

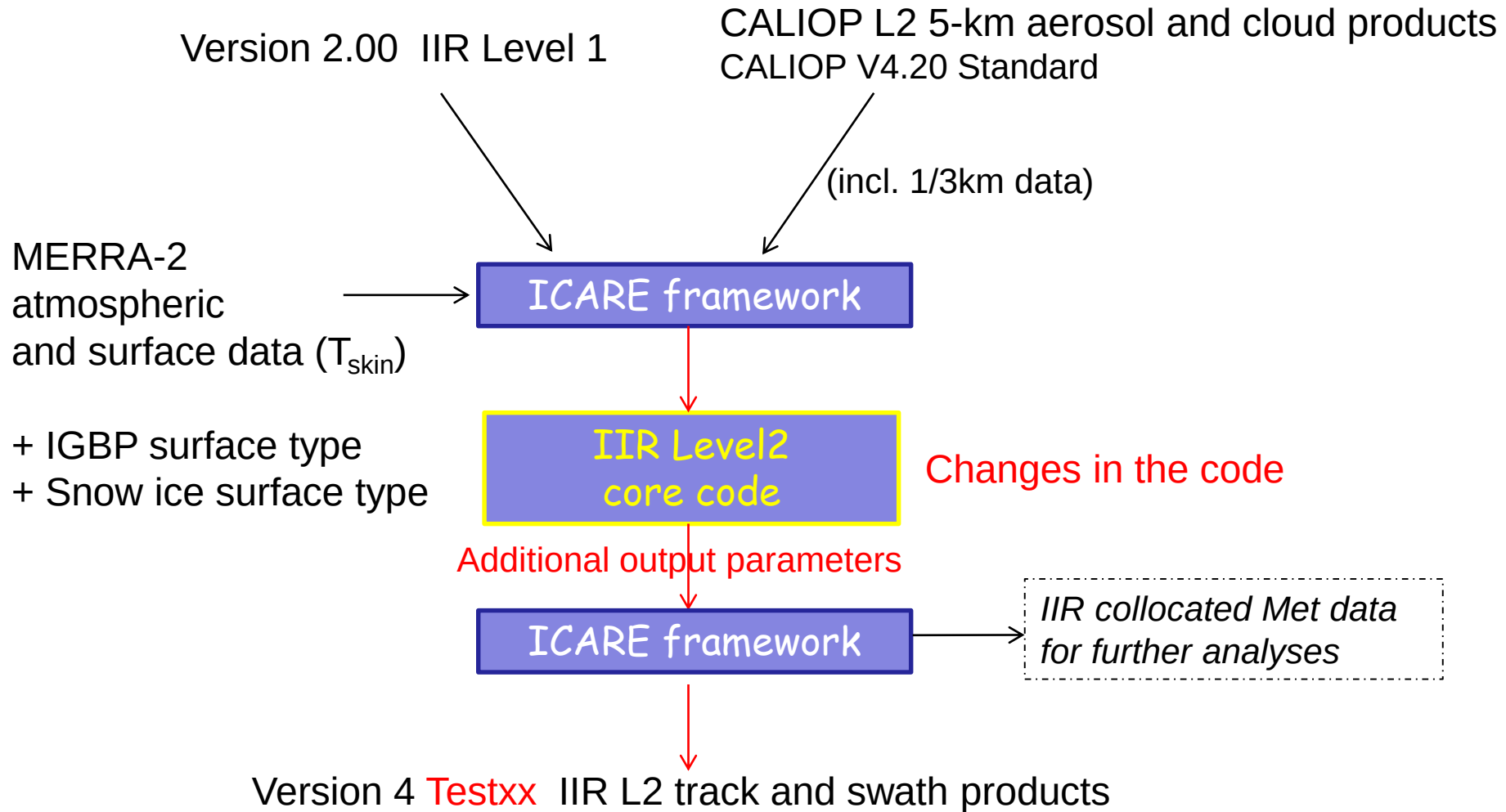
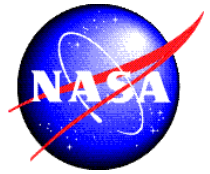
Product Quality Assessment/Validation and Development Plan

Version 4 IIR Level 2 development: status

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P. Dubuisson (LOA, Lille 1 University), and J. Pelon (LATMOS/IPSL)

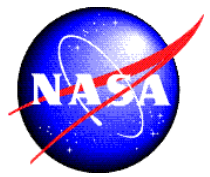


Version 4 IIR Level 2 development





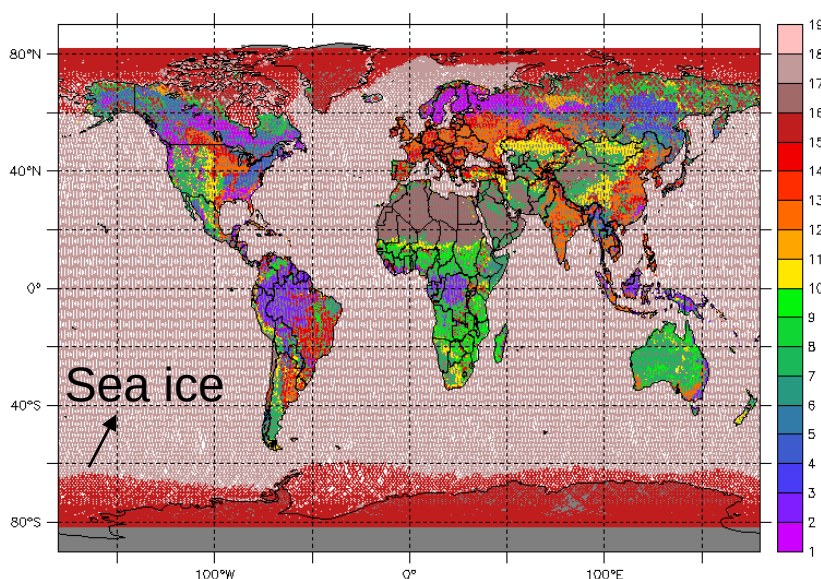
Main changes in Version 4 Algorithm



- ❑ Scene classification adapted to V4 CALIOP products.
- ❑ Improvements at small emissivity over oceans and **over land**.
- ❑ Improvements at large emissivity in ice clouds (radiative temperature correction).
- ❑ Improvements in multi-layer cloud systems.
- ❑ Microphysics:
 - state-of-the-art Look-Up Tables for ice clouds.
 - retrievals for water clouds added.
- ❑ Additional output parameters

- In Version 3, surface emissivity values are based on the static IGBP surface type, possibly changed to snow or sea/ice according to the daily snow ice surface type.

IGBP surface type, May 2008



Version 3 surface emissivity

Surface emissivities are computed accounting for the IIR spectral response functions (D. P. Kratz, NASA Langley, CERES team, see also Wilbert et al, 1999). The following values are used:

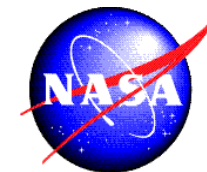
IIR Ch. 1 8.2 - 9.2 μm	IIR Ch. 2 10.35 - 10.95 μm	IIR Ch. 3 11.50 - 12.50 μm	IGBP surface static
0.9904	0.9888	0.9909	(1) evergreen needleleaf
0.9904	0.9888	0.9909	(2) evergreen broadleaf
0.9775	0.9738	0.9733	(3) deciduous needleleaf
0.9775	0.9738	0.9733	(4) deciduous broadleaf
0.9839	0.9813	0.9821	(5) mixed forests
0.9478	0.9653	0.9685	(6) closed shrublands
0.8754	0.9332	0.9411	(7) open shrublands
0.9801	0.9812	0.9886	(8) woody savannas
0.9801	0.9812	0.9886	(9) savannas
0.9801	0.9812	0.9886	(10) grasslands
0.9819	0.9857	0.9871	(11) permanent wetlands
0.9801	0.9812	0.9886	(12) croplands
1.0000	1.0000	1.0000	(13) urban
0.9820	0.9812	0.9854	(14) mosaic
0.9951	0.9967	0.9854	(15) snow/ice
0.8392	0.9171	0.9275	(16) barren/sparsely vegetated
0.9838	0.9903	0.9857	(17) water
0.9753	0.9936	0.9909	(18) tundra

- In Version 3, large differences between observed and computed brightness temperatures (BT) in clear sky conditions are observed, especially over desertic areas (differences up to 10 K).
- A new approach had to be developed for Version 4.



Background radiance over land

Initial approaches (REVEX 10 & 11)

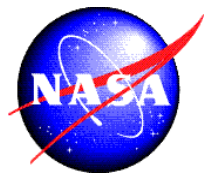


- ❑ Defining new surface emissivity values per IGBP type (REVEX 10) was not successful because we could not reproduce observed geographical, diurnal and seasonal variations.
- ❑ The second approach (REVEX 11) was to correct the computed BTs using monthly daytime and nighttime correction maps. This required a two-pass procedure:
 - Pass 1: compute the brightness temperatures **monthly correction maps** in clear sky conditions
 - resolution: latitude x longitude = $1^\circ \times 2^\circ$
 - **day and night**
 - Pass 2: re-compute using the correction maps.
- ❑ However, this second approach was difficult to implement in the operational algorithm.



Background radiance over land

New approach in Version 4

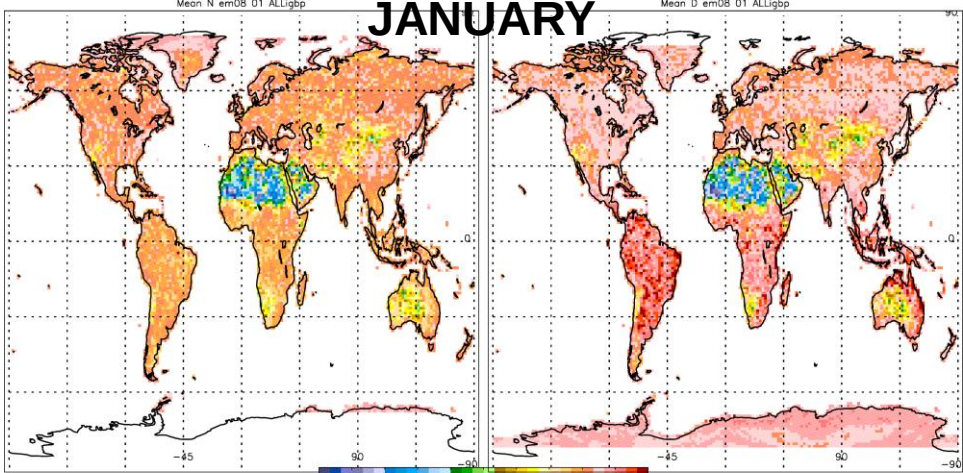


- For each channel k , in clear sky conditions, skin temperature (T_{skin}) and surface emissivity in channel k ($\epsilon_{\text{surf}}(k)$) are such that

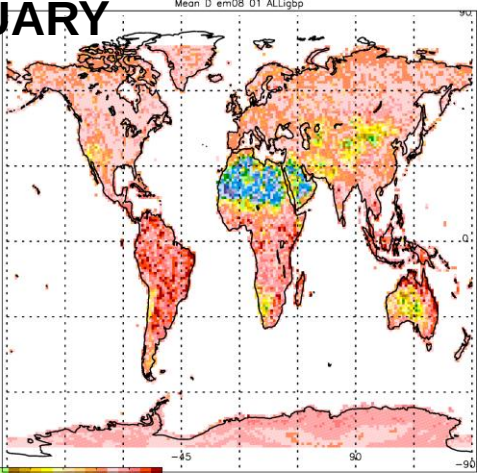
$$\text{Computed BT } [T_{\text{skin}}, \epsilon_{\text{surf}}(k)] = \text{Observed BT } (k)$$

- Reference channel approach:
 - Channel $12.05 \mu\text{m}$ is used as a reference: $\epsilon_{\text{surf}}(12.05) = 0.975$ (Capelle et al., 2012).
 - T_{skin} derived using channel 12.05.
 - $\epsilon_{\text{surf}}(08.65)$ and $\epsilon_{\text{surf}}(10.6)$ derived using T_{skin} .
- Analysis of two years (2008 and 2013) of IIR V4 test data in clear sky conditions.
- IGBP based surface emissivity values replaced with monthly daytime and nighttime maps (latitude x longitude = $1^\circ \times 2^\circ$) of surface emissivity values $\epsilon_{\text{surf}}(08.65)$ and $\epsilon_{\text{surf}}(10.6)$.
- In addition, Version 4 uses monthly daytime and nighttime maps (latitude x longitude = $1^\circ \times 2^\circ$) of T_{skin} corrections ($= T_{\text{skin}} - T_{\text{skin_MERRA-2}}$).

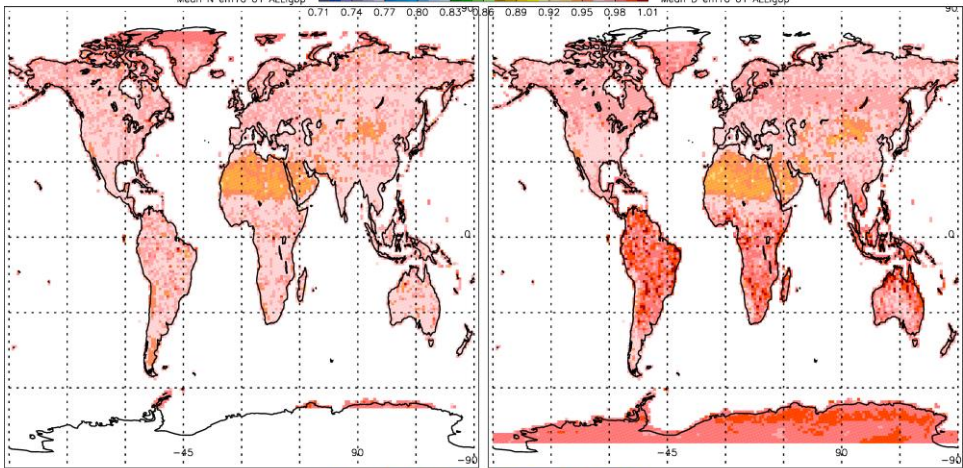
Surface emissivity
08.65 μm , night



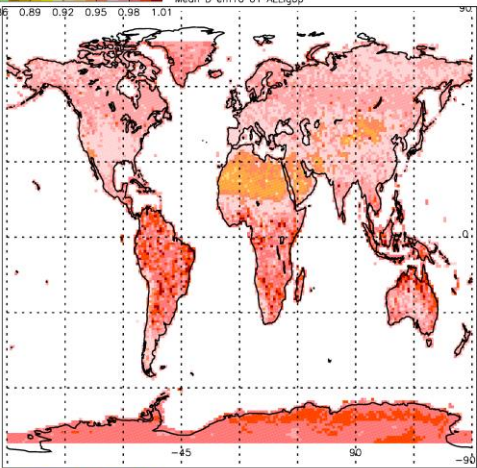
Surface emissivity
08.65 μm , day



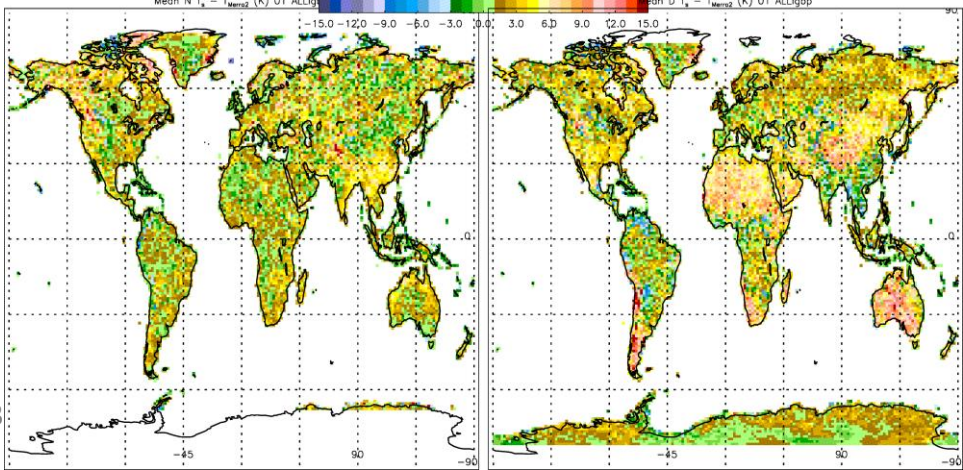
Surface emissivity
10.6 μm , night



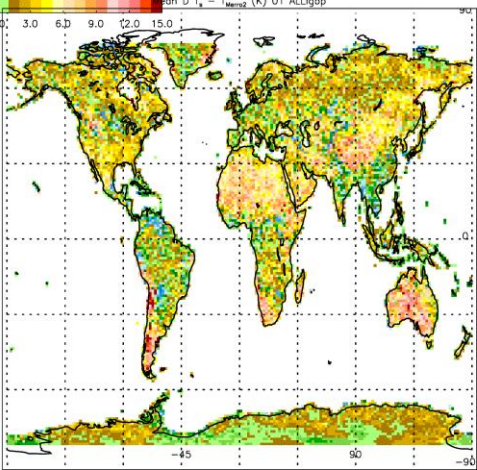
Surface emissivity
10.6 μm , day



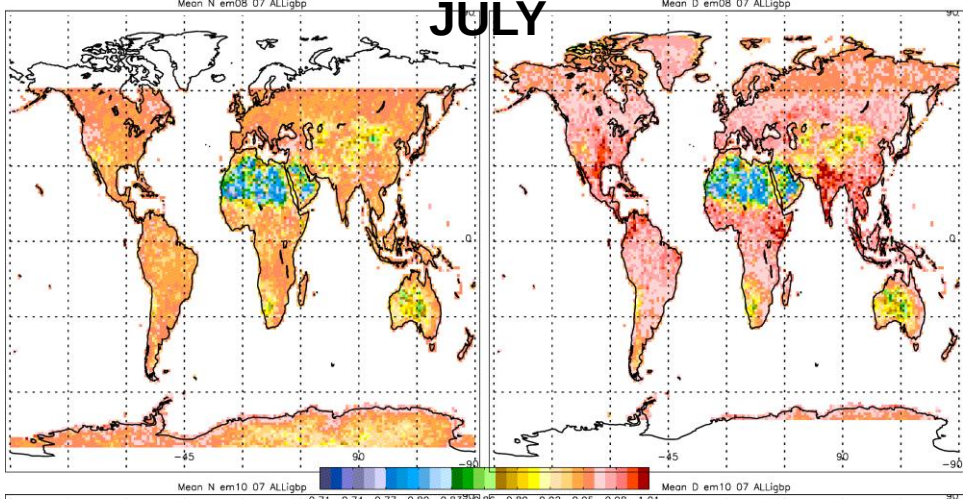
Skin temperature
correction, night



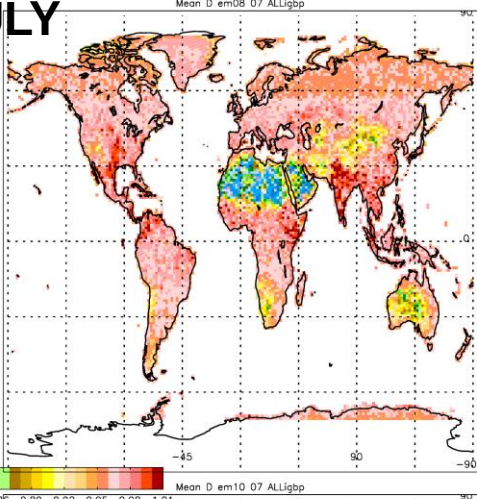
Skin temperature
correction, day



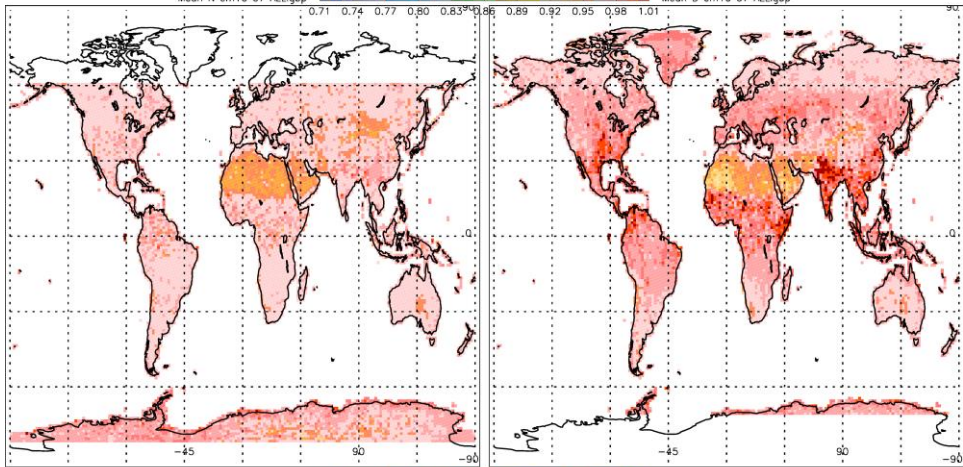
Surface emissivity
08.65 μm , night



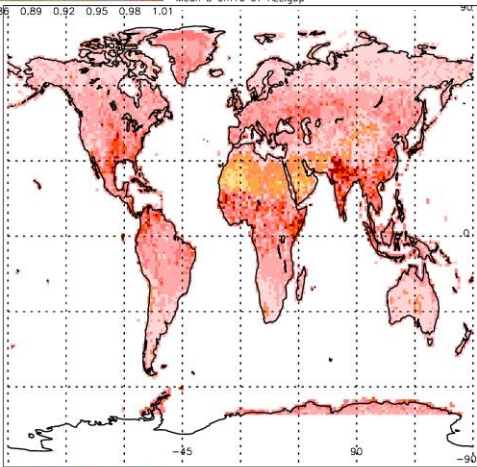
Surface emissivity
08.65 μm , day



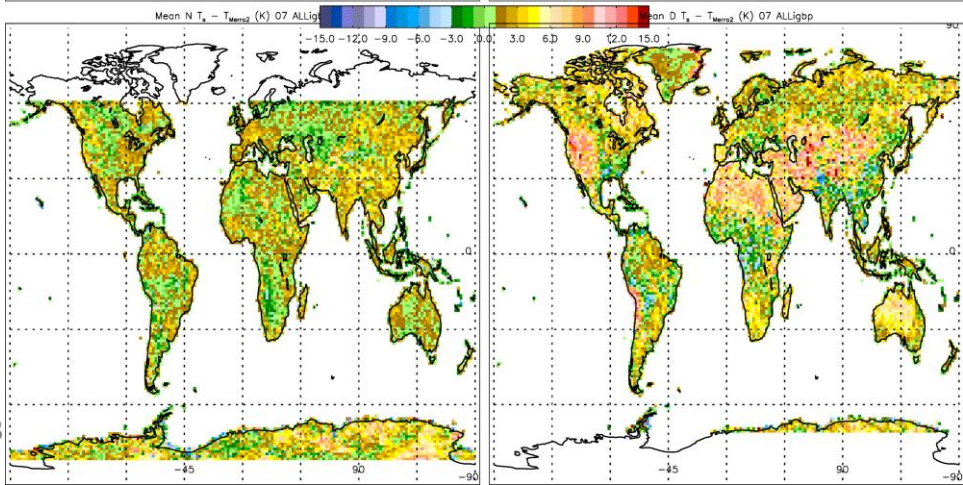
Surface emissivity
10.6 μm , night



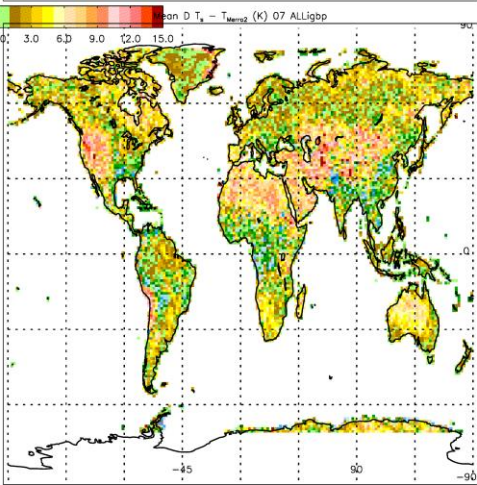
Surface emissivity
10.6 μm , day



Skin temperature
correction, night

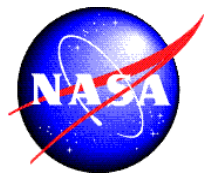


Skin temperature
correction, day





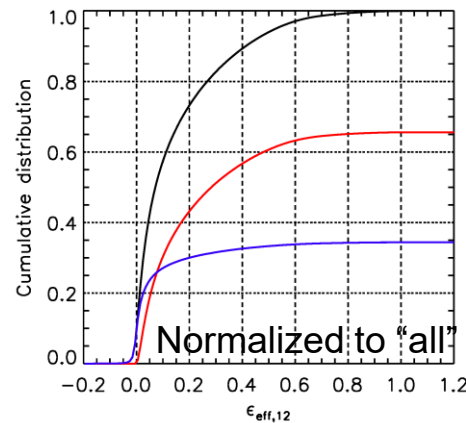
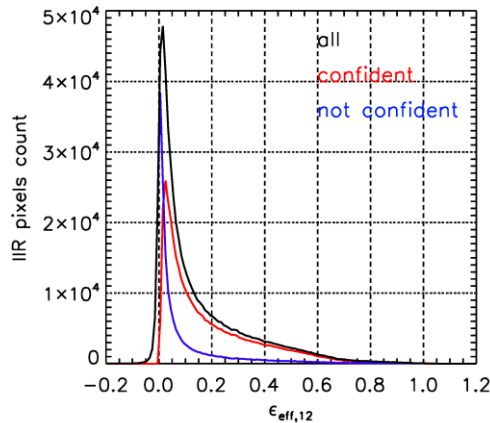
Effective diameter retrievals (1/3)



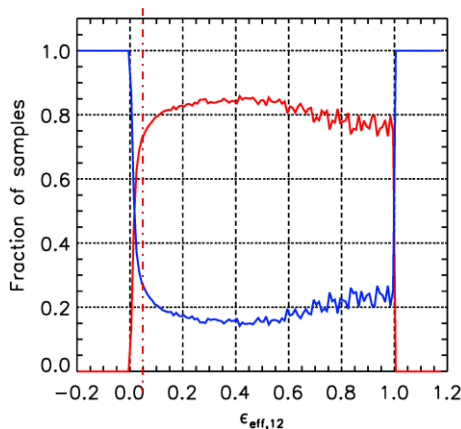
- ❑ Oceans, January 2008, 60°N-60°S
- ❑ Semi-transparent single-layer high confidence ice cloud (randomly oriented ice).

Confident

Both microphysical indices in expected range of values:
 $D_{e12/10}$ and $D_{e12/08}$ both $>1 \mu\text{m}$ and $\leq 120 \mu\text{m}$.



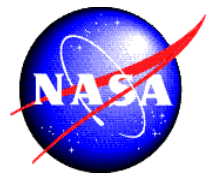
65 % confident retrievals overall



- 10 % have $\epsilon_{\text{eff},12} < 0 \Rightarrow$ no retrievals possible.
- Sharp increase of fraction of confident retrievals from 0 to 0.7 as $\epsilon_{\text{eff},12}$ increases from 0 to 0.05 and uncertainties decrease.



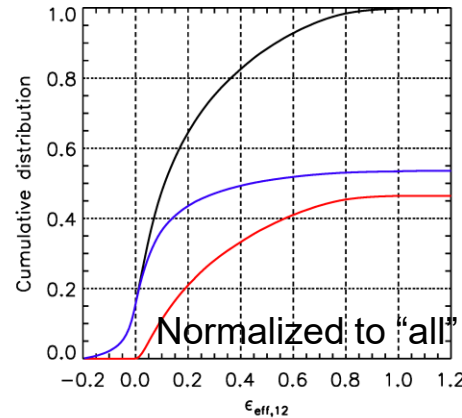
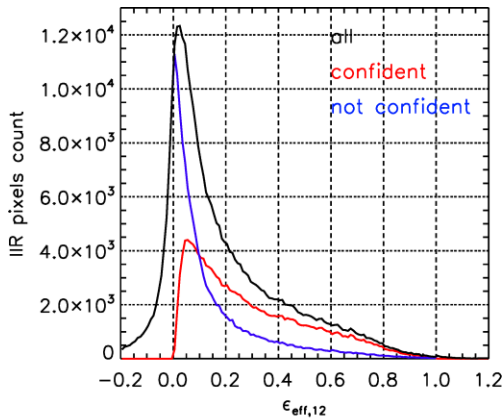
Effective diameter retrievals (2/3)



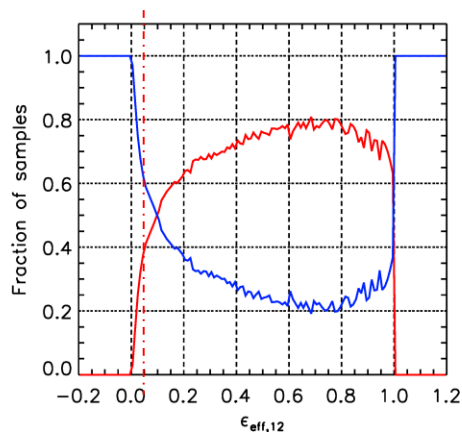
- Land, January 2008, 60°N-60°S
- Semi-transparent single-layer high confidence ice cloud (randomly oriented ice).

Confident

Both microphysical indices in expected range of values:
 $D_{e12/10}$ and $D_{e12/08}$ both $>1 \mu\text{m}$ and $\leq 120 \mu\text{m}$.



46 % confident retrievals overall



➤ 15 % have $\epsilon_{\text{eff},12} < 0 \Rightarrow$ no retrievals possible.

➤ Sharp increase of fraction of confident retrievals from 0 to 0.35 as $\epsilon_{\text{eff},12}$ increases from 0 to 0.05 and uncertainties decrease.

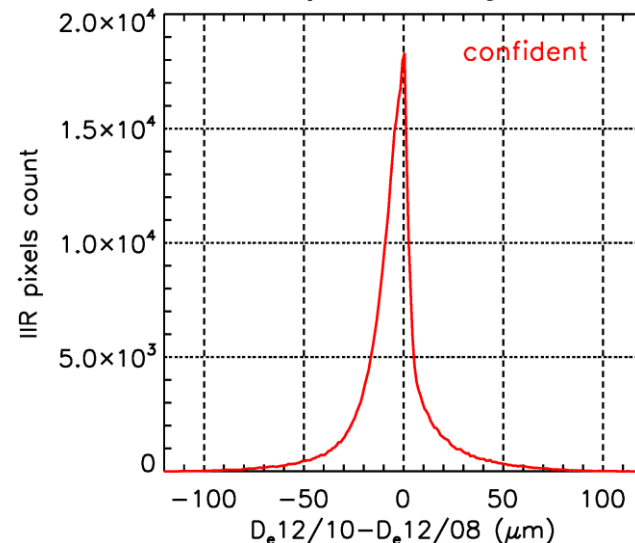
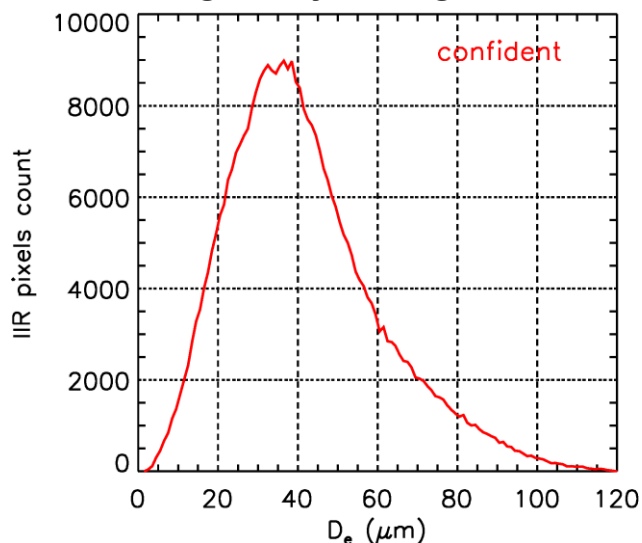


Effective diameter retrievals (3/3)

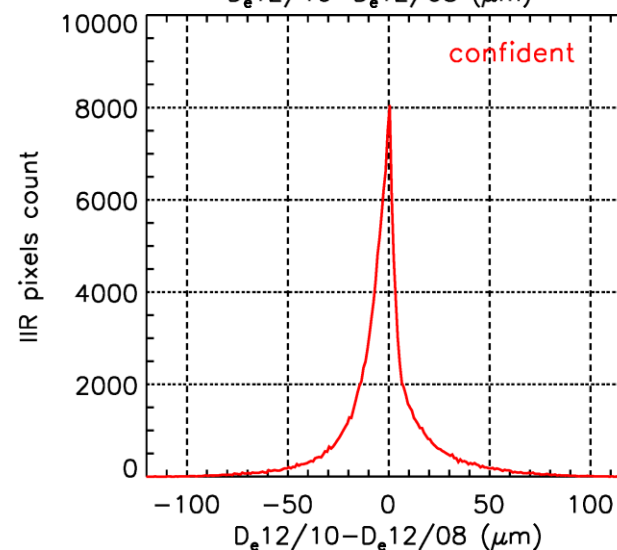
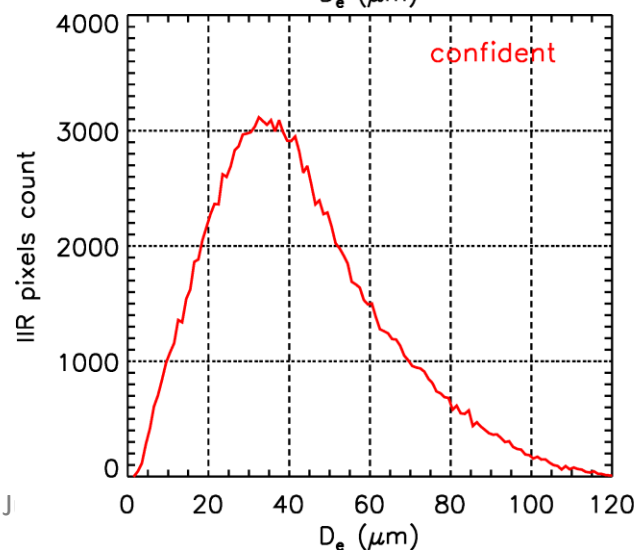


- January 2008, 60°N-60°S
- Semi-transparent single-layer high confidence ice cloud (randomly oriented ice).

Oceans

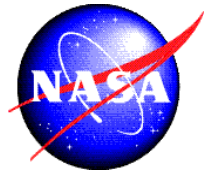


Land





Status as of May 30th, 2019



- ❑ Main remaining task in IIR L2 core code:
 - liquid water path

- ❑ Third code delivery to LaRC: April 2019
- ❑ Integration into LaRC production environment and testing: ongoing
- ❑ Final code delivery to LaRC: June 2019

- ❑ Documentation: ongoing

- ❑ Public release: June/July