
TherMap
Thermal Maps
Use of Topographic Radar Scans to
Identify Thermal Hotspots in Alpine Areas

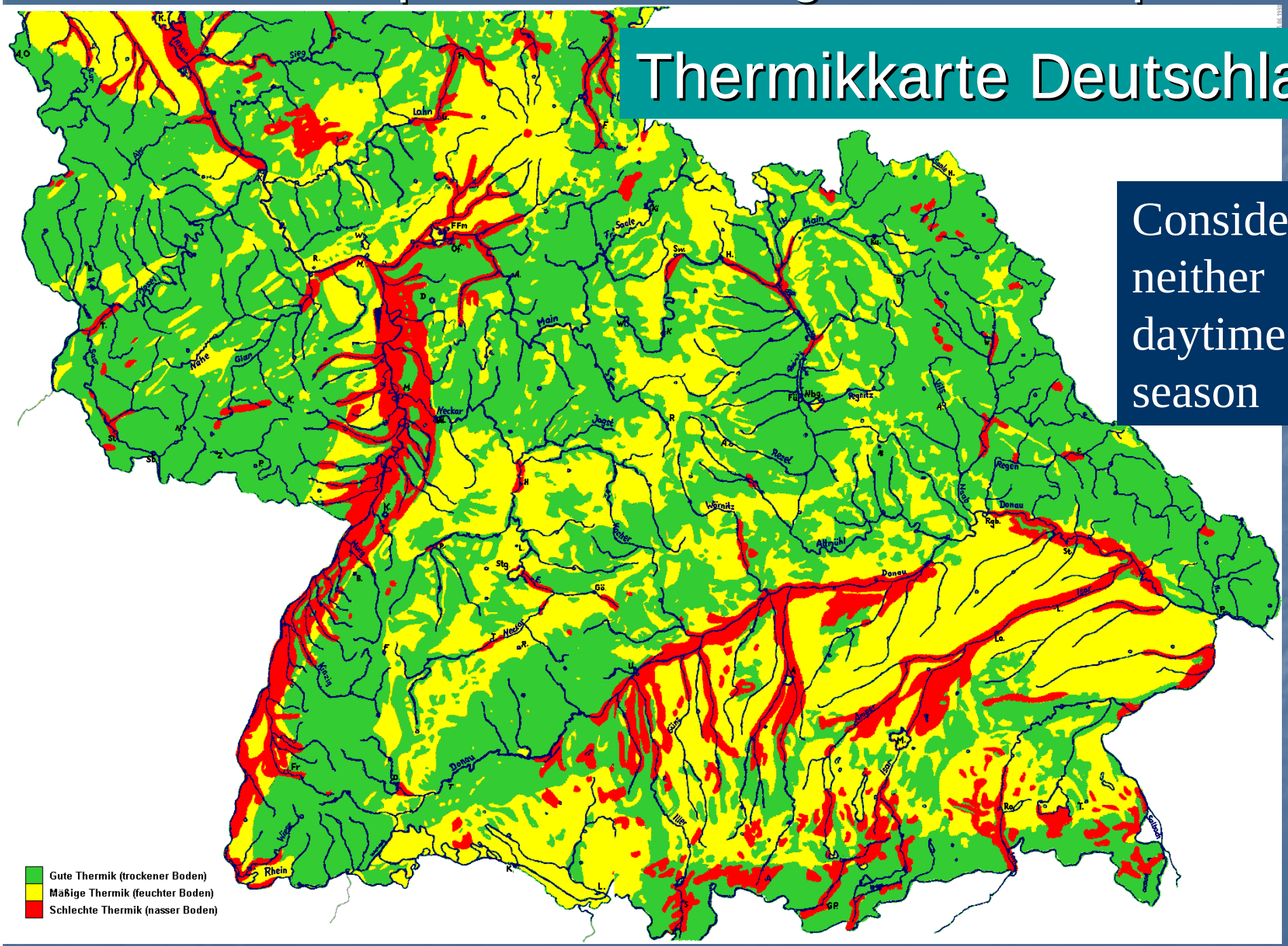
Contents

- History and present state of thermal maps
- The TherMap approach
  - Topography – Irradiance – Temperature
  - Thermal Take-Off Spots
- Model validation
- Conclusions

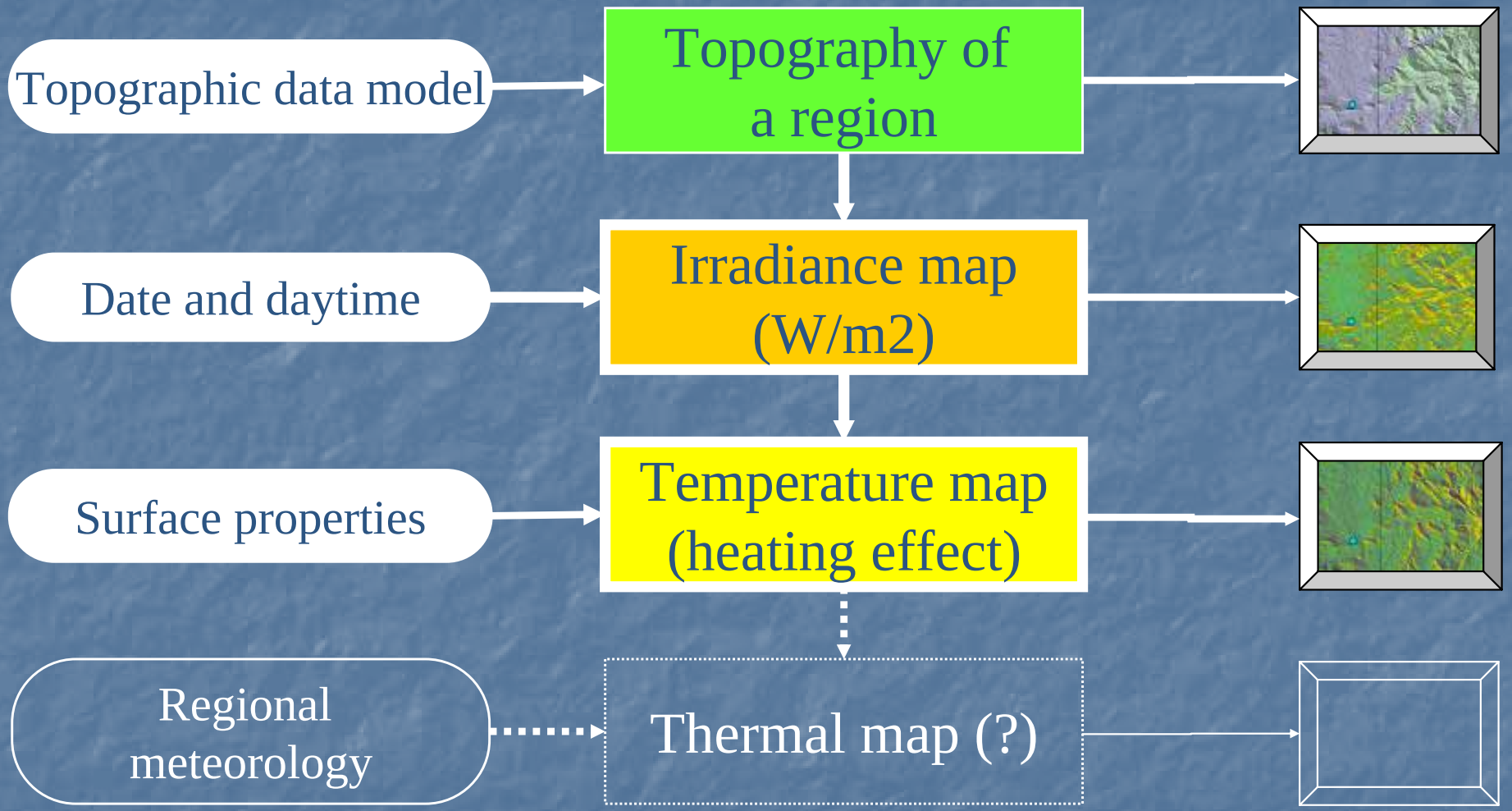
“Flashlight Analogy” of 1955

Hans Nietlisbach

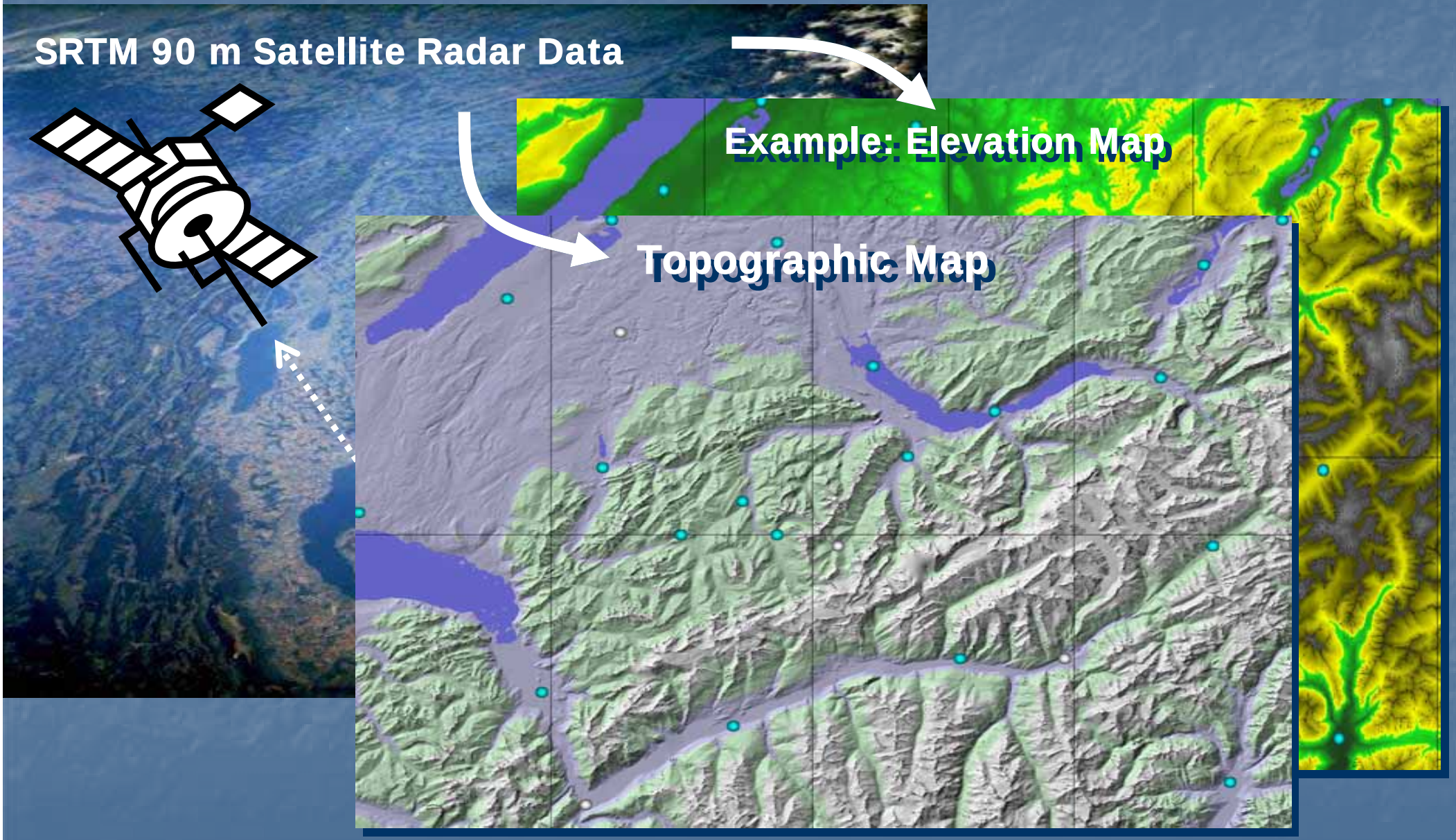
Example of an Existing Thermal Map



Topographic Approach by **TherMap**



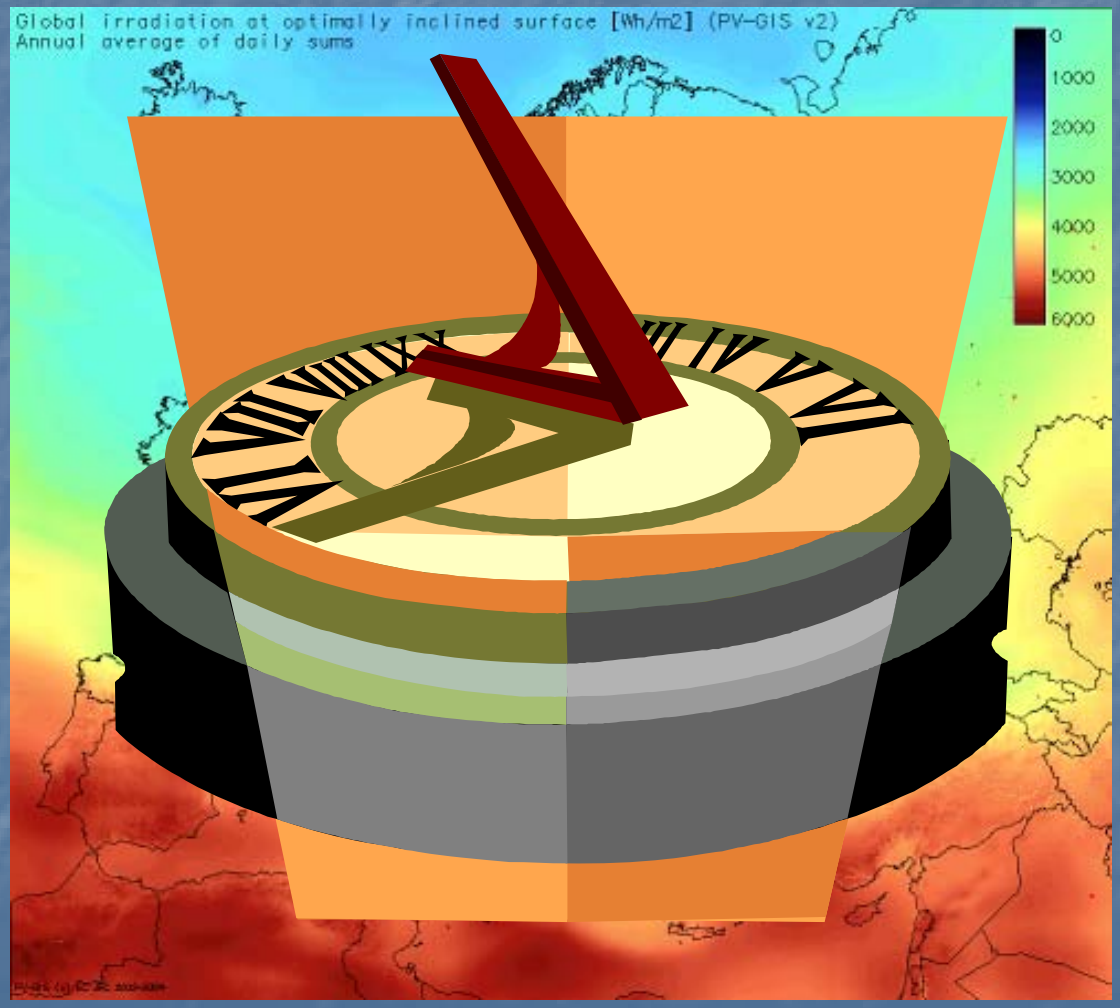
A. Topography



B. Irradiance

The intensity of solar radiation (W/m2)

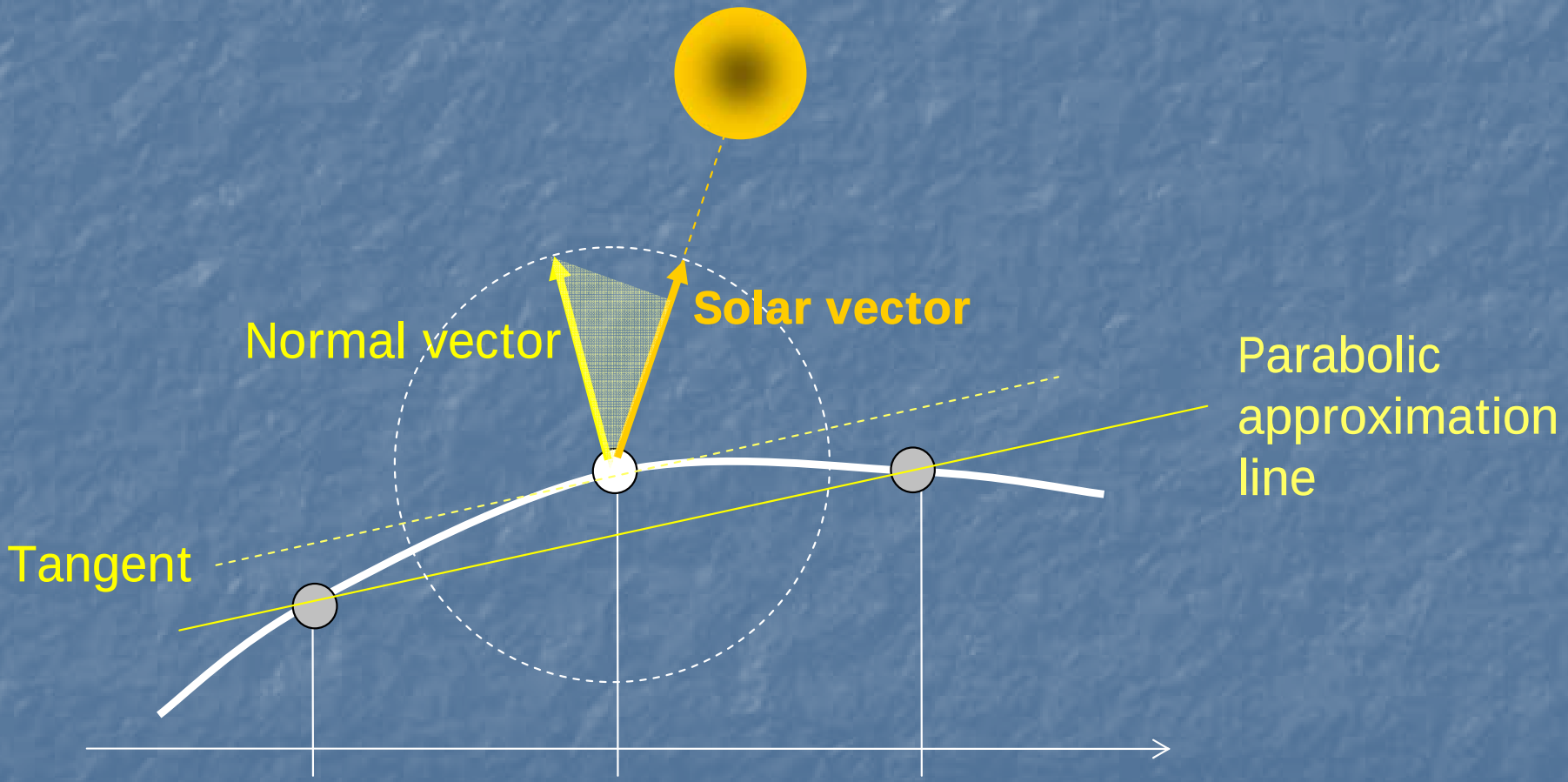
- at a given location,
- date and time



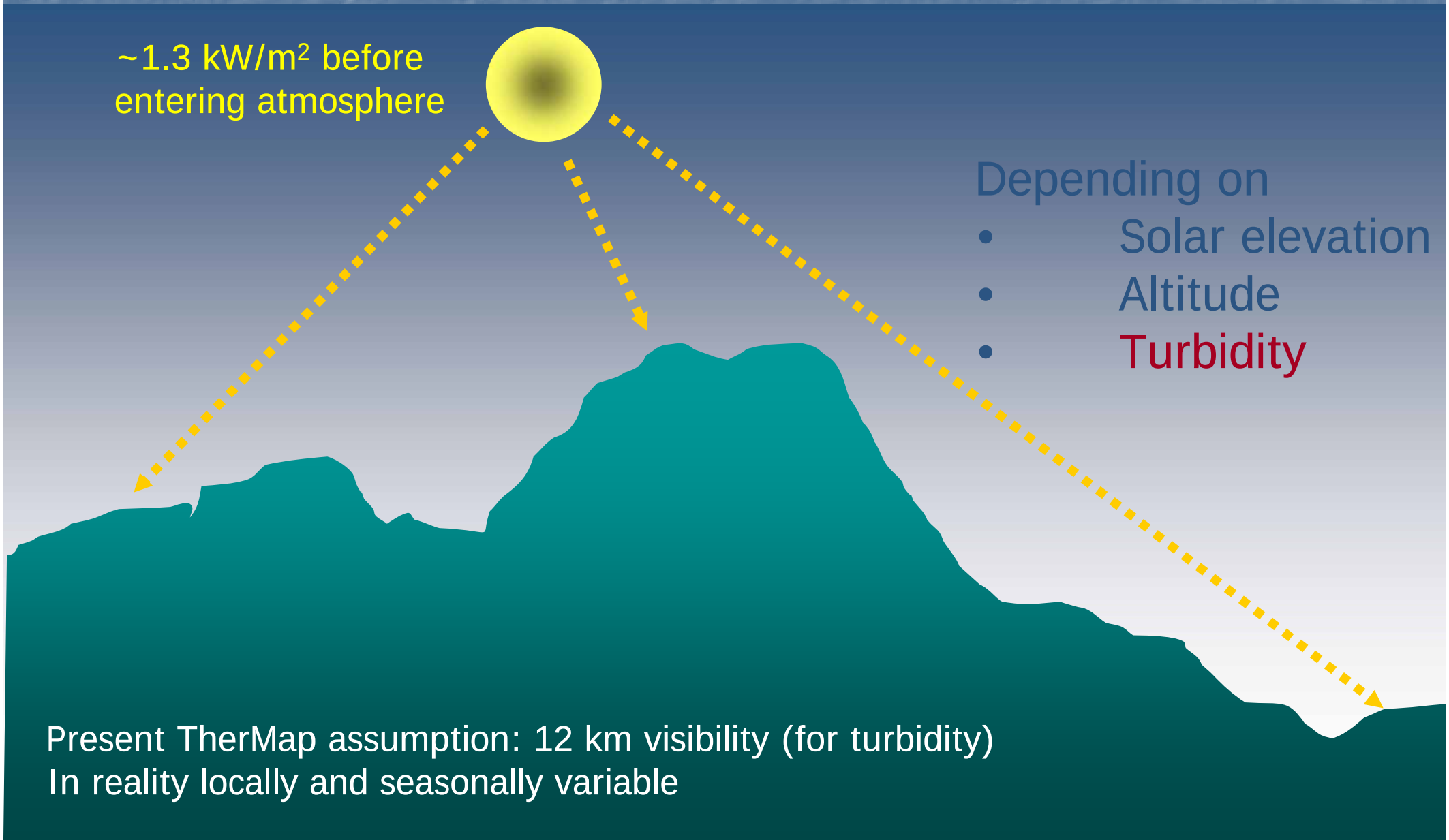
PVGIS © European Communities, 2002-2006
Šúri M., Huld T.A., Dunlop E.D. (2005). PVGIS: a web-based solar radiation database for the calculation of PV potential in Europe.

International Journal of Sustainable Energy, 24, 2, 55-67.

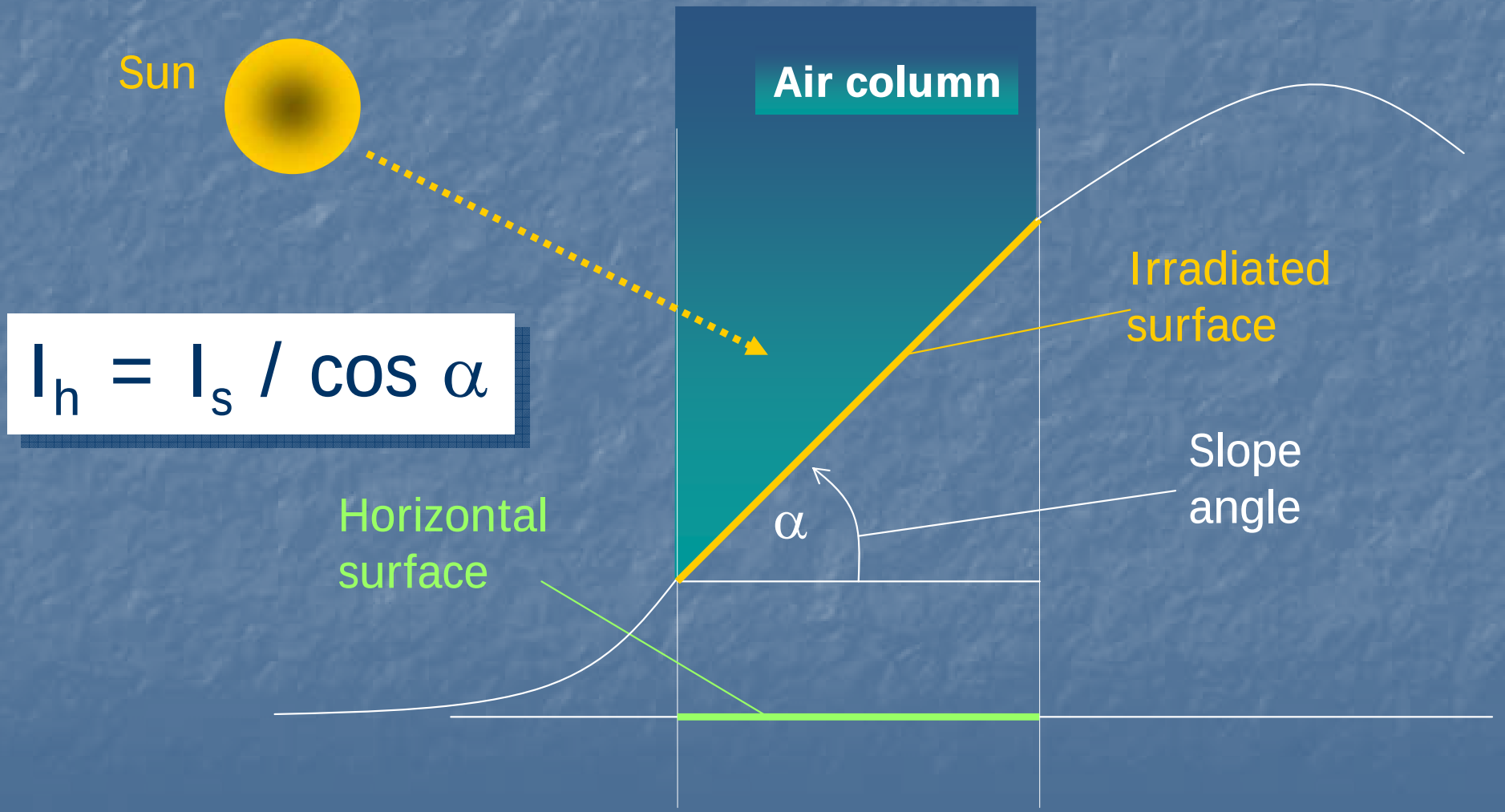
(1) Basic **Irradiance** = Projection of solar vector on normal vector



(2) Irradiance is diminished as light penetrates the atmosphere

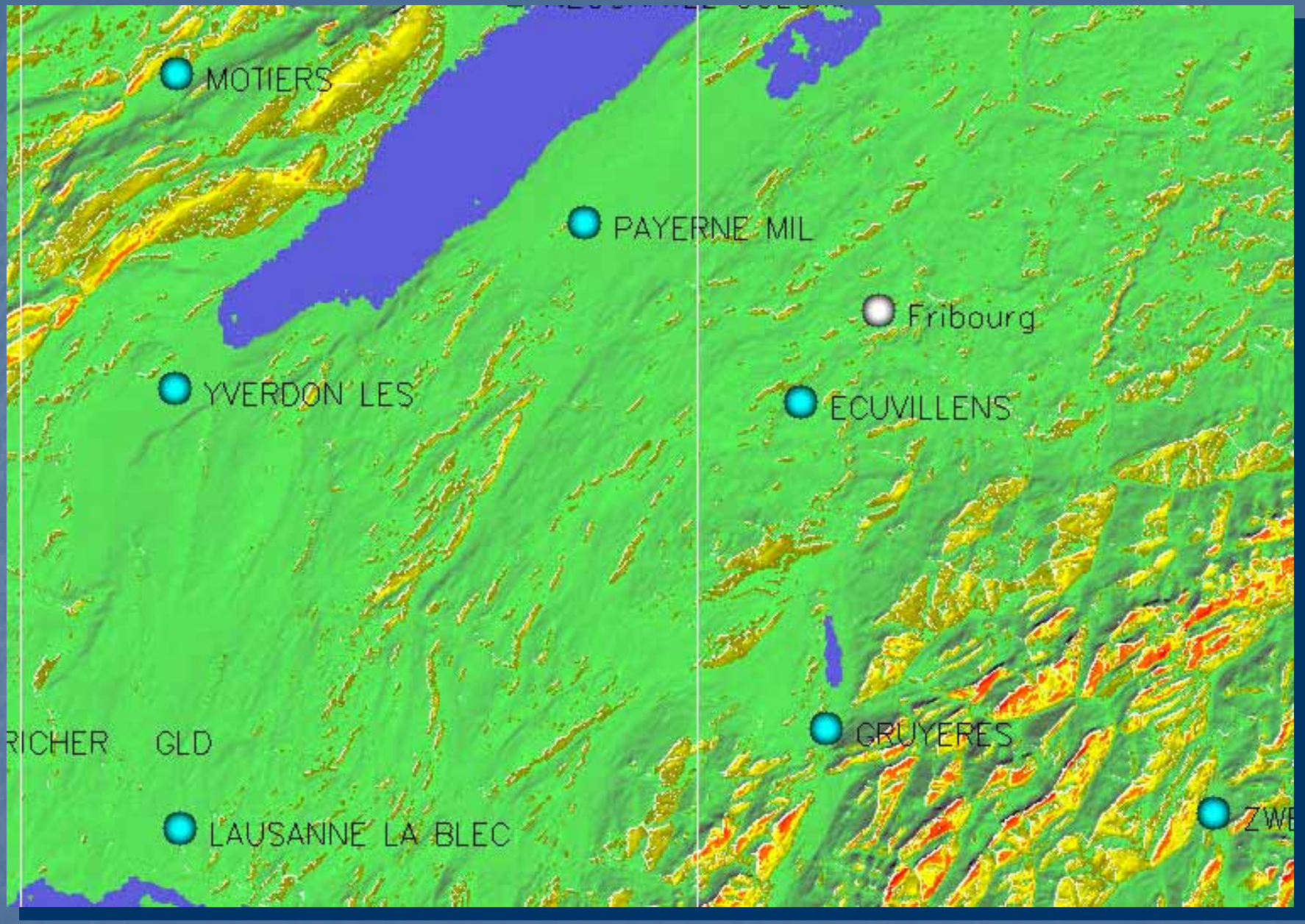


(3) Irradiance per air column is scaled by the slope of the surface (solar pannel)



$$I_h = I_s / \cos \alpha$$

Example: **Irradiance**, Jura-Gruyères/CH, May 6, 1100 MEZ



C. Temperature

Temperature increase due to cumulative effect of solar irradiation minus radiation losses

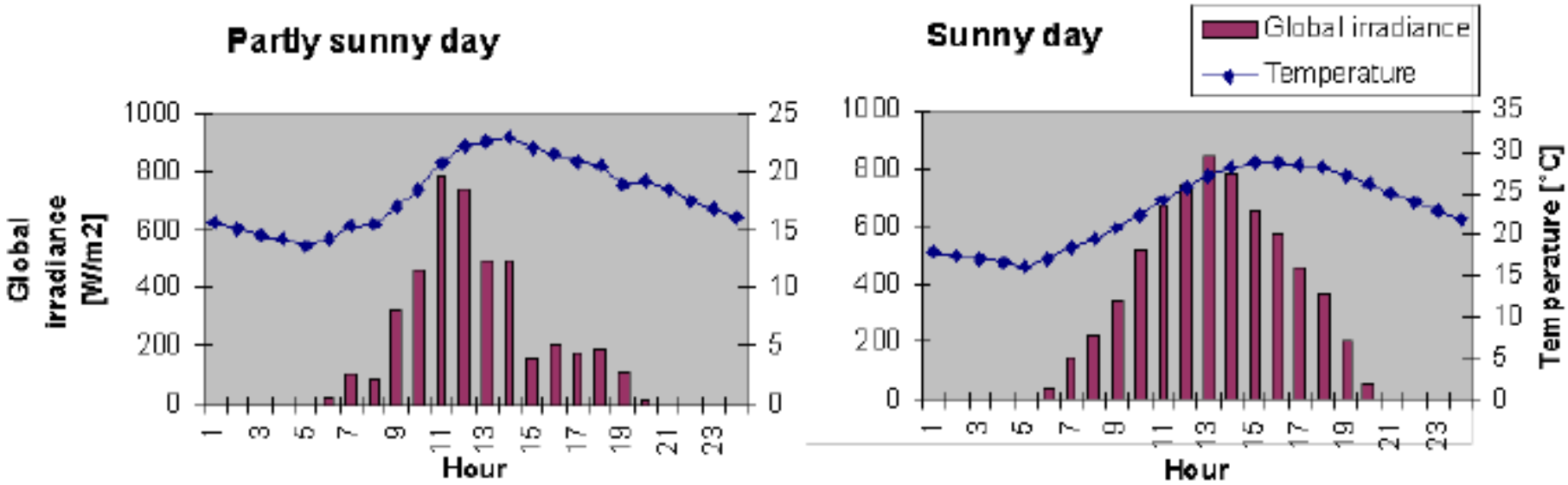
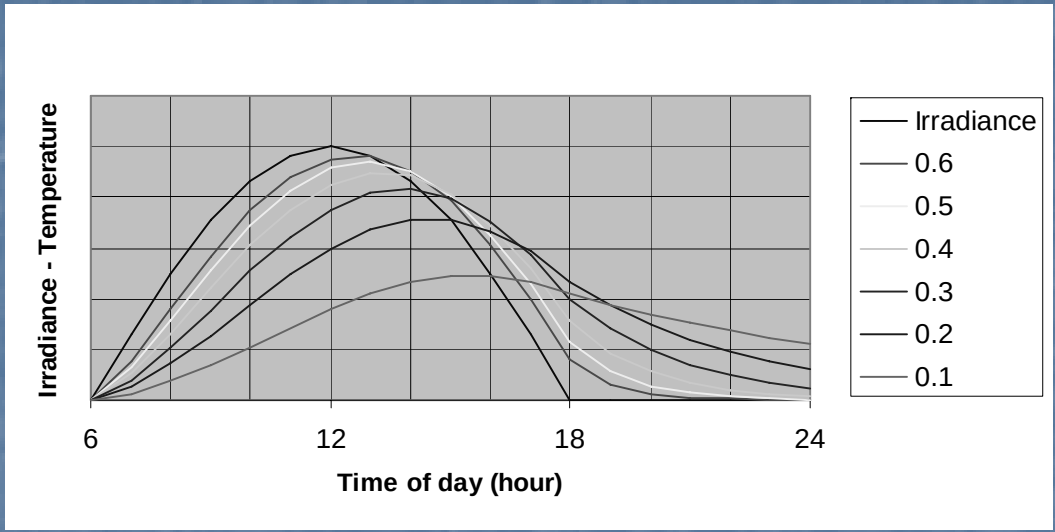


Fig. 7.1.11: Example of hourly values of temperature and global irradiance for 2 different types of days (partly sunny, sunny) for **Locarno-Magadino** CH.

Solar Engineering Handbook Part 2, "Temperature Theory", ed. 2003, Meteonorm, http://www.meteotest.ch/en/mn_dl?w=ber

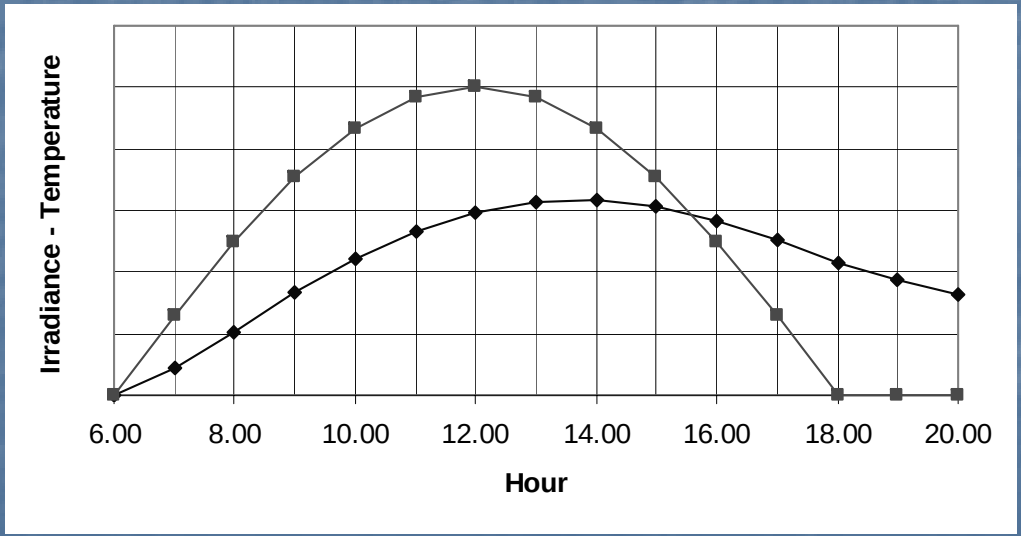
On a sunny day the **Temperature** is peaking about 2 hours after the **Irradiance** peak

Temperature: Approximation by a time-phased smoothing model



Smoothing model with smoothing factor

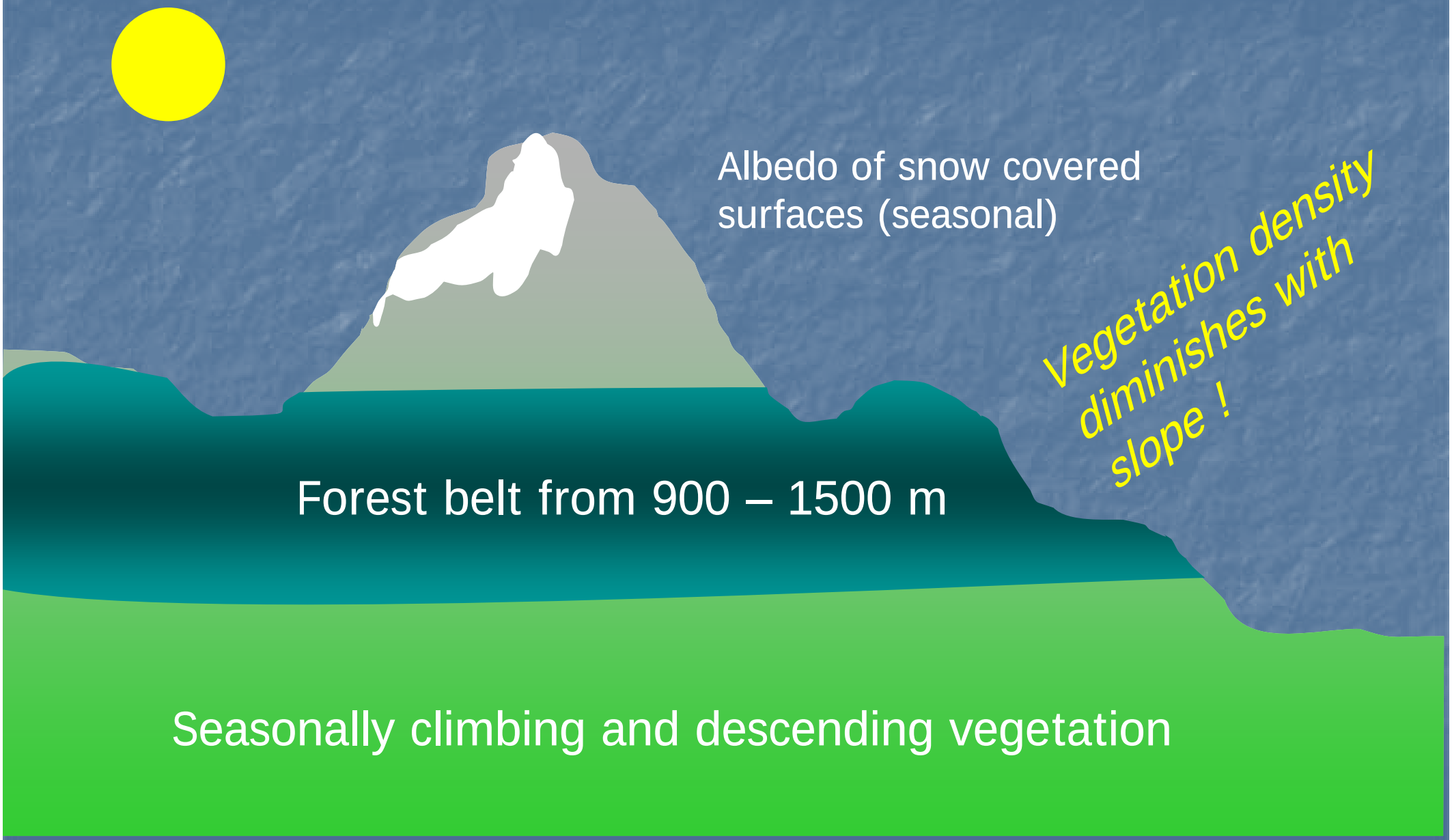
a = 0.1 to 0.6



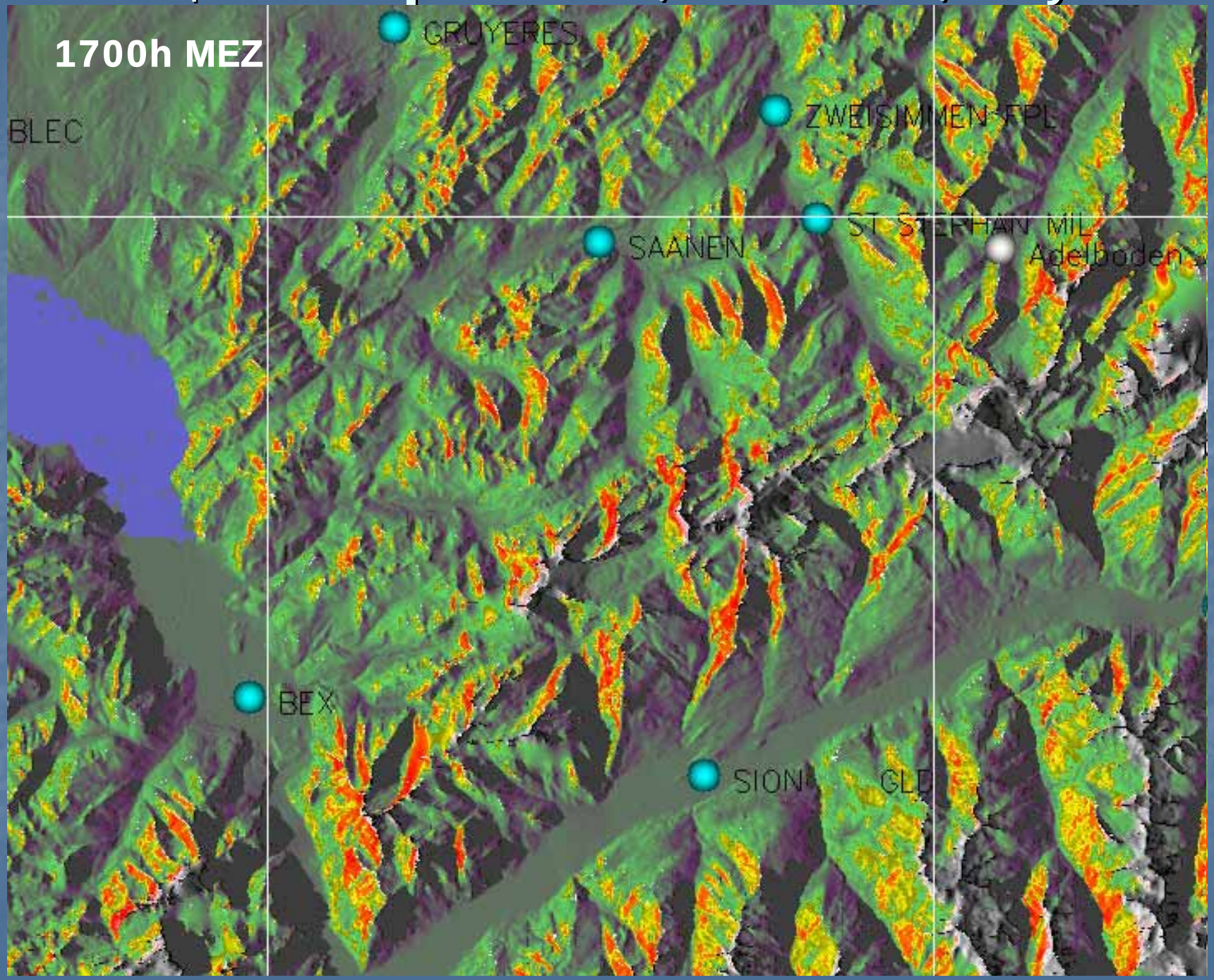
Present best fit: Smoothing model with time-phased smoothing factor

$a = 0.2 \times 0.9^{(hr-12)}$

Effects diminishing **Temperature** increase

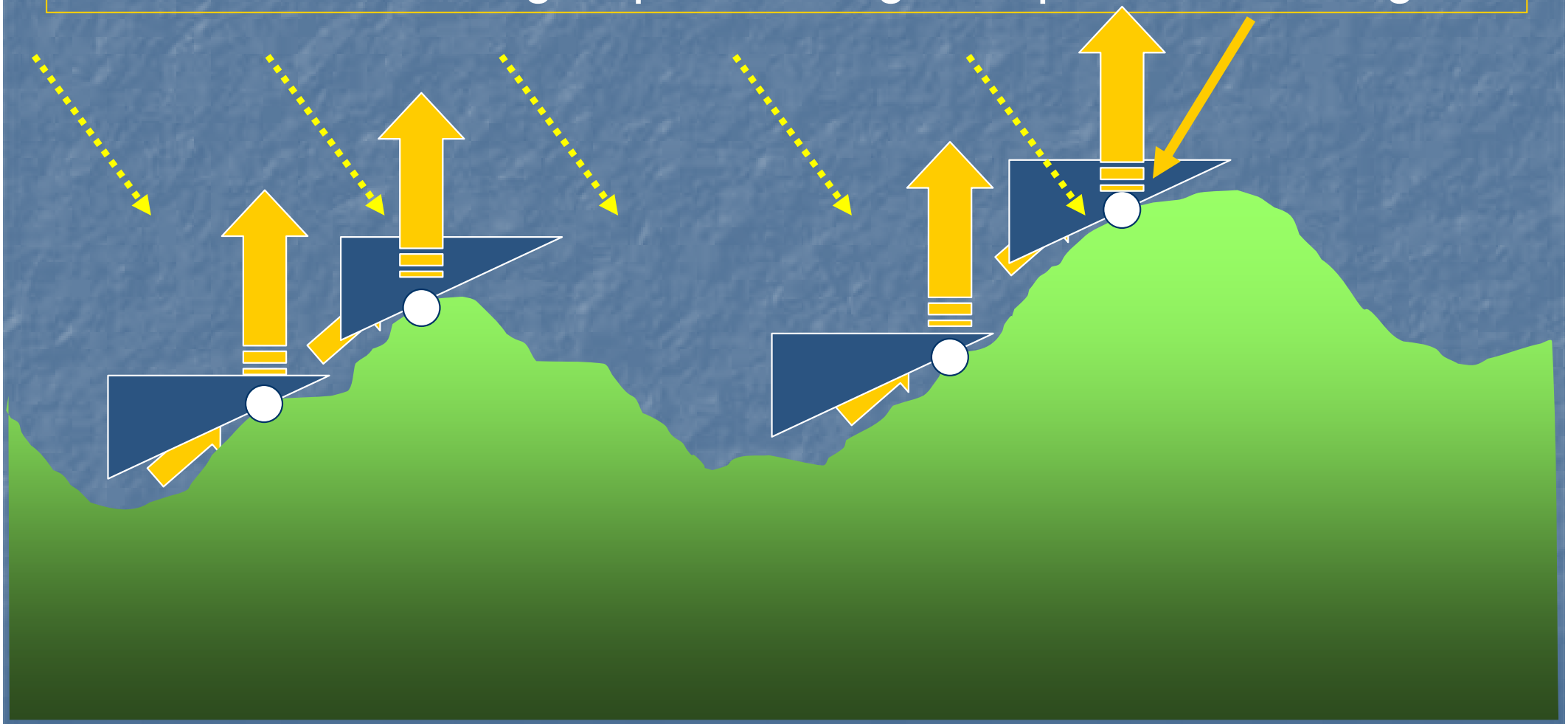


Example: **Temperature**, Valais/CH, May 6th

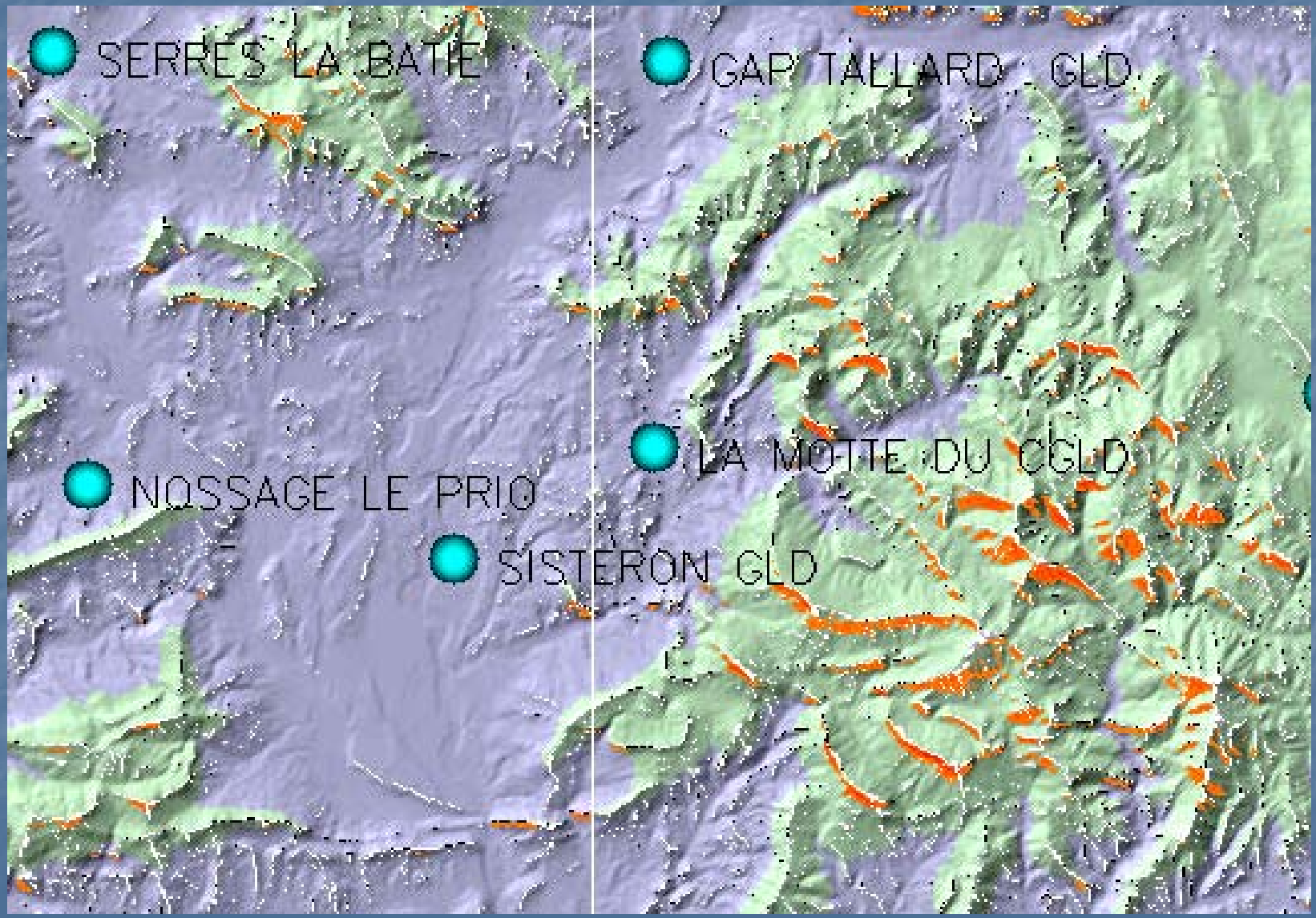


Thermal **Take-Off Spots**
(von Kalckreuth's rule)

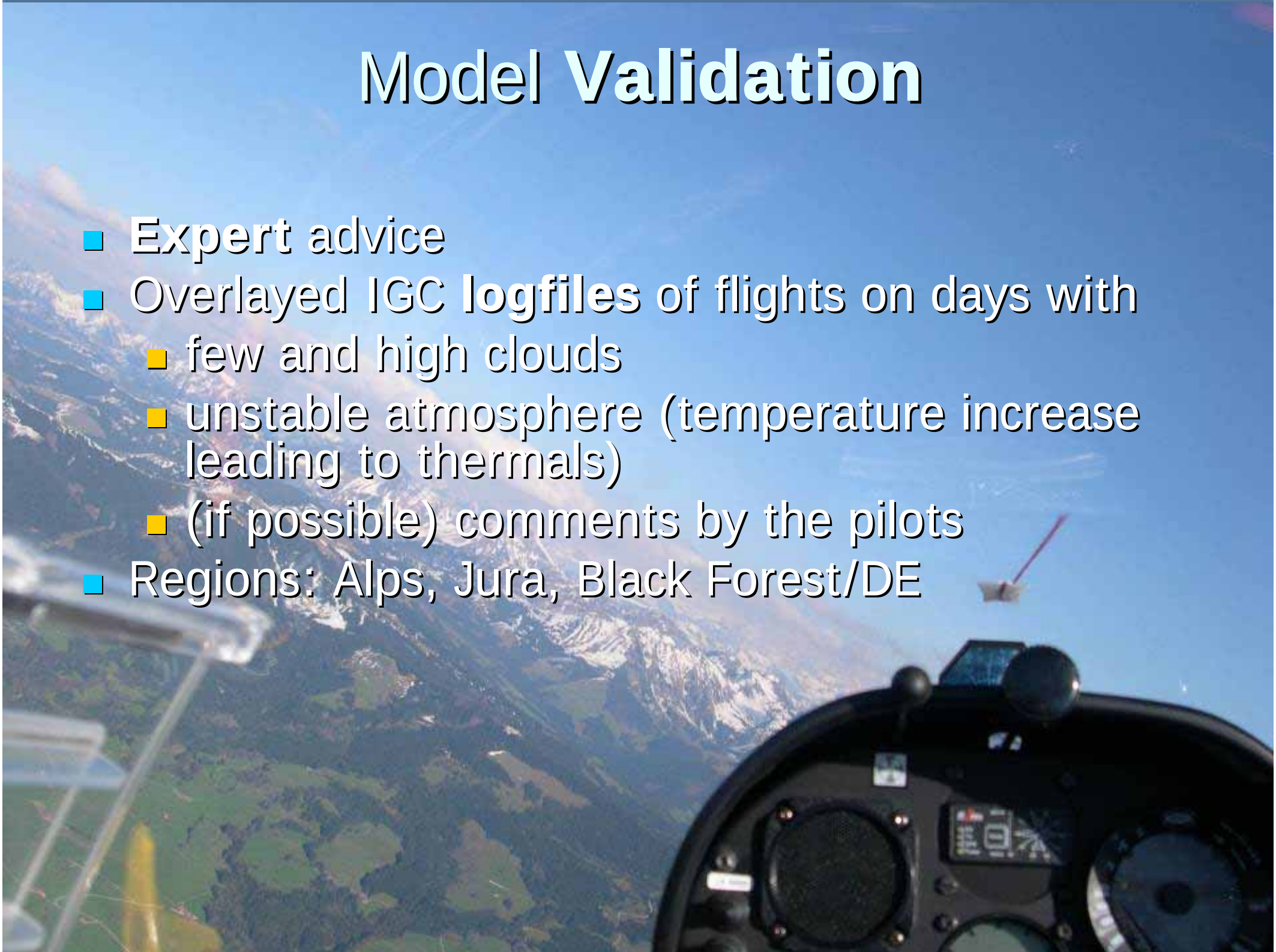
Thermals climb along slope until angle drops below 30 degrees



Example: **Take-Off Spots** on Overlay Temperature Map (Sisteron May 6, 1300 MEZ)

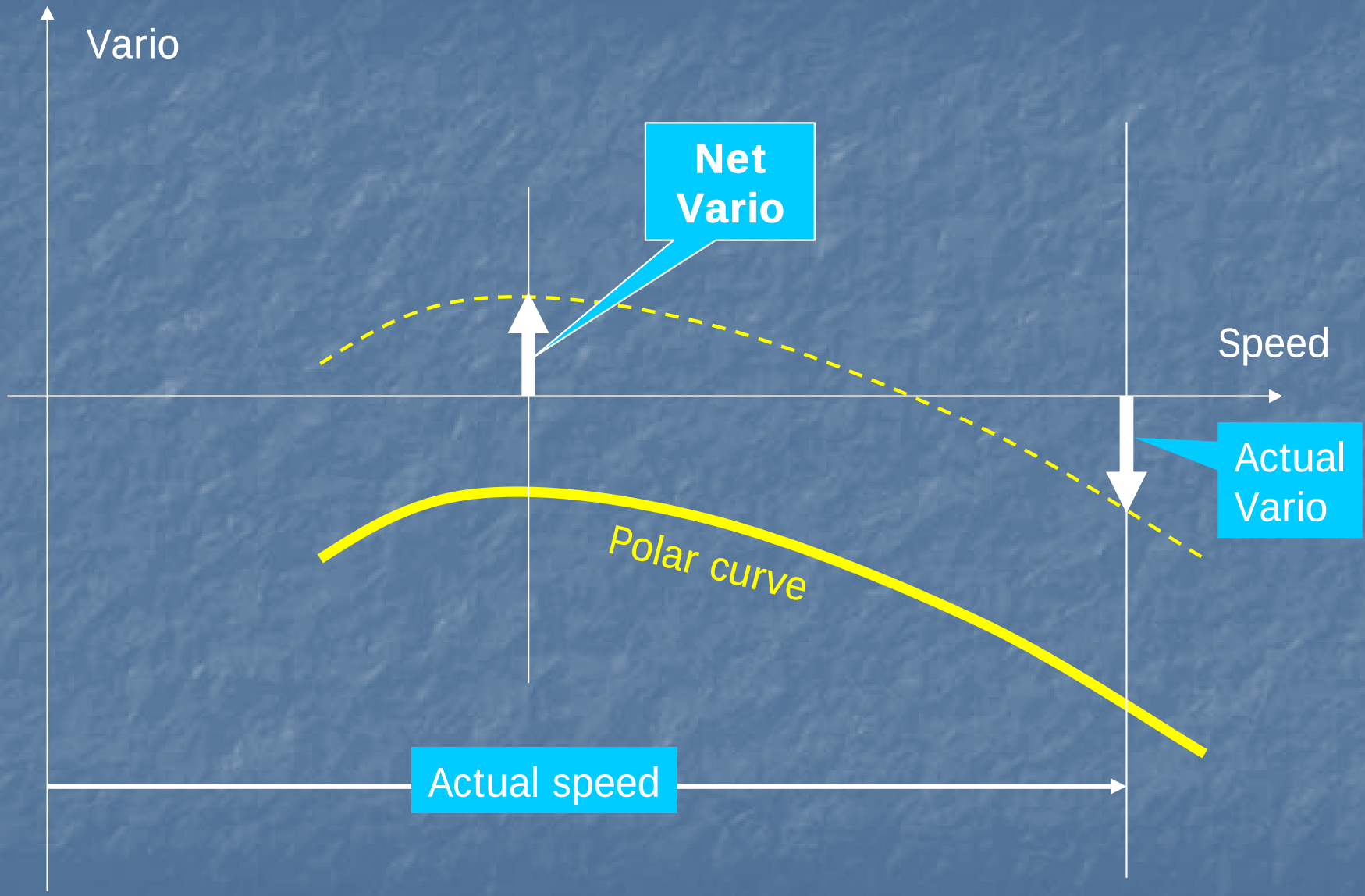


Model **Validation**

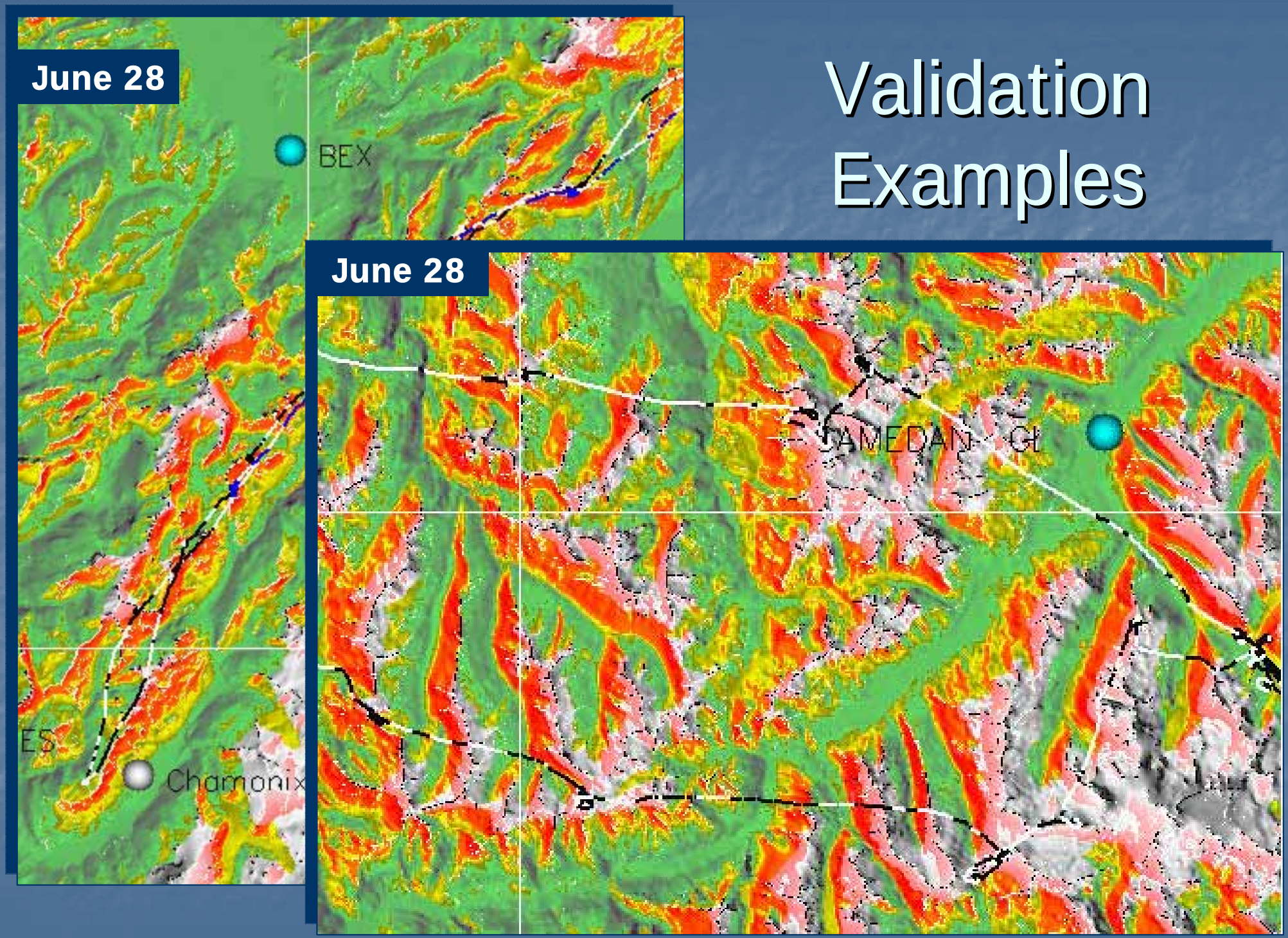


- **Expert** advice
- Overlayed IGC **logfiles** of flights on days with
  - few and high clouds
  - unstable atmosphere (temperature increase leading to thermals)
  - (if possible) comments by the pilots
- Regions: Alps, Jura, Black Forest/DE

Validation: **Net Vario**

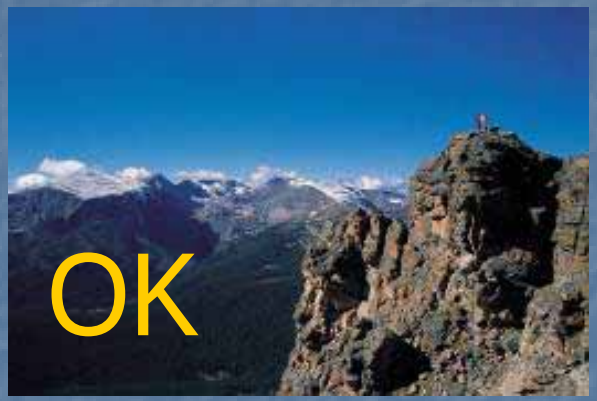


Validation Examples

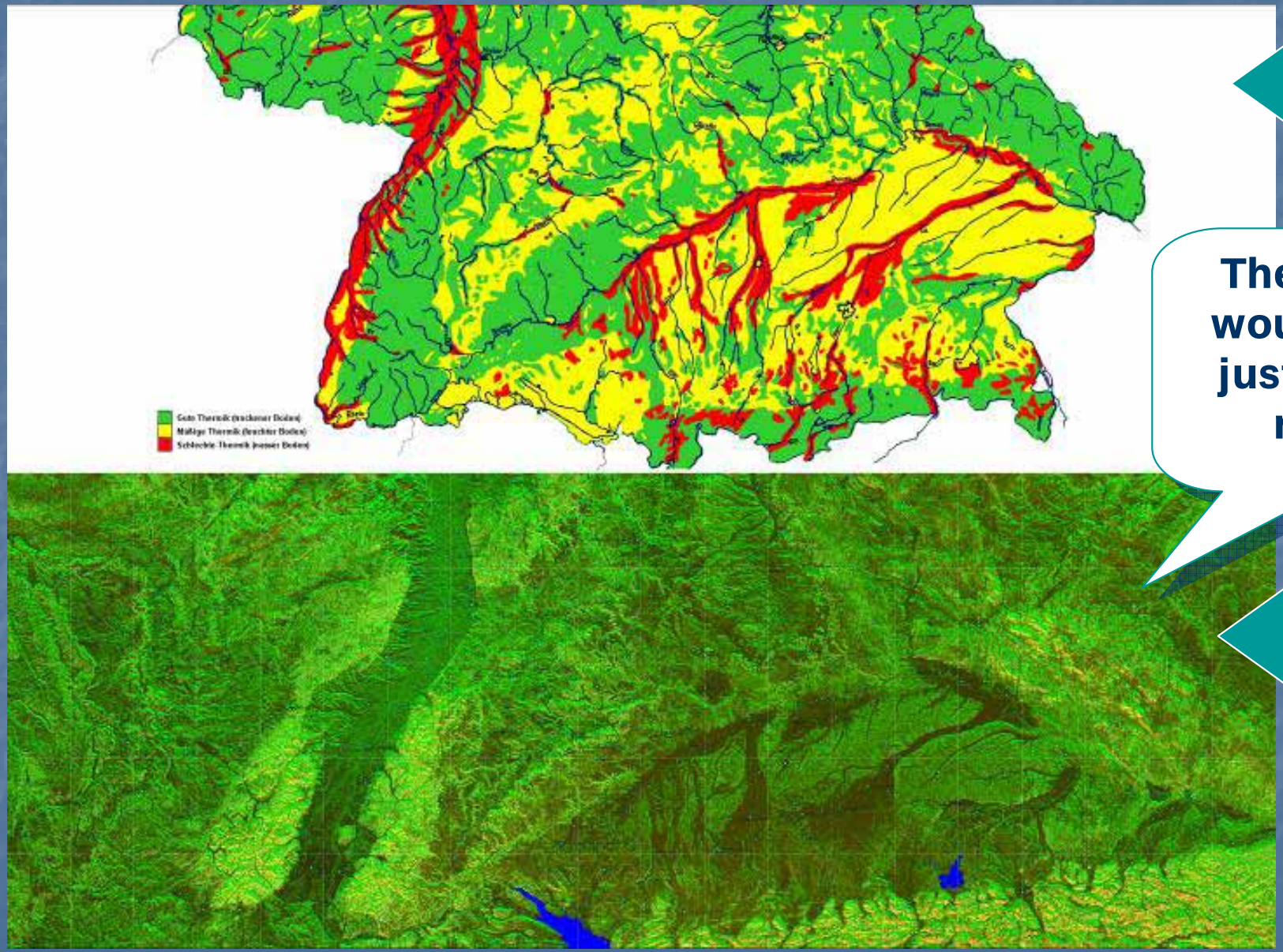


Conclusions

- TherMap model seems to be valid for topographically highly differentiated areas, such as the **Alps**
- Mixed results for topographically smoother regions, such as the **Jura**:
  - (+) Irradiance
  - (~) Temperature
- Not sufficient for still smoother regions



Note on Irradiance Maps in “Smooth” Areas



Thermal map

The similarity would seem to justify further research

Irradiance map

Next Steps

- Internet publication: Maps, forum, services
- R&D on
  - Secondary IR effects (lakes, ice, vegetation, satellite IR scans)
  - Variation of turbidity
  - Temperature model
  - Secondary aerodynamic effects
  - Refined flight tracking (wind drift, ground tracks)
  - Extention to non-Alpine regions

Help and Advice Welcome !


Thank You
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RADIO
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