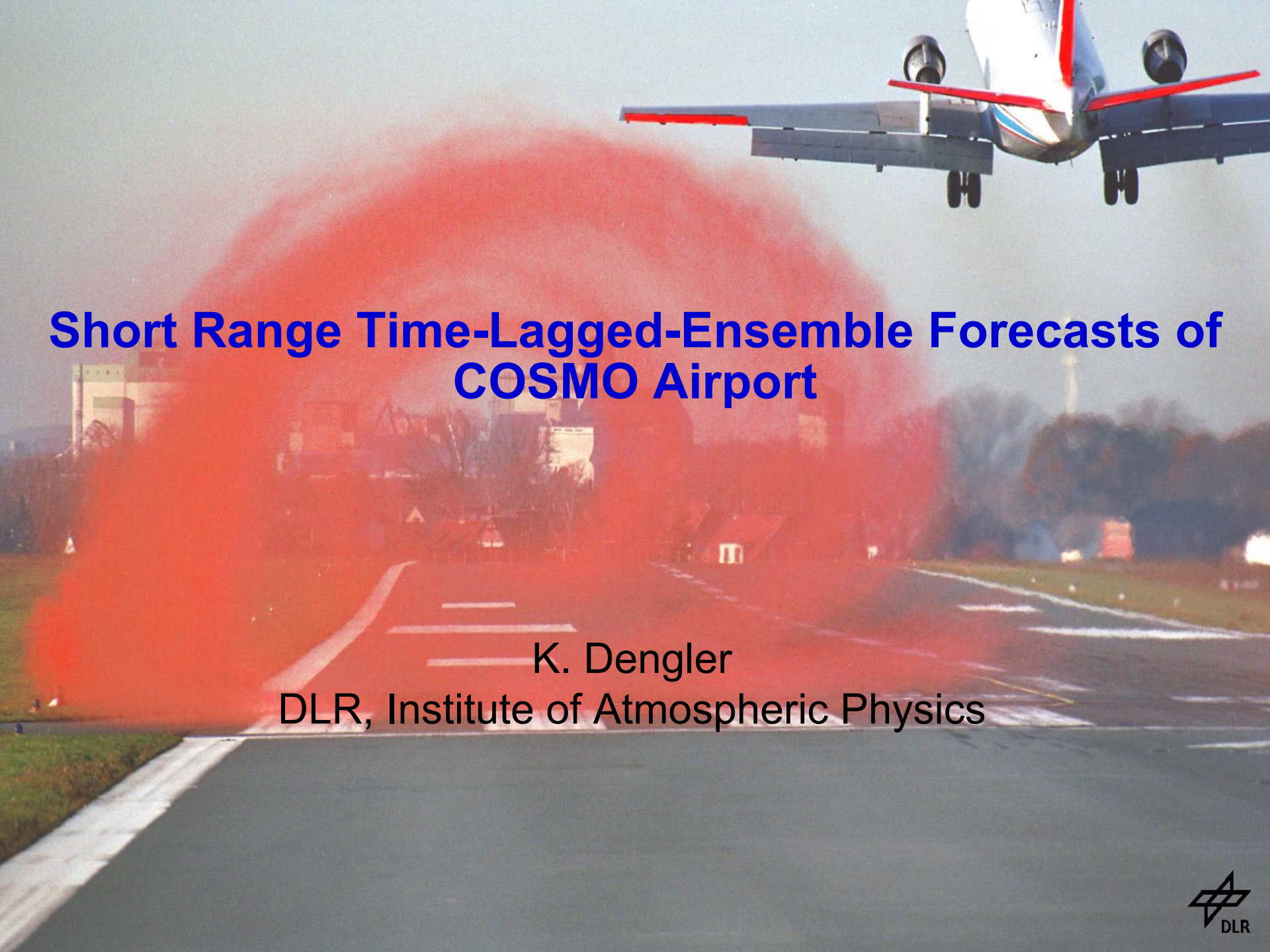


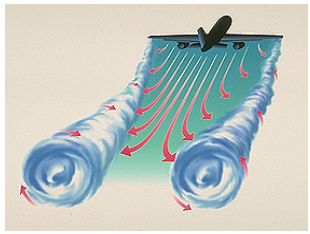
Short Range Time-Lagged-Ensemble Forecasts of COSMO Airport

K. Dengler
DLR, Institute of Atmospheric Physics

Outline

1. Motivation
2. Configuration of COSMO-FRA
3. Time-Lagged Ensemble Forecasts (TLE)
4. Summary & Outlook



B747 approaching Hongkong airport

Strength of vortices depends on:

- speed
- wing span
- weight

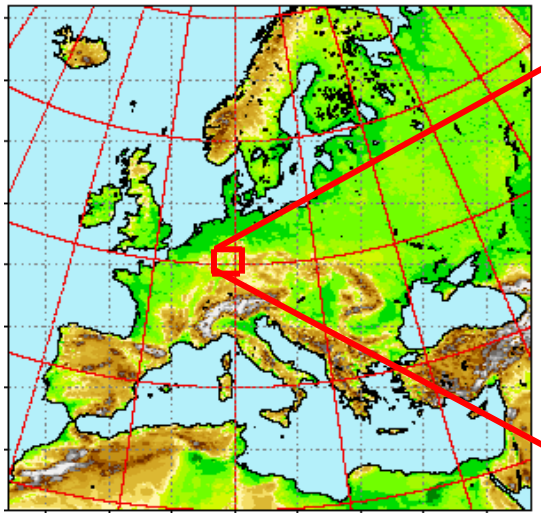
Important Meteorological Parameters for WV-prediction

u, v, w, θ_v, TKE, EDR

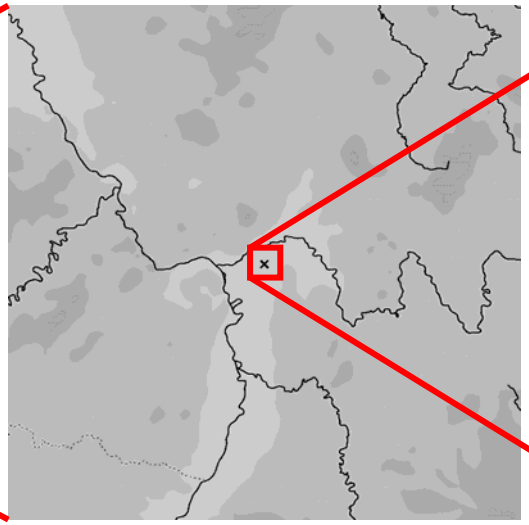
High demand for accurate high frequency (temporal and spacial) predictions

2. Configuration of COSMO-FRA

COSMO-EU



COSMO-FRA



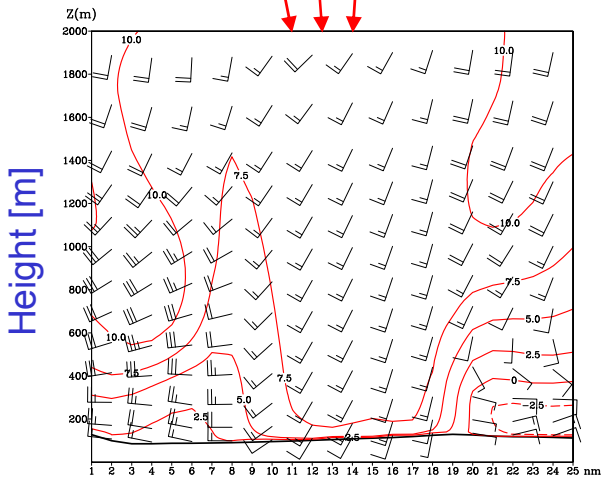
Airport Area

Wake-Vortex Prediction Model

P2P

Prediction of WV lateral displacement, altitude and circulation

u, v, w, ρ, θ_v, TKE, EDR, p



Glidepath Points (GP)

Assimilation Scheme: Nudging

$$\frac{\partial}{\partial t}\psi(\mathbf{x},t) \;=\; F(\boldsymbol{\psi},\mathbf{x},t) \;+\; G_\psi \cdot \sum_{k_{(obs)}} W_k(\mathbf{x},t)\cdot[\psi_k^{obs} - \psi(\mathbf{x}_k,t)]$$

Prognostic Variable ψ | Dynamics ***F*** | Nudging Coefficient ***G*** | Weights ***W***

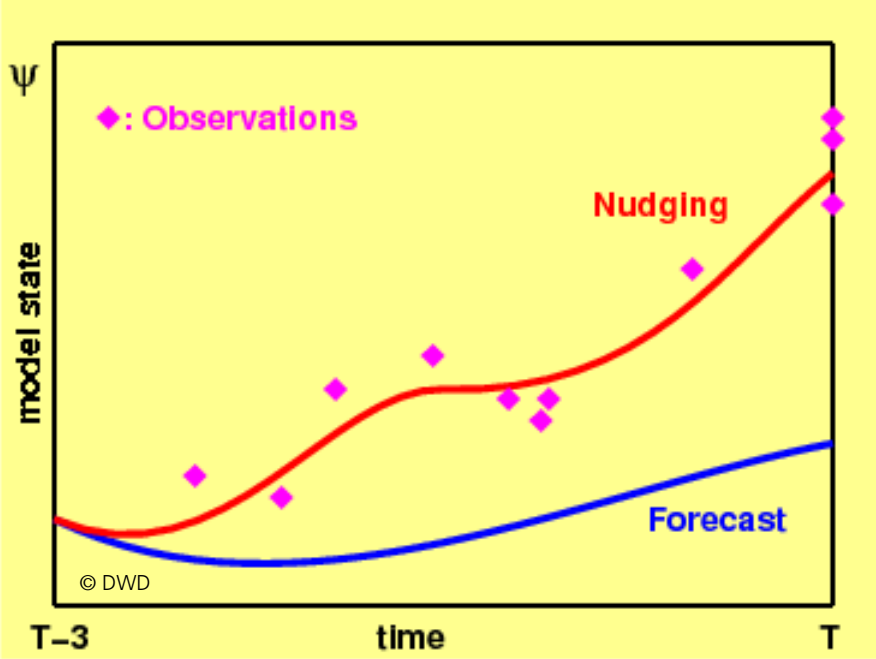
Weights depend on:

- Difference between observation and forecast (temporal & spacial)
- Observation quality

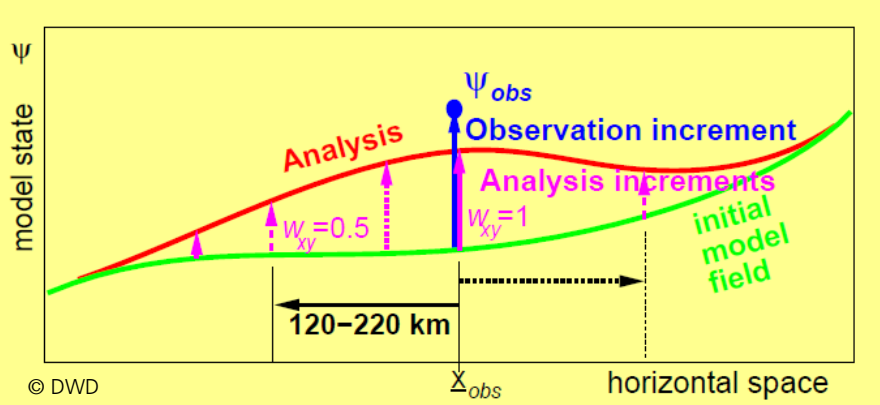
Default values:

1/G ~ 15 minutes for p

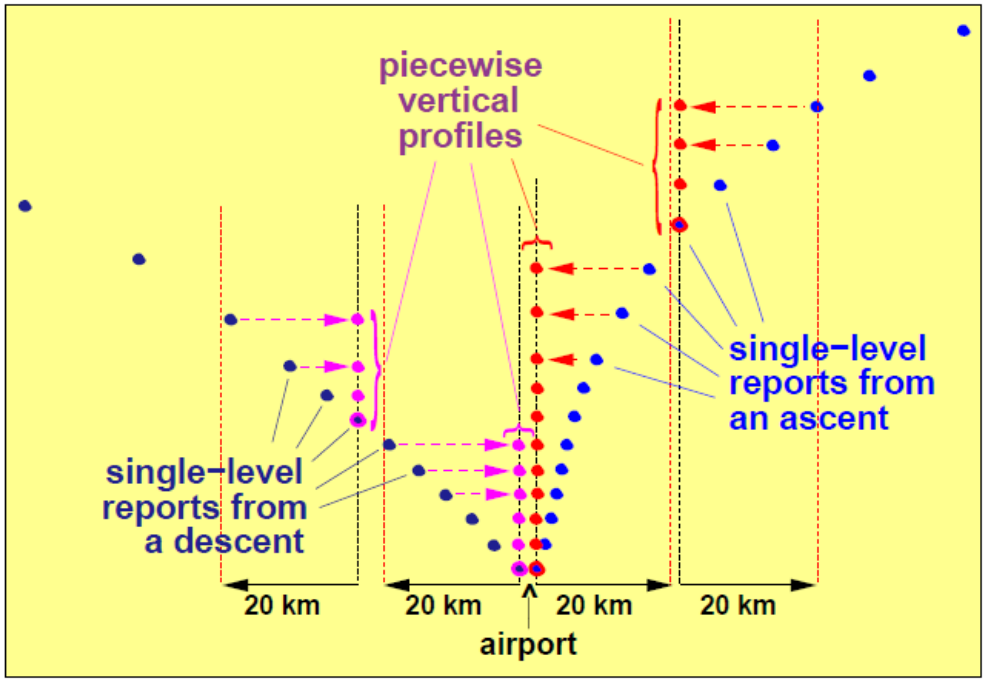
~ 30 minutes for other



Horizontal



AMDAR



Concept of "Piecewise Vertical Profiles"

Default Values:

Δt = 15 Min

Δx = 20 km

Δp = 55 hPa

Min 3 Reports

Configuration COSMO-FRA

- Model domain centered at FRA airport: 280 x 280 km^2 (Δx=2.8 km)
- 10 min output of wind, temperature, TKE, EDR, ...
- Vertical resolution 15 – 130 m (16 levels up to z=1100 m)
- Forcing with hourly COSMO-EU analyses

- Hourly model runs, 6 hour forecasts creating time-lagged ensembles (TLE) with 6 members
- Assimilation of various data

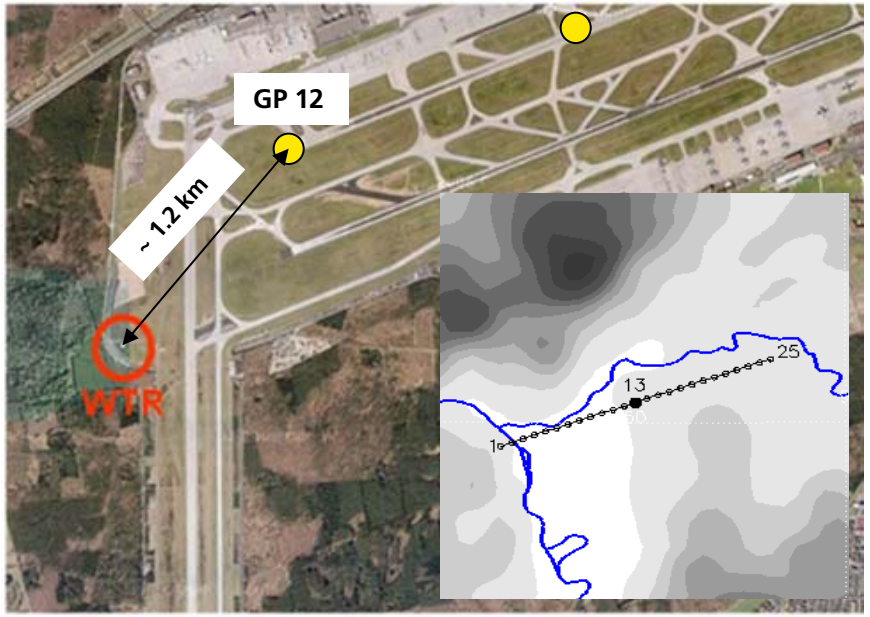
All forecasts are compared with measurements of a Wind Temperature-Radar (WTR/RASS)

DFS-WTR/RASS

(Wind-Temperature Radar / Radio Acoustic Sounding System)

Vertical Resolution:	**30 m**
Height range:	**60 bis 1650 m**
Data:	**every 2 minutes**

Frankfurt Airport (FRA)

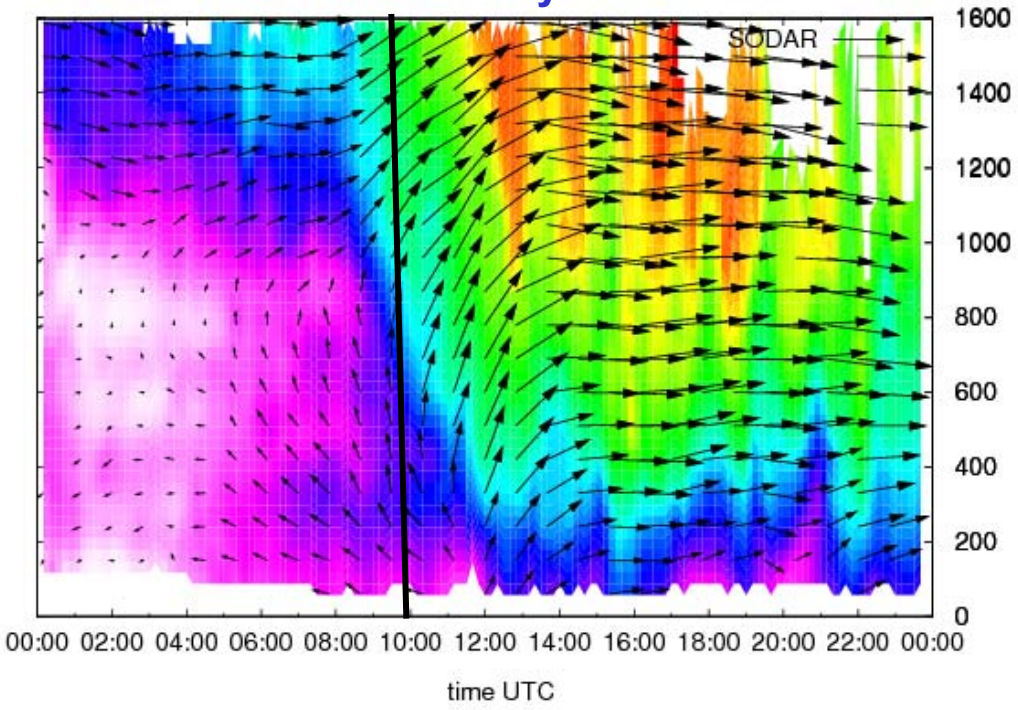


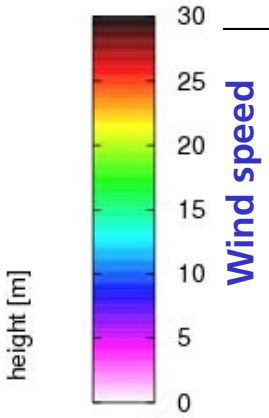
Parameters:

- Wind speed (m/s)
- Wind direction (°)
- Parallel wind (m/s)
- **Crosswind (m/s)**
- Vertical wind speed (m/s)
- TKE (m^2/s^2)
- Virtual temperature (°C)
- ...

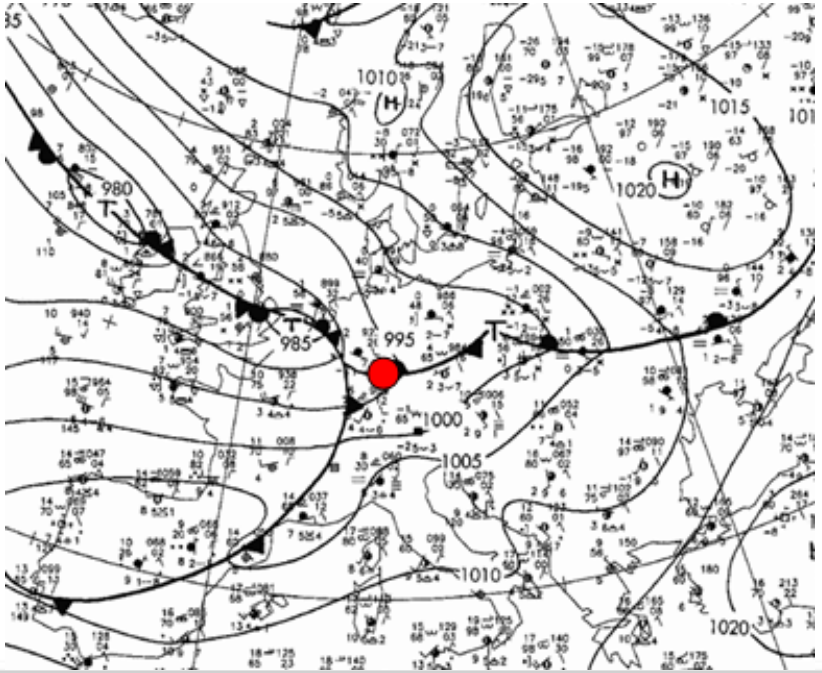
3. Time Lagged Ensemble Forecasts

08. February 2007





Measured wind vector (WTR) at GP 12

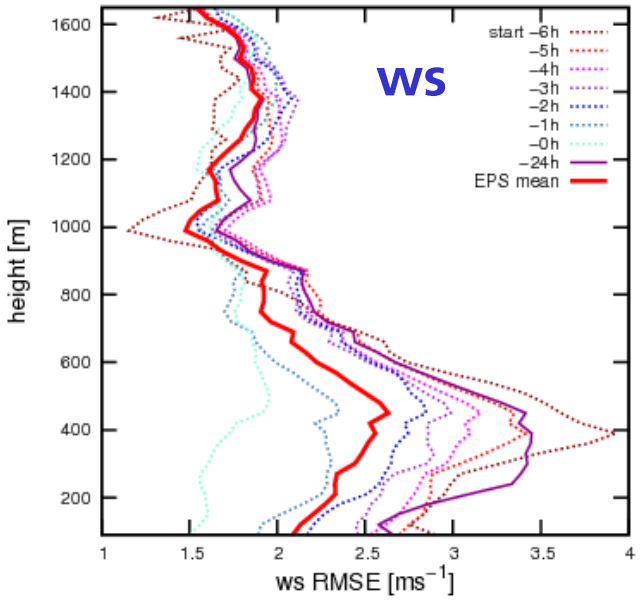


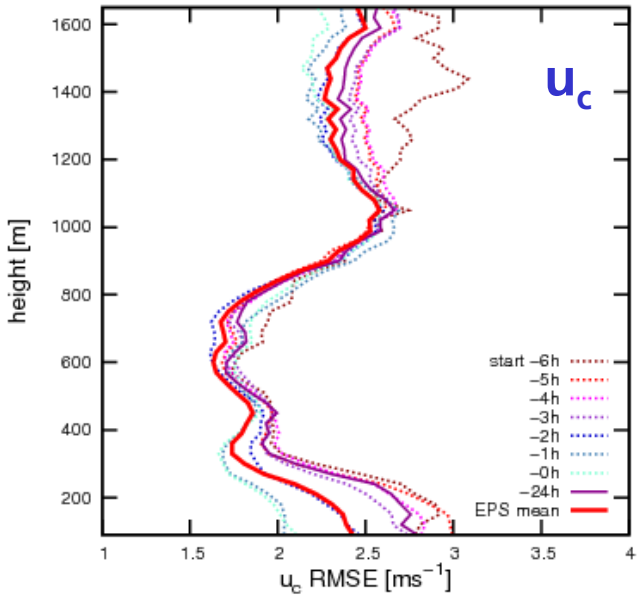
- Light south-easterly winds below 1000 m before 10 UTC
- Increase of wind speed and change of wind direction after 10 UTC

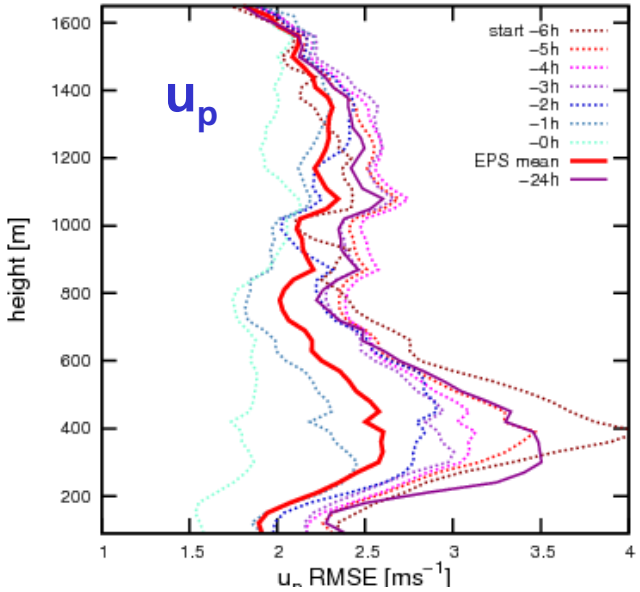
3. Time Lagged Ensemble Forecasts

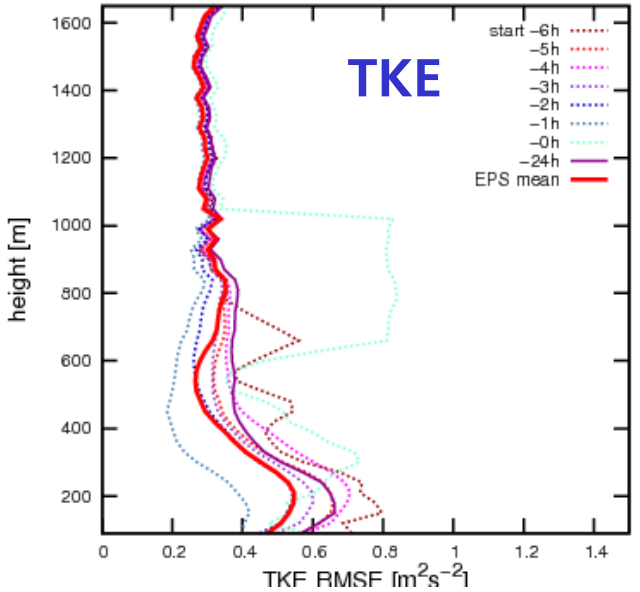
RMSE

(No DA)





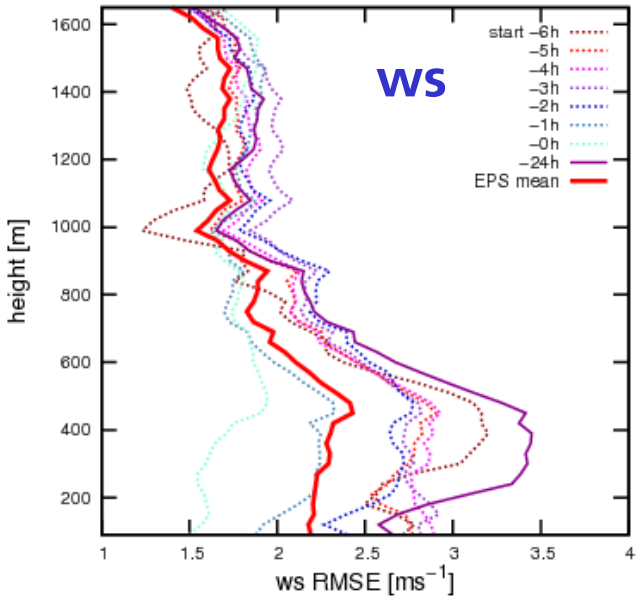


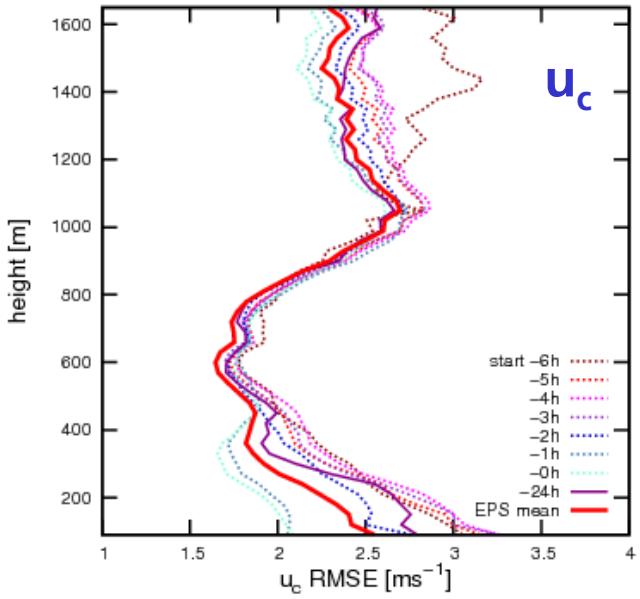


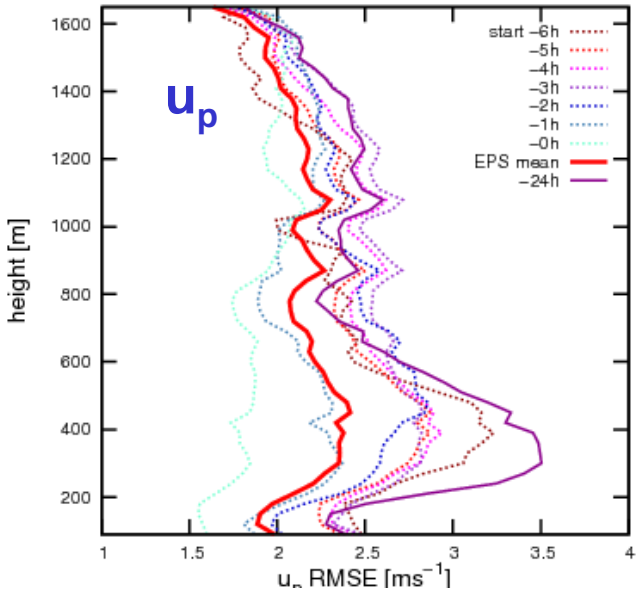
3. Time Lagged Ensemble Forecasts

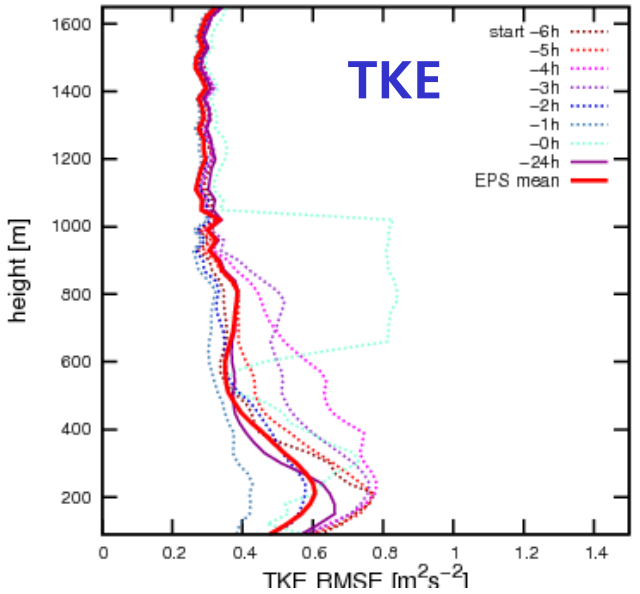
RMSE

(DA: LHN)



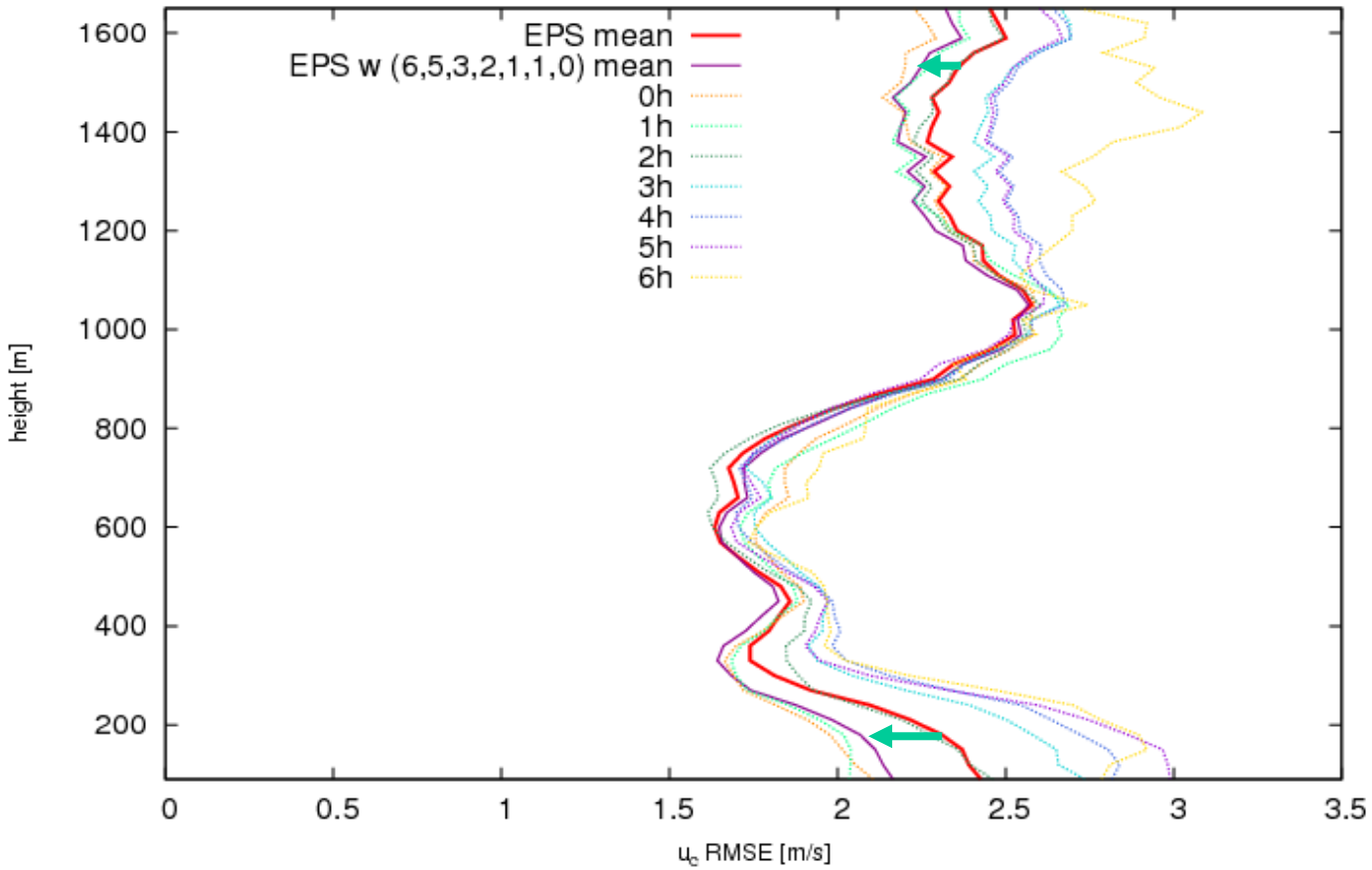






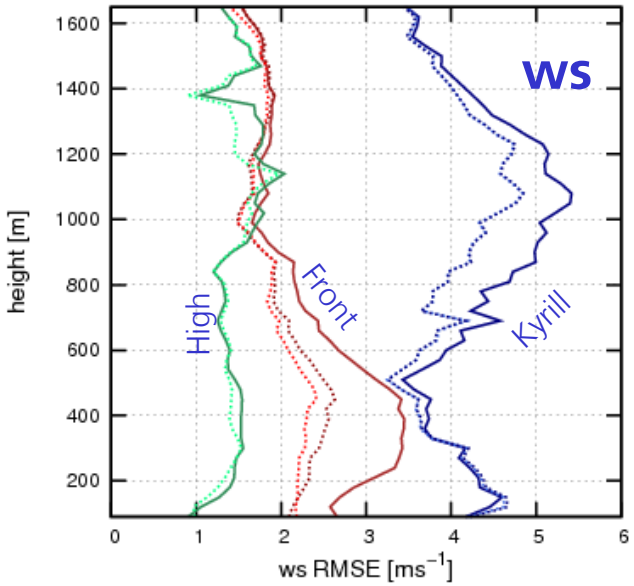
3. Time Lagged Ensemble Forecasts

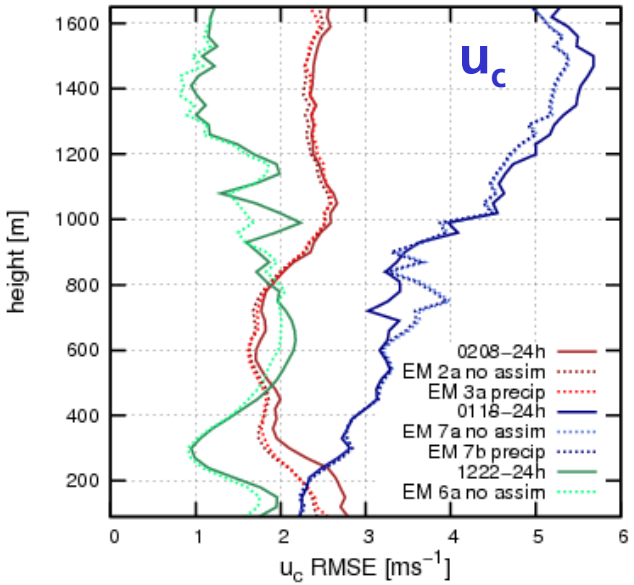
Weighted Mean - 08. February 2007

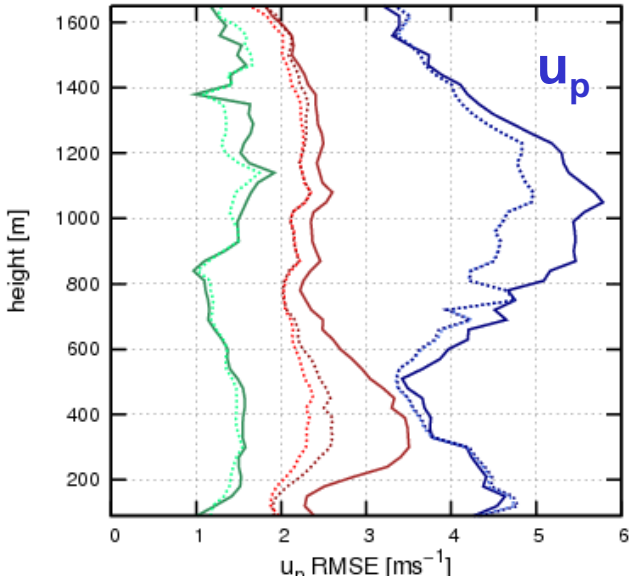


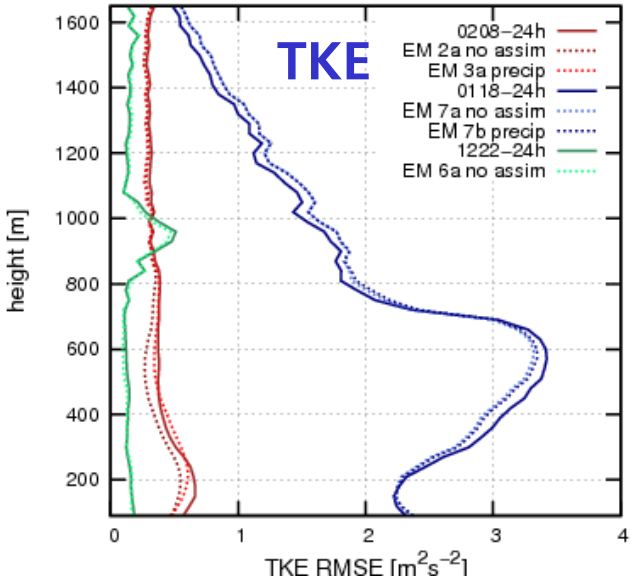
3. Time Lagged Ensemble Forecasts

RMSE

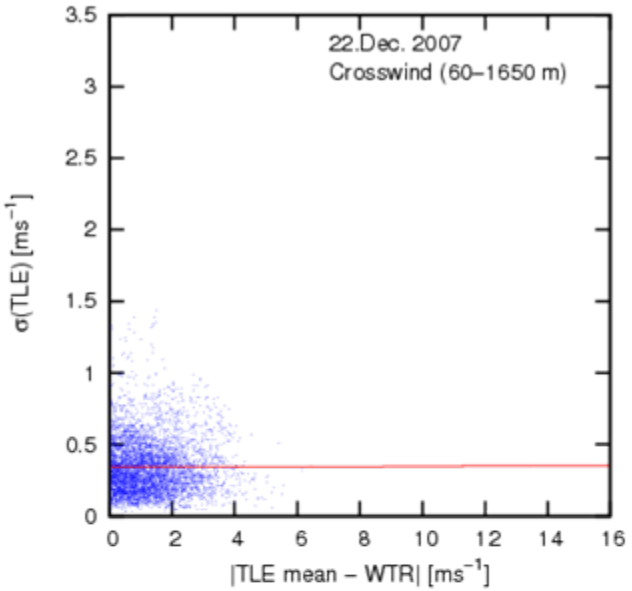


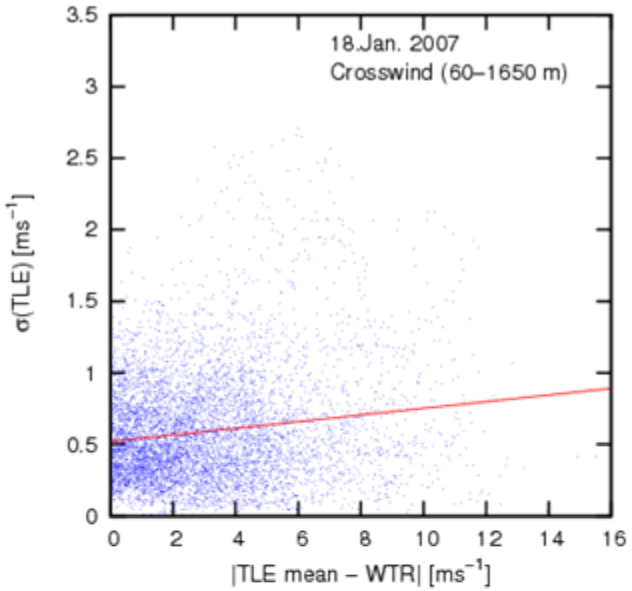


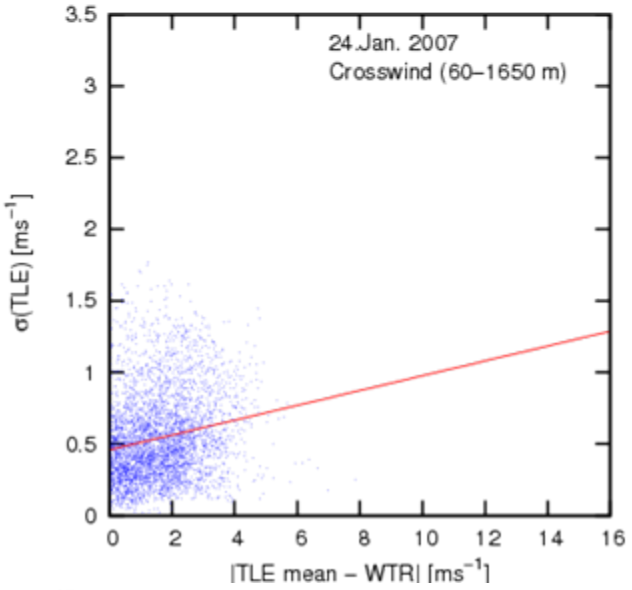


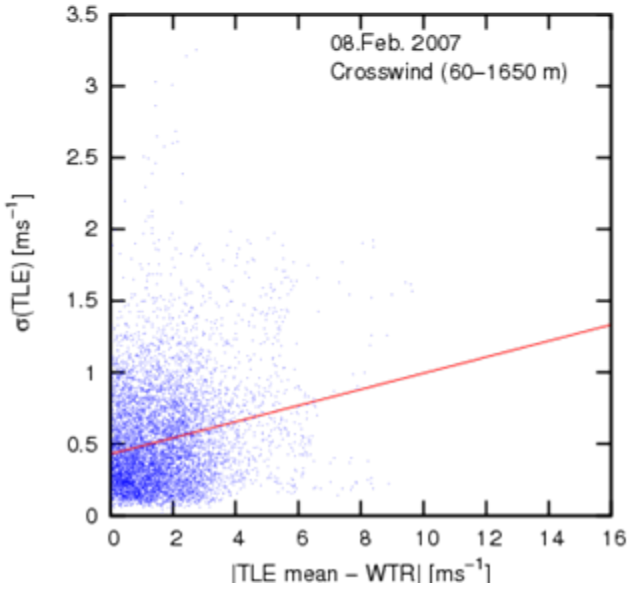


3. Time Lagged Ensemble Forecasts

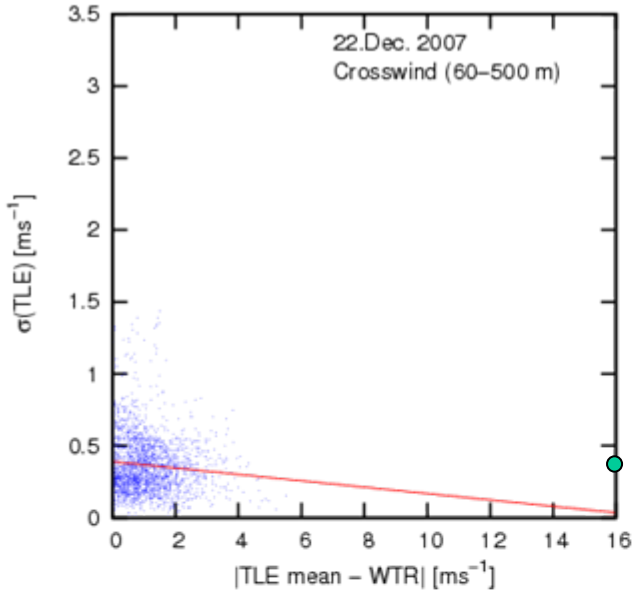


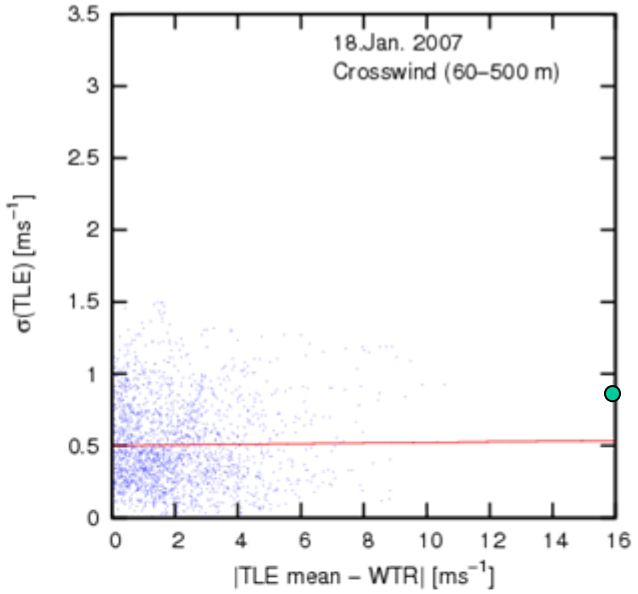


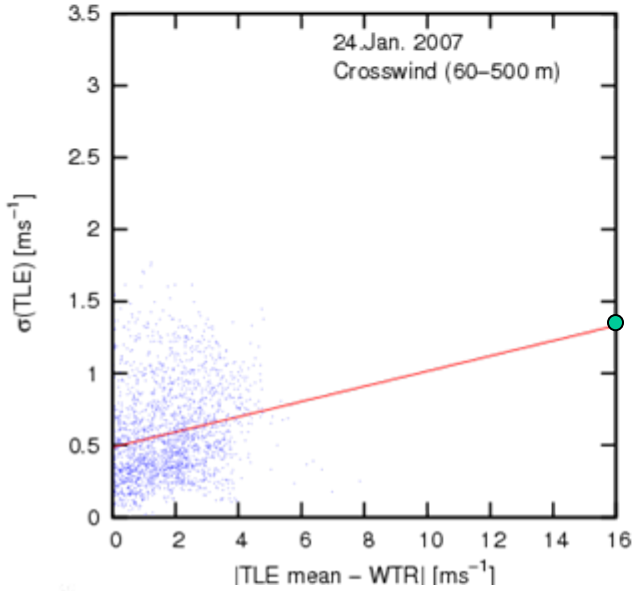


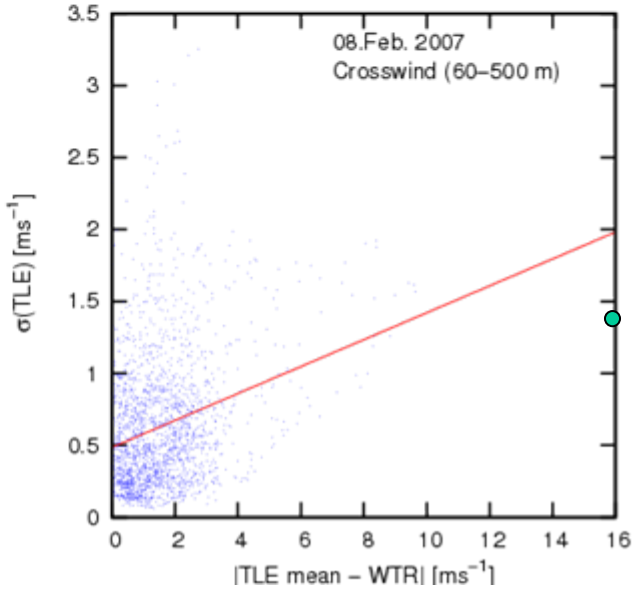


3. Time Lagged Ensemble Forecasts









Summary of Correlations

Day	Condition	60-1650 m	60-500 m	500-1650 m	DA
22.12.2006	High Pressure	0.04	-0.03	0.11	N
		-0.08	0	-0.12	SYN,TEMP, AMDAR
		0.40	*0.49*	*0.36*	RASS (<~1000 m)
24.01.2007	L N-Italy	0.24	0.24	0.18	N
08.02.2007	Front	0.26	0.35	0.24	N
		0.36	**0.50**	**0.32**	SYN,TEMP, AMDAR,LHN

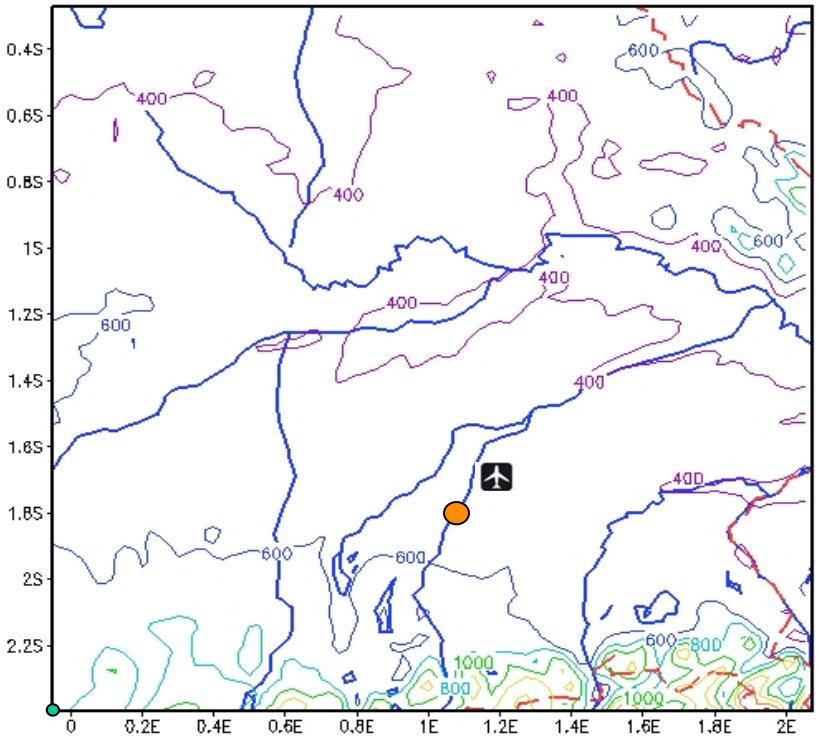
Summary & Outlook:

- Reduction of RMSE by using TLE-mean (compared to 24-h run)
- Short range forecasts (≤ 2 h) show smaller RMSE than TLE-mean for wind speed (below ~ 1000 m)
- Assimilation of data:
    - **LHN:**
        - Reduction of RMSE of TLE-mean for wind speed & parallel wind below 800 m
        - Reduction of TLE Spread
    - **AIREP:**
        - Some reduction of RMSE visible above ~ 1000 m (little data below)

June - July 2010: Airport Munich (MUC)

- SODAR/RASS, LIDAR, ...
- Hourly COMSO-MUC TLE

COSMO-MUC DOMAIN



Further Questions:

- Is an improvement of the forecasts of the hourly update cycle visible when compared to the operational 3-hour update cycle of COSMO-DE?
- How far is it possible to improve the spread-skill-score in a hourly update cycle with assimilated data?
- How sensitive are the forecasts on the quality of the observations?
- What alternative data assimilation methods are useful for a rapid update cycle model?


Thank you for your attention!
Questions?
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