WIRwolf:

A pipeline for calibrating and stacking WIRCam data

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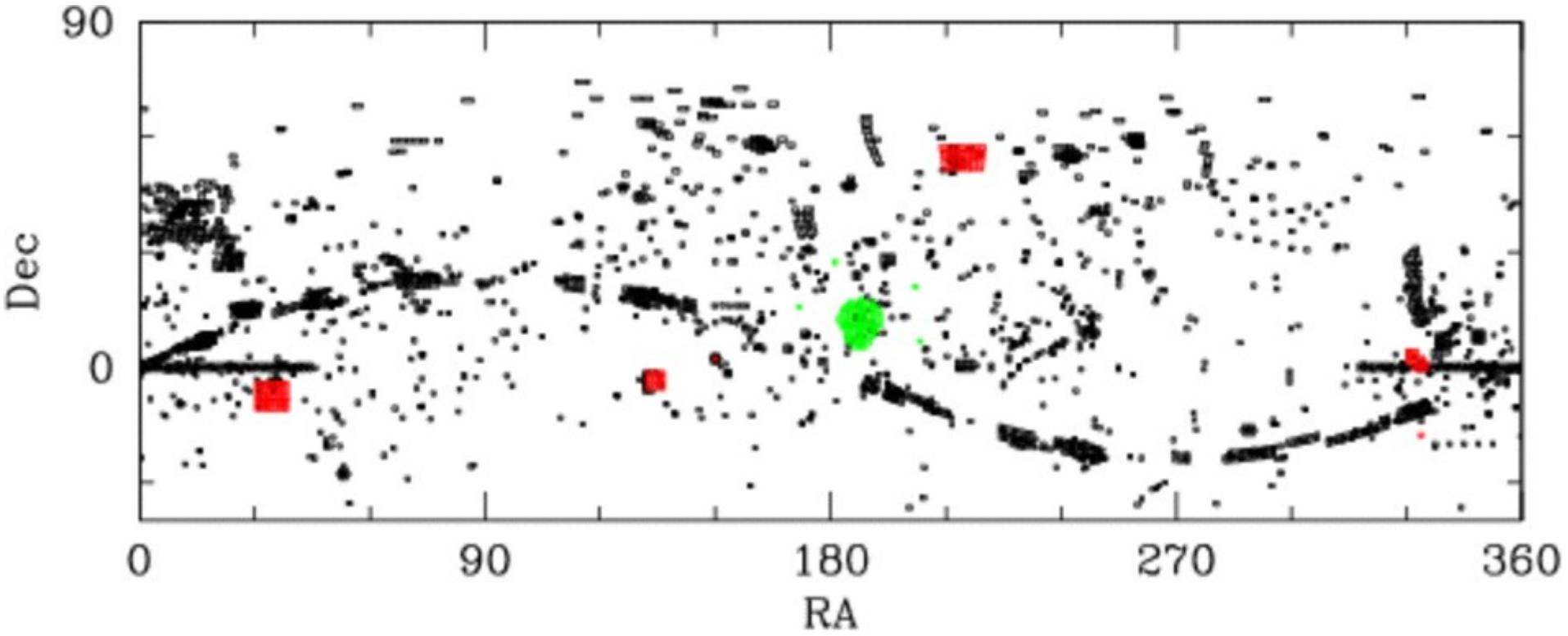
Background: MegaPipe

- MegaPipe has been operating since 2005
- Original purpose: to stack all public MegaCam data
- 3094 square degree pointings and counting
- Now also supports large programs: NGVS, MATLAS and OSSOS



Red = CFHTLS
Green = NGVS
Black = other PI

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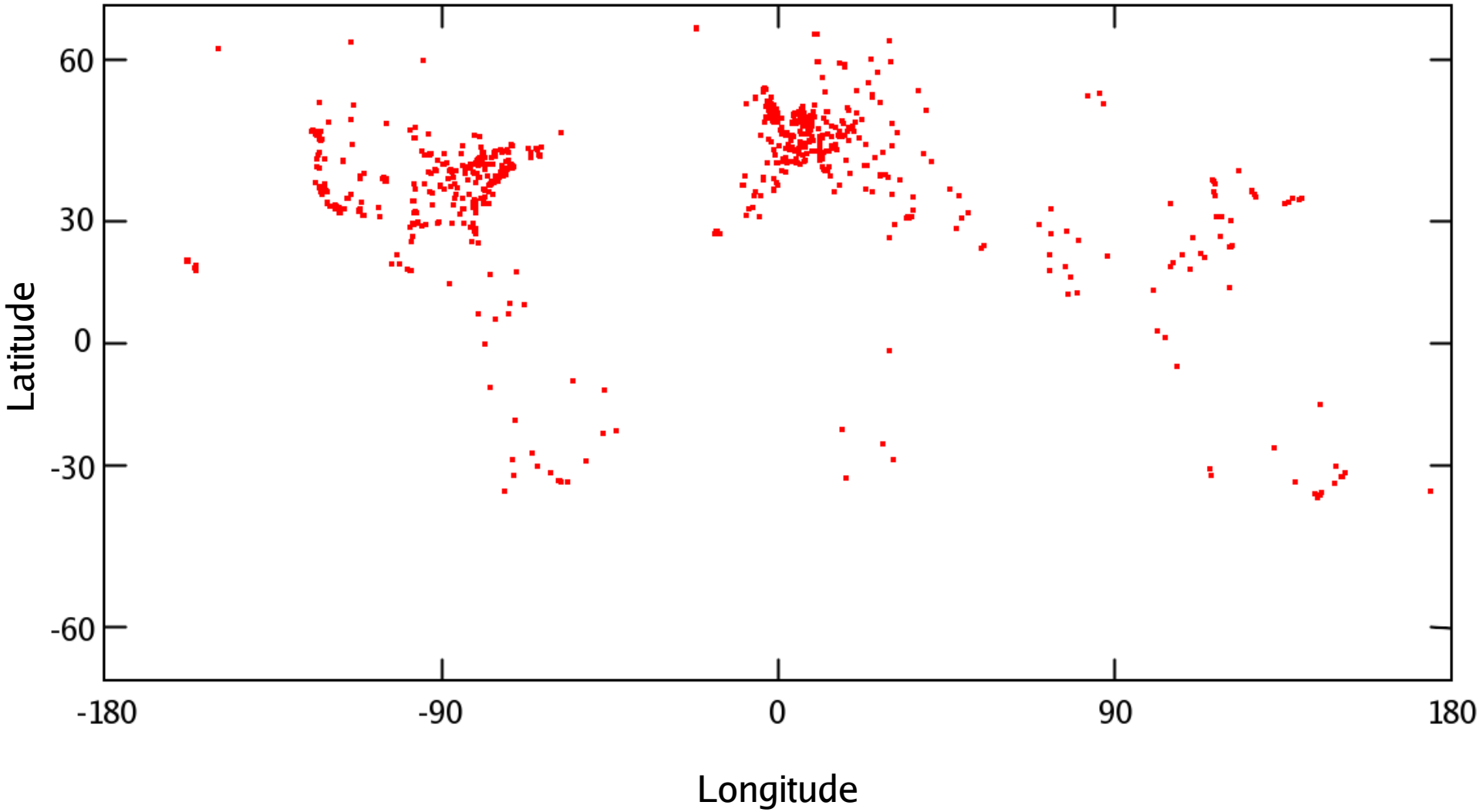
Background: MegaPipe



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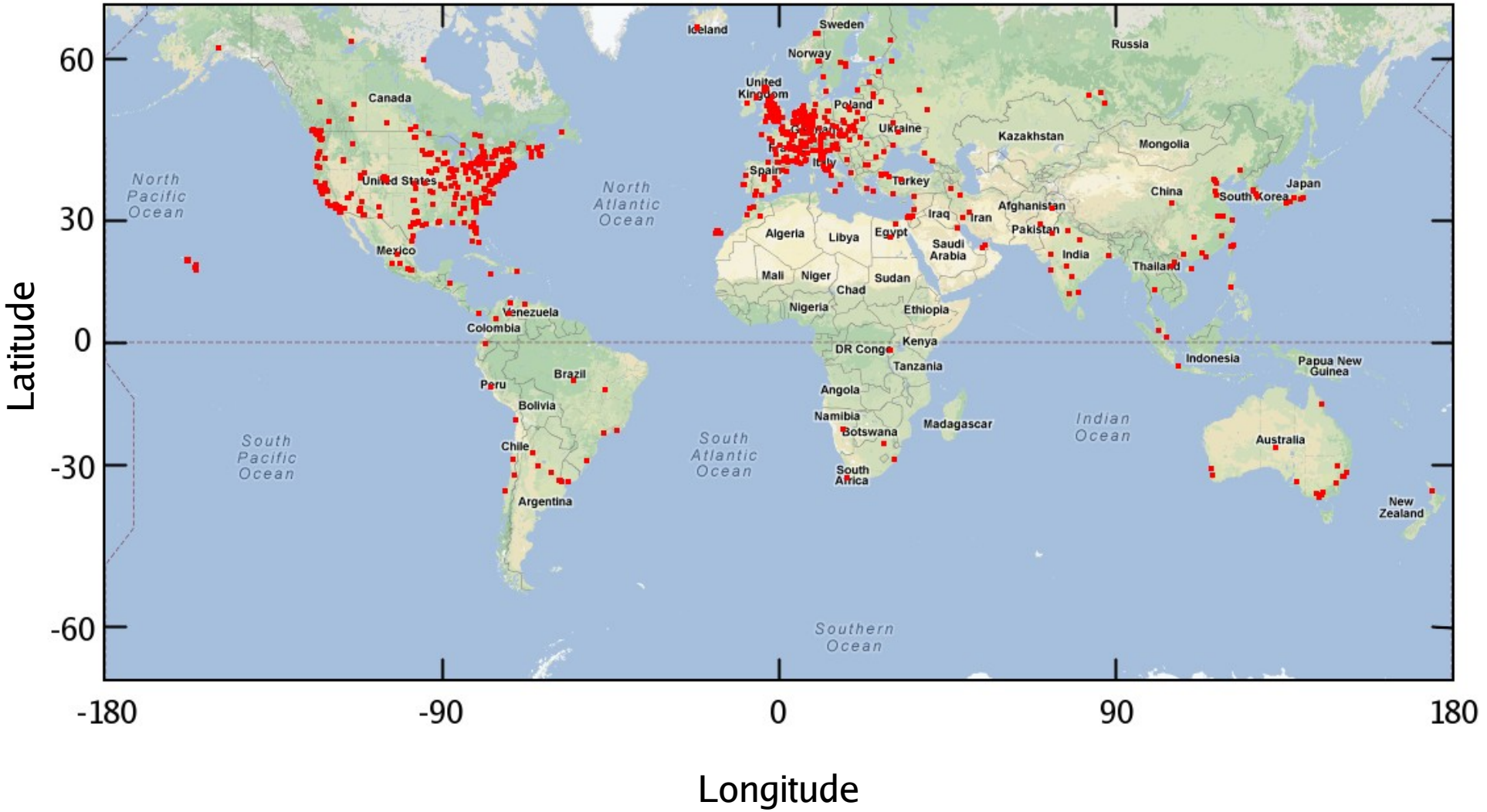
Background: MegaPipe



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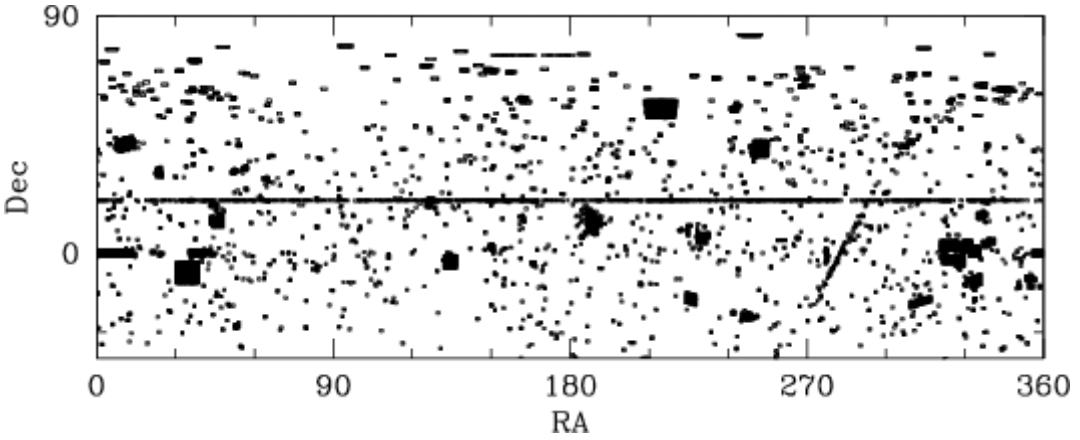
WIRCam archival data

- On the sky since 2005
- 250000 images
- 700 square degrees
  (allowing for overlaps)



But:
- Underutilized: MegaCam images
  downloaded 5 times as often

- Although 'I'wii facilitates usage, stacks are necessary

Hence: **WIRwolf**

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Overview

- Stack everything worth stacking
- Astrometric calibration: 2MASS as reference
- Photometric calibration: 2MASS as reference
- Background subtraction: local double pass or 'I'wii
- Resampling/scaling: SWarp
- Image combination: artificial skepticism

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Astrometry

- MegaPipe astrometric software converted to WIRwolf
- only small modifications necessary

- First filter in group:
  - Individual images matched to 2MASS
  - Merge catalogs
  - Match images to merged catalog for improved internal astrometry

- Subsequent filters in group:
  - Use first stack

- Astrometric residuals to 2MASS typically 0.15"
- Internal astrometric residuals typically 0.04"

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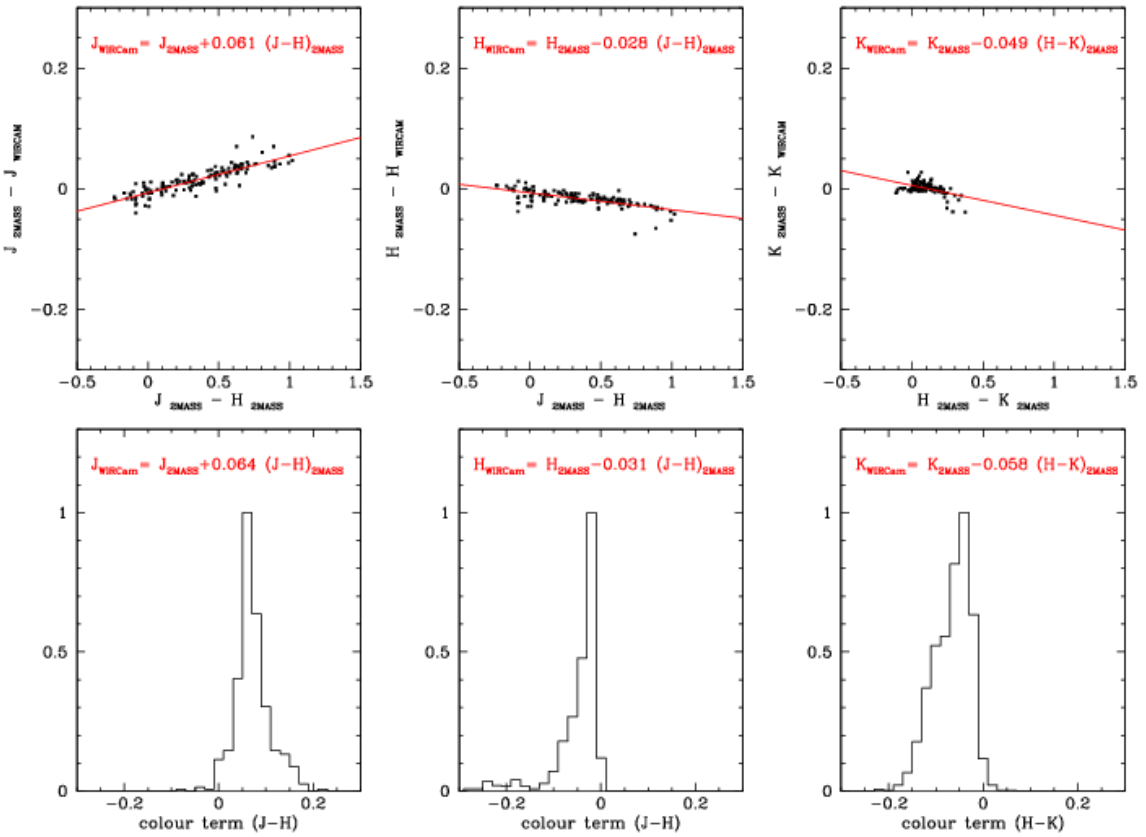
Photometry: colour terms relative to 2MASS

- Small but measurable
- Theoretical:
  - filters multiplied by Pickles stars

- Empirical:
  - individual measurement noisy
  - do it on 100 000 images

-Adopted:

$$J_{WIR} = J_{2M} + 0.064\ (J-H)_{2M}$$
$$H_{WIR} = H_{2M} - 0.031\ (J-H)_{2M}$$
$$K_{WIR} = K_{2M} - 0.058\ (H-K)_{2M}$$



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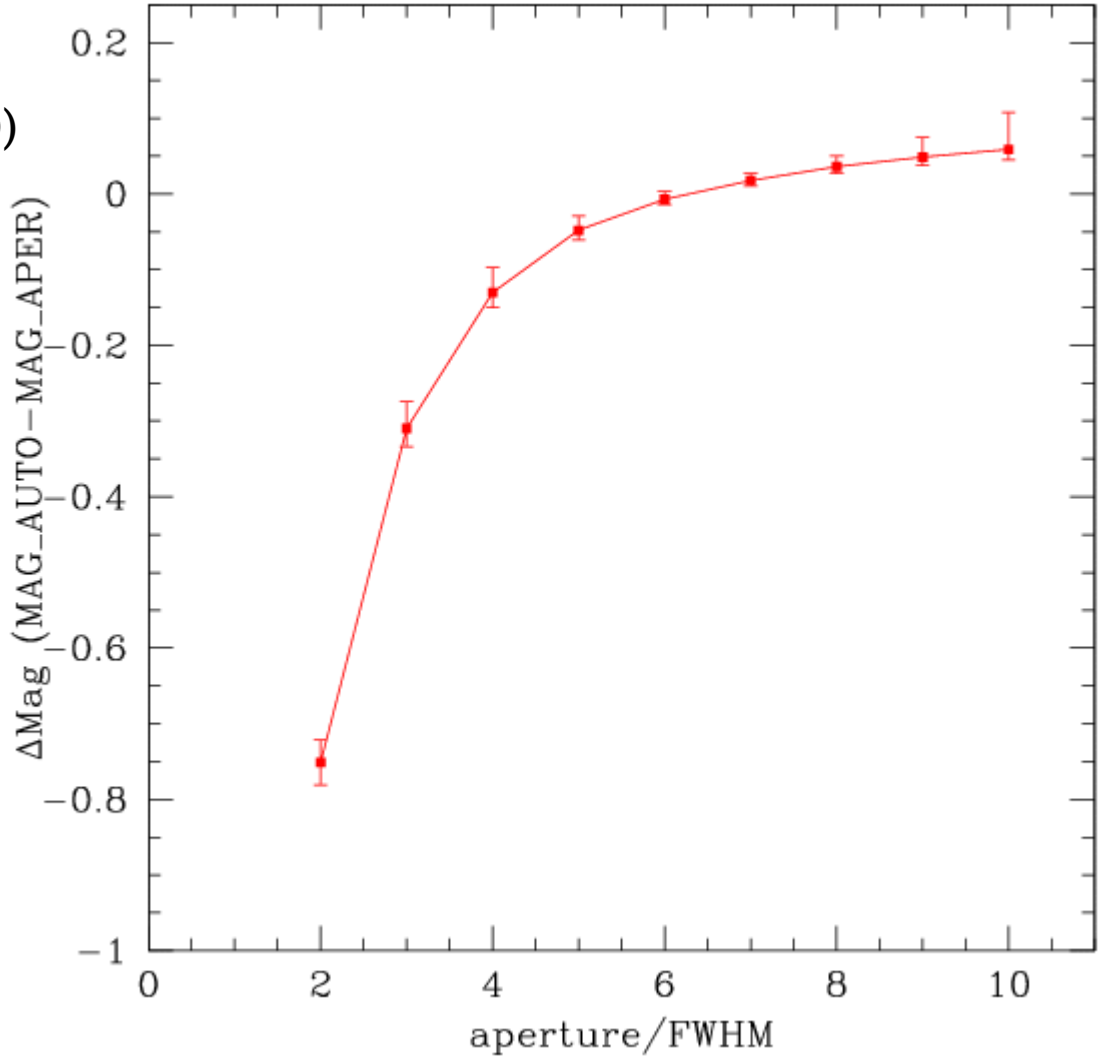
Photometry: aperture choice

What kind of magnitudes?
- Galaxies: Kron magnitudes (MAG_AUTO)
- Stars: small aperture, corrected
- Calibration sources mostly stars

Solution:
- Determine a circular aperture such that MAG_APER = MAG_AUTO
- After examining ~100 000 images:
  big aperture = 6.28 x FWHM
  small aperture = 3.14 x FWHM



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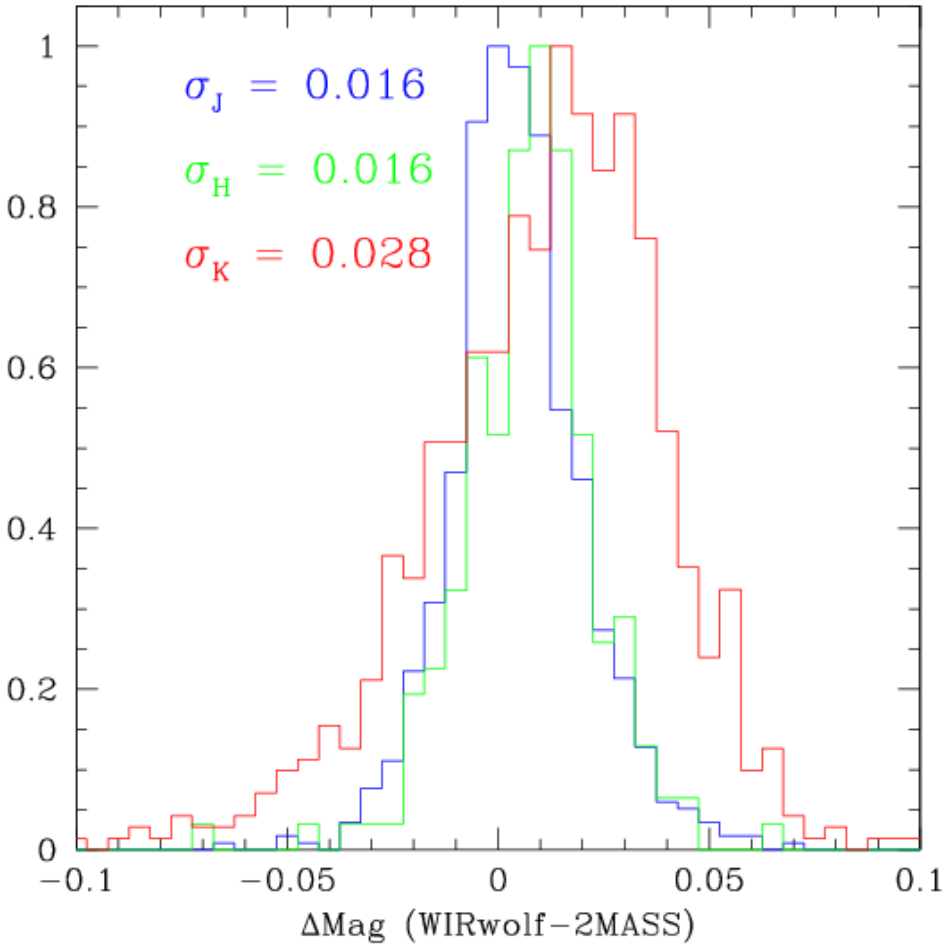
Photometry: uncertainties

- Compare final catalogs to 2MASS
- Compare overlapping catalogs
- 2% photometry



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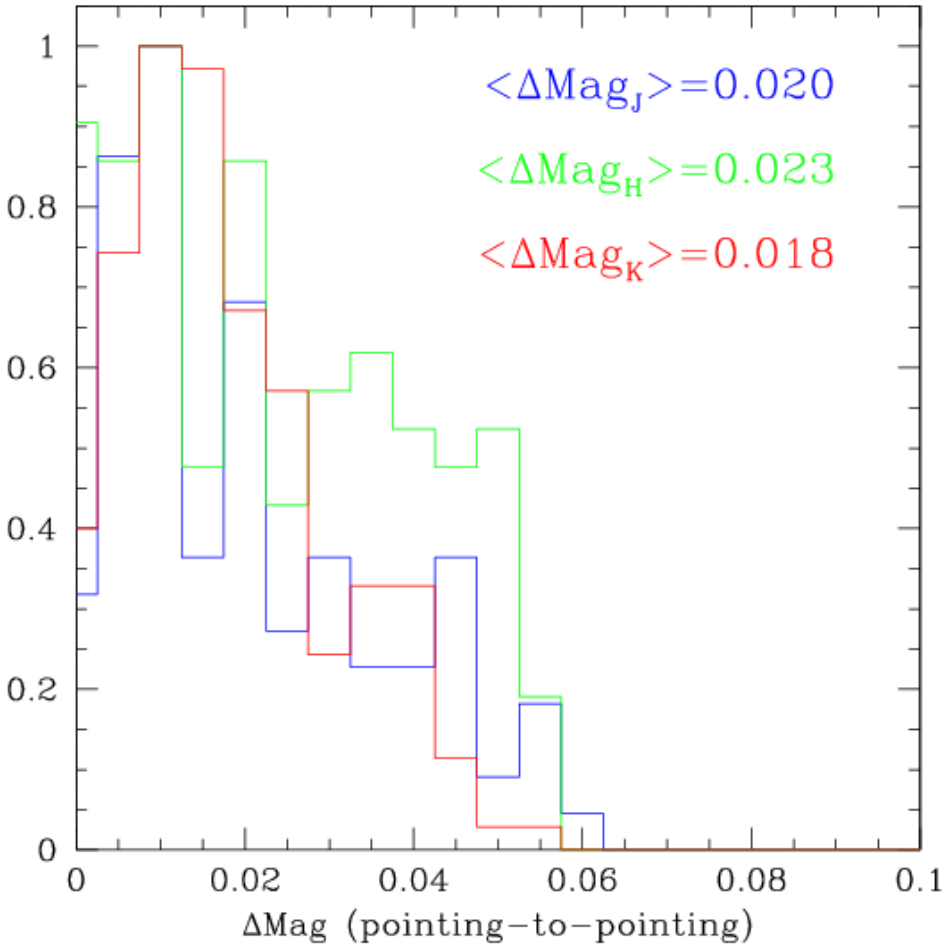

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Background subtraction

Method 1:
- Run SExtractor, find sources
- Mask them
- Determine background on masked image on local grid
- Remove it
- Works fine on most fields

Method 2:
- Use 'I'wii background subtraction
- better for nebulae and crowded fields

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Resampling and combination

- Images are resampled and scaled with SWarp
- Images are combined with artificial skepticism
  - optimum depth
  - optimum outlier rejection

$$w_i = \frac{1}{\sigma_i^2} \frac{1}{1 + \alpha \left(\frac{|r_i|}{\sigma_i} \right)^{\beta}}$$

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Production

- Software installed on a virtual machine
- VM is cloned and run on ~200 mid-level machines
- 1-2 weeks to process all available images
- Quality control takes 1-2 days

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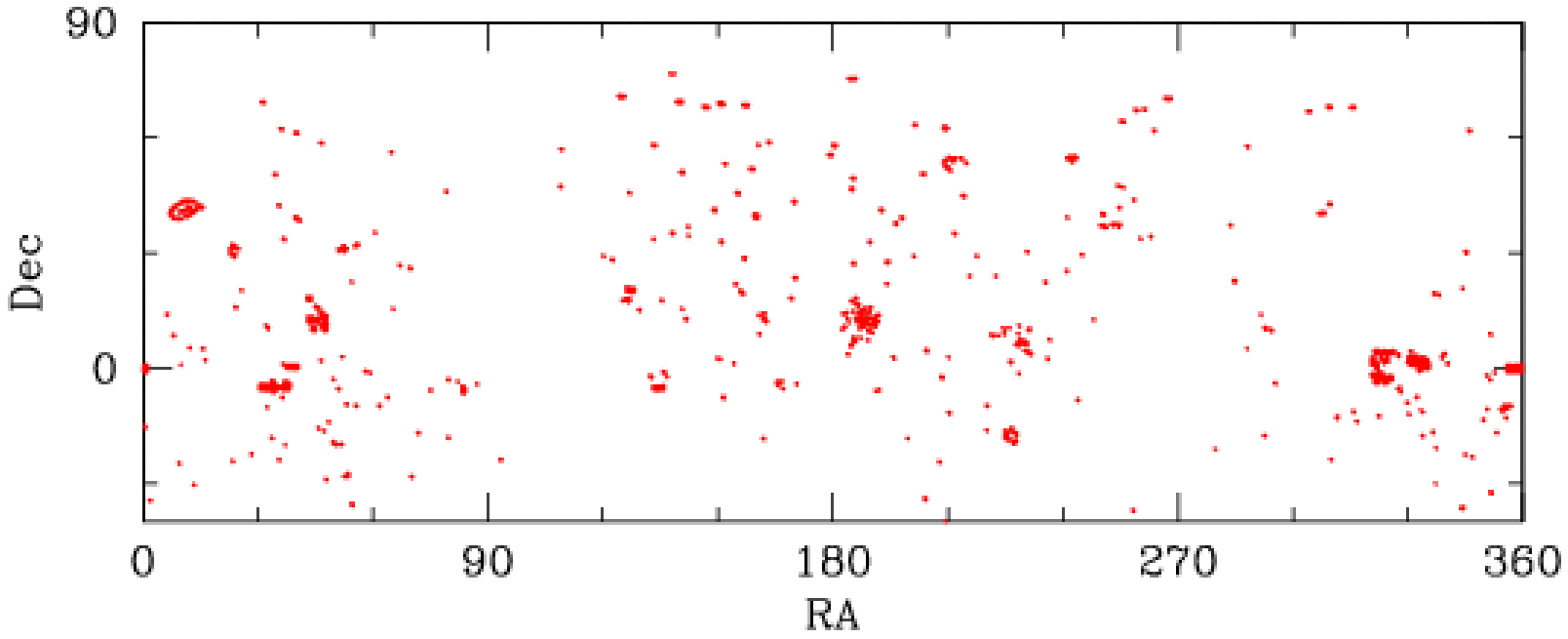
Production



over 1200 WIRcam pointings currently available

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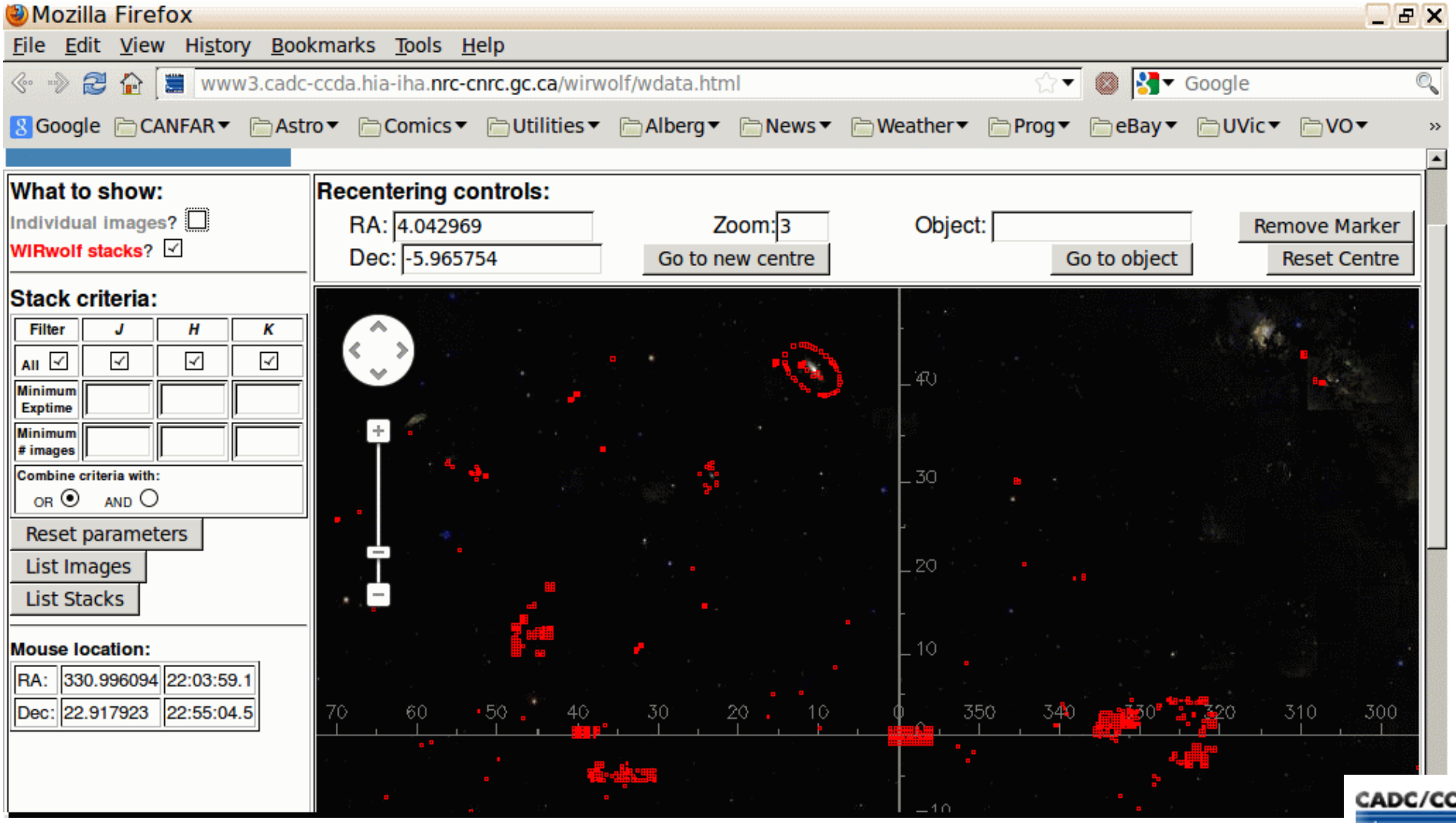
Distribution

http://www.cadc.hia.nrc.gc.ca/wirwolf (or Google “wirwolf”)



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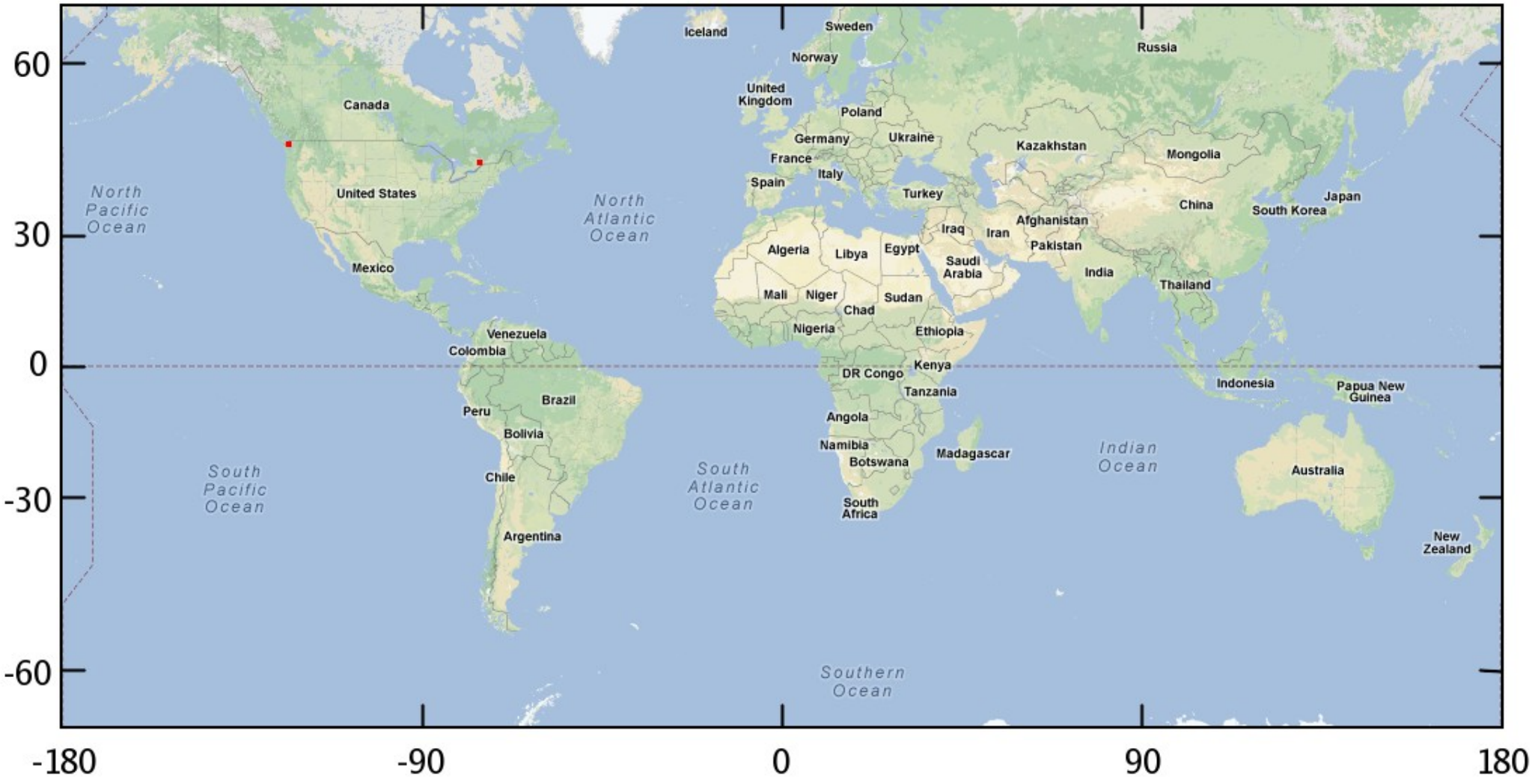

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