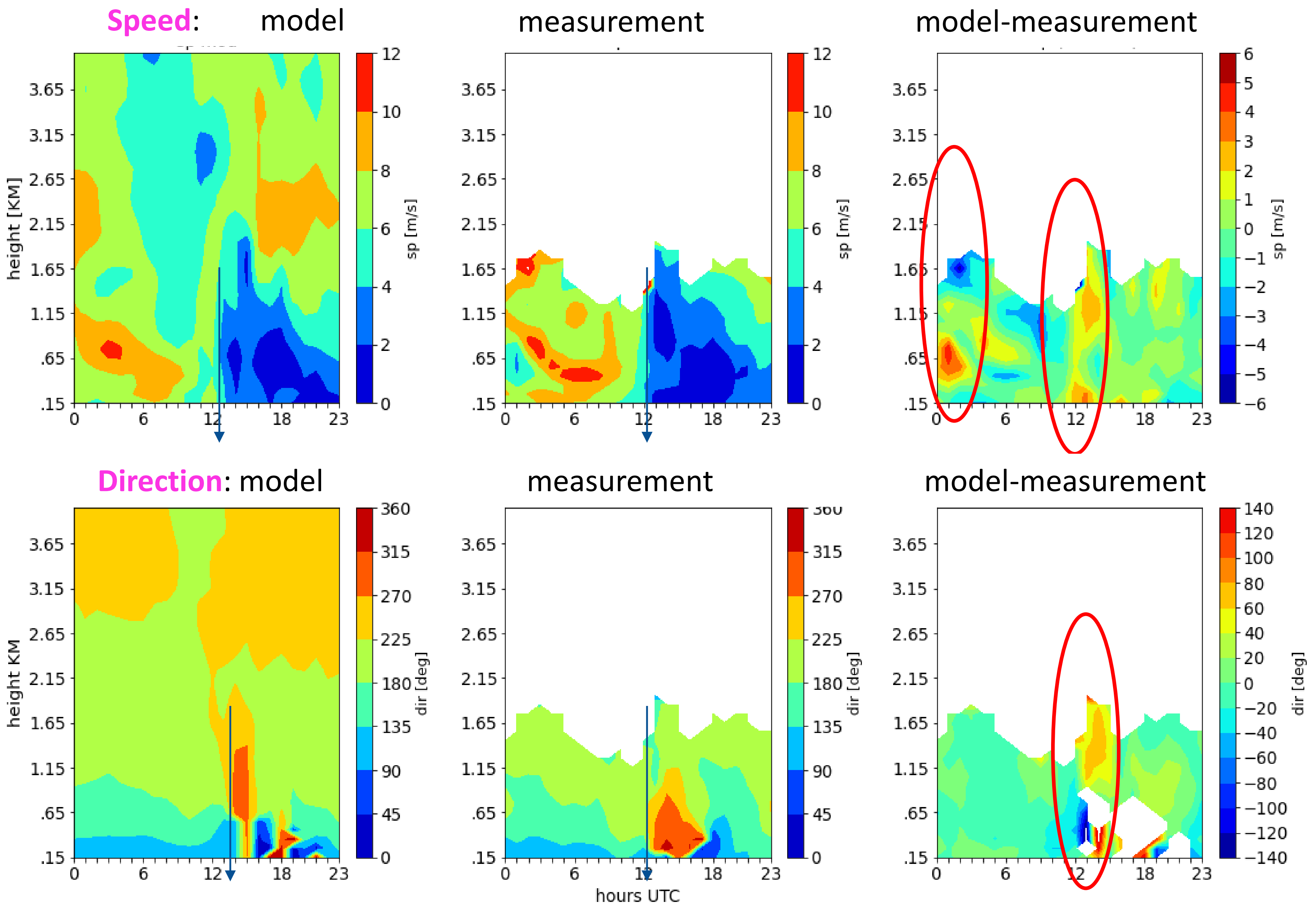
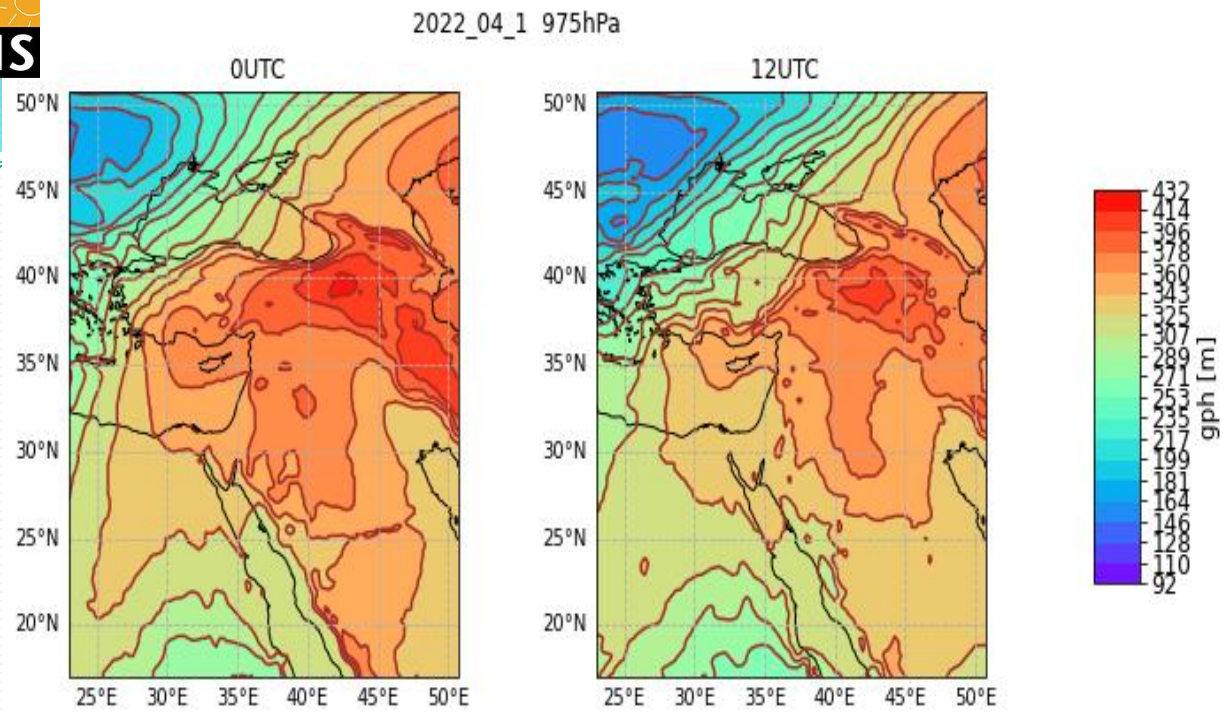
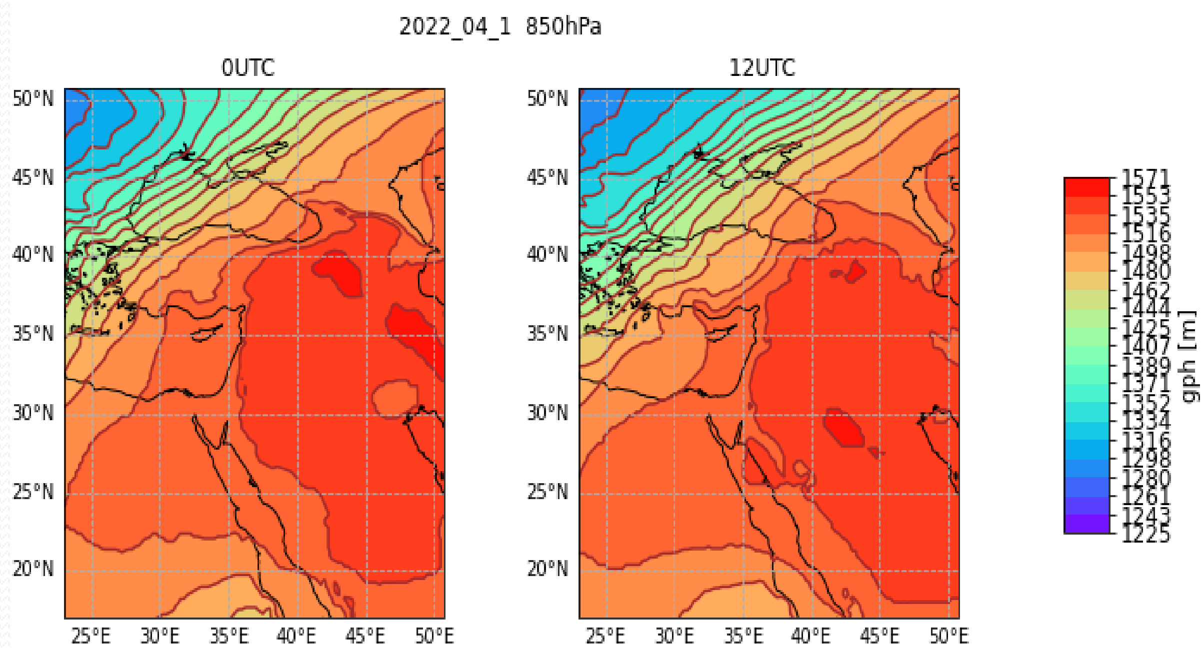
Model measurements comparison 01/04/2022

Max Diff: 2-4 m/s, 60-80 deg





Withdrawal of High to the East

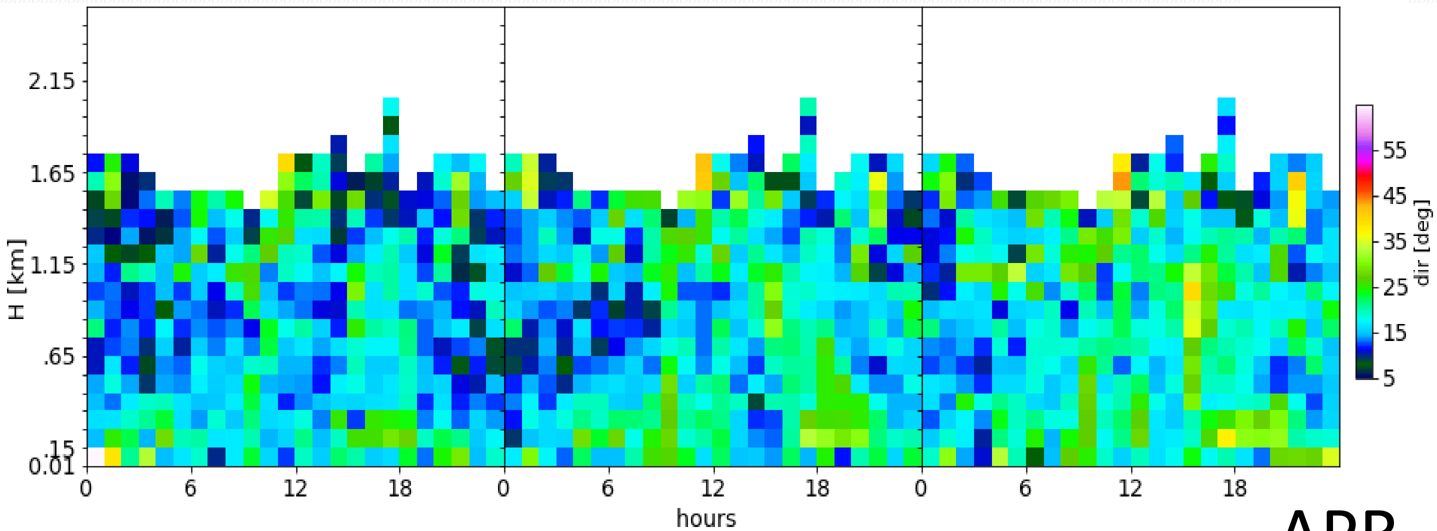


conclusions

- The model predicts the main features of the wind profile
- 1-2 hours mismatch , transition time
- Max 100 deg, 10 m/s differences

Monthly verification:
Surface and profile measurements
0 UTC initialization

JAN



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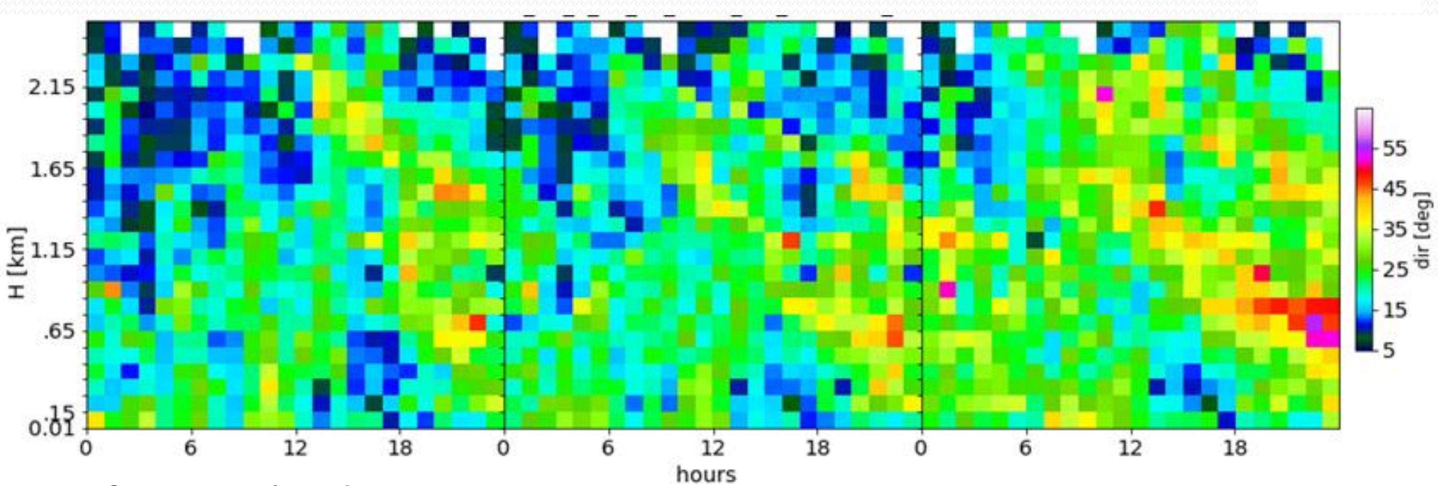
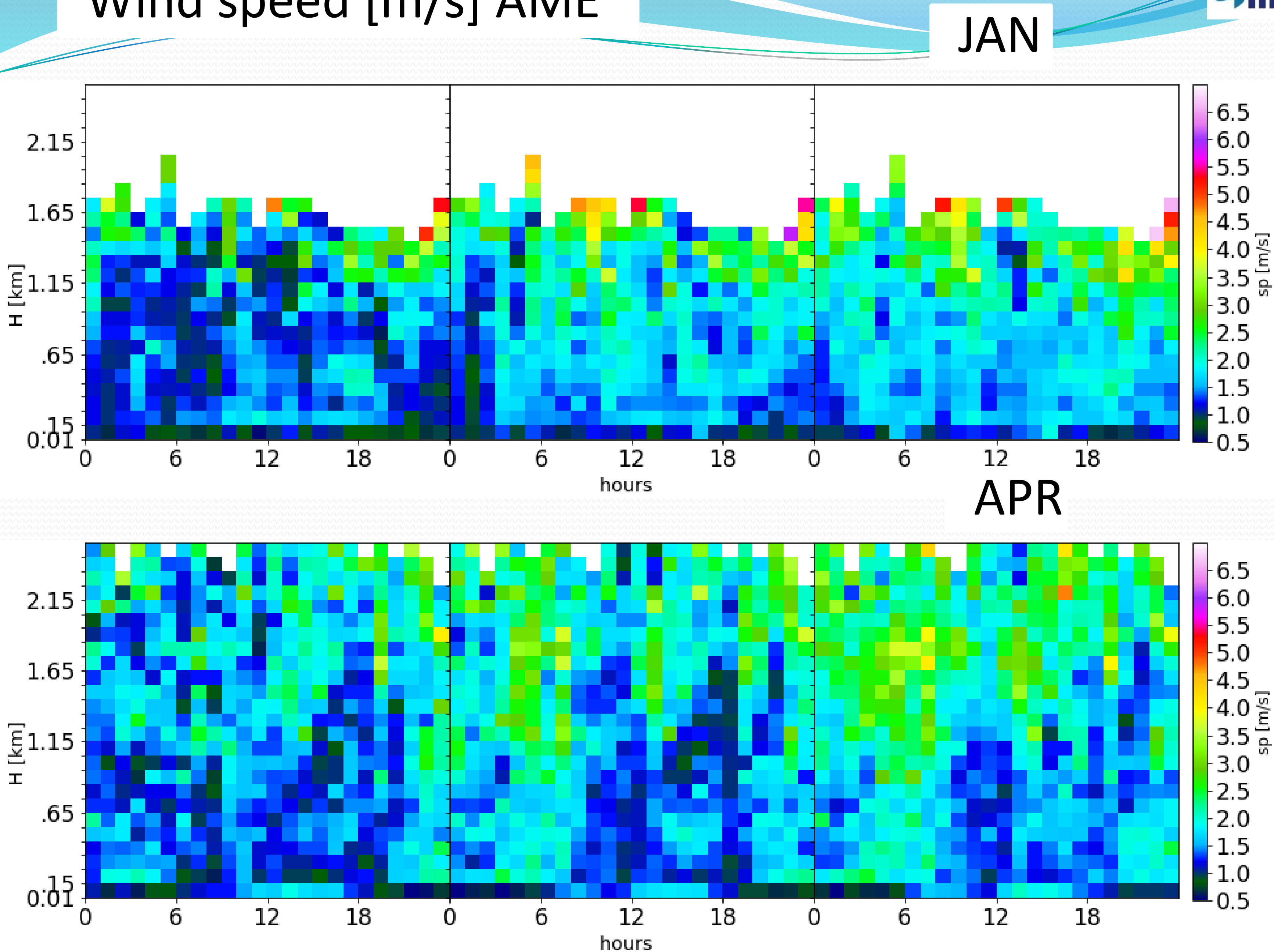


forecast lead time

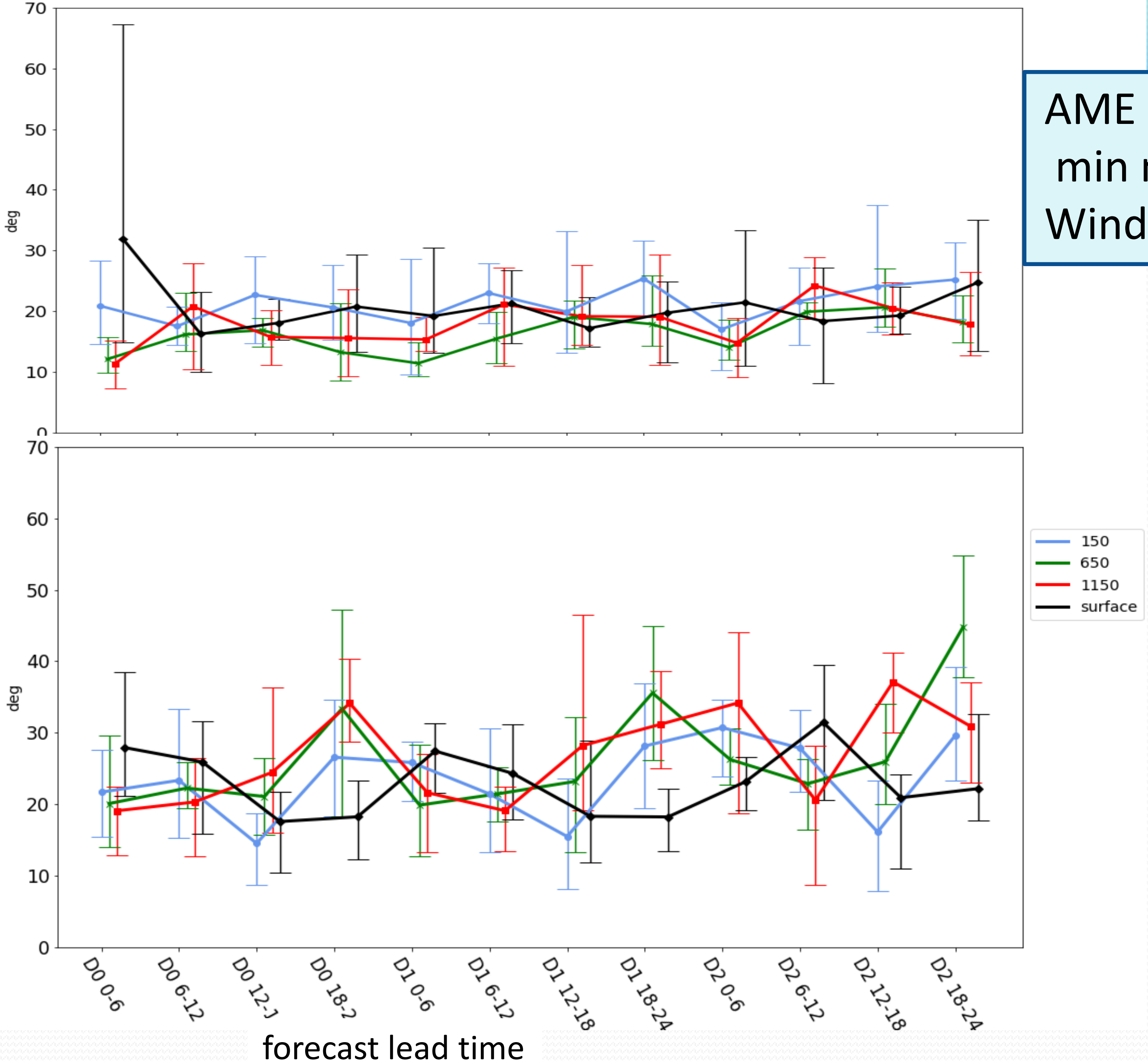
Direction
Monthly
AME
100m slabs+
Surface data
10 m a.g.l
1 hour

Wind speed [m/s] AME



forecast lead time

AME mean min max (6h) Wind direction



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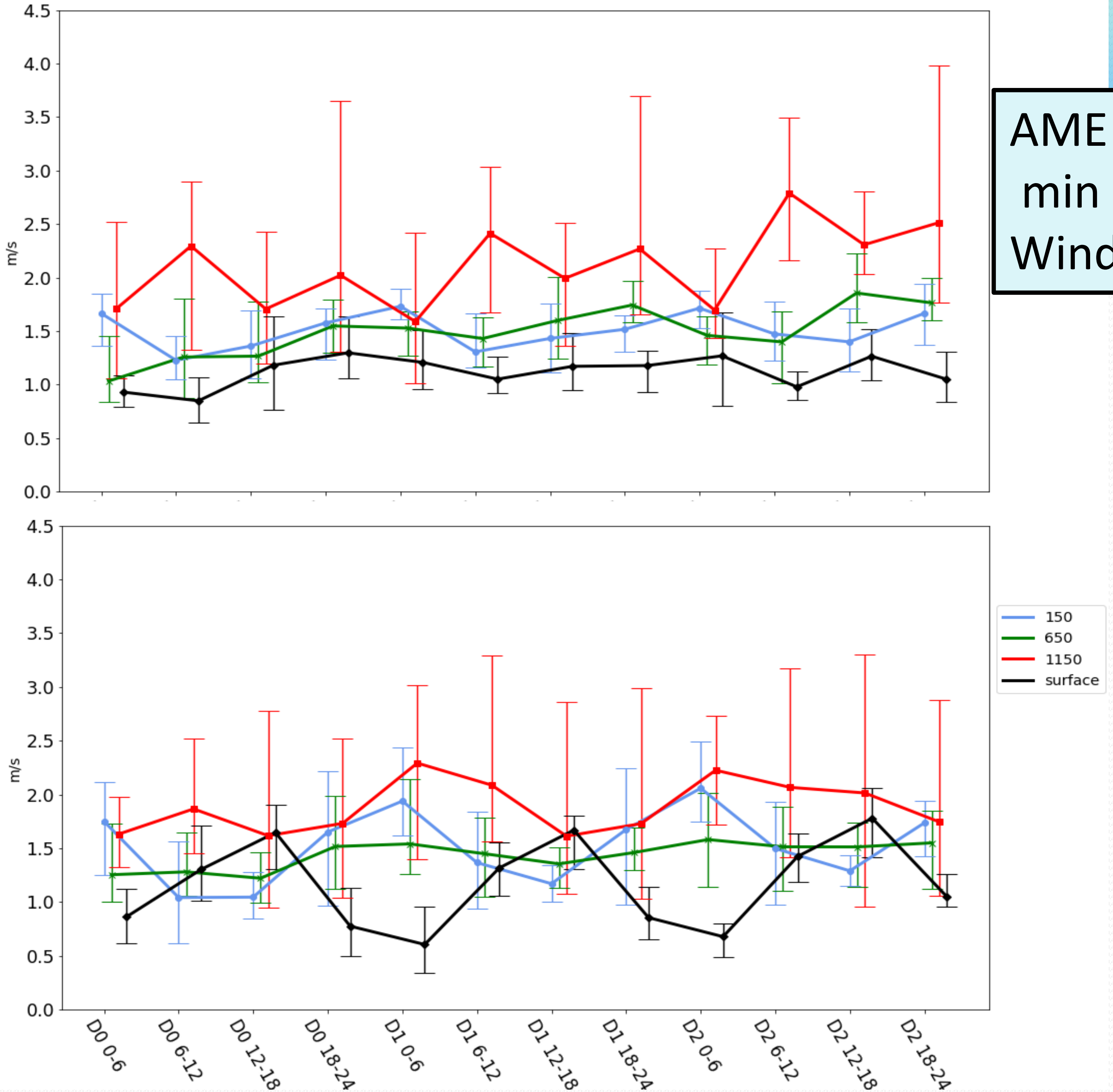
>20 events up to 1 km

AME mean
min max (6h)
Wind speed [m/s]



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forecast lead time

*Constant bias as a function of
time distance from initialization

Mean (6h) errors 1st day 0.01-1 km init 0UTC

Month	Bias		AME	
	sp[m/s]	dir[°]	sp[m/s]	dir[°]
Jan	-0.5 – 0.5	-5 - 20	1 - 2.5	10 - 20
Feb	-1 – 1	-10 - 20	1 - 2.5	15 - 30
Mar	-1.5 – 1	0 - 20	0.8 - 2	15 - 25
Apr	-1.5 – 1.5	-10 - 15	0.5 - 2.5	15 - 35

Init 12UTC similar results

Take home message (THM)

- Transitional days: 1-2 hours difference, horizontal wind direction shear
- Initializations 0,12 UTC - Similar AME bias
- AME 3rd day vs 1st day: 25°-45° , < 35 °
- 1.5-4m/s , < 2 m/s
- Similar wind direction AME , bias, 0.1 -1 km
- Higher speed AME at 1 km .vs. lower levels (2 , 0.5-1 m/s)
- Stronger diurnal variability of errors during Apr, Mar .vs. Jan Feb
- Lower AME direction Jan vs Feb-Apr (10-20° ; 15-35°)