

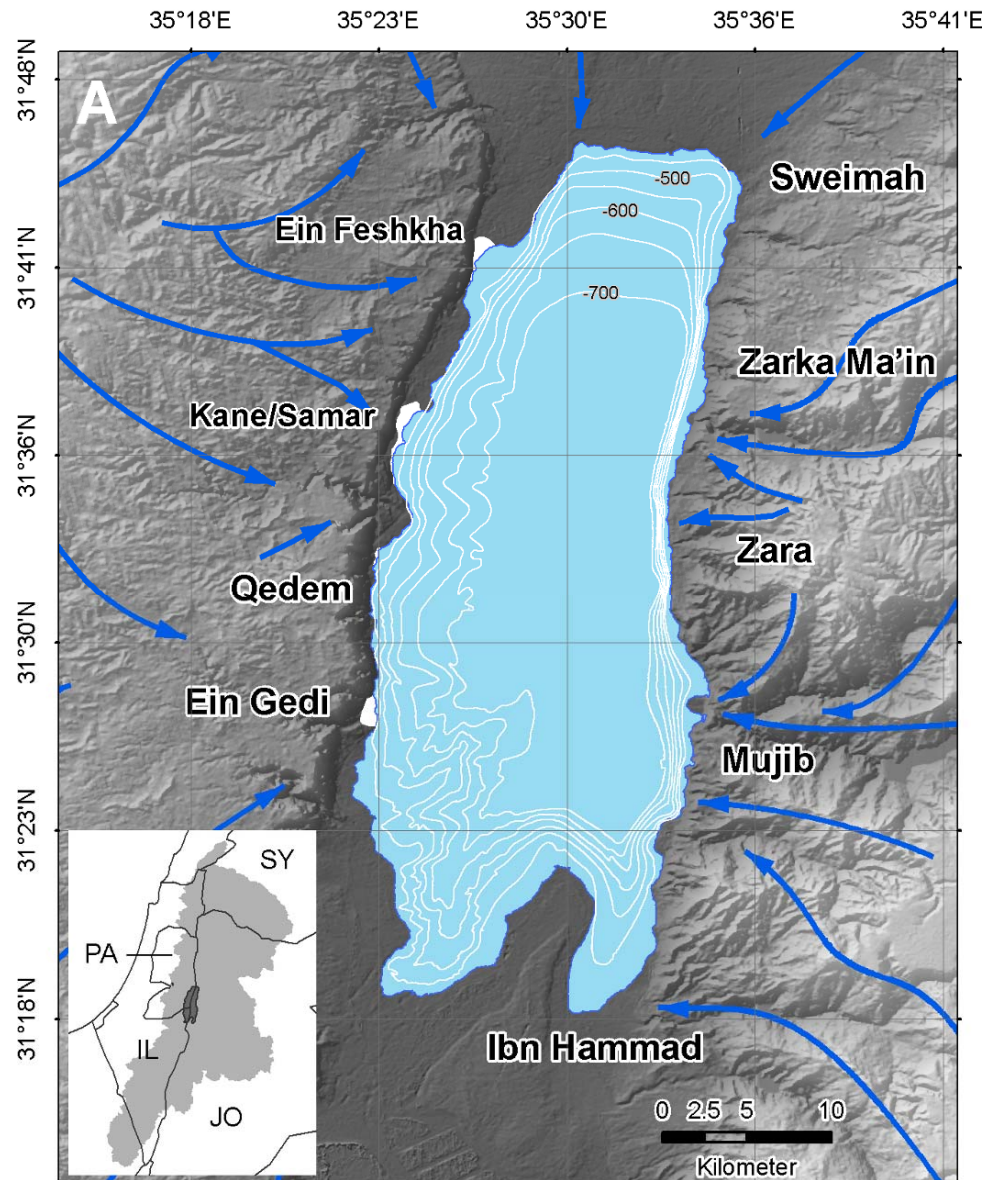
Application of Thermal Data for Groundwater Studies in Arid Regions -Example of the Dead Sea-

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Hannover, 15.03.2012



Problems



1. Decreasing recharge rates
2. Increasing water demand

Direct Natural Effects

- Drop of Dead Sea level of $\sim 0.7\text{m a}^{-1}$
- Reduction of lake area
- Sinkhole occurrences since 1990s
- Emergence of springs along sediment heterogeneities and faults along the coast

Motivation

Alternative to obtain information on groundwater discharge

Temporal variability of groundwater

Reliable Groundwater Quantities

→ **Improvement of the Sustainable Water Management (main objective of project SUMAR)**

Benefit from Thermal Remote Sensing

Satellite platform

- Spatial Resolution of 60 m
- Multi-temporal (every 16 days Landsat)

→ Localization of groundwater discharge

→ Temporal discharge variability

Airborne platform

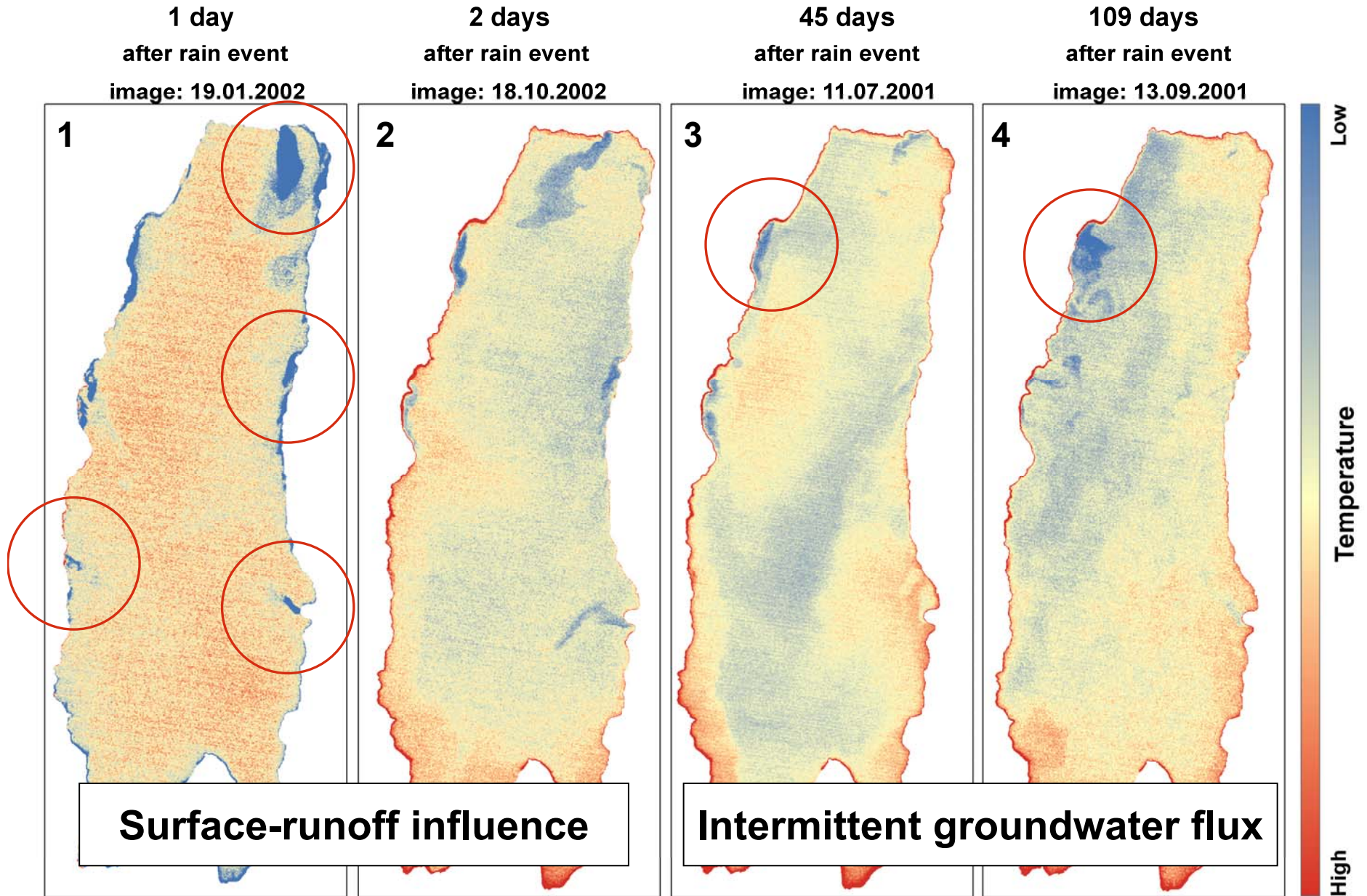
- Spatial Resolution of <1 m
- Uni-temporal

→ Localization of groundwater discharge

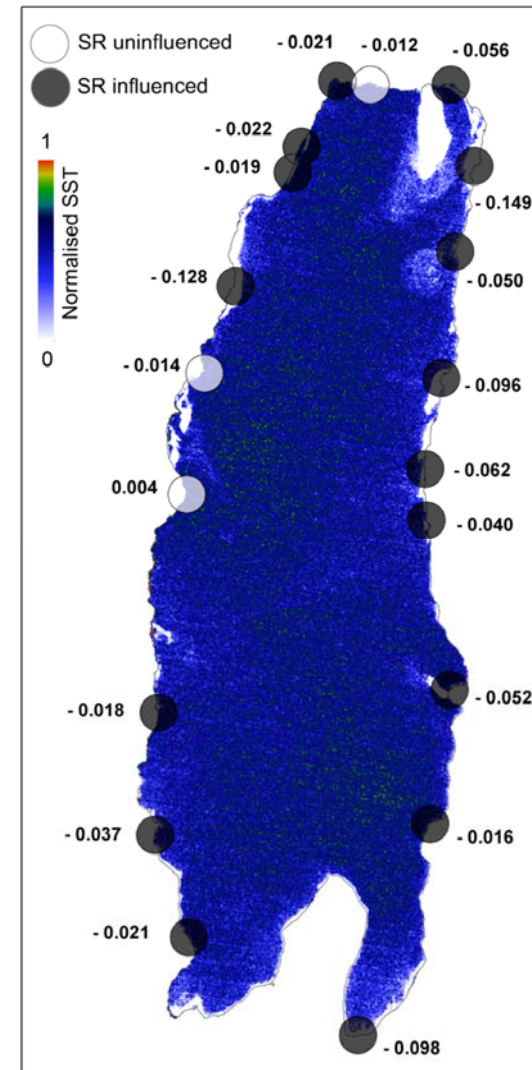
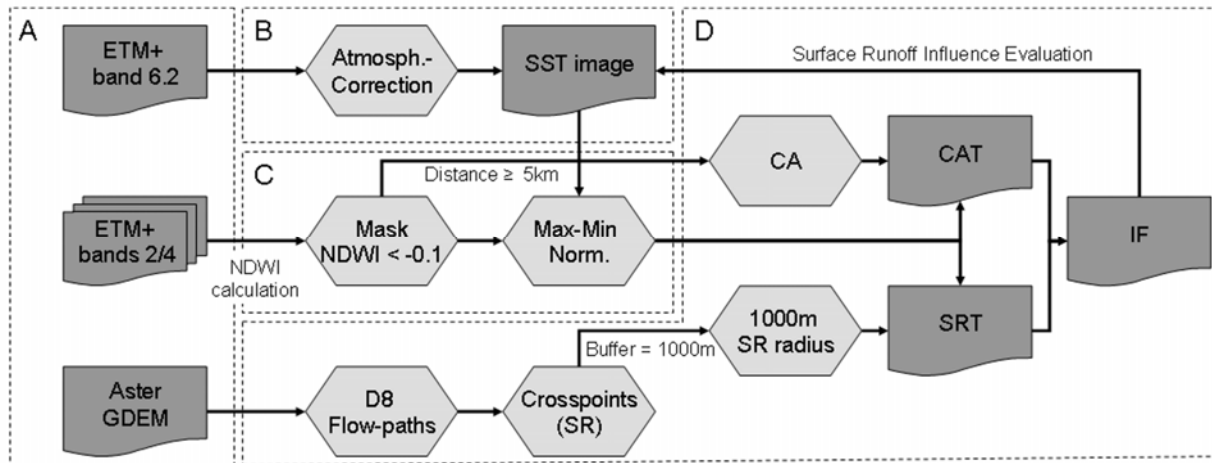
→ Quantification of groundwater

Condition: Sufficient temperature contrast between groundwater and the water body

Preliminary considerations

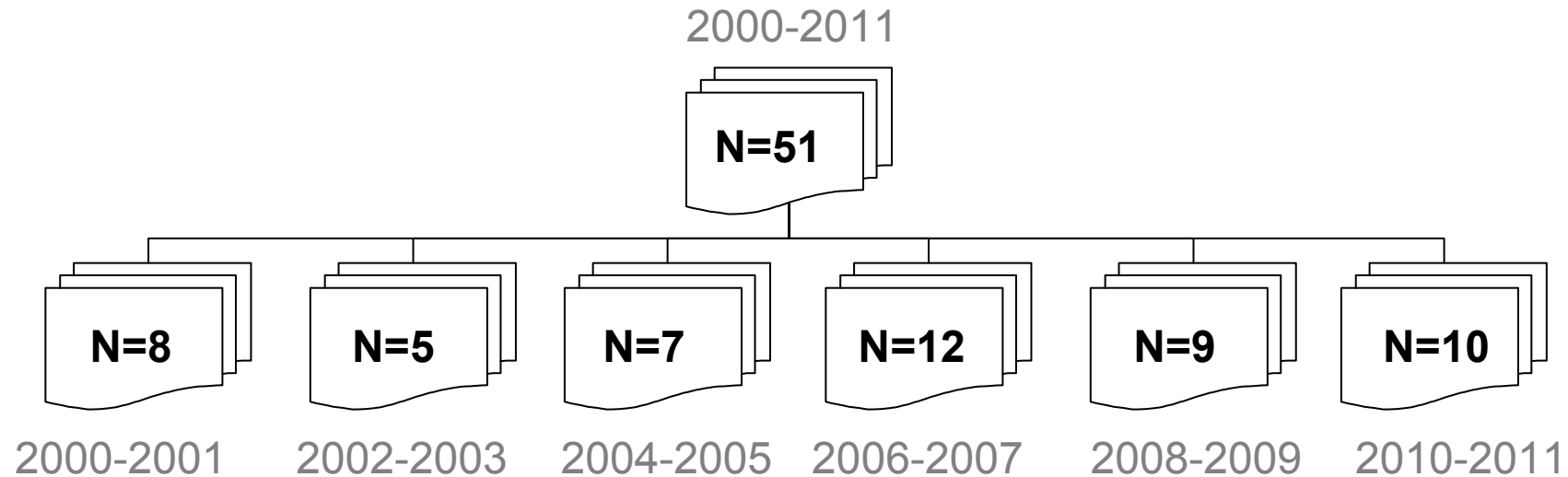


Surface-runoff influence



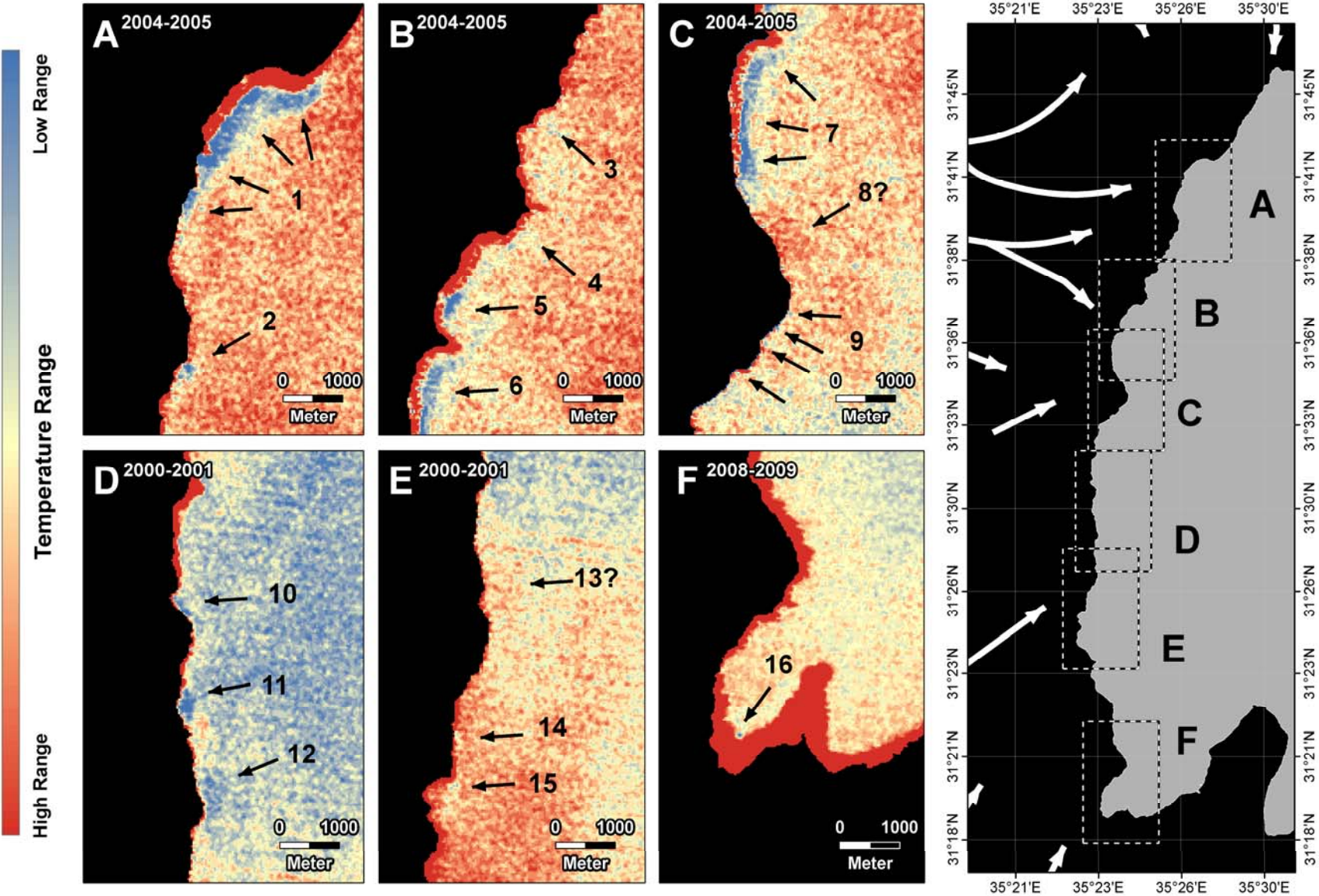
- Evaluation of surface runoff individually per satellite image
- Automatic image exclusion in the positive case
- From 100 images 49 were excluded

Intermittent GW flux

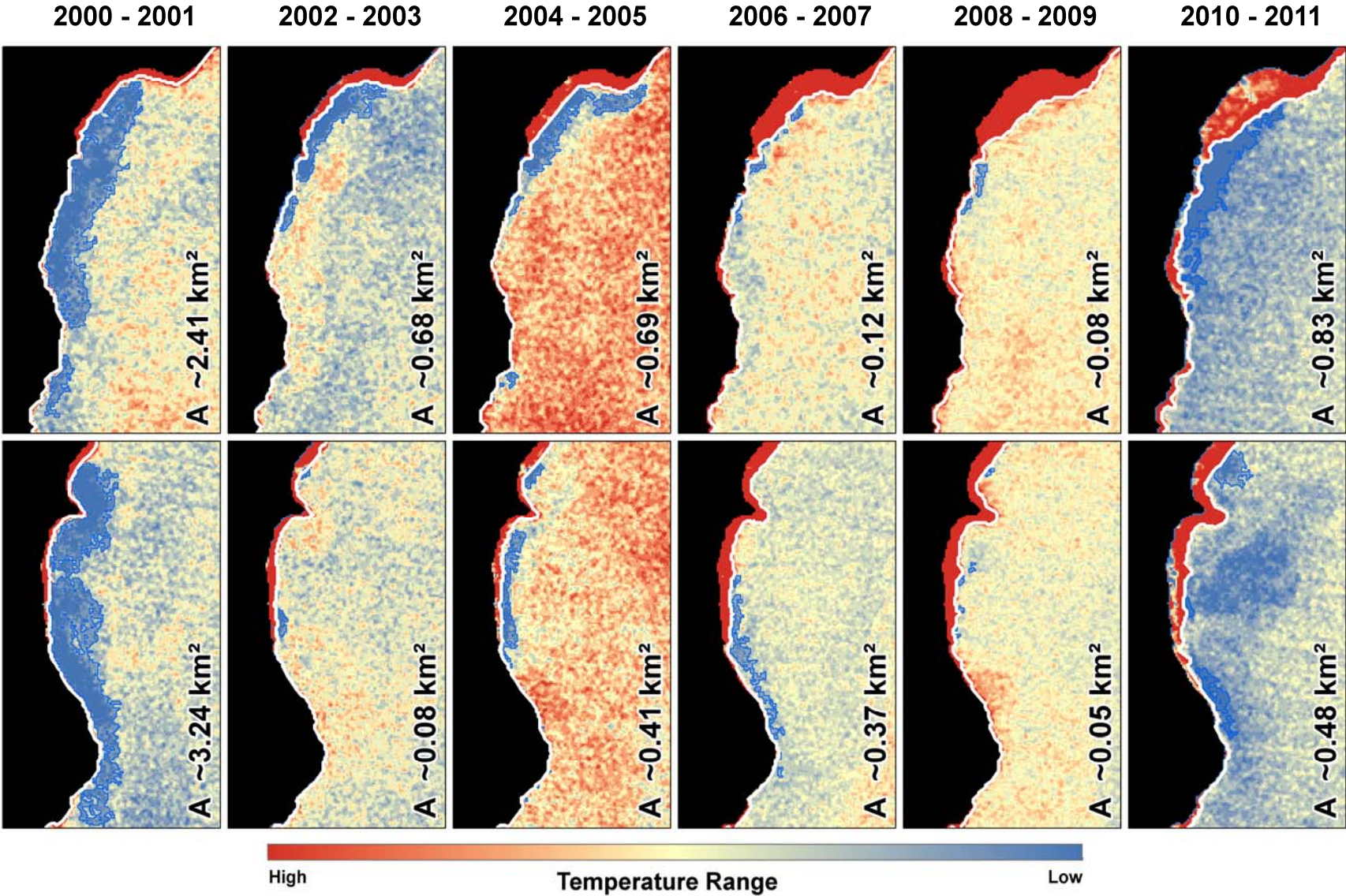


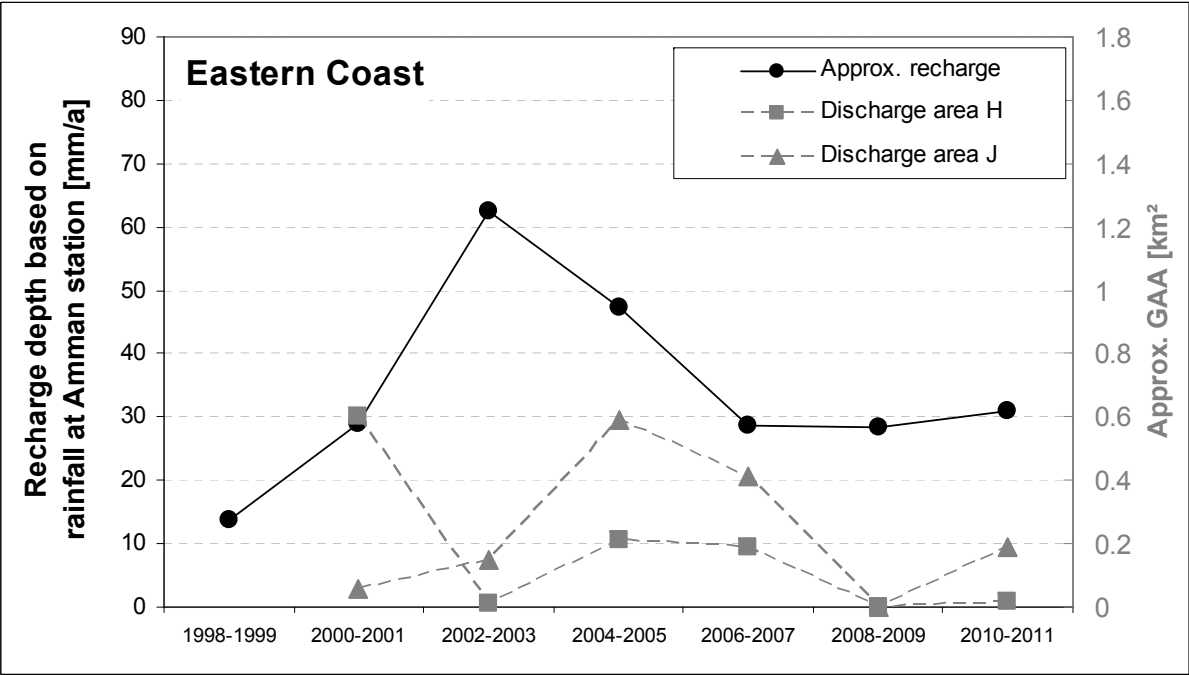
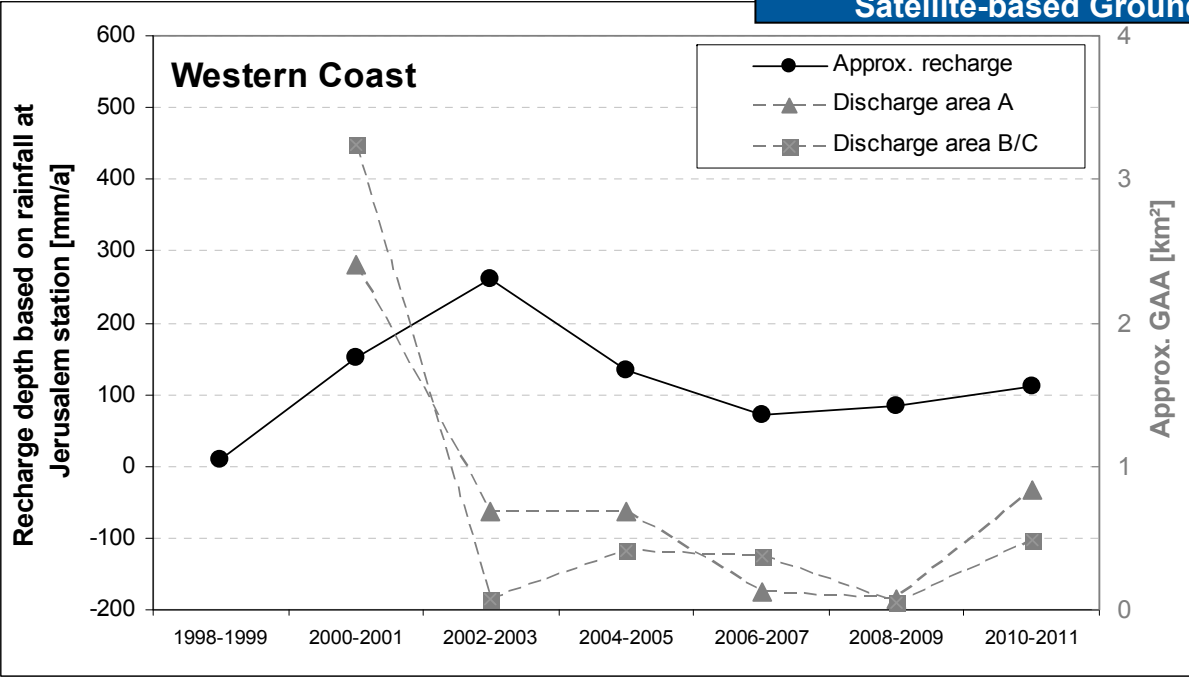
- Integration to biennial series to guarantee representativeness
- Analyses of temperature variability per pixel as a function of temperature range
- Small ranges represent groundwater areas induced by a thermal stabilization

Discharge Locations

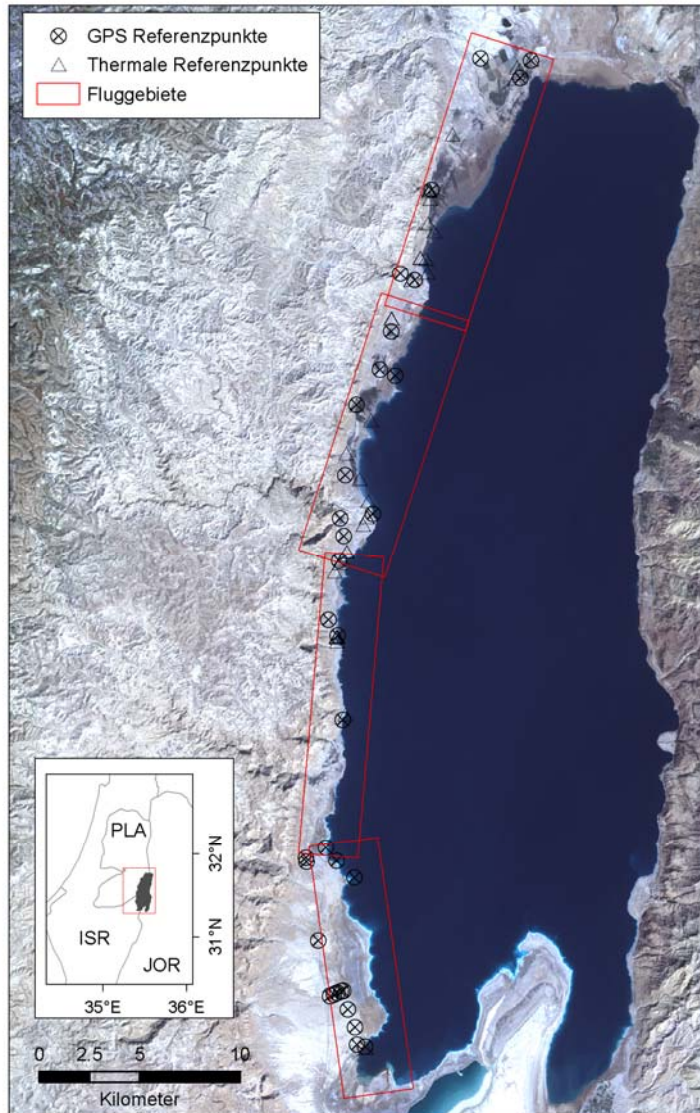


Temporal Discharge Variability





Airborne Thermal Campaign



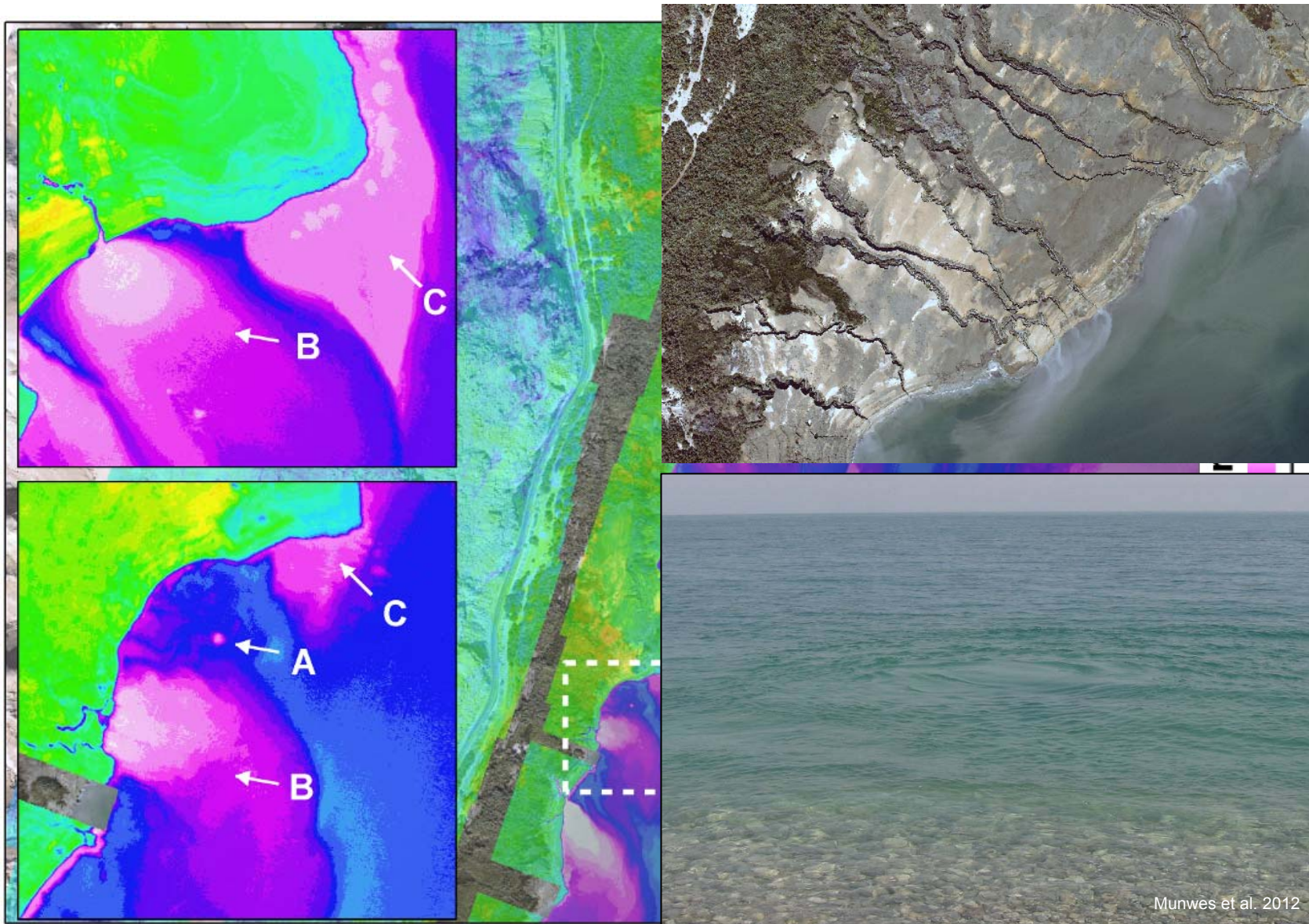
Thermal images

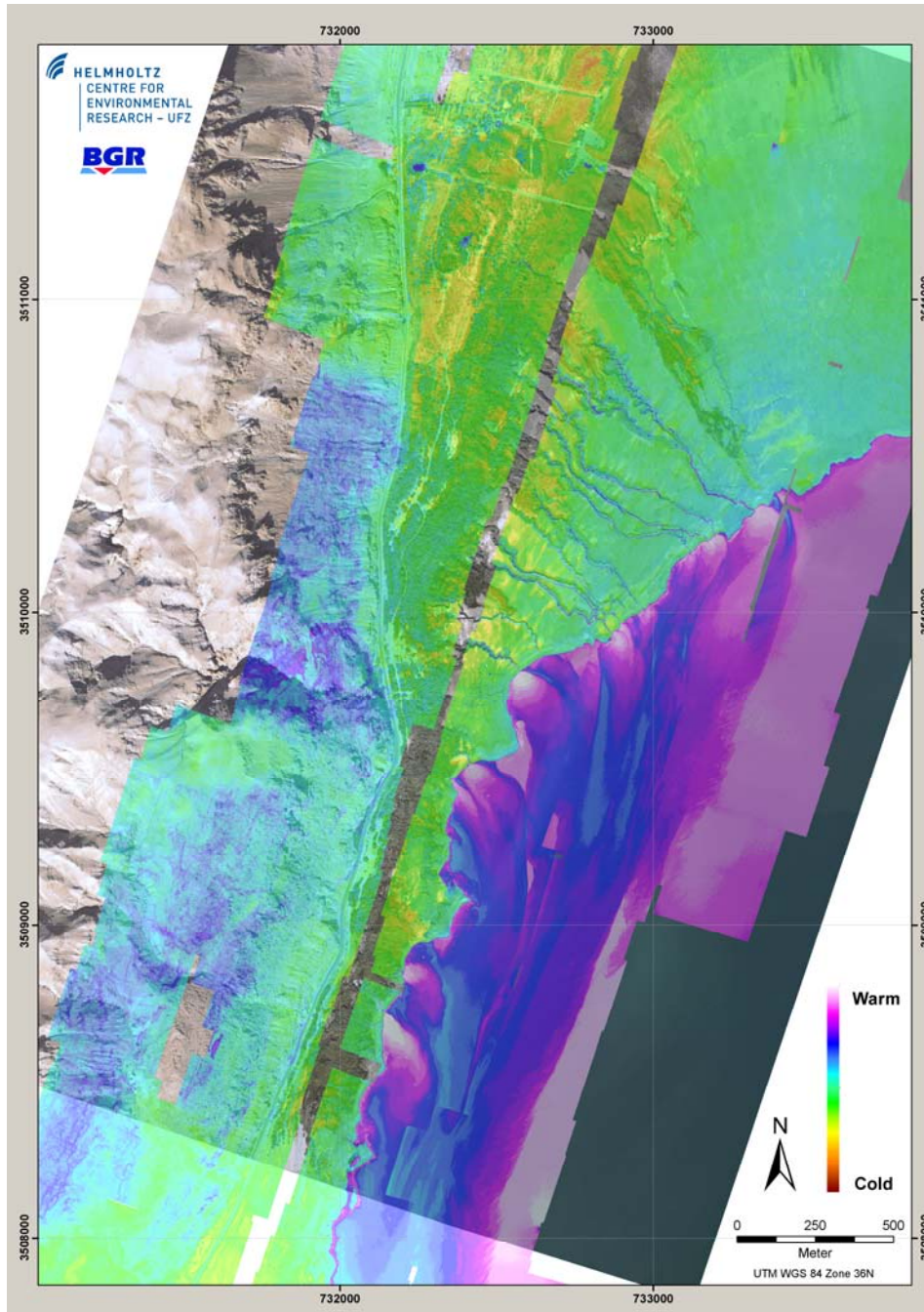
Time:	2 - 5 a.m.
Areas:	4 (total 200 km ²)
Flight altitude:	1000 - 1700 m (NN)
Spatial resolution:	0.5 m GSD

Ground Truth/ Calibration

Water	WTW 340i (36 Measuring locations ML) Onset HOBO® TidbiT v2 Templogger (12 ML)
Land	Ahlborn AMIR 7814-20 Remote Thermometer (50 ML)
dGPS	Trimble GeoExplorer XT (35 ML)

Airborne Thermal Results





Practical use:

Sustainable pond planning for Ein Feshkha Nature Reserve

Processes in Progress:

Delineation of discharge plumes
Simple regression modelling
Physical based 3D modelling

Overall result:

Quantification of the groundwater discharge on the western coast

Thank you for your attention!

Acknowledgements:



**Bundesministerium
für Bildung
und Forschung**

