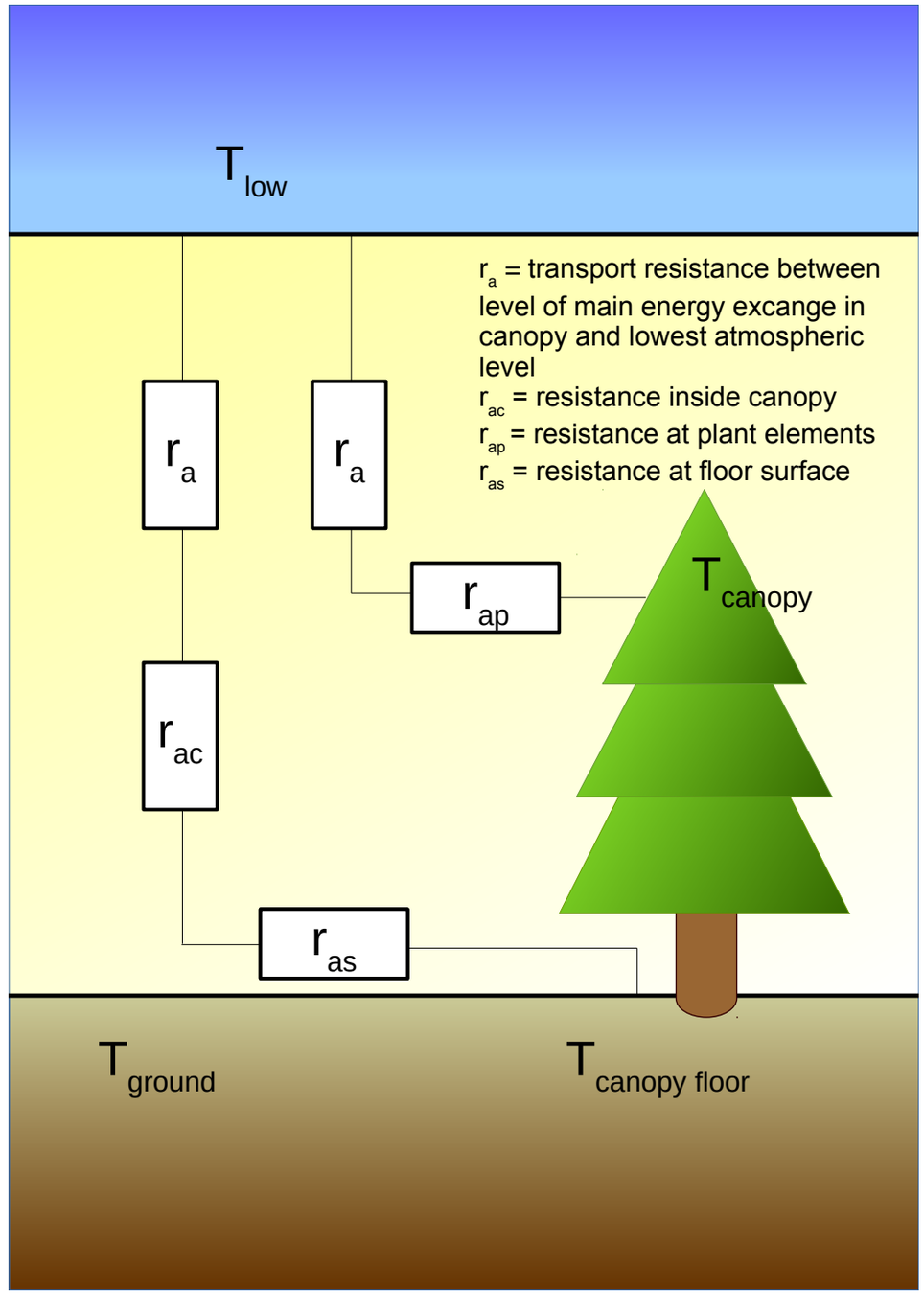
Possible Implementations to consider the vegetation temperature in the COSMO model

Canopy Scheme

- **resistance approach** from **AMBETI**-model (Braden 1995)
- **prognostic equation for canopy surface temperature** from a land-surface scheme of the Rossby Centre regional atmospheric climate model (**Samuelsson** et al. 2006)

$$\frac{\partial T_{canp}}{\partial t} = \frac{1}{C_{canp}} \left(R_{canp} + H_{canp} + L_{canp} \right)$$



implementation by Jürgen Helmert (DWD)

Canopy Scheme

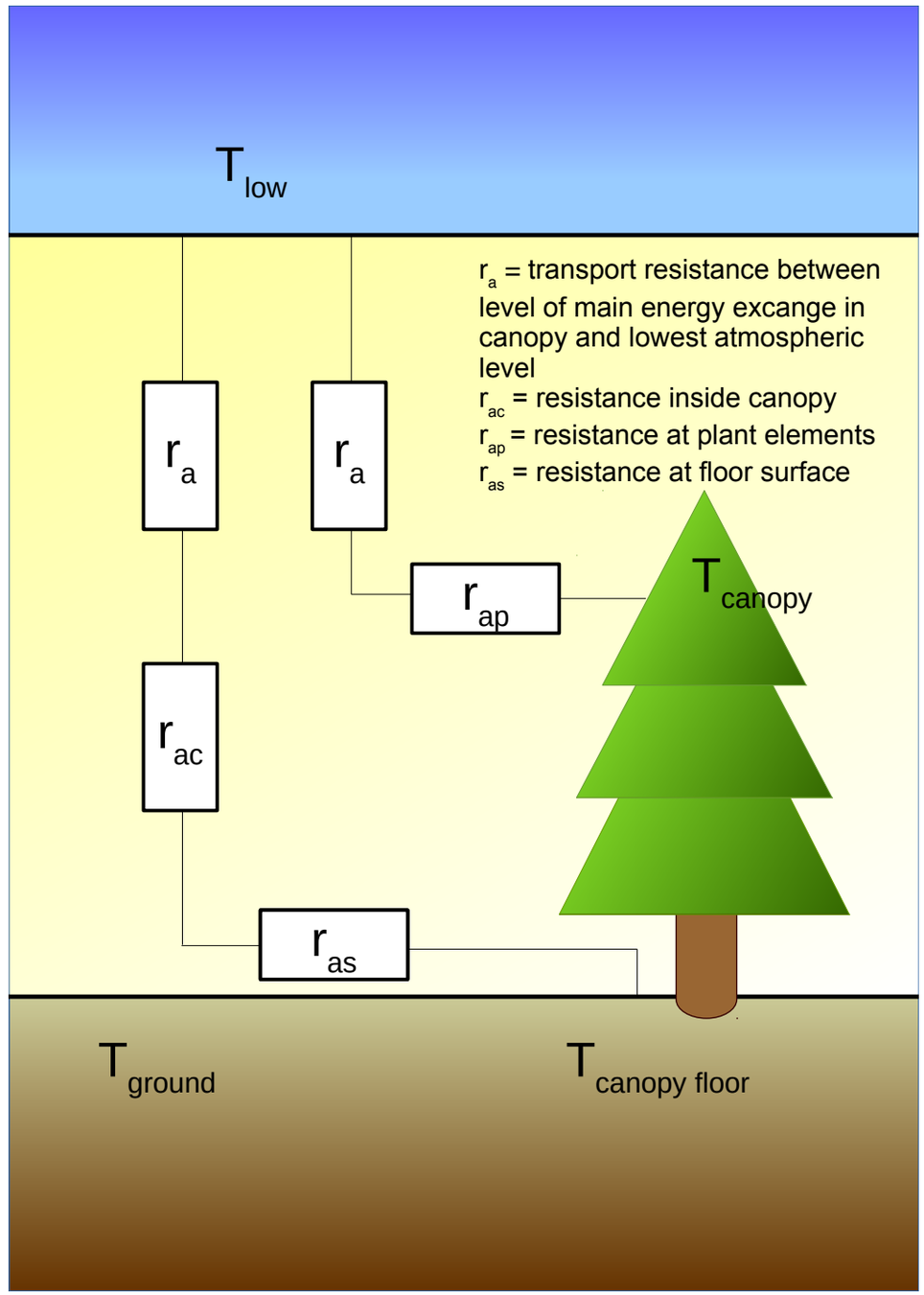
$$\frac{\partial T_{canp}}{\partial t} = \frac{1}{C_{canp}} \left(R_{canp} + H_{canp} + L_{canp} \right)$$

land surface temperature composite

$$T_{sk} = SVF \cdot T_{ground} + (1 - SVF)\, T_{canp}$$

Sky View Fraction

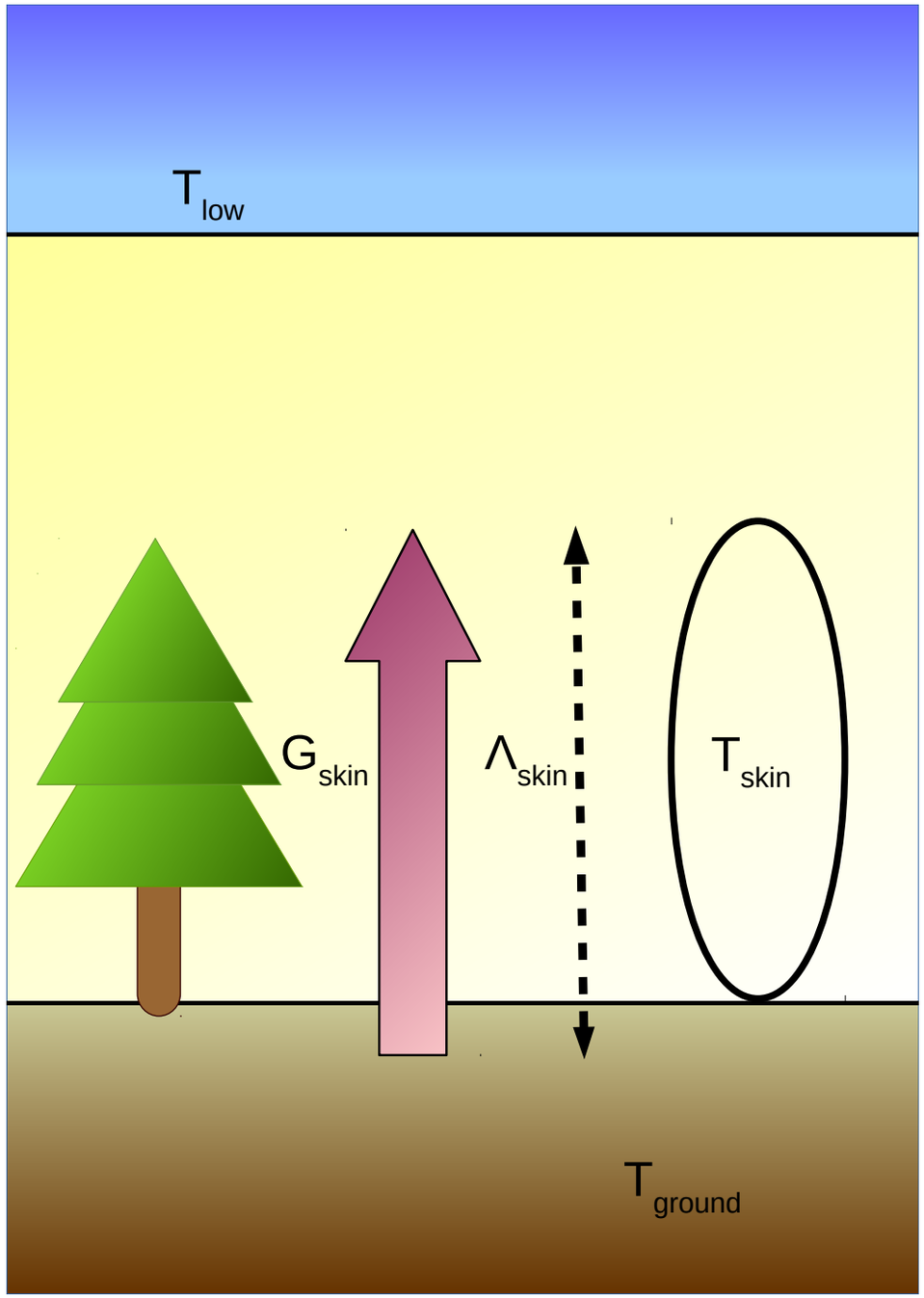
$$SVF = e^{-0.75 \cdot TAI}$$



implementation by Jürgen Helmert (DWD)

Skin Conductivity Scheme

- based on the representation of **skin temperature** in the ECMWF land surface model (**H-TESSEL**, Viterbo and Beljaars 1995; Verhoef and Vidale 2011)
- skin represents vegetation layer and top layer of the bare soil (no snow)



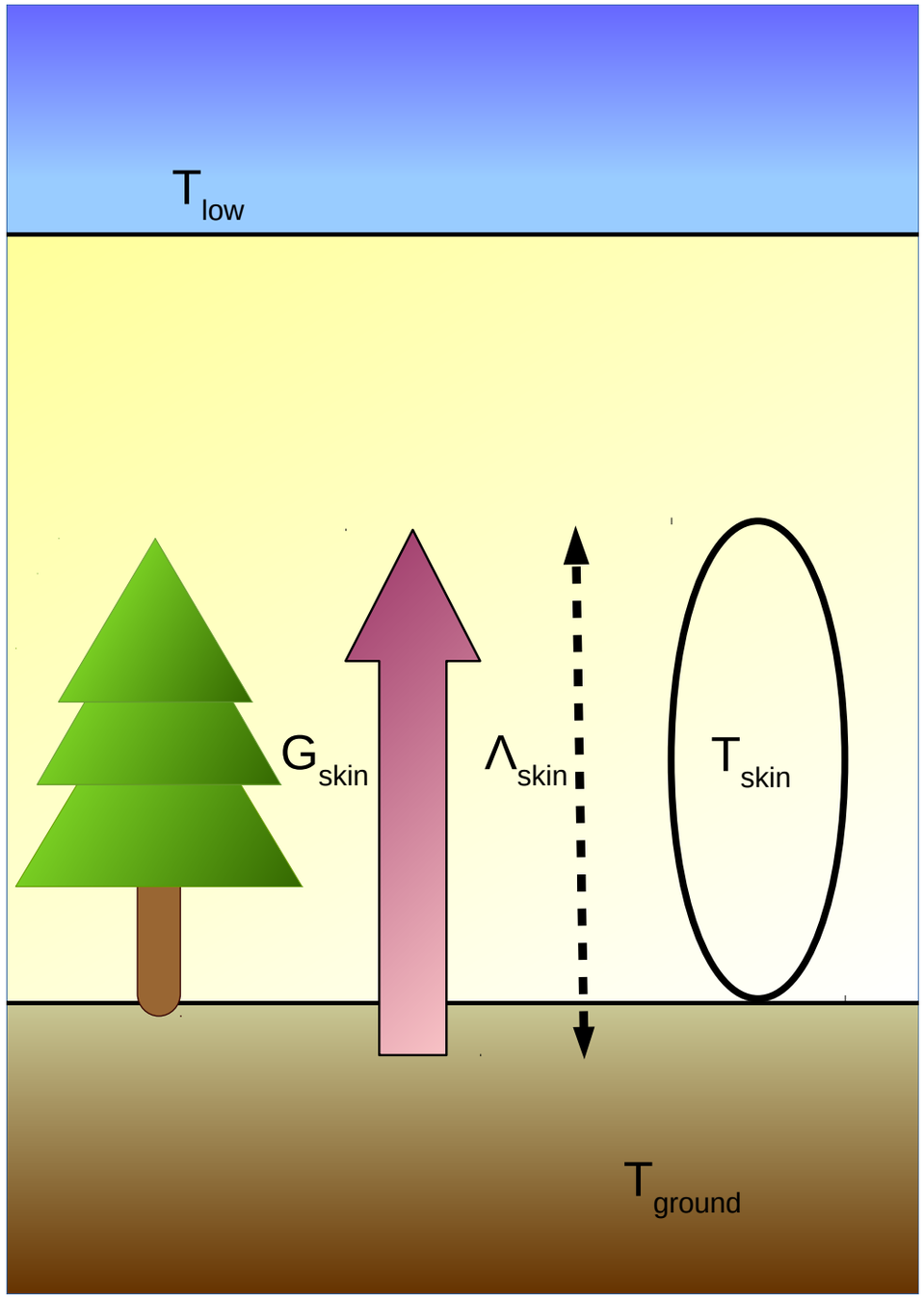
implementation by Jan-Peter Schulz (DWD)

Skin Conductivity Scheme

- uniform **skin conductivity Λ_{sk}** (based on Fourier's law) provides thermal connection between skin level and soil deck

$$G_{skin} = \Lambda_{skin}\left(T_{skin} - T_{ground}\right)$$

- COSMO/TERRA: uniform $\boldsymbol{\Lambda_{skin}}$ **= 10 W/Km²**
- H-TESSEL: $\boldsymbol{\Lambda_{skin}}$ depends on soil deck



implementation by Jan-Peter Schulz (DWD)

Model Setup

- atmospheric model: **COSMO-DE v5.04**
- soil model: **TERRA_ML**
  - horizontal grid: 421x461 (resolution ~ **2.8km**)
  - vertical grid: 50 atmosphere and 8 soil layers
  - boundary/initial conditions: COSMO-EU/COSMO-DE analyses
  - 24 hour forecasts

comparison by Christine Sgoff (HErZ, Universität Frankfurt)

Satellite Data

- land surface temperature (**LST**) retrieval is derived from SEVIRI/MSG and provided by LANDSAF

- **LST** product is available every **15 minutes**

- disk centered at 0° longitude with spatial resolution of **3km** at sub satellite point

- derived by split-window algorithm (uses MSG IR10.8 and MSG IR12.0)

comparison by Christine Sgoff (HErZ, Universität Frankfurt)

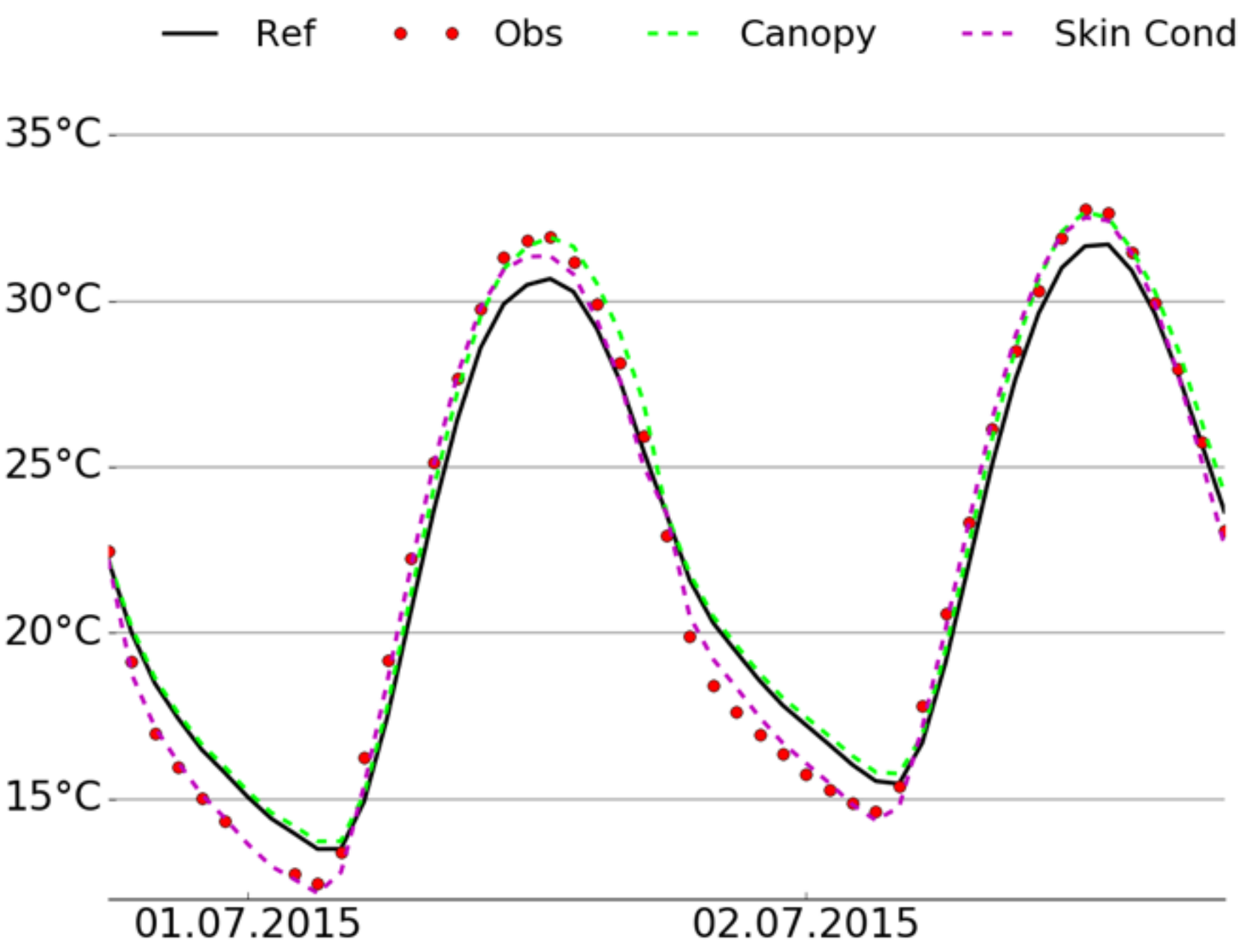
Cloud Mask

- **SATELLITE**: includes only cloud-free pixels with cloud mask provided by NWC (NoWCasting) SAF

- **MODEL**: includes all areas where the model simulates a total cloud cover lower than 10%

comparison by Christine Sgoff (HErZ, Universität Frankfurt)

Comparison



averaged T_{skin} = T_G over whole COSMO-DE domain (only cloud free pixels)

Ref: COSMO-DE run
Obs: satellite retrieval
Canopy: COSMO-DE run with canopy scheme
Skin Cond.: COSMO-DE run with skin conductivity scheme

comparison by Christine Sgoff (HErZ, Universität Frankfurt)

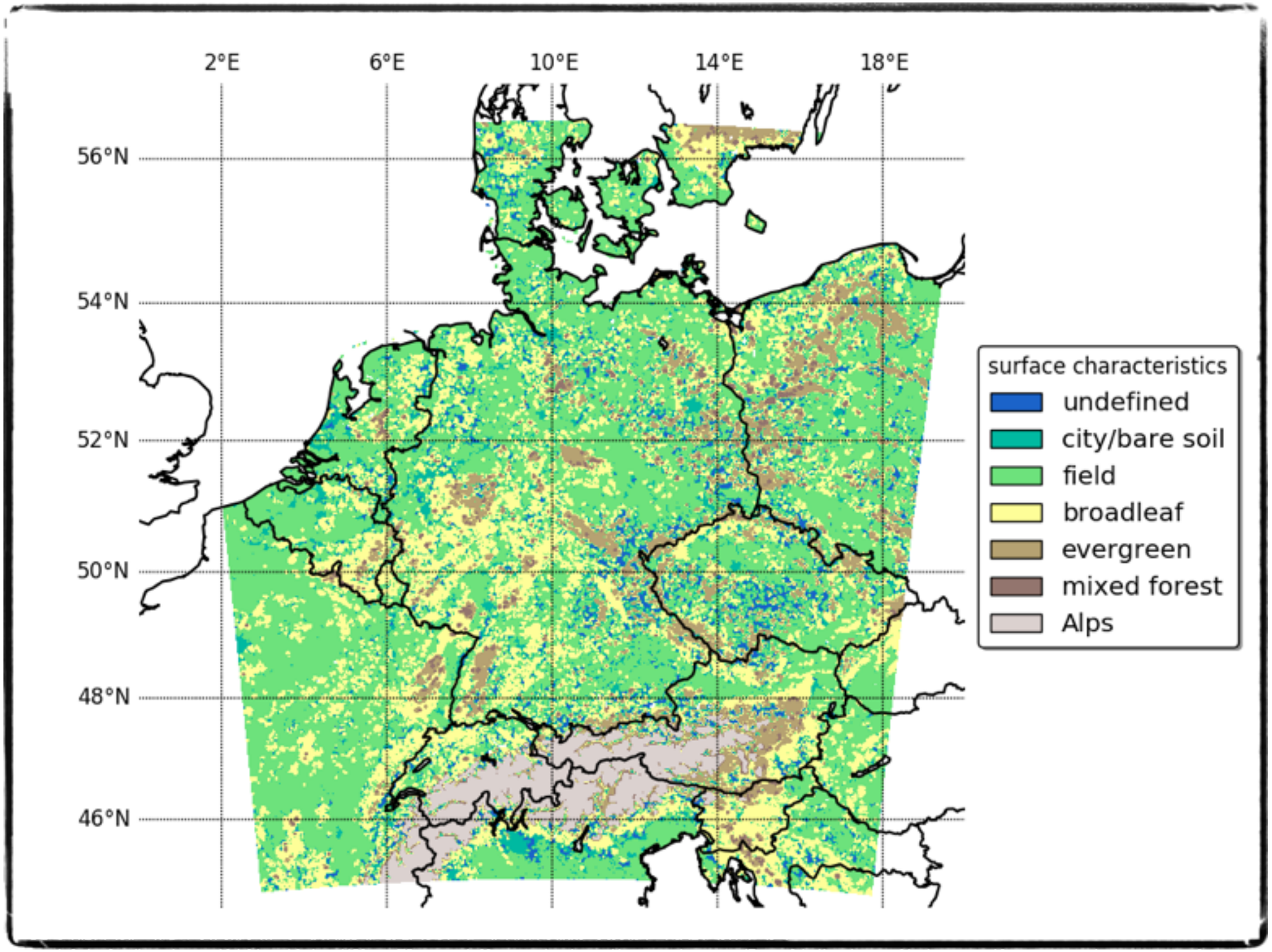
Surface Characteristics

No.	Surface	Characteristic parameters
1	undefined	———
2	city/bare soil	z0 ≤ 1.5m and plcov ≤ 0.6
3	fields	z0 ≤ 0.2m and 0.2m ≤ rootdp ≤ 1m
4	broadleaf forest	for_d ≥ 0.4
5	evergreen forest	for_e ≥ 0.4
6	mixed forest	for_d ≥ 0.4 and for_e ≥ 0.4
7	Alps	rootdp ≤ 0.2 m

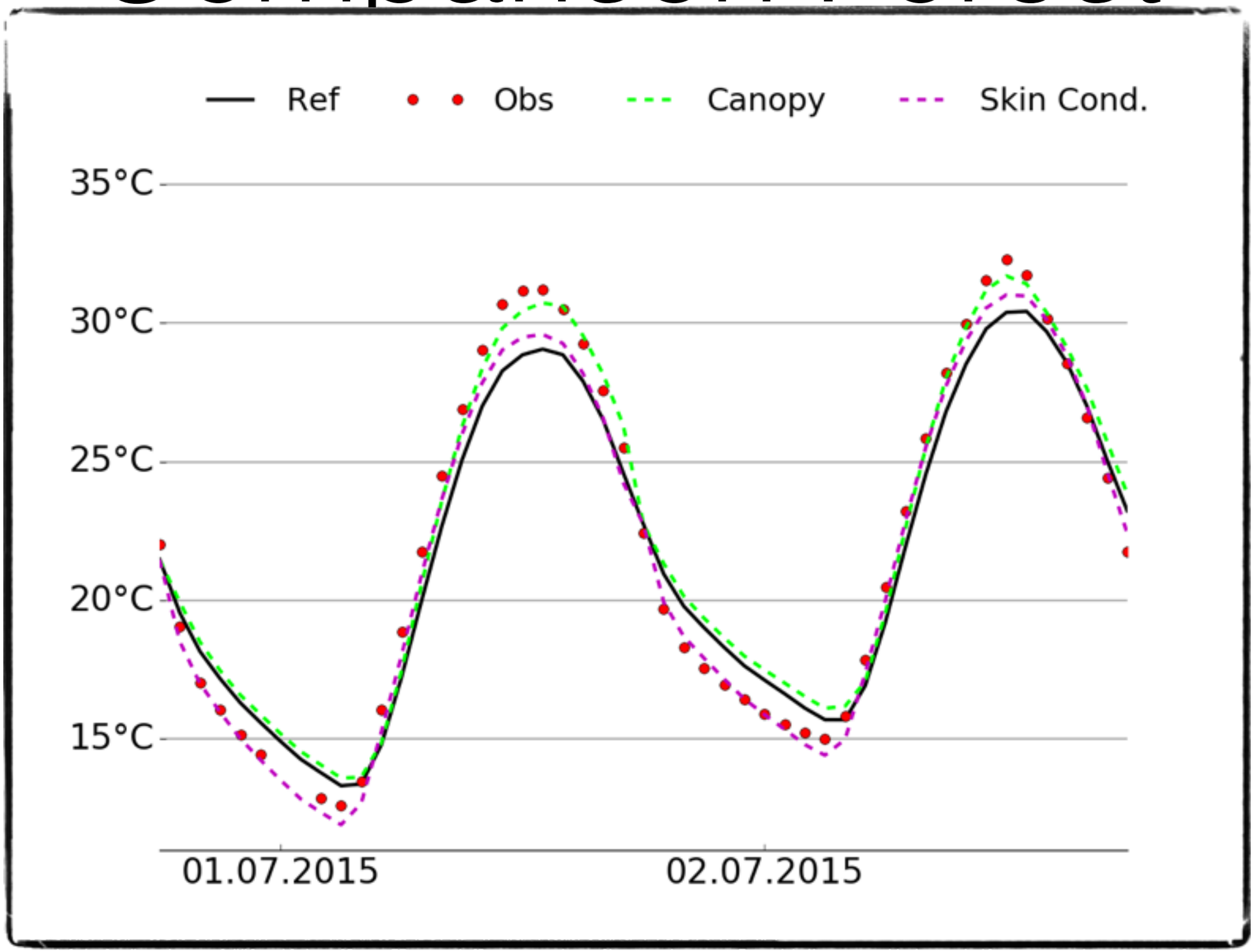
forest

- surface characteristics are mainly based on the definitions of the GlobeCover-data set

Surface Characteristics



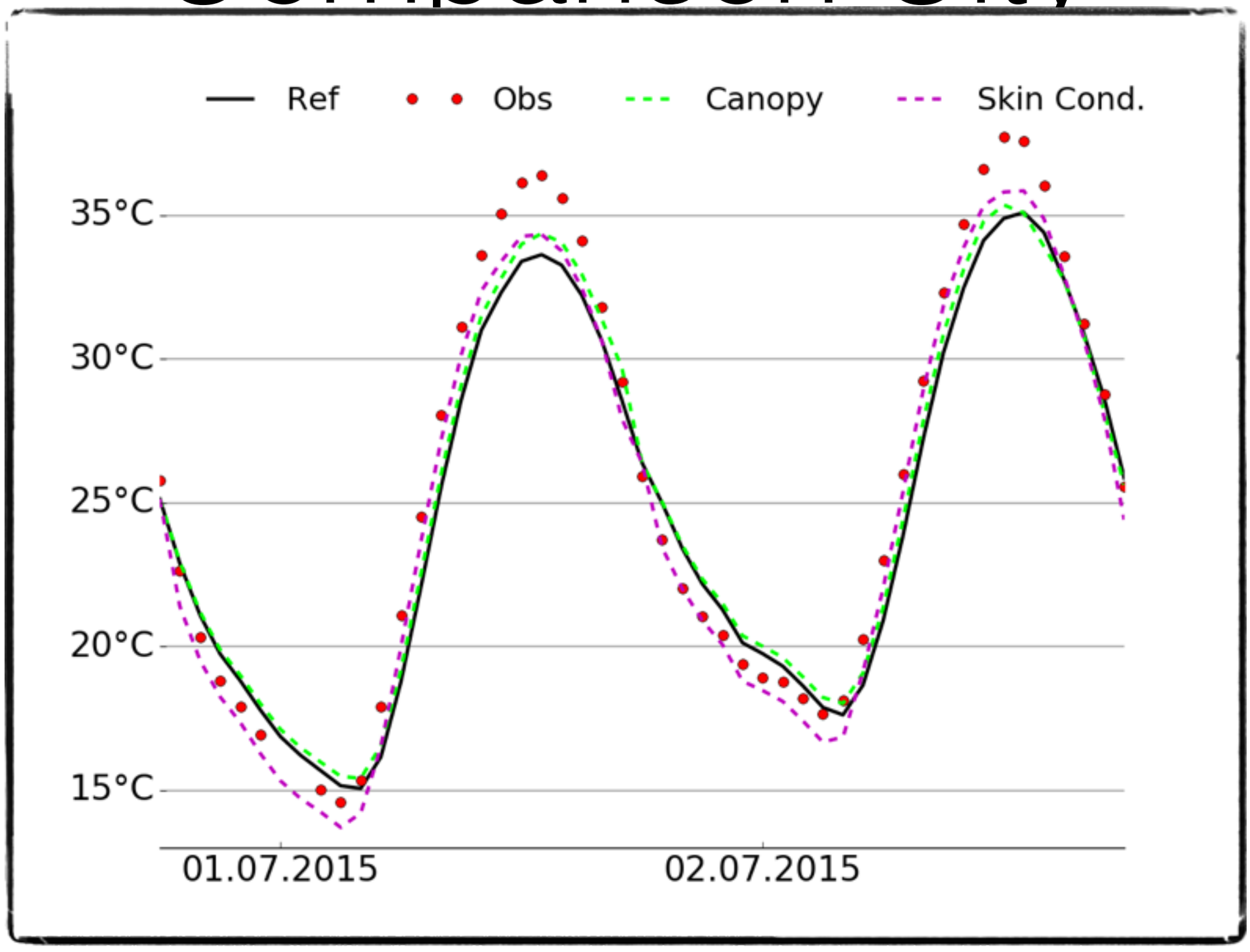
Comparison Forest



Hans-Ertel-Zentrum
für Wetterforschung

GOETHE UNIVERSITÄT
FRANKFURT AM MAIN

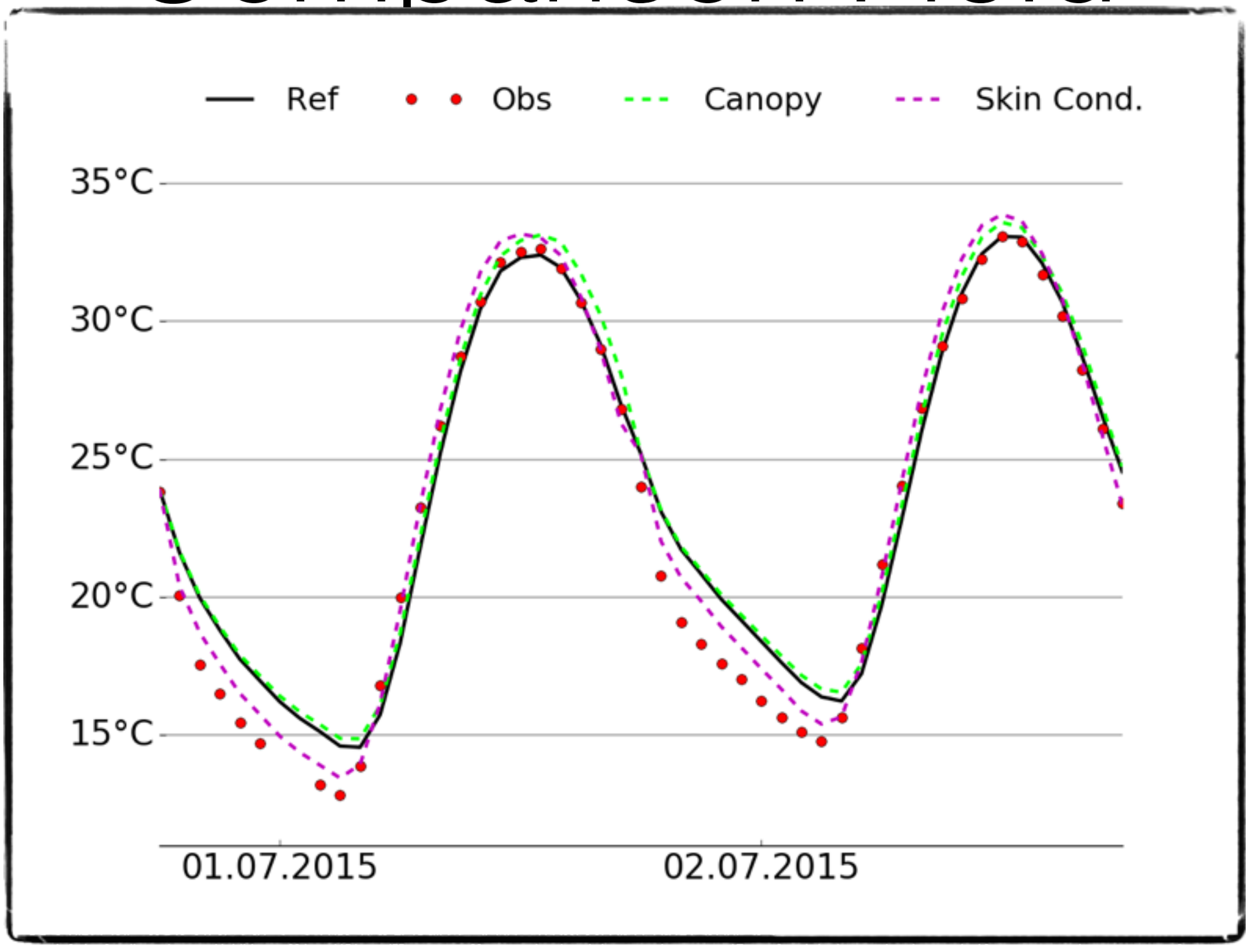
Comparison City



Hans-Ertel-Zentrum
für Wetterforschung

GOETHE UNIVERSITÄT
FRANKFURT AM MAIN

Comparison Field



Comparison Alps