Impacts of extreme events seen by top-down vs. bottom up approaches

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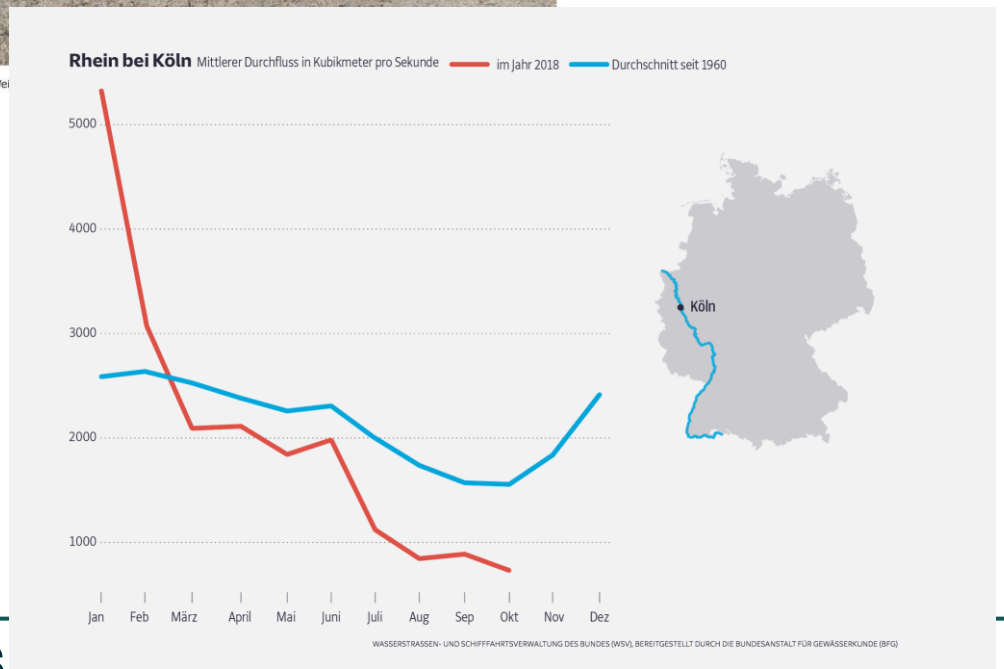
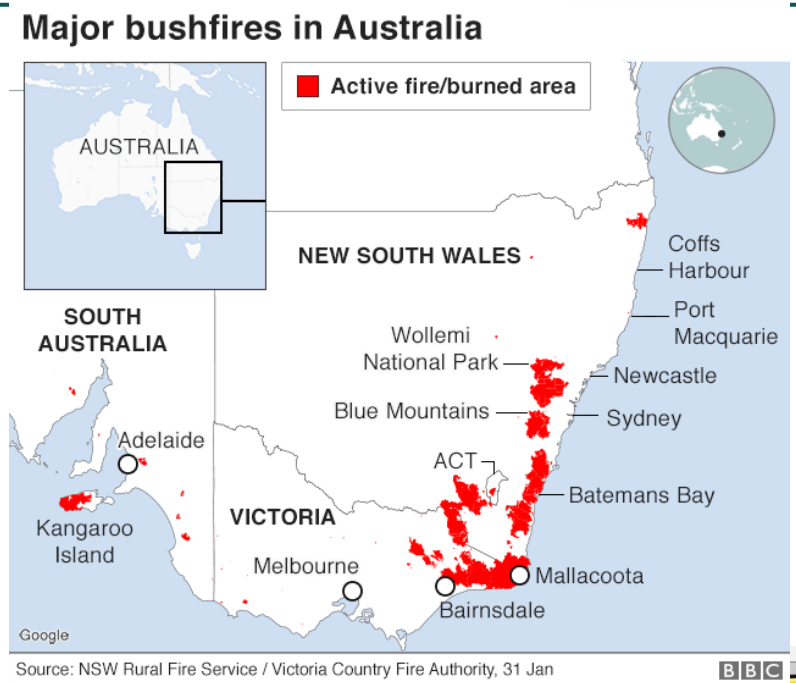
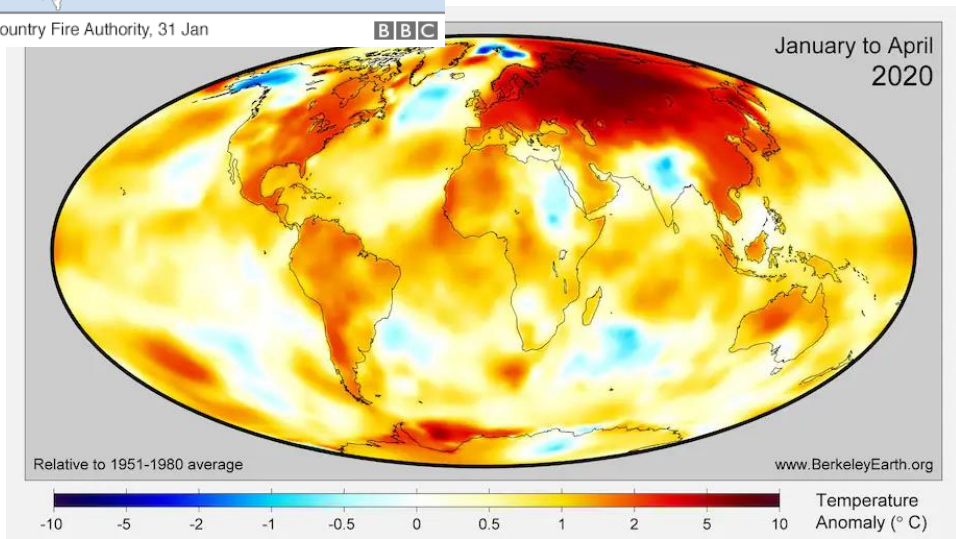
4th Carbon From Space | 25 October 2022 | Frascati

Motivation

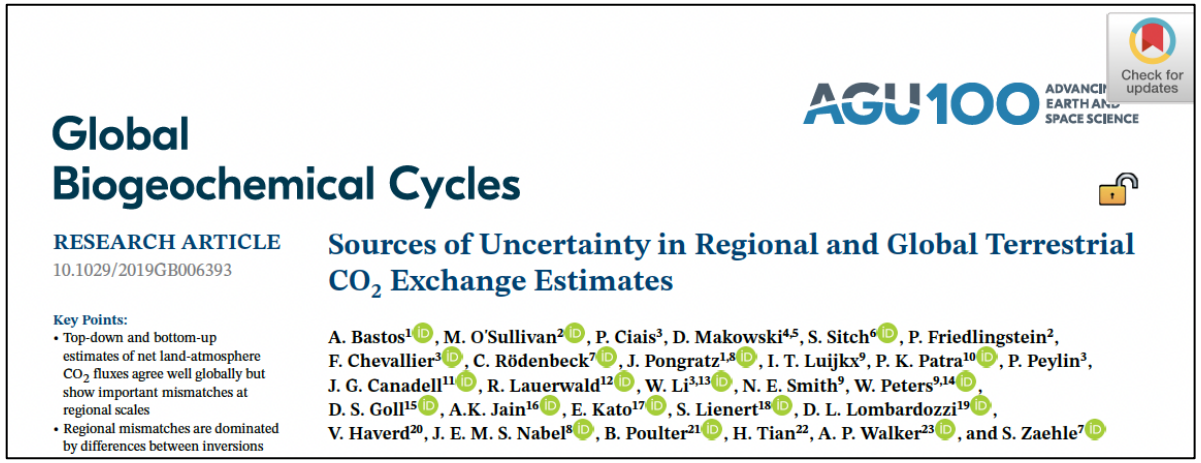

SPIEGEL ONLINE
SPIEGEL+
Anmelden
Schätzungen aus den Ländern
Dürre richtet in Deutschland mehr als eine Milliarde Euro Schaden an
Die wochenlange Dürre hat in der deutschen Landwirtschaft bereits einen Schaden von mehr als einer Milliarde Euro angerichtet. Das haben erste Schätzungen der Länder ergeben.
Kuh auf einer vertrockneten Wei


Rhein bei Köln Mittlerer Durchfluss in Kubikmeter pro Sekunde
im Jahr 2018
Durchschnitt seit 1960
5000
4000
3000
2000
1000
Jan
Feb
März
April
Mai
Juni
Juli
Aug
Sep
Okt
Nov
Dez
Köln
WASSERSTRASSEN- UND SCHIFFFAHRTSVERWALTUNG DES BUNDES (WSV), BEREITGESTELLT DURCH DIE BUNDESANSTALT FÜR GEWÄSSERKUNDE (BFG)


Major bushfires in Australia
Active fire/burned area
AUSTRALIA
NEW SOUTH WALES
SOUTH AUSTRALIA
VICTORIA
Coffs Harbour
Port Macquarie
Wollemi National Park
Newcastle
Blue Mountains
Sydney
ACT
Batemans Bay
Adelaide
Kangaroo Island
Melbourne
Mallacoota
Bairnsdale
Google
Source: NSW Rural Fire Service / Victoria Country Fire Authority, 31 Jan
BBC


January to April
2020
Relative to 1951-1980 average
www.BerkeleyEarth.org
-10
-5
-2
-1
-0.5
0
0.5
1
2
5
10
Temperature Anomaly (° C)

Motivation



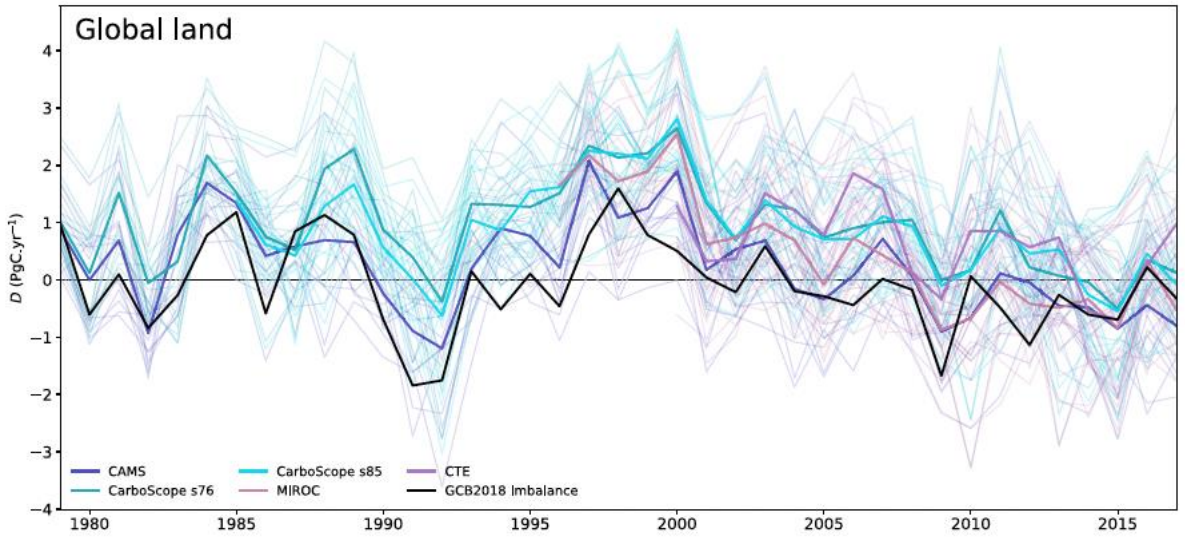
Global Biogeochemical Cycles

RESEARCH ARTICLE
10.1029/2019GB006393

Sources of Uncertainty in Regional and Global Terrestrial CO_2 Exchange Estimates

Key Points:
- Top-down and bottom-up estimates of net land-atmosphere CO_2 fluxes agree well globally but show important mismatches at regional scales
- Regional mismatches are dominated by differences between inversions

A. Bastos[1], M. O'Sullivan[2], P. Ciais[3], D. Makowski[4,5], S. Sitch[6], P. Friedlingstein[2], F. Chevallier[3], C. Rödenbeck[7], J. Pongratz[1,8], I. T. Luijkx[9], P. K. Patra[10], P. Peylin[3], J. G. Canadell[11], R. Lauerwald[12], W. Li[3,13], N. E. Smith[9], W. Peters[9,14], D. S. Goll[15], A.K. Jain[16], E. Kato[17], S. Lienert[18], D. L. Lombardozzi[19], V. Haverd[20], J. E. M. S. Nabel[8], B. Poulter[21], H. Tian[22], A. P. Walker[23], and S. Zaehle[7]



Difference between inversions and DGVMs in GCB2019

Datasets

Atmospheric Inversions

- 5 inversions from RECCAP2: **2000 - 2020**
- Ensemble of 13 inversions from OCO2_v10mip: **2015 - 2020**
- Gridded to common grid at 1x1 degree lat/lon spatial resolution
- Calculate mean + std across inversions
- Monthly time-steps
- Deasonalized anomalies

!!! Temporal discontinuity in datasets

DGVMs

- 2 DGVMs from ESA-CCI RECCAP2: JULES + OCN for **1950 - 2020**
- Gridded to common grid at 1x1 degree lat/lon spatial resolution
- Simulations "S2": CO_2 and climate change but no LUC
- ERA5 climate forcing
- Monthly time-steps
- Deasonalized anomalies

SMOS L-VOD

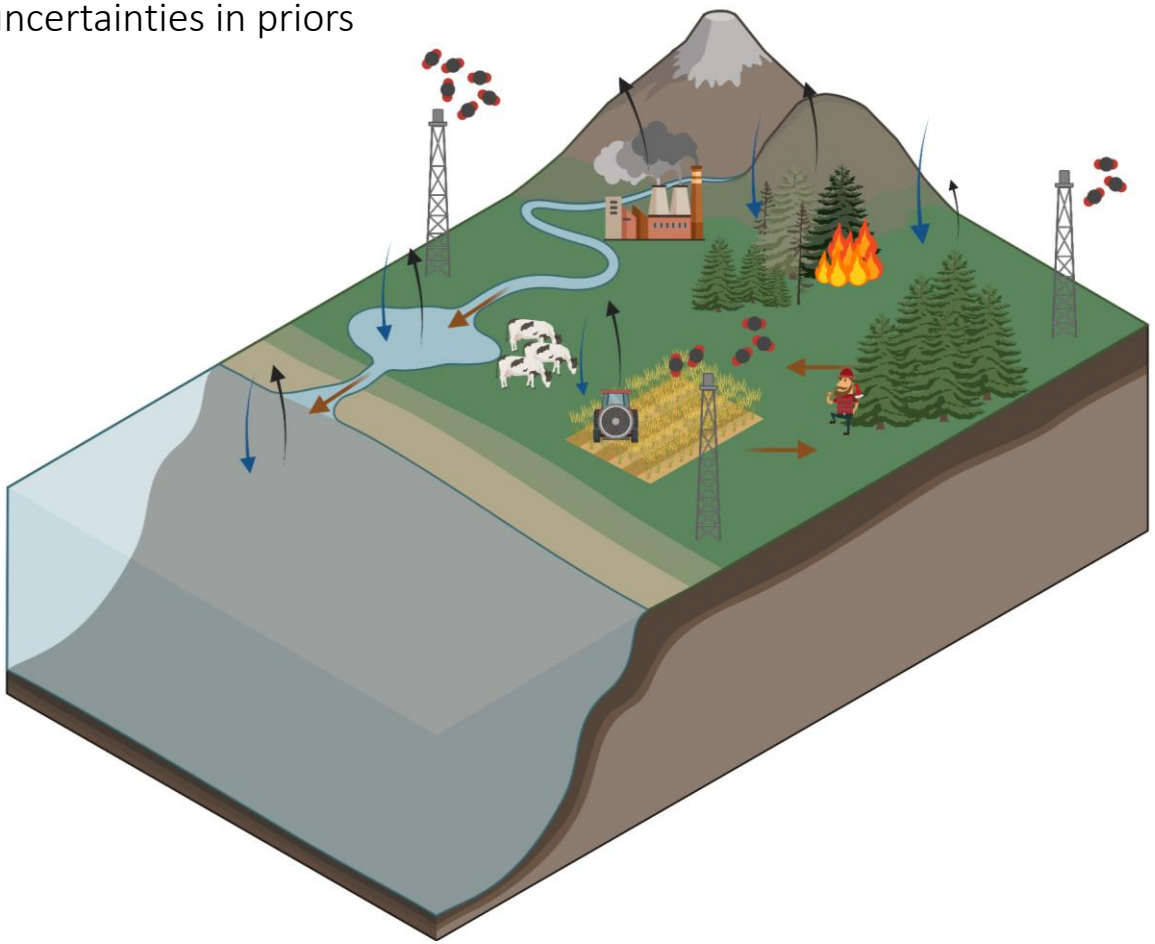
- Aboveground biomass changes based on SMOS L-VOD **2010-2020**
- L-VOD → AGB using ESA-CCI coefficients
- Regridded to 1x1 degree lat/lon spatial resolution
- Annual mean
- Analyse ΔAGB → closer to net aboveground C flux
- Departures from mean for anomalies

Anomalies calculated relative to 2015-2020 for consistency with OCO-2 MIP inversions

Datasets

Inversions

- consistent with global atmospheric CO_2 growth rate
- regional/national fluxes uncertain
- uncertainties in priors



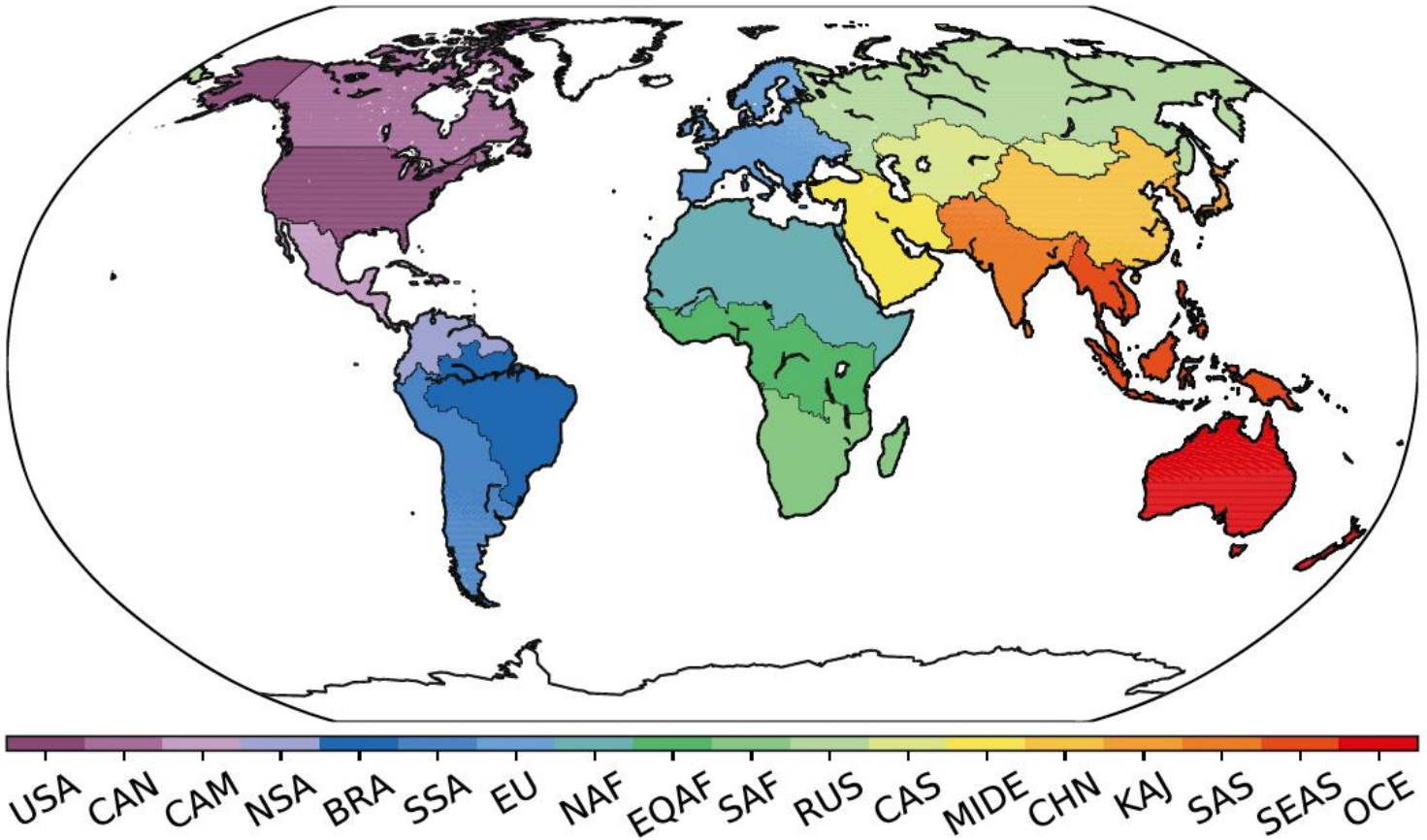
L-VOD

- allow to infer biomass changes
- coarse resolution
- RFI interference
- only aboveground components

DGVMs

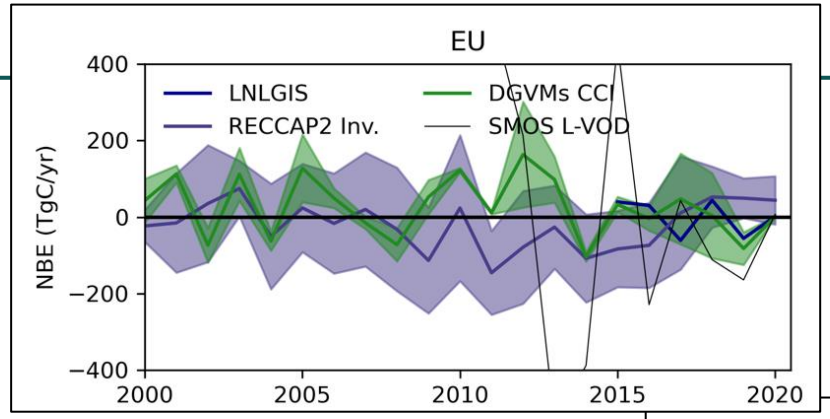
- allow for attribution to specific processes
- no lateral C transport
- poor representation of disturbances & mortality
- inconsistent definitions
- uncertainties in forcing data and parameters

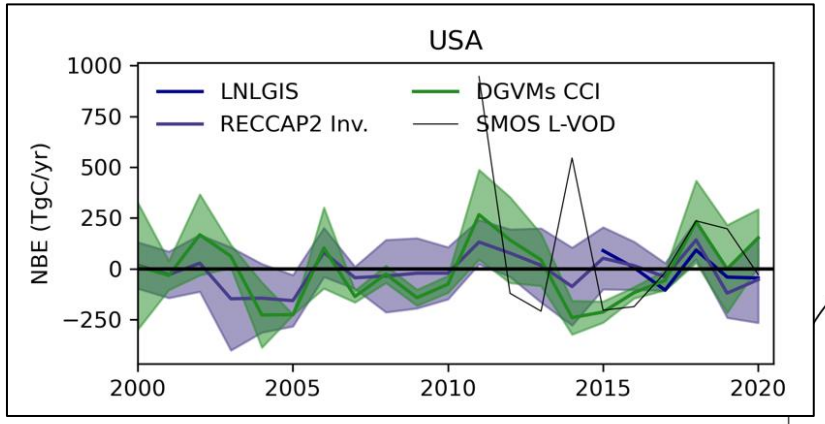
Regional fluxes

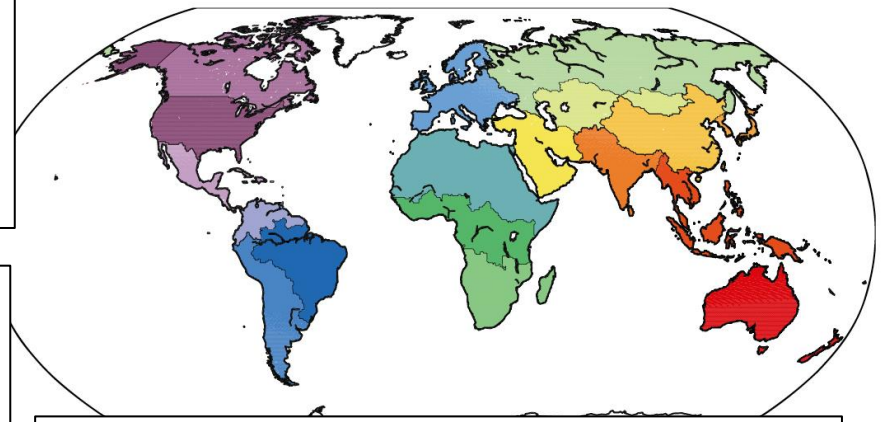


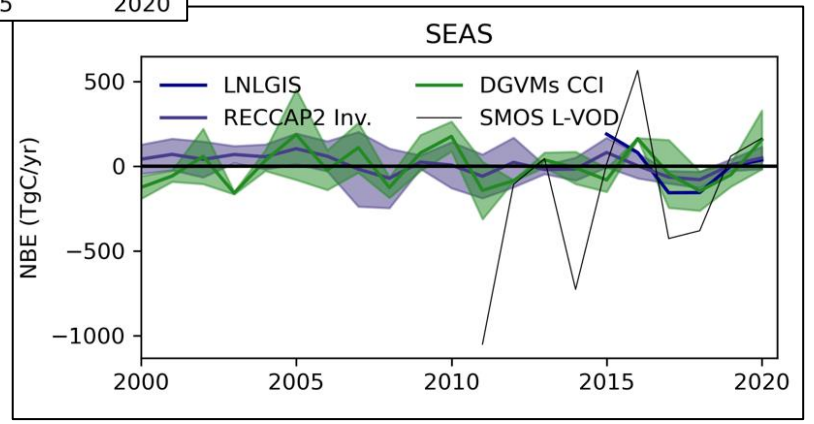
- Annual fluxes:
  - Identification of “high impact” extreme events
- Comparison of sensivity of carbon fluxes to temperature and water

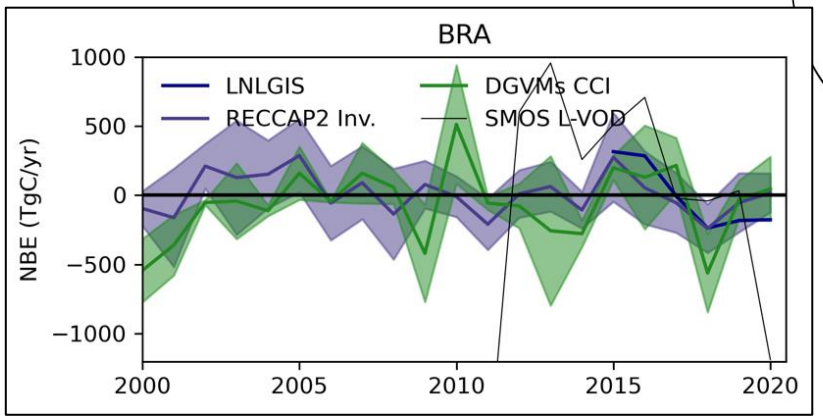
Interannual variability

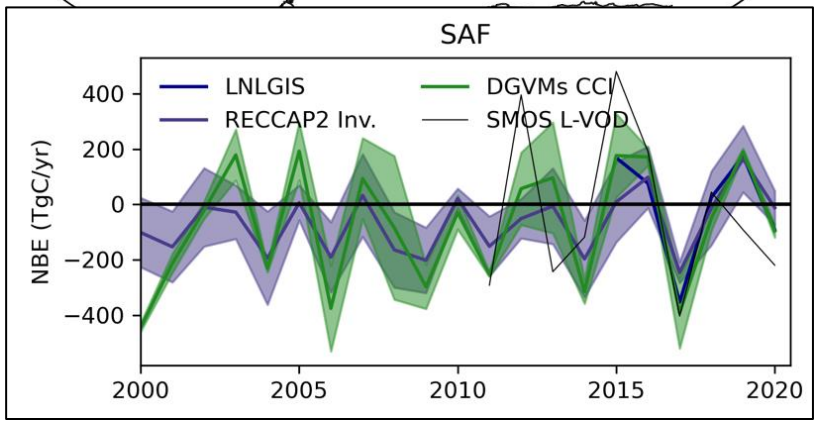


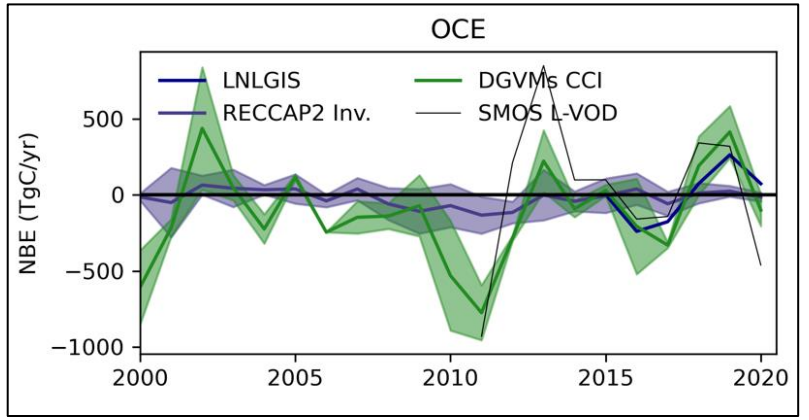






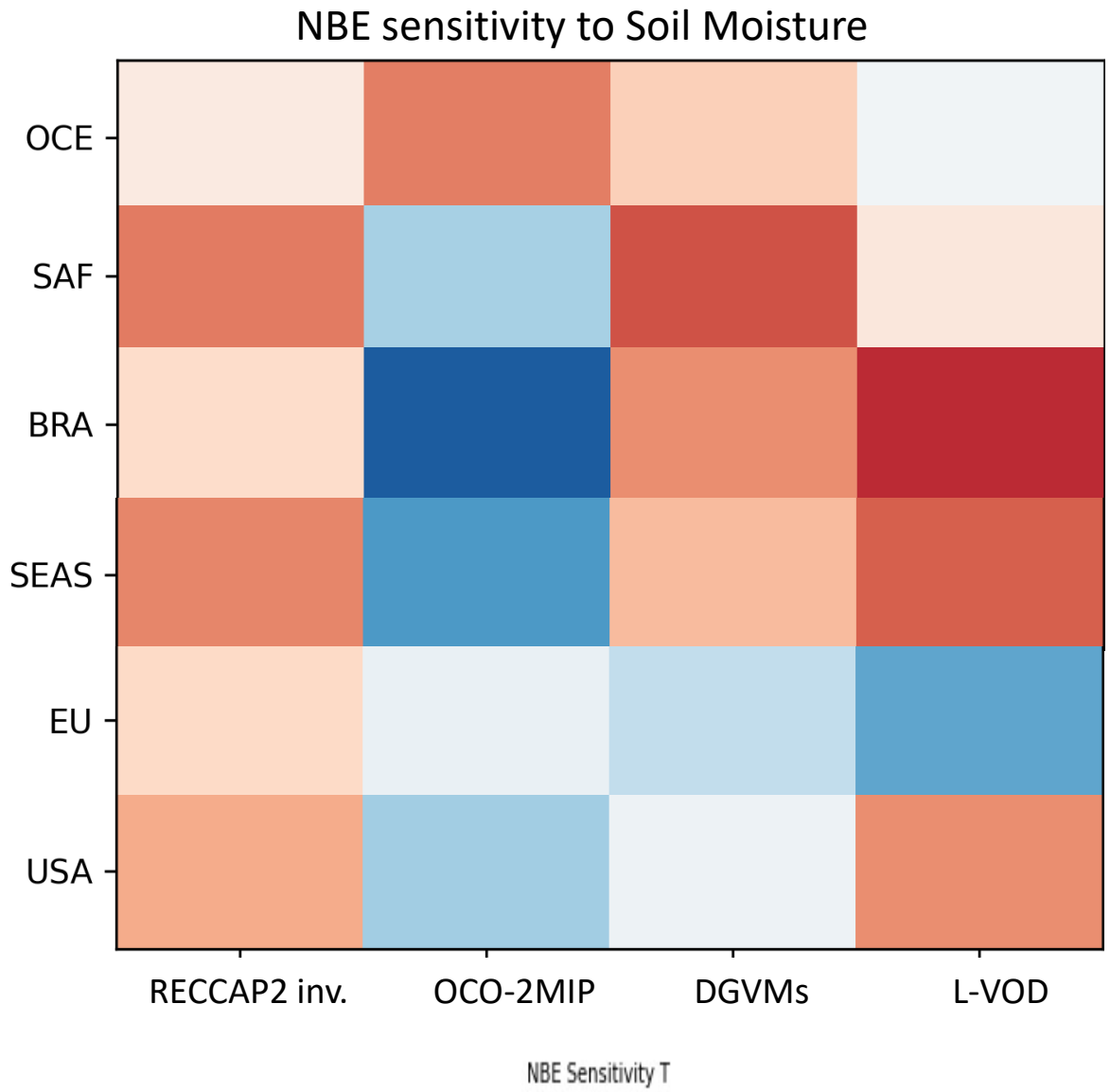






- Agreement strongly region-dependent
- Better agreement during extreme events (?)

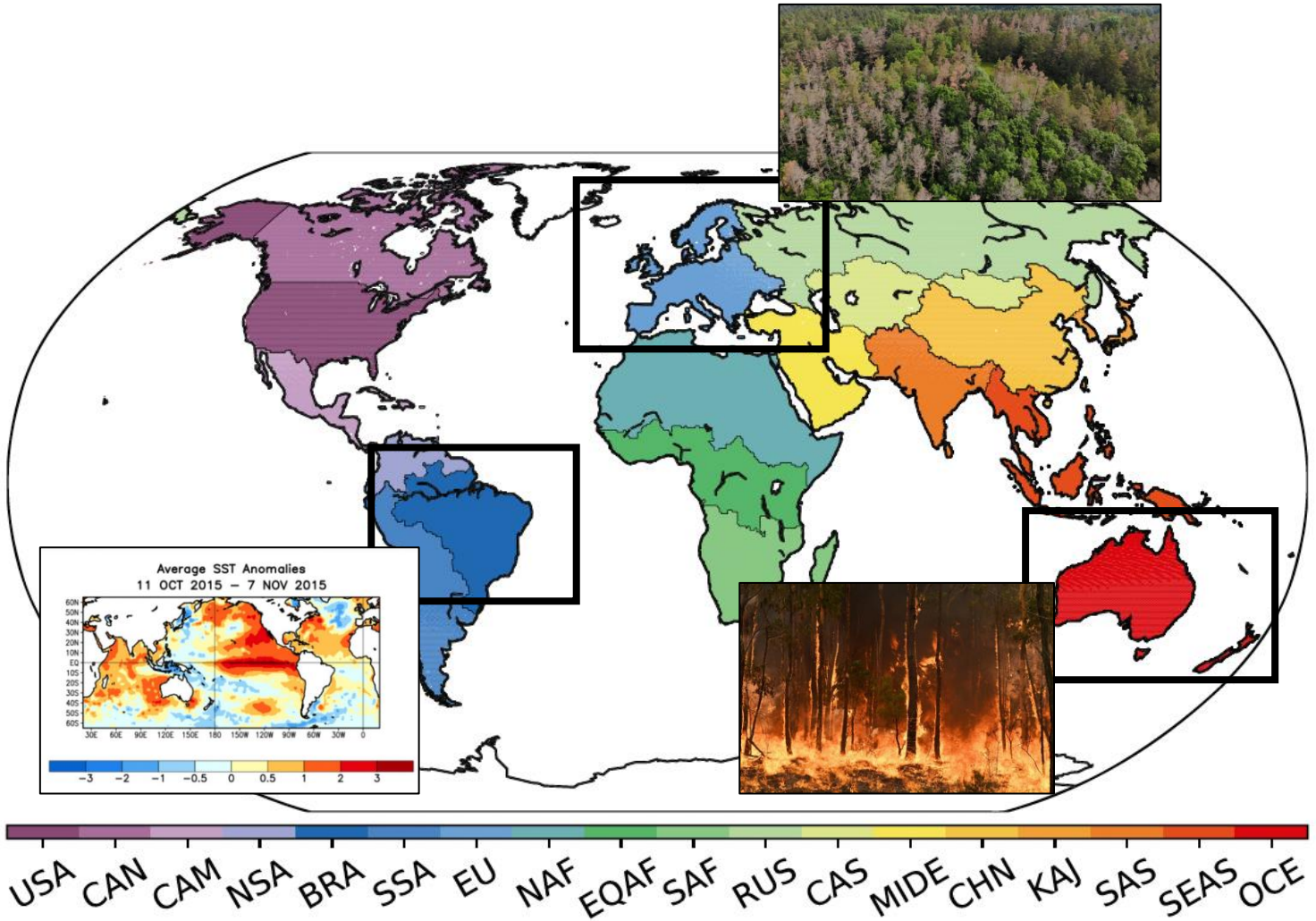
Sensitivity to drought



Drought
→ Source anomaly

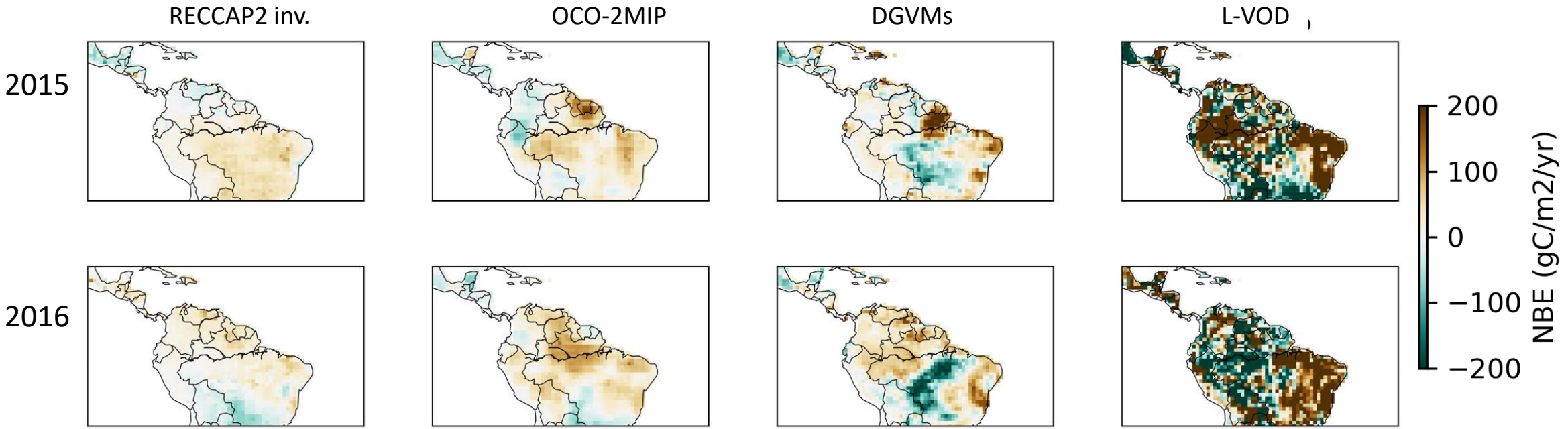
Dry
→ Sink anomaly

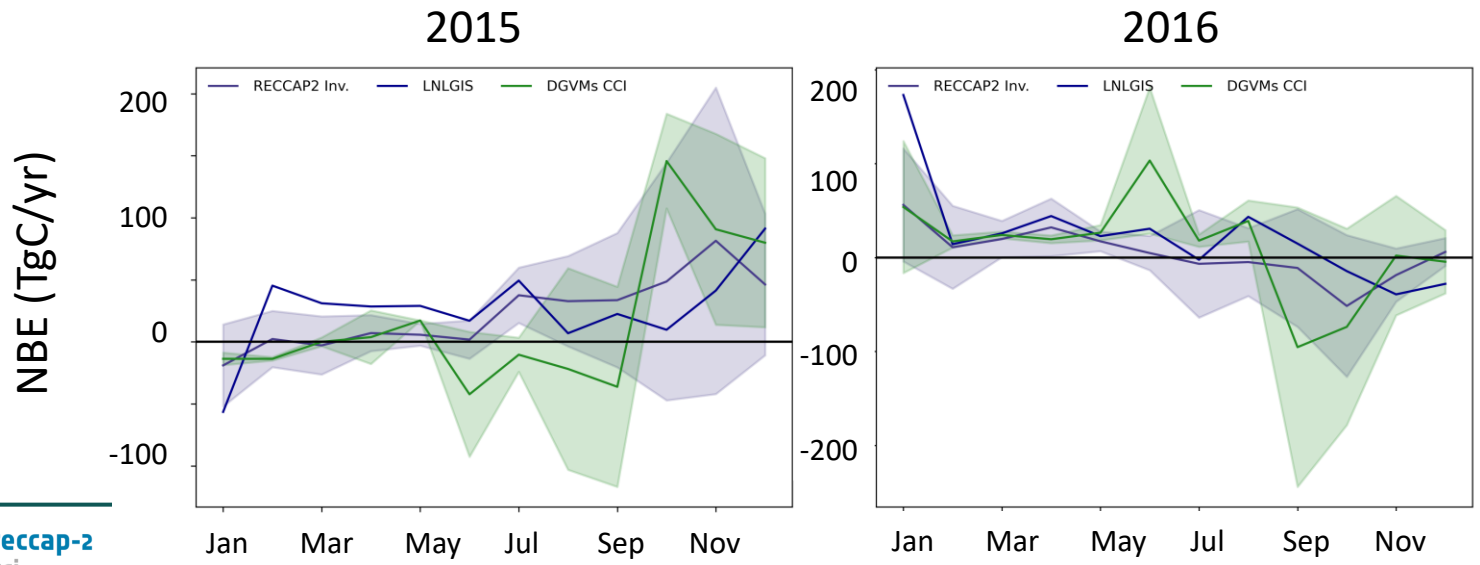
Regional anomalies during extremes



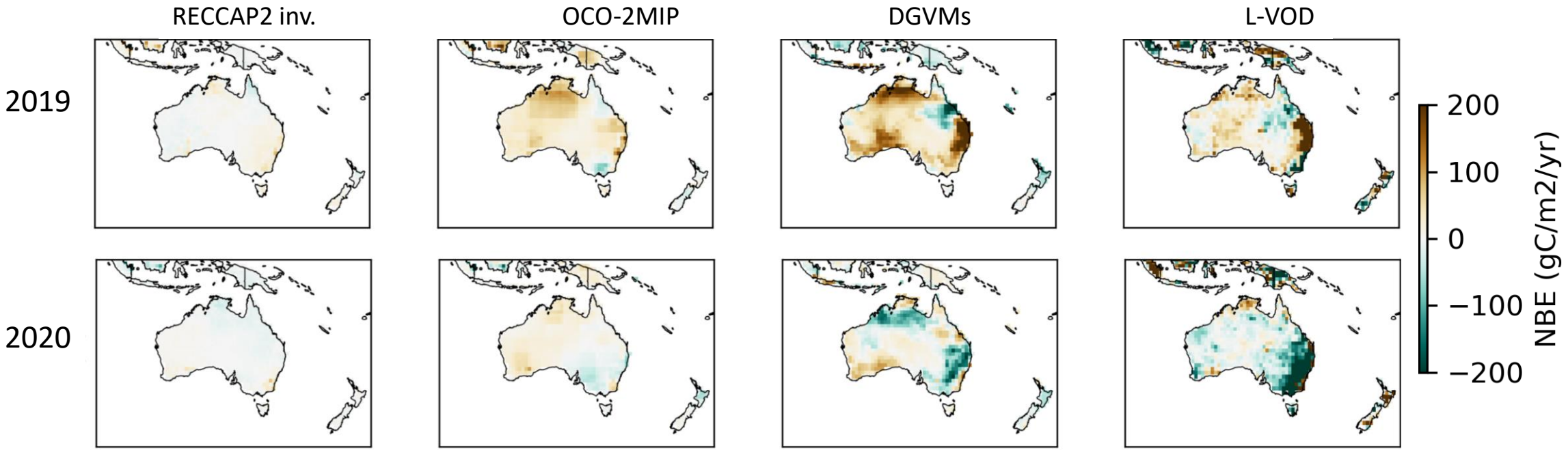
- Annual fluxes:
  - Identification of “high impact” extreme events
- Comparison of sensivity of carbon fluxes to temperature and water
- Selected extreme events:
  - Spatial distribution of anomalies
  - Seasonal evolution of anomalies

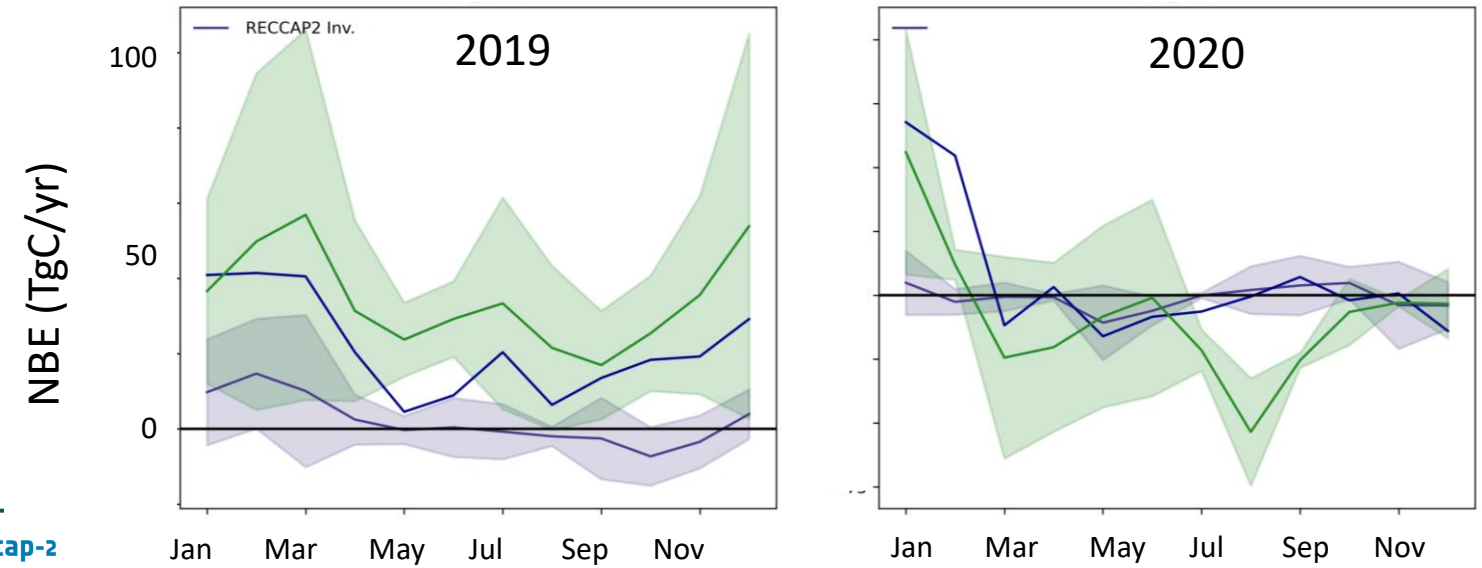
BRAZIL: 2015/16



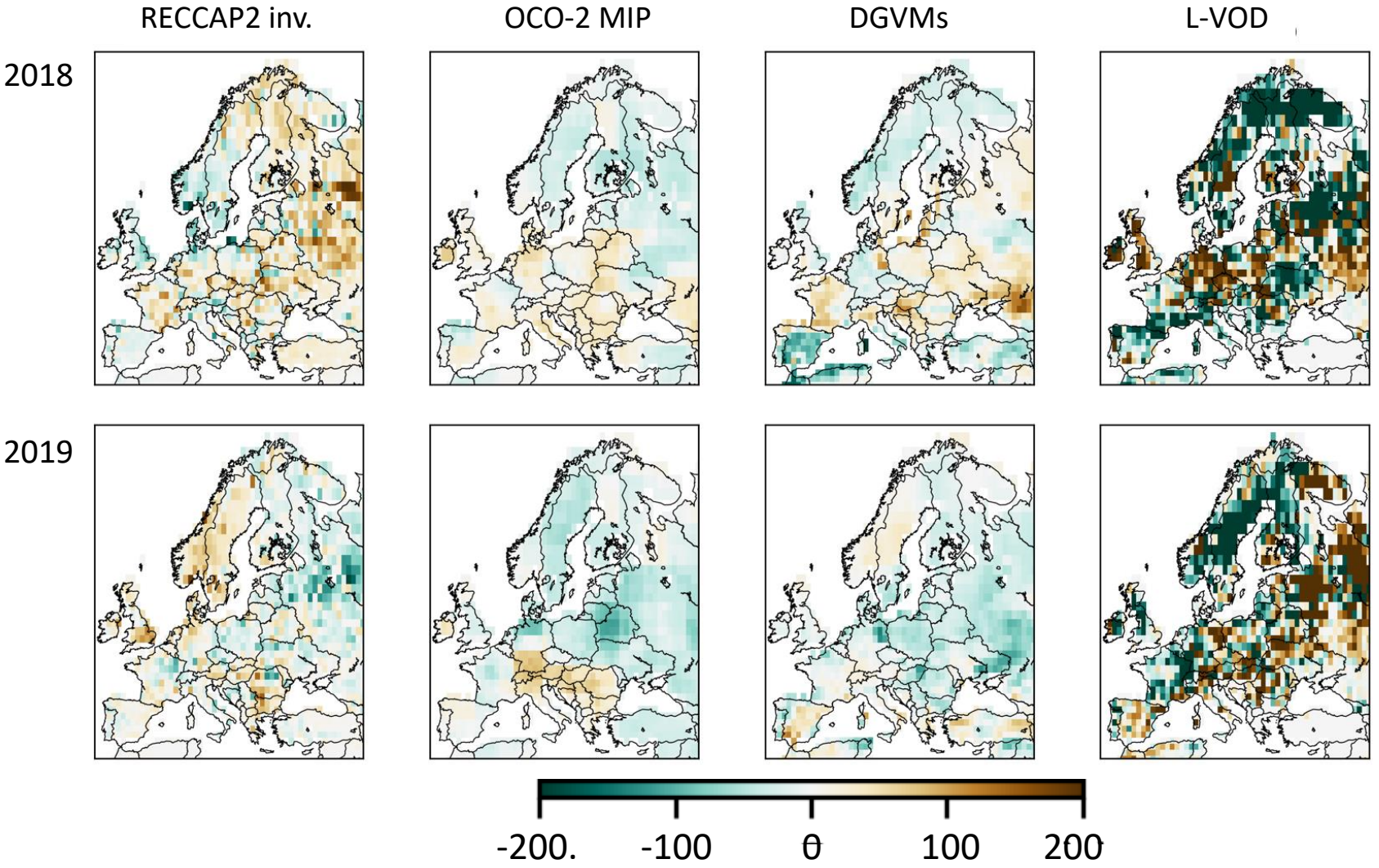


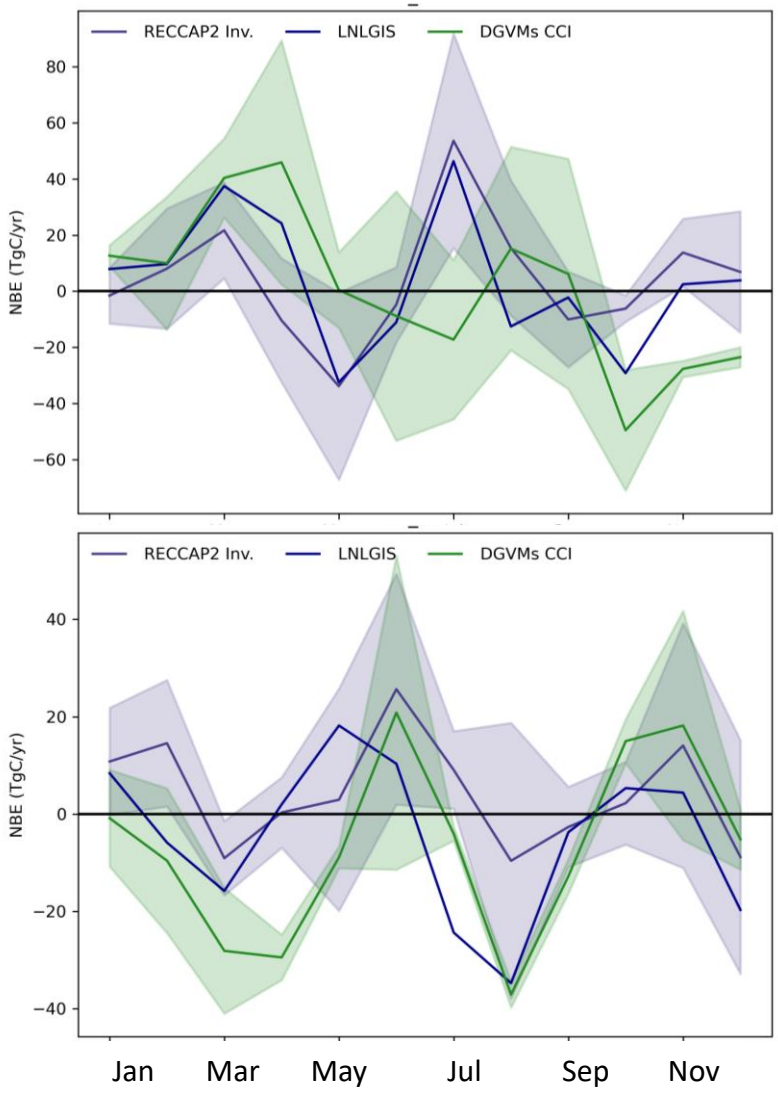
OCE: 2019 and 2020



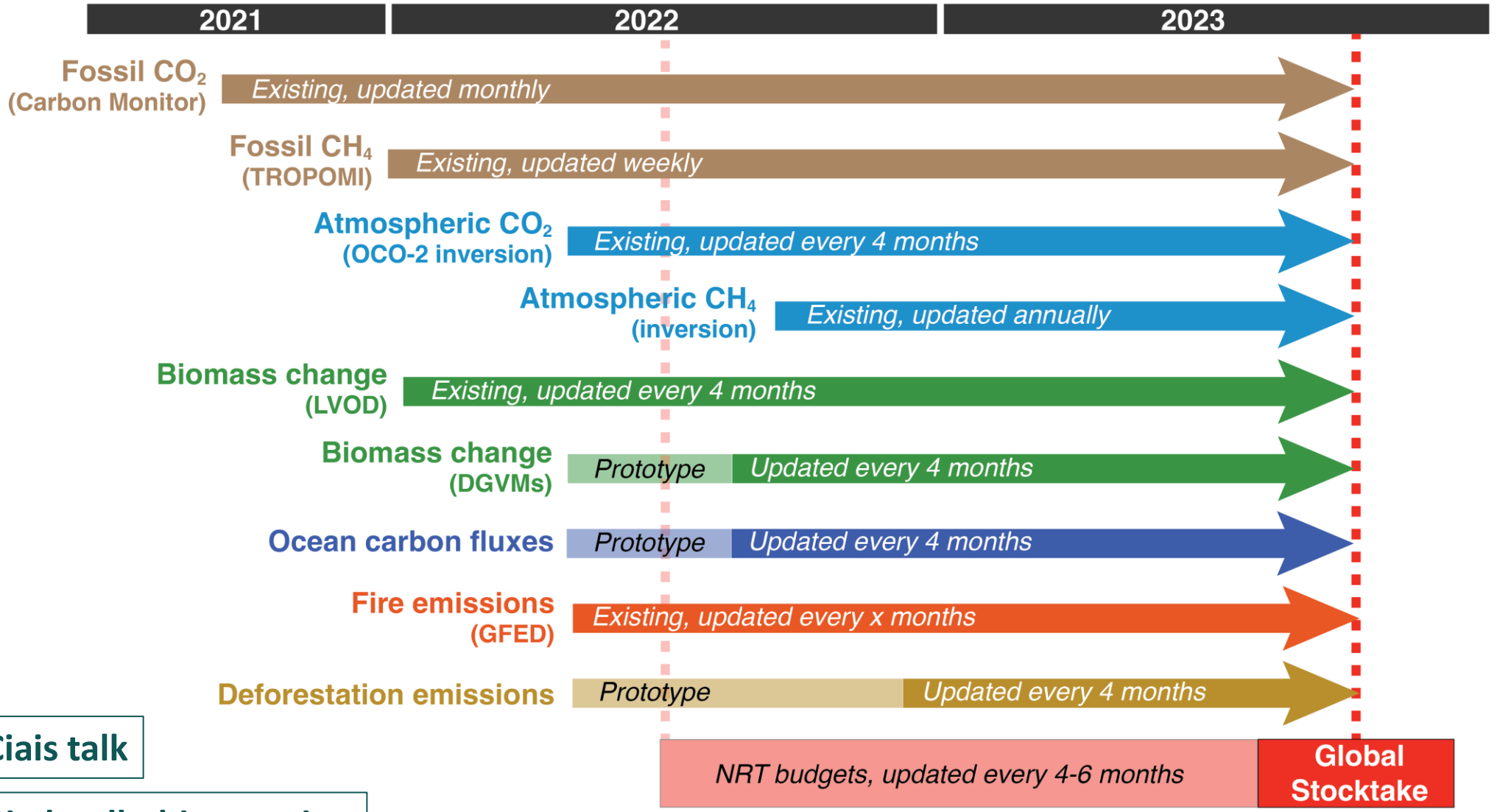


EU: 2018/19


RECCAP2 inv.
OCO-2 MIP
DGVMs
L-VOD
2018
2019
-200.
-100
0
100
200


RECCAP2 Inv.
LNLGIS
DGVMs CCI
NBE (TgC/yr)
80
60
40
20
0
−20
−40
−60
RECCAP2 Inv.
LNLGIS
DGVMs CCI
NBE (TgC/yr)
40
20
0
−20
−40
Jan
Mar
May
Jul
Sep
Nov

Towards NRT C budgets



P.Ciais talk

S.Sitch talk this morning

Ciais et al. *in prep*

Summary

- Land C fluxes increasingly better constrained by top down & bottom-up approaches
- Still disagreements in sensitivity to climate drivers across datasets
- Anomalies in responses to extremes relatively well constrained
- Disagreements are still highly informative
- Progress towards NRT information about C impacts of extremes (but constraining uncertainty is key)