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1
2 set city      city codes
3 $INCLUDE E:\Chen\Air pollution\YJJ\API\R&R_2018_May\GAMS_spatialPM\citycodes.txt
4 ;
5 set year      /2014*2016/
6   month      /1*12/
7   day         /1*31/
8   coordinate  /latitude, longitude/
9
10 alias (city cityj)
11
12 *$call =xls2gms
13 Table c_c(city,coordinate)  city coordinates
14 $include E:\Chen\Air pollution\YJJ\API\R&R_2018_May\GAMS_spatialPM\city_coordinates.inc
15 ;
16 display c_c;
17
18 *parameter integerpart(city,coordinate), decimalpart(city,coordinate);
19 *integerpart(city,coordinate)=  ceil(c_c(city,coordinate)/100)-1;
20 *decimalpart(city,coordinate)= c_c(city,coordinate)- integerpart(city,coordinate)*100;
21 *c_c(city,coordinate)= integerpart(city,coordinate)+ decimalpart(city,coordinate)/60;
22 *display c_c;
23
24 parameter c_c_radian(city,coordinate) converting city coordinates into radians;
25 c_c_radian(city,coordinate)= c_c(city,coordinate)*PI/180;
26
27 parameter distance(city,cityj) in kilometers;
28 distance(city,cityj)$ (ord(city) ne ord(cityj))= 6371*ARCCOS(COS(c_c_radian(city,'latitude'))*COS(c_c_radian(cityj,'latitude'))*COS(c_c_radian(»
city,'longitude')-c_c_radian(cityj,'longitude'))+SIN(c_c_radian(city,'latitude'))*SIN(c_c_radian(cityj,'latitude')));
29 display distance;
30
31 parameter CityC(city,cityj,coordinate), distanceA_C(city,cityj), ratio(city,cityj), theta(city,cityj);
32
33 LOOP((city,cityj)$ (ord(city) ne ord(cityj)),
34
35   CityC(city,cityj,'latitude')= c_c_radian(city,'latitude');
36   CityC(city,cityj,'longitude')= c_c_radian(cityj,'longitude');
37
38   distanceA_C(city,cityj)= 6371*ARCCOS(COS(c_c_radian(city,'latitude'))*COS(CityC(city,cityj,'latitude'))*COS(c_c_radian(city,'longitude')-»
CityC(city,cityj,'longitude'))+SIN(c_c_radian(city,'latitude'))*SIN(CityC(city,cityj,'latitude')));

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39
40     ratio(city,cityj)$distance(city,cityj)= distanceA_C(city,cityj)/distance(city,cityj);
41     ratio(city,cityj)$(ratio(city,cityj) ge 1)=0.998;
42     ratio(city,cityj)$(ratio(city,cityj) eq 0)=0.002;
43     theta(city,cityj)$distance(city,cityj)=ARCCOS(ratio(city,cityj))*180/PI;
44 );
45 display distanceA_C, ratio, theta;
46
47 parameter relativelocation(city,cityj) identify location of cityj relative to city;
48
49 Loop((city,cityj)$(ord(city) ne ord(cityj)),
50     relativelocation(city,cityj)$(c_c(cityj,'latitude') ge c_c(city,'latitude') and c_c(cityj,'longitude') ge c_c(city,'longitude')) =1;
51     relativelocation(city,cityj)$(c_c(cityj,'latitude') ge c_c(city,'latitude') and c_c(cityj,'longitude') le c_c(city,'longitude')) =2;
52     relativelocation(city,cityj)$(c_c(cityj,'latitude') le c_c(city,'latitude') and c_c(cityj,'longitude') le c_c(city,'longitude')) =3;
53     relativelocation(city,cityj)$(c_c(cityj,'latitude') le c_c(city,'latitude') and c_c(cityj,'longitude') ge c_c(city,'longitude')) =4;
54 );
55 *display relativelocation;
56
57     theta(city,cityj)$(relativelocation(city,cityj) eq 1) = 90-theta(city,cityj);
58     theta(city,cityj)$(relativelocation(city,cityj) eq 2) = 270+theta(city,cityj);
59     theta(city,cityj)$(relativelocation(city,cityj) eq 3) = 270-theta(city,cityj);
60     theta(city,cityj)$(relativelocation(city,cityj) eq 4) = 90+theta(city,cityj);
61 *display theta;
62
63
64 parameter direction(city,cityj);
65 $ontext
66 direction(city,cityj)$(theta(city,cityj) le 22.5)= 1;
67 direction(city,cityj)$(theta(city,cityj) gt 22.5 and theta(city,cityj) le 67.5)= 2;
68 direction(city,cityj)$(theta(city,cityj) gt 67.5 and theta(city,cityj) le 112.5)= 3;
69 direction(city,cityj)$(theta(city,cityj) gt 112.5 and theta(city,cityj) le 157.5)= 4;
70 direction(city,cityj)$(theta(city,cityj) gt 157.5 and theta(city,cityj) le 202.5)= 5;
71 direction(city,cityj)$(theta(city,cityj) gt 202.5 and theta(city,cityj) le 247.5)= 6;
72 direction(city,cityj)$(theta(city,cityj) gt 247.5 and theta(city,cityj) le 292.5)= 7;
73 direction(city,cityj)$(theta(city,cityj) gt 292.5 and theta(city,cityj) le 337.5)= 8;
74 direction(city,cityj)$(theta(city,cityj) gt 337.5)= 1;
75 direction(city,city)=0;
76 $offtext
77
78 direction(city,cityj)$(theta(city,cityj) le 11.25)= 1;

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79 direction(city,cityj)$(theta(city,cityj) gt 11.25 and theta(city,cityj) le 56.25)= 2;
80 direction(city,cityj)$(theta(city,cityj) gt 56.25 and theta(city,cityj) le 101.25)= 3;
81 direction(city,cityj)$(theta(city,cityj) gt 101.25 and theta(city,cityj) le 146.25)= 4;
82 direction(city,cityj)$(theta(city,cityj) gt 146.25 and theta(city,cityj) le 191.25)= 5;
83 direction(city,cityj)$(theta(city,cityj) gt 191.25 and theta(city,cityj) le 236.25)= 6;
84 direction(city,cityj)$(theta(city,cityj) gt 236.25 and theta(city,cityj) le 281.25)= 7;
85 direction(city,cityj)$(theta(city,cityj) gt 281.25 and theta(city,cityj) le 326.25)= 8;
86 direction(city,cityj)$(theta(city,cityj) gt 326.25)= 1;
87 direction(city,city)=0;
88 display direction;
89
90
91 *****city size measured by GDP*****
92 *$call =xls2gms
93 Table citysize(city,*)
94 $include E:\Chen\Air pollution\YJJ\API\R&R_2018_May\GAMS_spatialPM\city_gdp.inc
95 ;
96 citysize(city,'GDP')= citysize(city,'GDP');
97 *display citysize;
98
99 *$call =xls2gms
100 Table api(city,year,month,day,*)
101 $include E:\Chen\Air pollution\YJJ\API\R&R_2018_May\GAMS_spatialPM\city_api_2014_2016.inc
102 ;
103
104 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 3)= 2;
105 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 4)= 3;
106 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 5)= 3;
107 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 6)= 4;
108 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 7)= 4;
109 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 8)= 5;
110 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 9)= 5;
111 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 10)= 6;
112 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 11)= 6;
113 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 12)= 7;
114 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 13)= 7;
115 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 14)= 8;
116 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 15)= 8;
117 api(city,year,month,day,'maxspeeddirection')$(api(city,year,month,day,'maxspeeddirection') eq 16)= 1;
118 *api(city,year,month,day,'api')$(api(city,year,month,day,'gasline') and api(city,year,month,day,'api') eq 0)= 0.001;

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119 *display api;
120
121
122
123
124
125 *$ontext
126 *****part 1: constructing spatial weights matrix: considering wind speed, wind direction, and distance*****
127 parameter wind_traveltime(cityj,city,year,month,day) in seconds from cityj to city;
128 wind_traveltime(cityj,city,year,month,day)$api(cityj,year,month,day,'windspeed') = distance(city,cityj)*1000/(10*api(cityj,year,month,day,'win»
    dspeed'));
129 *display wind_traveltime;
130
131 scalar oneday in seconds /86400/
132 twodays in seconds /172800/
133
134 parameter delta_direction(city,cityj,year,month,day,*) difference in direction i j and wind direction in city j
135 spatial_weight(city,cityj,year,month,day) zero or one;
136
137 delta_direction(city,cityj,year,month,day,'delta_direction')$(direction(city,cityj) and api(cityj,year,month,day,'maxspeeddirection'))
138 = direction(city,cityj)- api(cityj,year,month,day,'maxspeeddirection');
139
140 spatial_weight(city,cityj,year,month,day)=0;
141 spatial_weight(city,cityj,year,month,day)$(direction(city,cityj) and wind_traveltime(cityj,city,year,month,day) le oneday and api(cityj,year,m»
    onth,day,'maxspeeddirection') and delta_direction(city,cityj,year,month,day,'delta_direction') eq 0)=1;
142 ***considering wind speed, api should arrive within 24hours or 86400 seconds*****
143
144
145 parameter distance_inverse(city,cityj);
146 *distance_inverse(city,cityj)$distance(city,cityj)=1/distance(city,cityj);
147 *Scenario 1: 1/x
148 *distance_inverse(city,cityj)$distance(city,cityj)=1/(distance(city,cityj)+ distance(city,cityj)*distance(city,cityj));
149 *Scenario 2:1/(x+x2)
150 *distance_inverse(city,cityj)$distance(city,cityj)=1/(distance(city,cityj)**0.5);
151 *Scenario 3:1/(x**0.5)
152 distance_inverse(city,cityj)$distance(city,cityj)=
153 1/(abs(distance(city,cityj)-50) +0.5*(abs(distance(city,cityj)-50))**2+ 1/6*(abs(distance(city,cityj)-50))**3 + 1/24*(abs(distance(city,cityj)»
    -50))**4);
154 *Scenario 4:1/(exp(x)) around 50 kilometers
155

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156 distance_inverse(city,city)=0;
157 *display distance, distance_inverse;
158
159 set items /PM_J_distanceonly, PM_J_withwind, PM_J_withwind_onedaylag/
160
161 parameter mutiplier_distance(city,cityj)
162         sum_dist_inverse(city) row standardization
163         X_distance(city)
164         SPATIALWEIGHT_PM(city,year,month,day,*) consider PM effects from neighboring cities;
165
166 mutiplier_distance(city,cityj)= citysize(cityj,'GDP')*distance_inverse(city,cityj);
167 sum_dist_inverse(city)= sum(cityj, mutiplier_distance(city,cityj));
168 X_distance(city)$sum_dist_inverse(city)=1/sum_dist_inverse(city);
169 SPATIALWEIGHT_PM(city,year,month,day,'PM_J_distanceonly')= sum(cityj, X_distance(city)*mutiplier_distance(city,cityj)*api(cityj,year,month,day »
, 'concentration_PM25' ));
170
171 parameter mutiplier(city,cityj,year,month,day)
172         sum_dist_inverse_windstandard(city,year,month,day) row standardization
173         X_wind(city,year,month,day);
174
175 mutiplier(city,cityj,year,month,day)$api(cityj,year,month,day,'windspeed')= citysize(cityj,'GDP')/API(cityj,year,month,day,'windspeed')*distan»
ce_inverse(city,cityj)*spatial_weight(city,cityj,year,month,day);
176 sum_dist_inverse_windstandard(city,year,month,day)= sum(cityj$direction(city,cityj), mutiplier(city,cityj,year,month,day));
177 X_wind(city,year,month,day)$sum_dist_inverse_windstandard(city,year,month,day)=1/sum_dist_inverse_windstandard(city,year,month,day);
178 SPATIALWEIGHT_PM(city,year,month,day,'PM_J_withwind')= sum(cityj$direction(city,cityj), X_wind(city,year,month,day)*mutiplier(city,cityj,year, »
month,day)*API(cityj,year,month,day,'concentration_PM25' ));
179 *$offtext
180
181 $ontext
182 parameter test_MUL(cityj,*), test_X;
183 test_MUL(cityj,'CITYSIZE')= citysize(cityj,'realgdp');
184 test_MUL(cityj,'wind_mean')= pm10(cityj,'2009','1','7','wind_mean');
185 test_MUL(cityj,'distinverse')= distance_inverse('ANSHAN',cityj);
186 test_MUL(cityj,'spatialweights')= spatial_weight('ANSHAN',cityj,'2009','1','7');
187 test_MUL(cityj,'MULTIPLIER1')= mutiplier('ANSHAN',cityj,'2009','1','7');
188 test_X= X_wind('ANSHAN','2009','1','7');
189 test_MUL(cityj,'PM10')= PM10(cityj,'2009','1','7','PM10');
190 DISPLAY spatial_weight, test_MUL, test_X;
191 $offtext
192

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193
194
195 *$ontext
196 *****part 2: considering air pollutants on day d-1*****
197 parameter spatial_weight_dlag(city,cityj,year,month,day) spatial weights matrix on day d-1;
198 spatial_weight_dlag(city,cityj,year,month,day)=0;
199 spatial_weight_dlag(city,cityj,year,month,day)$(wind_traveltime(cityj,city,year,month,day) le twodays and wind_traveltime(cityj,city,year,month,day) gt oneday
200 and direction(city,cityj) and api(cityj,year,month,day,'maxspeeddirection') and delta_direction(city,cityj,year,month,day,'delta_direction') eq 0)=1;
201
202 parameter mutiplier_dlag(city,cityj,year,month,day)
203 sum_dist_inverse_windstandard_dlag(city,year,month,day) row standardization
204 X_wind_dlag(city,year,month,day);
205
206 mutiplier_dlag(city,cityj,year,month,day)$api(cityj,year,month,day,'windspeed')= citysize(cityj,'GDP')/api(cityj,year,month,day,'windspeed')*d»
instance_inverse(city,cityj)*spatial_weight_dlag(city,cityj,year,month,day);
207 sum_dist_inverse_windstandard_dlag(city,year,month,day)= sum(cityj$direction(city,cityj), mutiplier_dlag(city,cityj,year,month,day));
208 X_wind_dlag(city,year,month,day)$sum_dist_inverse_windstandard_dlag(city,year,month,day)=1/sum_dist_inverse_windstandard_dlag(city,year,month,day);
209
210 SPATIALWEIGHT_PM(city,year,month,day,'PM_J_withwind_onedaylag')=
211 sum(cityj$direction(city,cityj), X_wind_dlag(city,year,month,day)*mutiplier_dlag(city,cityj,year,month,day)*api(cityj,year,month,day,'concentration_PM25'));
212
213 SPATIALWEIGHT_PM(city,year,month,day,'PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,month,day-1,'PM_J_withwind_onedaylag');
214 SPATIALWEIGHT_PM(city,year,'1','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year-1,'12','31','PM_J_withwind_onedaylag');
215 SPATIALWEIGHT_PM(city,year,'2','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'1','31','PM_J_withwind_onedaylag');
216 SPATIALWEIGHT_PM(city,year,'3','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'2','28','PM_J_withwind_onedaylag');
217 SPATIALWEIGHT_PM(city,year,'4','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'3','31','PM_J_withwind_onedaylag');
218 SPATIALWEIGHT_PM(city,year,'5','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'4','30','PM_J_withwind_onedaylag');
219 SPATIALWEIGHT_PM(city,year,'6','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'5','31','PM_J_withwind_onedaylag');
220 SPATIALWEIGHT_PM(city,year,'7','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'6','30','PM_J_withwind_onedaylag');
221 SPATIALWEIGHT_PM(city,year,'8','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'7','31','PM_J_withwind_onedaylag');
222 SPATIALWEIGHT_PM(city,year,'9','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'8','31','PM_J_withwind_onedaylag');
223 SPATIALWEIGHT_PM(city,year,'10','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'9','30','PM_J_withwind_onedaylag');
224 SPATIALWEIGHT_PM(city,year,'11','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'10','31','PM_J_withwind_onedaylag');
225 SPATIALWEIGHT_PM(city,year,'12','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,year,'11','30','PM_J_withwind_onedaylag');
226 SPATIALWEIGHT_PM(city,'2016','3','1','PM_J_withwind_onedaylag')= SPATIALWEIGHT_PM(city,'2016','2','29','PM_J_withwind_onedaylag');
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228 SPATIALWEIGHT_PM(city, year, '2', '29', items)$(ord(year) ne 3)=0;
229 SPATIALWEIGHT_PM(city, year, '2', '30', items)=0;
230 SPATIALWEIGHT_PM(city, year, '2', '31', items)=0;
231 SPATIALWEIGHT_PM(city, year, '4', '31', items)=0;
232 SPATIALWEIGHT_PM(city, year, '6', '31', items)=0;
233 SPATIALWEIGHT_PM(city, year, '6', '31', items)=0;
234 SPATIALWEIGHT_PM(city, year, '9', '31', items)=0;
235 SPATIALWEIGHT_PM(city, year, '11', '31', items)=0;
236 display SPATIALWEIGHT_PM;
237 *$offtext
238
239
240 *$ontext
241 execute_unload 'E:\Chen\Onal\NationalModel\NM_Dec\results\modelresult.gdx' SPATIALWEIGHT_PM
242 $onecho > E:\Chen\Onal\NationalModel\NM_Dec\results\modelparameter.inc
243 trace 2
244 O=E:\Chen\spatialPMS4.xlsx
245 PAR=SPATIALWEIGHT_PM          RNG=S1!A1:ZZ2000000000000000
246 $offecho >
247 execute 'gdxrw E:\Chen\Onal\NationalModel\NM_Dec\results\modelresult.gdx @E:\Chen\Onal\NationalModel\NM_Dec\results\modelparameter.inc' ;
248 *$offtext
249
250
251

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