TOPOCLIMATOLOGICAL AND SNOWHYDROLOGICAL SURVEY OF SWITZERLAND

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1. Techniques

1.1. Available Data

- Following the data acquisition charts provided by NASA (11 July, 1979) the central part of Switzerland has been registered by HCMM 222 times. In this number scenes are included, which show our test areas very lateral. The period is covering May 1978 - May 1979.
- By the end of the first report period we have got 51 scenes, including 16 quick-looks provided by the Lannion facilities.
- For topoclimatological purposes 8 scenes are interpretable (no cloud cover or fog layer), 10 more scenes could be evaluated at least partially.

1.2. Data type, techniques

The investigation bases on the use of standard film products and digital data.

- Photographic imageries:
  - For first look interpretations or purely descriptive and qualitative evaluations photographic products are most useful (restrictions see Chap.3).
    The use of conventional image interpretation devices (binocular microscope, Zoom Transferscope) has proven to be a very adequate tool for non-quantitative approaches.
  - Due to their only little geometric distortion photographic superposition of topographic maps and thermal imageries or equidensity extracts provide good results for small- and mediumscale topoclimatic surveys.
  - Quantitative interpretation of IR-data using semiautomatic image-interpretation devices (Omnicon Alpha, improved version) give adequate information about:
    - areal percentage of selected gray-shades (or thermal regions) within distinct geographic areas.
    - Topography / Temperature profiles.
    - Thermal differentiation within built-up areas.
    - Fractions of terrain coverage types (forests, rural and urban, water bodies).
- Digital data:

  Digital analysis using HCMM-CCT has recently begun on a first scene (3 June 1978). Previous tests with digital NOAA-CCT (provided by the Lannion station) served to establish the geometric and radiometric correction procedures.

- To fit the HCMM-scene to official Swiss map projections, up to 10 landmarks are used for the determination of a correlation matrix.
- Another Computer-Program for the elimination of the shift of single scan lines (see Chp. 3) has been developped, using correlation between adjacent scan lines.
- Graphs have been produced showing surface temperature versus elevation of the terrain (topography) to determine the vertical extent of inversion layers. The procedure - previously tested with NOAA-data - provided astonishing good results.

- Ground truth:

  - Topoclimatological survey:

    3 types of ground truth data has been collected:

    - Lake temperatures: on Lake Murten a continuous record of water temperature (1 cm below surface) is available. Two interruptions due to vandalism has been completed by point measurements.
    - Radiometric temperature measurements: An extensive ground truth program using PRT-5 and PRT-10 instrumentation has been executed along profiles of about 5 km length during night-overflights. Aircraft overflights had to be cancelled due to noise problems during nighttime.
    - Radiometric temperature measurements from aircraft: On clear days with HCMM overflights the radiant temperature of Lake Murten, agricultural and forested areas as well as of snow covered ice fields has been measured from a plane flying in different altitudes.

  - Snowhydrological survey and cloud meteorology:

    Ground truth for snow surveys is collected in collaboration with federal agencies and in close relation to the ongoing LANDSAT-program of Prof. H. Haefner. More detailled information will be provided in progress report No 2.

- Atmospheric corrections:

  To eliminate the influence of the atmosphere on the absolute accuracy of the measurements, the model provided by NASA is used in combination with the temperature and humidity data of the radiosonde Payerne. In our area with its typical relief (significant altitude differences within small areas), it seems to be necessary to vary the atmospheric influence depending the changing thickness of the ground covering air mass.

2. Significant results

Preliminary results can be summarized as follows:

2.1. The chosen time of overflight of HCMM seems to be ideal for the study of basic climatological events:

- Nocturnal temperature inversion zones are easily detectable and their dependency on the relief is clearly seen. Especially the alpine valleys show a very differentiated pattern of "cold lakes", separated by warmer zones as a consequence of rock and forest barriers or changes in the valley profile. Wet areas on the other hand are usually colder than dry parts under comparable topographic conditions.

- Even very small topographic obstacles are able to block up the flow of cold air masses (or ground water flows). An amazing example is the exit of the Aosta Valley (Italian Alps close to the Swiss border), where the moraines of the last glaciation delineate a very distinct zone of lower temperature (16 November 1978).
- Slopes seem generally to be warmer compared to the top of the mountains or to valley floors. This fact is also reflected in phenological findings.

These facts are specially true during winter time but much weaker in summer.

2.2. Urban areas are clearly detectable. Differences to the surface temperatures of surrounding rural land are much more significant during day-time (mainly during summer months). Ad midnight built-up areas are sometimes not distinguishable from the general temperature field.

Circular temperature patterns - with an increase of surface temperature towards the center of a city - can be seen in Swiss towns only occasionally but are most clearly developped in metropolitan areas like Milan or Munich.

2.3. Cloud observations:

- Fog layers are clearly defined in the visible channel (day time), but much more difficult to identify in the IR (mainly during the night). Spatial resolution is also sufficient for mapping the most clearly defined surface patterns of the fog layer (waves). In this respect HCMM-data are much superior to NOAA-imagery, because wave lengths are very often in the order of km.
- Cloud systems: There results not a fundamental difference to NOAA-analysis. The most important advantage is the better detectability of convective cloud systems (small cumulus clouds).
  A rare case of very extended Cb (thunderstorm cells) is observed on 3 June 1978. Rainfall areas are interpretable and can be verified with the aid of radar observations (provided by the Swiss meteorological service).

3. Problems

The following problems seriously affect our investigation:

3.1. The delay in delivrance of data brought up a few problems (changes in the personnel, decay of finances) which hopefully will not affect the investigation far-sighted.

3.2. The coordination between HCMM-data collection and ground truth campaigns are sometimes very difficult. Fast weather changes make short-dated decisions necessary and usually announcements of intended field work to NASA is only possible within a few hours. This period of time seems obviously to be too short to make shure that HCMM is really collecting data.

3.3. Image quality is affecting interpretation sometimes in a suspicious manner:
- Density distribution (low and high radiances): difficulties arise for cloud analysis (vertical extension on IR images), snow cover

conditions (melting processes) and delineation of cold temperature fields (valley floors). Following NASA (11 July 1979) the characteristic curve will be changed.

- Some images show very disturbing patterns. These are sometimes regular, as on 17 July 1978 (night-IR) or 30 October 1978 (day-Vis). A qualitative interpretation is sometimes still possible, but quantitative approaches are excluded.
- The CCT we ordered first (3 June 1978) is heavily disturbed: missing lines, shifted portions or single shifted lines required complicate reconstruction procedures.

4. Recommendations

-The main desire is concerning the image quality. But following the most recent communications by NASA we can expect significant improvements.
-If possible data acquisition charts should be provided to the investigators monthly. Evaluation of ground truth data could be accelerated.

5 Conclusions

- HCMM data seem to become an extremely useful tool for the solution of fundamental problems of topoclimatology: Thermal patterns at medium scale as a function of surface coverage, topography, time of the day.
- Together with other meteorological satellite data (TIROS-N, NOAA-6, Meteosat) HCMM provides very valuable information for the spatial and temporal development of meteorological phenomena (inversion layers, heat islands, fog layers etc.). The same is true for comparisons (or calibration) of data between different satellites.
- A final statement for the use of HCMM-data for snow-hydrological surveys can not yet been given, but theoretically snow under melting conditions should be separable from still frozen snow covers.