Australian National University

ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Evaluating Fog Detection Using Himawari-8 Satellite Imagery and Bispectral Image Processing

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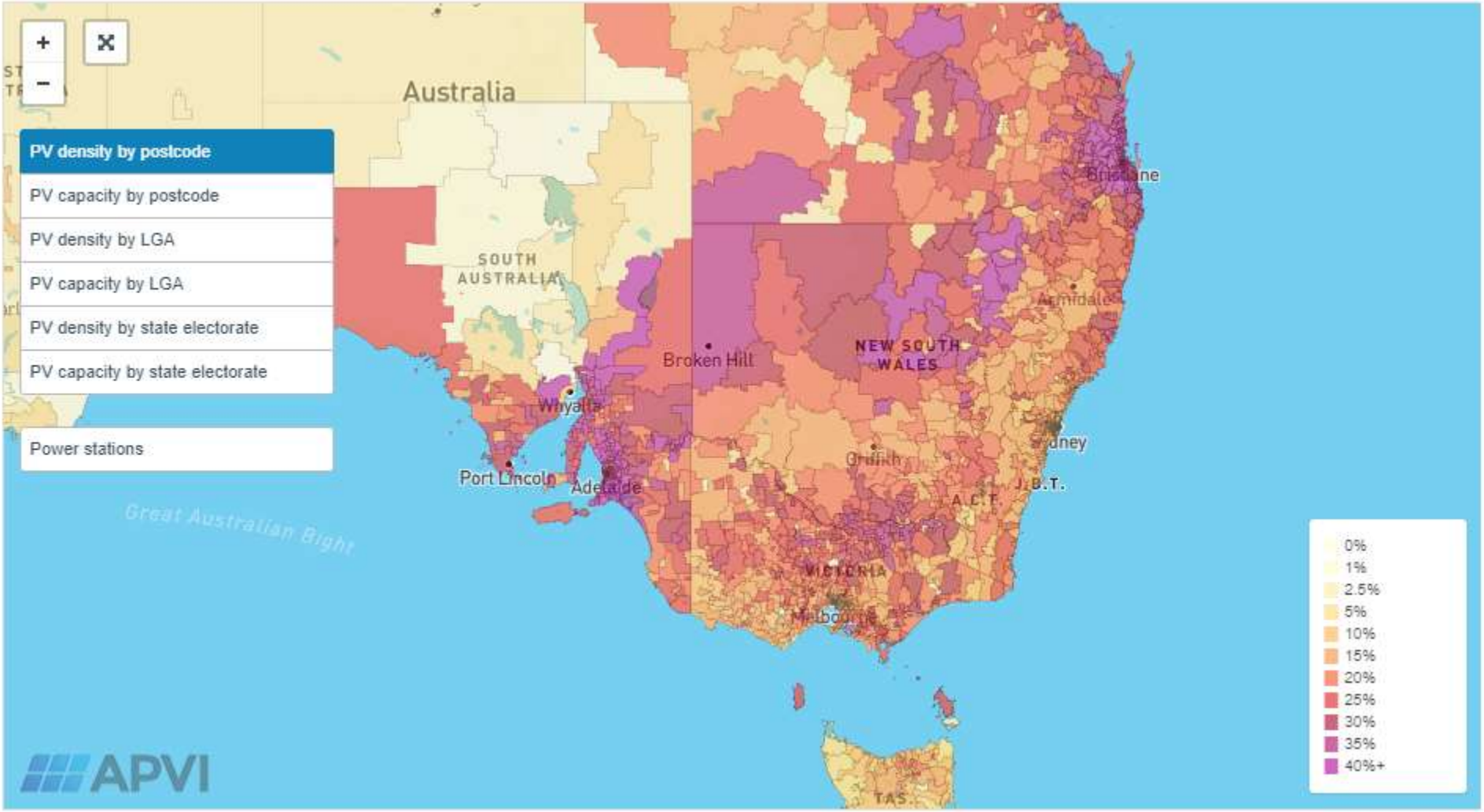
Momentum: Residential PV penetration

Very high compared to elsewhere in the world.



The Project at ANU

$4M Project, ARENA & Industry backed [2016-2019]

Australian Government
Australian Renewable Energy Agency
ARENA

Delivering solar PV forecasts to participating distribution network service providers (DNSPs).

End Goal: Enable higher penetrations of solar in Australian distribution networks

AusNet services
United Energy
Horizon Power
Endeavour Energy
TasNetworks
CitiPower
Powercor Australia
evoenergy
Ergon Energy
essential energy
SA Power Networks
PowerWater
western power

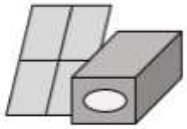
Distribution Network Service Providers (DNSPs) partnered with the project

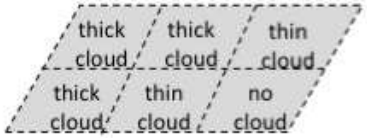
Australian National University

ANU Partnership with Solcast

SOLCAST

Solar Forecasting Engine





Himawari 8 Satellite
0-6 hours
1km² at 10min

Numerical Weather Model Ensemble
6-168 hours (7 days)
30 minute

Probabilistic Radiation Forecast

PV Power Model

Inputs: Metadata & Forecast Radiation
Output: PV Power & Probability

PV Power Forecast Aggregation

Network API Service

Call: Zone/Feeder/ Transformer ID
Return: Aggregated PV Power at Asset

Raw Data via DNSP Connection Agreements

Data Processing

DNSP PV Data

Database
Small-scale Solar by Network Asset

Solar Metadata

DNSP Delivery

API Key
Make Call, Get PV Forecast By Network Asset of Interest

My role with ANU

Research and Development

In depth research objectives to improve solar forecasting

DNSP Feedback

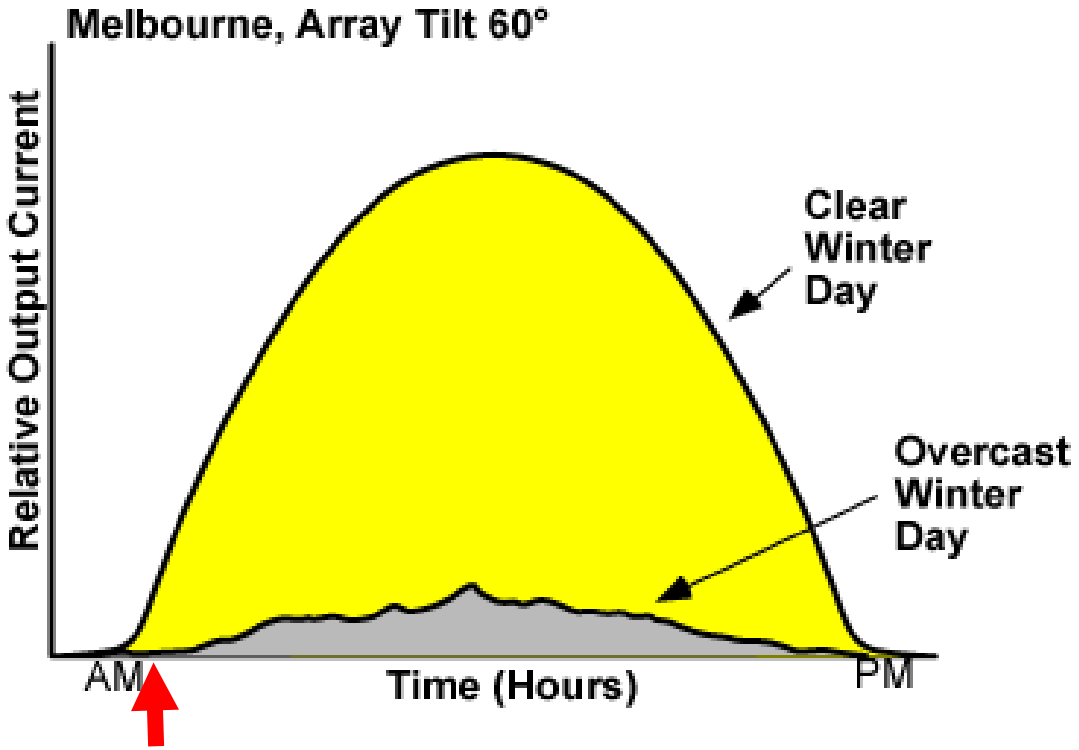
Research Question

Look into whether fog events can be identified and forecasted through satellite imagery?

evoenergy

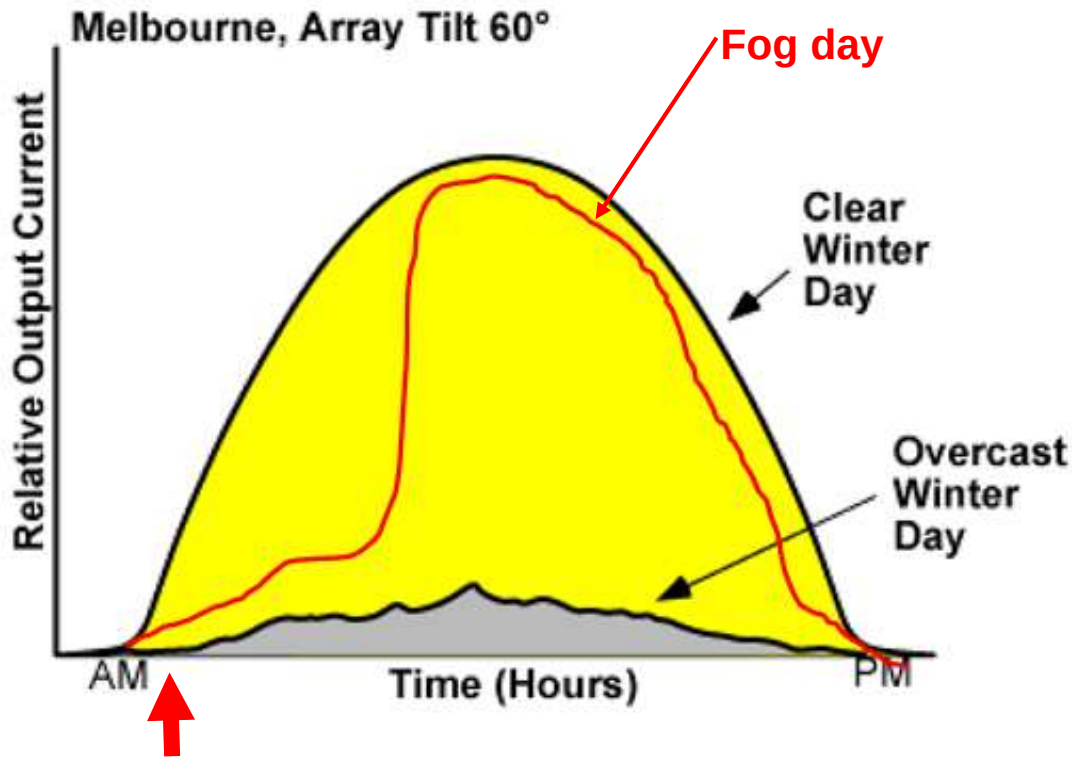
Canberra experiences more fog events than any other city in Australia

Cloud Impacts on PV



Day ahead forecast occurs here and every 10 minutes after

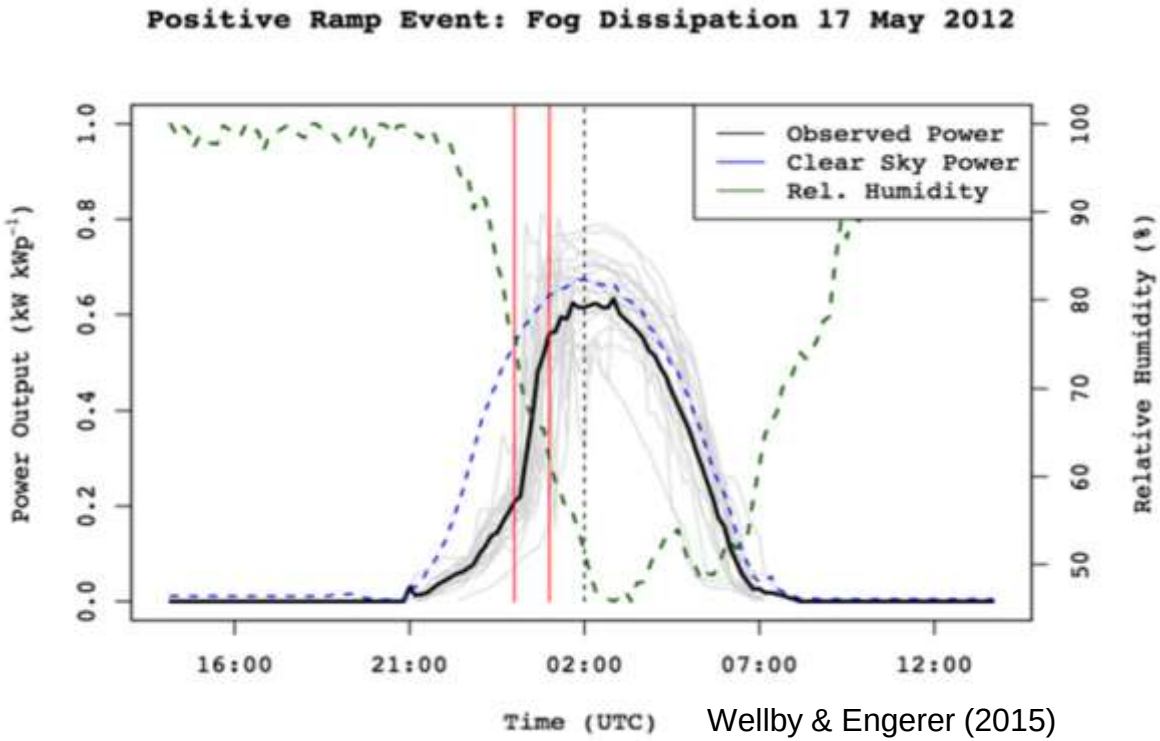
Fog Impacts on PV



Day ahead forecast occurs here and every 10 minutes after

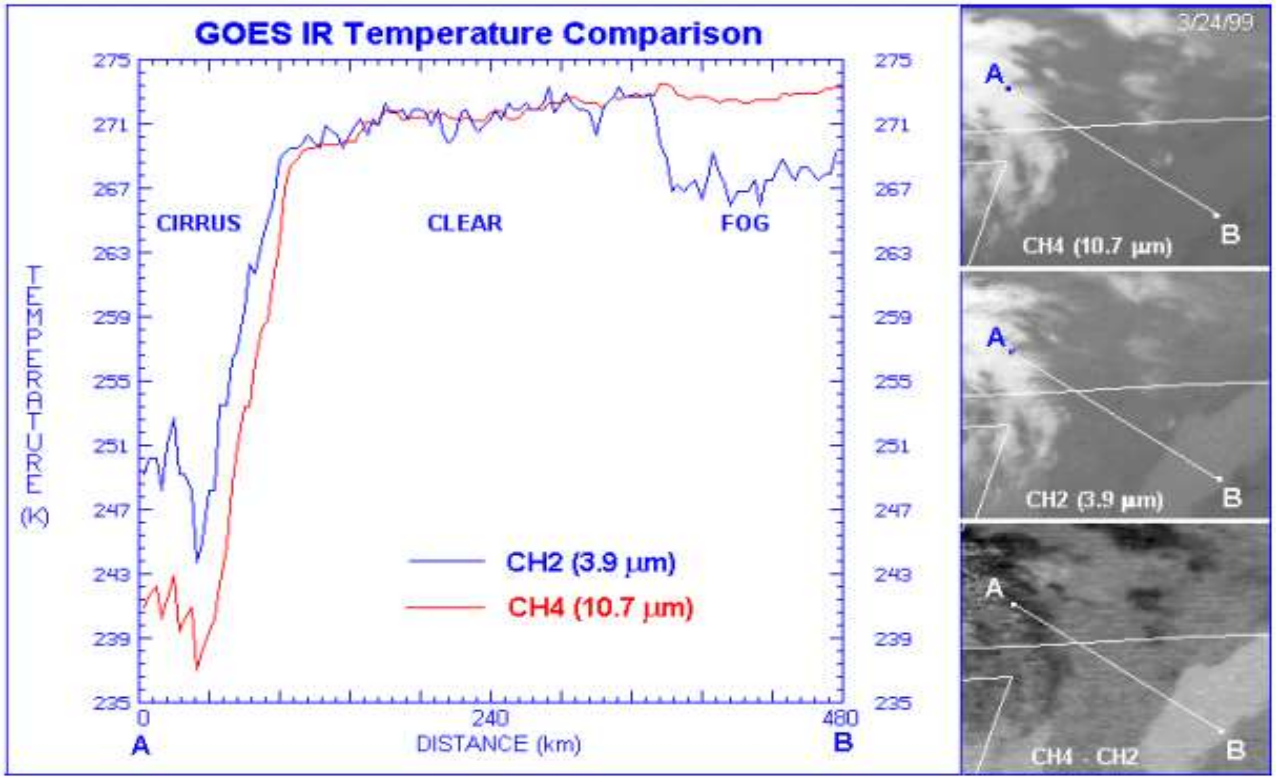
Why not just categorise as a cloud?

- Unlike most clouds, fog is static
- Fog dissipates rapidly, known to cause power ramp events
- If categorised as cloud, grid load planning, battery management and solar forecasts can be inaccurate.



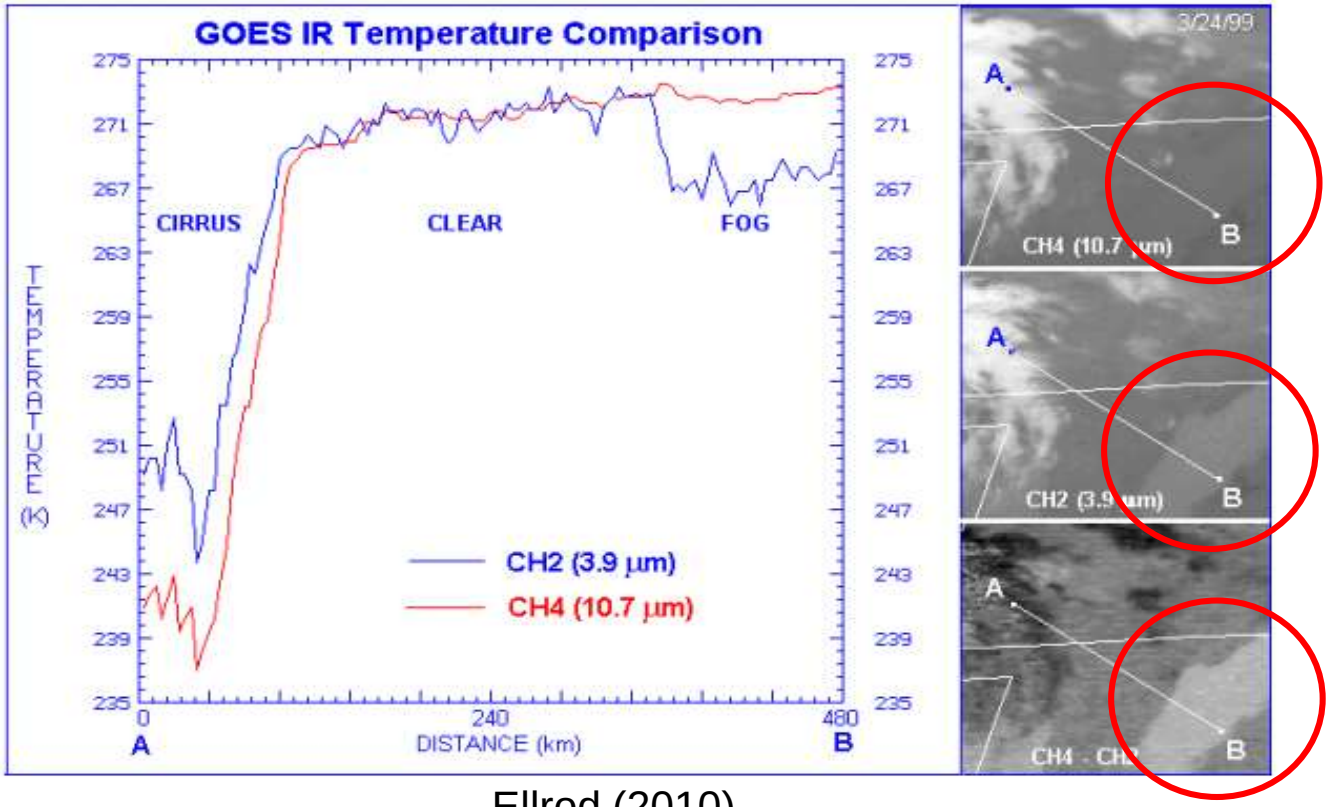
Wellby & Engerer (2015)

Bispectral Image Processing (BIP)



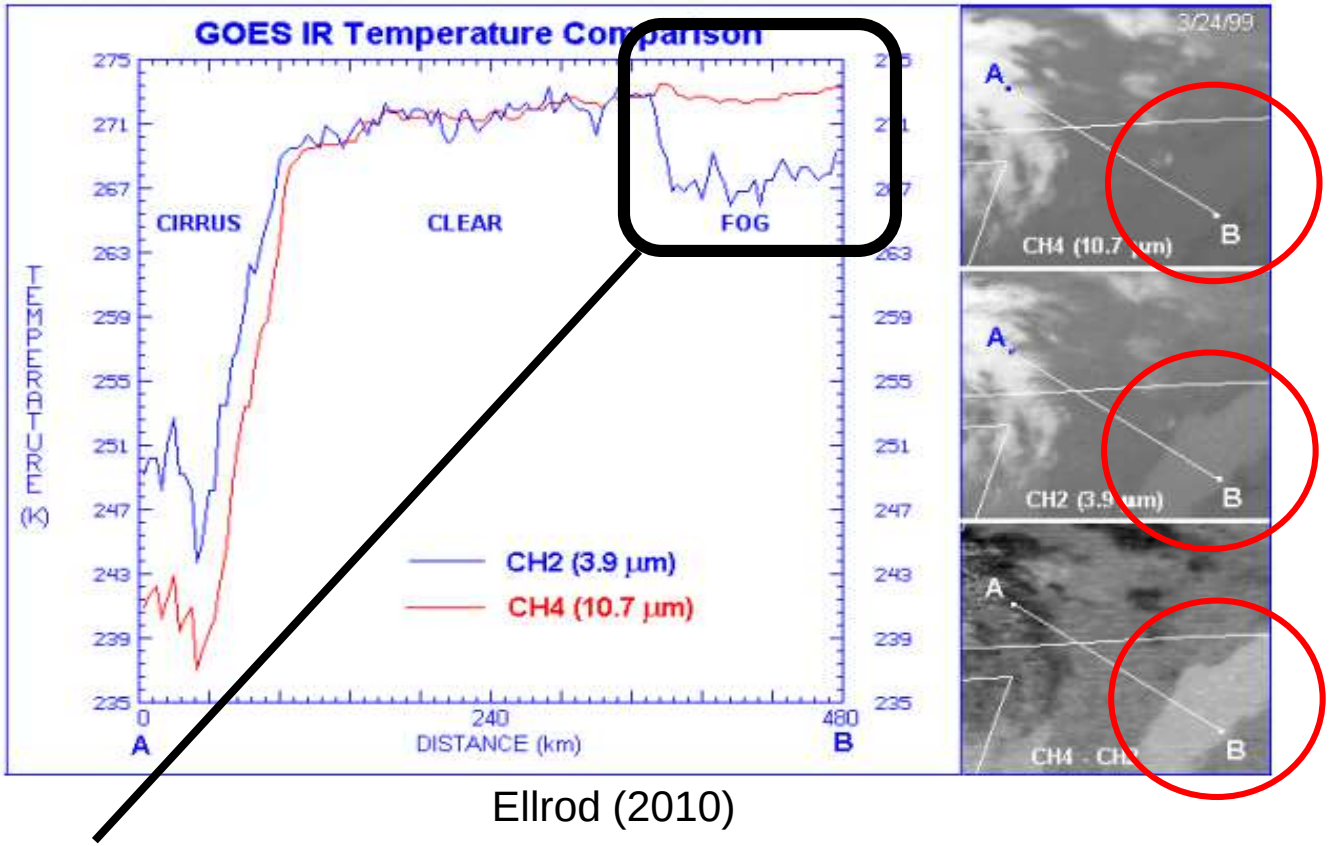
Ellrod (2010)

Bispectral Image Processing (BIP)



Ellrod (2010)

Bispectral Image Processing (BIP)



Ellrod (2010)

"small but sufficient to provide clear discrimination"

Our Methodology

Time-Step Statistic

- Mean pixel value
- Median pixel value
- 25th percentile pixel value
- Individual pixel value

Our Methodology

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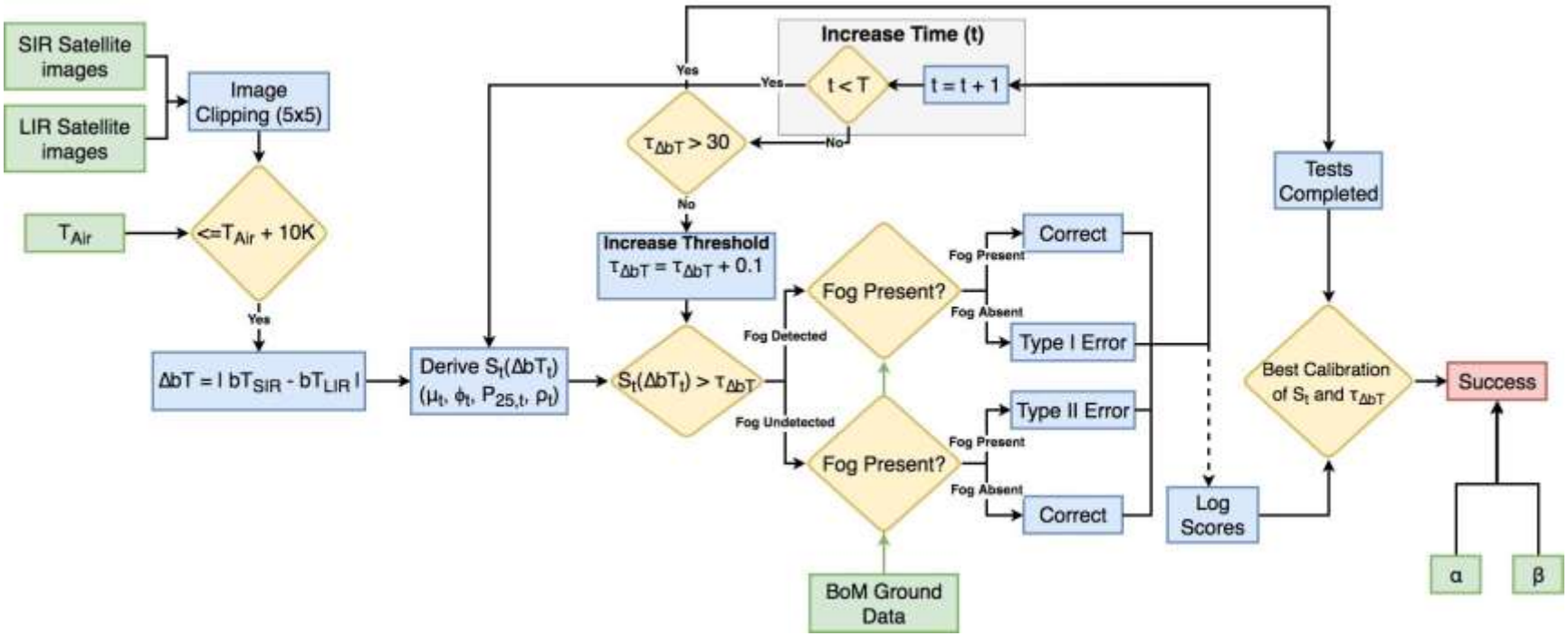
Threshold Comparison

- 0 : 0.1 : 30 K
- 301 threshold values tested

Our Methodology



Simulation Outcomes

Correct (=1)

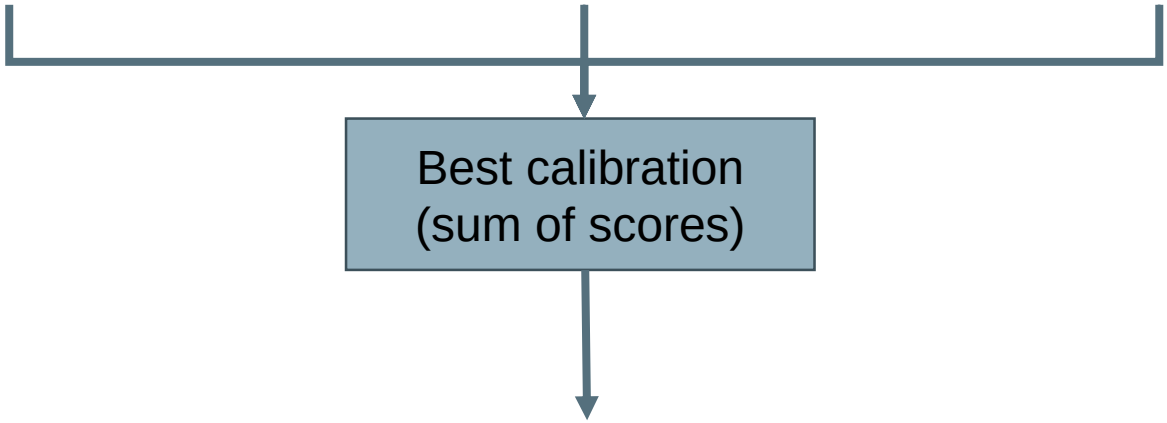
- Fog detected & fog present
- Fog undetected & fog absent

Type I Error
False-Positive (=-1)

- Fog detected & fog absent

Type II Error
False-Negative (=-1)

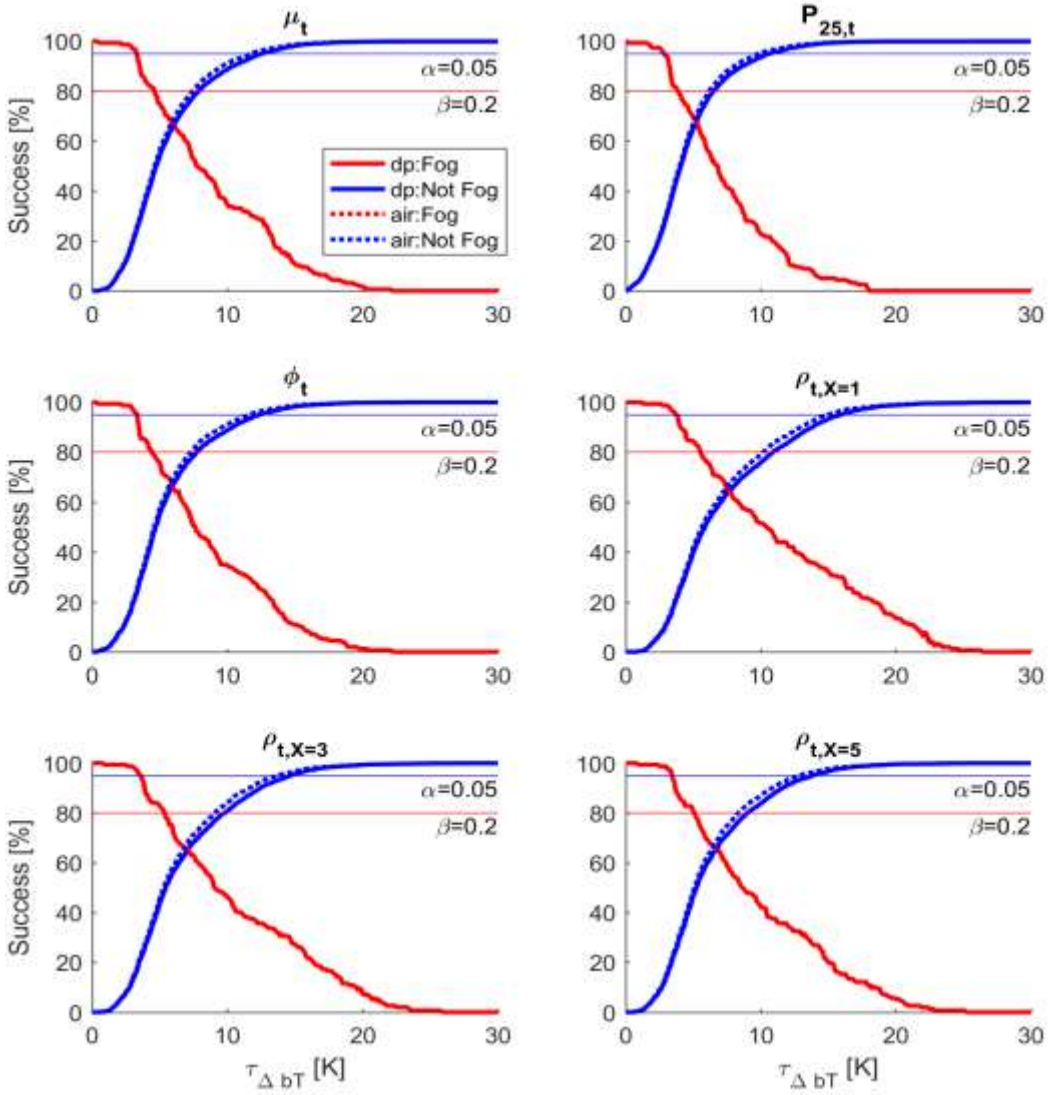
- Fog undetected & fog present



The 25th percentile with a threshold value of 5.2K gave us the best result.

?

Results


μ_t
$P_{25,t}$
ϕ_t
$\rho_{t,X=1}$
$\rho_{t,X=3}$
$\rho_{t,X=5}$
α=0.05
β=0.2
dp:Fog
dp:Not Fog
air:Fog
air:Not Fog
Success [%]
$\tau_{\Delta\ bT}$ [K]

Key Findings

- The BIP method works in clear sky conditions, however the addition of a cloud detection strategy is required.
- Removal of time-steps where cloud is known to be present above recorded fog.
- Integration of cloud motion vectors could help identify cloud presence, ultimately discounting those pixels from fog analysis.
- Feedback from DNSPs: There is potential that 70% accuracy in overall detection may be sufficient for operational implementation to some extent.

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