Completing the meteorological archive missing data at the daily and sub-daily time scales
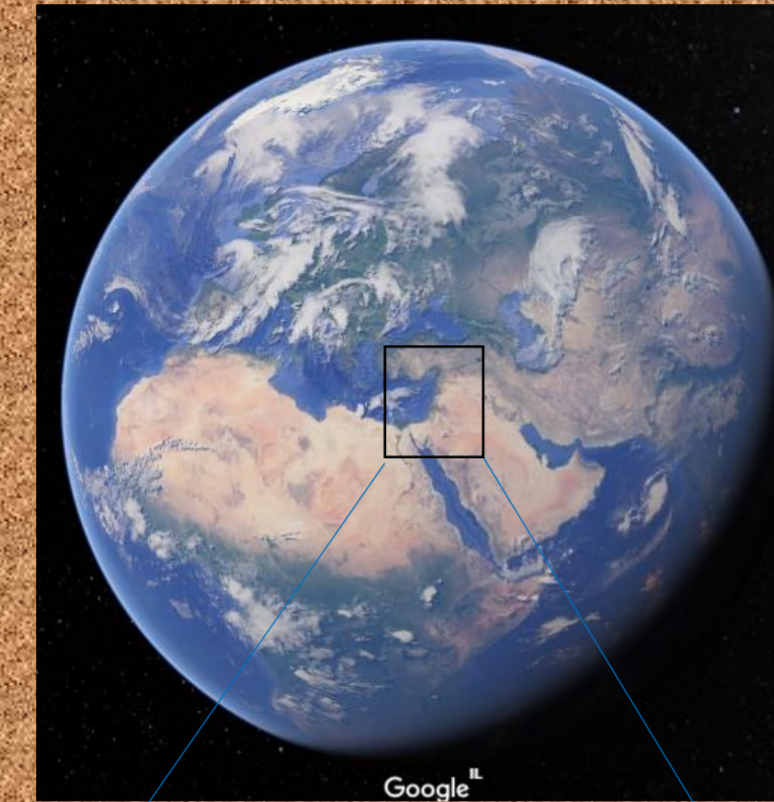
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*at the time of working on this project, was affiliated with Israel Meteorological Service

Background

(1) Several algorithms for objective completing the meteorological archive missing data *at the daily time scale* has been offered recently. Yet, a general workable solution for the regions with complex terrain and mixed climatology remains an open question due to uncertainty in defining the reference stations.

(2) Regarding the problem of objective completing the missing data at the **sub-daily time scale,** as far as we know, *a solution has still to be found.*

Solved Problems

The presented algorithms were developed in the Israel Meteorological Service (IMS)* in 2018-2019.

<u>Algorithm 1. (A1)</u> Completing the missing *daily* observations of maximum and minimum temperatures (TMAX, TMIN) for both the manual and automatic weather stations.
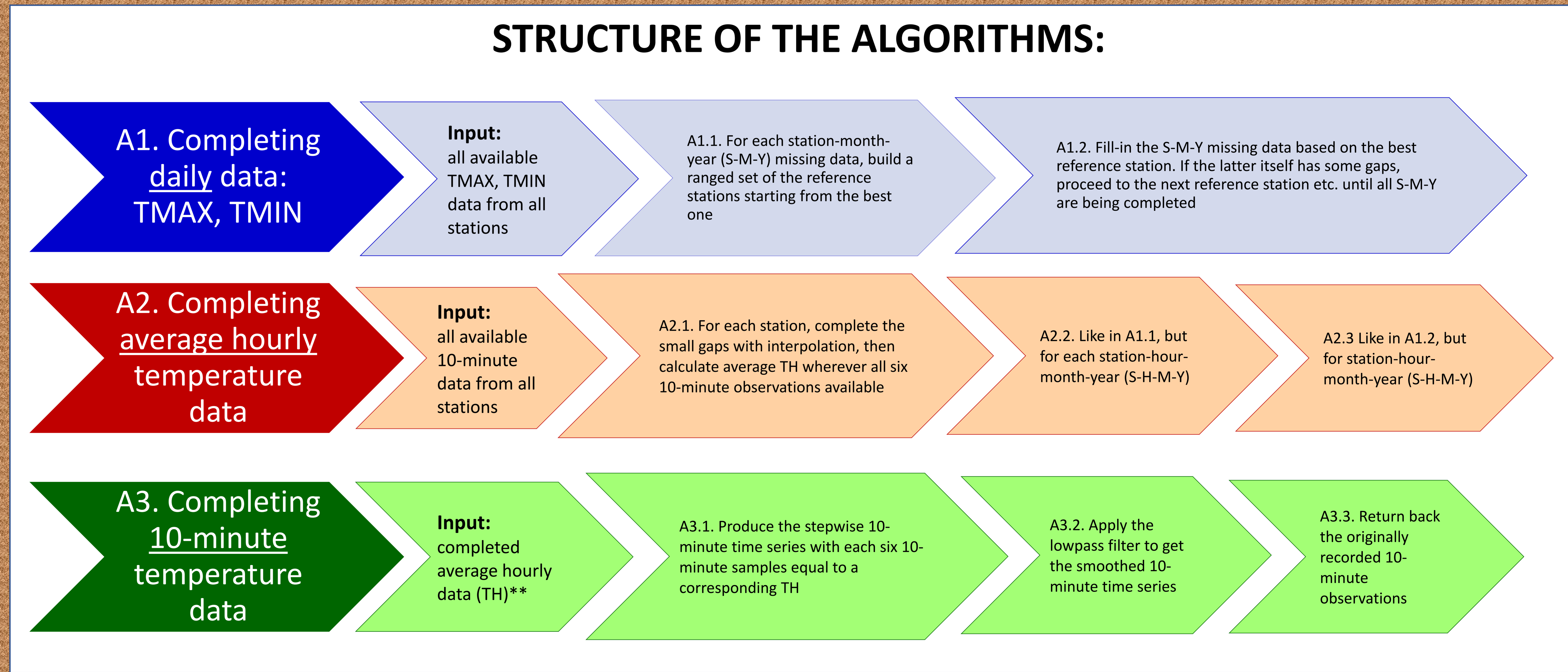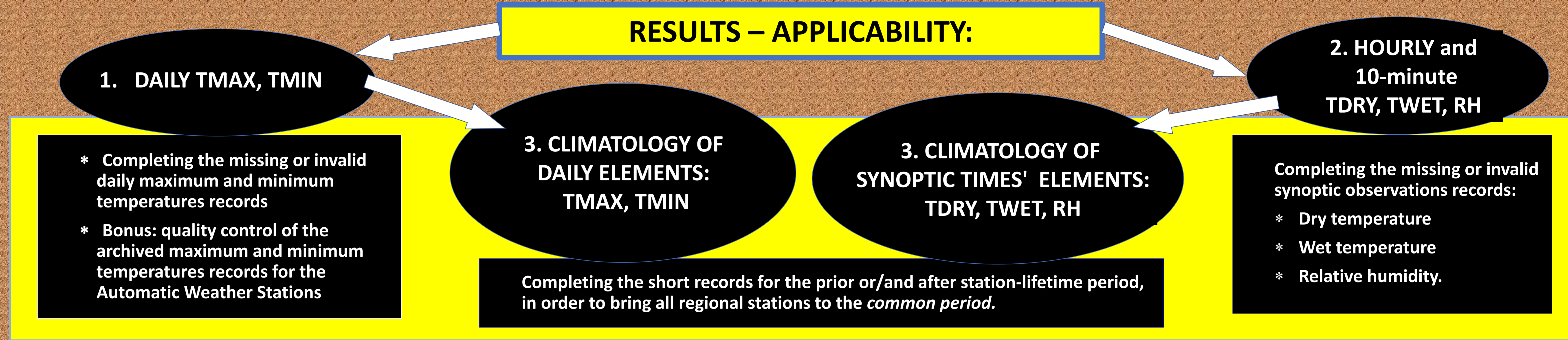
<u>Algorithm 2. (A2)</u> Completing the missing *average hourly* temperature data (TH) for the automatic weather stations (AWS).

<u>Algorithm 3. (A3)</u> Completing the missing *10-minute* temperature data for the AWS. These results allow:
- ❑ completing the AWS missing observations at *synoptic times*;
- ❑ *updating the completed daily* TMAX, TMIN for the AWS (A.1)
- ❑ <u>Bonus:</u> extra quality control of the automatically archived daily TMAX, TMIN for the AWS.

These algorithms were developed and implemented based on the IMS historical and AWS's archives.

Data SIO, NOAA, U.S. Navy, NGA, GEBCO IBCAO Landsat/Copernicus

Google

www.eosnap.com/public/media/2009/09/israel/20090934-israel-full.jpg

Location of the Israel Meteorological Service AWS
https://ims.data.gov.il/sites/default/files/israelIMS.pdf

IMS

RESULTS – APPLICABILITY:

1. DAILY TMAX, TMIN

2. HOURLY and 10-minute TDRY, TWET, RH

3. CLIMATOLOGY OF DAILY ELEMENTS: TMAX, TMIN

3. CLIMATOLOGY OF SYNOPTIC TIMES' ELEMENTS: TDRY, TWET, RH

* Completing the missing or invalid daily maximum and minimum temperatures records

* Bonus: quality control of the archived maximum and minimum temperatures records for the Automatic Weather Stations

Completing the short records for the prior or/and after station-lifetime period, in order to bring all regional stations to the *common period*.

Completing the missing or invalid synoptic observations records:
* Dry temperature
* Wet temperature
* Relative humidity.

STRUCTURE OF THE ALGORITHMS:

A1. Completing <u>daily</u> data: TMAX, TMIN

Input: all available TMAX, TMIN data from all stations

A1.1. For each station-month-year (S-M-Y) missing data, build a ranged set of the reference stations starting from the best one

A1.2. Fill-in the S-M-Y missing data based on the best reference station. If the latter itself has some gaps, proceed to the next reference station etc. until all S-M-Y are being completed

A2. Completing <u>average hourly</u> temperature data

Input: all available 10-minute data from all stations

A2.1. For each station, complete the small gaps with interpolation, then calculate average TH wherever all six 10-minute observations available

A2.2. Like in A1.1, but for each station-hour-month-year (S-H-M-Y)

A2.3 Like in A1.2, but for station-hour-month-year (S-H-M-Y)

A3. Completing <u>10-minute</u> temperature data

Input: completed average hourly data (TH)**

A3.1. Produce the stepwise 10-minute time series with each six 10-minute samples equal to a corresponding TH

A3.2. Apply the lowpass filter to get the smoothed 10-minute time series

A3.3. Return back the originally recorded 10-minute observations

** Direct completing of the 10-minute data produces the very noisy time series

Ref: S.Kotsiantis, A.Kostoulas, S.Lykoudis, A.Argiriou, K.Menagias, 2006. Filling missing values in weather data banks. 2nd IEE Int. Conf. on Intelligent Environ., 5-6 July, 2006, Athens, Greece, V. 1, pp. 327-334