

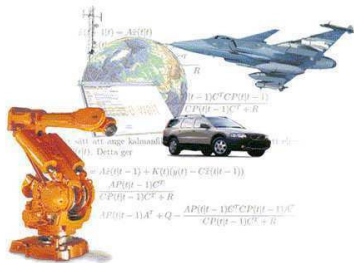
A Voyage to Africa by Mr Swift

Geolocation using light levels

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Lund University



Mr Swift

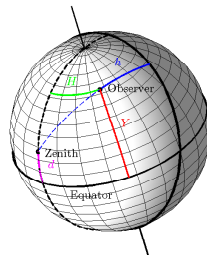
- Common swift, *Apus apus*. Weight: 40 g
- Equipped with light logger (light sensor, battery, memory, clock).
Weight: 2g
- Released on Aug. 5, 2010, found 298 days later



We want to track Mr Swift!



Light levels

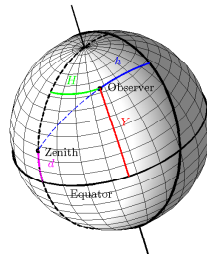
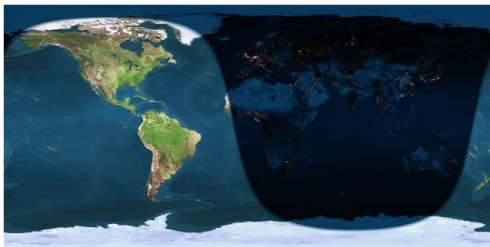


State of the art:

- Compute time for sunrise and sunset
- For each time instance convert to
 - Midday (gives longitude)
 - Day length (gives latitude)



Light levels



Nonlinear filtering solution

- Measurement update at each sunrise and sunset
- Motion model with two modes (stationary and migration mode).
- Solve with a marginalized particle filter.



Contribution

- Light levels localizing animals has been used since the 80's
- Nonlinear statistical filtering has also been used for a while.
- Not much has been done combining the two.

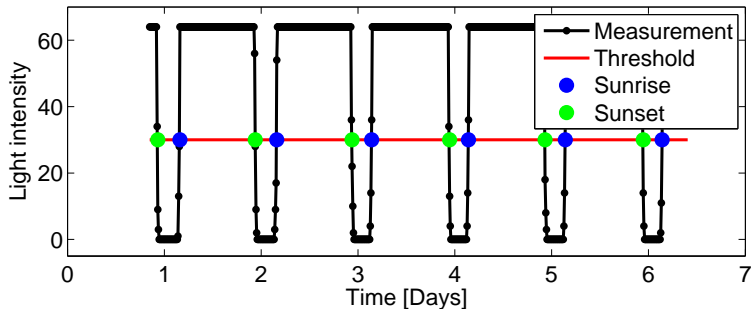
Contribution:

Using light levels in a statistical filtering framework.



Light intensity data

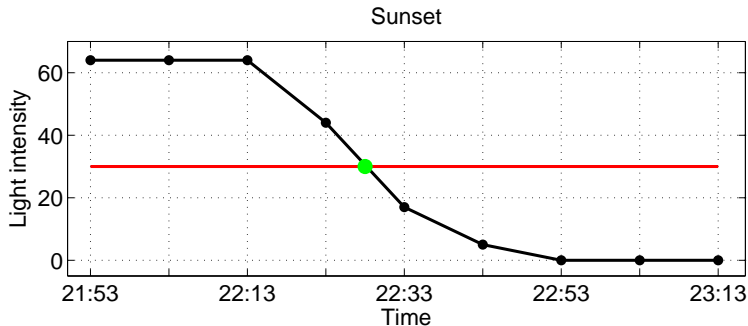
- Sampling time: 10 minutes.
- Resolution: 6 bits ($2^6 = 64$ values)
- Saturated for both low and high values.



Light intensity data

Some problems

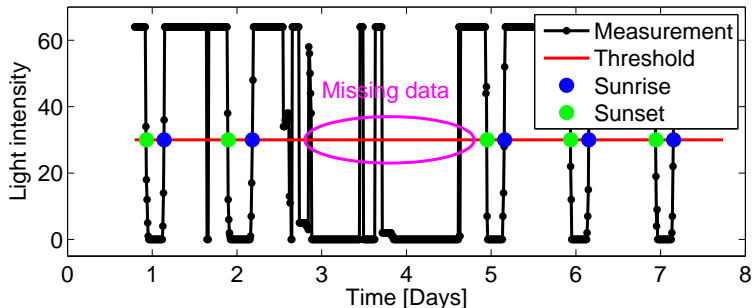
- The event will shift several minutes depending on the threshold.
- Will also depend on weather conditions and geographic environment.



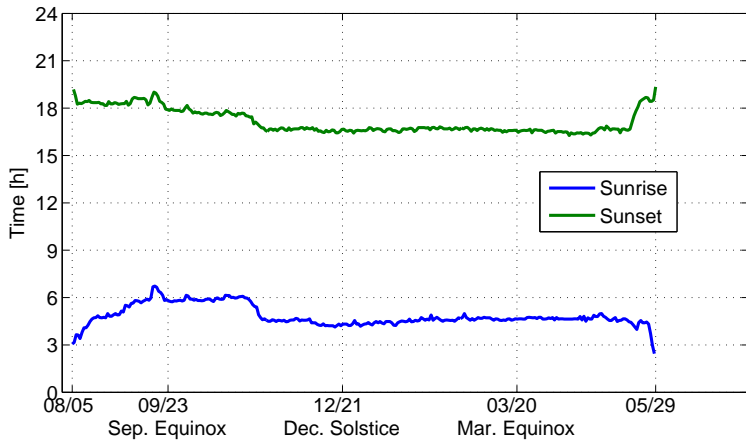
Light intensity data

More problems

- If the bird is hidden during sunrise and/or sunset, it might cause missing data.

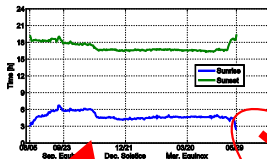


Sunrise and sunset



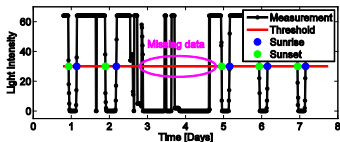
The data

Sunrise and sunset events

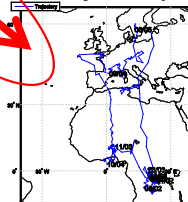


This work

Light intensity data

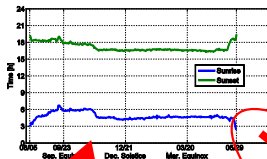


Trajectory



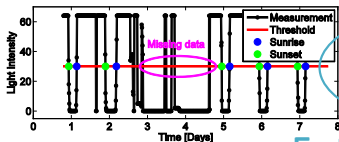
The data

Sunrise and sunset events



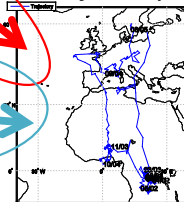
This work

Light intensity data



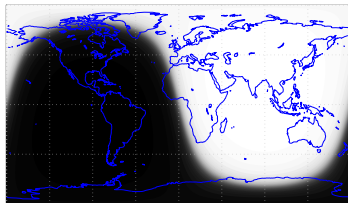
Future work

Trajectory

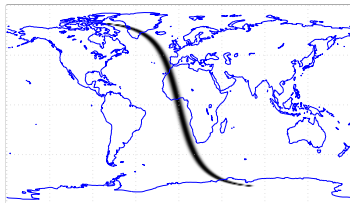


The likelihood - May 6

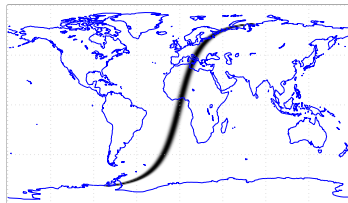
Daylight map, 06-May-2011 06:00:00



Likelihood, sunrise, 06-May-2011 06:00:00

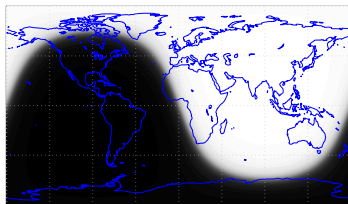


Likelihood, sunset, 06-May-2011 18:00:00

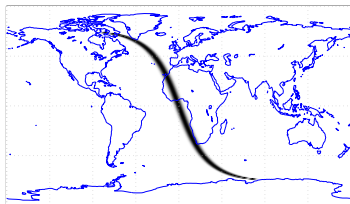


The likelihood - Summer solstice

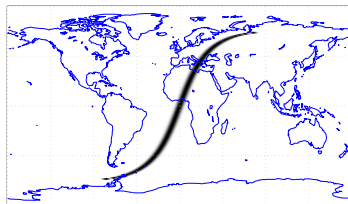
Daylight map, 21-Jun-2011 06:00:00



Likelihood, sunrise, 21-Jun-2011 06:00:00

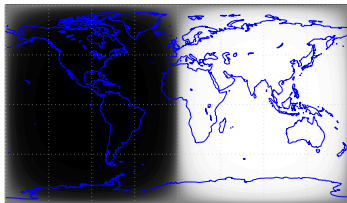


Likelihood, sunset, 21-Jun-2011 18:00:00

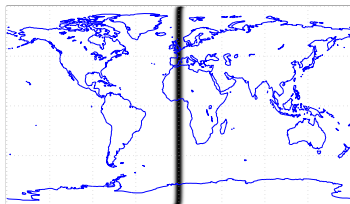


The likelihood - Autumn equinox

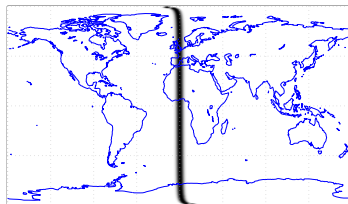
Daylight map, 21-Sep-2011 06:00:00



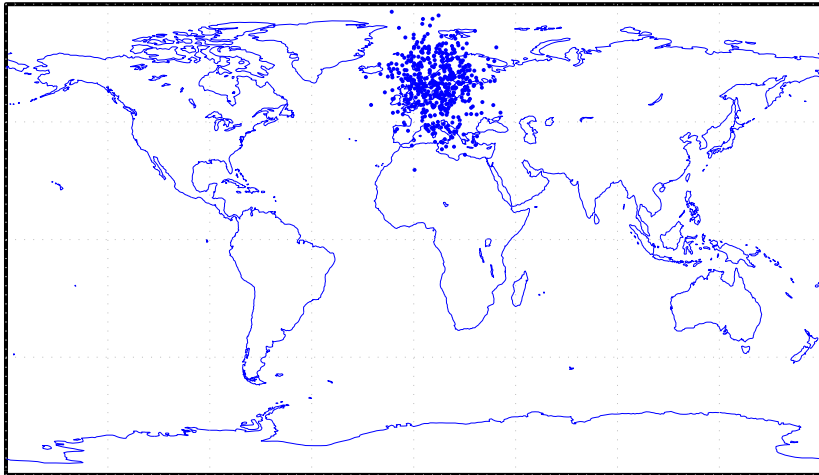
Likelihood, sunrise, 21-Sep-2011 06:00:00



Likelihood, sunset, 21-Sep-2011 18:00:00

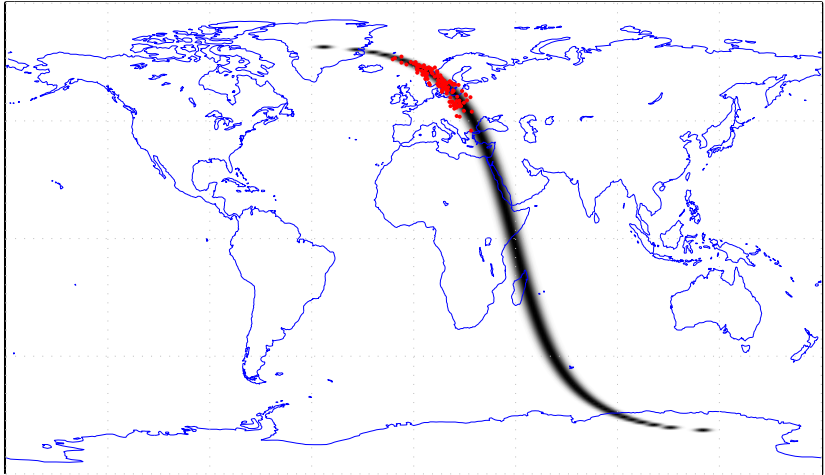


Prior

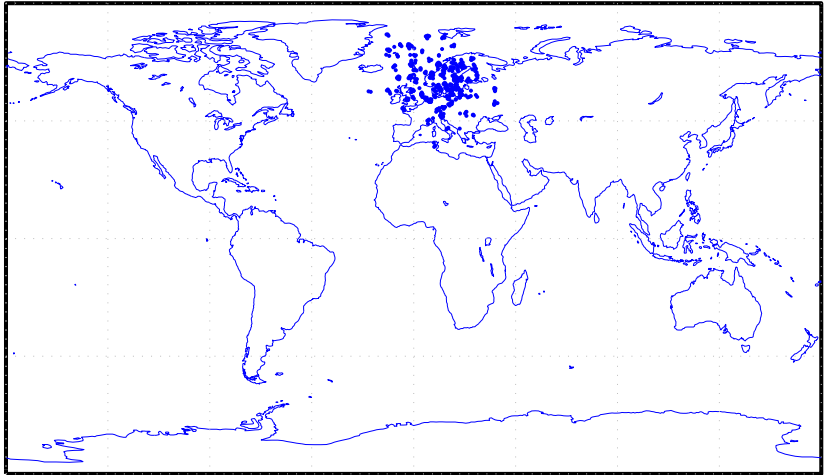


Measurement update - sunrise.

Time: 05-Aug-2010 03:04:00

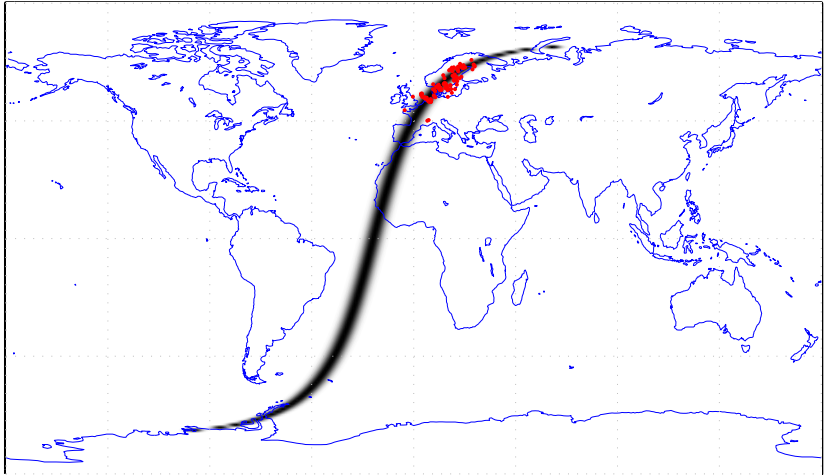


Time update.
Time: 05-Aug-2010 19:10:59

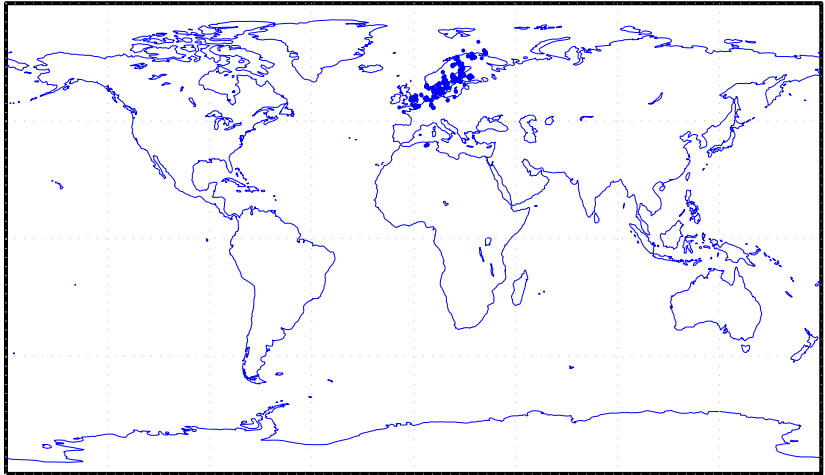


Measurement update - sunset.

Time: 05-Aug-2010 19:11:00

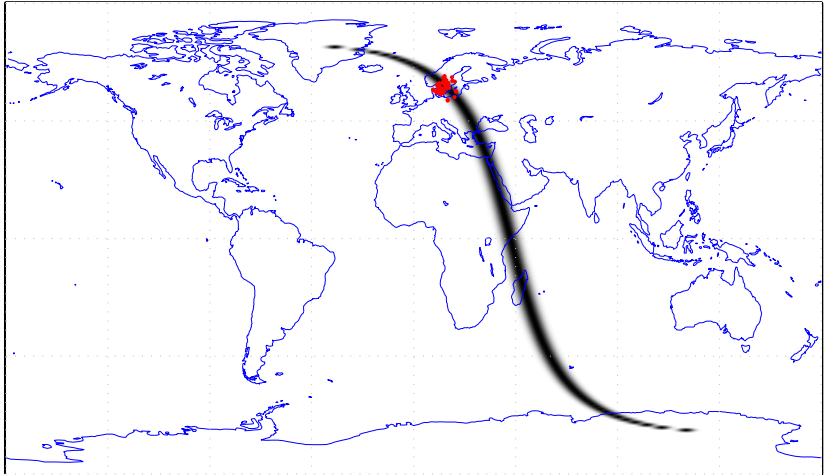


Time update.
Time: 06-Aug-2010 03:08:59

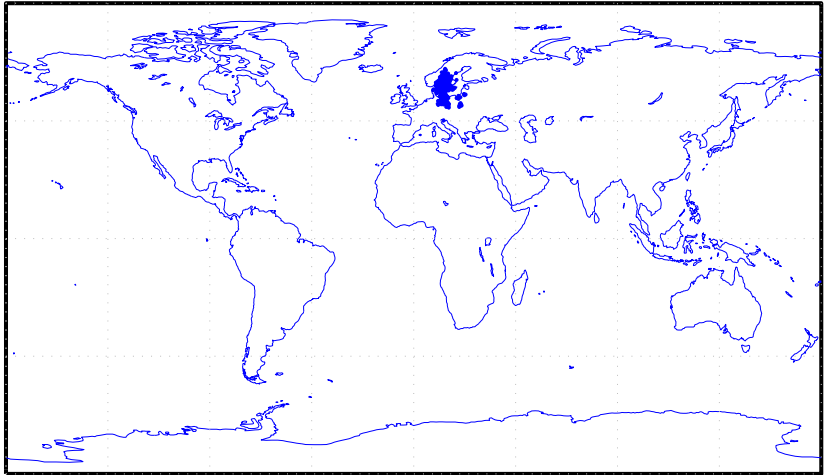


Measurement update - sunrise.

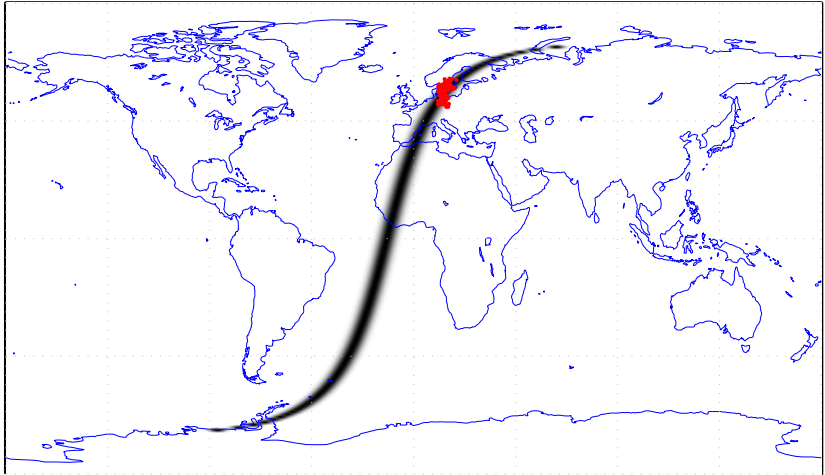
Time: 06-Aug-2010 03:09:00



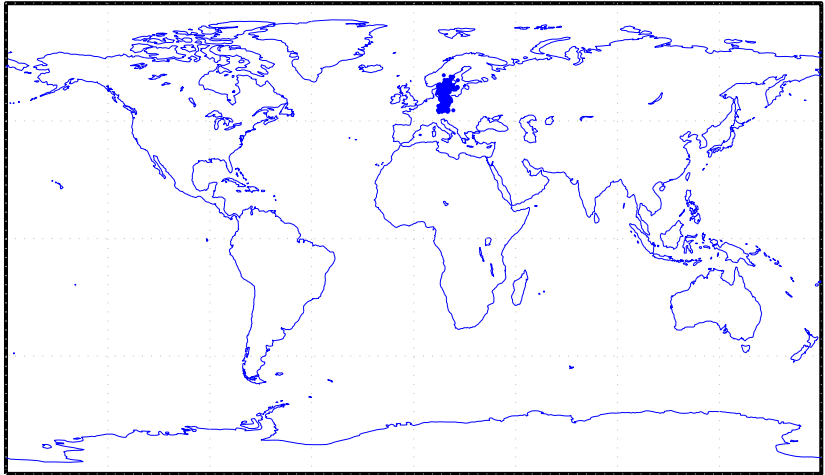
Time update.
Time: 06-Aug-2010 18:46:59



Measurement update - sunset.
Time: 06-Aug-2010 18:47:00



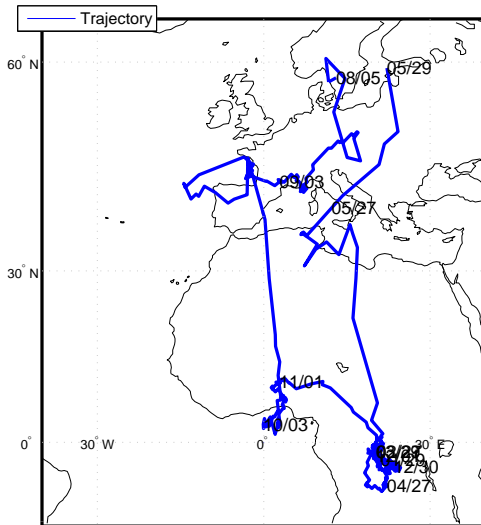
Time update.
Time: 07-Aug-2010 03:38:59



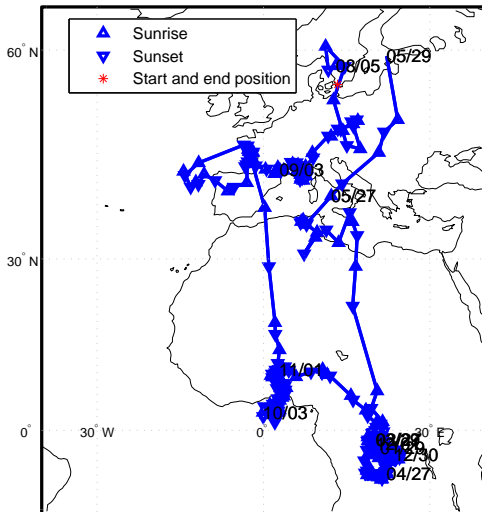
Animation



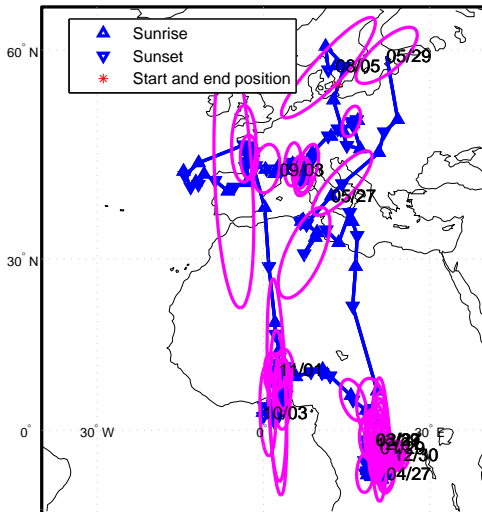
The Voyage



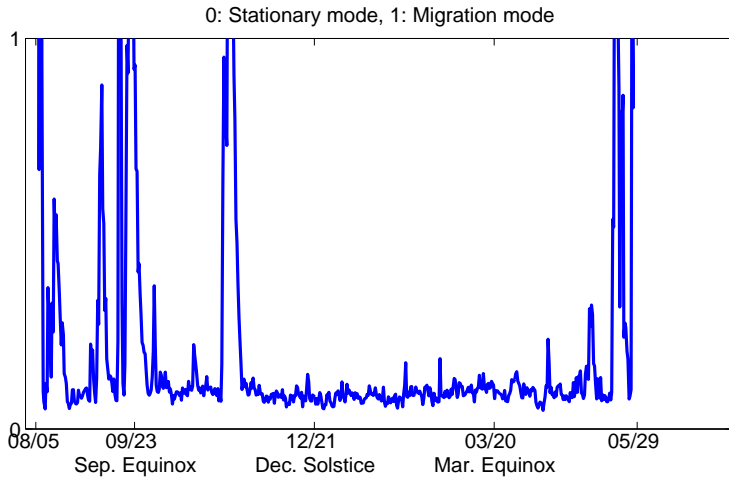
The Voyage



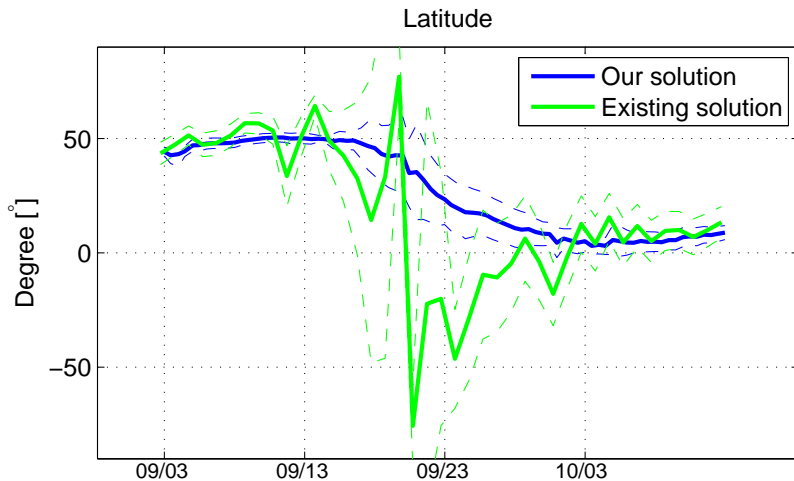
The Voyage



The estimated mode



Comparison



Summary and future work

Summary

- Tracking using light levels
- Measurement update at each sunrise and sunset
- Applied on real world data

Future work

- Do smoothing
- Process light intensity data, handle missing data, false alarms etc.
- Validate on data with ground truth (GPS mounted on heavier birds)

