

Chapter 7

Conclusions and Recommendations

1 Observations from the ground, aircraft, and satellites provide a wealth of evidence that
2 intercontinental and hemispheric scale transport of ozone and its precursors and aerosols, and their
3 precursors impact the distribution of these species throughout the troposphere of the Northern
4 Hemisphere. In some instances, the impacts of intercontinental transport are profound. Observations
5 from mountain top sites or from aircraft can track distinct plumes of polluted air with elevated levels of
6 ozone, particulate matter, CO, and other trace components of specific sources, such as Hg from coal
7 combustion. These plumes are often confined in altitude and can be traced backward using chemical
8 transport models to specific source regions. Satellite-borne instruments provide direct observations of the
9 general patterns of O₃ transport, NO_x emissions, and direct observations of the intercontinental transport
10 of dust and CO. Ground- and space-based lidars are providing new information on the vertical structure
11 of aerosol transport events and the meteorological conditions that drive them. Very clear observations of
12 intercontinental transport have been documented associated with forest fires in Siberia and North America
13 and dust storms carrying particulate matter from the Asian deserts over the Pacific Ocean and from the
14 North African desert across the Atlantic and across the Mediterranean Sea.

15 While there is clear observational evidence of intercontinental transport on an episodic basis,
16 particularly at high altitudes, intercontinental transport also impacts surface air quality and background air
17 pollution concentrations. These impacts, however, are harder to discern. Long time series of
18 tropospheric ozone indicate an increase of background ozone in many places in the Northern Hemisphere.
19 At the same time, the emissions of ozone precursors and peak ozone pollution levels have been reduced in
20 North America and Europe. The observed increase of background ozone is consistent with the more
21 general increase of ozone precursor emissions across the Northern Hemisphere. For particulate matter,
22 large interannual variability in dust transport tends to obscure long-term trends. Available trends from
23 isolated islands for nitrate and anthropogenic sulphate are generally consistent with estimated trends in
24 emissions.

25 **7.1 Key Processes Driving Intercontinental Transport**

26 Our understanding of the key processes that drive intercontinental and hemispheric transport of
27 air pollution is based on combining the observational evidence with process characterizations provided by
28 meteorological and chemical transport models. These models are based on mathematical descriptions of
29 physical and chemical processes that govern the emissions, transport, transformation, and deposition of
30 pollutants. Emissions inventories are key inputs to these models. Together, models, observations, and
31 emissions inventories suggest that intercontinental and hemispheric transport is determined by the
32 location and timing of emissions; the chemical and physical transformation of pollutants in the
33 atmosphere, and the prevailing patterns of meteorology and atmospheric circulation. The dominant
34 processes differ by geographic region and season.

35 In the Arctic region, there are few anthropogenic emissions sources and transport into and out of
36 the region are dominated by low-level flows near the ground. The lack of vertical transport is mainly due
37 to the lack of strong convection and the low input of solar radiation, which also has important
38 implications for the chemical and physical transformation of pollutants. Recent studies have suggested
39 that anthropogenic pollution (both black carbon and ozone) transported to the Arctic have significant
40 effects on atmospheric warming in the region, which further enhances the potential for transport from the
41 mid-latitudes.

42 In the mid-latitudes, prevailing winds are from the west to east, creating stronger west-east flows
43 compared to north-south flows. Wind speeds increase with height, so processes that lift pollutants out of
44 the boundary layer near the ground and into the free troposphere increase the potential for rapid
45 intercontinental transport. Two mechanisms for such lifting are cyclonic weather systems and deep
46 convection, which are primarily responsible for the transport of pollution from North America to Europe
47 and from Asia to North America. In mid-latitude cyclonic systems, lifting takes place in the airstream
48 known as the Warm Conveyor Belt (WCB), which can loft pollutants into the jet stream, transporting
49 them from North America to Europe in 2-4 days and from Asia to North America with slightly longer
50 transport times. Cyclonic systems, which track from west to east, occur throughout the year although
51 they are weakest in the summer. The formation of WCBs is most common along the east coasts of North
52 America and Asia, where there are also heavy concentrations of emissions. Deep convection, which is
53 strongest in the summer over the middle of North America and Asia, is also an important mechanism for
54 lofting pollutants into the free troposphere. In both WCBs and deep convection, as the air rises and cools,
55 water vapour condenses and wet scavenging removes many water soluble pollutants. The pollutants that
56 make it out of the boundary layer are subject to chemical reactions, physical transformations, and mixing
57 with stratospheric air as they are transported downwind. Eventually, the lofted pollutants are mixed back
58 down to the surface in areas of atmospheric subsidence, such as over western North America and Europe,
59 particularly over the Mediterranean. The subsidence process tends to disperse the pollutants and dilute
60 significantly the pollutant concentrations reaching the surface. Subsidence can also have important
61 effects on the chemical and physical transformations of the transported pollutants, such as when
62 transported PAN decomposes as it subsides, contributing to the formation of ozone.

63 Topography can also have a strong impact on the transport of pollutants into the free troposphere.
64 Winds associated with mountains and valleys can loft pollution, potentially playing an important role in
65 the flow of pollution from Europe to Asia. Also, the entrainment of dust from the Gobi Desert is
66 facilitated by its high elevation at the source.

67 Long-range pollutant transport may also occur near the ground without significant lifting. Such
68 transport may occur in association with passing weather fronts or may occur in a stable atmospheric layer,
69 such as a residual layer that forms after the collapse of a daytime boundary layer. This sort of transport
70 dominates the flow of pollutants out of Europe and into the Arctic, in winter, and across the
71 Mediterranean, in summer. Such processes may also play an important role in the transport of Saharan
72 dust across the Mediterranean to Europe.

73 Transport in the tropics is less well understood than transport in the mid-latitudes. In the tropics,
74 prevailing winds are generally from the east to the west. The deep convective clouds of the shifting inter-
75 tropical convergence zone (ITCZ) lift air pollution into the free troposphere, with subsidence occurring
76 elsewhere in the tropics. The Asian monsoon circulation can have important impacts on the transport of
77 pollutants from South Asia, carrying pollutants westward from India to Northern Africa and Europe. The
78 majority of biomass burning globally occurs in the tropics with activity peaking in different regions at
79 different times of the year. The exchange of air, and the pollutants it carries, between the tropics and the
80 mid-latitudes is limited, such that air in the mid-latitudes tends to recirculate in the mid-latitudes and air
81 in the tropics tends to recirculate in the tropics.

82 The intercontinental and hemispheric transport of ozone and fine particles has important effects
83 on global and regional climate change. Likewise, future changes in temperature, humidity, precipitation,
84 the strength of convective systems, and the paths and frequency of cyclonic systems are likely to change
85 emissions from natural sources as well as the atmospheric lifetimes and intercontinental flows of
86 anthropogenic pollutants. Also, profound changes in intercontinental transport are likely due to changes
87 in anthropogenic emissions, which are expected to continue to decline in Europe and North America, but
88 are expected to continue to increase in Asia and other parts of the world, particularly in the tropics. The

89 combined effects of emissions changes and climate change on the absolute and relative impacts of
90 intercontinental transport on air quality and deposition is unclear, but some expected changes may cancel
91 each other.

92 To assess the significance of intercontinental and hemispheric transport processes on surface air
93 quality, both now and in the future, it is necessary to quantitatively compare the contribution of
94 intercontinental or hemispheric transport to that of local and regional sources of pollution. Moreover, to
95 develop effective air quality management strategies, it is useful to understand how observed
96 concentrations and deposition in one region will change as a result of emission changes in another region.
97 This sort of information about source-receptor relationships can only come from models. Our confidence
98 in the models, however, is grounded in how well the models are able to reproduce and explain the
99 observational evidence.

100 Current models, using available emission inventories, can reproduce much of the observed spatial
101 and seasonal patterns of intercontinental transport, but have difficulty reproducing decadal trends or the
102 location and timing of individual plumes. Some physical and chemical processes that are important for
103 assessing intercontinental transport are not well represented in current models and robust emissions
104 inventories do not exist for many regions of the world and important source categories. However,
105 comparisons to observations collected in field campaigns studying continental outflows suggest that
106 correlations between tracers are typically captured correctly, providing some evidence that the models
107 adequately represent pollutant export. Furthermore, intercomparisons of regional and global models have
108 shown that an ensemble of models usually has greater predictive skill than each of the individual models
109 in the ensemble.

110 **7.2 Estimates of Source-Receptor Relationships**

111 Previously published studies of intercontinental S/R relationships for ozone have estimated
112 annual or seasonal mean influences of one continent on the other are in the range of 1-5 ppbv with
113 enhancements due to individual transport episodes around 10 ppbv. For fine particles, previous modeling
114 studies suggest large fractions of aerosols, 40-80%, are exported from source regions through
115 intercontinental transport. The impact of this export on long-term average surface concentrations or
116 deposition in other regions has not been extensively examined. Reported estimates of annual or seasonal
117 intercontinental influences on total column loadings have ranged from 1% to 50% depending on the
118 region, season, and chemical fraction of interest. However, it is difficult to directly compare previously
119 published studies because of differences in the methodologies, definitions of regions, and metrics used.

120 To provide comparable results, examine and improve the ability of models to represent transport
121 processes, and estimate uncertainty in current estimates of S/R relationships, the HTAP intercomparison
122 was organized to conduct a series of coordinated model experiments. In the first set of experiments,
123 emissions of NO_x, CO, NMVOCs, were perturbed individually and combined by 20% in four Northern
124 Hemispheric regions (North America, Europe, East Asia, and South Asia). The HTAP intercomparison
125 also examined the effects of a 20% reduction of methane abundances. Similar 20% perturbation analyses
126 were conducted for aerosol precursors (SO₂, NO_x, and NH₃) and primary aerosol (EC, POM and PM_{2.5})
127 emissions.

128 For each of the four regions and each pollutant, the relative sensitivity to imported pollution
129 versus domestic emissions, or "import sensitivity," was calculated as the change in concentration within a
130 receptor region to the combined influence of the 20% emission reduction in the three other source regions
131 divided by the change in concentration due to the 20% emission reduction in the region itself.

132 The initial results from these experiments have begun to narrow the range of estimates for S/R
133 relationships, but significant uncertainties still remain. The initial results for ozone, particulate matter,
134 and nitrogen deposition are discussed further below.

135 For ground-level ozone, the primary impact of intercontinental transport has been to increase the
136 hemispheric background concentration upon which local and regional influences are added. The
137 influence of one continent on another is small, but is significant from a management perspective when
138 compared to levels of ozone decrease that can be achieved through local and regional emission controls.

139 For the 20 models contributing to the ozone experiments, the seasonal cycle in surface ozone
140 concentrations is similar across the models, although the monthly mean values vary by as much as 10-30
141 ppbv in some regions and seasons. The mean results from the models suggest that a 20% decrease in
142 anthropogenic NO_x emissions will decrease annual mean surface ozone concentrations within the same
143 region by 0.46 to 1.08 ppbv, depending on the region. Combined emission reductions in the three foreign
144 source regions will decrease annual mean surface concentrations in the fourth receptor region by 0.24 to
145 0.34 ppbv, depending on the receptor region. Thus, the import sensitivity of annual mean surface ozone
146 varies between 30% for North America and South Asia to 75% for Europe.

147 These annual average S/R relationships may mask large seasonal variations, which will require
148 further analysis to illuminate. Intercontinental influences on ozone are generally strongest in the Northern
149 Hemisphere spring season, not when ozone is highest. But surface ozone is still sensitive to foreign
150 influences (import sensitivity of 10-30 %) in the (3-month) high ozone season. The initial results further
151 suggest that changes in emissions on a hemispheric scale may change the frequency of ozone pollution
152 events defined relative to a threshold concentration.

153 NO_x emission perturbations generally exert a stronger influence on surface ozone than changes in
154 NMVOC, except in Europe where NMVOC emission perturbations are equally important. Perturbations
155 in CO emissions had less of an impact than changes in either NO_x or NMVOC in all regions. Initial
156 results suggest that the combined effect of NO_x, NMVOC, and CO perturbations may be slightly less than
157 sum of their individual effects, however more analysis is needed to assess the linearity of the reductions.

158 The initial results of the 20% decrease in methane abundances, which implies a 20-30% decrease
159 in global anthropogenic emissions of methane, suggest an annual mean surface ozone decrease of
160 approximately 1 ppbv across all of the regions.

161 The largest influence of a single source region on ozone in another receptor region is associated
162 with the impact of North American NO_x emissions on Europe. North American NO_x emissions exert
163 roughly 20% of the response from European NO_x emissions on European surface ozone in summer.
164 Sources in North America and Europe tend to contribute as much to surface ozone over East Asia and
165 South Asia as the Asian sources contribute to each other.

166 For fine particles, results from 8-11 models, depending on the chemical component of interest,
167 are available from the HTAP intercomparison. The mean results suggest that a 20% decrease in
168 anthropogenic gas and aerosol emissions will decrease annual mean surface particulate matter
169 concentrations within the same region by 0.35 to 0.74 µg/m³, depending on the region. Combined
170 emission reductions in the three foreign source regions will decrease annual mean surface concentrations
171 in the fourth receptor region by 0.02 to 0.1 µg/m³, depending on the receptor region. Thus, the import
172 sensitivity of annual mean surface particulate matter concentrations varies between 5%-10% for Europe,
173 North America, and East Asia and 25% for South Asia.

174 The contribution to the aerosol column loading is significantly larger than that for the surface
175 concentrations. The import sensitivity of the regional sulphate annual mean aerosol column loadings is
176 31-59%. The import sensitivity of black carbon annual mean column loadings is a little less, 13 to 30%.
177 The impacts on total column loadings have significant, but not yet quantified, implications for regional
178 aerosol radiative forcing and climate change.

179 The contributions of imported aerosol are similar in Europe, North America, and East Asia, but
180 are much larger for the South Asia region. The large response due to imported aerosol for the South Asia
181 region can be explained in part by several peculiarities of the HTAP experiment design, and these require
182 further study.

183 The import sensitivity of annual mean deposition varies from 10-30% for sulphate to 1-13% for
184 carbonaceous aerosols and 3-15% for total reactive nitrogen.

185 The impact of one region on another depends on the modelled aerosol lifetimes, which vary
186 significantly (a factor of four) between models. In general models with longer lifetimes predict larger
187 import sensitivities. The diversity in modelled lifetimes reflects differences in the process-level model
188 formulations, which require further evaluation and analysis.

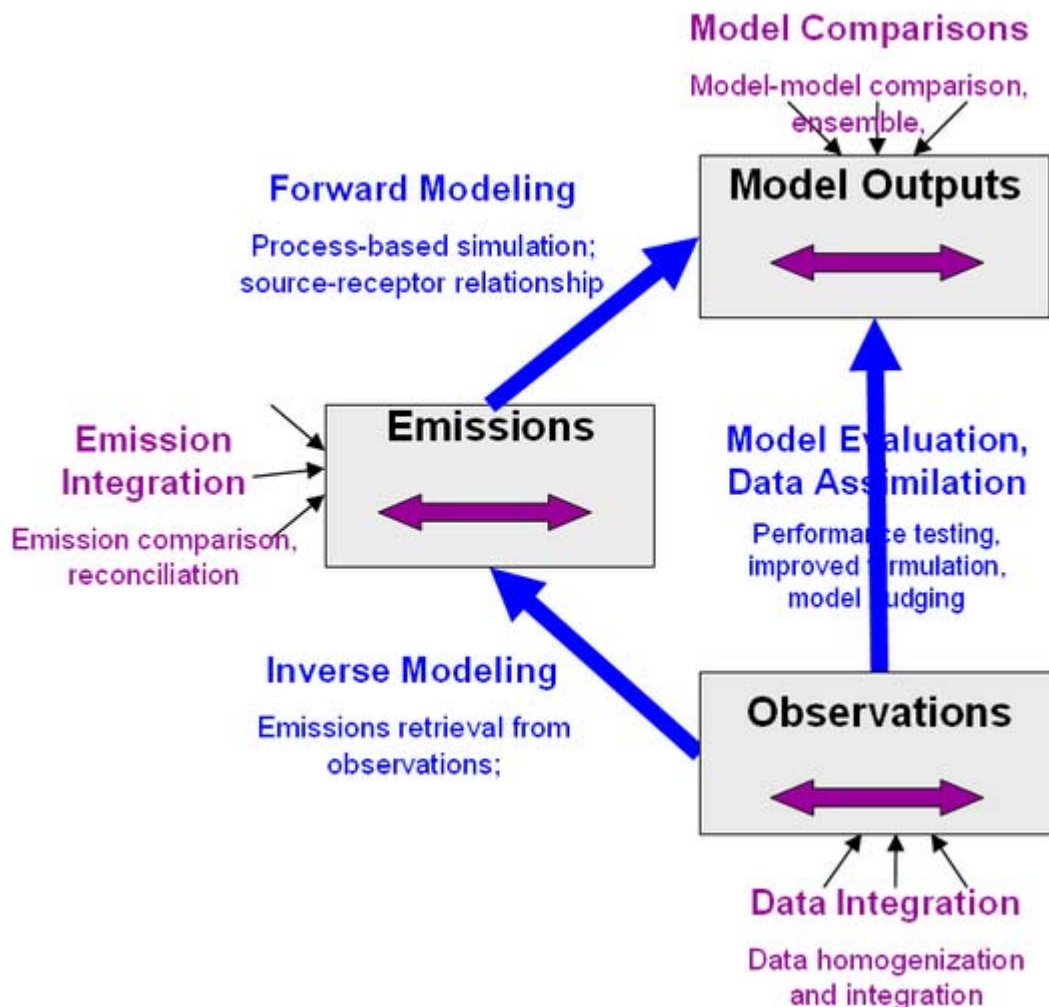
189 Given the consistent definition of source-receptor regions and emission perturbations, the HTAP
190 intercomparison has begun to narrow the range of estimates of S/R relationships substantially from that in
191 the literature. However, the spread among individual models remains large, and significant uncertainties
192 remain. The results of the first set of experiments do not address the issue of interannual variability,
193 which has been shown to increase with increasing distances between source and receptors. Further model
194 evaluation (model-to-observations) and comparison (model-to-model) efforts will lead to improvements
195 in model skill and our confidence in the assessment of intercontinental transport.

196 **7.3 Key Challenges**

197 The assessment of the current observational evidence (Chapter 3), emission inventories (Chapter
198 4) and chemical transport modeling (Chapter 5) indicates that these three aspects of understanding
199 hemispheric transport are interdependent as shown schematically in Figure 7-1. The boxes represent
200 information resources from observations, emission inventories, and modeling, whereas arrows indicate
201 connections and operations within and between these aspects. Operations within aspects or areas of
202 activity (in purple) include intercomparisons, reconciliation, and homogenization of data. The
203 interconnecting arrows (in blue) represent the major connections and operations that link observations,
204 emission inventories, and modeling. Observations are an essential foundation, providing the data for
205 model evaluation as well as for data assimilation into the models. Through inverse modeling,
206 observations also allow estimation of emissions.

207 Improving our assessment of intercontinental and hemispheric transport will require an integrated
208 approach where the best available knowledge from observations, emissions, and models is combined.
209 Furthermore, reconciliation of the three areas or aspects (observations, emission inventories, models)
210 requires considerable iteration until the deviations are minimized.

211 In the preceding chapters addressing each of the three aspects, we have identified issues that need
212 to be addressed by future research or other efforts to improve our understanding of intercontinental
213 transport. Below we highlight some of the key challenges and discuss how efforts to link the different
214 aspects or areas of activity may help address these needs. Meeting each of these challenges requires
215 making better use of existing information in addition to acquiring new information.



216

217 **Figure 7-1.** Interdependence of emissions, models and observations.

218

219 • **Improving the modeling of transport processes using existing and new field campaign data.**

220 There are a number of chemical and physical processes that could have important effects on
 221 intercontinental transport that are poorly represented in current models. These include boundary layer
 222 mixing and small scale venting processes that allow pollutants to leave the boundary layer, such as dry
 223 convection, local circulations (valley or land-ocean), and gravity wave mixing. Likewise, subsidence and
 224 other processes that transport pollutants from the free troposphere back to the boundary layer are not well
 225 quantified in large-scale models or in observations.

226 The transport of species out of the boundary layer is often associated with wet-deposition as
 227 water vapour is condensed during the transport events. The extent to which soluble species are wet
 228 deposited depends on details of the microphysics; i.e. to what extent: 1) convective clouds are able to
 229 transport soluble species to the upper troposphere, 2) soluble species are retained as liquid water freezes,
 230 and 3) rain is evaporated as it falls through the atmosphere. Again, these processes are not suitably
 231 modelled on the large scale and have not been adequately measured.

232 Finally, transport processes in the tropics and subtropics have received far less attention than in
233 the mid-latitudes. With the growth of future emissions expected in the tropics and subtropics, these
234 processes may gain greater importance for intercontinental transport of air pollution.

235 Improving our ability to model these various processes requires careful comparison of models to
236 the rich observational data provided by intensive field campaigns. Much information can be mined from
237 the existing integrated data sets collected by past field campaigns. One of the foci of HTAP
238 intercomparison Experiment Set 3 will be to evaluate the representation of pollutant export and chemical
239 evolution in models by comparing with observations from the TRACE-P and ICARTT field campaigns in
240 2001 and 2004. It may also be necessary to design new field campaigns specifically to illuminate key
241 processes and evaluate model parameterizations. Several new intensive field campaigns will be
242 conducted in 2007 and 2008 as part of the POLARCAT component of the International Polar Year. For
243 the full value of the observations collected in past and future field campaigns to be realized, further efforts
244 must be made to facilitate access to the integrated data sets.

245 • **Improving emissions inventories using local information and inverse modeling.**

246 Major uncertainties exist in the emission inventories for many regions of the world and some
247 important source categories, such as shipping, aviation, and lightning. To improve the global emissions
248 inventories used in the assessment of intercontinental transport, existing emissions information from
249 national and sub-national governments and other research activities focused on specific source categories
250 need to be incorporated into the global inventories. Such efforts are especially needed to improve the
251 inventories in regions where emission factors and activity data are poorly known.

252 Models can be used to identify those emission estimates and uncertainties that are most important
253 for understanding intercontinental transport and hemispheric pollution and the temporal and spatial
254 resolution of emission estimates needed to understand intercontinental transport. To improve confidence
255 in emission estimates and identify potential weaknesses, comparisons of the absolute values, pollutant
256 ratios, and trends of emission estimates contained in emissions inventories can be compared to emission
257 estimates, pollutant ratios, and trends derived through inverse modeling from ground-based, aircraft, and
258 satellite observations.

259 • **Identifying and explaining long-term trends by filling gaps in the observing system and
260 improving model descriptions.**

261 Increasing trends of background pollution concentrations, particularly for ozone, have been
262 observed at a number of remote locations across the Northern Hemisphere consistent with increases in
263 emissions. However, these trends are not consistent with other available observations (such as data from
264 ozone sondes), and are not well reproduced by chemical transport models. The inability to explain these
265 observed trends is due to limitations of the current observational system and limitations in current models
266 (and possibly emissions inventories).

267 Although some important regional data sets are available for aerosol composition and gas phase
268 concentrations, and valuable long-term data sets are available for a few remote locations, there are many
269 regions of the world that are poorly covered by current observational systems. Information about the
270 vertical distribution of pollutants in the atmosphere is very limited.

271 Over the coming decades significant changes are expected in the intercontinental transport of air
272 pollutants due to changing emissions globally. The present observational system, however, is not
273 sufficient to capture these changes. A surface measurement network suitable for following the evolution
274 of long-range transport of air pollution in the Northern Hemisphere has to include monitoring in regions

275 which are now poorly covered, such as over the seas and in the interior of the Asian continent. Both high
276 elevation and remote island sites should be included. Surface networks must be complimented by vertical
277 profiling (such as from sondes, lidar, and aircraft) and measurements from satellite sensors to characterize
278 the tropospheric pollution distribution. Coincident measurements of ozone, aerosol components, and their
279 precursors and atmospheric tracers, such as carbon monoxide and mercury, will strengthen the utility of
280 the observations for model evaluation and assessments.

281 Unprecedented satellite-borne measurement capability is presently in orbit, but the utility of the
282 measurements is limited by a clear understanding of the accuracy and precision of the retrieved results
283 (i.e. satellite validation). Facilitating broader access to satellite data sets for analysis and comparison to
284 other observations and model results, and appropriate collaborations between the satellite, modelling, and
285 emissions communities, would increase the value to these measurements. Furthermore, new satellites will
286 be required to maintain this current measurement capability into the future.

287 Further experiments under the HTAP intercomparison will generate insights into the differences
288 between current models and sensitivities to model parameterizations. Likewise in the context of
289 AEROCOM, and the new joint IGBP-IGAC/WCRP-SPARC initiative in atmospheric chemistry and
290 climate, experiments are planned that further assess the processes that lead to variability among models
291 and examine the ability to reproduce observed trends.

292 • **Developing a robust understanding of current source-receptor relationships using multiple**
293 **modeling techniques and analyses of observations.**

294 The initial results of the HTAP intercomparison provide some useful information about the
295 significance of intercontinental transport from an air quality management perspective. However, further
296 analyses are needed to develop a robust understanding of current S/R relationships, including addressing
297 issues of the scalability of the sensitivities, the large variability across the models in the sensitivity of
298 ozone to NMVOC emissions changes, the ability to reproduce observed frequency distributions of
299 pollution, the contribution of intercontinental transport under clean versus polluted conditions, the S/R
300 relationships for other aerosol components, and the influence of interannual meteorological variability.

301 A link between the HTAP intercomparison and ongoing regional-scale model intercomparisons
302 may inform the assessment of the uncertainties associated with the calculation of import-export budgets
303 of ozone, aerosol, and their precursors.

304 There are no generally accepted ‘benchmark’ tests that can be used for model evaluation at the
305 intercontinental scale. Therefore, the HTAP intercomparison should strive to establish some standard tests
306 and a well-documented reference set of observations drawn from different sources that can be used to
307 establish a baseline of model performance against which future improvements can be demonstrated.

308 Alternative methods for calculating mass fluxes and sensitivities to emission changes, including
309 direct calculations from observations, should be explored and compared with the results from global
310 CTMs. Adjoint models are currently under development in regional and global CTMs, and provide an
311 interesting alternative for the forward model sensitivity simulations. Adjoint models need to be compared
312 to one another and to other methods for calculating sensitivities. Future assessments of S/R relationships
313 may also benefit from the use of chemical data assimilation to improve the analysis of specific episodes.

314 • **Estimating future source-receptor relationships under changing emissions and climate.**

315 Future changes in the spatial distribution and magnitudes of emissions associated with future
316 development and control combined with changes in the atmospheric lifetimes of pollutants and transport

317 processes associated with climate change will alter intercontinental source-receptor relationships.
318 Scenarios of future emissions and climate change should be assessed with the available modeling tools –
319 the typical time horizon could both be intermediate aiming at 2020 and 2030 as well as longer time
320 perspectives of 2050 and 2100. The development of such scenarios should be coordinated with efforts
321 under the IPCC and the IGBP-IGAC/WCRP-SPARC initiative in atmospheric chemistry and climate.

322 • **Improving organizational relationships and information management infrastructures to**
323 **facilitate necessary research and analysis.**

324 Recent developments in information technology, observational capabilities, data assimilation, and
325 modeling and analysis tools have made it possible to begin to combine the best available knowledge from
326 observations, emissions, and models to inform assessments of intercontinental transport. However,
327 further organizational efforts and investments are needed to put the pieces of an integrated
328 observations/modeling system into place. A strategy for Integrated Global Atmospheric Chemistry
329 Observations (IGACO, 2004) has been formulated and is being implemented at many different scales
330 ranging from regional to hemispheric to global, contributing an atmospheric component of the Global
331 Earth Observing System of Systems. Building upon the existing WMO Global Atmospheric Watch
332 program, the proposed IGACO system is intended to provide an observations, modeling, and information
333 infrastructure for atmospheric chemistry analogous to the global infrastructure currently in place for the
334 meteorological community. In addition to the needs for additional observations and model
335 improvements, the strategy also addresses issues of data quality assurance, data distribution, and data
336 archiving. Such an integrated infrastructure would greatly facilitate the assessment of intercontinental
337 transport. Efforts organized by the TF HTAP should build upon or work to further the implementation of
338 this strategy.

339 **7.4 The Continuing Role of the TF HTAP**

340 Addressing the challenges outlined above and in the preceding chapters will require the combined
341 effort of many individual scientists, research organizations, and governmental authorities. In this
342 combined effort, the TF HTAP can continue to play several important roles.

343 The TF HTAP can continue to serve as a forum to identify scientific consensus concerning the
344 current understanding of intercontinental and hemispheric transport and priorities for future research and
345 development through the organization of workshops, meetings, and assessment writing activities.

346 By organizing cooperative research and analysis efforts, such as the HTAP intercomparison, and
347 fostering networks for data exchange and delivery, the TF HTAP can serve as a forum for information
348 exchange and collaboration.

349 Finally, the TF HTAP can assist in raising awareness of transboundary and intercontinental air
350 pollution in regions where the concept is less well known and in linking this awareness to the need for
351 building robust national and regional emission inventories and observational systems. The TF HTAP can
352 assist in creating crucial links between institutions both within countries and across regional and
353 hemispheric scales. Creating these linkages could be an important step in increasing the capacity to
354 manage the sources of air pollution in these regions.