Catalog of Coronal holes in TAP service

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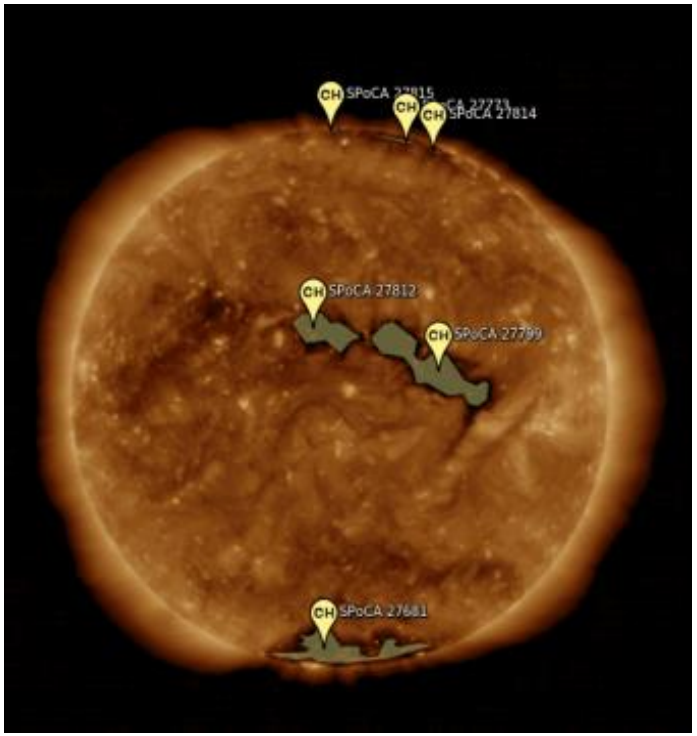
What are Coronal holes ?

- Coronal holes (CH) are low-density regions of one dominant magnetic polarity in the solar atmosphere.
- As the source regions of high-speed solar wind, they are the dominant contributors to space weather disturbances at times of quiet solar activity.
- It is of interest to identify, extract, and track them over time in view of empirical modelling of the high speed solar wind
  - Catalogs of Coronal holes are important !

How to detect coronal holes?

- In Extreme Ultra-violet (EUV) images, CH are seen as dark areas due to their lower temperature and electron density compared to the ambient coronal plasma.
- We have developed the Spatial Possibilistic Clustering Algorithm (SPoCA), which allows decomposing an EUV image into regions of similar intensity, typically active regions, coronal holes, and quiet sun.

- Example of SPoCA-CH detection on EUV images taken by SDO/AIA image on April 8, 2018. (Source: helioviewer.org)



Ref: Verbeeck et al 2014, DOI: 10.1051/0004-6361/201321243

Some SPoCA-CH catalogs already exist…

Heliophysics Event Knowledgebase

- Part of the Event Detection System (EDS) of LMSAL which provide various catalogs (flares, Coronal Mass Ejection, Active region, coronal holes, etc,…)
- Event available in VOEvent or JSON
- API to visualization tools such as Helioviewer
- Runs since 2010, level 1.5 data
- Only CH older than 3 days are kept (avoid spurious detection)

ROB Event Database

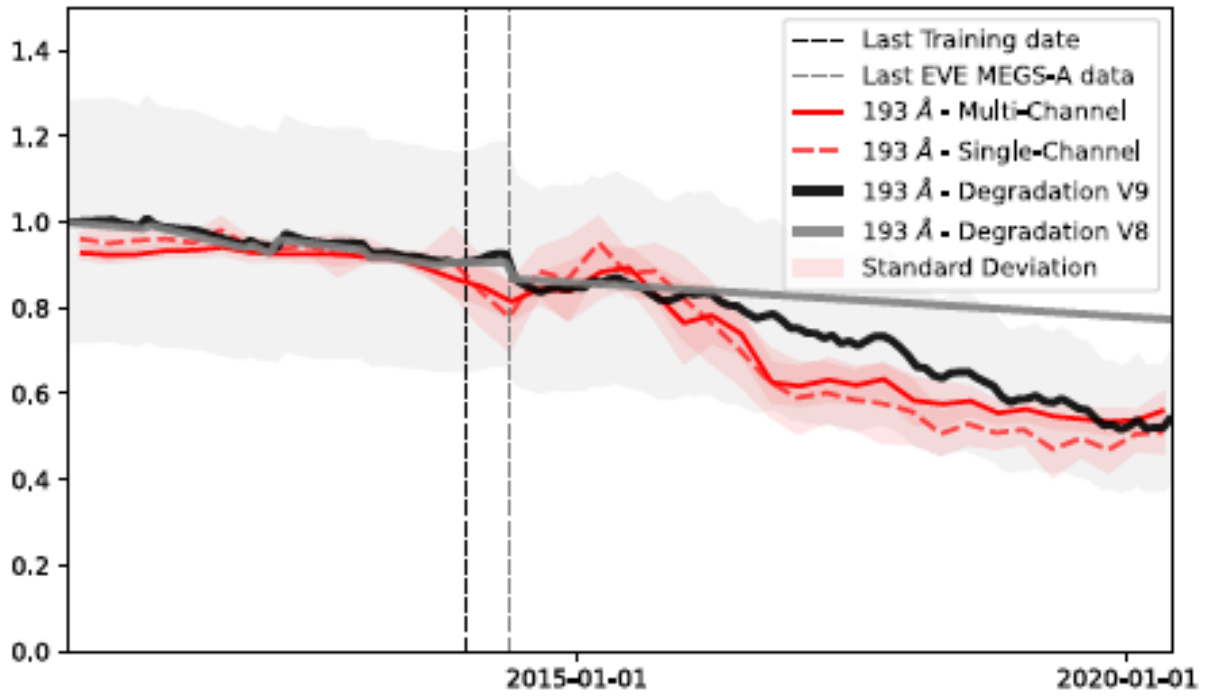
- Part of ESA-SWE portal for operational space weather service
- Runs since 2019 on quicklook data
- All CH detections kept
- Possible to construct meta-event from a collection of CH detections

… So why a new ROB SPoCA CH TAP catalog ?

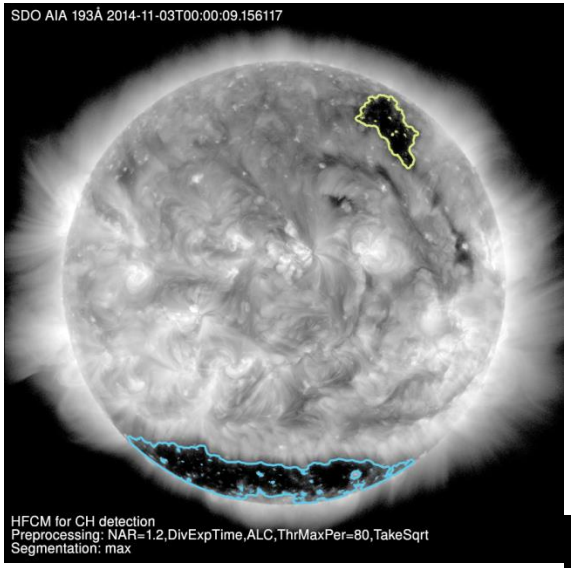
- Take the best from HEK and ROB Event DB
- Complete control on algorithm and catalog production
- New characteristics
  - Correction for instrument degradation
  - Statistics for EUV imager (AIA) and magnetogram (HMI) data, useful for further studies
  - Provide URL links to CH maps (this is what the users often are asking for)
- Two tables in ROB SPoCA-CH TAP service: a main table, and a tracking table

Correction for degradation – SDO/AIA 193Å channel

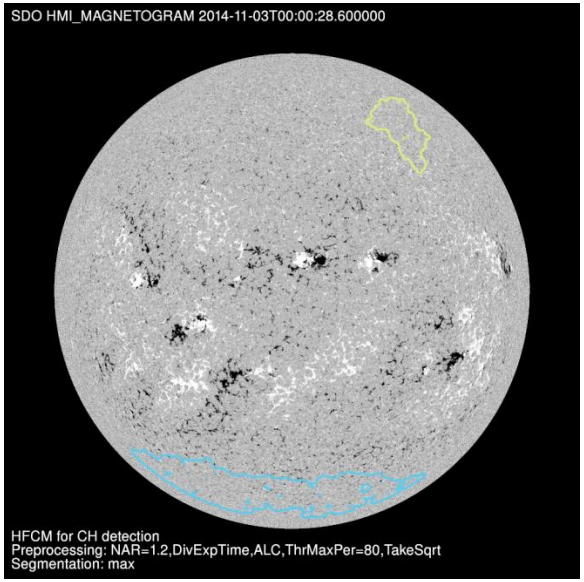
- Degradation of about 40% since the start of the mission
- Regular sound rocket (irradiance measurement) to estimate the degradation factor
- Important to correct for, if you are giving statistics on pixel intensity values over a long time.



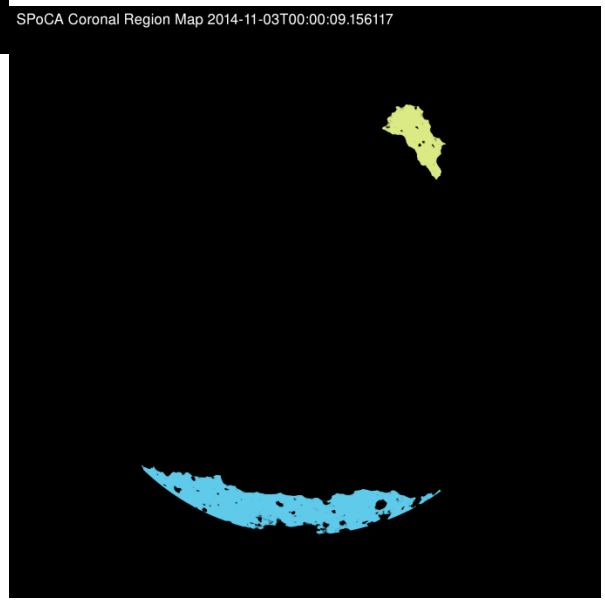
Statistics for AIA and HMI



Mapping back the CH maps on AIA and HMI, compute Mean, median, variance, skewness, kurtosis, etc,…



From AIA 193A images, obtain CH maps



Important to provide CH maps e.g. if user wants to compute other quantities (textural, geometrical information, etc,…)

- access_url
- datalink_url

Setting up EPNcore parameters

- Definition of granule_uid, granule_gid, obs_id
- Reusability: What is the best way to encode configuration parameter in the service itself?
- Adding a tracking table to the main table

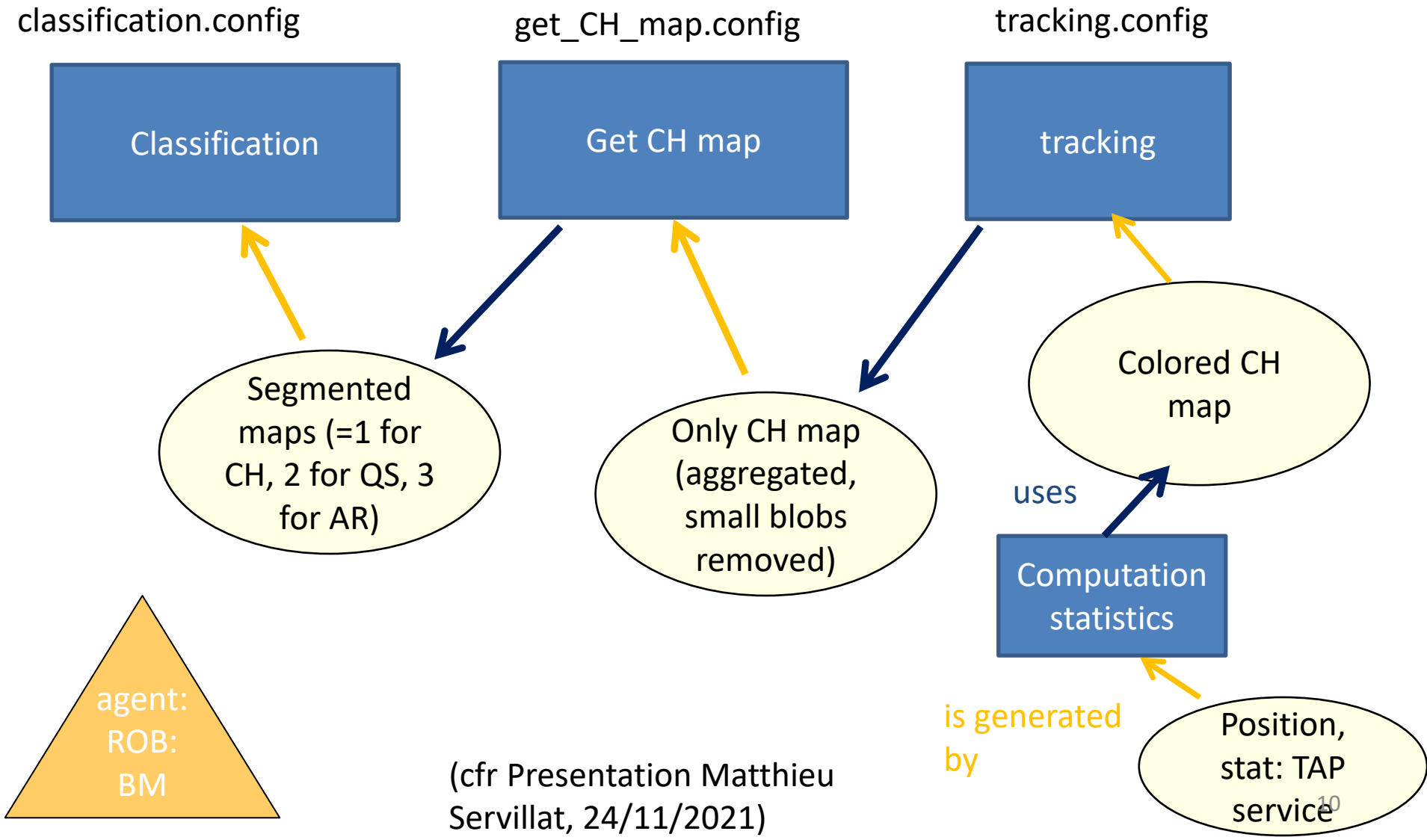
granule_uid, granule_gid, obs_id?

The CH are tracked over time (using de-rotation and graph model), each CH receives a 'color' in the CH map and keeps this 'color' over time. We propose:

- granule_uid: indicates the CH number and the time
- granule_gid: identical for all the detections of a same CH
- obs_id: provide the information to find back the original AIA 193 images (lots of websites are providing AIA data)

- granule_uid : *spoca_coronalhole_198_20100112_120000*
- granule_gid: *spoca_coronalhole_198*
- obs_id: *aia_193_20100112_120000*

Reusability – high level provenance information



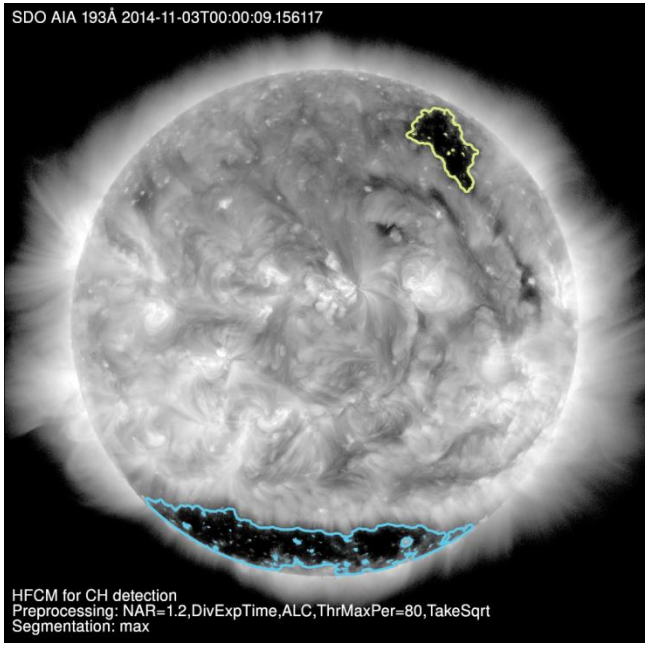
(cfr Presentation Matthieu Servillat, 24/11/2021)

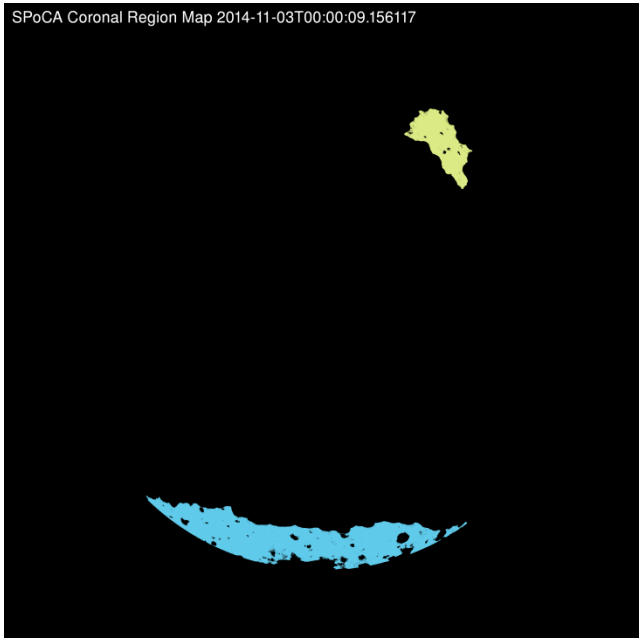
Provenance vs configuration

- Ideally: encode **how** a data product was produced **(provenance)** e.g. using ProvTAP
- In the absence of ProvTAP, is there a structured way to provide information about what **detailed options** were used (**Configuration)** ?

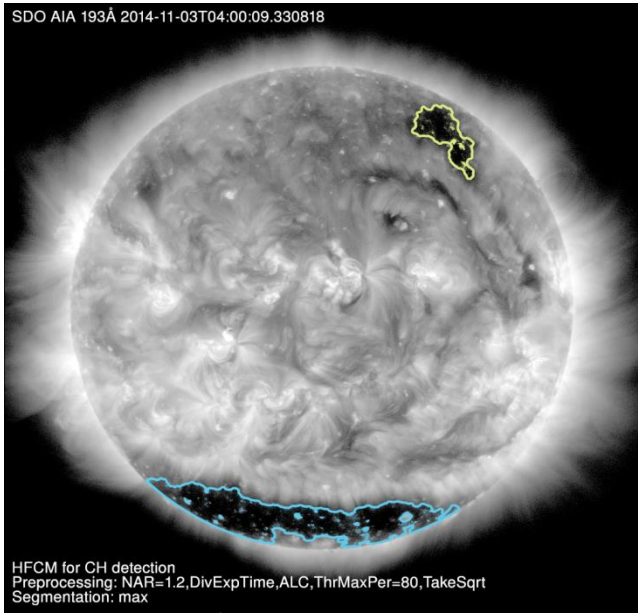
Tracking

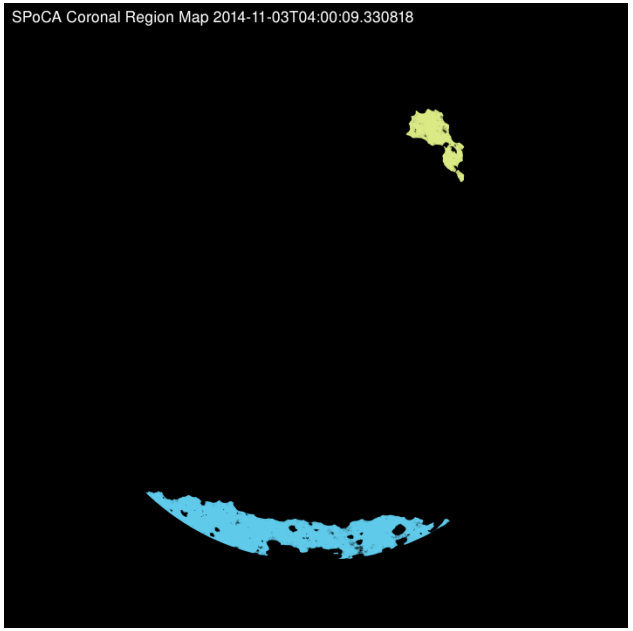
T=00:00:00





T=04:00:00





Tracking table: previous, next, overlap

- Previous: id of previous CH detection
- Next: id of next CH detection
- Overlap: number of pixel that overlap in 'previous' and 'next' detection, after solar de-rotation. The CH detection which has maximum overlap keeps the same 'color'.

previous	next	overlap
spoca_coronalhole_198_20100112_120000	spoca_coronalhole_198_20100112_160000	300px
spoca_coronalhole_198_20100112_120000	spoca_coronalhole_200_20100112_160000	100px

What's next ?

- VESPA workshop next week
- Catalog is updated every 4hours

  -> find a clever way to update TAP service

- Investigate possibility to have a TAP client from our Solar Virtual Observatory to access SPoCA-CH TAP service