

# Challenge II: Spatial continuity and weather prediction

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*25 6 2017*

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# 1 Libraries

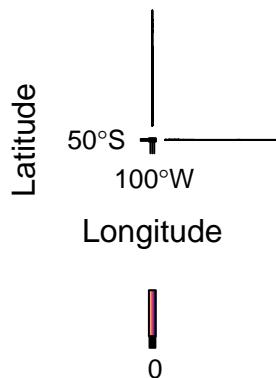
The following libraries are needed, to execute the code:

- **ggplot2** – Plots – [@ggplot2]
- **plyr** – Splitting, applying and combining data – [@plyr]
- **rgdal** – Open Shapefiles – [@rgdal]
- **sp** – Spatial datatypes – [@sp2; @sp1]
- **gstat** – Spatial statistics –[@gstat]
- **FNN** – Spatial statistics –[@FNN]

# 2 Data



id	meanWi_before1970	meanSu_before1970	meanWi_after1990	meanSu_after1990	elev
1	11.83	23.27	13.09	24.75	7
2	10.21	22.43	11.35	23.94	4
3	10.83	22.78	11.32	24.76	25
4	10.30	22.00	11.44	24.02	2
5	6.13	22.37	7.00	24.56	694
6	8.14	24.90	9.35	26.15	715



### 3 TaskI: Spatial continuity

#### 3.1 First impressions of spatial variation

##### 3.1.1 Winter before 1970

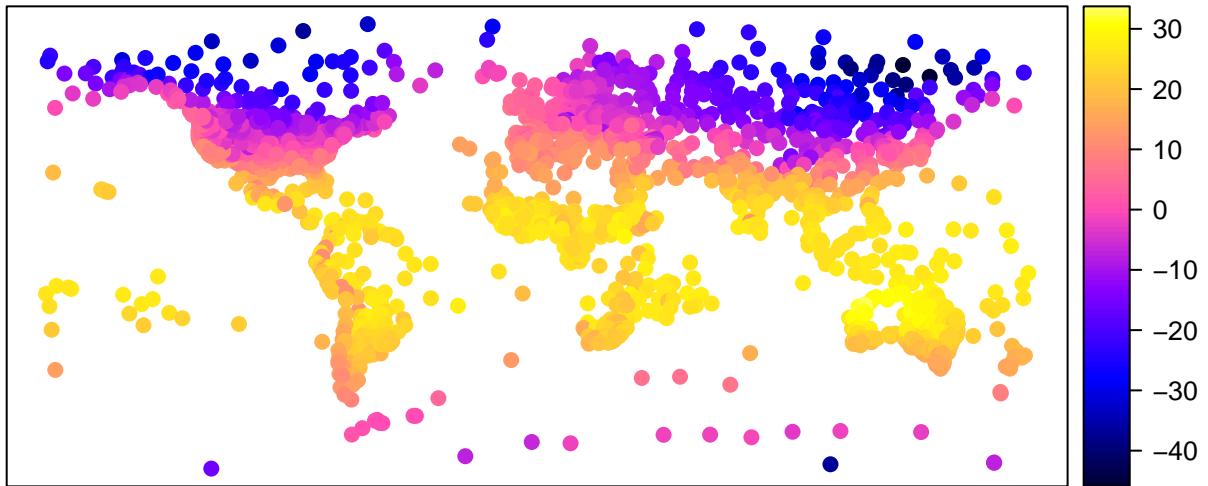


Figure 1: Mean temperature Winter from 1950 to 1970

##### 3.1.2 Summer before 1970

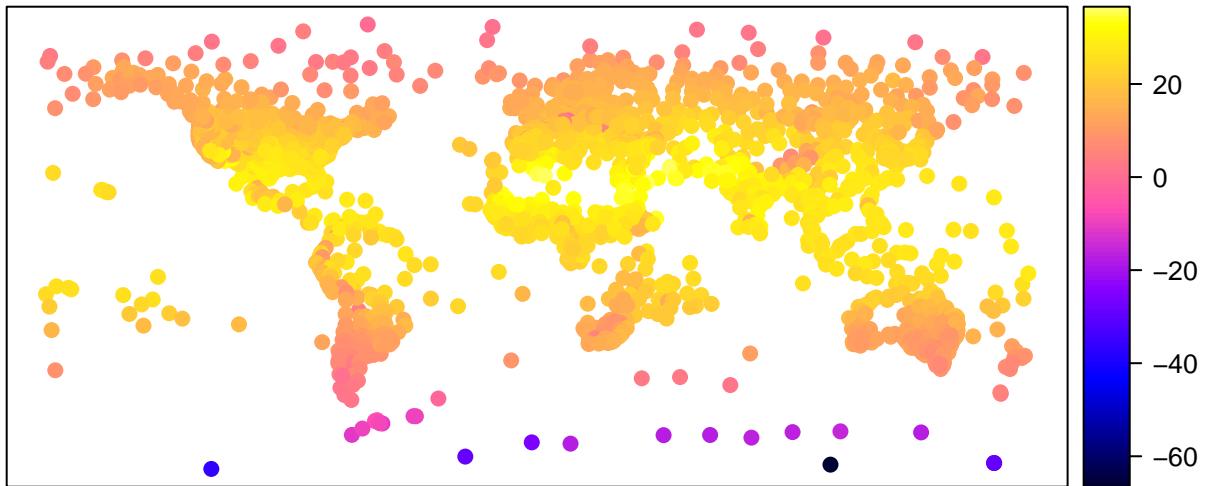


Figure 2: Mean temperature Winter from 1950 to 1970

### 3.1.3 Winter after 1990

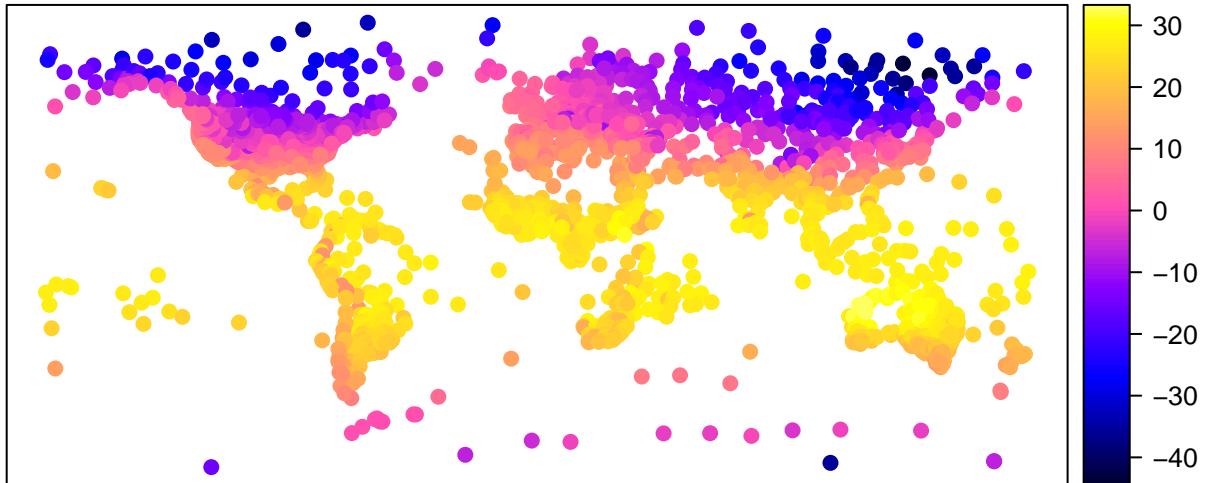


Figure 3: Mean temperature Winter from 1990 to 2010

### 3.1.4 Summer after 1990

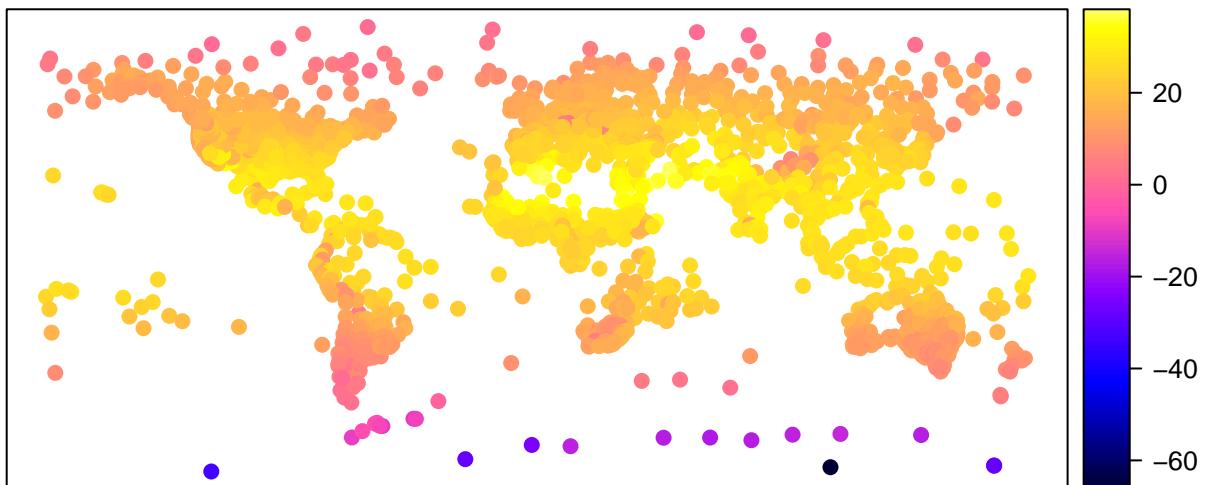
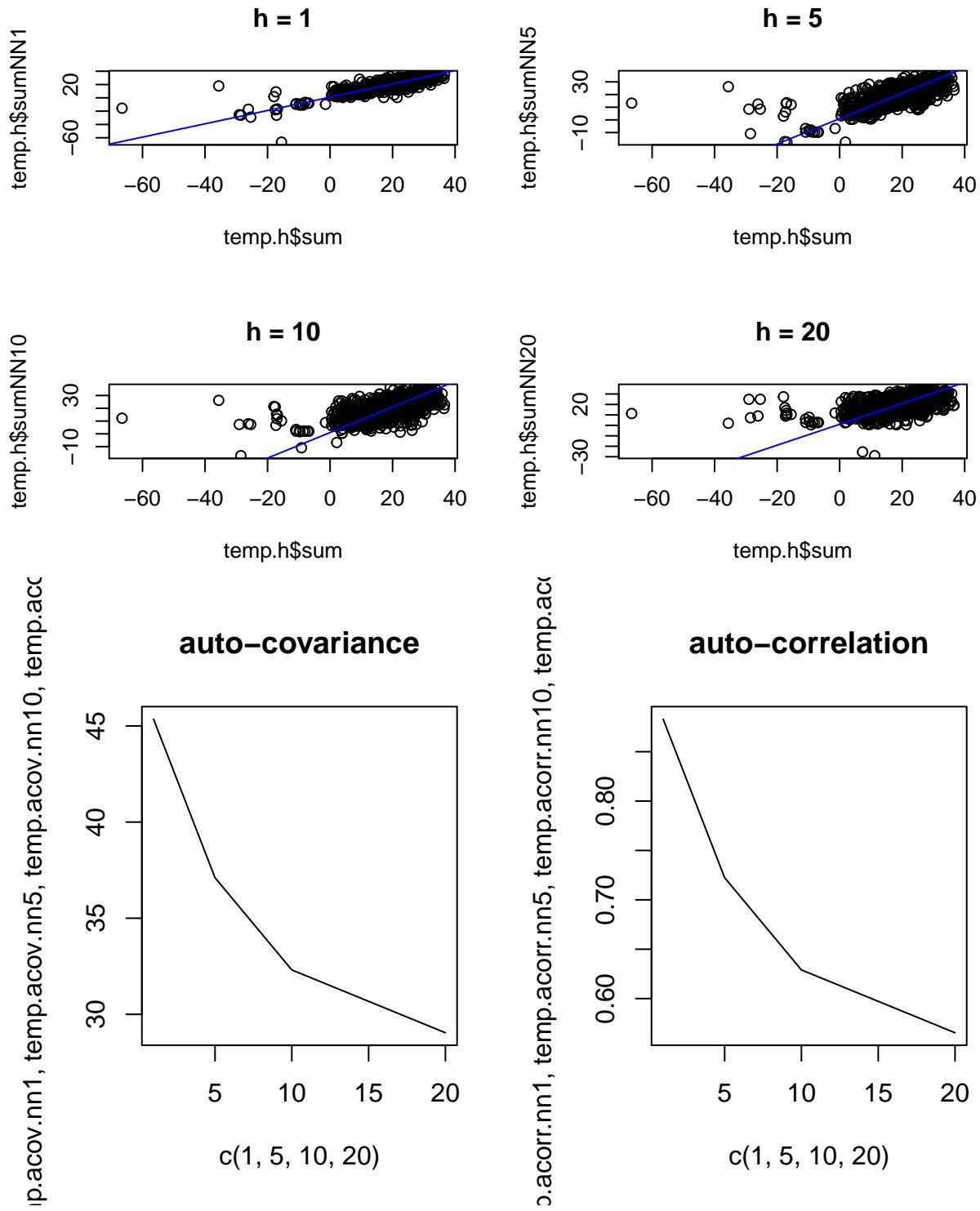


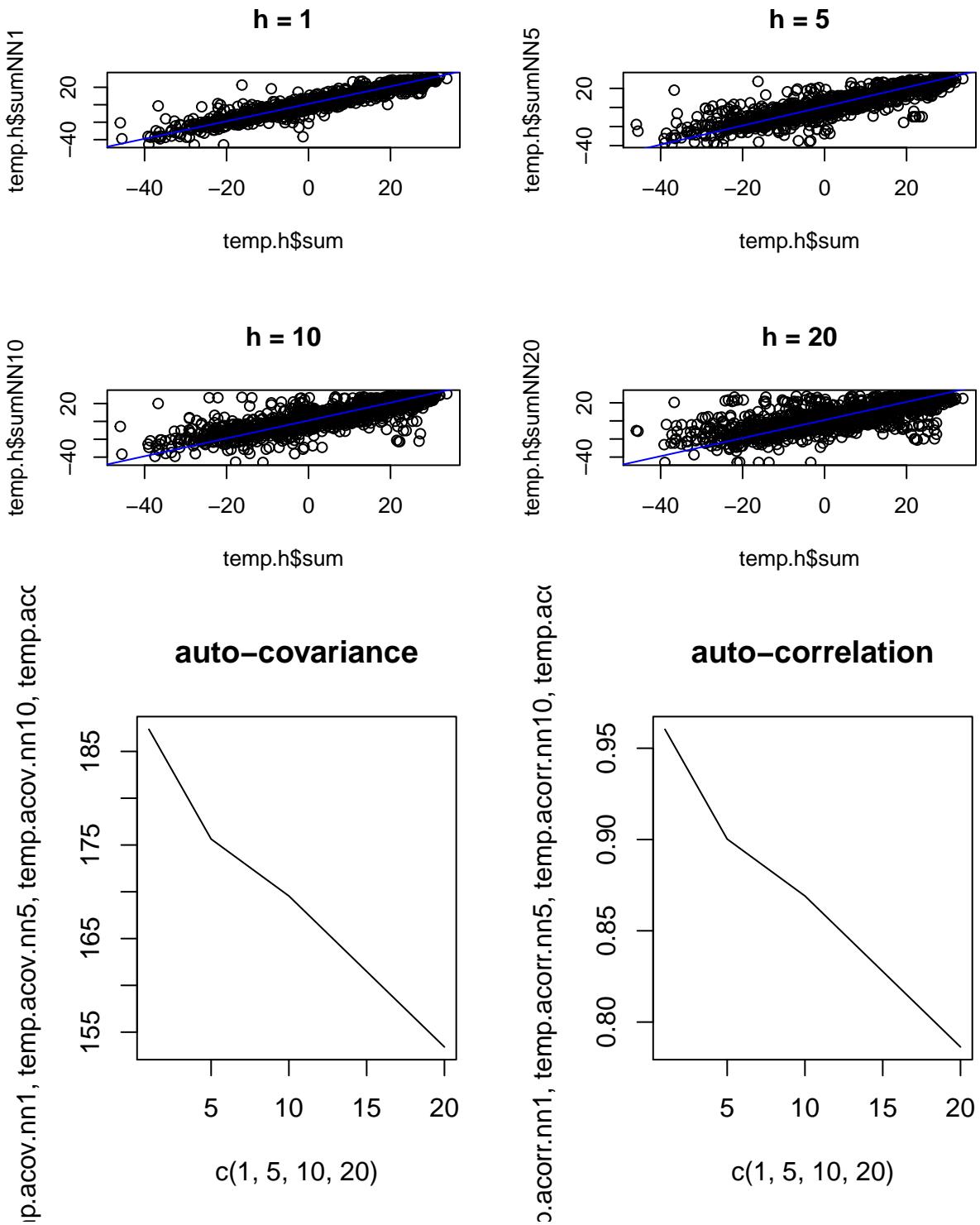
Figure 4: Mean temperature Winter from 1990 to 2010

## 3.2 H - Scatterplots and autocovariance plots

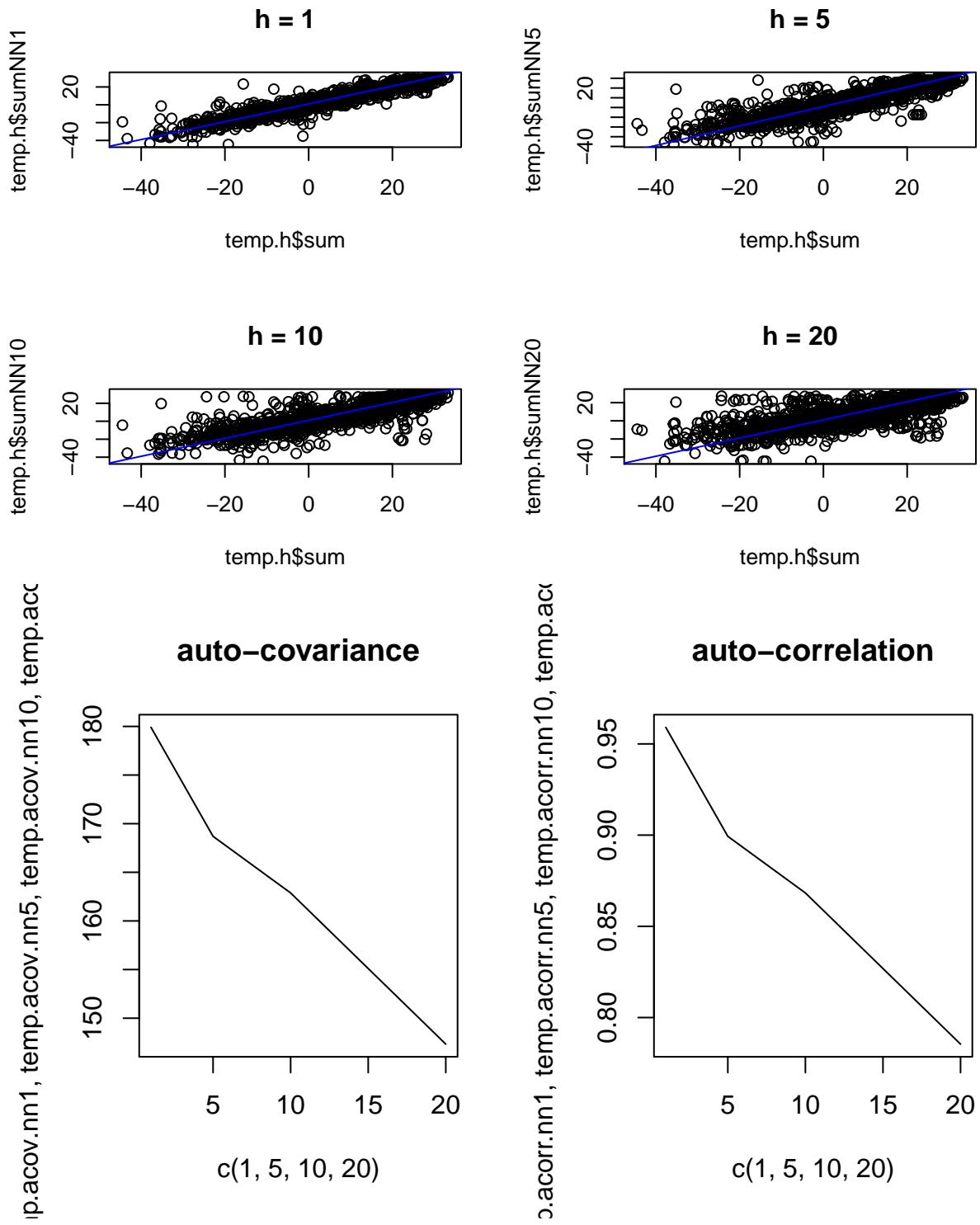
### 3.2.1 Summer before 1970



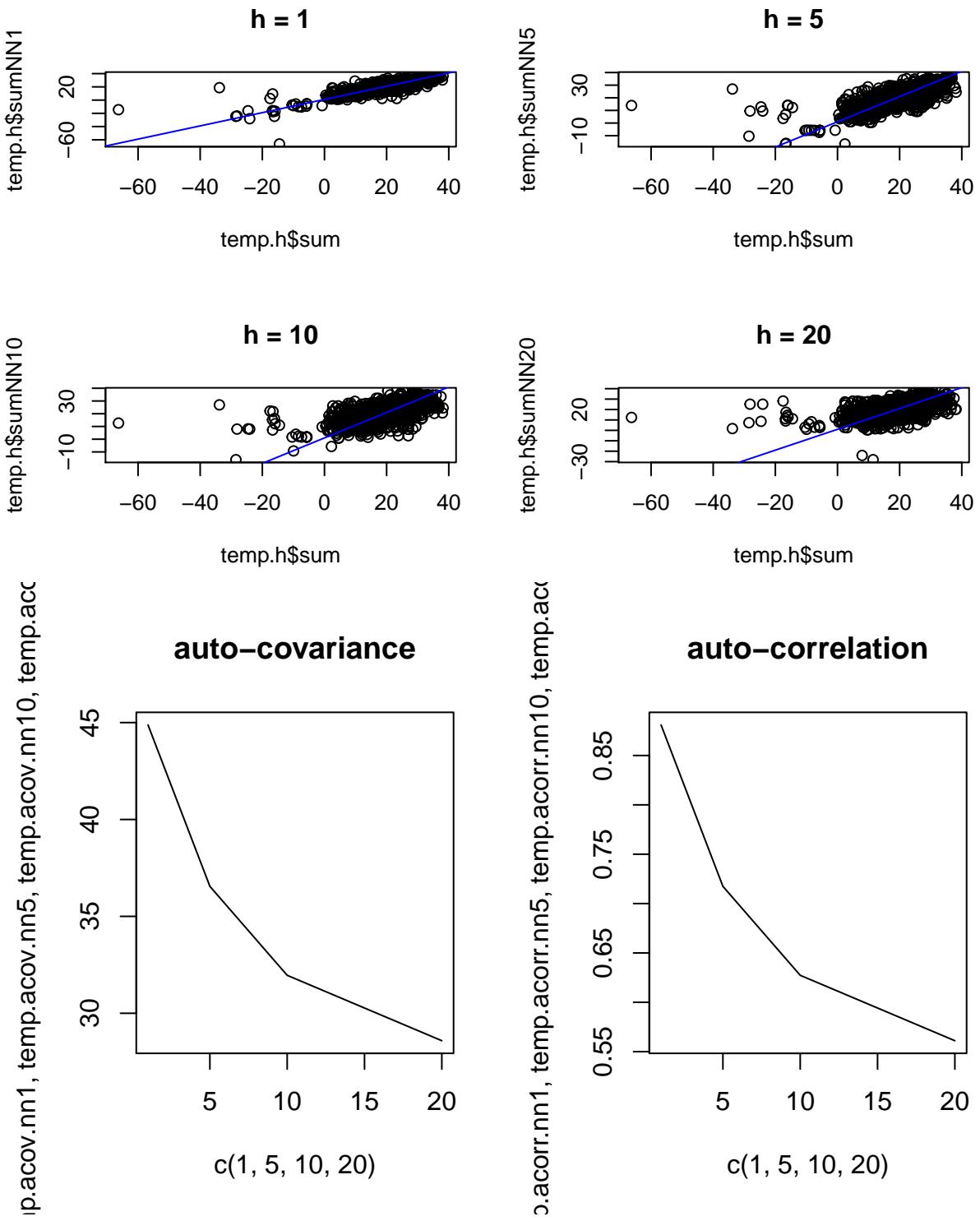
### 3.2.2 Winter before 1970



### 3.2.3 Winter after 1990

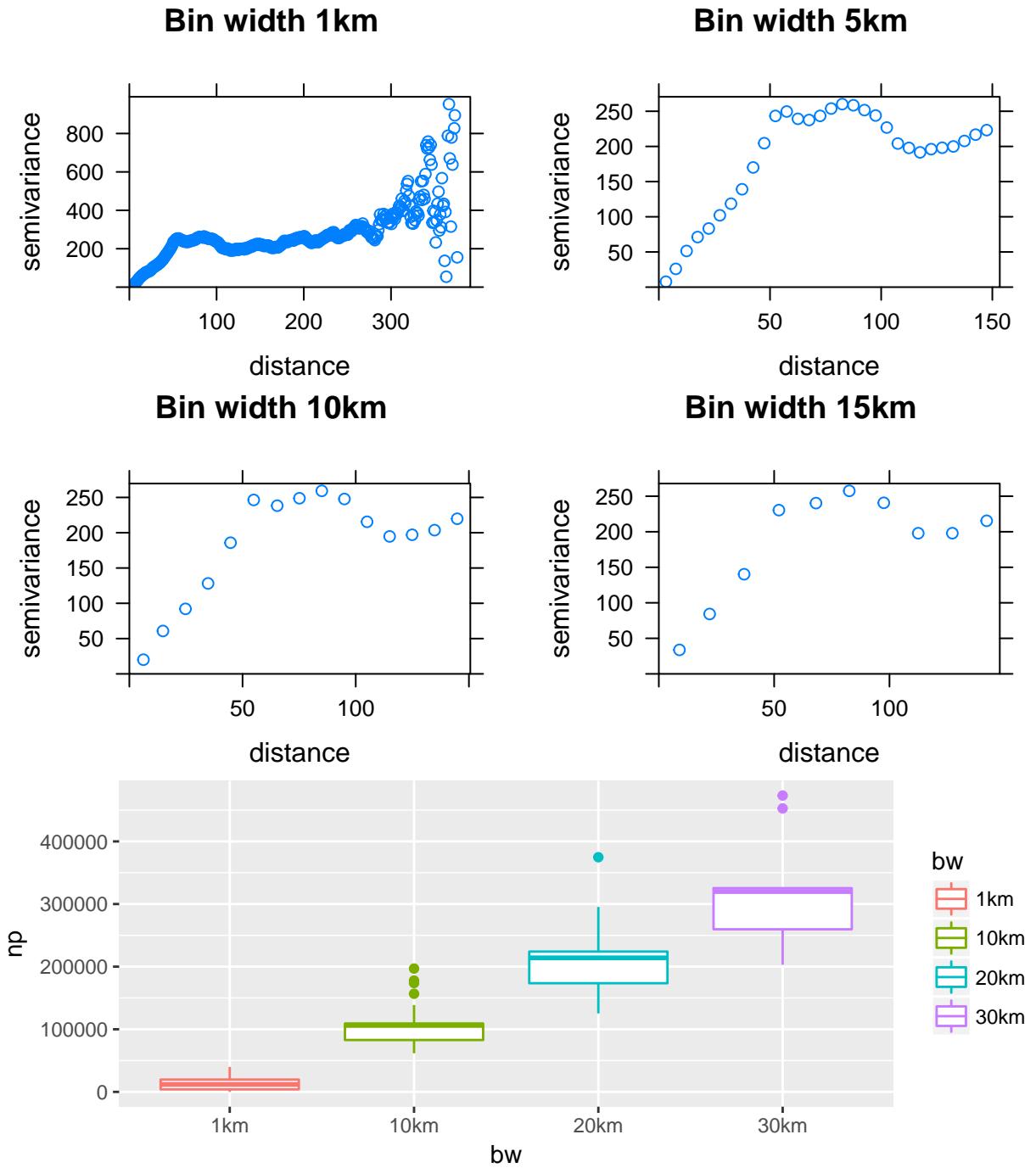


### 3.2.4 Summer after 1990

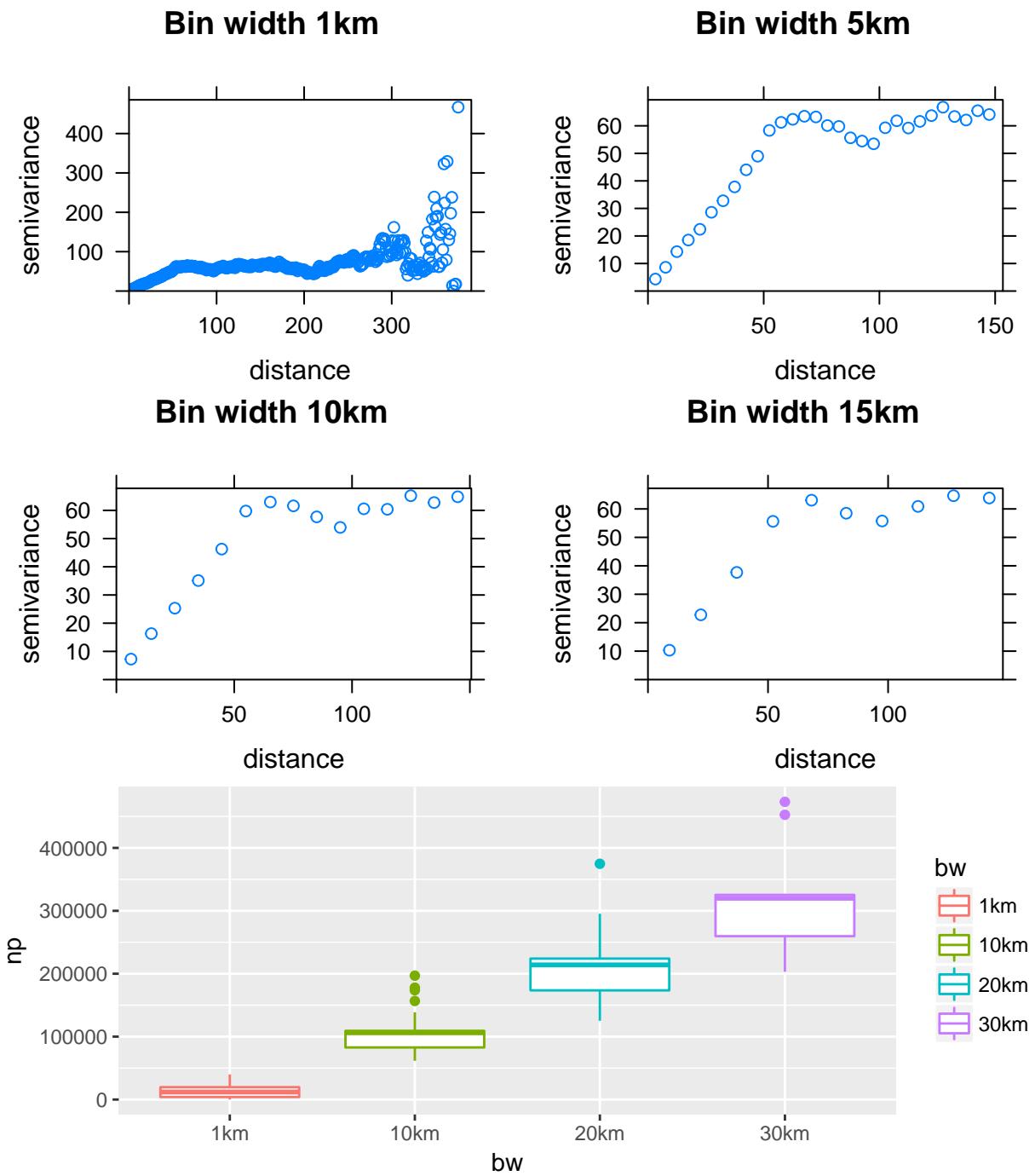


### 3.3 Empirical Variogram

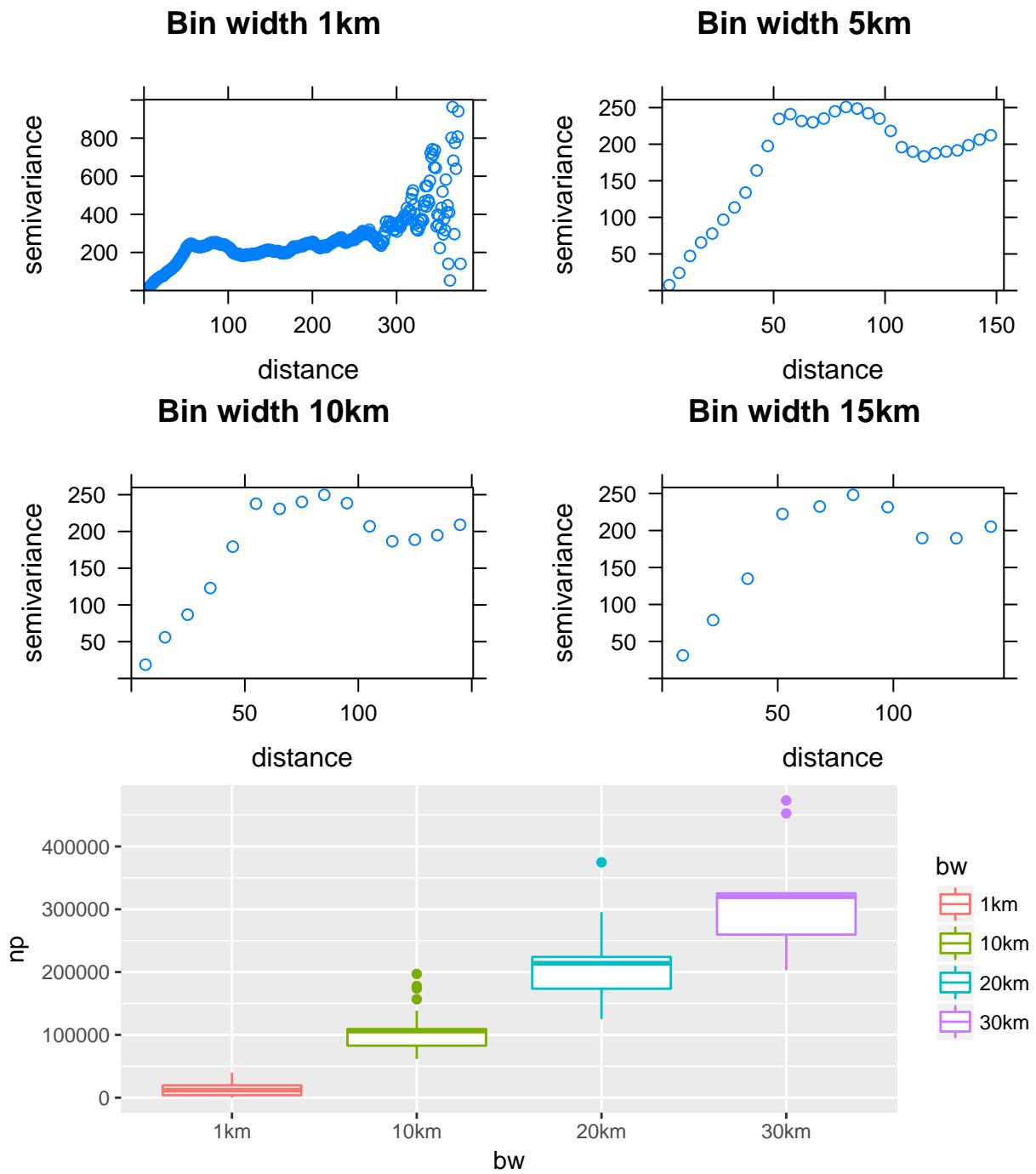
#### 3.3.1 Winter before 1970



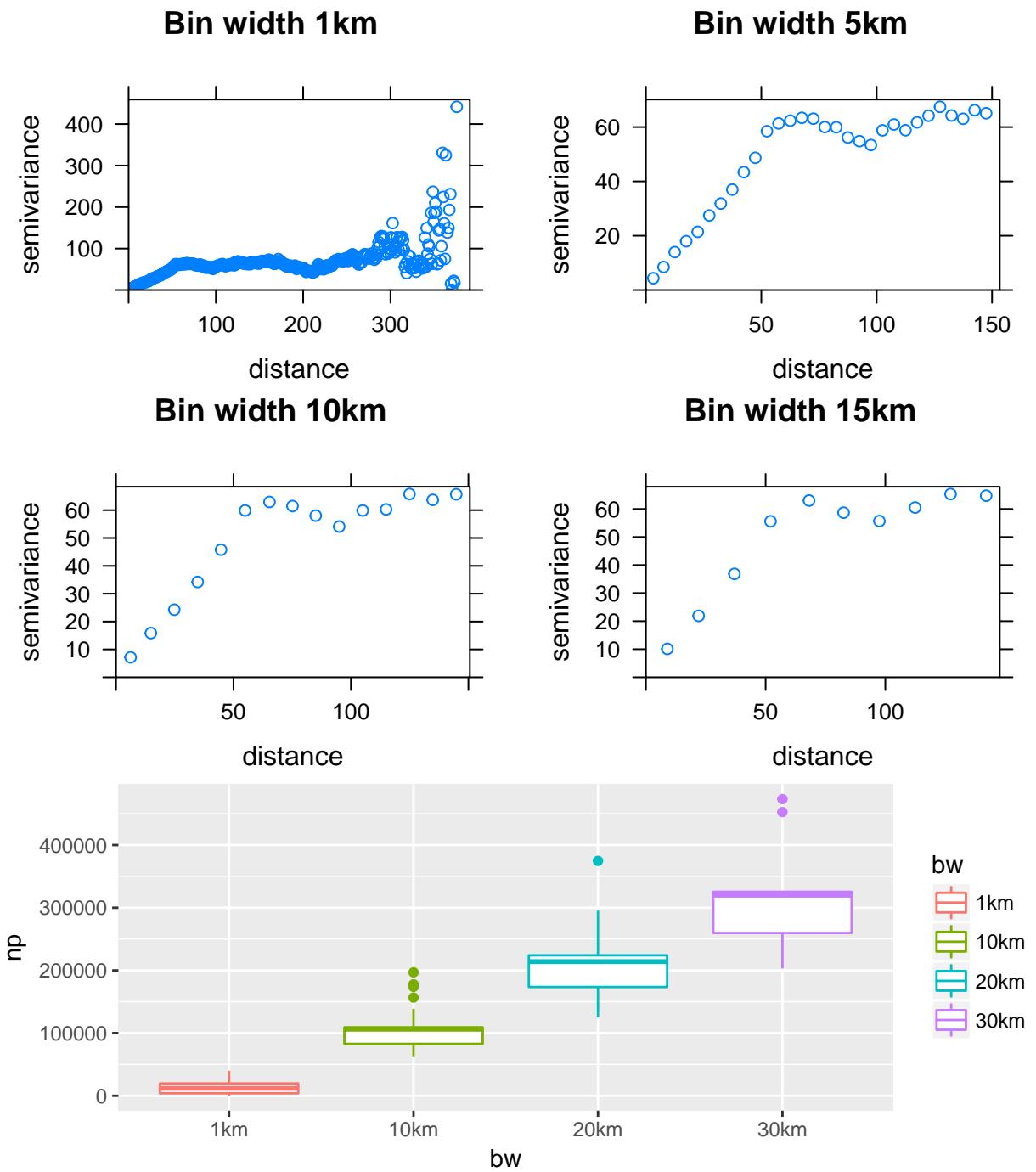
### 3.3.2 Summer before 1970



### 3.3.3 Winter before 2010



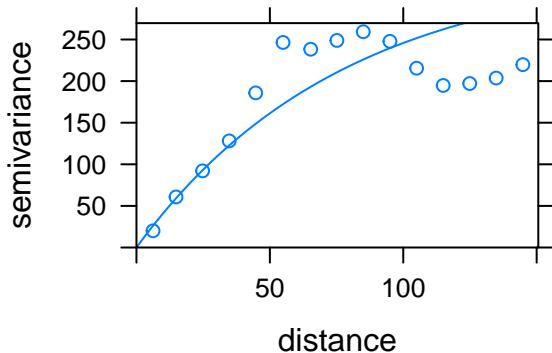
### 3.3.4 Summer before 2010



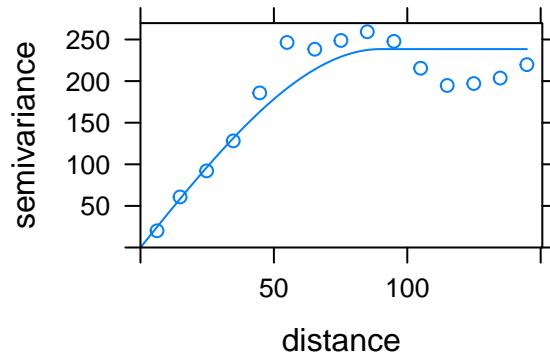
## 3.4 Fitted Semivariogram

### 3.4.1 Winter before 1970

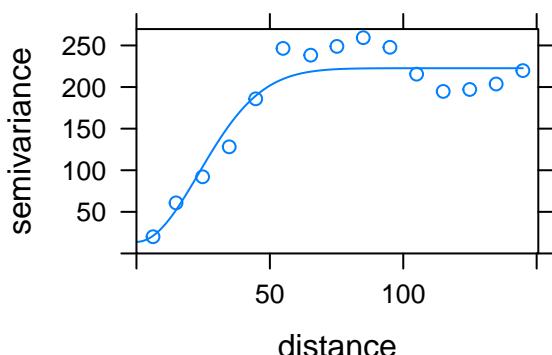
**Exponential: 10km**



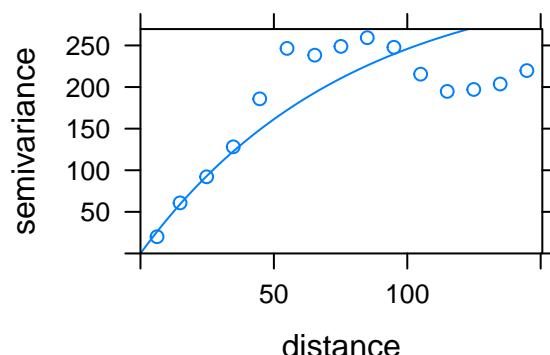
**Spherical: 10km**



**Gaussian: 10km**

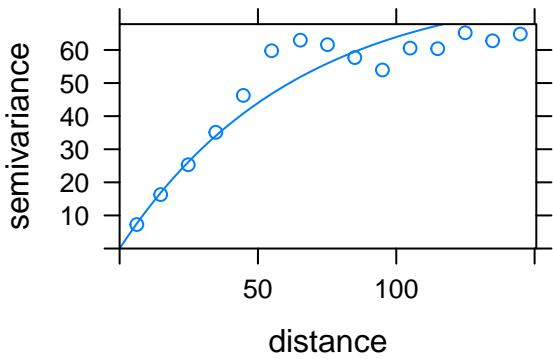


**Mat: 10km**

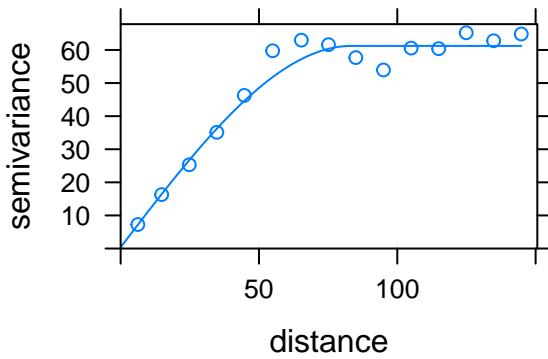


### 3.4.2 Summer before 1970

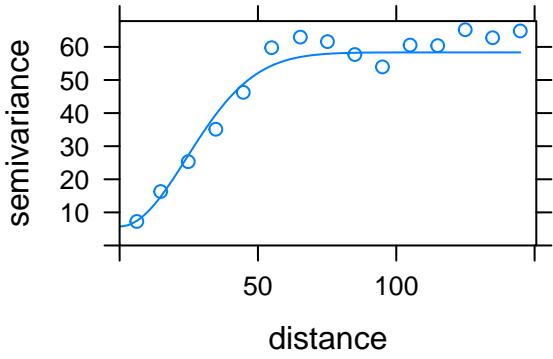
**Exponential: 10km**



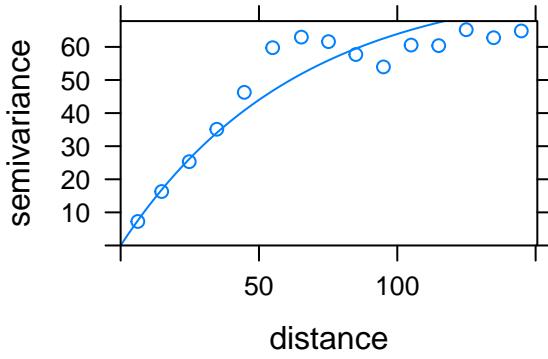
**Spherical: 10km**



**Gaussian: 10km**

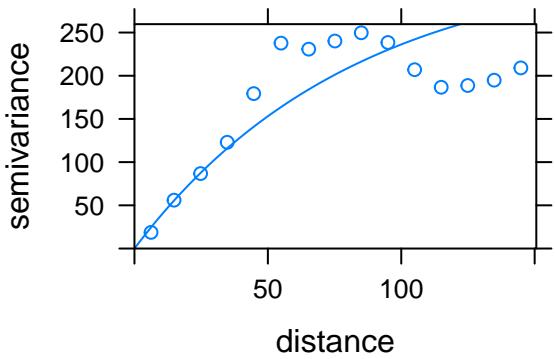


**Mat: 10km**

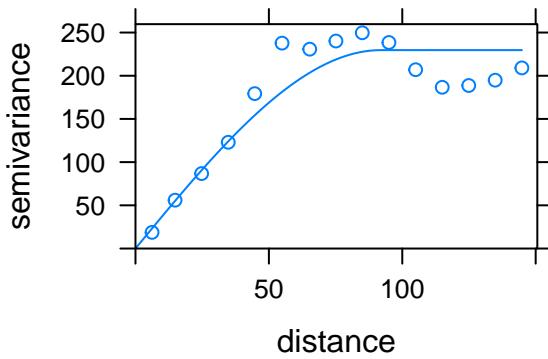


### 3.4.3 Winter after 1990

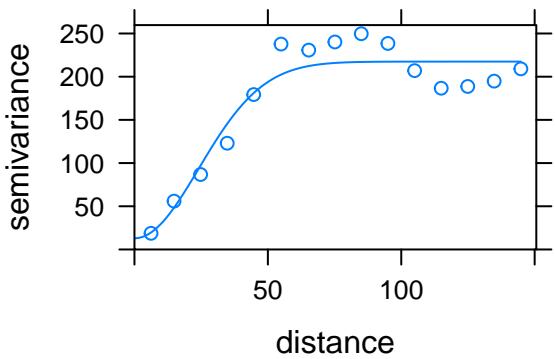
**Exponential: 10km**



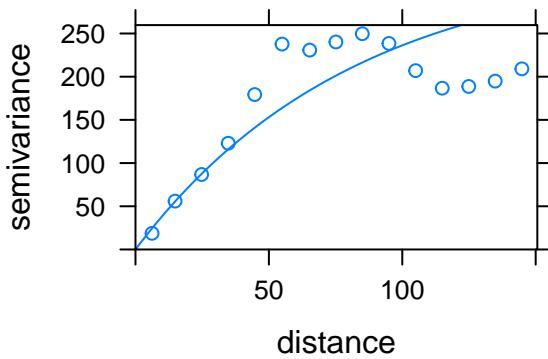
**Spherical: 10km**



**Gaussian: 10km**

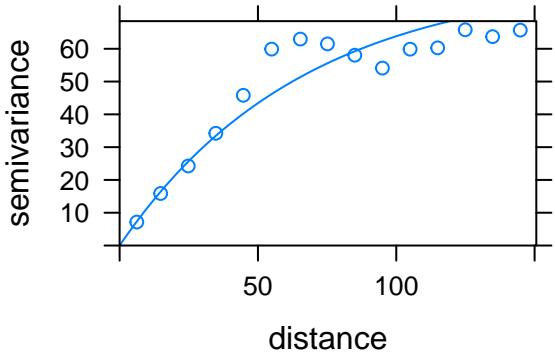


**Mat: 10km**

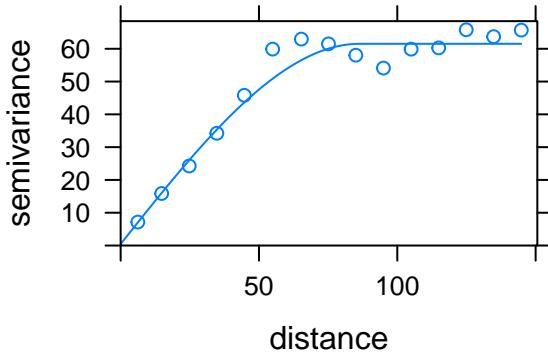


### 3.4.4 Summer after 1990

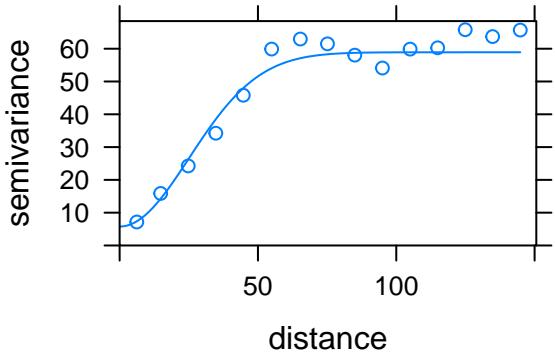
**Exponential: 10km**



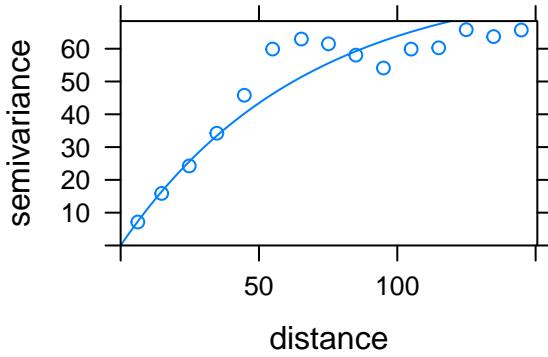
**Spherical: 10km**



**Gaussian: 10km**



**Mat: 10km**



## 4 Ordinary krigin cross-validation

### 4.1 Winter before 1970

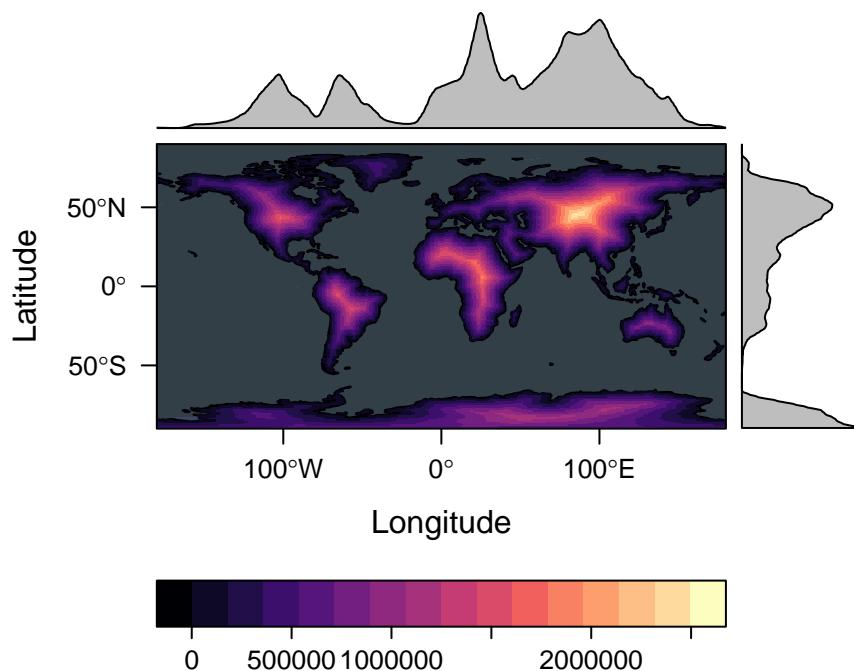
### 4.2 Summer before 1970

### 4.3 Winter after 1990

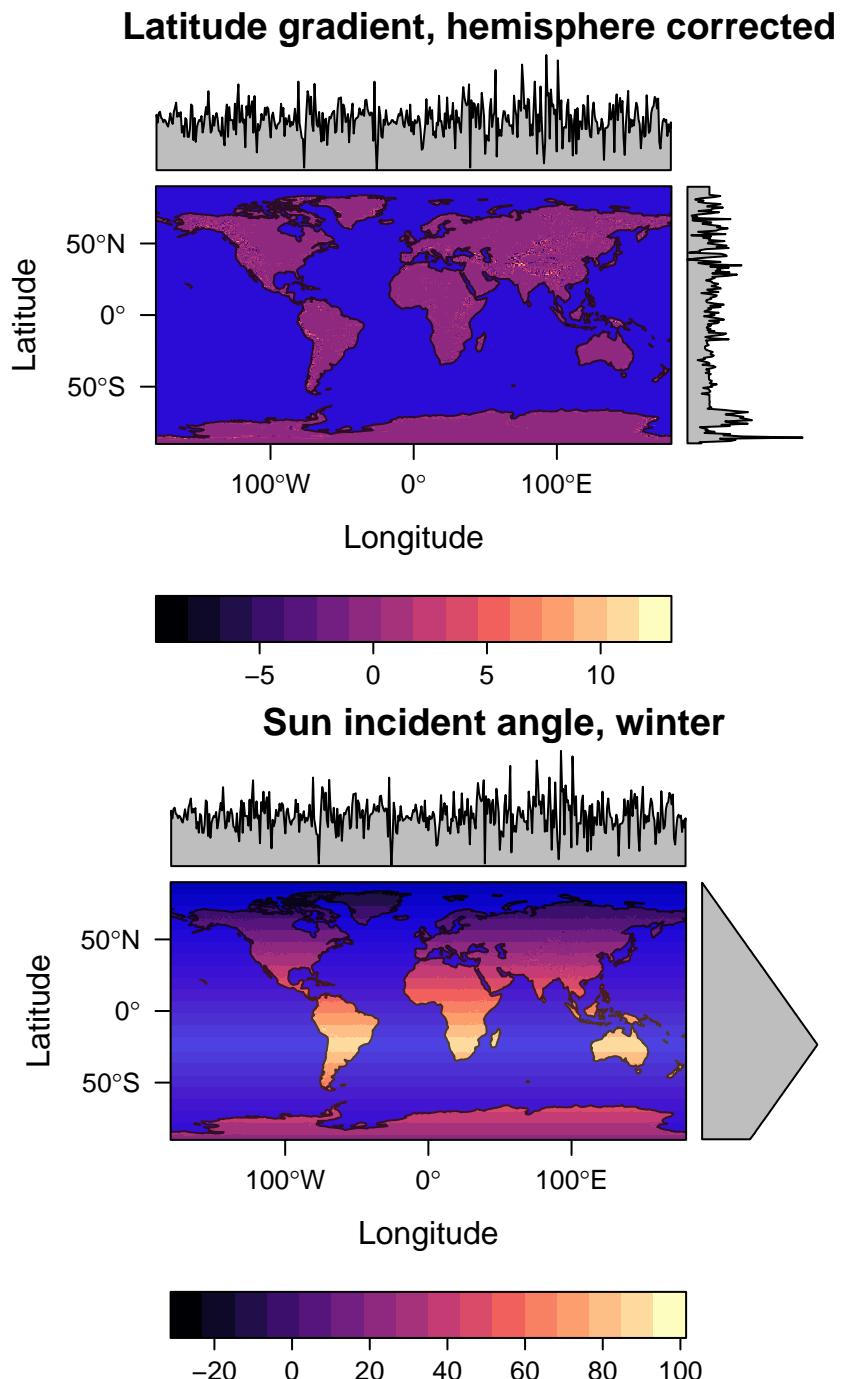
### 4.4 Summer after 1990

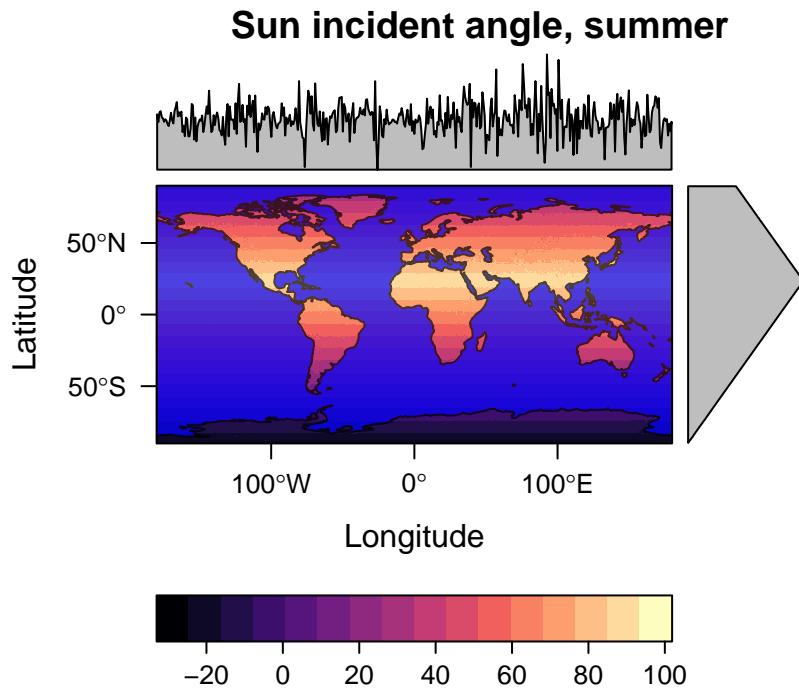
## 5 Task II: Universal ordinary Krigin

### 5.1 Continentiality: Create distance to ocean layer



## 5.2 Sun incidence angle

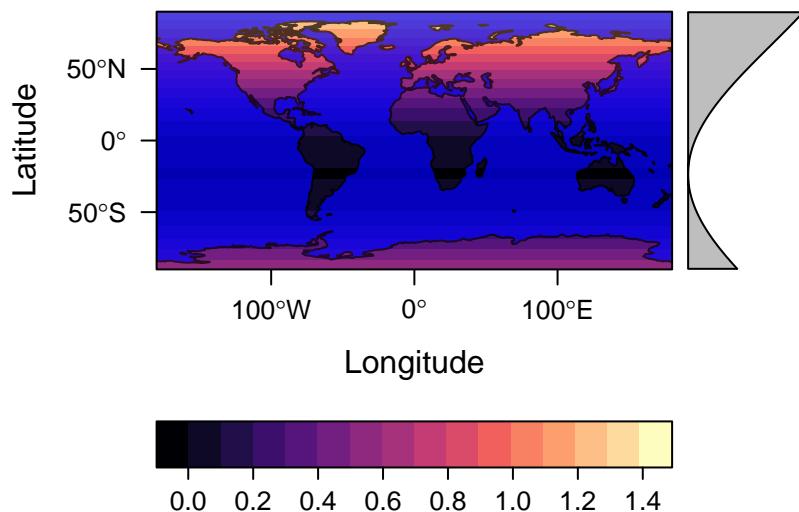




### 5.3 Atmospheric distance

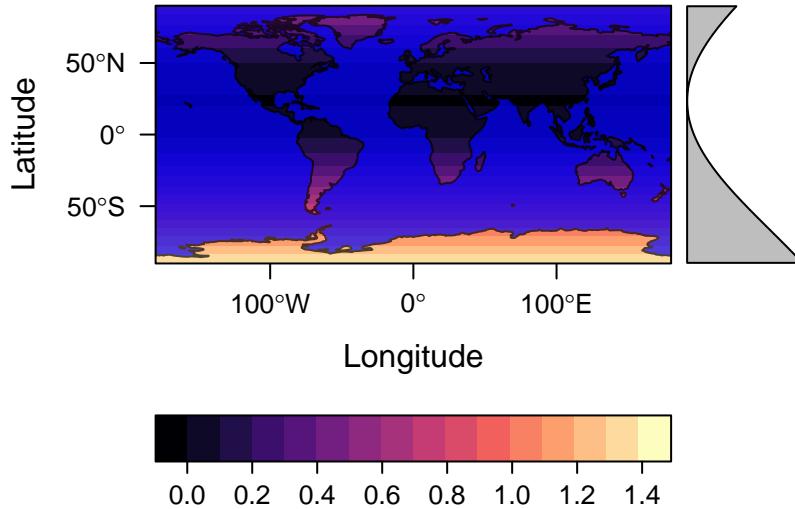
```
## Warning in min(x): kein nicht-fehlendes Argument für min; gebe Inf zurück
## Warning in max(x): kein nicht-fehlendes Argument für max; gebe -Inf zurück
```

**Atmospheric distance, winter**



```
## Warning in min(x): kein nicht-fehlendes Argument für min; gebe Inf zurück
## Warning in min(x): kein nicht-fehlendes Argument für max; gebe -Inf zurück
```

## Atmospheric distance, winter

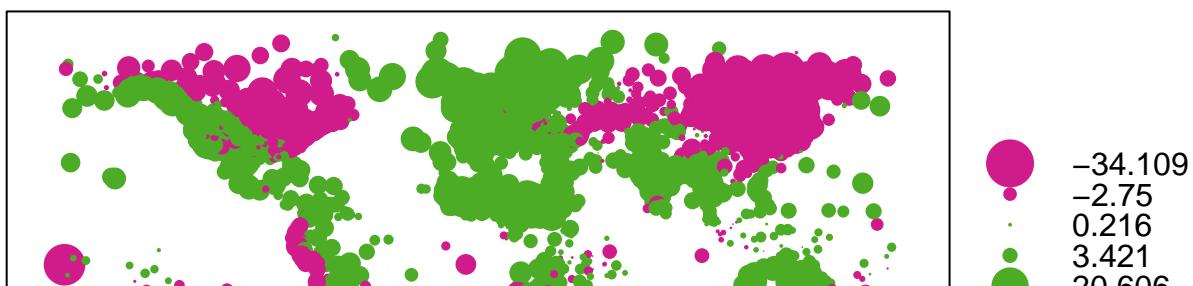


### 5.4 Interpolation

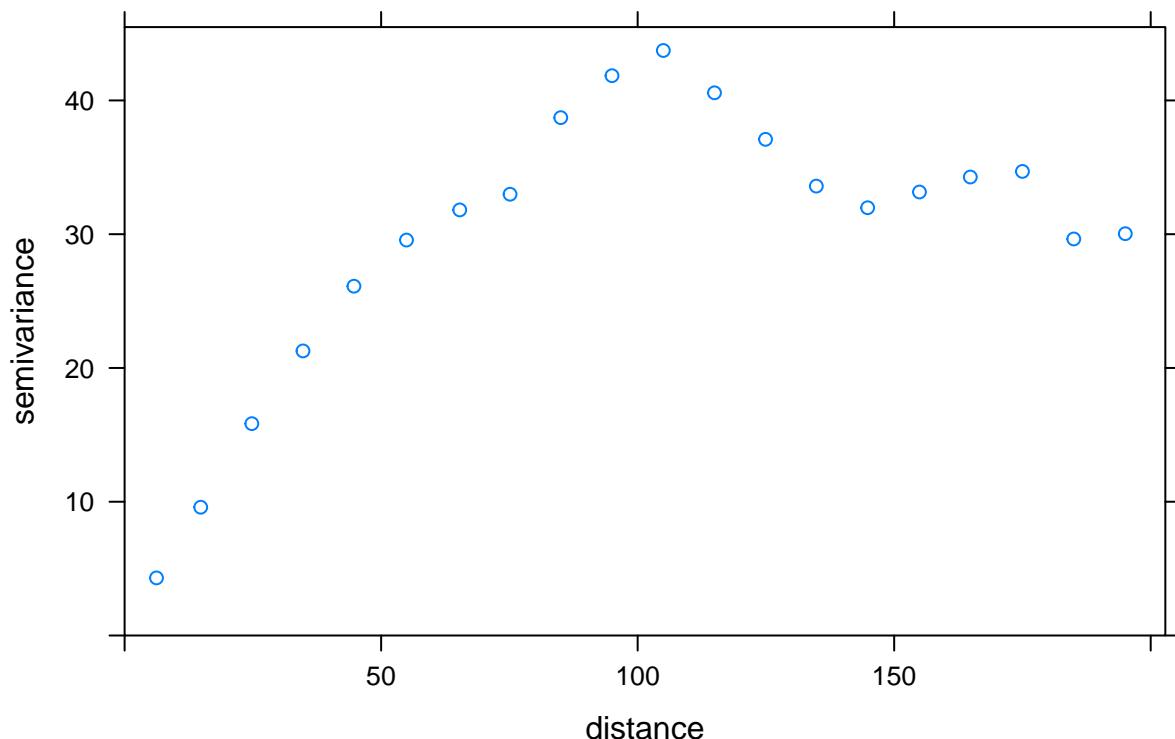
#### 5.4.1 Winter before 1970

```
##  
## Call:  
## lm(formula = meansum ~ elev + cont + hsun + dist, data = temp1970w@data)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -34.109  -2.750    0.216   3.421  20.606  
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 52.2396444411 1.5299244402 34.15 <2e-16 ***  
## elev        -0.0024463224 0.0001861152 -13.14 <2e-16 ***  
## cont        -0.0000047861 0.0000002419 -19.79 <2e-16 ***  
## hsun        -0.3100218749 0.0198648394 -15.61 <2e-16 ***  
## dist        -71.2441908822 1.7474754031 -40.77 <2e-16 ***  
## ---  
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 5.381 on 3024 degrees of freedom  
## Multiple R-squared: 0.8518, Adjusted R-squared: 0.8516  
## F-statistic: 4345 on 4 and 3024 DF, p-value: < 2.2e-16
```

## Residual Values

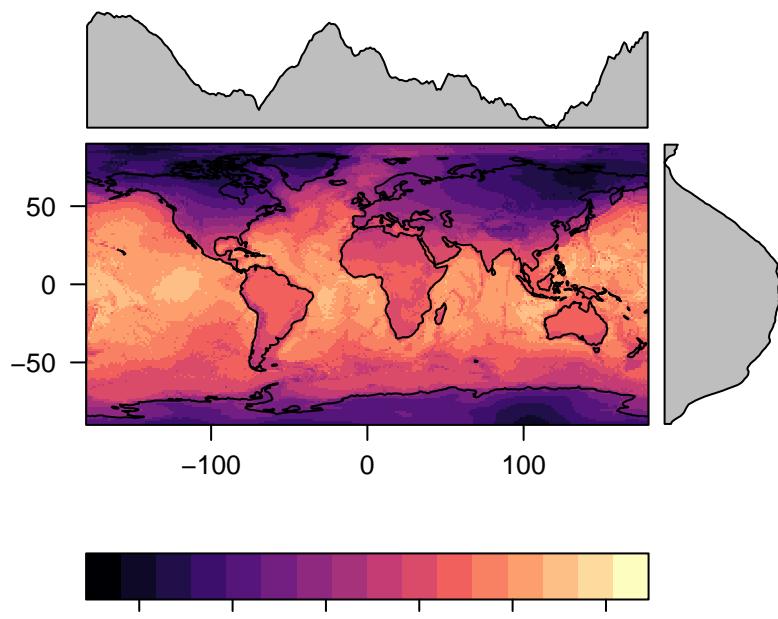


## Residual Variogram

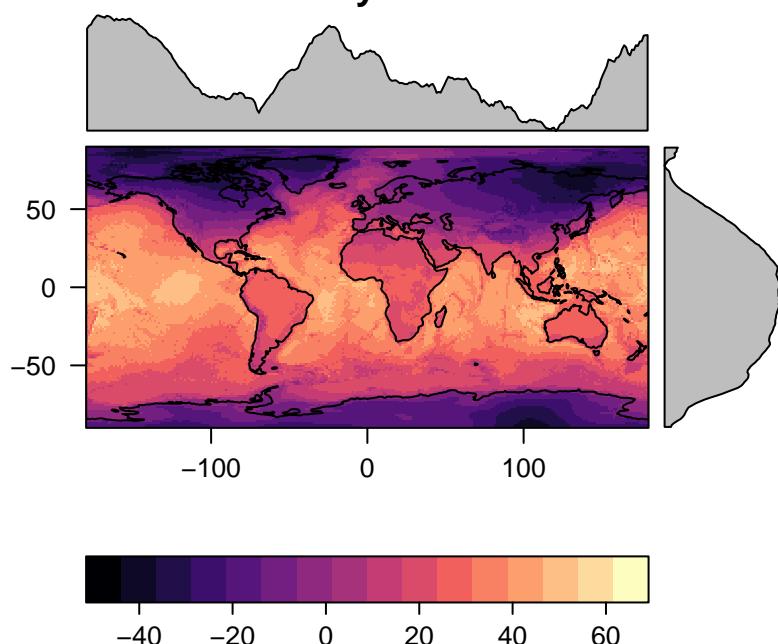


```
## [1] "Observed autocorrelation: 0.200251309290595 | p-value of H0 (residuals are randomly distributed)"  
## [using universal kriging]
```

**Prediction: Winter before 1970**



**Uncertainty: Winter before 1970**



**5.4.2 Summer before 1970**

**5.4.3 Winter after 1990**

**5.4.4 Summer after 1990**

**5.5 Ordinary Krigin**

**5.5.1 Winter before 1970**

**5.5.2 Summer before 1970**

**5.5.3 Winter after 1990**

**5.5.4 Summer after 1990**