

# Obtaining equatorial projections of Saturn's ENA emissions observed by Cassini-INCA

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technical report in preparation

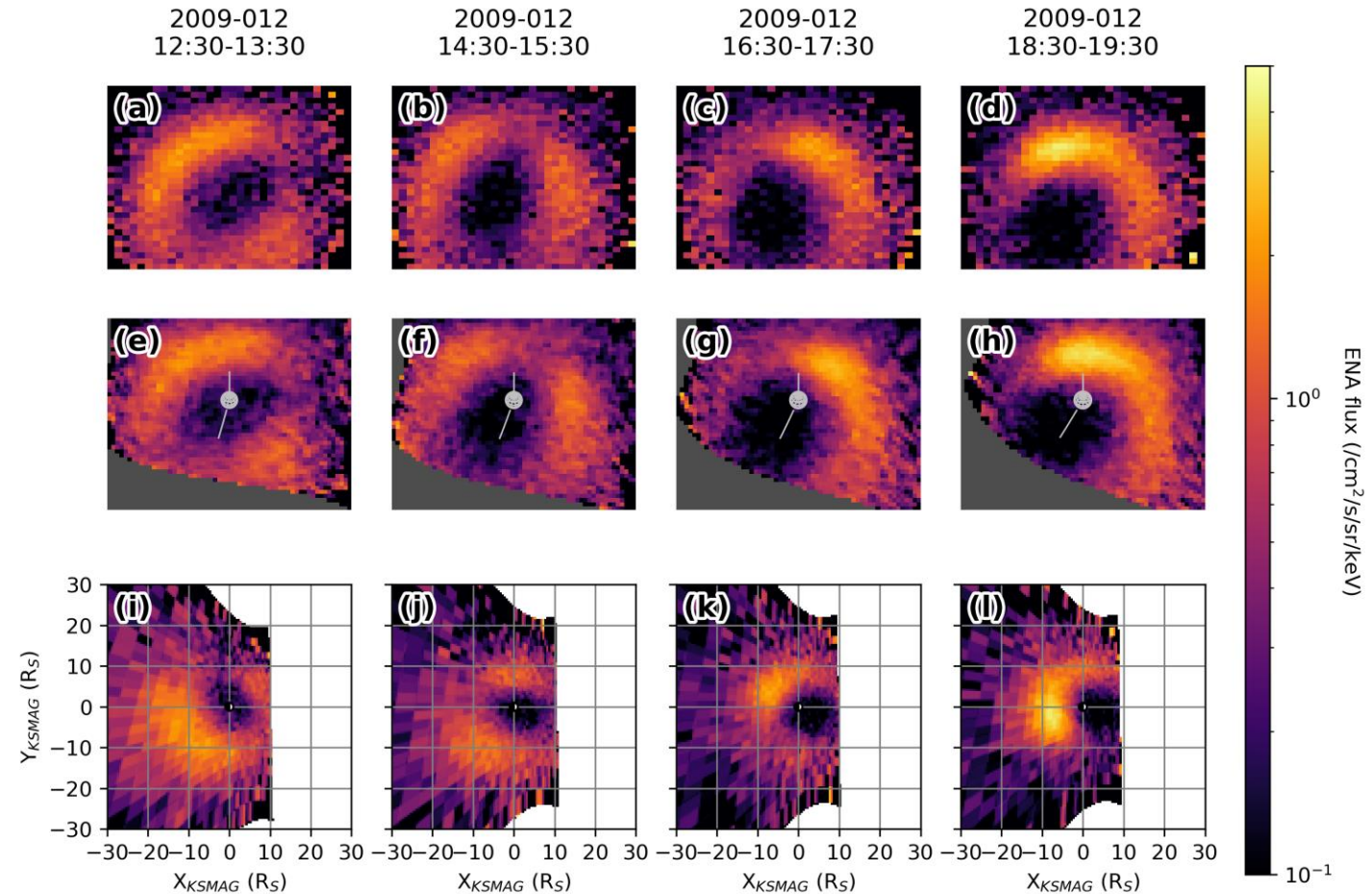
# Data, calibration and projection

## Original data:

- Uncalibrated Cassini MIMI-INCA observations of energetic neutral atoms (ENAs) in Saturn's magnetosphere, calibrated according to the INCA manual
- ENAs are created by charge exchange between hot plasma and neutral gas, their motion is not controlled by the magnetic field so they can be sensed remotely
- ENA observations are useful for characterizing global magnetospheric dynamics such as reconnection events and injections as well as their aftermath and relation to, e.g., in situ data and aurorae

## Projection:

- Assumes all emission is created in Saturn's equatorial plane – realistic since the planet's rapid rotation confines most neutrals and plasma into the (equatorial) magnetodisc
- Eliminates perspective changes due to varying orbits, simplifies usage of the INCA data
- Done by ray tracing using the SPICE toolkit & Python



(Top) Raw images in the original detector grid, (middle) projected into a realistic camera perspective and (bottom) projected into the eq. plane

# Dataset availability & stats

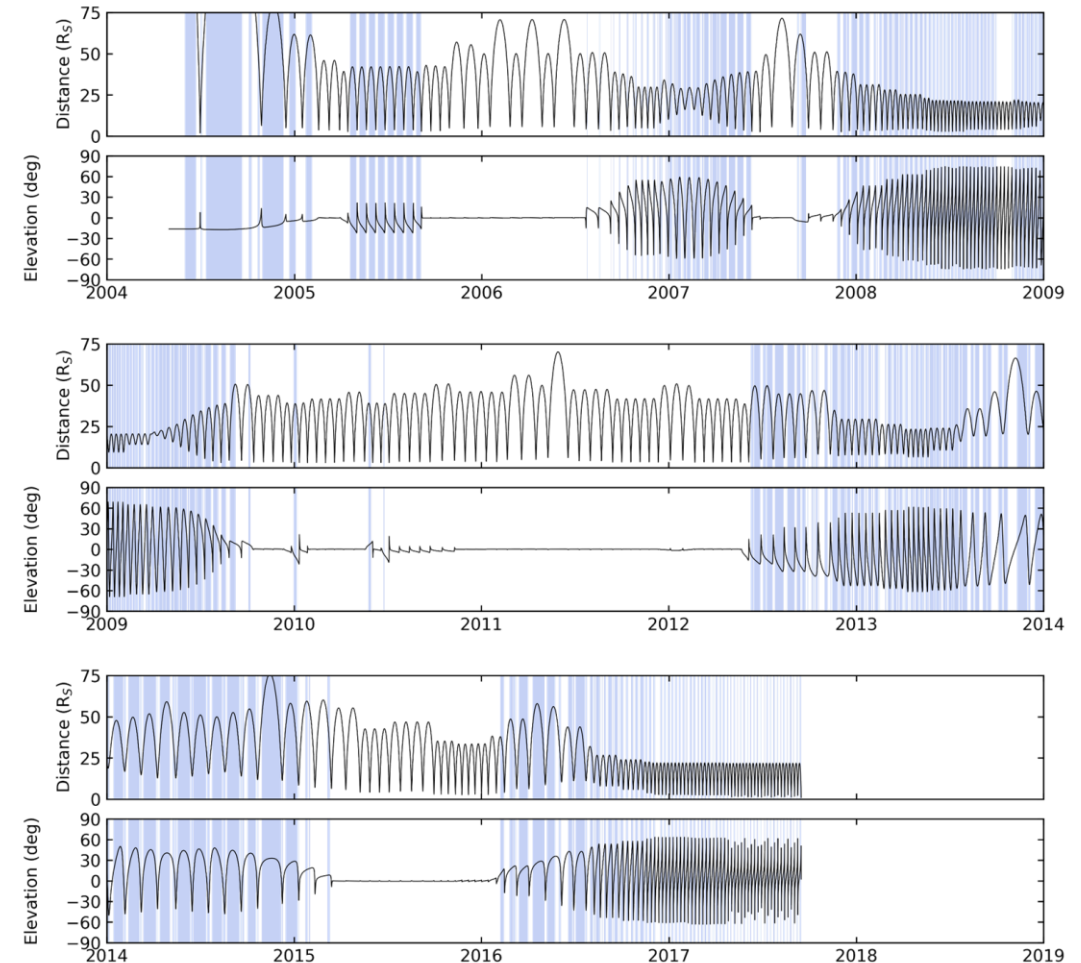
Data from the entire mission has been processed using this algorithm and will be released together with a descriptive JGR: Space Physics technical report.

Total # of exposures	Temporal resolution	Total exposure time
> 600,000	ca 5 mins per exposure	> 5 years
Spatial coverage	Spatial resolution	Dataset size
$[-30, 30] R_S$ in $X/Y_{KSMAG}$	2 pixels per $R_S$	22.5 GB (zipped)

Validity of equatorial projections is constrained by:

- Distance from the equatorial plane (to avoid being submerged in the source region) – we suggest at least 4-5  $R_S$  (see blue shading →)
- Elevation above area of interest (to minimize pixel stretching / mapping & brightness uncertainties) – we suggest at least 45-50°

Cassini's variable orbit featured many high-latitude sections, providing many extended observation periods where the dynamics of magnetospheric injections etc. can be investigated over long timescales (often several Saturn rotations of continuous observations).

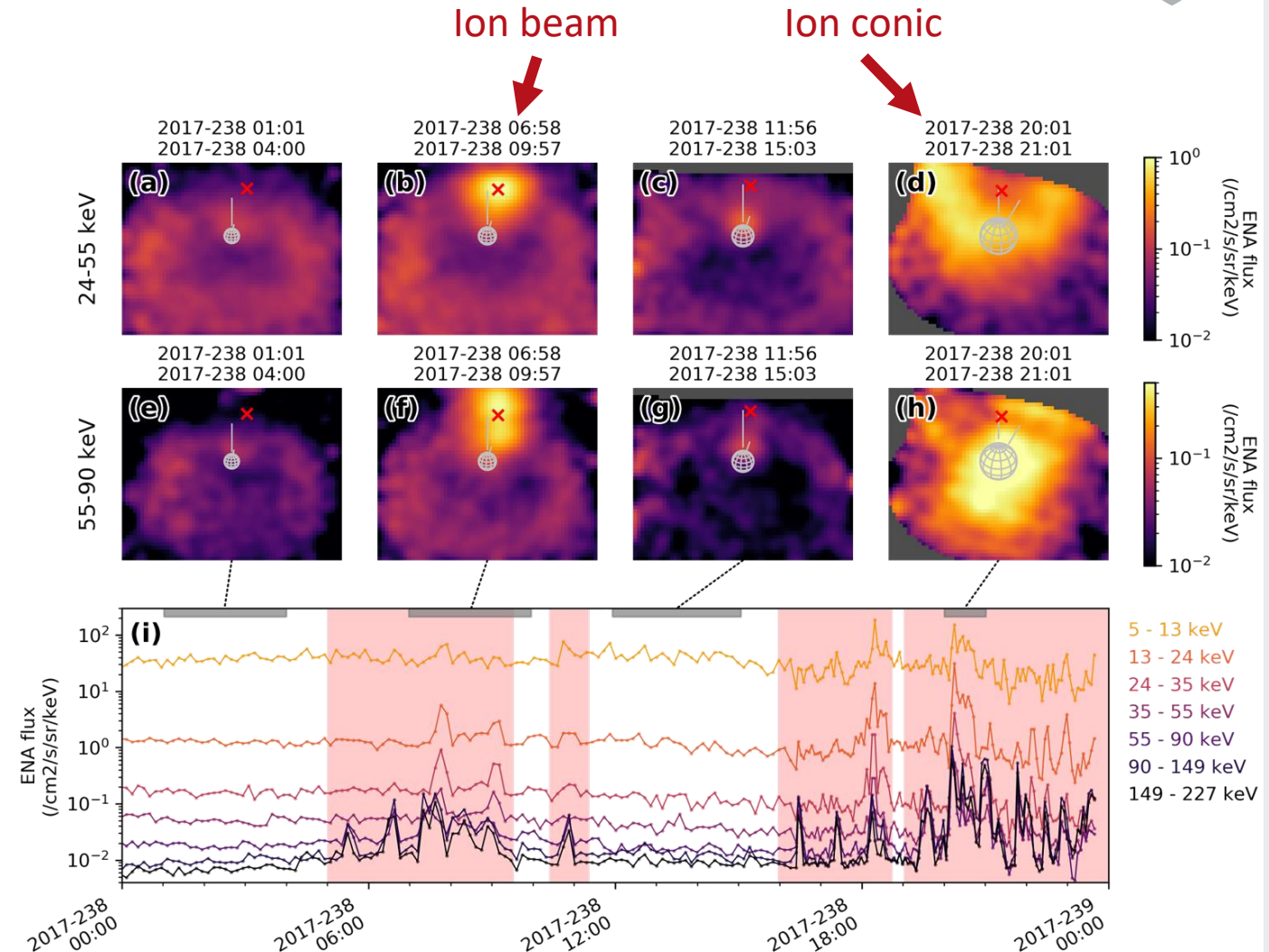


*Cassini's distance from and elevation relative to Saturn through its mission (blue shading = ENA observations from  $> 4 R_S$  above eq. plane)*

# Contamination handling

The data show different types of contamination; we identified and labelled all occurrences in the dataset using different methods:

- "Out of calibration" events (INCA time of flight sensor voltages outside their calibration range) – list of events provided by the instrument team
- Bit errors and sunlight contamination – identified using simple thresholding algorithms
- Ion contamination (ions passing into the detector through the deflection field intended to keep them out) – identified by looking for spikes in the highest energy bands of high energy resolution data, see figure to the right
- Flux enhancements due to mode switching (delay in deflection voltage de/activation or inconsistent data labelling close to switches between ion and ENA observation phases) – outlier detection using thresholding



ENA observations contaminated by ions as seen with (a-h) high spatial resolution and (i) high energy resolution. Red "x" = B-field direction.