Cloud CCI Uncertainty

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Cloud CCI Uncertainty

- All cloud CCI algorithms use Optimal Estimation so can propagate uncertainty to pixel level.
- Significant sources of uncertainty
  - Many are random
  - Many are systematic
- Not all are currently addressed
  - Currently addressed: measurement noise, surface, some forward model uncertainty
- Lots of work has gone on to minimise potential sources on uncertainty

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Sources of uncertainty

- Calibration
  - Particularly of the visible channels
    - Uncertainty, offset, drift, noise
- Assumptions on the cloud vertical structure
  - Multi layer cloud, mixed phase cloud, view angle dependence
- Assumptions associated with an inhomogeneous cloud field
  - Shadowing, edge effects, sub pixel cloud
- Misidentification of aerosol and cloud

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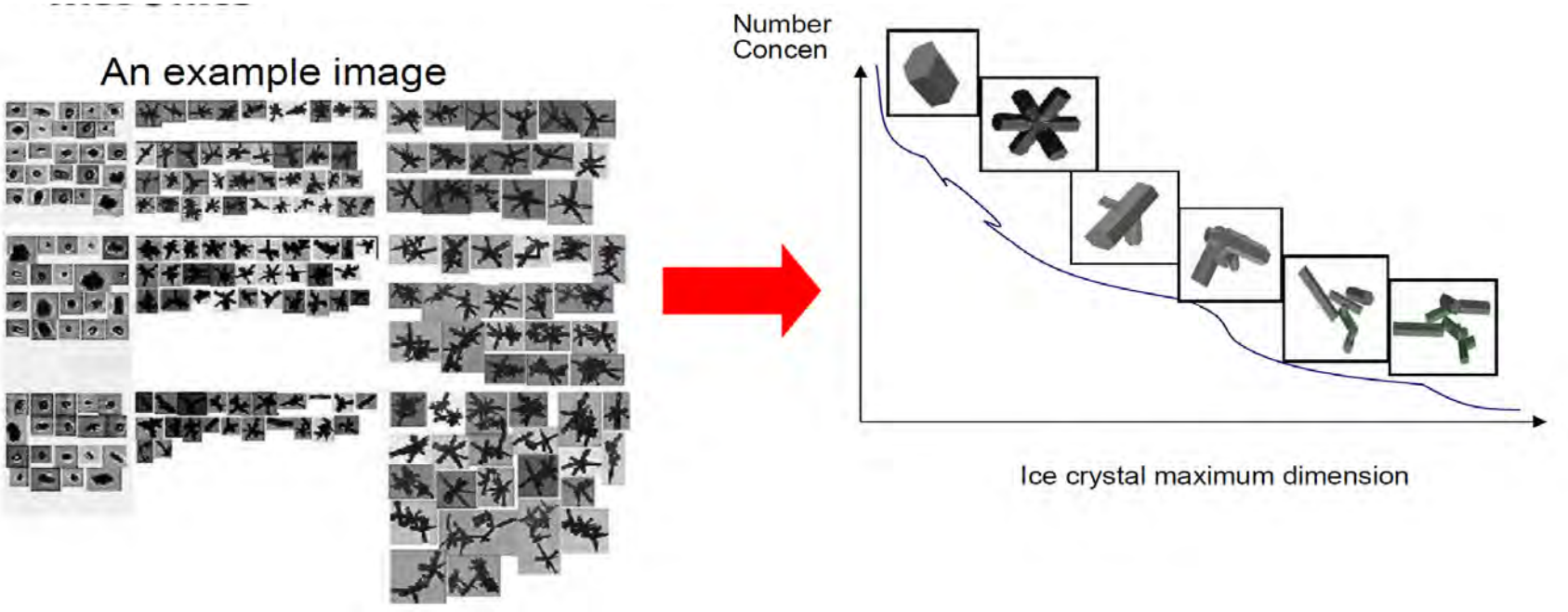
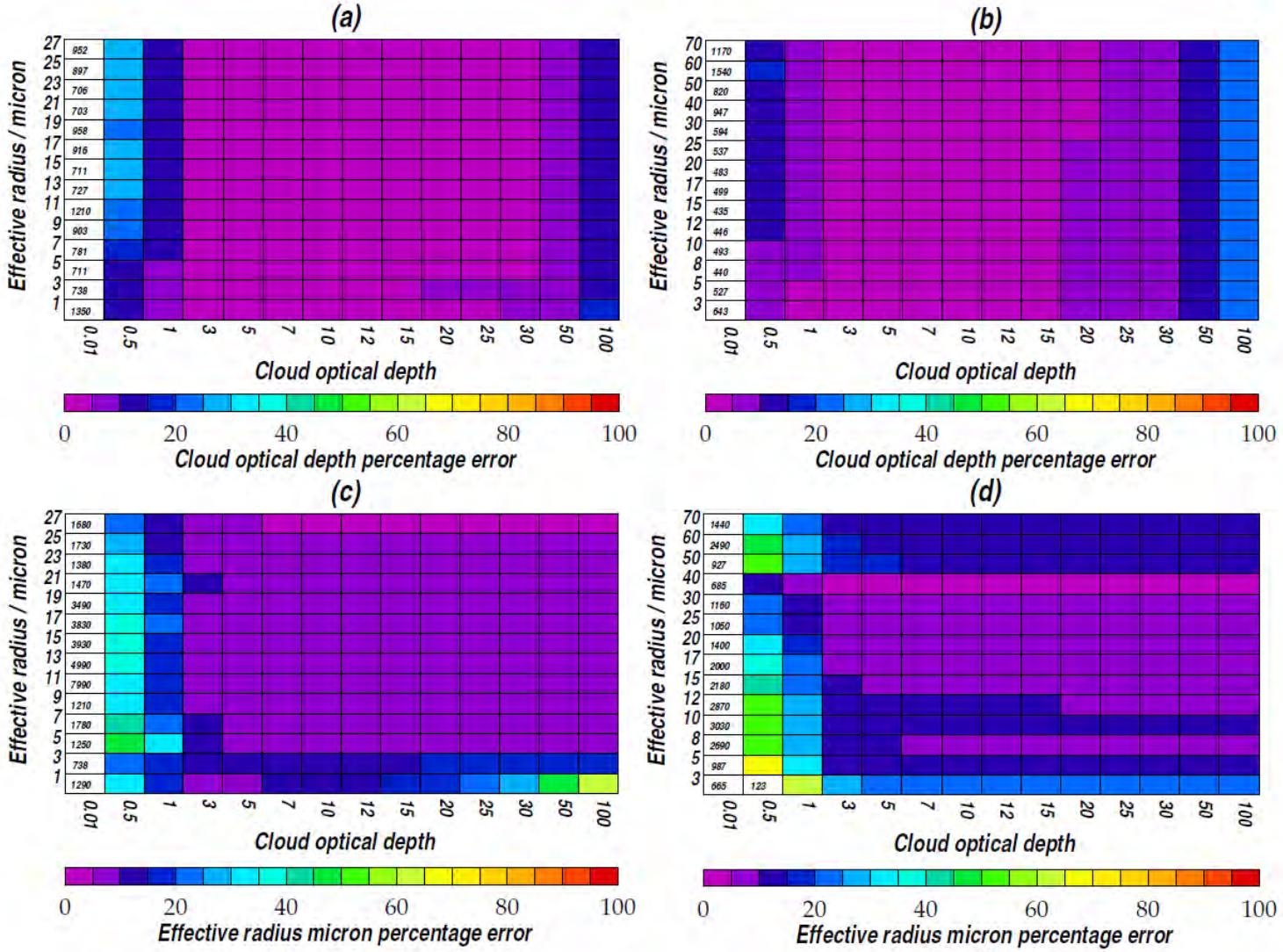
Uncertainty in cloud retrievals

- Sensitivity to modelled surface reflectivity
  - Other auxiliary data sets
- Cloud optical property models
  - Small sensitivity for water clouds
  - Significant for ice cloud



Simulations of expected uncertainty

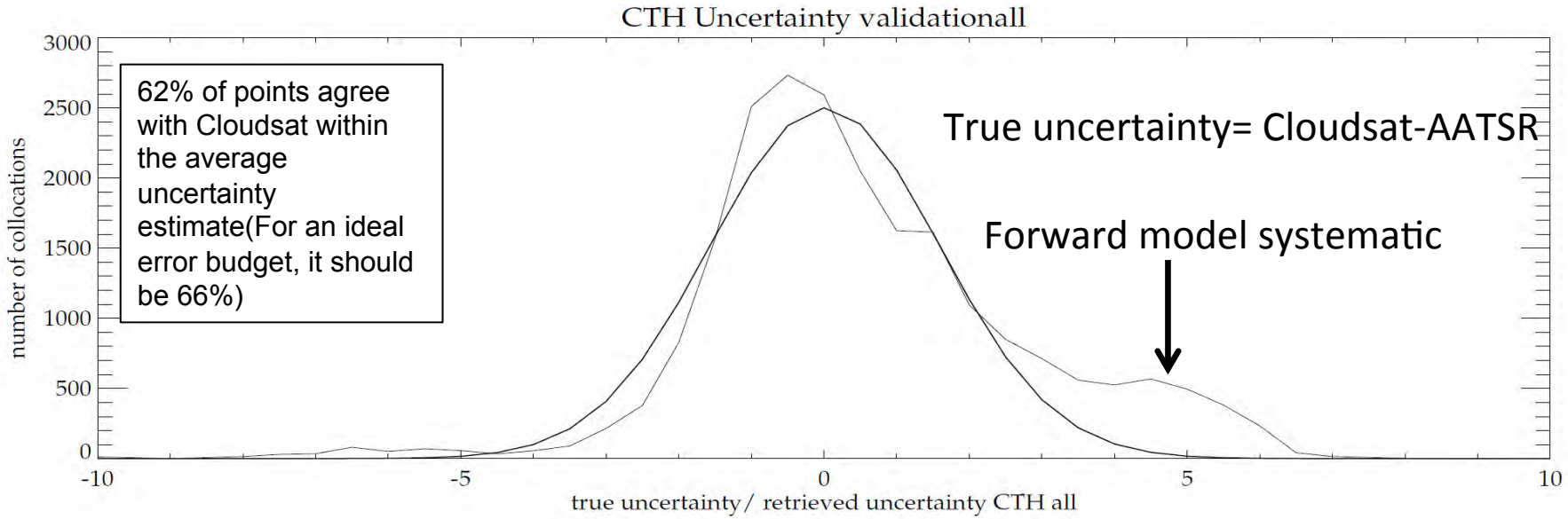
water **ice**



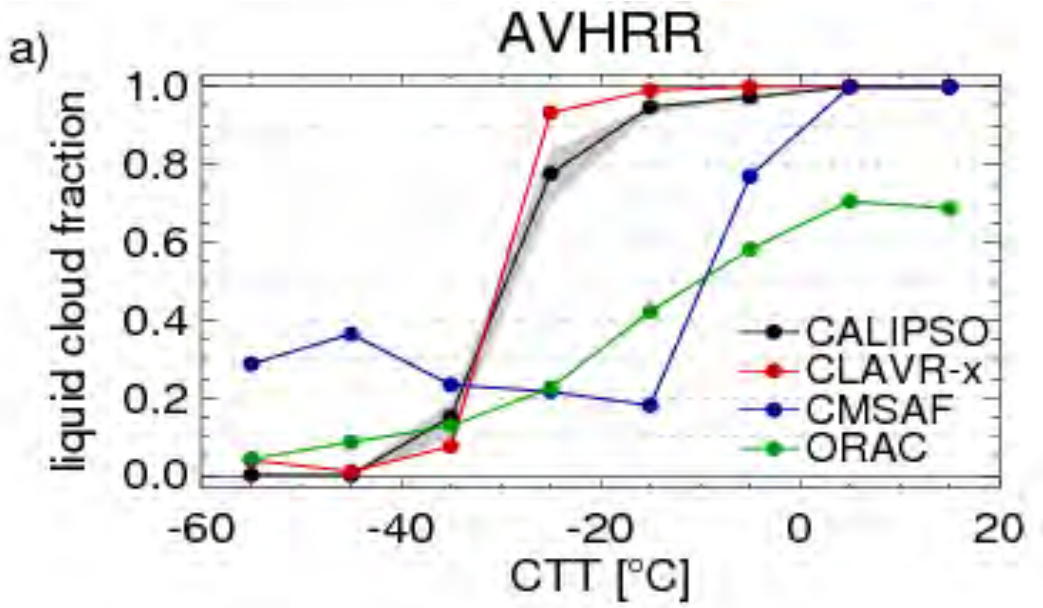
Poulsen et al. 2012

Validation of Cloud uncertainty

- Many cloud parameters
  - Optical depth, effective radius, Ice and liquid water path, height, albedo, mask, phase
- Not many accurate validation sources.
  - Poor statistics
  - Require careful interpretation



Validation of phase using Calipso



- New treatment of phase

Stengel et al 2013

L3 uncertainty

- Diurnal cycles

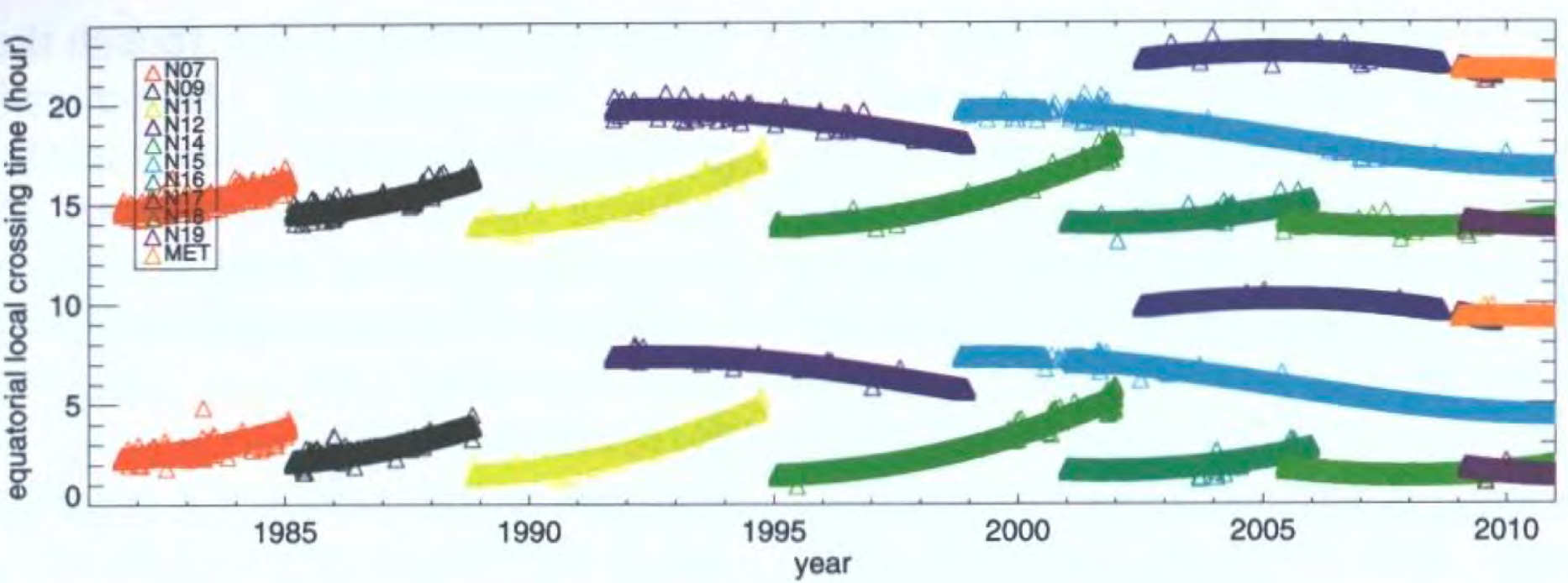


FIG. 1. Equatorial crossing time of the NOAA and MetOp polar-orbiting satellite series spanning 1981–2010.

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L3 uncertainty

- When forming monthly means, what is the role of natural variability versus errors/ uncertainties in the observations?
- How do correlations in L2 uncertainties affect the L3 data?

Bennartz visiting scientist report

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L3 uncertainty

$$\sigma^2_{TRUE} = \sigma^2_{STD} - (1-c)\left\langle \sigma^2_i \right\rangle$$

- Where 'TRUE' is the natural variability
- 'STD' the variability measured (include natural +noise)
- Observation uncertainty $\left\langle \sigma^2_i \right\rangle$
- C the correlation
  - Uncorrelated: c=0
  - Perfectly correlated: c=1

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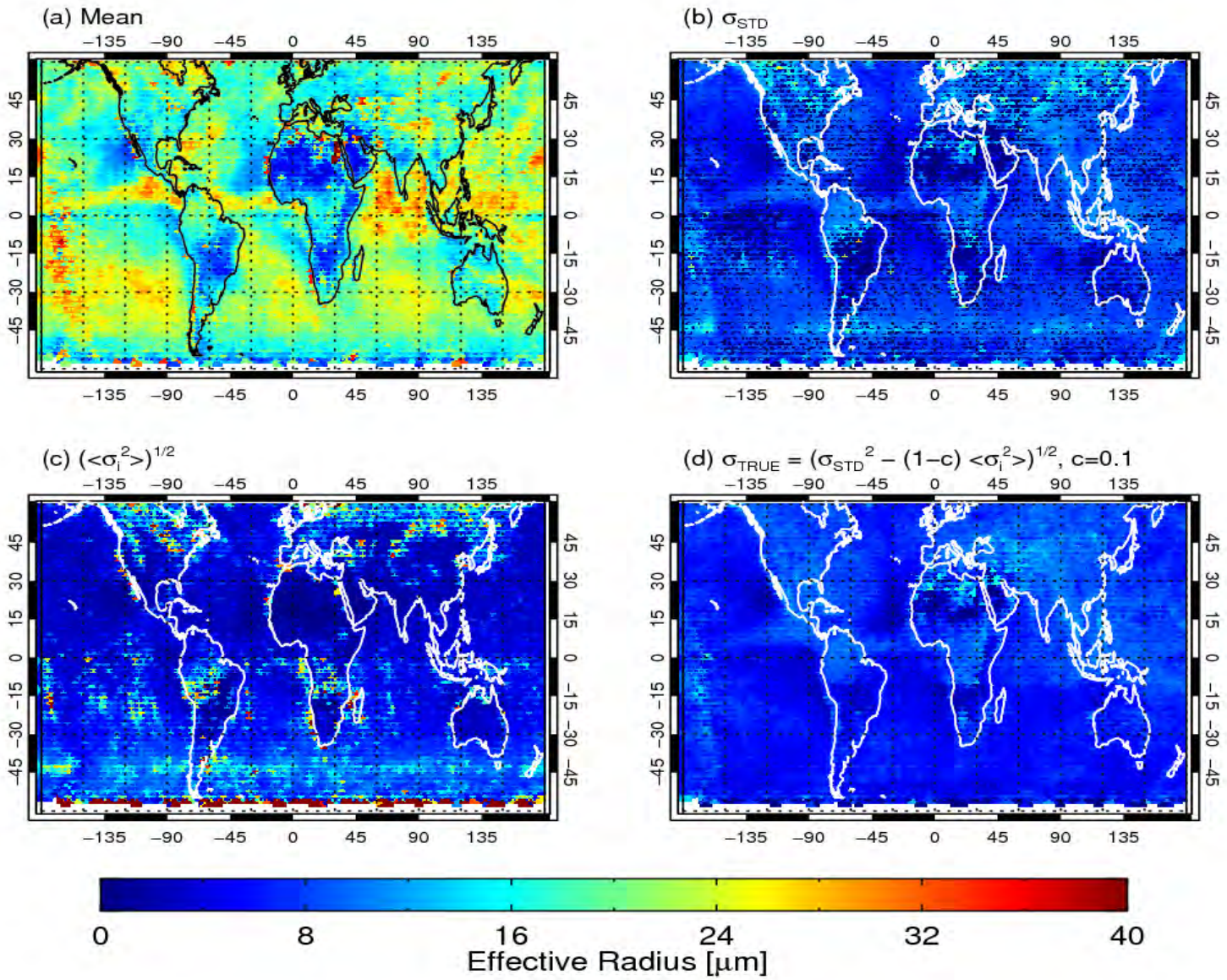
From Bennartz report on L3 uncertainty



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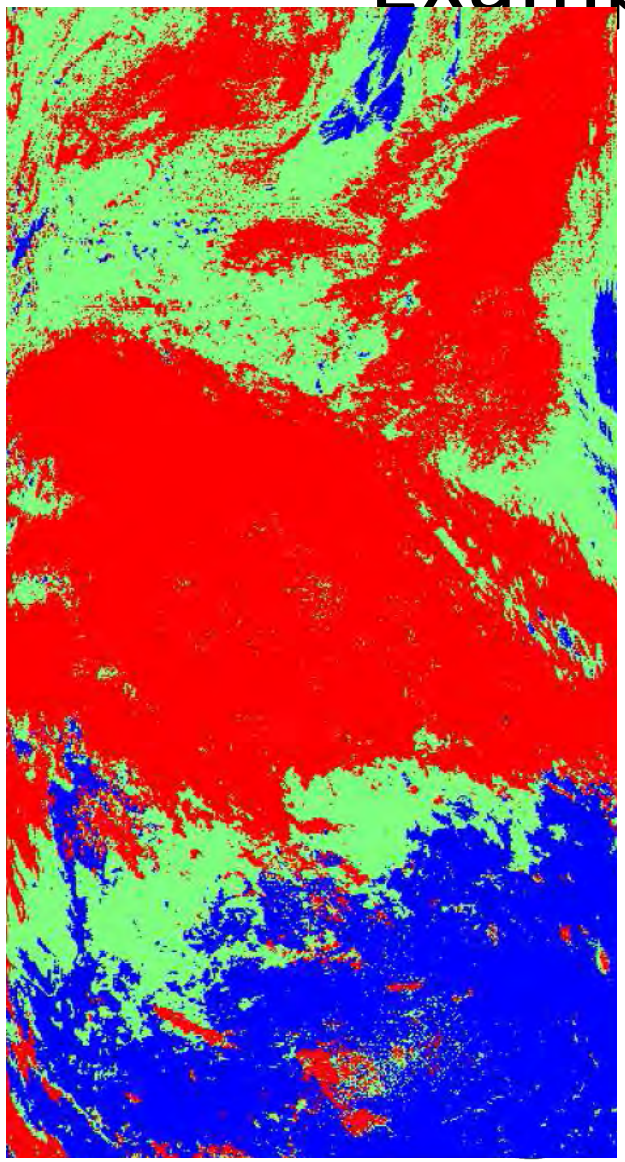
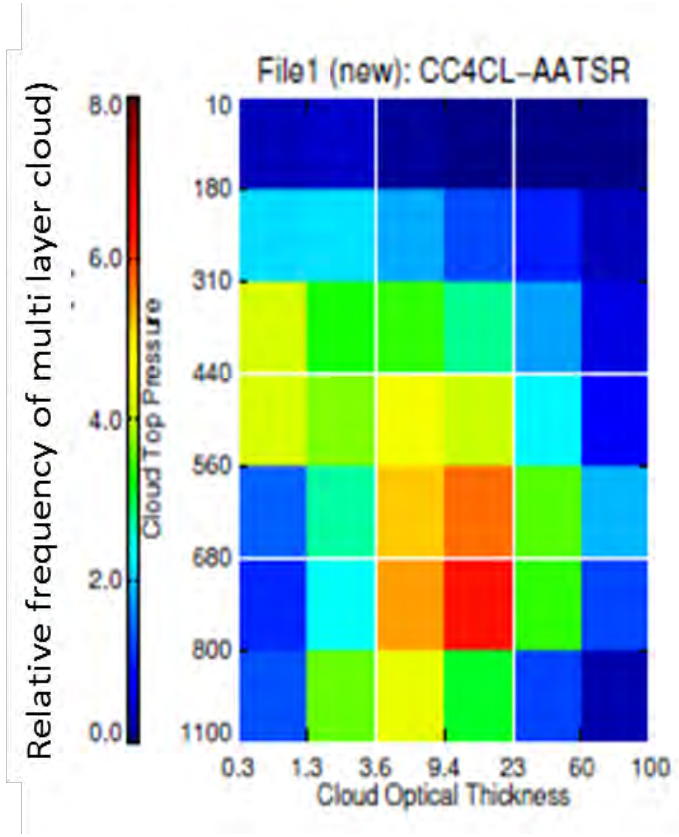
From Bennartz report on L3 uncertainty

Systematic Uncertainty L2→L3
Example: Multi layer cloud





Bit 0=clear
Bit 1=N/A
Bit 2=fog
Bit 3=water
Bit 4=supercooled
Bit 5=mixed
Bit 6=opaque_ice
Bit 7=cirrus
Bit 8=overlap **Ice over cloud**

What will we report in L3 data

- Generation L3 products with
  - The standard deviation of the pixels;
  - The propagation of pixel uncertainties into the average value
- Generation of histograms (consistent with ISCCP histograms)
  - The standard deviation of the pixels;
  - The propagation of pixel uncertainties into the average value
  - Probability of multi layer cloud
- Is this too much?

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What next?

- Work is underway to understand and express more uncertainty in Cloud CCI products.
- Exists a new group under ICWG (International Cloud Working Group) that will address uncertainty and validation
- Need to be clear how we communicate uncertainty
  - Could overwhelm users with to many diagnostics

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