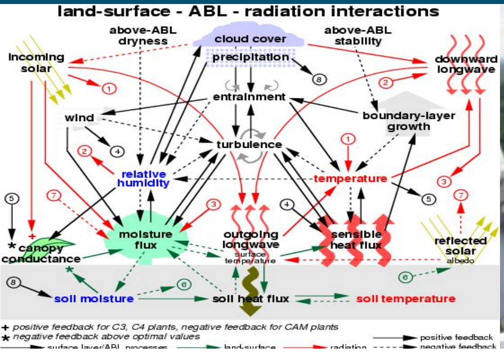
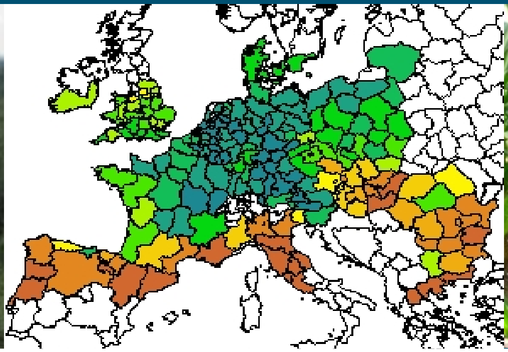
Identification of global hotspots of land-surface – precipitation interaction from reanalysis fields

Cor Jacobs[1], Michael Ek[2], Jan Elbers[1], Ronald Hutjes[1], Joe Santanello[3] and Obbe Tuinenburg[1]

1) *Wageningen UR / Earth System Science – Climate Change*
2) *NOAA Science Center, NCEP/EMC*
3) *NASA/GSFC/HSB*





Contents

- Background and Goal
- Considerations regarding present analysis
- Diagnostic framework
- Global maps
- Some discussion highlights

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WATCH[1] (Water and Global Change)

- *Overarching goal*
  Analyze, quantify an predict the components of the current and future global water cycles and related water resources states

- *Specific goal*
  Quantify feedbacks between the climate system and hydrological processes

  - Identify location and strength of "feedback hotspots" across the globe
    [inspired by Koster et al., *Science* **305** (2004),1138-1140]

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1) WATCH more: SPM1.18
(Wed. 19-20 LT, SM1)

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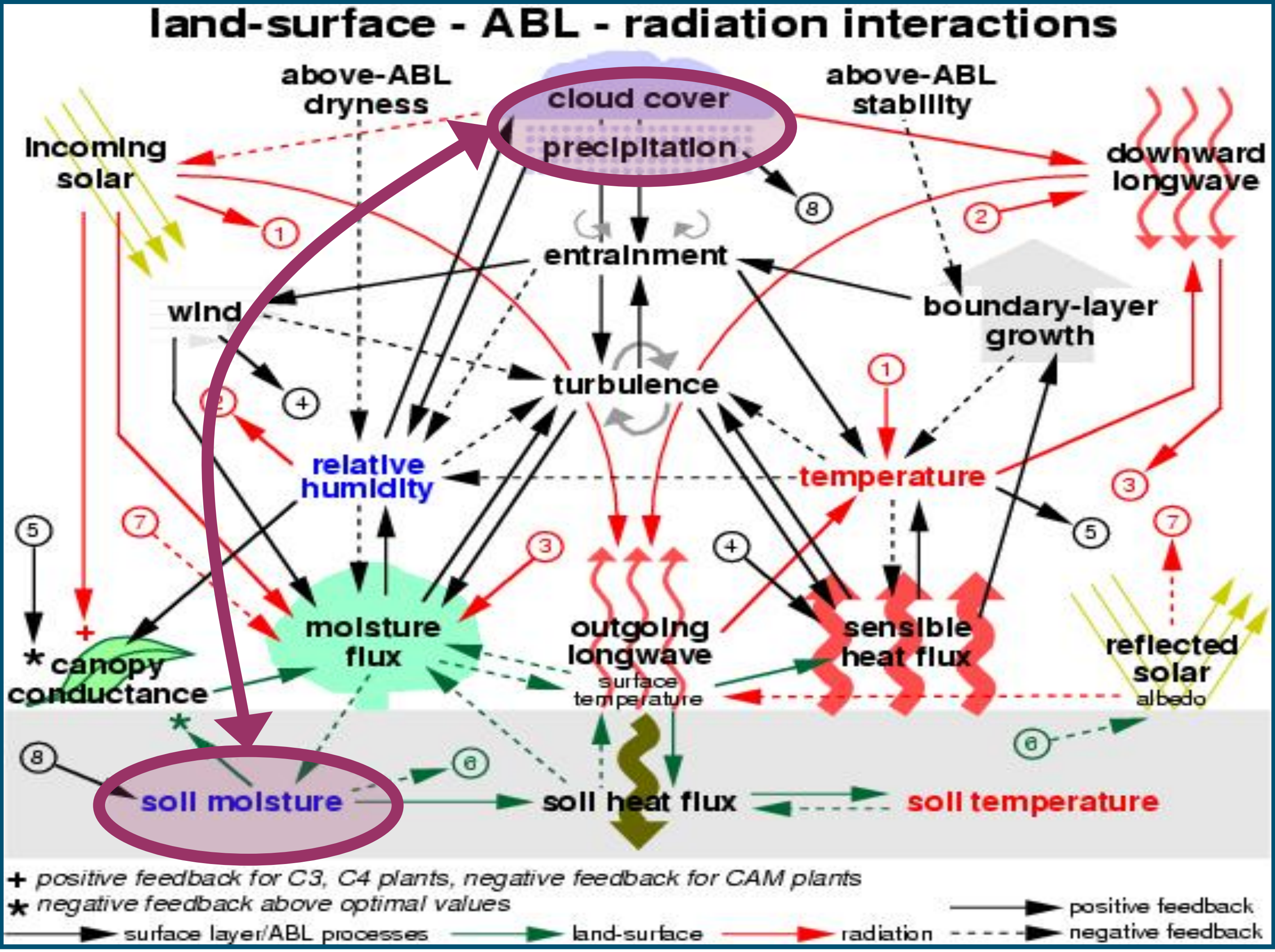
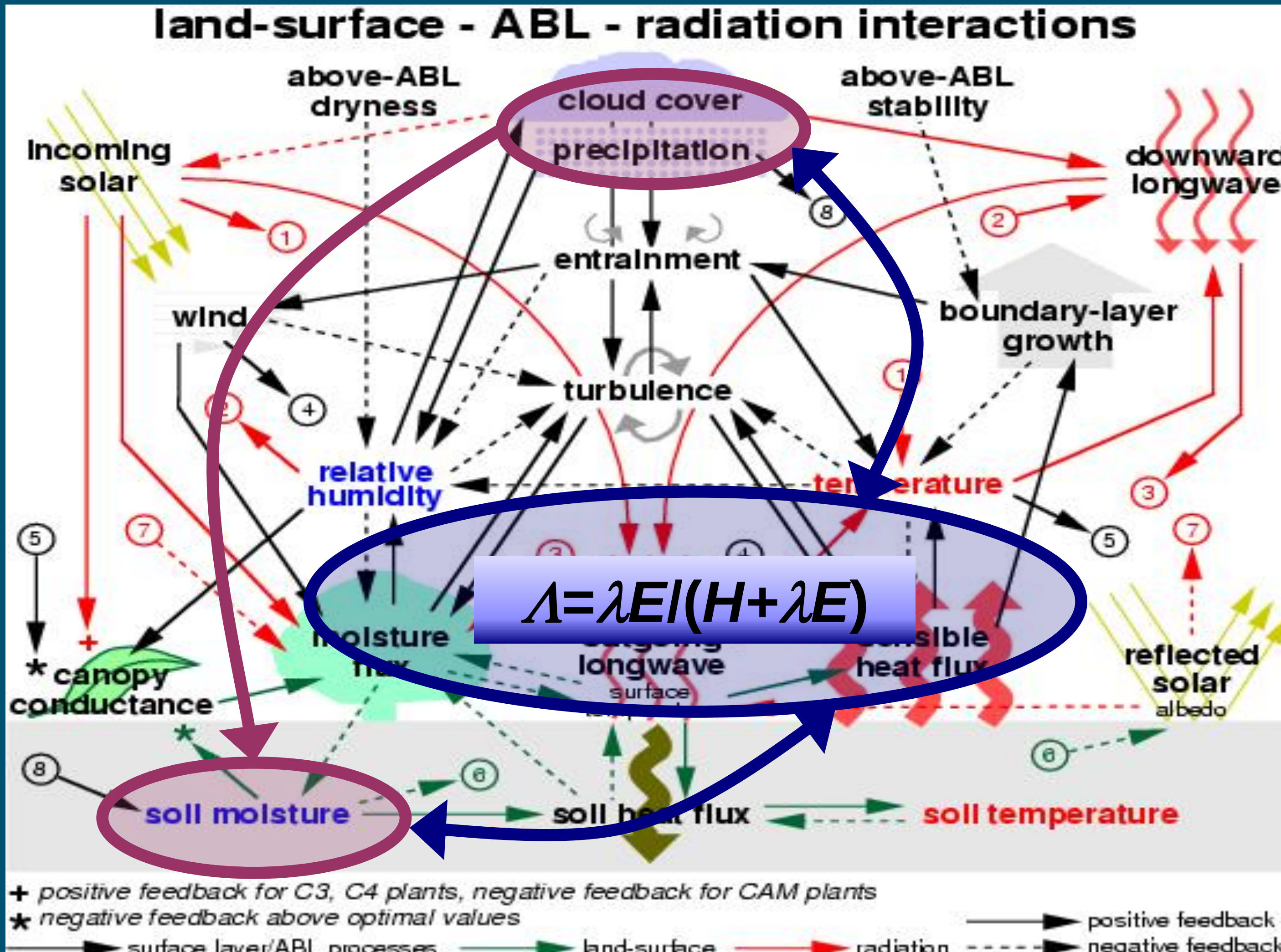
Considerations

- Construct climatology → use observations as much as possible
  - Use reanalyses, but
  - These may be model dependent
- Role of Atmospheric Boundary Layer (ABL)
  - Relates to “Local Coupling” (LoCo) analysis
  - Use convective precipitation
- Use “simple” diagnostics
  - “Easy” to obtain, but with physical meaning
  - Complementary

Towards a diagnostic framework



Diagnostic 1: Evaporative Fraction Λ



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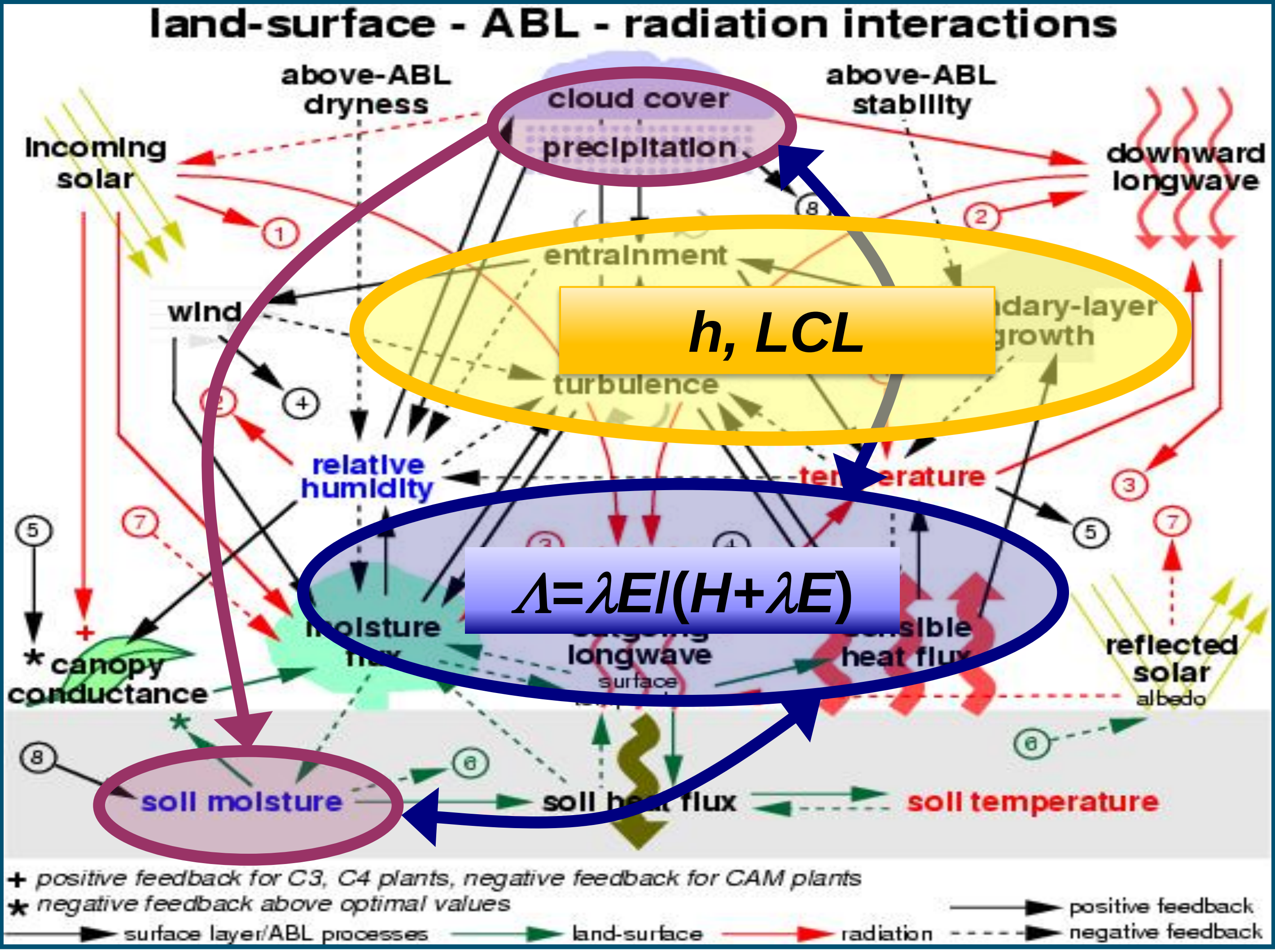
Diagnostic 2: ABL height - Lifting Condensation Level



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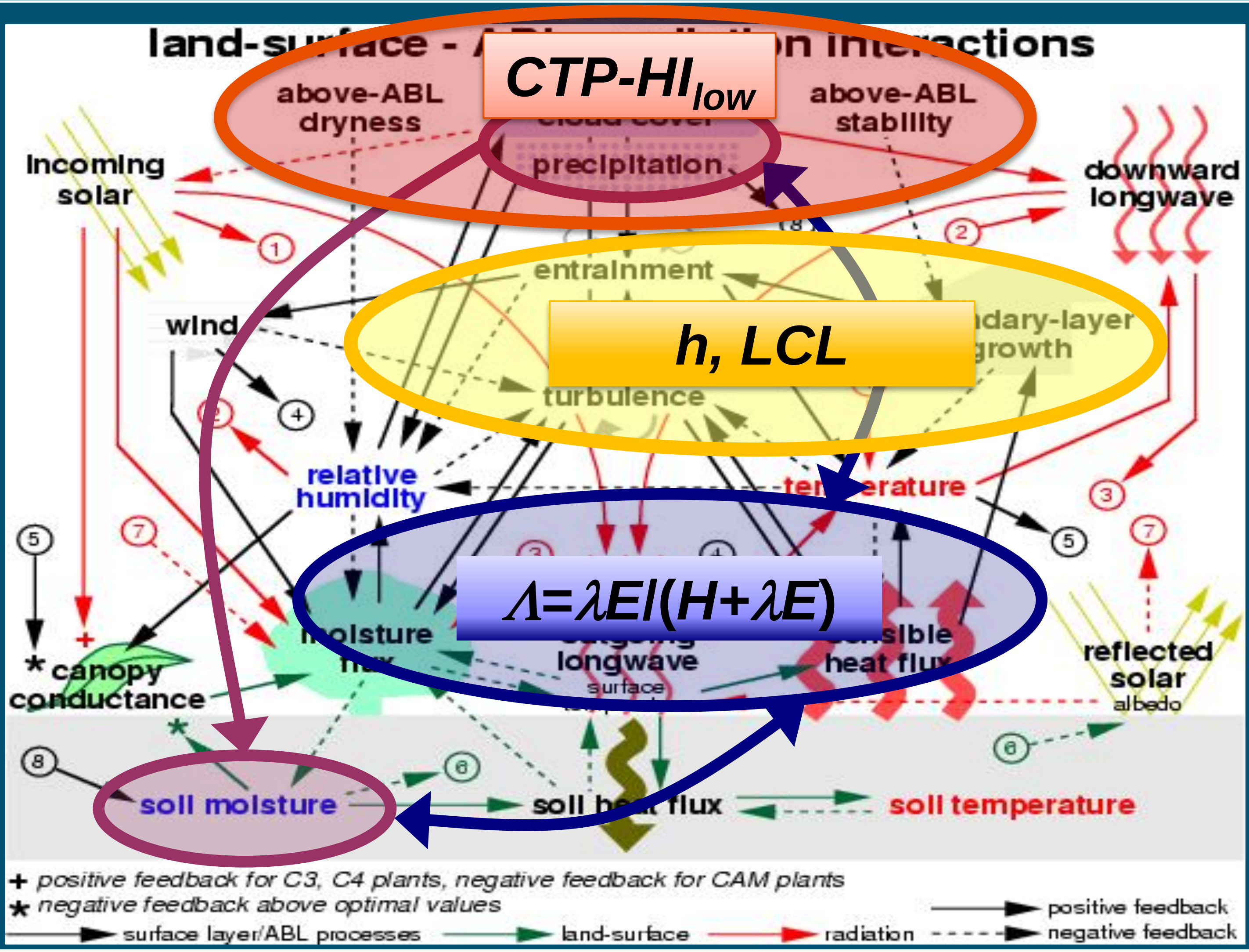
Diagnostic 3a: CTP-HI_{low}

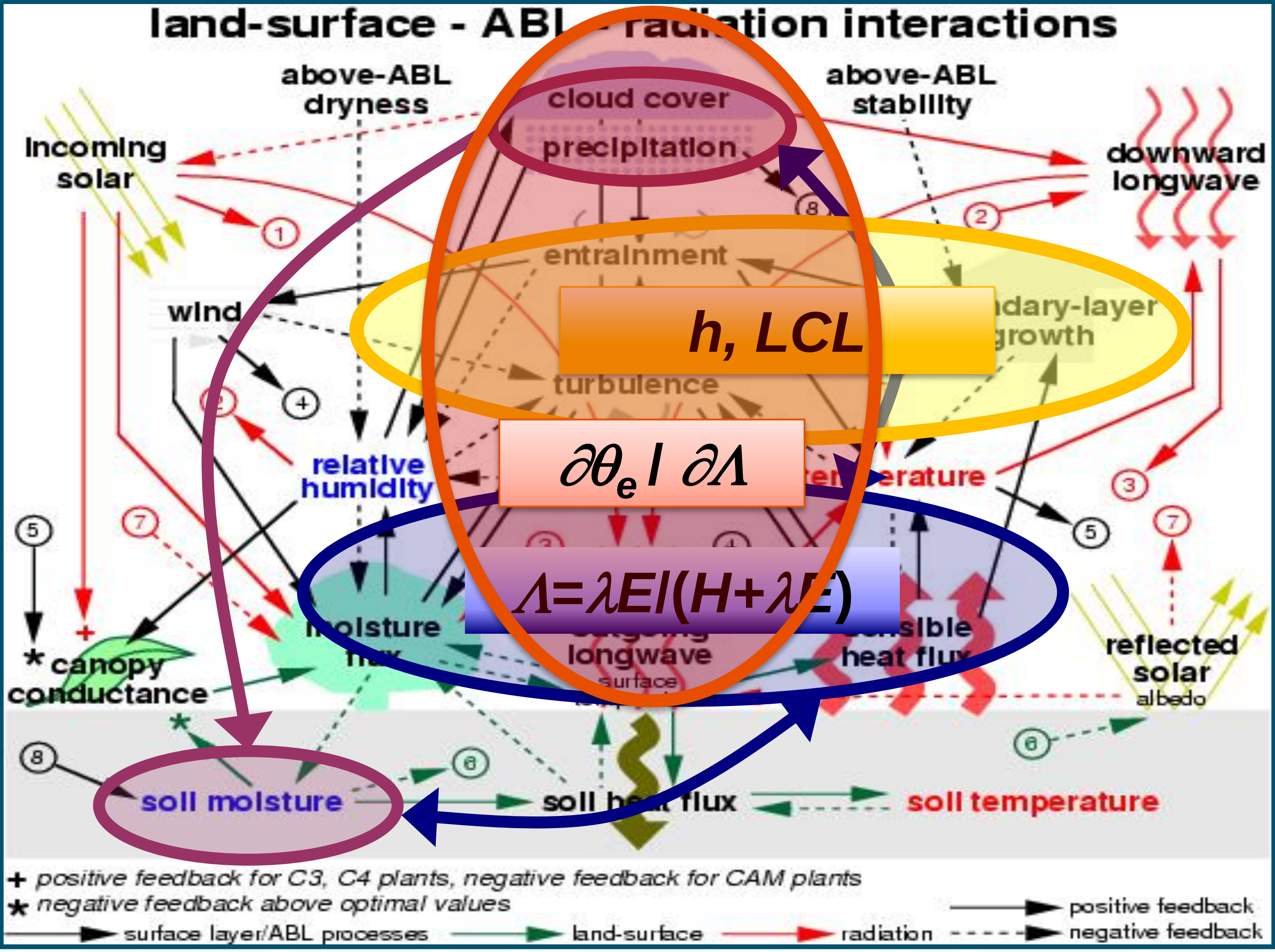


Diagnostic 3a: CTP-HI_{low}

- Components:
  - Convective Triggering Potential ("ABL-CAPE") = diagnostic of available potential convective energy
  - HI_{low} = Humidity Index or dewpoint depression
  - In atmospheric layers often influenced by ABL
- Links land-surface properties, ABL dynamics and convective precipitation via offline calibration of the CTP-Hi_{low} space
- Assesses likelihood of surface-state dependent generation of convection
  - Atmospherically controlled (most cases)
  - Wet soil advantage: convection more likely over wet surfaces
  - Dry soil advantage: convection more likely over dry surfaces
  - Here: surface wetness linked to evaporative fraction Λ

Findell and Eltahir, J. Hydromet. ***4*** *(2003), 552-569*

Diagnostic 3b: $\partial\theta_e / \partial\Lambda$



θ_e= equivalent potential temperature

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Diagnostic 3b: $\partial\theta_e / \partial\Lambda$

- $\partial\theta_e / \partial\Lambda$ derived by De Ridder (1997)
  - "Predicts" effect on CAPE and therefore on convection [see, e.g., Kohler et al. (2010), *Q.J.R. Meteorol. Soc.* **135(s1)**:442-455]
  - Links surface energy balance to conditions in the ABL, taking into account the properties of the lower free atmosphere (entrainment)
  - Requires assumptions regarding ABL-dynamics
  - Behavior to be established

De Ridder, J.Geophys.Res. ***102*** *(1997), 30085-30090*

Conditions with possible feedback

CTP/Hilow	LCL/h	Conv-Sm *coupling*	P-Sm *Feedback*
Wetadv	<1	y (if wet soil)	+ if P>0 **a+**
Dryadv	<1	y (if dry soil)	- if P>0

$\partial\theta_e/\partial\Lambda$	LCL/h	Conv-Sm *Coupling*	P-Sm *Feedback*
$\partial\theta_e/\partial\Lambda > 3$	<1	y	+ if P > 0 **b+**
$\partial\theta_e/\partial\Lambda < -0.2$	<1	y	- if P > 0

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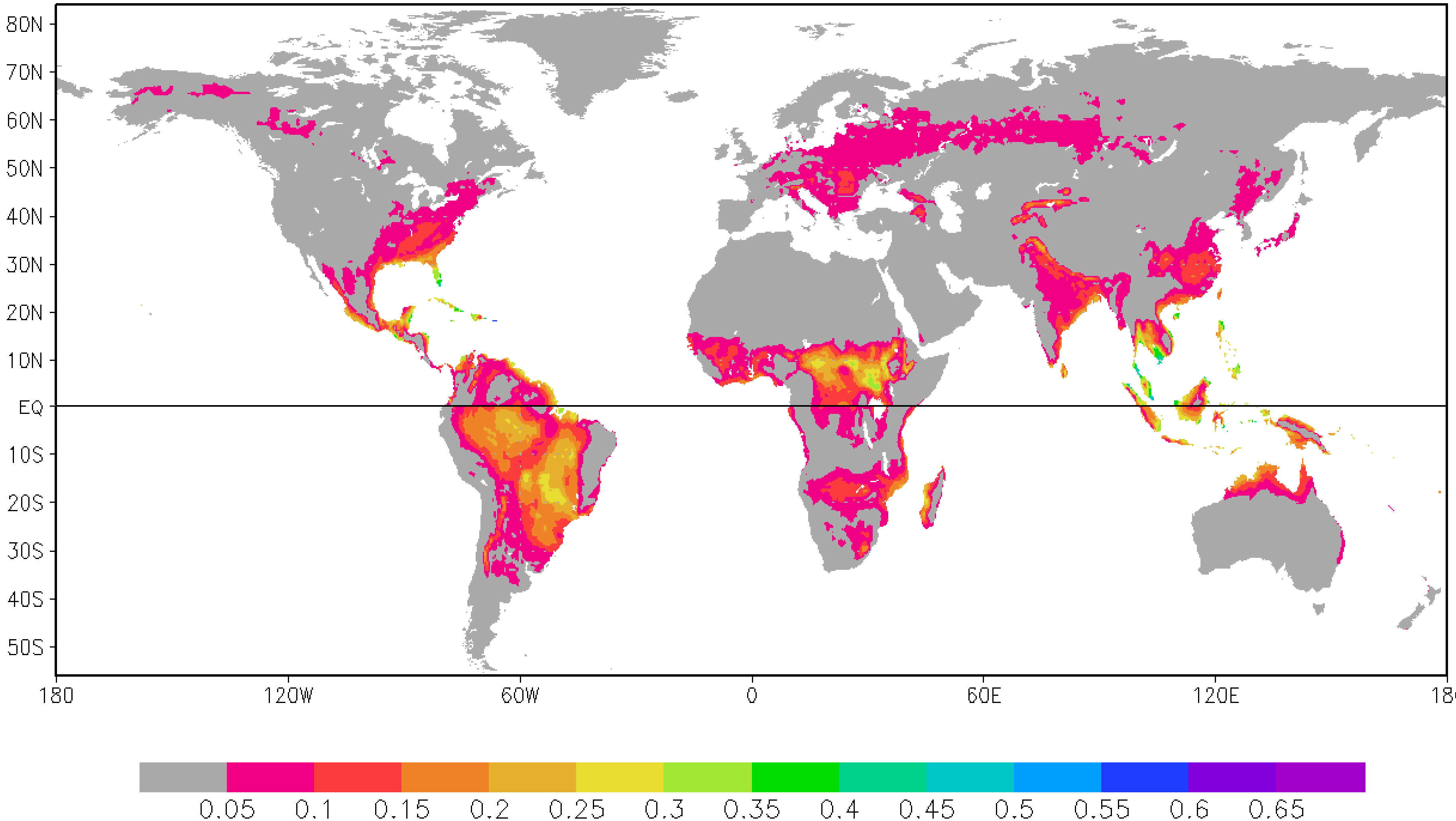
Global maps

- Reanalyses:
  - ERA Interim (ECMWF), 1999-2008
  - MERRA (NASA), 2003-2009
- Summer season
  - Northern Hemisphere: AMJJAS
  - Southern Hemisphere: ONDJFM
- On display: number of days with *possible*
  - +a feedback ($CTP\text{-}Hi_{low}$)
  - +b feedback ($\partial\theta_e/\partial\Lambda$)

Fraction of a+ summer days (CTP-Hi$_{low}$, Λ >0.7, Era-Int)



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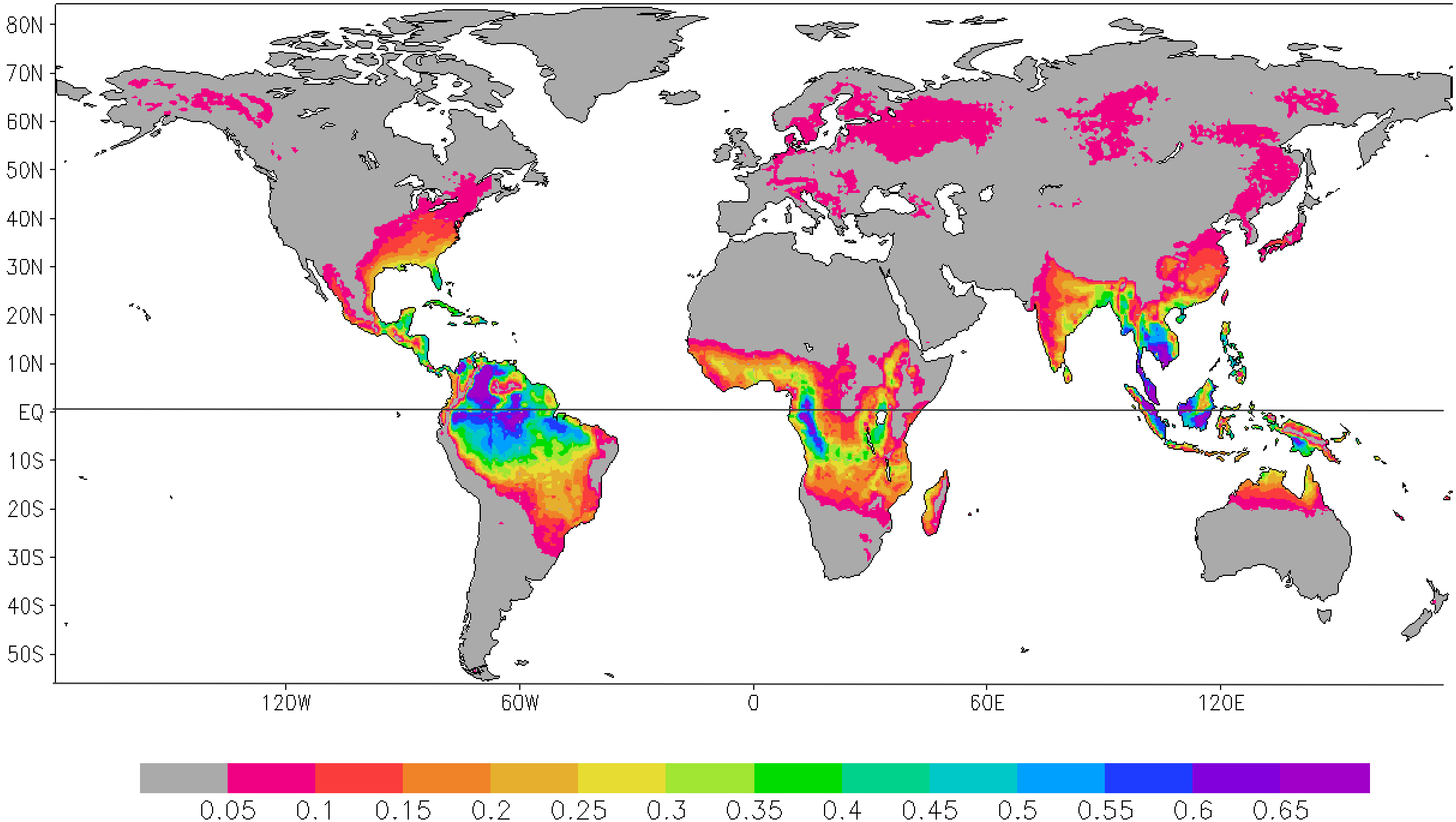
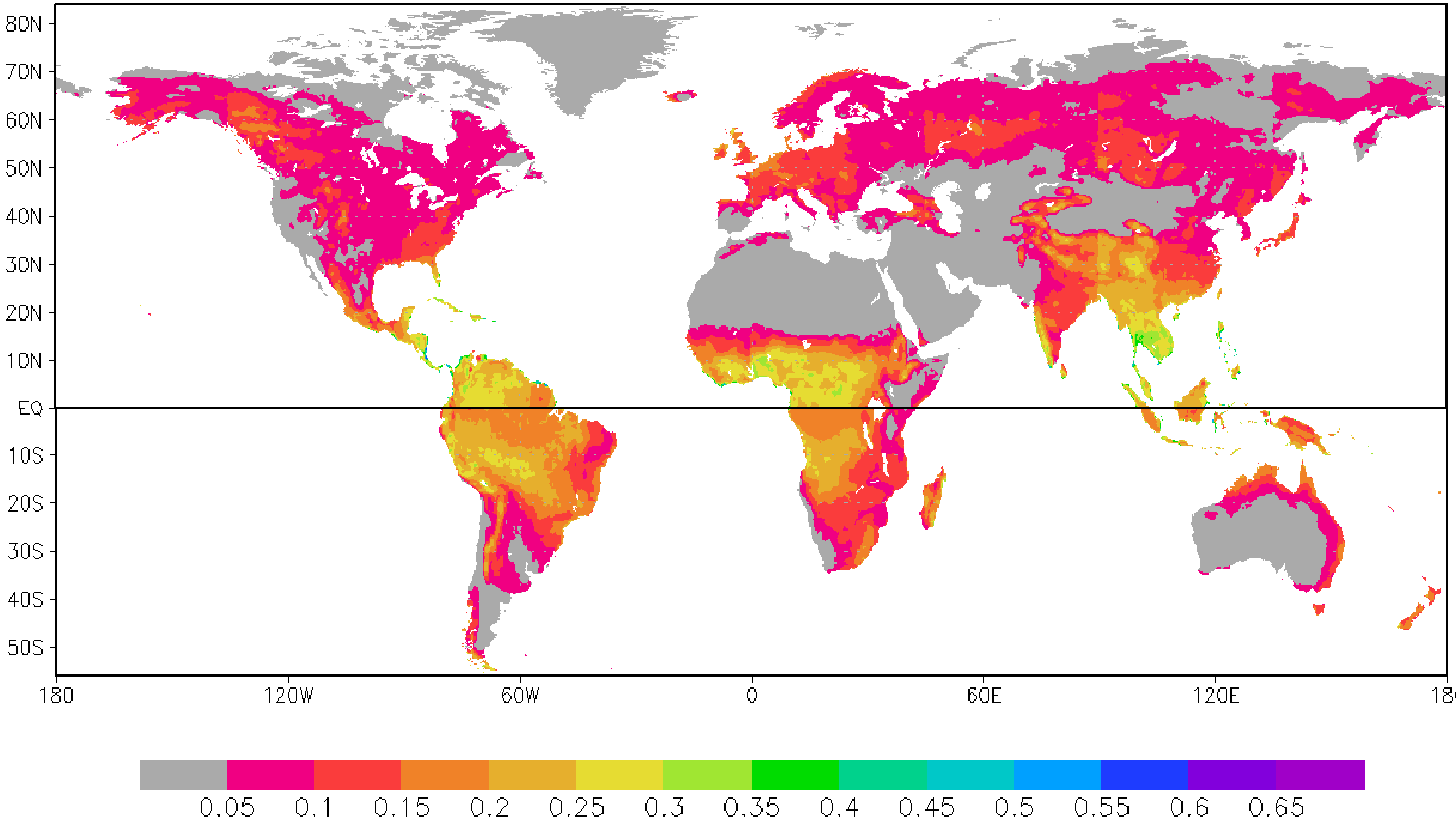
Fraction of a+ summer days (CTP-Hi$_{low}$, Λ >0.7, MERRA)



Fraction of b+ summer days ($\partial\theta_e / \partial\Lambda$, Era-Int)



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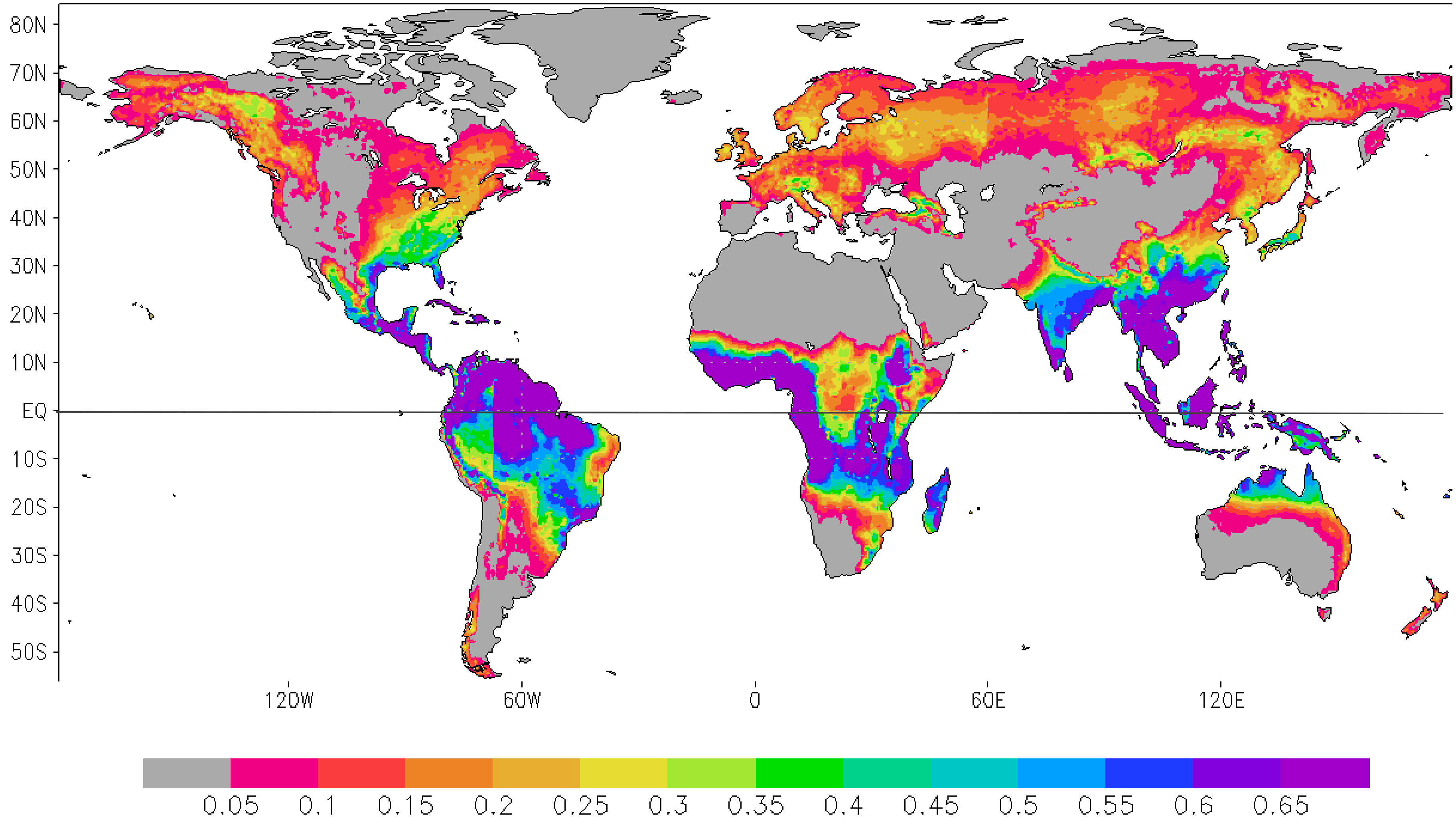
Fraction of b+ summer days ($\partial\theta_e / \partial\Lambda$, MERRA)



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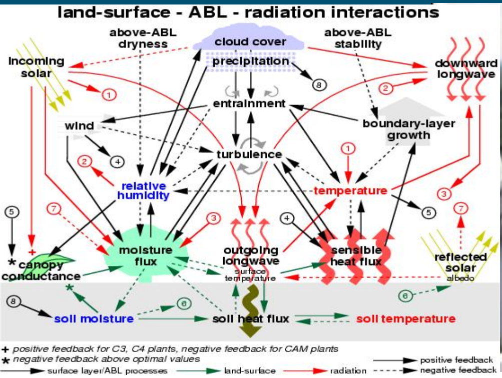
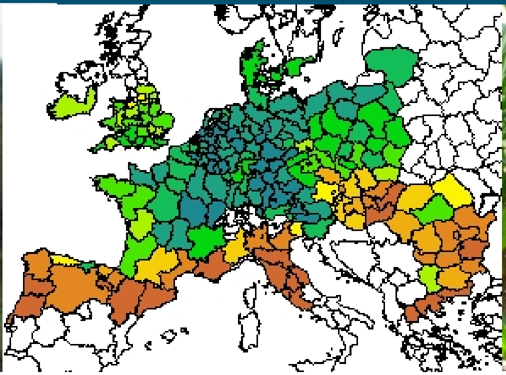
Discussion highlights

- Local Coupling frameworks seem to be useful for construction of an “observed” climatology of land surface - precipitation feedback hotspots, ***but***
  - Frameworks need some further evaluation and development
  - Extension to account for remote influences?
- ERA-Interim (1999-2008) and MERRA (2003-2009) lead to similar locations regarding feedback hotspots, ***but***
  - Notable exceptions may be some parts of tropical regions
  - Intensity differs

Thank you!

We appreciate feedback!





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