



# Parameterization of soil processes - "bare soil" - results

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## Content

- Introduction.
- Numerical experiments.
- Plans.

## Modified Darcy equation

- We considered modified Darcy equation:

$$F_m = \rho_w \left( 1 + 1550 \frac{D_{\min}}{D_{\max}} \frac{B - 3,7 + \frac{5}{B}}{B + 5} \right) 1,02 D_{\max} S_u^{B+2} \left( \frac{S_t}{S_u} \right)^{\left\{ 5,5 - 0,8B \left[ 1 + 0,1(B-4) \log \frac{K_0}{K_R} \right] \right\}} \frac{S_t}{\sqrt{z_u z_t}}$$

⇓

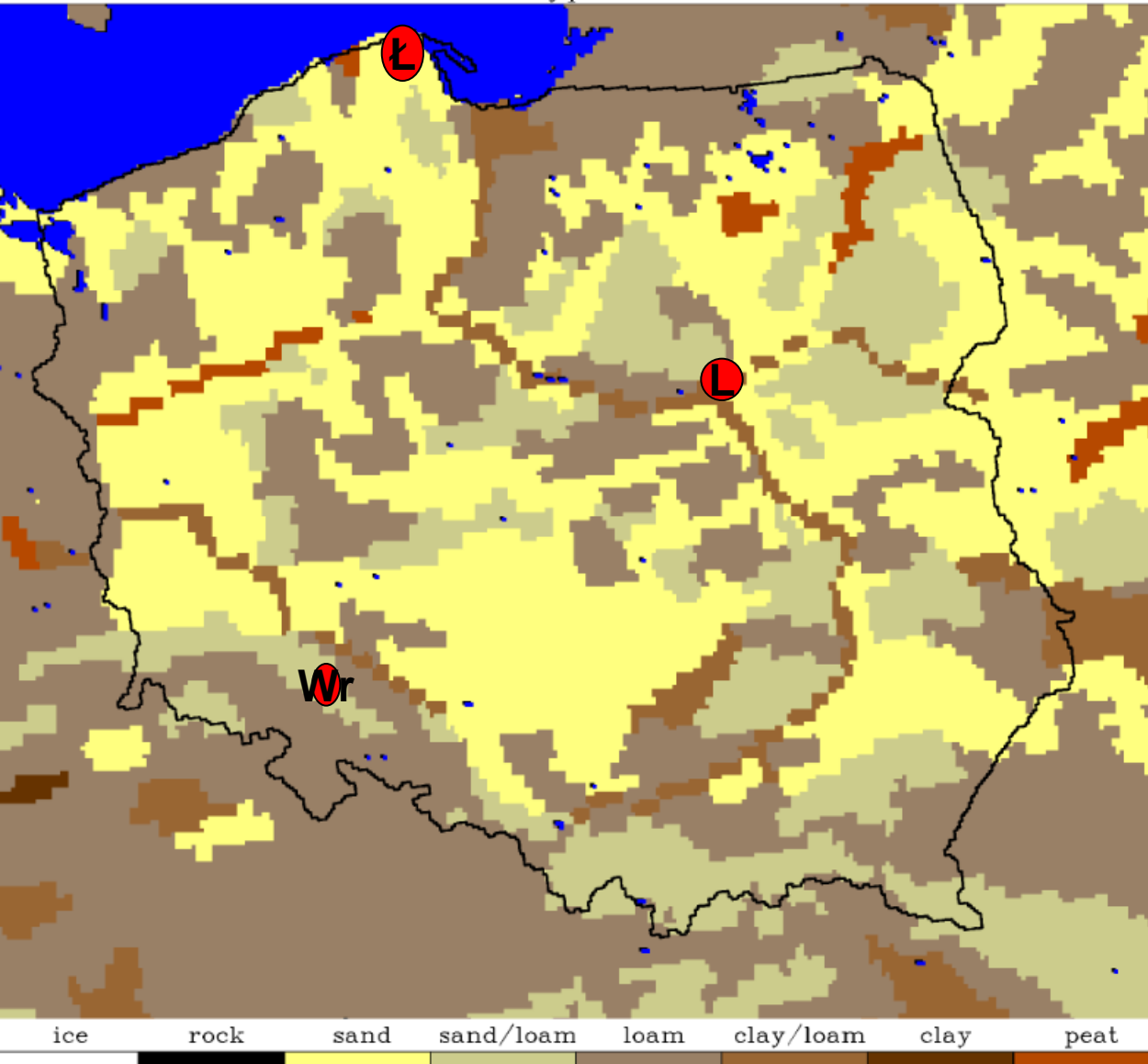
$$\vec{F}_m = -D(\theta) e^{\left( \frac{T}{T_0} \right)} \vec{\nabla} \theta$$

- **We considered following meteorological profiles:**
  - a) **Air temperature profile;**
  - b) **Wind speed profile;**
  - c) **Profile of wind direction;**
  - d) **Specific water vapor content profile.**

- **We chose two seasons:**
  1. Spring,
  2. Summer.
- Numerical experiment includes time from April of 1st to September of 30th, 2013.
- **We compared:**
  - Results from COSMO Model (reference – without change, flux) – data from meteorological stations.
  - Results from COSMO Model (after changed flux) – data from meteorological stations.

## Basic soil types in Poland

Basic soil types in Poland

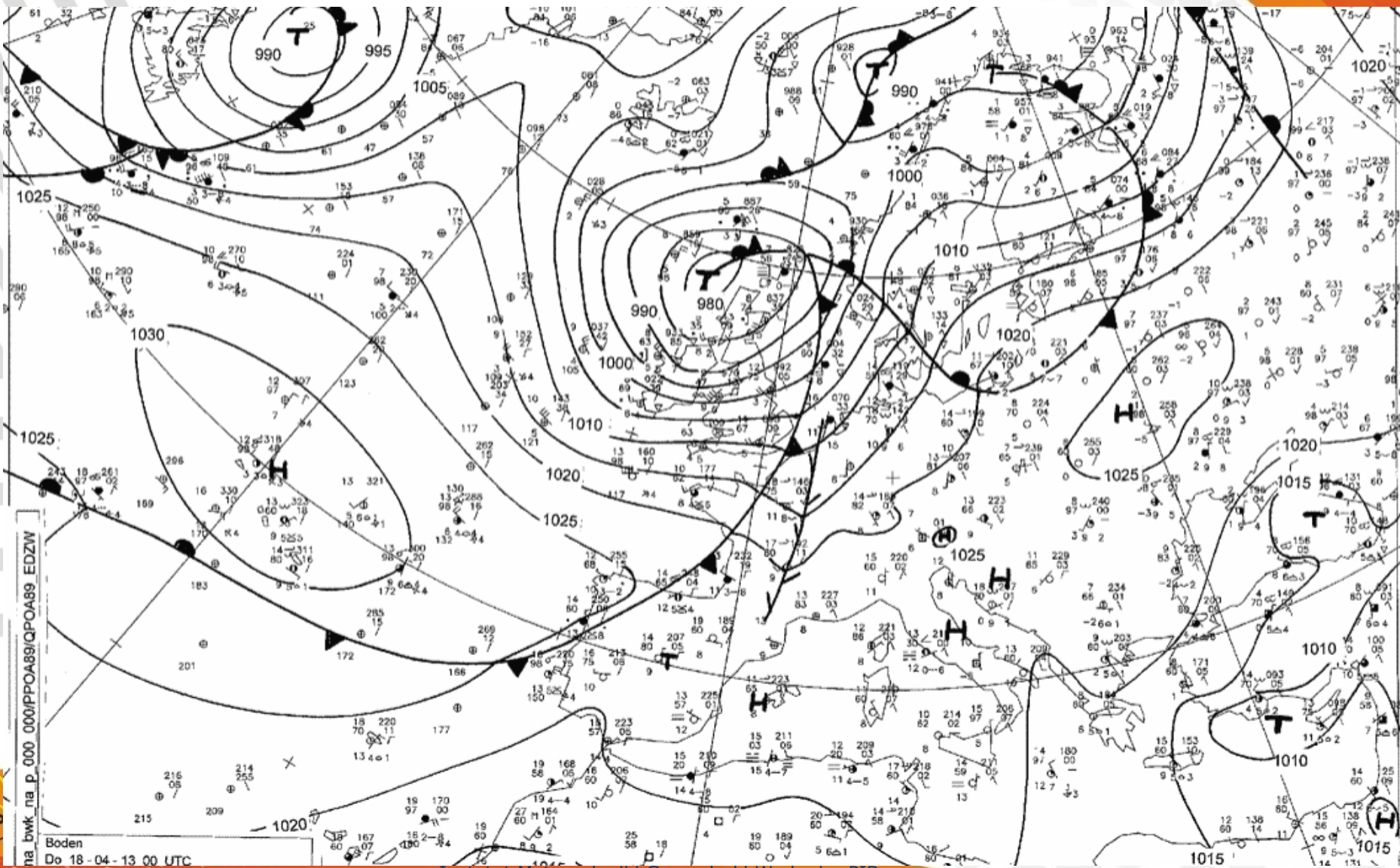


Wrocław - sand/loam

Legionowo - clay/loam

Łeba - sand

Synoptic chart for 18.04.2013-12 UTC



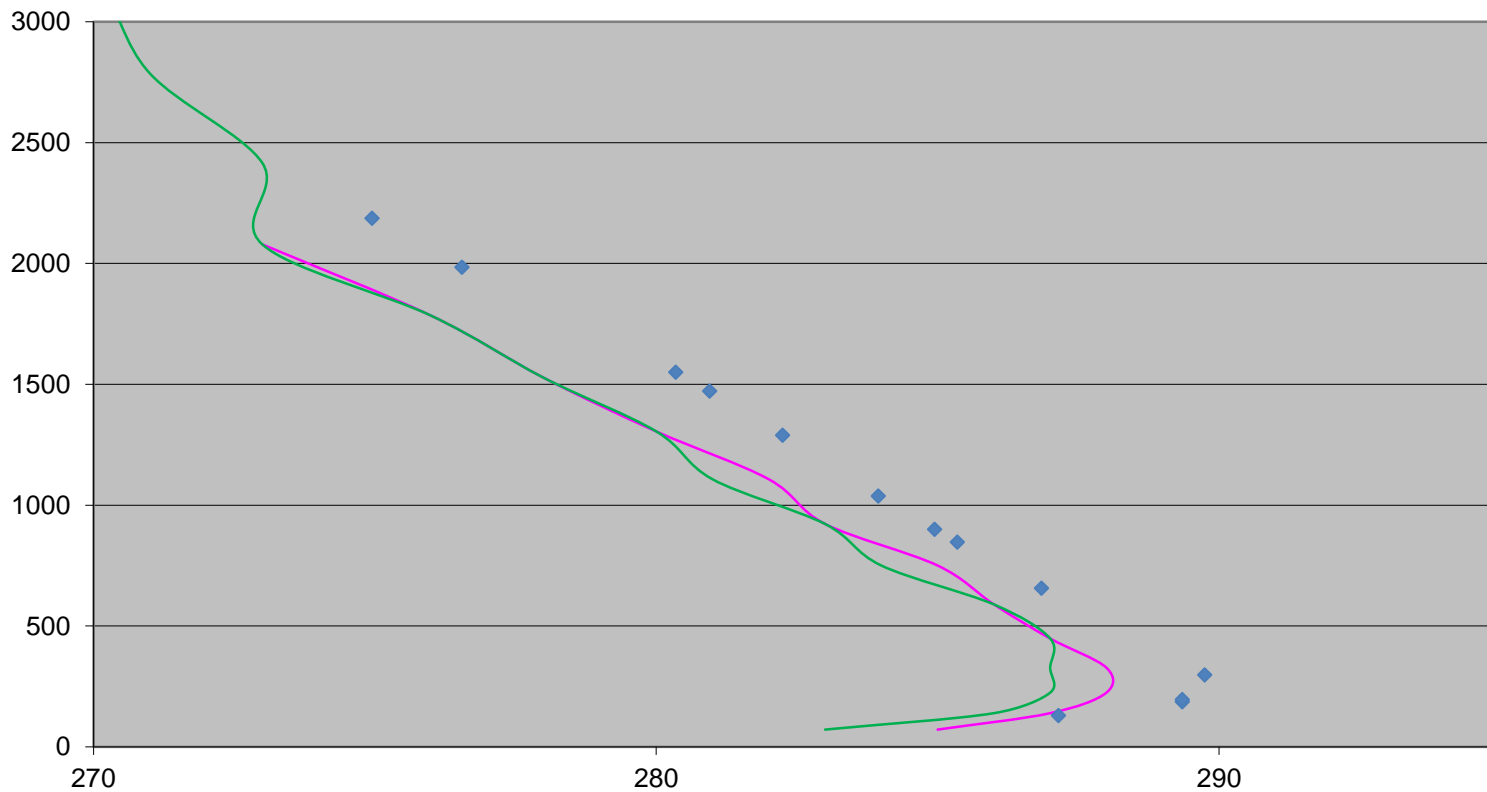
na bmk na p.000 000/PP0A89/QP0A89 EDZW

Boden  
Do 18-04-13 00 UTC

- **Meteorological and soil condition (at 6 am UTC):**
  1. **Air temperature at surface: from  $-1^{\circ}\text{C}$  to  $-10^{\circ}\text{C}$**
  2. **Soil condition: unfrozen (frozen places) in upper part**
  3. **Falls: -----**
  4. **Wind: week**
  5. **Cloud cover: from FEW to OVC (Ac, As, Ci, Cs)**



### Legionowo - T profile



blue diamonds - measurement,

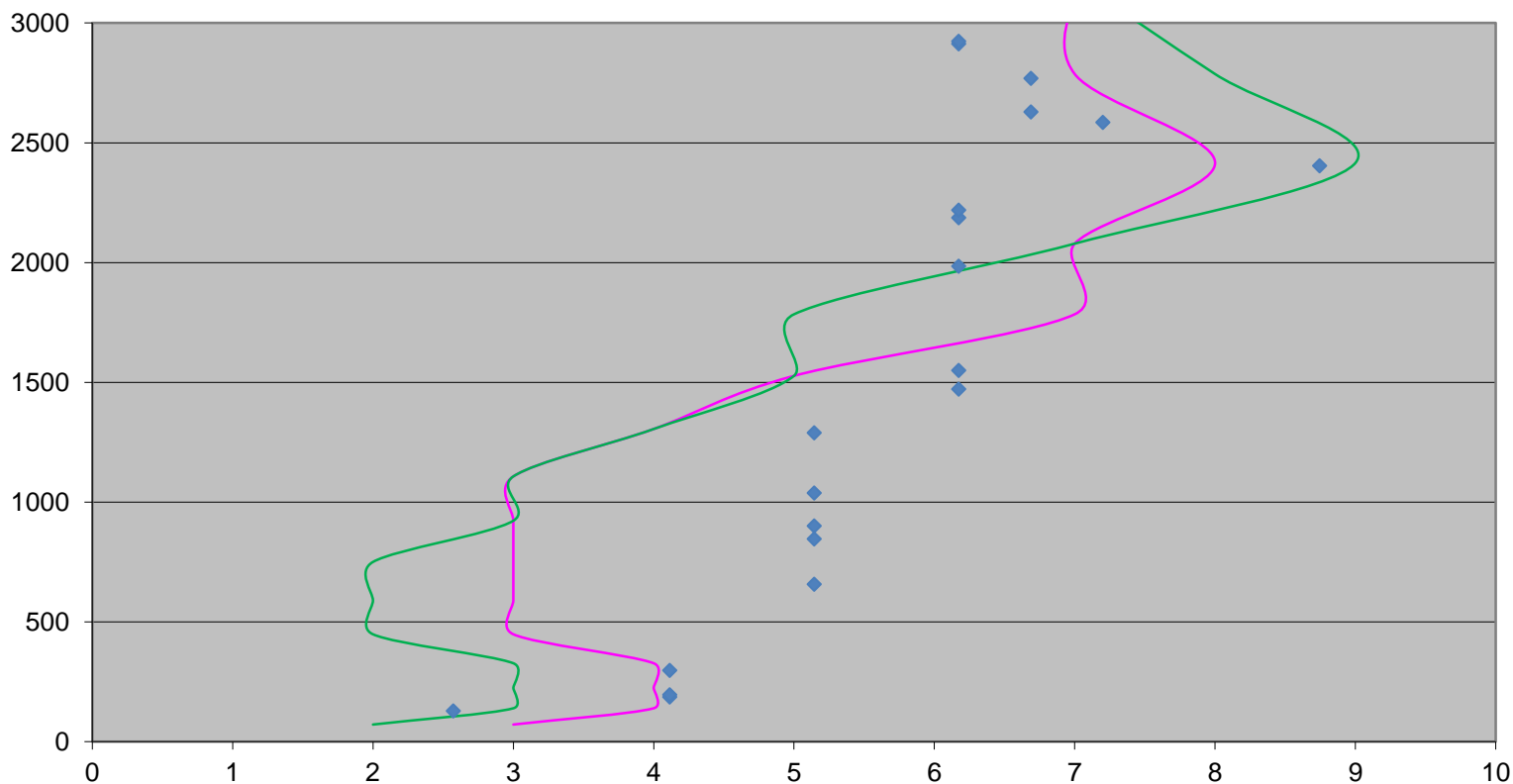
green – Dickenson's parameterization (reference),

pink – Darcy equation with temperature dependence

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Profile of wind speed - 12 hour forecast (18 IV 2013 – 00 UTC)

## Legionowo - U profile



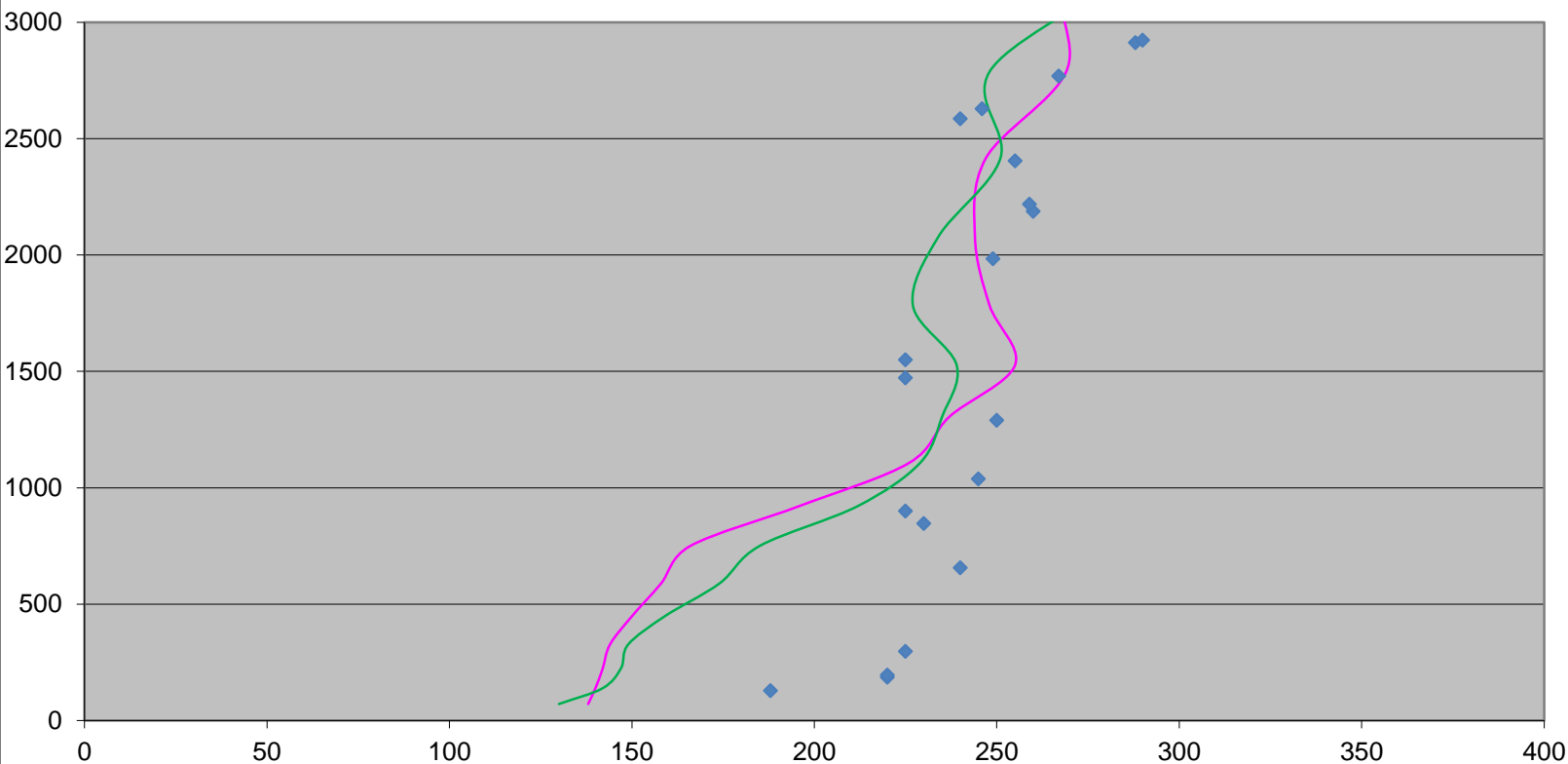
blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Darcy equation with temperature dependence

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### Legionowo - profile of wind direction



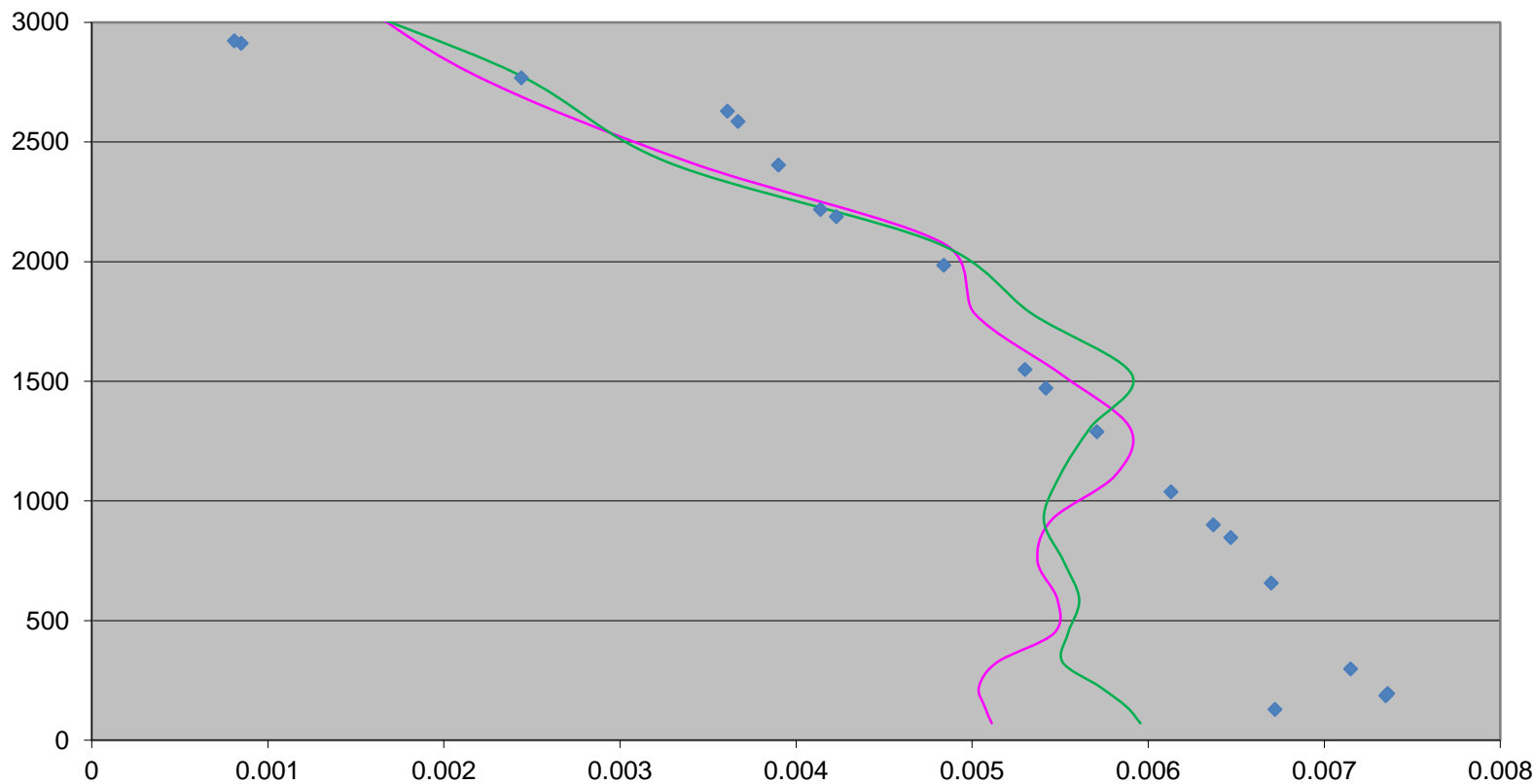
blue diamonds - measurement,

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### Legionowo – q profile



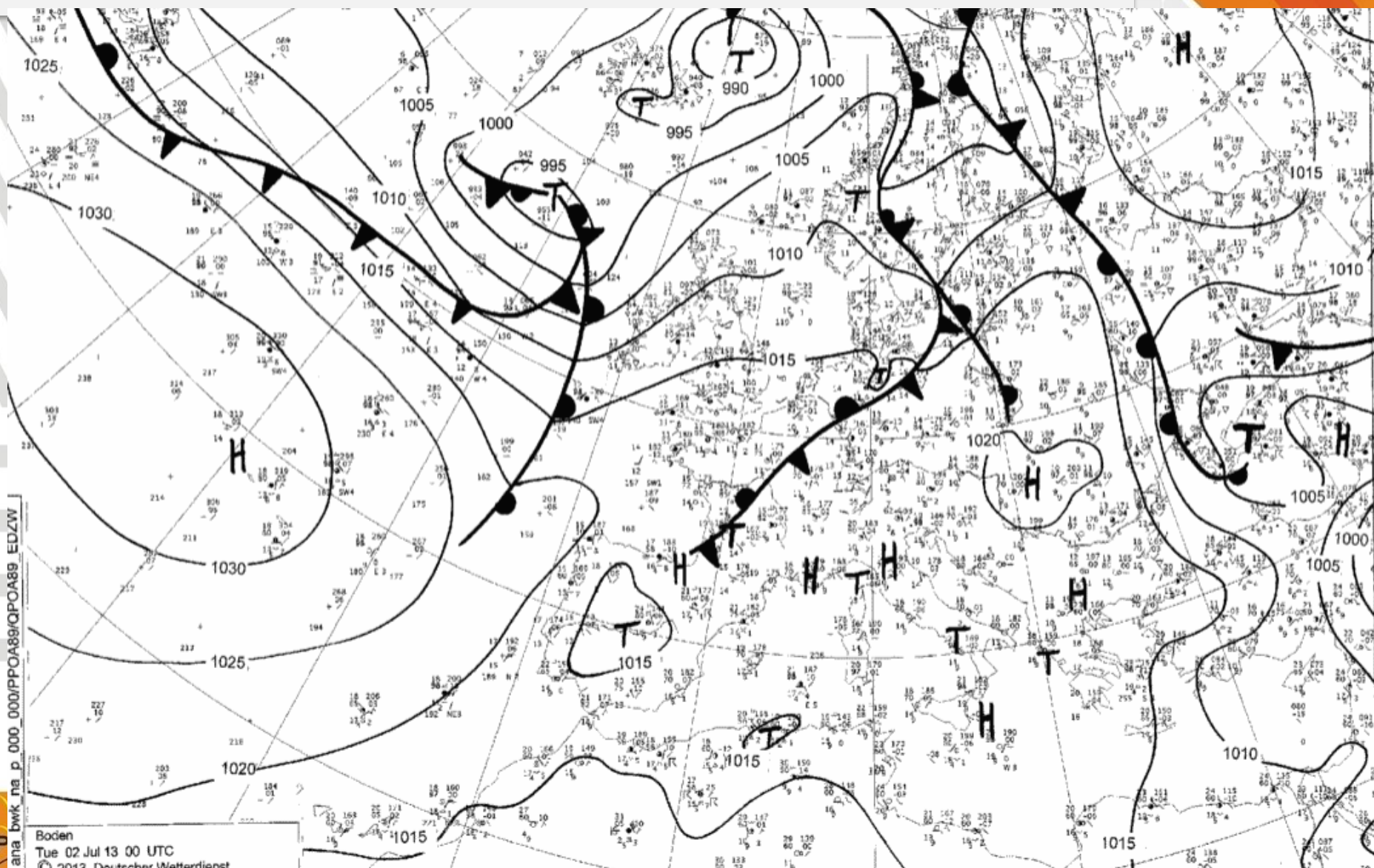
blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Darcy equation, with temperature dependance

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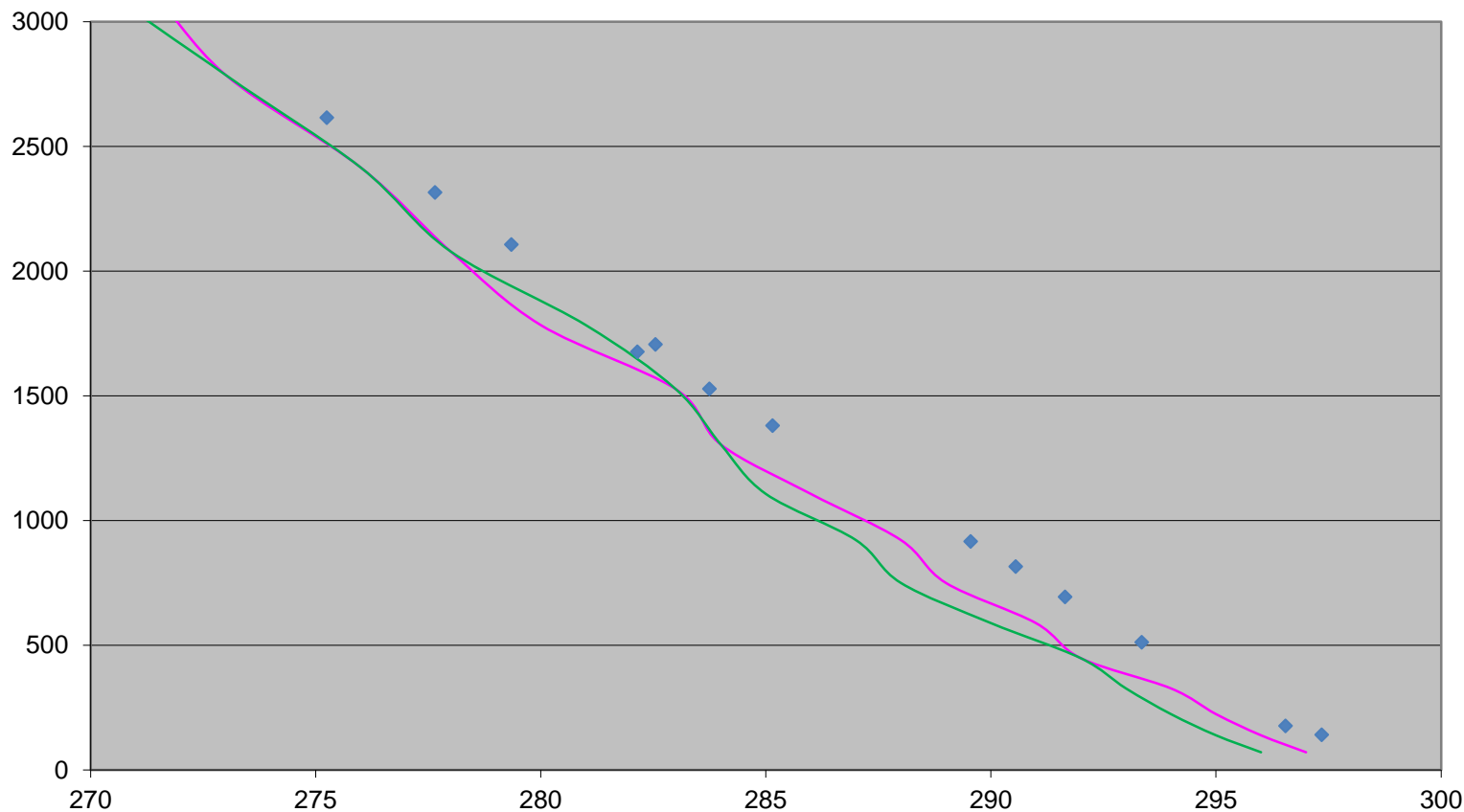
Synoptic chart for 2.07.2013-00 UTC



- **Meteorological and soil condition (at 6 am UTC):**
  1. **Air temperature at surface: above 0° C**
  2. **Soil condition: unfrozen**
  3. **Falls: rainfall**
  4. **Wind: week**
  5. **Cloud cover: overcast (Cb cap)**

Profile of air temperature - 24 hour forecast (2 VII 2013 – 12 UTC)

## Legionowo - T profile



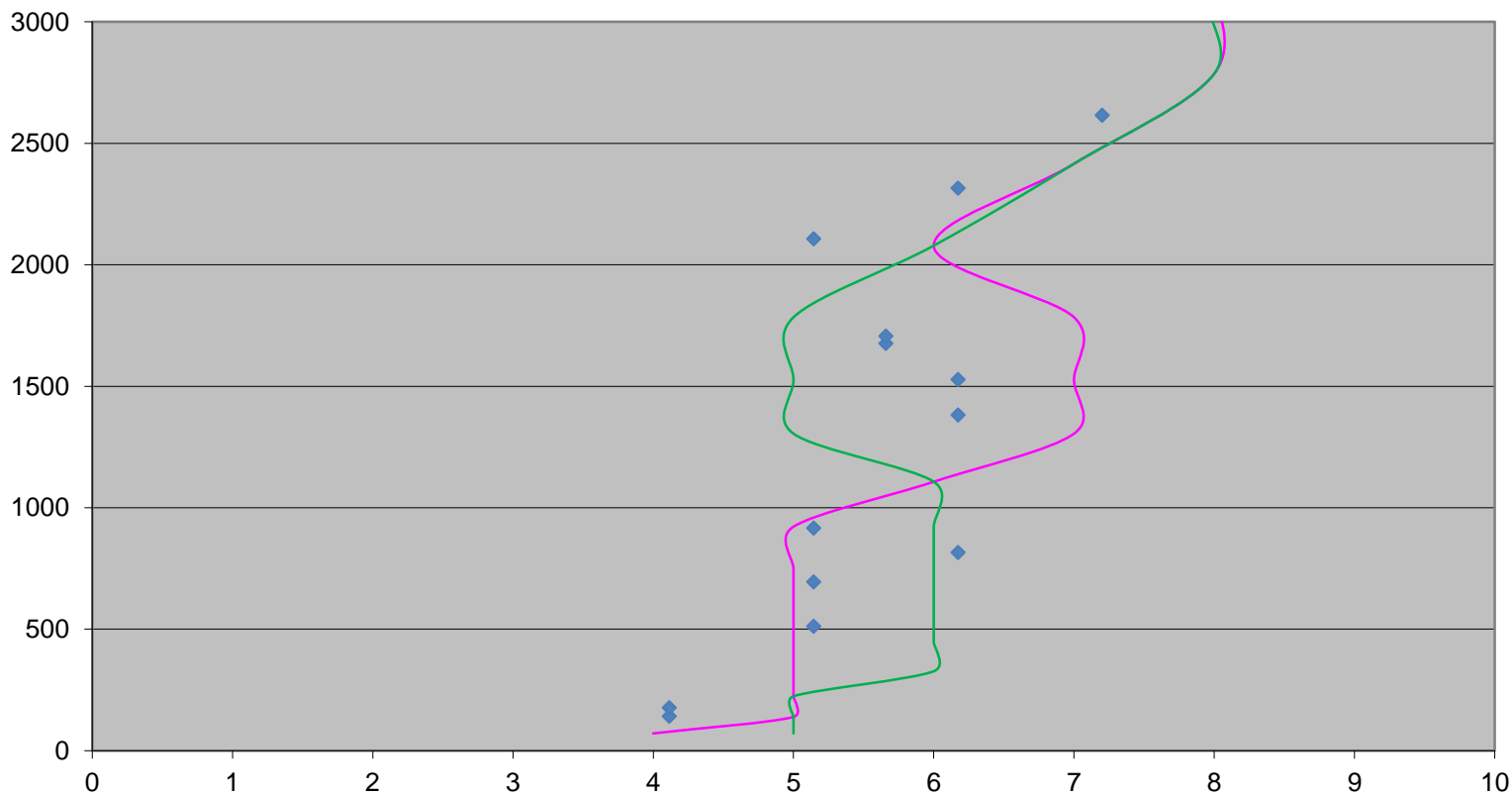
blue diamonds - measurement,

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### Legionowo - U profile



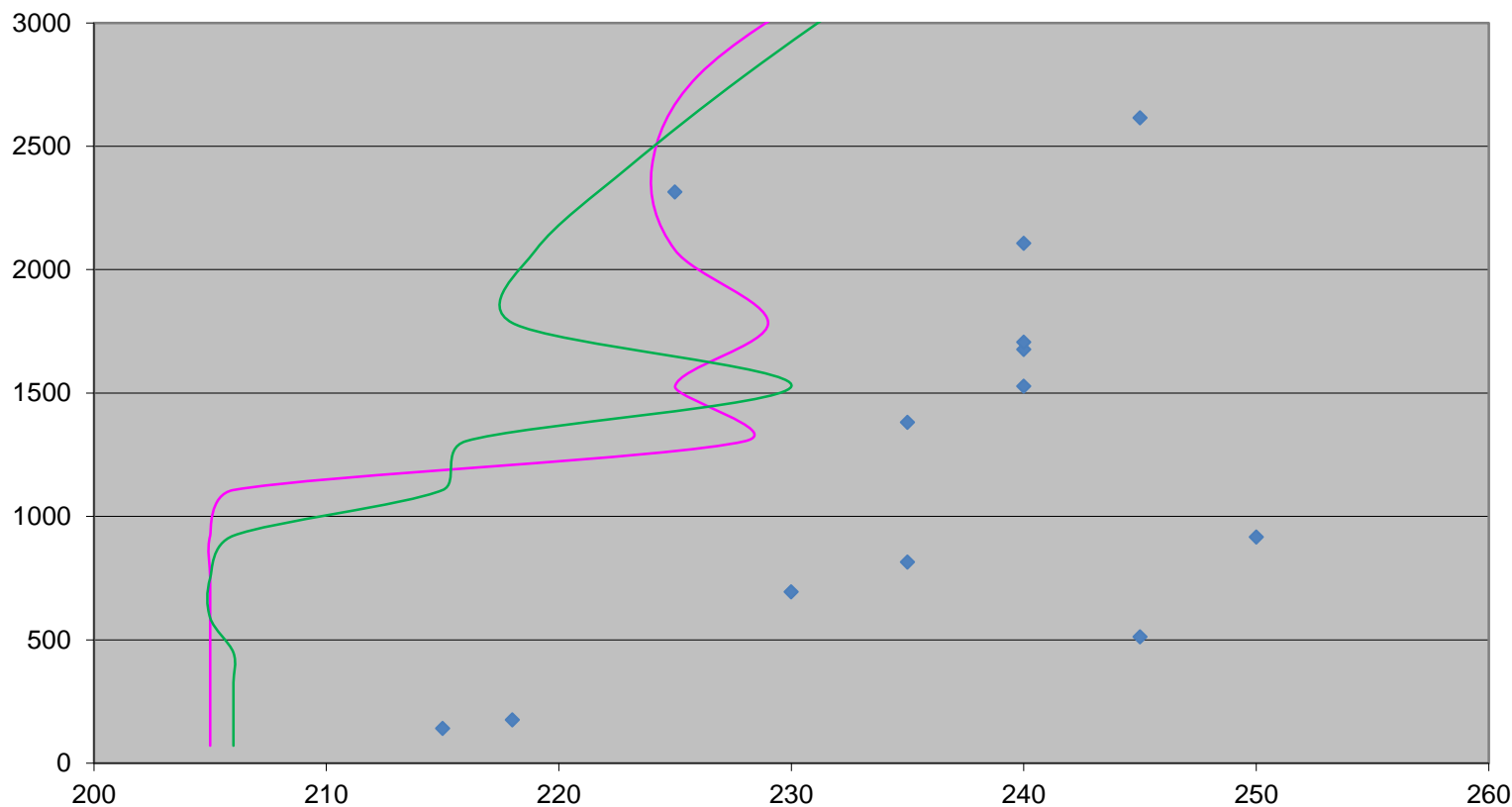
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### Legionowo - profile od wind direction



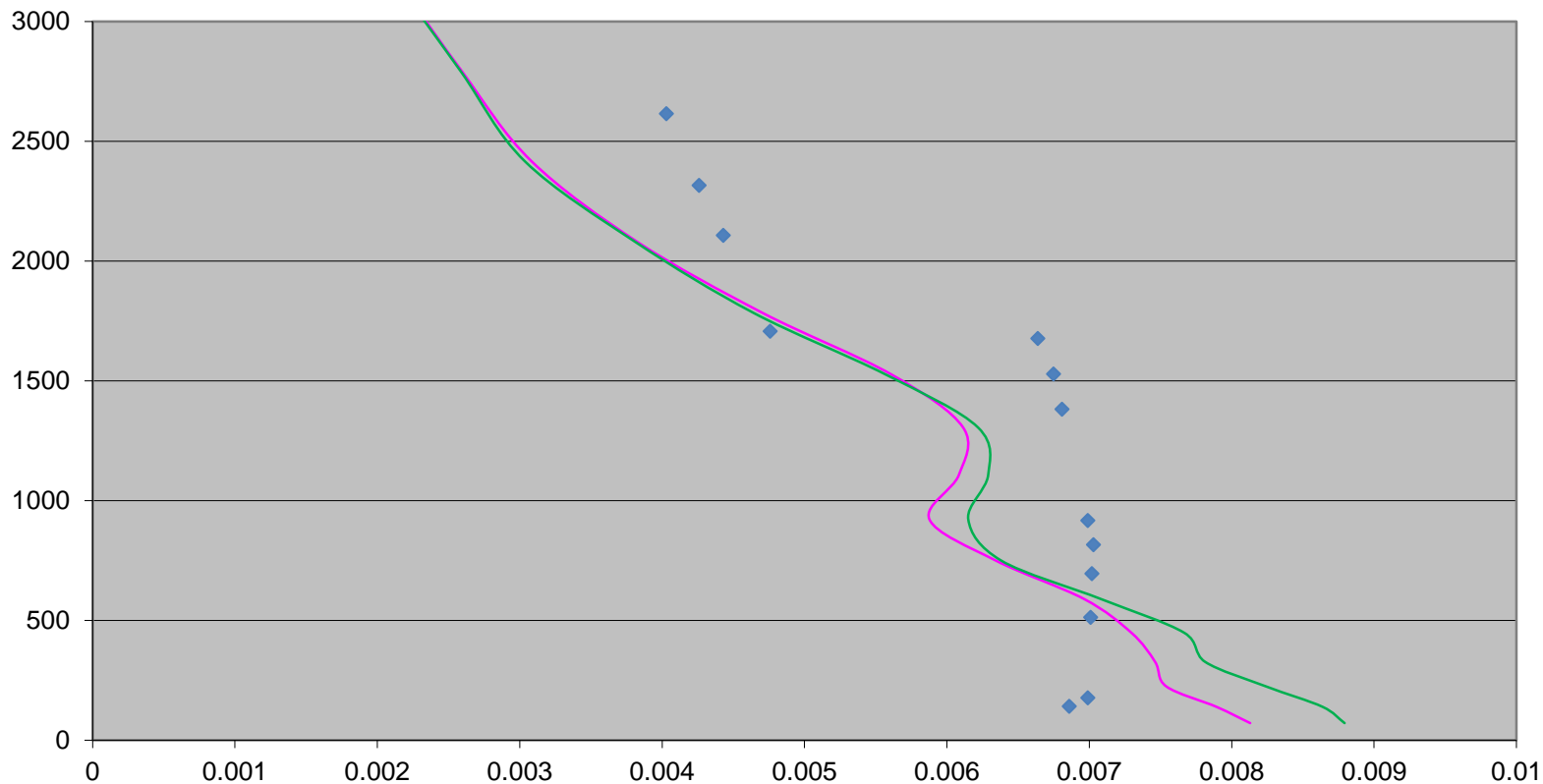
blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Darcy equation with temperature dependance

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### Legionowo - q profile



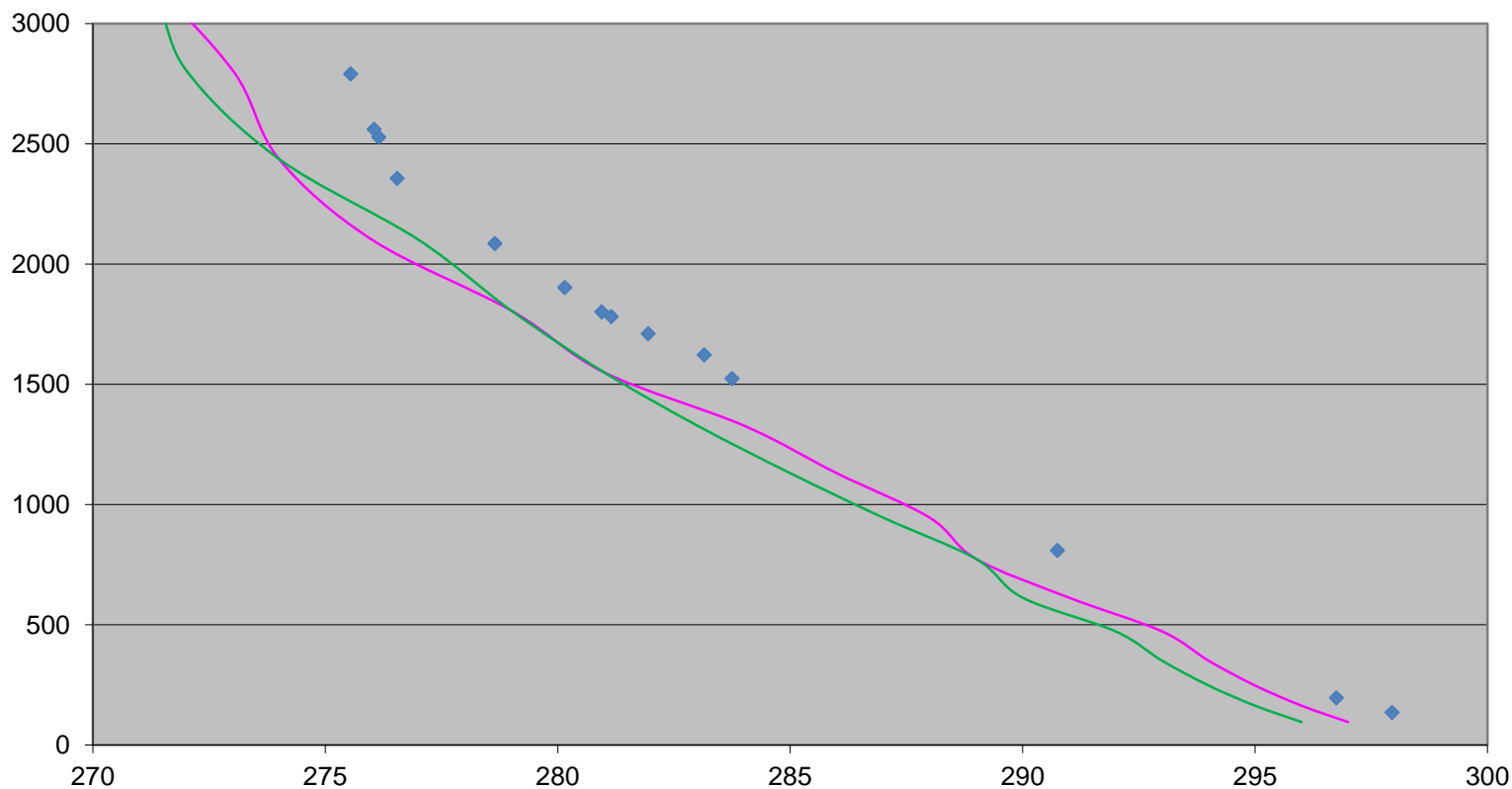
blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Darcy equation with temperature dependance

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### WROCLAW - T profile



blue diamonds - measurement,

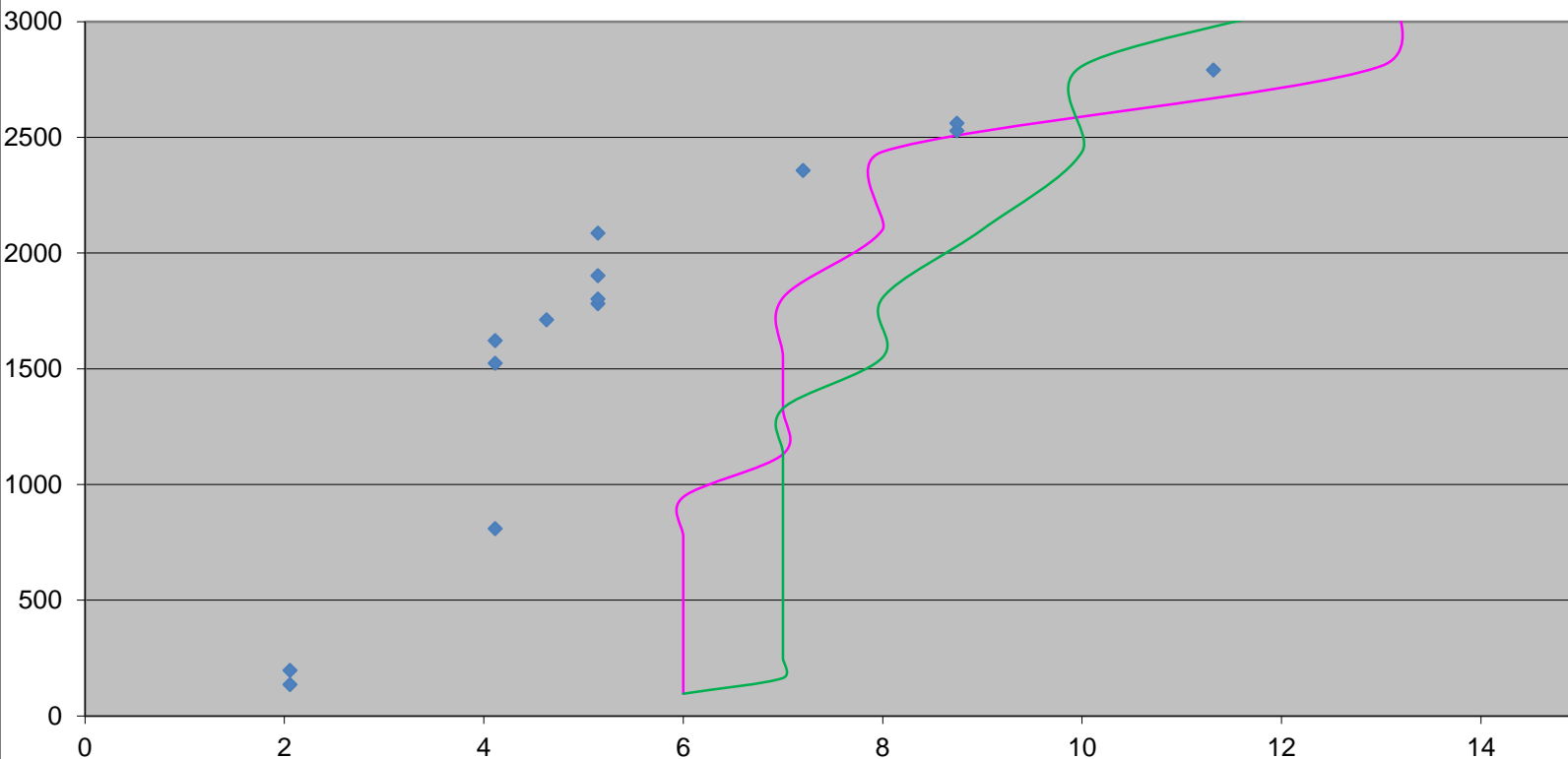
green - Dickenson's parameterization (reference),

pink - Darcy equation with temperature dependance

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Profile of wind speed - 24 hour forecast (2 VII 2013 – 12 UTC)

WROCLAW - U profile



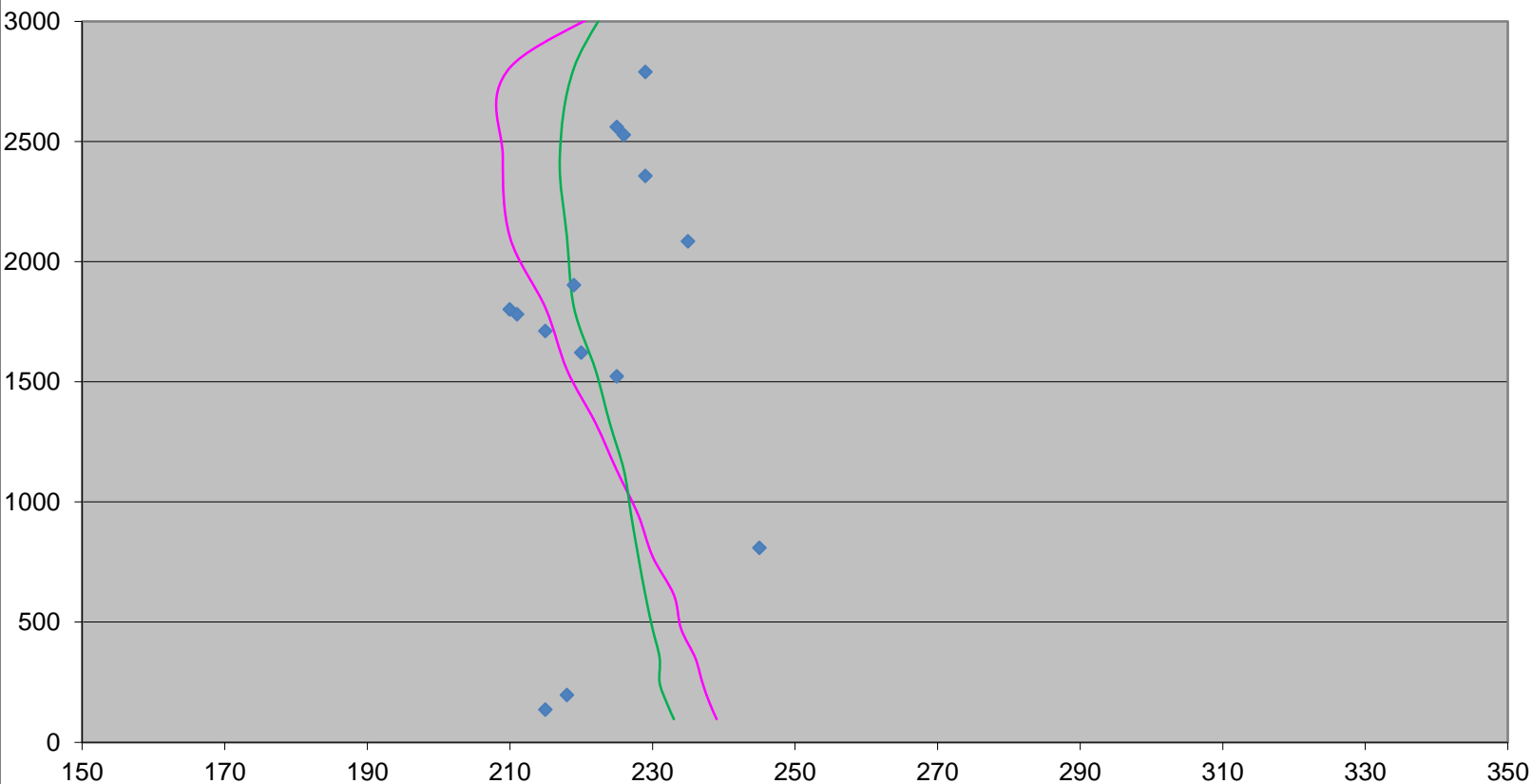
blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Darcy equation with temperature dependence

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### WROCLAW - profile of wind direction



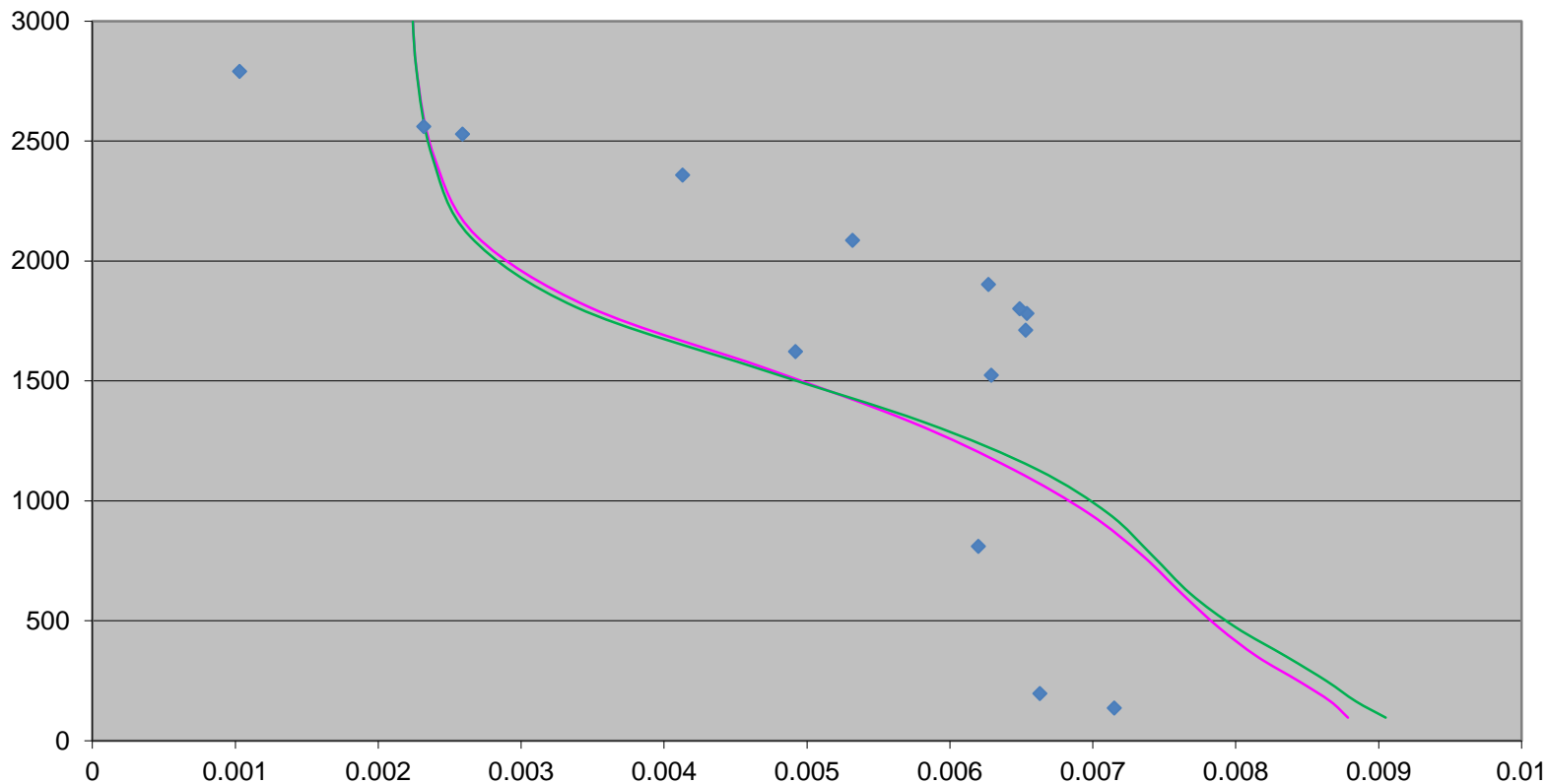
blue diamonds - measurement,

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pink – Darcy equation, with temperature dependence

Profile specific water vapor content – 24 hour forecast (2 VII 2013 – 12 UTC)

### WROCLAW - q profile



blue diamonds - measurement,

green – Dickenson's parameterization (reference),

pink – Dancy equation with temperature dependence

## Tortuosity factor

- We included tortuosity factor in flux:
- Equation of tortuosity was developed by Millington in 1959.

$$\zeta(\theta) = \frac{\theta^{\frac{7}{3}}}{\phi_S^2}$$

## Tortuosity factor

- We modified Darcy equation by an introduction tortuosity correction factor:

$$\vec{F}_m = -\frac{\theta^{\frac{7}{3}}}{\phi_s^2} D(\theta) \vec{\nabla} \theta$$

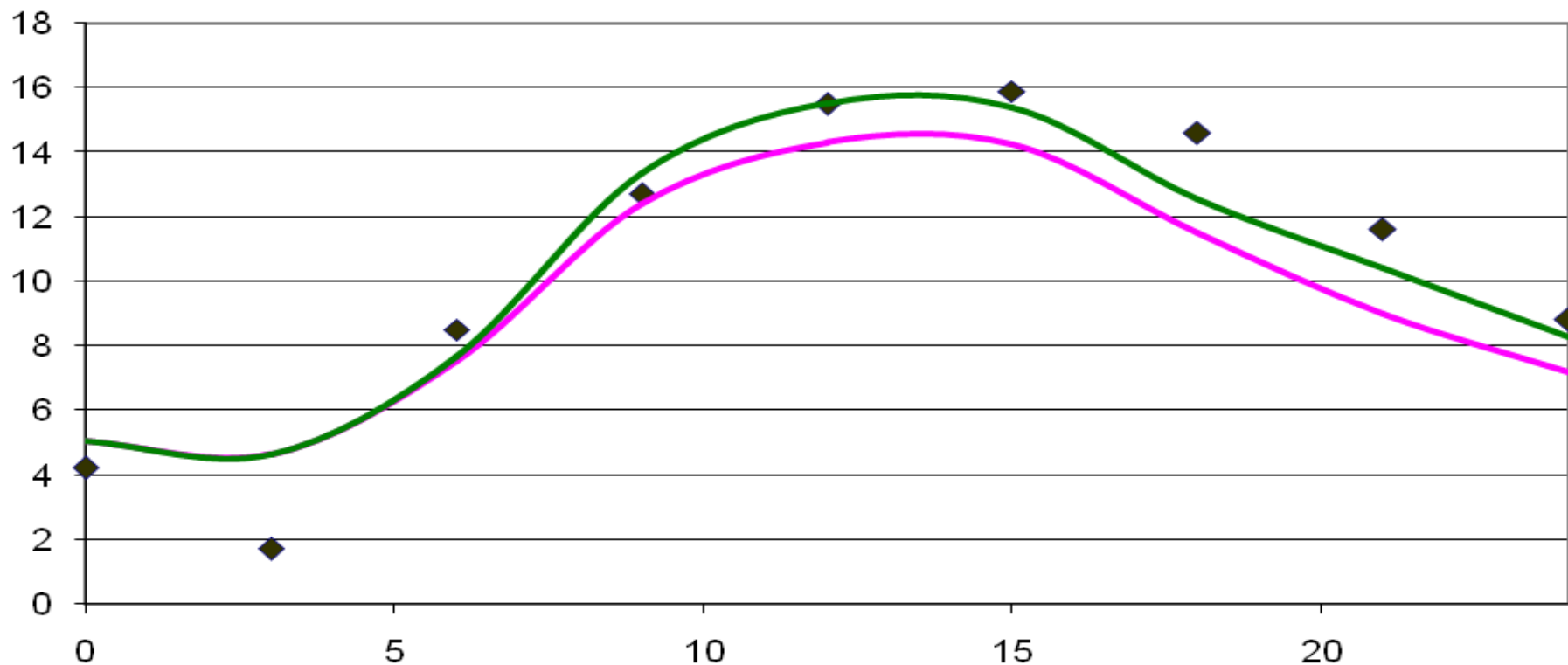


## Numerical experiments and what we analyzed

- **We chose two seasons:**
  1. Spring,
  2. Summer.
- a) **We analyzed:**
  - **Measurement;**
  - **Results from COSMO Model;**

Air temperature at 2 m. a.g.l. (18 V 2012, Kalisz)- sand soil

## Air temperature



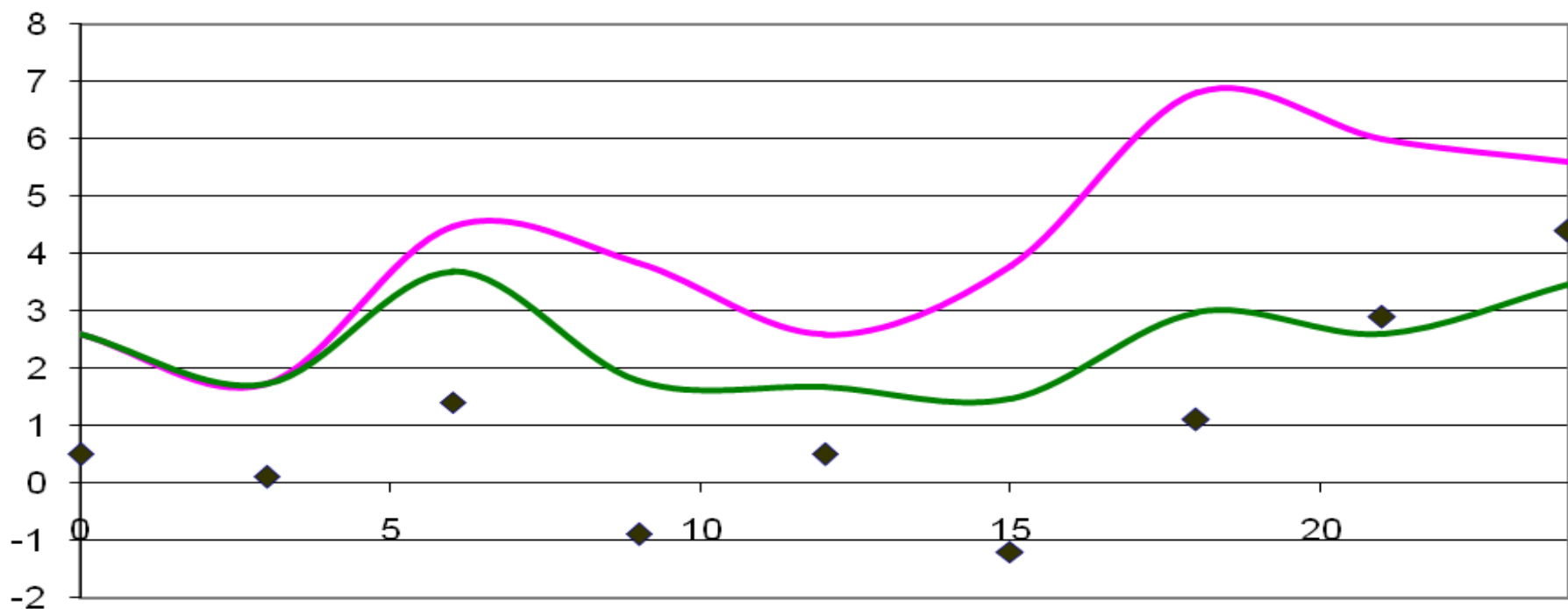
black diamonds - measurement,

pink – Dickenson's parameterization (reference),

green –Darcy equation with tortuosity correction factors.

Dew point temperature at 2 m. a.g.l. (18 V 2012, Kalisz)

## Dew point temperature



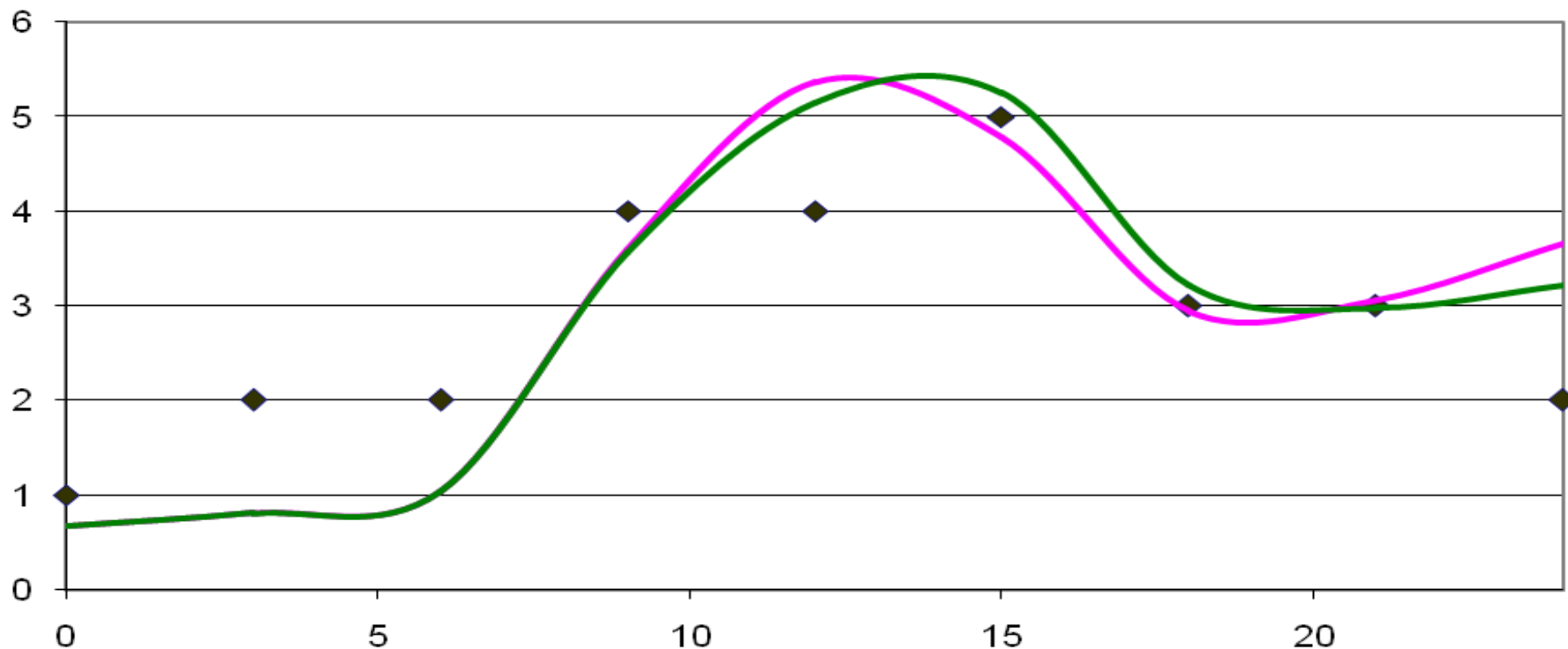
black diamonds - measurement,

pink – Dickenson's parameterization (reference),

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Wind speed (18 V 2012, Kalisz).

## Wind speed



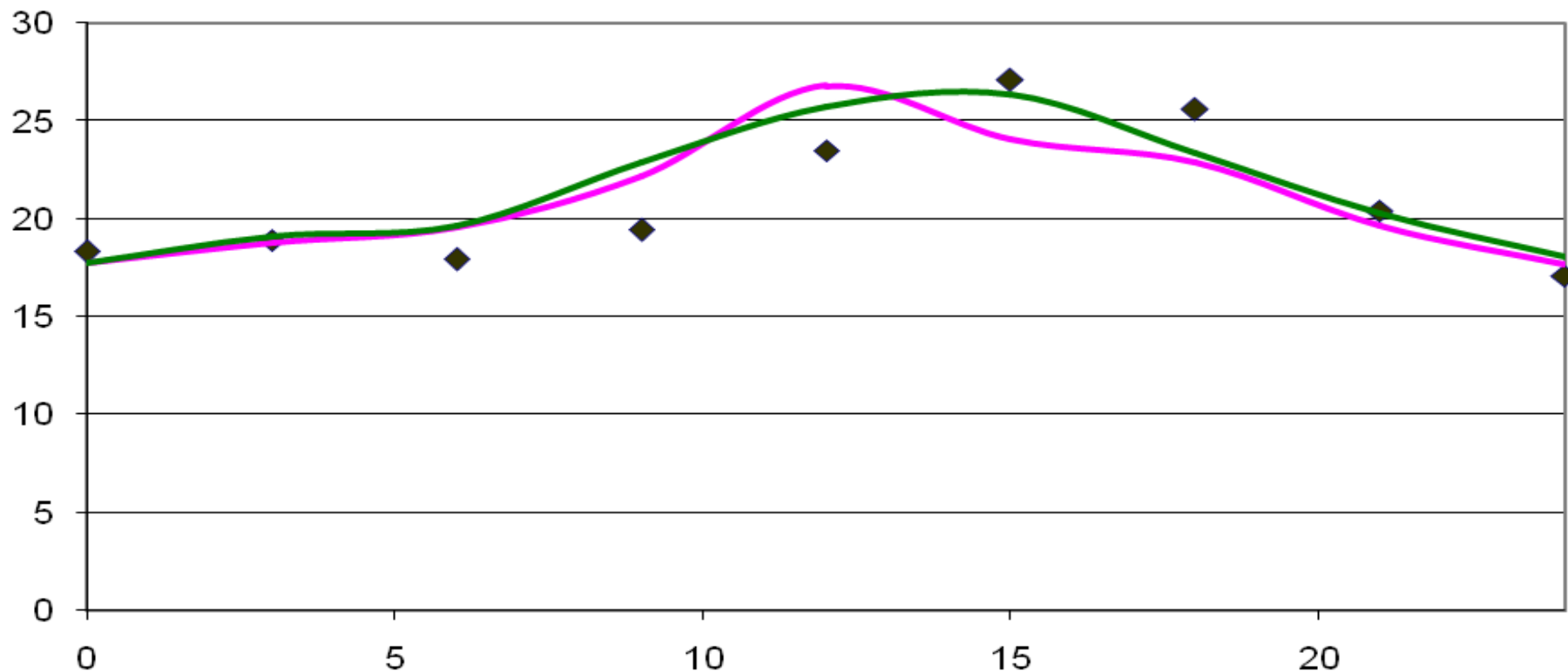
black diamonds - measurement,

pink – Dickenson's parameterization (reference),

green – Darcy equation with tortuosity correction factors.

Air temperature at 2 m. a.g.l. (18 V 2012, Elbląg)-loam/clay soil

## air temperature



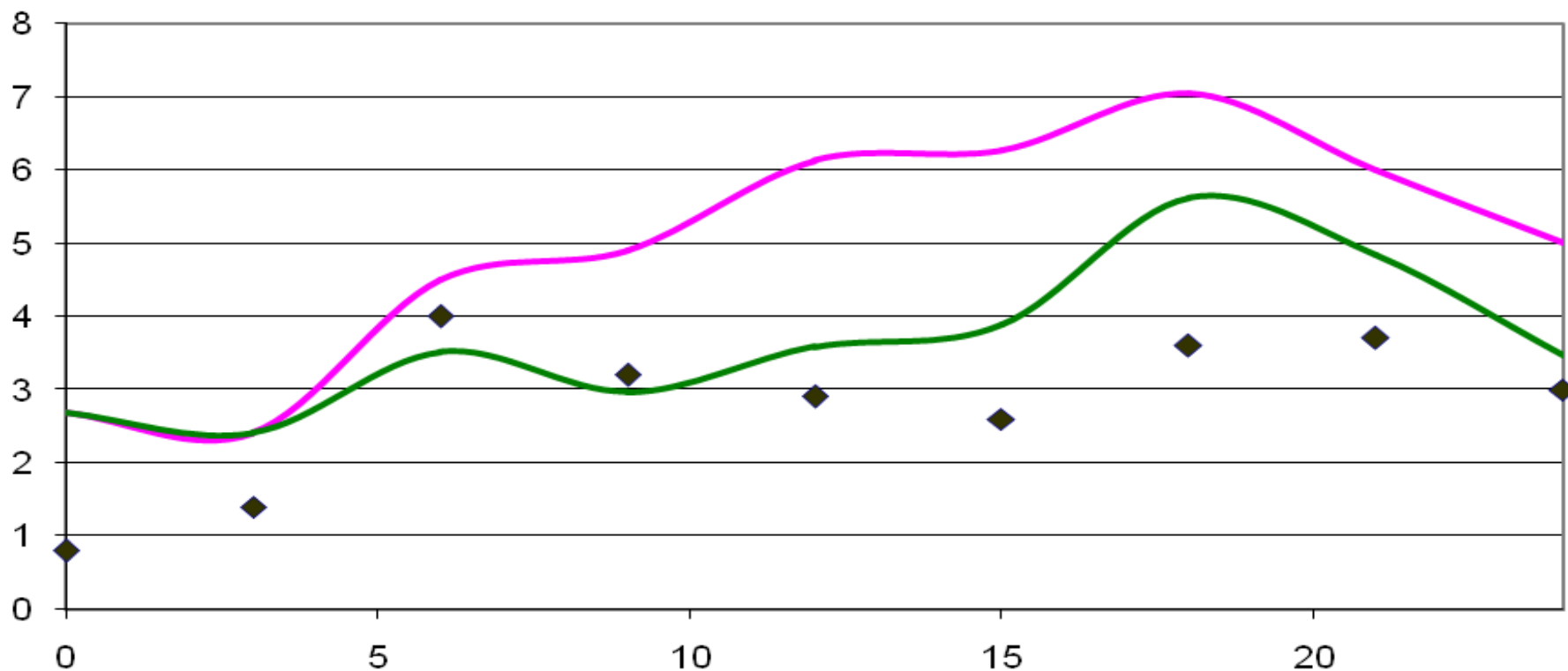
black diamonds - measurement,

pink – Dickenson's parameterization (reference),

green –Darcy equation with tortuosity correction factors.

Dew point temperature at 2 m. a.g.l. (18 V 2012, Elblag)

## dew point temperature



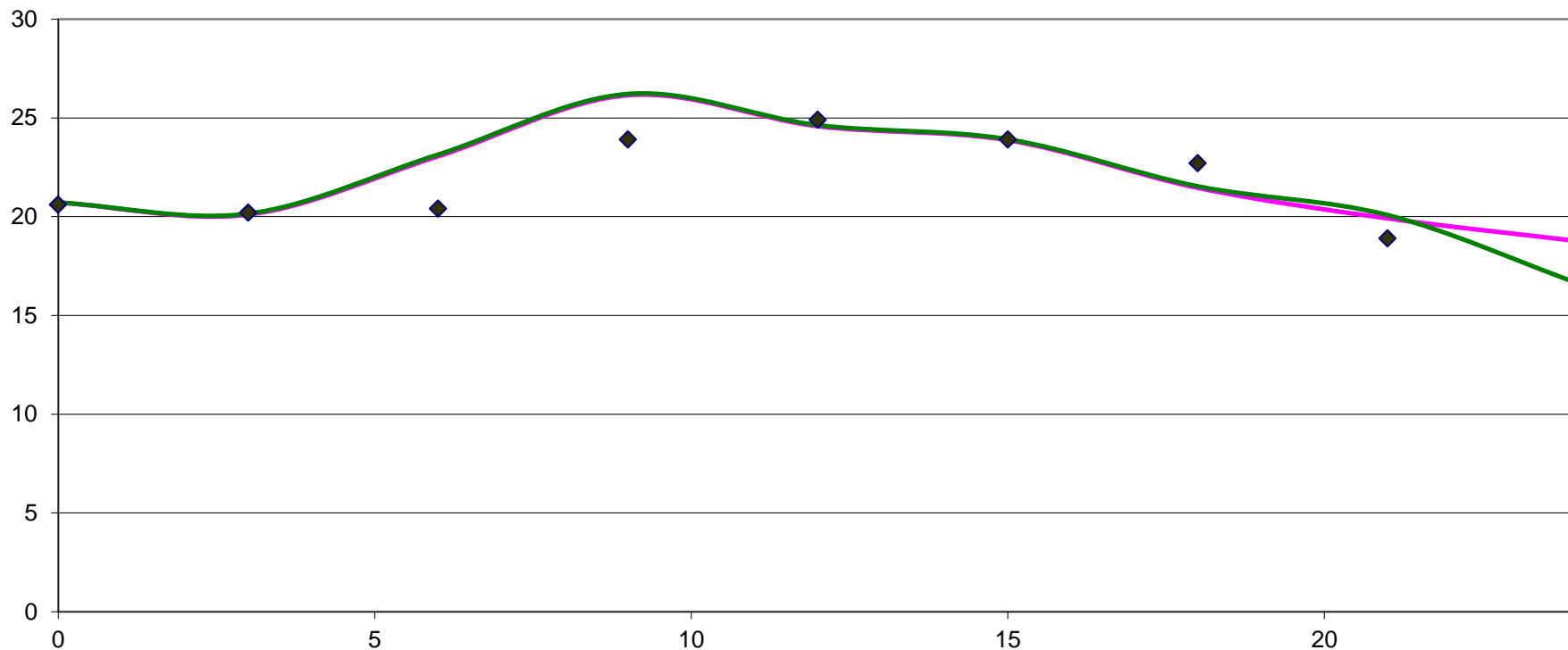
black diamonds - measurement,

pink – Dickenson's parameterization (reference),

green – Darcy equation with tortuosity correction factors.

Wind speed (18 V 2012, Elblag).

wind speed



black diamonds - measurement,

pink – Dickenson's parameterization (reference),

green –Darcy equation with tortuosity correction factors.

# Outline results

- The modified parameterization influences on:
  - a) profile of air temperature;
  - b) profile of dew point temperature;
  - c) profile of wind direction;
  - d) profile of specific water vapor content.
- Tortuosity effect influences on meteorological field.





# Thank you for your attention



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