Model comparison and validation using data of the 1950s nuclear weapon tests

PREDICT Task 3.1

Sarah Millington (UK Met Office) on behalf of
PREDICT Task 3.1 collaborators

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NERIS Workshop, Rome, 11th November 2024

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Aim of the task

- To identify and select a number of 1950s tests
- Produce cases for verification of model outputs
- First model intercomparison performed
  - Areas for potential improvement identified
  - Output from other tasks and work packages

  } Changes made to model parameters, set-up, inputs
- Second model intercomparison performed

Use of 1950s test data

- Many nuclear tests reviewed
- Upshot-Knothole Nancy
- 24th March 1953, 24 kt
- Using ECMWF's ERA-5 data
- Simulations for a 12-hour period with outputs visualised on a map and compared with monitor data

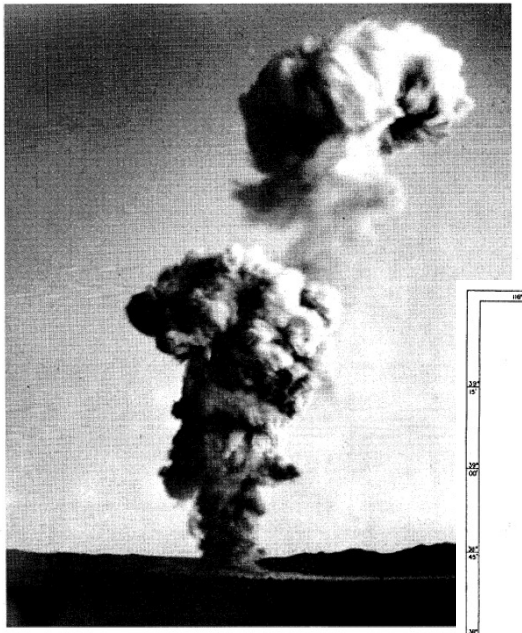
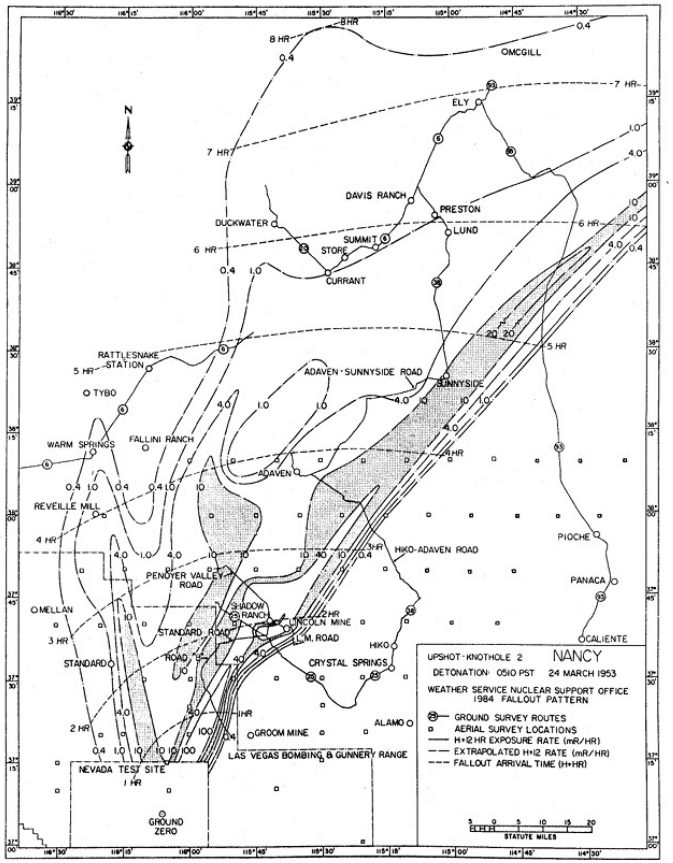


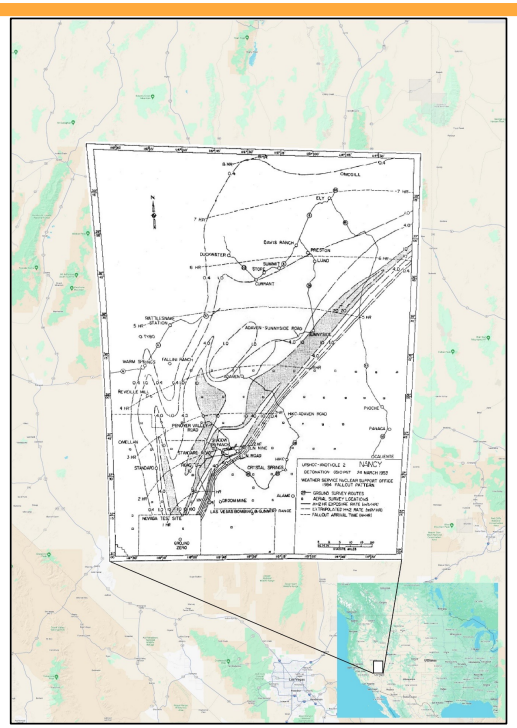
FIGURE 4. THE NANCY DEBRIS CLOUD OVER THE NEVADA TEST SITE



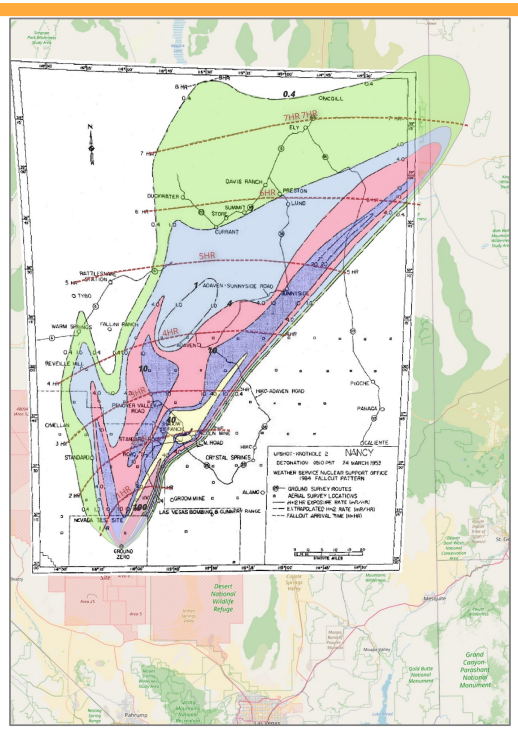
1984 reanalysis 12-hour fallout pattern

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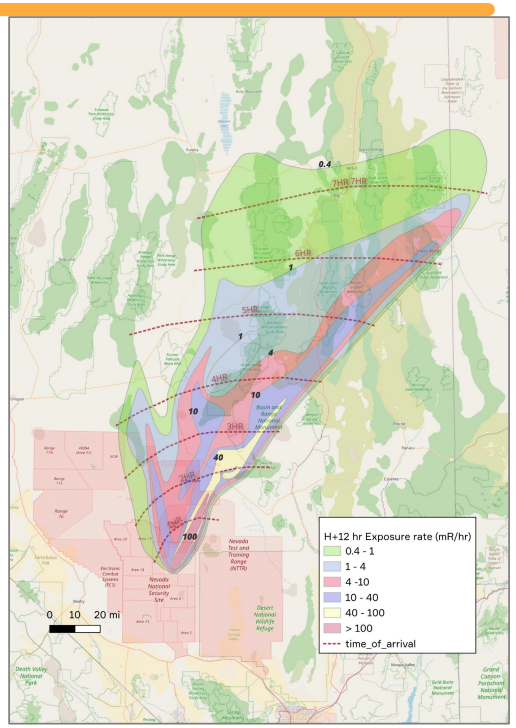
Georeferencing published information - Nancy



Georeferenced WSNSO 1984 NANCY FALLOUT PATTERN (Figure 3 from Steadman et al., 1984)



Georeferenced WSNSO 1984 NANCY FALLOUT PATTERN (Figure 3 from Steadman et al., 1984) with exposure rate polygons traced.



Traced exposure rate polygons (original WSNSO 1984 NANCY FALLOUT PATTERN map removed) with Time of Arrival.

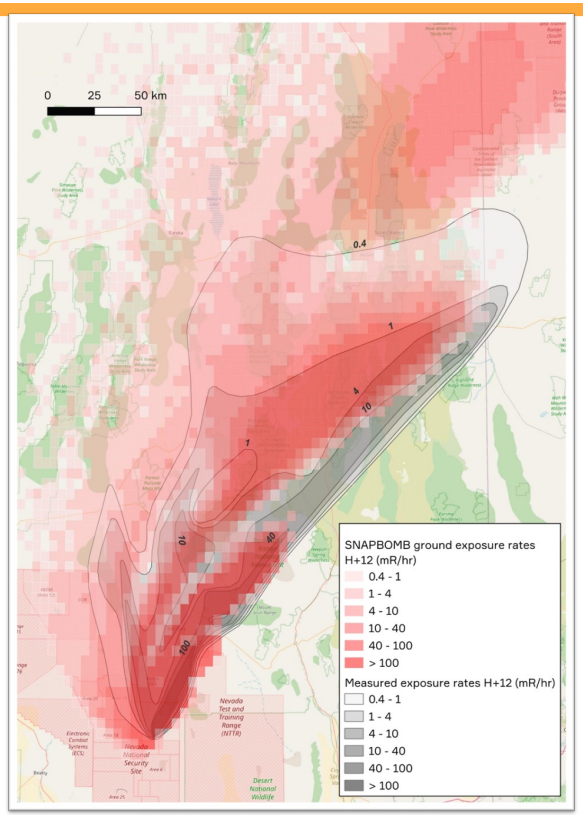
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Work in progress

Nancy simulation – Norwegian Meteorological Institute/DSA

- Model = SNAP (Severe Nuclear Accident Programme)
- Initial assessment
  - Exposure rates (mR/h) from model runs and measured data correspond quite closely
  - Red and pink squares from the model output delineate all exposure rates > 4 mR/hr
    - these more or less fall within the measurement contours for 0.4 mR/hr apart from small areas to the west and to the north of the main plume.
  - Some of the measured high exposure rates to the northeast of the detonation site are not captured by the model.



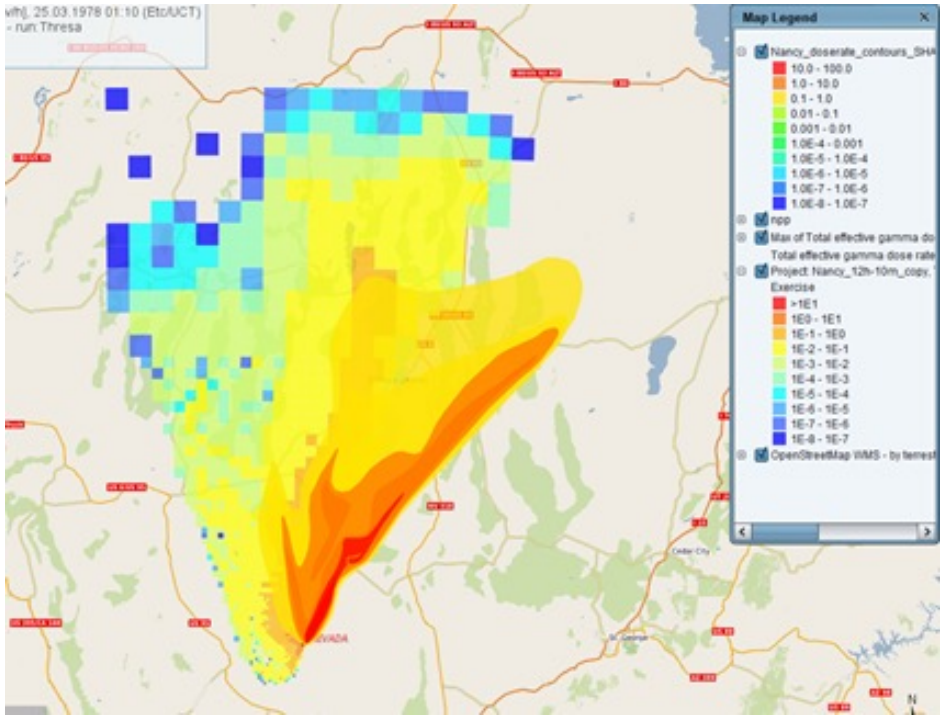
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Work in progress

Nancy simulation – KIT

- Model = JRODOS with default settings
  - 43 nuclides based on Kraus and Foster 2014
  - Geometry of source term based on Rolph at al. 2014
  - Particle size distribution based on Glasstone and Dolan 1977
- Initial assessment
  - Max dose rates and shapes similar but shifted by about 20 degrees

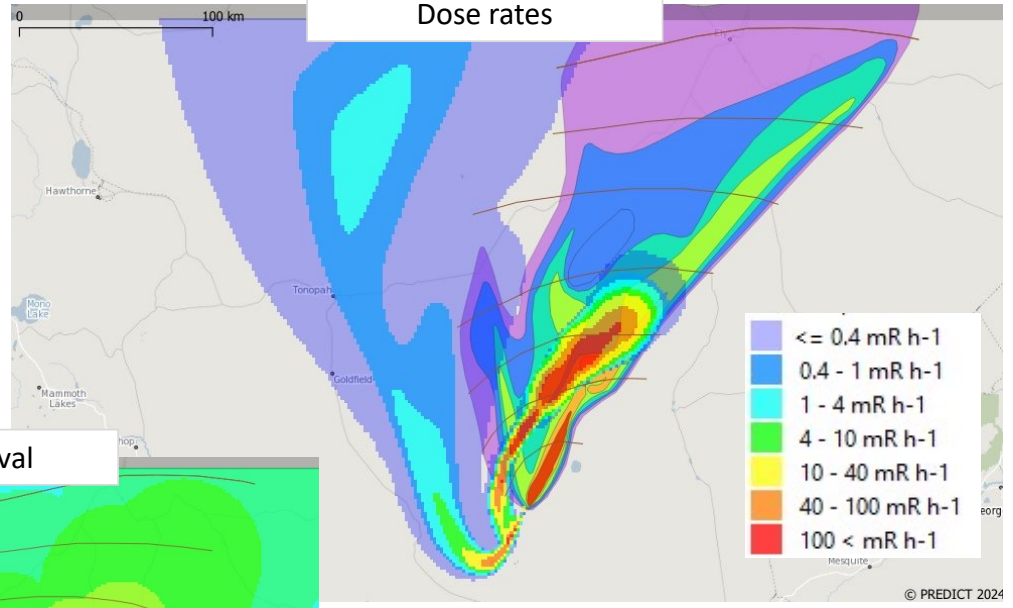


Work in progress

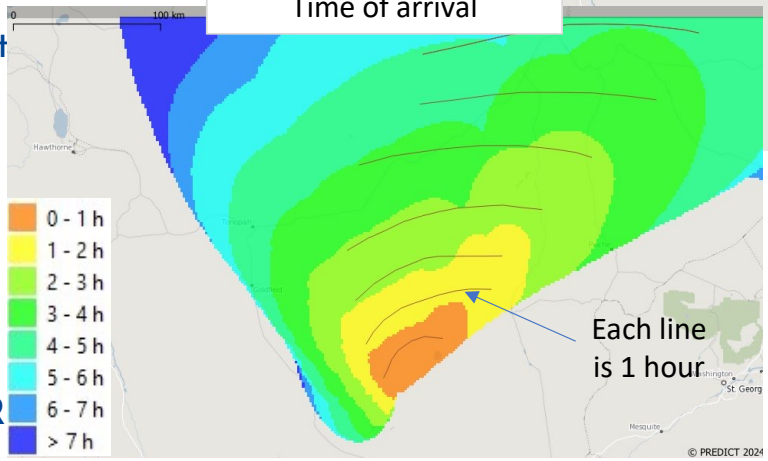
Nancy simulation – RIVM

- Model = IRIS (in-house model)
  - Based on KDFOC3
  - Particles density and size: (Ledger, 2014; Baker, 1987)
  - Source term from SSM; Axelsson et al. (2023)
- Initial assessment
  - Simulated output is too far west
  - Top of the release and base disperse in different directions

Dose rates



Time of arrival



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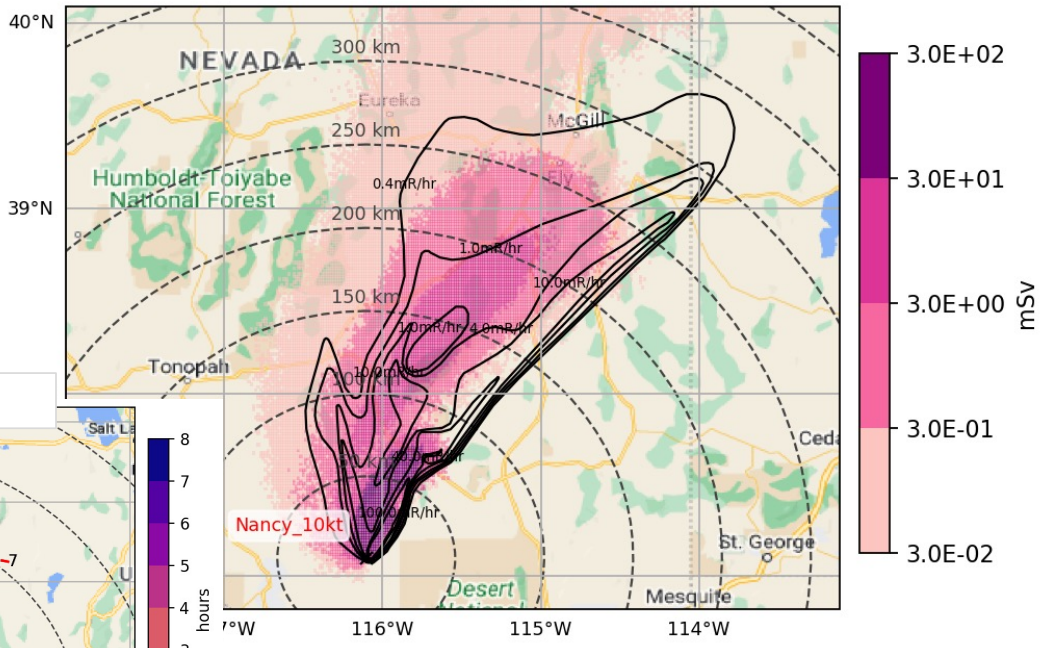
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Work in progress

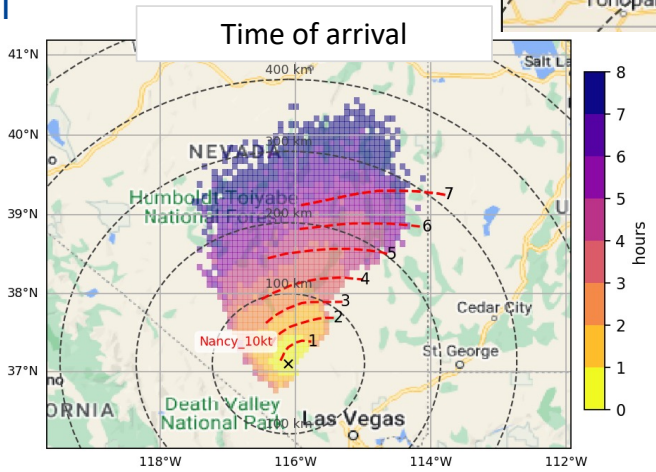
Nancy simulation – UK Met Office

- Model = JAM-IntND
  - 69 nuclides based on Kraus and Foster 2014
  - Particle size distribution based on Glasstone and Dolan 1977
- Initial assessment
  - Areas correspond quite well
  - Conversion of dose units still required
  - Travel time matches well

Effective external ground dose for an adult over 12 hours from 24/03/1953 13:10 UTC



Time of arrival



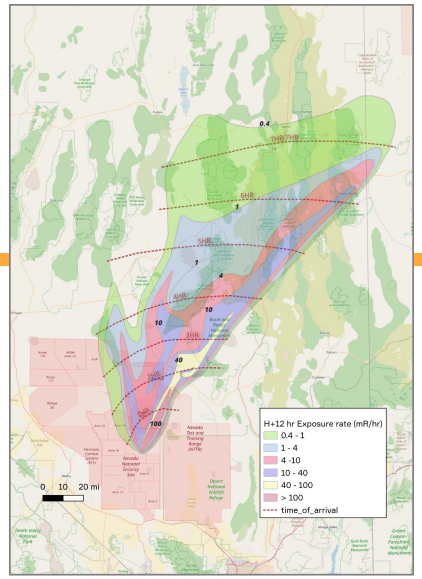
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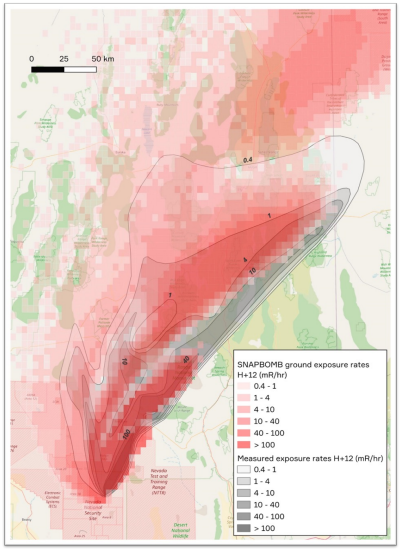
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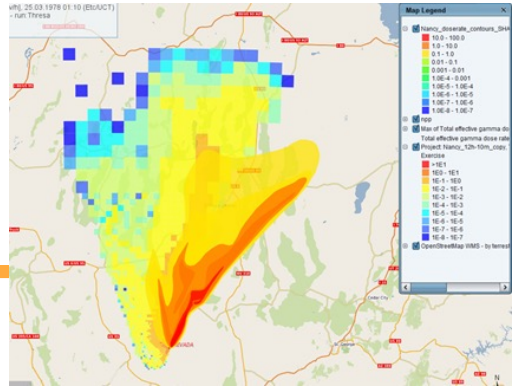
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Summary

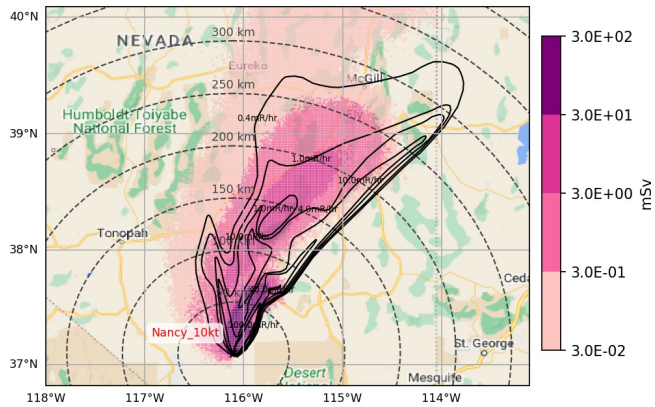
- Digitised nuclear test data
- Model intercomparison and validation
- ERA-5 met data – accuracy of these data crucial to assessment
- Next steps:
  - Analysis of simulations
  - Visual comparison and statistical if possible
  - Repeat with other test data
  - Draw conclusions

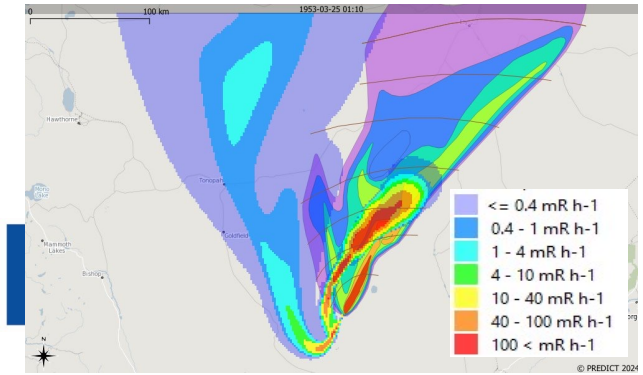






Effective external ground dose for an adult over 12 hours from 24/03/1953 13:10 UTC





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