A STUDY OF ESTIMATION GROUND SURFACE TEMPERATURE BY TIME-SHIFT PROCESSING

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Abstract: The time shift processing of ground measured surface temperature with the meteorological variables has no evaluated function. We introduce new evaluating function. To use this evaluating function, the algorithm of time-shift processing will be able to be reliable and get error-bar for all moving measured point's data. We will finally obtain the area averaged surface temperature by land observation.
key word: coefficient order , propagation error

1. Introduction

The radiation temperature sensor had in the satellite is verified at this laboratory. This research is aimed at flat ground for validation. I aim establishment of the ground observation system. The groundobservation for validation has established more points which walk using one set of thermo radio meter at moving measure ment points. Measurement time differs and the observation value acquired at the moving measurement point is not the temperature in satellite passage time. For this reason, the point which measures temperature change of fixed observation point is established. From ground surface temperature change obtained from the fixed observationpoint, it processes by shifting the value acquired at the moving measurement point time presuming the value of satellite passage time (Time shift processing).After time shift processing, field equalization processing is performed using the observation value of each moving measurement points , and it estimate for average ground surface temperature, and compares with the value acquired from the satellite, and the value acquired by ground observation. Fig.1 and Fig.2 show the flow of the ground surface temperature validation scheme and the schematic of measurement area layout. I show change of the temperature obtained at the fixed observation point shows what can be presumed with high precision by taking change of a weather element into consideration. Time shift processing using alignment presumption containing the metrological element, the evaluation method of the processing method is considered, and ground surface temperature is estimated.

2. Data processing

1) About time shift processing

Time shift processing adds a fluctuated part of the temperature from ground surface temperature change obtained at the fixed observation point to the measurement time and satellite passage time of the moving measurement point to the temperature of the moving measurement point. It is the processing method for asking for the ground surface temperature of satellite passage time. The ground surface temperature data of the point fixed observation point is changed varying. It is thought that the factor of this variation is based on a measurement error or a weather element. Therefore, adding a simple difference of temperature to the observation value of the moving measurement point using the observation value acquired at the fixed observation point has a possibility of causing increase with error. It is necessary to express the observation value of the fixed observation point with a certain function, and to presume the difference of ground surface temperature during 2 time

2) Vector auto regression model

It is thought that change of a weather element is included in temperature change of Fixed observation point. The alignment presumption model which took this in dynamically is used.

$$T_S(t_j) = \sum_{i=1}^{N} a_i T_S(t_{j-i}) + \sum_{i=1}^{o} b_i S(t_{j-i}) + \sum_{i=1}^{P} c_i W(t_{j-i}) \quad (1)$$

- T_S: surface temperature
- S: solar flux
- W: wind speed
- a_i, b_i, c_i : each auto regression coefficient order

3) Decision best coefficient order

When applying AR model and a VAR model, each auto regression coefficient order are problem. AR model and a VAR model have FPE etc. as an evaluation function of the optimal degree determination. Those evaluation functions evaluate only the merit to which a model is applied. A measurement error exists in the observation value acquired at the Fixed observation point and a meteorological observatory. AR model and a VAR model are models by alignment combination of the past observation value. Therefore, since the observation value of a certain time is presumed, a measurement error will be accumulated by the degree and value of a auto regression coefficient at a presumption value. The propagation error has a possibility that will increase and an error will arise in a presumed value. Therefore, error[1] σ_q in a VAR model is expressed with the following "Eq(2)".

$$s_q = \sqrt{\left(\sum_{i=1}^{N} a_i s_x\right)^2 + \left(\sum_{i=1}^{Q} b_i s_y\right)^2 + \left(\sum_{i=1}^{P} c_i s_z\right)^2} \quad (2)$$

-error of thermo radiometer σ_x: 0.3 [℃]
-error of sun flux meter σ_y : $1.0/(12)^{1/2}$
-error of anemometer σ_z : $0.1/(12)^{1/2}$

Therefore, it is stabilized and error σ_q spread to this presumed value makes the optimal degree the value used as the minimum, or the value to converge. This error σ_q becomes the error bar of the observation value acquired not only at evaluation of a degree but at each moving observation points.

4. Field measurement data

Ground observation was performed by Nevada Rail-Road Playa on August 17, 2001. Fig. 3 expresses the change from the time of the observation start of the Fixed observed point and a meteorological observatory. The absolute value of wind velocity is large in the middle stage from the first half of observation. There may be little wind velocity and its change is large in the second half of observation. Therefore, it turns out that change of surface temperature is also large. Table 1 is each observation value in the time of an observation start.

5. Result

Table 2 are each degree of a VAR model, and the value of σ_q . In this case, the optimal degree of the VAR model from which error σ_q becomes the minimum is N= 5. : O= 1 : It is P= 1. Fig. 5 is as a result of VAR model application. The optimal AR model for reference was also applied (Fig. 4 is error σ_q of AR model, and a FPE value). For the model, by having used the meaningful valuation basis, it shifted time and the reliability of a VAR model went up as algorithm of processing. I want to compare as the temperature data obtained from the satellite loading sensor from now on according to the verification procedure of Fig.1.

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References

1. John R. Taylor: ERROR ANALYSIS、pp. 46-83

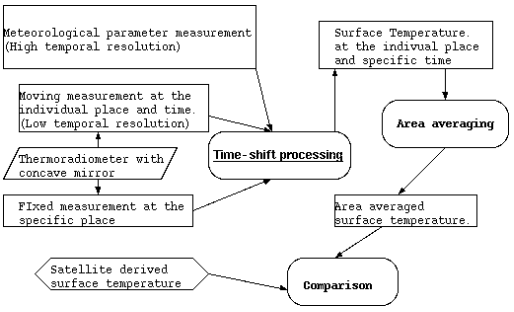

Fig .1 Validation flow.

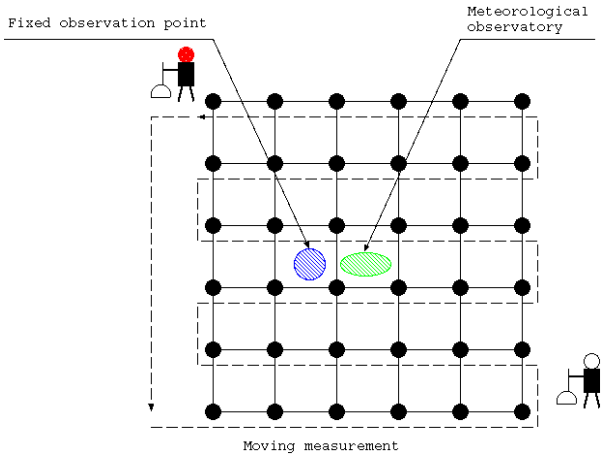

Fig.2 measurement area layout

Table 1 Measured value of observatory starts time.

Fixed temperature [deg.C]	Solar flux [mv]	Wind speed [m/s]	Data number
51.9	80.0	2.49	45

Table 2 Propagated error of VAR MODEL coefficient order.

N coefficient order of surface temperature	O coefficient order of solar flux	P coefficient order of wind speed	Propagated error [℃]
1	1	1	0.300
2	1	1	0.261
3	1	1	0.252
4	4	1	0.241
5	**1**	**1**	**0.220**
6	6	6	0.243
7	4	1	0.272
8	1	1	0.330
9	1	1	0.330
10	1	3	0.285

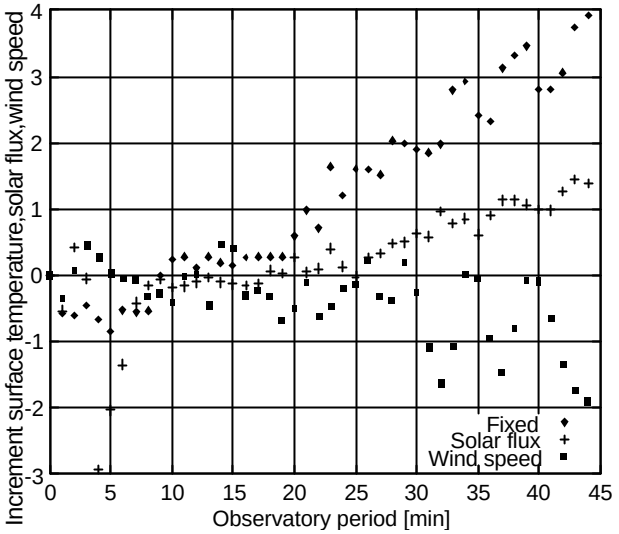

Fig.3 Change of surface temperature, solar flux, wind speed in observatory period.

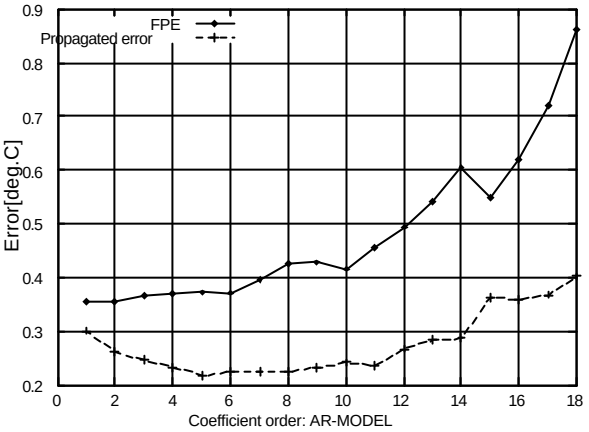

Fig. 4 Relationship between Propagated error, FPE value and AR MODEL coefficient order.

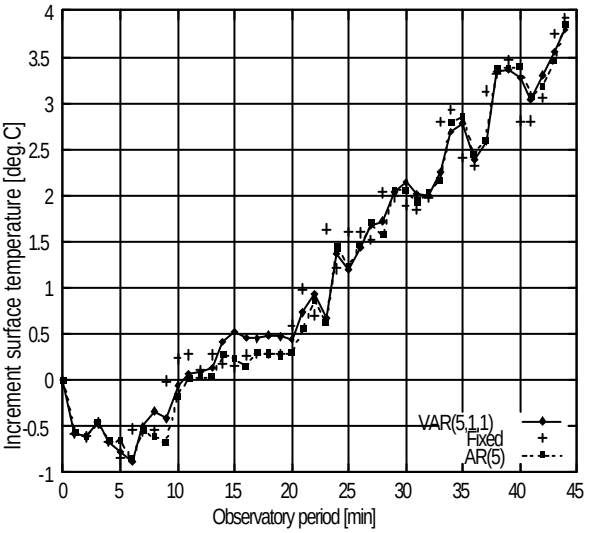

Fig. 5 Estimated surface temperature.