The Consequence Analysis Comparison of Severe Accident Using WinMACCS/RASCAL/EPZDose

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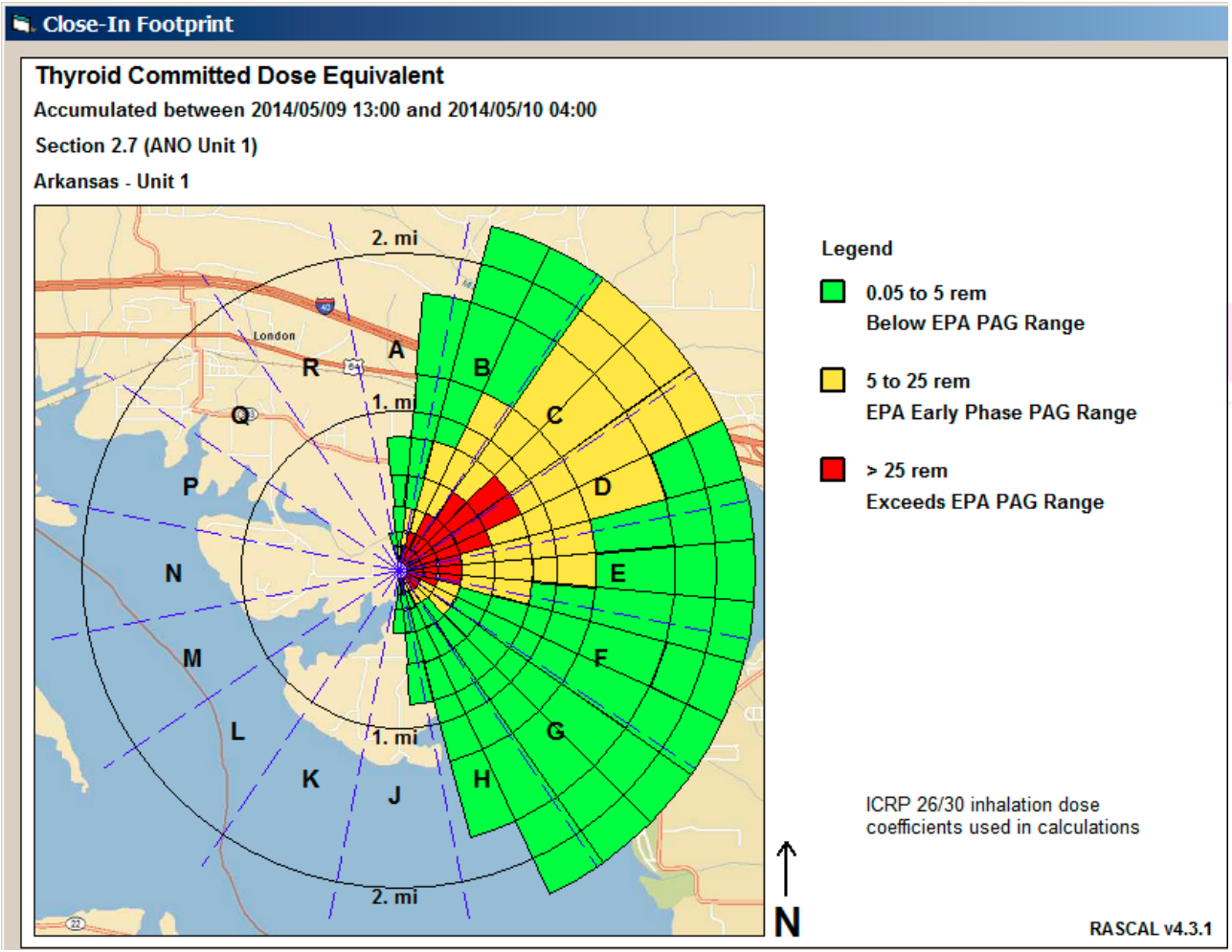
Introdutcion

- Our lab have developed an offsite dose consequences assessment tool, EPZDose, and have made some comparisons of the accumulated thyroid dose calculated results between EPZDose and RASCAL.
- We also have done many severe accident consequence assessment research using MELCOR and WinMACCS.
- In this study, we would like to compare the dose simulation results of the three codes with the same source term calculated from the SBO scenario case with the MELCOR Chinshan NPP model.
- For comparison, we developed a small GUI tool for showing the WinMACCS peak dose.

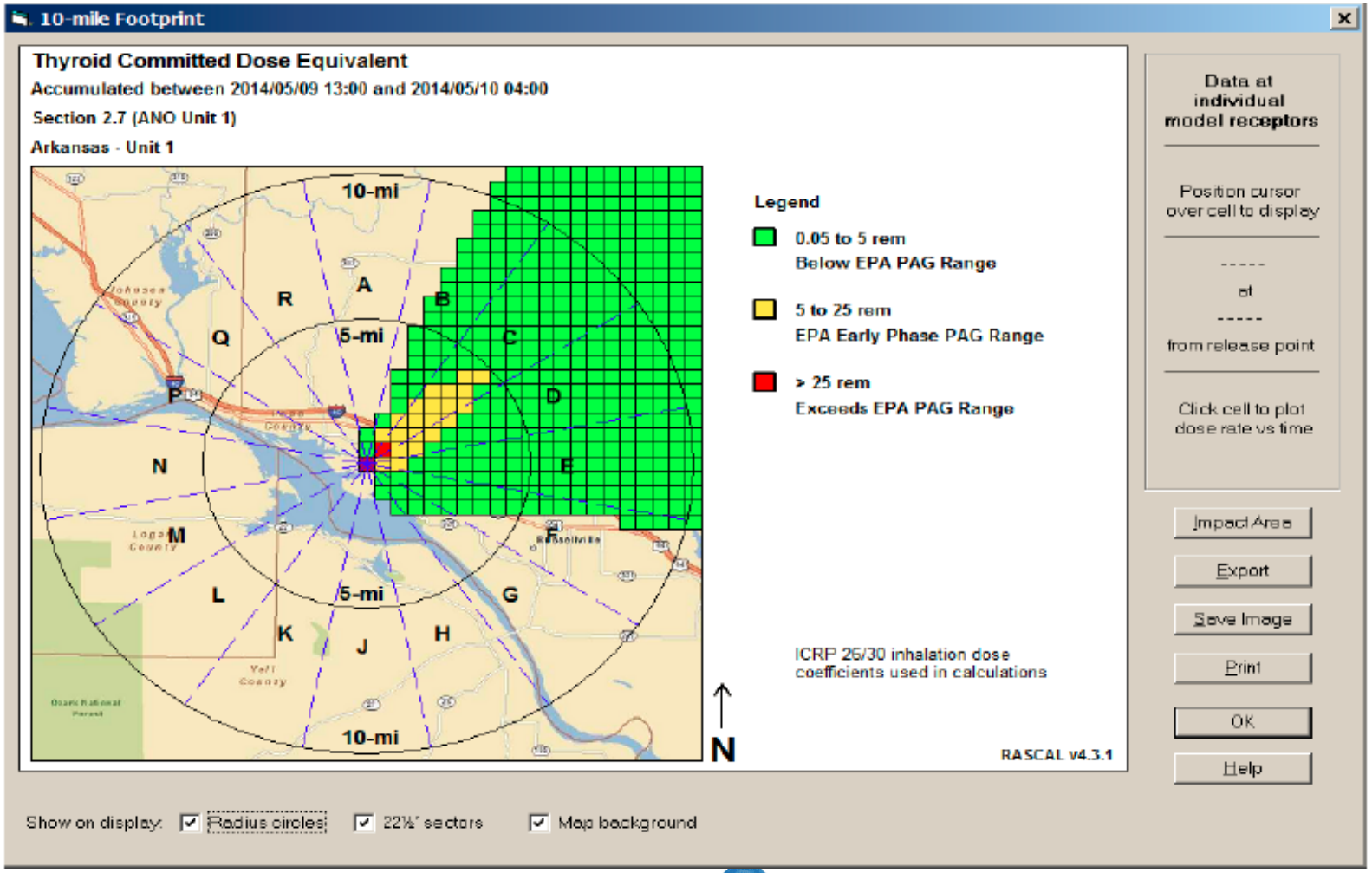
Introduction to RASCAL

- An emergency response code for NPP and fuel cycle facilities radioactive material release events developed by NRC.
- Purpose
  - Make dose and consequence projections during radiological incidents and emergencies.
  - Aid decision-making such as whether the public should evacuate or shelter in place

RASCAL Near Field Footprint

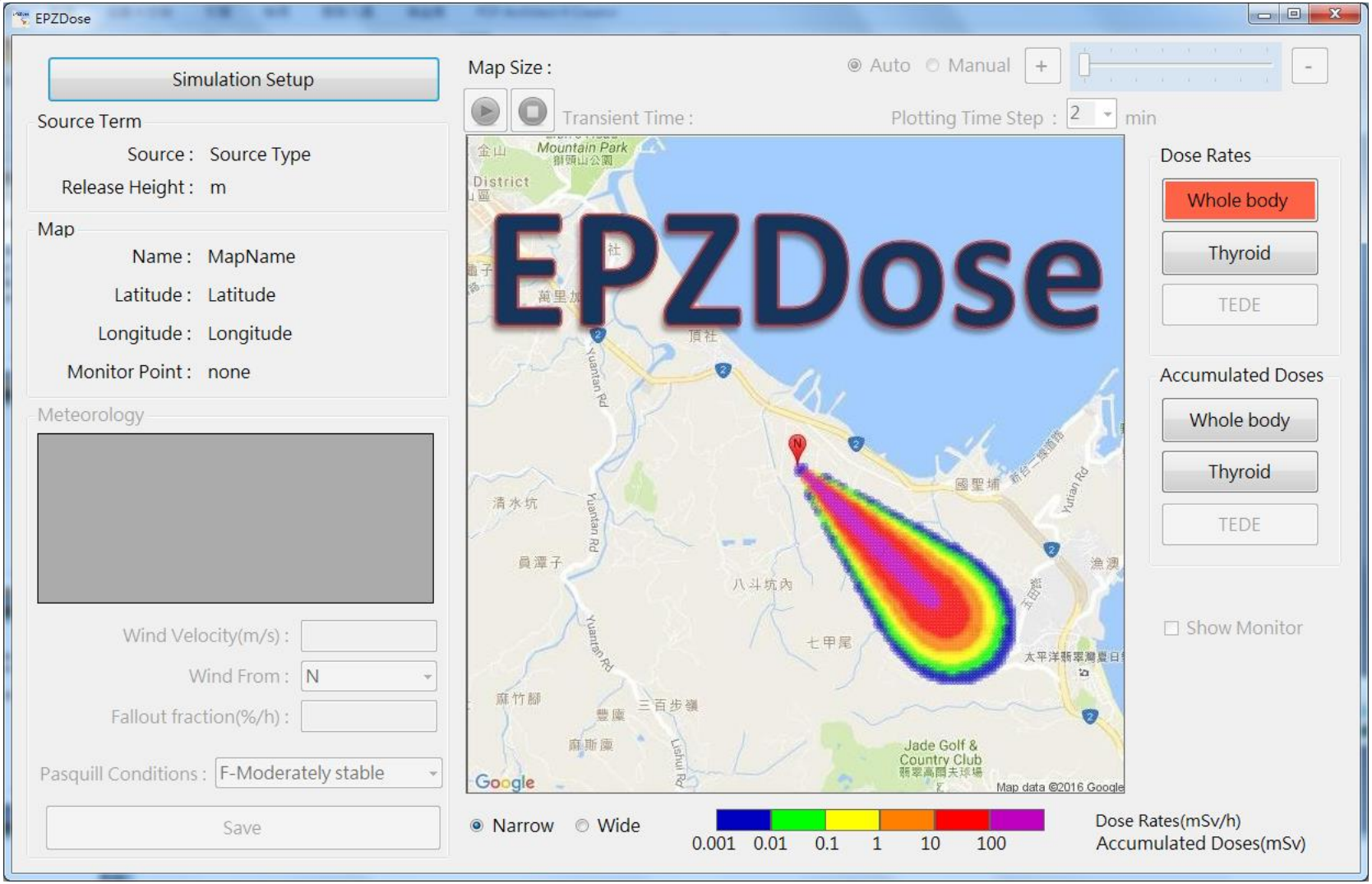


RASCAL Far Field Footprint



Introduction to EPZDose(1/4)

- An simple offsite dose consequences evaluation code developed by NTHU.
- Purpose
  - Rapidly assesses the dose consequences of the time-dependent input source terms and the meteorology conditions.
- Uses modified Gaussian plume model.
- Input : source term, meteorology conditions.
- Output : whole body and thyroid dose.
- Roughness and terrain are not concerned.
- Do not calculate decay.


EPZDose
Simulation Setup
Source Term
Source : Source Type
Release Height : m
Map
Name : MapName
Latitude : Latitude
Longitude : Longitude
Monitor Point : none
Meteorology
Wind Velocity(m/s) :
Wind From : N
Fallout fraction(%/h) :
Pasquill Conditions : F-Moderately stable
Save
Map Size :
Auto
Manual
Transient Time :
Plotting Time Step : 2 min
EPZDose
Dose Rates
Whole body
Thyroid
TEDE
Accumulated Doses
Whole body
Thyroid
TEDE
Show Monitor
Narrow
Wide
0.001 0.01 0.1 1 10 100
Dose Rates(mSv/h)
Accumulated Doses(mSv)
Google
Map data ©2016 Google

Introduction to EPZDose(2/4)

- Use Access database for the input source term and meteorology data.
- The time-dependent source term (called puffs) can be generated by the nuclear power plant simulation program, PCTRAN, or input by user. We can also convert the source term generated from other software to the EPZDose source term format.
- The meteorology status can be input with file or be set during simulation via GUI.

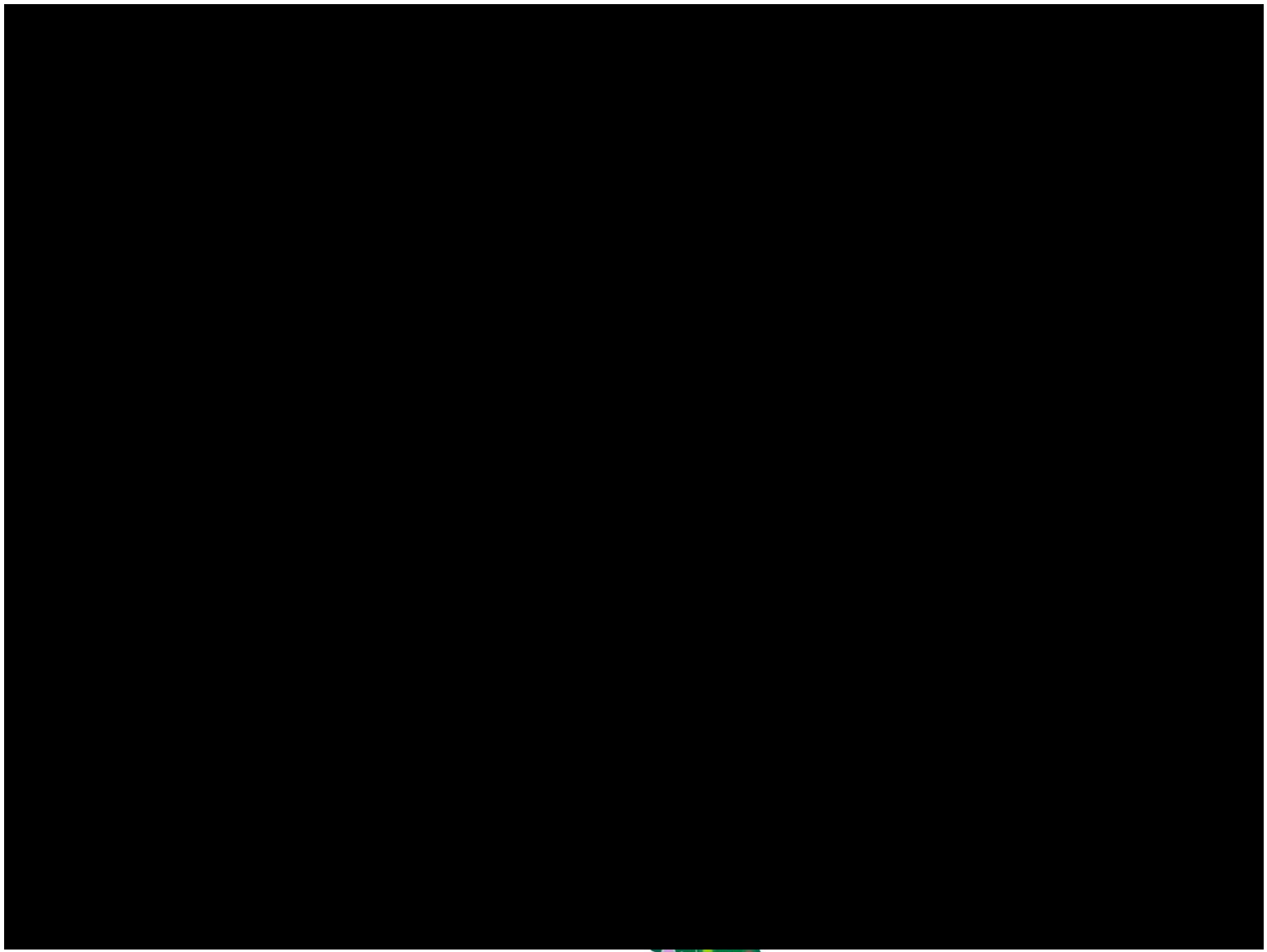
Introduction to EPZDose(3/4)

- The motion of every puff is determined by meteorological conditions, such as wind velocity, wind direction, and stability categories.
- The locations of center of mass of all puffs are traced in the code and the dispersions of all puffs are calculated.
- The ground level dose consequences of receptors are calculated by adding up the influences of all released puffs.

Introduction to EPZDose(4/4)

- The background map of the event sites can be retrieved through the internet for 8 different zoom levels of the map, from 3km to 367km radius.

- The calculated result of dose consequences displayed with animation and the background map can be adjusted manually or automatically according to the distance between the release point and released puffs.



Comparison of the WinMACCS peak dose polar output with EPZDose

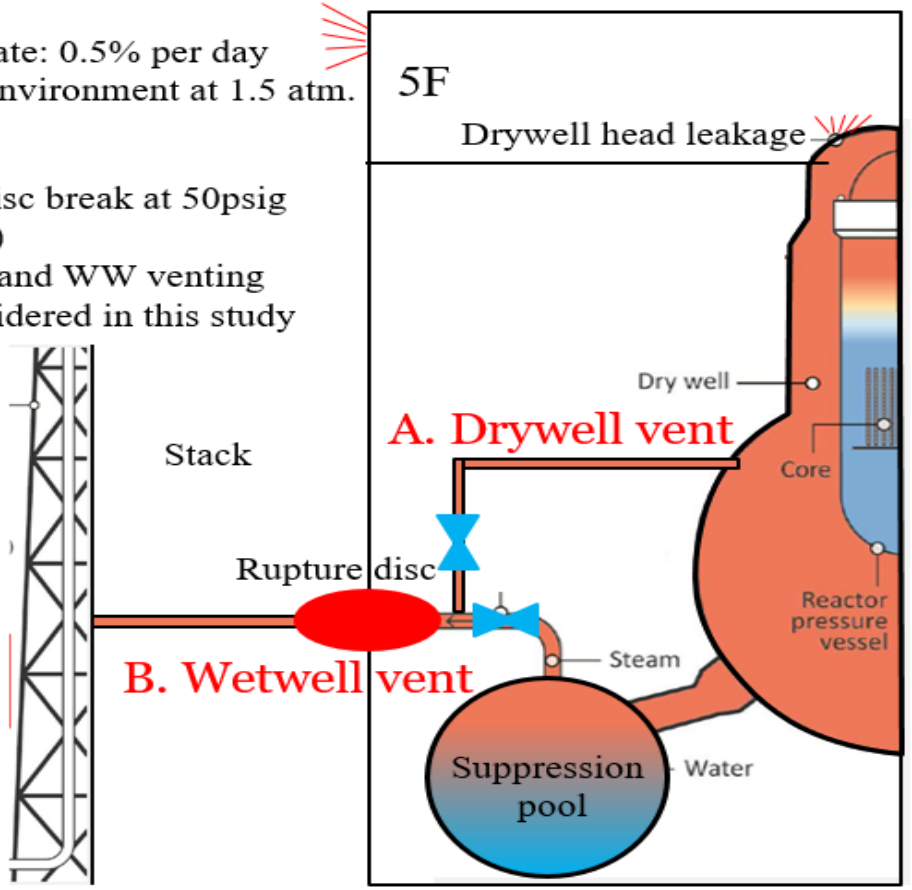
- Using MELCOR to simulate an SBO scenario.
- Using MELMACCS to create the input files containing the source term data of the scenario.
- Parsing the source term and converting it to meet the input source term format of RASCAL and EPZDose.
- Using WinMACCS/RASCAL/EPZDose to do the simulation with the same source term and meteorology conditions.
- Showing the A-Thyroid peak dose calculated output with a customized GUI.
- Trying to compare the calculated results.

MELCOR SBO Model Scenarios

C. Roof break

- ✓ Leakage rate: 0.5% per day
- ✓ Break to environment at 1.5 atm.

- ✓ Rupture disc break at 50psig (0.34MPa)
- ✓ Both DW and WW venting were considered in this study



Model Descriptions

	Case A	Case B	Case C
Event	SBO without RCIC	SBO without RCIC	SBO without RCIC
Drywell head leakage	Yes	Yes	Yes
5F leakage rate	0.5% per day	0.5% per day	0.5% per day
Rupture disc	Available	Available	Failed
Venting method	Through rupture disc (Drywell venting)	Through rupture disc (Wetwell venting)	Reactor building failed because of over pressure

Release and Meteorology Description

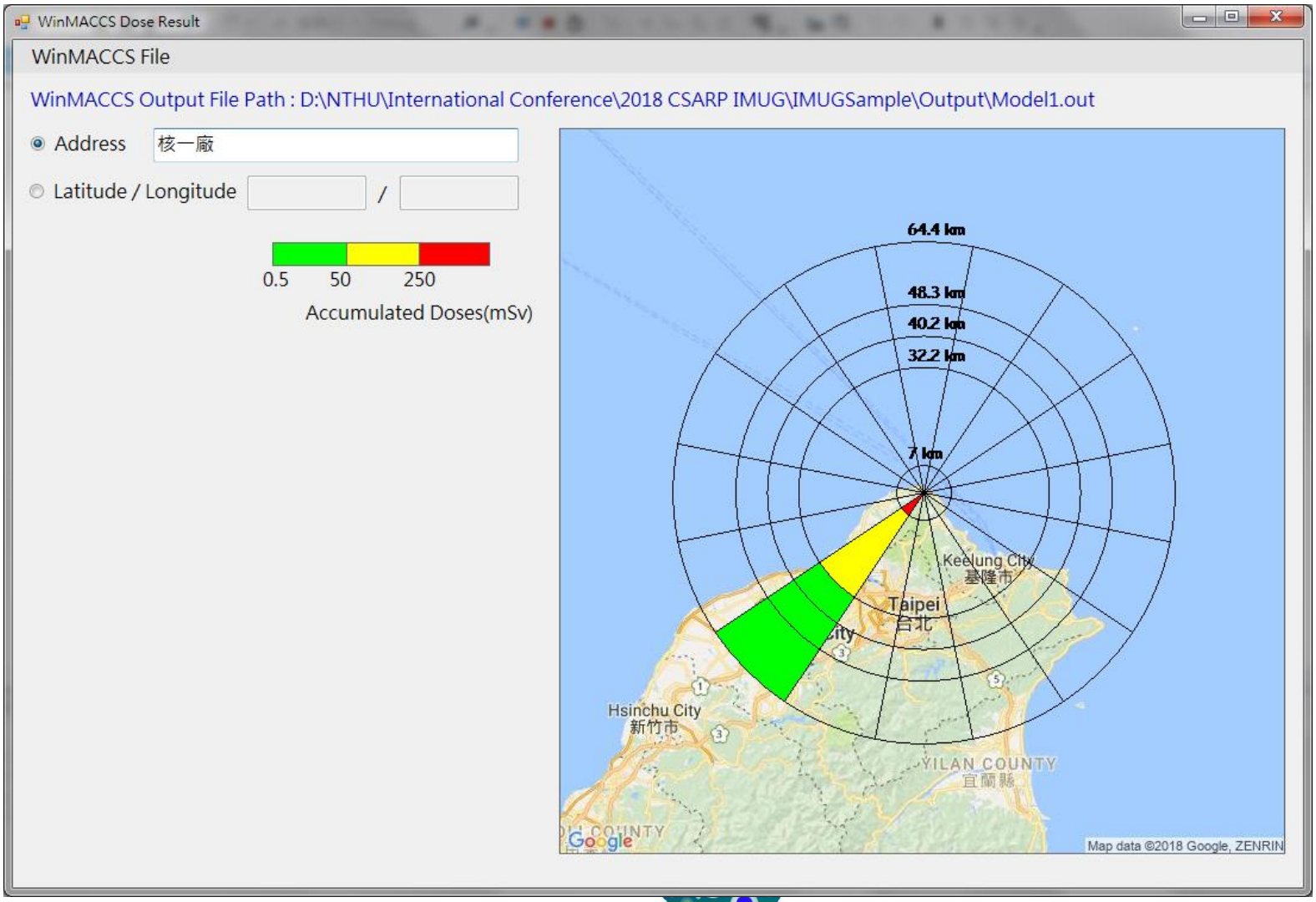
- Case B Release:
  - Start at 88801 sec.(about 24.5 hours after the start of the accident) till 127550 sec.(about 35.5 hours)

	Release fraction								
	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
SOARCA	0.947	0.017	0.095	0.115	0.104	0.009	0.002	0.000	0.000
Case B	0.8724	0.0053	0.0013	0.0276	0.0613	0.0000	0.0019	0.0000	0.0000

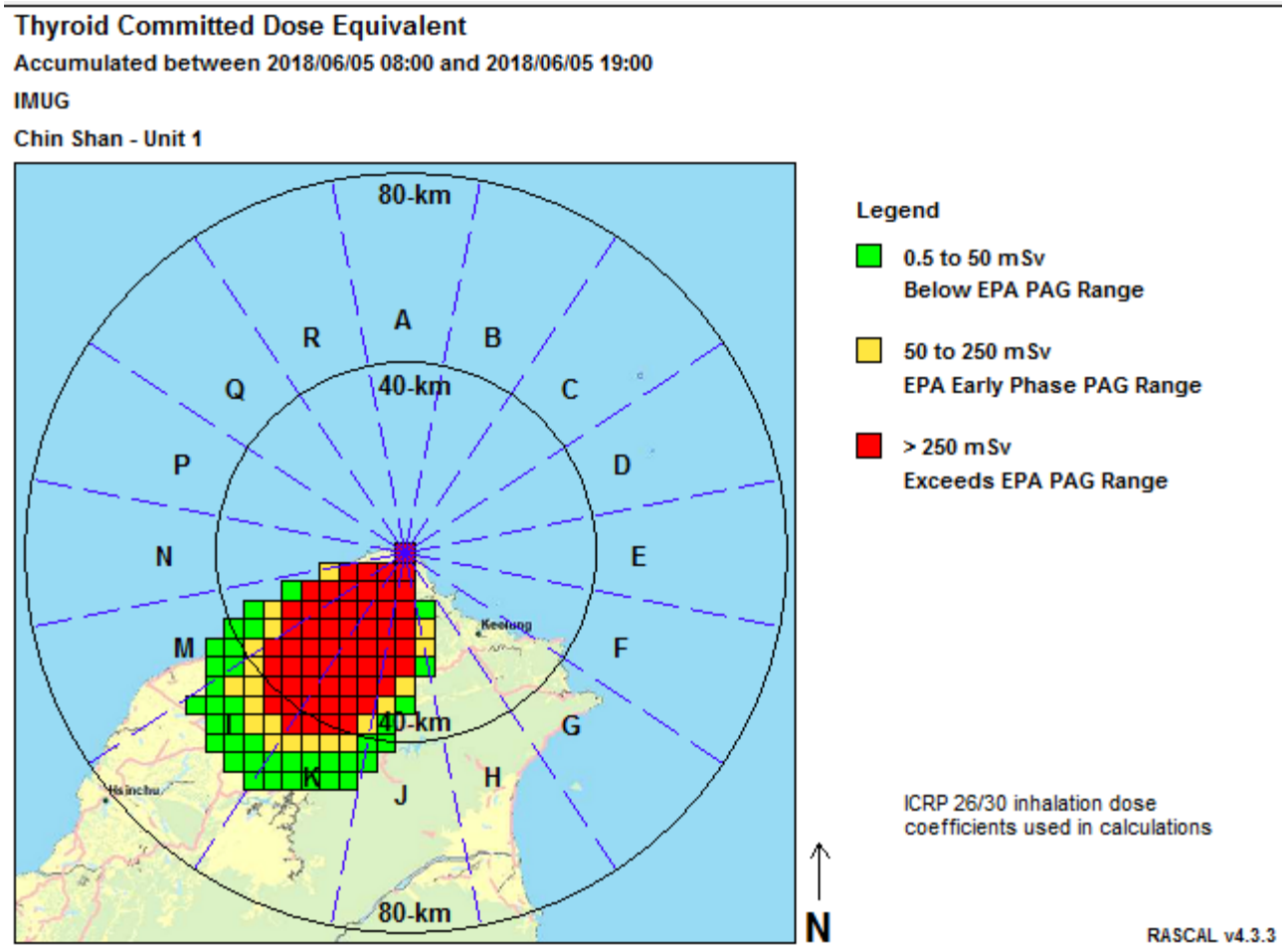
- Meteorology condition(after the first release) :

Type	Date	Time	Wind Direct from(deg)	Speed (m/s)	Stability Class	Precipitation
Obs	<date>	00:00	NE	1.0	F	No Precip
Obs	<date>	7:30	NNE	2.0	F	No Precip

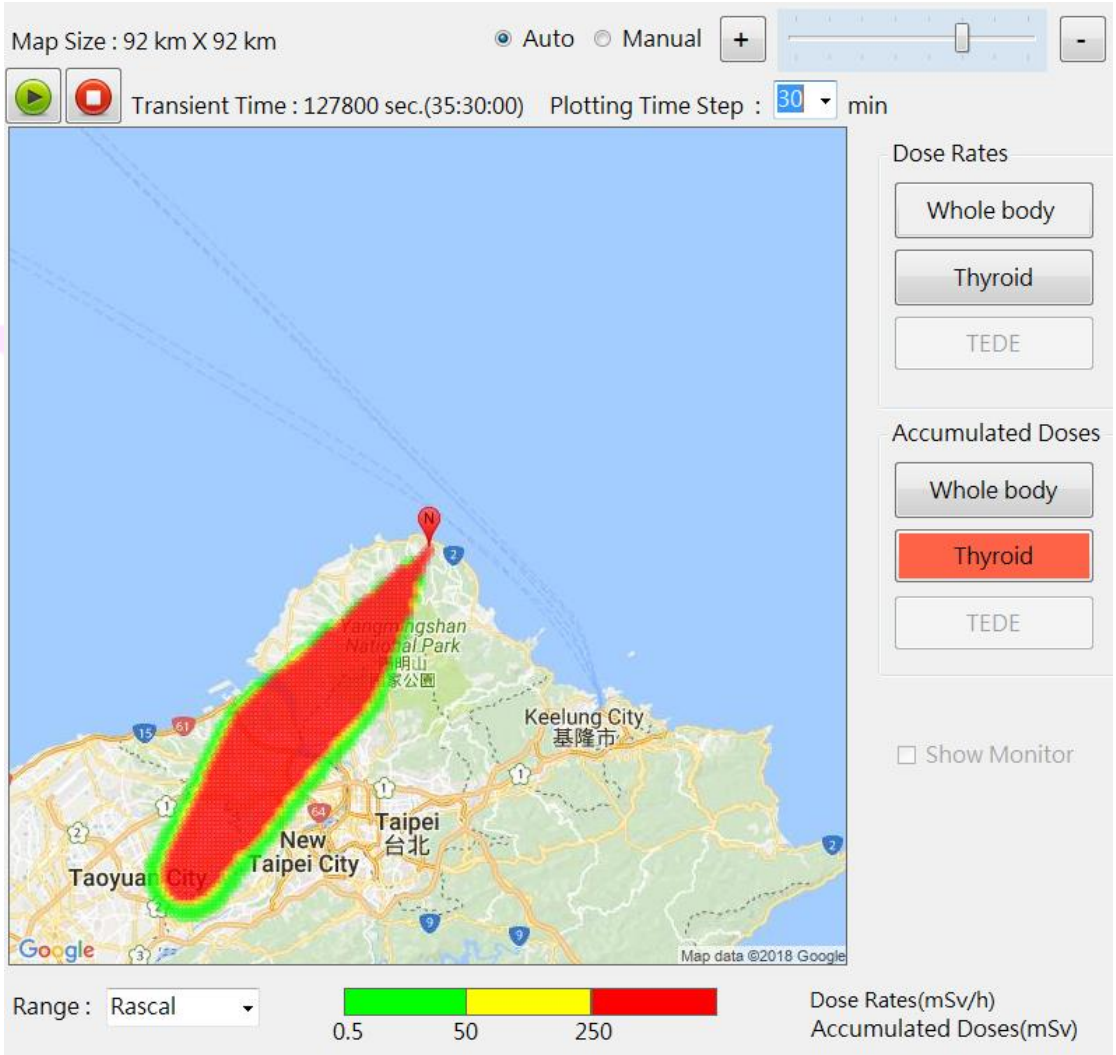
WinMACCS Peek Dose Polar



RASCAL : The accumulated Thyroid Doses at 35.5 hours after the event start(11 hours after the first release)

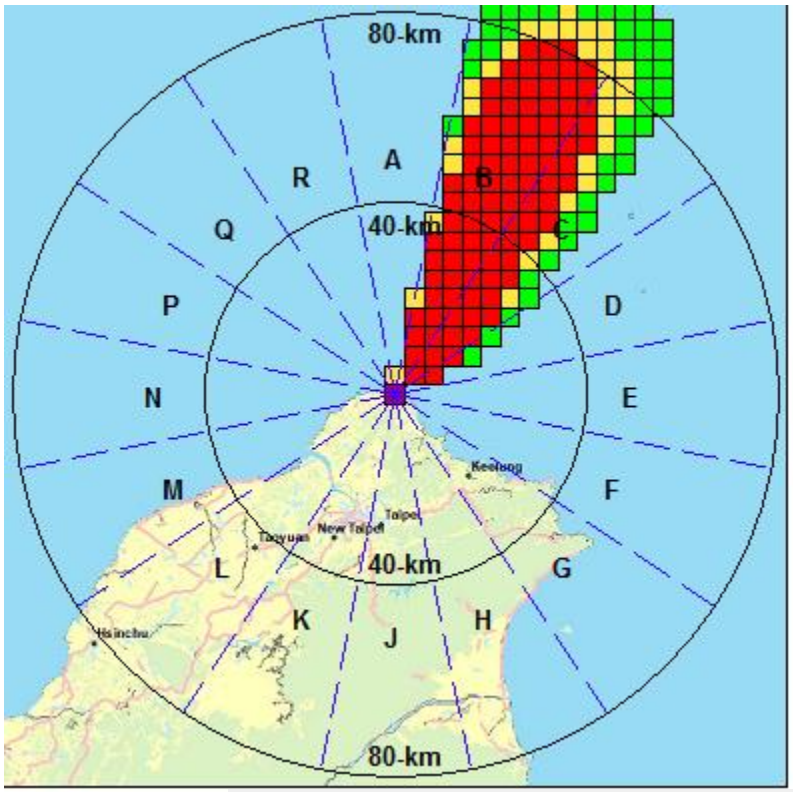


EPZDose : The accumulated Thyroid Doses at 35.5 hours after the event start(11 hours after the first release)

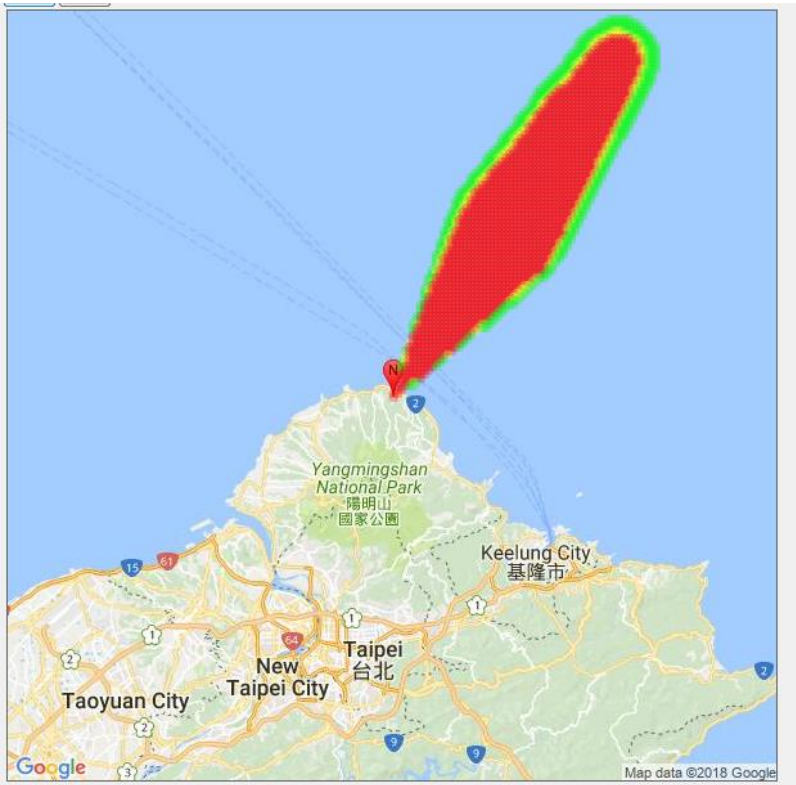


The accumulated Thyroid Doses at 35.5 hours after the event start(11 hours after the first release) when the wind direction changes 180 degree

RASCAL



EPZDose



Dose Rates(mSv/h)
Accumulated Doses(mSv)

Conclusion

- The accumulated thyroid dose consequences calculated by RASCAL and EPZDose are similar to the same source term and meteorology status in flat terrain.
- Topography has a significant impact on dose calculation results.
- We've developed a customized code for displaying the WinMACCS peek dose polar results.
- The peak dose values calculated by WinMACCS seem to be much small then the accumulated thyroid dose calculated by RASCAL and EPZDose under the same source term and meteorology status.

Thank you
for your attention!