Application of the Lagrangian model GRAL and the online coupled meteorology-chemistry model WRF/chem to the Santiago de Chile region

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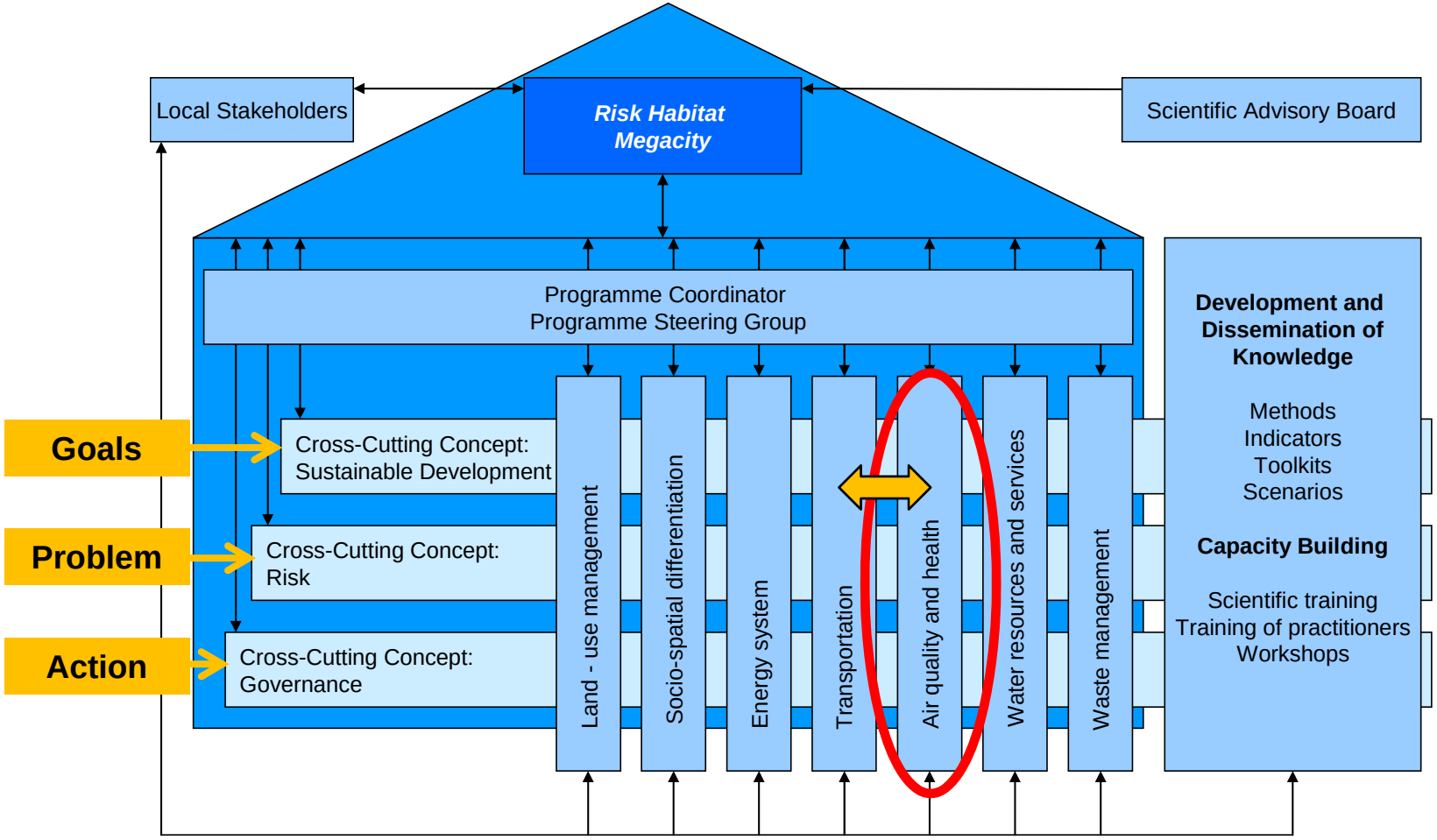
Motivation

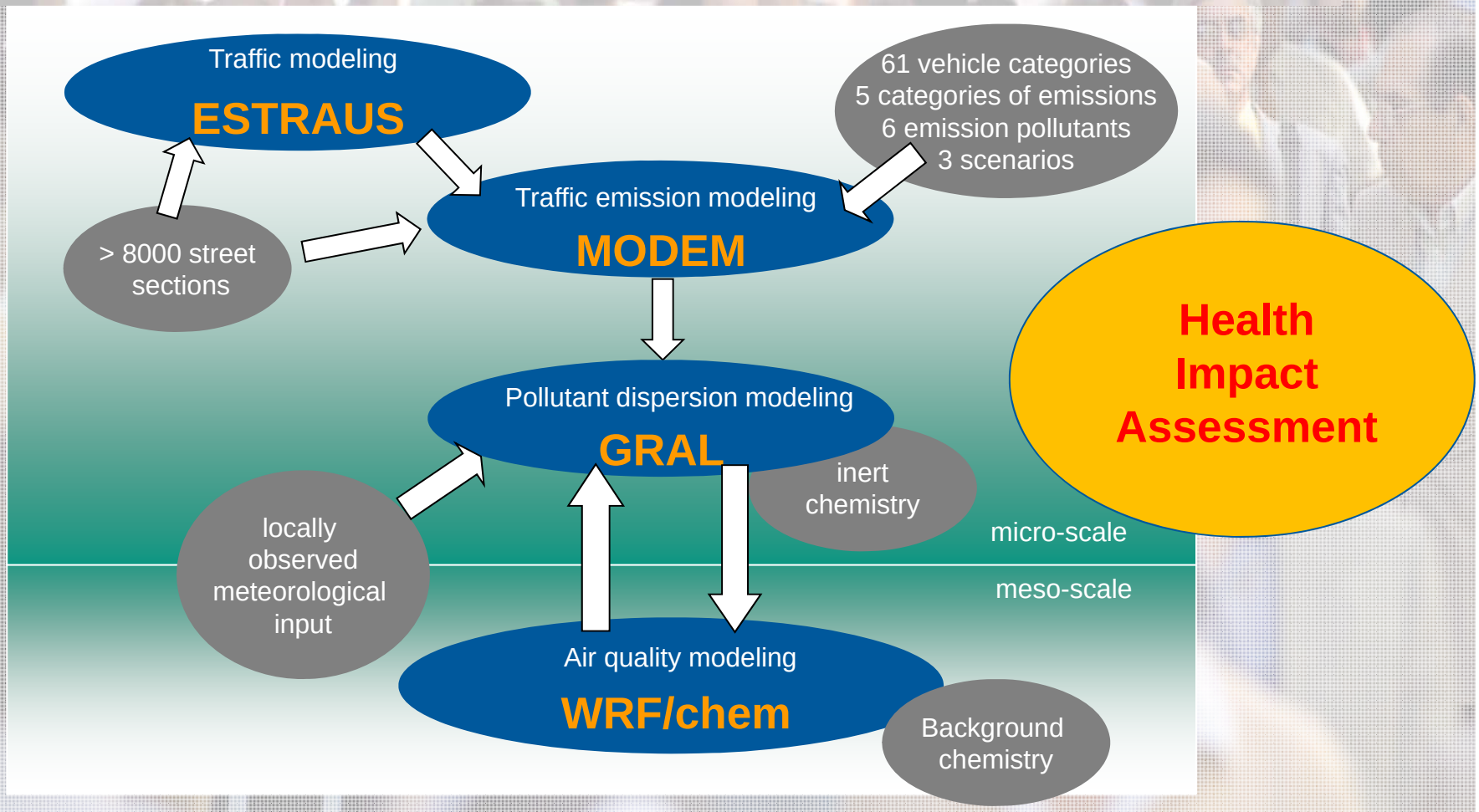
- Risk-Habitat-Megacity
- Multi-disciplinary research task
- Development of a modeling chain
- Development of scenarios

Risk Habitat Megacity

¿sostenibilidad en riesgo?



Modeling Chain



Scenarios

Background

- Strong **participation** with civil society **stakeholders** and **political decision-makers** of the regional government and national ministries
- Essential **precondition** for producing relevant and broadly **acceptable project results**
- **Inputs** for current **planning** and **decision-making processes** in the Santiago Metropolitan Region
- Likewise a necessary **precondition** for considering longer-term perspectives which are essential in the **sustainable development** context
- Approach represents an important distinctive feature compared to other projects on Megacity issues

Framework Scenarios

Scenarios based on storylines of societal driving factors (→ until 2030)

- Economic development
- Institutional frameworks
- Demographics
- Technical development
- Societal value system

Business-as-usual (BAU)	Collective Responsibility (CR)	Market Individualism (MI)
Continuation of liberalisation and privatisation trends, persistence of strong market forces and weak public regulation activities, continuation of existing social protection measures and subsidy schemes for the poorest	**Characterised** by social and environmental justice as principal goals of public regulation, strong regulation of market activities and large public investments, together with the embedding of technologies in society and decoupling of socioeconomic development from resource use	**Increasing** individual freedom and freedom of action, markets as the dominant vehicle for all societal transactions, together with resources and services generation and distribution strongly subject to supply and demand principles.

But also basic socioeconomic variables are estimated:

GDP growth rate, population, household income, persons per household, share of economic branches

Contextualization of Scenarios

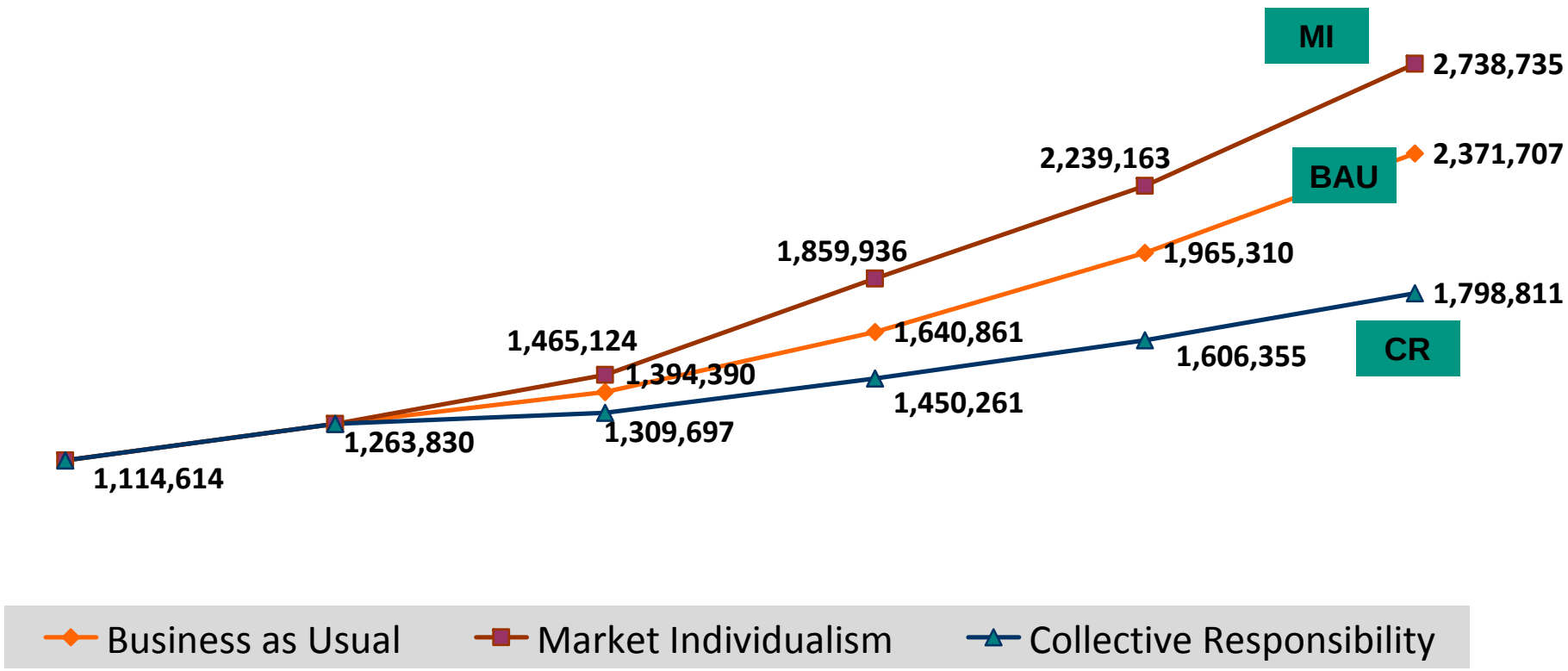
Translation into Transportation / Air Quality & Health

Modal Split:

	2010	2030		
		BAU	MI	CR
Population (Mill.)	6.0	7.3	7.5	6.7
Car trips	36.6 %	38.5 %	48.1 %	41.6 %
Bus & Metro trips	49.0 %	45.9 %	35.7 %	43.1 %
Bicycle trips	---	7.0 %	7.0 %	10.0 %
Increase of highways	---	30 %	130 %	0 %
Additional metro lines	---	Line 6	Line 6	Line 6, 3
Transport tariffs	400 CHP	600 CHP	1000 CHP	400 CHP
Emission Standards	EURO3	EURO5: 2017	EURO5: 2018	EURO5: 2015
		EURO6: 2020	EURO6: 2020	EURO6: 2018
		10 % e-propulsion	15 % e-propulsion	15 % e-propulsion

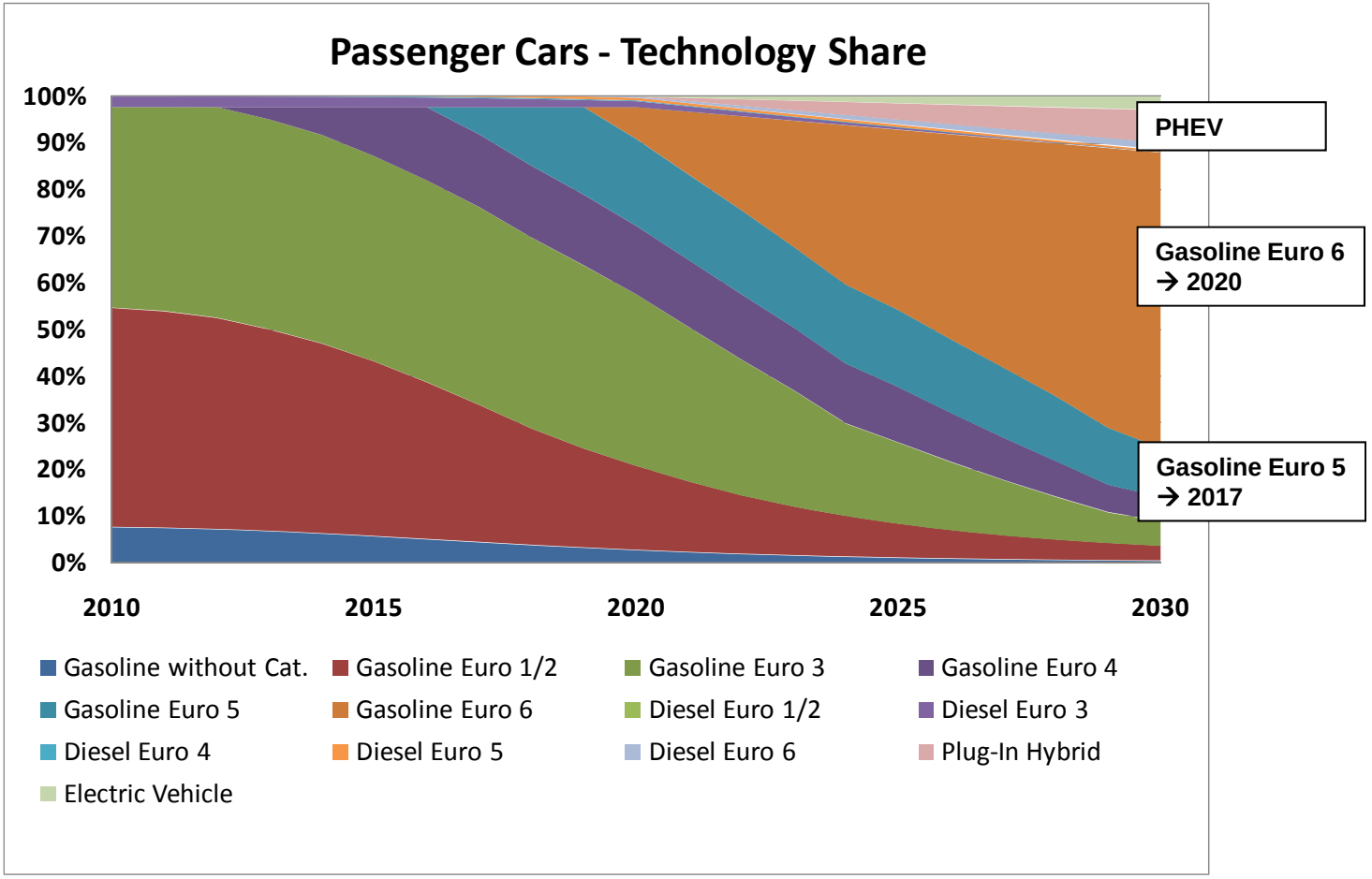
Results

Traffic Development



Source: Andreas Justen, DLR

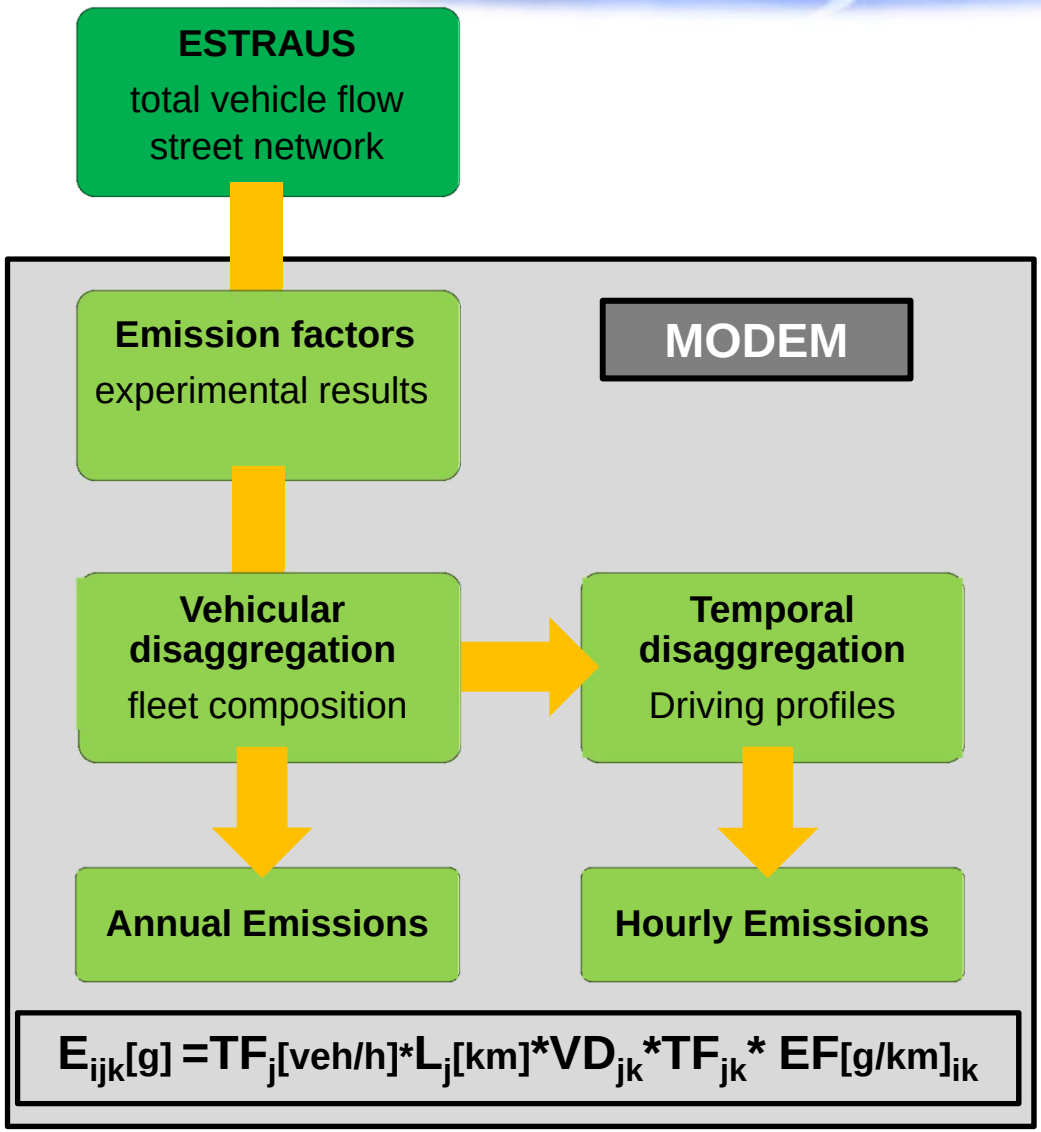
Development of Technology Share



Passenger cars technology share in Santiago de Chile based on the **Business As Usual** scenario

Martin Nogalski (IMK-IFU) -
Master–Thesis

Traffic & Emission Modelling: Santiago



61 vehicle categories

Buses licitados Diesel convencional
Buses licitados Diesel tipo 1
Buses licitados Diesel tipo 2
Buses licitados Diesel tipo 3
Buses licitados DIesel tipo 3 Articulando
Buses licitados Diesel tipo 2 con filtro
Buses licitados Diesel tipo 3 con filtro
Buses Interurbanos Diesel convencional
Buses Interurbanos Diesel tipo 1
Buses Alimentador Diesel tipo 2
Buses Alimentador Diesel tipo 3
Buses Alimentador Diesel tipo 3 con filtro
.....

5 categories of emissions

cold emissions
hot emissions
evaporation
resuspension (→ abrasion tyres, abrasion brakes)

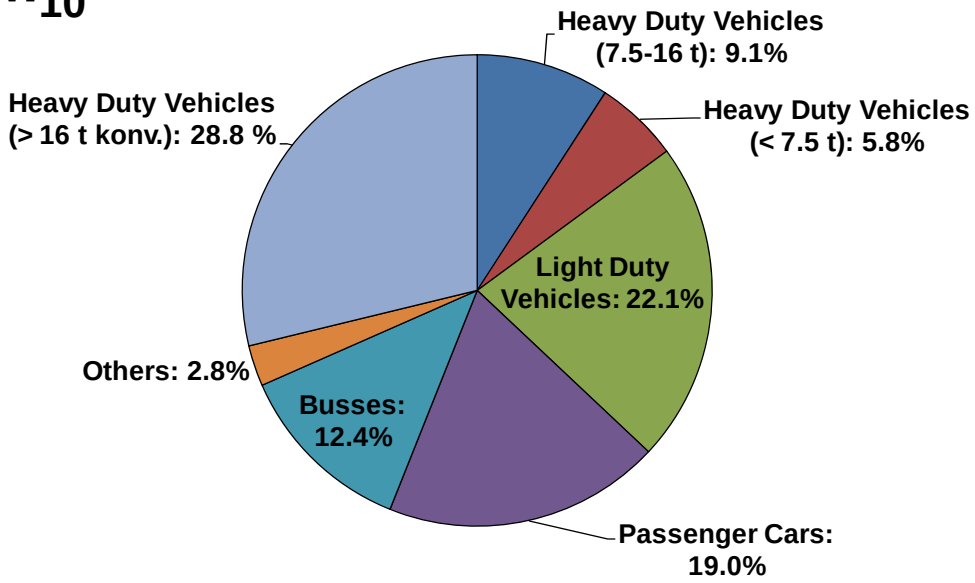
6 emission pollutants

PM10
SO2
NOx
HC
CO
CO2
[Gasoline consumption]

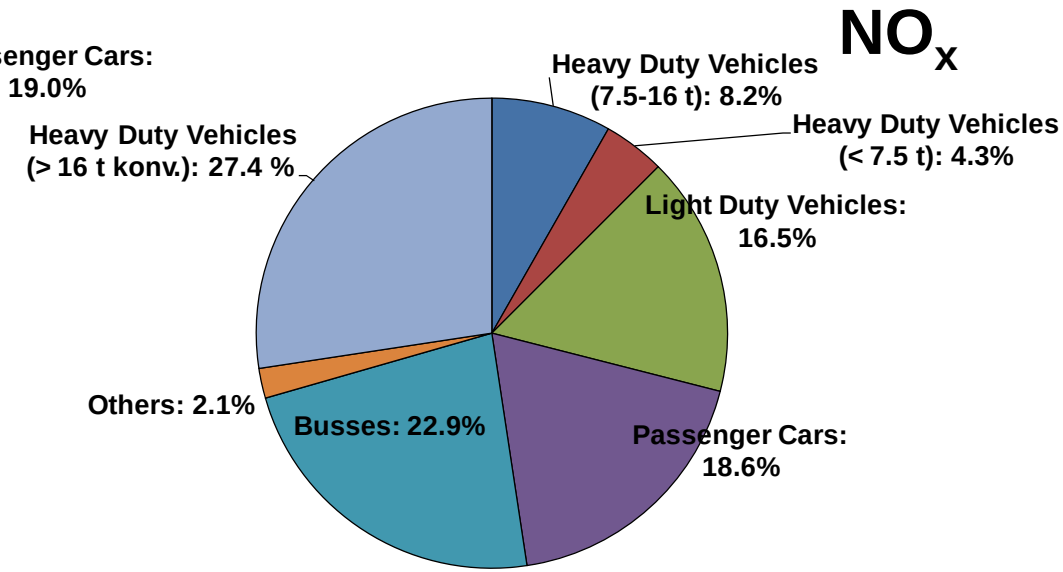
Input data for the simulation of traffic emissions

Traffic Emissions

PM_{10}



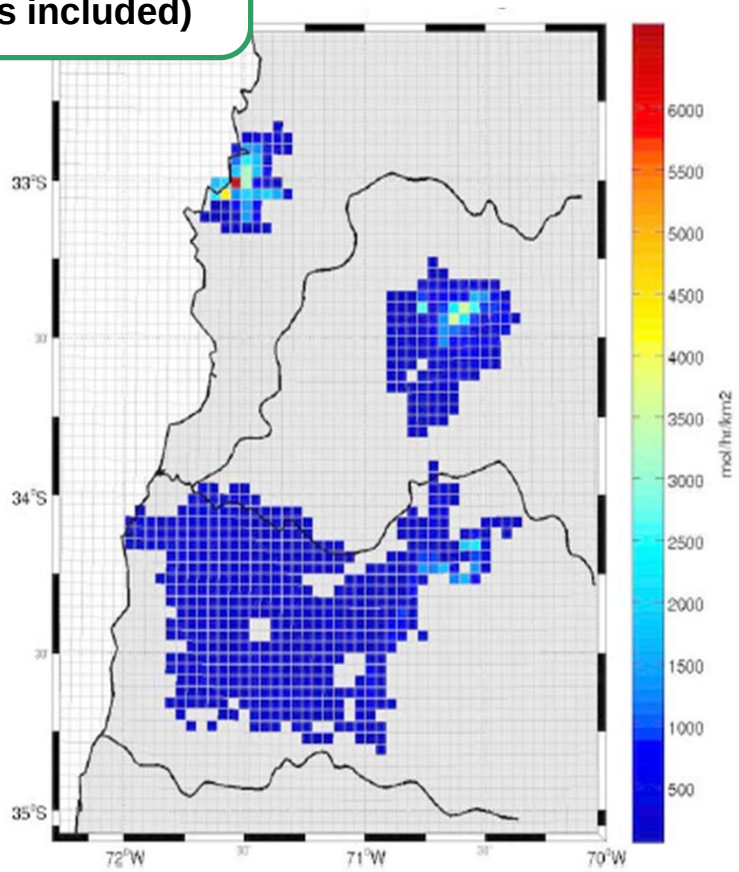
NO_x



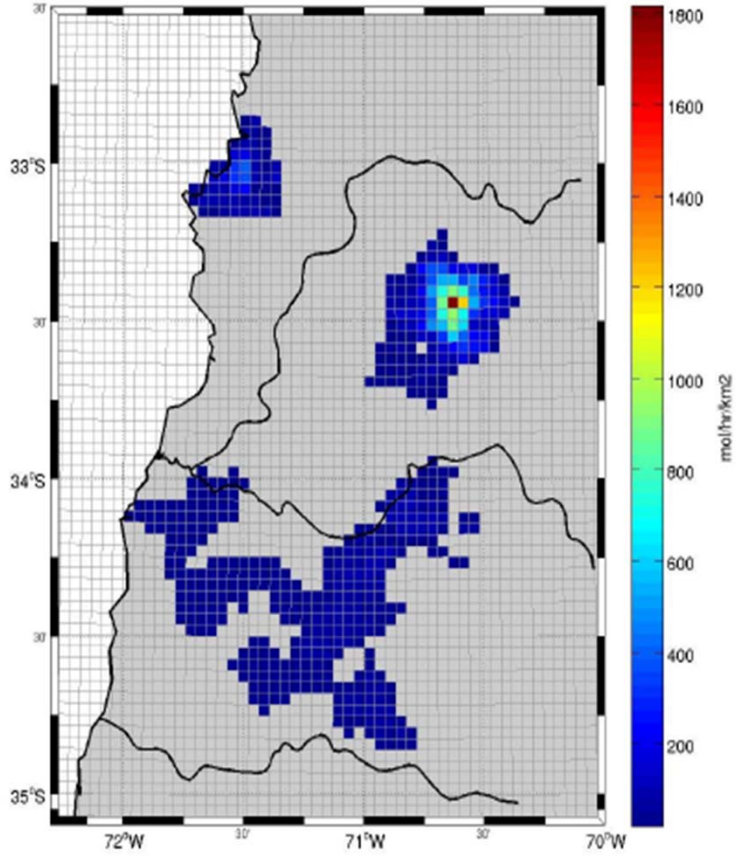
Traffic emission distribution for PM_{10} and NO_x in the Greater Region of Santiago de Chile in 2010

Emission inventory

Official Emission Inventory (all sources included)



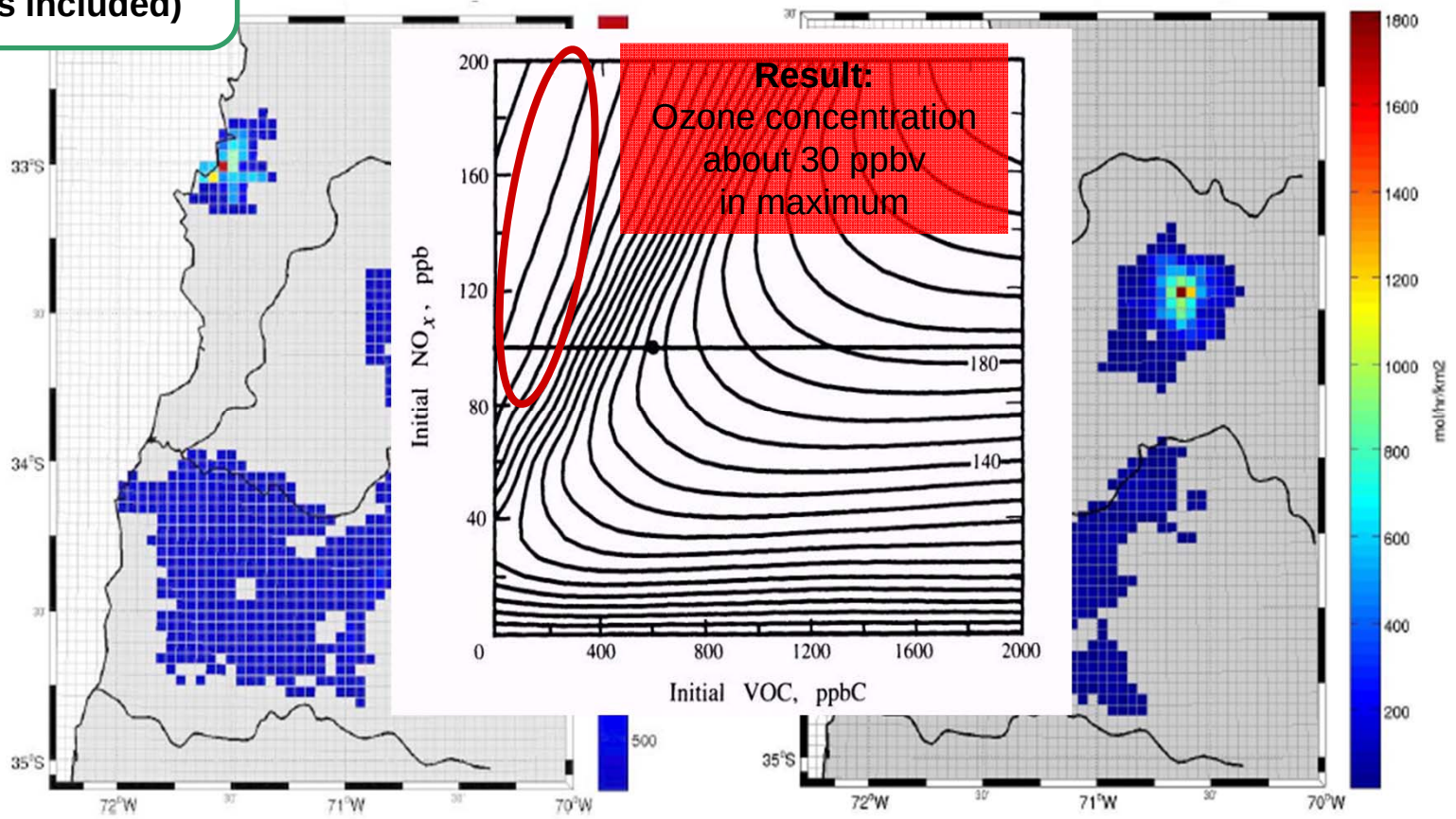
NOx



VOCs

Emission inventory

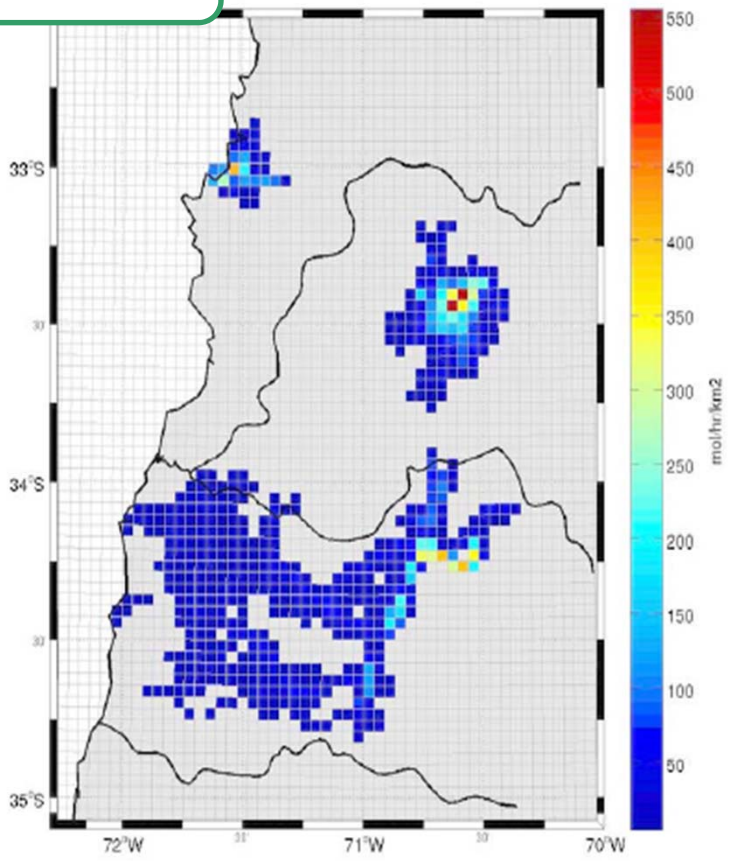
Official Emission Inventory (all sources included)



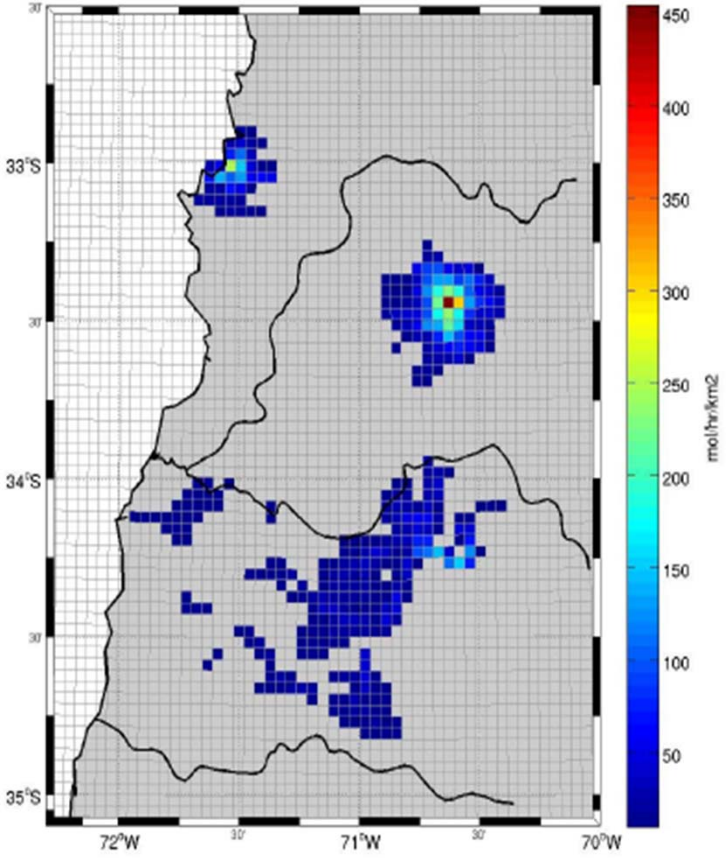
NOx **VOCs**

Emission inventory

Manually Adapted Emission Inventory



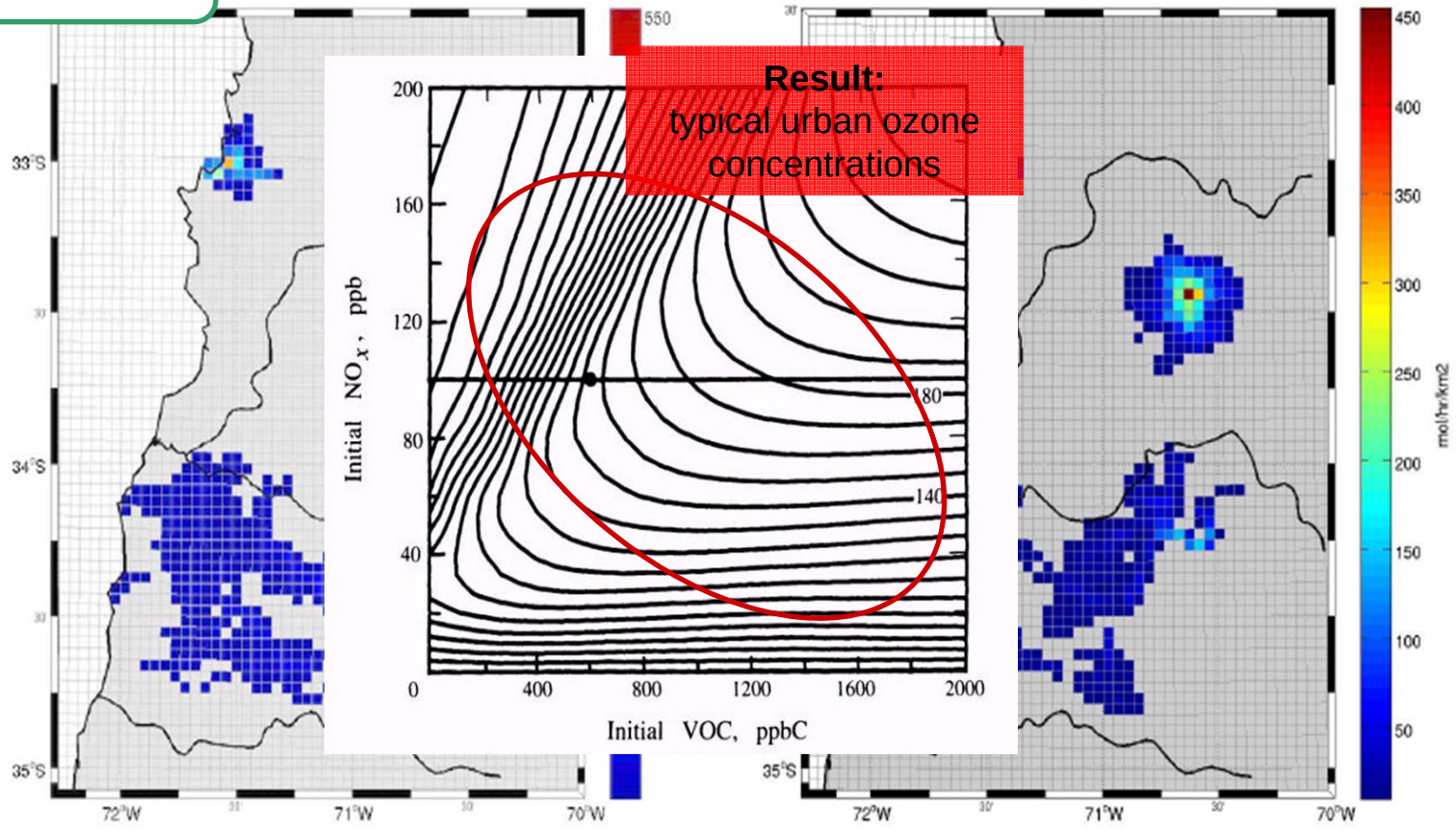
NOx



VOCs

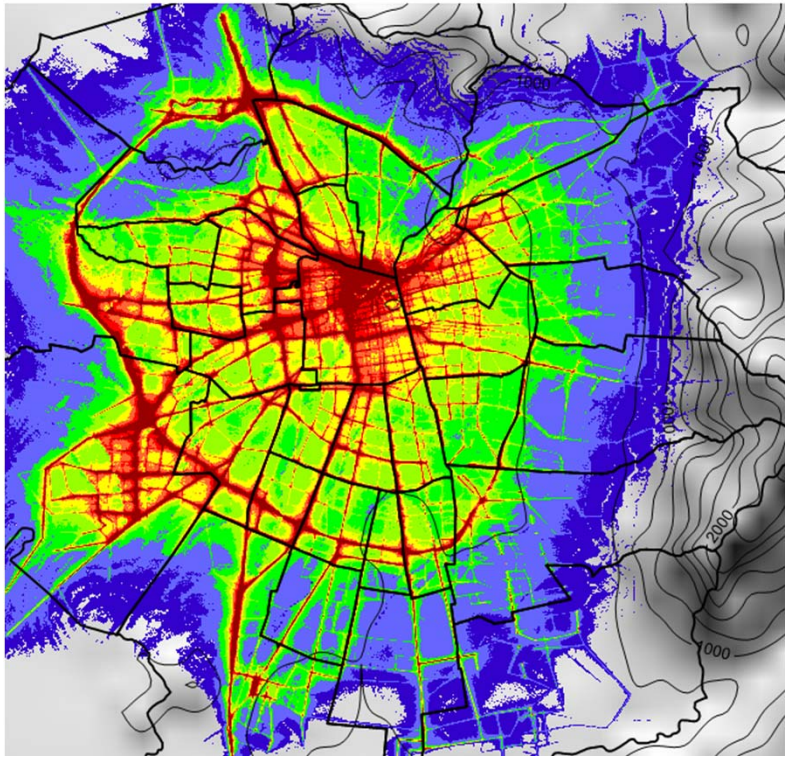
Emission inventory

Manually Adapted Emission Inventory

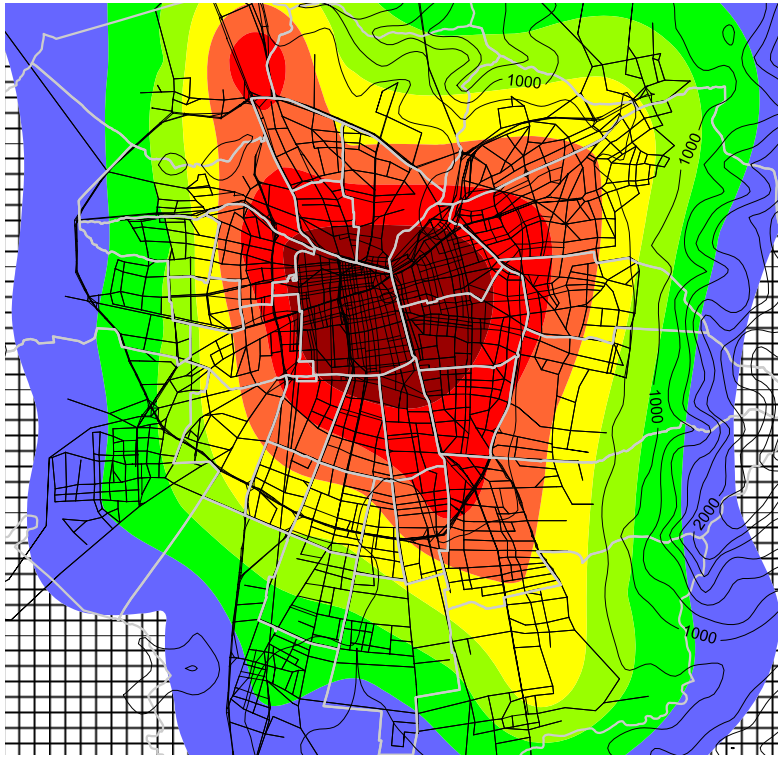


NOx **VOCs**

Coupling of Scales



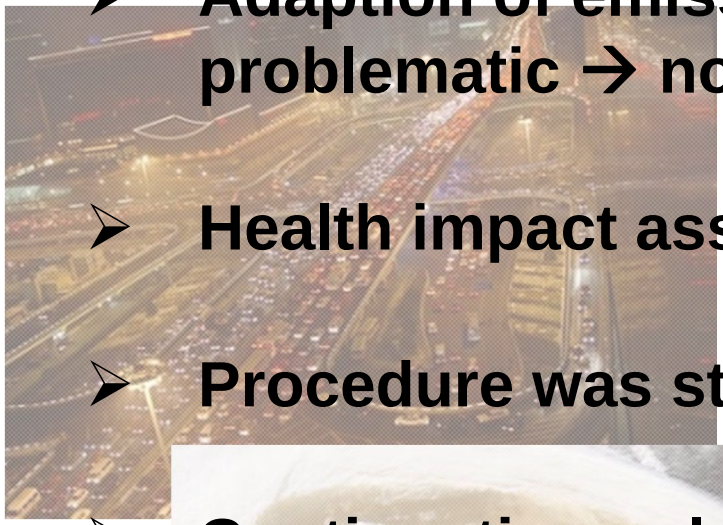
Micro-scale modelling e.g. NO_x with GRAL

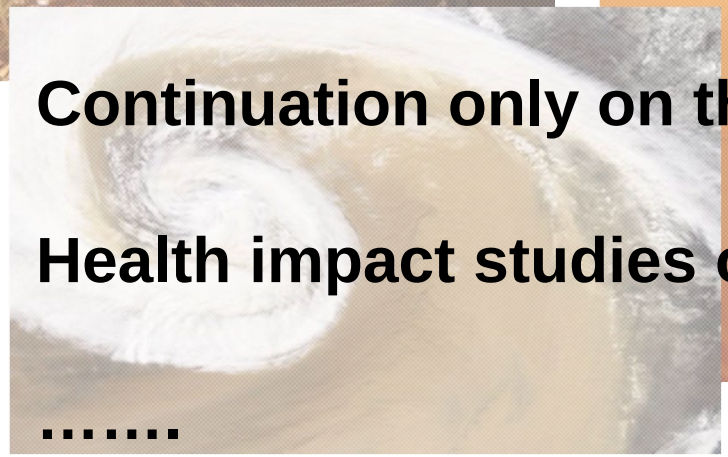


Meso-scale modeling e.g. NO_2 with WRF/chem

Idealized performance of interaction between scales

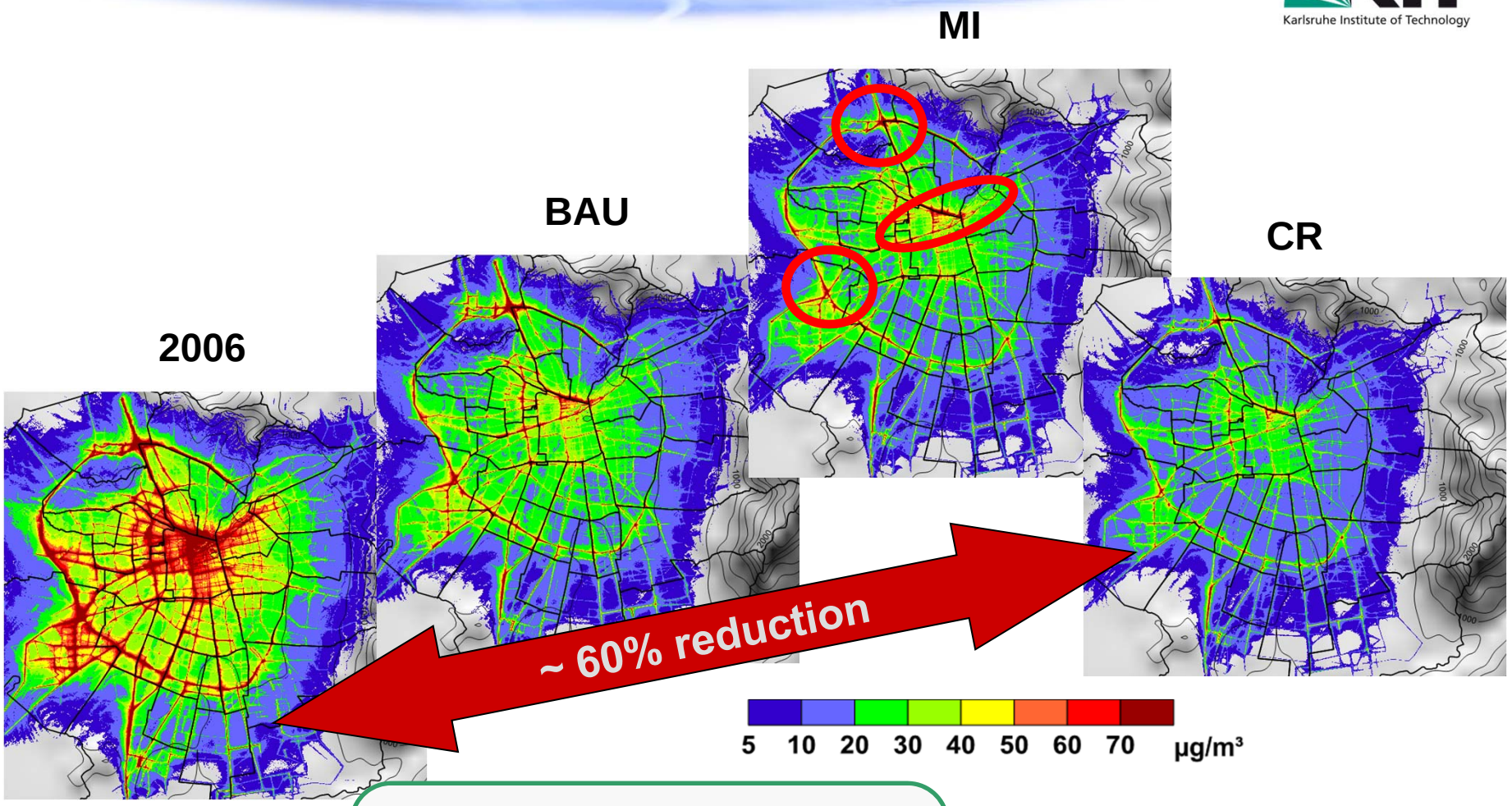
Problem





- Adaption of emission inventory far too problematic → not scientifically sound
- Health impact assessment not reliable
- Procedure was stopped
- Continuation only on the micro scale
- Health impact studies on observations
- …….

Air Pollution Distribution

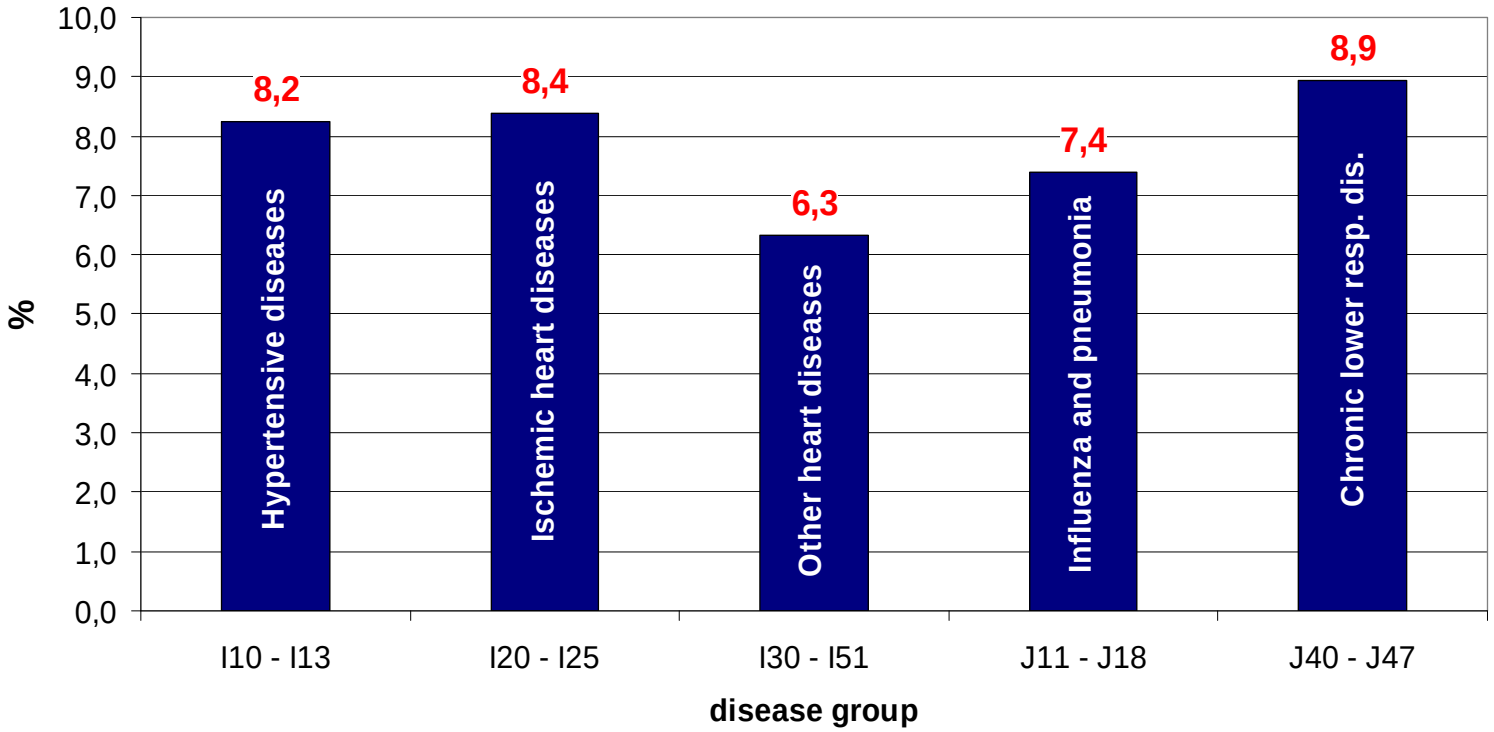


Annual mean NOx distribution for 2006 (only traffic emissions) in the Greater Region of Santiago de Chile

BAU - business as usual
MI - market individualism
CR - collective responsibility

Johannes Werhahn, IMK-IFU

Adverse Health Effects: Santiago



Source: Ulrich Franck, UFZ

Mortality Risks
per 10 µg/m³ PM_{10}

Conclusions

- Scenario development needs multidisciplinary views and approaches
- Assessment of traffic emissions is a straight forward process
- Air quality modeling needs reliable input data
- Coupled micro-mesoscale modeling is needed to describe the air pollution levels for further analysis

„It is now understood that the battle against climate change will likely be won - or lost - in cities. However, research thus far has concentrated mostly at the sector (e.g. agriculture, water, energy) and national levels. Targeted research at the city level is needed to enable policy makers to understand the magnitude of the impacts and the alternatives to improve resilience of the cities (World Bank 2008)

Thank you very much for your attention

HELMHOLTZ GEMEINSCHAFT