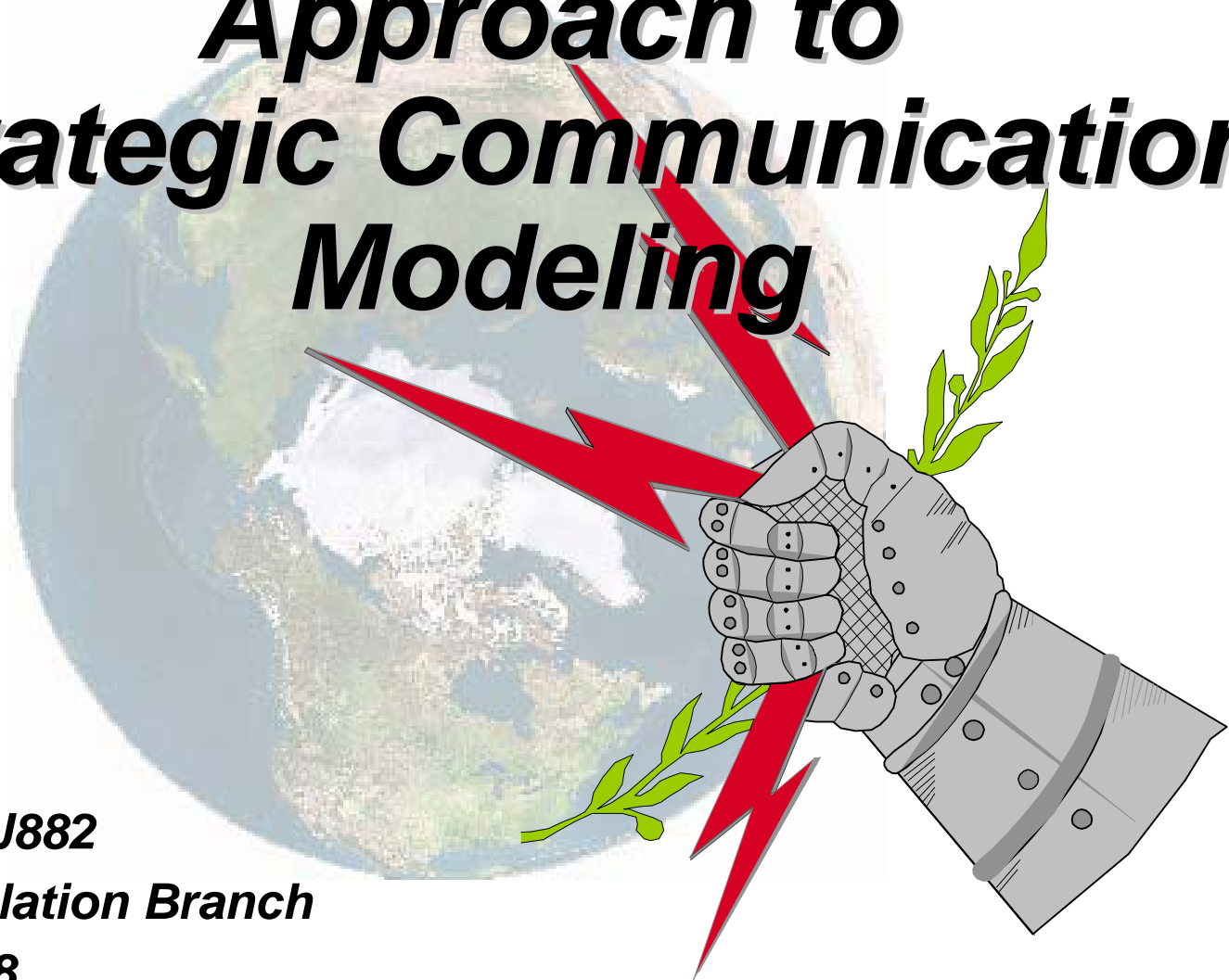




A System Dynamics Approach to Strategic Communication Modeling

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USSTRATCOM / J882
Modeling & Simulation Branch
5-7 February 2008***





Overview

- **Strategic Communication and Deterrence**
- **Systems Thinking and System Dynamics**
- **Strategic Communication Cause and Effect Diagram**
- **Strategic Communication Model Implementation**



What is Strategic Communication?

- **As defined in the Deterrence Operations Joint Operating Concept (DO JOC, Dec 2006):**

“Strategic Communication constitutes focused United States Government (USG) efforts to understand and engage key audiences in order to create, strengthen, or preserve conditions favorable for the advancement of USG interests, policies, and objectives through the use of coordinated programs, plans, themes, messages, and products synchronized with the actions of all elements of national power.”

Note – DO JOC references JP 3-13 Information Operations (Feb 2006) as the source of this definition



What is Deterrence?

- **From the Deterrence Operations Joint Operating Concept (DO JOC, Dec 2006):**

“Deterrence operations convince adversaries not to take actions that threaten US vital interests by means of decisive influence over their decision-making. Decisive influence is achieved by credibly threatening to deny benefits and/or impose costs, while encouraging restraint by convincing the actor that restraint will result in an acceptable outcome.”



What is Deterrence?

- **As defined in JP 1-02 Department of Defense Dictionary of Military and Associated Terms (dated 12 April 2001, as amended through 17 October 2007):**

“DETERRENCE — The prevention from action by fear of the consequences. Deterrence is a state of mind brought about by the existence of a credible threat of unacceptable counteraction.”



System Dynamics Basics → Systems Thinking

- **Systems Thinking is**
 - the discipline of an integrated world view
 - a lens to view and understand complex systems
 - a language to describe interdependencies and relationships in a system
 - a mechanism for discovering performance measurements and leverage points in a system
- **Relationship Diagrams**
 - also known as Cause and Effect, Influence, Causal Loop, or Feedback Loop diagrams
 - provide a qualitative depiction of systemic relationships



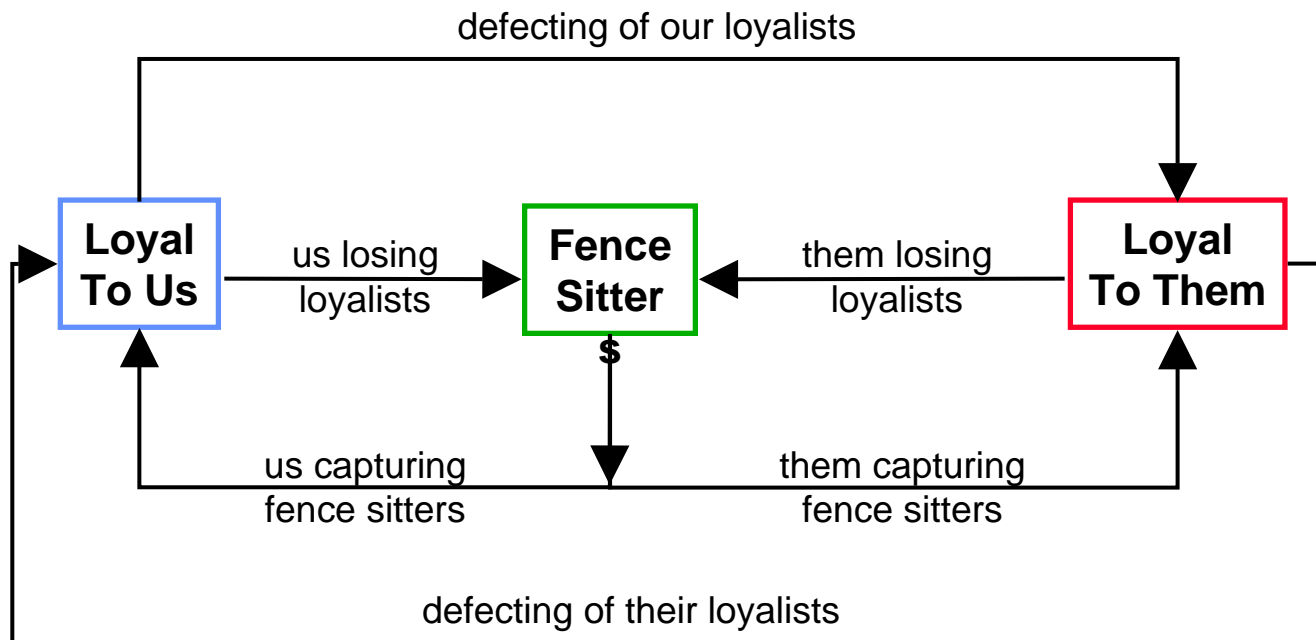
System Dynamics Basics → System Dynamics

- **System Dynamics**
 - A methodology for application of Systems Thinking concepts through dynamic simulation of processes
 - Transitions from qualitative to quantitative
 - Developed by Jay Forrester at MIT in the 1960s
- **Benefits of Systems Thinking**
 - A catalyst for system understanding
 - Gaining a shared systemic view of the enterprise
 - Illumination of system physics
- **Additional Benefits of System Dynamics**
 - Provides a platform for experimentation
 - Allows for comparisons of future views
 - Exposes unintended consequences and systemic delays



System Dynamics Basics → Stocks & Flows

- Stocks represent potential states
- Flows represent transitions between states





System Dynamics Basics → Models & Simulations

- **Model Development**

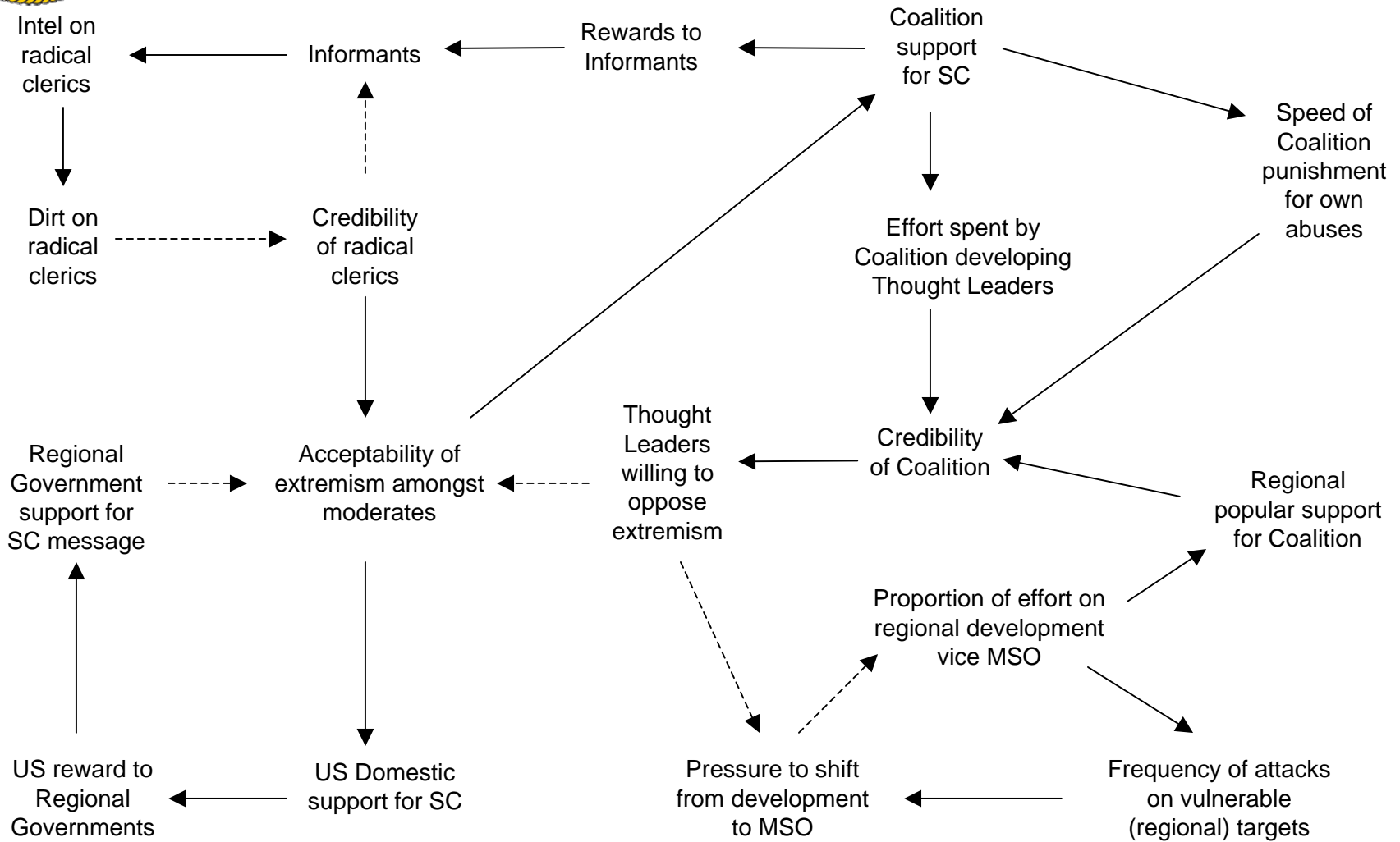
- Begin with relationships
- Define stocks (What flows? Where does it collect?)
- Define flows (Why does it flow? e.g., business rules)
- Only include necessary variables (don't model the world)
- Aggregate entities to the highest level that is acceptable

- **Simulation**

- Continuous (time step), vice discrete event
- Evaluation of all rate equations at each time step is required to represent continuously changing variables



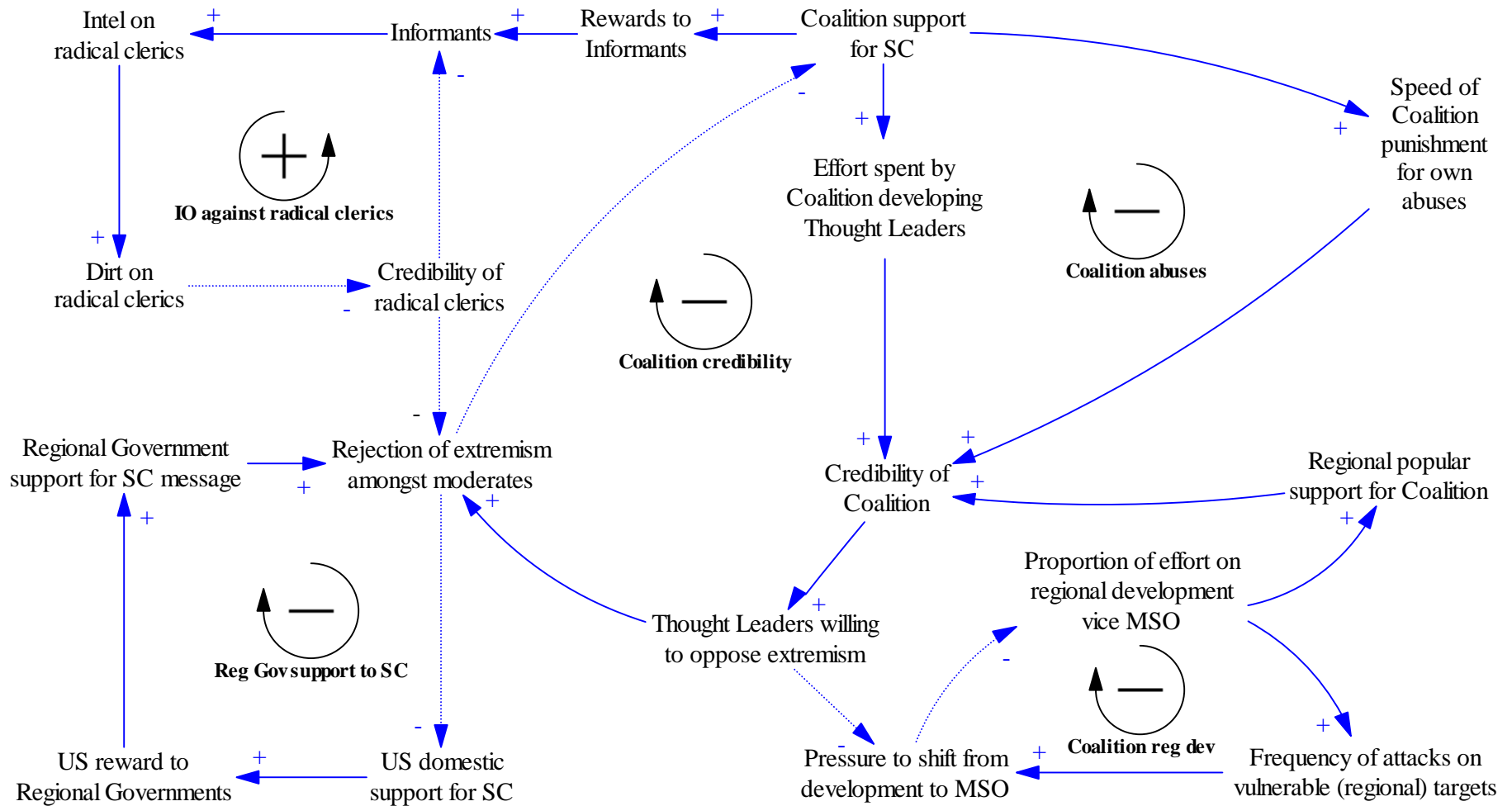
Integrated Cause and Effect Diagram for SC



Breakdown



Causal Loop Diagram (CLD)

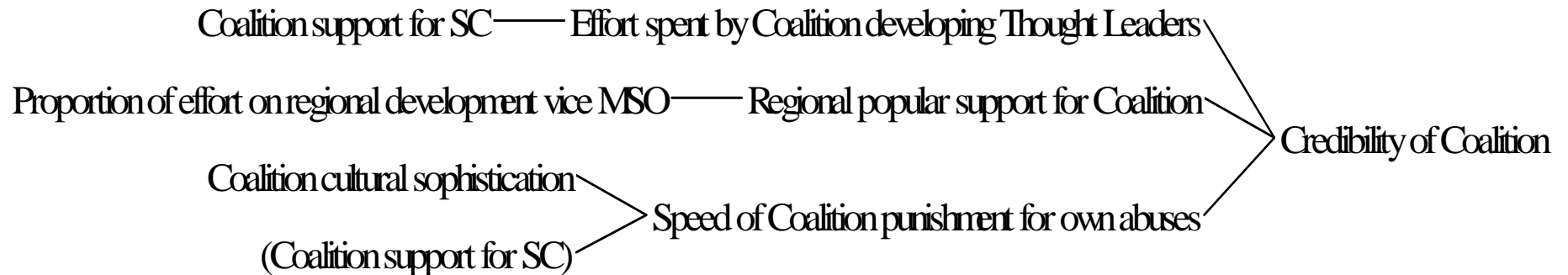


More Details

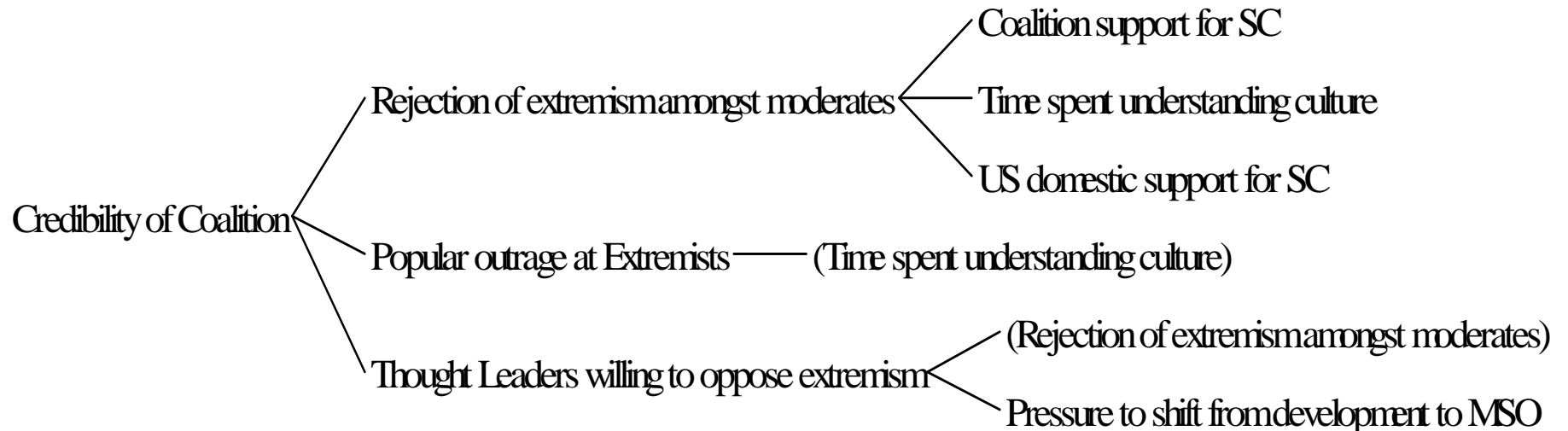


CLD Analysis Capabilities - Trees

Causes Tree (for Credibility of Coalition)



Uses Tree (for Credibility of Coalition)





CLD Analysis Capabilities - Loops

Loops

Loop Number 1 of length 3 - Credibility of Coalition

Rejection of extremism amongst moderates

Coalition support for SC

Speed of Coalition punishment for own abuses

Loop Number 2 of length 3 - Credibility of Coalition

Rejection of extremism amongst moderates

Coalition support for SC

Effort spent by Coalition developing Thought Leaders

Loop Number 3 of length 4 - Credibility of Coalition

Thought Leaders willing to oppose extremism

Pressure to shift from development to MSO

Proportion of effort on regional development vice MSO

Regional popular support for Coalition

**Note – additional loops exist for Credibility of Coalition,
but are not shown in this example**

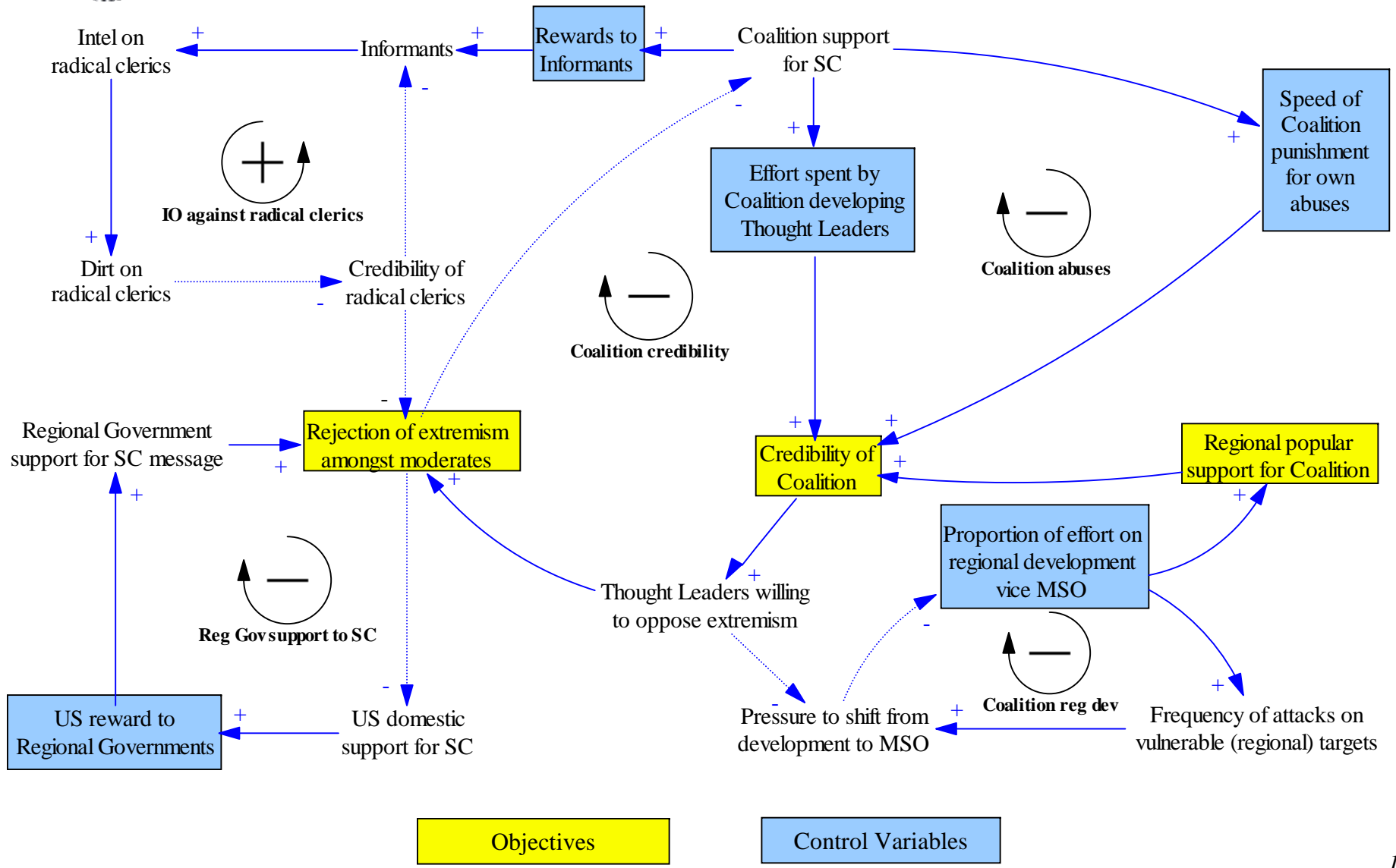


Stock & Flow Development

- **Strategic Communication objectives might include:**
 - Extremism discredited
 - Moderate mainstream Muslims empowered
 - Coalition presence and actions accepted by moderate Muslims
- **Variables in CLD that can be “controlled”**
 - US reward to Regional Governments
 - Rewards to Informants
 - Effort spent by Coalition developing Thought Leaders
 - Speed of Coalition punishment for own abuses
 - Proportion of effort on regional development vice MSO

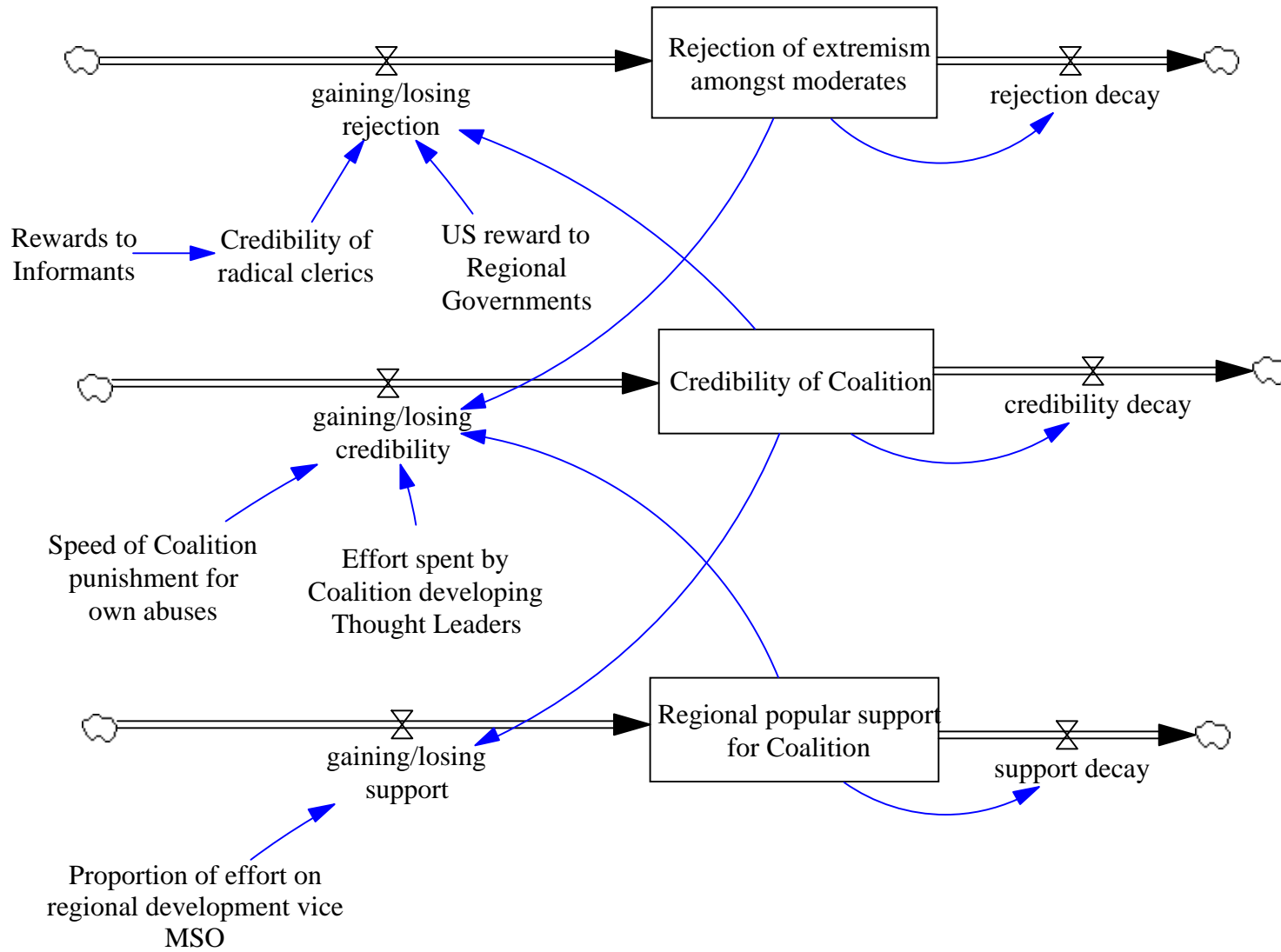


Causal Loop Diagram (CLD)



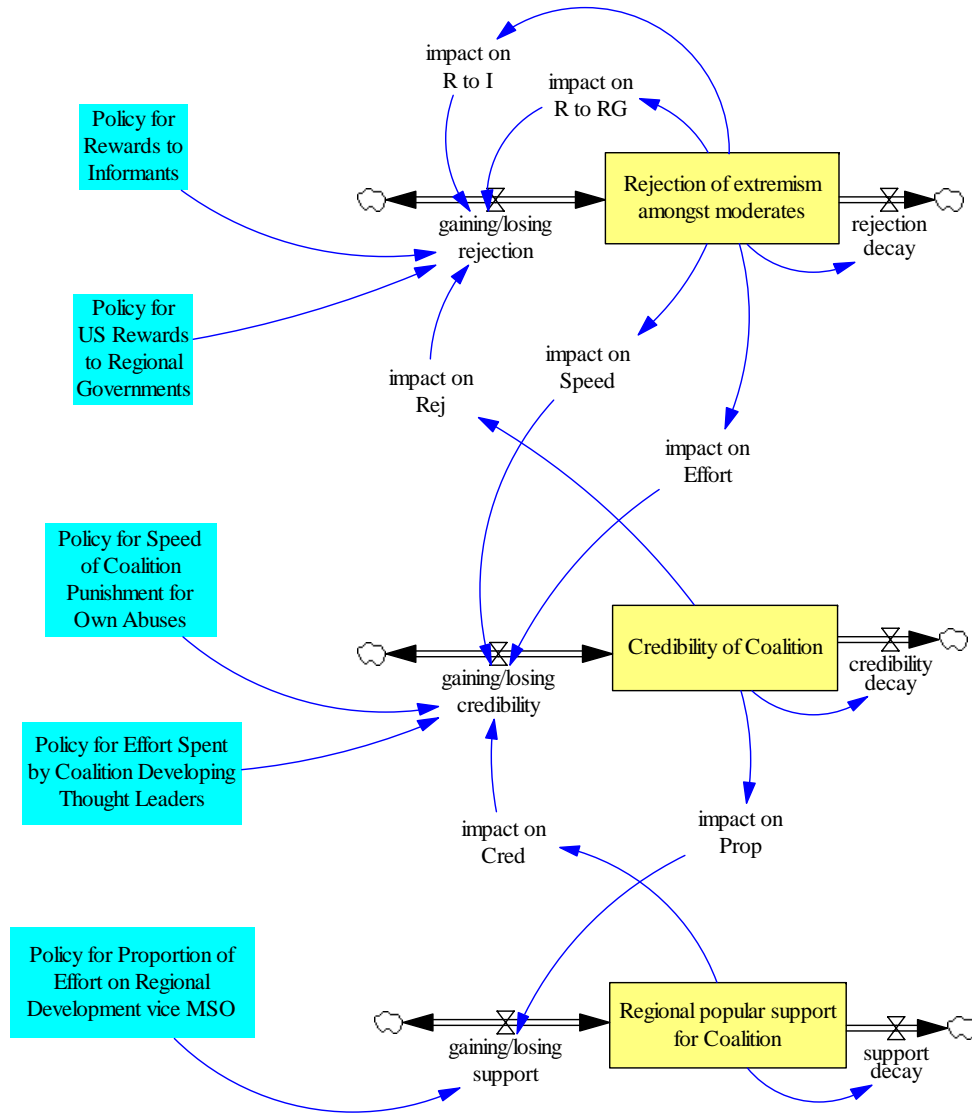


Strategic Communication Model (v1)





Strategic Communication Model (v2)



Impact Function



Strategic Communication Model

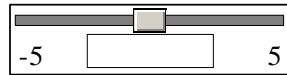
- **“Acceptability of extremism amongst moderates” was implemented as “Rejection of extremism amongst moderates” so that positive is better for all Objectives**
- **Effects from all Control Variables are equally weighted**
- **Control Variables can be varied from -5 to 5**
- **“Impact” functions also vary from -5 to 5**
- **Initial steady state conditions are established with all Control Variables and Objective levels set to zero**



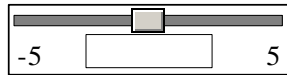
Inputs from sliders - Control Panel View



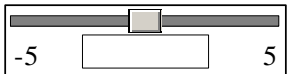
Policy for Rewards to Informants



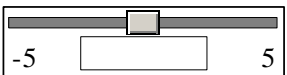
Policy for US Rewards to Regional Governments



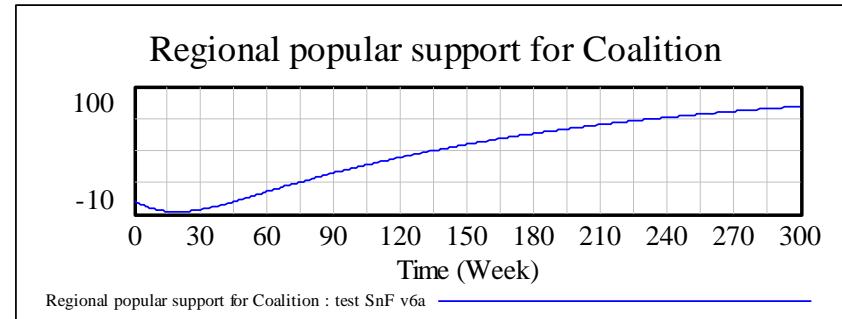
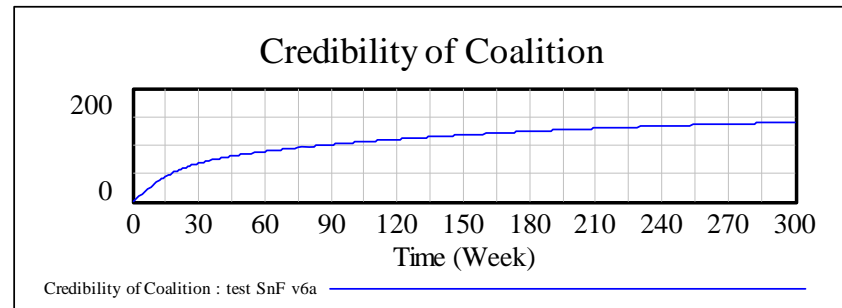
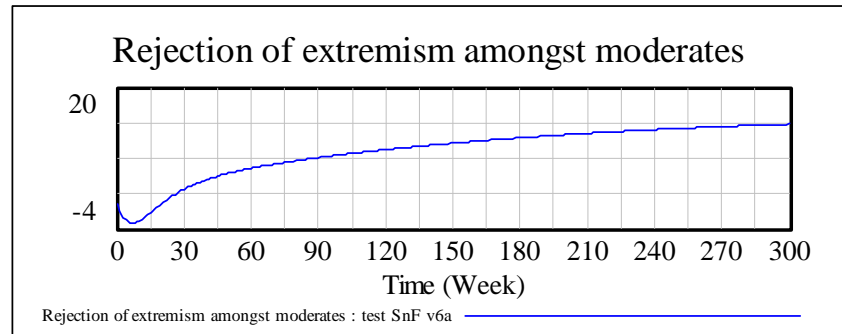
Policy for Speed of Coalition Punishment for Own Abuses



Policy for Effort Spent by Coalition Developing Thought Leaders

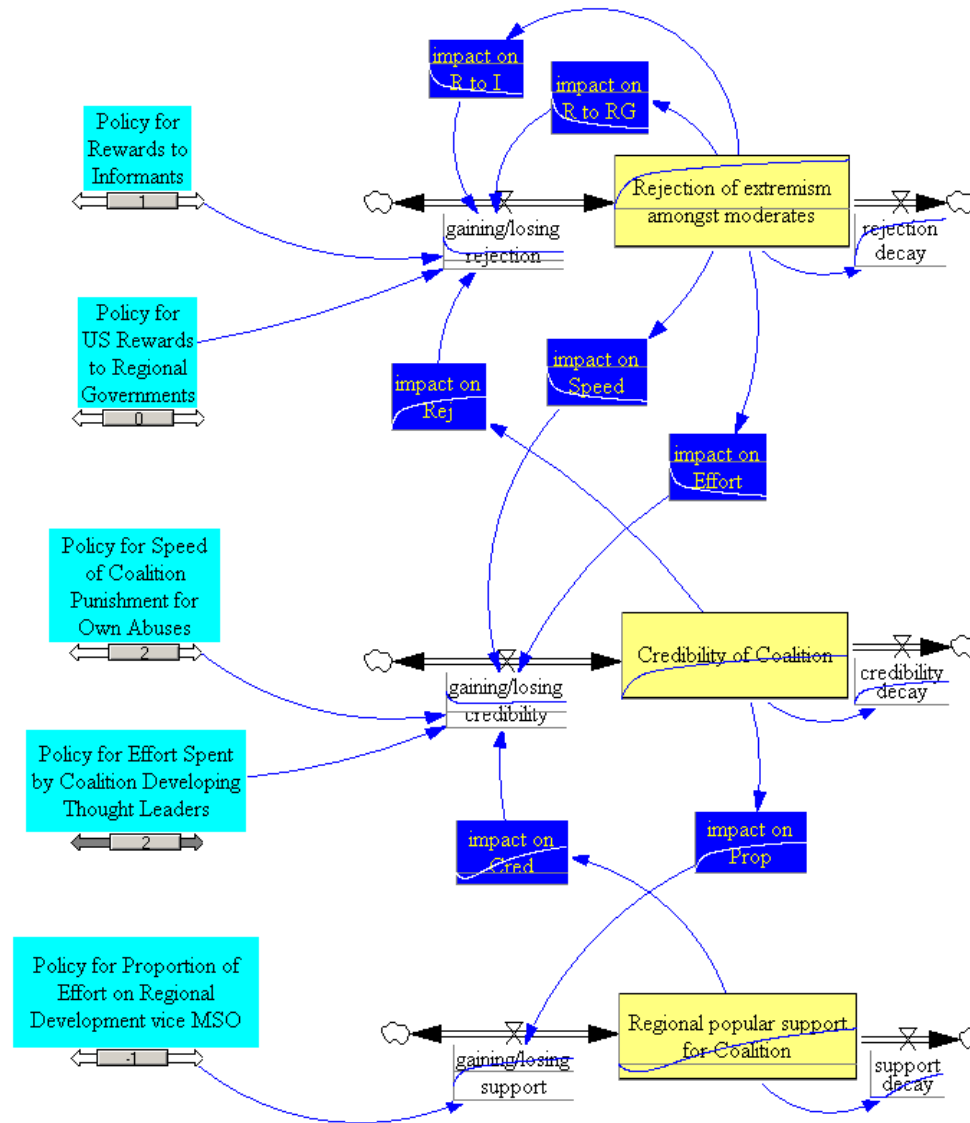


Policy for Proportion of Effort on Regional Development vice MSO





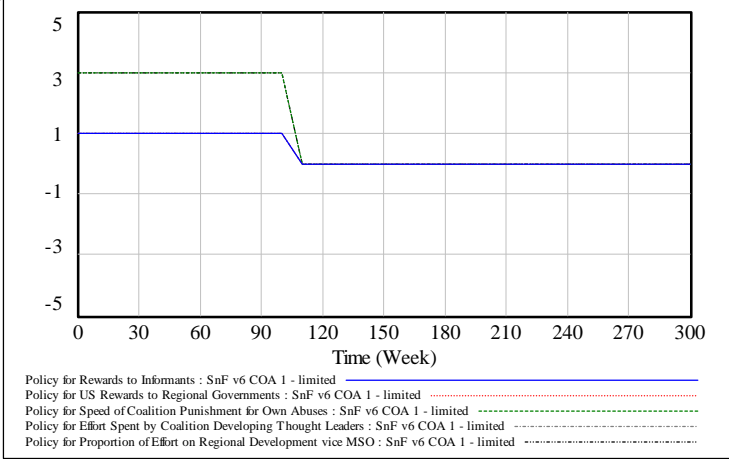
Inputs from sliders - Model View



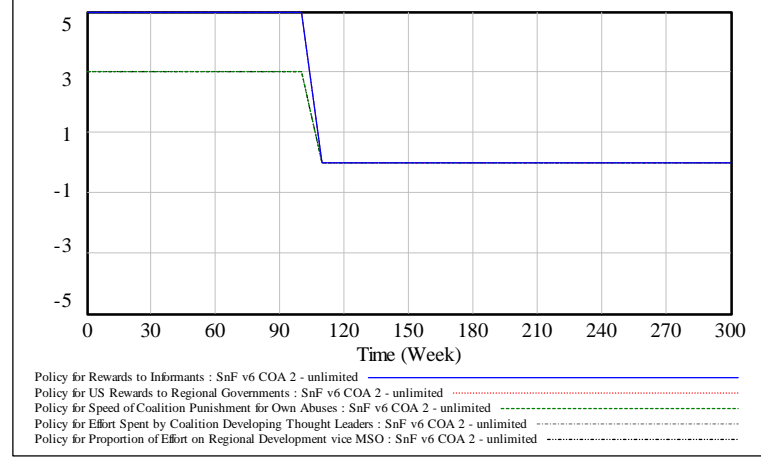


Inputs from file - COA Input Comparison

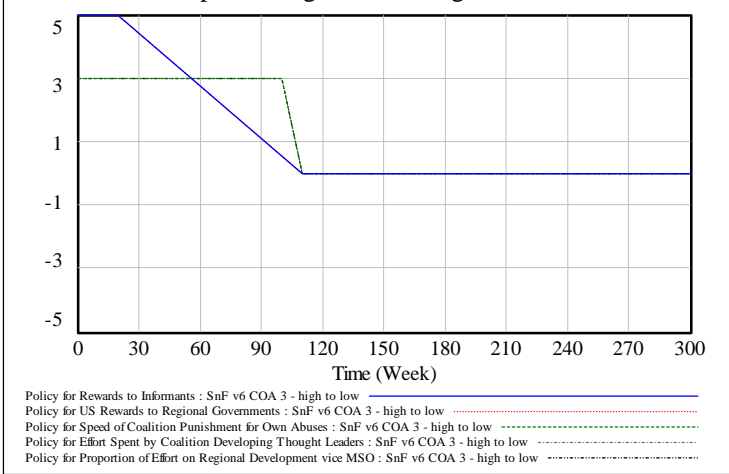
Input Settings COA 1 - limited



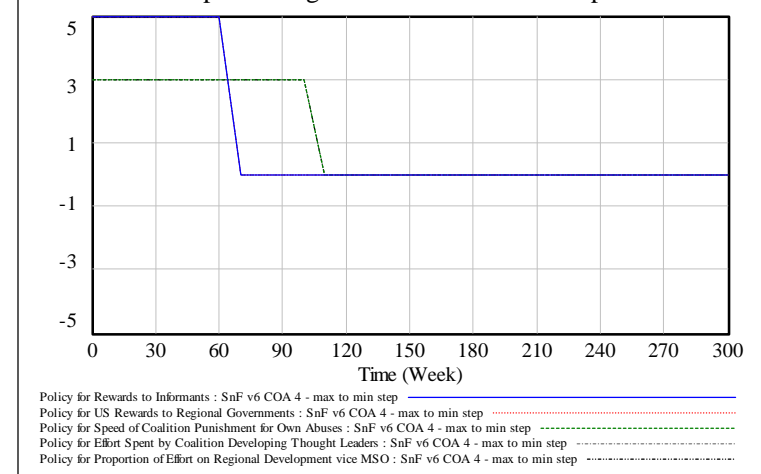
Input Settings COA 2 - unlimited



Input Settings COA 3 - high to low



Input Settings COA 4 - max to min step

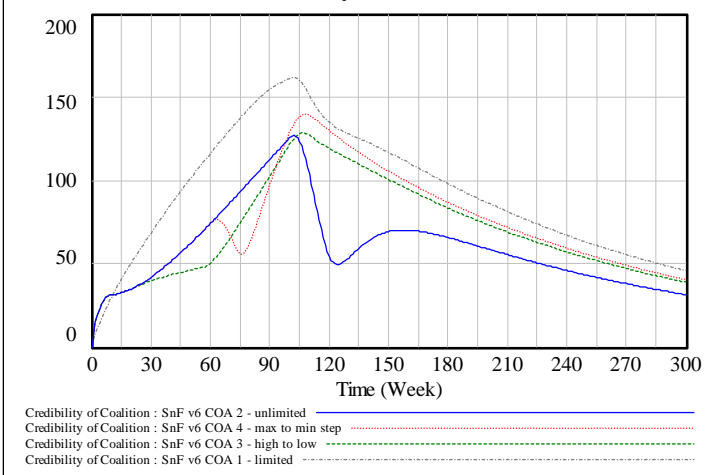


BLUE = Rewards to Informants, Rewards to Regional Governments, Effort Spent Developing Thought Leaders
GREEN = Speed of Coalition Punishment, Proportion of Effort Spent on Development

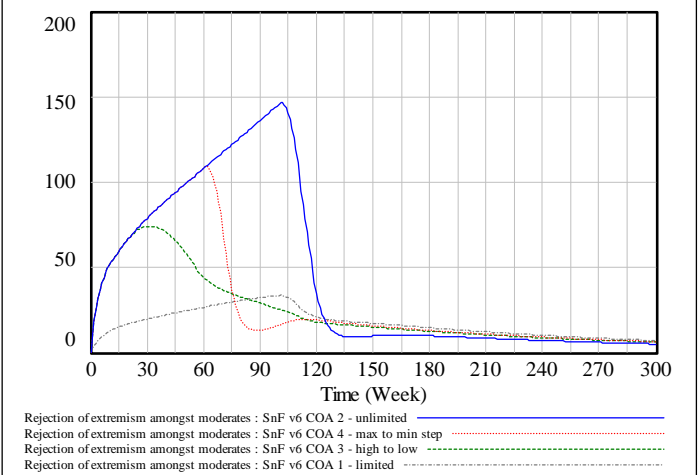


Inputs from file - COA Output Comparison

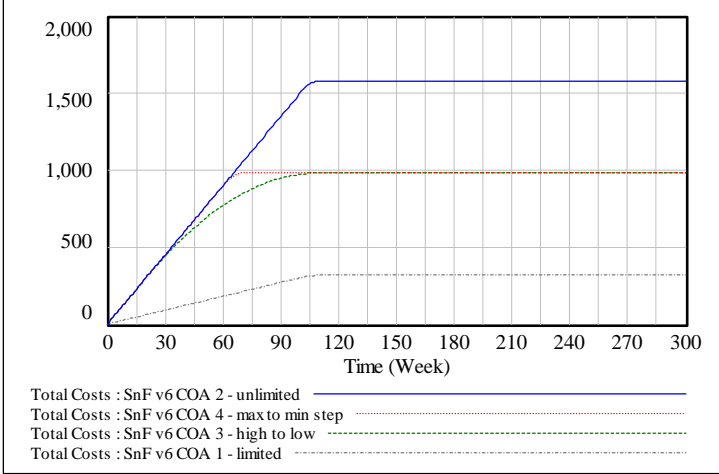
Credibility of Coalition



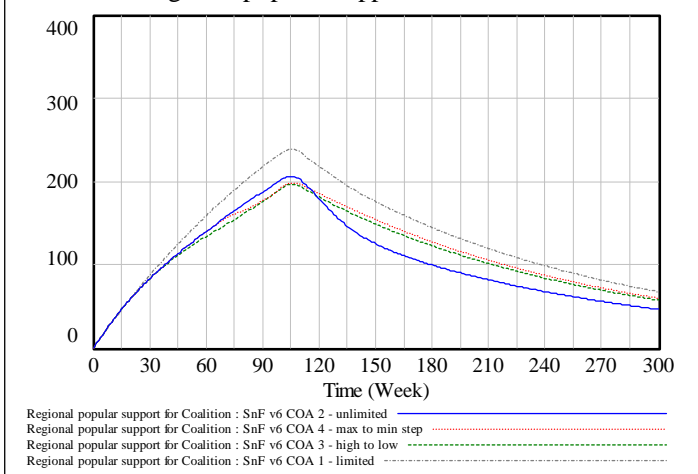
Rejection of extremism amongst moderates



Total Costs



Regional popular support for Coalition



GRAY = COA 1 – limited **RED = COA 3 – high to low**
BLUE = COA 2 – unlimited **GREEN = COA 4 – max to min step**



Modeling Issues (1)

- **Variable Selection**

- Are the correct objectives (MOEs) being used?
- Are the correct control variables being used?
- Are the items that are going to be measured during post-decision assessment represented in the model?
- Are there items in the model that cannot be measured?

- **Implementation**

- Quantifying the variables
- Weighting or scaling of variables
- Accurately defining the impact functions
- Additional relationships
- Prioritize the objectives
- Decay of objectives



Modeling Issues (2)

- **Validation**
 - What historical datasets exist?
 - Do they fall between the upper and lower model bounds?
- **Representation of Risk**
- **Representation of Uncertainty**
- **Recurring discussions with SMEs**
 - Ensure model modifications are implemented correctly
 - Recommend additional requirements or functionality
- **How can this type of model be used?**
 - Exploration tool
 - ???



Vensim[®] Model Analysis Capabilities

- **Graphs**
- **Tables**
- **Real time / interactive simulation response**
- **Sensitivity analysis**
- **Data can be exported in database format**
- **Control variable data can be imported from a database**
 - Allows variables to be modified at predetermined time steps
- **Vensim[®] is a product of Ventana Systems, Inc.**
 - www.vensim.com

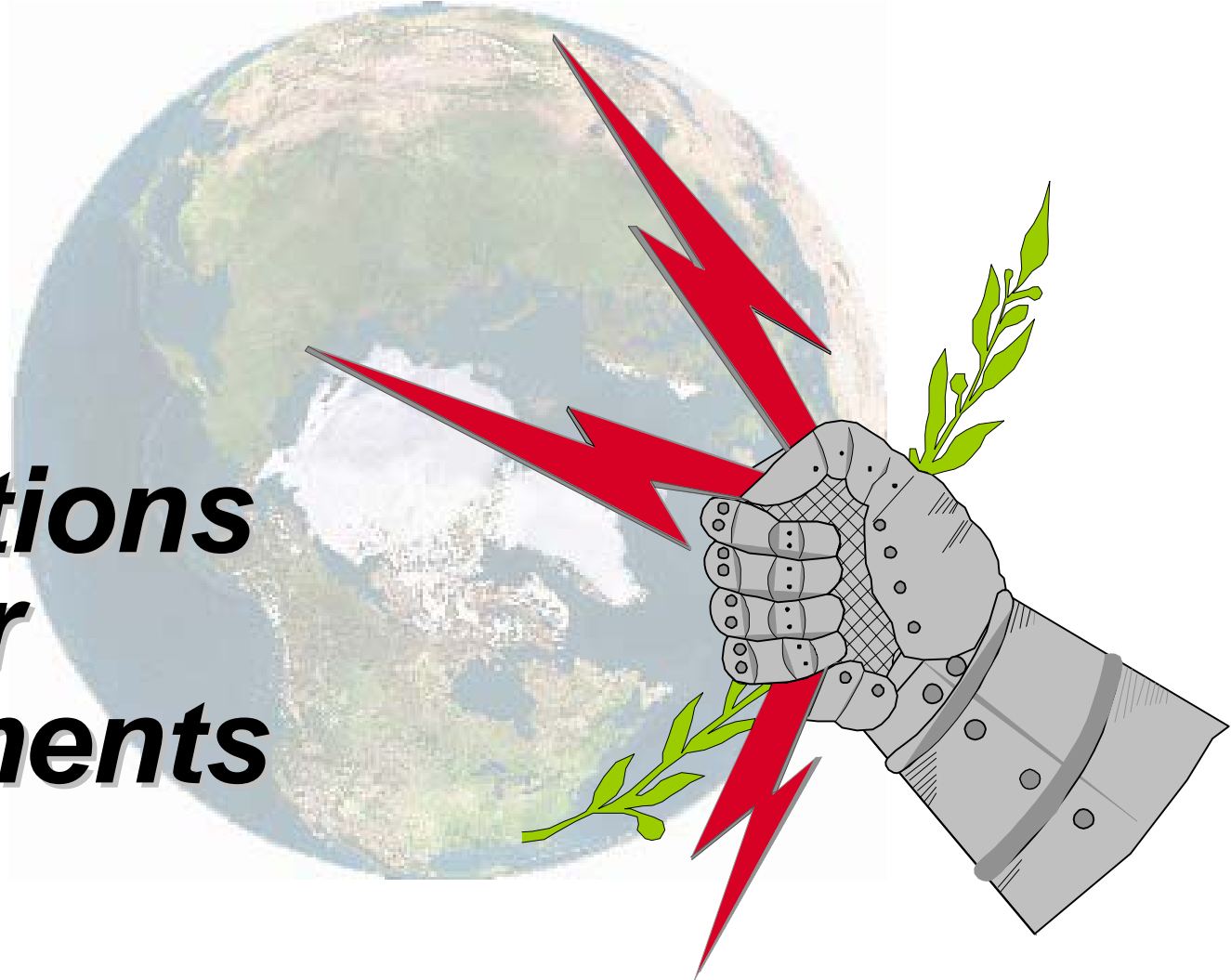


Summary

- **System Dynamics is an aggregated, macro-level (strategic) analysis methodology that can:**
 - provide decision makers a quick-turn evaluation of a scenario's tradespace
 - be used to identify areas of interest for further analysis using higher fidelity models
 - identify unintended/intended consequences and leverage points

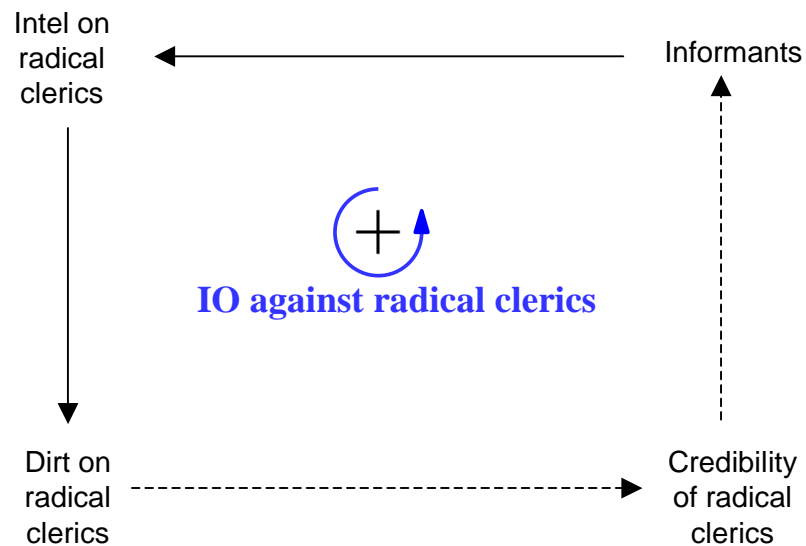


Questions or Comments





AQAM C&E Diagram for SC

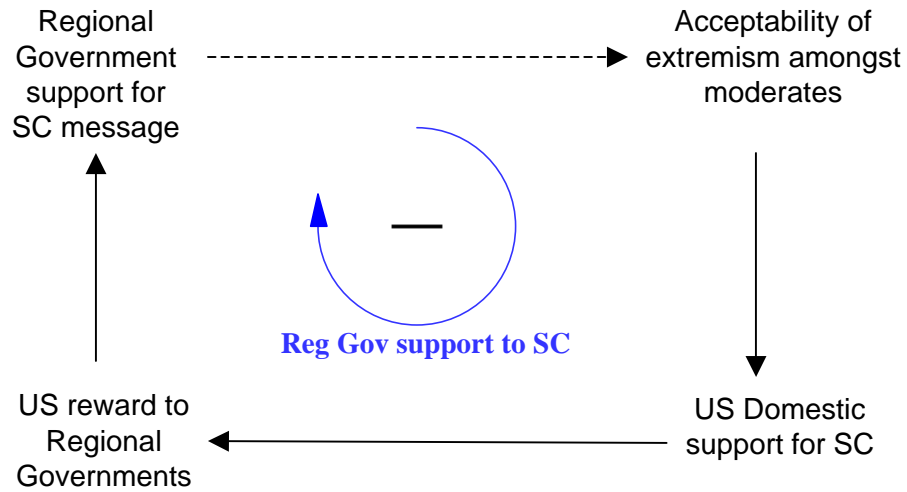


Note - AQAM = Al Qaeda and Affiliated Movements



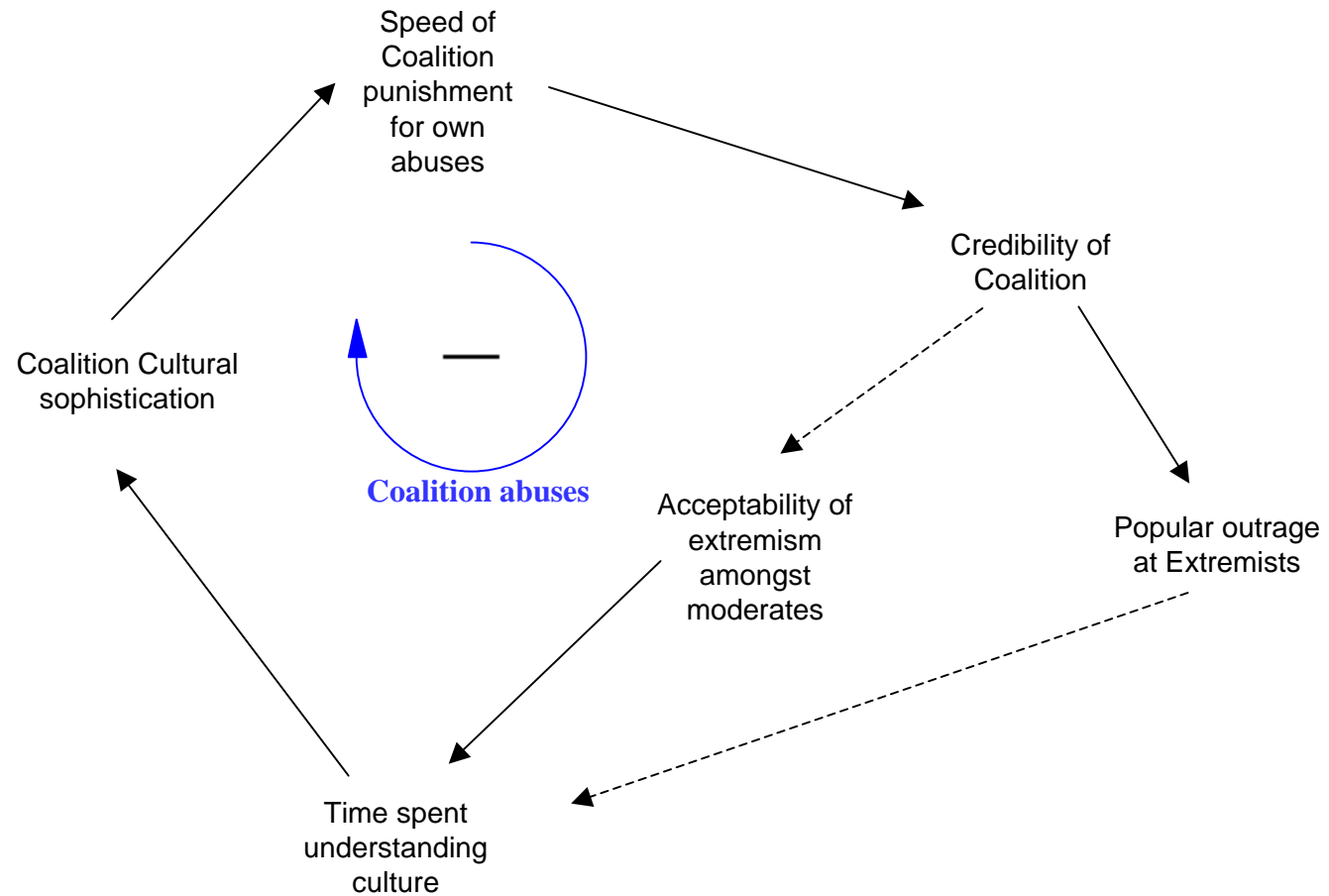


Regional Government C&E Diagram for SC



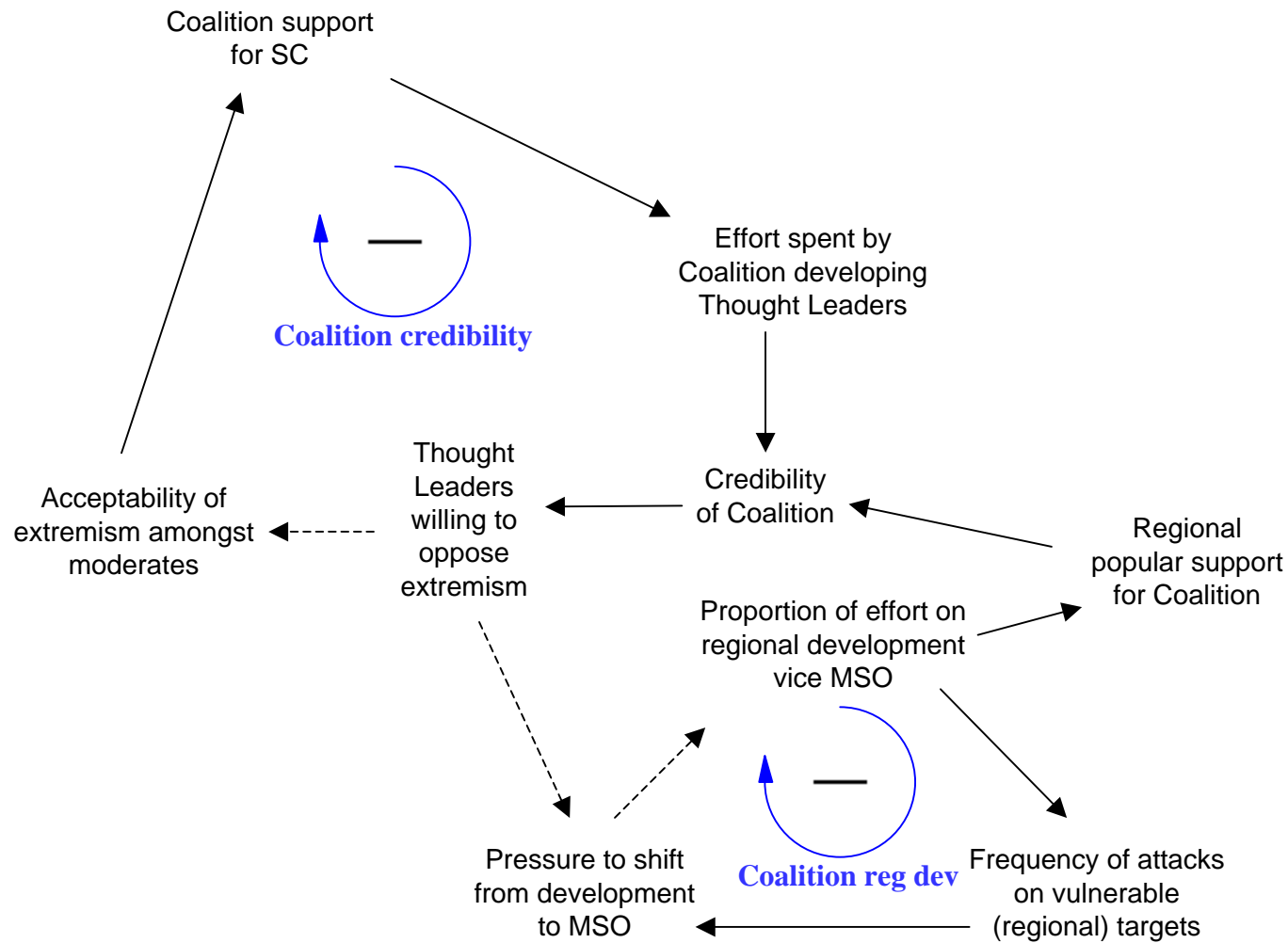


Coalition C&E Diagram for SC





Regional Public C&E Diagram for SC





Impact Function

Editing equation for - impact on R to RG

impact on R to RG Add Eq

= WITH Rejection of extremism amongst moderates
 LOOKU
 P (

Look up {{{(-200,-5),(-200,5),(-200,5),(-50,4),(50,-4),(200,-5)}}

Type
 Auxiliary Undo 7 8 9 + Variables Functions More
 with Lookup {() 4 5 6 . Choose Variable... Inputs
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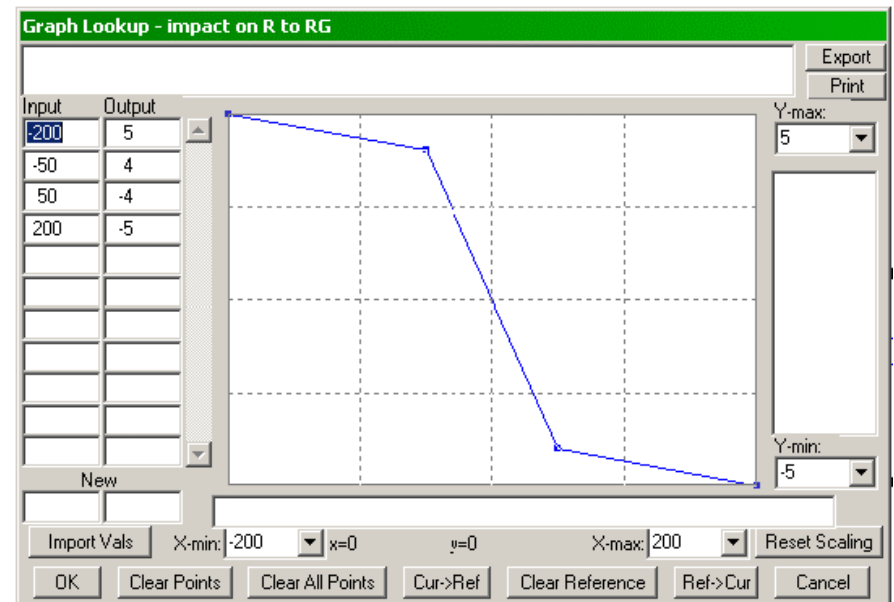
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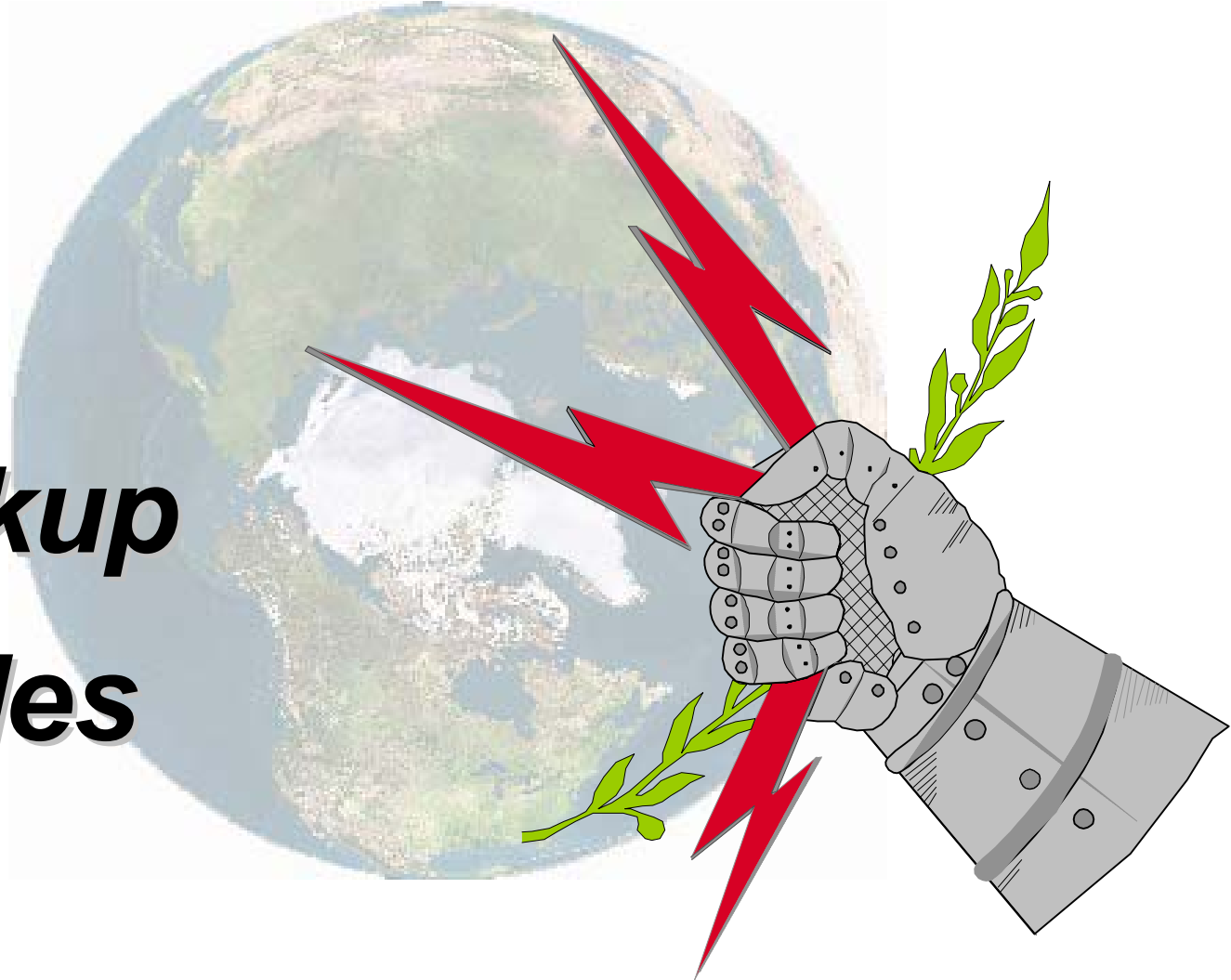
Errors: Equation OK

OK Check Syntax Check Model Delete Variable Cancel





Backup Slides





Problem Environments Suitable for SD

- **Dynamically complex**
 - Contains underlying feedback processes that lead to consequences (intended and unintended) which cannot be easily foreseen without a computer model
 - SD can address potential effects of a decision better than multi-attribute utility decision making
 - SD can identify causes of a problem better than a brainstorming approach to generate potential solutions



Problem Environments Suitable for SD (2)

- **Long term problems**
 - Policies that are effective in the short-term often prove to be ineffective in the long-term due to systemic feedback processes that counteract the policy
- **Generates a reference mode of behavior**
 - Reference mode = trends of key variables over time
 - Reference mode may be historical or hypothetical
- **Flow processes**
 - Stock and flow variables can be identified



Problem Environments Suitable for SD (3)

- **Is the system under scrutiny complex and interdependent?**
 - **Can the system be described verbally?**
 - **Are there both quantitative and non-quantitative factors that affect system behavior?**
 - **Is gaining an understanding of system behavior over time important to you?**
 - **Is there a general consensus that there is a need to apply high resolution tools, but a lack of understanding where they should be applied?**
 - **Is rapid analysis of alternatives important?**
- Then SD is an appropriate first step, and it might offer the final solution**