Deep Space Observations of Sun Glints: A New EPIC product

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Thank you to Mashall Sutton and to the ASDC team

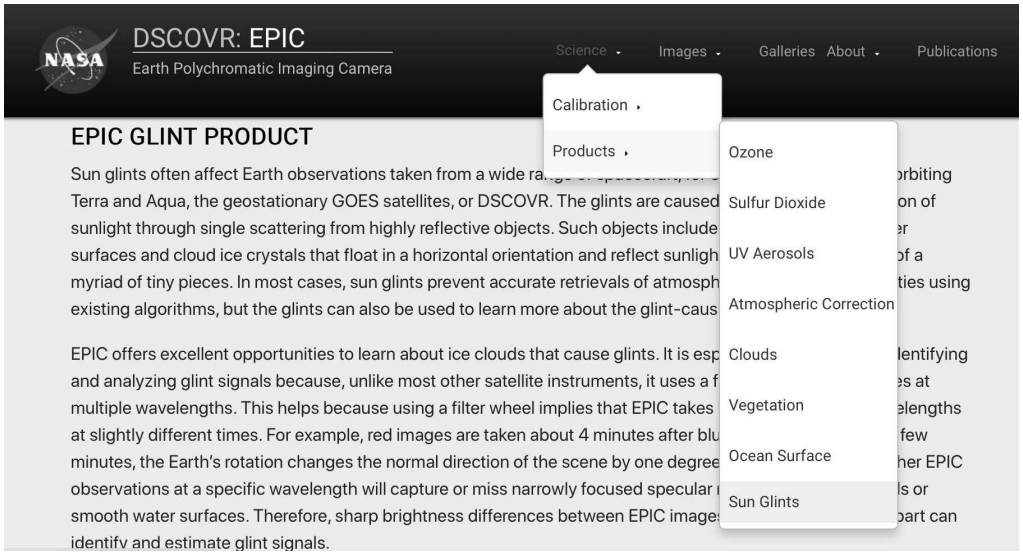
Current status of EPIC glint product

Released in August 2021

Publicly available at https://eosweb.larc.nasa.gov/project/DSCOVR/DSCOVR_EPIC_L2_GLINT_01

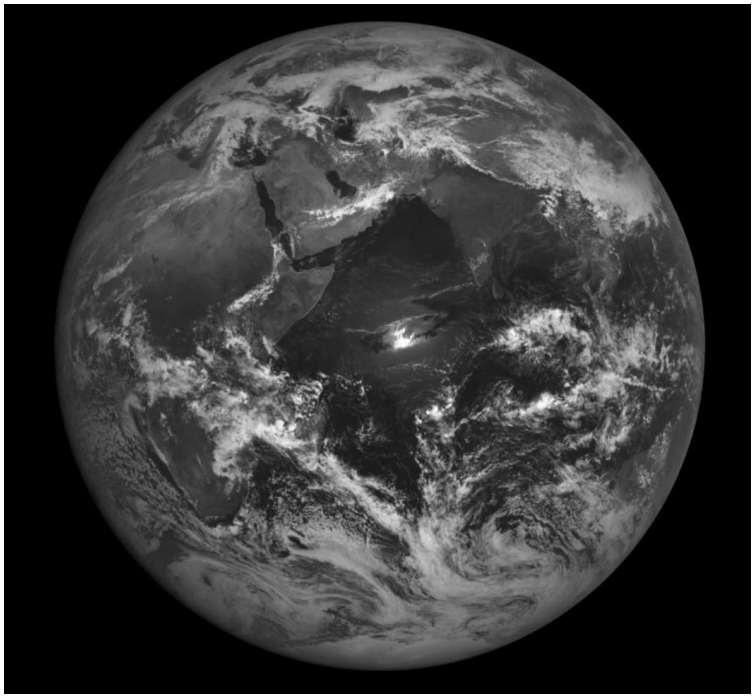
Dataset covers entire time since DSCOVR launch, new data is added continuously

Product is described in a manuscript under review at Frontiers in Remote Sensing



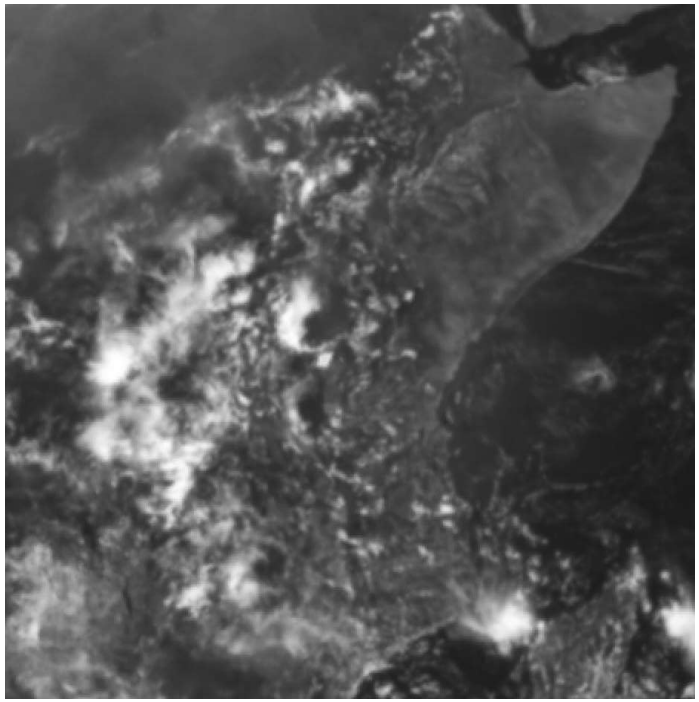
EPIC images often feature glints from ocean or clouds

Glint from ocean surface



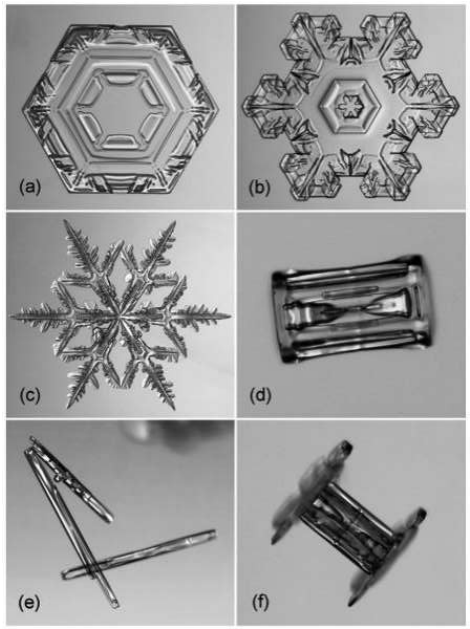
2016 03 23, 07:39 UTC

Glint from clouds



2016 03 17, 09:46 UTC

Cloud glints come mostly from plate-shaped crystals



Libbrecht (2005)

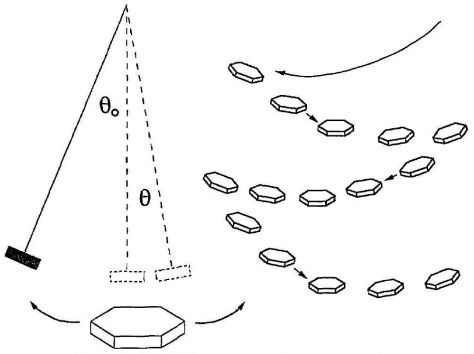
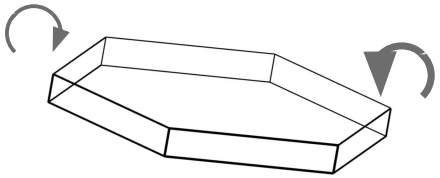


Fig. 8. Pendulum motion of a plate crystal.

Lynch (1994, Appl. Optics)

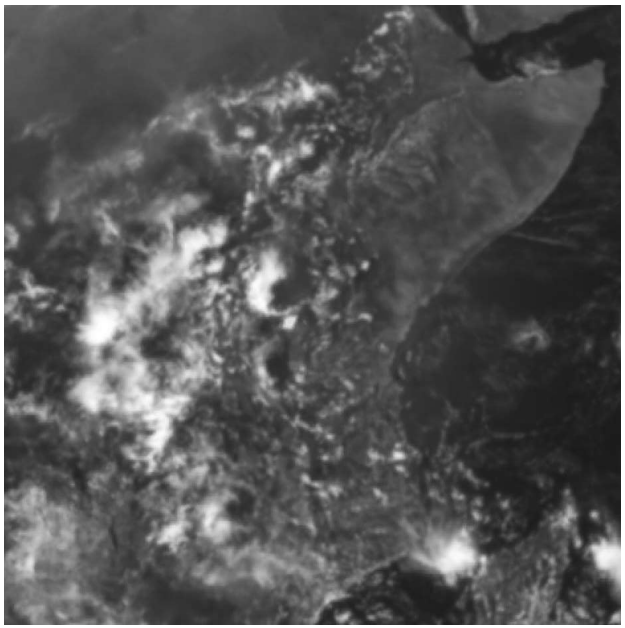
$\theta \approx 1°$



Glint from horizontal ice crystals is often called subsun

Photo from aircraft

EPIC image



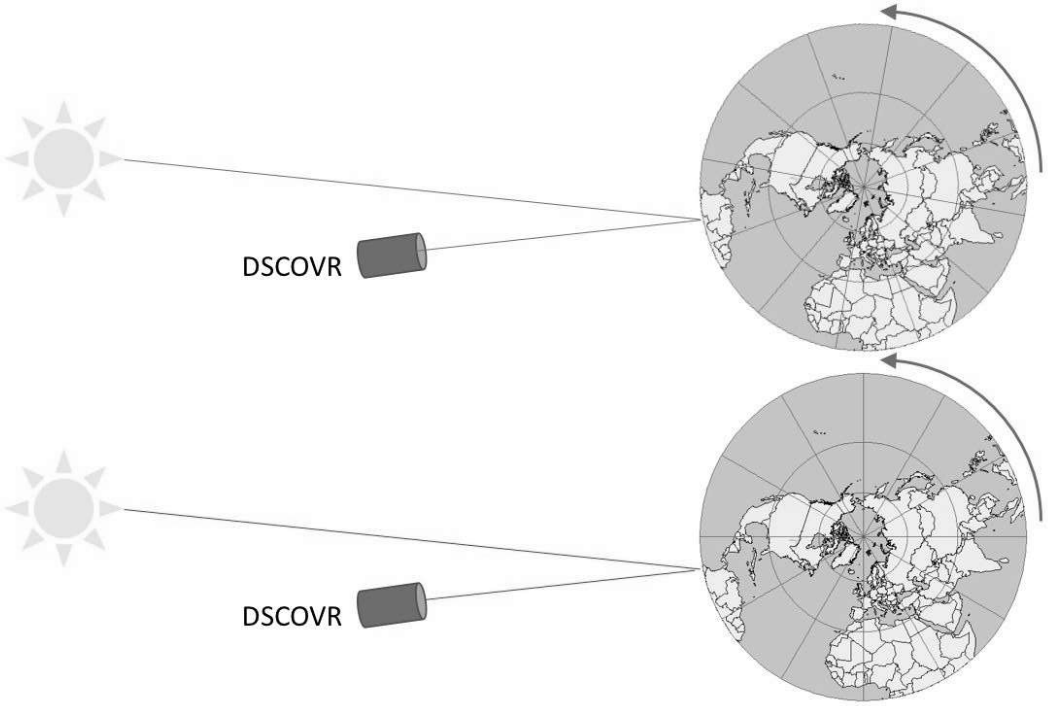
Können (2017, BAMS)

2016 03 17, 09:46 UTC

Glints appear colorful, as the Earth turns between blue & red images

Time of blue image

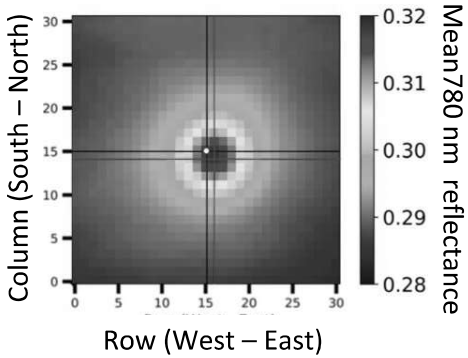
Time of red image
(≈4 minutes later)
Glint shifts by ≈ 100 km



EPIC can be used as a multiangle instrument having a high angular resolution

Some potential uses of glint data

- Warn retrieval algorithms, especially over land
- Provide new information on ice clouds
  (Chepfer et al., 1999; Bréon and Dubrulle, 2004; Li et al., 2019)
- Monitoring geolocation accuracy far from coastlines
  (Kostinski et al., 2021)
- Estimate aerosol properties, including absorption
  (Kaufman et al., 2002; Ottaviani et al., 2003; Knoebelspiesse et al., 2021)



All EPIC data from 2017
Kostinski et al. (2021, Earth & Space Sci.)

Cloud glint data can help reduce uncertainties caused by horizontally oriented ice crystals in

- Calculations of cloud radiative effects (albedo)

  (Takano and Liu, 1989; Stillwell et al., 2019)

- Spaceborne microwave retrievals of cloud ice water path

  (Gong and Wu, 2017)

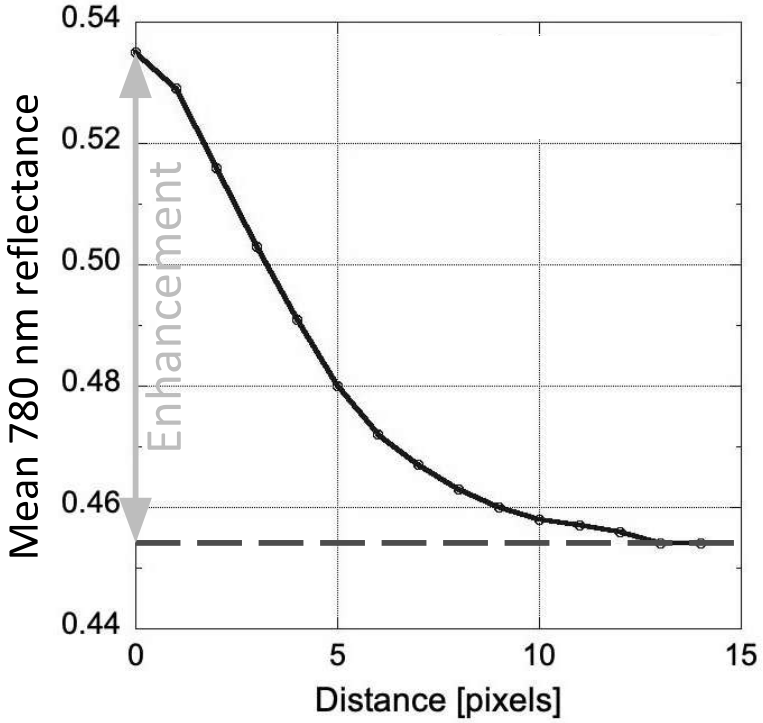
- Calculations of crystal fall speed and cloud lifetime

  (Heymsfield and Iaquinta, 2000; Westbrook, 2008; Zeng et al., 2021)

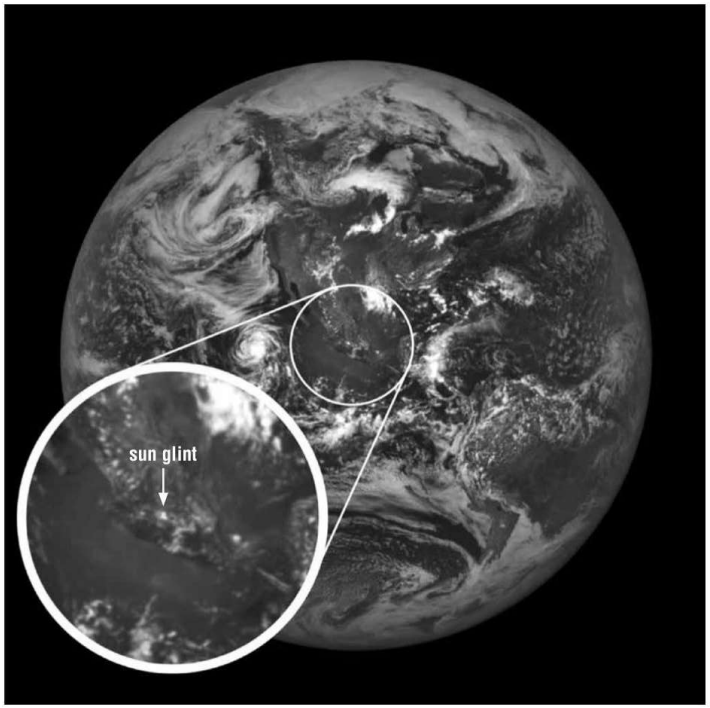
- Cloud conditions (e.g., crystal shape, turbulence, radiative cooling)

  (Katz, 1998; Bréon and Dubrulle, 2004; Zeng et al., 2021)

Cloud glints affect small parts of EPIC images



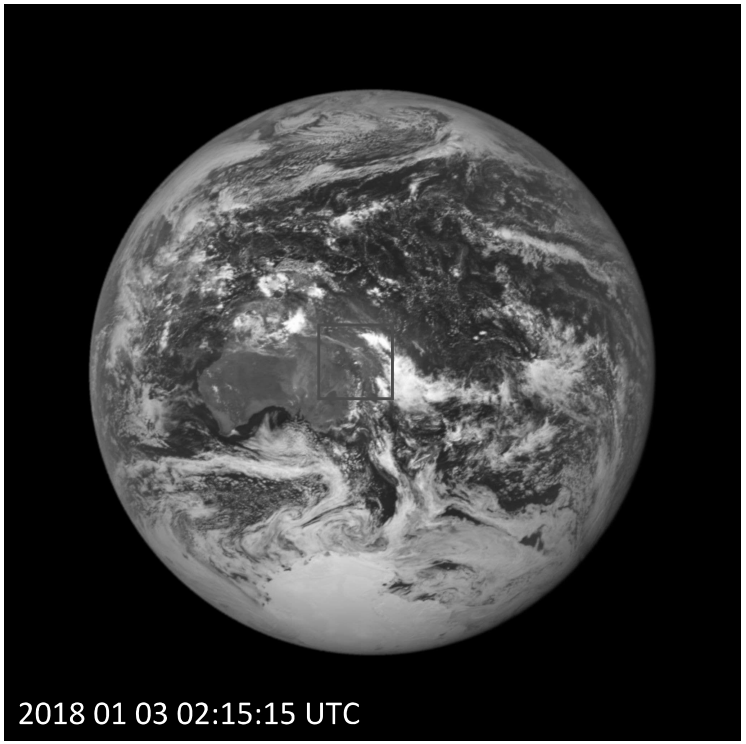
All land areas throughout 2017, based on Fig. 5 of Kostinski et al. (2021)

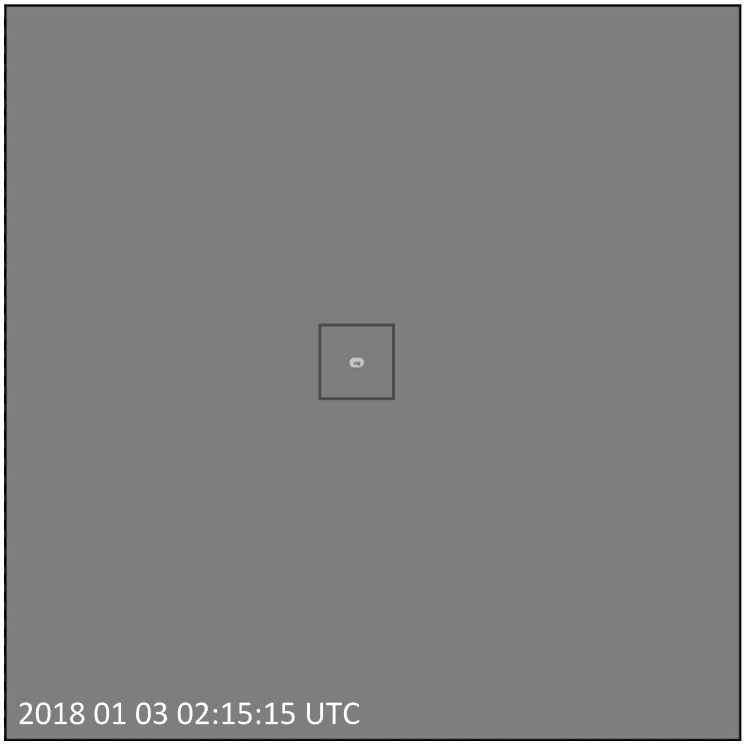


Front page of Earth Observer, July-August 2021
2018 07 04 19:00:06 UTC

Glint product has fill values for most of EPIC images

Glint product for each image < 1 MB; entire dataset < 20 GB





Even though the glint product covers only small portion of each EPIC image, it can allow statistical analysis

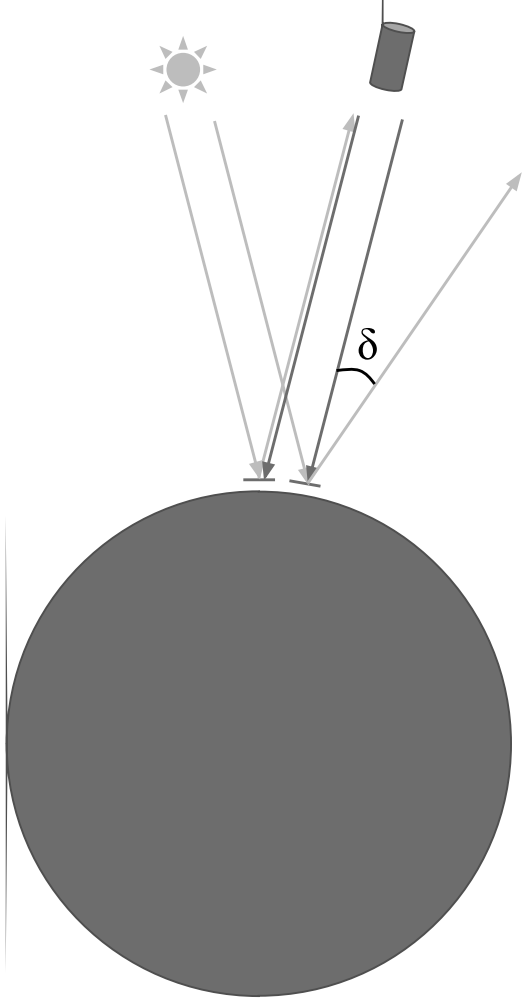
Based on Fig. 2 of Marshak et al.

Current glint product includes three data arrays

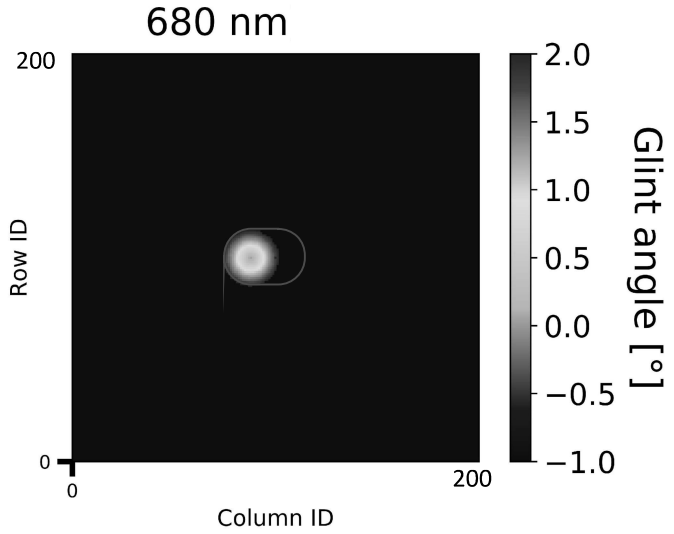
- Glint angle
- Surface type
- Glint mask

Glint angle (δ)

- Can tell whether conditions are favorable for detection of glint (& horizontal ice crystals)
- Can help learn about glint-causing objects

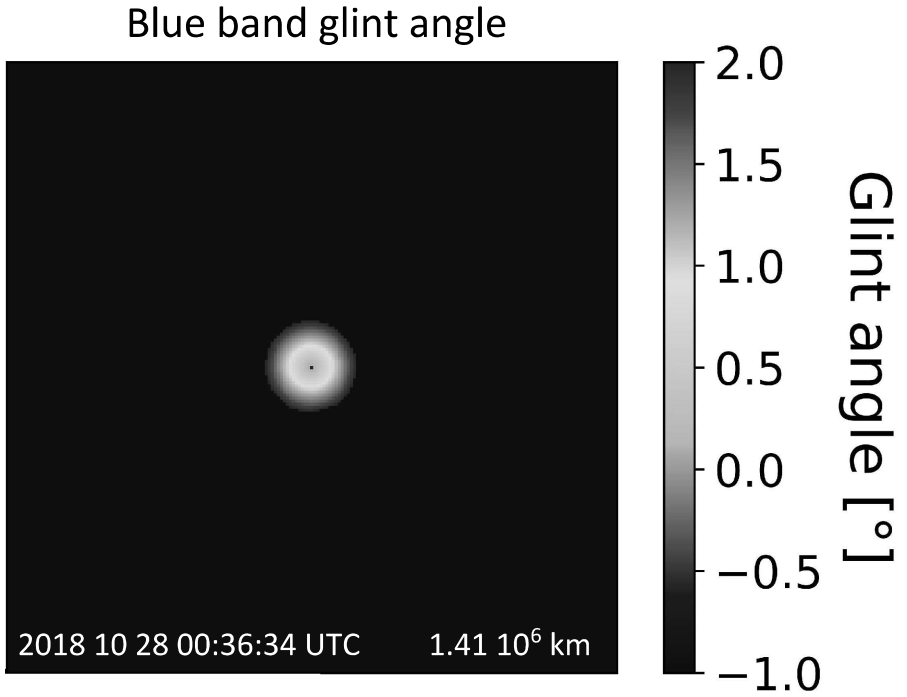


Glint angle provided for red, green & blue bands



2018 01 03 02:15:15 UTC

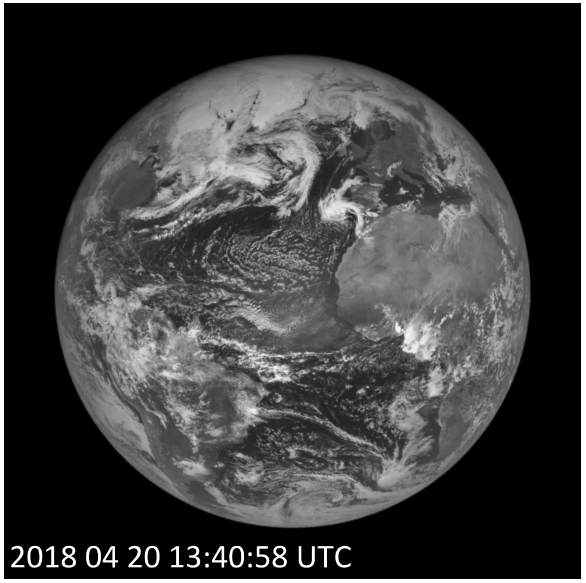
Glint angle varies with DSCOVR-Earth distance

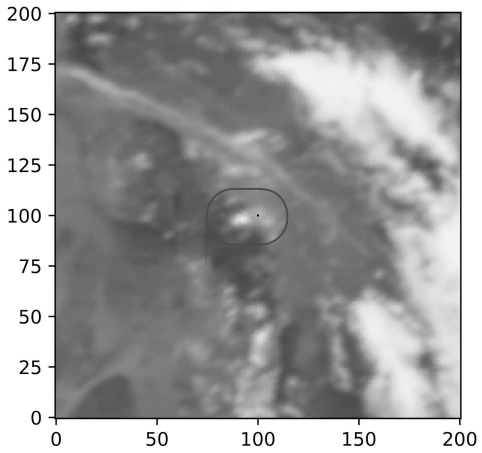


Surface type in glint product

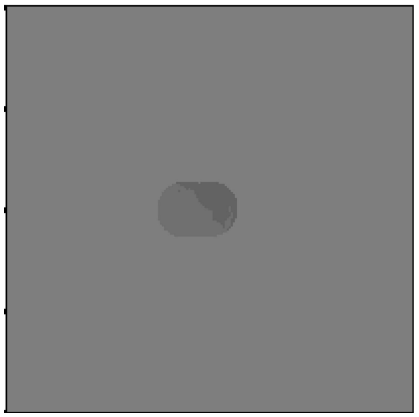
Surface type helps:

- Is glint from surface likely?
- What colors we can expect without glint?





Source:
MODIS land cover type product



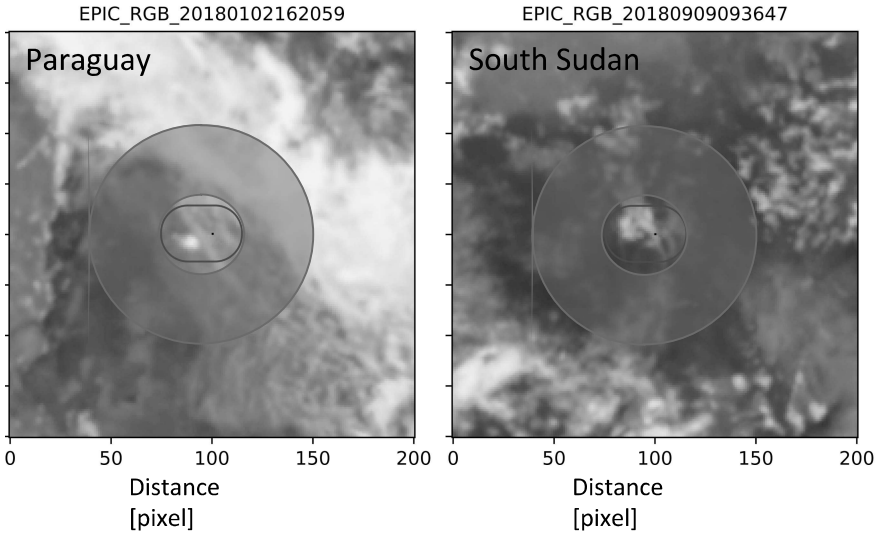
Water

Non-desert land

Desert

2018 01 03 02:15:15 UTC

Glint mask: basis for glint detection



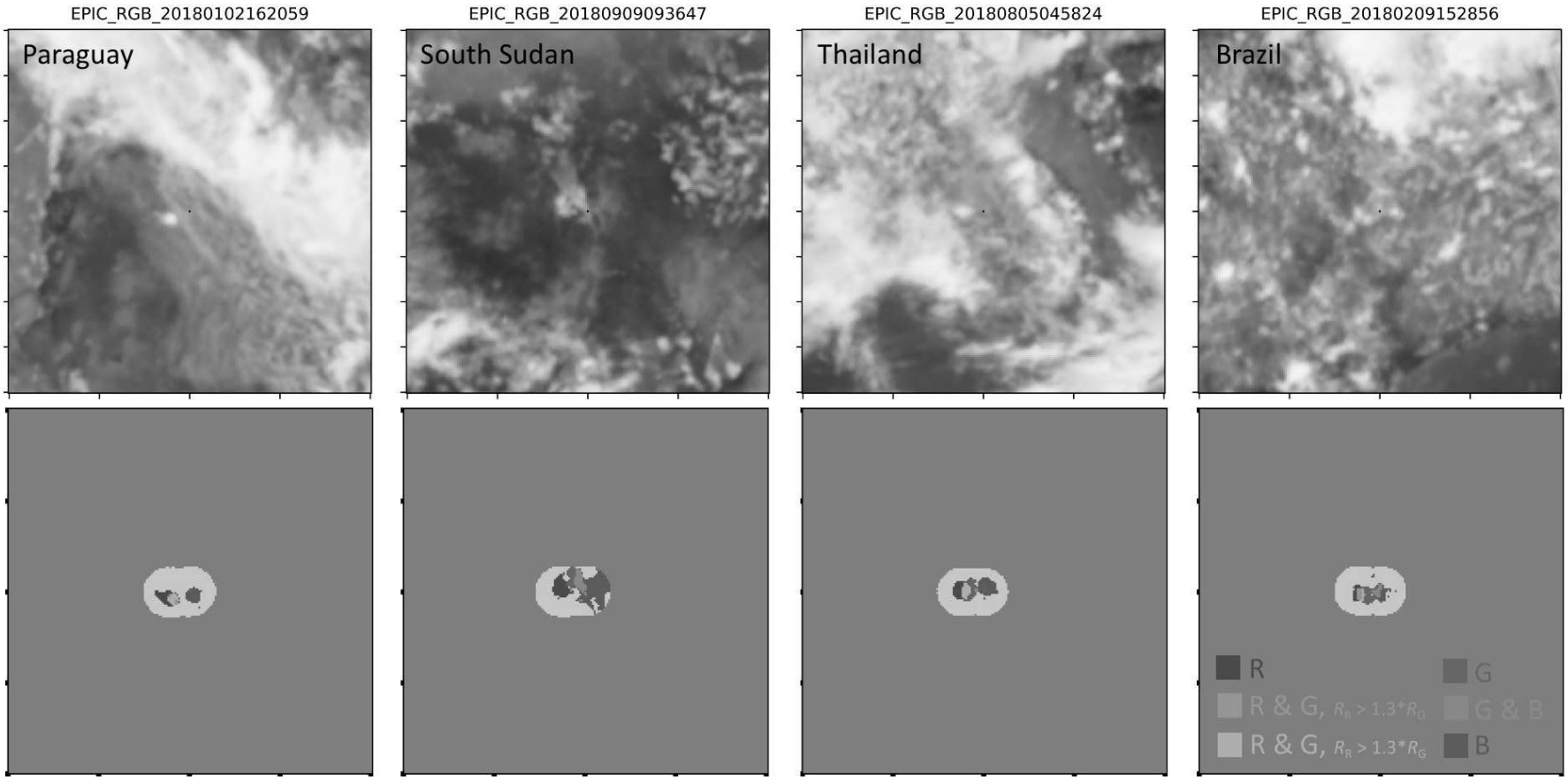
	Enhanced by glint		No glint
Red glint:	R_{red}	>>	R_{blue}, R_{green}
Green glint:	R_{green}	>>	R_{blue}, R_{red}
Blue glint:	R_{blue}	>>	R_{red}, R_{green}
Yellow glint:	R_{red}, R_{green}	>>	R_{blue}

Use statistical analysis to obtain threshold values

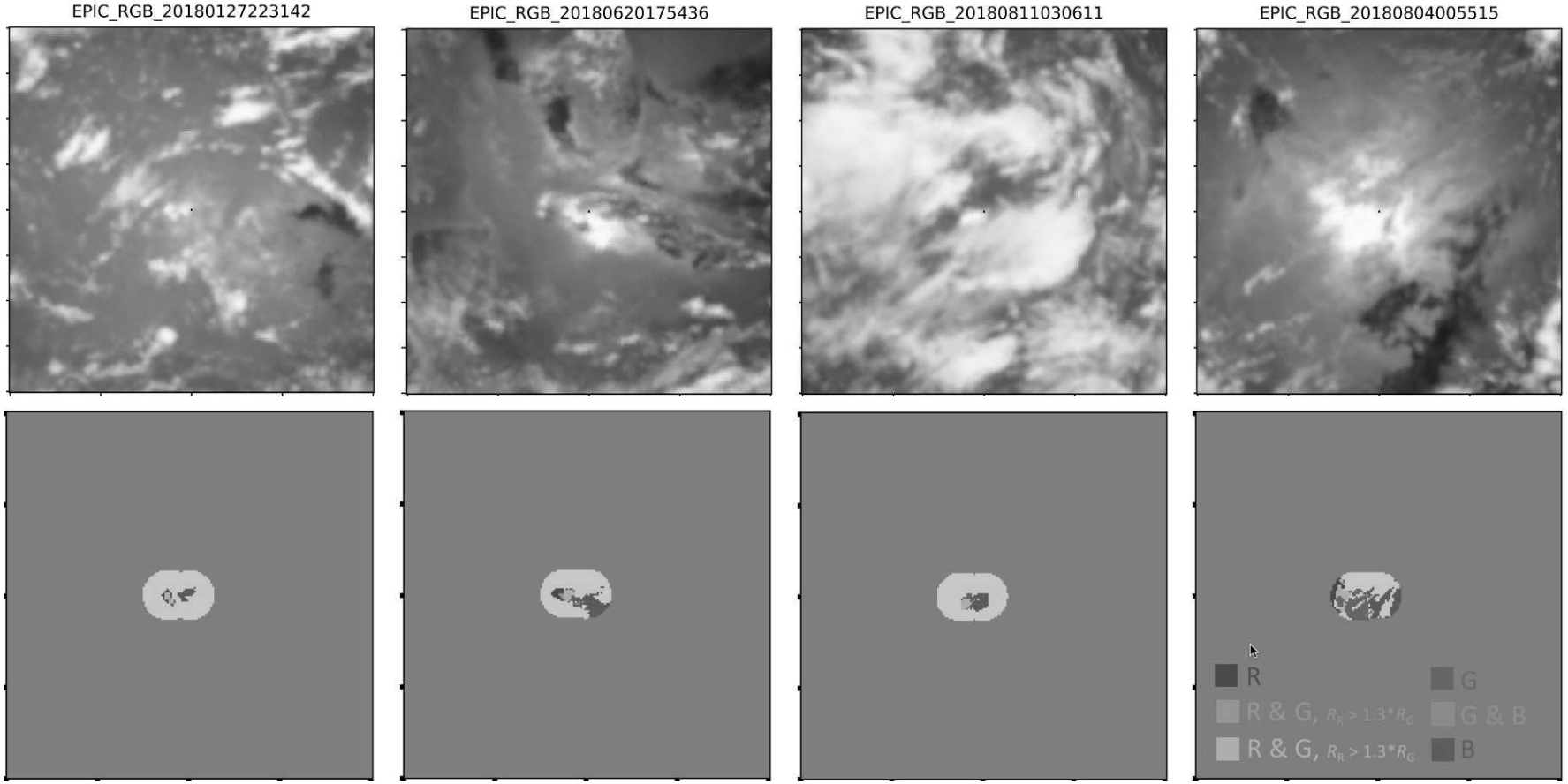
Red glint detection:

Given R_{blue}, what R_{red} is likely in (green) no-glint areas?

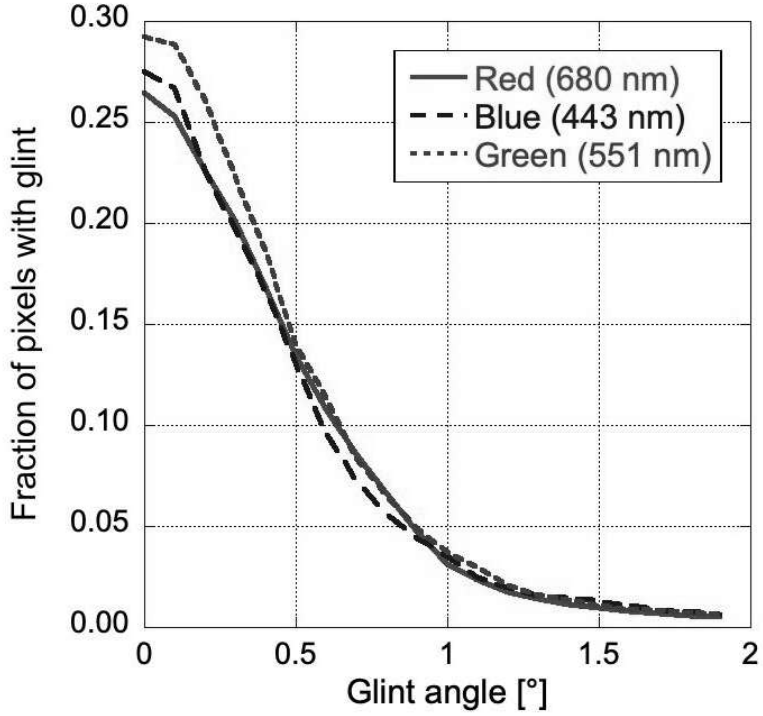
Glint mask: examples over land



Glint mask: examples over water



Glint detection frequency drops with glint angle



All EPIC data over non-desert land during 2017

Plans

Improve and expand glint product, for example to

- Distinguish cloud and surface glints using O_2 absorption bands
- Estimate reflectance enhancement caused by glints
- Expand uncertainty estimates (esp. on missed glints)

Use glint data to improve our understanding of tropical ice clouds

- Prevalence, size, seasonal and diurnal cycle, radiative effect of horizontal crystals

Summary

The recently released EPIC glint product identifies glints from clouds and smooth water surfaces.

The analysis of the glint product is expected to yield new information on tropical ice clouds (horizontally oriented ice crystals affecting cloud albedo, lifetime, microwave remote sensing) and may help other studies (e.g., on aerosol absorption).