Remotely judging the weather on MK
“How does Gemini do it?”

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What is weather?

1.) Astronomical 'weather'

2.) Telescope 'weather'
What is weather?

1.) Astronomical 'weather'
   - Cloud Cover (CC)
   - Seeing (IQ)
   - Water vapour (WV)
   - Background (BG)

2.) Telescope 'weather'
What is weather?

1.) Astronomical 'weather'
- Cloud Cover (CC)
- Seeing (IQ)
- Water vapour (WV)
- Background (BG)

2.) Telescope 'weather'
- Humidity/fog/valley clouds
- Low/rain clouds (above or maybe close to dome)
- Ice, snow, sleet, ...
- Dust
- Wind
Our approach in going remote?

- replace any 'going outside' with new tools
- our goal: new tools are as good or better as before
- not goal: upgrade all of our old tools
How do we sense it?

➲ **Cloud Cover:**

- **Ext. tools:**
  - CFHTs ASIVA, skyprobe, cloudCam, Kecks cosmic camera

- **Our old tools:**
  - guide counts
    - only rough estimate unless clear patch in between
    - need to disentangle seeing effects
  - quick analysis pipeline (QAP) for GMOS img → not fully comm.
  - check outside: eye → takes time to adapt
    - NVG → thin, slow moving clouds hard to spot
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Our new tools:
  - 5 cloudCams (N/S/W/E and South-up)
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CloudCam movies are even better than being outside
How do we sense it?

Image Quality:

- Ext. tools:
  - CFHTs tower DIMM
  - ask around (phone, Slack)

- Our old tools:
  - calibrated guider (Altair)
  - uncalibrated guiders → rough idea + trend
  - measurements (e.g. QAP) on images/spectra → delivered IQ

- Our new tools:
  - none
  - should we put our measurements on webpage?
How do we sense it?

Water Vapour:

- Ext. tools:
  - CSO 225 GHz corrected
  - if CSO down, we use JCMT

- Our old tools:
  - none

- Our new tools:
  - none
How do we sense it?

Background:

- Ext. tools:
  - none

- Our old tools:
  - calculated from model (sun, moon, target)
  - quick analysis pipeline (QAP) for GMOS img → not fully comm.

- Our new tools:
  - none
How do we sense it?

➲ Humidity/fog/valley clouds:

- Ext. tools:
  - rel. humidity measurements of other telescopes (CFHT/UKIRT)

- Our old tools:
  - check outside: touch metal → very easy to spot condensation
    flashlight → very efficient to spot fog
  - check in dome: touch metal
- **Our old tools:**
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- **Our new tools:**
  - 2 new humidity sensors to E/W of our support building
  - East cloudCam is actually HiloCam → rolling in clouds easily seen
  - fogCamera plus flashlight (East) → still able to spot East fog
How do we sense it?

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East fog covered pretty well, but humidity (condensation) not so
How do we sense it?

- **Low/rain clouds:**
  - Ext. tools:
    - humidity sensor on top of CFHT dome
    - ask around (phone, Slack)
  - Our old tools:
    - check outside: twilight → easy to look for mammatus clouds
      flashlight → very hard to spot clouds above dome
    - twilight: roofCam
How do we sense it?

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- **Our new tools:**
  - 4 precipitation sensors on our support building
  - twilight: fogCam, UH88Cam, CFHTCam
  - night: 5 cloudCams
How do we sense it?

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  - humidity sensor on top of CFHT dome
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rare; warning less good, but start even better detected
How do we sense it?

Ice, snow, sleet ...:

- **Ext. tools:**
  - ice road monitor at UKIRT
  - ask around (phone, Slack)

- **Our old tools:**
  - check outside: ice on railing (~3mm) → linked to ice on dome
  - check outside: ice on road → decision to evacuate
  - dayCrew inspects dome → only M-F and start of night
  - twilight: roofCam
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- **Our new tools:**
  - snow and ice sensor on our support building
  - twilight: UH88Cam, CFHTCam
  - night: fogCam + flashlight onto E.-weather station
    UH88Cam + fogCam flashlight
How do we sense it?

- Ice, snow, sleet ...

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    - night: fogCam + flashlight onto E.-weather station
    - UH88Cam + fogCam flashlight

harder to spot, so more conservative, but crew safe
How do we sense it?

Dust:

- Ext. tools:
  - none

- Our old tools:
  - particle sensor → only inside, uncalibrated (see Sunny's talk)
  - check outside: particles (thick) in flashlight
  - check outside: 'dust in mouth' → time to close
  - check in dome: flashlight, wiped CDROM
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- **Our new tools:**
  - fogCam + flashlight
  - (domeCams + light)
How do we sense it?

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  - (domeCams + light)

*not very well at summit, worse from down here*
How do we sense it?

Wind:

- Ext. tools:
  - CFHT weather tower, UKIRT windspeed

- Our old tools:
  - anemometer inside dome (at M1/M2)

- Our new tools:
  - none
Conclusions

➲ No need to be at summit (as the others proved well before)
➲ CloudCam movies beats being up there
➲ CloudCam movies show ASIVA not 100% but ~98%
➲ Need to be more conservative
  ● more downtime, less pushing limits
  ● but, most timeloss is bad weather data anyway
➲ Dust monitoring is weakest link
➲ Leaky shutter plus run-off requires tricky remote dome drain