Further constraints on activity models of comet 67P/Churyumov-Gerasimenko with Rosetta data

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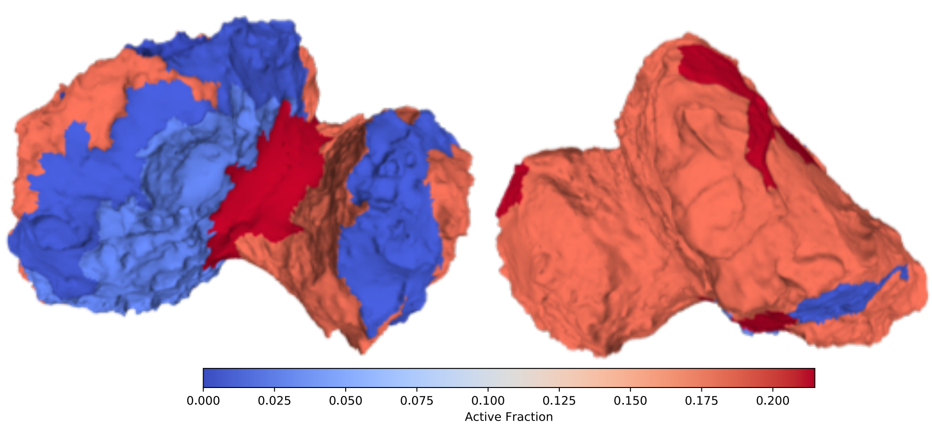


Cometary outgassing produces a non-gravitational (NG) acceleration and torque that have a measurable effect on comet trajectories and spin states

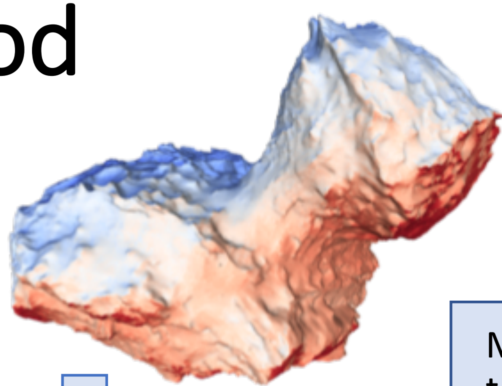
Comparing activity models to Rosetta datasets helps us understand 67P's surface activity pattern and gas/nucleus coupling, aiding our understanding of cometary activity in general

Previous work (see Mottola et al. 2020, Attree et al. 2019, etc.) has shown a time-varying activity, above that expected from varying heliocentric distance, for 67P

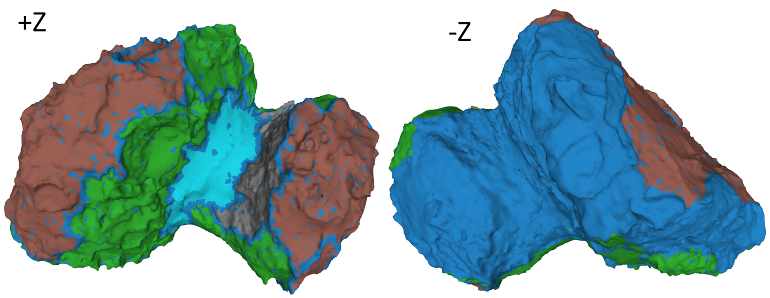
Here we extend the work of Attree et al. 2019 and investigate two different activity patterns in space and time, comparing their fit to the Rosetta data

Method

Temperature computed from surface energy balance on shape model



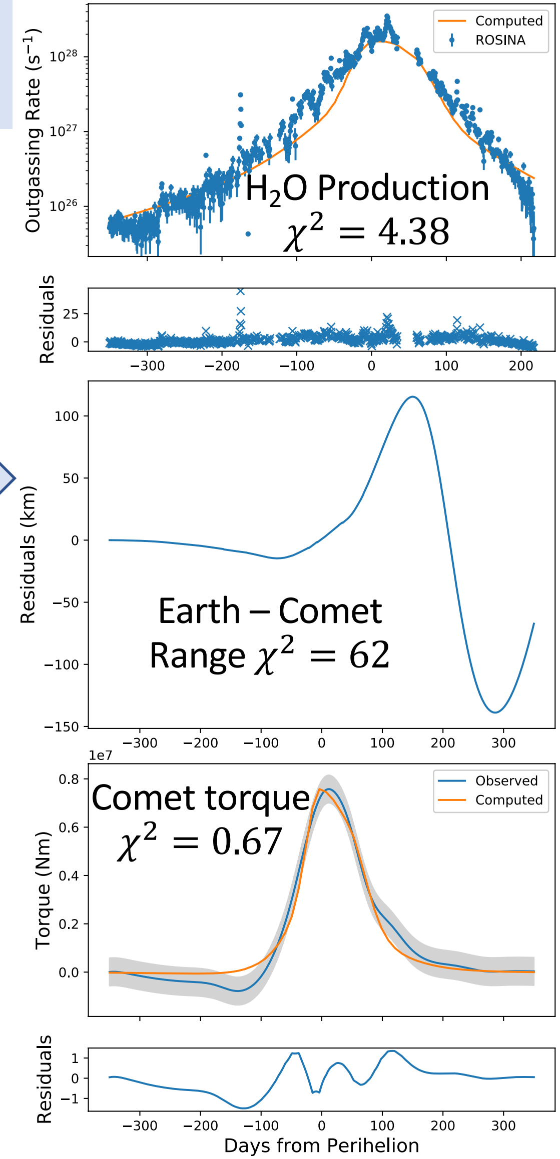
A Distribution in space and time of Effective Active Fraction (EAF), relative to pure water ice



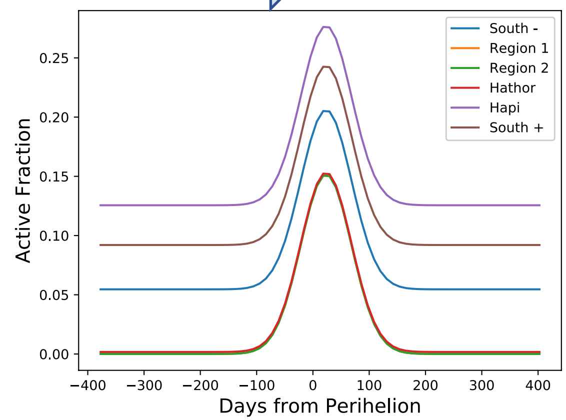
Attree et al. 2019 previous solution. Combined $\chi^2 = 124$

Model outputs gas production, NG torque, and NG force into N-body trajectory solution.

χ^2 fit of outputs to 3 Rosetta datasets, while varying EAF parameters



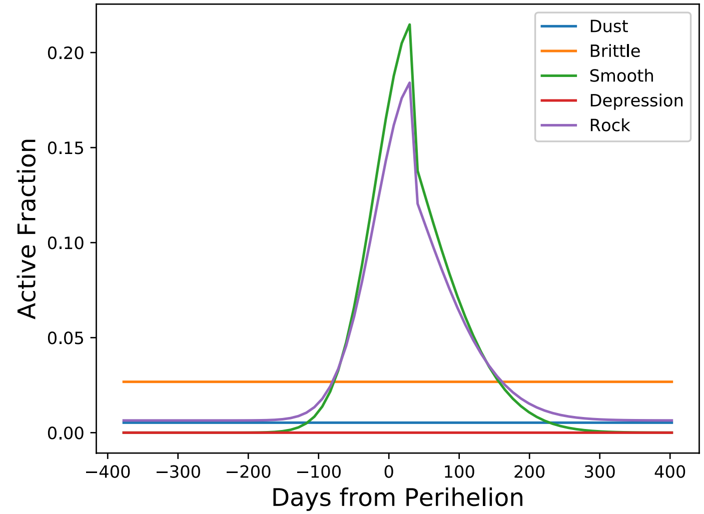
Preliminary Results

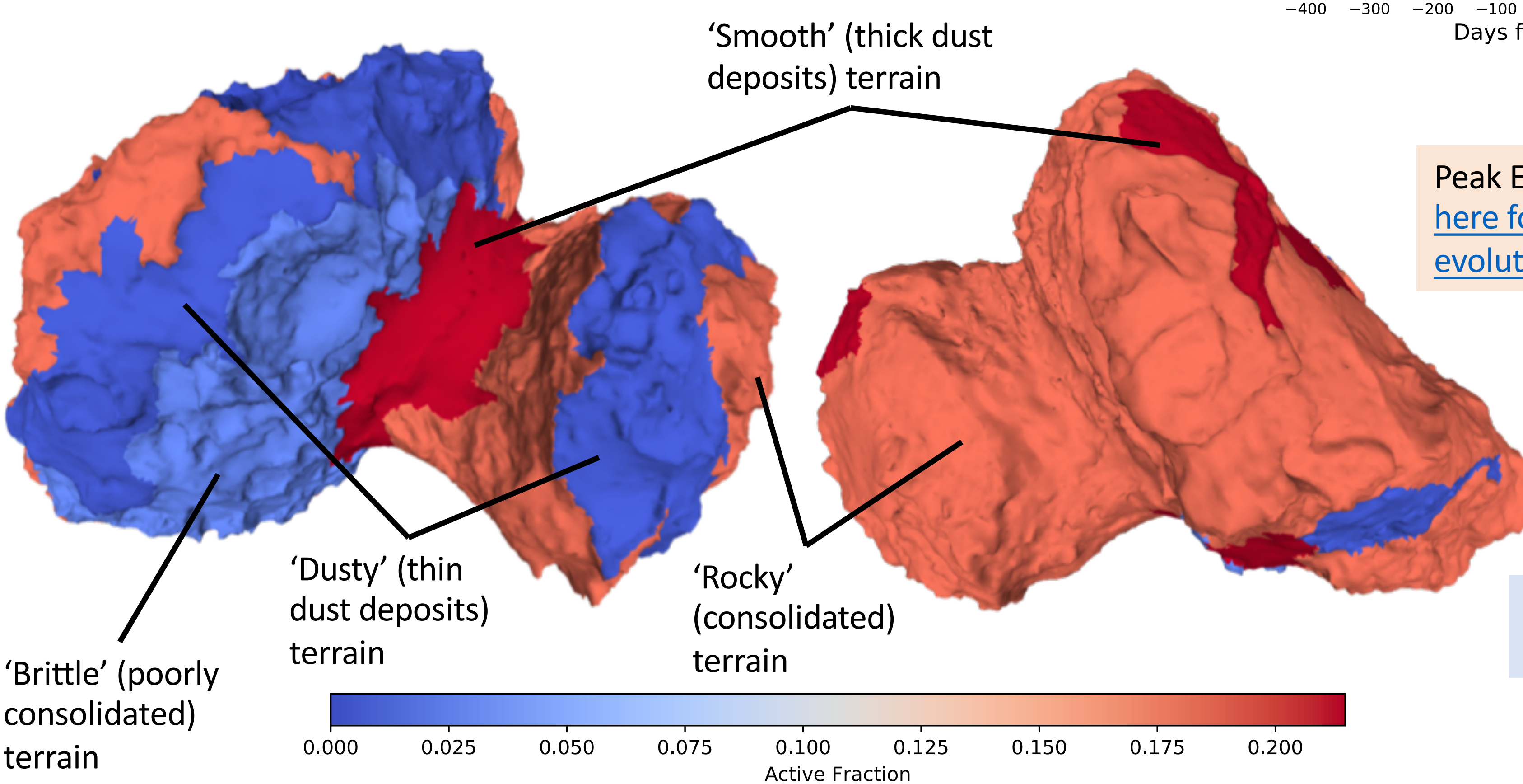


Attree et al. 2019 solution with constant increase for all regions. Combined $\chi^2 = 136$, Production $\chi^2 = 3.54$, Range $\chi^2 = 159$, Torque $\chi^2 = 0.78$

Results

Geological regions solution: subregions, as defined in Thomas et al. 2018, grouped according to Thomas et al. 2015 type, with ‘Smooth’ and ‘Rocky’ types allowed to vary with time. Combined $\chi^2 = 113$





Peak EAF. Click here for time evolution

H_2O Production
$\chi^2 = 3.48$

Earth – Comet Range $\chi^2 = 103$

Comet torque
$\chi^2 = 0.68$

Conclusions

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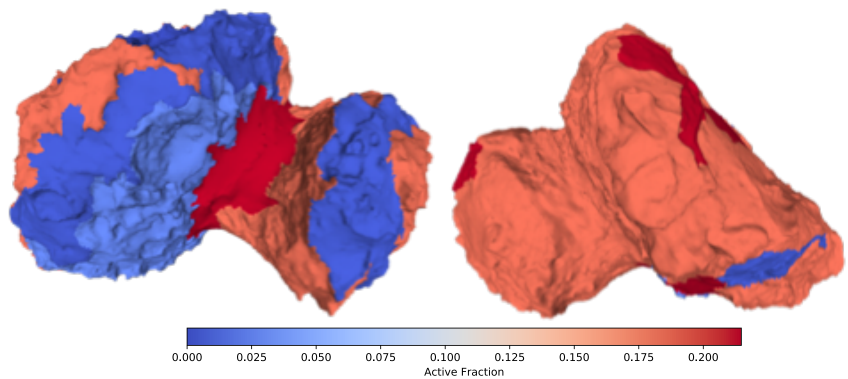
- Rosetta datasets can be matched with time-varying Effective Active Fraction over 67P's surface; here, for the first time, tied to different morphological terrain types
- Best-fit solution has different time-variation for different terrain types, with 'Rocky' and 'Smooth' terrains having generally more activity than 'Dusty', 'Brittle', and 'Depression' terrains
- This likely reflects different depths of dust coverage on different terrains and different amounts of dust lifting over time via outgassing
- 'Smooth' terrain may be active due to wet airfall (e.g. pieces of transported active 'Rocky' material), whereas 'Dusty' terrains may be quenched

Future Work

- Investigate changes in comet rotation axis (in addition to torque)
- Feed-in terrain types result into more complex thermal models (e.g. Gundlach et al 2020, Skorov et al. 2020)



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