

RETO MOD

Dispersion modelling of accidental toxic gas releases – a model comparison study

S. Stenzel, K. Baumann-Stanzer

Zentralanstalt für Meteorologie und Geodynamik



Sicherheitsforschungsprogramm KIRAS
im Auftrag
des BMVIT





Why modelling the accidental release of toxic gases?

Prediction of the threat zones by accidental released toxic gases

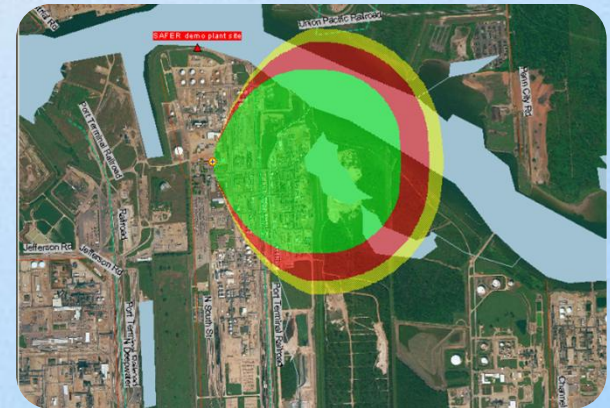
- Accidents in establishments (chemical plants)
- Transport accidents

Calculation of the Maximal concentration / Dose

- for the next 1 hour after the accident
- from the first few meters up to 20 km

Application:

- Training
- Planing (Emergency plans)
- Support for the emergency responders



Explosion in the rail station Viareggio, Italy

30. June 2009

Railcar with fluid gas

22 dead, ~50 injured

Damages up to 300m



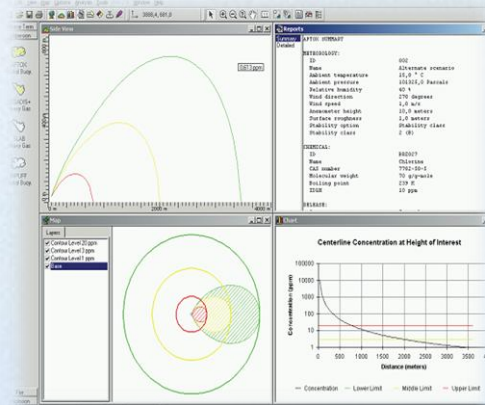
Modelling of accidental released toxic gases

- Dispersion models calculate averaged concentrations:
 - short time peaks in the concentrations can be higher or smaller depending on the wind fluctuations.
- Estimation of the threat zones with comparison to threshold values.
- Release terms are complex, mostly unknown and insufficient.
- Chemical features of the substances can influence the dispersion.



Modelling of accidental released toxic gases

- ALOHA (CAMEO)
- HAZMAT RESPONDER
- TRACE
- MEMPLEX MET
- BREEZE HAZ
- SAM-S



Chlor

Eingabe Wetter

Wind: 1 m/s | Windstille, Rauch steigt gerade empor

270° West | Kein Nebel | Kein Bodennebel | Rel. Feuchte: 40 %

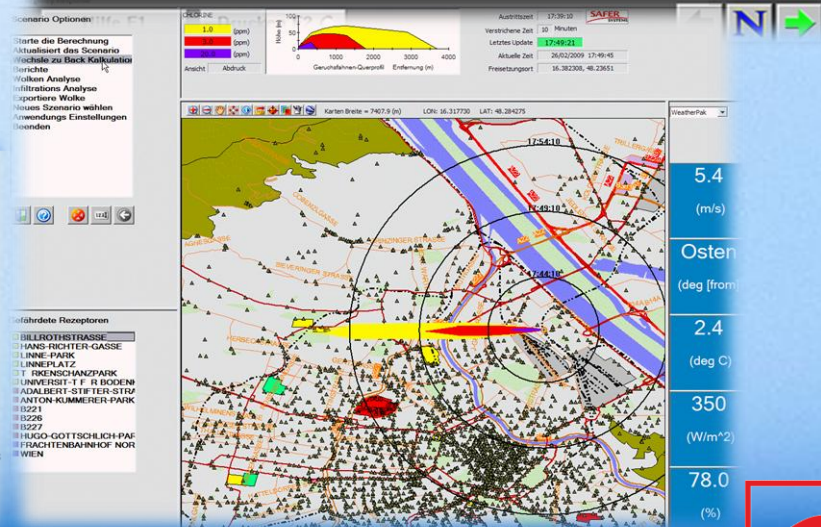
Kein Regen | Weniger als 50% bedeckter Himmel | Luftdruck: 1013 hPa

Tag | Winterhalbjahr | Lufttemp.: 15 °C

Szenario | Wettermonitor AUS

Aufschlagpunkt	0 m	0	10000	20000	30000	40000	50000 m	
Sektoruell	Bereiche	16730 m	Geruch	<input checked="" type="checkbox"/>				
		k.A. m	Explosion	<input checked="" type="checkbox"/>				
	Gift	9330 m	Im Haus	<input checked="" type="checkbox"/>				2:34h
		11850 m	Im Freien	<input checked="" type="checkbox"/>				3:15h
Wolkenexplosion	k.A. m	Ohr	<input type="checkbox"/>					
	k.A. m	Glasbruch	<input type="checkbox"/>					
Tankexplosion	0 m	Ohr	<input type="checkbox"/>					
	0 m	Glasbruch	<input type="checkbox"/>					
	0 m	Fragment	<input type="checkbox"/>					
BLEVE	k.A. m	1. Grad	<input type="checkbox"/>					
	k.A. m	2. Grad	<input type="checkbox"/>					
Radial		k.A. m	Holz	<input type="checkbox"/>				

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Select tank type and orientation:

Horizontal cylinder | Vertical cylinder | Sphere

Enter two of three values:

diameter: [] feet [x] meters

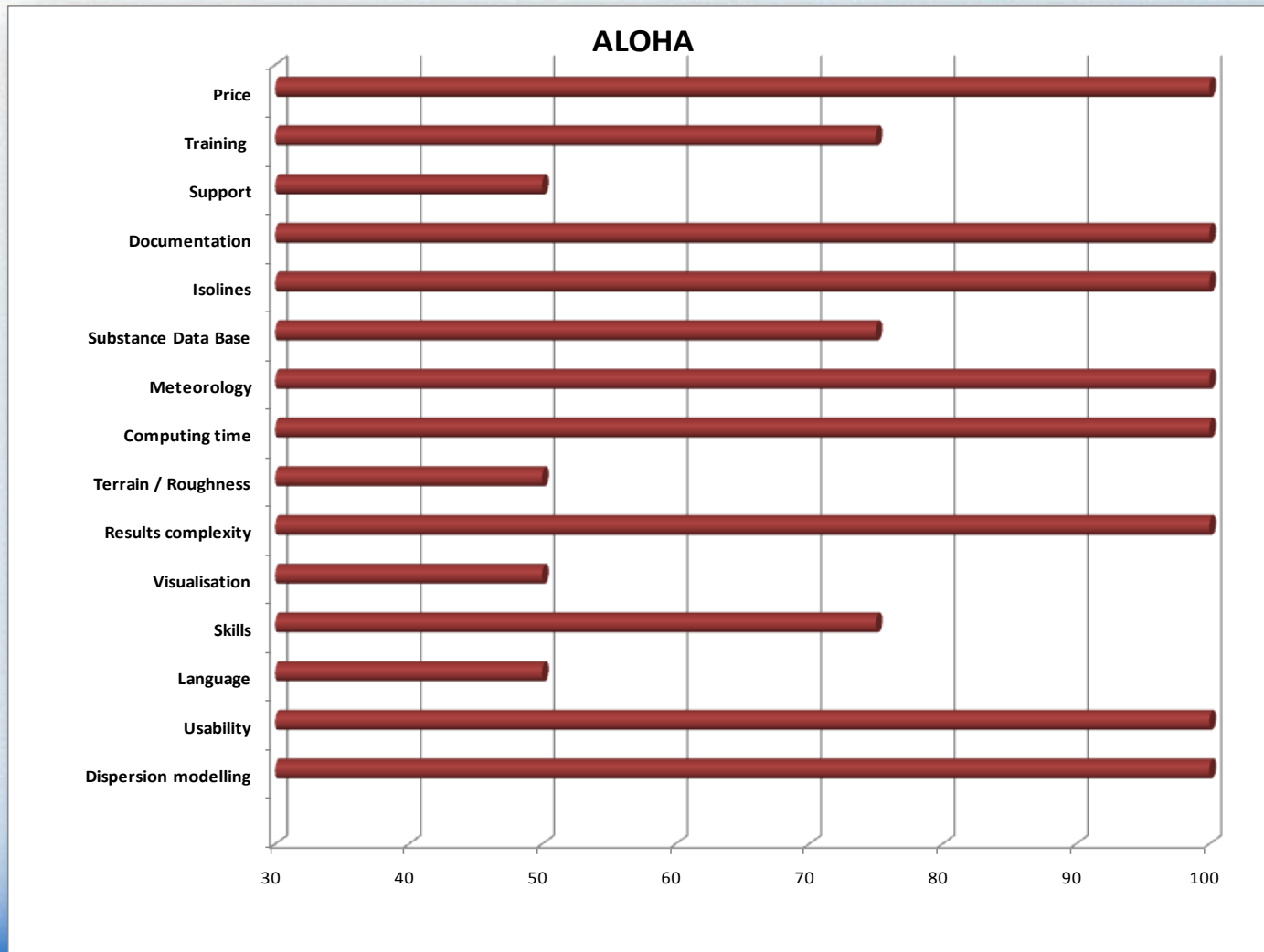
length: [] feet [x] meters

volume: [] liters [x] cu meters

OK | Cancel | Help



Assessment of the model utility for the fire brigades



Interpretation of the results

Estimation of the threat zones – threshold values

Substance	IDLH (30min)	ERPG-1 (60min)	ERPG-2 (60min)	ERPG-3 (60min)	AEGL-1 (30min)	AEGL-2 (30min)	AEGL-3 (30min)	MAK TmW	MAK Kzw
Ammoniac [ppm]	300	25	150	750	30	160	1 600	20	50
Chlorine [ppm]	10	1	3	20	0,5	2,8	28	2	4
Conversion factor to IDLH		10- 12	2 – 3,5	0,4–0,5					

IDLH = Immediate Dangerous to Life and Health,

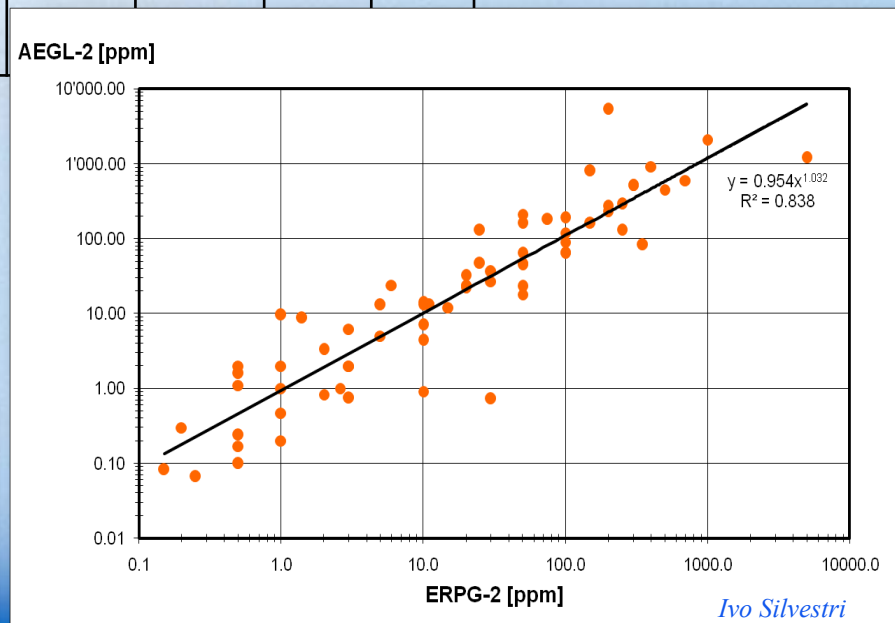
ERPG = Emergency Response Planning Guide,
American Industrial Hygiene Association

AEGL = Acute Exposure Guideline Levels, EPA

Concentration (ERPG-2) ~ 2 x Concentration (MAK)

Concentration (ERPG-2) ~ 4 x Concentration (MAK)

IDLH ~ 10 x MAK

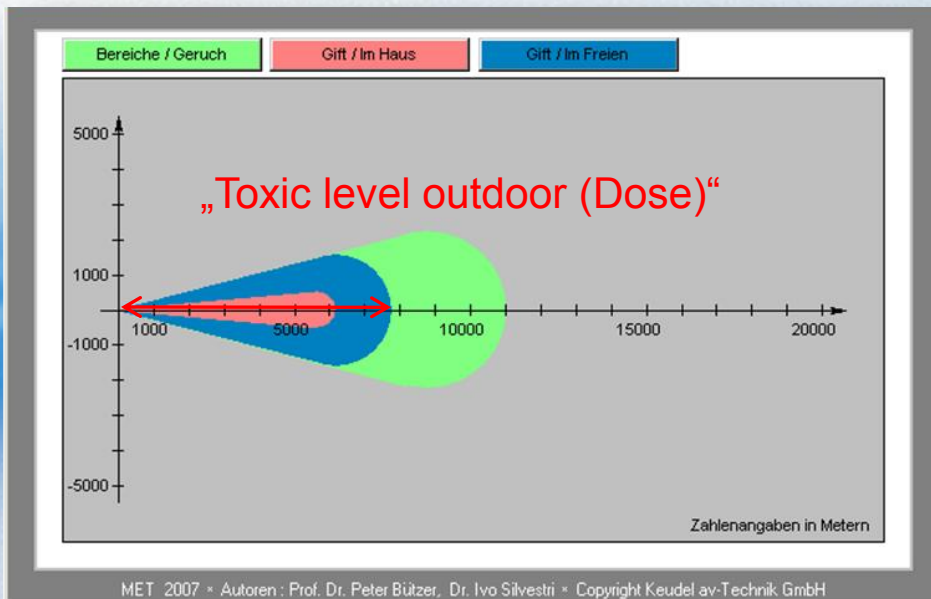


Ivo Silvestri

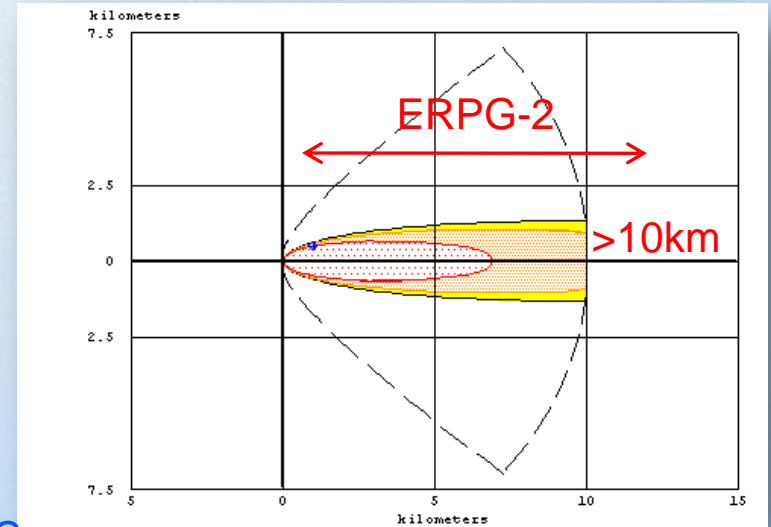


Model comparison

MEMPLEX



ALOHA

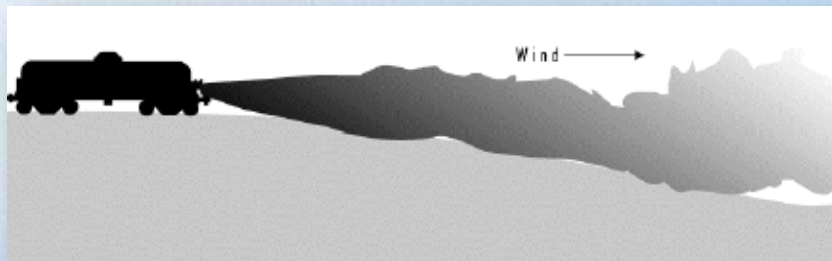


SAMS



Reference scenarios

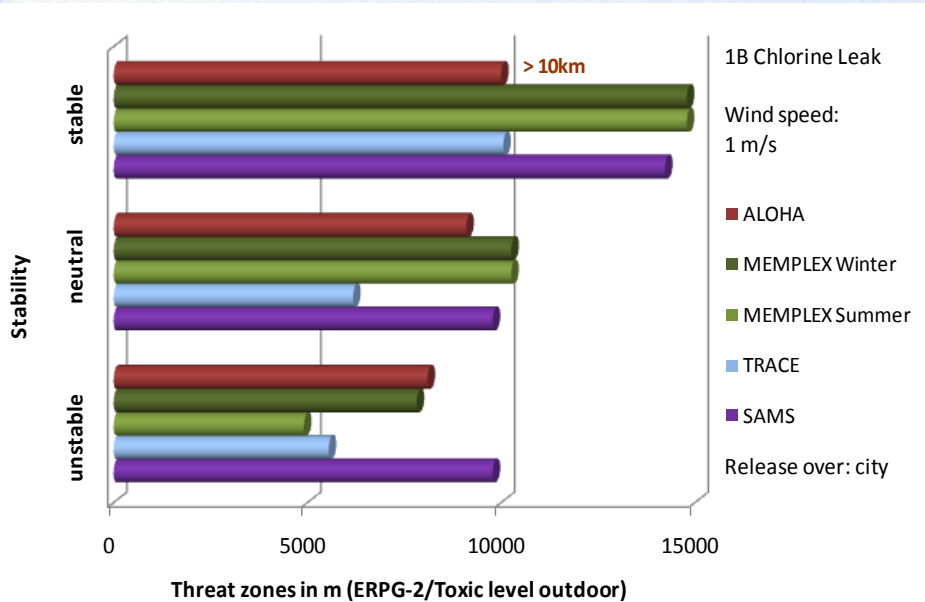
Scenario	Substance	Tank	Volume [m ³]	Filling level [%]	Mass [t]
1	Chlorine	Railway car	30	90	40
2	Ammoniac	Railway car	95	90	55
3	Butane	Truck	17	70	7
4	Petrol	-	-	-	1



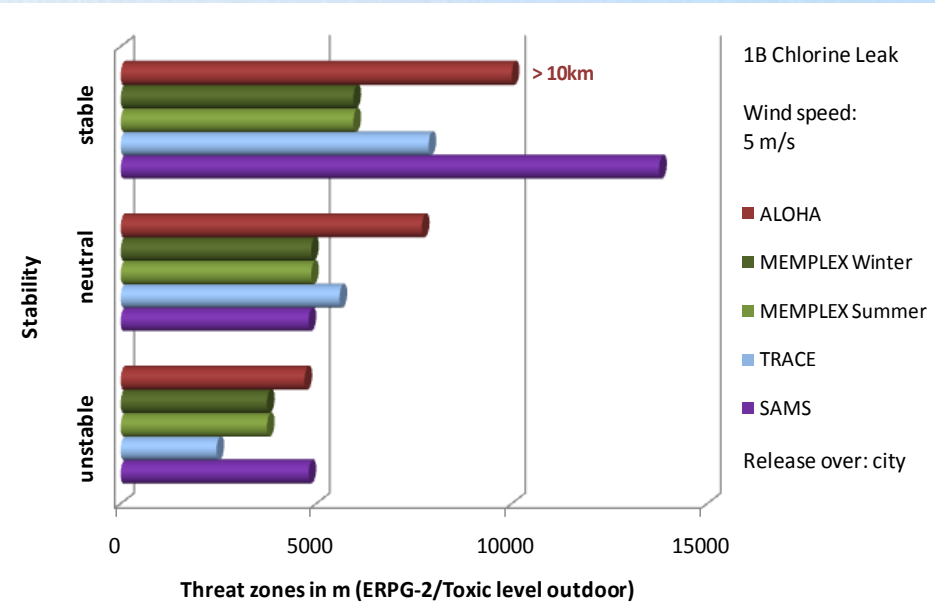
Model comparison

Chlorine

1 m/s



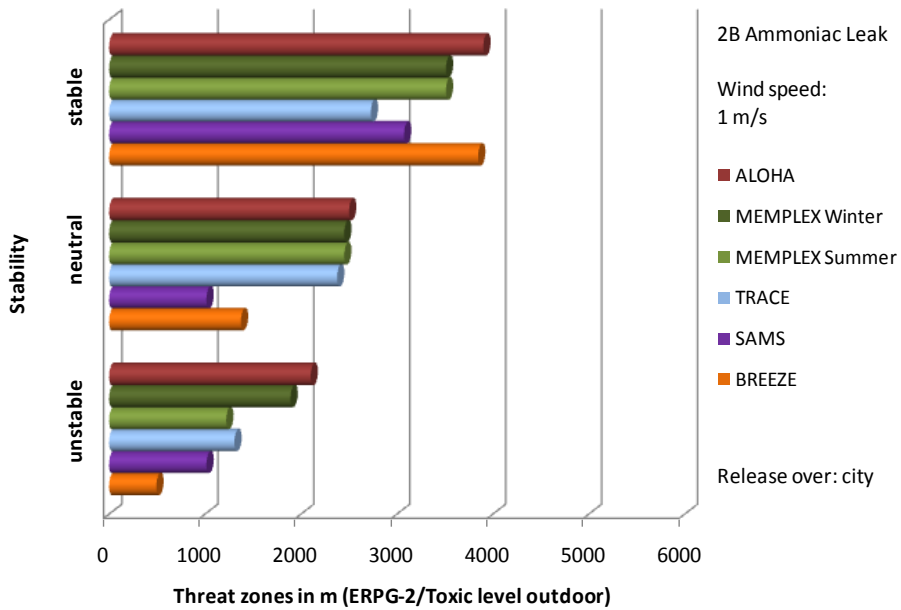
5 m/s



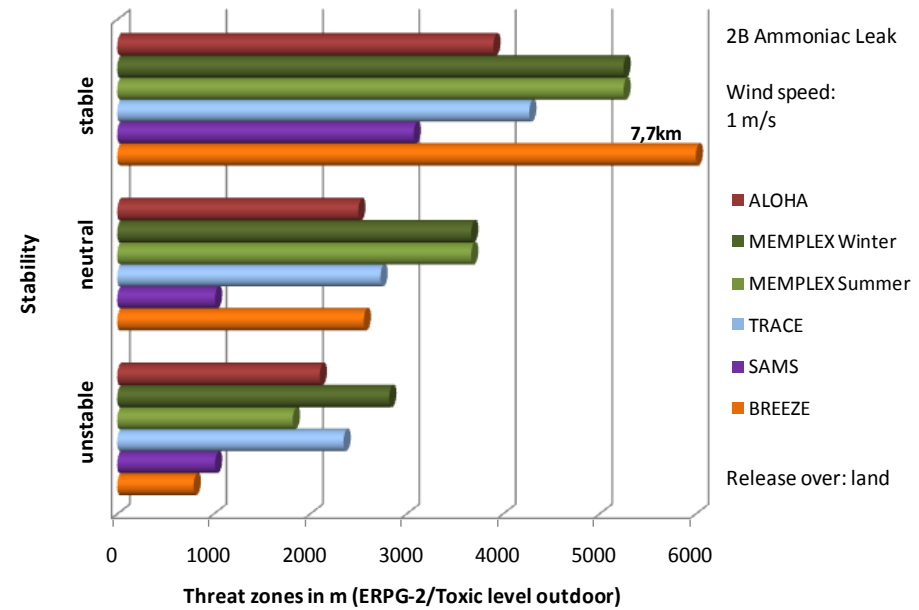
Model comparison

Ammoniac

City



Land



Importance of meteorological input parameters

Accident Report: Fire-accident in Ineos Köln-Worringen on 17.3.2008
Burning tank with acrylonitrile, after inflammation from broken pipe.

BR Feyrer: *„The wind turns. Because a tank with propylene close to the fire became at risk, we must started immediately with the countermeasures.“*



Conclusions

Models comparisons based on reference scenarios show partly big differences:

- Need of verification studies – e.g. COST Action in preparation

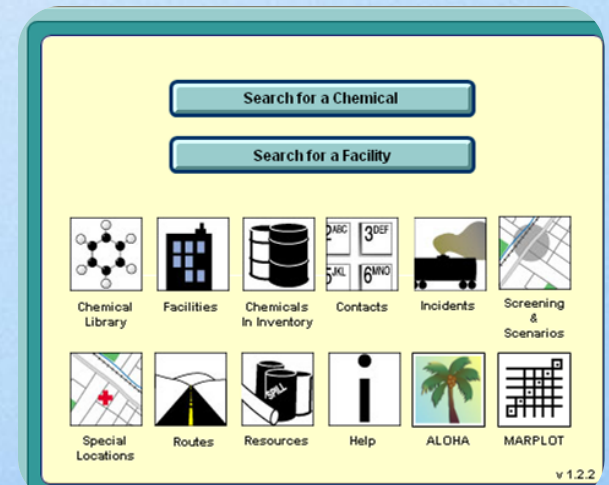
Recommendations for the model choice:

- For establishments (e.g. plant or chemical factory): e.g. SAFER or SAM-S.
- For mobile applications: e.g. MEMPLEX/MET, ALOHA.

Importance of the meteorological input:

- Wind, atmospheric stability
- Air temperature (relative to release temperature)
- Humidity, fog, rain

The choice of the appropriate model is up to the particular demands of the authorities.



Thank you very much for your attention!

