Understanding Model Confirmation in Climate Modeling

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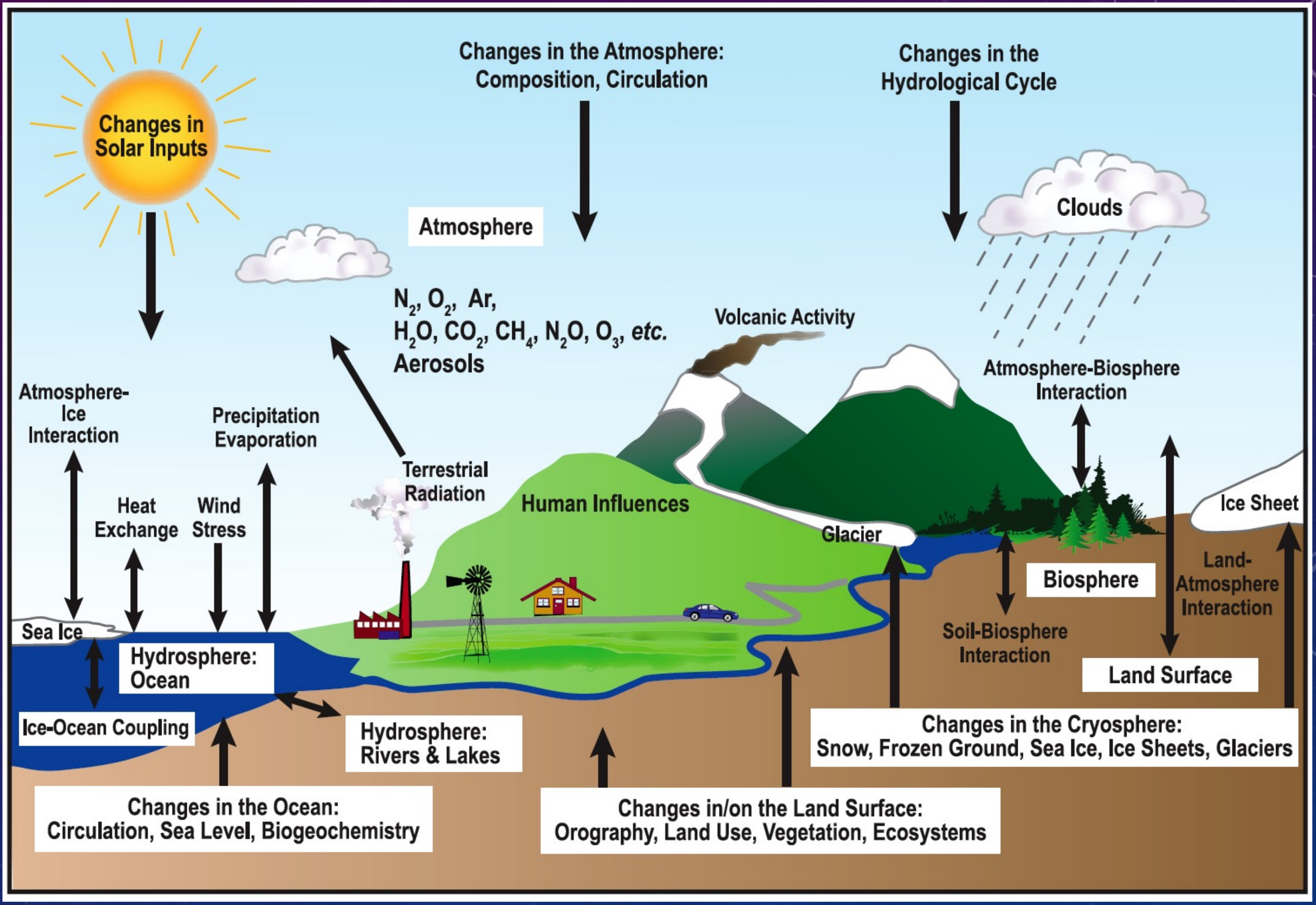
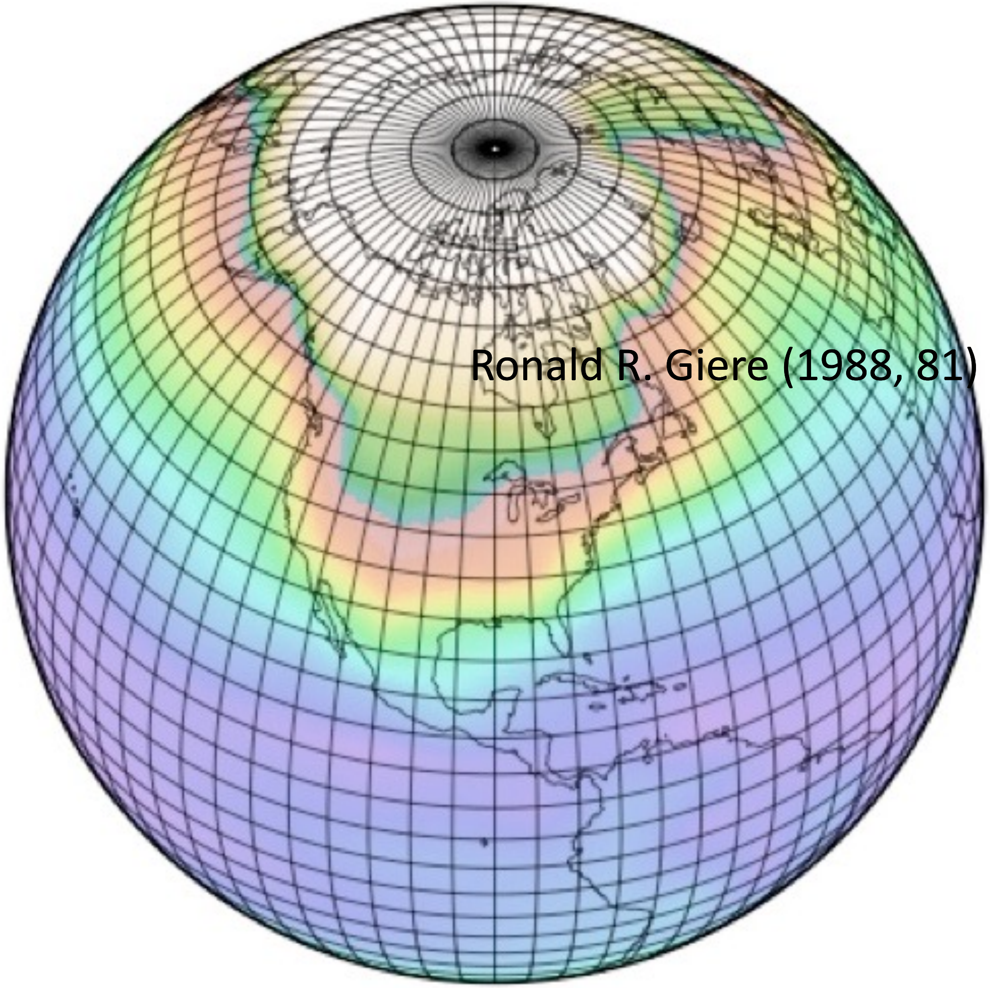
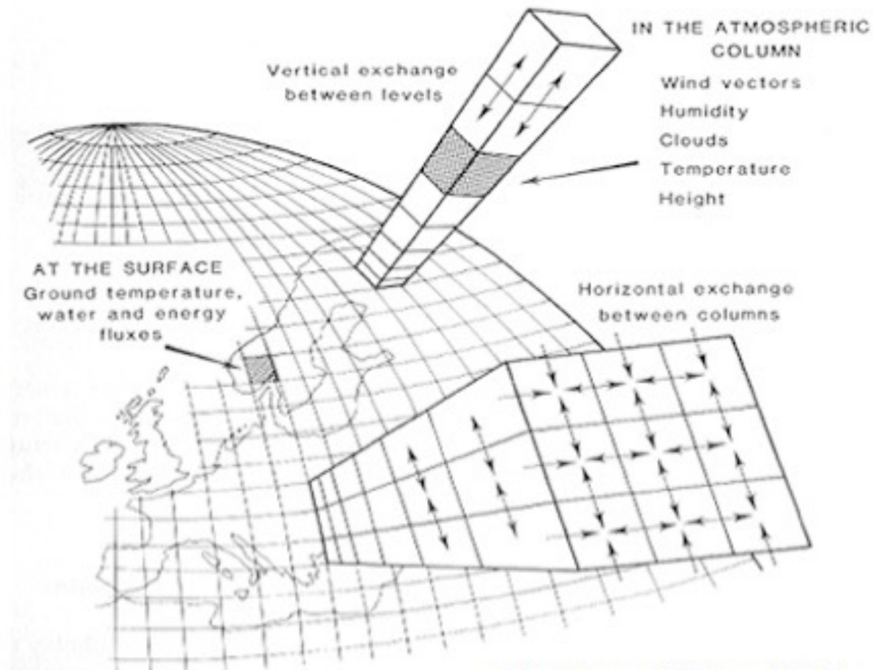
BOULDER, CO (2013-2020)



Changes in Solar Inputs
Changes in the Atmosphere: Composition, Circulation
Changes in the Hydrological Cycle
Atmosphere
Clouds
N_2, O_2, Ar,
H_2O, CO_2, CH_4, N_2O, O_3, *etc.*
Aerosols
Volcanic Activity
Atmosphere-Biosphere Interaction
Atmosphere-Ice Interaction
Precipitation Evaporation
Terrestrial Radiation
Human Influences
Heat Exchange
Wind Stress
Glacier
Ice Sheet
Biosphere
Land-Atmosphere Interaction
Sea Ice
Hydrosphere: Ocean
Soil-Biosphere Interaction
Land Surface
Ice-Ocean Coupling
Hydrosphere: Rivers & Lakes
Changes in the Cryosphere: Snow, Frozen Ground, Sea Ice, Ice Sheets, Glaciers
Changes in the Ocean: Circulation, Sea Level, Biogeochemistry
Changes in/on the Land Surface: Orography, Land Use, Vegetation, Ecosystems



Ronald R. Giere (1988, 81)



(Henderson-Sellers, 1985)

RONALD R. GIERE (1988, 81)

Theoretical Hypothesis:

“such-and-such identifiable real system, is similar to a designated model in indicated respects and degrees” “scientists use models to represent aspects of the world for specific <u>purposes</u>” (Giere 2004, p. 742).

RONALD R. GIERE (2009, 1; VAN FRAASSEN 2008, 309))

“Agents intend to use a model, M, to represent a part of the world, W, for some purpose, P.”

MODEL VALIDATION

Data used in model construction:

1900-1980

Data used in model validation:

1981-2010, 1860-1899

SHUGART 1984,

POWER 1993,

RYKIEL 1996

“No climate model has been scientifically validated.””

Marshall Institute

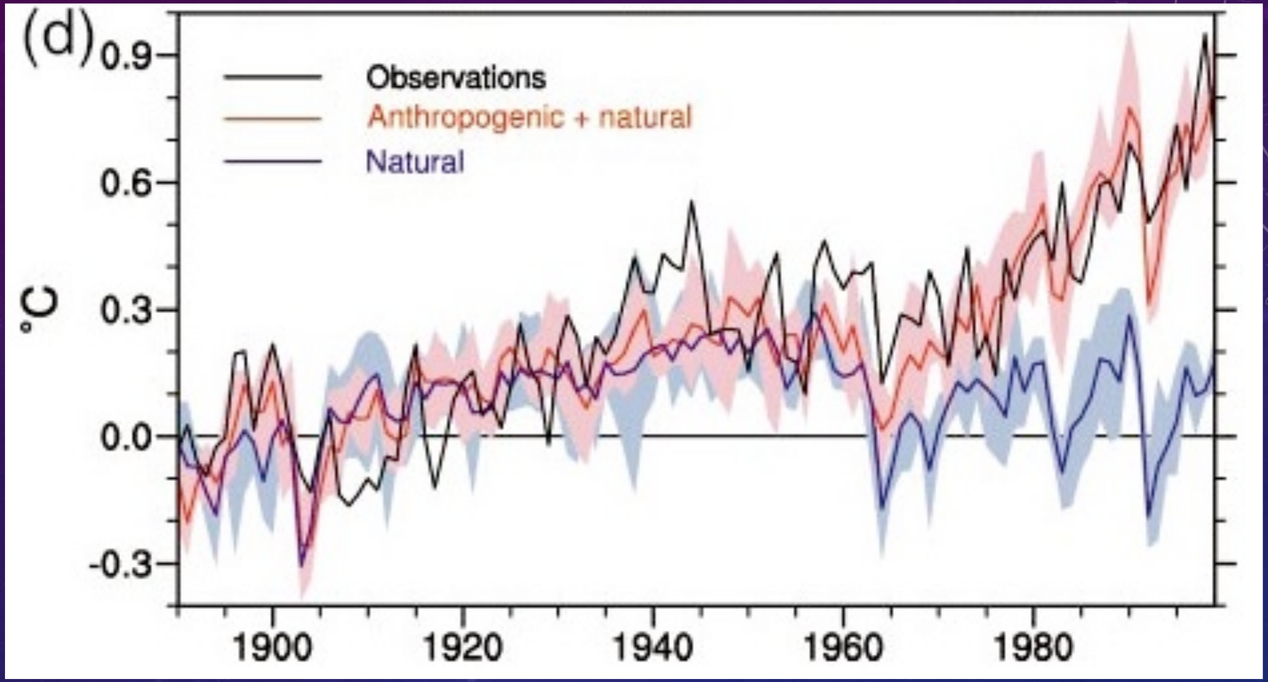
(2006)

“Observational evidence does not support today’s computer climate models, so there is little reason to trust model predictions of the future.”

Open letter to Canadian Prime Minister Stephen Harper

signed by 66 scientsts

April 16, 2006, Financial Post



Meehl et al.
(2004)

Variety Of Good Model Fit

- Global mean temperature
- Precipitation
- Radiation
- Wind
- Oceanic temp
- Currentsratures

Randall et al.
(2007)

Variety Of Good Model Fit

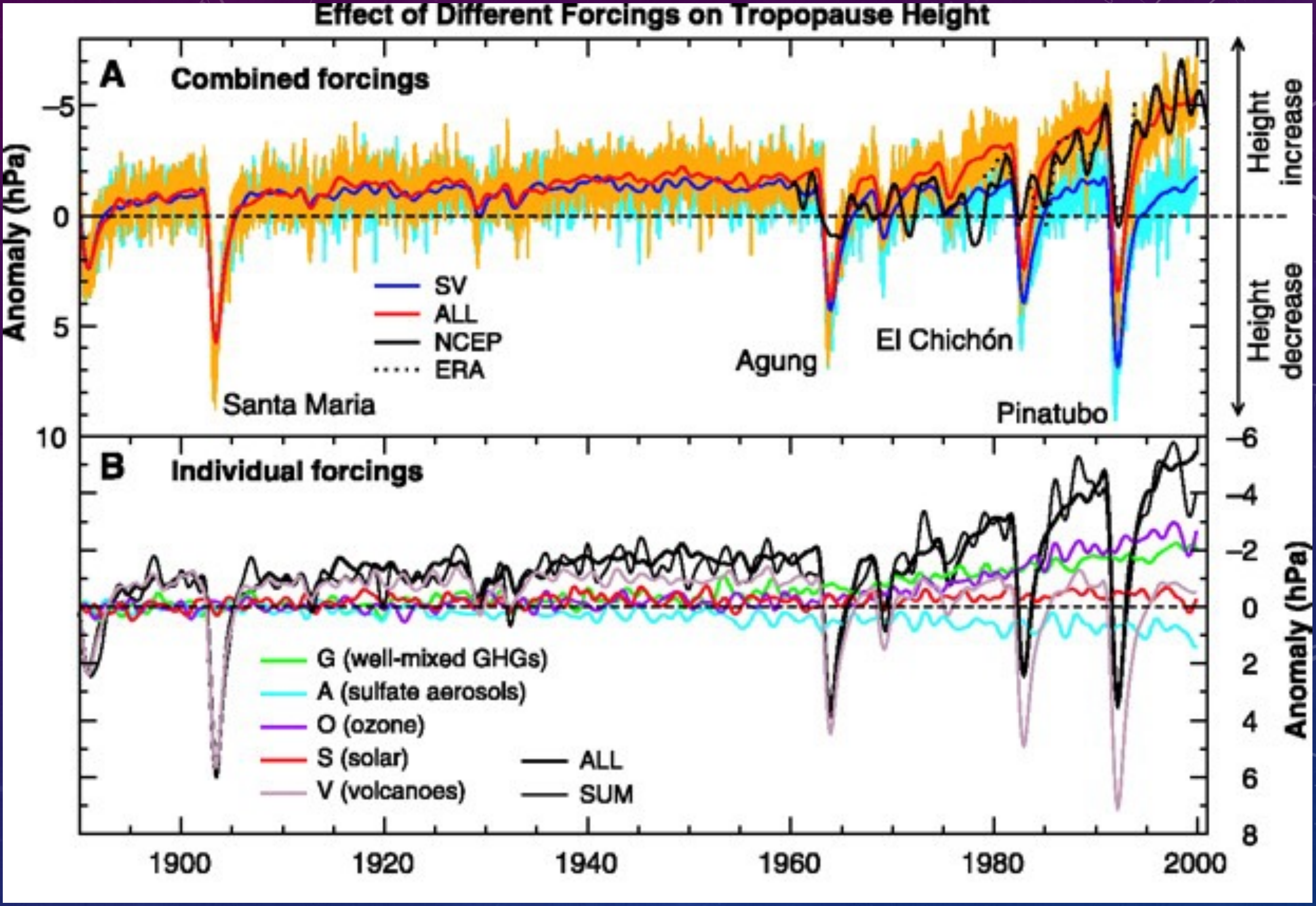
- Advance/retreat of major monsoon systems
- Seasonal shifts in temperature
- Storm tracks
- Rain belts

Randall et al.
(2007)

Variety Of Good Fit:
Different Climate Contexts

- Mid-Holocene warming (6,000 years ago)
- Last Glacial Maximum (21,000 years ago)

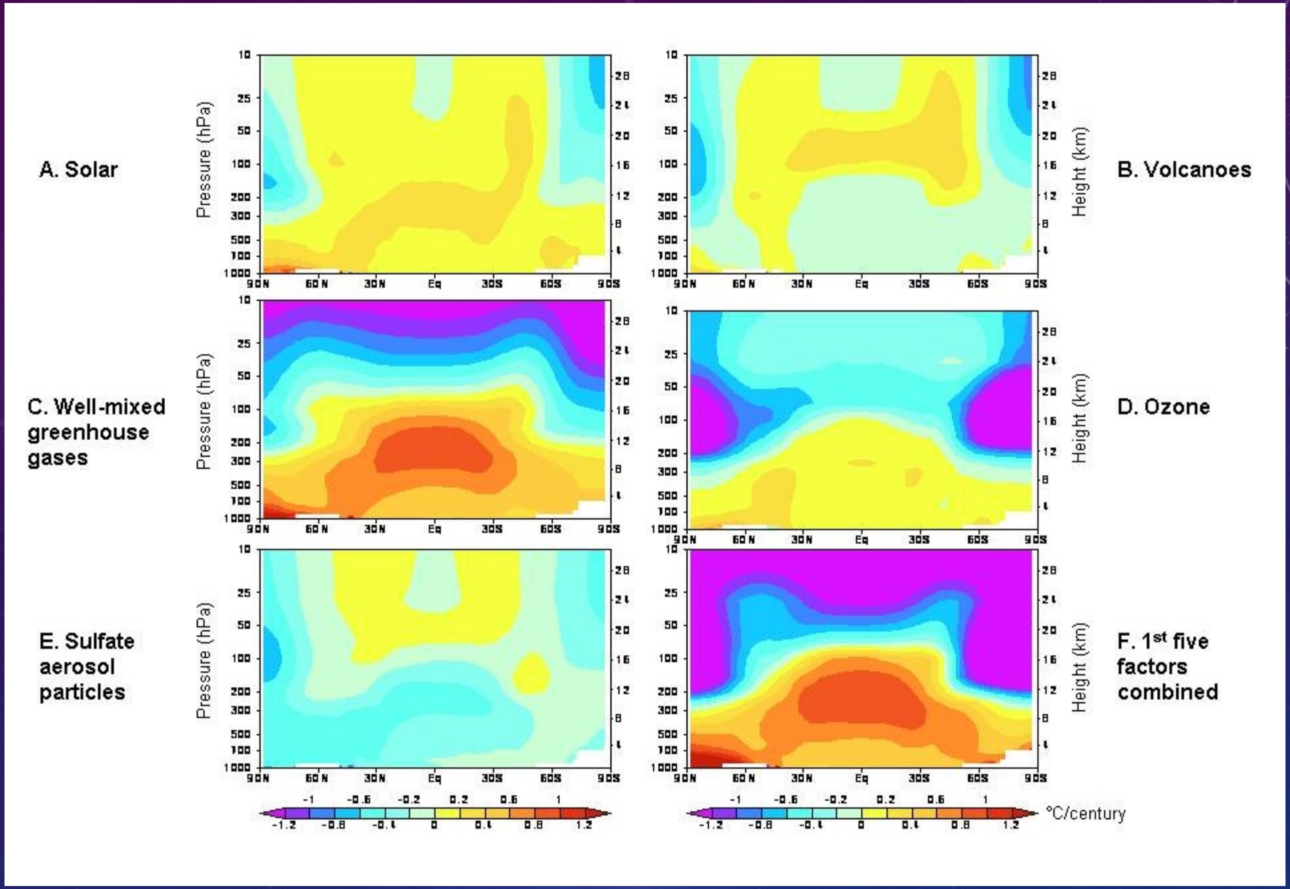
Randall et al.
(2007)



Santer et al. 2003

Santer et al.

(2003)



Santer et al. 2003

Santer et al.
(2003)

EA Lloyd (2009, 2010)

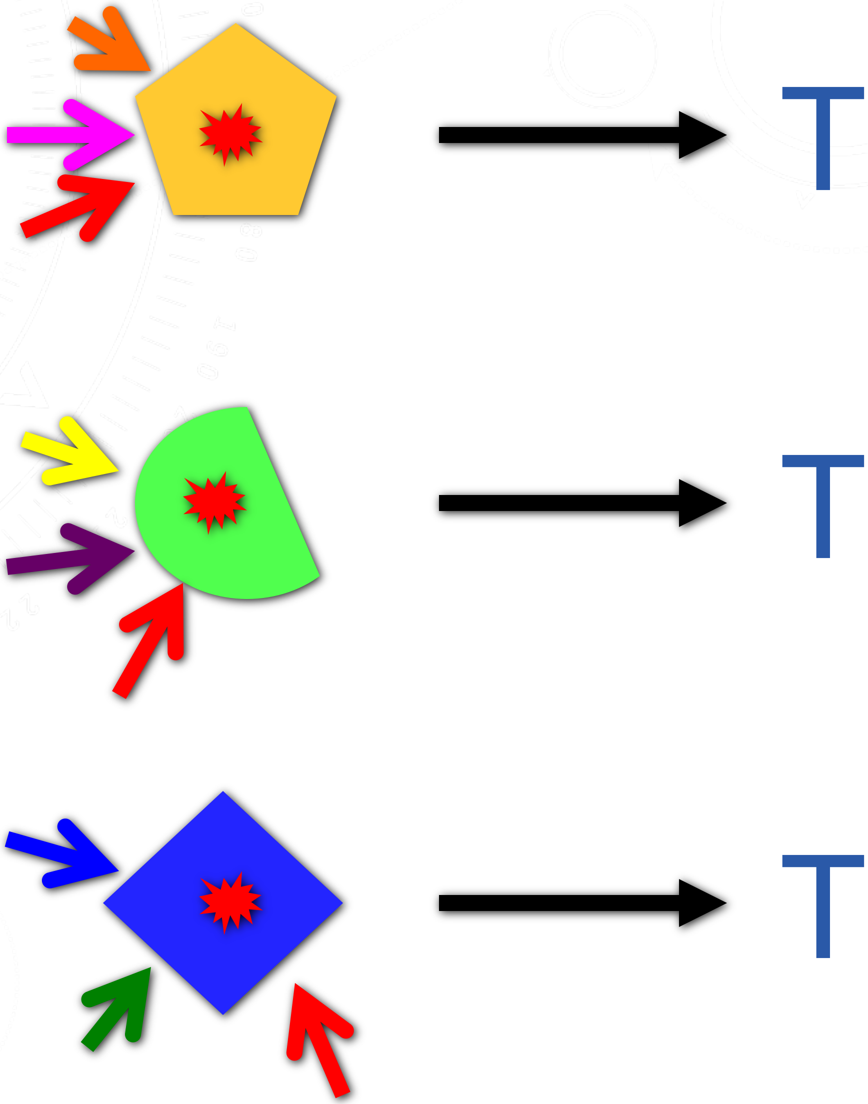
Ways to support or confirm a climate model:

1. Model fit
2. Independent support for aspects of the model

EA Lloyd (2009, 2010)

Ways to support or confirm a climate model:

1. Model fit
2. Independent support for aspects of the model
3. Variety of evidence –Model fit
4. Variety of evidence –Independent aspects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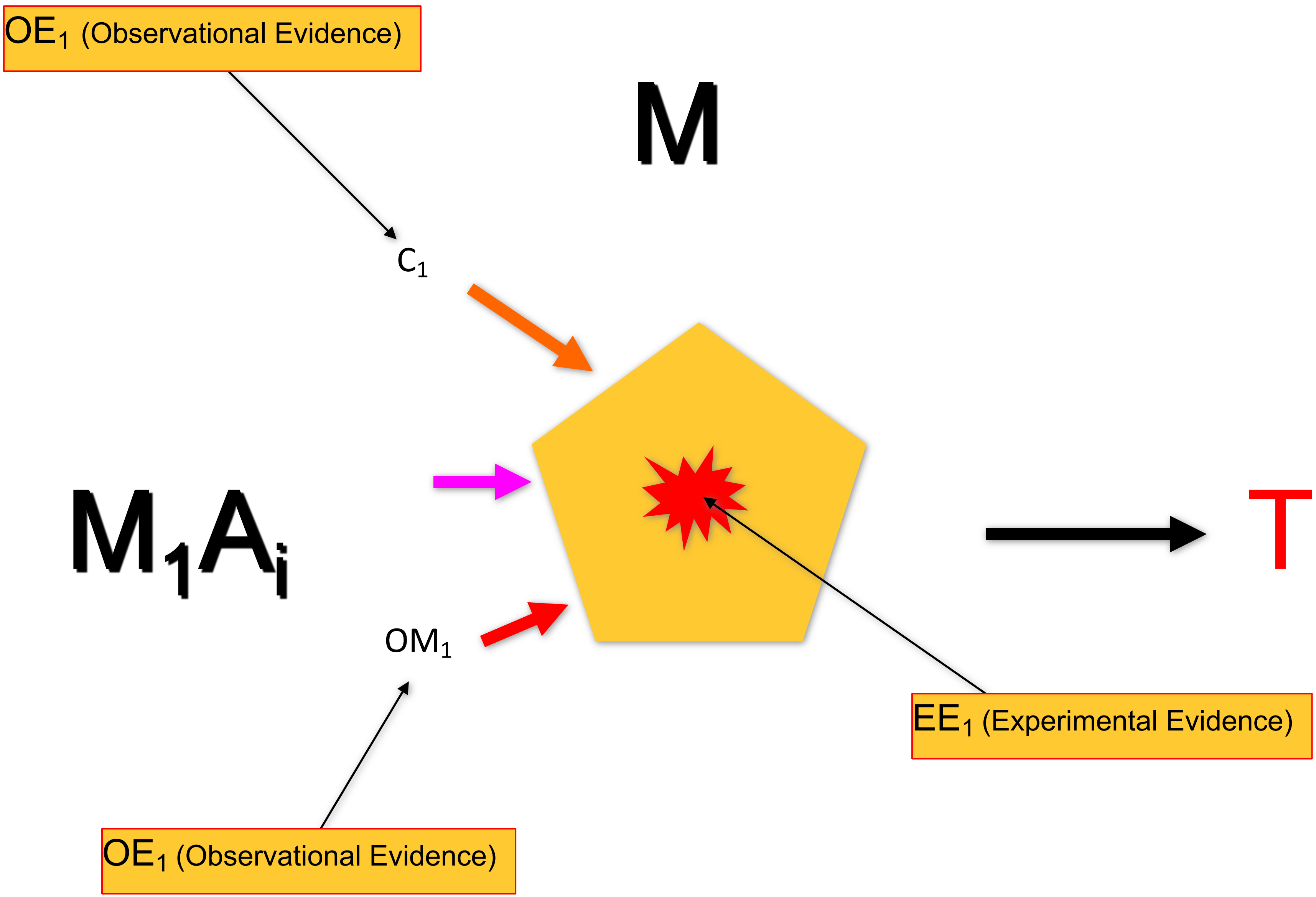


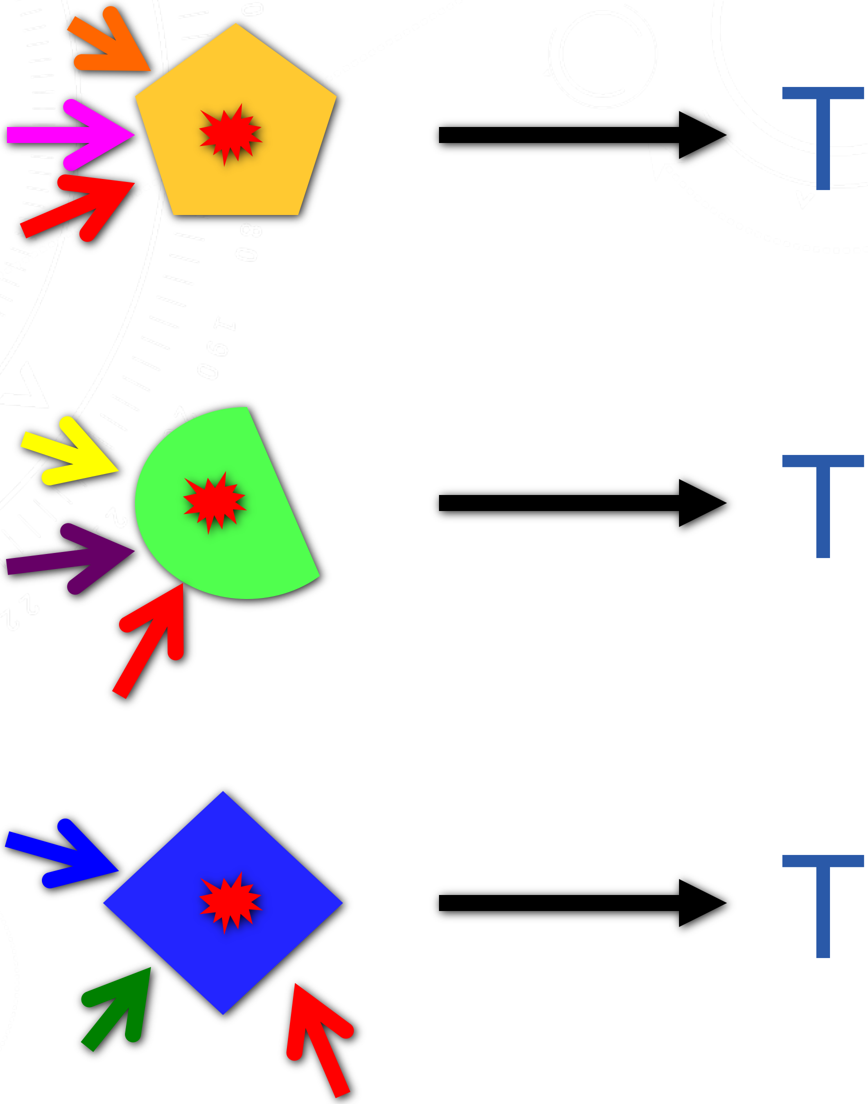
OE1 (Observational Evidence)
M
C1
M1Ai
OM1
T
EE1 (Experimental Evidence)
OE1 (Observational Evidence)

Z. Pirtle, A. Hamilton, & Ryan Meyer (2010, 3)

- Qualitative survey of 6 leading climate journals since 1990
- 118 articles: authors relied on a concept of **agreement between climate models** to inspire confidence in their results

“even if all models agreed perfectly with each other, this would not prove that they are right.”

Jouni Raisenen (2007, 9)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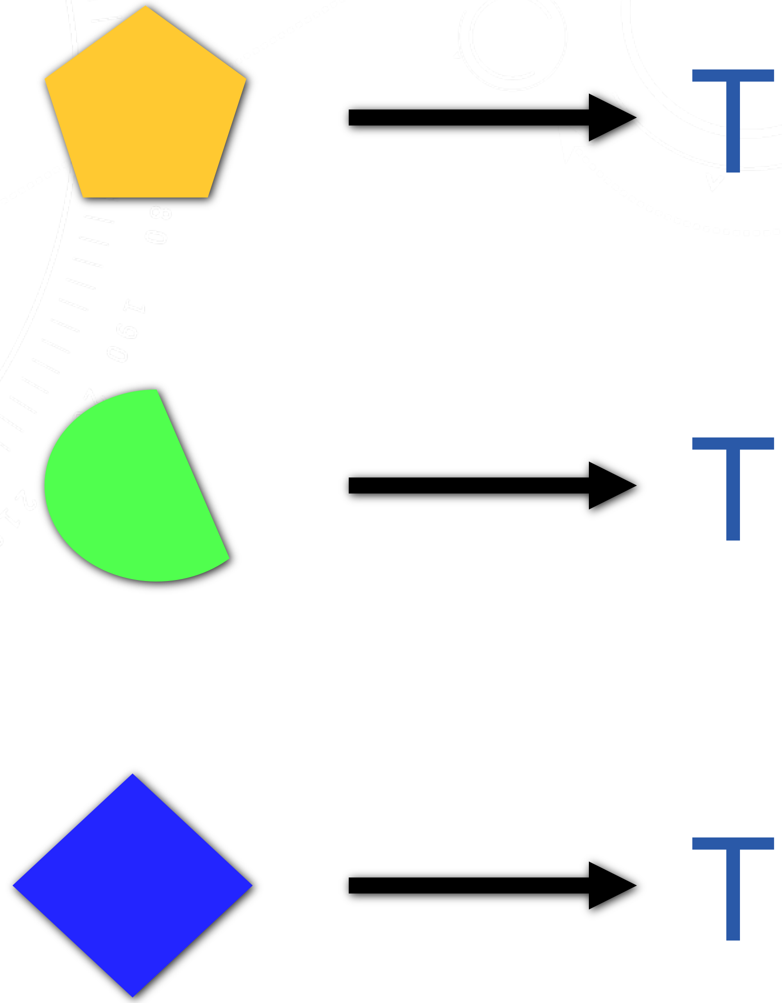
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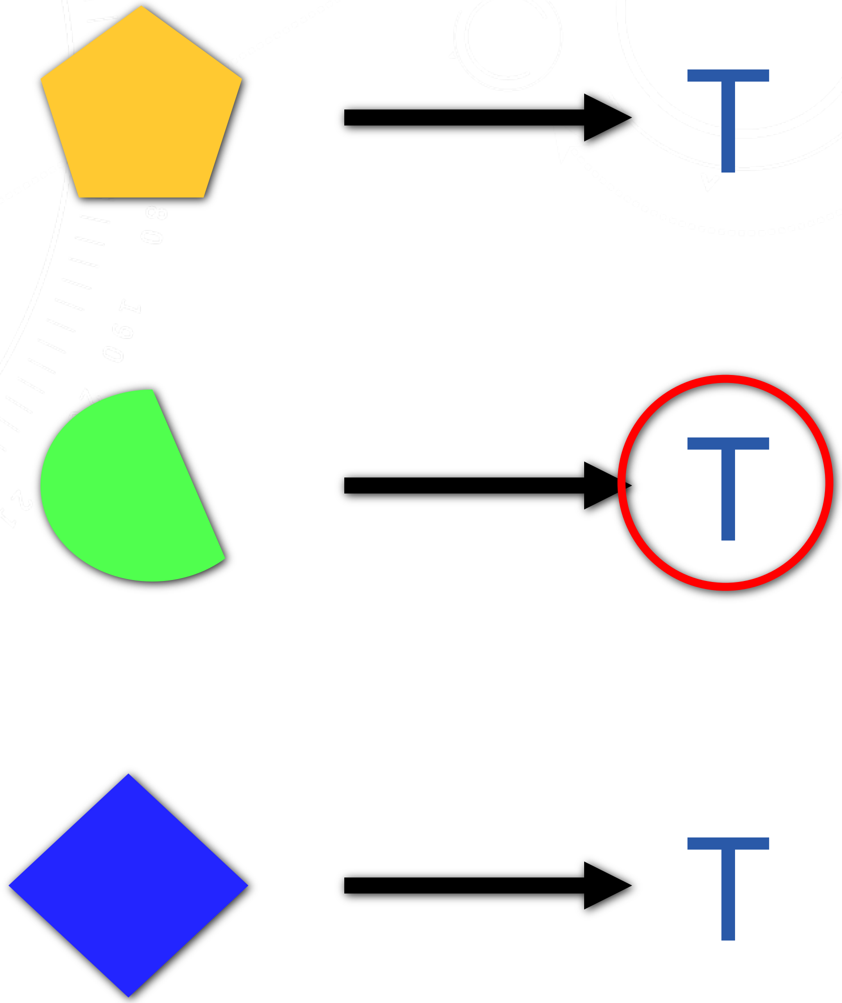
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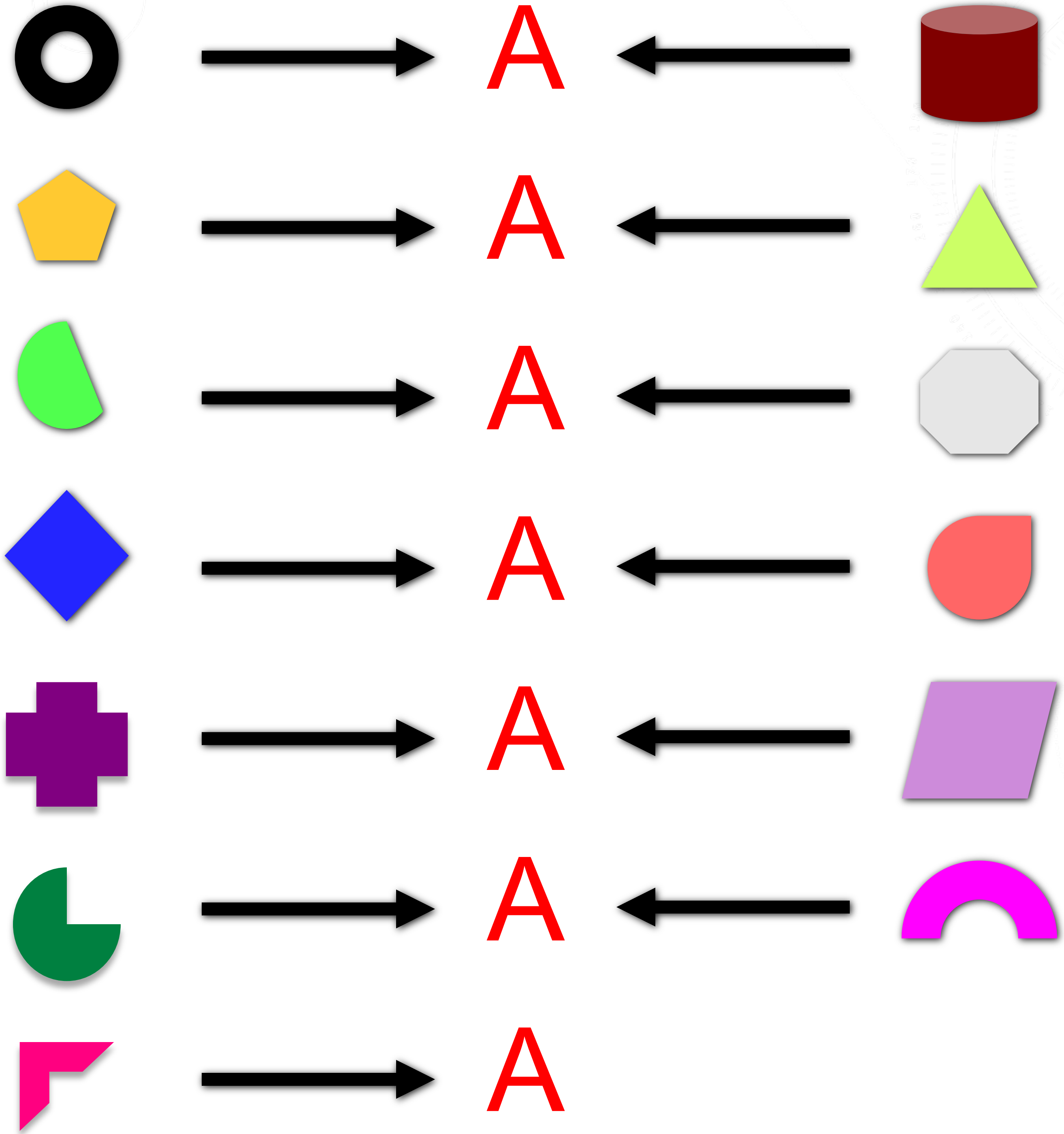
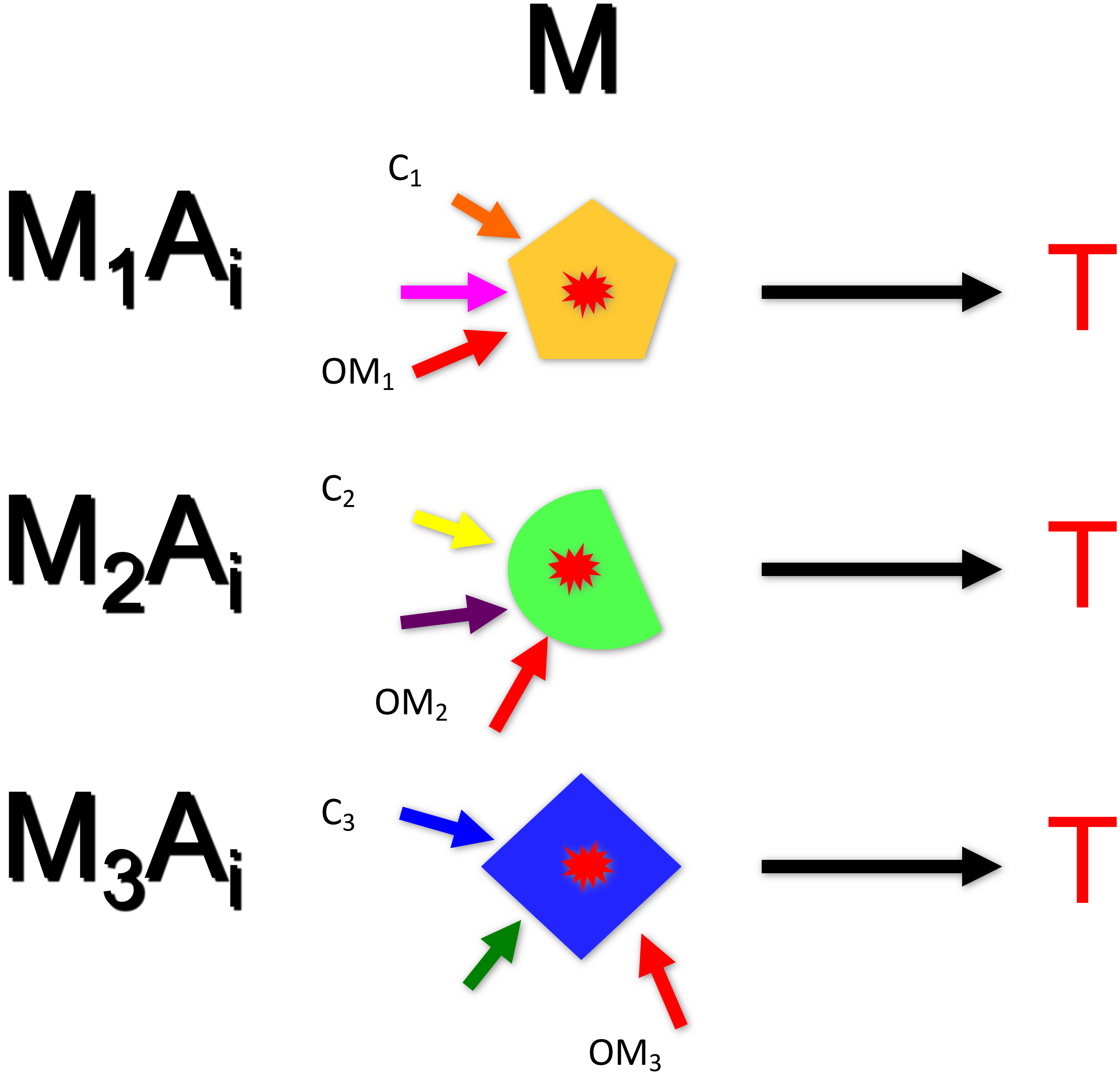
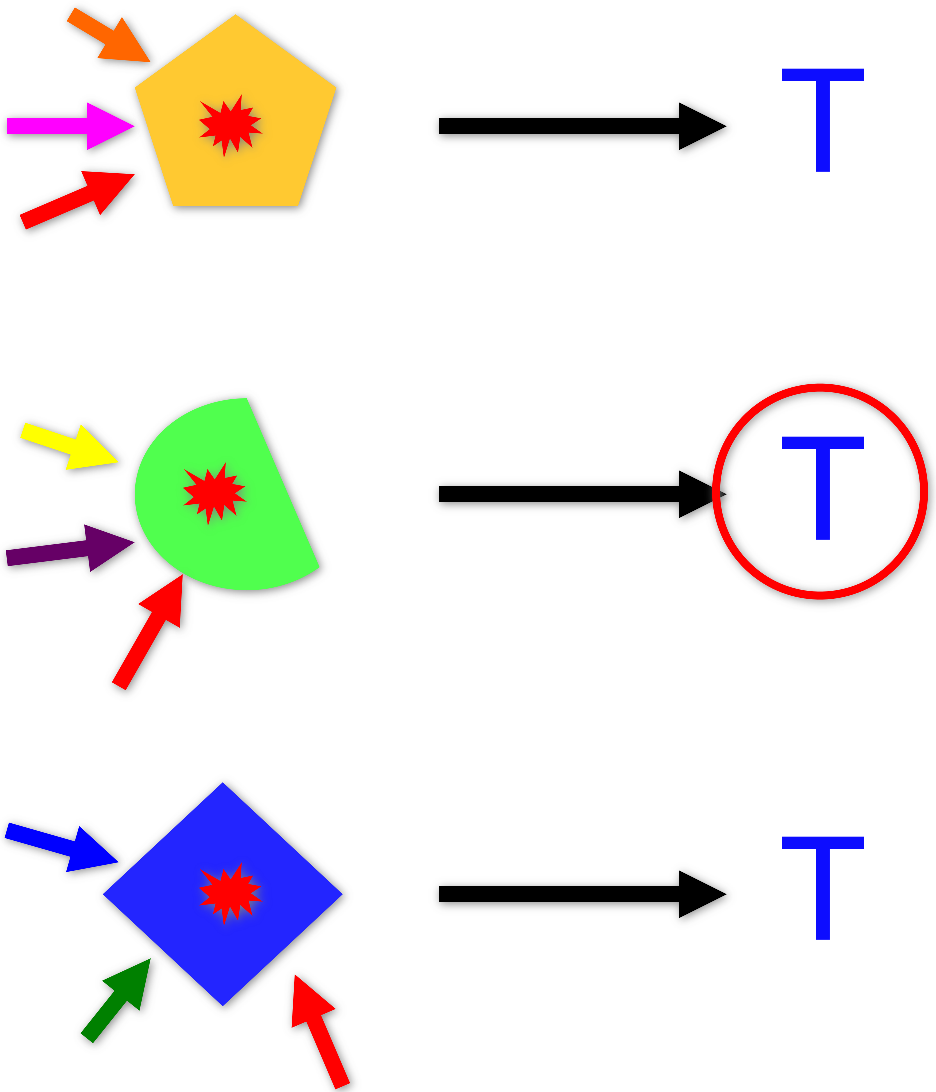
MEARUREMENT ROBUSTNESS

using multiple channels to infer and converge on the correct value (or range of values) of a variable, or the reduction of error by repetition in independent contexts


A
A
A
A
A
A
A



M
M1Ai
C1
OM1
T
M2Ai
C2
OM2
T
M3Ai
C3
OM3
T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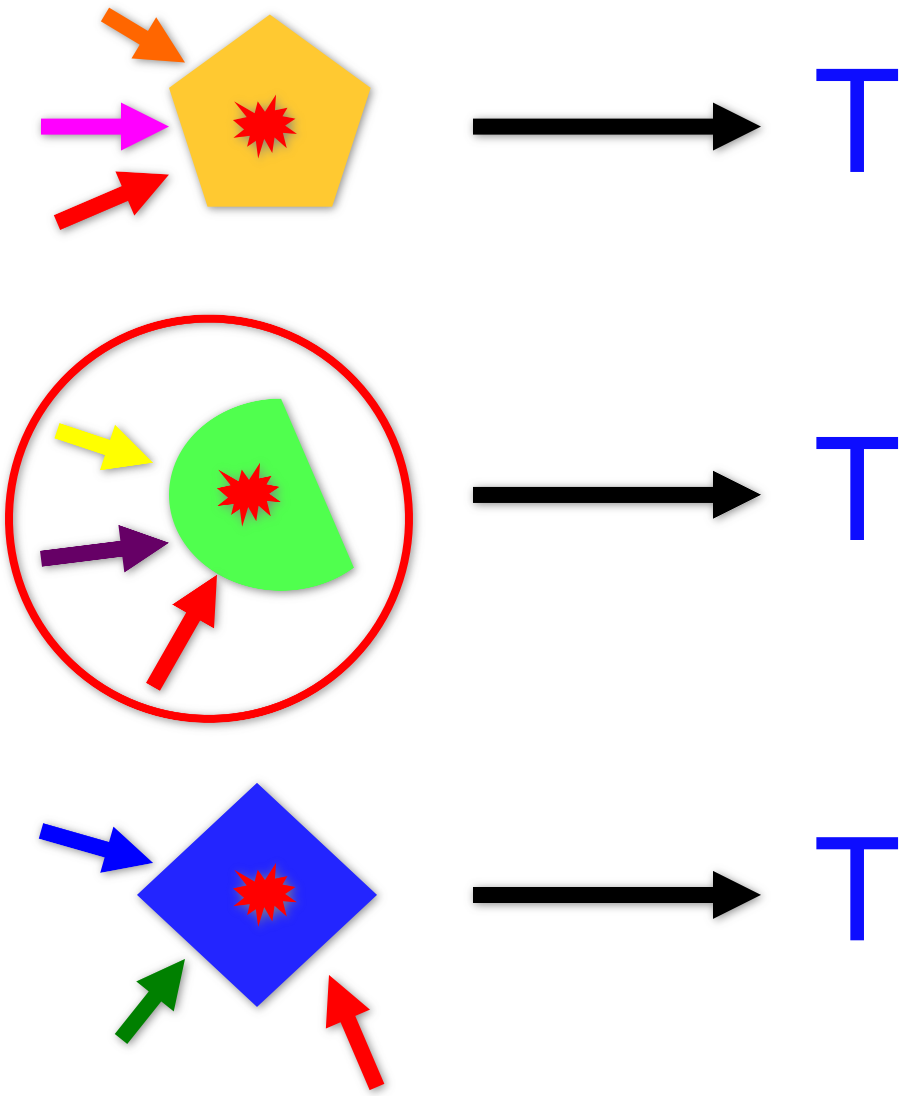
T
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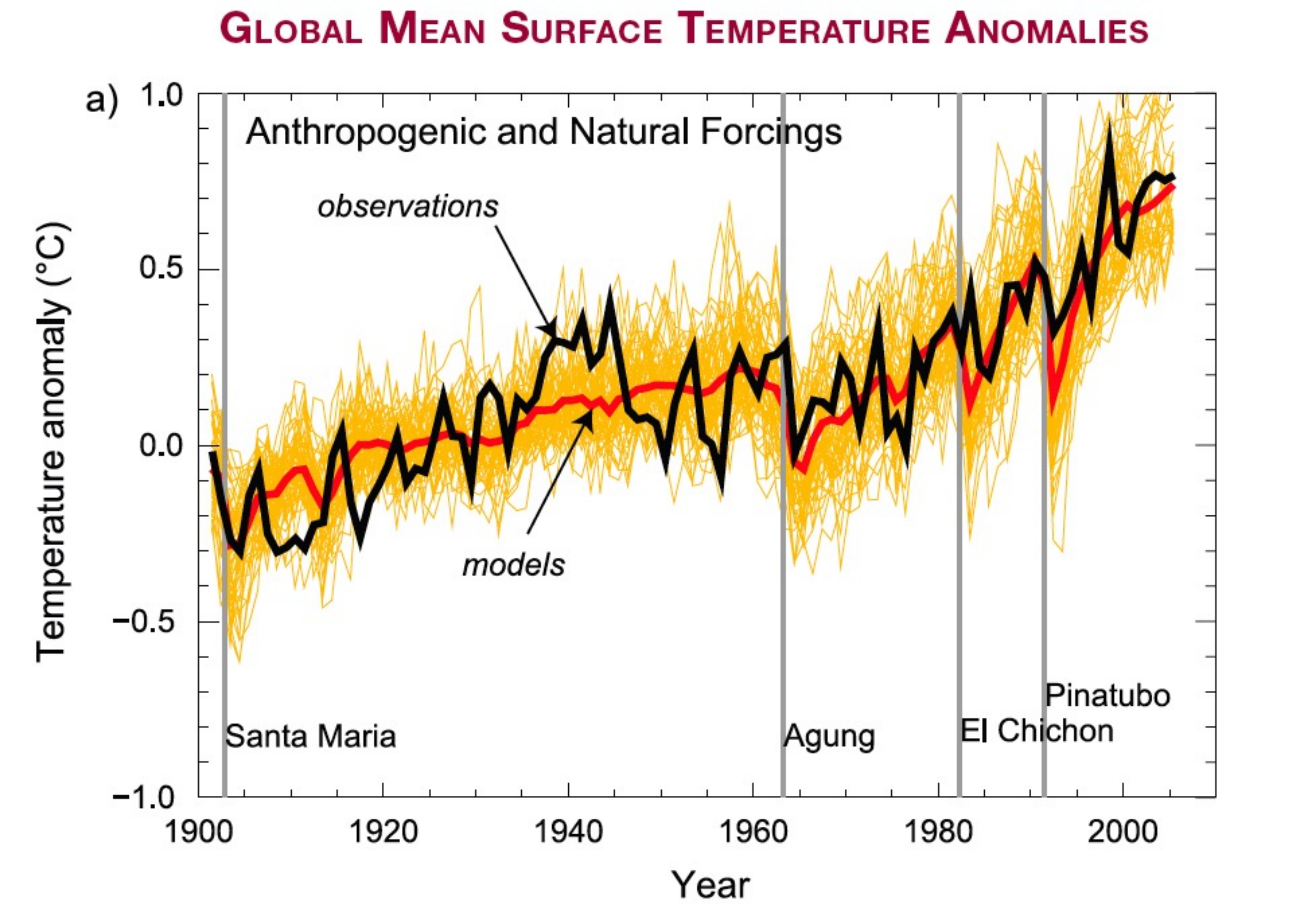
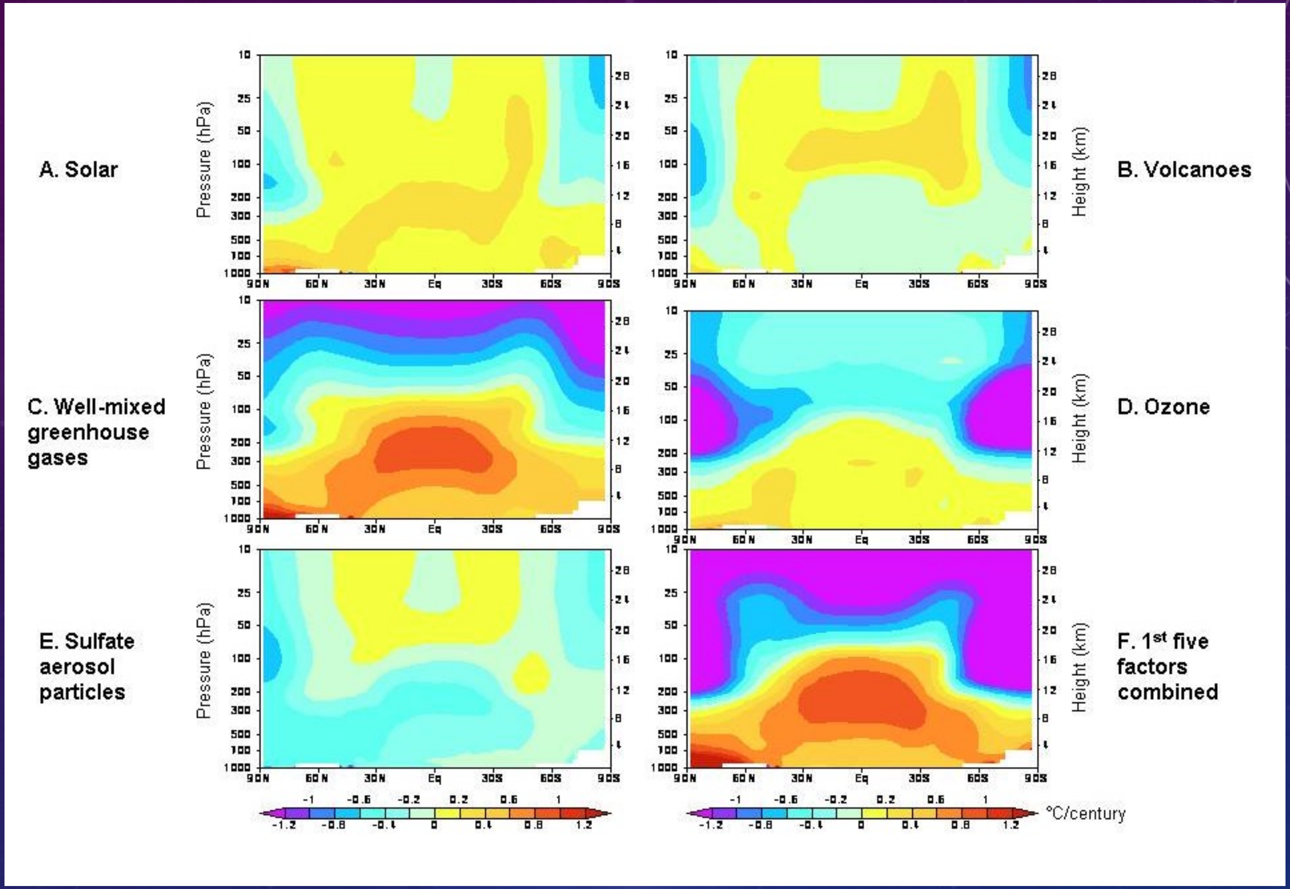
Figure 1



Randall , D., R.A. Wood et al. (2007) "Climate Models and their Evaluation", In Climate Change 2007. Solomon, S. et al. Eds. Cambridge UP, NY. NY, p. 600..

GG is the common "causal focus" or "causal core" of *model type* named M_{GG}, or M for short



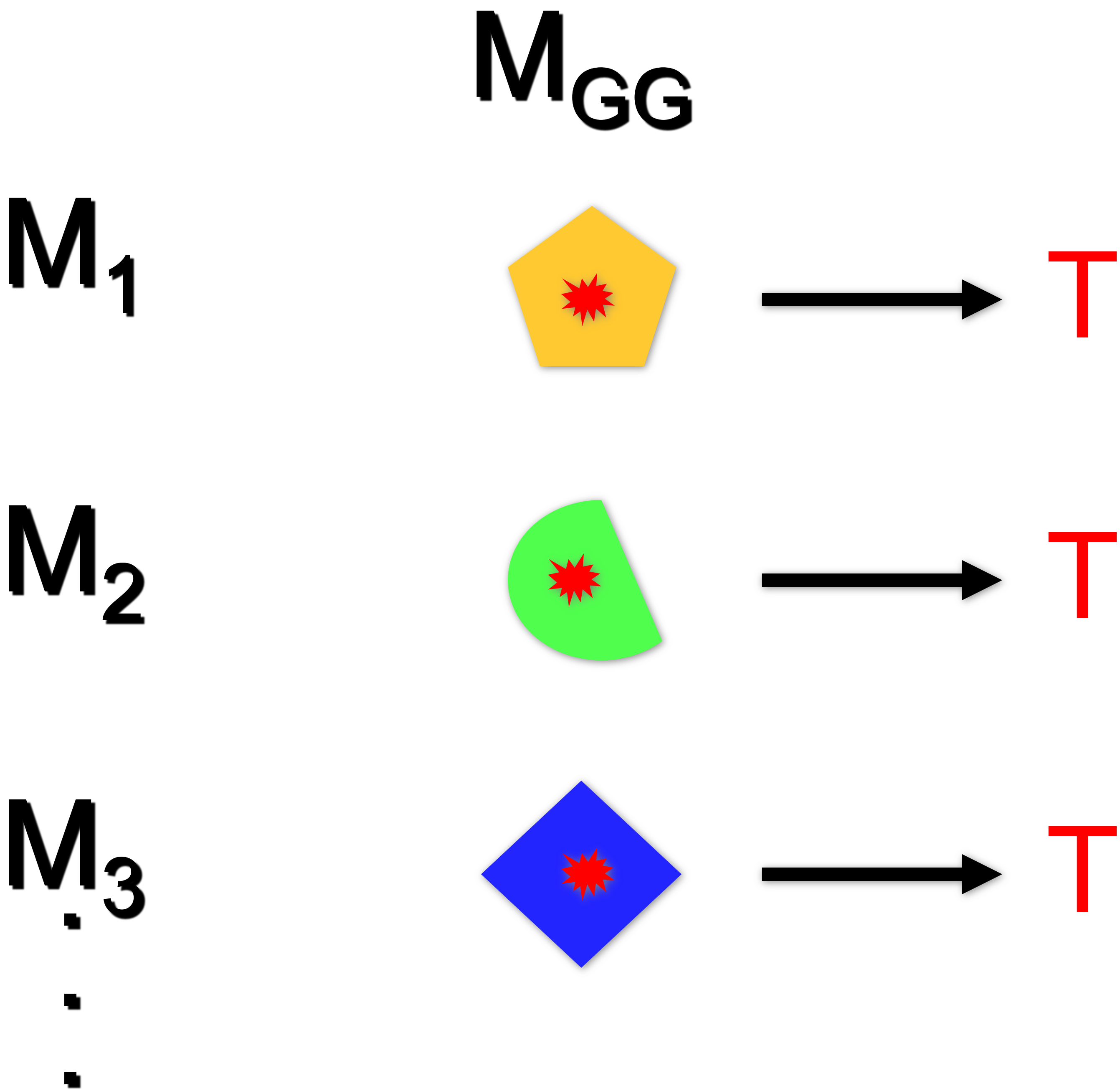
Santer et al. 2003

Santer et al.
(2003)

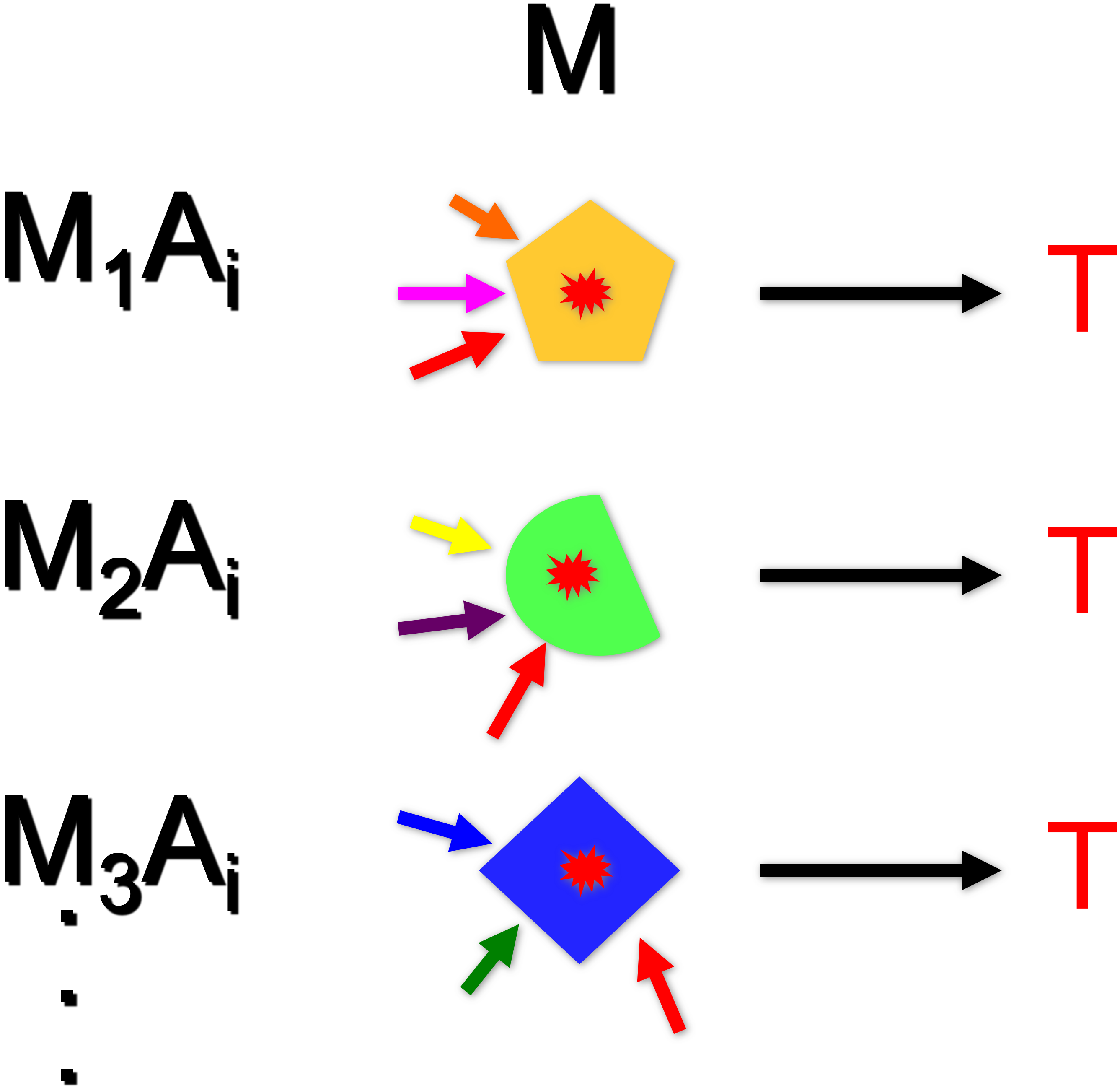
Defining T and To

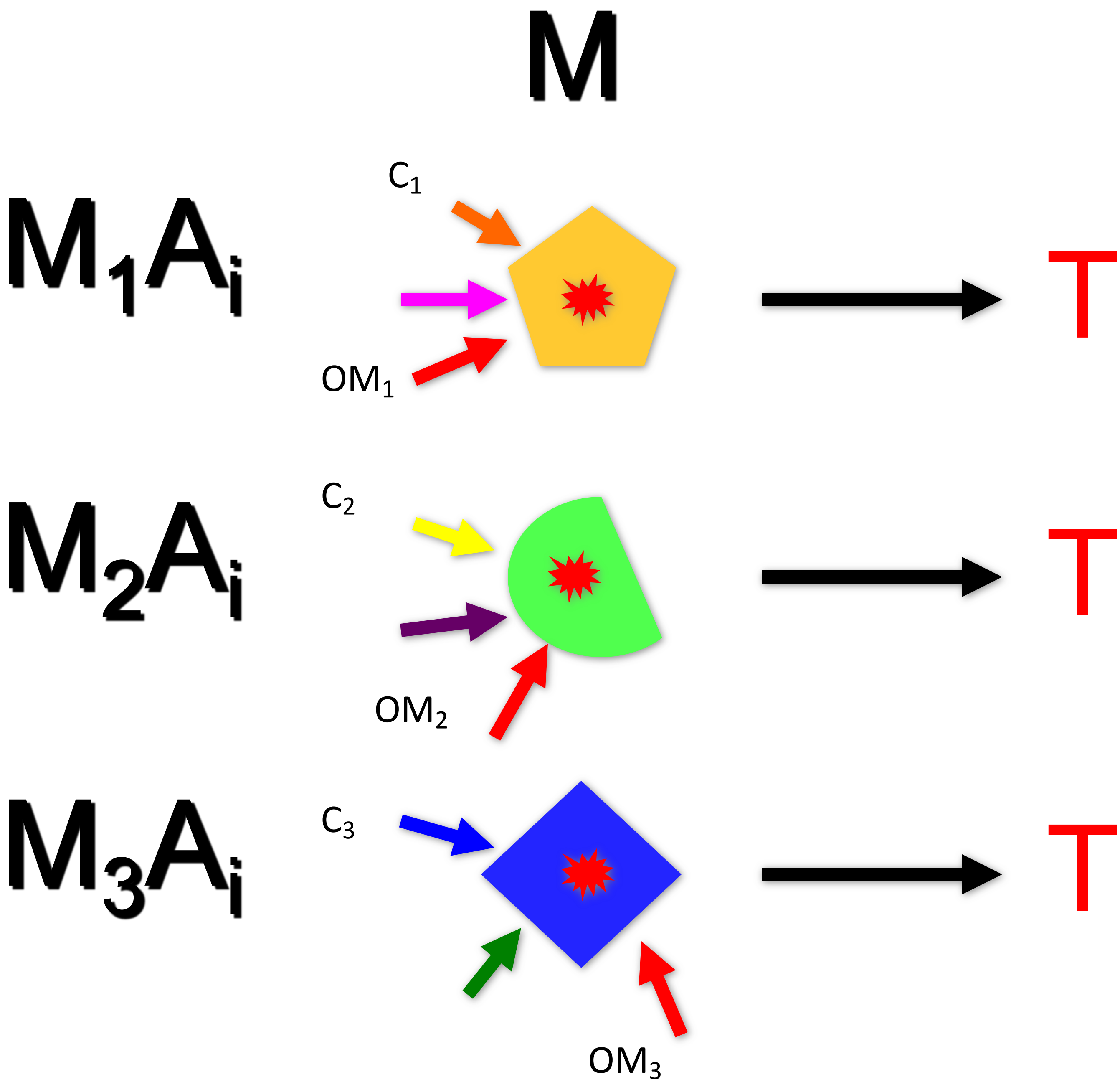
T: temperature spatio-temporal profiles predicted from the model-type, M

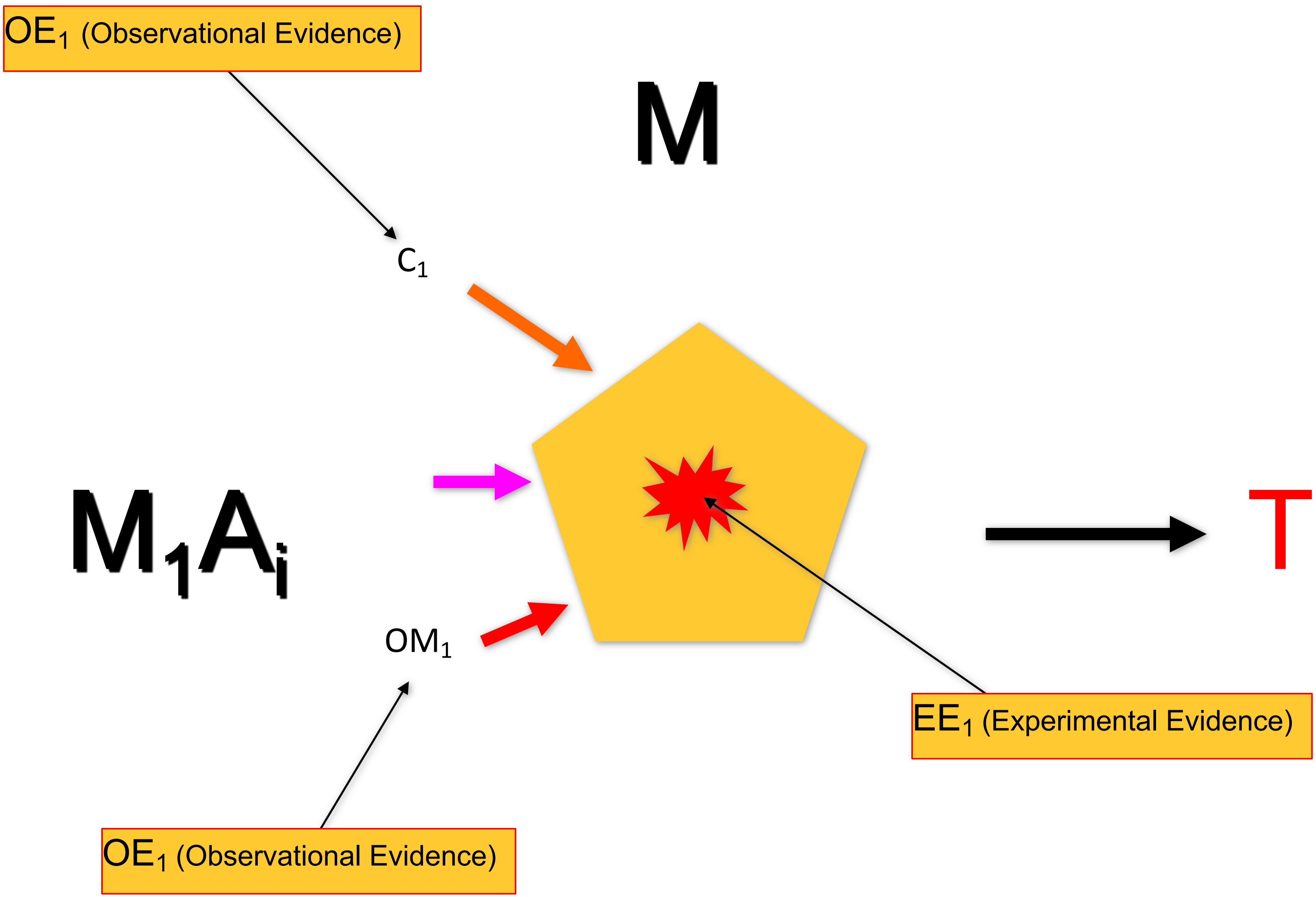
To: Temperature Observations: observational evidence of spatio-temporal profiles of predicted temperature from models, T



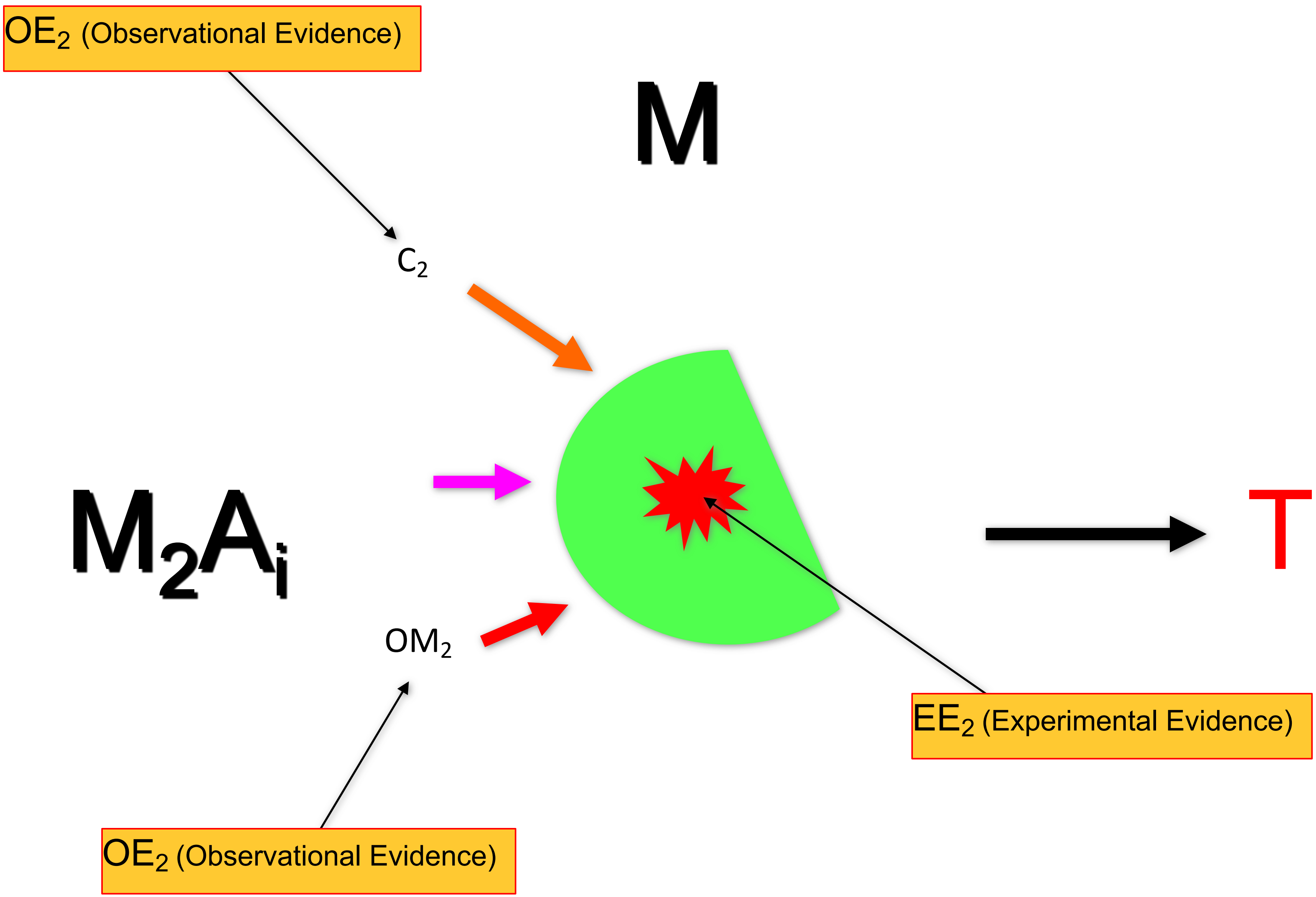
M_{GG}
M_1
T
M_2
T
M_3
T
⋮


M
M_1A_i
T
M_2A_i
T
M_3A_i
T

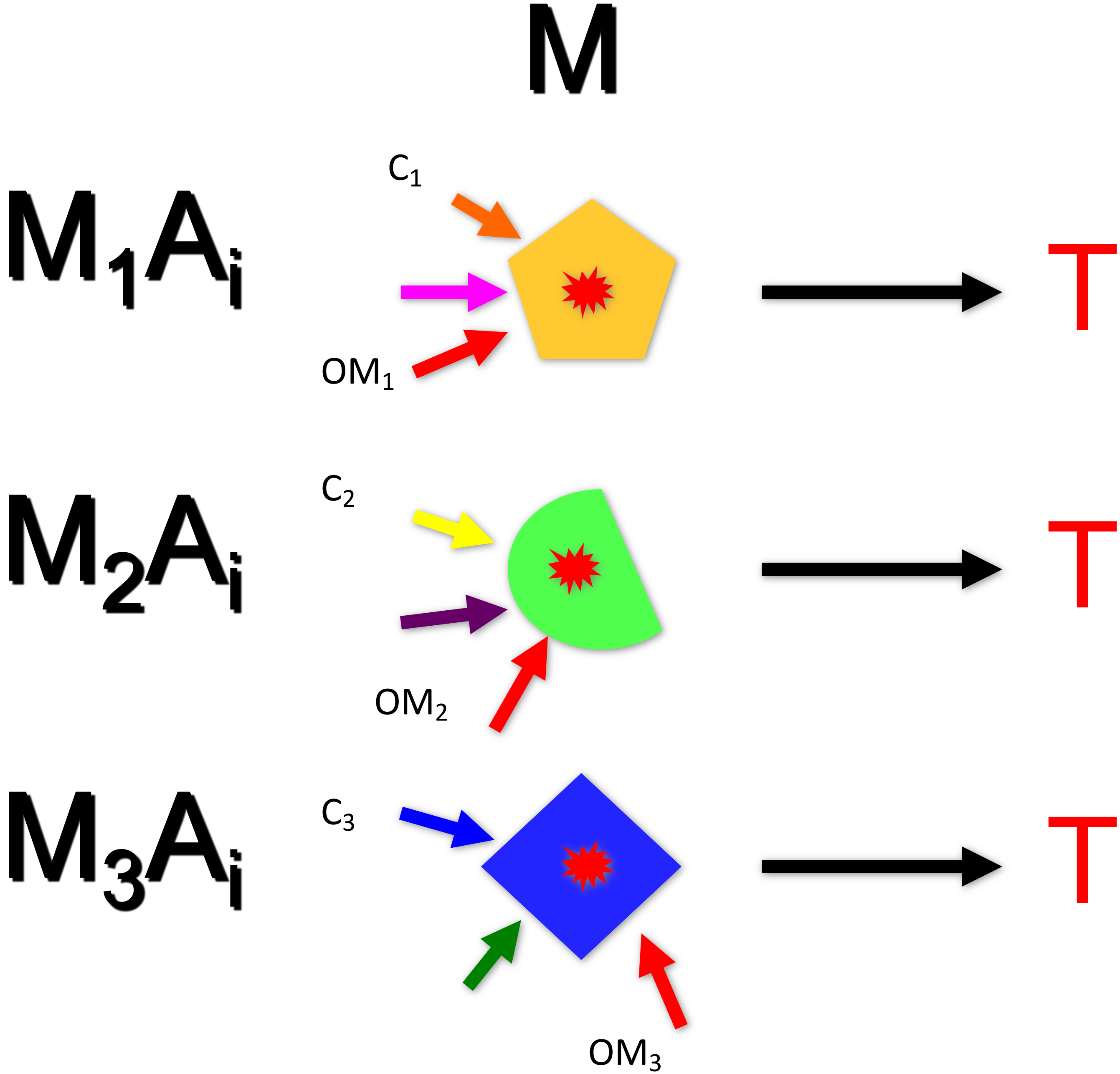

M
M1Ai
C1
OM1
T
M2Ai
C2
OM2
T
M3Ai
C3
OM3
T

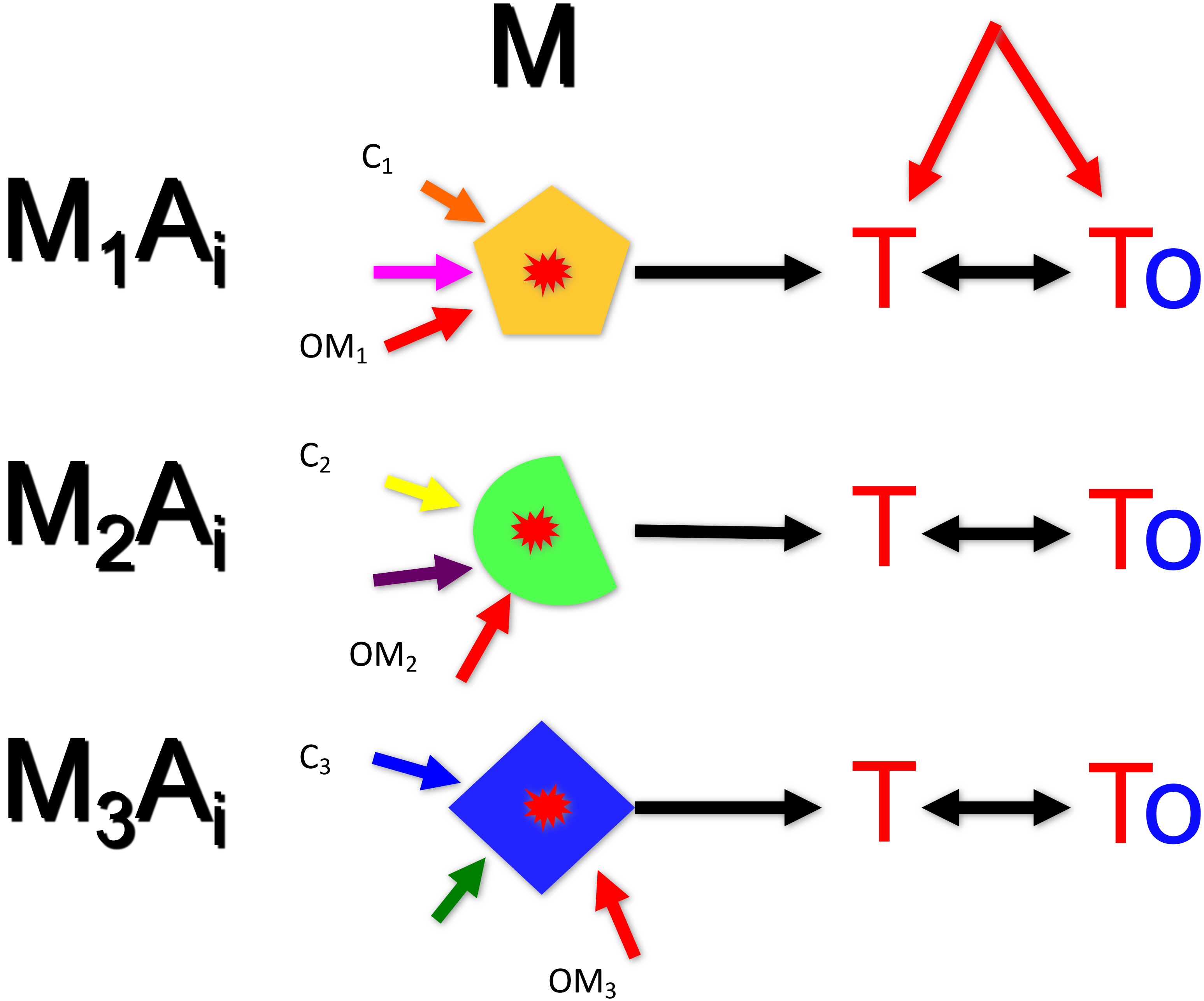


OE1 (Observational Evidence)
M
C1
M1Ai
T
OM1
EE1 (Experimental Evidence)
OE1 (Observational Evidence)

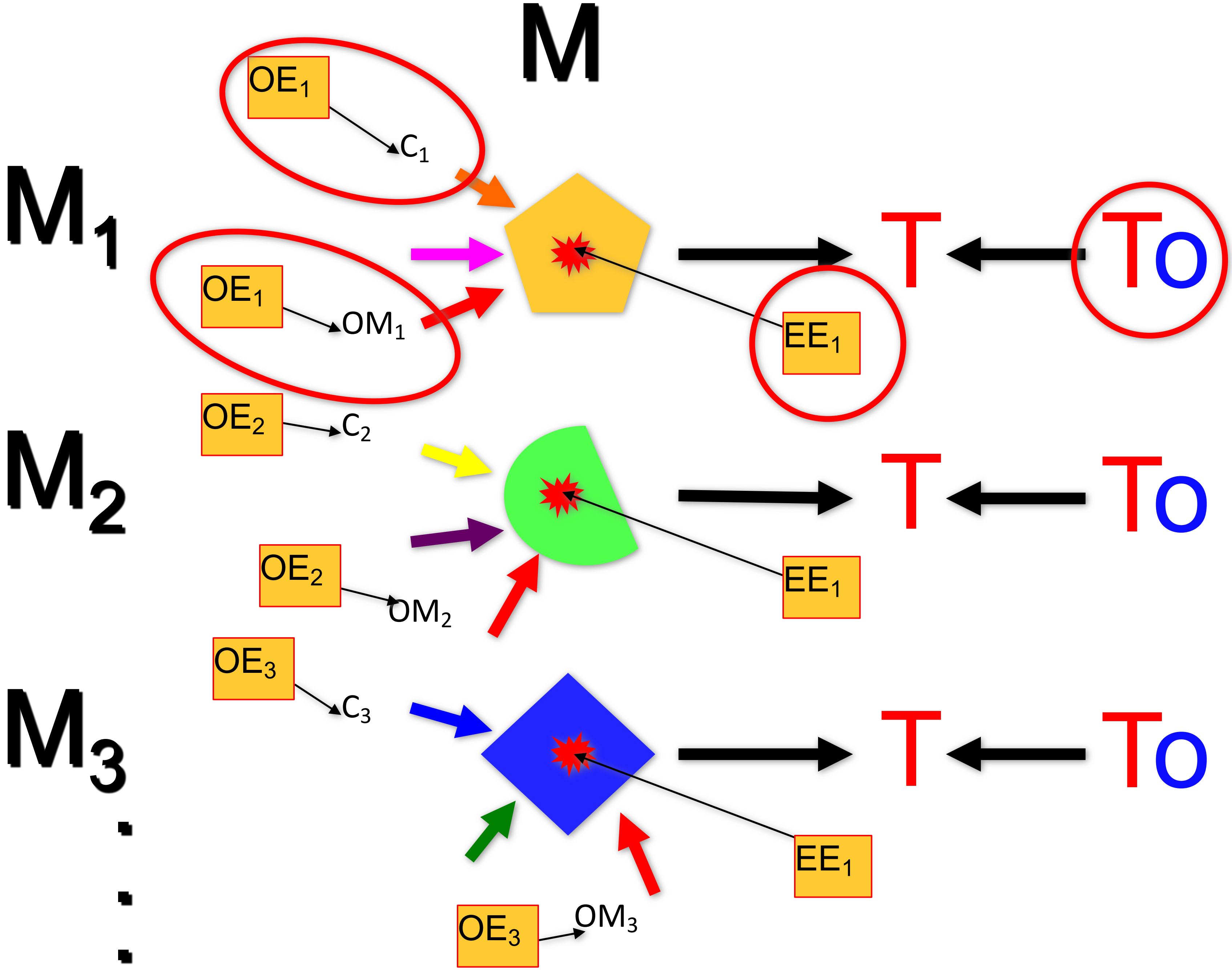


OE2 (Observational Evidence)
M
C2
M2Ai
T
OM2
EE2 (Experimental Evidence)
OE2 (Observational Evidence)


M
M_1A_i
C_1
OM_1
T
M_2A_i
C_2
OM_2
T
M_3A_i
C_3
OM_3
T

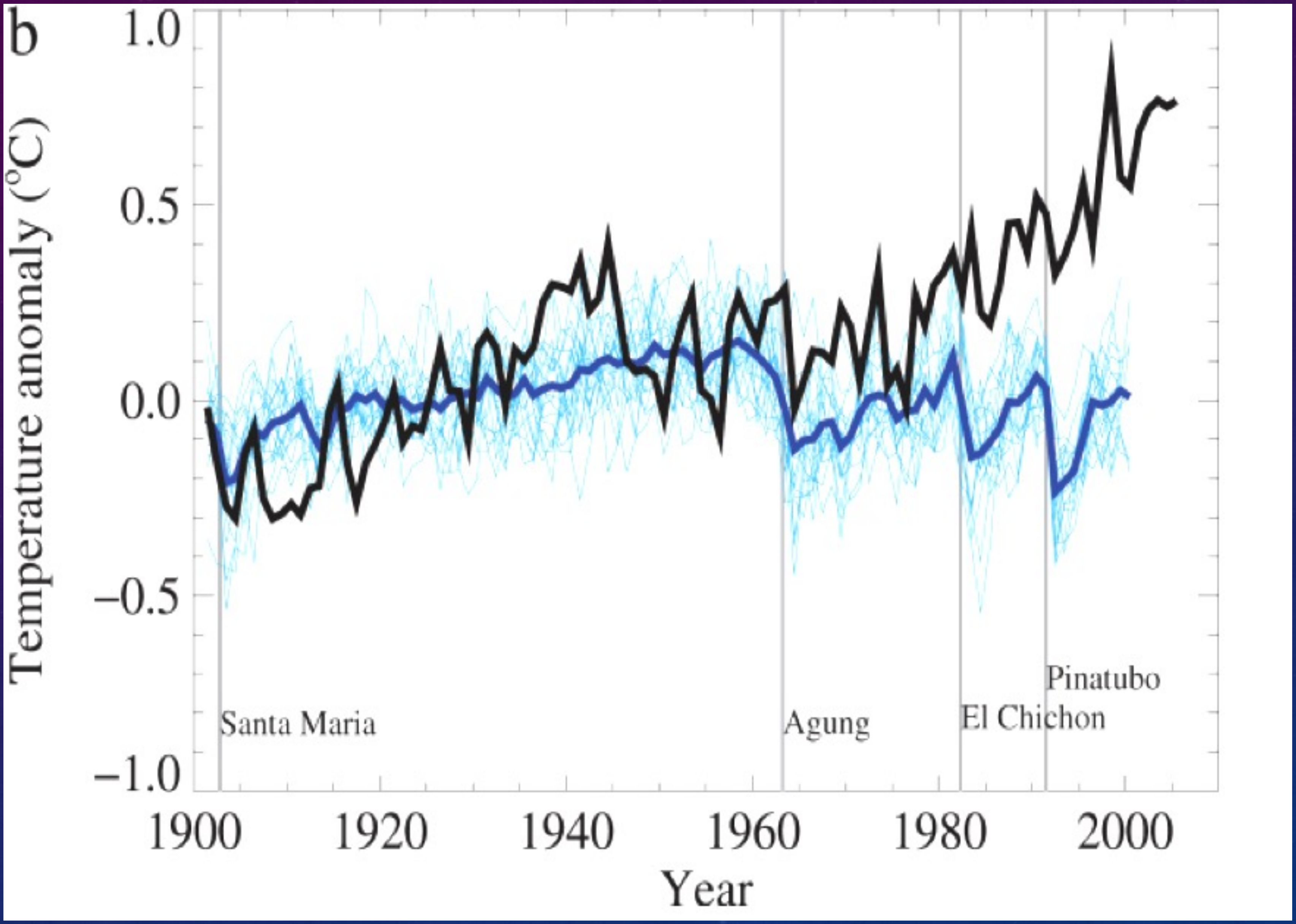


M
M_1A_i
C_1
OM_1
T
To
M_2A_i
C_2
OM_2
T
To
M_3A_i
C_3
OM_3
T
To

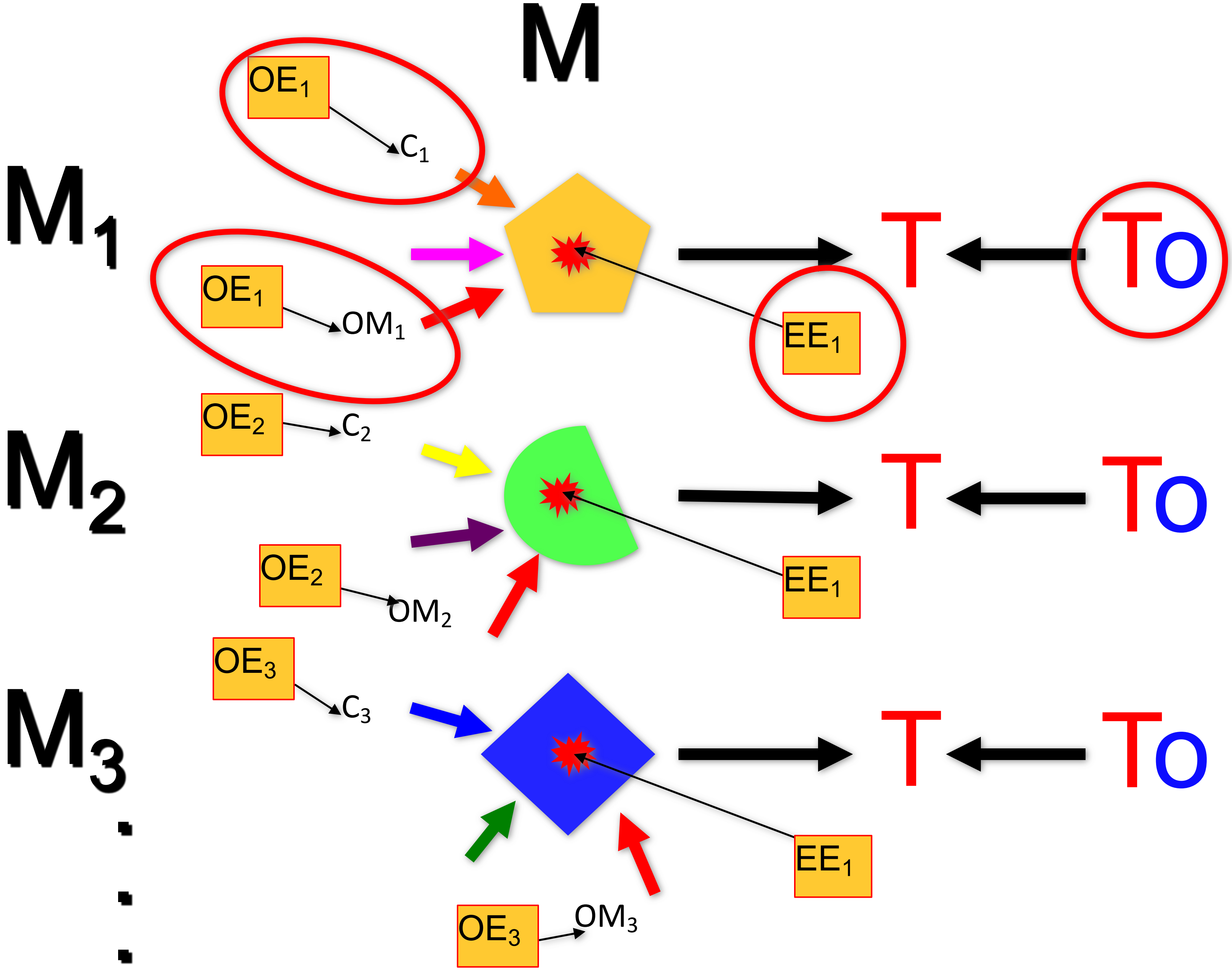


M
M1
OE1
C1
OE1
OM1
EE1
T
TO
M2
OE2
C2
OE2
OM2
EE1
T
TO
M3
OE3
C3
EE1
OE3
OM3
T
TO

Figure 2



Hegerl, GC., F.W. Zwiers et al. (2007) “Climate Models and their Evaluation”, In Climate Change 2007. Solomon, S. et al. Eds. Cambridge UP, NY. NY, p. 684.


M
M1
M2
M3
OE1
C1
OE1
OM1
OE2
C2
OE2
OM2
OE3
C3
OE3
OM3
EE1
EE1
EE1
T
TO
T
TO
T
TO

Model Robustness

Family of related, not independent, models

Empirically0-supported model com[ponents and assumptions

Shared and empirically-supported model outcomes

➔ Confirmatory evidence for explanatory application of causal focus or causal core of model type

Model confirmation

Model ft
Variety of fit
Independent support for aspects of the model
Variety of independent support
Model Robustness

SOME REFERENCES

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Acknowledgements

Thanks to climate researchers Caspar Ammann, Jeffrey Kiehl, Doug Nychka, Kevin Trenberth, Tom Wigley, and Linda Mearns, of the National Center for Atmospheric Research, as well as Richard Somerville, of the Scripps Institute Reto Knutti of ETH Zurich, and Gabriele Hegerle of the U. of Edinburgh for their assistance regarding climate models. I also thank Brenden Fitelson, Ron Giere, Andrew Hamilton, Ryan Ketcham, Noretta Koertge, Steve Lawrie, Gordon McOuat, Jay Odenbaugh, Wendy Parker, Zach Pirtle, Trevor Pearce and his colleagues at the U. of Chicago, Kari Theurer, Trin Turner, Sean Valles, Bas van Fraassen, Michael Weisberg, and Eric Winsberg, and especially Jim Woodward for their helpful comments. Supported by NSF STS grant #0646253.