Simulations and evaluation of the transport of the Holuhraun 2014 SO2 emissions with FLEXPART, WRF-Chem and satellite data

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Outline

- The Holuhraun event – basic description
  - The Holuhraun study – simulation studies
    - Evaluation of the simulation studies
      - Understanding the transport patterns
      - What is TAMP?
      - Qualitative evaluation of the results with satellite data and TAMP
      - Conclusions

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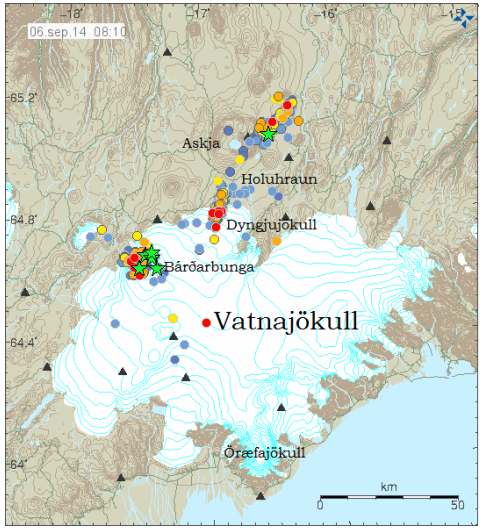
The Holuhraun event – basic description 1

- During the second half of September 2014 – increased seismic activity in the Bardarbunga system

- 08.29.2014 to February 2015: Non - explosive fissure eruption in Holuhraun lava field in Iceland Highlands .

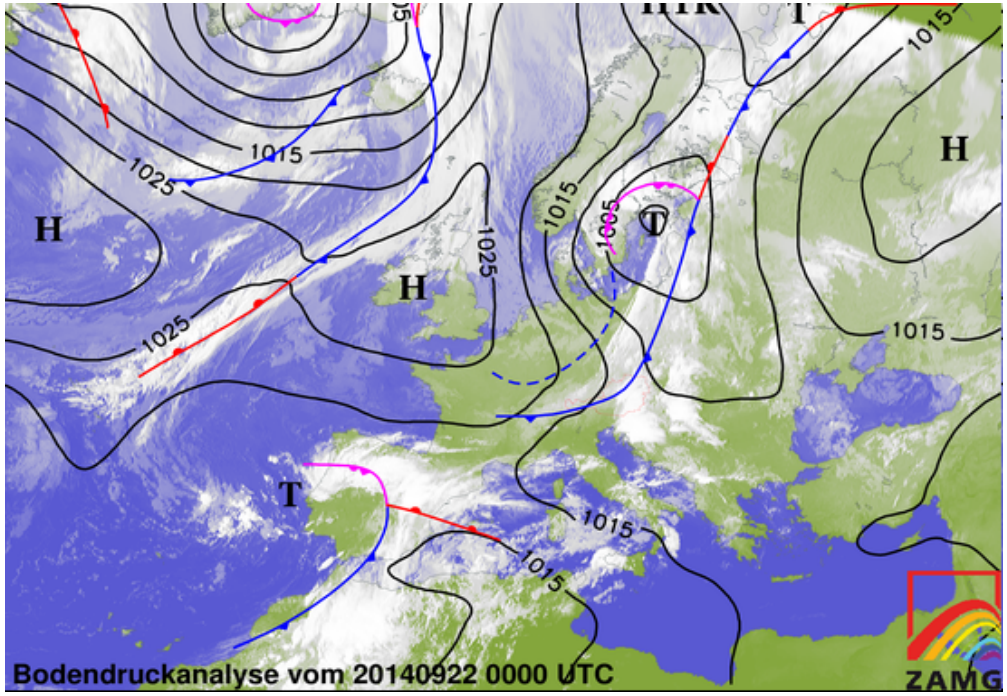
- High ground level concentrations in Iceland, with peaks of 21000 µg/m³ SO_2 in the Icelandic town of Höfn at 26.10. (WHO 10 minute limit at 375 µg/ m³)



Fotos: Iceland Review and Icelandic Weather Service (IMO)

The Holuhraun event – basic description 2

- The meteorological conditions favoured a rapid transport towards mainland Europe
- The SO2, emitted at low levels, remained below 5 km a.g.l / a.s.l on its path to Europe, facilitating significant concentrations at ground level in several regions of Europe



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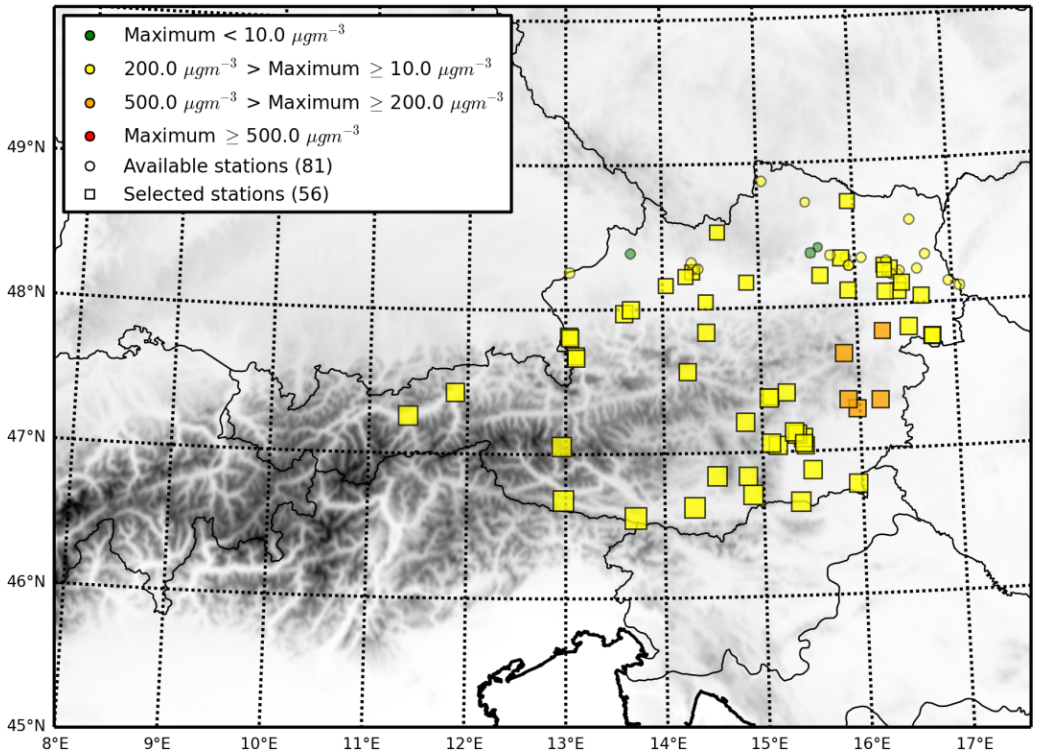
The Holuhraun event – basic description

- In Austria, the north Foehn in the lee of the Alps leads to observed ground level SO2 maxima with exceedances of the regulatory levels
- Maximum concentrations in Burgenland and Styria (beyond 200 µg/m³) btw. 11:00 to 17:30 UTC
- 200 µg/m³ (exceeded 5 stations) is health-based half-hour limit.
- Vienna, Carinthia, Lower and Upper Austria show clear but lower peaks.
- Maximum ratio measurement baseline at the station Zödelboden / Wildwiese in Upper Austria from 264



The Holuhraun event – simu. studies

Questions:

- How able are we to represent these transport patterns with our operational modelling tools?
- How well can we understand the transport and mixing processes that led to such unusual concentrations on Austrian soils?
- How well (qualitative and quantitatively) our tools compare with measurements not only at ground level (GB data) but also at elevated levels and column - integrated values (->**satellite data**)? Evaluation studies

TAMP

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The Holuhraun event – simu. studies

MODELS:

FLEXPART

- Lagrangian particle dispersion model
- Basic linear non-aqueuous chemical reactions of SO2 with OH. No complex chemistry included
- Off-line model. Driving data ECMWF (1 deg with a 0.2 deg nest – 3 hourly)
- Emission: umbrella-shape with maximum emission between 4-6 km a.s.l. 112 kt/day

WRF-CHEM

- Chemical Transport Model
- Full chemistry implemented
- On-line integrated model -> meteorology and chemistry at the same time (also feedbacks)
- Allowing for dynamical downscaling. Driven by ECMWF data (0.125°, ML)
- Emission: volanic emissions umbrella shaüe and anthropogenic ground emissions (TNO)+ local for Austria)

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Evaluation – understanding the transport 1

Preliminary visual evaluation of the transport patters as outcome from the simulations:

animation_1.gif

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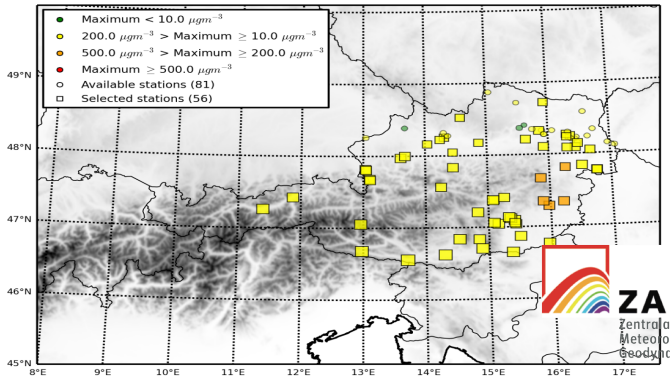
Evaluation – understanding the transport 2

Preliminary visual evaluation of the transport patters as outcome from the simulations:

Animation_2.gif



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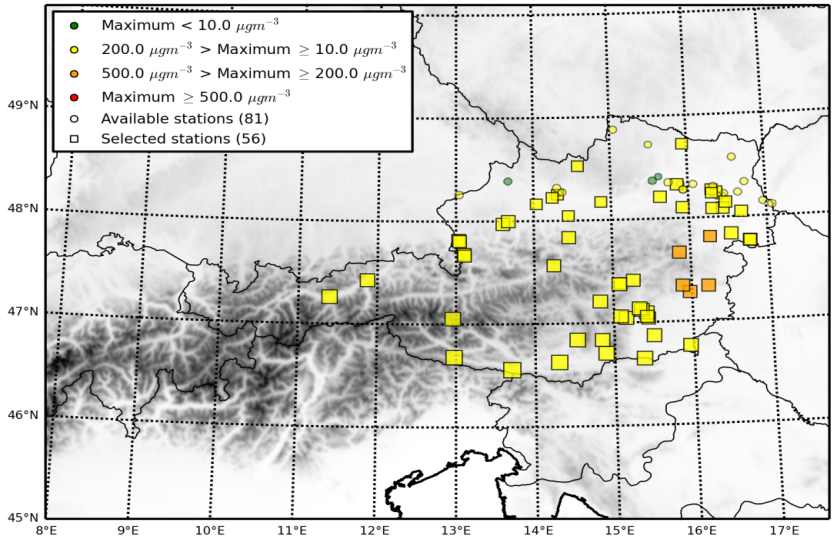
Evaluation – understanding the transport 3

Preliminary visual evaluation of the transport patters as outcome from the simulations:



Animation_3.gif

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TAMP

- Support of scientific access and use of past, current and future Atmospheric sciences data

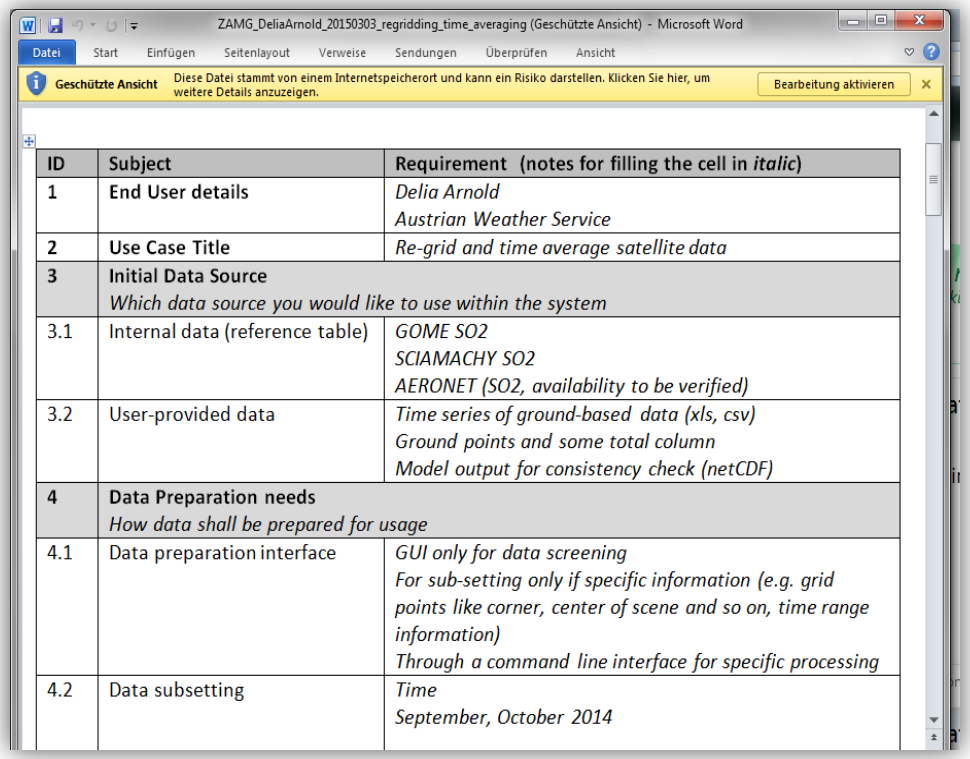
- Data:
  - Model data
  - Ground measurements
  - Satellite data

- Services:
  - Data access services
  - View services
  - Processing services

Evaluation – with TAMP and sat. data 5

Specification of the case data

- For each use case, the user fills in questionnaire with needs and requirements
- User provides additional data if accessible (e.g. ground-based data)
- Data is uploaded into the system
- User has access to the system
- Customised evaluation approaches
- Multiple layered datasets


ZAMG_DeliaArnold_20150303_regridding_time_averaging (Geschützte Ansicht) - Microsoft Word

Datei Start Einfügen Seitenlayout Verweise Sendungen Überprüfen Ansicht

Geschützte Ansicht Diese Datei stammt von einem Internetspeicherort und kann ein Risiko darstellen. Klicken Sie hier, um weitere Details anzuzeigen. Bearbeitung aktivieren

ID	Subject	Requirement (notes for filling the cell in *italic*)
1	**End User details**	*Delia Arnold* *Austrian Weather Service*
2	**Use Case Title**	*Re-grid and time average satellite data*
3	**Initial Data Source** *Which data source you would like to use within the system*	
3.1	Internal data (reference table)	*GOME SO2* *SCIAMACHY SO2* *AERONET (SO2, availability to be verified)*
3.2	User-provided data	*Time series of ground-based data (xls, csv)* *Ground points and some total column* *Model output for consistency check (netCDF)*
4	**Data Preparation needs** *How data shall be prepared for usage*	
4.1	Data preparation interface	*GUI only for data screening* *For sub-setting only if specific information (e.g. grid points like corner, center of scene and so on, time range information)* *Through a command line interface for specific processing*
4.2	Data subsetting	*Time* *September, October 2014*

Available satellite data for the Holuhraun use case

- Available sensors:
  - OMI on AURA:
    - Level 2 Total Column SO2 data (swath) 15 – 30 Sept. 2014 (DU)
    - Level 3 data Total Column SO2 data (best daily pixel, 0.125°): 15 – 30 Sept. 2014 (DU)
  - GOME-2 on Metop A
    - Total Column SO2 data (swath) 15 – 30 Sept. 2014 (DU)
  - GOME-2 on Metop B
    - Total Column SO2 data (swath) 15 – 30 Sept. 2014 (DU)
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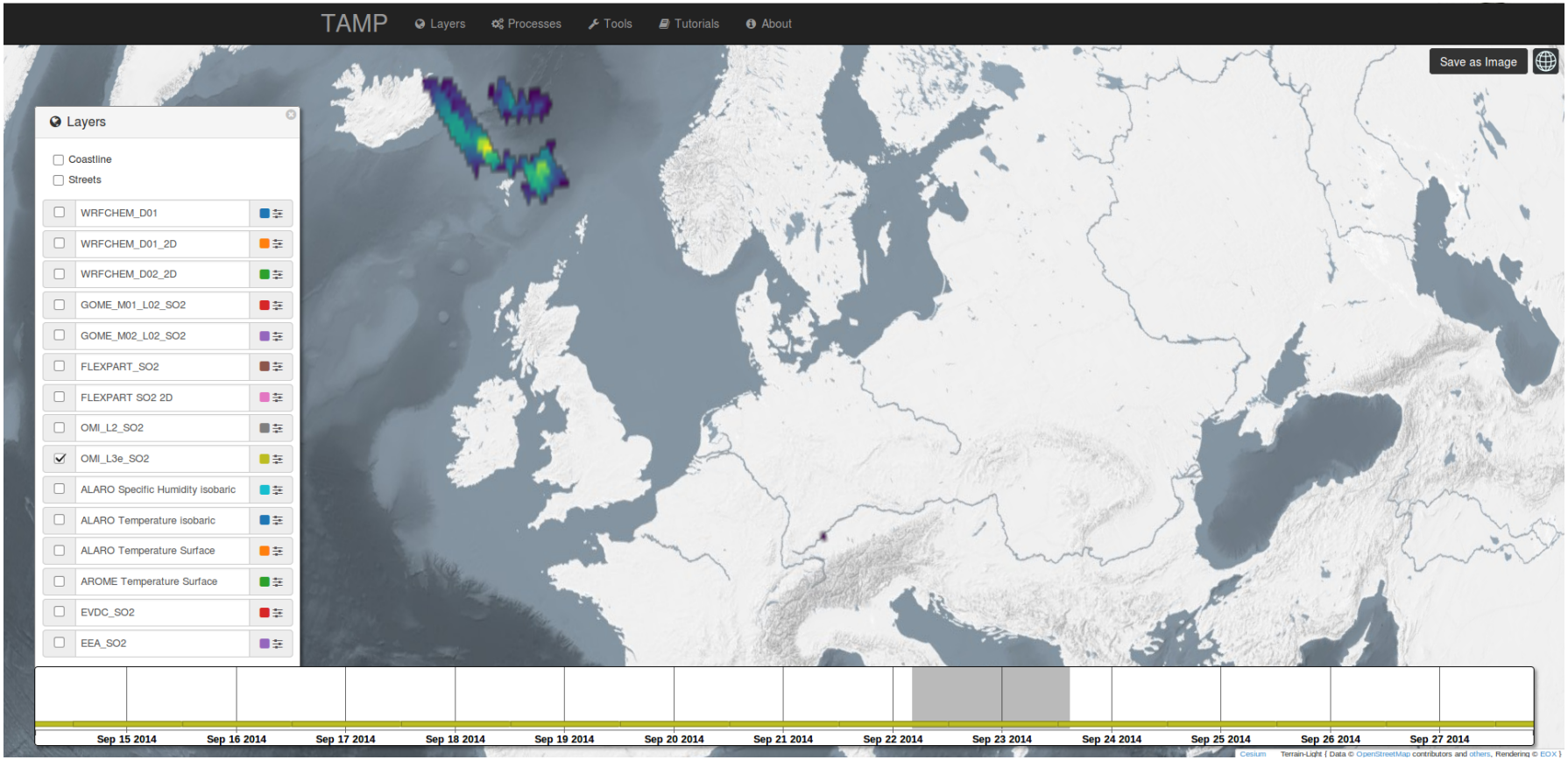
Evaluation – with TAMP and sat. data

SAT DATA - OMI



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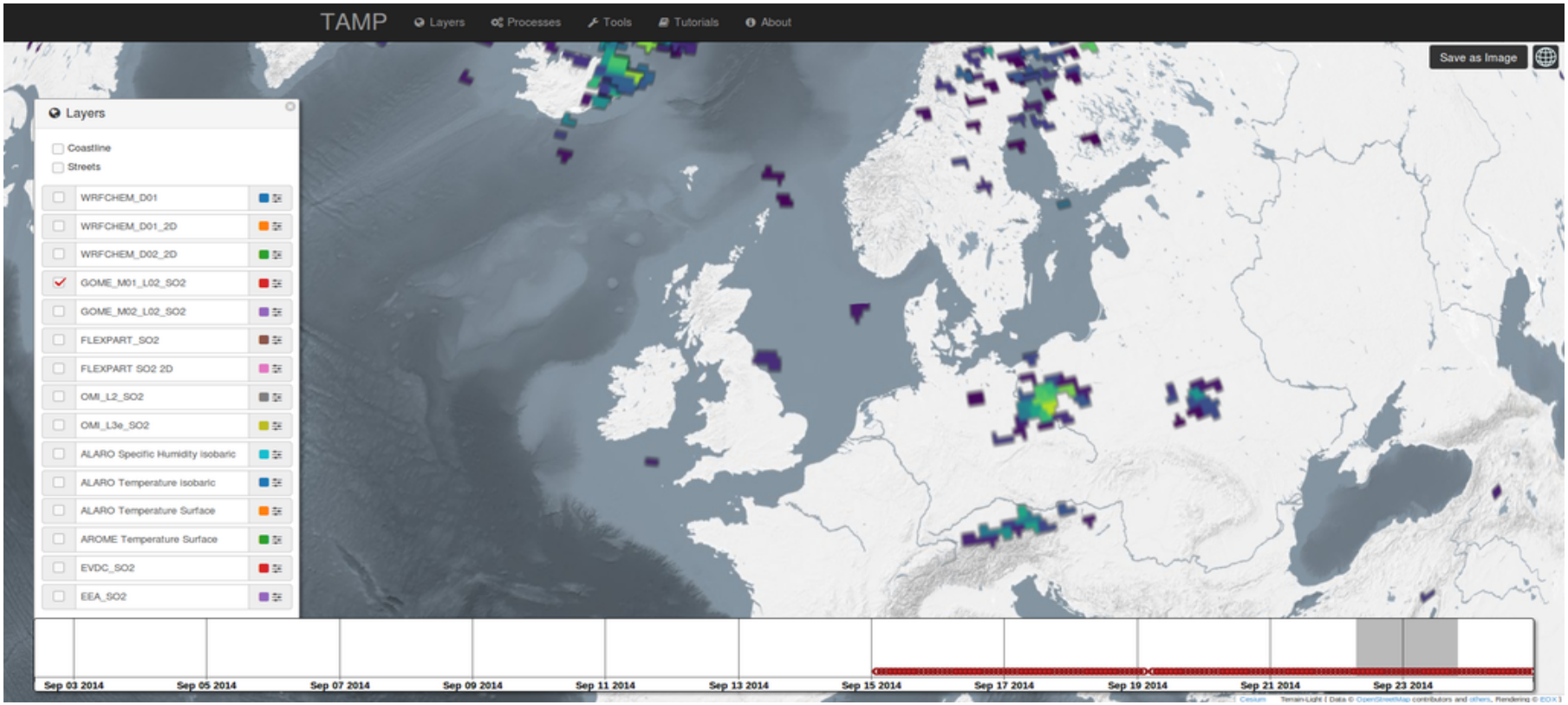
Evaluation – with TAMP and sat. data

SAT DATA – GOME A



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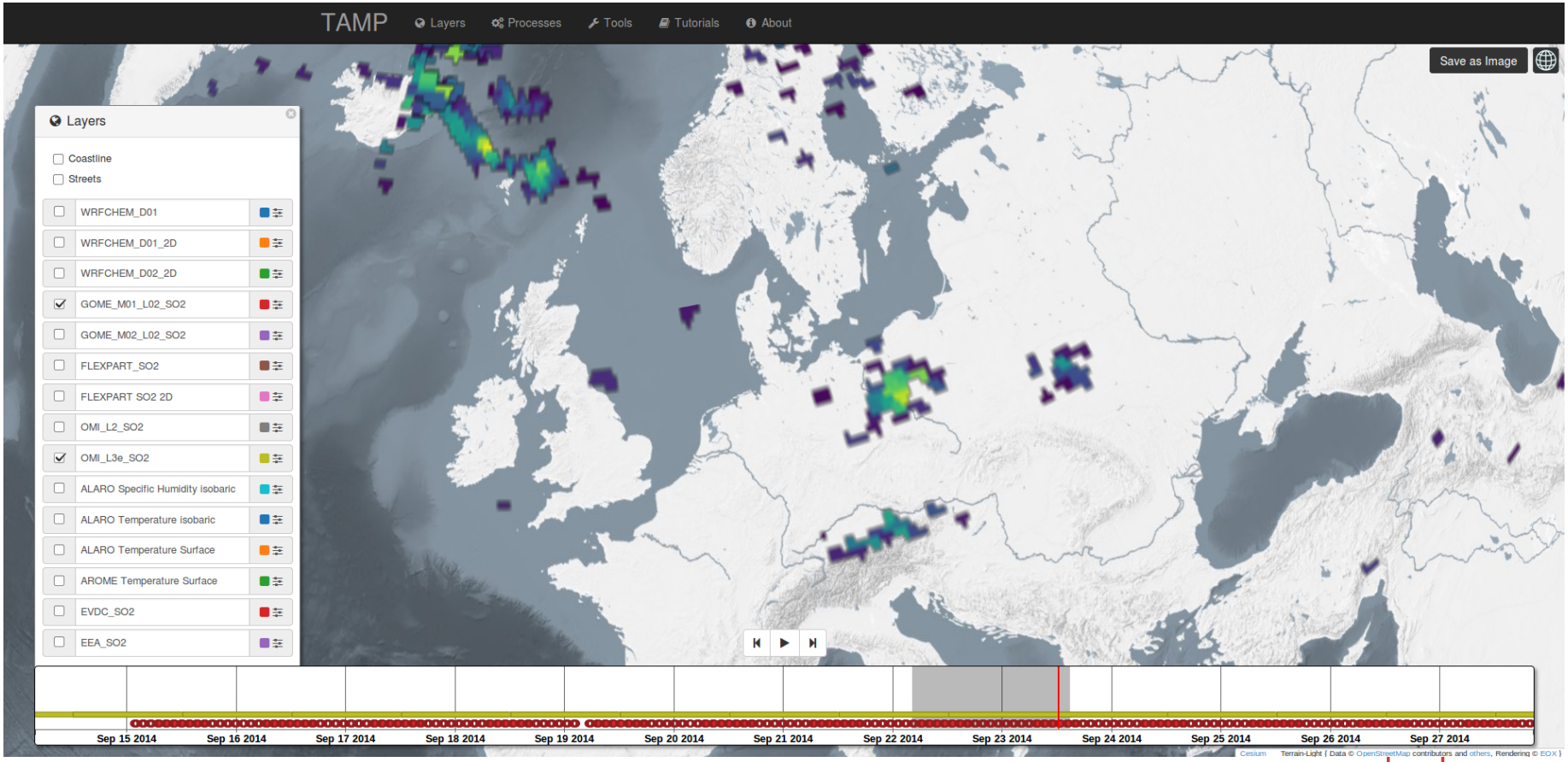
Evaluation – with TAMP and sat. data

SAT DATA – OMI and GOME A



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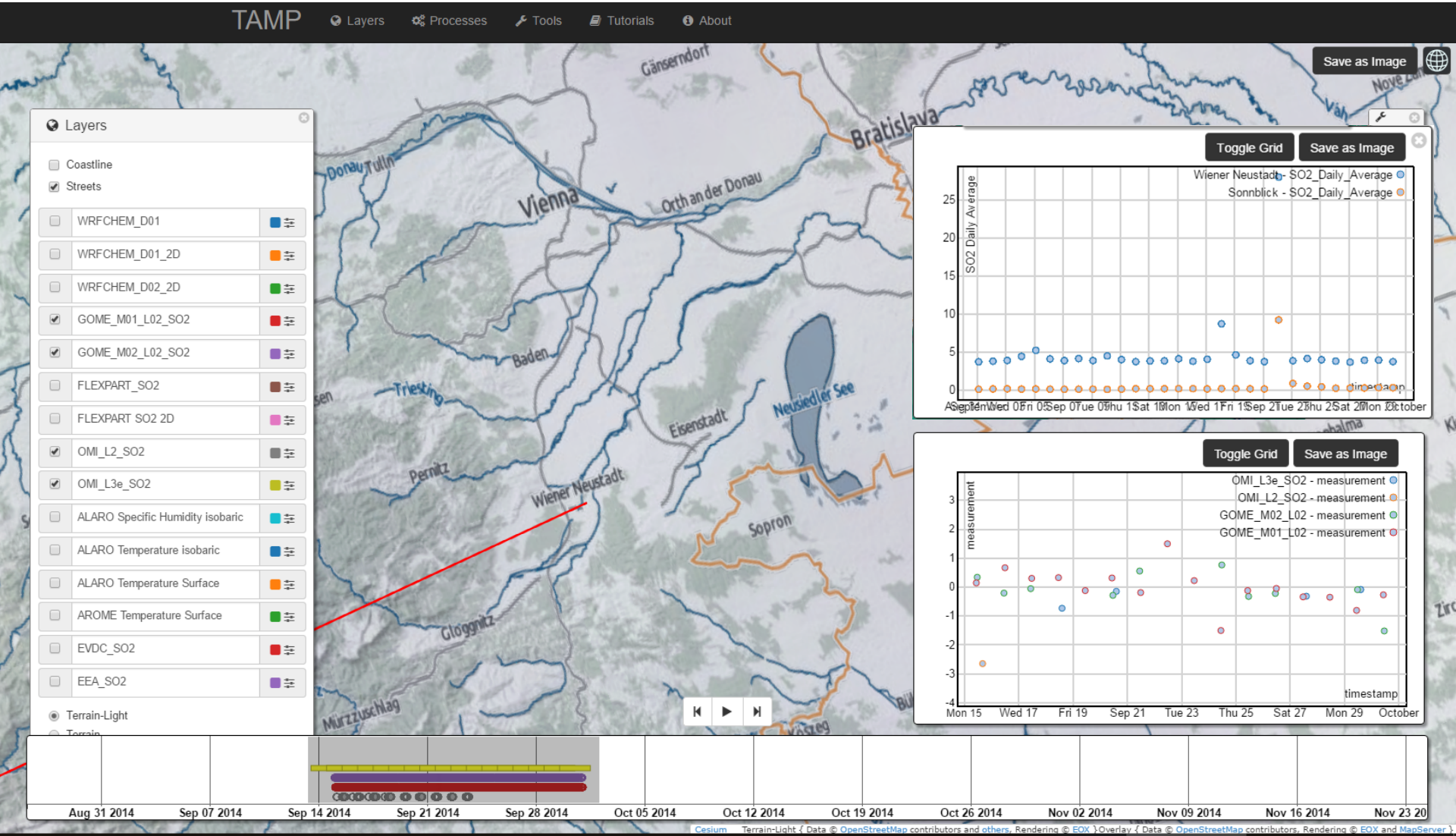
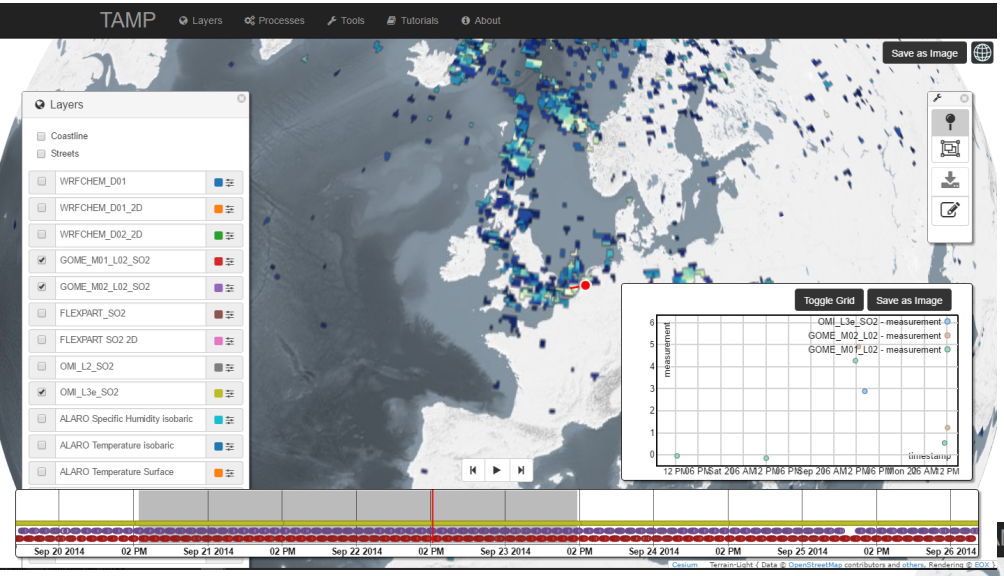
Evaluation – with TAMP and sat. data

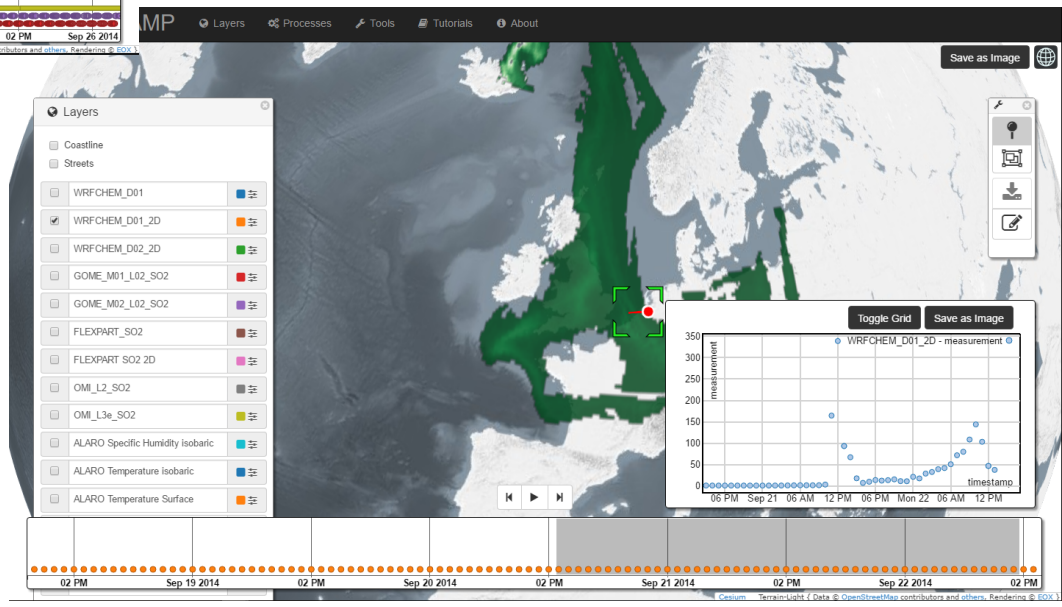
SAT DATA + DATA PICKING + STATIONS



Evaluation – with TAMP and sat. data

SAT DATA + DATA PICKING + STATIONS





WRFCHEM – FLEXPART Integrated maps - animations

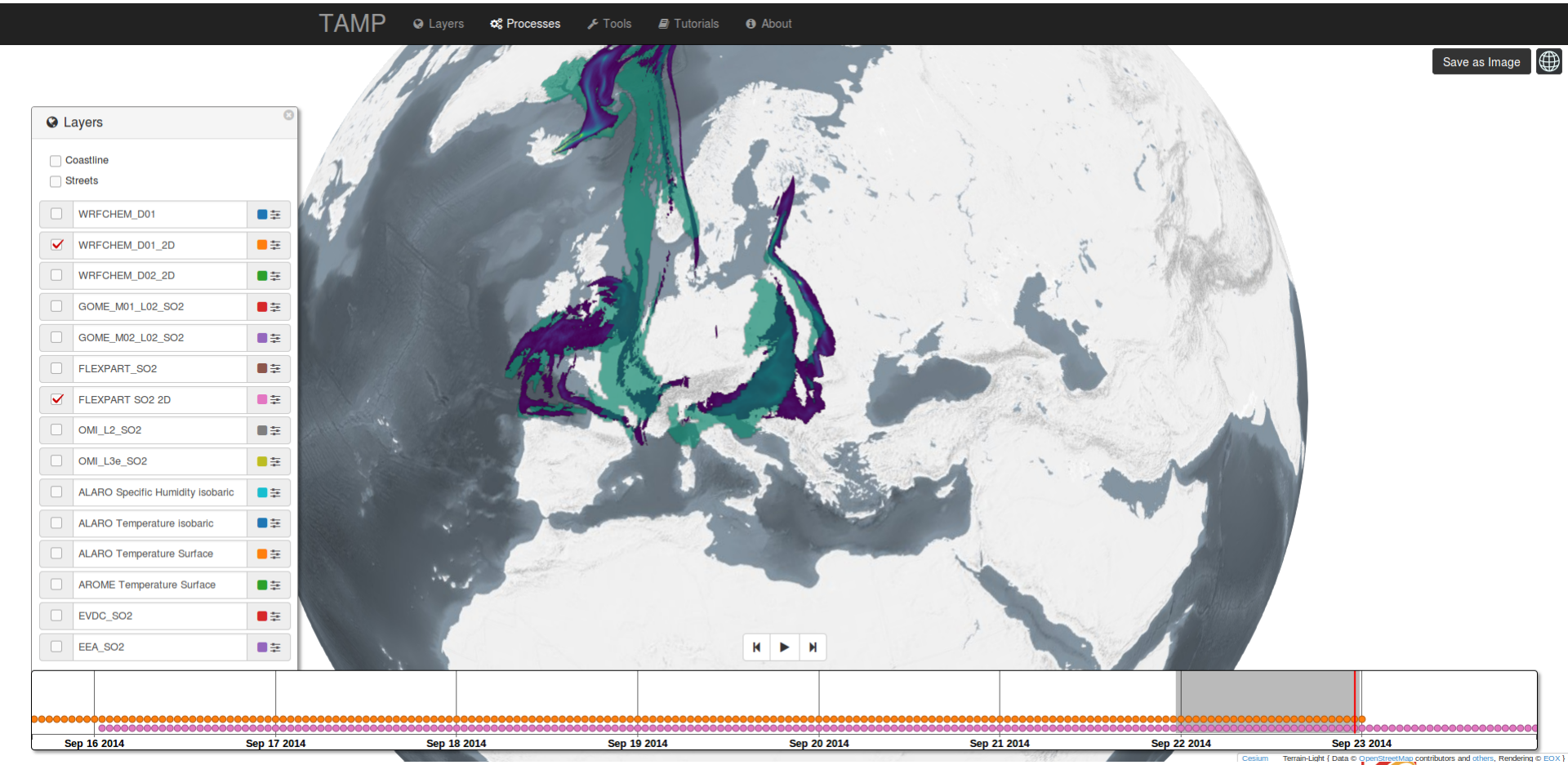
Animation_4.gif

WRFCHEM – FLEXPART Integrated maps - animations

Animation_5.gif

Evaluation – with TAMP and sat. data

Model to model comparison (WRFCHEM in green, FLEXPART in purple)



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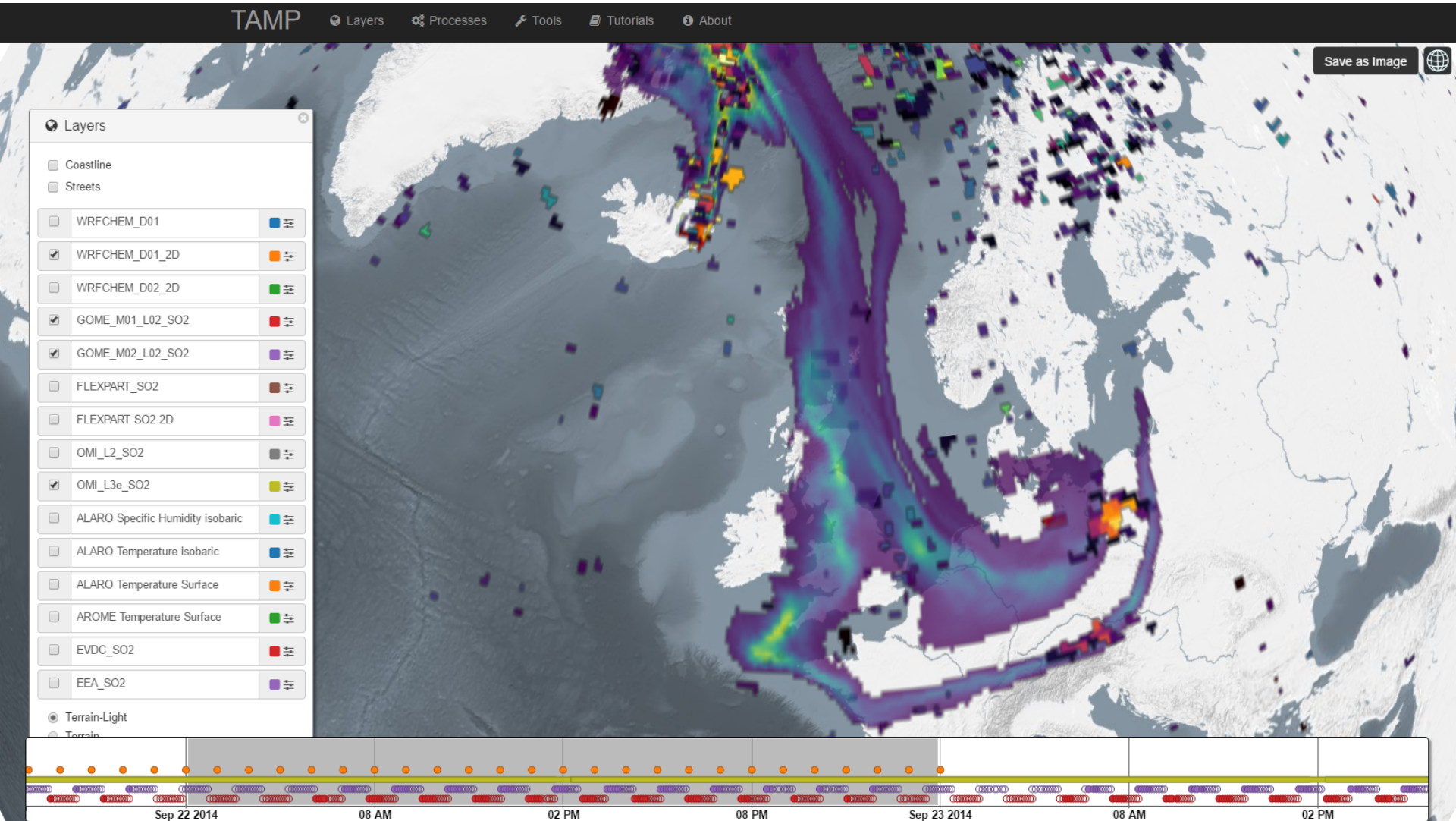
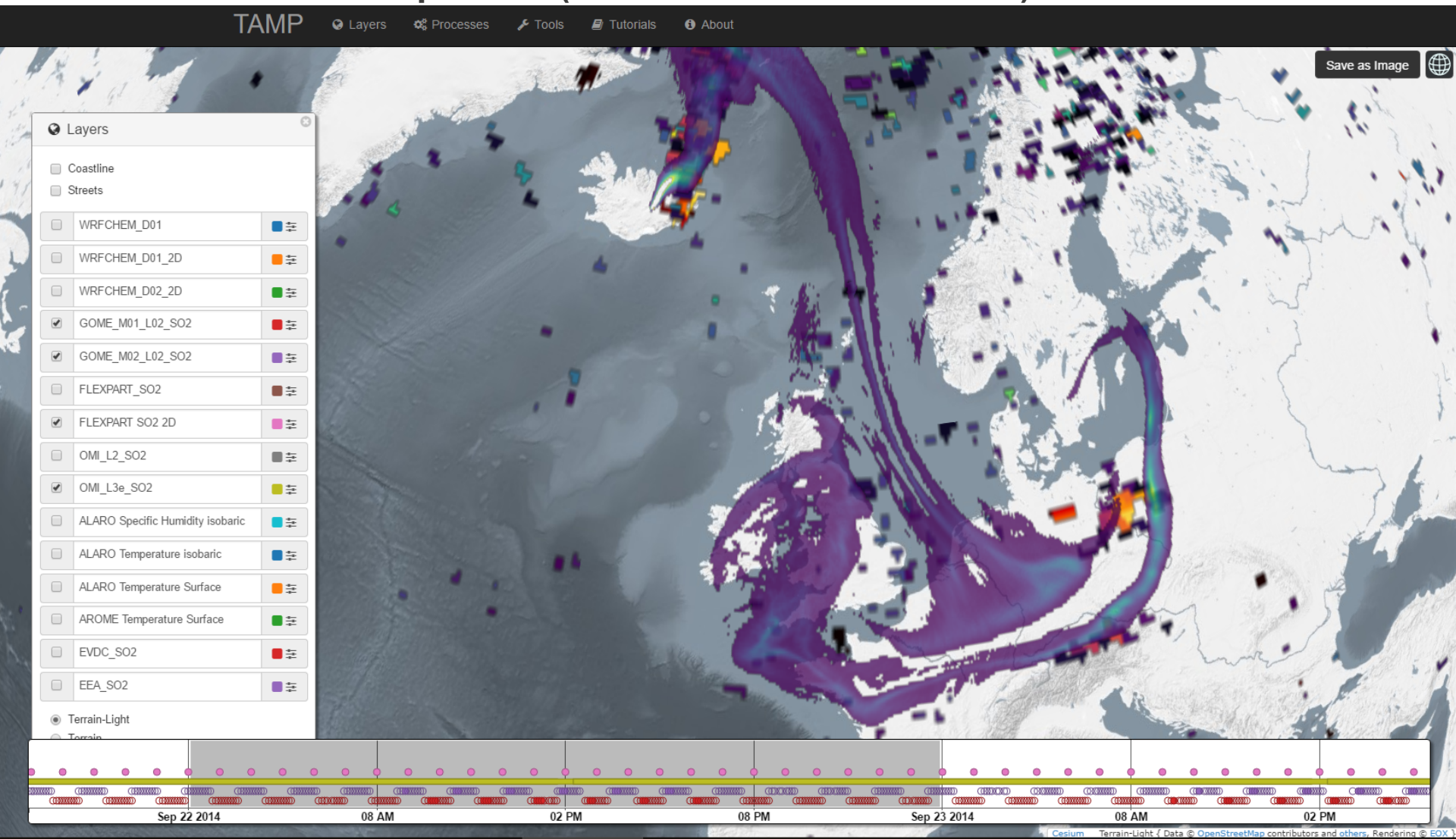
Evaluation – with TAMP and sat. data

Model to satellite comparison (WRFCHEM – Satellite data)



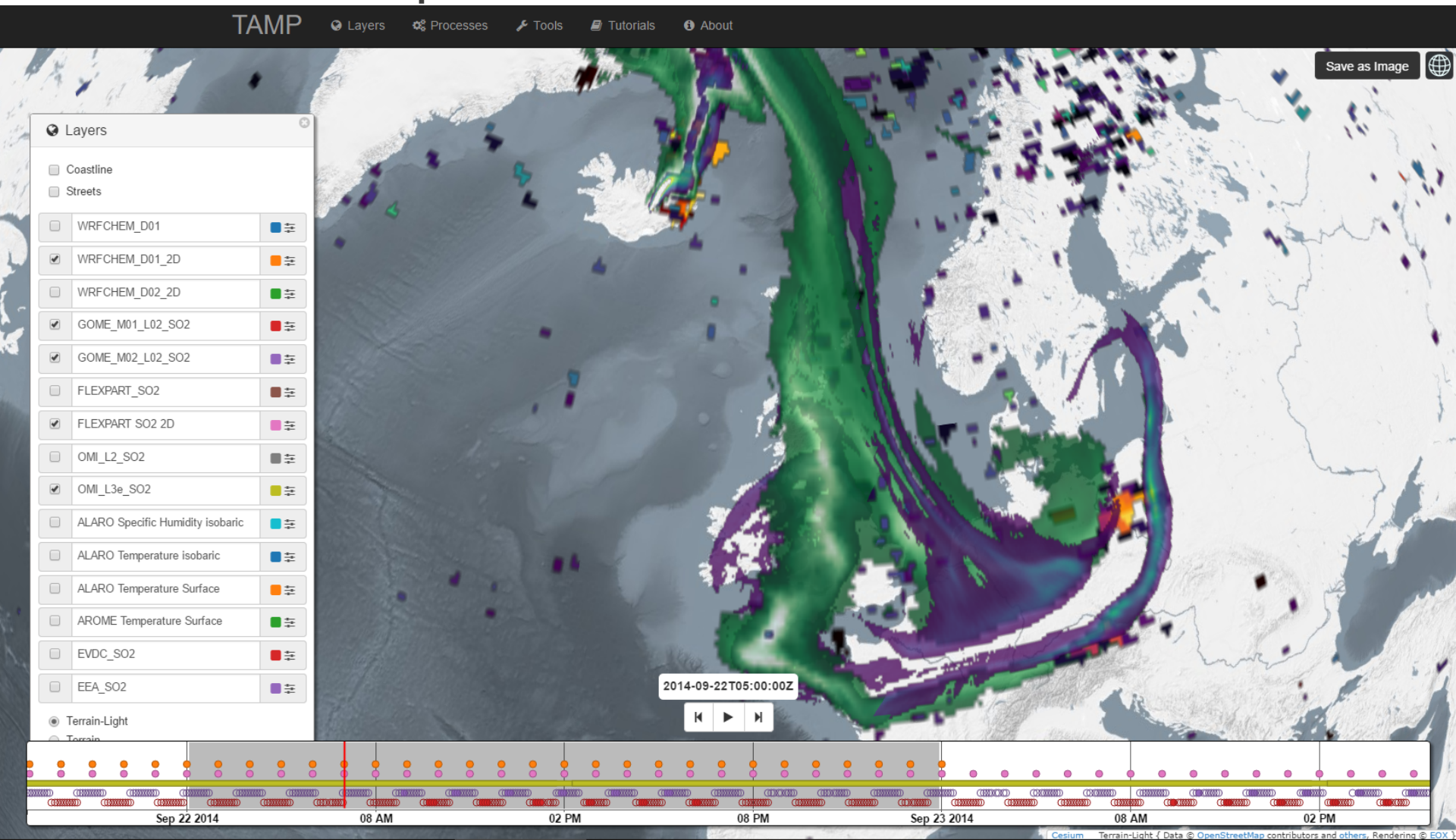
Evaluation – with TAMP and sat. data

Model to satellite comparison (FLEXPART – satellite data)



Evaluation – with TAMP and sat. data

Model to satellite comparison



Conclusions

- A combination of atmospheric transport models, ground based data, satellite data and the TAMP platform helps understanding the transport patterns and unusual high SO2 concentrations at ground level in mainland Europe
- Multiple satellite data-sets may be needed to evaluate a single event
- If aerosols are considered (SO2 to SO4 transformations) additional satellite products could be useful as well

Outlook

- Quantitative evaluation with the TAMP platform (implementation in the system of appropriate statistical metrics)