Knowledge for Climate (KvK)
Terms of Reference

Hotspot Mainport Schiphol

Basic registration details	
Project ID:	HSMS03
Submission date:	18-08-2008
Title:	Improved Meteorological Predictions for Airport Capacity Tuning
Short title:	***IMPACT***
Project leader:	Dhr. dr.ir. A.J.M. Jacobs
Contact person:	Dhr. dr.ir. A.J.M. Jacobs
Institute:	KNMI
Full address:	KNMI, PO Box 201, 3730 AE, de Bilt, The Netherlands
E-mail:	Albert.Jacobs@knmi.nl
Website:	www.knmi.nl

Project description *(max. 1 ½ page)*	
Objective:	The impact of climate change on Schiphol Mainport is determined by the effect that the future weather has on the airport operation. Due to its location near the sea, the weather at Schiphol is often adverse and subject to sudden changes. Certain weather conditions such as fog, stormy southwest winds and heavy precipitation, lead to an enormous loss in the available operational airport capacity and, if not foreseen in time, to additional delays, diversions and holdings, resulting in increasing costs. In order to reduce the adverse effect that the weather has on Schiphol operation, reliable weather forecasts and timely weather warnings on small spatial scales (1–2 km) are needed. This will be even more pressing when in a future climate adverse weather occurs more often, is more intense and is due to more sudden changes. In order to maintain its position as mainport, it is important that Schiphol anticipates to the negative effects that climate change may have on the airport operation. The IMPACT (Improved Meteo Predictions for Airport Capacity Tuning)-project will contribute to this by the development and transfer of fundamental and applied meteorological knowledge on climate change and the occurrence of adverse future and present weather conditions at the airport. IMPACT will increase the quality of the meteorological component and its use at the airport so that unnecessary flow restrictions can be reduced and safety increased, both in the present and future climate. IMPACT will do that by: a) increasing our understanding of local weather processes, e.g. in relation to higher temperatures in a warmer climate and to the physiographic properties and heterogeneity of the landscape, b) implementing this knowledge in a state-of-the-art weather model, c) strengthening the use of this model in decision making. Knowledge from IMPACT can be used to develop adaptation strategies for: ▪ spatial planning in the Schiphol area, ▪ pavement design and water drainage management at Schiphol airport ▪ improved weather forecasts and coupling of weather information to decision support in short-term operational plans and on the actual day-of-operation at the airport* ***By integrating knowledge, forecasting and decision making, IMPACT provides a strategy for adaptation, guaranteeing an optimal use of the available airport capacity and the sustainability and reliability of the operation at present and in a changing climate.***
Central research question:	The central question for Hotspot Mainport Schiphol is how global climate change will impact the regional and local climate at the airport, its consequences on the local weather conditions at the airport and the effect on airport operation. These questions are relevant to decide which adaptations are needed to reduce the adverse effects of climate change on Schiphol operation. IMPACT will focus on the local weather conditions and its adverse effect on airport operation, such as unnecessary flow restrictions and flow

* Improved weather forecasts for Schiphol airport should be regarded as adaptation as well.

	restrictions which are enforced too late. Specific weather related research questions for IMPACT in this context are: ▪ How will rainfall patterns and intensity for Schiphol airport change when air temperature and sea-surface temperature increases in a future climate? ▪ How much influence have changes in physiographic properties of the landscape, such as land-use, soil type and vegetation, on local weather conditions at the airport (e.g. on the occurrence of fog)? ▪ How will an increase in (air) temperature effect the height of the freezing level at Schiphol airport, and what changes in precipitation type (freezing rain, snow, black-ice) may we expect from this?
Socio-economic relevance:	IMPACT intends to increase efficiency in the use of Schiphol's infrastructure at present and in the future, by improving the accuracy of weather forecasts and by timely weather warnings. This will also help to minimize flight delays and diversions, and will limit aircraft holdings, resulting in less waste of fossil fuels.
Political relevance:	A better forecast and better monitoring of extreme weather conditions will moreover lead to more use of runway combinations which are to be preferred form a noise point of view. Improved weather forecasts contribute to the growth of Schiphol mainport at its present location, within legal standards of safety, noise and air pollution. By improving the operational reliability, Schiphol can maintain its position as a primary hub for Air France – KLM, resulting in a stronger economic position in Europe and in more employment.
Scientific relevance:	The heart of IMPACT is HARMONIE, an advanced weather prediction model which is currently being developed by 24 European countries as state-of-the-art model to analyse and forecast the weather on small spatial (1–2 km) scales. The model dynamics is non-hydrostatic and the model will contain our most advanced physical knowledge, e.g. on surface exchange processes of heat and moisture which is important for the formation of fog and convective showers. This model will be our primary knowledge base that will be used to analyse the local weather at Schiphol airport in our present and future climate. To improve short-term forecasts with the model, HARMONIE will be suited to assimilate local observations (remote-sensing) and make rapid updates of model forecasts. Model output will be made representative and therefore more useful for local (terrain) conditions. In order to deal with forecast uncertainty, different weather scenarios will be computed and used to construct probabilistic forecasts for visibility, clouds, winds and precipitation. For this, a short range ensemble forecasts system will be used.
Innovative value:	By involving end-users, especially air traffic control, IMPACT aims to integrate and strengthen all parts of the weather prediction and decision making chain at the airport. IMPACT will set up a virtual environment in which the impact of the improved meteorological forecasts on airport capacity and connectivity can be simulated. In this environment weather forecasts are coupled to a capacity prognoses system which has been developed for this purpose in 2003. This integrated concept is rather new.
Main activities:	IMPACT is divided in several phases. In the first phase a **knowledge base** will be developed that can be used to study the local weather at Schiphol airport. This knowledge base will consist of: 1) an academic version of the HARMONIE model that can be used by KNMI and Dutch Universities to study more general weather parameters (wind, temperature, precipitation), and 2) a Column model which is suited to study more specific weather parameters (fog, low clouds). The models will be coupled to a Test bed environment in which various model components, e.g. model physics, can be validated by directly comparing model output to observed parameters. In phase 1 various model sensitivity studies will be performed, e.g. on the intensity of convective showers in relation to sea-surface temperature, and on the occurrence of fog and low clouds in relation to the properties of the landscape. In this phase we will also identify the relevant weather parameters for decision making at the airport and we will provide an inventory of available forecast methods and observation technologies that can be used to better observe and forecast adverse weather at the airport. The part of the work related to new observation technologies will be done in cooperation with the KvK project "*WindVisions*". The knowledge base of phase 1 will be used throughout follow-up phases to: a) Increase our understanding of local atmospheric processes, e.g. surface heat/moisture exchange, radiative cooling and vertical mixing, that may lead to adverse weather; b) Determine the impact of the physiographic properties of

	the landscape and their heterogeneity, such as vegetation, topography, soil type and land–use, on the local weather conditions; c) Compute more accurate weather forecasts at the airport; and d) Dynamically downscale future climate large scale conditions, as produced by climate models, to derive climatologies of adverse weather parameters, e.g. for fog and low clouds, in a future climate. In these phases HARMONIE will be adapted so that it can be used for airport capacity planning. This includes improving model physics, postprocessing of model output for local use, assimilation of local (remote-sensing) observations in HARMONIE and a rapid update cycle, development of different weather scenarios from a short-range ensemble and coupling of weather forecasts to a capacity prognoses system that can be used for airport decision making. The results from these phases will finally be used to develop guidelines for adaptations that may be needed to make Schiphol operation "Climate Proof". Note: In phase 2 of IMPACT, the effect of climate change on the airport weather will be studied. For this additional computational resources, estimated at a budget of 1000 K€, are needed.
Main results:	1. Making HARMONIE available for fundamental and applied research, such as analysis, monitoring and local climate studies at Schiphol airport; 2. Provide the 1D column model as a tool to study the occurrence of fog and low clouds at any location on Schiphol airport; 3. First validation results available of HARMONIE parameters that are relevant for airport operation, such as local wind field, fog, low clouds, wind gustiness and precipitation, on scales of a few km; 4. Overview of all weather parameters that impact decision making at Schiphol airport and their order of relevance; 5. Overview of new forecast methods and observation technologies that improve the observed and forecasted weather parameters at the airport; 6. Advise on activities in follow-up phases;
End users:	Schiphol airport authorities, air traffic control, KLM airlines, KNMI.

Relationschip to KvK *(max. ½ page)*
IMPACT will contribute to prepare Schiphol mainport to climate change and to reduce the uncertainty in airport operation. IMPACT develops knowledge on local weather processes, related to higher air and sea-surface temperatures and to landscape heterogeneity, which are relevant for local climate studies and spatial planning.
Links to other KvK projects, other programmes and international initiatives *(max. ½ page)*
IMPACT fits to the modelling strategy of the KKF which proposes to develop a national climate facility. It uses the same model infrastructure as in the global and regional model of the KKF. The HARMONIE model that will be provided by IMPACT, can also be used for the development of the regional climate model in the KKF. HARMONIE is chosen by a large number of European countries as the basis for the development of a non-hydrostatic high resolution numerical weather prediction model. This is done by the HiRLAM – ALADIN consortium, consisting of 24 weather institutes among which KNMI. The same consortium has initiated GLAMEPS, the development of a short-range ensemble forecasting system for Europe, whose results will be used in IMPACT as well. The improvement of forecasts for low visibility conditions such as fog, is done in cooperation with the Knowledge and Development Centre (KDC) at Schiphol airport, and by joining in various activities of the MET Alliance, an alliance of several providers of aviation meteorological forecasts in Europe. IMPACT will determine the local implications of a future climate on the weather conditions at the airport. The HARMONIE model will be used for this. In order to run this model in a future climate, large scale boundary conditions, such as wind and temperature at the upper boundary and sea-surface temperature at the lower boundary, are needed. These will be provided by climate models (from KKF / Model Platform – Future Weather). General climatological knowledge and information, e.g. on the frequency at which adverse weather conditions at the airport will occur in a future climate, will be provided by the KvK project "Climatology and Climate Scenario's Mainport Schiphol". In a later phase IMPACT will also focus on new observation technologies. Here is a link with the KvK project "Wind *and Visibility Monitoring System (WindVisions)*". W.r.t. the activities in Schiphol Area, there is a relation with: ▪ Water management: protection against floodings and drainage of extreme precipitation amounts; ▪ Noise reduction: sound propagation in a changing atmosphere; ▪ Air pollution: reduction of emissions by using direct routes, efficient scheduling and continuous decent approach;

Project consortium
KNMI – government: Provider of weather prediction forecasts for aviation AAS – business: Airport authorities, airport operator LVNL – government: Air traffic control WUR – research: University of Wageningen – atmospheric research TU Delft – research: University of Technology – atmospheric research (not formally contacted yet)

Knowledge transfer *(max. ½ page)*
Knowledge will be transferred by interaction between project partners, different Hotspots, and the KKF. Furthermore knowledge will be made available by publication of the project results. IMPACT will also assist in transferring data from high resolution model experiments. Furthermore, IMPACT will collaborate with the KKF project on "*Future Weather*".

Timing	
Proposed start date:	1 January 2009
Proposed end date:	30 June 2010
Proposed phases:	• Access to HARMONIE at ECMWF: Q1 – 2009 • Inventory "weather in decision making" : Q3 – 2009 • Preliminary validation for Schiphol airport: Q4 - 2009 • Academic version of HARMONIE: Q4 – 2009 • 1D column model: Q4 – 2009 • Coupling to Testbed for physics: Q4 – 2009 • Inventory new observation/forecast technology: Q1 – 2010 • Extensive validation for Schiphol airport: Q2 - 2010

Budget constraints
Total budget (in K€):
Maximum KvK subsidy (in K€):
Indicative contra-finance (in K€):